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PROGRAM PLOTTAB: A Code Designed to Plot Continuous and/or Discrete Physical Data (Version 2013-1) Parts A and B

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Abstract: PLOTTAB is designed as a general purpose plotting utility code to plot continuous and/or discrete physical data for use in almost any application. It is designed to be easily used by your application codes to produce your output results in a form that can be immediately used by PLOTTAB to allow you to see your results. This code is available on CD-ROM from the IAEA Nuclear Data Section, free of charge upon request or can be downloaded from
http://www-nds.iaea.org/plottab/

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Conditions for use of this code

Any comments on the use of this code, including difficulties encountered or any suggestions should be sent to the IAEA Nuclear Data Section. If any results obtained from using this code are used or referenced in a publication, a copy of the publication should be sent to the IAEA Nuclear Data Section.

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PLOTTAB is designed as a general purpose plotting utility code to plot continuous and/or discrete physical data for use in almost any application. It is designed to be easily used by your application codes to produce your output results in a form that can be immediately used by PLOTTAB to allow you to see your results.

It produces on screen graphics as well as Postscript formatted output files that can be viewed or printed on any Postscript printer. The code is designed to be easily used on any computer - not only today's computers, but also anything that comes along in the future. So you can be assured that once you start using PLOTTAB your graphics problems are over - not just today, but well into the future.

Part A of this report documents the basic features of PLOTTAB.

Part B is designed to aid users in using the code, by describes a variety of applications, including listings of input parameters and output plots.

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Introduction

PLOTTAB is designed as a simple plotting code that can be used on virtually any computer and graphics device to plot continuous and/or discrete physical data for use in almost any application. It is designed to be easily used by your application codes to produce your output results in a form that can be immediately used by PLOTTAB to allow you to see your results.

It produces on screen graphics as well as Postscript formatted output files that can be viewed or printed on any Postscript printer. The code is designed to be easily used on any computer - not only today's computers, but also anything that comes along in the future.

Acknowledgments

First I MUST acknowledge the contribution of **Bojan Zefran**, who created the LINUX, 32-bit and 64-bit executables, and **Jean-Christian Sublet**, who created the MAC executable. Not only did they volunteer to create these executables, but by having PLOTTAB compiled on as many different computers/compilers as possible led to significant improvements in the coded we have today. So for all PLOTTAB users I say: Thank you Bojan and Jean-Christophe.

Only Do the Job Once

Best of all you can be assured that unlike other computer graphics codes that quickly come and go, PLOTTAB will be here not only today to meet your needs, but also into the future to meet your needs. The code has been conservatively designed to not only run on virtually any of today's computers, but also be to easily implemented on any new computers that come along in the future. I have now been using PLOTTAB and its predecessors for over 25 years [1], and during that time as each new computer has come along PLOTTAB has been a complete plug-in that has smoothly and effortlessly moved from one computer to the next.

With this approach you can be assured that once you start using PLOTTAB your plotting problems are over, not only for today, but also into the future. You only have to do the job once to modify your codes to produce output in the PLOTTAB input format, and then you can be assured that you will be able to produce graphic output well into the future.

Concentrate on Your Applications

You will find that in order to use PLOTTAB you do not have to be a graphics expert, nor do you have to spend much time learning how to use the code. This allows you to concentrate on your applications, instead of worrying about how you are going to plot your results. Once you have started using PLOTTAB you can take graphics output for granted; something that you never have to worry about or spend much time on ever again. It will simply always be there when you need it.

What Computer Can You USE?

The non-interactive version can be run on ANY computer. The non-interactive code is written in standard FORTRAN and outputs standard formatted Postscript files that can be printed on any Postscript printer, or viewed with any Postscript viewer, such as Ghostview. **The non-interactive version runs on 32 or 64 bit systems.**

The interactive version can be run on IBM-PC, LINUX, Power MAC and even small Laptop computers. The interactive code is identical to the non-interactive code, except that a very simple graphics interface for on screen graphics is loaded with the code. The code is distributed with graphic interfaces for IBM-PC, LINUX, and Power MAC. However, it should be very simple to interface this code for on screen graphics on any computer, e.g., it took me 3 days to write the IBM-PC interface and 2 days for the Power MAC version. **The interactive version runs on 32 or 64 bit systems.**

Reading and Interpreting Data

All data is read by this code in character form and internally translated into integer or floating point form as needed. This means: 1) it's difficult to get the code to crash by improperly defining input. 2) your input can be in quite general form and will still be properly interpreted by the code, e.g., 14, 1.4+1, 14E+00, 1.4D+01, are all 14 as far as this code is concerned. 3) the code can distinguish between **BLANK** and **ZERO** input - **WARNING** - when this documentation says **BLANK**, it means **BLANK** - in this case nothing else except a BLANK will be interpreted correctly as input.

Data Formats

The formats of the continuous and discrete physical data read by this code are designed to be very simple, so that any of your computer codes can be simply modified to produce output results in the PLOTTAB input format. There up to two different types of data used by PLOTTAB; Continuous Data defining curves and Discrete Points.

Continuous Data Format

The continuous data includes a one line title, followed by a series of (x,y) coordinates, one per line. Each "curve" of continuous data is terminated by a **blank** line. One curve can be followed by another, starting with the one line title, another followed by a series of (x,y) coordinates and terminated by a **blank** line. The input to this code can include any number of such "curves", one curve after the other in the continuous data input file **PLOTTAB.CUR**. Each pair of (x,y) coordinates are in fixed fields each 11 columns wide, corresponding to **FORTRAN 2E11.4 format**. For example,

```
Example Curve # 1
 17       43.0
 19       37.0
      .
      .
 71       12.9
                    (BLANK LINE ENDS CURVE)
Example Curve # 2
      .
      .
```

WARNING - again, I'll stress that a **BLANK LINE** means **completely blank in the first 22 columns - NOT zero**, which is considered by the code to be perfectly legal input as part of a "curve". There are no implied units - everything is absolute - below you will learn how to physically interpret and identify your data.

Discrete Data Format

The format of the discrete data is very similar to the continuous data. Each set of discrete points starts with a one line title, followed by a series of points, and ends with a **blank** line. Each point is defined by an (x,y) coordinate plus uncertainties in both x and y - each point is defined by six values: x, -dx, +dx, y, -dy and +dy, one point per input line. The input to this code may include any number of sets of discrete points, one set after the other in the discrete data input file **PLOTTAB.PNT**. Each point of six values is in fixed fields each 11 columns wide, corresponding to **FORTRAN 6E11.4 format**. For example,

```
Example Set # 1
 17       1.2      2.4    43.0     17.2    12.1
 19       1.6      2.6    37.0     15.8     9.3
      .
      .
 71       8.2     10.7    12.9      7.2     2.3
                                                (BLANK LINE ENDS CURVE)
Example Set # 2
      .
      .
```

Note, uncertainties -dx, +dx, -dy and +dy are always interpreted as positive (sign ignored) in the same units as the data (not % or fraction or anything else), and they are interpreted x +/- dx - not a minimum, average and maximum, e.g., for the first x value 17 1.2 2.4, means an average value of 17 with errors extending -1.2 below 17, and +2.4 above 17 -

there are no implied units - everything is absolute - below you will learn how to physically interpret and identify your data.

Note, this format allows for zero, or blank, error fields, as well as asymmetric errors. If the errors are symmetric you must define both of them separately.

.
WARNING - again, I'll stress that a **BLANK LINE** means **completely blank in the first 66 columns - NOT zero**, which is considered by the code to be perfectly legal input as part of a set of discrete points.

Interpretation of the Data

When you generate data in these formats using one of your application codes you do not have to decide in advance how they will actually be interpreted and appear on a plot. This is controlled by an input file named **PLOTTAB.INP**. This file defines how many curves and/or sets of discrete points will appear on each plot, allows for a two line title to appear at the top of each plot, x and y axis labels and scaling (linear or log scaling), and x and y ranges (in case you do not want to plot all of the data on a single plot). Using these options you can customize each plot to exactly meet your needs. As in the case of the continuous and discrete point files, almost all input fields in **PLOTTAB.INP** are 11 columns wide corresponding to **FORTRAN E11.4 or I11 format**.

How Do You Produce Output

Let's first see how simple it is to update any of your codes to produce output that can be read as input to PLOTTAB. Assume that you have a code that is calculating lots of results in tabular form that until now you have had to wade through by hand to see what your results mean. Here's what you add to your code to output the results in a form that PLOTTAB can read as input,

```
C-----LOOP OVER CURVES
      DO ICURVE = 1,NCURVE
C-----PRINT FIRST LINE TITLE
      WRITE(16,1600) TITLE(ICURVE)
 1600 FORMAT(A40)
C-----PRINT DATA POINTS
      DO IPOINT = 1,NPOINT(ICURVE)
      WRITE(16,1610) X(IPOINT,ICURVE),Y(IPOINT,ICURVE)
 1610 FORMAT(2E11.4)
C-----END OF POINT LOOP
      ENDDO
C-----PRINT BLANK LINE FOR END OF CURVE
      WRITE(16,1620)
 1620 FORMAT(30X,'(BLANK LINE ENDS CURVE)')
C-----END OF CURVE LOOP
      ENDDO
```

That's all you have to add to your application codes. You just output any number of curves (defined by **NCURVE**), each with its own title line to identify it (defined by **TITLE**), each with any number of points defining each curve (defined by **X, Y**), and each curve ended with a **blank** line. What could be simpler? The above example is for outputting continuous curves, but outputting discrete sets of points is no more difficult. The only difference in the above coding for curves we output two numbers for each (x,y) point, whereas for discrete points we would output six numbers to include the x and y uncertainty in the order x -dx +dx y -dy +dy.

That's it!!! You are now an expert at producing output that can immediately be read by PLOTTAB to show you your results. That's all you need to know about producing output. Once you start using this very simple approach never again you will have to wade through piles of results trying to figure out what they mean. Instead you can immediately see your results, and you will see them on plots that are of high enough quality to be accepted by journals for publication without any modifications.

Interpreting and Plotting Your Data

Let's assume that you have now produced some output results that you want to plot, i.e., you have your results in the correct format, described above, in a file named **PLOTTAB.CUR** for continuous curves and in **PLOTTAB.PNT** for discrete points. First let me make it clear that you don't need both; you can plot continuous and/or discrete data in any combination. For the following example I'll assume both merely so that I can discuss how to control both.

Now we will edit the control file **PLOTTAB.INP** to tell PLOTTAB how to interpret and plot your data. Below is an example **PLOTTAB.INP** that I recently used to produce a plot. At first this may look complicated, but let me point out that although I have now been using PLOTTAB and its predecessors for almost 20 years, I still have only one **PLOTTAB.INP** and every time I want to produce a plot all I do is edit a few things and bingo! Out come the plots I want. This is the approach that I suggest you also use - don't start from scratch - start with the PLOTTAB.INP file distributed with the code and modify it to meet your needs.

```
    0.00000    13.50000     0.00000    10.00000           1           1 1.5
          3          2           0           0           0           0
Neutron Energy (MeV)
Cross Section (barns)
Lithium-6 Major Cross Sections
From the Livermore ENDL Cross Section Library
                                 0           0           0           0
                                 0           0           0           0
```

Let me first cover the input things that I change for each new plot that I want. Above are eight (8) lines from PLOTTAB.INP that are used to produce one plot and I'll discuss the important parameters from top to bottom. I've highlighted the parameters I will discuss so that you can more easily find them.

The first important thing to tell PLOTTAB is how many continuous curves and/or discrete sets of points to put on the plot. This is done on the second line, where my input says to display **3** continuous curves and **2** sets of discrete data. Regardless of how many curves and sets of points you have produced in PLOTTAB.CUR and PLOTTAB.PNT you can use these 2 input fields to tell PLOTTAB how many to actually read and put on the next plot. For example, I can use the above input to produce a plot with 3 curves on the plot, or I can easily change the input (as we will see below) to display the curves one at a time on a series of plots.

Next we want to physically describe what data we are plotting. This is done using the next four (4) input lines. These are,

1) A label for the x axis - in this example **`Neutron Energy (MeV)`**
2) A label for the y axis - in this example **`Cross Section (barns)`**
3-4) A two line title to appear at the top of the plot - in this example

```
Lithium-6 Major Cross Sections
From the Livermore ENDL Cross Section Library
```

In most cases that's all I modify - the code takes care of everything else - so I can immediately run PLOTTAB and get the plots I want. That's all you need to know to successfully use PLOTTAB to generate plots for you.

Note, with this approach the code does not have to have any idea what the physical significance of the data is, and any data can be put into the PLOTTAB input format and plotted. Physical interpretation of the data is all in your hands - by changing plot titles and axis labels you are free to interpret the data any way that you see fit - and you can easily produce plots to specifically meet your needs.

Let me briefly cover the meaning of the other input fields, just in case you want to get fancy.

The first input line, again shown below, defines the (x,y) dimensions of the plot, how many sub-plots to put on each plot, and how large to make the characters. Reading left to right the below line says the plot size is x=0 to 13.5, and y=0 to 10. This will give you a full page plot on 8-1/2 by 11" paper, and except for special purpose you won't want to change this. One case in which you will want to change them is if your plotter doesn't use inches, but rather use cm, mm, anything - no problem - just change these once for your system and you probably will never have to change them again. The next 2 fields say that each page will contain 1 plot in the x direction and 1 y in the y direction = one single, full page plot. If I would like 6 plots on each page I could change these to 3 plots in the x direction and 2 in the y direction. The last field, 1.5, says to make the characters 1-1/2 times normal size.

```
    0.00000   13.50000    0.00000   10.00000          1          1 1.5
```

On the next line you already know about the first two fields. The remaining fields, from left to right, allow you to:
1) add a border around each plot
2) add an (x,y) grid - the code has 6 built-in grids
3) plot the ratio of everything to the first curve
4) change the thickness of all lines drawn

```
          3          2          0          0          0          0
```

You already know about the next four lines, so all we need discuss is the last two lines.

These two lines are used to control the x and y features of the plot: the first line is for x and the second for y. Again from left to right, the six (6) fields on each line control,

1) the lower x limit
2) the upper x limit
3) should discrete point x errors be plotted = no(0), yes (1)
4) x scaling = automatic (0), linear (1), log(2)
5) round x limit to avoid touching edge of plot = yes(0), no(1)
6) show legend box = yes(0), no(1)

1) the lower y limit
2) the upper y limit
3) should discrete point y errors be plotted = no(0), yes (1)
4) y scaling = automatic (0), linear (1), log(2)
5) round y limit to avoid touching edge of plot = yes(0), no(1)
6) show data points on curves = no(0), yes(1)

```
                                0          0          0          0
                                0          0          0          0
```

WARNING - let me again stress that this code can tell the difference between **BLANK** and **ZERO** - for example, on the above two input lines the **BLANK** x and y lower and upper limits means scale the plot to show all of the data as read. In contrast, if one of these fields contained **0.0** the specified limit would be forced to be zero, regardless of the range of the data read.

Again, that's it!!!If you want to get fancy you can use these parameters to customize plots to obtain almost any output that you want to meet any specific need.

Multiple Plots

Let's now generalize to more than one plot. Don't worry there isn't much to generalize. For more than one plot you basically have two options:

1) If the layout of each plot is the same you need merely copy the last four lines as many times as you want, changing any parameters that you want on these lines. You can do this as many times as you want for as many plots as you want. For example here's a generalization of our above input for three plots - in this case all I did was copy the last four lines twice and change the titles for Li^{6}, Al^{27} and U^{238} - this assumes that in PLOTTAB.CUR I have 3 curves for each plot (at least 9 curves), and that in PLOTTAB.PNT I have 2 sets of discrete points for each (at least 6 sets).

```
    0.00000   13.50000    0.00000   10.00000          1          1 1.5
          3          2          0          0          0          0
Neutron Energy (MeV)
Cross Section (barns)
Lithium-6 Major Cross Sections
From the Livermore ENDL Cross Section Library
                                0          0          0          0
                                0          0          0          0
```

```
Aluminum-27 Major Cross Sections
From the Livermore ENDL Cross Section Library
                                0          0          0          0
                                0          0          0          0
Uranium-238 Major Cross Sections
From the Livermore ENDL Cross Section Library
                                0          0          0          0
                                0          0          0          0
```

2) If the layout of each plot is different you can follow the eight (8) line input for one plot by a **BLANK** (not 0, BLANK) line, and then add eight lines for the next plot. You can do this as many times as you want for as many plots as you want. For example here's a generalization of our above input for three plots using this second method - in this case the input is EXACTLY equivalent to what I have shown above using the first method - use either method, or a combination of the two, in any order that you want - the choice is your’s.

```
0.00000   13.50000    0.00000   10.00000          1          1 1.5
          3          2          0          0          0          0
Neutron Energy (MeV)
Cross Section (barns)
Lithium-6 Major Cross Sections
From the Livermore ENDL Cross Section Library
                                0          0          0          0
                                0          0          0          0

    0.00000   13.50000    0.00000   10.00000          1          1 1.5
          3          2          0          0          0          0
Neutron Energy (MeV)
Cross Section (barns)
Aluminum-27 Major Cross Sections
From the Livermore ENDL Cross Section Library
                                0          0          0          0
                                0          0          0          0

    0.00000   13.50000    0.00000   10.00000          1          1 1.5
          3          2          0          0          0          0
Neutron Energy (MeV)
Cross Section (barns)
Uranium-238 Major Cross Sections
From the Livermore ENDL Cross Section Library
                                0          0          0          0
                                0          0          0          0
```

You might wonder why I wrote out the names instead of just using Li^{6}, Al^{27} and U^{238} - if you prefer this form, no problem - see the documentation within the code on how to use sub and super-scripts, as well as Greek characters and other interesting goodies that I cannot cover in detail in a brief introduction.

Data is Read in Order

In controlling the flow of curves from PLOTTAB.CUR and sets of discrete data points from PLOTTAB.PNT remember each time you use input in PLOTTAB.INP to tell it to read data from these files the code continues to read further and further into each file. For example, in the above case the first plot will contain the first three curves from PLOTTAB.CUR and first two sets of points from PLOTTAB.PNT. The second plot will contain curves four through six from PLOTTAB.CUR and sets of points three and four from PLOTTAB.PNT, etc. It's your responsibility to insure that you have properly ordered the curves and sets of points, and properly arrange their grouping on successive plots.

Terminating Plotting

Execution terminates when there are no more requests for plots in PLOTTAB.INP, or no more data to plot from PLOTTAB.CUR and PLOTTAB.PNT. Note, regardless of how many curves and sets of points you have in PLOTTAB.CUR and PLOTTAB.PNT only as many plots will be produced as you define in the control file PLOTTAB.INP. Also if one input stream of data (curves or sets of points) is exhausted, but the other isn't, the code will continue producing any plots that you request. For example, for the above three plots if there are 9 curves in PLOTTAB.CUR, but only 2 sets of points in PLOTTAB.PNT, the first plot will contain 3 curves and 2 sets of points (which exhausts the sets of points), and the following two plots will each contain 3 curves and 0 sets of points.

Editing Files

All of the files PLOTTAB.CUR, PLOTTAB.PNT and PLOTTAB.INP are simple text files, so you can use any editor to edit them. For example, after you have produced output in PLOTTAB.CUR if you can want to change anything just open the file and do it. You can change titles for the curves, deletes curves, rearrange the order of curves, anything you want to do to meet your needs.

How Do You Define Input Parameters
Before You Have Seen ANY Plots

It very nice to have all of these options to select x and y scaling, x and y ranges, etc. But how can you possibly know what options to select before you have seen plots of you data? The answer is: you don't! PLOTTAB is supplied in two versions: an interactive version that only produces on-screen output, and a non-interactive version that only produces Postscript hardcopy output.

What I recommend is that you start by not selecting any special options and first run the interactive version. This version will allow you to interactively select many of the options described above, e.g., x and y scaling, x range, etc. Then after you have seen your data and played with it you can decide what options you want to set to produce your final Postscript output.

As I use PLOTTAB well over 90 % of the plots that I look at are generated by the interactive code and I never even bother to generate Postscript output. In this way PLOTTAB can be used very simply to quickly look at enormous amounts of data. In this case I don't care what the x and y axis labels are or what the two lines at the top of the plot say - I know how to physically interpret the data I'm looking at - so I just use my existing PLOTTAB.INP file and all I have to tell it is how many curves and sets of discrete points to display on each plot, and I quickly start looking at my results.

Only when I see something of interest that I need a hardcopy of do I bother making any of the changes I have described above. If you also use this pragmatic approach you can save yourself a lot of time and energy and use PLOTTAB much more effectively in your work.

How Do You Remember ALL of the Options

You don't - or at least, I don't. Whenever I want to find out what a given field in the PLOTTAB.INP input parameters means I run PLOTTAB, immediately kill it (use CONTROL C) and then look in the output file PLOTTAB.LST that contains an interpretation of all of the input parameters. For example, for the following input,

```
    0.00000   13.50000    0.00000   10.00000          1          1 1.5
          3          0          0          1          0          0
Neutron Energy (MeV)
Production, Absorption and Leakage
Production, Absorption and Leakage
For Test Problem
                                0         -2          1          0
                                0         -2          1          0
```

Here's the interpretation of the above input from the output file PLOTTAB.LST. As you can see there is a line by line and field by field interpretation of the input parameters in exactly the order they appear in the input. For example, if I can't remember which input field controls plotting ratios, from the below listing I can see that it is the fifth field of the second input line.

```
=======================================================================
 PLOT TABULATED DATA (PLOTTAB VERSION 97-1)
=======================================================================
 DESCRIPTION OF PLOTTER AND FRAME LAYOUT
 ----------------------------------------------------------------------
 X DIMENSIONS (X-MIN TO X-MAX).....   .00000+ 0 TO   1.35000+ 1
 Y DIMENSIONS (Y-MIN TO Y-MAX).....   .00000+ 0 TO   1.00000+ 1
 PLOTS PER FRAME (X BY Y)..........           1 BY            1
 CHARACTER SIZE MULTIPLIER.........       1.500
=======================================================================
 READ AND PLOT (FOR EACH PLOT).....     3 CURVES
 SETS OF POINTS PER PLOT........... NONE
 SHOULD BORDER BY PLOTTED.......... NO
 TYPE OF GRID......................DASHED GRID (COARSE)
 SHOULD RATIOS BE PLOTTED.......... NO
 LINE THICKNESS....................    0
 ----------------------------------------------------------------------
 X AXIS LABEL AND UNITS............ Neutron Energy (MeV)
 Y AXIS LABEL AND UNITS............ Production, Absorption and Leakage
 ----------------------------------------------------------------------
 ----------------------------------------------------------------------
```

```
 PLOT TITLE
.......................................................................
 Production, Absorption and Leakage
 For Test Problem
 ----------------------------------------------------------------------
 REQUESTED X RANGE................. PLOT ALL POINTS
 PLOT X ERROR BARS................. NO
 X PLANE ON PLOTS (IF POSSIBLE)....LOG (NO INTERPOLATION)
 ROUND X LIMITS.................... NO
 LEGEND BOX ON PLOT................ YES
 ----------------------------------------------------------------------
 REQUESTED Y RANGE................. PLOT ALL POINTS
 PLOT Y ERROR BARS................. NO
 Y PLANE ON PLOTS (IF POSSIBLE)....LOG (NO INTERPOLATION)
 ROUND Y LIMITS.................... NO
 SHOW DATA POINTS.................. NO
 ----------------------------------------------------------------------
 X LIMITS (PLANE)..................  1.02360-10 TO   1.99760+ 1 (LOG)
 Y LIMITS (PLANE)..................  2.02610- 5 TO   1.57230+ 7 (LOG)
 ----------------------------------------------------------------------
 CONTINUOUS CURVES
.......................................................................
 INDEX POINTS DESCRIPTION
.......................................................................
     1    566 Production
     2    566 Absorption
     3    498 Leakage
```

Postscript Output Files

When you run the non-interactive version of the code it will produce a series of Postscript output files, one plot per file. The files will be named,
PLOT0001.ps
PLOT0002.ps
.
.

These postscript files can be printed on any Postscript printer, or viewed with any Postscript viewer, such as Ghostview; note, Ghostview is available FREE on the web.

WARNING - every time you run the code it uses the same file names. So if you want to save any file make sure you rename it before you again run the code.

Interpolation Along Curves

When you start using PLOTTAB you will find that your results can look quite different depending upon how you display the data, e.g., linear or log scaling in the x or y direction.

By default PLOTTAB assumes that between tabulated points of curves it should interpolate assuming linear interpolation in x and y. If your data is not linearly interpolable you can get some very strange looking results when PLOTTAB interpolates in say log/log x/y scaled plots. PLOTTAB ALWAYS uses the defined interpolation to show the TRUE shape of each curve between tabulated points in each possible combination of linear and log x and y scaling. For example, if I have only two tabulated points at x=1 and x=100, using standard linear interpolation this will be a straight line on a linearly scaled x and y plot. But if you use log x and/or y scaling PLOTTAB will display a curved line corresponding to the TRUE (assuming linear interpolation) shape of the curve.

You can control how PLOTTAB interpolates in x and y separately by defining the interpolation to be linear or log in each dimension. Above I briefly described how to control the x and y scaling of each plot = automatic (0), linear (1), log(2). In this case, any non-negative values specify scaling with **linear** interpolation. To control interpolation, any negative values specify scaling and the same type of interpolation; the only meaningful negative value is -2 = **log** scaling and interpolation.

An important point to note, is that generally if you are using tabulated data in your applications it is important how the data is interpreted not only at the points that you tabulate data, but AT EVERY SINGLE POINT along the curve, e.g., integrals and interpolate values depend crucially on EXACTLY HOW YOU INTERPOLATE.

This PLOTTAB option can supply you with value information that you can use in your applications. For example, if you assume your data is linearly interpolable, but you see funny bumps and cusps in the results when you plot it in various combinations of linear and log, x and y scaling, you better think again about your assumption, because your data is not smoothly linearly interpolable. In this case you should consider either adding more, closer spaced points along your curves, or try PLOTTAB's log interpolation and see if this solves your problem. It ONLY SOLVES YOUR PROBLEM if you are willing to interpret your data in your applications using more complicated log interpolation. What should you do? The choice is yours. But whatever you do, be sure that you use PLOTTAB to check your final results to insure that you are not incorrectly interpreting your data in your applications.

You are NOW a PLOTTAB Expert

Sorry, that's about all I can quickly teach you about PLOTTAB. If you now understand how to produce output from your codes to be used as input to PLOTTAB, and how to edit PLOTTAB.INP to define the layout of each plot, you are now an expert, and you can immediately start generating plots. If you want to get even fancier, see the following documentation for more details - there's a lot more that this code can do to meet your specific needs than I have been able to cover in this brief introduction.

Characters

In order to make this code as computer independent as possible it uses an input file PLOT.CHR to define the strokes necessary to plot each character – this is called a **software character set.** Using this method the graphics interface for each computer and plotting device need only be able to draw lines from one (X, Y) coordinate to another, and all character sizes and aspect ratios will be plotted identically on all plotters.

Control Characters

This code uses three control characters for special effects,
{ - Shift the following character up – for **superscript.**
} - Shift the following character down = for **subscript.**
| - Shift the following character left 1 character = for **backspace.**

Standard and Alternate Character Sets

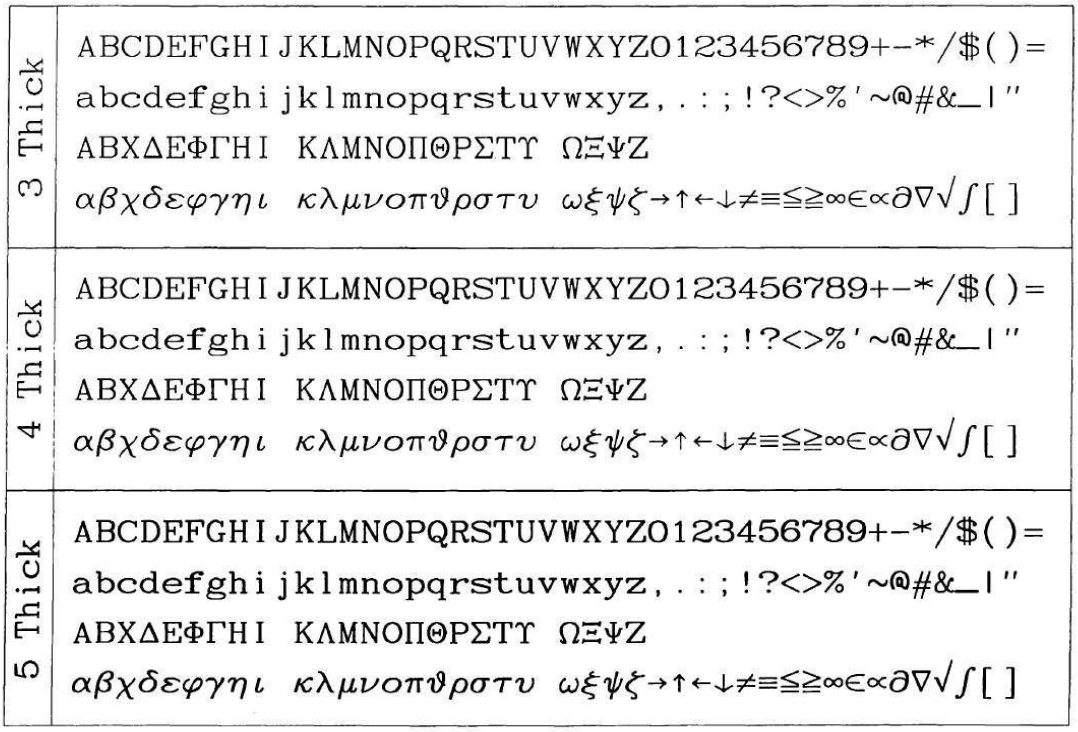
The software character set includes two sets of characters: a Standard and an Alternate Set. **To use the standard character** as input you need merely type the desired character; all of the standard characters are available on most computer keyboards.

To use the alternate character set you should consult the following equivalence table and precede each character by]. For example, to plot (n, Greek alpha), you should type (n,]a); here the] indicates that the next character is from the alternate character set and the following equivalence table indicate that – a – is equivalent to a low case Greek alpha.

A = A	M = M	Y = Ψ	k = κ	w = ω	8 = ∞
B = B	N = N	Z = Z	l = λ	x = ξ	9 = $\in$
C = X	O = O	a = α	m = μ	y = ψ	+ = $\propto$
D = Δ	P = Π	b = β	n = ν	z = ζ	− = ∂
E = E	Q = Θ	c = χ	o = o	0 = $\rightarrow$	* = ∇
F = Φ	R = P	d = δ	p = π	1 = $\uparrow$	/ = $\surd$
G = Γ	S = Σ	e = ε	q = ϑ	2 = $\leftarrow$	$ = $\int$
H = H	T = T	f = φ	r = ρ	3 = $\downarrow$	(= [
I = I	U = Υ	g = γ	s = σ	4 = $\neq$	) =]
J =	V =	h = η	t = τ	5 = $\equiv$	
K = K	W = Ω	i = ι	u = υ	6 = $\leq$	
L = Λ	X = Ξ	j =	v =	7 = $\geq$	

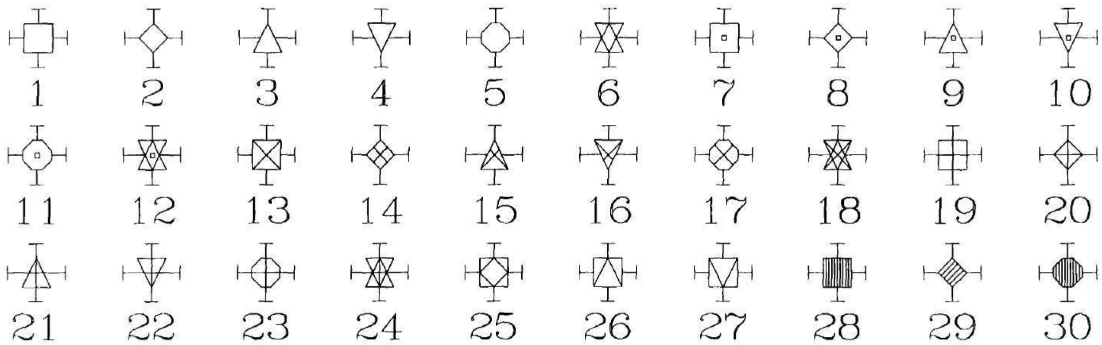
Character Thickness

All lines on a plot, except the grid, may be drawn using a specified line thickness. This option may be used to good advantage to insure that data can properly and easily distinguished from the background grid. For reference purposes the following tables illustrate the effect of using line thickness from 0 (standard) to 5 (maximum allowed).

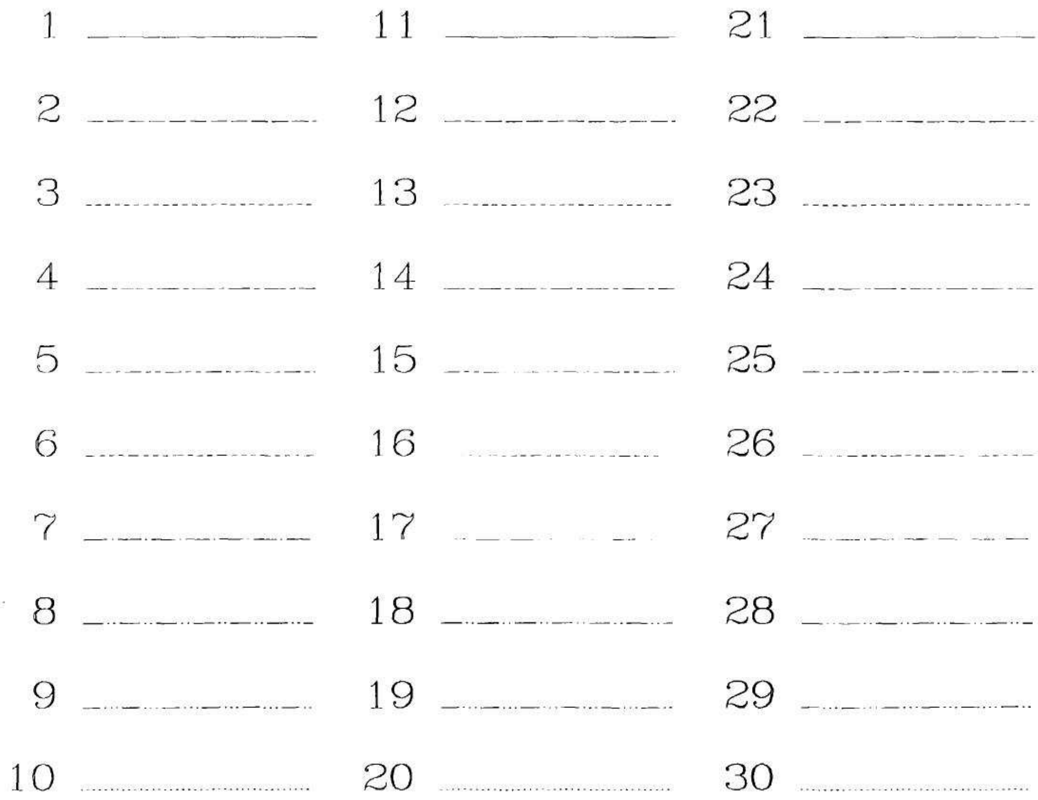


Software Symbols and Line Types

In order to identify sets of points or curves this code uses in input file PLOT.SYM to define the strokes required to draw any one of 30 different symbols (to identify sets of points),

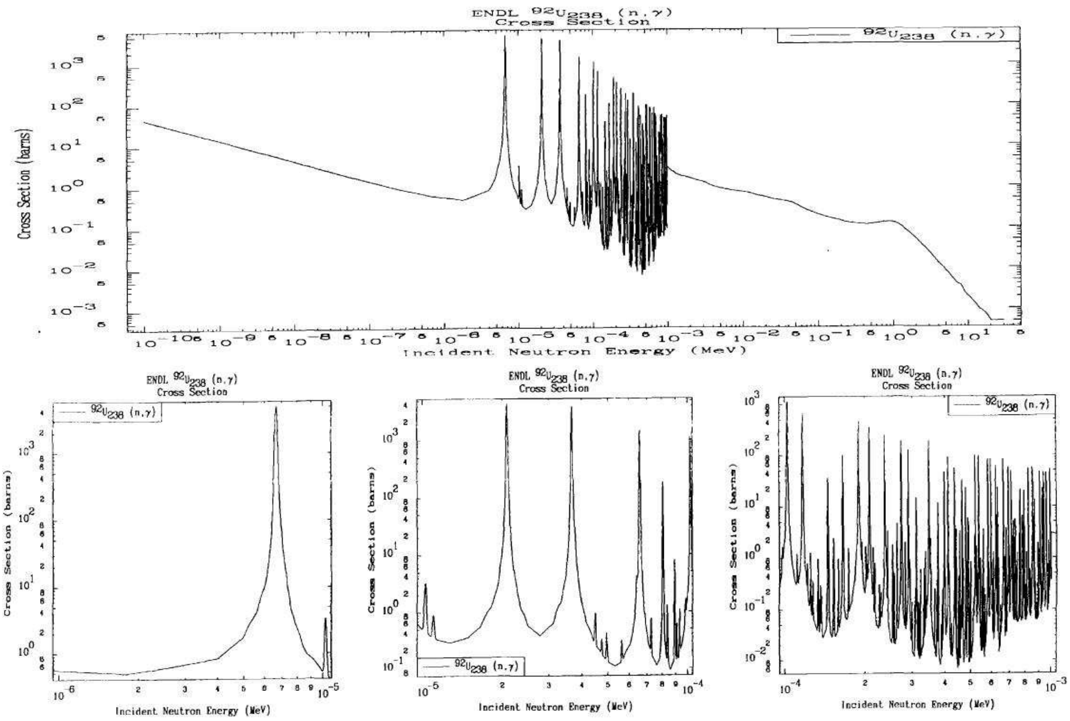


and any one of 30 different types of lines (to identify curves).

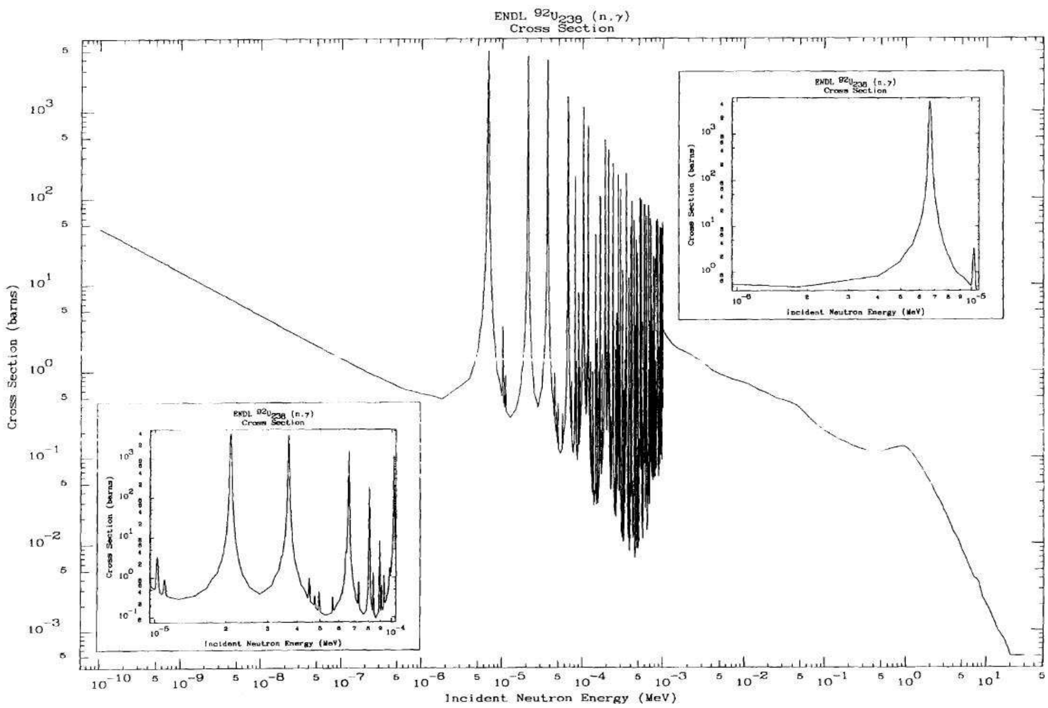


Composite Plots

Below are examples of composite plots, first with sub-plots outside the main frame,

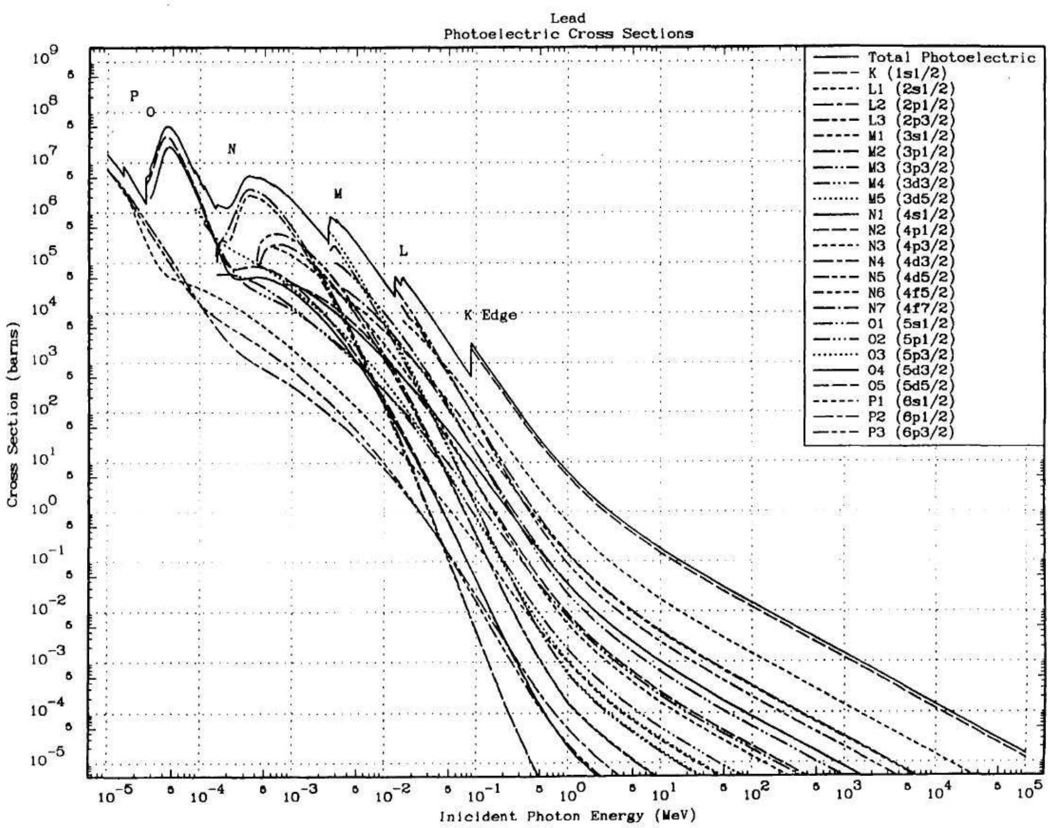


and the second with sub-plots inside the main frame.



Randomly Positioned Titles

Below is an example of adding additional title information randomly anywhere on the plot. In this case the legend box identifies the individual sub-shell cross sections, and the randomly positioned titles indicate the approximate position of the shell energies, K through P.



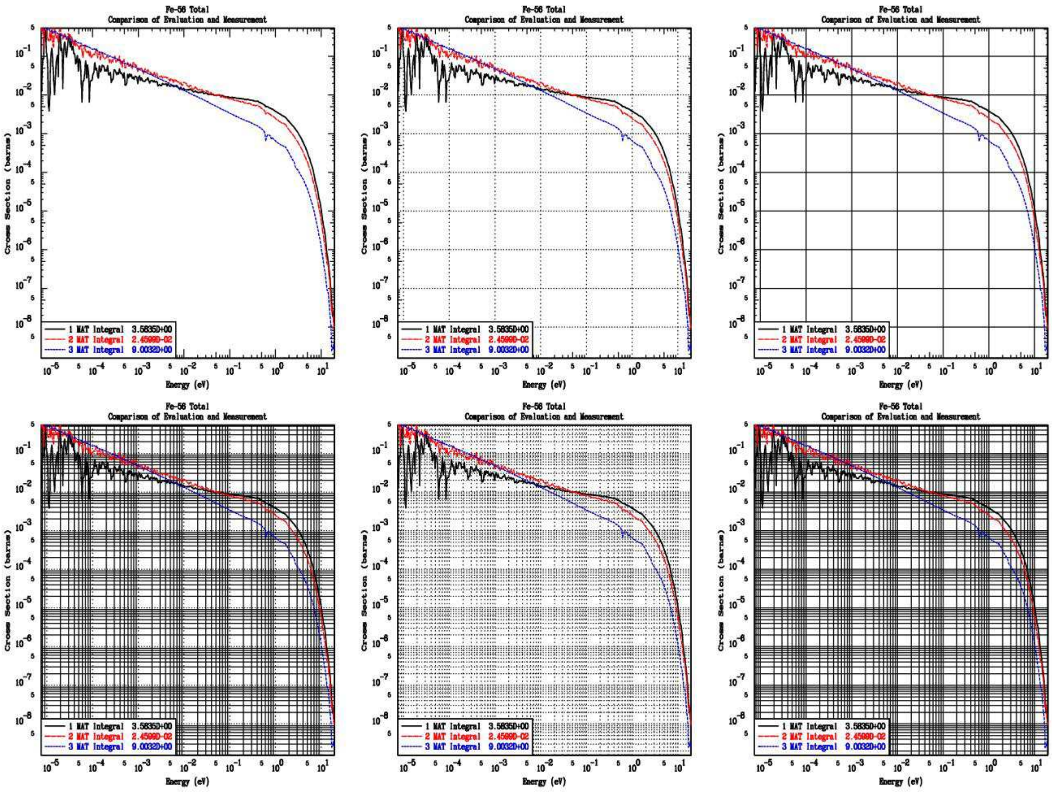
Code Installation

The code is distributed with detailed instructions concerning installation and testing of the code. These instructions are periodically updated for distribution with the code, to insure that the instructions are as up-to-date as possible, and exactly correspond to the version of the code that you will be implementing and using.

When you receive this code system you will find it arranged in a file directory structure. At each level of the directory you will find a file named **README** - be sure that you read all such files as you proceed with installation and testing.

Example of Different Grid Types (0 through 5)

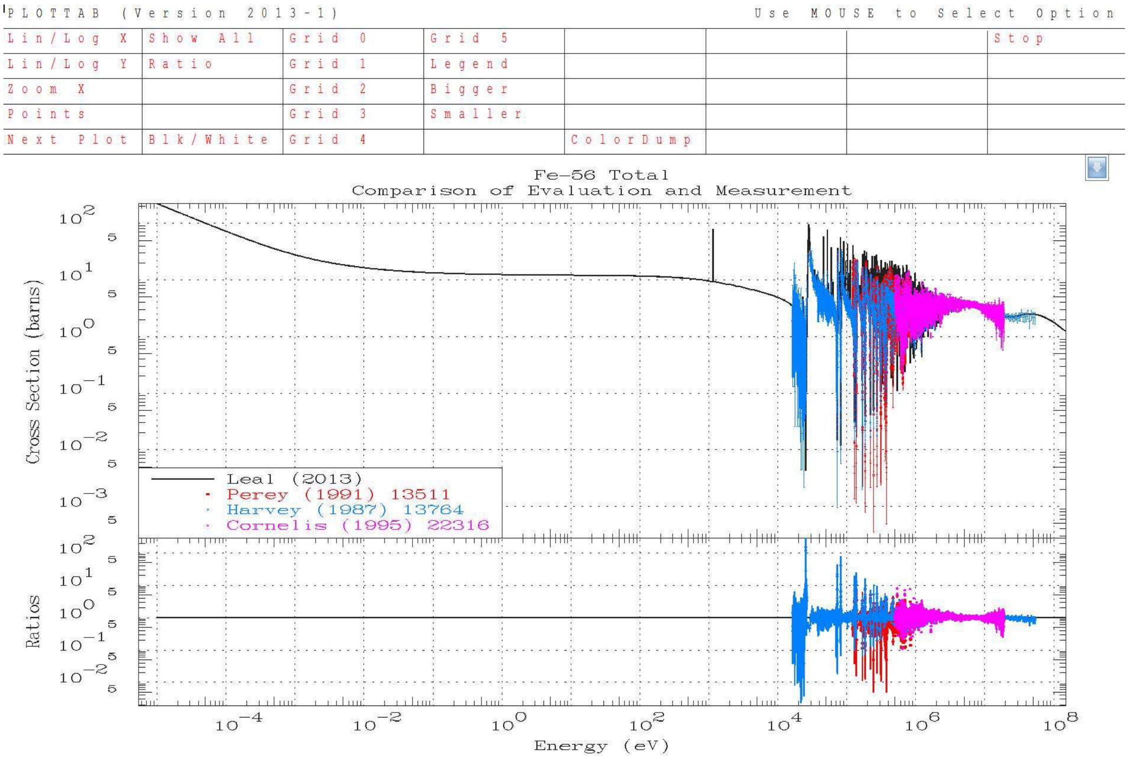
Below I illustrate the six (6) different types of grid available, varying from simply tick marks on the border (grid 0) through very detailed (grid 5). Here I use exactly the same data on all six plots, and I used the option to plot 3 X 2 plots all on the same page.

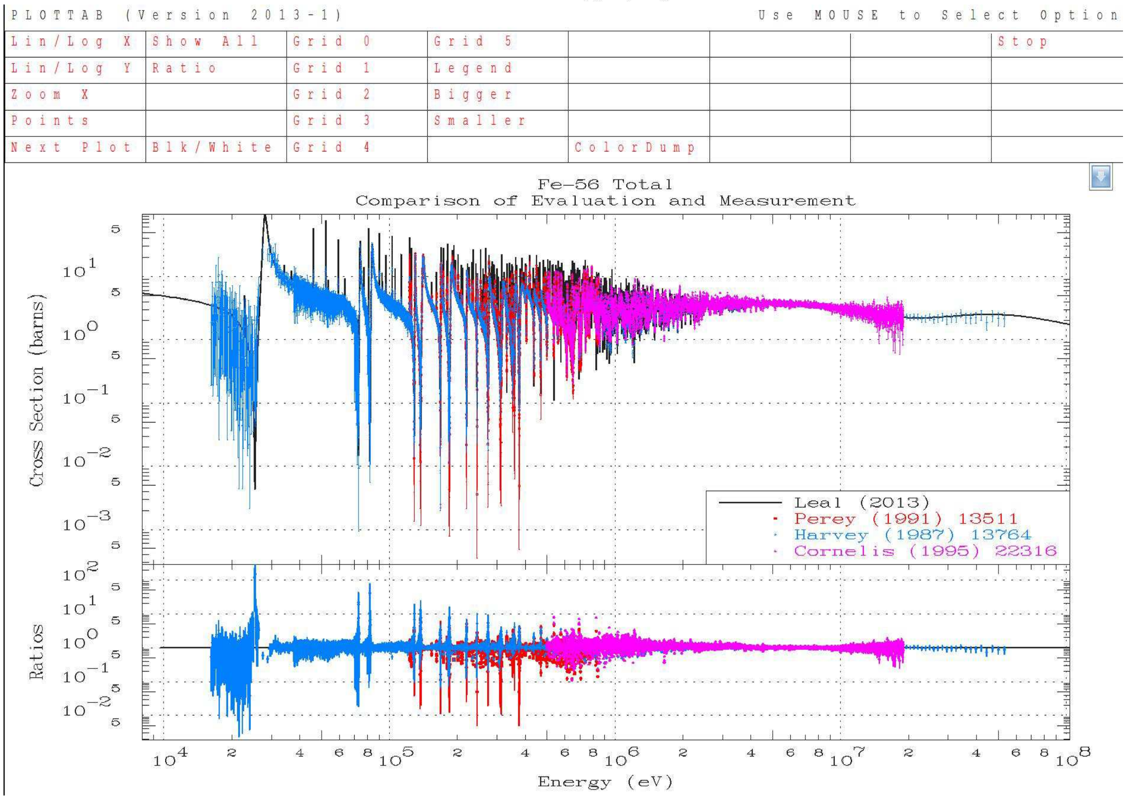


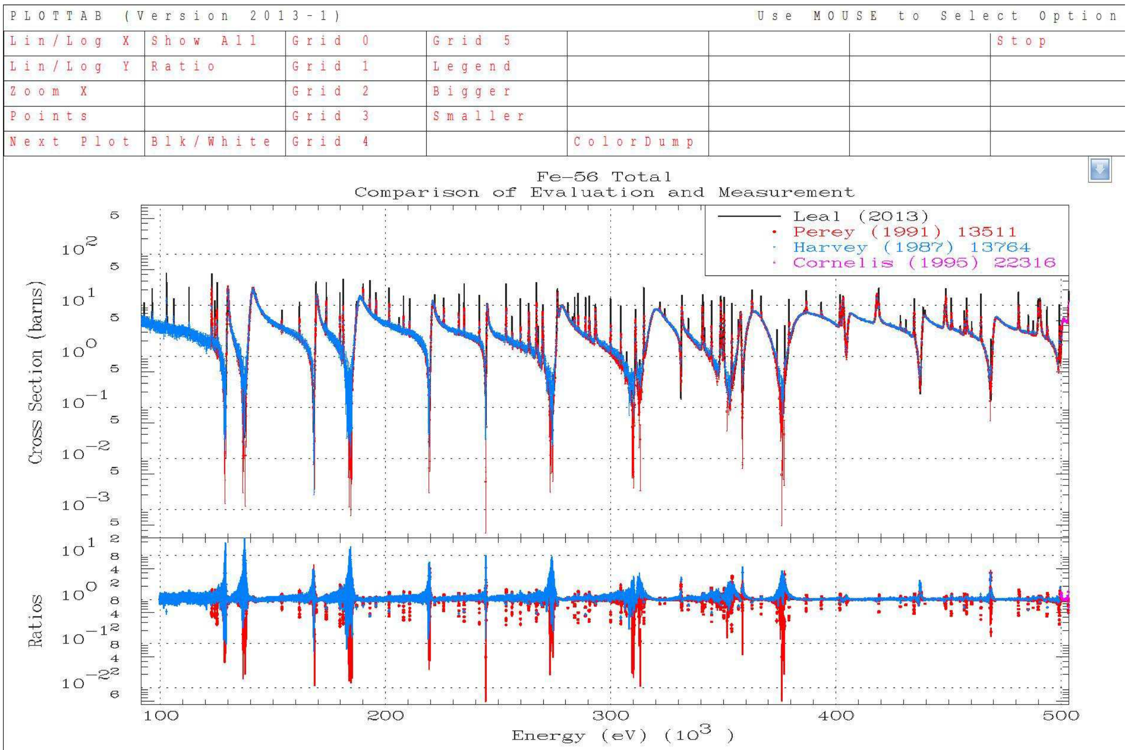
Example PLOTTAB Problem

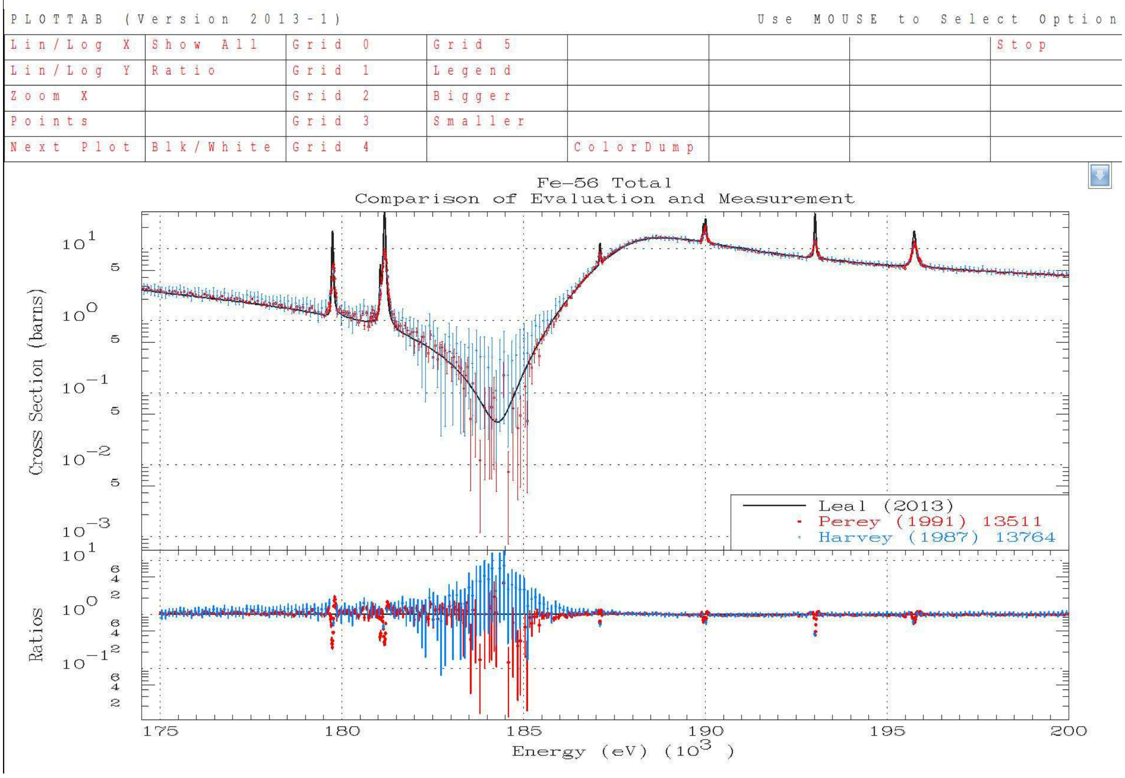
When I run the PLOTTAB test problem I have no idea what the results will look like, so I first used PLOTTAB to produce on-screen graphics. The below PLOTTAB.INP will produce one plot of the entire energy range of the data. I then used the ZOOM option to look at energy ranges I am interested in; in doing this I produced the following four on-screen plots,

```
     0.0000     13.5000      0.0000     10.0000          1          1 1.5
          1           3           0           1          1          0   1
Energy (eV)
Cross Section (barns)
Fe-56 Total
Comparison of Evaluation and Measurement
                                2           1          2          0   0
                                2           2          2          0   0
```


PLOTTAB (Version 2013-1)
Use MOUSE to Select Option
Lin/Log X
Show All
Grid 0
Grid 5
Stop
Lin/Log Y
Ratio
Grid 1
Legend
Zoom X
Grid 2
Bigger
Points
Grid 3
Smaller
Next Plot
Blk/White
Grid 4
ColorDump
Fe-56 Total
Comparison of Evaluation and Measurement
Cross Section (barns)
Leal (2013)
Perey (1991) 13511
Harvey (1987) 13764
Cornelis (1995) 22316
Ratios
Energy (eV)


PLOTTAB (Version 2013-1)
Use MOUSE to Select Option
Lin/Log X
Show All
Grid 0
Grid 5
Stop
Lin/Log Y
Ratio
Grid 1
Legend
Zoom X
Grid 2
Bigger
Points
Grid 3
Smaller
Next Plot
Blk/White
Grid 4
ColorDump
Fe-56 Total
Comparison of Evaluation and Measurement
Cross Section (barns)
Leal (2013)
Perey (1991) 13511
Harvey (1987) 13764
Cornelis (1995) 22316
Ratios
Energy (eV)

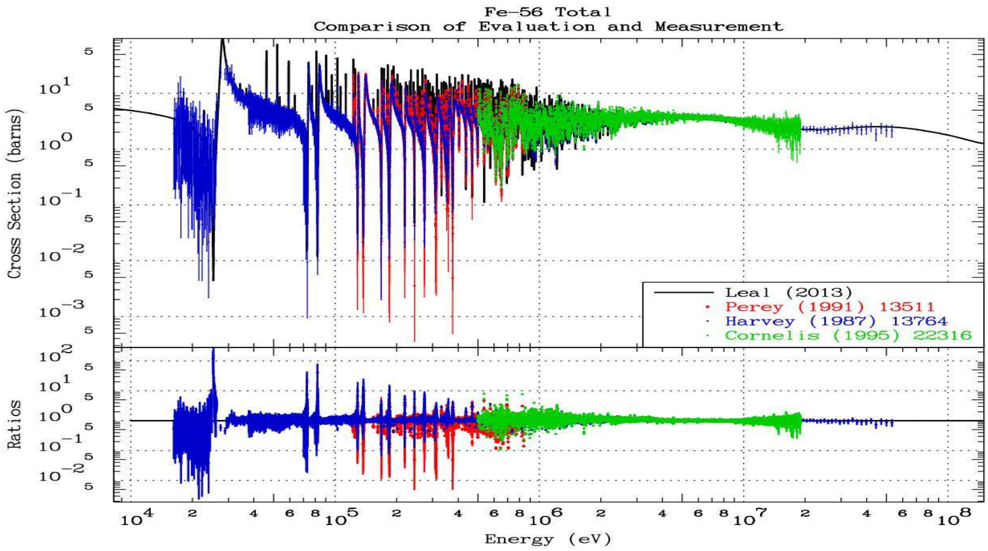

PLOTTAB (Version 2013-1)
Use MOUSE to Select Option
Lin/Log X
Show All
Grid 0
Grid 5
Stop
Lin/Log Y
Ratio
Grid 1
Legend
Zoom X
Grid 2
Bigger
Points
Grid 3
Smaller
Next Plot
Blk/White
Grid 4
ColorDump
Fe-56 Total
Comparison of Evaluation and Measurement
Leal (2013)
Perey (1991) 13511
Harvey (1987) 13764
Cornelis (1995) 22316
Cross Section (barns)
Ratios
Energy (eV) (10^3)

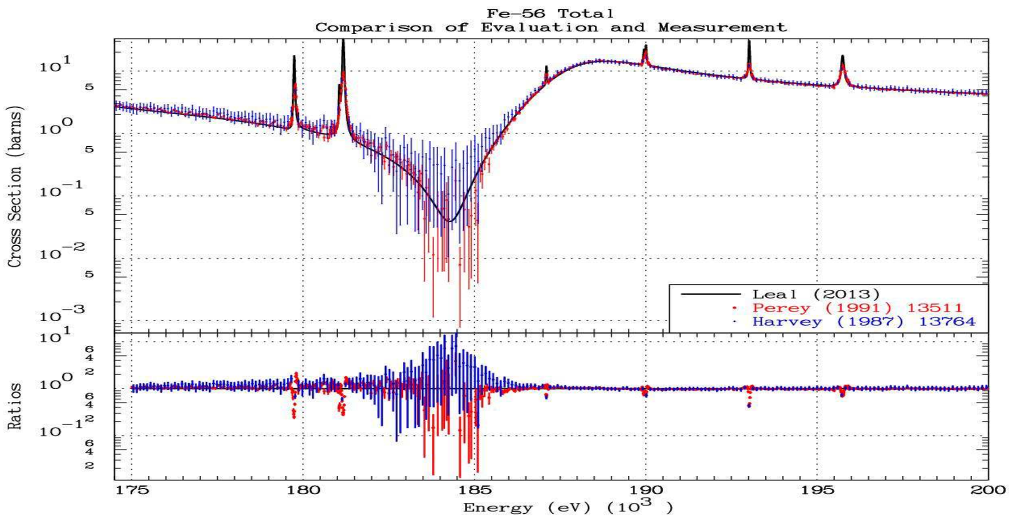

PLOTTAB (Version 2013-1)
Use MOUSE to Select Option
Lin/Log X
Show All
Grid 0
Grid 5
Stop
Lin/Log Y
Ratio
Grid 1
Legend
Zoom X
Grid 2
Bigger
Points
Grid 3
Smaller
Next Plot
Blk/White
Grid 4
ColorDump
Fe-56 Total
Comparison of Evaluation and Measurement
Leal (2013)
Perey (1991) 13511
Harvey (1987) 13764
Cross Section (barns)
Ratios
Energy (eV) (10^3)

Once I saw the data on the screen I selected the energy ranges I was interested in and I ran PLOTSAVE to produce the below plots as hardcopy PostScript files,

```
     0.0000     13.5000      0.0000     10.0000           1           1 1.5
         -1          -3           0           1           1           0   1
Energy (eV)
Cross Section (barns)
Fe-56 Total
Comparison of Evaluation and Measurement
   10000.                         2           1           2           0   0
                                  2           2           2           0   0

     0.0000     13.5000      0.0000     10.0000           1           1 1.5
         -1          -3           0           1           1           0   1
Energy (eV)
Cross Section (barns)
Fe-56 Total
Comparison of Evaluation and Measurement
  175000.     200000.             2           1           2           0   0
                                  2           2           2           0   0
```





Original Reference

[1] "**Program PLOTTAB. General plotting program**.", by Dermott E. Cullen, International Atomic Energy Agency, Nuclear Data Section (IAEA/NDS), IAEA-NDS-82, June 1987.

Latest Documentation

This code is designed to be self-documenting, in the sense that the latest documentation for the code is included as comment lines at the beginning of the code. Printed documentation, such as this report, is periodically published and consists mostly of a copy of the comment lines from the beginning of the code. The user should be aware that the comment lines in the code are continuously updated to reflect the most recent status of the code and these comment lines should always be considered to be the most recent documentation for the code and may supersede published documentation, such as this report. Therefore users are advised to always read the documentation within the actual code.

Comment Lines from the Beginning of PLOTTAB

```
C=====================================================================
C
C      Program PLOTTAB
C      ---------------
C
C      OWNED, MANTAINED AND DISTRIBUTED BY
C      -----------------------------------
C      THE NUCLEAR DATA SECTION
C      INTERNATIONAL ATOMIC ENERGY AGENCY
C      P.O BOX 100
C      A-1400, VIENNA, AUSTRIA
C      EUROPE
C
C      ORIGINALLY WRITTEN BY
C      ---------------------
C      Dermott E. Cullen
C      University of California (retired)
C-----Present Home Address---------------------------------------------
C      1466 Hudson Way
C      Livermore, CA 94550
C      U.S.A.
C      Telephone  925-443-1911
C      E. Mail    RedCullen1@Comcast.net
C      Website    http://home.comcast.net/~redcullen1
C=======================================================================
c      HISTORY
C      -------
C      VERSION 87-1 (JANUARY, 1987) *Original WINDOWS Version
C      VERSION 87-2 (MAY, 1987)     *SOFTWARE UPPER AND LOWER CASE
C                                    CHARACTERS
C                                   *SOFTWARE SPECIAL SYMBOLS TO IDENTIFY
C                                    SETS OF DISCRETE POINTS.
C                                   *SOFTWARE LINE TYPES TO IDENTIFY
```

```
C                                    CURVES.
C     VERSION 87-3 (NOVEMBER, 1987)*IMPROVED GROUPING OF DATA ON PLOTS
C                                    (NOTE, CHANGE IN DEFINITION OF
C                                    INPUT VARIABLES).
C                                   *ALL INPUT READ AS CHARACTERS AND
C                                    INTERNALLY CONVERTED TO FLOATING
C                                    OR FIXED POINT AS NEEDED.
C                                   *IMPROVED LINE TYPES TO DESCRIBE
C                                    CURVES.
C                                   *IMPROVED SCALING.
C     VERSION 88-1 (JULY, 1988)     *SIMPLER INTERFACE TO ALLOW PROGRAM
C                                    TO BE USED ON VIRTUALLY ANY PLOTTER
C                                   *OPTION..TURN OFF INTERPOLATION FROM
C                                    LINEAR-LINEAR TO PLANE OF PLOT.
C                                   *OPTION..INTERNALLY DEFINE FILENAMES
C                                    (SEE SUBROUTINE FILEIO FOR DETAILS).
C                                   *ALLOW RE-DEFINITION OF GLOBAL
C                                    PARAMETERS DURING RUN (ALLOW
C                                    IMPROVED GROUPING OF DATA ON PLOTS)
C                                   *IMPROVED COMPUTER COMPATIBILITY.
C     VERSION 88-2 (OCTOBER 1988)   *UPDATED BASED ON USER COMMENTS.
C                                   *UPDATED TO USE NEW PROGRAM CONVERT
C                                    KEYWORDS.
C                                   *TREAT CHARACTER ARRAYS AS EITHER
C                                    - CHARACTER (FORTRAN-77 CONVENTION)
C                                    - INTEGER (FORTRAN-H CONVENTION)
C     VERSION 89-1 (MAY 1989)       *UPDATED BASED ON USER COMMENTS.
C                                   *ONE SIDED X AND Y LIMITS
C                                   *10,000 POINTS FOR CURVES AND
C                                     2,000 DISCRETE POINTS
C                                   *3 CHARACTER FONTS
C                                   *LINEAR OR LOG X AND Y INTERPOLATION
C                                   *OPTIONAL ROUNDING OF PLOT LIMITS
C                                   *OPTIONAL LEGEND BOX ON PLOT
C     VERSION 89-1 (JULY 1989)      *UPDATED BASED ON USER COMMENTS.
C                                   *UP TO 20000 POINTS FOR CURVES
C                                   *IMPROVED LEGEND BOX POSITIONING.
C                                   *ADDITIONAL GRIDS COMBINING TICK
C                                    MARKS WITH SOLID OR DASHED GRID.
C                                   *ONE SIDED X AND Y ROUNDING
C                                   *THICK CURVES, ETC., BUT NOT THICK
C                                    CHARACTERS.
C     VERSION 90-1 (MAY 1991)       *UPDATED BASED ON USER COMMENTS.
C                                   *ADDED NEW GRID TYPES
C                                   *UP TO 10000 DISCRETE POINTS
C     VERSION 92-1 (MARCH 1992)     *UPDATED BASED ON USER COMMENTS.
C                                   *ADDED THICK MASTER CURVE OPTION
C                                   *ADDED MANY NEW FEATURES
C                                   *CORRECTED MANY OLD PROBLEMS
C     VERSION 92-2 (APRIL 1992)     *VARIABLE CHARACTER SIZE INPUT OPTION
C                                   *ALLOW COMPLETE FLEXIBILITY TO CHANGE
C                                    PAGE LAYOUT ANY NUMBER OF TIMES
C                                    DURING A SINGLE RUN.
C                                   *UPDATED BASED ON USER COMMENTS.
C     VERSION 93-1 (MARCH 1993)     *UPDATED GRAPHICS INTERFACE FOR LAHEY
C                                    IBM-PC FORTRAN COMPILER FOR ON
C                                    SCREEN GRAPHICS (SEE, DESCRIPTION
C                                    OF GRAPHICS INTERFACE BELOW).
```

```
C                                 *INCREASED MAXIMUM NUMBER OF POINTS
C                                  FOR CURVES FROM 20000 TO 200000.
C     VERSION 94-1 (JANUARY 1994)  *ADDED OPTION - SHOW POINTS OF CURVES
C                                  (SEE, BELOW DESCRIPTION OF INPUT
C                                  PARAMETERS).
C                                 *ADDED INTERACTIVE INTERFACE USING
C                                  MOUSE.
C     VERSION 96-1 (SEPTEMBER 1996)*GENERAL UPDATE BASED ON USER
C                                  COMMENTS
C     VERSION 97-1 (SEPTEMBER 1997)*GENERAL UPDATE BASED ON USER
C                                  COMMENTS
C     VERSION 98-1 (MAY 1998)     *GENERAL UPDATE BASED ON USER
C                                  COMMENTS
C     VERSION 2000-1 (MAY 2000)   *GENERAL UPDATE BASED ON USER
C                                  COMMENTS
C     VERSION 2002-1 (Nov. 2002)  *GENERAL UPDATE BASED ON USER
C                                  COMMENTS
C     VERSION 2004-1 (April 2004) *REAL*8 VERSION
C                                 *ADDED INCLUDE FOR COMMON
C                                 *IMPROVED POSTSCRIPT FILES
C     VERSION 2005-1 (Dec. 2005)  *READY FOR 2005 DISTRIBUTION
C     VERSION 2011-1 (Mar. 2011)  *Many Updates
C     VERSION 2013-1 (Nov. 2013)  *32 and 64 bit Compatible.
C                                 *Limit discrete data
C                                  *Data MUST be positive
C                                  *ERRORS cannot exceed 90% of Data
C                                 *Replaced Old Routines for character
C                                  translation by Current IN9 and OUT9
C                                  for ALL Floating Point Translation.
C                                 *Removed arbitrary positioned titles.
C                                  This can now be accomplished easier
C                                  by editing finished plots.
C
C     PURPOSE
C     ================================================================
C     THIS PROGRAM IS DESIGNED TO PLOT ANY COMBINATION OF CONTINUOUS
C     CURVES AND/OR DISCRETE POINTS (WITH ASSOCIATED ERROR BARS) USING
C     USER SUPPLIED TITLES AND X AND Y AXIS LABELS AND UNITS.
C
C     IN ADDITION IF CURVES ARE PLOTTED THE FIRST CURVE MAY BE USED AS
C     A STANDARD AND NOT ONLY THE DATA, BUT ALSO THE RATIO OF THE DATA
C     TO THE STANDARD WILL BE PLOTTED.
C
C     USING THIS METHOD THE PROGRAM HAS NO IDEA OF WHAT DATA IS BEING
C     PLOTTED AND YET BY SUPPLYING TITLES, X AND Y AXIS LABELS AND
C     UNITS THE USER CAN PRODUCE ANY NUMBER OF PLOTS WITH EACH PLOT
C     CONTAINING ALMOST ANY COMBINATION OF CURVES AND POINTS WITH EACH
C     PLOT PROPERLY IDENTIFIED.
C
C     GRAPHICS INTERFACE
C     ================================================================
C     THIS PROGRAM USES A SIMPLE CALCOMP LIKE GRAPHICS INTERFACE WHICH
C     REQUIRES ONLY 4 SUBROUTINES...EACH SUBROUTINE IS DESCRIBED IN
C     DETAIL BELOW. ALL CHARACTERS AND SYMBOLS ARE DRAWN USING TABLES
C     OF PEN STROKES (SUPPLIED WITH THIS PROGRAM). USING THIS METHOD
C     THE PROGRAM SHOULD BE SIMPLE TO INTERFACE TO VIRTUALLY ANY PLOTTER
C     OR GRAPHICS TERMINAL AND THE APPEARANCE AND LAYOUT OF THE PLOTS
C     SHOULD BE INDEPENDENT OF WHICH PLOTTER IS USED.
```

```
C
C     ON WHAT COMPUTERS WILL THE PROGRAM RUN
C     ==================================================================
C     THIS PROGRAM WILL RUN ON ALMOST ANY COMPUTER. PERSONAL COMPUTERS
C     ALLOW ON-SCREEN GRAPHICS AND INTERACTION WITH THE PLOTS, AS WELL
C     AS HARDCOPY PLOTS IN POSTSCRIPT FORMAT. CONTRAL COMPUTERS CAN ALSO
C     BE USED WITHOUT INTERACTION TO PRODUCE HARDCOPY PLOTS POSTSCRIPT
C     FORMAT.
C
C     ON WHAT PLOTTERS WILL THE PROGRAM RUN
C     ==================================================================
C     THE PLOTTER MAY USE UNITS OF INCHES, CENTIMETERS, MILLIMETERS,
C     VIRTUALLY ANYTHING. INTERNALLY THE PROGRAM WILL DEFINE PLOTS IN
C     APPROXIMATELY A4 OR 8-1/2 BY 11 INCH FORMAT. AS PART OF THE
C     INPUT THE USER DEFINES THE ACTUAL SIZE OF THE PLOT IN THE UNITS
C     (I.E., INCHES, CENTIMETERS, MILLIMETERS, WHATEVER) OF THE REAL
C     PLOT. THE PLOT IS TRANSFORMED TO THE SIZE OF THE LOCAL PLOTTER
C     AND OUTPUT. USING THIS CONVENTION THIS PROGRAM SHOULD BE EASY
C     TO INTERFACE TO VIRTUALLY ANY PLOTTER OR GRAPHICS TERMINAL.
C
C     OPTIONAL FILE NAMES
C     ==================================================================
C     THIS PROGRAM CONTAINS A SUBROUTINE FILEIO WHICH MAY BE USED TO
C     OPTIONALLY DEFINE STANDARD FILE NAMES TO EACH I/O FILE. SEE THIS
C     SUBROUTINE FOR DETAILS ON HOW TO MODIFY THIS PROGRAM TO EITHER
C     (1) ASSUME ALL FILE NAMES ARE DEFINED FROM OUTSIDE THE PROGRAM
C     (E.G. USING JOB CONTROL LANGUAGE) OR (2) DEFINE ALL FILE NAMES
C     INTERNALLY USING SUBROUTINE FILEIO.
C
C     METHOD
C     ==================================================================
C     STARTING FROM FILES OF,
C     (1) OPTIONS = TO CONTROL SELECTION AND PLOTTING OF DATA.
C     (2) CURVES  = IDENTIFIED BY A TITLE AND (X,Y) COORDINATES.
C     (3) POINTS  = IDENTIFIED BY A TITLE AND (X,+DX,-DX,Y,+DY,-DY)
C                   COORDINATES.
C
C     THIS PROGRAM IS DESIGNED TO CREATE PLOTS OF THE USER SELECTED DATA
C
C     FORMAT OF INPUT OPTIONS, CURVES AND DISCRETE POINTS
C     ==================================================================
C     THE FORMAT OF ALL FIXED AND FLOATING POINT DATA USED BY THIS
C     PROGRAM ARE ALL IN FIELDS 11 COLUMNS WIDE (E.G. I11 OR E11.4)
C     WHICH WAS SELECTED TO BE COMPATIBLE WITH THE ENDF/B (EVALUATED
C     NUCLEAR DATA FILE/VERSION B), ENDL (LIVERMORE EVALUATED NUCLEAR
C     DATA LIBRARY) AND EXFOR (EXPERIMENTAL NUCLEAR DATA LIBRARY)
C     FORMATS. DATA IN THE ENDF/B, ENDL OR EXFOR FORMAT CAN EASILY BE
C     TRANSLATED INTO THE FORMATS READ BY THIS PROGRAM.
C
C     DATA UNITS AND IDENTIFICATION
C     ==================================================================
C     BY INPUT PARAMETERS THE USER CAN SPECIFY THE UNITS OF THE DATA
C     FOR THE X AND Y AXIS OF THE PLOTS (E.G., EV, KEV, MEV, BARNS,
C     CM**2,....) AND THE PHYSICAL IDENTIFICATION OF THE DATA TO APPEAR
C     AT THE TOP OF THE PLOT (E.G., 26-FE-56 (N,2N) CROSS SECTION,
C     HELIUM ELECTRON IONIZATION CROSS SECTIONS,....). AS SUCH THE DATA
C     TO BE PLOTTED MAY BE IN ANY UNITS THAT THE USER FINDS CONVENIENT
C     (E.G., EXFOR DATA IN KEV VS. MILLI-BARNS NEED NOT BE CONVERTED TO
```

```
C      EV AND BARNS UNLESS THE USER FINDS IT CONVENIENT TO DO SO).
C
C      IF THE USERS WISHES TO USE THIS PROGRAM TO COMPARE DIFFERENT SETS
C      OF DATA (E.G., COMPARE AN EVALUATION TO A NUMBER OF EXPERIMENTAL
C      MEASUREMENTS OR COMPARE A NUMBER OF DIFFERENT EVALUATION) ALL OF
C      THE DATA TO BE COMPARED MUST BE IN THE SAME UNITS.
C
C      BLANK VERSUS ZERO
C      ================================================================
C      THIS PROGRAM WILL READ ALL DATA AS CHARACTERS AND INTERNALLY
C      CONVERT THEM TO NUMERICAL VALUES AS NEEDED. AS SUCH THIS PROGRAM
C      CAN DISTINGUISH BETWEEN BLANK AND ZERO INPUT. THIS CAPABILITY
C      IS IMPORTANT TO ALLOW THE PROGRAM TO DISTINGUISH BETWEEN WHEN
C      YOU ARE TRYING TO TELL THE PROGRAM NOTHING VERSUS ZERO, E.G.,
C      THE DIFFERENCE BETWEEN SPECIFYING A LOWER X LIMIT OF ZERO OR
C      NO LOWER LIMIT (IN WHICH CASE THE LIMIT WILL BE DEFINED BY THE
C      X RANGE OF THE DATA).
C
C      INPUT OPTIONS
C      ================================================================
C      I/O UNIT 2 CONTAINS CONTROL INFORMATION OF 3 TYPES (NOTE, UNIT
C      3 IS RESERVED FOR COMPUTER TERMINAL INTERACTION),
C
C      PLOTTER PARAMETERS
C      ----------------------------------------------------------------
C      PARAMETERS WHICH DEFINE THE PHYSICAL X AND Y DIMENSIONS OF A
C      FRAME AND THE NUMBER OF PLOTS TO APPEAR ON EACH FRAME (A FRAME
C      MAY BE SUBDIVIDED INTO ANY NUMBER OF PLOTS IN THE X AND Y
C      DIRECTION).
C
C      PLOTTER PARAMETERS ARE READ AS THE FIRST LINE OF INPUT AND CAN
C      BE USED TO APPLY TO ALL SUBSEQUENT PLOTS OR CAN BE READ AGAIN
C      TO CHANGE THE LAYOUT OF A FRAME AND/OR THE GLOBAL PARAMETERS
C      WHICH FOLLOW (SEE, HOW TO RE-DEFINE THE PLOTTER AND GLOBAL
C      PARAMETERS, BELOW).
C
C      GLOBAL PARAMETERS
C      ----------------------------------------------------------------
C      PARAMETERS WHICH APPLY TO ALL PLOTS, INCLUDING,
C      (1) WHETHER OR NOT TO PLOT CURVES AND HOW TO GROUP THEM.
C      (2) WHETHER OR NOT TO PLOT POINTS AND HOW TO GROUP THEM.
C      (3) WHETHER OR NOT TO PLOT AN OUTER BORDER ON EACH PLOT.
C      (4) TYPE OF GRID (TICK MARKS, FULL GRID OR DASHED GRID).
C      (5) WHETHER ONLY DATA SHOULD BE PLOTTED OR DATA AND RATIO OF ALL
C          DATA TO FIRST CURVE.
C      (6) THE WIDTH OF PLOTTED LINES (APPLIES TO ALL LINES EXCEPT THE
C          GRID).
C      (7) X AND Y AXIS LABELS AND UNITS.
C
C      THERE ARE 3 LINES OF GLOBAL PARAMETERS AND THESE PARAMETERS WILL
C      APPLY TO ALL SUBSEQUENT PLOTS UNTIL THE END OF THE RUN OR THE
C      USER CHOOSES TO RECYCLE BACK TO THE PLOTTER PARAMETER AND GLOBAL
C      PARAMETERS (SEE, HOW TO RE-DEFINE THE PLOTTER AND GLOBAL
C      PARAMETERS, BELOW).
C
C      PLOT PARAMETERS
C      ----------------------------------------------------------------
C      PARAMETERS WHICH ONLY APPLY TO ONE PLOT, INCLUDING,
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C     (1) A 2 LINE TITLE TO BE CENTERED AND APPEAR AT TOP OF PLOT.
C     (2) A REQUESTED X RANGE (IF ANY).
C     (3) WHETHER OR NOT X ERROR BARS SHOULD BE PLOTTED FOR POINTS.
C     (4) X SCALING AND INTERPOLATION (AUTOMATIC, LINEAR OR LOG)
C     (5) WHETHER OR NOT TO ROUND X LIMITS OUTWARD SO THAT DATA DOES
C         EXTEND ALL THE WAY TO THE BORDER OF THE PLOT.
C     (6) A REQUESTED Y RANGE (IF ANY).
C     (7) WHETHER OR NOT Y ERROR BARS SHOULD BE PLOTTED FOR POINTS.
C     (8) Y SCALING AND INTERPOLATION (AUTOMATIC, LINEAR OR LOG)
C     (9) WHETHER OR NOT TO ROUND Y LIMITS OUTWARD SO THAT DATA DOES
C         EXTEND ALL THE WAY TO THE BORDER OF THE PLOT.
C
C     FOR EACH PLOT THERE ARE 3 LINES OF PLOT PARAMETERS.
C
C     PLOTTING IS CONTROLLED BY PLOT PARAMETERS, NOT THE CURVE OR POINT
C     DATA. EACH SET OF PLOT PARAMETERS WILL PRODUCE ONE PLOT. PLOTTING
C     ENDS WHEN ALL SETS OF PLOT PARAMETERS HAVE BEEN READ OR WHEN THERE
C     IS NO MORE DATA TO PLOT.
C
C     RE-DEFINING THE PLOTTER AND GLOBAL PARAMETERS
C     ==================================================================
C     IF THE FIRST LINE OF THE TITLE INCLUDED WITH THE PLOT PARAMETERS
C     (DESCRIBED ABOVE) IS BLANK THE PROGRAM WILL RE-CYCLE BACK TO
C     THE POINT OF READING THE PLOTTER PARAMETERS, FOLLOWED BY THE
C     GLOBAL PARAMETERS, FOLLOWED BY PLOT PARAMETERS FOR ANY NUMBER
C     OF PLOTS. THIS METHOD MAY BE USED ANY NUMBER OF TIMES DURING
C     EXECUTION IN ORDER TO CHANGE THE FRAME LAYOUT AND/OR GLOBAL
C     PARAMETERS.
C
C     CURVES
C     ==================================================================
C     I/O UNIT 10 CONTAINS INFORMATION DESCRIBING THE CURVES TO BE
C     PLOTTED (IF ANY), INCLUDING,
C     (1) A ONE LINE TITLE TO IDENTIFY EACH CURVE.
C     (2) TABULATED (X,Y) PAIRS, ONE PAIR PER LINE, TERMINATED BY
C         A BLANK (NOT 0.0) LINE.
C
C     THE SEQUENCE OF CURVE TITLE FOLLOWED BY A TABLE OF VALUES AND
C     TERMINATED BY BLANK MAY BE REPEATED ANY NUMBER OF TIMES TO CREATE
C     A SERIES OF CURVES. INPUT PARAMETERS MAY BE USED TO PLOT EACH
C     CURVE SEPARATELY OR TO GROUP CURVES ON ONE OR MORE PLOTS.
C
C     IF REQUESTED, THE PROGRAM WILL USE THIS DATA TO DRAW CONTINUOUS
C     CURVES CONNECTING THE TABULATED VALUES. EACH CURVE (UP TO 30 MAY
C     APPEAR ON EACH PLOT) WILL BE IDENTIFIED BY ITS TITLE IN A LEGEND
C     BOX WITHIN THE PLOTTING AREA. FOR EACH PLOT THE TOTAL NUMBER OF
C     DATA POINTS USED TO DEFINE THE CURVE MAY BE UP 200000 (IF THIS IS
C     EXCEEDED ONLY THE FIRST 200000 POINTS WILL BE USED).
C
C     POINTS
C     ==================================================================
C     I/O UNIT 11 CONTAINS INFORMATION DESCRIBING THE POINTS TO BE
C     PLOTTED (IF ANY), INCLUDING,
C     (1) A ONE LINE TITLE TO IDENTIFY EACH SET OF POINTS.
C     (2) TABULATED (X,+DX,-DX,Y,+DY,-DY) SEXTUPLETS, ONE SEXTUPLET PER
C         LINE, TERMINATED BY A BLANK (NOT 0.0) LINE.
C
C     THE SEQUENCE OF POINT TITLE FOLLOWED BY A TABLE OF POINTS AND
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C     TERMINATED BY BLANK MAY BE REPEATED ANY NUMBER OF TIMES TO CREATE
C     A SERIES OF SETS OF POINTS. INPUT PARAMETERS MAY BE USED TO PLOT
C     THE SETS OF POINTS SEPARATELY OR TO GROUP SETS OF POINTS ON ONE
C     OR MORE PLOTS.
C
C     IF REQUESTED, THE PROGRAM WILL USE THIS DATA TO DRAW A SET OF
C     DISCRETE POINTS AND ASSOCIATED ERROR BARS (IF REQUESTED). EACH
C     SET OF POINTS (UP TO 30 SETS MAY APPEAR ON EACH PLOT) WILL BE
C     IDENTIFIED BY ITS TITLE IN A LEGEND BOX WITHIN THE PLOTTING AREA.
C     FOR EACH PLOT THE TOTAL NUMBER OF DISCRETE DATA POINTS MAY BE UP
C     TO 100000 (IF THIS NUMBER IS EXCEEDED ONLY THE FIRST 100000 POINTS
C     WILL BE USED).
C
C     COMBINED CURVES AND POINTS
C     ==================================================================
C     A COMBINATION OF UP TO 30 CURVES AND SETS OF DISCRETE POINTS MAY
C     APPEAR ON EACH PLOT (E.G., IF THERE ARE 10 CURVES THERE CANNOT BE
C     MORE THAN 20 SETS OF DISCRETE POINTS).
C
C     WARNING...THE PROGRAM WILL ALLOW THE USER TO SPECIFY UP TO 30
C     CURVES AND 30 SETS OF DISCRETE POINTS, BUT WILL NOT READ MORE THAN
C     A COMBINATION OF UP TO 30 CURVES AND DISCRETE POINTS FOR ANY ONE
C     PLOT. IF THE USER EXCEEDS THIS LIMIT IT MAY CAUSE THE DATA THAT
C     APPEARS ON EACH PLOT TO GET OUT OF SYNC WITH THE PLOT PARAMETERS
C     AND APPEAR ON THE WRONG PLOT.
C
C     OPERATION
C     ==================================================================
C     THE PROGRAM WILL,
C     (1) READ PLOTTER PARAMETERS
C     (2) READ ALL GLOBAL PARAMETERS
C     (3) READ ALL THE FIRST TITLE LINE (PLOT PARAMETERS). IF THE LINE
C         IS COMPLETELY BLANK THE PROGRAM WILL GO TO (1) - ABOVE, TO
C         RE-DEFINE THE PLOTTER AND GLOBAL PARAMETERS. IF THE LINE IS
C         NOT COMPLETELY BLANK IT WILL PROCEED TO (4) BELOW.
C     (4) READ THE SECOND TITLE LINE AND TWO PLOT PARAMETER LINES.
C     (5) READ ALL REQUESTED CURVE AND/OR POINT DATA (BASED ON CURRENT
C         GLOBAL PARAMETERS).
C     (6) DETERMINE THE MINIMUM AND MAXIMUM X AND Y VALUES.
C     (7) DECIDE WHETHER FOR X AND Y AXIS TO USE LINEAR OR LOG SCALING.
C         LOG SCALING IS USED UNLESS,
C         (A) USER INPUT SPECIFIES LINEAR
C         (B) THE MINIMUM IS NOT POSITIVE
C         (C) THE MAXIMUM IS LESS THAN 10 TIMES THE MINIMUM
C     (8) IF LINEAR SCALING IS USED FOR THE X AND/OR Y AXIS THE DATA
C         WILL BE SCALED TO OBTAIN AXIS ANNOTATION IN NORMAL FORM TO 3
C         DIGITS ACCURACY (I.E., IF THE X UNITS ARE EV AND THE MAXIMUM
C         X VALUE IS 0.00350 THE AXIS ANNOTATION WILL BE SCALED TO
C         3.50 AND THE UNITS MODIFIED TO (10**-3 EV))
C     (9) PRODUCE A PLOT CONTAINING THE USER SUPPLIED TITLES, X AND Y
C         AXIS LABEL AND UNITS IDENTIFYING EACH CURVE AND SET OF POINTS.
C         THE PLOT WILL ALWAYS CONTAIN THE DATA (CURVES AND/OR DISCRETE
C         POINTS). IF PLOTTING CURVES THE USER MAY OPTIONALLY SPECIFY BY
C         INPUT THAT THE FIRST CURVE IS TO BE USED AS A STANDARD AND THE
C         RATIO OF ALL OTHER DATA (CURVES AND/OR POINTS) TO THE STANDARD
C         SHOULD ALSO APPEAR ON THE PLOT (DATA = TOP 2/3 OF PLOT, RATIO=
C         BOTTOM 1/3 OF PLOT).
C
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C      THE CYCLE OF STEPS (3)-(9) IS REPEATED UNTIL ALL SETS OF PLOT
C      PARAMETERS HAS BEEN READ.
C
C      USING THIS METHOD THE PROGRAM HAS NO IDEA OF WHAT DATA IS BEING
C      PLOTTED AND YET BY SUPPLYING TITLES, X AND Y AXIS LABELS AND
C      UNITS THE USER CAN PRODUCE A SERIES OF PLOTS OF ALMOST COMBINATION
C      OF CURVES AND POINTS WITH EACH PLOT PROPERLY IDENTIFIED.
C
C      X ORDER OF DATA
C      ===============================================================
C      IF ALL DATA IS TO APPEAR ON THE PLOTS (I.E., THE USER DOES NOT
C      SPECIFY AN X RANGE..SEE DESCRIPTION OF INPUT OPTIONS) THE DATA FOR
C      EACH CURVE OR SET OF DISCRETE POINTS MAY BE IN ANY X ORDER, E.G.,
C      THE POINTS FOR A CURVE MAY BE ASCENDING OR DESCENDING ORDER OR MAY
C      EVEN REVERSE IN X.
C
C      IF YOU WISH TO SPECIFY X RANGES OR HAVE RATIOS ON A PLOT THE DATA
C      FOR EACH CURVE OR SET OF DISCRETE POINTS MUST BE IN ASCENDING
C      OR DESCENDING (DISCONTINUITY ALLOWED) X ORDER. FAILURE TO CONFORM
C      TO THIS RULE CAN RESULT IN UNPREDICTABLE RESULTS.
C
C      INTERPOLATION OF CURVES
C      ===============================================================
C      IN ORDER TO DEFINE A CONTINUOUS CURVE BETWEEN TABULATED POINTS
C      THIS PROGRAM MUST KNOW HOW TO INTERPOLATE BETWEEN POINTS. BY
C      INPUT THE USER MAY SPECIFY EITHER THE DEFAULT OPTION OF LINEAR X
C      VERSUS LINEAR Y INTERPOLATION OR ALTERNATIVELY LOG X AND/OR LOG
C      Y INTERPOLATION. IN ALL CASES, REGARDLESS OF THE INTERPOLATION
C      SPECIFIED, THE PROGRAM WILL ALWAYS INTERPOLATE THE DATA TO THE
C      PLANE OF THE PLOT (LINEAR OR LOG X AND Y PLANE) IN ORDER TO
C      PRESENT THE TRUE VARIATION OF THE DATA BETWEEN TABULATED POINTS,
C      BASED ON THE USER SPECIFIED INTERPOLATION LAW.
C
C      IF THE USER WISHES THE CURVES TO MERELY BE STRAIGHT LINES BETWEEN
C      TABULATED POINTS IN THE PLANE OF THE PLOT THE INTERPOLATION LAW
C      NEED ONLY CORRESPOND TO THE PLANE OF THE PLOT (LINEAR OR LOG X
C      AND Y PLANE), WHICH CAN BE SPECIFIED BY INPUT.
C
C      TABULATED POINTS SHOULD BE TABULATED AT A SUFFICIENT NUMBER OF X
C      VALUES TO INSURE THAT THE DIFFERENCE BETWEEN THE SPECIFIED
C      INTERPOLATION AND THE 'TRUE' VARIATION OF A CURVE BETWEEN
C      TABULATED VALUES IS RELATIVELY SMALL.
C
C      FOR SOME APPLICATIONS THIS CAN BE VERY IMPORTANT, E.G., CONSIDER
C      THE CASE WHEN WE HAVE THE SIMPLE FUNCTION Y=1/X. TRY COMPARING
C      THE RESULTS OBTAINED AT X=500.0 FOR,
C      (1) THE EXACT VALUE.....Y=1/500.=0.002
C      (2) THE RESULT OBTAINED BY ONLY TABULATING THE FUNCTION AT X=1.0
C          (Y=1.0) AND X=1000.0 (Y=0.001) AND LINEARLY INTERPOLATING
C          BETWEEN THESE 2 VALUES.....Y=ABOUT 0.5
C      (3) THE RESULTS OBTAINED BY TABULATING THE FUNCTION AT X=1.0 UP
C          TO X=1000.0 USING STEPS IN X OF 1.0.....Y=0.002
C
C      IN (2) WHERE AN INSUFFICIENT NUMBER OF POINTS WERE USED THE
C      PREDICTED Y IS A FACTOR OF 250 TOO HIGH. IF THIS TABULATED DATA
C      IS EVER USED IN AN INTEGRAL THE INTEGRAL OF THE DATA IN (2) IS
C      ABOUT 500. WHEREAS THE EXACT INTEGRAL IS ABOUT 6.9 (THE CASE (2)
C      INTEGRAL IS OVER 70 TIMES TOO HIGH).
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C
C     THE ABOVE EXAMPLE IS NATURALLY AN EXTREME EXAMPLE, BUT HOPEFULLY
C     IT ILLUSTRATES THE PROBLEMS WHICH CAN OCCUR WHEN TRYING TO PRODUCE
C     ACCURATE CURVES FROM TABULATED VALUES.
C
C     IF YOU HAVE A FUNCTION WHICH YOU WISH TO TABULATE AND YOU ARE NOT
C     SURE HOW MANY TABULATED VALUES TO USE AND WHERE TO LOCATE THEM
C     CONTACT THE AUTHOR FOR A COPY OF PROGRAM LINTAB, WHICH IS DESIGNED
C     TO START FROM ANY USER SUPPLIED FUNCTION AND TO CREATE A TABLE OF
C     LINEARLY INTERPOLABLE POINTS TO WITHIN ANY USER DESIRED ACCURACY.
C
C     NOTE, IF IN THE ABOVE EXAMPLE THE FUNCTION Y=1/X WERE TABULATED
C     AT ONLY X=1.0 AND X=1000.0 THE CORRECT INTERPOLATED VALUES AND
C     INTEGRALS WOULD BE OBTAINED IF LOG-LOG INTERPOLATION WERE ASSUMED.
C     IN THIS CASE INPUT PARAMETERS CAN BE USED TO (1) FORCE THE PLOT
C     TO BE INTO THE LOG-LOG PLANE, (2) SPECIFY LOG X VERSUS LOG Y
C     INTERPOLATION AND THE RESULTING PLOT WILL ACCURATELY REPRESENT
C     THE VARIATION OF THE CURVE BETWEEN TABULATED VALUES.
C
C     LAYOUT OF A FRAME
C     ===================================================================
C     EACH FRAME MAY CONTAIN ANY NUMBER OF PLOTS - AS CONTROLLED BY
C     THE PLOTTER PARAMETERS (THE FIRST LINE OF INPUT) AND WHETHER OR
C     NOT YOU ARE IN THE COMPOSITION MODE. EACH PLOT WILL BE ANNOTATED
C     BY A 2 LINE TITLE AT THE TOP OF THE PLOT, X AND Y AXIS LABELS
C     TO DEFINE THE PHYSICAL SIGNIFICANCE AND DIMENSIONS OF EACH AXIS
C     AND A LEGEND BOX WITH THE PLOT TO IDENTIFY EACH CURVE AND SET OF
C     PLOTS AND IF PLOTTING RATIOS, THE MAXIMUM DIFFERENCE AND WHERE
C     (IN TERMS OF X) THIS DIFFERENCE OCCURRED.
C
C     LEGEND BOX
C     -------------------------------------------------------------------
C     FOR SIMPLE PLOTS WHICH ONLY INVOLVE A SINGLE CURVE OR A SINGLE
C     SET OF POINTS THE LEGEND BOX IS USUALLY REDUNDANT, SINCE IN
C     THIS CASE THE 2 LINE TITLE IS SUFFICIENT TO IDENTIFY THE DATA
C     BEING PLOTTED - FOR SOME APPLICATIONS YOU MAY WISH NOT TO
C     USE A LEGEND BOX AND TO IDENTIFY EACH CURVE AND/OR SET OF
C     SEPARATELY. FOR WHATEVER REASON IF YOU CHOOSE NOT TO HAVE THE
C     LEGEND BOX PLOTTED, YOU CAN SPECIFY THIS AS AN INPUT OPTION
C     TO THE CODE.
C
C     VERTICAL VS. HORIZONTAL PLOTS
C     =============================
C     IF YOUR PLOTTING AREA IS NOT SQUARE YOU MAY WISH TO RE-ORIENT
C     THE PLOTS BY SWITCHING THE X AND Y AXI. FOR EXAMPLE, IF YOUR
C     PLOTTING AREA IS 13.5 BY 10 INCHES (X BY Y), NORMALLY YOU WILL
C     OBTAIN A PLOT WHICH IS UPRIGHT WHEN THE X AXIS IS HORIZONTAL.
C     IF YOU WISH TO OBTAIN A PLOT WHICH IS UPRIGHT WHEN THE Y AXIS
C     IS HORIZONTAL THIS MAY BE DONE BY SETTING THE UPPER X LIMIT OF
C     THE PLOTTING AREA TO ITS NEGATIVE.
C
C     FOR EXAMPLE, FOR 13.5 BY 10.0 INCH PLOTS WITH THE X AXIS
C     HORIZONTAL, COLUMNS 1-44 OF THE FIRST INPUT LINE SHOULD BE,
C
C      0.0       13.5      0.0     10.0
C
C     IN CONTRAST FOR 13.5 BY 10.0 INCH PLOTS WITH THE Y AXIS HORIZONTAL
C     COLUMNS 1-44 OF THE FIRST INPUT LINE SHOULD BE,
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C
C      0.0      -13.5      0.0     10.0
C
C     NOTE, THESE 2 CASES DIFFER ONLY IN THE SIGN OF 13.5.
C
C     THAT IS ALL YOU NEED DO - THE NEGATIVE UPPER X LIMIT WILL SERVE
C     AS A SIGNAL TO THE PROGRAM TO ROTATE THE PLOT THROUGH 90 DEGREES.
C
C     NOTE - THE PRESENT CONVENTION DIFFERS FROM THE CONVENTION USED
C     IN EARLIER VERSIONS OF THIS CODE - IN EARLIER VERSIONS IT WAS
C     NECESSARY TO NOT ONLY CHANGE THE SIGN OF THE UPPER X DIMENSION,
C     BUT ALSO TO SWITCH THE X AND Y DIMENSIONS OF THE PLOT - THIS WAS
C     CUMBERSOME AND IS NO LONGER REQUIRED.
C
C     I/O UNITS
C     ==================================================================
C     UNIT  DESCRIPTION
C     ==================================================================
C       2   INPUT OPTIONS (NOTE, UNIT 3 IS RESERVED FOR KEYBOARD
C           INTERACTION ON A COMPUTER TERMINAL OR PERSONAL COMPUTER).
C       5   KEYBOARD INTERACTION (USUALLY JUST TO INDICATE WHEN TO
C           PROCEED TO THE NEXT PLOT).
C       3   OUTPUT REPORT
C      10   TITLES AND SETS OF POINTS FOR EACH CURVE.
C      11   TITLES AND SETS OF DISCRETE POINTS.
C      12   SOFTWARE CHARACTER TABLE
C      14   SOFTWARE SYMBOL AND LINE TYPE TABLE
C
C     OPTIONAL STANDARD FILE NAMES (SEE SUBROUTINE FILEIO)
C     ==================================================================
C     UNIT  FILE NAME
C     ==================================================================
C           STANDARD
C     ==================================================================
C       2   PLOTTAB.INP
C       3   PLOTTAB.LST
C      10   PLOTTAB.CUR
C      11   PLOTTAB.PNT
C      12   PLOT.CHR
C      14   PLOT.SYM
C
C     INPUT PARAMETERS (ON I/O UNIT 2)
C     ==================================================================
C     DESCRIPTION OF PLOTTER AND FRAME LAYOUT
C     ------------------------------------------------------------------
C     LINE  COLUMNS  FORMAT  DESCRIPTION
C     ------------------------------------------------------------------
C     CARD  COLUMNS  FORMAT  DESCRIPTION
C     ----  -------  ------  -----------
C       1     1-11    E11.4  LOWER X LIMIT OF PLOTTER
C            12-22    E11.4  UPPER X LIMIT OF PLOTTER
C            23-33    E11.4  LOWER Y LIMIT OF PLOTTER
C            34-44    E11.4  UPPER Y LIMIT OF PLOTTER
C            45-55     I11   NUMBER OF PLOTS PER FRAME IN X DIRECTION
C            56-66     I11   NUMBER OF PLOTS PER FRAME IN Y DIRECTION
C            67-70     F4.2  CHARACTER SIZE MULTIPLIER.
C                            =0 OR 1    = STANDARD CHARACTER SIZE.
C                            =OTHERWISE = SCALE CHARACTER SIZE BY THIS
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C                                         FACTOR.
C                            IF GREATER THAN 2 IT IS SET = 2
C                            IF LESS THAN 1/2 IT IS SET = 1/2
C
C     EXAMPLE DEFINITION OF PLOTTER
C     ----------------------------
C     THE FIRST INPUT LINE DEFINES THE DIMENSIONS OF THE PLOTTER BEING
C     USED IN ANY UNITS (INCHES, CENTIMETERS, MILLIMETERS, ANYTHING)
C     WHICH APPLY TO THE PLOTTER. IN ADDITION THE FIRST LINE DEFINES
C     HOW MANY PLOTS SHOULD APPEAR ON EACH FRAME. THE PLOTTING AREA
C     DEFINED ON THE FIRST INPUT LINE MAY BE SUBDIVIDED INTO ANY NUMBER
C     OF PLOTS IN THE X AND Y DIRECTION. FOR EXAMPLE, TO PRODUCE A
C     SERIES OF FRAMES EACH CONTAINING 3 PLOTS IN THE X DIRECTION AND
C     2 PLOTS IN THE Y DIRECTION (6 PLOTS PER FRAME) COLUMN 45-55 OF
C     THE FIRST INPUT LINE SHOULD BE 3 AND COLUMNS 56-66 SHOULD BE 2.
C
C     IF THE LOCAL PLOTTER USES DIMENSIONS OF INCHES IN ORDER TO OBTAIN
C     10 X 10 INCH FRAMES WITH 3 X 2 PLOTS PER FRAME THE FIRST INPUT
C     LINE SHOULD BE,
C
C       0.0       10.0      0.0     10.0             3          2   0
C
C     IF THE LOCAL PLOTTER USES DIMENSION OF MILLIMETERS THE SAME
C     PHYSICAL SIZE PLOT MAY BE OBTAINED IF THE FIRST INPUT LINE IS,
C
C       0.0      254.0      0.0    254.0             3          2   0
C
C     FOR THE SAME PHYSICAL SIZE AND PLOT LAYOUT AS INDICATED ON THE
C     ABOVE LINE, IF YOU WOULD LIKE THE CHARACTERS TO BE 1.5 TIMES THEIR
C     STANDARD SIZE, YOU NEED MERELY DEFINE COLUMNS 67-70 TO BE 1.5,
C     AS INDICATED BELOW.
C
C       0.0      254.0      0.0    254.0             3          2 1.5
C
C     FOR SIMPLICITY THE FOLLOWING EXAMPLE INPUTS WILL NOT DISCUSS THE
C     PHYSICAL DIMENSIONS OF THE PLOTTER AND THE FIRST INPUT LINE WILL
C     IN ALL CASES INDICATE 10 X 10 INCH PLOTS WITH ONLY 1 PLOT PER
C     FRAME.
C
C     THIS FIRST INPUT CARD IS ALWAYS READ AS THE FIRST LINE OF INPUT
C     PARAMETERS. IT IS POSSIBLE TO RE-CYCLE BACK TO THIS POINT IN
C     THE INPUT TO RE-DEFINE THE LAYOUT OF EACH FRAME AND/OR THE
C     GLOBAL PARAMETERS WHICH FOLLOW (AS DESCRIBED ABOVE).
C
C     GLOBAL PARAMETERS
C     -----------------------------------------------------------------
C     LINE  COLUMNS  FORMAT  DESCRIPTION
C     -----------------------------------------------------------------
C       2     1-11    I11    NUMBER OF CURVES ON EACH PLOT.
C                            = 0        - NO CURVES. IGNORE CURVE FILE.
C                            =+1 TO +30 - FOR EACH PLOT READ 1 TO 30
C                                         CURVES AND PLOT. AFTER PLOT
C                                         READ 1 TO 30 AGAIN AND PLOT.
C                                         CONTINUE READING AND PLOTTING
C                                         UNTIL EITHER ALL CURVE DATA
C                                         OR INPUT PARAMETERS HAVE BEEN
C                                         READ.
C                            =-1 TO -30 - READ 1 TO 30 CURVES ONLY ONCE
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C                                    AND SAVE IN CORE TO ALLOW ANY
C                                    NUMBER OF PLOTS OF THE SAME
C                                    DATA (E.G., OVER DIFFERENT X
C                                    RANGES). CONTINUE PLOTTING
C                                    UNTIL ALL INPUT PARAMETERS
C                                    HAVE BEEN READ. AFTER READING
C                                    THE INITIAL DATA FOR 1 TO 30
C                                    CURVES DO NOT READ ANY MORE
C                                    CURVE DATA.
C                       = OTHER    - TREAT AS INPUT ERROR AND DO
C                                    NOT PLOT ANY CURVE DATA.
C        12-22    I11   NUMBER OF SETS OF POINTS ON EACH PLOT.
C                       = 0        - NO POINTS. IGNORE POINTS FILE.
C                       =+1 TO +30 - FOR EACH PLOT READ 1 TO 30
C                                    SETS AND PLOT. AFTER PLOT
C                                    READ 1 TO 30 AGAIN AND PLOT.
C                                    CONTINUE READING AND PLOTTING
C                                    UNTIL EITHER ALL SETS OF DATA
C                                    OR INPUT PARAMETERS HAVE BEEN
C                                    READ.
C                       =-1 TO -30 - READ 1 TO 30 SETS ONLY ONCE
C                                    AND SAVE IN CORE TO ALLOW ANY
C                                    NUMBER OF PLOTS OF THE SAME
C                                    DATA (E.G., OVER DIFFERENT X
C                                    RANGES). CONTINUE PLOTTING
C                                    UNTIL ALL INPUT PARAMETERS
C                                    HAVE BEEN READ. AFTER READING
C                                    THE INITIAL DATA FOR 1 TO 30
C                                    SETS DO NOT READ ANY MORE
C                                    SETS OF DATA.
C                       = OTHER    - TREAT AS INPUT ERROR AND DO
C                                    NOT PLOT ANY POINT DATA.
C        23-33    I11   SHOULD BORDER BE DRAWN AROUND PLOTS.
C                       = 0 - NO
C                       = 1 - YES
C        34-44    I11   TYPE OF GRID ON PLOTS
C                       (NOTE, DEFINITION CHANGED IN VERSION 90-1)
C                       = 0 - TICK MARKS ON BORDER OF PLOT.
C                       = 1 - DASHED COARSE INTERVALS.
C                       = 2 - SOLID COARSE INTERVALS.
C                       = 3 - DASHED COARSE AND FINE INTERVALS.
C                       = 4 - SOLID COARSE/DASHED FINE INTERVALS.
C                       = 5 - SOLID COARSE AND FINE INTERVALS.
C        45-55    I11   SHOULD RATIO OF ALL DATA TO FIRST CURVE BE
C                       PLOTTED.
C                       = 0 - NO
C                       = 1 - YES (GENERAL RATIO RANGE)
C                       = 2 - YES (10000 % MAXIMUM DIFFERENCES)
C                       = 3 - YES ( 1000 % MAXIMUM DIFFERENCES)
C                       = 4 - YES (  100 % MAXIMUM DIFFERENCES)
C                       = 5 - YES (   10 % MAXIMUM DIFFERENCES)
C                       = 6 - YES (    1 % MAXIMUM DIFFERENCES)
C                       = 7 - YES (  0.1 % MAXIMUM DIFFERENCES)
C        56-66    I11   LINE THICKNESS
C                       = 0       - NORMAL
C                       = 1 TO 5  - ALL LINES EXCEPT GRID
C                       =-1 TO -5 - ONLY CURVES AND POINTS
C                                   (NO THICK CHARACTERS)
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C          67-70     I4    MASTER CURVE INDEX (THIS CURVE WILL BE
C                          PLOTTED AS A THICK (THICKNESS=3), SOLID
C                          CURVE). ZERO INDICATES NO MASTER CURVE.
C       3    1-40   40A1    X LABEL LABEL, E.G. INCIDENT ENERGY
C          41-72   32A1    X LABEL UNITS, E.G. EV
C                          (NOTE, ON THE PLOT THE PROGRAM WILL PLOT
C                          PARENTHESIS AROUND THE UNITS, AS SUCH THE
C                          UNITS AS INPUT NEED NOT INCLUDE A SET OF
C                          ENCLOSING PARENTHESIS).
C       4    1-40   40A1    Y LABEL LABEL, E.G. CROSS SECTION
C          41-72   32A1    Y LABEL UNITS, E.G. BARNS
C                          (NOTE, ON THE PLOT THE PROGRAM WILL PLOT
C                          PARENTHESIS AROUND THE UNITS, AS SUCH THE
C                          UNITS AS INPUT NEED NOT INCLUDE A SET OF
C                          ENCLOSING PARENTHESIS).
C
C     THE ABOVE 3 LINES ARE LINES 2 - 4  OF INPUT AND IF THE USER
C     WISHES TO USE THE SAME GLOBAL PARAMETERS FOR ALL PLOTS THESE 3
C     LINES WILL ONLY BE READ ONCE (NOT FOR EACH PLOT).
C
C     IF THE USER WISHES TO CHANGE THE GLOBAL PARAMETERS IN THE MIDDLE
C     OF A RUN THE FIRST LINE OF THE PLOT PARAMETERS, DESCRIBED BELOW,
C     SHOULD BE BLANK (AS DESCRIBED ABOVE).
C
C     NOTE, ONLY A COMBINATION OF UP TO 30 CURVES AND SETS OF POINTS
C     MAY BE READ AND PLOTTED ON THE SAME PLOT. THE USER MAY REQUEST
C     MORE THAN THIS NUMBER BUT THE PROGRAM WILL ONLY READ AND PLOT UP
C     TO 30 (E.G., IF IT FIRST READS 17 CURVES IT WILL ONLY READ UP TO
C     13 SETS OF POINTS).
C
C     PLOT PARAMETERS
C     ---------------------------------------------------------------
C     LINE  COLUMNS  FORMAT  DESCRIPTION
C     ---------------------------------------------------------------
C       5    1-72    72A1   FIRST LINE OF TITLE (FOR TOP OF PLOT)
C                          IF THIS LINE IS BLANK THE PROGRAM WILL
C                          ASSUME THAT THE 4 LINES FOLLOWING THIS ONE
C                          ARE A RE-DEFINITION OF THE PLOTTER AND
C                          GLOBAL PARAMETERS (DESCRIBED ABOVE).
C       6    1-72    72A1   SECOND LINE OF TITLE (FOR TOP OF PLOT)
C       7    1-11    E11.4  MINIMUM X LIMIT OF PLOT (BLANK INDICATES NO
C                          LIMIT = USE MINIMUM X VALUE OF DATA).
C          12-22    E11.4  MAXIMUM X LIMIT OF PLOT (BLANK INDICATES NO
C                          LIMIT = USE MAXIMUM X VALUE OF DATA).
C          23-33     I11   SHOULD X ERROR BARS BE PLOTTED.
C                          = 0 - NO
C                          = 1 - YES
C          34-44     I11   X AXIS SCALING
C                          = 0 - AUTOMATIC
C                          = 1 - LINEAR SCALING AND INTERPOLATION
C                          = 2 - LOG SCALING AND LINEAR INTERPOLATION
C                          =-1 - LINEAR SCALING AND INTERPOLATION
C                                (IDENTICAL TO +1)
C                          =-2 - LOG SCALING AND INTERPOLATION
C          45-55     I11   SHOULD X LIMITS BE ROUNDED OUTWARD TO AVOID
C                          TOUCHING EDGE OF PLOT
C                          = 0 - YES
C                          = 1 - NO
```

```
C                            = 2 - ONLY ROUND BOTTOM
C                            = 3 - ONLY ROUND TOP
C            56-66     I11   OMIT LEGEND BOX FROM PLOT
C                            = 0 - NO - LEGEND BOX WILL APPEAR ON PLOT
C                            = 1 - YES - NO LEGEND BOX ON PLOT
C       8     1-11    E11.4  MINIMUM Y LIMIT OF PLOT (BLANK INDICATES NO
C                            LIMIT = USE MINIMUM Y VALUE OF DATA).
C            12-22    E11.4  MAXIMUM Y LIMIT OF PLOT (BLANK INDICATES NO
C                            LIMIT = USE MAXIMUM Y VALUE OF DATA).
C            23-33     I11   SHOULD Y ERROR BARS BE PLOTTED.
C                            = 0 - NO
C                            = 1 - YES
C            34-44     I11   Y AXIS SCALING
C                            = 0 - AUTOMATIC
C                            = 1 - LINEAR SCALING AND INTERPOLATION
C                            = 2 - LOG SCALING AND LINEAR INTERPOLATION
C                            =-1 - LINEAR SCALING AND INTERPOLATION
C                                  (IDENTICAL TO +1)
C                            =-2 - LOG SCALING AND INTERPOLATION
C            45-55     I11   SHOULD Y LIMITS BE ROUNDED OUTWARD TO AVOID
C                            TOUCHING EDGE OF PLOT
C                            = 0 - YES
C                            = 1 - NO
C                            = 2 - ONLY ROUND BOTTOM
C                            = 3 - ONLY ROUND TOP
C            56-66     I11   SHOW DATA POINTS
C                            = 0 - NO
C                            = 1 - YES
C
C      WARNING - DO NOT USE THE SHOW DATA POINTS OPTIONS IF YOU HAVE MANY
C      POINTS ON A PLOT, E.G., MORE THAN A FEW HUNDRED. THIS OPTION WILL
C      WORK WITH ANY NUMBER OF POINTS, BUT IF THERE ARE TOO MANY POINTS
C      YOU MAY NOT BE ABLE TO SEE CURVES BETWEEN POINTS. THE PROPER WAY
C      TO USE THIS OPTION IS TO RESTRICT THE X, Y RANGE OF THE PLOT TO
C      INSURE THAT NOT TOO MANY POINTS WILL APPEAR ON THE PLOT.
C
C      NOTE, INPUT LINES 7 AND 8 ARE ALMOST IDENTICAL EXCEPT THAT LINE 7
C      APPLIES TO THE X AXIS AND LINE 8 TO THE Y AXIS.
C
C      NOTE, ONE SIDED LIMITS MAY BE SPECIFIED FOR X AND/OR Y, E.G.,
C      FOR X LIMITS BETWEEN 5.0 AND THE UPPER X LIMIT OF THE DATA
C      MERELY SPECIFY THE MINIMUM X LIMIT TO BE 5.0 AND LEAVE THE
C      MAXIMUM LIMIT BLANK (NOT 0.0). SIMILARLY FOR X BETWEEN THE
C      LOWER X LIMIT OF THE DATA AND 12.0 MERELY LEAVE THE MINIMUM
C      LIMIT BLANK (NOT 0.0) AND SPECIFY THE MAXIMUM X LIMIT TO BE
C      12.0. THE Y LIMITS CAN BE TREATED IN A SIMILAR MANNER.
C
C      NOTE, THE X AND Y SCALING CONTROL BOTH THE PLANE IN WHICH THE
C      PLOT IS PRESENTED (LINEAR OR LOG X AND Y SCALING) AND HOW THE
C      DATA IS INTERPOLATED INTO THIS PLANE.
C
C      THE ABOVE 4 LINES ARE READ FOR EACH PLOT. PROGRAM EXECUTION
C      TERMINATES AT THE END OF INPUT.
C
C      NOTE, REGARDLESS OF WHETHER OR NOT THE POINTS INCLUDE UNCERTAINTY
C      (+DX,-DX,+DY,-DY) COLUMNS 23-33 OF LINES 7 AND 8 CONTROL WHETHER
C      OR NOT THE X AND Y UNCERTAINTY IS CONSIDERED IN SCALING THE PLOT
C      AND WHETHER OR NOT ERROR BARS WILL APPEAR ON THE PLOT.
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C
C     GROUPING DATA ON PLOTS
C     ================================================================
C     BY USING INPUT OPTIONS THE USER HAS CONTROL OVER HOW MANY SETS OF
C     CURVES AND/OR POINTS WILL APPEAR ON EACH PLOT. ON THE GLOBAL INPUT
C     LINE COLUMNS 1-11 CONTROL HOW CURVES SHOULD APPEAR ON EACH PLOT
C     AND COLUMNS 12-22 CONTROL HOW POINTS SHOULD APPEAR ON EACH PLOT.
C     THESE OPTIONS CONTROL HOW MANY SETS (IF ANY) OF A GIVEN TYPE OF
C     DATA (CURVES OR POINTS) WILL BE READ OR KEPT IN CORE FOR THE NEXT
C     PLOT. THE AVAILABLE OPTIONS ARE,
C
C     (LESS THAN -30 OR MORE THAN +30)
C     ----------------------------------------------------------------
C     IS TREATED AS AS AN ERROR, NO DATA IS READ (I.E., IT IS TREATED
C     AS 0, AS DESCRIBED BELOW).
C
C     (0)
C     ----------------------------------------------------------------
C         DATA IS NOT TO BE READ OR APPEAR ON PLOT. WHEN YOU WISH TO
C         PLOT ONE TYPE OF DATA (CURVES OR POINTS) THIS OPTION SHOULD
C         BE SPECIFIED FOR THE OTHER TYPE OF DATA. YOU CANNOT SPECIFY
C         THIS OPTION FOR BOTH TYPES OF DATA. IF YOU DO THE PROGRAM WILL
C         SIMPLY TELL YOU THAT YOU ARE NOT REQUESTING ANY PLOTS AND
C         TERMINATE. E.G., IF YOU WISH TO ONLY PLOT CURVES SPECIFY THIS
C         OPTION FOR POINTS (COLUMNS 12-22 = 0).
C
C     (+1 TO +30)
C     ----------------------------------------------------------------
C         FOR THE NEXT PLOT READ 1 TO 30 SETS OF DATA (POINTS OR CURVES)
C         AND USE THEM ONLY FOR THE NEXT PLOT. THIS OPTION MAY BE USED
C         WHEN YOU WISH TO CREATE A SERIES OF PLOTS EACH CONTAINING 1 TO
C         30 SETS OF A TYPE OF DATA (POINTS OR CURVES) PLUS ANY NUMBER
C         (0 TO 30) OF SETS OF THE OTHER TYPE OF DATA. NOTE, THE SETS OF
C         DATA WILL ONLY APPEAR ON ONE PLOT, SO THAT YOU CANNOT FIRST
C         SPECIFY THE ENTIRE X RANGE FOR ONE PLOT AND THEN SPECIFY A
C         MINIMUM AND MAXIMUM RANGE FOR A SECOND PLOT. E.G., IF YOU WISH
C         TO CREATE A SERIES OF PLOTS EACH CONTAINING 5 CURVES SPECIFY
C         THIS OPTION FOR CURVES (COLUMNS 1-11 = 5).
C
C     (-1 TO -30)
C     ----------------------------------------------------------------
C         READ 1 TO 30 SETS OF DATA (POINTS OR CURVES) AND USE THEM ON
C         ALL PLOTS. AFTER THE INITIAL READ NO MORE DATA (POINTS OR
C         CURVES) WILL BE READ. THIS OPTION MAY BE USED IF YOU WISH TO
C         CREATE A SERIES OF PLOTS EACH CONTAINING ALL OR THE FIRST 1 TO
C         30 SETS OF DATA OF A GIVEN TYPE (POINTS OR CURVES). NOTE,
C         IN THIS CASE YOU MAY FIRST PLOT THE ENTIRE X RANGE AND THEN
C         SPECIFY MINIMUM AND MAXIMUM RANGES FOR ANY NUMBER OF FOLLOWING
C         PLOTS. E.G., IF YOU WISH TO A CREATE A SERIES OF PLOTS EACH
C         CONTAINING 15 CURVES AND EACH INVOLVING A DIFFERENT X RANGES
C         SPECIFY THIS OPTION FOR CURVES (COLUMNS 1-11 =-15).
C
C     IF YOU WISH TO CREATE A SERIES OF PLOTS CONTAINING A DIFFERENT
C     NUMBER OF CURVES AND OR POINTS YOU MAY RE-DEFINE THE GLOBAL
C     PARAMETERS, AS DESCRIBED ABOVE, IN THE MIDDLE OF A RUN TO PLOT
C     ALMOST ANY COMBINATION OF CURVES AND/OR POINTS ON A SERIES OF
C     PLOTS.
C
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C      IN ORDER TO CREATE OTHER COMBINATIONS OF CURVES AND PLOTS IT IS
C      USUALLY EASIER TO EDIT YOUR CURVE AND POINT FILES TO CONTAIN THE
C      THE DATA TO APPEAR ON THE PLOTS THAN TO INCLUDE MORE INPUT OPTIONS
C      IN THIS PROGRAM. E.G., IF YOU HAVE A SERIES OF CURVES AND YOU WISH
C      TO PLOT EACH SEPARATELY, BUT YOU WOULD LIKE A SERIES OF PLOTS OF
C      DIFFERENT X RANGES FOR EACH CURVE, CREATE A NUMBER OF CURVE FILES
C      EACH CONTAINING ONLY ONE CURVE AND RUN EACH FILE SEPARATELY WITH
C      COLUMNS 1-11 = -1.
C
C      FOR VERSION 88-1 AND LATER VERSIONS THE ABOVE SERIES OF PLOTS MAY
C      BE CREATED BY RE-DEFINING THE GLOBAL PARAMETERS IN THE MIDDLE OF
C      A RUN. FOR EACH OF THE SERIES OF CURVES USE GLOBAL PARAMETERS
C      WITH COLUMNS 1-11 = -1, TO FORCE THE NEXT CURVE TO BE READ AND
C      KEPT IN CORE TO ALLOW A NUMBER OF DIFFERENT X RANGES TO BY PLOTTED
C      SEPERATELY. WHEN ALL RANGES HAVE BEEN PLOTTED INSERT A BLANK LINE
C      IN THE INPUT, FOLLOWED BY 3 LINES RE-DEFINING GLOBAL PARAMETERS
C      WITH COLUMNS 1-11 = -1 TO FORCE THE NEXT CURVE TO BE READ AND
C      KEPT IN CORE WHILE DIFFERENT X RANGES ARE PLOTTED. THIS CYCLE OF
C      RE-DEFINING GLOBAL PARAMETERS FOLLOWED BY A SERIES OF PLOTS MAY
C      BE REPEATED ANY NUMBER OF TIMES DURING A RUN.
C
C      COMPOSITION MODE
C      ================================================================
C      IT IS POSSIBLE TO USE THIS CODE TO COMPOSE FRAMES WITH ANY NUMBER
C      OF PLOTS APPEARING ANYWHERE ON EACH FRAME. THIS COMPOSITION MODE
C      SHOULD ONLY TO USED TO POSITION ONE PLOT AT A TIME ON THE FRAME
C      AND THEN RE-CYCLE BACK TO THE PLOTTER PARAMETERS (AS DESCRIBED
C      ABOVE) TO POSITION THE NEXT PLOT ON THE SAME FRAME. THIS MODE IS
C      TURNED ON BY SPECIFYING A -1 FOR THE NUMBER OF PLOTS IN THE X
C      DIRECTION ON THE PLOTTER PARAMETER LINE. THIS -1 MERELY INDICATES
C      TO THE PROGRAM NOT TO ADVANCE TO THE NEXT PLOTTING AREA OR FRAME
C      AT THE END OF THE CURRENT PLOT. THE USER CAN THEN USE THE X AND
C      Y DIMENSIONS OF THE PLOTTER TO SPECIFY WHERE THIS PLOT SHOULD
C      APPEAR ON THE FRAME, E.G., FOR A PLOT LOCATED BETWEEN X = 3.0
C      AND 7.0 AND Y = 2.0 AND 8.0, MERELY SPECIFY THESE X AND Y LIMITS
C      AS THE LIMIT OF THE PLOTTER ON THE PLOTTER PARAMETER LINE.
C
C      IN THIS MODE YOU HAVE COMPLETE FREEDOM TO COMPOSE FRAMES, BUT
C      YOU HAVE THE RESPONSIBILITY TO EXACTLY DEFINE WHERE YOU WANT
C      EACH PLOT POSITIONED. COMPOSITION CAN USUALLY BE DONE QUITE
C      QUICKLY USING A COMPUTER TERMINAL SCREEN. ONCE THE INPUT
C      CORRECTLY DEFINES THE COMPOSED FRAME YOU CAN THEN USE THIS
C      INPUT TO PRODUCE A HARD COPY PLOT.
C
C      AGAIN, WARNING...THIS MODE SHOULD ONLY TO USED TO POSITION ONE
C      PLOT AT A TIME ONTO A FRAME AND YOU SHOULD THEN USE THE PROPER
C      SEQUENCE OF INPUT TO RE-CYCLE BACK TO RE-DEFINE THE PLOTTER
C      AND GLOBAL PARAMETERS...FAILURE TO HEED THIS WARNING MAY PRODUCE
C      UNPREDICTABLE RESULTS.
C
C      IN ORDER TO STAY IN THE COMPOSITION MODE FOR A SERIES OF PLOTS
C      THE USER SHOULD CONTINUE TO SPECIFY -1 FOR THE NUMBER OF PLOTS
C      IN THE X DIRECTION (DO NOT ADVANCE AFTER PLOT). FOR THE LAST PLOT
C      OF A COMPOSED FRAME SPECIFY 1 FOR THE NUMBER OF PLOTS IN THE X
C      DIRECTION (LEAVE COMPOSITION MODE AND ADVANCE AFTER PLOT).
C      REMEMBER, TO LEAVE THE COMPOSITION MODE AND ADVANCE TO THE NEXT
C      FRAME THE LAST PLOT ON A FRAME MUST SPECIFY +1 FOR THE NUMBER OF
C      PLOTS IN THE X DIRECTION - IF YOU CREATE A NUMBER OF PLOTS ON A
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C      FRAME AND THEN FINISH EXECUTING WITHOUT ADVANCING TO THE NEXT
C      FRAME, DEPENDING ON THE PLOTTING SYSTEM THAT YOU USE, YOU MAY
C      NOT GET ANY OUTPUT PLOTTING, I.E., YOU DIDN'T FINISH THE PLOT.
C
C      ONE SPECIAL CONVENTION HAS BEEN INTRODUCED FOR USE WITH THE
C      COMPOSITION MODE - THE MOST USEFUL PURPOSE OF THIS MODE IS TO
C      ALLOW A FULL SIZED PLOT OF THE FULL X AND Y RANGE AND THEN TO
C      INSERT ONTO THIS FRAME ONE OR MORE EXPANDED VIEWS OF SPECIFIC
C      X AND Y RANGES - IN ORDER TO ALLOW THIS TO BE DONE THE PROGRAM
C      MUST KEEP THE SAME CURVES AND/OR POINTS IN CORE AS YOU MOVE
C      FROM ONE PLOT OF THE COMPOSITION TO THE NEXT - NORMALLY WHEN
C      THE PROGRAM READS THE GLOBAL PARAMETERS IT IS TOLD HOW MANY
C      CURVES AND/OR POINTS TO READ FOR THE NEXT PLOT - WHEN IN
C      COMPOSITION MODE FOR THE FIRST PLOT OF A FRAME THIS IS WHAT
C      THE CODE WILL DO - BUT IF YOU USE A MINUS COUNT FOR THE
C      NUMBER OF CURVES AND/OR SETS OF POINTS (SEE, DESCRIPTION OF
C      INPUT PARAMETERS ABOVE) YOU ARE TELLING THE CODE TO READ
C      AND KEEP THIS DATA IN CORE - IF SUCCESSIVE PLOTS FOR THE
C      SAME COMPOSITION FRAME ALSO SPECIFY A MINUS COUNT THE CODE
C      WILL NOT READ AND SAVE MORE DATA - IT WILL ASSUME THAT
C      WHAT YOU MEAN IS USE THE DATA ALREADY IN CORE, I.E., THE
C      DATA WHICH APPEARED ON THE LAST PLOT.
C
C      PLOTTING RATIOS
C      ================================================================
C      WHICHEVER DATA IS REQUESTED (CURVES AND/OR POINTS) WILL ALWAYS BE
C      PLOTTED. WHEN PLOTTING CURVES THE USER HAS THE OPTION TO USE THE
C      FIRST CURVE AS A STANDARD AND TO PLOT NOT ONLY THE DATA (UPPER 2/3
C      OF PLOT), BUT ALSO THE RATIO OF ALL CURVES AND/OR DATA POINTS TO
C      THE STANDARD (LOWER 1/3 OF PLOT). THIS OPTION IS EXTREMELY HANDY
C      WHEN YOU WOULD LIKE TO QUANTITATIVELY DEFINE THE AGREEMENT BETWEEN
C      CURVES AND/OR POINTS (E.G., IT IS EASY TO SEE FROM THE PLOT THAT
C      2 CURVES DIFFER BY 15 PER-CENT).
C
C      IF YOU WISH TO CHANGE THE STANDARD TO WHICH ALL OTHER DATA IS TO
C      BE COMPARED SIMPLY MOVE THE DATA THAT YOU WISH TO BE USED AS A
C      STANDARD TO THE BEGINNING OF THE CURVE FILE TO BE THE FIRST CURVE.
C
C      ALL OF THE FOLLOWING EXAMPLE INPUTS ASSUME A STANDARD 13.5 BY 10
C      SIZE FOR THE PLOTTER AND 1 BY 1 (FULL SIZE) PLOTS PER FRAME, AS
C      DEFINED BY THE BELOW INPUT, AND WILL NOT BE DISCUSSED FOR EACH
C      EXAMPLE INPUT.
C
C      EXAMPLE NO. 1 UNIT 2 INPUT
C      ----------------------------------------------------------------
C      IF WE HAVE EVALUATED DATA FOR 27-CO-59 (N,2N) FROM 3 DIFFERENT
C      EVALUATED DATA LIBRARIES (ASSUME ENDF/B-V, ENDL AND JENDL-2) AND
C      EXPERIMENTAL DATA FROM A NUMBER OF MEASUREMENTS WE CAN PUT THE
C      EVALUATED DATA ON THE CURVE FILE AS 3 SEPARATE CURVES IDENTIFYING
C      EACH BY LIBRARY NAME AND THE EXPERIMENTAL DATA ON THE POINT FILE
C      IDENTIFYING EACH BY FIRST AUTHOR AND YEAR.
C
C      TO CREATE SEPARATE PLOTS OF EACH EVALUATION, EACH PLOT CONTAINING
C      ONE EVALUATION AND ALL EXPERIMENTAL DATA WE CAN SPECIFY 1 CURVE
C      (READ AND PLOT 1 CURVE PER PLOT) AND -30 SETS OF POINTS (READ ONCE
C      AND INCLUDE ON ALL PLOTS). THE FOLLOWING INPUT WILL CREATE 3 FULL
C      SIZED PLOTS WITH TICKS MARKS ON THE BORDER, NO RATIOS AND LINE
C      THICKNESS 0. X AND Y ERRORS FOR EXPERIMENTAL DATA (IF ANY) WILL BE
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C     PLOTTED ON THE FIRST 2 PLOTS BUT WILL NOT APPEAR ON THE 3-RD PLOT.
C     NOTE, IN THIS EXAMPLE THE BELOW INPUT IS USED TO IDENTIFY THE
C     TARGET (27-CO-59) AND REACTION (N,2N) (FOR CONTRAST SEE EXAMPLE
C     INPUT NO. 3).
C
C             0.0       13.5        0.0       10.0          1          1
C               1        -30          0          0          0          0
C     INCIDENT ENERGY                         EV
C     CROSS SECTION                           BARNS
C     27-CO-59                                                 (N,2N)
C     CROSS SECTIONS
C                                     1          0          0
C                                     1          0          0
C     27-CO-59                                                 (N,2N)
C     CROSS SECTIONS
C                                     1          0          0
C                                     1          0          0
C     27-CO-59                                                 (N,2N)
C     CROSS SECTIONS
C                                     0          0          0
C                                     0          0          0
C
C     NOTE, TO OBTAIN A PLOT OF EACH EVALUATION SEPARATELY WITHOUT
C     EXPERIMENTAL DATA ONE CAN CHANGE COLUMNS 12-22 OF THE 2-ND INPUT
C     LINE FROM -30 TO 0 AND USE THE ABOVE INPUT.
C
C     EXAMPLE NO. 2 UNIT 2 INPUT
C     ---------------------------------------------------------------------
C     ASSUMING WE HAVE ALL OF THE DATA DESCRIBED IN EXAMPLE NO. 1 AND
C     WE WOULD LIKE TO CREATE PLOTS CONTAINING ALL EVALUATED AND
C     EXPERIMENTAL DATA AND THE RATIO OF ALL EVALUATED AND EXPERIMENTAL
C     DATA TO THE FIRST EVALUATION. TO DO THIS SPECIFY -30 FOR BOTH
C     CURVES AND POINTS (READ ONCE AND INCLUDE ON ALL PLOTS). IF WE
C     WOULD LIKE TO OBTAIN 2 PLOTS, ONE FOR THE ENTIRE ENERGY RANGE AND
C     A SECOND FROM 10 TO 20 MEV (ASSUMING DATA IS GIVEN IN EV) THE
C     FOLLOWING INPUT CARDS WILL CREATE 2 FULL SIZED PLOTS WITH A
C     DASHED GRID, RATIOS AND LINE THICKNESS 3. X AND Y ERRORS (IF ANY)
C     WILL BE INCLUDED ON BOTH PLOTS. THE PLANE OF THE PLOT (LINEAR OR
C     LOG IN X OR Y) WILL BE AUTOMATICALLY SELECTED FOR THE FIRST PLOT.
C     THE SECOND PLOT WILL BE LOG IN X AND LINEAR Y WITH THE LOWER Y
C     LIMIT OF ZERO. THE Y LIMITS WILL NOT BE ROUNDED OUTWARD, SO THE
C     LOWER Y LIMIT OF THE PLOT WILL BE EXACTLY ZERO.
C
C             0.0       13.5        0.0       10.0          1          1
C             -30        -30          0          2          1          3
C     INCIDENT ENERGY                         EV
C     CROSS SECTION                           BARNS
C     27-CO-59                                                 (N,2N)
C     CROSS SECTIONS
C                                     1          0          0
C                                     1          0          0
C     27-CO-59                                                 (N,2N)
C     CROSS SECTIONS
C      1.00000+07 2.00000+07          1          2          0
C      0.0                            1          1          1
C
C     NOTE, TO OBTAIN PLOTS OF ALL EVALUATIONS TOGETHER WITHOUT
C     EXPERIMENTAL DATA ONE CAN CHANGE COLUMNS 12-22 OF THE 2-ND INPUT
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C     LINE FROM -30 TO 0 AND USE THE ABOVE INPUT.
C
C     NOTE, IF YOU WOULD LIKE THE EXPERIMENTAL DATA TO ONLY APPEAR ON
C     THE FIRST PLOT CHANGE COLUMNS 12-22 OF THE FIRST INPUT LINE FROM
C     -30 TO 30 (ASSUMING THERE ARE 30 OR FEWER SETS OF EXPERIMENTAL
C     DATA). SIMILARLY TO HAVE THE FIRST 6 EXPERIMENTAL REFERENCES
C     APPEAR ON THE FIRST PLOT AND THE NEXT 6 ON THE SECOND PLOT CHANGE
C     COLUMNS 12-22 OF THE FIRST INPUT LINE FROM -30 TO 6.
C
C     EXAMPLE NO. 3 UNIT 2 INPUT
C     ----------------------------------------------------------------
C     IF WE HAVE THE ENDF/B-V 27-CO-59 (N,N'), (N,2N) AND (N,3N) DATA
C     WE CAN PUT THE DATA ON THE CURVE FILE AND IDENTIFY EACH BY THE
C     REACTION (AS OPPOSED TO LIBRARY NAME AS IN EXAMPLE NO. 1). TO
C     PLOT ALL 3 REACTIONS AND THE RATIO OF ALL REACTIONS TO THE (N,N')
C     OVER THE ENTIRE ENERGY RANGE AND THEN OVER 10 TO 20 MEV THE
C     FOLLOWING INPUT MAY BE USED. NOTE, IN THIS EXAMPLE THE BELOW
C     INPUT IS USED TO IDENTIFY THE TARGET AND LIBRARY NAME (AS OPPOSED
C     TO THE REACTION AS IN EXAMPLE NO. 1).
C
C             0.0       13.5        0.0       10.0          1          1
C              -3          0          0          0          1          3
C     INCIDENT ENERGY                       EV
C     CROSS SECTION                         BARNS
C     27-CO-59                                              ENDF/B-V
C     CROSS SECTIONS
C                                 0          0          0
C                                 0          0          0
C     27-CO-59                                              ENDF/B-V
C     CROSS SECTIONS
C      1.00000+ 7 2.00000+ 7      0          0          0
C                                 0          0          0
C
C     NOTE, TO OBTAIN PLOTS ONLY COMPARING (N,N') AND (N,2N) (I.E.,
C     IGNORE (N,3N)) ONE CAN CHANGE COLUMNS 1-11 OF THE FIRST INPUT
C     LINE FROM -3 TO -2 AND USE THE ABOVE INPUT.
C
C     EXAMPLE NO. 4 UNIT 2 INPUT
C     ----------------------------------------------------------------
C     IF WE HAVE PHOTON INTERACTION DATA FOR THE ENTIRE PERIODIC TABLE
C     WITH 5 CURVES FOR EACH ELEMENT (TOTAL, COHERENT, INCOHERENT,
C     PHOTOELECTRIC AND PAIR PRODUCTION) WE CAN PUT THE DATA ON THE
C     CURVE FILE IN ELEMENT ORDER (I.E., HYDROGEN FIRST) AND IDENTIFY
C     EACH CURVE BY REACTION. TO OBTAIN A SERIES OF PLOTS 1 FOR EACH
C     ELEMENT THE FOLLOWING INPUT MAY BE USED.
C
C             0.0       13.5        0.0       10.0          1          1
C               5          0          0          0          1          0
C     INCIDENT ENERGY                       MEV
C     CROSS SECTION                         BARNS
C     HYDROGEN                                              ENDL
C     PHOTON INTERACTION CROSS SECTIONS
C                                 0          0          0
C                                 0          0          0
C     HELIUM                                                ENDL
C     PHOTON INTERACTION CROSS SECTIONS
C                                 0          0          0
C                                 0          0          0
```

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C     LITHIUM                                              ENDL
C     PHOTON INTERACTION CROSS SECTIONS
C                                 0          0          0
C                                 0          0          0
C                .                .          .          .
C                .                .          .          .
C                .                .          .          .
C     (3 LINES FOR EACH ELEMENT TO THE END OF THE PERIODIC TABLE)
C
C     EXAMPLE NO. 5 UNIT 2 INPUT
C     -----------------------------------------------------------------------
C     ASSUMING WE HAVE ALL OF THE DATA DESCRIBED IN EXAMPLE NO. 3, BUT
C     WE ONLY HAVE EXPERIMENTAL DATA FOR (N,3N) AND WE WOULD LIKE TO
C     PLOT (N,N') AND (N,2N) SEPARATELY WITHOUT EXPERIMENTAL DATA AND
C     THEN WE WOULD LIKE TO PLOT (N,3N) COMPARED TO EXPERIMENTAL DATA
C     OVER THE ENTIRE ENERGY RANGE FOLLOWED BY A PLOT OF 10 TO 20 MEV
C     WE MAY USE THE FOLLOWING INPUT TO RE-DEFINE THE GLOBAL PARAMETERS
C     AFTER THE FIRST TWO PLOTS TO OBTAIN THE DESIRED PLOTS.
C
C             0.0       13.5        0.0       10.0          1          1
C               1          0          0          0          1          0
C     INCIDENT ENERGY                         EV
C     CROSS SECTION                           BARNS
C     27-CO-59                                              ENDF/B-V
C     CROSS SECTIONS
C                                 1          0          0
C                                 1          0          0
C     27-CO-59                                              ENDF/B-V
C     CROSS SECTIONS
C                                 1          0          0
C                                 1          0          0
C     (IF THIS LINE IS BLANK NEXT 4 LINES = PLOTTER/GLOBAL PARAMETERS)
C             0.0       13.5        0.0       10.0          1          1
C              -1        -30          0          0          1          0
C     INCIDENT ENERGY                         EV
C     CROSS SECTION                           BARNS
C     27-CO-59                                              ENDF/B-V
C     CROSS SECTIONS
C                                 1          0          0
C                                 1          0          0
C     27-CO-59                                              ENDF/B-V
C     CROSS SECTIONS
C      1.00000+ 7 2.00000+ 7      1          0          0
C                                 1          0          0
C
C     CURVE DATA (ON I/O UNIT 10)
C     =======================================================================
C     LINE  COLUMNS  FORMAT  DESCRIPTION
C     -----------------------------------------------------------------------
C       1     1-26    26A1   TITLE FOR CURVE
C     2-N     1-11   E11.4   X VALUE
C            12-22   E11.4   Y VALUE
C
C     EACH CURVE IS TERMINATED BY BLANK (NOT 0.0). THE SEQUENCE OF
C     TITLE FOLLOWED BY TABULATED POINTS MAY BE REPEATED ANY NUMBER OF
C     TIMES. THE CURVE FILE MAY CONTAIN DATA FOR ANY NUMBER OF CURVES
C     AND ANY NUMBER OF DATA POINTS. EACH PLOT MAY CONTAIN UP TO 200000
C     POINTS (IF MORE ARE PRESENT ONLY THE FIRST 200000 WILL BE USED).
```

```
C
C     EXAMPLE  UNIT 10 INPUT
C     -----------------------------------------------------------------
C     IF UNIT 10 CONTAINS THE 27-CO-59 (N,2N) EVALUATIONS FROM ENDF/B-IV
C     JENDL-II AND ENDL84 THE DATA COULD LOOK LIKE,
C
C     ENDF/B-IV                                      27-CO-59 (N,2N)
C      1.10000+ 7 0.00000+ 0
C      1.20000+ 7 1.20000- 3
C          .          .
C          .          .
C      2.00000+ 7 3.00000- 2
C                                (NOTE, BLANK CARD TERMINATES CURVE).
C     JENDL-II                                       27-CO-59 (N,2N)
C      1.07000+ 7 0.00000+ 0
C      1.16000+ 7 1.13000- 3
C          .          .
C          .          .
C      2.00000+ 7 2.80000- 2
C                                (NOTE, BLANK CARD TERMINATES CURVE).
C     ENDL84                                        27-CO-59 (N,2N)
C      1.12000+ 7 0.00000+ 0
C      1.22000+ 7 1.27000- 3
C          .          .
C          .          .
C      2.00000+ 7 2.90000- 2
C                                (NOTE, BLANK CARD TERMINATES CURVE).
C
C     NOTE, FOR IDENTIFICATION ON EACH PLOT THE PROGRAM WILL ONLY READ
C     AND USE THE FIRST 40 CHARACTERS OF THE TITLE. THE USER MAY USE
C     THE REMAINDER OF THE TITLE LINE TO FURTHER PHYSICALLY IDENTIFY
C     THE DATA (AS IN THE ABOVE EXAMPLE WHERE THE DATA IS FURTHER
C     IDENTIFIED AS 27-CO-59 (N,2N)).
C
C     NOTE, THE ABOVE DATA IS FOR ILLUSTRATION PURPOSES ONLY AND DOES
C     NOT CORRESPOND TO THE ACTUAL DATA FROM THESE EVALUATED LIBRARIES.
C
C     POINT DATA (ON I/O UNIT 11)
C     =================================================================
C     LINE  COLUMNS  FORMAT  DESCRIPTION
C     -----------------------------------------------------------------
C       1     1-26    26A1   TITLE FOR CURVE
C     2-N     1-11   E11.4   X VALUE
C            12-22   E11.4   POSITIVE X UNCERTAINTY
C            23-33   E11.4   NEGATIVE X UNCERTAINTY
C            34-44   E11.4   Y VALUE
C            45-55   E11.4   POSITIVE Y UNCERTAINTY
C            55-66   E11.4   NEGATIVE Y UNCERTAINTY
C
C     EACH SET OF POINTS IS TERMINATED BY BLANK (NOT 0.0). THE SEQUENCE
C     TITLE FOLLOWED BY TABULATED POINTS MAY BE REPEATED ANY NUMBER OF
C     TIMES. THE POINT FILE MAY CONTAIN DATA FOR ANY NUMBER OF SETS
C     AND ANY NUMBER OF DATA POINTS. EACH PLOT MAY CONTAIN UP TO 100000
C     POINTS (IF MORE ARE PRESENT ONLY THE FIRST 100000 WILL BE USED).
C
C     UNCERTAINTIES
C     -----------------------------------------------------------------
C     UNCERTAINTIES MUST BE IN THE SAME UNITS AS THE DATA (E.G., EV OR
```

```
C     BARNS). THE UNCERTAINTIES WILL BE INTERPRETED TO DEFINE THE ERROR
C     BARS RELATIVE TO THE DATA POINT. THE ERROR BARS FOR A POINT WILL
C     EXTEND FROM THE POINT MINUS THE NEGATIVE ERROR TO THE POINT PLUS
C     THE POSITIVE ERROR (E.G., 10 BARNS +/- 2 BARNS DEFINES AN ERROR
C     BAR FROM 8 TO 12 BARNS). NEVER TRY TO USE THE UNCERTAINTIES TO
C     DIRECTLY DEFINE THE ERROR BARS (E.G., IN THE ABOVE EXAMPLE YOU
C     CANNOT DEFINE THE UNCERTAINTIES AS 8 AND 12 BARNS). NEVER SPECIFY
C     ERRORS IN PER-CENT (E.G., 10 BARNS +/- 5 PER-CENT WILL BE TREATED
C     AS 10 BARNS +/- 5 BARNS, SINCE THE PROGRAM KNOWS NOTHING ABOUT THE
C     REAL UNITS OF THE DATA).
C
C     THE UNCERTAINTIES CAN BE SYMMETRIC OR NON-SYMMETRIC AND CAN BE
C     GIVEN OR SIMPLY LEFT BLANK (NO UNCERTAINTY GIVEN). NOTE, FOR A
C     SYMMETRIC UNCERTAINTY YOU MUST ENTER BOTH A POSITIVE AND NEGATIVE
C     UNCERTAINTIES.
C
C     IT DOES NOT MATTER WHETHER YOU DEFINE THE UNCERTAINTIES TO BE
C     POSITIVE OR NEGATIVE ON UNIT 11 (YOU CAN USE ANY CONVENTION THAT
C     YOU LIKE). INTERNALLY THE PROGRAM WILL DEFINE ALL UNCERTAINTIES TO
C     BE POSITIVE NUMBERS AND USE THE UNCERTAINTIES TO DEFINE A POSITIVE
C     ERROR BAR (EXTENDING FROM THE POINT TO THE POINT PLUS THE POSITIVE
C     ERROR) AND A NEGATIVE ERROR BAR (EXTENDING FROM THE POINT TO THE
C     POINT MINUS THE NEGATIVE ERROR).
C
C     EXAMPLE  UNIT 11 INPUT
C     ------------------------------------------------------------------
C     IF UNIT 11 CONTAINS THE EXPERIMENTAL MEASURED DATA 27-CO-59 (N,2N)
C     THE DATA COULD LOOK LIKE,
C
C     L.R.VEESER, ET AL. (77)                          27-CO-59 (N,2N)
C      1.10000+ 7 1.10000+ 6 1.10000+ 6 1.10000- 4 2.30000- 4 1.10000- 4
C      1.20000+ 7                       1.20000- 3
C          .          .
C          .          .
C      2.00000+ 7 2.20000+ 6 2.20000+ 6 3.00000- 2
C                               (NOTE, BLANK CARD TERMINATES DATA SET).
C     S.OKAMURA (67)                                  27-CO-59 (N,2N)
C      1.07000+ 7 1.07000+ 6 1.07000+ 6 1.30000- 4 3.40000- 4 1.10000- 4
C      1.16000+ 7                       1.40000- 3
C          .          .
C          .          .
C      2.00000+ 7 2.20000+ 6 2.20000+ 6 3.10000- 2
C                               (NOTE, BLANK CARD TERMINATES DATA SET).
C     A.PAULSEN, ET AL (65)                            27-CO-59 (N,2N)
C      1.13000+ 7 1.13000+ 6 1.13000+ 6 1.80000- 4 3.40000- 4 1.10000- 4
C      1.37000+ 7                       2.80000- 3
C          .          .
C          .          .
C      2.00000+ 7 2.20000+ 6 2.20000+ 6 3.30000- 2
C                               (NOTE, BLANK CARD TERMINATES DATA SET).
C          .          .
C          .          .
C     (NOTE, ANY NUMBER OF REFERENCES MAY FOLLOW)
C
C     NOTE, FOR IDENTIFICATION ON EACH PLOT THE PROGRAM WILL ONLY READ
C     AND USE THE FIRST 40 CHARACTERS OF THE TITLE. THE USER MAY USE
C     THE REMAINDER OF THE TITLE LINE TO FURTHER PHYSICALLY IDENTIFY
C     THE DATA (AS IN THE ABOVE EXAMPLE WHERE THE DATA IS FURTHER
```

```
C     IDENTIFIED AS 27-CO-59 (N,2N)).
C
C     NOTE, THE ABOVE DATA IS FOR ILLUSTRATION PURPOSES ONLY AND DOES
C     NOT CORRESPOND TO THE ACTUAL DATA FROM THESE REFERENCES.
C
C     REPORTING ERRORS
C     ===================================================================
C     IN ORDER TO IMPROVE THIS CODE AND MAKE FUTURE VERSIONS MORE
C     COMPATIBLE FOR USE ON AS MANY DIFFERENT TYPES OF COMPUTERS AS
C     POSSIBLE PLEASE REPORT ALL COMPILER DIAGNOSTICS AND/OR OPERATING
C     PROBLEMS TO THE AUTHOR AT THE ABOVE ADDRESS.
C
C     PLEASE REMEMBER IF YOU SIMPLY REPORT 'I'VE GOT A PROBLEM' AND DO
C     NOT ADEQUATELY DESCRIBE EXACTLY HOW YOU WERE USING THE PROGRAM
C     IT WILL BE IMPOSSIBLE FOR THE AUTHOR TO HELP YOU. WHEN A PROBLEM
C     ARISES PLEASE WRITE TO THE AUTHOR, DESCRIBE THE PROBLEM IN AS MUCH
C     DETAIL AS POSSIBLE, IDENTIFY THE VERSION OF THE PROGRAM THAT YOU
C     ARE USING (E.G. VERSION 90-1) AND SEND THE FOLLOWING INFORMATION
C     ON MAGNETIC TAPE TO THE AUTHOR,
C
C     (1) A COPY OF THE FORTRAN PROGRAM YOU ARE USING
C     (2) A COPY OF COMPILER DIAGNOSTICS (IF ANY)
C     (3) A COPY OF YOUR JCL AND INPUT OPTIONS (UNIT 2)
C     (4) A COPY OF YOUR CURVE DATA (UNIT 10)
C     (5) A COPY OF YOUR POINT DATA (UNIT 11)
C     (6) A COPY OF SOFTWARE CHARACTER TABLE (UNIT 12)
C     (7) A COPY OF SOFTWARE SYMBOL AND LINE TYPE TABLE (UNIT 14)
C     (8) A COPY OF THE OUTPUT REPORT FROM THE PROGRAM (UNIT 6)
C     (9) A COPY OF THE PLOTS FROM THE PROGRAM
C
C     WITHOUT ALL OF THIS INFORMATION IT IS IMPOSSIBLE TO EXACTLY
C     SIMULATE THE PROBLEM THAT YOU RAN AND TO DETERMINE THE SOURCE
C     OF YOUR PROBLEM.
C
C***** PLOTTER/GRAPHICS TERMINAL INTERFACE *****************************
C
C      PLOTTING
C      --------
C      THIS PROGRAM USES A SIMPLE CALCOMP LIKE INTERFACE INVOLVING
C      ONLY 7 SUBROUTINES,
C
C      STARPLOT              - INITIALIZE PLOTTER
C      NEXTPLOT              - END OF A PLOT - CLEAR SCREEN FOR NEXT
C      ENDPLOTS              - END OF PLOTTING
C
C      PLOT(X,Y,IPEN)        - DRAW OR MOVE FROM LAST LOCATION TO (X,Y),
C                              END OF CURRENT PLOT OR END OF PLOTTING.
C               IPEN         =   2 - DRAW
C                            =   3 - MOVE
C
C      PEN(IPEN)             - SELECT COLOR.
C          IPEN              = COLOR = 1 TO N (N = ANY POSITIVE INTEGER)
C
C      BOXCOLOR(X,Y,IFILL,IBORDER) - FILL A RECTANGLE WITH COLOR
C               X,Y                = DEFINES THE CORNERS OF THE BOX
C                   IFILL          = COLOR TO FILL BOX WITH
C                         IBORDER  = COLOR OF THE BORDER OF THE BOX
C
```

```
C     IN ORDER TO INTERFACE THIS PROGRAM FOR USE ON ANY PLOTTER WHICH
C     DOES NOT USE THE ABOVE CONVENTIONS IT IS MERELY NECESSARY FOR THE
C     THE USER TO WRITE 7 SUBROUTINES WITH THE NAMES AND ARGUMENTS
C     DESCRIBED ABOVE AND TO THEN CALL THE LOCAL EQUIVALENT ROUTINES.
C
C     INTERACTION
C     -----------
C     THIS PROGRAM USES 2 SUBROUTINES TO CONTROL INTERACTION,
C
C     INTERACT(MYACTION)           - INDICATE WHETHER OR NOT PROGRAM
C                                    IS IN ITS INTERACTIVE MODE
C              MYACTION            = 0 - NO INTERACTION
C                                  = 1 - INTERACTION
C                                    (MYACTION IS RETURNED BY INTERACT)
C     MOUSEY(IWAY,X,Y,IWAY1,IWAY2) - READ MOUSE AND/OR KEYBOARD
C            IWAY                  = 0      - NO INPUT
C                                  = 1 TO 3 - MOUSE INPUT
C                                  = 4      - KEYBOARD INPUT
C                 X,Y              = COORDINATES FOR MOUSE INPUT
C                     IWAY1        = LOWEST VALUE OF IWAY ALLOWED
C                           IWAY2  = HIGHEST VALUE OF IWAY ALLOWED
C
C     FOR NON-INTERACTIVE INPUT YOUR GRAPHIC INTERFACE SHOULD CONTAIN
C     ROUTINES INTERACT AND MOUSEY. WHEN CALLED INTERACT SHOULD RETURN
C     MYACTION = 0. MOUSEY CAN THEN BE A DUMMY THAT SIMPLY RETURNS.
C
C     AVAILABLE PLOTTER INTERFACES
C     -------------------------------------------------------------------
C     THIS PROGRAM HAS AVAILABLE PLOTTER INTERFACES TO OPERATE AS
C     FOLLOWS,
C     (1) MAINFRAME - HARDCOPY PLOTS IN BLACK AND WHITE.
C     (2) MAINFRAME - SCREEN PLOTS IN 7 COLORS ON IBM GRAPHICS TERMINAL.
C     (3) IBM-PC    - HARDCOPY PLOTS IN 6 COLORS ON A HEWLETT-PACKARD
C                     7475A PLOTTER.
C     (4) IBM-PC    - SCREEN PLOTS IN 16 COLORS - REQUIRES LAHEY
C                     FORTRAN COMPILER.
C     (5) SUN       - HARDCOPY PLOTS IN BLACK AND WHITE.
C     (6) SUN       - SCREEN PLOTS IN BLACK AND WHITE.
C     (7) SUN       - X-WINDOWS SCREEN PLOTS IN 256 COLORS.
C
C     CONTACT THE AUTHOR TO OBTAIN COPIES OF ANY OF THE ABOVE PLOTTER
C     INTERFACES.
C
C     COLOR PLOTS
C     -------------------------------------------------------------------
C     TO SELECT PLOTTING COLORS SUBROUTINE PEN (DESCRIBED ABOVE) IS USED
C     TO SELECT ONE OF THE AVAILABLE COLORS. WHEN RUNNING ON A MAINFRAME
C     USING AN IBM GRAPHICS TERMINAL OR ON AN IBM-PC USING A HEWLETT-
C     PACKARD PLOTTER THE GRAPHICS INTERFACE (DESCRIBED ABOVE) WILL
C     PRODUCE COLOR PLOTS.
C
C     BLACK AND WHITE PLOTS
C     -------------------------------------------------------------------
C     WHEN PRODUCING BLACK AND WHITE HARDCOPY ON A MAINFRAME THE USER
C     SHOULD ADD A DUMMY SUBROUTINE PEN TO THE END OF THE PROGRAM TO
C     IGNORE ATTEMPTS TO CHANGE COLOR. ADD THE FOLLOWING SUBROUTINE,
C
C     SUBROUTINE PEN(IPEN)
```

```
C      RETURN
C      END
C
C      SIMILARLY FOR BOXCOLOR,
C
C      SUBROUTINE BOXCOLOR(X,Y,IFILL,IBORDER)
C      RETURN
C      END
C
C      CHARACTER SET
C      -----------------------------------------------------------------
C      THIS PROGRAM USES COMPUTER AND PLOTTER DEVICE INDEPENDENT SOFTWARE
C      CHARACTERS. THIS PROGRAM COMES WITH A FILE THAT DEFINES THE PEN
C      STROKES REQUIRED TO DRAW ALL CHARACTERS ON AN IBM KEYBOARD (UPPER
C      AND LOWER CASE CHARACTERS, NUMBERS, ETC.) PLUS AN ALTERNATE SET OF
C      ALL UPPER AND LOWER CASE GREEK CHARACTERS AND ADDITIONAL SPECIAL
C      SYMBOLS.
C
C      THE SOFTWARE CHARACTER TABLE CONTAINS X AND Y AND PEN POSITIONS TO
C      DRAW EACH CHARACTER. IF YOU WISH TO DRAW ANY ADDITIONAL CHARACTERS
C      OR TO MODIFY THE FONT OF THE EXISTING CHARACTERS YOU NEED ONLY
C      MODIFY THIS TABLE.
C
C      CONTROL CHARACTERS
C      -----------------------------------------------------------------
C      IN THE SOFTWARE CHARACTER TABLE ALL CHARACTERS TO BE PLOTTED WILL
C      HAVE PEN POSITION = 2 (DRAW) OR = 3 (MOVE). IN ADDITION THE TABLE
C      CURRENTLY CONTAINS 4 CONTROL CHARACTERS,
C
C      PEN POSITION = 0
C      ---------------
C      SHIFT THE NEXT PRINTED CHARACTER BY X AND Y. 3 CONTROL CHARACTERS
C      ARE PRESENTLY INCLUDED IN THE SOFTWARE CHARACTER TABLE TO ALLOW
C      SHIFTING.
C
C      {   = SHIFT UP (FOR SUPERSCRIPTS.............X= 0.0, Y= 0.5)
C      }   = SHIFT DOWN (FOR SUBSCRIPTS.............X= 0.0, Y=-0.5)
C      \   = SHIFT LEFT 1 CHARACTER (FOR BACKSPACE...X=-1.0, Y= 0.0)
C
C      PEN POSITION =-1
C      ---------------
C      SELECT THE NEXT PRINTED CHARACTER FROM THE ALTERNATE CHARACTER
C      SET. AT PRESENT THIS CONTROL CHARACTER IS,
C
C      ]   = SWITCH TO ALTERNATE CHARACTER SET
C
C      THESE 4 CONTROL CHARACTERS ARE ONLY DEFINED BY THE VALUE OF THE
C      PEN POSITION IN THE SOFTWARE CHARACTER TABLE (I.E., THEY ARE NOT
C      HARD WIRED INTO THIS PROGRAM). AS SUCH BY MODIFYING THE SOFTWARE
C      CHARACTER TABLE THE USER HAS THE OPTION OF DEFINING ANY CONTROL
C      CHARACTERS TO MEET SPECIFIC NEEDS.
C
C      THESE CHARACTERS MAY BE USED IN CHARACTER STRINGS TO PRODUCE
C      SPECIAL EFFECTS. FOR EXAMPLE, TO PLOT SUBSCRIPT 5, B, SUPERSCRIPT
C      10 USE THE STRING,
C
C      }5B{1{0
C
```

```
C      TO PLOT B, SUBSCRIPT 5 AND SUPERSCRIPT 10 WITH THE 5 DIRECTLY
C      BELOW THE 1 OF THE 10 WE CAN USE THE BACKSPACE CHARACTER TO
C      POSITION THE 1 DIRECTLY ABOVE THE 5 USING THE STRING,
C
C      B}5\{1{0
C
C      TO PLOT UPPER CASE GREEK GAMMA FOLLOWED BY THE WORD TOTAL (I.E.,
C      RESONANCE TOTAL WIDTH) USE THE STRING.
C
C      ]G TOTAL
C
C      NOTE, WHEN THESE CONTROL CHARACTERS ARE USED THEY ONLY EFFECT THE
C      NEXT 1 PRINTED CHARACTER (SEE, ABOVE EXAMPLE OF PLOTTING SUPER-
C      SCRIPT 10 WHERE THE SHIFT UP CONTROL CHARACTER WAS USED BEFORE THE
C      1 AND THEN AGAIN BEFORE THE 0 AND THE BACKSPACE AND SHIFT UP
C      CONTROL CHARACTERS WERE USED IN COMBINATION).
C
C      IF THESE 4 CONTROL CHARACTERS ARE NOT AVAILABLE ON YOUR COMPUTER
C      YOU CAN MODIFY THE SOFTWARE CHARACTER TABLE TO USE ANY OTHER 4
C      CHARACTERS THAT YOU DO NOT NORMALLY USE IN CHARACTER STRINGS (FOR
C      DETAILS SEE THE SOFTWARE CHARACTER TABLE).
C
C      STANDARD/ALTERNATE CHARACTER SETS
C      -----------------------------------------------------------------
C      THE SOFTWARE CHARACTER TABLE CONTAINS 2 SETS OF CHARACTERS WHICH
C      ARE A STANDARD SET (ALL CHARACTERS ON AN IBM KEYBOARD) AND AN
C      ALTERNATE SET (UPPER AND LOWER CASE GREEK CHARACTERS AND SPECIAL
C      CHARACTERS). TO DRAW A CHARACTER FROM THE ALTERNATE CHARACTER SET
C      PUT A RIGHT BRACKET CHARACTER (]) BEFORE A CHARACTER (SEE THE
C      ABOVE EXAMPLE AND THE SOFTWARE CHARACTER TABLE FOR DETAILS). THIS
C      CONTROL CHARACTER WILL ONLY EFFECT THE NEXT 1 PLOTTED CHARACTER.
C
C      SUB AND SUPER SCRIPTS
C      -----------------------------------------------------------------
C      TO DRAW SUBSCRIPT PRECEDE A CHARACTER BY }. TO DRAW SUPERSCRIPT
C      PRECEDE A CHARACTER BY { (SEE THE ABOVE EXAMPLE AND THE SOFTWARE
C      CHARACTER TABLE FOR DETAILS). THESE CONTROL CHARACTER WILL ONLY
C      EFFECT THE NEXT 1 PLOTTED CHARACTER.
C
C      BACKSPACING
C      -----------------------------------------------------------------
C      TO BACKSPACE ONE CHARACTER PRECEDE A CHARACTER BY \ (SEE, THE
C      ABOVE EXAMPLE AND THE SOFTWARE CHARACTER TABLE FOR DETAILS). THIS
C      CONTROL CHARACTER WILL PERFORM A TRUE BACKSPACE AND WILL EFFECT
C      ALL FOLLOWING CHARACTERS IN THE SAME CHARACTER STRING.
C
C      PLOT DIMENSIONS
C      ---------------
C      ARE DEFINED BY USER INPUT. INTERNALLY THE PROGRAM WILL CREATE A
C      PLOT IN APPROXIMATELY A4 OR 8-1/2 BY 11 INCH FORMAT. DURING
C      OUTPUT THE PLOT IS TRANSFORMED TO THE UNITS (INCHES, CENTIMETERS,
C      MILLIMETERS, WHATEVER) OF THE PLOTTER BEING USED AND OUTPUT.
C
C      DEFINING THE DIMENSIONS OF YOUR PLOTTER
C      ---------------------------------------
C      WHEN IMPLEMENTING THIS CODE FOR USE ON ANY PLOTTER THE FIRST THING
C      TO DO IS DETERMINE THE PHYSICAL SIZE OF THE PLOT TO SPECIFY ON
C      THE FIRST INPUT LINE. ONCE YOU HAVE DETERMINED THE APPROPRIATE
```

```
C     X AND Y DIMENSIONS YOU WILL NEVER HAVE TO CHANGE THEM AGAIN.
C
C     TO DEFINE THE APPROPRIATE DIMENSIONS YOU CAN USE THE FIRST PLOT
C     GENERATED BY THIS CODE. THE FIRST PLOT IS A SIMPLE PLOT MERELY
C     TO IDENTIFY THE CODE AND VERSION, E.G., 90-1. USE THE INPUT
C     PARAMETERS TO TURN ON THE BORDER FOR PLOTS (SEE, DESCRIPTION
C     OF INPUT PARAMETERS ABOVE) - THE BORDER DEFINES THE EXTREME
C     X AND Y LIMITS OF THE PLOTTING AREA. BY CHANGING THE X AND Y
C     PHYSICAL LIMITS THAT YOU SPECIFY ON THE FIRST INPUT LINE YOU
C     WILL BE ABLE TO RAPIDLY POSITION THE PLOT AND DEFINE ITS SIZE
C     FOR YOUR PLOTTER.
C
C     REMEMBER THE BORDER DEFINES THE EXTREME X AND Y LIMITS OF THE
C     PLOT - THERE IS A PLOTTING AREA WHICH IS SURROUNDED BY TITLE
C     INFORMATION AT TOP, BOTTOM AND LEFT OF THE PLOT - THEREFORE
C     YOU MUST TURN ON THE BORDER FOR THE FIRST PLOT AND INSURE
C     THAT THE ENTIRE BORDER APPEARS ON YOUR PLOTTING SURFACE -
C     FAILURE TO FOLLOW THESE INSTRUCTIONS MAY CAUSE YOU TO LOSE
C     A PORTION OF SOME PLOTS, I.E., THEY MAY NOT BE WITHIN THE
C     PHYSICAL LIMITS OF YOUR PLOTTING SURFACE.
C
C***** PLOTTER/GRAPHICS TERMINAL INTERFACE *****************************
C
C     ACKNOWLEDGEMENTS
C     ================================================================
C     THE AUTHORS ACKNOWLEDGES THE CONTRIBUTION OF JIM SMITH, NUCLEAR
C     DATA SECTION, IAEA, VIENNA, FOR SUGGESTING MANY OF THE OPTIONS
C     WHICH ARE NOW INCORPORATED IN THIS CODE AS WELL AS FOR TESTING
C     THE CODE EXTENSIVELY DURING ITS DEVELOPMENT PHASE.
C
C     THE AUTHOR ACKNOWLEDGES THE CONTRIBUTION OF DAVE RESLER, LAWRENCE
C     LIVERMORE NATIONAL LABORATORY FOR PROVIDING THE GRAPHICS INTERFACE
C     WHICH ALLOWS THIS PROGRAM TO BE USED ON A SUN TERMINAL
C
C=======================================================================
```

PROGRAM PLOTTAB:
A Code Designed to Plot
Continuous and/or Discrete Physical Data
(Version 2013-1)
Part B: Examples

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November 22, 2013

Abstract

PLOTTAB is designed as a general purpose plotting utility code to plot continuous and/or discrete physical data for use in almost any application. It is designed to be easily used by your application codes to produce your output results in a form that can be immediately used by PLOTTAB to allow you to see your results.

It produces on screen graphics as well as Postscript formatted output files that can be viewed or printed on any Postscript printer. The code is designed to be easily used on any computer - not only today's computers, but also anything that comes along in the future. So you can be assured that once you start using PLOTTAB your graphics problems are over - not just today, but well into the future.

Part A of this report documents the basic features of PLOTTAB.

Part B is designed to aid users in using the code, by describes a variety of applications, including listings of input parameters and output plots.

PROGRAM PLOTTAB:
Continuous and/or Discrete Physical Data
(Version 2013-1)
Part B: Examples

A Code Designed to Plot

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November 22, 2013

Introduction

The code PLOTTAB is designed as a simple plotting code which can be used on virtually any computer and graphics device to plot continuous and/or discrete physical data. To date this code has been successfully interfaced and used on a wide variety of computers as simple as IBM-PCs and as advanced as CRAY supercomputers.

In order to use this code on any given computer all you have to be able to do is turn your plotting device on or off and draw a line from one (X,Y) position to another. That's all you have to be able to do to interface this code to any plotting device; for details see below.

Although the graphics interface used by this code is very simple, it can still take advantage of many features of individual plotting devices in order to produce either hardcopy or images on screens, either in black and white or in full color.

This code can be used with plotting devices of any physical size, whose size is defined in any set of units. This code allows you to define the physical size of your plotting device in whatever dimensions you are used to using, e.g., inches, millimeters, centimeters - anything; so that you can properly size the plots for use with any plotting device.

The formats of the continuous and discrete physical data read by this code are designed to be extremely simple, so that virtually any computer code can be simply modified to produce output results in the input format required by this code. The continuous data includes a one title line, followed by a series of (X,Y) coordinates, one per line. Each "curve" of continuous data is terminated by a blank line. One curve can be followed by another, starting with the one line title line. The input to this code may include any number of such "curves". The format of the discrete data is very similar to the continuous data; each set of discrete points starts with a one line title and ends with a blank line. Each point is defined by an (X,Y) value plus uncertainties in both X and Y; each point is defined by up to six values X,-DX,+DX,Y,-DY,+DY, one point per input line. The input to this code may include any number of such sets of discrete points. See below for details of the continuous and discrete data formats.

This code has been designed to meet the needs of a wide variety of users. The code has been designed to allow the casual user to simply produce plots without becoming familiar with all of the options available in this code. This design feature allows some users to concentrate on applications and still produce meaningful graphic results without having to become an expert in graphics. At the same time this code includes many options which may be used to produce customized plots to meet most needs, varying from very simple and fast plots which can be quickly produced and used, to complicated, detailed figures of a quality suitable for publications (for examples of the latter see the below list of publications).

For extensive examples of the results produced by this code see,

"Tables and Graphs of Photon-Interaction Cross Sections from 10 eV to 100 GeV Derived from the LLNL Evaluated Photon Data Library (EPDL), Part A: Z = 1 to 50, Part B: Z = 51 to 100", UCRL-50400, Vol. 6, Rev. 4, Oct. 1989, Lawrence Livermore National Laboratory.

"Tables and Graphs of Atomic Subshell and Relaxation Data Derived from the LLNL Evaluated Atomic Data Library (EADL), Z = 1 - 100", UCRL-50400, Vol. 30, Oct. 1991, Lawrence Livermore National Laboratory.

"Tables and Graphs of Electron-Interaction Cross Sections from 10 eV to 100 GeV Derived from the LLNL Evaluated Electron Data Library (EEDL), Z = 1 - 100", UCRL-50400, Vol. 31, Nov. 1991, Lawrence Livermore National Laboratory.

Software Character Sets

In order to make this code as computer independent as possible it uses an input file (PLOT.CHR) to define the strokes necessary to plot each character - this is called a software character set. Using this method the interface for each computer and plotting device need only be able to draw lines from one (X,Y) coordinate to another - and all character sizes and aspect ratios will be plotted identically on all plotters.

This code is distributed with three sets of software characters, which in the order of character detail are called SIMPLEX, DUPLEX and COMPLEX. Each of these sets is distributed as a separate computer file and to use any one of them you need merely copy it to PLOT.CHR before executing this code. The three files of strokes are completely compatible and this code will simply use whichever set you have in PLOT.CHR.

Each of these sets can be used in given situations. The SIMPLEX set is a fairly simple set of characters, each of which may be drawn with a minimum number of strokes; this makes using this set very economical. At the other extreme the COMPLEX set included detailed characters, each of which may require a large number of strokes to draw; this set can be expensive to use, but it can produce finished plots suitable for use in publications.

The following page illustrates all available characters for each of the three software character sets. For each set the upper two lines illustrate the standard characters and the lower two lines illustrate the alternate character set.

Complex

ABCDEFGHIJKLMNOPQRSTUVWXYZ0123456789+-*/$()=

abcdefghijklmnopqrstuvwxyz,.:;!?<>%'~@#&_|"

ABXΔEΦΓHI KΛMNOΠΘPΣTΥ ΩΞΨZ

αβχδεφγηι κλμνοπϑρστυ ωξψζ→↑←↓≠≡≦≧∞∈∝∂∇√∫[ ]

Duplex

ABCDEFGHIJKLMNOPQRSTUVWXYZ0123456789+-*/$()=

abcdefghijklmnopqrstuvwxyz,.:;!?<>%'~@#&_|"

ABXΔEΦΓHI KΛMNOΠΘPΣTΥ ΩΞΨZ

αβχδεφγηι κλμνοπϑρστυ ωξψζ→↑←↓≠≡≦≧∞∈∝∂∇√∫[ ]

Simplex

ABCDEFGHIJKLMNOPQRSTUVWXYZ0123456789+-*/$()=

abcdefghijklmnopqrstuvwxyz,.:;!?<>%'~@#&_|"

ABXΔEΦΓHI KΛMNOΠΘPΣTΥ ΩΞΨZ

αβχδεφγηι κλμνοπθρστυ ωξψζ→↑←↓≠≡≦≧∞∈∝∂∇√∫[ ]

Standard vs. Alternate Character Set

To use the standard character set as input to this code one need merely type the desired character; all of the standard characters are available on most computer keyboards.

To use the alternate character set you should consult the following equivalence table and precede each character by]. For example, to plot (n, Greek alpha), you should type (n,]a) -] indicates that the next character is from the alternate character set and the following equivalence table indicates that - a - is equivalence to a lower case Greek alpha.

Alternate Character Equivalences

A = A	M = M	Y = Ψ	k = κ	w = ω	8 = ∞
B = B	N = N	Z = Z	l = λ	x = ξ	9 = ∈
C = X	O = O	a = α	m = μ	y = ψ	+ = ∝
D = Δ	P = Π	b = β	n = ν	z = ζ	- = ∂
E = E	Q = Θ	c = χ	o = ο	0 = →	* = ∇
F = Φ	R = P	d = δ	p = π	1 = ↑	/ = √
G = Γ	S = Σ	e = ε	q = ϑ	2 = ←	$ = ∫
H = H	T = T	f = φ	r = ρ	3 = ↓	(= [
I = I	U = Υ	g = γ	s = σ	4 = ≠	) =]
J =	V =	h = η	t = τ	5 = ≡	
K = K	W = Ω	i = ι	u = υ	6 = ≦	
L = Λ	X = Ξ	j =	v =	7 = ≧	

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Character Thicknesses

All lines on a plot, except the grid, may be drawn using a specified line thickness. This option may be used to good advantage to insure that data can be properly and easily distinguished from the background grid.

As input you can specify that all lines should be of thickness between 0 (only draw each line once) up to 5 (with thickness 5 each line is drawn and then slightly offset to either side of the line and drawn 5 times - each line is drawn 11 times). Using line thickness can be very effective as far as improving the end product plots, but it can be very expensive if not properly used. For example, with thickness 5 each line is drawn 11 times and between drawing the beam or pen must be returned to the start of the line. Therefore plots with thickness 5 will contain 20 times as many strokes as a plot with thickness 0, and as such will take 20 times as long to create.

For most plots it is sufficient to have thickness for curves and points, but generally it is not necessary to have thickness for characters; the basic COMPLEX characters already contain an intrinsic thickness. In order to allow this option you can specify as input thickness 0 through 5, which indicates thickness for all lines, except the grid, on each plot, or -1 through -5 which indicates thickness only for curves and set of data points - but not for characters. Using the latter option can significant decrease the time required to produce plots, and this option is recommended.

For reference purposes the following pages illustrate each of the three software character sets in the order COMPLEX, DUPLEX and SIMPLEX, using line thickness 0 through 5. As stated above, the recommended procedure is not to use a line thickness for characters, and this recommendation will be followed in all of the examples included in this report.

<table>
<tr><td>0 Thick</td><td>ABCDEFGHIJKLMNOPQRSTUVWXYZ0123456789+−*/$()=
abcdefghijklmnopqrstuvwxyz,.:;!?<>%'~@#&_|"
ΑΒΧΔΕΦΓΗΙ ΚΛΜΝΟΠΘΡΣΤΥ ΩΞΨΖ
αβχδεφγηι κλμνοπϑρστυ ωξψζ→↑←↓≠≡≦≧∞∈∝∂∇√∫[ ]</td></tr>
<tr><td>1 Thick</td><td>ABCDEFGHIJKLMNOPQRSTUVWXYZ0123456789+−*/$()=
abcdefghijklmnopqrstuvwxyz,.:;!?<>%'~@#&_|"
ΑΒΧΔΕΦΓΗΙ ΚΛΜΝΟΠΘΡΣΤΥ ΩΞΨΖ
αβχδεφγηι κλμνοπϑρστυ ωξψζ→↑←↓≠≡≦≧∞∈∝∂∇√∫[ ]</td></tr>
<tr><td>2 Thick</td><td>ABCDEFGHIJKLMNOPQRSTUVWXYZ0123456789+−*/$()=
abcdefghijklmnopqrstuvwxyz,.:;!?<>%'~@#&_|"
ΑΒΧΔΕΦΓΗΙ ΚΛΜΝΟΠΘΡΣΤΥ ΩΞΨΖ
αβχδεφγηι κλμνοπϑρστυ ωξψζ→↑←↓≠≡≦≧∞∈∝∂∇√∫[ ]</td></tr>
</table>

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<table>
<tr><td>3 Thick</td><td>ABCDEFGHIJKLMNOPQRSTUVWXYZ0123456789+-*/$()=
abcdefghijklmnopqrstuvwxyz,.:;!?<>%'~@#&_|"
ΑΒΧΔΕΦΓΗΙ ΚΛΜΝΟΠΘΡΣΤϒ ΩΞΨΖ
αβχδεφγηι κλμνοπϑρστυ ωξψζ→↑←↓≠≡≦≧∞∈∝∂∇√∫[ ]</td></tr>
<tr><td>4 Thick</td><td>ABCDEFGHIJKLMNOPQRSTUVWXYZ0123456789+-*/$()=
abcdefghijklmnopqrstuvwxyz,.:;!?<>%'~@#&_|"
ΑΒΧΔΕΦΓΗΙ ΚΛΜΝΟΠΘΡΣΤϒ ΩΞΨΖ
αβχδεφγηι κλμνοπϑρστυ ωξψζ→↑←↓≠≡≦≧∞∈∝∂∇√∫[ ]</td></tr>
<tr><td>5 Thick</td><td>ABCDEFGHIJKLMNOPQRSTUVWXYZ0123456789+-*/$()=
abcdefghijklmnopqrstuvwxyz,.:;!?<>%'~@#&_|"
ΑΒΧΔΕΦΓΗΙ ΚΛΜΝΟΠΘΡΣΤϒ ΩΞΨΖ
αβχδεφγηι κλμνοπϑρστυ ωξψζ→↑←↓≠≡≦≧∞∈∝∂∇√∫[ ]</td></tr>
</table>

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0 Thick

ABCDEFGHI JKLMNOPQRSTUVWXYZ0123456789+-*/$()=

abcdefghi jklmnopqrstuvwxyz,.:;!?<>%'~@#&_|"

ABXΔEΦΓHI KΛMNOΠΘPΣTϒ ΩΞΨZ

αβχδεφγηι κλμνοπϑρστυ ωξψζ→↑←↓≠≡≦≧∞∈∝∂∇√∫[ ]

1 Thick

ABCDEFGHI JKLMNOPQRSTUVWXYZ0123456789+-*/$()=

abcdefghi jklmnopqrstuvwxyz,.:;!?<>%'~@#&_|"

ABXΔEΦΓHI KΛMNOΠΘPΣTϒ ΩΞΨZ

αβχδεφγηι κλμνοπϑρστυ ωξψζ→↑←↓≠≡≦≧∞∈∝∂∇√∫[ ]

2 Thick

ABCDEFGHI JKLMNOPQRSTUVWXYZ0123456789+-*/$()=

abcdefghi jklmnopqrstuvwxyz,.:;!?<>%'~@#&_|"

ABXΔEΦΓHI KΛMNOΠΘPΣTϒ ΩΞΨZ

αβχδεφγηι κλμνοπϑρστυ ωξψζ→↑←↓≠≡≦≧∞∈∝∂∇√∫[ ]

3 Thick

ABCDEFGHIJKLMNOPQRSTUVWXYZ0123456789+-*/$()=

abcdefghijklmnopqrstuvwxyz,.:;!?<>%'~@#&_|"

ΑΒΧΔΕΦΓΗΙ ΚΛΜΝΟΠΘΡΣΤΥ ΩΞΨΖ

αβχδεφγηι κλμνοπϑρστυ ωξψζ→↑←↓≠≡≦≧∞∈∝∂∇√∫[ ]

4 Thick

ABCDEFGHIJKLMNOPQRSTUVWXYZ0123456789+-*/$()=

abcdefghijklmnopqrstuvwxyz,.:;!?<>%'~@#&_|"

ΑΒΧΔΕΦΓΗΙ ΚΛΜΝΟΠΘΡΣΤΥ ΩΞΨΖ

αβχδεφγηι κλμνοπϑρστυ ωξψζ→↑←↓≠≡≦≧∞∈∝∂∇√∫[ ]

5 Thick

ABCDEFGHIJKLMNOPQRSTUVWXYZ0123456789+-*/$()=

abcdefghijklmnopqrstuvwxyz,.:;!?<>%'~@#&_|"

ΑΒΧΔΕΦΓΗΙ ΚΛΜΝΟΠΘΡΣΤΥ ΩΞΨΖ

αβχδεφγηι κλμνοπϑρστυ ωξψζ→↑←↓≠≡≦≧∞∈∝∂∇√∫[ ]

Ø Thick

ABCDEFGHIJKLMNOPQRSTUVWXYZØ123456789+-*/$()=

abcdefghijklmnopqrstuvwxyz,.:;!?<>%'~@#&_|"

ΑΒΧΔΕΦΓΗΙ ΚΛΜΝΟΠΘΡΣΤΥ ΩΞΨΖ

αβχδεφγηι κλμνοπθρστυ ωξψζ→↑←↓≠≡≤≥∞∈∝∂∇√∫[ ]

1 Thick

ABCDEFGHIJKLMNOPQRSTUVWXYZØ123456789+-*/$()=

abcdefghijklmnopqrstuvwxyz,.:;!?<>%'~@#&_|"

ΑΒΧΔΕΦΓΗΙ ΚΛΜΝΟΠΘΡΣΤΥ ΩΞΨΖ

αβχδεφγηι κλμνοπθρστυ ωξψζ→↑←↓≠≡≤≥∞∈∝∂∇√∫[ ]

2 Thick

ABCDEFGHIJKLMNOPQRSTUVWXYZØ123456789+-*/$()=

abcdefghijklmnopqrstuvwxyz,.:;!?<>%'~@#&_|"

ΑΒΧΔΕΦΓΗΙ ΚΛΜΝΟΠΘΡΣΤΥ ΩΞΨΖ

αβχδεφγηι κλμνοπθρστυ ωξψζ→↑←↓≠≡≤≥∞∈∝∂∇√∫[ ]

3 Thick

ABCDEFGHIJKLMNOPQRSTUVWXYZ0123456789+-*/$()=

abcdefghijklmnopqrstuvwxyz,.:;!?<>%'~@#&_|"

ΑΒΧΔΕΦΓΗΙ ΚΛΜΝΟΠΘΡΣΤϒ ΩΞΨΖ

αβχδεφγηι κλμνοπθρστυ ωξψζ→↑←↓≠≡≦≧∞∈∝∂∇√∫[]

4 Thick

ABCDEFGHIJKLMNOPQRSTUVWXYZ0123456789+-*/$()=

abcdefghijklmnopqrstuvwxyz,.:;!?<>%'~@#&_|"

ΑΒΧΔΕΦΓΗΙ ΚΛΜΝΟΠΘΡΣΤϒ ΩΞΨΖ

αβχδεφγηι κλμνοπθρστυ ωξψζ→↑←↓≠≡≦≧∞∈∝∂∇√∫[]

5 Thick

ABCDEFGHIJKLMNOPQRSTUVWXYZ0123456789+-*/$()=

abcdefghijklmnopqrstuvwxyz,.:;!?<>%'~@#&_|"

ΑΒΧΔΕΦΓΗΙ ΚΛΜΝΟΠΘΡΣΤϒ ΩΞΨΖ

αβχδεφγηι κλμνοπθρστυ ωξψζ→↑←↓≠≡≦≧∞∈∝∂∇√∫[]

Software Symbols and Line Types

In order to identify sets of points or curves this code uses a file defining the strokes required to draw any one of 30 different symbols (to identify sets of points) or any one of 30 types of lines (to identify curves).

This code is distributed with two files: PLOT.SYM containing the strokes required to draw the standard symbol set, and PLOT.ALT containing the strokes required to draw the alternate symbol set. In both cases the types of lines are identical in the two files. In order to use either of these sets of symbols it is merely necessary to insure that the selected set is copied to the file PLOT.SYM prior to executing this code.

The following pages illustrate the standard and alternate symbol sets and the types of lines. The standard symbol set includes 30 different symbols which can be readily distinguished from one another on a plot. When symbols severely overlap on plots it may not be easy to distinguish symbols. Each member of the alternate symbol set is merely a square containing a number (1 through 9) or letter (A through Y). The alternate set is not as elegant as the standard set, but when symbols severely overlap the alternate symbols can be more easily distinguished than the standard symbols.

The types of lines allow for up to 30 different types of lines, but as distributed there are really only 10 different types of lines; line types 11-20 or 21-30 are merely repeats of line types 1-10. Even with only 10 different types of lines it is often difficult to distinguish between them and the author has not been able to define more than this number of different types of lines.

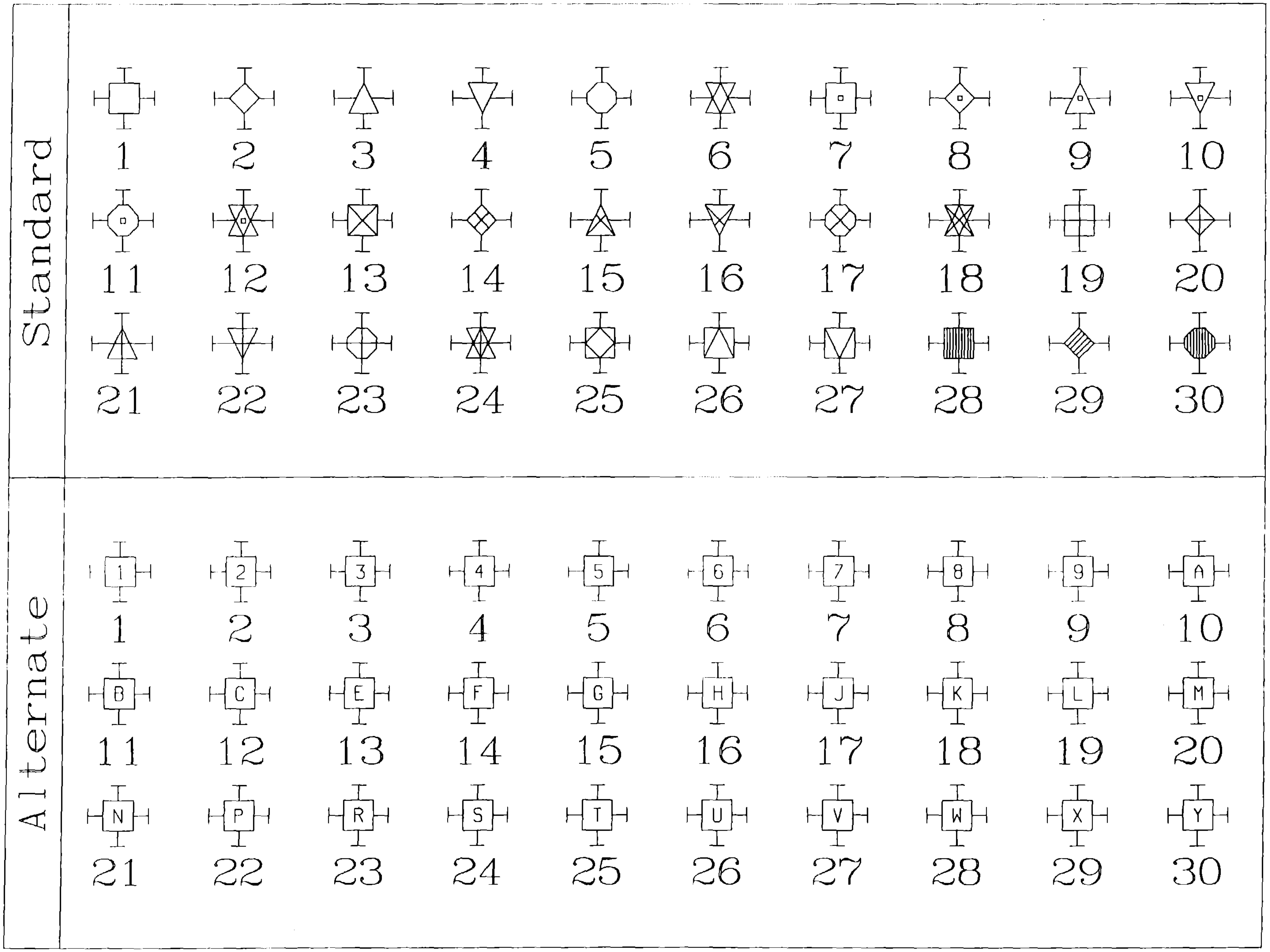
The symbols and line types are used in the order that they are read from the file (PLOT.SYM). The user is free to re-order the symbols and line types in any manner, e.g., if you would like symbols 28-30 to be used for the first 3 sets of points, merely move these symbols to be the beginning of the file. Similarly you are free to modify these symbols and line types to create your own sets. The only restriction to modifying this file is that there MUST BE EXACTLY 30 symbols followed by 30 line types - otherwise the results will be unpredictable.

The files containing the symbols and line types define the strokes required to draw symbols and lines. Each stroke is defined by (X,Y) and either 3 = move (blank) or 2 = draw. For each symbol the first line defines an index (1 to 30 - not used by the code), the number of strokes required to draw the symbol (e.g., for a box, 5 strokes) and the X width of the symbol at the Y midpoint (to allow error bars to be easily and correctly connected to symbols). The first line is then followed by the indicated number of strokes. The first stroke must always include 3 = move, in order to move to the beginning of the symbol without drawing a line from the last location of the beam or pen. Below are the first three symbols from the standard symbol set. See the following page illustrating these symbols.

```
1     5  1.000    BOX
 0.000  0.000     3
 0.000  1.000     2
 1.000  1.000     2
 1.000  0.000     2
 0.000  0.000     2
2     5  1.000    DIAMOND
 0.500  0.000     3
 0.000  0.500     2
 0.500  1.000     2
 1.000  0.500     2
 0.500  0.000     2
3     4  0.500    UP TRIANGLE
 0.000  0.000     3
 0.500  1.000     2
 1.000  0.000     2
 0.000  0.000     2
```

Similarly, each line type is defined by a series of strokes. The first line defines an index (1 to 30 - not used by this code) and the number of strokes. The following field is not used by this code. The following lines define each stroke as either 3 = drawn or 2 = blank. Once the pattern has been used it is merely repeated. Below are the first three line types. See the following page illustrating these line types.

```
1     1  1.000    SOLID
 1.000  0.000     2
2     2  1.000    LONG DASH-SPACE
 0.180  0.000     2
 0.045  0.000     3
3     2  1.000    SHORT DASH-SPACE
 0.060  0.000     2
 0.045  0.000     3
```


Standard
1 2 3 4 5 6 7 8 9 10
11 12 13 14 15 16 17 18 19 20
21 22 23 24 25 26 27 28 29 30
Alternate
1 2 3 4 5 6 7 8 9 A
1 2 3 4 5 6 7 8 9 10
B C E F G H J K L M
11 12 13 14 15 16 17 18 19 20
N P R S T U V W X Y
21 22 23 24 25 26 27 28 29 30

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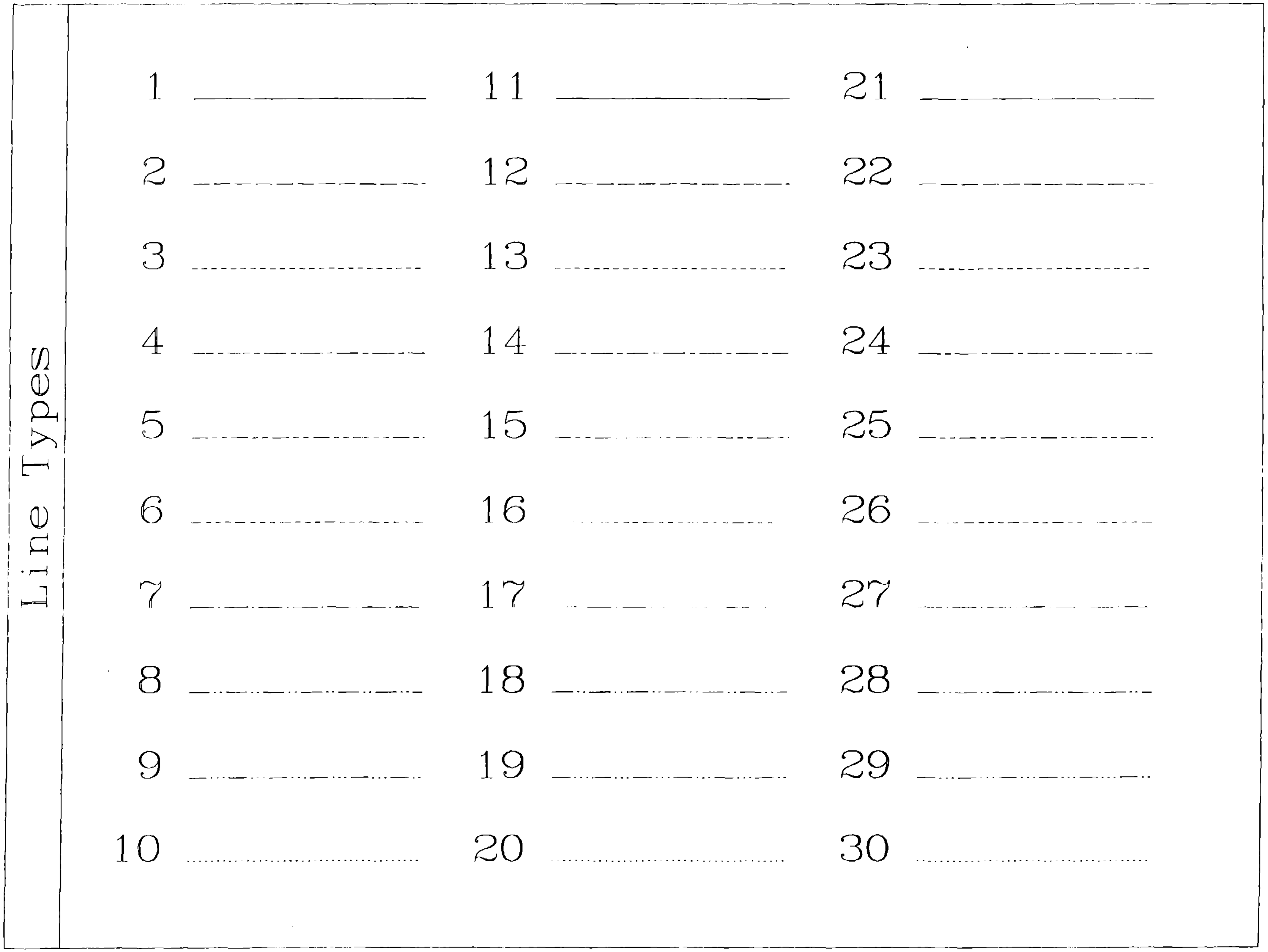

Line Types
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30

44

A Basic Series of Plots

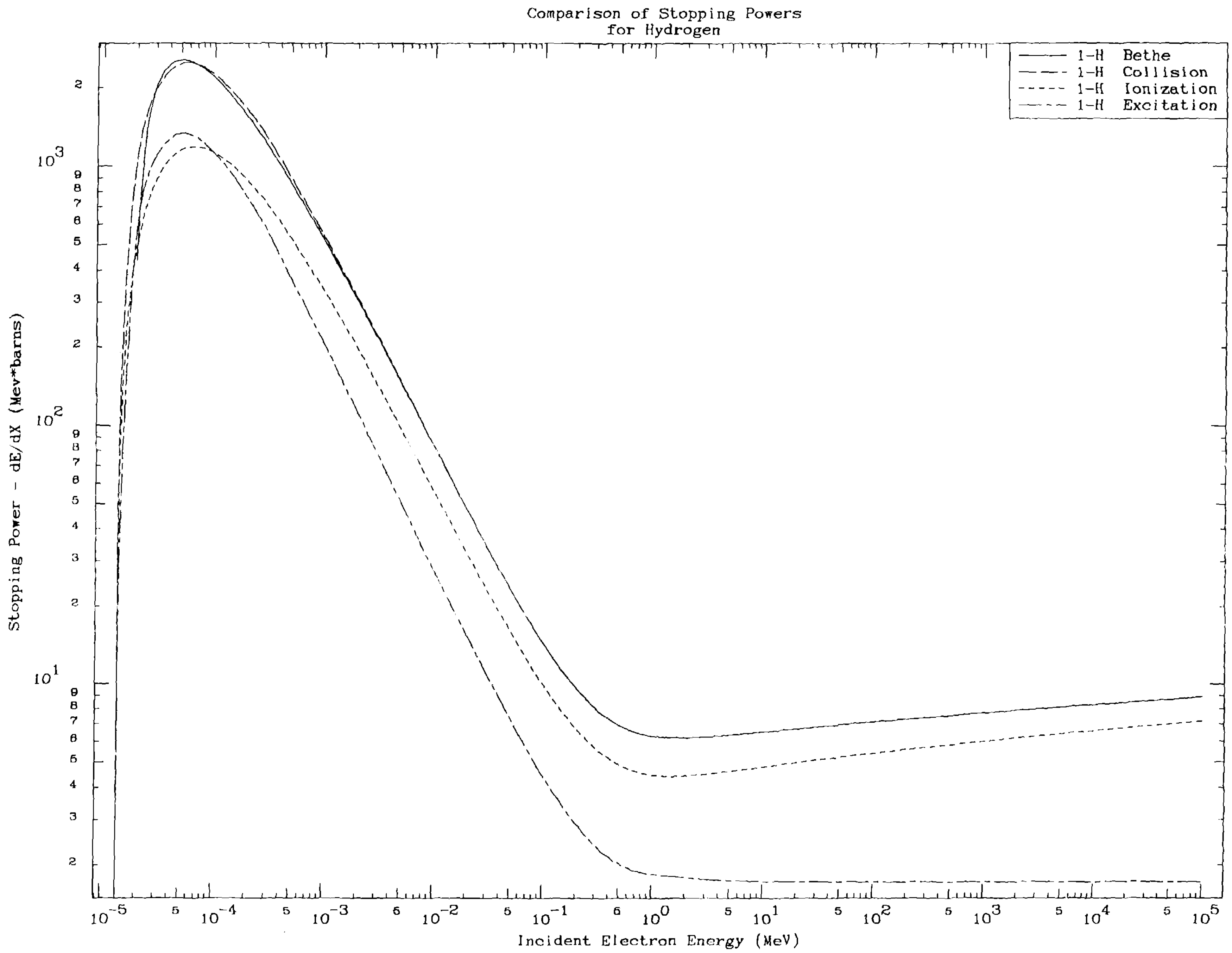
The following four plots illustrate the simplest use of the code to plot four curves on each of a series of plots. The X and Y axis labels will be identical on all four plots. Only the titles at the top of each plot will be different from one plot to the next.

In this case you need only define the physical size of each page (in this case 13.5 by 10.0) and the number of plots per page (in this case 1 by 1), the number of curves to read and plot on each plot (4) and the X and Y axis labels; all of these will be the same for all plots and these first four lines of input need only appear once.

Next there are four input lines for each plot. The first two lines define a two line title to appear at the top of the plot. The next two lines define options for the X and Y dimensions of the plot. Note in this case these lines are completely blank or 0, in which case the code will use all of the standard options; this illustrates that in most cases the user need not be familiar with all of the options available, since generally acceptable results can be obtained using the standard code options.

These four lines for a plot can be immediately followed by another four lines for the next plot. This cycle can be repeated any number of times and each four lines will produce one plot, e.g., in this case the cycle is repeated four times to produce the following four plots.

```
    0.00000   13.50000    0.00000   10.0                1          1 1.0
          4          0          0          0           0          0    0
Incident Electron Energy (MeV)
Stopping Power - dE/dX (Mev*barns)
Comparison of Stopping Powers
for Hydrogen
                                0          0          0          0
                                0          0          0          0
Comparison of Stopping Powers
for Helium
                                0          0          0          0
                                0          0          0          0
Comparison of Stopping Powers
for Lithium
                                0          0          0          0
                                0          0          0          0
Comparison of Stopping Powers
for Beryllium
                                0          0          0          0
                                0          0          0          0
```


Comparison of Stopping Powers
for Hydrogen
1-H Bethe
1-H Collision
1-H Ionization
1-H Excitation
Stopping Power - dE/dX (Mev*barns)
Incident Electron Energy (MeV)
10^{-5} 5 10^{-4} 5 10^{-3} 5 10^{-2} 5 10^{-1} 5 10^{0} 5 10^{1} 5 10^{2} 5 10^{3} 5 10^{4} 5 10^{5}
10^{1} 10^{2} 10^{3}

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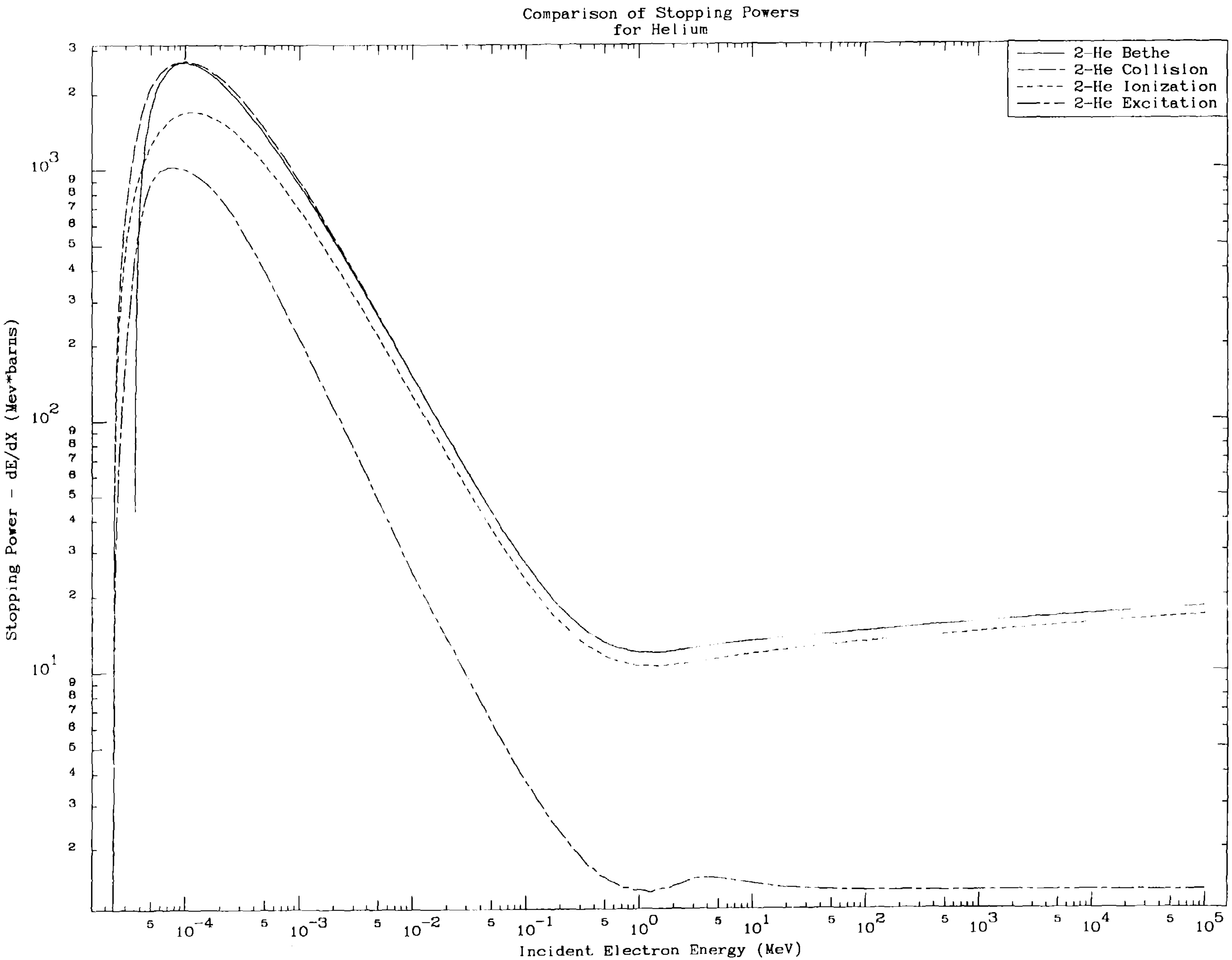
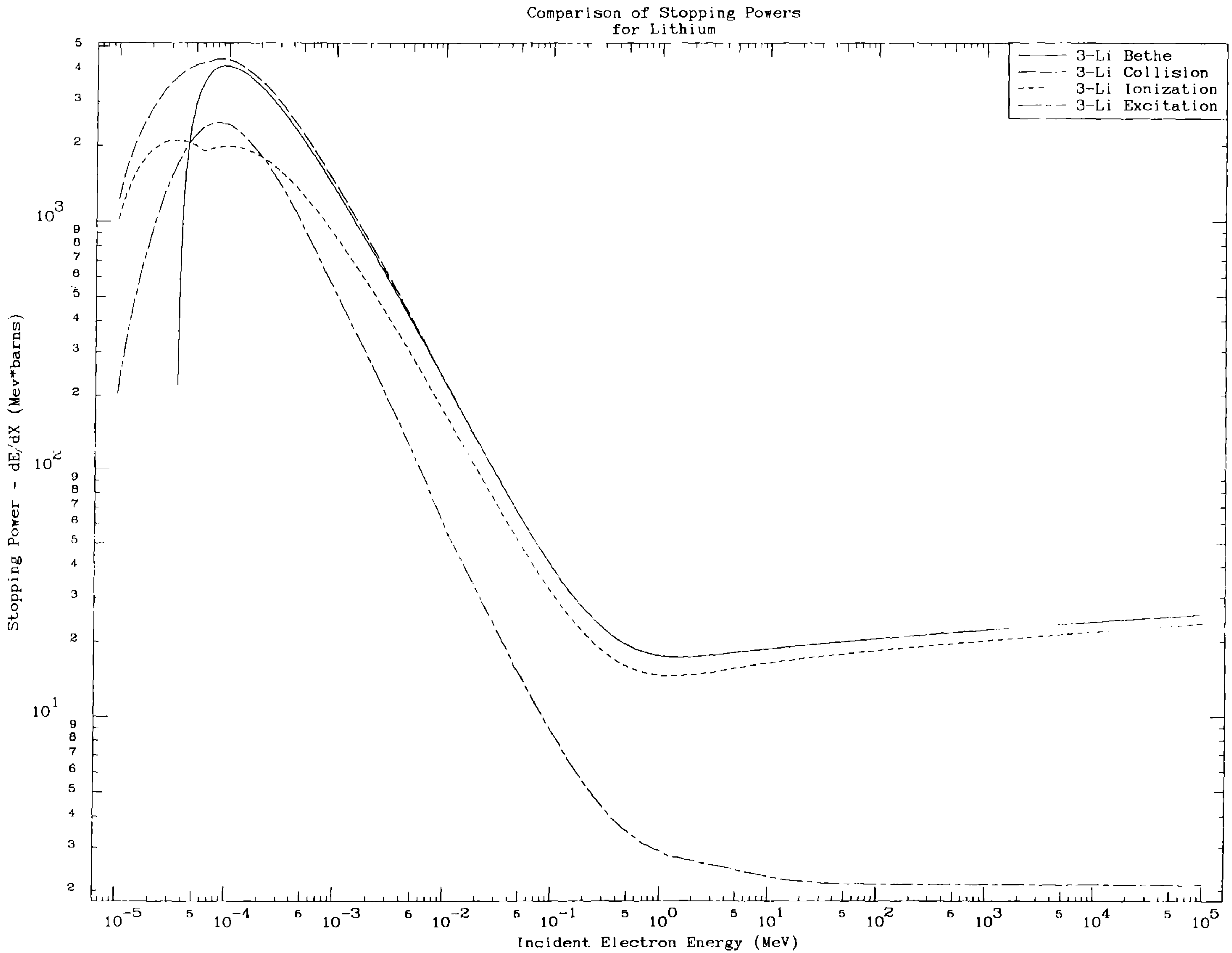


Comparison of Stopping Powers
for Helium
2-He Bethe
2-He Collision
2-He Ionization
2-He Excitation
Stopping Power - dE/dX (Mev*barns)
Incident Electron Energy (MeV)

47



Comparison of Stopping Powers
for Lithium
3-Li Bethe
3-Li Collision
3-Li Ionization
3-Li Excitation
Stopping Power - dE/dX (Mev*barns)
Incident Electron Energy (MeV)

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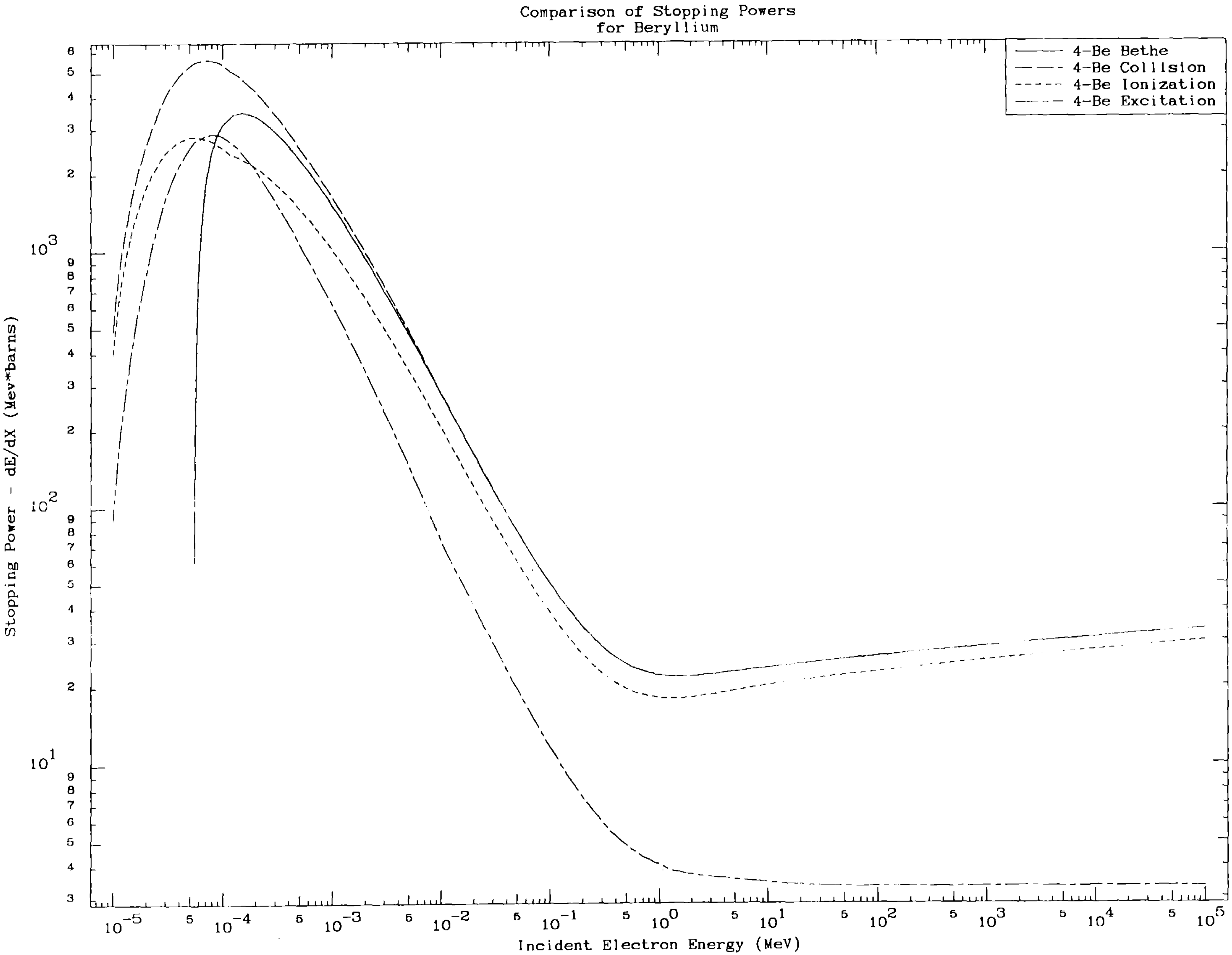

Comparison of Stopping Powers
for Beryllium
4-Be Bethe
4-Be Collision
4-Be Ionization
4-Be Excitation
Stopping Power - dE/dX (Mev*barns)
Incident Electron Energy (MeV)

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Multiple Plots per Page

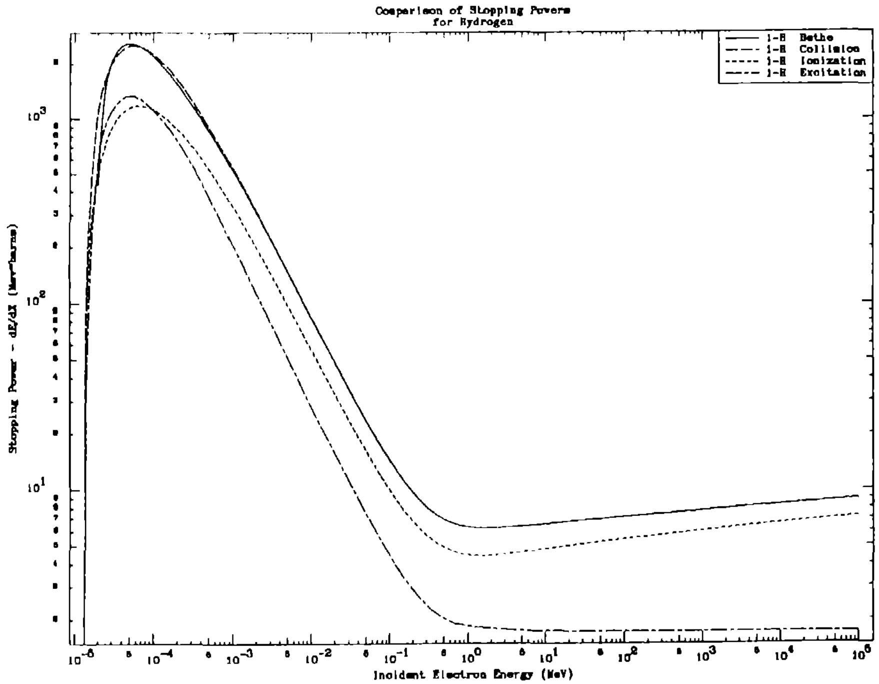
When you have a series of similar plots and each does not contain too much information this code can be used to plot a number of plots on each page.

For example, the preceding four pages of plots could have been condensed onto a single page. The only change in the input parameters would be to specify 2 by 2 plots per page (cols. 45-66 on line 1).

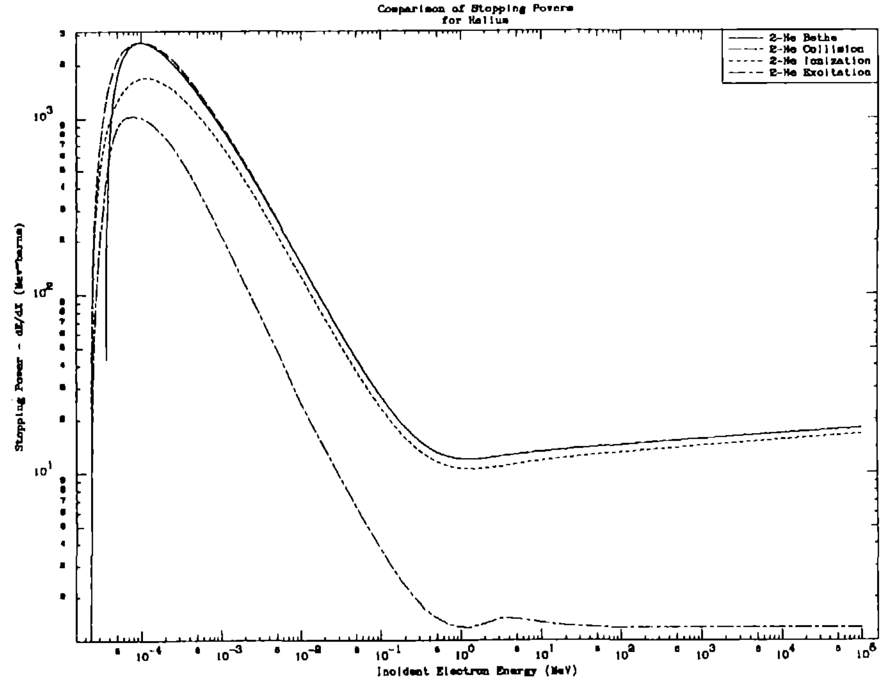
Note, that in this case there is an advantage in presenting the results in this form, since it allows us to see the atomic number (Z) dependence of the stopping power, without having to consult a number of different pages.

```
    0.00000   13.50000    0.00000   10.0              2          2 1.0
          4          0          0          0          0          0   0
Incident Electron Energy (MeV)
Stopping Power - dE/dX (Mev*barns)
Comparison of Stopping Powers
for Hydrogen
                                0          0          0          0
                                0          0          0          0
Comparison of Stopping Powers
for Helium
                                0          0          0          0
                                0          0          0          0
Comparison of Stopping Powers
for Lithium
                                0          0          0          0
                                0          0          0          0
Comparison of Stopping Powers
for Beryllium
                                0          0          0          0
                                0          0          0          0
```

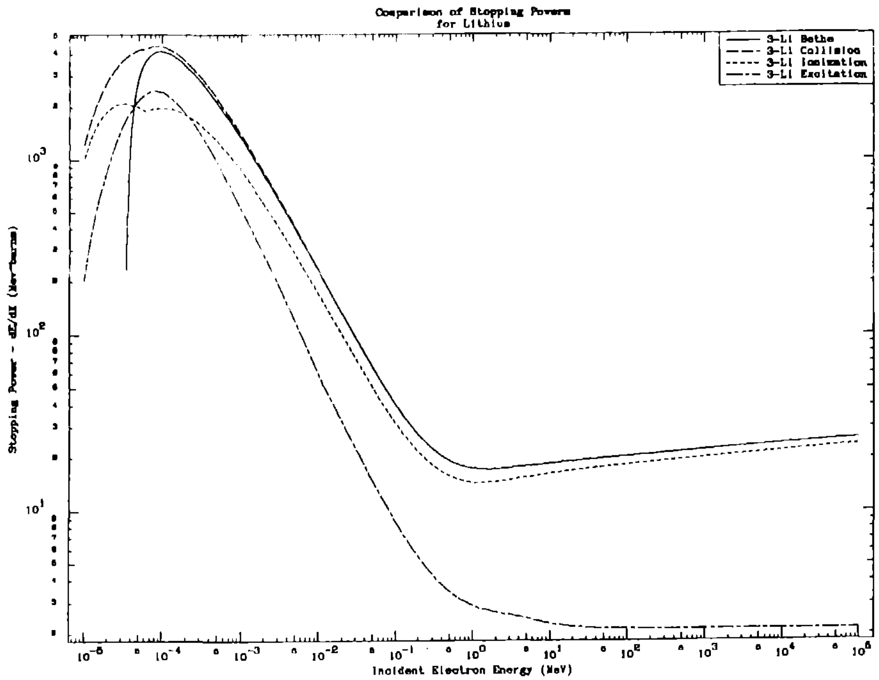
A second page of four plots are presented here. The second page contains exactly the same data as on the first page. The only difference is that for the second page a character size multiplier of 1.5 (cols. 67-70 on first input line) has been used. The basic limitation on the number of plots per pages is that with more plots per page the characters become progressively smaller and are eventually impossible to read. This effect can be at least partially offset by using larger characters for multiple plots per page.



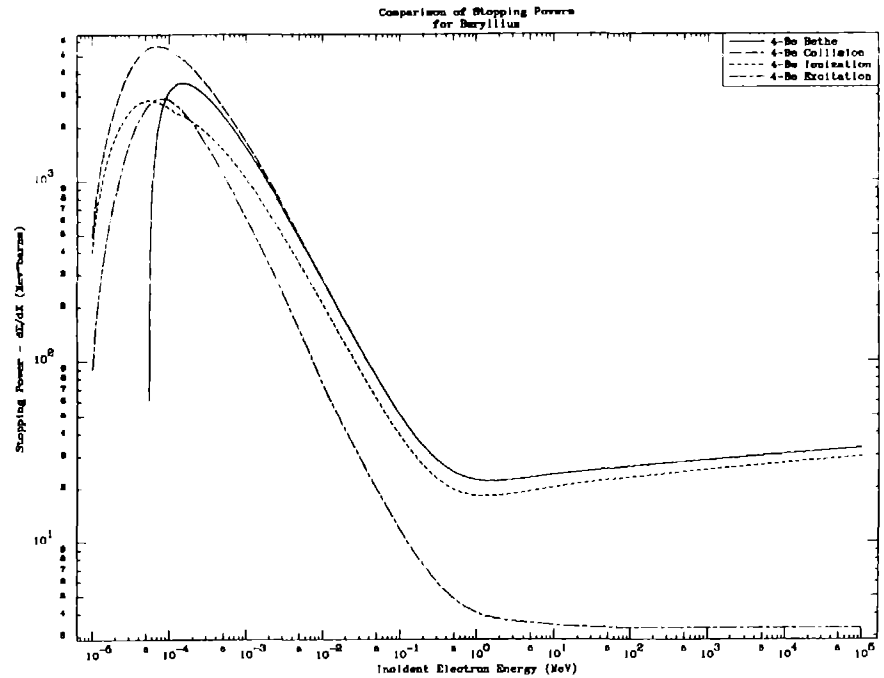
Comparison of Stopping Powers
for Hydrogen
1-H Bethe
1-H Collision
1-H Ionization
1-H Excitation
Stopping Power - dE/dX (Mev*barns)
Incident Electron Energy (MeV)



Comparison of Stopping Powers
for Helium
2-He Bethe
2-He Collision
2-He Ionization
2-He Excitation
Stopping Power - dE/dX (Mev*barns)
Incident Electron Energy (MeV)

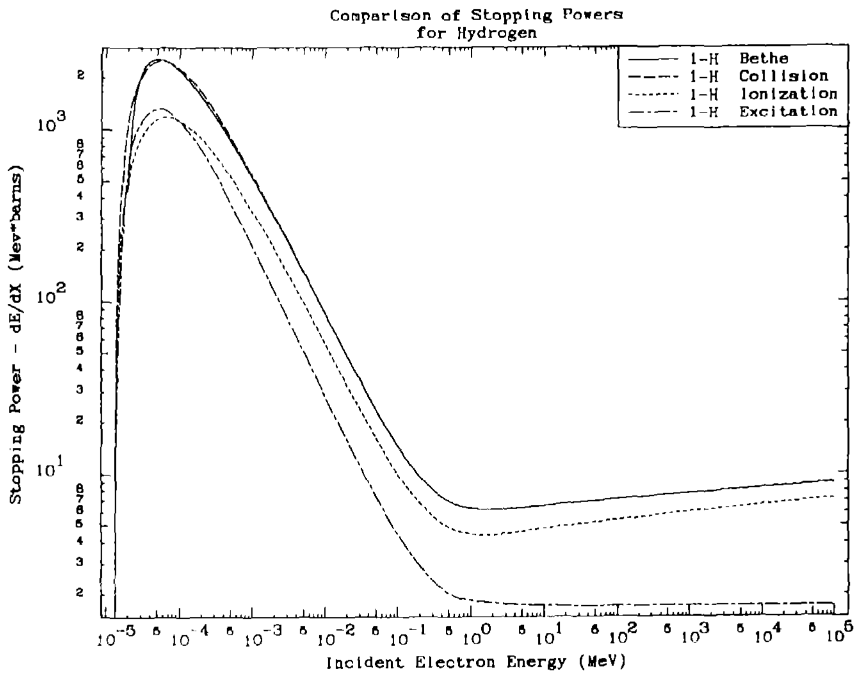


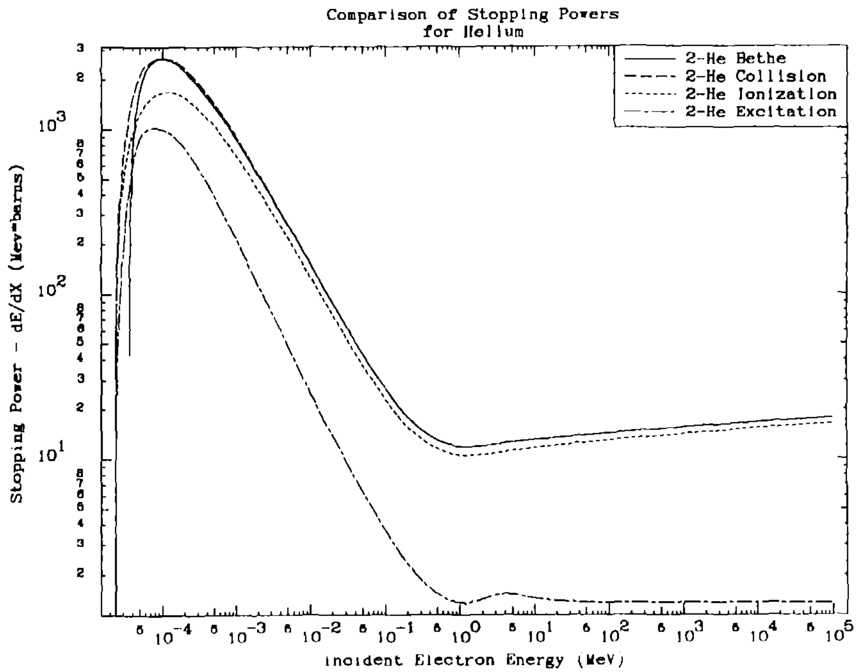
Comparison of Stopping Powers
for Lithium
3-Li Bethe
3-Li Collision
3-Li Ionization
3-Li Excitation
Stopping Power - dE/dX (Mev*barns)
Incident Electron Energy (MeV)

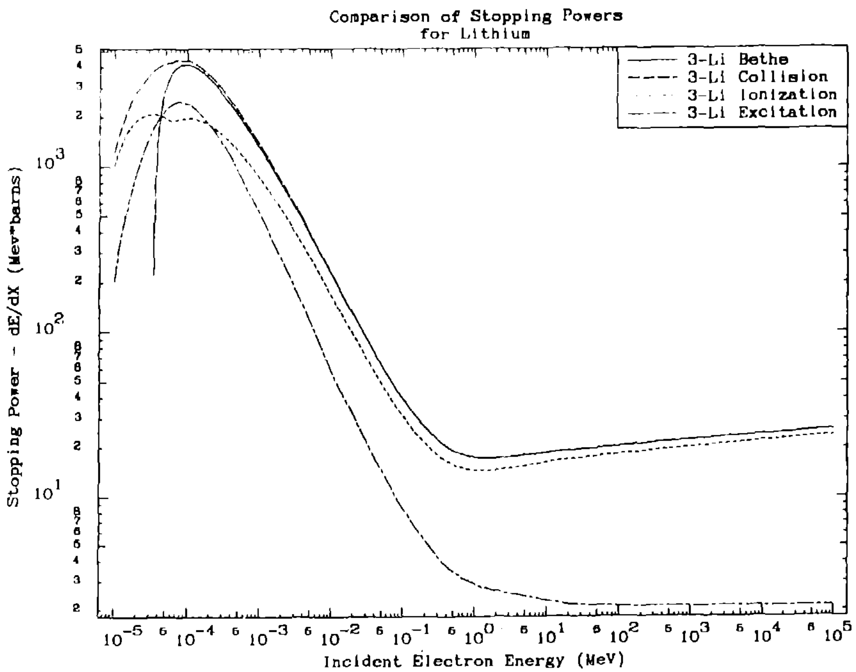


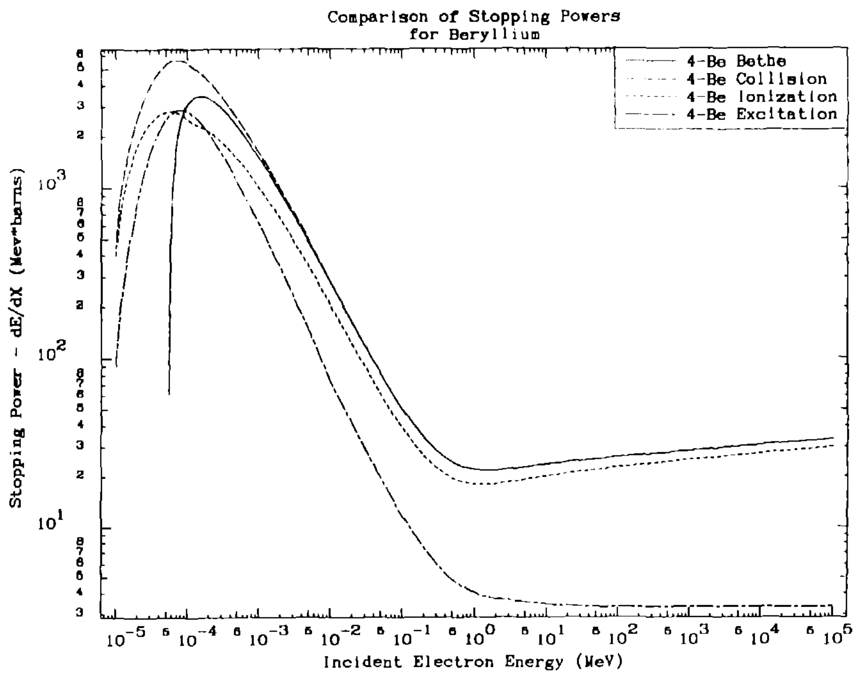
Comparison of Stopping Powers
for Beryllium
4-Be Bethe
4-Be Collision
4-Be Ionization
4-Be Excitation
Stopping Power - dE/dX (Mev*barns)
Incident Electron Energy (MeV)

51


Comparison of Stopping Powers
for Hydrogen
1-H Bethe
1-H Collision
1-H Ionization
1-H Excitation
Stopping Power - dE/dX (Mev*barns)
Incident Electron Energy (MeV)


Comparison of Stopping Powers
for Helium
2-He Bethe
2-He Collision
2-He Ionization
2-He Excitation
Stopping Power - dE/dX (Mev*barns)
Incident Electron Energy (MeV)


Comparison of Stopping Powers
for Lithium
3-Li Bethe
3-Li Collision
3-Li Ionization
3-Li Excitation
Stopping Power - dE/dX (Mev*barns)
Incident Electron Energy (MeV)


Comparison of Stopping Powers
for Beryllium
4-Be Bethe
4-Be Collision
4-Be Ionization
4-Be Excitation
Stopping Power - dE/dX (Mev*barns)
Incident Electron Energy (MeV)

Zoom and Ratios

Two of the most important capabilities of this code are the ability,

1) *to select any X and/or Y ranges which you wish to "see" - this is called ZOOMING. This option allows you to examine data in any detail that you consider to be necessary.*

2) *to define the ratio of all other curves and all sets of data points to the first (standard) curve, and to quantitatively define the position and magnitude of the maximum difference between the first curve and all the other data. In comparing data, plots can be extremely misleading in making different sets of data appear to be very similar - particularly when log scaling scaling is used in the Y dimension. By presenting the ratio one can not only quantitatively define differences, but one can also more clearly "see" trends in differences.*

The following example input will produce the three plots which follow this page. The plots include,

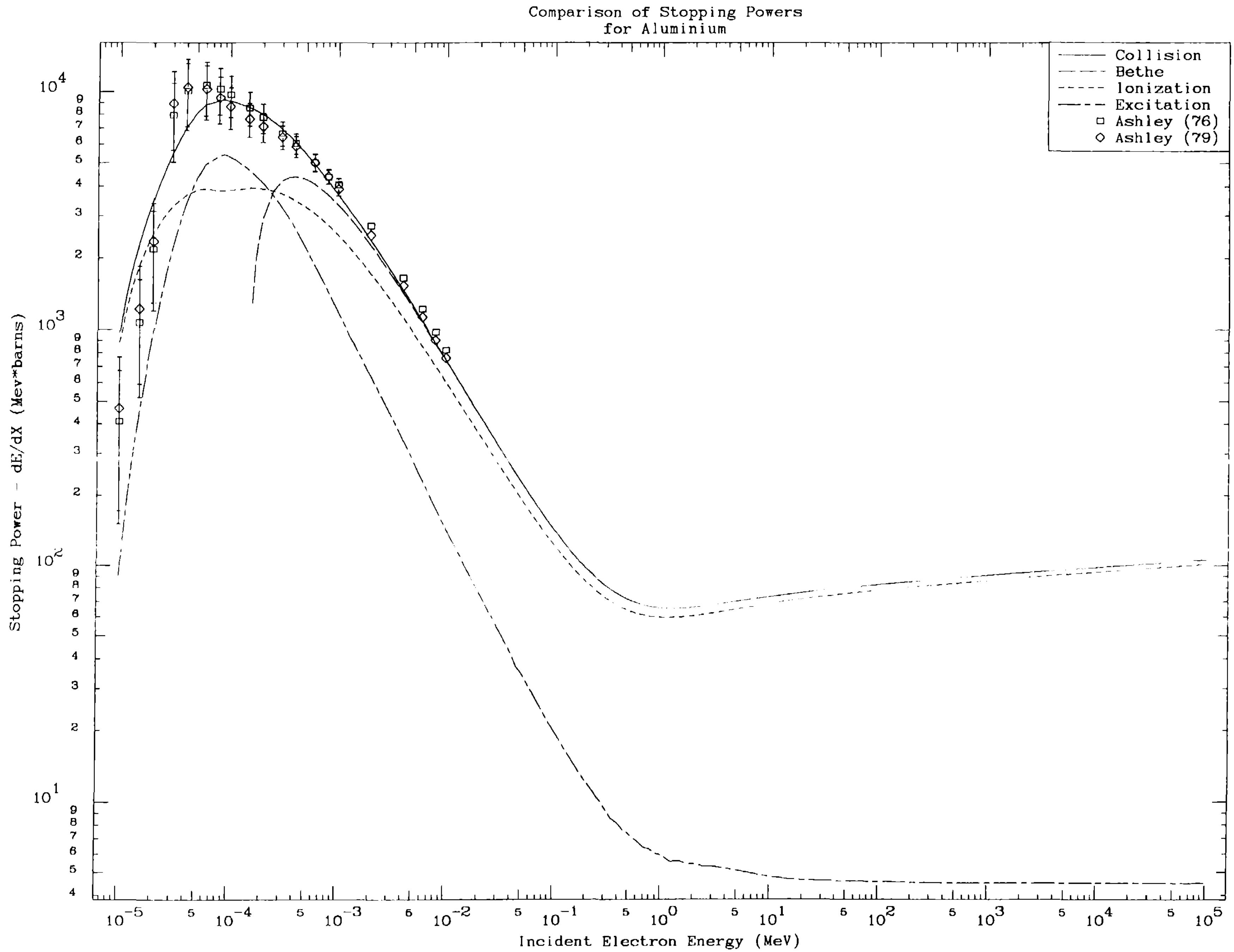
1) *4 curves and 2 sets of points are read and kept in core for all plots. The first plot is of the entire X and Y range of data using a log-log plot and including Y error bars for the sets of points.*

2) *The second plot is of the X range up to 0.01; otherwise all of the parameters are the same as the first plot. This is an example of specifying the X and/or Y range to create a ZOOMED plot of a portion of the data.*

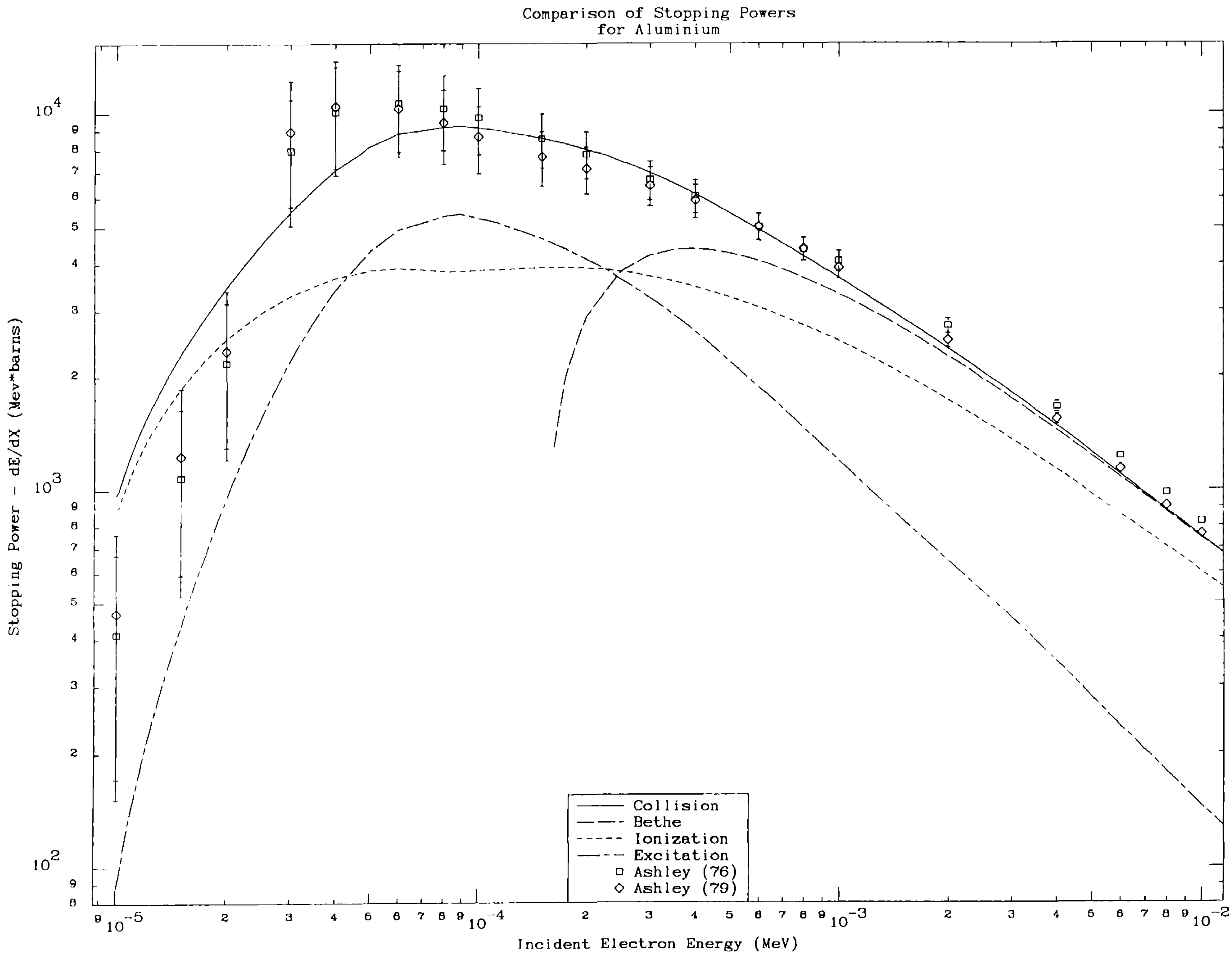
3) *The third plot uses all of the same parameters as for the second plot, except that the RATIO option has been turned on to show the ratio of everything to the first curve. In order to do this it was necessary to insert a blank line after the lines for the second plot and to then start all over again defining the plot layout, etc.*

```
   0.00000    13.50000    0.00000    10.0                1             1 1.0
        -4          -2          0          0             0             0   0
Incident Electron Energy (MeV)
Stopping Power - dE/dX (Mev*barns)
Comparison of Stopping Powers
for Aluminium
                                0          2             0             0
                                1          2             0             0
Comparison of Stopping Powers
for Aluminium
           1.00000- 2           0          2             0             0
                                1          2             0             0

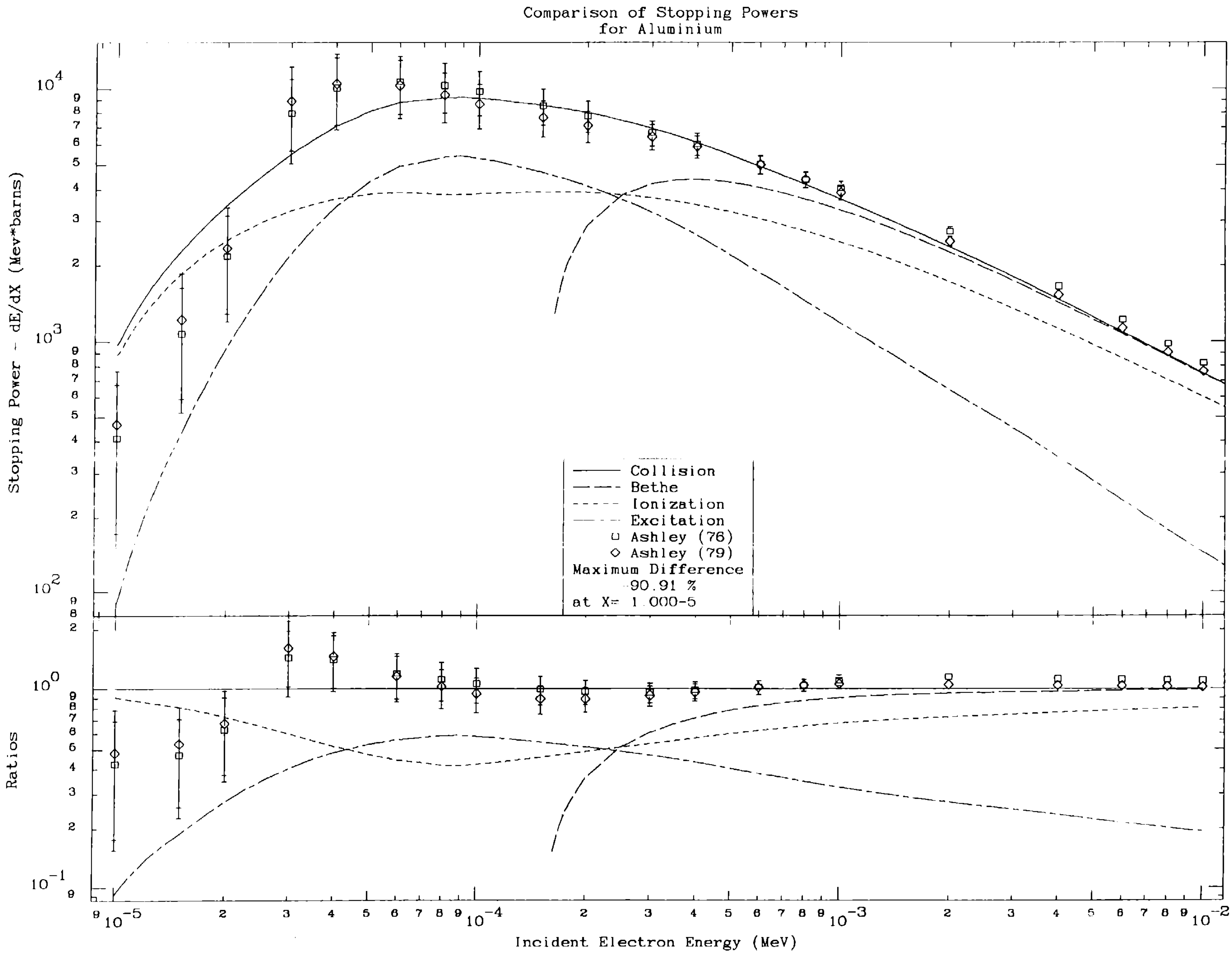
   0.00000    13.50000    0.00000    10.0                1             1 1.0
        -4          -2          0          0             1             0   0
Incident Electron Energy (MeV)
Stopping Power - dE/dX (Mev*barns)
Comparison of Stopping Powers
for Aluminium
           1.00000- 2           0          2             0             0
                                1          2             0             0
```


Comparison of Stopping Powers
for Aluminium
Collision
Bethe
Ionization
Excitation
Ashley (76)
Ashley (79)
Stopping Power - dE/dX (Mev*barns)
Incident Electron Energy (MeV)

54



Comparison of Stopping Powers
for Aluminium
Stopping Power - dE/dX (Mev*barns)
Incident Electron Energy (MeV)
Collision
Bethe
Ionization
Excitation
Ashley (76)
Ashley (79)



Comparison of Stopping Powers
for Aluminium
Stopping Power - dE/dX (Mev*barns)
Ratios
Incident Electron Energy (MeV)
Collision
Bethe
Ionization
Excitation
Ashley (76)
Ashley (79)
Maximum Difference
90.91 %
at X= 1.000-5

56

Rotate Plots and Multiple Plots per Page

The following example uses exactly the same data that appeared on the preceding three plots. The only difference is in the presentation of the data.

1) *All of the plots have been ROTATED by specifying a negative upper X limit for the size of the plots (cols. 12-22 on first line).*

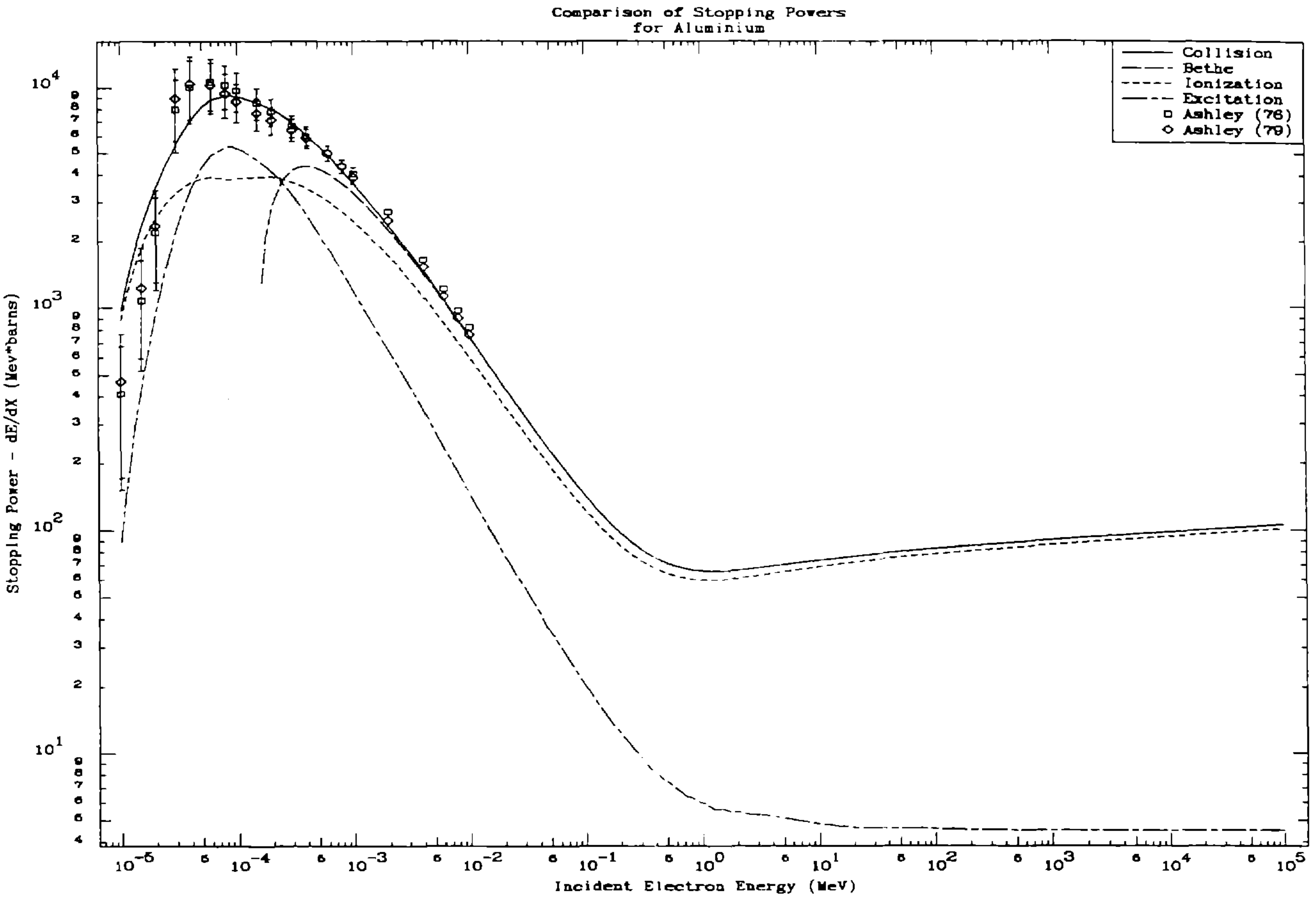
2) *The first two plots are presented on a single page by specifying 1 by 2 plots (cols. 45-66 on first line).*

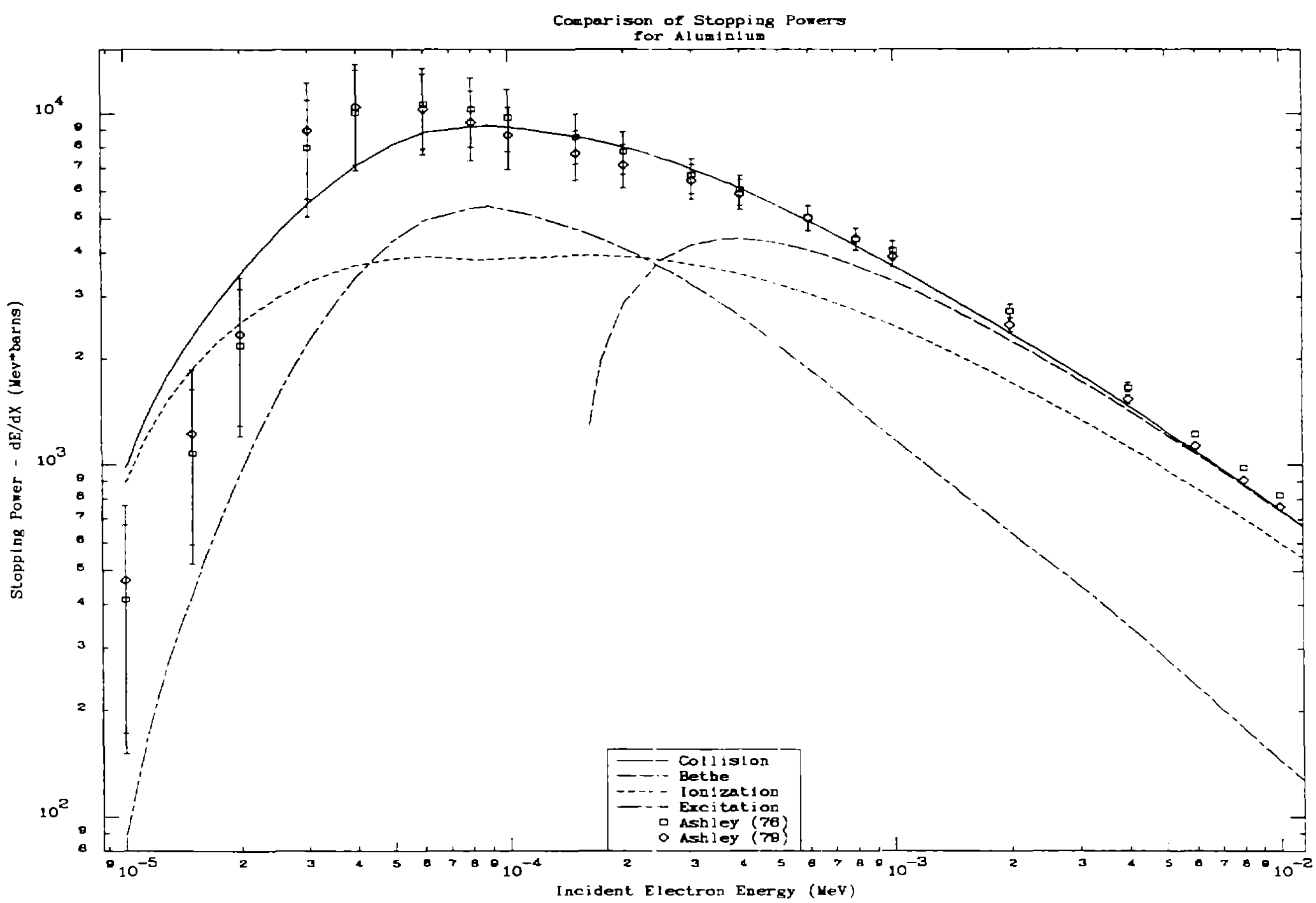
3) *The third plot is presented as one plot per page.*

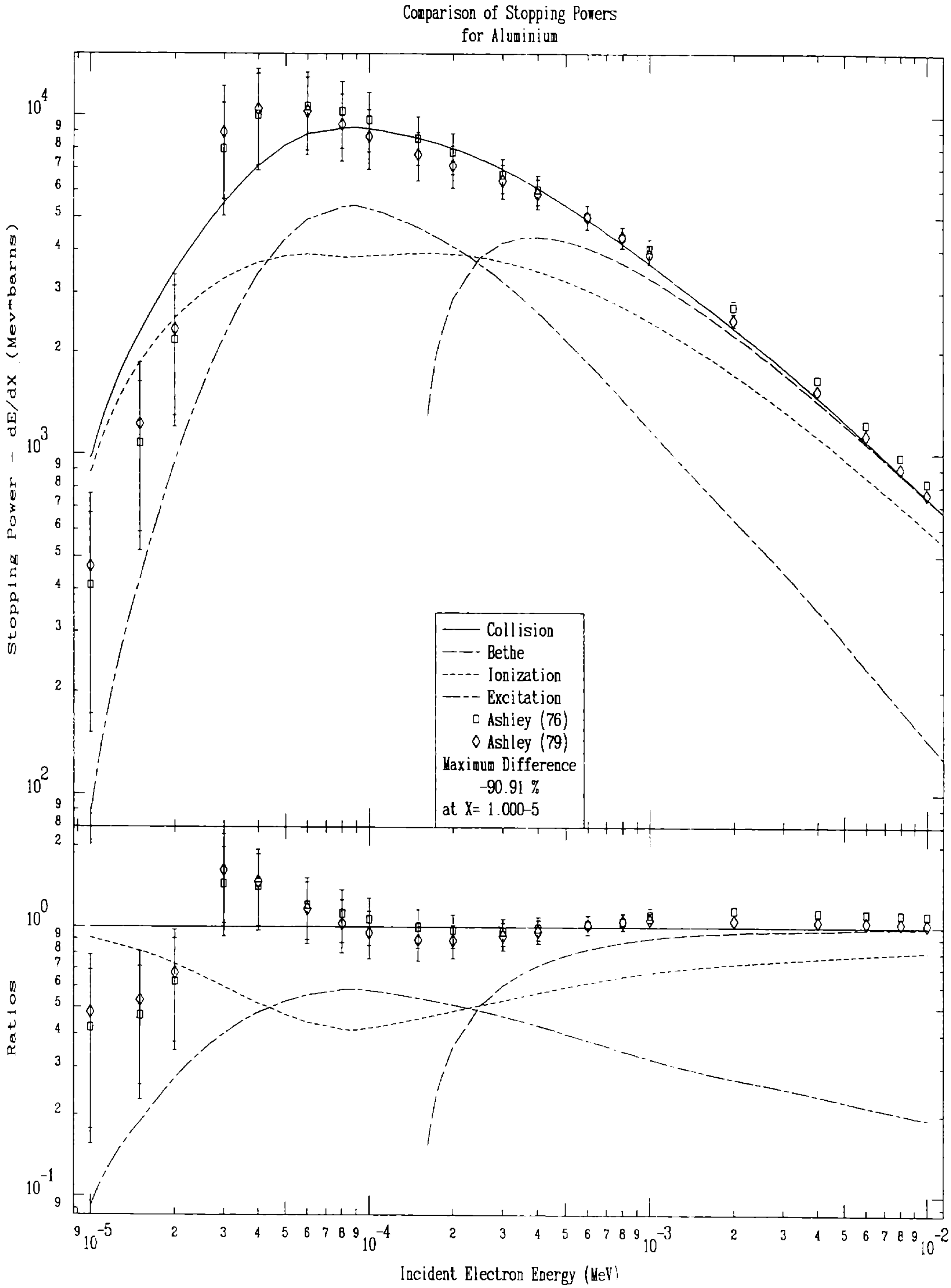
Except for these modifications the presentation of the plots is identical to that of the preceding three plots.

```
    0.00000  -13.50000    0.00000   10.0                   1          2 1.0
         -4         -2          0          0               0          0    0
Incident Electron Energy (MeV)
Stopping Power - dE/dX (Mev*barns)
Comparison of Stopping Powers
for Aluminium
                                0          2          0          0
                                1          2          0          0
Comparison of Stopping Powers
for Aluminium
            1.00000- 2          0          2          0          0
                                1          2          0          0

    0.00000  -13.50000    0.00000   10.0                   1          1 1.0
         -4         -2          0          0               1          0    0
Incident Electron Energy (MeV)
Stopping Power - dE/dX (Mev*barns)
Comparison of Stopping Powers
for Aluminium
            1.00000- 2          0          2          0          0
                                1          2          0          0
```


Comparison of Stopping Powers
for Aluminium
Collision
Bethe
Ionization
Excitation
Ashley (76)
Ashley (79)
Stopping Power - dE/dX (Mev*barns)
Incident Electron Energy (MeV)


Comparison of Stopping Powers
for Aluminium
Collision
Bethe
Ionization
Excitation
Ashley (76)
Ashley (79)
Stopping Power - dE/dX (Mev*barns)
Incident Electron Energy (MeV)


Comparison of Stopping Powers
for Aluminium
Stopping Power - dE/dX (Mev-barns)
Ratios
Collision
Bethe
Ionization
Excitation
Ashley (76)
Ashley (79)
Maximum Difference
-90.91 %
at X= 1.000-5
Incident Electron Energy (MeV)

Linear vs. Log Scaling

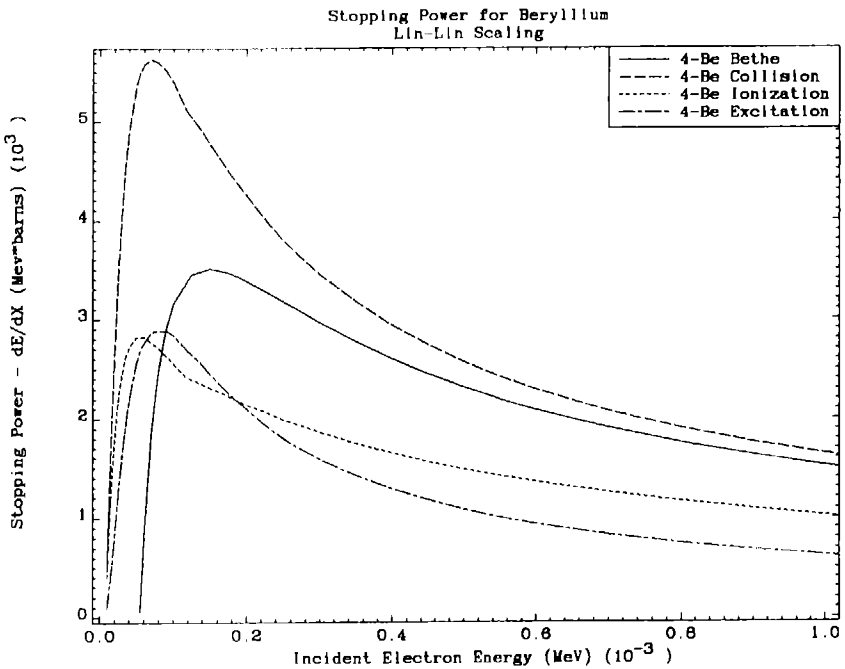
Normally the automatic scaling conventions built into the code are adequate to select either linear or log scaling for the X and Y axis. The automatic scaling convention is extremely simple: if the X or Y range is positive and the maximum of the range is more than ten times the minimum, log scaling is used. Otherwise linear scaling is used. Automatic scaling is indicated by specifying blank or 0 in cols. 34-44 of the third (for X) or fourth (for Y) input line for each plot.

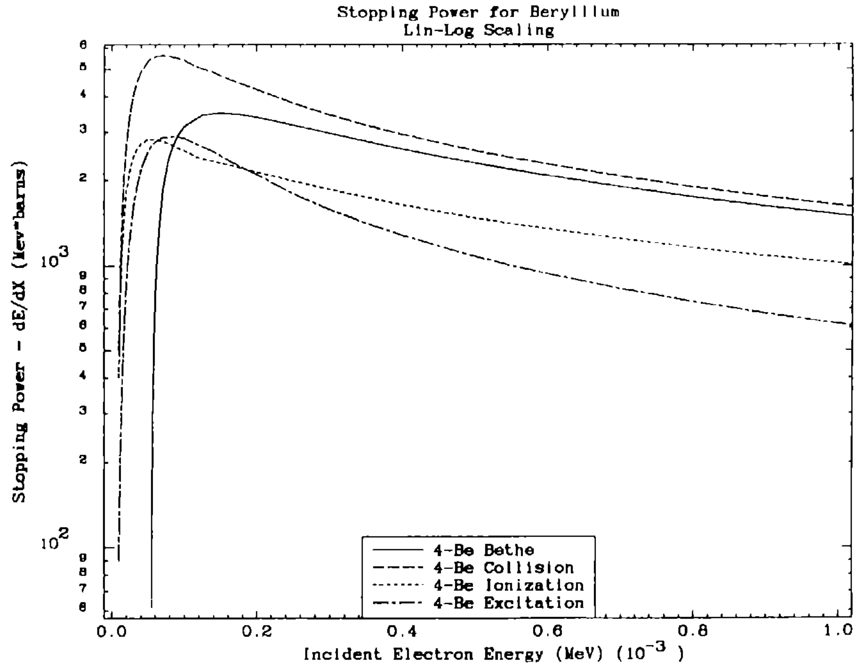
However, occasionally you may wish to force the scaling to be either linear or log. The following page presents four plots to illustrate the results obtained using exactly the same data on each plot and using all combinations of X and Y linear or log scaling.

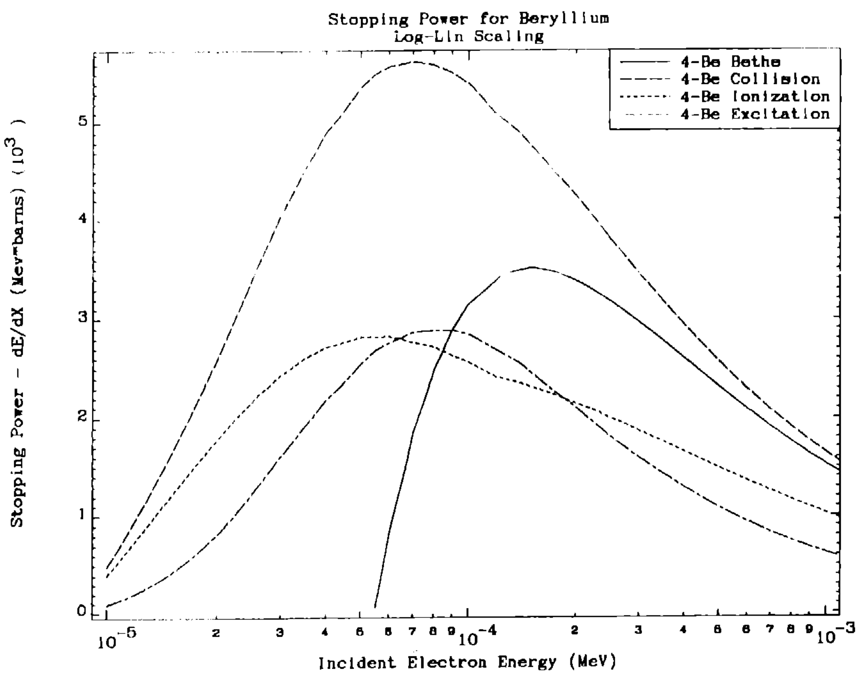
Note, on the input lines below how the scaling is forced by specifying either 1 (linear) or 2 (log) in cols. 34-44 of the third (for X) or fourth (for Y) input line for each plot. When log scaling is forced by input any non-positive values are ignored and not considered in defining the range of the plot, i.e., log scaling is forced by only considering positive values to plot.

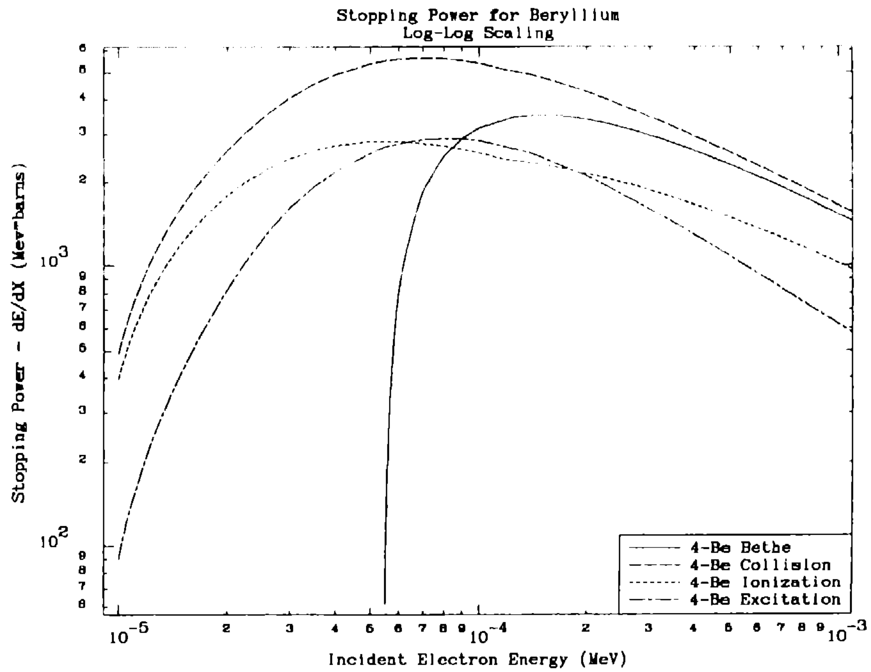
For these plots the character size has been increased by a factor of 1.5 (cols. 67-70 on the first input line) and the upper limit of the X range has been set to 0.001. Note, on the plots for linear scaling the axis annotation will always be in normal form containing numbers in the range 1 to 999. In order to do this the axis labels may have a scale factor added to them, e.g., on the enclosed plot where the Y axis label includes a scale factor of 10**3 and the X axis label a scale factor of 10**(-3).

```
    0.00000   13.50000    0.00000   10.0              2          2 1.5
         -4          0          0          0          0          0   0
Incident Electron Energy (MeV)
Stopping Power - dE/dX (Mev*barns)
Stopping Power for Beryllium
Lin-Lin Scaling
            1.00000- 3          0          1          0          0
                                0          1          0          0
Stopping Power for Beryllium
Lin-Log Scaling
            1.00000- 3          0          1          0          0
                                0          2          0          0
Stopping Power for Beryllium
Log-Lin Scaling
            1.00000- 3          0          2          0          0
                                0          1          0          0
Stopping Power for Beryllium
Log-Log Scaling
            1.00000- 3          0          2          0          0
                                0          2          0          0
```


Stopping Power for Beryllium
Lin-Lin Scaling
4-Be Bethe
4-Be Collision
4-Be Ionization
4-Be Excitation
Stopping Power - dE/dX (Mev*barns) (10^3)
Incident Electron Energy (MeV) (10^-3)


Stopping Power for Beryllium
Lin-Log Scaling
4-Be Bethe
4-Be Collision
4-Be Ionization
4-Be Excitation
Stopping Power - dE/dX (Mev*barns)
Incident Electron Energy (MeV) (10^-3)


Stopping Power for Beryllium
Log-Lin Scaling
4-Be Bethe
4-Be Collision
4-Be Ionization
4-Be Excitation
Stopping Power - dE/dX (Mev*barns) (10^3)
Incident Electron Energy (MeV)


Stopping Power for Beryllium
Log-Log Scaling
4-Be Bethe
4-Be Collision
4-Be Ionization
4-Be Excitation
Stopping Power - dE/dX (Mev*barns)
Incident Electron Energy (MeV)

Linear vs. Log Interpolation

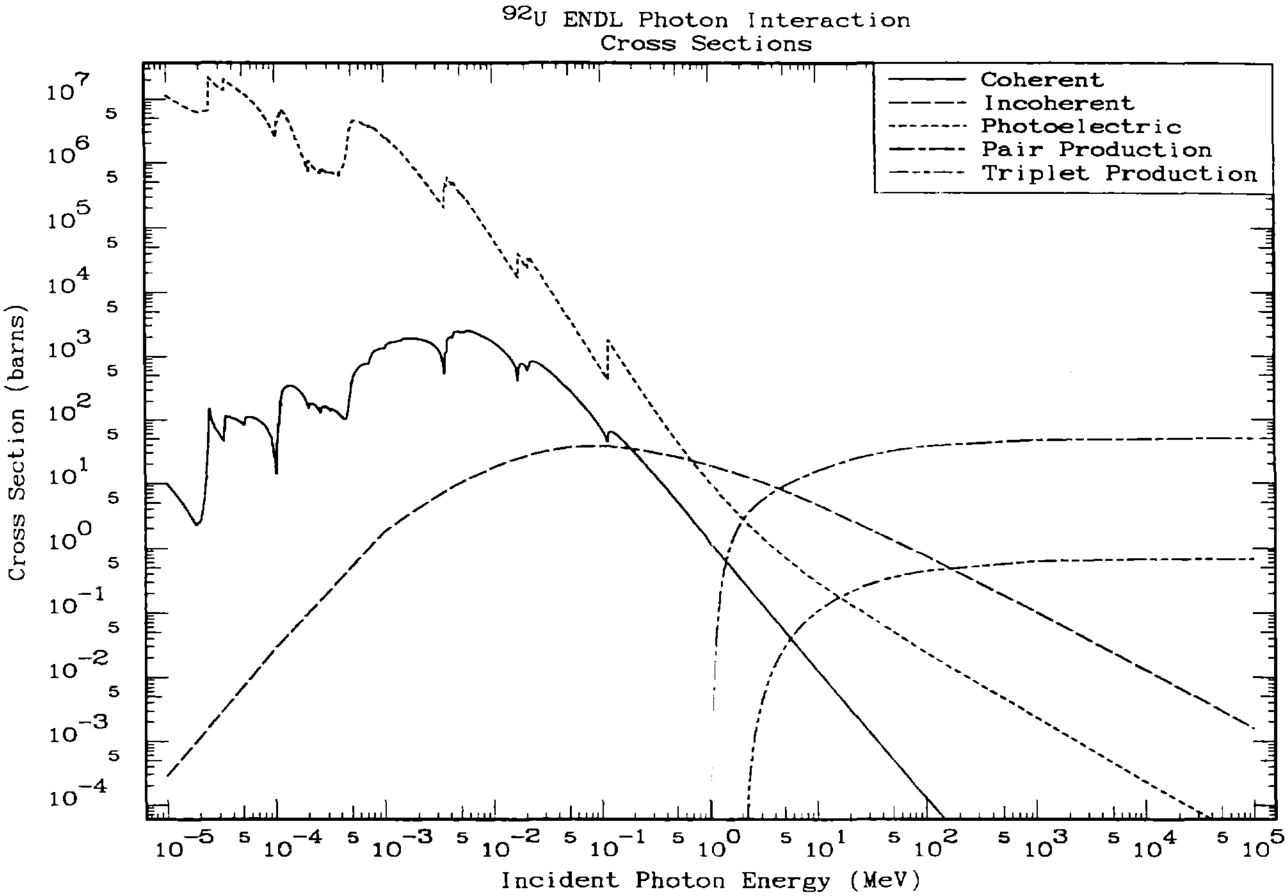
The preceding example illustrated the effect of presenting exactly the same data using either linear or log scaling in the X and/or Y directions. Here we illustrate the effect of using either linear or log interpolation to define data between the points where it is tabulated.

The ENDL photon interaction cross sections are defined to be log-log interpolable between tabulated values. The plot on the upper half of the following page illustrates the results obtained using log-log interpolation between tabulated values. The input parameters indicate log interpolation for X and Y by using -2 in columns 34-44 of the 7-th (for X) and 8-th (for Y) input lines. At high photon energies the cross sections all follow simple power laws, i.e., vary as E**n. As such, at high energies the cross sections can be represented by just a few widely spaced tabulated energy points with log-log interpolation between tabulated values.

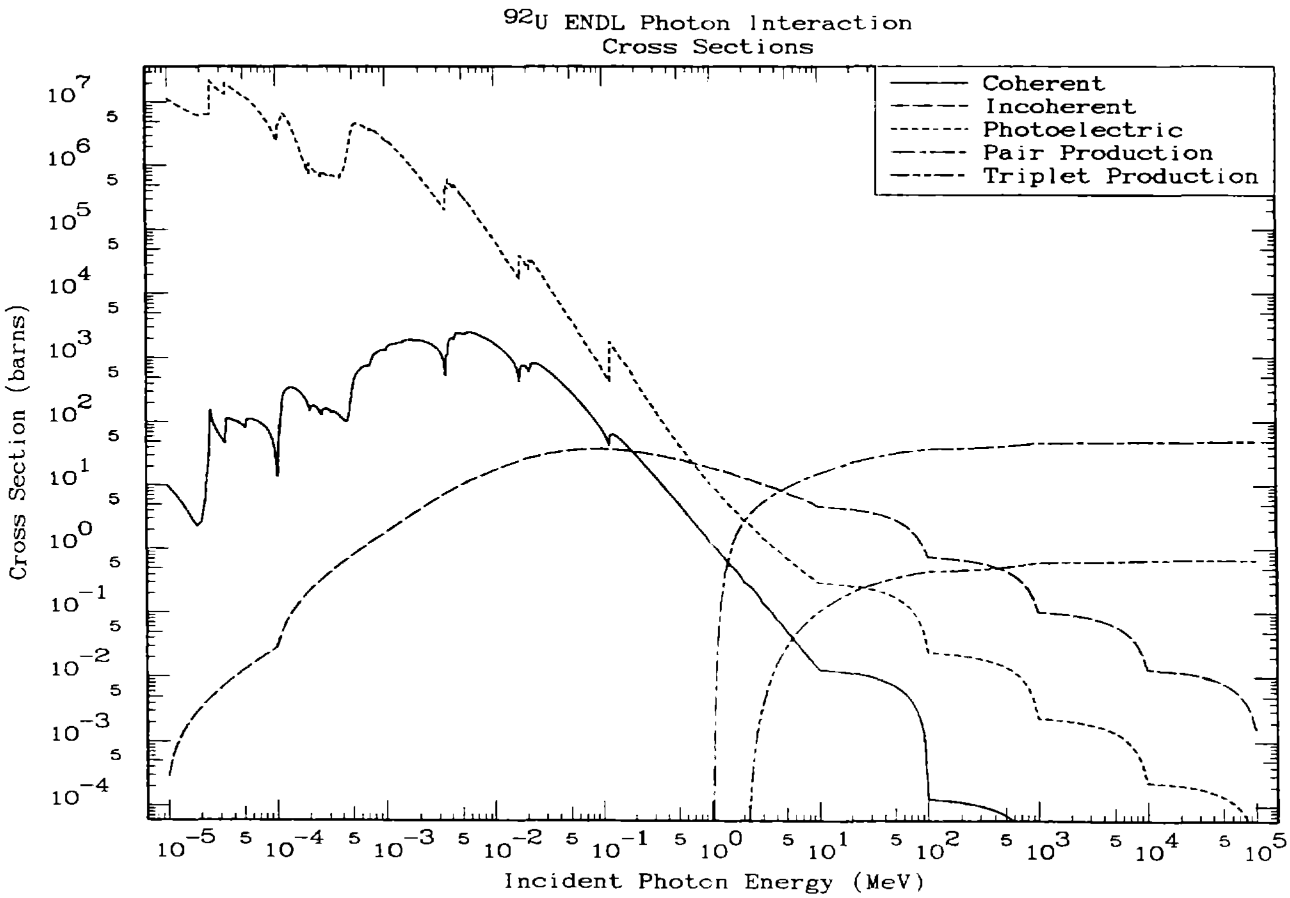
The plot in the lower half of the following page illustrates the results obtained using linear-linear interpolation between tabulated values. Note, the "bumps" or "bubbles" at high energy, due to improperly interpolating between the tabulated values. In this example improperly interpolating can lead to values of the cross section which are an order of magnitude or more too large at some energies; needless to say similar results will occur in integrals.

Hopefully this example clearly illustrates the importance of properly interpolating data, not only in order to obtain acceptable plots using this code, but even more importantly in using data in applications, e.g., in a Monte Carlo transport code linearly interpolating high energy photon interaction cross sections can overestimate the actual cross sections by an order of magnitude or more.

```
    0.00000  -13.50000    0.00000   10.0                  1          2 1.5
        -30          0          0          0          0         -2    0
Incident Photon Energy (MeV)
Cross Section (barns)
{9{2 U ENDL Photon Interaction
Cross Sections
                                0         -2          0          0
 1.00000- 4                     0         -2          0          0
{9{2 U ENDL Photon Interaction
Cross Sections
                                0          2          0          0
 1.00000- 4                     0          2          0          0
```



92U ENDL Photon Interaction
Cross Sections
Coherent
Incoherent
Photoelectric
Pair Production
Triplet Production
Cross Section (barns)
Incident Photon Energy (MeV)



92U ENDL Photon Interaction
Cross Sections
Coherent
Incoherent
Photoelectric
Pair Production
Triplet Production
Cross Section (barns)
Incident Photon Energy (MeV)

Line Thicknesses

The following example illustrates the effect of using line thicknesses 0 through -5 (thick lines, but not characters). Line thickness is controlled by cols. 56-66 of the second input line. This example also includes a border around each plot (cols. 23-33 of the second input line), a solid-dash grid (cols. 34-44 of the second input line) and log-log interpolation between tabulated data points (cols. 34-44 of the 7-th [for X] and 8-th [for Y] input lines - in this case this option is set to -2 to force log scaling and interpolation).

In this example it can be seen that since we decided that we need a grid on the plot, at thickness 0 it is difficult to see the actual curves; this becomes even more true when any portion of a curve approaches being horizontal or vertical. Thickness can be used to make the curves stand out from the background and generally make the plots more acceptable for use in publications.

Line thicknesses should be used carefully, since it can be quite expensive and time consuming to produce plots with thick lines. For low resolution plotting devices (e.g., pen and paper plotters) it can also be a waste of time, since the small offset in strokes used by this code to create line thickness may be less than the resolution of your plotter.

On low resolution plotters line thickness should not be used. On high resolution plotters generally good quality plots can be obtained using line thickness -2. For an illustration of extensive results using a dashed grid and line thickness -2 see UCRL-50400, Vol. 6 and 30, the documentation for the Livermore photon and electron interaction data.

```
    0.00000   13.50000    0.00000   10.0                1           1 1.0
         -5          0          1           4           0           0   0
Incident Neutron Energy (MeV)
Cross Section (barns)
Uranium Photon Interaction
Cross Sections
             1.00000+ 2           0          -2           0           0
 1.00000- 3                       0          -2           0           0

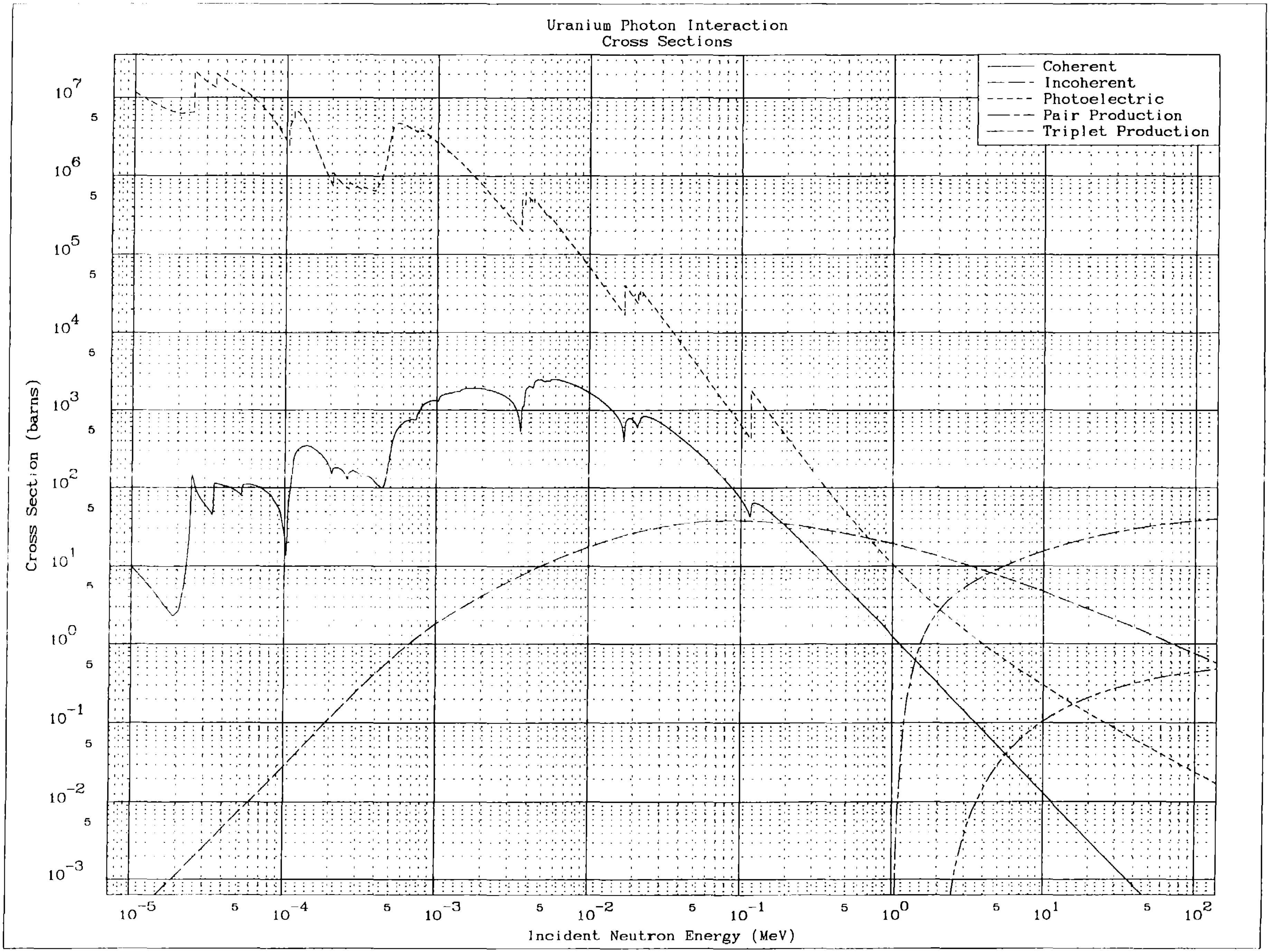
    0.00000   13.50000    0.00000   10.0                1           1 1.0
         -5          0          1           4           0          -1   0
Incident Neutron Energy (MeV)
Cross Section (barns)
Uranium Photon Interaction
Cross Sections
             1.00000+ 2           0          -2           0           0
 1.00000- 3                       0          -2           0           0

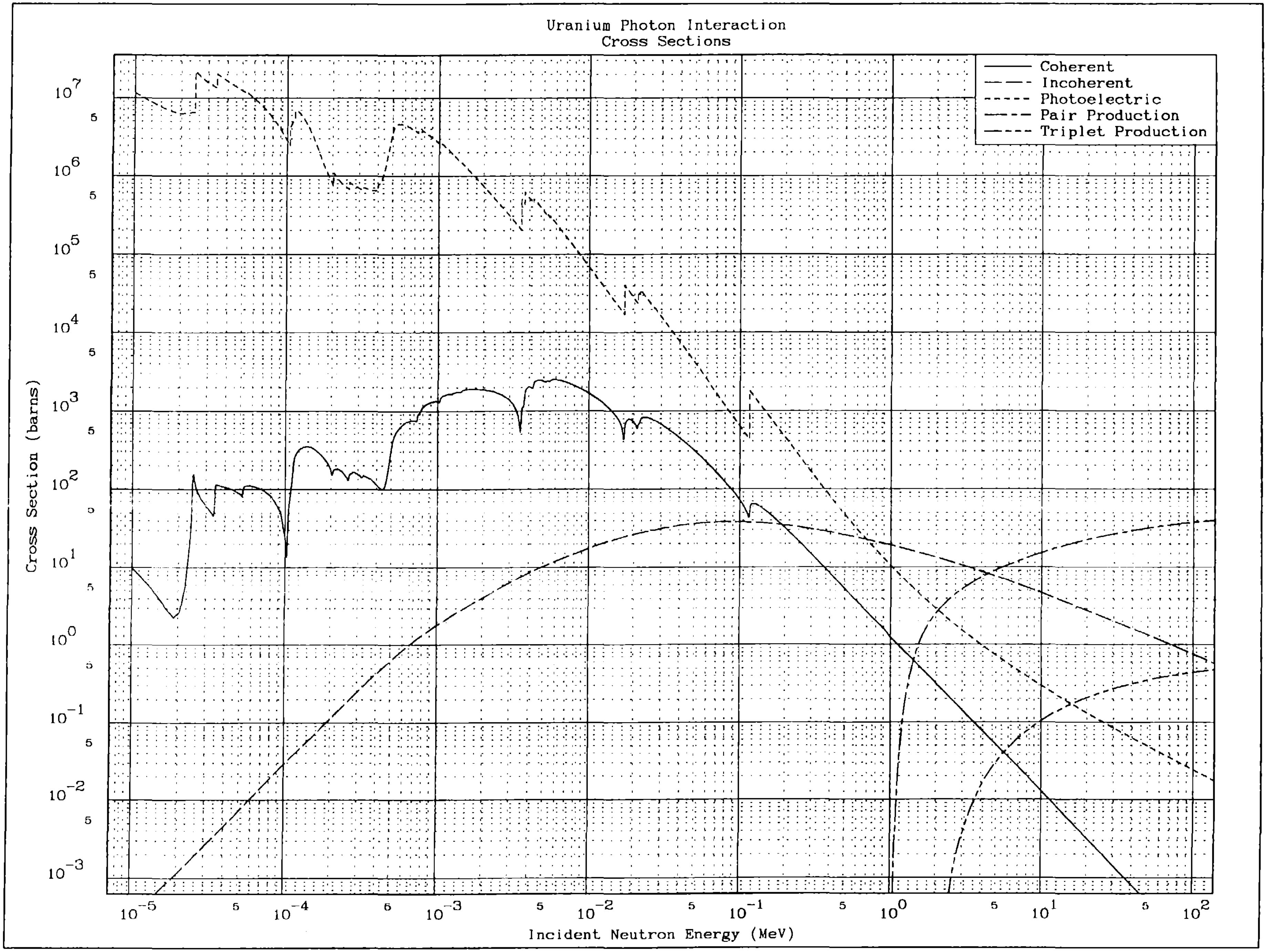
    0.00000   13.50000    0.00000   10.0                1           1 1.0
         -5          0          1           4           0          -2   0
Incident Neutron Energy (MeV)
Cross Section (barns)
Uranium Photon Interaction
Cross Sections
             1.00000+ 2           0          -2           0           0
 1.00000- 3                       0          -2           0           0

    0.00000   13.50000    0.00000   10.0                1           1 1.0
         -5          0          1           4           0          -3   0
Incident Neutron Energy (MeV)
Cross Section (barns)
Uranium Photon Interaction
Cross Sections
             1.00000+ 2           0          -2           0           0
 1.00000- 3                       0          -2           0           0

    0.00000   13.50000    0.00000   10.0                1           1 1.0
         -5          0          1           4           0          -4   0
Incident Neutron Energy (MeV)
Cross Section (barns)
Uranium Photon Interaction
Cross Sections
             1.00000+ 2           0          -2           0           0
 1.00000- 3                       0          -2           0           0

    0.00000   13.50000    0.00000   10.0                1           1 1.0
         -5          0          1           4           0          -5   0
Incident Neutron Energy (MeV)
Cross Section (barns)
Uranium Photon Interaction
Cross Sections
             1.00000+ 2           0          -2           0           0
 1.00000- 3                       0          -2           0           0
```


Uranium Photon Interaction
Cross Sections
Coherent
Incoherent
Photoelectric
Pair Production
Triplet Production
Cross Section (barns)
Incident Neutron Energy (MeV)



Uranium Photon Interaction
Cross Sections
Coherent
Incoherent
Photoelectric
Pair Production
Triplet Production
Cross Section (barns)
Incident Neutron Energy (MeV)

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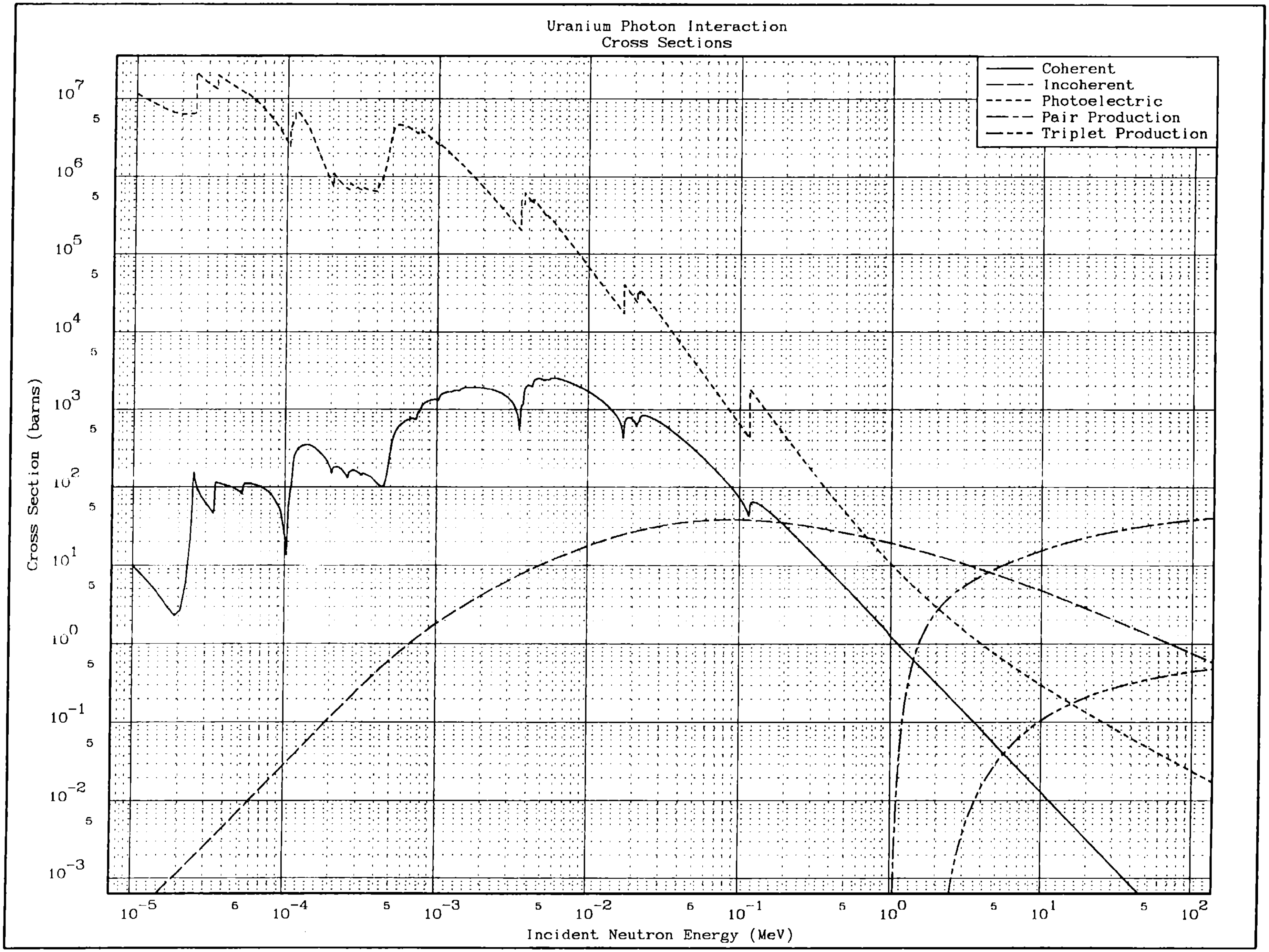
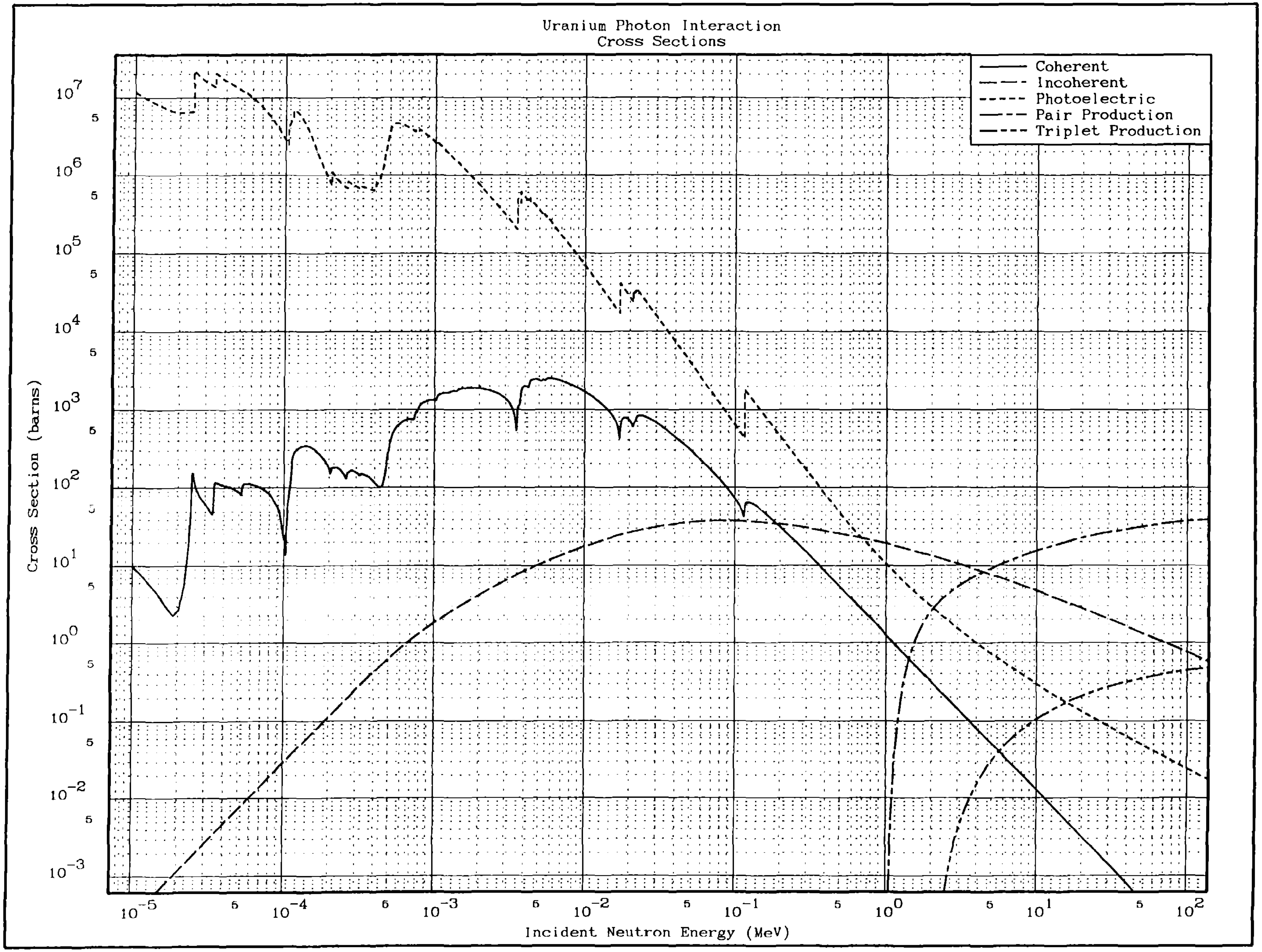
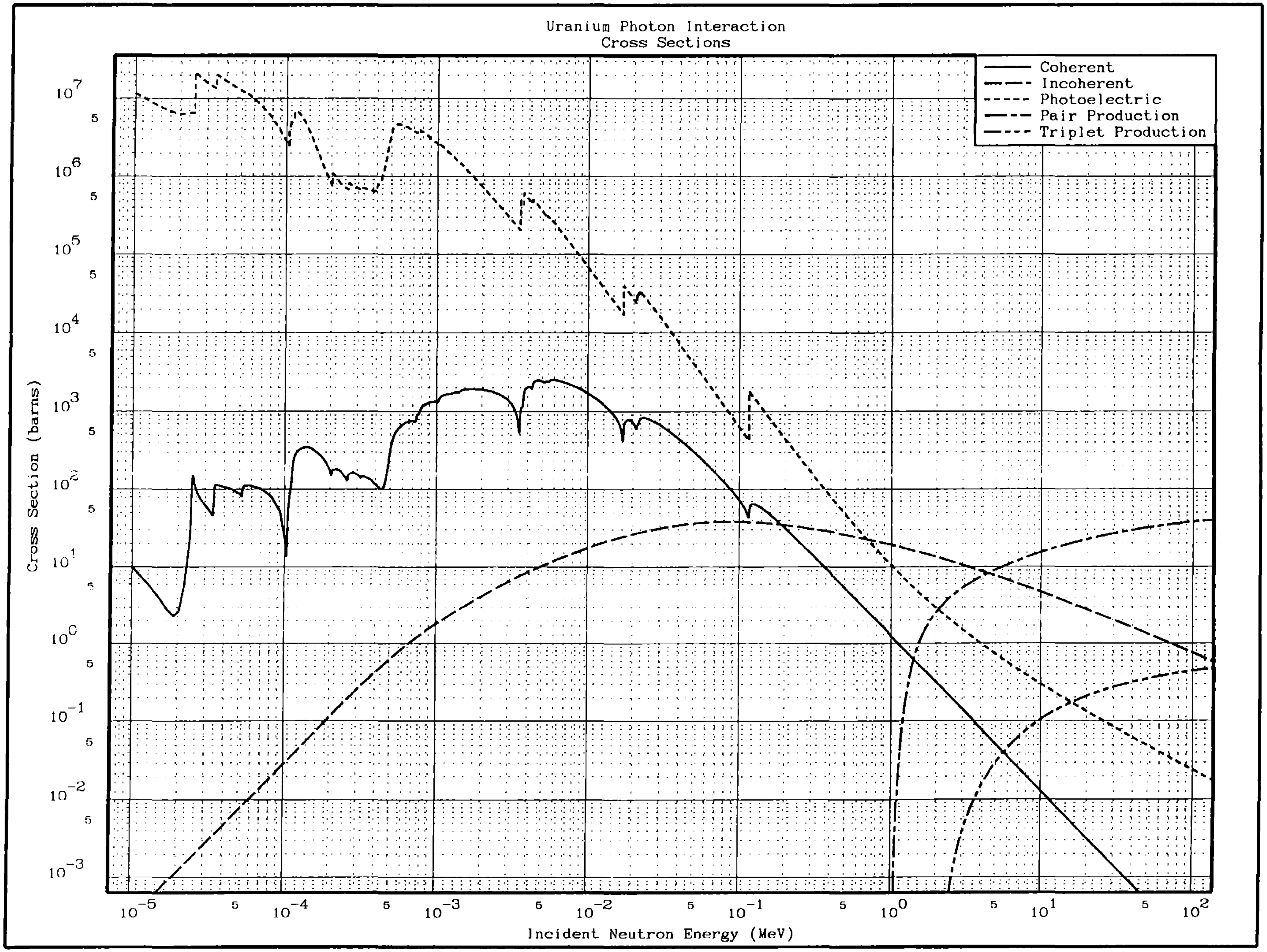
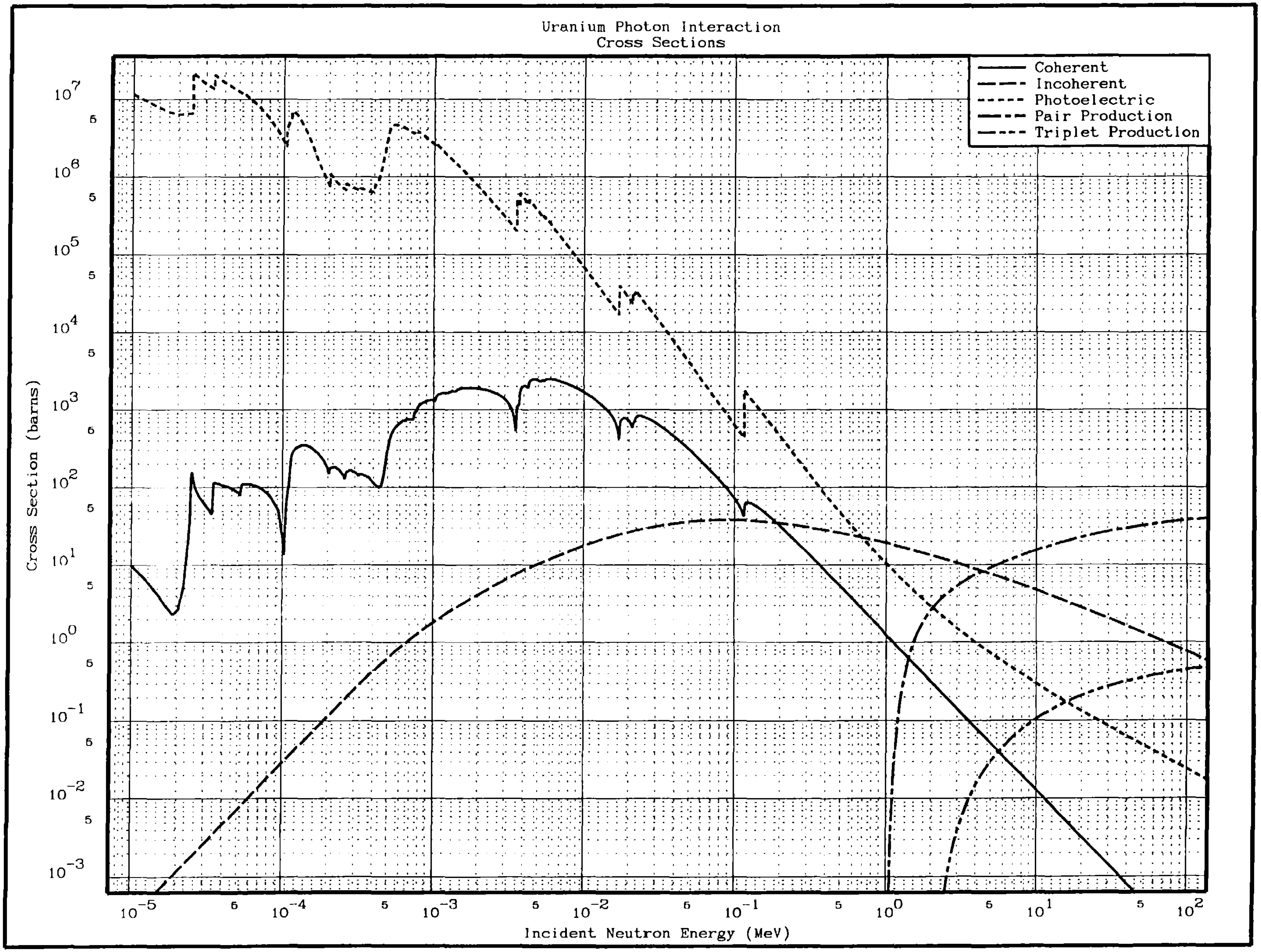

Uranium Photon Interaction
Cross Sections
Coherent
Incoherent
Photoelectric
Pair Production
Triplet Production
Cross Section (barns)
Incident Neutron Energy (MeV)


Uranium Photon Interaction
Cross Sections
Coherent
Incoherent
Photoelectric
Pair Production
Triplet Production
Cross Section (barns)
Incident Neutron Energy (MeV)

69


Uranium Photon Interaction
Cross Sections
Coherent
Incoherent
Photoelectric
Pair Production
Triplet Production
Cross Section (barns)
Incident Neutron Energy (MeV)

70


Uranium Photon Interaction
Cross Sections
Coherent
Incoherent
Photoelectric
Pair Production
Triplet Production
Cross Section (barns)
Incident Neutron Energy (MeV)
10^{7}
10^{6}
10^{5}
10^{4}
10^{3}
10^{2}
10^{1}
10^{0}
10^{-1}
10^{-2}
10^{-3}
10^{-5}
10^{-4}
10^{-3}
10^{-2}
10^{-1}
10^{0}
10^{1}
10^{2}

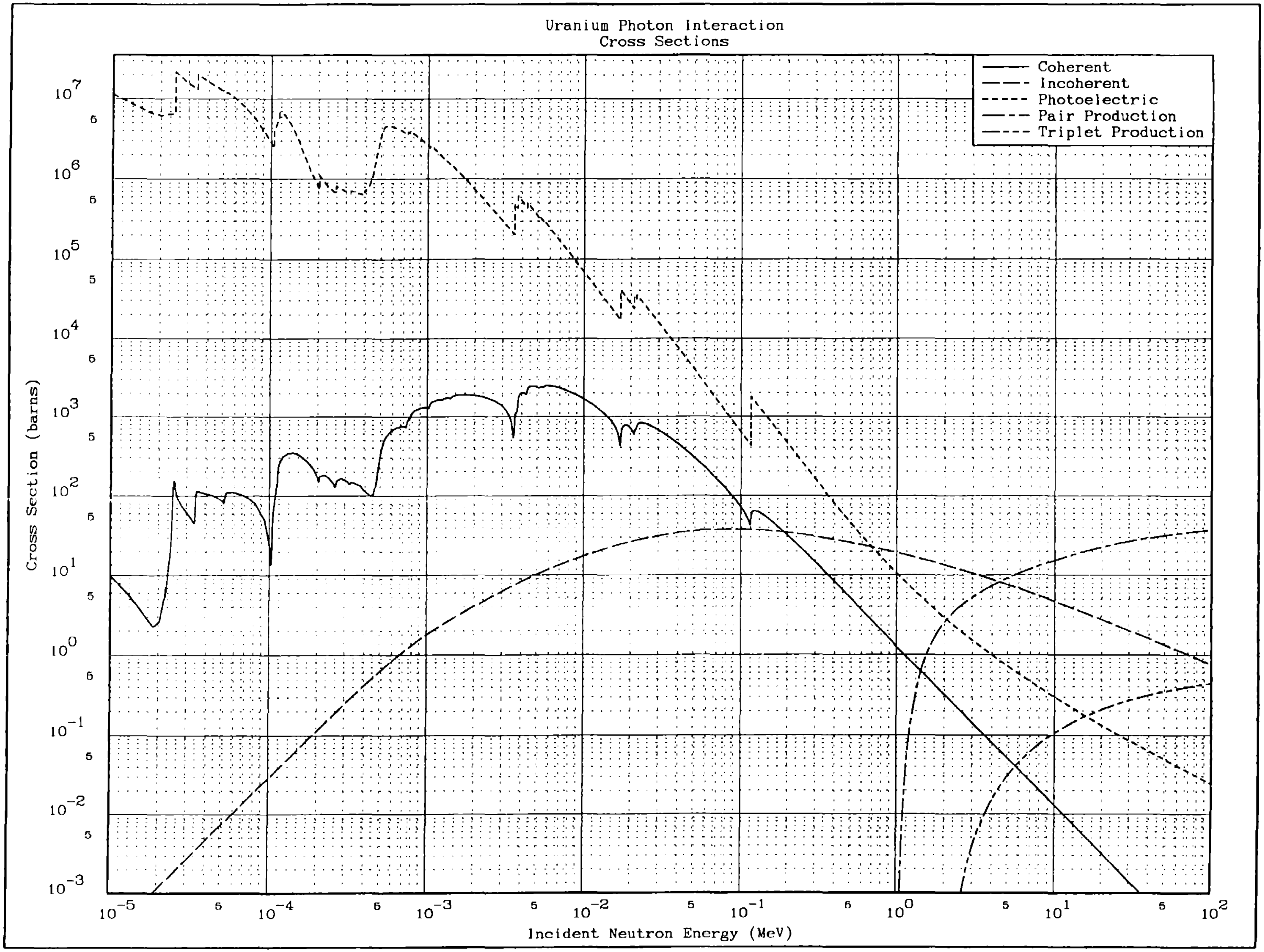
Rounded vs. Non-rounded Limits

The default option for this code is that it will read the data and determine its X and Y limits (i.e., X and Y minimum and maximum). These limits will then be rounded outward from the middle of the plot to insure that all data will be clearly shown away from the border of the plot without any interference from tick marks on the border. For most applications this default option is acceptable.

However, if you wish to absolutely control the X and/or Y limits of a plot you may do so using the rounded vs. non-rounded limits option (cols. 45-55 on input line 7 [for X] and 8 [for Y]). In the following example the X limits are not rounded, so that the X limits of the plot are from the lower X limit of the data (10 eV) up to the specified upper X limit (100 MeV). Only the upper Y limit is rounded, so that the lower Y limit will be the specified Y limit (0.001 barns).

The most frequent use of this option is when the user wishes to fix the lower X and/or Y limits of a plot to exactly zero. For example, for data which is inherently non-negative (e.g., cross sections), but starts with Y = 0.0 at some threshold value, you may want to set the lower Y limit to exactly zero.

```
    0.00000   13.50000    0.00000   10.0               1           1 1.0
         -5          0          1          4           0          -2    0
Incident Neutron Energy (MeV)
Cross Section (barns)
Uranium Photon Interaction
Cross Sections
             1.00000+ 2         0         -2           1          0
  1.00000- 3                    0         -2           3          0
```


Uranium Photon Interaction
Cross Sections
Coherent
Incoherent
Photoelectric
Pair Production
Triplet Production
Cross Section (barns)
Incident Neutron Energy (MeV)

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Master Curve

When a plot contains many curves you may want one curve to stand out from all the others; use of the master curve option (cols. 67-70 of the second input line) will allow you be do this.

In the following example the (n,2n) double differential spectrum due to 14.2 MeV neutrons incident on beryllium is shown at 21 fixed cosine values between -1.0 and +1.0. In addition the spectrum that results when one averages over cosine is also shown.

On the first plot the master curve option is not used and it is very difficult to see the average value. On the second plot the master curve option is used to make the average value stand out from all the other curves.

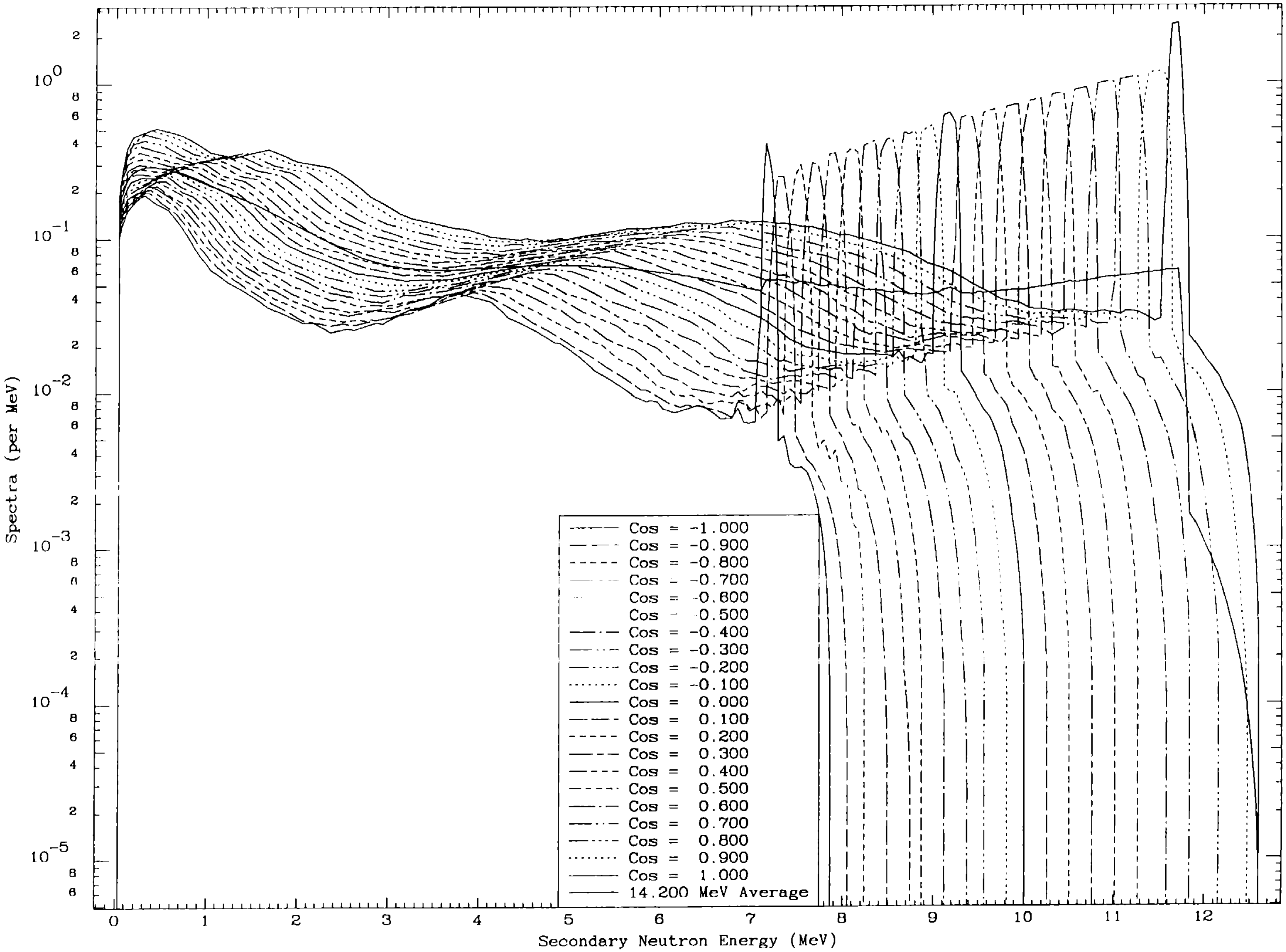
On a third plot the same data and options are used as were used for the second plot, except that log X scaling is used. This plot is included here merely to once again illustrate the effect that linear vs. log scaling can have on graphic results, i.e., compare the second and third plots.

```
    0.00000    13.50000    0.00000    10.0              1           1 1.0
        -22           0          0          0           0           0    0
Secondary Neutron Energy (MeV)
Spectra (per MeV)
(n,2n) Double Differential and Angular Averaged Spectra
due to 14.2 MeV Neutrons Incident on Beryllium
                                 0          1           0           0
                                 0          2           0           0

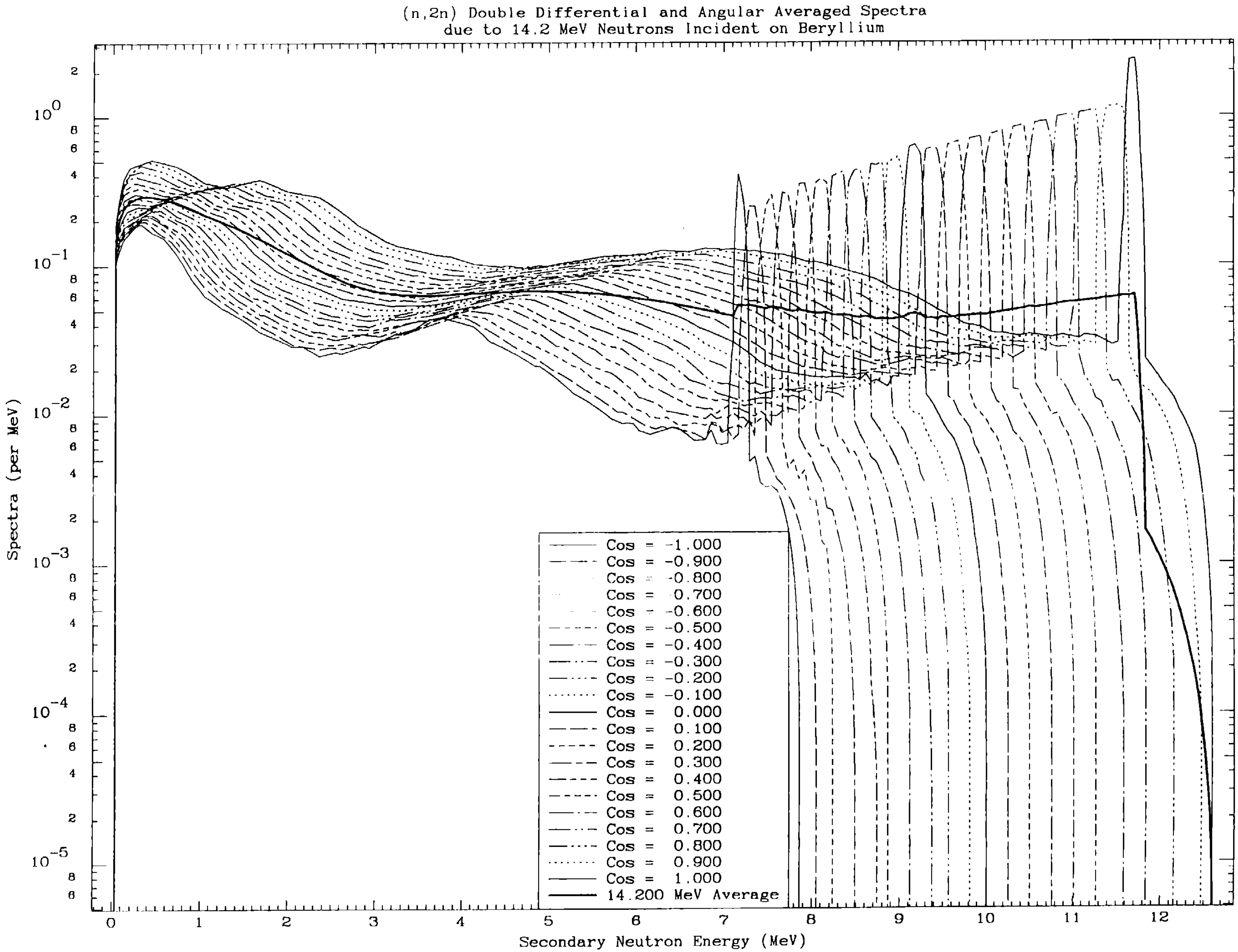
    0.00000    13.50000    0.00000    10.0              1           1 1.0
        -22           0          0          0           0           0   22
Secondary Neutron Energy (MeV)
Spectra (per MeV)
(n,2n) Double Differential and Angular Averaged Spectra
due to 14.2 MeV Neutrons Incident on Beryllium
                                 0          1           0           0
                                 0          2           0           0

    0.00000    13.50000    0.00000    10.0              1           1 1.0
        -22           0          0          0           0           0   22
Secondary Neutron Energy (MeV)
Spectra (per MeV)
(n,2n) Double Differential and Angular Averaged Spectra
due to 14.2 MeV Neutrons Incident on Beryllium
                                 0          2           0           0
                                 0          2           0           0
```

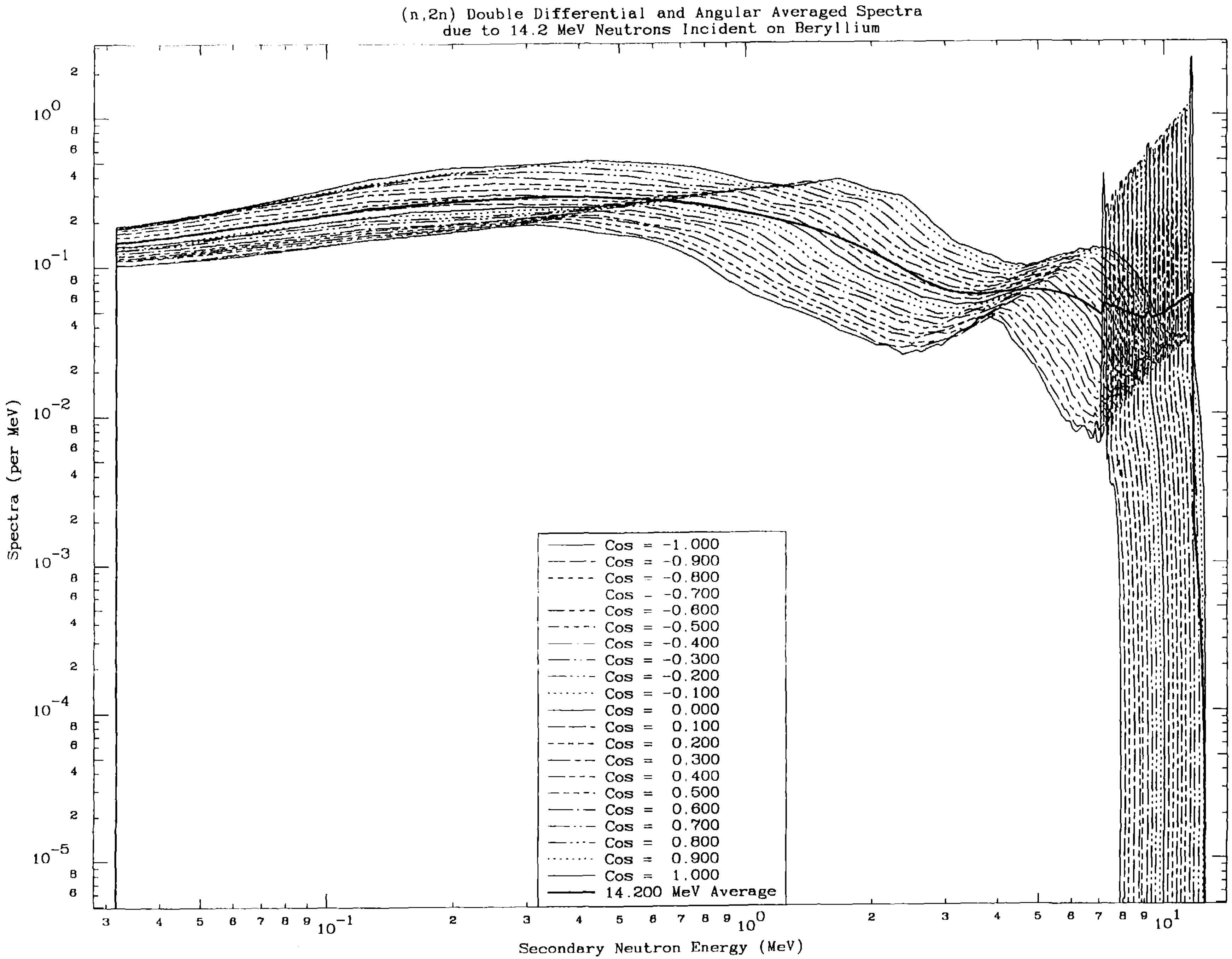
(n,2n) Double Differential and Angular Averaged Spectra
due to 14.2 MeV Neutrons Incident on Beryllium



75



(n,2n) Double Differential and Angular Averaged Spectra
due to 14.2 MeV Neutrons Incident on Beryllium
Spectra (per MeV)
Secondary Neutron Energy (MeV)
Cos = -1.000
Cos = -0.900
Cos = -0.800
Cos = -0.700
Cos = -0.600
Cos = -0.500
Cos = -0.400
Cos = -0.300
Cos = -0.200
Cos = -0.100
Cos = 0.000
Cos = 0.100
Cos = 0.200
Cos = 0.300
Cos = 0.400
Cos = 0.500
Cos = 0.600
Cos = 0.700
Cos = 0.800
Cos = 0.900
Cos = 1.000
14.200 MeV Average



(n,2n) Double Differential and Angular Averaged Spectra
due to 14.2 MeV Neutrons Incident on Beryllium
Spectra (per MeV)
Secondary Neutron Energy (MeV)
Cos = -1.000
Cos = -0.900
Cos = -0.800
Cos = -0.700
Cos = -0.600
Cos = -0.500
Cos = -0.400
Cos = -0.300
Cos = -0.200
Cos = -0.100
Cos = 0.000
Cos = 0.100
Cos = 0.200
Cos = 0.300
Cos = 0.400
Cos = 0.500
Cos = 0.600
Cos = 0.700
Cos = 0.800
Cos = 0.900
Cos = 1.000
14.200 MeV Average

77

Alternate Character Set - Super and Subscripts

The following example illustrates how to use the alternate character set, as well as super and subscripts.

To use the alternate character set each character from the alternate character set is preceded by] - using the enclosed table of alternate character set equivalences we can see that]a will be plotted as a Greek alpha. In the following example there is a plot of a number of (n,alpha) cross sections. In order to have this plotted as (n, Greek character alpha) the below input parameters includes on the second title line (n,]a) - which from the following plot can be seen to be plotted in exactly the form we require.

To use superscripts each character is preceded by {. Similarly to use subscripts each character is preceded by }. For the following plot the titles in the curve file (PLOTTAB.CUR) are of the form,

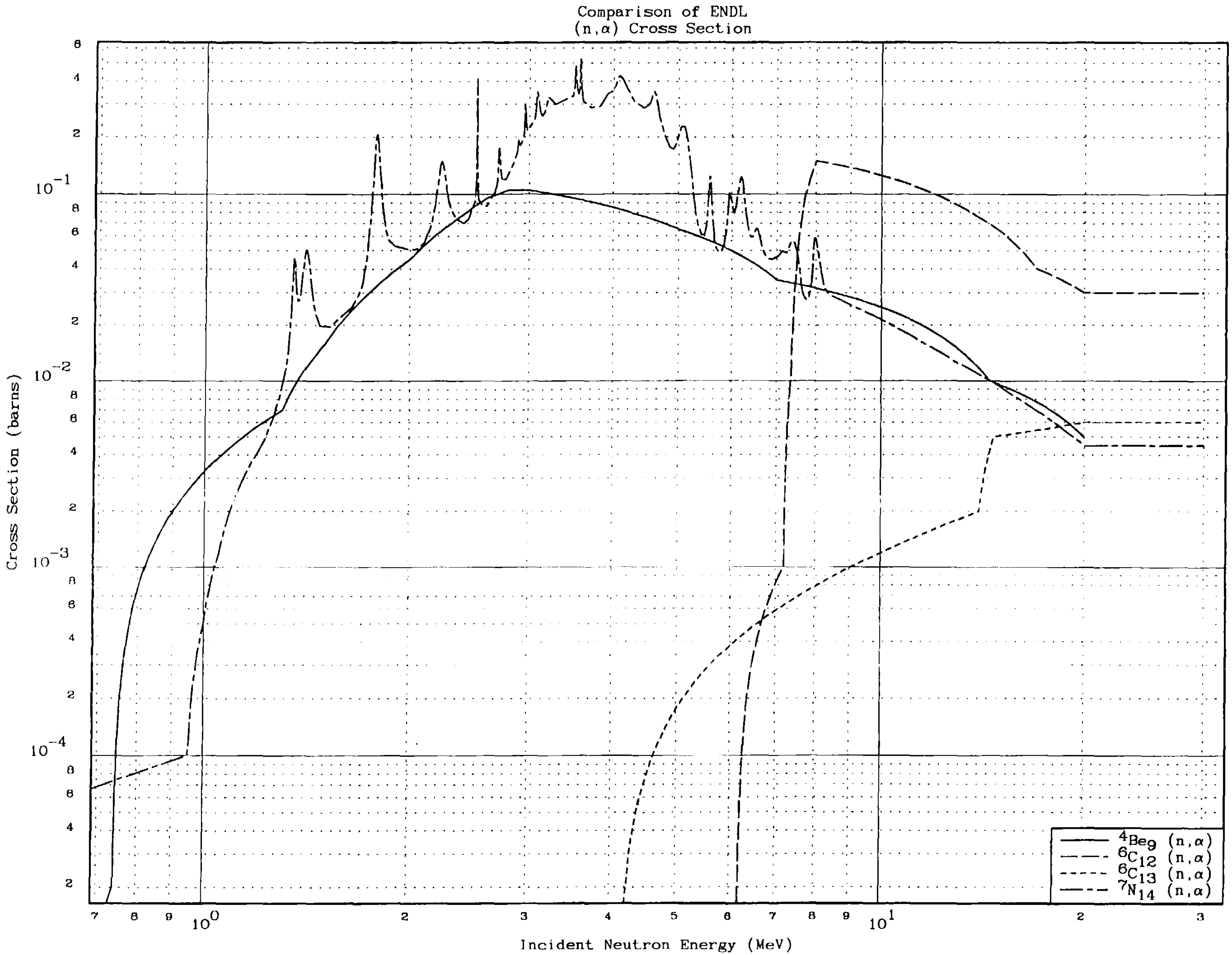
{6C}1}2

which from the following plot we can see is plotted as,

superscript 6, C, subscript 1, subscript 2

The input parameters used to produce the following plot are listed below.

```
    0.00000   13.50000    0.00000   10.0              1               1 1.0
         -4          0          0          4          0              -2   0
Incident Neutron Energy (MeV)
Cross Section (barns)
Comparison of ENDL
(n,]a) Cross Section
                                0          2          0          0
                                0          2          0          0
```



Comparison of ENDL
(n,α) Cross Section
Cross Section (barns)
Incident Neutron Energy (MeV)
4Be9 (n,α)
6C12 (n,α)
6C13 (n,α)
7N14 (n,α)

79

Change Character Size

In the following example each of the three plots contains exactly the same data and the only difference between them is that each has a different multiplier for the character size (cols. 67-70 on the first line). The three plots have character size multipliers of 0.7, 1.0 and 1.5, respectively.

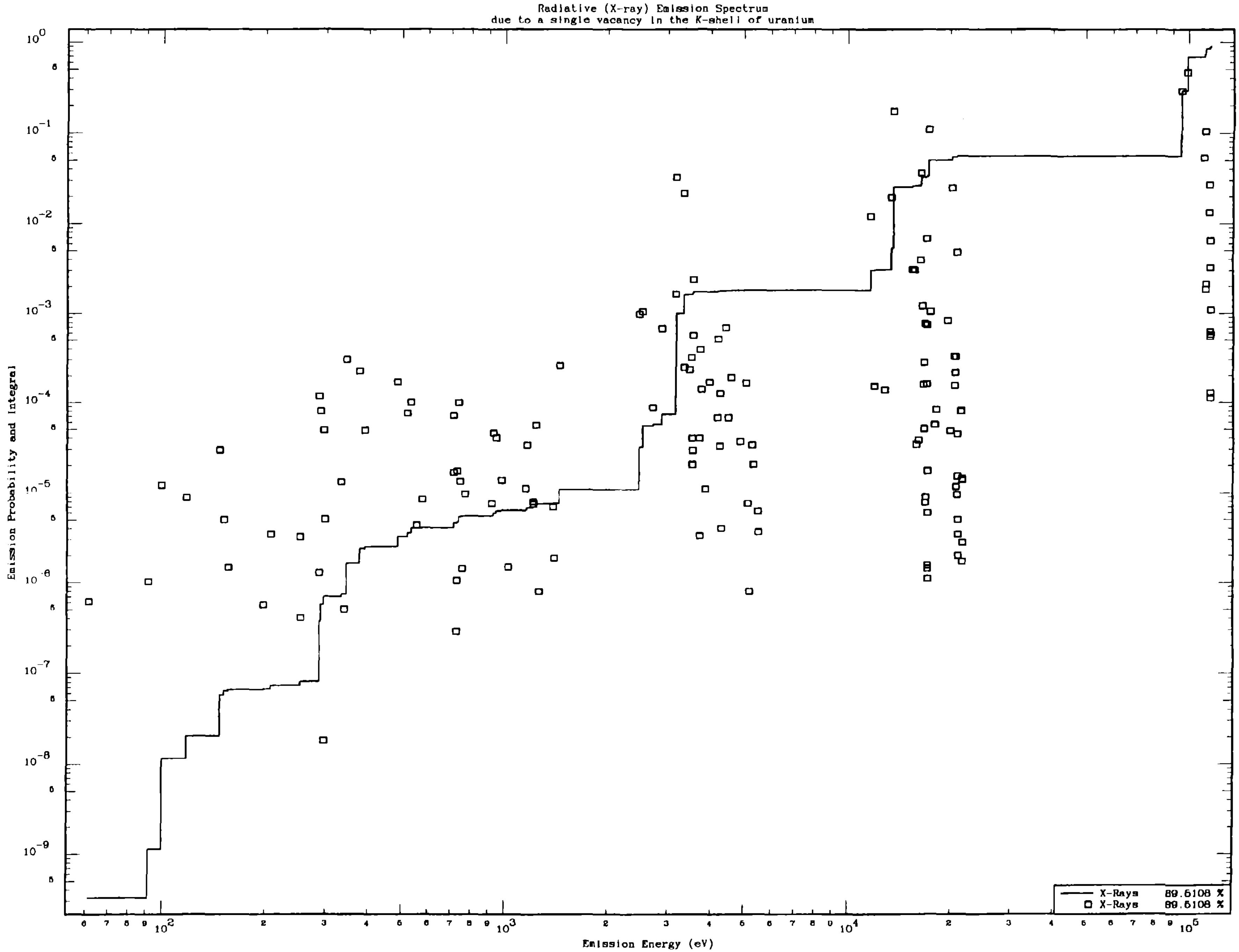
These multipliers correspond to roughly increasing the size of the characters to 150 % in each successful plot; an increase in the area of the characters (which is what your eye registers) of a factor of roughly 2.25.

From these three plots it can be seen that for plots of this overall size the range of multipliers considered here more or less span the useful range of the character multiplier, i.e. a smaller multiplier would make the characters difficult to read and a larger multiplier would make the characters disproportionally large.

```
    0.00000    13.50000     0.00000    10.0                 1           1 0.7
         -1          -1           0           0             0          -2   0
Emission Energy (eV)
Emission Probability and Integral
Radiative (X-ray) Emission Spectrum
due to a single vacancy in the K-shell of uranium
                                  0           2             0           0
                                  0           2             0           0

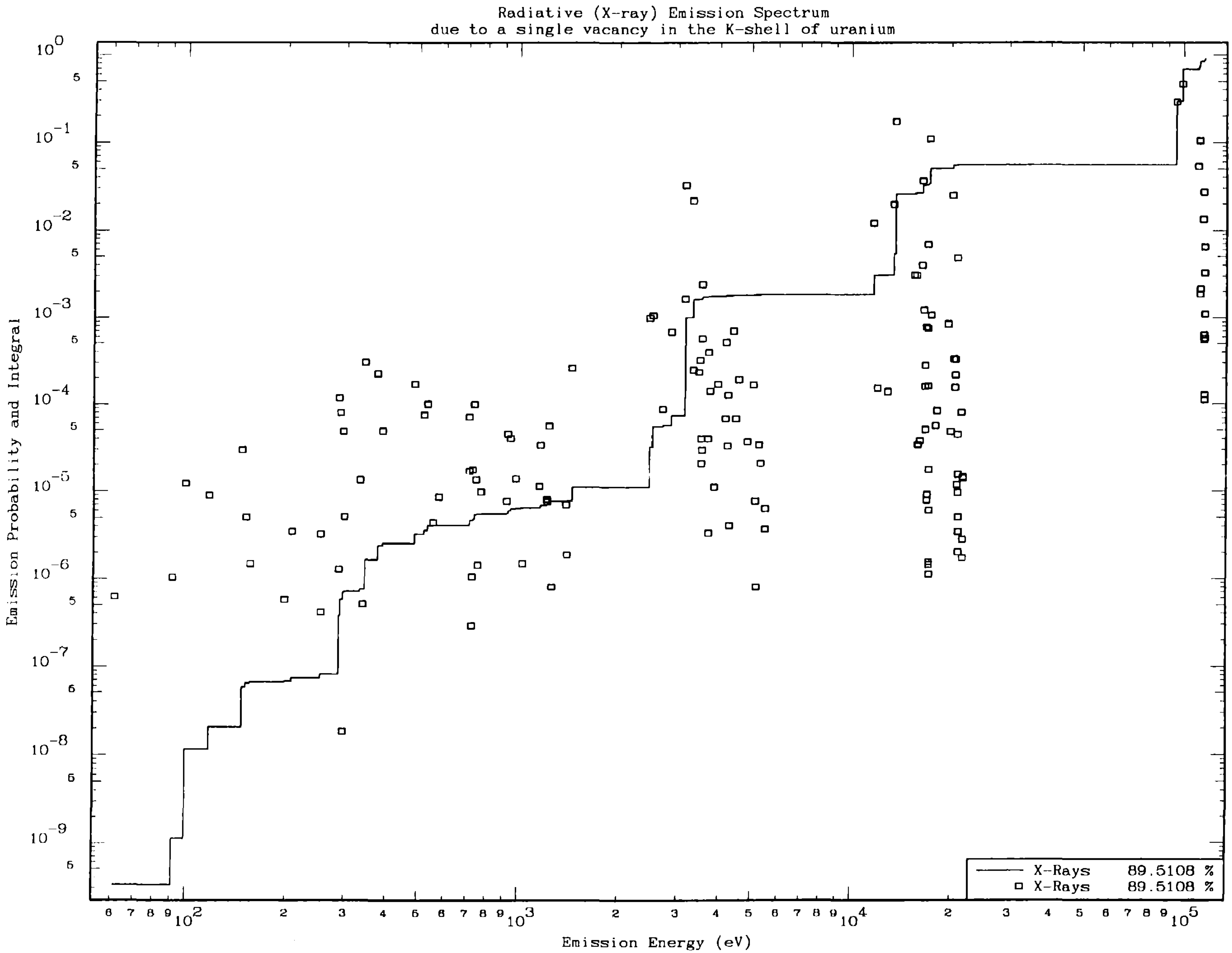
    0.00000    13.50000     0.00000    10.0                 1           1 1.0
         -1          -1           0           0             0          -2   0
Emission Energy (eV)
Emission Probability and Integral
Radiative (X-ray) Emission Spectrum
due to a single vacancy in the K-shell of uranium
                                  0           2             0           0
                                  0           2             0           0

    0.00000    13.50000     0.00000    10.0                 1           1 1.5
         -1          -1           0           0             0          -2   0
Emission Energy (eV)
Emission Probability and Integral
Radiative (X-ray) Emission Spectrum
due to a single vacancy in the K-shell of uranium
                                  0           2             0           0
                                  0           2             0           0
```

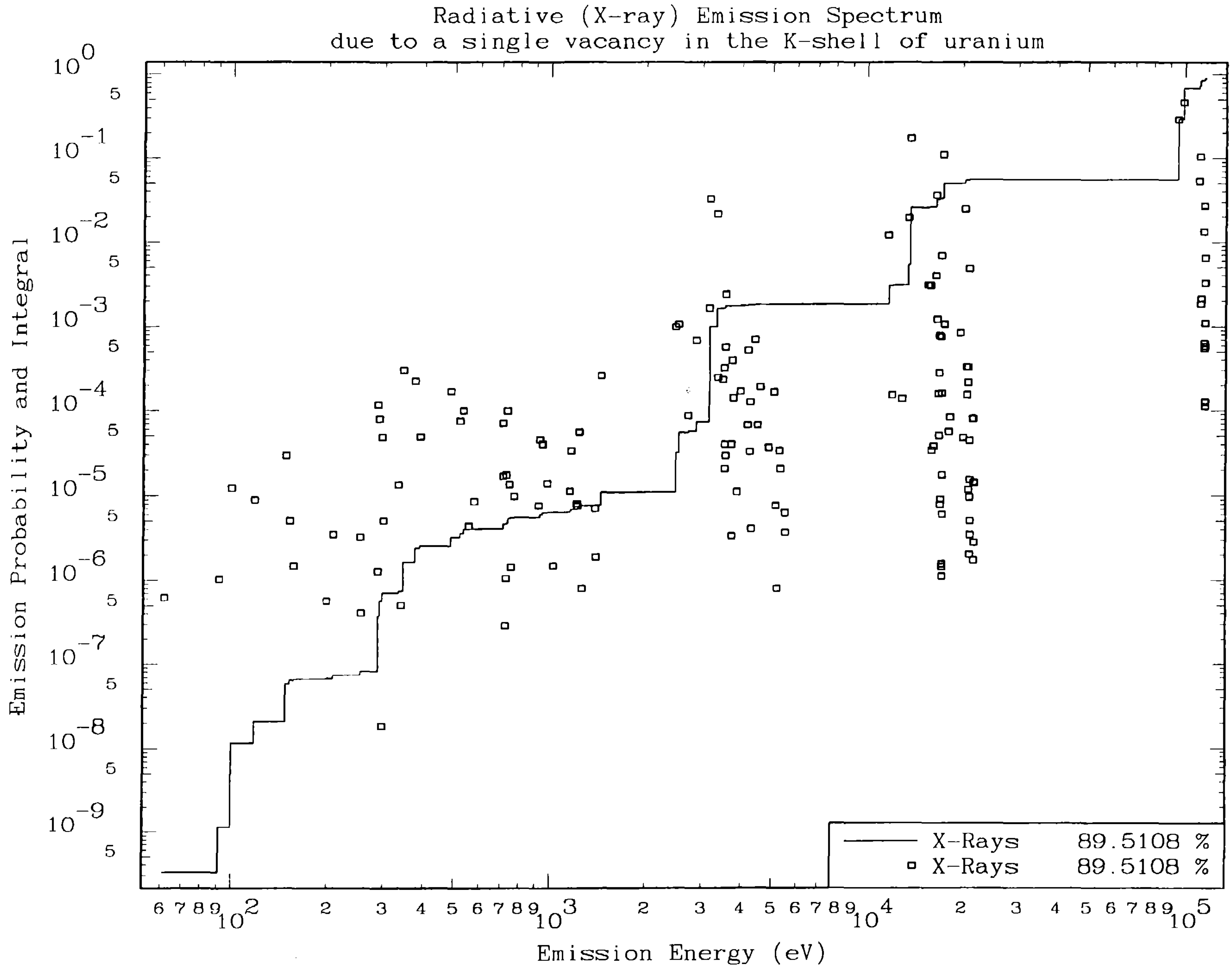


Radiative (X-ray) Emission Spectrum
due to a single vacancy in the K-shell of uranium
Emission Probability and Integral
Emission Energy (eV)
X-Rays 89.5108 %
X-Rays 89.5108 %

81


Radiative (X-ray) Emission Spectrum
due to a single vacancy in the K-shell of uranium
Emission Probability and Integral
Emission Energy (eV)
X-Rays 89.5108 %
X-Rays 89.5108 %

82


Radiative (X-ray) Emission Spectrum
due to a single vacancy in the K-shell of uranium
Emission Probability and Integral
Emission Energy (eV)
X-Rays 89.5108 %
X-Rays 89.5108 %

83

Types of Grids

In the following example each of the six plots contains exactly the same data and the only difference between them is that each has a different type of grid, corresponding to grid types 0 through 5 (cols. 34-44 on the second line).

```
     0.00000    13.50000     0.00000    10.0                    1          1 1.0
          -1          -1           0           0           0         -2    0
Emission Energy (eV)
Emission Probability and Integral
Radiative (X-ray) Emission Spectrum
due to a single vacancy in the K-shell of uranium
                                   0           2           0          0
                                   0           2           0          0

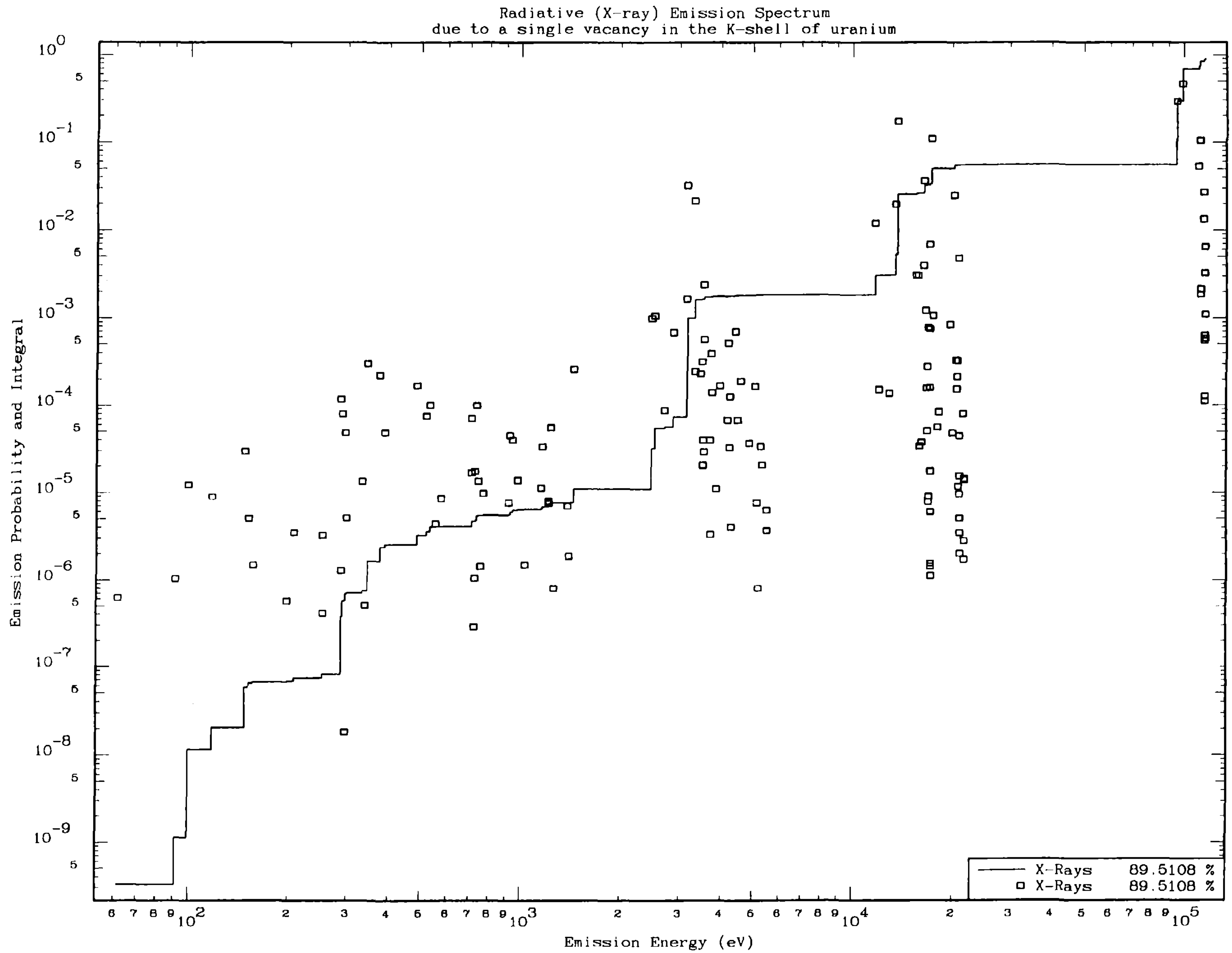
     0.00000    13.50000     0.00000    10.0                    1          1 1.0
          -1          -1           0           1           0         -2    0
Emission Energy (eV)
Emission Probability and Integral
Radiative (X-ray) Emission Spectrum
due to a single vacancy in the K-shell of uranium
                                   0           2           0          0
                                   0           2           0          0

     0.00000    13.50000     0.00000    10.0                    1          1 1.0
          -1          -1           0           2           0         -2    0
Emission Energy (eV)
Emission Probability and Integral
Radiative (X-ray) Emission Spectrum
due to a single vacancy in the K-shell of uranium
                                   0           2           0          0
                                   0           2           0          0

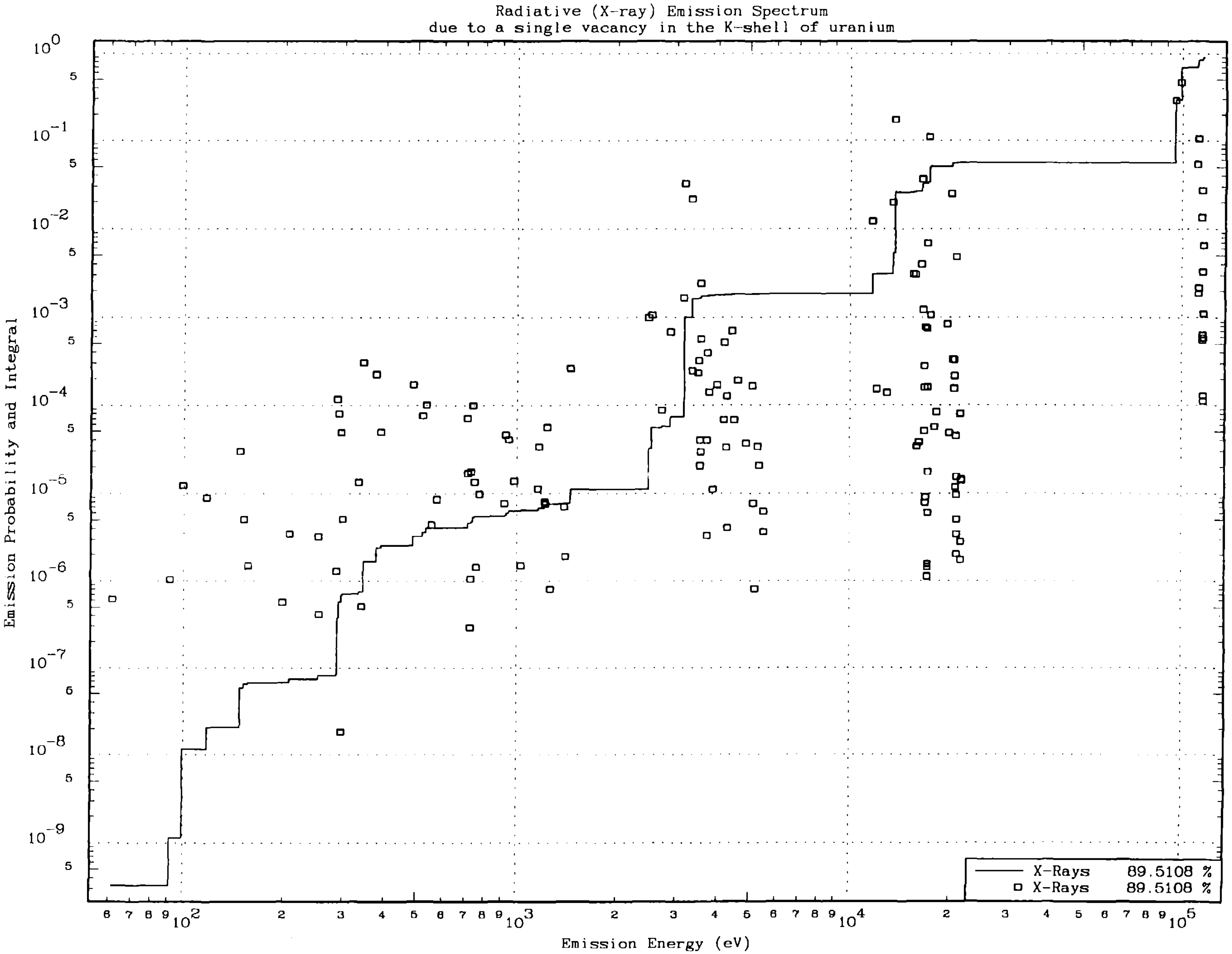
     0.00000    13.50000     0.00000    10.0                    1          1 1.0
          -1          -1           0           3           0         -2    0
Emission Energy (eV)
Emission Probability and Integral
Radiative (X-ray) Emission Spectrum
due to a single vacancy in the K-shell of uranium
                                   0           2           0          0
                                   0           2           0          0

     0.00000    13.50000     0.00000    10.0                    1          1 1.0
          -1          -1           0           4           0         -2    0
Emission Energy (eV)
Emission Probability and Integral
Radiative (X-ray) Emission Spectrum
due to a single vacancy in the K-shell of uranium
                                   0           2           0          0
                                   0           2           0          0

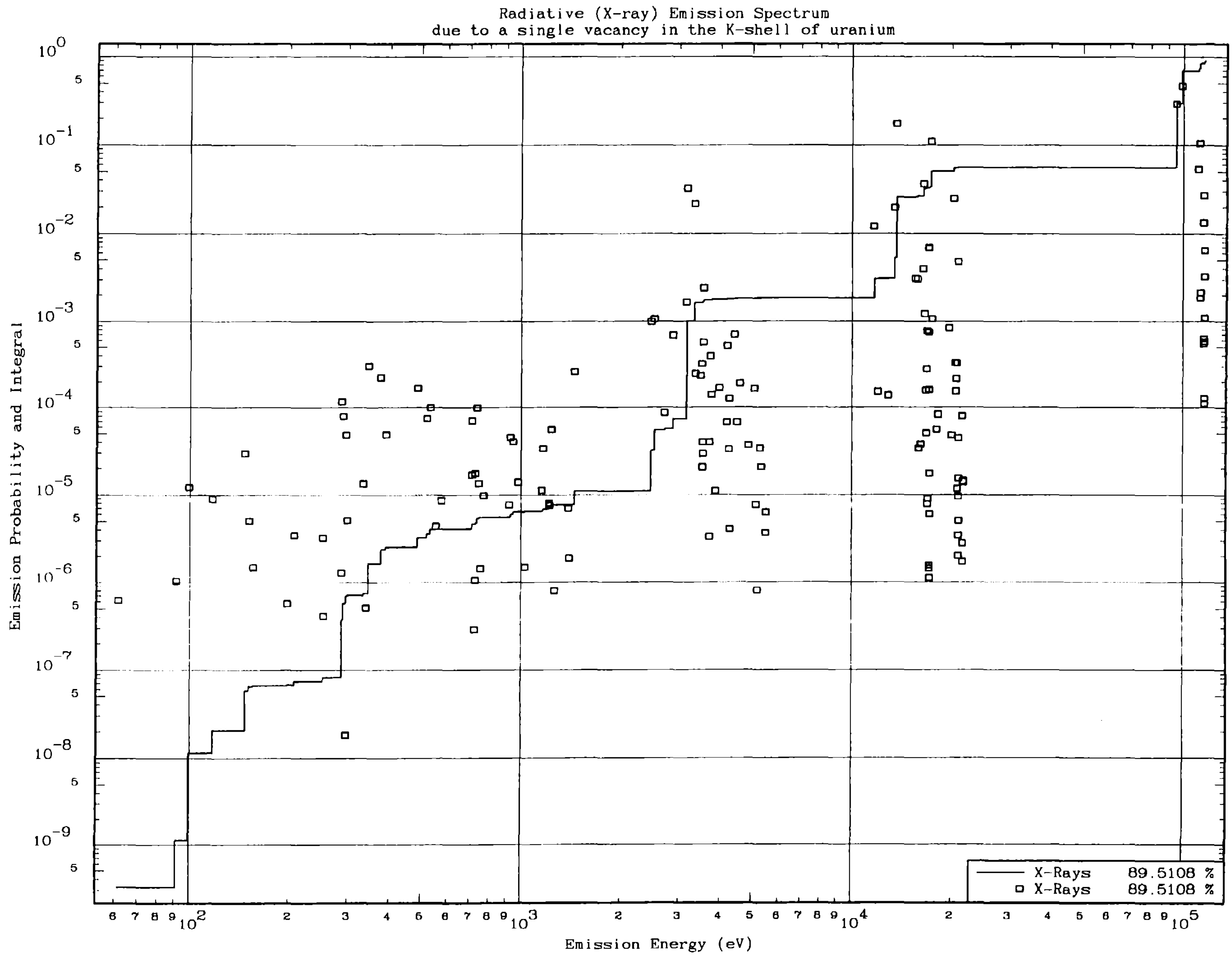
     0.00000    13.50000     0.00000    10.0                    1          1 1.0
          -1          -1           0           5           0         -2    0
Emission Energy (eV)
Emission Probability and Integral
Radiative (X-ray) Emission Spectrum
due to a single vacancy in the K-shell of uranium
                                   0           2           0          0
                                   0           2           0          0
```


Radiative (X-ray) Emission Spectrum
due to a single vacancy in the K-shell of uranium
Emission Probability and Integral
Emission Energy (eV)
X-Rays 89.5108 %
X-Rays 89.5108 %

85

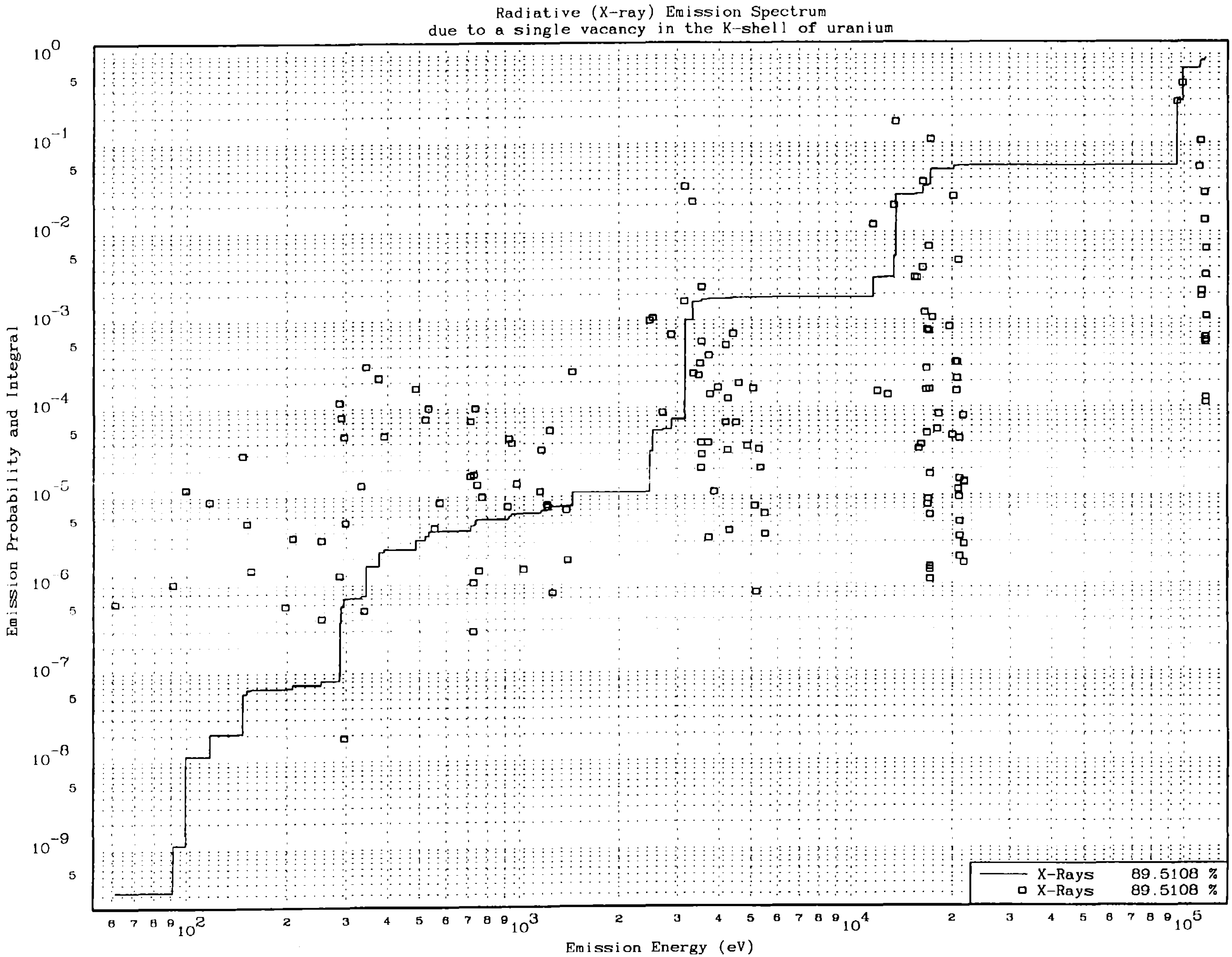

Radiative (X-ray) Emission Spectrum
due to a single vacancy in the K-shell of uranium
Emission Probability and Integral
Emission Energy (eV)
X-Rays 89.5108 %
X-Rays 89.5108 %

98



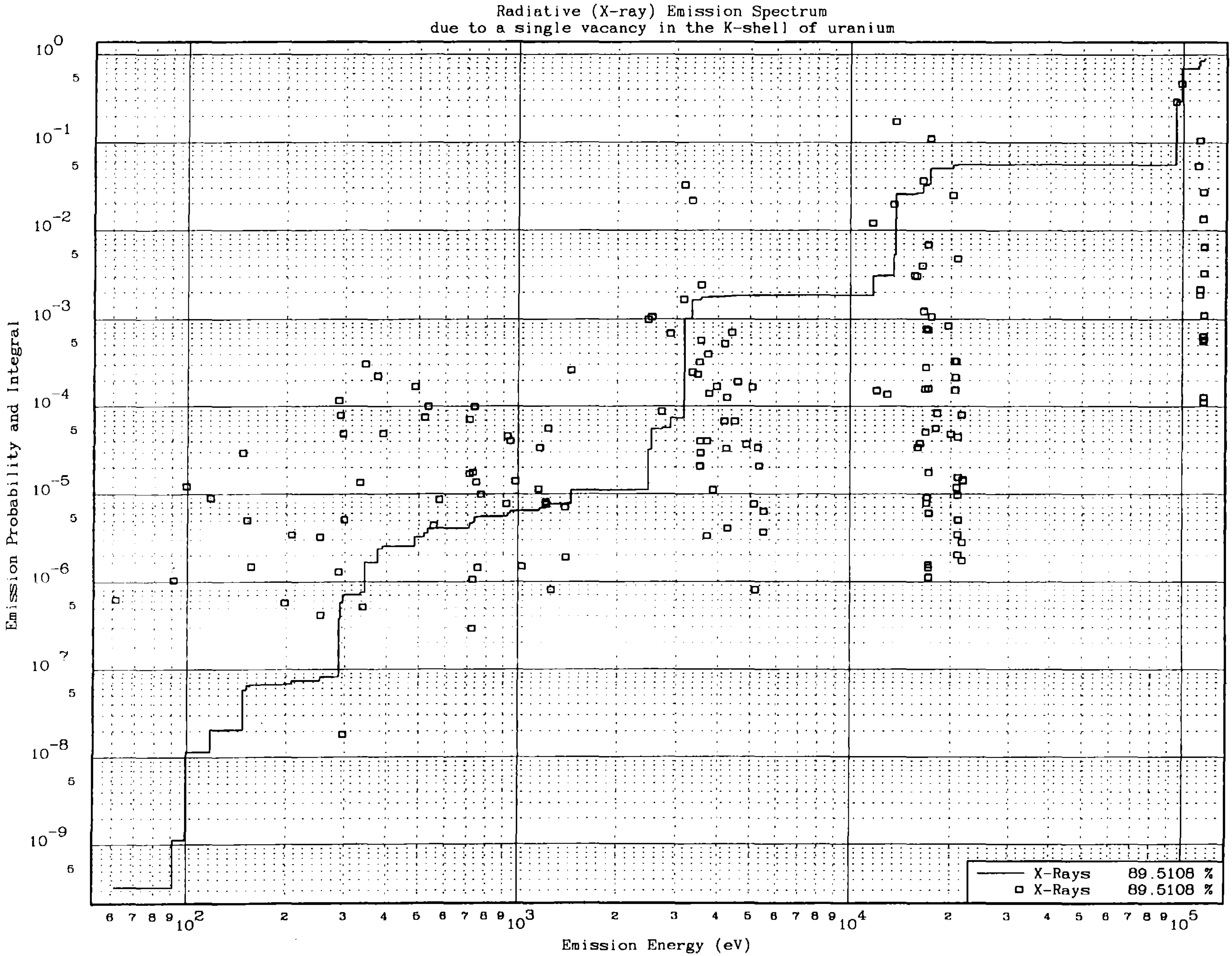
Radiative (X-ray) Emission Spectrum
due to a single vacancy in the K-shell of uranium
Emission Probability and Integral
Emission Energy (eV)
X-Rays 89.5108 %
X-Rays 89.5108 %

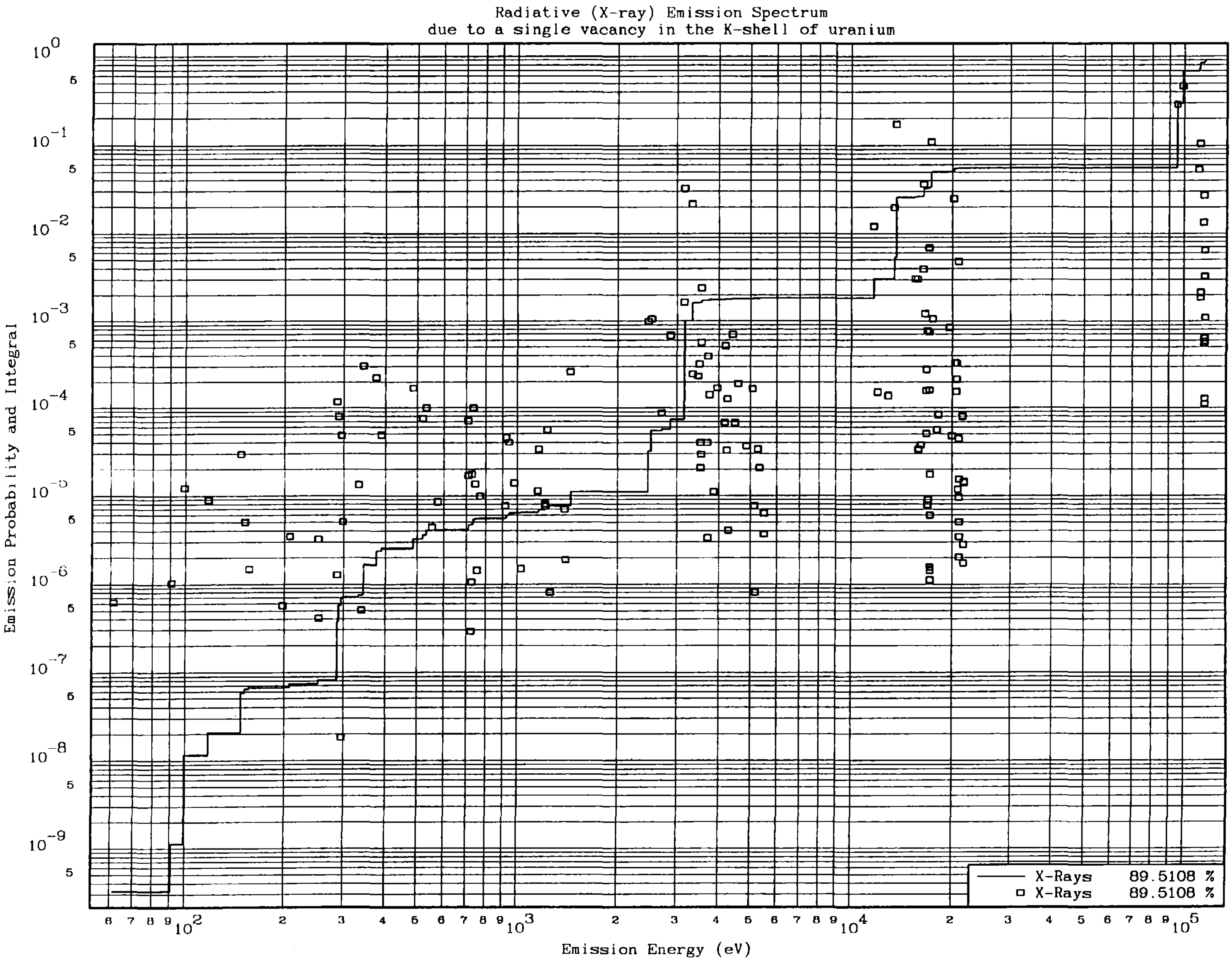
87



Radiative (X-ray) Emission Spectrum
due to a single vacancy in the K-shell of uranium
Emission Probability and Integral
Emission Energy (eV)
X-Rays 89.5108 %
X-Rays 89.5108 %

88


Radiative (X-ray) Emission Spectrum
due to a single vacancy in the K-shell of uranium
Emission Probability and Integral
Emission Energy (eV)
X-Rays 89.5108 %
X-Rays 89.5108 %



Radiative (X-ray) Emission Spectrum
due to a single vacancy in the K-shell of uranium
Emission Probability and Integral
Emission Energy (eV)
X-Rays 89.5108 %
X-Rays 89.5108 %

Composition Mode - Non-overlapping Subplots

In composition mode you are free to position any number of plots, anyplace on a page. To enter the composition mode the number of plots per page in the X direction should be a negative integer (cols. 45-55 on the first input line); this is a signal to the code not to advance to the next plotting area at the end of the current plot. The code will stay in this mode until you specify a positive number of plots in the X direction; AFTER this plot is completed the code will advance to the next plotting area.

In the below example four subplots are positioned on a page. For the first three of these the number of plots in the X direction is set to -1 (cols. 45-55 on the first input line). For the fourth (last) subplot the number of plots in the X direction is set to 1 - indicating the end of the page AFTER this plot is completed.

The first subplot occupies the entire upper half of the page (X= 0 to 13.5, Y= 5 to 10 - on the first input line). The following three subplots occupy the lower half of the page (Y = 0 to 5), in three adjacent X ranges (X = 0 to 4.5, 4.5 to 9, 9 to 13.5).

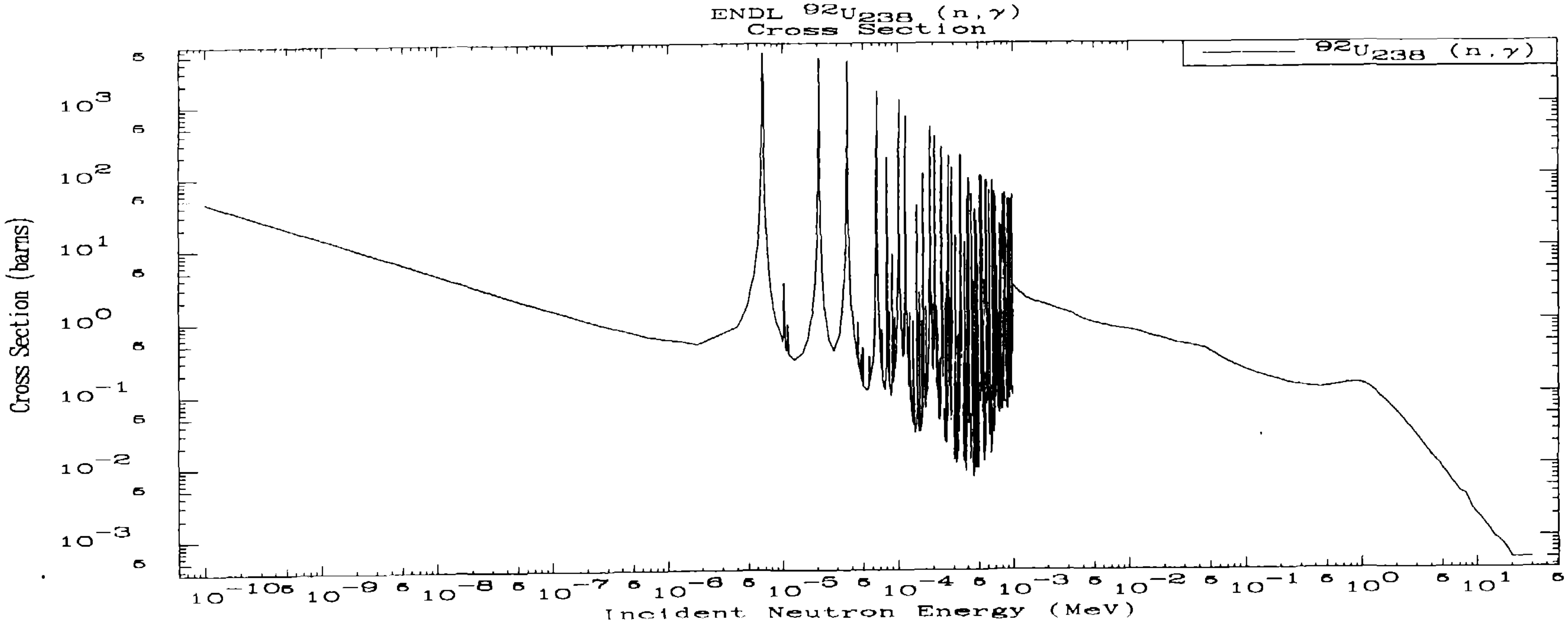
One important restriction on the use of the composition mode - you must only specify one subplot at a time (cols. 45-66 of the first input line) and individually position each subplot.

```
    0.00000   13.50000    5.00000    10.0               -1          1 1.5
         -1          0          0          0          0          0    0
Incident Neutron Energy (MeV)
Cross Section (barns)
ENDL {9{2U}2}3}8 (n,]g)
Cross Section
                                0          2          0          0
                                0          2          0          0

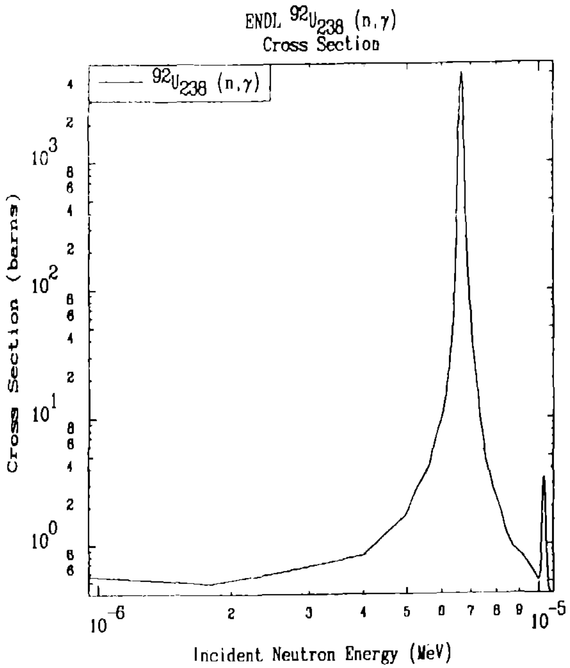
    0.00000    4.50000    0.00000     5.0               -1          1 2.0
         -1          0          0          0          0          0    0
Incident Neutron Energy (MeV)
Cross Section (barns)
ENDL {9{2U}2}3}8 (n,]g)
Cross Section
 1.00000- 6 1.00000- 5          0          2          0          0
                                0          2          0          0

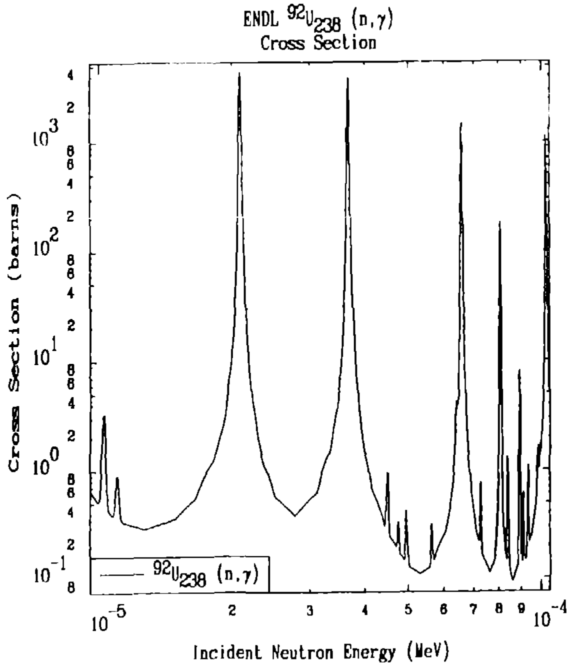
    4.50000    9.00000    0.00000     5.0               -1          1 2.0
         -1          0          0          0          0          0    0
Incident Neutron Energy (MeV)
Cross Section (barns)
ENDL {9{2U}2}3}8 (n,]g)
Cross Section
 1.00000- 5 1.00000- 4          0          2          0          0
                                0          2          0          0

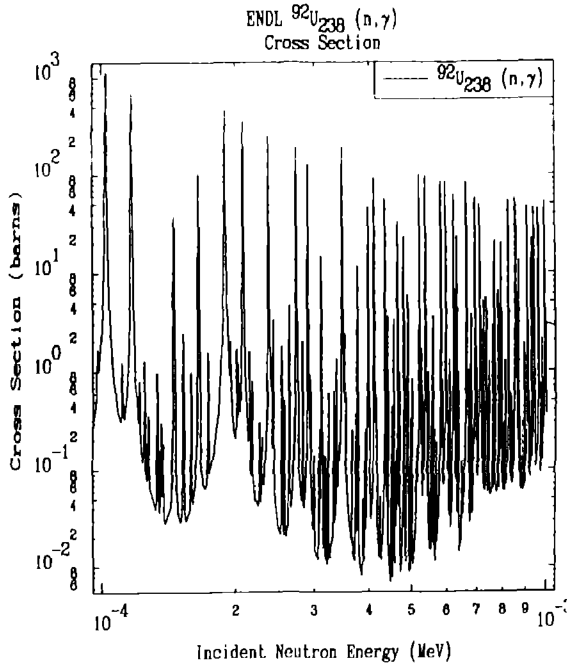
    9.00000   13.50000    0.00000     5.0                1          1 2.0
         -1          0          0          0          0          0    0
Incident Neutron Energy (MeV)
Cross Section (barns)
ENDL {9{2U}2}3}8 (n,]g)
Cross Section
 1.00000- 4 1.00000- 3          0          2          0          0
                                0          2          0          0
```


ENDL 92U238 (n,γ)
Cross Section
92U238 (n,γ)
Cross Section (barns)
Incident Neutron Energy (MeV)

92


ENDL 92U238 (n,γ)
Cross Section
92U238 (n,γ)
Cross Section (barns)
Incident Neutron Energy (MeV)


ENDL 92U238 (n,γ)
Cross Section
92U238 (n,γ)
Cross Section (barns)
Incident Neutron Energy (MeV)


ENDL 92U238 (n,γ)
Cross Section
92U238 (n,γ)
Cross Section (barns)
Incident Neutron Energy (MeV)

Composition Mode - Non-overlapping Subplots (continued)

The following plot presents exactly the same data in exactly the same page layout as the preceding plot. The only differences between this plot and the preceding one are,

1) *Each subplot has a border around it, to more clearly delineate the subplots. This is accomplished by setting cols. 23-33 of the second input line to 1. This option can be handy when preparing plots which will appear in a report as a part of a page mixed in with text.*

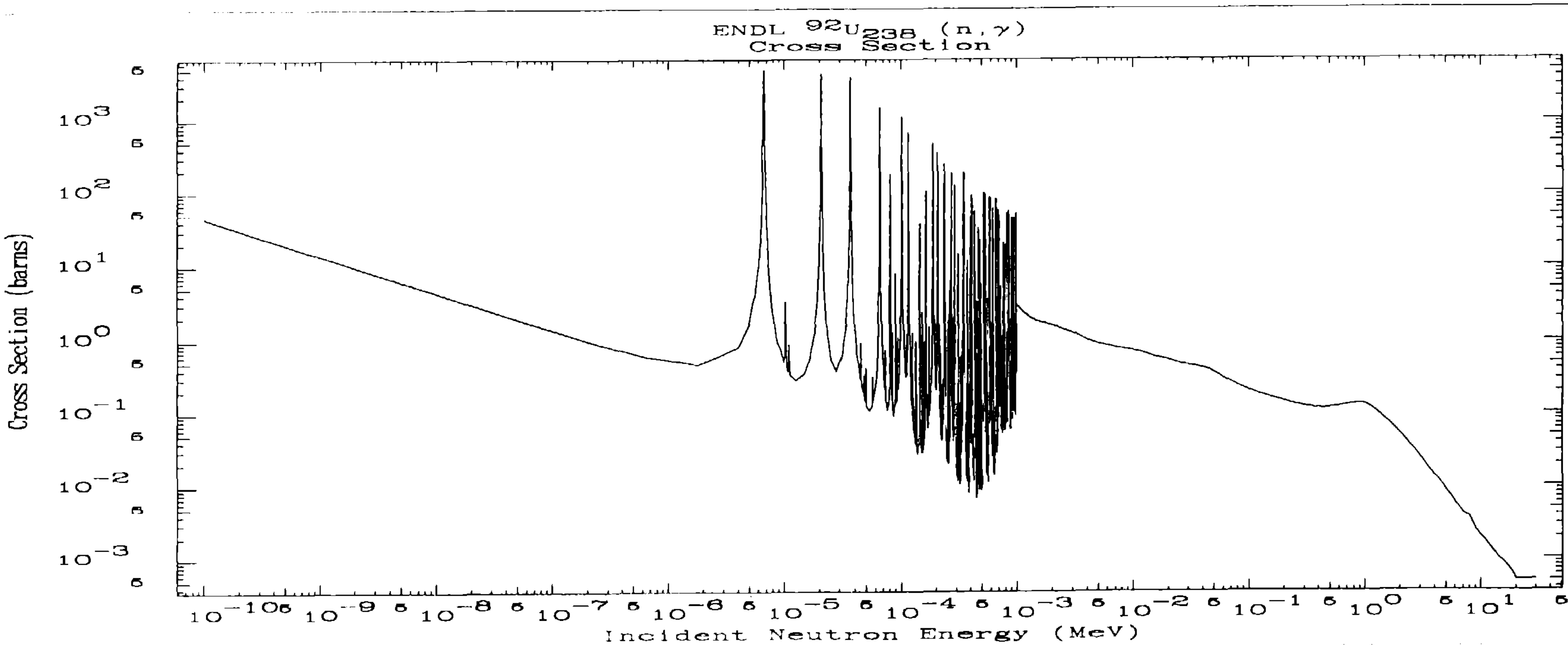
2) *The legend box has been removed from all subplots. In this case there is only one curve and the information presented in the legend on the preceding plot is redundant in the sense that it merely repeats what is stated in the title lines at the top of the plot. The legend box will not appear on the plot if cols. 56-66 of the seven line are set to 1.*

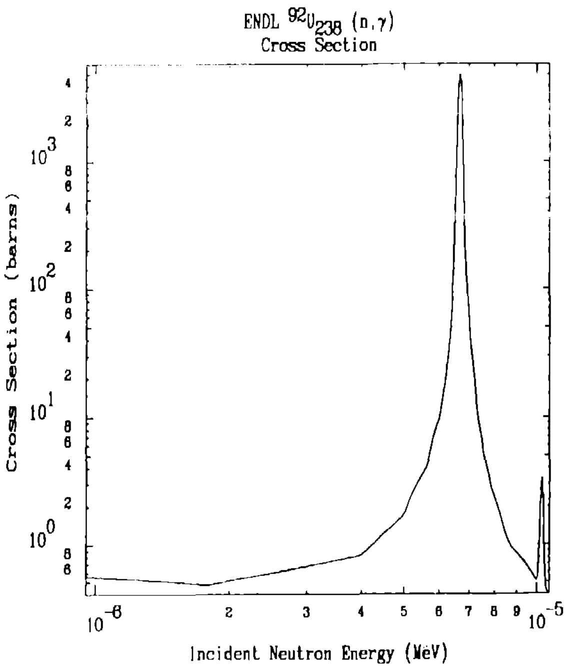
```
    0.00000    13.50000    5.00000    10.0          -1          1 1.5
         -1           0          1       0           0          0   0
Incident Neutron Energy (MeV)
Cross Section (barns)
ENDL {9{2U}2}3}8 (n,]g)
Cross Section
                                 0          2          0          1
                                 0          2          0          0

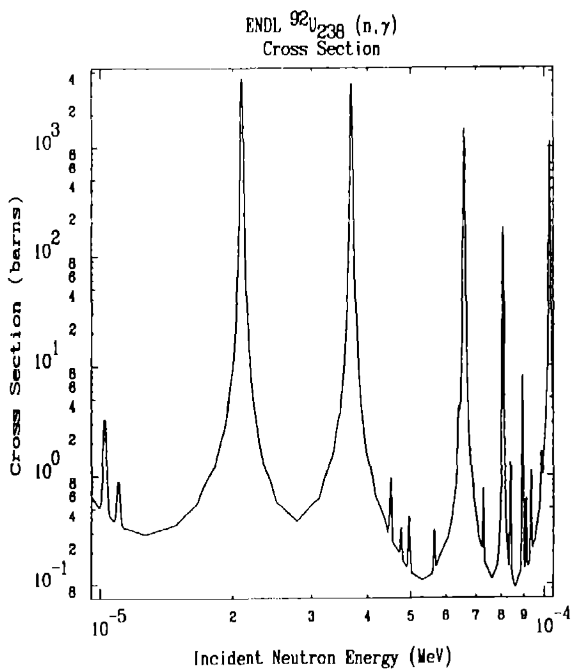
    0.00000     4.50000    0.00000     5.0          -1          1 2.0
         -1           0          1       0           0          0   0
Incident Neutron Energy (MeV)
Cross Section (barns)
ENDL {9{2U}2}3}8 (n,]g)
Cross Section
 1.00000- 6 1.02000- 5           0          2          0          1
                                 0          2          0          0

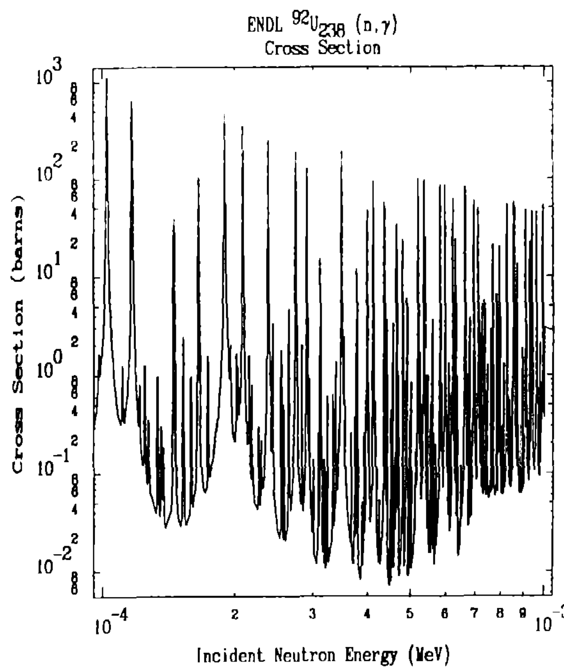
    4.50000     9.00000    0.00000     5.0          -1          1 2.0
         -1           0          1       0           0          0   0
Incident Neutron Energy (MeV)
Cross Section (barns)
ENDL {9{2U}2}3}8 (n,]g)
Cross Section
 1.00000- 5 1.00000- 4           0          2          0          1
                                 0          2          0          0

    9.00000    13.50000    0.00000     5.0           1          1 2.0
         -1           0          1       0           0          0   0
Incident Neutron Energy (MeV)
Cross Section (barns)
ENDL {9{2U}2}3}8 (n,]g)
Cross Section
 1.00000- 4 1.00000- 3           0          2          0          1
                                 0          2          0          0
```


ENDL $^{92}U_{238}$ (n,γ)
Cross Section
Cross Section (barns)
Incident Neutron Energy (MeV)


ENDL $^{92}U_{238}$ (n,γ)
Cross Section
Cross Section (barns)
Incident Neutron Energy (MeV)


ENDL $^{92}U_{238}$ (n,γ)
Cross Section
Cross Section (barns)
Incident Neutron Energy (MeV)


ENDL $^{92}U_{238}$ (n,γ)
Cross Section
Cross Section (barns)
Incident Neutron Energy (MeV)

94

Composition Mode - Overlapping Subplots

The preceding examples of the composition mode only considered the case of non-overlapping subplots. In the following example the true power of the composition mode is illustrated in positioning subplots anywhere on a page to create special effects.

In this example there are three subplots. The first subplot occupies the entire page (X = 0 to 13.5 and Y = 0 to 10). The following two subplots are positioned within the same plotting area; one is located in X = 8.5 to 12.5, Y = 5.5 to 9.0, and the another in X = 1.3 to 5.3, Y = 0.85 to 4.35 (in each case a 4 by 3.5 subplot). The positions of these subplots were defined in a trial and error manner using a computer terminal screen; once their positions were defined the following hardcopy was produced.

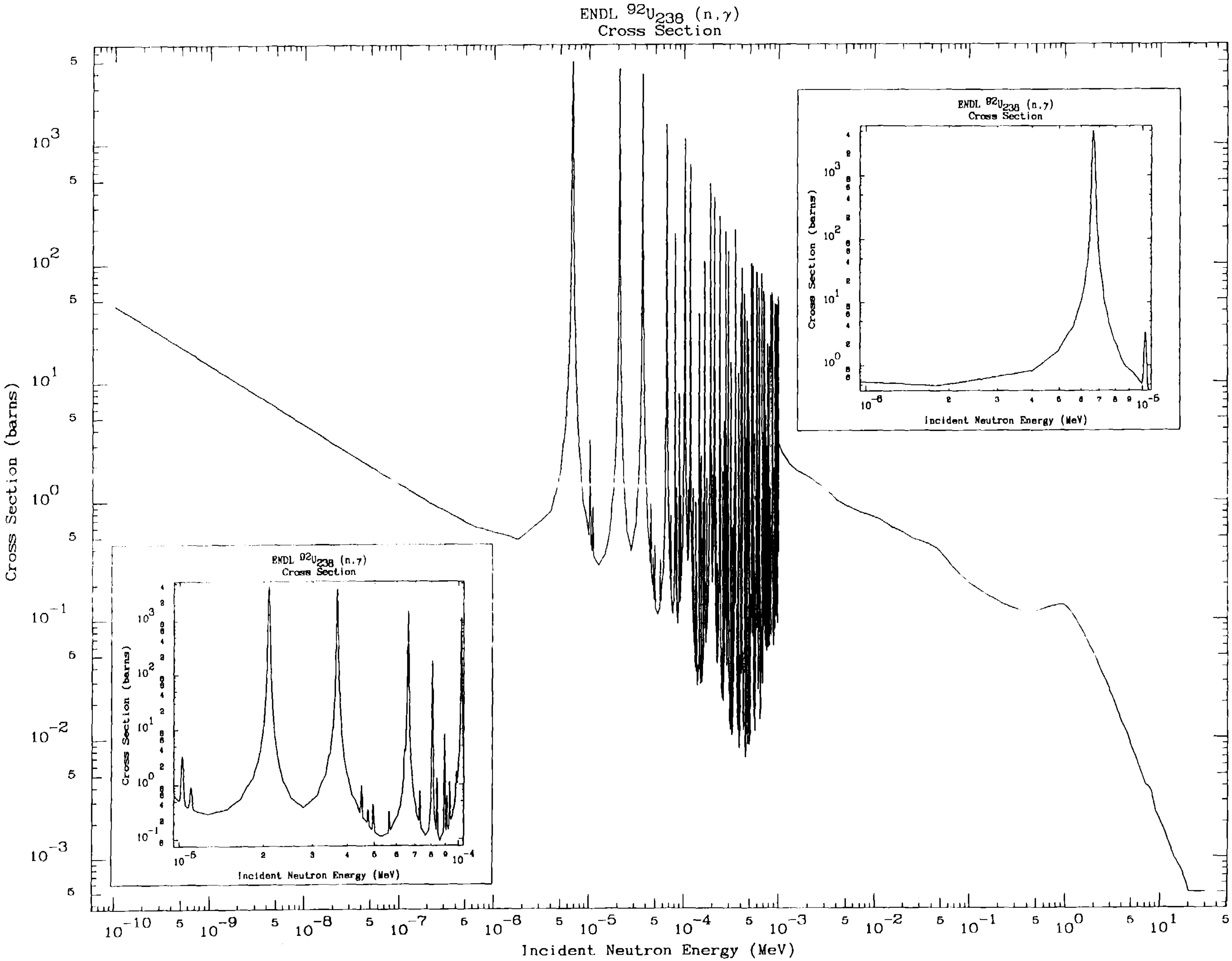
The restrictions in using overlapping subplots includes the general restriction, described earlier, that each subplot must be positions separately, plus the restriction that only the inner most subplots can contain grids other than simple tick marks on the border. Each subplot is positioned and drawn separately without any knowledge of the other subplots. Therefore if subplots other than the inner most subplot include grids, the grid will overwrite the area occupied by the inner subplot and the results will not be very pleasing.

Note, all three examples of using the composition mode also used the alternate character set -]g is plotted as a Greek gamma, as well as super and subscripts to identify 92-U-238.

```
    0.00000   13.50000    0.00000    10.0                  -1          1 1.0
         -1          0          0          0          0          0    0
Incident Neutron Energy (MeV)
Cross Section (barns)
ENDL {9{2U}2}3}8 (n,]g)
Cross Section
                                0          2          0          1
                                0          2          0          0

    8.50000   12.50000    5.50000     9.0                  -1          1 2.0
         -1          0          1          0          0          0    0
Incident Neutron Energy (MeV)
Cross Section (barns)
ENDL {9{2U}2}3}8 (n,]g)
Cross Section
 1.00000- 6 1.03000- 5          0          2          0          1
                                0          2          0          0

    1.30000    5.30000    0.85000    4.35                   1          1 2.0
         -1          0          1          0          0          0    0
Incident Neutron Energy (MeV)
Cross Section (barns)
ENDL {9{2U}2}3}8 (n,]g)
Cross Section
 1.00000- 5 1.00000- 4          0          2          0          1
                                0          2          0          0
```


ENDL 92U238 (n,γ)
Cross Section
Cross Section (barns)
Incident Neutron Energy (MeV)
ENDL 92U238 (n,γ)
Cross Section
Cross Section (barns)
Incident Neutron Energy (MeV)
ENDL 92U238 (n,γ)
Cross Section
Cross Section (barns)
Incident Neutron Energy (MeV)

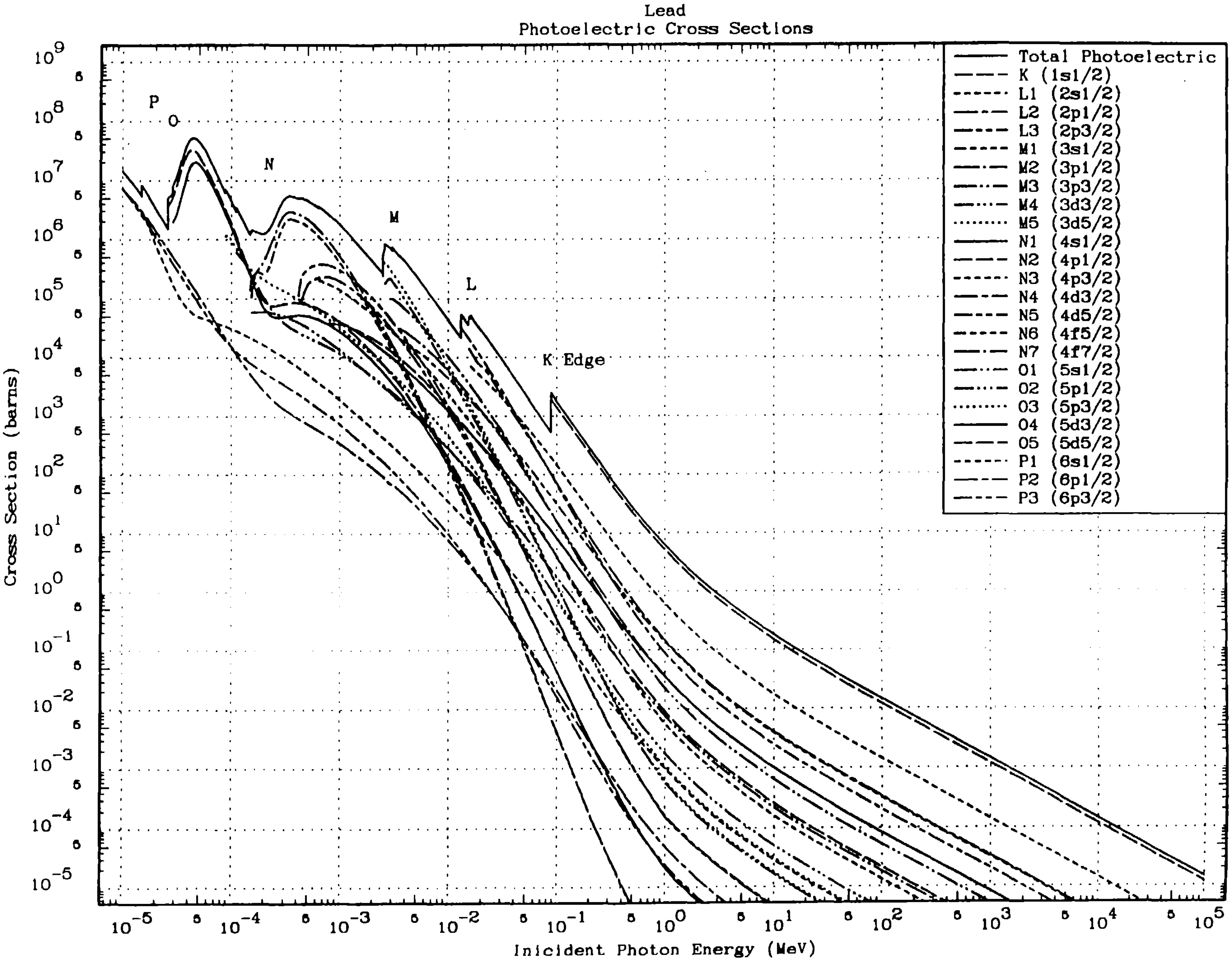
Randomly Positioned Titles

For use in special applications this code has the ability to position titles anywhere on the plotting surface. As distributed this option is internally turned off. However, if you wish to use it, it is fairly easy to reactivate this option; use a text edit to search for the word DEBUG and activate all FORTRAN statements between pairs of DEBUG lines.

Once activated this option will read X and Y coordinates followed by a title from a file named TITLES.DAT. There may be up to 30 sets of X and Y coordinates and titles. Each title may be up to 72 characters in length. X and Y coordinates are absolute in the units of the plotter, e.g., inches, centimeters, etc.

The following plot illustrates the results obtained when this option is used to identify the photoelectric edges of lead. In this case the file TITLES.DAT contained the following 12 lines, used to define 6 sets of X and Y coordinates and titles. The X and Y coordinates for these titles were defined in a trial and error manner using a computer terminal screen; once their positions were defined the following hardcopy was produced.

```
 1.70000+ 0 9.00000+ 0
P
 1.90000+ 0 8.80000+ 0
O
 2.90000+ 0 8.35000+ 0
N
 4.20000+ 0 7.80000+ 0
M
 5.00000+ 0 7.10000+ 0
L
 5.80000+ 0 6.30000+ 0
K Edge
```


Lead
Photoelectric Cross Sections
Cross Section (barns)
Incident Photon Energy (MeV)
P
O
N
M
L
K Edge
Total Photoelectric
K (1s1/2)
L1 (2s1/2)
L2 (2p1/2)
L3 (2p3/2)
M1 (3s1/2)
M2 (3p1/2)
M3 (3p3/2)
M4 (3d3/2)
M5 (3d5/2)
N1 (4s1/2)
N2 (4p1/2)
N3 (4p3/2)
N4 (4d3/2)
N5 (4d5/2)
N6 (4f5/2)
N7 (4f7/2)
O1 (5s1/2)
O2 (5p1/2)
O3 (5p3/2)
O4 (5d3/2)
O5 (5d5/2)
P1 (6s1/2)
P2 (6p1/2)
P3 (6p3/2)

86

Comparison of Evaluated and Experimental Data

The following example uses many of the options described so far to produce a series of plots, first comparing two evaluation to all of the available experimental data, and then comparing only the two evaluations.

The first plot is over the energy range 1 keV to 30 MeV; the entire energy range over which both evaluations are defined. This plot really doesn't show us very much, except that: 1) at low energy the two evaluations are quite different and, 2) there are no experimental data below about 10 keV. Usually if these data haven't been "seen" yet a plot such as this is first generated and based on examining the plot energy ranges or options are selected for additional plots, as is done below.

The second plot shows all of the data from 10 keV to 30 MeV. The third through fifth plots show the energy ranges 10-100 keV, 100 keV-1 MeV and 1-30 MeV, including the ratio of everything to the first evaluation. Here by using the ratio we can quantitatively define the actual spread in the evaluated and experimental data. From these plots we can easily see that above 10 keV the two evaluations are very similar, with differences exceeding 10 % only below about 20 keV, and differences of only 6-7 % above 30 keV; these differences are small compared to the spread in the experimental data.

The next two plots compare only the two evaluations over the energy ranges 1 keV-30 MeV and 10 keV-30 MeV. From these plots we can see the importance of interpolation. The tabulated values in the ENDL Old evaluation are quite close to the values in the ENDL New evaluation. However, in the 1-10 keV energy range the ENDL Old evaluation does not contain enough energy points, resulting in the unrealistic "bumps" in the cross section between tabulated points. The result is that between tabulated energies the interpolated values of the cross sections differ by factors of almost 20 (i.e., almost 2000 %). In this energy range there are no experimental values and the cross section is extremely small, i.e., less than 0.1 micro-barns.

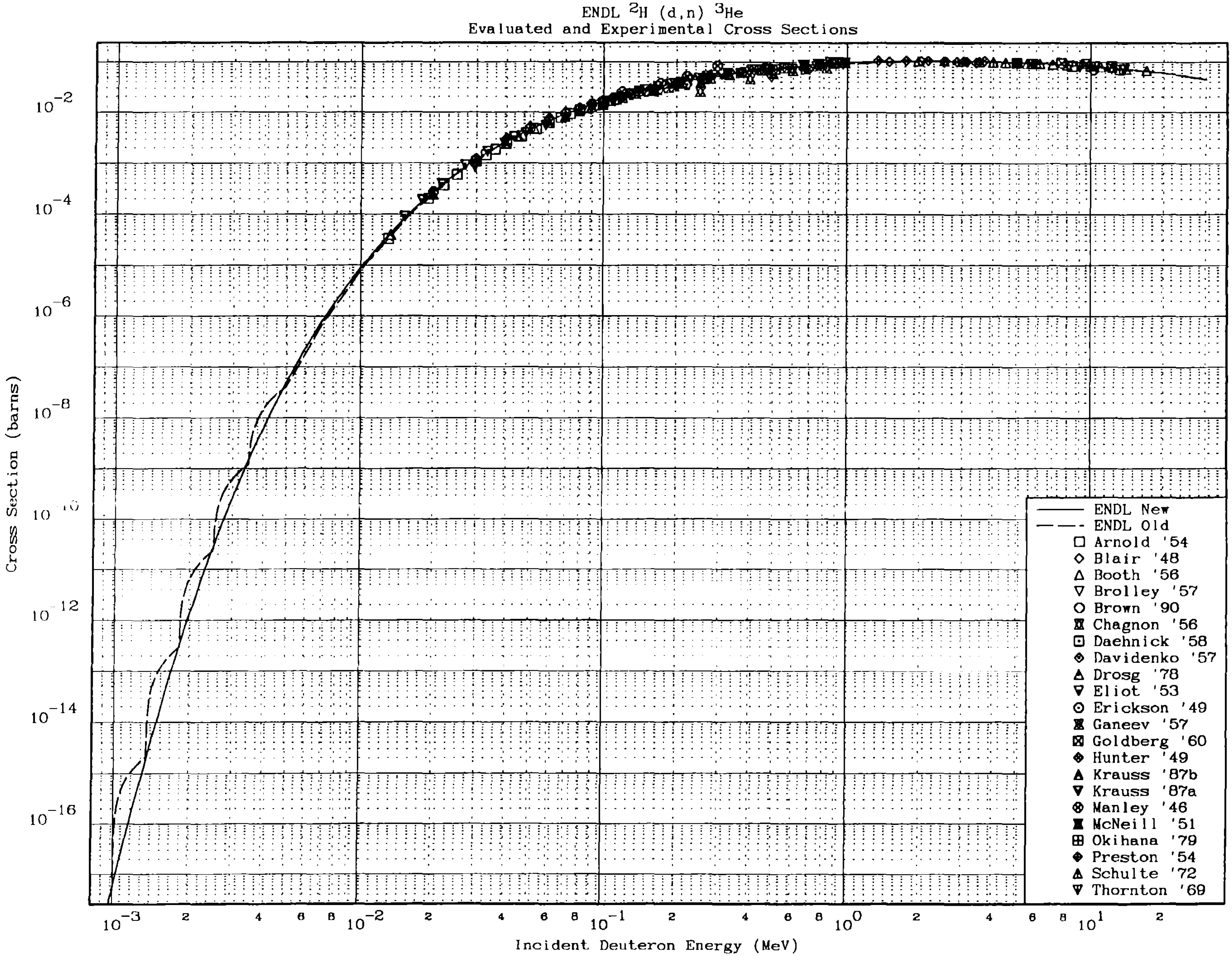
The next plot even more dramatically demonstrates the importance of proper interpolation. This plot is exactly the same as the previous plot comparing the two evaluations over the energy range 1 keV-30 MeV, except that the input parameters indicates log-log interpolation between tabulated data points (cols. 34-44 of the 7-th [for X] and 8-th [for Y], input lines). In the previous plot using linear-linear interpolation differences of almost 2000 % were found. Here using exactly the same data but log-log interpolation the differences are less than 60 %, and less than 25 % for all energies above 1.2 keV.

The last two plots illustrate that using the character size multiplier also effects the size of symbols used to define sets of data points. In this case the two plots correspond to previous plots of this series for the energy range 1-30 MeV, but in this case character size multipliers of 1.2 and 1.5, respectively, are used. For plots containing various sets of data points this effect can often be used to more clearly see the individual symbols representing each set of points.

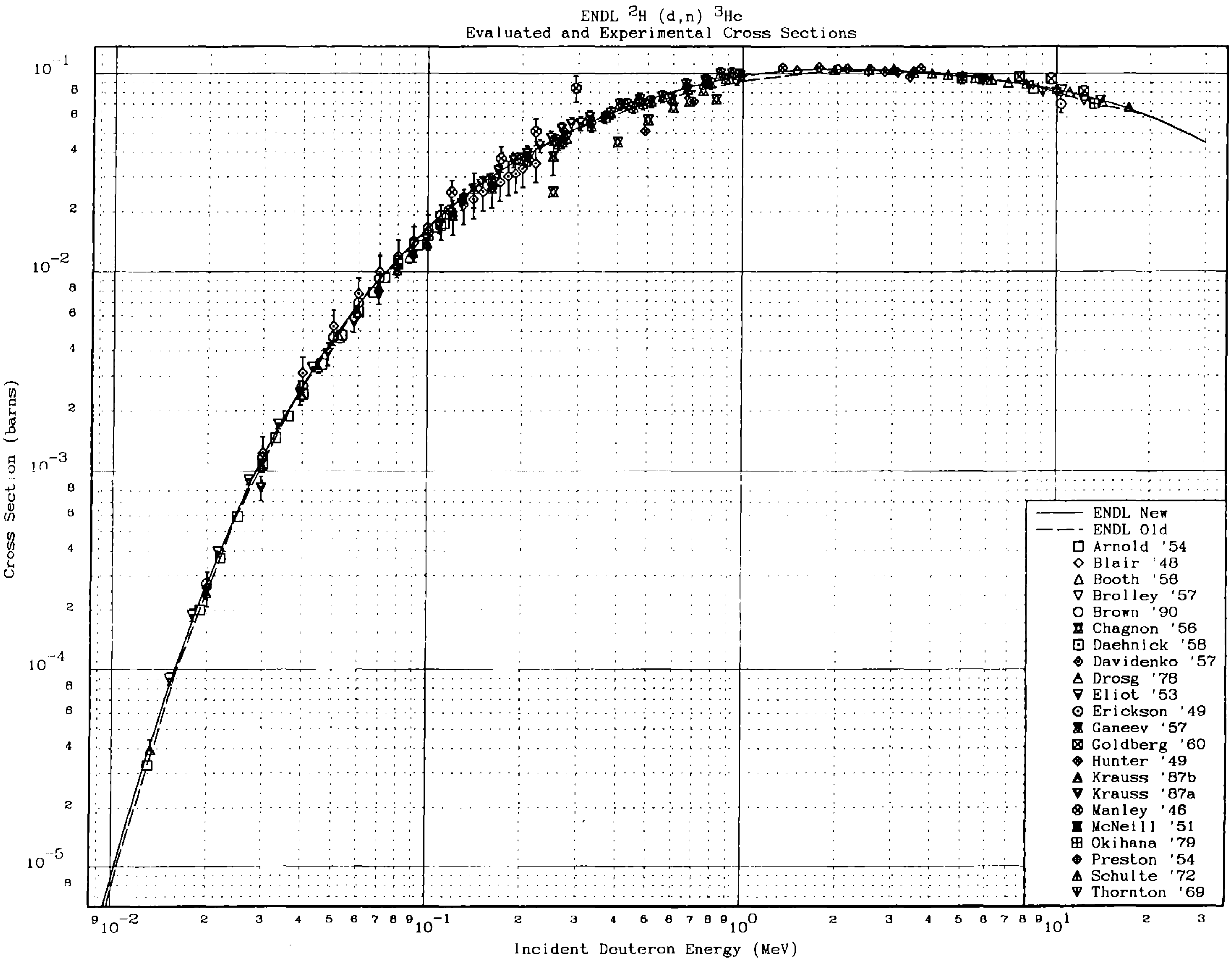
```
    0.00000    13.50000    0.00000    10.0                 1              1 1.0
         -2         -30          0            4            0             -2    0
Incident Deuteron Energy (MeV)
Cross Section (barns)
ENDL {2H (d,n) {3He
Evaluated and Experimental Cross Sections
 1.00000- 3                      0            2            0              0
                                 1            2            0              0
ENDL {2H (d,n) {3He
Evaluated and Experimental Cross Sections
 1.00000- 2                      0            2            0              0
                                 1            2            0              0

    0.00000    13.50000    0.00000    10.0                 1              1 1.0
         -2         -30          0            4            4             -2    0
Incident Deuteron Energy (MeV)
Cross Section (barns)
ENDL {2H (d,n) {3He
Evaluated and Experimental Cross Sections
 1.00000- 2 1.00000- 1           0            2            0              0
                                 1            2            0              0
ENDL {2H (d,n) {3He
Evaluated and Experimental Cross Sections
 1.00000- 1 1.00000+ 0           0            2            0              0
                                 1            2            0              0
ENDL {2H (d,n) {3He
Evaluated and Experimental Cross Sections
 1.00000+ 0 3.00000+ 1           0            2            0              0
                                 1            2            0              0

    0.00000    13.50000    0.00000    10.0                 1              1 1.0
         -2           0          0            4            4             -2    0
Incident Deuteron Energy (MeV)
Cross Section (barns)
ENDL {2H (d,n) {3He
Evaluated Cross Sections
 1.00000- 3                      0            2            0              0
                                 1            2            0              0
ENDL {2H (d,n) {3He
Evaluated Cross Sections
 1.00000- 2                      0            2            0              0
                                 1            2            0              0
ENDL {2H (d,n) {3He
Evaluated Cross Sections
 1.00000- 3                      0           -2            0              0
                                 1           -2            0              0
```

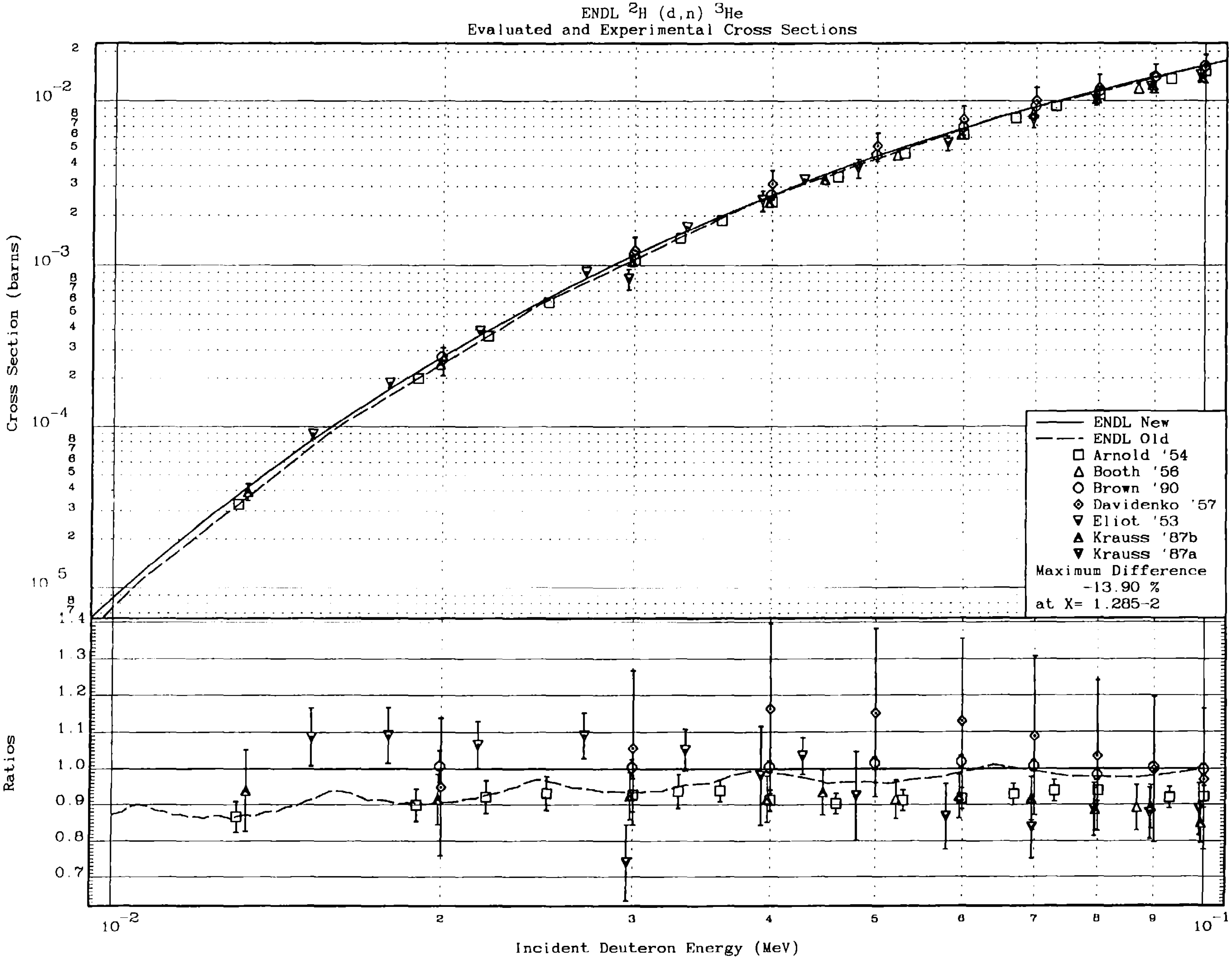


ENDL ^{2}H (d,n) ^{3}He
Evaluated and Experimental Cross Sections
Cross Section (barns)
Incident Deuteron Energy (MeV)
ENDL New
ENDL Old
Arnold '54
Blair '48
Booth '56
Brolley '57
Brown '90
Chagnon '56
Daehnick '58
Davidenko '57
Drosg '78
Eliot '53
Erickson '49
Ganeev '57
Goldberg '60
Hunter '49
Krauss '87b
Krauss '87a
Manley '46
McNeill '51
Okihana '79
Preston '54
Schulte '72
Thornton '69

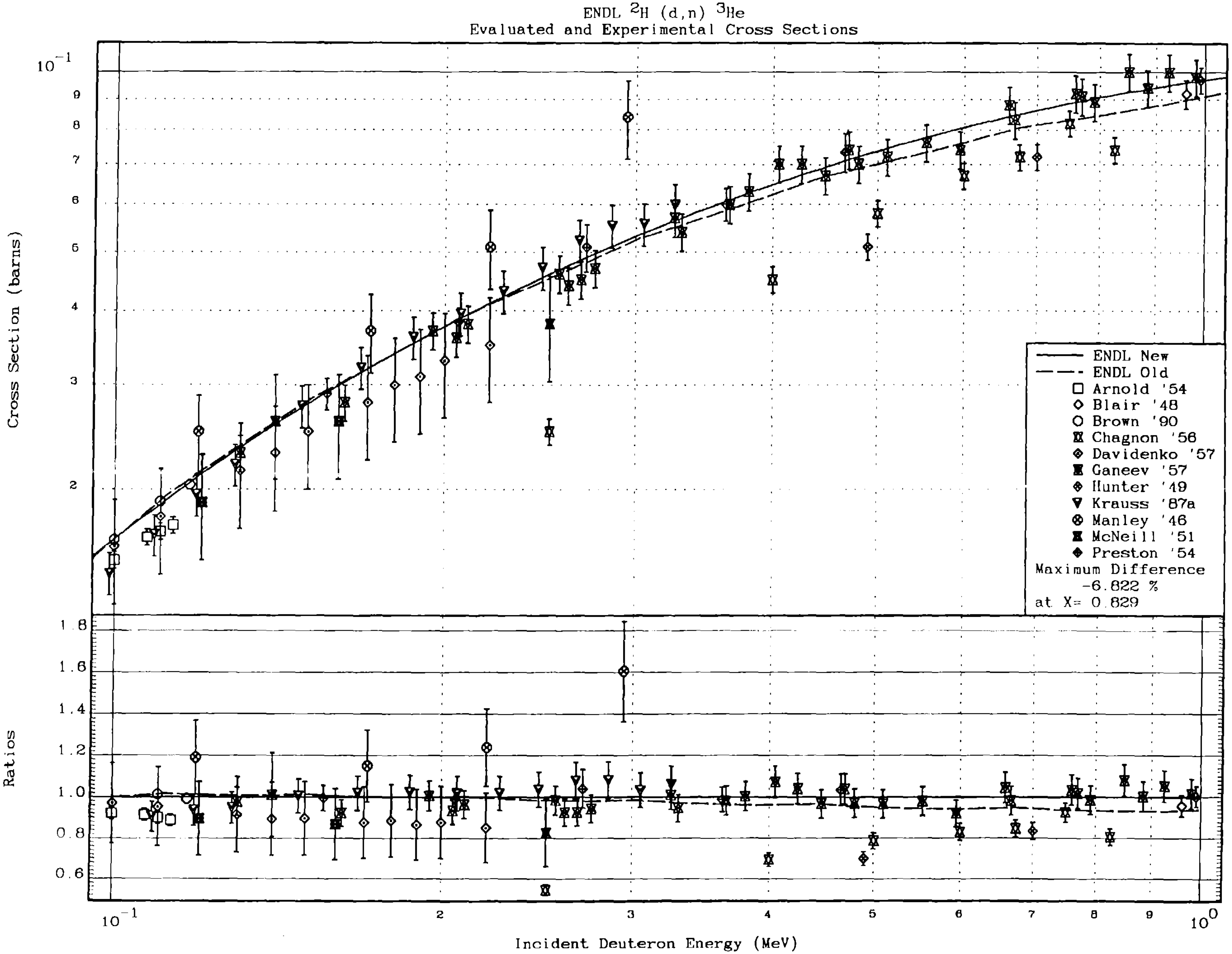


ENDL ^{2}H (d,n) ^{3}He
Evaluated and Experimental Cross Sections
Cross Section (barns)
Incident Deuteron Energy (MeV)
ENDL New
ENDL Old
Arnold '54
Blair '48
Booth '56
Brolley '57
Brown '90
Chagnon '56
Daehnick '58
Davidenko '57
Drosg '78
Eliot '53
Erickson '49
Ganeev '57
Goldberg '60
Hunter '49
Krauss '87b
Krauss '87a
Manley '46
McNeill '51
Okihana '79
Preston '54
Schulte '72
Thornton '69

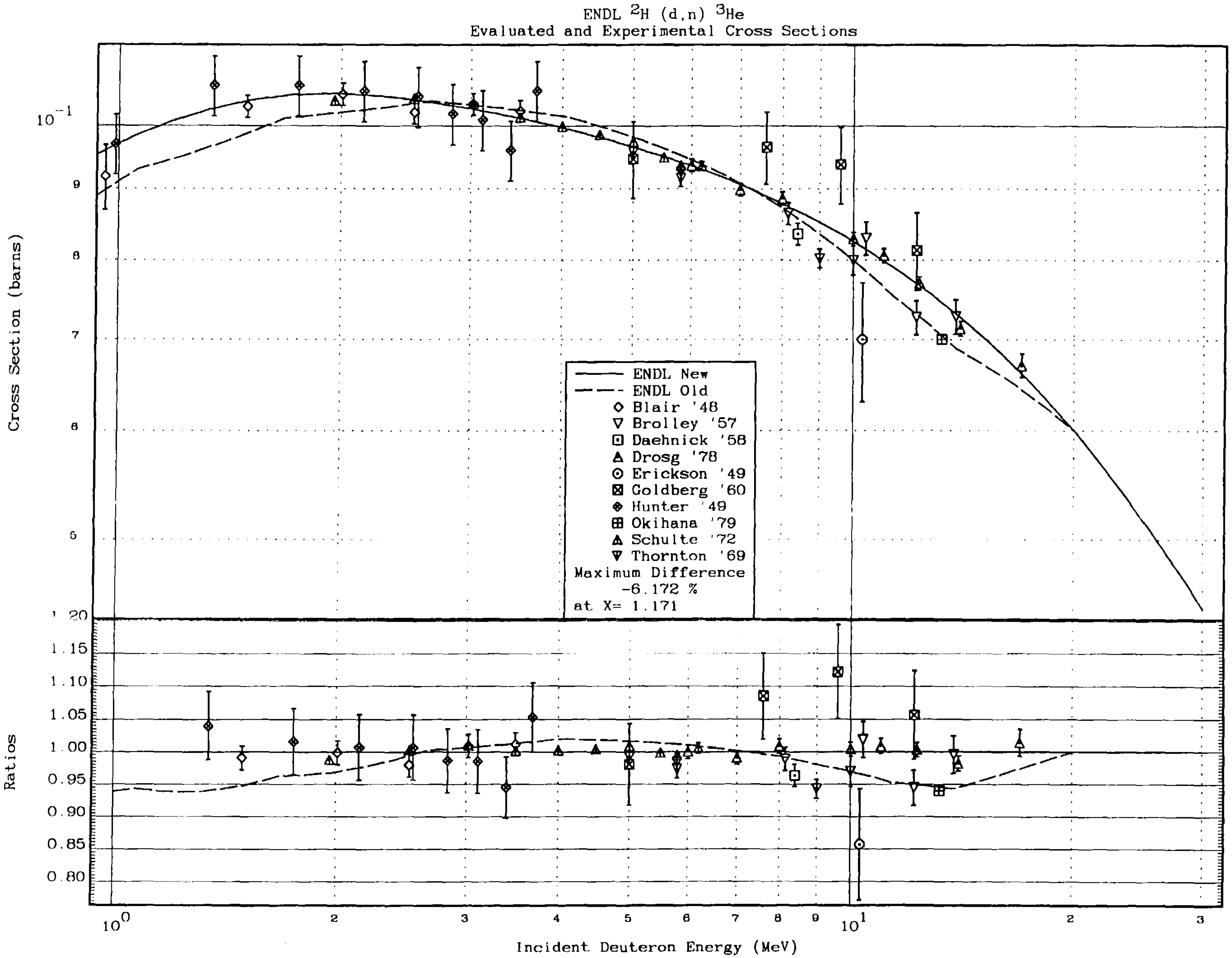
102


ENDL ^{2}H (d,n) ^{3}He
Evaluated and Experimental Cross Sections
Cross Section (barns)
Ratios
Incident Deuteron Energy (MeV)
ENDL New
ENDL Old
Arnold '54
Booth '56
Brown '90
Davidenko '57
Eliot '53
Krauss '87b
Krauss '87a
Maximum Difference
-13.90 %
at X= 1.285-2

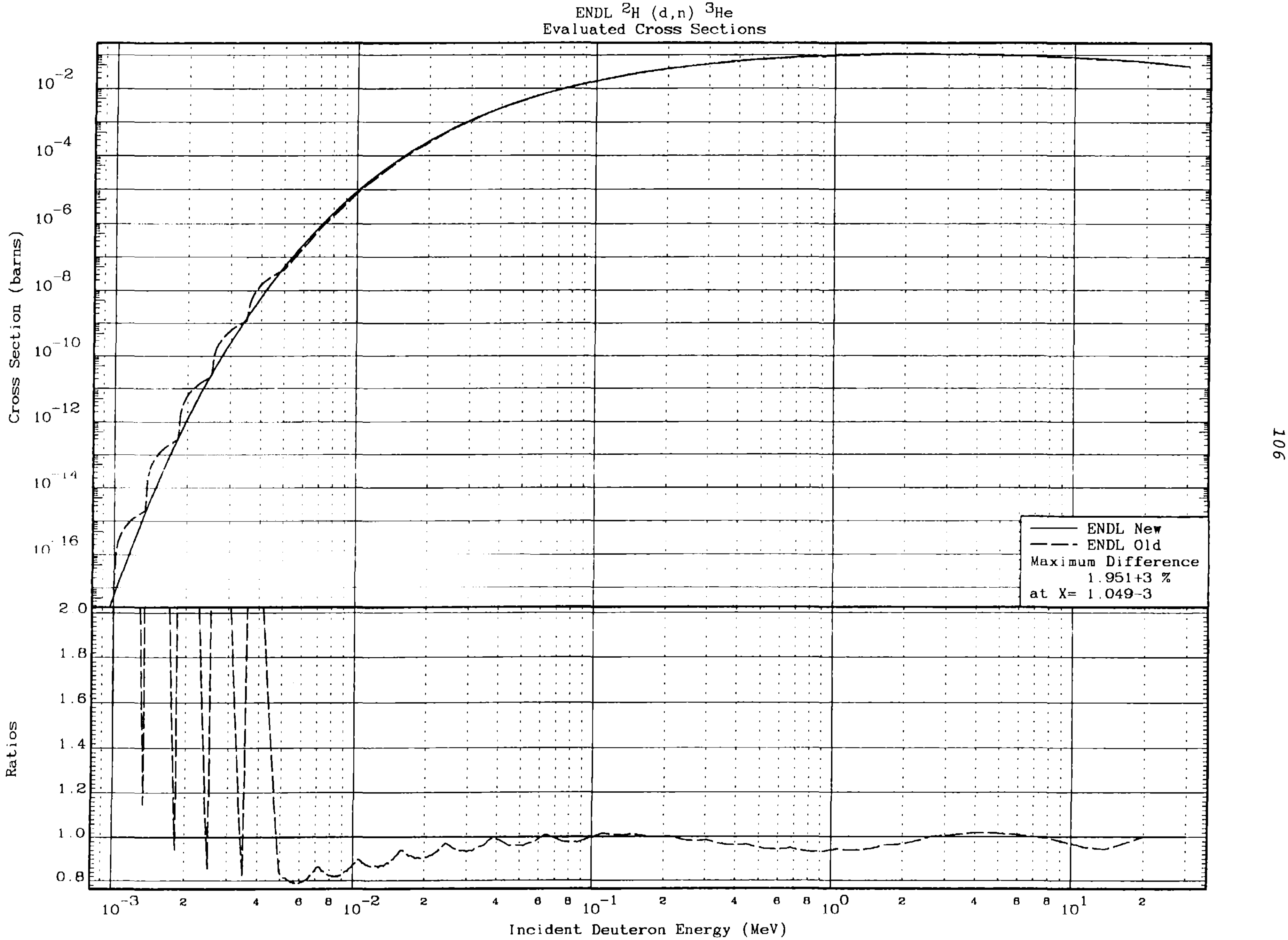
103

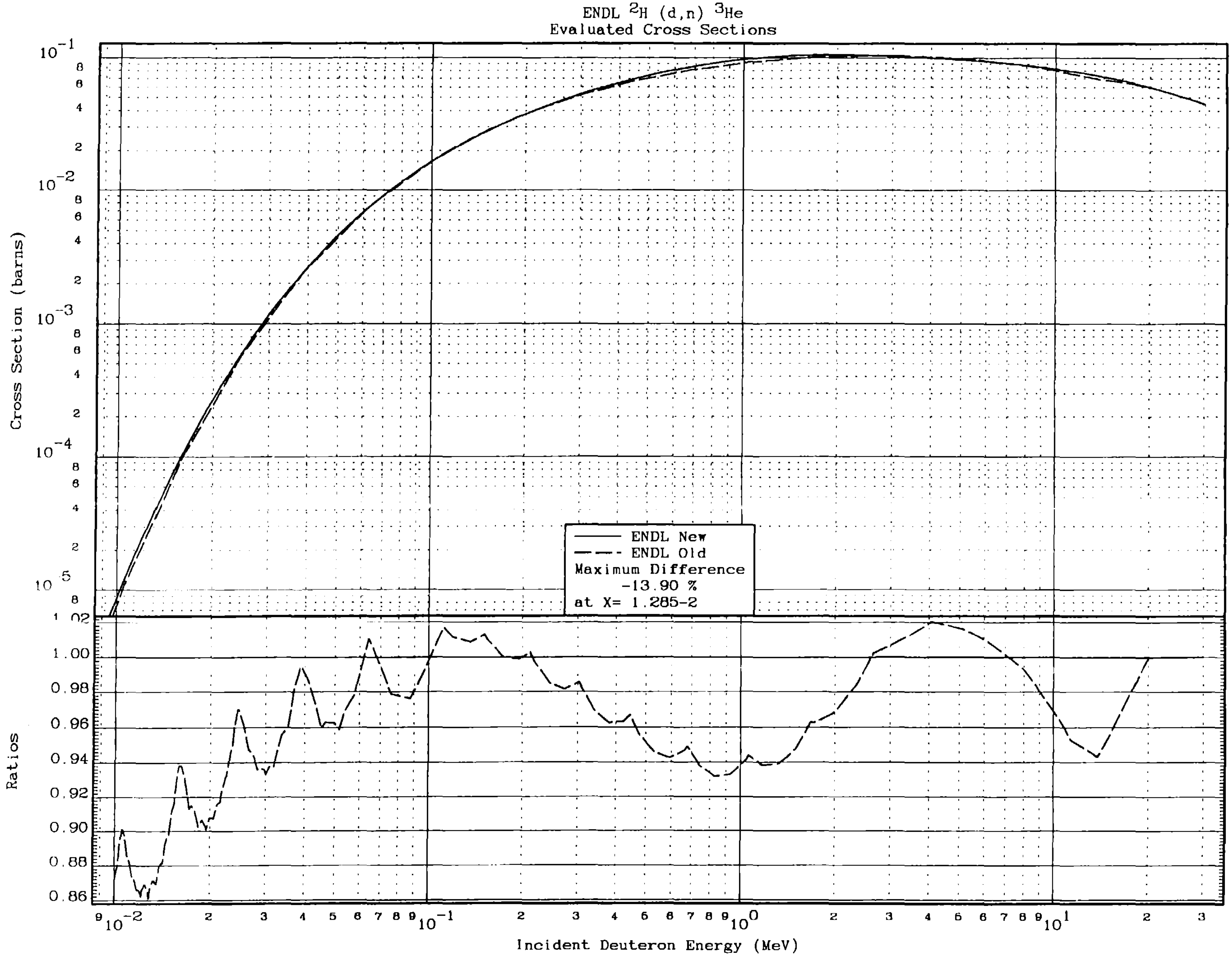

ENDL ^{2}H (d,n) ^{3}He
Evaluated and Experimental Cross Sections
Cross Section (barns)
Ratios
Incident Deuteron Energy (MeV)
ENDL New
ENDL Old
Arnold '54
Blair '48
Brown '90
Chagnon '56
Davidenko '57
Ganeev '57
Hunter '49
Krauss '87a
Manley '46
McNeill '51
Preston '54
Maximum Difference
-6.822 %
at X= 0.829

104

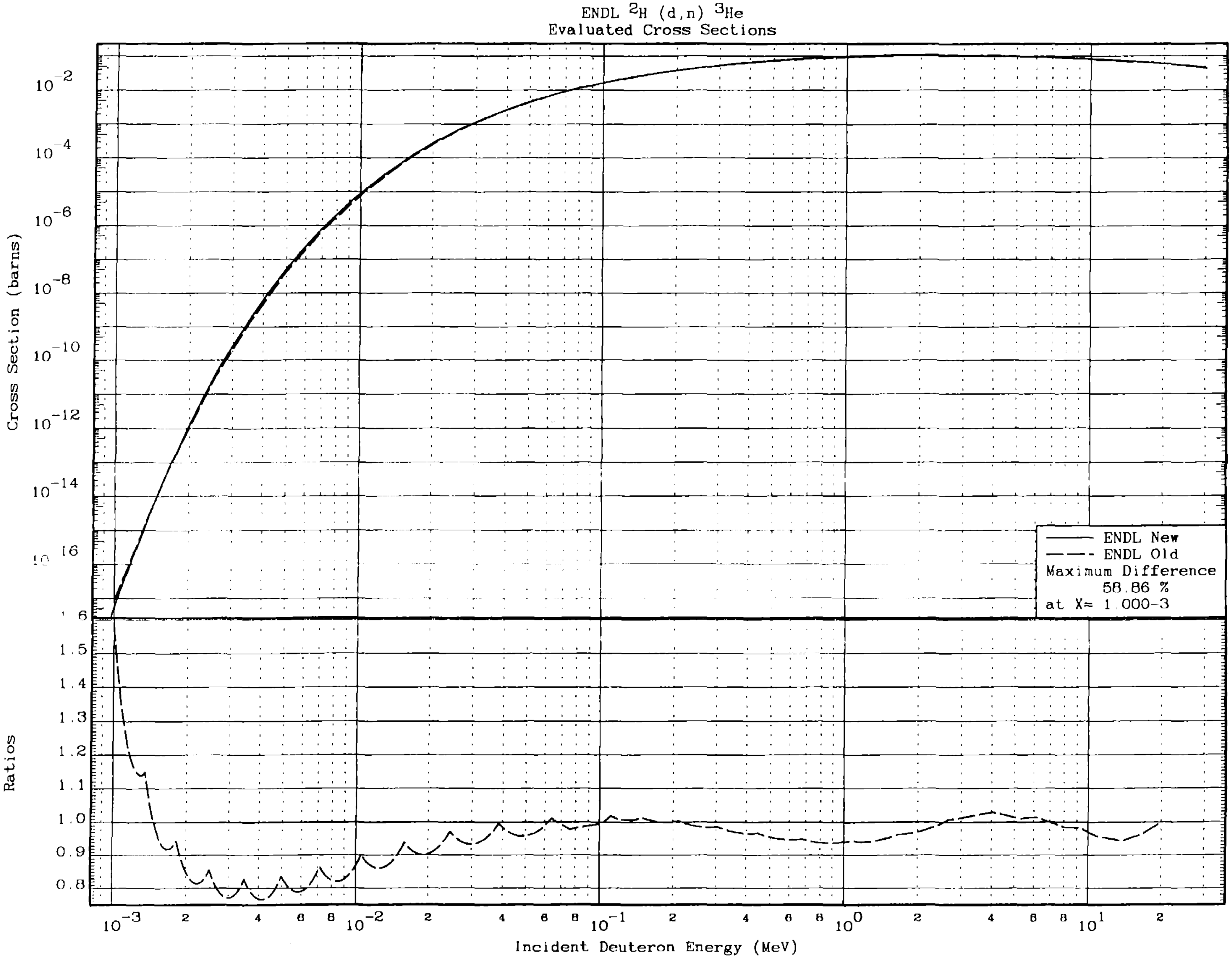

ENDL ^{2}H (d,n) ^{3}He
Evaluated and Experimental Cross Sections
Cross Section (barns)
Ratios
Incident Deuteron Energy (MeV)
ENDL New
ENDL Old
Blair '48
Brolley '57
Daehnick '58
Drosg '78
Erickson '49
Goldberg '60
Hunter '49
Okihana '79
Schulte '72
Thornton '69
Maximum Difference
-6.172 %
at X= 1.171

105


ENDL ^{2}H (d,n) ^{3}He
Evaluated Cross Sections
Cross Section (barns)
Ratios
Incident Deuteron Energy (MeV)
ENDL New
ENDL Old
Maximum Difference
1.951+3 %
at X= 1.049-3
106

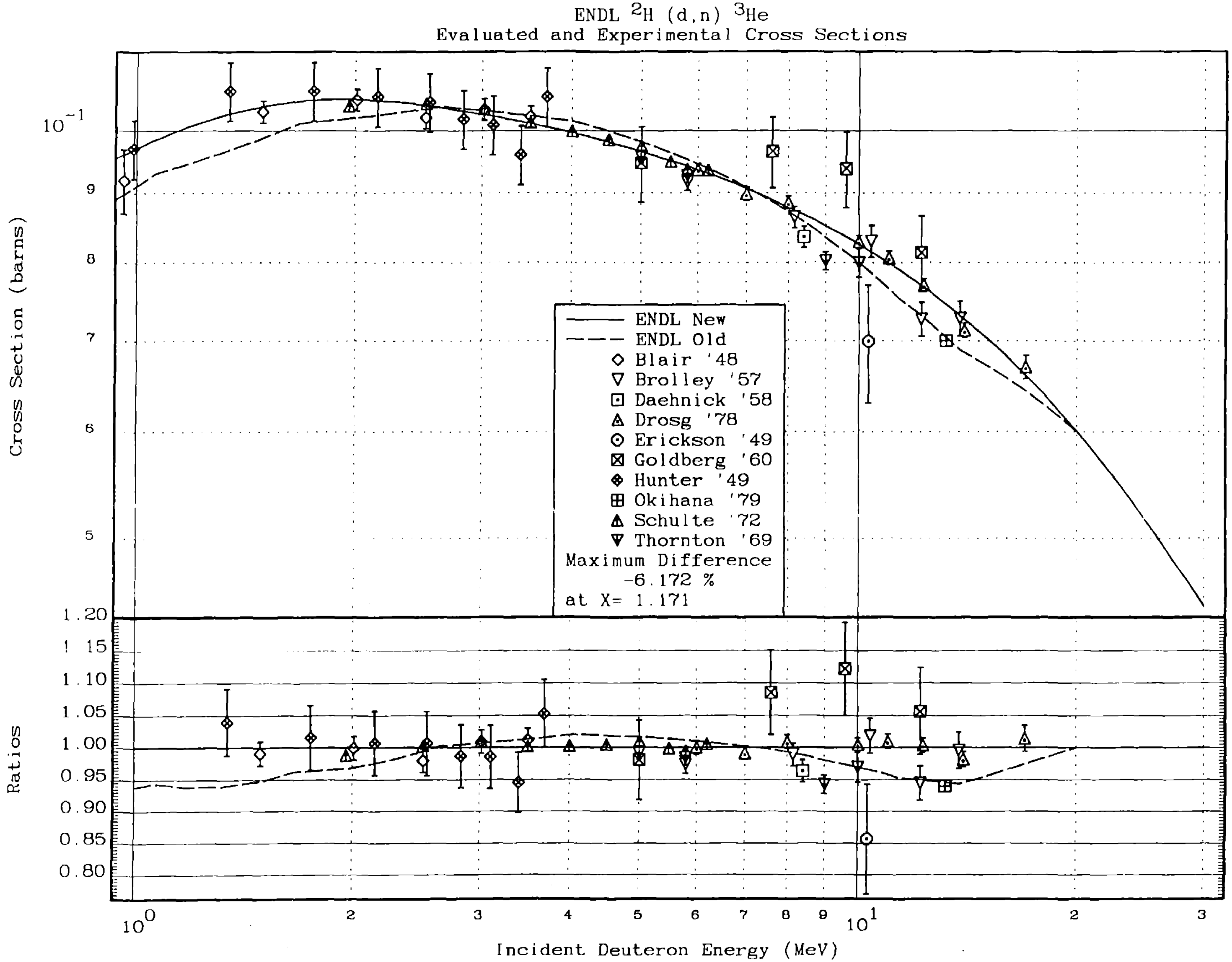


ENDL ^{2}H (d,n) ^{3}He
Evaluated Cross Sections
Cross Section (barns)
Ratios
ENDL New
ENDL Old
Maximum Difference
-13.90 %
at X= 1.285-2
Incident Deuteron Energy (MeV)



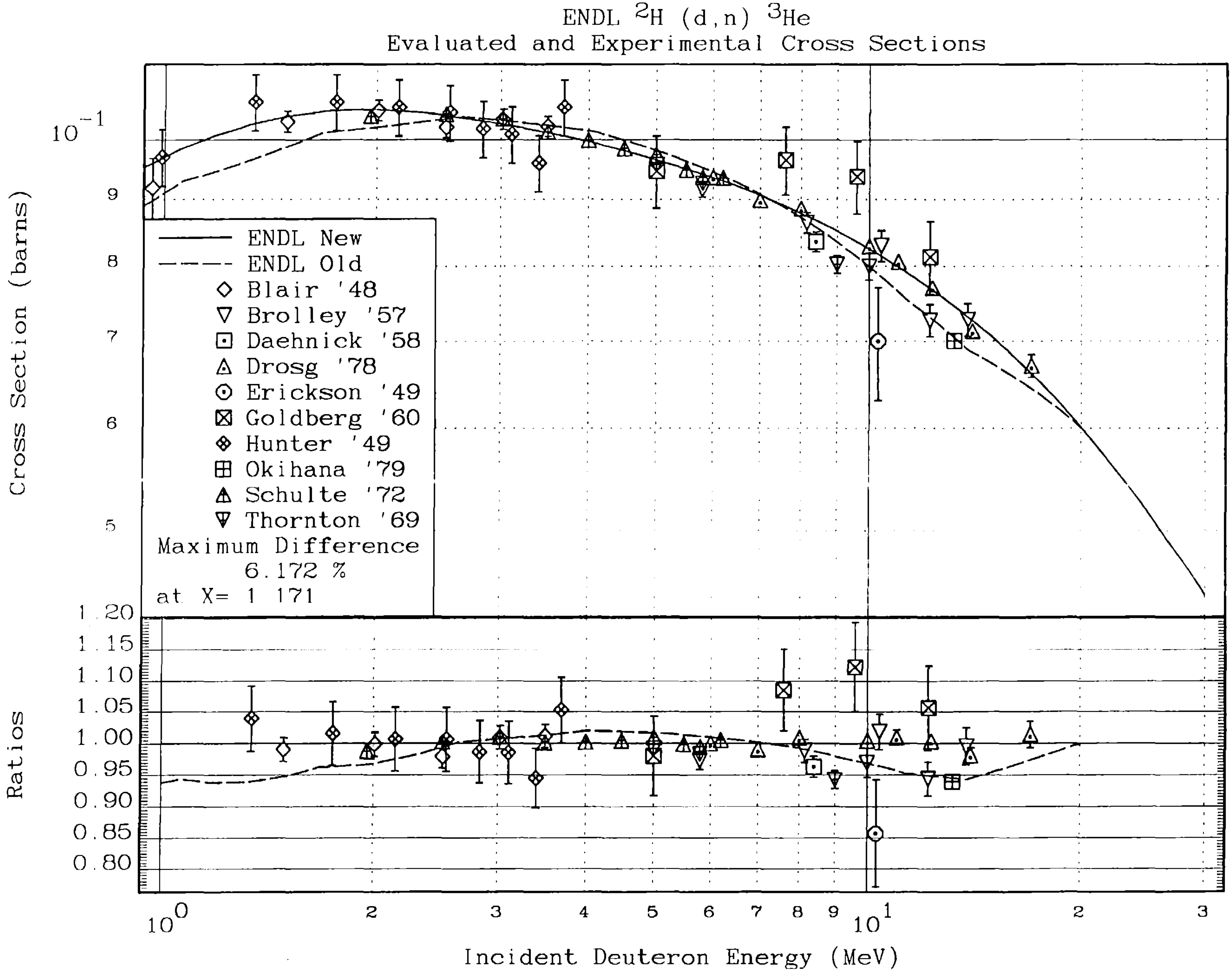
ENDL ²H (d,n) ³He
Evaluated Cross Sections
Cross Section (barns)
Ratios
ENDL New
ENDL Old
Maximum Difference
58.86 %
at X= 1.000-3
Incident Deuteron Energy (MeV)

108



ENDL ^{2}H (d,n) ^{3}He
Evaluated and Experimental Cross Sections
Cross Section (barns)
Ratios
Incident Deuteron Energy (MeV)
ENDL New
ENDL Old
Blair '48
Brolley '57
Daehnick '58
Drosg '78
Erickson '49
Goldberg '60
Hunter '49
Okihana '79
Schulte '72
Thornton '69
Maximum Difference
-6.172 %
at X= 1.171

109


ENDL ^{2}H (d,n) ^{3}He
Evaluated and Experimental Cross Sections
Cross Section (barns)
Ratios
Incident Deuteron Energy (MeV)
ENDL New
ENDL Old
Blair '48
Brolley '57
Daehnick '58
Drosg '78
Erickson '49
Goldberg '60
Hunter '49
Okihana '79
Schulte '72
Thornton '69
Maximum Difference
6.172 %
at X= 1.171

110