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## ENDF/B-VII.1 versus ENDF/B-VII.0 Comparison

by

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## ABSTRACT

Recently the new ENDF/B-VII.1 library was released; this completely replaces the earlier ENDF/B-VII.0 library. One of the first questions we ask about a new library is: **What's Different?** Here I attempt to at least partially answer this question. I present results in both tabulated form (so you can quickly determine if any evaluations of interest to you have changed), and graphic form (so that you can see how much evaluations have changed and in what energy ranges).

March 2015



## Table of Contents

Differences in Data and Computer Codes .....	7
Overview.....	7
120 Evaluations where total cross section differs by 1% or more.....	8
Detailed Differences .....	10
Acknowledgments.....	14
References.....	15
120 Plots.....	16



## Differences in Data and Computer Codes

It is extremely important to distinguish between differences that we see in the data we use in our applications due to changes in our evaluated data as opposed to differences due to changes in the computer codes that we use to process our evaluated data.

In this report I describe the differences that I find in the evaluations themselves as included in the ENDF/B-VII.1 and VII.0 evaluated nuclear data libraries. For this comparison I have processed both data libraries using exactly the same PREPRO 2010 [3] codes, so that we can be sure that any differences we see here are due solely due to differences in the evaluated data.

In a separate report on POINT 2015 [4] I document differences that we see in the ENDF/B-VII.1 data we use in our applications due to differences in the PREPRO codes. Hopefully readers will understand that these two reports are complementary: the present report showing differences due to changes in the evaluations, and the POINT 2015 report showing differences due to changes in the PREPRO codes [5].

## Overview

For the table I have compared what I refer to as the ENDF neutron data, namely MF=1 through 6. Here I did a character-by-character comparison of the same sections (MF/MT) that appear in both ENDF/B-VII.0 and VII.1; here I found differences in 170 evaluations.

For the plots I have only compared the total cross sections for all evaluations that are common to both libraries, and I found that of the 423 evaluations in ENDF/B-VII.1, 120 of these have total cross sections that differ by 1% or more from the evaluation of the same isotope in ENDF/B-VII.0.

**WARNING:** This should be considered only a preliminary comparison; obviously there can be more subtle important differences that do not effect of total cross sections.

Here I present plots comparing the total cross section of these 120 isotopes. The plots are only broad overviews of the total cross sections over their entire energy range. If you have interest in more detailed plots for specific evaluations, you can download the evaluations [1, 2]

<https://www-nds.iaea.org/point2009/pt2009.htm>

<https://www-nds.iaea.org/point2012/>

and the PREPRO [3] codes.

<http://www-nds.iaea.org/ndspub/endl/prepro/>

I used to prepare and view the data. This is all I needed to do my comparisons, and is all you should need to do any more detailed comparisons to meet your individual needs.

What I present in the plots is the original ENDF/B-VII.0 and VII.1 data after it has been processed by my PREPRO codes [3]; these codes linearized all of the data and added any resonance contributions to the cross sections. The result is “cold” 0 Kelvin data [1, 2]

### 120 Evaluations where total cross section differs by 1% or more

The below tables defines all 120 evaluations where the total cross section differs by 1% or more between ENDF/B-VII.0 and VII.1. From this table you should be able to quickly see whether or not any material of interest to you is affected; for more details see the plots later in his report.

The following page lists all 423 evaluations included in ENDF/B-VII.1. Comparing these two tables you can see that many evaluations are identical in both ENDF/B-VII.0 and VII.1.

1-H -3	28-Ni-58	47-Ag-109	72-Hf-179	92-U -232	96-Cm-243
2-He-4	28-Ni-60	48-Cd-106	72-Hf-180	92-U -233	96-Cm-244
3-Li-6	28-Ni-61	48-Cd-108	73-Ta-181	92-U -237	96-Cm-245
4-Be-9	28-Ni-62	48-Cd-110	74-W -182	92-U -239	96-Cm-246
15-P -31	28-Ni-64	48-Cd-111	74-W -183	93-Np-235	96-Cm-247
17-Cl-35	33-As-75	48-Cd-112	74-W -184	93-Np-236	96-Cm-248
17-Cl-37	36-Kr-78	48-Cd-113	74-W -186	93-Np-237	96-Cm-249
19-K -39	36-Kr-86	48-Cd-114	75-Re-185	93-Np-238	96-Cm-250
19-K -41	39-Y -89	48-Cd-116	75-Re-187	93-Np-239	97-Bk-249
22-Ti-46	40-Zr-90	50-Sn-125	89-Ac-225	94-Pu-236	97-Bk-250
22-Ti-47	40-Zr-91	54-Xe-123	89-Ac-226	94-Pu-237	98-Cf-249
22-Ti-48	40-Zr-92	54-Xe-124	89-Ac-227	94-Pu-238	98-Cf-250
22-Ti-49	40-Zr-93	55-Cs-133	90-Th-227	94-Pu-240	98-Cf-251
22-Ti-50	40-Zr-94	60-Nd-145	90-Th-228	94-Pu-242	98-Cf-252
24-Cr-50	40-Zr-95	63-Eu-153	90-Th-229	94-Pu-244	98-Cf-253
24-Cr-52	40-Zr-96	64-Gd-157	90-Th-230	94-Pu-246	98-Cf-254
24-Cr-53	42-Mo-92	72-Hf-174	90-Th-232	95-Am-241	99-Es-253
24-Cr-54	42-Mo-95	72-Hf-176	90-Th-233	95-Am-243	99-Es-254
25-Mn-55	43-Tc-99	72-Hf-177	90-Th-234	96-Cm-241	99-Es-255
27-Co-58	45-Rh-103	72-Hf-178	91-Pa-232	96-Cm-242	100-Fm-255



423 Evaluations in VII.1 (32 new evaluations in RED)

1-H -1	20-Ca-44	32-Ge-74	42-Mo-92	49-In-115	54-Xe-131	61-Pm-147	68-Er-166	88-Ra-224	94-Pu-242
1-H -2	20-Ca-46	32-Ge-76	42-Mo-94	50-Sn-112	54-Xe-132	61-Pm-148	68-Er-167	88-Ra-225	94-Pu-243
1-H -3	20-Ca-48	33-As-74	42-Mo-95	50-Sn-113	54-Xe-133	61-Pm-148m	68-Er-168	88-Ra-226	94-Pu-244
2-He-3	21-Sc-45	33-As-75	42-Mo-96	50-Sn-114	54-Xe-134	61-Pm-149	68-Er-170	89-Ac-225	94-Pu-246
2-He-4	22-Ti-46	34-Se-74	42-Mo-97	50-Sn-115	54-Xe-135	61-Pm-151	69-Tm-168	89-Ac-226	95-Am-240
3-Li-6	22-Ti-47	34-Se-76	42-Mo-98	50-Sn-116	54-Xe-136	62-Sm-144	69-Tm-169	89-Ac-227	95-Am-241
3-Li-7	22-Ti-48	34-Se-77	42-Mo-99	50-Sn-117	55-Cs-133	62-Sm-147	69-Tm-170	90-Th-227	95-Am-242
4-Be-7	22-Ti-49	34-Se-78	42-Mo-100	50-Sn-118	55-Cs-134	62-Sm-148	71-Lu-175	90-Th-228	95-Am-242m
4-Be-9	22-Ti-50	34-Se-79	43-Tc-99	50-Sn-119	55-Cs-135	62-Sm-149	71-Lu-176	90-Th-229	95-Am-243
5-B -10	23-V -50	34-Se-80	44-Ru-96	50-Sn-120	55-Cs-136	62-Sm-150	72-Hf-174	90-Th-230	95-Am-244
5-B -11	23-V -51	34-Se-82	44-Ru-98	50-Sn-122	55-Cs-137	62-Sm-151	72-Hf-176	90-Th-231	95-Am-244m
6-C -Nat	24-Cr-50	35-Br-79	44-Ru-99	50-Sn-123	56-Ba-130	62-Sm-152	72-Hf-177	90-Th-232	96-Cm-240
7-N -14	24-Cr-52	35-Br-81	44-Ru-100	50-Sn-124	56-Ba-132	62-Sm-153	72-Hf-178	90-Th-233	96-Cm-241
7-N -15	24-Cr-53	36-Kr-78	44-Ru-101	50-Sn-125	56-Ba-133	62-Sm-154	72-Hf-179	90-Th-234	96-Cm-242
8-O -16	24-Cr-54	36-Kr-80	44-Ru-102	50-Sn-126	56-Ba-134	63-Eu-151	72-Hf-180	91-Pa-229	96-Cm-243
8-O -17	25-Mn-55	36-Kr-82	44-Ru-103	51-Sb-121	56-Ba-135	63-Eu-152	73-Ta-180	91-Pa-230	96-Cm-244
9-F -19	26-Fe-54	36-Kr-83	44-Ru-104	51-Sb-123	56-Ba-136	63-Eu-153	73-Ta-181	91-Pa-231	96-Cm-245
11-Na-22	26-Fe-56	36-Kr-84	44-Ru-105	51-Sb-124	56-Ba-137	63-Eu-154	73-Ta-182	91-Pa-232	96-Cm-246
11-Na-23	26-Fe-57	36-Kr-85	44-Ru-106	51-Sb-125	56-Ba-138	63-Eu-155	74-W -182	91-Pa-233	96-Cm-247
12-Mg-24	26-Fe-58	36-Kr-86	45-Rh-103	51-Sb-126	56-Ba-140	63-Eu-156	74-W -183	92-U -230	96-Cm-248
12-Mg-25	27-Co-58	37-Rb-85	45-Rh-105	52-Te-120	57-La-138	63-Eu-157	74-W -184	92-U -232	96-Cm-249
12-Mg-26	27-Co-58m	37-Rb-86	46-Pd-102	52-Te-122	57-La-139	64-Gd-152	74-W -186	92-U -233	97-Bk-245
13-Al-27	27-Co-59	37-Rb-87	46-Pd-104	52-Te-123	57-La-140	64-Gd-153	75-Re-185	92-U -234	97-Bk-246
14-Si-28	28-Ni-58	38-Sr-84	46-Pd-105	52-Te-124	58-Ce-136	64-Gd-154	75-Re-187	92-U -235	97-Bk-247
14-Si-29	28-Ni-59	38-Sr-86	46-Pd-106	52-Te-125	58-Ce-138	64-Gd-155	77-Ir-191	92-U -236	97-Bk-248
14-Si-30	28-Ni-60	38-Sr-87	46-Pd-107	52-Te-126	58-Ce-139	64-Gd-156	77-Ir-193	92-U -237	97-Bk-249
15-P -31	28-Ni-61	38-Sr-88	46-Pd-108	52-Te-127m	58-Ce-140	64-Gd-157	79-Au-197	92-U -238	97-Bk-250
16-S -32	28-Ni-62	38-Sr-89	46-Pd-110	52-Te-128	58-Ce-141	64-Gd-158	80-Hg-196	92-U -239	98-Cf-246
16-S -33	28-Ni-64	38-Sr-90	47-Ag-107	52-Te-129m	58-Ce-142	64-Gd-160	80-Hg-198	92-U -240	98-Cf-248
16-S -34	29-Cu-63	39-Y -89	47-Ag-109	52-Te-130	58-Ce-143	65-Tb-159	80-Hg-199	92-U -241	98-Cf-249
16-S -36	29-Cu-65	39-Y -90	47-Ag-110m	52-Te-132	58-Ce-144	65-Tb-160	80-Hg-200	93-Np-234	98-Cf-250
17-Cl-35	30-Zn-64	39-Y -91	47-Ag-111	53-I -127	59-Pr-141	66-Dy-156	80-Hg-201	93-Np-235	98-Cf-251
17-Cl-37	30-Zn-65	40-Zr-90	48-Cd-106	53-I -129	59-Pr-142	66-Dy-158	80-Hg-202	93-Np-236	98-Cf-252
18-Ar-36	30-Zn-66	40-Zr-91	48-Cd-108	53-I -130	59-Pr-143	66-Dy-160	80-Hg-204	93-Np-237	98-Cf-253
18-Ar-38	30-Zn-67	40-Zr-92	48-Cd-110	53-I -131	60-Nd-142	66-Dy-161	81-Tl-203	93-Np-238	98-Cf-254
18-Ar-40	30-Zn-68	40-Zr-93	48-Cd-111	53-I -135	60-Nd-143	66-Dy-162	81-Tl-205	93-Np-239	99-Es-251
19-K -39	30-Zn-70	40-Zr-94	48-Cd-112	54-Xe-123	60-Nd-144	66-Dy-163	82-Pb-204	94-Pu-236	99-Es-252
19-K -40	31-Ga-69	40-Zr-95	48-Cd-113	54-Xe-124	60-Nd-145	66-Dy-164	82-Pb-206	94-Pu-237	99-Es-253
19-K -41	31-Ga-71	40-Zr-96	48-Cd-114	54-Xe-126	60-Nd-146	67-Ho-165	82-Pb-207	94-Pu-238	99-Es-254
20-Ca-40	32-Ge-70	41-Nb-93	48-Cd-115m	54-Xe-128	60-Nd-147	67-Ho-166m	82-Pb-208	94-Pu-239	99-Es-254m
20-Ca-42	32-Ge-72	41-Nb-94	48-Cd-116	54-Xe-129	60-Nd-148	68-Er-162	83-Bi-209	94-Pu-240	99-Es-255
20-Ca-43	32-Ge-73	41-Nb-95	49-In-113	54-Xe-130	60-Nd-150	68-Er-164	88-Ra-223	94-Pu-241	100-Fm-255

## Detailed Differences

I have compared in more detail the original evaluations, exactly as distributed by the National Nuclear data Center (NNDC), Brookhaven. For this comparison I have not changed the original evaluations in any way; that is I have not performed any processing of the files; these are what are identified at the on-line POINT libraries as “Original” [1, 2].

Of the 423 evaluation in VII.1, 391 were also included in VII.0. I have checked what I will call the “neutron” ENDF files, MF=1 through 6, and major reactions (MT=2, 102, 18, 4 and 16), character by character for differences between the evaluations in VII.1 and VII.0. I have found differences in 170 of these evaluations, i.e., the remaining 221 evaluations are character by character identical in both libraries.

The below table summarizes my results. I have only listed results for the 170 evaluations where I found differences. **An “X” in any position indicates that both VII.1 and VII.0 include the same section (the same MF/MT), but these sections are NOT IDENTICAL in VII.1 and VII.0.**

What I have checked and listed in the below table, reading left to right,

- 1) The evaluation identification
- 2) MF=1/MT=452 = total neutrons per fission
- 3) MF=2 = resonance parameters

Beyond this point the organization of the table switches to group results by MT, including MT=2 (elastic), MT=102 (capture), MF=18 (fission), MT=4 (total inelastic), and M T=16 (n,2n). Under each of these 5 reactions I define whether or not I found differences in MF=3 through 6,

3 = cross sections

4 = angular distributions

5 = energy distributions

6 = double differential distributions

For example, if you look at the below table, for 17-Cl-35, I found differences for resonance parameters (MF=2), tabulated elastic cross sections (MT/MF=2/3), and tabulated capture cross sections (MT/MF=102/3).

Evaluation	MF=1	MF=2	MT=2	MT=102	MT=18	MT=4	MT=16
MF	Nu	Res	3 4 5 6	3 4 5 6	3 4 5 6	3 4 5 6	3 4 5 6
1-H -1				X			
1-H -3							X
2-He-3				X			
2-He-4			X X				
3-Li-6			X X			X	
4-Be-9			X	X			X
6-C -Nat				X			
8-O -16				X			
11-Na-22		X					
15-P -31			X	X			
16-S -33			X				
16-S -34			X				
17-Cl-35		X	X	X			
17-Cl-37		X	X	X			
18-Ar-40			X				
19-K -39		X	X X	X			
19-K -41		X	X	X			
21-Sc-45							X
22-Ti-46		X	X X	X			X X
22-Ti-47		X	X X	X			X X
22-Ti-48		X	X X	X			X X
22-Ti-49		X	X X	X			X X
22-Ti-50		X	X X	X			X X
24-Cr-50		X	X	X			X X
24-Cr-52		X	X	X			X X
24-Cr-53		X	X	X		X	X X
24-Cr-54		X	X	X			
25-Mn-55		X	X X	X		X	X X
27-Co-58		X	X X	X		X	
28-Ni-58		X	X X	X			
28-Ni-60		X	X	X			
28-Ni-61		X	X	X			X X
28-Ni-62		X	X	X			X X
28-Ni-64		X	X	X			X X
31-Ga-69							X
33-As-75			X X	X		X	X X
36-Kr-78			X X	X			X
36-Kr-86				X			
37-Rb-86		X					
39-Y -89		X	X	X		X	X
40-Zr-90		X	X X	X	X	X	X X
40-Zr-91		X	X X	X	X	X	X X
40-Zr-92			X X	X	X	X	X X
40-Zr-93		X	X X	X	X	X	X X
40-Zr-94			X X	X	X	X	X X
40-Zr-95		X	X X	X	X	X	X X
40-Zr-96			X X	X	X	X	X X
42-Mo-92		X		X			
42-Mo-95		X					
43-Tc-99		X	X	X		X	

Evaluation	MF=1	MF=2	MT=2				MT=102				MT=18				MT=4				MT=16				
MF	Nu	Res	3	4	5	6	3	4	5	6	3	4	5	6	3	4	5	6	3	4	5	6	
45-Rh-103		X																					
47-Ag-109		X	X				X								X								
48-Cd-106		X																					
48-Cd-108		X																					
48-Cd-110		X																					
48-Cd-111		X																					
48-Cd-112		X																					
48-Cd-113		X																					
48-Cd-114		X																					
48-Cd-116		X																					
50-Sn-115		X																					
50-Sn-125				X																		X	
51-Sb-123				X																			
52-Te-124		X																					
52-Te-126		X																					
54-Xe-123			X	X			X												X				
54-Xe-124		X	X	X			X												X				
54-Xe-126				X																			
54-Xe-130				X																			
55-Cs-133		X																					
56-Ba-137							X																
57-La-139				X			X																
58-Ce-139																						X	
58-Ce-141		X																					
60-Nd-144																						X	
60-Nd-145		X																					
61-Pm-148				X																			
62-Sm-148																						X	
63-Eu-152		X																					
63-Eu-153		X																					
64-Gd-157		X	X																				
72-Hf-174		X	X	X			X							X					X	X	X		
72-Hf-176		X	X	X			X							X					X	X	X		
72-Hf-177		X	X	X			X							X					X	X	X		
72-Hf-178		X	X	X			X							X					X	X	X		
72-Hf-179		X	X	X			X							X					X	X	X		
72-Hf-180		X	X	X			X							X					X	X	X		
73-Ta-181			X	X			X												X				
74-W -182		X	X	X			X							X					X				
74-W -183		X	X	X			X							X					X				
74-W -184		X	X	X			X							X					X				
74-W -186		X	X	X			X							X					X				
75-Re-185			X	X			X												X				
75-Re-187			X	X			X												X				
80-Hg-196				X																			
80-Hg-198				X																			
80-Hg-199				X																			
80-Hg-200				X																			
80-Hg-201				X																			
80-Hg-202				X																			

Evaluation	MF=1	MF=2	MT=2	MT=102	MT=18	MT=4	MT=16
MF	Nu	Res	3 4 5 6	3 4 5 6	3 4 5 6	3 4 5 6	3 4 5 6
80-Hg-204			X				
82-Pb-206			X				
82-Pb-207			X				
82-Pb-208			X				X
89-Ac-225		X	X X	X		X	X
89-Ac-226		X	X X	X		X	X
89-Ac-227	X	X	X X	X	X X X	X	X
90-Th-227		X	X X	X	X X X	X	X
90-Th-228	X	X	X X	X	X X X	X	X
90-Th-229	X	X	X X	X	X X X	X	X
90-Th-230	X	X	X X	X	X X X	X	X
90-Th-232		X	X X	X	X X X	X	X X
90-Th-233	X	X	X X	X	X X X	X	X
90-Th-234	X	X	X X	X	X X X	X	X
91-Pa-231		X			X X		
91-Pa-232	X	X	X X	X	X X X	X	X
91-Pa-233					X		
92-U -232	X	X	X X	X	X X X	X	X X
92-U -233	X		X X	X		X	
92-U -234		X					X
92-U -235		X			X X		
92-U -236		X	X X	X	X		X
92-U -237		X	X	X	X		X
92-U -238			X		X		
92-U -239		X	X	X	X		X
92-U -240			X		X		
92-U -241					X		
93-Np-235	X	X	X X	X	X X	X	X
93-Np-236	X	X	X X	X	X X X	X	X
93-Np-237		X	X				X X
93-Np-238	X	X	X X	X	X X X	X	X
93-Np-239	X	X	X X	X	X X X	X	X
94-Pu-236	X	X	X X	X	X X X	X	X
94-Pu-237	X	X	X X	X	X X	X	X
94-Pu-238	X	X	X X	X	X X X	X	X
94-Pu-239		X			X X		
94-Pu-240	X		X X	X	X X X	X	X
94-Pu-241		X					
94-Pu-242	X	X	X X	X	X X	X	X
94-Pu-243					X		
94-Pu-244	X	X	X X	X	X X	X	X
94-Pu-246	X	X	X X	X	X X	X	X
95-Am-241		X	X	X	X	X	X
95-Am-242					X		X
95-Am-242.M					X		X
95-Am-243	X	X	X	X	X	X	X
95-Am-244			X		X		
95-Am-244.M			X		X		
96-Cm-241	X	X	X X	X	X X	X	X
96-Cm-242	X	X	X X	X	X X	X	X

Evaluation	MF=1	MF=2	MT=2	MT=102	MT=18	MT=4	MT=16
MF	Nu	Res	3 4 5 6	3 4 5 6	3 4 5 6	3 4 5 6	3 4 5 6
96-Cm-243		X	X X	X	X X	X	X
96-Cm-244	X	X	X X	X	X X	X	X
96-Cm-245	X	X	X X	X	X X	X	X
96-Cm-246	X	X	X X	X	X X	X	X
96-Cm-247		X	X X	X	X X	X	X
96-Cm-248	X	X	X X	X	X X	X	X
96-Cm-249		X	X X	X	X X	X	X
96-Cm-250	X	X	X X	X	X X	X	X
97-Bk-249	X	X	X X	X	X X X	X	X
97-Bk-250		X	X X	X	X X X	X	X
98-Cf-249	X	X	X X	X	X X X	X	X
98-Cf-250	X	X	X X	X	X X	X	X
98-Cf-251	X	X	X X	X	X X	X	X
98-Cf-252	X	X	X X	X	X X	X	X
98-Cf-253	X	X	X X	X	X X X		
98-Cf-254		X	X X	X	X X X	X	X
99-Es-253		X	X X	X			
99-Es-254		X	X X	X	X X X	X	X
99-Es-255		X	X X	X	X X X	X	X
100-Fm-255	X	X	X X	X	X X X	X	X

### Acknowledgments

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## References

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<https://www-nds.iaea.org/point2012/>
- [2] “**POINT 2009**: A Temperature Dependent ENDF/B-VII.0 data Cross Section Library”, June 2009, by D.E. Cullen.  
<http://www-nds.iaea.org/point2009/pt2009.htm>
- [3] “**PREPRO 2010**: 2010 ENDF/B Pre-Processing Codes”, IAEA-NDS-39, Rev. 14, October 2010, by D.E. Cullen; particularly the code COMPLIT, which was used to produce the plots in this report.  
<http://www-nds.iaea.org/ndspub/endl/prepro/>
- [4] “**POINT 2015**: ENDF/B-VII.1 Final Temperature Dependent Cross Section Library”, IAEA-NDS-221, March 2015, by D.E. Cullen.  
<https://www-nds.iaea.org/point2015/>
- [5] “**PREPRO 2015**: 2015 ENDF/B Pre-Processing Codes”, IAEA-NDS-39, Rev. 15, January 2015, by D.E. Cullen.  
<http://www-nds.iaea.org/ndspub/endl/prepro/>

## 120 Plots

The following plots only present an overview of the difference in the total cross section (MF/MT=3/2) for the 120 cases where I found differences of 1% or more. For each evaluation there is only one plot covering the entire energy range of each evaluation; for most ENDF/B evaluations this spans the energy range from  $10^{-5}$  eV to 20 MeV, or more.

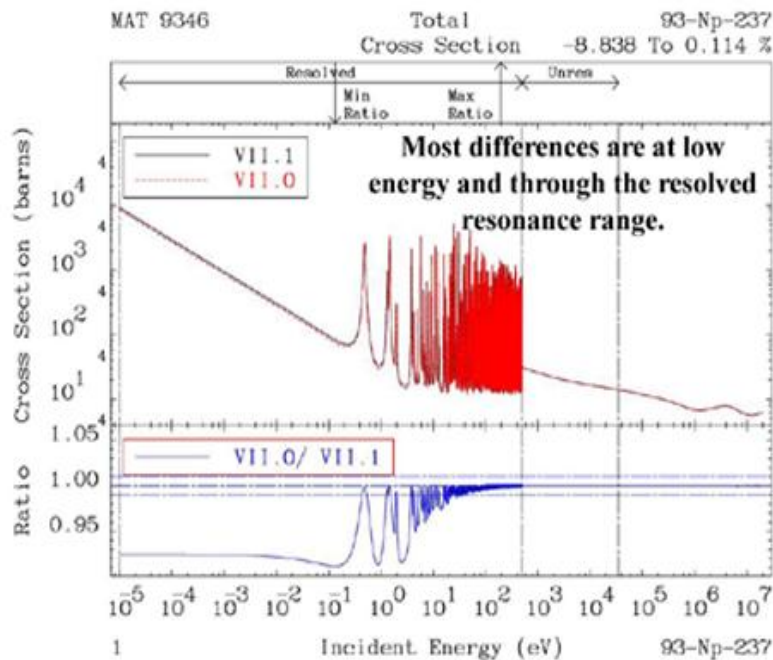
The 120 plots are grouped 4 per page, for a total of 30 pages; I judged 120 pages of plots to be excessive and larger plots add little additional information.

Each plot is divided into the upper two-thirds to show the total cross section for VII.1 (**black**) and VII.0 (**red**). The lower third of each plot shows the ratio of the VII.0 total divided by the VII.1 total.

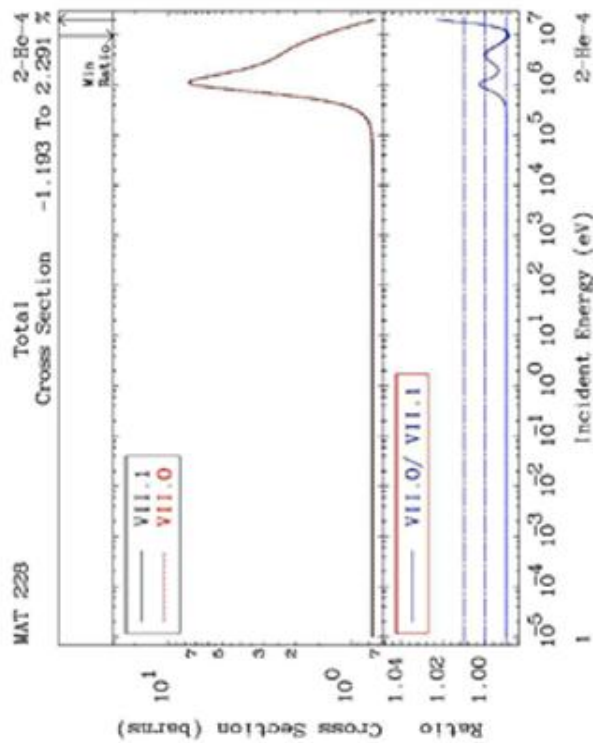
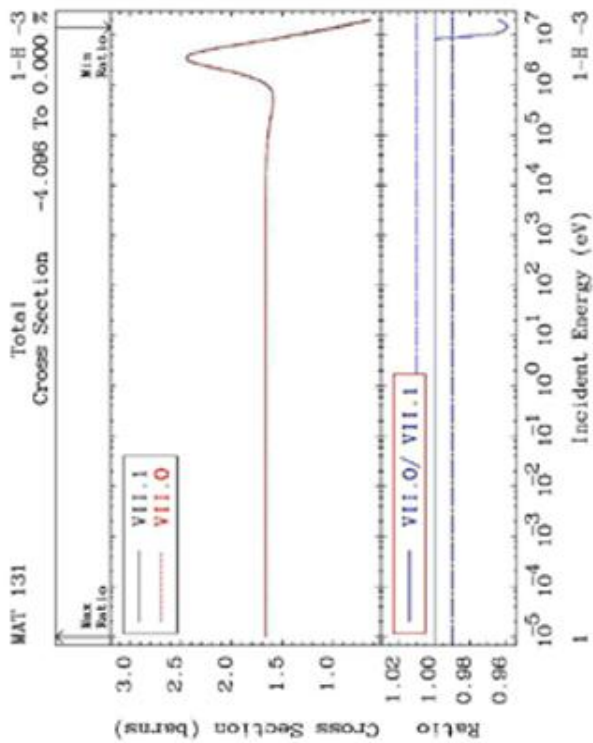
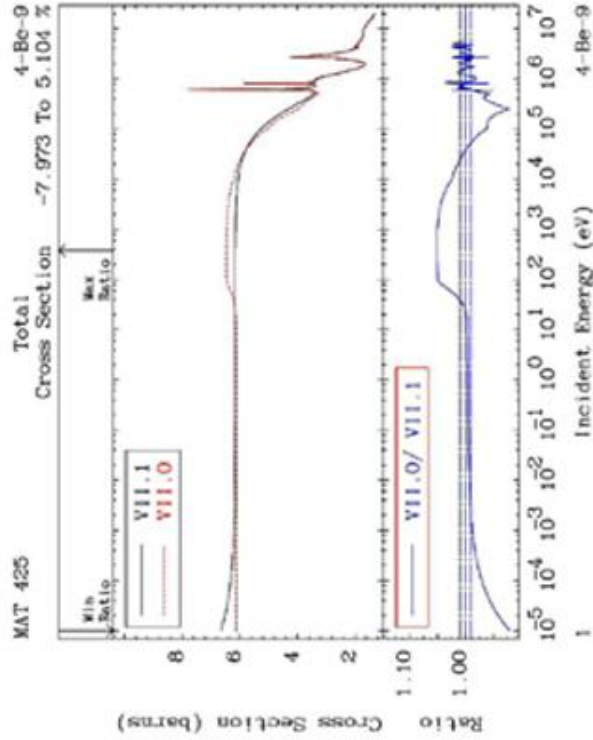
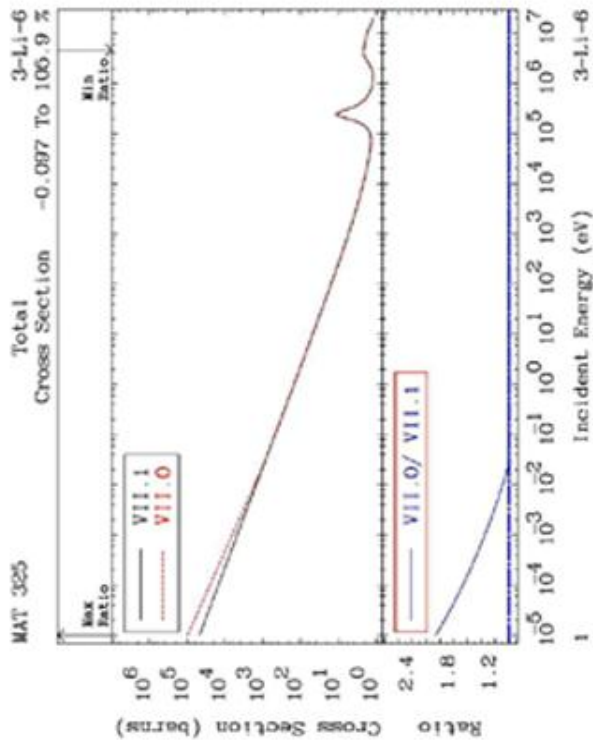
From each plot you can see,

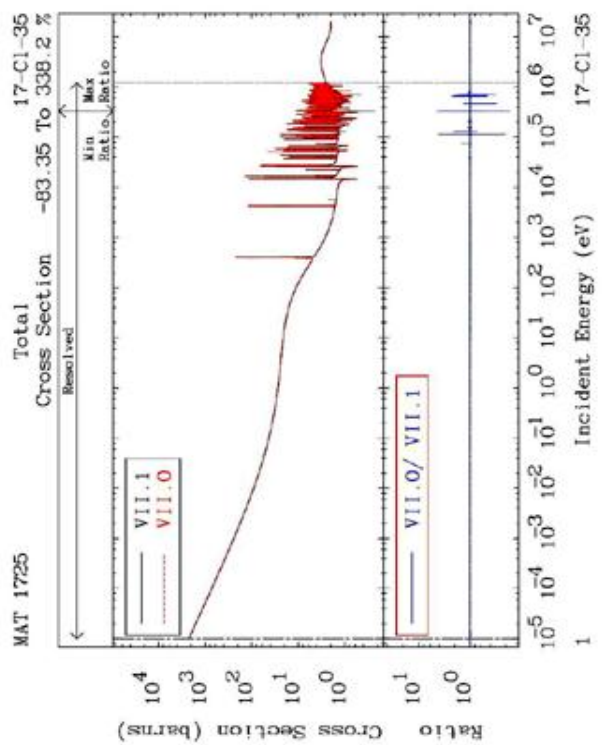
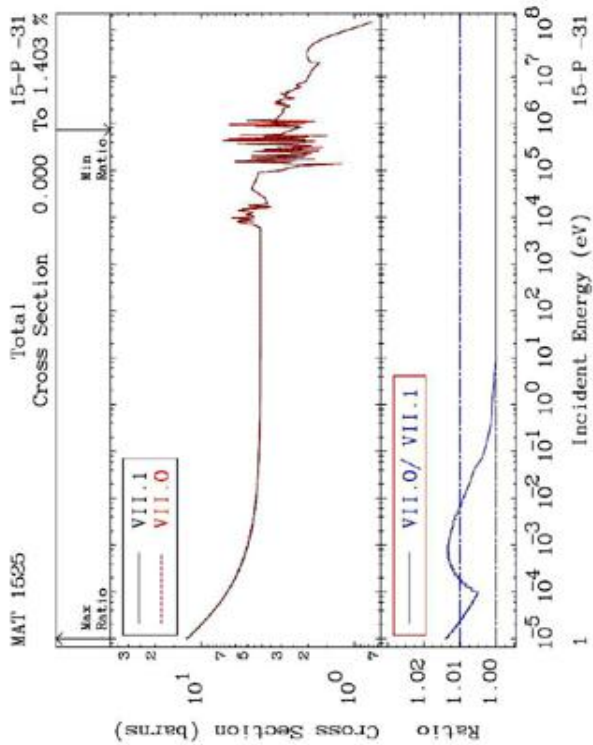
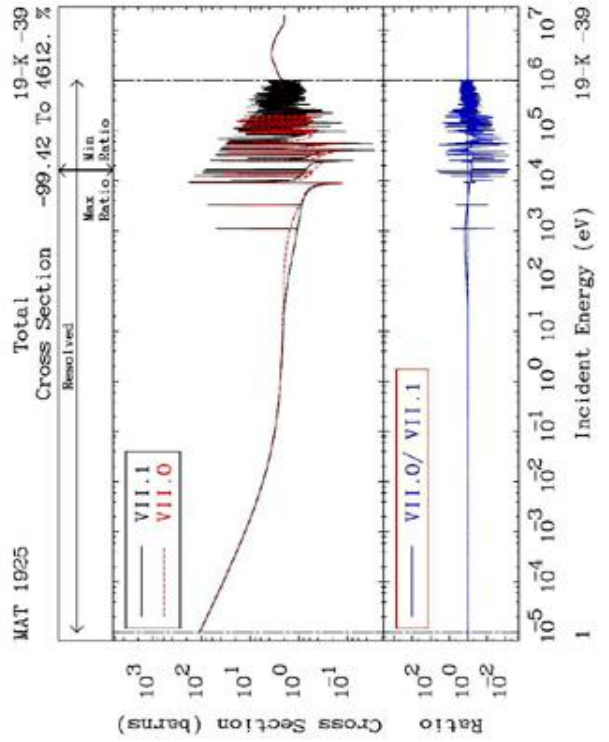
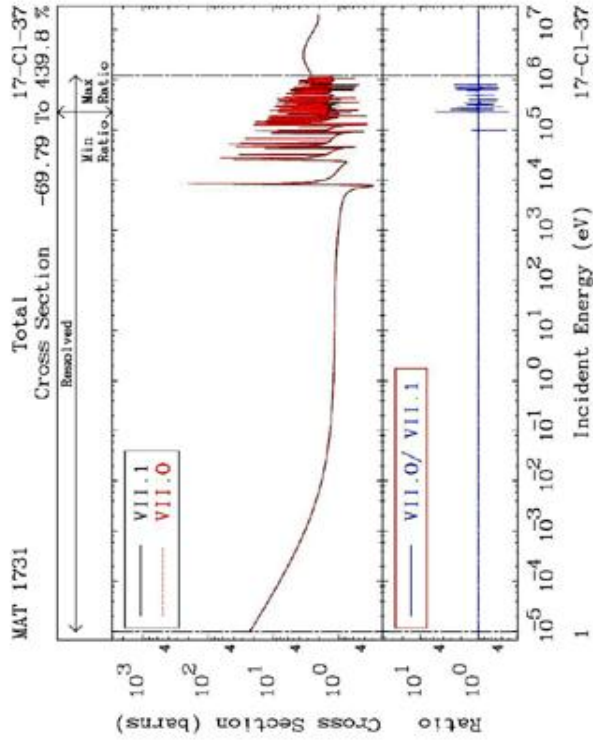
- 1) The isotope identification, in the upper right hand corner
- 2) Maximum negative and positive % differences, below isotope id
- 3) The energy range of resolved and unresolved energy ranges, if any
- 4) Vertical arrows show the position of maximum differences
- 5) The energy and cross section scales.

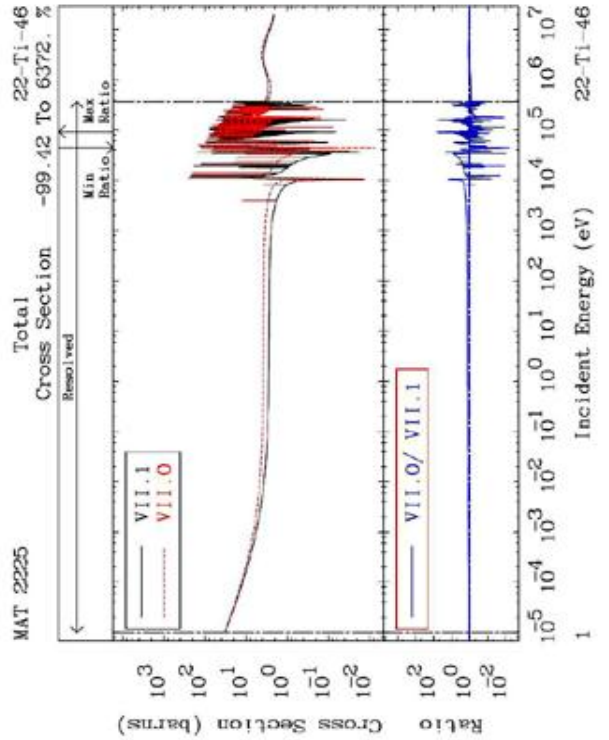
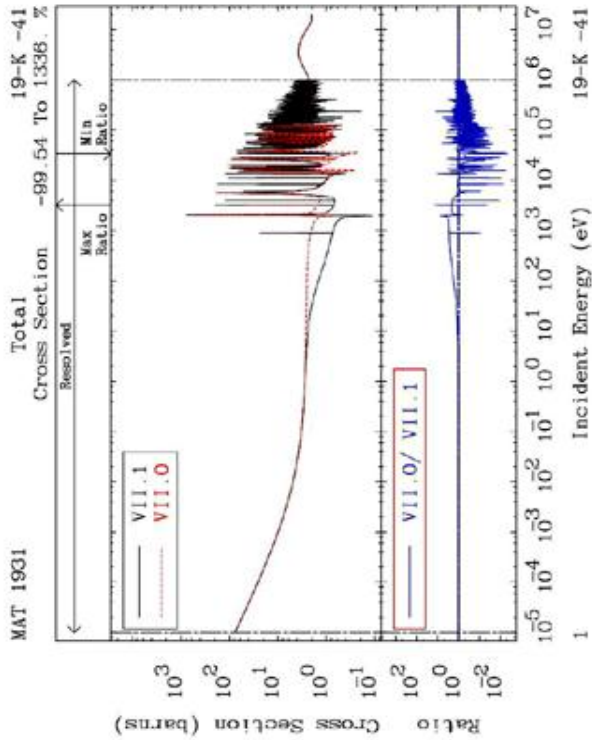
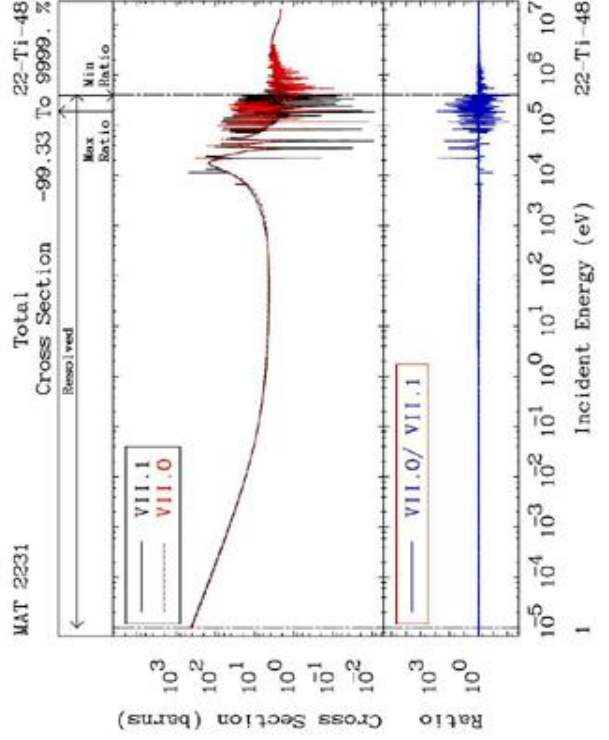
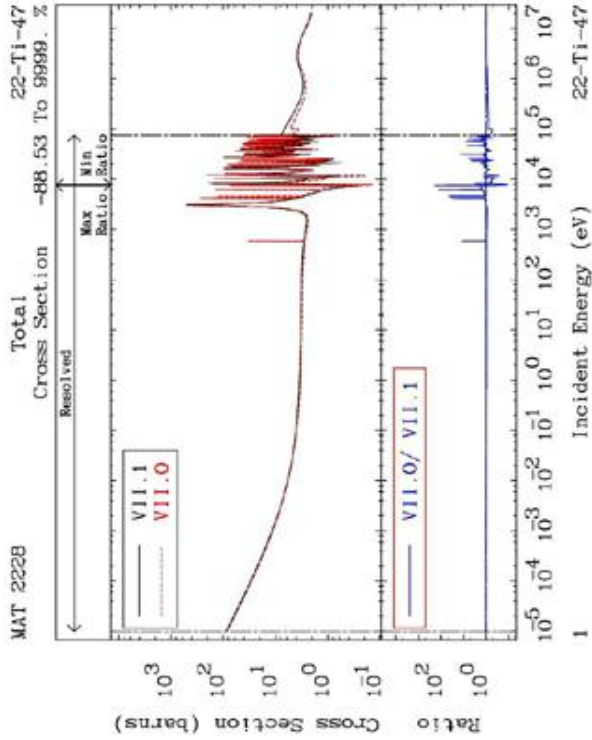
Below is an example to which I added an explanatory comment



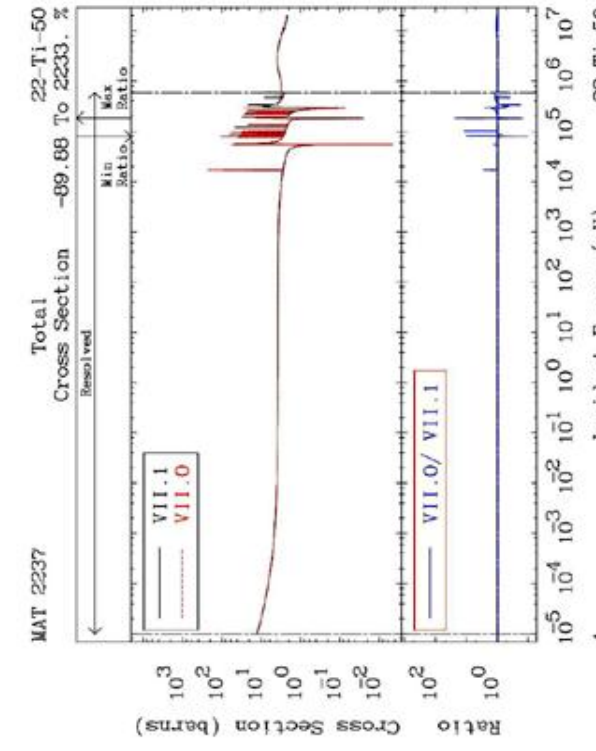
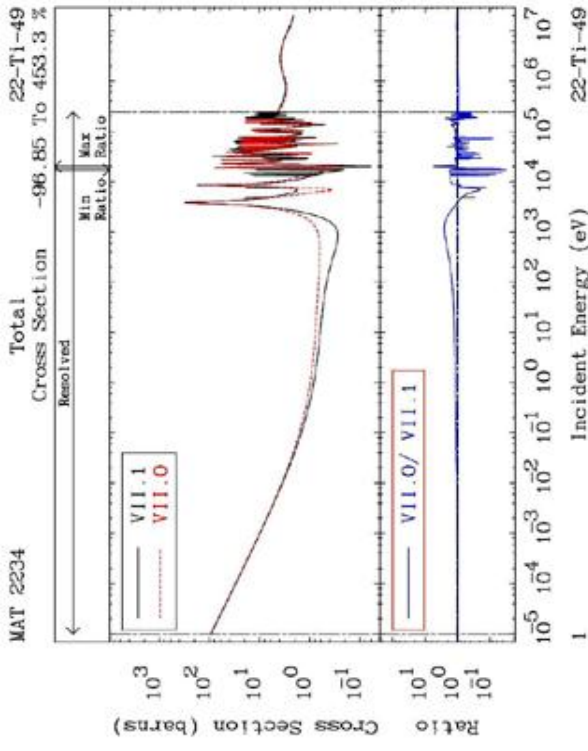
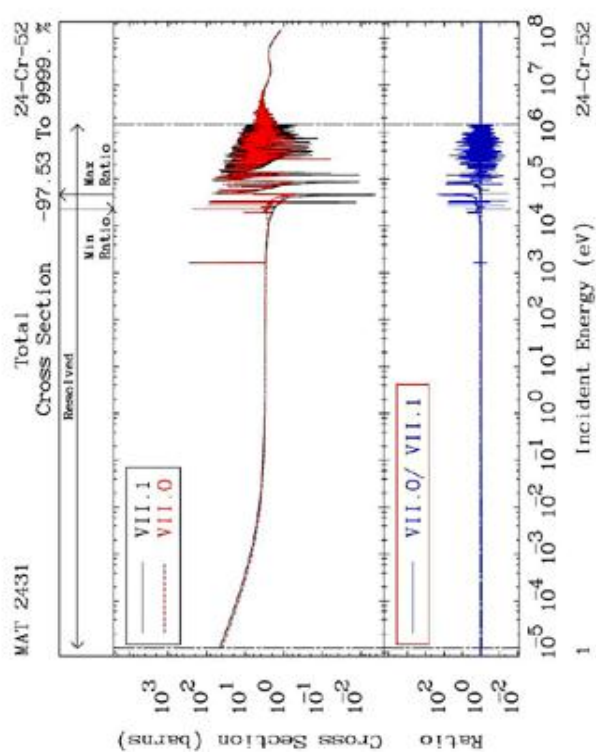
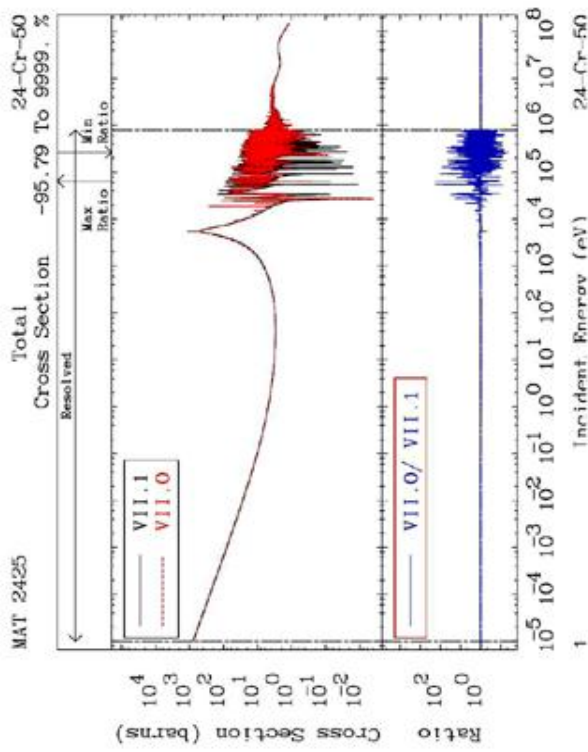


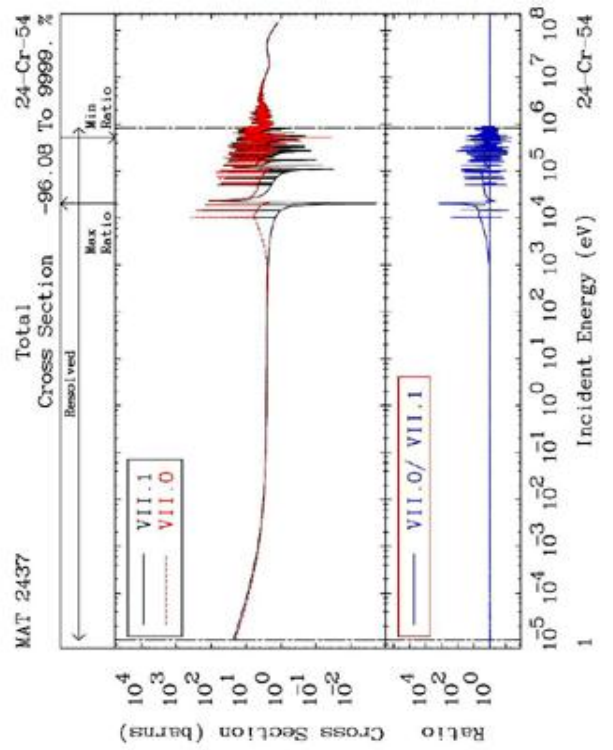
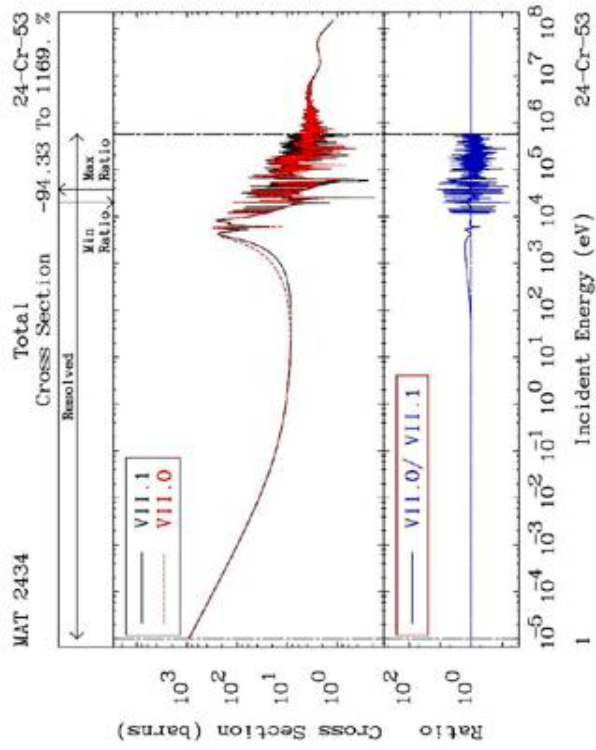
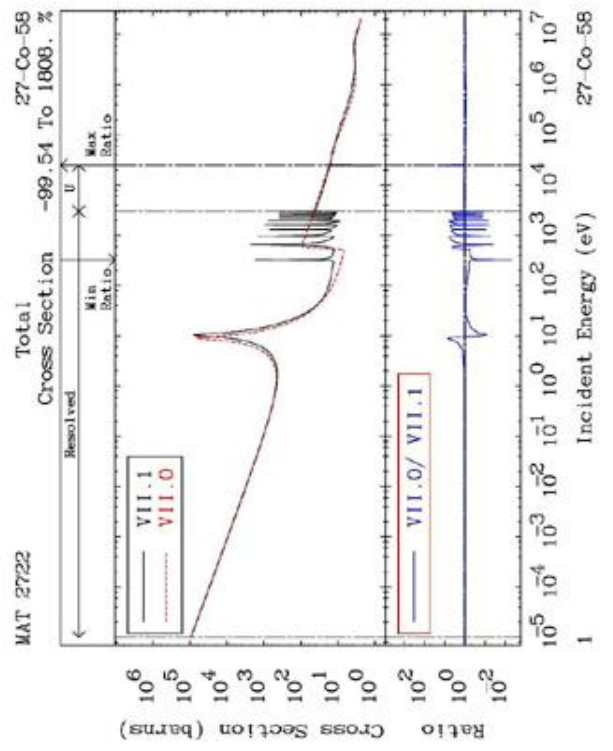
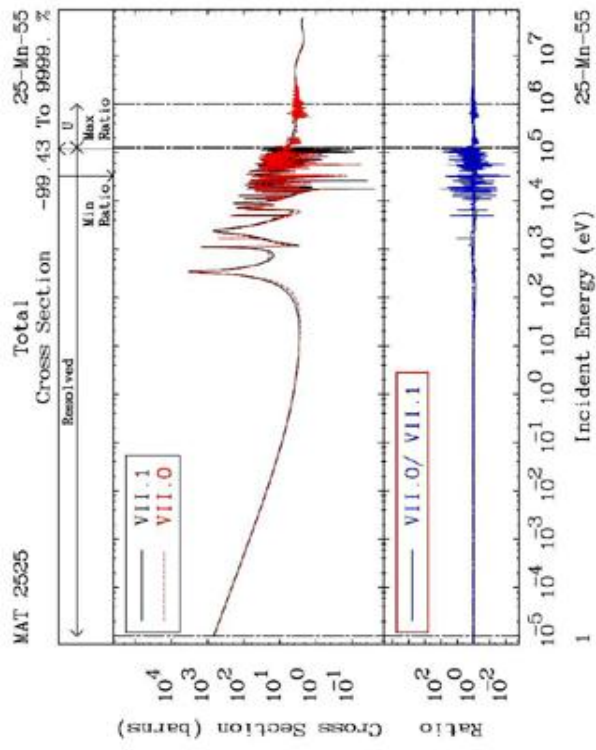


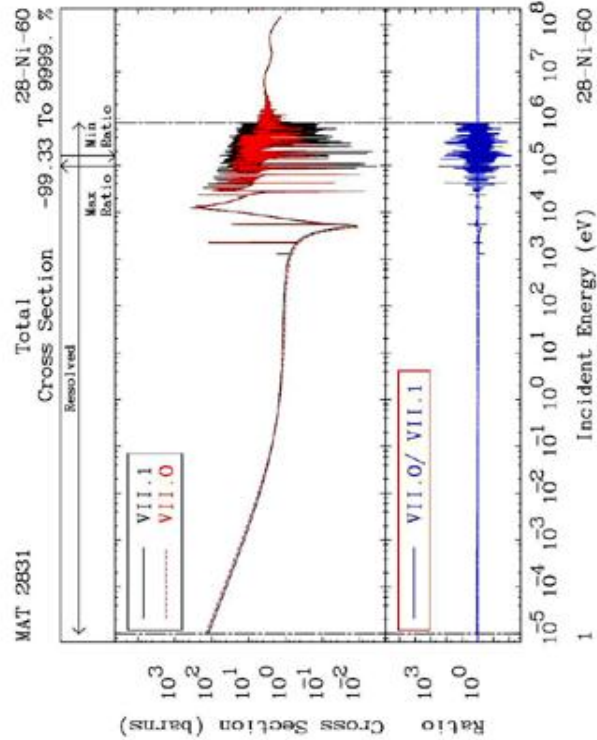
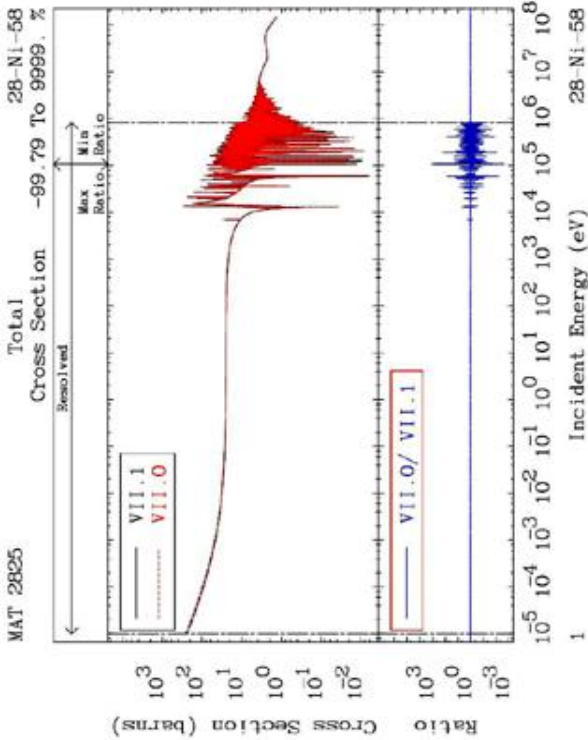
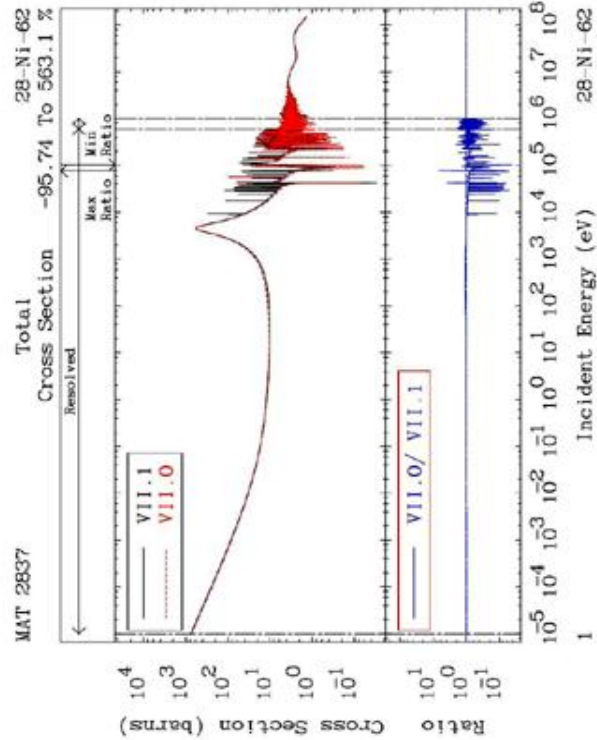
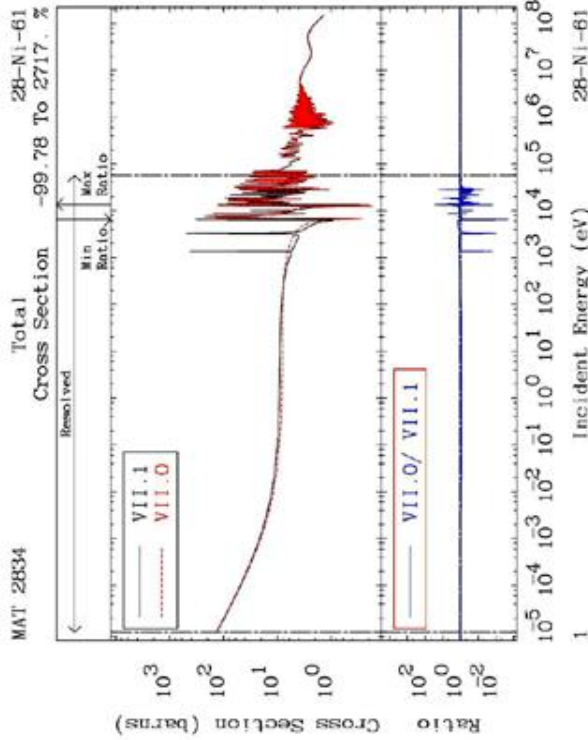




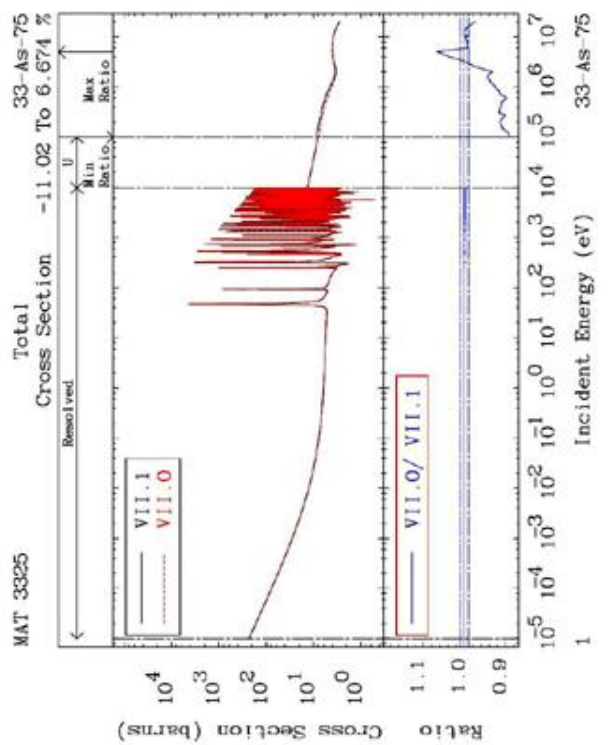
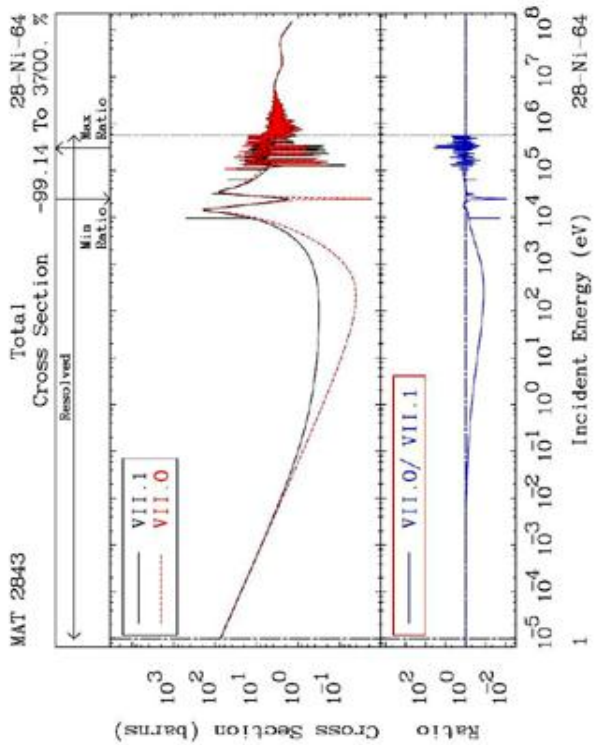
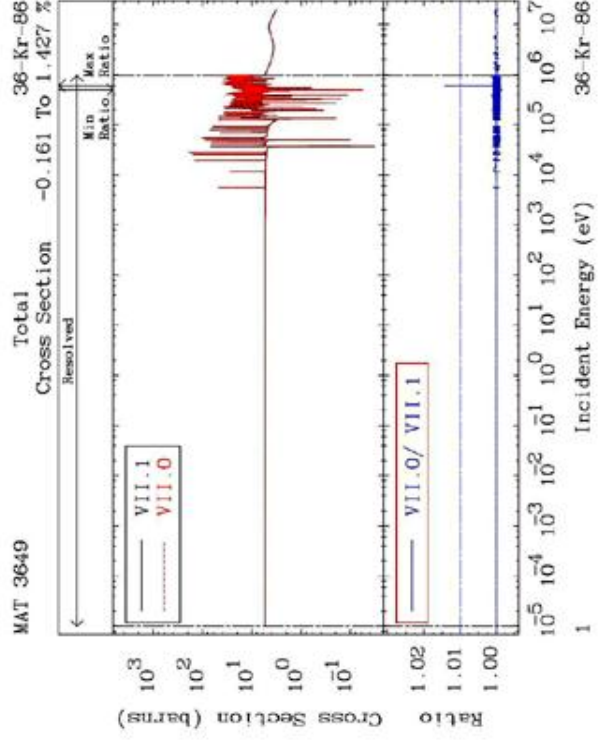
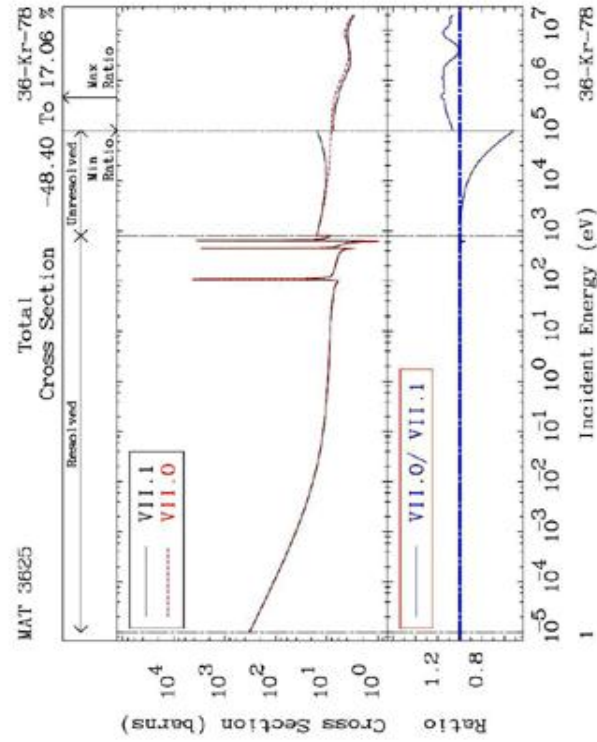


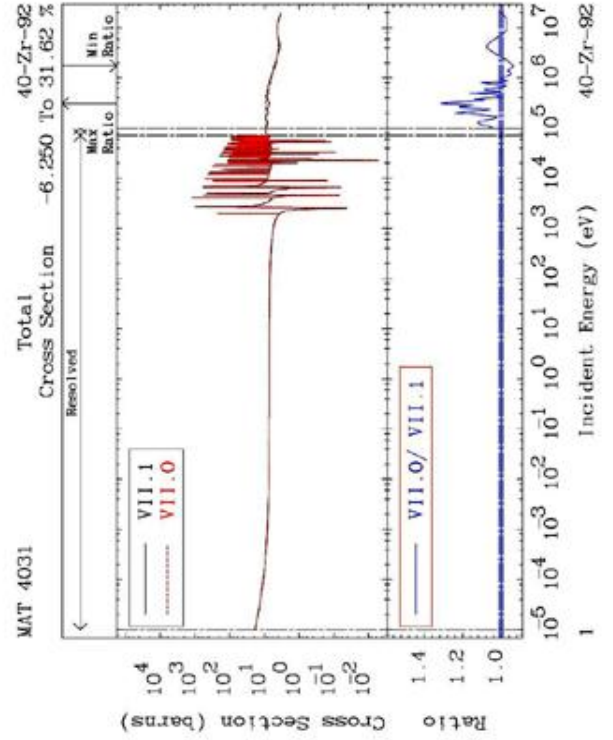
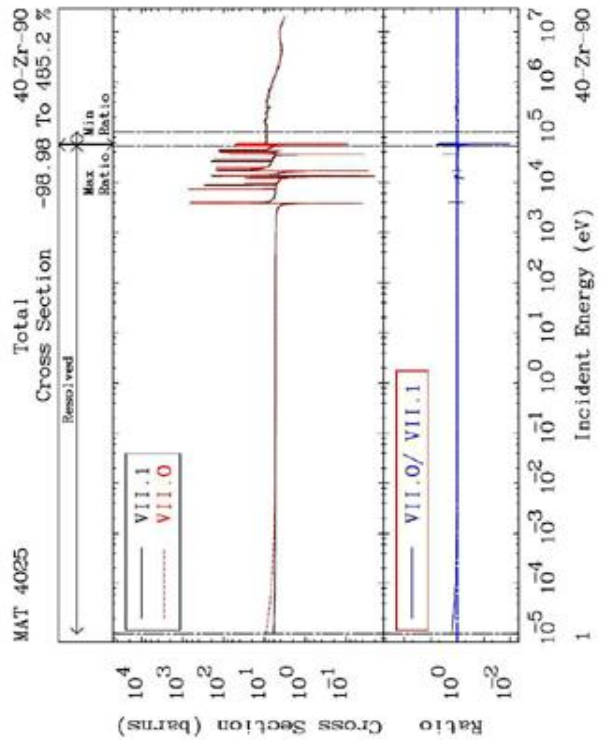
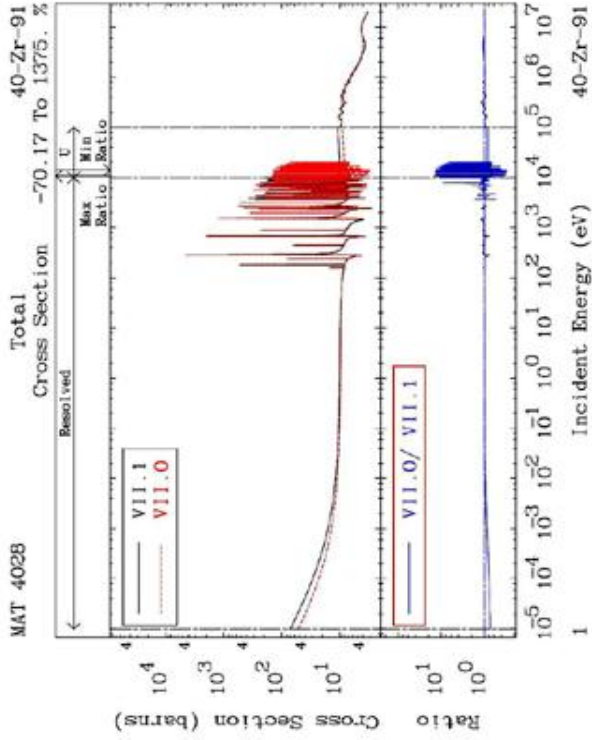
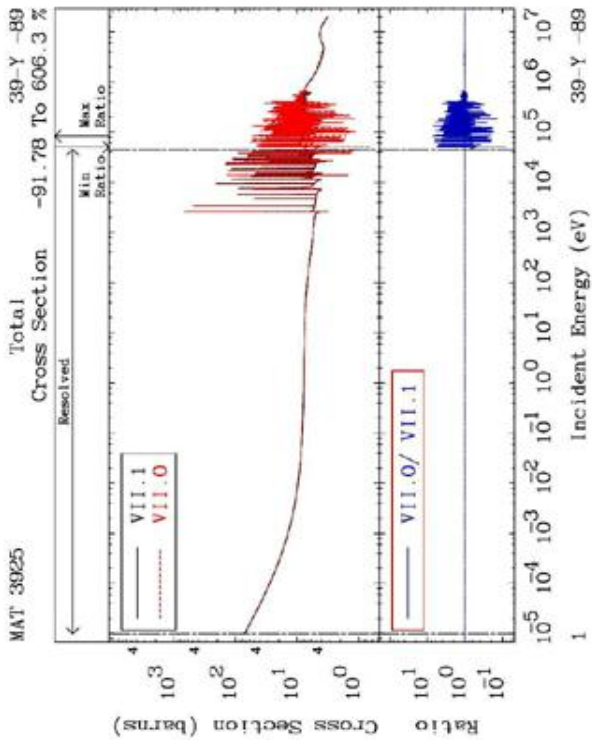




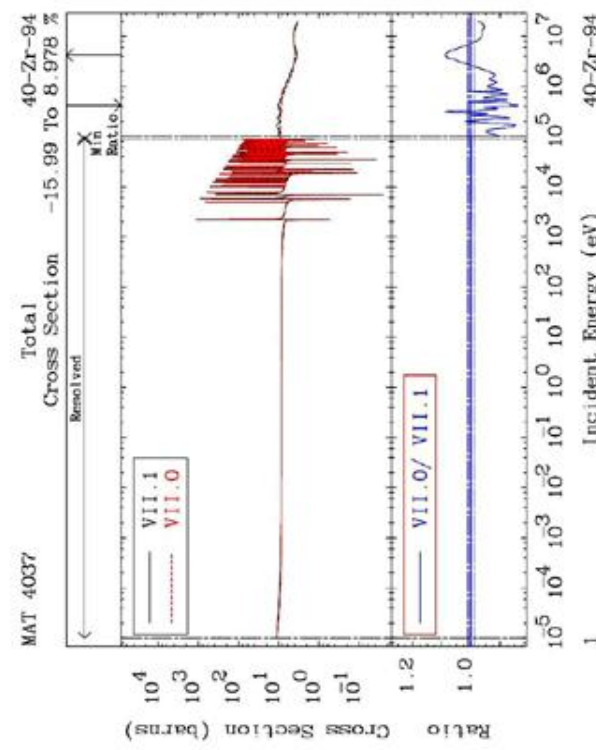
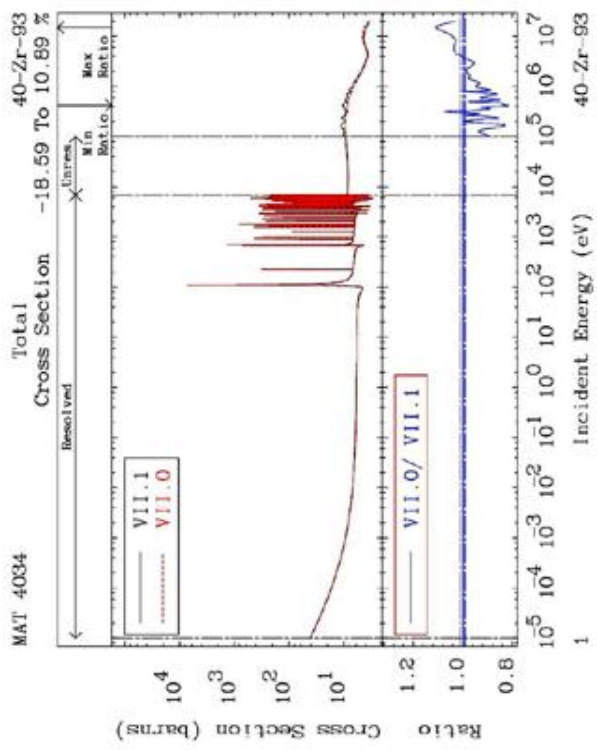
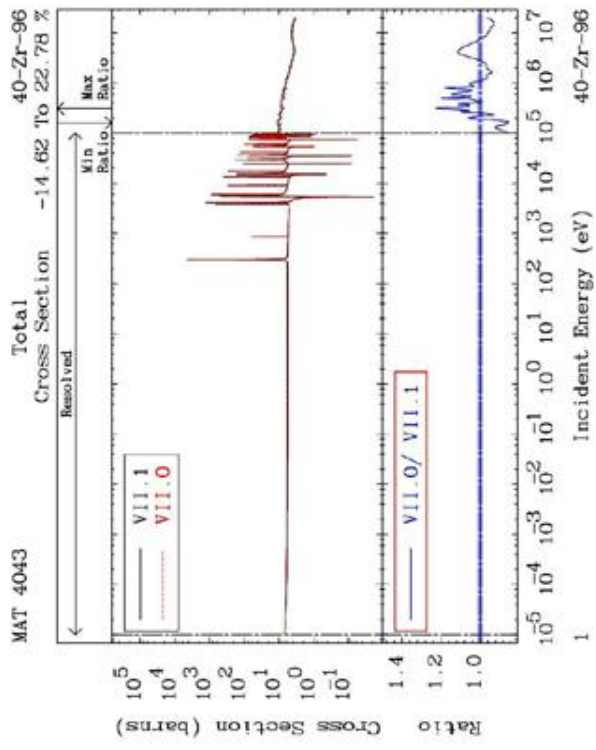
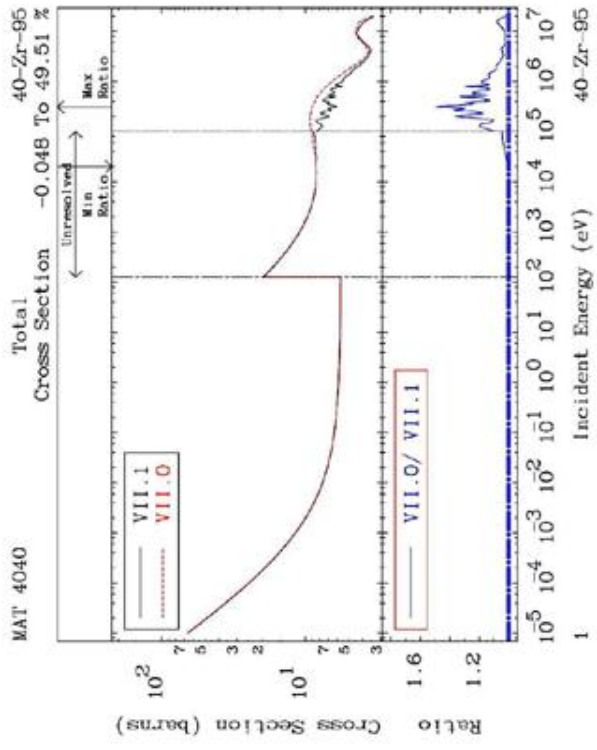


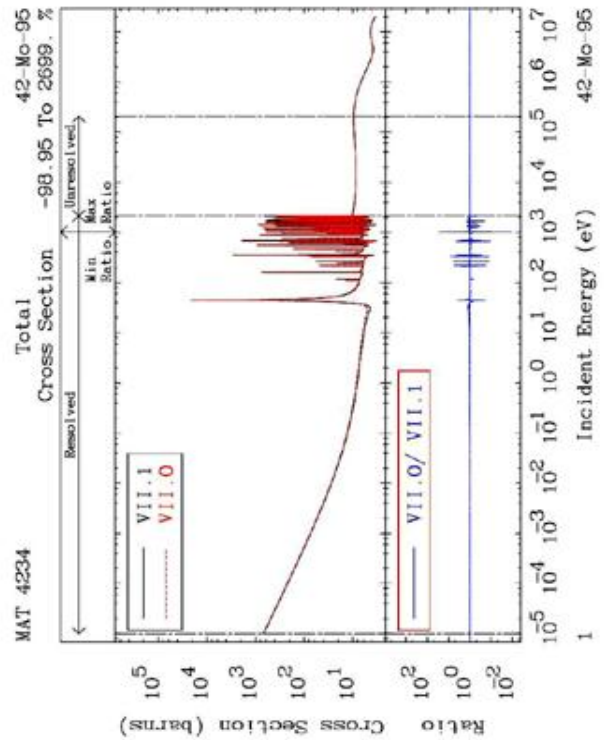
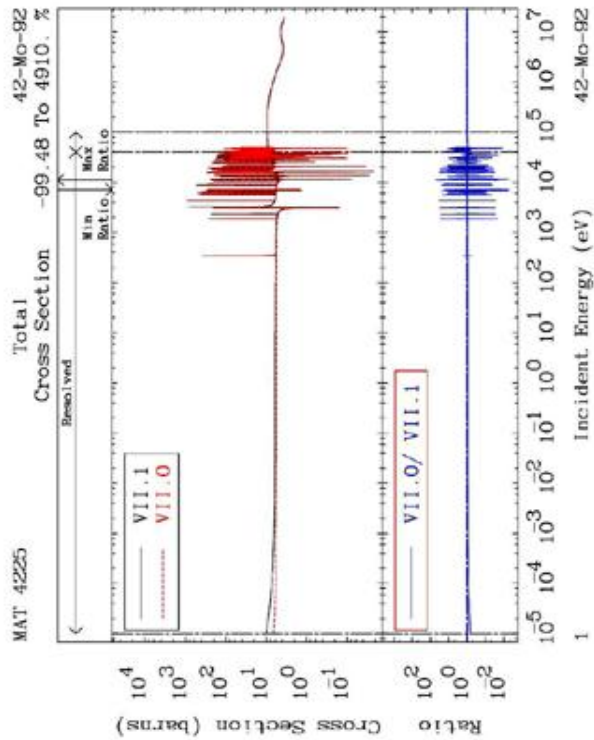
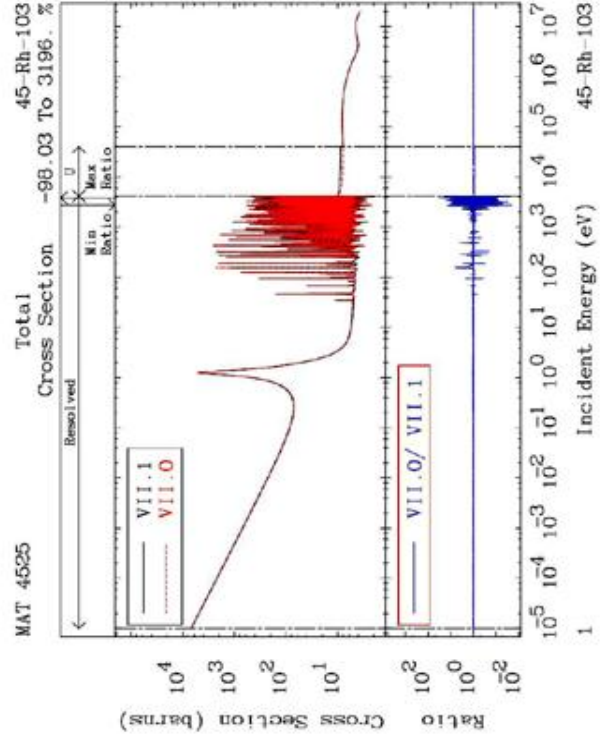
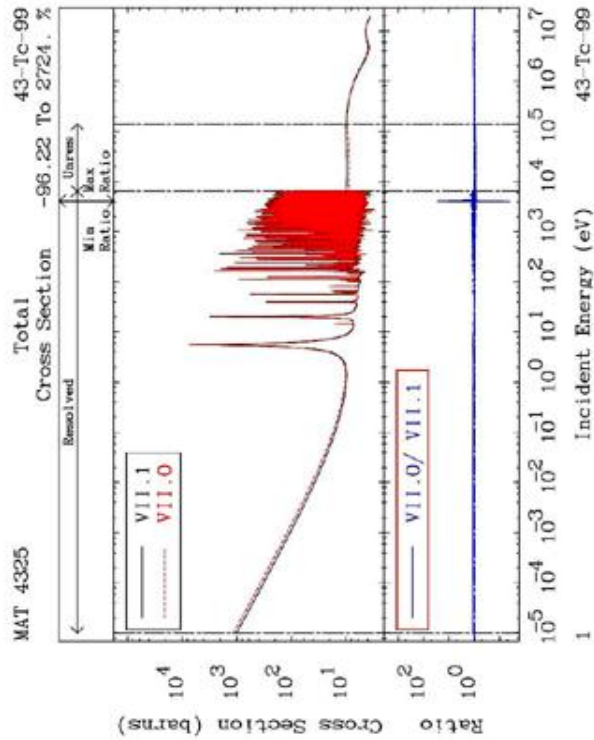


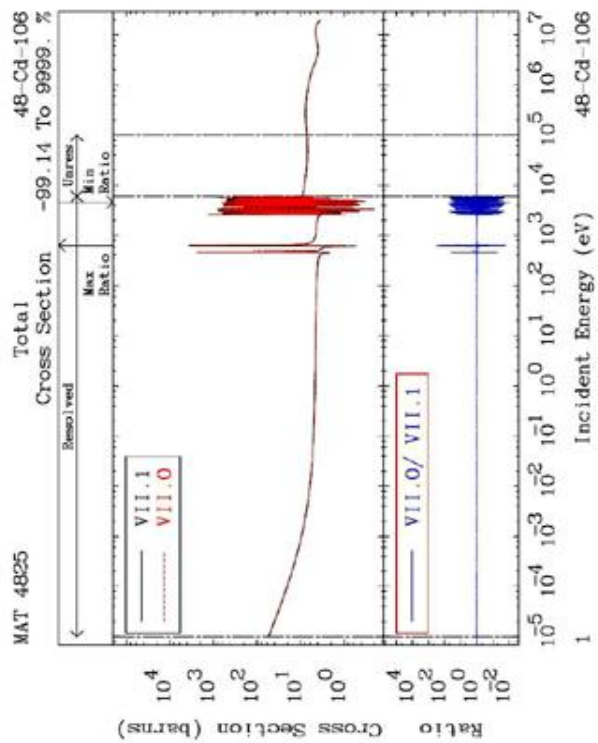
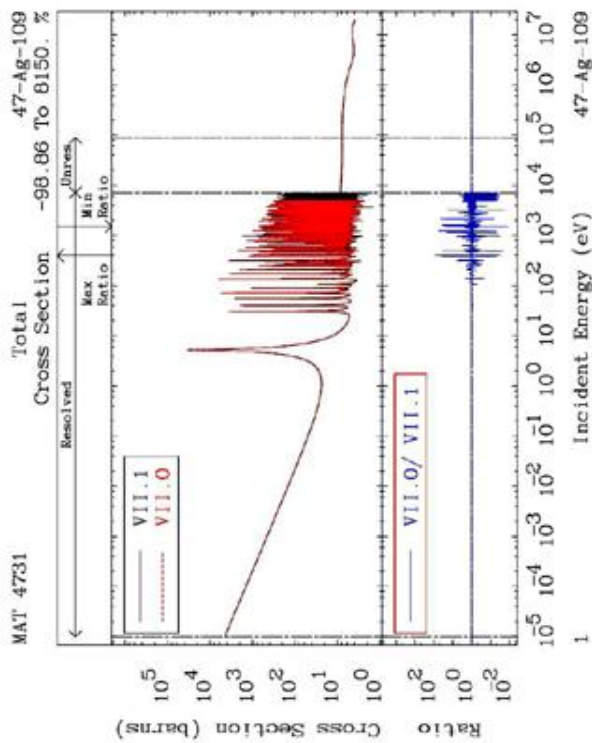
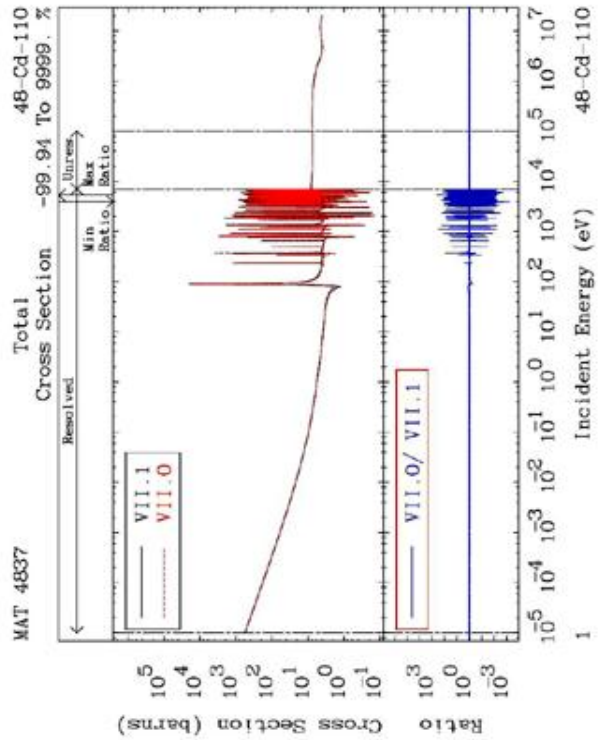
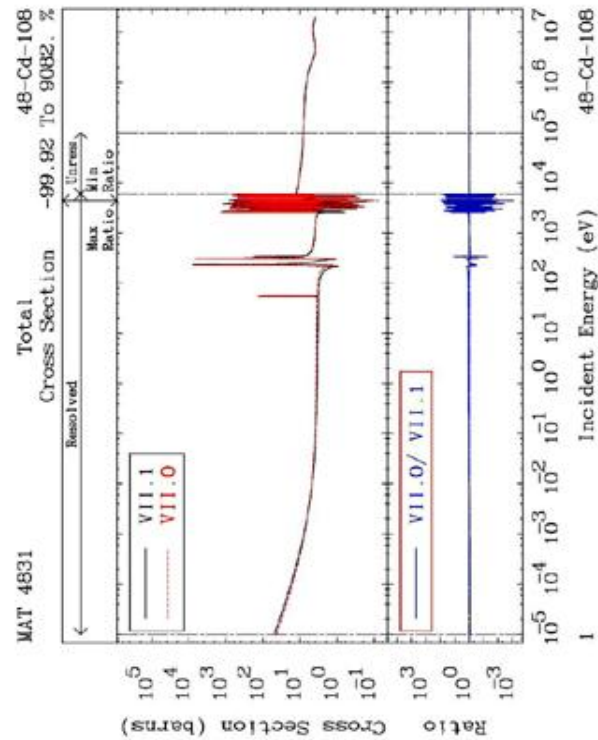




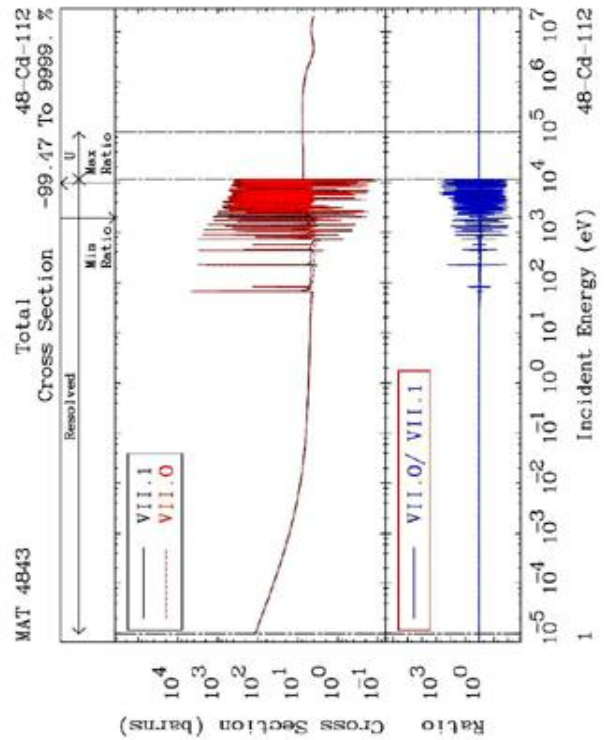
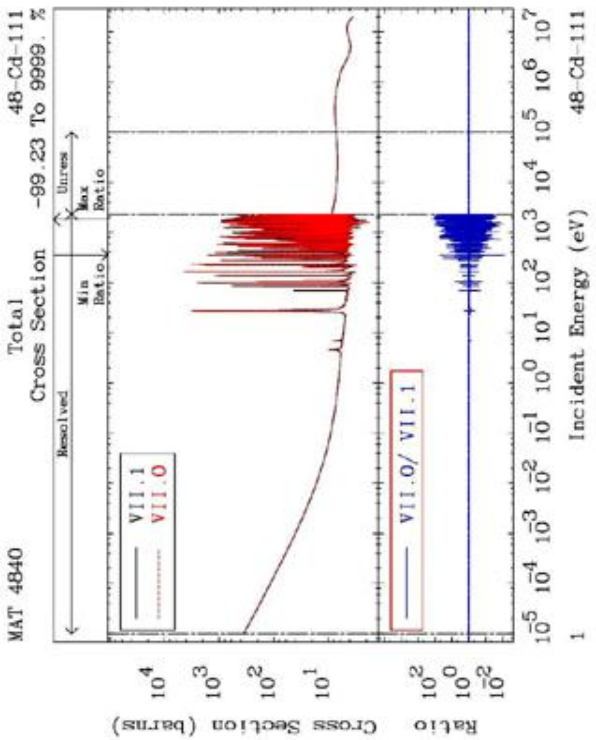
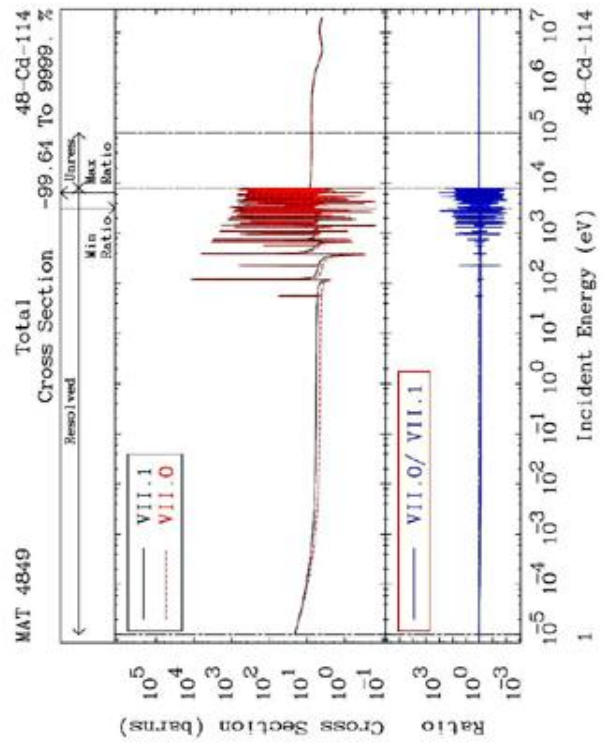
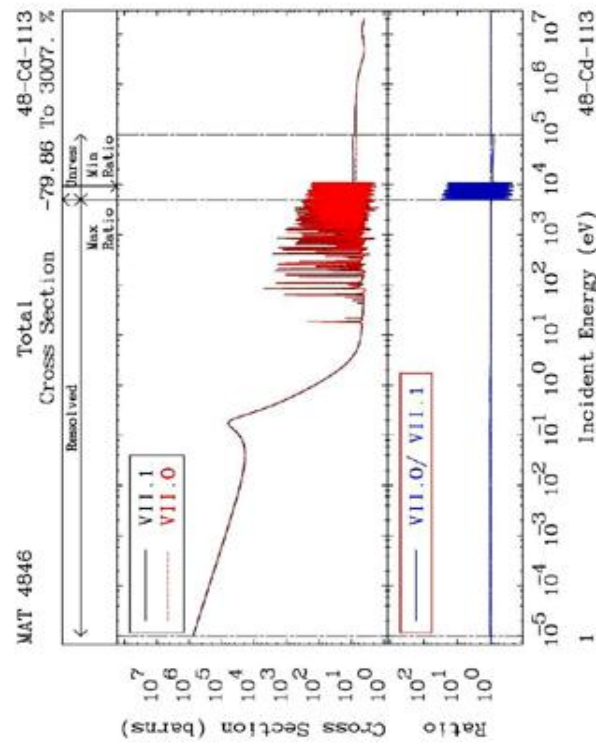


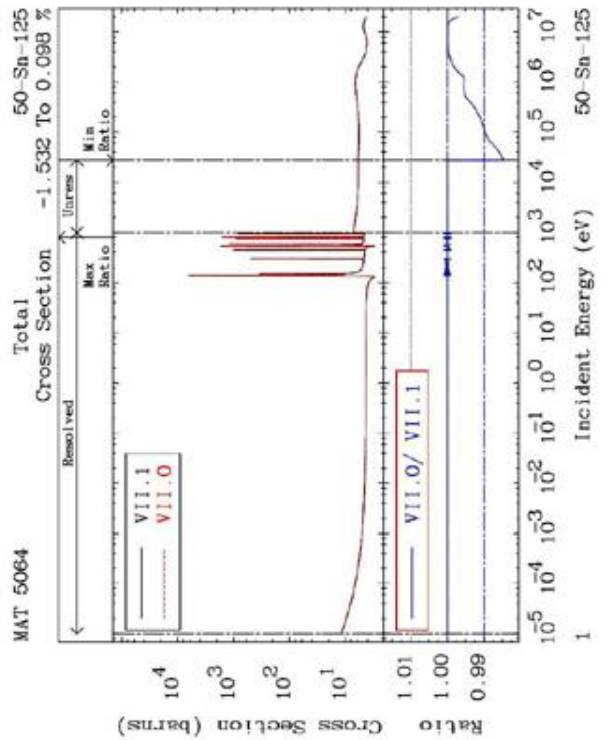
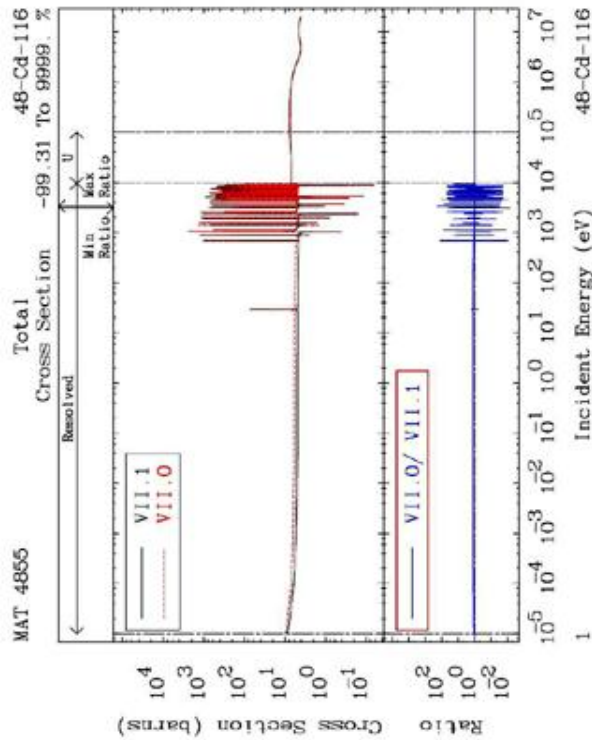
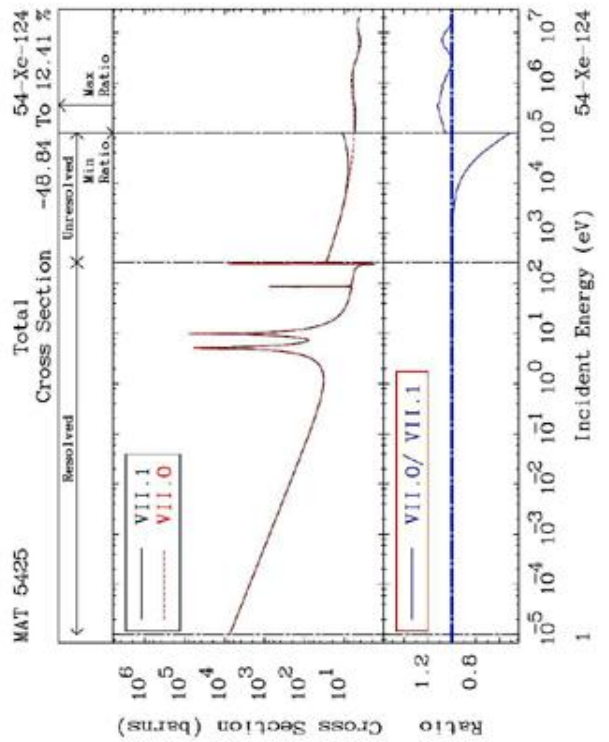
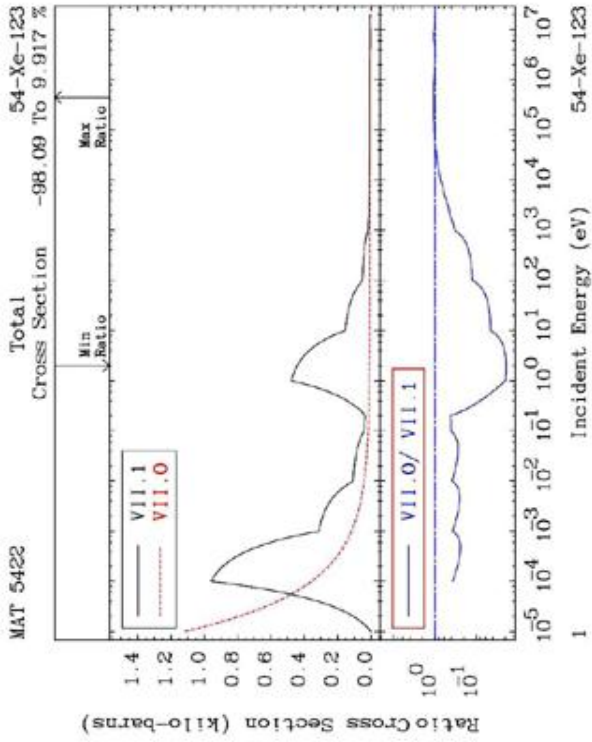


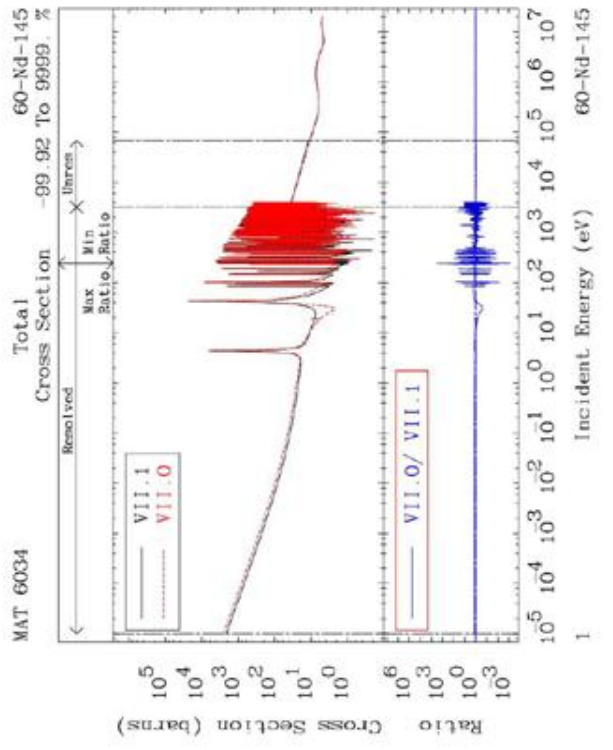
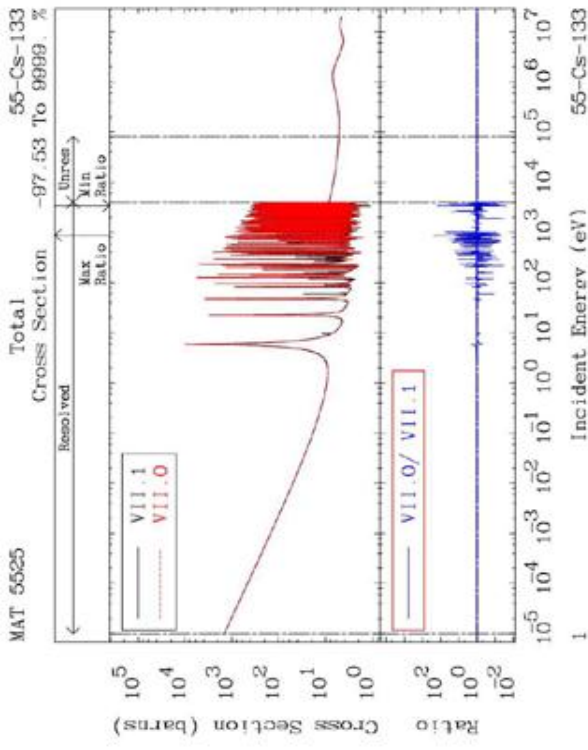
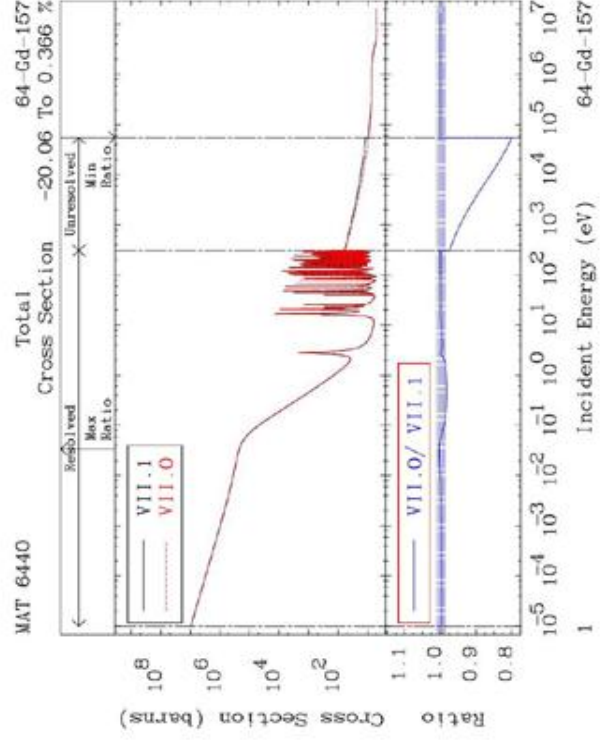
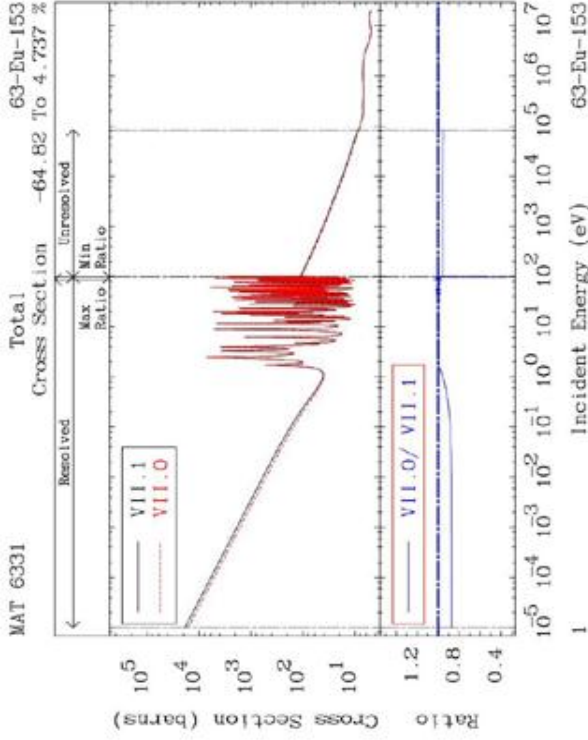




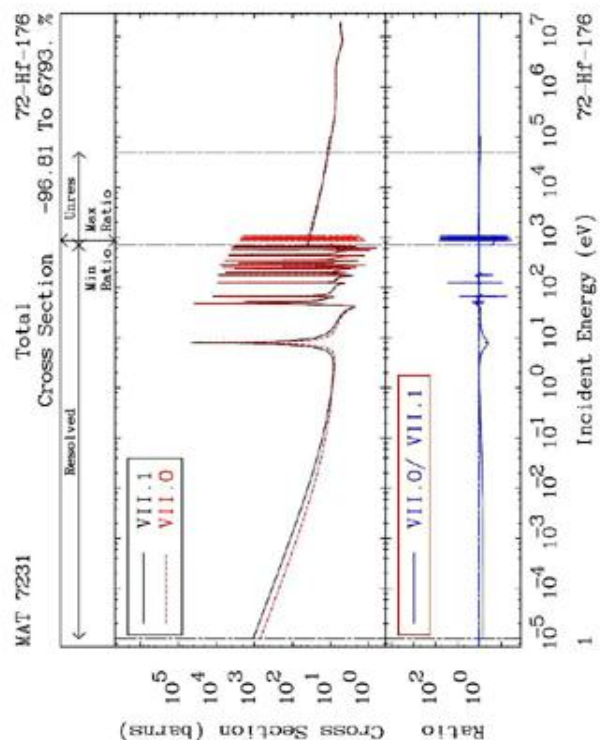
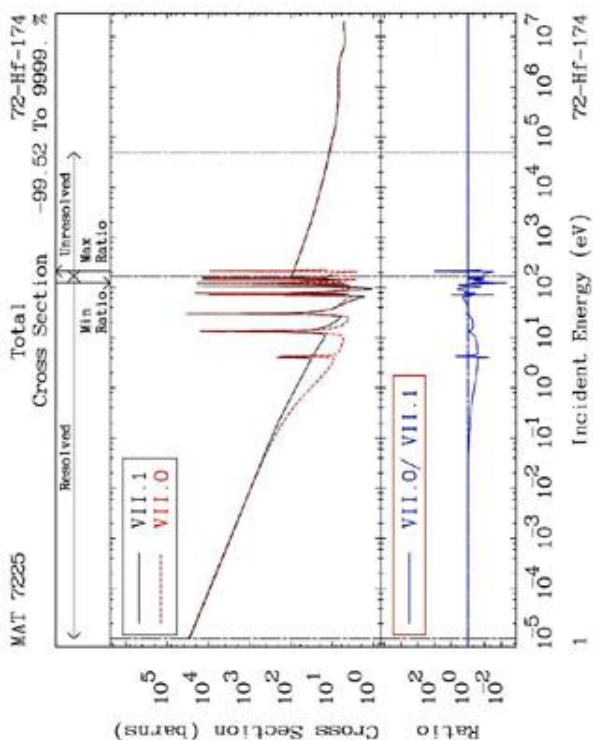
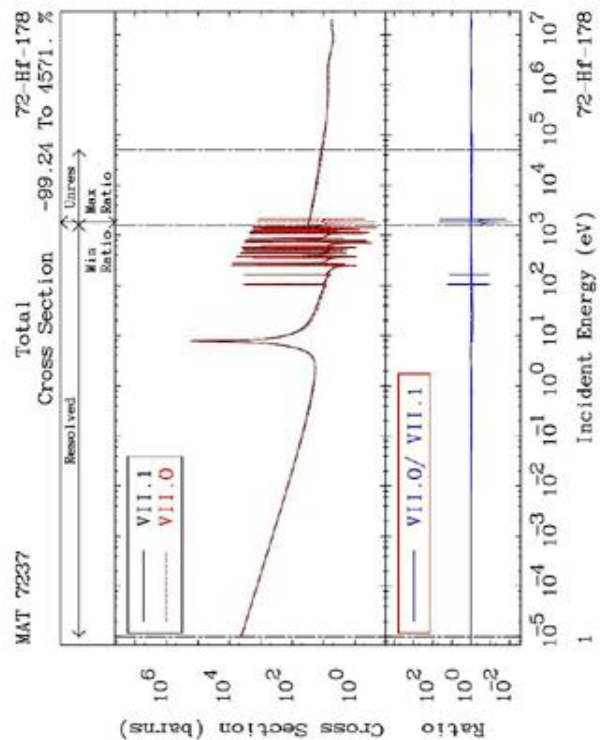
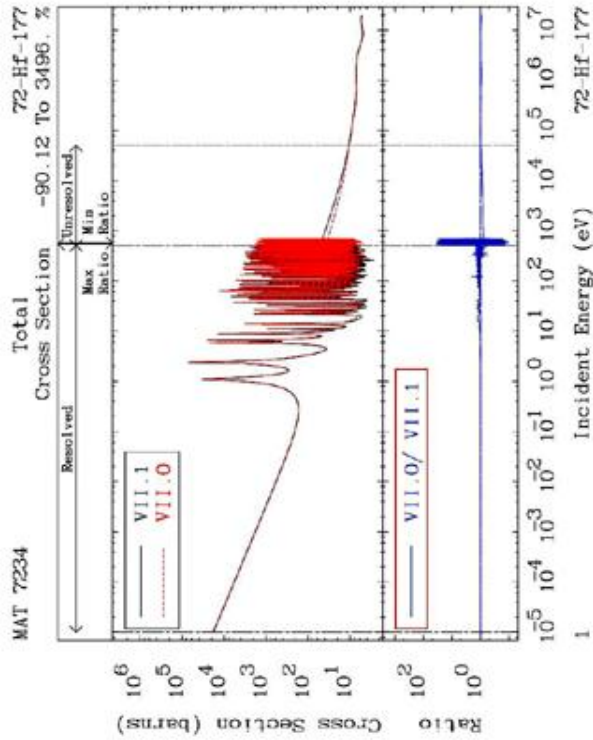


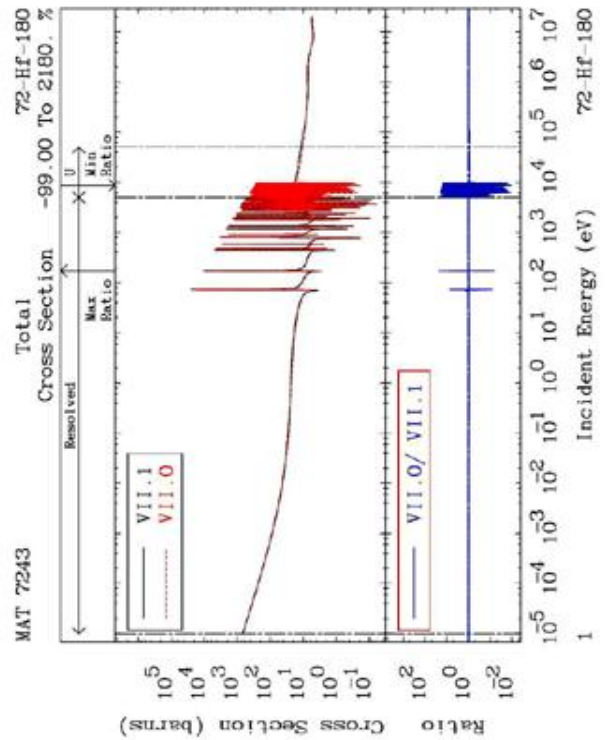
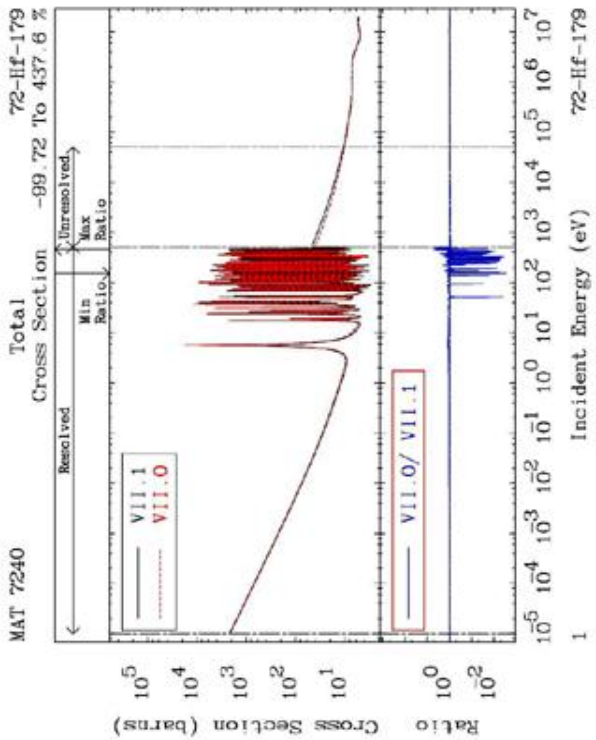
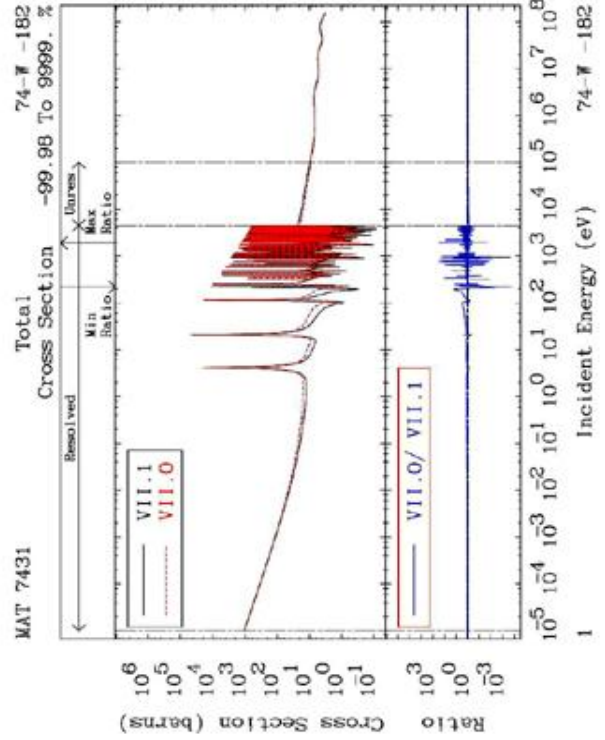
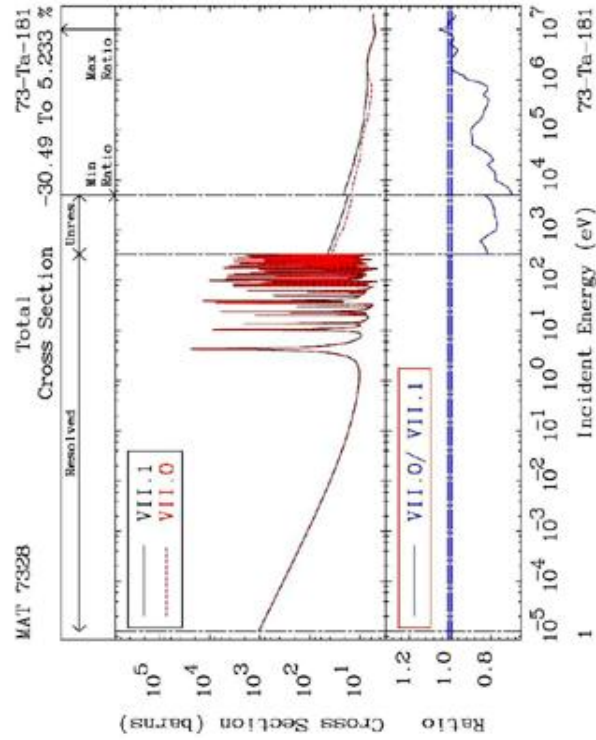




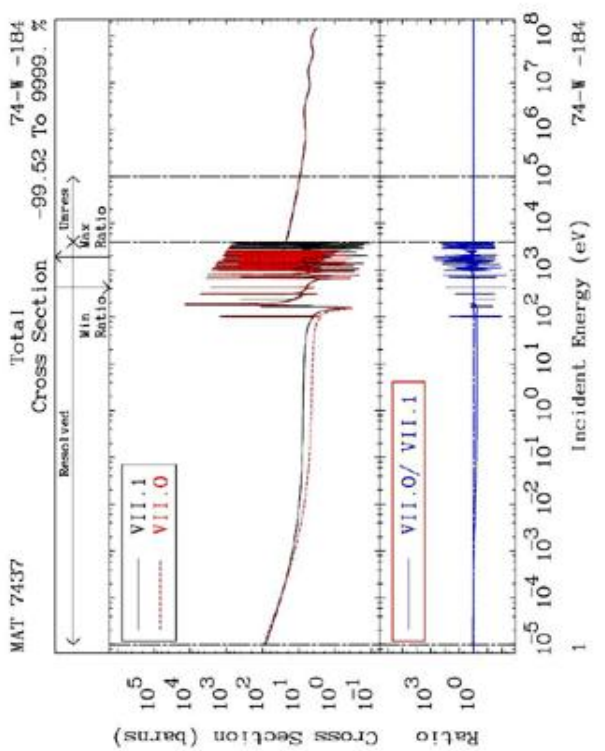
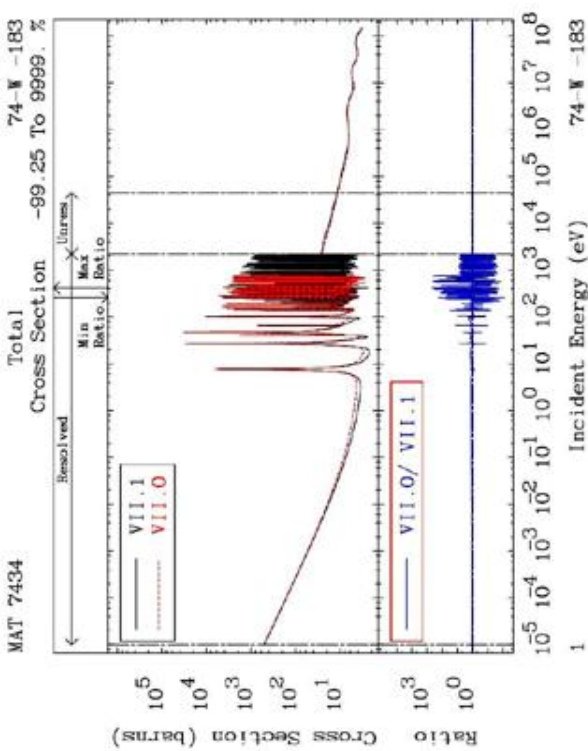
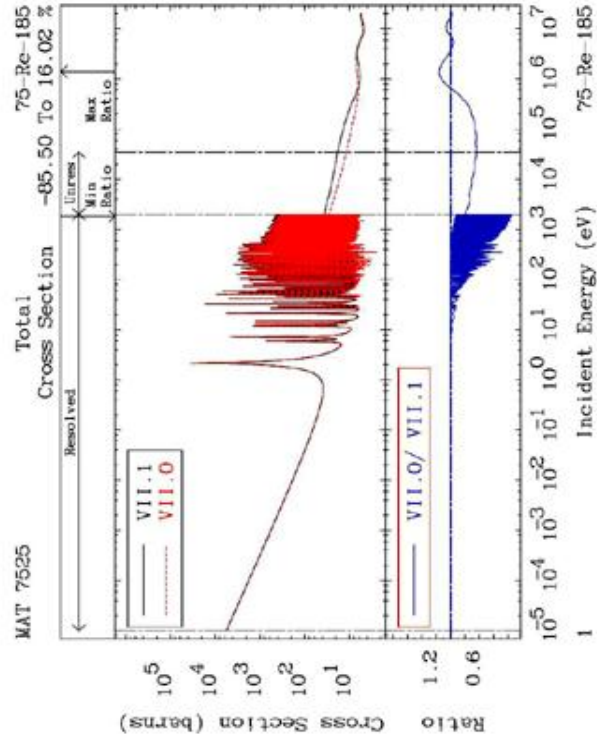
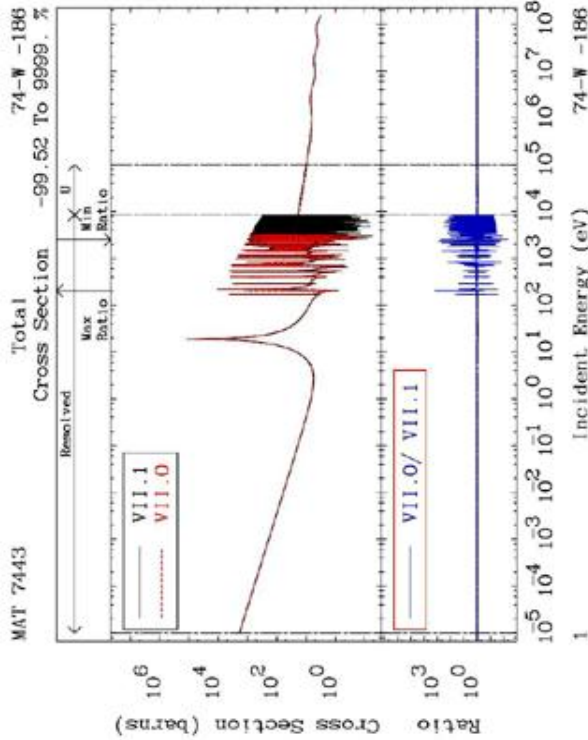


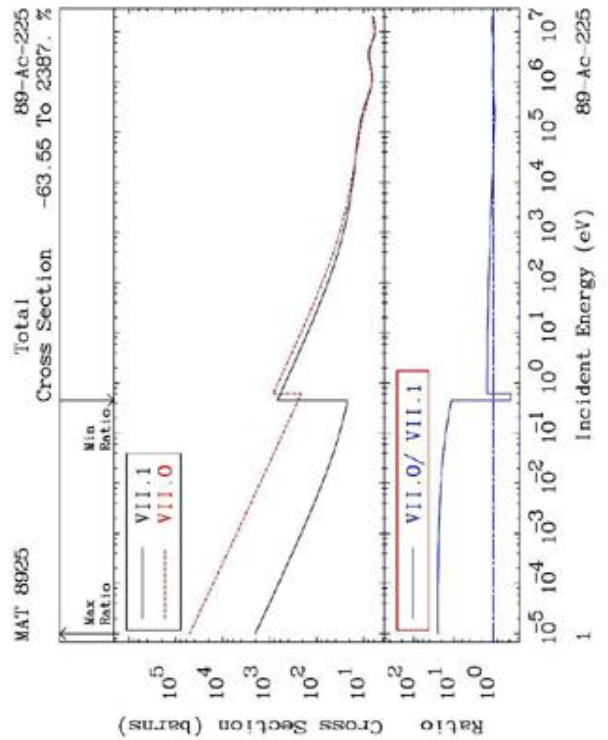
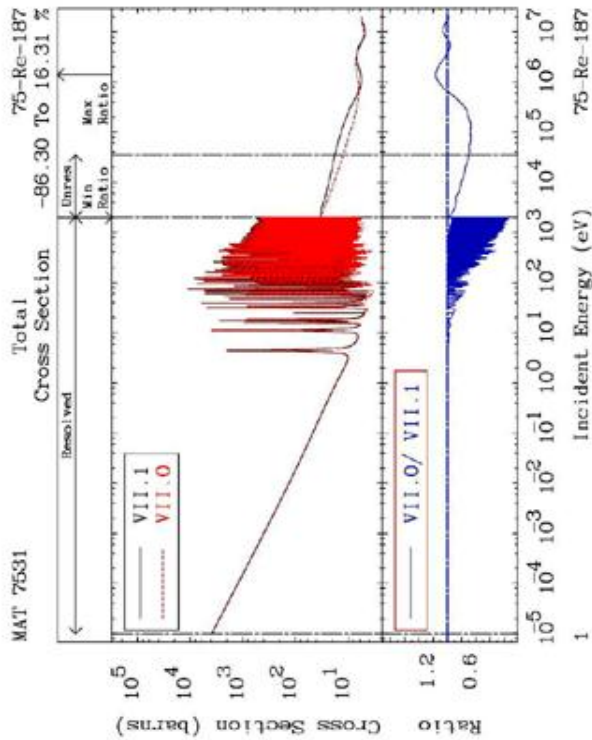
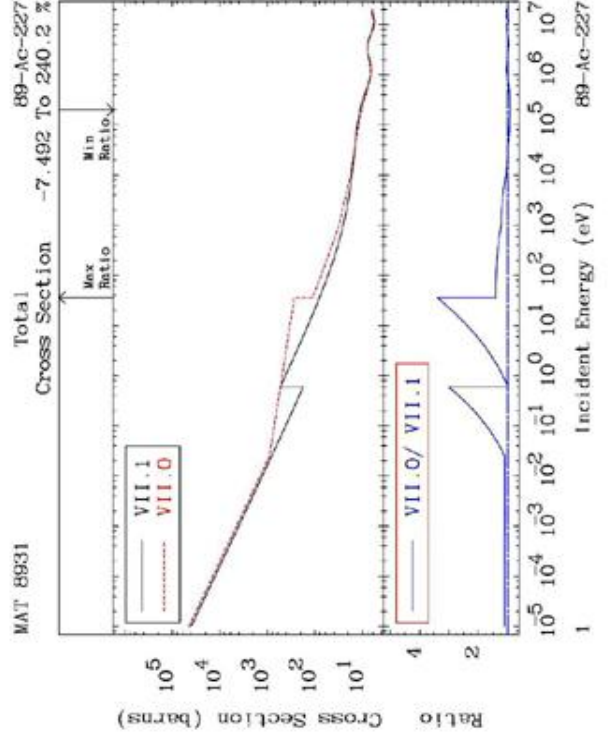
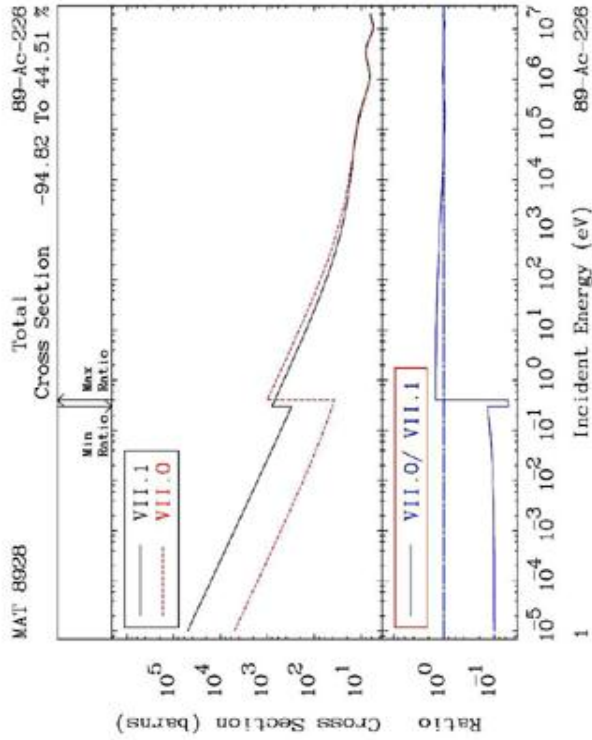


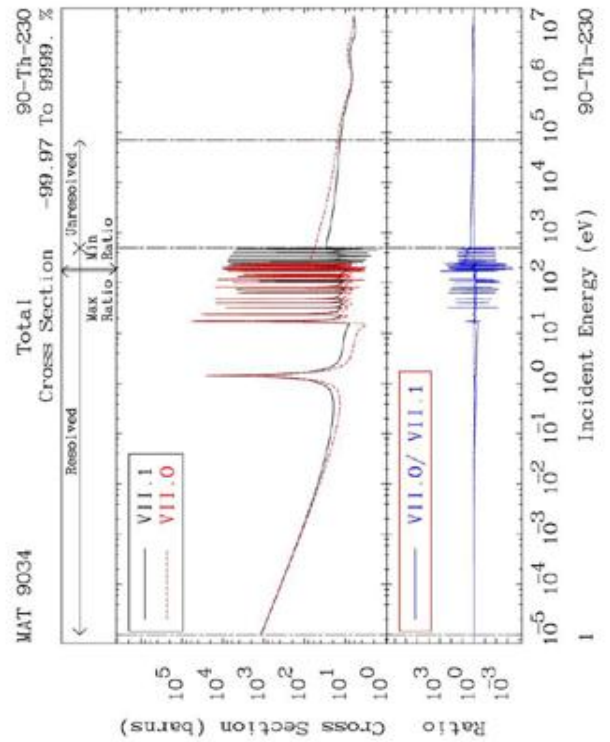
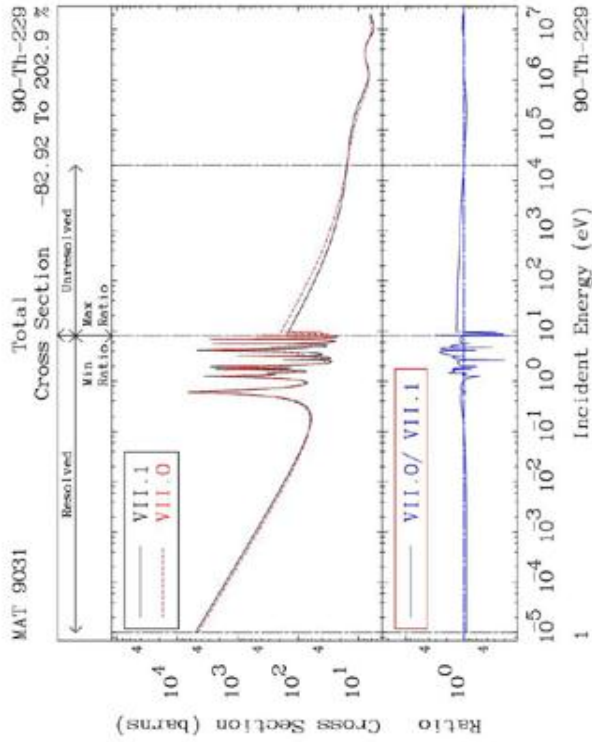
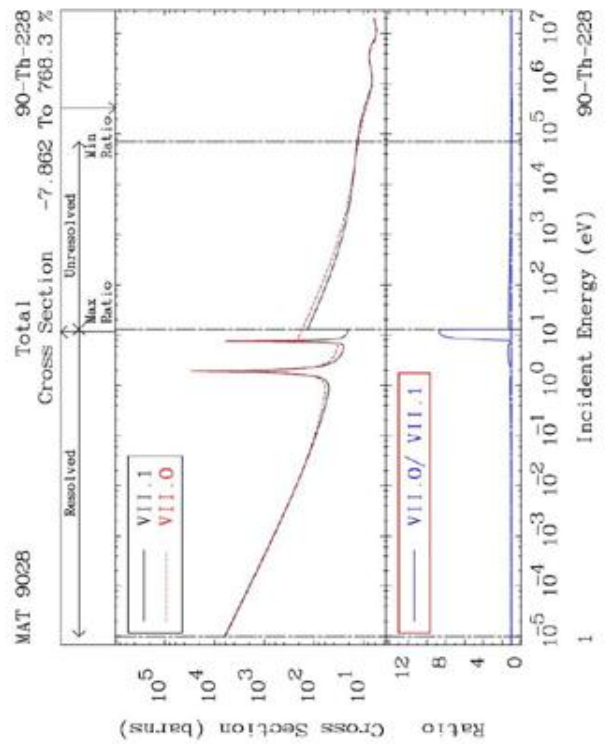
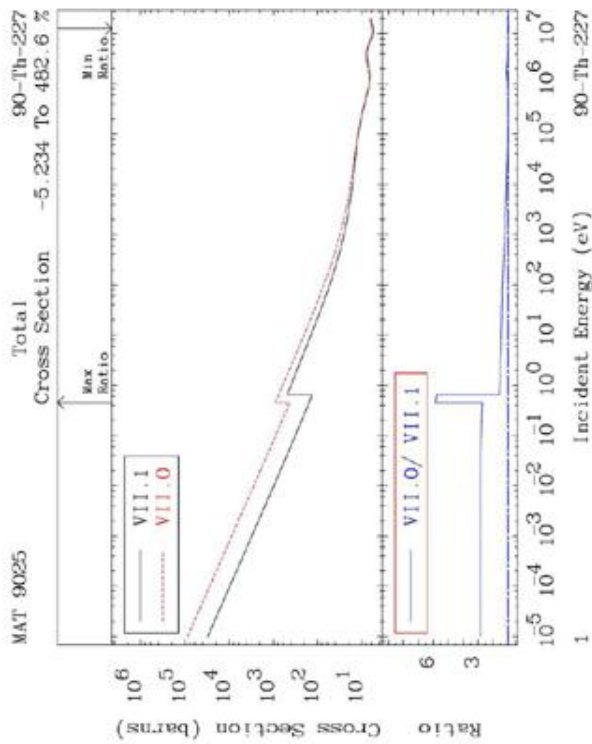




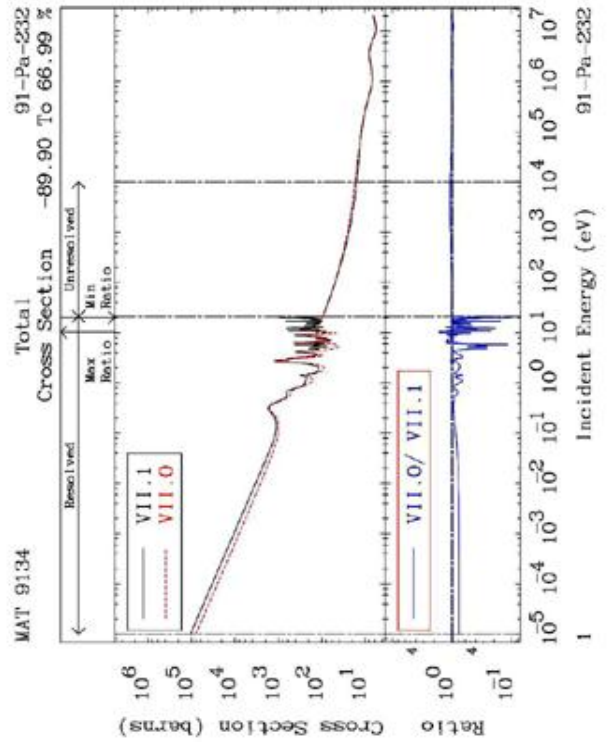
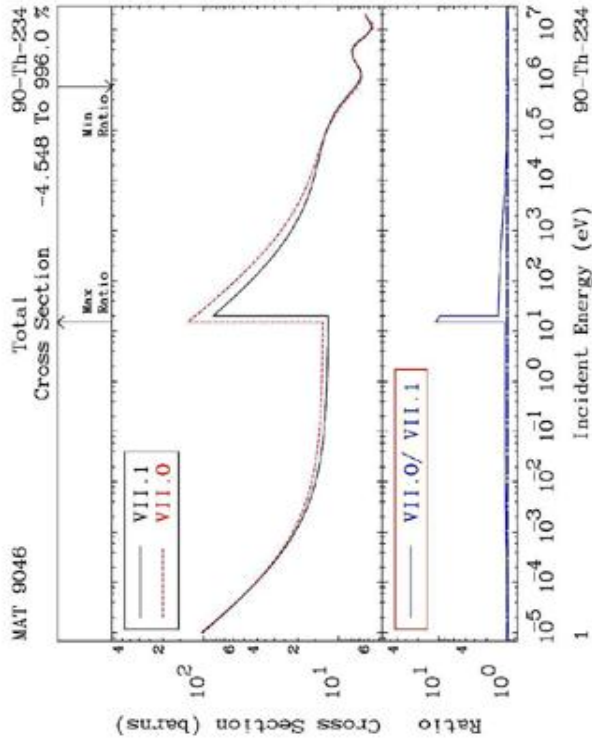
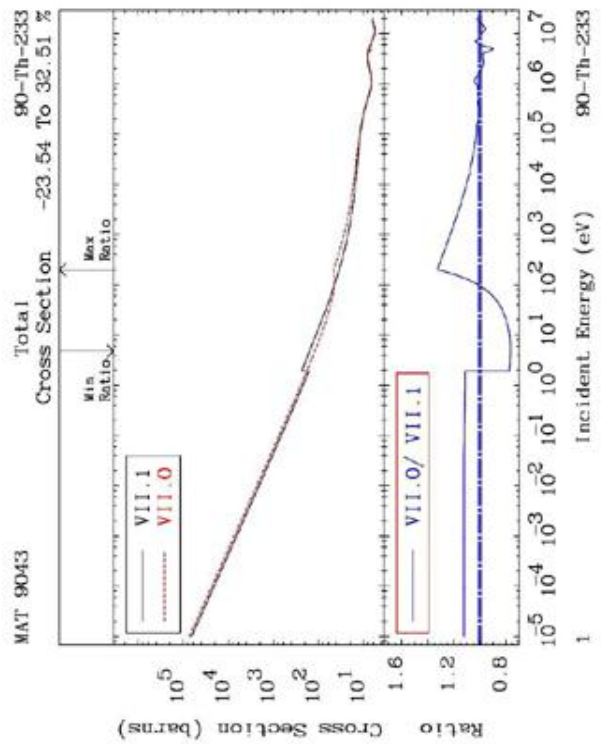
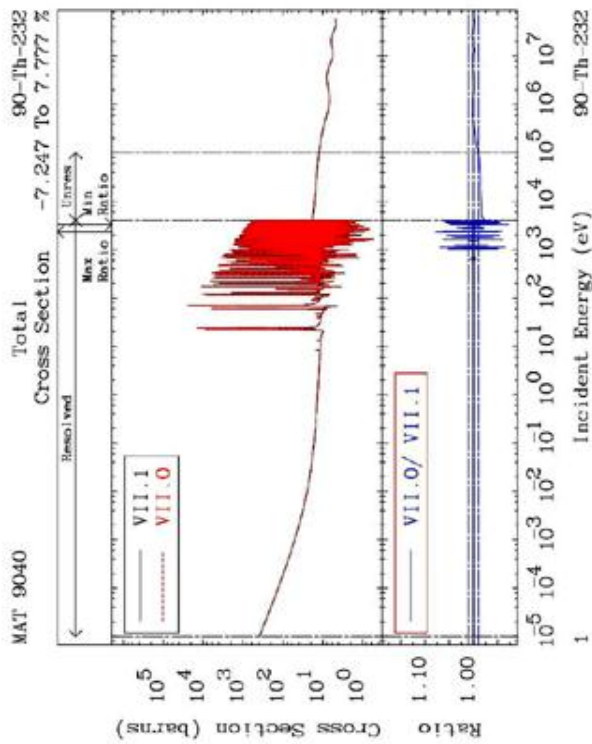


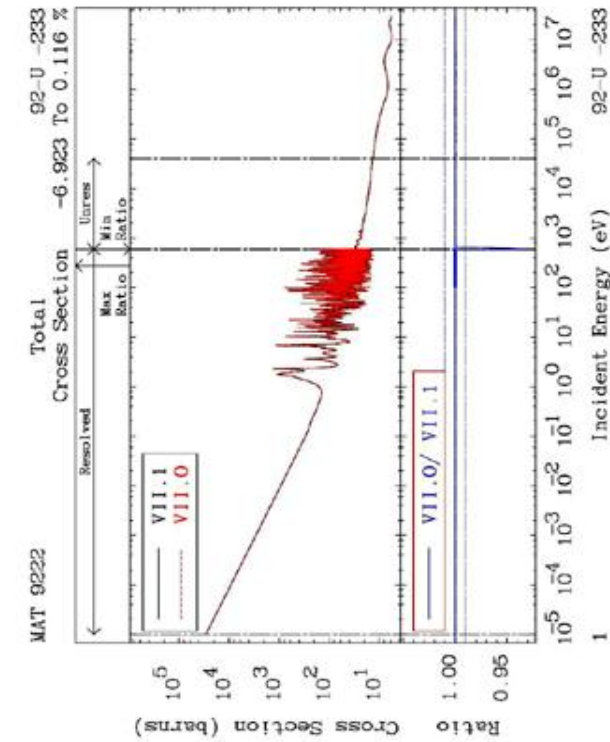
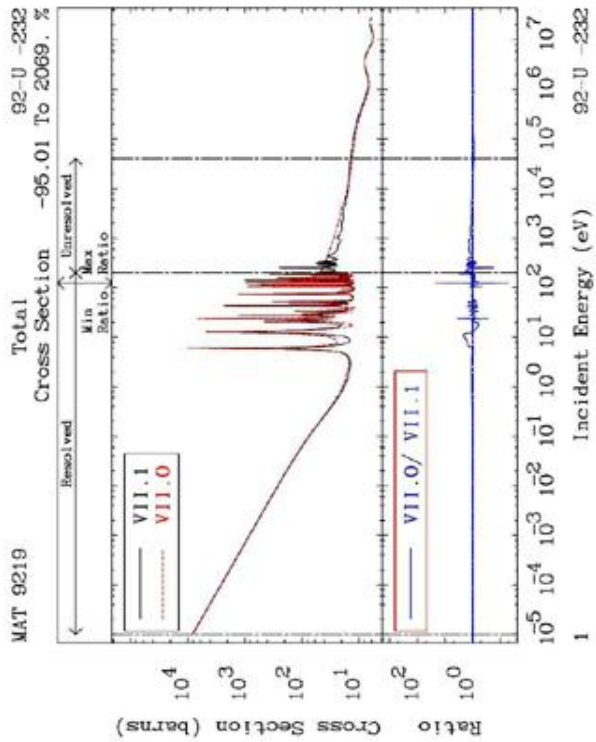
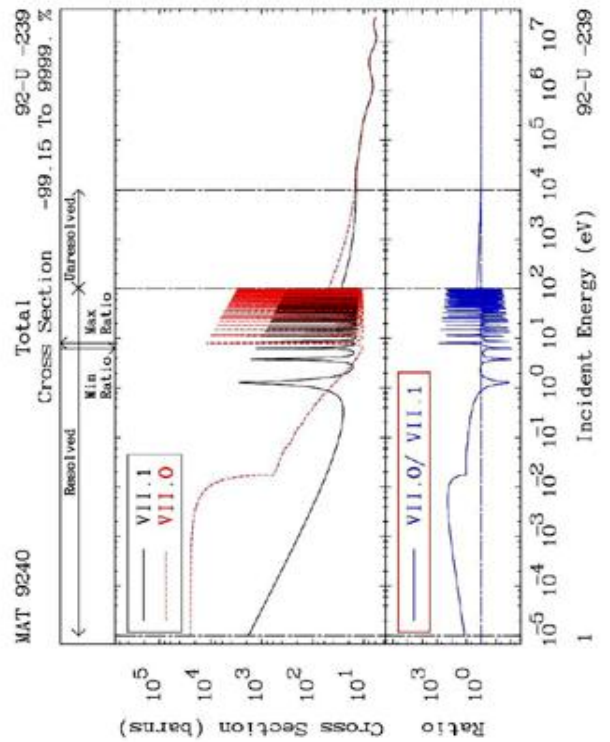
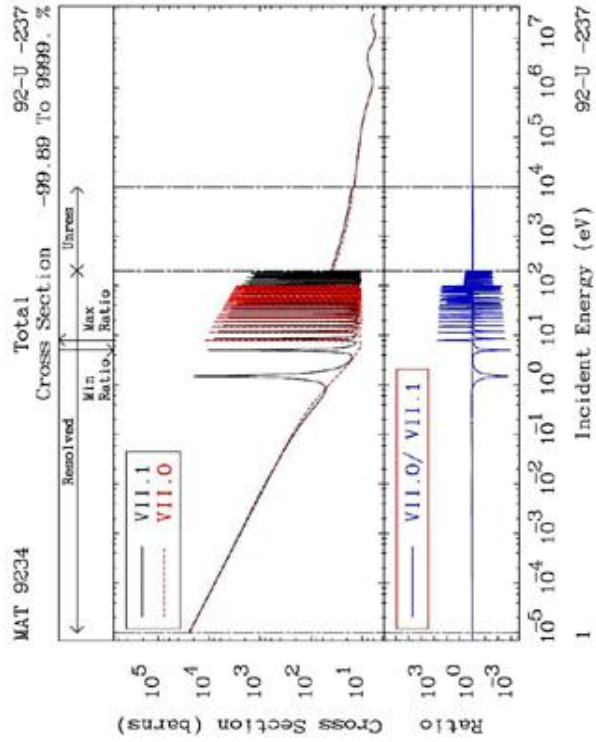


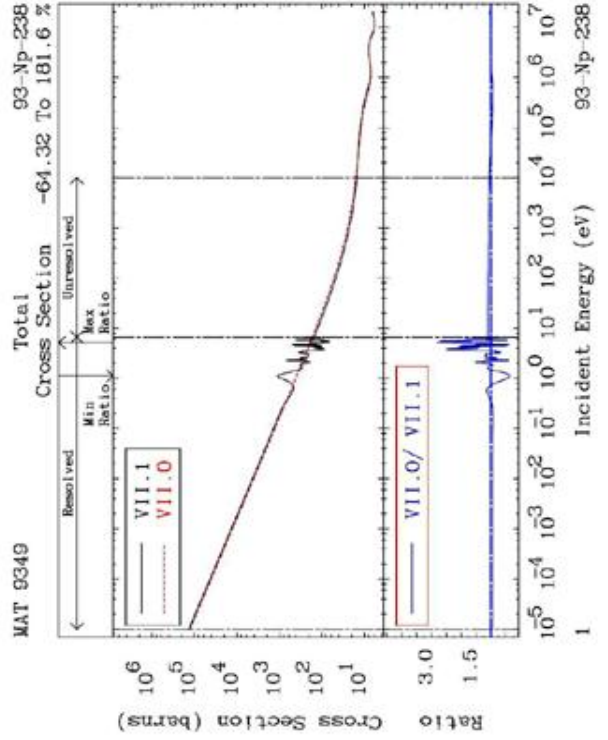
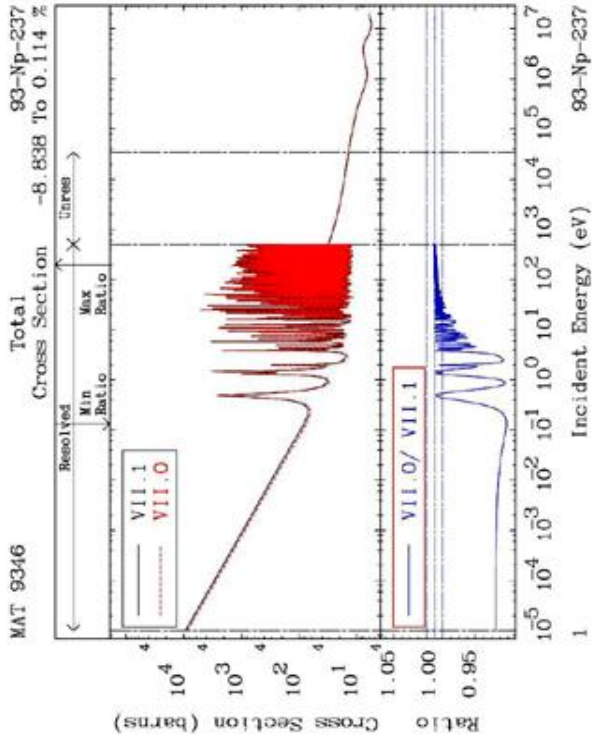
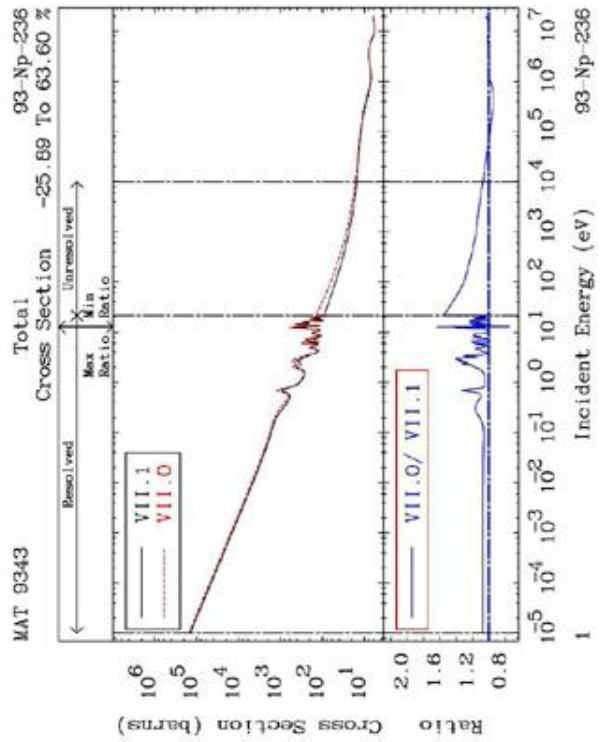
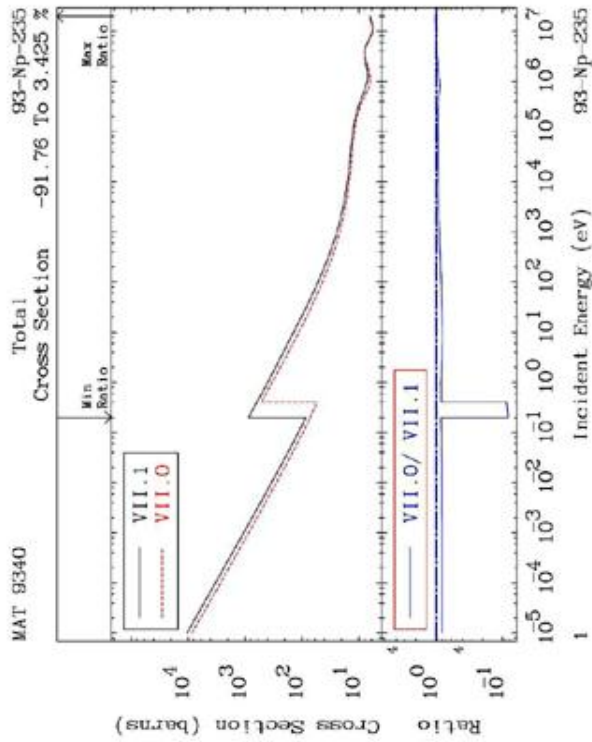




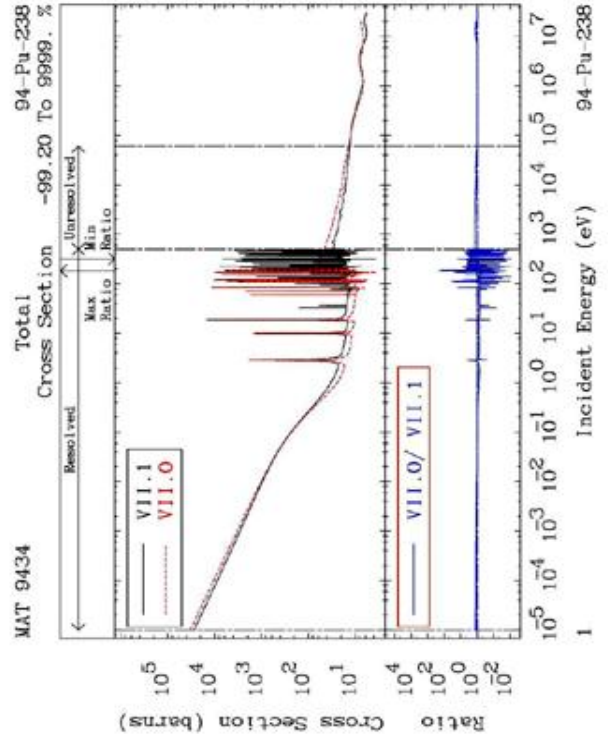
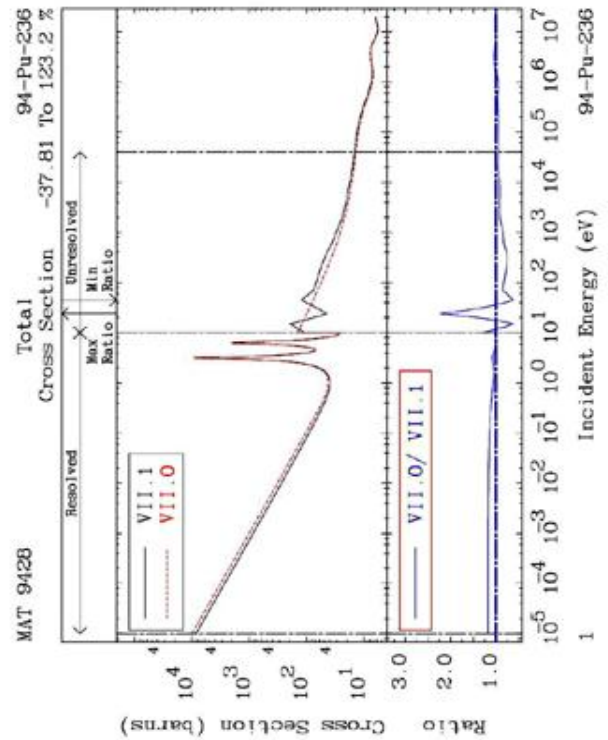
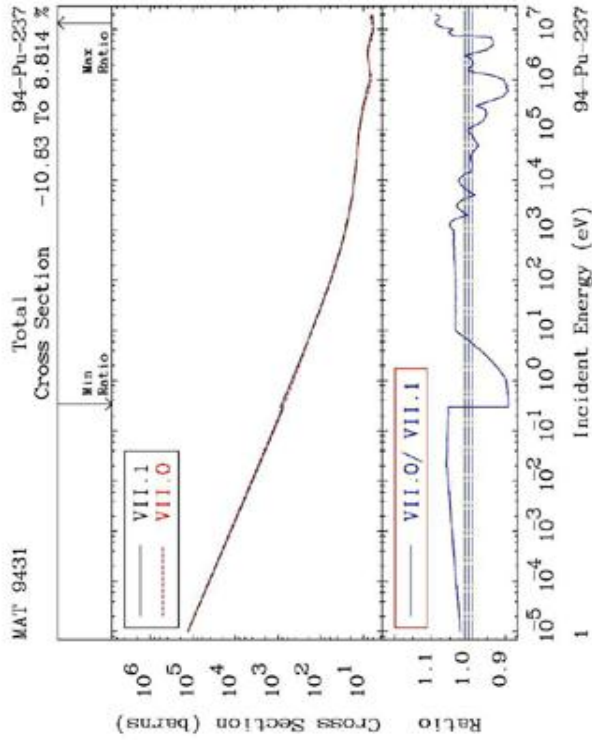
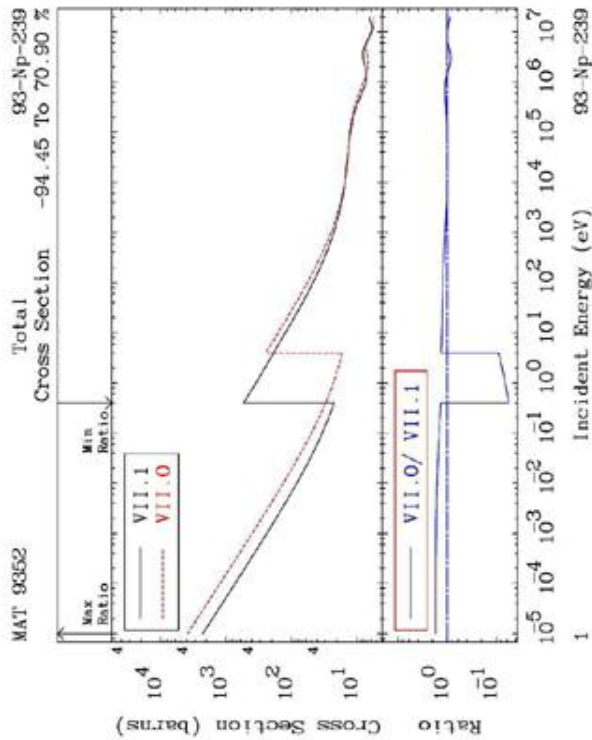


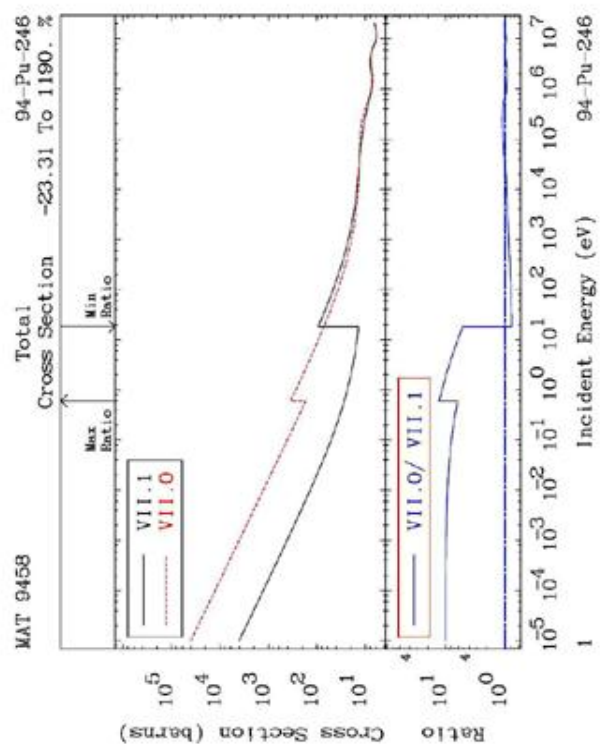
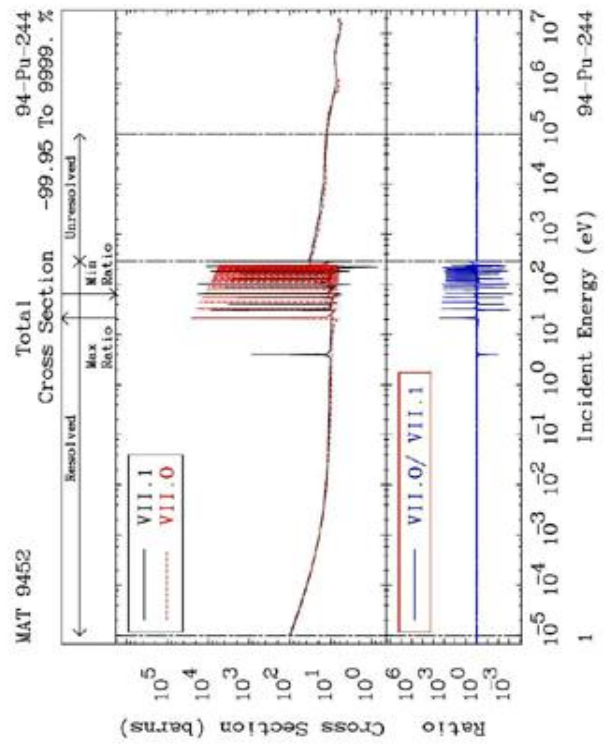
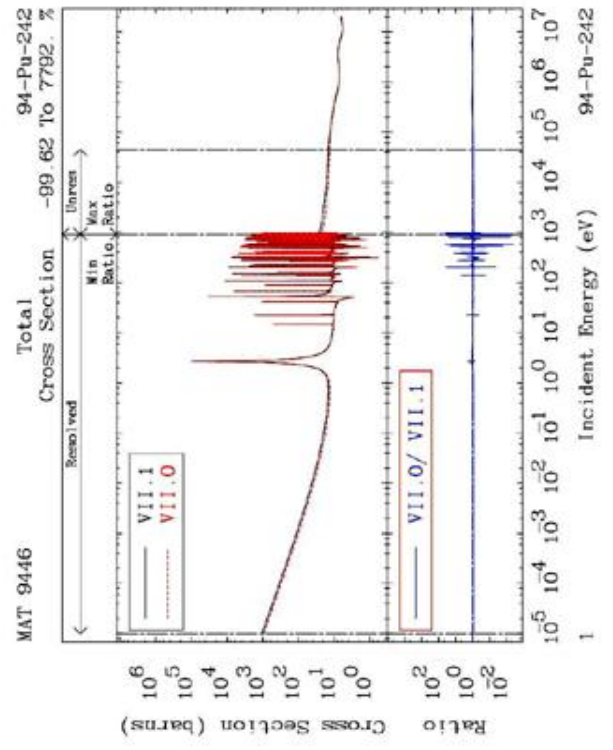
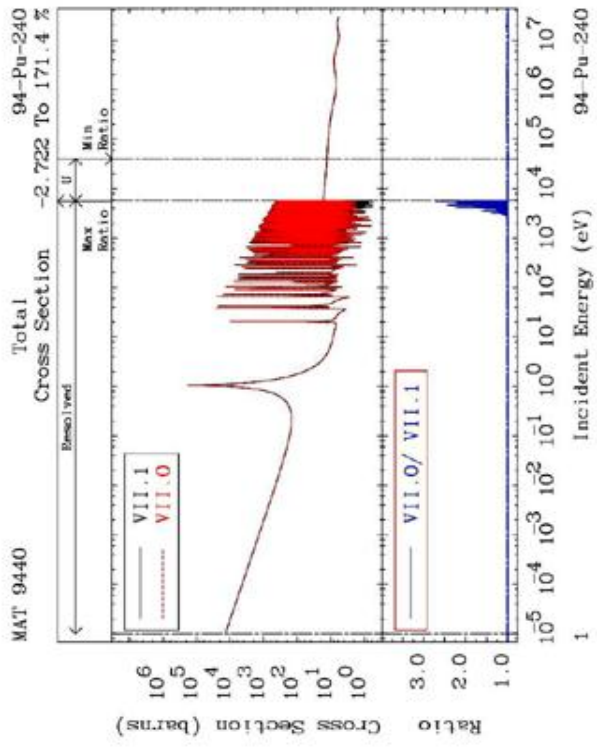




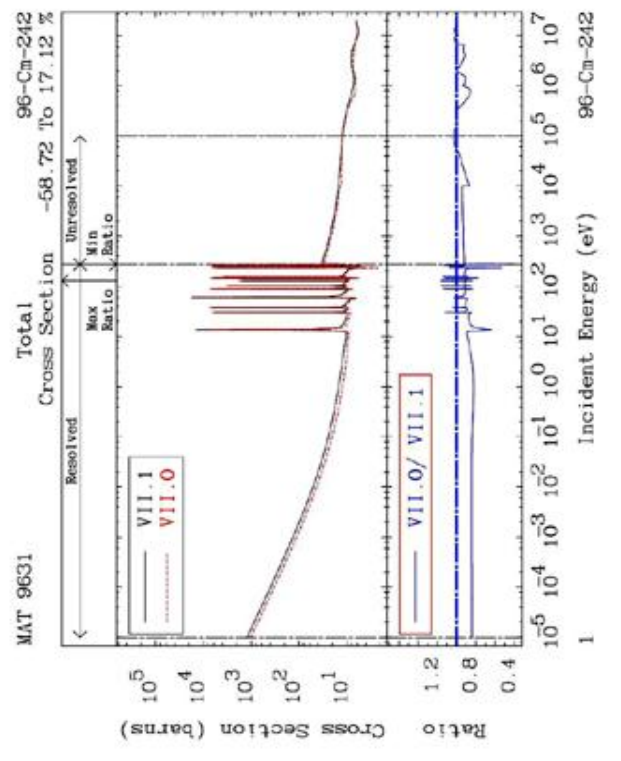
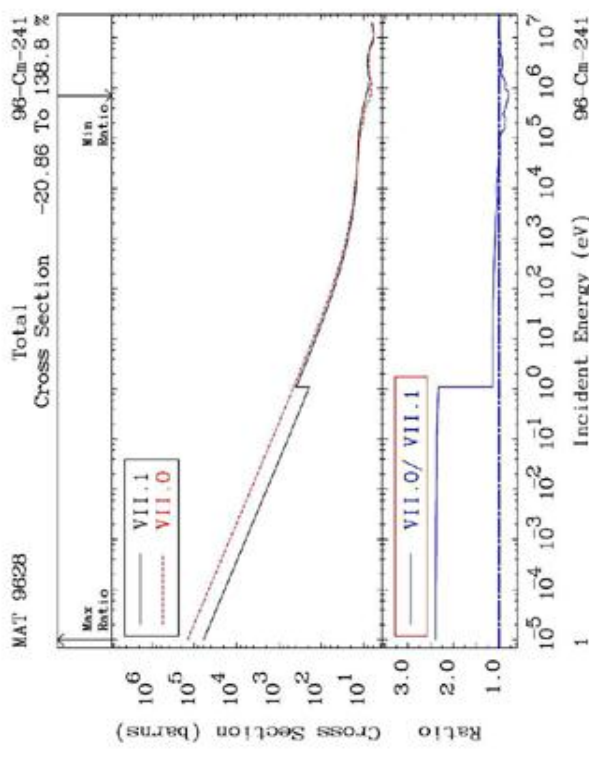
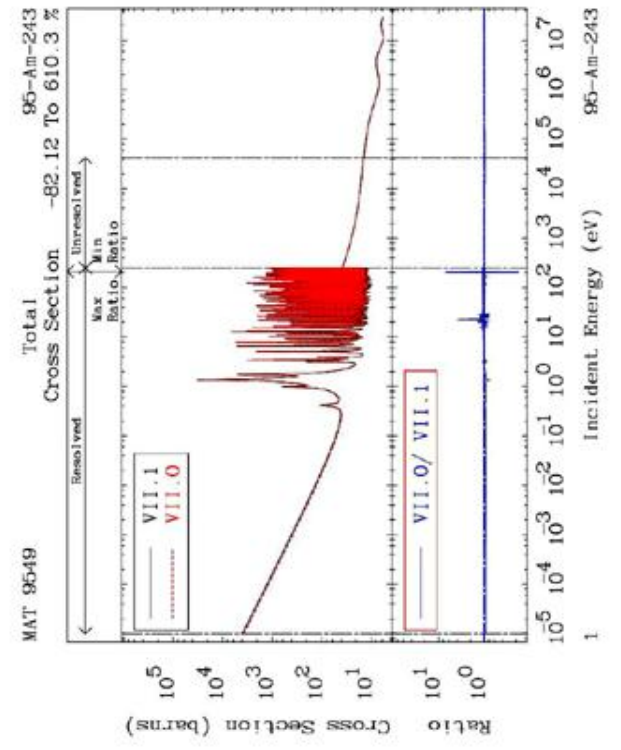
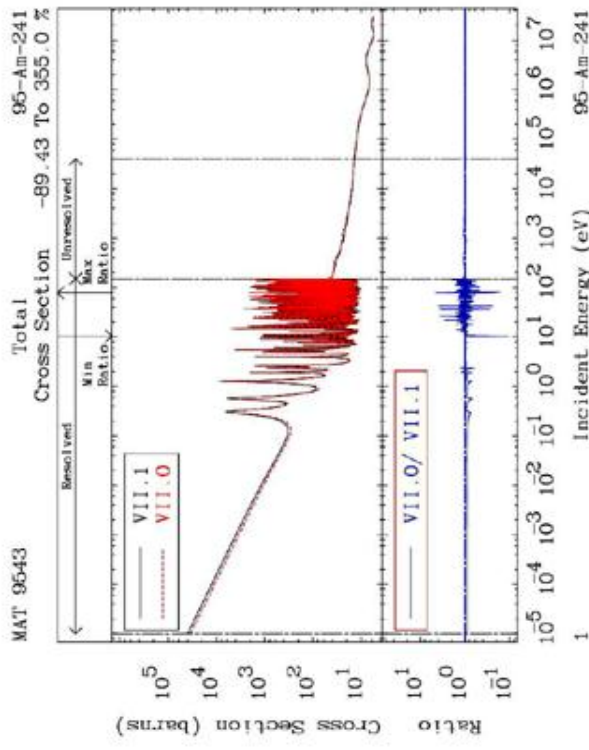


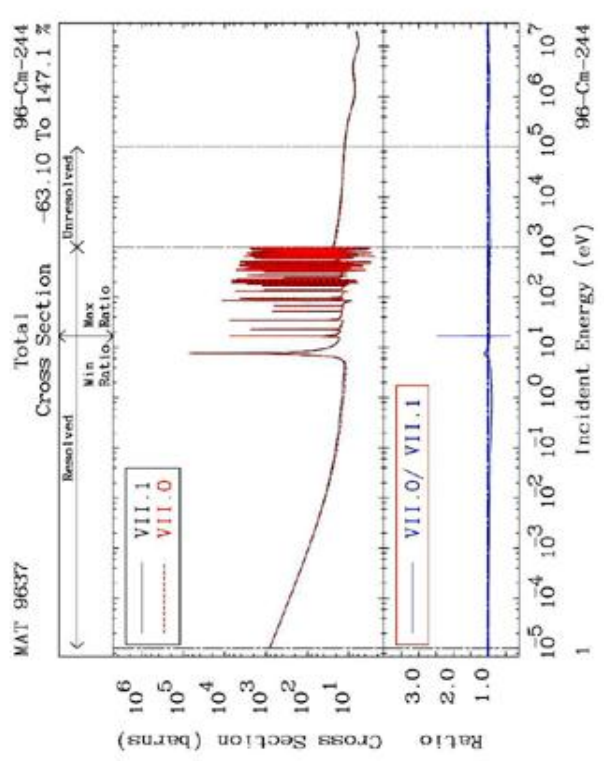
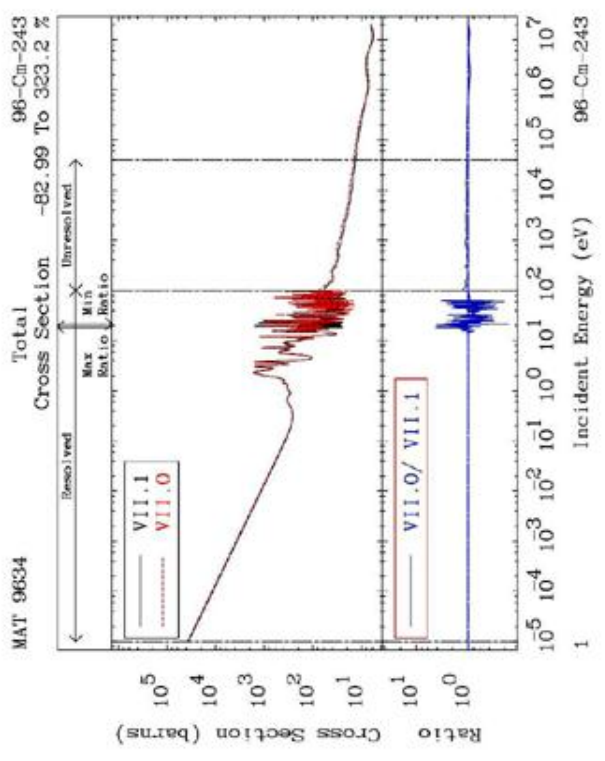
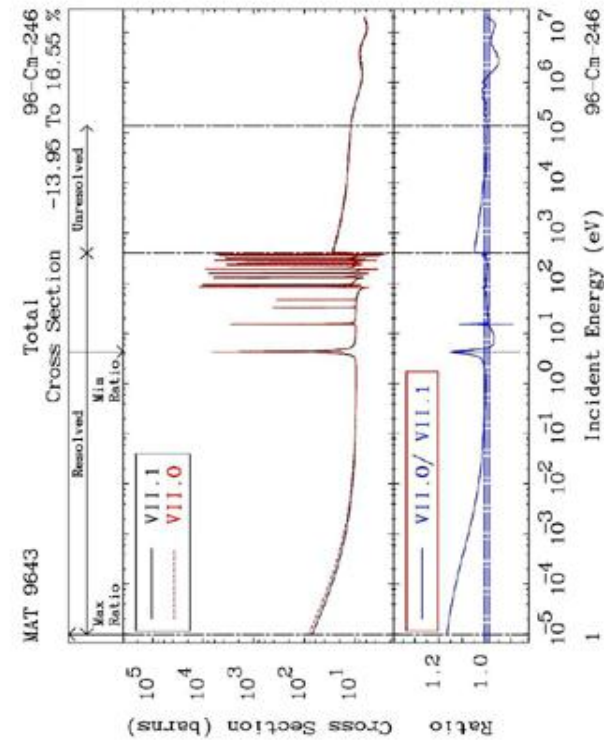
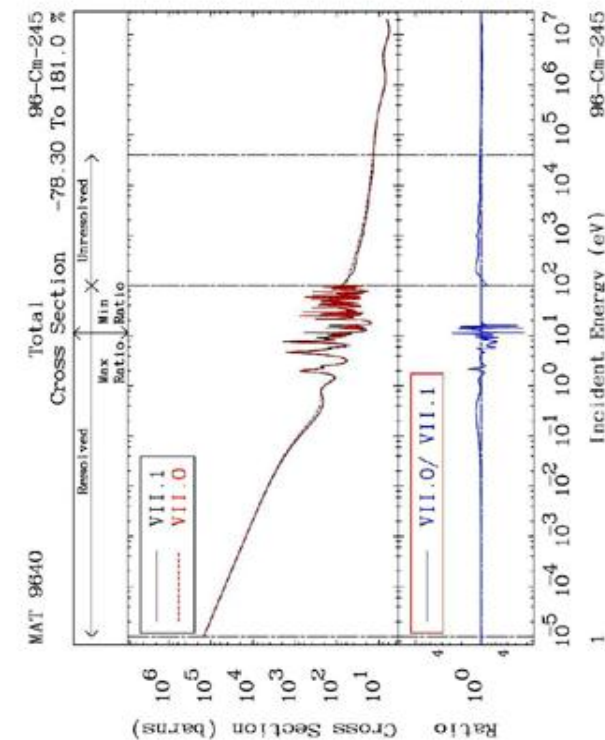


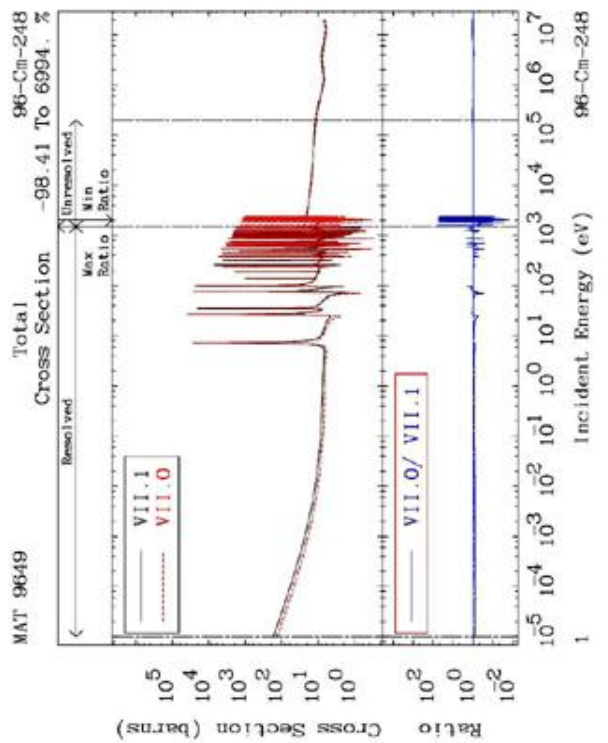
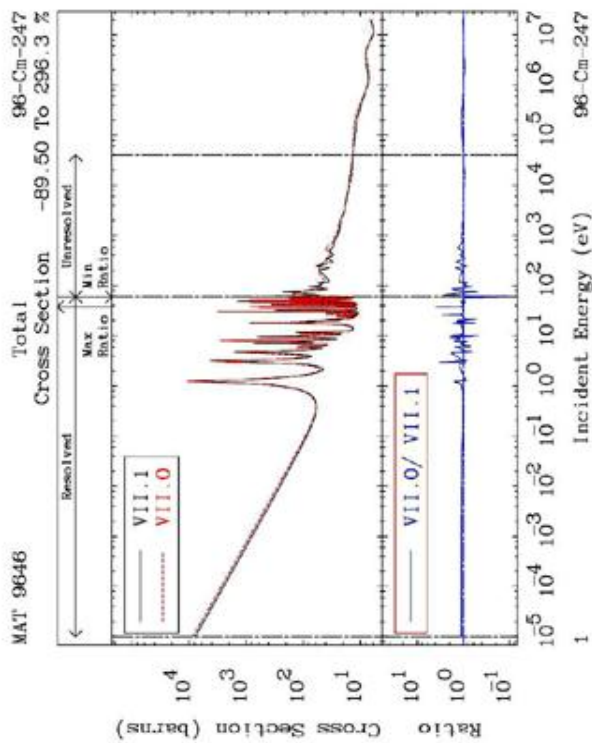
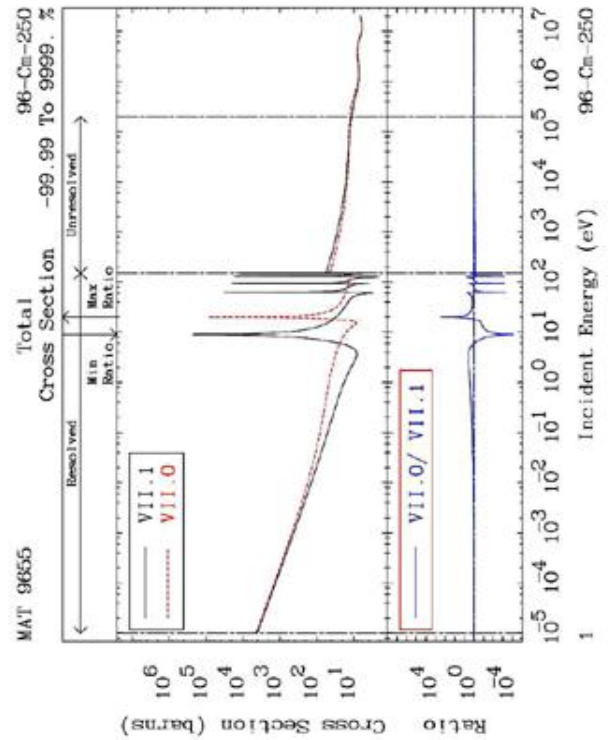
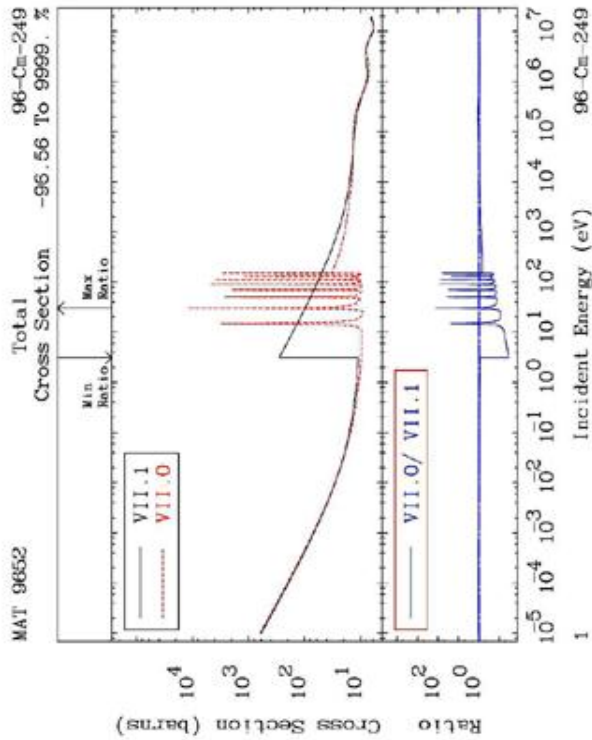




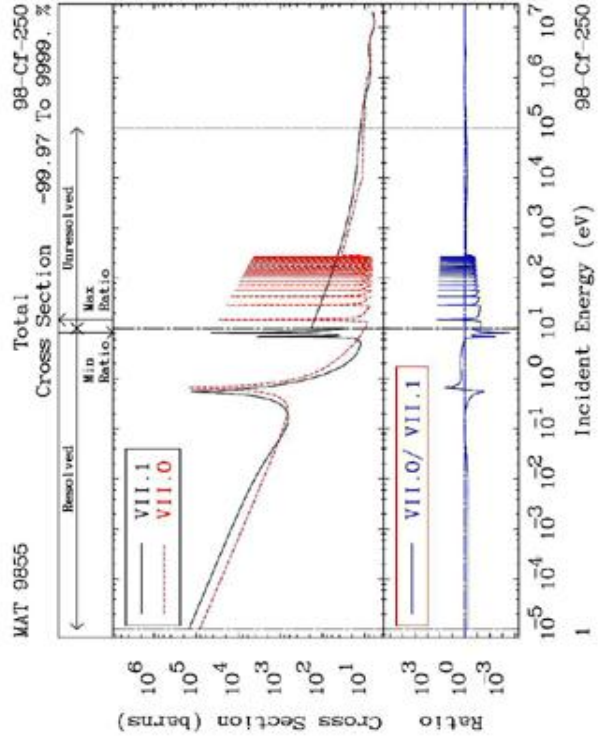
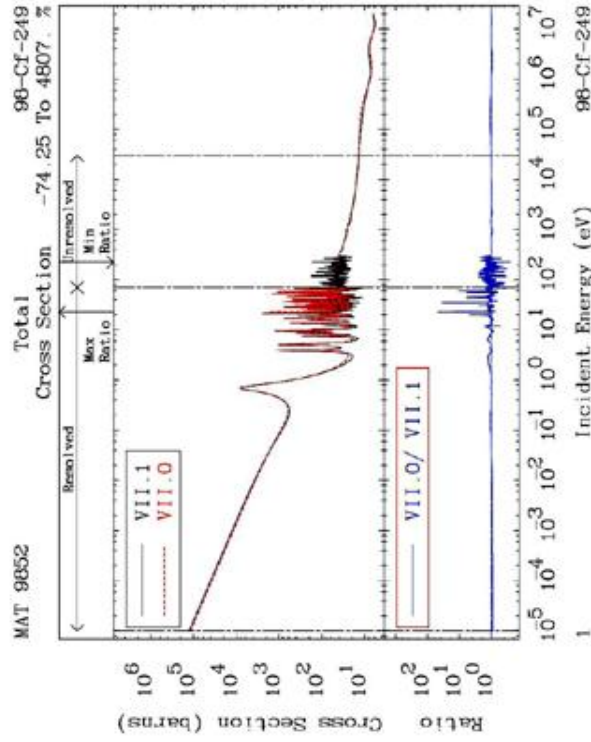
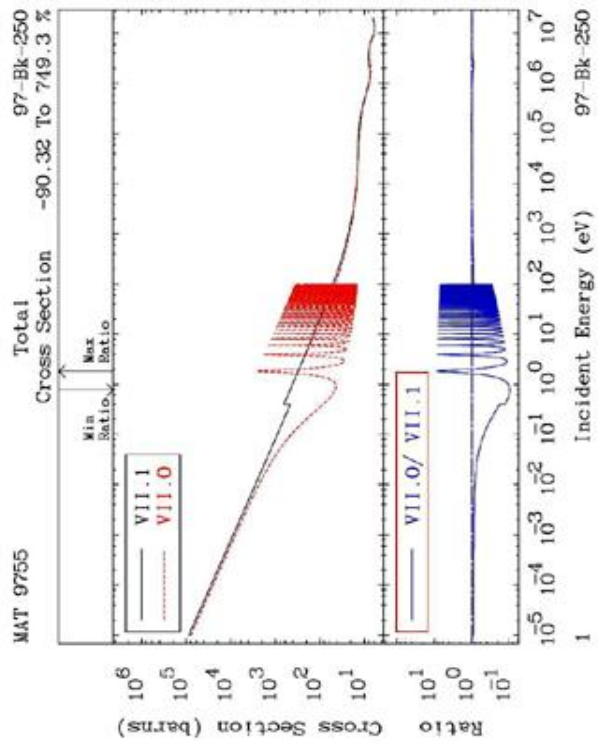
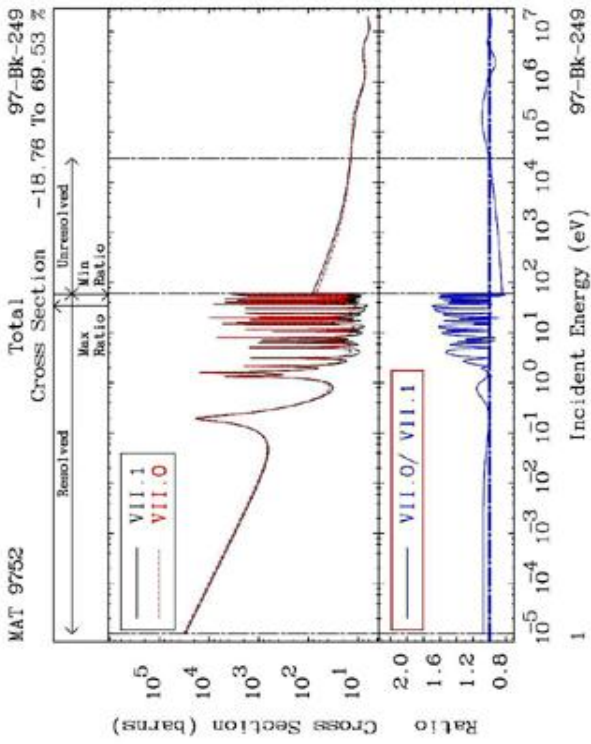


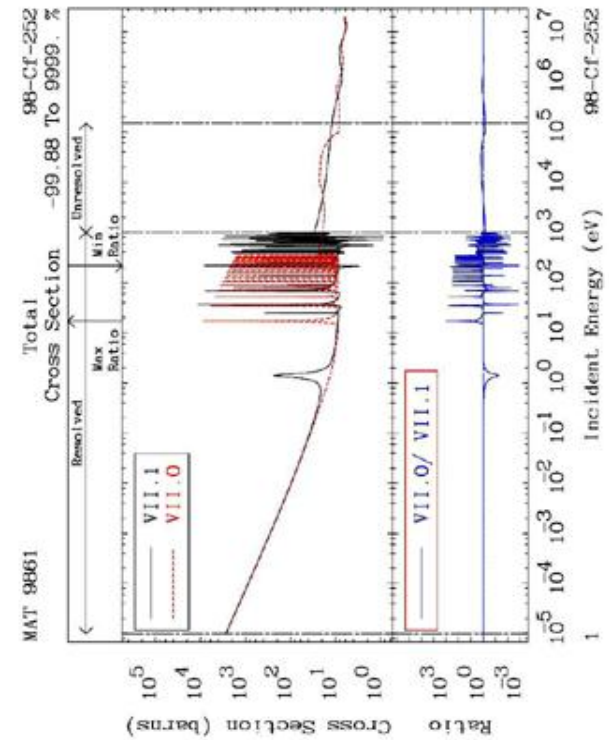
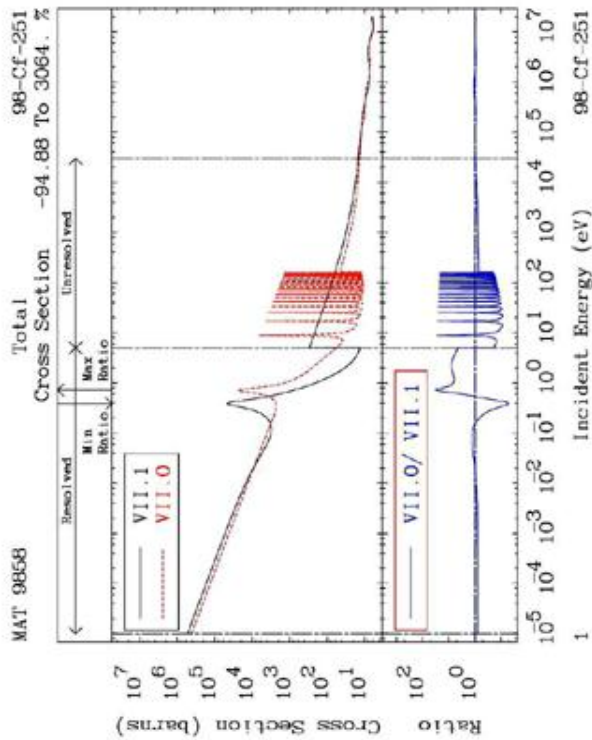
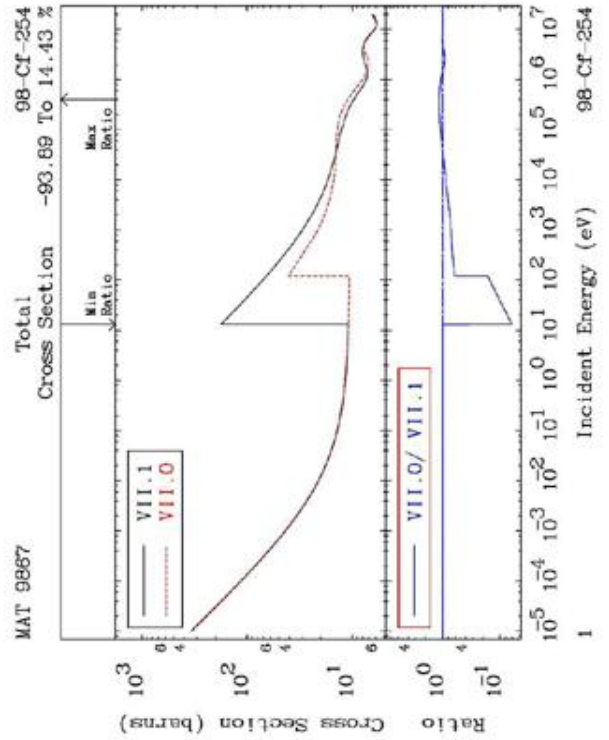
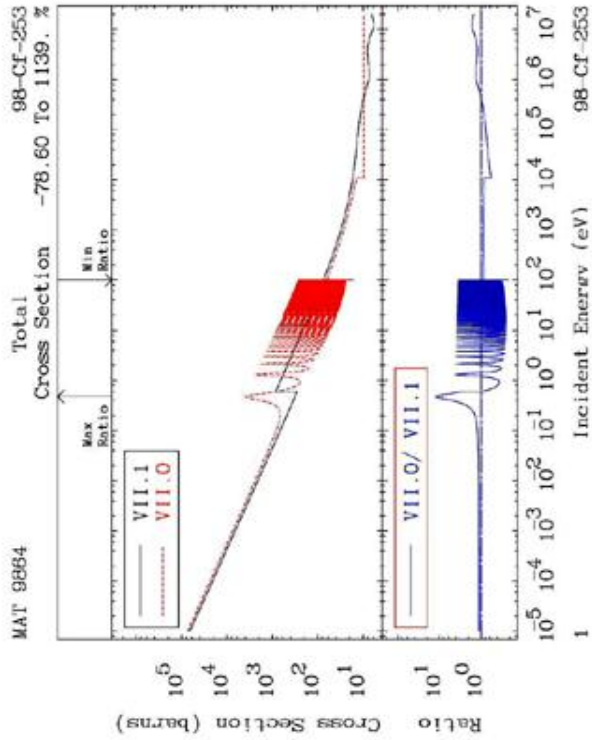


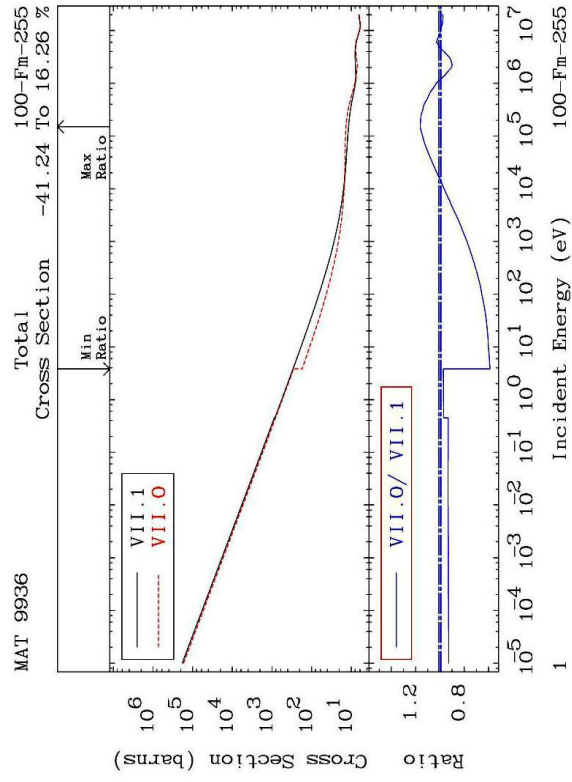
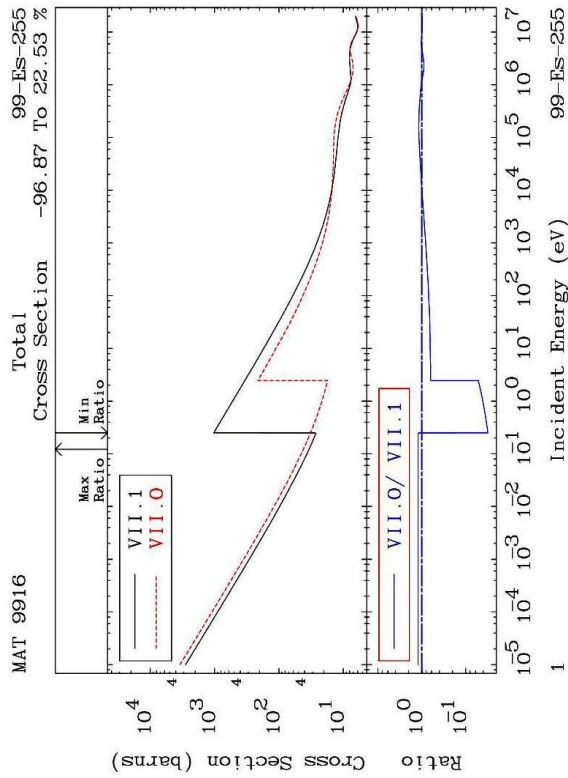
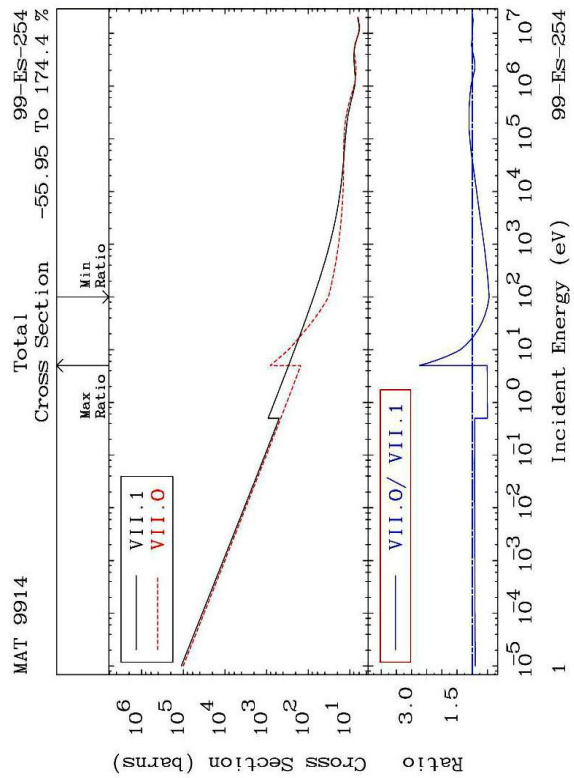
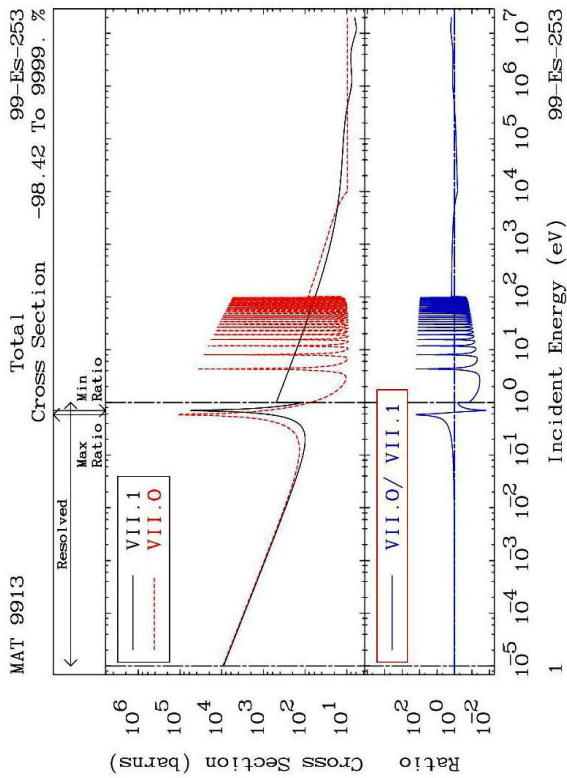














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