# Translating ENDF/B-VIII into GND

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### FUDGE tool rePrint.py translates ENDF-GNDS and back

- Translation code is strict (perhaps even pedantic!) about following ENDF-6 format manual: helps uncover data quality issues
  - Identified and fixed many problems especially during the last hackathon (August 2017). Examples:
    - internal inconsistencies (common problems included inconsistent isomer indices, discrepancies between files 2 and 32),
    - missing or incorrect MAT numbers,
    - incorrect target ZA numbers, etc.
- Re-translating back to ENDF-6 helps check how well GNDS preserves the original evaluation.



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## Translating ENDF-VIII-b5+ (rev 1388) to GNDS

- Sub-libraries currently being translated:
  - Incident n, p, d, t, He3, alpha, gamma and electron data
  - standards
  - photo-atomic
  - atomic relaxation (writing back to ENDF-6 not yet implemented)
  - thermal\_scattering
  - decay (writing back to ENDF-6 not yet implemented)
- Not yet translated
  - Neutron-induced and spontaneous fission yields
    - nfy and sfy translation is simple, but need to finalize how to store them in GNDS



### Status of neutron sub-library:

- 557 / 557 files translated
- 653969 / 15,982,667 lines (about 4%) have at least one difference after translating back to ENDF-6
  - Most differences are trivial, often the result of not running STANEF. Example from Kr79:

	-	-	-		-	-				-	-	-			-
78.2421200	0	0	0	03628	3	2		3.607900+4	7.824212+1	0	0	0	0362	8 3	2
0.0	0	0	1	573628	3	2		0.000000+0	0.000000+0	0	0	1	57362	8 3	2
2	0	0	0	03628	3	2		57	2	0	0	0	0362	83	2
0.0	.025300000	0.0	100.000000	0.0 3628	3	2		1.00000 <mark>0</mark> -5	0.000000+0	2.530000-2	0.000000+0	1.000000+2	0.000000+0362	8 3	2
52.0808100	200.000000	49.3543100	500.000000	35.70030003628	3	2		1.000000+2	5.208081+1	2.000000+2	4.935431+1	5.000000+2	3.570030+1362	83	2
31.6789000	1000.00000	27.9247000	2000.00000	21.94510003628	3	2		7.000000+2	3.167890+1	1.0 <mark>00000+</mark> 3	2.792470+1	2.000000+3	2.194510+1362	8 3	2
16.2542000	7000.00000	14.6939000	10000.0000	13.30650003628	3	2		5.000000+3	1.625420+1	7.000000+3	1.469390+1	1.000000+4	1.330650+1362	8 3	2
11.2684000	50000.0000	9.57599100	70000.0000	9.15929 <mark>00</mark> 03628	3	2		2.000000+4	1.126840+1	5.000000+4	9.575991+0	7.000000+4	9.15929 <mark>0+</mark> 0362	8 3	2
8.79341900	200000.000	7.86655100	300000.000	6.85766 <mark>00</mark> 03628	3	2		1.000000+5	8.793419+0	2.000000+5	7.866551+0	3.000000+5	6.85766 <mark>0+</mark> 0362	8 3	2
6.00801 <mark>000</mark>	500000.000	5.26864 <mark>000</mark>	700000.000	4.22485 <mark>00</mark> 03628	3	2		4.000000+5	6.00801 <mark>0+0</mark>	5.000000+5	5.26864 <mark>0+0</mark>	7.000000+5	4.22485 <mark>0+</mark> 0362	8 3	2
3.63748000	1000000.00	3.20748000	1300000.00	2.63353 <mark>00</mark> 03628	3	2		8.500000+5	3.63748 <mark>0+0</mark>	1.000000+6	3.20748 <mark>0+0</mark>	1.300000+6	2.63353 <mark>0+</mark> 0362	8 3	2
2.37814000	1800000.00	2.08964000	2000000.00	1.93998 <mark>00</mark> 03628	3	2		1.500000+6	2.37814 <mark>0+0</mark>	1.800000+6	2.08964 <mark>0+0</mark>	2.000000+6	1.93998 <mark>0+</mark> 0362	8 3	2
1.80180000	2500000.00	1.70878000	2750000.00	1.64713 <mark>00</mark> 03628	3	2		2.250000+6	1.8018 <mark>00+0</mark>	2.500000+6	1.70878 <mark>0+0</mark>	2.750000+6	1.64713 <mark>0+</mark> 0362	8 3	2
1.60169 <mark>000</mark>	3200000.00	1.59124000	3400000.00	1.5904 <mark>000</mark> 03628	3	2		3.000000+6	1.60169 <mark>0+0</mark>	3.200000+6	1.59124 <mark>0+0</mark>	3.400000+6	1.5904 <mark>00+</mark> 0362	8 3	2
					3	2		3.600000+6	1.59717 <mark>0+0</mark>	3.800000+6	1.60986 <mark>0+0</mark>	4.000000+6	1.62707 <mark>0+</mark> 0362	83	2
1.64761 <mark>000</mark>	4400000.00	1.67050000	4600000.00	1.69496 <mark>00</mark> 03628	3	2		4.200000+6	1.64761 <mark>0+0</mark>	4.400000+6	1.6705 <mark>00+0</mark>	4.600000+6	1.69496 <mark>0+</mark> 0362	8 3	2
1.72033000	5000000.00	1.74608000	5500000.00	1.80955 <mark>00</mark> 03628	3	2		4.800000+6	1.72033 <mark>0+0</mark>	5.000000+6	1.74608 <mark>0+0</mark>	5.500000+6	1.80955 <mark>0+</mark> 0362	8 3	2
1.86824 <mark>000</mark>	7000000.00	1.96137000	8000000.00	2.01587 <mark>00</mark> 03628	3	2		6.000000+6	1.86824 <mark>0+0</mark>	7.000000+6	1.96137 <mark>0+0</mark>	8.000000+6	2.01587 <mark>0+</mark> 0362	8 3	2
		2.01679 <mark>000</mark>	11000000.0	1.97561 <mark>00</mark> 03628	3	2		9.000000+6	2.03251 <mark>0+0</mark>	1.000000+7	2.01679 <mark>0+0</mark>	1.100000+7	1.97561 <mark>0+</mark> 0362	8 3	2
1.91598000	13000000.0	1.84444000	14000000.0	1.76649 <mark>00</mark> 03628	3	2		1.200000+7	1.91598 <mark>0+0</mark>	1.300000+7	1.84444 <mark>0+0</mark>	1.400000+7	1.76649 <mark>0+</mark> 0362	8 3	2
1.68634000	16000000.0	1.60716 <mark>000</mark>	17000000.0	1.53142 <mark>00</mark> 03628	3	2		1.500000+7	1.68634 <mark>0+0</mark>	1.600000+7	1.001100.0		1.53142 <mark>0+</mark> 0362	8 3	2
11101110000	19000000.0	1.39783000	20000000.0	1101201000000	3	2		1.00000011	11101110-0		1.397830+0	2.000000+7	11012010-0002	~ ~	2
0.000000+0	0	0	0	03628	3	0		0.000000+0	0.000000+0	0	0	0	0362	8 3	0
	0.0 2 0.0 52.0808100 31.6789000 16.2542000 8.79341900 6.00801000 3.63748000 2.37814000 1.80180000 1.60169000 1.60169000 1.59717000 1.64761000 1.72033000 1.86824000 2.03251000 1.91598000 1.68634000 1.68634000	0.0     0       2     0       0.0     .025300000       52.0808100     200.00000       31.6789000     1000.00000       16.2542000     7000.00000       11.2684000     50000.0000       8.79341900     200000.000       3.63748000     1000000.00       3.63748000     1000000.00       3.63748000     2500000.00       1.80180000     2500000.00       1.60169000     3200000.00       1.59717000     3800000.00       1.72033000     5000000.00       1.86824000     7000000.00       2.03251000     1000000.0       1.91598000     13000000.0       1.46114000     1900000.0	0.0     0     0     0       2     0     0     0       52.0808100     200.00000     49.3543100     31.6789000     1000.00000     27.9247000       31.6789000     1000.00000     27.9247000     14.6939000     11.2684000     50000.0000     9.57599100       8.79341900     200000.000     7.86655100     6.00801000     500000.000     5.26864000       3.63748000     1000000.00     3.20748000     2.03964000     1.80180000     200900.00     1.70878000       1.80180000     2500000.00     1.59124000     1.59717000     380000.00     1.60986000       1.60169000     3200000.00     1.60986000     1.67050000     1.7468000       1.72033000     500000.00     1.74678000     1.96137000     2.03251000     1000000.00     2.01679000       1.91598000     13000000.00     1.84444000     1.66834000     160716000     1.60716000       1.46114000     1900000.00     1.33783000     1.33783000     1.33783000     1.46114000	0.0     0     0     1       2     0     0     0     0       52.0808100     200.00000     49.3543100     500.00000     31.6789000     1000.00000     27.9247000     2000.00000       31.6789000     7000.00000     27.9247000     2000.00000     1000.0000       11.2684000     50000.0000     3.57599100     70000.0000     8.79341900     200000.000     7.86655100     300000.000       8.79341900     200000.000     5.26864000     700000.000     3.63748000     1300000.00     3.20748000     1300000.00       3.63748000     1000000.00     2.08964000     200000.00     1.8018000     275000.00       3.63748000     1300000.00     1.59124000     340000.00     1.60169000     320000.00     1.59124000     340000.00       1.60169000     320000.00     1.60386000     400000.00     1.72033000     500000.00     1.74608000     500000.00       1.72033000     500000.00     1.74608000     500000.00     1.91598000     1300000.00     1.91598000     13000000.00     1.91598000     1300000.00 <td>0.0     0     1     573628       2     0     0     0     03628       0.0     .02530000     0.0     100.00000     3628       52.0808100     200.00000     49.3543100     500.00000     21.94510003628       31.6789000     1000.00000     27.9247000     2000.00000     21.94510003628       16.2542000     7000.0000     14.6939000     10000.0000     9.15929003628       8.79341900     200000.000     7.86655100     30000.000     6.857660003628       8.79341900     200000.000     5.26864000     70000.0000     4.22495003628       3.63748000     100000.000     3.20748000     1300000.00     4.22495003628       3.63748000     100000.00     3.20748000     130000.00     4.22495003628       3.63748000     100000.00     3.20748000     130000.00     1.647130003628       1.60169000     320000.00     1.70878000     275000.00     1.647130003628       1.60169000     320000.00     1.60986000     400000.00     1.62707003628       1.59717000     380000.00     <t< td=""><td>0.0     0     1     573628     3       2     0     0     0     03628     3       0.0     .02530000     0.0     100.00000     0.0     3628     3       52.0808100     200.00000     49.3543100     500.00000     35.70030003628     3       31.6789000     1000.00000     27.9247000     2000.0000     21.94510003628     3       11.2684000     50000.0000     9.57599100     70000.0000     13.30650003628     3       8.79341900     20000.000     7.86655100     30000.000     6.857660003628     3       3.63748000     100000.00     3.20748000     130000.00     2.633530003628     3       3.63748000     100000.00     2.08964000     20000.00     1.89398003628     3       3.63748000     100000.00     2.08964000     200000.00     1.89398003628     3       3.63748000     100000.00     2.08964000     200000.00     1.89398003628     3       3.6016900     320000.00     1.70878000     275000.00     1.647130003628     3</td><td>0.0     0     1     573628     2       2     0     0     1     573628     3     2       0.0     .02530000     0.0     100.00000     0.0     3628     3     2       52.0808100     200.00000     49.3543100     500.00000     35.7003003628     3     2       31.6789000     1000.00000     27.9247000     2000.00000     21.94510003628     3     2       16.2542000     7000.0000     14.6939000     10000.0000     21.94510003628     3     2       11.2684000     50000.0000     9.57599100     70000.0000     9.15929003628     3     2       8.79341900     20000.000     7.86655100     30000.000     4.22485003628     3     2       3.63748000     100000.00     3.20748000     130000.00     4.2485003628     3     2       3.63748000     100000.00     2.08964000     200000.00     1.89398003628     3     2       3.63748000     100000.00     1.70878000     275000.00     1.64713003628     3     &lt;</td><td>0.0     0     0     1     573628     3     2       2     0     0     0     03628     3     2       0.0     .02530000     0.0     100.00000     0.0     3628     3     2       52.0808100     200.00000     49.3543100     500.00000     35.7003003628     3     2       31.6789000     1000.00000     27.9247000     2000.00000     21.94510003628     3     2       16.2542000     7000.0000     9.57599100     70000.0000     13.30650003628     3     2       11.2684000     50000.0000     9.57599100     70000.0000     6.857660003628     3     2       8.79341900     20000.000     7.8665100     30000.000     4.224850003628     3     2       3.63748000     100000.00     3.20748000     130000.00     1.647130003628     3     2       1.8018000     250000.00     1.70878000     275000.00     1.647130003628     3     2       1.60169000     320000.00     1.60986000     400000.00     1.69946</td><td>0.0     0     1     573628     2     0.0000000       2     0     0     0.3628     3     2     57       0.0     .025300000     0.0     100.00000     35.7003003628     3     2     57       52.0808100     200.00000     49.3543100     500.00000     35.7003003628     3     2     1.000000-5       52.0808100     200.00000     27.9247000     2000.0000     21.94510003628     3     2     1.00000-5       11.2684000     5000.0000     1.33065003628     3     2     5.00000+3       11.2684000     5000.0000     7.8665100     30000.000     9.15929003628     3     2     1.00000+5       6.0801000     50000.000     7.8665100     30000.000     4.2485003628     3     2     1.00000+5       5.0380400     100000.00     3.20748000     130000.00     2.63353003628     3     2     1.50000+5       3.63748000     100000.00     2.08964000     200000.00     1.64713003628     3     2     3.500000</td><td>0.0     0     1     573628     3     2     0.00000000     0.000000000       2     0     0     0     03628     3     2     57     2       0.0     .02530000     0.0     100.00000     0.0     3628     3     2       1.0000000     49.3543100     500.00000     35.70030003628     3     2     1.000000-5     0.000000+0       1.6.2542000     7000.0000     27.9247000     2000.0000     21.9451003628     3     2     7.000000+3     1.62542041       1.2684000     50000.0000     9.57599100     70000.0000     9.15929003628     3     2     7.00000+3     1.62542041       1.2684001     50000.000     5.26864000     70000.000     4.22485003628     3     2     1.00000+5     6.008010+0       3.63748000     1000000.00     2.63353003628     3     2     1.50000+5     6.008010+0       3.618000     250000.00     1.7087800     275000.00     1.64713003628     2     2.50000+6     1.80180+0     2.50000+6     1.80180+0&lt;</td><td>0.0     0     1     573628     2     0.0000000     0.0000000     0       2     0     0     0     03628     3     2     57     2     0       52.0808100     200.00000     49.3543100     500.000000     35.7003003628     3     2     1.000000-5     0.0000000     2.530000-2       51.678900     1000.00000     27.924700     200.00000     35.7003003628     3     2     1.000000-5     0.0000000     2.530000-2       11.2684000     50000.0000     9.35599100     70000.0000     9.15929003628     3     2     5.00000+3     1.625420+1     7.00000+3       1.2684000     50000.000     9.57599100     70000.000     9.15929003628     3     2     1.00000+5     8.793419+0     2.00000+4     1.126840+1     5.00000+5       6.0881000     50000.000     9.57599100     70000.000     4.24850003628     2     4.00000+5     6.08010+0     5.00000+5       6.0881000     2.00000.00     1.6876003628     2     2.50000+6     1.80180+0     2.50000+6 &lt;</td><td>0.0     0     1     573628     3     2     0.00000+0     0.00000+0     0.00000+0     0     0       2     0     0     0.3628     3     2     57     2     0     0     0       52.0808100     200.00000     49.3543100     500.000000     35.7033003628     3     2     1.00000+5     0.00000+0     2.53000-2     0.0000+0     4.3354310       31.6789000     1000.00000     27.9247000     2000.0000     21.9451003628     3     2     7.00000+2     3.167890+1     1.00000+3     2.792470+1       16.2542007     7000.0000     9.57599100     70000.0000     4.2956003628     2     2.00000+4     1.126840+1     5.00000+4     9.575991+0       8.79341900     20000.000     5.26864000     70000.000     4.22485003628     2     1.00000+5     6.00801+0     5.00000+5     5.26864+0       3.63748000     100000.00     2.63353003628     2     2.25000+6     1.801000+6     2.3784+0+0     1.00000+6     2.0896+0+0       3.63748000     100000.00</td><td>0.0     0     1     573628     3     2     0.000000+0     0.00000+0     0     0     1       2     0     0     0     0.02828     3     2     57     2     0     &lt;</td><td>0.0     0     1     573628     3     2     0.00000+0     0.00000+0     0.00000+0     0     1     57362       2     0     0     0     03628     3     2     57     2     0     0     0     0362     0.00000+0     2.50000+0     2.50000+0     1.00000+2     4.935431+1     5.00000+2     3.570300+1362     3.2       31.6789001     1000.0000     27.9247000     2000.00000     3.57593100     2.000000-2     3.1625420+1     7.00000+2     3.1625420+1     7.00000+3     2.782470+1     2.00000+4     1.3305001+362     3.2     2.00000+4     1.126840+1     5.00000+3     2.782470+1     2.00000+4     3.152920+0362     3.2     2.000000+4     1.126840+1     5.00000+3     2.782470+1     2.000000+4     3.152920+0362     3.2     2.000000+4     3.1625420+1     7.000000+4     3.575931+0     7.00000+4     3.575931+0     7.00000+4     3.575931+0     7.00000+4     3.575931+0     7.00000+4     3.575931+0     7.00000+4     3.575931+0     7.00000+4     3.575931+0     7.00000+4     3.575931+0</td><td>0.0     0     1     573628     3     2     0.000000+0     0.00000+0     0     1     573628     3       2     0     0     0.3628     3     2     0     0     0.00000+0     0.00000+0     0.00000+0     0.0000+0     0</td></t<></td>	0.0     0     1     573628       2     0     0     0     03628       0.0     .02530000     0.0     100.00000     3628       52.0808100     200.00000     49.3543100     500.00000     21.94510003628       31.6789000     1000.00000     27.9247000     2000.00000     21.94510003628       16.2542000     7000.0000     14.6939000     10000.0000     9.15929003628       8.79341900     200000.000     7.86655100     30000.000     6.857660003628       8.79341900     200000.000     5.26864000     70000.0000     4.22495003628       3.63748000     100000.000     3.20748000     1300000.00     4.22495003628       3.63748000     100000.00     3.20748000     130000.00     4.22495003628       3.63748000     100000.00     3.20748000     130000.00     1.647130003628       1.60169000     320000.00     1.70878000     275000.00     1.647130003628       1.60169000     320000.00     1.60986000     400000.00     1.62707003628       1.59717000     380000.00 <t< td=""><td>0.0     0     1     573628     3       2     0     0     0     03628     3       0.0     .02530000     0.0     100.00000     0.0     3628     3       52.0808100     200.00000     49.3543100     500.00000     35.70030003628     3       31.6789000     1000.00000     27.9247000     2000.0000     21.94510003628     3       11.2684000     50000.0000     9.57599100     70000.0000     13.30650003628     3       8.79341900     20000.000     7.86655100     30000.000     6.857660003628     3       3.63748000     100000.00     3.20748000     130000.00     2.633530003628     3       3.63748000     100000.00     2.08964000     20000.00     1.89398003628     3       3.63748000     100000.00     2.08964000     200000.00     1.89398003628     3       3.63748000     100000.00     2.08964000     200000.00     1.89398003628     3       3.6016900     320000.00     1.70878000     275000.00     1.647130003628     3</td><td>0.0     0     1     573628     2       2     0     0     1     573628     3     2       0.0     .02530000     0.0     100.00000     0.0     3628     3     2       52.0808100     200.00000     49.3543100     500.00000     35.7003003628     3     2       31.6789000     1000.00000     27.9247000     2000.00000     21.94510003628     3     2       16.2542000     7000.0000     14.6939000     10000.0000     21.94510003628     3     2       11.2684000     50000.0000     9.57599100     70000.0000     9.15929003628     3     2       8.79341900     20000.000     7.86655100     30000.000     4.22485003628     3     2       3.63748000     100000.00     3.20748000     130000.00     4.2485003628     3     2       3.63748000     100000.00     2.08964000     200000.00     1.89398003628     3     2       3.63748000     100000.00     1.70878000     275000.00     1.64713003628     3     &lt;</td><td>0.0     0     0     1     573628     3     2       2     0     0     0     03628     3     2       0.0     .02530000     0.0     100.00000     0.0     3628     3     2       52.0808100     200.00000     49.3543100     500.00000     35.7003003628     3     2       31.6789000     1000.00000     27.9247000     2000.00000     21.94510003628     3     2       16.2542000     7000.0000     9.57599100     70000.0000     13.30650003628     3     2       11.2684000     50000.0000     9.57599100     70000.0000     6.857660003628     3     2       8.79341900     20000.000     7.8665100     30000.000     4.224850003628     3     2       3.63748000     100000.00     3.20748000     130000.00     1.647130003628     3     2       1.8018000     250000.00     1.70878000     275000.00     1.647130003628     3     2       1.60169000     320000.00     1.60986000     400000.00     1.69946</td><td>0.0     0     1     573628     2     0.0000000       2     0     0     0.3628     3     2     57       0.0     .025300000     0.0     100.00000     35.7003003628     3     2     57       52.0808100     200.00000     49.3543100     500.00000     35.7003003628     3     2     1.000000-5       52.0808100     200.00000     27.9247000     2000.0000     21.94510003628     3     2     1.00000-5       11.2684000     5000.0000     1.33065003628     3     2     5.00000+3       11.2684000     5000.0000     7.8665100     30000.000     9.15929003628     3     2     1.00000+5       6.0801000     50000.000     7.8665100     30000.000     4.2485003628     3     2     1.00000+5       5.0380400     100000.00     3.20748000     130000.00     2.63353003628     3     2     1.50000+5       3.63748000     100000.00     2.08964000     200000.00     1.64713003628     3     2     3.500000</td><td>0.0     0     1     573628     3     2     0.00000000     0.000000000       2     0     0     0     03628     3     2     57     2       0.0     .02530000     0.0     100.00000     0.0     3628     3     2       1.0000000     49.3543100     500.00000     35.70030003628     3     2     1.000000-5     0.000000+0       1.6.2542000     7000.0000     27.9247000     2000.0000     21.9451003628     3     2     7.000000+3     1.62542041       1.2684000     50000.0000     9.57599100     70000.0000     9.15929003628     3     2     7.00000+3     1.62542041       1.2684001     50000.000     5.26864000     70000.000     4.22485003628     3     2     1.00000+5     6.008010+0       3.63748000     1000000.00     2.63353003628     3     2     1.50000+5     6.008010+0       3.618000     250000.00     1.7087800     275000.00     1.64713003628     2     2.50000+6     1.80180+0     2.50000+6     1.80180+0&lt;</td><td>0.0     0     1     573628     2     0.0000000     0.0000000     0       2     0     0     0     03628     3     2     57     2     0       52.0808100     200.00000     49.3543100     500.000000     35.7003003628     3     2     1.000000-5     0.0000000     2.530000-2       51.678900     1000.00000     27.924700     200.00000     35.7003003628     3     2     1.000000-5     0.0000000     2.530000-2       11.2684000     50000.0000     9.35599100     70000.0000     9.15929003628     3     2     5.00000+3     1.625420+1     7.00000+3       1.2684000     50000.000     9.57599100     70000.000     9.15929003628     3     2     1.00000+5     8.793419+0     2.00000+4     1.126840+1     5.00000+5       6.0881000     50000.000     9.57599100     70000.000     4.24850003628     2     4.00000+5     6.08010+0     5.00000+5       6.0881000     2.00000.00     1.6876003628     2     2.50000+6     1.80180+0     2.50000+6 &lt;</td><td>0.0     0     1     573628     3     2     0.00000+0     0.00000+0     0.00000+0     0     0       2     0     0     0.3628     3     2     57     2     0     0     0       52.0808100     200.00000     49.3543100     500.000000     35.7033003628     3     2     1.00000+5     0.00000+0     2.53000-2     0.0000+0     4.3354310       31.6789000     1000.00000     27.9247000     2000.0000     21.9451003628     3     2     7.00000+2     3.167890+1     1.00000+3     2.792470+1       16.2542007     7000.0000     9.57599100     70000.0000     4.2956003628     2     2.00000+4     1.126840+1     5.00000+4     9.575991+0       8.79341900     20000.000     5.26864000     70000.000     4.22485003628     2     1.00000+5     6.00801+0     5.00000+5     5.26864+0       3.63748000     100000.00     2.63353003628     2     2.25000+6     1.801000+6     2.3784+0+0     1.00000+6     2.0896+0+0       3.63748000     100000.00</td><td>0.0     0     1     573628     3     2     0.000000+0     0.00000+0     0     0     1       2     0     0     0     0.02828     3     2     57     2     0     &lt;</td><td>0.0     0     1     573628     3     2     0.00000+0     0.00000+0     0.00000+0     0     1     57362       2     0     0     0     03628     3     2     57     2     0     0     0     0362     0.00000+0     2.50000+0     2.50000+0     1.00000+2     4.935431+1     5.00000+2     3.570300+1362     3.2       31.6789001     1000.0000     27.9247000     2000.00000     3.57593100     2.000000-2     3.1625420+1     7.00000+2     3.1625420+1     7.00000+3     2.782470+1     2.00000+4     1.3305001+362     3.2     2.00000+4     1.126840+1     5.00000+3     2.782470+1     2.00000+4     3.152920+0362     3.2     2.000000+4     1.126840+1     5.00000+3     2.782470+1     2.000000+4     3.152920+0362     3.2     2.000000+4     3.1625420+1     7.000000+4     3.575931+0     7.00000+4     3.575931+0     7.00000+4     3.575931+0     7.00000+4     3.575931+0     7.00000+4     3.575931+0     7.00000+4     3.575931+0     7.00000+4     3.575931+0     7.00000+4     3.575931+0</td><td>0.0     0     1     573628     3     2     0.000000+0     0.00000+0     0     1     573628     3       2     0     0     0.3628     3     2     0     0     0.00000+0     0.00000+0     0.00000+0     0.0000+0     0</td></t<>	0.0     0     1     573628     3       2     0     0     0     03628     3       0.0     .02530000     0.0     100.00000     0.0     3628     3       52.0808100     200.00000     49.3543100     500.00000     35.70030003628     3       31.6789000     1000.00000     27.9247000     2000.0000     21.94510003628     3       11.2684000     50000.0000     9.57599100     70000.0000     13.30650003628     3       8.79341900     20000.000     7.86655100     30000.000     6.857660003628     3       3.63748000     100000.00     3.20748000     130000.00     2.633530003628     3       3.63748000     100000.00     2.08964000     20000.00     1.89398003628     3       3.63748000     100000.00     2.08964000     200000.00     1.89398003628     3       3.63748000     100000.00     2.08964000     200000.00     1.89398003628     3       3.6016900     320000.00     1.70878000     275000.00     1.647130003628     3	0.0     0     1     573628     2       2     0     0     1     573628     3     2       0.0     .02530000     0.0     100.00000     0.0     3628     3     2       52.0808100     200.00000     49.3543100     500.00000     35.7003003628     3     2       31.6789000     1000.00000     27.9247000     2000.00000     21.94510003628     3     2       16.2542000     7000.0000     14.6939000     10000.0000     21.94510003628     3     2       11.2684000     50000.0000     9.57599100     70000.0000     9.15929003628     3     2       8.79341900     20000.000     7.86655100     30000.000     4.22485003628     3     2       3.63748000     100000.00     3.20748000     130000.00     4.2485003628     3     2       3.63748000     100000.00     2.08964000     200000.00     1.89398003628     3     2       3.63748000     100000.00     1.70878000     275000.00     1.64713003628     3     <	0.0     0     0     1     573628     3     2       2     0     0     0     03628     3     2       0.0     .02530000     0.0     100.00000     0.0     3628     3     2       52.0808100     200.00000     49.3543100     500.00000     35.7003003628     3     2       31.6789000     1000.00000     27.9247000     2000.00000     21.94510003628     3     2       16.2542000     7000.0000     9.57599100     70000.0000     13.30650003628     3     2       11.2684000     50000.0000     9.57599100     70000.0000     6.857660003628     3     2       8.79341900     20000.000     7.8665100     30000.000     4.224850003628     3     2       3.63748000     100000.00     3.20748000     130000.00     1.647130003628     3     2       1.8018000     250000.00     1.70878000     275000.00     1.647130003628     3     2       1.60169000     320000.00     1.60986000     400000.00     1.69946	0.0     0     1     573628     2     0.0000000       2     0     0     0.3628     3     2     57       0.0     .025300000     0.0     100.00000     35.7003003628     3     2     57       52.0808100     200.00000     49.3543100     500.00000     35.7003003628     3     2     1.000000-5       52.0808100     200.00000     27.9247000     2000.0000     21.94510003628     3     2     1.00000-5       11.2684000     5000.0000     1.33065003628     3     2     5.00000+3       11.2684000     5000.0000     7.8665100     30000.000     9.15929003628     3     2     1.00000+5       6.0801000     50000.000     7.8665100     30000.000     4.2485003628     3     2     1.00000+5       5.0380400     100000.00     3.20748000     130000.00     2.63353003628     3     2     1.50000+5       3.63748000     100000.00     2.08964000     200000.00     1.64713003628     3     2     3.500000	0.0     0     1     573628     3     2     0.00000000     0.000000000       2     0     0     0     03628     3     2     57     2       0.0     .02530000     0.0     100.00000     0.0     3628     3     2       1.0000000     49.3543100     500.00000     35.70030003628     3     2     1.000000-5     0.000000+0       1.6.2542000     7000.0000     27.9247000     2000.0000     21.9451003628     3     2     7.000000+3     1.62542041       1.2684000     50000.0000     9.57599100     70000.0000     9.15929003628     3     2     7.00000+3     1.62542041       1.2684001     50000.000     5.26864000     70000.000     4.22485003628     3     2     1.00000+5     6.008010+0       3.63748000     1000000.00     2.63353003628     3     2     1.50000+5     6.008010+0       3.618000     250000.00     1.7087800     275000.00     1.64713003628     2     2.50000+6     1.80180+0     2.50000+6     1.80180+0<	0.0     0     1     573628     2     0.0000000     0.0000000     0       2     0     0     0     03628     3     2     57     2     0       52.0808100     200.00000     49.3543100     500.000000     35.7003003628     3     2     1.000000-5     0.0000000     2.530000-2       51.678900     1000.00000     27.924700     200.00000     35.7003003628     3     2     1.000000-5     0.0000000     2.530000-2       11.2684000     50000.0000     9.35599100     70000.0000     9.15929003628     3     2     5.00000+3     1.625420+1     7.00000+3       1.2684000     50000.000     9.57599100     70000.000     9.15929003628     3     2     1.00000+5     8.793419+0     2.00000+4     1.126840+1     5.00000+5       6.0881000     50000.000     9.57599100     70000.000     4.24850003628     2     4.00000+5     6.08010+0     5.00000+5       6.0881000     2.00000.00     1.6876003628     2     2.50000+6     1.80180+0     2.50000+6 <	0.0     0     1     573628     3     2     0.00000+0     0.00000+0     0.00000+0     0     0       2     0     0     0.3628     3     2     57     2     0     0     0       52.0808100     200.00000     49.3543100     500.000000     35.7033003628     3     2     1.00000+5     0.00000+0     2.53000-2     0.0000+0     4.3354310       31.6789000     1000.00000     27.9247000     2000.0000     21.9451003628     3     2     7.00000+2     3.167890+1     1.00000+3     2.792470+1       16.2542007     7000.0000     9.57599100     70000.0000     4.2956003628     2     2.00000+4     1.126840+1     5.00000+4     9.575991+0       8.79341900     20000.000     5.26864000     70000.000     4.22485003628     2     1.00000+5     6.00801+0     5.00000+5     5.26864+0       3.63748000     100000.00     2.63353003628     2     2.25000+6     1.801000+6     2.3784+0+0     1.00000+6     2.0896+0+0       3.63748000     100000.00	0.0     0     1     573628     3     2     0.000000+0     0.00000+0     0     0     1       2     0     0     0     0.02828     3     2     57     2     0     <	0.0     0     1     573628     3     2     0.00000+0     0.00000+0     0.00000+0     0     1     57362       2     0     0     0     03628     3     2     57     2     0     0     0     0362     0.00000+0     2.50000+0     2.50000+0     1.00000+2     4.935431+1     5.00000+2     3.570300+1362     3.2       31.6789001     1000.0000     27.9247000     2000.00000     3.57593100     2.000000-2     3.1625420+1     7.00000+2     3.1625420+1     7.00000+3     2.782470+1     2.00000+4     1.3305001+362     3.2     2.00000+4     1.126840+1     5.00000+3     2.782470+1     2.00000+4     3.152920+0362     3.2     2.000000+4     1.126840+1     5.00000+3     2.782470+1     2.000000+4     3.152920+0362     3.2     2.000000+4     3.1625420+1     7.000000+4     3.575931+0     7.00000+4     3.575931+0     7.00000+4     3.575931+0     7.00000+4     3.575931+0     7.00000+4     3.575931+0     7.00000+4     3.575931+0     7.00000+4     3.575931+0     7.00000+4     3.575931+0	0.0     0     1     573628     3     2     0.000000+0     0.00000+0     0     1     573628     3       2     0     0     0.3628     3     2     0     0     0.00000+0     0.00000+0     0.00000+0     0.0000+0     0

 Another common cause for differences: duplicate points are dropped by FUDGE during translation, can cause many lines to differ



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#### Other common reasons for differences after rePrint.py

- When duplicate (x,y) points appear in TAB1, the translator drops the second point where possible. Can result in many diffs that are not important!
- ENDF stores mass (AWR) many times, GND picks the most frequently-used value and only stores that.
- Small (few eV) domain mismatch between cross section and multiplicity/distribution
  - Re-written file uses MF3 domain everywhere
  - Larger mismatch is treated as an error
- INTG records (compact correlation matrix in MF32) are inconsistent: some files store 0 correlations explicitly, other files use blank spaces instead



### Status of neutron sub-library (continued):

- Important differences between original and re-translated files include:
  - MOD1 numbers in the MF1 MT451 directory: currently not preserved during translation
  - Sub-actinide fission cross sections (MF10 / MT18).
    - Planned resolution: store these in the 'incompleteReactions' section, need to update FUDGE to handle that
  - Some rarely-used covariance formats (LB=8 and LB=9) are currently skipped during translation.
    - Planned resolution: make special interpolation rules. When grouping, size of covariance must vary either inversely (LB=8) or directly (LB=9) with size of the group
  - P(nu) (MF6 / MT18)
    - Two options for handling this:
      - store P(nu) as a pdf similar to P(E' | E), or
      - break fission into multiple reactions, one for each prompt neutron multiplicity.



#### Status of photo-nuclear sub-library:

- 163 / 163 files translated
  - 46458 / 2,830,869 lines differ (1.6%)
- Most differences appear to be duplicate points removed by FUDGE. Example from Pu241:

9.424100+4	2.389860+2	0	0	1	09443	5 16	9.424100+4	2.389860+2	0	0	1		09443 5	5 16
0.000000+0	0.000000+0	0	1	1	29443	5 16	0.000000+0	0.000000+0	0	1	1		29443 5	5 16
2	2	0	0	0	09443	5 16	 2	2	0	0	0		09443 5	5 16
1.177400+7 1.000000+0 2.000000+7 1.000000+0					9443	5 16	 1.177400+7	1.000000+0	2.000000+7	1.000000+0			9443 5	5 16
0.000000+0	0.000000+0	0	0	1	99443	5 16	 0.000000+0	0.000000+0	0	0	1		99443 5	5 16
9	2	0	0	0	09443	5 16	 9	2	0	0	0		09443 5	5 16
0.000000+0	1.177400+7	0	0	1	39443	5 16	 0.000000+0	1.177400+7	0	0	1		39443 5	5 16
3	2	0	0	0	09443	5 16	3	2	0	0	0		09443 5	5 16
0.000000+0	0.000000+0	2.000000-5	5.000000+4	4.000000-5	0.000000+09443	5 16	0.000000+0	0.000000+0	2.000000-5	5.000000+4	4.000000-5	0.000000+	09443 5	5 16
0.000000+0	1.200000+7	0	0	1	929443	5 16	0.000000+0	1.200000+7	0	0	1	9	9 <mark>1</mark> 9443 5	5 16
92	2	0	0	0	09443	5 16	91	2	0	0	0		09443 5	5 16
1.000000-5	0.000000+0	1.000000-5	0.000000+0	2.832120+2	1.478777-89443	5 16	1.000000-5	0.000000+0	2.832120+2	1.478777-8	5.664241+2	2.955908-	89443 5	5 16
5.664241+2	2.955908-8	8.496361+2	4.431394-8	1.132848+3	5.905 <mark>238</mark> -89443	5 16	8.496361+2	4.431394-8	1.132848+3	5.905238-8	1.699272+3	8.848001-	89443 5	5 16
1.699272+3	8.848001-8	2.265696+3	1.178421-7	3.398544+3	1.763701-79443	5 16	2.265696+3	1.178421-7	3.398544+3	1.763701-7	4.531393+3	2.346373-	79443 5	5 16
4.531393+3	2.346373-7	5.664241+3	2.926446-7	6.797089+3	3.503 <mark>929</mark> -79443	5 16	5.664241+3	2.926446-7	6.797089+3	3.503929-7	7.929937+3	4.078831-	79443 5	5 16
7.929937+3	4.078831-7	9.062785+3	4.651162-7	1.132848+4	5.788143-79443	5 16	9.062785+3	4.651162-7	1.132848+4	5.788143-7	1.359418+4	6.914945-	79443 5	5 16
1.359418+4	6.914945-7	1.585987+4	8.031639-7	1.812557+4	9.138295-79443	5 16	1.585987+4	8.031639-7	1.812557+4	9.138295-7	2.039127+4	1.023498-	<mark>6</mark> 9443 5	5 16
2. <mark>039127+4</mark>	1.023498-6	2.265696+4	1.132178-6	2.492266+4	1.2398 <mark>74-</mark> 69443	5 16	2.265696+4	1.132178-6	2.492266+4	1.2398 <mark>74-6</mark>	2.718836+4	1.346594-	69443 5	5 16



LINI-PRES-XXXXXX

### Status of charged-particle sub-libraries:

- Incident protons: 49 / 49 files translated
  - 637 / 677839 lines differ (0.1%)
- Incident deuterons: 5 / 5
  - 50 / 5164 lines differ (1%)
- Incident tritons: 5 / 5 V
  - 38 / 9179 lines differ (0.4%)
- Incident helions: 3 / 3
  - 12 / 10161 lines differ (0.1%)
- Incident alphas: 1 / 1
  - 0 / 101 lines differ (0%)



### Status of other sub-libraries:

- Incident electrons: 100 / 100 files translated
  - ~272,000 / 303,923 lines differ (90%)
    - Nearly all differences due to not running STANEF
- Photo-atomic: 100 / 100 files translated
  - ~210,000 / 286,928 lines differ (90%)
    - STANEF not run
- Standards: 8 / 8 🗹
  - 52 / 11,053 lines differ (0.5%)
- Thermal scattering: 35 / 35
  - 264 / 3,279,002 lines differ (0.0008%)
- Atomic relaxation: 100 / 100
  - Translation back to ENDF-6 not yet supported
- Decay: 3821 / 3821
  - Translation back to ENDF-6 not yet supported



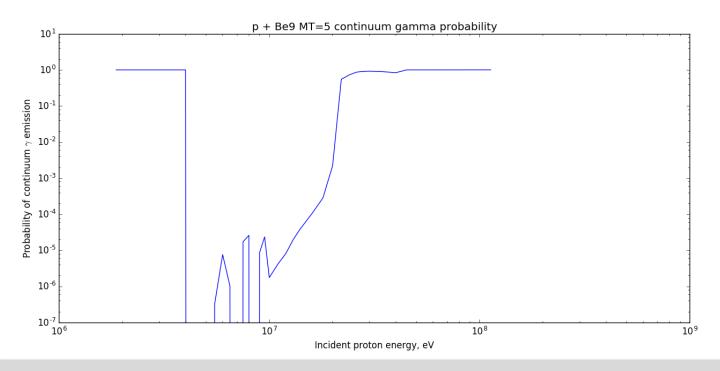
#### Some files still have problem data

- The translator complains about some data issues, but can "recover" from them with the proper flag
- Missing evaluation date in MT451
  - GND requires evaluation date. n + Pu239 fails without '--skipBadDate'
- Unnormalizable continuum gammas in MF6
  - GND stores gammas like MF12,15 does, thus MF6 gamma data must be converted to MF12,15 like data
  - At some incident energies, the continuum gamma spectrum integrates to 0 and cannot be normalized as needed for MF12 like data.
  - Translator crashes unless option --continuumSpectraFix is set
  - Affected isotopes:
    - n + Cl35, Ca42-46, As73, Pb204-207
    - p + Be9
- Still many problems with energy balance!



## More detail on continuum gamma problem

- In MF6, continuum, primary and discrete gammas are all listed together for each incident energy, along with total multiplicity for all gammas
  - Each primary & discrete has a probability, continuum has a spectrum
  - Some continuum spectra are all 0s
    - probability distribution at these incident energies cannot be normalized
  - Probability can go from non-zero to zero and back multiple times:



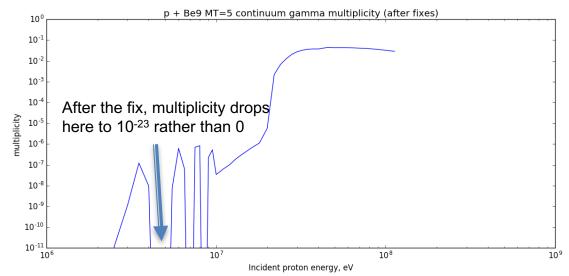


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## Patching continuum gamma problems

 When option --continuumSpectraFix is supplied, the translator replaces 0-norm continuum spectra with a delta function, weighted by total gamma multiplicity



 This is just a temporary work-around. Gamma spectra need more attention!



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