# Summary of BNL activities for ENDF/B-VIII.1 FYSL

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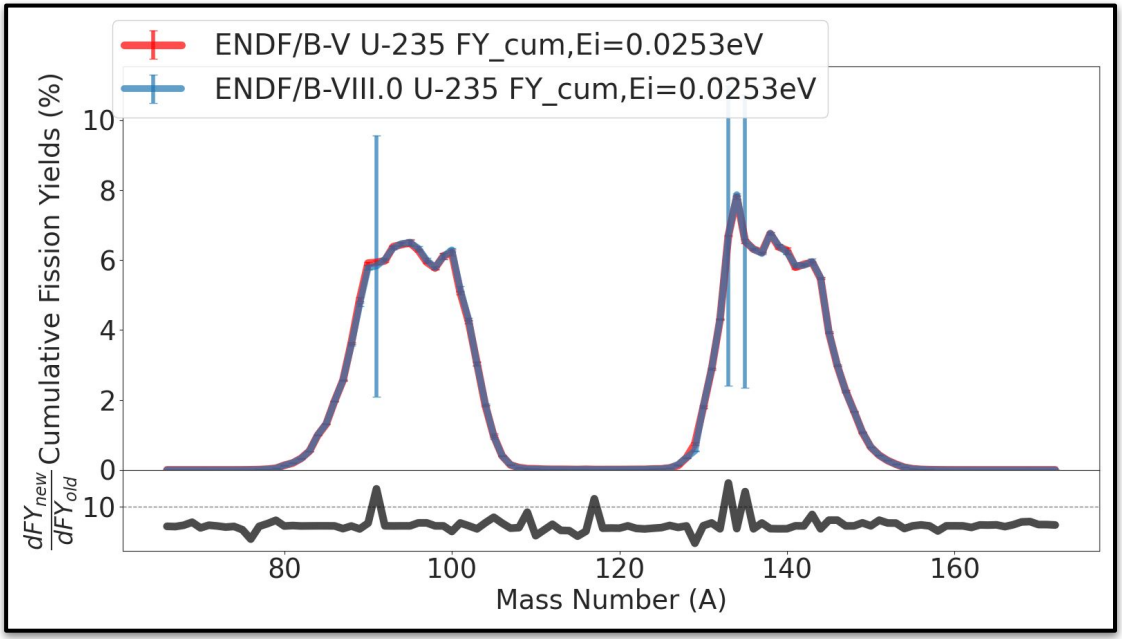
Not Export Controlled

# Previous work -- uncertainty corrections




After ENDF/B-VI.8 anomalously large uncertainties were introduced for some end-of-chain CYs
(up to 180 times the value in the older version of the library)

End-of-chain (**nearly stable**) CYs are generally **experimentally well determined** and their uncertainty is comparable or better than the shorter-lived nuclides in the chain

Correction applied to all NFY and SFY files, at all energies. Changes have been reviewed and included in ENDF/B-VIII.1-beta1
BNL-220804-2021-INRE

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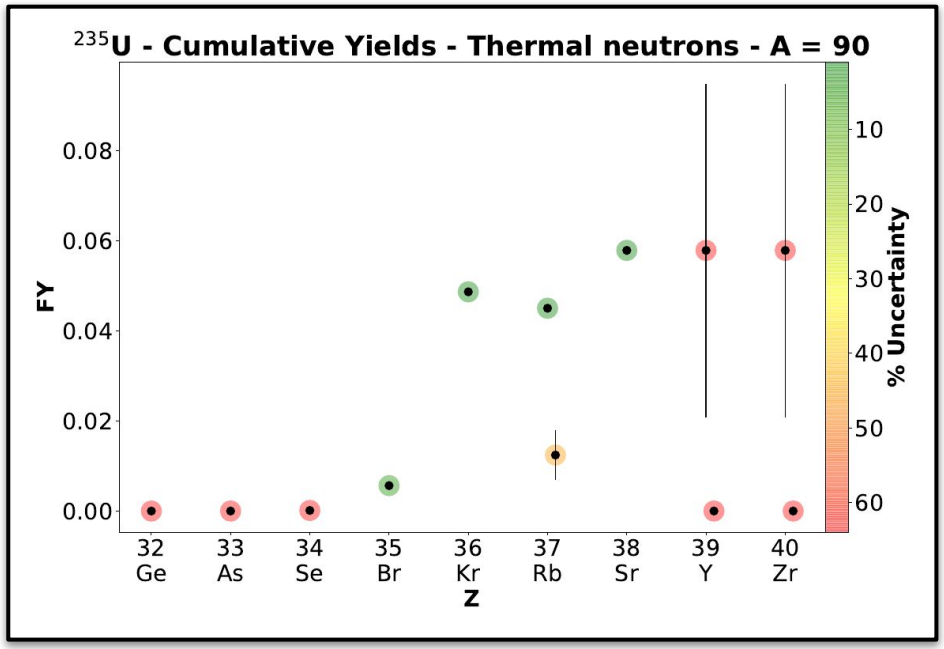
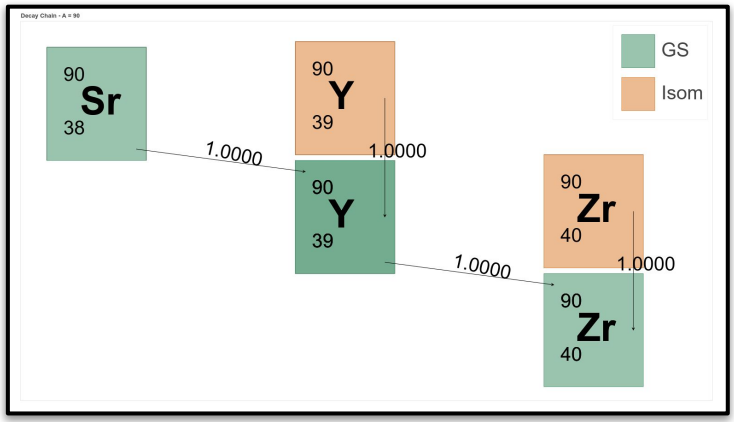
# Correction of CYs

We identified 8 mass chains where the uncertainty was anomalously large, and re-calculated it for 15 fission products

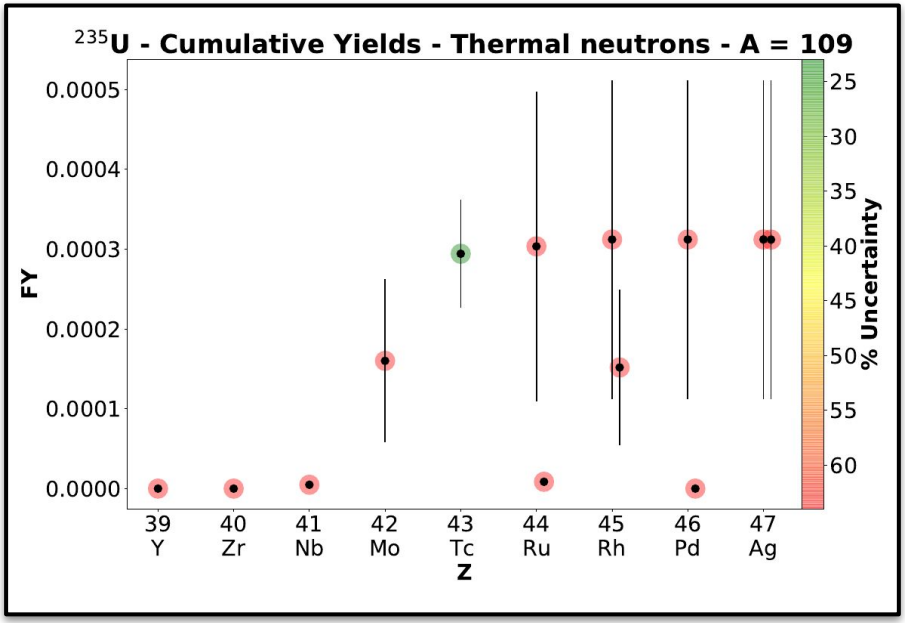


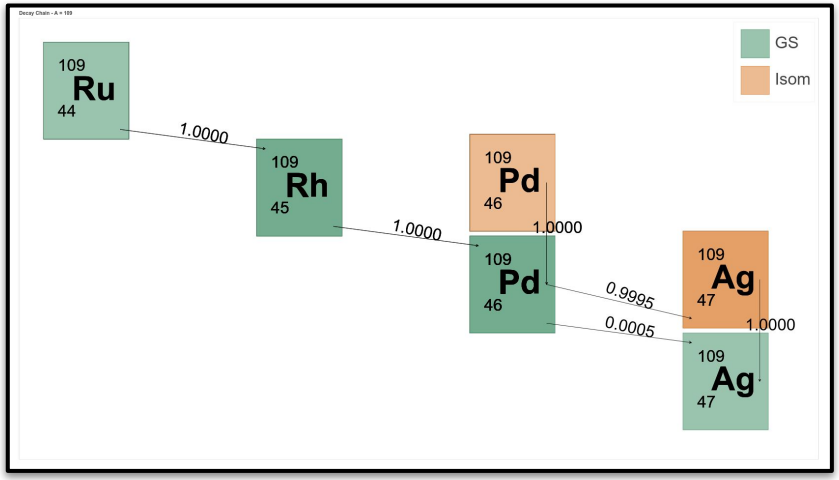




The dCY in ENDF/B-VIII.0 reflects the uncertainty on the IYR (50%), but the dCYs of $^{90}Y_{GS}$ and $^{90}Zr_{GS}$ do not depend on their isomeric yield ratios (the IS decay by IT to the GS), and the largest contribution is from decay of precursors

# Correction of CYs and IYs

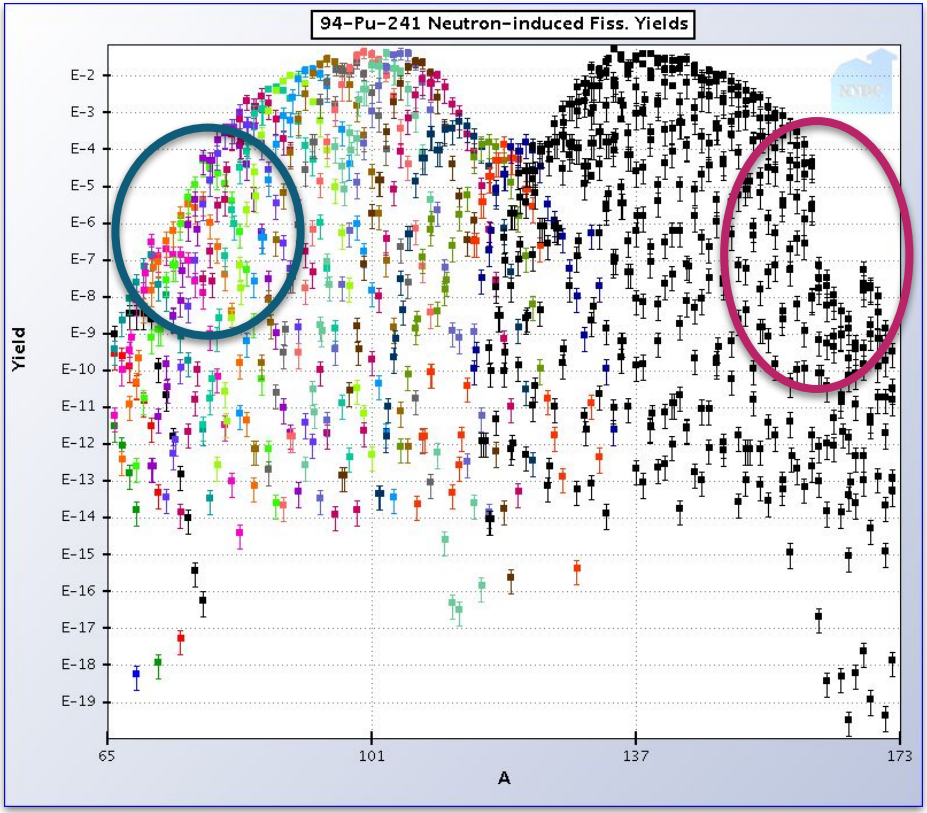
In A = 109, we also removed isomers for $^{109}$Ru and $^{109}$Rh, that were added in ENDF/B-VI.0, but not confirmed in measurements since




The IY of $^{109m}$Ru and $^{109m}$Rh was reassigned to the GS, and the uncertainties of the nuclides along the decay chain were re-calculated accordingly.

# Correction of $^{241}$Pu thermal NFY

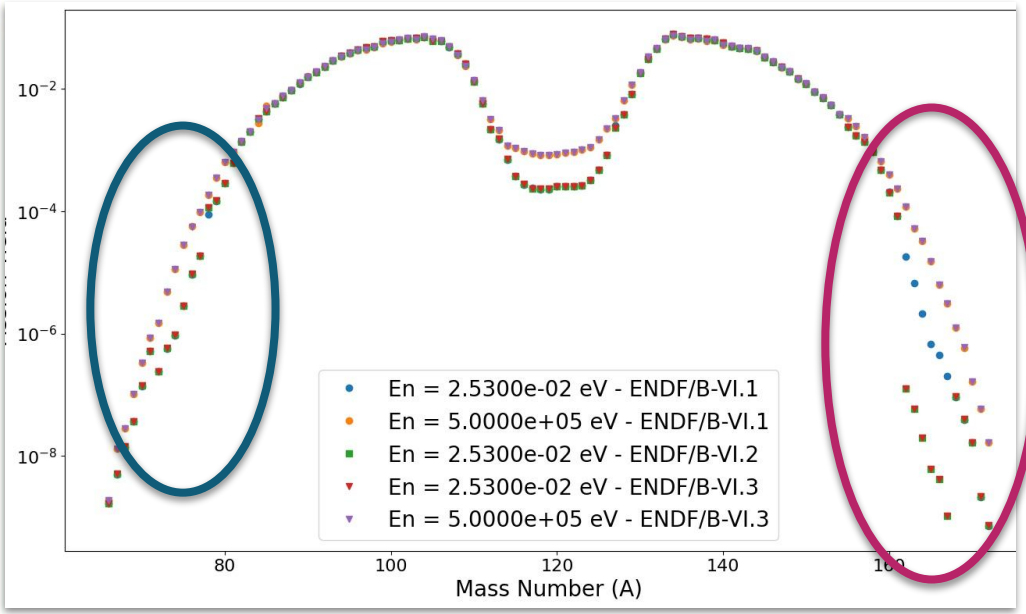



An issue was logged in 2019 on the NNDC git concerning the FYs of $^{241}$Pu having a **'hole' in the heavy-mass peak**.

This appears for all FPs between A = 162-168. On closer analysis, also masses **A = 66-71 show scaling issues**.

This issue only appears for the first energy point ($E_n$ = 0.0253 eV), and it affects both 8454 (IFY) and 8459 (CFY).

# Origin of the issue




The NFY sublibrary is based on the work of England & Rider, summarized in the report ENDF-349 (LA-UR-94-3106), first included in ENDF/B-VI.

In a first release of the library (VI.1) the thermal FYs of $^{241}$Pu did not include this issue (tape 125-126).

In a subsequent revision (ENDF/B-VI.2), the fast NFY of $^{241}$Pu were mistakenly not included, and the thermal yields showed the issue for the first time.

The fast NFY of $^{241}$Pu were finally included in the following revision (ENDF/B-VI.3) with the inclusion of a new *tape* containing $^{241}$Pu FY, but the issue with the heavy peak yields remained.

# Origin of the issue (ctd.)

No experimental yields exist for any of the masses in question, so that the chain yields, as well as the Y(Z|A) are based on calculations from the $Z_p$ model by Wahl.

In the appendix to the ENDF-349 report, England & Rider annotate that the information on the mass yields of A = 162-168 is based on ref. 87RID1 (1987RIZT).

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 162 | pu241t | es | cu | 0.0000127 | 30.0 | 0.0000123 | 0.0000000 | 87rid1 |
| 163 | pu241t | es | cu | 0.0000059 | 30.0 | 0.0000057 | 0.0000000 | 87rid1 |
| 164 | pu241t | es | cu | 0.0000020 | 30.0 | 0.0000019 | 0.0000000 | 87rid1 |
| 165 | pu241t | es | cu | 0.0000006 | 30.0 | 0.0000006 | 0.0000000 | 87rid1 |
| 166 | pu241t | es | cu | 0.0000004 | 30.0 | 0.0000004 | 0.0000000 | 87rid1 |
| 167 | pu241t | es | cu | 0.0000001 | 30.0 | 0.0000001 | 0.0000000 | 87rid1 |
| 168 | pu241t | es | cu | 0.0000095 | 30.0 | 0.0000918 | 0.0000000 | 87rid1 |
| 169 | pu241t | es | cu | 0.0000040 | 30.0 | 0.0000388 | 0.0000000 | 87rid1 |
| 170 | pu241t | es | cu | 0.0000016 | 20.0 | 0.0000016 | 20.0000000% | 74mee1 |
| 171 | pu241t | es | cu | 0.0000002 | 30.0 | 0.0000212 | 0.0000000 | 87rid1 |
| 172 | pu241t | es | cu | 0.0000001 | 30.0 | 0.0000706 | 0.0000000 | 87rid1 |

# Origin of the issue (ctd.)

The issue in the mass yields of A=162-168 may be tracked down to a typo in the transfer of information from Table VIII(b) (p.30 in **1987RIZT**) to the yields that were used as the starting point of the evaluation (and that were documented in the appendix to the ENDF-349 report).

Table VIII(B) CURRENT CHAIN YIELDS[a]

| MASS | U235T | U235F | U235HE | U238F | U238HE | PU239T | PU239F | PU241T | U233T | TH232F |
|---|---|---|---|---|---|---|---|---|---|---|
| 119 | 0.011936J | 0.033272J | 1.098942K | 0.037512K | 0.735983K | 0.036993J | 0.059918K | 0.023518N | 0.019415L | 0.057295L |
| 120 | 0.012711K | 0.034239J | 1.107407J | 0.036557K | 0.790881K | 0.033450K | 0.056470K | 0.025113M | 0.022980L | 0.054409L |
| 121 | 0.012951I | 0.035861J | 1.047567H | 0.038498K | 0.823687H | 0.038078J | 0.064087K | 0.013253K | 0.023319J | 0.048788I |
| 122 | 0.015089J | 0.038463K | 1.161814K | 0.038753K | 0.856664K | 0.052494J | 0.077046K | 0.025155N | 0.043396L | 0.036571L |
| 123 | 0.015737H | 0.042703K | 1.209025K | 0.041407L | 0.937468K | 0.044758L | 0.078294K | 0.026600M | 0.058537M | 0.029374L |
| 124 | 0.026366J | 0.060299K | 1.306310K | 0.043856K | 1.052831K | 0.093124L | 0.124257K | 0.031201N | 0.074152M | 0.026511L |
| 125 | 0.032769G | 0.056665J | 1.591546J | 0.045978J | 1.204832I | 0.115873J | 0.137898J | 0.047845J | 0.117942J | 0.034466K |
| 126 | 0.057414J | 0.098555J | 1.830374H | 0.052856J | 1.367261L | 0.249848I | 0.294800I | 0.080479L | 0.250837K | 0.048181L |
| 127 | 0.125400J | 0.205732H | 2.118146H | 0.133794H | 1.505019I | 0.568015I | 0.517385J | 0.249063J | 0.550650K | 0.080885I |
| 128 | 0.346837G | 0.428189K | 2.468037K | 0.457488I | 1.682820J | 0.728105K | 0.884268I | 0.371737M | 0.835150J | 0.182905L |
| 129 | 0.742869I | 0.912920I | 3.545362J | 0.933766H | 2.067407J | 1.384063H | 1.504301I | 0.803581M | 1.569262L | 0.310660H |
| 130 | 1.803248F | 1.794188H | 3.628556J | 1.862881I | 2.233996L | 2.167837K | 2.445689I | 1.800646K | 2.097680K | 0.811958L |
| 131 | 2.894208A | 3.220241B | 4.117061G | 3.255275D | 4.050593F | 3.859874B | 3.877266B | 3.083374E | 3.589924C | 1.615370F |
| 132 | 4.314098A | 4.672264C | 4.896437G | 5.152430D | 4.841297E | 5.410223B | 5.320056C | 4.545688E | 4.935586C | 2.895250F |
| 133 | 6.698352A | 6.731973B | 5.566997I | 6.756724B | 6.111694F | 7.037036B | 6.974407B | 6.763402C | 6.069910D | 3.967821F |
| 134 | 7.878904A | 7.677694B | 5.739800G | 7.777647F | 6.549018F | 7.681931B | 7.383634B | 7.888140E | 6.284782C | 5.353135F |
| 135 | 8.537217A | 8.601989C | 5.457093H | 8.980776C | 8.881499F | 7.618407B | 7.558295B | 7.196058D | 6.286879E | 5.509580F |
| 136 | 8.319644A | 8.241077B | 5.331777H | 8.984906G | 8.743724F | 7.120889D | 7.057915D | 7.080074E | 6.875767D | 5.624157F |
| 137 | 8.189449B | 8.220586A | 4.937970G | 8.015020C | 8.624339B | 6.624339B | 6.580908C | 6.883154C | 6.834154C | 5.825684H |
| 138 | 8.706268C | 8.688563C | 4.585424I | 8.748695E | 8.933280G | 6.122709D | 6.132335C | 6.637684E | 6.898865F | 7.053089K |
| 139 | 8.351662D | 8.346406B | 4.783408H | 8.646318D | 8.084380G | 5.622146G | 5.612943E | 6.206921F | 6.294299G | 7.104540G |
| 140 | 8.218594B | 8.596093B | 4.506785F | 8.855534B | 8.610445E | 5.378775D | 5.295866B | 5.736587E | 6.384103E | 7.824724G |
| 141 | 8.814498D | 8.910705E | 4.493854H | 8.413045F | 8.372855G | 5.244479F | 5.118224G | 4.893774E | 6.459099F | 7.333770G |
| 142 | 8.831785B | 8.547840D | 4.234229I | 8.579580D | 8.082930H | 4.941037C | 4.739387D | 4.750759D | 6.552543E | 6.474817H |
| 143 | 8.958381A | 8.734286B | 3.816884G | 8.585819C | 8.914669G | 4.410158B | 4.351913B | 4.597295C | 5.954413C | 6.692704F |
| 144 | 8.500767A | 8.274925C | 3.171484G | 8.537693C | 8.663624G | 3.738851A | 3.676707C | 4.237876C | 4.724042C | 7.920811G |
| 145 | 8.935179A | 8.779486B | 2.723109I | 8.779640C | 8.920461H | 3.285408A | 3.005561B | 3.276179D | 3.442979C | 5.377465F |
| 146 | 8.997441A | 8.926177B | 2.221787K | 8.416984C | 8.986008K | 2.456225A | 2.460902B | 2.779035C | 2.553358C | 4.596336G |
| 147 | 8.246307C | 8.127921C | 1.824978G | 8.556163D | 8.088517F | 2.005813D | 1.991404C | 2.284794E | 1.725848G | 2.930812H |
| 148 | 1.674663A | 1.685278A | 1.210412K | 2.094594B | 1.764180L | 1.640307A | 1.660521A | 1.945512C | 1.298981C | 2.020361G |
| 149 | 1.079582D | 1.037291C | 0.656757J | 1.613443D | 1.421095I | 1.218840D | 1.241343C | 1.473753E | 0.774276G | 1.079540H |
| 150 | 0.853400B | 0.686783B | 0.514751K | 1.263601D | 1.101862L | 0.969670B | 0.995681B | 1.214947D | 0.508772E | 0.348904L |
| 151 | 0.416266D | 0.412459C | 0.360384J | 0.796236D | 0.808529I | 0.748654E | 0.773639D | 0.810618E | 0.314234F | 0.362574I |
| 152 | 0.267216D | 0.276125Q | 0.260346K | 0.525711D | 0.590064L | 0.575557D | 0.618260E | 0.717080E | 0.212384G | 0.075658L |
| 153 | 0.157649Q | 0.166400G | 0.205720K | 0.399716F | 0.394434I | 0.362379I | 0.426381H | 0.539683H | 0.102093I | 0.067449J |
| 154 | 0.074354D | 0.075366H | 0.150260D | 0.257031L | 0.260925E | 0.267619E | 0.379111F | 0.046422G | 0.006891M | 0.006891M |
| 155 | 0.031992H | 0.041912K | 0.134272L | 0.155281L | 0.167464K | 0.212759K | 0.240396J | 0.021174L | 0.003625M | 0.003625M |
| 156 | 0.014777G | 0.021986Q | 0.057600G | 0.073814F | 0.115129G | 0.124805H | 0.154708H | 0.172268Q | 0.012568I | 0.002670K |
| 157 | 0.006202J | 0.007155L | 0.038098K | 0.039059L | 0.084026L | 0.074562I | 0.107213J | 0.135283H | 0.006259J | 0.000934M |
| 158 | 0.003252K | 0.006545L | 0.023713K | 0.017452L | 0.043422L | 0.042038L | 0.067364L | 0.090410M | 0.002019M | 0.000466N |
| 159 | 0.001006I | 0.002988K | 0.012203J | 0.008127L | 0.026378K | 0.020722I | 0.033170K | 0.047998H | 0.000872I | 9.80E-05N |
| 160 | 0.000307N | 0.001141L | 0.007246K | 0.003270K | 0.009841L | 0.009741L | 0.023474L | 0.020092M | 0.000310M | 6.94E-05N |
| 161 | 8.52E-05H | 0.000352J | 0.005286J | 0.001260J | 0.008494H | 0.005480K | 0.008553H | 0.008461H | 0.0001201 | 1.45E-05M |
| 162 | 1.51E-05Q | 5.83E-05N | 0.002812K | 0.000304N | 0.006052L | 0.002263L | 0.006333L | 0.002612M | 1.22E-05Q | 8.01E-06N |
| 163 | 8.81E-06Q | 9.72E-06N | 0.001601K | 0.000183N | 0.003460L | 0.000960N | 0.003338N | 0.000942M | 5.71E-06Q | 4.66E-06N |
| 164 | 1.72E-06P | 5.83E-06M | 0.000986K | 0.000112N | 0.002031L | 0.000361N | 0.001984Q | 0.000302M | 1.88E-06Q | 2.04E-06N |
| 165 | 9.15E-07N | 2.33E-06M | 0.000543K | 7.07E-05M | 0.001119L | 0.000137M | 0.000955N | 9.44E-05M | 6.16E-07N | 3.54E-07M |
| 166 | 3.49E-07N | 9.72E-07M | 0.000276J | 3.07E-05N | 0.000636J | 6.80E-05L | 0.000676N | 6.33E-05M | 3.55E-07Q | 1.39E-07N |
| 167 | 2.35E-07Q | 3.89E-07M | 0.000187K | 1.41E-05L | 0.000378L | 1.57E-05Q | 0.000279N | 2.86E-05M | 4.90E-08Q | 9.80E-08N |
| 168 | 5.43E-08Q | 9.72E-08M | 0.000108K | 2.54E-05N | 0.000204L | 4.43E-06Q | 7.99E-05N | 1.31E-05M | 1.24E-08Q | 5.32E-08N |
| 169 | 2.22E-08Q | 5.83E-08M | 7.86E-05J | 1.52E-05N | 0.000131J | 1.52E-06Q | 2.69E-05N | 5.52E-06M | 4.24E-09Q | 2.70E-08N |
| 170 | 4.67E-09Q | 1.94E-08M | 3.27E-05K | 9.13E-06N | 5.07E-05L | 3.29E-07Q | 7.99E-06N | 1.61E-06M | 1.58E-09N | 1.07E-08N |
| 171 | 2.19E-09Q | 6.81E-09M | 1.78E-05K | 5.11E-06N | 3.36E-05L | 1.62E-07Q | 2.69E-06N | 3.01E-07M | 4.30E-10Q | 4.66E-09N |
| 172 | 7.18E-10Q | 1.94E-09M | 1.66E-05J | 9.54E-06N | 2.17E-05L | 4.92E-08Q | 7.99E-07N | 1.00E-07M | 1.45E-10Q | 2.39E-09N |

[a]The letters indicate the accuracy of the weighted yields stored in the file: A=0.35, B=0.50, C=0.70, D=1.0, E=1.4, F=2, G=2.8, H=4, I=6, J=8, K=11, L=16, M=23, N=32, O=45, P=>64% (P stands for all values greater than 64% and should suggest poorly known; very small yields could be in error by a factor of 100 or more.)

# Origin of the issue (ctd.)

The chain yields transcribed and assigned to $^{241}$Pu for masses A=162-168 seem to be taken from the $^{233}$U column

Table VIII(B) CURRENT CHAIN YIELDS[a]

| MASS | U235T | U235F | U235HE | U238F | U238HE | PU239T | PU239F | PU241T | U233T | TH232F |
|---|---|---|---|---|---|---|---|---|---|---|
| 119 | 0.011936J | 0.033272J | 1.098942K | 0.037512K | 0.735983K | 0.036993J | 0.059918K | 0.023518N | 0.019415L | 0.057295L |
| 120 | 0.012711K | 0.034239J | 1.107407J | 0.036557K | 0.790881K | 0.033450K | 0.056470K | 0.025113M | 0.022980L | 0.054409L |
| 121 | 0.012961I | 0.035861J | 1.047567H | 0.038498K | 0.823687H | 0.038078J | 0.064087K | | | |
| 122 | 0.015089J | 0.038462K | 1.161814K | 0.038753K | 0.864664K | 0.052494J | 0.077046K | | | |
| 123 | 0.015737H | 0.042703K | 1.209025K | 0.041407L | 0.937468K | 0.044758L | 0.078294K | | | |
| 124 | 0.026366J | 0.060299K | 1.306310K | 0.043856K | 1.052831K | 0.093124L | 0.124257K | | | |
| 125 | 0.032769G | 0.056665J | 1.591546J | 0.045978J | 1.204832I | 0.115873J | 0.137898J | | | |
| 126 | 0.057414J | 0.098555J | 1.830374H | 0.052856J | 1.367261L | 0.249848I | 0.294800I | | | |
| 127 | 0.125400H | 0.305732H | 2.118146H | 0.133794H | 1.505019I | 0.568015I | 0.517385J | | | |
| 128 | 0.346837G | 0.428189K | 2.468037K | 0.457488I | 1.682820J | 0.728105K | 0.884268I | | | |
| 129 | 0.742869I | 0.912920I | 3.545362J | 0.933766H | 2.067407J | 1.384063H | 1.504301I | | | |
| 130 | 1.803248I | 1.794188H | 3.628556J | 1.862881I | 3.233996L | 2.167837K | 2.445689J | | | |
| 131 | 2.894208A | 3.220241B | 4.117061G | 3.255275D | 4.050593F | 3.859874B | 3.877266B | | | |
| 132 | 4.314098A | 4.672264C | 4.896437G | 5.152430D | 4.843297E | 5.410223B | 5.320056C | | | |
| 133 | 6.698352A | 6.731973B | 5.566997I | 6.756724B | 6.111694F | 7.037036B | 6.974407B | | | |
| 134 | 7.878904A | 7.677694B | 5.739800G | 7.777647F | 6.549018F | 7.681931B | 7.383634B | | | |
| 135 | 6.537217A | 6.601989C | 5.457093H | 6.980776C | 5.881499F | 7.618407B | 7.558295B | 7.196058D | 6.286873E | 5.509580F |
| 136 | 6.319644A | 6.240177B | 5.331777H | 6.984906G | 5.743724F | 7.120889D | 7.057915D | 7.080074E | 6.875767D | 5.624157F |
| 137 | 6.189449B | 6.220586A | 4.937970G | 6.015020C | 5.044450F | 6.624339B | 6.588399B | 6.680908C | 6.834154C | 5.825684H |
| 138 | 6.706268C | 6.688563C | 4.585424I | 5.748695E | 4.933280G | 6.122709D | 6.132335C | 6.637684E | 5.898865F | 7.053089K |
| 139 | 6.351662D | 6.346406B | 4.783408H | 5.646318D | 5.084380G | 5.622146G | 5.612943E | 6.206921F | 6.294299G | 7.104540G |
| 140 | 6.218594B | 5.966093B | 4.506785F | 5.855534B | 6.610445E | 5.378775D | 5.295866B | 5.736687E | 6.384103E | 7.824724G |
| 141 | 5.814498D | 5.910705E | 4.493854H | 5.413045F | 4.372855G | 5.244479F | 5.118224G | 4.897374E | 6.459099F | 7.333770G |
| 142 | 5.831785B | 5.547840D | 4.234229I | 4.579580D | 4.082930H | 4.941037C | 4.739387D | 4.750796D | 6.652543E | 6.474817H |
| 143 | 5.958381A | 5.734286B | 3.816884G | 4.585819C | 3.914669G | 4.410156B | 4.359129C | 4.597295C | 5.954413C | 6.692704F |
| 144 | 5.500767A | 5.274925C | 3.171484G | 4.537693C | 3.663624G | 3.738851A | 3.676707C | 4.237876C | 4.724042C | 7.920811G |
| 145 | 3.935179A | 3.779486B | 2.723109I | 3.779640C | 3.020461H | 2.989408A | 3.005561B | 3.276179D | 3.442979C | 5.377465F |
| 146 | 2.997441A | 2.926177B | 2.221787K | 3.416984C | 2.096008K | 2.456225A | 2.460902B | 2.779035C | 2.579358C | 4.596336G |
| 147 | 2.246307C | 2.127921C | 1.624978G | 2.556163D | 2.088517F | 2.005813D | 1.991404C | 2.284794E | 1.725848G | 2.930812H |
| 148 | 1.674663A | 1.685278A | 1.210412K | 2.094594B | 1.764180L | 1.640307A | 1.660521A | 1.945512C | 1.298981C | 2.020361G |
| 149 | 1.079582D | 1.037291C | 0.656757J | 1.613443D | 1.421096I | 1.218840D | 1.241343C | 1.473753E | 0.774276G | 1.079540H |
| 150 | 0.653400B | 0.686783B | 0.514751K | 1.263601D | 1.101862L | 0.969668B | 0.995681B | 1.214947D | 0.508772E | 0.348904L |
| 151 | 0.416266D | 0.412459C | 0.360384J | 0.796236D | 0.808929I | 0.748654E | 0.773639D | 0.910618E | 0.314234F | 0.362574I |
| 152 | 0.267216D | 0.276125G | 0.260346K | 0.525711D | 0.590064L | 0.575557D | 0.618260E | 0.717080E | 0.212384G | 0.075658L |
| 153 | 0.157649G | 0.166400G | 0.205720K | 0.399716F | 0.394434I | 0.362379I | 0.426381H | 0.539683H | 0.102093I | 0.067449J |
| 154 | 0.074354D | 0.075366H | 0.080759K | 0.215026D | 0.257031L | 0.260925E | 0.287619E | 0.379111F | 0.046422G | 0.006891K |
| 155 | 0.031992H | 0.041912K | 0.064341K | 0.134272L | 0.158281L | 0.167464K | 0.212759K | 0.240396J | 0.021174L | 0.003625K |
| 156 | 0.014777G | 0.021986G | 0.057600G | 0.073814F | 0.115129G | 0.124805H | 0.154708H | 0.172268G | 0.012568I | 0.002670K |
| 157 | 0.006202J | 0.007155L | 0.038098K | 0.039059L | 0.084026L | 0.074562I | 0.107213J | 0.135283H | 0.006259J | 0.000934K |
| 158 | 0.003252K | 0.006545L | 0.023713K | 0.017452L | 0.043422L | 0.042038L | 0.057364L | 0.090410M | 0.002019M | 0.000466K |
| 159 | 0.001006I | 0.002988K | 0.012203J | 0.008127L | 0.026378K | 0.020722I | 0.029130K | 0.043898M | 0.000823J | 0.00E-05N |
| 160 | 0.000307N | 0.001141L | 0.007246K | 0.003270M | 0.015970L | 0.009841L | 0.013474L | 0.020092M | 0.000310N | 6.91E-05N |
| 161 | 8.52E-05H | 0.000352J | 0.005286J | 0.001260J | 0.008494H | 0.005480K | 0.008553H | 0.008461H | 0.0001201 | 1.45E-05K |
| 162 | 1.51E-05D | 5.83E-05N | 0.002812K | 0.000304N | 0.006052L | 0.002263L | 0.006333L | 0.002612M | 1.22E-05D | 8.01E-06N |
| 163 | 8.81E-06D | 9.72E-06N | 0.001601K | 0.000183N | 0.003460L | 0.000960N | 0.003338N | 0.000942M | 5.71E-06D | 4.66E-06N |
| 164 | 1.72E-06D | 5.83E-06N | 0.000986K | 0.000112N | 0.002031L | 0.000361N | 0.001984O | 0.000302M | 1.88E-06D | 2.01E-06N |
| 165 | 9.15E-07N | 2.33E-06N | 0.000543K | 7.07E-05N | 0.001119L | 0.000137M | 0.000955N | 9.44E-05M | 6.16E-07N | 3.51E-07K |
| 166 | 3.49E-07N | 9.72E-08M | 0.000276J | 5.07E-05N | 0.000636J | 6.80E-05L | 0.000676N | 6.33E-05M | 3.55E-07D | 1.39E-07K |
| 167 | 2.35E-07D | 3.89E-07N | 0.000187K | 4.11E-05L | 0.000378L | 1.57E-05D | 0.000279N | 2.86E-05M | 4.90E-08D | 9.80E-08N |
| 168 | 5.43E-08D | 9.72E-08M | 0.000108K | 2.54E-05N | 0.000204L | 4.43E-06D | 7.99E-05N | 1.31E-05M | 1.24E-08D | 5.31E-08N |
| 169 | 2.22E-08D | 5.83E-08M | 7.86E-05J | 1.52E-05N | 0.000131J | 1.52E-06D | 2.69E-05N | 5.52E-06N | 4.24E-09D | 2.70E-08N |
| 170 | 4.67E-09D | 1.94E-08M | 3.27E-05K | 9.13E-06N | 6.07E-05L | 3.29E-07D | 7.99E-06N | 1.61E-06M | 1.58E-09N | 1.07E-08N |
| 171 | 2.19E-09D | 6.81E-09M | 1.78E-05K | 5.11E-06N | 3.36E-05L | 1.62E-07D | 2.69E-06N | 3.01E-07M | 4.30E-10D | 4.66E-09N |
| 172 | 7.18E-10D | 1.94E-09M | 1.66E-05J | 9.54E-06N | 2.17E-05L | 4.92E-08D | 7.99E-07N | 1.00E-07M | 1.45E-10D | 2.39E-09N |

[a]The letters indicate the accuracy of the weighted yields stored in the file: A=0.35, B=0.50, C=0.70, D=1.0, E=1.4, F=2, G=2.8, H=4, I=6, J=8, K=11, L=16, M=23, N=32, O=45, P=>64% (P stands for all values greater than 64% and should suggest poorly known; very small yields could be in error by a factor of 100 or more.)

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 162 | pu241t | es | cu | 0.0000127 30.0 | 0.0000123 | 0.0000000 | 0.0000000 | 87rid1 | 0 |
| 163 | pu241t | es | cu | 0.0000059 30.0 | 0.0000057 | 0.0000000 | 0.0000000 | 87rid1 | 0 |
| 164 | pu241t | es | cu | 0.0000020 30.0 | 0.0000019 | 0.0000000 | 0.0000000 | 87rid1 | 0 |
| 165 | pu241t | es | cu | 0.0000006 30.0 | 0.0000006 | 0.0000000 | 0.0000000 | 87rid1 | 0 |
| 166 | pu241t | es | cu | 0.0000004 30.0 | 0.0000004 | 0.0000000 | 0.0000000 | 87rid1 | 0 |
| 167 | pu241t | es | cu | 0.0000001 30.0 | 0.0000001 | 0.0000000 | 0.0000000 | 87rid1 | 0 |
| 168 | pu241t | es | cu | 0.0000095 30.0 | 0.0000918 | 0.0000000 | 10.0000000 | 87rid1 | 0 |

from E&R appendix to ENDF-349

| PU239F | PU241T | U233T | TH232F |
|---|---|---|---|
| 0.039170K | 0.047999H | 0.0008721 | 9.80E-0 |
| 0.023474L | 0.020092M | 0.000310N | 6.94E-0 |
| 0.008553H | 0.008461H | 0.0001201 | 1.45E-0 |
| 0.006333L | 0.002612M | 1.22E-05D | 8.01E-0 |
| 0.003338N | 0.000942M | 5.71E-06D | 4.66E-0 |
| 0.001984O | 0.000302M | 1.88E-06D | 2.01E-0 |
| 0.000955N | 9.44E-05M | 6.16E-07N | 3.54E-0 |
| 0.000676N | 6.33E-05M | 3.55E-07D | 1.39E-0 |
| 0.000279N | 2.86E-05M | 4.90E-08D | 9.80E-0 |
| 7.99E-05N | 1.31E-05M | 1.24E-08D | 5.32E-0 |
| 2.69E-05N | 5.52E-06N | 4.24E-09D | 2.70E-0 |
| 7.99E-06N | 1.61E-06M | 1.58E-09N | 1.07E-0 |

from 1987RIZT

# Possible actions

## Rescale affected yields

1. correct the mass yields of the IFY (MT=8454) to the intended values based on *1987RIZT* for masses 162-168 and 66-71
2. renormalize the IFY distribution to 2.0
3. rescale (or recalculate) CFY (MT=8459)

## Revert to ENDF/B-VI.1 ?

Downgrade the $^{241}$Pu evaluation to those included in ENDF/B-VI.1 where the issue was not present.

## No action

Leave the evaluation as-is

# Procedure & Results

| A | Correction Factor | A | Correction Factor |
|---|---|---|---|
| 66 | 0.802 | 162 | 2.057E2 |
| 67 | 0.493 | 163 | 1.597E2 |
| 68 | 0.408 | 164 | 1.533E2 |
| 69 | 0.343 | 165 | 1.535E2 |
| 70 | 0.321 | 166 | 1.529E2 |
| 71 | 0.128 | 167 | 2.750E1 |
| | | 168 | 1.379 |

renormalization factor = 0.99998

- The correction factors have been calculated as the ratio between the values in Table VIII in 1987RIZT and those reported in the ENDF-349
- The correction factors were applied to IFY.
- The entire distribution was rescaled by the renormalization factor to have a sum of IFY = 2.0

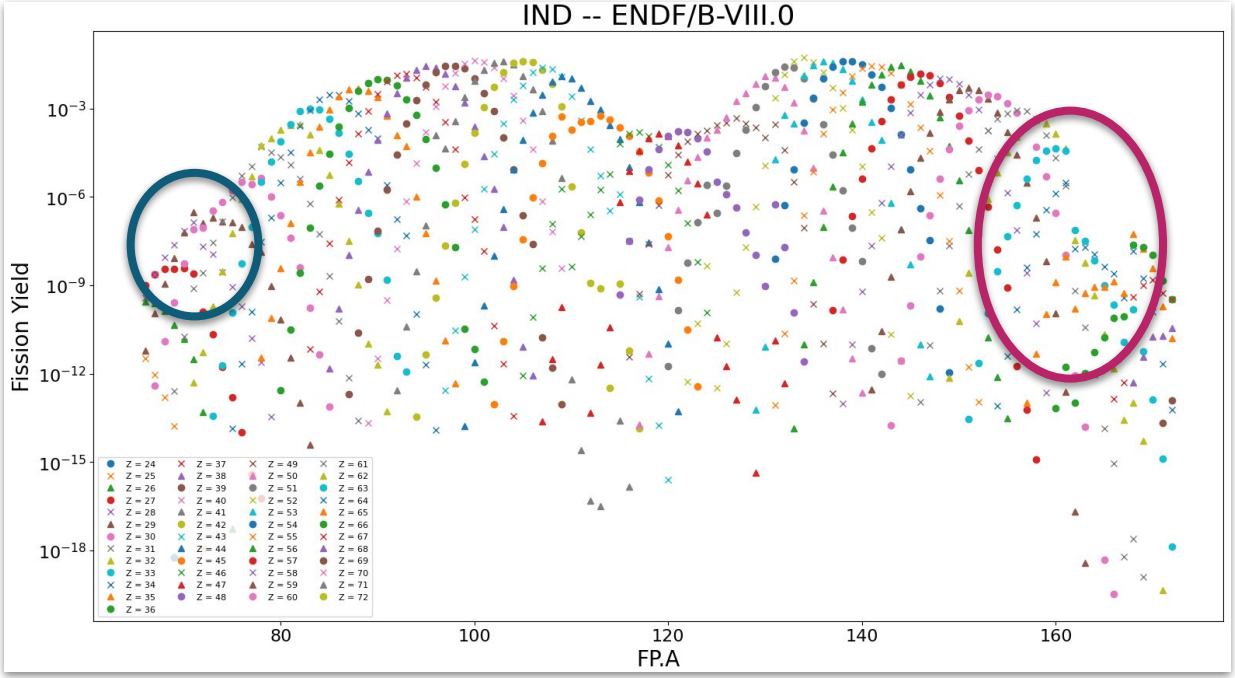
# Procedure & Results (ctd.)

The CFY can be produced:

- rescaling CFY with the same factors used for IFY (if there is no transfer of yields between masses via β-n)
- from IFY using the decay data sublibrary

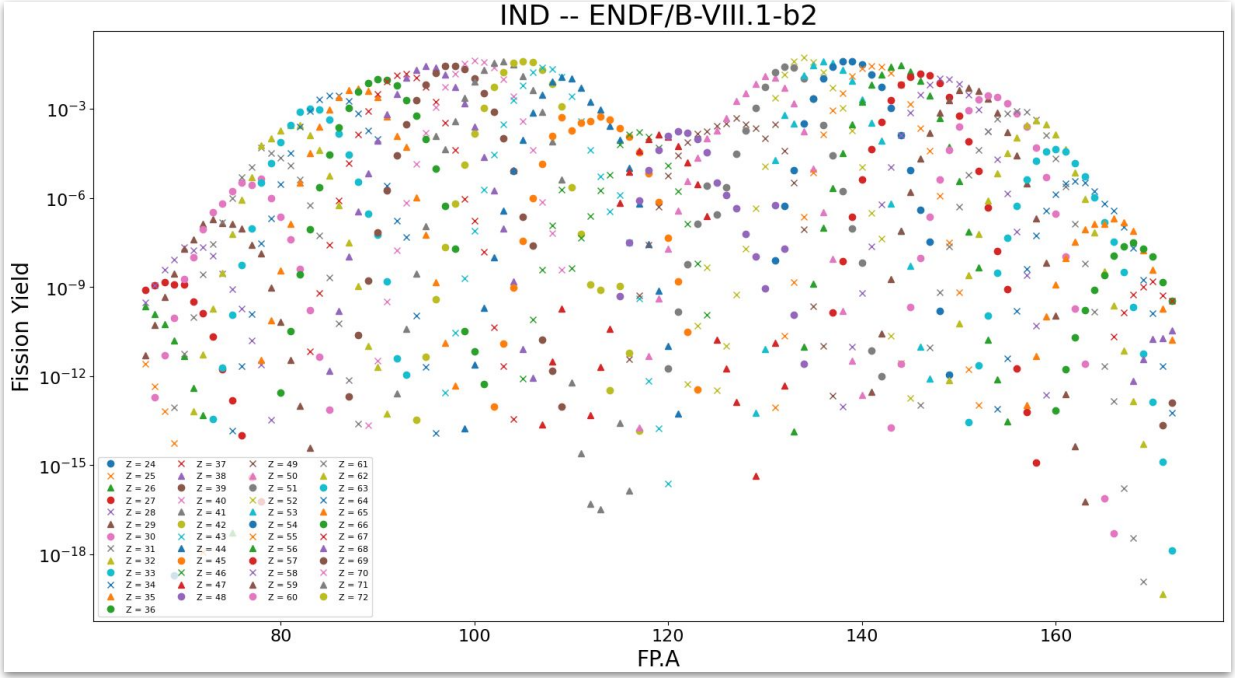
Both methods lead to very similar cumulative yields, but we preferred rescaling CFY to ensure that the decay data (branching ratios, delayed neutron emission) used for PU241T were identical to those in other fissioning systems in the NFY sublibrary.

# Procedure & Results (ctd.)




| ORIGINAL (ENDF/B-VIII.0) | | | |
|---|---|---|---|
| | **Light** | **Heavy** | **Full Dist.** |
| **Sum** | 0.99999741 | 1.00000278 | 2.00000019 |
| **Residual** | 2.587e-06 | -2.776e-06 | -1.882e-07 |
| | **Zlow** | **Zhigh** | **Full Dist.** |
| **Sum** | 1.00015263 | 0.99984756 | 2.00000019 |
| **CORRECTED (ENDF/B-VIII.1-$\beta$)** | | | |
| | **Light** | **Heavy** | **Full Dist.** |
| **Sum** | 0.99997721 | 1.00002336 | 2.00000057 |
| **Residual** | 2.279e-05 | -2.336e-05 | -5.740e-07 |
| | **Zlow** | **Zhigh** | **Full Dist.** |
| **Sum** | 1.00013243 | 0.99986814 | 2.00000057 |

# Procedure & Results (ctd.)




| ORIGINAL (ENDF/B-VIII.0) | | | |
|---|---|---|---|
| | **Light** | **Heavy** | **Full Dist.** |
| **Sum** | 0.99999741 | 1.00000278 | 2.00000019 |
| **Residual** | 2.587e-06 | -2.776e-06 | -1.882e-07 |
| | **Zlow** | **Zhigh** | **Full Dist.** |
| **Sum** | 1.00015263 | 0.99984756 | 2.00000019 |
| **CORRECTED (ENDF/B-VIII.1-$\beta$)** | | | |
| | **Light** | **Heavy** | **Full Dist.** |
| **Sum** | 0.99997721 | 1.00002336 | 2.00000057 |
| **Residual** | 2.279e-05 | -2.336e-05 | -5.740e-07 |
| | **Zlow** | **Zhigh** | **Full Dist.** |
| **Sum** | 1.00013243 | 0.99986814 | 2.00000057 |

# Summary

- proposed and included in beta-2 a proposed update of IFY and CFY for PU241T
- We fixed the ‘hole’ in masses 162-167, and also adjusted discontinuities in the yields at masses 67-71
- Conservation laws are still valid
- Heavy/Light peak sums slightly worsen, but are still an order of magnitude lower than differences accepted in other fissioning systems
- Technical report coming out soon to document changes

# Acknowledgements

The work at Brookhaven National Laboratory was sponsored by the Office of Nuclear Physics, Office of Science of the U.S. Department of Energy under Contract No. DE-SC0012704 with Brookhaven Science Associates, LLC. Additionally, this work was supported by the National Nuclear Security Administration, Defense Nuclear Nonproliferation Research and Development (NNSA DNN R&D).

The research described herein is Fundamental Research as defined in the ITAR (22 CFR 120.34(a)(8)), EAR (15 CFR 734.8), or Part 810 (10 CFR 810.3), as applicable, and as described in the USD (AT&L) memoranda on Fundamental Research, dated May 24, 2010, and on Contracted Fundamental Research, dated June 26, 2008.

# Procedure & Results (ctd.)

correction factors were applied to IFY.
Since no β-delayed neutron precursor is in any of the masses included in the correction, we can apply the same factors also to CFY (as the mass-dependent factors wouldn't

Rescaling of CFY would not be possible if there was some transfer of yields between masses ($\beta^-n$), but in E&R compilation none of the masses that went through the correction step has any β-delayed precursor or is populated by an adjacent mass (A+1).