LA-UR-13-26571
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Title: Spectral Data from Multiplying Assemblies

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Intended for: Report

Issued: 2013-08-20

Spectral Data from Multiplying Assemblies

Introduction

In this report we focus on the data obtained from various assemblies using fissionable materials. These assemblies have gamma and neutron spectral data at delayed critical (DC), prompt critical (PC), and subcritical for various assemblies that use fissile and/or fissionable material as the primary source of radiation. There are a few categories of data that have been measured. The data was measured using many types of detectors. The data may have been differential fluxes, integral fluxes, or currents. Unfortunately some of these assemblies may not have data in an easily accessible format, or we do not have a model suitable for calculations. All have to be examined in more detail to determine which meet acceptability and applicability criteria.

Summary of Assemblies

The Omega West Reactor (OWR) has extensive data, which is in tabular, scanned "pdf" format. The OWR operated at TA-0 for many years, but a model suitable for calculations does not exist. There were some one and two dimensional Anisn models using buckling factors, but nothing close to the detail needed for modern calculations. There were also other proprietary data, which utilized similar Anisn models and proprietary photo-nuclear data. GE and Westinghouse, known corporations owning the data at the time it was obtained. Often the nuclear and photo-nuclear data and models were "kludged" to match measurement(s). The proprietary data is excluded. Although not specifically researched, the VVER experiments may be satisfactory. The VVER operated in Romania and much data was collected and satisfactory models exist.

Data was recorded for many LANL assemblies, but not necessarily published. The data is in logbooks or other informal documents. As with the subsequent pulsed spheres, the gamma data has not been the subject of peer-review or evaluation. This list is not "all inclusive". The author of this report has direct knowledge of data measured for the following critical assemblies:

1) WG Pu Jezebel,
2) "Dirty" Jezebel (reactor grade Pu, 20.1 at% ^{240}Pu),
3) ^{233}U Jezebel,
4) Godiva I-IV,
5) UH_3,
6) BRP Ball and,
7) Thor.

Other subcritical measurements have been performed using core pieces from the previous critical assemblies. These measurements have been performed using a variety of detection methods. In the past, these measurements were performed on a formal and informal basis using a variety of reflectors in the High Bay at TA-18. The only requirement being that neutron multiplication was kept lower than the "hand stacking limit" in effect at the time, which has varied between 10 and 20. The hand stacking limit changed over the years. Other multiplications would have been lower if the measurements were performed outside the boundaries of TA-18.

Godiva-I and all of its successors have recorded integral and differential data. As a result, each was accepted as a National Institute of Standards (NIST) radiation source (gamma and neutron radiation). Godiva-IV has been and is a NIST source and has been used to calibrate nuclear accident detection equipment. At least at LANL, accident equipment is set to alarm at 20 mr/hr γ. Godiva-IV has gamma and neutron data for various configurations between 0 to 360^{o}. Data was recorded for all versions of Godiva, but the configuration and power level may not be known to a high degree of accuracy. Also models of Skua, Godiva II and III may not be available. Skua operated at DC once and was not operated again. Operators of other burst assemblies recorded gamma and neutron data, but the data may not be readily available. Burst assemblies typically operate at both DC and PC at various power levels. There are many assemblies, which have gamma and neutron measured data that the author has direct knowledge of:

1) Godiva I through IV (LANL),
2) Skua (LANL),
3) Aberdeen Reactor (DoD, Aberdeen, MD),
4) White Sands Burst Reactor (DoD, White Sands, NM),
5) SPR-I through III (Sandia Pulsed Reactors I, II, and III),
6) Kukla and Super Kukla (LLNL),
7) Viper (AWE),
8) HPRR (Health Physics Research Reactor, ORNL),
9) LLNL Pulsed Spheres,
10) LANL Pulsed Oralloy Sphere,
11) Omega West Reactor (^{233}U, ^{235}U and ^{239}Pu),
12) Silene and Crac (Valduc, France) and,
13) KIWI-TNT (INEL operated for a few years, then burst to destruction; hence TNT).

The LLNL pulsed sphere program consisted of many assemblies, all subcritical, which operated at LLNL between the late 1960's and 1985. The program involved using spheres of various materials, from water up to and including ^{239}Pu. This report focuses on the multiplying spheres, ^{239}Pu, ^{238}U, and ^{235}U. In each case the sphere of material had a bore hole to allow a 14 MeV neutron generator to produce neutrons in a small region close to the center of the sphere. Neutrons were generated in time dependent pulses; hence the name "Pulsed Spheres". Detectors were placed at different angles around the sphere, some distance from the spheres, to measure the time dependent response of each neutron pulse. For the spheres, which were fielded in the later years of the program, spectral and differential gamma data was measured. Most work has focused on the neutron data and the gamma data is not as "popular". The

gamma data has not been evaluated to a high degree of confidence. LANL fielded its own "pulsed sphere" in the early 1970's. It was a single sphere of HEU and extensive high quality data was recorded. To the author's knowledge, it has not been modeled or evaluated.

One avenue, which may have been overlooked to this point, is the criticality and/or nuclear accidents. In some cases, gamma and neutron radiation levels were measured during the accident. The integral doses are certainly inferred after the accident. The accident configurations have been published. Many of the criticality accidents have been investigated and recreated to better understand how the accident occurred and the doses received by nearby personnel. A summary of the known (by the author) accidents are as follows:

1) LANL accidents at TA-0 (two each; one with a Be reflector and another with a WC reflector),
2) LANL accident at TA-21 (DP Site),
3) Y-12 accident,
4) Godiva-I accident,
5) LLNL accident,
6) Windscale,
7) Brazilian accidents (Empresas Nucleares Brasileiras),
8) JAERI accidents (Japanese Atomic Energy Research Institute),
9) Hanford,
10) Chalk River (Atomic Energy of Canada),
11) Argentina,
12) Belgium and,
13) Russian accidents (similar number as in US).

Conclusion

Each accident and assembly would have to be evaluated individually. Some are simple or described in sufficient detail to be modeled easily using Mcnp or a similar code. Some are process accidents (varying degrees of model difficulty) and some are complex reactors. Others, like the two accidents at TA-0, are simple geometries, but the radiation fluxes and doses are inferred and integral. Others, like the Godiva-I accident, are simple geometries with differential and some spectral data. In summary, gamma data has not been used as much and would require some effort to investigate the acceptability of the data and the models.

Some assemblies would require some research. The data and models would have to be evaluated (much like an ICSBEP evaluation). The following assemblies have accessible data and satisfactory Mcnp models:

1) WG Pu Jezebel,
2) "Dirty" Jezebel (reactor grade Pu, 20.1 at% ^{240}Pu),
3) ^{233}U Jezebel,
4) Godiva IV,
5) UH_3,
6) BRP Ball,

7) Thor,
8) LLNL Pulsed Spheres,
9) LANL Pulsed Oralloy Sphere and,
10) Omega West Reactor (^{233}U, ^{235}U and ^{239}Pu).

In the author's opinion the following assemblies have high quality data and the models have been evaluated:

1) WG Pu Jezebel,
2) "Dirty" Jezebel (reactor grade Pu, 20.1 at% ^{240}Pu),
3) Godiva IV,
4) BRP Ball,
5) LLNL Pulsed Spheres and,
6) LANL Pulsed Oralloy Sphere.

These six assemblies are judged to be acceptable for initial research. The other assemblies could be researched if the program expands or requires more data. The pulsed spheres (LANL and LLNL) are the assemblies, which have the highest quality data and models of the highest fidelity.

Sampling of Recorded Data

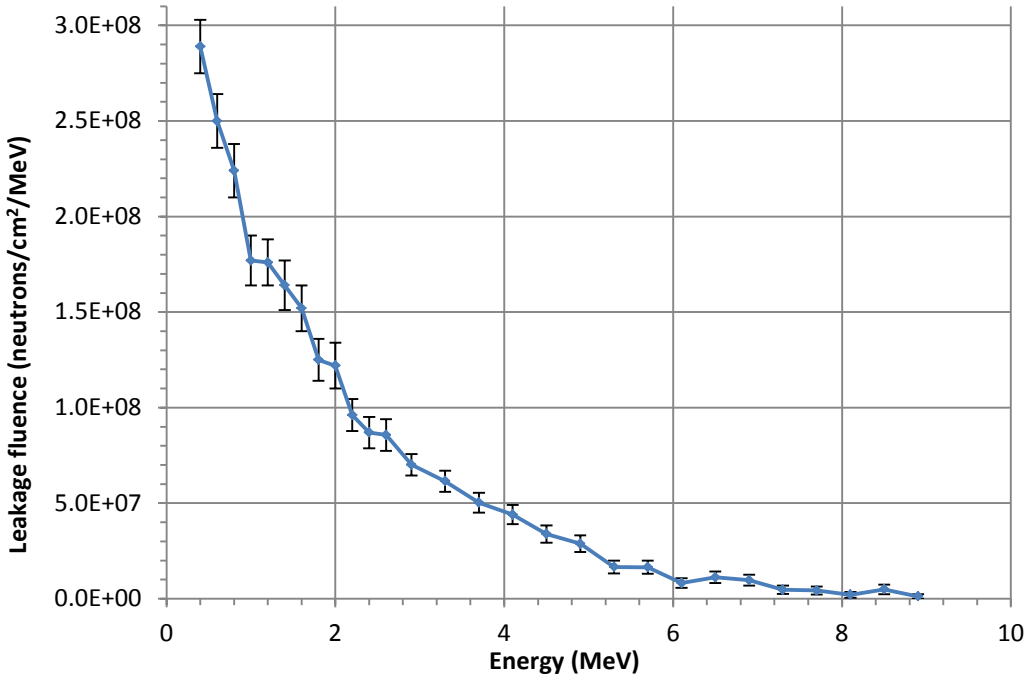

Figure 1: ^{239}Pu Assembly Leakage Spectrum

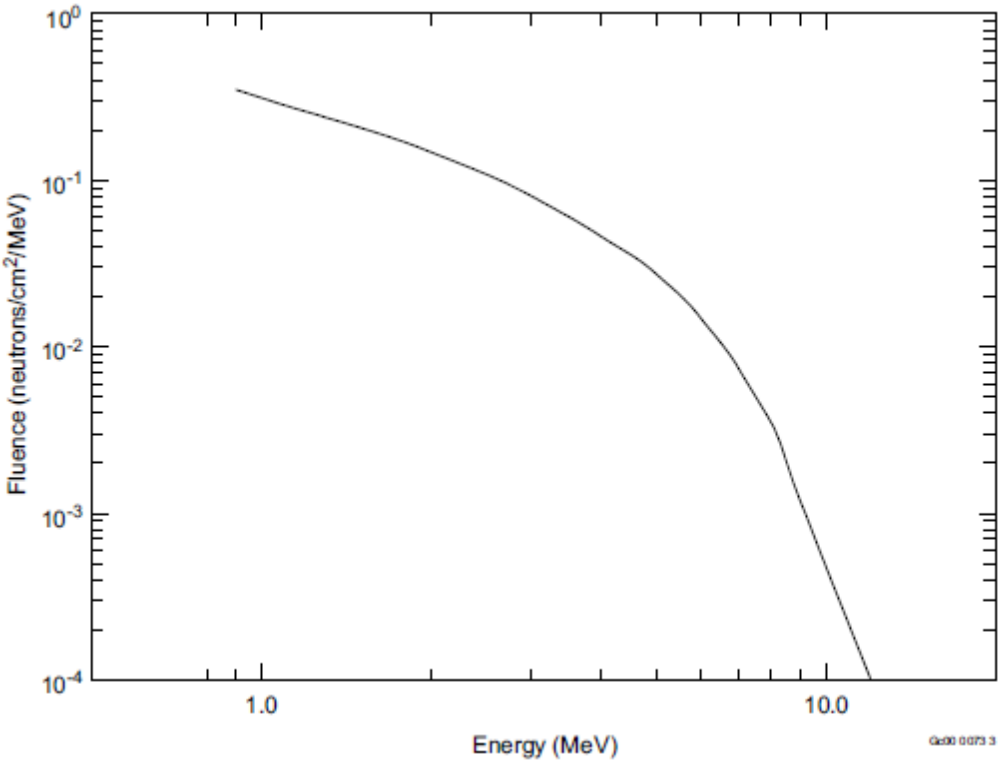

Figure 2: Neutron Spectrum of the UH_3 Critical Assembly with a Beryllium Reflector

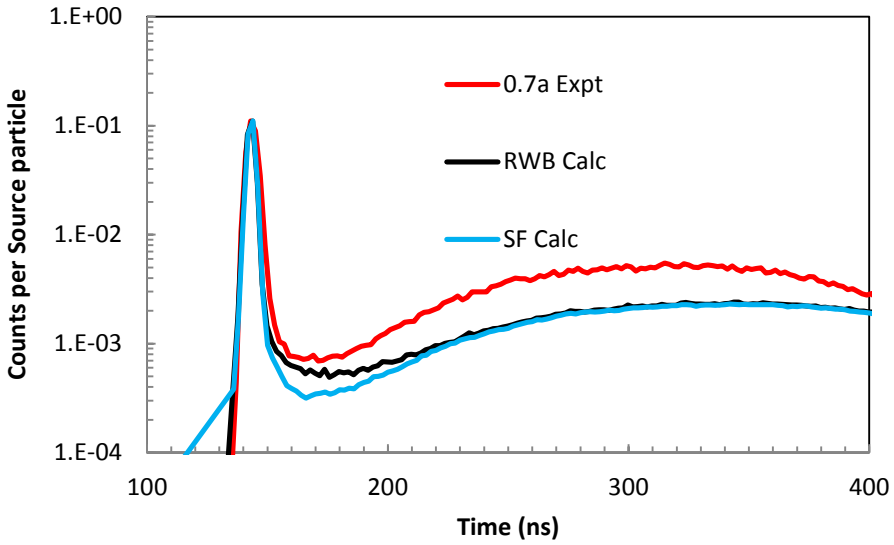

Figure 3: LLNL Pulsed Sphere, 0.7 MFP ^{239}Pu

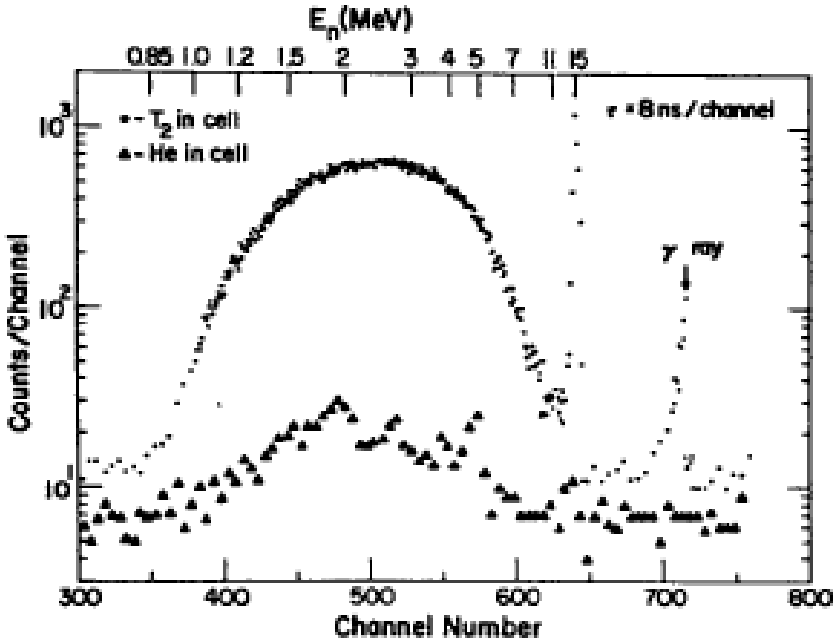

Figure 4: Neutron Spectrum of a LANL Oy Pulsed Sphere

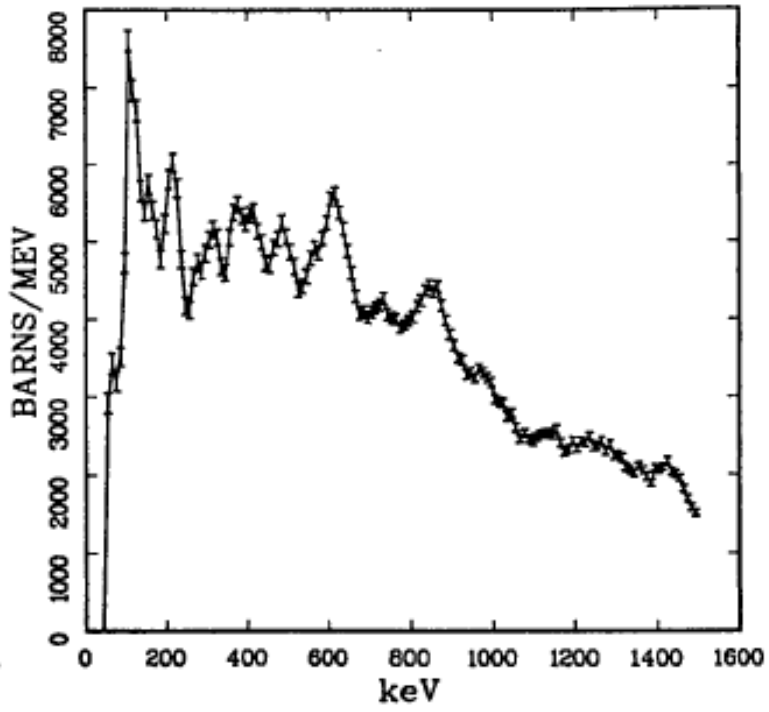

Figure 5: Gamma Spectrum of ^{233}U from the OWR

Sample Input Files

Godiva-I Detailed Model

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2   7  0.000025   3 -4 1
3   2  0.048154   4 -5 1
4   7  0.000025   5 -6 1
5   3  0.048155   6 -7 1
6   7  0.000025   7 -8 1
7   4  0.048153   8 -9 1
8   7  0.000025   9 -10 1
9   5  0.048154  10 -11 1
10  7  0.000025  35 -25
11  8  0.087561  -1 2 -28 149 150 #72 #73 #74 #75 #76
                                   #77 #78 #79 #104
12  7  0.000025  25 -26
13  5  0.048154 -12 13 -2
14  4  0.048153 -15 16 -14
15  3  0.048155 -18 19 -17
16  2  0.048154 -21 22 -20
17  1  0.048151 -24 -23
18  7  0.000025 -13 15 -2
19  7  0.000025 -15 16 14 -2
20  7  0.000025  18 -16 -2
21  7  0.000025 -18 19 17 -2
22  7  0.000025 -19 21 -2
23  7  0.000025 -21 22 20 -2
24  7  0.000025 -22 24 -2
25  7  0.000025 -24 -2 23
26  9  0.060240  27 -28 -29 1 149 150 #72 #73 #74 #75 #76
                                       #77 #78 #79 #104
27  9  0.060240  27 -28 30 -2 149 150 #72 # 73 #74 #75 #76
                                       #77 #78 #79 #104
28  9  0.060240  31 -32 -33 34
29  7  0.000025  11 -27 1 -29
30  7  0.000025  12 -2 -27 30
31  7  0.000025  11 29 -28 -35 152 150 #36 #40 #44 #48 #68
32  7  0.000025  12 -31 -35 -33
33  7  0.000025 -34 31 -32 -35
34  7  0.000025  12 -30 -28 33
35  7  0.000025  28 -35
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38  8  0.087561 -39 40 43 -44 -36 29
39  8  0.087561 -39 40 -41 42 -36 29
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50  8  0.087561  64 -63 65 -66 -36 29
51  8  0.087561  64 -63 68 -67 -36 29
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53  8  0.087561  72 -71 76 -75 -36 29
54  8  0.087561  69 -70 73 -74 -36 29
55  8  0.087561  69 -70 76 -75 -36 29
56  8  0.087561  77 -78 81 -82 -36 29
57  8  0.087561  77 -78 84 -83 -36 29
58  8  0.087561  80 -79 81 -82 -36 29
59  8  0.087561  80 -79 84 -83 -36 29
60  8  0.087561  86 -85 89 -90 -36 29
61  8  0.087561  86 -85 92 -91 -36 29
62  8  0.087561  87 -88 89 -90 -36 29
```

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64  8  0.087561  93 -94 97 -98 -36 29
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67  8  0.087561  96 -95 100 -99 -36 29
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69  8  0.087561 104 -103 106 -105 -36 29
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108 8  0.087561 -29 30 -147
110 8  0.087561 -29 30 -148
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113 9  0.060240  27 -28 -29 1 -149 150 #80 #81 #82 #83 #84 #85 #86 #87 #106
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115 9  0.060240  27 -28 -29 1 -149 -150 #96 #97 #98 #99 #100 #101 #102 #103 #108
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118 9  0.060240  27 -28 30 -2 149 -150 #88 #89 #90 #91 #92 #93 #94 #95 #110
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6   so    6.2937
7   so    7.7525
```

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15  sz   -0.04640 8.2527
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18  sz   -0.05590 7.7525
19  sz   -0.05590 6.2937
20  pz   -0.06870
21  sz   -0.06870 6.2809
22  sz   -0.06870 1.0414
23  pz   -0.08140
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26  so  100.00000
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28  cz   29.525
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74  py   21.779
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77  px   12.728
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kopts kinetics=yes
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imp:p 1.0 123r 0.0
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       0.0 0.0 -1.0
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      92235. .93323
      92238. .056516
m2    92234. .010250
      92235. .93957
      92238. .050189
m3    92234. .010250
      92235. .94005
      92238. .049694
m4    92234. .010250
      92235. .93639
      92238. .053351
m5    92234. .010250
      92235. .93947
      92238. .050287
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       8016. .3
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      42099. 7.24865E-04
      42100. 2.89285E-04
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totnu
prdmp 2j 1 4
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e11 0.0 99i 4 10
t0 0.0 99i 50.0
f21:n 26
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    1.3401E-02 1.4071E-02 1.4775E-02 1.5513E-02 1.6289E-02 1.7103E-02 &
    1.7959E-02 1.8856E-02 1.9799E-02 2.0789E-02 2.1829E-02 2.2920E-02 &
    2.4066E-02 2.5270E-02 2.6533E-02 2.7860E-02 2.9253E-02 3.0715E-02 &
    3.2251E-02 3.3864E-02 3.5557E-02 3.7335E-02 3.9201E-02 4.1161E-02 &
    4.3219E-02 4.5380E-02 4.7649E-02 5.0032E-02 5.2533E-02 5.5160E-02 &
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```

```
    7.7616E-02 8.1497E-02 8.5572E-02 8.9850E-02 9.4343E-02 9.9060E-02 &
    1.0401E-01 1.0921E-01 1.1467E-01 1.2041E-01 1.2643E-01 1.3275E-01 &
    1.3939E-01 1.4636E-01 1.5367E-01 1.6136E-01 1.6943E-01 1.7790E-01 &
    1.8679E-01 1.9613E-01 2.0594E-01 2.1623E-01 2.2705E-01 2.3840E-01 &
    2.5032E-01 2.6283E-01 2.7598E-01 2.8978E-01 3.0426E-01 3.1948E-01 &
    3.3545E-01 3.5222E-01 3.6984E-01 3.8833E-01 4.0774E-01 4.2813E-01 &
    4.4954E-01 4.7201E-01 4.9561E-01 5.2040E-01 5.4641E-01 5.7374E-01 &
    6.0242E-01 6.3254E-01 6.6417E-01 6.9738E-01 7.3225E-01 7.6886E-01 &
    8.0730E-01 8.4767E-01 8.9005E-01 9.3455E-01 9.8128E-01 1.0303E+00 &
    1.0819E+00 1.1360E+00 1.1928E+00 1.2524E+00 1.3150E+00 1.3808E+00 &
    1.4498E+00 1.5223E+00 1.5984E+00 1.6783E+00 1.7622E+00 1.8504E+00 &
    1.9429E+00 2.0400E+00 2.1420E+00 2.2491E+00 2.3616E+00 2.4797E+00 &
    2.6036E+00 2.7338E+00 2.8705E+00 3.0140E+00 3.1647E+00 3.3230E+00 &
    3.4891E+00 3.6636E+00 3.8468E+00 4.0391E+00 4.2410E+00 4.4531E+00 &
    4.6758E+00 4.9095E+00 5.1550E+00 5.4128E+00 5.6834E+00 5.9676E+00 &
    6.2660E+00 6.5793E+00 6.9082E+00 7.2536E+00 7.6163E+00 7.9971E+00 &
    8.3970E+00 8.8168E+00 9.2577E+00 9.7206E+00 1.0207E+01 1.0717E+01 &
    1.1253E+01 1.1815E+01 1.2406E+01 1.3026E+01 1.3678E+01 1.4362E+01 &
    1.5080E+01 1.5834E+01 1.6625E+01 1.7457E+01 1.8330E+01 1.9246E+01 &
    2.0000E+01
print
```

Godiva-IV

```
1   1  0.08786712   1 -2 4 -5
2   1  0.08786712   2 69 -85 -86
3   7  0.04762641   2 -7 8 -9
4   7  0.04762641   2 -6 9 -11
5   7  0.04762641   2 -7 11 -12
6   7  0.04762641  10 -7 12 -13
7   6  0.047100   2 -14 16 -15
8   1  0.08786712 -17 19 -20
9   1  0.08786712 -16 -18 20
10  1  0.08786712  -2 -15 16
11  501 4.77950e-5 -24 30 -31 34 -35
                36 #57
12  501 4.77950e-5 -24 30 -31 -37 -39
                40 #58
13  501 4.77950e-5 -24 30 -31 -38 -41
                42 #59
14  5  0.04762272 -24 25 26 27 28
                62 -29 #11 #12 #13
               #57 #58 #59
15  5  0.04762272  22 28 -29 -61
                25 26 27
16  5  0.04762272  -9 22 -24 25 26
                27 29 #11 #12 #13
               #57 #58 #59
17  5  0.04762272   9 21 -24 25 26
                27 -31 #11 #12 #13
               #57 #58 #59
18  5  0.04762272 -11 21 -24 31
               #11 #12 #13 #57 #58
               #59
19  5  0.04762272  11 22 -24 -32 #11
               #12 #13
               #57 #58 #59
20  5  0.04762272  22 32 -33 -64
21  5  0.04762272 -24 32 -33 65
               #11 #12 #13
               #57 #58 #59
22  501 4.77950e-5 -25 59 -31
23  501 4.77950e-5 -25 44 51 -59
24  501 4.77950e-5 -43 57 -59
25  8  0.048437  43 -44 51 -54
26  8  0.048437 -44 54 -57
27  8  0.048437  43 -44 57 -59
28  501 4.77950e-5 -27 60 -31
29  501 4.77950e-5 -27 48 52 -60
30  501 4.77950e-5 -47 58 -60
31  8  0.048437  47 -48 52 -55
```

```
32  8  0.048437 -48 55 -58
33  8  0.048437  47 -48 58 -60
34  501 4.77950e-5 -26 -31 56
35  501 4.77950e-5 -26 46 28 -56
36  9  0.049553  45 -46 49 -50
37  9  0.049553 -46 50 -53
38  9  0.049553  45 -46 53 -56
39  501 4.77950e-5 -45 53 -56
40  501 4.77950e-5 -43 51 -54
41  501 4.77950e-5 -47 52 -55
42  501 4.77950e-5 -45 49 -50
43  2  0.08598250 -29 61 -62 63
                25 26 27
44  2  0.08598250  32 64 -65 -66
45  501 4.77950e-5   3 13 -67 -69
46  501 4.77950e-5  13 -22 67 -68
47  2  0.08598250  22 33 -23 -69
48  2  0.08598250 -22 67 68 -69
49  501 4.77950e-5 -70 74 -75
50  501 4.77950e-5  25 -71 74 -75
51  501 4.77950e-5  26 -72 74 -75
52  501 4.77950e-5  27 -73 74 -75
53  4  0.058593  70 71 72 73 74
               -75 -87
54  1  0.08786712  75 -76 77 -78 79
               -80
55  like 54 but trcl (0 0 0 -0.5 -0.8660254 0
                                -0.8660254 -0.5 0 0 0 1)
56  like 54 but trcl (0 0 0 -0.5  0.8660254 0
                                -0.8660254 0.5 0 0 0 1)
57  3  0.08293492  34 -35 -79
                63 -66 84
58  like 57 but trcl (0 0 0 -0.5 -0.8660254 0
                                -0.8660254 -0.5 0 0 0 1)
59  like 57 but trcl (0 0 0 -0.5  0.8660254 0
                                -0.8660254 0.5 0 0 0 1)
60  3  0.08293492  34 -35 -63 -79 81
                83
61  like 60 but trcl (0 0 0 -0.5 -0.8660254 0
                                -0.8660254 -0.5 0 0 0 1)
62  like 60 but trcl (0 0 0 -0.5  0.8660254 0
                                -0.8660254 0.5 0 0 0 1)
63  3  0.08293492  34 -35 -79 -82 66
                83
64  like 63 but trcl (0 0 0 -0.5 -0.8660254 0
                                -0.8660254 -0.5 0 0 0 1)
65  like 63 but trcl (0 0 0 -0.5  0.8660254 0
                                -0.8660254 0.5 0 0 0 1)
66  501 4.77950e-5  17 19 -20 -22
67  501 4.77950e-5 -16 18 20 -22
68  501 4.77950e-5   7 8 -9 -22
69  501 4.77950e-5   6 9 -11 -21
70  501 4.77950e-5   5 -82 -87
              #63 #64 #65
71  501 4.77950e-5  -5 24 75 -87 88
                89 #54 #57 #60 #63
72  501 4.77950e-5  -5 24 75 -87 -88
                89 #54 #57 #60 #63
73  501 4.77950e-5  -5 24 75 -87 -88
               -89 #55 #58 #61 #64
74  501 4.77950e-5  -5 24 75 -87 88
               -89 #56 #59 #62 #65
75  501 4.77950e-5  23 33 -64 -69
76  501 4.77950e-5 -25 74 -51
77  501 4.77950e-5 -27 74 -52
78  501 4.77950e-5 -26 74 -49
79  501 4.77950e-5 -26 -28 46 49
80  501 4.77950e-5  22 -24 25 26 27
               -63 75 #60 #61 #62
81  501 4.77950e-5 -24 25 26 27 -28
                62 63 #57 #58 #59
```

```
82  501 4.77950e-5  22 25 26 27 -28
                -61 63
83  501 4.77950e-5 -19 -22 75
84  501 4.77950e-5  22 -64 -66 69
85  501 4.77950e-5  22 -24 33 65 -66
                #57 #58 #59
86  501 4.77950e-5  -5 22 -24 66
                #63 #64 #65
87  501 4.77950e-5  -8 14 16 -22
88  501 4.77950e-5   7 11 -13 -22
89  501 4.77950e-5   2 -5 -22 69 #2
90  501 4.77950e-5   2 -3 12 -69
91  501 4.77950e-5  -8 -14 15
92  501 4.77950e-5  -2 -4 8
93  501 4.77950e-5  -1 4 -5
94  501 4.77950e-5   3 -10 12 -13
100 501 4.77950e-5  -100
                    (82:-74:87)
200  0               100

1  cz   0.31750
2  cz   1.27000
3  cz   1.42875
4  pz   0.00254
5  pz  11.43254
6  cz   3.92430
7  cz   4.38150
8  pz   0.0
9  pz   2.54000
10 cz   3.50520
11 pz   4.96570
12 pz   6.98754
13 pz   7.64794
14 cz   4.29260
15 pz  -0.25400
16 pz  -7.85128
17 cz   2.45000
18 cz   3.65760
19 pz -12.81320
20 pz  -9.30148
21 cz   3.97510
22 cz   4.44500
23 cz   5.08000
24 cz   8.89000
25 c/z  3.33375 -5.774224 1.11125
26 c/z -6.66750  0.0      1.11125
27 c/z  3.33375  5.774224 1.11125
28 pz  -7.80455
29 pz  -7.43839
30 pz  -4.89458
31 pz   4.64820
32 pz   7.27160
33 pz   7.78416
34 py  -1.11125
35 py   1.11125
36 px   8.49376
37 p    1.0        1.7320508 0.0 -16.9857200
38 p    1.0       -1.7320508 0.0 -16.9857200
39 p    1.7320508 -1.0       0.0   1.9247415
40 p    1.7320508 -1.0       0.0  -1.9247415
41 p    1.7320508  1.0       0.0   1.9247415
42 p    1.7320508  1.0       0.0  -1.9247415
43 c/z  3.33375   -5.774224  0.47625
44 c/z  3.33375   -5.774224  1.09220
45 c/z -6.66750    0.0       0.47625
46 c/z -6.66750    0.0       1.09220
47 c/z  3.33375    5.774224  0.47625
48 c/z  3.33375    5.774224  1.09220
49 pz -10.79627
50 pz  -8.89127
51 pz -19.84121
```

```
52 pz -12.02055
53 pz -1.27127
54 pz -17.93621
55 pz -10.11155
56 pz   1.90373
57 pz  -9.04621
58 pz  -1.22555
59 pz  -7.14121
60 pz   0.67945
61 cz   5.71695
62 cz   7.29488
63 pz  -9.02589
64 cz   5.08381
65 cz   7.29615
66 pz   8.75411
67 cz   1.43510
68 pz   8.00680
69 pz   8.32430
70 cz   5.23875
71 c/z  3.33375  -5.774224 1.27000
72 c/z -6.66750   0.0      1.27000
73 c/z  3.33375   5.774224 1.27000
74 pz -20.37715
75 pz -16.56715
76 pz   4.38785
77 py  -1.42875
78 py   1.42875
79 px  12.94130
80 px  18.94130
81 pz -12.67587
82 pz  12.40409
83 px   5.08000
84 px   8.49630
85 cz   2.22250
86 pz   9.59430
87 cz  44.45
88 py   0.0
89 px   0.0
100 so 500.0

mode n p
kcode 25000 1.0 50 1050
rand hist=7314730
kopts kinetics=yes
imp:n 1.0 94r 0.0
imp:p 1.0 94r 0.0
ksrc 0.0 0.0 -1.0
m1    6000. 3.0083e-4
     14028. 1.5821e-3
     14029. 8.0109e-5
     14030. 5.3177e-5
     15031. 1.5554e-4
     16033. 3.38003E-06
     16034. 1.89732E-05
     16036. 9.01340E-08
     24050. 7.2466e-4
     24052. 1.3974e-2
     24053. 1.5844e-3
     24054. 3.9443e-4
     25055. 8.7693e-4
     26054. 3.5742e-3
     26056. 5.5564e-2
     26057. 1.2722e-3
     26058. 1.6962e-4
     28058. 5.0437e-3
     28060. 1.9282e-3
     28061. 8.3482e-5
     28062. 2.6522e-4
     28064. 6.7229e-5
     42092. 2.23565E-05
     42094. 1.39351E-05
```

```
     42095. 2.39835E-05
     42096. 2.51284E-05
     42097. 1.43871E-05
     42099. 3.63518E-05
     42100. 1.45076E-05
m2    6000. 1.5940e-3
     14028. 3.4929e-4
     14029. 1.7686e-5
     14030. 1.1740e-5
     15031. 2.7472e-5
     16033. 2.21108E-07
     16034. 1.24115E-06
     16036. 5.89620E-09
     24050. 3.1603e-5
     24052. 6.0944e-4
     24053. 6.9097e-5
     24054. 1.7202e-5
     25055. 6.2385e-4
     26054. 4.7824e-3
     26056. 7.4345e-2
     26057. 1.7022e-3
     26058. 2.2696e-4
     28058. 9.8985e-4
     28060. 3.7842e-4
     28061. 1.6384e-5
     28062. 5.2051e-5
     28064. 1.3194e-5
     42092. 1.82814E-05
     42094. 1.13951E-05
     42095. 1.96118E-05
     42096. 2.05481E-05
     42097. 1.17646E-05
     42099. 2.97257E-05
     42100. 1.18632E-05
m3    6000. 8.0221e-5
     13027. 1.7855e-4
     14028. 7.9104e-5
     14029. 4.0054e-6
     14030. 2.6588e-6
     15031. 7.7770e-6
     16033. 5.63340E-08
     16034. 3.16222E-07
     16036. 1.50224E-09
     22046. 1.998E-07
     22047. 1.807E-07
     22048. 1.787E-06
     22049. 1.315E-07
     22050. 1.256E-07
     25055. 4.3847e-5
     26054. 3.4070e-3
     26056. 5.2965e-2
     26057. 1.2127e-3
     26058. 1.6169e-4
     27059. 7.1938e-3
     28058. 1.0367e-2
     28060. 3.9635e-3
     28061. 1.7160e-4
     28062. 5.4518e-4
     28064. 1.3819e-4
     42092. 3.57689E-04
     42094. 2.22953E-04
     42095. 3.83720E-04
     42096. 4.02038E-04
     42097. 2.30184E-04
     42099. 5.81605E-04
     42100. 2.32112E-04
m4   13027. 5.8593e-2
m5   42092. 2.52725E-04
     42094. 1.57528E-04
     42095. 2.71118E-04
     42096. 2.84060E-04
```

```
     42097. 1.62637E-04
     42099. 4.10934E-04
     42100. 1.63999E-04
     92233. 4.6343e-6
     92234. 4.7016e-4
     92235. 4.2801e-2
     92236. 3.1112e-4
     92238. 2.3328e-3
m6   42092. 1.69161E-04
     42094. 1.05441E-04
     42095. 1.81472E-04
     42096. 1.90135E-04
     42097. 1.08860E-04
     42099. 2.75058E-04
     42100. 1.09772E-04
     92233. 4.6384e-6
     92234. 4.7068e-4
     92235. 4.2848e-2
     92236. 3.1140e-4
     92238. 2.3253e-3
m7   42092. 2.55960E-04
     42094. 1.59544E-04
     42095. 2.74588E-04
     42096. 2.87697E-04
     42097. 1.64718E-04
     42099. 4.16194E-04
     42100. 1.66098E-04
     92233. 4.6326e-6
     92234. 4.7007e-4
     92235. 4.2791e-2
     92236. 3.1101e-4
     92238. 2.3249e-3
m8   42092. 2.30762E-04
     42094. 1.43838E-04
     42095. 2.47556E-04
     42096. 2.59374E-04
     42097. 1.48503E-04
     42099. 3.75222E-04
     42100. 1.49747E-04
     92233. 4.7315e-6
     92234. 4.8008e-4
     92235. 4.3703e-2
     92236. 3.1765e-4
     92238. 2.3767e-3
m9   42092. 2.36090E-04
     42094. 1.47158E-04
     42095. 2.53271E-04
     42096. 2.65362E-04
     42097. 1.51931E-04
     42099. 3.83884E-04
     42100. 1.53204E-04
     92233. 4.8405e-6
     92234. 4.9114e-4
     92235. 4.4710e-2
     92236. 3.2497e-4
     92238. 2.4314e-3
m501  7014. 3.81291E-05
      8016. 9.49949E-06
     18036. 6.22913E-10
     18038. 1.10334E-10
     18040. 1.65708E-07
totnu
prdmp 2j 1 4
f11:p 100
e11 0.0 99i 4 10
t0 0.0 99i 50.0
f21:n 100
e21 1.0000E-02 1.0500E-02 1.1025E-02 1.1576E-02 1.2155E-02 1.2763E-02 &
    1.3401E-02 1.4071E-02 1.4775E-02 1.5513E-02 1.6289E-02 1.7103E-02 &
    1.7959E-02 1.8856E-02 1.9799E-02 2.0789E-02 2.1829E-02 2.2920E-02 &
    2.4066E-02 2.5270E-02 2.6533E-02 2.7860E-02 2.9253E-02 3.0715E-02 &
```

```
    3.2251E-02 3.3864E-02 3.5557E-02 3.7335E-02 3.9201E-02 4.1161E-02 &
    4.3219E-02 4.5380E-02 4.7649E-02 5.0032E-02 5.2533E-02 5.5160E-02 &
    5.7918E-02 6.0814E-02 6.3855E-02 6.7048E-02 7.0400E-02 7.3920E-02 &
    7.7616E-02 8.1497E-02 8.5572E-02 8.9850E-02 9.4343E-02 9.9060E-02 &
    1.0401E-01 1.0921E-01 1.1467E-01 1.2041E-01 1.2643E-01 1.3275E-01 &
    1.3939E-01 1.4636E-01 1.5367E-01 1.6136E-01 1.6943E-01 1.7790E-01 &
    1.8679E-01 1.9613E-01 2.0594E-01 2.1623E-01 2.2705E-01 2.3840E-01 &
    2.5032E-01 2.6283E-01 2.7598E-01 2.8978E-01 3.0426E-01 3.1948E-01 &
    3.3545E-01 3.5222E-01 3.6984E-01 3.8833E-01 4.0774E-01 4.2813E-01 &
    4.4954E-01 4.7201E-01 4.9561E-01 5.2040E-01 5.4641E-01 5.7374E-01 &
    6.0242E-01 6.3254E-01 6.6417E-01 6.9738E-01 7.3225E-01 7.6886E-01 &
    8.0730E-01 8.4767E-01 8.9005E-01 9.3455E-01 9.8128E-01 1.0303E+00 &
    1.0819E+00 1.1360E+00 1.1928E+00 1.2524E+00 1.3150E+00 1.3808E+00 &
    1.4498E+00 1.5223E+00 1.5984E+00 1.6783E+00 1.7622E+00 1.8504E+00 &
    1.9429E+00 2.0400E+00 2.1420E+00 2.2491E+00 2.3616E+00 2.4797E+00 &
    2.6036E+00 2.7338E+00 2.8705E+00 3.0140E+00 3.1647E+00 3.3230E+00 &
    3.4891E+00 3.6636E+00 3.8468E+00 4.0391E+00 4.2410E+00 4.4531E+00 &
    4.6758E+00 4.9095E+00 5.1550E+00 5.4128E+00 5.6834E+00 5.9676E+00 &
    6.2660E+00 6.5793E+00 6.9082E+00 7.2536E+00 7.6163E+00 7.9971E+00 &
    8.3970E+00 8.8168E+00 9.2577E+00 9.7206E+00 1.0207E+01 1.0717E+01 &
    1.1253E+01 1.1815E+01 1.2406E+01 1.3026E+01 1.3678E+01 1.4362E+01 &
    1.5080E+01 1.5834E+01 1.6625E+01 1.7457E+01 1.8330E+01 1.9246E+01 &
    2.0000E+01
print
```

Bare WG Pu-239 Jezebel

```
1    1    0.04029014 -1 imp:n=1
2    0     1  imp:n=0

1    so   6.3849

m1   94239.66c 0.037047
     94240.66c 0.0017512
     94241.66c 0.00011674
     31000.66c 0.0013752
kcode  10000  1.0  50  550
ksrc 0 0 0
print
```

```
Bare Pu-240 Jezebel, ref. PU-MET-FAST-002
1    1    0.04055292 -1 imp:n=1
2    0     1  imp:n=0

1    so   6.6595

m1   94239.66c 0.029934
     94240.66c 0.0078754
     94241.66c 0.0012146
     94242.66c 0.00015672
     31000.66c 0.0013722
kcode  10000  1.0  50  550
ksrc 0 0 0
print
```

UH3 Case 1 D38 Inner and Outer Refl

```
1     15   0.060240   -11   12  -13                 $ Al Support
2     11   0.048066     9  -10   14  -34           $ Inner Reflector
3     11   0.048066     9  -11   13  -36   #2      $ Outer Reflector
4     11   0.048066    -6   13  -14                 $ Bottom Outer Refl
5     11   0.048066    -6   14  -15                 $ Bottom Inner Refl
6     14   0.069986    -3   15  -16                 $ Steel Filler
7     14   0.069986     3   -6   15  -16            $ Steel Ring
8     14   0.069986    -6   16  -17                 $ Steel Bottom
9      8   0.098864    -4   17  -18                 $ UH3 Part A
10     0               4   -5   17  -18            $ Air Gap
11    14   0.069986     5   -6   17  -18            $ Steel Side
12    14   0.069986    -6   18  -19                 $ Steel Top
13    14   0.069986    -6   19  -20                 $ Steel Bottom
14     3   0.101868    -4   20  -21                 $ UH3 Part II
15     0               4   -5   20  -21            $ Air Gap
```

```
16    14   0.069986     5   -6   20  -21            $ Steel Side
17    14   0.069986    -6   21  -22                 $ Steel Top
18    14   0.069986     3   -6   22  -23            $ Steel Ring
19    15   0.060240     1   -2   22  -25            $ Al Spacer
20     0               -6   22  -25  #18  #19  #21   $ Void
21    14   0.069986     3   -6   24  -25            $ Steel Ring
22    14   0.069986    -6   25  -26                 $ Steel Bottom
23     1   0.101798    -4   26  -27                 $ UH3 Part I
24     0               4   -5   26  -27             $ Air Gap
25    14   0.069986     5   -6   26  -27            $ Steel Side
26    14   0.069986    -6   27  -28                 $ Steel Top
27    14   0.069986    -6   28  -29                 $ Steel Bottom
28     9   0.099069    -4   29  -30                 $ UH3 Part B
29     0               4   -5   29  -30             $ Air Gap
30    14   0.069986     5   -6   29  -30            $ Steel Side
31    14   0.069986    -6   30  -31                 $ Steel Top
32    14   0.069986     3   -6   31  -32            $ Steel Ring
33    14   0.069986    -3   31  -32                 $ Steel Filler
34    11   0.048066    -6   32  -33                 $ Top Inner Refl
35    11   0.048066    -6   33  -35                 $ Top Outer Refl
36     0               6   -7    13  -36            $ Inner Gap
37    14   0.069986     7   -8    13  -36            $ Steel sleeve
38     0               8   -9    13  -36            $ Outer Gap
39     0              -6   35   -36                 $ Void above Top Refl
40     0              11:-12:36

1      cz   6.03250                  $ Spacer IR
2      cz   6.35000                  $ Spacer OR
3      cz   7.49300                  $ Steel Filler OR
4      cz   7.50500                  $ UH3 OR
5      cz   7.51480                  $ Air Gap OR
6      cz   7.54380                  $ Steel Container OR
7      cz   7.54888                  $ Inner Void OR
8      cz   7.67588                  $ Sleeve OR
9      cz   7.70128                  $ Outer Void OR
10     cz  10.04315                  $ Inner Reflector OR
11     cz  15.14094                  $ Outer Reflector OR
12     pz  -1.27000                  $ Bottom of Al Support
13     pz   0.00000                  $ Top of Al Support
14     pz   5.08000                  $ Bottom of Inner Reflector
15     pz   7.42000                  $ Top of Bottom Reflector
16     pz   7.57875                  $ Top of Steel Filler
17     pz   7.60415                  $ Bottom of Bottom UH3
18     pz   9.60415                  $ Top of Bottom UH3
19     pz   9.62955                  $ Top of Steel Container
20     pz   9.65495                  $ Bottom of Second UH3
21     pz  12.65495                  $ Top of Second UH3
22     pz  12.68035                  $ Top of Steel Container
23     pz  12.83910                  $ Top of Steel Ring
24     pz  14.76569                  $ Bottom of Steel Ring
25     pz  14.92444                  $ Bottom of Steel Container
26     pz  14.94984                  $ Bottom of Third UH3
27     pz  17.94984                  $ Top of Third UH3
28     pz  17.97524                  $ Top of Steel Container
29     pz  18.00064                  $ Bottom of Fourth UH3
30     pz  20.00064                  $ Top of Fourth UH3
31     pz  20.02604                  $ Top of Steel Container
32     pz  20.18479                  $ Top of Steel Ring
33     pz  22.52479                  $ Top of Top Inner Reflector
34     pz  24.98852                  $ Top of Inner Reflector
35     pz  27.60533                  $ Top of Top Reflector
36     pz  30.06852                  $ Top of Outer Reflector

kcode  10000  1.0  50  550
ksrc   0  0  8.60415   0  0 11.15495
       0  0 16.44984   0  0 19.00064
imp:n  1.0  37r  0.0   0.0
m1      1001.66c 7.3871E-02
        8016.66c 8.5553E-04
        6000.66c 1.4562E-04
        7014.66c 1.3593E-03
```

```
        26054.66c 2.1456E-06
        26056.66c 3.3651E-05
        26057.66c 7.7755E-07
        26058.66c 1.0270E-07
        79197.66c 3.7472E-04
        92234.66c 2.5279E-04
        92235.66c 2.3450E-02
        92236.66c 1.1027E-04
        92238.66c 1.3421E-03
m3       1001.66c 7.5396E-02
         8016.66c 5.6703E-04
         6000.66c 1.9943E-04
         7014.66c 1.9699E-04
        26054.66c 2.2386E-06
        26056.66c 3.5109E-05
        26057.66c 8.1124E-07
        26058.66c 1.0714E-07
        79197.66c 3.6162E-04
        92234.66c 2.5484E-04
        92235.66c 2.3409E-02
        92236.66c 1.0757E-04
        92238.66c 1.3371E-03
m6       1001.66c 6.9913E-02
         8016.66c 4.8424E-04
         6000.66c 1.5288E-04
         7014.66c 2.0644E-04
        26054.66c 6.0641E-07
        26056.66c 9.5108E-06
        26057.66c 2.1976E-07
        26058.66c 2.9025E-08
        79197.66c 3.3764E-04
        92234.66c 2.5651E-04
        92235.66c 2.3550E-02
        92236.66c 1.0829E-04
        92238.66c 1.3584E-03
m8       1001.66c 7.2639E-02
         8016.66c 6.0377E-04
         6000.66c 9.6792E-05
         7014.66c 4.4263E-04
        26054.66c 5.2565E-06
        26056.66c 8.2442E-05
        26057.66c 1.9049E-06
        26058.66c 2.5159E-07
        79197.66c 3.0333E-04
        92234.66c 2.4557E-04
        92235.66c 2.3030E-02
        92236.66c 1.0085E-04
        92238.66c 1.3124E-03
m9       1001.66c 7.3240E-02
         8016.66c 4.9360E-04
         6000.66c 1.2804E-04
         7014.66c 2.3019E-04
        26054.66c 3.9608E-06
        26056.66c 6.2120E-05
        26057.66c 1.4354E-06
        26058.66c 1.8958E-07
        79197.66c 3.0012E-04
        92234.66c 2.5226E-04
        92235.66c 2.2951E-02
        92236.66c 1.0055E-04
        92238.66c 1.3058E-03
m10      1001.66c 7.2725E-02
         8016.66c 6.3714E-04
         6000.66c 1.5539E-04
         7014.66c 2.4400E-04
        26054.66c 1.1942E-05
        26056.66c 1.8729E-04
        26057.66c 4.3276E-06
        26058.66c 5.7156E-07
        79197.66c 3.4333E-04
        92234.66c 2.4873E-04
```

```
       92235.66c 2.2939E-02
       92236.66c 1.0390E-04
       92238.66c 1.3117E-03
m11    92235.66c 9.7360E-05
       92238.66c 4.7969E-02
m12     4009.66c 1.2295E-01
m13    26054.66c 5.0213E-03
       26056.66c 7.8753E-02
       26057.66c 1.8197E-03
       26058.66c 2.4034E-04
m14     6000.66c 5.4977E-04
       25055.66c 1.6969E-04
       26054.66c 4.0521E-03
       26056.66c 6.3552E-02
       26057.66c 1.4685E-03
       26058.66c 1.9395E-04
m15    13027.66c 6.0240E-02
totnu
print
```

LLNL pulsed Pu-239, 0.7 mfp

```
1    515 0.04296039     -2  -5                        imp:p,n=1
2    515 0.04296039      2   4  -5                    imp:p,n=1
3    502 0.08768103      (-1   2  -3):(2    3 -4  -6) imp:p,n=1
4    502 0.08768103       (1   5  -6  4):( -1  5  -6) imp:p,n=1
5    501 4.77950e-5   1  -3  -6  #(-101 -111 103)     imp:p,n=1
6    501 4.77950e-5   6  -99     #(-101 -111 103)
          #(145 -146 147 -100)
          #(155 -156 157 -100)
          #(165 -166 167  100)                        imp:p,n=1
7    0               99                              imp:p,n=0
101  583 0.26654354   -101  -104   103                imp:p,n=1
102  582 0.09851961   -101  -105   104                imp:p,n=1
103  581 0.04448858   -101  -108   105                imp:p,n=1
104  584 0.863301886   -101   102  -115   108         imp:p,n=1
105  585 0.060292402   -101   102  -110   115         imp:p,n=1
106  587 0.29969056  -101  -111   110                 imp:p,n=1
107  586 0.060391857   -114   113  -110   109         imp:p,n=1
108  0               (-102  -110   108) #107          imp:p,n=0
140  501 4.77950e-5  141  -142  147  -148  -100       imp:p,n=1
141  501 4.77950e-5  143  -144  148  -99   -100       imp:p,n=1
142  521 0.07519419      143  -141  147  -148  -100   imp:p,n=1
143  521 0.07519419      142  -144  147  -148  -100   imp:p,n=1
144  521 0.07519419      145  -143  147  -99   -100   imp:p,n=1
145  521 0.07519419      144  -146  147  -99   -100   imp:p,n=1
150  501 4.77950e-5  151  -152  157  -158  -100       imp:p,n=1
151  501 4.77950e-5  153  -154  158  -99   -100       imp:p,n=1
152  521 0.07519419      153  -151  157  -158  -100   imp:p,n=1
153  521 0.07519419      152  -154  157  -158  -100   imp:p,n=1
154  521 0.07519419      155  -153  157  -99   -100   imp:p,n=1
155  521 0.07519419      154  -156  157  -99   -100   imp:p,n=1
160  501 4.77950e-5  161  -162  167  -168   100       imp:p,n=1
161  501 4.77950e-5  163  -164  168  -99    100       imp:p,n=1
162  521 0.07519419      163  -161  167  -168   100   imp:p,n=1
163  521 0.07519419      162  -164  167  -168   100   imp:p,n=1
164  521 0.07519419      165  -163  167  -99    100   imp:p,n=1
165  521 0.07519419      164  -166  167  -99    100   imp:p,n=1

1    px  -0.470
2    px  -0.62
3    x   -0.478  1.305  3.0   1.548
4    x   -0.62   1.455  2.85  1.698
5    so   3.515
6    so   3.665
99   so   1100
100  px   0.0
101    x   0.0005 0.8231  24.9 2.5411
102    x   0.0005 0.772   24.9 2.49
103    px -0.0775
104    px -0.0515
105    px -0.0005
```

```
108    px  0.0005
109    px  11.9
110    px  24.9
111    px  25.9
113    cx  0.63
114    cx  0.75
115    px  0.2505
141    x        -22.81172  0.0  -921.60572  438.3711
142    x         22.81172  0.0  -875.98228  438.3711
143    x        -45.62344  0.0  -944.41744  438.3711
144    x         45.62344  0.0  -853.17056  438.3711
145    x        -68.43516  0.0  -967.22916  438.3711
146    x         68.43516  0.0  -830.35884  438.3711
147    so        524.0
148    so        724.0
151    x        -24.68955  0.0  -803.06805  627.7953
152    x         24.68955  0.0  -753.68895  627.7953
153    x        -40.61829  0.0  -818.99679  627.7953
154    x         40.61829  0.0  -737.76021  627.7953
155    x        -56.54703  0.0  -834.92553  627.7953
156    x         56.54703  0.0  -721.83147  627.7953
157    so        605.0631
158    so        836.0032
161    x         17.35077  0.0   466.74777  893.3321
162    x        -17.35077  0.0   432.04623  893.3321
163    x         28.54481  0.0   477.94181  893.3321
164    x        -28.54481  0.0   420.85219  893.3321
165    x         39.73886  0.0   489.13586  893.3321
166    x        -39.73886  0.0   409.65814  893.3321
167    so        704.3673
168    so        935.3074

mode   n p
nps     500000
sdef  pos=0 0 0 dir=d100 erg=fdir=d200 rad=d300 vec=-1 0 0
      sur=100 tme=d400
si100 a  -1.0 -0.9 -0.8 -0.7 -0.6 -0.5 -0.4 -0.3 -0.2 -0.1 0.0
          0.1  0.2  0.3  0.4  0.5  0.6  0.7  0.8  0.9  1.0
sp100     452  454  457  459  461  464  466  469  471  473  476
          478  481  483  485  488  490  493  495  497  500
ds200 q  -1.0  21  -0.9  20  -0.8  19  -0.7  18  -0.6  17
         -0.5  16  -0.4  15  -0.3  14  -0.2  13  -0.1  12
          0.0  11   0.1  10   0.2   9   0.3   8   0.4   7
          0.5   6   0.6   5   0.7   4   0.8   3   0.9   2
          1.0   1
c **** spatial distribution of source ****
si300 h     0 0.6
sp300 d   -21 1
c **** energy distribution ****
si1   a 14.00 14.10 14.20 14.30
        14.40 14.50 14.60 14.70
        14.80 14.90 15.00 15.10
        15.20 15.30 15.40 15.50
        15.60 15.70 15.80 15.90
sp1     0.0000   0.0000   0.0067   0.2389
        2.2621   8.5730  15.3913  32.3405
       28.8480  27.8023  21.1403  18.0844
       15.4055  12.0301  10.9308   9.2068
        2.4887   0.0000   0.0000   0.0000
si2   a 14.00 14.10 14.20 14.30
        14.40 14.50 14.60 14.70
        14.80 14.90 15.00 15.10
        15.20 15.30 15.40 15.50
sp2     0.0000   0.0000   0.0394   0.5737
        5.0394  13.6361  29.4833  34.1046
       28.6987  24.5471  19.8926  14.8446
       13.9361  11.1899   7.7501   0.0000
si3   a 14.00 14.10 14.20 14.30
        14.40 14.50 14.60 14.70
        14.80 14.90 15.00 15.10
        15.20 15.30 15.40 15.50
```

```
sp3     0.0000   0.0000   0.0785   1.7539
        9.2111  23.6081  38.5865  34.3417
       28.0617  21.6143  17.0287  12.9269
       12.2382   3.2725   0.0000   0.0000
si4   a 14.00 14.10 14.20 14.30
        14.40 14.50 14.60 14.70
        14.80 14.90 15.00 15.10
        15.20 15.30 15.40 15.50
sp4     0.0000   0.0000   0.3960   3.9776
       18.2301  40.7022  40.1637  31.6909
       23.2557  17.6923  15.2267  10.3729
        0.0000   0.0000   0.0000   0.0000
si5   a 14.00 14.10 14.20 14.30
        14.40 14.50 14.60 14.70
        14.80 14.90 15.00 15.10
sp5     0.0000   0.0067   1.3001  12.0979
       35.0174  50.8234  35.4343  26.4734
       17.7935  16.0088   5.7390   0.0000
si6   a 14.00 14.10 14.20 14.30
        14.40 14.50 14.60 14.70
        14.80 14.90 15.00 15.10
sp6     0.0000   0.0783   4.2829  30.0627
       56.3041  43.4709  27.8980  21.5204
       16.0633   0.0000   0.0000   0.0000
si7   a 14.00 14.10 14.20 14.30
        14.40 14.50 14.60 14.70
        14.80 14.90 15.00 15.10
sp7     0.0000   0.3948  15.6730  61.0622
       54.0018  33.3282  23.2337  10.9731
        0.0000   0.0000   0.0000   0.0000
si8   a 14.00 14.10 14.20 14.30
        14.40 14.50 14.60 14.70
sp8     0.0000   3.3188  54.4578  70.2145
       39.9746  25.7899   3.8975   0.0000
si9   a 13.60 13.70 13.80 13.90
        14.00 14.10 14.20 14.30
        14.40 14.50 14.60 14.70
sp9     0.0000   0.0000   0.0000   0.0000
        0.0067  26.0337  95.8453  51.5943
       23.1595   0.0000   0.0000   0.0000
si10  a 13.60 13.70 13.80 13.90
        14.00 14.10 14.20 14.30
        14.40 14.50 14.60 14.70
sp10     0.0000   0.0000   0.0000   0.0000
         0.9035 111.2102  68.1255  15.3864
         0.0000   0.0000   0.0000   0.0000
si11  a 13.60 13.70 13.80 13.90
        14.00 14.10 14.20 14.30
sp11     0.0000   0.0000   0.0000   0.0000
        85.1427 106.4852   2.9840   0.0000
si12  a 13.60 13.70 13.80 13.90
        14.00 14.10 14.20 14.30
sp12     0.0000   0.0000   0.0000   0.0000
         193.5982   0.0000   0.0000   0.0000
si13  a 13.60 13.70 13.80 13.90
        14.00 14.10 14.20 14.30
sp13     0.0000   0.0000   0.0000 192.5454
         0.0391   0.0000   0.0000   0.0000
si14  a 13.60 13.70 13.80 13.90
        14.00 14.10 14.20 14.30
sp14     0.0000   0.0000 165.8002  25.7705
         0.0000   0.0000   0.0000   0.0000
si15  a 13.20 13.30 13.40 13.50
        13.60 13.70 13.80 13.90
        14.00 14.10 14.20 14.30
sp15     0.0000   0.0000   0.0000   0.0000
         16.4808  98.6775  73.5932   1.8055
         0.0000   0.0000   0.0000   0.0000
si16  a 13.20 13.30 13.40 13.50
        13.60 13.70 13.80 13.90
        14.00 14.10 14.20 14.30
```

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sp16     0.0000   0.0000   0.0000  23.7296
        66.2040  83.8084  15.6593   0.1418
         0.0000   0.0000   0.0000   0.0000
si17  a 13.20 13.30 13.40 13.50
        13.60 13.70 13.80 13.90
        14.00 14.10 14.20 14.30
sp17     0.0000   0.0000  27.0418  48.8467
        70.2340  39.1286   3.2608   0.0175
         0.0000   0.0000   0.0000   0.0000
si18  a 12.80 12.90 13.00 13.10
        13.20 13.30 13.40 13.50
        13.60 13.70 13.80 13.90
        14.00 14.10 14.20 14.30
sp18     0.0000   0.0000   0.0000   0.0000
         2.0303  27.2502  37.3878  59.8453
        47.9052  12.2015   0.8937   0.0018
         0.0000   0.0000   0.0000   0.0000
si19  a 12.80 12.90 13.00 13.10
        13.20 13.30 13.40 13.50
        13.60 13.70 13.80 13.90
sp19     0.0000   0.0000   0.0000   6.3499
        22.6144  31.9989  46.6420  49.5506
        25.0656   4.0393   0.2414   0.0000
si20  a 12.80 12.90 13.00 13.10
        13.20 13.30 13.40 13.50
        13.60 13.70 13.80 13.90
sp20     0.0000   0.0000  10.2318  19.7166
        25.7756  38.8741  44.2171  33.6233
        11.2554   1.7554   0.0389   0.0000
si21  a 12.80 12.90 13.00 13.10
        13.20 13.30 13.40 13.50
        13.60 13.70 13.80 13.90
sp21     0.0000  12.6426  16.9782  23.3949
        29.9762  40.9741  38.6652  16.3497
         4.8927   0.5835   0.0174   0.0000
sp400  -41    .300  0
m501    7014.   3.81291E-05
        8016.   9.49949E-06
        18036.  6.22913E-10
        18038.  1.10334E-10
        18040.  1.65708E-07
m502    26054.  0.00357856
        26056.  0.05412236
        26057.  0.00122858
        26058.  0.00015947
        24050.  0.00076364
        24052.  0.01414446
        24053.  0.00157338
        24054.  0.00038363
        28058.  0.00515142
        28060.  0.00191897
        28061.  0.00008202
        28062.  0.00025726
        28064.  0.00006282
        14028.  0.00313673
        14029.  0.00015335
        14030.  0.00009841
        25055.  0.00086597
m515    94239.  0.03582304
        94240.  0.00240380
        94241.  0.00011812
        31069.  0.00280579
        31071.  0.00180964
m521    1001.   0.00821494
        8016.   0.04358412
        13027.  0.00248091
        14028.  0.01447204
        14029.  0.00070750
        14030.  0.00045402
        11023.  0.00103418
        20040.  0.00280817
```

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        20042.  0.00001785
        20043.  0.00000364
        20044.  0.00005494
        20046.  0.00000010
        20048.  0.00000451
        26054.  0.00004098
        26056.  0.00061980
        26057.  0.00001407
        26058.  0.00000183
        19039.  0.00063680
        19040.  0.00000008
        19041.  0.00004371
m581    1003.   0.02224429
        22046.  0.00183515
        22047.  0.00165498
        22048.  0.01639849
        22049.  0.00120342
        22050.  0.00115225
m582    74180.  0.00012077
        74182.  0.02637557
        74183.  0.01416983
        74184.  0.03016835
        74186.  0.02768509
m583    26054.  0.00661958
        26056.  0.10381997
        26057.  0.00239889
        26058.  0.00031683
        29063.  0.05565831
        29065.  0.02480766
        1001.   0.03268930
        8016.   0.02011649
        13027.  0.00502912
        6000.   0.01508737
m584    13027.  0.43165094
        1001.   0.25899057
        13027.  0.17266038
m585    13027.  0.06029240
m586    13027.  0.06039186
m587    13027.  0.19045674
        29063.  0.09113699
        29065.  0.01809683
fc205 DM118(T):  NE213-A (Bias=1.6) Det Resp vs T, Path=975.2 cm, 120 deg line
f205x:n        438.2520  871.1775  0.0
de205 lin  1.6      1.7      1.8      1.9      2.0      2.1      2.2      2.3
           2.4      2.5      2.6      2.7      2.8      2.9      3.0      3.1
           3.2      3.3      3.4      3.5      3.6      3.7      3.8      3.9
           4.0      4.1      4.2      4.3      4.4      4.5      4.6      4.7
           4.8      4.9      5.0      5.1      5.2      5.3      5.4      5.5
           5.6      5.7      5.8      5.9      6.0      6.1      6.2      6.3
           6.4      6.5      6.6      6.7      6.8      6.9      7.0      7.1
           7.2      7.3      7.4      7.5      7.6      7.7      7.8      7.9
           8.0      8.1      8.2      8.3      8.4      8.5      8.6      8.7
           8.8      8.9      9.0      9.1      9.2      9.3      9.4      9.5
           9.6      9.7      9.8      9.9     10.0     10.1     10.2     10.3
          10.4     10.5     10.6     10.7     10.8     10.9     11.0     11.1
          11.2     11.3     11.4     11.5     11.6     11.7     11.8     11.9
          12.0     12.1     12.2     12.3     12.4     12.5     12.6     12.7
          12.8     12.9     13.0     13.1     13.2     13.3     13.4     13.5
          13.6     13.7     13.8     13.9     14.0     14.1     14.2     14.3
          14.4     14.5     14.6     14.7     14.8     14.9     15.0     15.1
          15.2     15.3     15.4     15.5     15.6     15.7     15.8     15.9
          16.0
df205 $ NE213A (Bias=1.6 MeV) data, renormalized to 1.0 at 15.0 MeV:
        0.0010   0.2009   0.3721   0.5181   0.6449   0.7533   0.8481   0.9298
        1.0013   1.0634   1.1163   1.1614   1.1983   1.2231   1.2663   1.3015
        1.3156   1.3277   1.3394   1.3525   1.3656   1.3777   1.3901   1.4028
        1.4129   1.4185   1.4191   1.4178   1.4240   1.4293   1.4335   1.4348
        1.4348   1.4338   1.4329   1.4306   1.4280   1.4250   1.4156   1.4152
        1.4107   1.4061   1.4002   1.3946   1.3884   1.3812   1.3718   1.3401
        1.3613   1.3574   1.3574   1.3479   1.3417   1.3365   1.3293   1.3231
        1.3133   1.2917   1.2800   1.2734   1.2682   1.2512   1.2460   1.2431
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          1.2372   1.2306   1.2320   1.2287   1.2231   1.2176   1.2101   1.2035
          1.1967   1.1895   1.1820   1.1722   1.1637   1.1571   1.1516   1.1454
          1.1388   1.1330   1.1271   1.1202   1.1140   1.1085   1.1026   1.0960
          1.0889   1.0820   1.0758   1.0699   1.0634   1.0578   1.0510   1.0454
          1.0389   1.0330   1.0284   1.0225   1.0180   1.0131   1.0088   1.0042
          1.0003   0.9964   0.9931   0.9902   0.9873   0.9843   0.9820   0.9794
          0.9775   0.9762   0.9748   0.9742   0.9739   0.9735   0.9735   0.9739
          0.9742   0.9758   0.9775   0.9794   0.9814   0.9833   0.9853   0.9869
          0.9889   0.9905   0.9925   0.9941   0.9961   0.9980   1.0000   1.0020
          1.0039   1.0056   1.0072   1.0085   1.0101   1.0118   1.0134   1.0147
          1.0160
t205  $ time bins in shakes (not nanoseconds)
          1.84000E+01  1.86000E+01  1.88000E+01  1.90000E+01  1.92000E+01
          1.94000E+01  1.96000E+01  1.98000E+01  2.00000E+01  2.02000E+01
          2.04000E+01  2.06000E+01  2.08000E+01  2.10000E+01  2.12000E+01
          2.14000E+01  2.16000E+01  2.18000E+01  2.20000E+01  2.22000E+01
          2.24000E+01  2.26000E+01  2.28000E+01  2.30000E+01  2.32000E+01
          2.34000E+01  2.36000E+01  2.38000E+01  2.40000E+01  2.42000E+01
          2.44000E+01  2.46000E+01  2.48000E+01  2.50000E+01  2.52000E+01
          2.54000E+01  2.56000E+01  2.58000E+01  2.60000E+01  2.62000E+01
          2.64000E+01  2.66000E+01  2.68000E+01  2.70000E+01  2.72000E+01
          2.74000E+01  2.76000E+01  2.78000E+01  2.80000E+01  2.82000E+01
          2.84000E+01  2.86000E+01  2.88000E+01  2.90000E+01  2.92000E+01
          2.94000E+01  2.96000E+01  2.98000E+01  3.00000E+01  3.02000E+01
          3.04000E+01  3.06000E+01  3.08000E+01  3.10000E+01  3.12000E+01
          3.14000E+01  3.16000E+01  3.18000E+01  3.20000E+01  3.22000E+01
          3.24000E+01  3.26000E+01  3.28000E+01  3.30000E+01  3.32000E+01
          3.34000E+01  3.36000E+01  3.38000E+01  3.40000E+01  3.42000E+01
          3.44000E+01  3.46000E+01  3.48000E+01  3.50000E+01  3.52000E+01
          3.54000E+01  3.56000E+01  3.58000E+01  3.60000E+01  3.62000E+01
          3.64000E+01  3.66000E+01  3.68000E+01  3.70000E+01  3.72000E+01
          3.74000E+01  3.76000E+01  3.78000E+01  3.80000E+01  3.82000E+01
          3.84000E+01  3.86000E+01  3.88000E+01  3.90000E+01  3.92000E+01
          3.94000E+01  3.96000E+01  3.98000E+01  4.00000E+01  4.02000E+01
          4.04000E+01  4.06000E+01  4.08000E+01  4.10000E+01  4.12000E+01
          4.14000E+01  4.16000E+01  4.18000E+01  4.20000E+01  4.22000E+01
          4.24000E+01  4.26000E+01  4.28000E+01  4.30000E+01  4.32000E+01
          4.34000E+01  4.36000E+01  4.38000E+01  4.40000E+01  4.42000E+01
          4.44000E+01  4.46000E+01  4.48000E+01  4.50000E+01  4.52000E+01
          4.54000E+01  4.56000E+01  4.58000E+01  4.60000E+01  4.62000E+01
          4.64000E+01  4.66000E+01  4.68000E+01  4.70000E+01  4.72000E+01
          4.74000E+01  4.76000E+01  4.78000E+01  4.80000E+01  4.82000E+01
          4.84000E+01  4.86000E+01  4.88000E+01  4.90000E+01  4.92000E+01
          4.94000E+01  4.96000E+01  4.98000E+01  5.00000E+01  5.02000E+01
          5.04000E+01  5.06000E+01  5.08000E+01  5.10000E+01  5.12000E+01
          5.14000E+01  5.16000E+01
e205  $ energy bins in MeV
          1.87230E+00  1.88693E+00  1.90173E+00  1.91673E+00  1.93193E+00
          1.94728E+00  1.96278E+00  1.97848E+00  1.99438E+00  2.01048E+00
          2.02678E+00  2.04327E+00  2.05997E+00  2.07692E+00  2.09407E+00
          2.11137E+00  2.12892E+00  2.14667E+00  2.16462E+00  2.18287E+00
          2.20132E+00  2.21997E+00  2.23892E+00  2.25812E+00  2.27752E+00
          2.29717E+00  2.31707E+00  2.33727E+00  2.35772E+00  2.37842E+00
          2.39942E+00  2.42066E+00  2.44221E+00  2.46406E+00  2.48621E+00
          2.50866E+00  2.53141E+00  2.55446E+00  2.57781E+00  2.60151E+00
          2.62556E+00  2.64991E+00  2.67461E+00  2.69966E+00  2.72505E+00
          2.75080E+00  2.77690E+00  2.80340E+00  2.83030E+00  2.85760E+00
          2.88525E+00  2.91330E+00  2.94180E+00  2.97070E+00  3.00005E+00
          3.02984E+00  3.06004E+00  3.09069E+00  3.12184E+00  3.15349E+00
          3.18559E+00  3.21814E+00  3.25124E+00  3.28488E+00  3.31903E+00
          3.35368E+00  3.38888E+00  3.42468E+00  3.46103E+00  3.49793E+00
          3.53542E+00  3.57357E+00  3.61232E+00  3.65172E+00  3.69177E+00
          3.73247E+00  3.77386E+00  3.81591E+00  3.85866E+00  3.90216E+00
          3.94641E+00  3.99140E+00  4.03720E+00  4.08380E+00  4.13120E+00
          4.17939E+00  4.22844E+00  4.27839E+00  4.32924E+00  4.38098E+00
          4.43363E+00  4.48728E+00  4.54192E+00  4.59752E+00  4.65417E+00
          4.71191E+00  4.77071E+00  4.83061E+00  4.89165E+00  4.95385E+00
          5.01725E+00  5.08189E+00  5.14779E+00  5.21498E+00  5.28353E+00
          5.35342E+00  5.42472E+00  5.49742E+00  5.57161E+00  5.64736E+00
          5.72460E+00  5.80344E+00  5.88399E+00  5.96623E+00  6.05018E+00
          6.13592E+00  6.22351E+00  6.31301E+00  6.40445E+00  6.49789E+00
```

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        6.59338E+00  6.69103E+00  6.79087E+00  6.89296E+00  6.99740E+00
        7.10419E+00  7.21348E+00  7.32532E+00  7.43981E+00  7.55705E+00
        7.67704E+00  7.79993E+00  7.92581E+00  8.05475E+00  8.18689E+00
        8.32232E+00  8.46116E+00  8.60355E+00  8.74958E+00  8.89936E+00
        9.05300E+00  9.21068E+00  9.37256E+00  9.53879E+00  9.70952E+00
        9.88485E+00  1.00650E+01  1.02504E+01  1.04408E+01  1.06363E+01
        1.08373E+01  1.10442E+01  1.12577E+01  1.14772E+01  1.17031E+01
        1.19361E+01  1.21756E+01  1.24225E+01  1.26775E+01  1.29405E+01
        1.32114E+01  1.34909E+01  1.37798E+01  1.40783E+01  1.43862E+01
        1.47047E+01  1.50340E+01
fq205  f  d  u  s  m  c  e  t
f215x:p        438.2520  871.1775  0.0
e215 0.0 99i 4 10
t215 0.0 99i 50.0
print
prdmp  2j 1 4
```