



# Minor Actinide Evaluations

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CSEWG Meeting

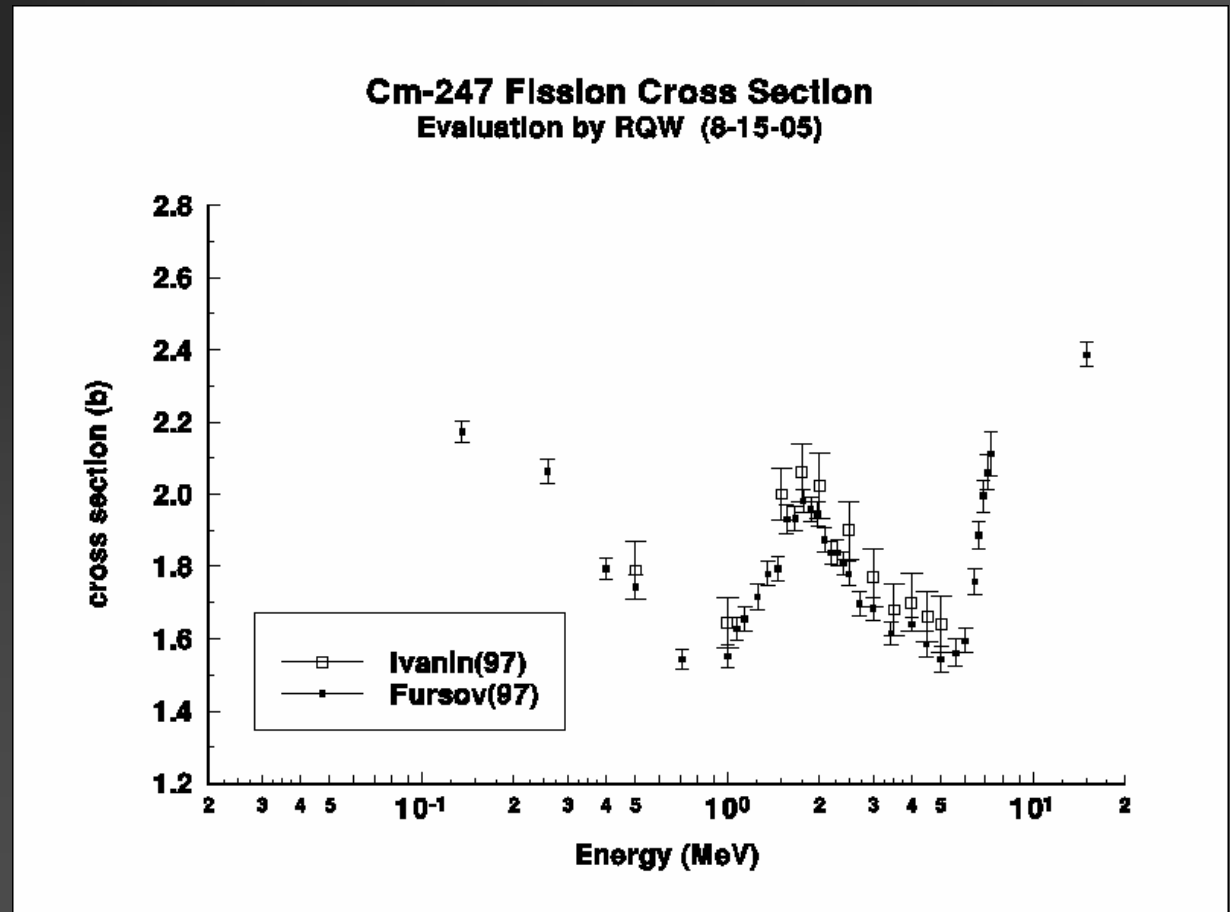
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# Cm-247 Evaluation

- The ENDF/B-VI evaluation is very old (July 1976) and needs to be revised.
- Revised evaluation starts with the JENDL-3.3 evaluation.
- Fission is revised between 0.03 and 20 MeV and elastic is changed to keep total cross section unchanged.
- Evaluation for revised fission cross section is based on measured data of Ivanin(97) and Fursov(97).
- For the energy range 0.5 to 3 MeV:
  - Compared to B6, fission is 15.3% lower.
  - Nubar is 5.8% higher and nu-fission is 10.4% lower.
- CHECKR, FIZCON, and PSYCHE were executed.
- No problems were detected in checking codes.

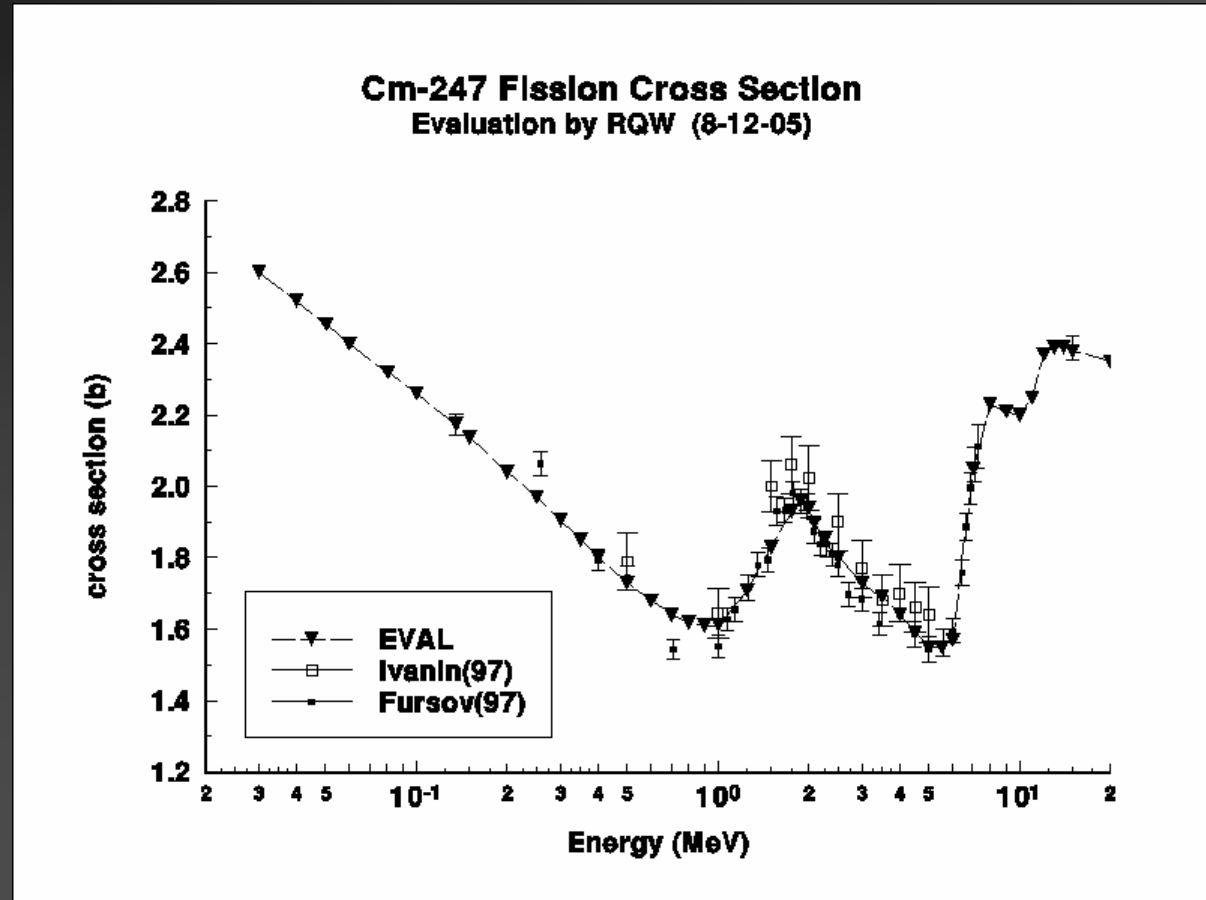
# Experimental Data

## ■ Figure 1



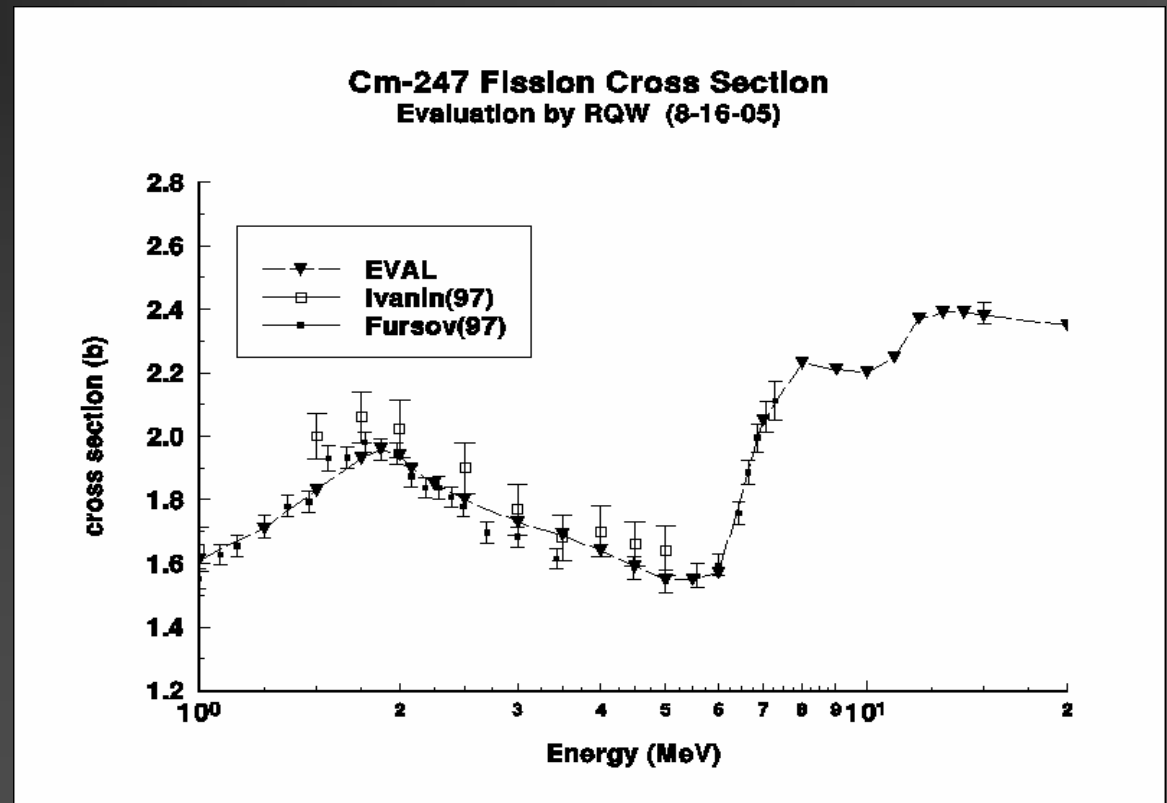
# Evaluation and exp. data

## ■ Figure 2



# Cm-247 Fission

Figure 3



# Impact of revised Cm-247 evaluation

- Lower fission rate in the 0.5 to 3 MeV range results in more Cm-247 and a higher production rate of Cm-248.
- The half-life of Cm-247 is 15.6 My
- (n, gamma) on Cm-247 produces Cm-248
- Cm-248 decays 91.6% by alpha and 8.4% by spontaneous fission (SF)
- SF rate is 2.7 times higher than the Cf-252 rate.
- Critical mass of unreflected Cm-247 metal sphere:
  - ENDF/B-VI 7.0 kg
  - Revised evaluation 9.4 kg

# Np-238 Evaluation

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- ENDF/B-VI evaluation is not only incomplete it is also wrong
  - The fission and capture are zero above 11 keV
    - Since Np-238 decays (2.117 d) to Pu-238, the
    - Pu-238 production rate will be in error.
  - We propose that JENDL-3.3 be used for ENDF/B -VII
  - CHECKR, FIZCON, and PSYCHE were executed.  
No problems were detected in the checking codes.
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# Pa-232 Evaluation

- Pa-232 was revised in Dec, 1999 starting from JENDL-3.2.
- The MLBW formalism was used for the resolved resonance range, 0 to 10 eV. (RQW)
- The thermal cross sections are not in agreement with more recent measurements:
  - Formushkin et al. EXFOR 41341 (fission)
  - Abramovich et al. EXFOR 41420 (capture)



# Pa-232 Evaluation

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- Changes to MF = 2 are as follows:
    - Bound level at  $-5.0$  eV revised
    - New level at  $-1.0$  eV is added
    - Number of resonances is increased from 13 to 14.
  - No other changes were made.
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# Pa-232 Evaluation

- Impact is to change cross sections below about 1 eV. Changes are small above 1 eV.
- The thermal cross sections are:

|         | ENDF/B-VI | Revised |
|---------|-----------|---------|
| Total   | 1762.2    | 1672.4  |
| Elastic | 32.8      | 43.9    |
| Fission | 1517.3    | 977.3   |
| Capture | 212.1     | 651.2   |

# Impact on applications

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- Pa-232 decays (1.31 days) to U-232.
  - A change in the low energy fission or capture cross section will impact the amount of Pa-232.
  - This will affect the amount of U-232 produced from Pa-232.
  - This in turn affects the quantity of U-232 and the amount of U-232 daughter nuclides.
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# Other minor actinide evaluations

Recommend that the following 23 nuclides available in JENDL-3.3 be considered for ENDF/B-VII. Review would be required.

|     |   |
|-----|---|
| 88  | $^{223}\text{Ra}$ , $^{224}\text{Ra}$ , $^{225}\text{Ra}$ , $^{226}\text{Ra}$                     |
| 89  | $^{225}\text{Ac}$ , $^{226}\text{Ac}$ , $^{227}\text{Ac}$   |
| 90  | $^{227}\text{Th}$ , $^{228}\text{Th}$ , $^{229}\text{Th}$ , $^{233}\text{Th}$ , $^{234}\text{Th}$ |
| 93  | $^{235}\text{Np}$   |
| 94  | $^{246}\text{Pu}$   |
| 95  | $^{244}\text{Am}$ , $^{244\text{m}}\text{Am}$   |
| 96  | $^{249}\text{Cm}$ , $^{250}\text{Cm}$   |
| 97  | $^{250}\text{Bk}$   |
| 98  | $^{254}\text{Cf}$   |
| 99  | $^{254}\text{Es}$ , $^{255}\text{Es}$   |
| 100 | $^{255}\text{Fm}$   |