Overview of Zirconium Cross Sections for ENDF/B-VII.0

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Round 1

- Subgroup 23 “Fission Products ...” provided new cross sections for the ENDF/B-VII zirconium isotopes.
- Testing at Bettis and KAPL showed a loss of reactivity in Monte Carlo analyses of proprietary benchmarks, relative to earlier ENDF data.
- A first round of sensitivity calculations was done to find the most likely source of the reactivity difference. We varied the elastic+inelastic, capture, and P1 angular moment for *elemental* zirconium up and down by 5%, 27 combinations in all.
- This pointed to the elastic+inelastic as the most important.

Rounds 2 - 4

- A second round of calculations tested the sensitivity to the different isotopes, pointing to Zr90.
- A third round varied the elastic and inelastic cross sections in Zr90 separately, pointing to the elastic.
- A fourth round split the elastic range in Zr90 at 400 keV, the top of the resonance region. The sensitivity to each range was about the same, and suggested ~5% increase in the high-energy region.
- Examination of the cross sections confirmed that the Subgroup 23 ZR90 elastic was several percent lower than other credible versions.

Round 5

- Mike Herman recalculated the Zr90 high-energy cross sections, using Empire in its default mode. This version (“beta2.5”) increased the elastic cross section and tested well in our benchmarks.
- Subsequently, he improved the data in beta3 and again in beta4 to better reproduce the high-energy cross sections.
- He has also recalculated the other four stable isotopes, which have a small effect on reactivity.

Conclusions

- Bettis and KAPL are satisfied with the performance of all three Empire versions, which are very close.
- It is worth noting that we did not have to tinker with the SG23 resonance parameters.
- The ICSBEP database for zirconium benchmarks is rather sparse, and the LWBR Seed-Blanket models suffer from uncertainties in the U233 cross sections.
- This was a nice demonstration of how integral benchmark calculations can lead to improvement of evaluated differential data.

^{90}Zr Elastic Cross Section Comparisons