Cr Evaluations

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[3]NAPC-Nuclear Data Section, International Atomic Energy Agency, Vienna, Austria
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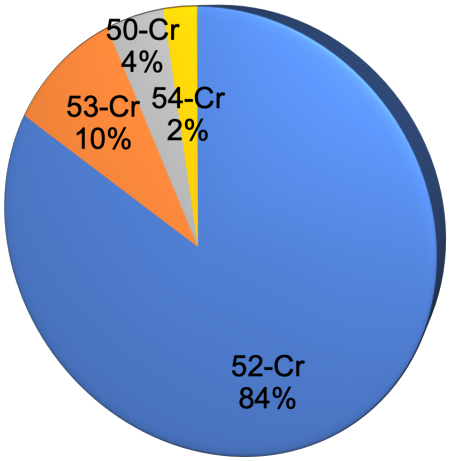
U.S. DEPARTMENT OF ENERGY

2020 Nuclear Data Week - CSEWG, November 30th - December 4th, 2020

Summary of Cr evaluations

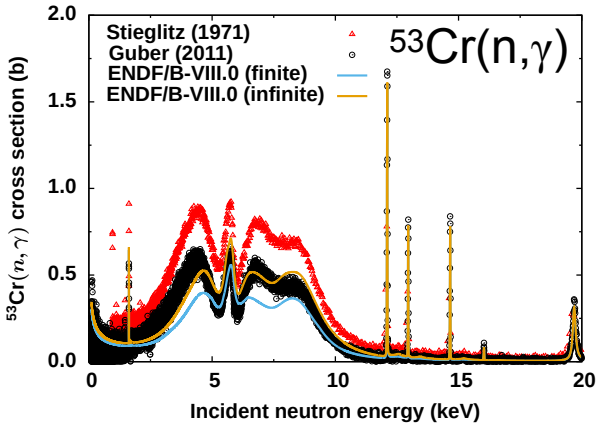


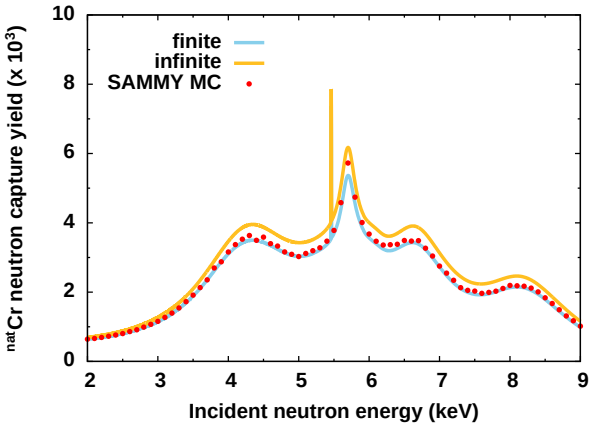
- Isotope and reactions to update?
  - *^{50,53}Cr: thermal and up to 10 keV; all reactions in fast region.*
  - *^{52,54}Cr: all reactions in fast region.*
  - *Reconstructed isotopic angular distributions in resonance region.*
- Motivation? Deficiencies in the current ENDF/B-VIII.0?
  - *Chromium is an important alloy in stainless steel. After recent evaluation of iron, it is essential to better constrain Cr files.*
  - *^{50,53}Cr: Cluster of capture resonances in the region 1-10 keV drive criticality in Cr-sensitive benchmarks. ENDF/B-VIII.0 followed data with inaccurate correction determination in this region (e.g., MS)*
- What new data/theory motivate a new evaluation/update?
  - *Appropriate normalization of Guber ^{53}Cr(n,g) data (ORNL) in the 1-10 keV region*
  - *Neutron and gamma ^{52}Cr inelastic data from Mihailescu (GEEL)*
  - *New soft-rotor dispersive optical potential for ^{50,52,54}Cr, interpolated as rigid rotor for ^{53}Cr*
- What validation testing has been/will be done?
  - *Chromium-sensitive benchmarks identified, in particular KBR-15 (HEU-COMP-INTER-005 k_∞) and ZPR-6/10 (PU-MET-INTER-002) with strong sensitivity to Cr – both are big outliers (11% and 2% in k, respectively)*
  - *Oktavian-Cr 14 MeV leakage: Not in SINBAD, new model developed in JSI*
  - *New evaluation greatly improves reactivity prediction and performs well for the 14 MeV benchmark*

Addressing the exp. discrepancy

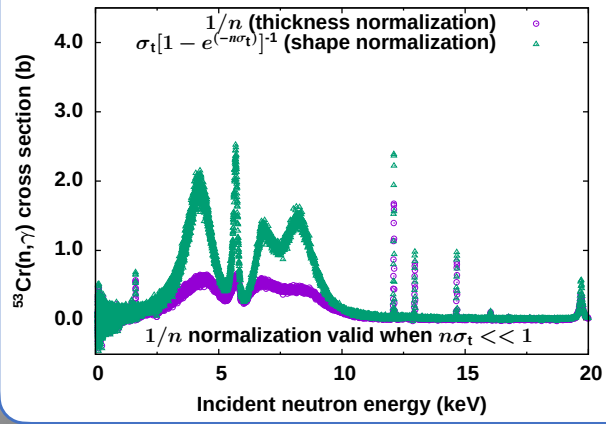
- Discrepancy between ^{53}Cr capture sets from Stieglitz and Guber
- ENDF/B-VIII.0 and BROND follow different improper corrections when converting data from yields to cross section
- Used ^{Nat}Cr transmission data to constrain the normalization of isotopic capture data

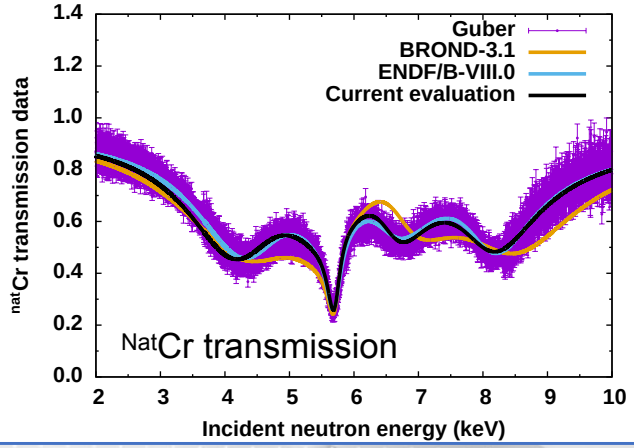
Normalized the neutron capture yield by the inverse of the sample thickness and tested for finite and infinite slab approximations.

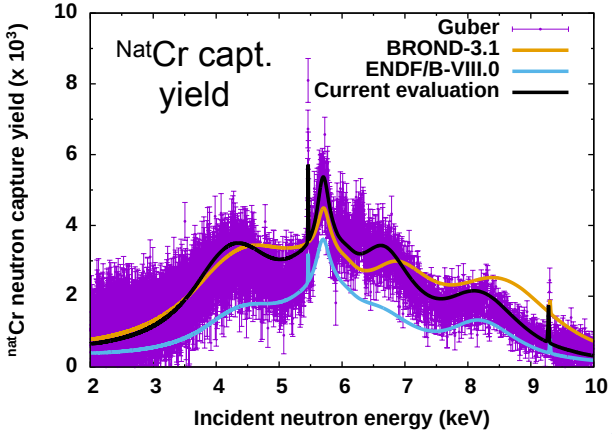




- Experimental validation of normalization of capture data
- Significantly increase in capture relative to ENDF/B-VIII.0
- Increased capture improves performance in criticality benchmarks
- BROND evaluation is not supported by data

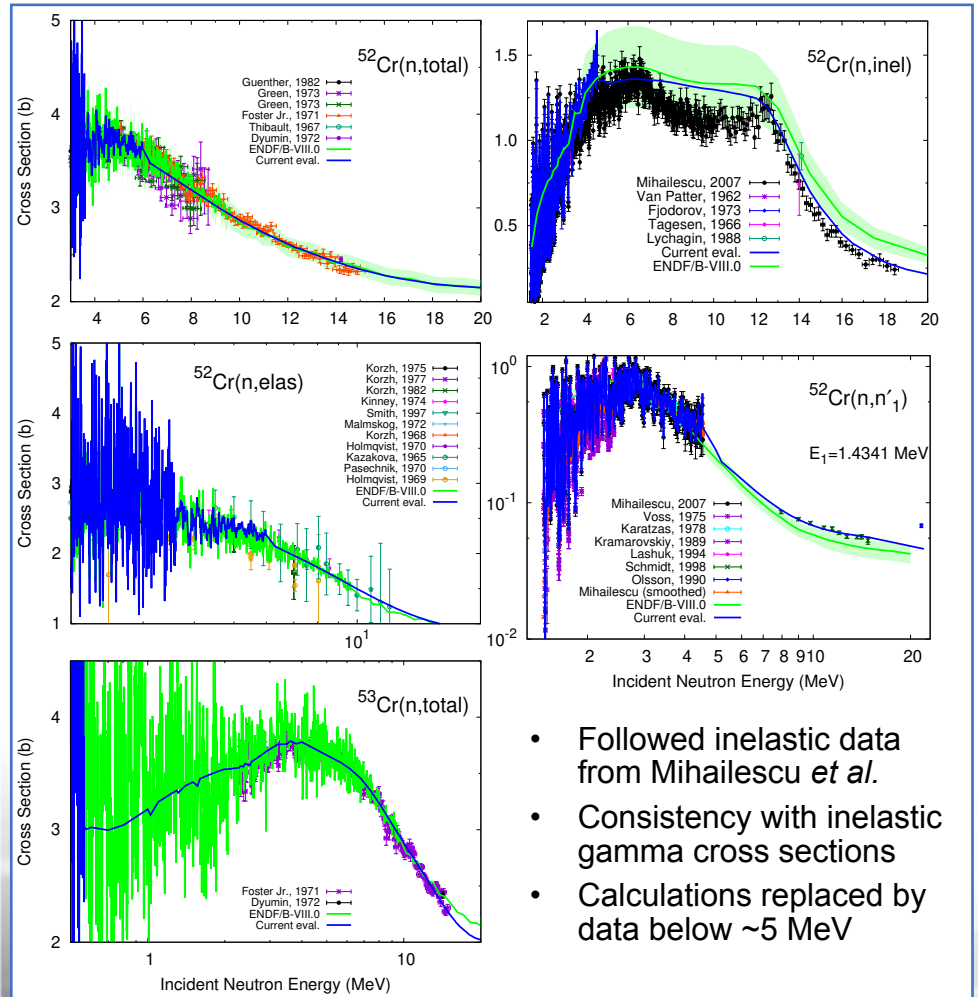






Fast neutron range

- New chromium-specific soft-rotor dispersive optical model potential, fitted to Abfalterer ^{nat}Cr(n,tot) data.
- Due to low-energy level densities being strongly parity asymmetric, we adopted tuned* RIPL-3 HFB LD for ^{52}Cr. Gilbert-Cameron for the minor isotopes
- Calculations done using the reaction code EMPIRE



- Followed inelastic data from Mihailescu *et al.*
- Consistency with inelastic gamma cross sections
- Calculations replaced by data below ~5 MeV

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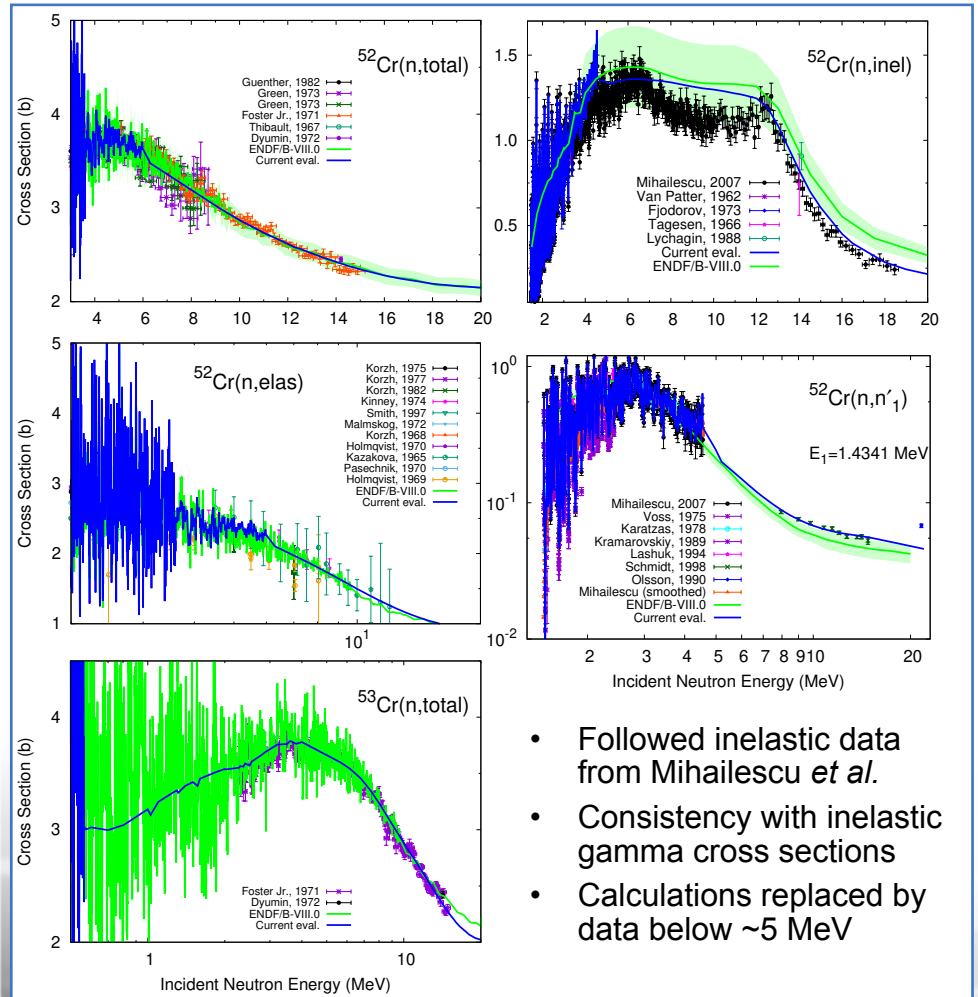

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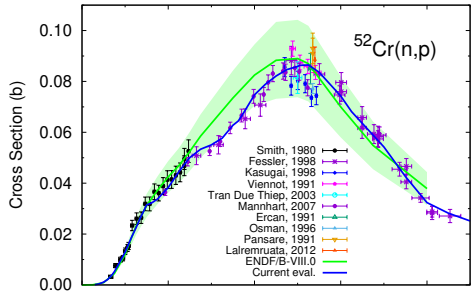

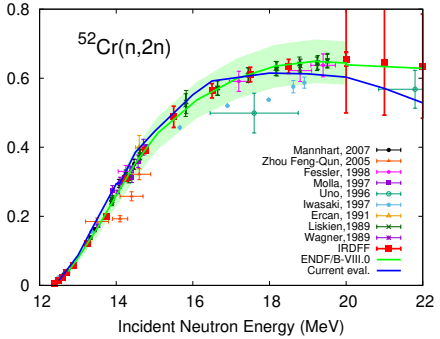

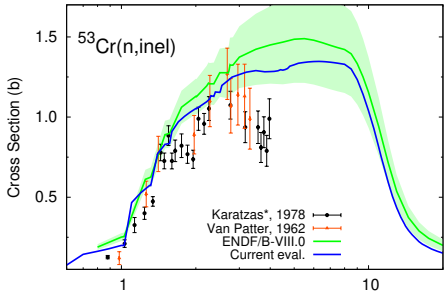

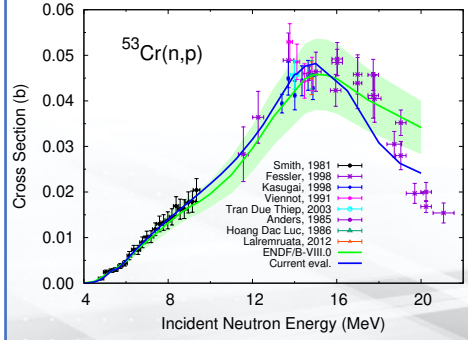

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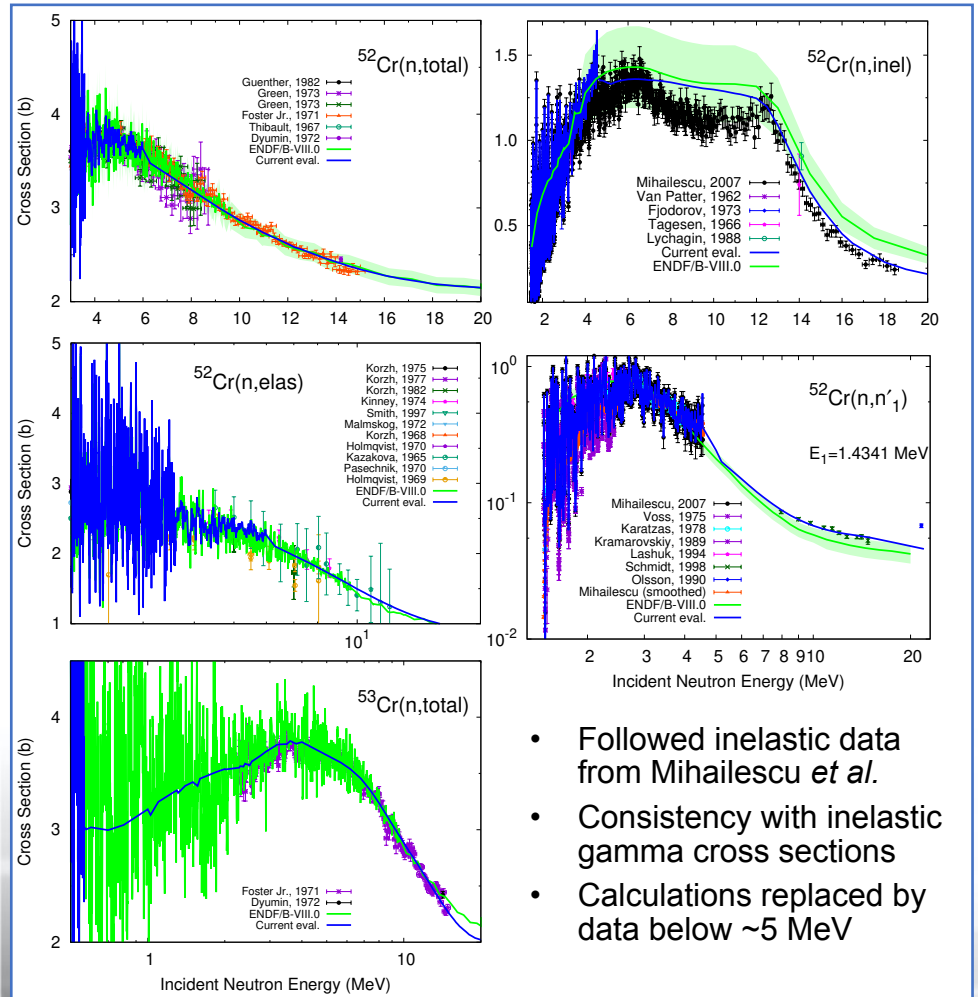

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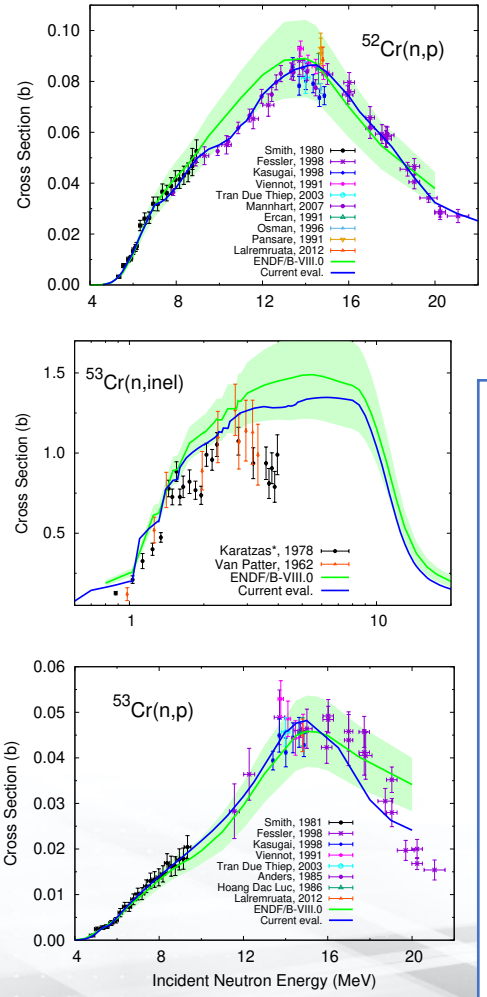

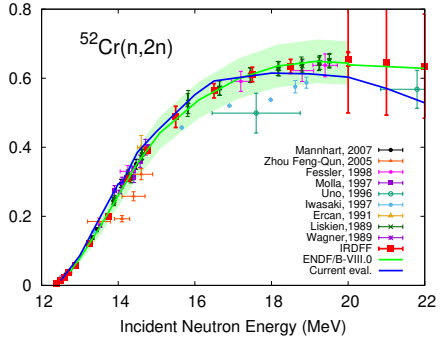

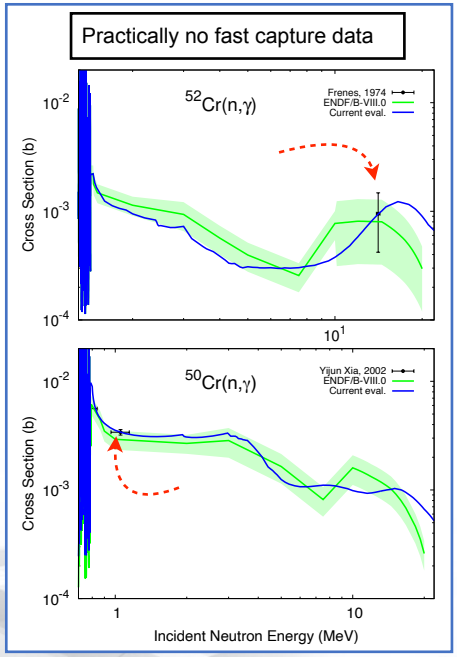

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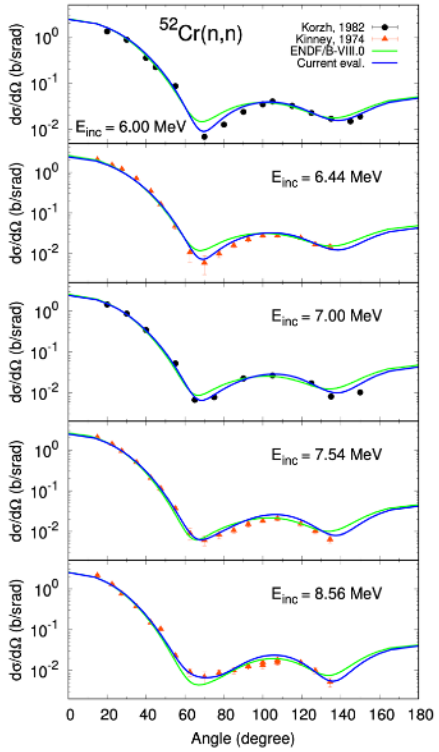
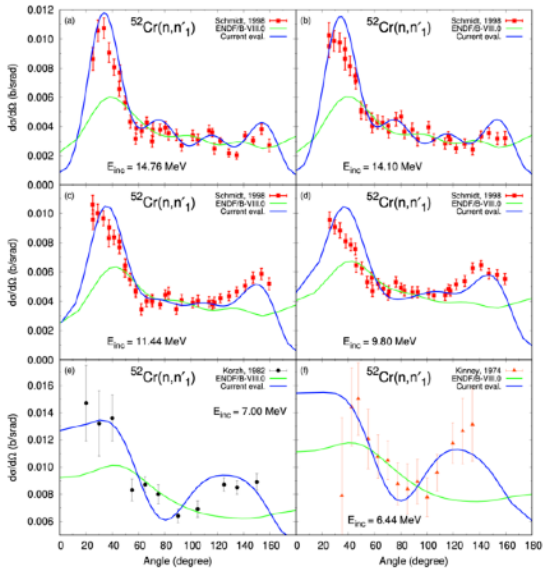
Angular distributions

- Improvements in descriptions of elastic and inelastic angular distributions is direct consequence of the more realistic optical potential





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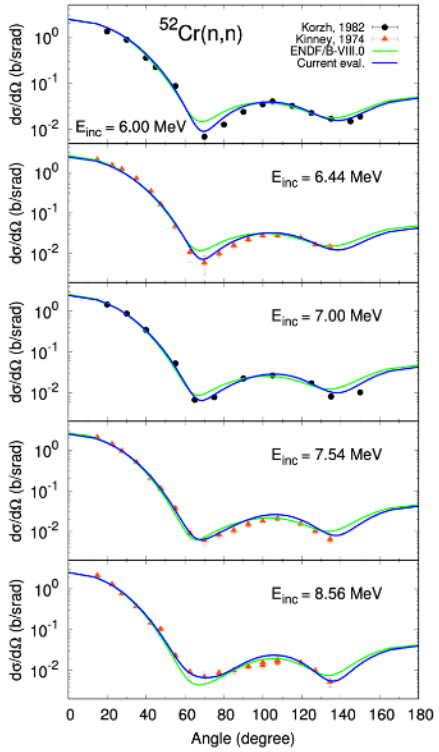

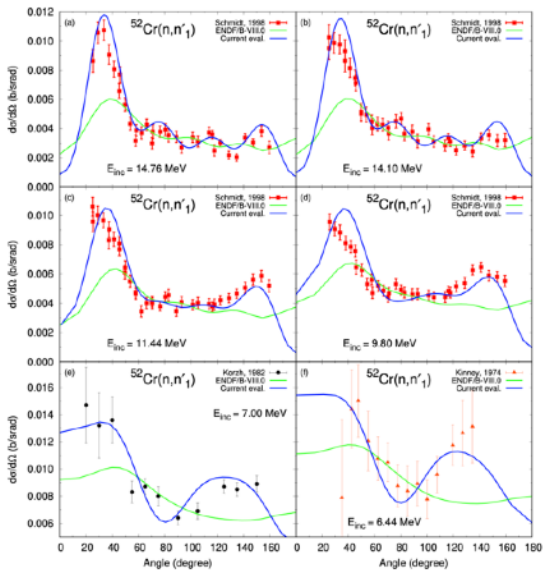

Summary

- **New evaluated files** for stable chromium isotopes represent a major improvement compared to existing files: Data agreement and Performance
- **Submitted** to ENDF/B library and IAEA for testing and distribution
- **Article** in final stages of preparation to be submitted to Nuclear Data Sheets
- **Details and results of validation** from criticality and leakage benchmarks will be presented tomorrow in the Validation session

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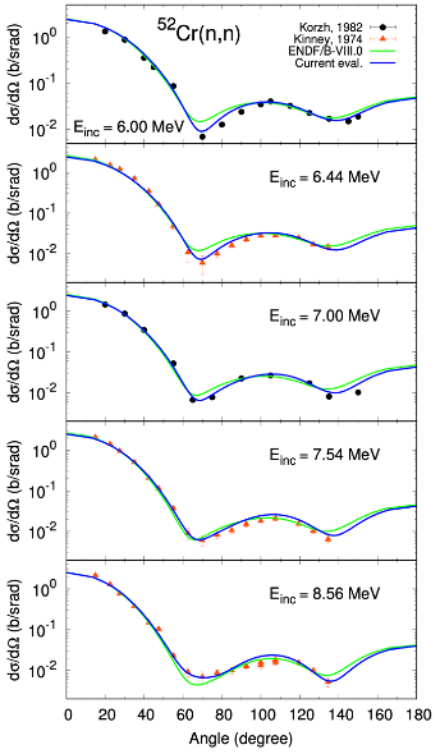

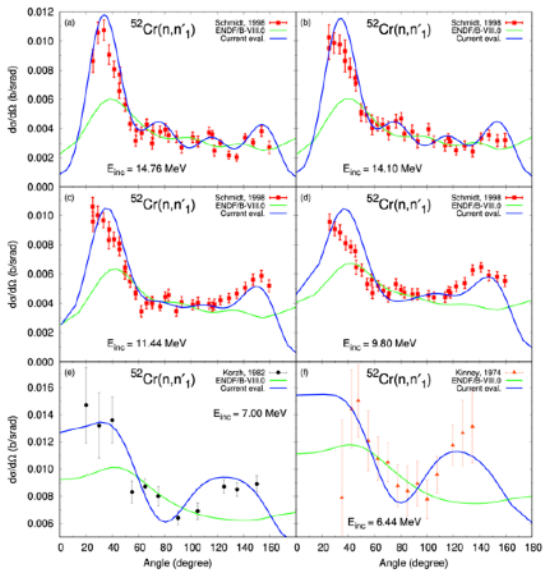

Newly Evaluated Neutron Reaction Data on Chromium Isotopes

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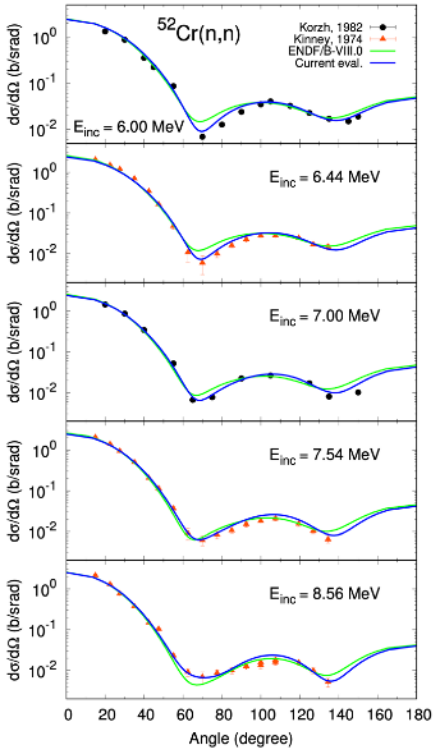

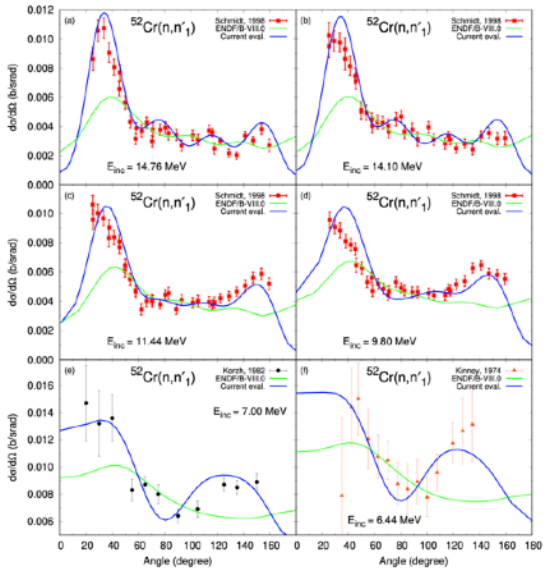

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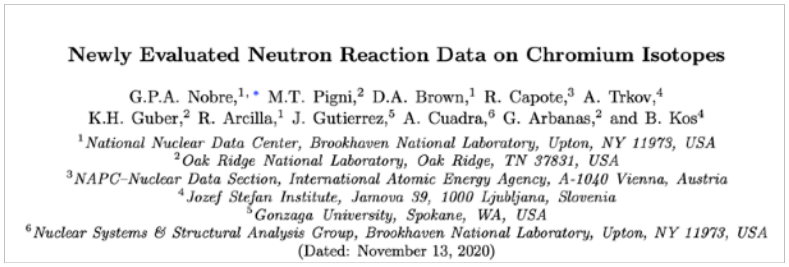

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