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TENDL-2019 and the Ni isotopes: what to expect

INDEN - International Nuclear Data Evaluation Network,
Vienna, IAEA, December 2-5, 2019

Summary

- The new TENDL-2019 library

- Ni isotopes in the RRR

- Ni isotopes in the fast range
  - TALYS calculations
  - Optimization based on differential data

TENDL-2019: new library

- Method: Quality evaluation, production automation, open source

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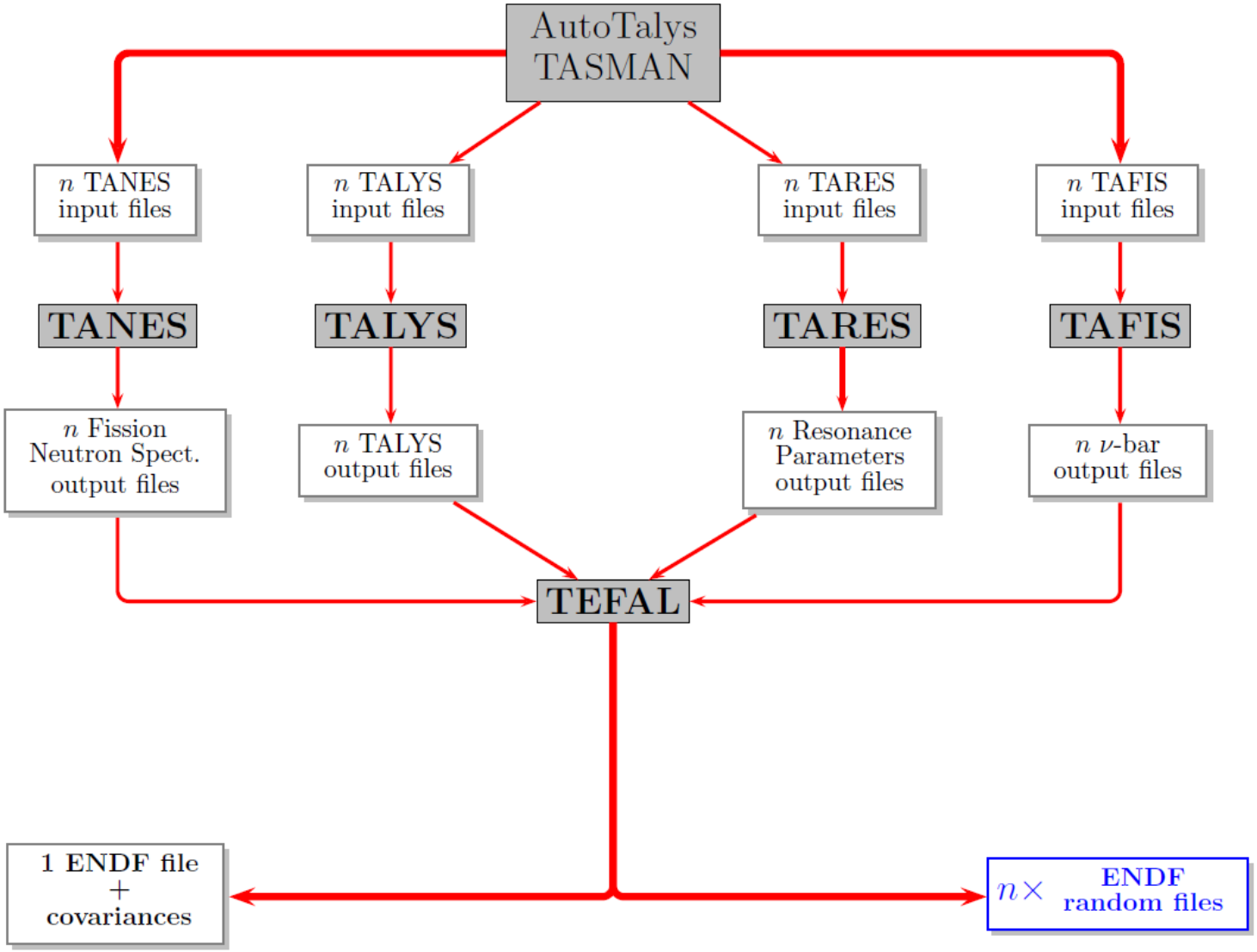


TENDL-2019, what is new ?

- To be release at the end of 2019
- Mainly developed between IAEA and PSI

- Beta versions already available (https://tendl.web.psi.ch/tendl_2019/tendl2019.html)

- Similar structure as the previous TENDL
  - 2813 isotopes, 200 MeV, with covariances
  - Neutrons, protons, deuterons, tritons, He3, alphas, and gammas

- New and simplified T6 available “on demand”

- TALYS-1.95 (above resonances)
- TARES-1.4 (resonances)
- NJOY-2016
- PREPRO-2018
- Other codes/tools

- New “library” database (comparisons, import…)

TENDL-2019, what is new ?

- TALYS-1.95
  - Improved photon strength function: Simplified Modified Lorenzian (better estimated of neutron capture c.s.)
  - (Again) solution of the remaining 30 MeV discontinuities (found by KIT and JAEA)
  - Improvement of specific nuclides (esp. Ni isotopes)

TENDL-2019, what is new ?

- TARES-1.4: resonance formatting and analyzing tool

- Measured/compiled/evaluated resonances:
  - Based on latest JENDL-4.0, ENDF/B-VIII.0 and JEFF-3.3
  - Based on the latest Atlas, 6th edition (2018)

- Statistical resonances:
  - Based on CALENDF
  - Translating the unresolved range from TALYS into statistically resolved range
  - Consistency between the RRR, URR and fast range

- Covariances in MF32 and MF33
  - Consistency between both format
  - Consistent with the random files (using the ENDSAM from IJS)

Ni isotopes in the RRR

- For stable Ni 58, 60, 61, 62 and 64, and unstable Ni59 and Ni63:
  - For thermal elastic

	Origin RRR	This work (barns)	END RRR (keV)	Atlas-2018 (barns)	ENDF/B-VIII.0 (barns)	JEFF-3.3 (barns)	JENDL-4.0 (barns)
Ni58	JENDL-4.0	24.8 ± 3.3	812	25.3 ± 0.4	25.0	25.0	25.0
Ni60	JENDL-4.0	1.4 ± 0.5	456	1.0 ± 0.1	1.1	1.0	1.4
Ni61	Atlas-2018	10.1 ± 0.6	69	8.2 ± 1.0	8.8	8.8	8.8
Ni62	Atlas-2018	9.6 ± 3.4	601	9.6 ± 0.4	9.7	9.6	9.6
Ni64	Altas-2018	0.01 ± 0.01	583	0.014 ± 0.005	0.3	0.3	0.03
Ni-nat		17.7 ± 2.2		17.8 ± 0.4	17.8	17.7	17.8
Ni59	Atlas-2018	1.8	15	-	2.3	6.7	2.3
Ni63	HFR	4.6	30	-	5.7	5.7	-

Ni isotopes in the RRR

- For stable Ni 58, 60, 61, 62 and 64, and unstable Ni59 and Ni63:
  - For thermal capture

	Origin RRR	This work (barns)		Atlas-2018 (barns)	ENDF/B-VIII.0 (barns)	JEFF-3.3 (barns)	JENDL-4.0 (barns)
Ni58	JENDL-4.0	4.6 ± 0.4		4.4 ± 0.1	4.2	4.6	4.6
Ni60	JENDL-4.0	2.9 ± 0.4		2.4 ± 0.1	2.4	2.8	2.9
Ni61	Atlas-2018	2.1 ± 0.5		2.1 ± 0.4	2.5	2.5	2.5
Ni62	Atlas-2018	14.9 ± 1.6		14.9 ± 0.3	14.9	14.3	14.3
Ni64	Altas-2018	1.6 ± 0.1		1.63 ± 0.02	1.5	1.5	1.5
Ni-nat		4.47 ± 0.29		4.49 ± 0.16	4.07	4.43	4.45
Ni59	Atlas-2018	73.9 ± 1.7		73.7 ± 1.8	75.8	73.4	75.6
Ni63	HFR	24.2 ± 12		24.4 ± 3.0	24.4	24.3	-

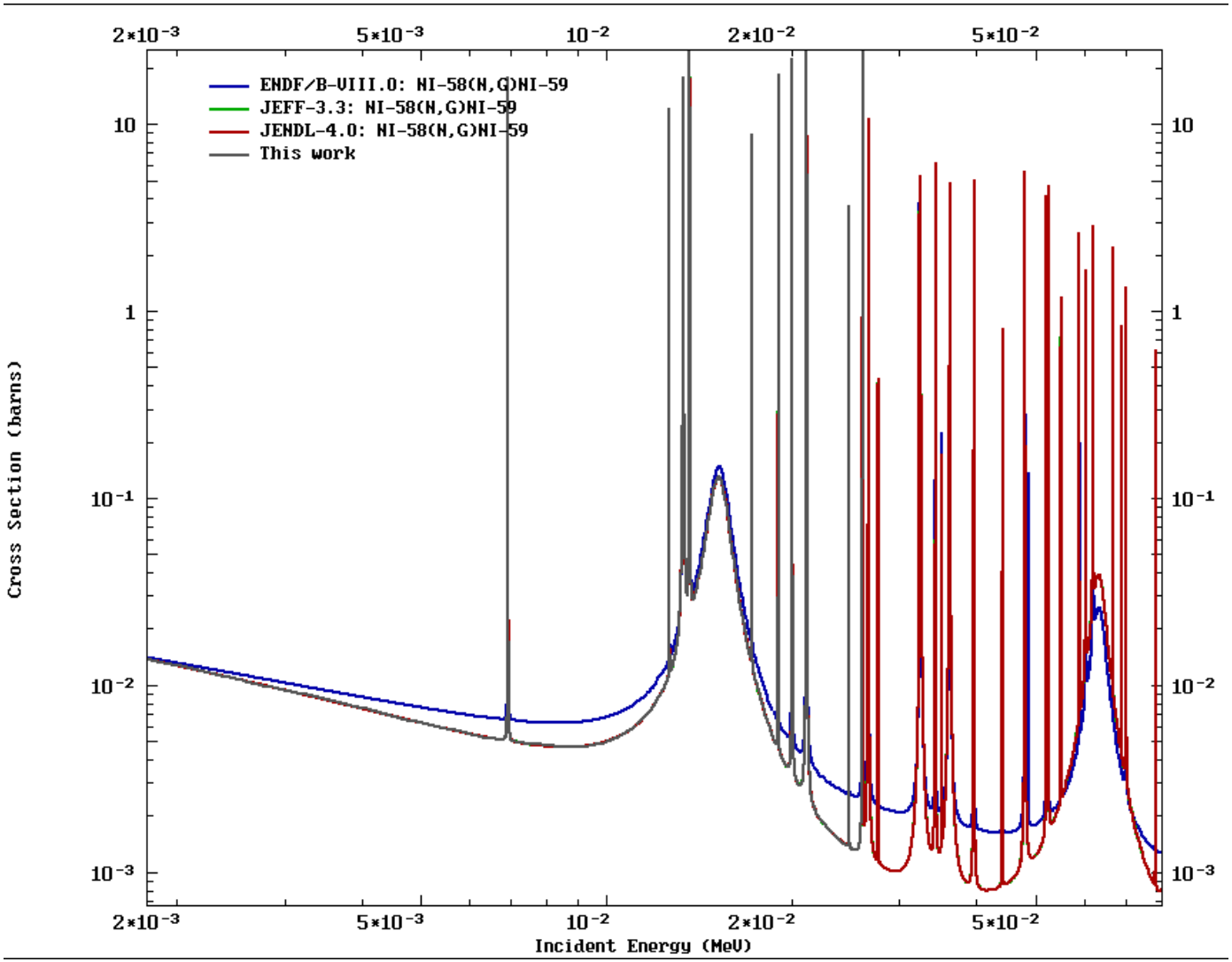
Ni isotopes in the RRR

- For stable Ni 58, 60, 61, 62 and 64, and unstable Ni59 and Ni63:
  - For resonance integral

	Origin RRR	RI (barns)		Atlas-2018 (barns)	ENDF/B-VIII.0 (barns)	JEFF-3.3 (barns)	JENDL-4.0 (barns)
Ni58	JENDL-4.0	2.1 ± 0.2		2.1 ± 0.2	1.9	2.1	2.1
Ni60	JENDL-4.0	1.4 ± 0.1		1.2 ± 0.1	1.2	1.3	1.4
Ni61	Atlas-2018	1.7 ± 0.1		1.8 ± 0.3	2.4	2.4	2.4
Ni62	Atlas-2018	6.8 ± 0.7		7.4 ± 0.4	7.0	6.6	6.6
Ni64	Altas-2018	0.9 ± 0.1		0.8 ± 0.1	0.8	0.8	0.8
Ni-nat		2.1		-	1.9	2.0	2.1
Ni59	Atlas-2018	116 ± 2		114 ± 8	118	108	118
Ni63	HFR	17.8		-	18.8	18.8	-

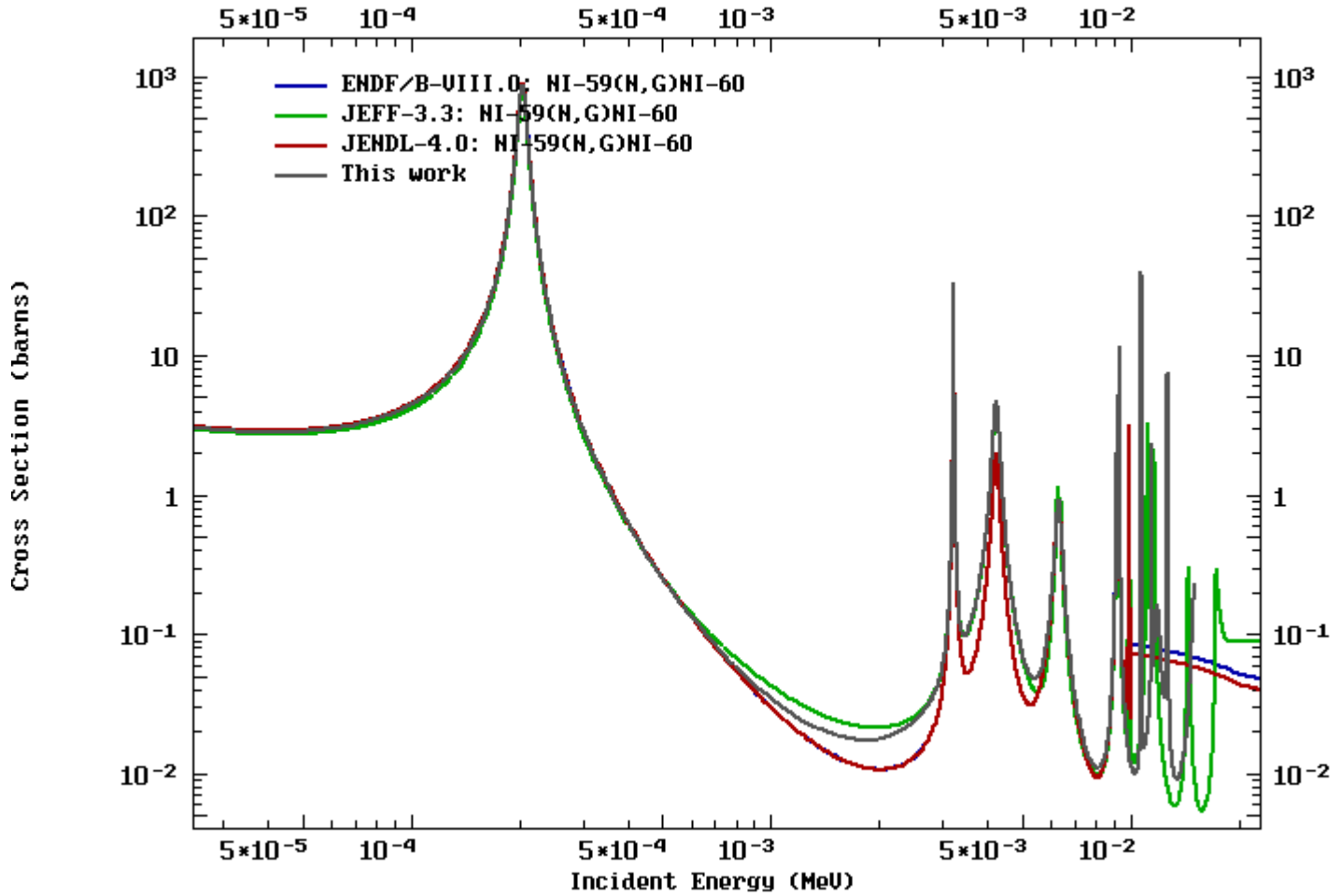
Ni isotopes in the RRR

- Plot of ^{58}Ni isotopes (n,g) in the RRR



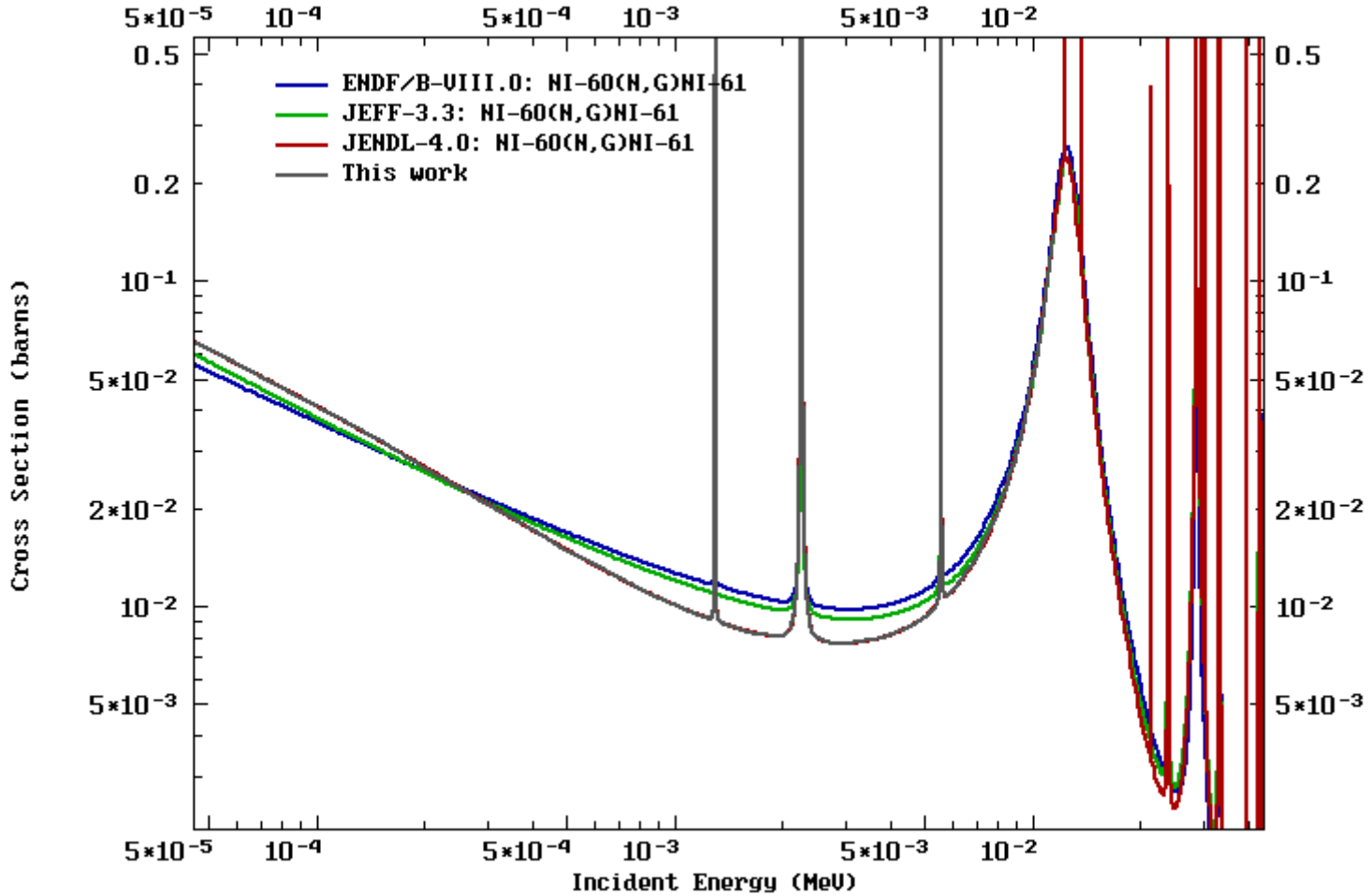
Ni isotopes in the RRR

- Plot of ^{59}Ni isotopes (n,g) in the RRR



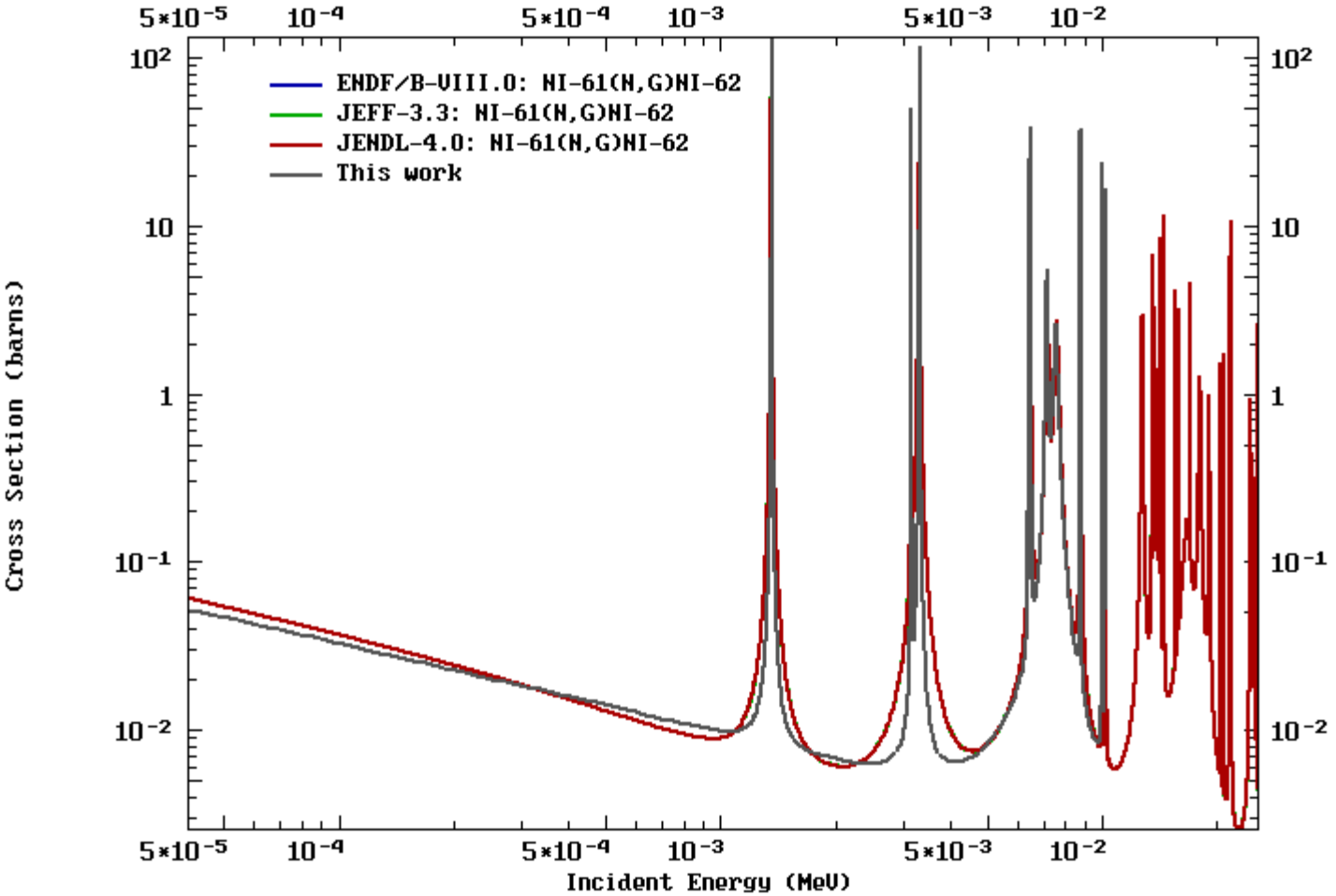
Ni isotopes in the RRR

- Plot of ^{60}Ni isotopes (n,g) in the RRR



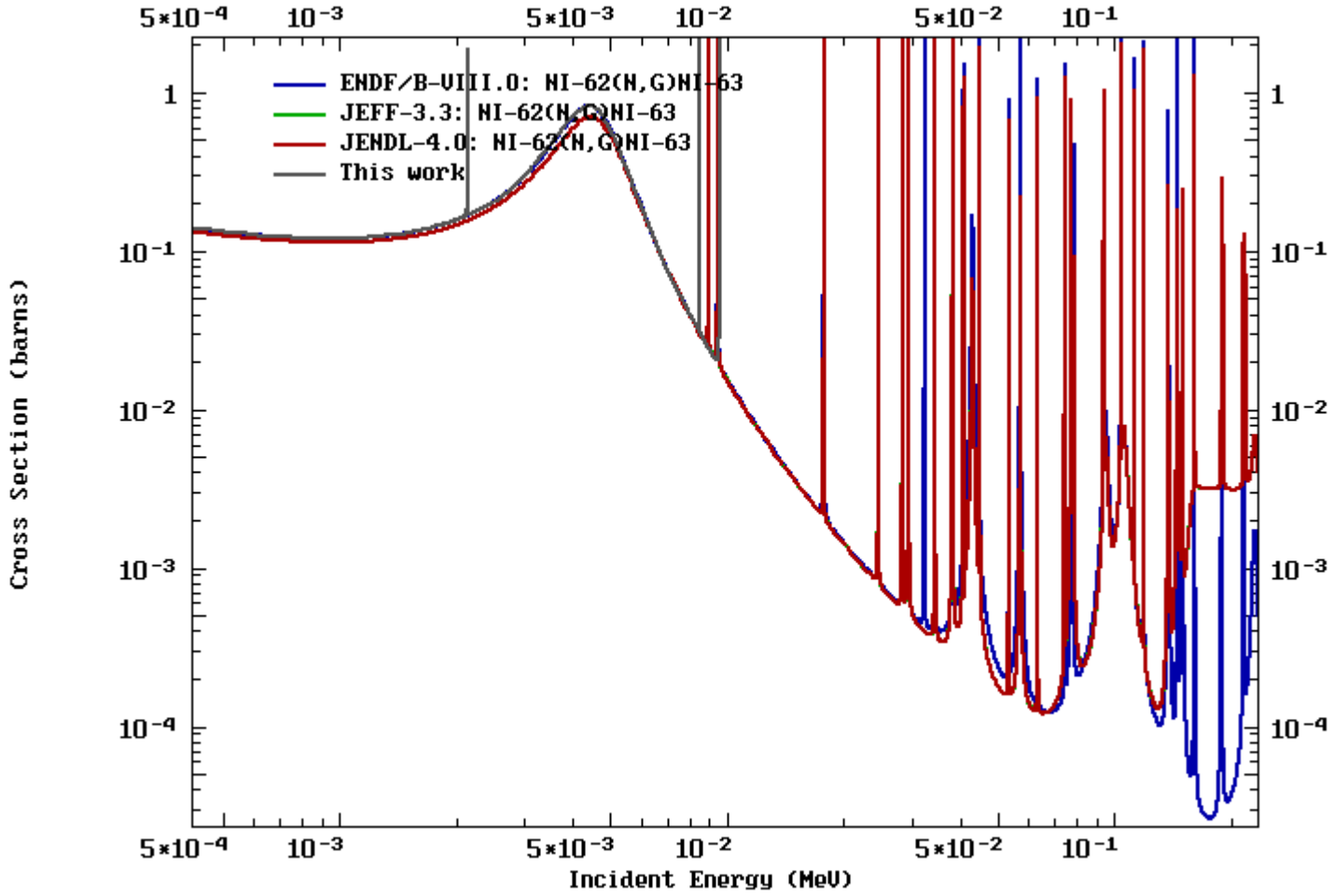
Ni isotopes in the RRR

- Plot of ^{61}Ni isotopes (n,g) in the RRR (new resonance parameters)



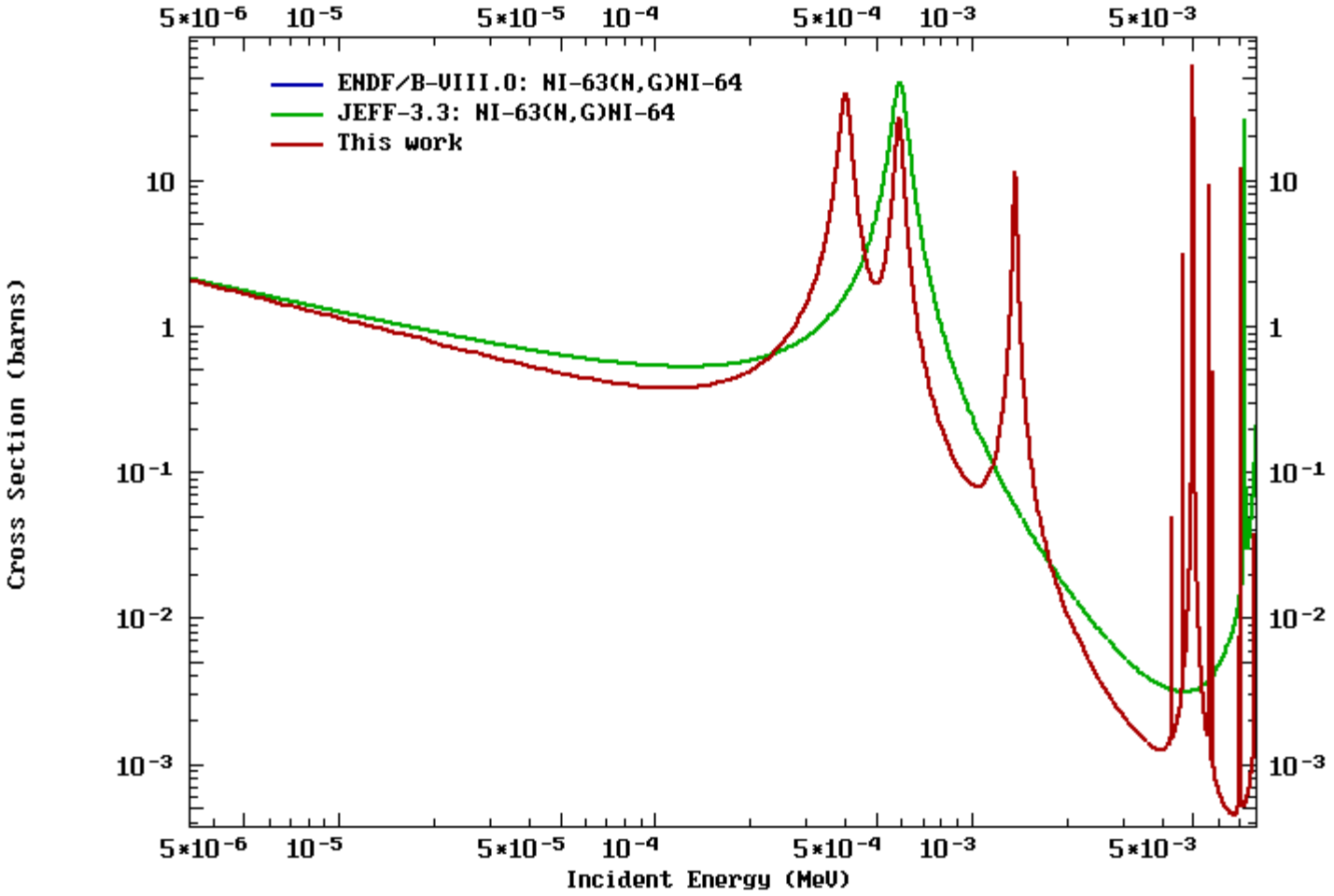
Ni isotopes in the RRR

- Plot of ^{62}Ni isotopes (n,g) in the RRR



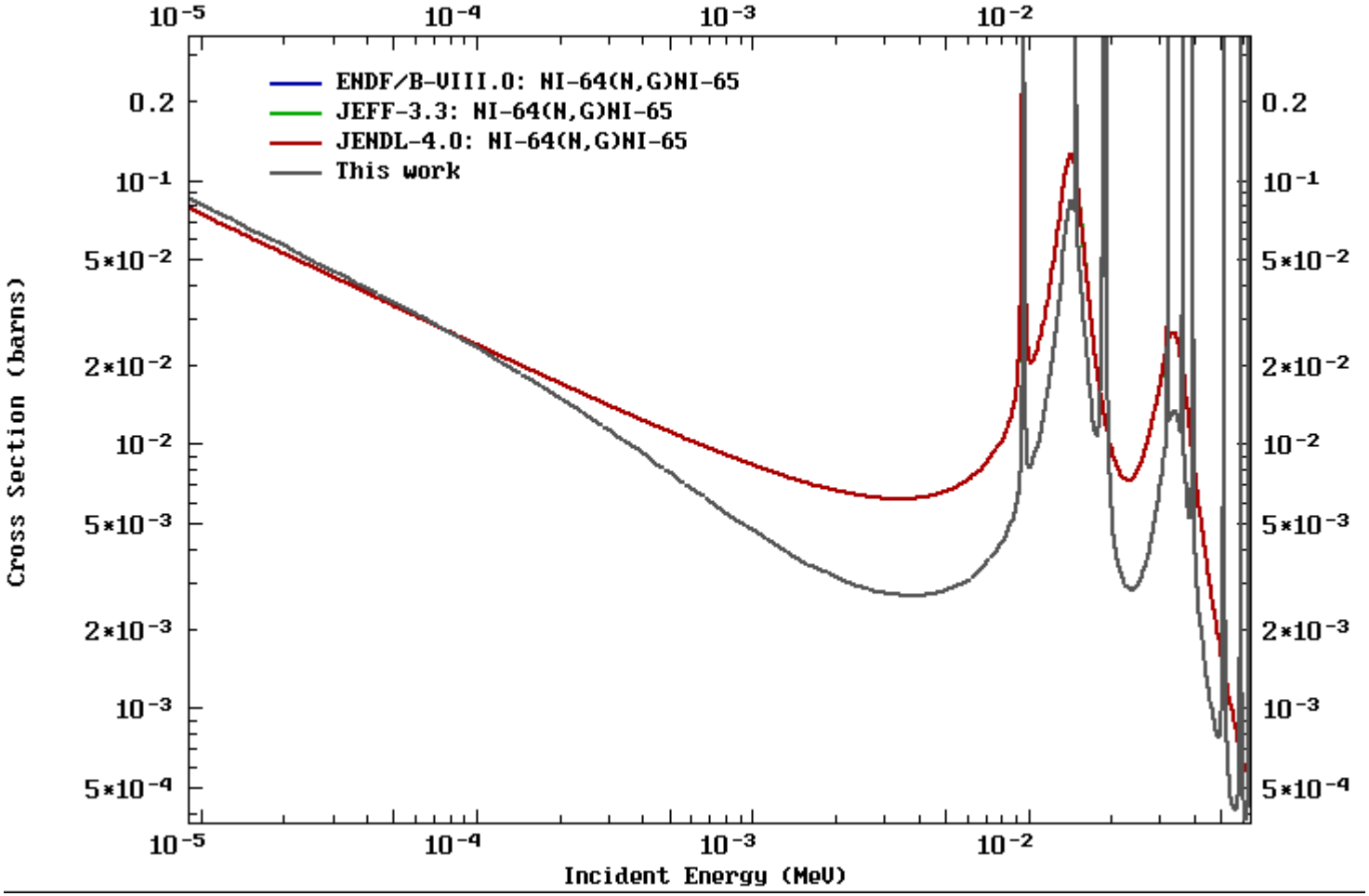
Ni isotopes in the RRR

- Plot of ^{63}Ni isotopes (n,g) in the RRR



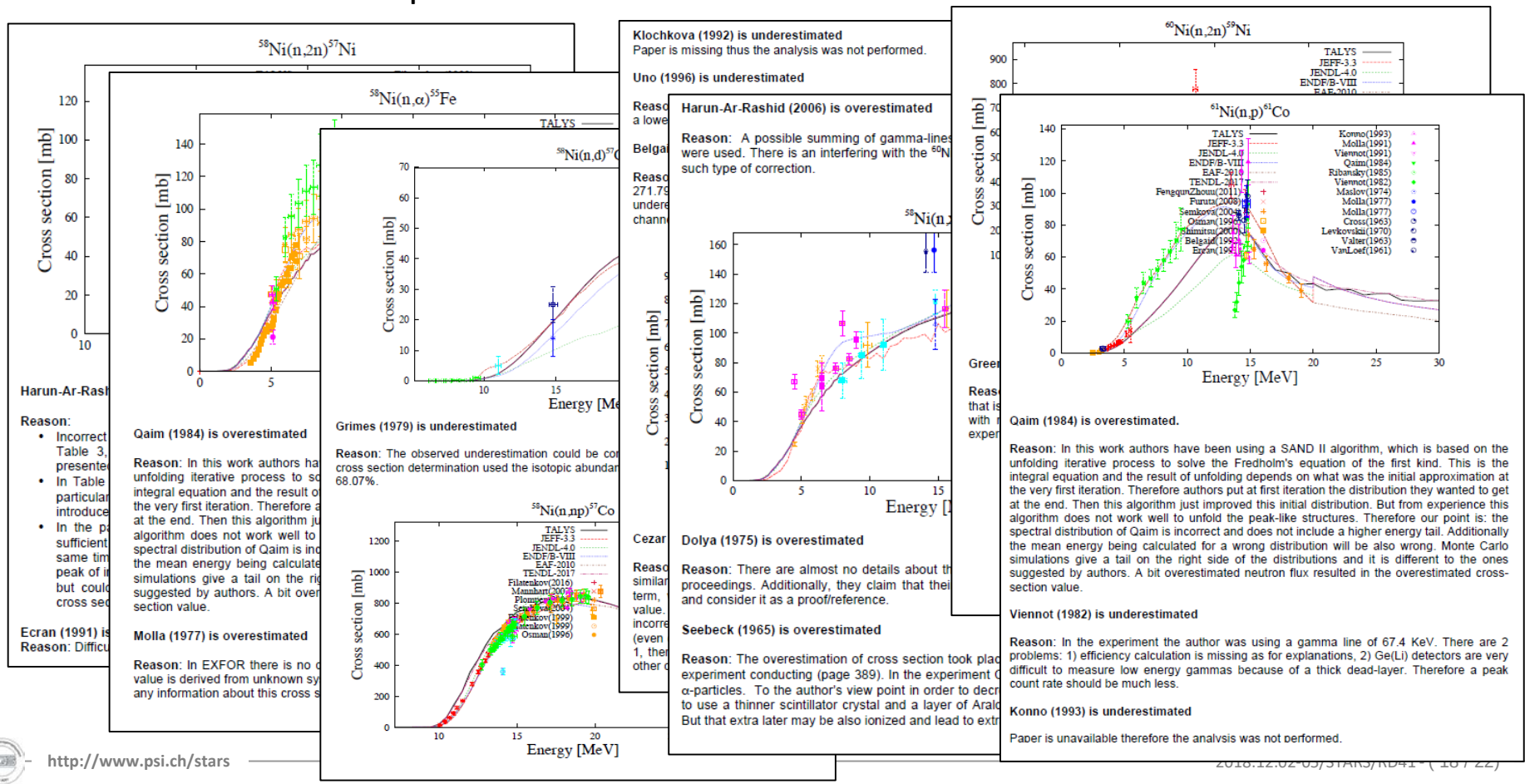
Ni isotopes in the RRR

- Plot of ^{63}Ni isotopes (n,g) in the RRR



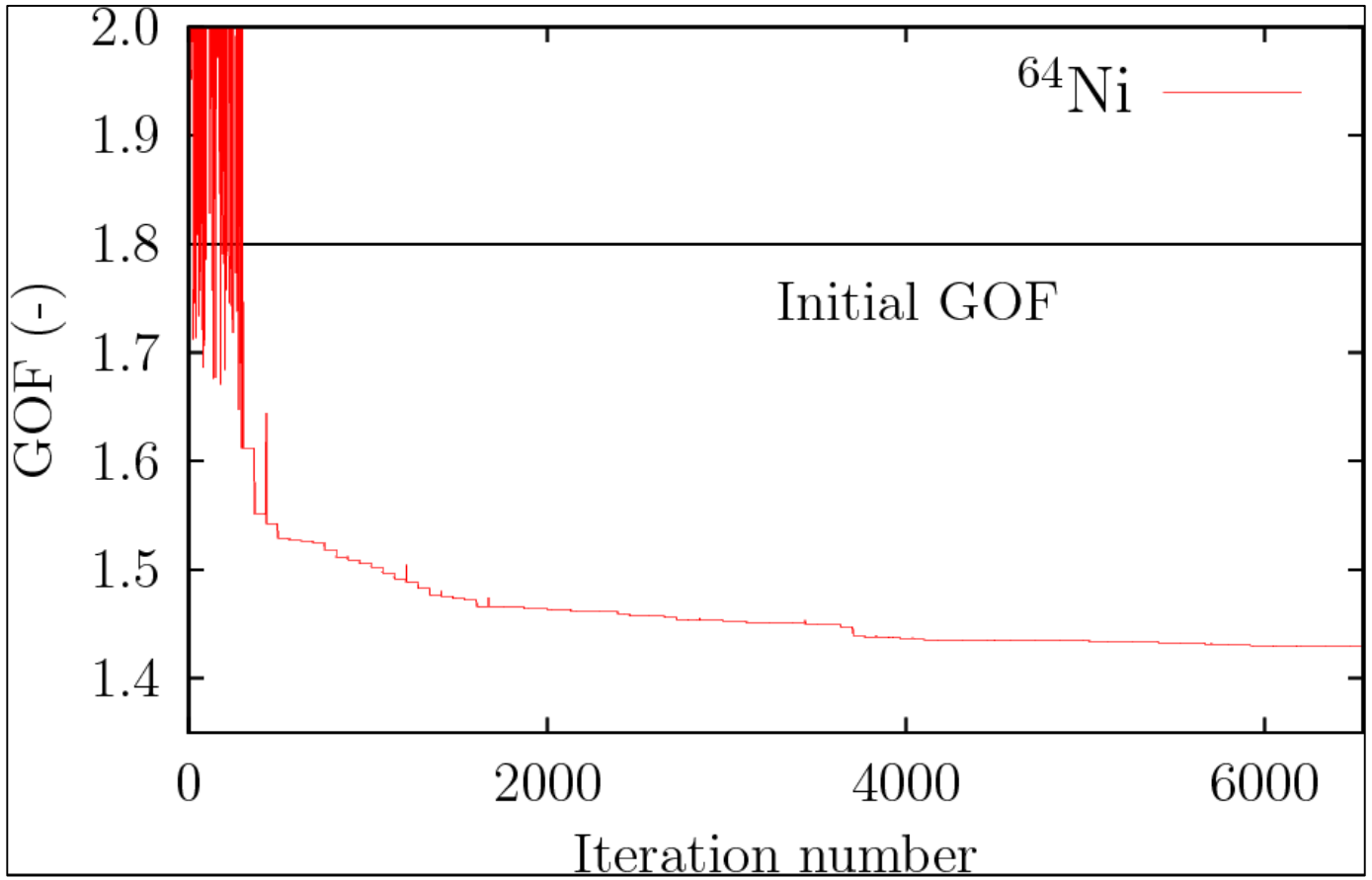
Ni isotopes in the fast range

- Performed with TALYS-1.9 and the latest T6
- Analyze EXFOR data
- Search of the model parameters to fit a selection of EXFOR data, and
- Search of the model parameters to fit ENDF/B-VIII.0 for other channels.
- Full ENDF-6 files produced from MF1 to MF40



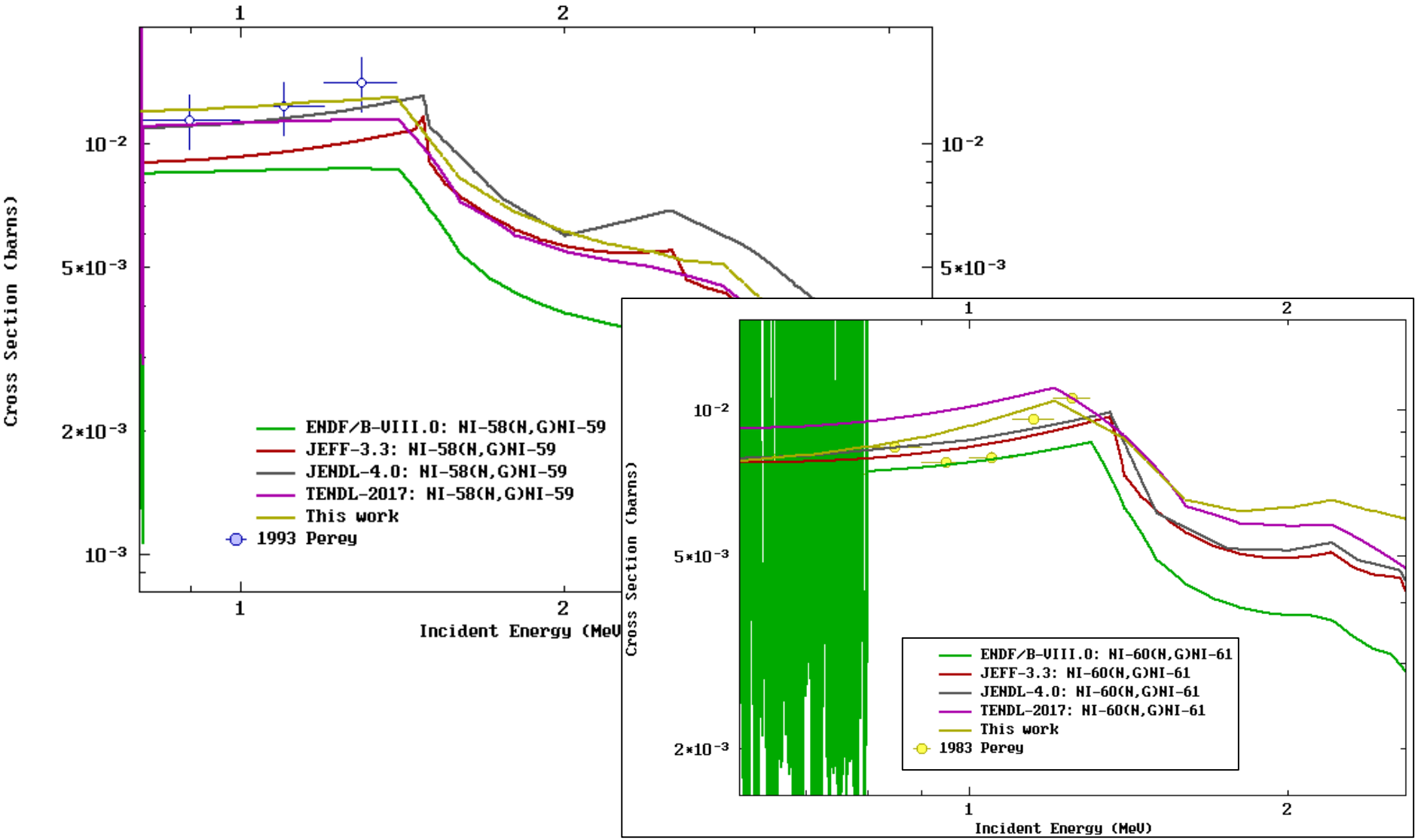
Ni isotopes in the fast range

- Example for GOF (goodness of fit estimator) for ^{64}Ni compared to ENDF/B-VIII.0:



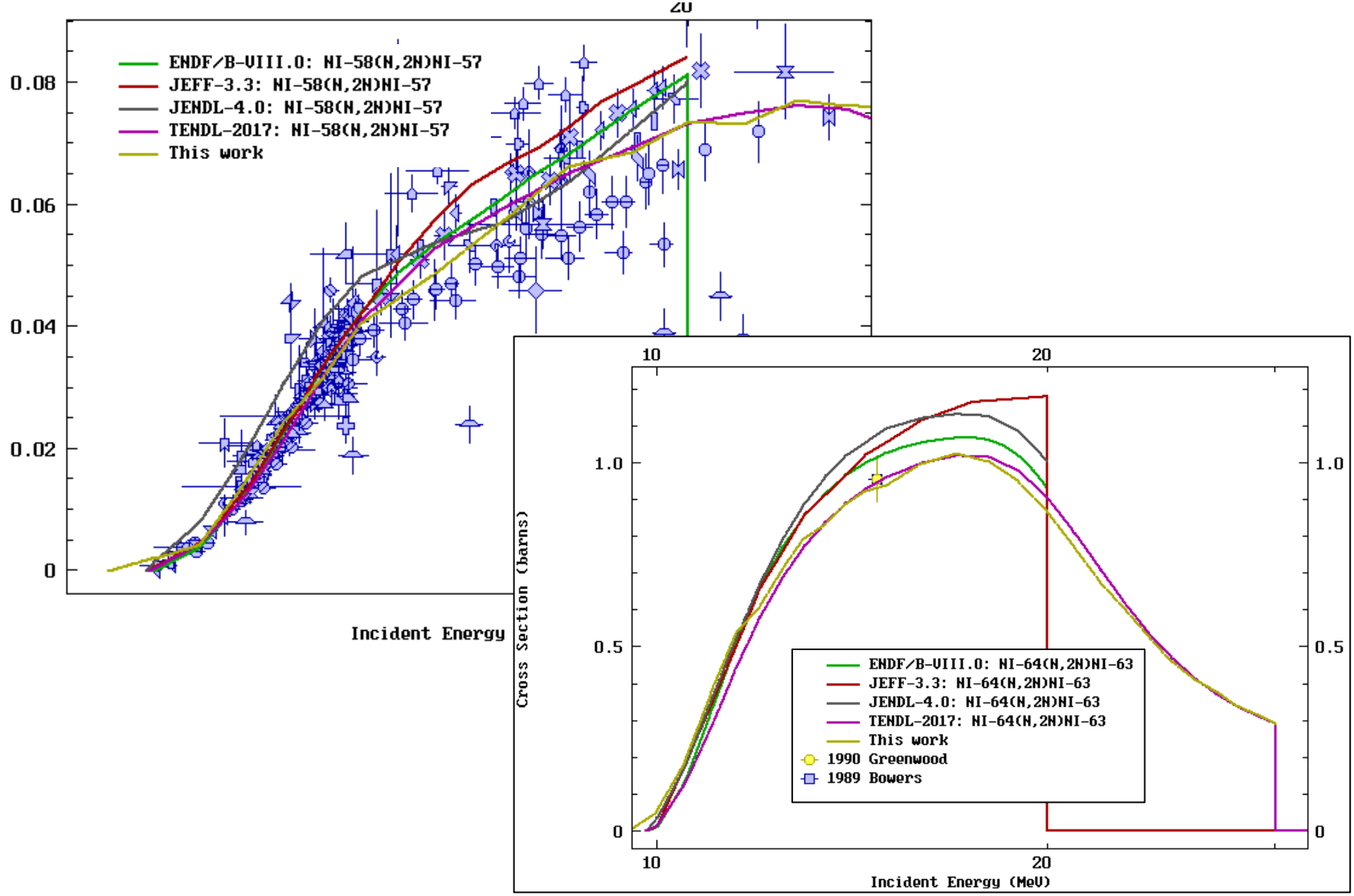
Ni isotopes in the fast range

- Example capture on Ni58 and Ni60:



Ni isotopes in the fast range

- Example for (n,2n) on Ni58 and Ni64:



Conclusions

- Latest T6 package as used in TENDL-2019
- Evaluation of the Ni still in progress with T6
- New resonance data
- Analysis of the EXFOR data in the fast range
- Parameter optimization for TALYS using a selection of EXFOR data
- Methods and results to be implemented in the next TENDL release

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Wir schaffen Wissen – heute für morgen