Feedback on JEFF-33t2 library using GALILEE code.

C. Jouanne, M. Costedelclaux

DE LA RECHERCHE À L'INDUSTRIE

FEEDBACK ON JEFF-33T2 LIBRARY USING GALILEE CODE.

C. Jouanne, M. Coste-Delclaux (CEA Saclay)

JEFF MEETING (NOVEMBER 2016)

VERIFICATION

GALILEE-1 Code : GALVANE Module (GALilée Verification of the Accuracy of Nuclear Evaluations)

Library (# nuclei / #nuclei with DD)	JENDL40 (406 / 3)	ENDFB7R1 (423 / 41)	JEFF32 (472 / 169)	JEFF33T1 (559 / 322)	ENDFB8B1 (446 / 46)	JEFF33T2 (559 / 320)
Inconsistencies						
Mass comparison	4	27	24	14	28	13
Resonance parameters	0	3	9	5	3	5
Q-reactions	5	92	53	33	97	32
Anisotropy	5	39	35	21	40	17*
Radioactive production	1	14	41	100	15	97
Missing gamma production for radiative capture	139	138	104	64	146	44*

* : Fixed, thanks to Dimitri Rochman

VERIFICATION / RESONANCE PARAMETERS

Angular momentum of a resonance state

Channel spin s sum of the spins of the two particles

$\vec{\ell}$: orbital angular momentum

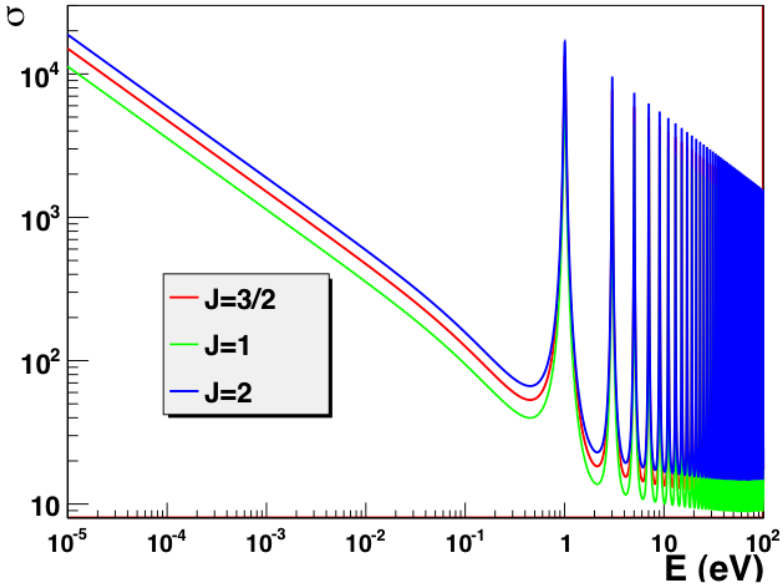
$\vec{j}$: total angular momentum

$$\vec{j} = \vec{\ell} + \vec{s}$$

Pu243, U241, Np238, Pm148M, Cf251

JEFF-3.2, Bk247 : Nucleus spin :3/2. l value : 0.
→ Theoretical: J=1 or J=2
but, Evaluation:J=3/2

Question :
J value from Evaluation ? (NJOY)
J value from Physics ?



VERIFICATION / RADIOACTIVE PRODUCTION

MF8 / Inelastic scattering (MT4) :

Final state with Exc > 0 MeV and LFS = 0 (GS identification) : 84 evaluations

TALYS correction ?

MF8 /

Inconsistencies between GP data and JEFF311/DD, JEFF32/DD or ENSDF for ID state (Energy Level) or Excitation Energy value

Delta ID STATE GP / J311 : 97

Delta ENER STATE GP / J311 : 5

Delta ID STATE GP / J32 : 91

Delta ENER STATE GP / J32 : 5

Delta ID STATE GP / ENSDF : 28

Delta ENER STATE GP / ENSDF : 5

→ Source of inconsistencies for depletion calculations

→ JEFF-3.3 Decay Data Library ?

INELASTIC SCATTERING IN MF6

JEFF-33T2 : kinematics data in MF6 (double differential energy/angle) : 98 nuclei

→ no correlation for gamma decays

25 nuclei without gamma production

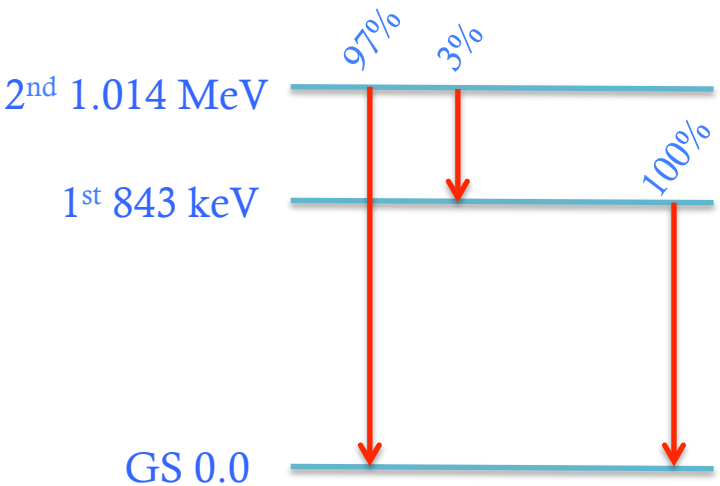
Ex : Al27

1st excited state : E=843 keV. 100% to GS

2nd excited state : E:1.014 MeV.

3% to 1st excited state : gamma cascade 843 keV and 171 keV

97% to GS. Gamma 1.014 MeV



MF6 (JEFF33T2) for 2nd Exc :

Yield gamma : 1.029 (multiplicity)

Proba : 94.3 % 1.014 MeV

2.8 % 843 keV

2.8 % 171 keV

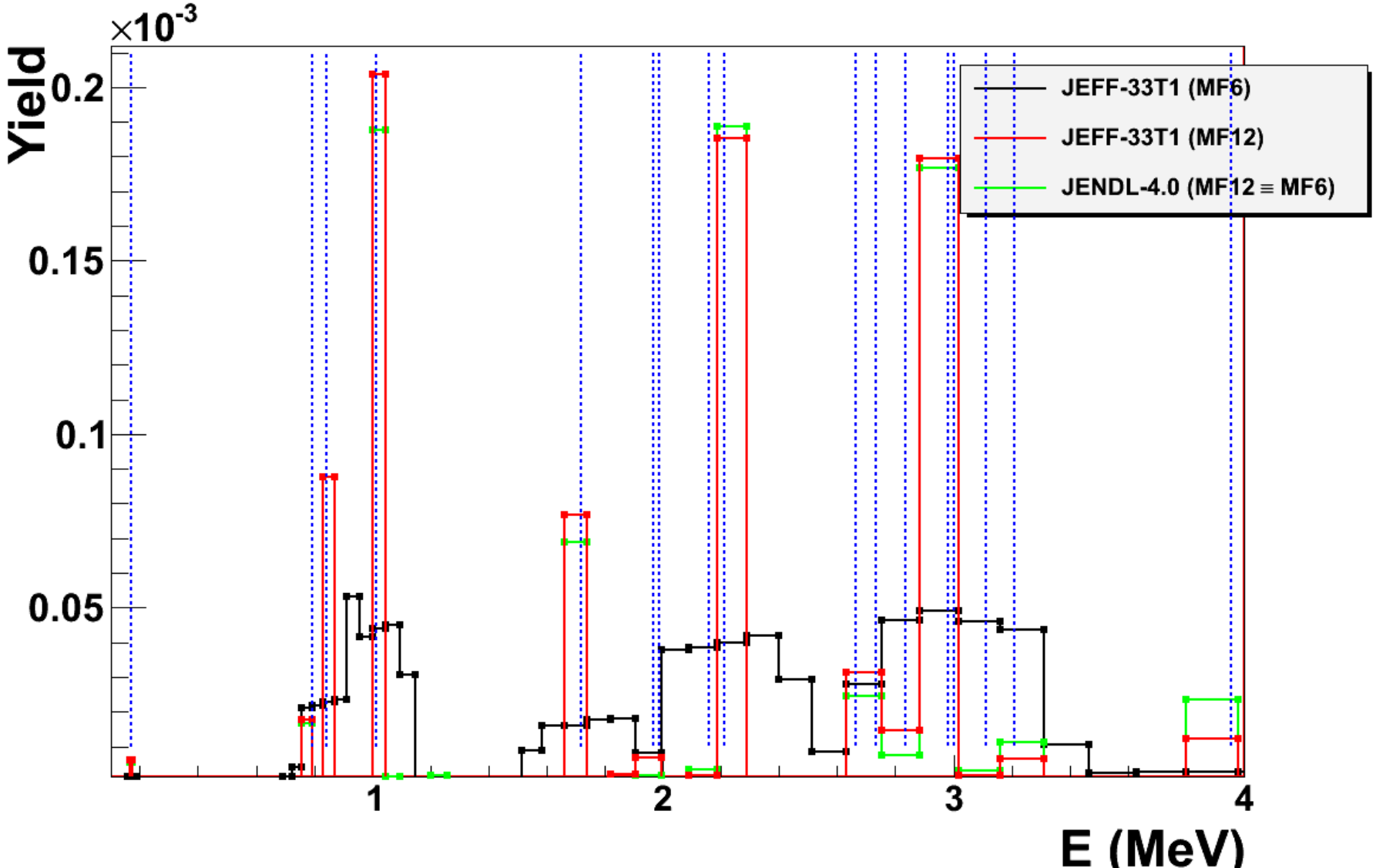
→ no correlation between 843 and 171 keV

1.029 = 1* 0.97+ 2 * 0.03

0.943 = 0.97 / 1.029

INELASTIC SCATTERING IN MF6 / MF12

Target Al27, neutron 4.5 MeV. Gamma production



INELASTIC SCATTERING IN MF6 → MF12

Solution : use of MF12 / MF14 files

1/ use SIXPAK (PREPRO) to generate MF4 from MF6 (neutron angular distributions)

2/ use ENSDF data to define gamma cascade for each excited state in agreement with excited state used in evaluation file

3/ add new MF4, MF12 and MF14 for discrete inelastic scatterings in evaluation file

We propose this correction for Al27 evaluation file
→ If JEFF agrees, we could apply this correction for other nuclei

CONCLUSION

- Use of MF12 (Transition probabilities) instead of MF6 or MF12 (multiplicities) for gamma cascade (discrete inelastic scatterings)
  → Improvement of Analog simulations

- Unit Base Interpolation for outgoing energy distribution (MF5, MF6, MF15)
  → Energy balance

- Depletion calculations : DD and GP should be in agreement

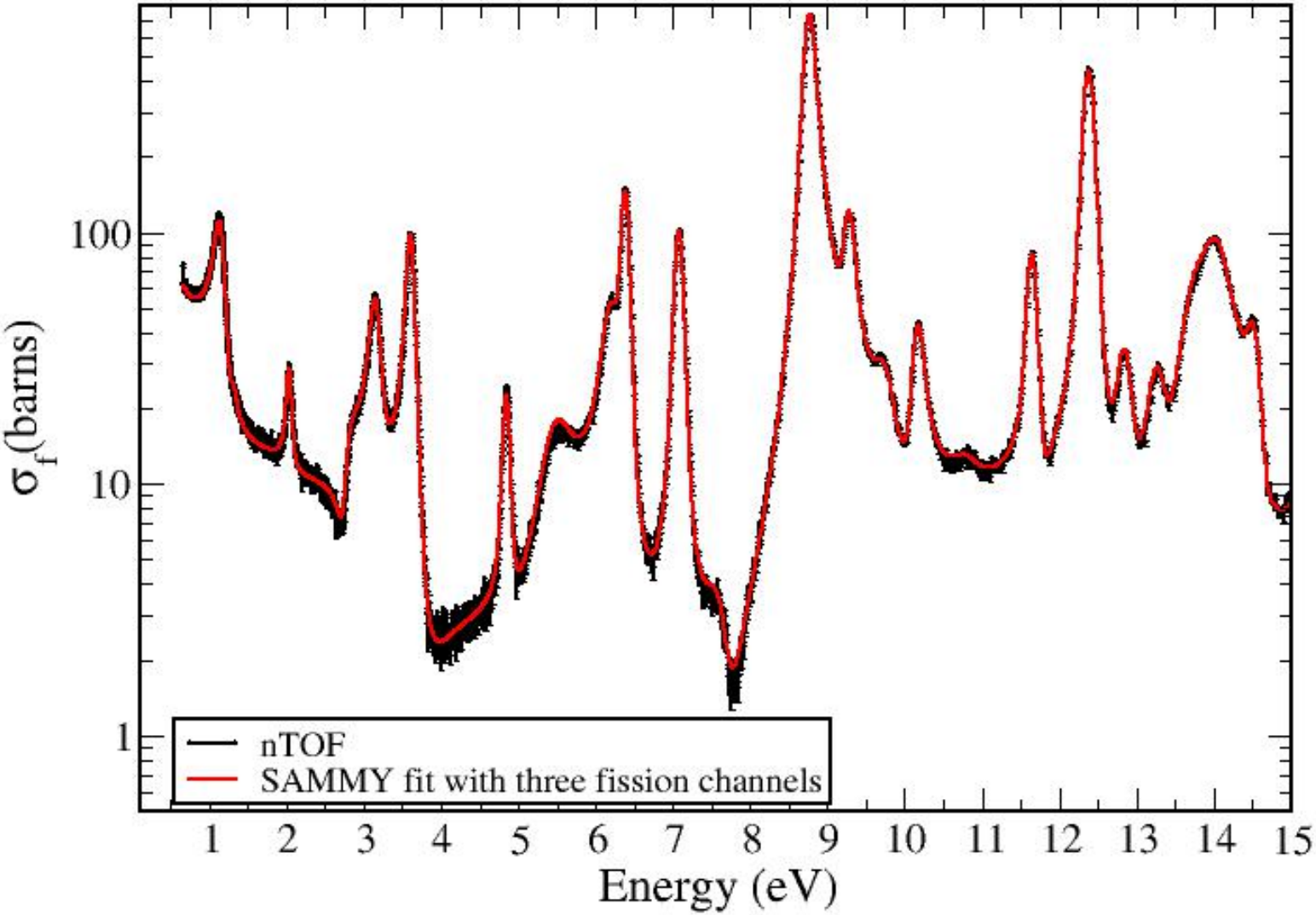
- Kinematics of outgoing particles at high energy (> 20 MeV)

^{235}U LRF=7 TESTING OF THE GALILÉE CROSS SECTION PROCESSING CODE

Collaboration CEA Saclay / IRSN : M. Coste-Delclaux, C. Jouanne, L. Leal

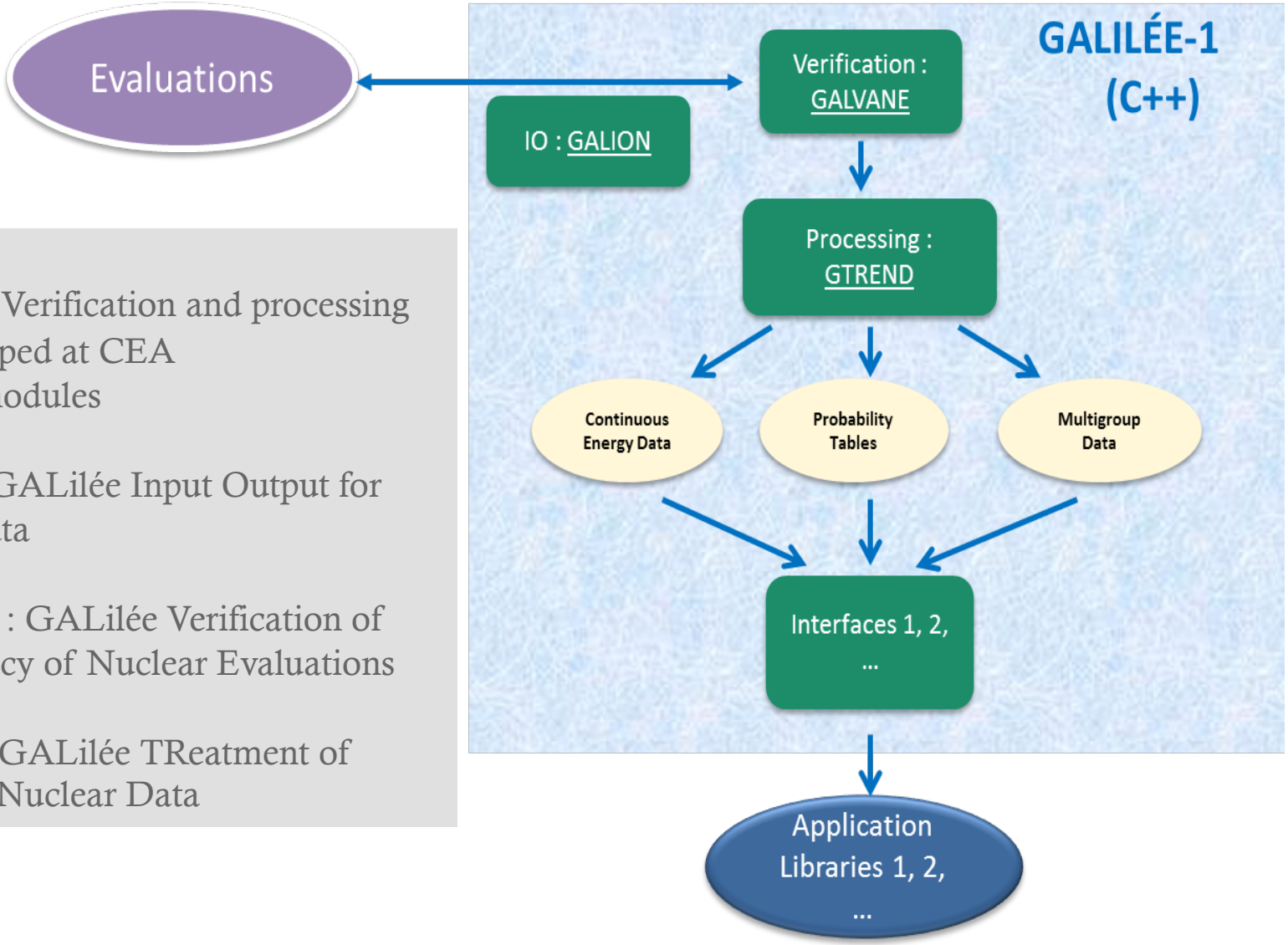
- Fission process using more than two fission channels for J=3- and J=4-
- First and second fission barrier potential investigation under way to support the three fission channels assumption;
- R-matrix fitting of the experimental data with SAMMY with E_r, Γ_γ, Γ_n, Γ_{f1}, Γ_{f2}, Γ_{f3}
- Experimental fitting converges much faster;
- Processing codes such as GALILEE and GAIA are able to process the resonance parameters

NTOF Fission data SAMMY fitting



GALILÉE-1 SYSTEM

- GALILÉE-1: Verification and processing system developed at CEA
- Three main modules
  - GALION: GALilée Input Output for Nuclear data
  - GALVANE : GALilée Verification of the Accuracy of Nuclear Evaluations
  - GTREND: GALilée TReatment of Evaluated Nuclear Data



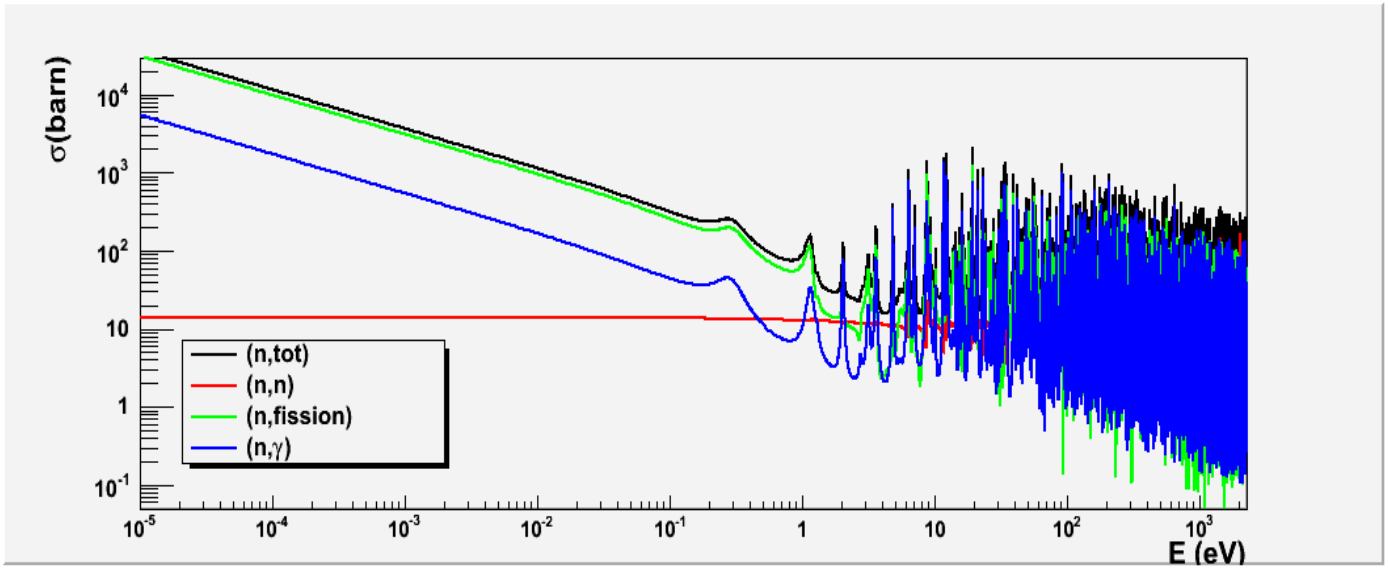
GALILÉE-1 STATUS

Renewed processing tools in progress

- Important steps completed
  - Evaluation Verification
  - Cross-Section Reconstruction in Resolved Resonant Range
  - Doppler Broadening (Sigma1)
  - Linearization
  - Probability Table Tools
    - Temperature Interpolation,
    - Mixture
    - Energy Condensation

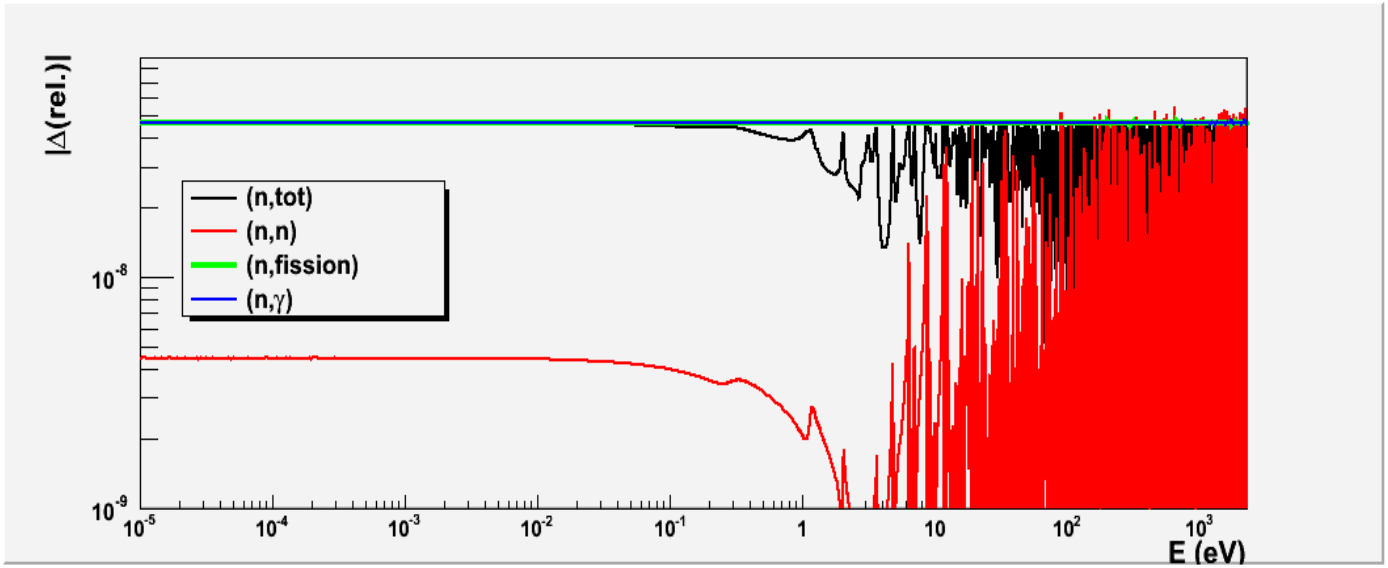
- Next steps
  - Unresolved Resonance Range Treatment (2017)
  - Thermal Scattering Treatment (2017)
  - Production of TRIPOLI-4 Libraries (2018)
  - GALVANE Release at AEN (2018)

U235 - 0K - RRR
ALL REACTIONS

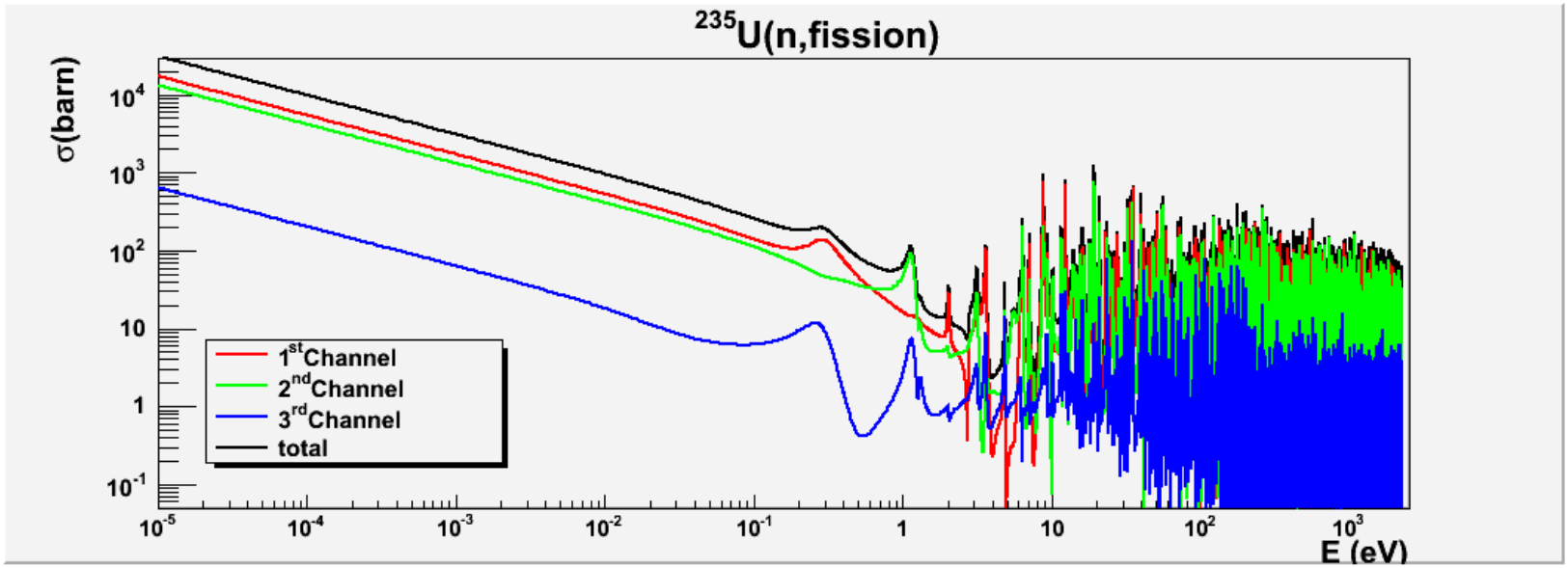


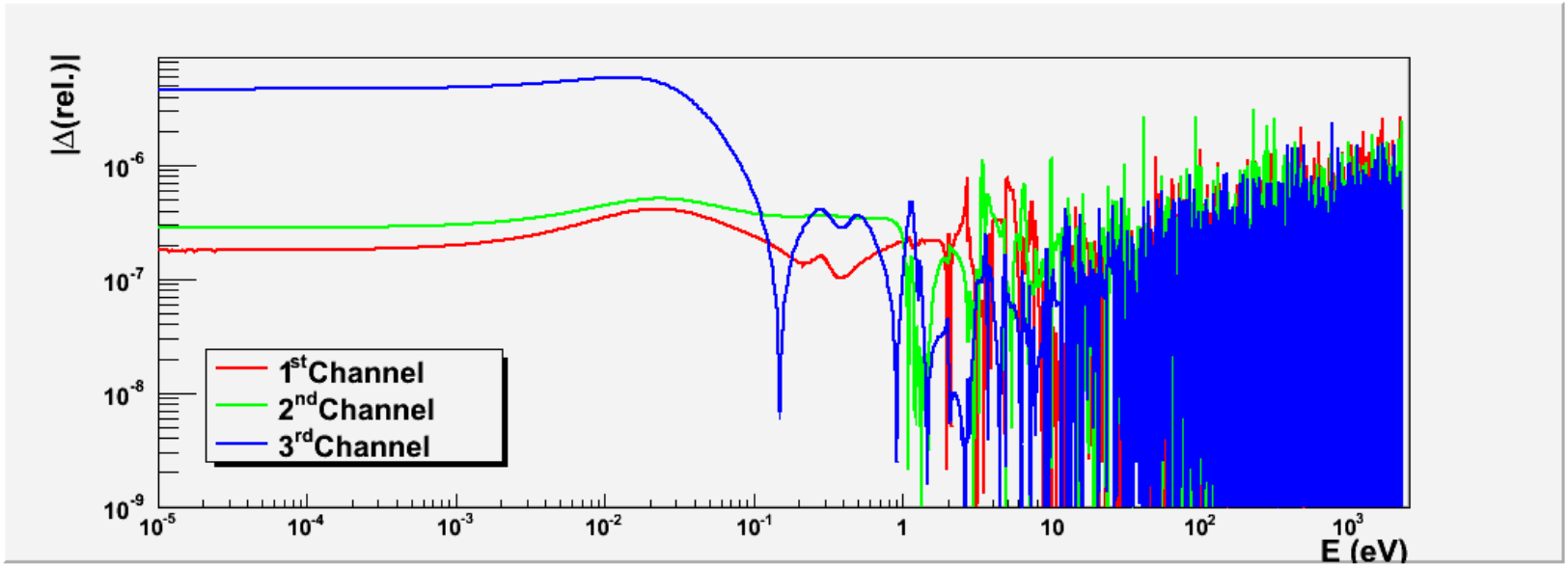
Reconstruction with SAMMY and GALILÉE-1

Absolute values of relative discrepancies less than $6\ 10^{-6}$ for all cross-sections

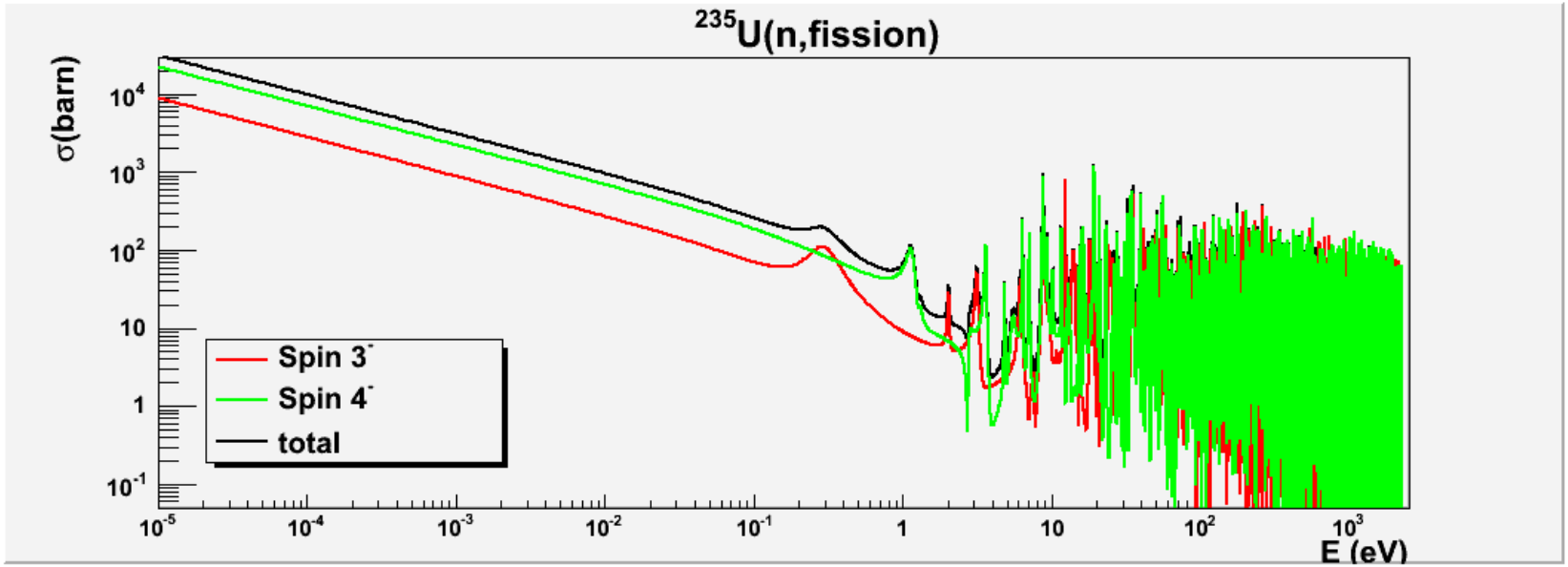


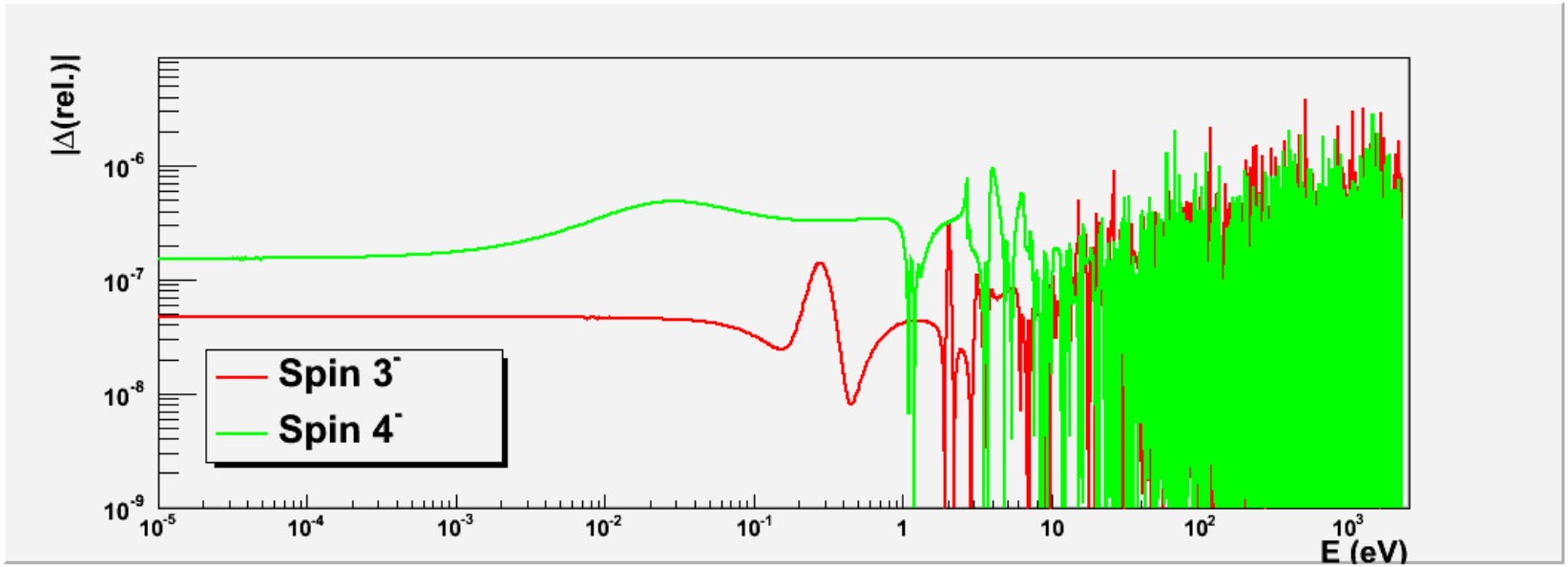
U235 – 0K – RRR
FISSION BY CHANNEL





U235 – 0K – RRR
FISSION BY SPINGROUP





VERIFICATION / NUCLEUS MASS

Comparison to Mass Excess (NUBASE2012) : $\Delta > 1$ MeV.

Cd106, Cd113, Ce141, Eu155, I135, La139,
Ru103, Ru104, Ru105, Th230, Xe134

→ Corrections on AWR + Q + Thresholds (MF4, MF5, MF6, ….)