# Status of the AMUR Code toward Cross-section Evaluation for Heavier Nuclei

**Japan Atomic Energy Agency**


**Satoshi Kunieda**

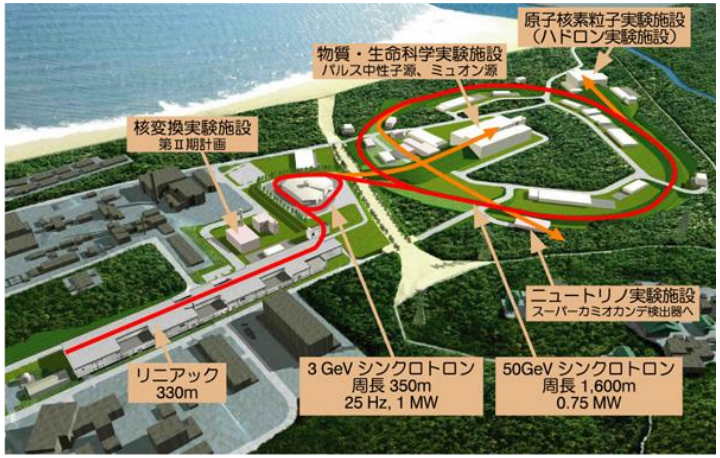
# Motivation

AMUR had initially designed for the evaluation of "light-nuclei" where the general R-matrix theory could be applied to. However, …

- J-PARC ANNRI measurement (MA, Hf, Cs, … )
- Analysis code had not been developed in Japan.
  → REFIT, SAMMY
- However, experimental facility has its own conditions

(e.g., double-bunch problem in J-PARC)

J-PARC facility



# **AMUR** (**A MU**lti-channel **R**-matrix Code)

Evaluation tool for the resonant cross-sections
(under development)

## Theoretical calculation

In case of R-matrix

→ $\sigma$, $d\sigma(\theta)/d\Omega$, $Pol(\theta)/d\Omega$

*--- Parameters ---*

- *Boundary condition* ($R_c$, $B_c$)
- *Energy eigenvalue* ($E_\lambda$)
- *Reduced-width amp.* ($\gamma_c$)

## Analysis of measurement

KALMAN method (GLSQ)

→ Parameter & covariance

*--- Parameters, e.g., ---*

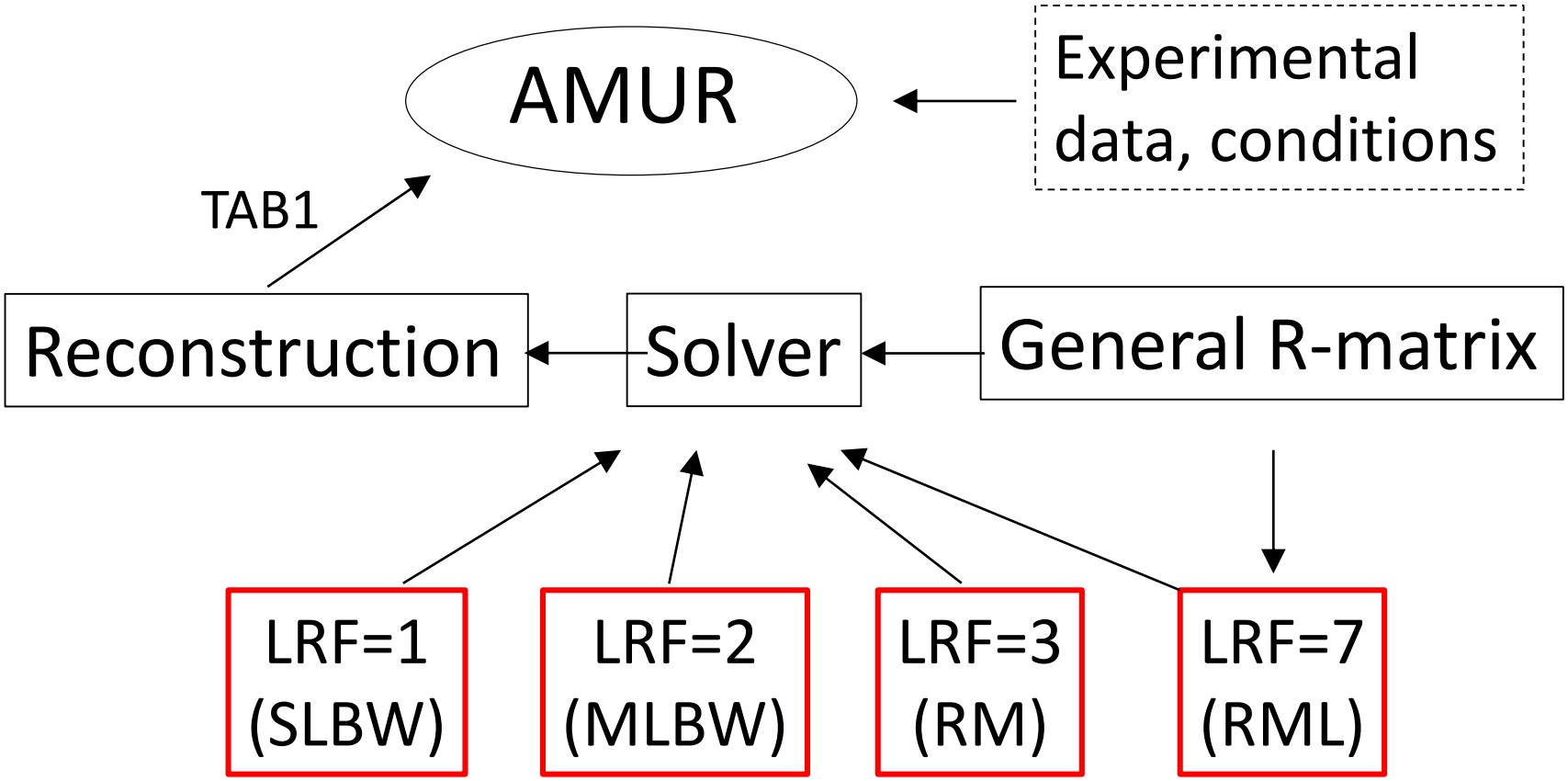
- *Renormalization*
- *Resolution*

Dynamic link (**Object-oriented**)

- All the parameter could have prior uncertainty
- Can be operated on ROOT (CERN scientific library)

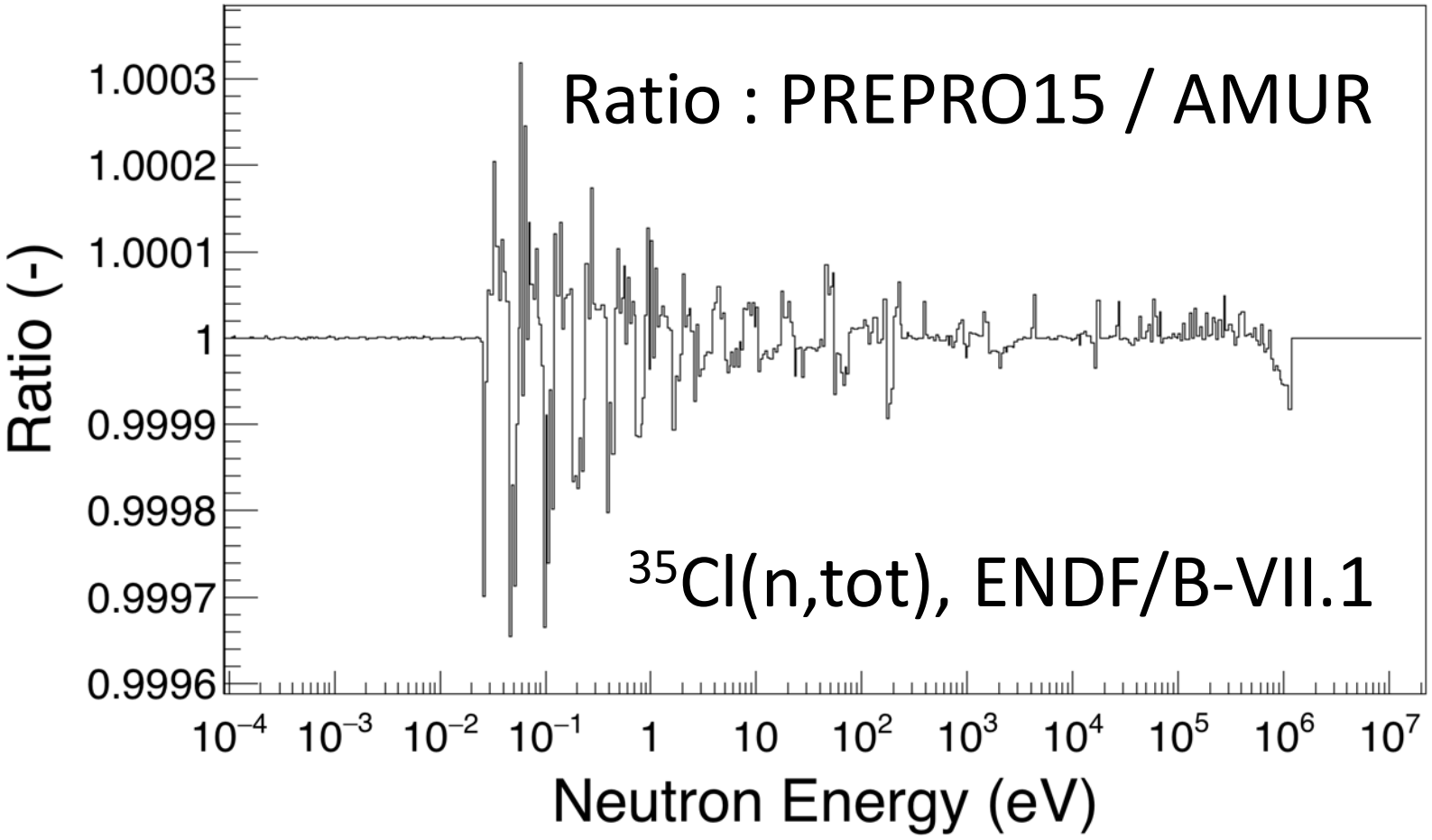
# Toward Heavier Nuclei

Theoretical part :




It was done

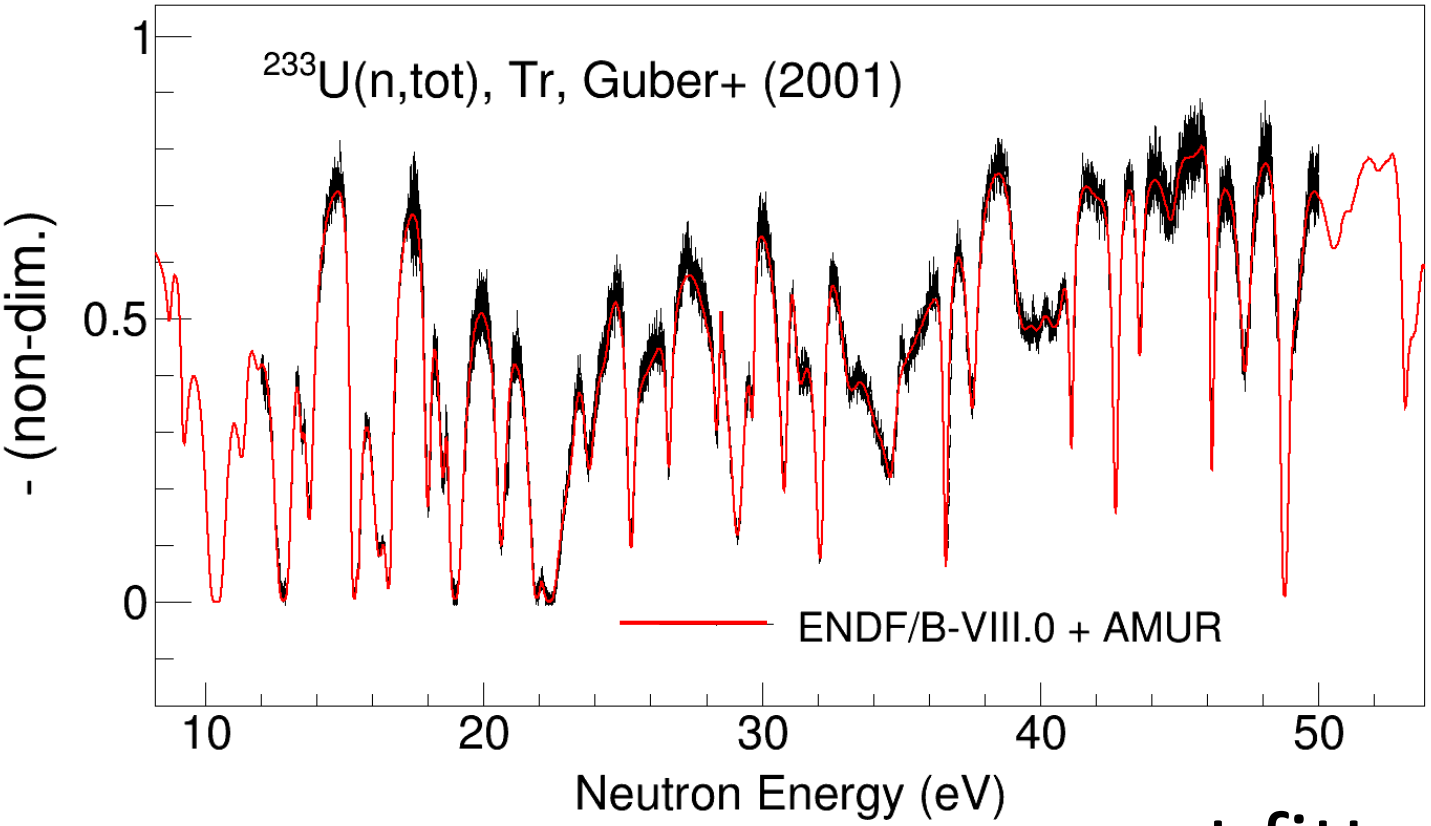
# Check for Reconstruction (e.g., LRF=7)




AMUR is consistent with PREPRO

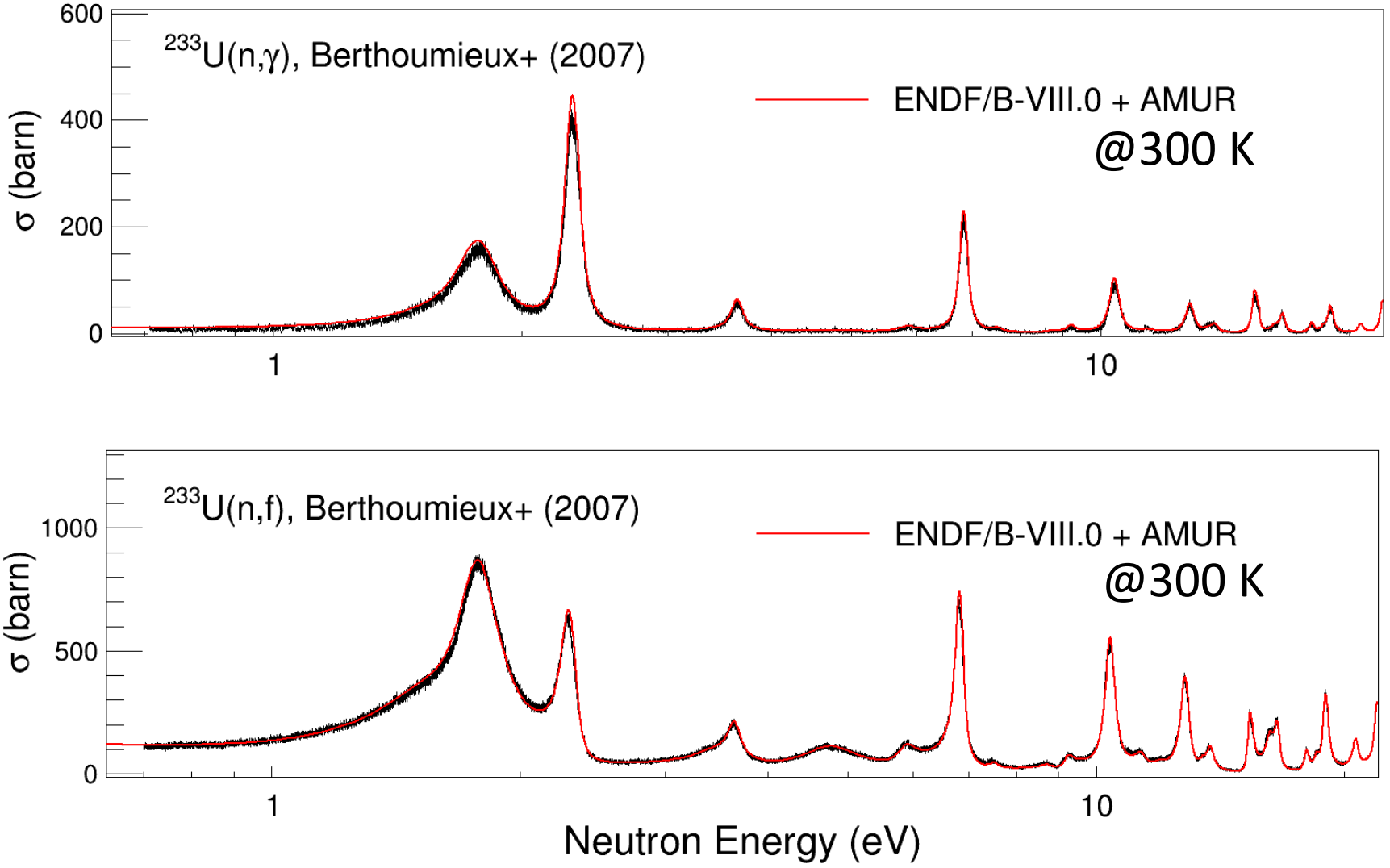
# Reconstructed Results by AMUR (LRF=3)

- It seems, calculation itself works well
- Sample thickness was taken from EXFOR




not fitted !!

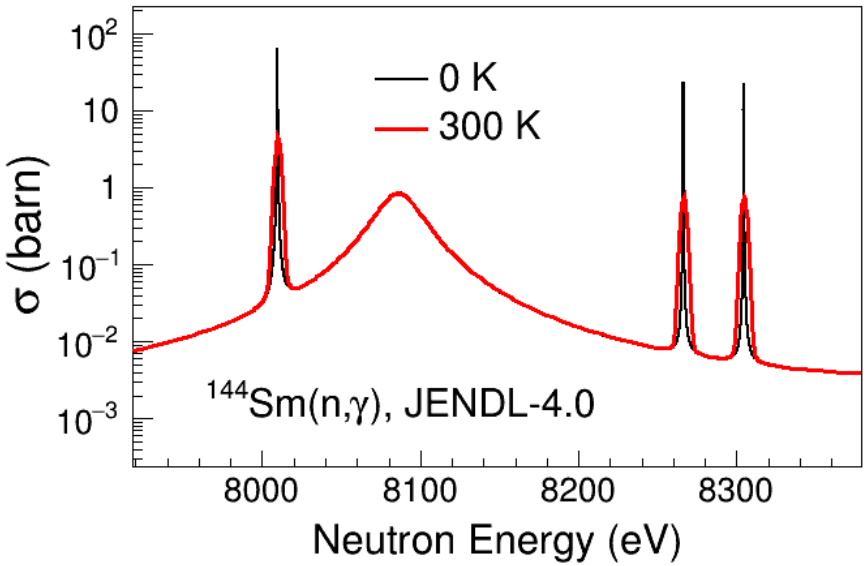
# Reconstructed Results by AMUR (LRF=3)

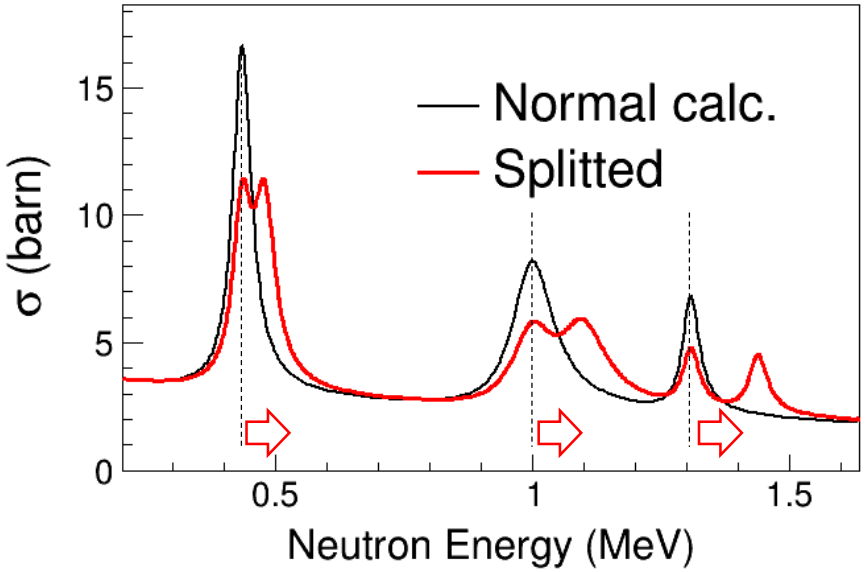


# Toward Heavier Nuclei

## Experimental part :

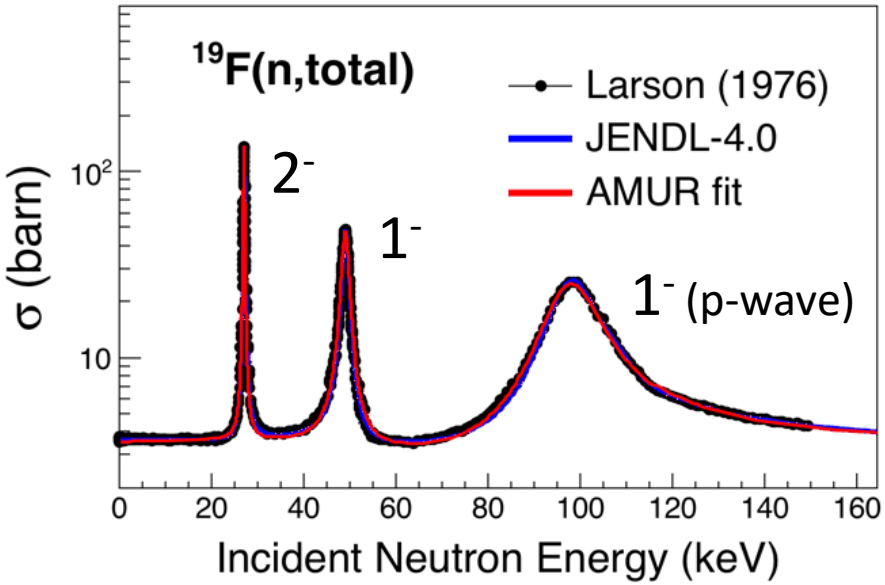
- Doppler broadening (Free-gas model)
- TAB1 container with various methods
  - Arithmetic operations, Scale, Shift, Broad, Integral, …
  - Correction by “arbitrary” functional/tabular forms

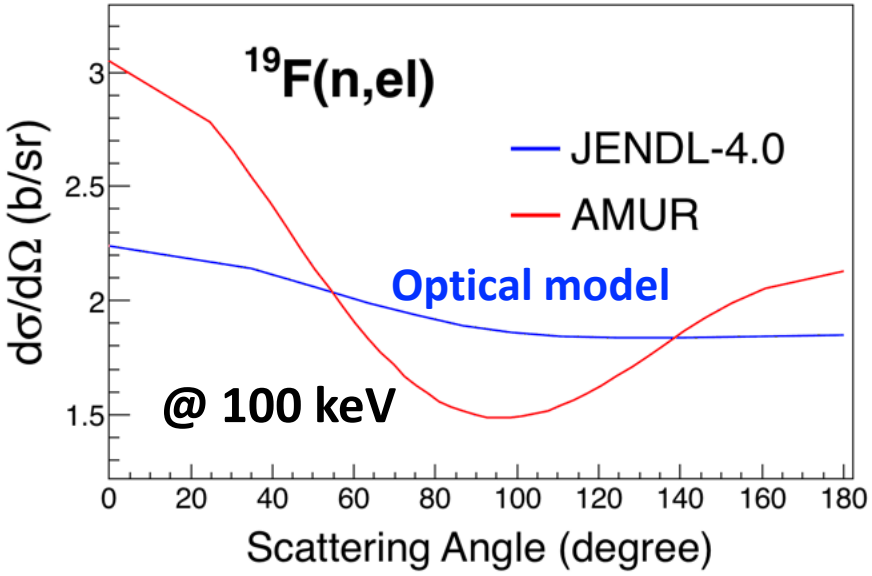


# An Open Question

Angular distribution of (n,n) could be estimated by R-matrix / LRF=7



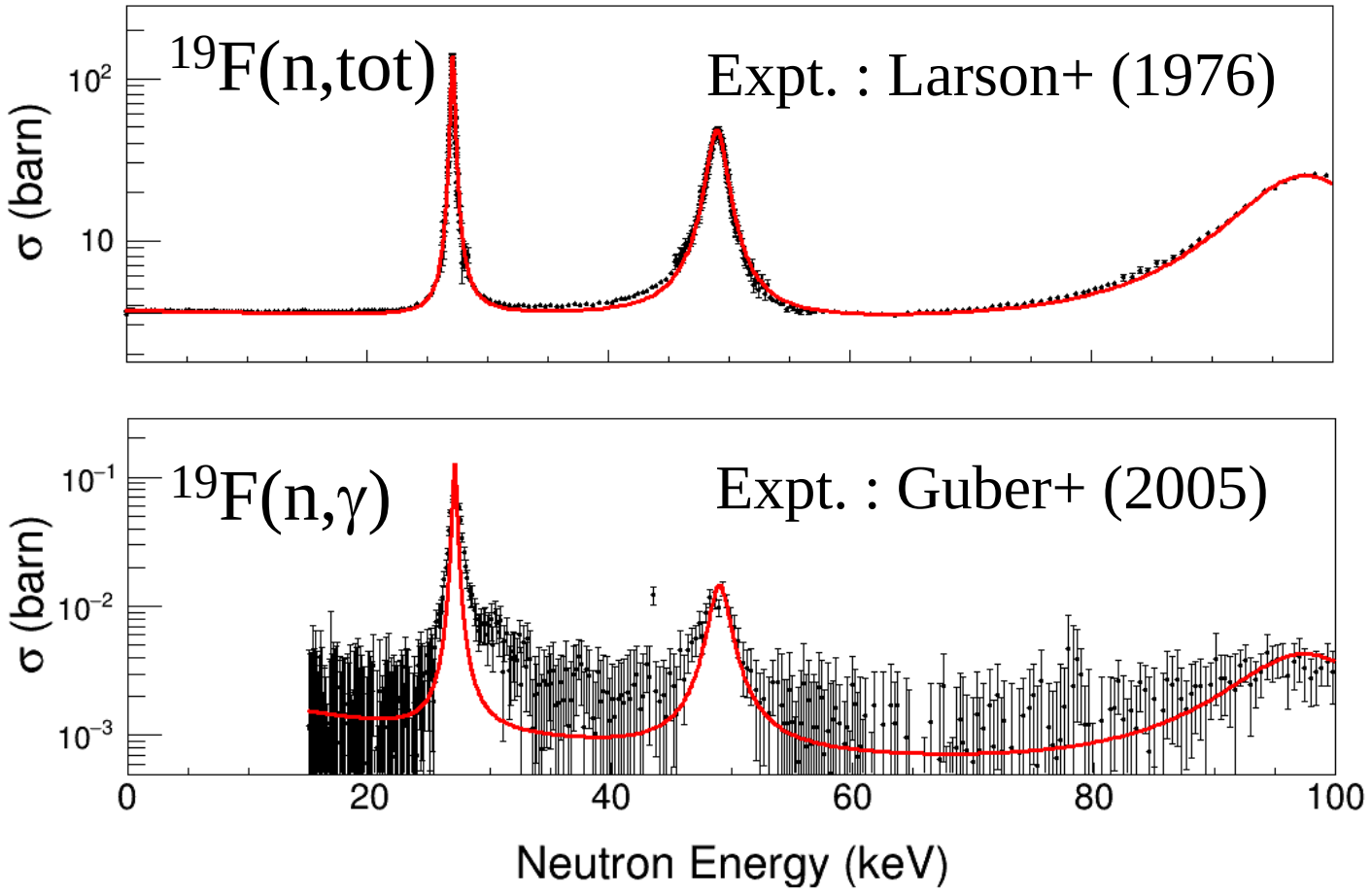




- R-matrix results are very different from the optical model estimation
- How affect on the neutronics calculation ?

# Plans on the AMUR code

- "Fitting" capability for LRF=1,2,3,7 (very soon)
- Self-shielding, multiple scattering corrections
- Case studies on the analysis of heavier nuclei
- Estimation of (n,n) angular distribution from the structural materials (LRF=7) to see impact on the reactor benchmarks.

# Example Fits by Reich-Moore Approx.




**Simultaneous fits including (n,g)**