



MÅSTE

GEN 4 CLEAN POWER PRODUCTION



UPPSALA
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Energimyndigheten

FREYA as a fission fragment generator in the TALYS nuclear reaction code

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Fission fragment generators in TALYS

ffmodel

Model for the distribution of fission fragments.

Examples

ffmodel 0: tables by user in subdirectory user/

ffmodel 1: GEF model , fission fragments generated by Ali Al-Adili and Fredrik Nordstroem.

ffmodel 2: Okumura model [151]

ffmodel 3: SPY model [152]

ffmodel 4: Langevin-4D model []

ffmodel X: FREYA

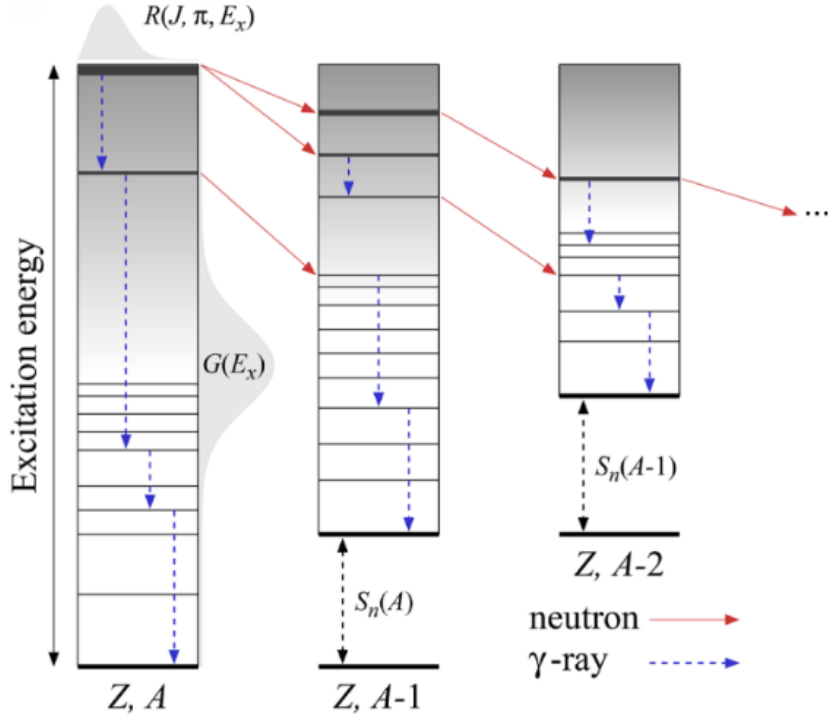
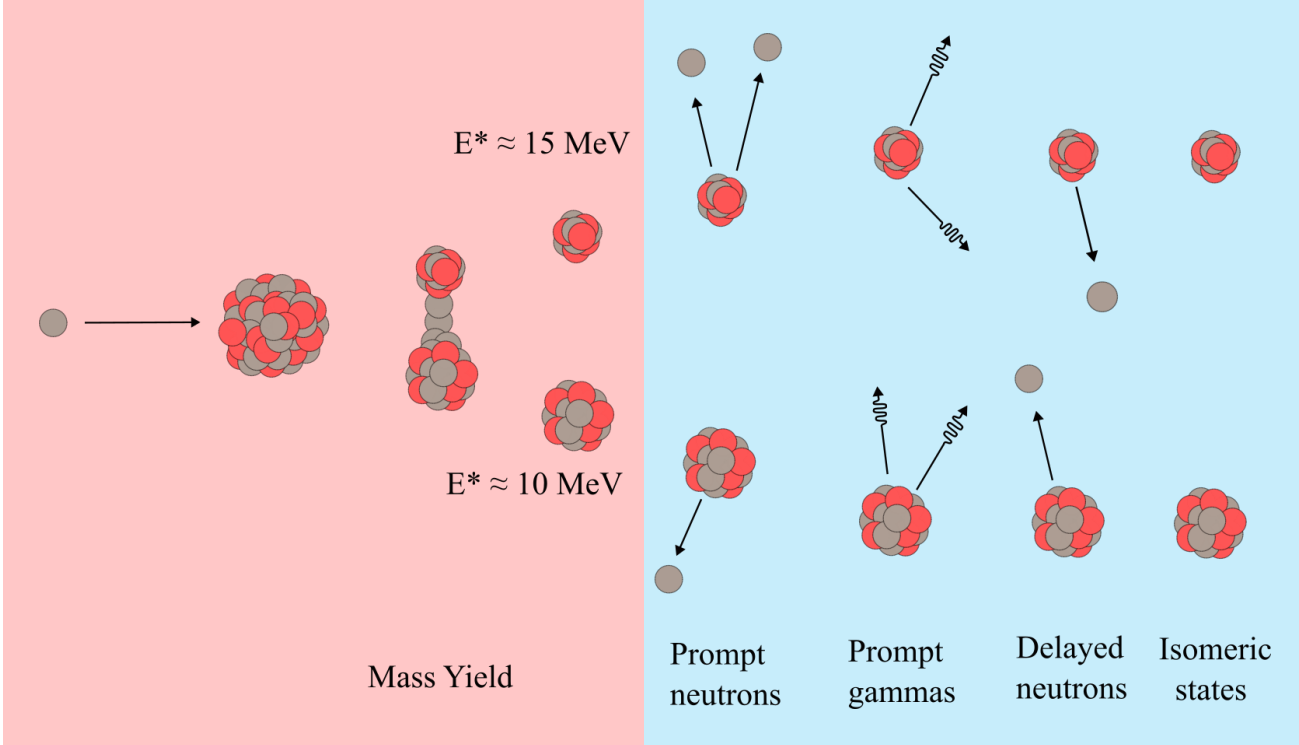
```
# Z      = 92
# A      = 236
# Ex (MeV) = 6.00e+00
# Ntotal = 187
# Z1 A1  Zh Ah  Yield      TKE[MeV]  TXE[MeV]  E1[MeV]  W1[MeV]  Eh[MeV]  Wh[MeV]
30 75  62 161  7.0001e-06  1.4227e+02  2.5406e+01  6.4914e+00  1.9400e+00  1.8914e+01  8.3818e+00
31 75  61 161  2.0000e-06  1.4190e+02  2.5245e+01  8.2200e+00  1.9233e+00  1.7025e+01  3.8254e+00
30 76  62 160  4.6001e-05  1.4700e+02  2.3982e+01  5.7154e+00  2.7350e+00  1.8267e+01  6.7190e+00
30 77  62 159  4.2001e-05  1.4528e+02  2.4163e+01  5.0024e+00  2.5476e+00  1.9161e+01  7.3343e+00
31 77  61 159  2.2000e-05  1.4609e+02  2.4902e+01  5.8482e+00  2.5095e+00  1.9054e+01  5.8153e+00
32 77  60 159  6.0001e-06  1.4696e+02  2.2508e+01  6.6067e+00  4.0692e+00  1.5902e+01  5.1561e+00
30 78  62 158  8.9002e-05  1.4595e+02  2.5228e+01  5.6374e+00  2.6056e+00  1.9590e+01  7.3700e+00
```

Different fission models
→ Investigate effect of model assumptions

Convert output to TALYS format
→ Get fission observables



Fission calculations in TALYS



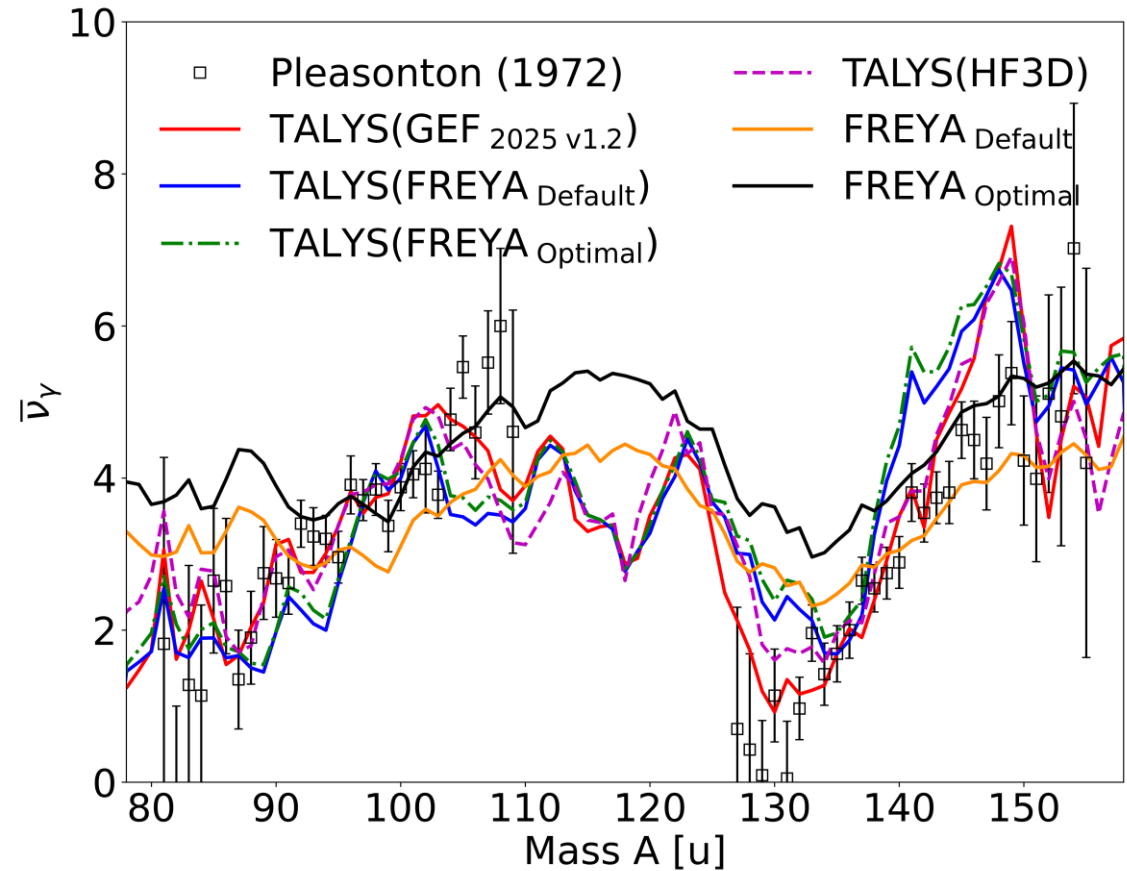
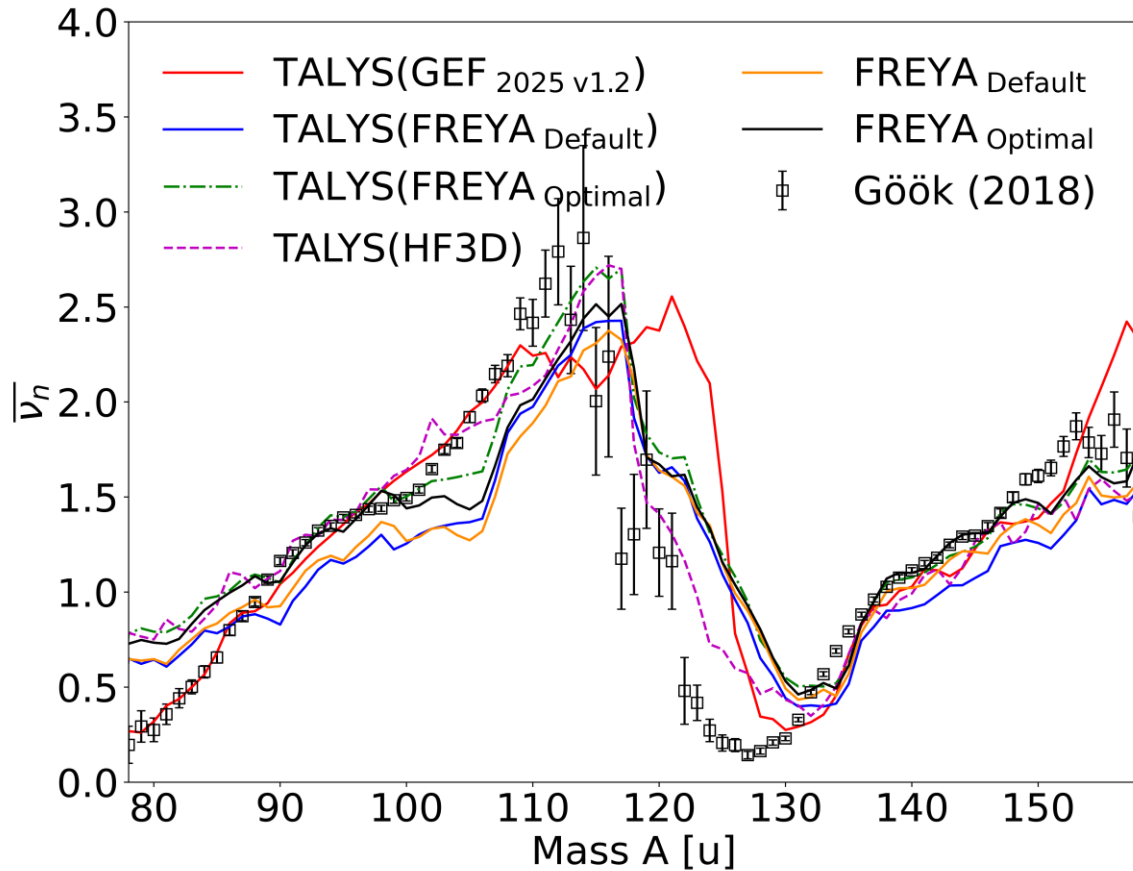
<https://link.springer.com/article/10.1140/epja/s10050-023-01095-4>

Fission fragment generators
 GEF / HF3D / FREYA etc
 → Provide yields, energies
 (excitation and kinetic) and
 angular momenta

TALYS
 Hauser – Feshbach

We can test assumptions on
 mass splits, energy sharing and
 angular momentum population

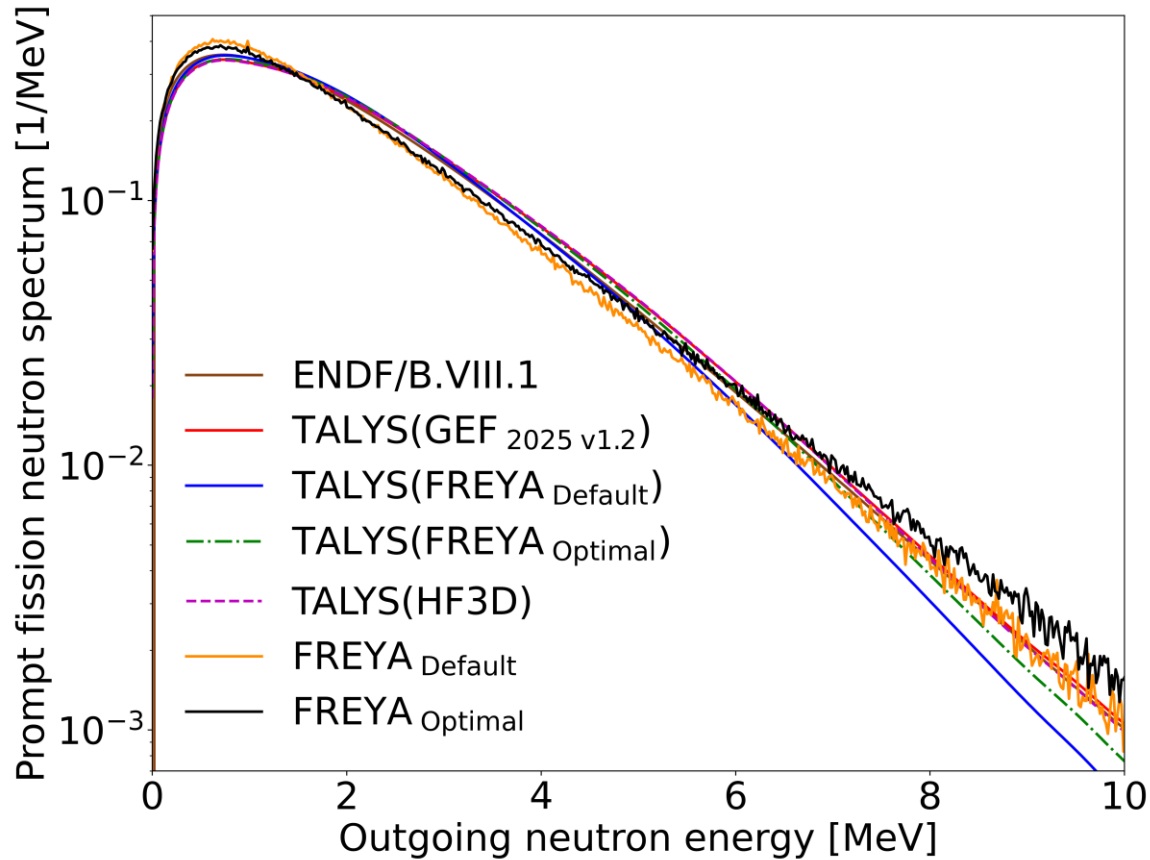
Results - fission observables from TALYS



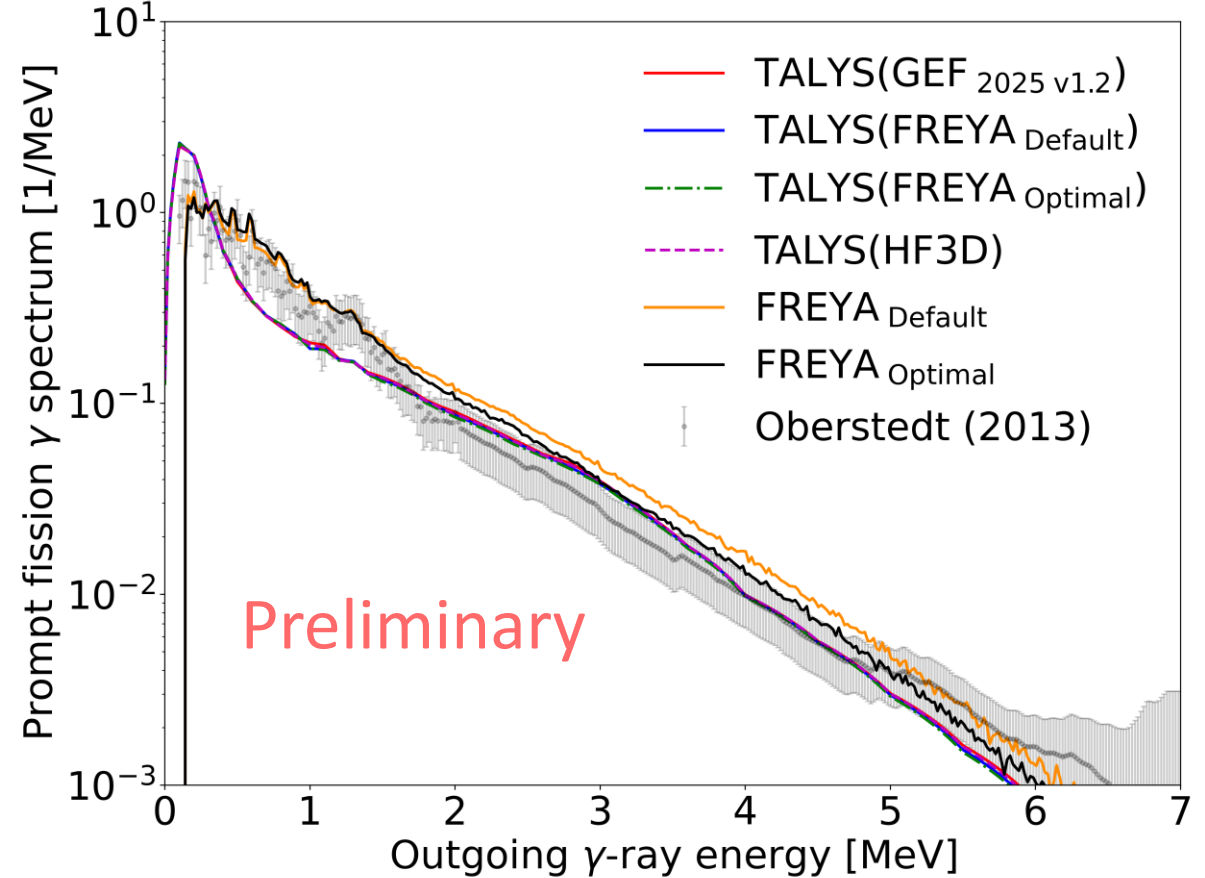
Prompt neutron multiplicity
 $\bar{\nu}_n(A) \rightarrow$ excitation energy sharing
 between partner fragments

Prompt γ -ray multiplicity
 $\bar{\nu}_\gamma(A) \rightarrow$ angular momentum,
 moment of inertia, deformation energy

Results - fission observables from TALYS



Prompt neutron energies
 PFNS → Energy distribution, fast
 neutron spectra for Gen IV reactors



Prompt γ -ray energies
 PFGS → γ -ray energy distribution,
 reactor heating



Results - fission observables from TALYS

	$\bar{\nu}_n$	$\bar{\epsilon}_n$	$\bar{\nu}_\gamma$	$\bar{\epsilon}_\gamma$
FREYA _{Optimized}	2.39	1.97	7.85	0.95
TALYS (FREYA _{Optimized})	2.43	2.04	7.42	0.68
ENDF/B.VIII.1	2.41	2.00	8.58	0.85

Energetics of the fission process.
How much goes into:
 $Q = TKE + TXE$ and how many neutrons
and gamma rays are emitted. → test
energy sharing and angular
momentum population

Outlook

- Model spontaneous fission for $^{252}\text{Cf}(\text{sf})$ with TALYS(FREYA)

