Fission measurements at nELBE

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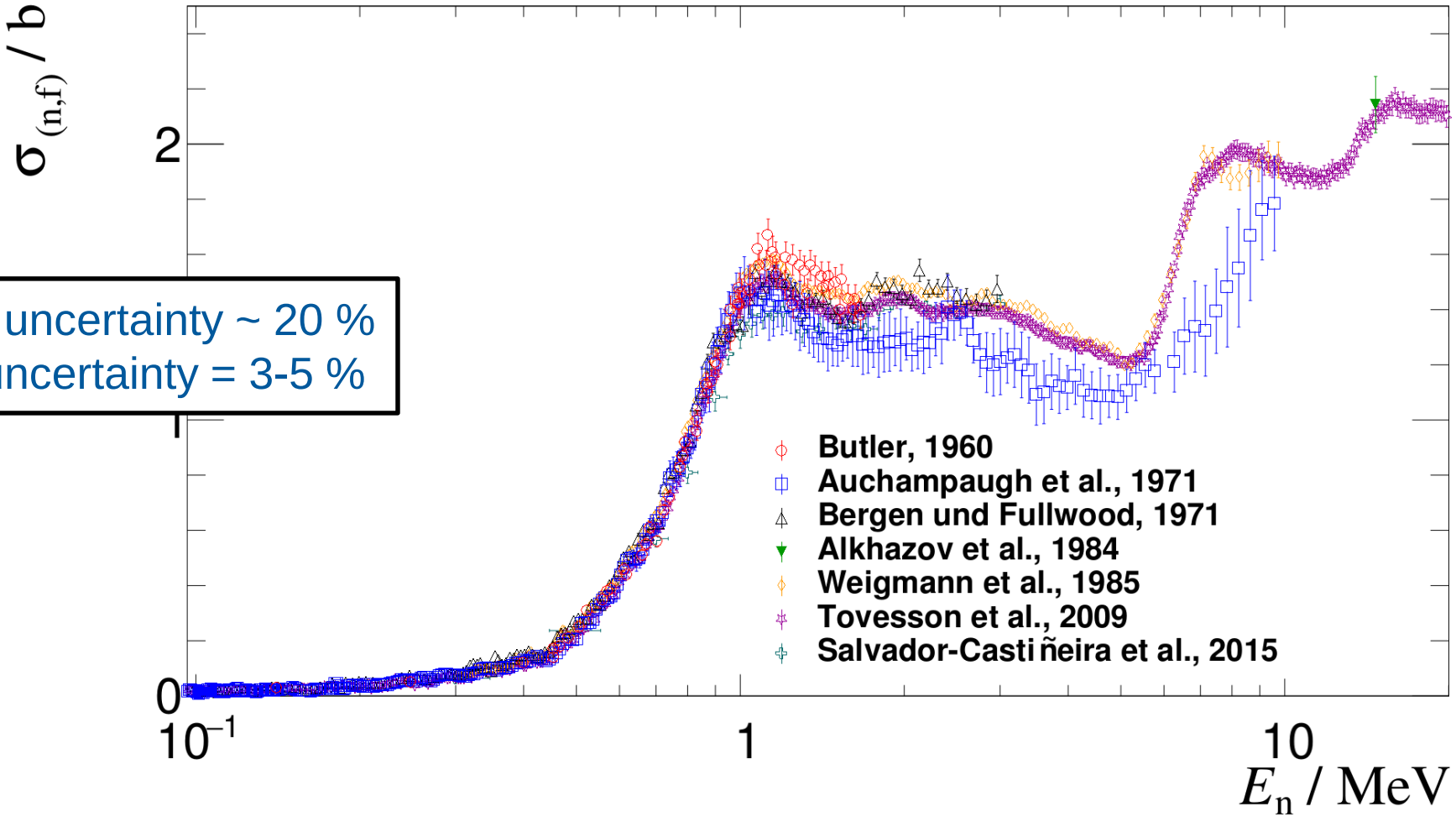
- The nELBE - neutron time-of-flight facility
- Neutron induced fission of ^{242}Pu (courtesy of Toni Kögler)

^{242}Pu(n,fis) - EXFOR

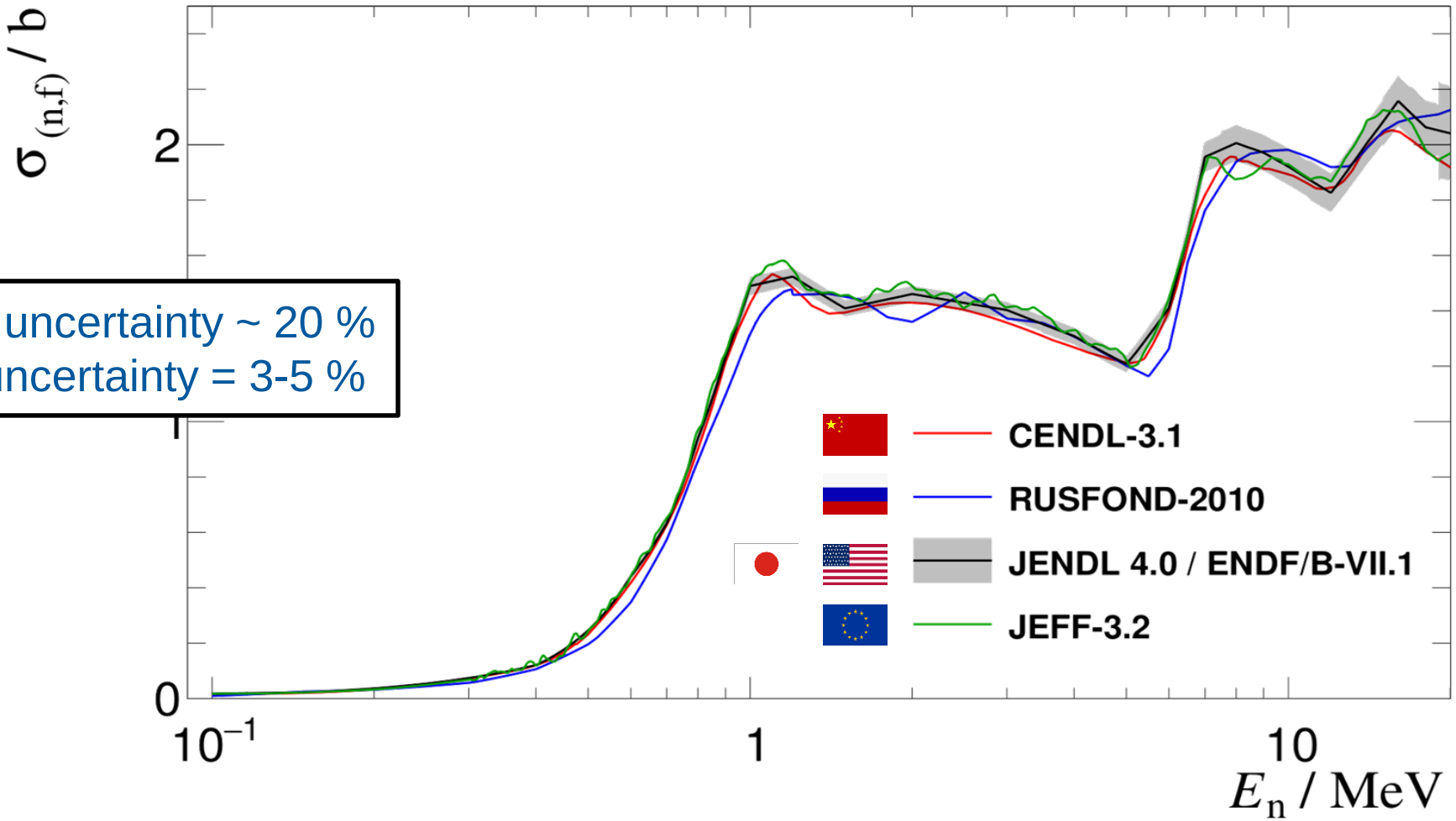
- Current uncertainty ~ 20 %
- Target uncertainty = 3-5 %



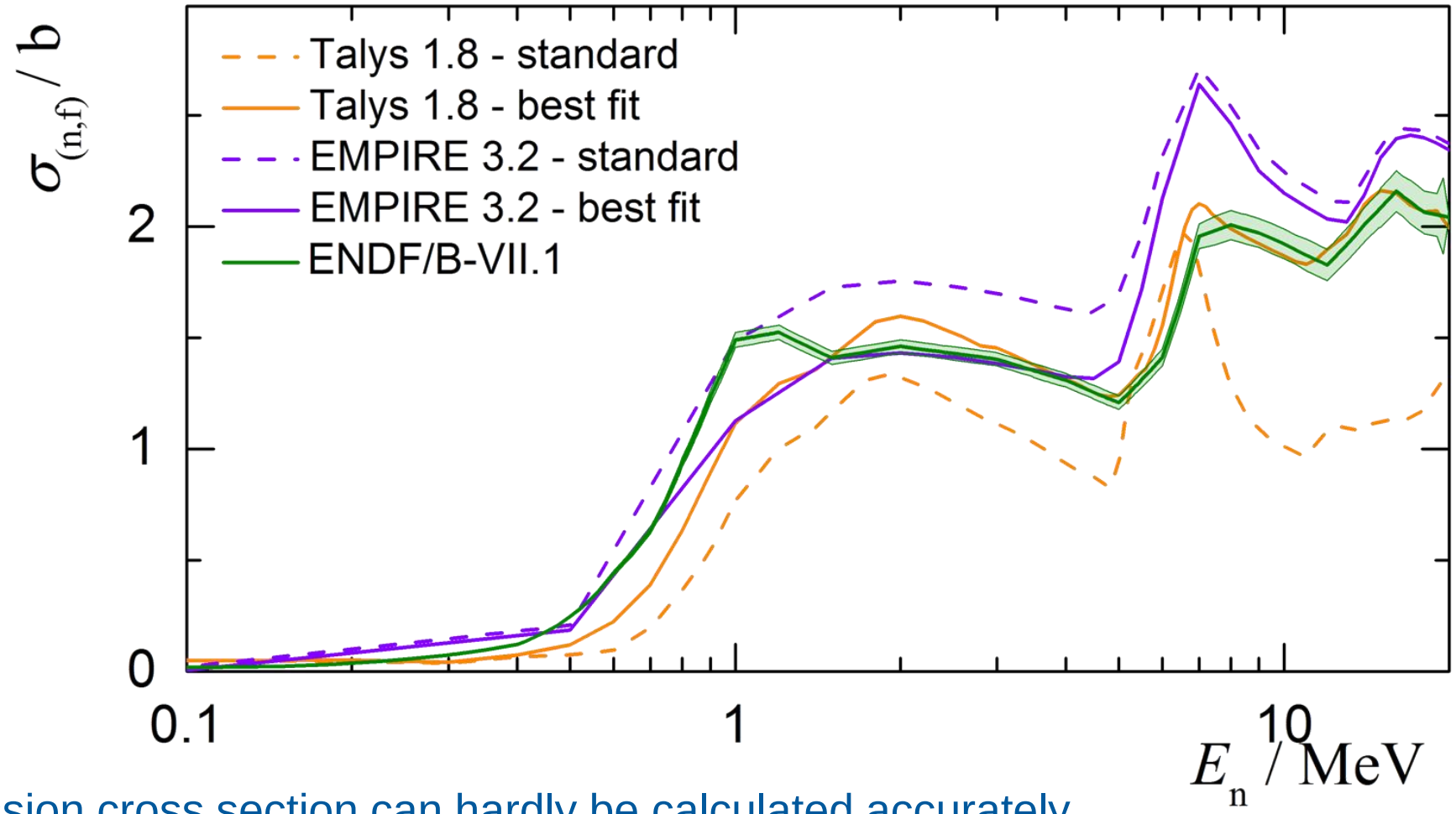
"Uncertainty and Target Accuracy Assessment for Innovative Systems Using Recent Covariance Data Evaluations",
Technical Report, Working Party in International Evaluation Co-Operation, OECD / NEA (2008)

^{242}Pu(n,fis) - Evaluations

- Current uncertainty ~ 20 %
- Target uncertainty = 3-5 %

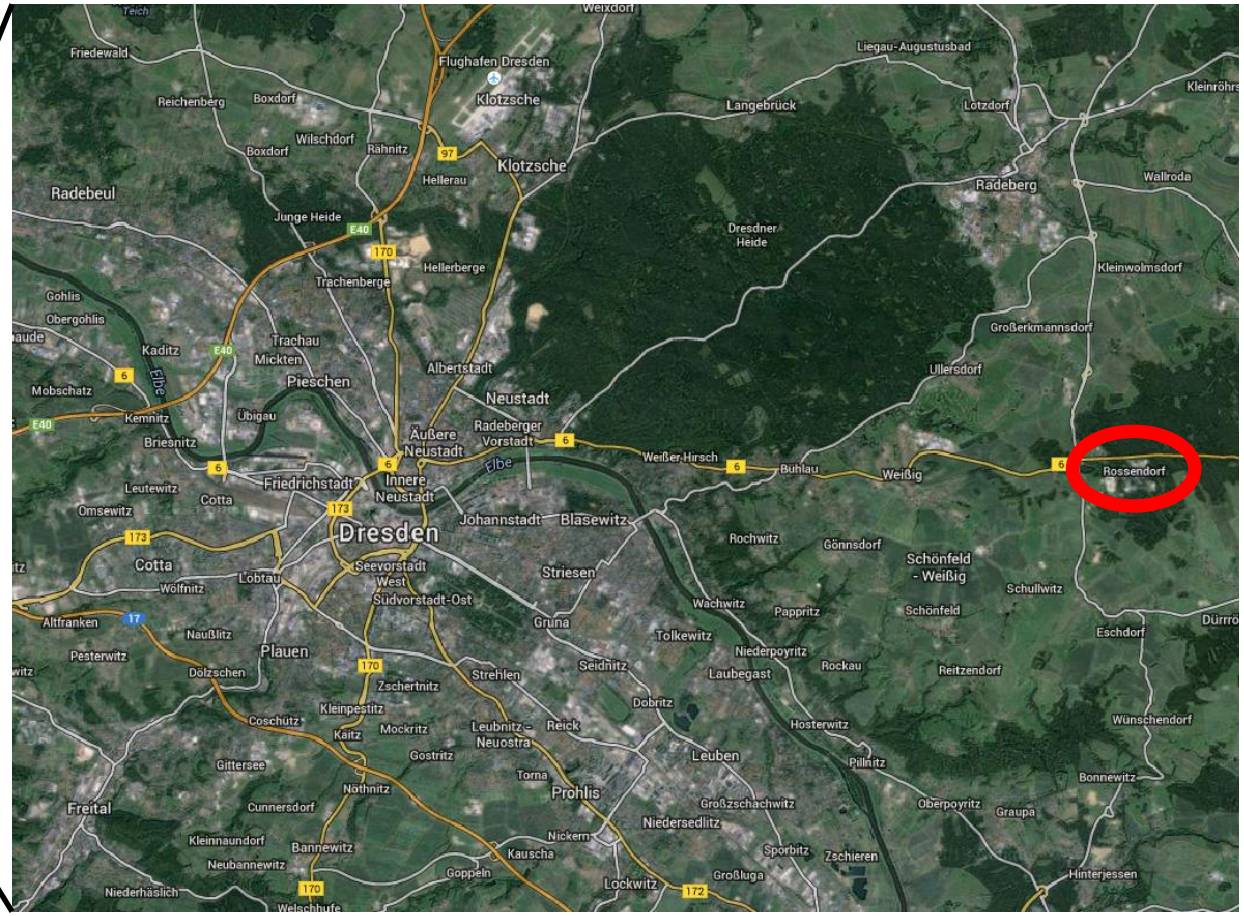


^{242}Pu(n,fis) - Nuclear model codes



- The fission cross section can hardly be calculated accurately by state-of-the-art nuclear reaction models.

nELBE – The neutron time-of-flight facility at ELBE



www.google.de/maps

nELBE – The neutron time-of-flight facility at ELBE

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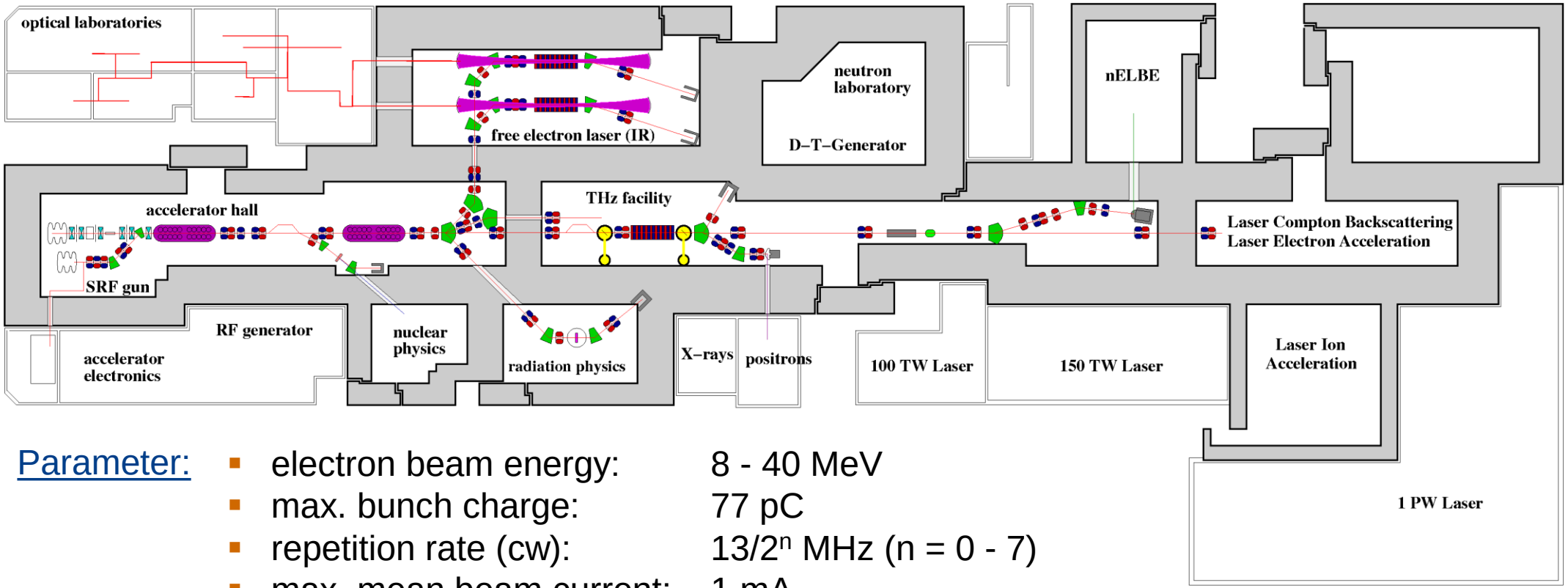
nELBE – The neutron time-of-flight facility at ELBE

ELBE - Center for high-power radiation sources (**E**lectron **L**inac for beams with high **B**rilliance and low **E**mittance)



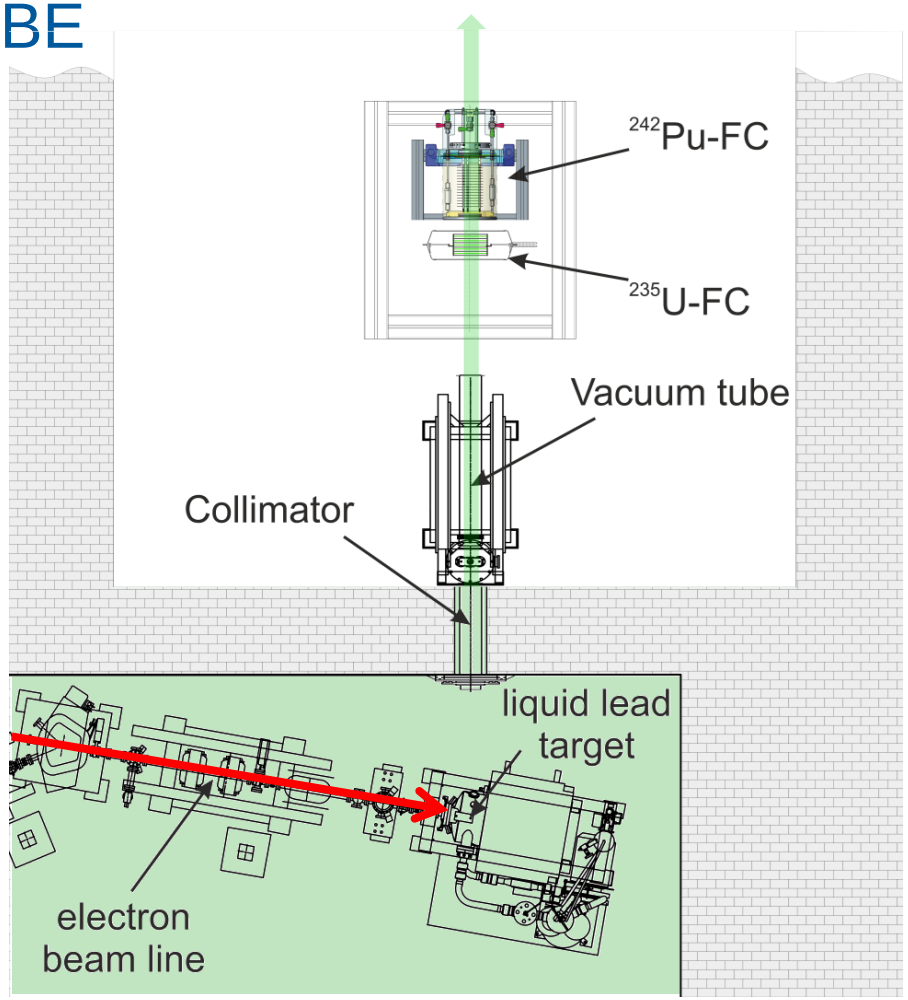
Parameter:

- electron beam energy: 8 - 40 MeV
- max. bunch charge: 77 pC
- repetition rate (cw): $13/2^n$ MHz (n = 0 - 7)
- max. mean beam current: 1 mA
- micro pulse length: 1 - 10 ps

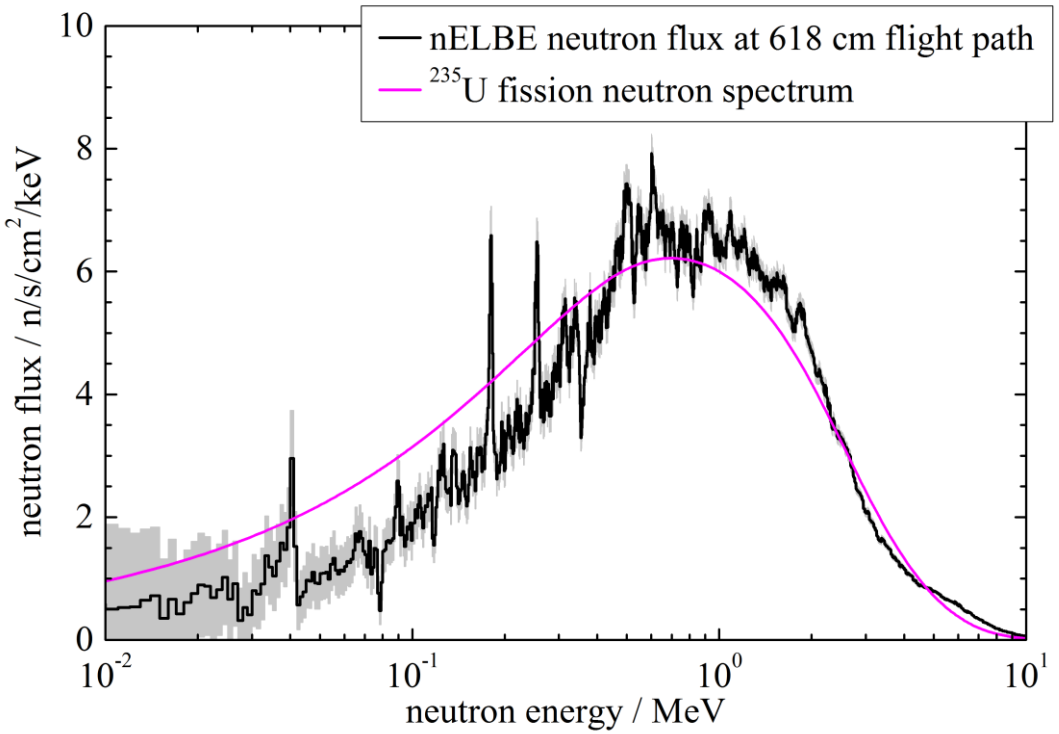
http://www.hzdr.de/elbe

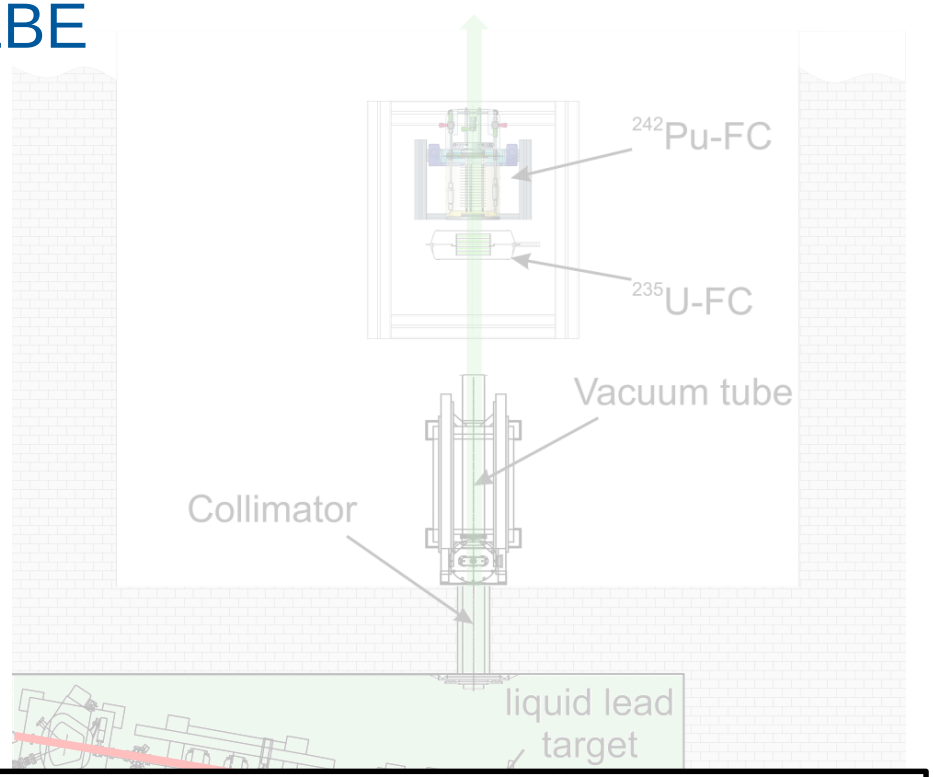
Gabriel et al., Nucl.Inst.Meth.B 161 (2000) 1143; Teichert et al., Nucl.Inst.Meth.A 507 (2003) 354

nELBE – The neutron time-of-flight facility at ELBE



nELBE – The neutron time-of-flight facility at ELBE

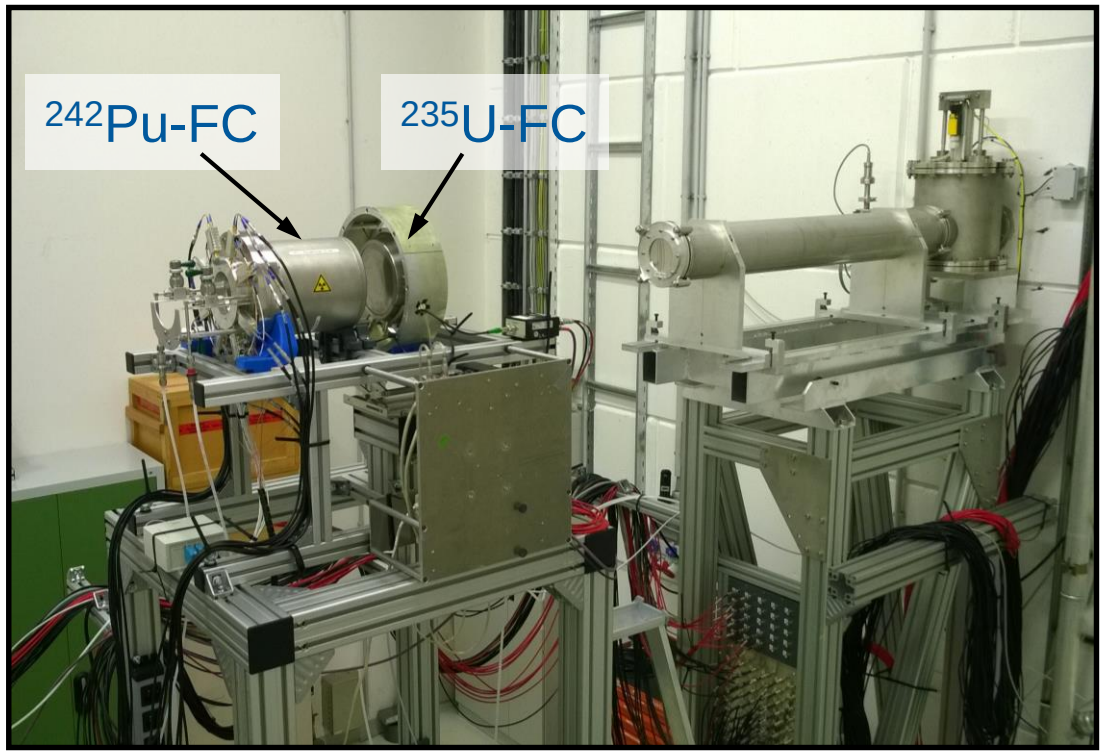




- energy range: 100 keV - 10 MeV
- repetition rate: 102, 203, 406 kHz
- source strength: ca. $2 \cdot 10^{11}$ n/s
- flux at sample: ca. $3 \cdot 10^{4}$ n/cm^2/s
- flight path: 5 - 11 m
- beam radius: 2.2 – 4.9 cm

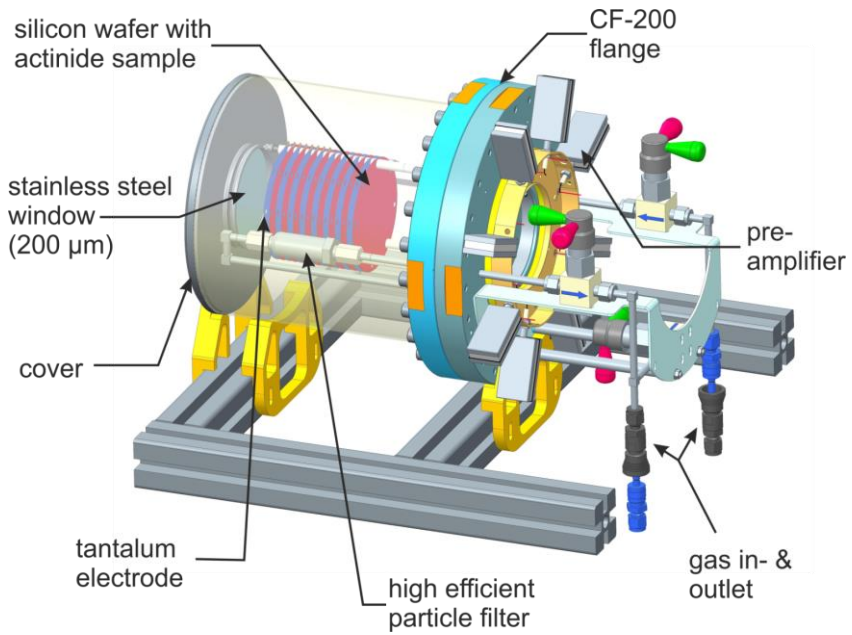
Beyer et al., Nucl.Instr.Meth.A 723 (2013) 151

^{242}Pu(n,fis) - The setup



^{242}Pu fission chamber:

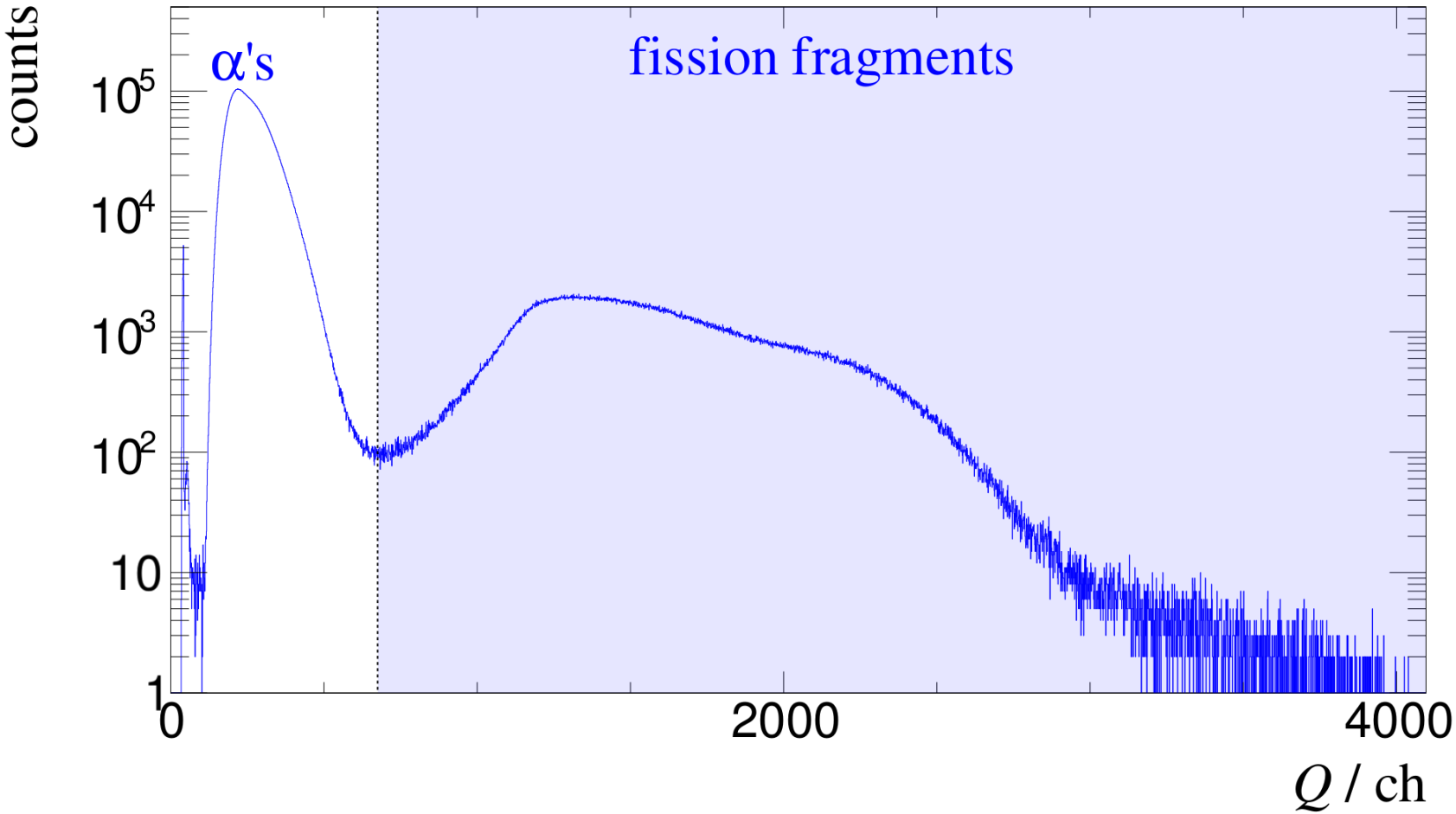
- $m_{tot} = 37.24(22)$ mg (8 deposits)
- $m_A = 108(4)\ \frac{\mu g}{cm^2}$
- $A_{tot} = 8.31$ MBq
- enrichment: 99.959 %
- homogeneity: 96.75(11) %



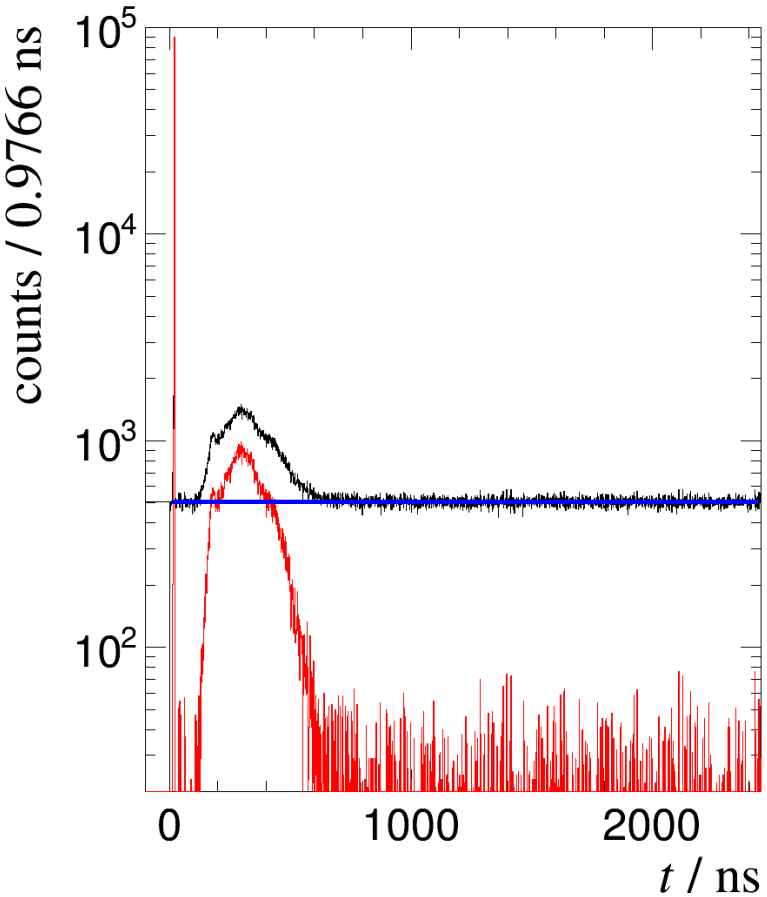
^{235}U fission chamber ("H19" PTB transfer instrument):

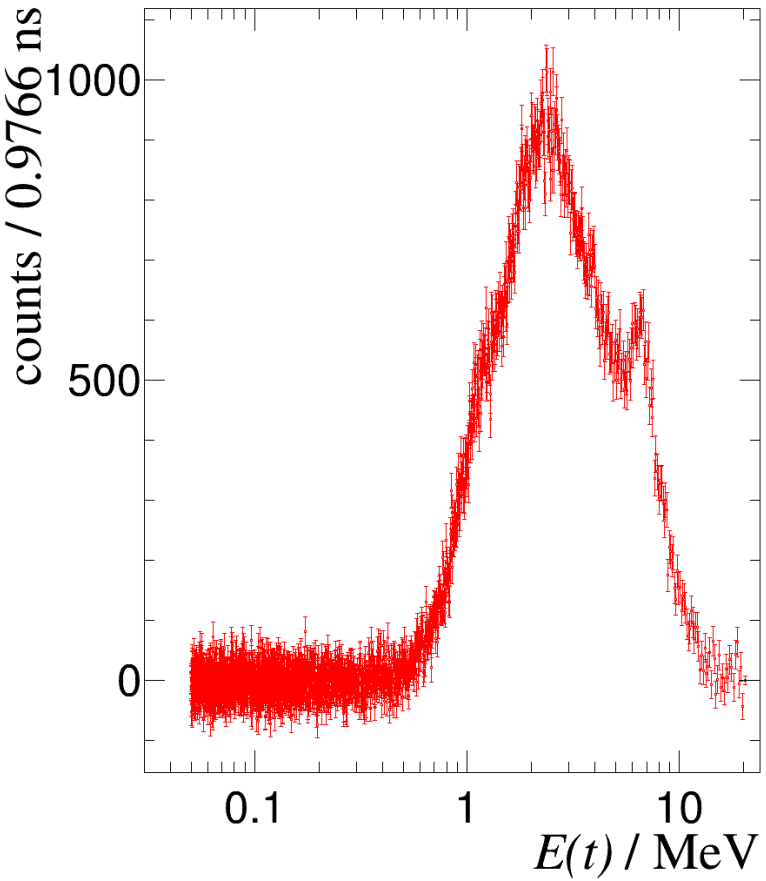
- $m_{tot} = 201.4(5)$ mg (10 deposits)
- $m_A = 444\ \frac{\mu g}{cm^2}$
- enrichment: 99.918 %

^{242}Pu(n,fis) - Charge spectrum



^{242}Pu(n,fis) - Time-of-flight spectra





time resolution:

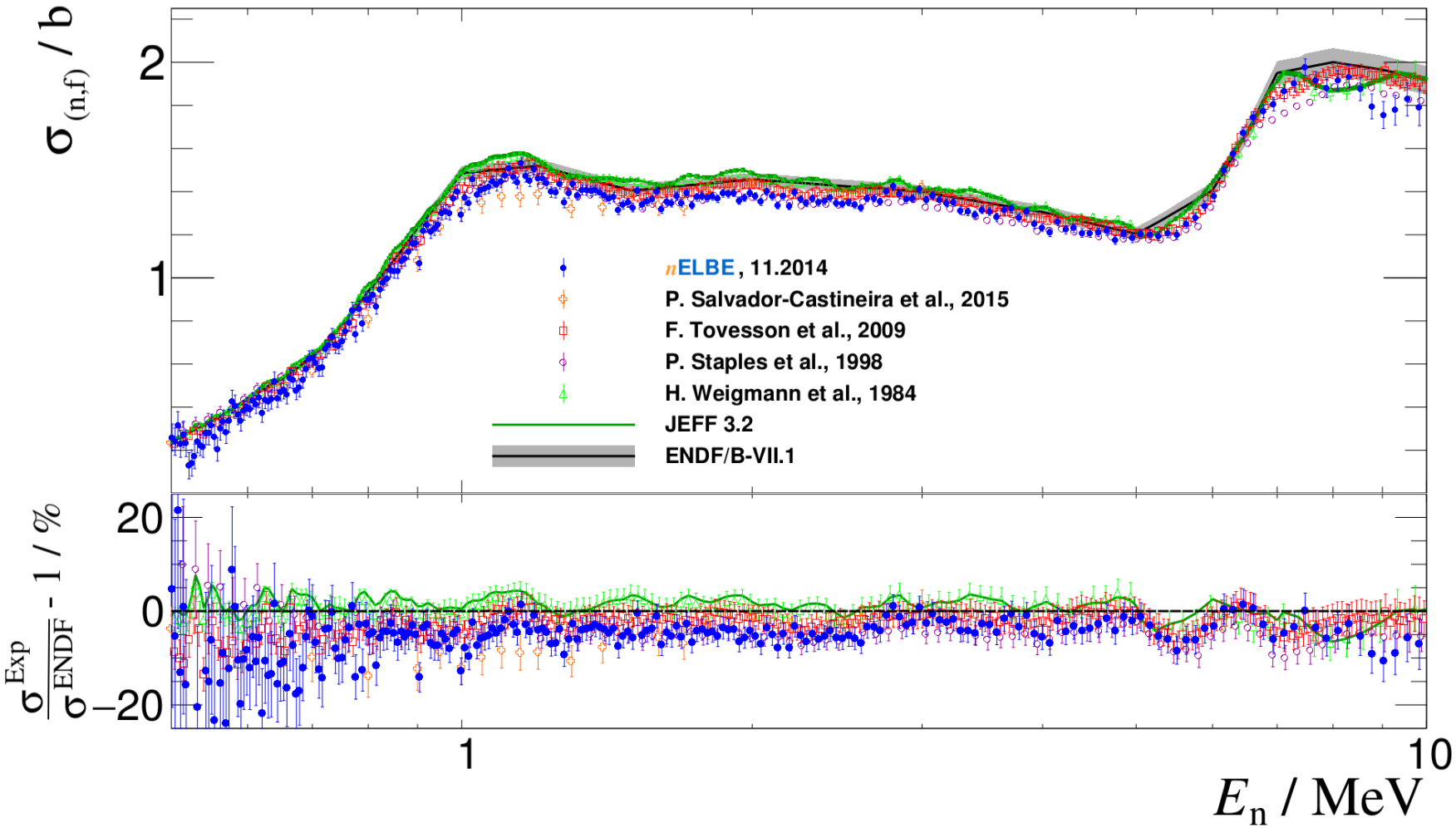
- PuFC: 1.3 ns
- H19: 3 ns

→ ΔE/E = 2-5 %

Analysis steps/Corrections:

- Dead time
- Fission fragment detection efficincy
- Neutron fluence
- Neutron transmission
- Loss of of ToF-energy-correlation

^{242}Pu(n,fis) - Reaction cross section



→ In agreement with latest experimental data sets
→ Measured cross section tend to be lower than JEFF 3.2 and ENDF/B-VII.1

^{242}Pu(n,fis) - Reaction cross section

Contribution	**Δx / x in %**		
	min	max	average
statistical:			
counting statistics:	1.1	47.4	**4.9**
systematical:			
normalization K $(\lambda, \gamma, \varepsilon n_A, \alpha, F)$			3.4
reference cross section σ^{H19}	0.6	0.9	0.7
Scattering C	0.19	0.24	0.21
anisotropy of FF ε^{FF}	1.0	2.3	1.6
combined			**3.8**

Summary

- The nELBE neutron time-of-flight facility provides
  - … neutrons in the energy range from about 100 keV to 10 MeV
  - … a flux of 10^4 n/cm^2/s at a repetition rate of 100 kHz
  - … a very defined time structure for time-of-flight measurements
  - … a broad pool of neutron and photon detectors
  - … flexible conditions for many kinds of experiments

- Construction and commissioning of a parallel plate fission ionization chamber with large homogenous Pu deposits

- Determination of the ^{242}Pu(n,fis) cross section in the energy range of 0.5 to 10 MeV

- Average statistical uncertainty < 5 % and systematic uncertainty < 4 %