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Title: Previous measurements on 239Pu(n,f) – review on methods, setups, and uncertainty estimates

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Previous measurements on ^{239}Pu(n,f) – review on methods, setups, and uncertainty estimates

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I will present the review on the previous measurements on the ^{239}Pu(n,f) reaction, ~~in~~ and focus on two contradicting sets of data in the low energy measurements (Starostov and Lajtai) and the high energy measurements (Staples and Knitter). The comparison on estimating the detector efficiencies and the uncertainties, and the summary and suggestions on improving the quality of data in the new measurements will be discussed.

Previous measurements on $^{239}Pu(n,f)$ – review on methods, detectors, and uncertainty estimates

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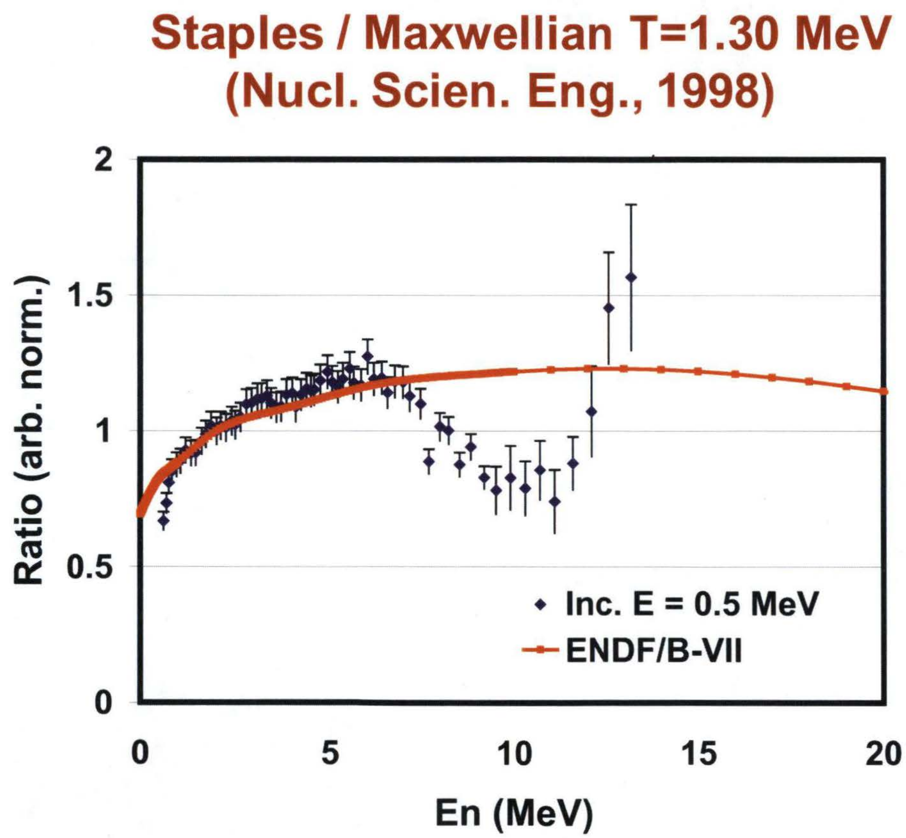
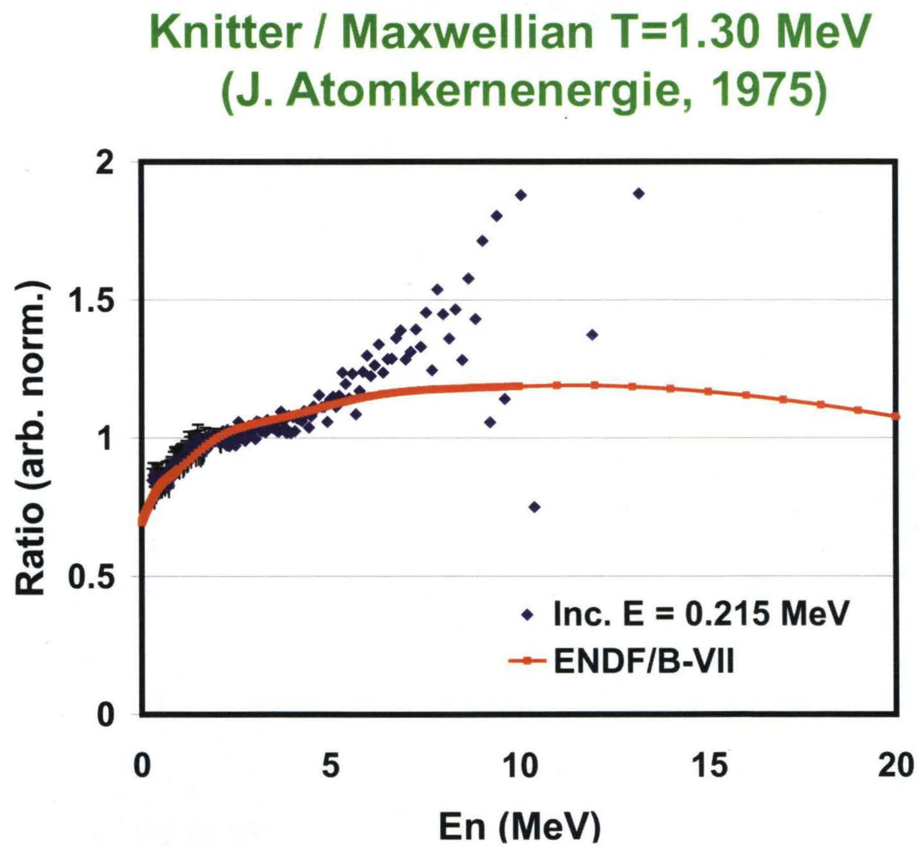
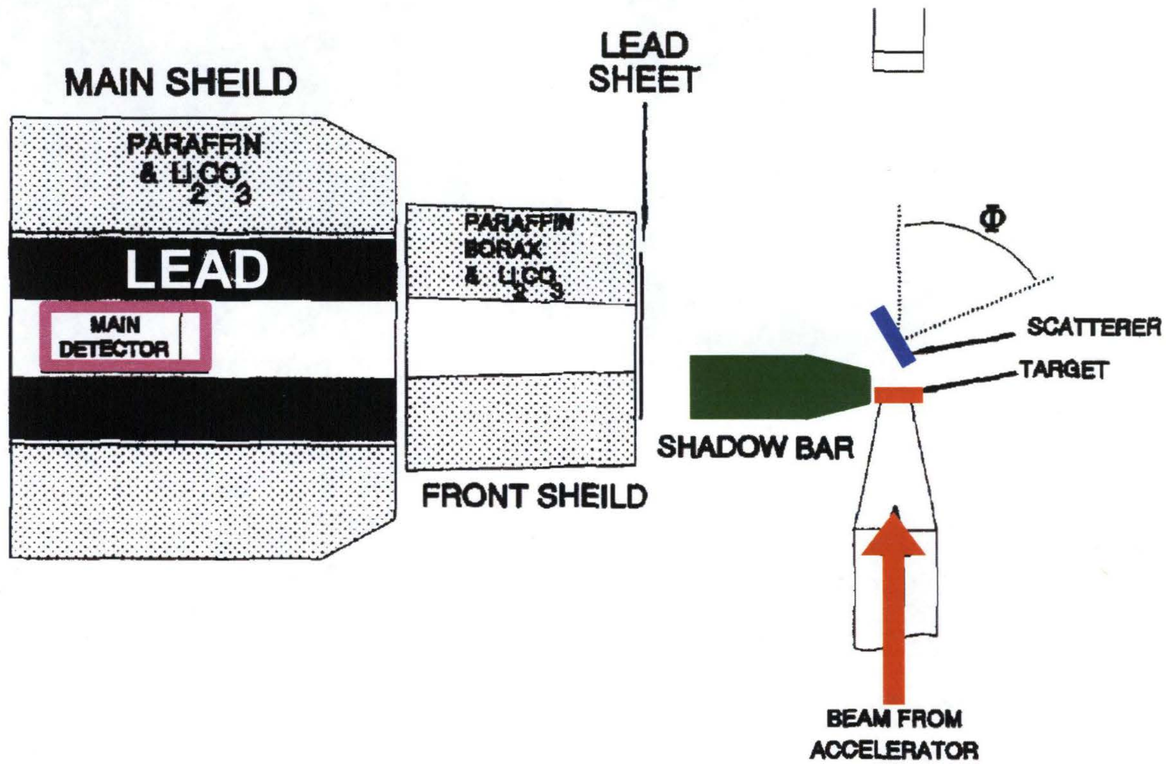
Experimental high energy data on ^{239}Pu





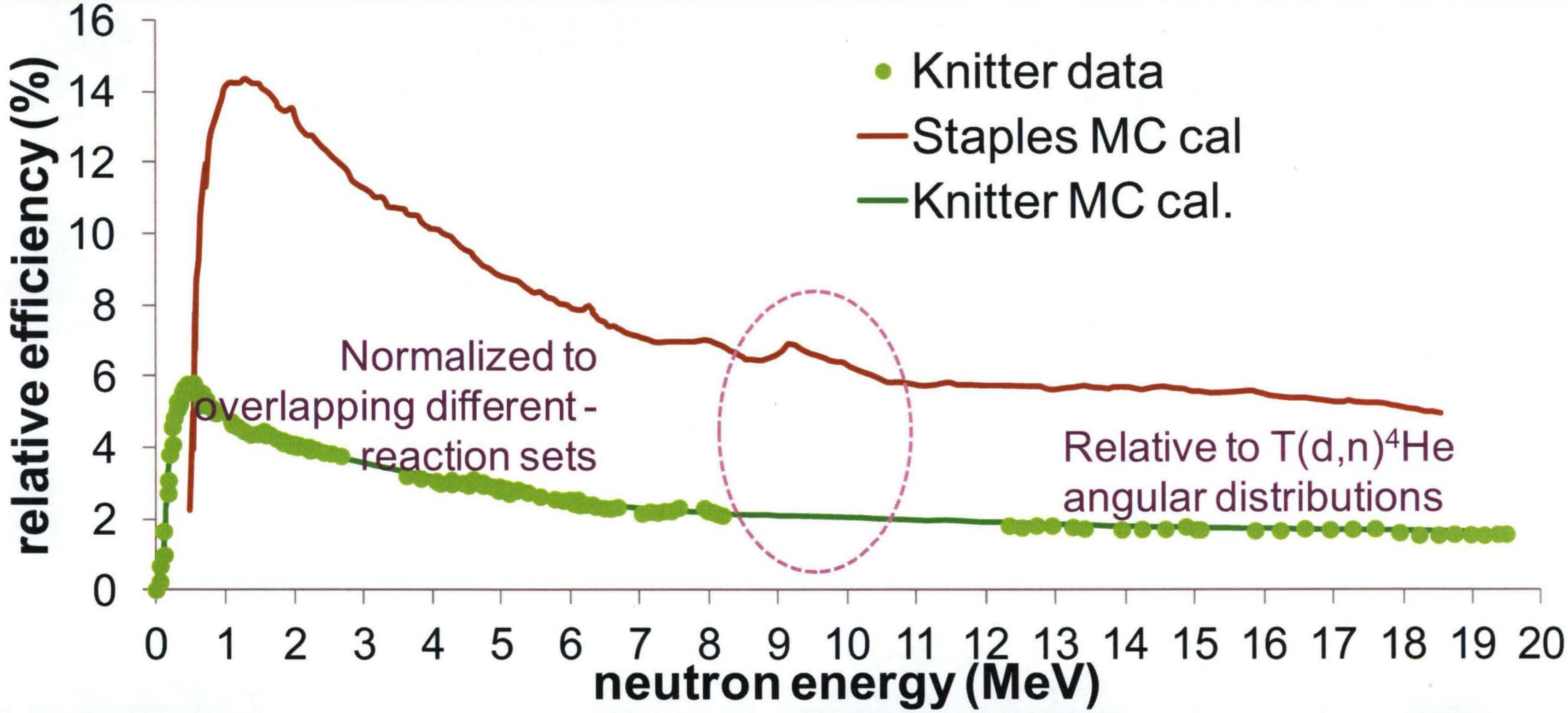
Measurement details on Staples vs. Knitter

1. Neutron source : $^{7}Li(p,n)$ with variable-energy and pulsed protons
2. Fissile samples
3. Neutron detector : liquid scintillators (BC501 vs. NE224)
4. Shadow bar to block direct neutrons



- TOF measurements
- No fission events detected
- Corrections & efficiency estimation using Monte Carlo calculations

Detector Efficiency (5-7 % and 2-5 % uncertainty)



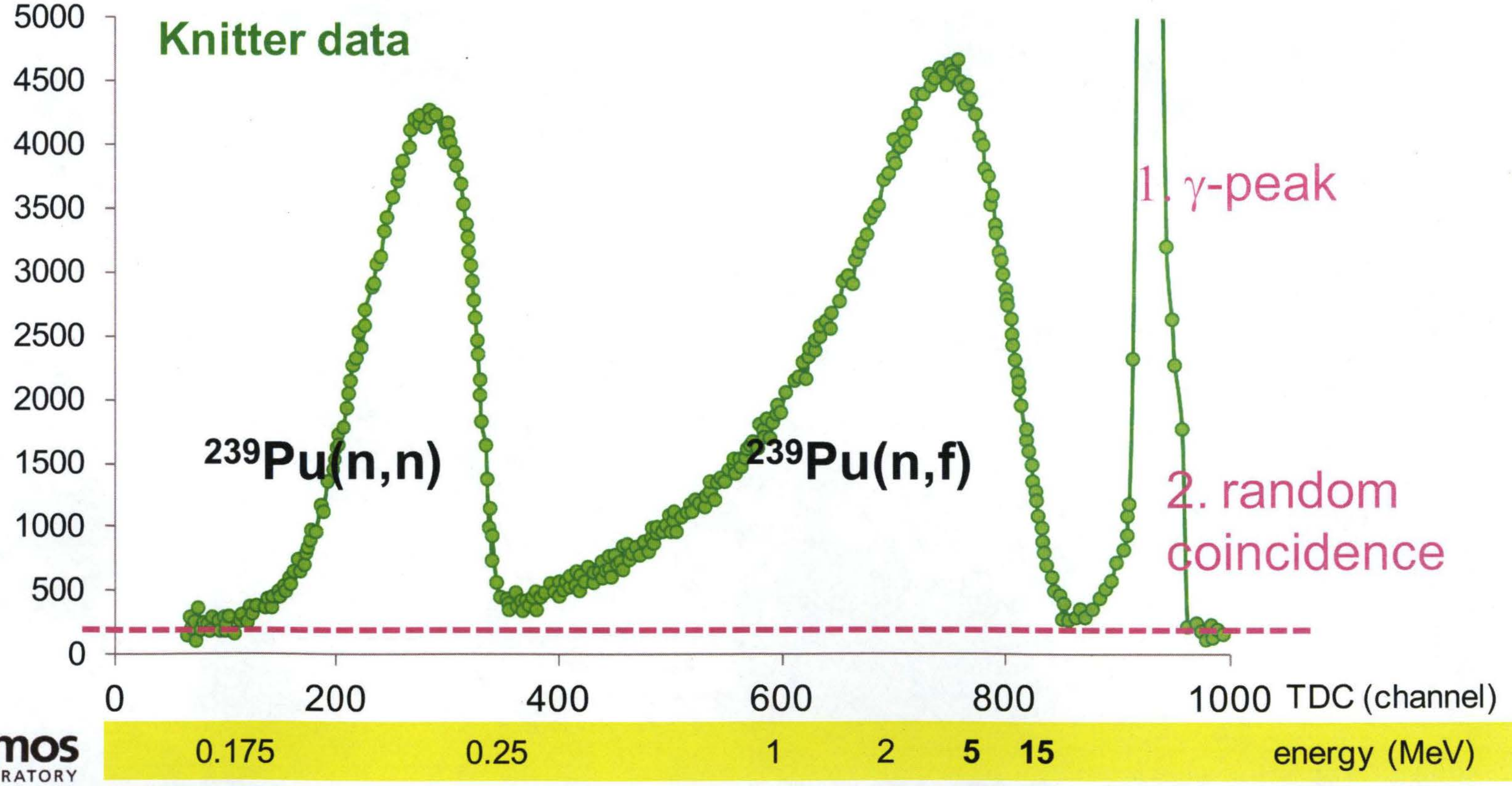
	Det. volume	Measurements	MC calculation
Staples	117 cm^3	^{235}U fission counter (E<3.5 MeV)	SCINFUL for the rest energy
Knitter	75 cm^3	Multiple reactions (E<20 MeV)	Maggie for corrections

High Energy measurements uncertainty in Knitter data

Knitter et al. Atomkernenergie (1973)

Systematic uncertainty :

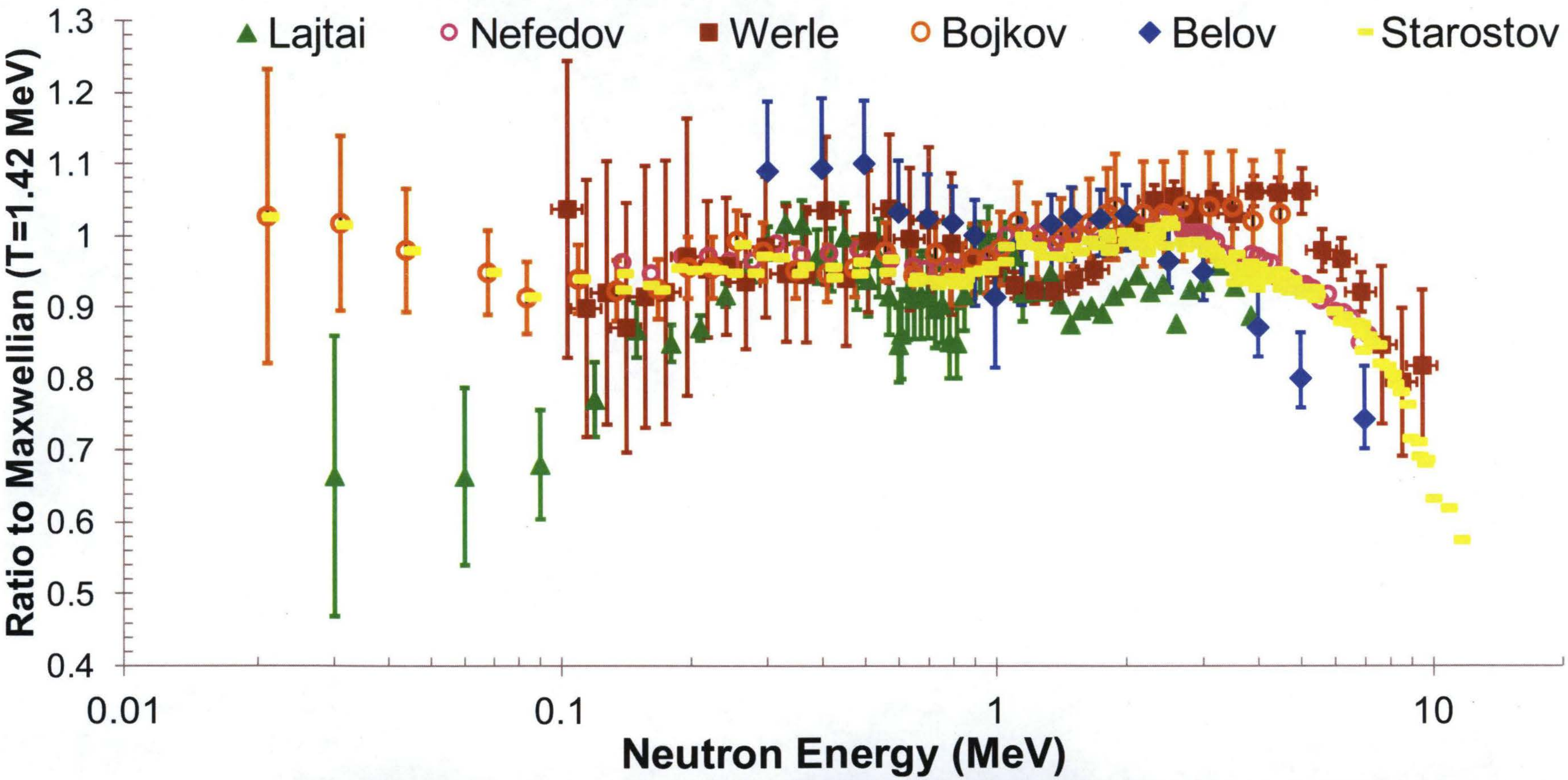
- correction for neutron inelastic scatterings
- constant background subtraction at ~15 MeV
- Timing correction is sensitive to the shape of neutron spectrum at 5-15 MeV



Summary on High Energy Measurements Uncertainty

- Systematic uncertainty :
  - Detector efficiency, based on simplified MC calculation
  - Shadow bars can cause additional down scatterings
  - random background & γ-peak subtraction
  - neutron production in excited states from $^{7}Li(p,n)^{7}Be^{*}$
- Statistical fluctuation :
  - critical constraint at E > 8 MeV

Experimental low energy data on ^{239}Pu (E_{inc} = thermal)

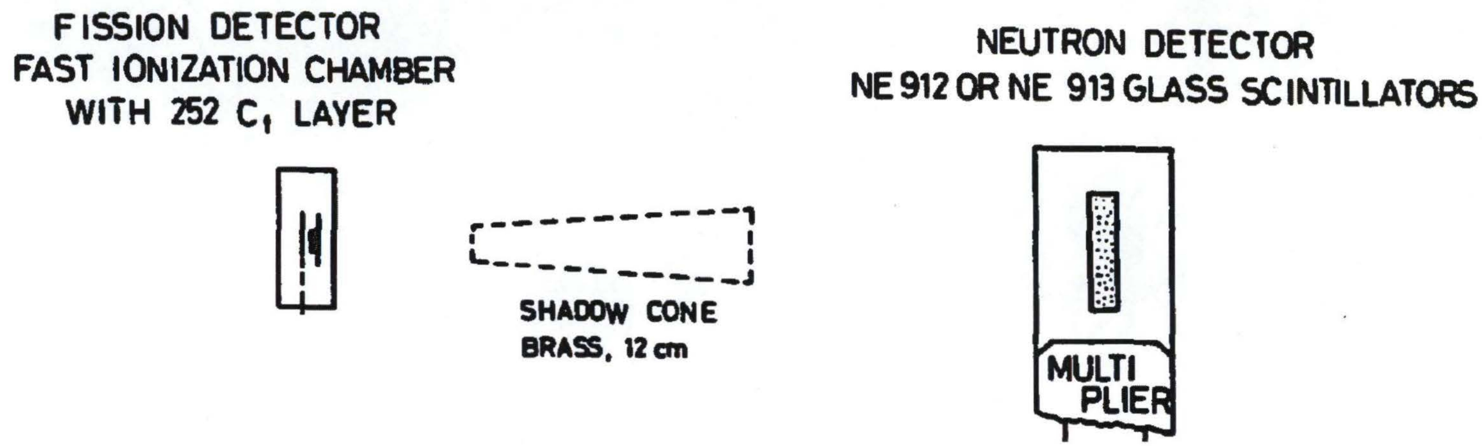


Bojkov-Nefedov (re-analysis) -Starostov, Laitai,
Werle (proton-recoil proportional counter), Belov (insufficient doc)

Starostov : notes on ^{239}Pu measurements

- Detector : Antracene scintillation detector (ϕ=18mm, 4mm thick)
- Correction for background neutrons : neutrons scattered by -the target backing, in the gas, by the walls of the miniature ionization chambers and gas scintillation detectors, by atoms in the air at a solid angle, by the lead shielding the scintillation detectors from delayed γ-rays, and by all the components of neutron detectors.
- Monte Carlo to calculate the efficiency of neutron detectors
  → double scattering needs to be counted in (n,p)
  →calculated the time shift due to the down scattering
- Used the ^{252}Cf compilation : weighted average over Starostov, Blinov, Lajtai
- NO CORRECTION FOR INELASTIC SCATTERING IN SAMPLE OR DETECTOR, NOR DELAYED FISSION NEUTRONS.

Lajtai : notes on ^{239}Pu measurement *Lajtai et al. NIM A (1990)*



- Cu shadow cone to estimate background neutron
- ^{7}Li-glass detector to measure the delayed γ-ray background
- Yield = Y(^{6}Li detector w/o cone) – Y(^{6}Li detector w cone) -Y(^{7}Li detector w/o cone) + Y(^{7}Li detector w cone)

Uncertainty Comparison

Starostov : 4.1-20 % at 1-0.02 MeV

-the neutron detector efficiency (unc. in the efficiency of 2.5-4 %)
-discrimination level stability
-delayed gammas
-statistical (random coincidence, "recycling" neutrons, experimental hall background)
-the flight time uncertainty
-scattered neutrons

Lajtai : 4.1-30 % at 2-0.03 MeV

-the measured neutron detector efficiency : 3-8 %

(statistical unc. & MC unc. < 2% & ^{6}Li(n,a)t cross section unc.)

-the measured ^{252}Cf spectrum unc. : 6-17 %

(*correction factor (t) ~ 2% in neutron det. Efficiency & number of detected fission events
*ambiguity in fission ionization chamber efficiency ~ ±3%
*determination of neutron flight path & solid angle ~ ± 2%)

Summary on low energy measurement uncertainty

- Systematic uncertainty :
  - normalization to ^{252}Cf source measurement
  - estimation on down-scattered low energy neutrons
  - room-induced background

- Statistical uncertainty :
  - yield at $E < 100$ keV