Study of neutron induced fission of ^{235}U and ^{237}Np with FALSTAFF spectrometer at NFS

Overview :

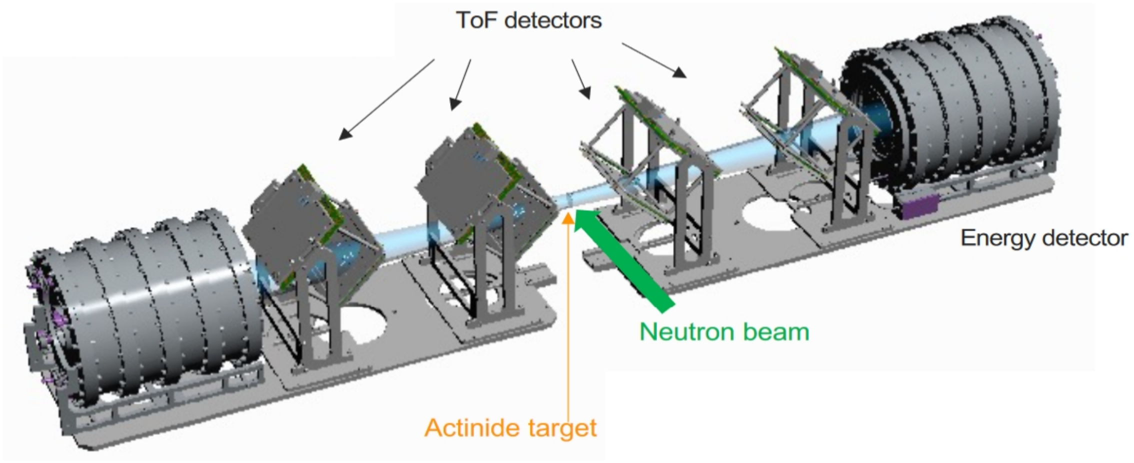
- ➔FALSTAFF: Detection principles, and experimental setup
- ➔Experiments and analysis
- ➔Falstaff@NFS : Results
- ➔Future plans: Running the first two-arm experiment

FALSTAFF

- Designed to study neutron induced fission of **actinide targets** in **direct kinematics**.
- Coincident fission fragment detection as a **function of neutron excitation energy**.
- For each fission fragment :
  - Velocity determination through time-of-flight and position reconstruction.

    ⇒ **2V method** to access velocity vectors of both FF.
  - Kinetic energy measurement calorimetry in an axial IC.

    ⇒ **EV method** to determine the mass of the FF.



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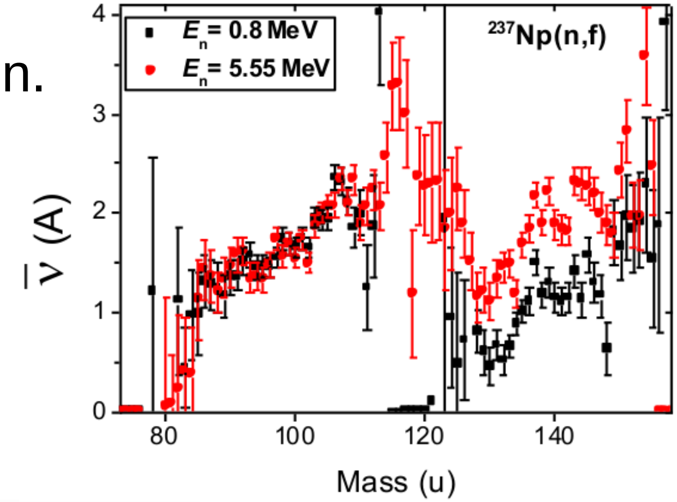
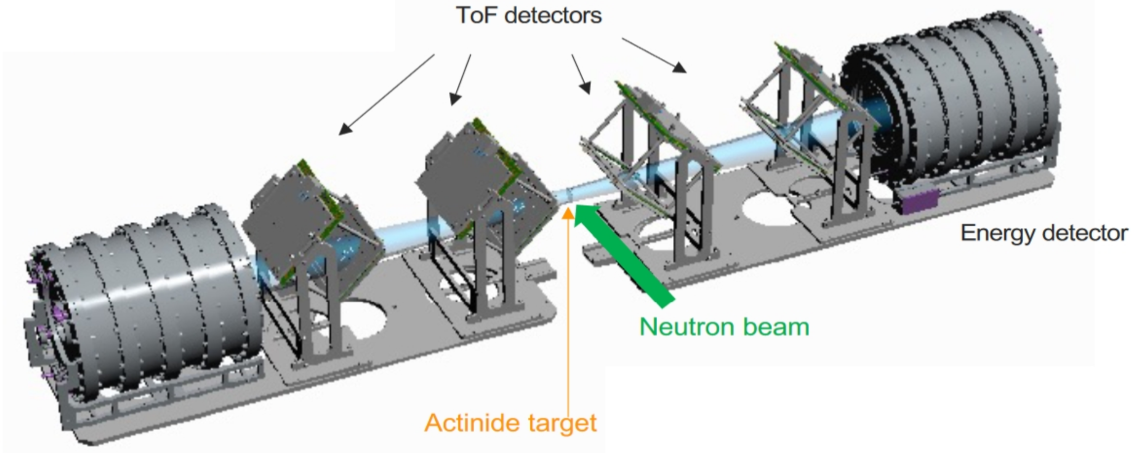
Naqvi et.al, Phys Rev C, 34, 218 (1986)





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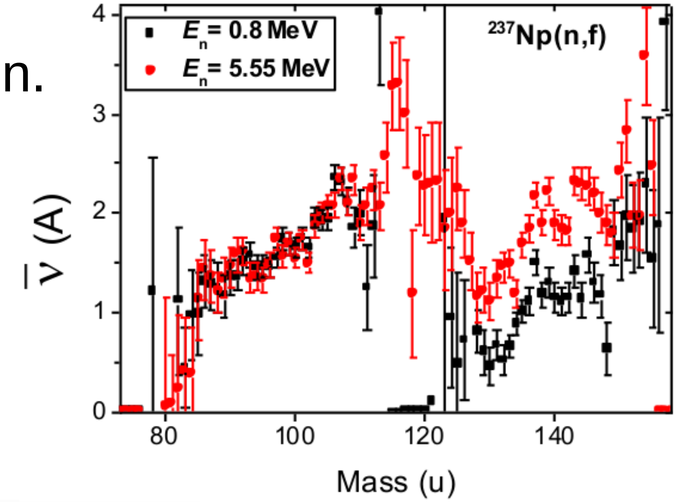

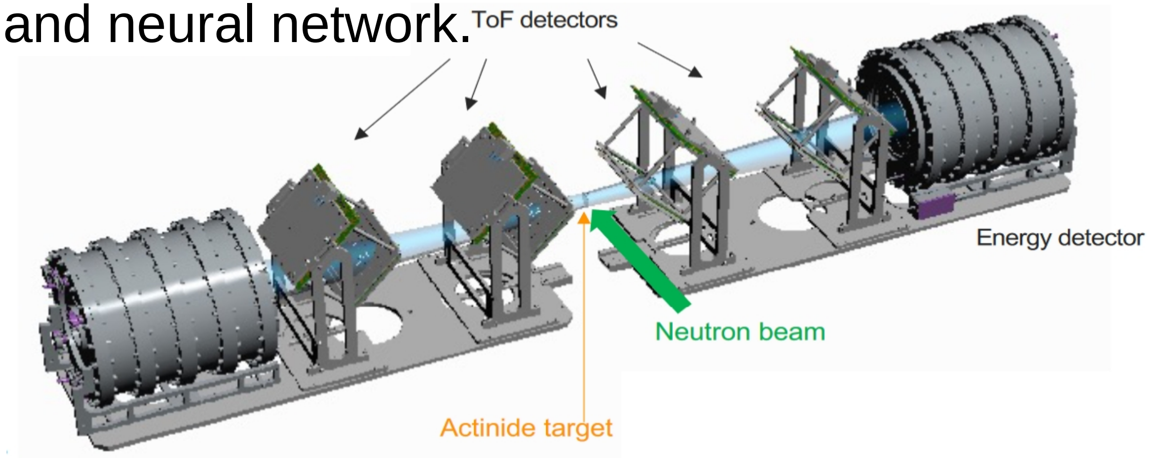

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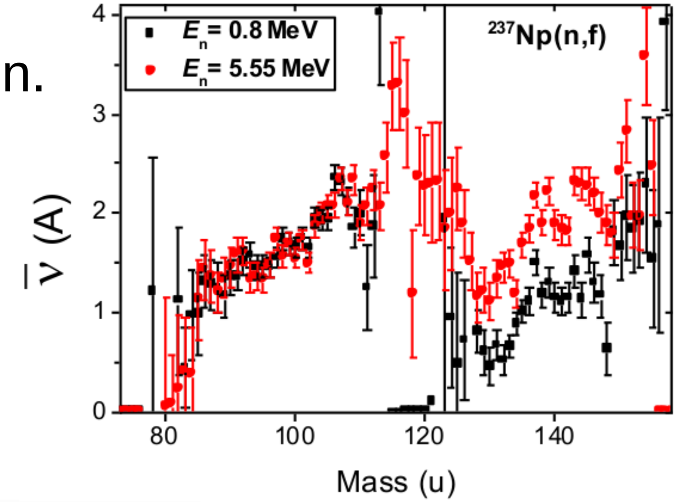
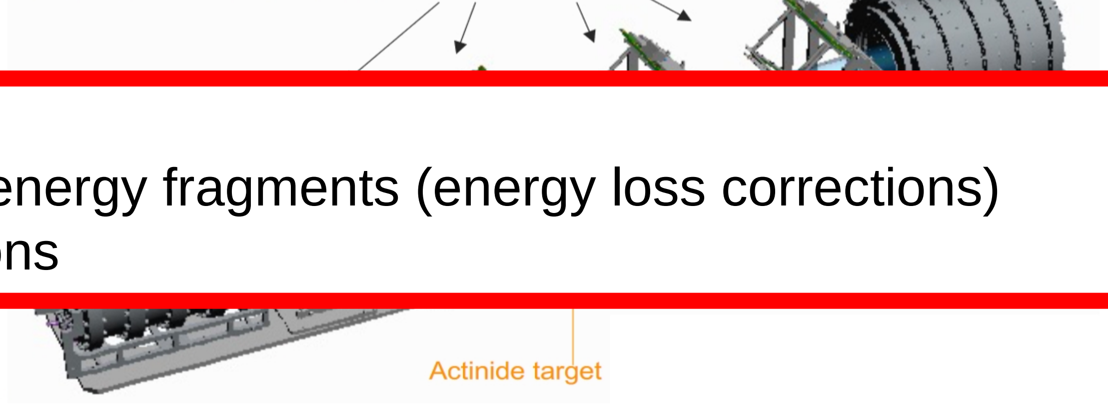




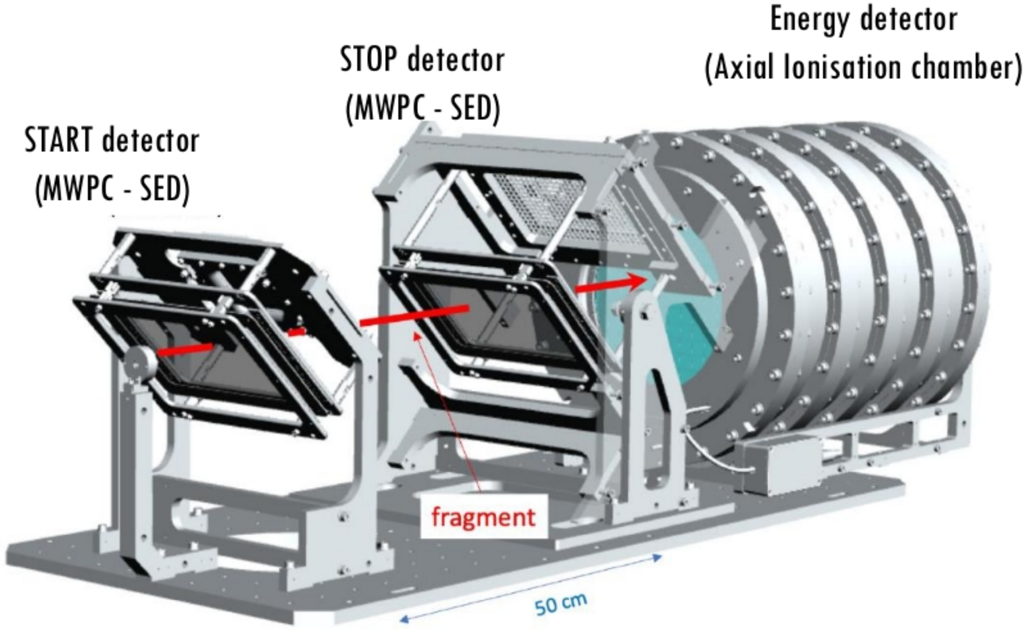
Challenges :
- Direct Kinematics ==> Low energy fragments (energy loss corrections)
- Experimental mass resolutions

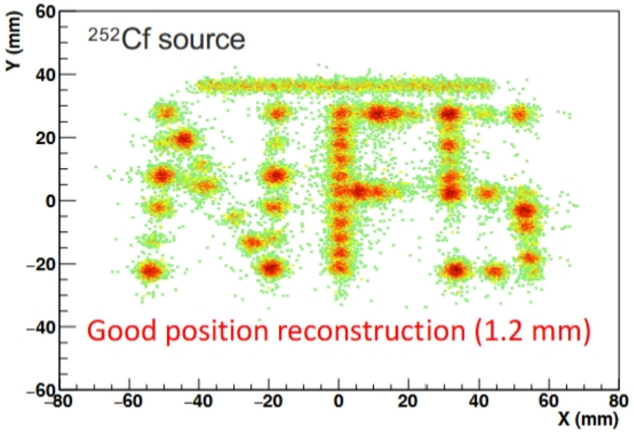
Velocity and energy measurement

1. Secondary-electron-emission detector (Se-D)

- X,Y position detection of secondary electrons emitted when fission fragments pass through emissive foil.
- Optimised for high time resolution.
- Resolution ⇒ Position : σ(X,Y) = 1.2 mm

  Time of flight : σ(t) = 120 ps





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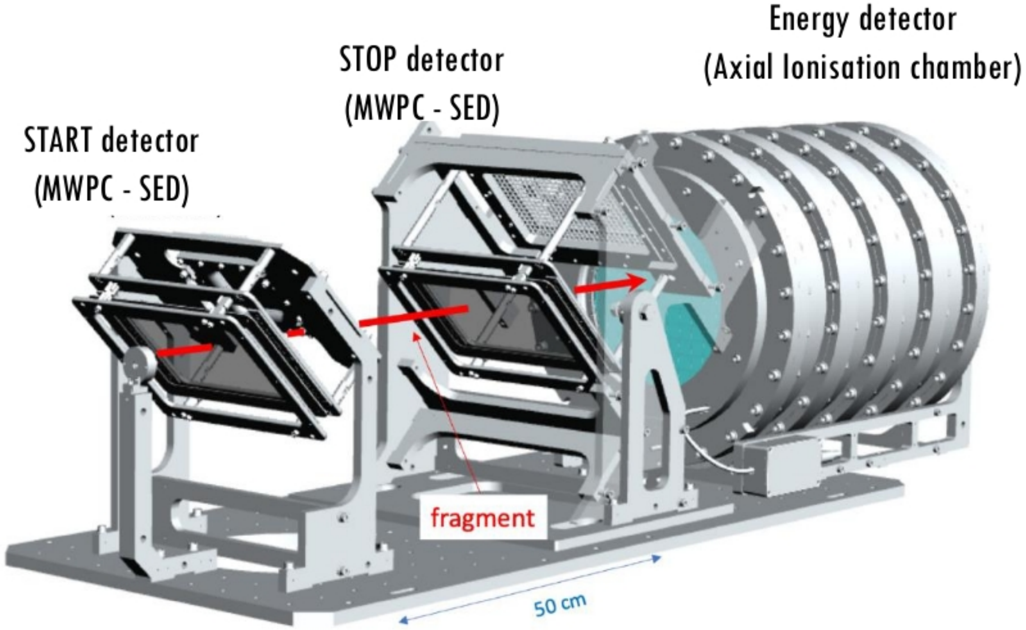
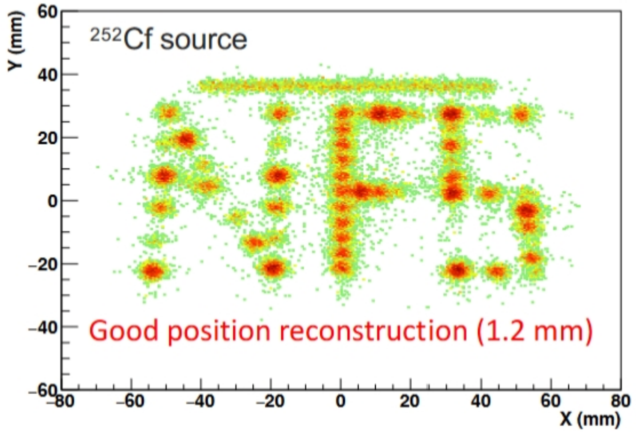
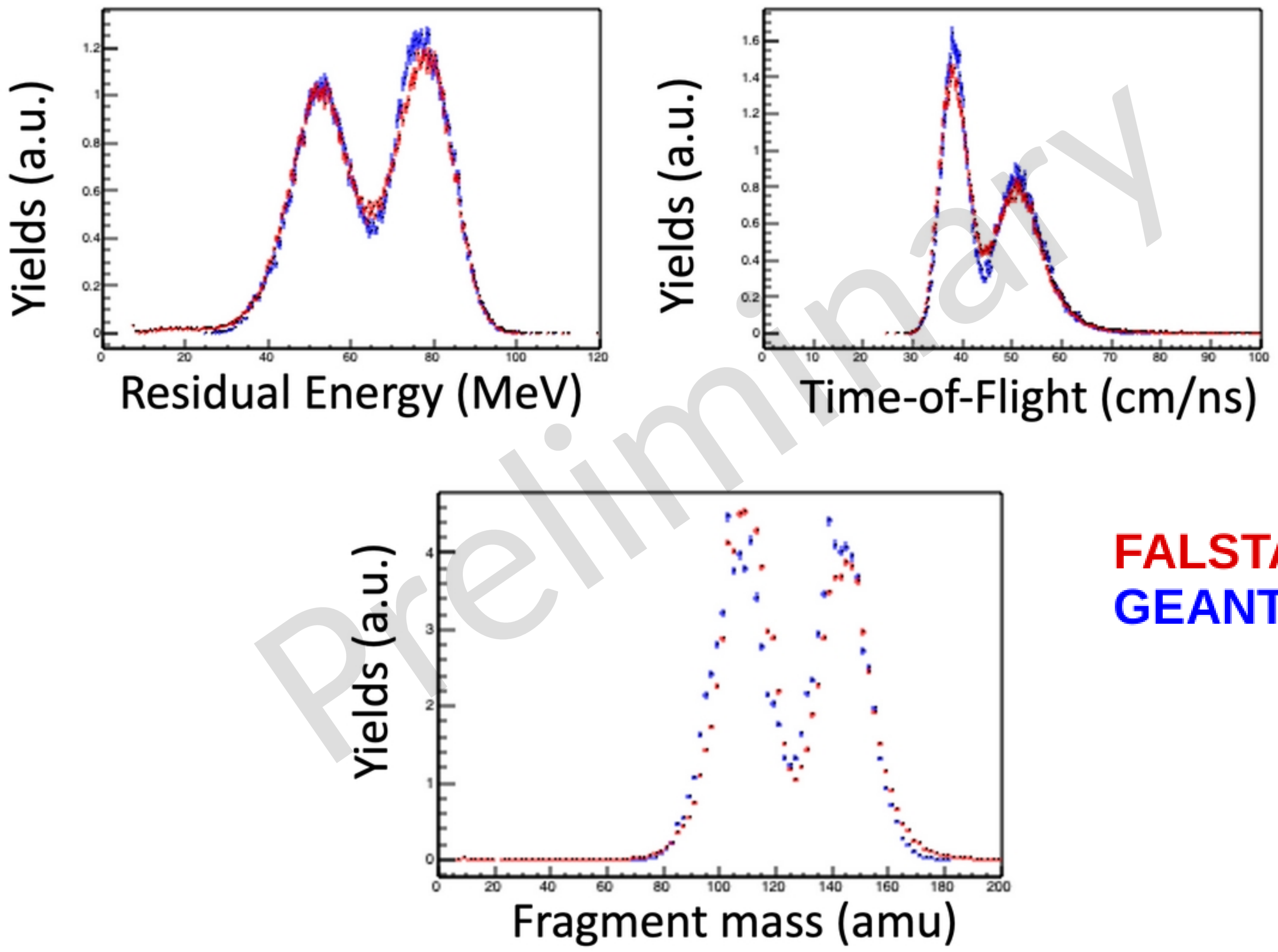
2. Axial ionisation-chamber (IC)

- FF stopped inside the gas of the IC.
- Calibration performed through GEANT4 simulation on ^{252}Cf with different material layer on the FF paths.
- Resolution ⇒ Energy : σ(E)/E ~ 1%





Measurement of $^{252}Cf(sf)$



FALSTAFF data
GEANT4 simulation

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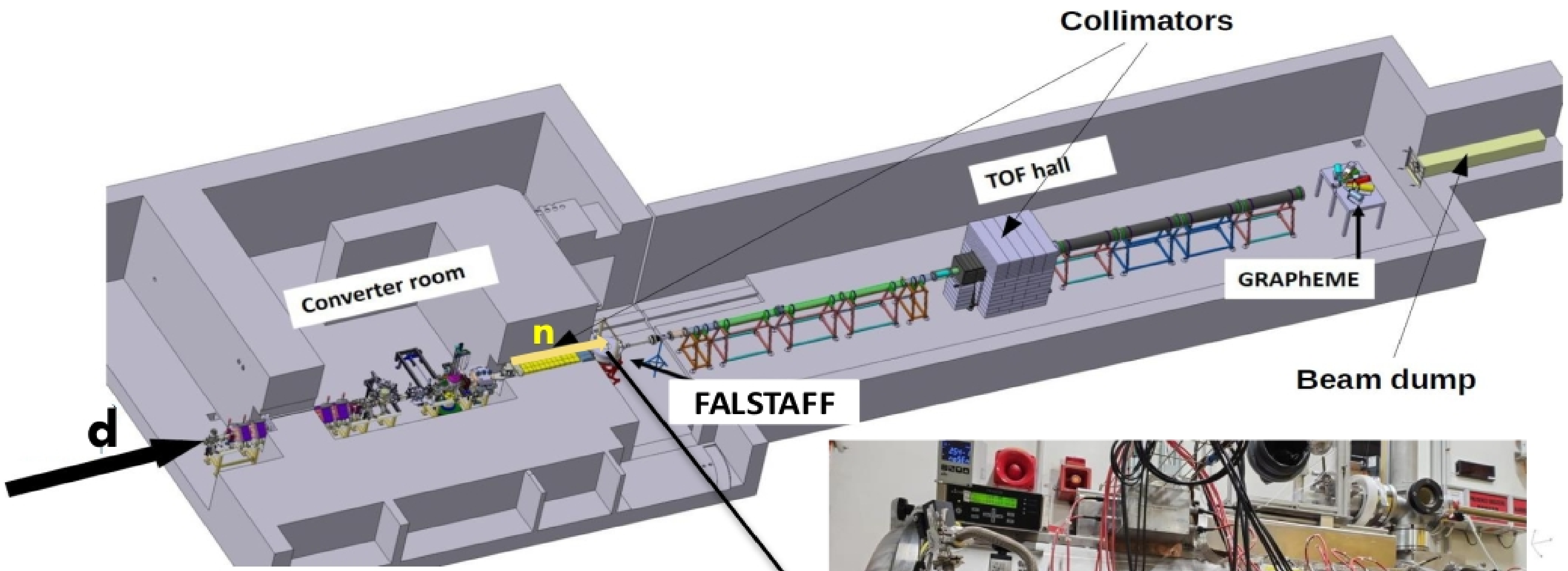
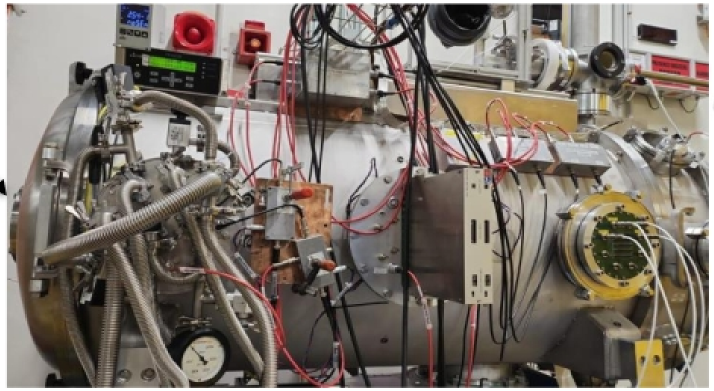
FALSTAFF @ NFS

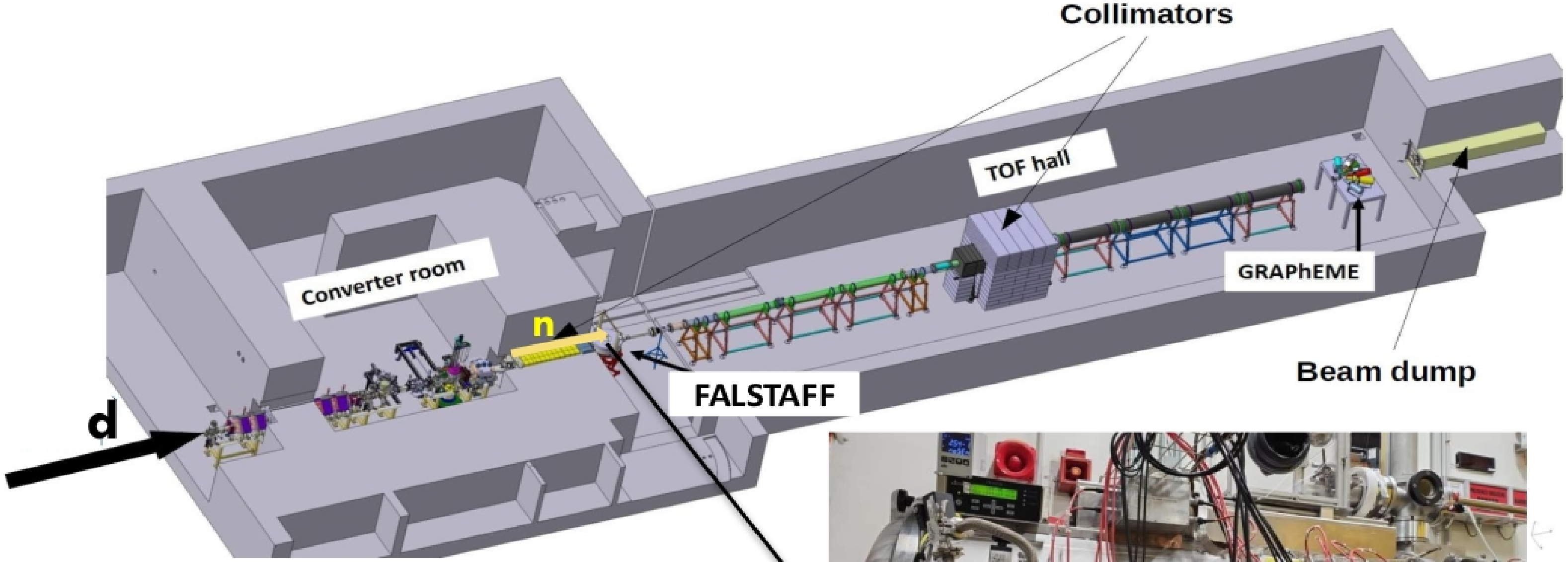


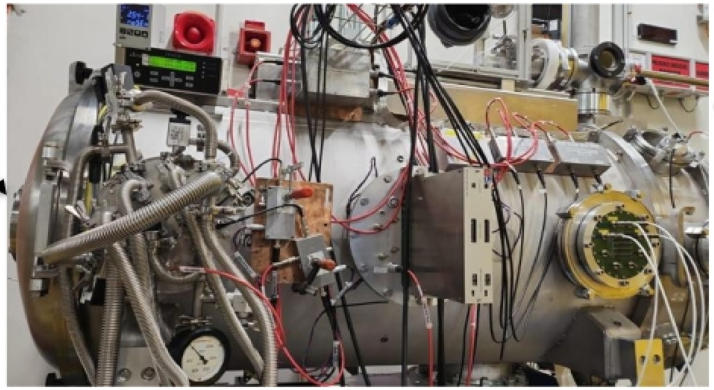


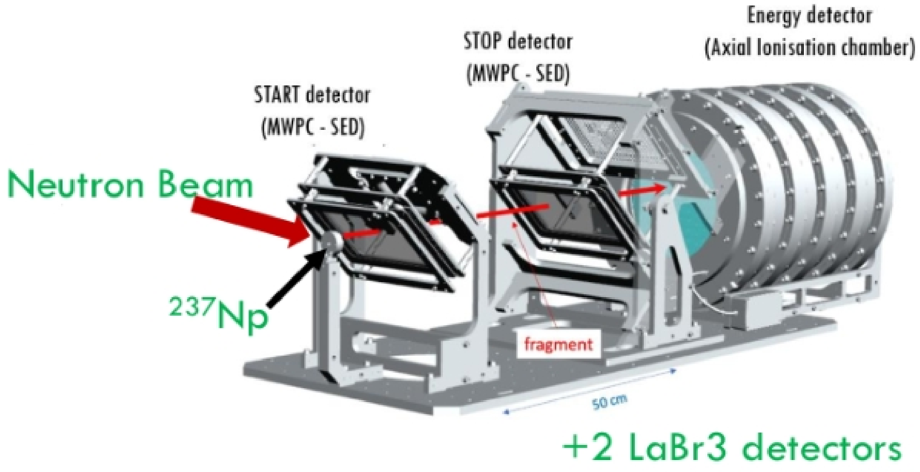
Neutron Beam @ NFS:

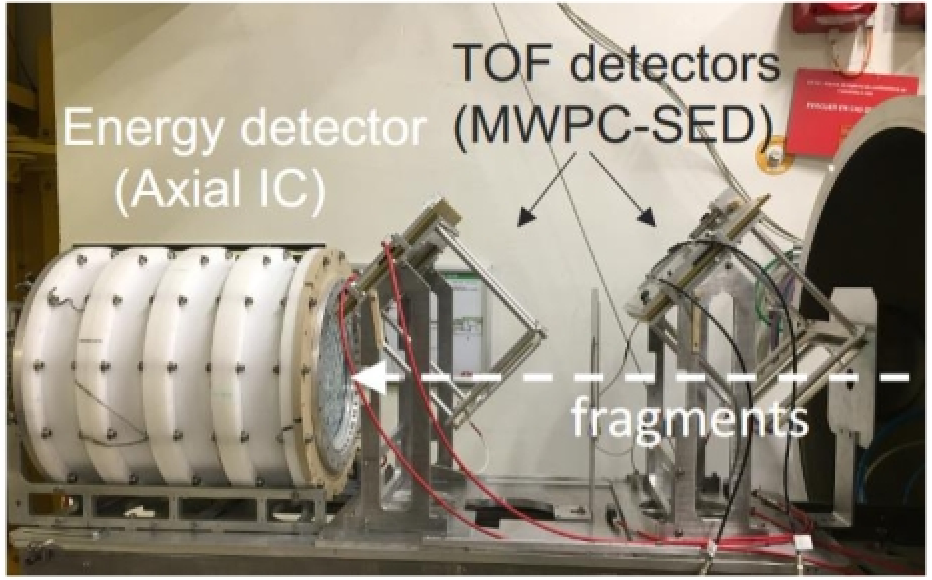
- Neutron beam production from d + ^{9}Be reaction
- Neutron energy measured from the **TOF technique**

FALSTAFF @ NFS









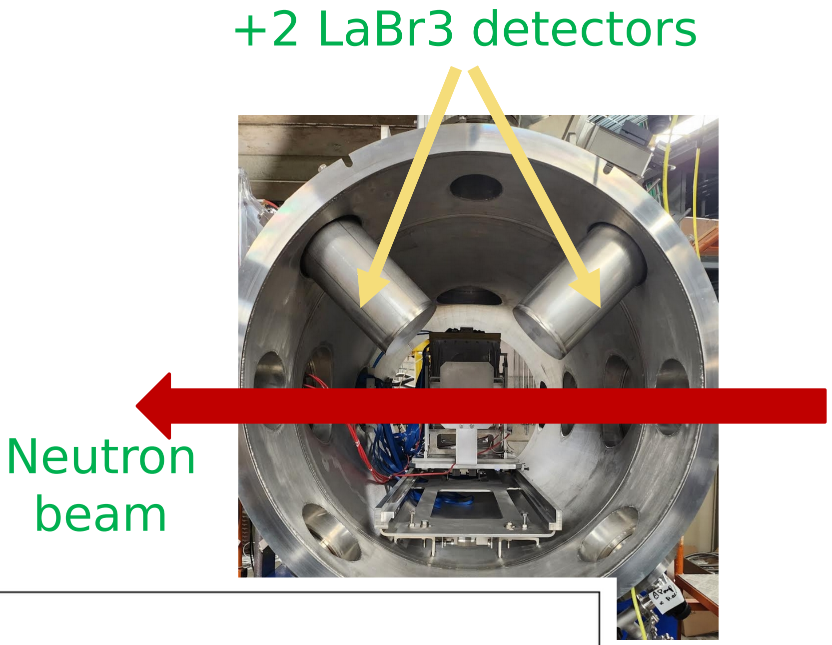
Neutron Beam @ NFS:

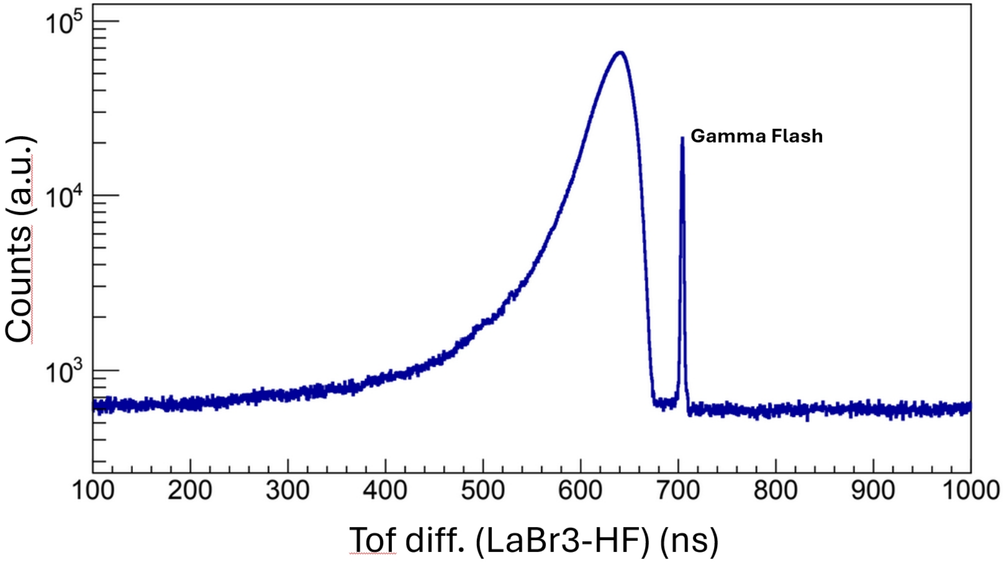
- Neutron beam production from d + ^{9}Be reaction
- Neutron energy measured from the **TOF technique**

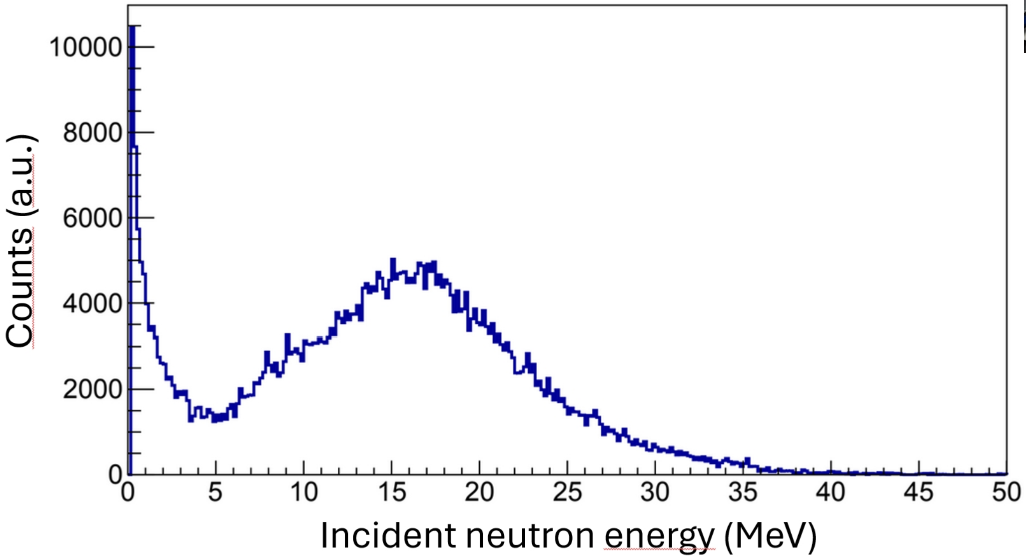
Incident neutron energy spectra

- Time reference : Low energy gamma flash from beam on converter.
- 2 LaBr3 detectors…
- Neutron time of flight spectra (in coincidence with FALSTAFF)

  ➔ Different TOF diff. combinations between HF, FALSTAFF and LaBr3



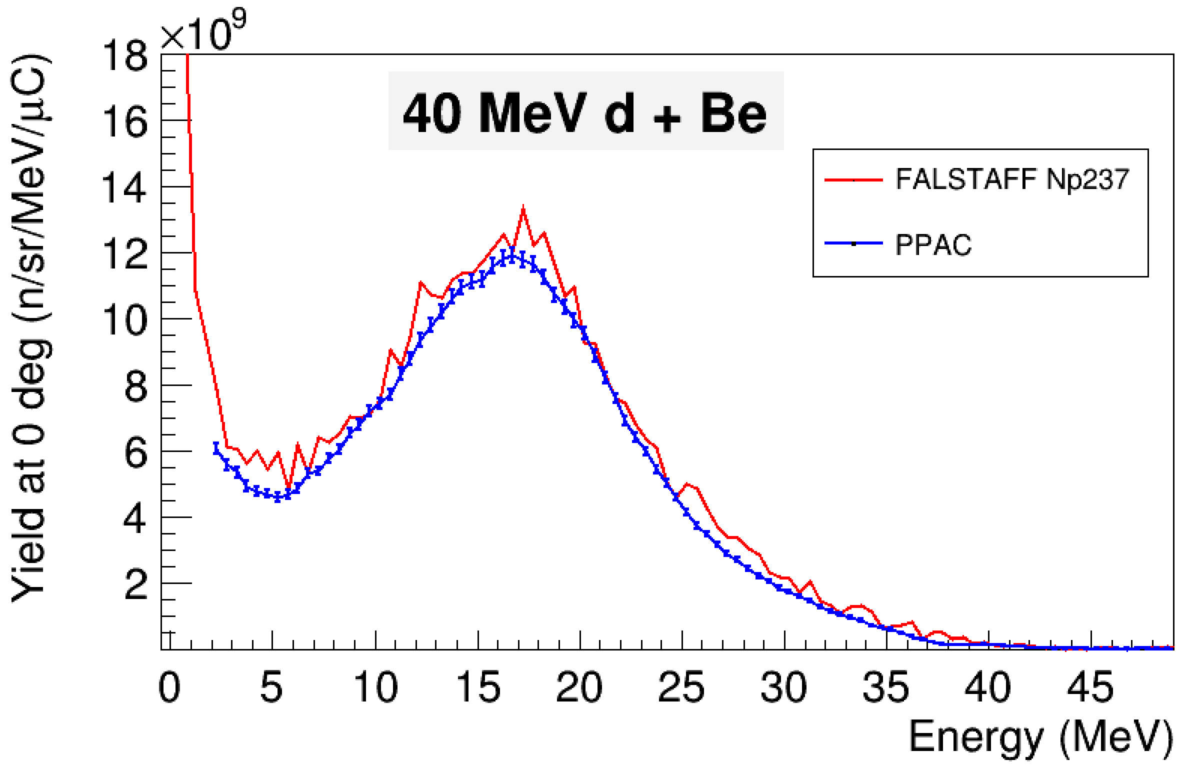




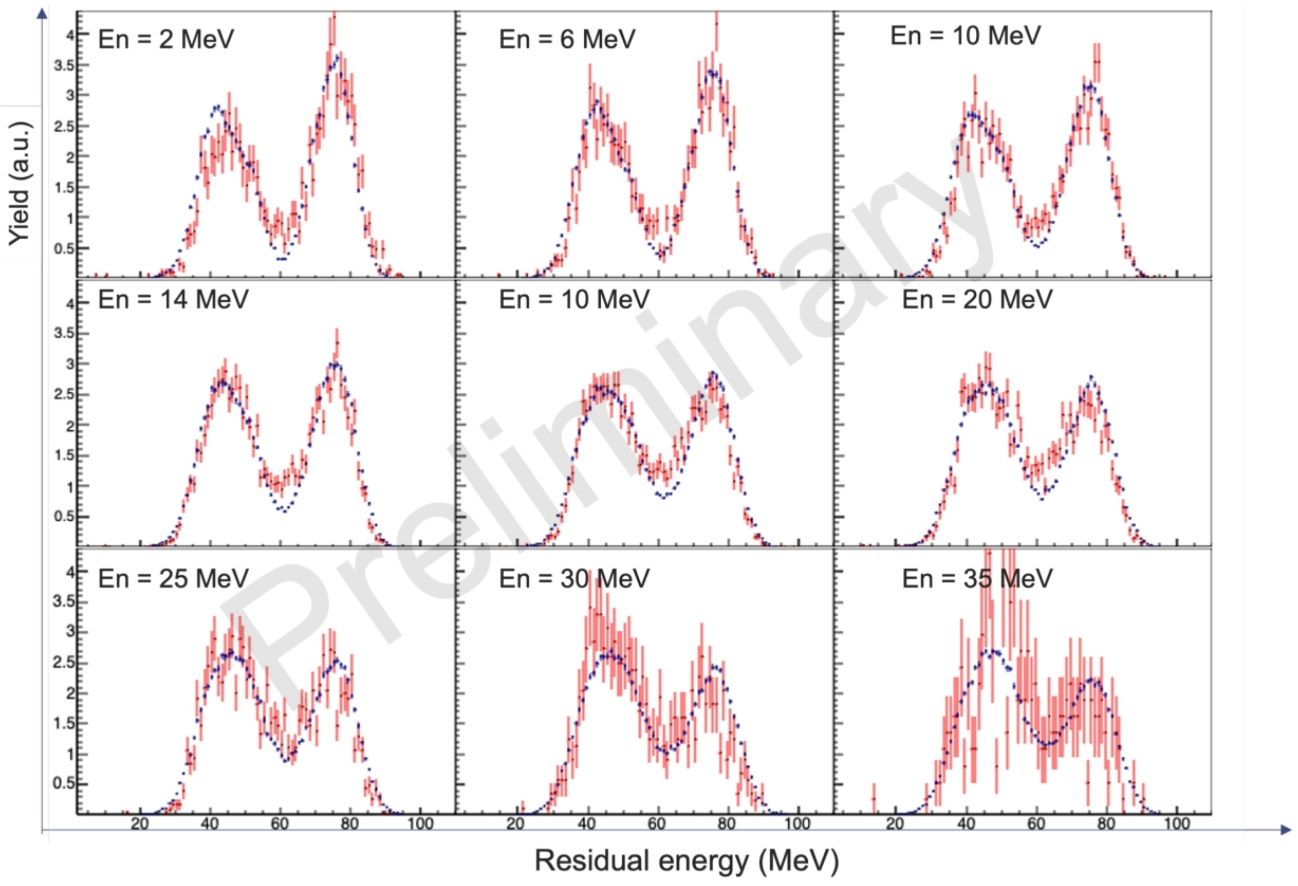
One-arm measurements with FALSTAFF

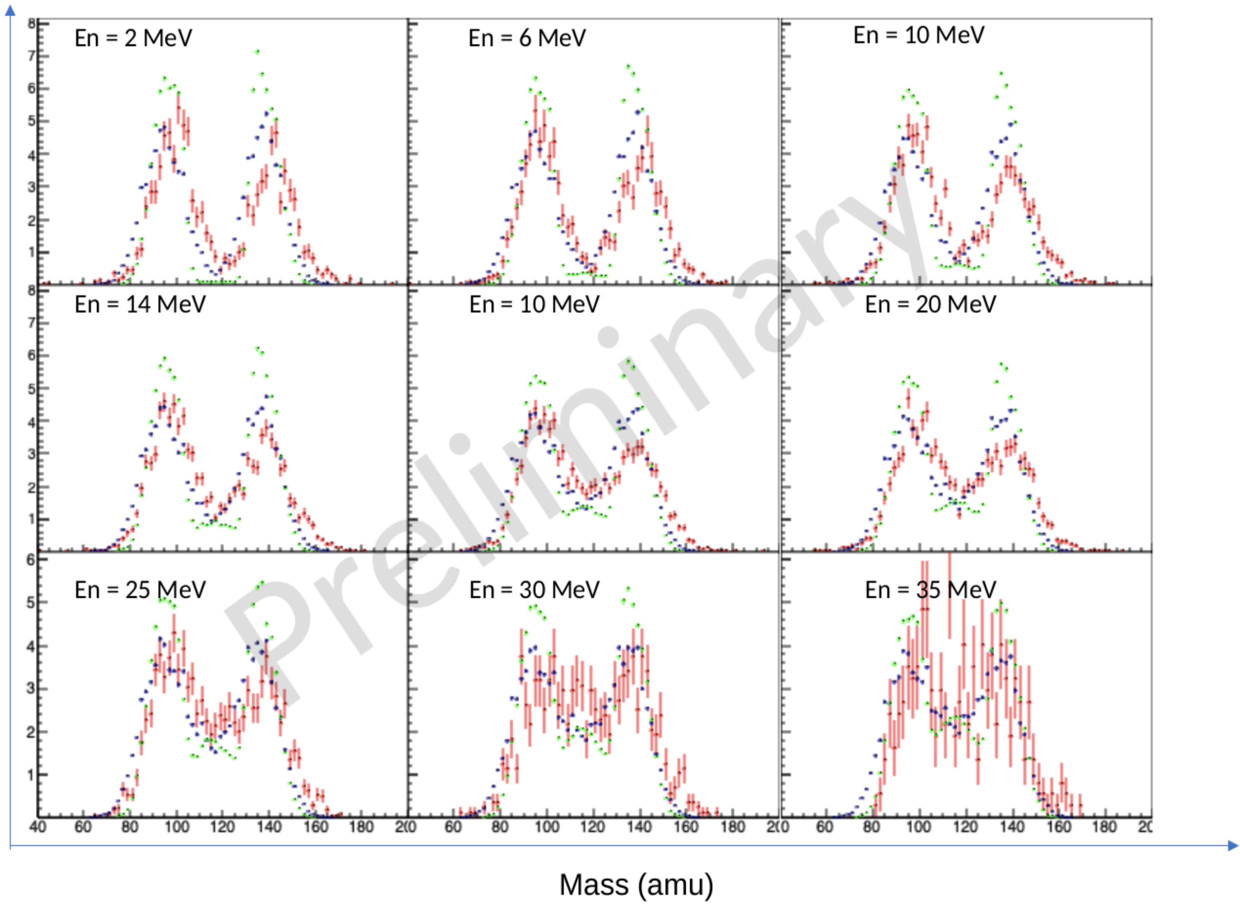
Two experiments performed so far with FALSTAFF one arm at the NFS facility in GANIL-SPIRAL2

- ^{235}U(n,f), Oct.-Nov. 2023
- ^{237}Np(n,f), Oct. 2024



Results : Energy and mass yields, ^{235}U(n,f)





FALSTAFF data
GEANT4 simulation
GEF

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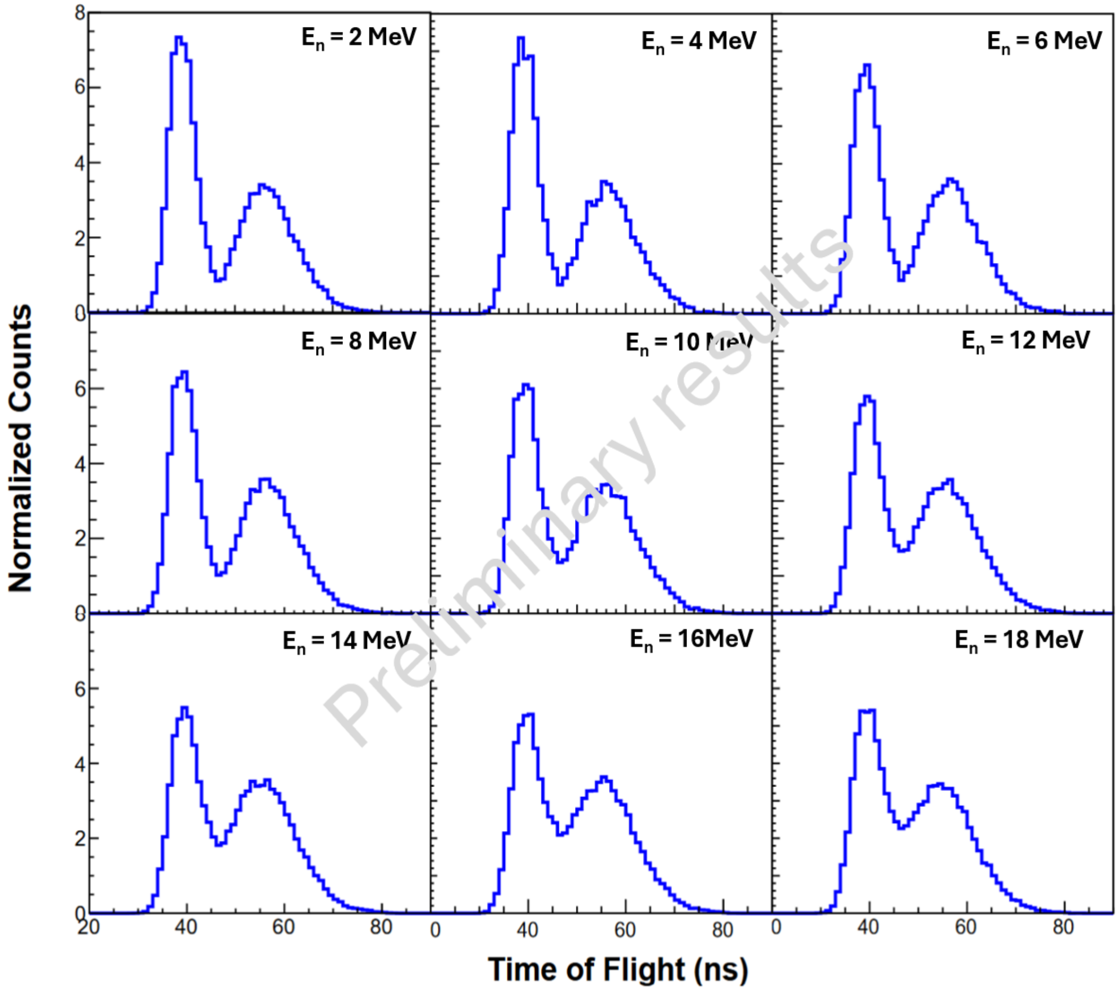
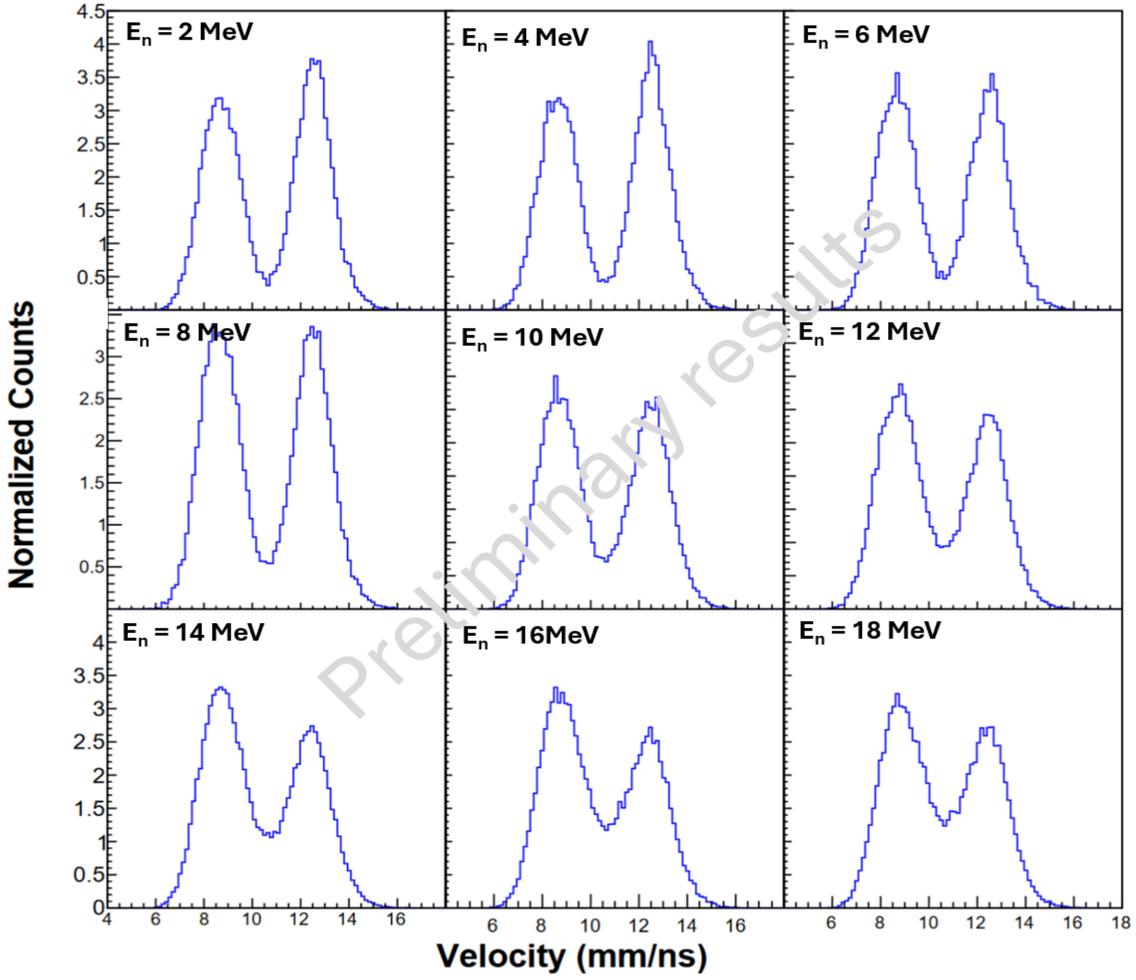
Results : Time of flight and velocity, $^{237}Np(n,f)$





Conclusions and Perspectives

- Data analysis of ^{237}Np (n,f) experiment to identify the **mass, energy** and **charge** of fission fragments and comparison with simulation as well as compare the results with E814 measurement of ^{235}U are under progress.
- Commissioning on the second arm of FALSTAFF ongoing.
- Preparing for the first experiment with both the arms of FALSTAFF for coincidenct fission fragment detection.
- Nuclear charge determination through neural-network learning under progress.

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FALSTAFF collaboration

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THANK YOU

Supplementary Slides