EUROPEAN UNION

Structural Instruments 2014-2020

Competitiveness Operational Programme (COP)

Extreme Light Infrastructure - Nuclear Physics (ELI-NP) – Phase II

Directional distributions of prompt fission neutrons from ^{252}Cf(sf)

Sangeeta Dhuri

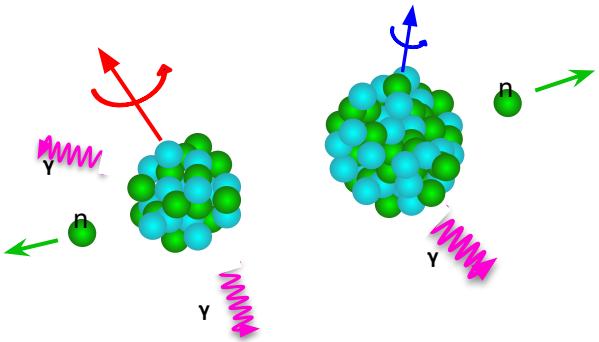
Post-doctoral Research Assistant
Gamma Driven Experiments Department

Outline of the talk

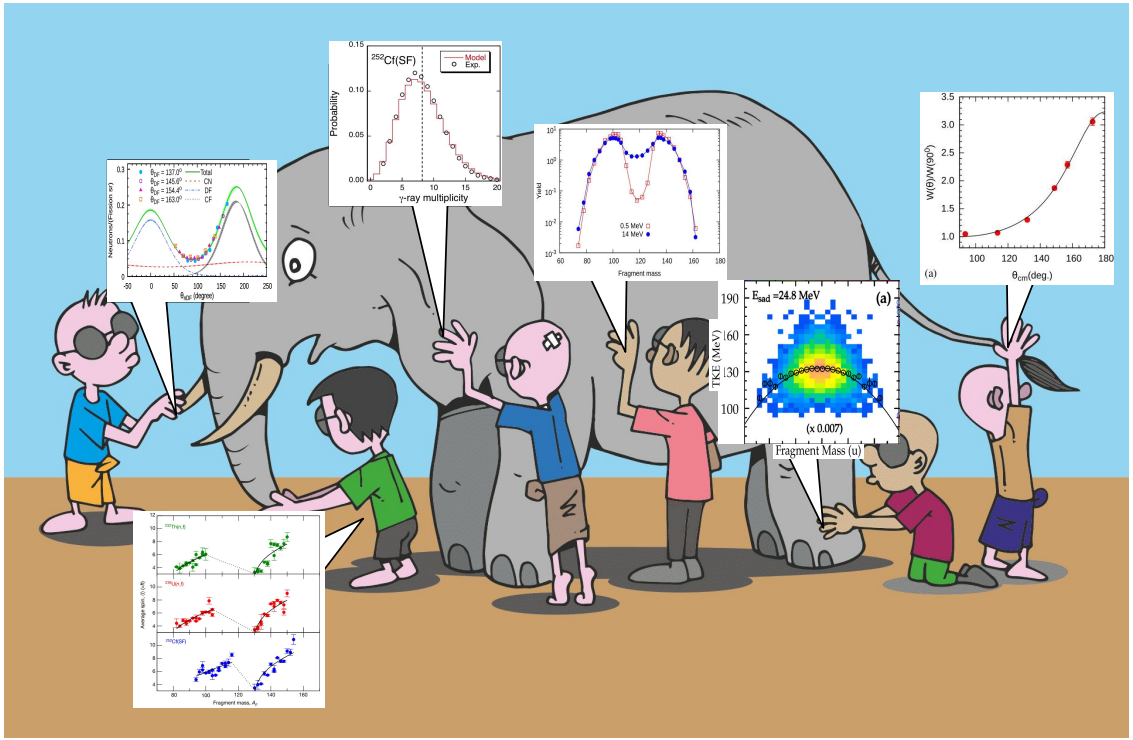
- Introduction and motivation
- The measurement of fragment – prompt fission neutron and prompt fission gamma from ^{252}Cf(sf)
- Preliminary results
- Summary

Nuclear Fission

- Dramatic examples of the nuclear decay

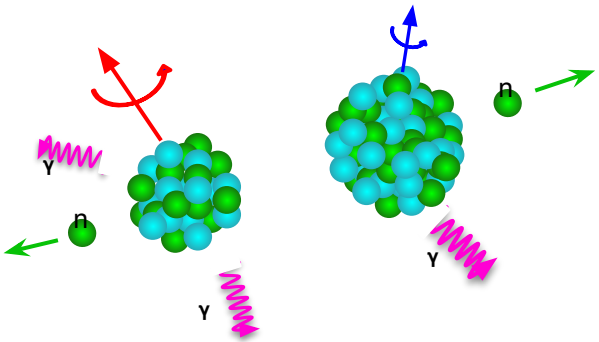


- Complex yet fascinating
- Different observables sensitive to the different stages along the fission path
- A measurement to investigate most of the observables simultaneously to get most consistent picture



Nuclear Fission

- Dramatic examples of the nuclear decay



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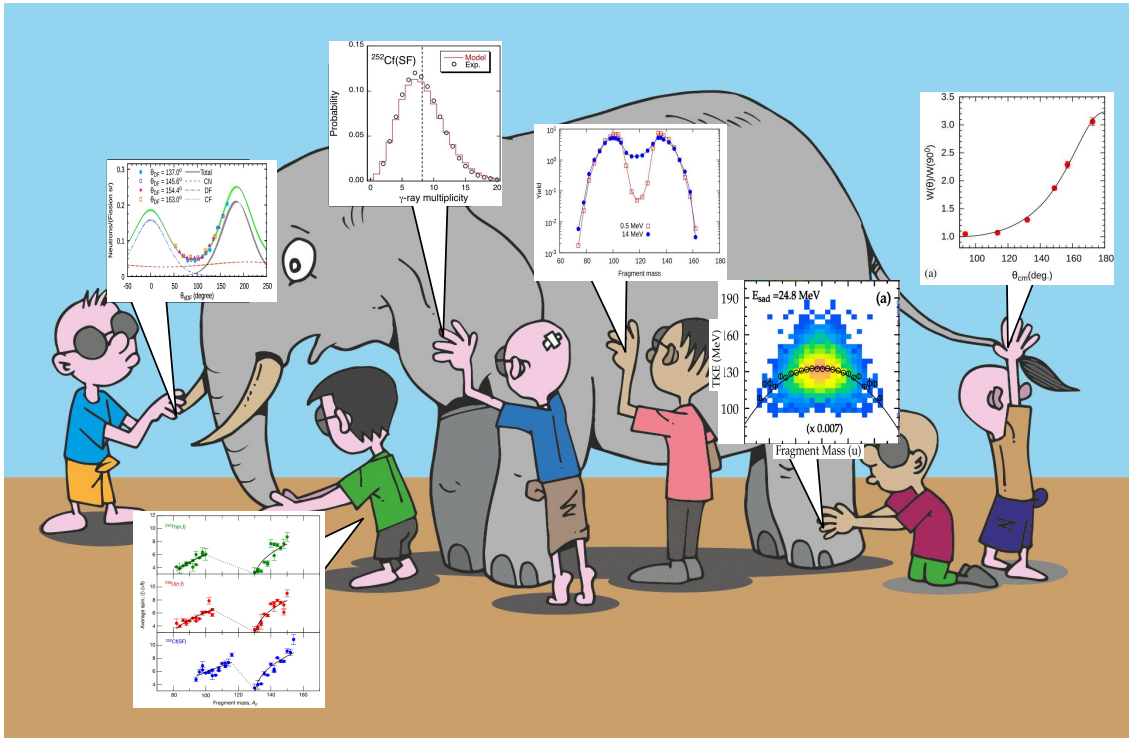
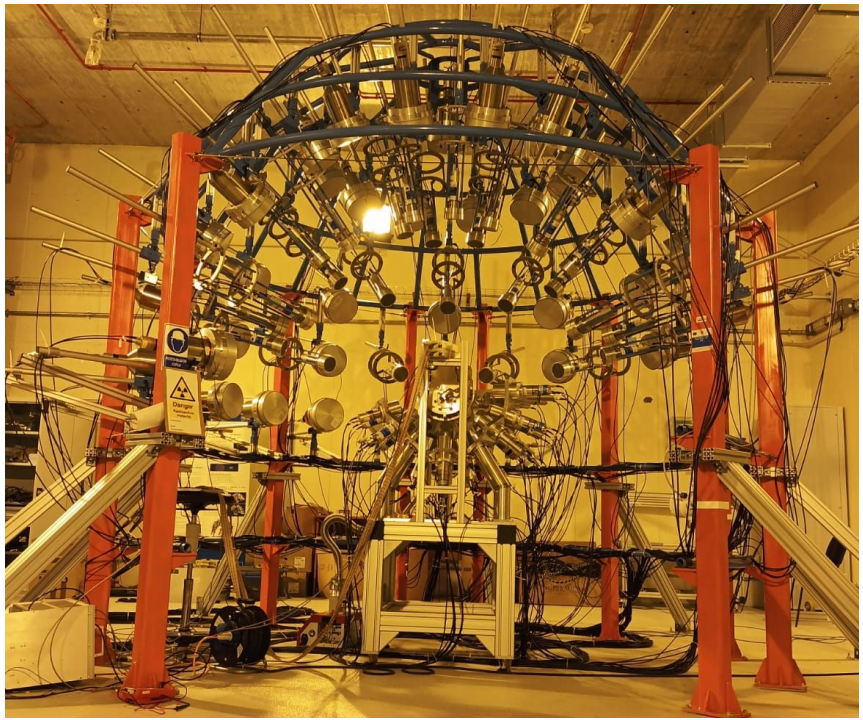
Motivation !!!



The measurement of FF-PFN-PFG from ^{252}Cf (sf)

- Experimental setup to measure the fission neutrons and γ-rays in coincidence with fission fragment



ELIGANT array at ELI-NP facility

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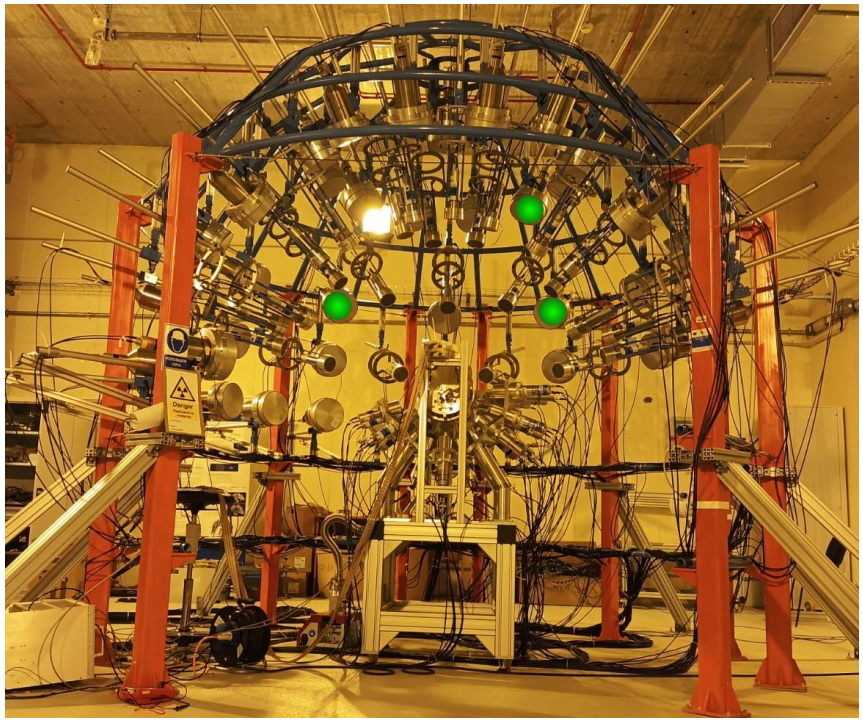

ELIGANT array at ELI-NP facility

Upper hemisphere

- **Fast Neutron Detection** (En>0.5 MeV)
  - EJ301 Liquid Scintillators (# 36)
  - 150 cm from the target center

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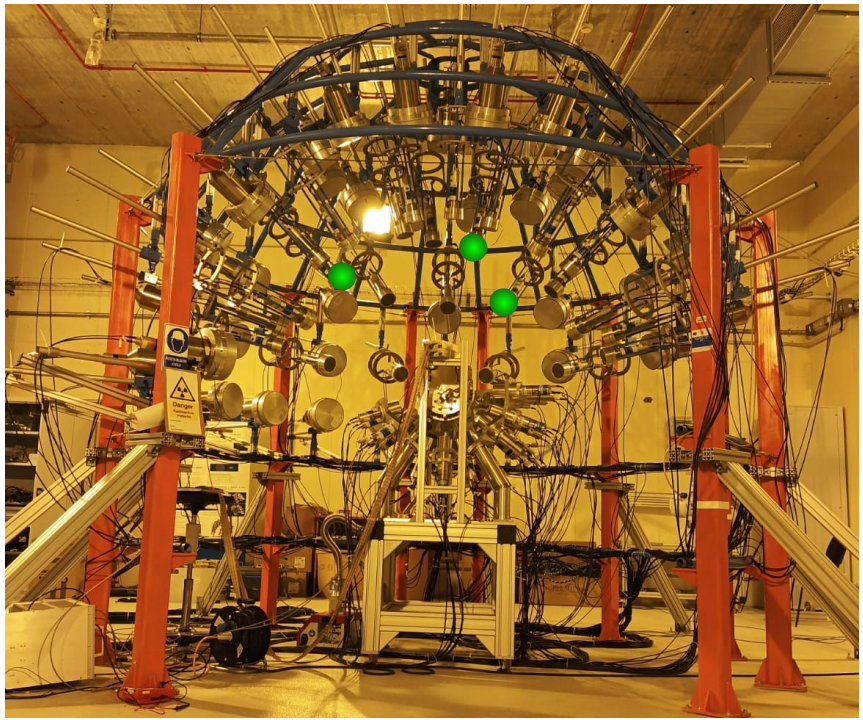

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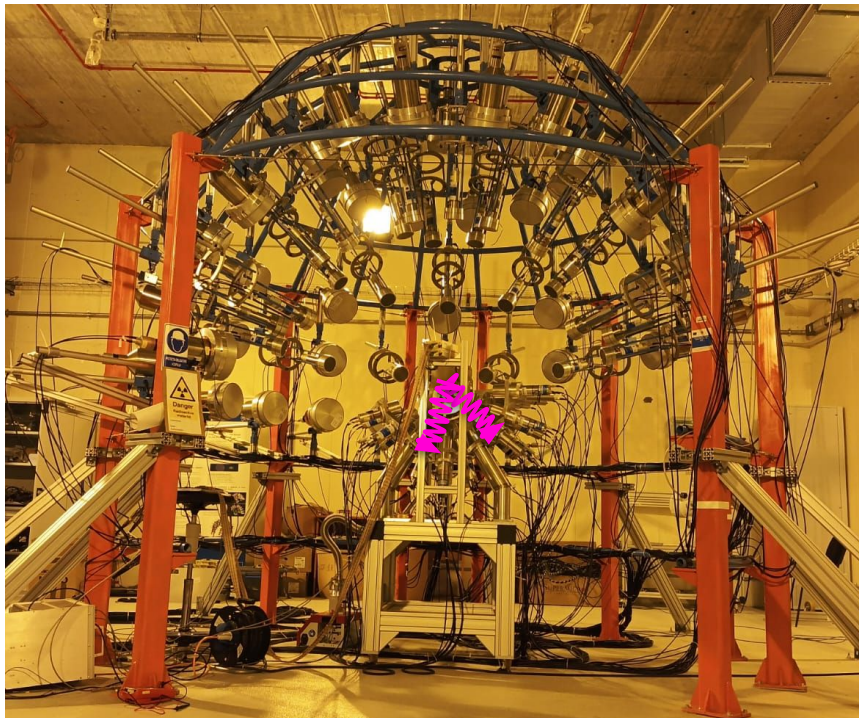

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Lower hemisphere

- **γ-ray Detection**
  - $LaBr_3$:Ce (# 15)
  - $CeBr_3$ (# 17)
  - 30 cm from the target center

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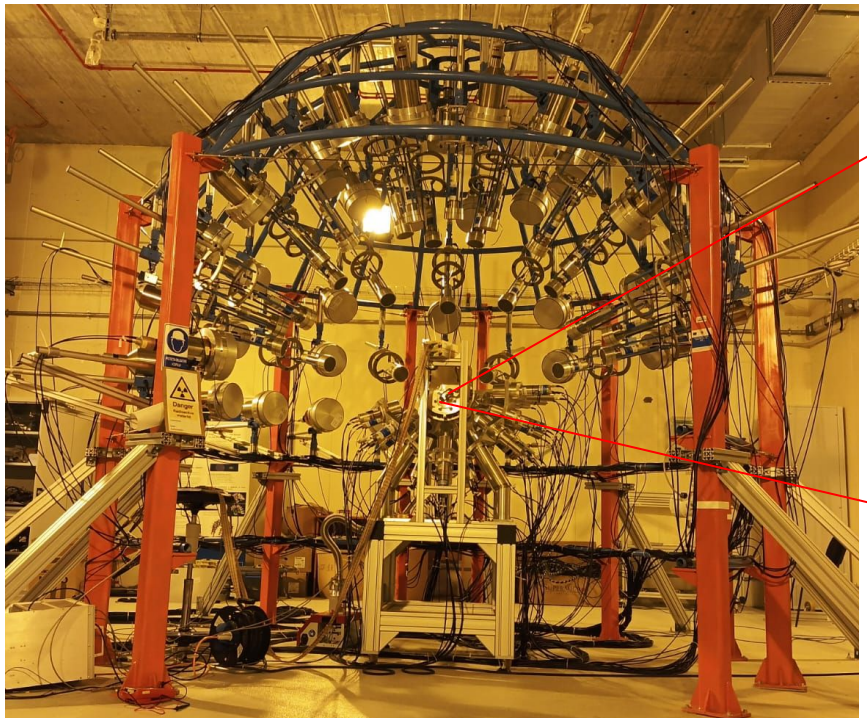

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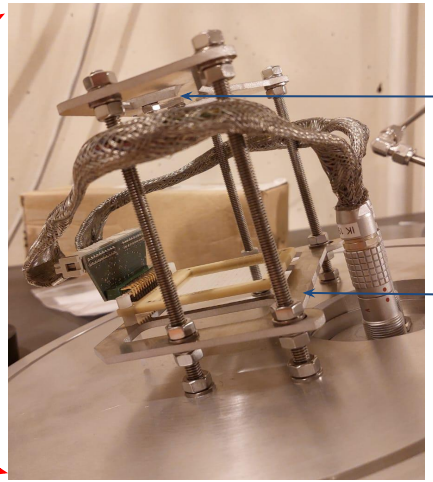


Holder for ^{252}Cf source mounting

Double sided silicon strip detector (DSSSD) for fission fragment detection

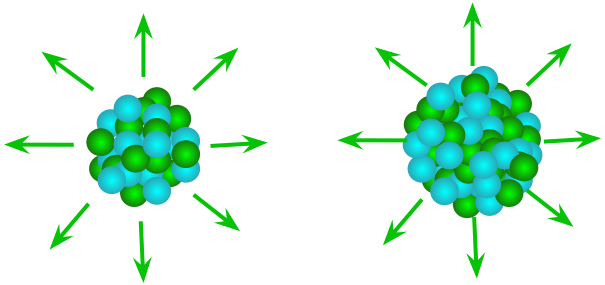
Inside view of the vacuum chamber

Fission rate ~ 400 FF/s

Data taking duration : 6 months

Neutron emission in fission

What we know so far !!!



Center of Mass frame

- Isotropic emission of prompt fission neutrons in CM frame

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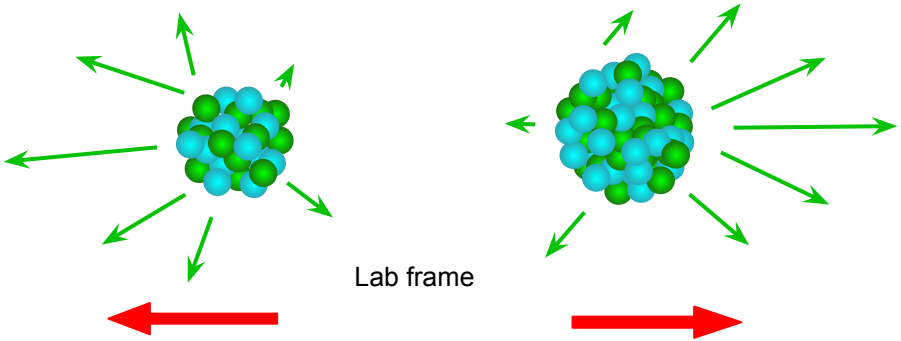

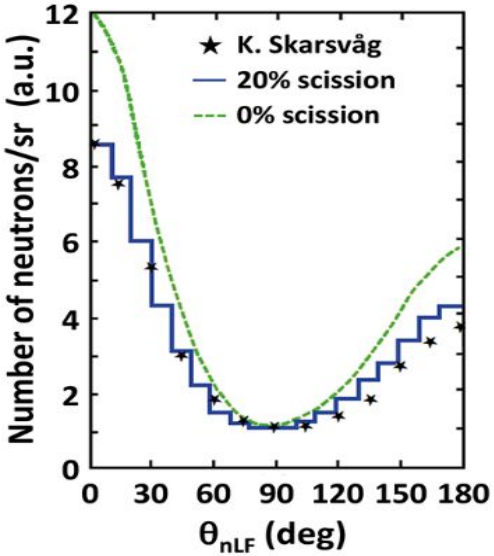

Chietera et al., EPJA (2018) 54: 98

- Isotropic emission of prompt fission neutrons in CM frame
- Kinematical focussing in the direction of fragment motion in Lab frame
- Contribution from scission neutrons
- Previous works are focused on n-n or n-f angular correlations

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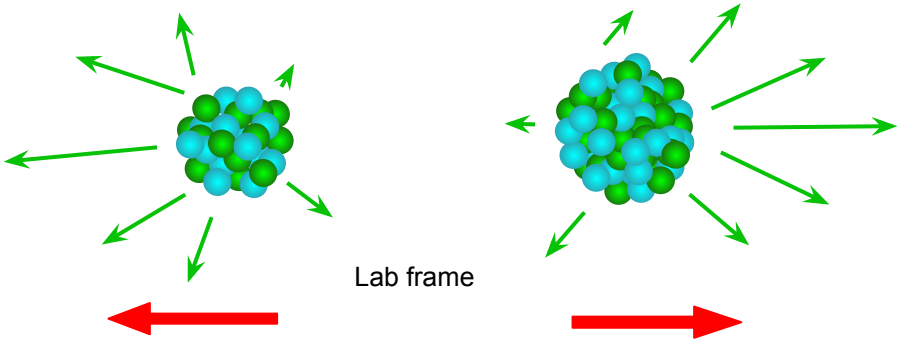

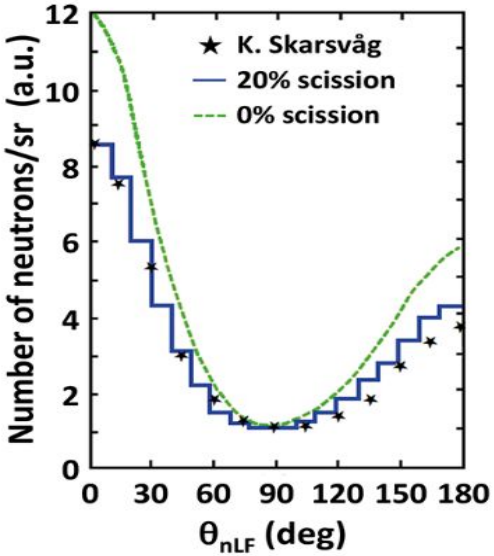

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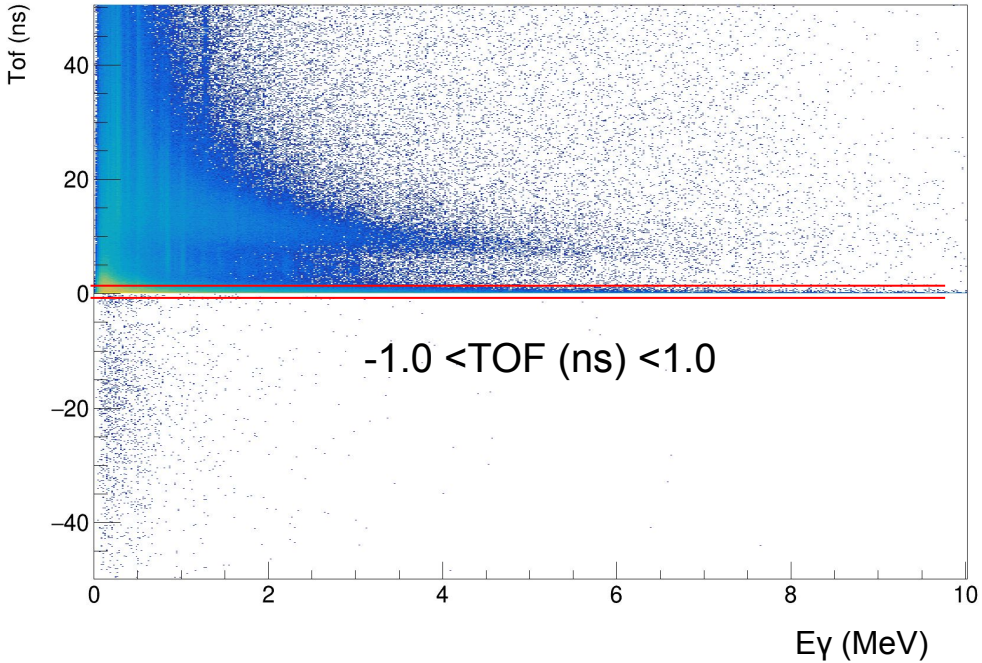
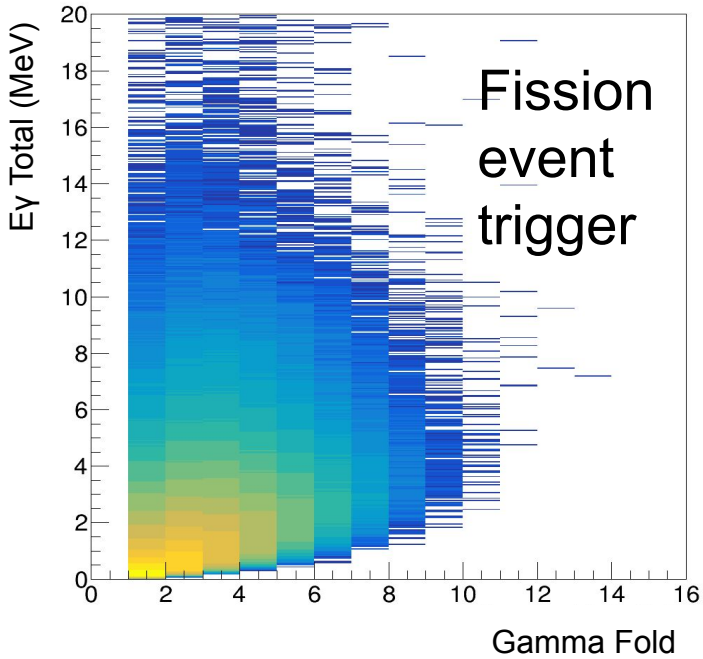
Current Measurement !! ***Dedicated investigation of neutron–neutron-fragment coincidences***

➡ ***Deeper insights into fission dynamics***

The measurement of FF-PFN correlations from ^{252}Cf(sf)

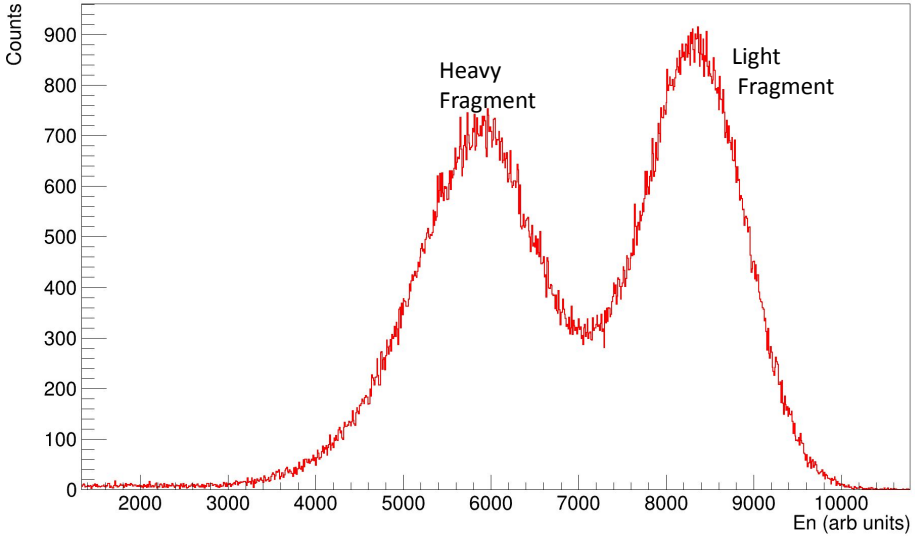
- Prompt fission gamma rays detected in $LaBr_3$ and $CeBr_3$ detectors



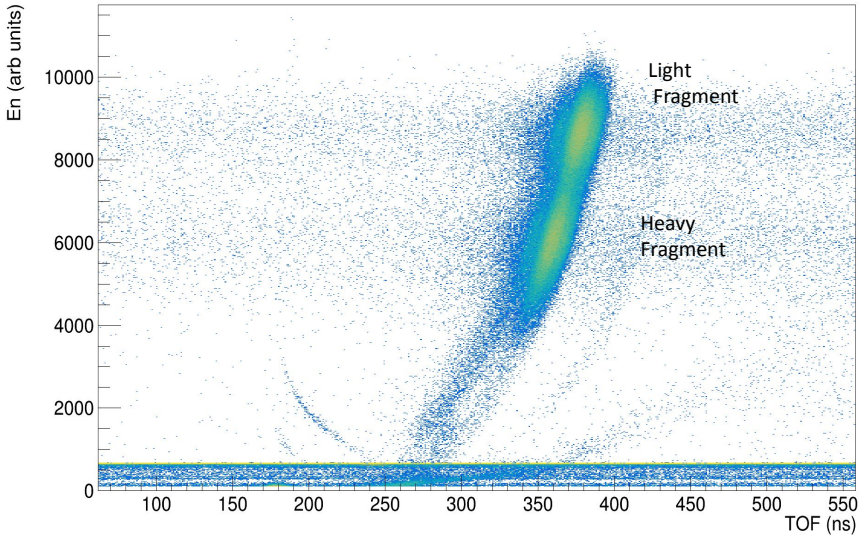


- Selection of Fission events

- Energy Spectrum in one of the strips of DSSSD

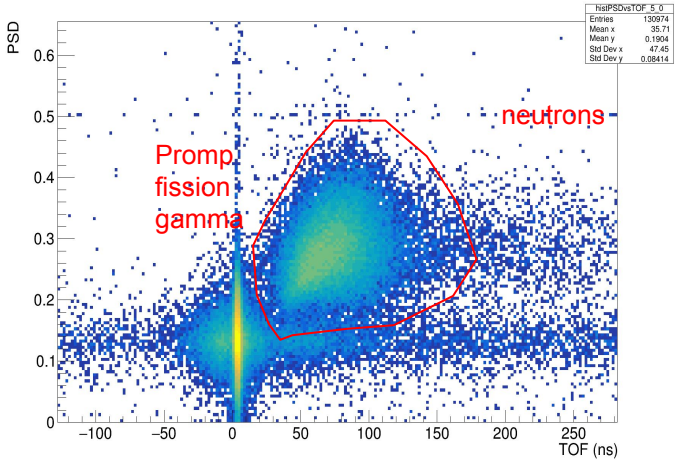


- Energy Vs Tof correlation for fission fragments



Fast neutron detection in liquid scintillators

- Neutron event selection using PSD Vs TOF correlations



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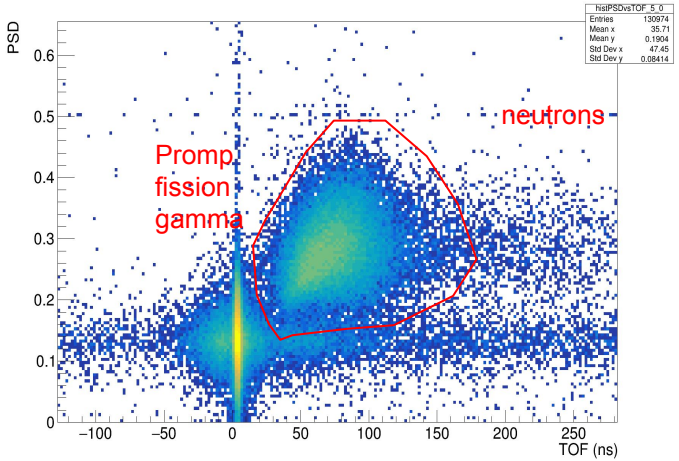
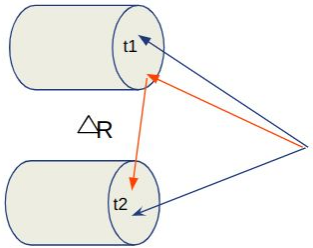
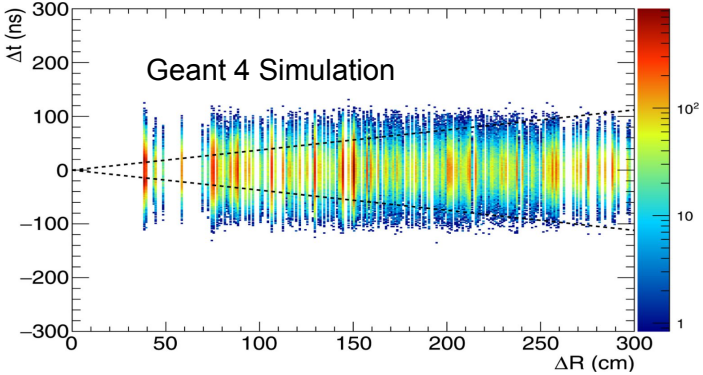




- Neutron cross talk correction



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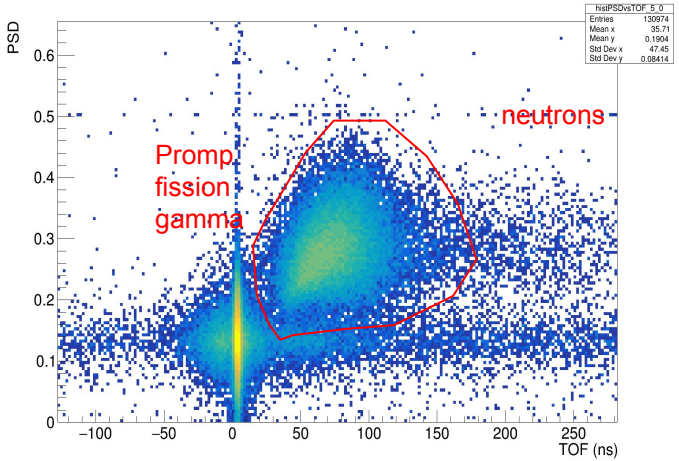

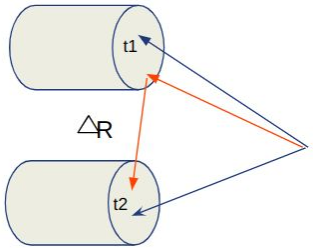

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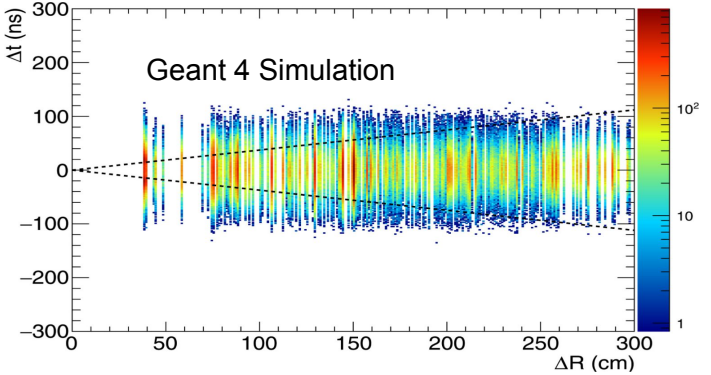
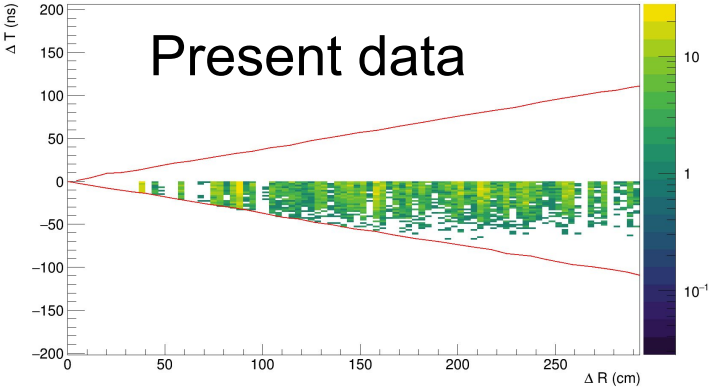
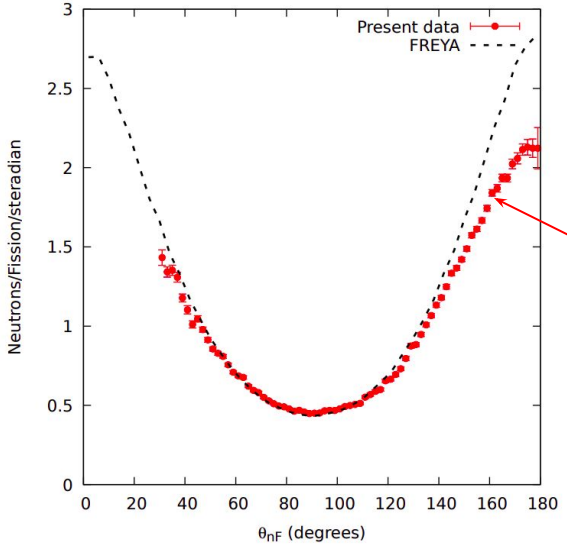
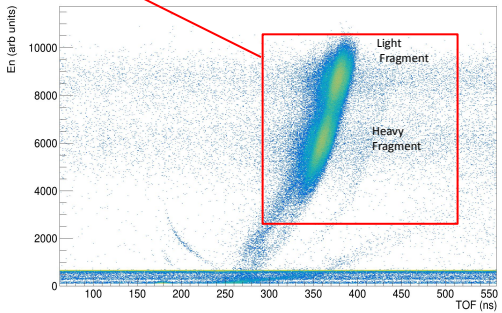




The measurement of FF-PFN correlations from ^{252}Cf(sf)

- Measured neutron-fragment angular correlations





- Overall trend observed in neutron emission is reproduced.

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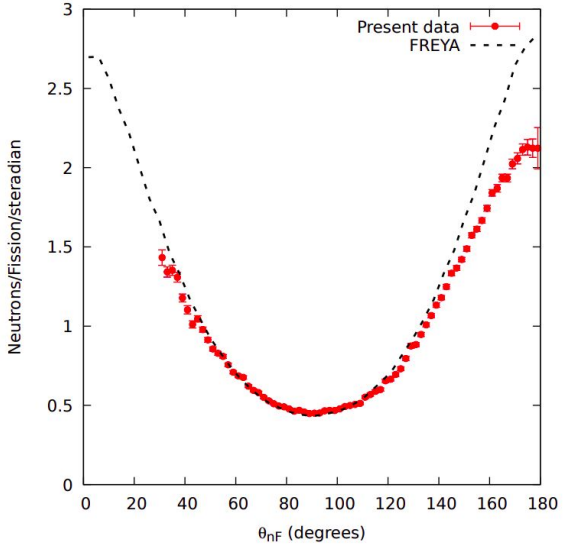

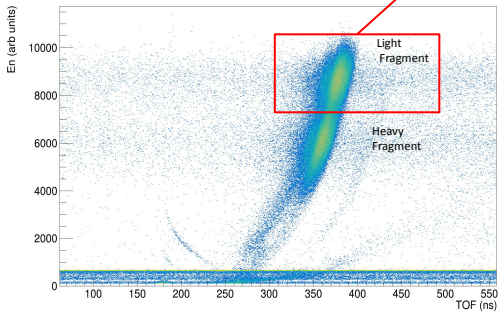

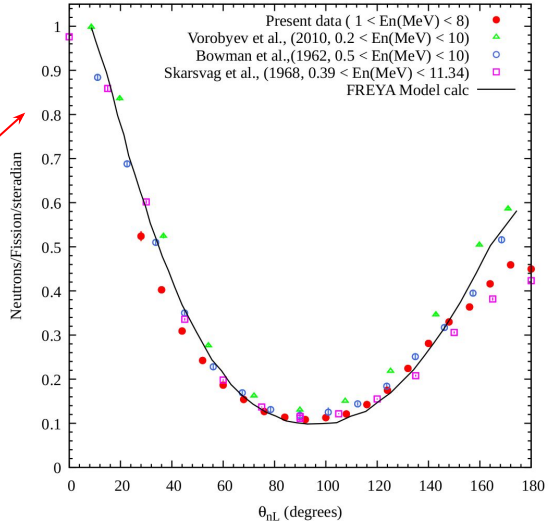

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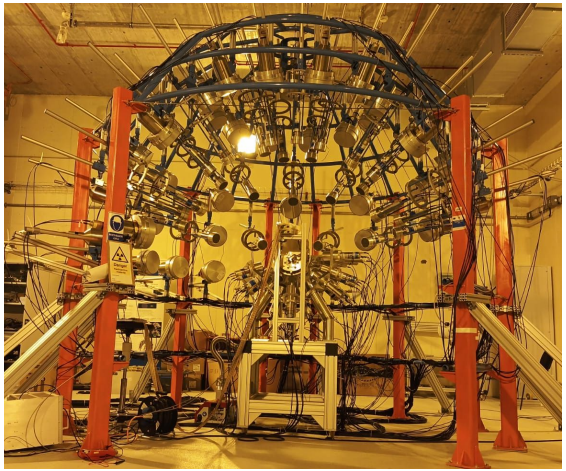
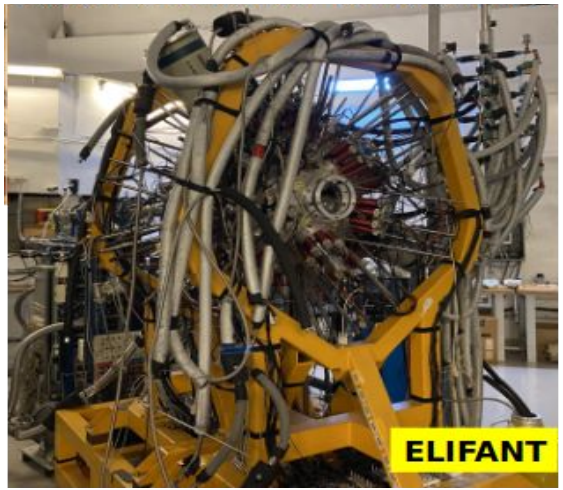
- Agreement with literature data
- Comparison with FREYA model calc.

ELIFANT campaign for measurement of Nuclear Level Density

- NLD's are important to understand the statistical decay of the nucleus





- 25 LaBr3:Ce and CeBr3 detectors from ELI-NP ELIGANT-GN array mounted in the **Rosphere antiCompton shield at IFIN-HH**
- Paired withS1 and S7 DSSSD

- Experiments with aim to measure the NLD's in various isotopes of Sn, Te and other nuclei
- A~110-140

A. Kuşoğlu et al., XLVII symposium on nuclear physics cocoyoc, Morelos Mexico

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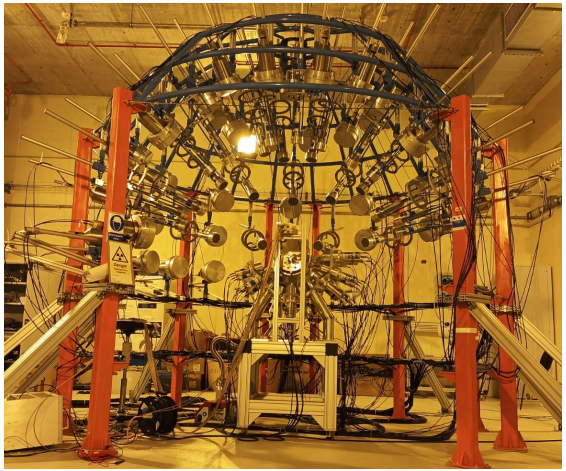

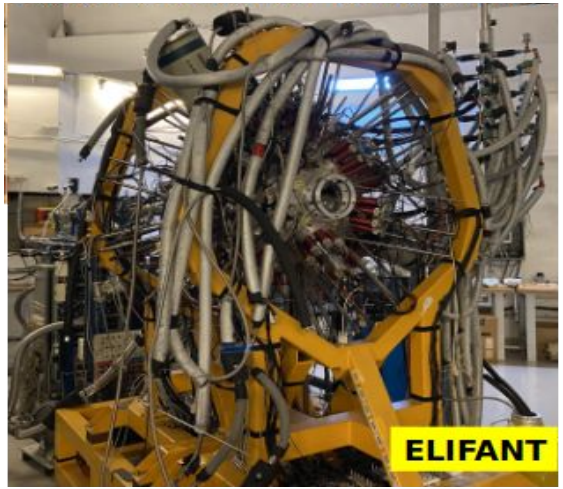

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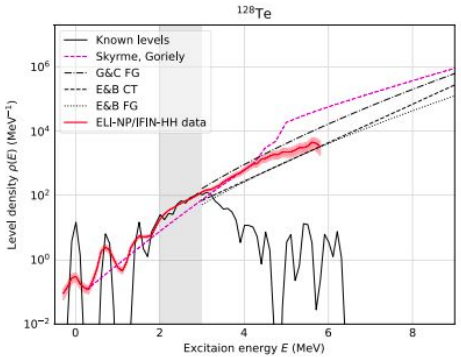
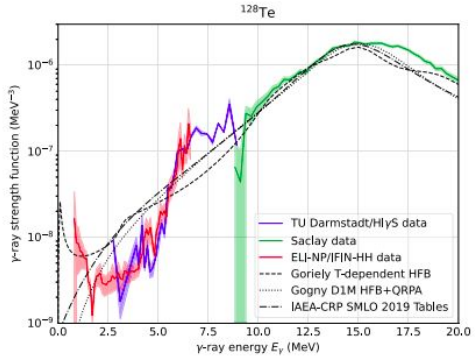
- Measured NLD's and γ-Strength Functions





A. Kuşoğlu et al., XLVII symposium on nuclear physics cocoyoc, Morelos Mexico

P-A Söderström et al, Phys. Scr. 100 (2025) 075301

Summary and conclusion

- We have performed a measurement to study the fission fragment (FF)- Prompt fission neutron correlations
- Measured neutron-fragment (n-FF) correlations agrees well with the existing data
- Angular correlations in n-n-FF coincidence are investigated
- Measured two neutron angular correlations relative to the fission fragment direction shows that Kinematical focussing is preserved
- Further investigations are in progress

Dr. M. Cuciuc

Prof. D. L. Balabanski

Dr. P-A Söderström

Dr. A. Kuşoğlu

Dr. S. Aogaki

Prof. A. Oberstedt

Ms. S. R. Ban

Dr. A. State

Dr. T. Petruse

Mr. R. Corbu

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Dr. D. Choudhury

Y. Gupta

(IIT Ropar, Punjab, India)

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Thank you for your kind attention !!!