



# Mesures des rendements de fission induit par neutrons thermiques

PEPR-SCIAM, 09/06/2026, Online

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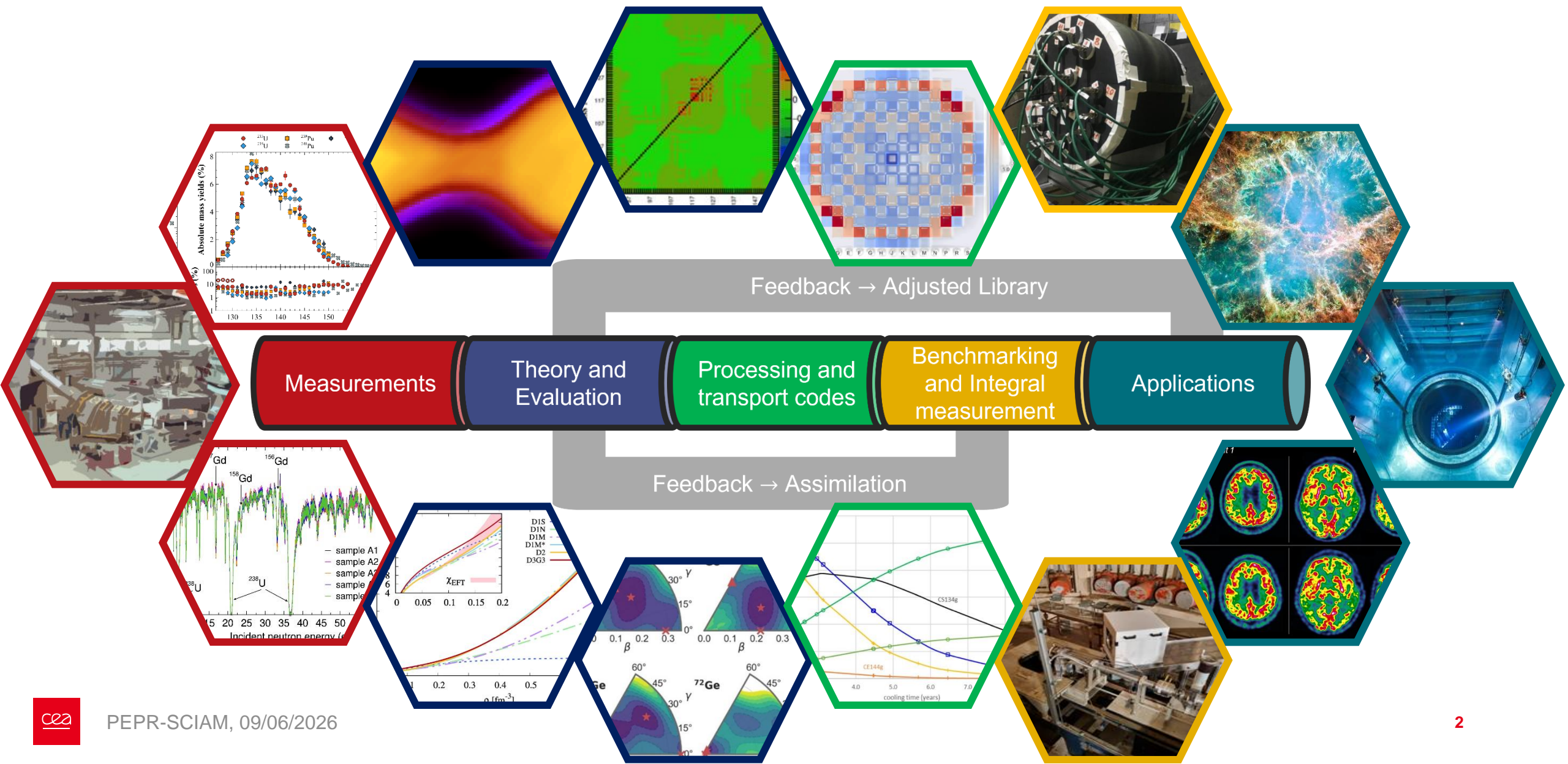
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# Nuclear data evaluation pipeline



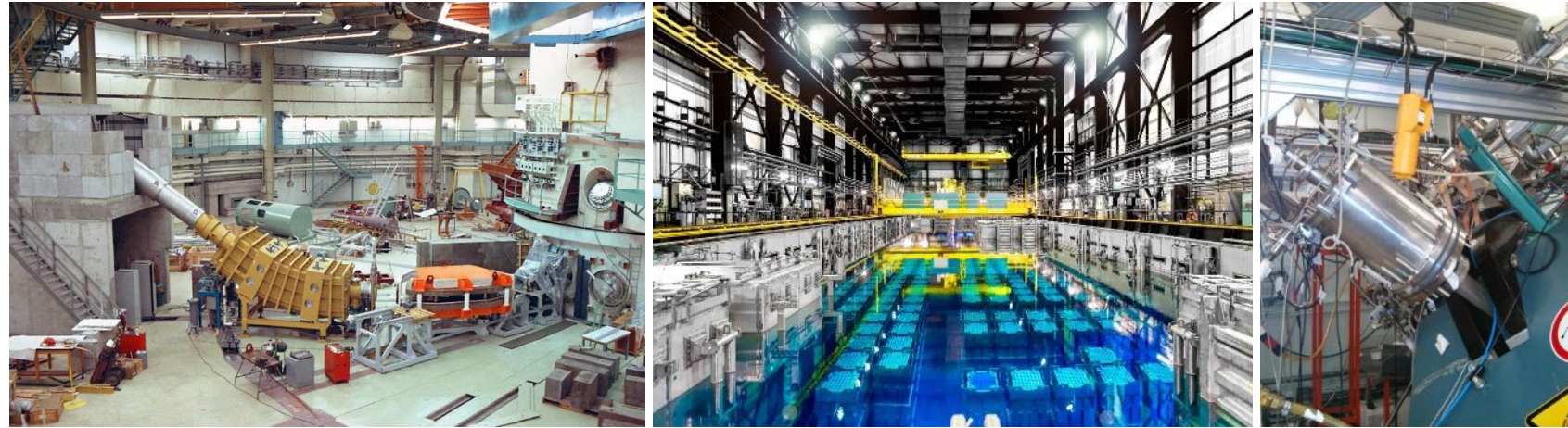
# Fission yield studies @ ILL

## What ... for?

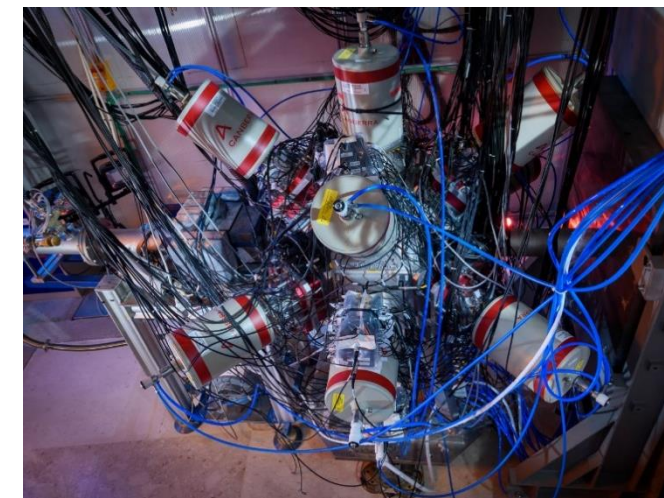
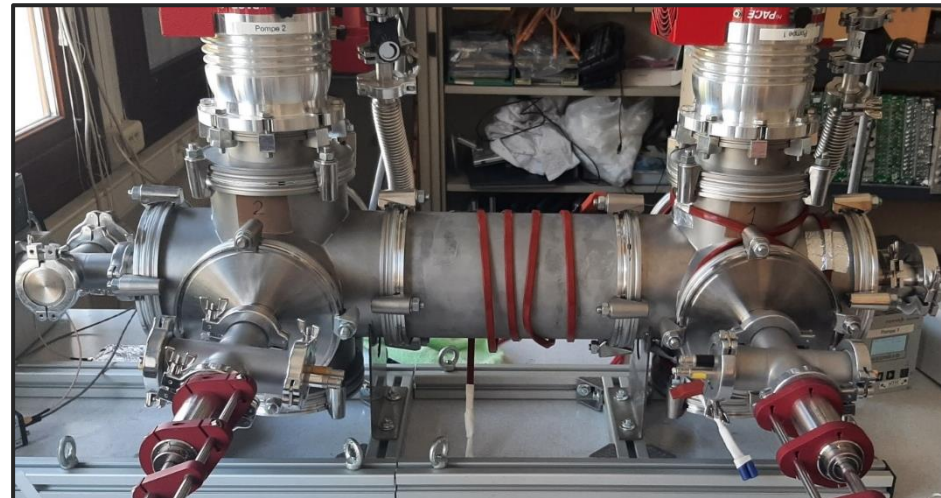
- Independent, cumulative and mass yields for  $^{235}\text{U}(n_{\text{th}},f)$  and  $^{239}\text{Pu}(n_{\text{th}},f)$  with high precision (<2%)
- Impact on nuclear reactor quantities : decay heat, reactivity loss, safety, radioprotection ...
- **Constrain on models used in evaluation and understanding of the fission process**

## How to?

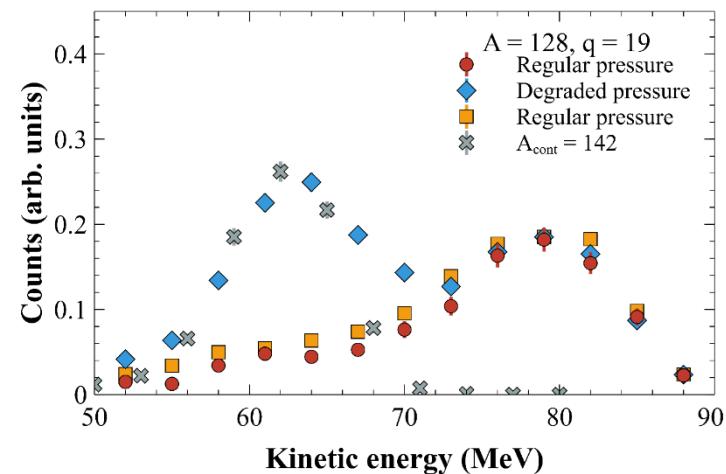
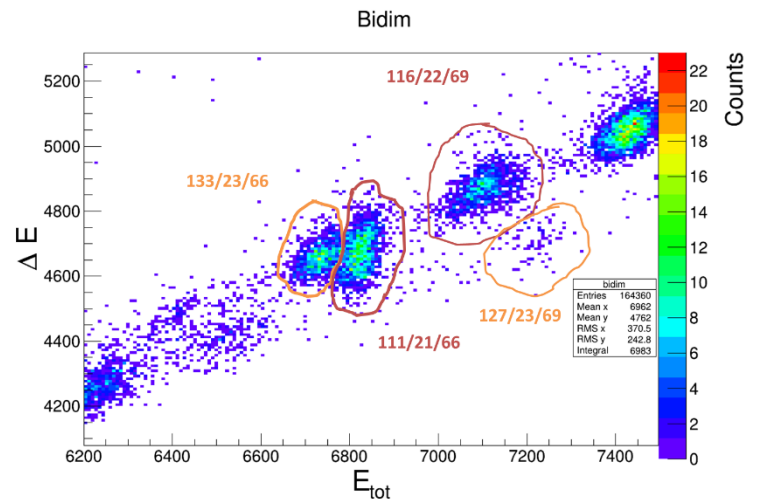
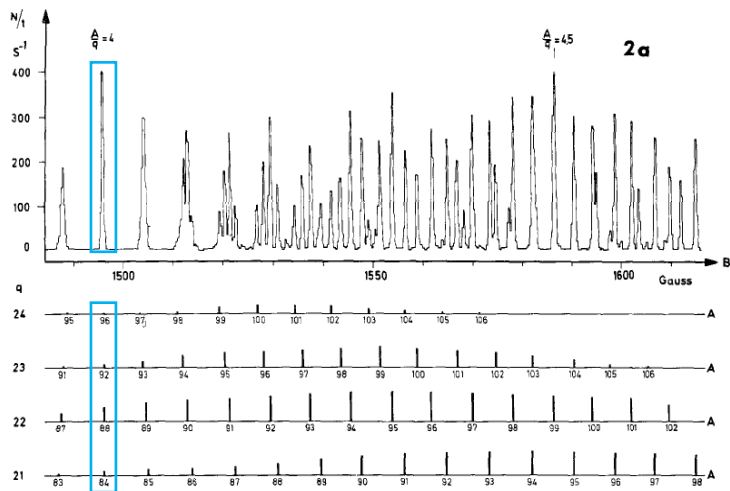
- **LOHENGRIN** coupled with ionization chamber or HPGe (mass and independent yields) and **ToF** for **symmetric and far-asymmetric masses**
- **FIPPS** (cumulative yields)



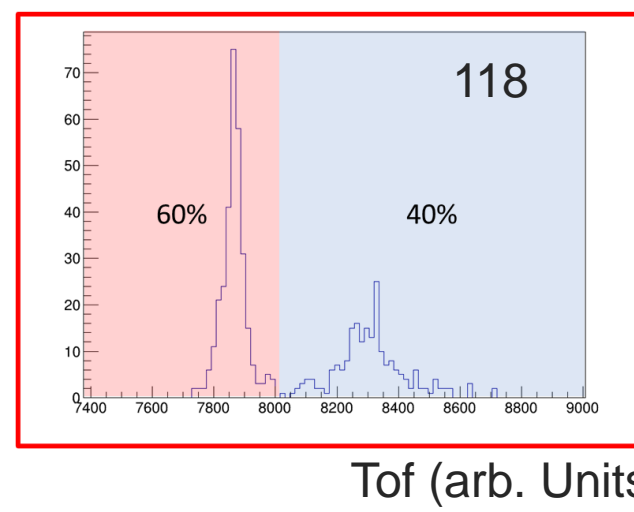
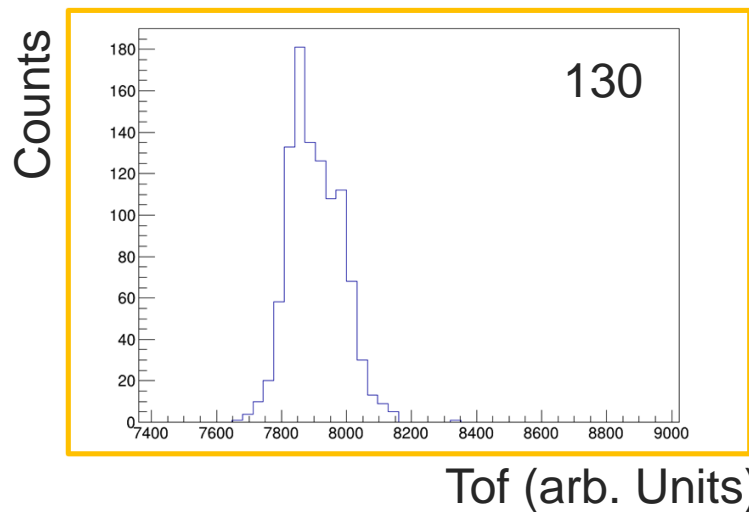
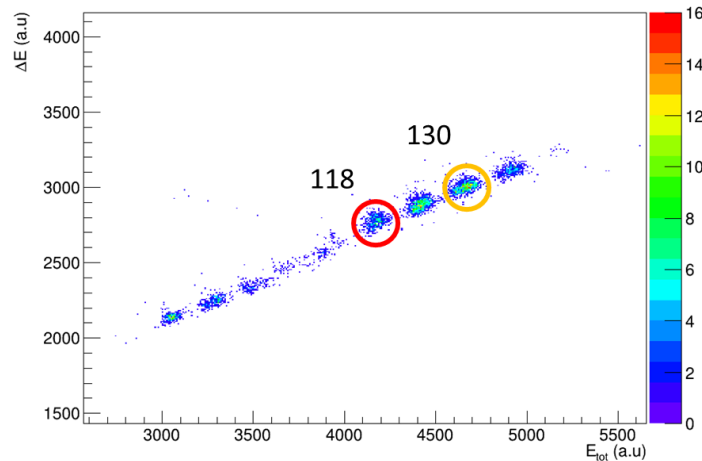
© Orano, La Hague



# LOHENGRIN $\otimes$ ToF



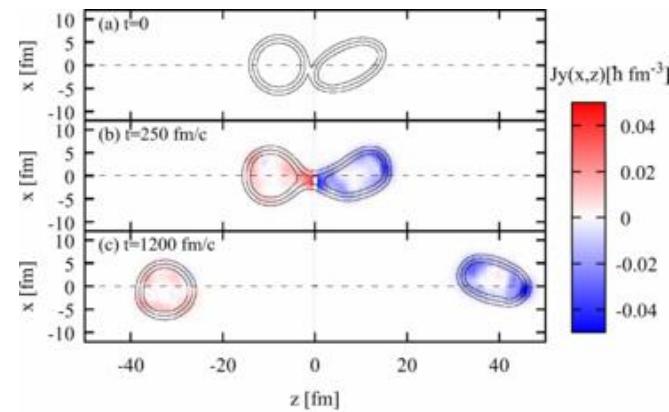
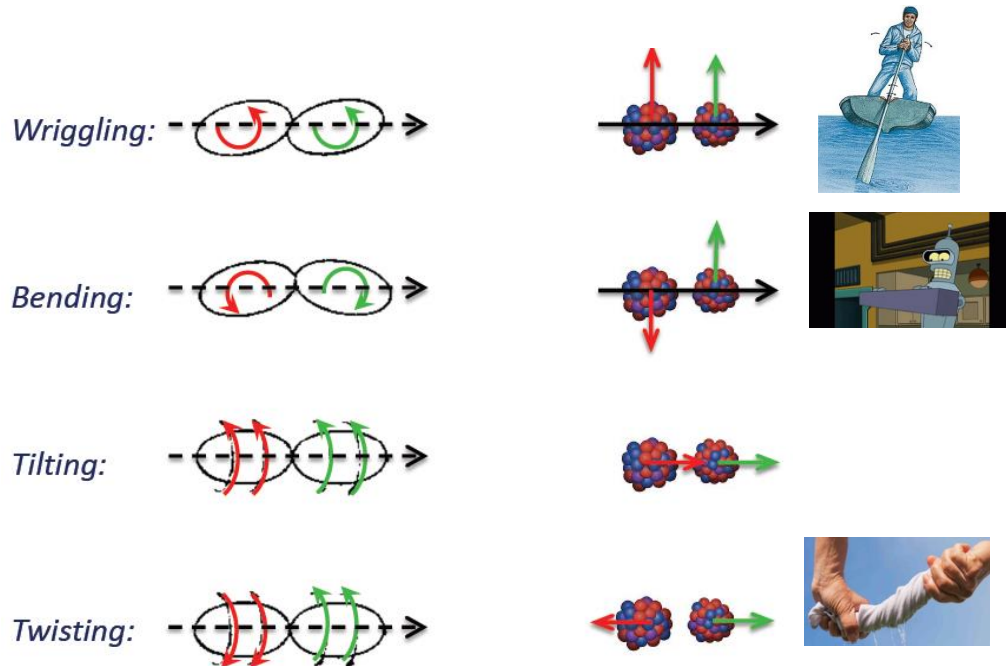
$$tof = t_{start} + t_{stop} + \frac{L}{c} \times \sqrt{A \times \frac{m_u}{2 \times E_{start}}}$$



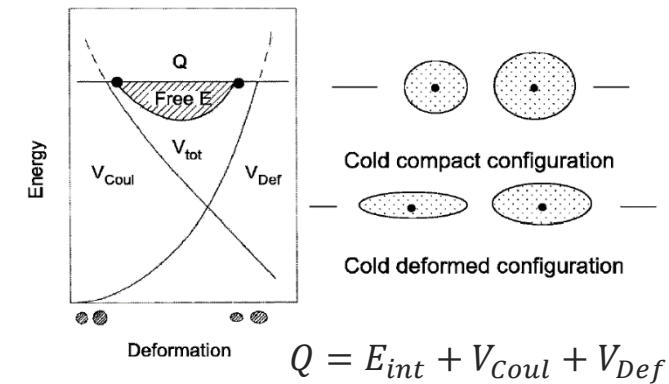
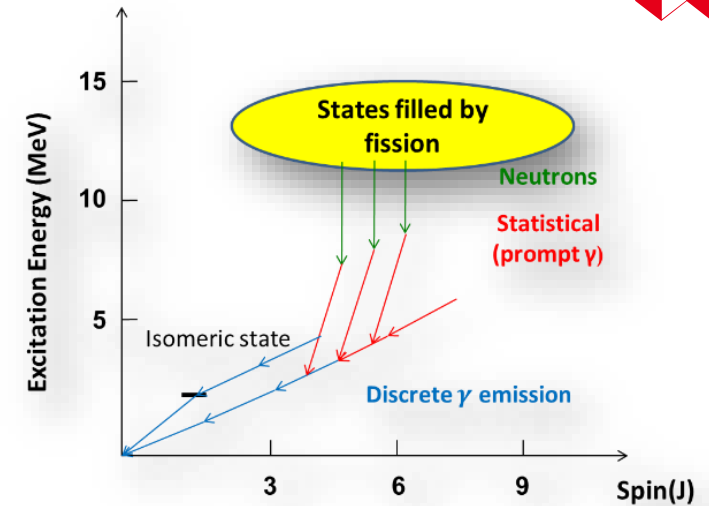
# Fission observable @ ILL

## What ... for?

- Investigation of fission fragment angular momentum origins (different masses and fissioning system)
- Feed FIFRELIN parameters which drives the prompt fission  $\gamma$  spectrum
- Impact on nuclear reactor simulations ( $\gamma$  heating for instance)



©G. Scamps, Microscopic description of the torque acting on fission fragments, *Phys. Rev. C* 106, 054614 (2022)



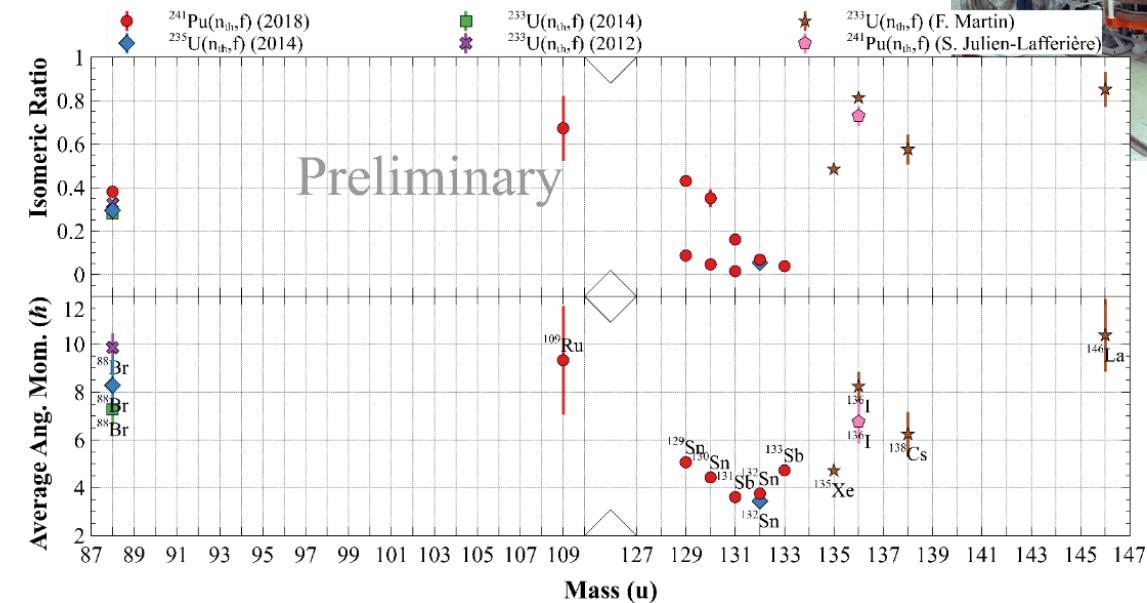
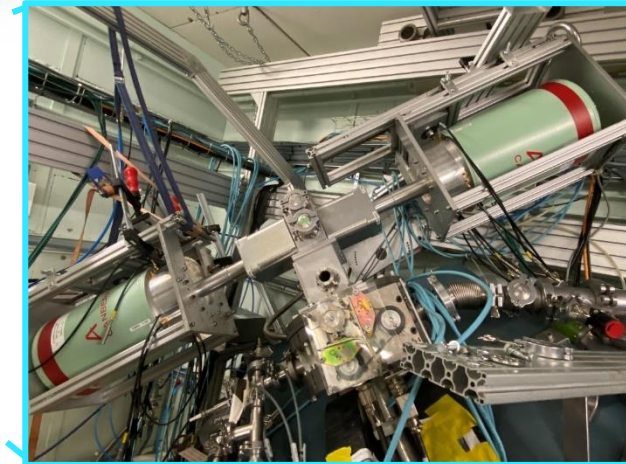
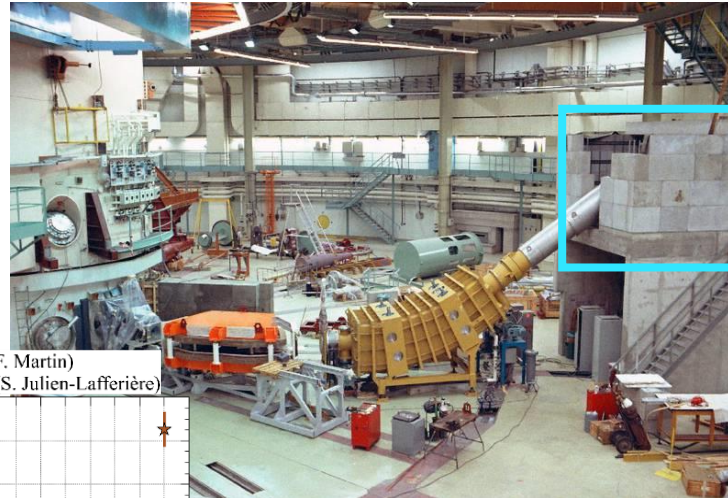
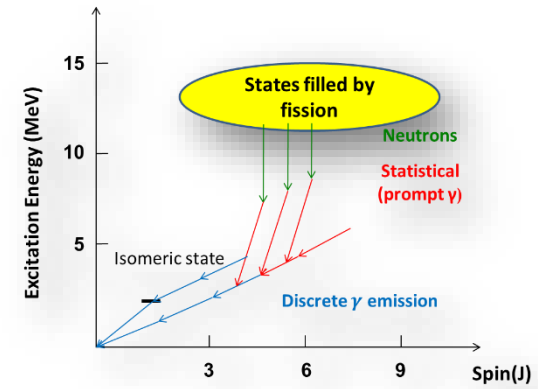
©F. Gonnemann et al., Angular Momenta of near-spherical fission fragments, *Int. J. Mod. Phys. E*, 16,2,410-424 (2007)

©J. Randrup et al., Generation of Fragment Angular Momentum in Nuclear Fission, *EPJ WoC*, 284,04004 (2023)

# Fission observable @ ILL

## How to?

- LOHENGRIN coupled with an ionization chamber surrounded by 2 clovers of HPGe



# Status of the collaboration

- Since 2006 : CEA/ILL
- Since 2009 : LPSC
- 2006 – 2018 : CEA/DRF

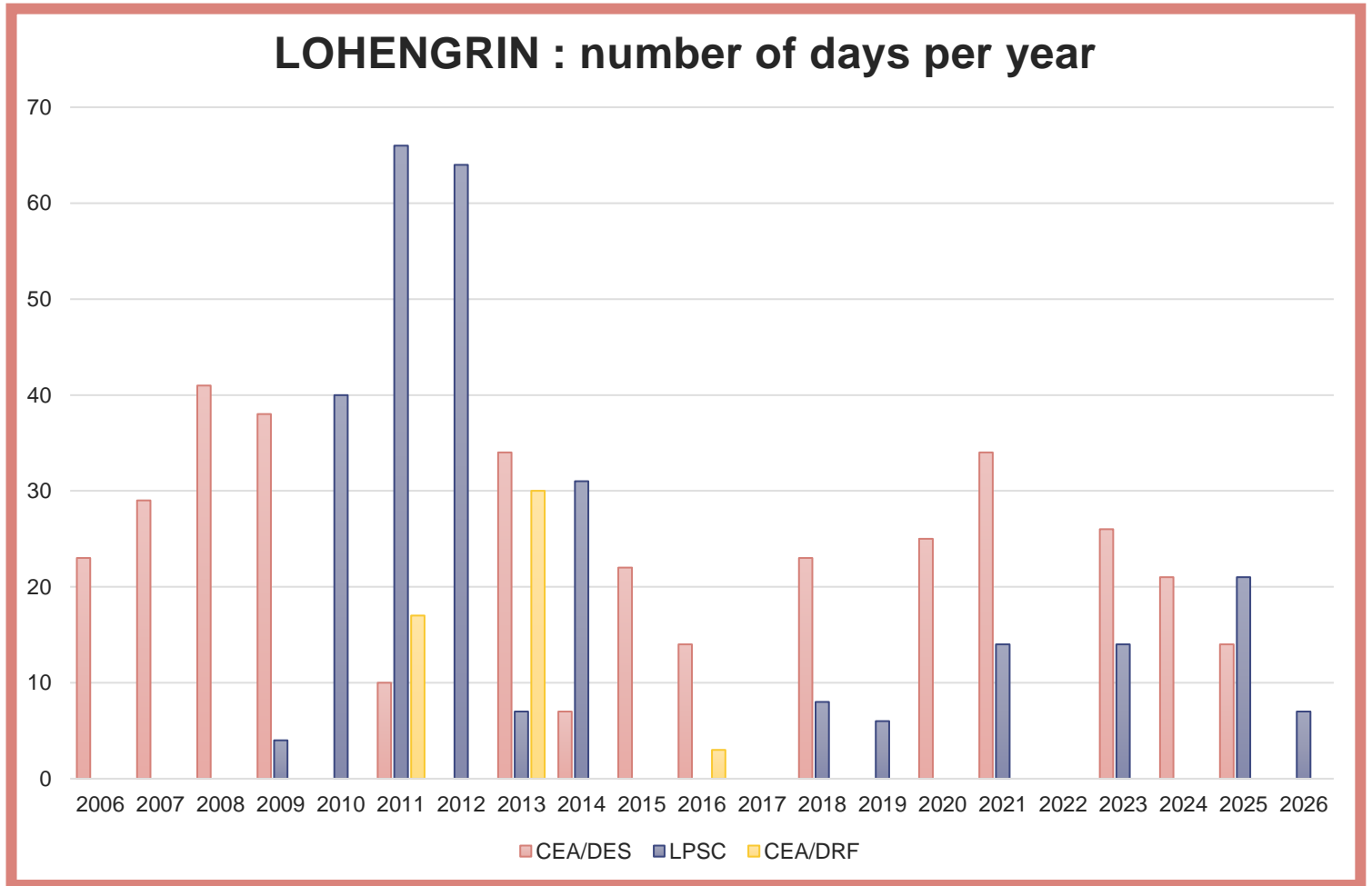
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*Special thanks for people providing targets : Ch.E. Düllman (Helmholtz Institute Mainz) + all interns, PhD, researchers*



# PEPR SCIAM

Budget (k€) sur 5 ans	CNRS/LPSC	CEA/LEPh
h/an (permanent)	~1	~1
Post-doc	180	0
Equipment	140	0
Consumable	50	0
Others	25	11

## Risks

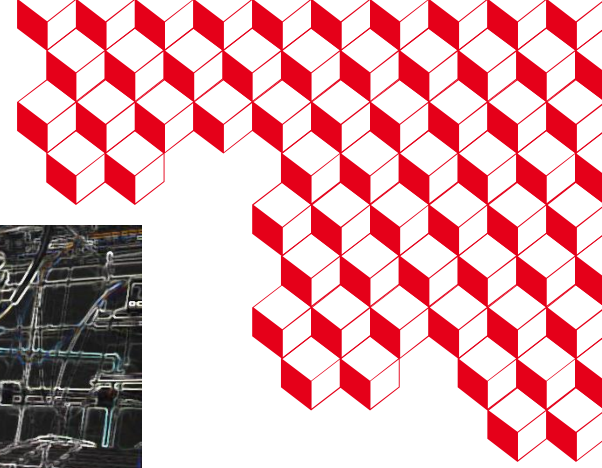
- **$^{239}\text{Pu}$  targets with spectroscopic quality !!!!!**
- Manpower @LPSC for maintaining skills for handling ToF
- LOHENGRIN

## Deliverables

- Conference participations
- Peer-review article
- Exfor database

# Conclusion

- Measurement of  $^{235}\text{U}(n_{\text{th}},f)$  fission mass yield in symmetry and far-asymmetry with LOHENGRIN + ToF
  - Measurement of  $^{239}\text{Pu}(n_{\text{th}},f)$  fission mass yield in whole range with LOHENGRIN (including ToF use)
  - Measurement of independent fission yield with LOHENGRIN in light fragment region for  $^{235}\text{U}(n_{\text{th}},f)$  and  $^{239}\text{Pu}(n_{\text{th}},f)$
  - Measurement of cumulative yield with FIPPS for  $^{239}\text{Pu}(n_{\text{th}},f)$
  - Study of fission fragment angular momentum through isomeric ratio measurement with LOHENGRIN ( $^{241}\text{Am}$ ,  $^{237}\text{Np}$ ,  $^{239}\text{Pu}$ )
- Produce covariance matrices, reduce uncertainties (<2%) to test and constrain models used in the evaluation process



# Thank you for your attention

