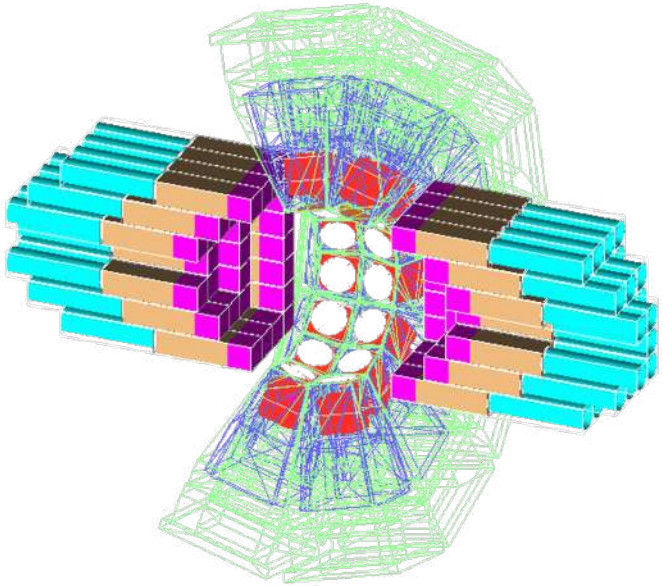
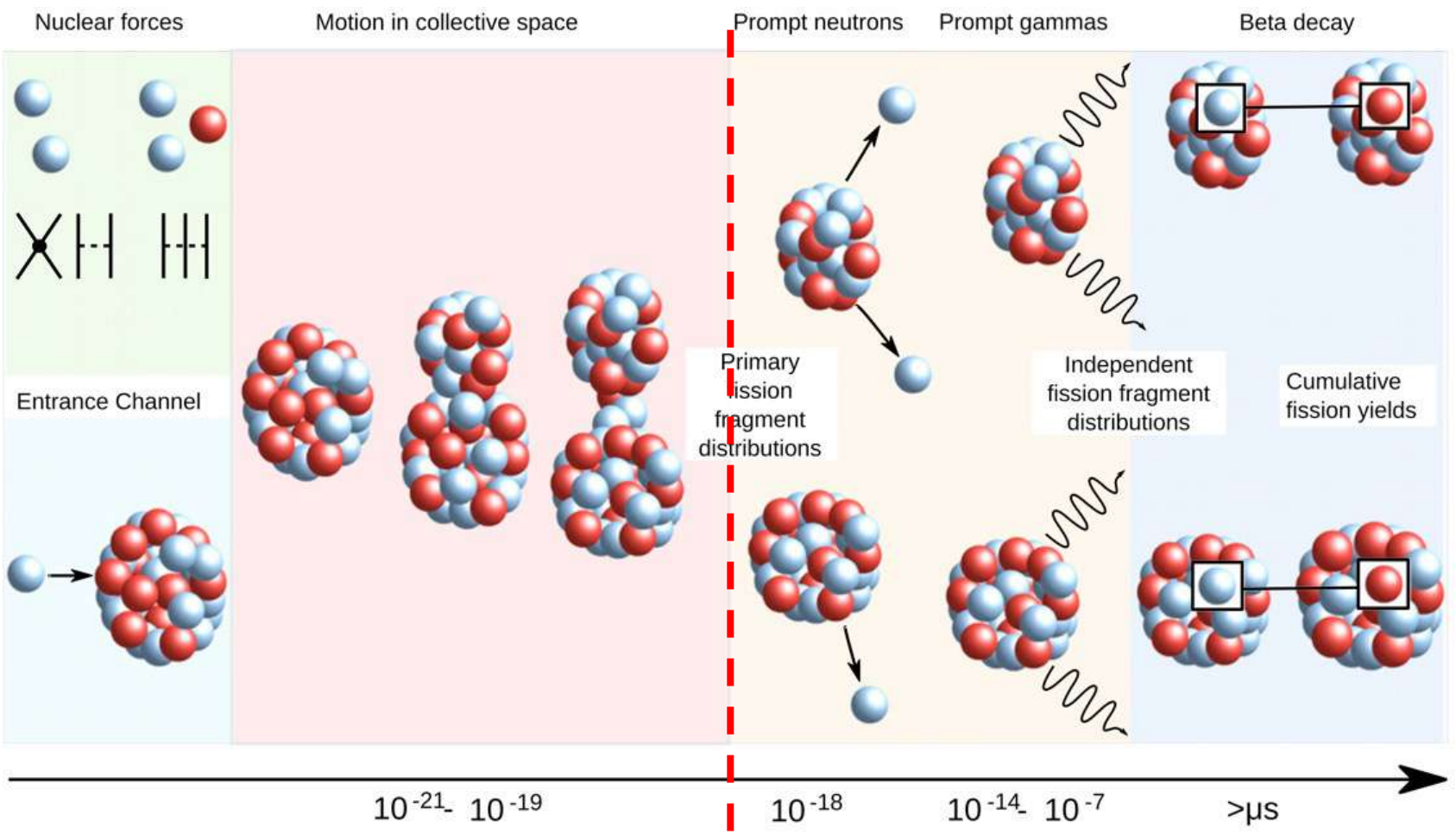
Perspectives about spontaneous fission studies

M. Lebois

FROZEN



γ and neutrons: a probe for the fission mechanism



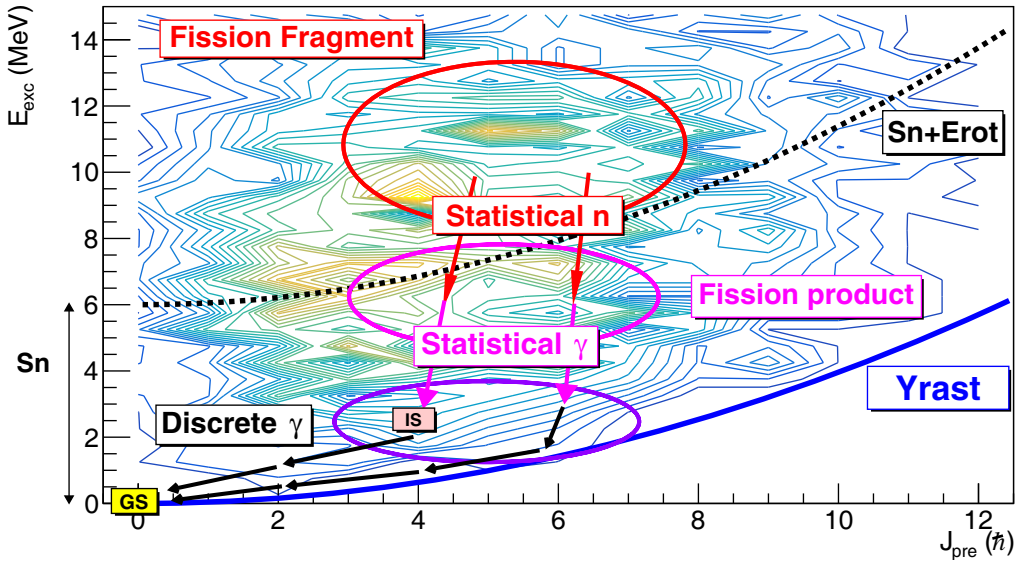
M. Bender et al., J. Phys. G: Nucl. Part. Phys. 47 (2020), 113002.

γ and neutrons: a probe for the fission mechanism

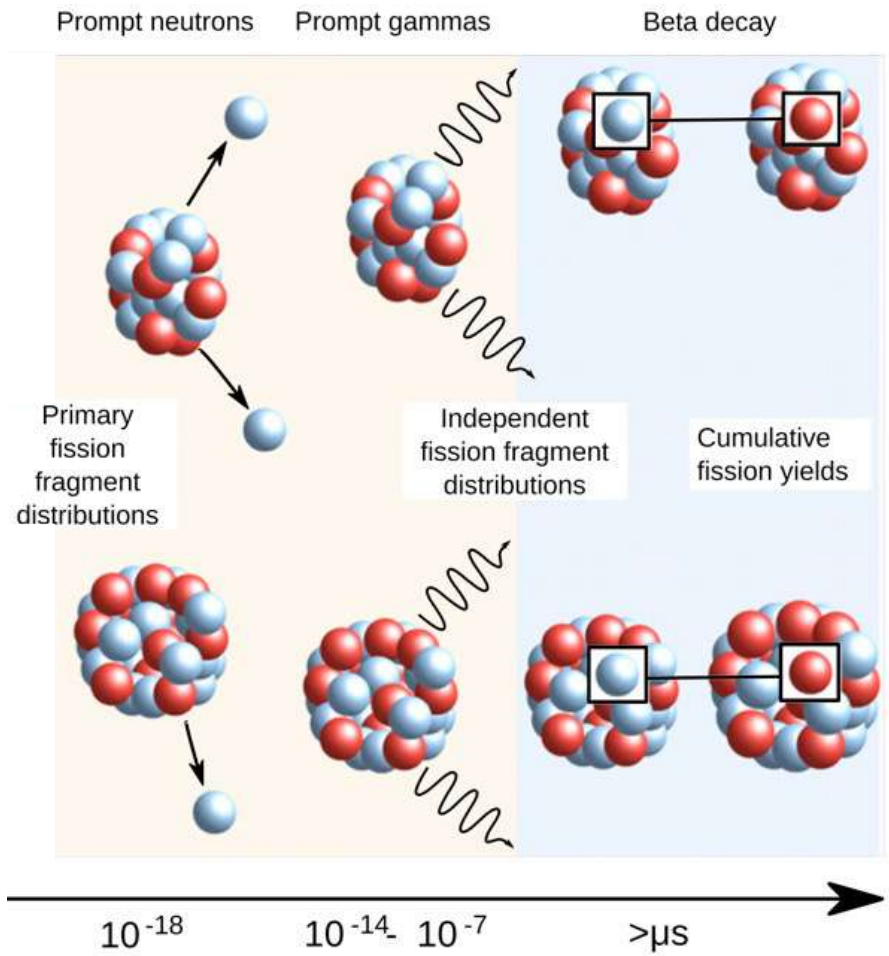
FF average excitation energy 20 MeV
FF average angular momentum 7-8 $\hbar$

- Neutrons: energy carriers
- γ: angular momentum carriers

J.N. Wilson et al., Nature **590** (2021), 566–570
Randrup & Vogt, PRL **127**, (2021) 062502



A. Al-Adili, V. Rakopoulos, and A. Solders, Eur. Phys. J. A **55**, p. 61 (2019).



M. Bender et al., J. Phys. G: Nucl. Part. Phys. 47 (2020), 113002.

γ and neutrons: a probe for the fission mechanism

Characterizing γ and neutron emission

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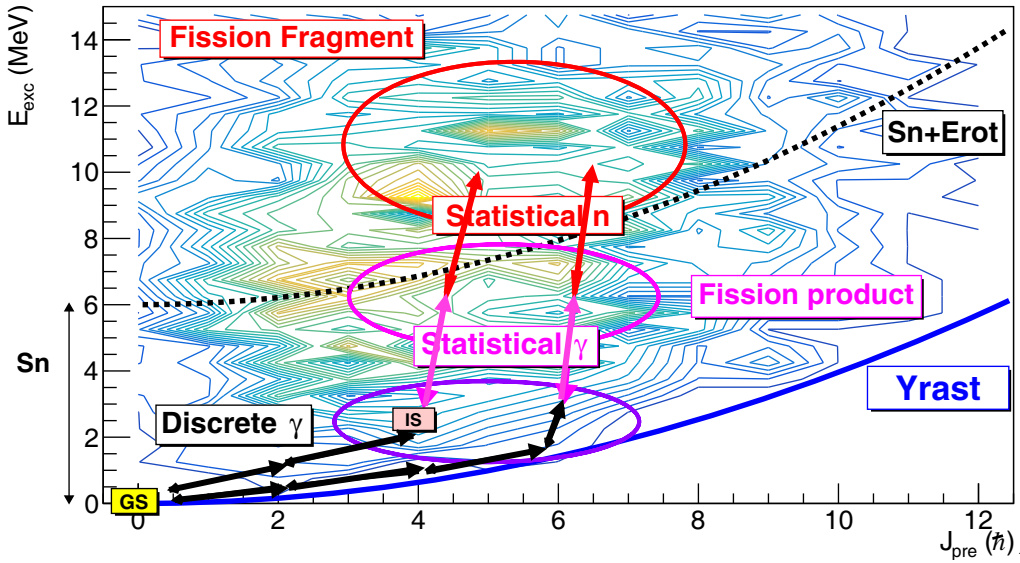
Going back in time to the scission point

J.N. Wilson et al., Nature **590** (2021), 566–570

Randrup & Vogt, PRL **127**, (2021) 062502



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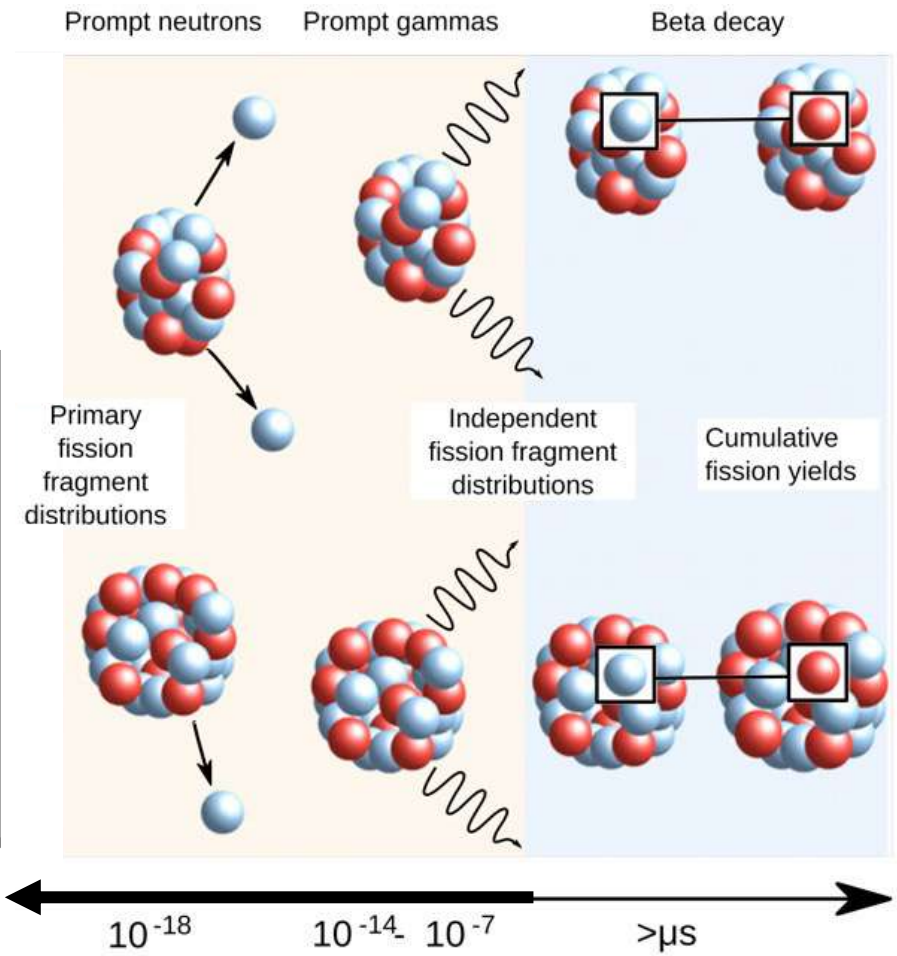


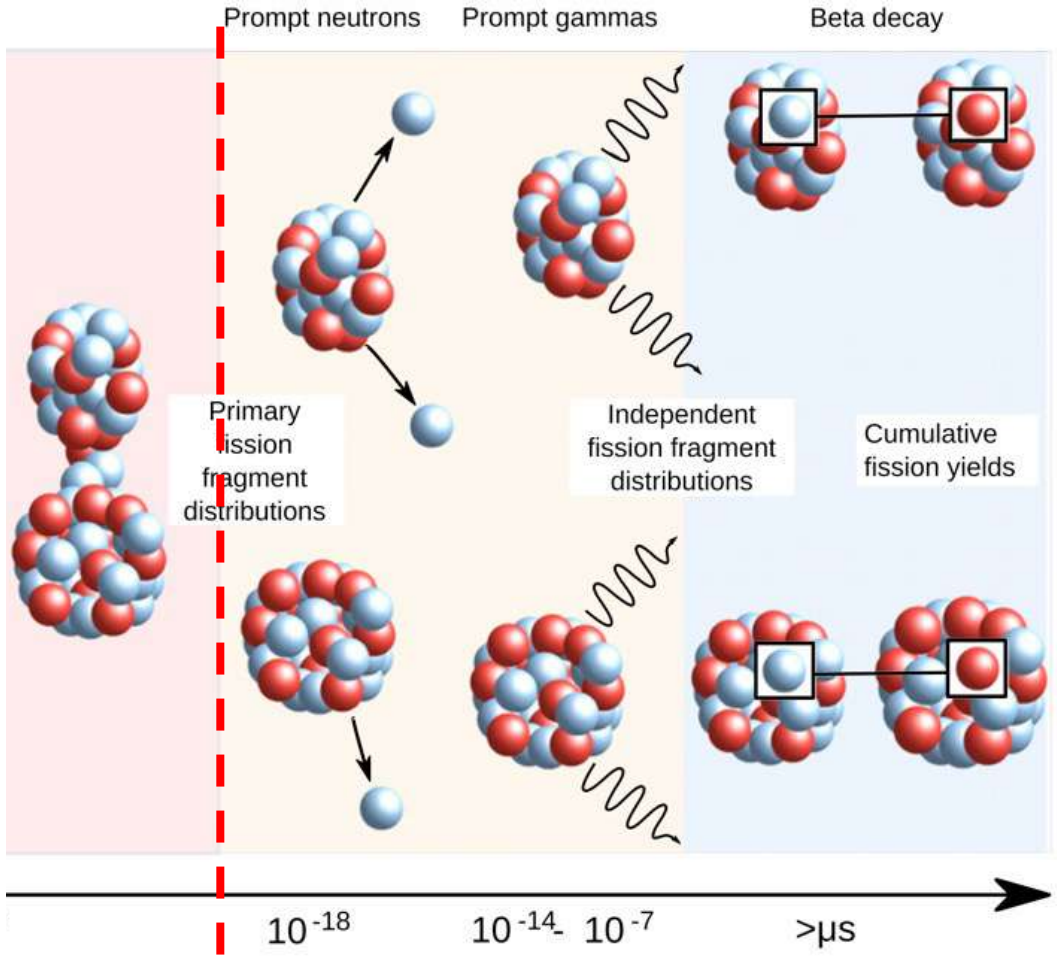
M. Bender et al., J. Phys. G: Nucl. Part. Phys. 47 (2020), 113002.

γ and neutrons: a probe for the fission mechanism

Emission angle between γ and fission axis correlated to the pre-scission shape

G.F. Bertsch, T. Kawano and L.M. Robledo, Phys. Rev. C ***99****, 034603 (2019)*
J.B. Wilhelmy et al., Phys Rev. C ***5****, 2041 (1972).*

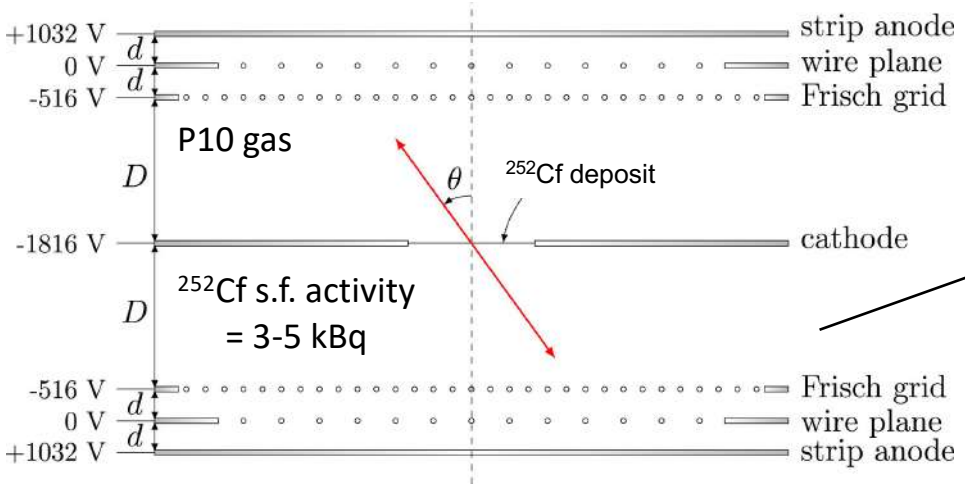
Also evaluated with TKE and fragment mass



M. Bender et al., J. Phys. G: Nucl. Part. Phys. 47 (2020), 113002.

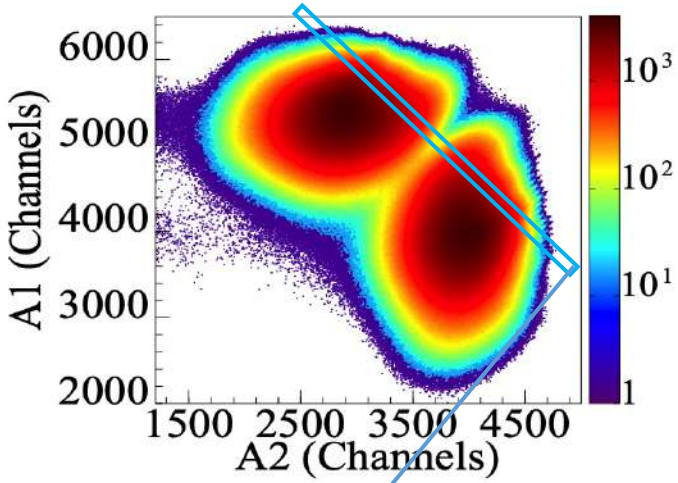
Fission Fragment detection

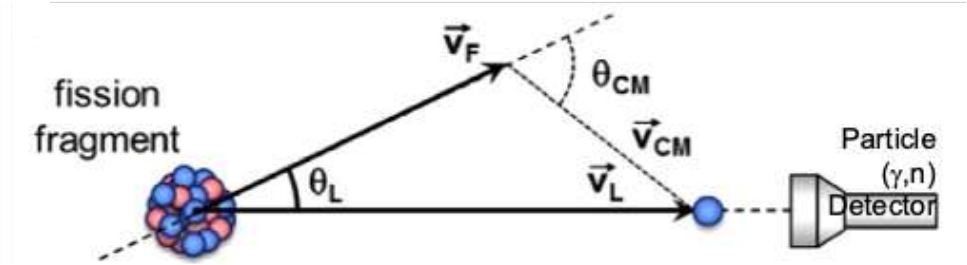
Position sensitive twin ionization chamber

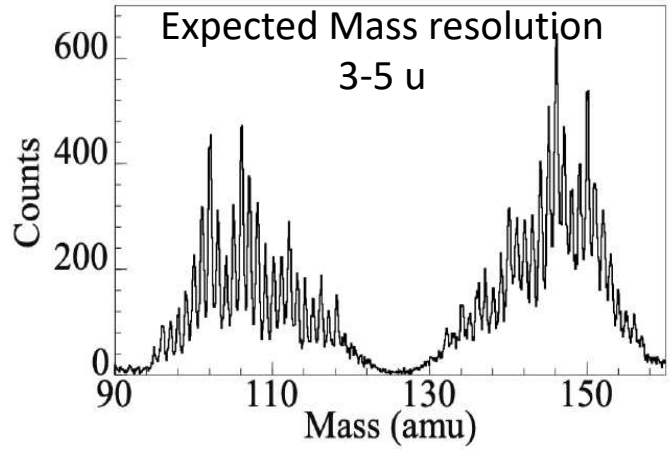


A. Göök *et al.*, NIM A **830**, p. 366 (2016)

Energy deposited

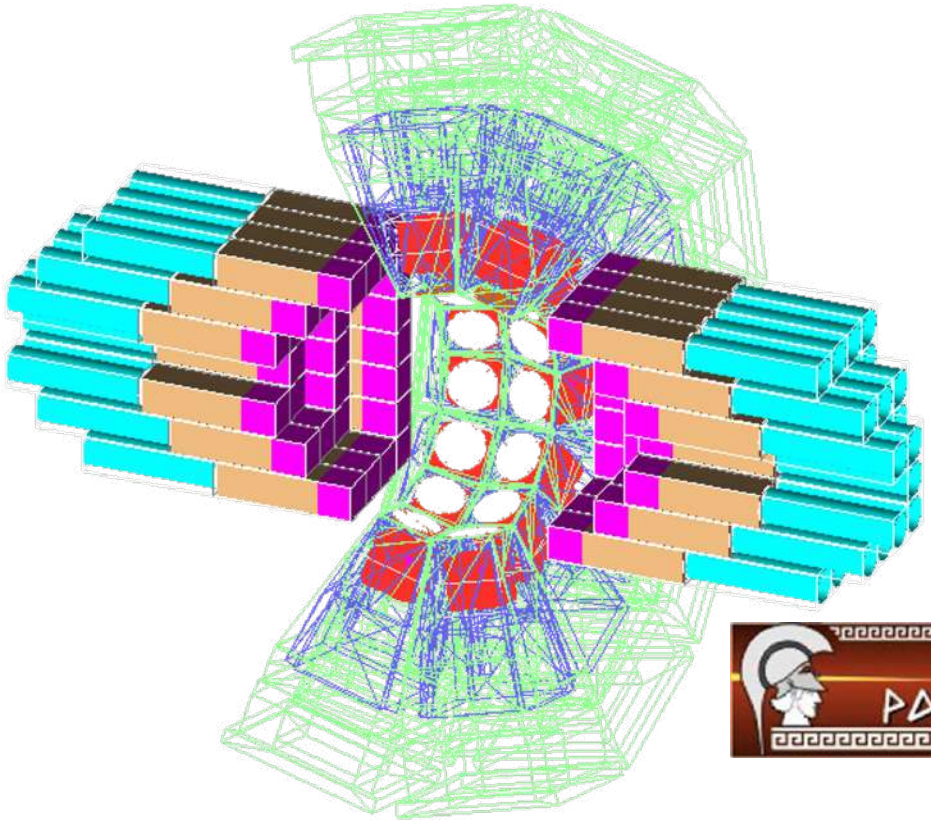




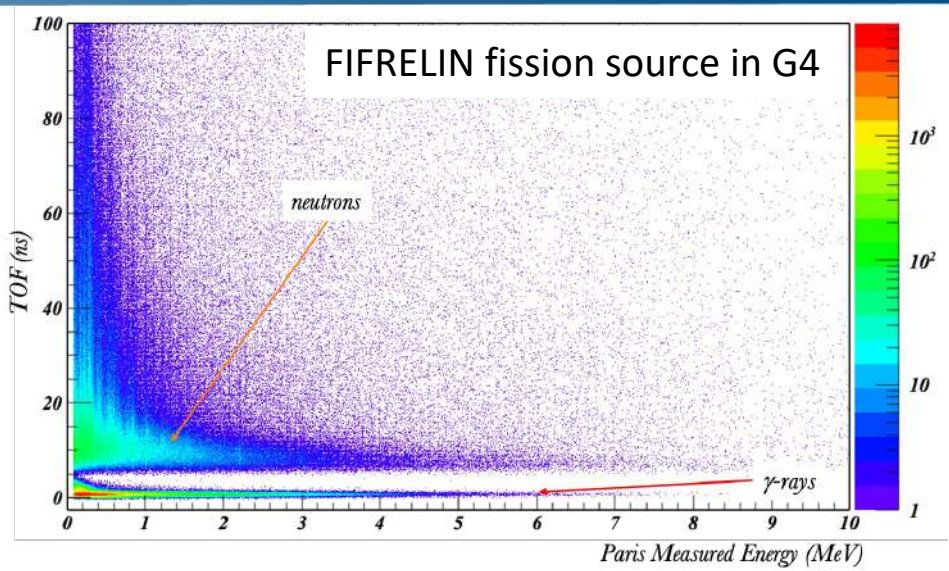


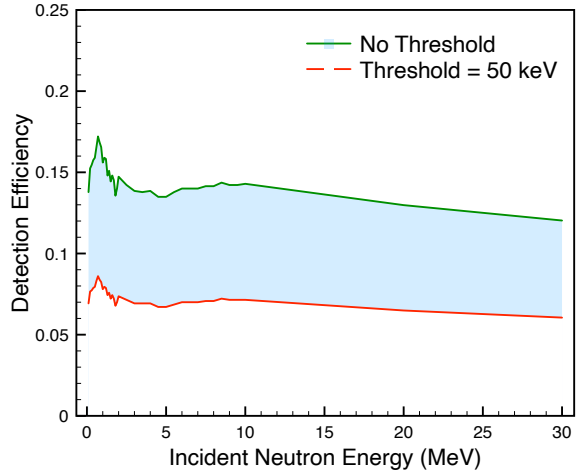
γ and neutrons: a probe for the fission mechanism

PARIS Configuration



GEANT4 Simulation





N-SI-125 Status

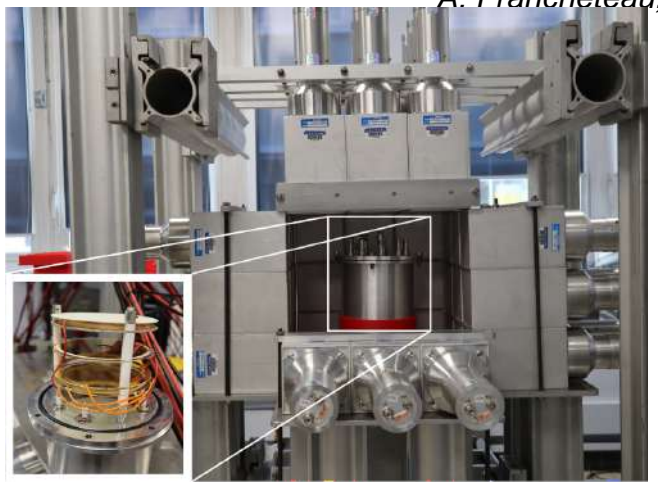
From B. Pertille presentation:

- Finalization of the trace analysis for the ionization chamber
- Calibration of PARIS & HPGe already started (but need to correct for non-linearities)
- Ongoing conversion from FASTER (with traces) -> ROOT with event reconstruction
- Need to work on chamber full characterization (proper TKE reconstruction, proper FF momentum reconstruction)
- Whatever I forgot or not foreseen…

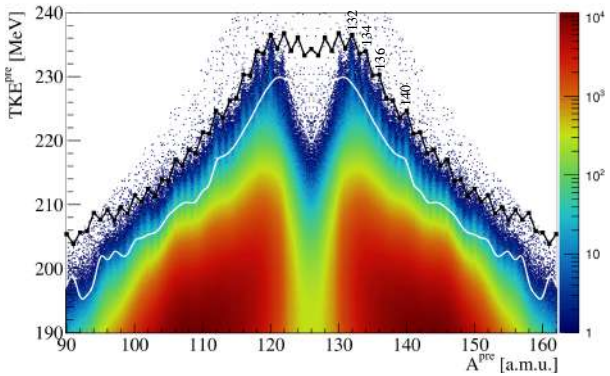
Despite FRØZEN: litterature update

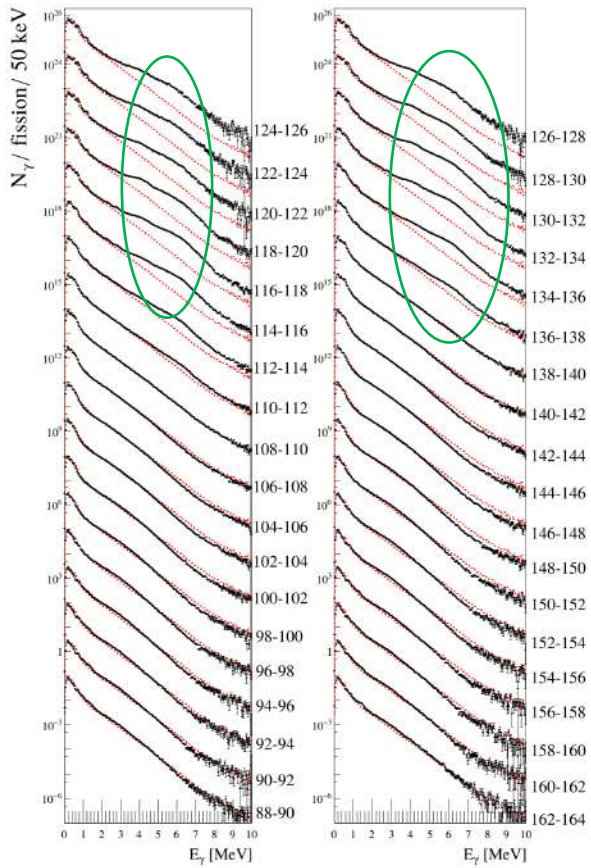
Study of the radiative decay of ^{252}Cf spontaneous fission fragments

A. Francheteau, PhD Thesis, UPSay, Sept. 29th 2023 & Phys. Rev. Lett. 132, 142501 April 2024



Search of “cold” fission (neutronless)





Structure due to continuous part of radiative decay in heavy fragments

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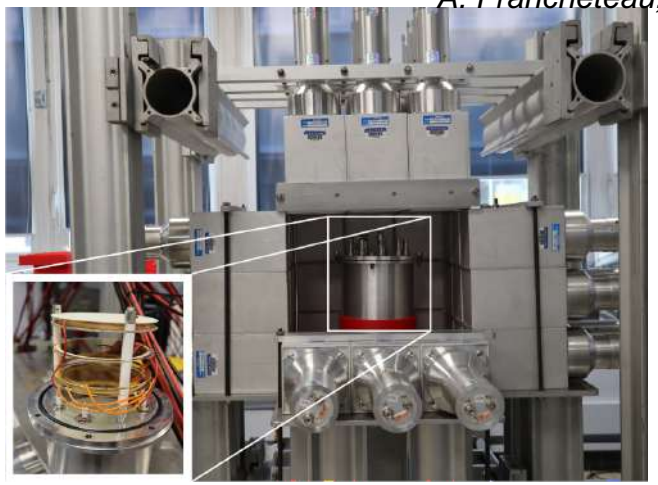

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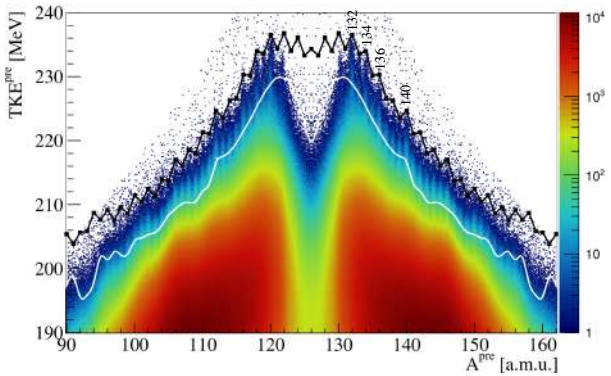

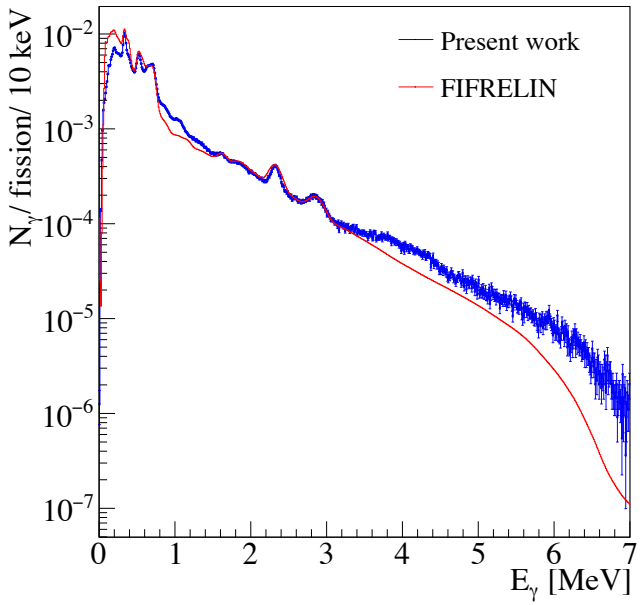

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FIFRELIN predicts more structured distributions that are incompatible with the experimental resolution.

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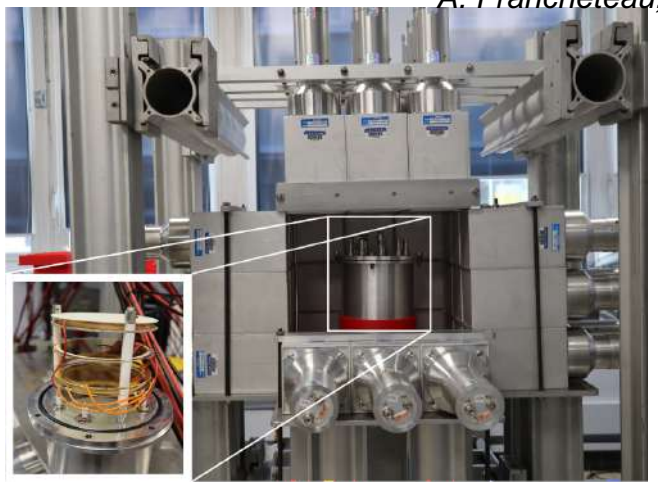

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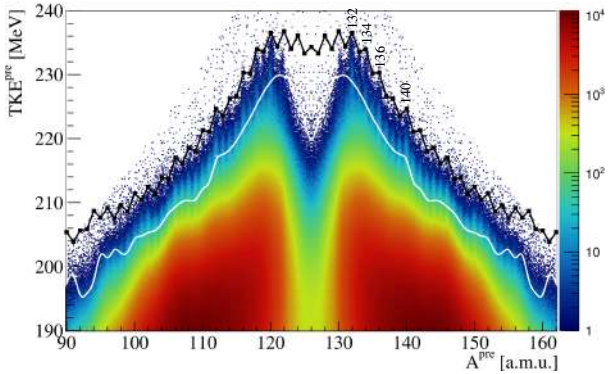
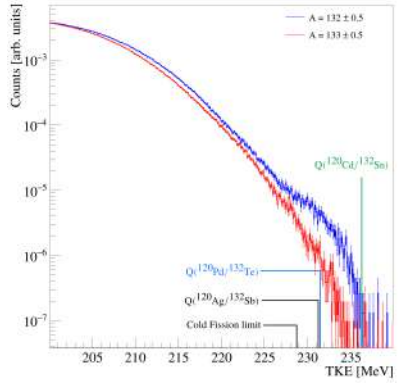
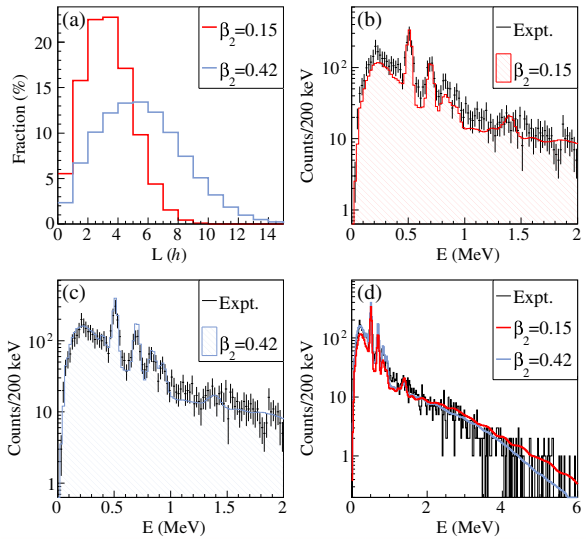






Structure due to continuous part of radiative decay in heavy fragments

FIFRELIN predicts more structured distributions that are incompatible with the experimental resolution.

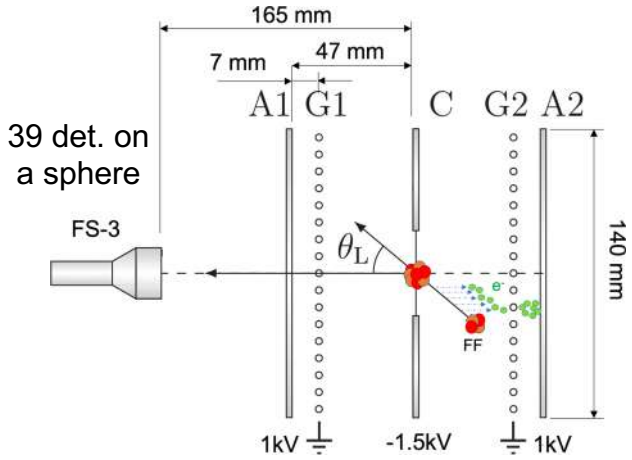
TKE Selection of neutronless fission (partial selection):

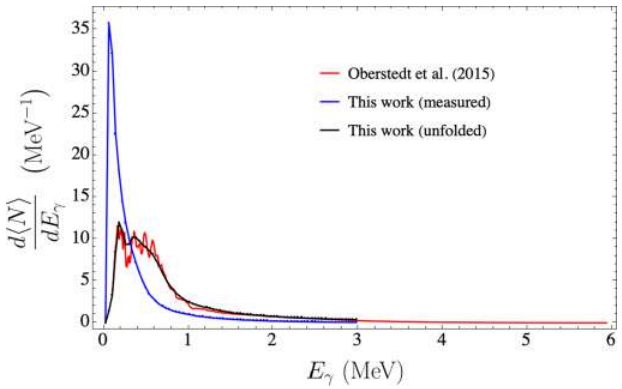
- Excitation energy distribution of ^{120}Cd/^{132}Sn pair
- Determination of angular distribution and deformation at scission for ^{120}Cd
- Population of ^{132}Sn directly in its ground state (98% of selected events)

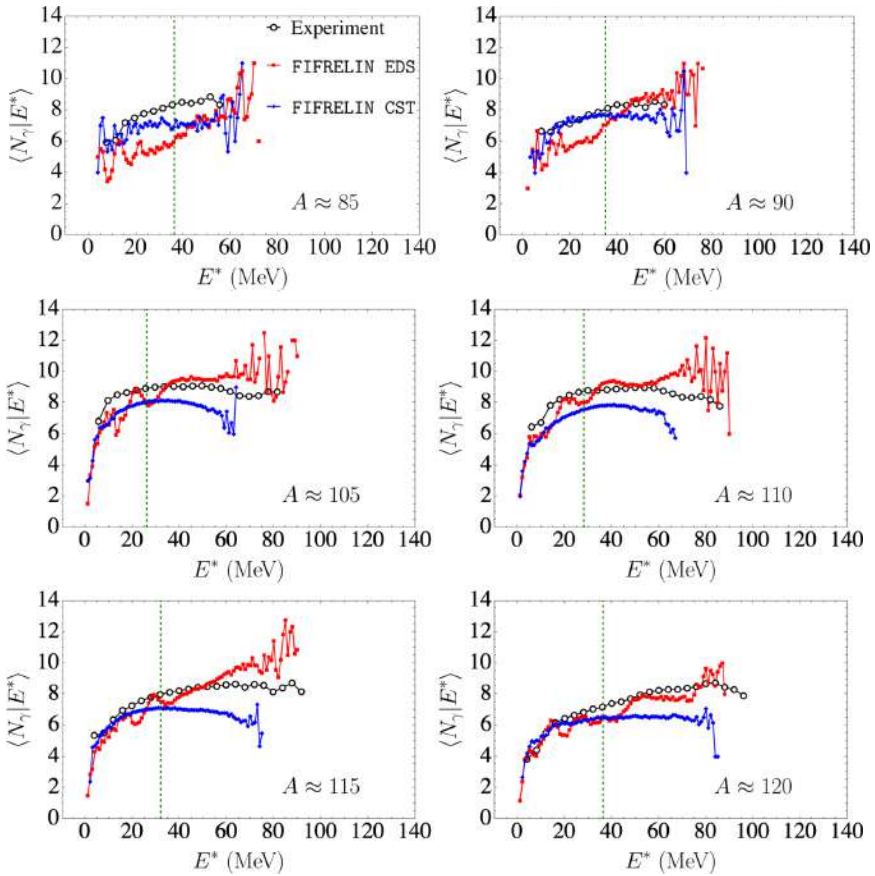
Despite FRØZEN: litterature update

Measurement of fragment correlated γ-ray emission from ^{252}Cf(sf)

*S. Marin et al., Phys. Rev. C **109**, 054617 (May 2024)*







The total γ-ray multiplicity from fission fragments saturates at high internal excitation energies.
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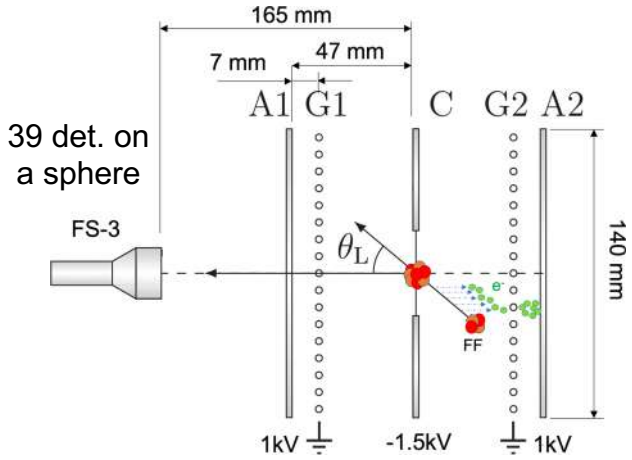

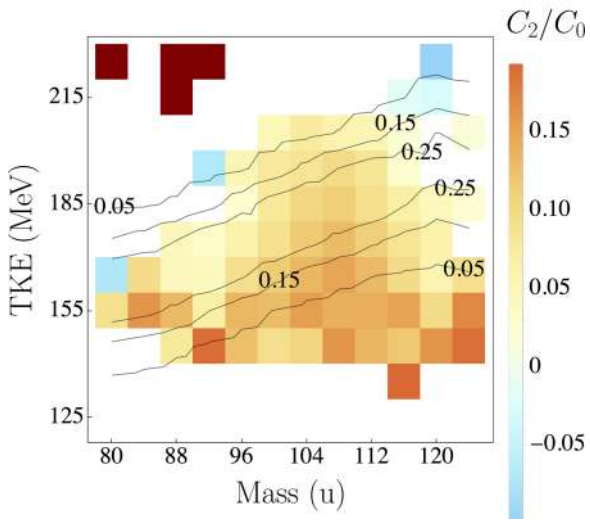

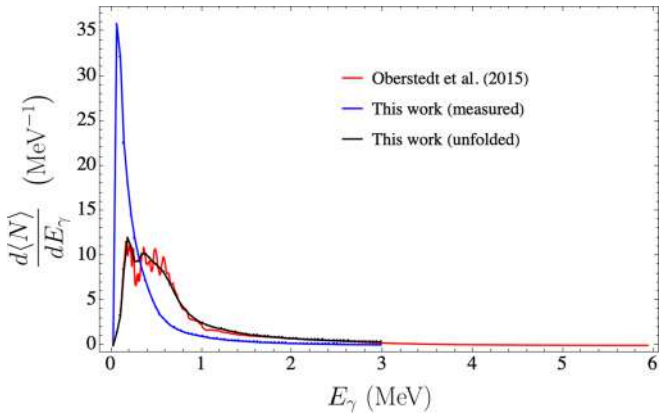

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Anisotropy of γ-ray emission depends on both the mass and TKE of the fragments
-> *AM's orientation and magnitude might be influenced by the specific fission channel,*

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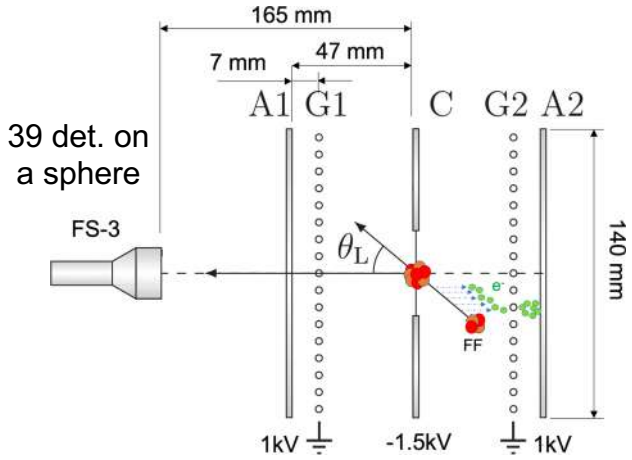

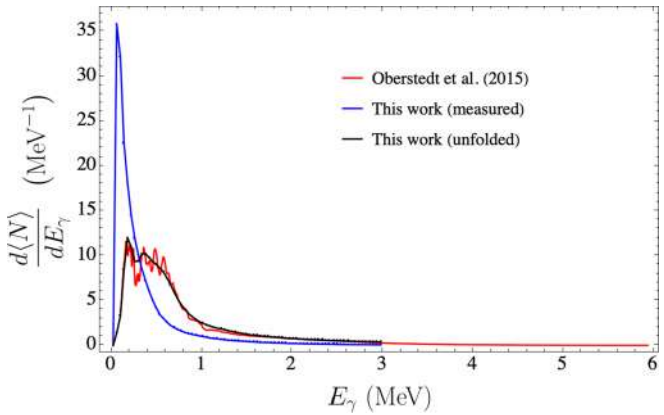

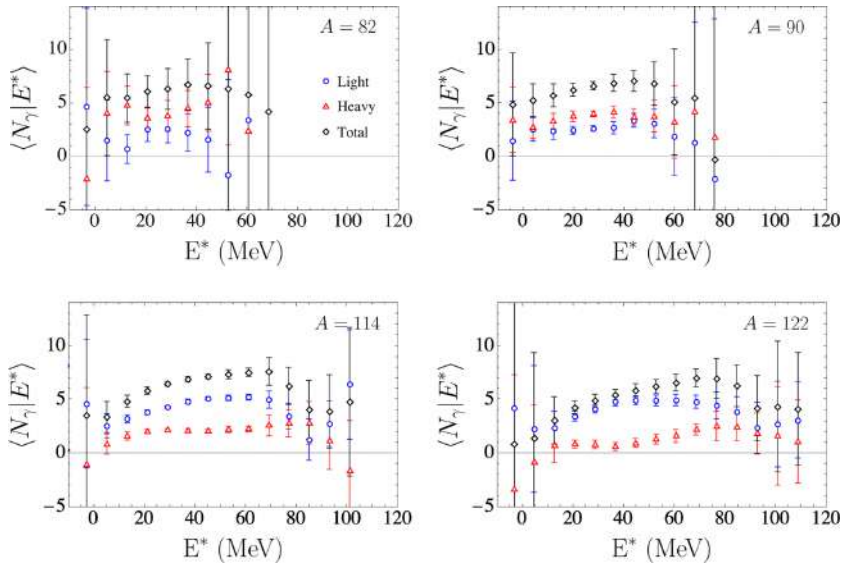

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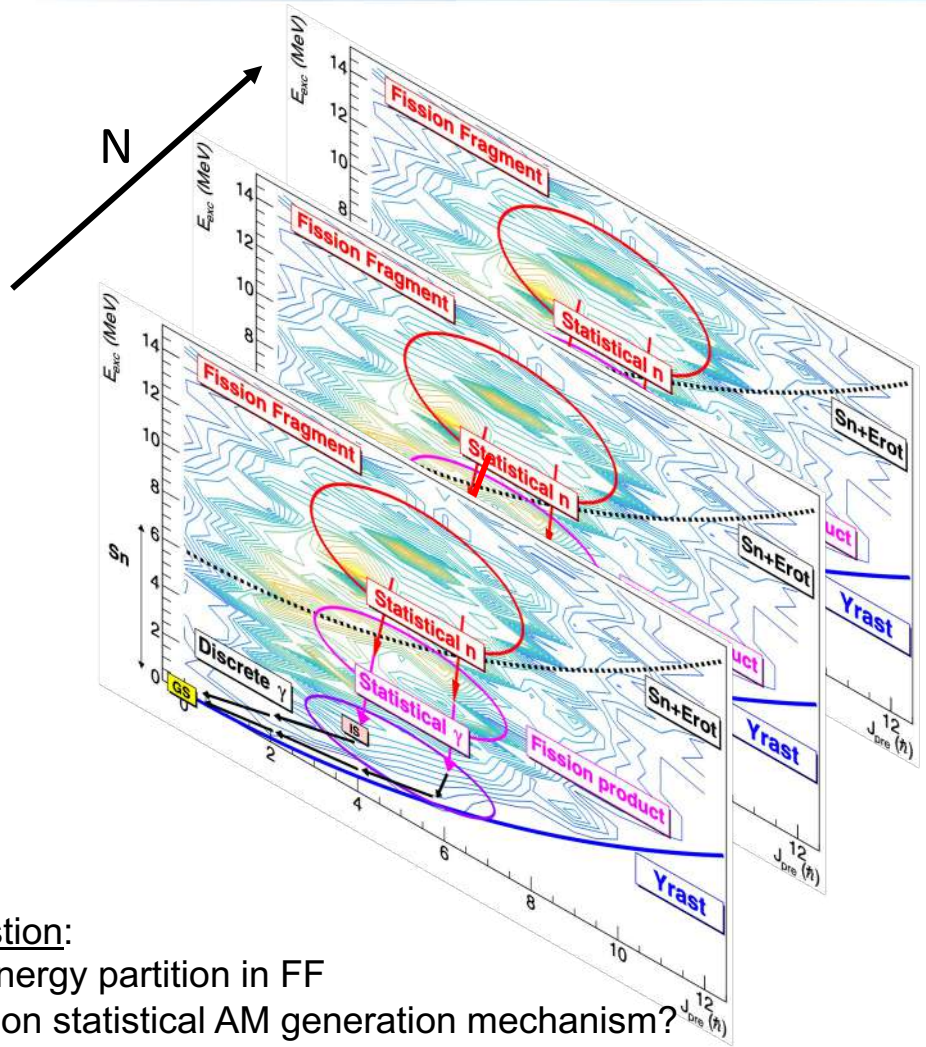
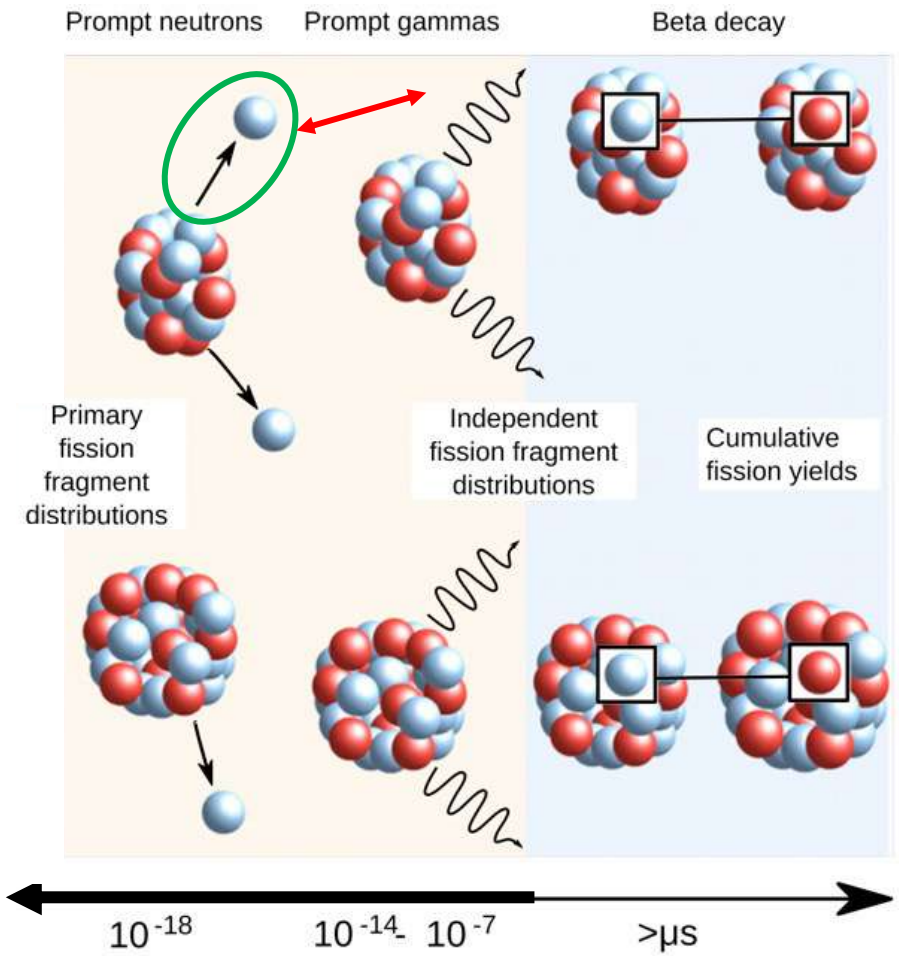
γ -ray yields are weakly or anti correlated
-> complex modes of AM generation and suggests that the γ-ray emission patterns vary significantly between different types of fragments.

γ and neutrons: a probe for the fission mechanism

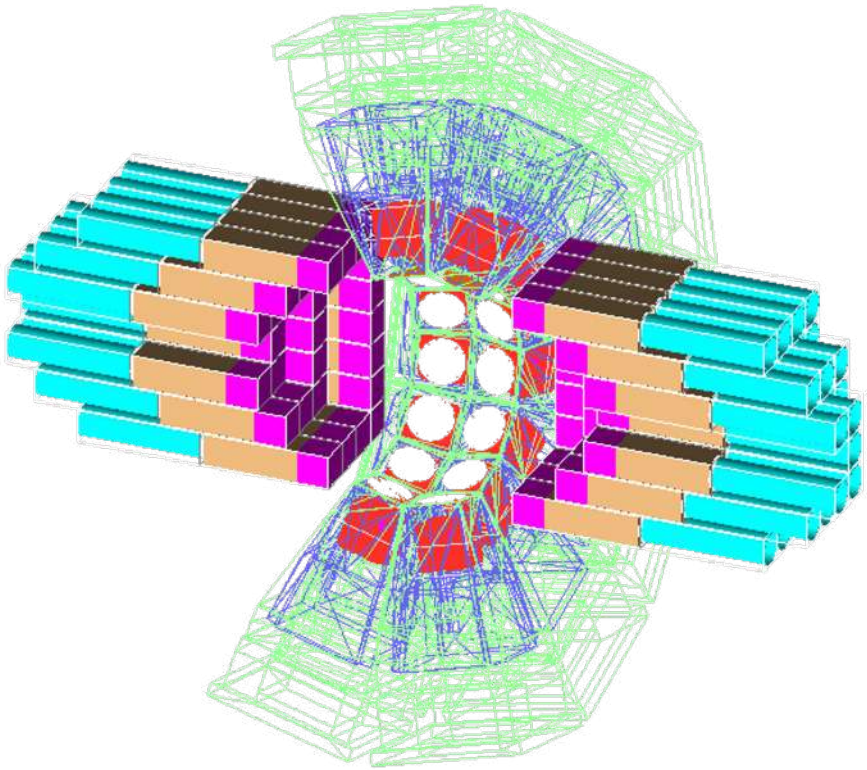




M. Bender et al., J. Phys. G: Nucl. Part. Phys. 47 (2020), 113002.

Question:
- energy partition in FF
- Non statistical AM generation mechanism?

What's next for s.f. measurements



Need for:

- n/γ correlated measurements
- γ-γ angular correlation
- Better TKE measurement & Z selection

Possibility of a ν-Ball3/Coffee (see Jon's talk):

- Better TOF IC/PARIS measurement
- Better ^{252}Cf sample…
- Try to skip as much as possible trace analysis -> and run for as long as possible