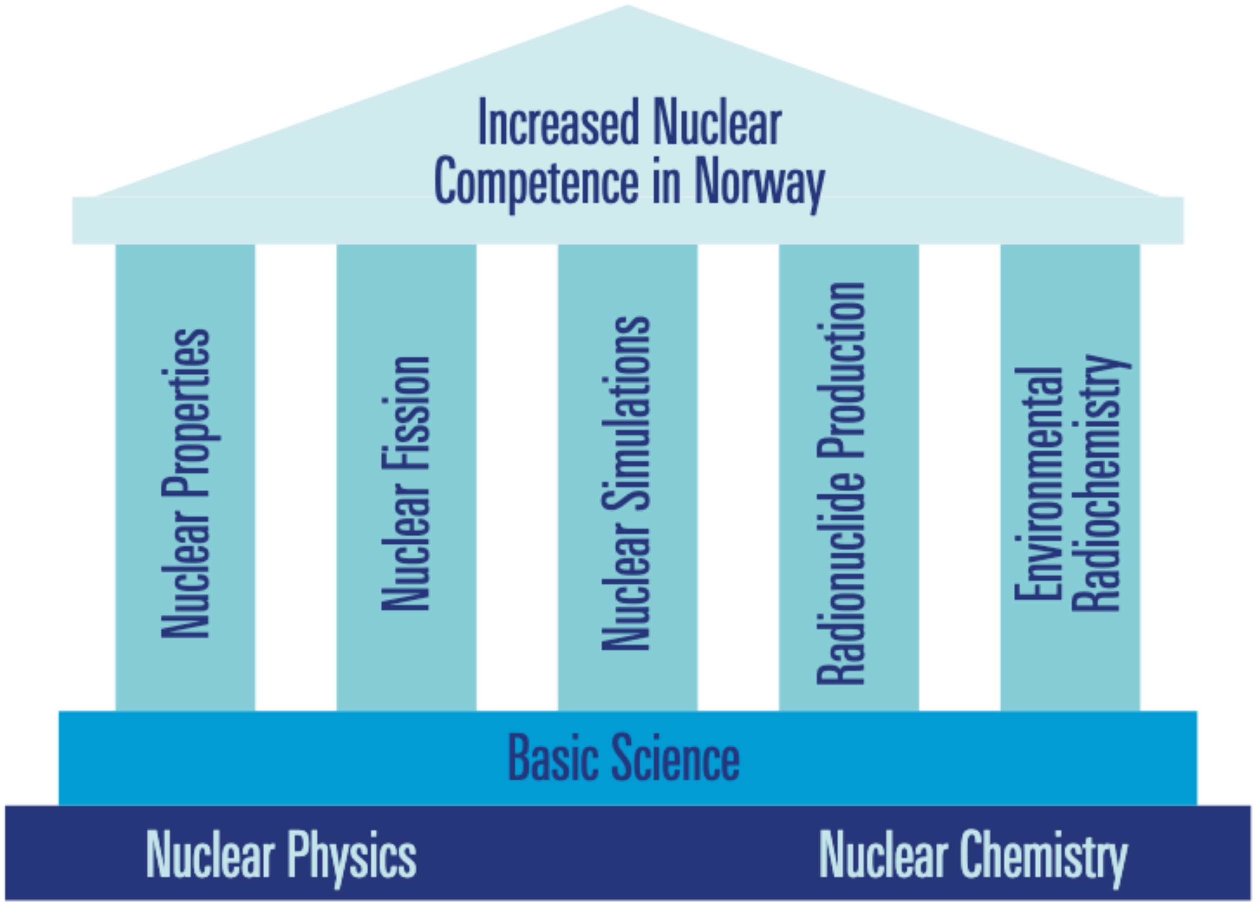
FISSION 2026

Future fission experiments at the Oslo Cyclotron laboratory

Sunniva Siem
University of Oslo

Chamrousse, France 9-13 March 2026,

Norwegian Nuclear Research Centre



UiO IFE NMBU

Forskningsrådet

Funding: 200 MKr (ca 20 M Euro) over 8 years, 2023-2031

New bachelor and master programs at UIO from 2023:

https://www.uio.no/studier/program/kjernefysikk-nukleartekologi/

Kjernefysikk og nukleærteknologi (bachelor)

Studiepoeng: 180 **Studiet varer:** 3 år

Fra klimavennlig energi til nye metoder for behandling av kreft: Samfunnet er avhengig av kunnskap om kjernefysikk og nukleærteknologi. I dette studieprogrammet lærer du om atomkjernen, radioaktivitet og stråling, og hvordan denne kunnskapen kan brukes i fremtidens kjernekraft, medisin og teknologi.

- → Hvorfor velge dette programmet?
- → Hva lærer du?
- → Opptak
- → Oppbygging og gjennomføring
- → Studieopphold i utlandet
- → Jobb og videre studier

Very popular:
2023: 76 applicants had it as first choice, 600 appllicants in total.
2024: 74 applicants had it as first choice, 573 appllicants in total.
2025: 86 applicants have it as first choice….

Livet som kjernefysikk-student

– Det er veldig fint å gjøre noe som potensielt kan redde liv

Hva kan du jobbe med?

Bruker fysikk for å forbedre pasienters livskvalitet

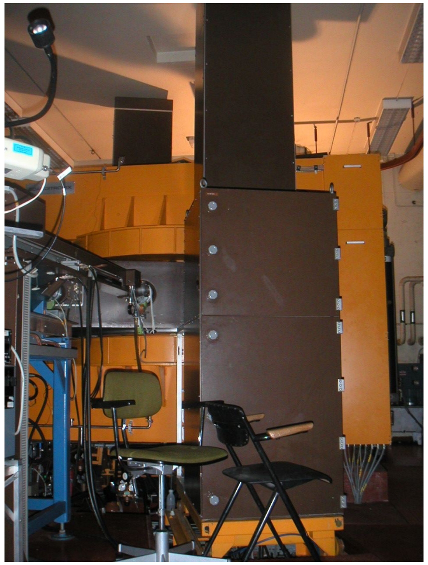
Jobber med nedrustning og ikke-spredning av atomvåpen

Nuclear Science (master's two years)

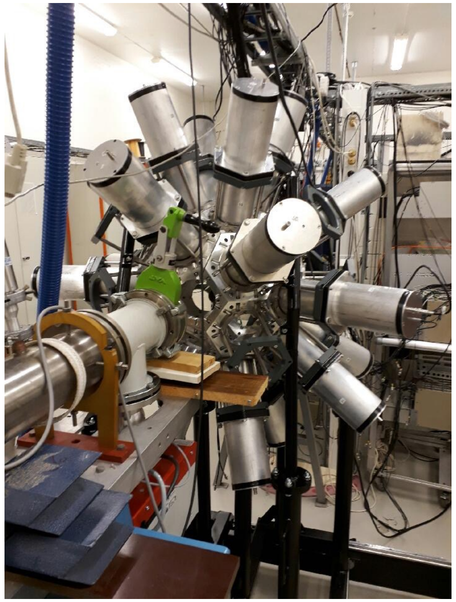
Oslo Cyclotron Laboratory

Research topics the Nuclear Physics group:

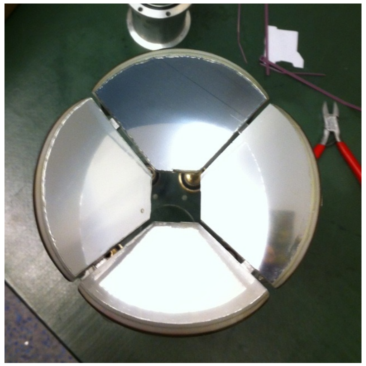
- Nuclear Fission
- Nuclear structure
- Nuclear astrophysics
- Energy applications
- Medical isotopes R&D
- Technology development



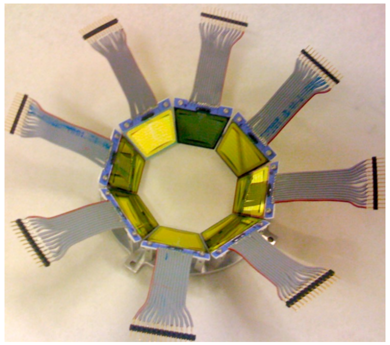
Cyclotron



OSCAR (gamma detectors)

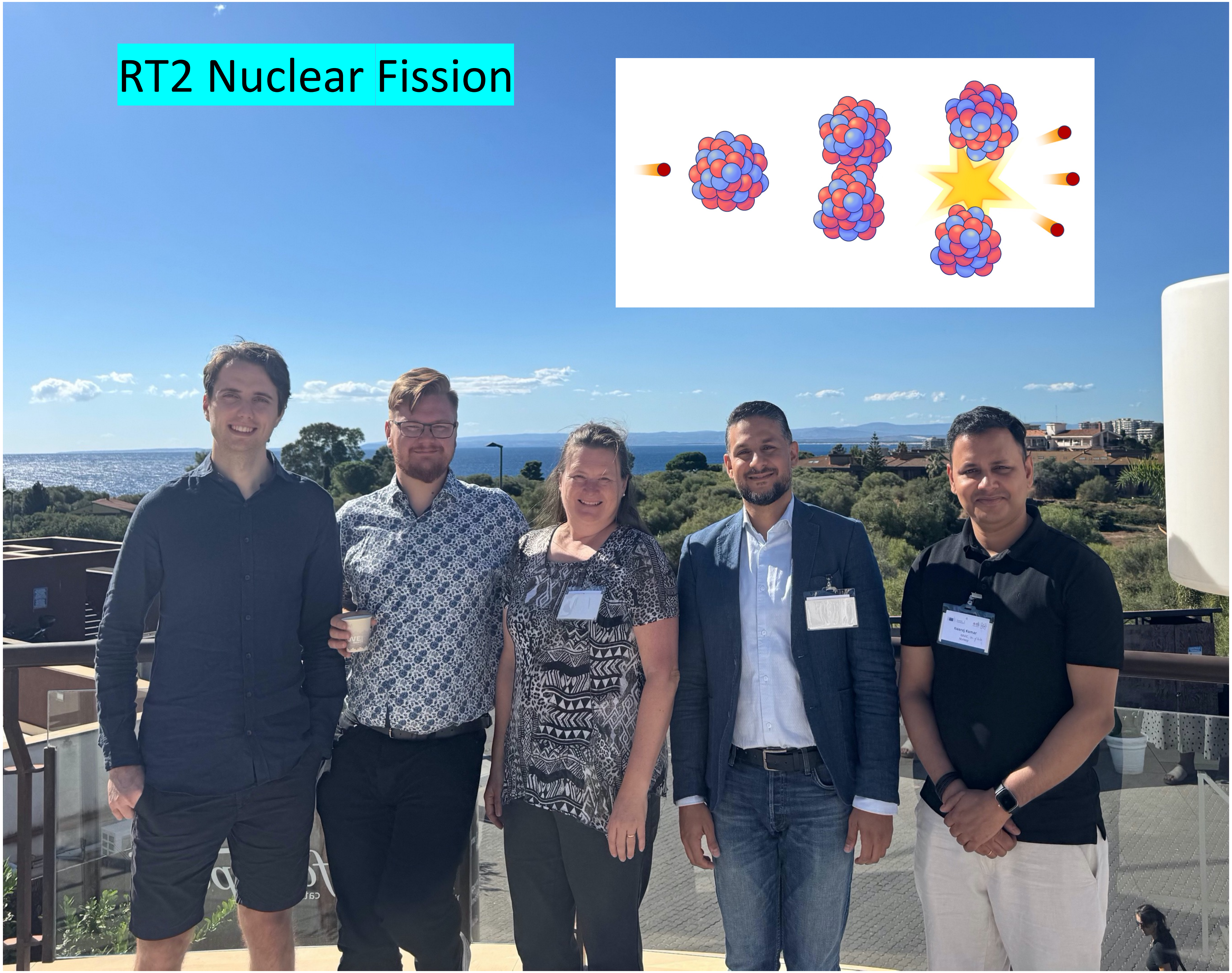


Old PPAC (fission det.)



SiRi (particle det.)

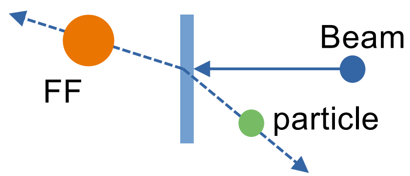
RT2 Nuclear Fission

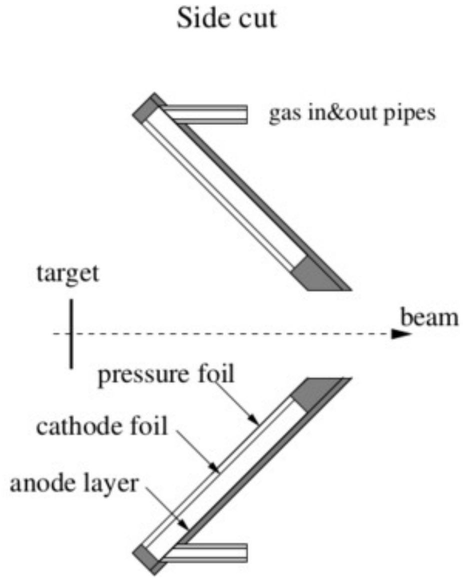


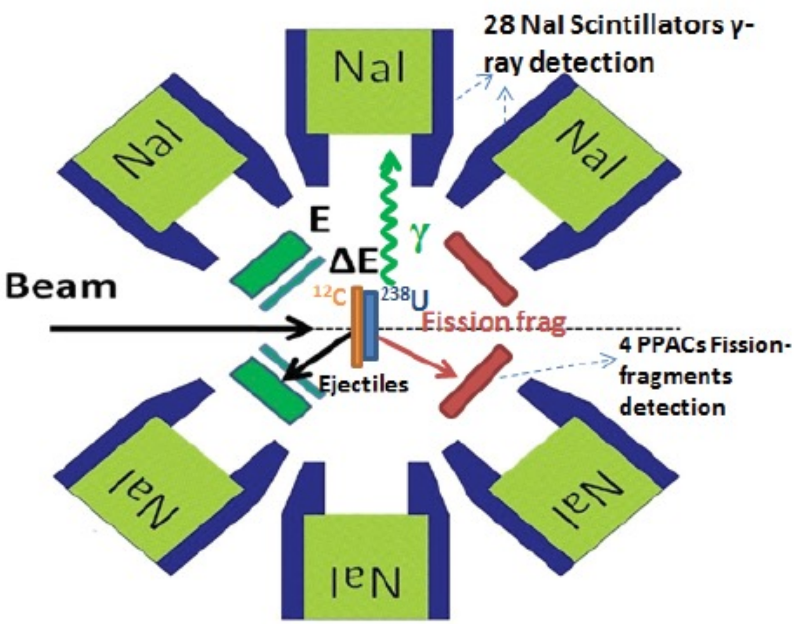
Earlier Actinide research Program with CACTUS

PPAC fission fragment detector

- Charged particle – ff – γ coincidences
- Originally fission veto only
- Later fission gate







actinide targets:

- ^{232}Th
- ^{233}U ^{235}U ^{238}U
- ^{237}Np
- ^{239}Pu ^{240}Pu ^{242}Pu ^{244}Pu

collaboration Oslo - Livermore

Energy dependence of the prompt γ-ray emission from the (d, p)-induced fission of ^{234}U* and ^{240}Pu*

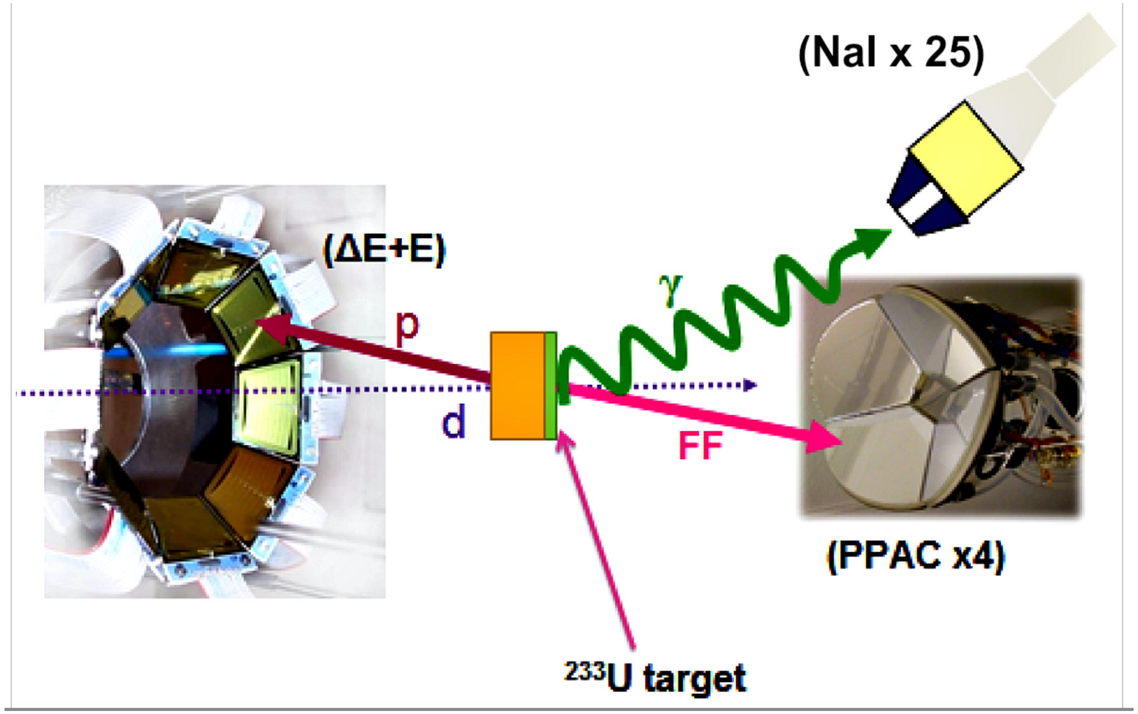
S. J. Rose[1,*], F. Zeiser[1,†], J. N. Wilson[2], A. Oberstedt[3], S. Oberstedt[4], S. Siem[1], G. M. Tveten[1], L. A. Bernstein[5,6], D. L. Bleuel[7] *et al.*

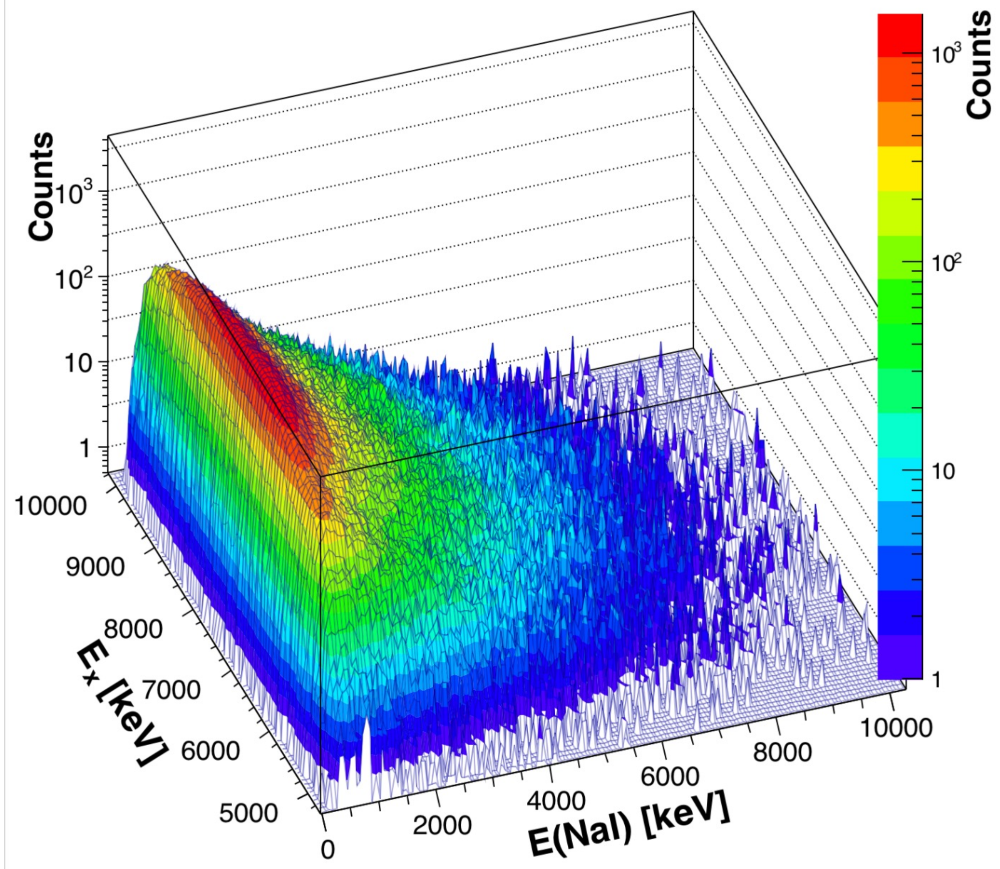
J. A. Brown[5], L. Crespo Campo[1], F. Giacoppo[1,‡], A. Görgen[1], M. Guttormsen[1], K. Hadyńska[1], A. Hafreager[1], T. W. Hagen[1], M. Klintefjord[1], T. A. Laplace[6,7], A. C. Larsen[1], T. Renstrøm[1], E. Sahin[1], C. Schmitt[8], T. G. Tornyi[1], and M. Wiedeking[9]

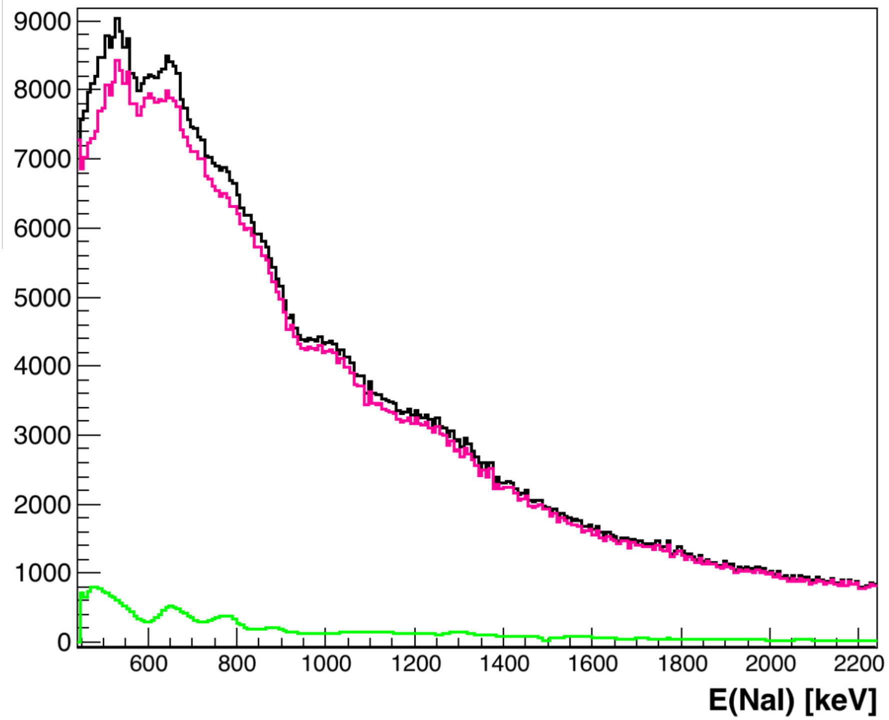
Phys. Rev. C **96**, 014601 – **Published 5 July, 2017**

DOI: https://doi.org/10.1103/PhysRevC.96.014601

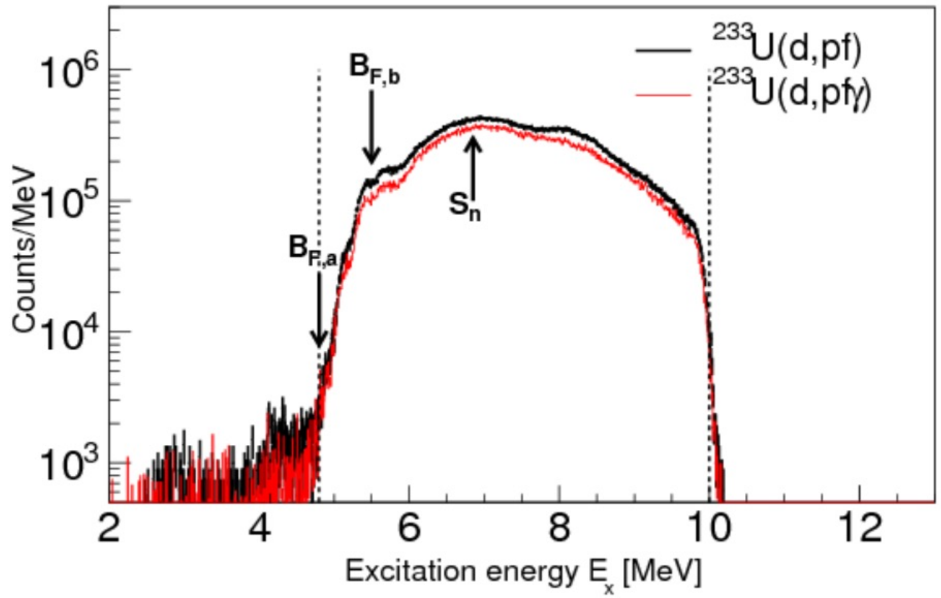
Idea + preliminary analysis during a small workshop in Oslo

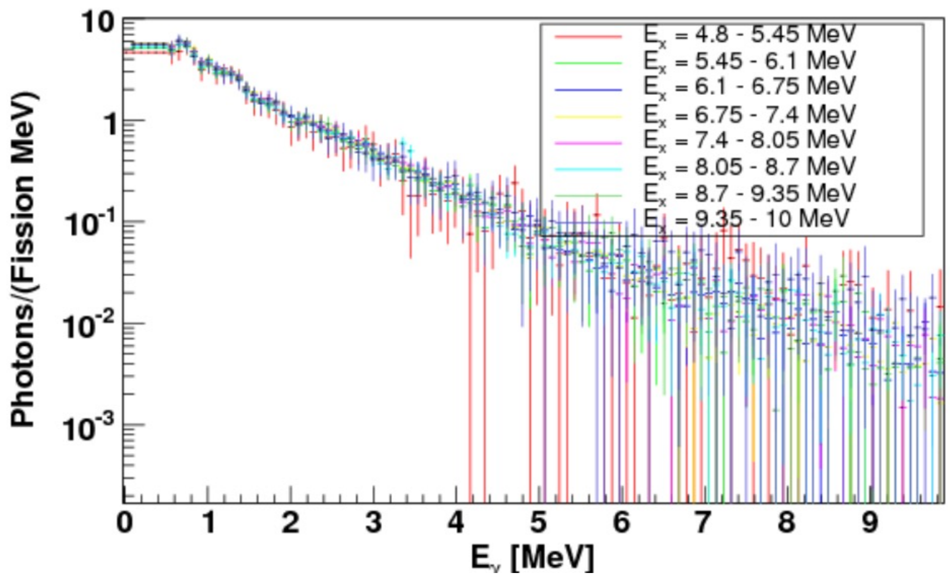


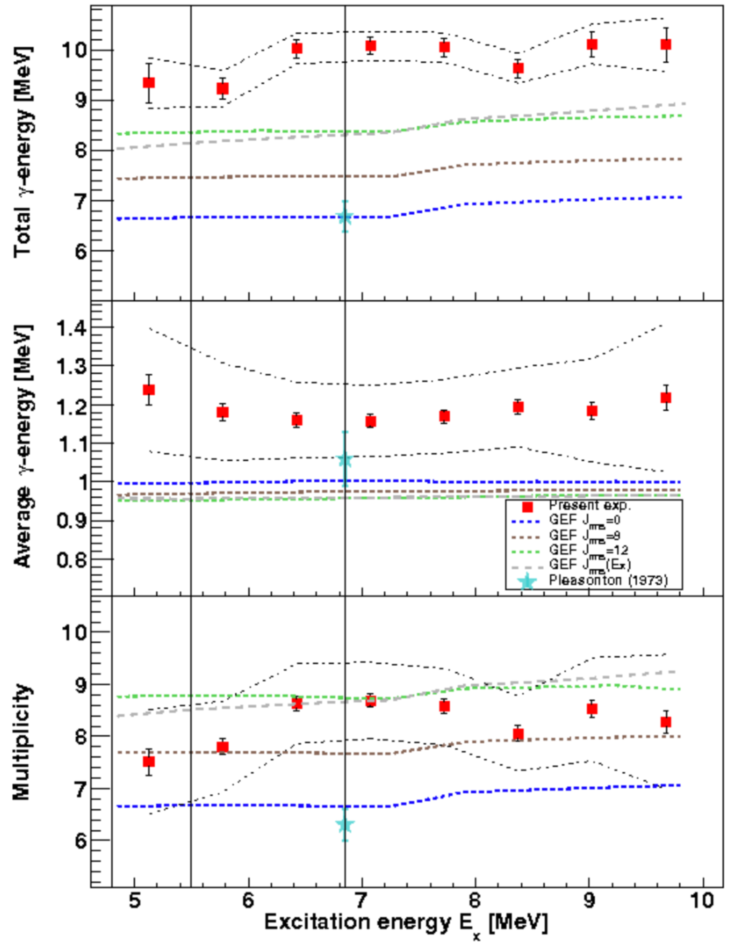

Counts
Counts
E(NaI) [keV]
Eₓ [keV]


E(NaI) [keV]

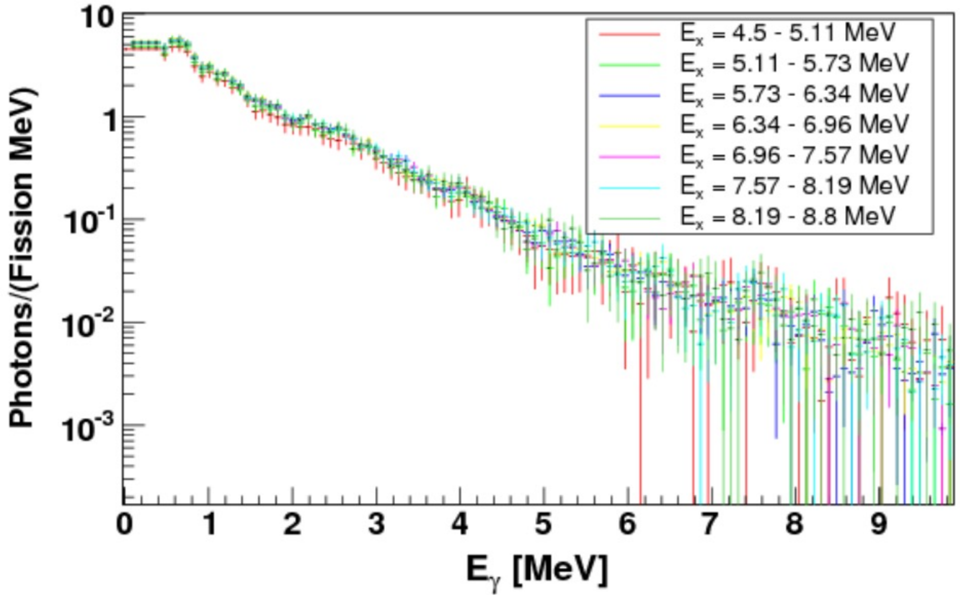
Gated on fission

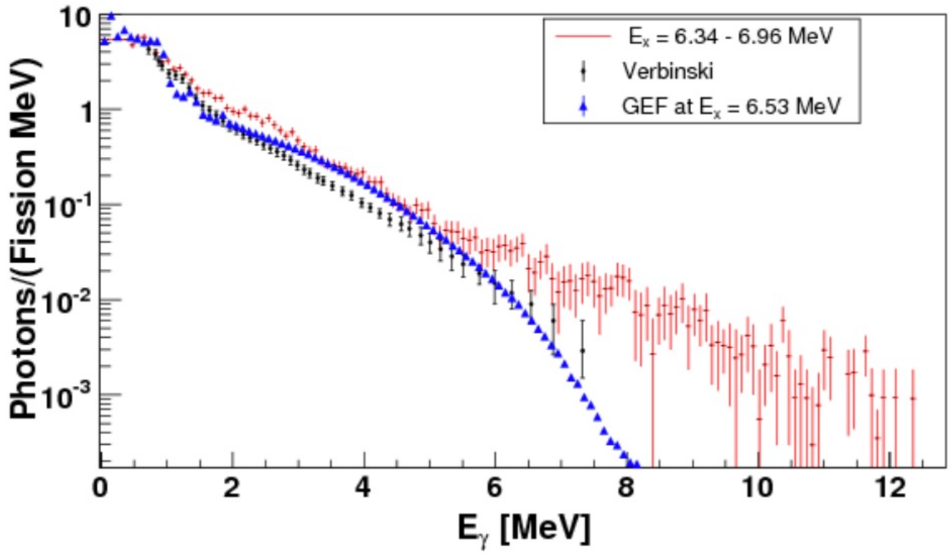


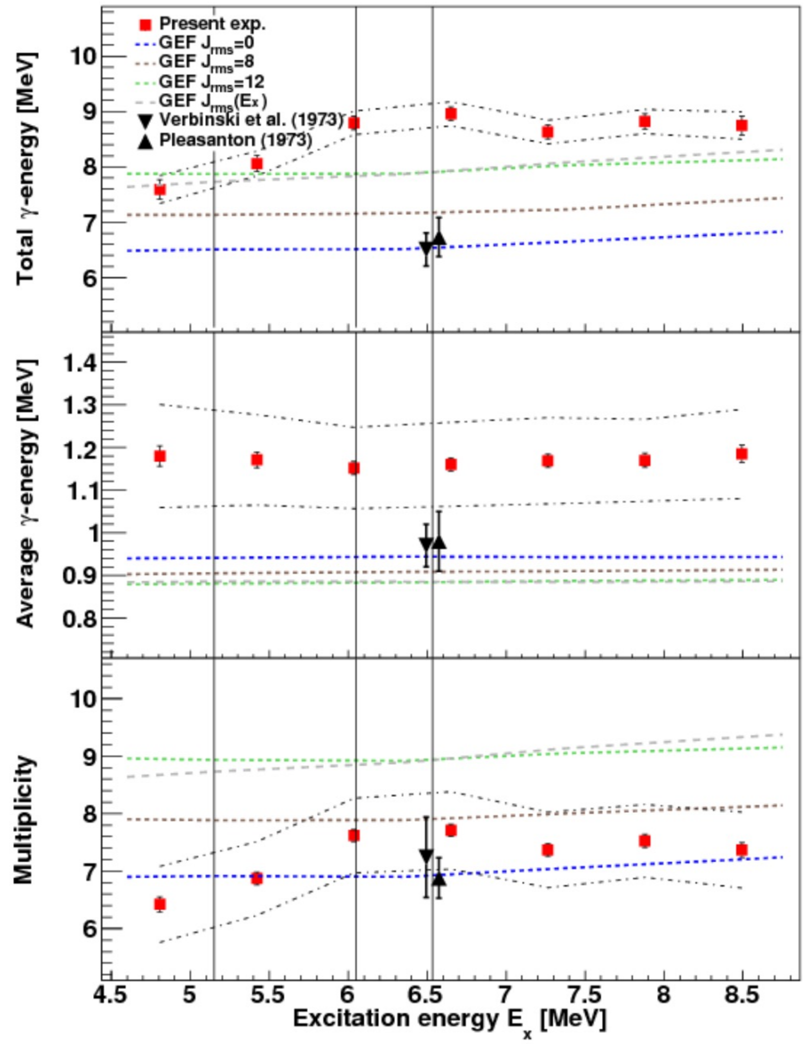




NaI detetors are slow:
Challenge to model the contributions from neutrons in the gamma spectrum





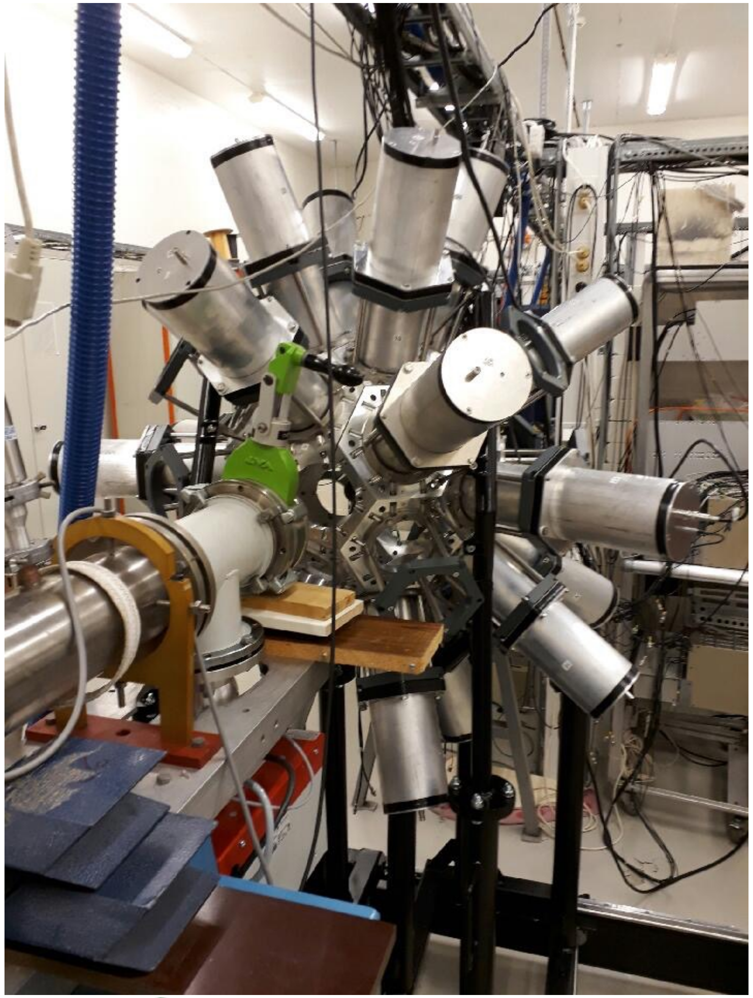


$^{239}Pu(d,pf)$

Blue from n_{th} induced fission

CACTUS replaced with OSCAR

OSCAR
Oslo Scintillator Array



- 30 Large volume (3,5 x 8) $LaBr_3$ detectors
- Better energy resolution
- Better timing
- Possibilities for new types of experiments

OCL
Oslo Cyclotron Laboratory

UNIVERSITAS OSLOENSIS MDCCCXI

Excitation energy dependence of prompt fission γ-ray emission from ^{241}Pu*

D. Gjestvang,[1,*] S. Siem,[1,†] F. Zeiser,[1] J. Randrup,[2] R. Vogt,[3,4] J. N. Wilson,[5] F. Bello-Garrote,[1] L. A. Bernstein,[2,6] D. L. Bleuel,[3] M. Guttormsen,[1] A. Görgen,[1] A. C. Larsen,[1] K. L. Malatji,[7,8] E. F. Matthews,[6] A. Oberstedt,[9] S. Oberstedt,[10] T. Tornyi,[11] G. M. Tveten,[1,‡] and A. S. Voyles[6]

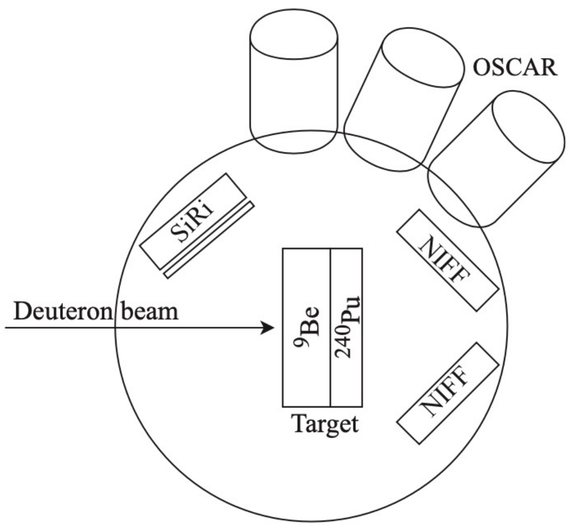


FIG. 1. Experimental setup for detecting PFGs from the ^{240}Pu(d,pf) reaction. Although only three $LaBr_3$ detectors are depicted, 28 were used in the experiment. Two of the four NIFF counters are illustrated. The figure is not to scale.

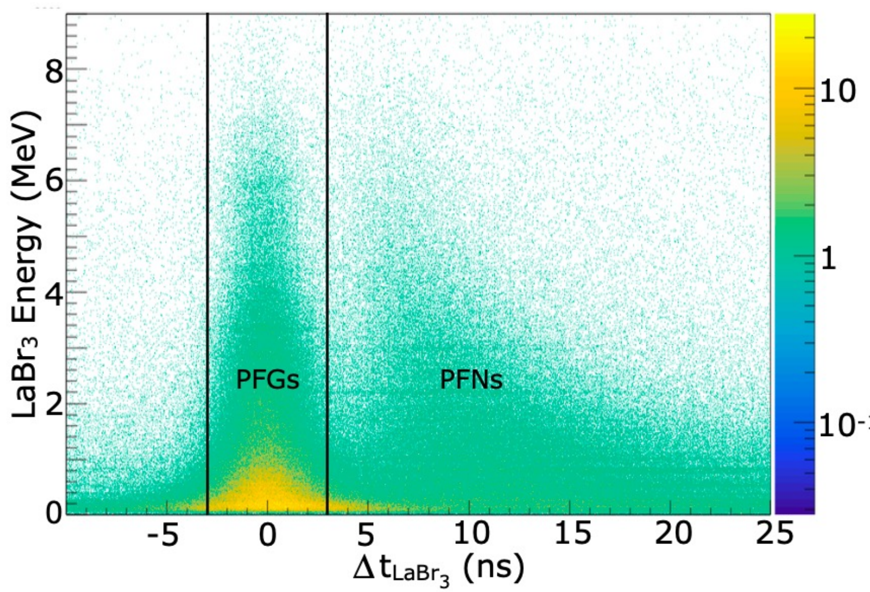
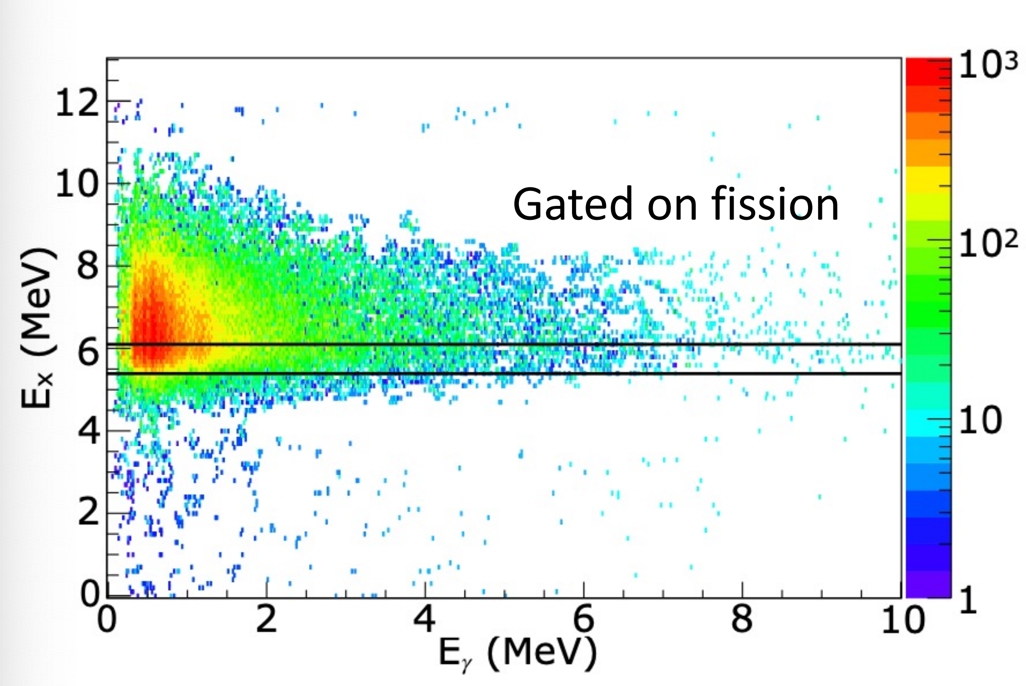


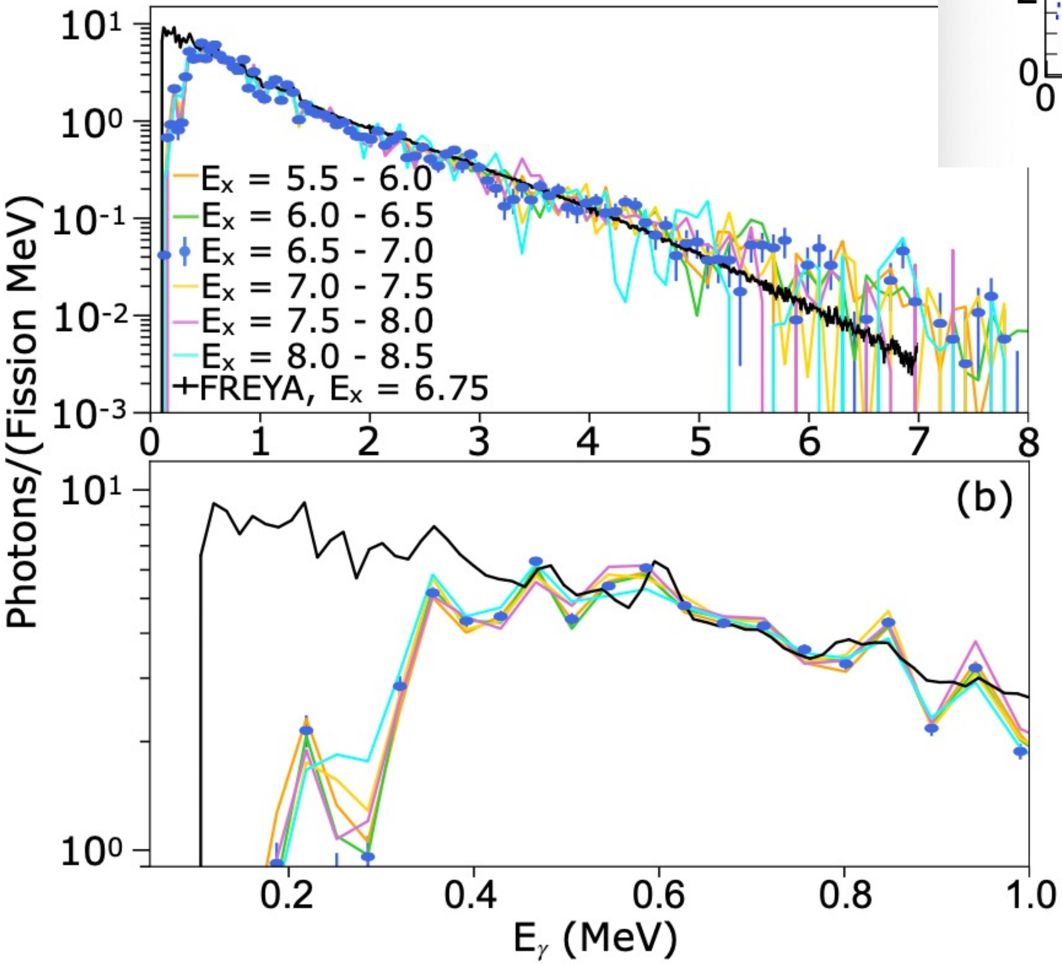
FIG. 2. Fission-gated spectrum showing the time difference Δt_{LaBr_3} between a proton in the ΔE detector and γ rays in OSCAR, plotted against the γ-ray energy detected by the $LaBr_3$. The time gates used to distinguish PFGs from PFNs via ToF are shown in black.

OSCAR distance 20 cm

Prompt fission gamma-rays from ^{240}**Pu(d,pf)** using OSCAR



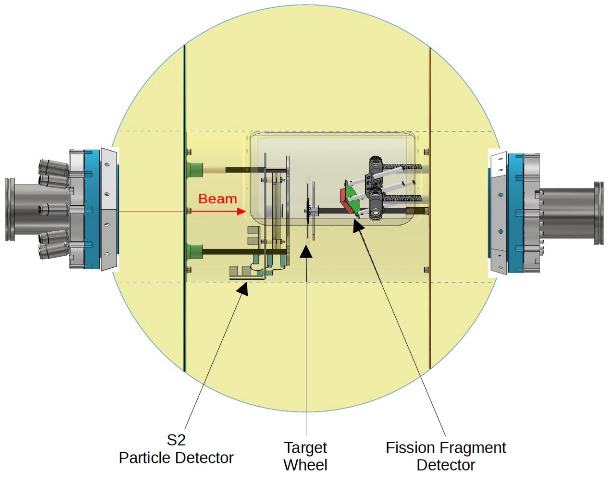
D. Gjestvang et alPRC103, 034609 (2021)



Plan to perform PFG experiment on a nucleus already studied with CACTUS to optain the neutron contribution.
Then we can re-analyse all the Data taken with CACTUS

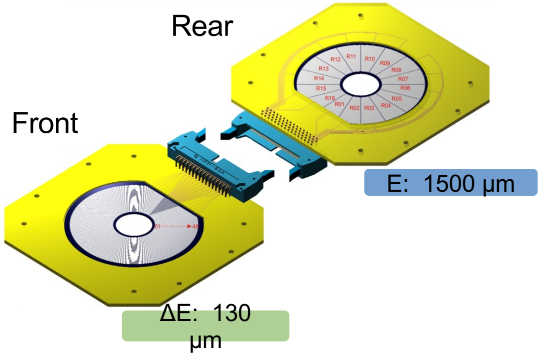
Fission @ OCL : New Developments

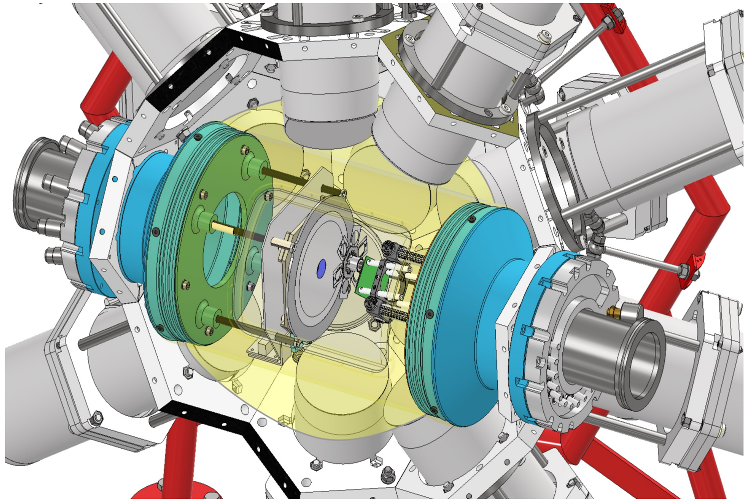
- New fission chamber @ OSCAR



Fission @ OCL : New Developments

- New fission chamber @ OSCAR
  - Particle Detectors: Highly segmented S2 detectors



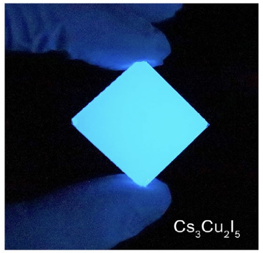


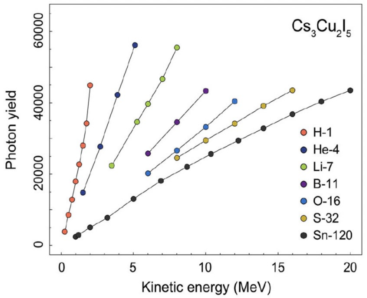
Fission @ OCL : New Developments

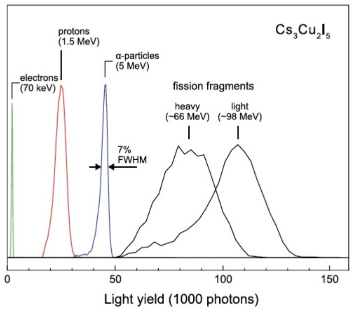
- New fission chamber @ OSCAR

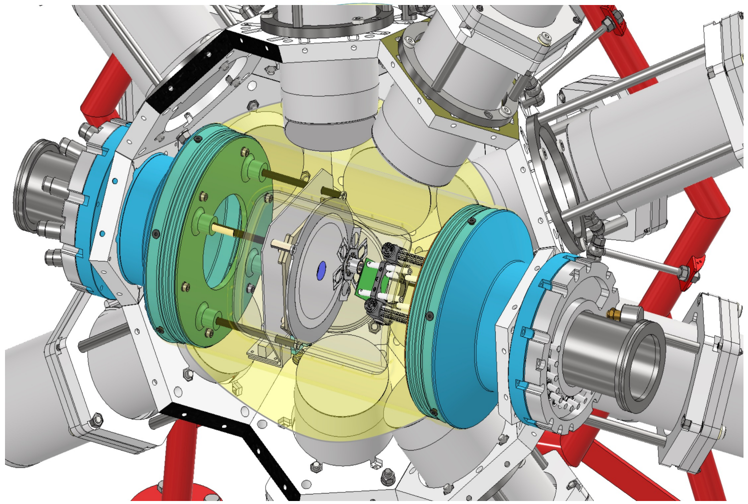
  - ❑ Fission Detectors: Ternary copper halides (TCHs) Scintillators:

Higher Stopping Power, Faster Timing Response, Compact & Mechanical Simplicity, Good Radiation Hardness, Less Sensitive to Thermal Noise



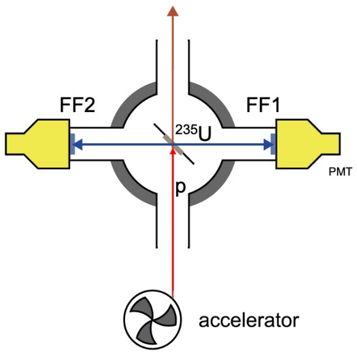


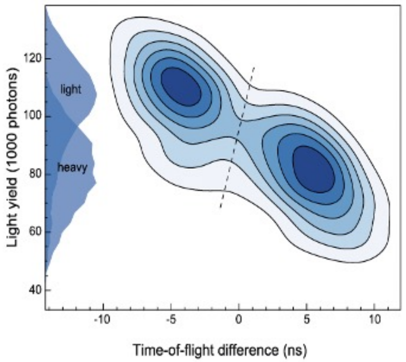




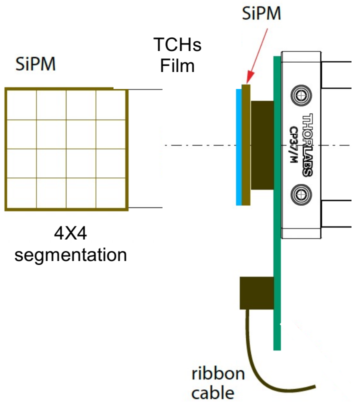
M. Hunyadi et al., Adv. Photonics Res. 2025, 2400217; Adv. Funct. Mater. 2022, 32, 2206645

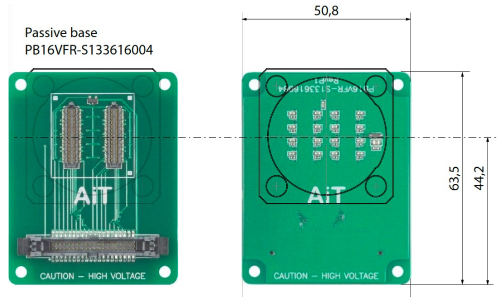
PMT based setup for fission fragments





Upgraded SiPM based setup: Scheduled to be test in beam experiment in June-2026 at Institute for Nuclear Research (Atomki), Debrecen, Hungary





16 Channel Active Base Readout

Summary

We have a very good experimental setup in Oslo,
With OSCAR for gamma and SiRi for charged particles
And soon a new better fission detector.

Plan to measure more Prompt fission gammas (PFG)
Now distinguishing neutrons and gammas.
And compare (p,p´f) and (a,a´f) on same targets
to see if spin of fissioning nucleus has an effect on PFG

And hope to discuss other possible experiments with you during this workshop

Thank you for your attention!

FISSION 2026

Main collaborators preparing for:

NUKLEÆRSENTERET

Future fission experiments at the Oslo Cyclotron laboratory.

S. Siem [1,2], A. Al-Adili [3], L.Csige [4], A. Görgen [1,2], H. Haug [1,2], J. Heines [1,2], M.Hunyadi [4], V. W. Ingeberg [1,2], N. Kumar [1,2],, M. Torsvoll [1,2], G. Torvund [1,2], J. Wilson [5]

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atomki DEBRECEN

IJCLab Irène Joliot-Curie Laboratoire de Physique des 2 Infinis

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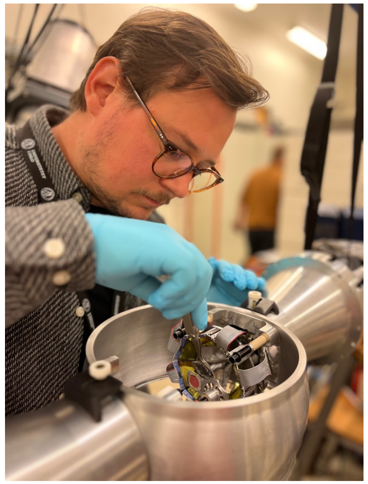
UiO



V.Ingeberg