DE LA RECHERCHE À L'INDUSTRIE

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Preliminary results on prompt fission neutron energy spectra measurements for ^{238}U(n,f)

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Outline

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- Important role in many applications
  - understanding of the fission process
  - accuracy of nuclear criticality calculations (conventional and advanced reactors, non-proliferation applications)

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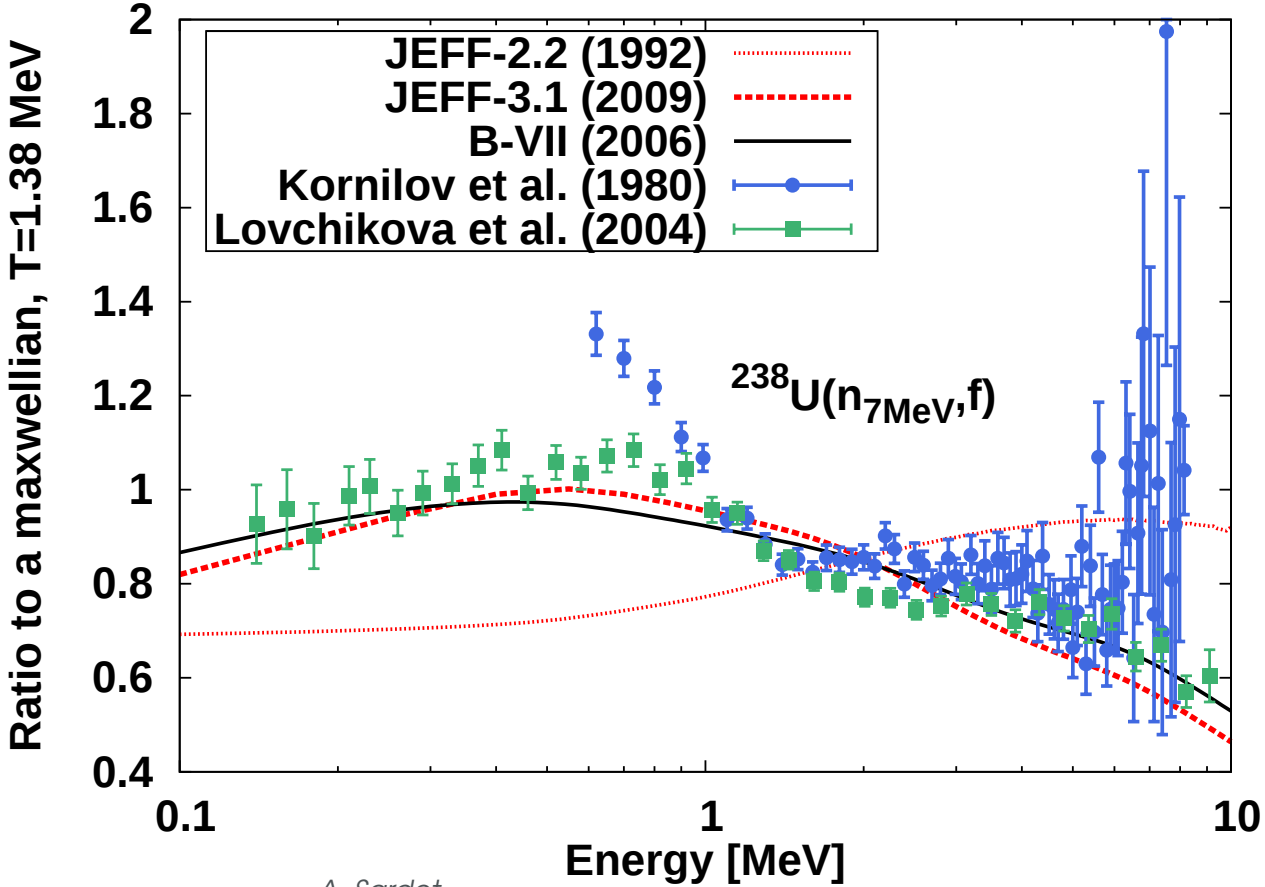
- Few experimental data sets (EXFOR) → sometimes in disagreement to some extent
- Discrepancies between measured PFNS and evaluations



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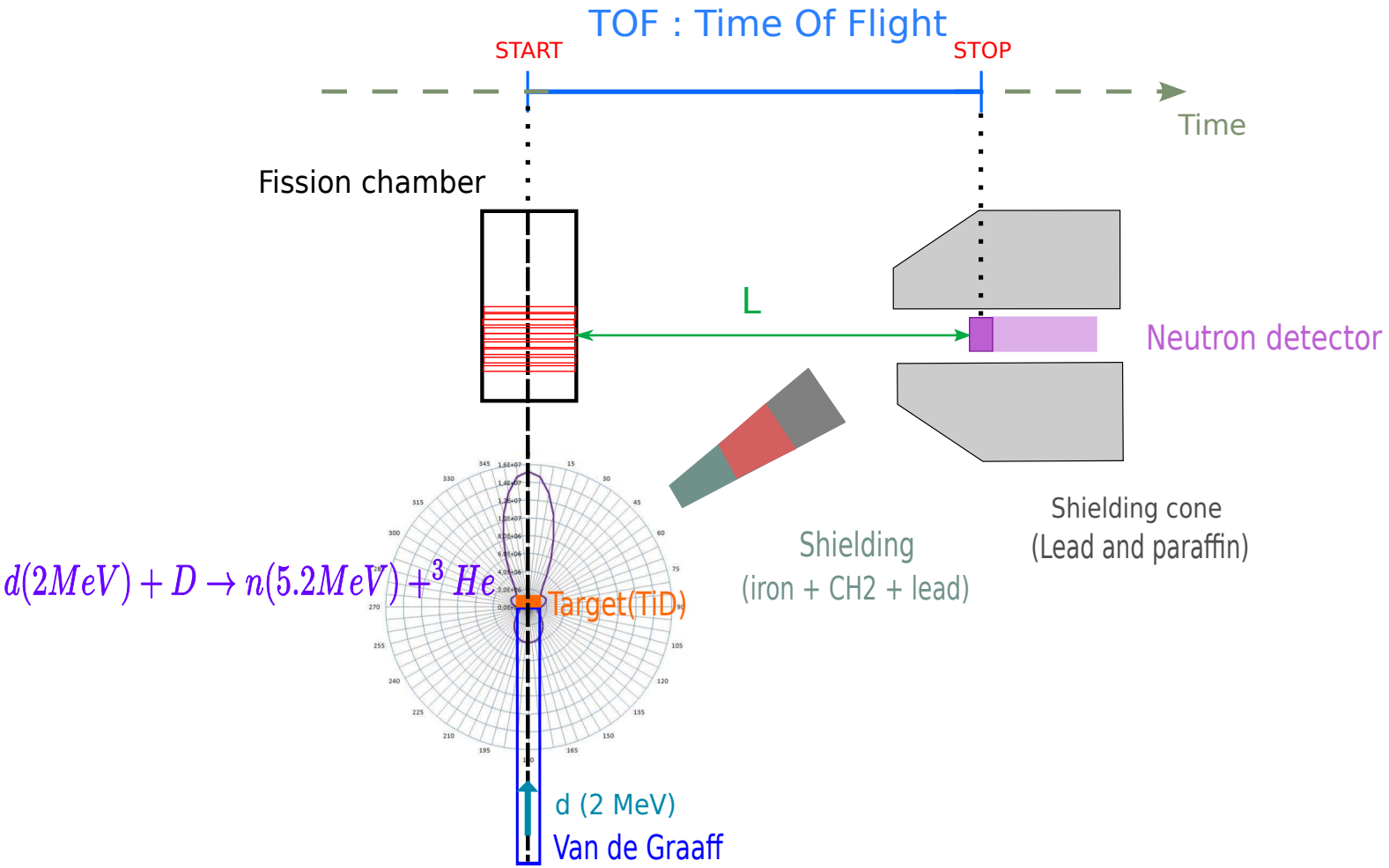
- Theoretical description of prompt fission neutron energy spectra (PFNS) difficult
- Few experimental data sets (EXFOR) $\rightarrow$ sometimes in disagreement to some extent
- Discrepancies between measured PFNS and evaluations
- 2009 : International program aiming at improving the adequacy and the quality of PFNS launched by the IAEA $\rightarrow$ *(INDC(NDS)-0541)*

Outline

Experimental setup



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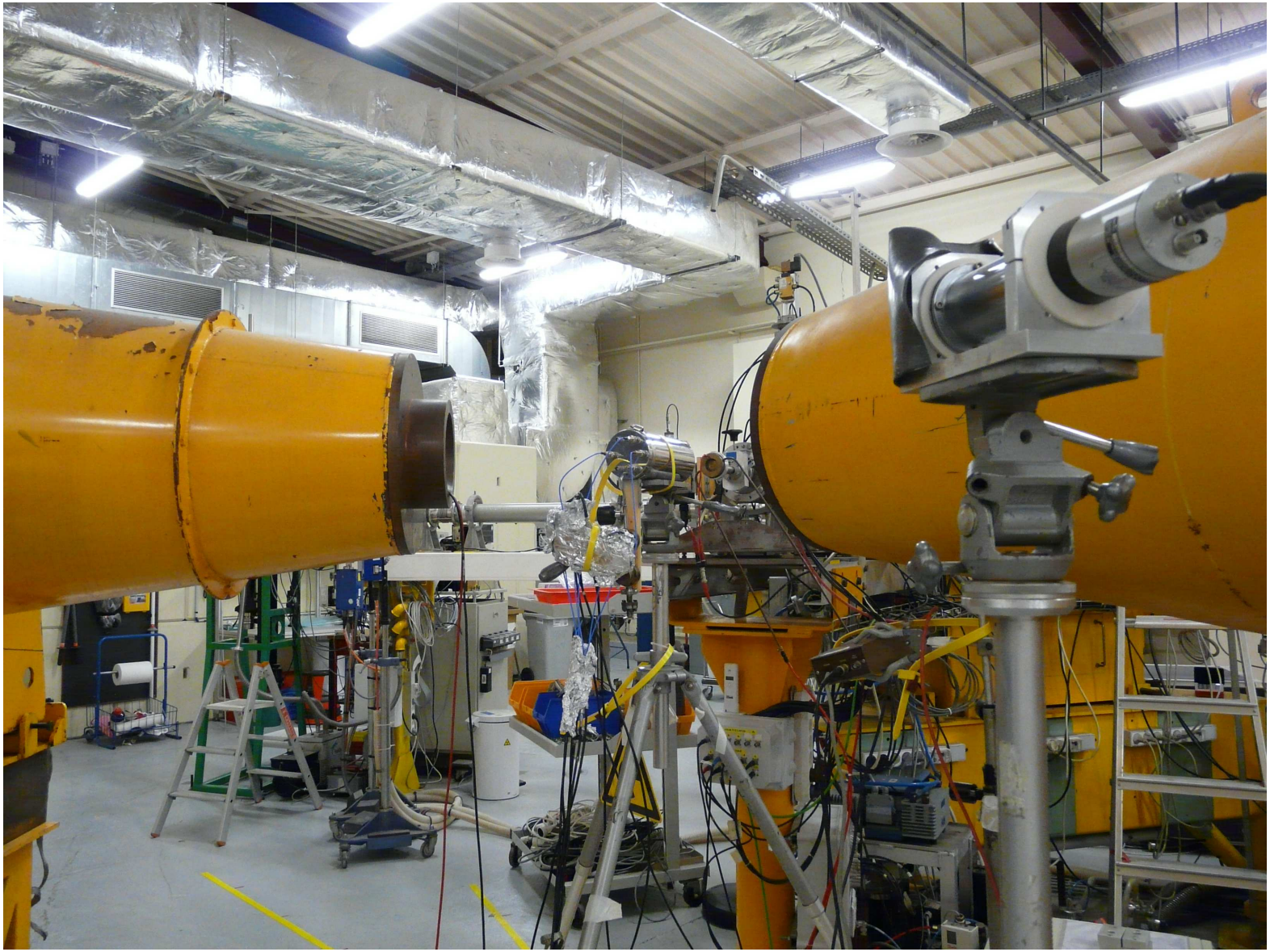
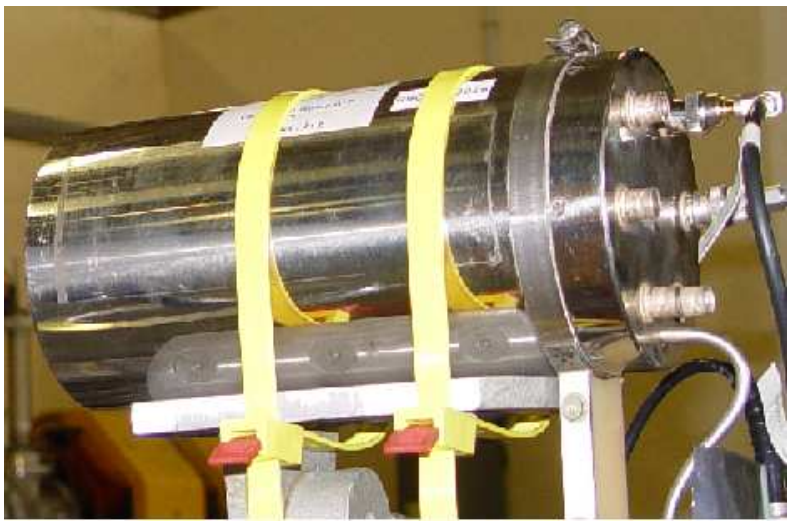
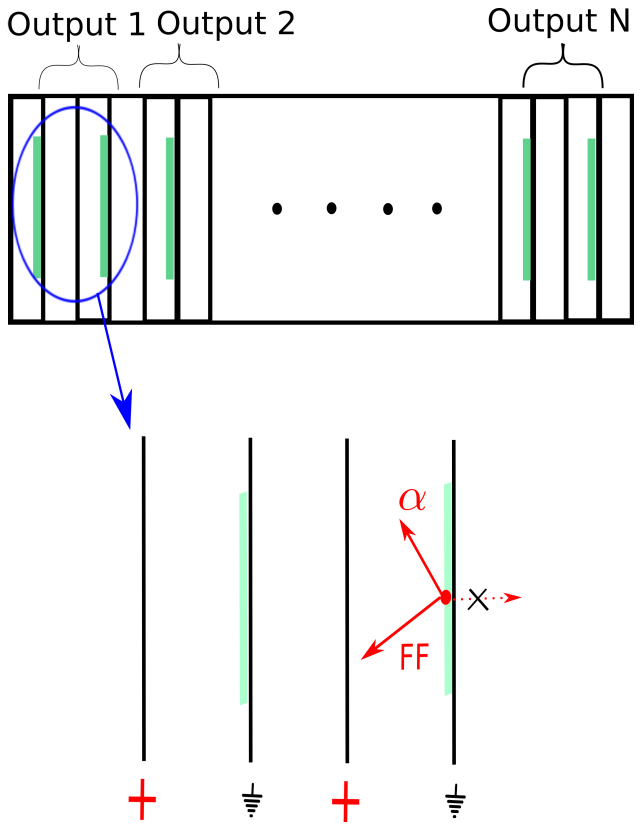


Fission chamber

- Cylinder containing electrodes on which the actinides are deposited
- Ionization gas : P20 (20% methane and 80% argon)





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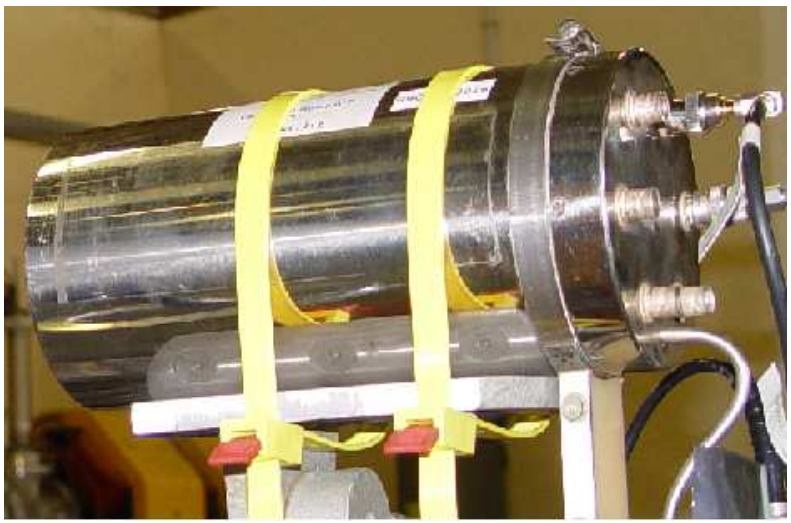
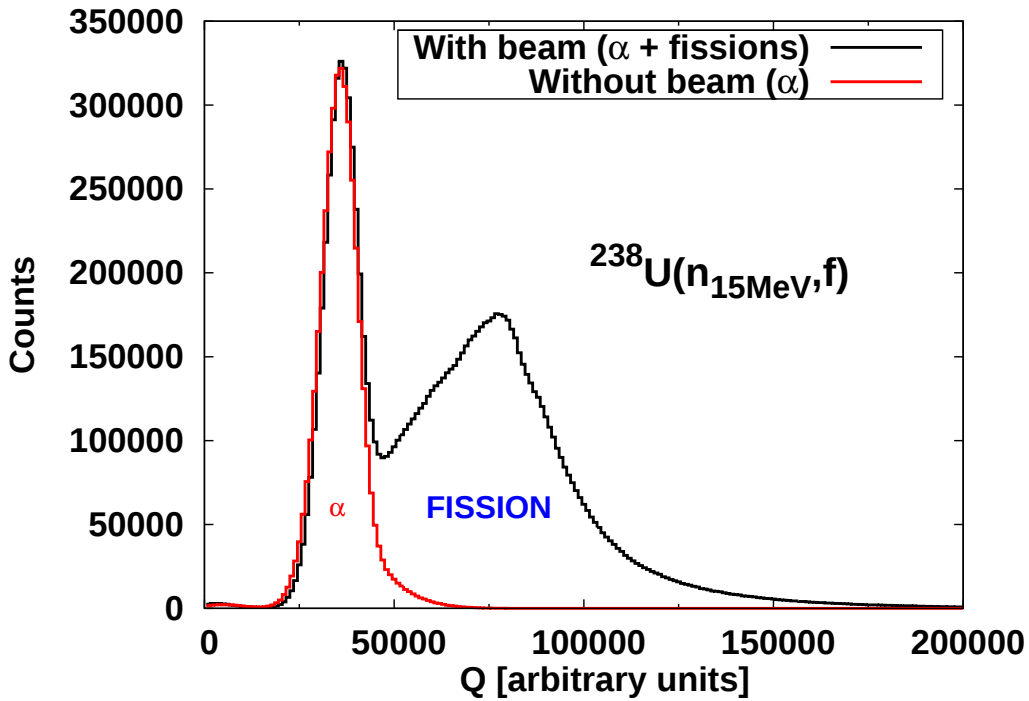
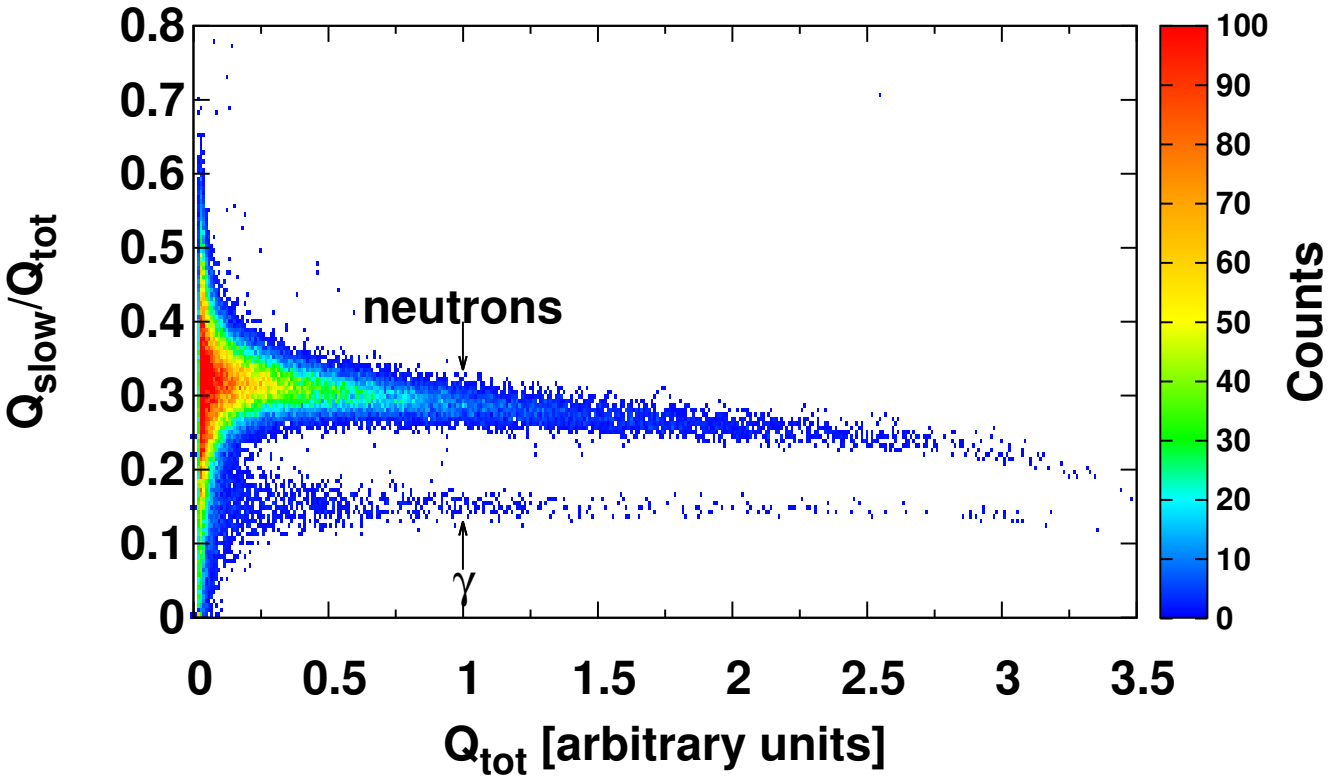




Fission source (START signal)

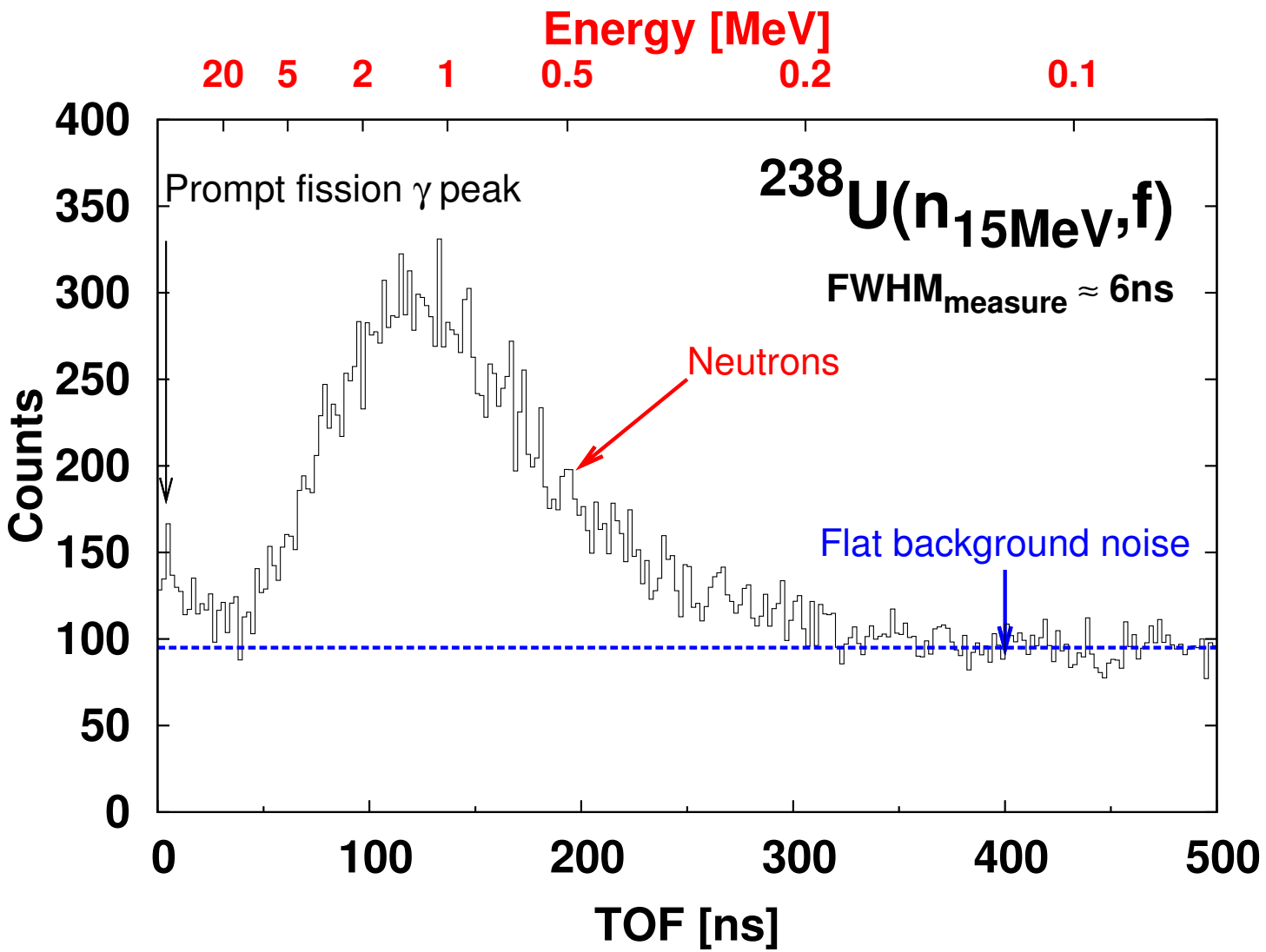
Neutron detectors

- Organic scintillators coupled to photomultipliers
- Excellent n-γ discriminations properties
- Detection in the low energy domain $\rightarrow$ threshold down to about 250 keV



STOP signal

Example of a TOF spectrum for ^{238}U(n,f) at 5.2 MeV



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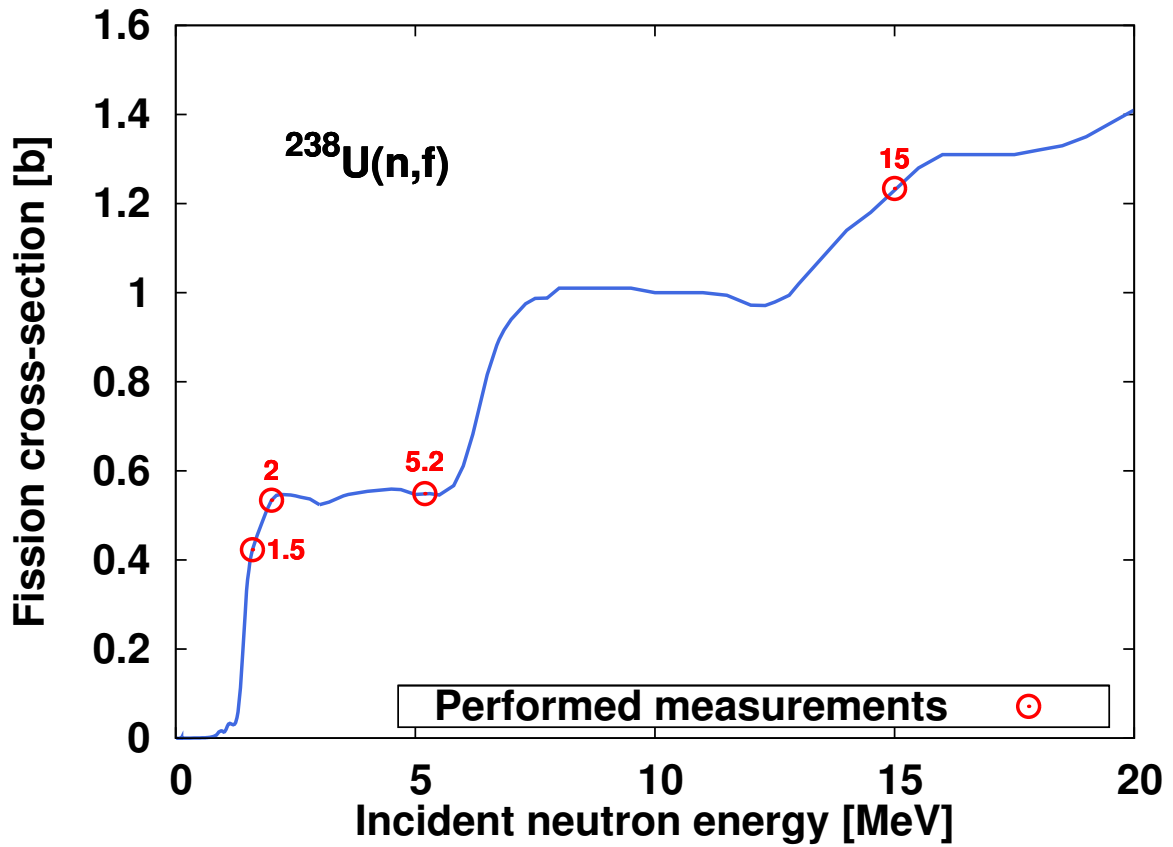
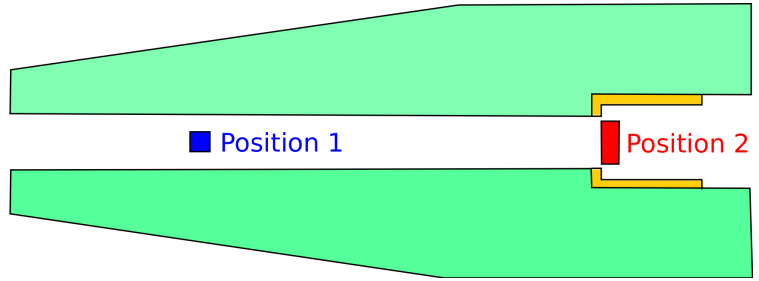
PFNS measurement campaigns on ^{238}U(n,f)

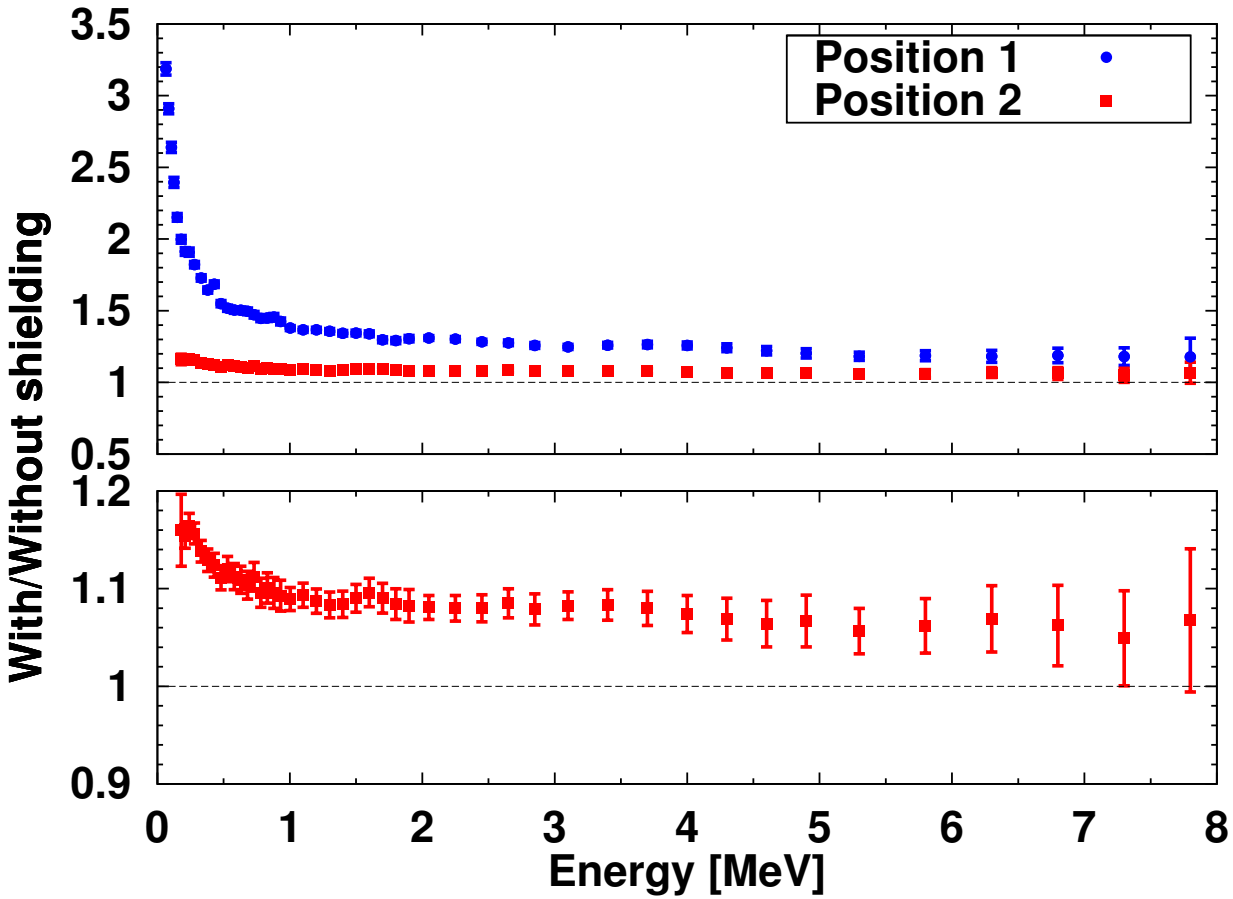
- 4 MV Van de Graaff accelerator of the CEA - Bruyères-le-Châtel
- Several setup configurations



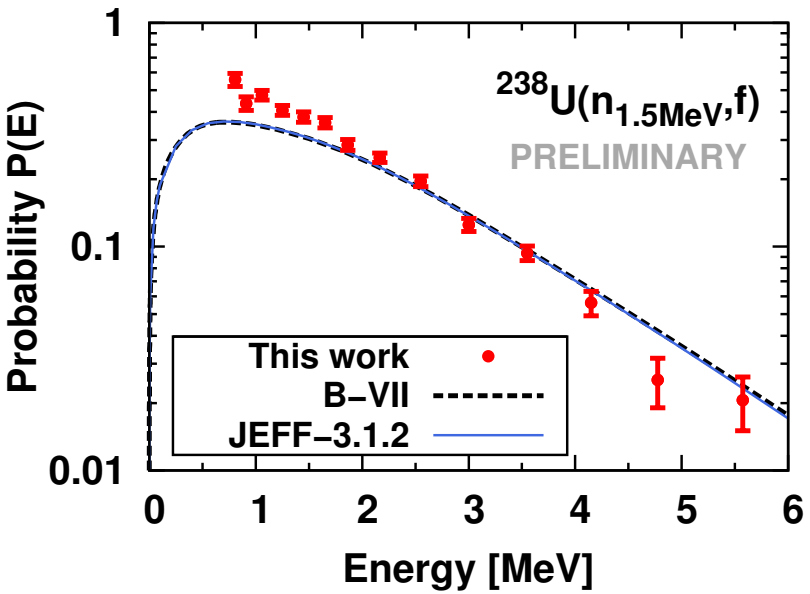
Effect of the shielding

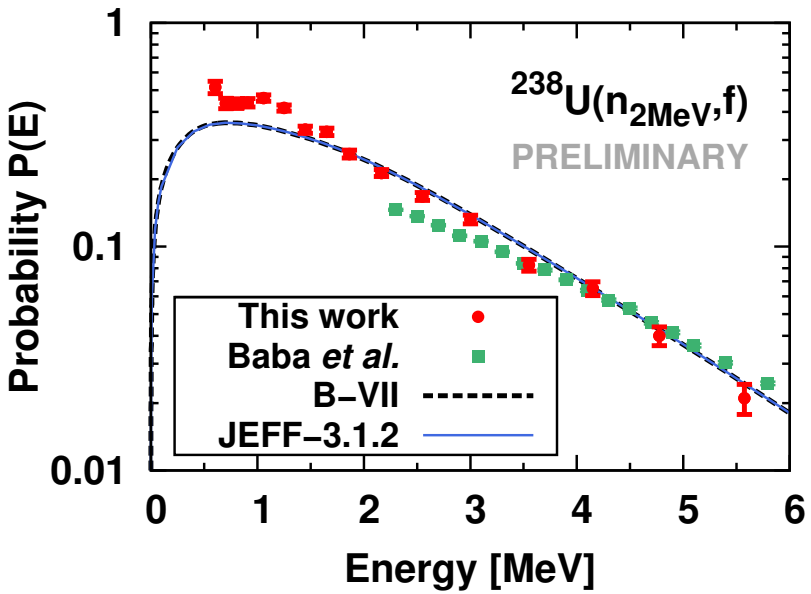
- MCNPX simulations using a fission spectrum

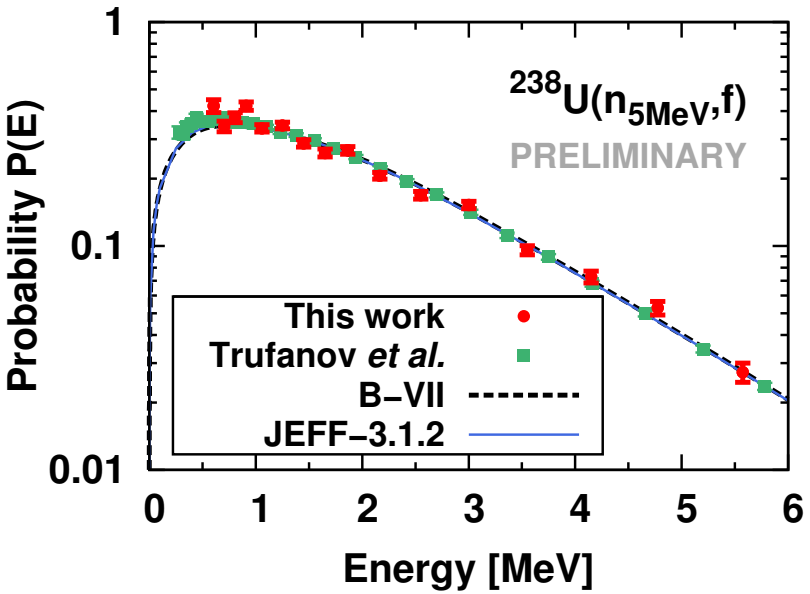


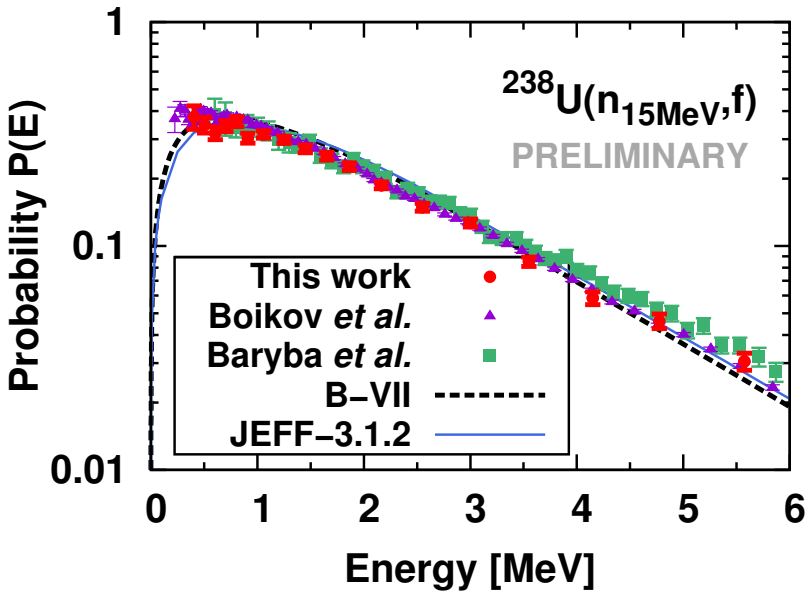


Preliminary PFNS for ^{238}U(n,f)









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Conclusion

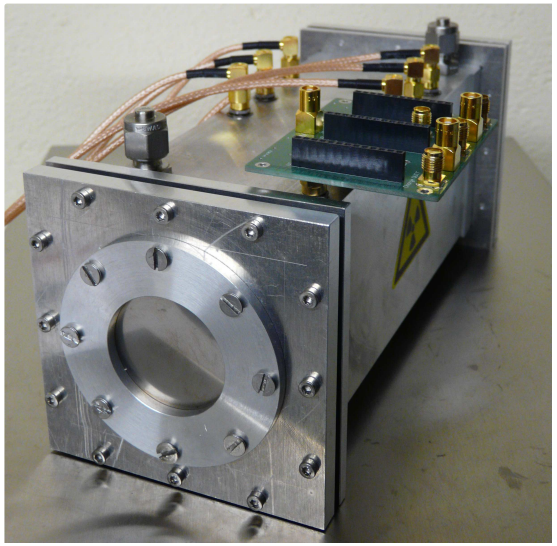
- Establishment of the optimum configuration for an open geometry
- ^{238}U(n,f) PFNS
  - Very encouraging results for all incident neutron energies
  - Simulations showed an important distortion that needs to be corrected for
  - Limited statistics

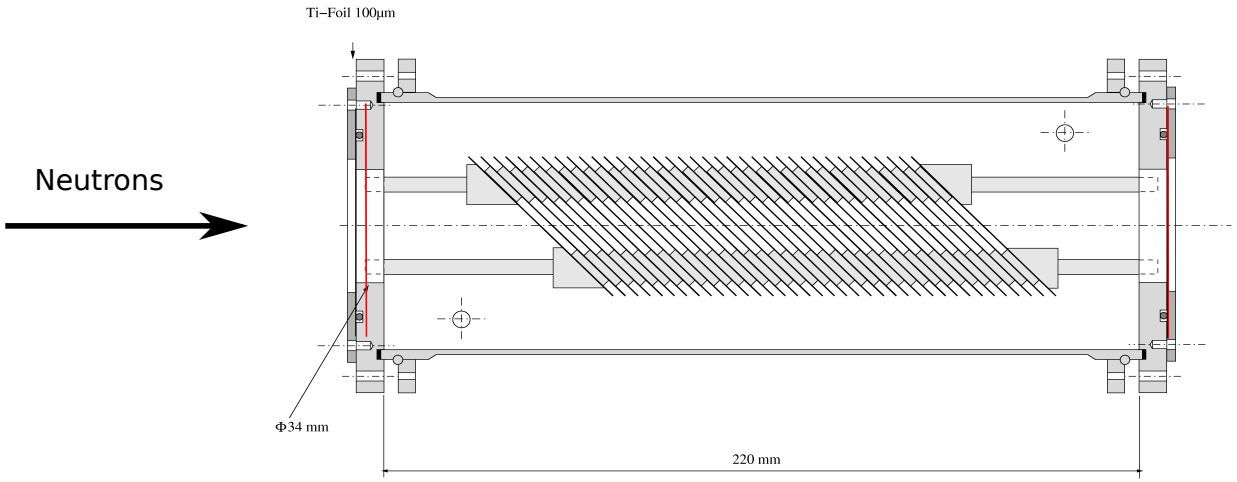
$\Rightarrow$ Strong limitations coming from the fission chamber (α-fission discrimination, timing resolution, scattering on the body and the electrodes)

Outline

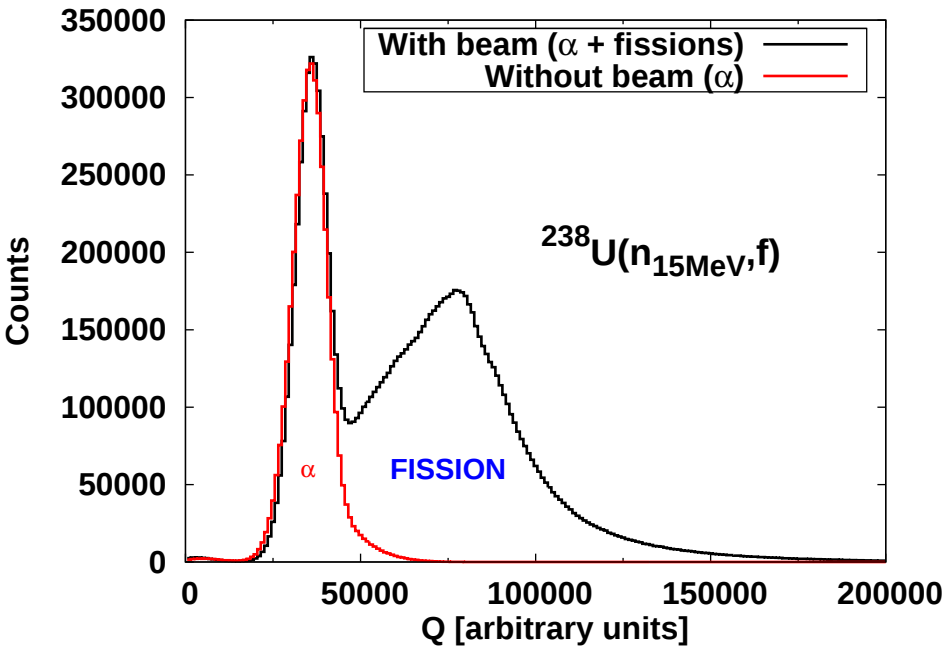
New fission chambers : requirements

- Low amount of matter in the beam line to reduce scattering
- Complete α-fission discrimination
- Improved timing resolution
- Optimisation of the $\frac{\text{signal}}{\text{noise}}$





α-fission discrimination performances



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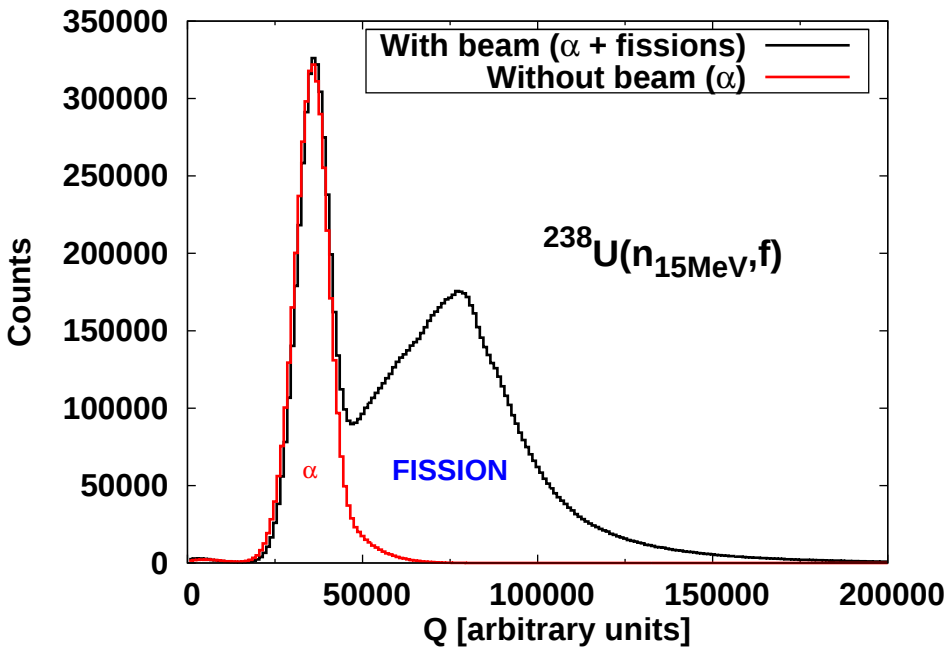
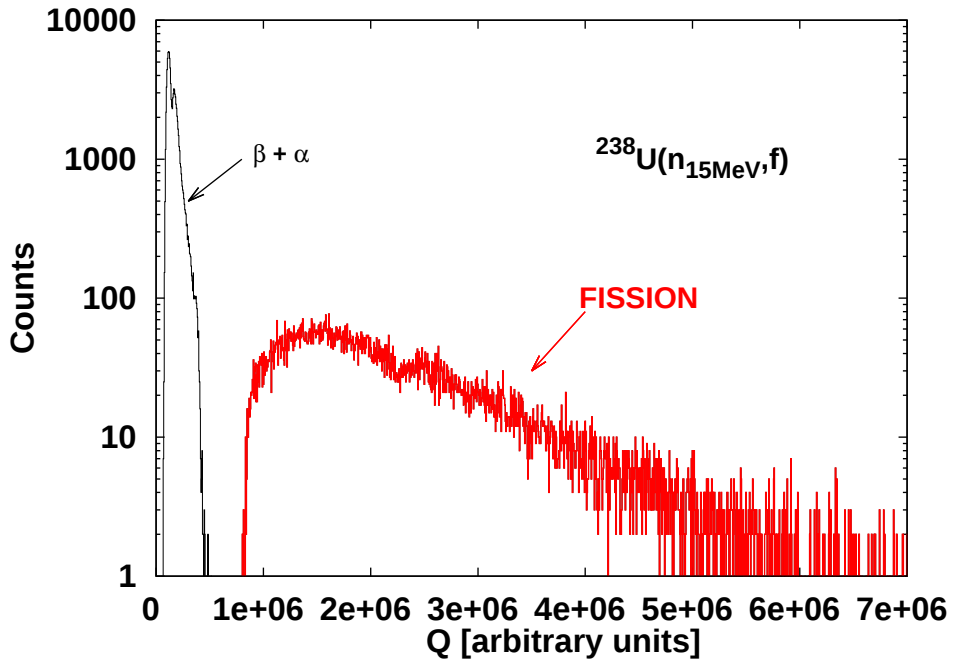
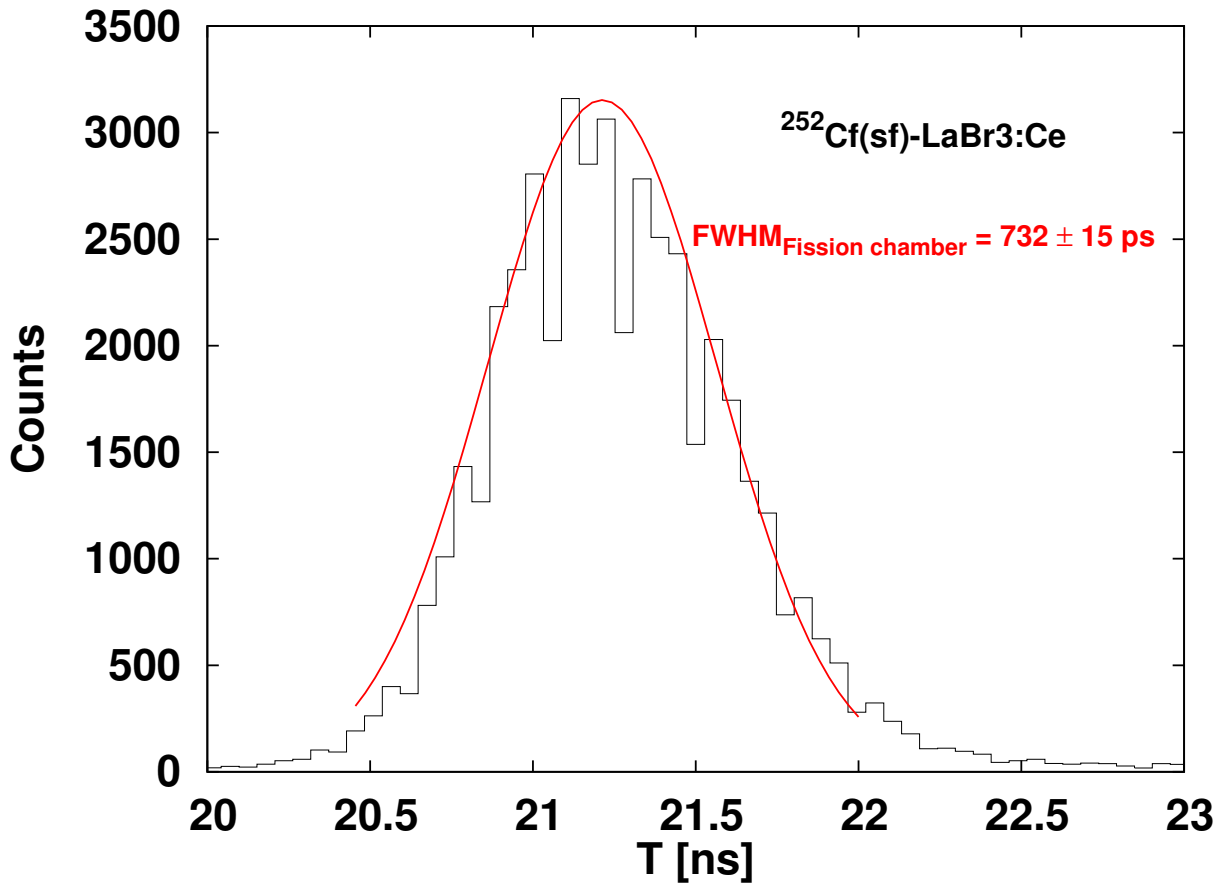




$\Rightarrow$ Complete α-fission discrimination

Timing performances

- Excellent timing resolution $\rightarrow$ $\mathrm{FWHM}_{\mathrm{Fission\ chamber}}$ = 0.73 $\pm$ 0.01 ns (previously : 6 ns)



What to do to have more precise measurements ?

- Use of new optimized fission chambers
  - ✓ Low amount of matter (body and electrodes)
  - ✓ Complete α-fission discrimination
  - ✓ Excellent timing resolution

    BUT small quantities of actinide (between 100 and 300 mg)

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    BUT small quantities of actinide (between 100 and 300 mg)

- Need for high neutron fluxes
- Collimated neutron beam :
  - no need for shielding
  - increase the number of neutron detectors

} WNR ($\chi - \nu$), NFS, LICORNE, ...