Profiling of the nTOF beam with the GEM detector

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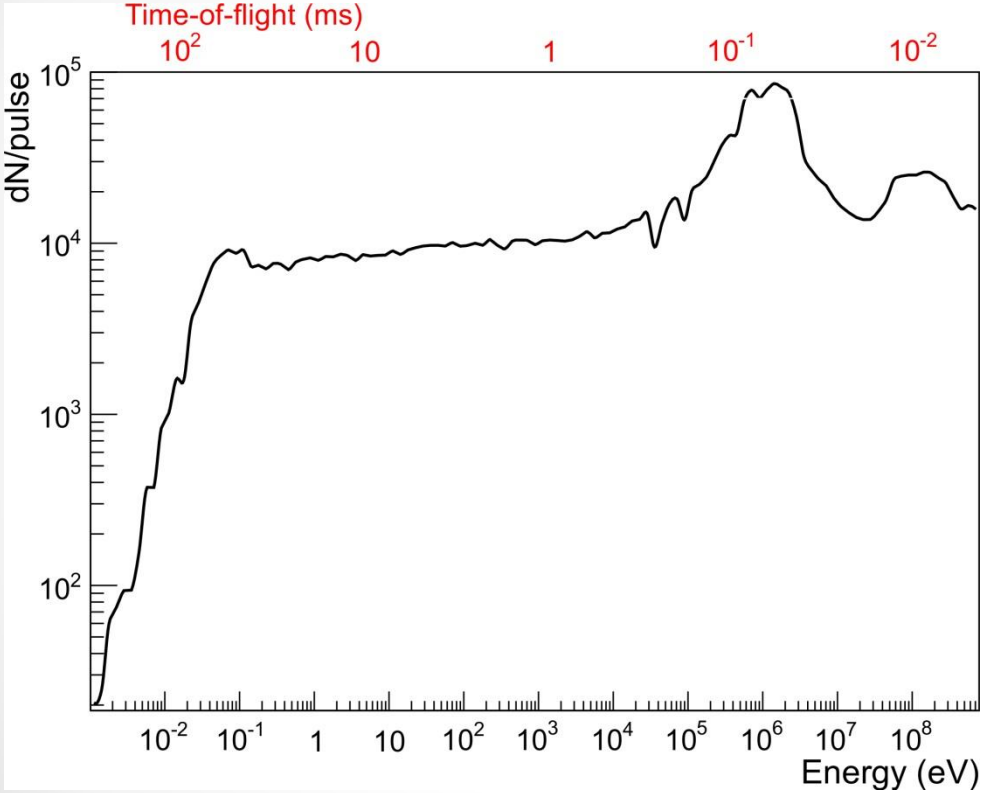
Workshop on Neutron Detection with MPGDs
17.03.15

Outline

- Beam profile at EAR1 of nTOF with side-on detector
- Beam profile at the Beam dump with 2 head-on detectors
- Total energy spectrum measurement
- Saturation effects
- GEM for neutron spectrometry

The nTOF spectrum at EAR1 (185 m) and the Beam dump (200 m)



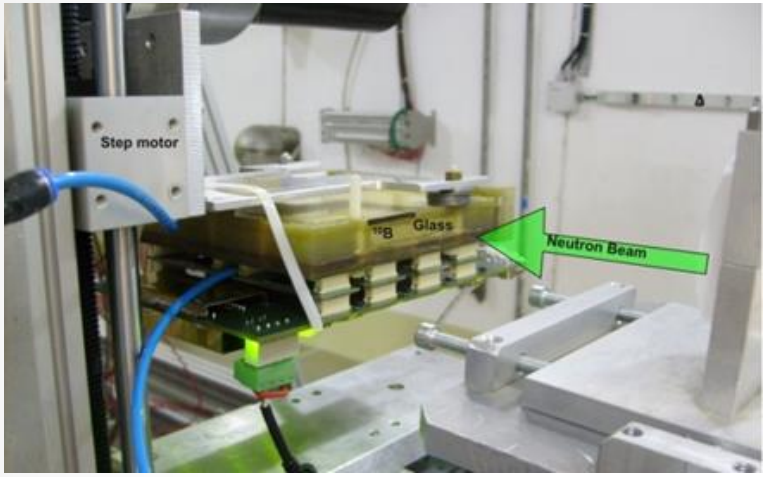
- 20 GeV/c protons on lead target
- 200 m flight path
- meV – GeV energy range
- 700 ns – 200 ms time-of-flight

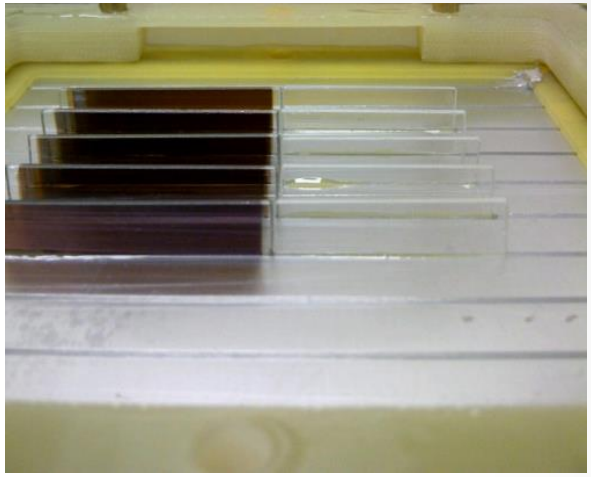
Beam profile and energy spectrum measured with 3 Triple GEM

Measurements @ EAR1

Slow neutrons

Side-on detector





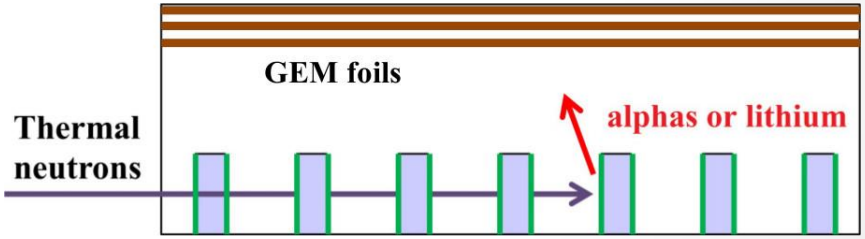
Side-on triple GEM detector*

^{10}B sheets (300 nm on both sides)

5 x 5 cm^2 active area

3 x 6 mm^2 pads (128)

Ar/CO_2 (70/30)



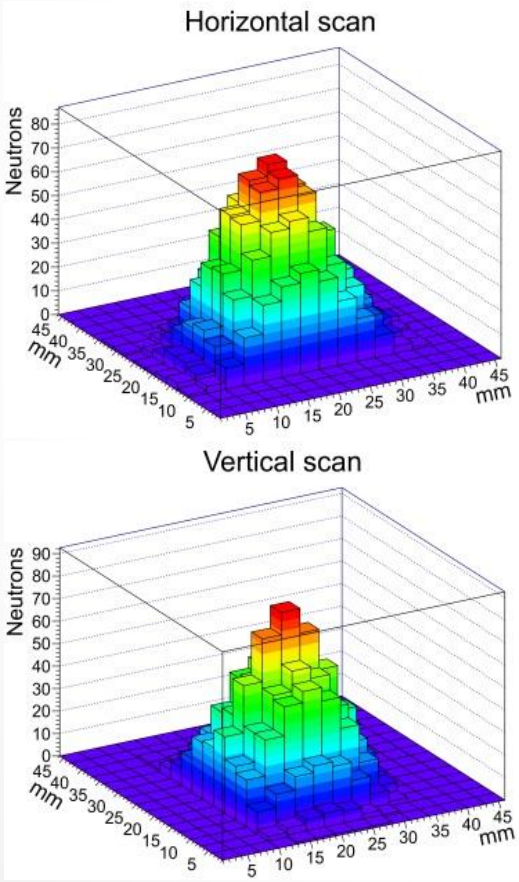
* Simulated by L. Quintieri
Boron deposition by A. Pietropaolo
(see previous presentations)

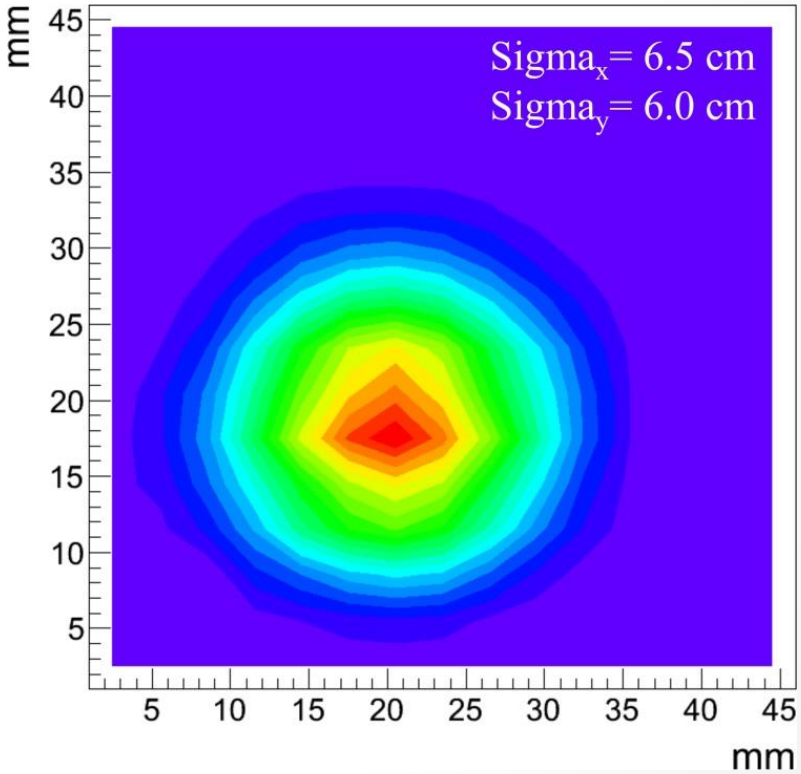
Measurements @ EAR1

Slow neutrons

Side-on detector

Horizontal and vertical scans (3 mm step) to measure the beam spot





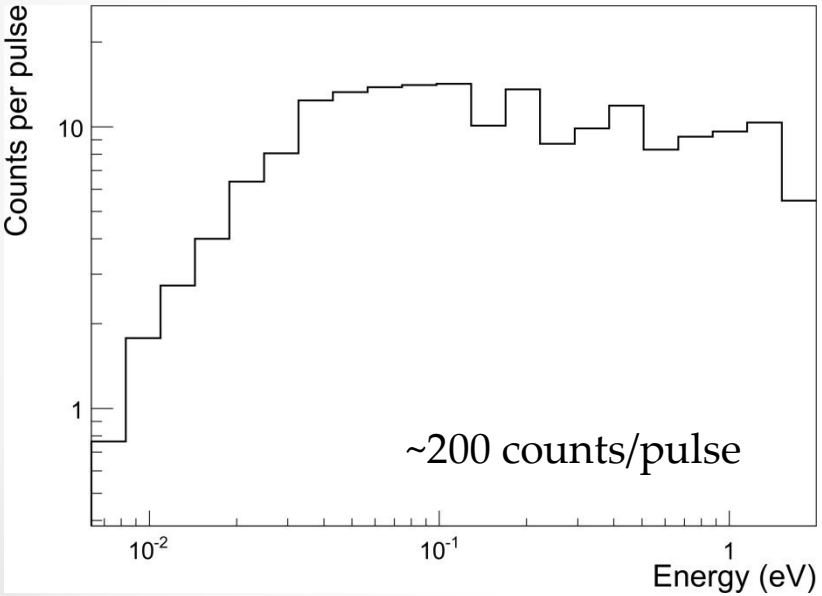
3 mm resolution

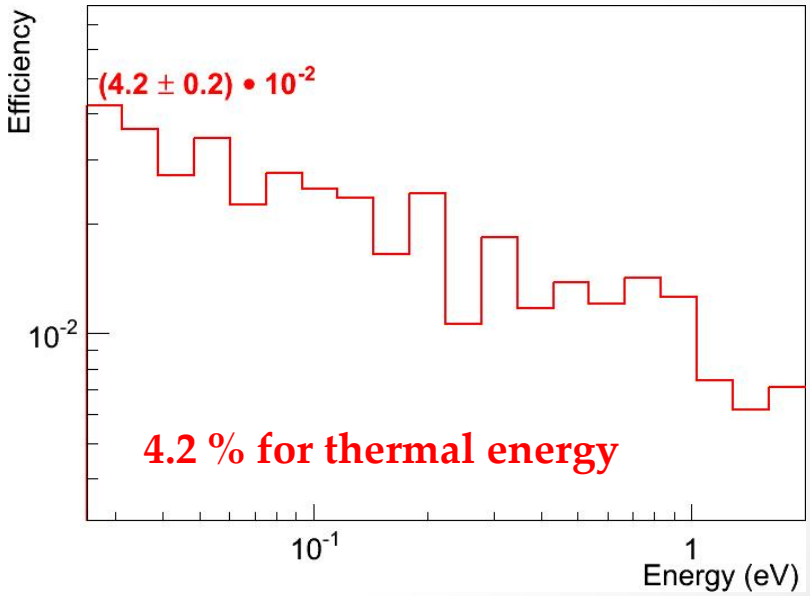
Measurements @ EAR1

Slow neutrons

Energy spectrum & efficiency

Measured from time-of-flight, externally triggered FPGA
Data acquisition organised in slices – 200 slices of 1 ms – 2 eV to thermal
Mean proton intensity 6.5 x 10^{12} per pulse



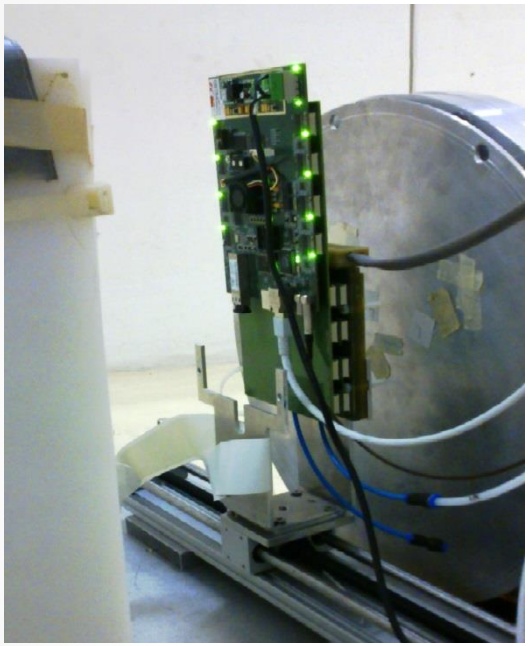


Estimated spectrum provided by the nTOF Collaboration

Measurements @ Beam Dump

Head-on detectors

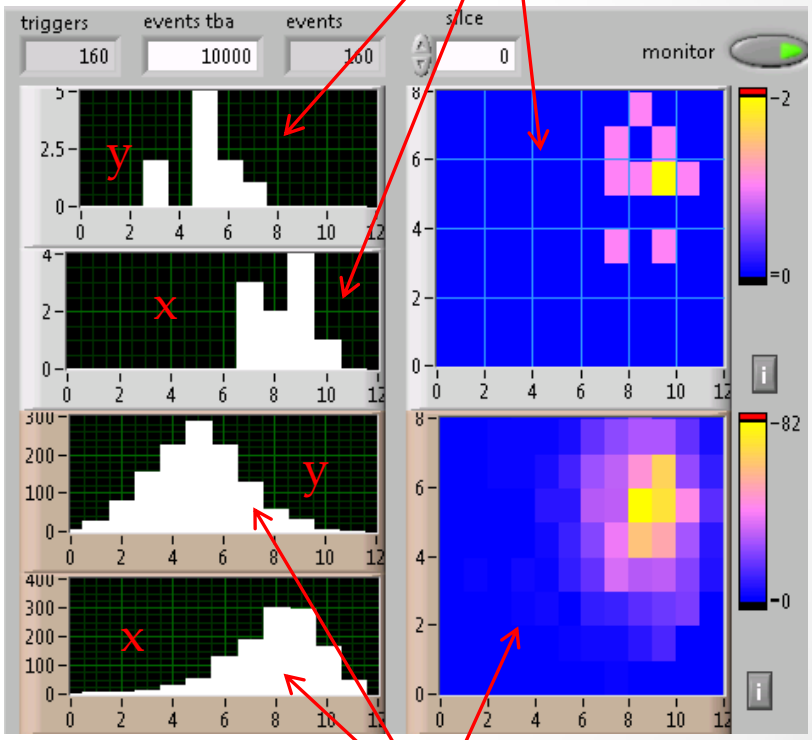
Beam profile



2 Head-on triple GEM detectors
B_4C (1 μm) and PE (60 μm)
10 x 10 cm^2 active area
8 x 8 mm^2 pads (128)
Ar/CO_2 (70/30)

Online beam profile

Instantaneous counts



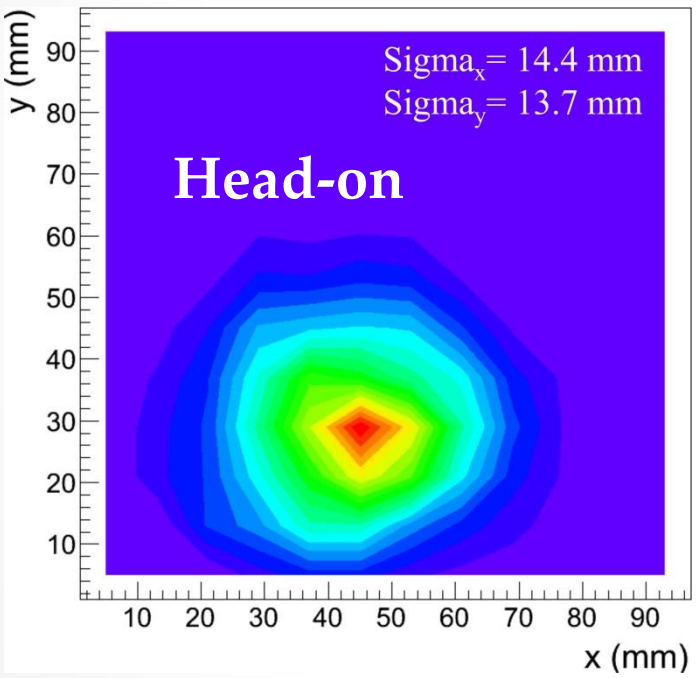
Accumulated counts

Measurements @ Beam Dump

Slow neutrons

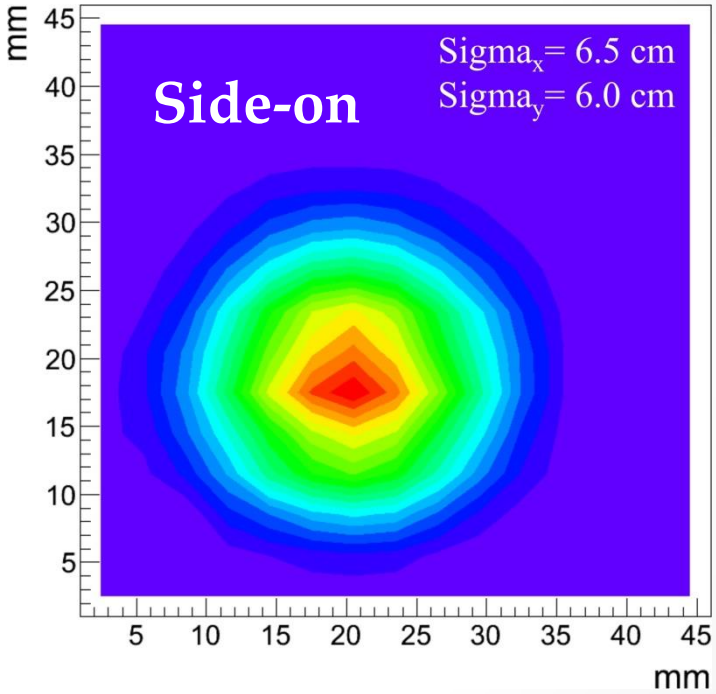
Beam profile

Dump (200 m), B_4C detector



Sigma X = 14.4 mm
Sigma Y = 13.7 mm
8 mm resolution

EAR1 (185 m), ^{10}B detector



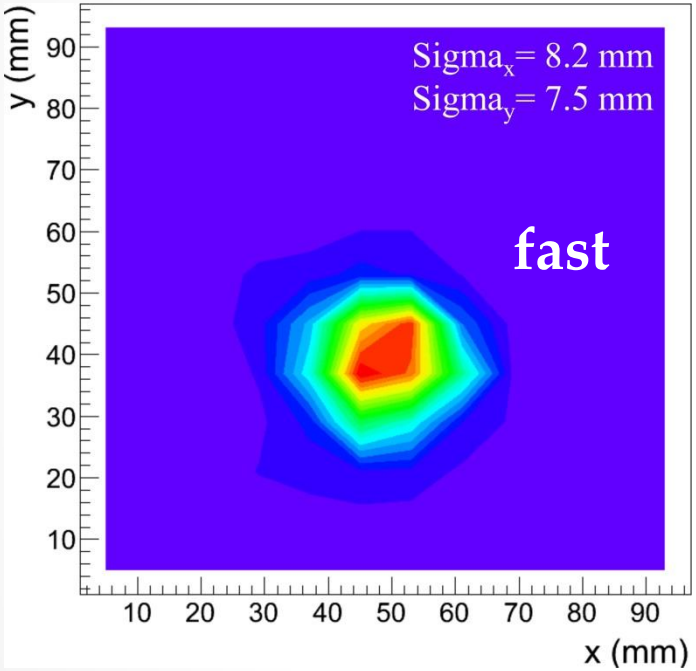
Sigma X = 6.5 mm
Sigma Y = 6.0 mm
3 mm resolution

Measurements @ Beam Dump

Fast neutrons

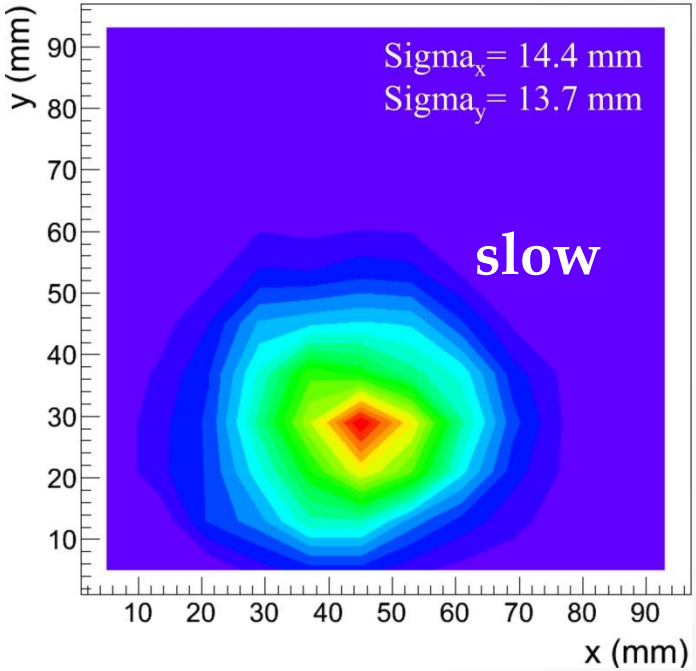
Beam profile

Dump (200 m), PE detector



Sigma X = 8.2 mm
Sigma Y = 7.5 mm
8 mm resolution

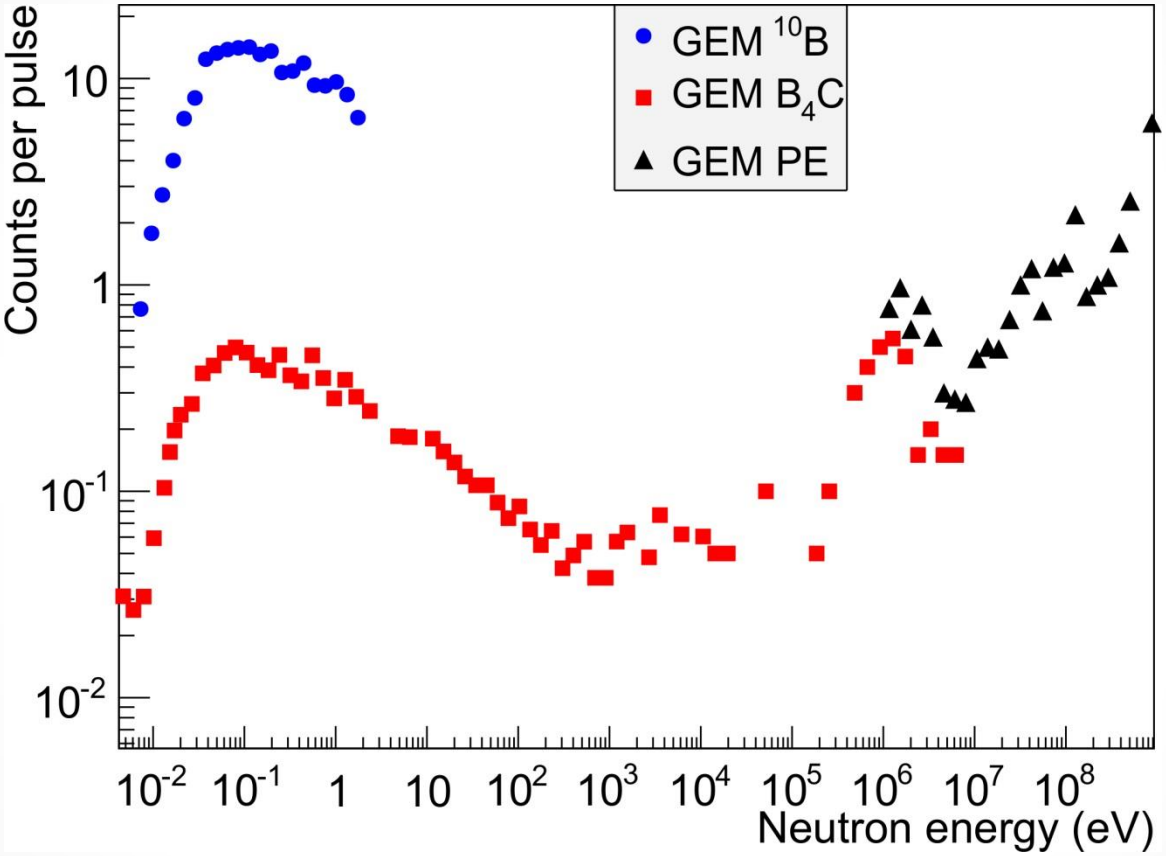
Dump (200 m), B_4C detector



Sigma X = 14.4 mm
Sigma Y = 13.7 mm
8 mm resolution

Measurements @ Beam Dump and EAR1

Total energy spectrum measured



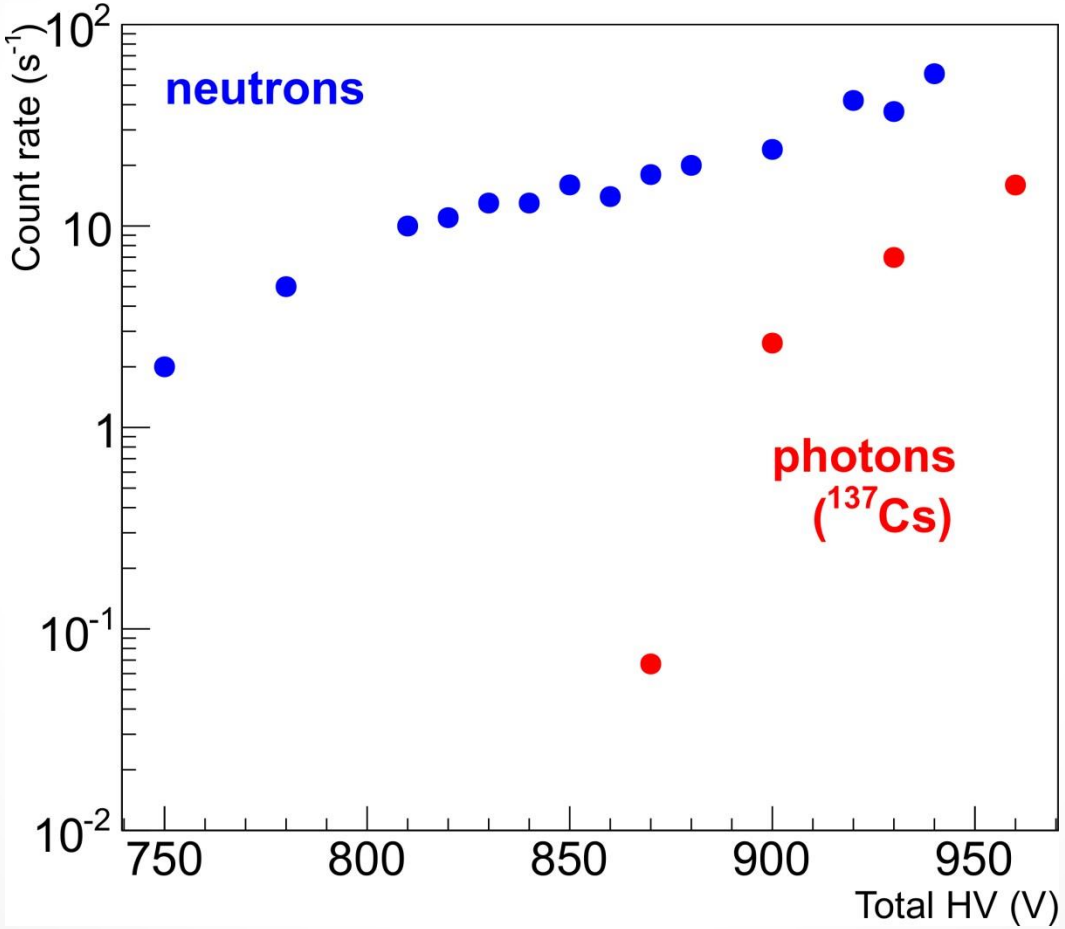
GEM ^{10}B: 200 slices (1 ms)

GEM B_4C: 200 slices (0.05 ms) + 400 slices (0.5 ms)

GEM PE: 154 slices (100 ns)

Photon rejection

At 870 V the efficiency to photons is 10^{-7}

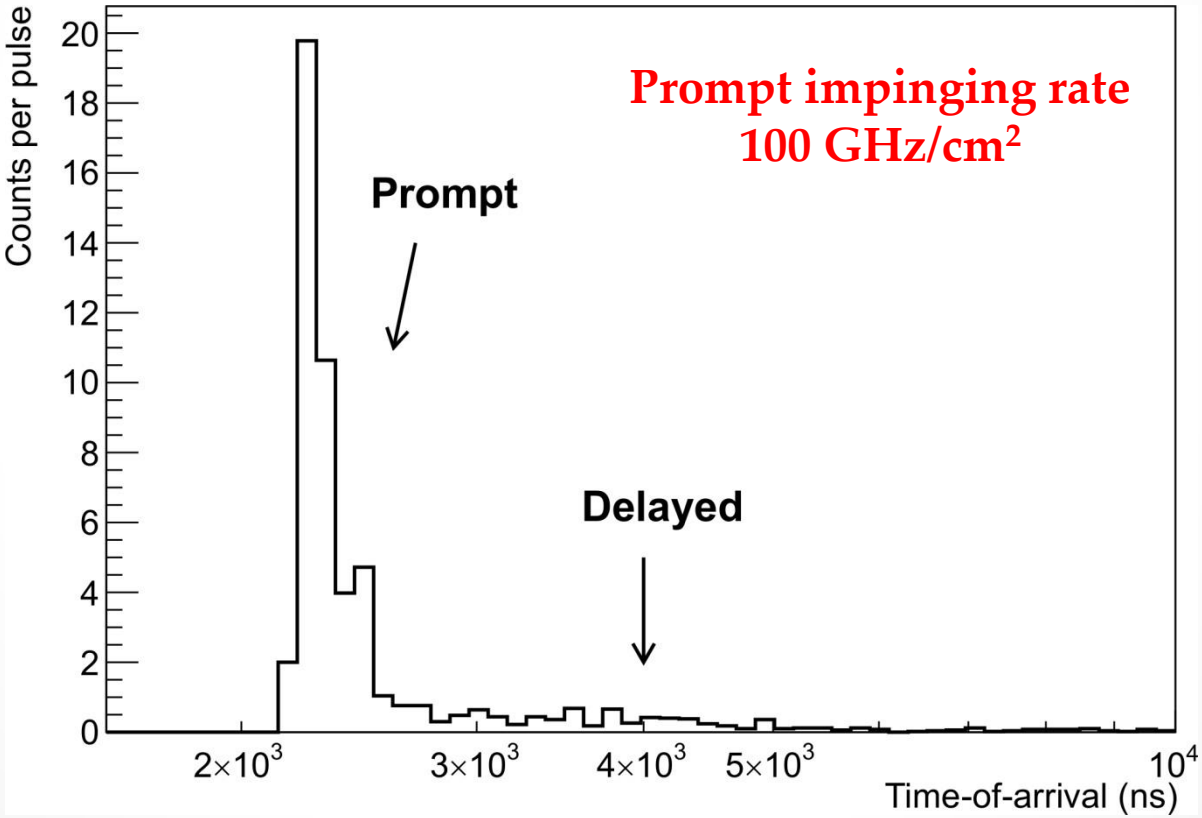


Measurements @ Beam Dump

Photon flash

GEM B_4C

Photon time-of-arrival (50 ns resolution)
Measured at 870 V

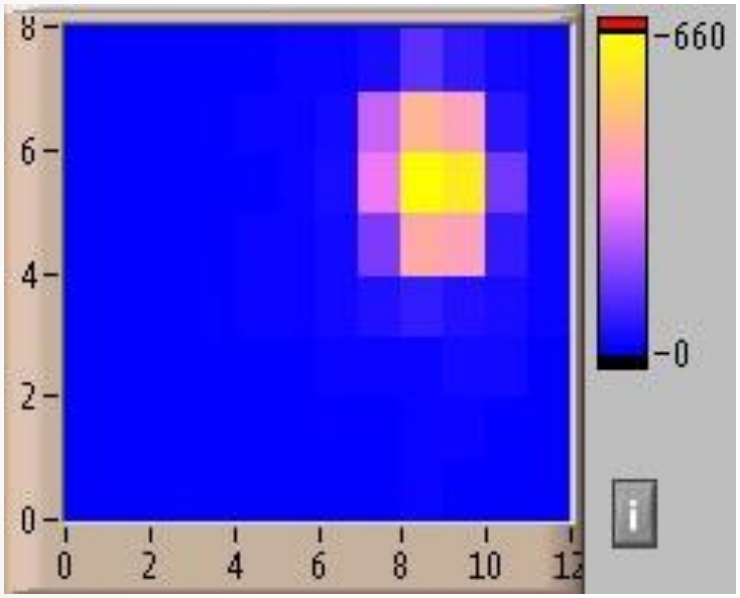


Measurements @ Beam Dump

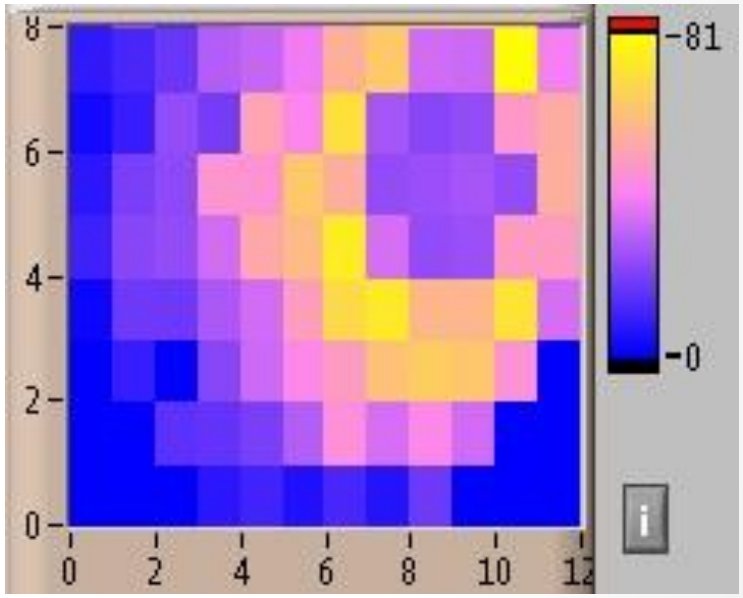
Photon flash

GEM B_4C

Online Acquisition Program*



900 V



1050 V

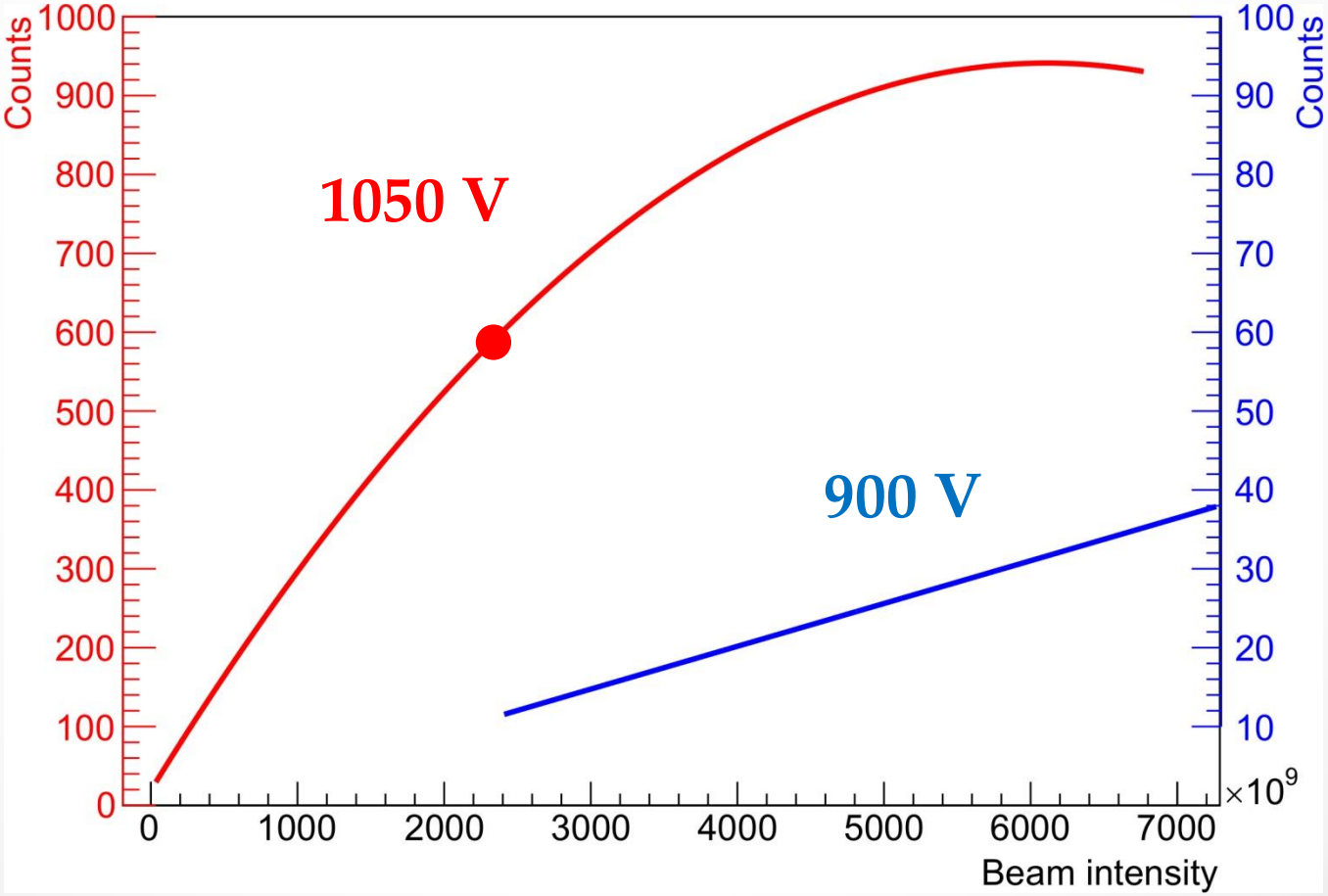
*Different number of events

Measurements @ Beam Dump

Photon flash

GEM B_4C

Saturation effect at 1050 V – Measured 20 MHz/cm^2

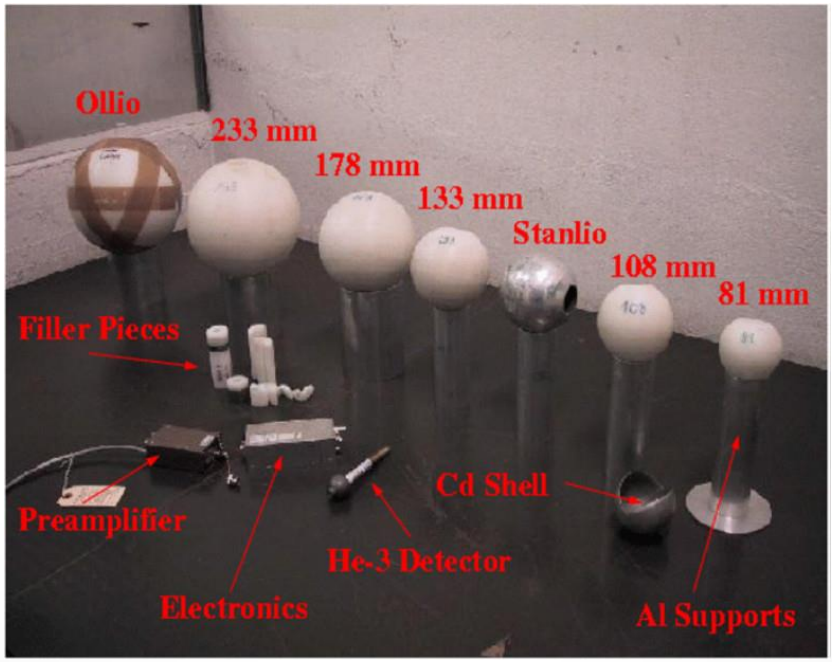


Neutron Spectrometry with the GEM

Work in progress

How can we measure a neutron spectrum of a field?

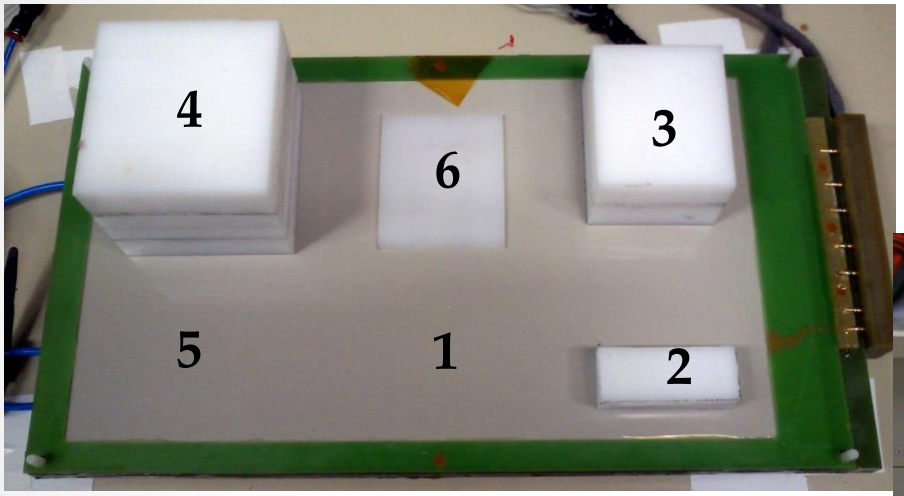
The BSS (Bonner Sphere Spectrometer)
is the most common instrument in Radiation Protection



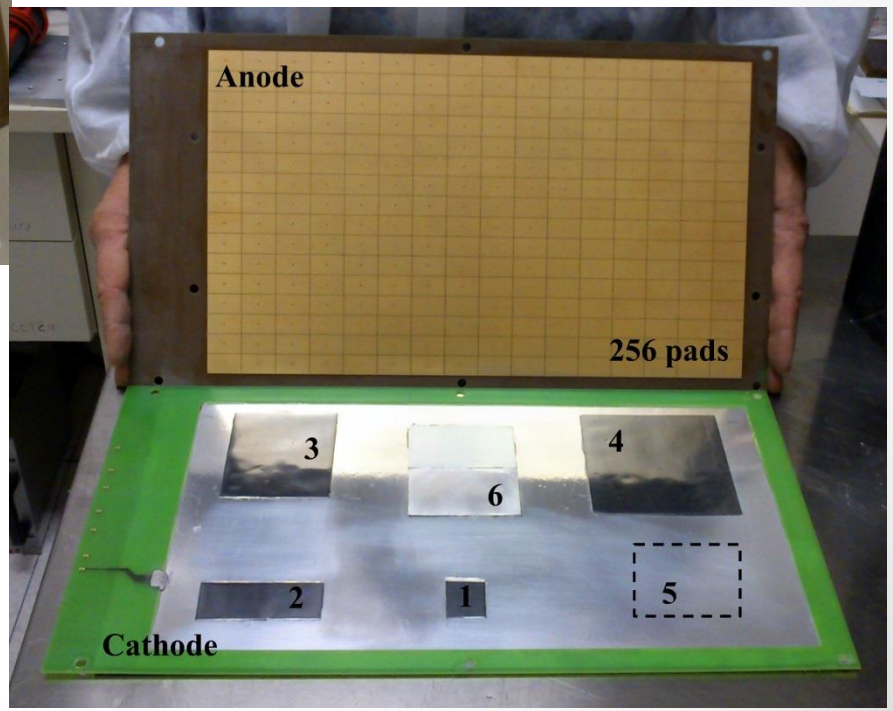
Neutron Spectrometry with the GEM

Work in progress

How we can do it with the GEM



35 x 20 cm^2, 256 pads



1, 2, 3, 4 : $^{10}B_4C$*

5, 6 : PE

* L. Robinson presentation

Conclusions

1. Online 2D beam image in 10x10 cm^2 for slow and fast neutrons with head-on detectors and 8 mm resolution

2. Reconstructed beam image with a side-on detector at EAR1 via scan procedure

3. Differences observed in spot dimensions at EAR1 and Beam dump due to low energy neutron diffusion

4. The energy spectrum was measured in both areas with photon rejection

5. The photon flash from spallation was measured with 50 ns resolution, yielding saturation effects at high voltage (1050 V)

6. Alternatives for neutron spectrometry are currently explored with the GEM detector

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