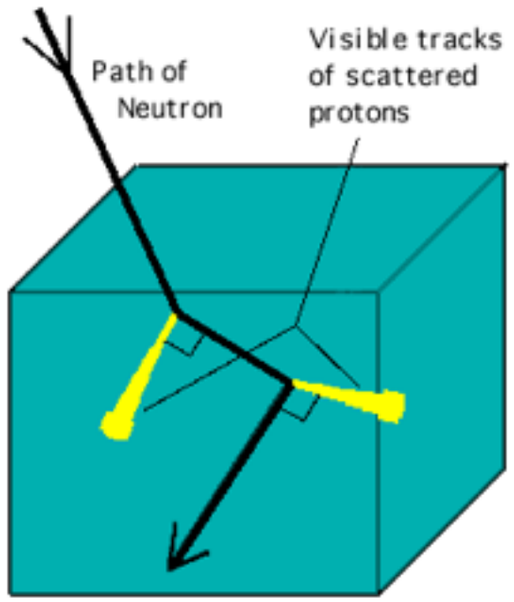
MONDO

October 2014

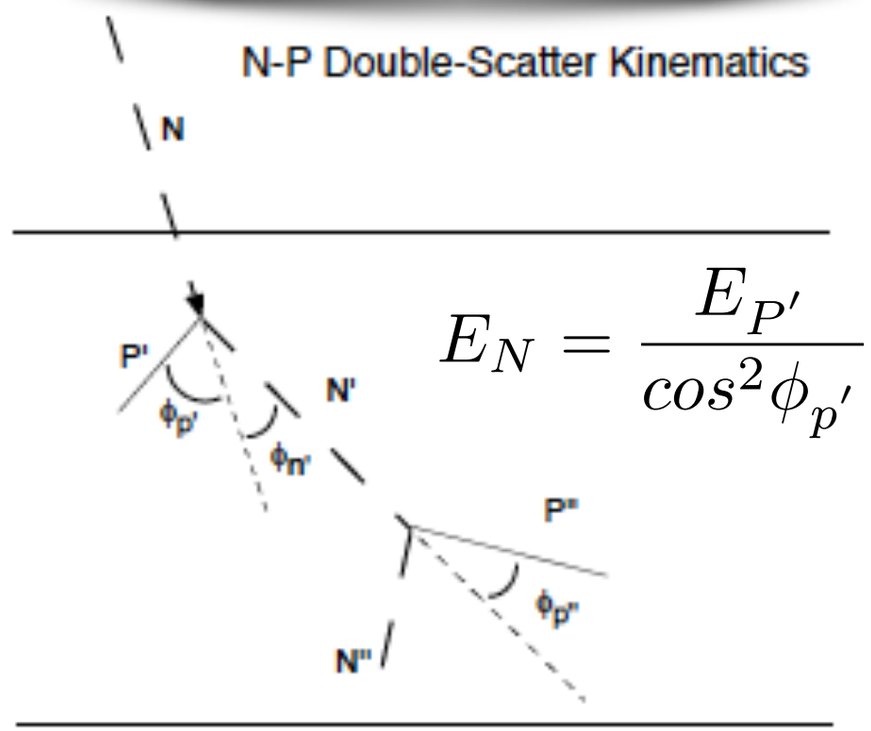
MONDO

- We need to measure (and track!) the neutrons emitted during a particle therapy treatment:
  - neutrons of [10 -200] MeV;



- We want to track the protons emitted via elastic scattering by the neutrons:
  - protons of [10 -200] MeV;

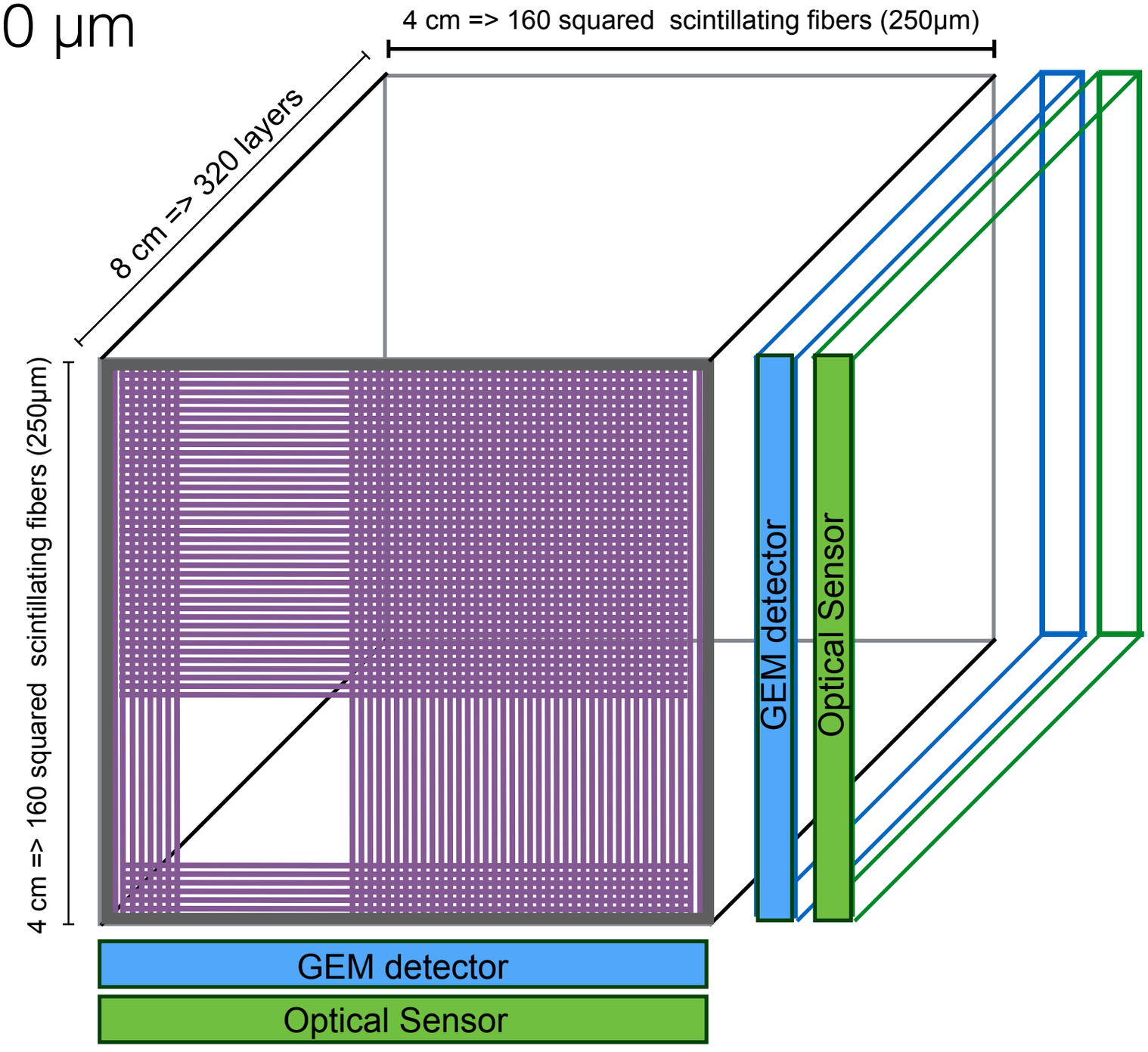
Neutron energy	Energy range
0.0–0.025 eV	Cold neutrons
0.025 eV	Thermal neutrons
0.025–0.4 eV	Epithermal neutrons
0.4–0.6 eV	Cadmium neutrons
0.6–1 eV	EpiCadmium neutrons
1–10 eV	Slow neutrons
10–300 eV	Resonance neutrons
300 eV–1 MeV	Intermediate neutrons
1–20 MeV	Fast neutrons
> 20 MeV	Relativistic neutrons



$$E_N = \frac{E_{P'}}{cos^2\phi_{p'}}$$

We design a detector to track neutral and charged particles

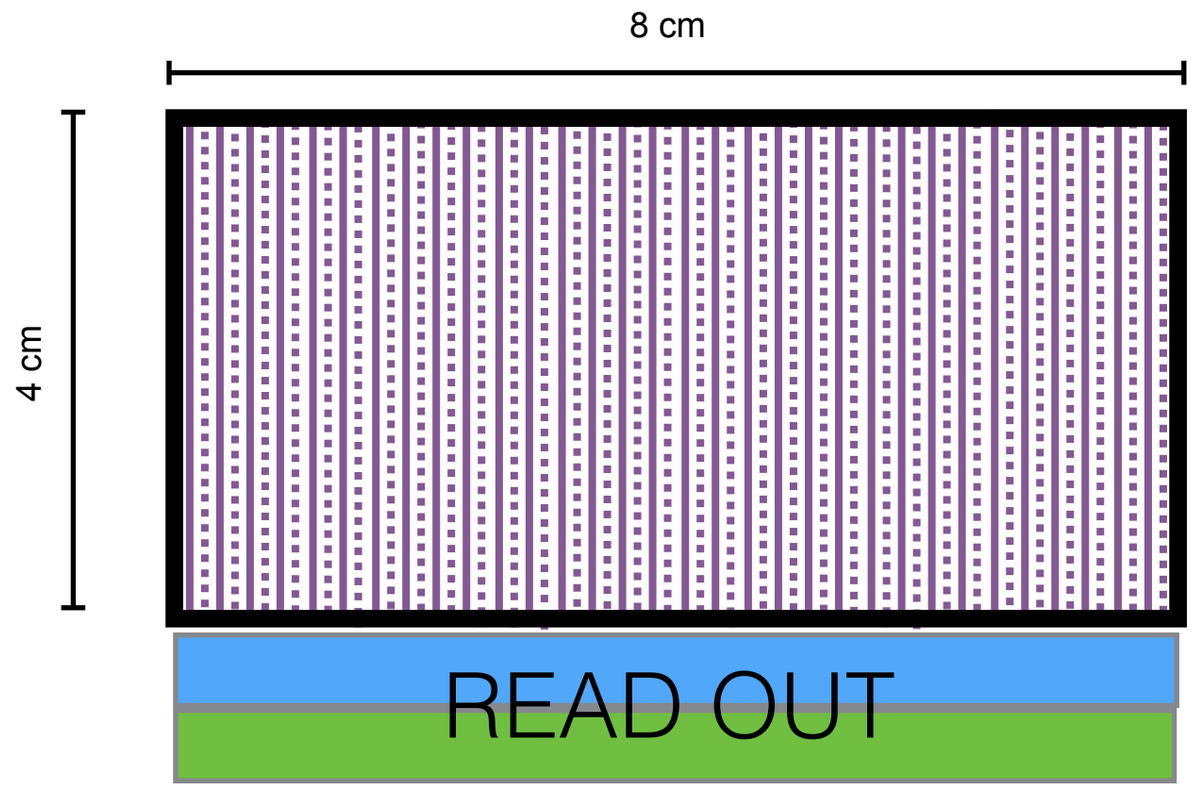
- Scintillating fibers of 250 μm
  - read out of the fibers in pixel in order to reconstruct the vertex of the interaction and the protons tracks.



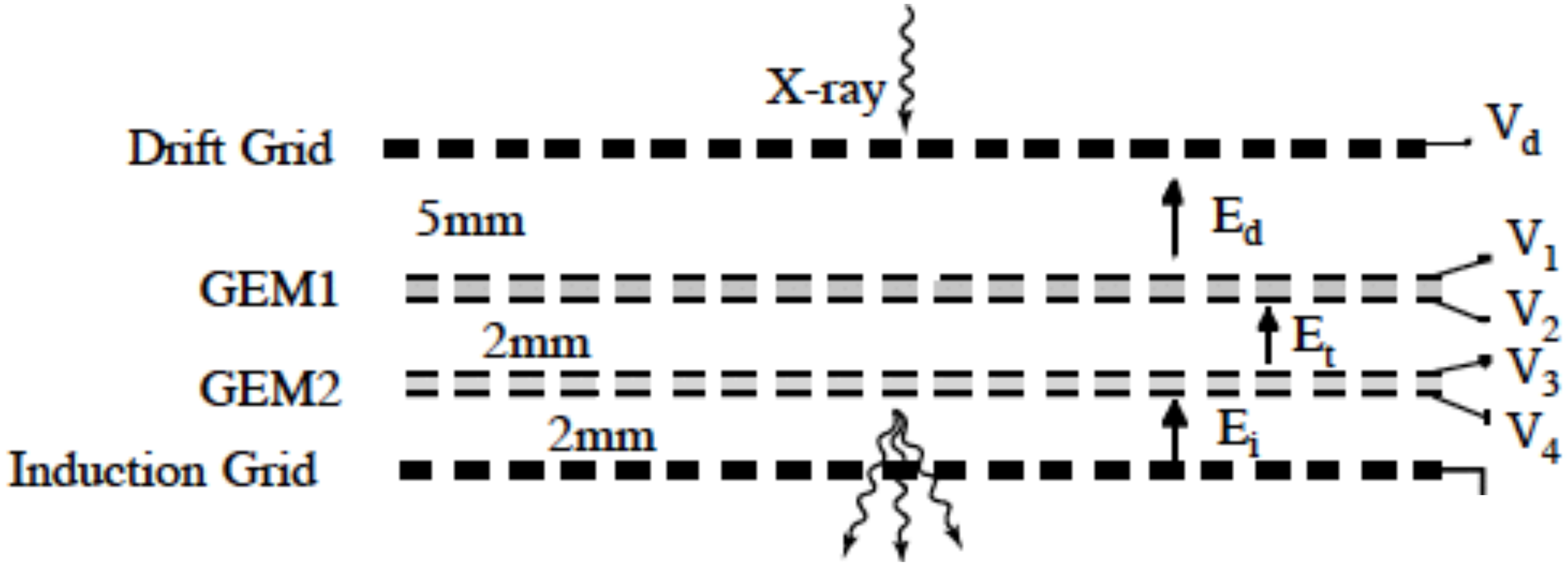
We design a detector to track neutral and charged particles

- Scintillating fibers of 250 μm
  - we want to use the GEM system in order to intensify the image..
  - the read out of the GEM is the main topic of the discussion..
- External trigger system
  - Multianods PMT;

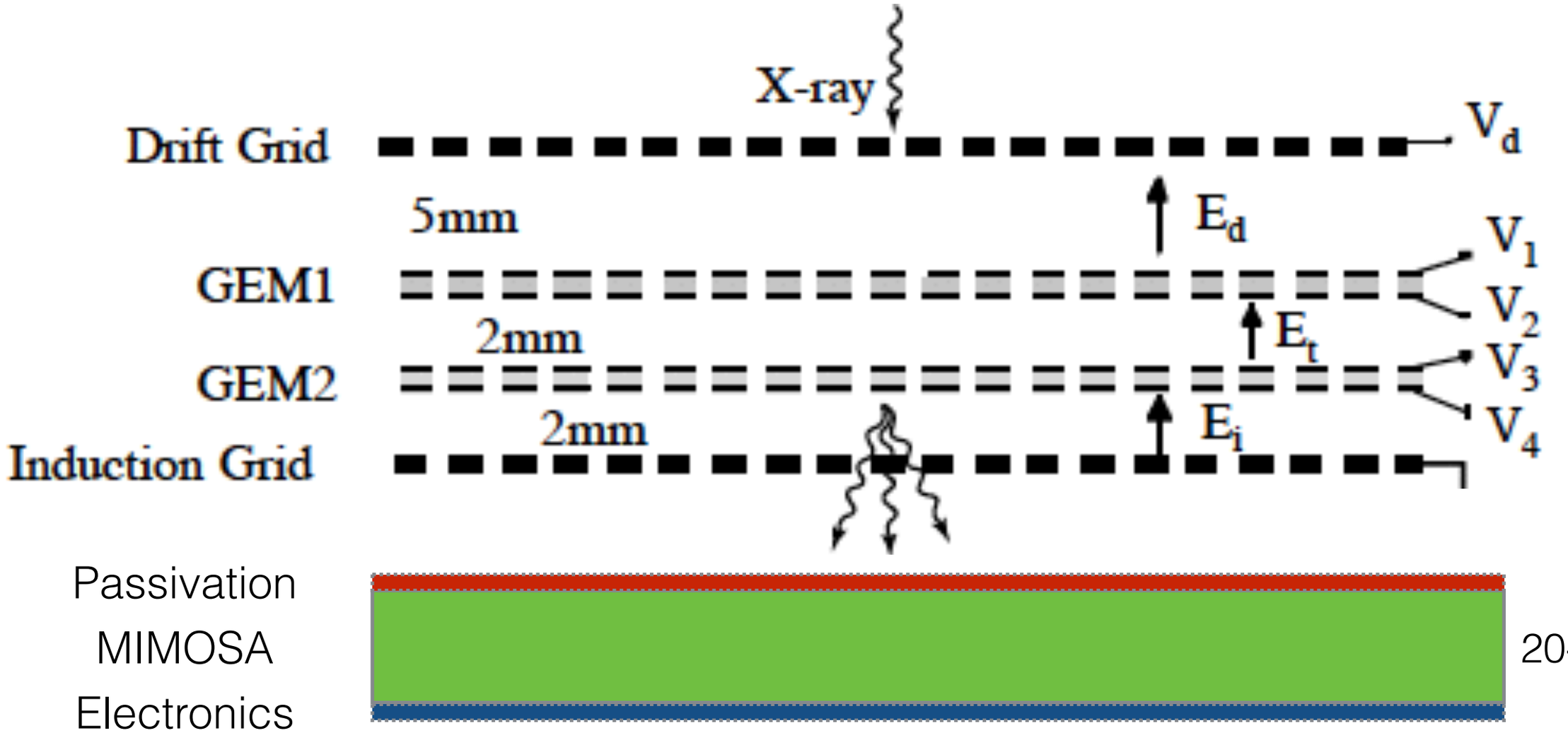
4 x 4 x 8 cm^3 scintillator



Readout of the fibers with GEM



Readout of the fibers with GEM

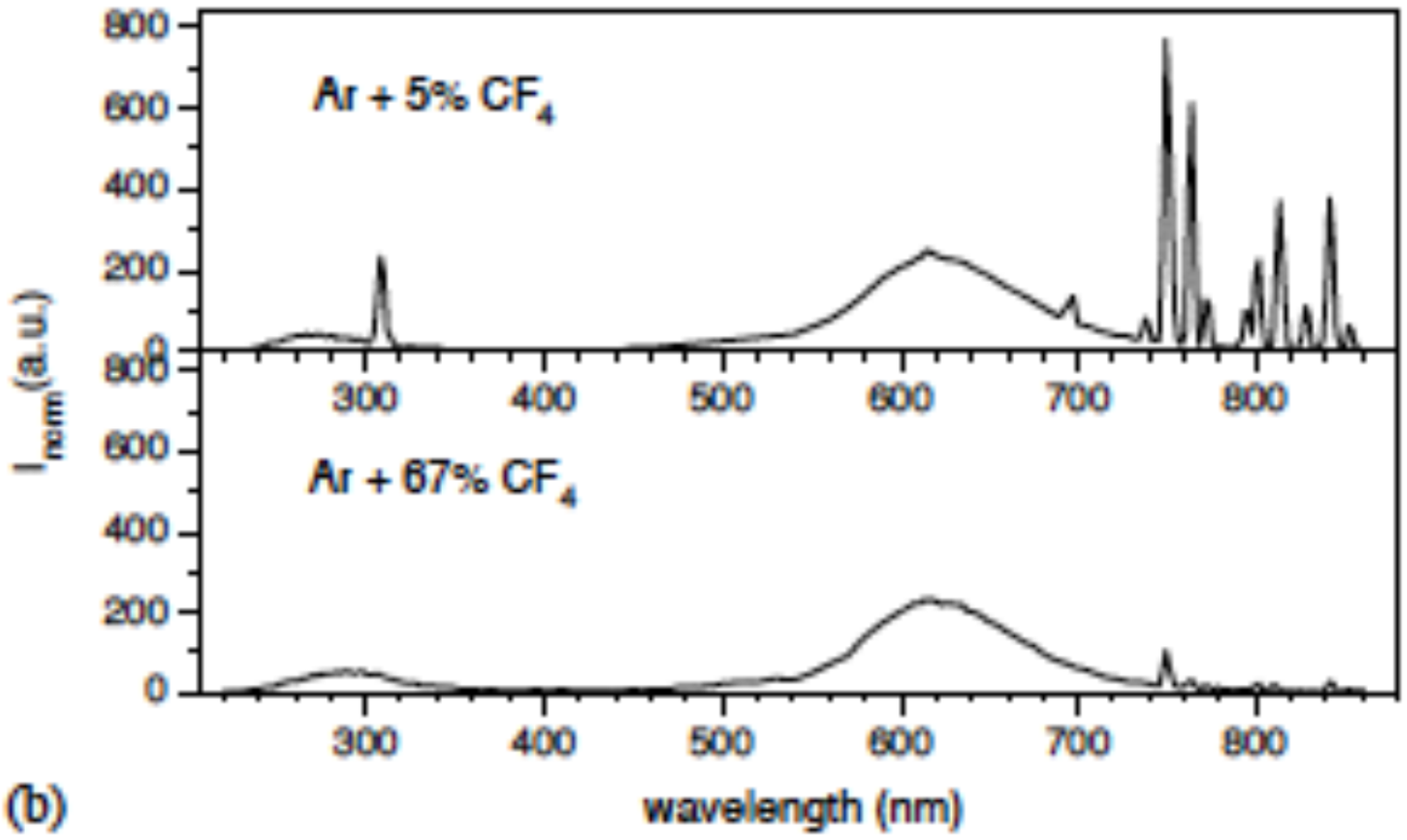


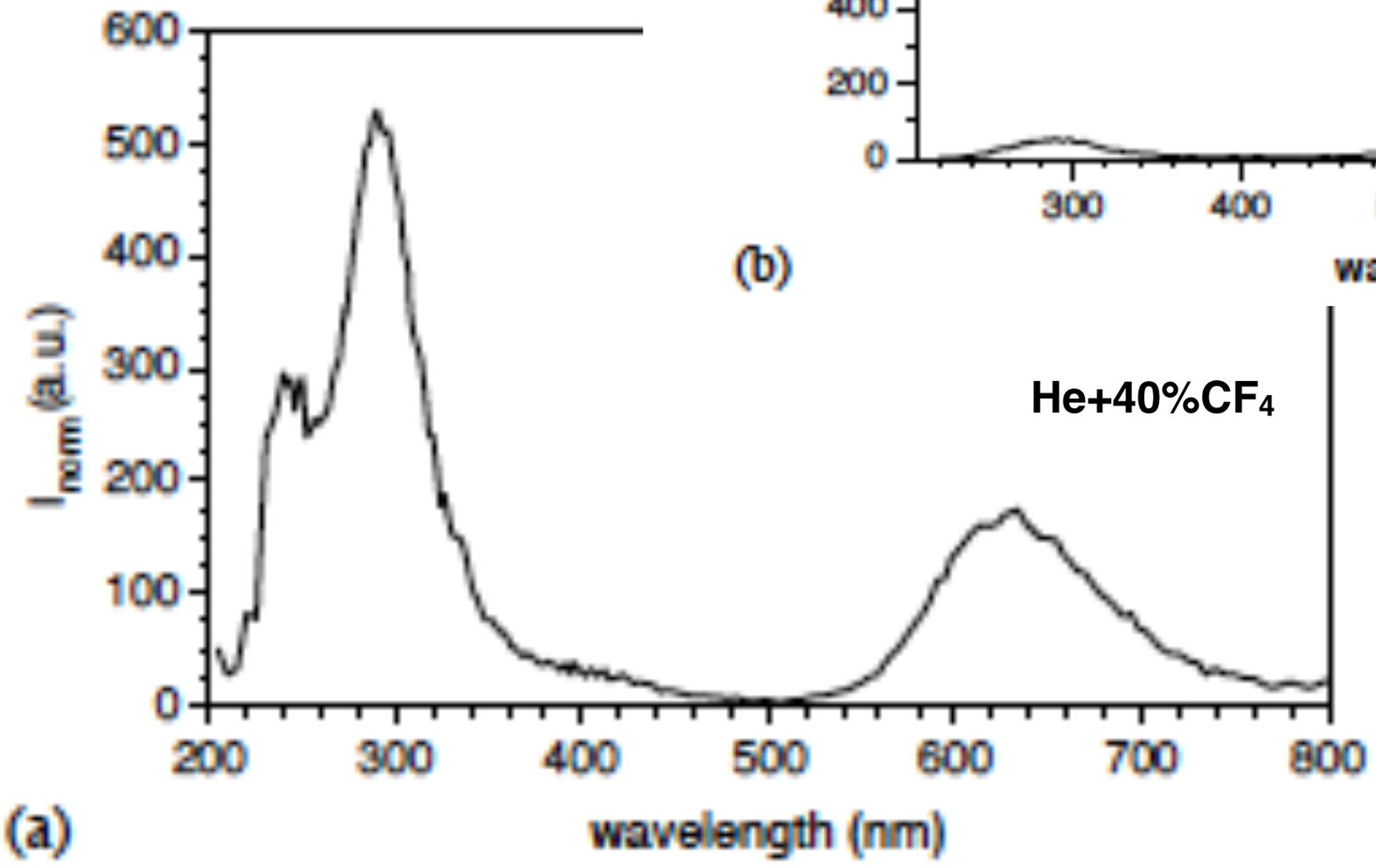
Together with electrons several photons are produced

=> we can detect those photons!!

Readout of the fibers with GEM

- The photon spectrum depends on the gas mixture





Readout of the fibers with GEM

- The ratio between the number of produced photons and electrons depends from the gas mixture as well;

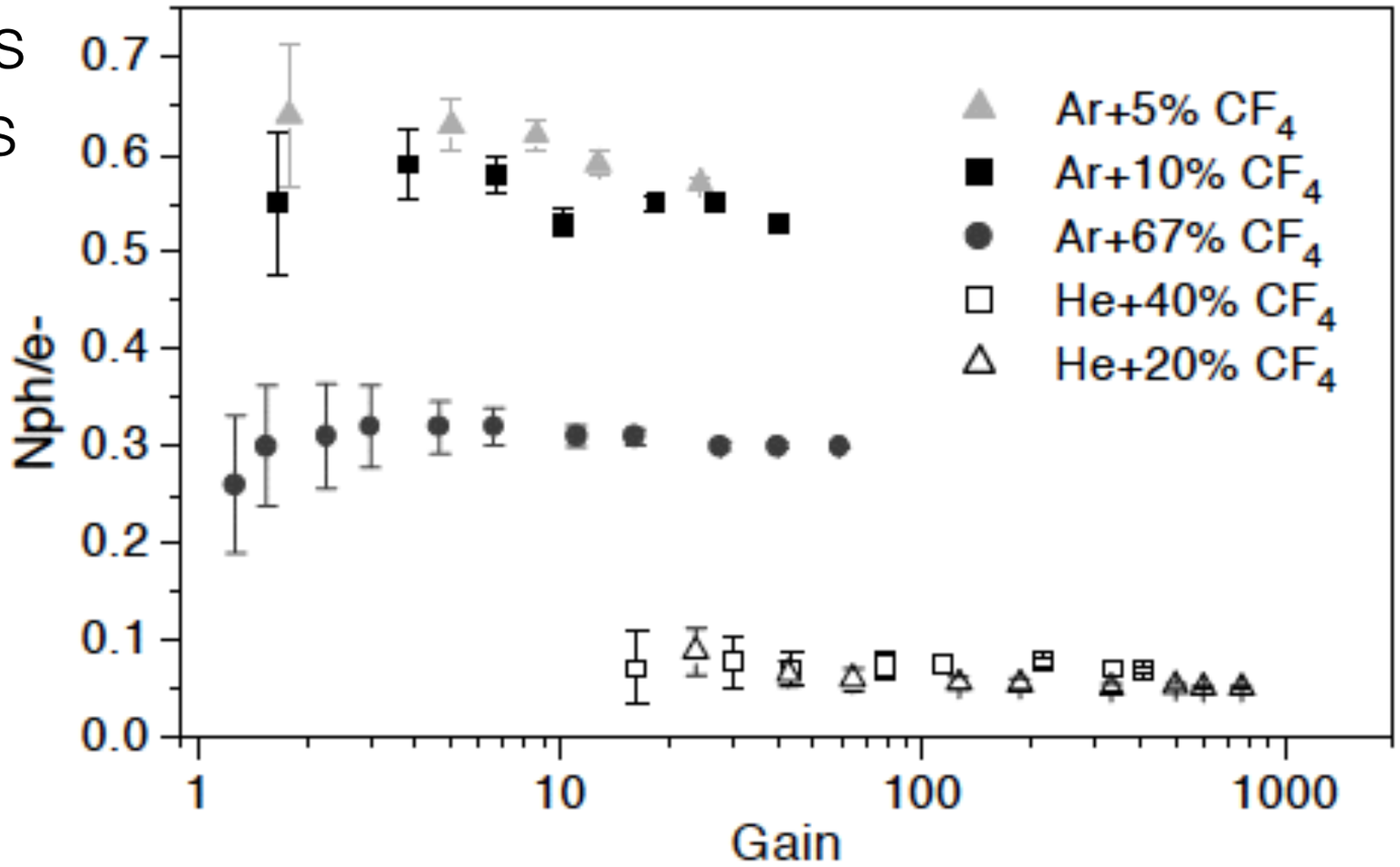


Fig. 3. Total number of photons emitted per secondary electron, above 400 nm, as a function of charge gain for several CF_4 mixtures. The systematic error is estimated to be less than 20%.

- A mixture of Ar +5%CF_4 gives a ratio of about 0.5;

Readout of the fibers with GEM

- With a triple GEM system a gain of 10^4 is achievable;

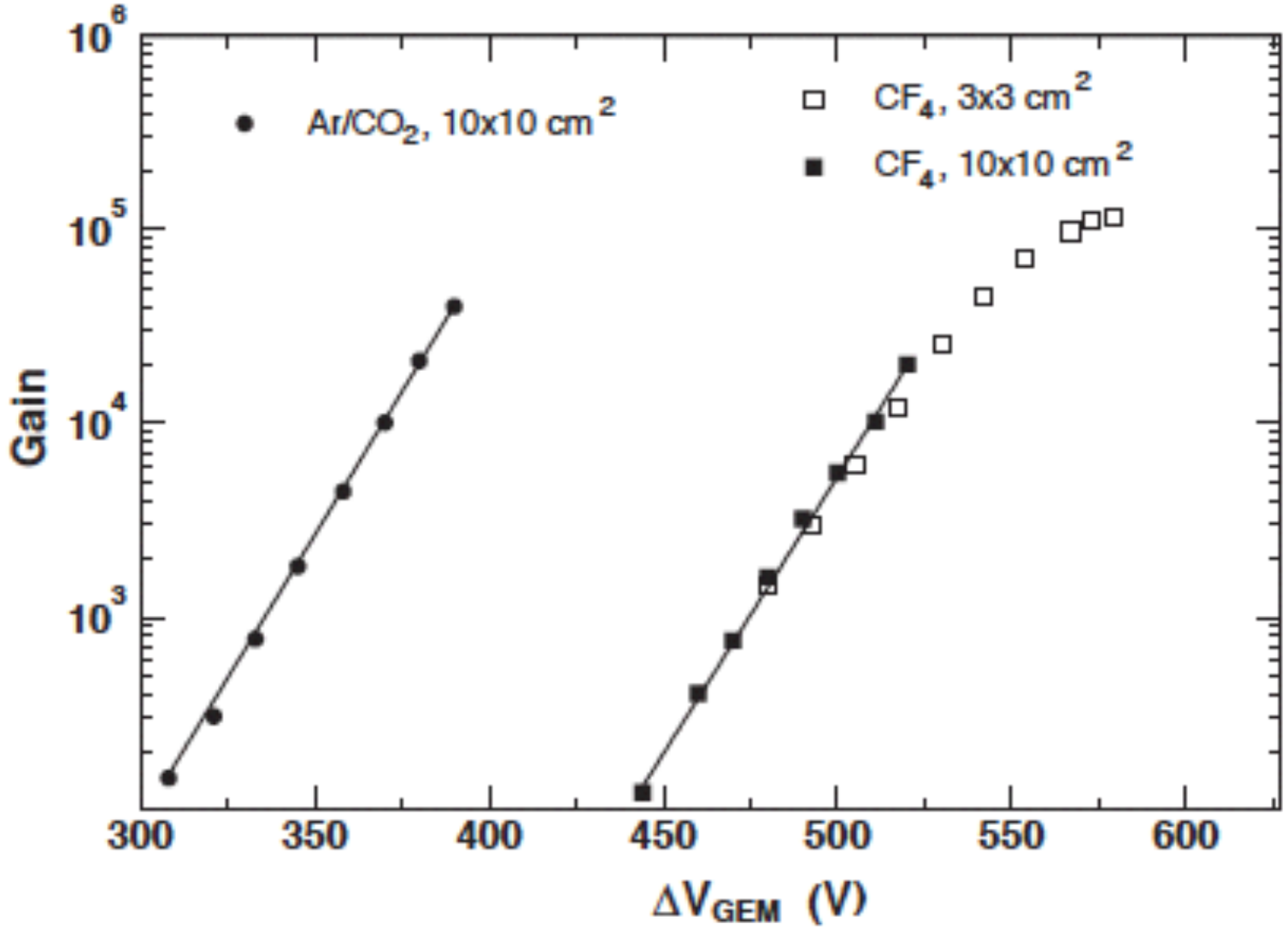


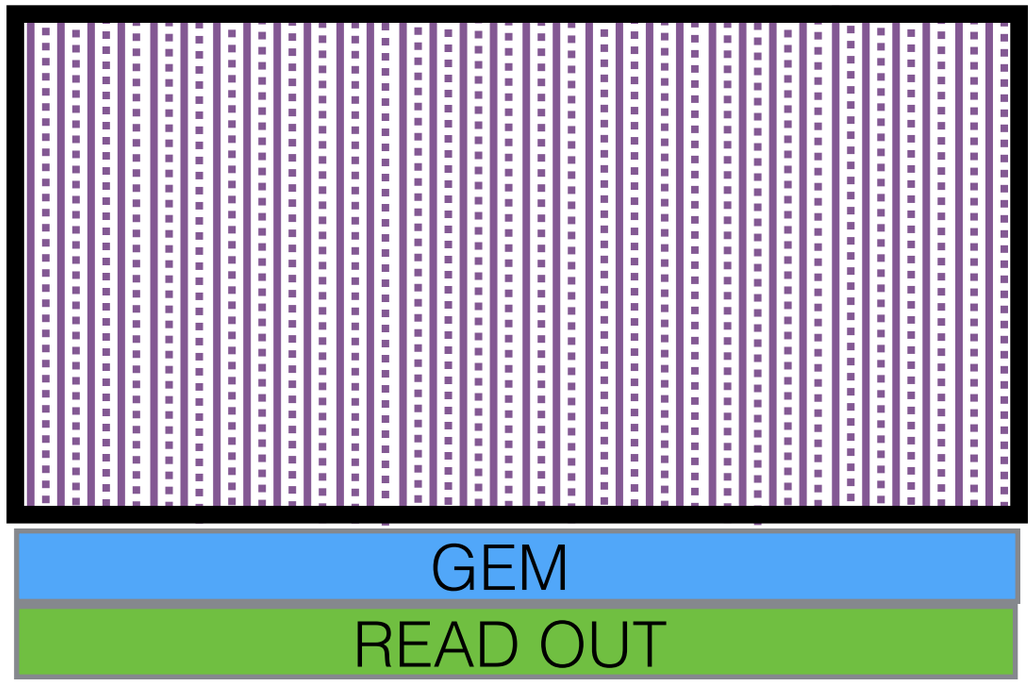
Fig. 3. Gain as a function of GEM voltage measured with ^{55}Fe X-ray source. The 3×3 cm^2 detector had a CsI layer deposited on the top face of GEM1. The lines represent exponential fits to the data with 10×10 cm^2 GEMs.

We design a detector to track neutral and charged particles

- the GEM produces several photons:
  - <50% geometrical collection efficiency;
  - about 0.5 photons/electrons;
  - with a gain of ~10^4

2000 optical photons
on the sensor

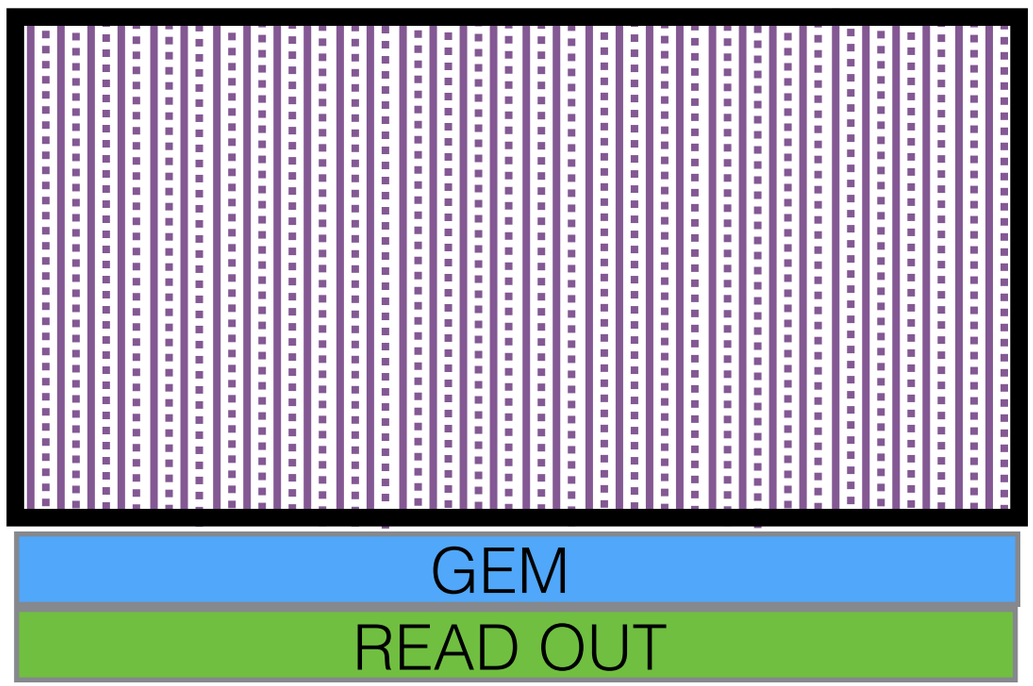
4 x 4 x 8 cm^3 scintillator



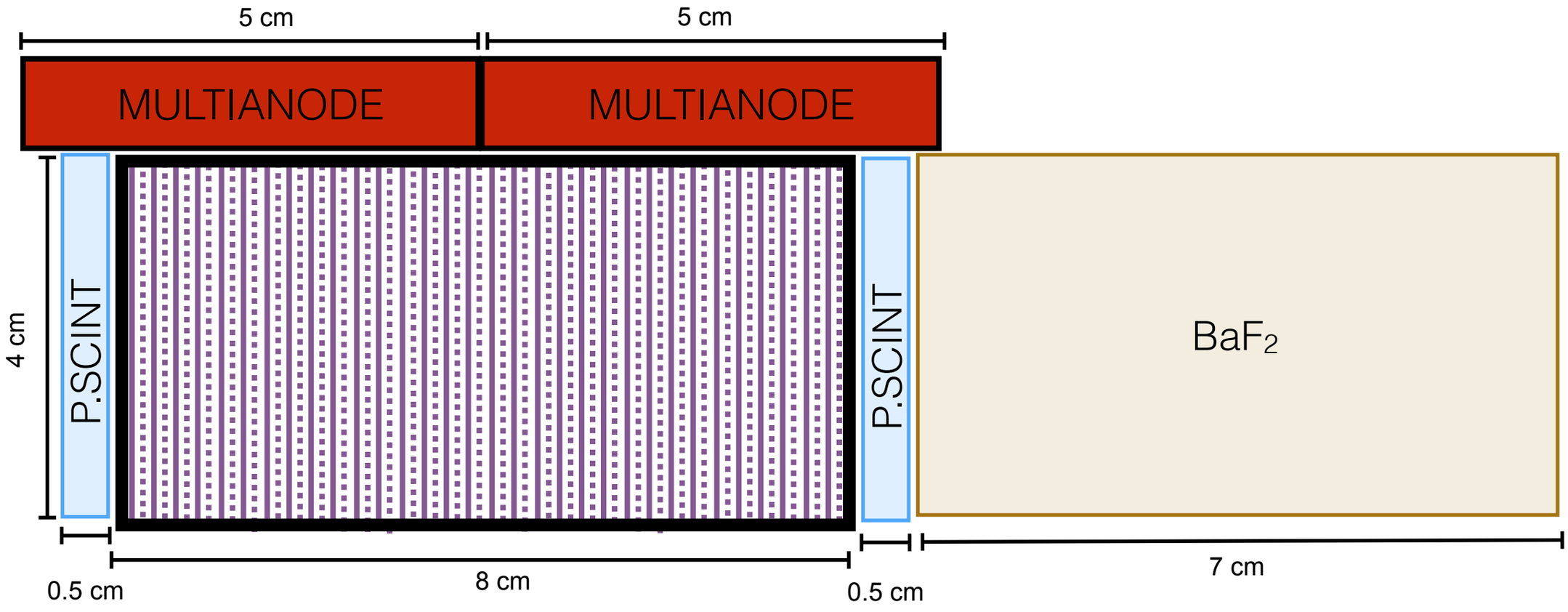
We design a detector to track neutral and charged particles

- READOUT:
  - the GEM produces several photons..
  - ..we need “something” to detect ~2000 optical photons with a resolution of about 50 μm..

4 x 4 x 8 cm^3 scintillator



Layout of the detector without the fibers read out



- **trigger definition:**
  - fast trigger => first two dynodes of each PMTs
  - slow trigger=> logic programmable with 2 x 64 anodes informations
- **test configuration:** BaF2? other?

Readout of the fibers with GEM

x_i - x_j DeltaV to be evaluated