UNIVERSITÉ
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FACULTÉ DES SCIENCES

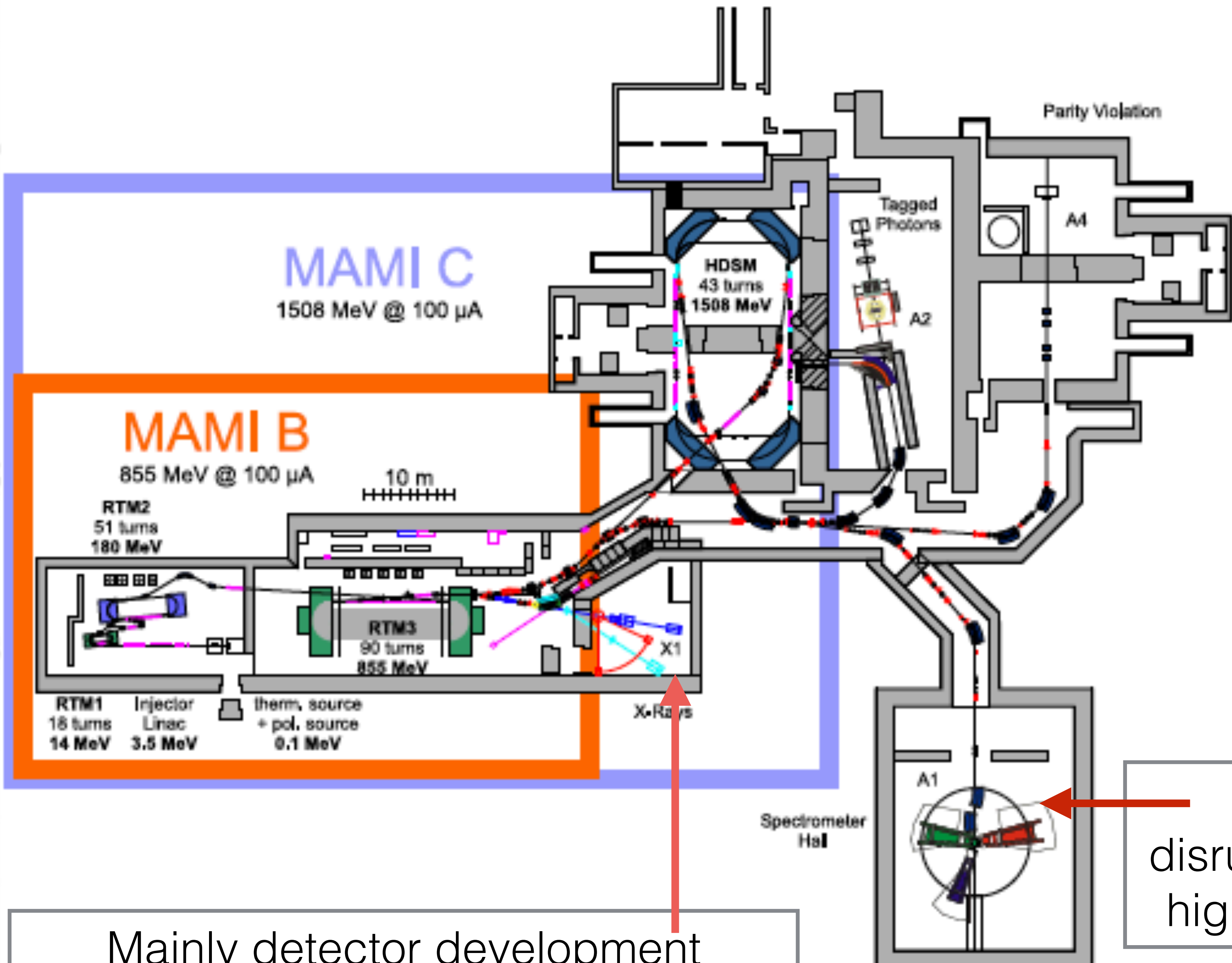
Electrons 4 neutrinos at Mainz?

Federico Sanchez
Université de Genève

Disclaimer

- This is just a very (very) preliminary thinking based on informal discussions with researches at Mainz.

Mami @ Mainz



No space available
disrupts standard physics program
higher electron energy (1.6 GeV)

Mainly detector development
Space available
lower electron energy (0.8 GeV)

Mami @ Mainz

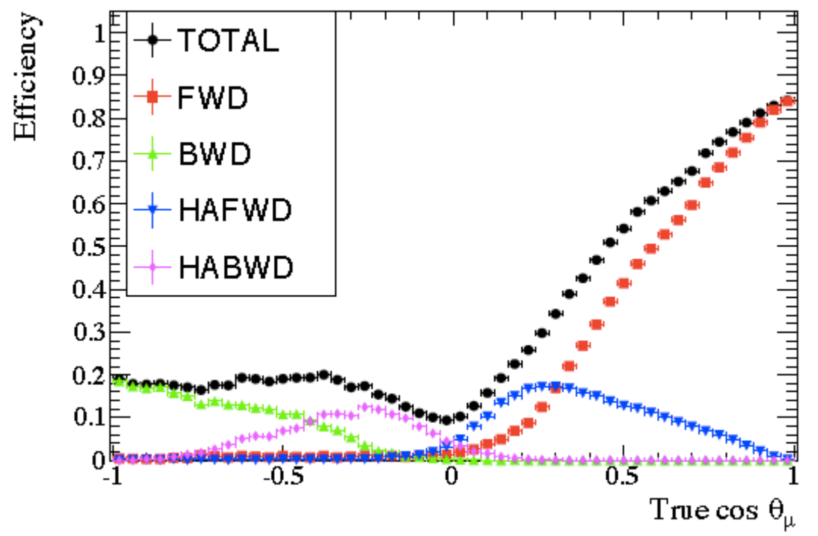
- We might be interested in low currents. The currents in Mami vary from 10pA to 100μA:
  - minimum current 6 x10^6 electrons/seconds
    - Minimum rate is ~1 electron/100 ns.
      - reference time is the drift velocity of electrons and ions.
    - ~ few 10^6 interactions in 10^7 s.
      - this is already a nice statistics and it would be more for lower scattered angles.
- Beam structure is also almost continuous with few ns gaps, so in the case of low intensities we will be dealing with almost 1 electron per time.

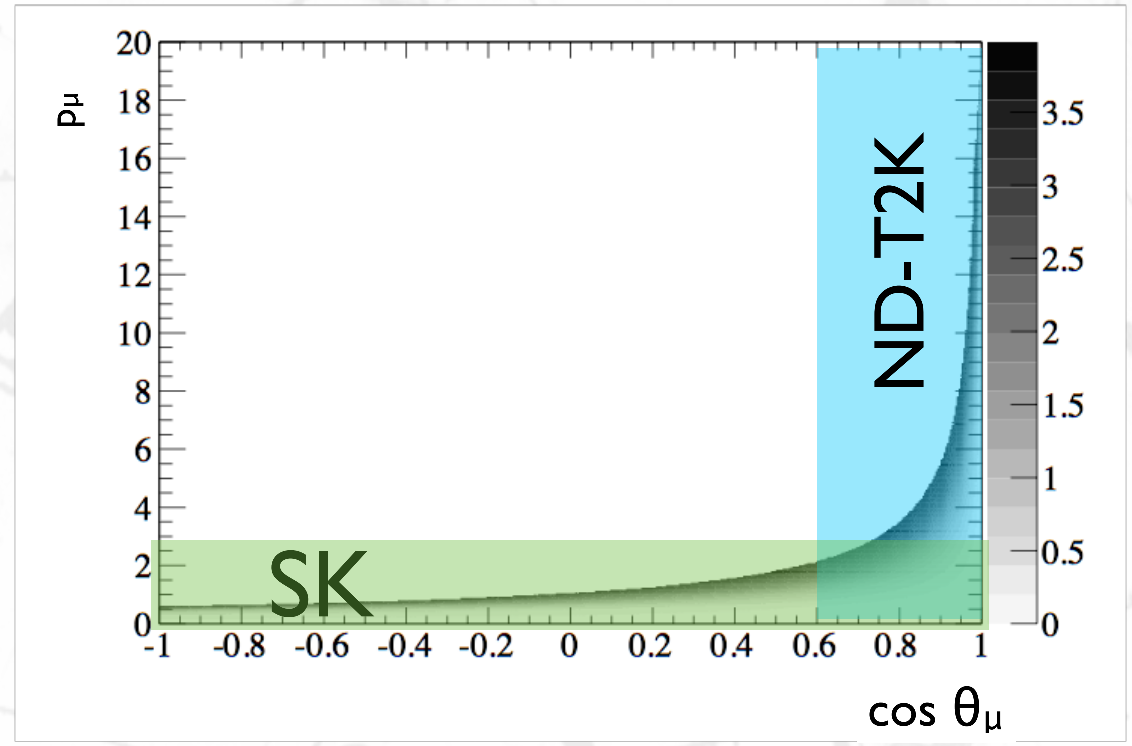
Idea

- Exchange acceptance by resolution:
  - give up on high precision trackers.
  - have high acceptance:
    - low energy pions and protons. (neutrons?)
    - close to 4π acceptance.
  - Possibility to exchange targets.
- Develop detectors that can be used both in electron scattering and neutrino interactions.
- Low cost.

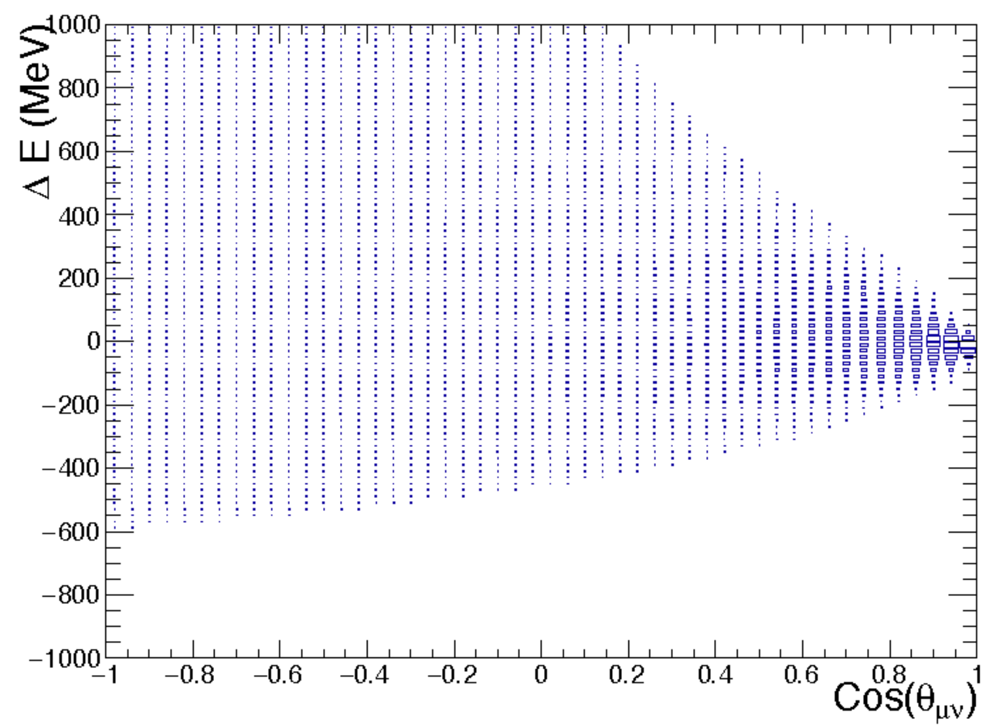
4π acceptance ?

Planar geometry experiments are bad !





$$E_{reco} = \frac{p_\mu^2 + m_p^2 - (m_n - V - E_\mu)^2}{2(|p_\mu \cos\theta_{\mu,\nu}| + (m_n - V - E_\mu))}$$



Large deviations in the energy reconstruction for large Q2 transfer!

Low energy threshold

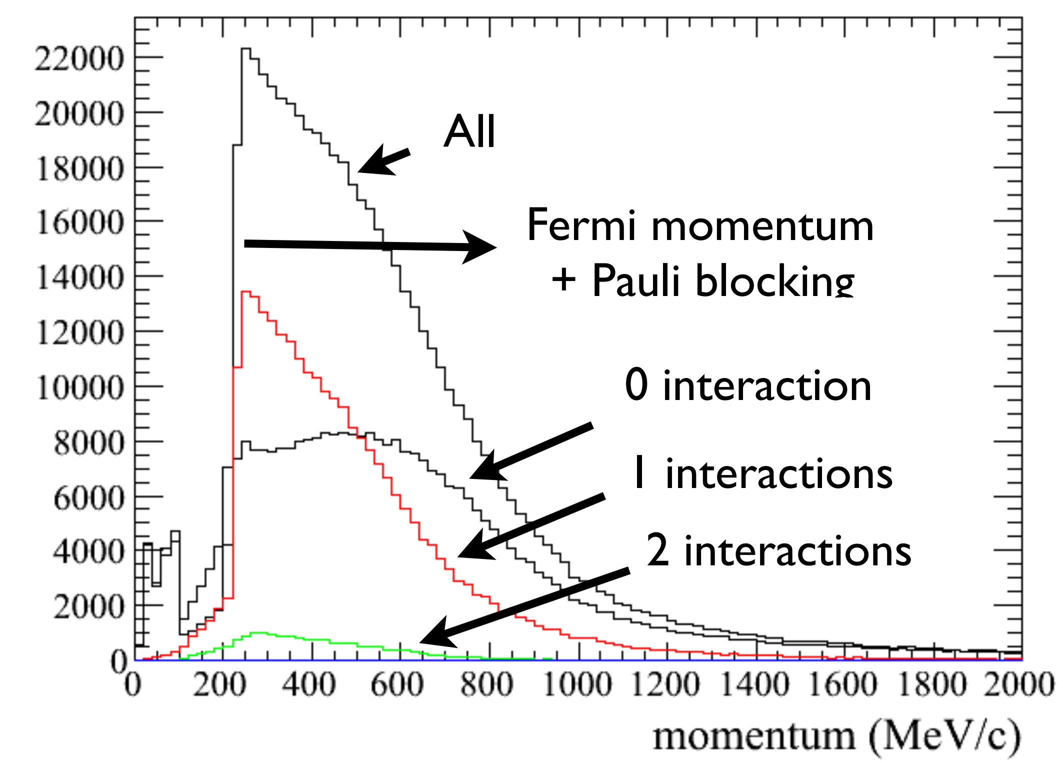
Typical detector threshold is 450 MeV/c (probably ~200 in LiqAr)

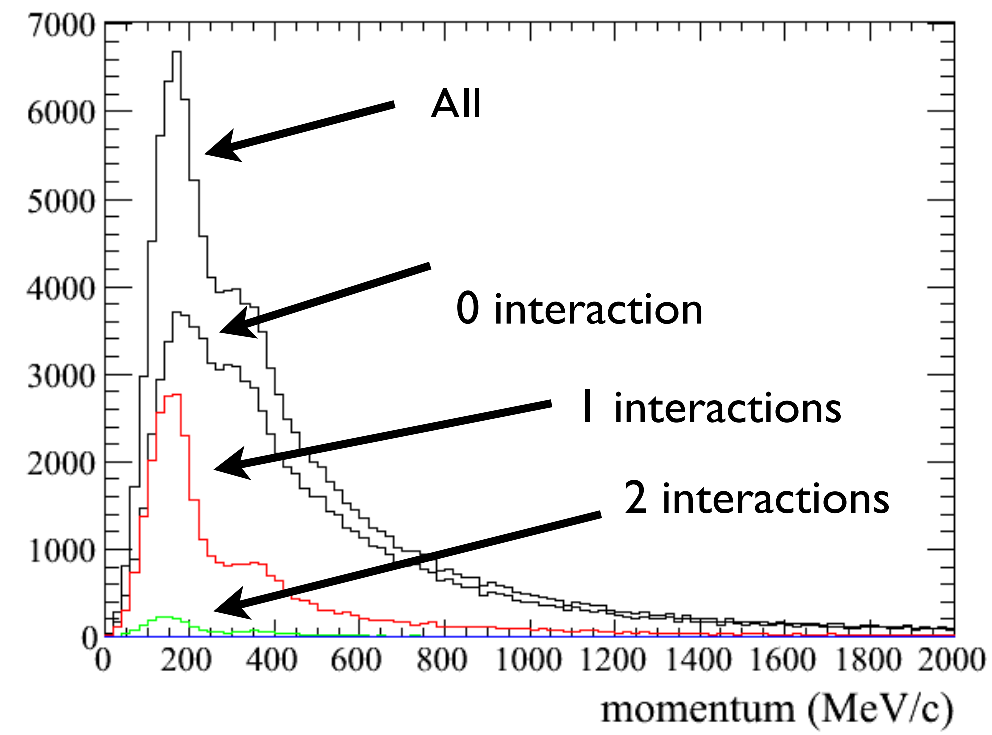
Information about FSI interactions

Information fermi model

Energy needed for calorimetric reconstruction: 400 MeV/c proton is ~80 MeV kinetic energy.

Relation between total energy and visible energy.





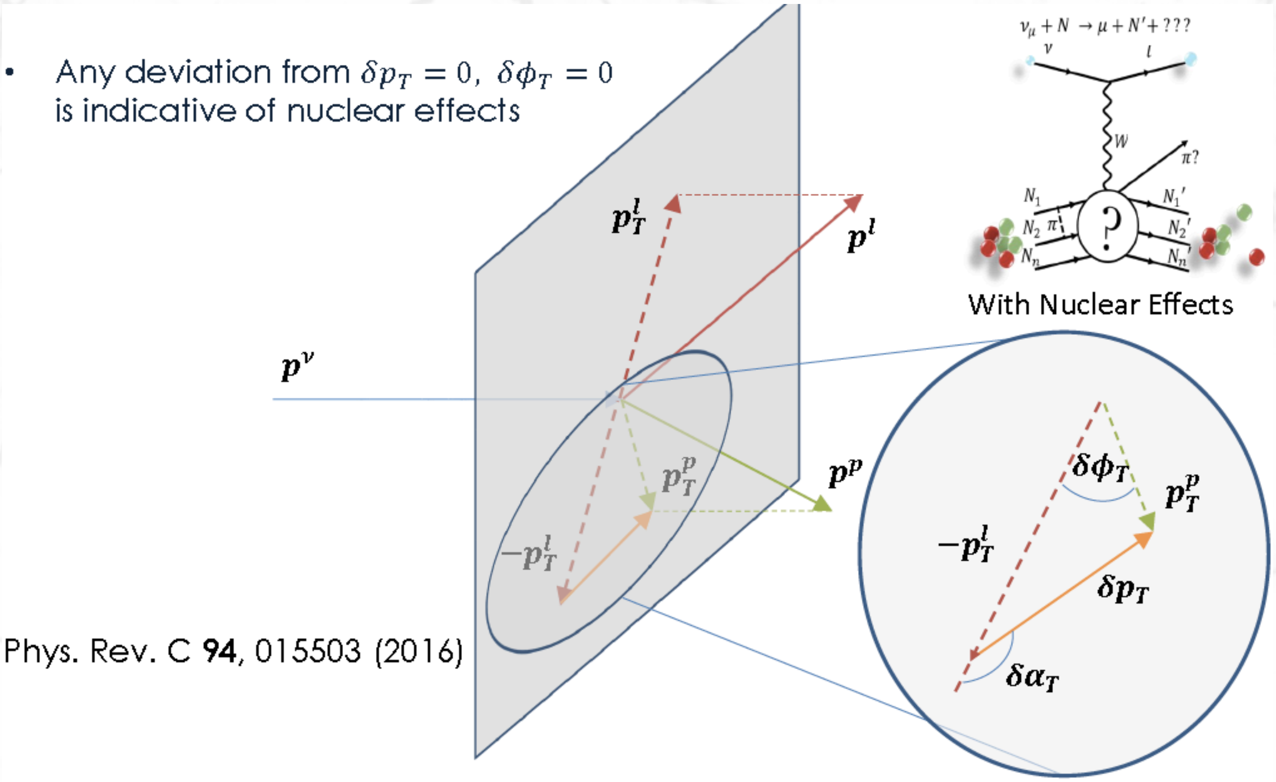
Threshold & acceptance

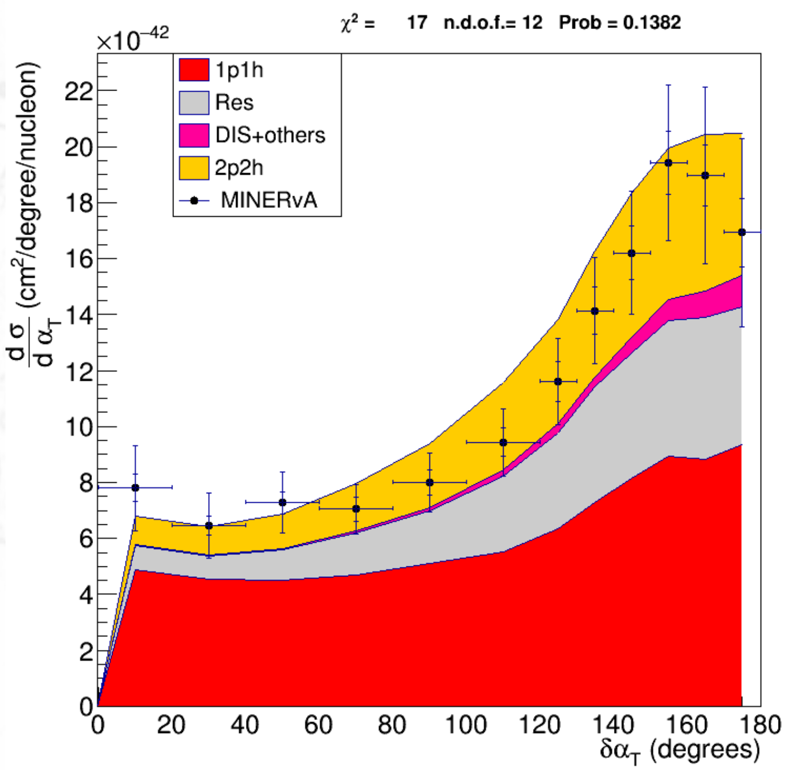
- New transverse variables have shown their potential to pin-down nuclear models.

- Higher acceptance in angle and momentum will allow us to monitor different regimes of nuclear dynamics and provide better models.

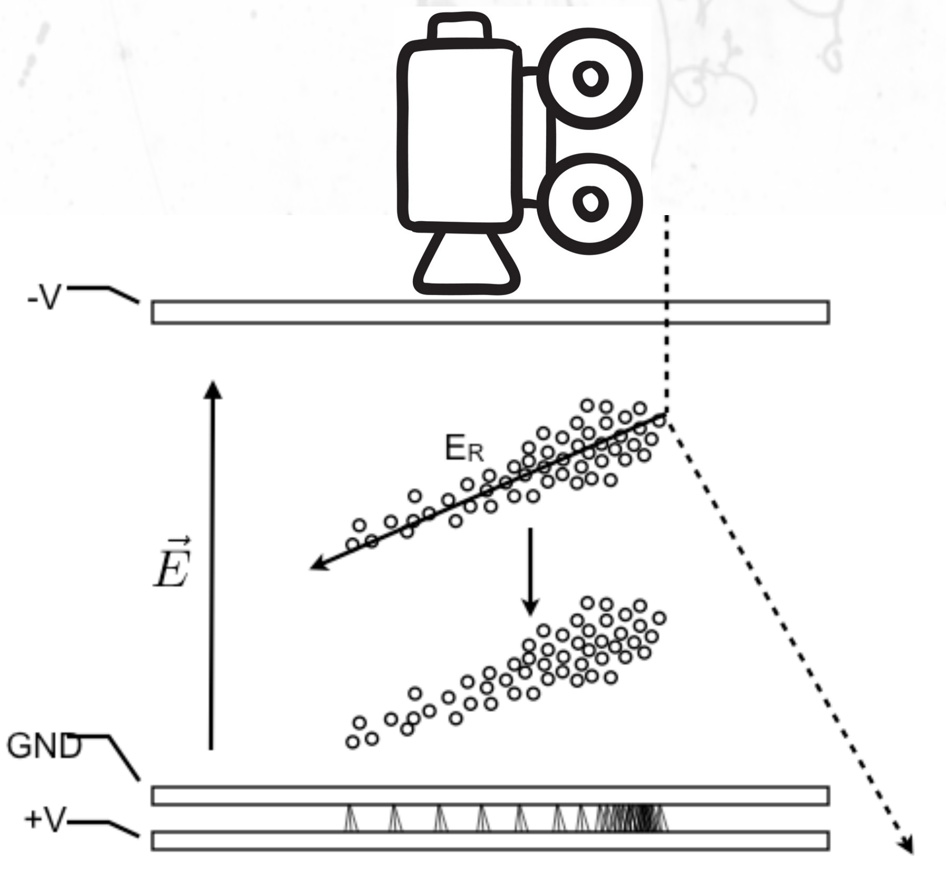
    - low momentum → FSI

    - high angle → large fermi momentum.

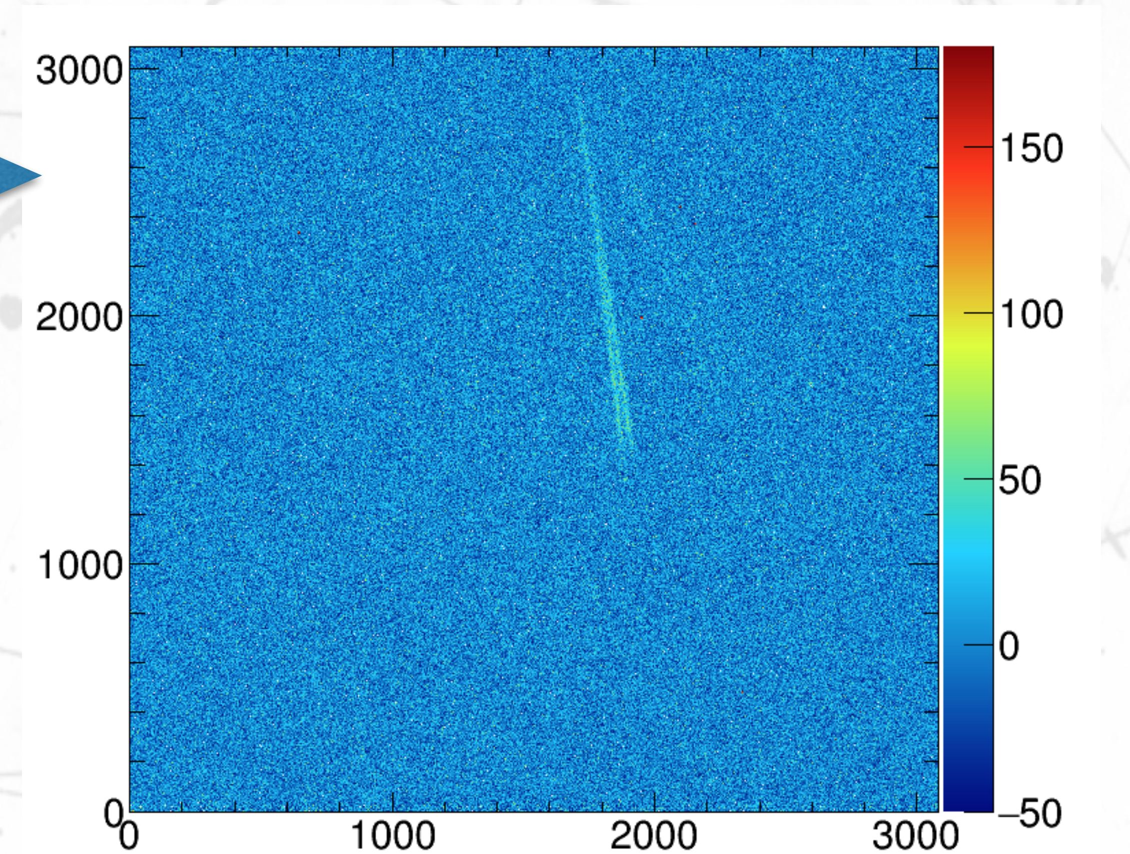




Light readout



Real data!



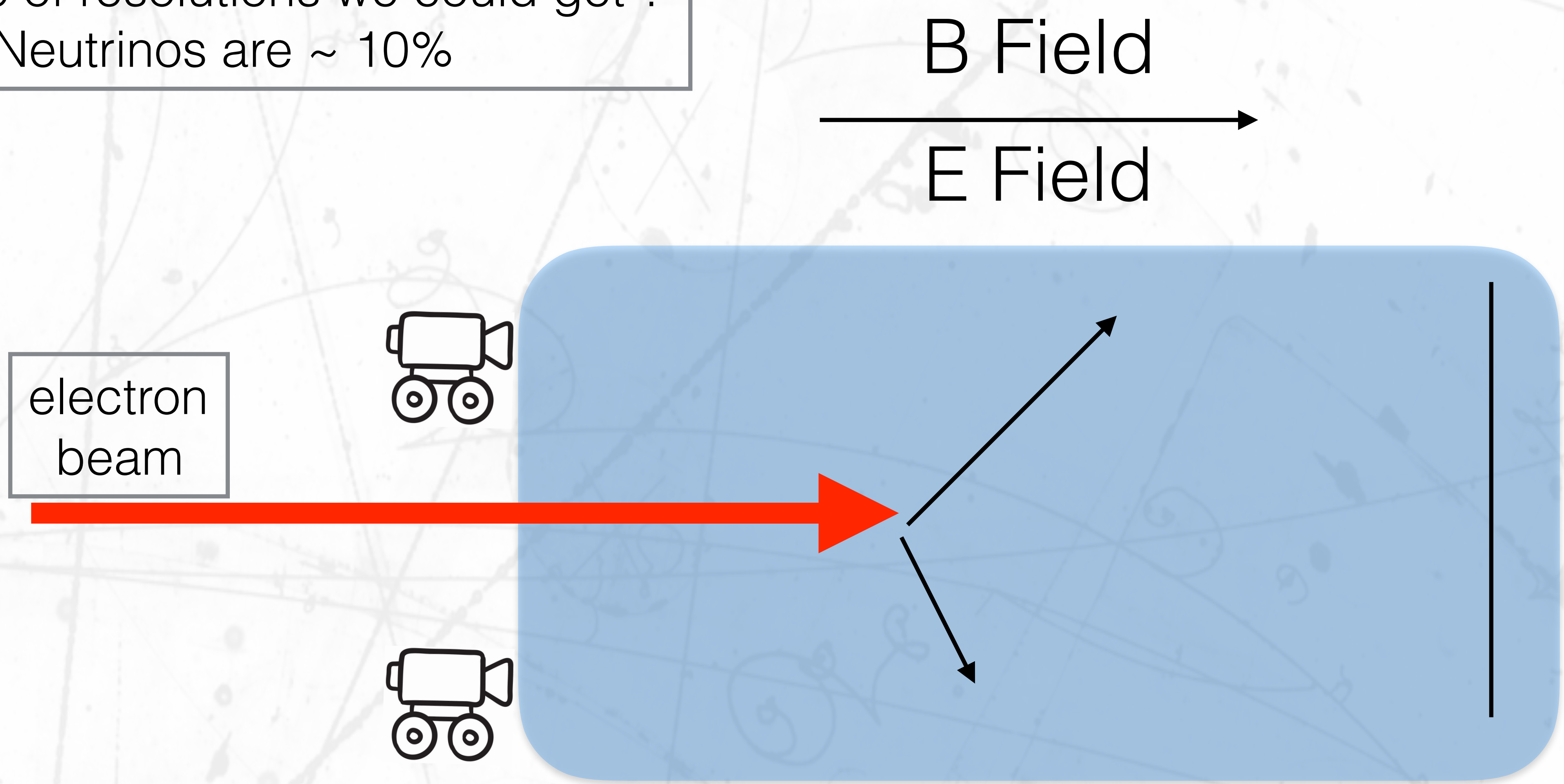
Affordable technology: 2000 $ / 65000 Channels
It can be operated with almost any gas (different target nuclei)
It runs better at high pressures contrary to charge amplification readouts.

Many options being explored:

- CCD, MediPix, MAPMT readouts.
- CF_4 N_2 as scintillators.
- Solid scintillator layer.

TPC detector

What type of resolutions we could get ?
Neutrinos are ~ 10%

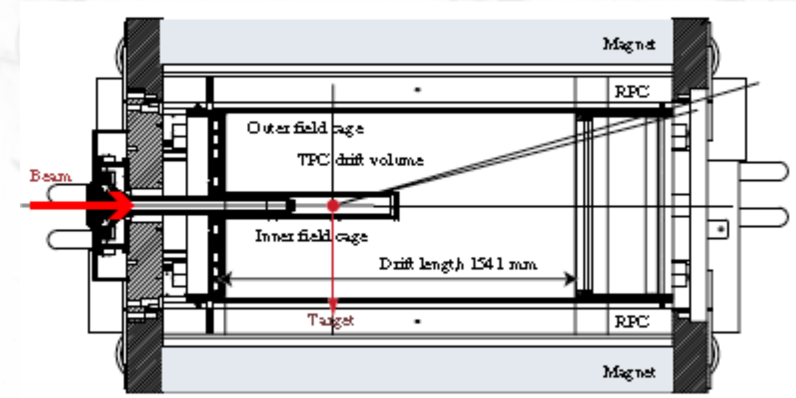


Plus
Lower thresholds.
full angular acceptance
Simple design

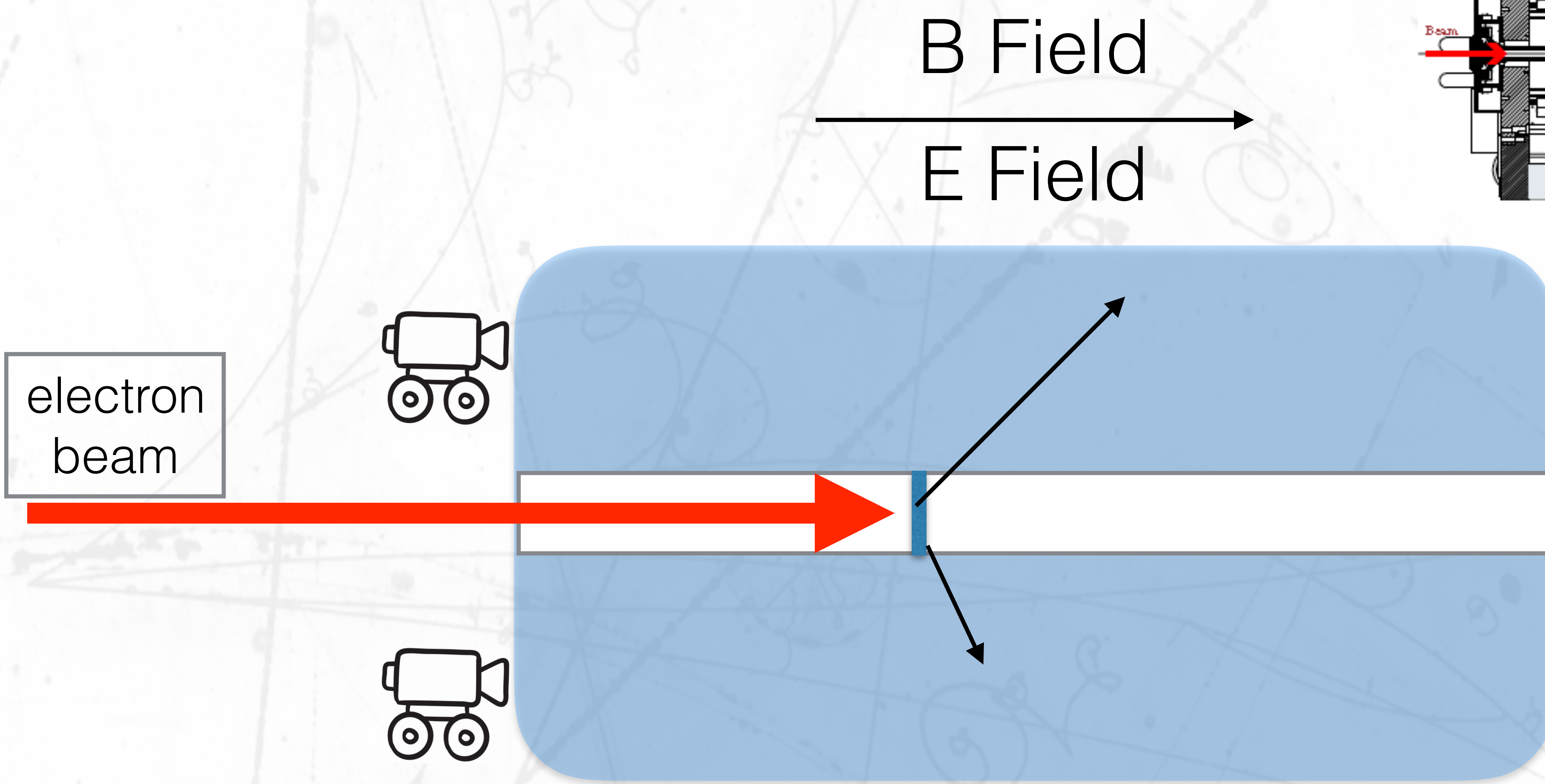
Minus
Non-uniform acceptance
Ion feed back and field distortions

Can we observe the nuclear recoil?

TPC detector: Option 2



Similar to HARP

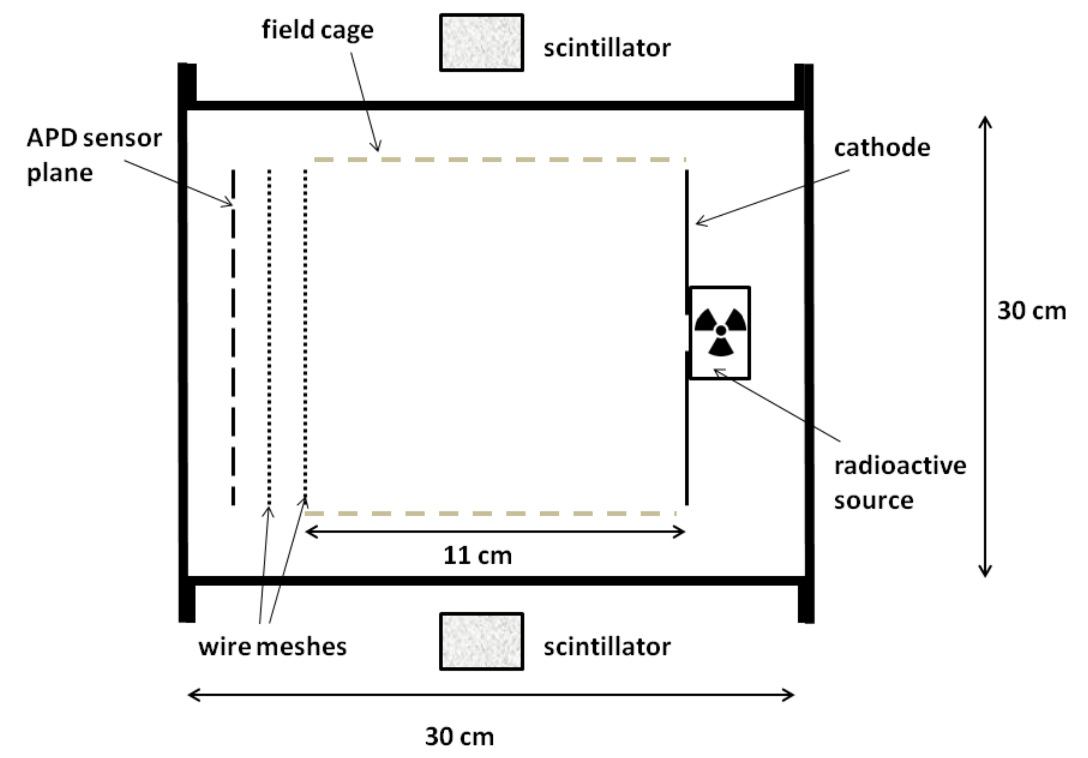


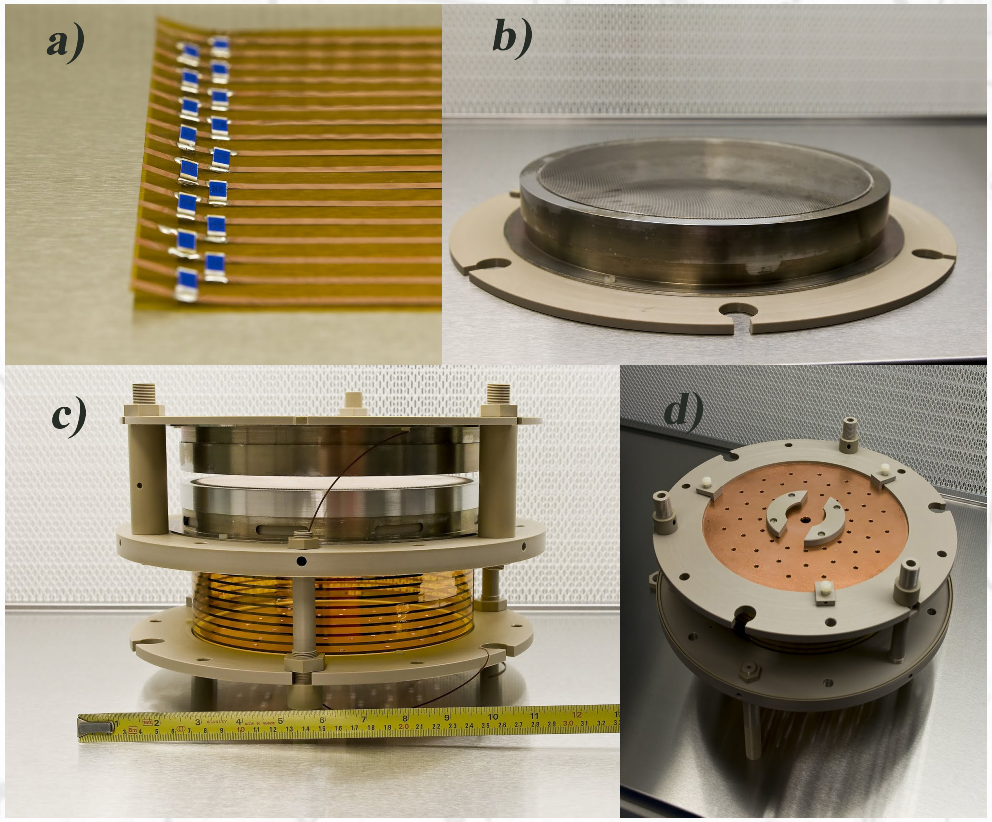
Plus
No ion feed-back
Easy to replace the target
Uniform acceptance (same interaction point)

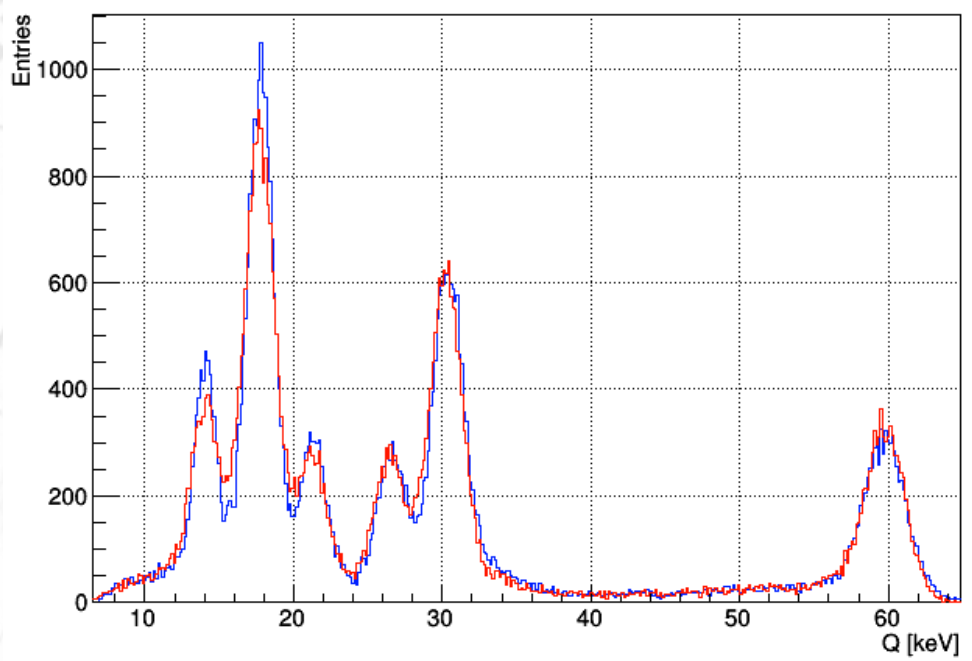
Minus
Not a full acceptance in p and angle
More complex field cage design.
Less similar to ν experiment.

R&D at UniGe

- Borrowed the HPTPC developed at IFAE(Barcelona).
- Chamber is 20x20x20 cm^3 with electroluminescence grid.
- Operated few years ago with APD readout and Xenon.
- Start a readout with MA-PMT and then try to implement a Medix readout.







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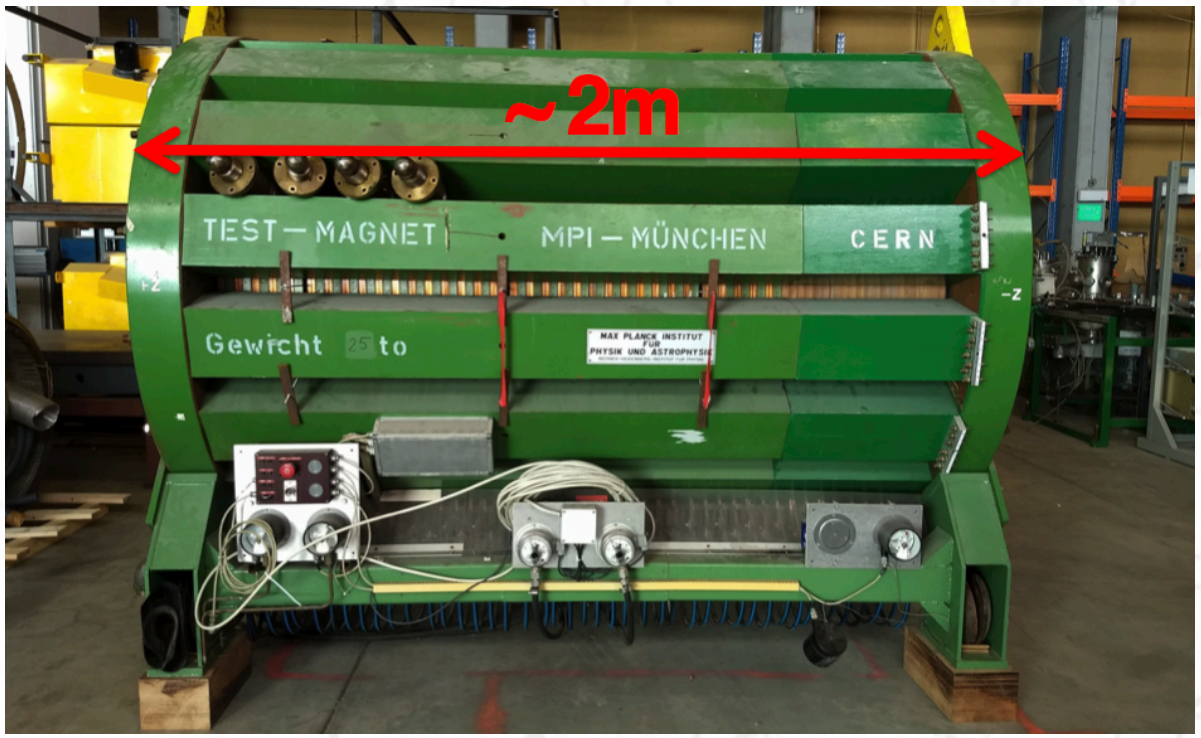
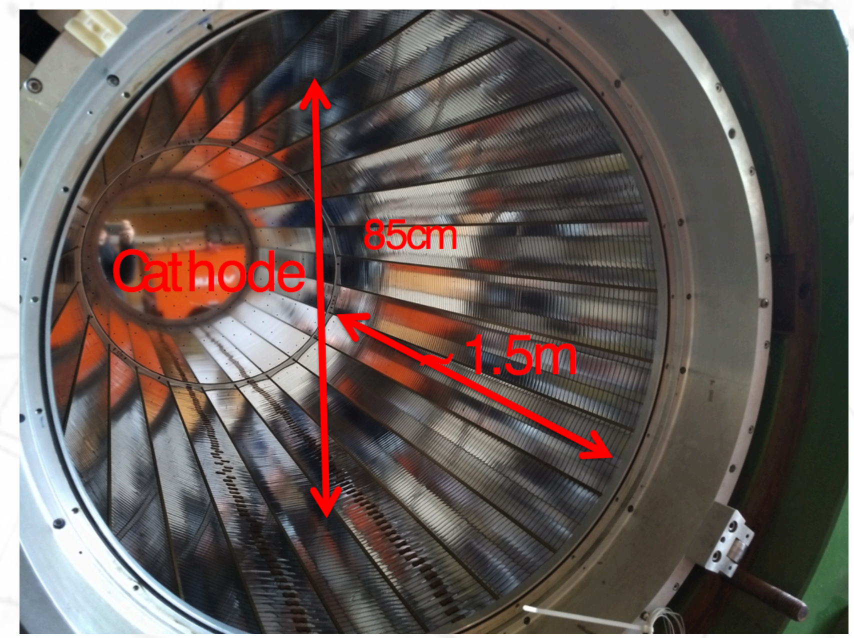
in a magnet

Even a 1bar TPC field cage from HARP is available





0.7 T solenoid magnet at CERN used for HARP and testbeds.

Some rough numbers

- Very crude cross-section estimation ($\theta > 30^{o}$) in carbon ~ 10^{-29} cm^2. I need more precise calculations (GiBUU?)

- Probability of interaction in the gas ($1e^{-3}$ g/cm^3) is ~$5x10^{-8}$/meter in a 1 bar detector.

  - It is a feasible number to get sufficient interactions.

  - The ratio of electrons to interacting electrons is very large (issues with detector performance).

Next steps

- It does not look a crazy idea but it needs refinement.
- Convince Mami this is an attractive experiment. Some simulations are needed to clarify:
  - S/N background in the TPC detector and effect on the TPC performance.
  - Sensitivity of detector to final states in the two configurations.
- Continue with the TPC R&D.
- Fine tune the physics reach of the experiment,
- Look for partners.
- Make a proposal.