GEM Detector Development for MAGIX

6th Apr 2016
LEPP Mainz

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Requirements & Challenges

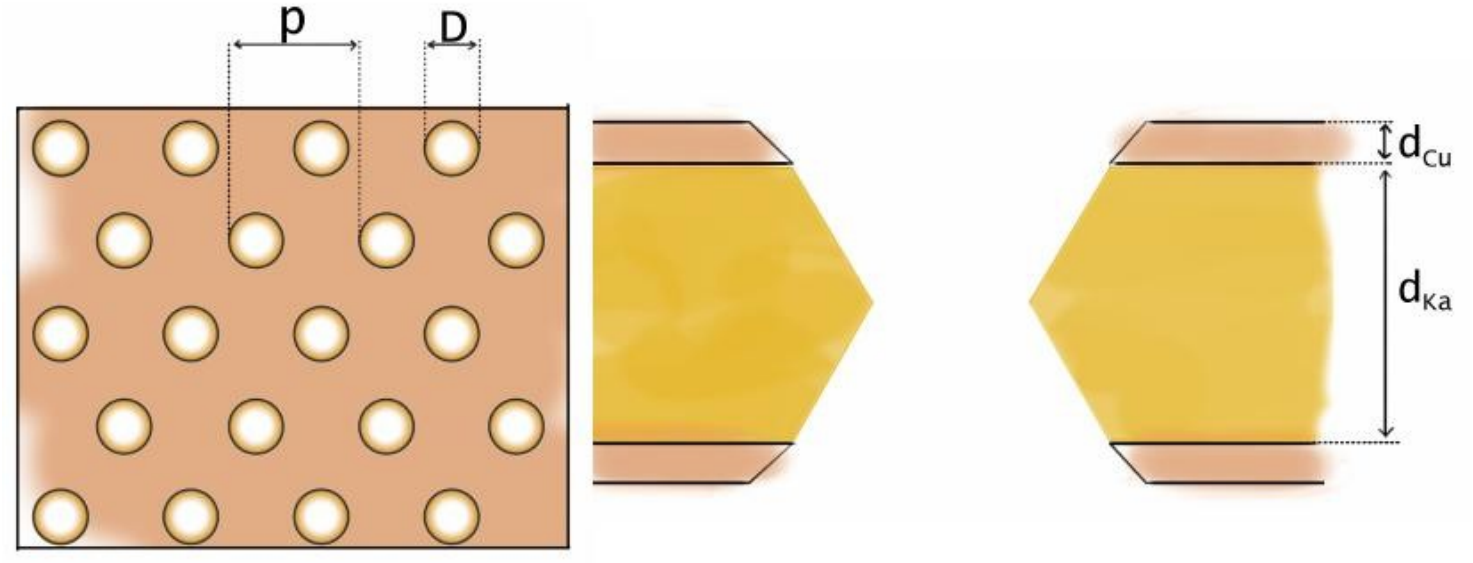
for the detector-system

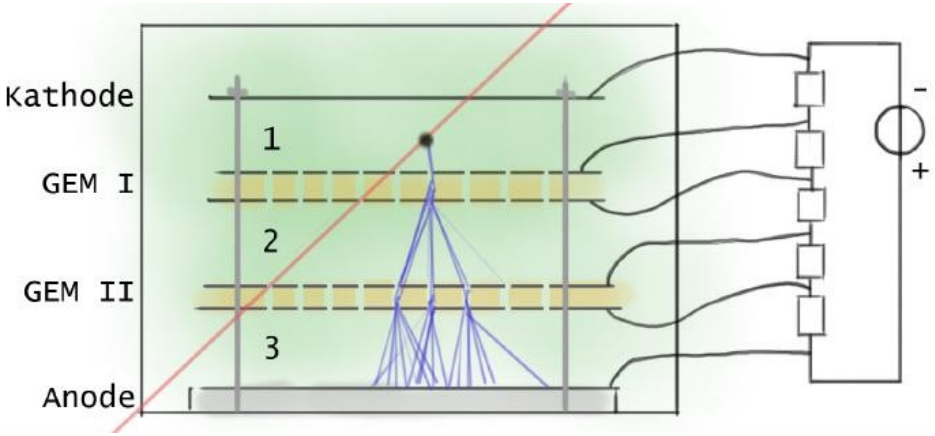
- Spatial Resolution < 50 µm
- Many Channels ~10k
- High Rate Capability ~1MHz

  (Luminosity: $10^{35}\ cm^{-2}\ s^{-1}$)
- Minimize Material Budget

  (Energy: < 105 MeV)
- Track Reconstruction
- Large Area 30 x 120 cm^2

GEM Gas Electron Multiplier





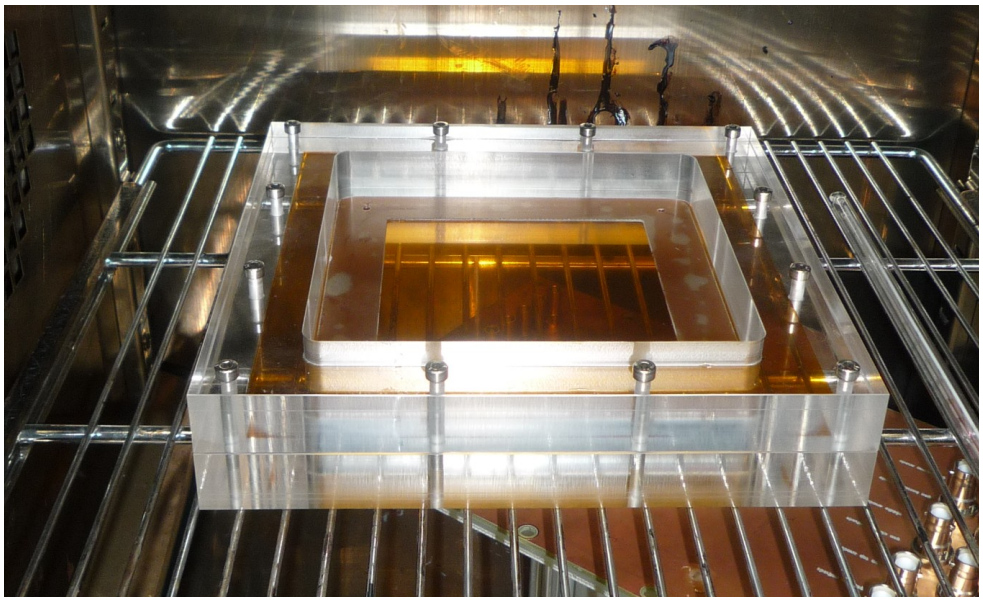
Pitch	p	=	70 µm
Diameter	D	=	140 µm
Copper	d_{Cu}	=	5 µm
Kapton	d_{Ka}	=	50 µm

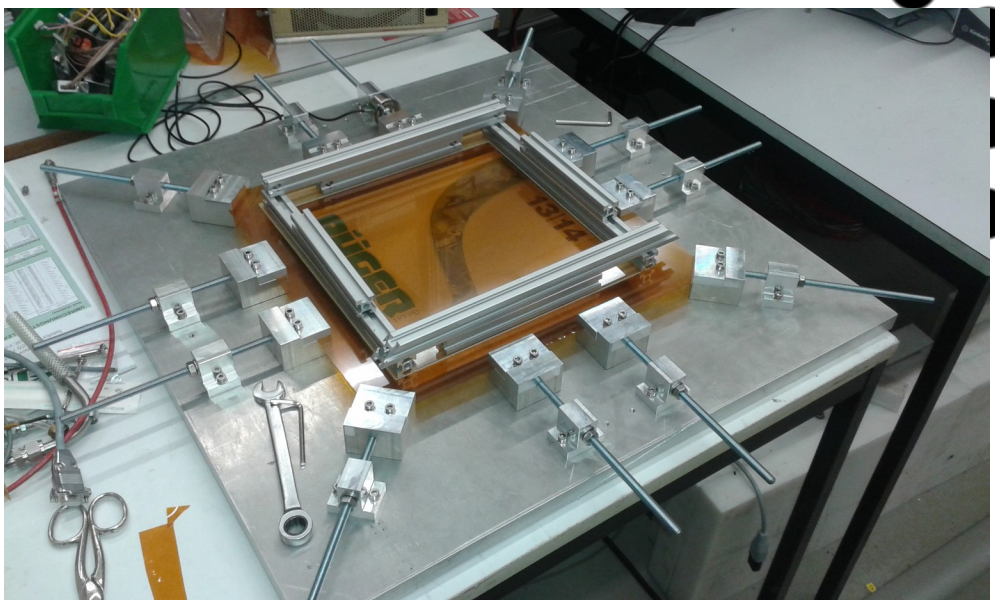
Requirements & Challenges

for the detector-system

- Spatial Resolution < 50 µm
  - → achieved by COMPASS
- Many Channels → APVs
- High Rate Capability ~1MHz
  - → Benlloch et al.
- Minimize Material Budget
  - → Simulation
- Track Reconstruction
  - → Try GEM hodoscope first!
- Large Area 30 x 120 cm^2

Stretching





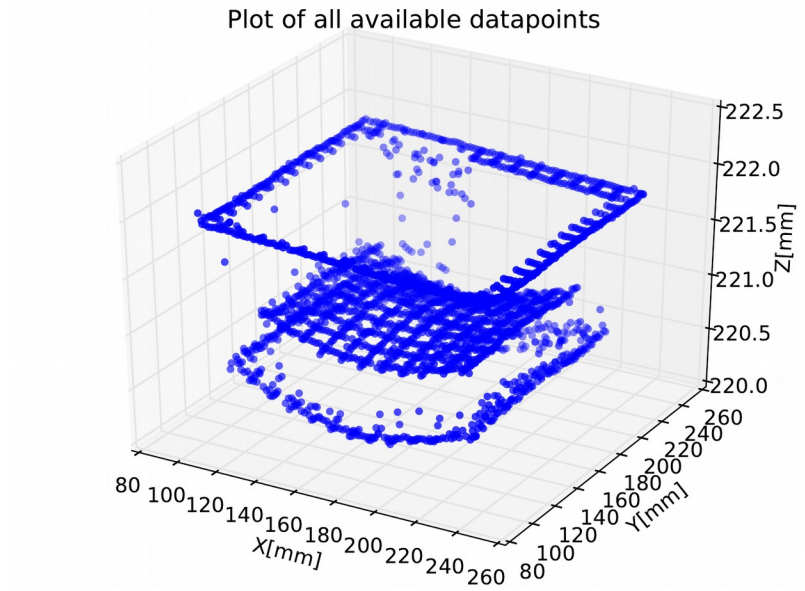
Thermal Stretching

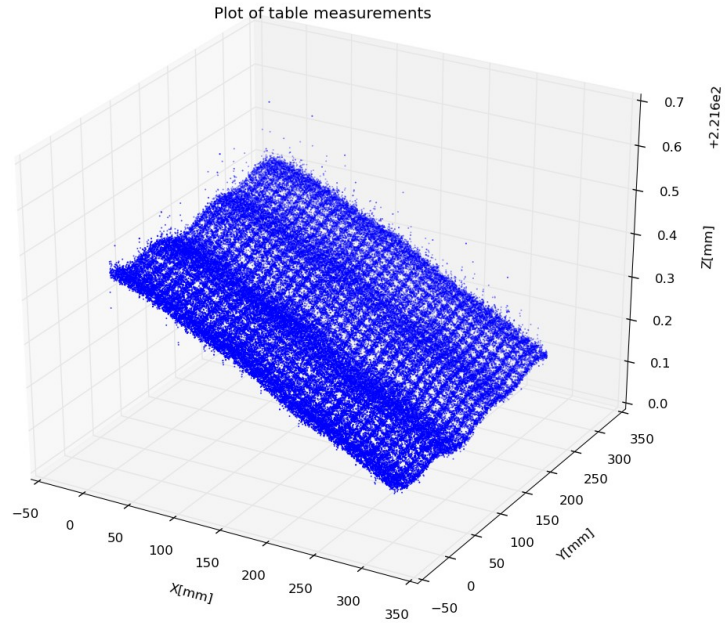
- ΔT ~ 80 K
- Used for 10x10 GEMs
- Not scalable

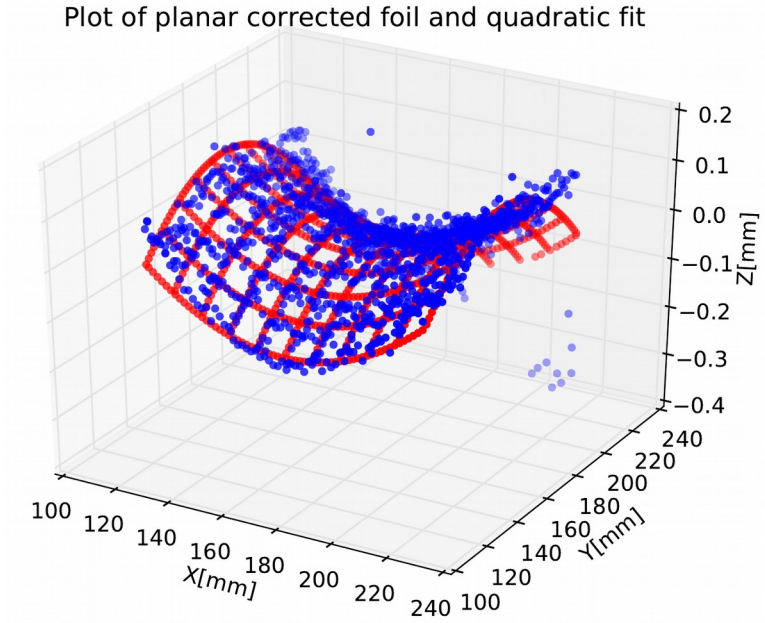
Mechanical Stretching

- Tensiometer controlled
- Method for 30x30 GEMs
- Under development
- Works for mashes as well

Profile Measurement



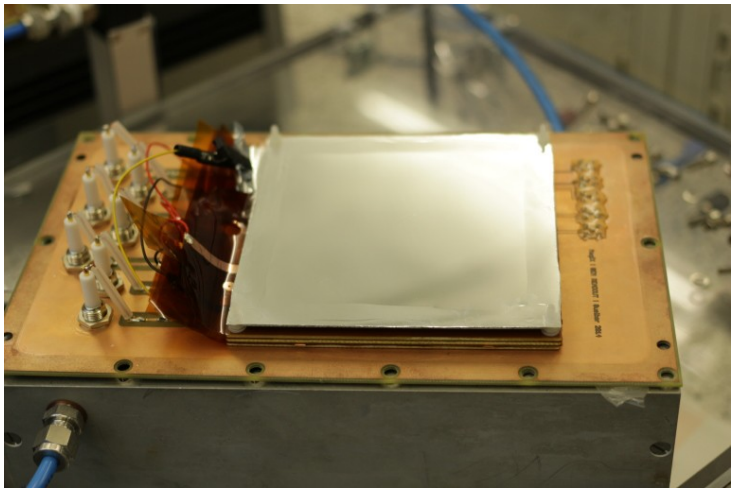


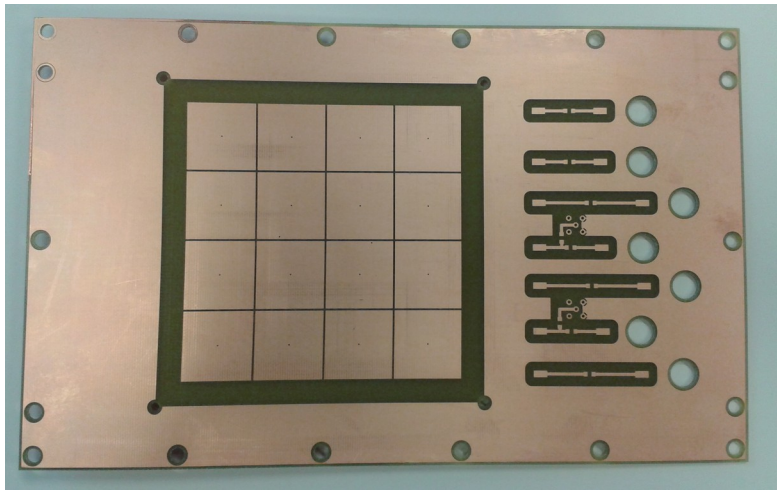


- Take data of foil
- Take data of table
- Correct foil data
- Apply linear and quadratic Fit

→ Sagging < 100 µm

GEM Development

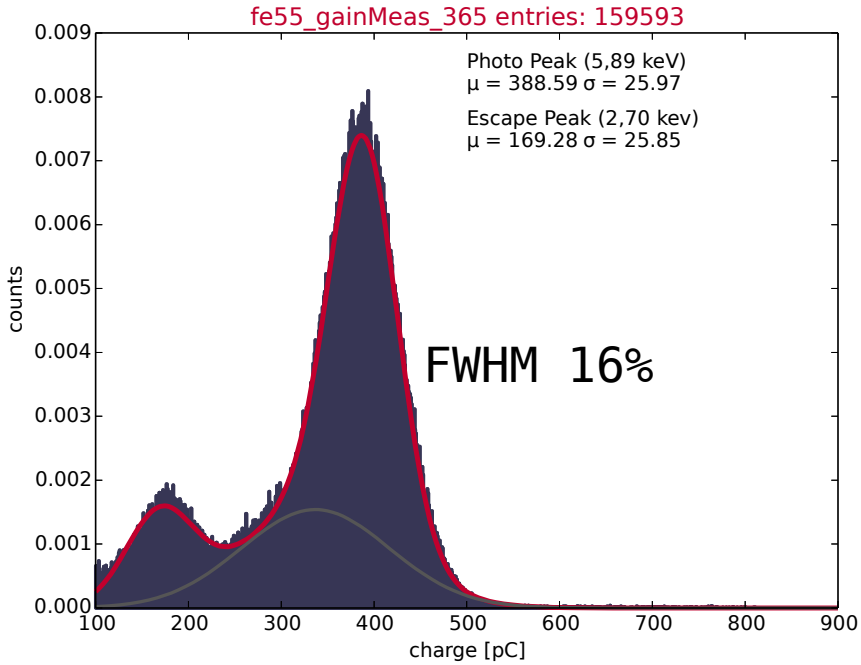


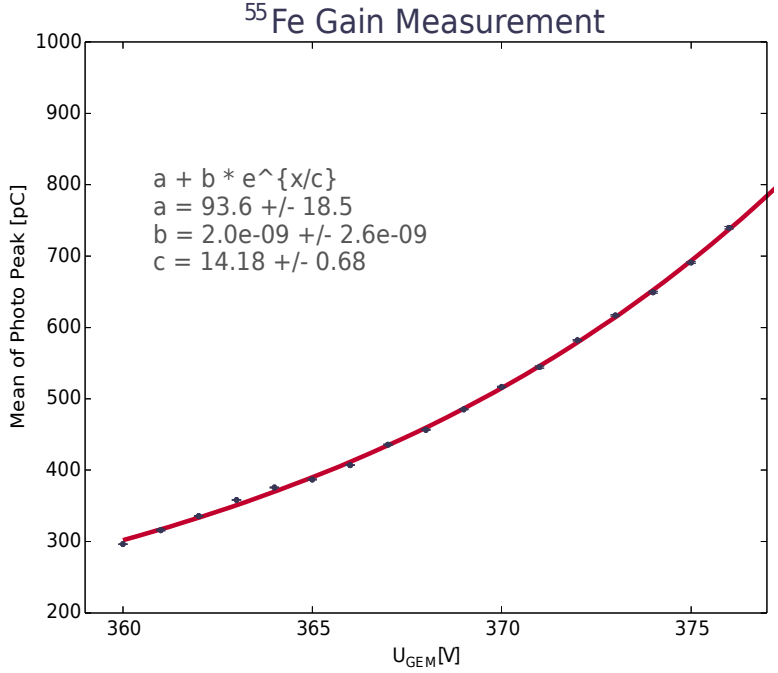


- GEMs trained and stretched
- 10x10 Prototype working

- In house production of readout PCBs
- 16 pad-readout to measure gain uniformity is set up

GEM Development





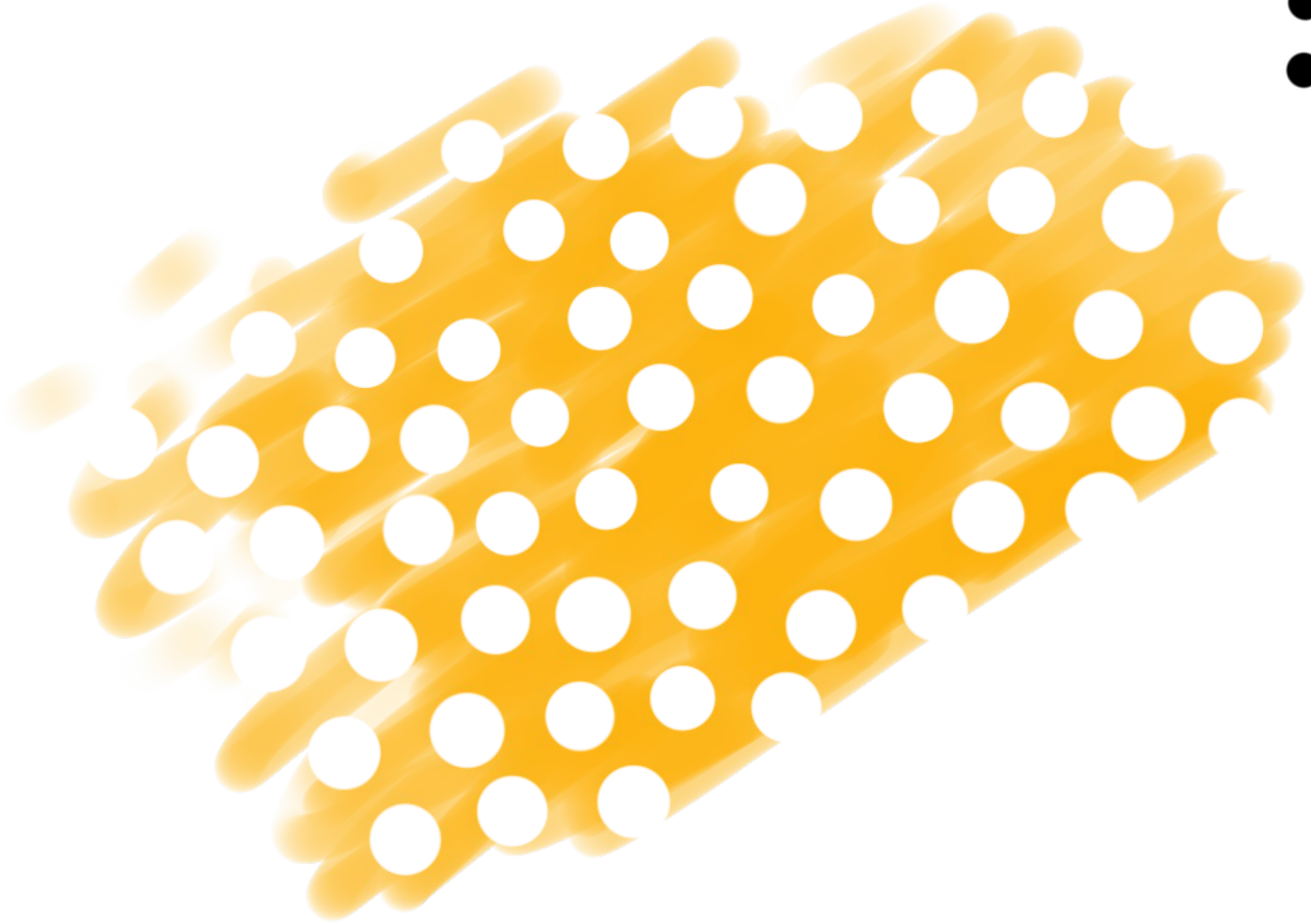
^{55}Fe-Spectra taken with QDC

- Single channel readout PCB
- Built PreAmp for GEMs
- Self triggered via LE-discriminator

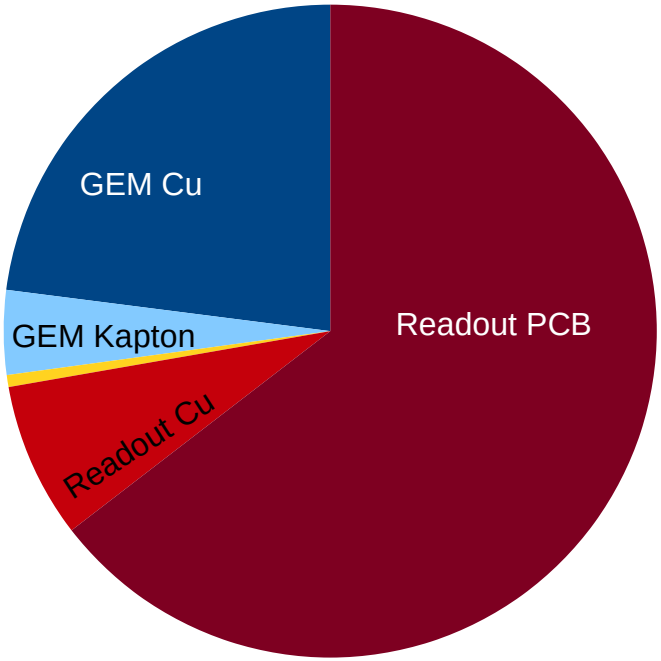
Vary U_{GEM}

- Fit charge of photo and escape peak for different voltages
- Plot and fit with exp-function

Ongoing

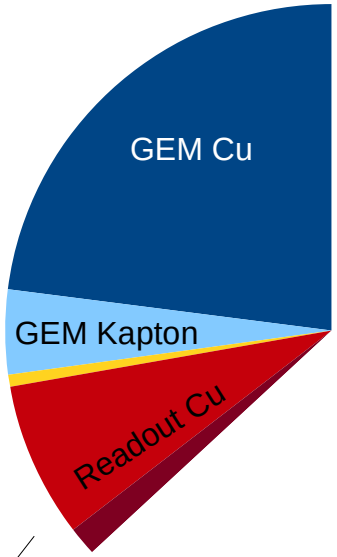


Material Budget



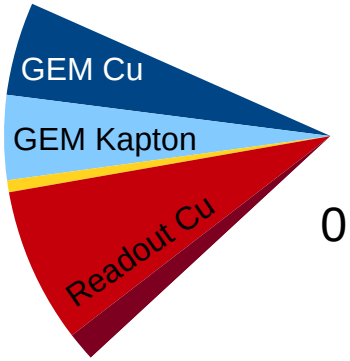
Default triple GEM detector
0.96% X_0

Foil
Readout
100 µm
Kapton



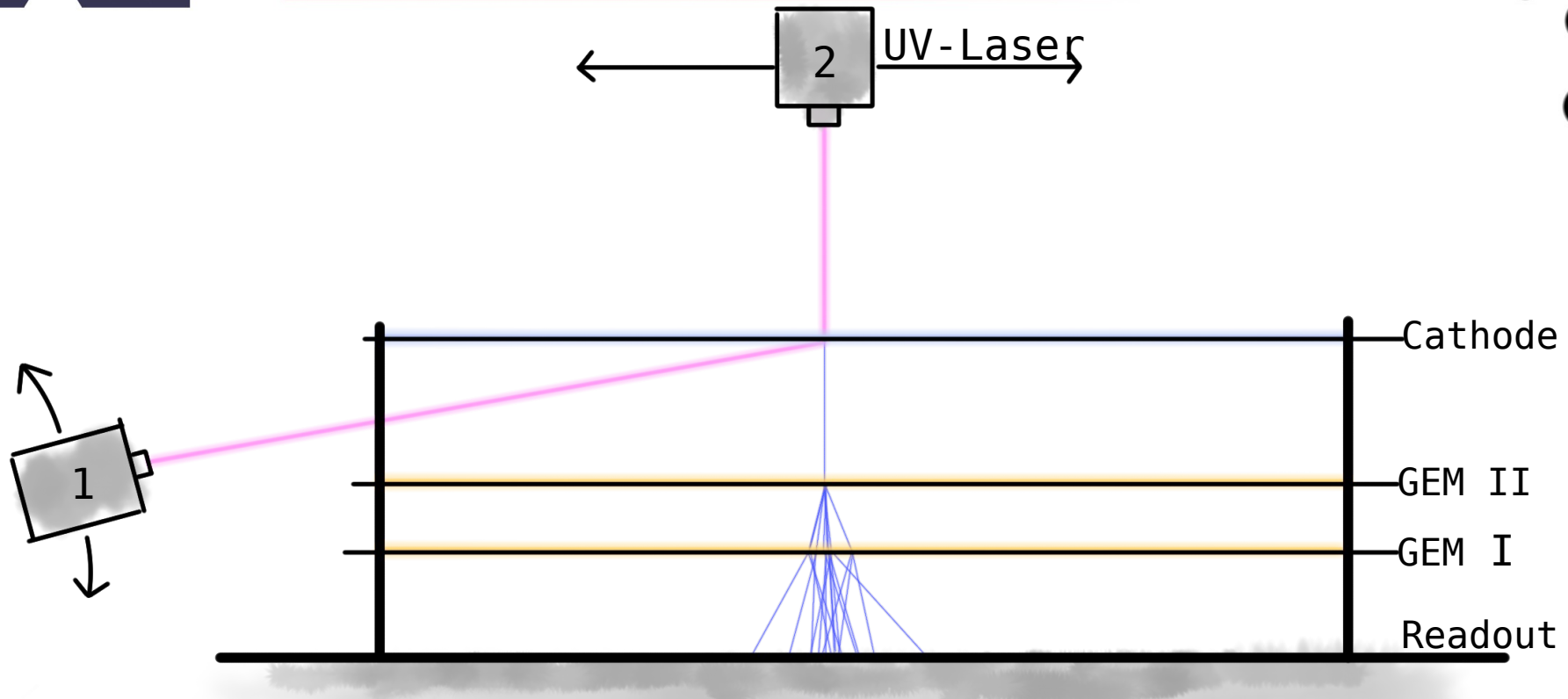
0.38% X_0

1 µm Cu
GEMs



0.22% X_0

Laser Calibration



Diploma Thesis: Mirco Christmann

Set up detector prototype (10x10) with multi channel readout.

Perform conventional calibration with MICROMEGAS-Hodoscope.

Proof of concept for the laser calibration setup.

Side (1)

W_{Cu} = 4,4 eV > W_{Al} = 4,1 eV

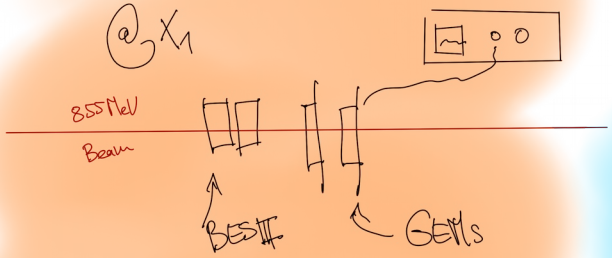
Illuminate Al-dots on Cu-cathode with UV light to extract electrons on fixed grid. (T2K-Method)

Top (2)

Use a movable UV-Laser to create electrons on the bottom side of a thin aluminized Mylar cathode.

Beam Times

1st Test 21/22

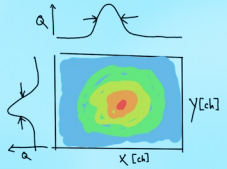


→ See Signals!

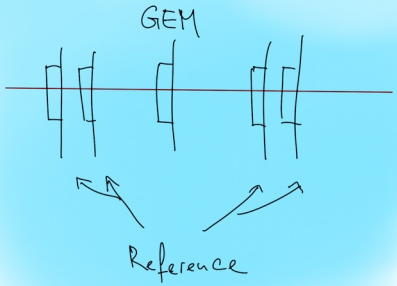
Requirements
- Gassystem
- HV
- DAQ

optional
- Multi Channel Daq

2nd Test 34/37



→ Point Resolution



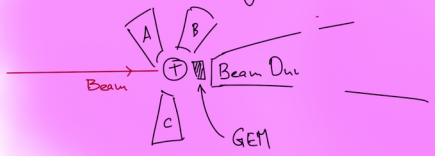
+Requirements
- Reference Detectors
- Multi Channel Daq

optional
- xy Table

3rd Test 47/49

@A1

→ High Rate Tests



Requirements
- Temperature Probe ?
- Camera
- Det in Spectrometer as well?

Summary

- GEM Tracker for focal plane
- Infrastructure for GEM development set up
- First prototype operational

next steps:

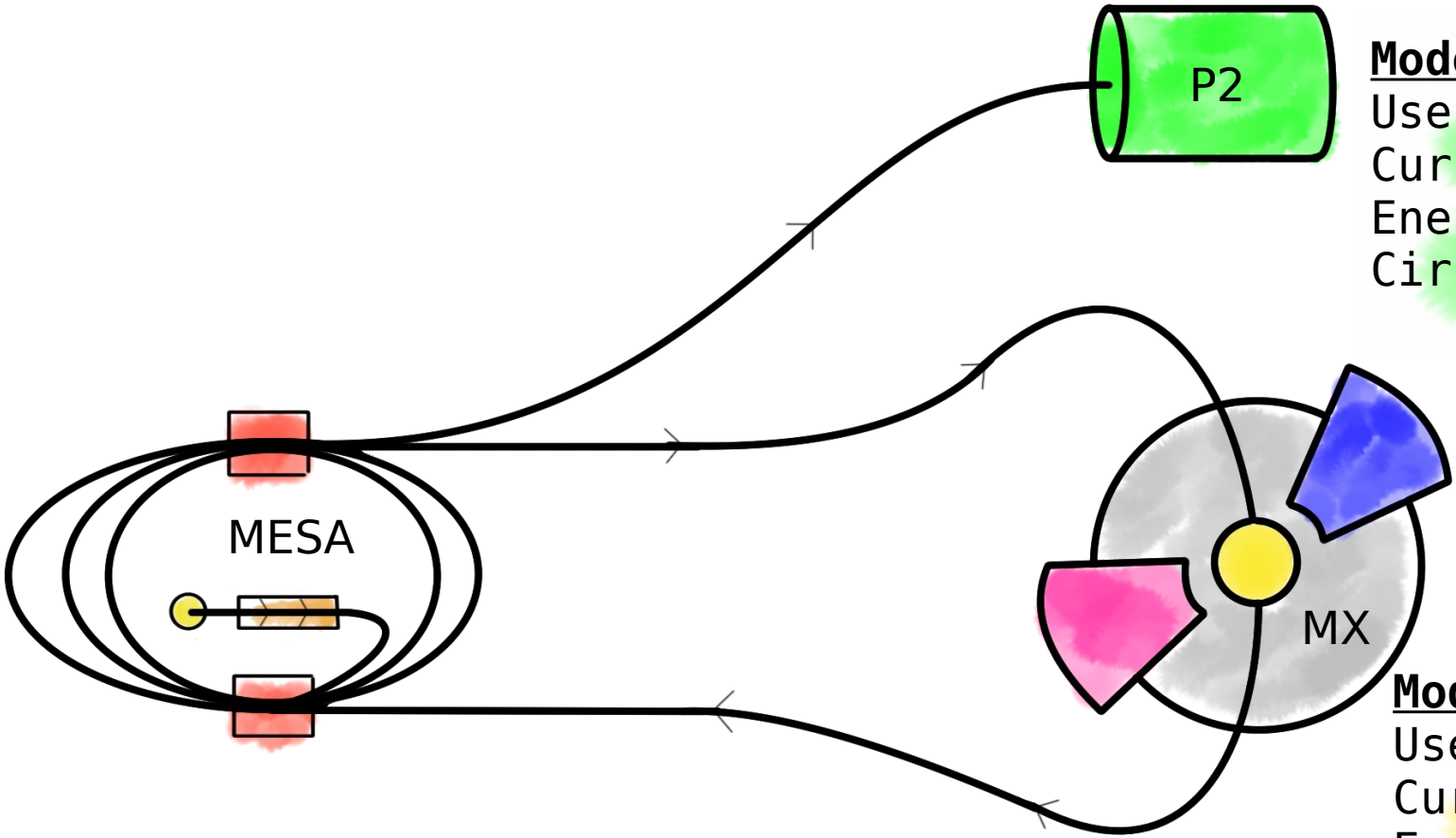
- Going bigger
- Going thinner

Thank you

magix.kph.uni-mainz.de

Backup

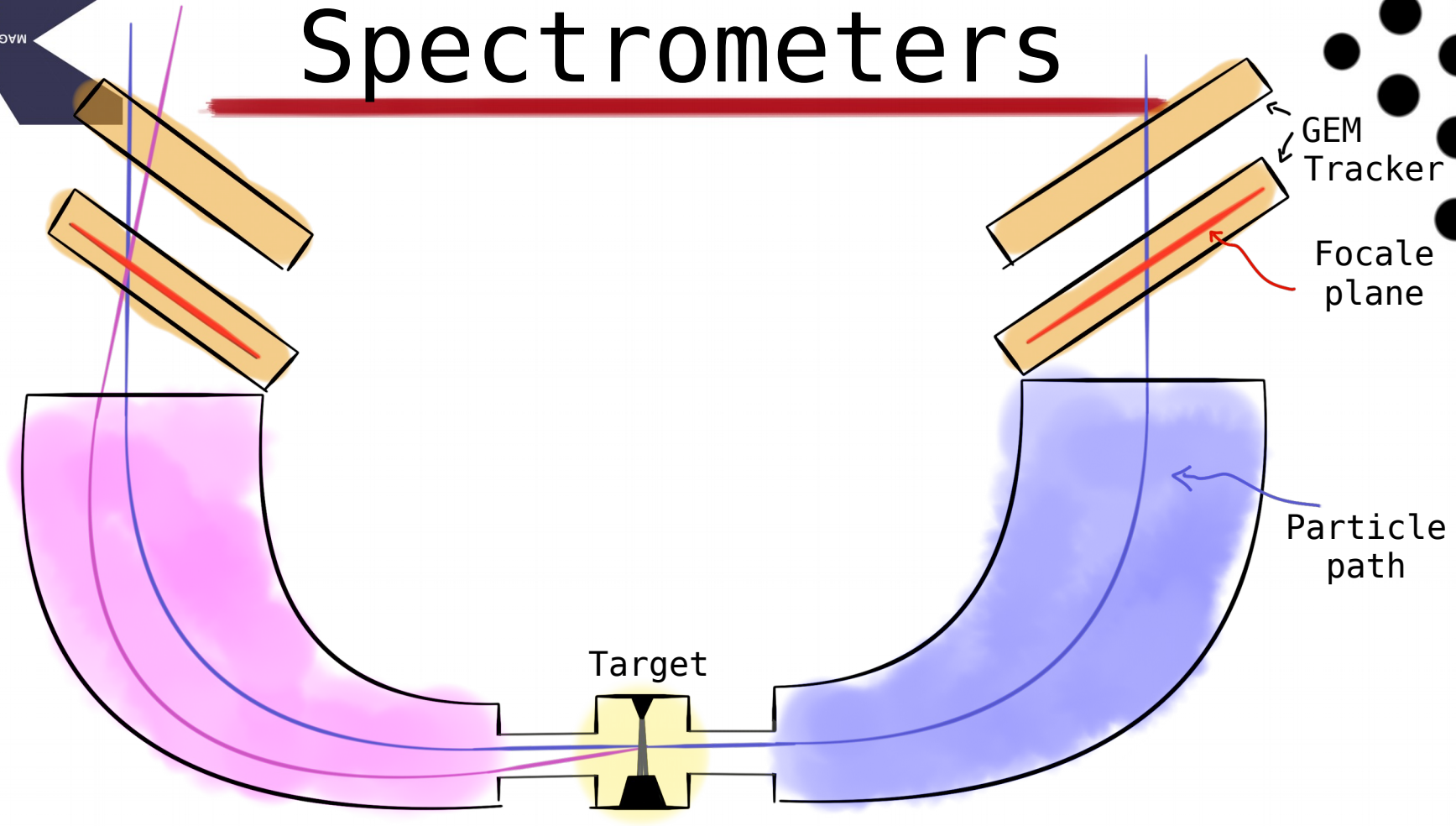
MESA - MAGIX



Mode: **EB**
User: P2
Current: 150 µA
Energy: 155 MeV
Circulations: 6

Mode: **ERL**
User: MAGIX
Current: 10 mA
Energy: 105 MeV
Circulations: 4

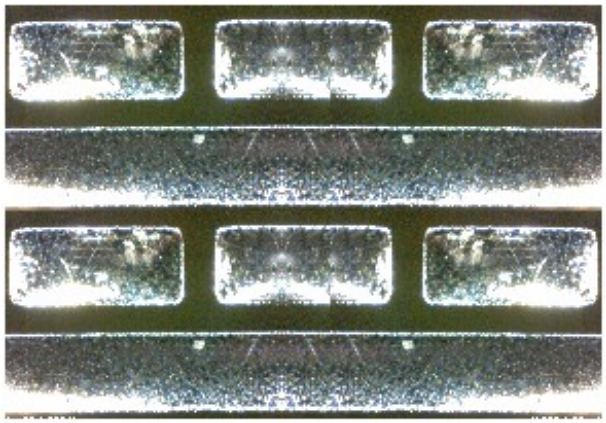
Spectrometers

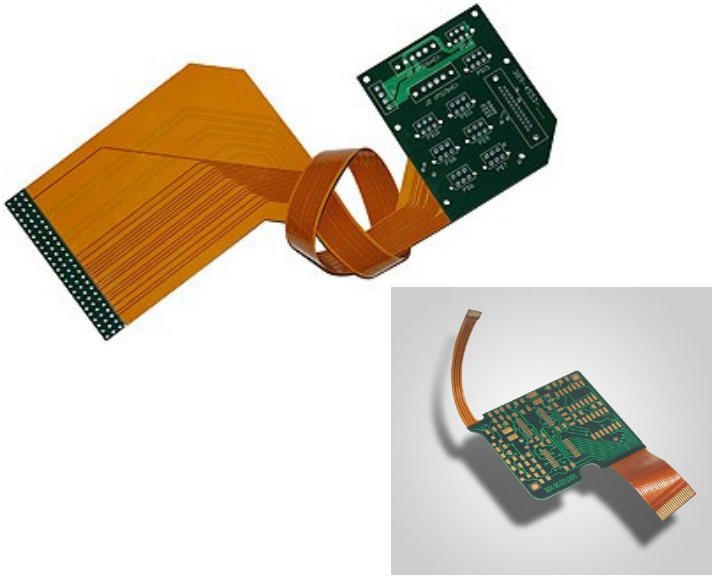


The particle paths are bended inside the magnet spectrometers in such a way that momenta and scattering angles are mapped to points in the focal plane, which are measured by GEM detectors.

Luminosity:	$10^{35}\ cm^{-2}\ s^{-1}$
rel. Momentum Res:	$< 10^{-4}$
Angular Res:	< 0,9 mrad

Readout PCB





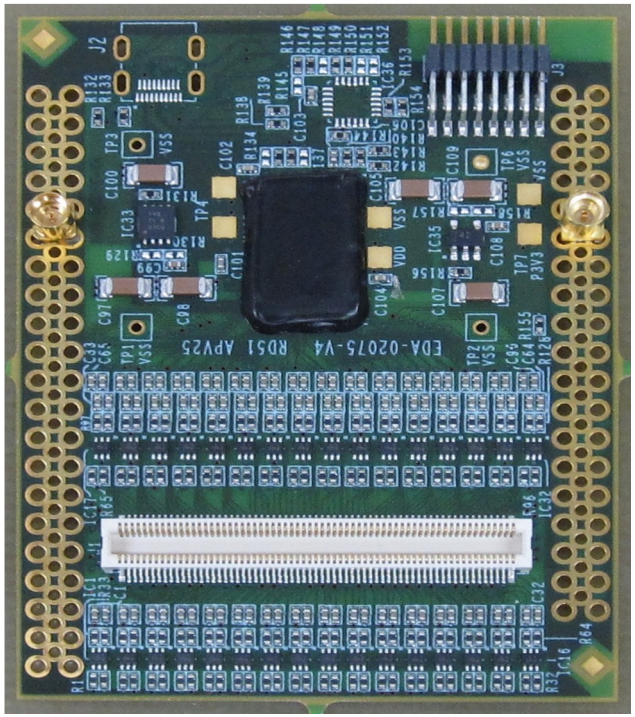
Design Readout PCB

- different pitches
- pads and stripes
- angle between coordinates
- hex pads?

Minimize Material Budget

- Use Kapton based readout foil
  → FlexPCB
- Use Electroplating
  → Peter Bernhard
- Think about Connectors

Multi Channel Readout



- INFN Readout System
  - APV25
  - 128 Channels per FrontEndCard
  - 40 MHz
  - Full Wavaform of each Channel