"Leopard" system progress within the AIDA-2020

Gábor Galgóczi, Gábor Nyitrai,
Gergő Hamar, Dezső Varga

Wigner RCP, Budapest
REGARD group

Eötvös Loránd University, Budapest, Hungary

Outline

- Motivation
- „Leopard” system
- AIDA-2020 Milestone – current status
- Ongoing R&D work
- Summary

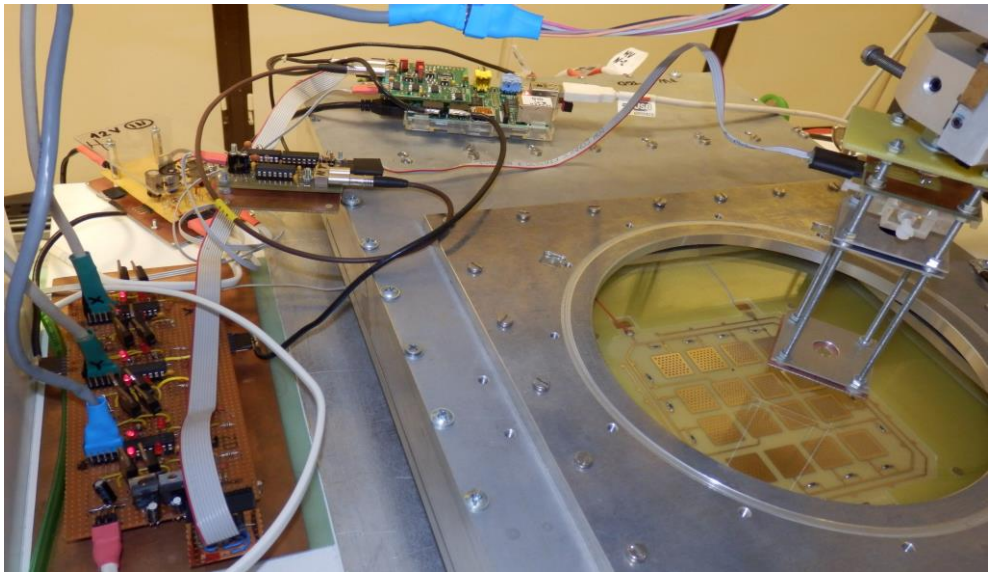
Motivation

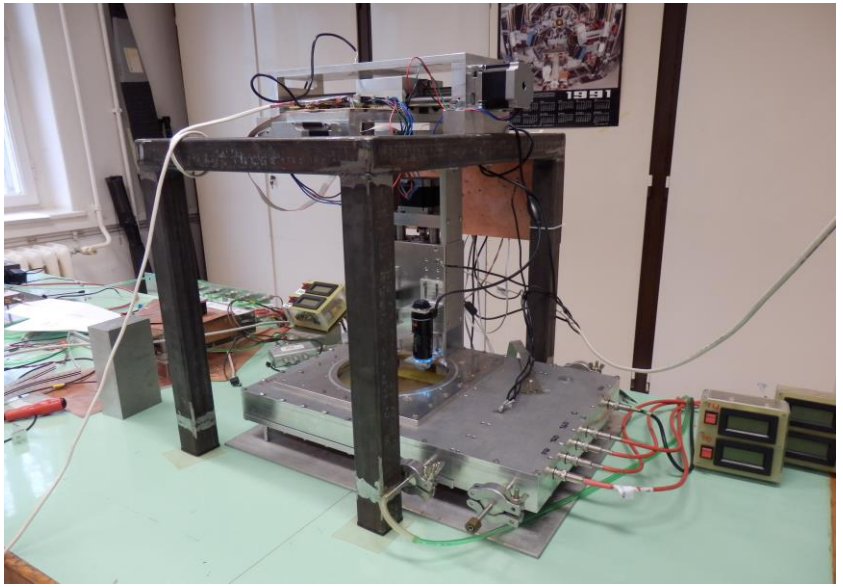
- 1. Building a gain scanner prototype for QA purposes of (T)GEMs → AIDA-2020
- 2. R&D:
  - Effect of defects on gain / stability
  - Role of bias voltages on photon sensitivity
  - Understanding microprocesses

"Leopard" -- a long story short

1. First paper on the concept in 2012
2. RD51 Common Funded Project
3. AIDA-2020 Sub-task 13.4.4

Partners: Wigner RCP (Budapest) and INFN Trieste





AIDA-2020 milestone

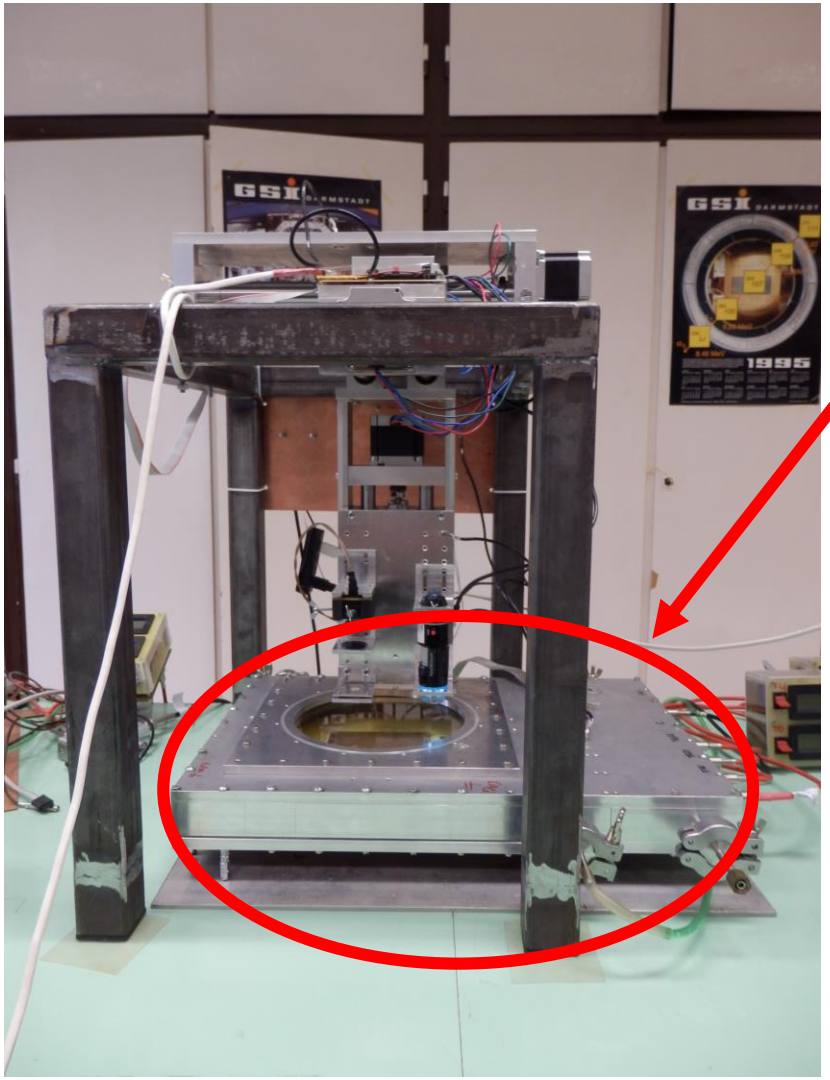
Month 12 milestone in May:

- Small size prototype of optical / gain scanning
- Establishing correlation
- Understanding key features towards industrial version
- Initiation of a longer term R&D in parallel with large version construction

Month 44 deliverable:

- Large size demonstrator for MPGD hole-by-hole gain map for QA purposes

Leopard system



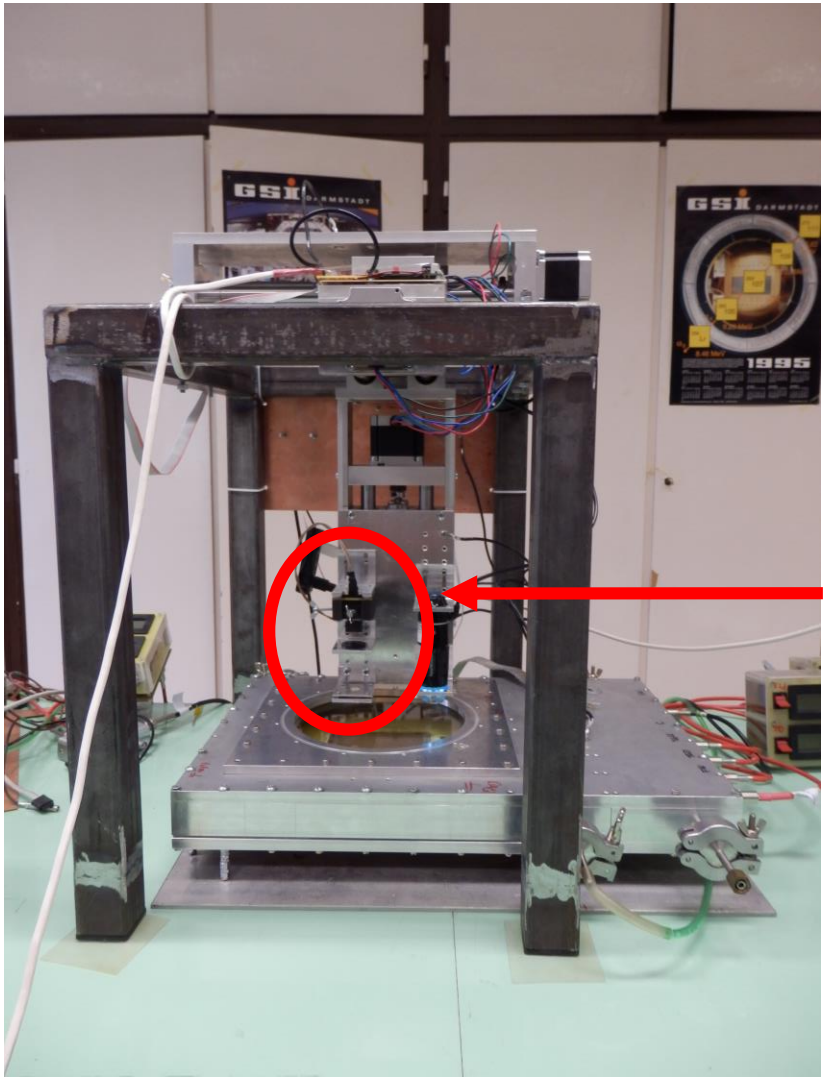
Built for high spatial resolution gain and p.e. yield scanning of (T)GEMs

- **Chamber:**
  - **Single layer of (T)GEM**
  - **Postamplification with wires**
- Optical system

→ focusing UV photons onto THGEM

- Microscope
- Stepping motor system → Scans
- DAQ with RPi

Leopard system



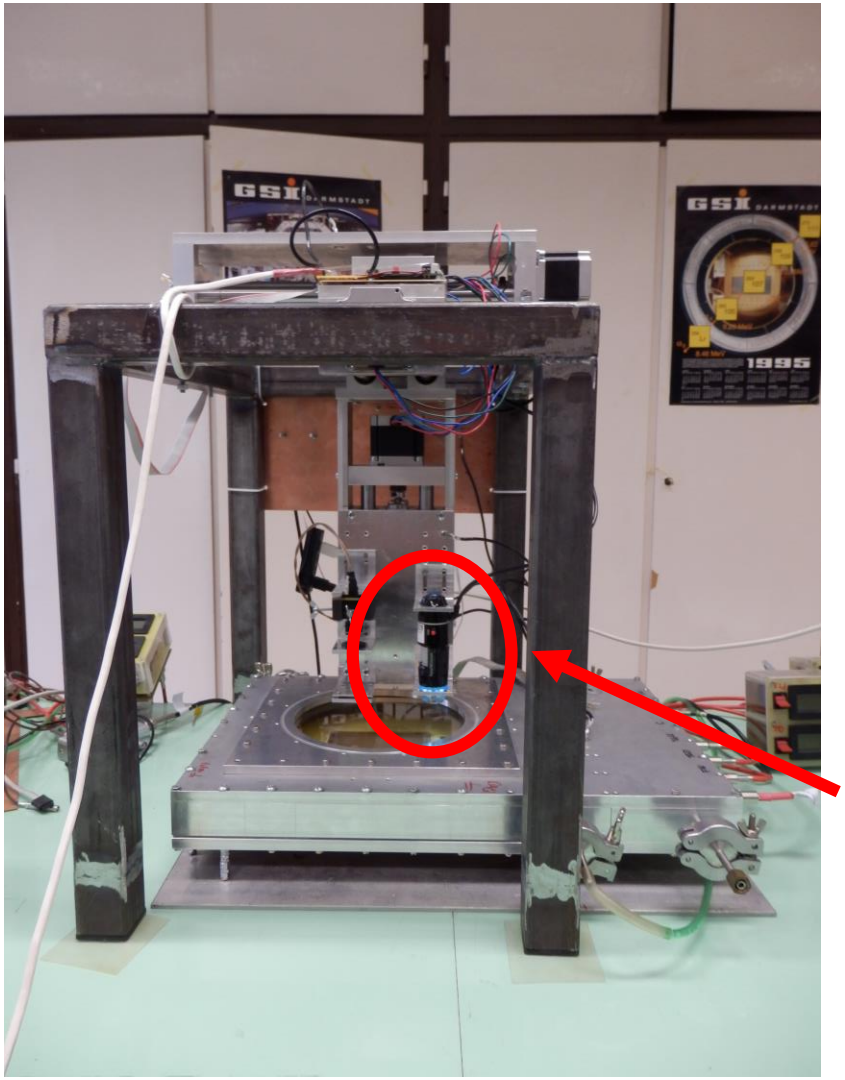
Built for high resolution scanning gain and p.e. yield of (T)GEMs

- Chamber:
  - Single layer of (T)GEM
  - Postamplification with wires
- **Optical system:**

→ focusing UV photons onto (T)GEM

- Microscope
- Stepping motor system → Scans
- DAQ with RPi

Leopard system



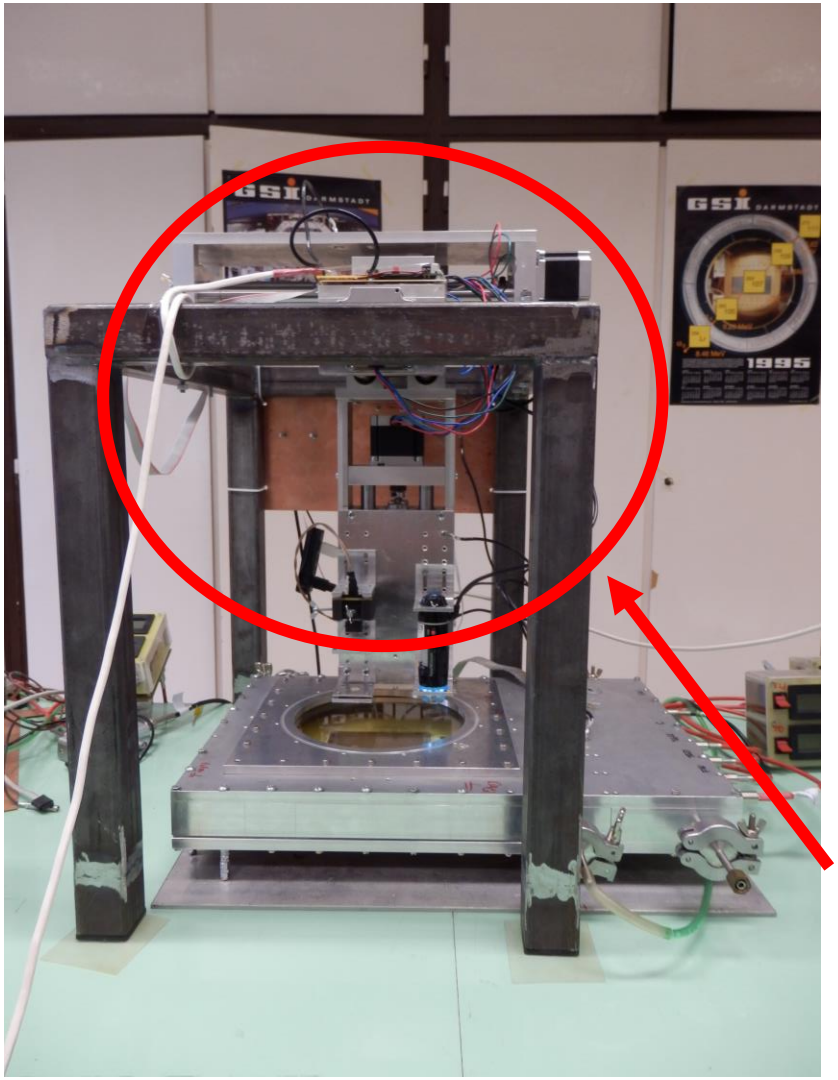
Built for high resolution scanning gain and p.e. yield of (T)GEMs

- Chamber:
  - Single layer of (T)GEM
  - Postamplification with wires
- Optical system:

→ focusing UV photons onto THGEM

- **Microscope**
- Stepping motor system → Scans
- DAQ with RPi

Leopard system



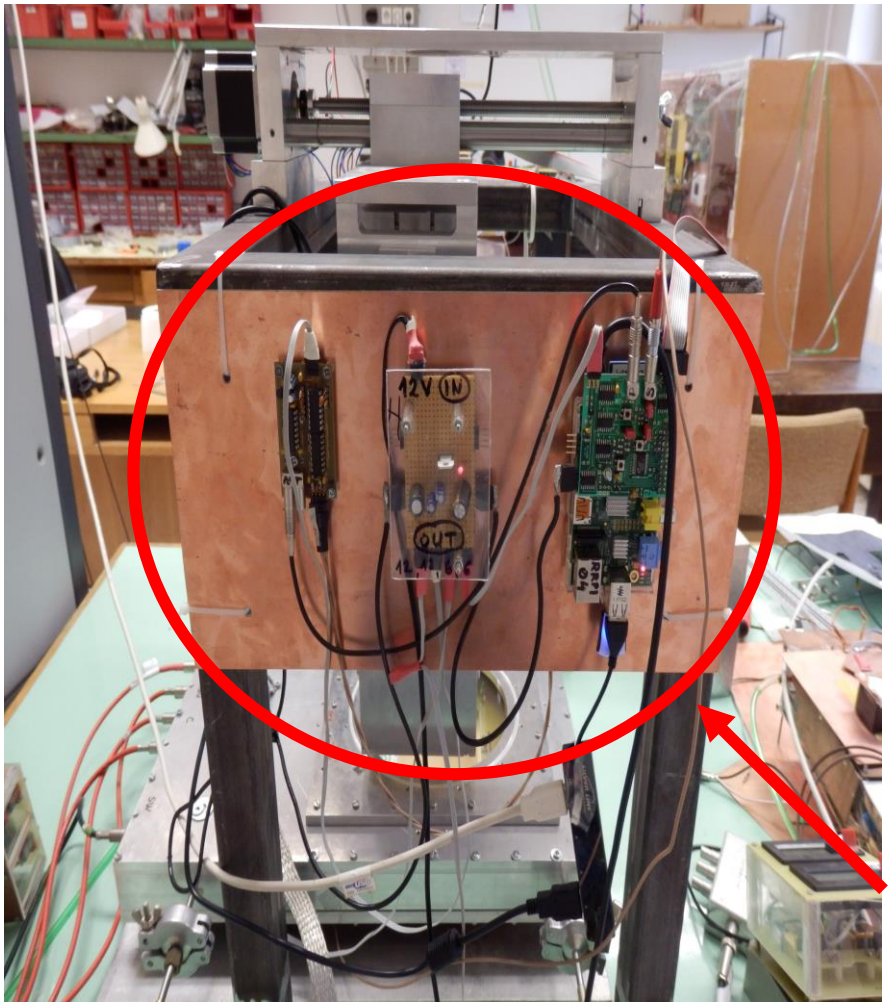
Built for high resolution scanning gain and p.e. yield of (T)GEMs

- Chamber:
  - Single layer of (T)GEM
  - Postamplification with wires
- Optical system:

→ focusing UV photons onto THGEM

- Microscope
- **Stepping motor system → Scans**
- DAQ with RPi

Leopard system



Built for high resolution scanning gain and p.e. yield of (T)GEMs

- Chamber:
  - Single layer of (T)HGEM
  - Postamplification with wires
- Optical system:

→ focusing UV photons onto THGEM

- Microscope
- Stepping motors → Scans
- **DAQ with RPi**

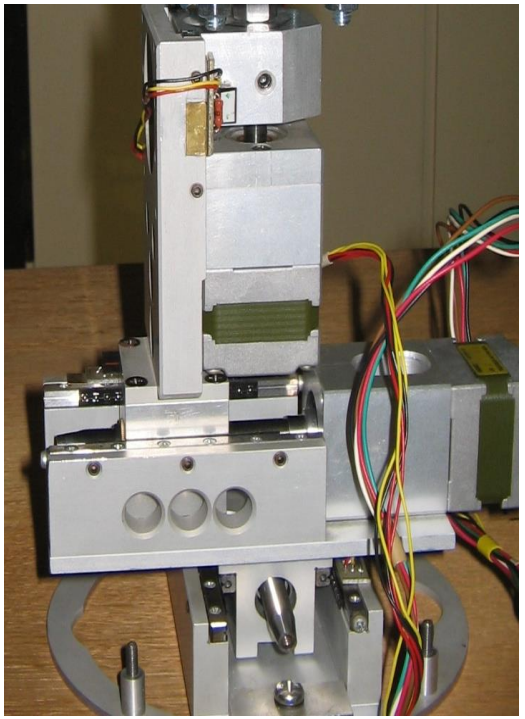
Towards ”production” tool

Main tasks:

- Fast positioning
- Fast focusing and setup
- Position verification with optical imaging
- Time efficient scanning

Stepping motor system

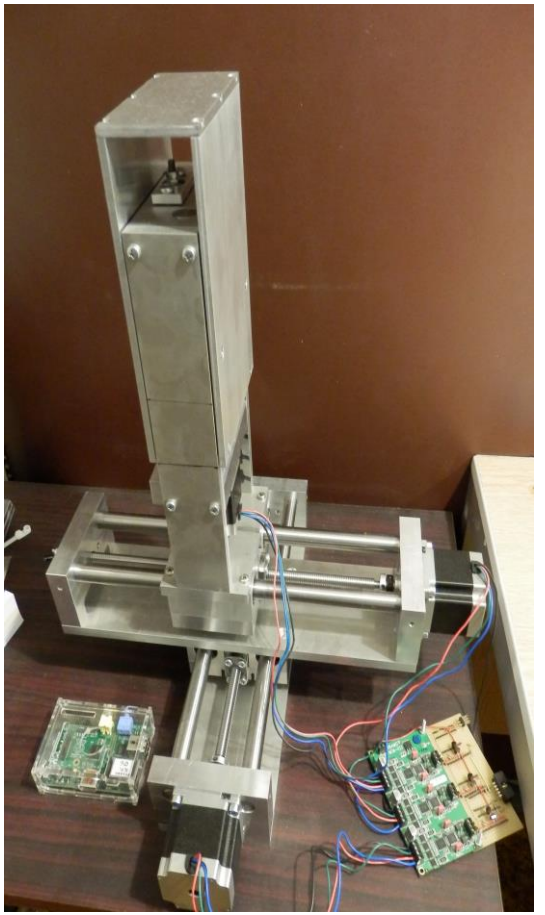
Previous version



New parameters:

- Covered area: 20x20 cm^2 (vs. 5 x 3.5 cm^2)
- Step size: 2.5 µm
- Programmable
- Faster motors → reduced time

Current version



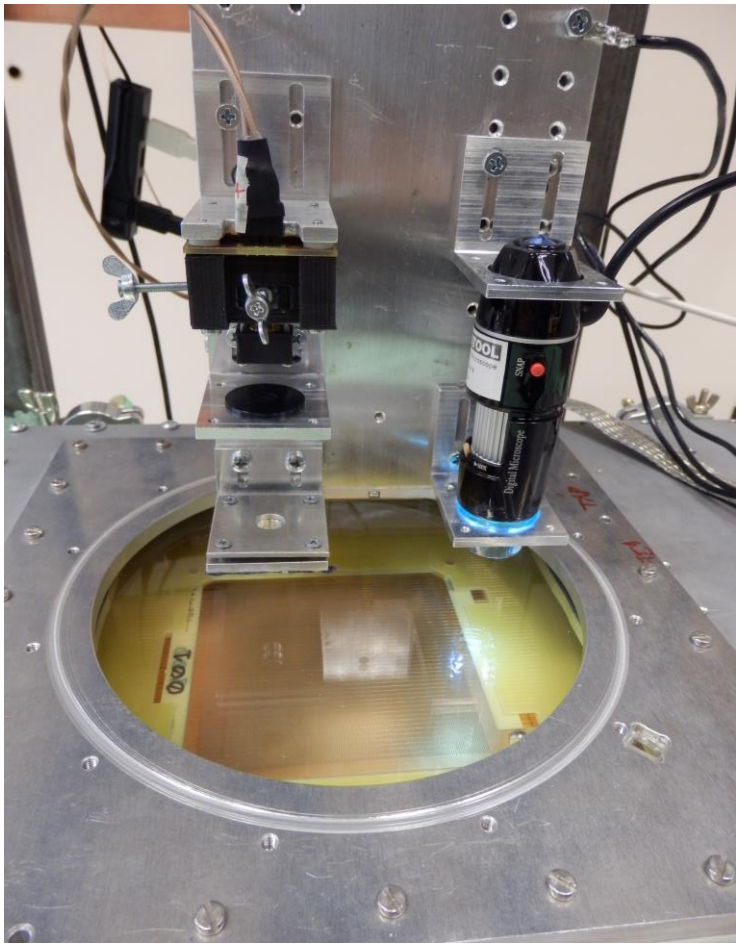
The optical system

New parameters:

- 3D printed LED adjuster
- Fine tune prefocused LED position
- Interchangable elements
- Robust structure

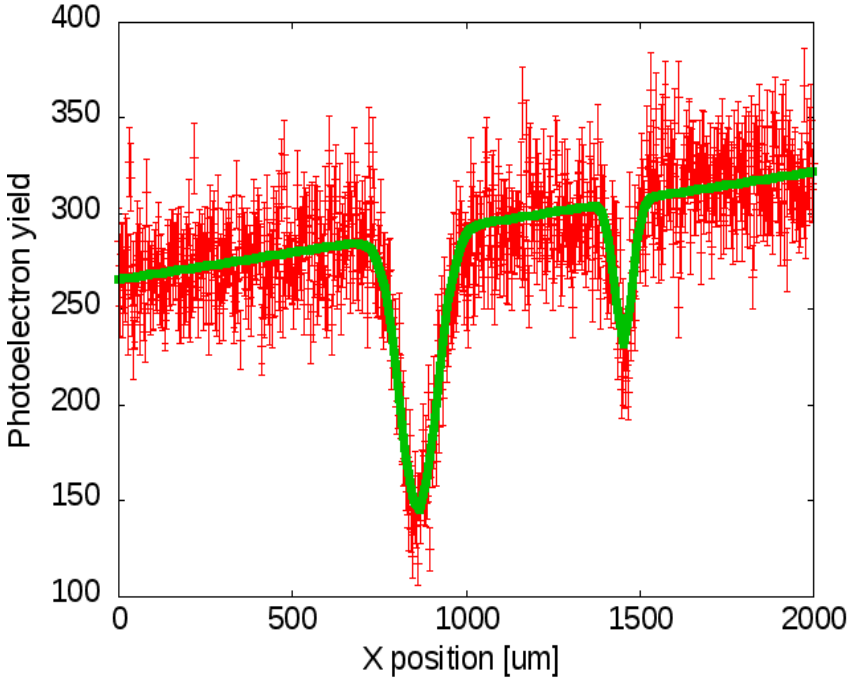
USB Microscope:

- Connected to RPi
- Correlating optical images with scans
- Tuning focal distance



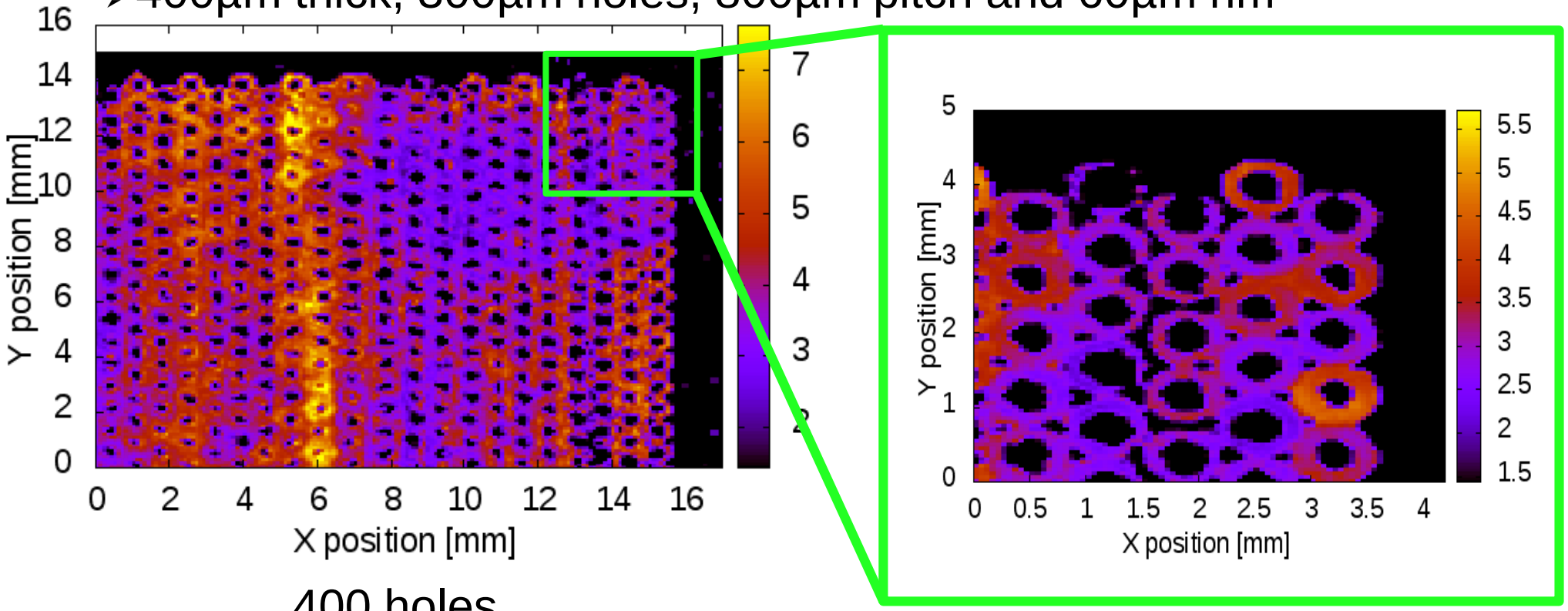
Position resolution

- Using a 30 µm pinhole
- Focusing the light on wires
- FWHM of 60 µm → GEMs!



Demonstrating gain scans

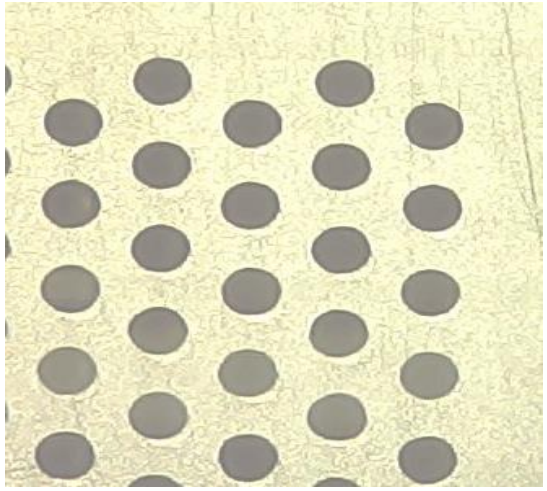
- TGEM (produced by Rui De Oliveira in 2009)
  - Well studied old reference piece
- 400µm thick, 300µm holes, 800µm pitch and 60µm rim



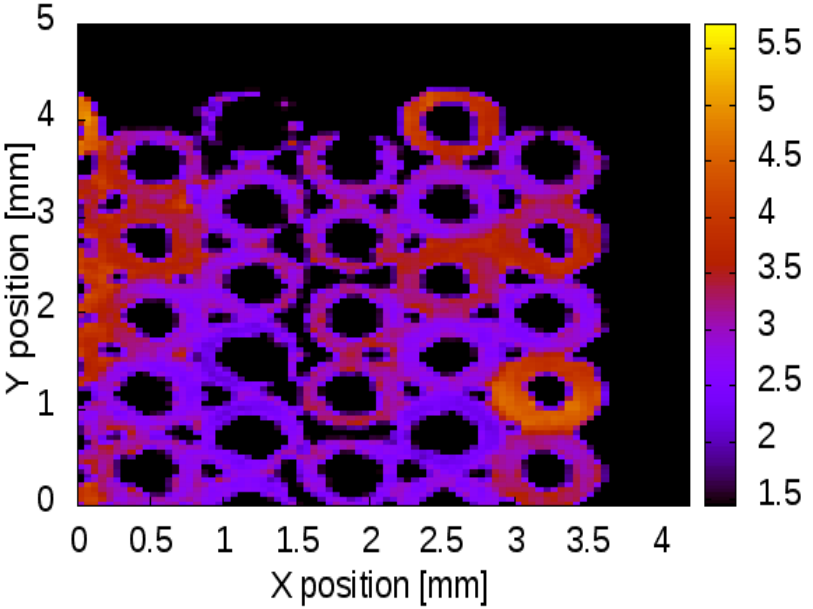
400 holes

Photo vs. measurements

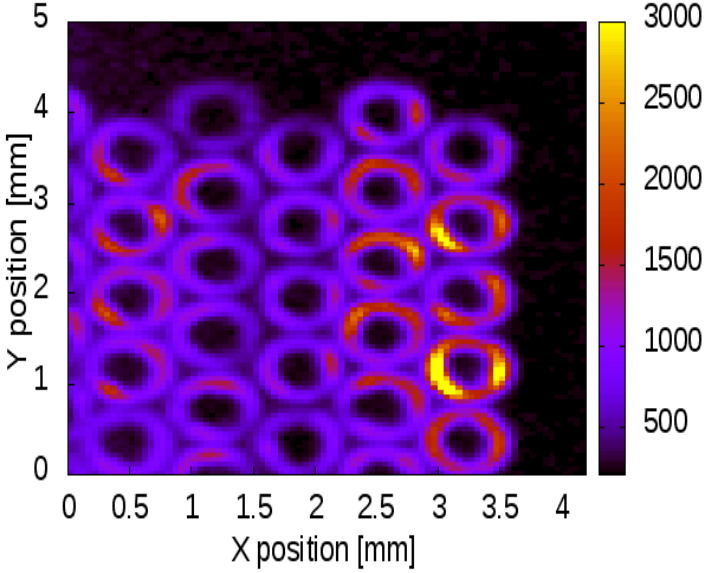
Photo



Gain map



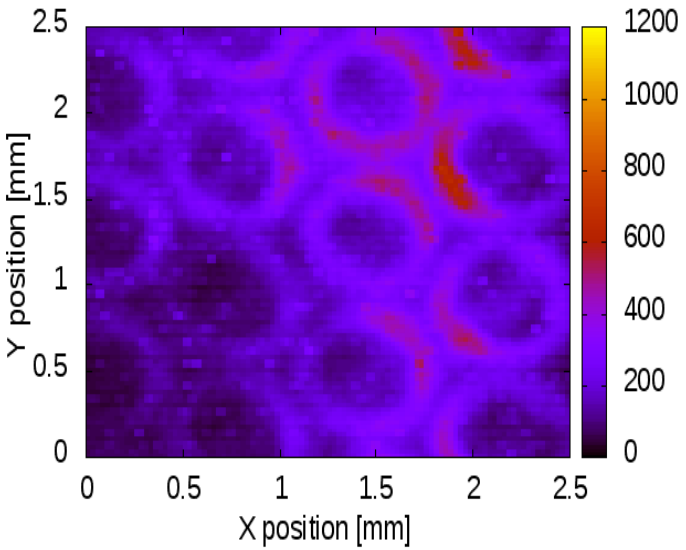
Yield map

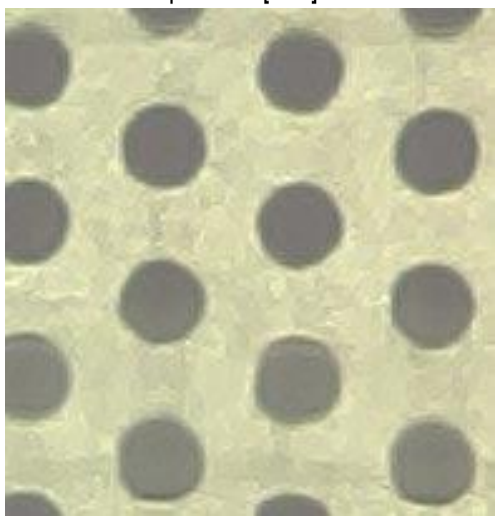


Position verification

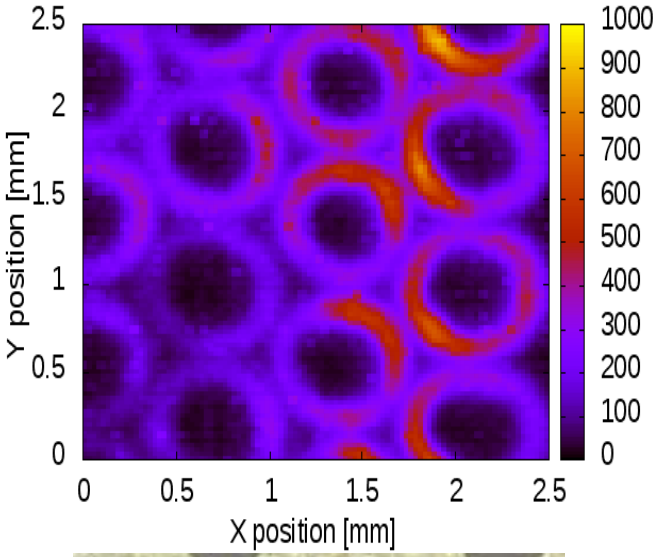
Focusing using microscope

Below focus by 2.5 mm

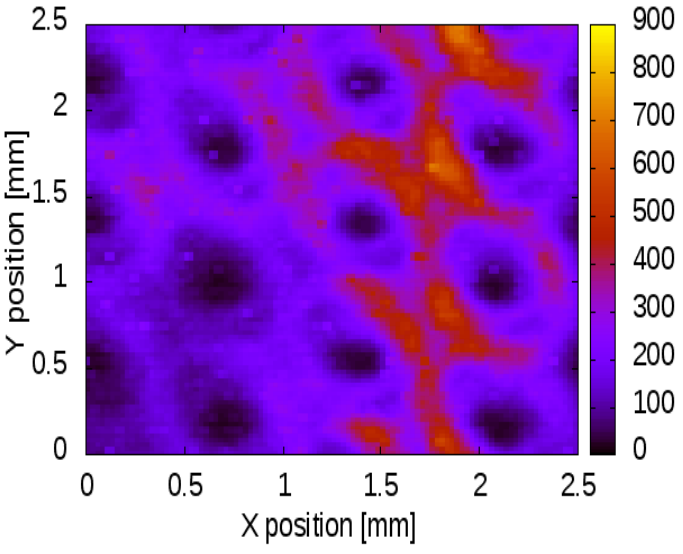


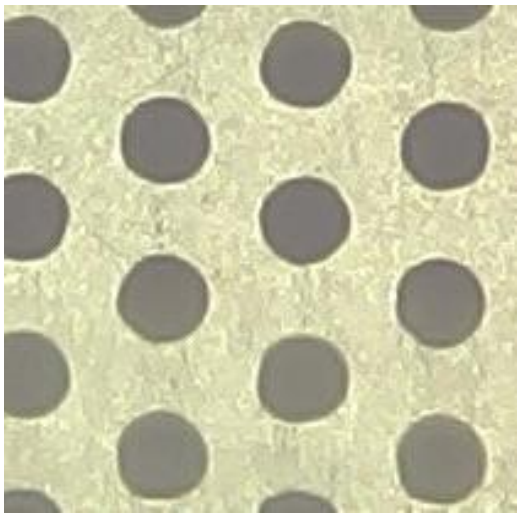


In focus



Above focus by 2.5 mm



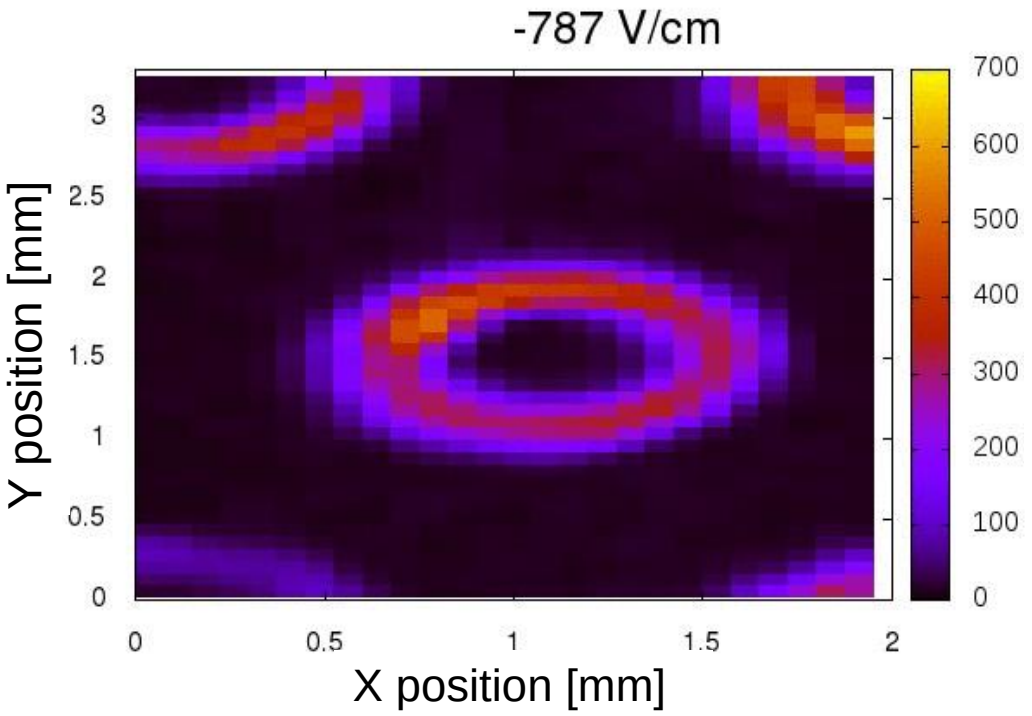


R&D work

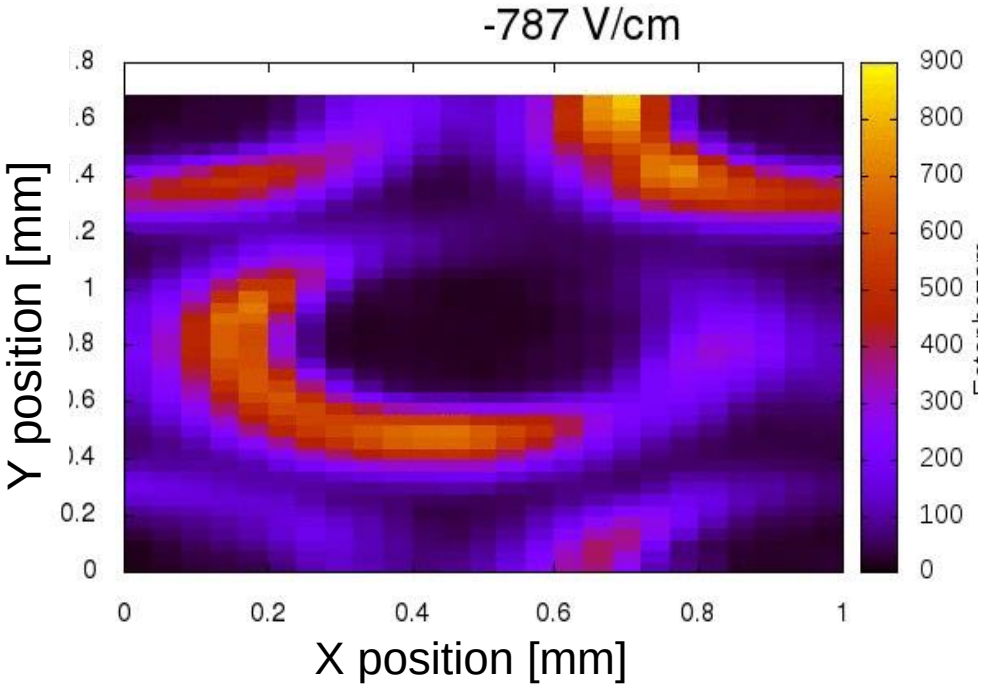
- Initiation of a longer term R&D in parallel with large version construction
- Investigate the effect of faults
- Effect of bias voltages on p.e. yield
- Gain uniformity
- Examination of edge effect

Drift field bias

Pitch of 2 mm



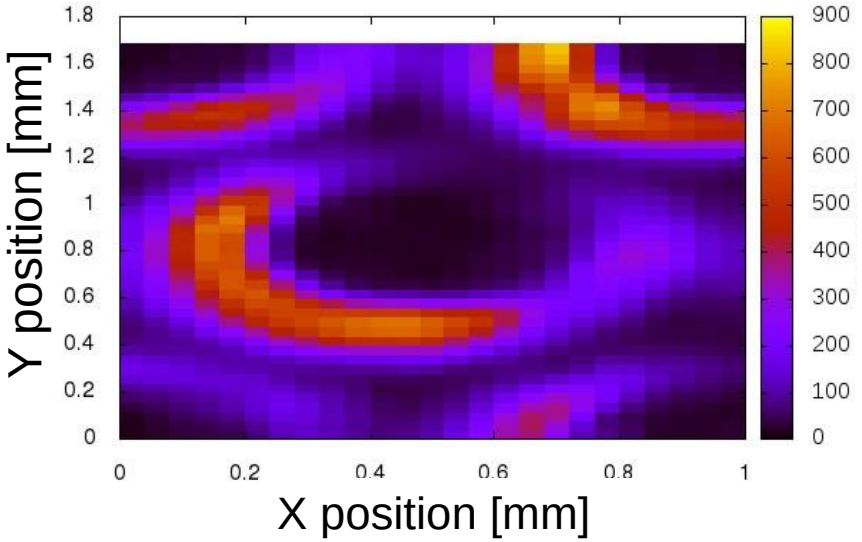
Pitch of 1 mm



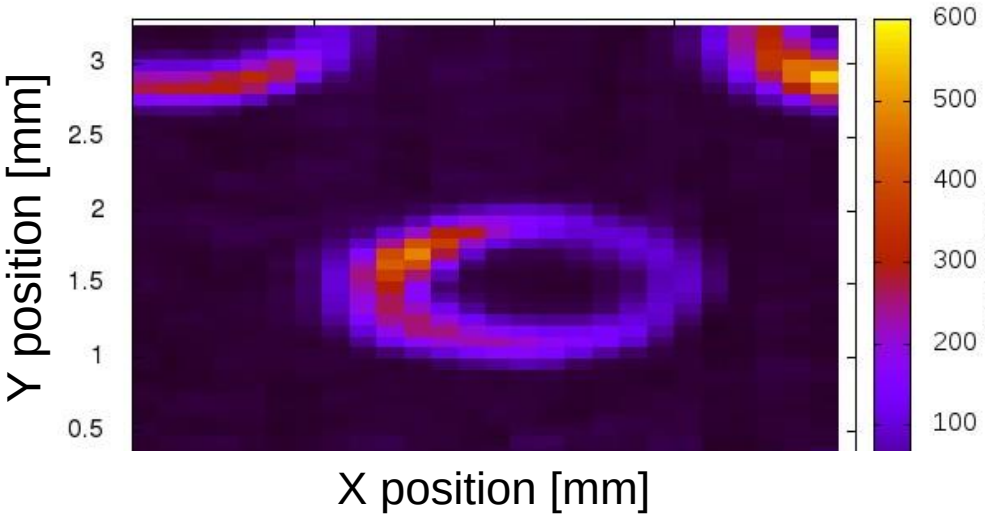
- Around the hole the field of TGEM ↔ Farther the drift field dominates

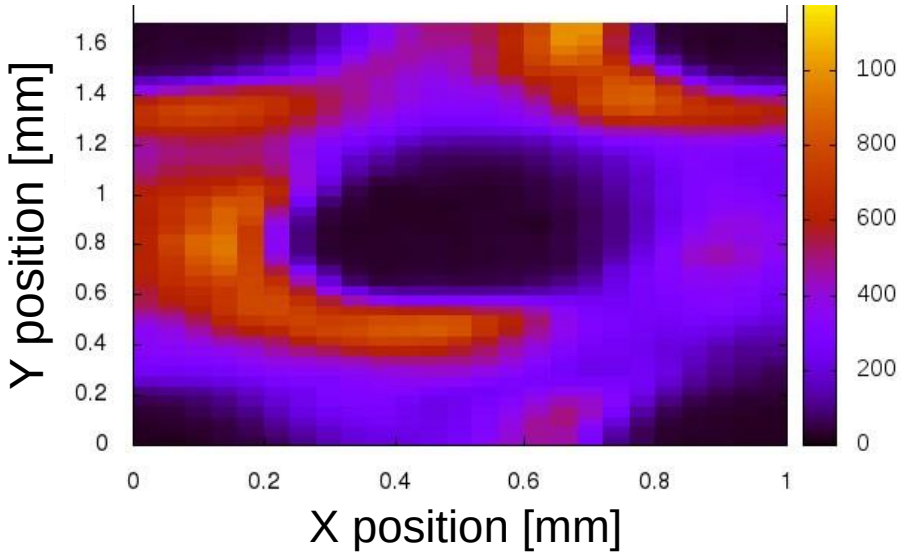
Photoelectron yield

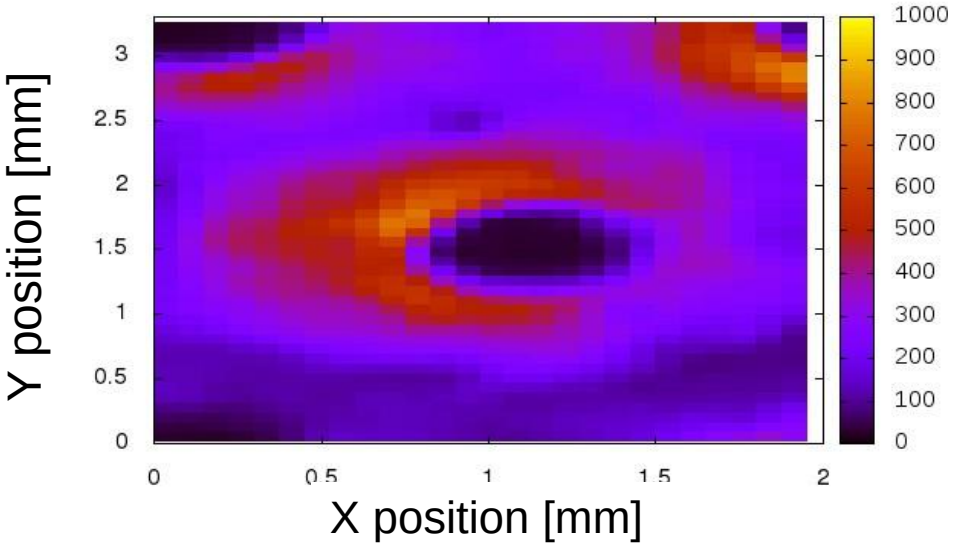
Pitch of 1 mm



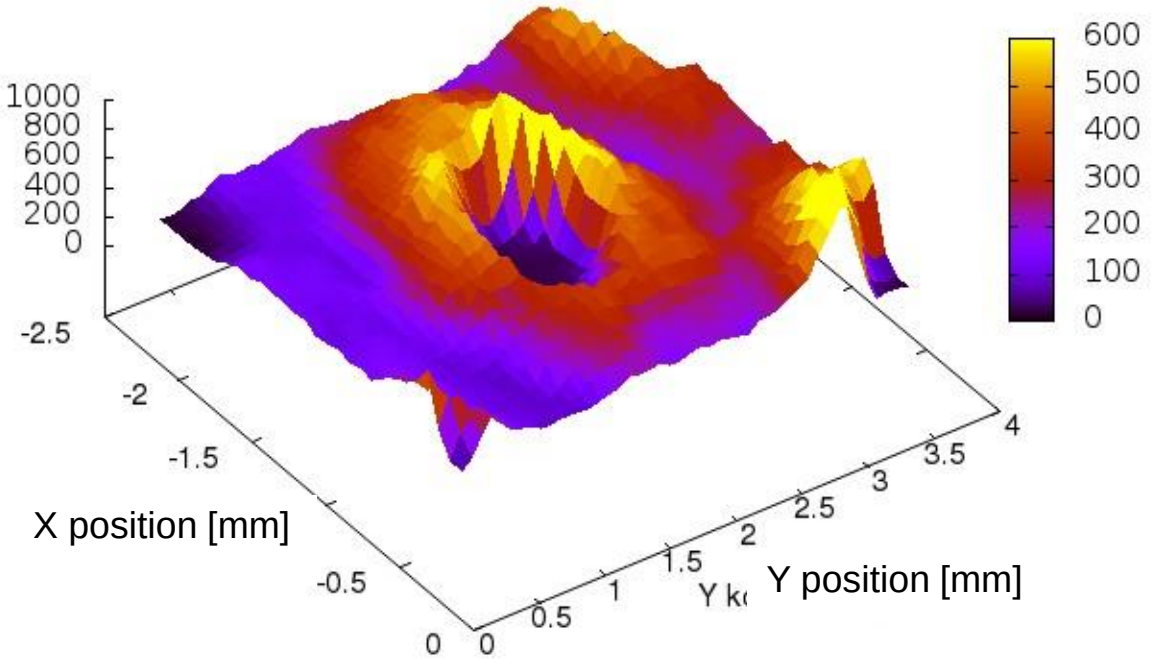
Pitch of 2 mm

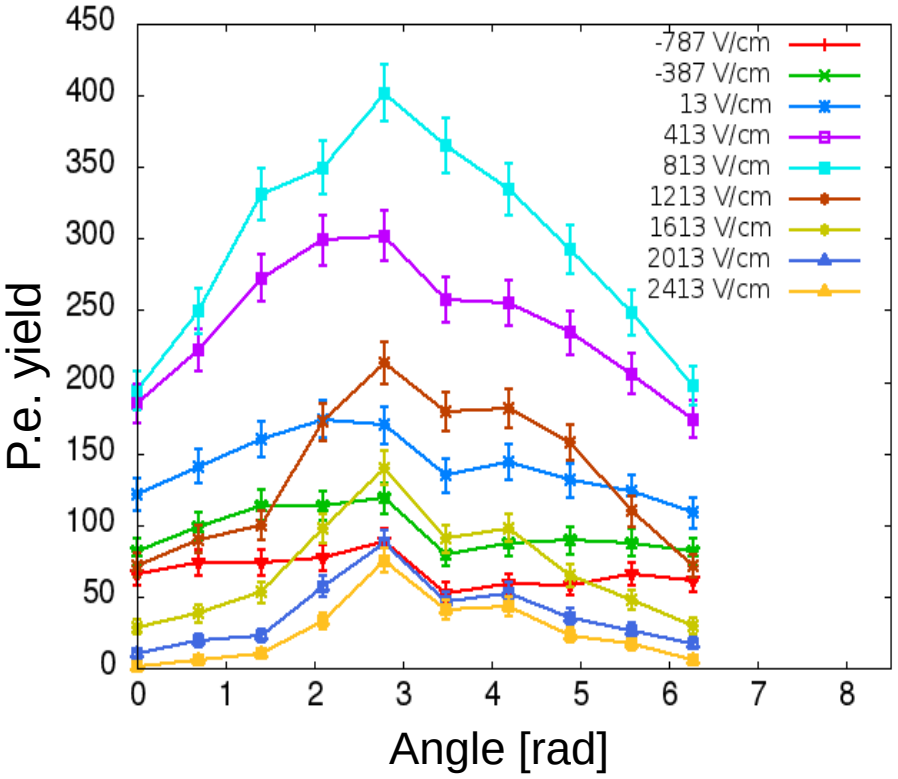






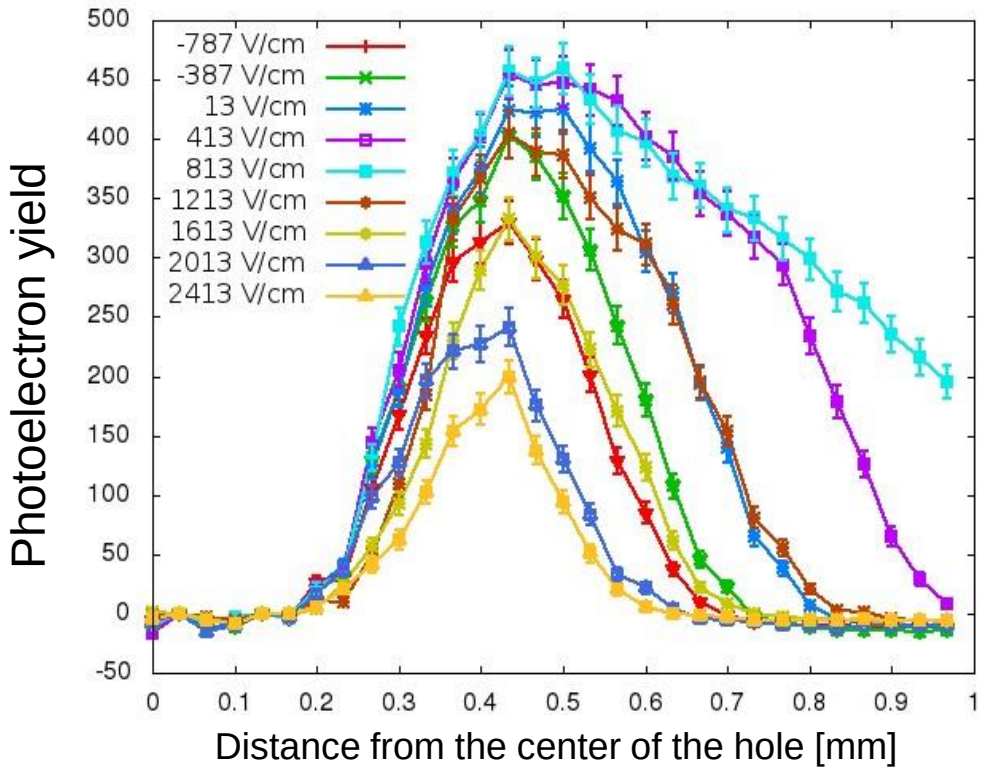
Photoelectron yield of holes

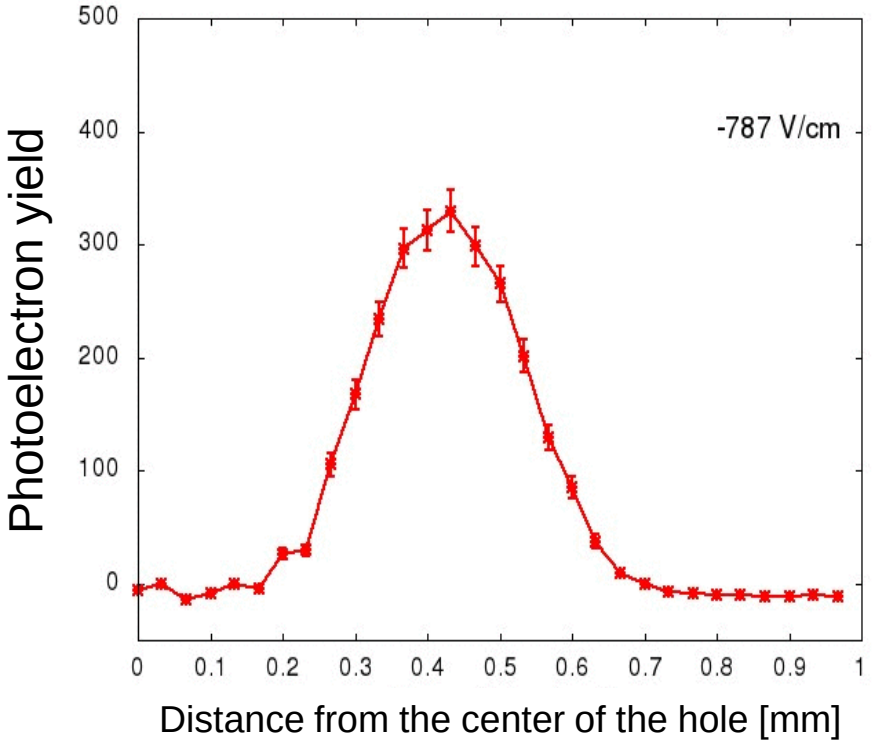




- No azimuthal symmetry around holes

Optimal drift field





- There is an optimal drift field
- With MIPs the optimal drift field could be different

Conclusion

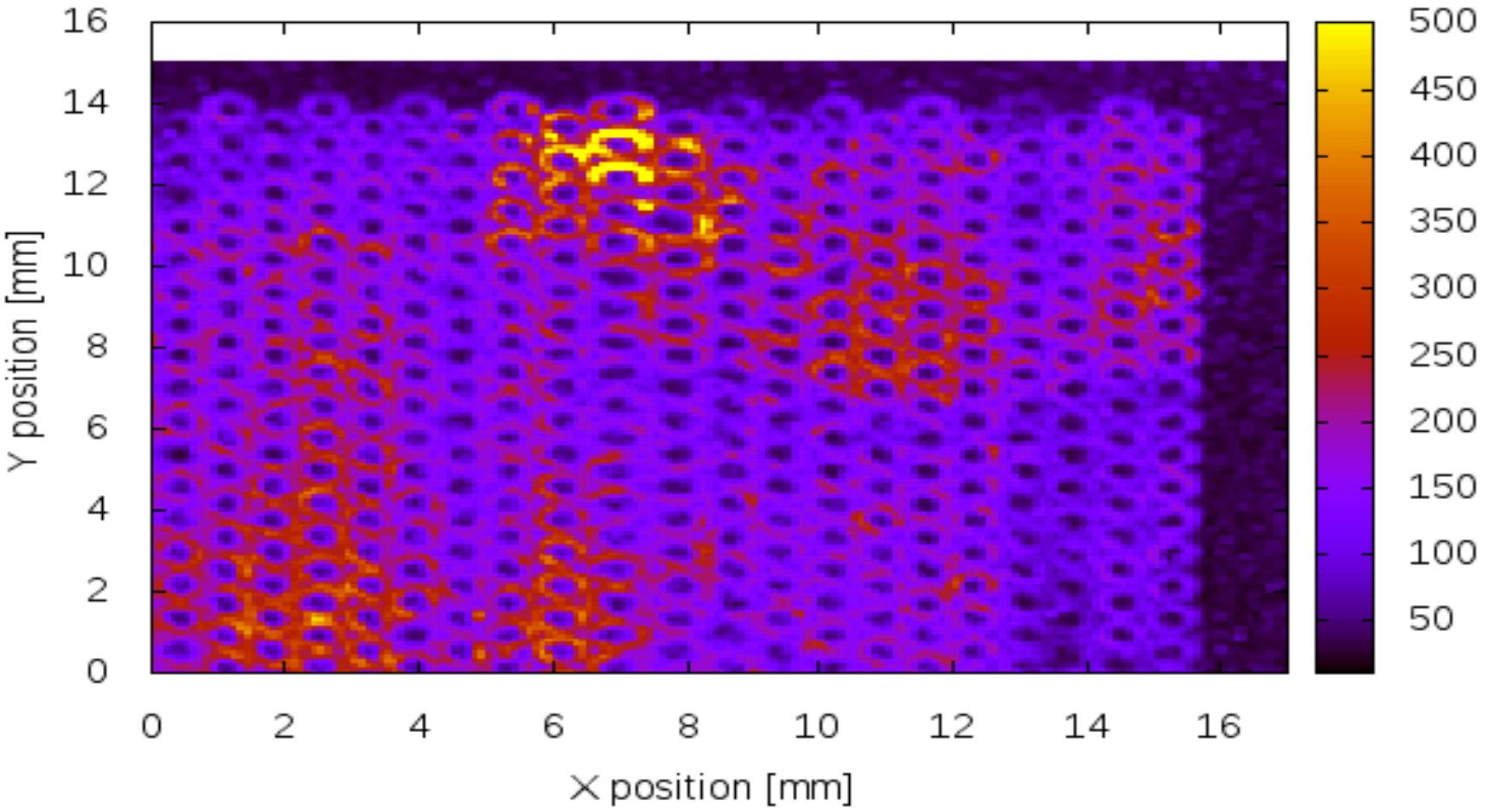
- Prototype Leopard system for (T)GEM QA:
  - Accessable area (20 x 20 cm^2)
  - Mounted USB microscope
  - Robust optical system sctructure
  - Verified performance
- Initation of R&D work:
  - Effect of drift field bias on p.e. yield

This project has received funding from the European Union's Horizon 2020 Research and Innovation programme under Grant Agreement no. 654168.

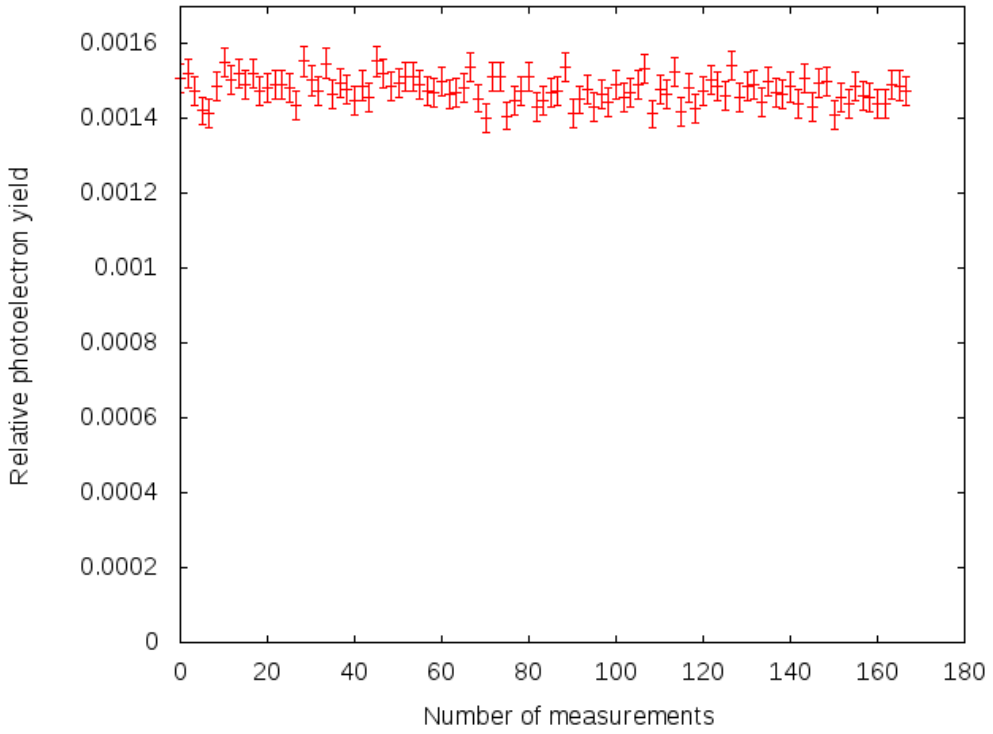
Thank you for your attention!

Backup slides

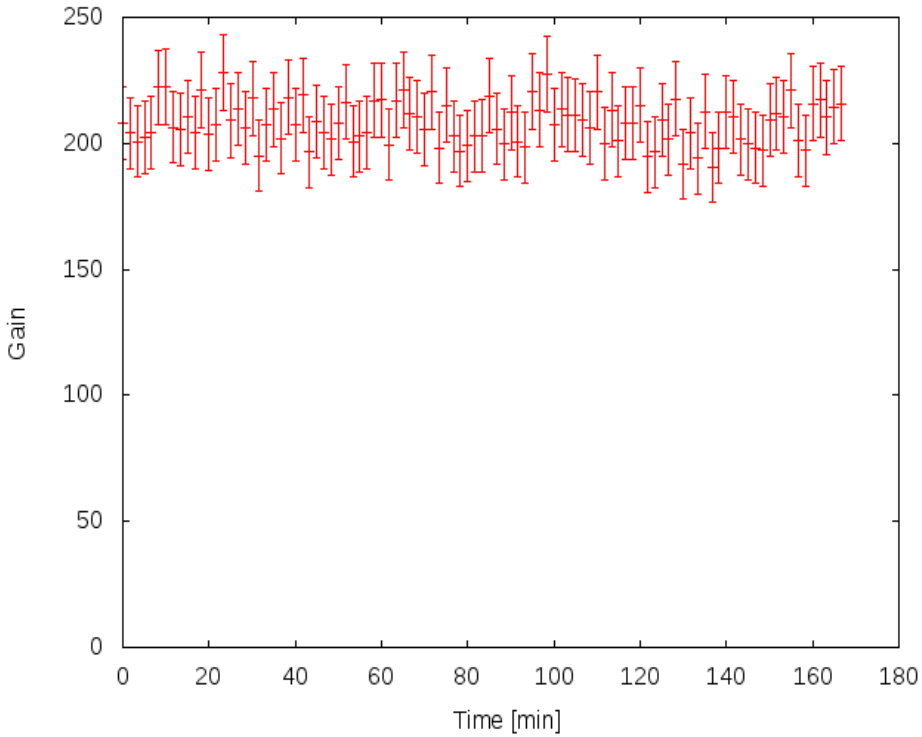
Photoelectron yield maps



Long term stability



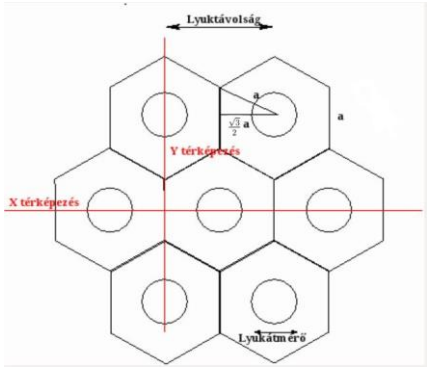
Yield



Gain

Photon yield of holes

- Approximation
- Photon yield of holes using different drift fields

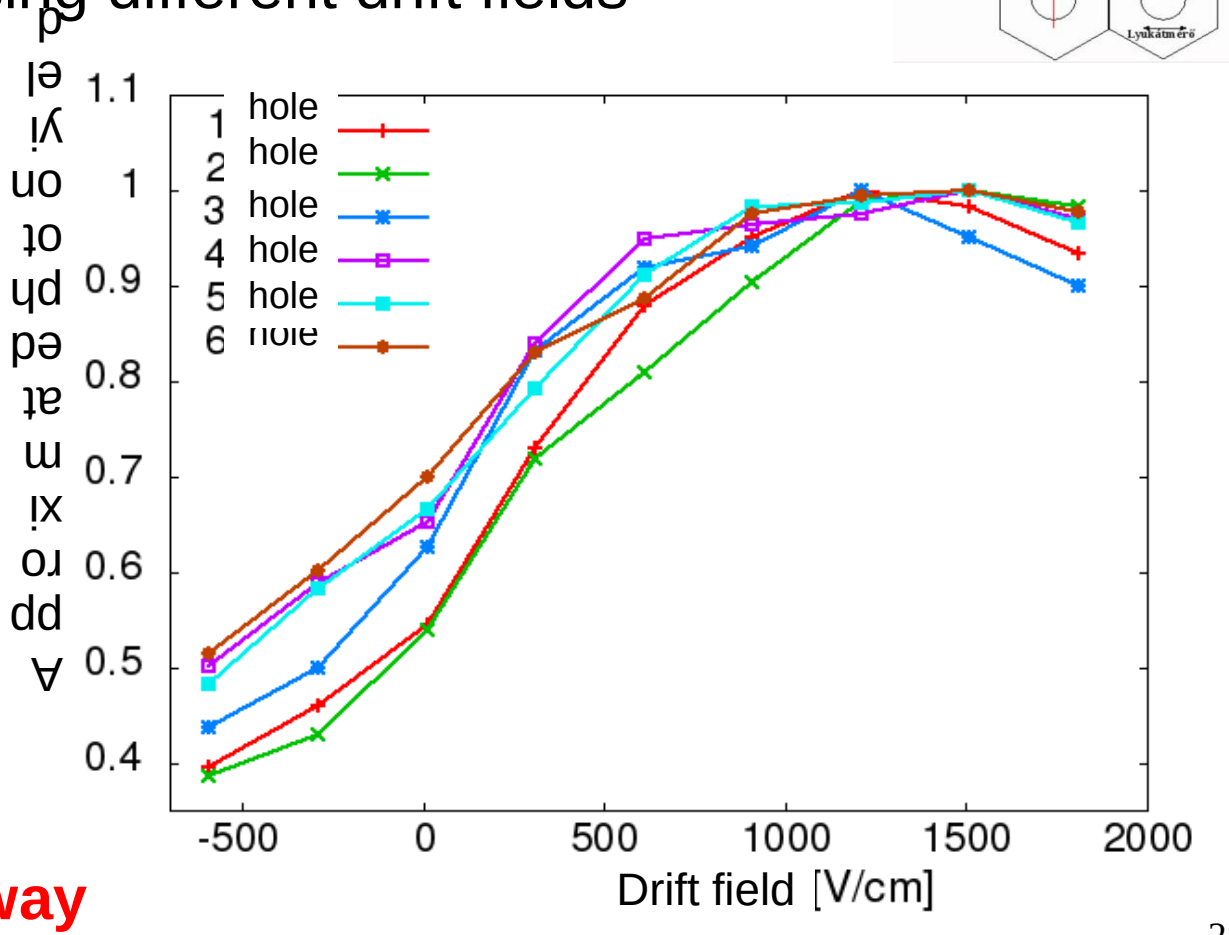


1. X scans:

$$N_{\text{approx}} = \sum_{x=0}^{\frac{\sqrt{3}}{2}a} x f(x),$$

2. Y scans:

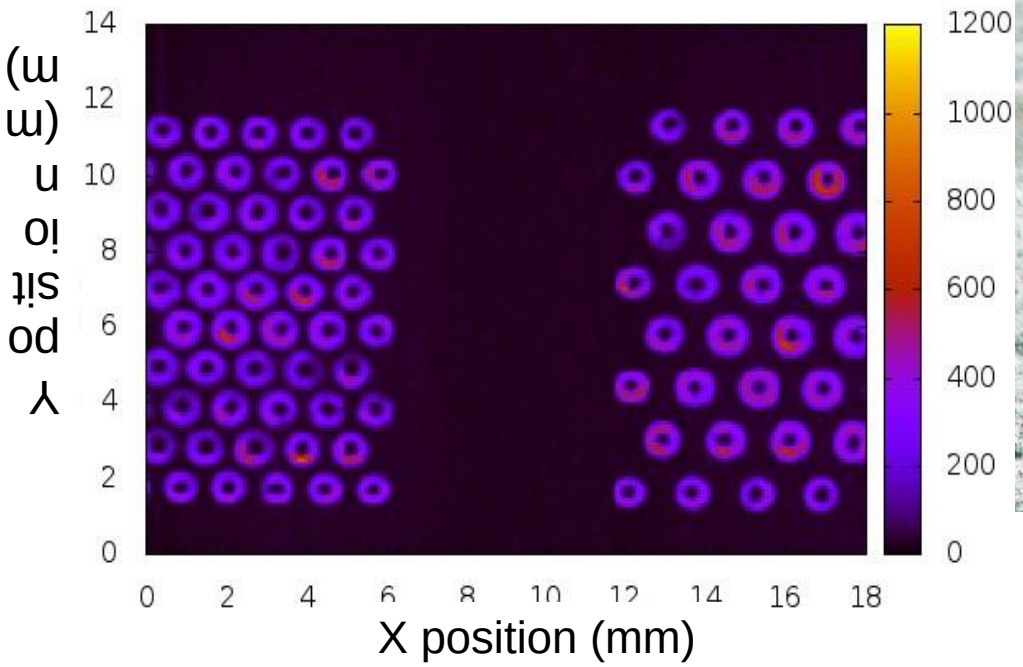
$$N_{\text{approx}} = \sum_{y=0}^{a} y f(y),$$



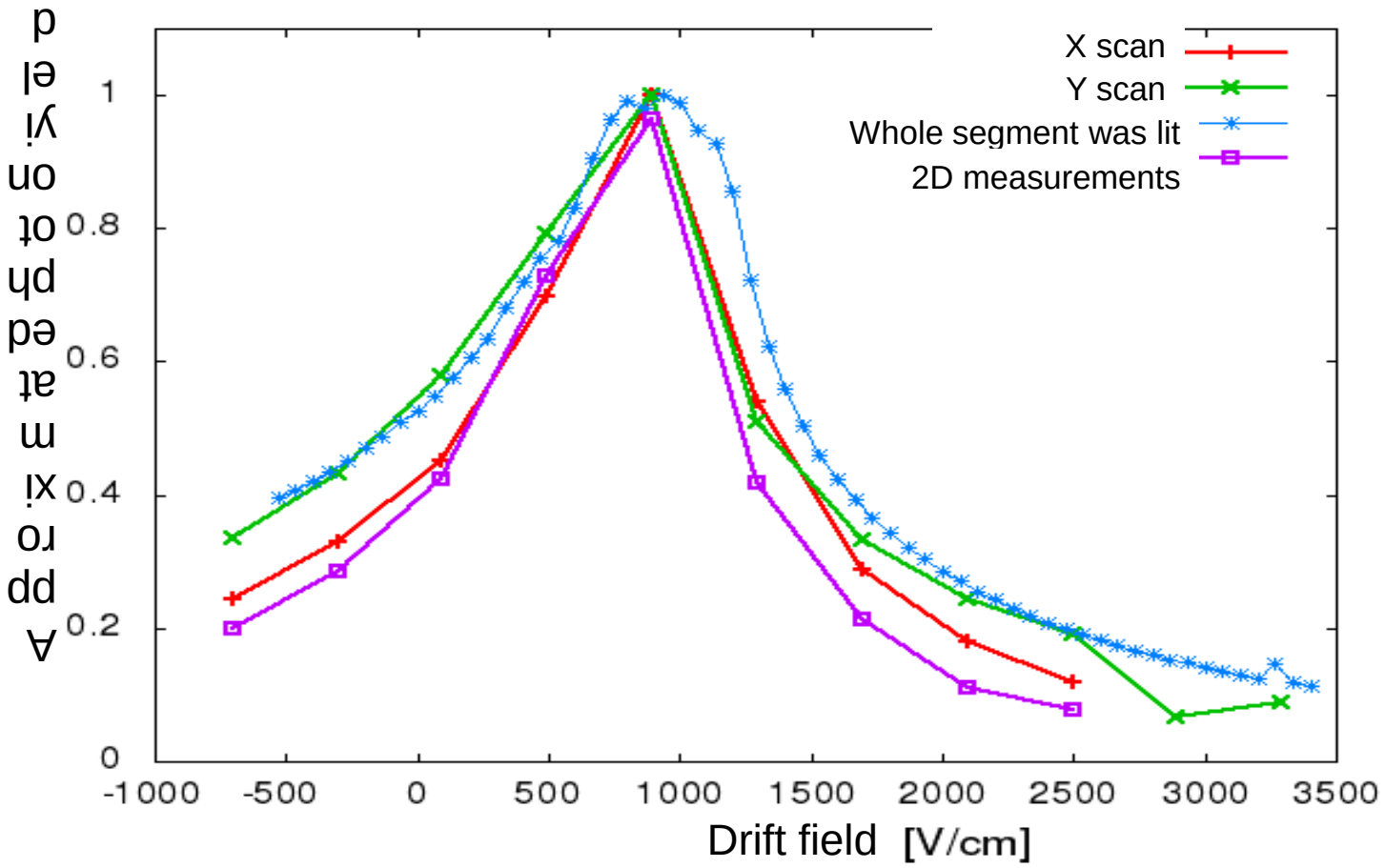
Holes behave the same way

2 dimensional scans

- Photon yield map
- Sensitive area
- Leopard



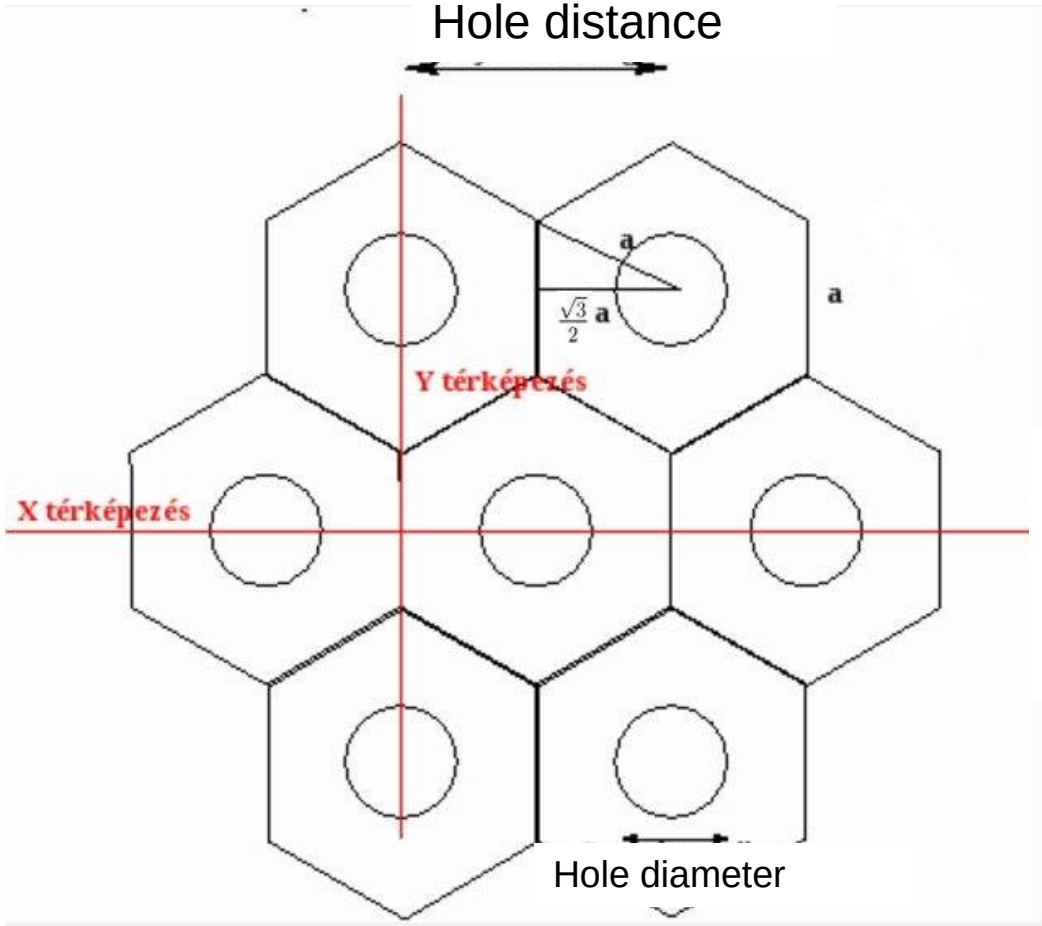
Hole distance of 2 mm



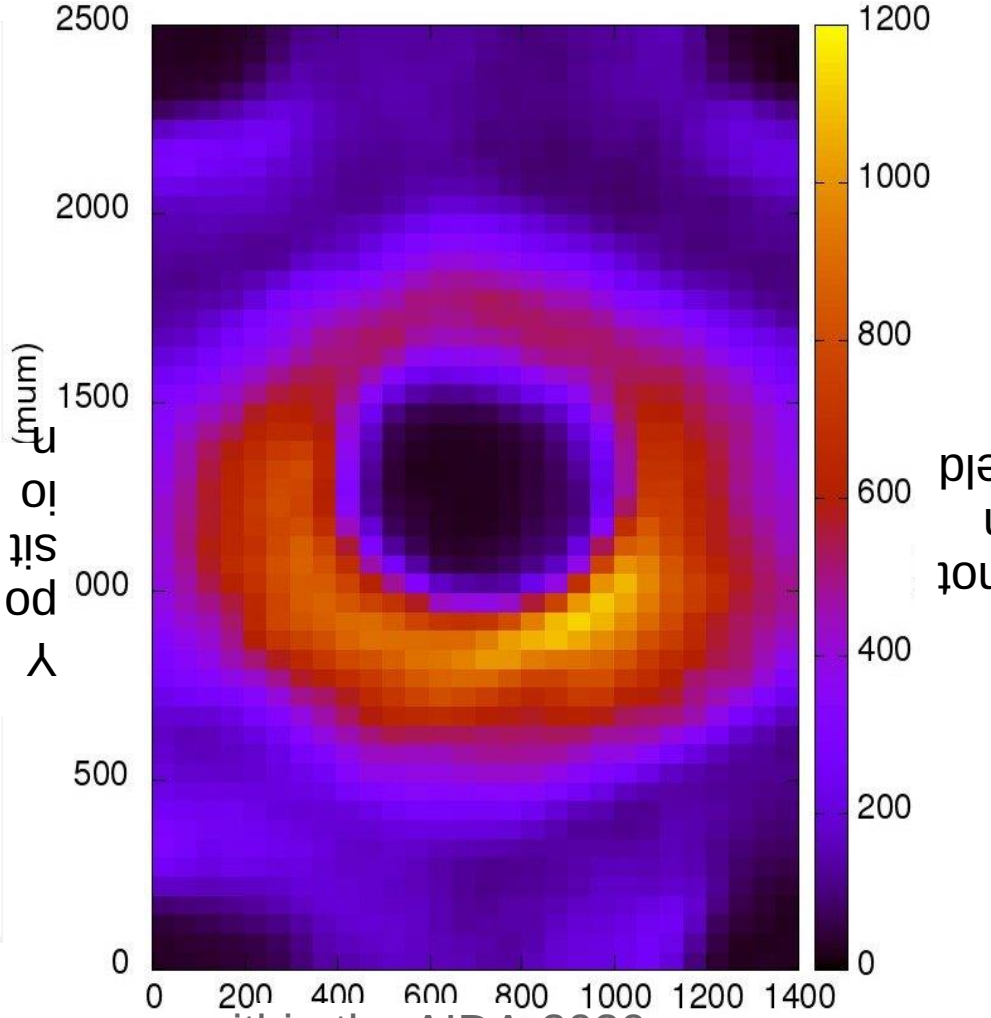
- Different methods → Correlate
- Optimal drift field

Investigation of single holes

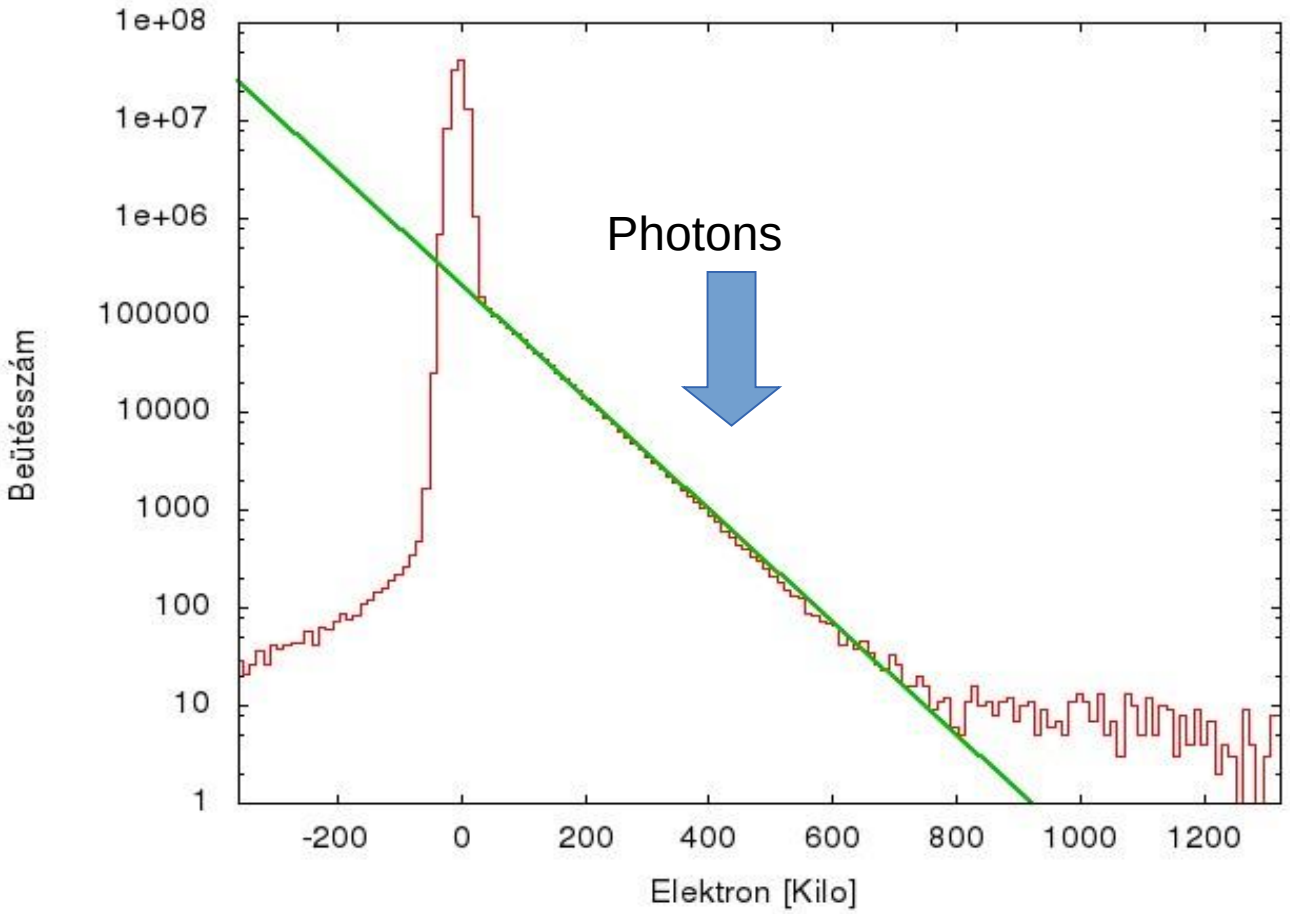
1 dimensional maps



2 dimensional maps

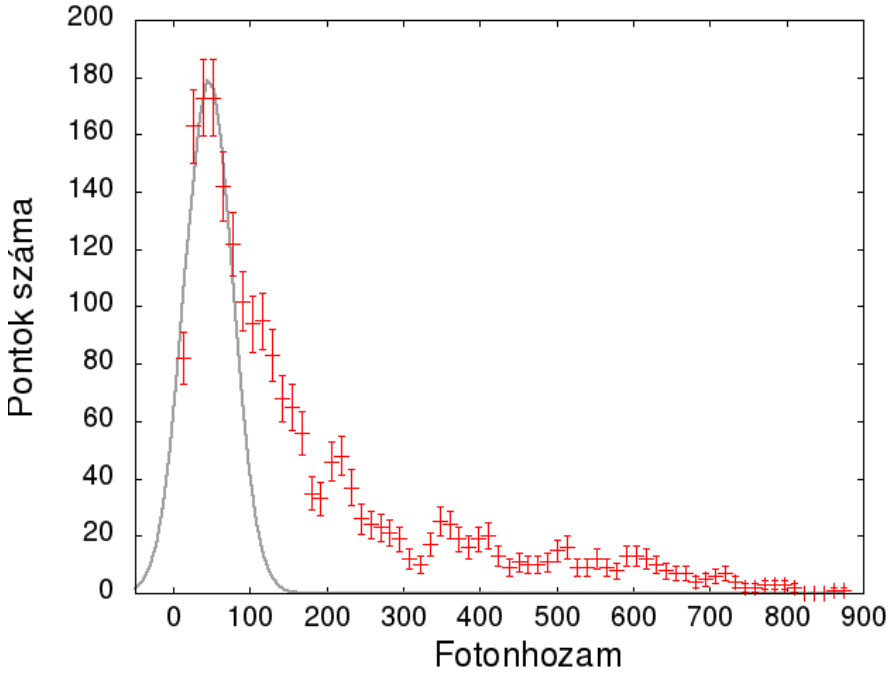


Data

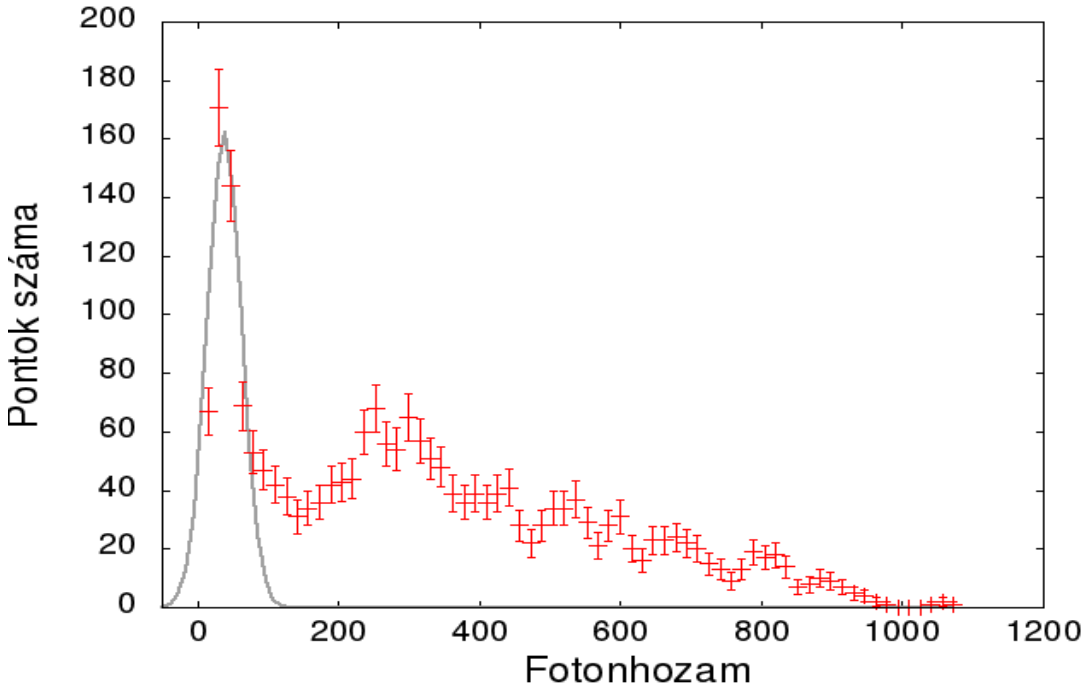


100 million stat

Yield histograms



Not optimal drift field



Optimal drift field

Focusing the LED