Leopard Measurements in Trieste

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for the joint group of
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REGARD
RMKI ELTE Collaboration
on Gaseous Detector
Research and Development

Outline

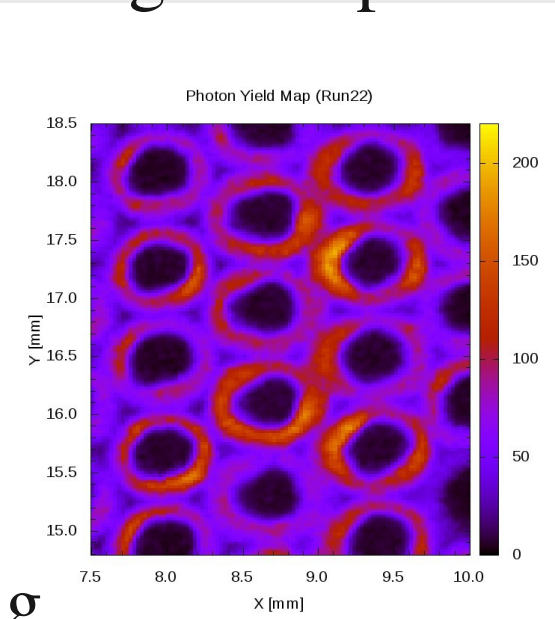
- TGEM+MM Hybrid
- Leopard Setup
- TGEMs in study
- Charge up aspects
- Gain uniformity studies
- Photo-electron extraction vs drift field
- Photo-electron extraction vs TGEM voltage
- Comparision of different TGEMs
- Outlook

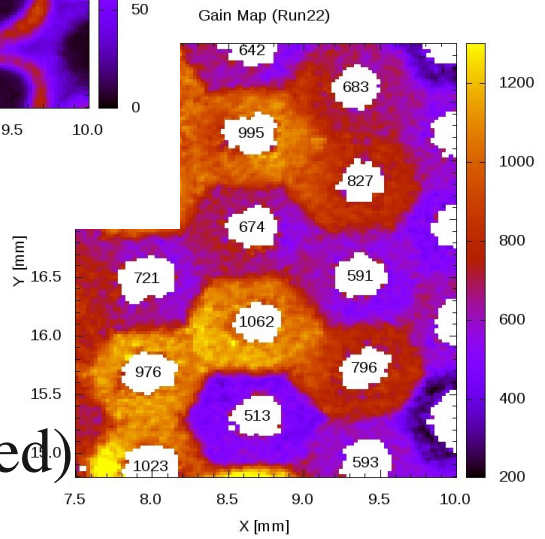
The Leopard Measurements

- Investigate microstucture of MPGDs
- RD51 Common Project
  (Budapest, Trieste, Bari)
  see talk: RD51 MiniWeek Feb.2014. G.Hamar
- Aim of the common work:
  systematic study of different TGEMs
  comparative measurements
  optimization of geometry

Reminder on Leopard

- High resolution scan of MPGDs with focused UV light
- Single photo-electrons: PE yield and gain separable
- Critical symmetry points
- Hole-by-hole differences





- Cherenkov detector optimization
- Simulation verification and tuning
- Quality check + info for production
- Applicability for various MPGDs
  (upto now TGEMs and standard GEMs were studied)

TGEM+MM Hybrid as Basic Setup in Trieste

- Standard hybrid system with:
  - Quartz window (for UV light)
  - Wire cathode : 100µm / 2mm spacing (along X axis)
  - TGEM in study
  - Bulk micromesh : 45/18 and 128µm for gap (CERN)
  - Padplane : 1D strips of 150/150 µm (alogn Y axis)

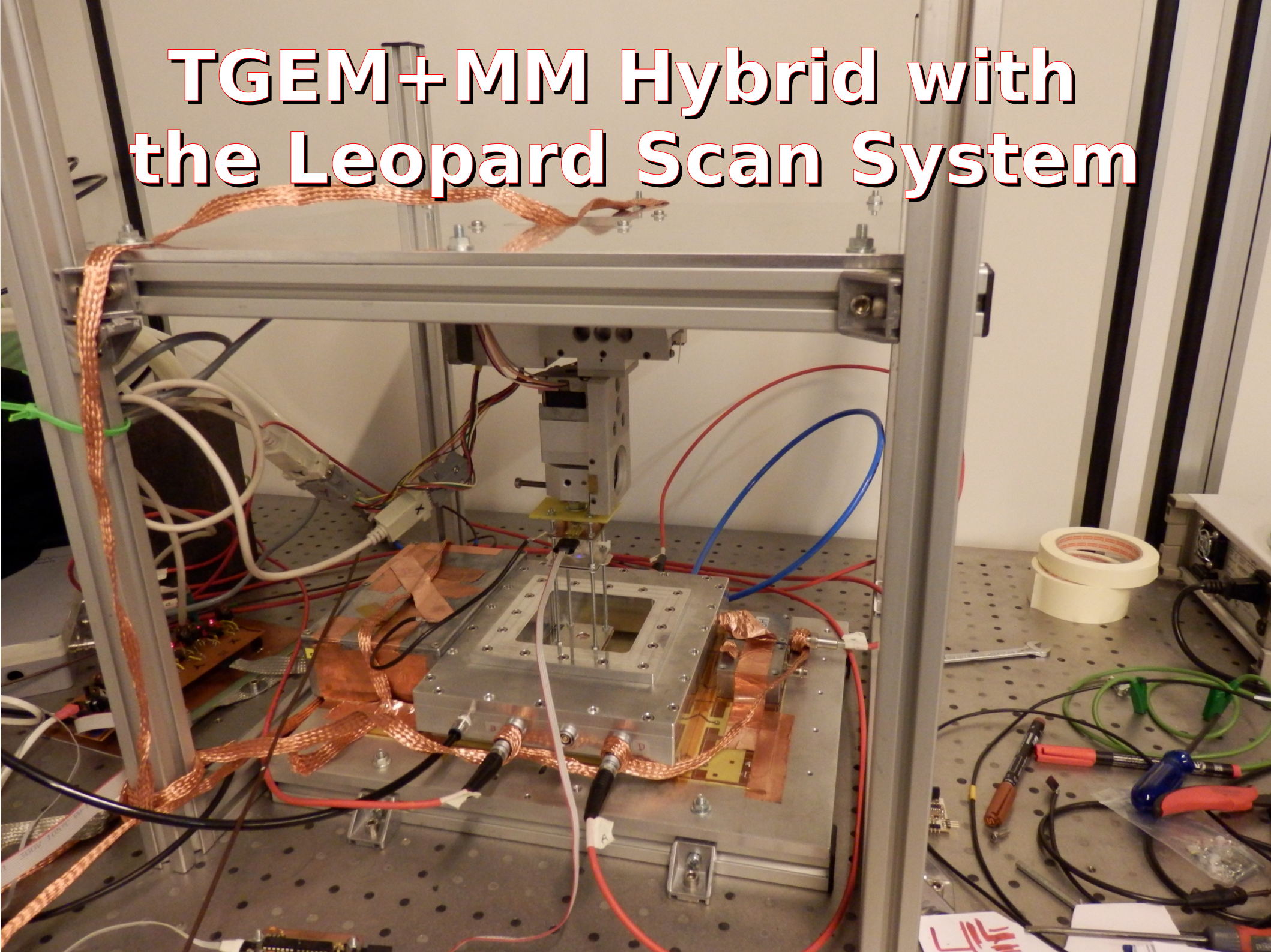
- Gas : Ar/CH_4 : 30/70

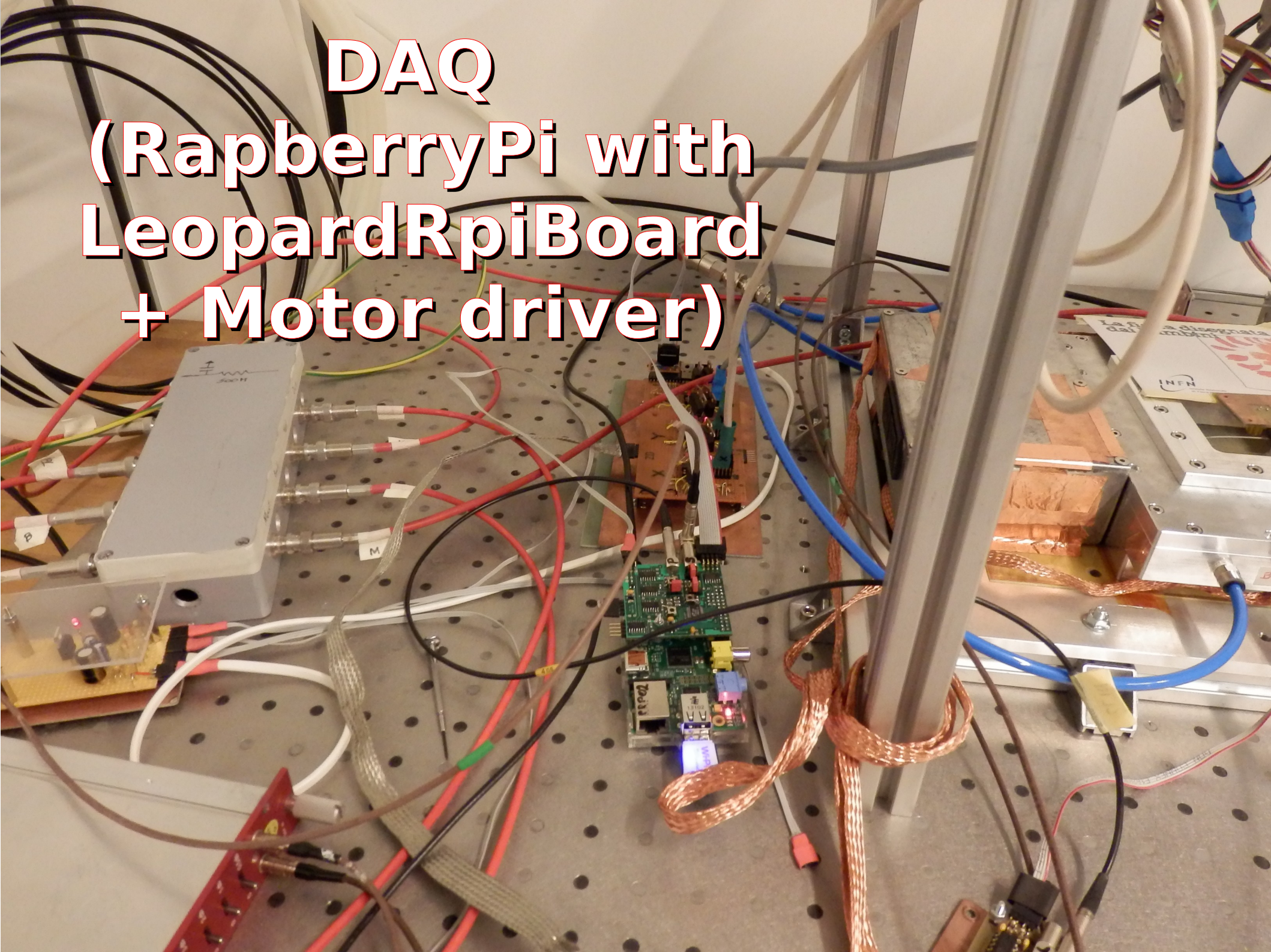
  and Ar/CO_2 for the long runs during the night

Data Acquisition

- Signal from connected strips of 14x100 mm^2
  - Preamp : CREMAT 101
  - Canberra Amplifier
  - Leopard Board (ADC: LT1415)
  - Raspberry Pi as readout computer (remote controlled)
- Stepping motor with precision of 2.5 µm
  (the used standard step was 20-50 µm)
- UV LED pusler with 130 KHz
- Calibration with pulse generator

see talk by G.Hamar at RD51CM Feb.2014.


TGEM+MM Hybrid with
the Leopard Scan System


DAQ
(RapberryPi with
LeopardRpiBoard
+ Motor driver)

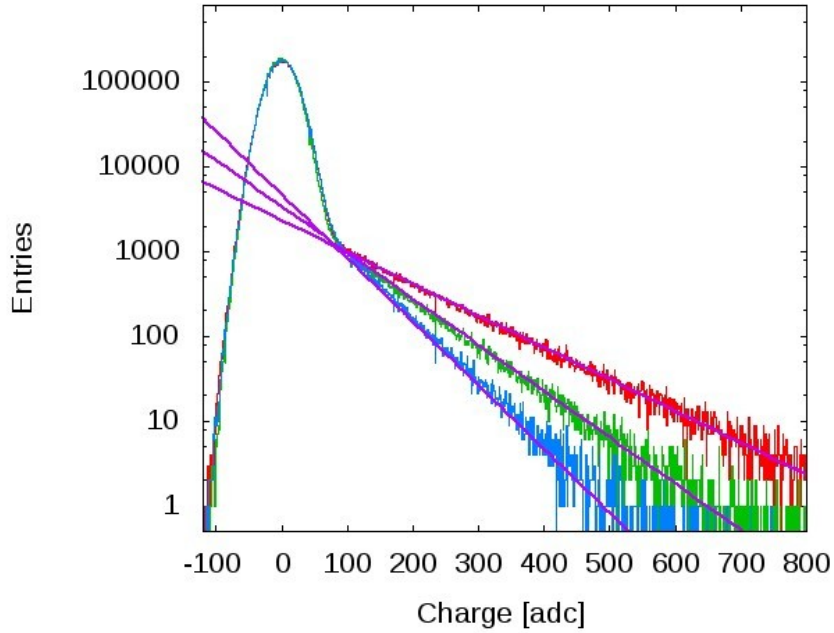
TGEMs in Study

- Several different TGEMs were sudied
  to compare:
  rim, thickness, hole size, production process

ThGEM Name	Hole [μm]	Pitch [μm]	Thickness [μm]	Rim [μm]
M1-III	400	800	400	0
DESTRO-I	400	800	400	5
C3HR-II	400	800	400	50
M2.4-G	400	800	600	0
M2.1-II	300	800	400	0

Data and Quantities

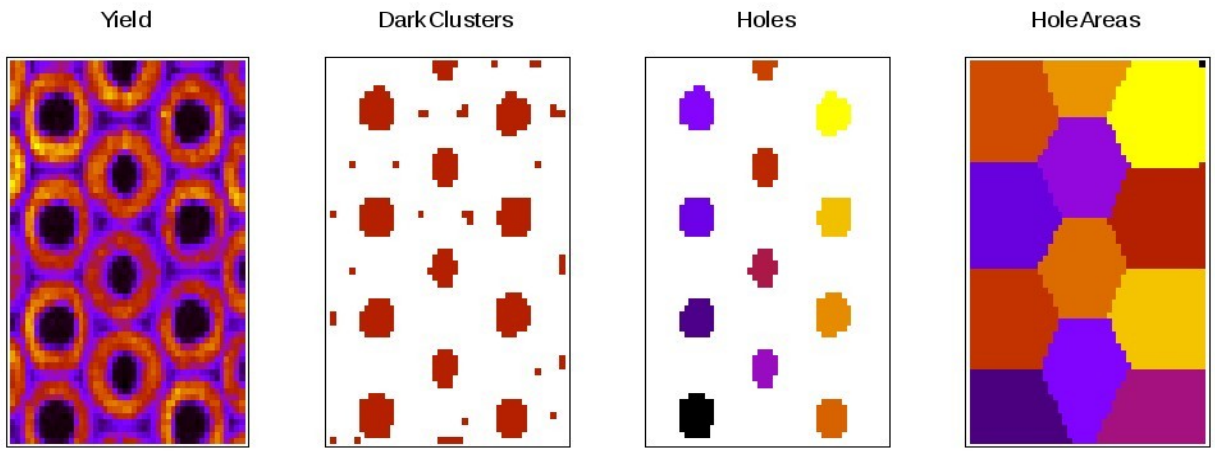
- UV light focused onto a 50 μm spot (MP)
- Single photo-electron spectrum in every MP
- Compute photo-electron yield and gain for every MP



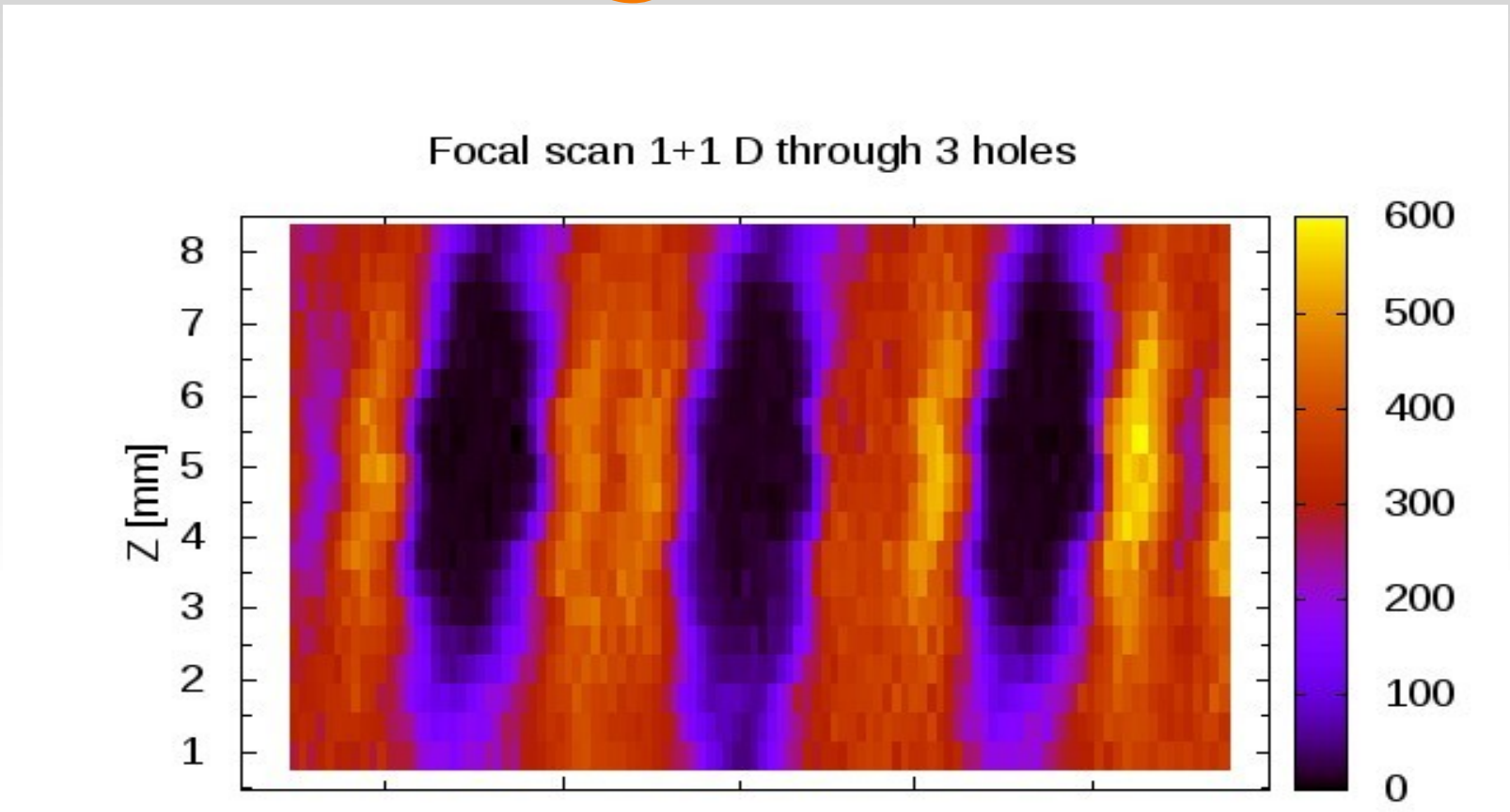
Data and Quantities

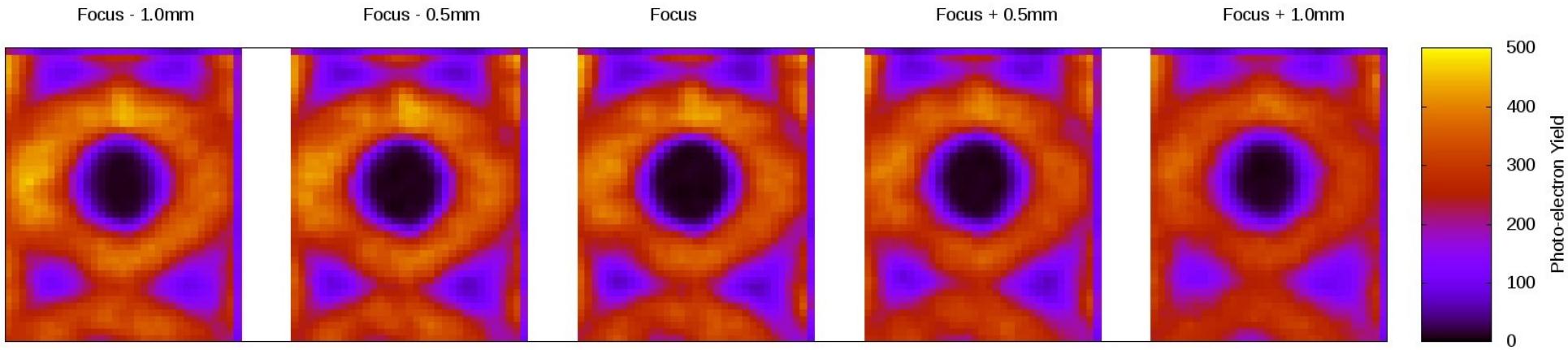
- UV light focused onto a 50 μm spot (MP)
- Single photo-electron spectrum in every MP
- Compute photo-electron yield and gain for every MP
- Search for holes, compute "hole-level" quantities

- Default plots:
  - Yield map
  - Gain map
  - Hole-gain distr.



Setting the Focus





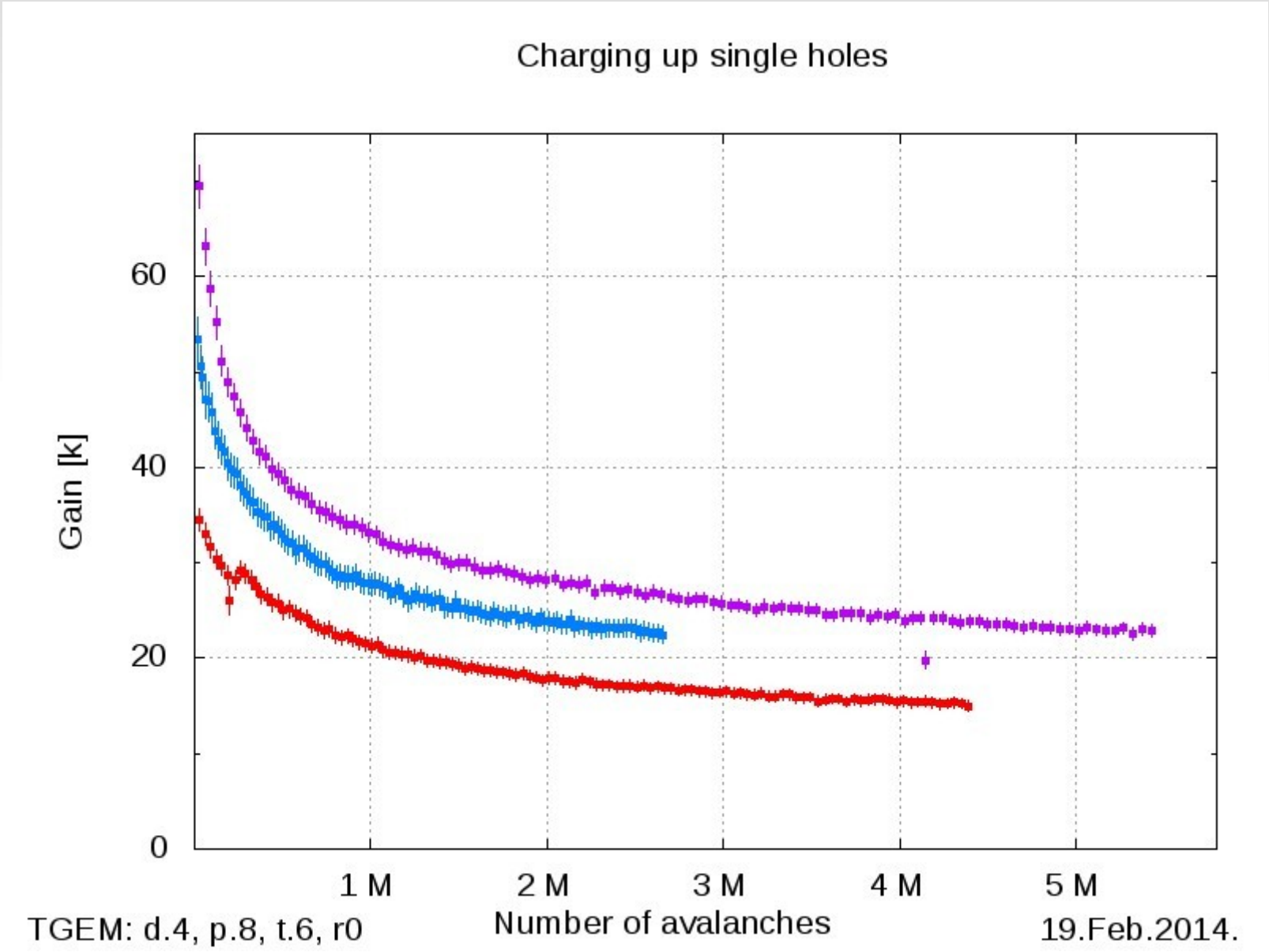
Charge Up Effect

- Charge up : an area or a single hole
- The **decrease of gain** has been seen
- With single photo-electrons the charge up effect for photon-yield has been measured :

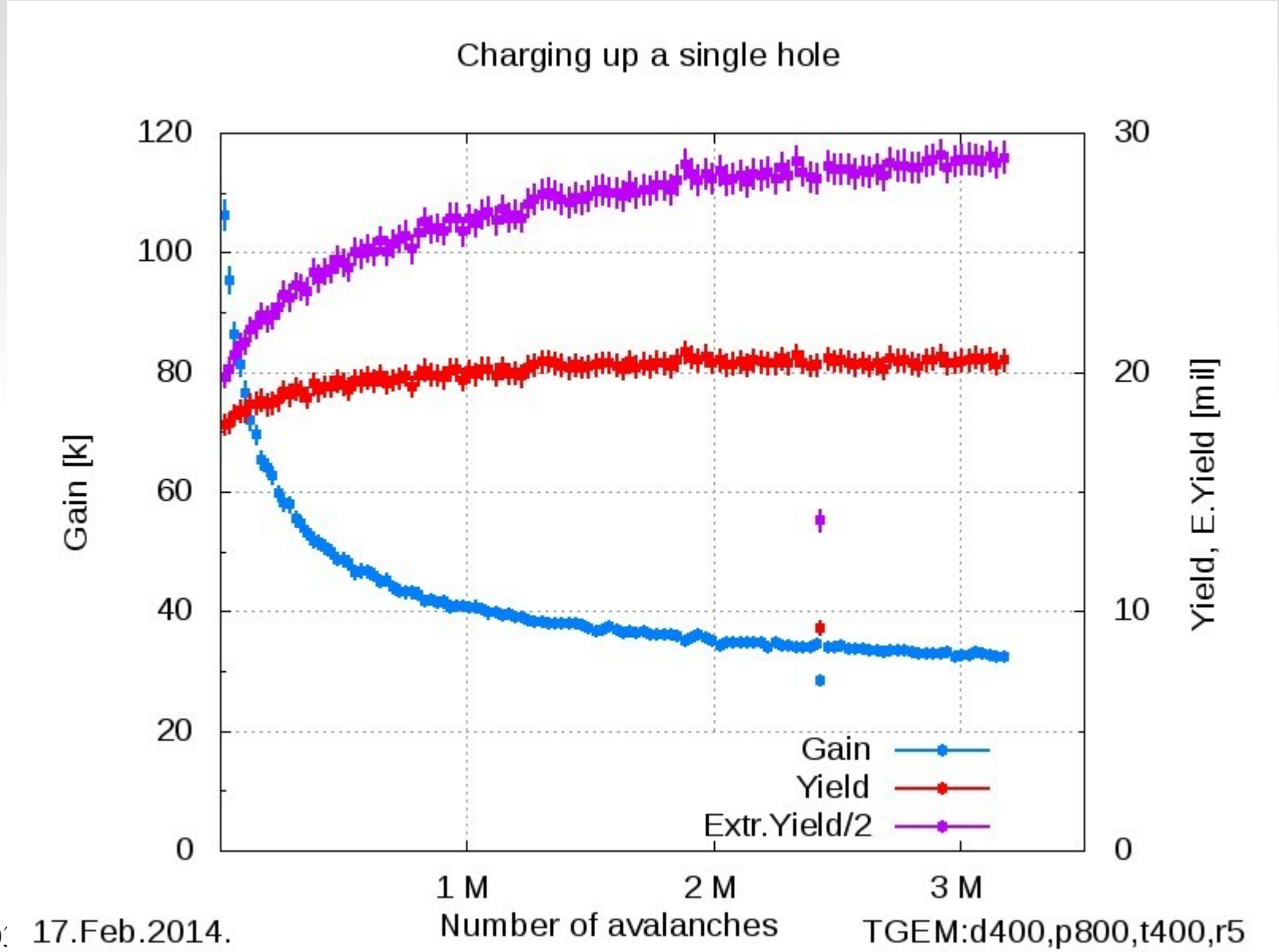
  Significant increase of the photon yield has been measured with various TGEMs and gains

  - Time constant is diffentent from the one in the change of gain
- Charge up during scans
  or : previously shine the area with high luminosity

Charging up single holes

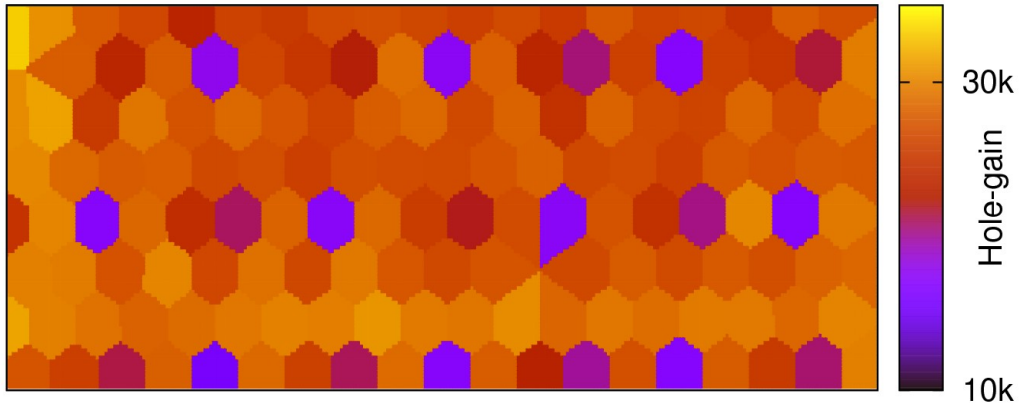


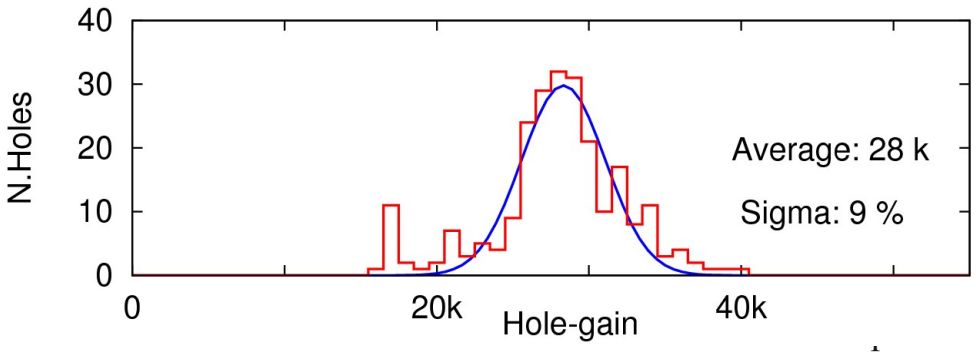
Charging up a single hole



Gain Uniformity Studies

- Long runs for statistics on large areas
- Evaluation of the "hole-gain" distribution



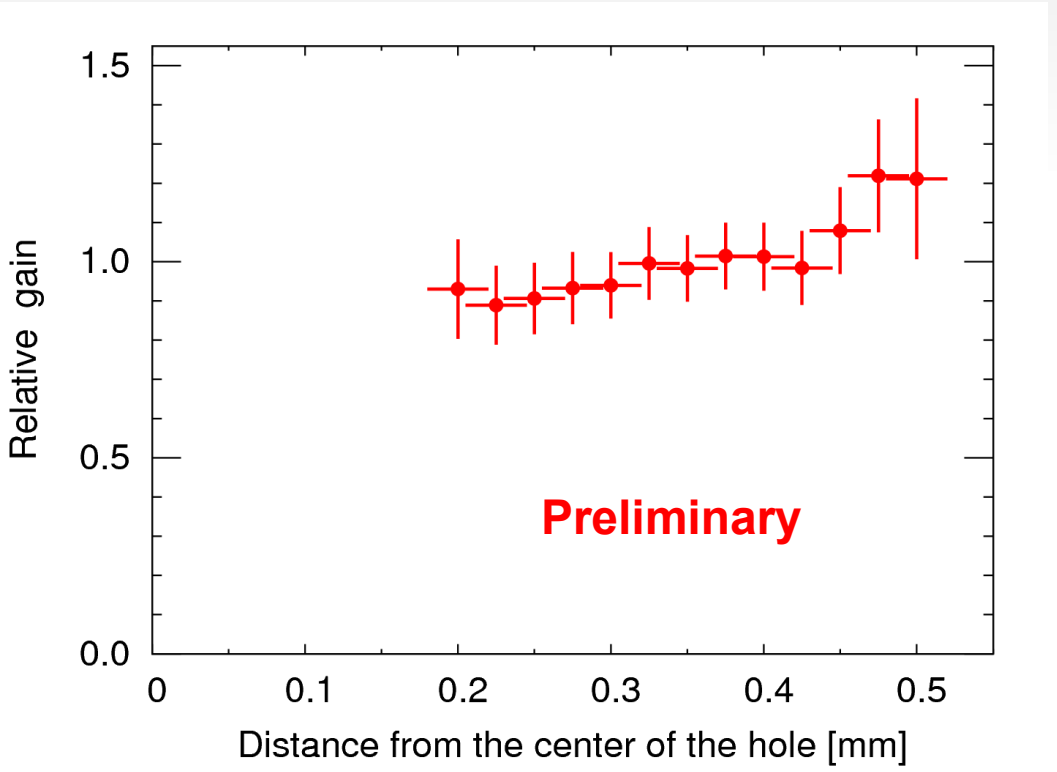


- Comparative test for all TGEMs

ThGEM Name	Applied averge gain	Standard deviation	Number of used holes
M1-III	39900	12.0%	317
DESTRO-I	24100	11.0%	194
C3HR-II	47100	21.6%	247
M2.4-G	76200	21.2%	268
M2.1-II	24000	8.3%	323

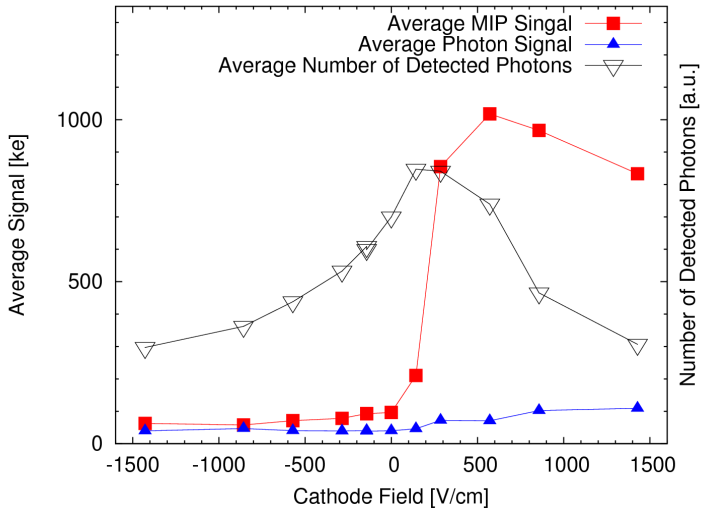
Avalanche Size

- Does the size of the electron avalanche depend on the point of entering ?
- Leopard :
  PE emission <=?=>
  point of entering
- Diffusion ...
- Preliminary results
  with DESTO-I
  are compatible with
  a flat distribution (?)

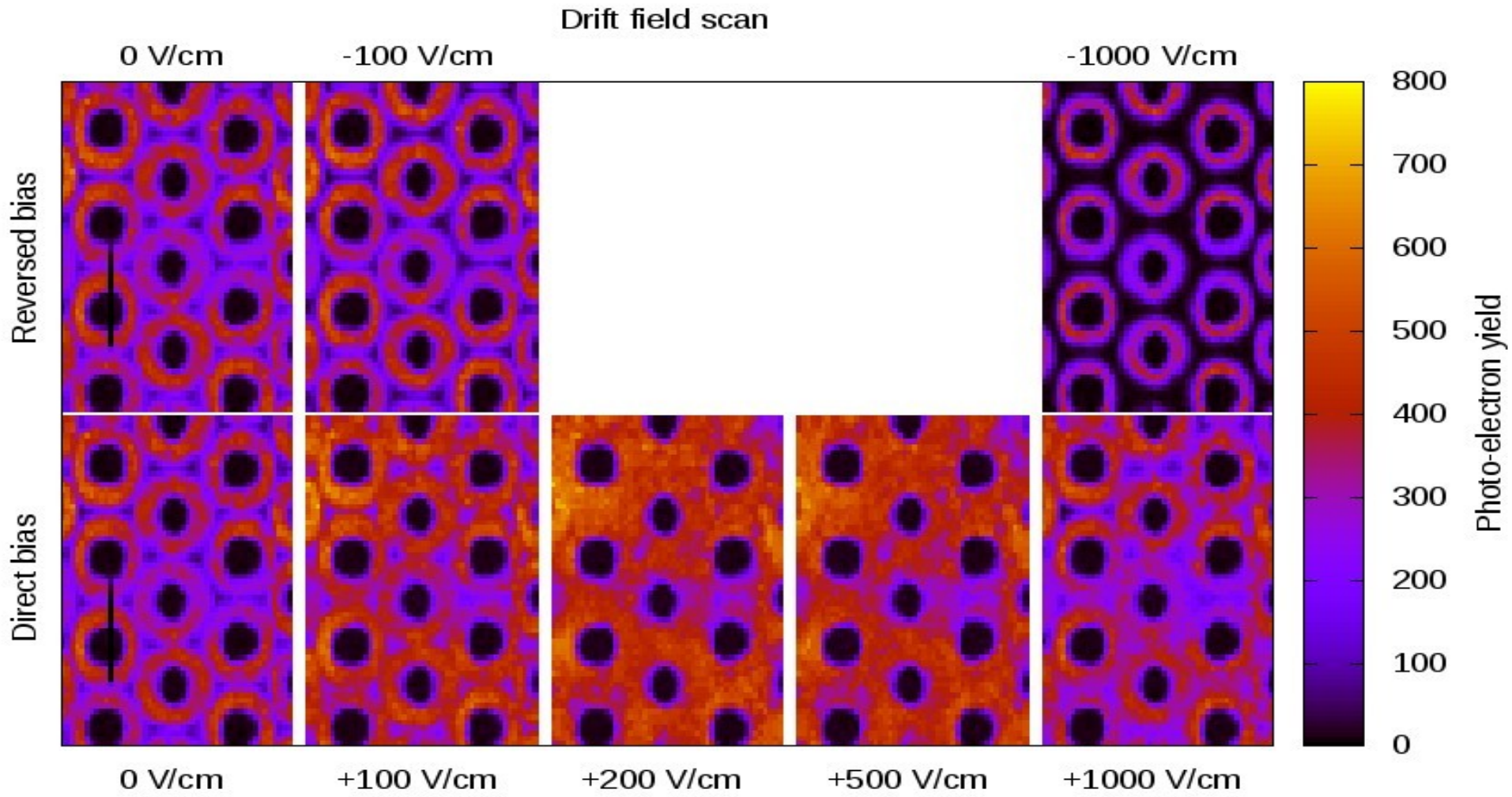


Effects of the Drift Field

- Optimization of drift field could be crucial
  - MIP suppression needs reversed drift field
  - HBD : close to zero field
  - For the critical symmetry points :
    relatively high normal drift is needed
- With the Leopard setup the point-by-point and integrated photo-electron yields can be examined

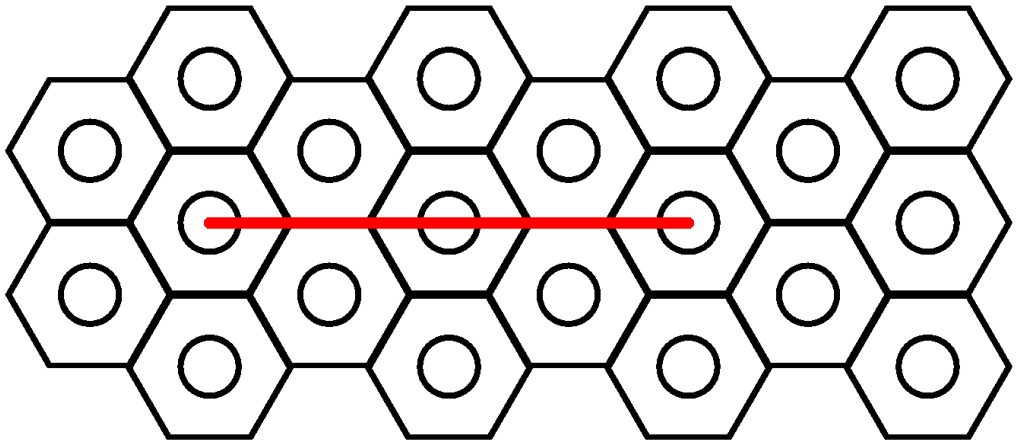


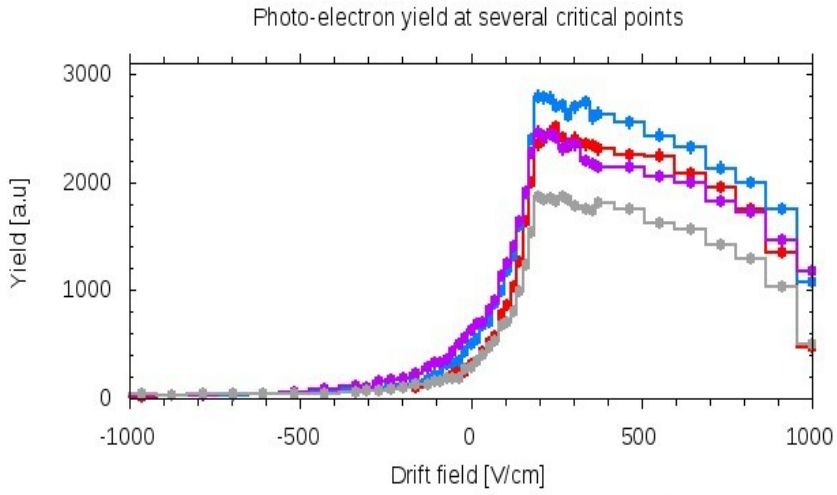
Drift Field Scan



"Critical Line" Scan

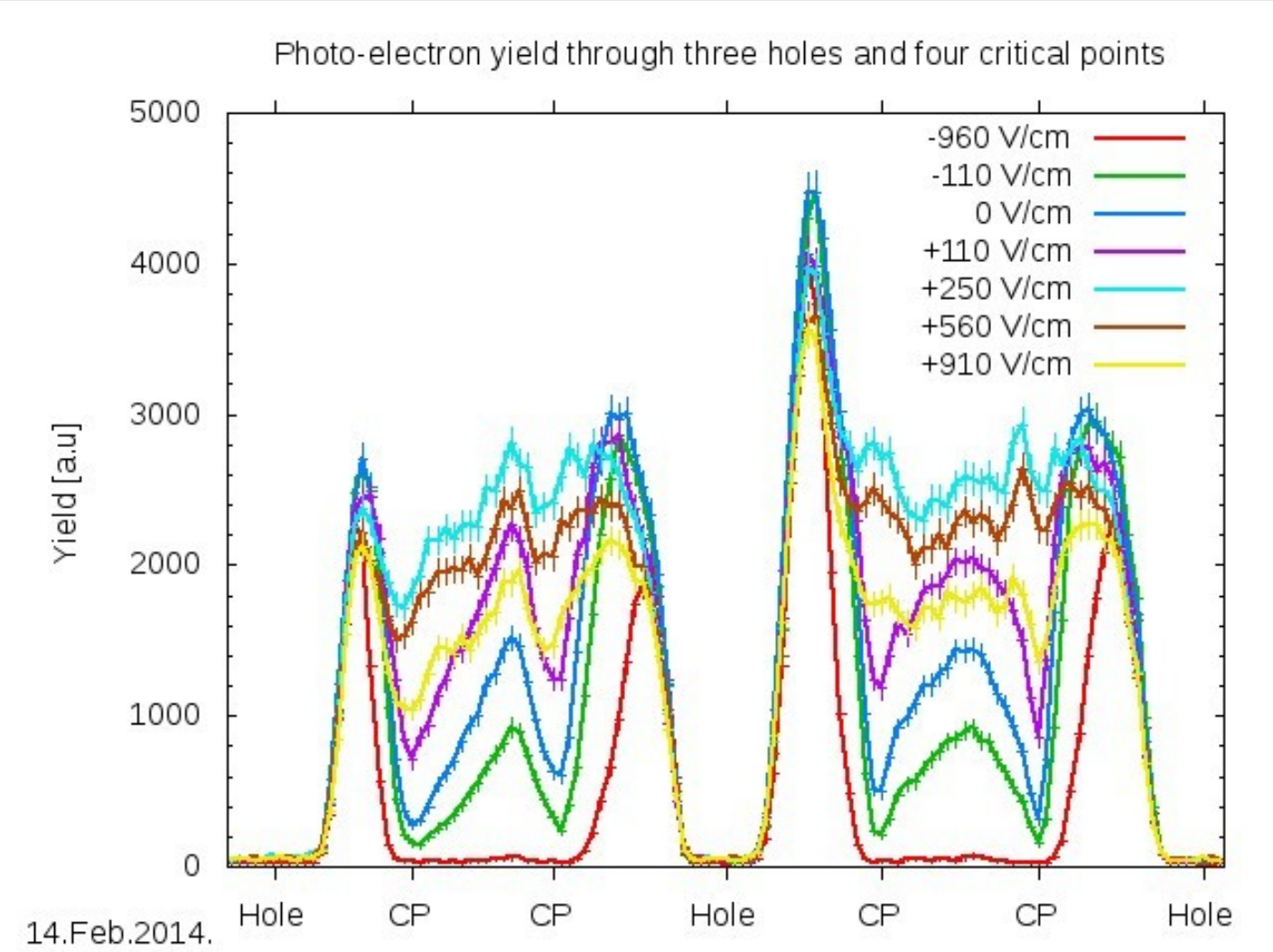
- Critical symmetry points and symmetry lines are most effected by the drift field
- Systematic study on these kind of points with 1 dim scan at several voltage settings



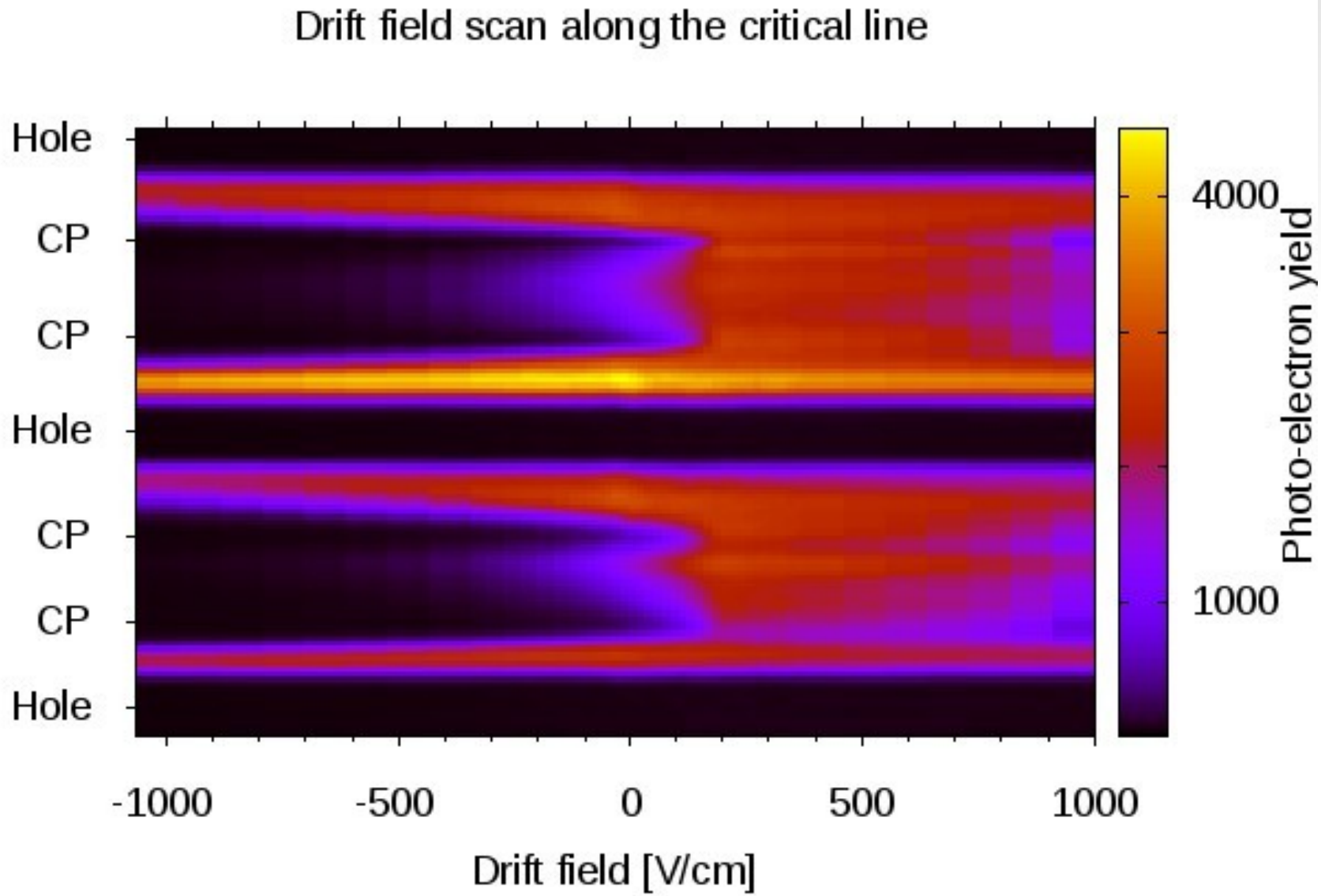


Critical Line Scan : Samples

- Critical points are clearly visible
- Evolution as expected from former measurements

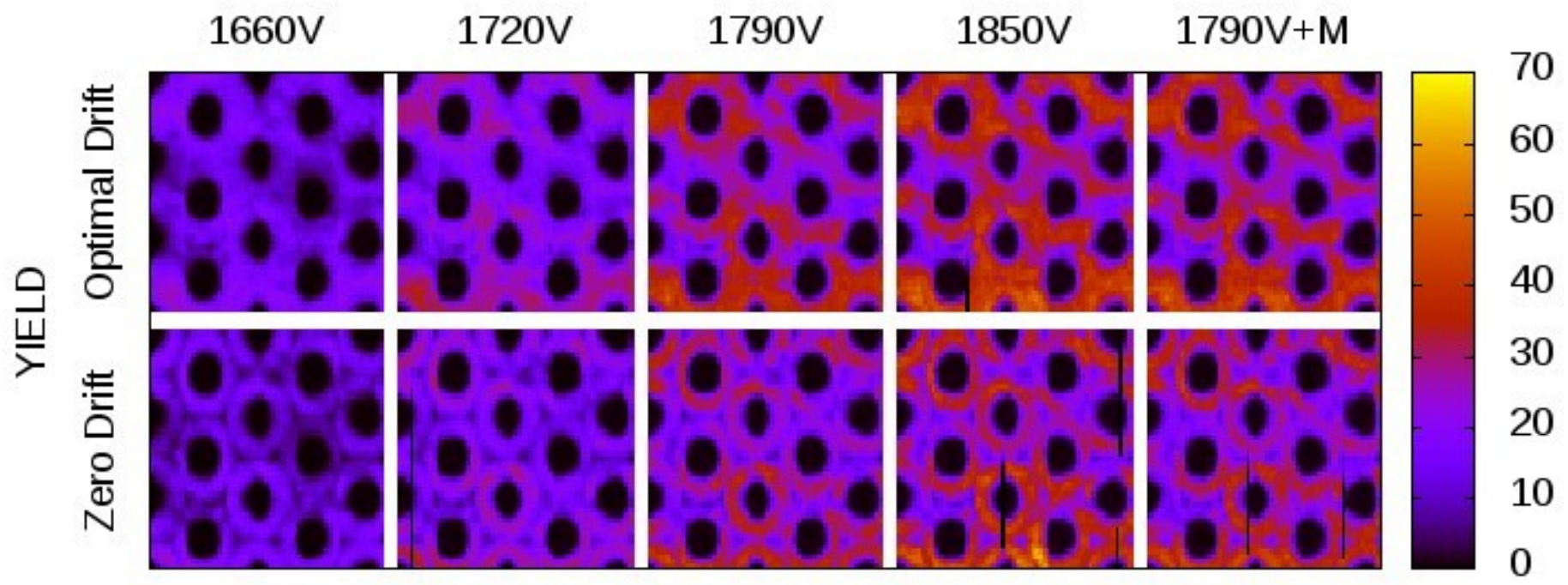


Critical Line vs. Drift



TGEM Voltage and Yield

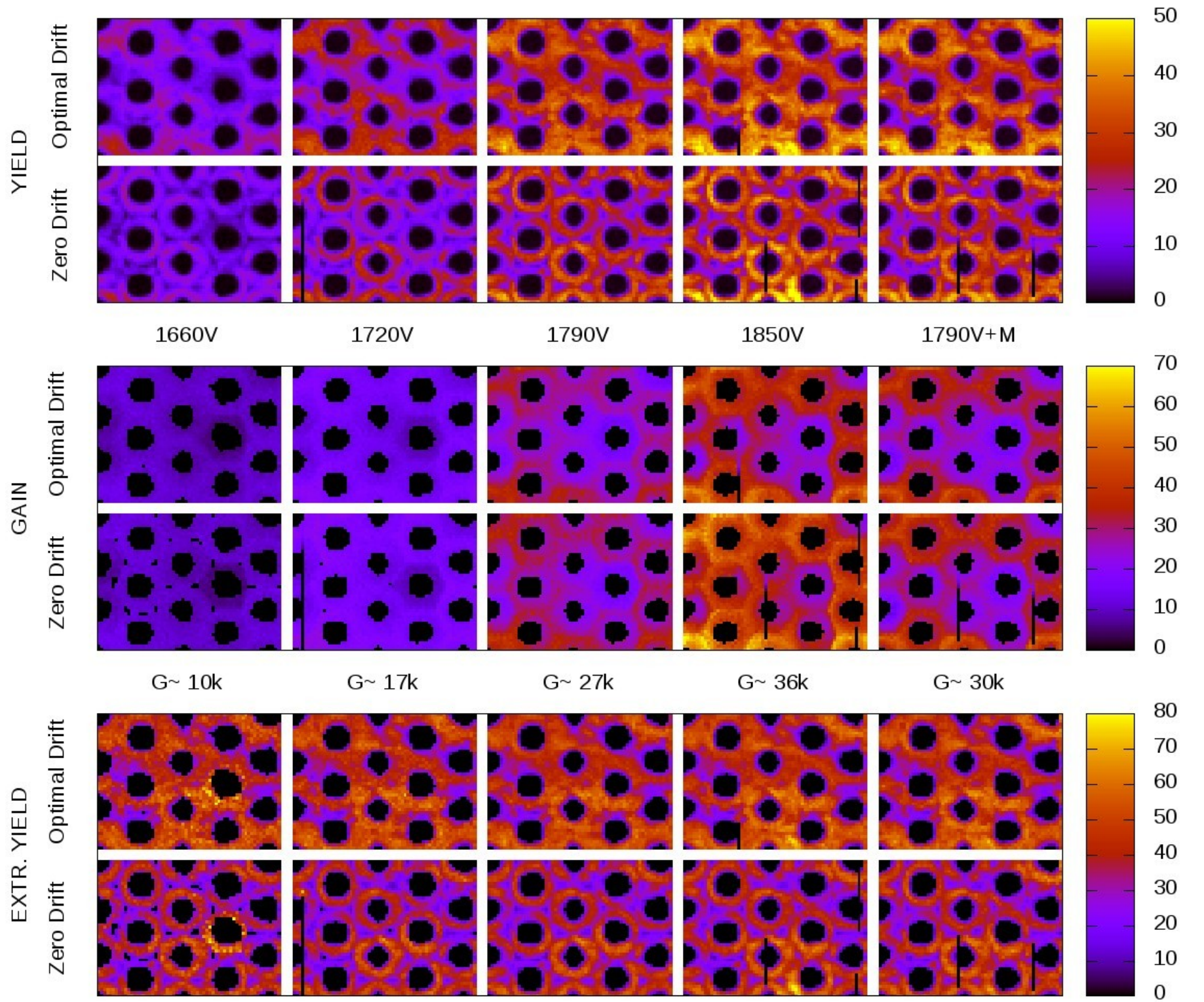
- Higher U_{TGEM} means higher field on the top
- What is the minimal necessary voltage
  (to have max yield without sparks)



Summary

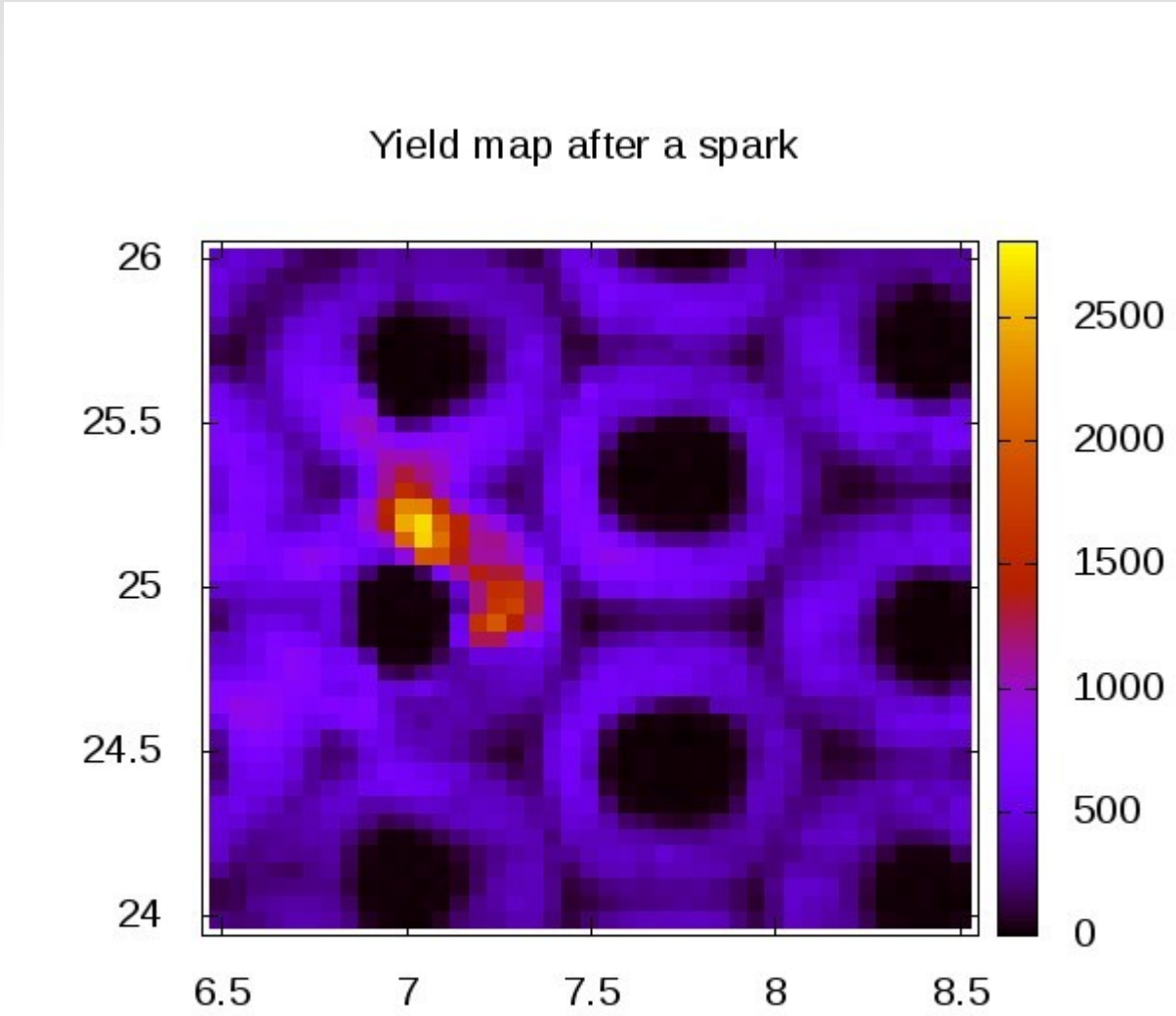
- Leopard : RD51 Common Project
- Leopard measurements in Trieste
  (INFN Trieste + Wigner RCP Budapest)
  for the COMPASS RICH-1 Upgrade
- Comparative systematic scans on 5 TGEMs
- Yield from critical symmetry points were studied wrt
  drift field and
  TGEM voltage
- Quantification of hole-gain uniformity (9-20%)
- Paper/RD51Note in preparation

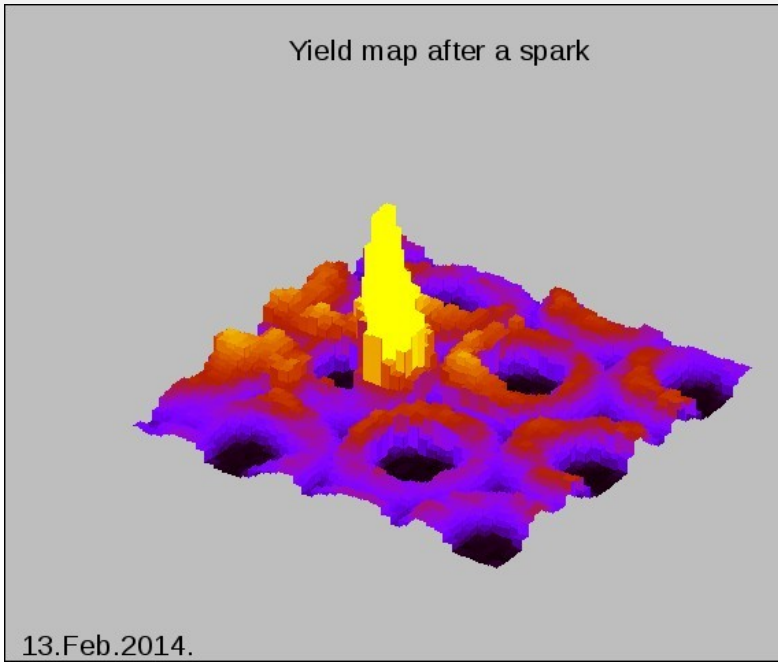
Extra slides


YIELD
Optimal Drift
Zero Drift
50
40
30
20
10
0
1660V
1720V
1790V
1850V
1790V+M
GAIN
Optimal Drift
Zero Drift
70
60
50
40
30
20
10
0
G~ 10k
G~ 17k
G~ 27k
G~ 36k
G~ 30k
EXTR. YIELD
Optimal Drift
Zero Drift
80
70
60
50
40
30
20
10
0

15.Feb.2014.

Sparks


Yield map after a spark
26
25.5
25
24.5
24
6.5
7
7.5
8
8.5
2500
2000
1500
1000
500
0


Yield map after a spark
13.Feb.2014.

Long runs during nights with Ar/CO_2