

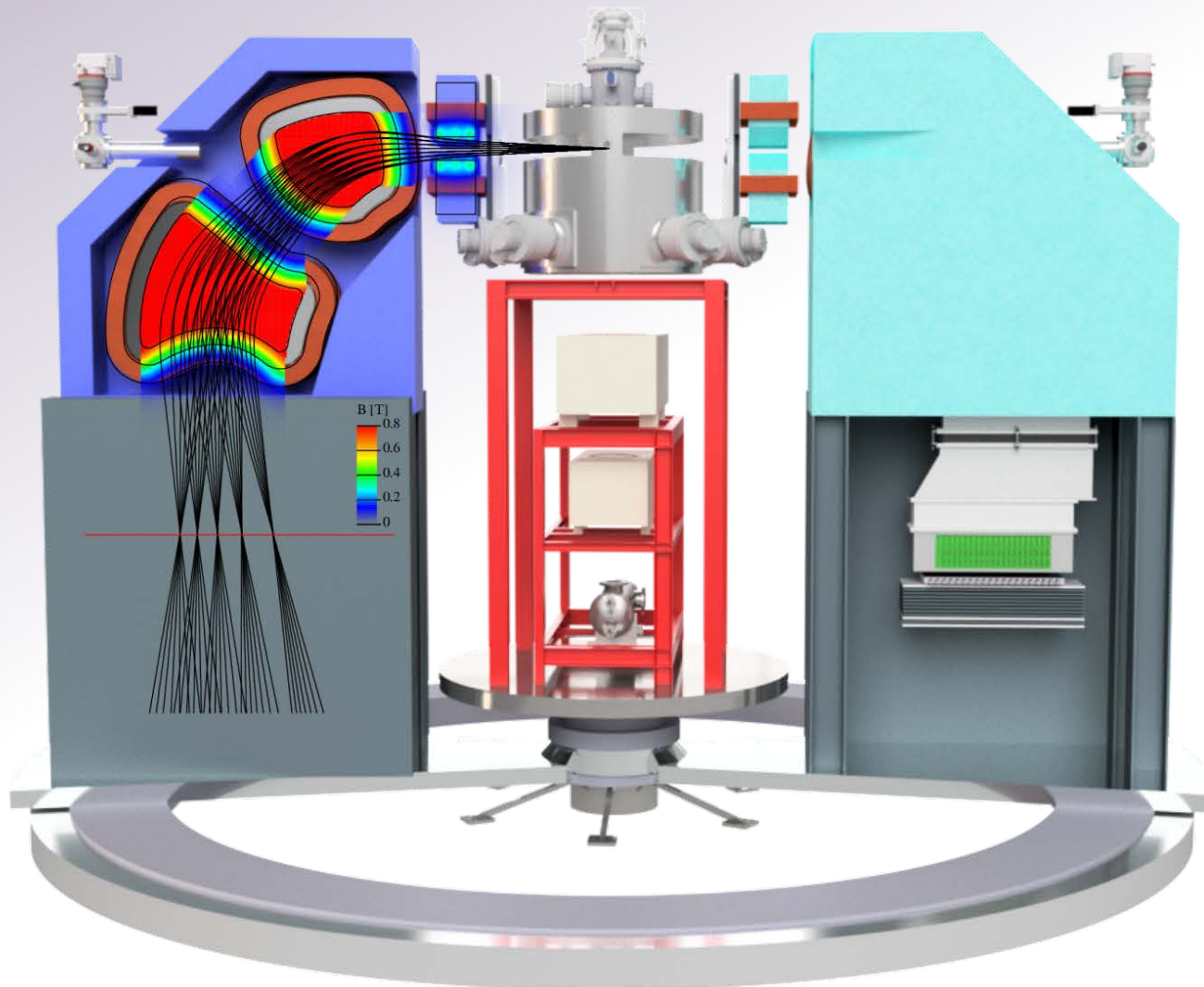
MXTPC

MAGXGAW

Pepe Gülker

RD51 Mini Week Feb 2020

MAGIXperiment @ MESA



Electron Beam

- $E \leq 105 \text{ MeV}$
- $I \leq 1 \text{ mA}$

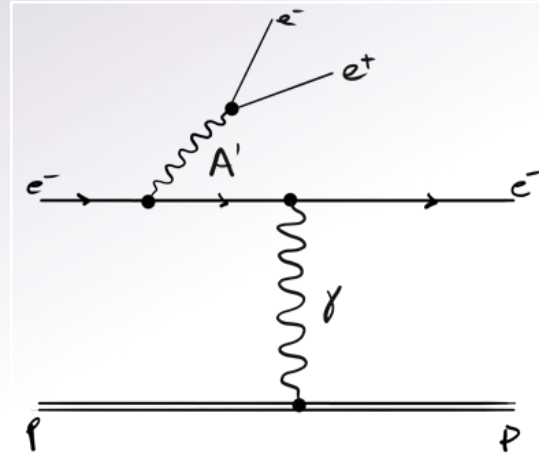
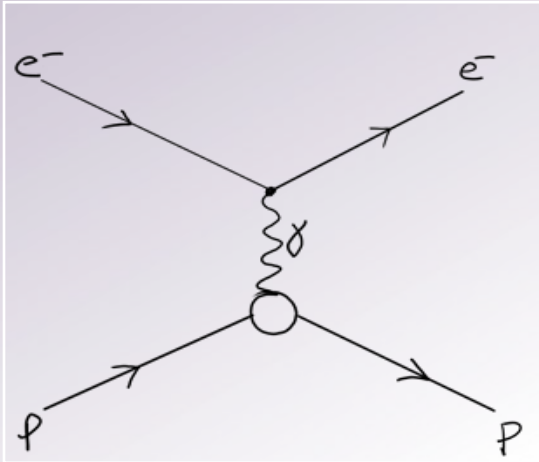
Jet Target

- windowless target
- from H to Xe

2 Spectrometers

- Focal Plane
 - 700 mm (dispersive)
 - 150 mm (drift)
 - 200 mm (depth)

Electrons & Positrons

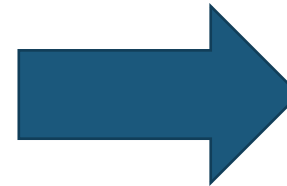


Electron Scattering

- Elastic or inelastic
- Form factor measurements
- Proton radius

Pair Production

- e^+e^- coincidence
- With SM or dark U(1) photons



Momenta
Angles

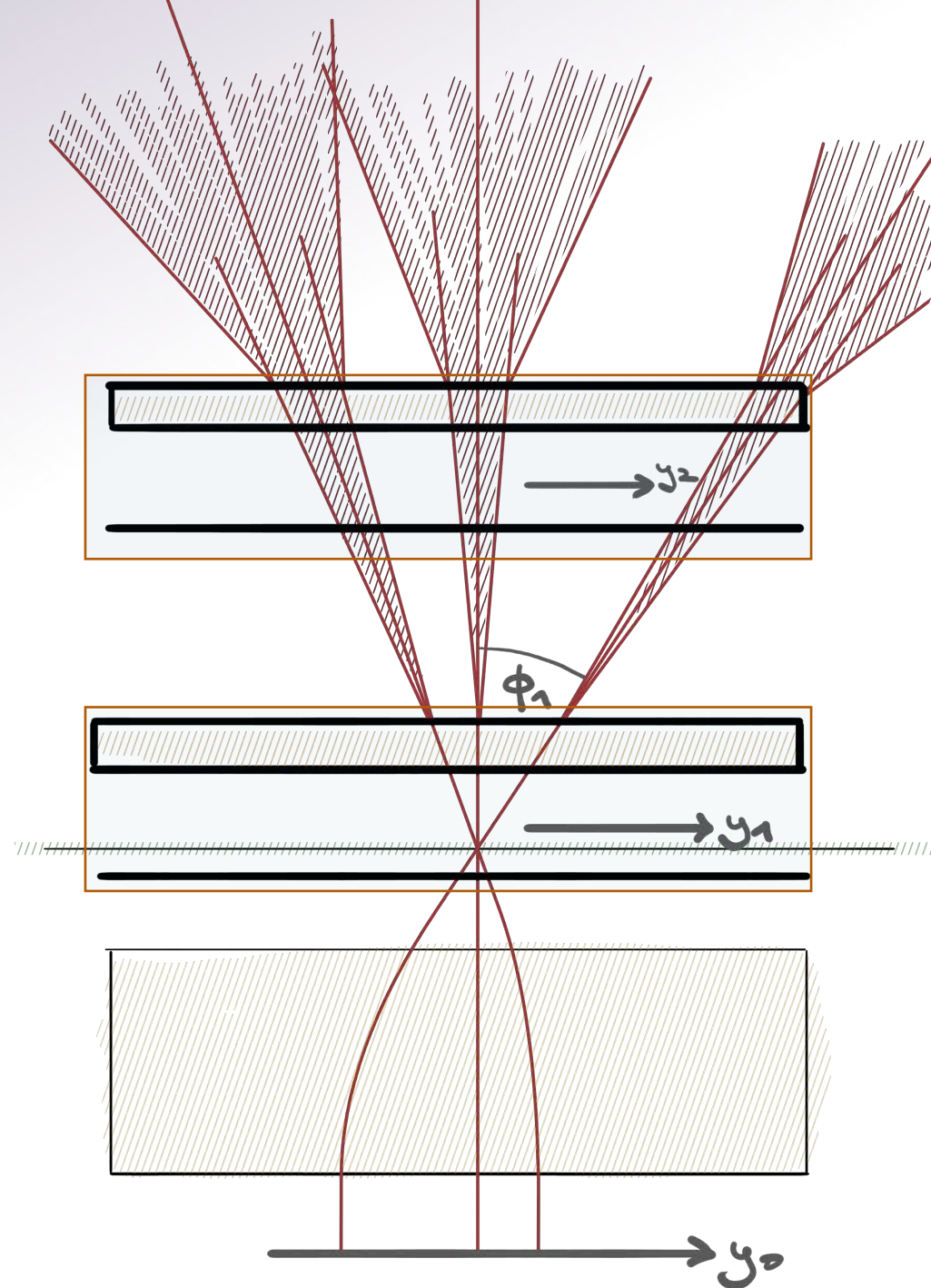
Focal Plane

Need detector to measure

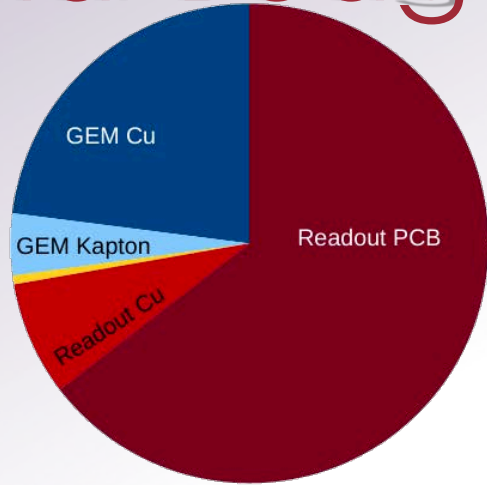
- Position x and y
- Angles φ and ϕ

How?

- Easiest approach: hodoscope
- Multiple scattering in 1st detector limits angular resolution
- Remember: 105 MeV electrons!

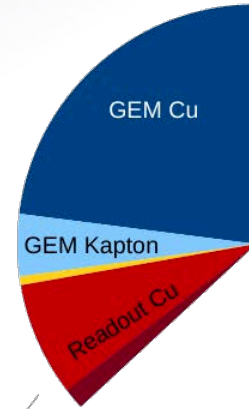


Material Budget



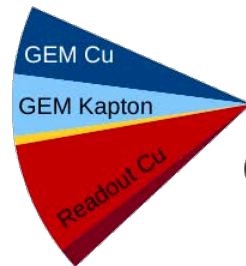
Default triple GEM detector
0.96% X_0

Foil
Readout
100 μm
Kapton



0.38% X_0

1 μm Cu
GEMs

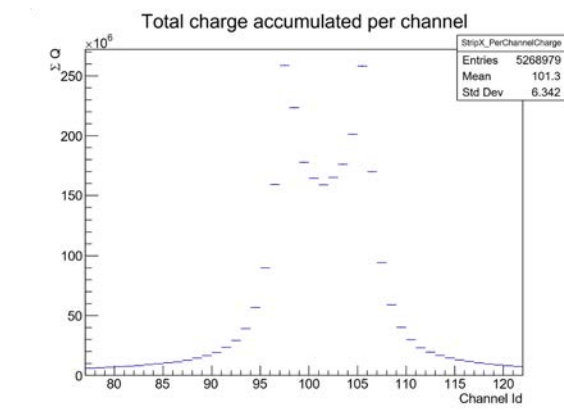
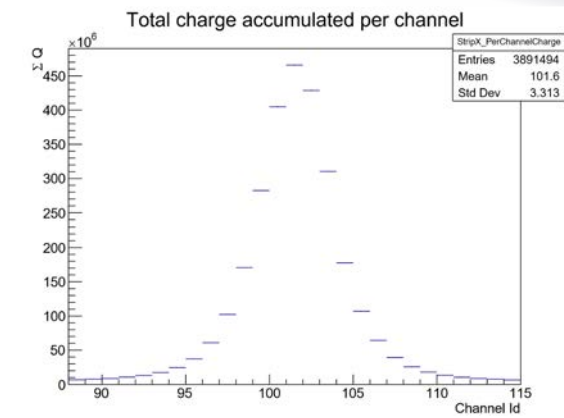


0.22% X_0

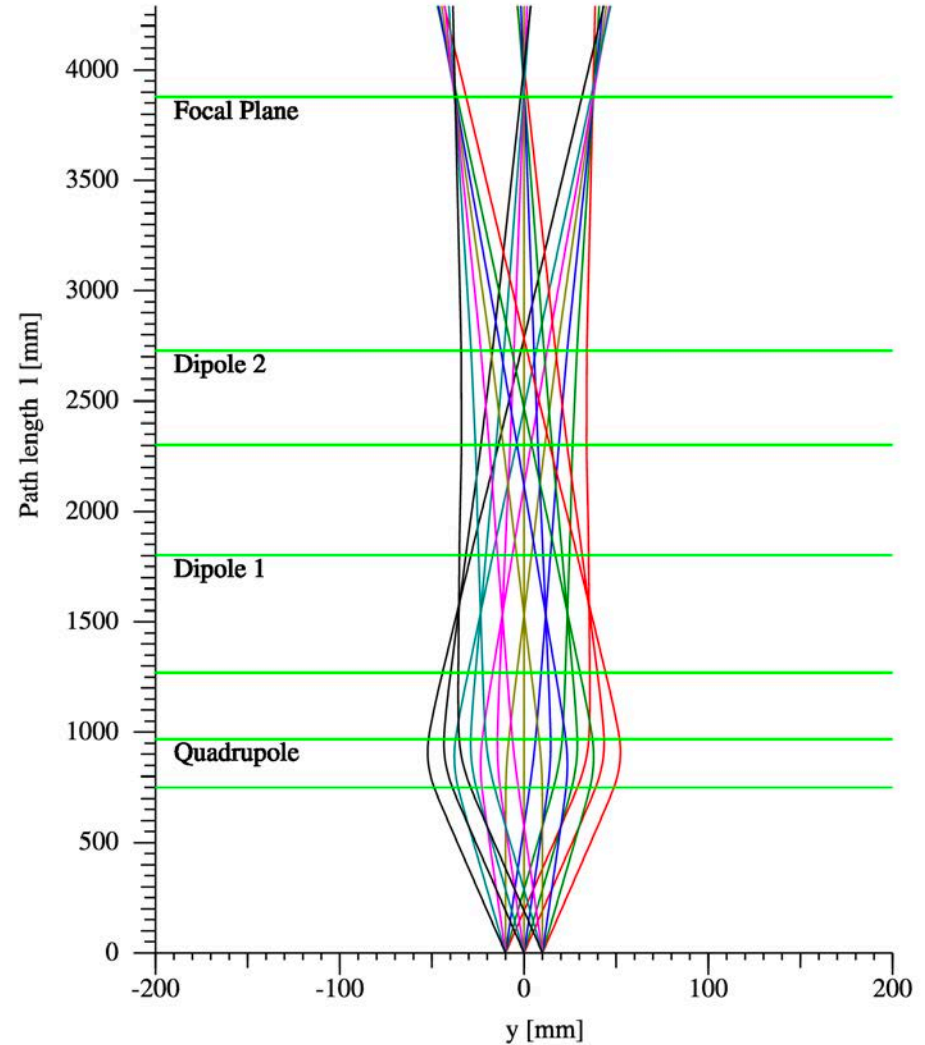
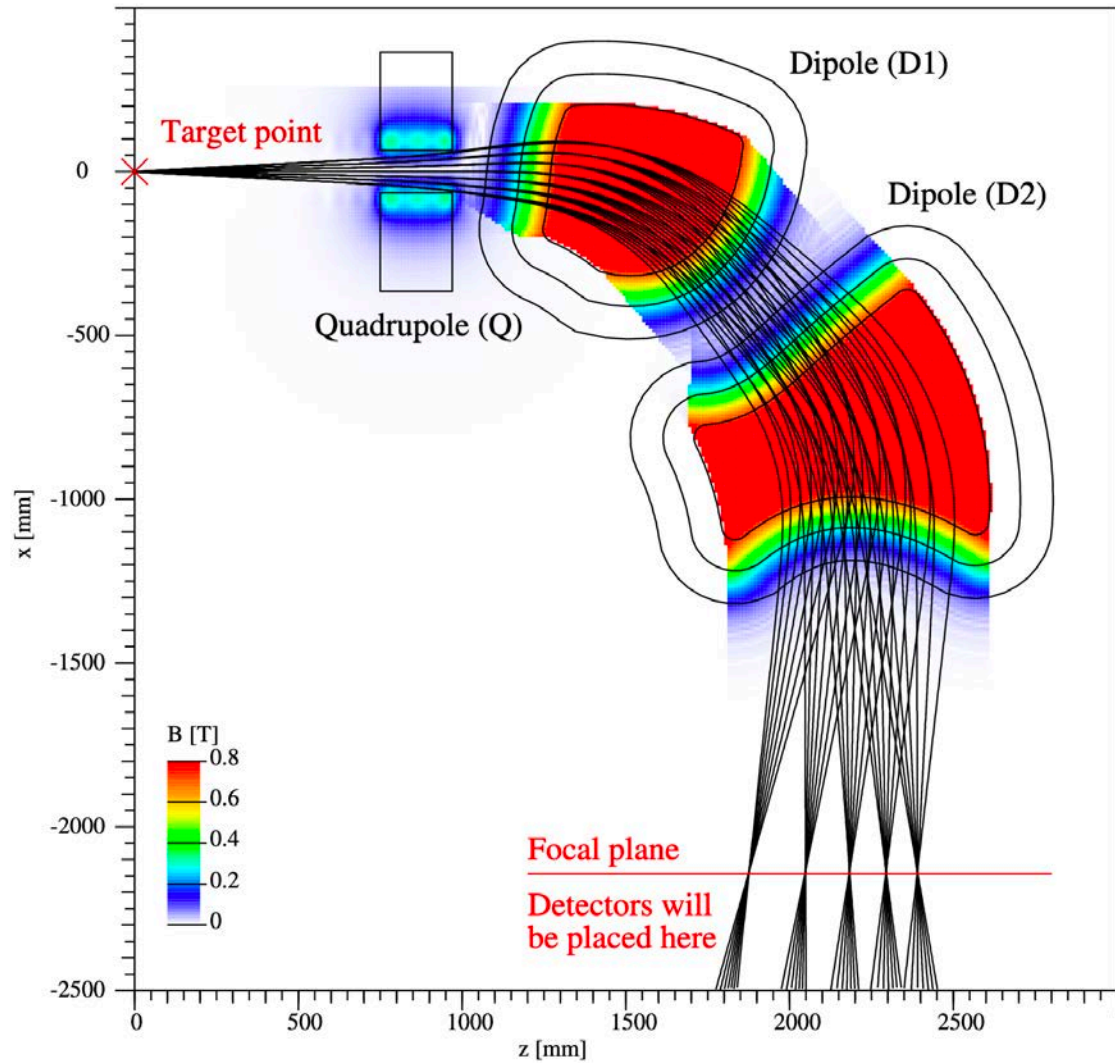


type	radiation thickness [X_0]	scattering angle [deg] @ 100 MeV
default	0.95 %	0.7
thin readout	0.38 %	0.4
chromium GEMs	0.22 %	0.3

The end of the hodoscope



New Spectrometer Design



New Spectrometer Design



Focal Plane Size

- 640 mm (dispersive)
- 140 mm (non-dispersive)
- 200 mm (depth)

Detector not tilted

- less material to traverse
- mapping not constant

- Magnification $M = -0.45701$

- Imaging:

$$J = \begin{pmatrix} \partial_z p & \partial_\phi p & \partial_\theta p & \partial_y p \\ \partial_z \phi & \partial_\phi \phi & \partial_\theta \phi & \partial_y \phi \\ \partial_z \theta & \partial_\phi \theta & \partial_\theta \theta & \partial_y \theta \\ \partial_z y & \partial_\phi y & \partial_\theta y & \partial_y y \end{pmatrix} = \begin{pmatrix} 0.00055 & 0.00001 & 0.00000 & 0.00000 \\ 0.01098 & 0.46056 & 0.00000 & 0.00000 \\ 0.00000 & 0.00000 & -3.74665 & 0.09838 \\ 0.00000 & 0.00000 & 0.31631 & 0.25873 \end{pmatrix}$$

- Resolutions:

Assumed Detector Resolutions:

beam size	=	0.10000 mm
x(displ)	=	0.10000 mm
y	=	0.10000 mm
disp	=	3.49066 mrad = 0.2°
non-d	=	3.49066 mrad = 0.2°

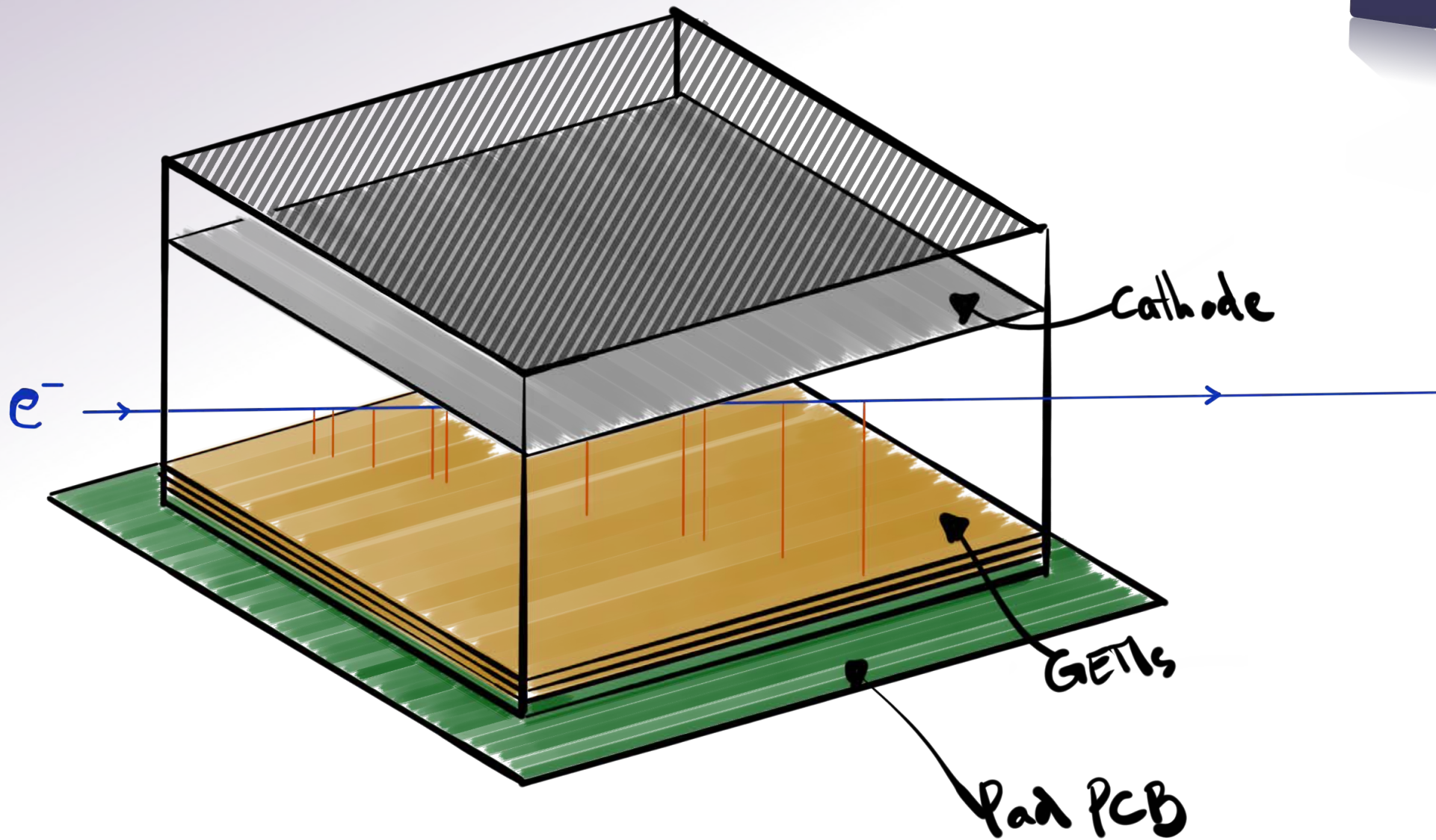
Target Resolutions:

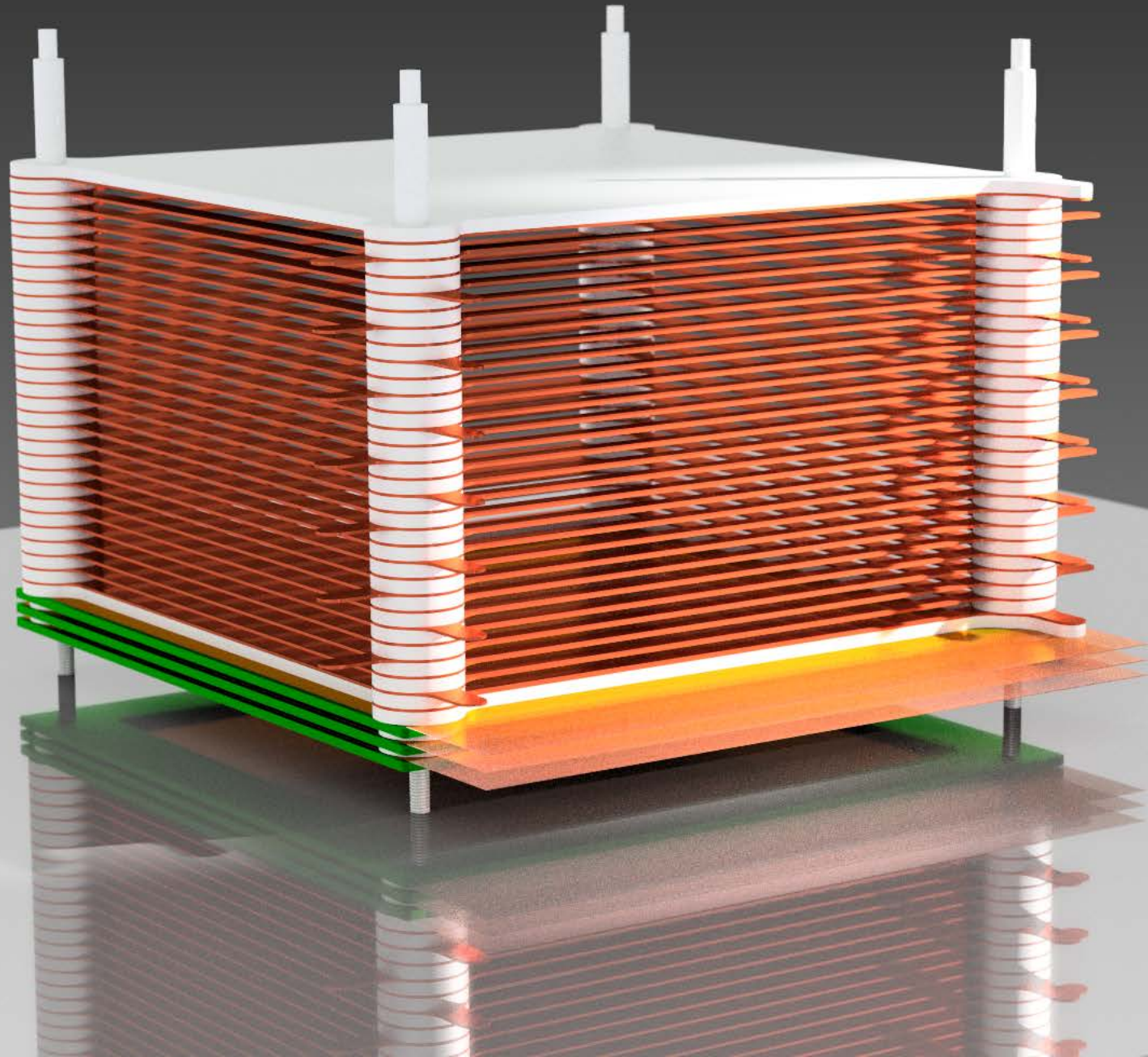
dp/p	=	0.00006
$d\phi$	=	1.60781 mrad = 0.09°
$d\theta$	=	6.54815 mrad = 0.38°
dy	=	0.06065 mm

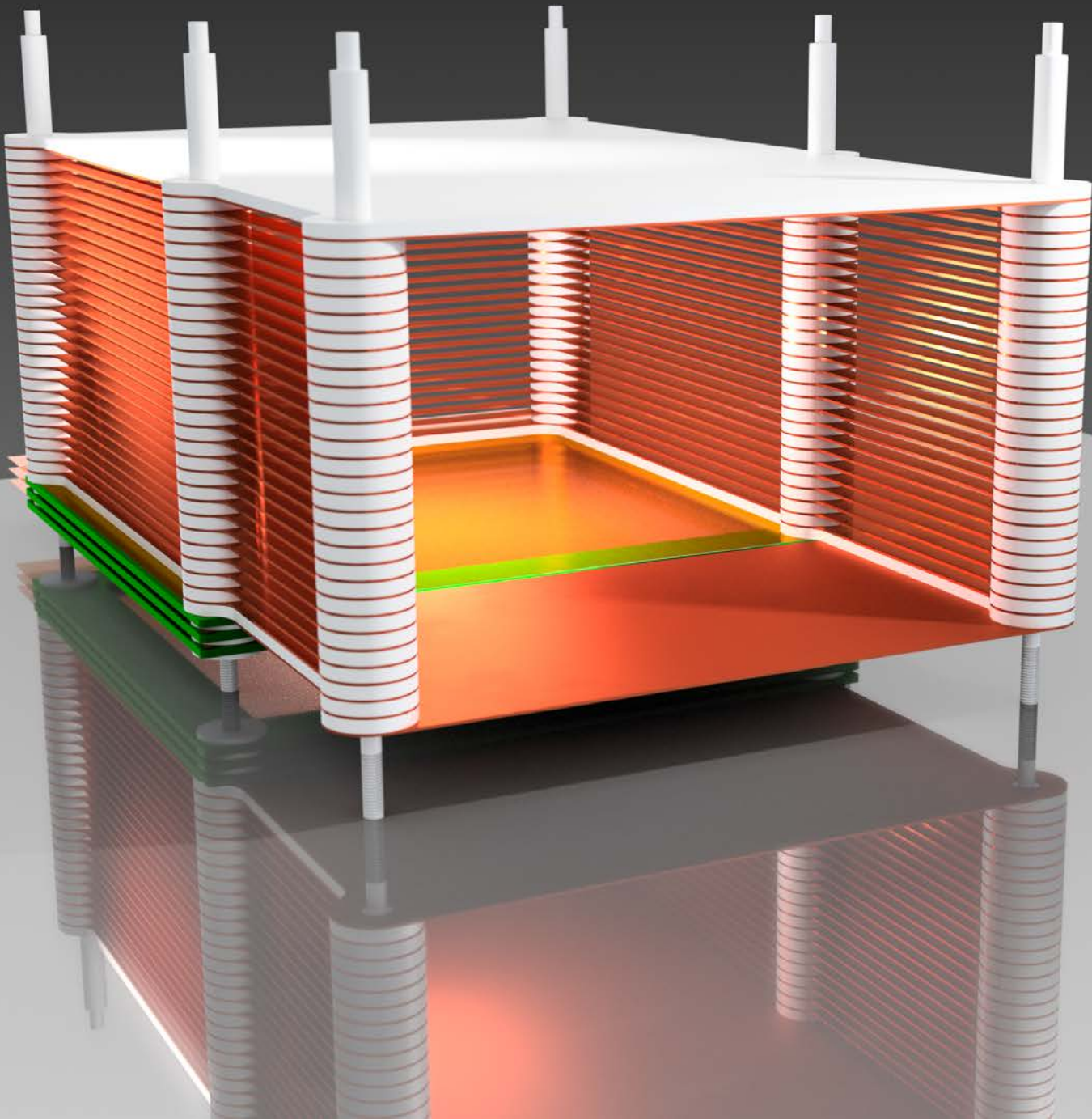
- Solid angle:

$$R = 76 \text{ mrad} \Rightarrow \Delta\Omega = 18.1 \text{ msr}$$

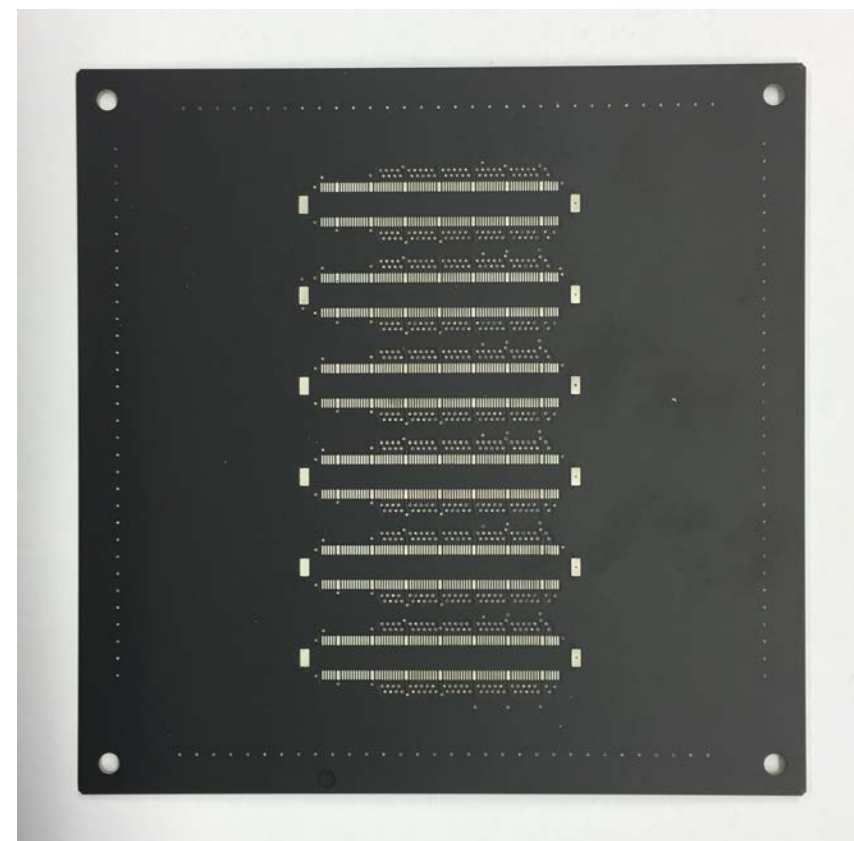
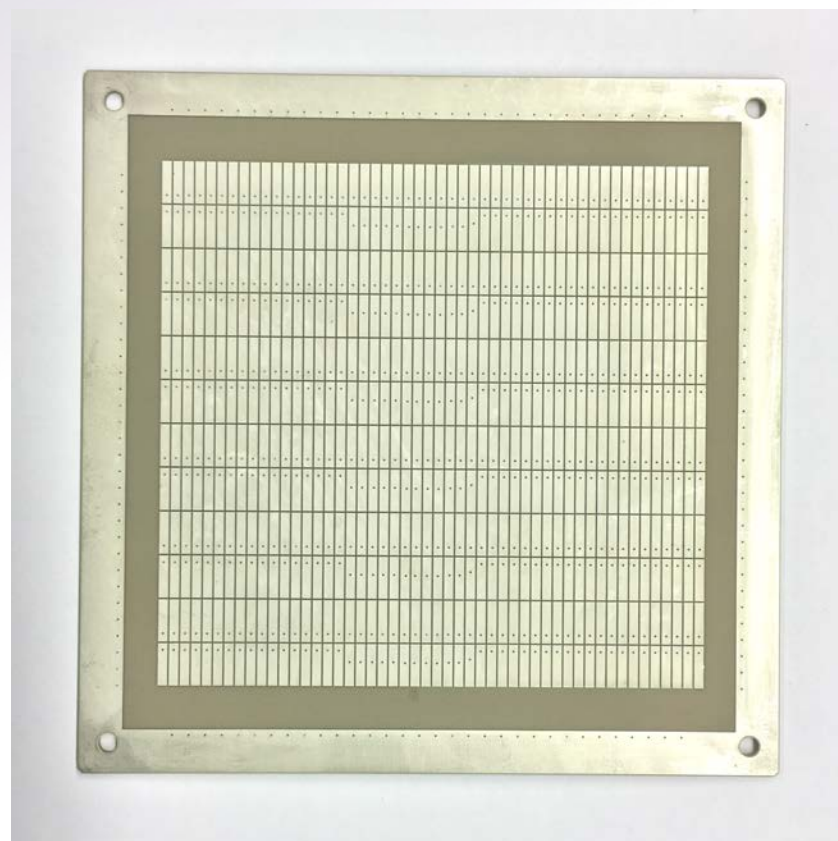
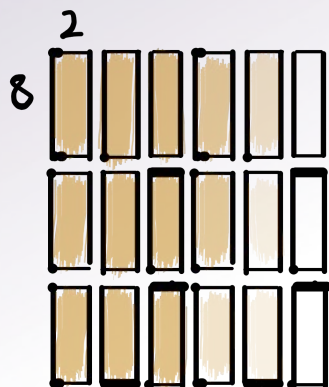
TPC – Time Projection Chamber







Pad PCB



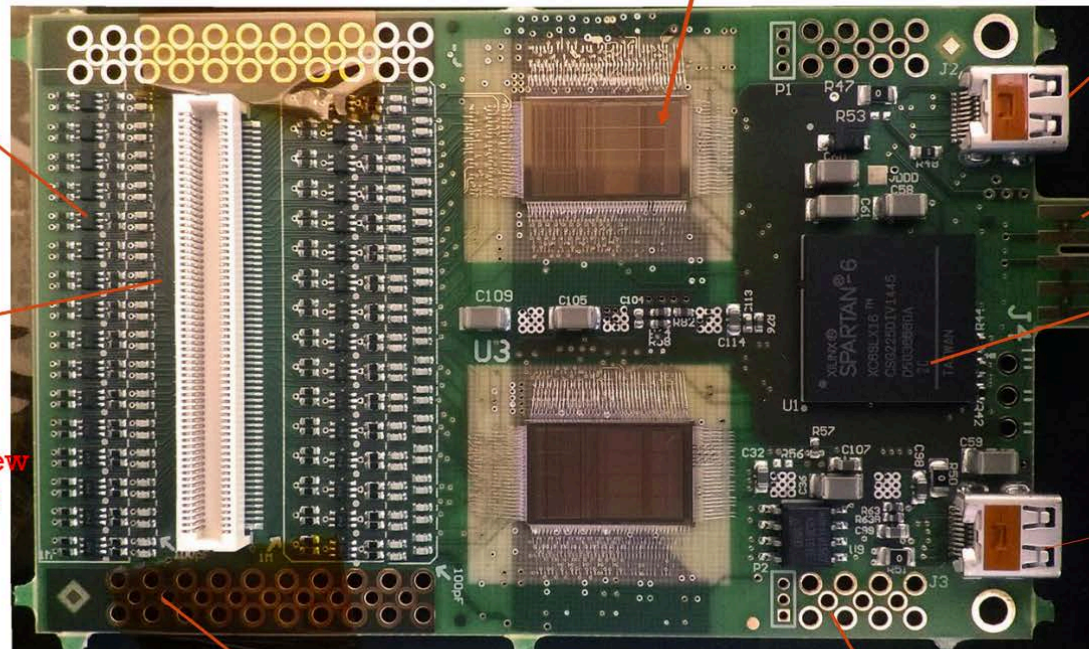
VMM



Photo: 2 x wire-bonded VMM2 chips -> new VMM3 board fully routed

AC coupling & spark protection

Panasonic 130 pin connector for MPGDs
Will be replaced by new 140 pin HRS connector



HDMI link 1 DTCCP

JTAG

Companion FPGA

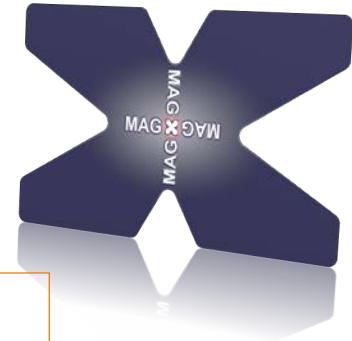
HDMI link 2 DTCCP

Detector GND MMCx

Neighbor-channel via MMCX

hans.muller@cern.ch

MXTPC - Numbers



Tripple GEM

- Voltages:
 - GEMs: 360 - 329 - 293
 - Transfer: 720 - 720 - 720

Gas

- Ar:CO₂ 90:10
- 10 L/h

Readout PCB

- Padsizes: 2 x 8 mm²
- 50 rows
- 12 columns
- 600 pads

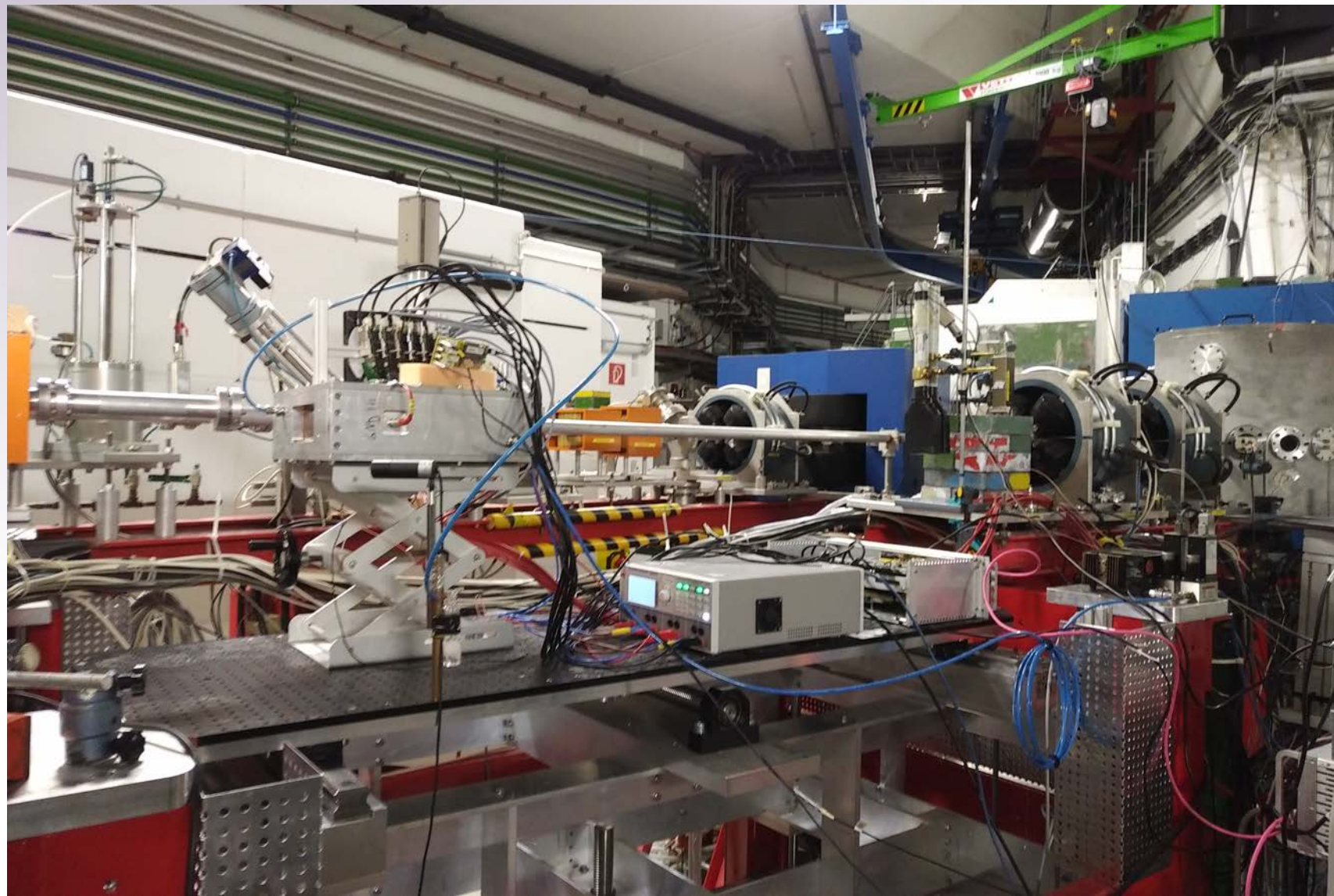
Readout Electronics

- 6 VMMs @ TPC
- 1 VMM @ Trigger

Fieldcage

- Copper rings 0.5 mm
- pitch 2.5 mm
- 28 rings
- 7 cm drift

Beamtime 2019



Beam

- Energy fixed 855 MeV
- Rates up to 1 MHz

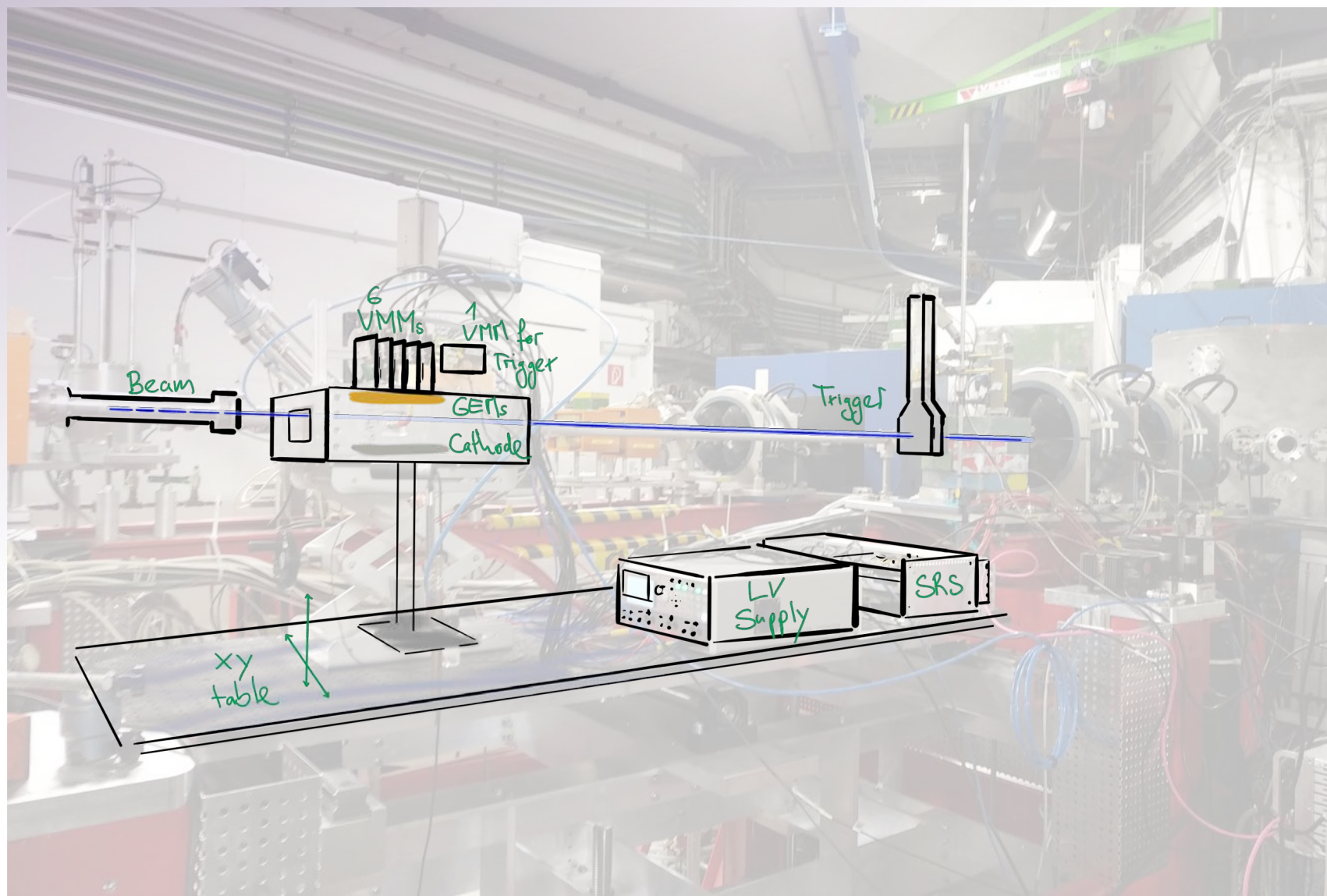
TPC

- 3 GEMs
- 7 cm drift

Readout

- 6 VMMs @ TPC
- 1 VMM @ Trigger

Beamtime 2019



Beam

- Energy fixed 855 MeV
- Rates up to 1 MHz

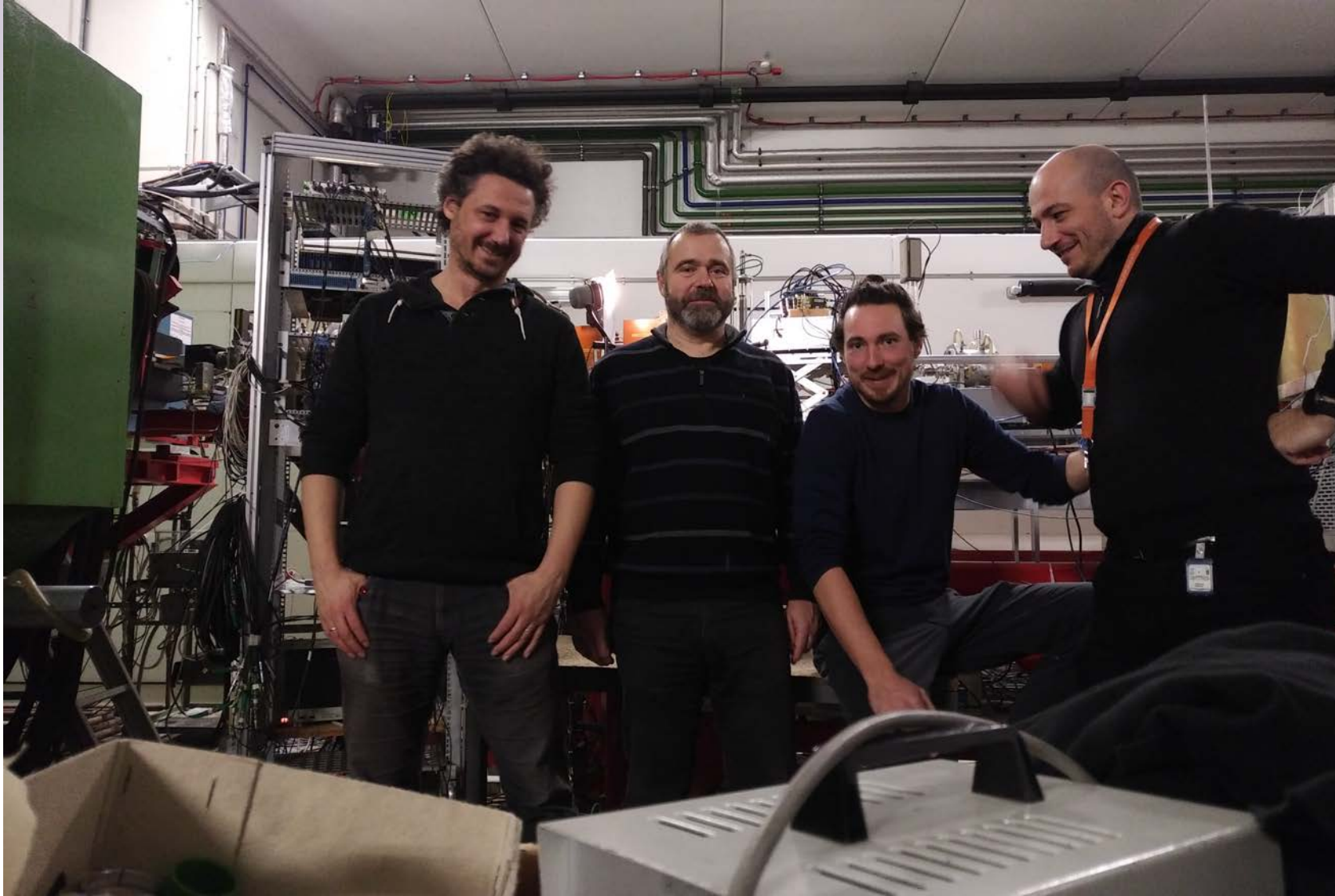
TPC

- 3 GEMs
- 7 cm drift

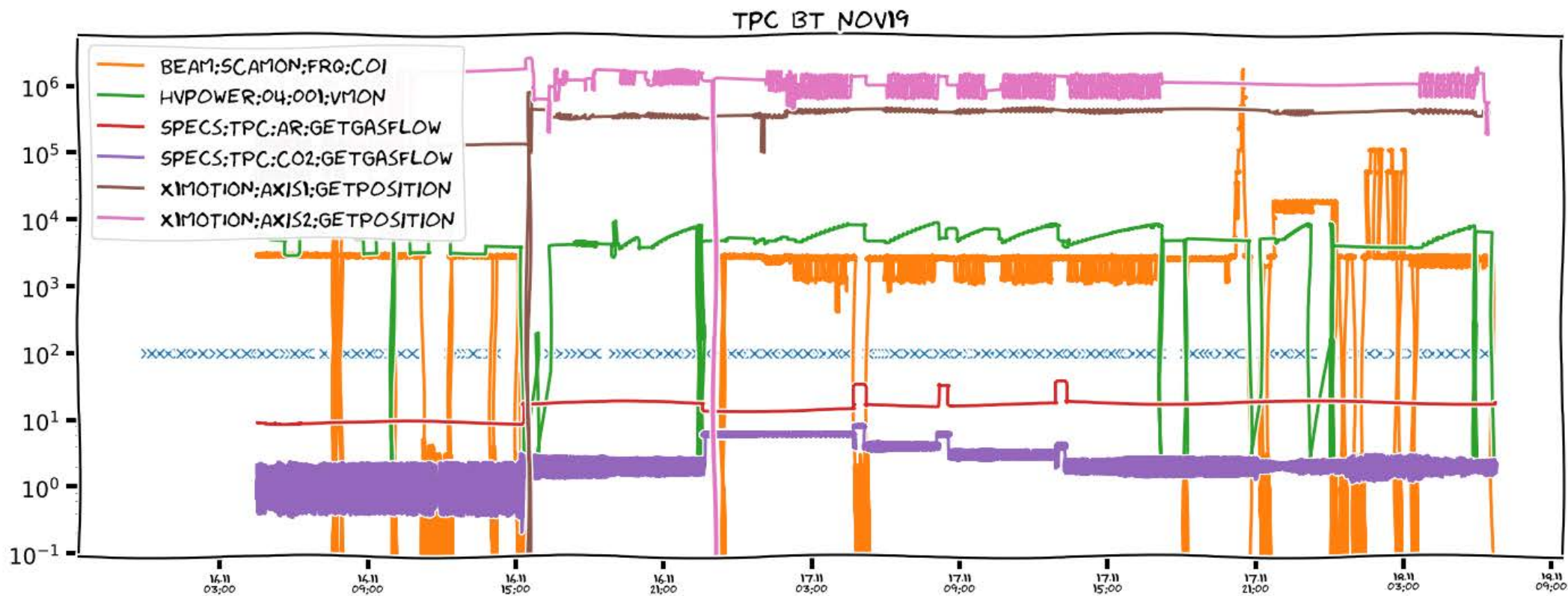
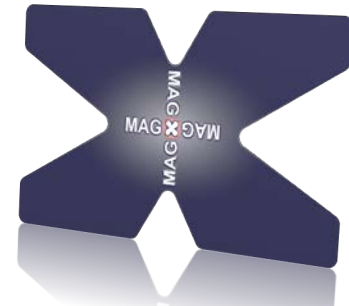
Readout

- 6 VMMs @ TPC
- 1 VMM @ Trigger

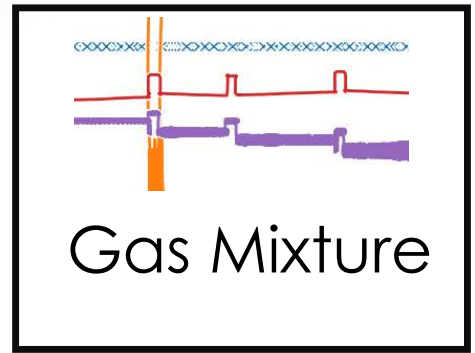
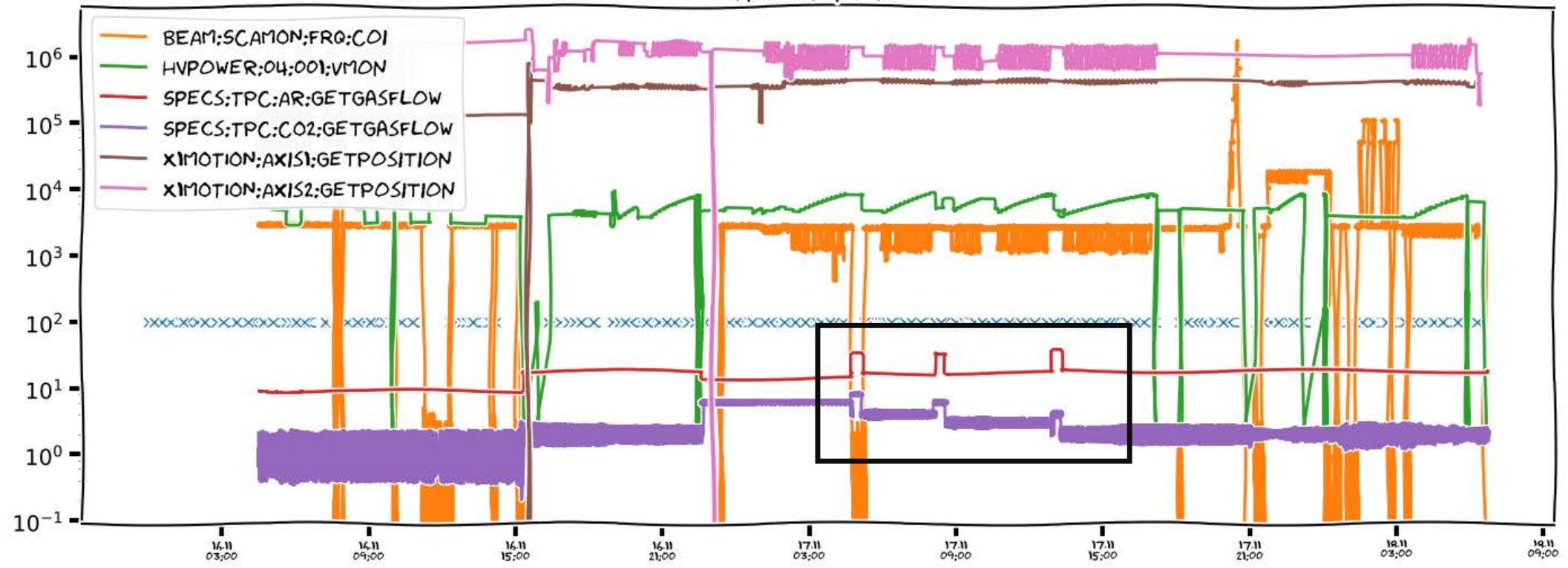
Beamtime 2019

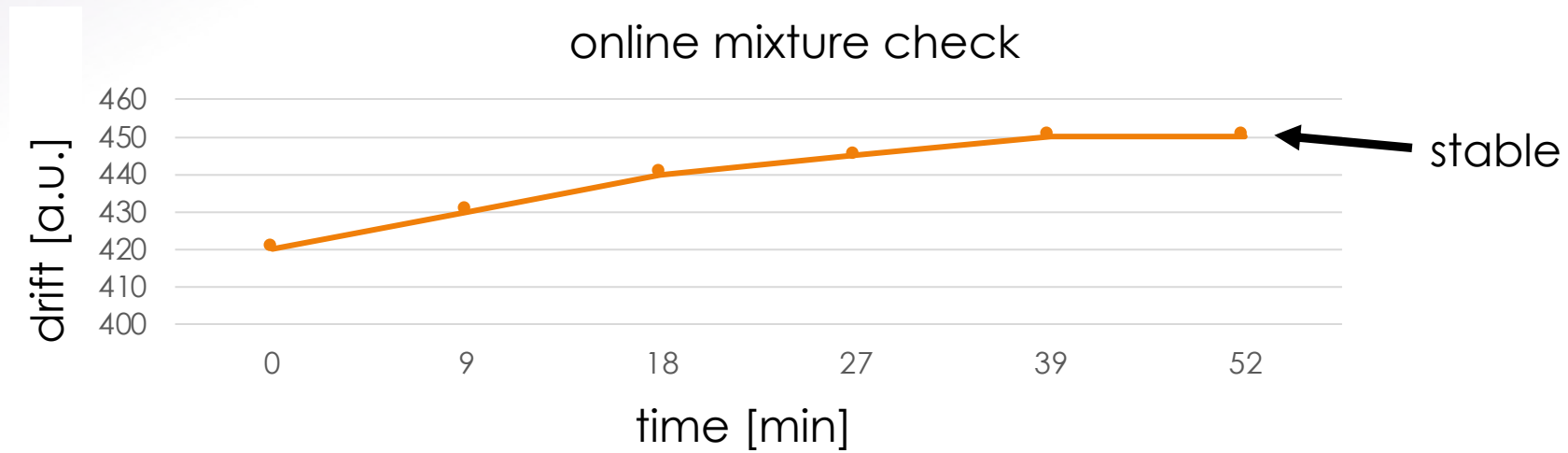
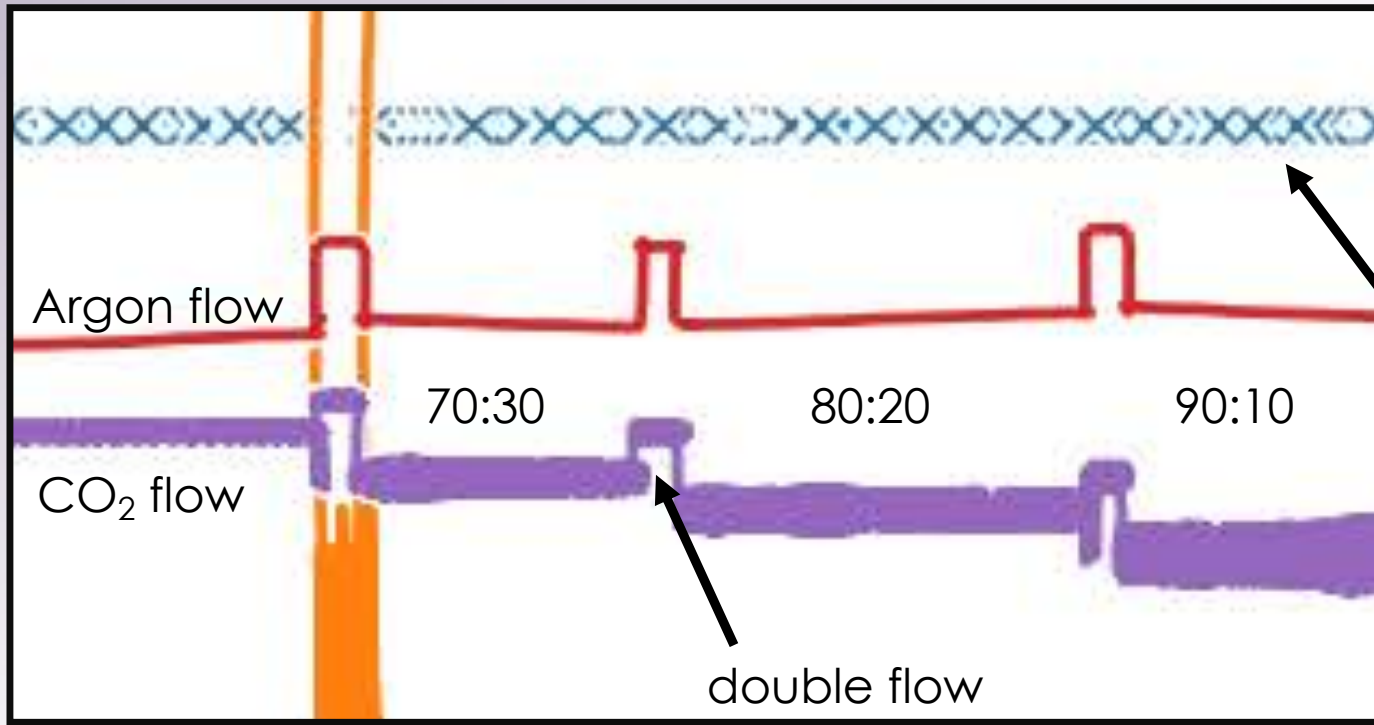


Beamtime 2019

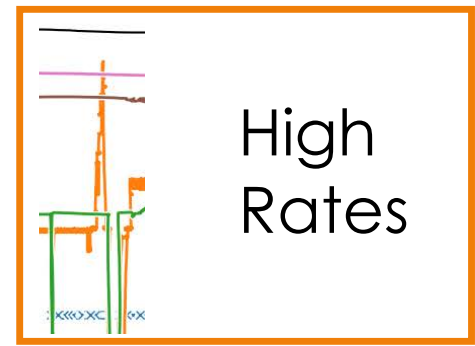
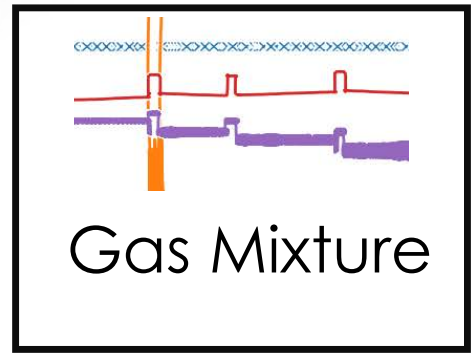
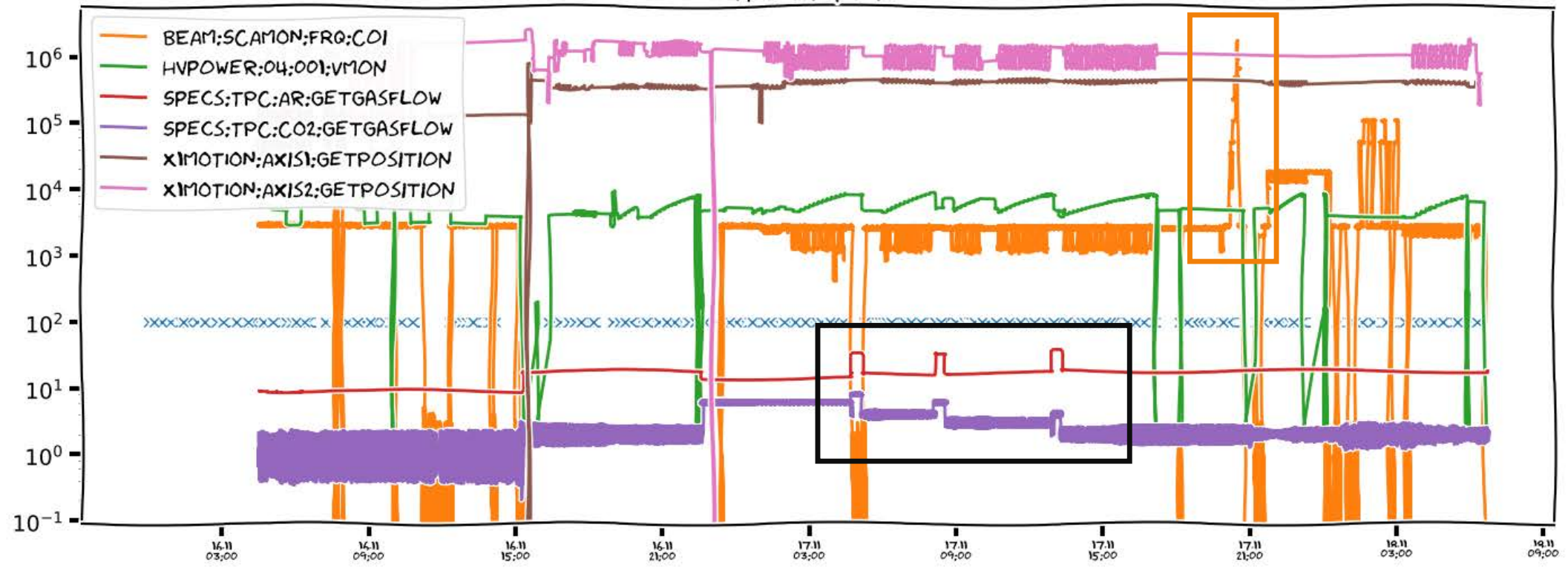


TPC BT NOV19

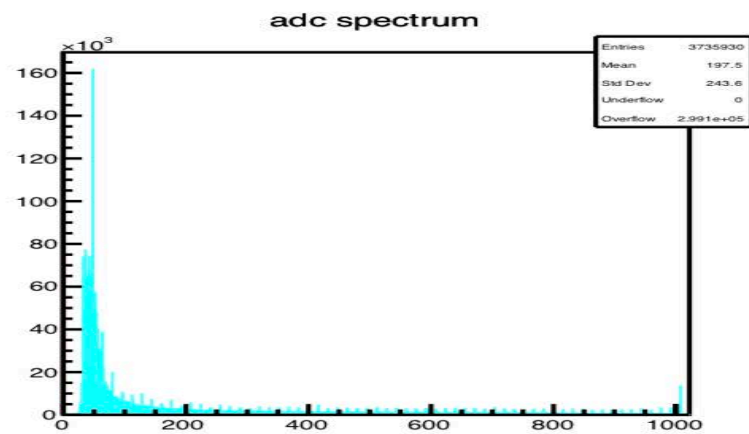
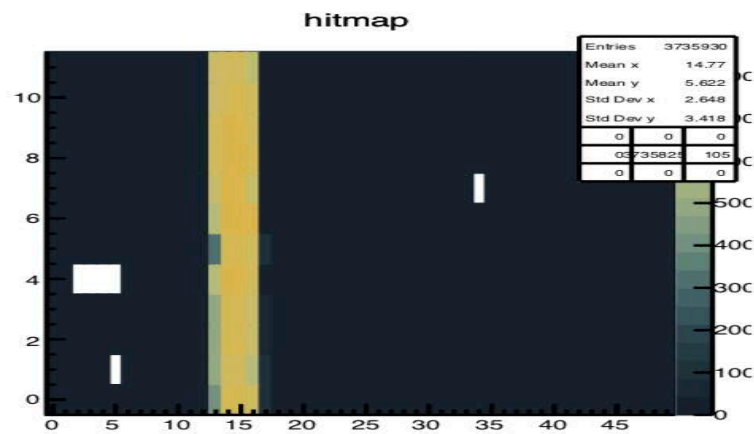
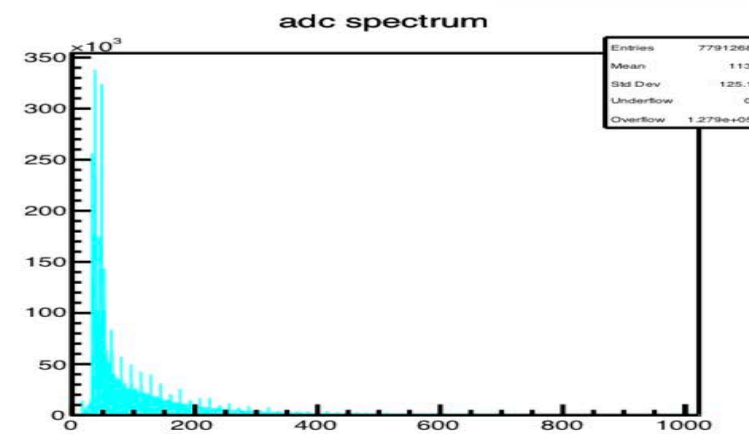
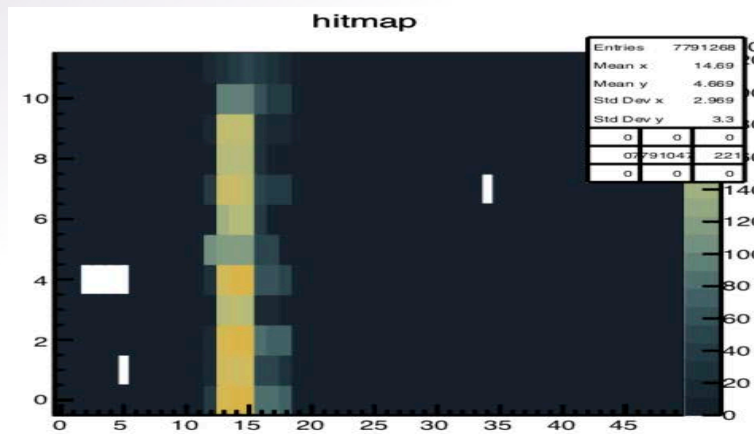
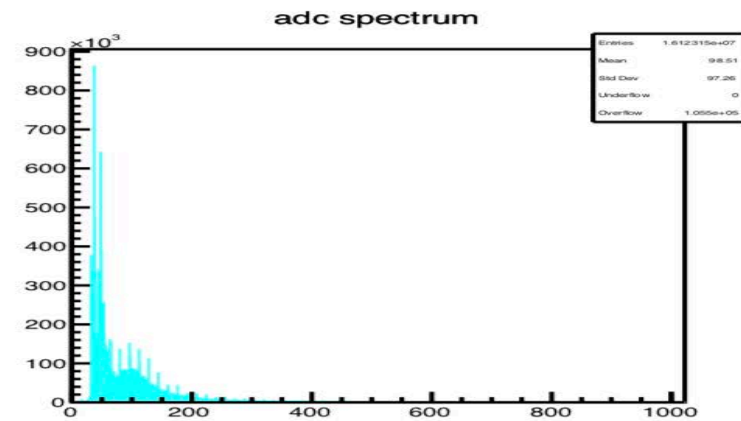
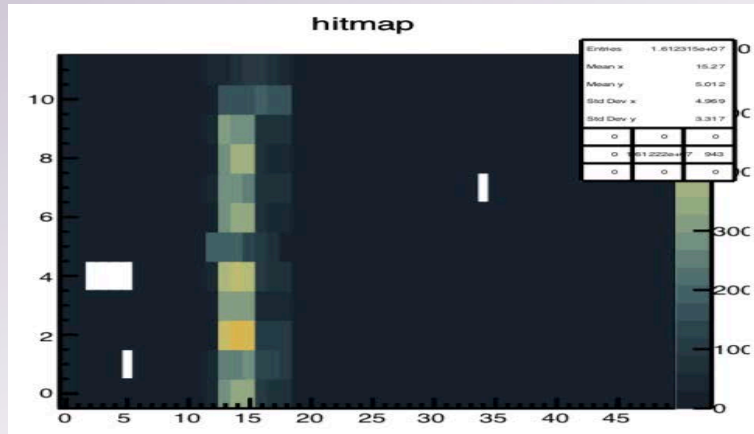
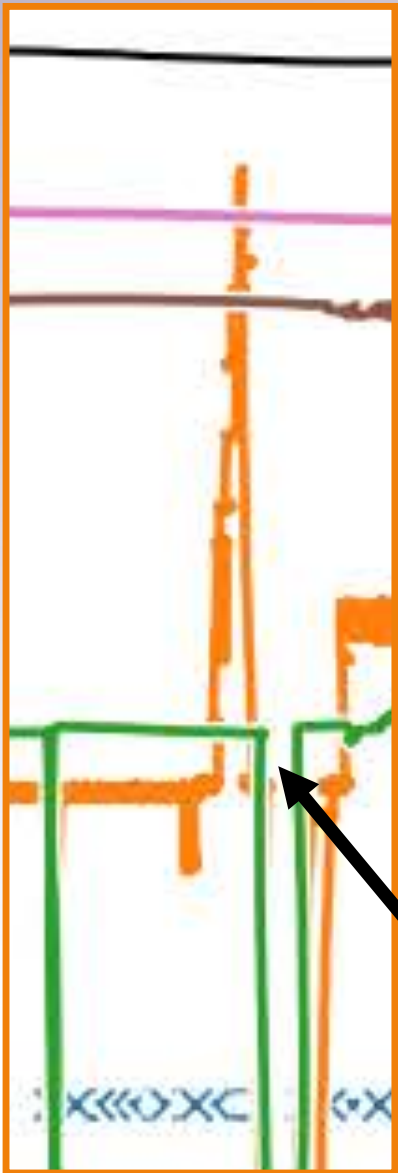




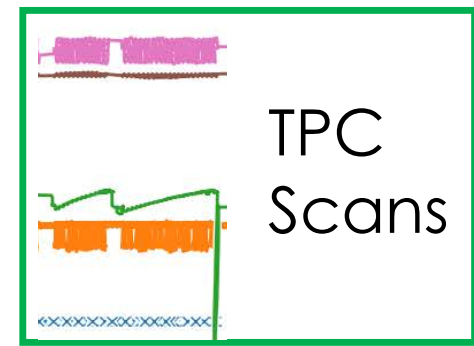
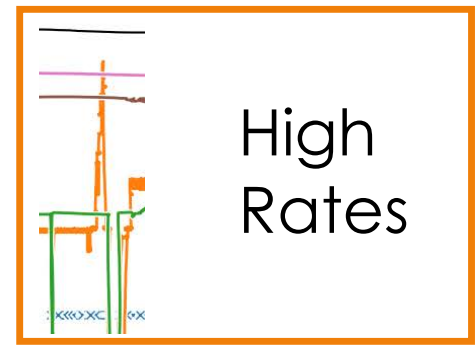
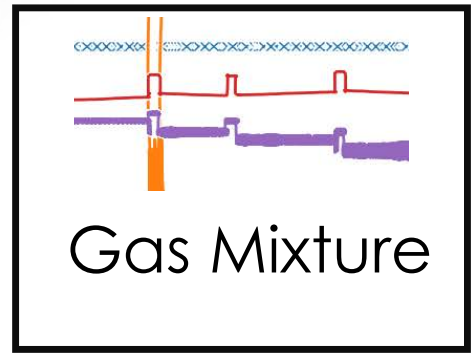
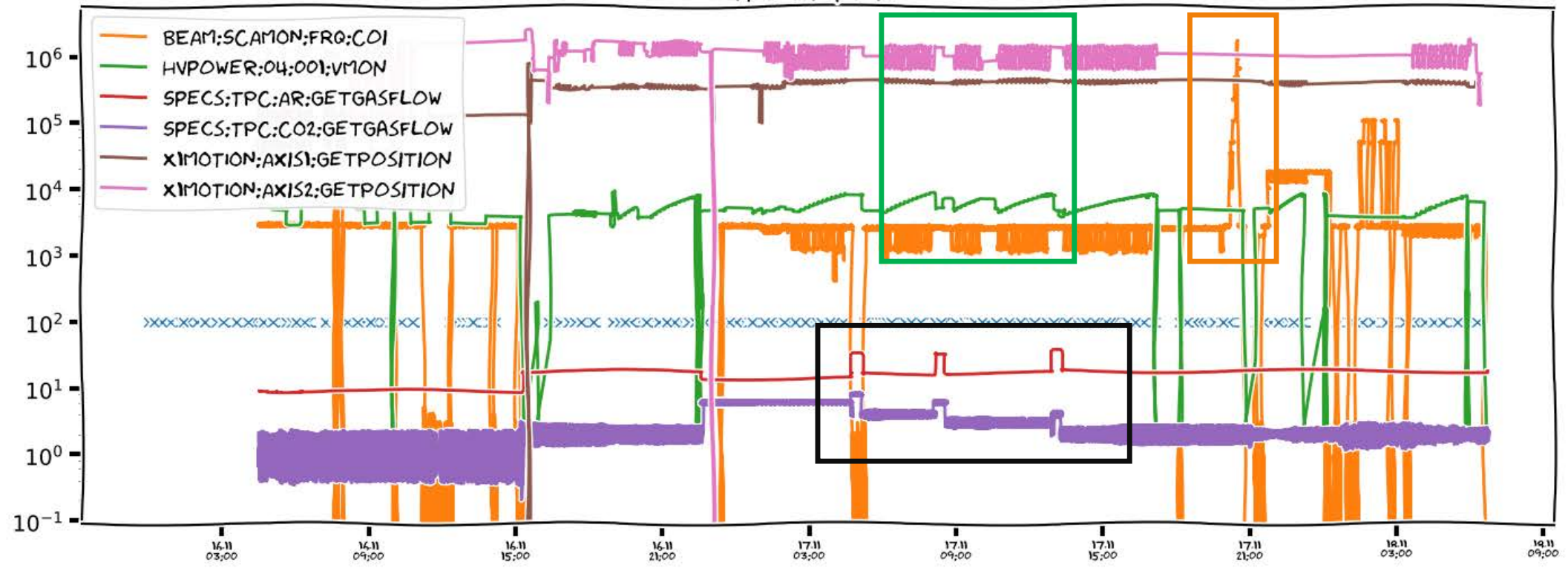
TPC BT NOV19



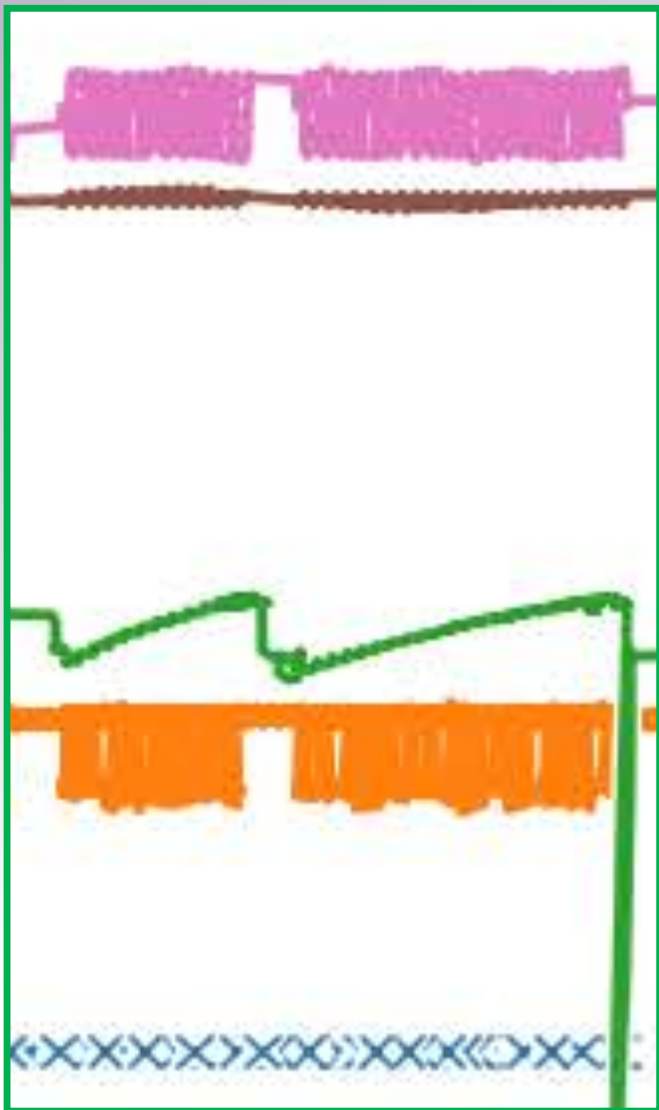
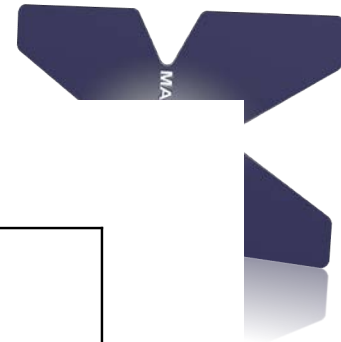
High Rates



TPC BT NOV19



TPC - Scans

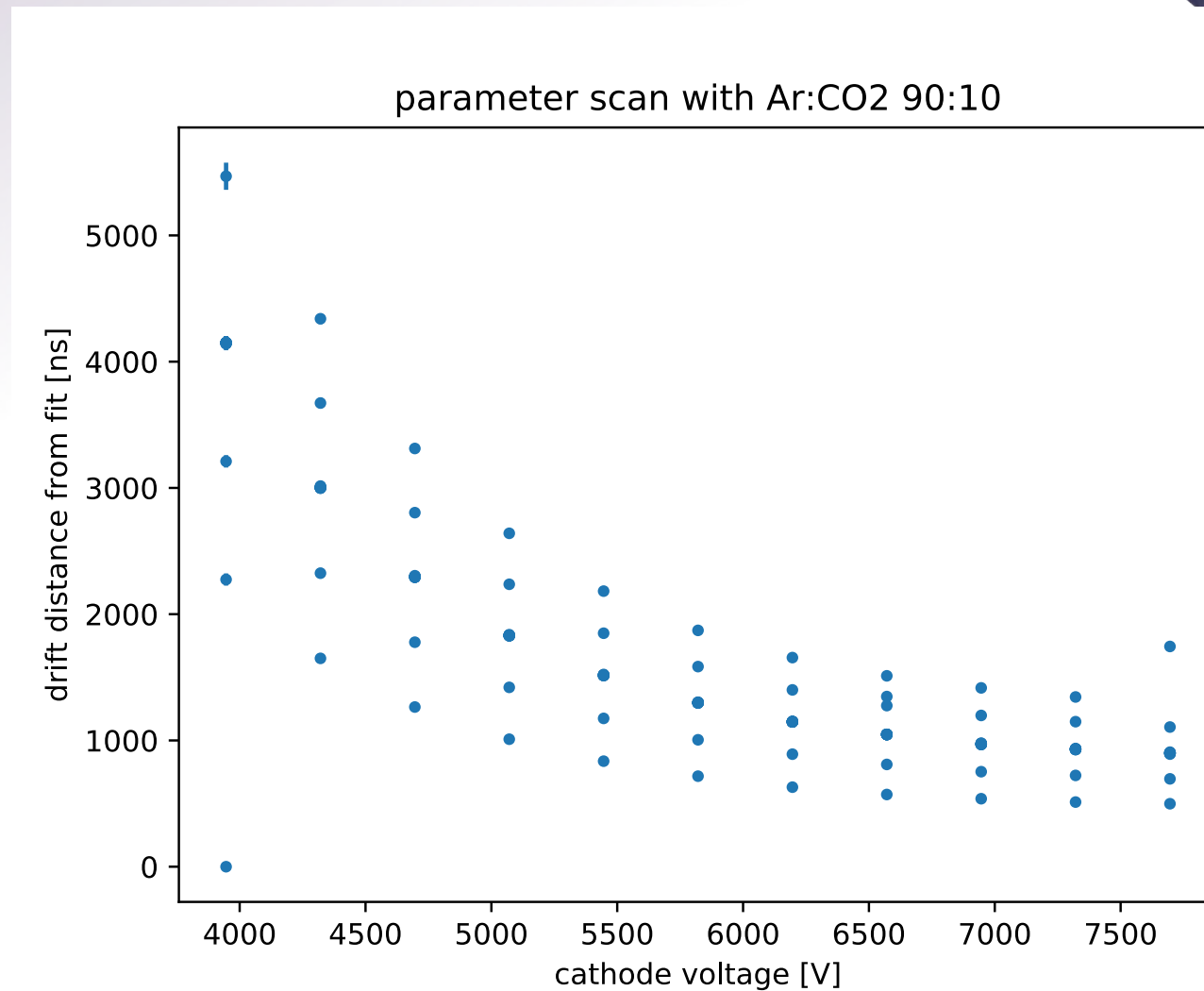


x-position

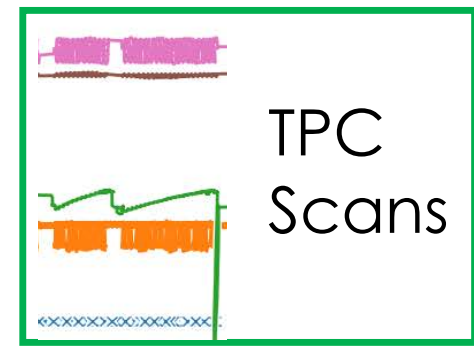
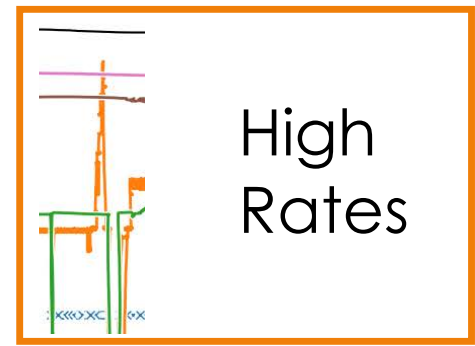
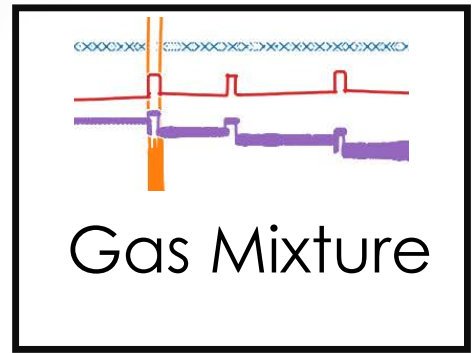
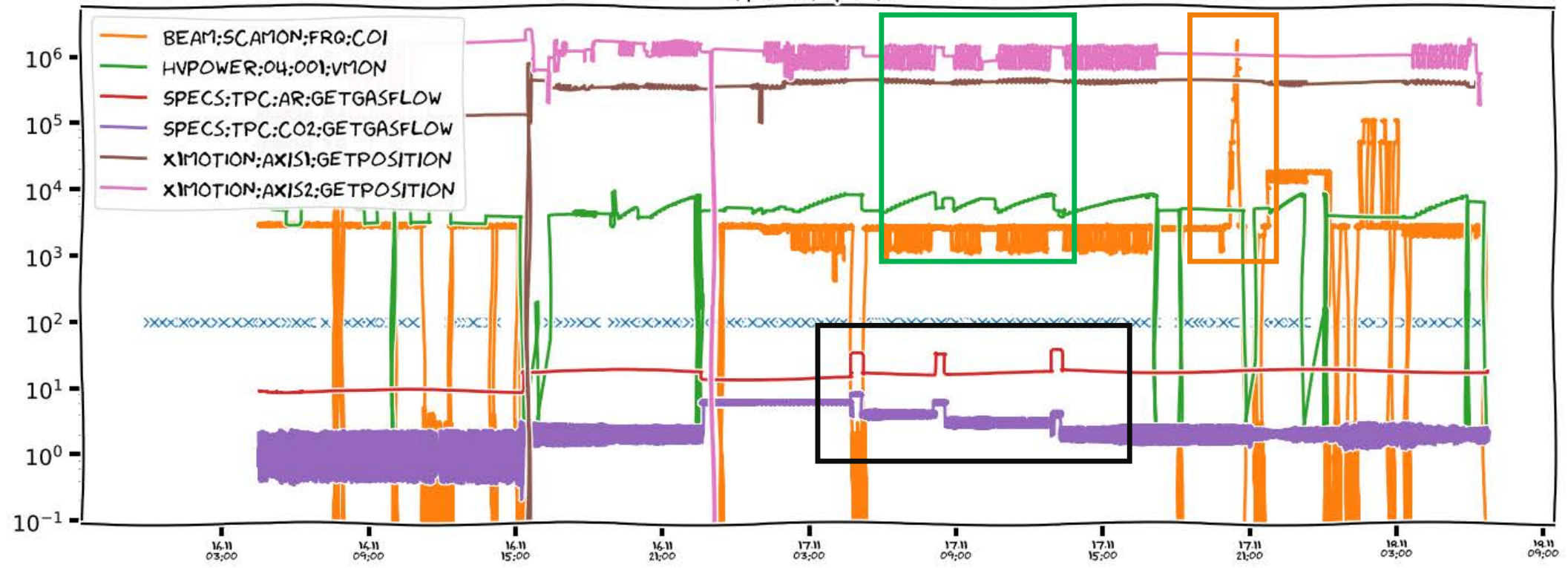
y-position

cathode
voltage

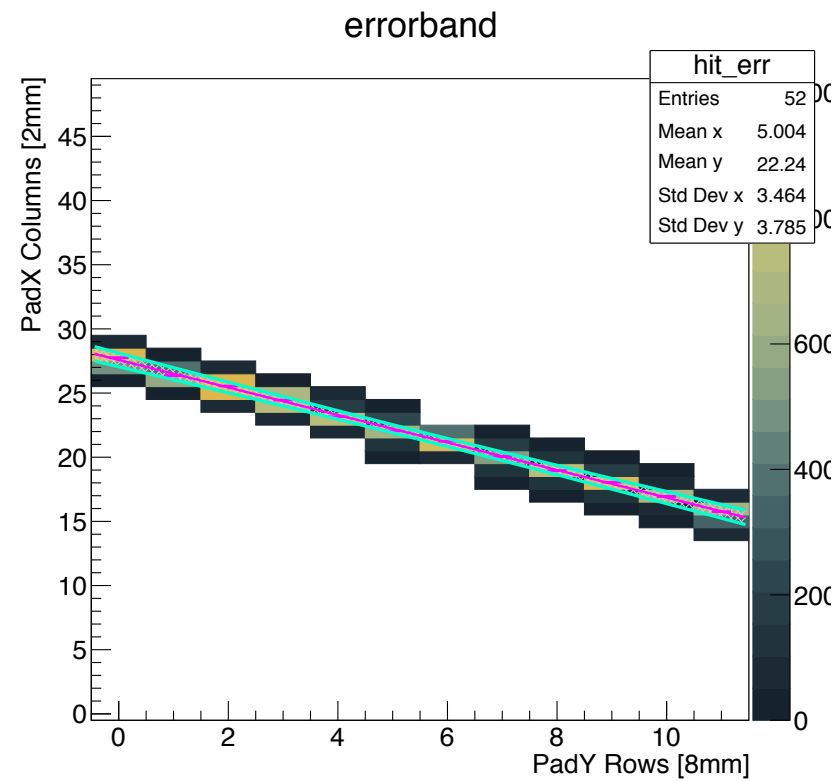
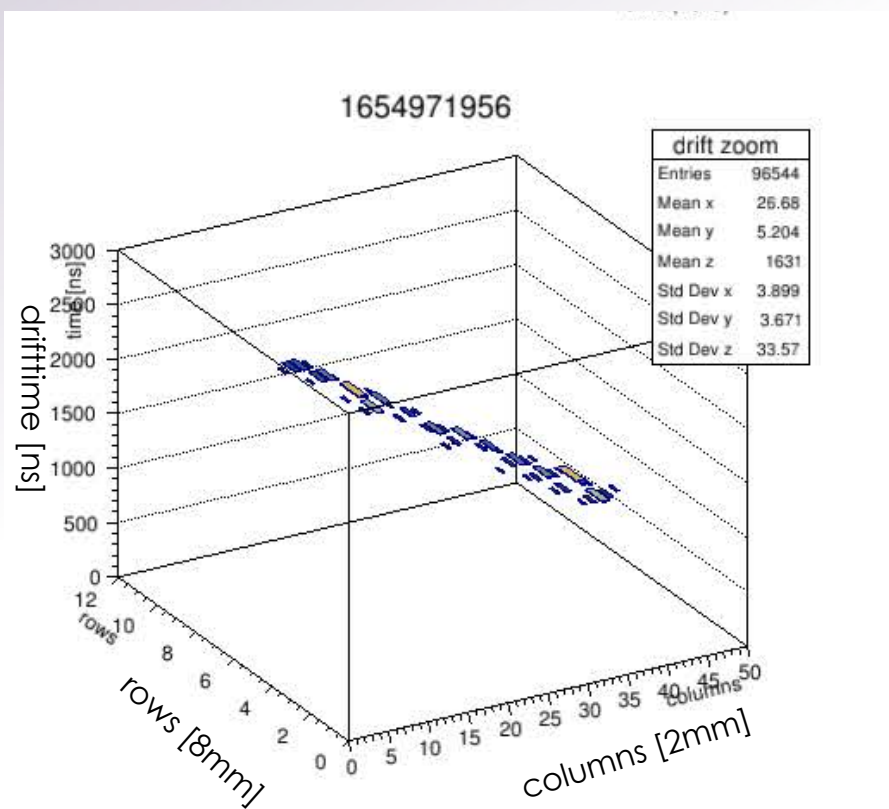
beam
rate



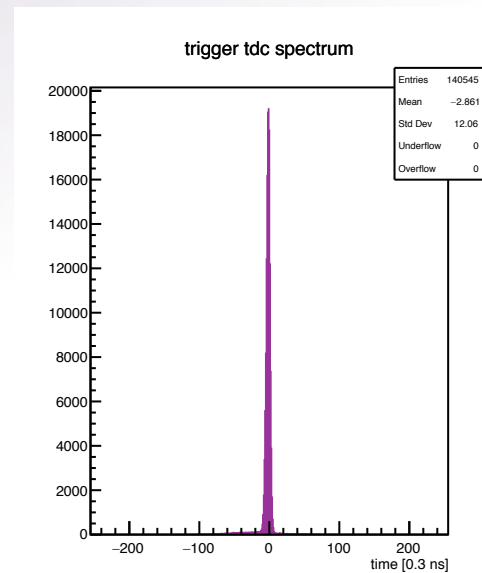
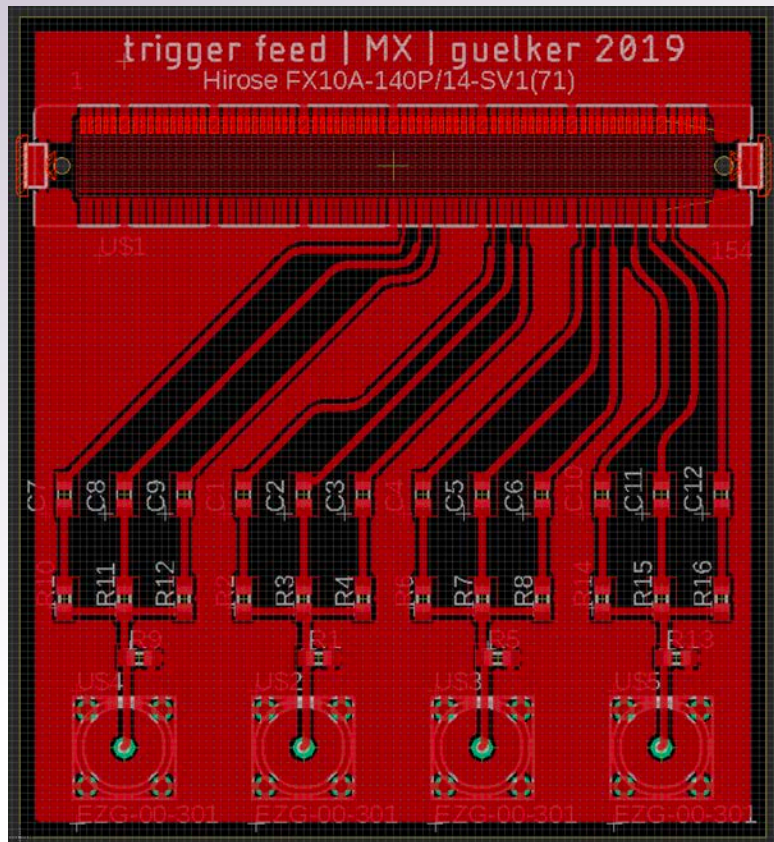
TPC BT NOV19



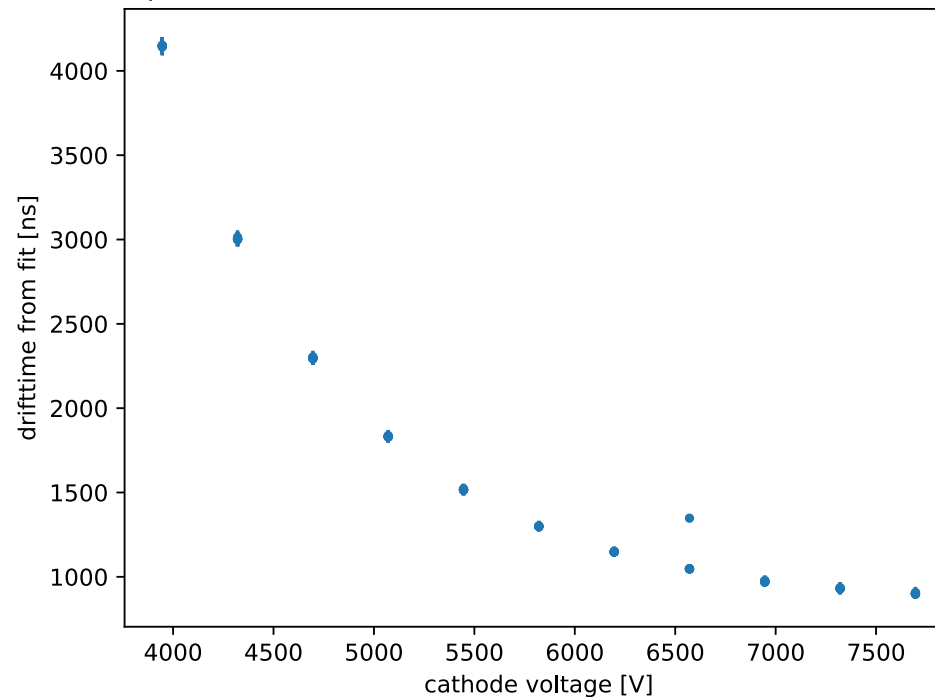
Beamtime 2019



Trigger2VMM



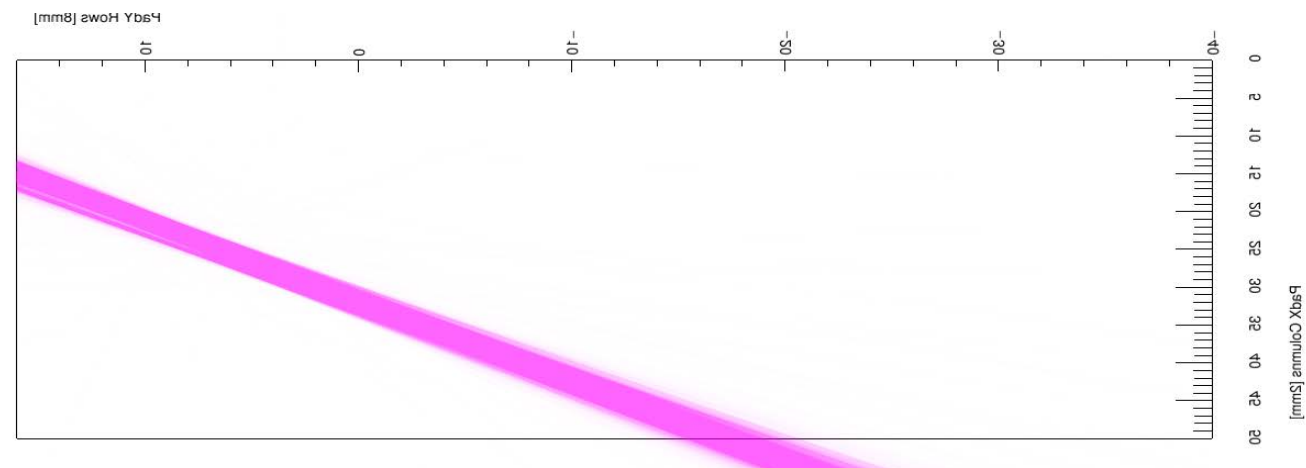
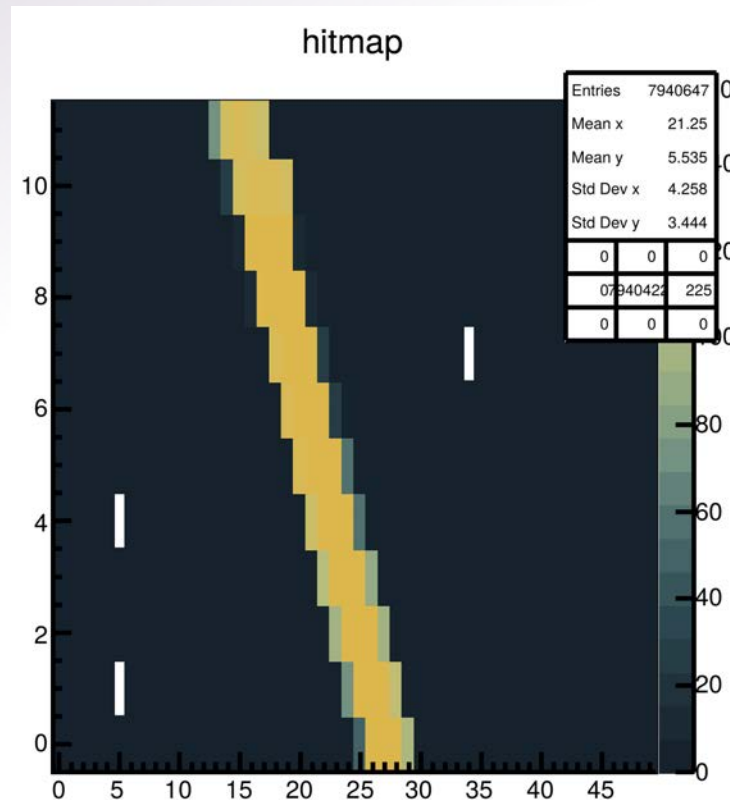
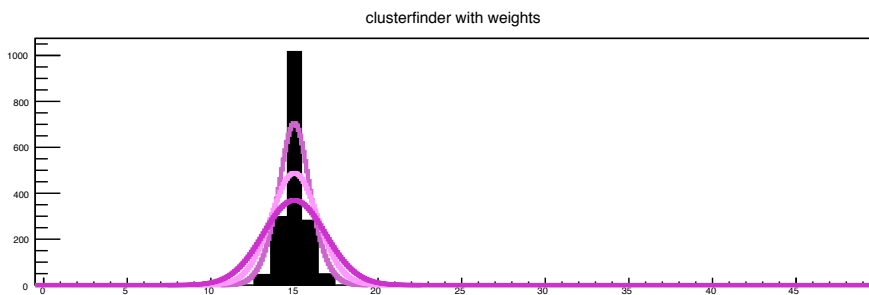
parameter scan with Ar:CO2 90:10 @ fixed driftdistance



Beamtime 2019

Analysis ongoing!

- Time resolution ~ 1 ns
- Point resolution < 500 μ m
- Track resolution?



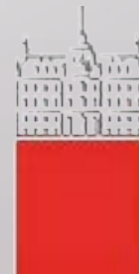


THANK YOU FOR YOUR ATTENTION!

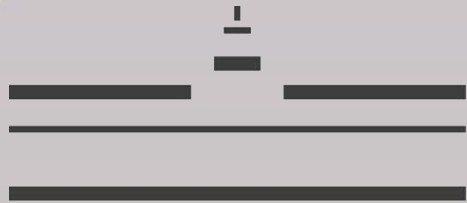
<http://magix.kph.uni-mainz.de>



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