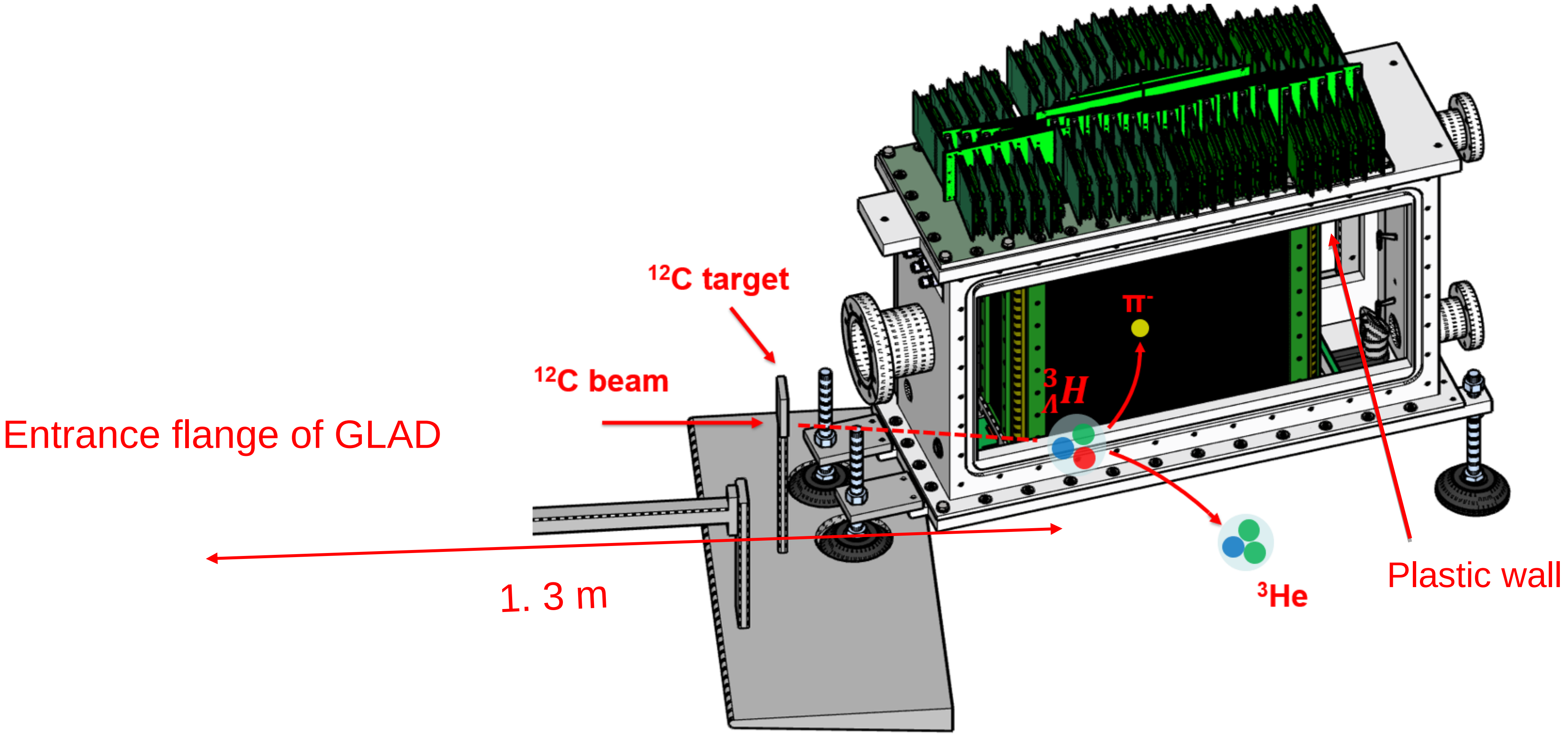
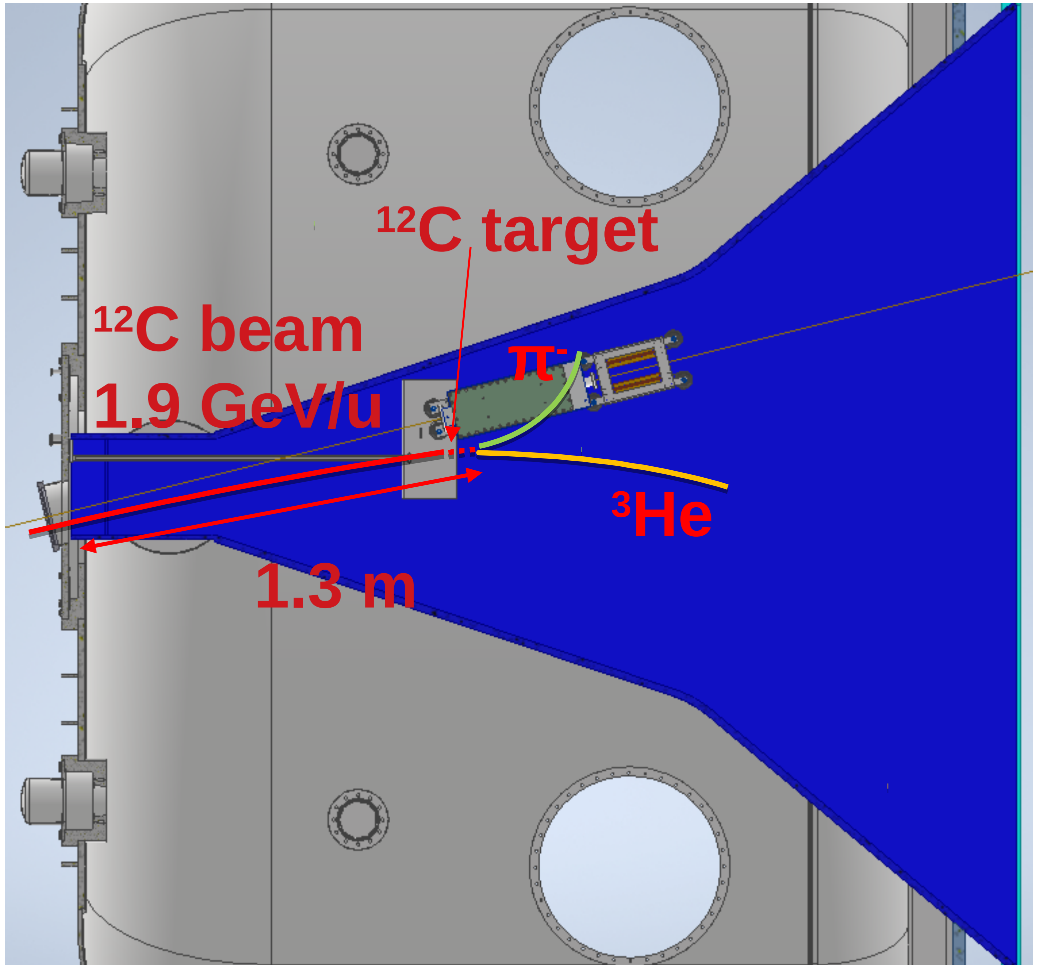
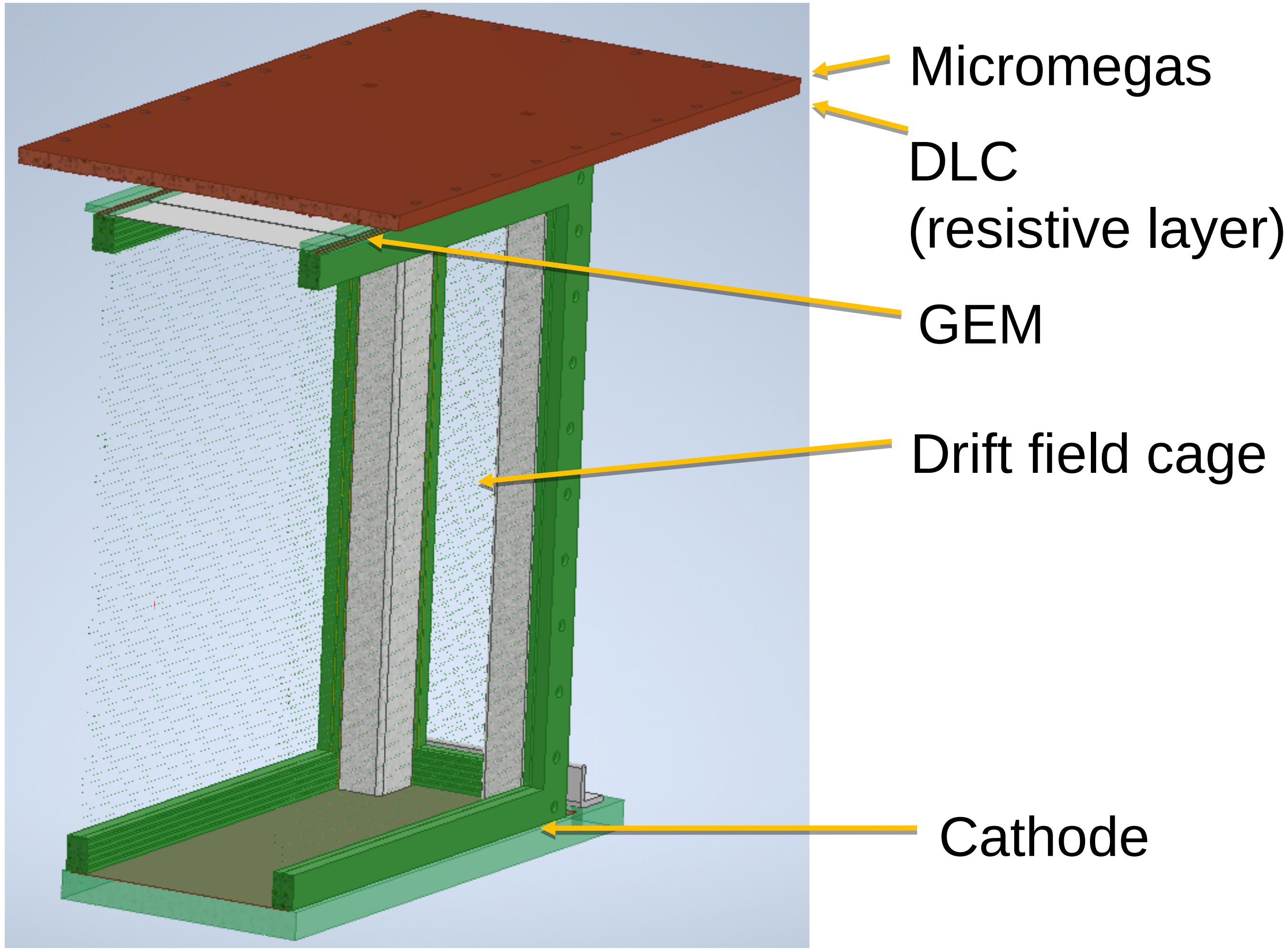
HYDRA TPC prototype



General concept of the TPC





Assembly of the chamber: the field cage

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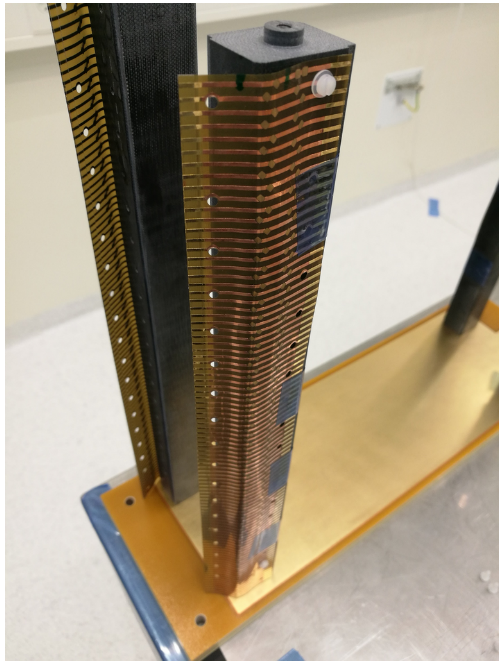
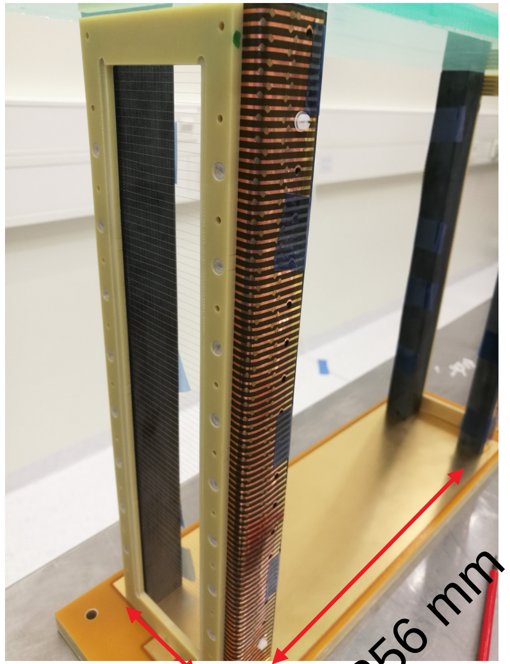
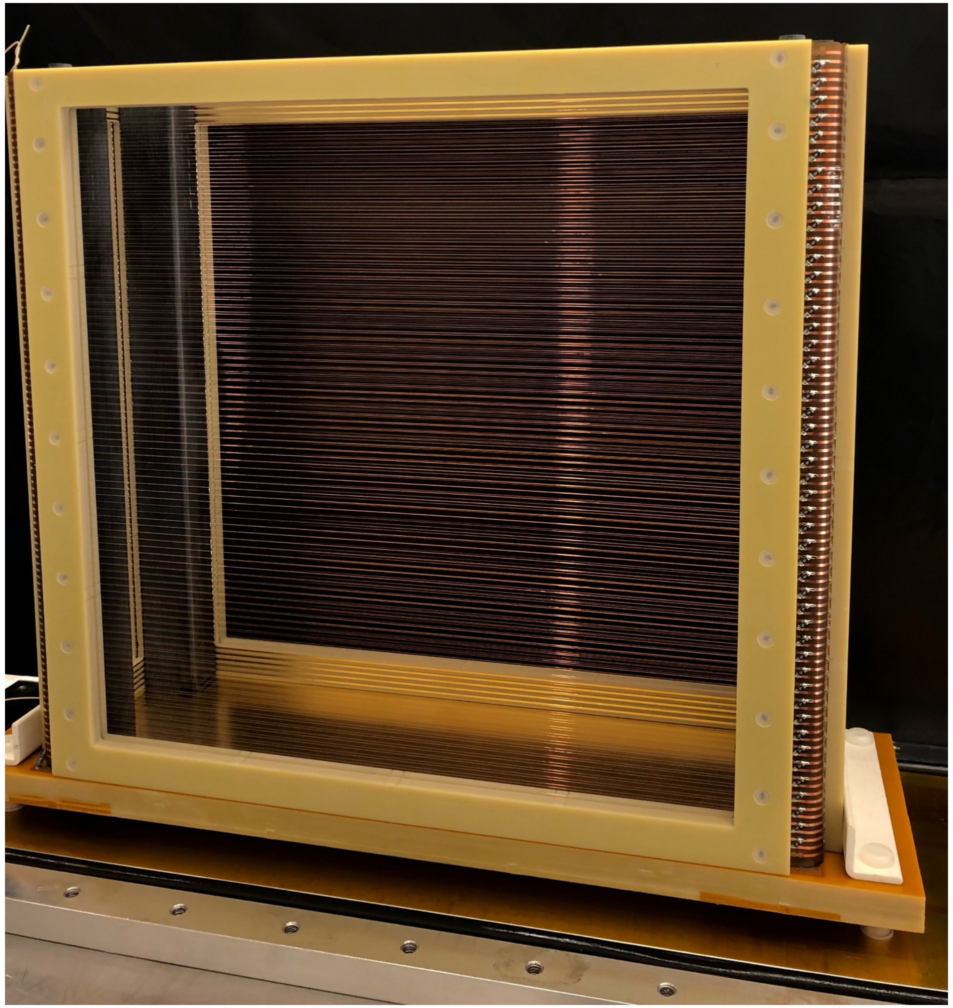
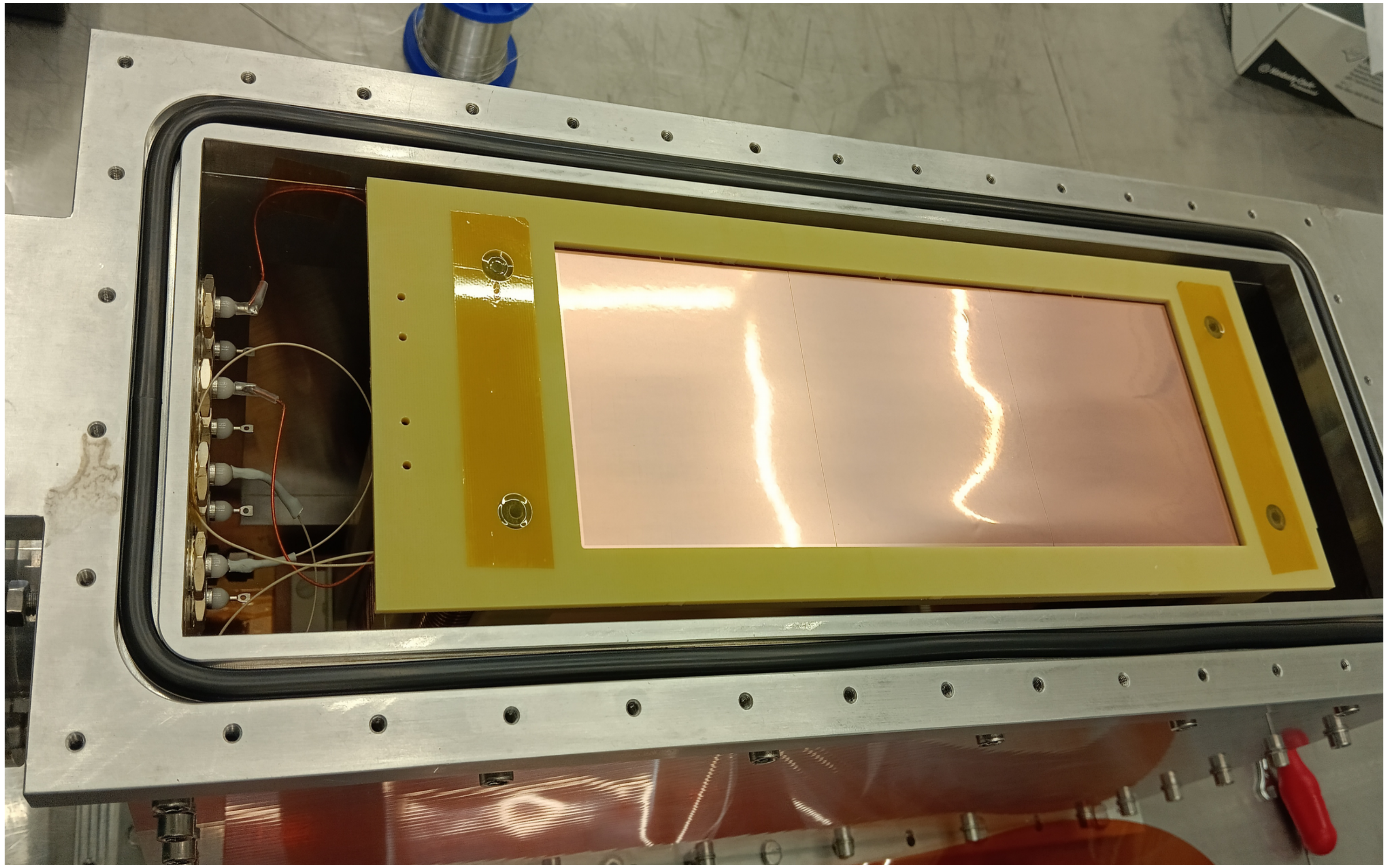






1. Two layers of wires
2. Active readout area: 88 × 256 mm^2
3. Drift length: 300 mm
4. Distance between two adjacent wires: 1.5 mm
5. Transparency = 94.8%

Assembly of the chamber: the GEM



1. GEM area: 100 × 300 mm^2
2. Thickness: 50 µm
3. Pitch: 140 µm
4. Holes diameter in copper: 70 µm
5. Holes diameter in Kapton: 50 µm
6. Leakage currents: less than 10 nA at 500 V

Top side of the GEM

Assembly of the chamber: the metal core pad plane

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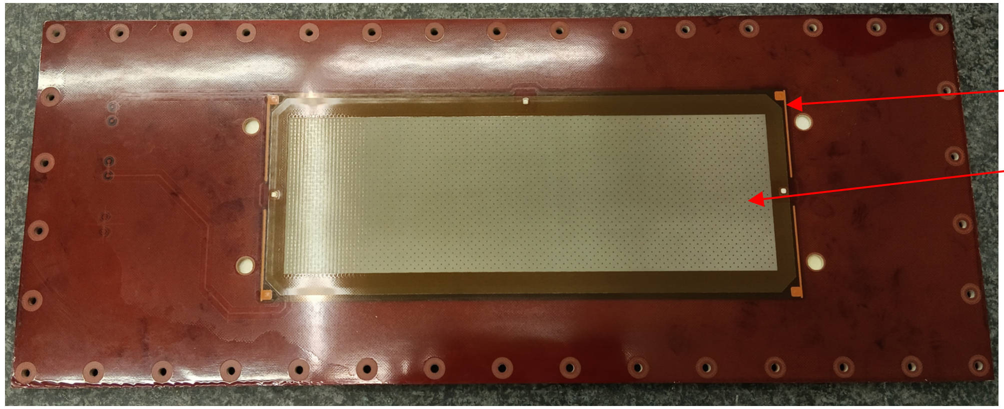
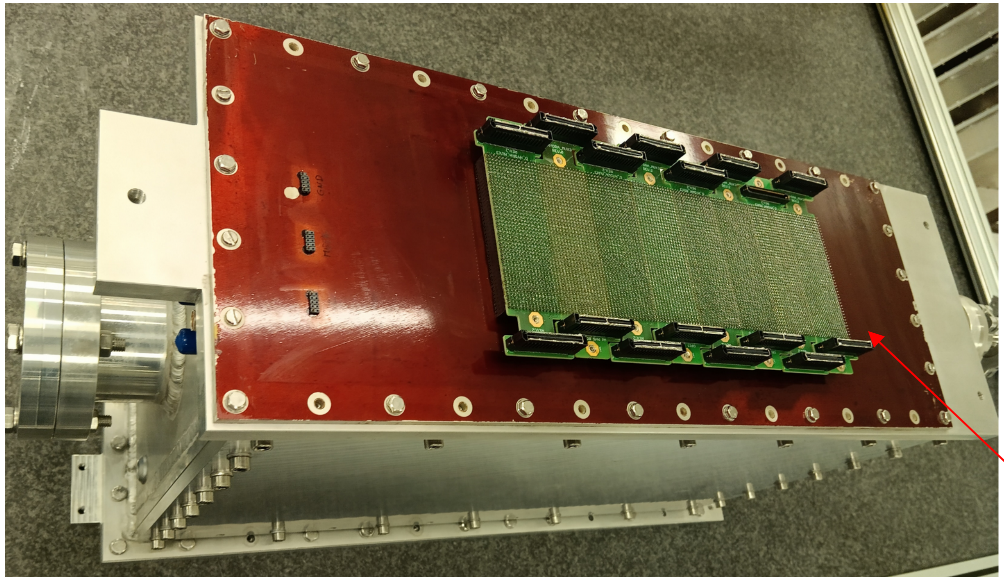
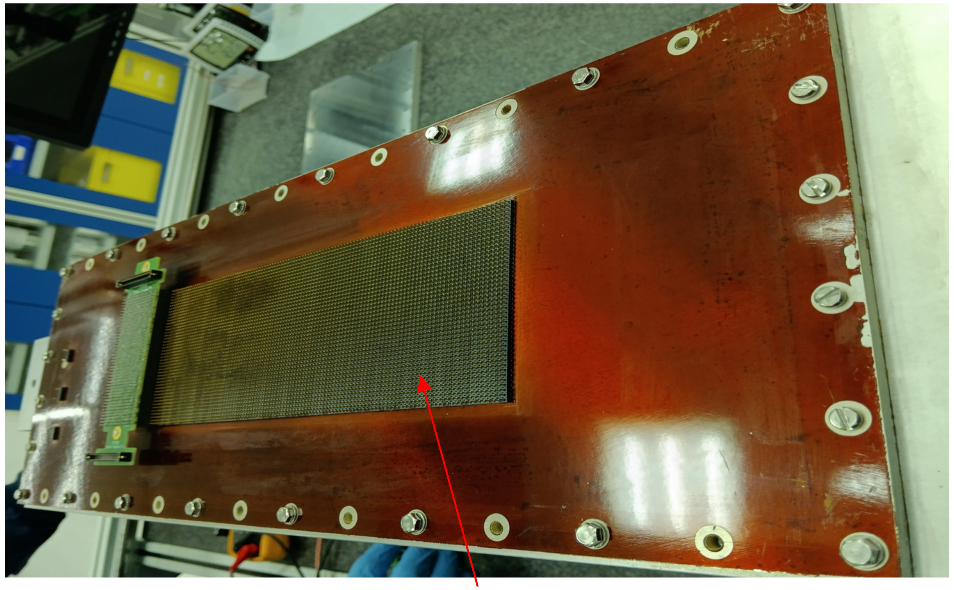


DLC (a resistive layer with 1 MΩ/Sq)

Micromegas
(in total 44 × 128 pads, 2 × 2 mm^2)



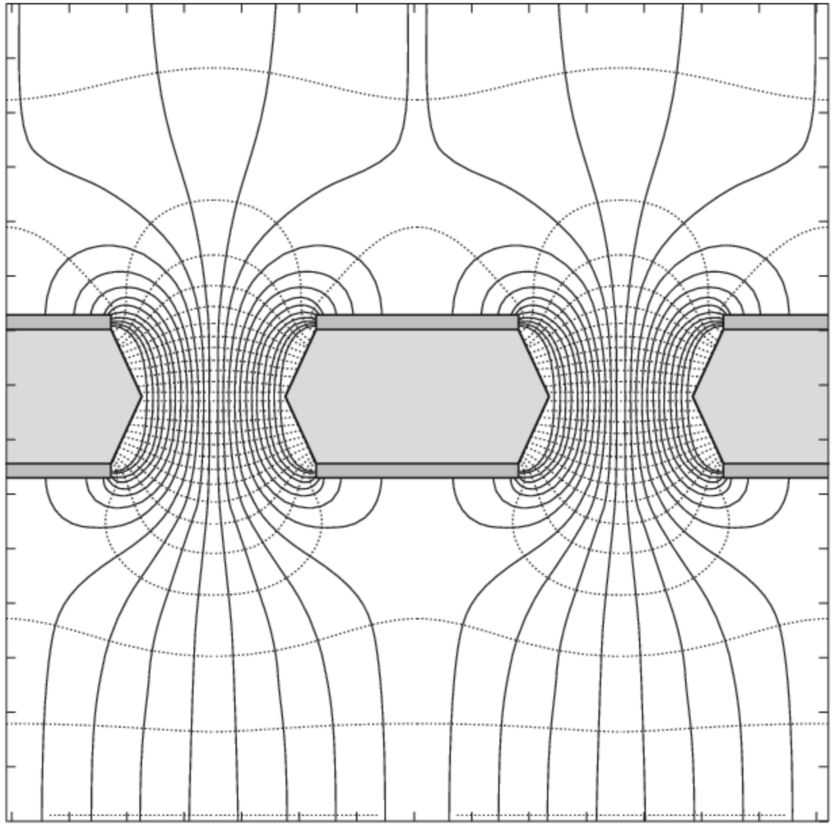


Readout MTMM pins

Multiplexing boards for testing

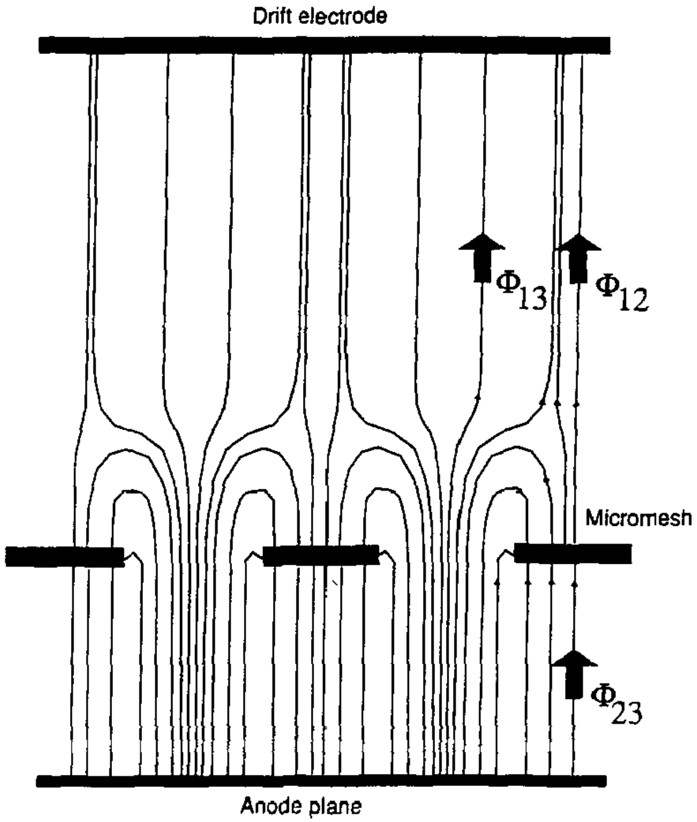
Amplification from the GEM and the Micromegas

Field lines of the GEM



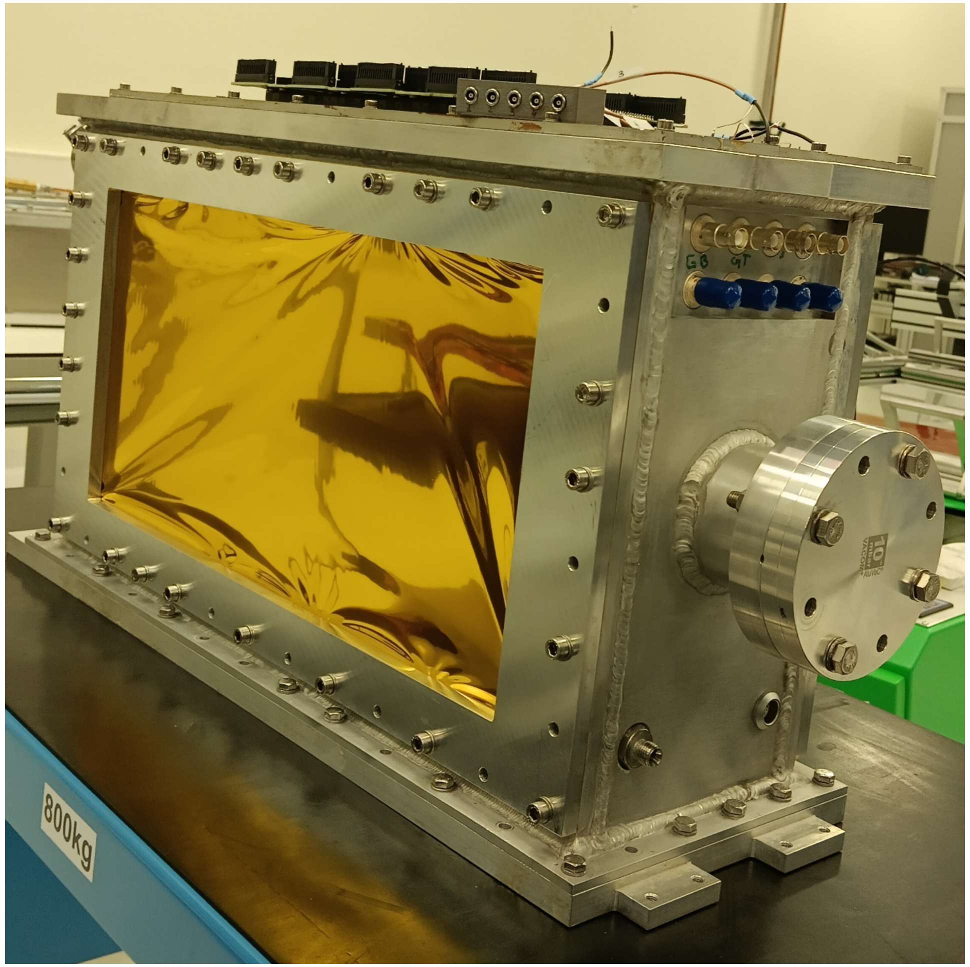
F. Sauli, NIM A, 805, 2 (2016)

Field lines of the Micromegas



Y. Giommataris et al., NIM A 376, 29 (1996)

Assembly of the chamber: the metalized window

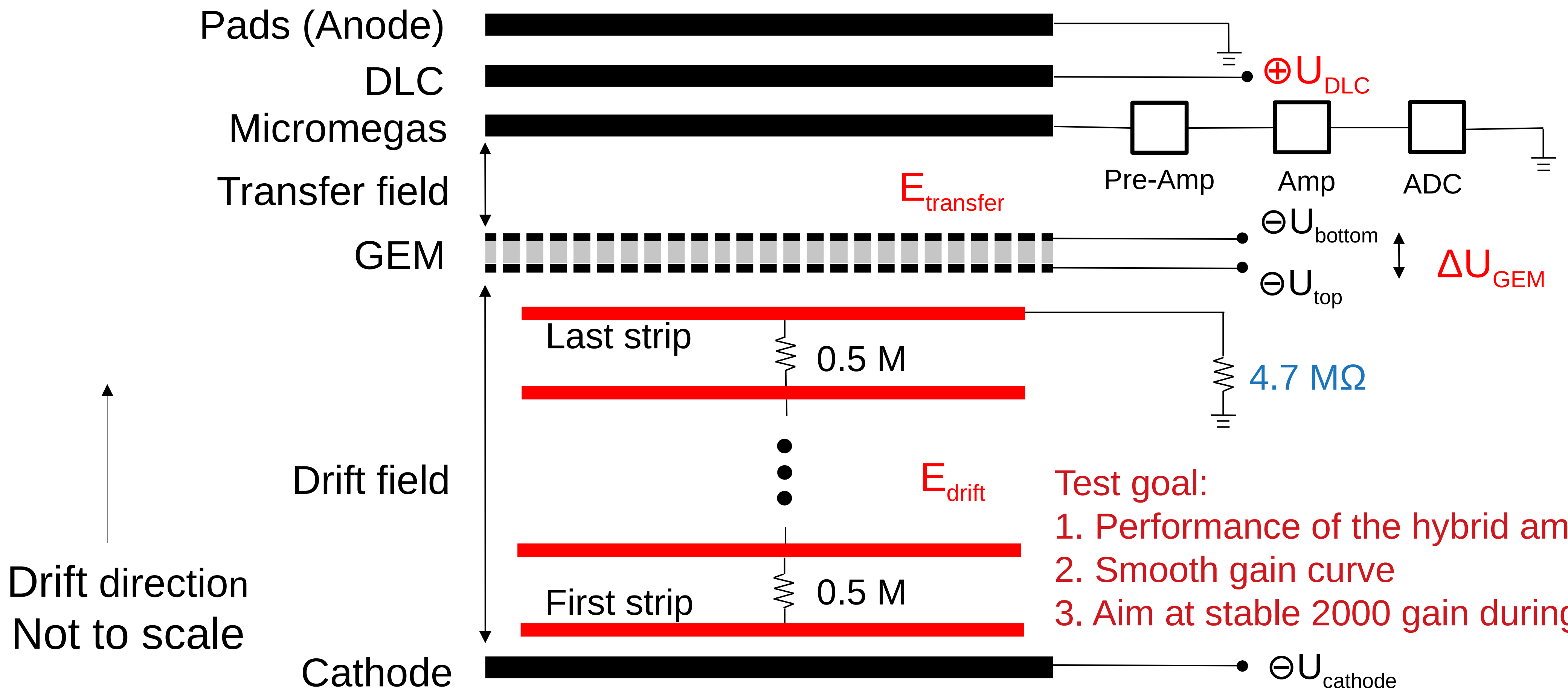


1. A 25 μm aluminized Kapton foil

2. The window is grounded with the chamber to avoid chargeing up in the TPC

3. Operation in atmospheric pressure to 5 mbar above atmosphere

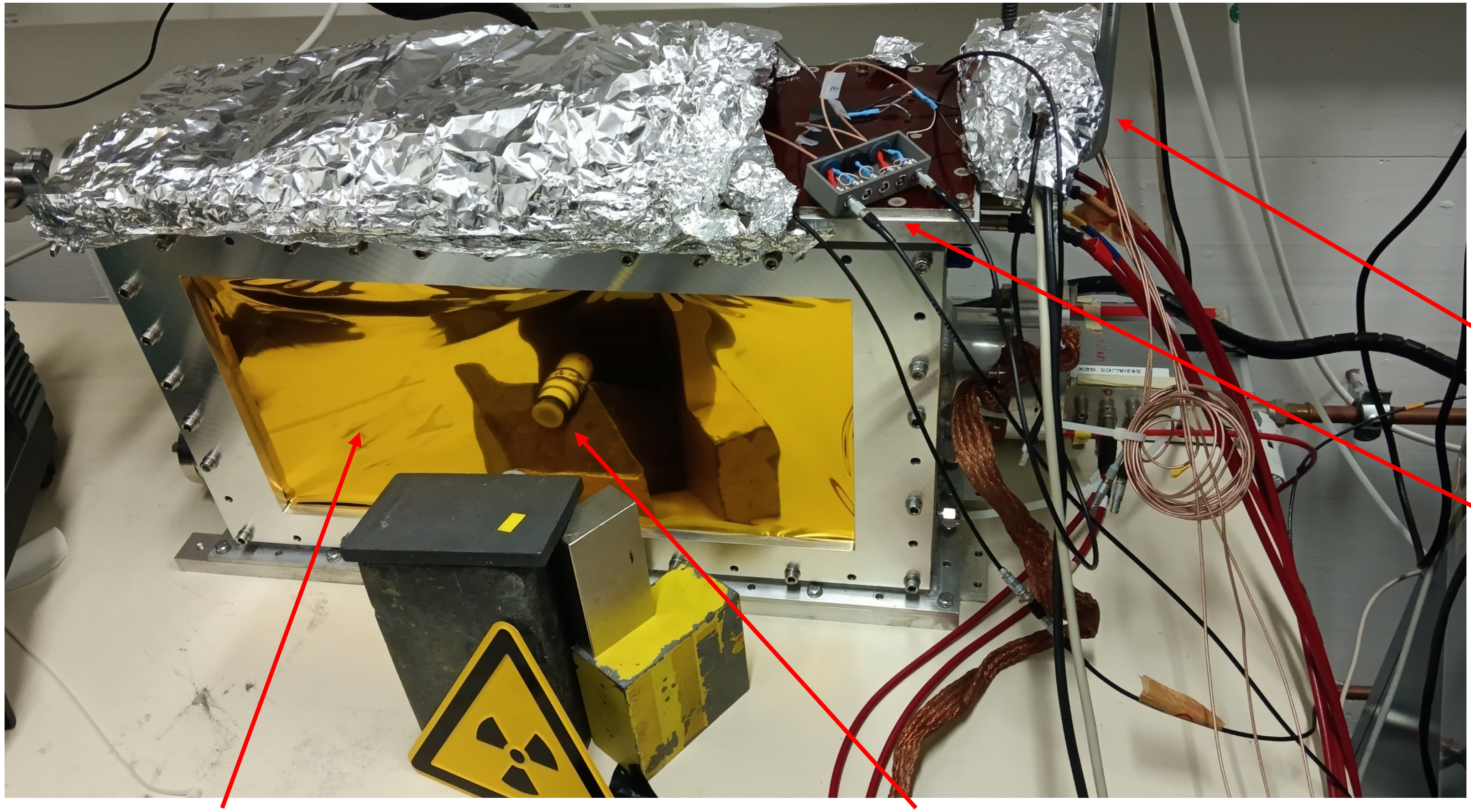
First test of the prototype TPC: voltage scheme



Test goal:

1. Performance of the hybrid amplification detector
2. Smooth gain curve
3. Aim at stable 2000 gain during operation

First test of the prototype TPC: test set-up



Test gas mixture:
90% Ar + 10% CO_2

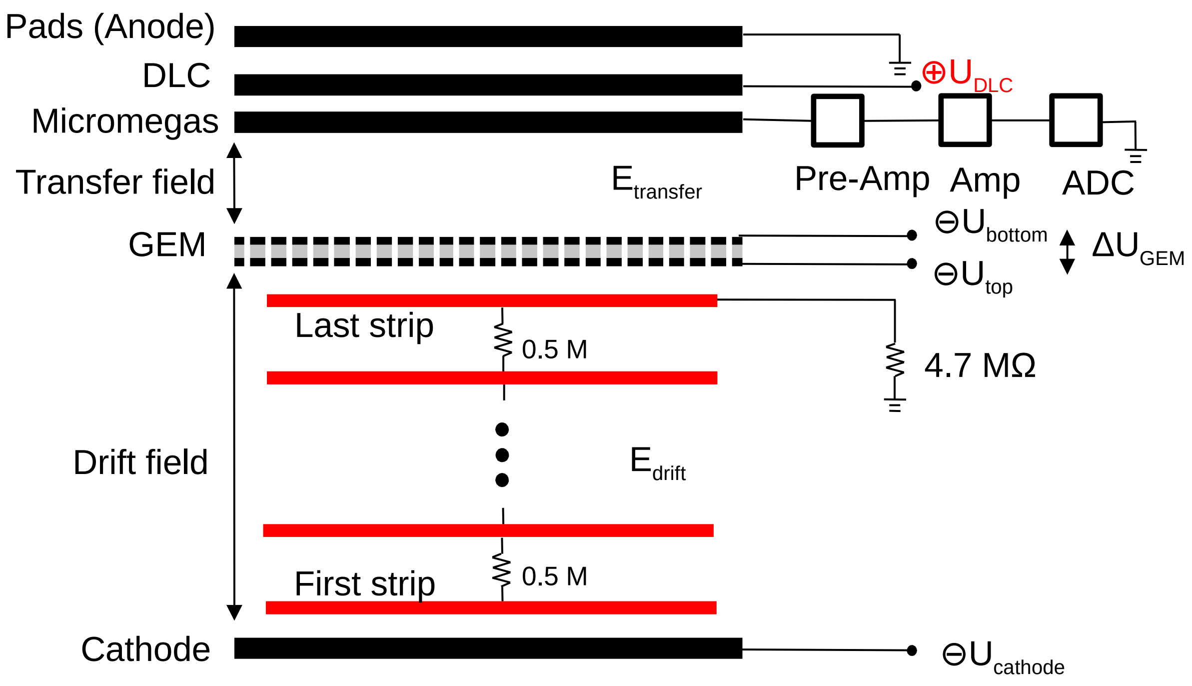
Reading signals from the Micromegas

Reading the amplified current from the DLC layer

25 µm Kapton foil

^{241}Am, activity: 74 Mbq; two main X-ray energy: 13.9 keV, 59.5 keV

First test of the Micromegas

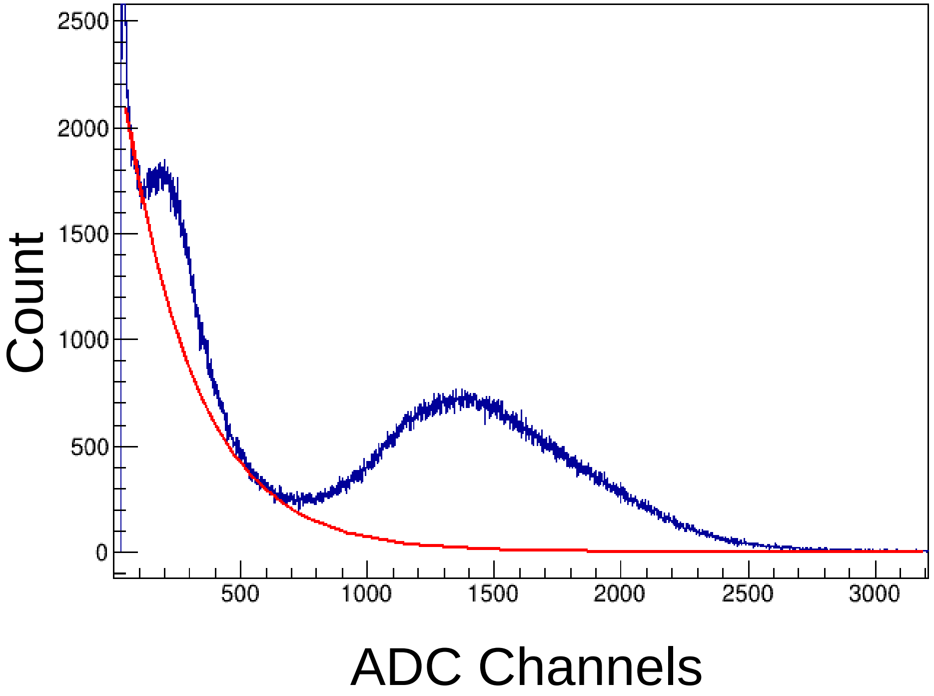


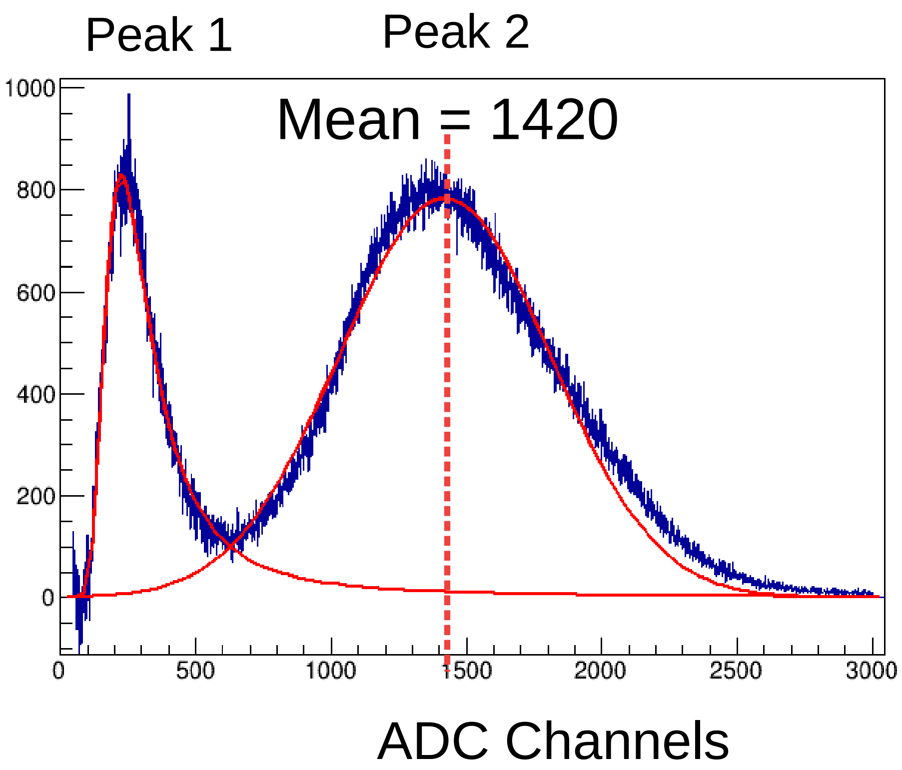
Gas mixture: 90% Ar + 10% CO_2

High voltages:

Pads:	GND
U_{DLC}:	[415 V, 465 V]
Micromegas:	GND
$E_{transfer}$:	500 V/cm
ΔU_{GEM}:	350 V
E_{drift}:	100 V/cm

Calculation of the primary current





Signal peak 2:

σ = 391
Integral ± 3σ = 7.65 × 10^5
Resolution = 27.5%
Primary current
= Integral × (59.5 × 10^3 / 28.8) / live time
= 0.478 pA

U_{DLC} = 465 V, amplified current = 5.16 nA

Gain curve of the Micromegas

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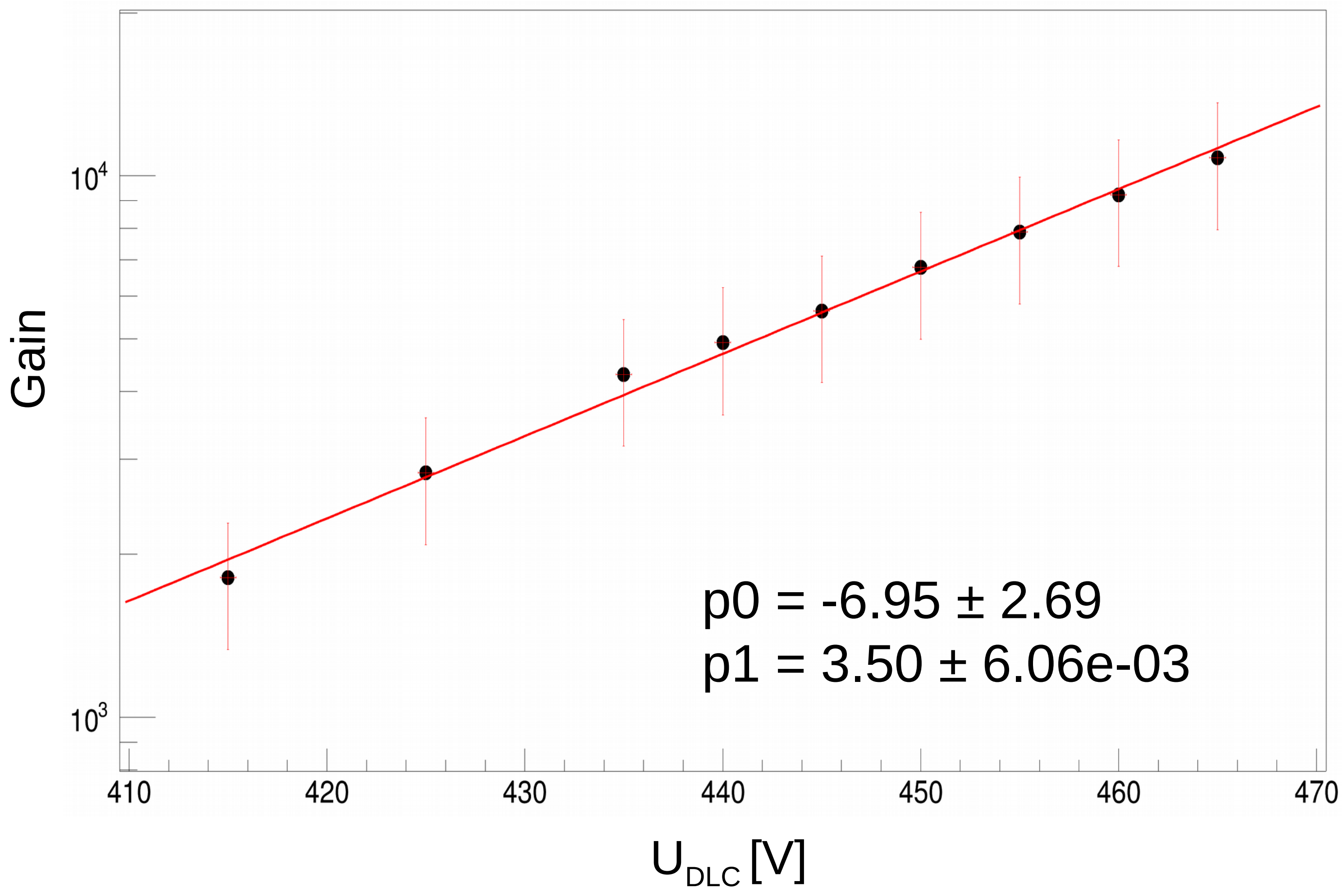


ΔU_{GEM} = 350 V

$E_{transfer}$ = 500 V/cm

E_{drift} = 100 V/cm

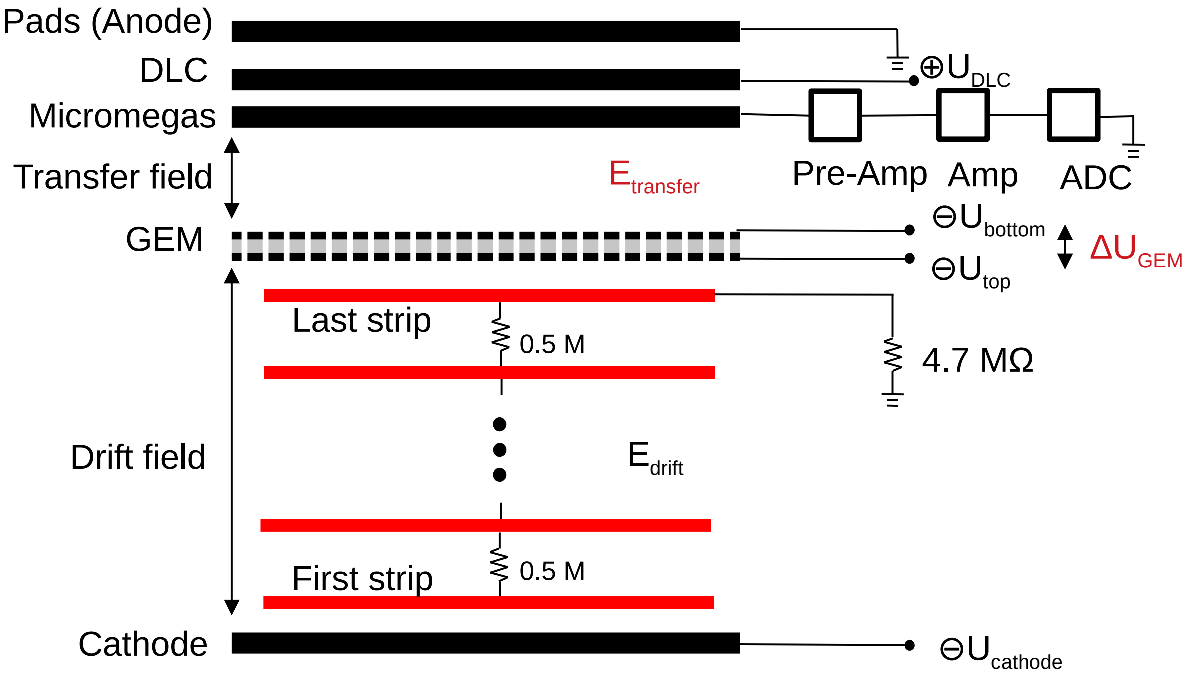
Gain:

$G_{eff} = I_{amplified} / I_{primary}$

Fit function:

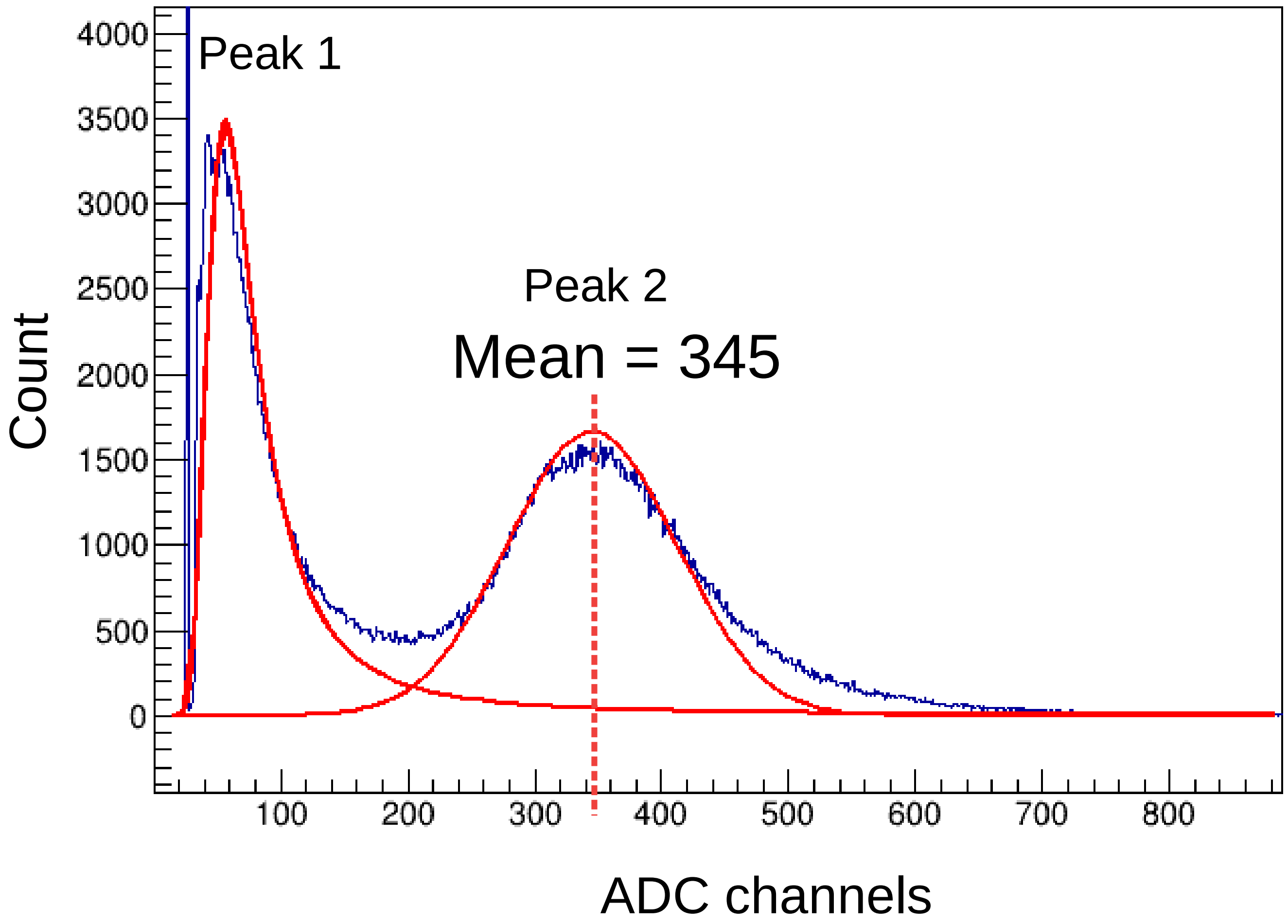
$f(x) = \exp(p0 + p1 \cdot x)$

First test of the GEM



Gas mixture:	90% Ar + 10% CO_2
High voltages:	
Pads:	GND
U_{DLC}:	440 V
Micromegas:	GND
$E_{transfer}$ 1:	300 V/cm
ΔU_{GEM} 1:	[340 V, 440 V]
$E_{transfer}$ 2:	400 V/cm
ΔU_{GEM} 2:	[300 V, 400 V]
$E_{transfer}$ 3:	500 V/cm
ΔU_{GEM} 3:	[260 V, 360 V]
$E_{transfer}$ 4:	600 V/cm
ΔU_{GEM} 4:	[220 V, 320 V]
E_{drift}:	100 V/cm

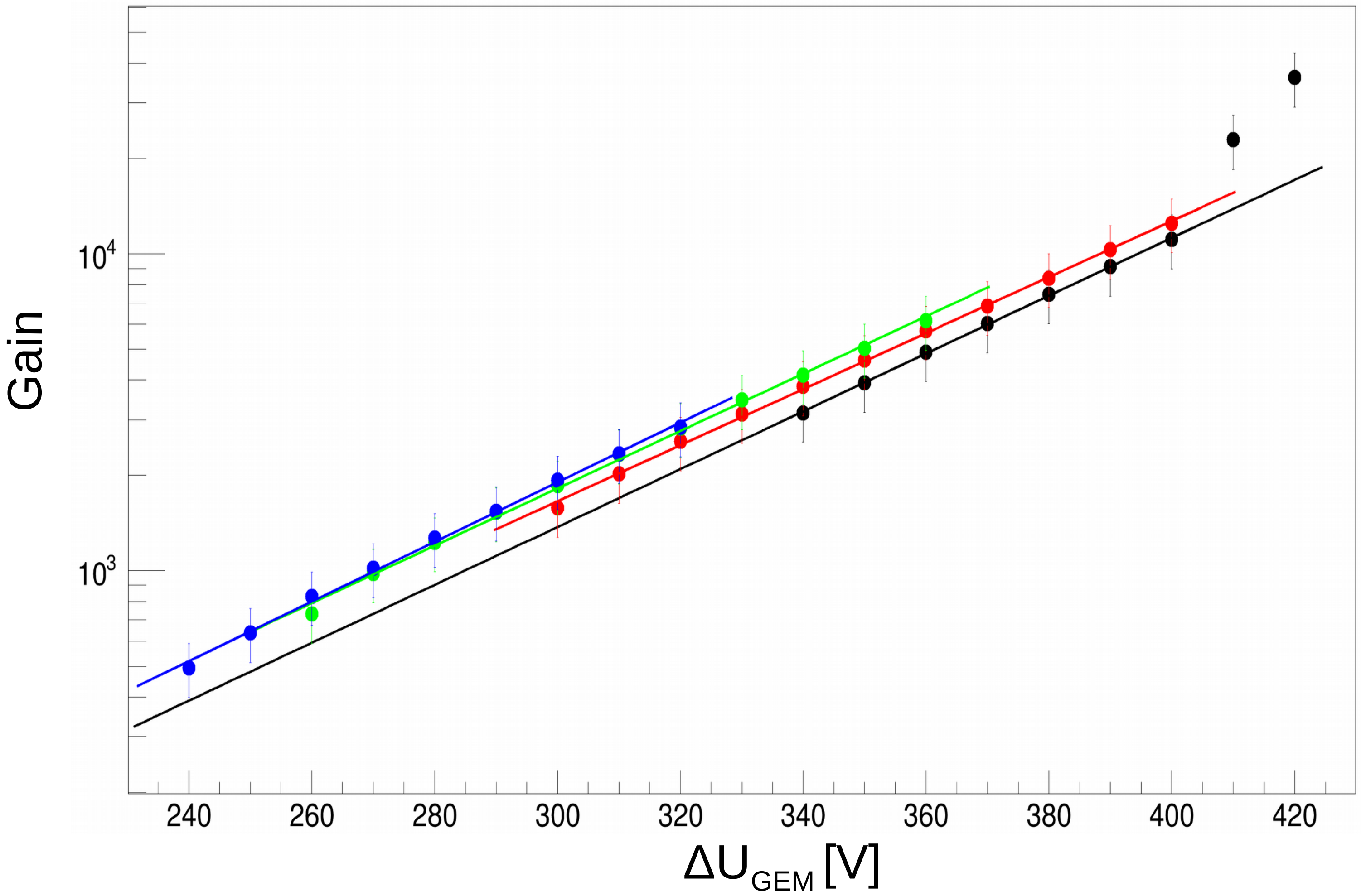
Calculation of the primary current



Signal peak 2:

σ = 66.6
Integral ± 3σ =2.77 × 10^5
Resolution = 19.3%
Primary current = 0.443 pA

Gain curve of the GEM

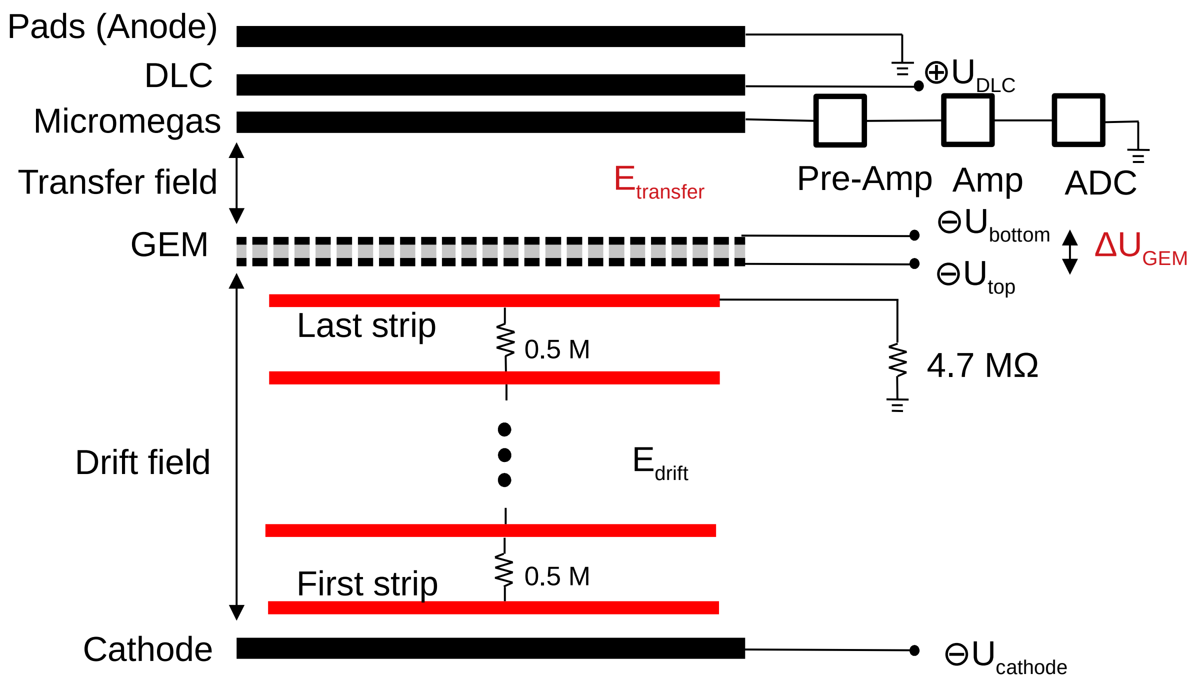


U_{DLC} = 440 V

E_{drift} = 100 V/cm

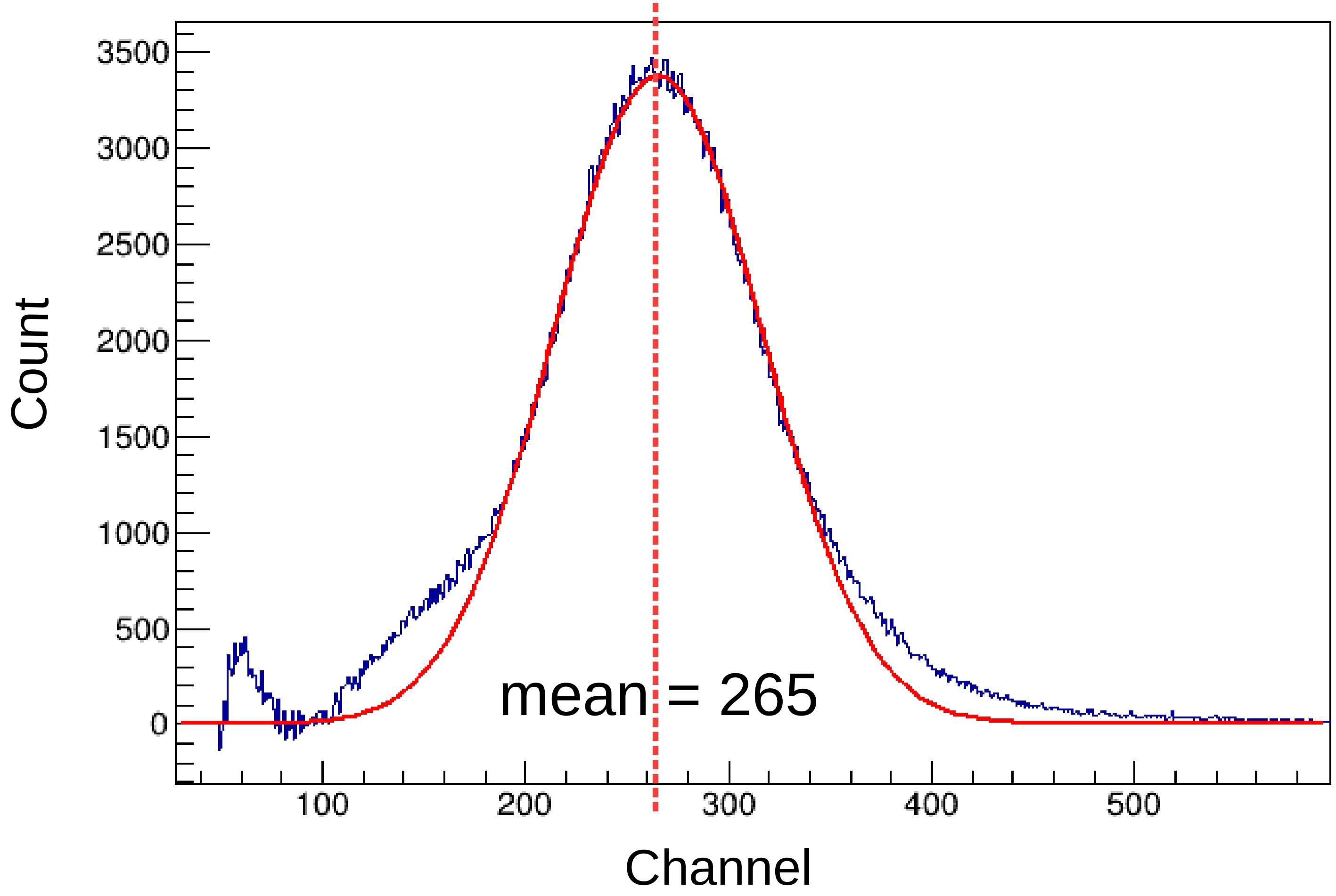
- $E_{transfer}$ = 300 V
- exponential fit
- $E_{transfer}$ = 400 V
- exponential fit
- $E_{transfer}$ = 500V
- exponential fit
- $E_{transfer}$ = 600 V
- exponential fit

Test of the transfer field



Gas mixture:	90% Ar + 10% CO_2
High voltages:	
Pads:	GND
U_{DLC}:	440 V
Micromegas:	GND
$E_{transfer}$ 1:	[400 V/cm, 640 V/cm]
ΔU_{GEM} 1:	300 V
$E_{transfer}$ 2:	[350 V/cm, 570 V/cm]
ΔU_{GEM} 2:	330 V
$E_{transfer}$ 3:	[250 V/cm, 510 V/cm]
ΔU_{GEM} 3:	360 V
E_{drift}:	100 V/cm

Calculation of the primary current



$\sigma = 51.3$

Integral $\pm 3\sigma = 4.33 \times 10^5$

resolution = 19.4%

Primary current = 0.452 pA

Gain curve of the transfer field

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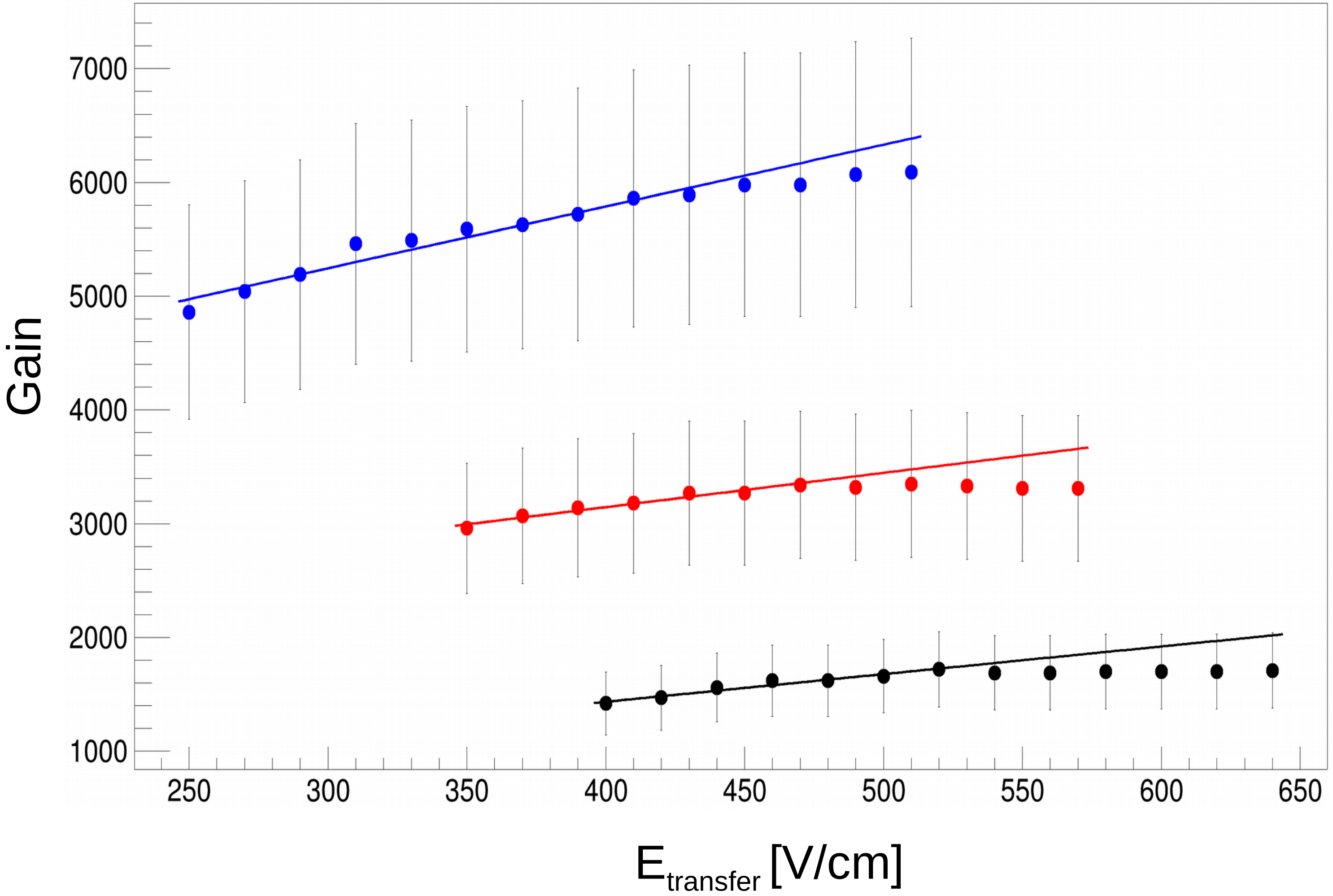
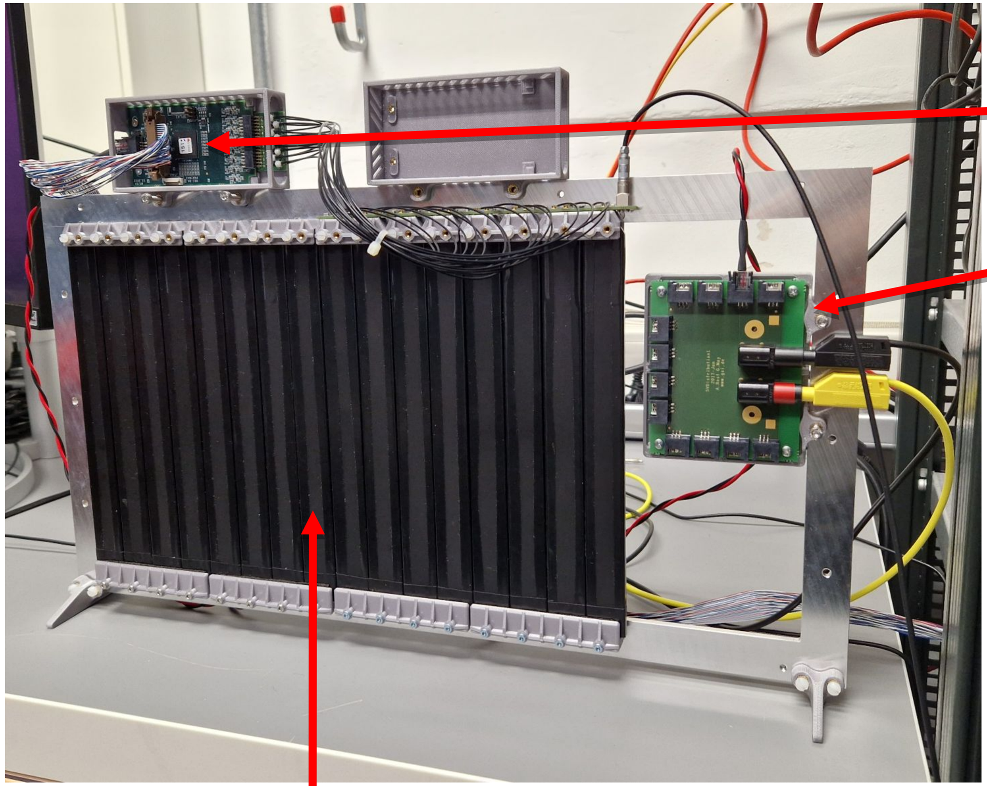


U_{DLC} = 440 V
E_{drift} = 100 V/cm

- ΔU_{GEM} = 300 V
  linear fit
- ΔU_{GEM} = 330 V
  linear fit
- ΔU_{GEM} = 360 V
  linear fit

Plastic wall



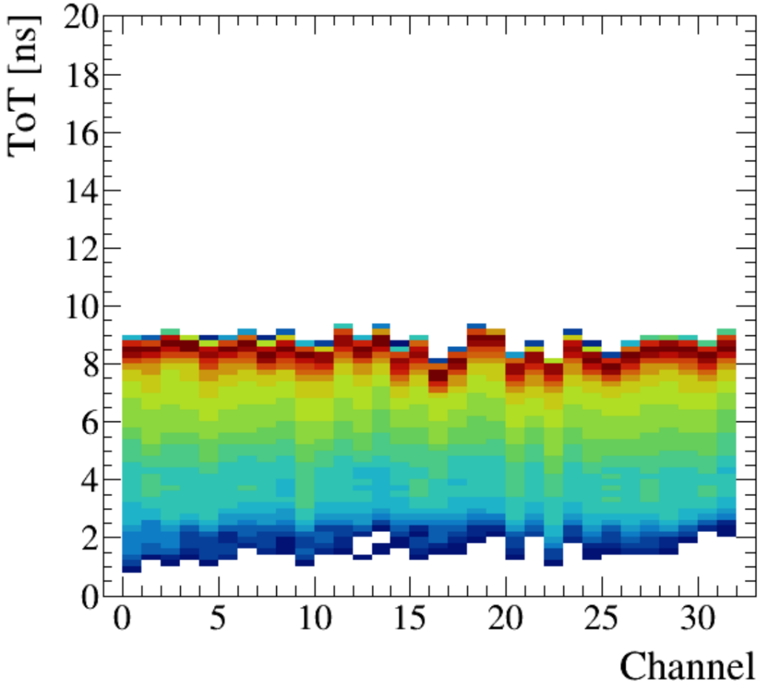
PADIWA3

Power dispenser

TRB3 board

16 EJ-200 plastic bars (total coverage: 25·37·0.4 cm^3)
32 SiPMs Hamamatsu S13360-3050PE

Cosmic ray test result



On behalf of S. Velardita and M. Duer

To do list

1. June to July, 2023:
   Improvements on the detector: resolution < 12%;
   Source tests of pads readout with GET electronics;
   Investigation of the space charge & the ion back flow;

2. July to September, 2023:
   Integration of the laser system;
   Tracking of laser beams inside the TPC;

3. From October, 2023:
   Test of the TPC in GLAD.

Thank you for your attention!

We acknowledge help and support from:

Osaka University (Shinsuke Ota)
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TU München ALICE group