Progress of TPC R&D and summary of TPC in Rome meeting

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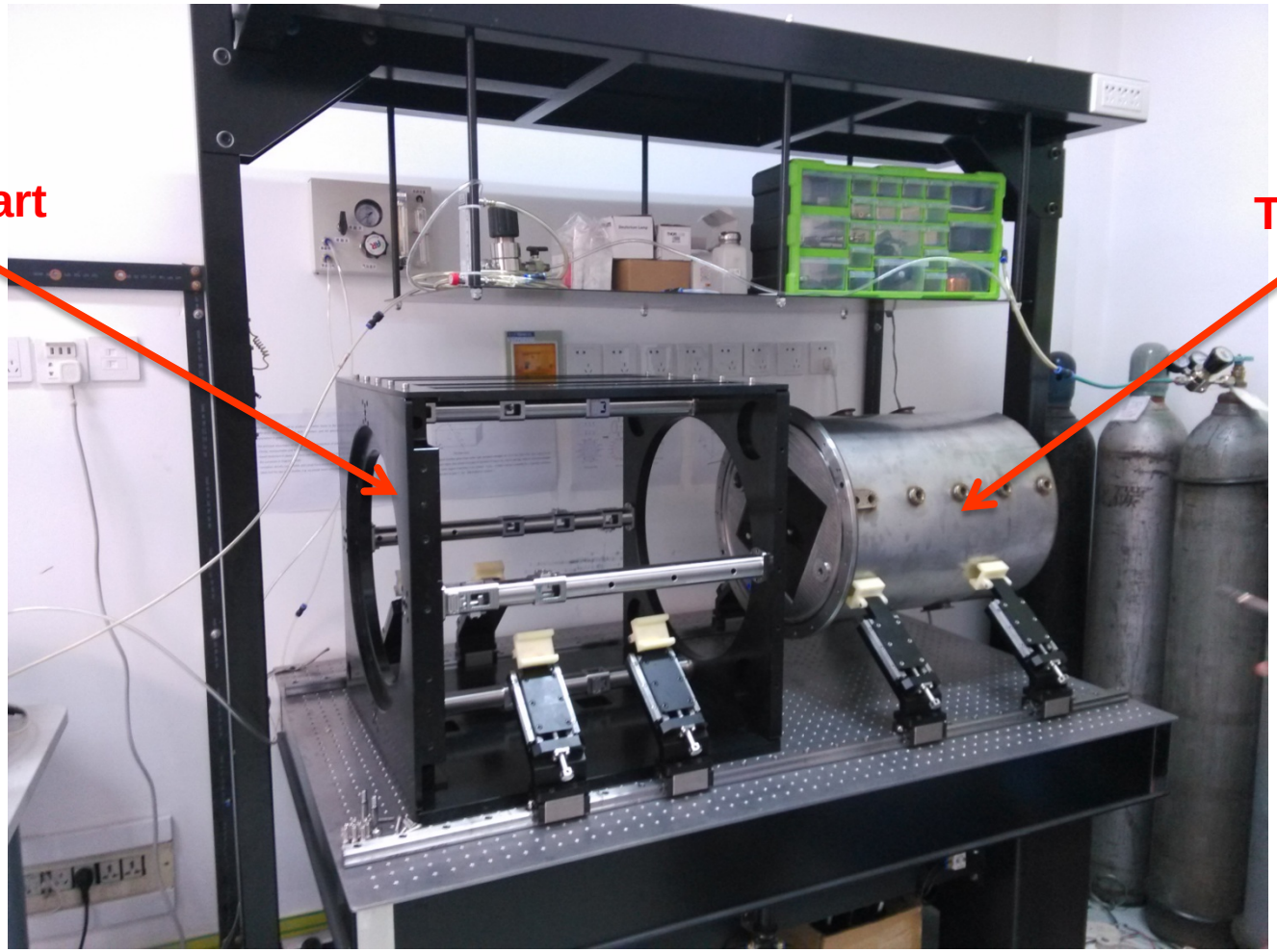
Institute of High Energy Physics, CAS
Saclay-IHEP Joint meeting, June, 06, 2018

Outline

- Progress of TPC R&D
- Summary of TPC in Rome meeting
- High LPI mesh

- Progress of TPC R&D

Design of the prototype



- Support platform: 1200mm×1500mm (all size as the actual geometry)
- TPC barrel mount and re-mount with the Auxiliary brackets
- Readout board (Done), Laser mirror (Done), PCB board (Done)

Laser map simulation

- New graduate student will be in our lab next month
  - Yuan zhiyang
- Do Boris has experiences for it and give some consideration?

- Summary of TPC in Rome meeting

Summary report of TPC part in Rome meeting

09:00 **ALICE Silicon & TPC** *30'*

Speaker: Werner Riegler

Material: **Slides**

12:30 **Progress on the low power readout ASIC for TPC with 65nm CMOS** *30'*

Speaker: Liu Wei (Tsinghua University)

Material: **Slides**

14:30 **The TPC for CepC** *30'*

Speaker: Dr. Huirong Qi (IHEP)

Material: **Slides**

17:30 **MPGD options** *30'*

Speaker: Marco Poli Lener (LNF)

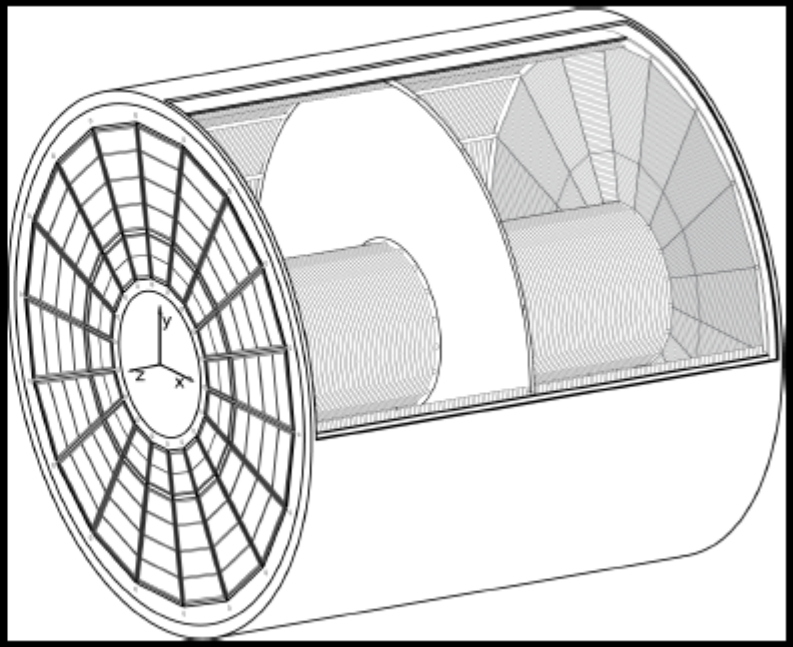
Material: **Slides**

ALICE TPC

ALICE TPC

- Diameter: 5 m, length: 5 m
- Gas: Ne-CO_2-N_2, Ar-CO_2
- Max. drift time: ~100 μs
- 18 sectors on each side
- Inner and outer read out chambers: IROC, OROC

- Current detector (Run 1, Run 2):
  - 72 MWPCs
  - ~550 000 readout pads
  - Wire gating grid (GG) to minimize Ion Back-Flow (IBF)
  - Rate limitation: few kHz



ALICE TPC

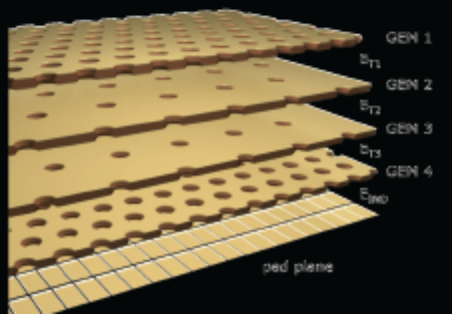
ALICE TPC Upgrade

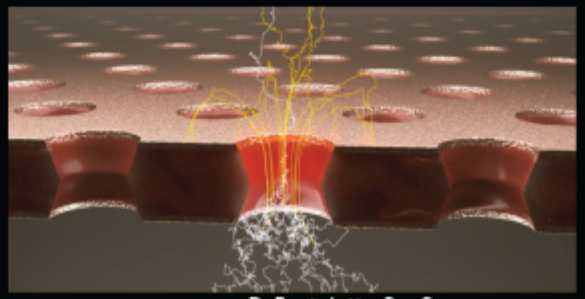
Production of 40 IROCs and 40 OROCs until September 2018

TPC Upgrade requirements:

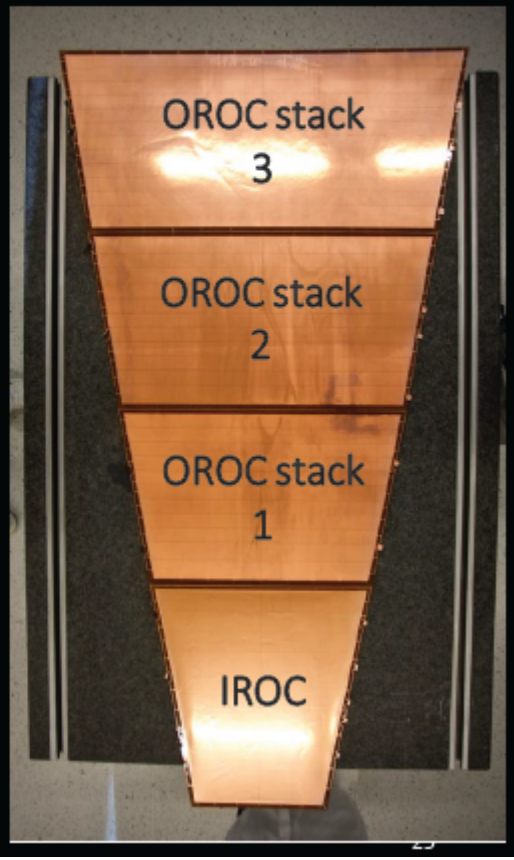
- Nominal gain = 2000 in Ne-CO_2-N_2 (90-10-5)
- IBF < 1% (ε = 20)
- Energy resolution: σ_E/E < 12% for ^{55}Fe
- Stable operation under LHC Run 3 conditions
- Unprecedented challenges in terms of loads and performance

Solution: 4-GEM stack
Combination of standard (S) and large pitch (LP) GEM foils
Highly optimized HV configuration
Result of intensive R&D





D. Bortoletto CepC

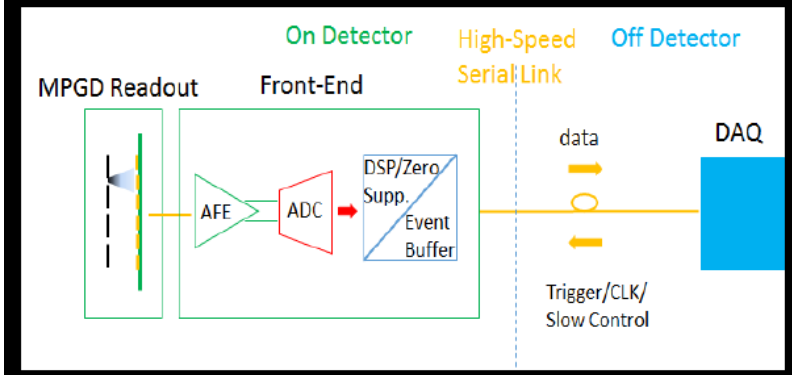


TPC readout ASIC chip R&D in Tsinghua

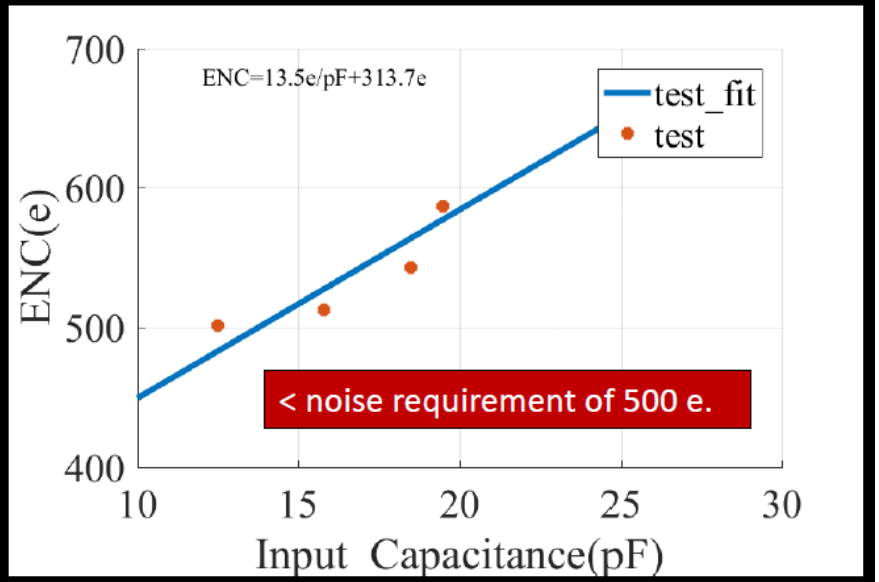
Low Power 65 nm TPC readout

Liu Wei

- Low power design is critical for the 1M channel TPC



- **The Power consumption : 2.18mW/ch (spec 2.5 mW/ch)**



- Three prototype chips have been designed for the first MPW run
  - Analog Front-end (Charge Sensitive Amplifier + CR-RC shaper) ASIC
  - Lower power SAR-ADC ASIC
  - Analog Front-end +SAR-ADC ASIC

TPC for CEPC

Motivation of TPC with MPGDs as readout

- Higher accuracy < 100mm(Overall along the drift)
- **Better two track resolution**
- Full 3-D track reconstruction
- Precise dE/dX
- **High magnetic field (>3T)**
- **Highly reduced E×B effect**
- Large detectors by industrial process
- **Easy assembled using the modules**
- **Minimal material budget**
- Much higher Ion feed back suppression
- Drift time gives the longitudinal coordinate

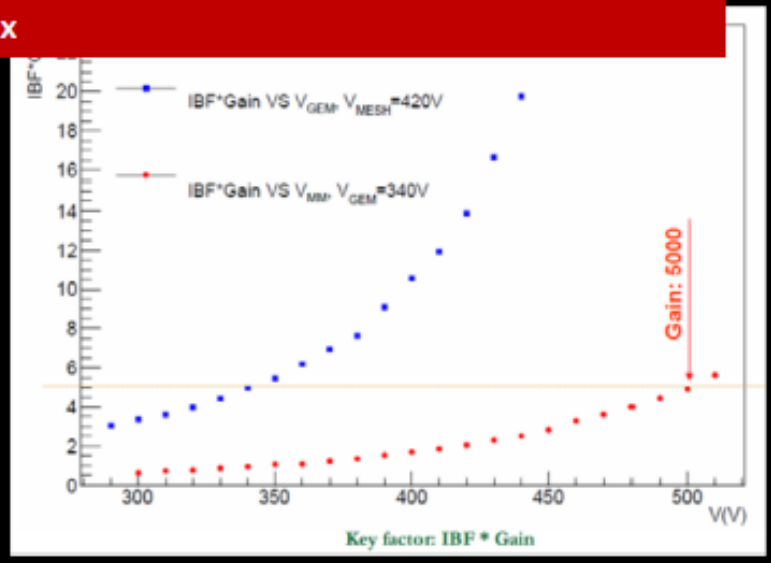
TPC for CEPC

Space charge effect !

CepC TPC

Warning due to ALICE expeirnce that this results could be misleading if measured with x-ray flux

- Continuous IBF module:
  - Gating device may be used for Higgs run
  - Open and close time of gating device for ions: ~ μs-ms
  - No Gating device option for Z-pole run
  - Continuous Ion Back Flow due to the continuous beam structure
  - Low discharge and spark possibility



- Laser calibration system:
  - Laser calibration system for Z-pole run
  - Calibration of the distortion using Nd:YAG laser device@266nm

Check and answer

http://iopscience.iop.org/article/10.1088/1748-0221/9/04/C04025/pdf

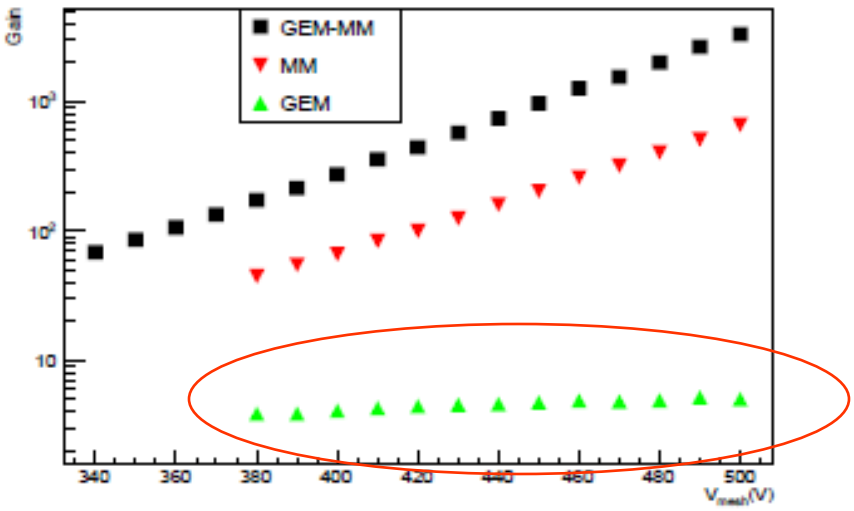
https://www.sciencedirect.com/science/article/pii/S0168900216308221

High rate and lots of ions make space charge effect to decrease IBF value !!!

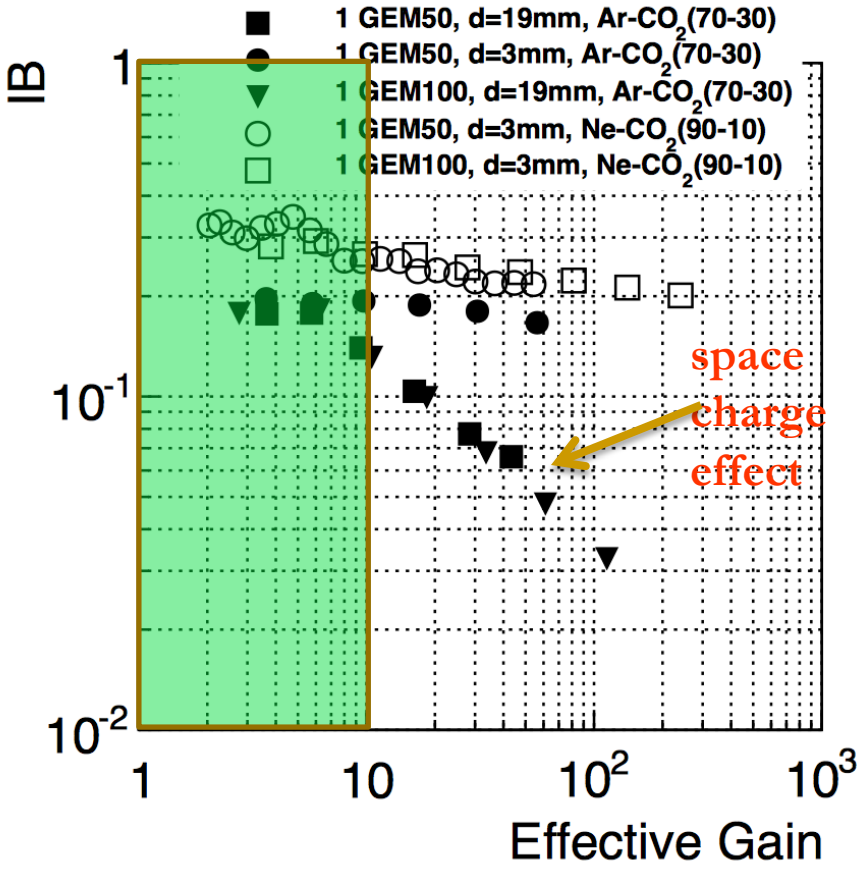
Check and answer -Gain

Single GEM with very low Gain in our Exp.

DOI: 1609.08010

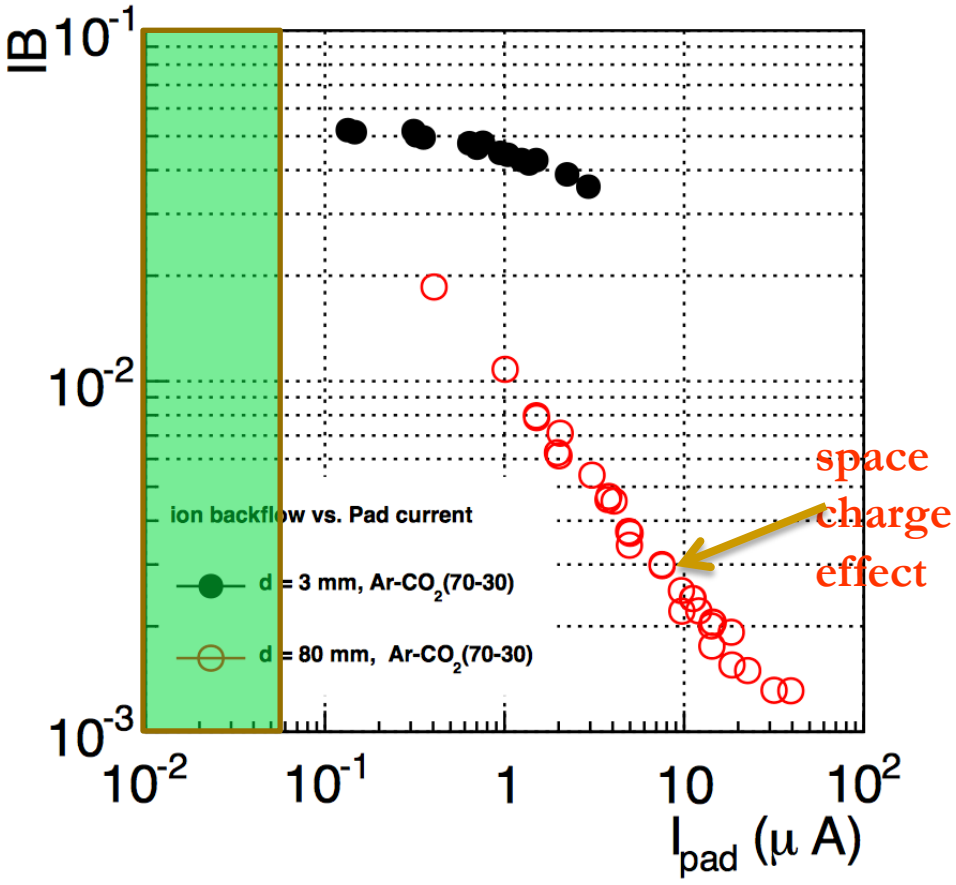


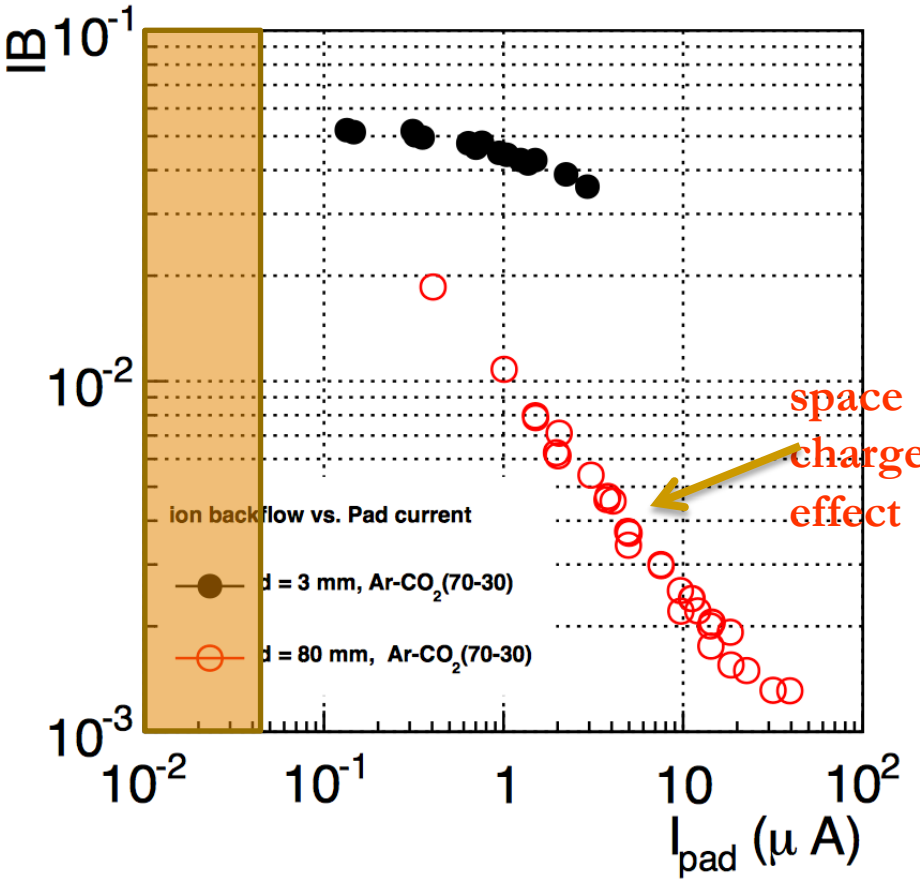
(b)



Check and answer- I_{pad}

Current of Pad is very low in our Exp.



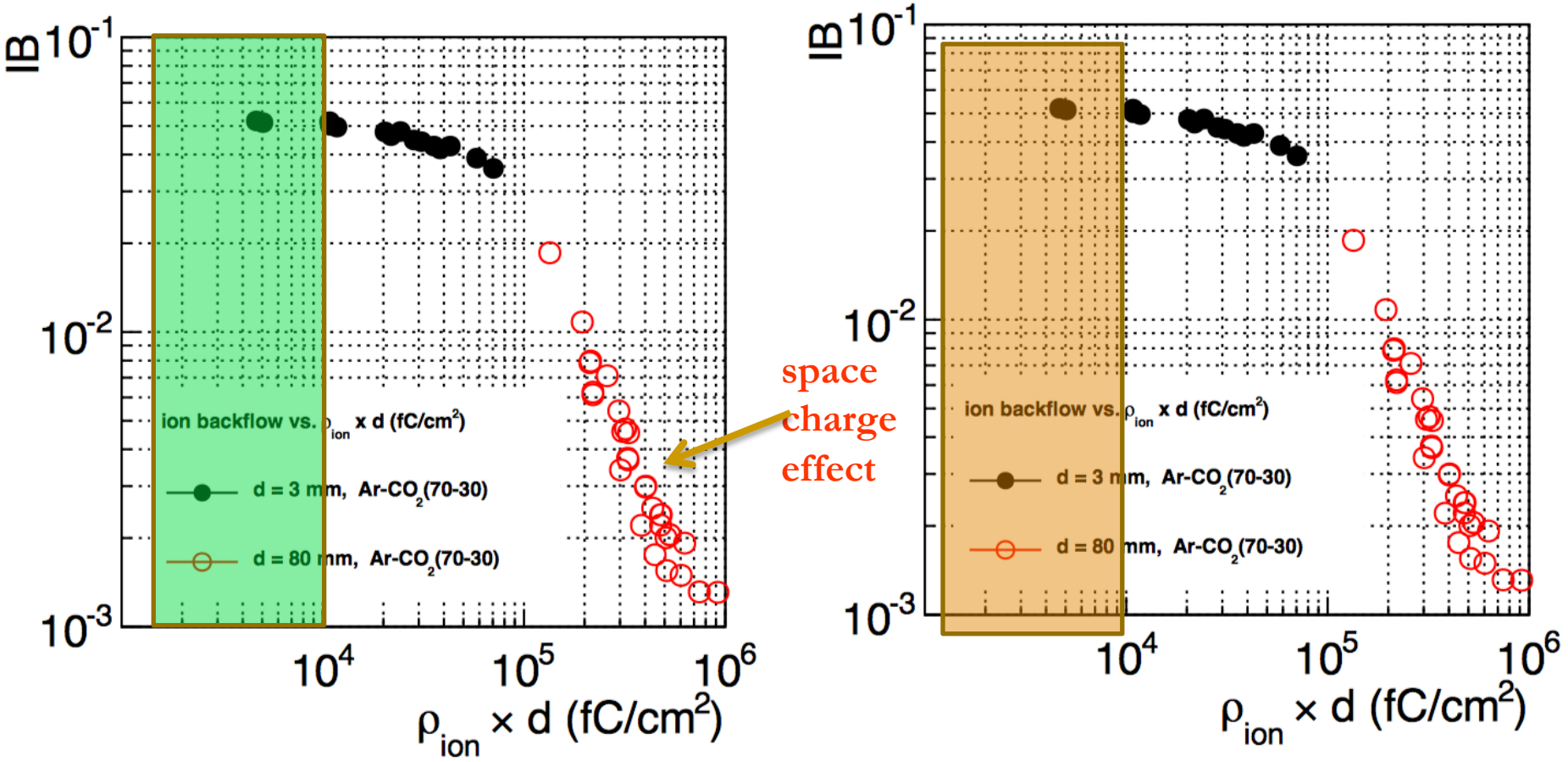


Green，T2K，Et=200V/cm, Ed=200V/cm, V_mesh=400V, V_Gem:30~300V

Yellow，Ar/iso(95/5)，Et=200V/cm, Ed=200V/cm, V_mesh=400V, V_Gem:30~300V

Check and answer- $p_{ion} \times d$

Current of Pad is very low in our Exp.



Green: T2K， Yellow: Ar/iso(95/5)

T2Kgas Ic: 4pA～59pA，～10^3 （fC/cm^2）

Ar/iso gas Ic : 3.5pA~53pA, ～10^3 （fC/cm^2）

GEM+MM@CEPC R&D

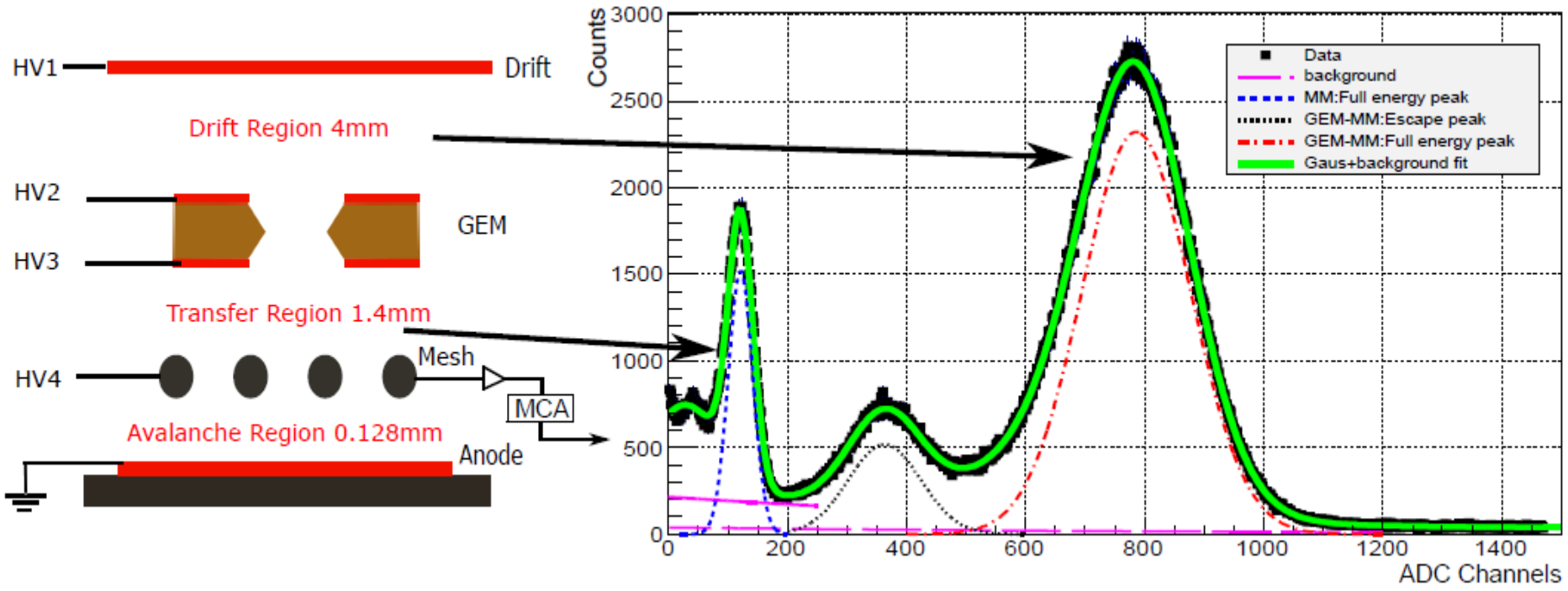
e+e- machine

Primary N_{eff} is small: ~30

Photo peak and escape peak are clear!

Good electron transmission.

Good energy resolution.

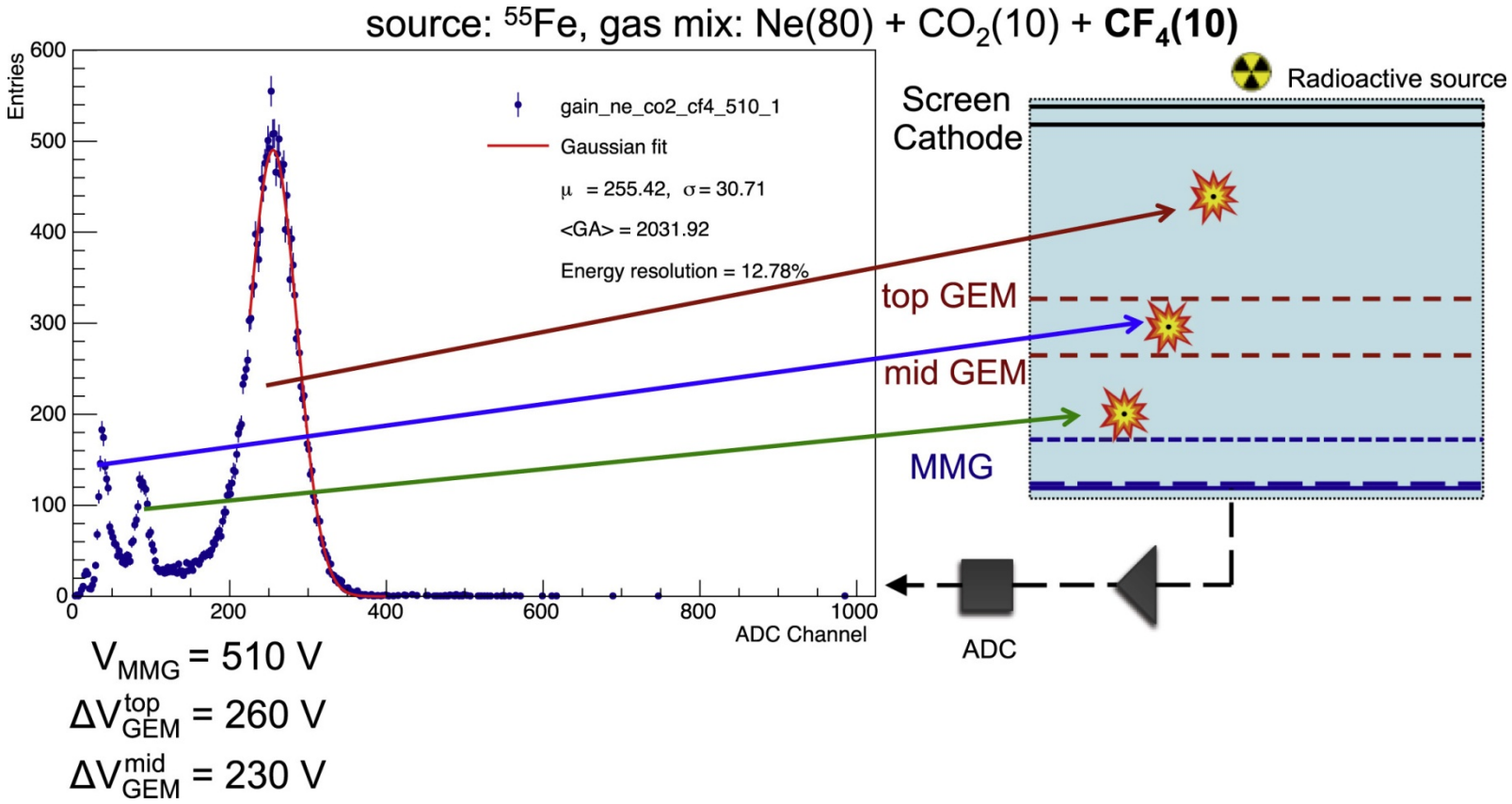


GEM+GEM+MM@ALICE R&D

Heavy ions machine

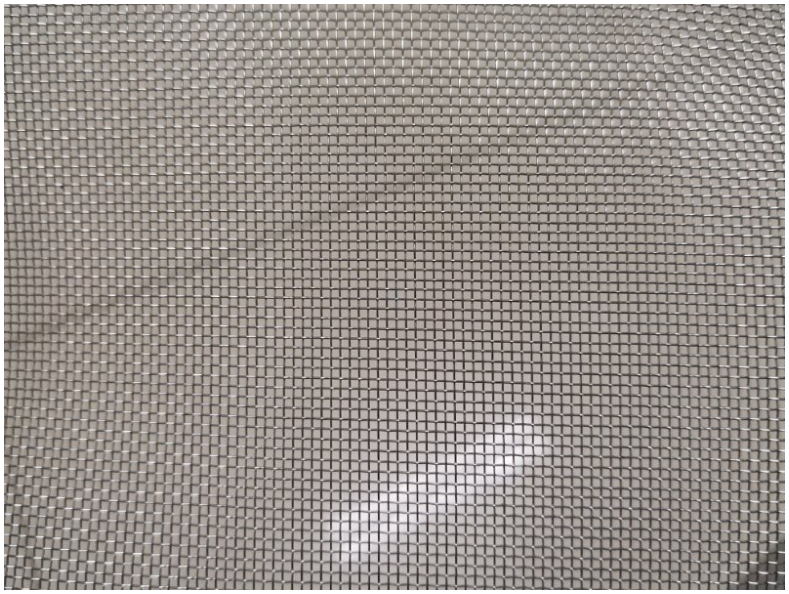
Primary N_{eff} is small: >300

Photo peak and escape peak are merged!
Electron transmission and the energy resolution are not good.



- High LPI mesh

High LPI mesh

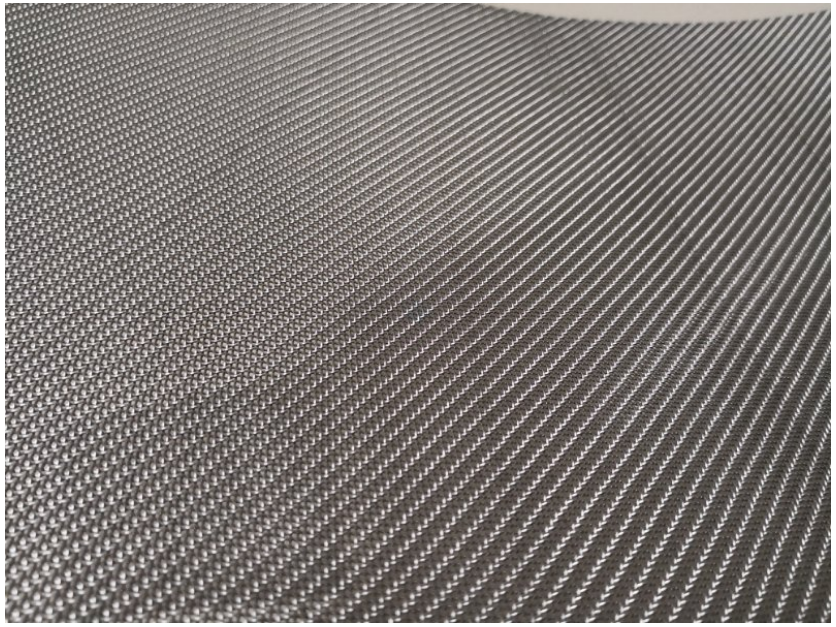


560LPI sample
1m*1m Got !

1. One warp wire plus one weft wire: -|-|-|-|-|- (example)

The 400LPI is normal and cheap. The high LPI could be reach to 500LPI, 600LPI and 735LPI and it's very difficult to find the more than 735LPI. The price will be 10 times than 400LPI. Of course, we could try the small active area of 100mmX100mm.

High LPI mesh



2. One warp wire plus two weft wires: -||-||-||-||- (example)

The thickness is more than the previous type.

The high LPI could be reach to 600LPI, 700LPI, 800LPI, 1200LPI and more. How about this type?

Thanks.