Summary report of TPC in Rome meeting and CDR plan

Huirong Qi

2018.06.06

Outline

- Summary report of Rome meeting
- Next steps of TPC part in CDR

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)

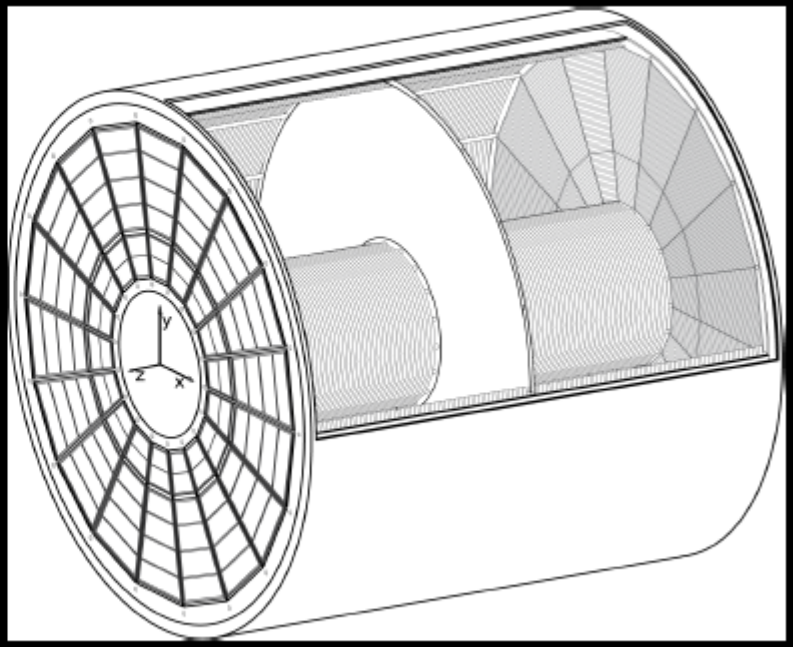
Material: **Slides**

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

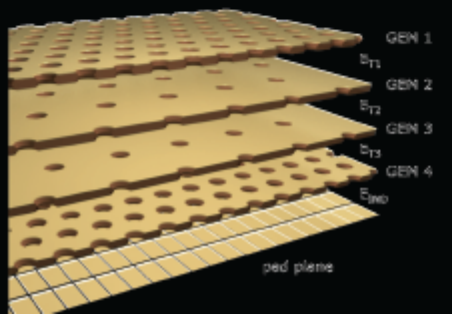
ALICE TPC Upgrade

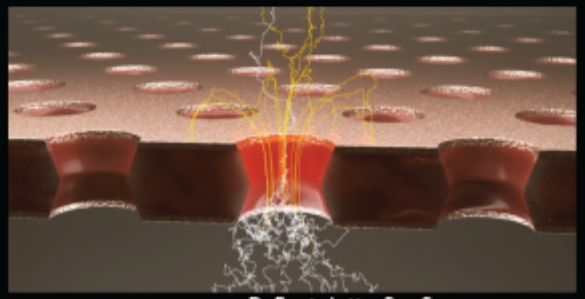
Production of 40 IROCs and 40 OROCs until September 2018

TPC Upgrade requirements:

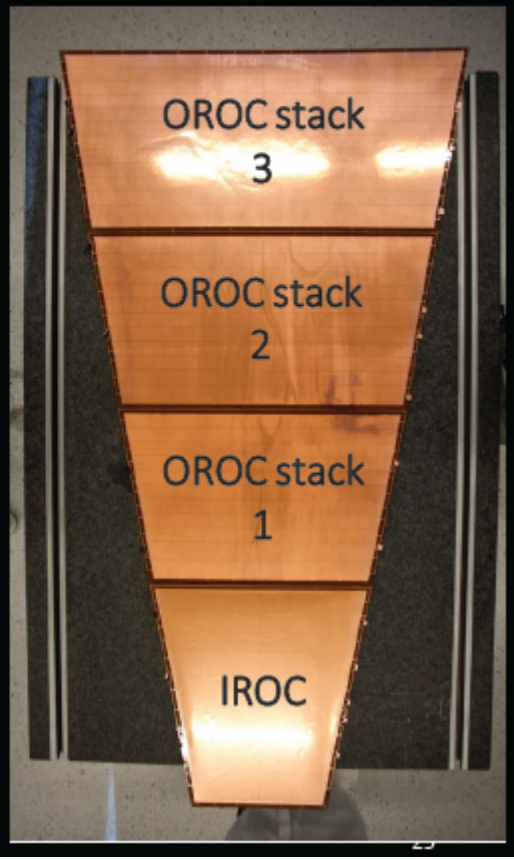
- Nominal gain = 2000 in Ne-CO_2-N_2 (90-10-5)
- IBF < 1% (ε = 20)
- Energy resolution: σ_E/E < 12% for ^{55}Fe
- Stable operation under LHC Run 3 conditions
- Unprecedented challenges in terms of loads and performance

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

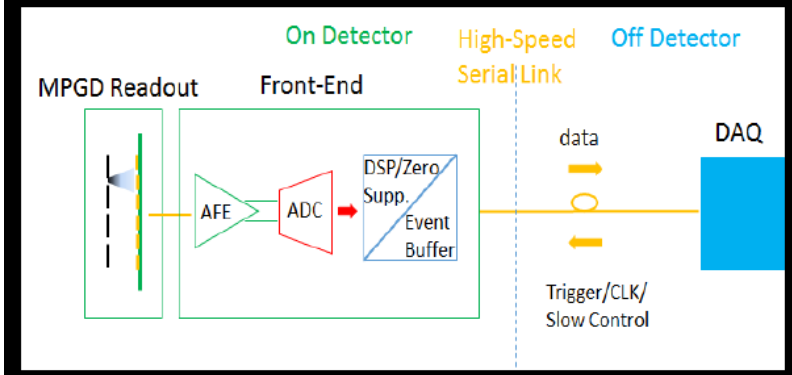


TPC readout ASIC chip R&D in Tsinghua

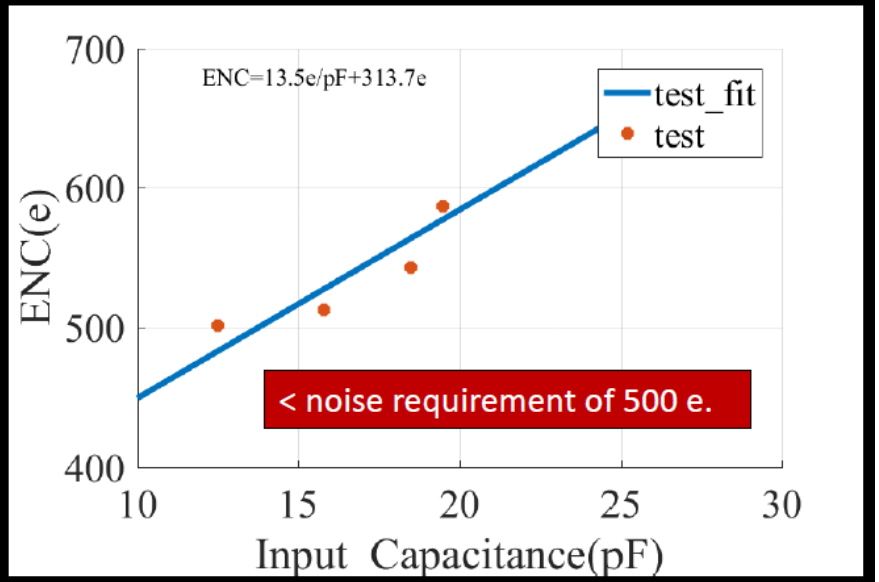
Low Power 65 nm TPC readout

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

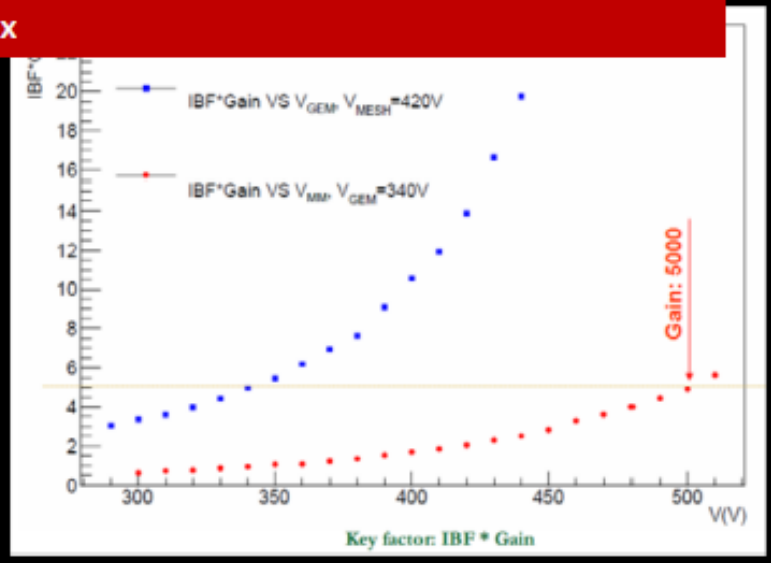
- Higher accuracy < 100mm(Overall along the drift)
- **Better two track resolution**
- Full 3-D track reconstruction
- Precise dE/dX
- **High magnetic field (>3T)**
- **Highly reduced E×B effect**
- Large detectors by industrial process
- **Easy assembled using the modules**
- **Minimal material budget**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

TPC for CEPC

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

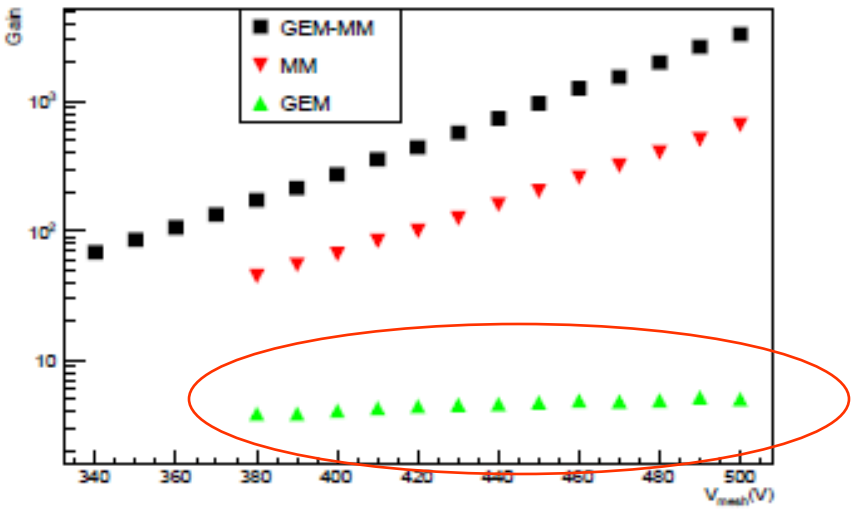
https://www.sciencedirect.com/science/article/pii/S0168900216308221

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

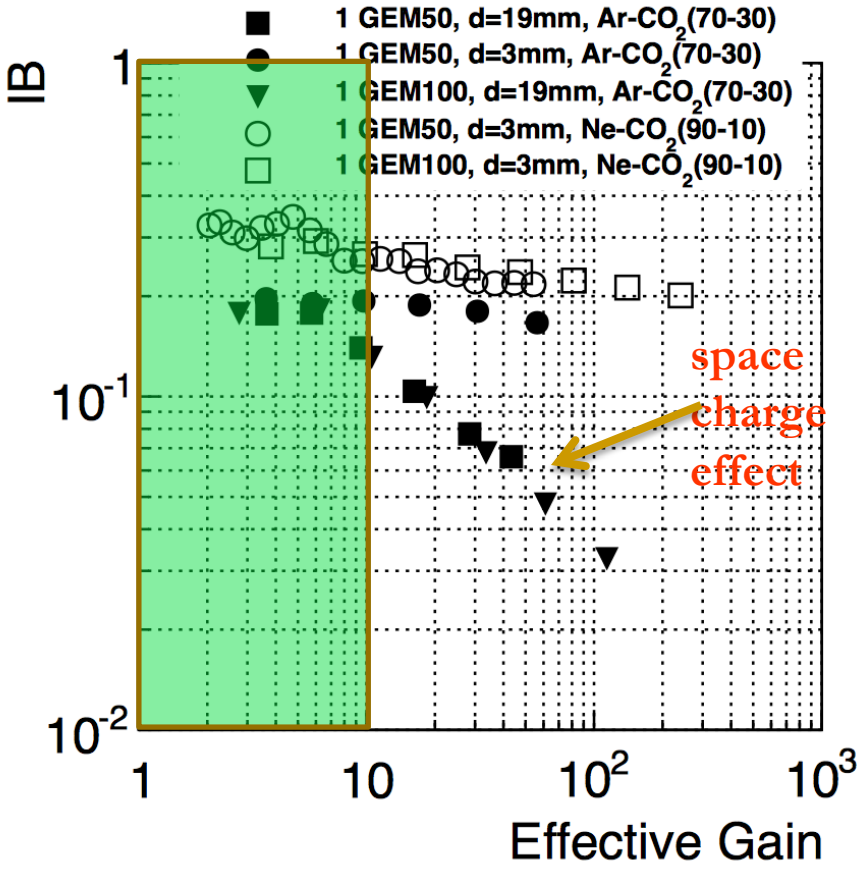
Check and answer -Gain

Single GEM with very low Gain in our Exp.

DOI: 1609.08010

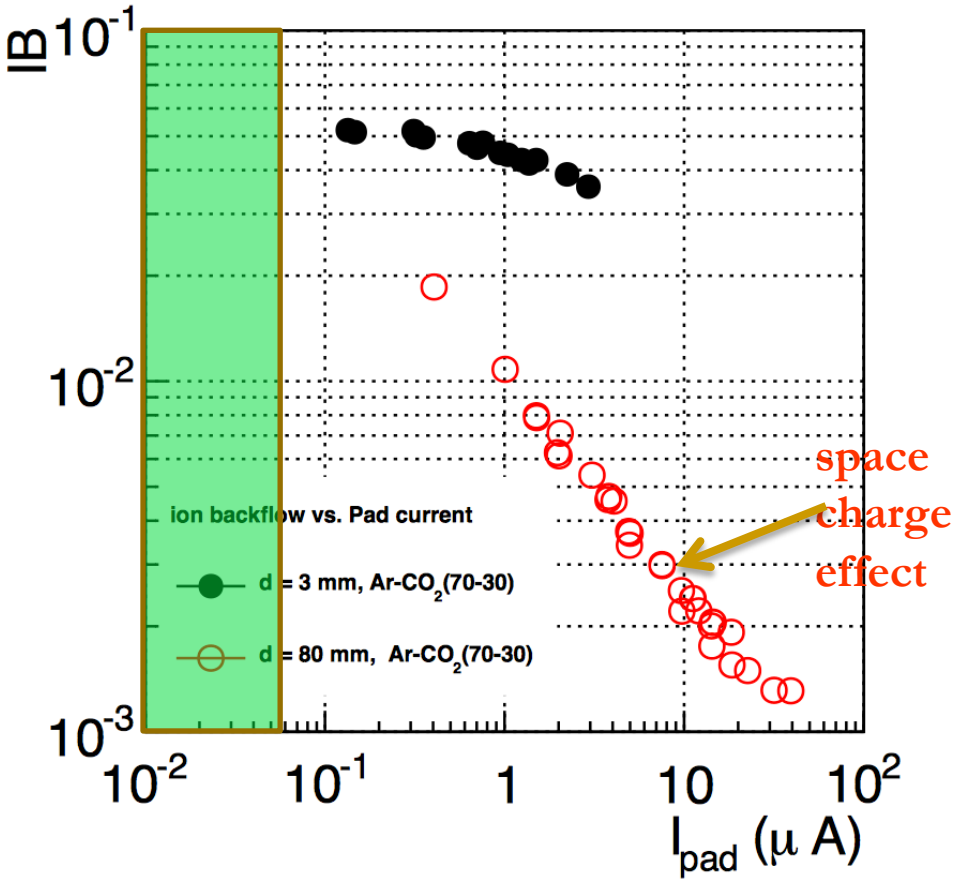


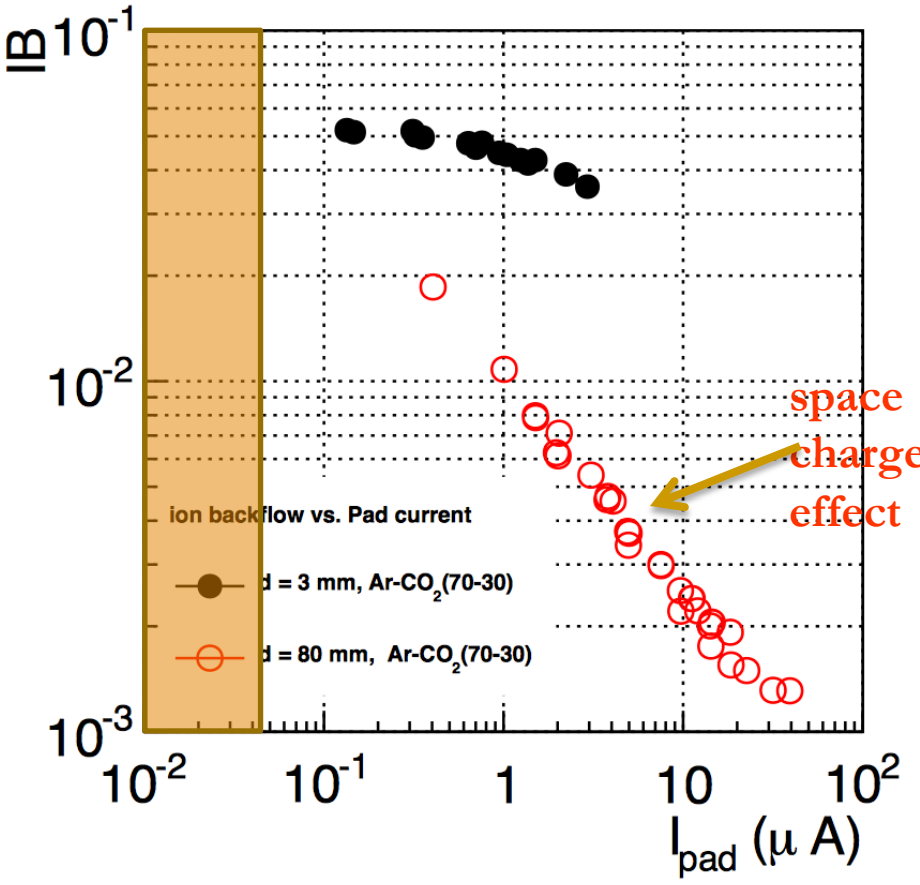
(b)



Check and answer- I_{pad}

Current of Pad is very low in our Exp.



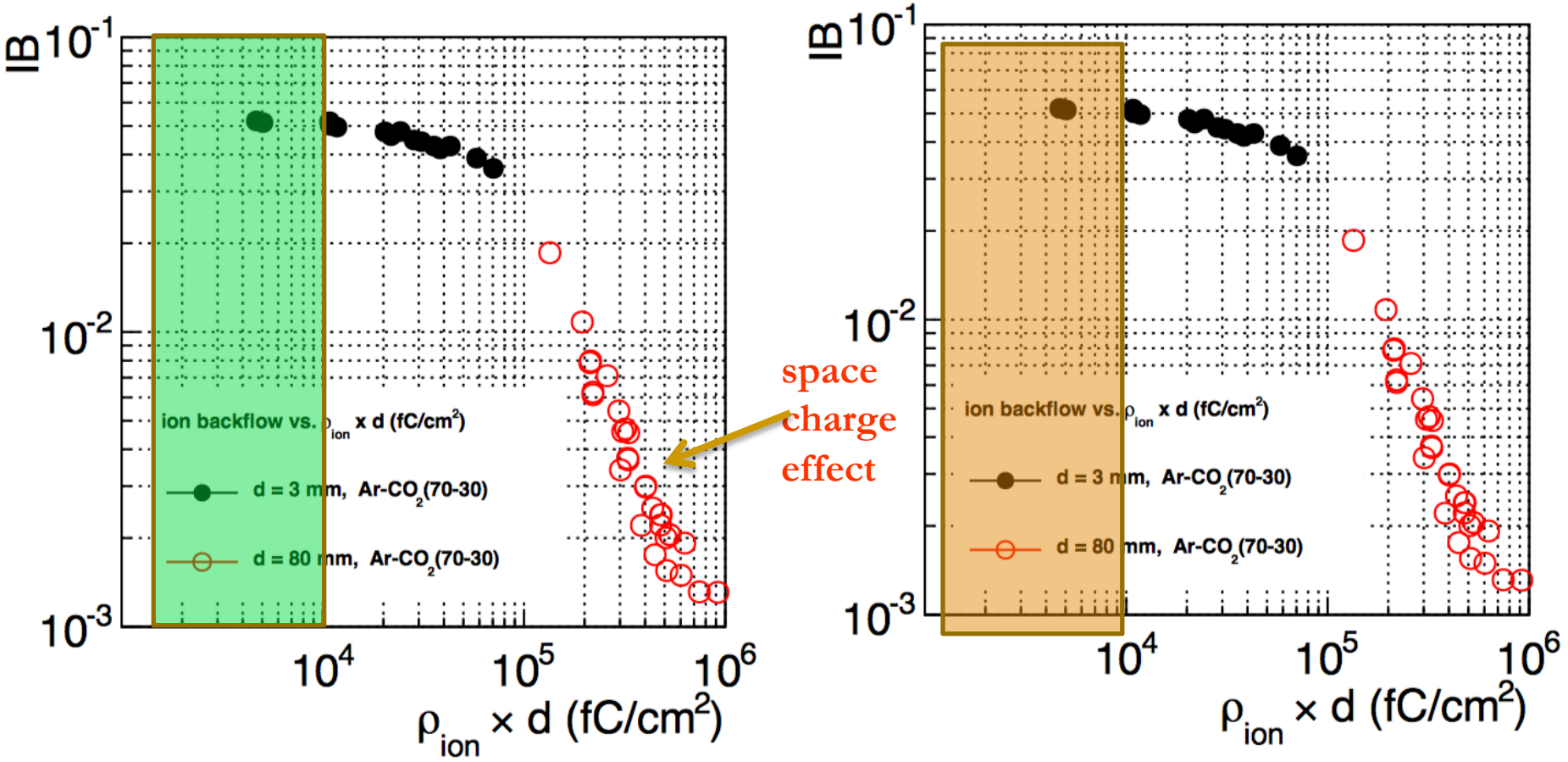


Green，T2K，Et=200V/cm, Ed=200V/cm, V_mesh=400V, V_Gem:30~300V

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

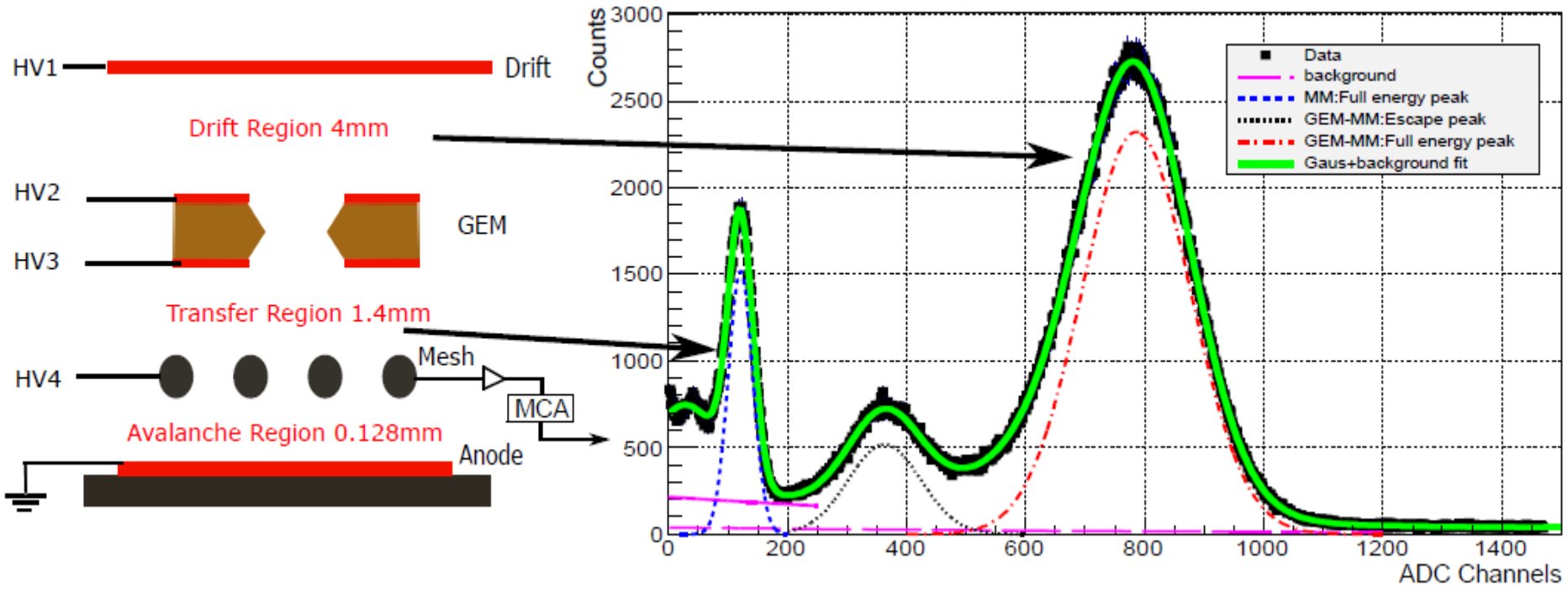
e+e- machine

Primary N_{eff} is small: ~30

Photo peak and escape peak are clear!

Good electron transmission.

Good energy resolution.

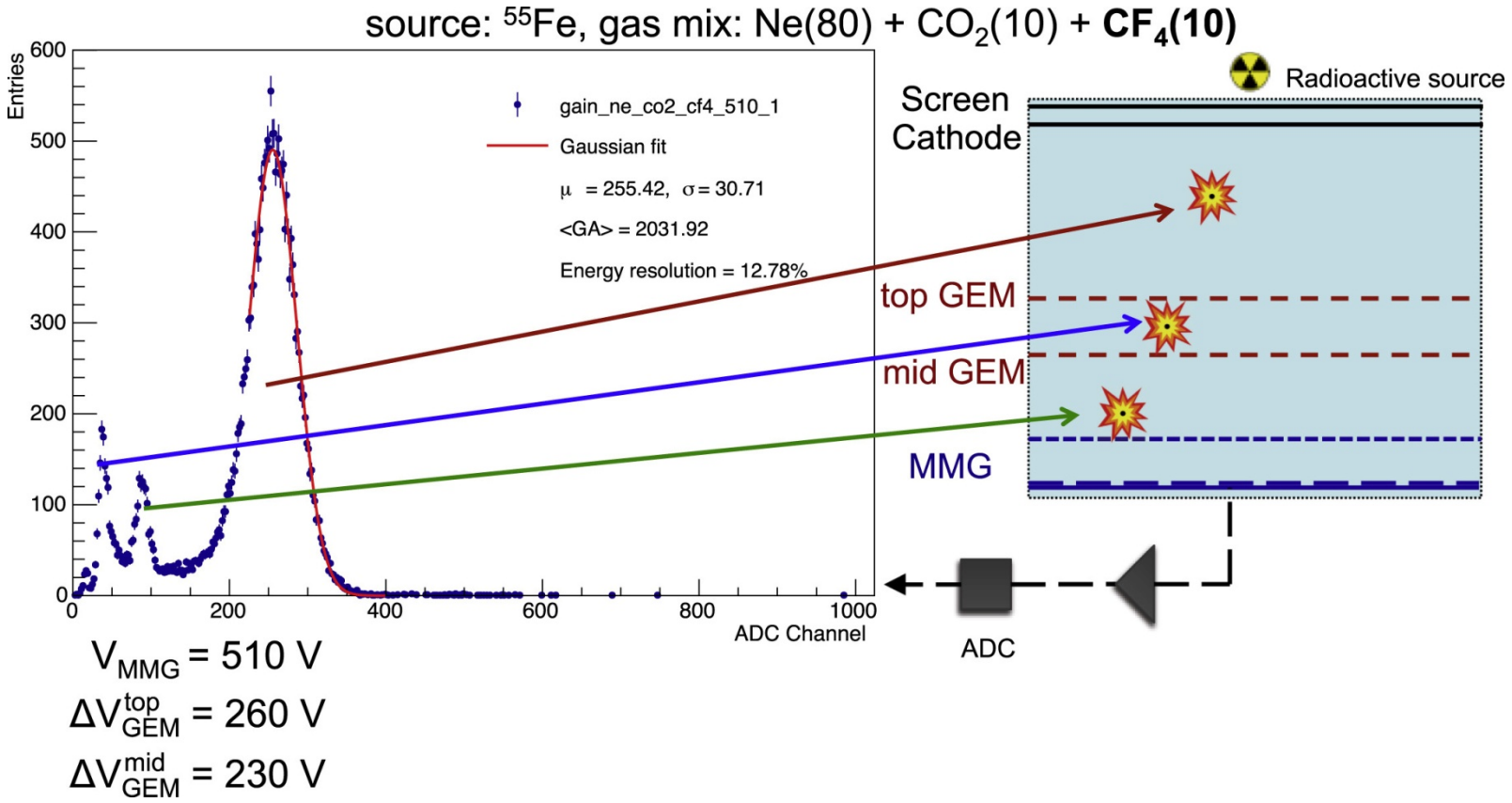


GEM+GEM+MM@ALICE R&D

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.



Next steps of TPC part in CDR

- The discussion will be added in TPC part.
- High rate of X-ray test will be done.