粒子物理前沿卓越中心考评报告（2019年）

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12月6日, 2019, IHEP

目录

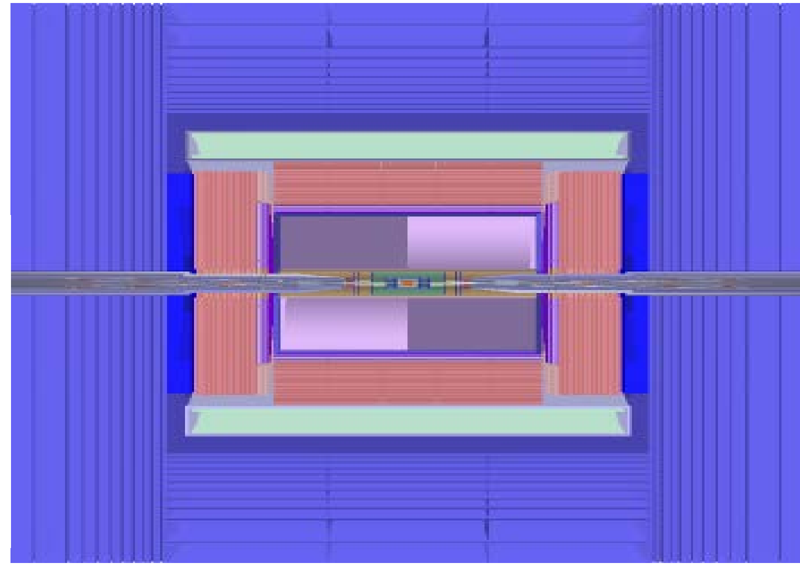
三种探测器概念(CEPC CDR)

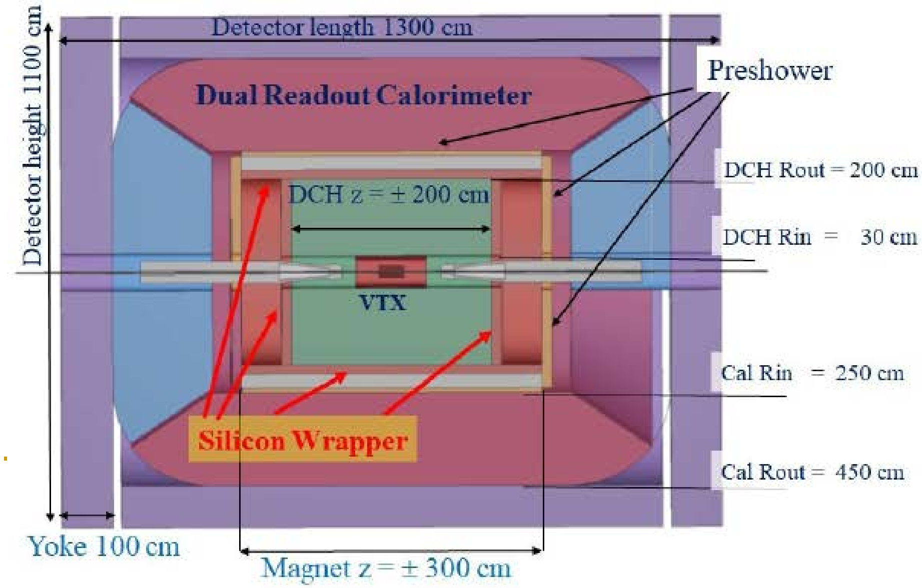
ArXiv:1811.10545

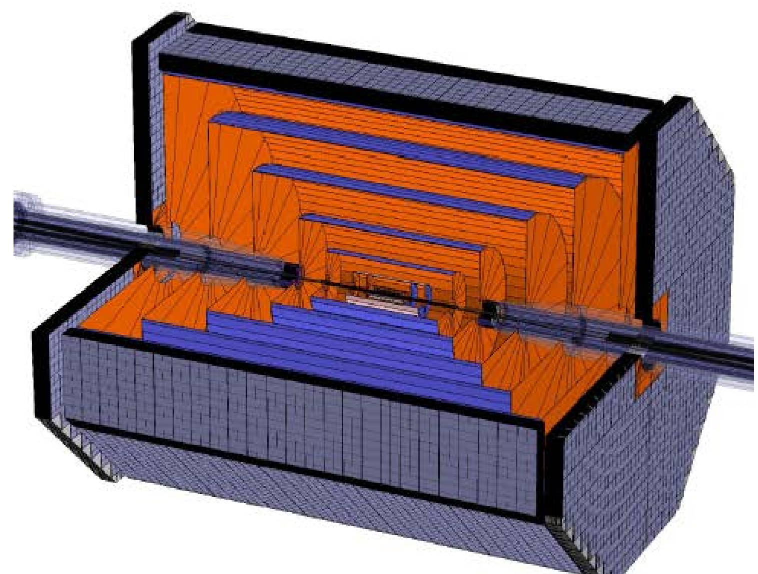
Operation mode	$\sqrt{s}$ (GeV)	L per IP (10^{34} cm^{-2}s^{-1})
H	240	3
Z	91.2	32 (*)
W^+W^-	158–172	10

- 粒子流探测：VTX+TPC+ECAL+HCAL
- 全硅像素探测器：SID
- 漂移室/双端量能探测: Silicon+Drift chamber (DCH)+DCAL

	Higgs	W	Z (3T)	Z (2T)
Number of IPs	2			
Beam energy (GeV)	120	80	45.5	
Circumference (km)	100			
Synchrotron radiation loss/turn (GeV)	1.73	0.34	0.036	
Crossing angle at IP (mrad)	16.5 × 2			







环形对撞机TPC技术的关键问题

- 位置畸变影响与占空比
  - 亮度提高的可行性
  - 电场畸变
  - 近对撞区内层本底

模拟研究

TPC技术能否应用在环形对撞机？

- 正离子反馈
  - 连续的束流时间结构
  - 100μm的位置分辨率
  - 探测器稳定工作性能
  - 有效的正离子控制，且不降低电子透过率

模块与原型机

能否有效的控制正离子并保证性能？

- 标定与刻度
  - 标定的物理需求
  - 激光标定的设计与实现
  - 磁场及束流验证

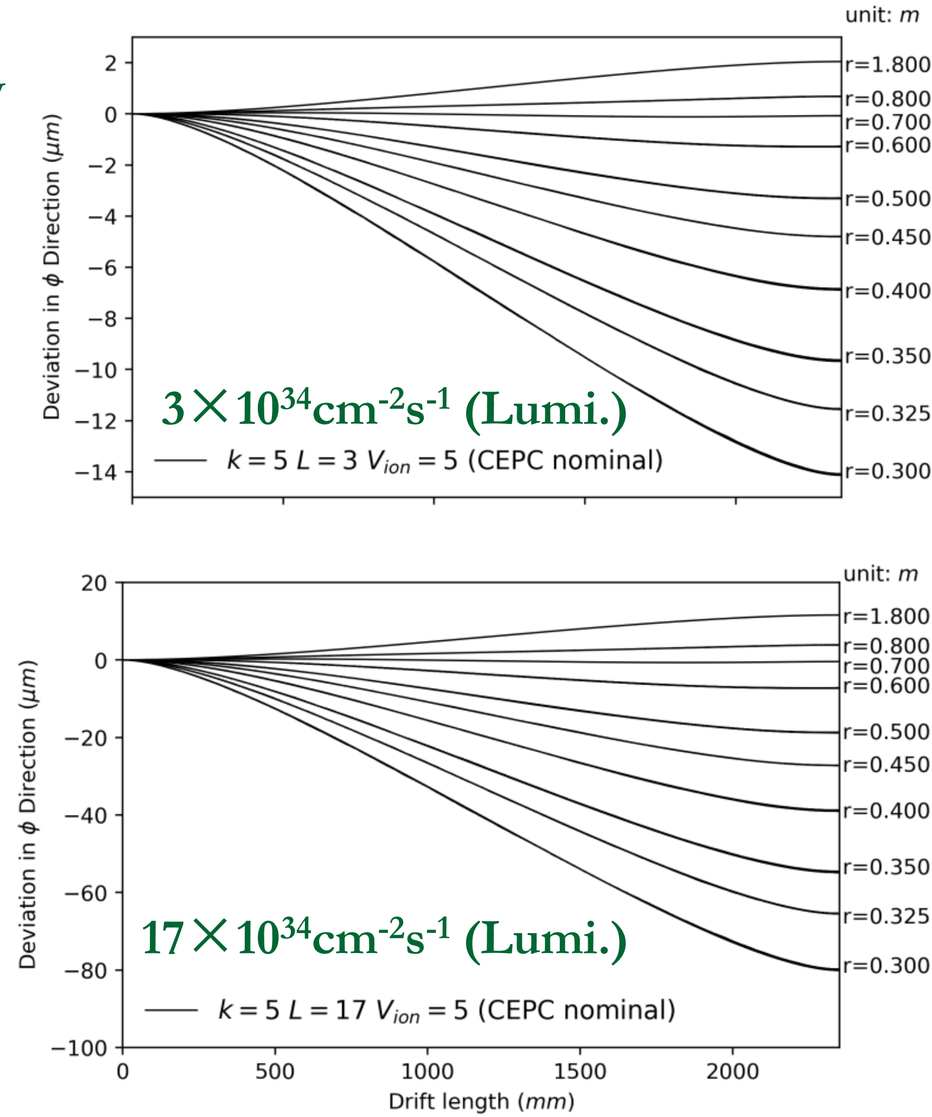
模块与原型机

如何实现工作条件改变的位置畸变标定与刻度？

Feasibility study at Z pole

DOI: 10.1142/S0217751X19400165, 2019
DOI: 10.1088/1748-0221/12/07/P07005, 2017

- Goal:
  - Operate TPC at higher luminosity
  - No Gating options
- Simulation
  - IBF×Gain default as the factor of 5
  - 9 thousand Z to qq events
  - 60 million hits are generated in sample
  - Average hit density: 6 hits/mm^2
  - Voxel size: 1mm×6mm ×2mm
  - Average voxel occupancy: 1.33×10^{-8}
  - Voxel occupancy at TPC inner most layer: ~2×10^{-7}
  - Validated with 3 ions disks
  - Simulation of the multi ions disk in chamber under the continuous beam structure
  - Without the charge of the beam-beam effects in TPC

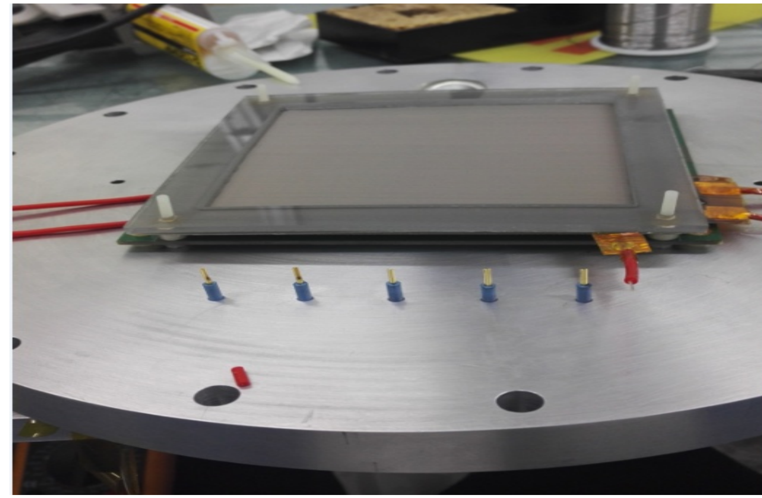


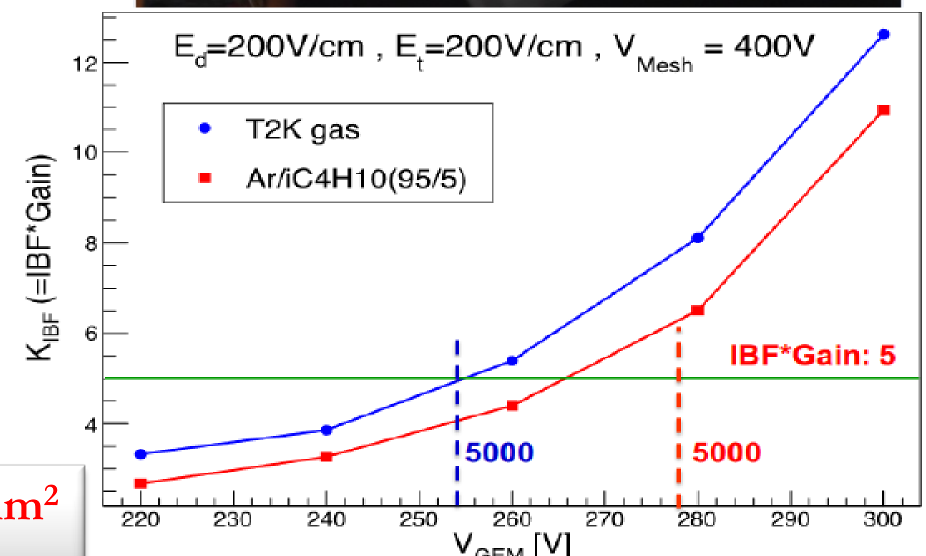
Deviation with the different TPC radius

TPC detector module R&D

DOI: 10.7498/aps.67.20172618.Acta Phys. Sin, 2018
DOI: 10.1088/1748-0221/12/04/P0401 JINST，2017
DOI: 10.7498/aps.66.072901Acta Phys. Sin. 2017
DOI: 10.1088/1674-1137/41/5/056003 , CPC,2016

- Study with GEM-MM module
  - New assembled module
  - Active area: 100mm×100mm
  - X-tube ray and 55Fe source
  - Bulk-Micromegas assembled from Saclay
  - Standard GEM from CERN
  - Avalanche gap of MM:128μm
  - Transfer gap: 2mm
  - Drift length:2mm~200mm
  - pA current meter: Keithley 6517B
  - Current recording: Auto-record interface by LabView
  - Standard Mesh: 400LPI
  - High mesh: 508 LPI



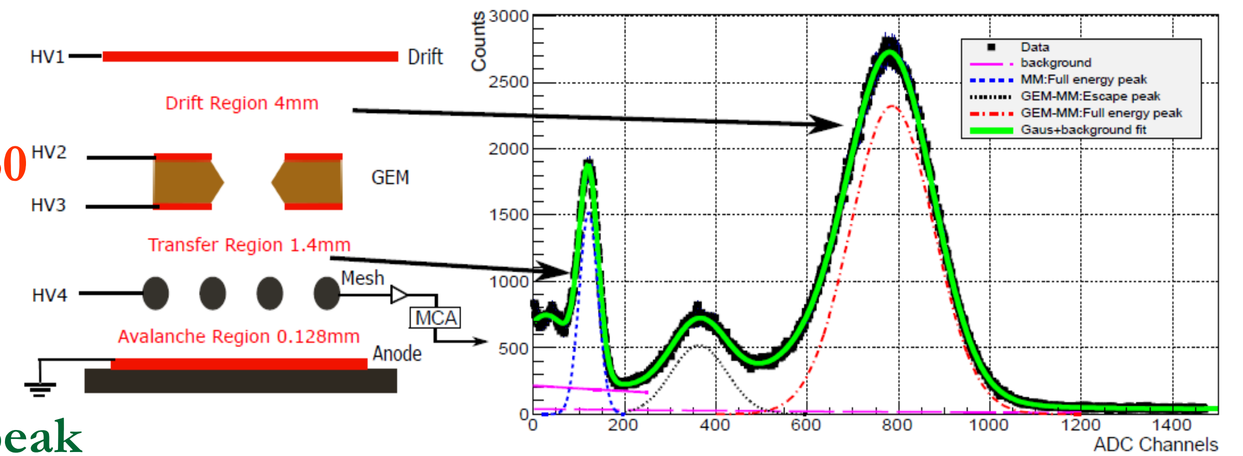


Micronegas + GEM detector module

50×50mm² 2015-2016	→	100×100mm² 2017-2018	→	200×200mm² 2019-

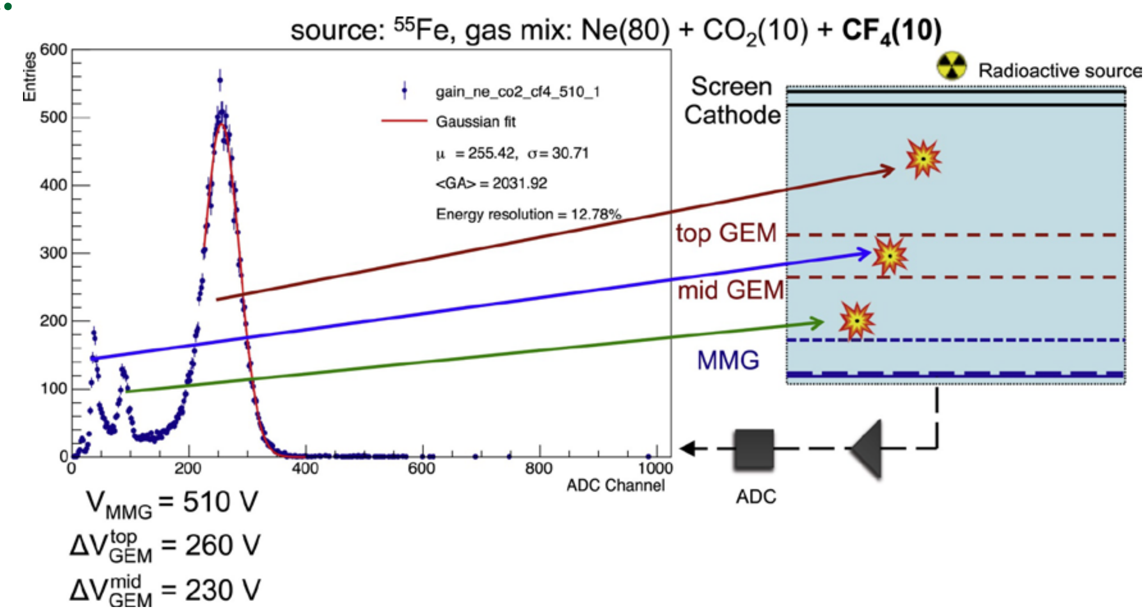
GEM+MM VS TPC@ALICE

For e^+e^- machine
Primary N_{eff} is small: ~30
Pad size:1mm×6mm



GEM+MM module:
Photo peak and escape peak are clear!
Good electron transmission.
Good energy resolution.

GEM+MM IBF suppression detector@55Fe

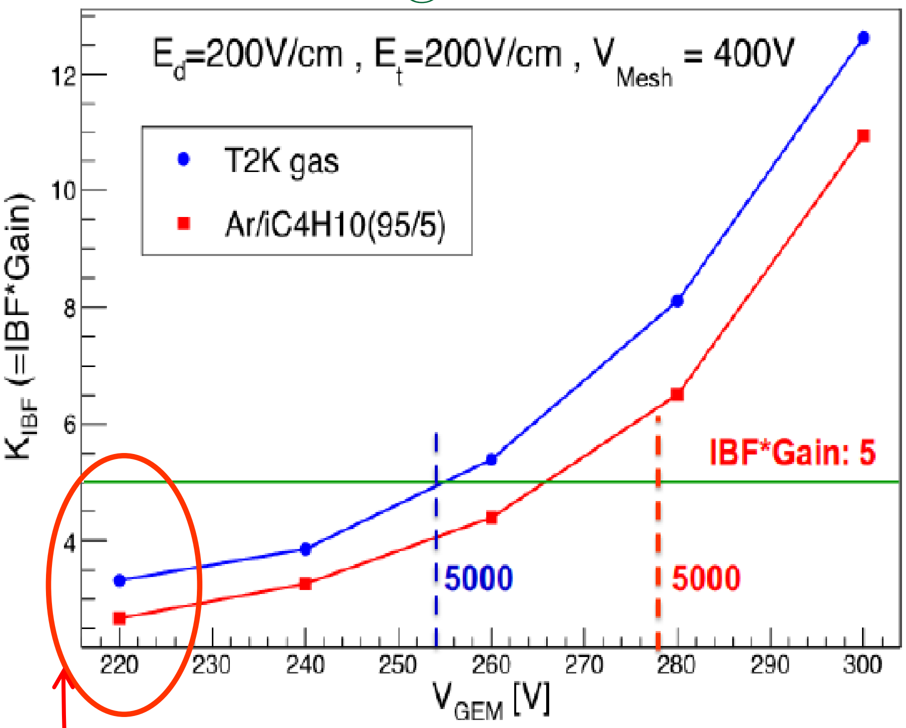


One option for ALICE TPC
GEM+GEM+MM
Gain of mid GEM: ×0.5

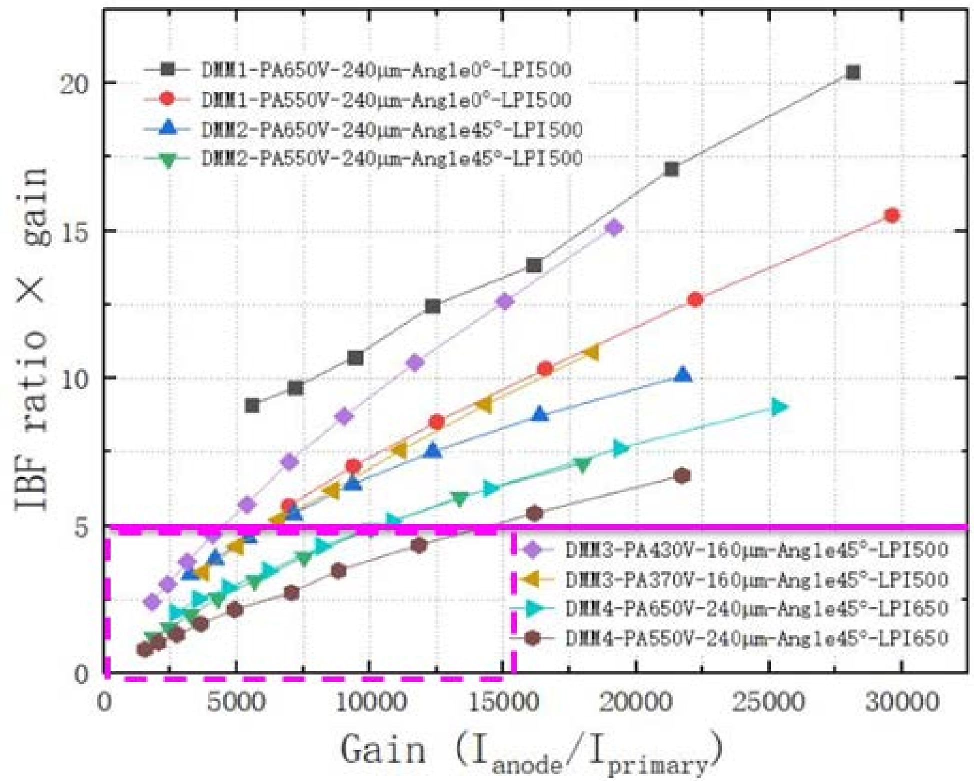
2GEM+MM IBF suppression detector@55Fe

GEM+MM VS DMM@USTC

Micronegas + GEM detector module @IHEP



IBF of double mesh MM @USTC/Jianbei Liu

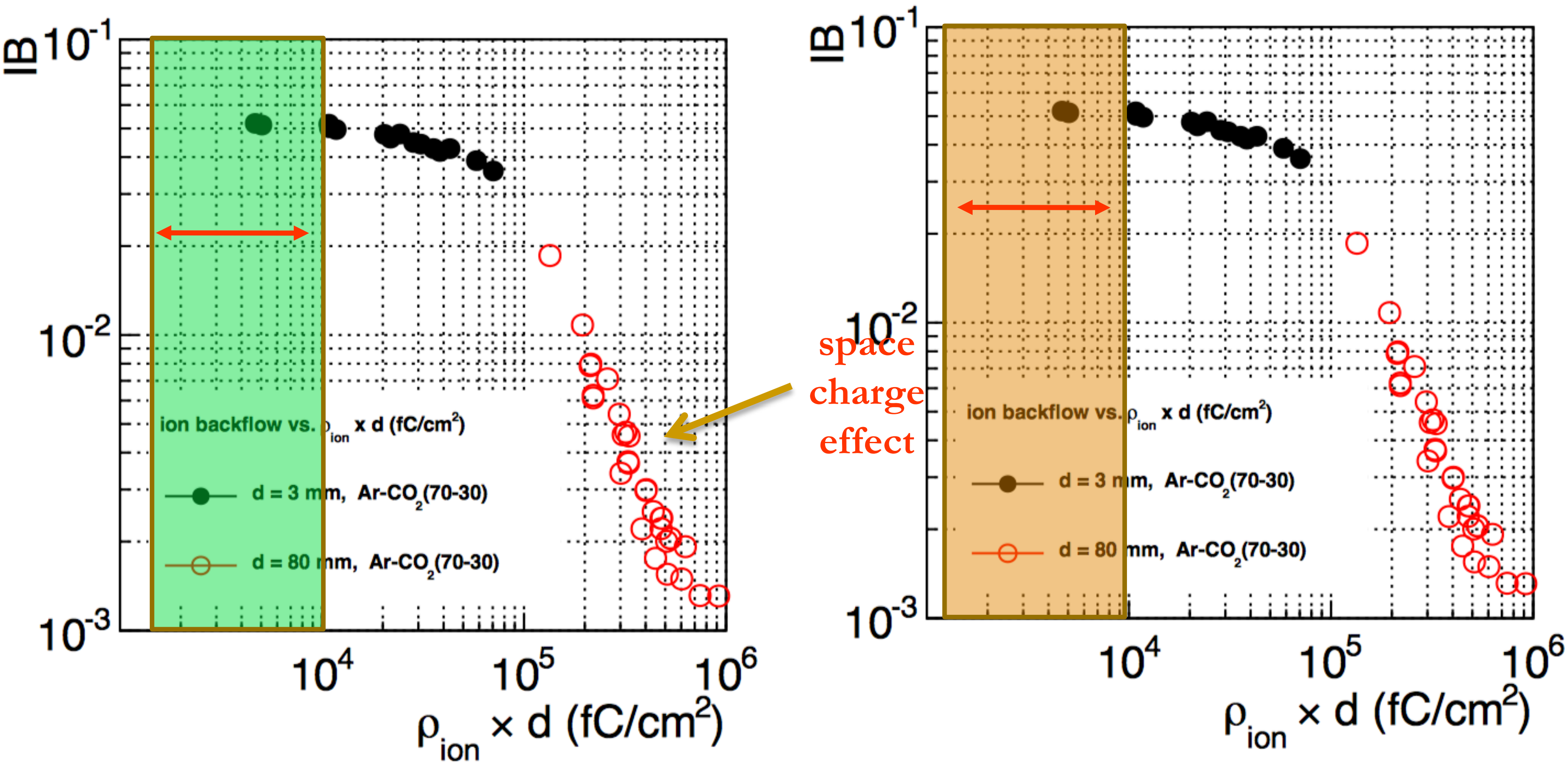


- IBF×Gain has the limitation ratio from the detector R&D at high gain.
- How to do it next ? Any new ideas? (Lower gain and no IBF)

Check $\rho_{ion} \times d$ of Space charge@ALICE

Conclusion: Current of Pad is very low in our Experiment results.

No any obvious space charge effect to decrease IBF.

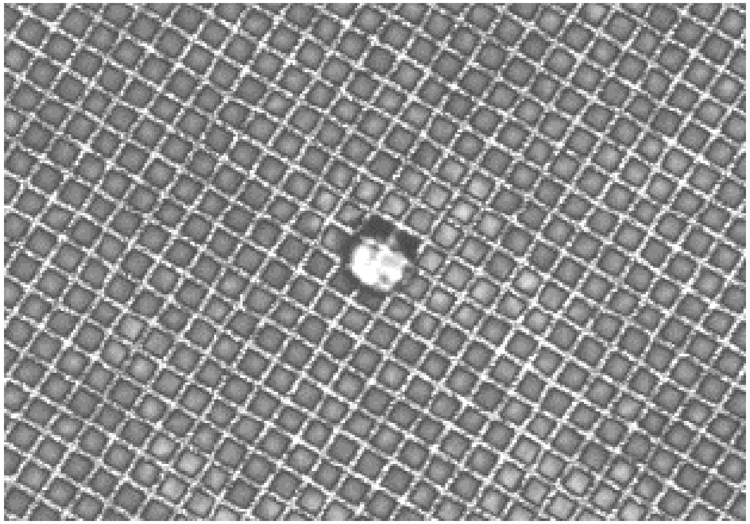


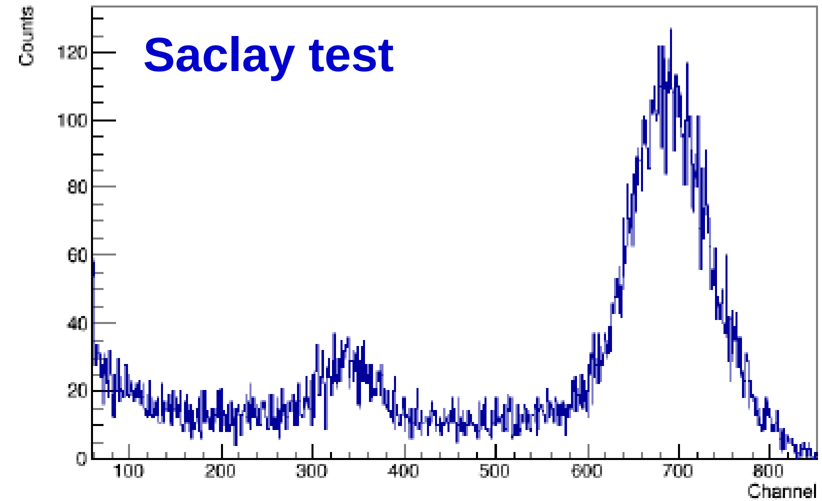
Green: T2K，Yellow: Ar/iso(95/5)

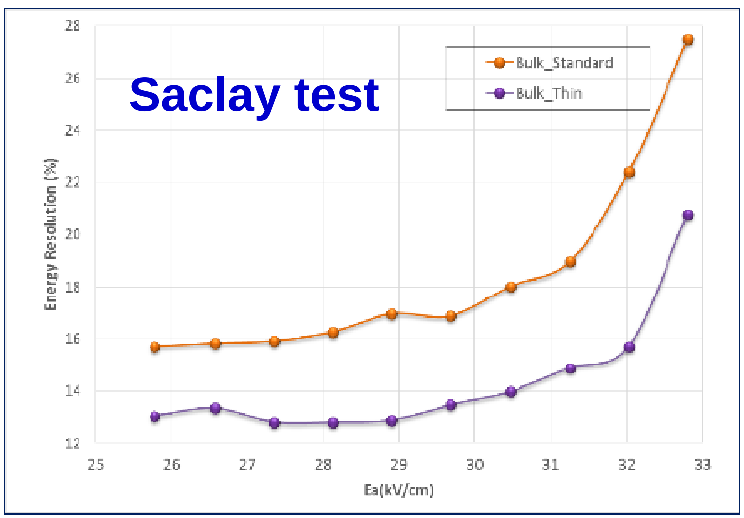
T2Kgas Ic: 4pA～59pA，～10^3 （fC/cm^2）

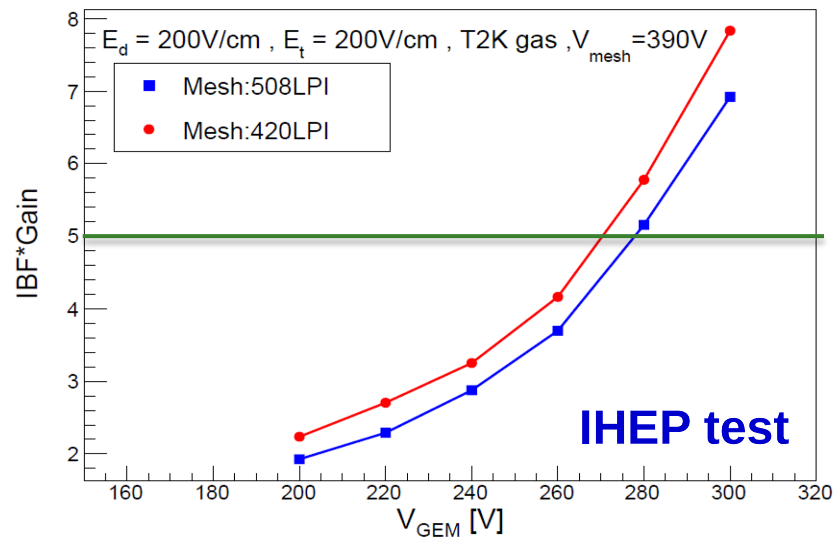
Ar/iso gas Ic : 3.5pA~53pA, ～10^3 （fC/cm^2）

High mesh and lower IBF@CEA-Saclay









- From July, the high mesh of 508LPI has been assembled with CEA-Saclay collaboration. The preliminary results indicates that it could reach the lower IBF and better performance.

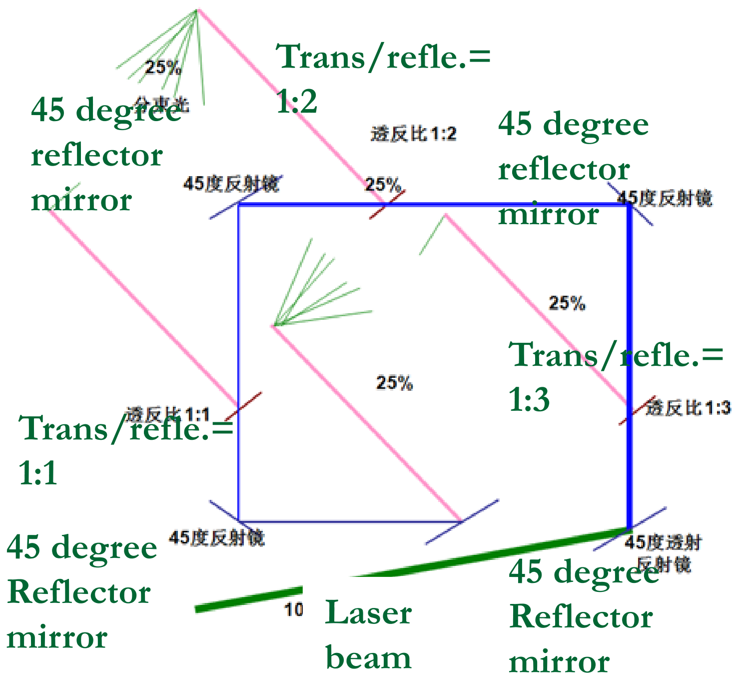
TPC detector prototype R&D

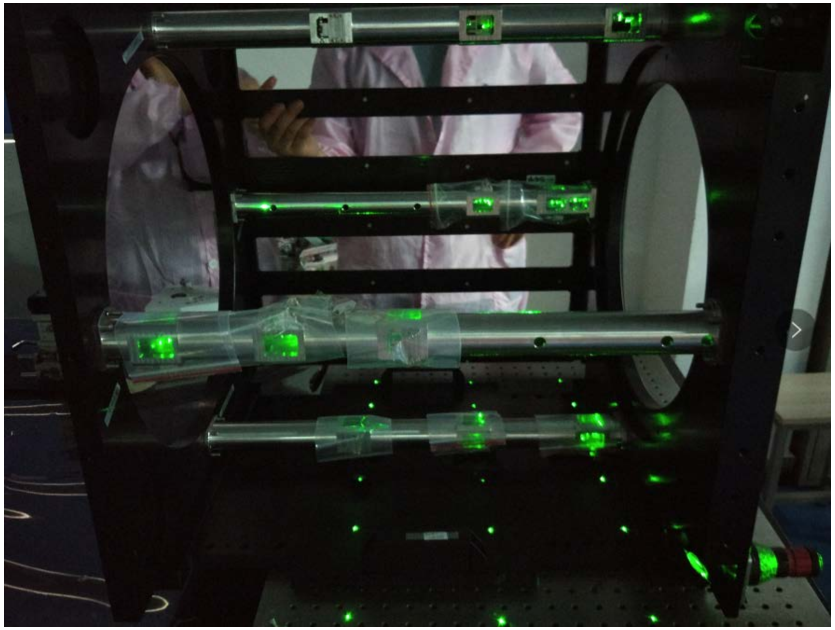
DOI: 10.7498/aps.68.20181613 (SCI) 2019
DOI: 10.1142/S0217751X19400165 (SCI) 2019
DOI: 10.1007/978-981-13-1316-5_20 (SCIE) 2018

- Study and estimation of the distortion from the IBF and primary ions with the laser calibration system
- Main parameters
  - Drift length: ~510mm, Active area: 200mm^2
  - Integrated the laser calibration with 266nm
  - GEMs/Micromegas as the readout
  - Matched to assembled in the 1.0T PCMAG

原型机+激光系统
自主设计2017-2018

成功研制原型机
完成调装-2019



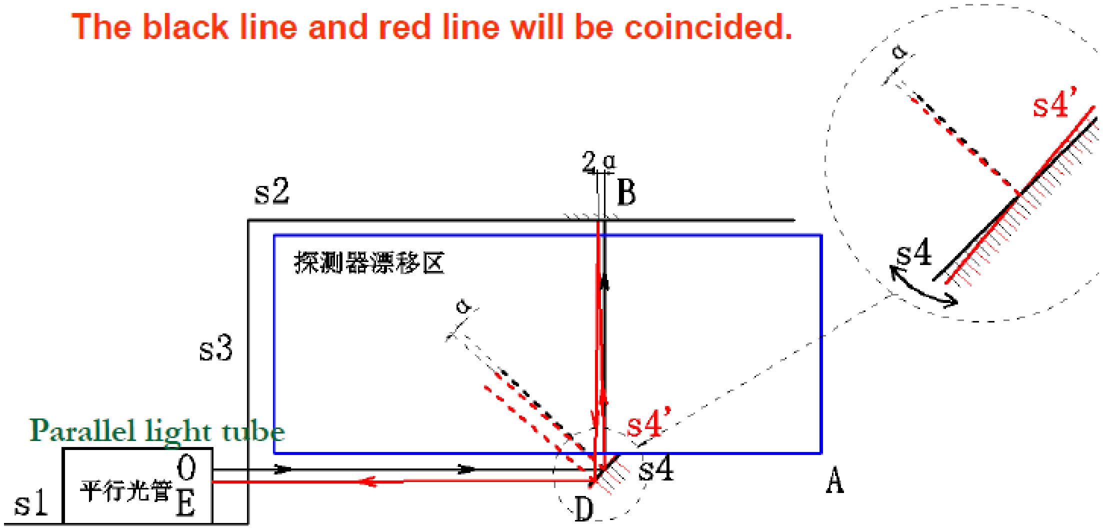


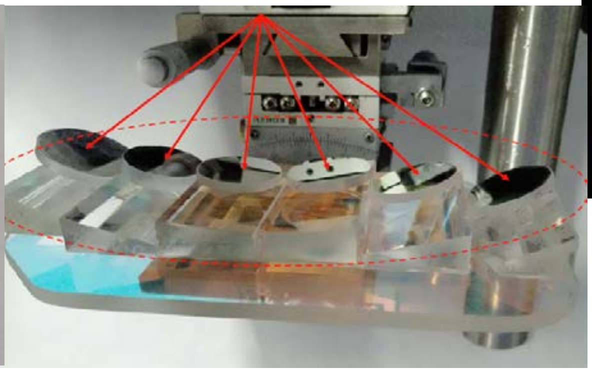
Laser point position adjustment

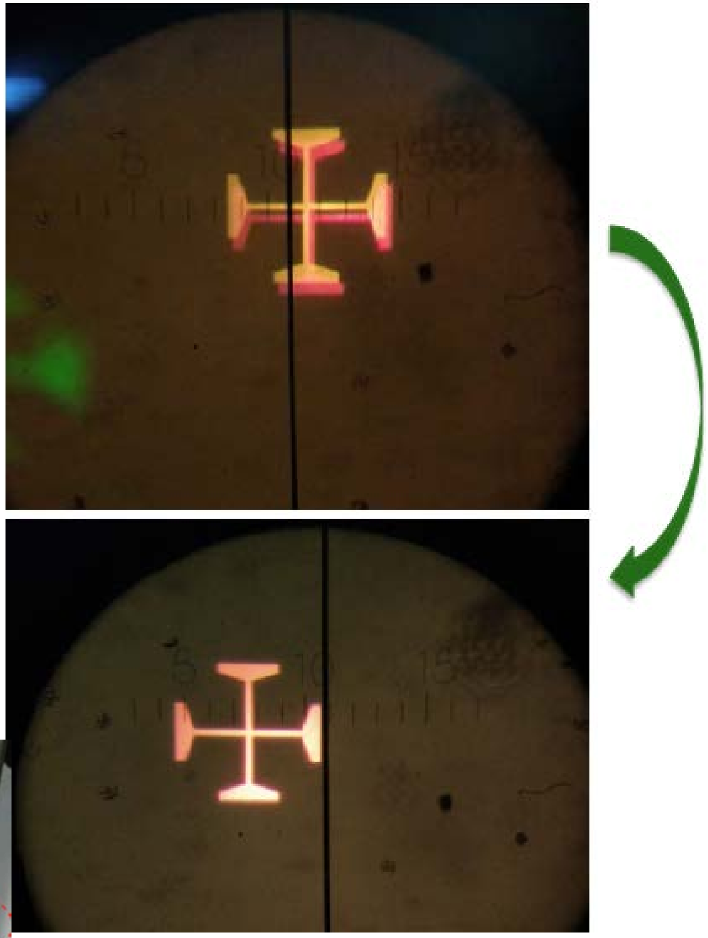
Parameters:

Reflection mirrors for UV light (0 degree and 45 degrees)
Parallel light tube: <5 seconds (1 seconds = 1/360 degree)

The black line and red line will be coincided.





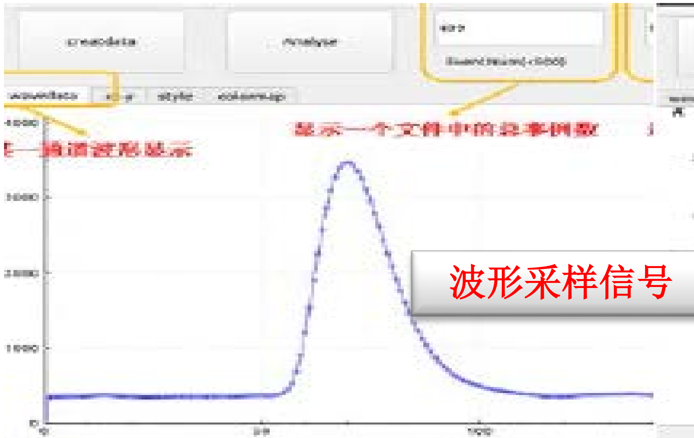


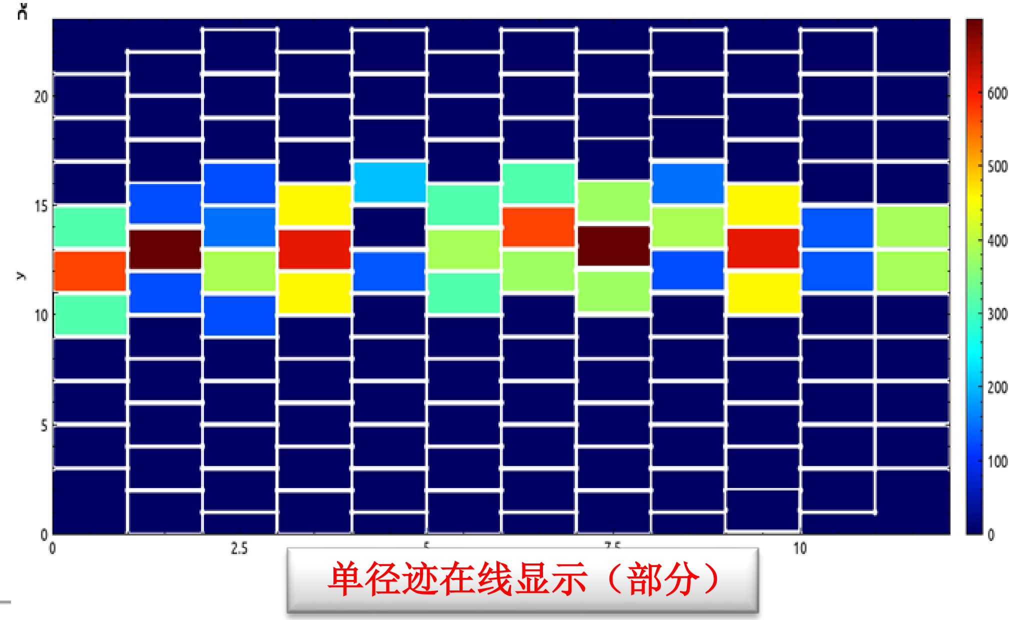
Prototype’s parameters

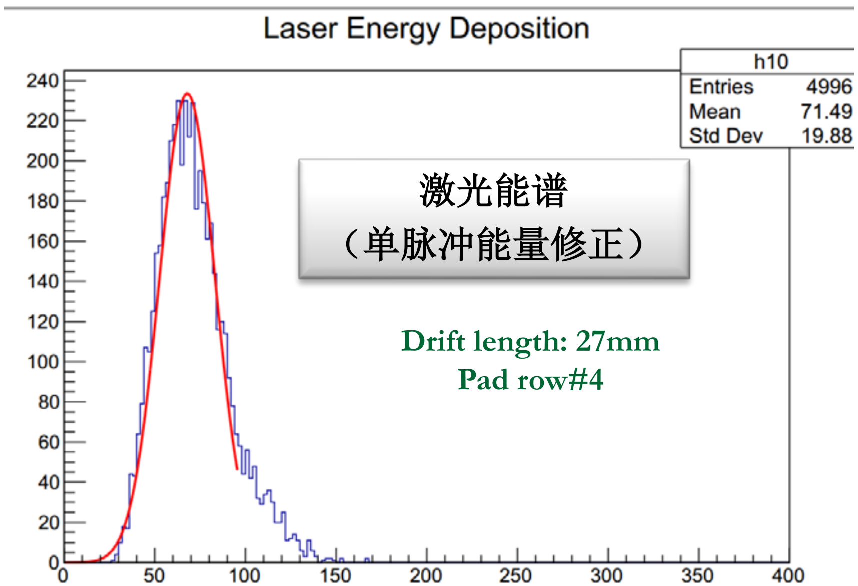
- Toward the position resolution with 100μm

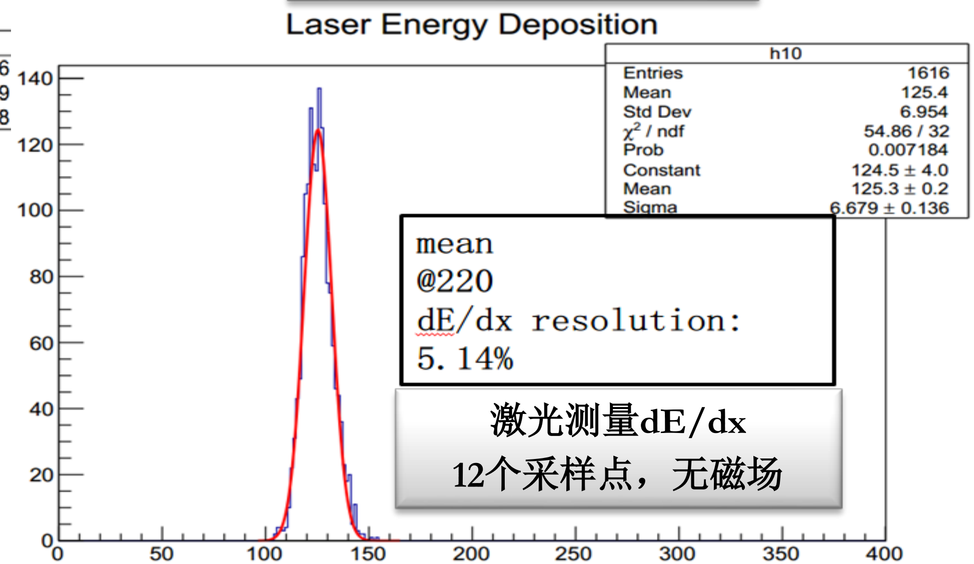
Items		Design	Realization parameters
Laser System	Pointing stability	< $10\mu m$	X@ 3.08μm Y@1.87 μm
	Track point accuracy	< 5’	< 3’
	Energy dynamic range	< 30%	<3.84%
	Duration time of cal.	< 5mins	90s
TPC Chamber			Assembled &Ready
High voltage power supply			
Support platform			
FEE electronics and DAQ			1280 channels ready & Testing more channels

Laser track test@128chs



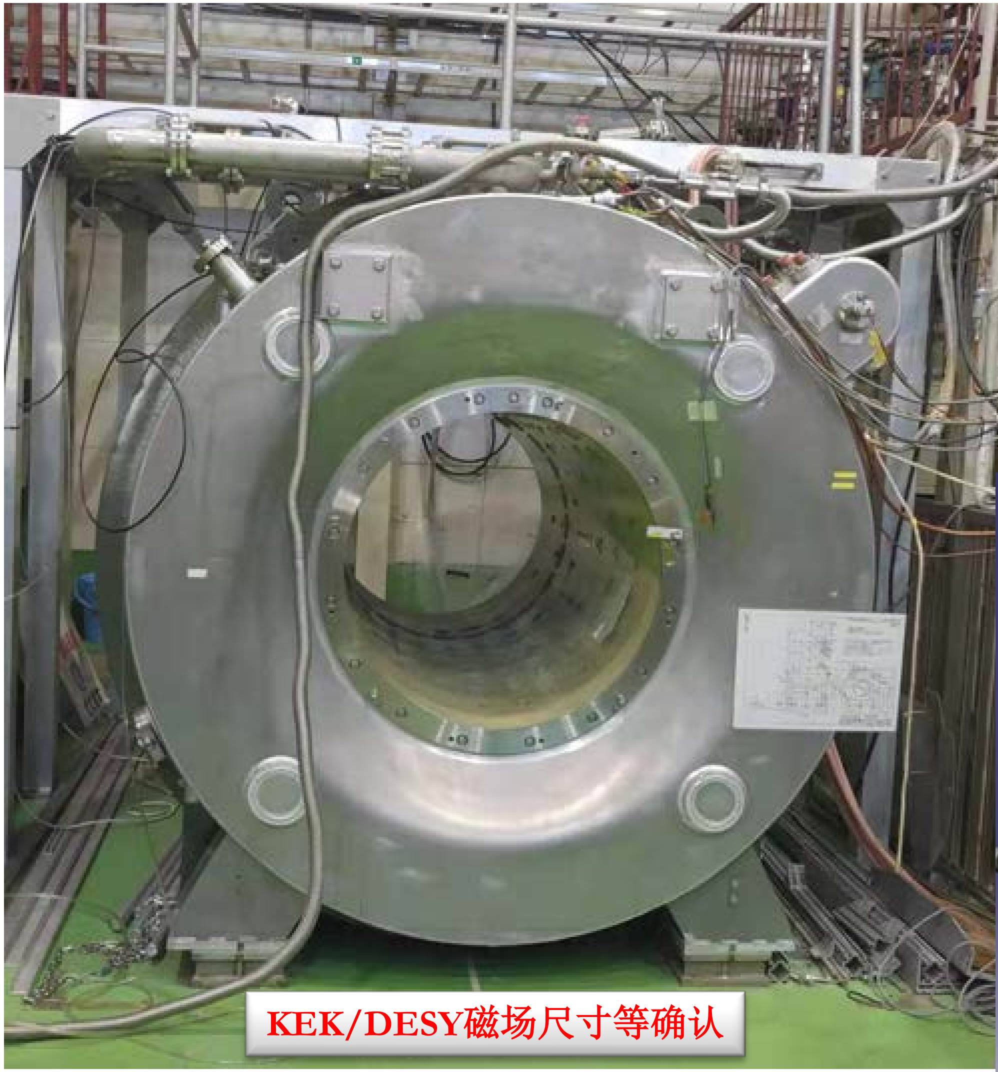


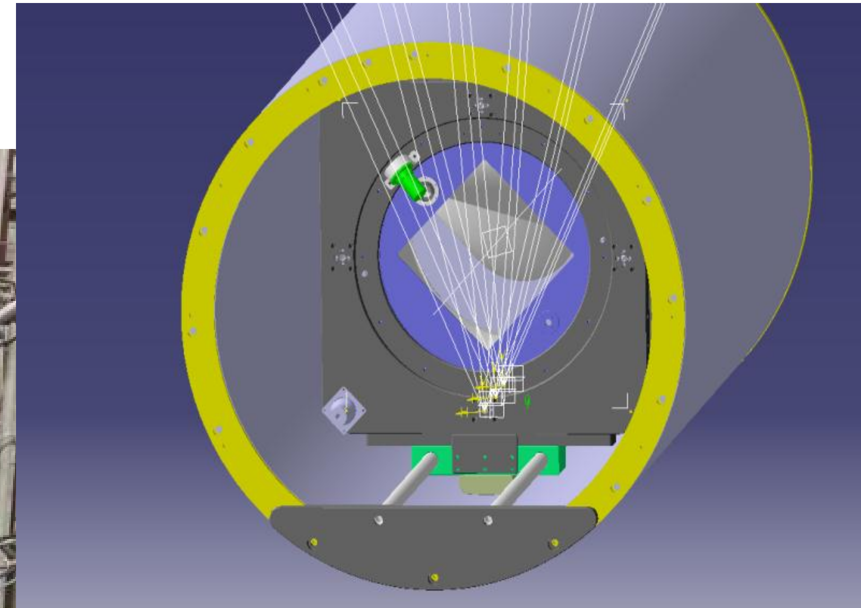


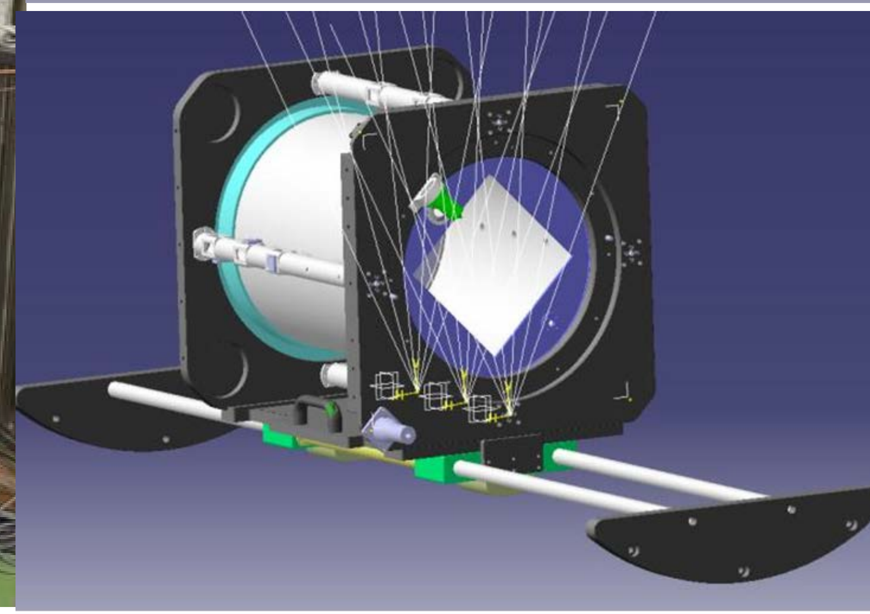


Preliminary results of Laser tracker energy spectrum and tracker

Study plan under 1.0T at 2020







Calibration: Drift velocity, Gain uniformity, Electric field uniformity, T&P, IBF

International cooperation (Activities)

- Singed MOA and joined in LC-TPC collaboration @Dec. 14,2016
- Collaboration with Keisuke Fujii's group from KEK
- Collaboration with Prof. Paul Colas, Aleksan Roy and Stephan Anne from Saclay
- Collaboration with Prof. Peter from Nikehf
- Collaboration with Zhi Deng from Tsinghua, Zhiyong and Jianbei from USTC

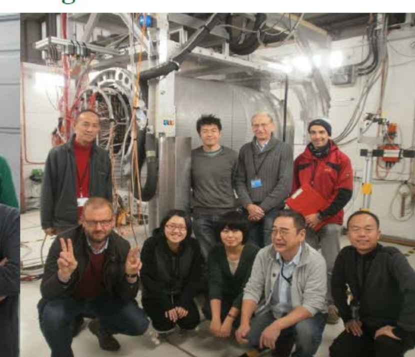
International cooperation

- CEA-Saclay IRFU group (FCPPL)
  - Three vidyo meetings with Prof. Aleksan Roy/ Prof. Yuanning/ Manqi and some related persons (2016~2017)
  - Exchange PhD students: Haiyun Wang participates Saclay's R&D six months in 2017~2018
  - Bulk-Micromegas detector assembled and IBF test
  - IBF test using the new Micromegas module with mor 590 LPI
  - UV+ laser tracker

International cooperation

- LCTPC collaboration group (LCTPC)
  - Singed MOA and joined in LC-TPC collaboration @Dec. 14,2016
  - As coordinator in ions test and the new module design work package
  - CSC funding: PhD Haiyun jiont CEA-Scalay TPC group(6 months)
  - Joint beam test in DESY with Micromegas detector module in 2018

Beam test in 2018

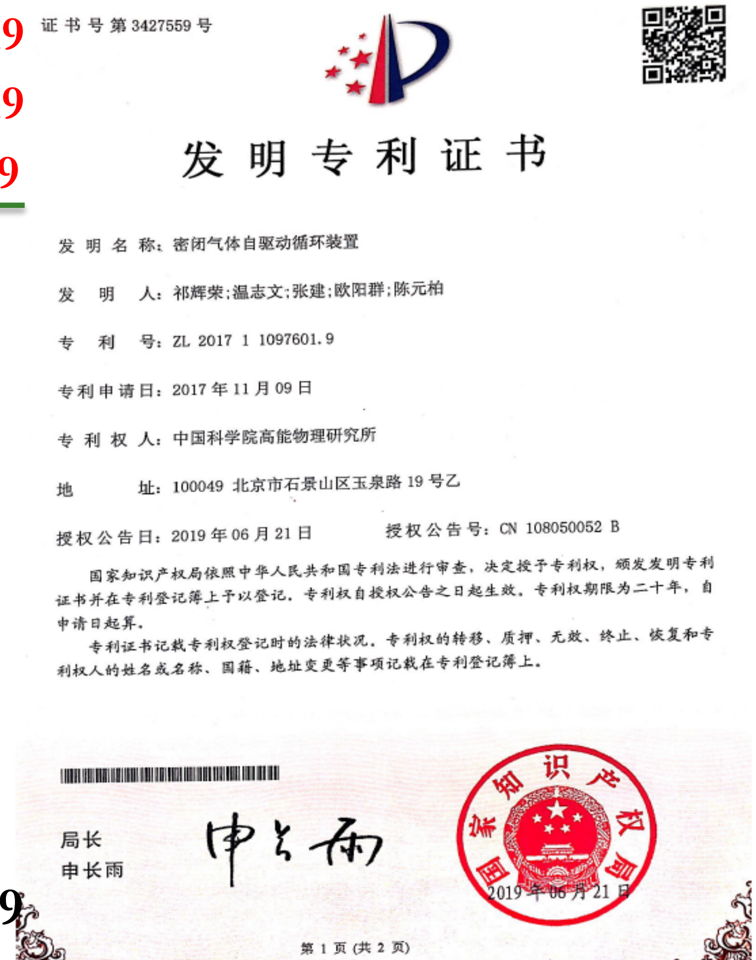


Beam test in 2016

已发表文章和专利

- 2016年-2019年
  - 合作指导：已毕业博士生3名
    - 张余炼，王海云，温志文
  - 通讯作者 （SCI 9篇+SCIE 2篇）

DOI: 10.7498/aps.68.20181613 (SCI) 2019
DOI: 10.1142/S0217751X19400165 (SCI) 2019
DOI: 10.11804/NuclPhysRev.36.03.273 (SCIE) 2019
DOI: 10.1142/S2010194518601217 (SCI) 2018
DOI: 10.1088/1748-0221/13/04/T04008 (SCI) 2018
DOI: 10.1007/978-981-13-1316-5_20 (SCIE) 2018
DOI: 10.7498/aps.67.20172618 (SCI) 2017
DOI: 10.7498/aps.66.142901 (SCI) 2017
DOI: 10.7498/aps.66.072901 (SCI) 2017
DOI: 10.1088/1748-0221/12/04/P0401 (SCI) 2017
DOI: 10.1088/1674-1137/41/5/056003 (SCI) 2016



证书号第3427559号

发明专利证书

发明名称：密闭气体自驱动循环装置

发明人：祁辉荣;温志文;张建;欧阳群;陈元柏

专利号：ZL 2017 1 1097601.9

专利申请日：2017年11月09日

专利权人：中国科学院高能物理研究所

地址：100049 北京市石景山区玉泉路19号乙

授权公告日：2019年06月21日 授权公告号：CN 108050052 B

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申长雨

2019年06月21日

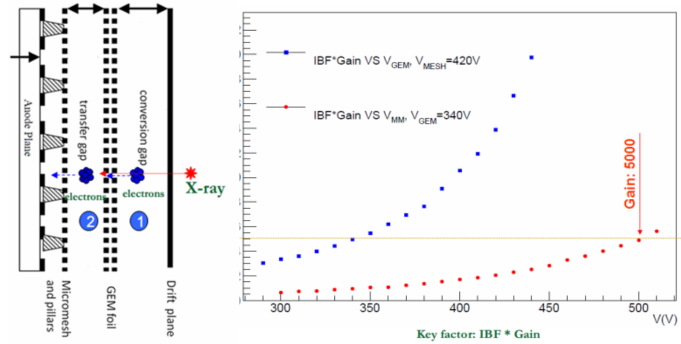
第1页（共2页）

- 2019年
  - 授权发明专利一 项 NO. 201711097601.9

Further R&D

Continuous IBF module for CEPC: 模块研制

- No Gating device options used for Higgs/Z pole run
- Continuous Ion Back Flow due to the continuous beam structure (Developed in IHEP)
- ~100 μm position resolution in rφ
- Key factor: IBF×Gain=5 and leas than (R&D)
- Low discharge and spark possibility

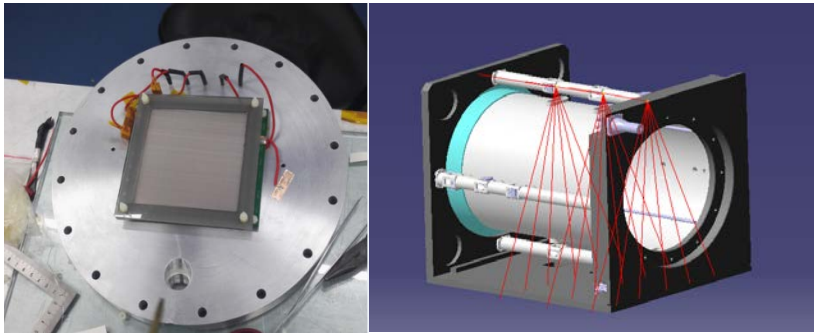


Continuous IBF prototype and IBF×Gain

模型研制

Prototype with laser calibration for CEPC :

- Laser calibration system integrated UV lamp
- Calibrated drift velocity, gain uniformity, ions back in chamber
- Prototype has been designed with laser (Developed in IHEP and Tsinghua)_
- Nd:YAG laser device@266nm, 42 separated laser beam along 510mm drift length

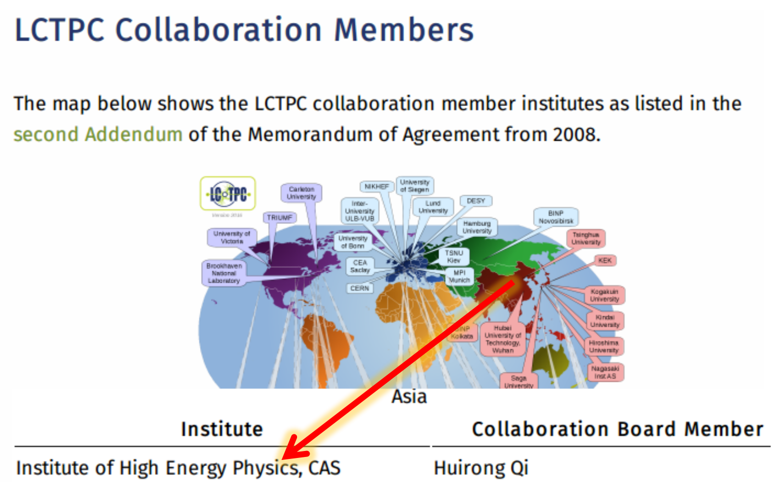


TPC prototype integrated with laser system

束流测试
国际合作

Collaboration:

- Joint LCTPC international collaboration to face the general TPC technology R&D
- New design detector collaborated with KEK CEA-Saclay and DESY
- Beam test under 1.0T magnetic field



Joint LCTPC international collaboration

谢谢各位专家老师！