

# $\mu$ RWELL探测器研究进展

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中国科学技术大学

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2017第七届全国先进气体探测器会议

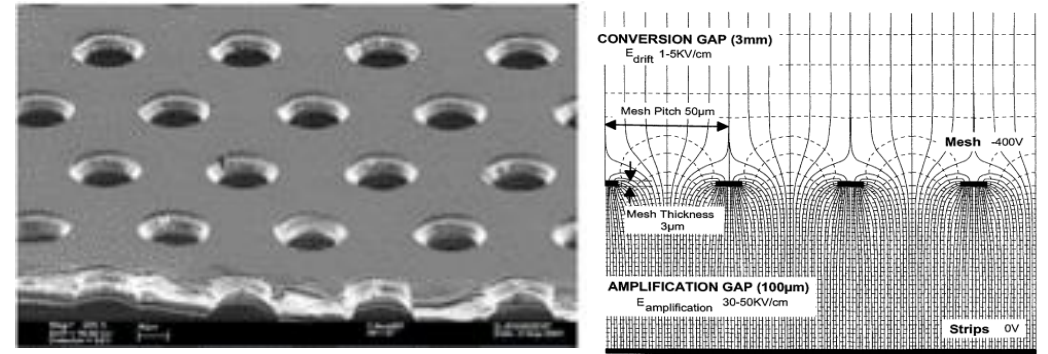


# 报告概要

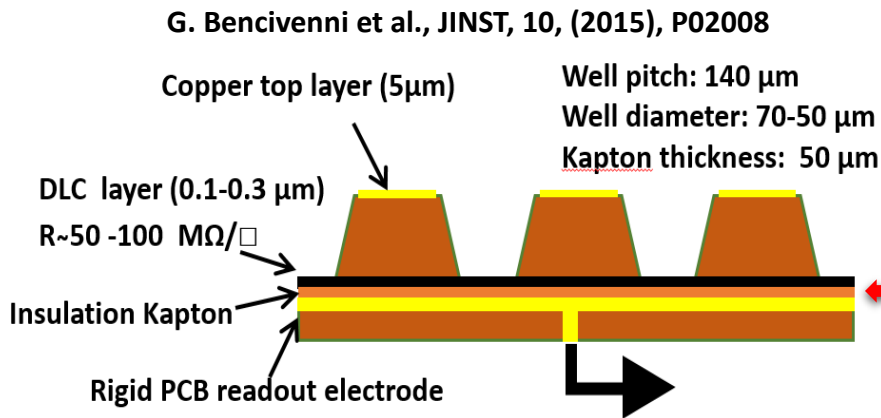
1.  $\mu$ RWELL 探测器介绍
2. 探测器原型制作及改进
  - $\mu$ RWELL探测器制作
  - 探测器改进
3. 性能测试
  - 增益测试
  - 计数率能力测试
  - 束流测试
  - 探测器改进设计
4. 总结

# 微结构气体探测器发展

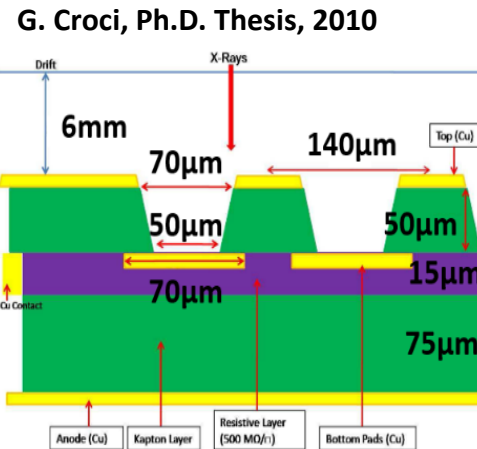
- 在当前的大型核与粒子物理实验中，随着对撞机的能量和亮度不断提高，对探测器的位置分辨以及计数率能力提出了很高的要求。
- 传统的微结构气体探测器制作需要张膜，张网，粘胶等复杂流程。
- 随着DLC工艺技术的成熟，将DLC阻性层应用到微结构气体探测器，提出了微结构阻性的井型气体探测器 ( $\mu$ RWELL)。



GEM&MicroMegas (~1997)

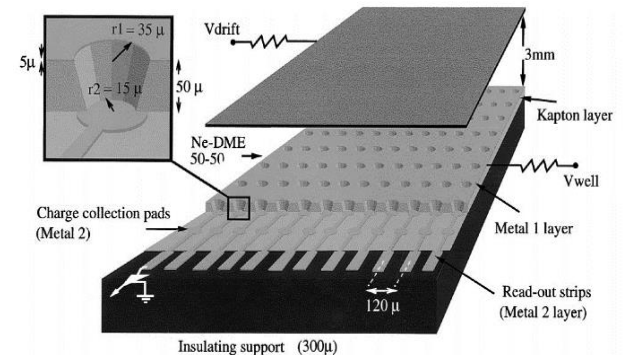


The  $\mu$ RWELL detector (~2014)



The "Blind" GEM detector (~2009)

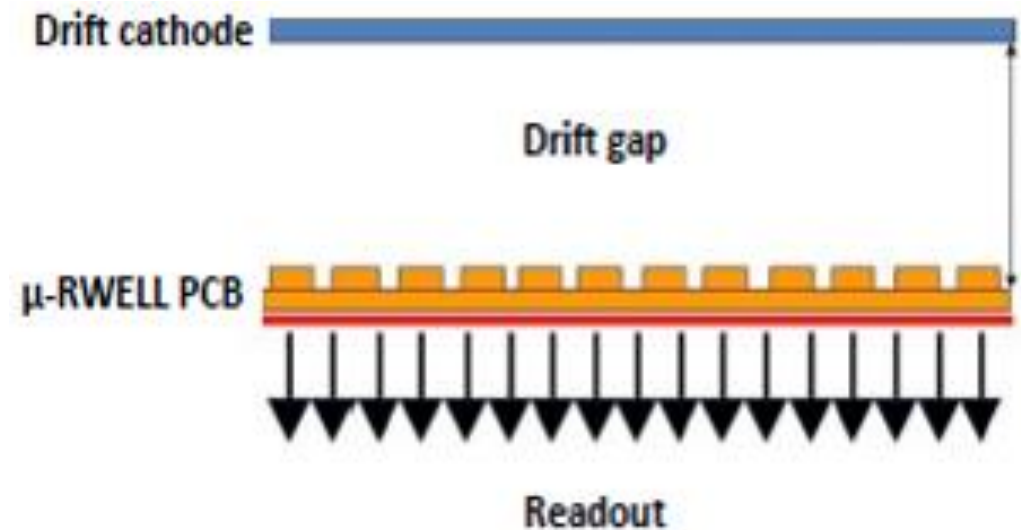
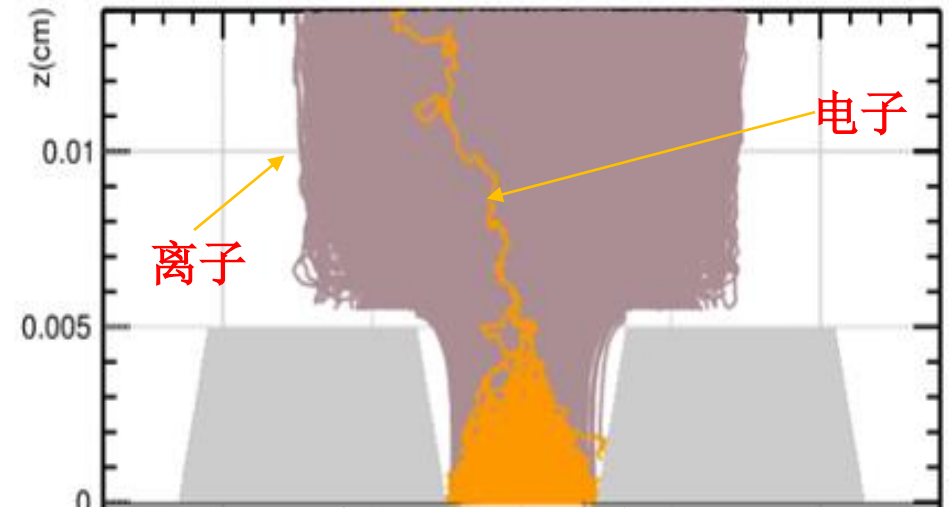
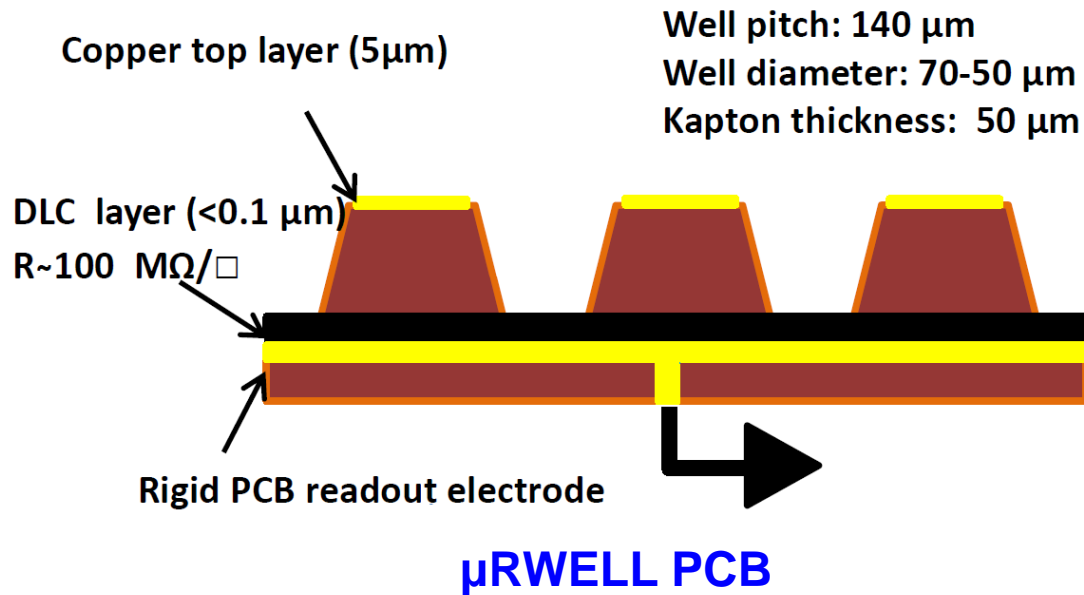
R. Bellazzini et al., NIM A 423 (1999) 125-134



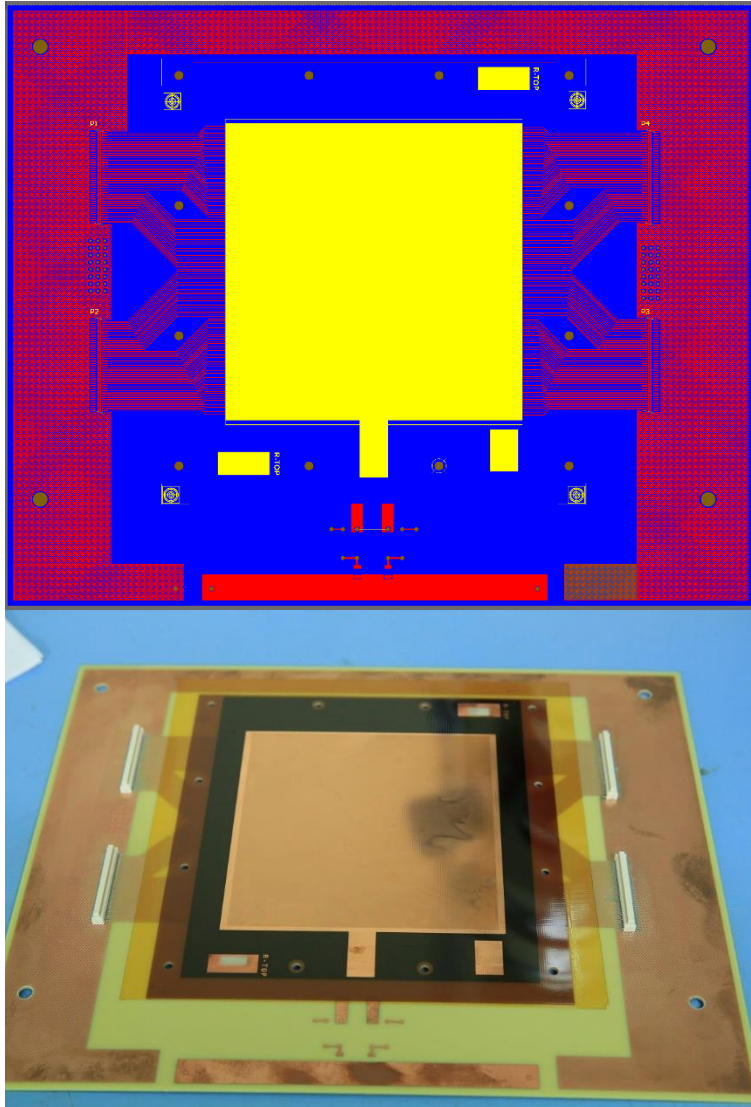
The WELL detector (~1997)

# $\mu$ RWELL 探测器介绍

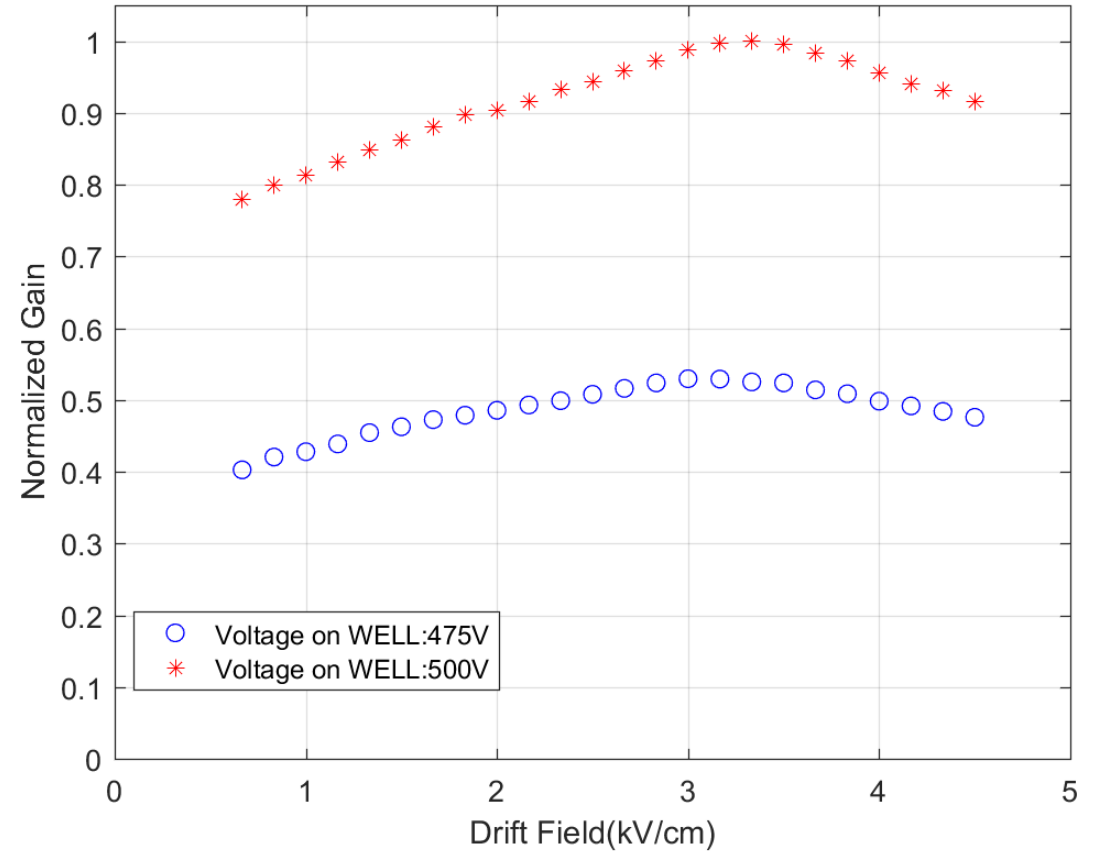
- 使用阻性电极材料，能够有效抑制放电。
- 井型单层放大结构，与读出板直接相连，没有传输区与感应区，增益均匀性更好。
- 探测器的安装过程简单迅速，无需使用张膜，粘胶等复杂的工艺。



# $\mu$ RWELL探测器制作



相对增益随漂移场强度的变化

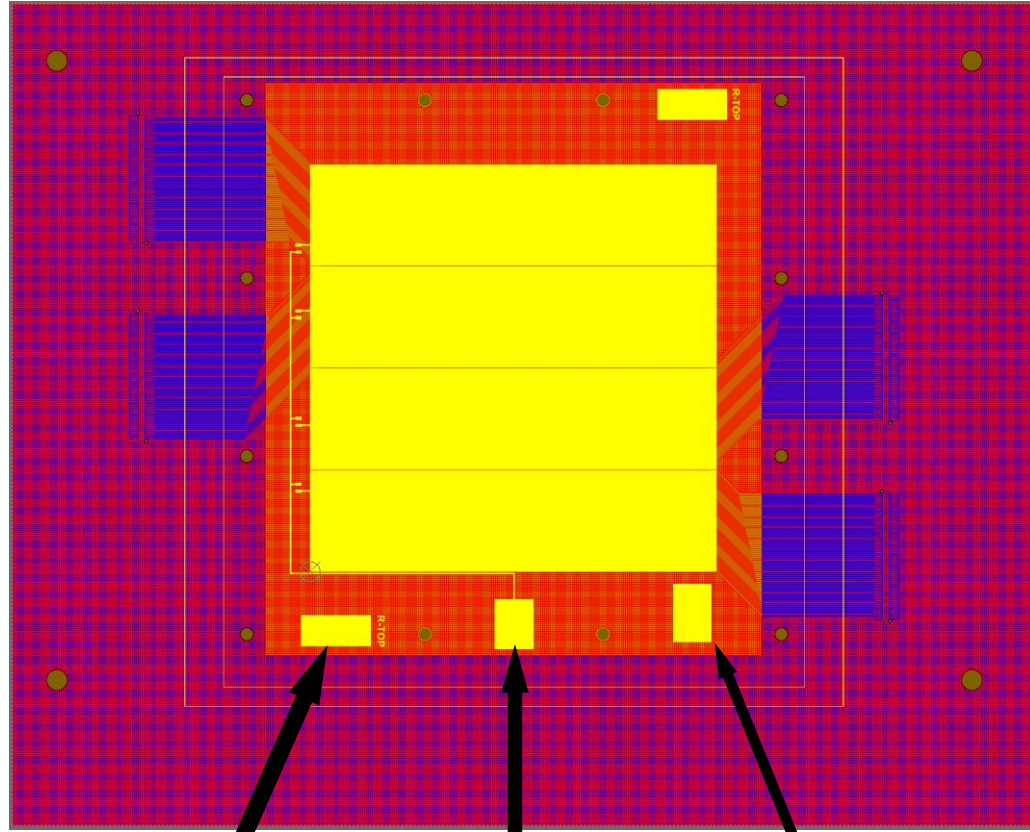


漂移场为3kV/cm时，电子收集效率达到峰值。

整个探测器灵敏区为1个pad，探测器某个区域短路时会使得整个探测器短路。

# 探测器改进

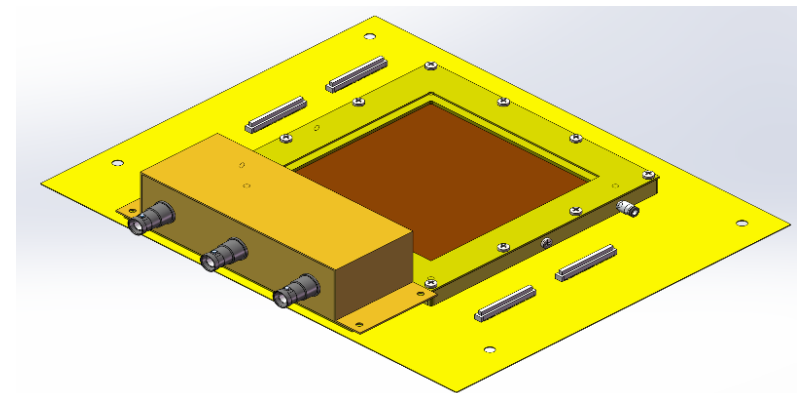
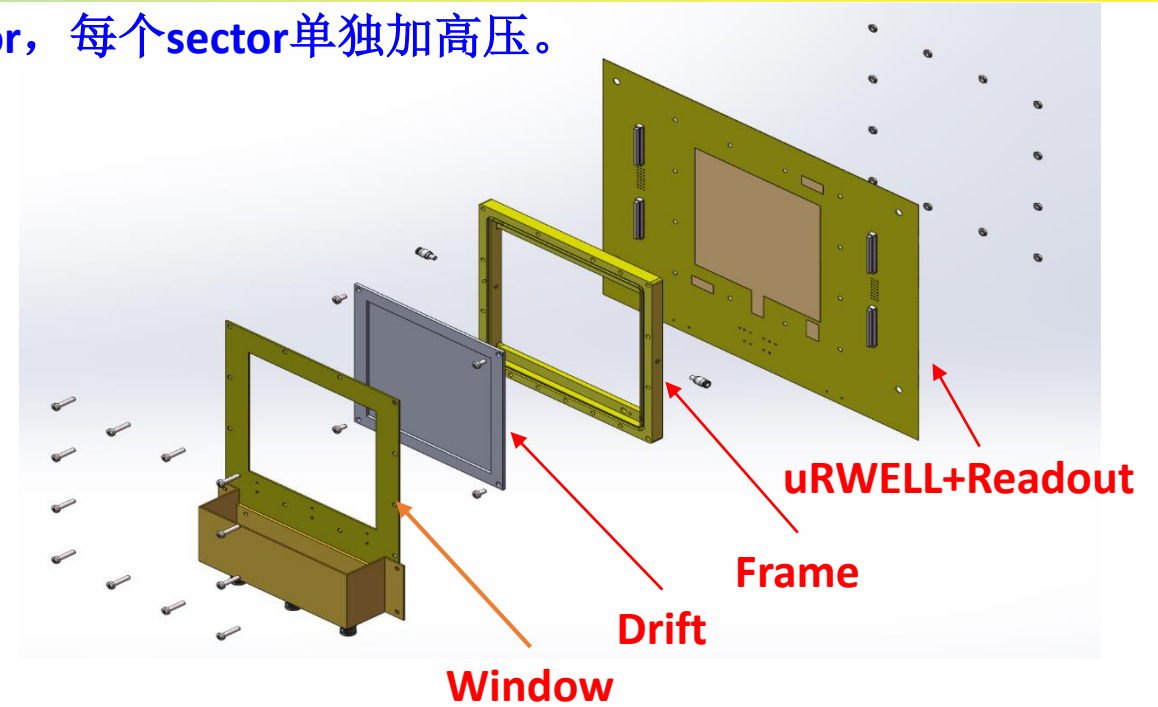
分区式 $\mu$ RWELL探测器设计。整个探测器灵敏区分为4个sector，每个sector单独加高压。



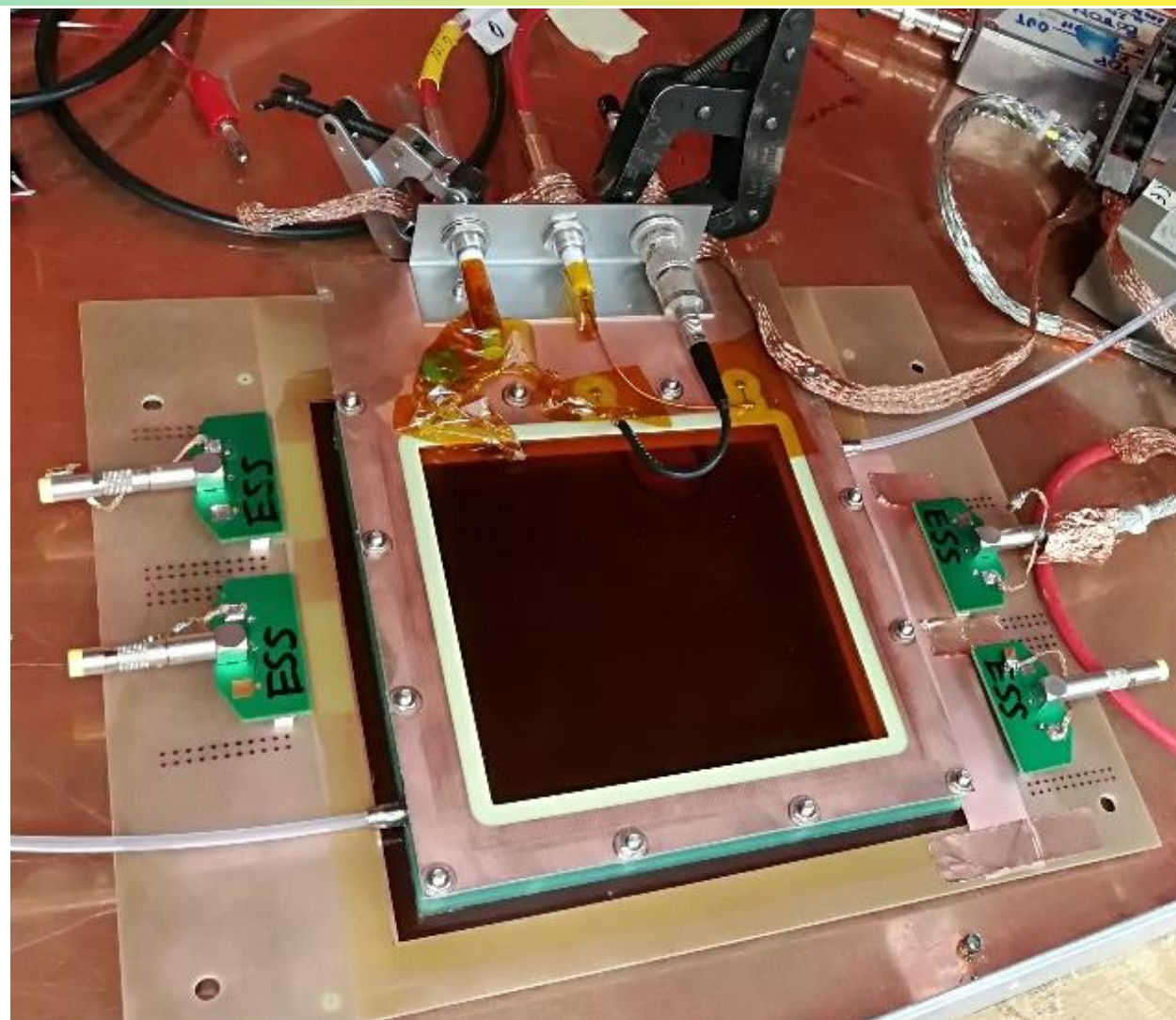
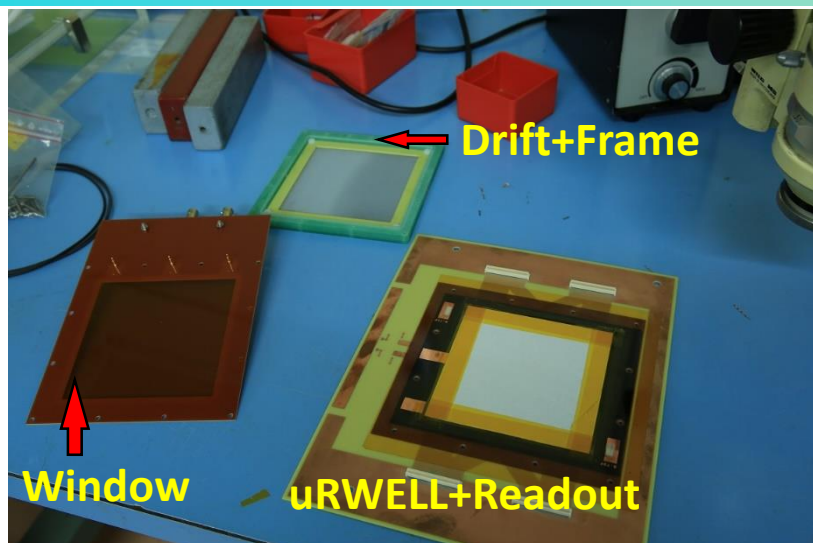
Resistive Layer Contact

Drift Contact

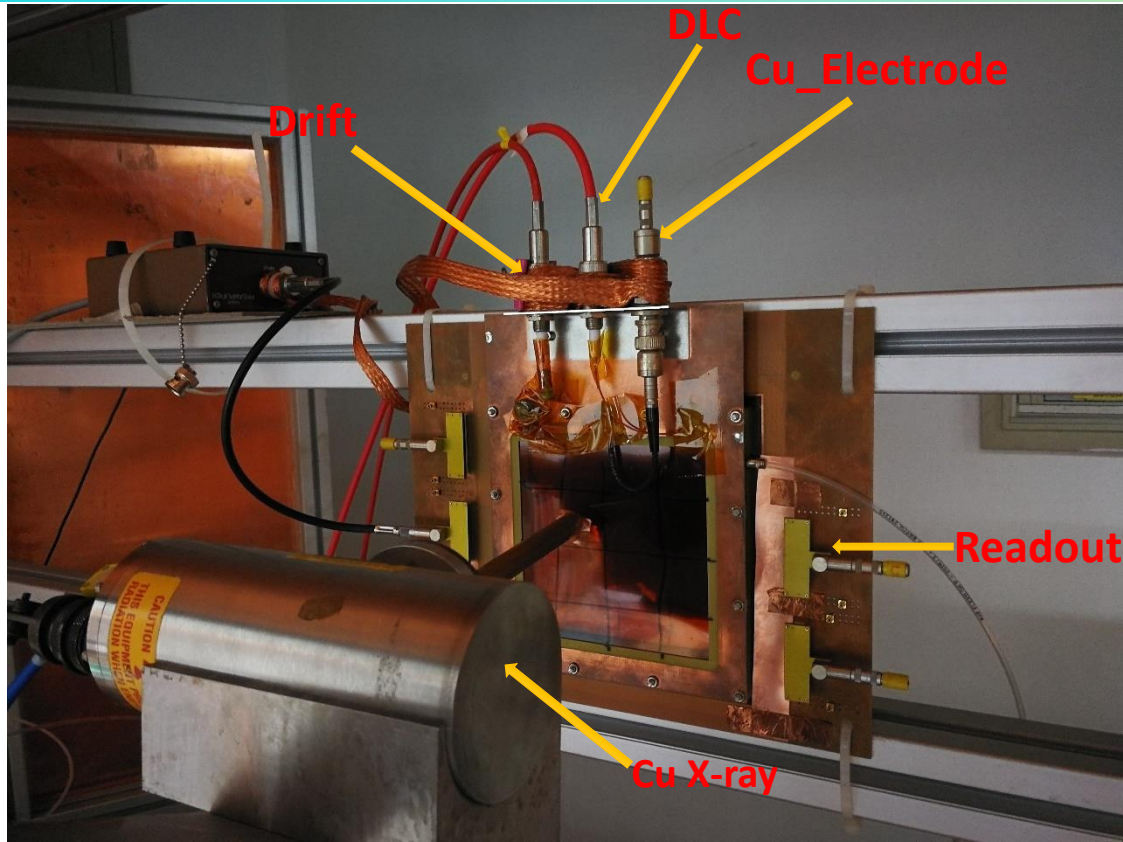
Top Copper contact



# 探测器组装

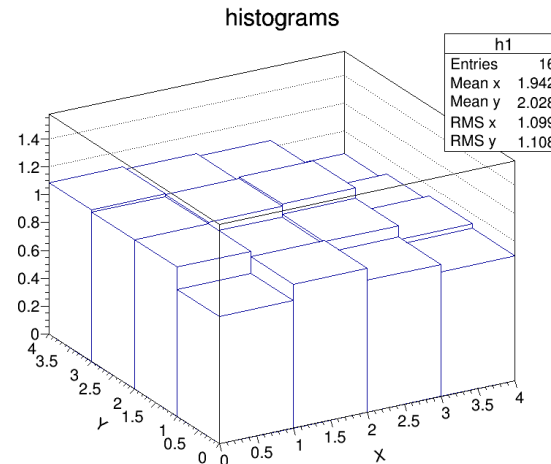
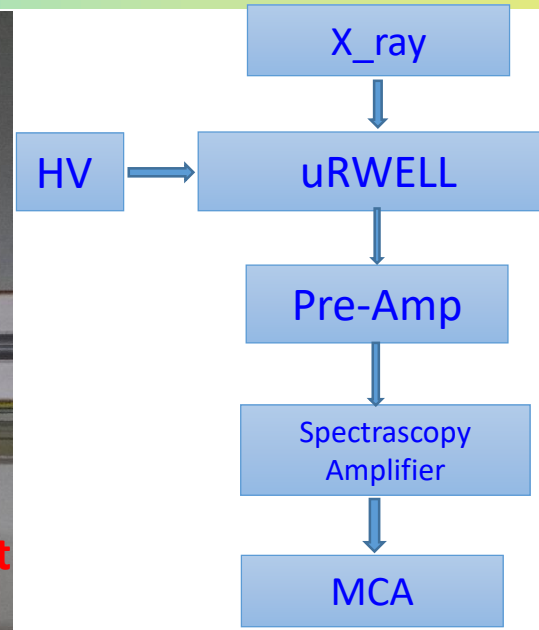


# 性能测试：增益测试

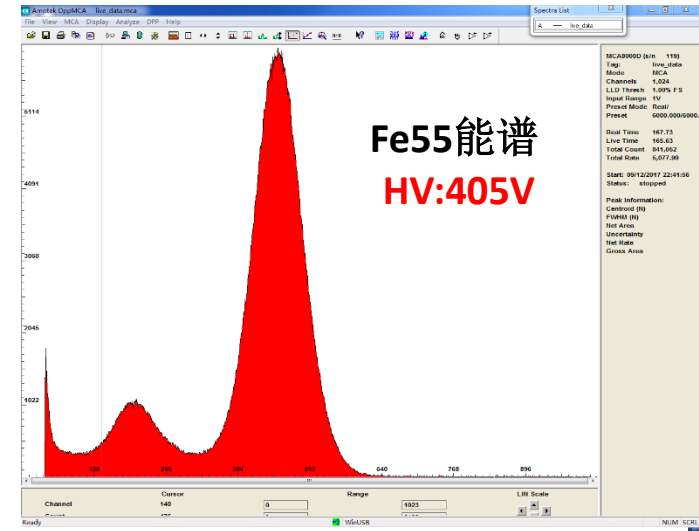


气体：  
Ar:CO<sub>2</sub>=93:7  
漂移区：3mm

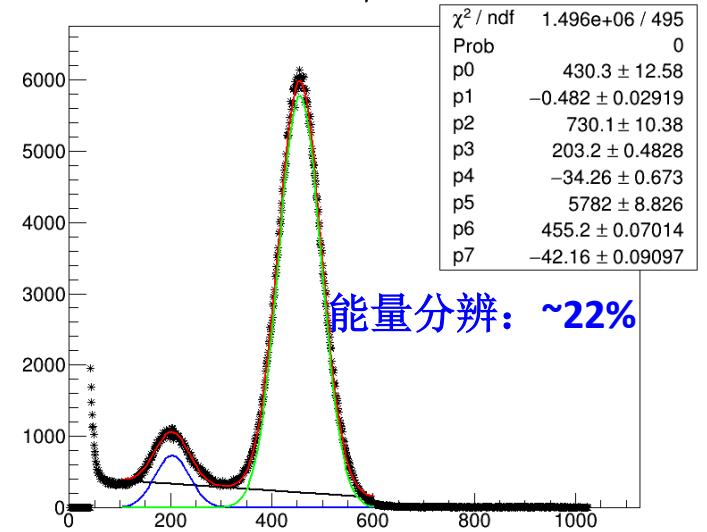
工作参数：  
Drift: -300V  
DLC: 405V  
Cu\_Electrode: 0V



增益：~1800 ± 10%

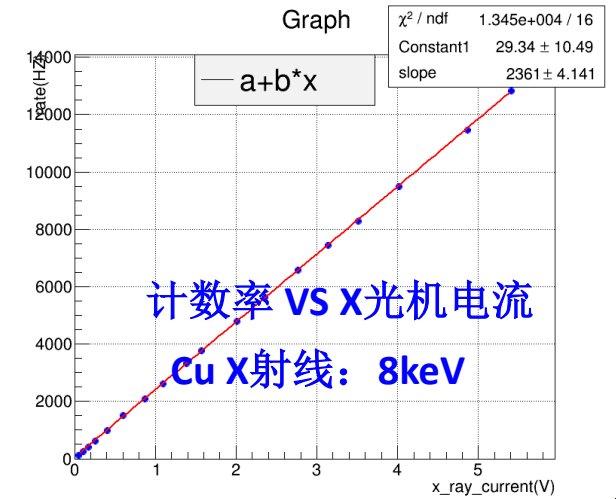
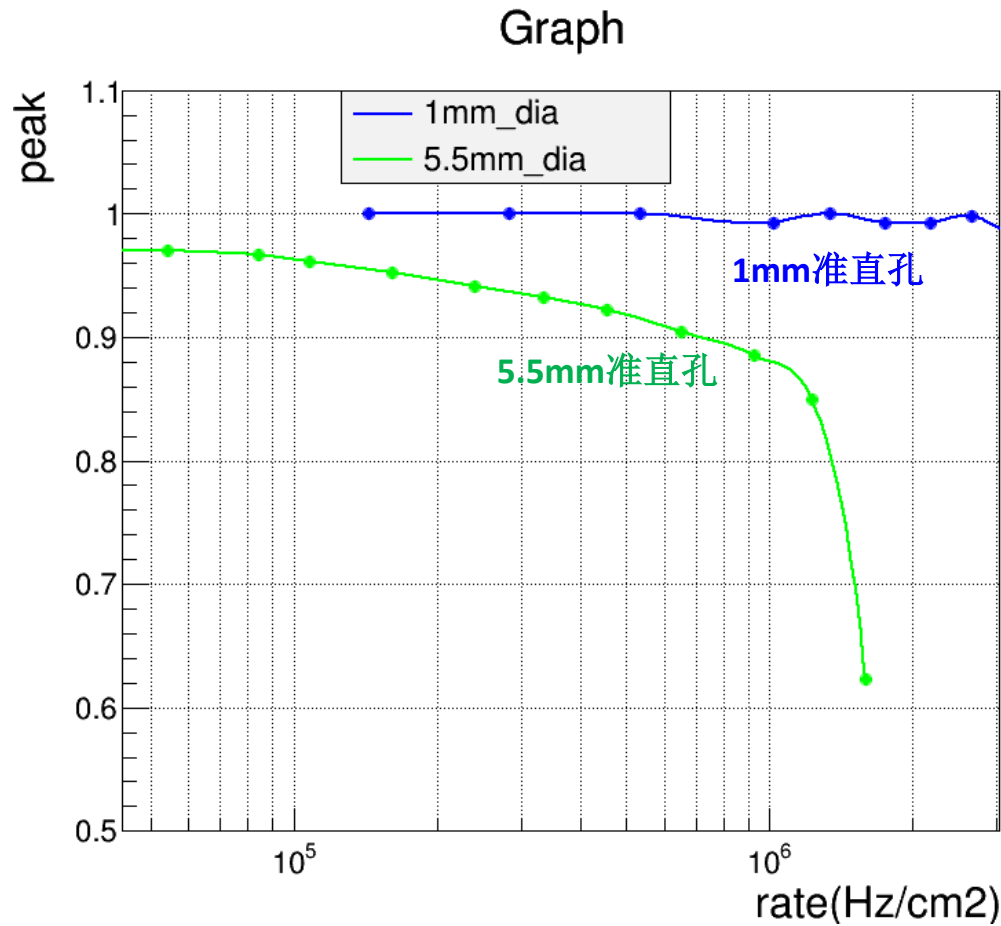
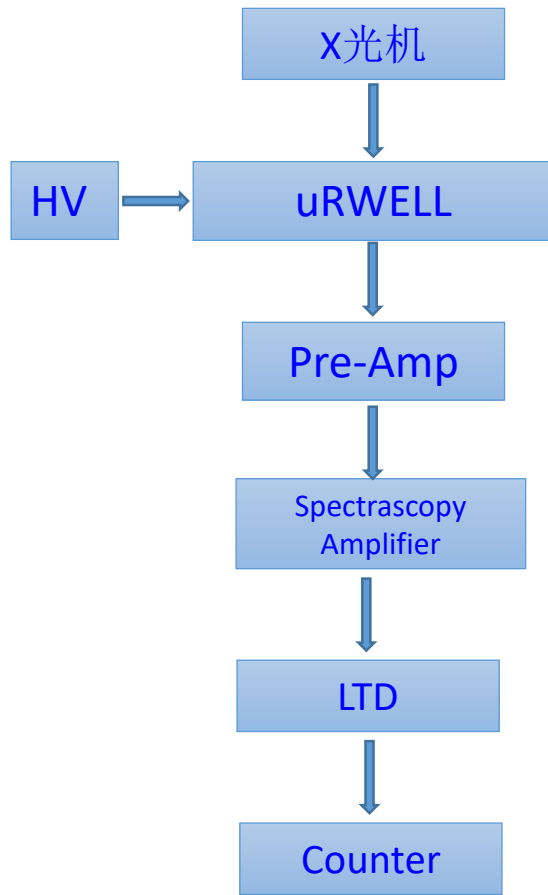


Graph





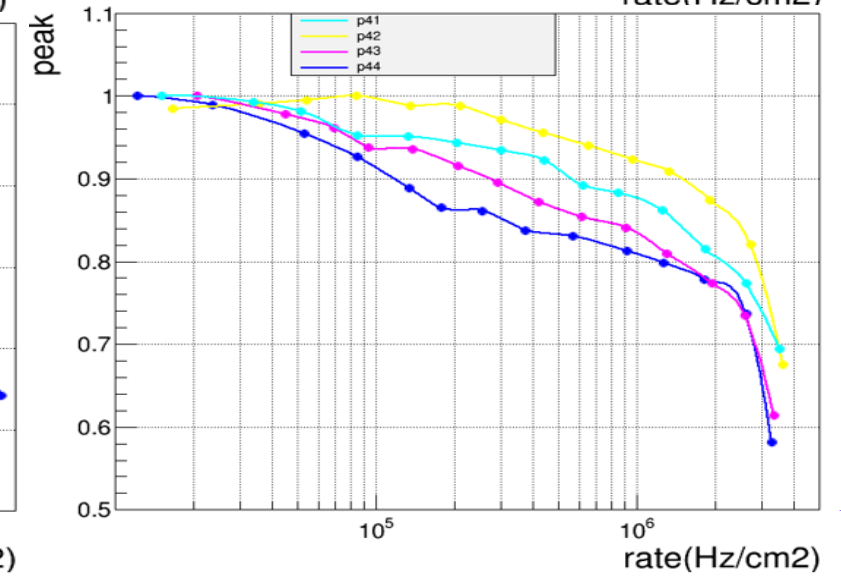
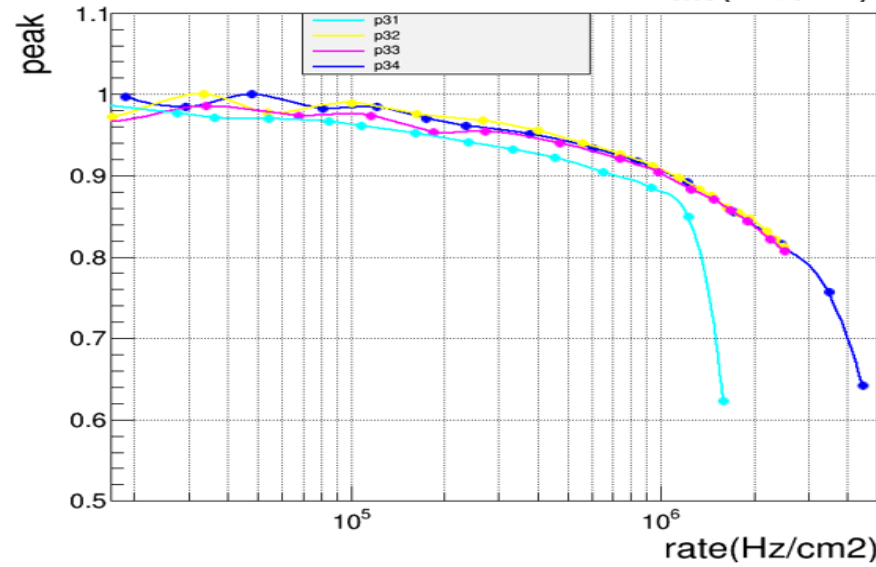
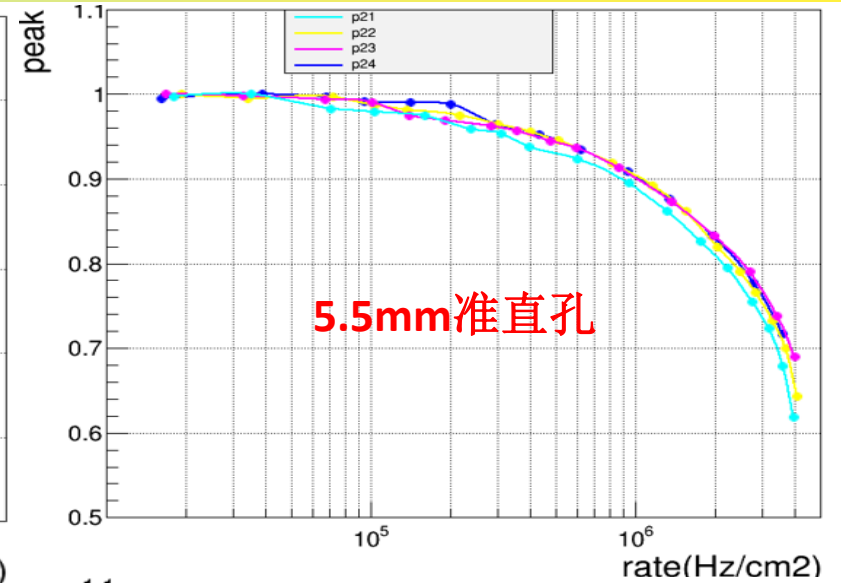
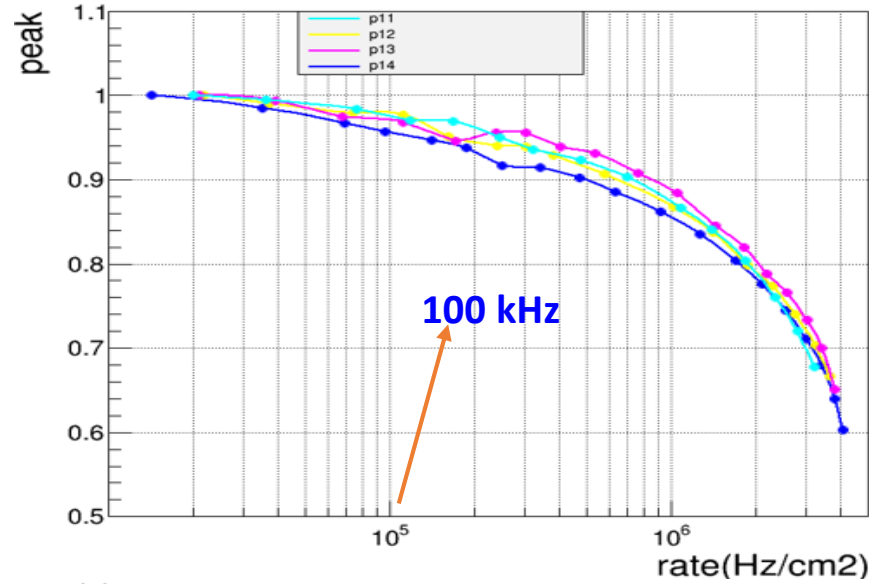
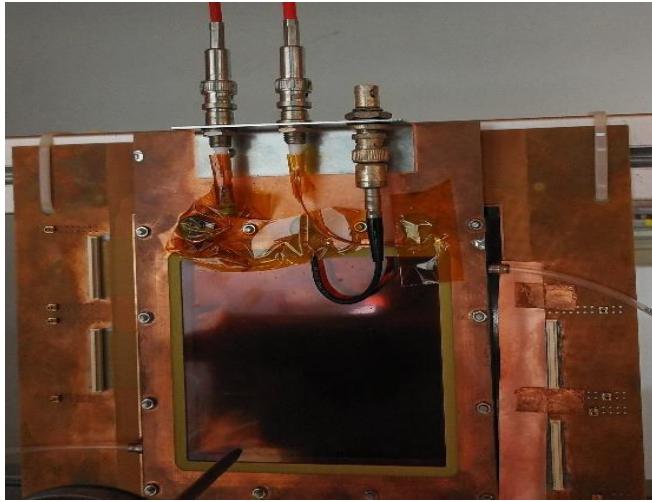
# 计数率能力测试系统



- X光机的计数率与X光机电流具有很好的线性关系。在高计数率情况下，通过测量X光机电流来计算计数率。
- 采用1mm准直孔时，单位时间内的计数低，不能很好表征计数率能力。之后测试采用5.5mm的准直孔。

# 计数率能力测试结果

计数率: 100 kHz 增益: ~98%



P41	P42	P43	P44
P31	P32	P33	P34
P21	P22	P23	P24
P11	P12	P13	P14

# 束流测试系统

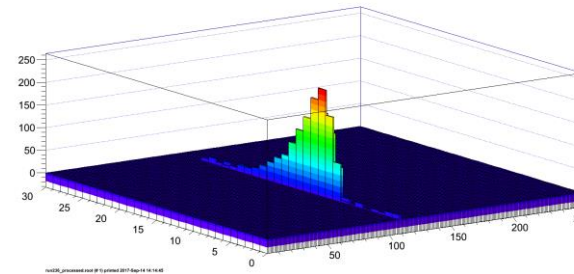
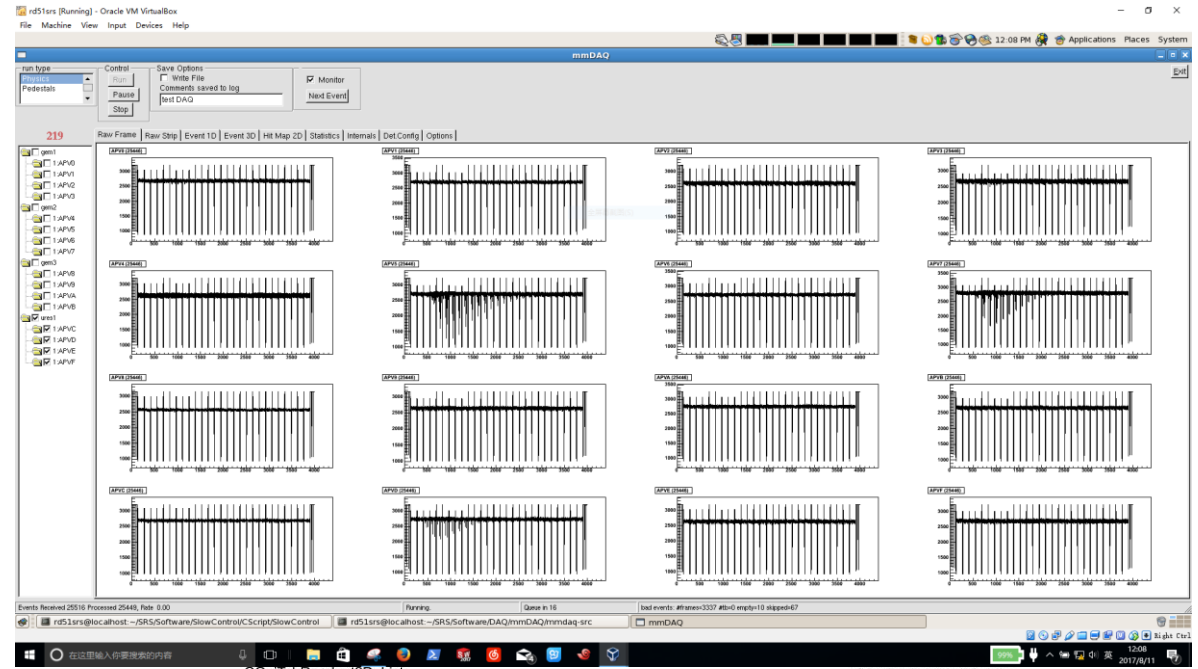


**APV25 FEE + SRS System**

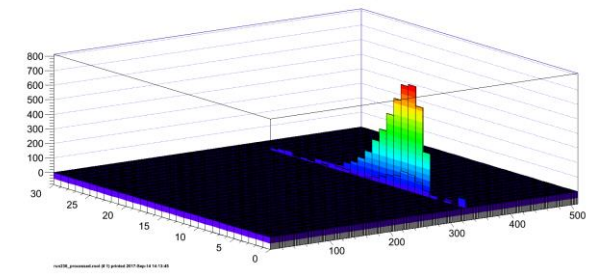
H4 North Area SPS Extraction Line July/Aug 2017

Trace: 3 GEM Gas: Ar/CO<sub>2</sub>=93/7 HV: 450V

150GeV muon Beam



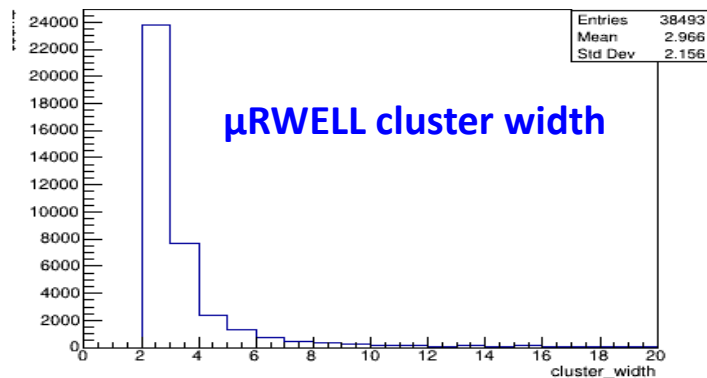
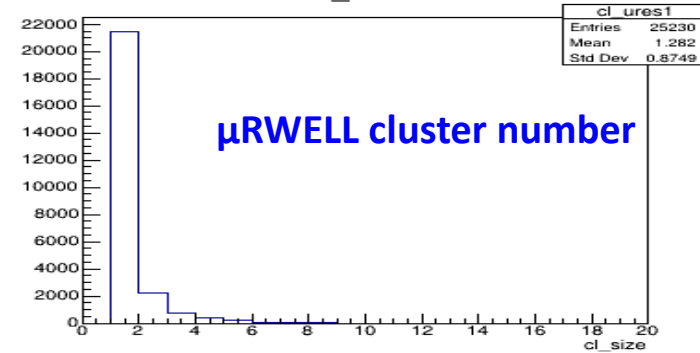
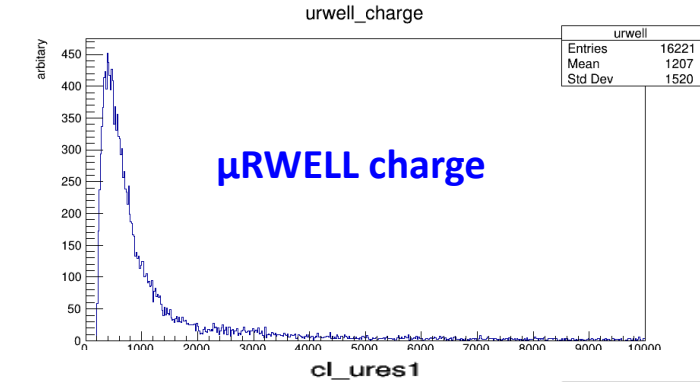
**GEM**



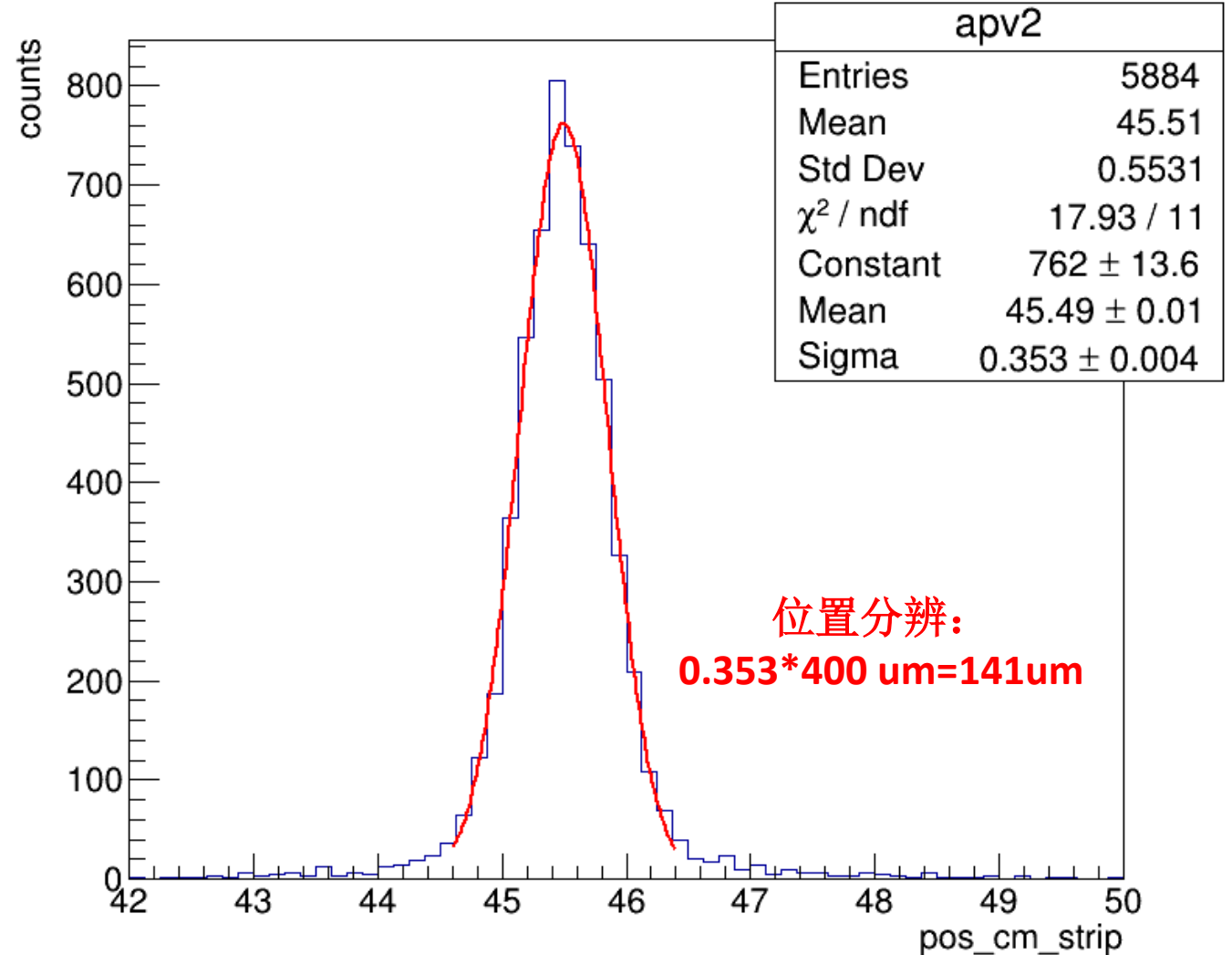
**μRWELL**

Special thanks to CERN GDD group for their help on Beam test setup.

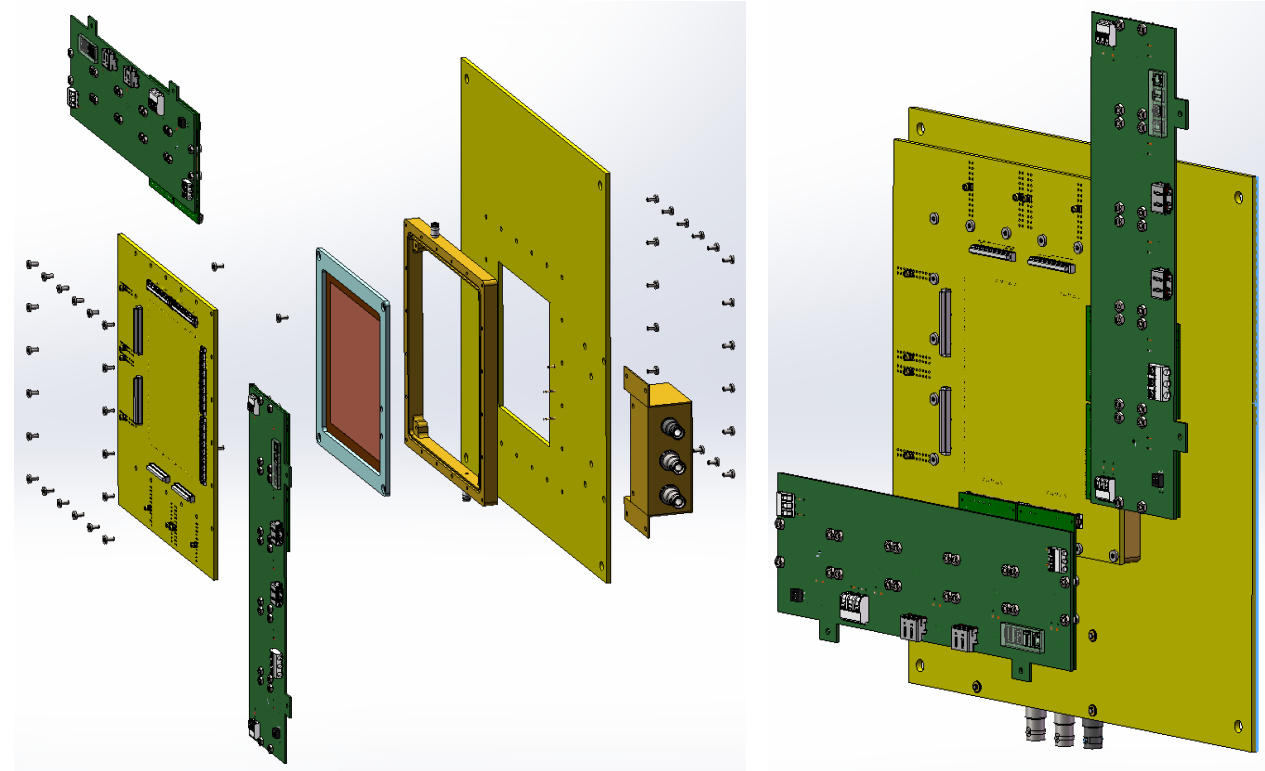
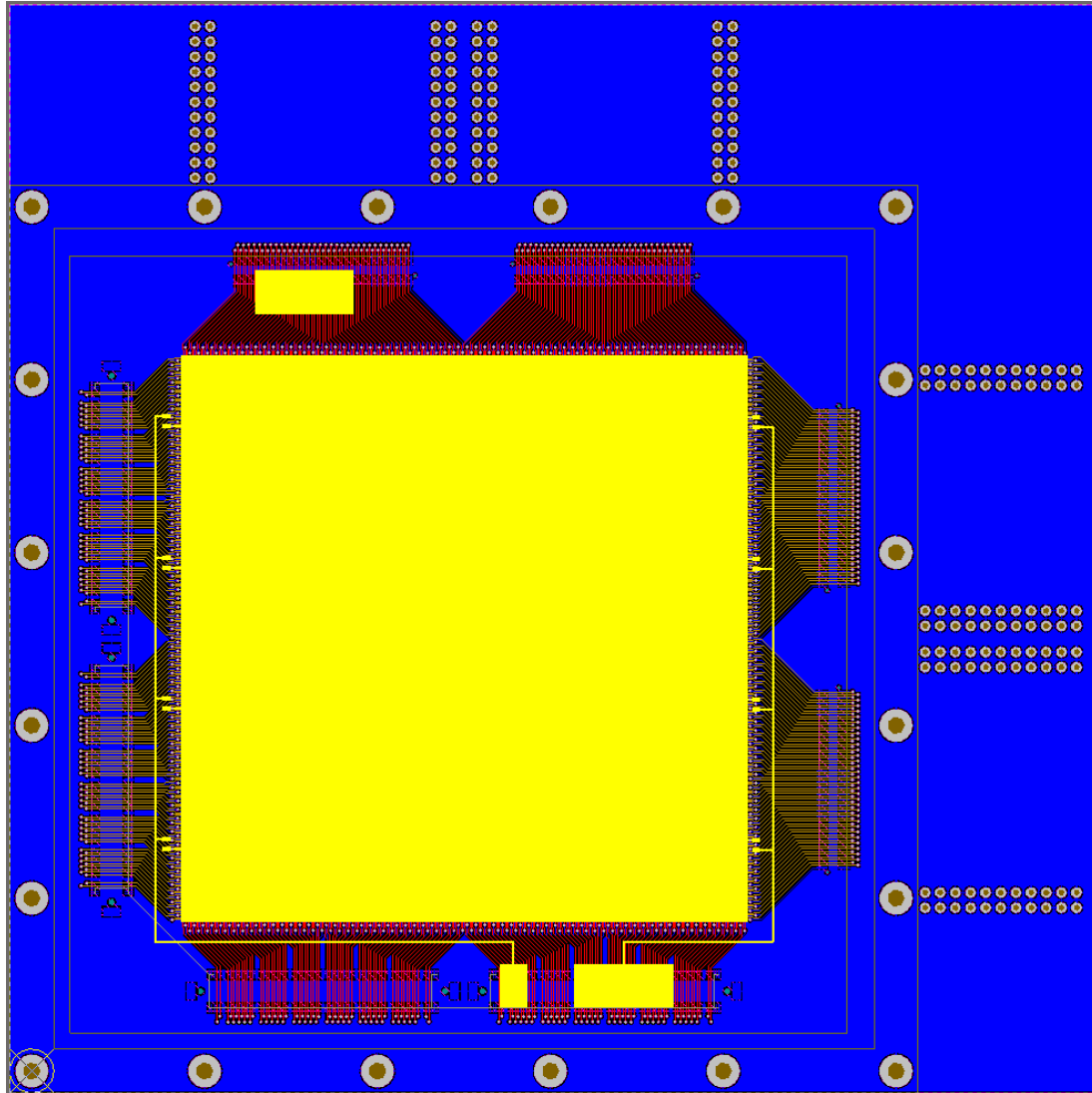
# 位置分辨测试结果



## pos\_cm\_strip\_distribution



# 探测器改进设计



Special thanks to:  
Antonio Teixeira,  
Rui De Oliveira,  
Giovanni Bencivenni.

探测器正在制作当中



# 总结

- 研究了 $\mu$ RWELL探测器的各项性能，制作出了探测器的原型机，并对探测器进行了改进，制作了分区式的探测器。
- 在实验室环境下对探测器的各性能进行了详细的测试。能谱结果给出，探测器的能量分辨为:**~22%**，工作电压为**405V(Ar:CO<sub>2</sub>=93:7)**时，探测器增益能够达到**1800**。当入射X射线的计数率达到**100kHz/cm<sup>2</sup>**时，探测器的增益下降幅度低于**2%**。
- 在束流环境下对探测器的位置分辨进行了测试，初步结果给出，位置分辨能够达到**141um**。
- 在测试结果基础上改进 $\mu$ RWELL探测器，目前探测器设计已完成，探测器正在制作当中。

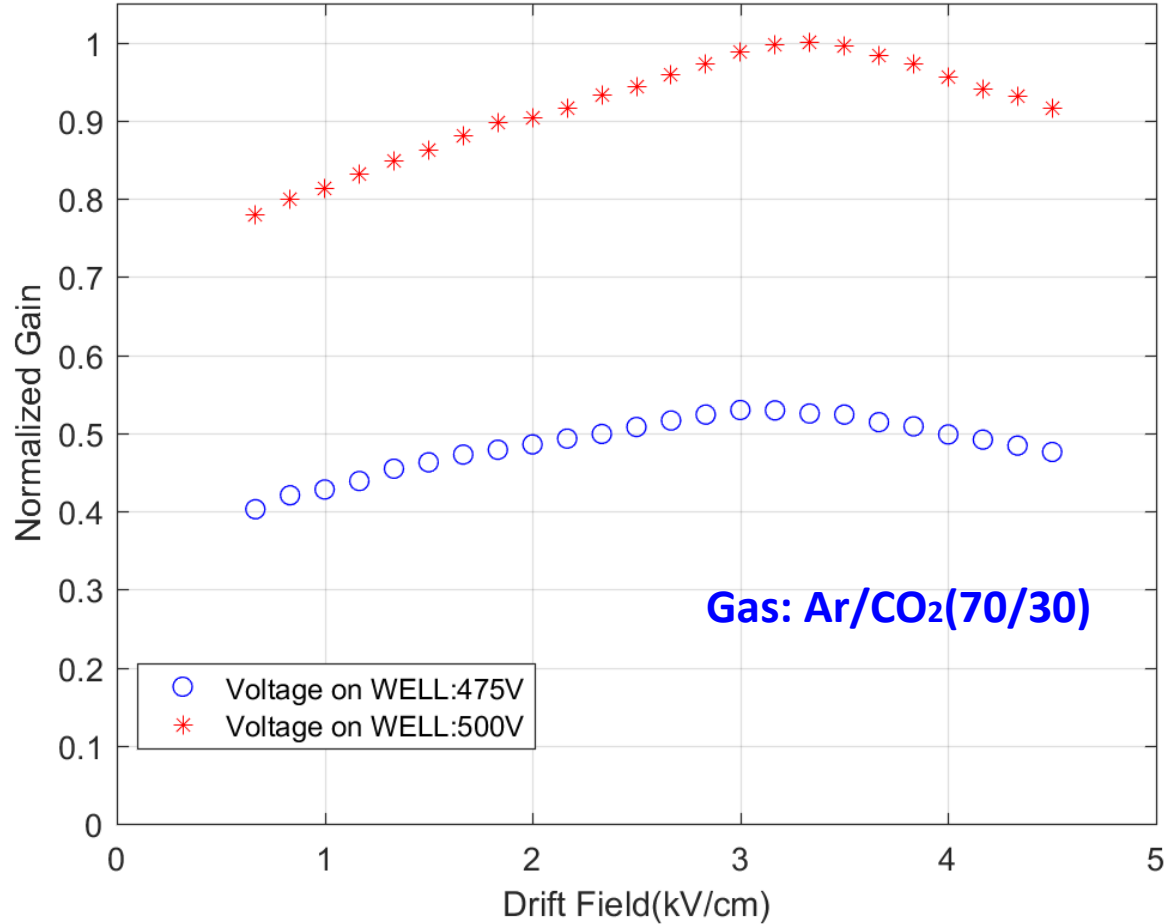
# Thanks



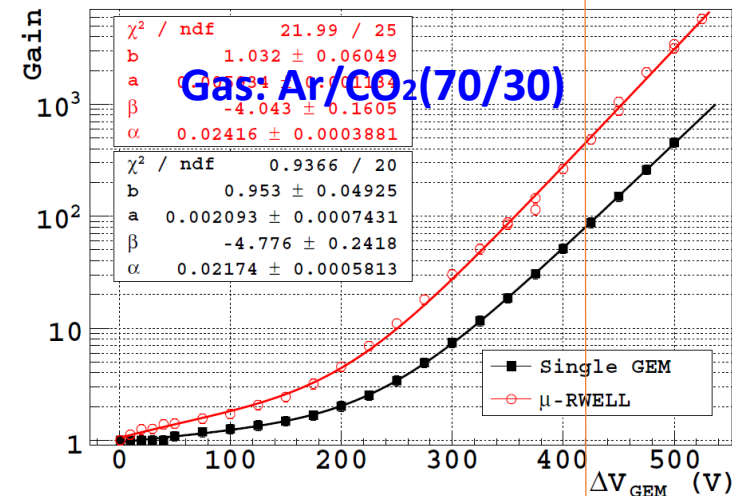
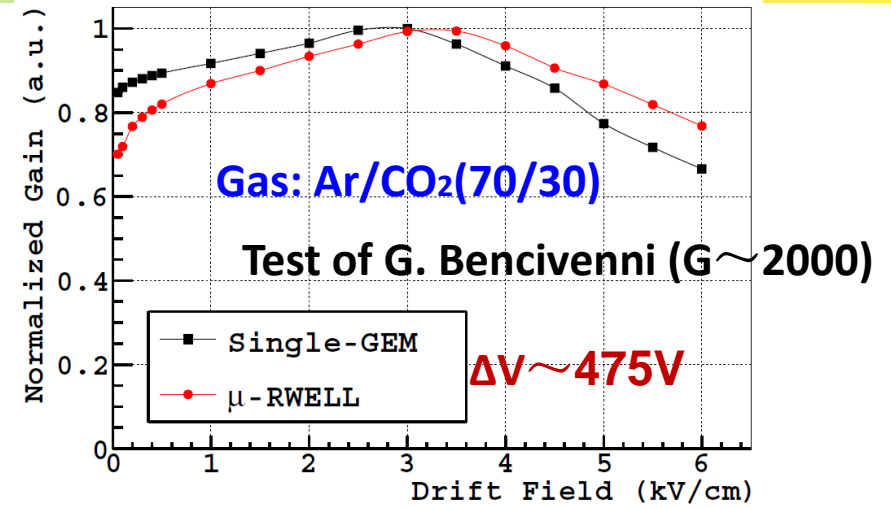
# BackUp

# 原初电子收集效率随漂移场强度的变化

Collection efficiency of primary electrons .VS. Drift field



漂移场为3kV/cm时，电子收集效率达到峰值。



G. Bencivenni et al., JINST, 10, (2015), P02008