



基于Bulk-Micromegas TPC 的快中子成像探测器研究

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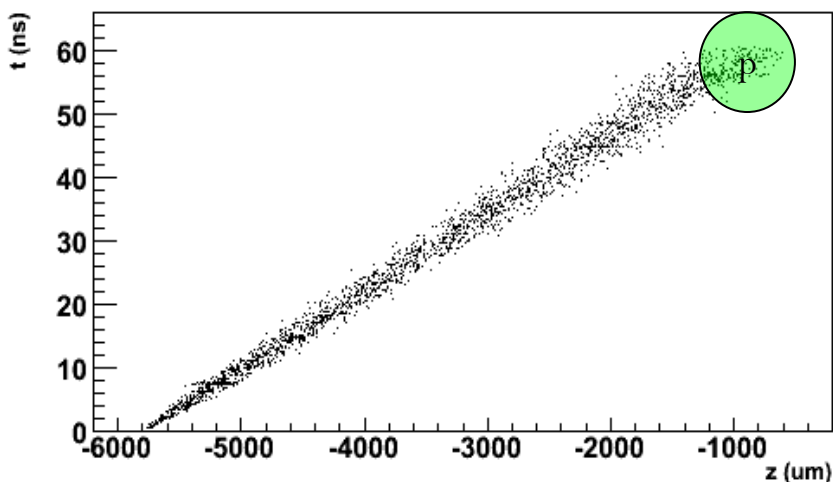
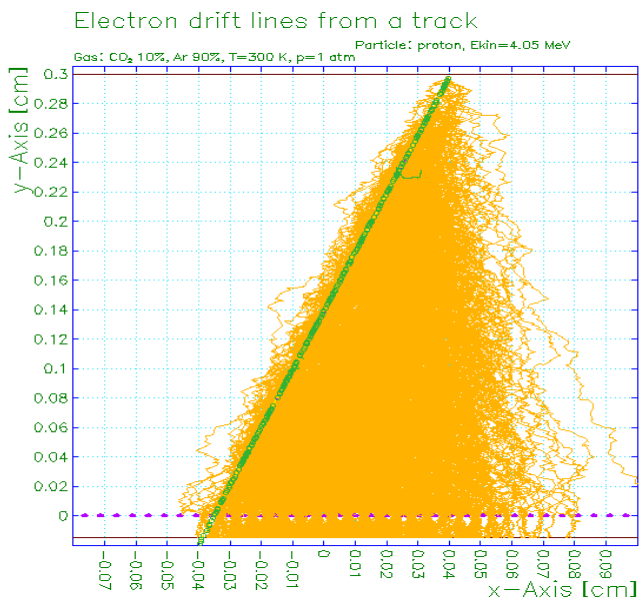
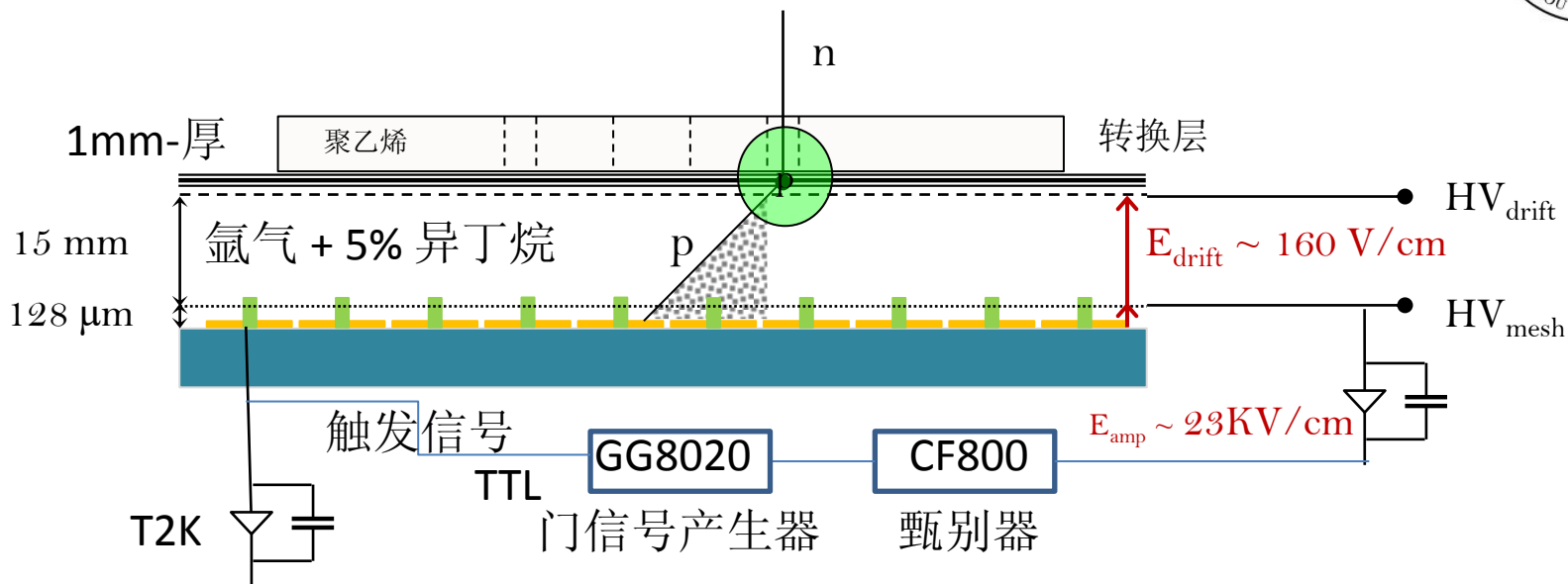
摘要



- 基本原理
- 设计和结构参数
- 能量分辨和增益
- 位置分辨和成像结果
- 探测效率
- 提高探测效率的方案
- 大面积 $20 \times 20 \text{ cm}^2$ 的探测器研制



探测器的基本原理

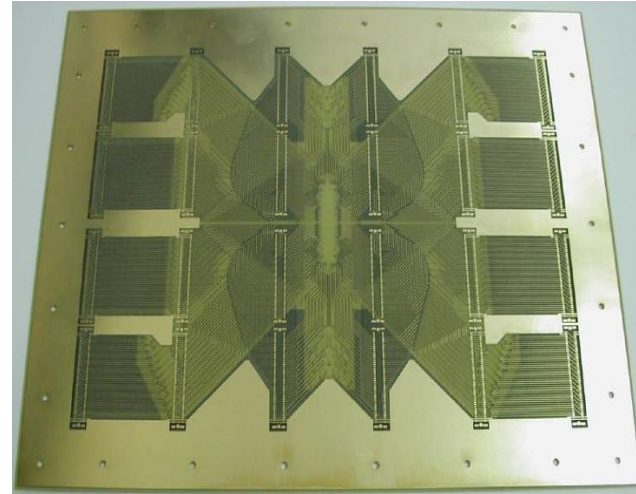


探测器的设计、结构参数

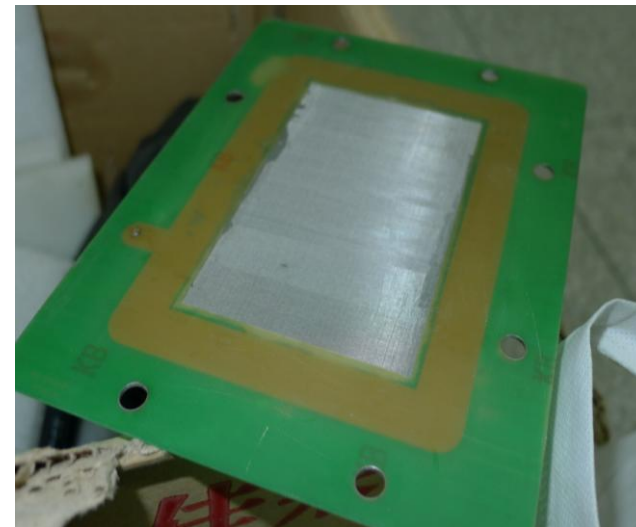


读出电极:

总面积: 365.5 mm X 306.0 mm
有效面积: 57.4 mm X 88.6 mm
像点数量: 1,728 (36 X 48)
像点尺寸: 1.75 mm X 1.50 mm
像点间距: 0.1 mm



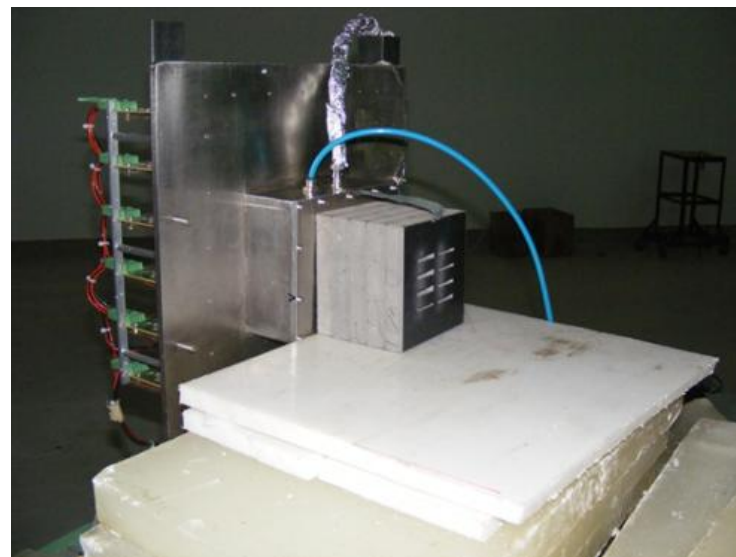
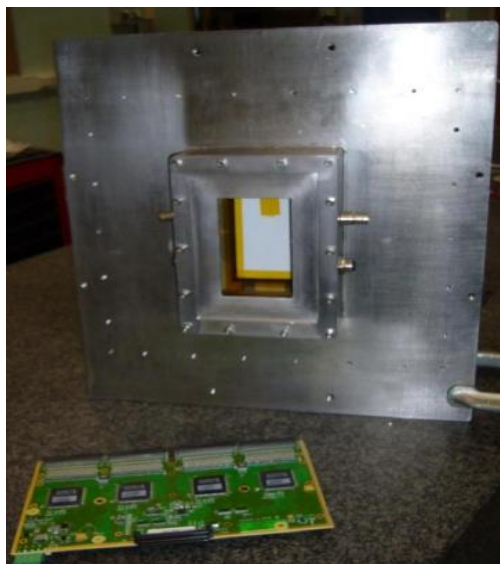
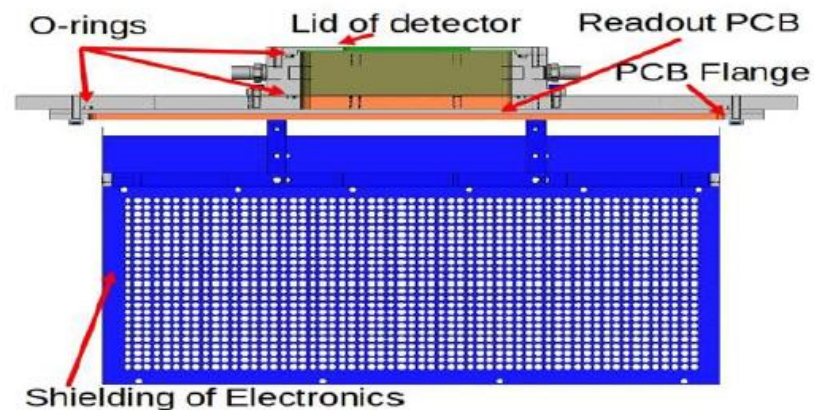
漂移电极:



探测器的设计、结构参数



T2K电子学:



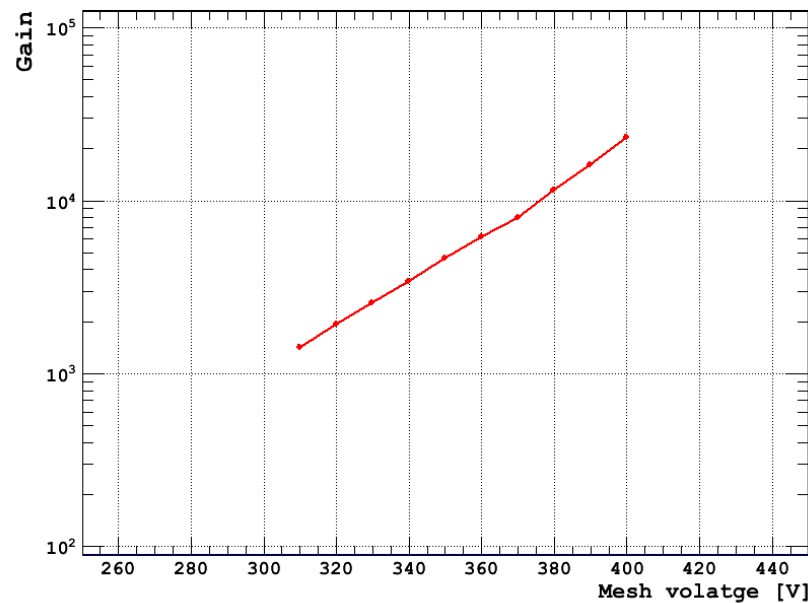
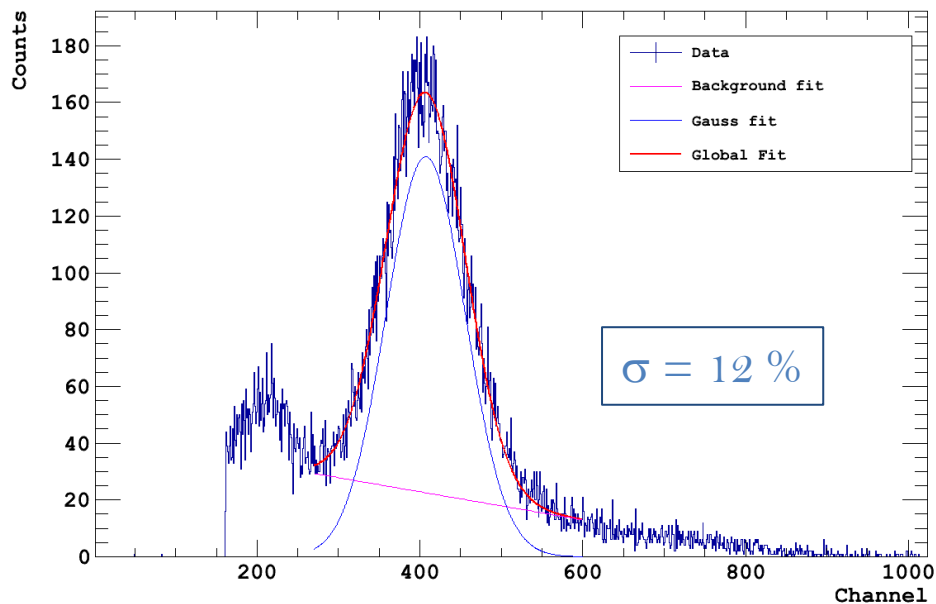


探测器的能量分辨和增益

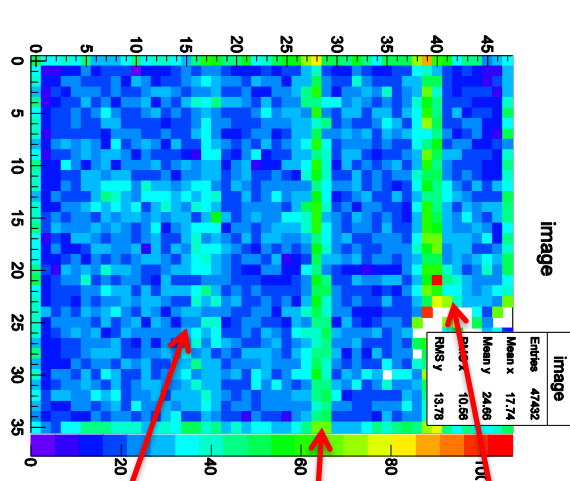
对于 ^{55}Fe 5.9keV X射线时（氩气 + 5% 异丁烷）：

能量分辨~12%

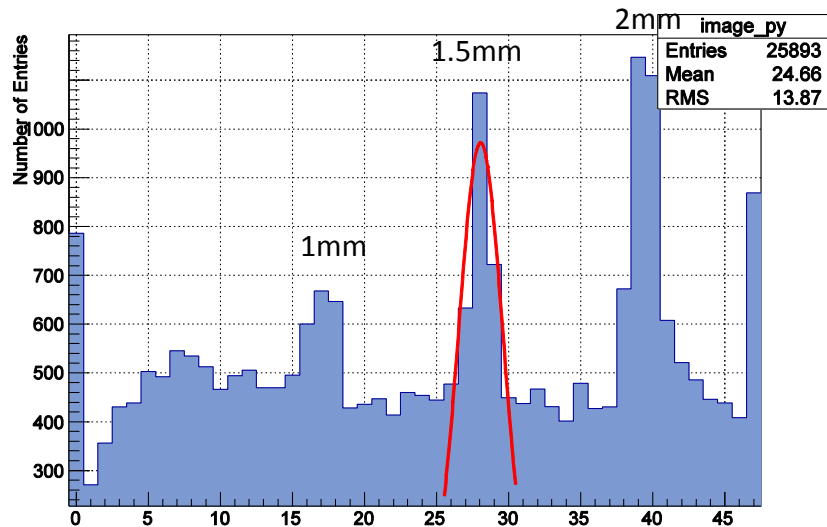
增益曲线如图所示



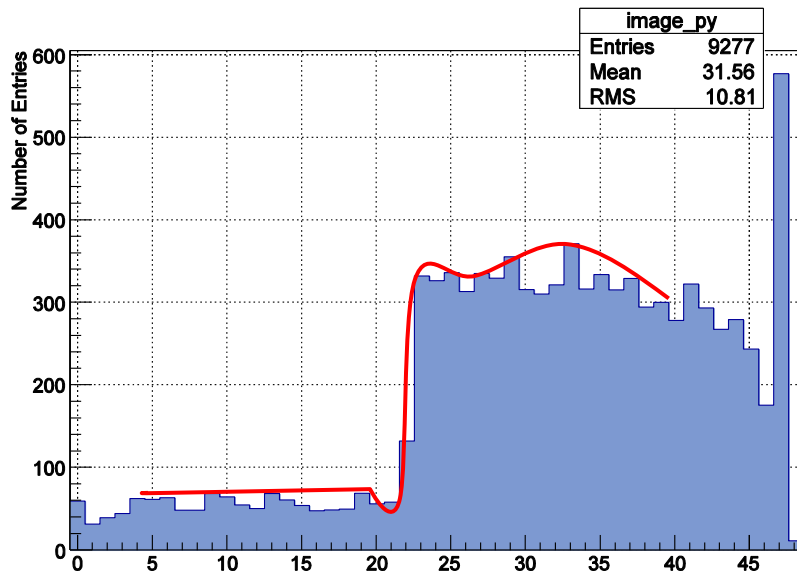
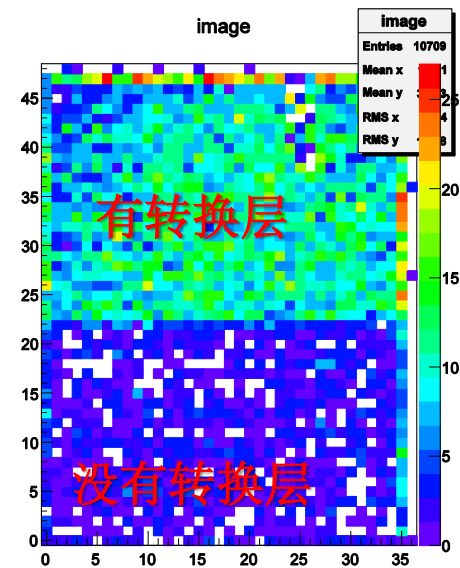
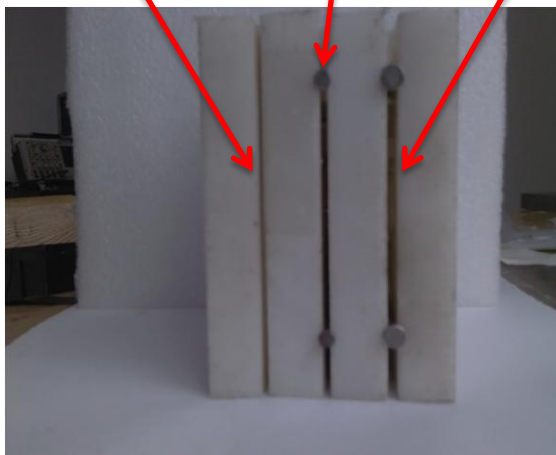
探测器的位置分辨和成像结果



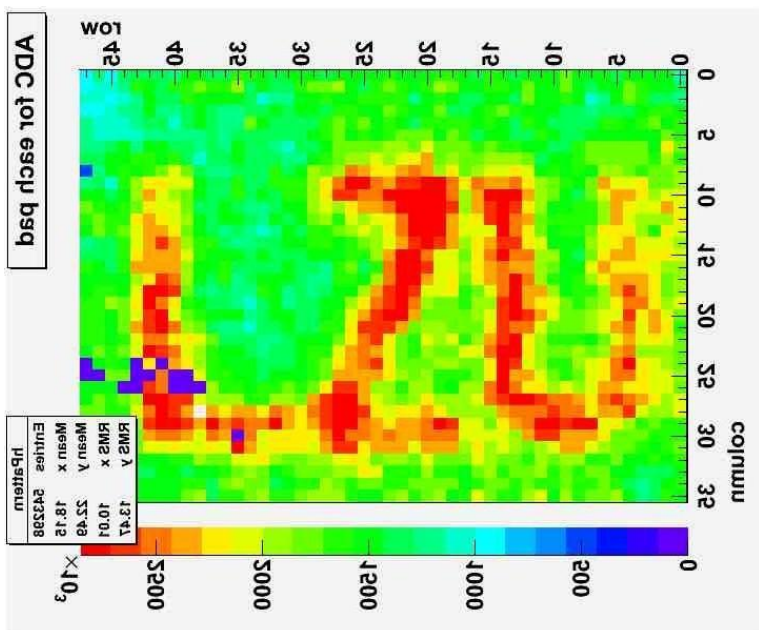
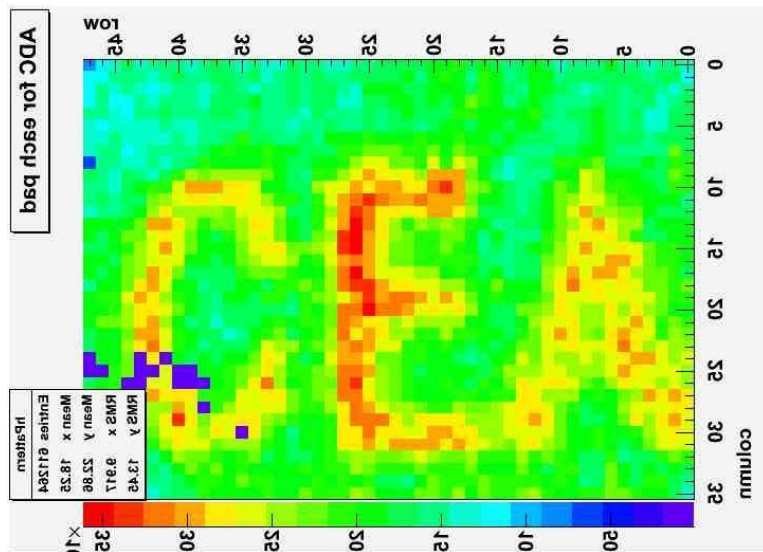
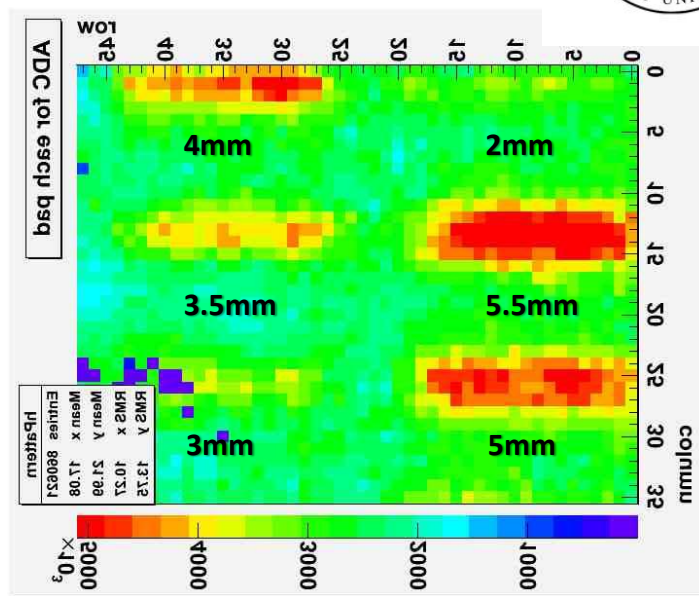
位置分辨~2mm



1 mm 1.5mm 2mm



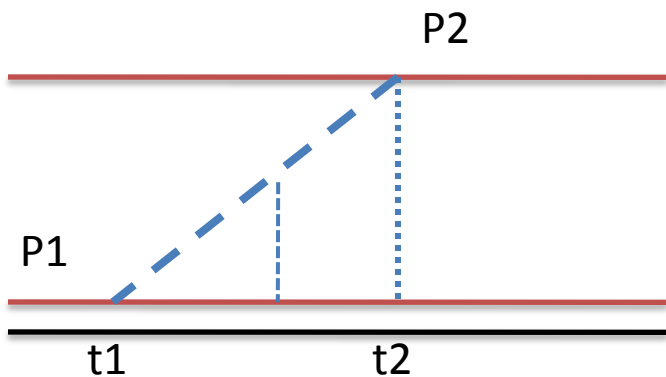
探测器的位置分辨和成像结果



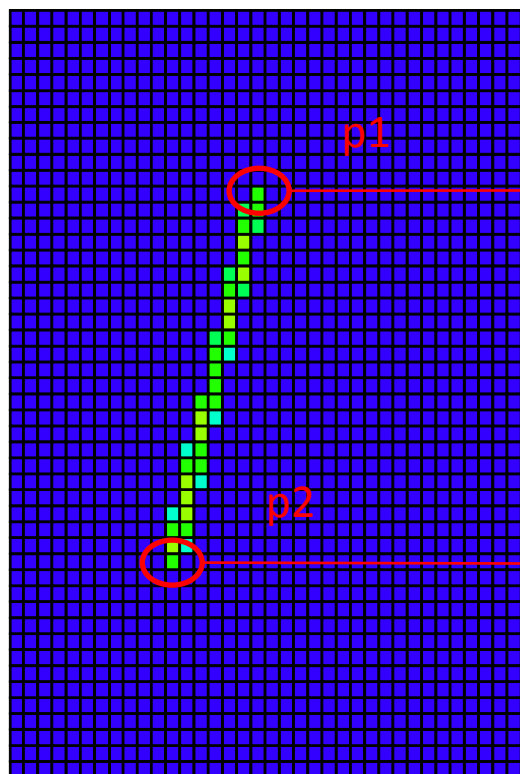
探测器的位置分辨和成像结果



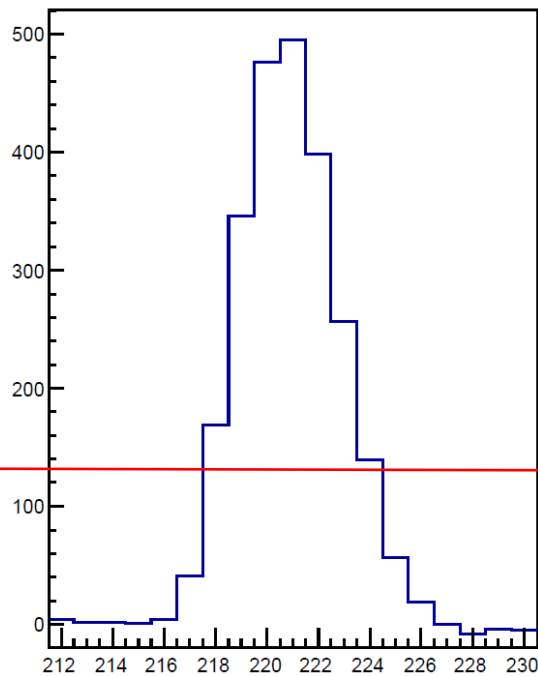
图像重建



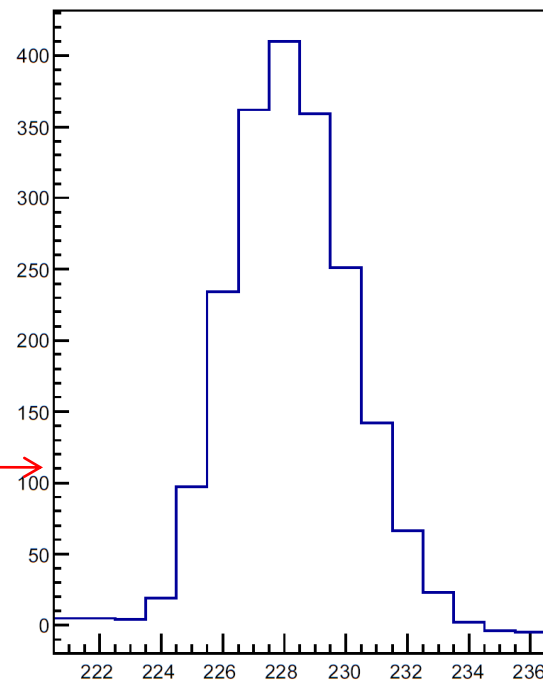
中子产生的反冲质子在其入射点 p_2 漂移距离最长，漂移时间最长，所以在其投影处 pad 上可读出 P_2 的时间投影



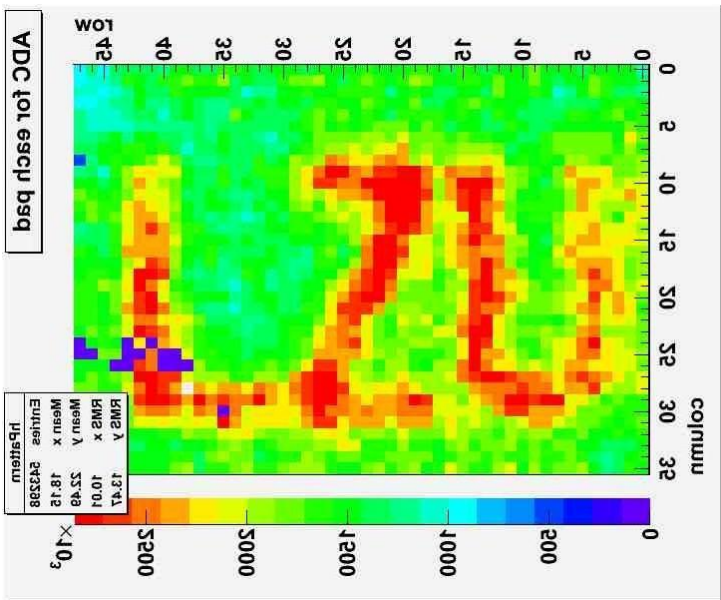
hADC 869



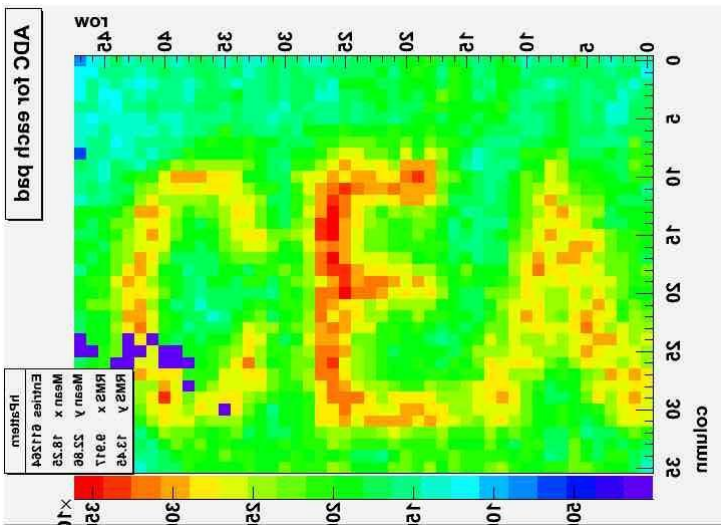
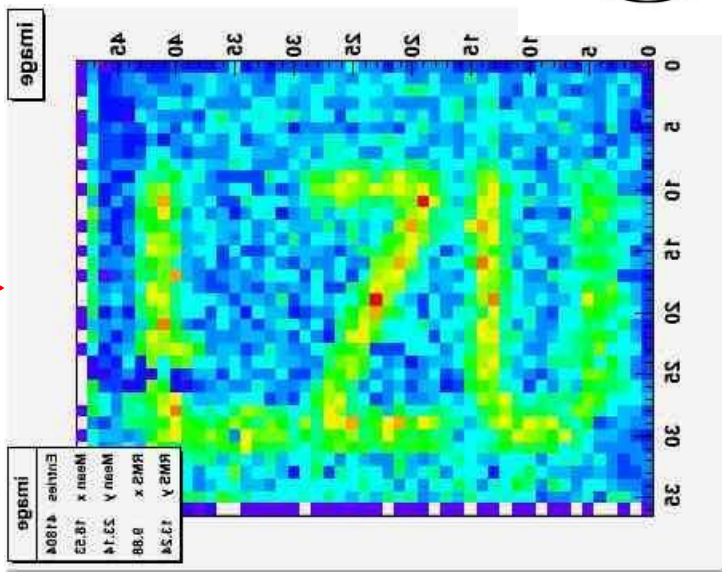
hADC 1303



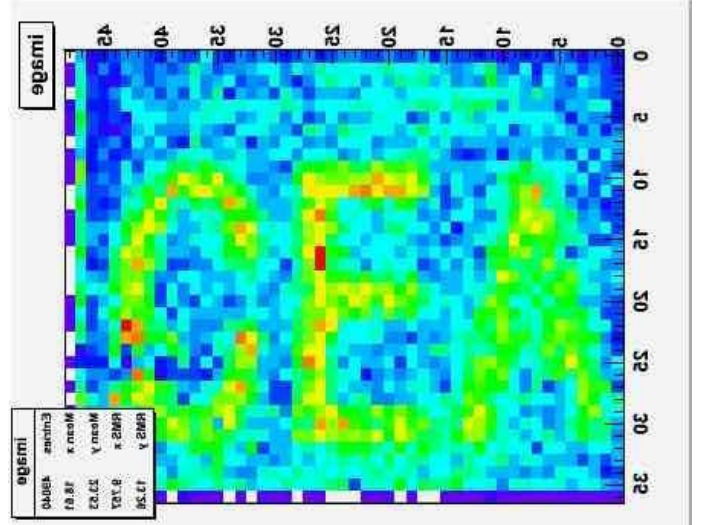
探测器的位置分辨和成像结果



Time cut



Time cut





探测器的效率

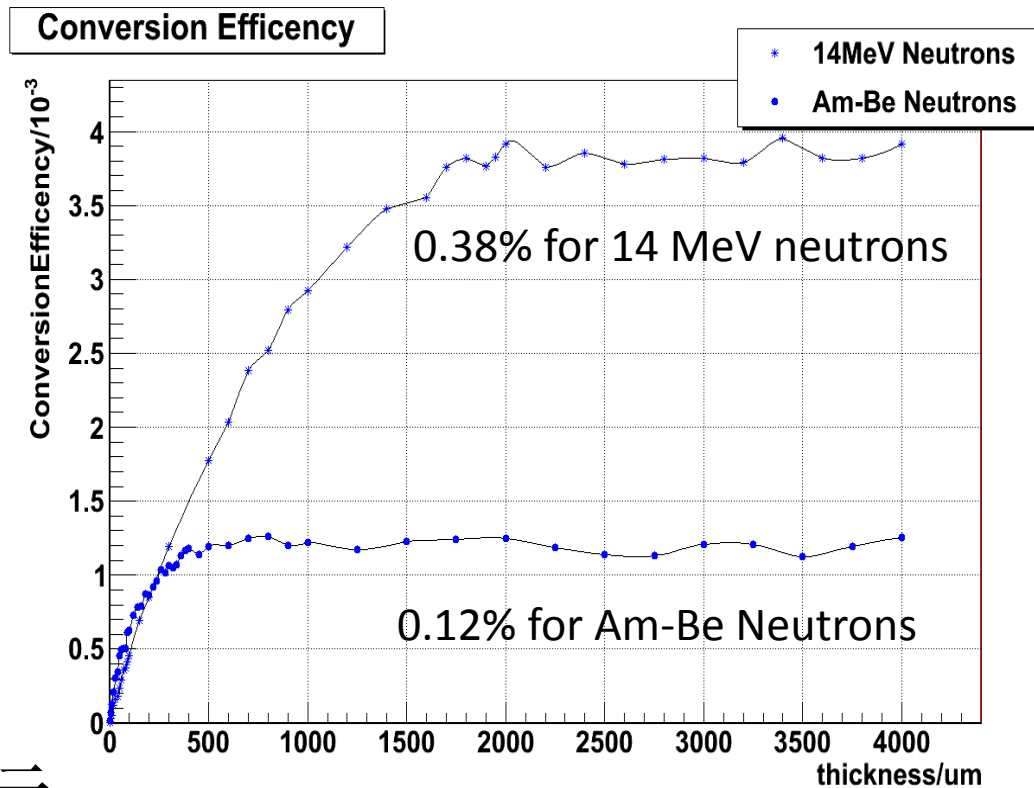
- Am-Be中子源时的探测器效率

实验结果: 0.08%

模拟结果: 0.12%



触发信号阈值导致效率较低, 离应用较远



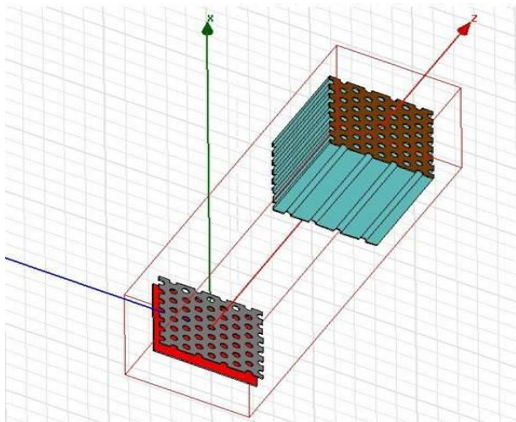
G4模拟结果: 聚乙烯转换层厚度和转换效率的关系

提高探测器的效率



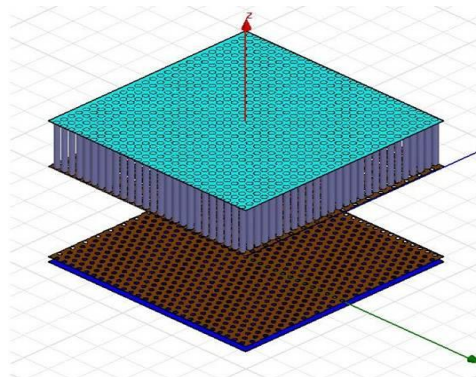
三种新转换层结构:

	传统 结构	微孔式 结构	柱形 结构	45° 倾斜柱状 结构
Am-Be		0.152%+0.119%	0.147%+0.096%	0.310%+0.114%
Neutrons	0.12%	0.271%	0.243%	0.424%
14MeV		0.445%+0.376%	0.403%+0.279%	0.685%+0.330%
Neutrons	0.35%	0.621%	0.662%	1.015%



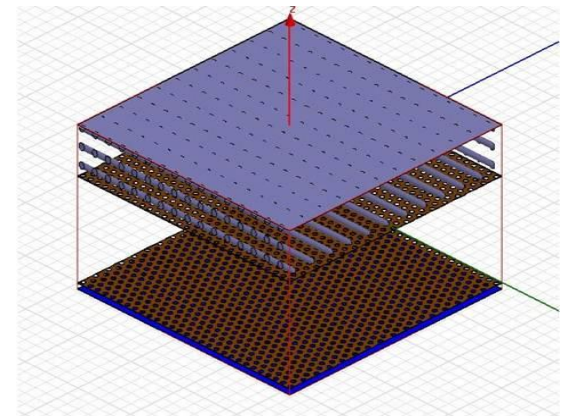
微孔状结构

孔径:1mm 孔中心距: 1.5mm
转换层厚度:5mm



柱状结构

圆柱直径: 1 mm 圆柱中心距: 1.5mm 转换层厚度: 5 mm



45° 倾斜柱状结构

大面积 $20 \times 20 \text{ cm}^2$ 的Bulk-Micromegas探测器研制



改良读出电极

阻抗式阳极读出

延迟线

条状电极

Pad
读出



谢谢

mpgd.lzu.edu.cn



中子事件与伽马事件的区分

两种区分Am-Be中子源的中子事件和伽马事件:

1. 利用时间多样性区分
2. 利用能量区分

