

Efficiency Analysis of HV-MAPS Prototypes

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DPG Frühjahrstagung, T41: Detektoren und DAQ 1

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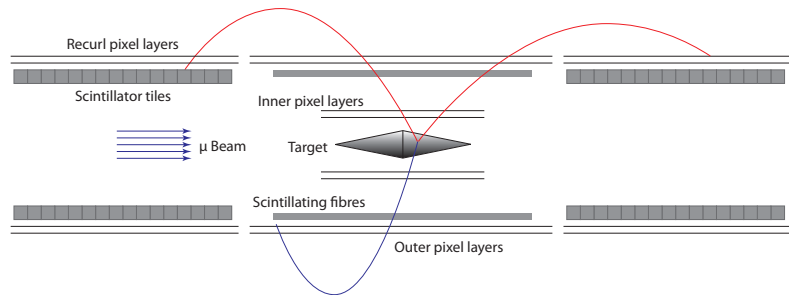
Physikalisches Institut Heidelberg

The Mu3e Detector

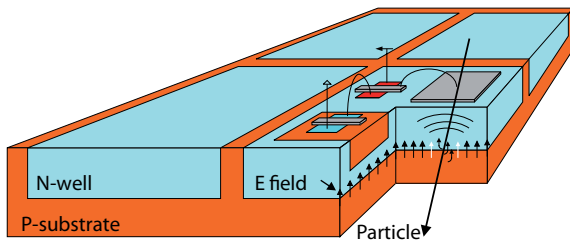


Requirements pixel detector:

- Pixel size: $80\ \mu\text{m} \times 80\ \mu\text{m}$
- Continuous readout frequency: 20 MHz
- Low material budget \rightarrow $50\ \mu\text{m}$ thickness



High Voltage Monolithic Active Pixel Sensors



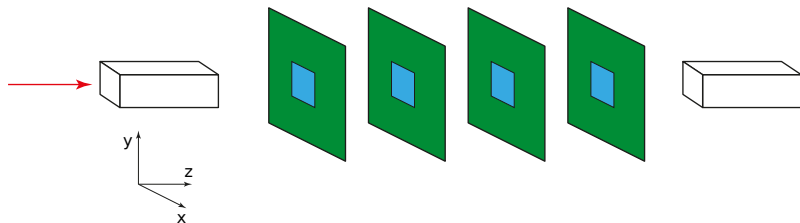
- Zero suppressed readout
- 8 bit timestamps
- HV applied: 50 - 90 V
- Charge collection via drift

(I. Peric, P. Fischer et al., NIM A 582 (2007) 876)

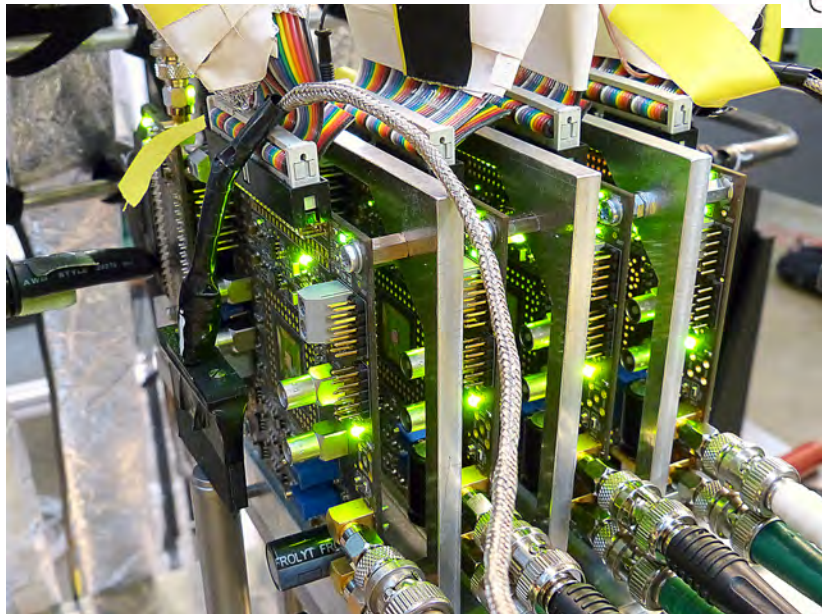
Telescope Setup



- 4 layers of Mupix6 sensors
- Read out by two FPGAs

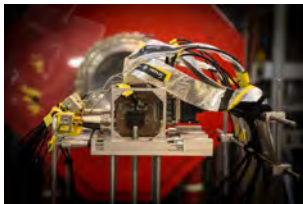


Telescope Setup





- π M1 beamline
- 250 MeV π , μ , e
- Test of Mupix6 prototype
- First test of our telescope with beam
- ~ 100 kHz tracks
- ~ 1 MHz hits per layer



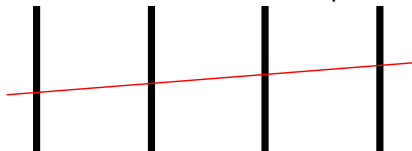


Simple straight track:

$$\vec{x}(z) = \vec{x}_0 + \vec{a} \cdot z$$

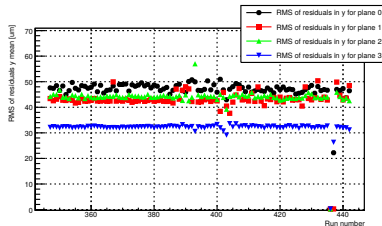
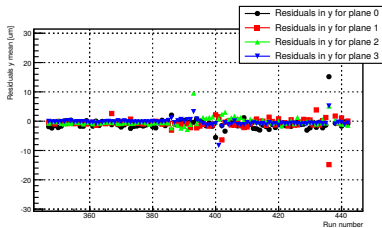
\vec{x} : x and y position

\vec{a} : two dimensional slope



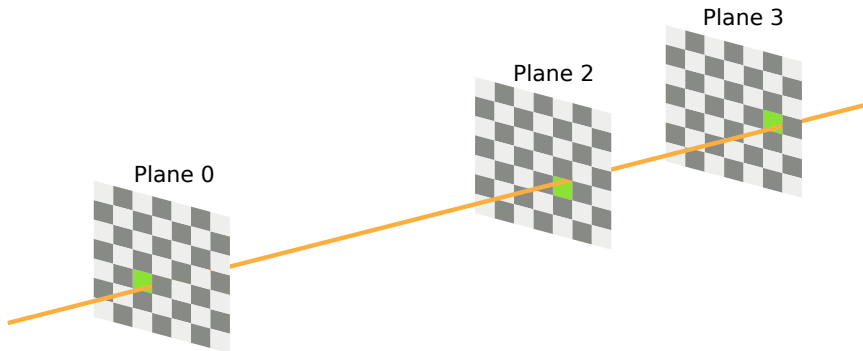
- Loop over all possible hit combinations and fit tracks with
 - 1 hit in each plane
 - $\Delta t < 250$ ns
 - Hot pixels removed

Residuals

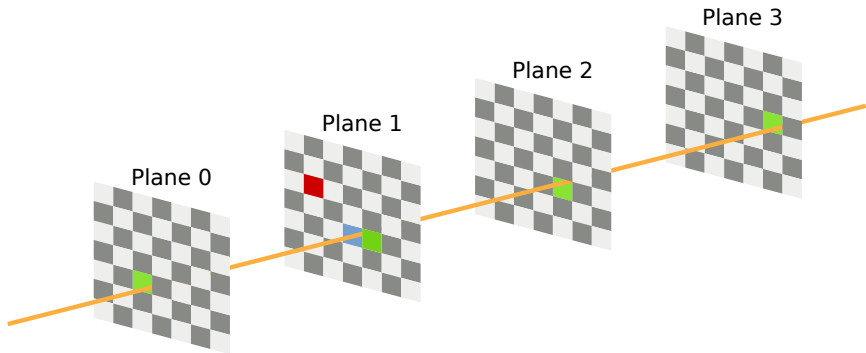


Aligned to within $10 \mu\text{m}$

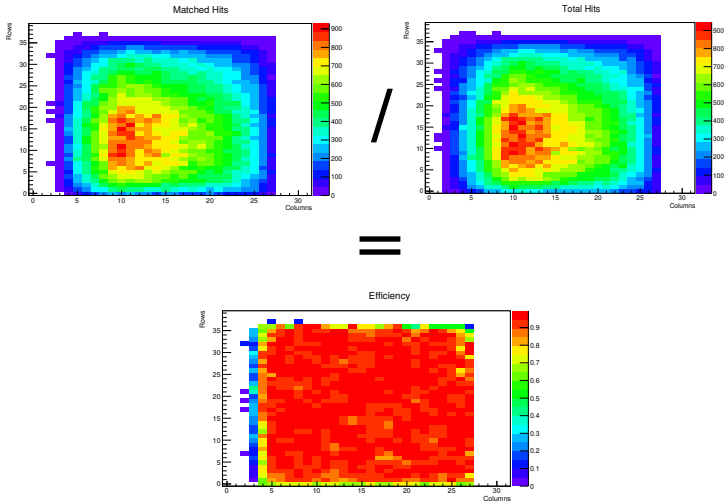
Tracking without DUT



Tracking without DUT

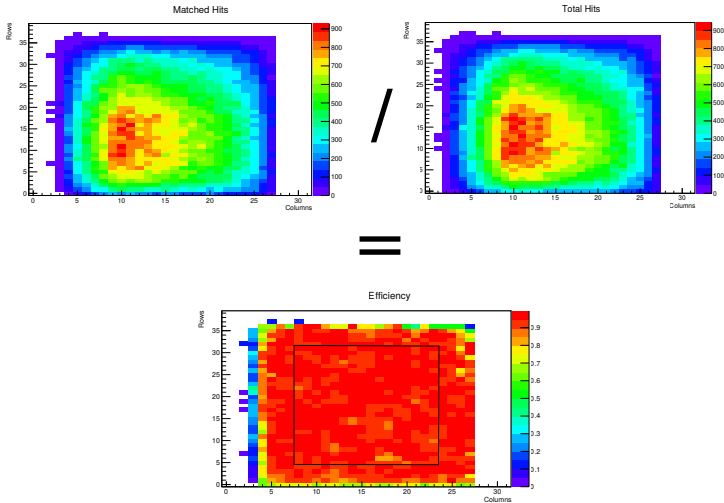


Efficiency Analysis



Threshold = 0.7V, HV = 60V

Efficiency Analysis

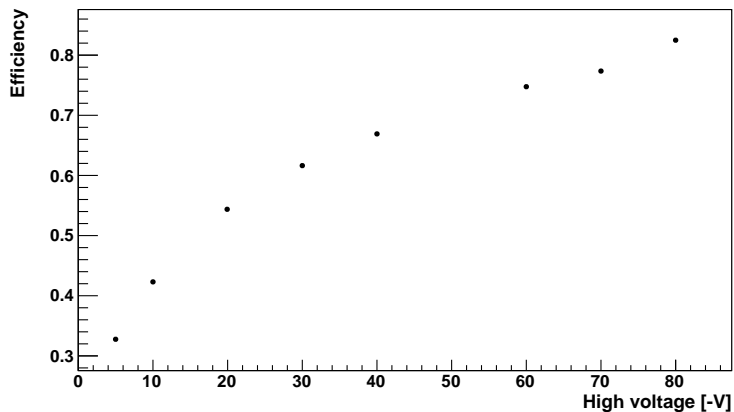


Threshold = 0.7 V, HV = 60 V

High Voltage Scan



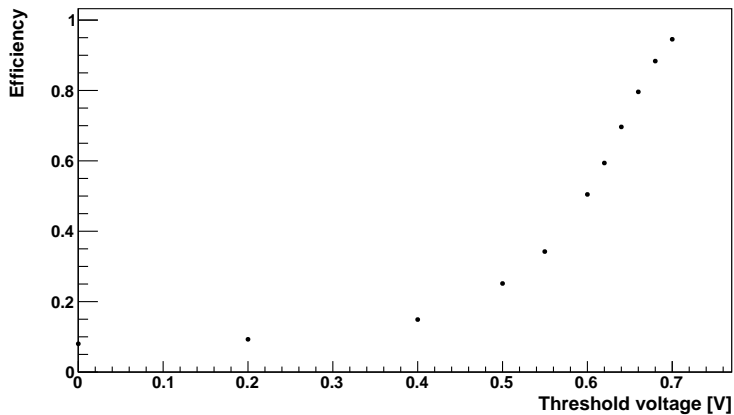
Threshold = 0.65 V



Threshold Scan



HV = 60 V





- Achieved alignment to within $10\ \mu\text{m}$
- Efficiency of Mupix6 determined to $> 94\%$
- Beam test at DESY last week: settings closer to noise, tuned chips
- New prototype Mupix7
- Various thicknesses



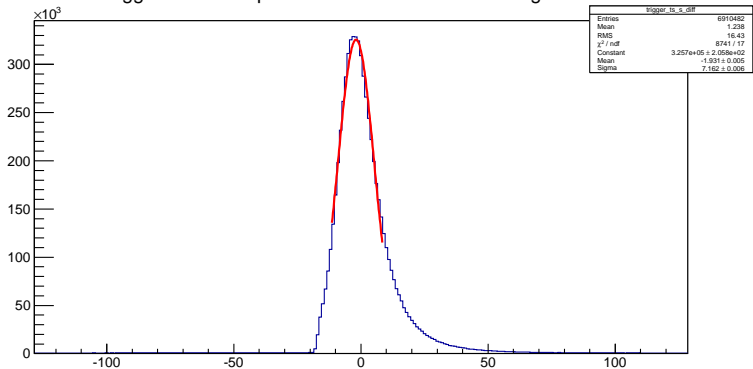


Backup Slides

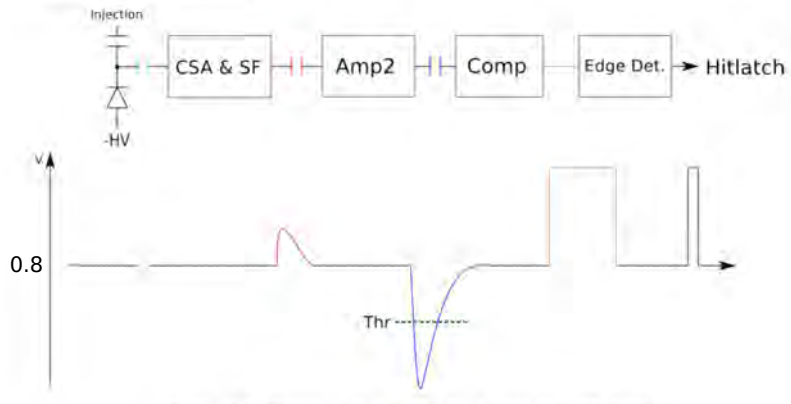
Time Resolution



Trigger TimeStamp Difference Distribution for Single Events

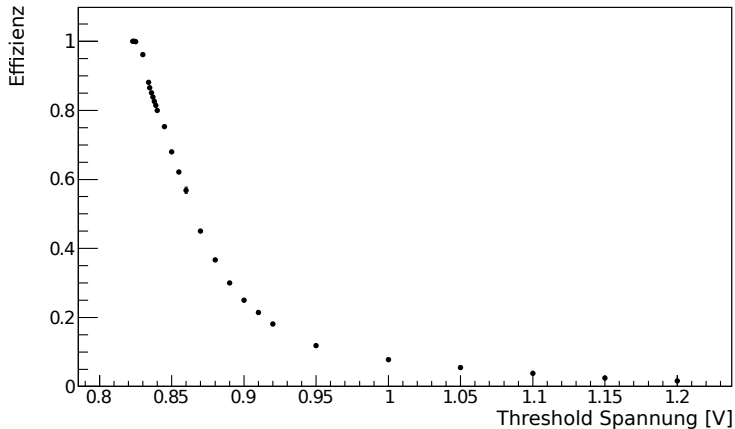


Signal Wave Form





Threshold Scan (HV=-70V, Suche in Spalten)



Residuals

