SM2 Micromegas Modules in the Cosmic Ray Facility

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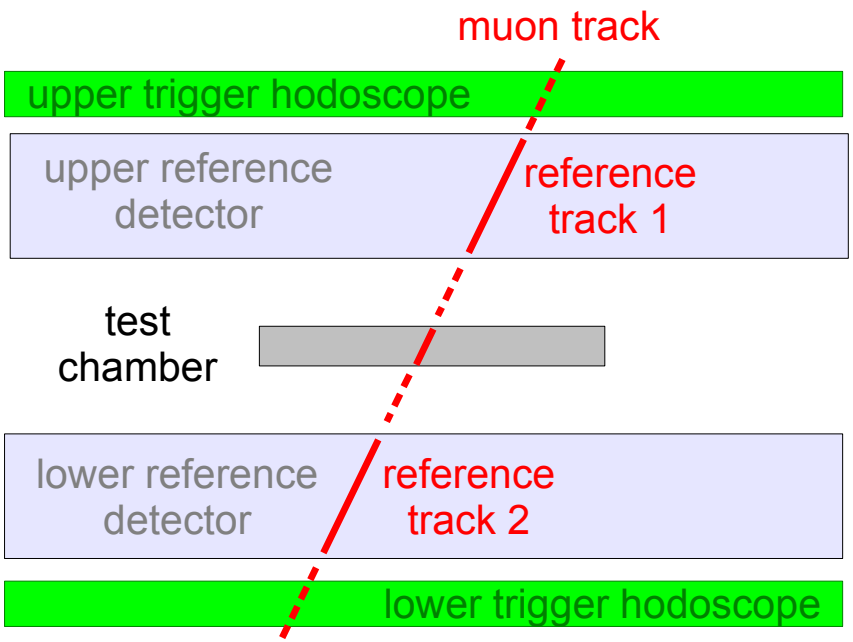
Quality Control Using Cosmic Muon Passages

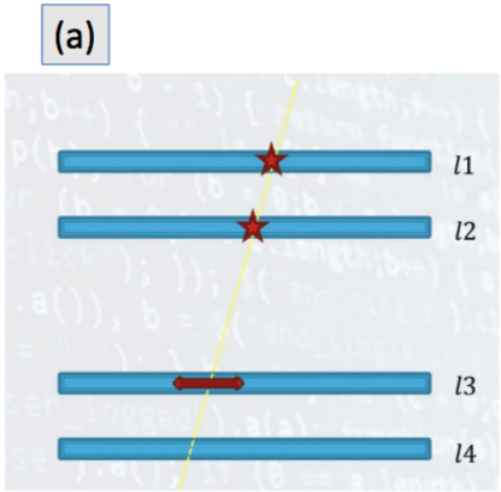
MDT tracks

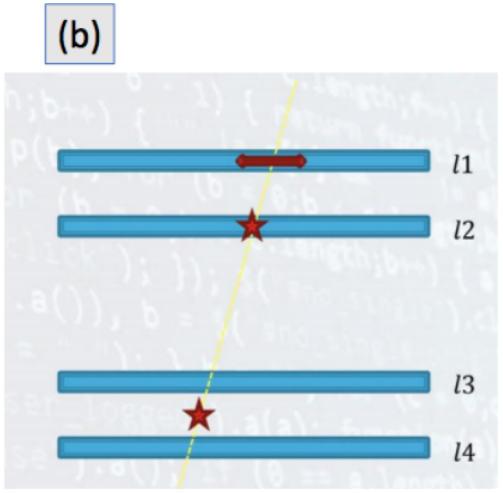


$\Rightarrow$

comparison of both methods to check for compatibility

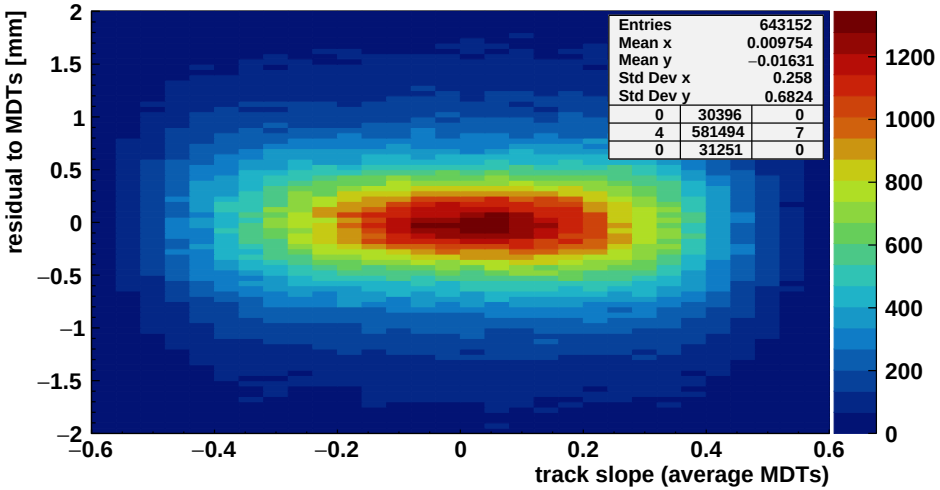
internal



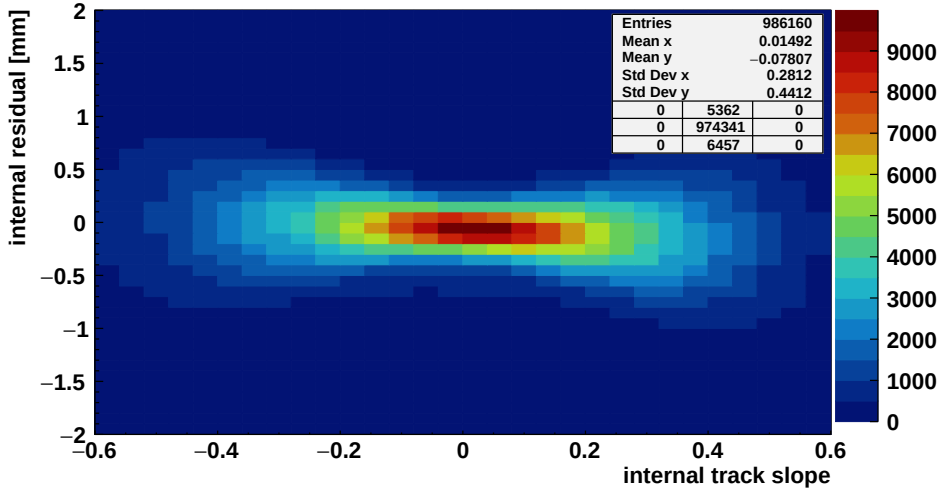


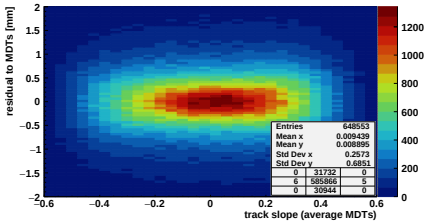
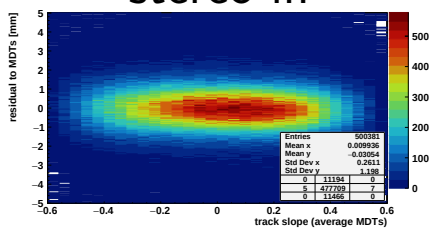
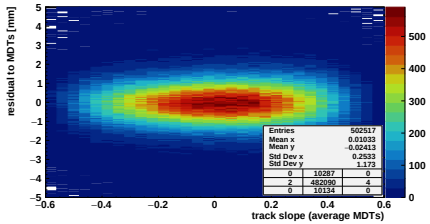
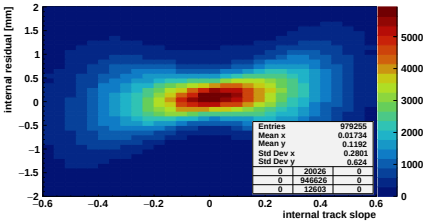
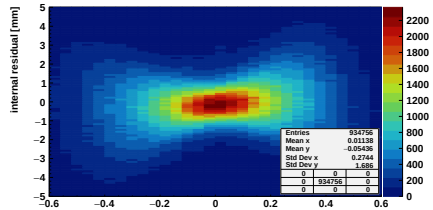
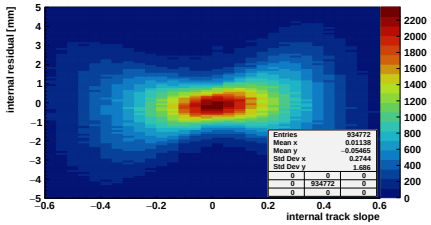
Comparison of External and Internal Tracking (e.g. M29)

MDT tracks (at eta-in)



internal tracking (for eta-in)

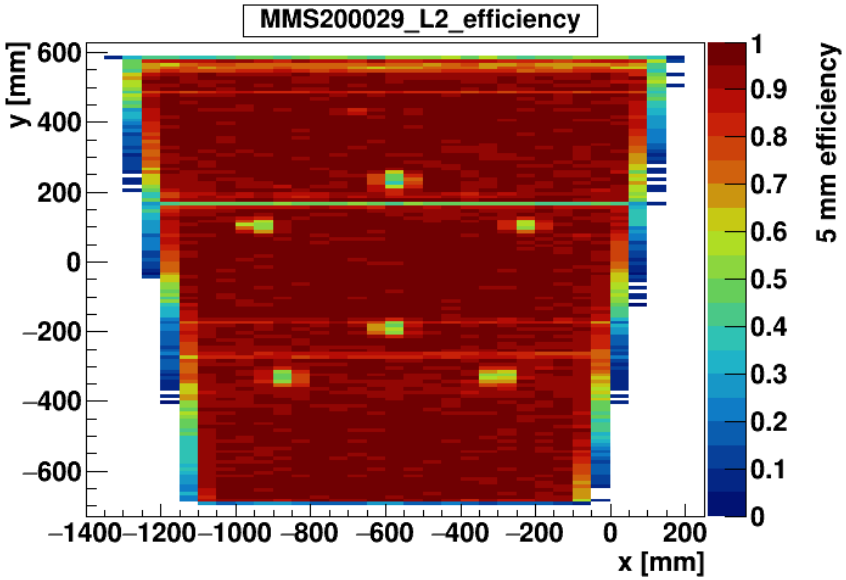


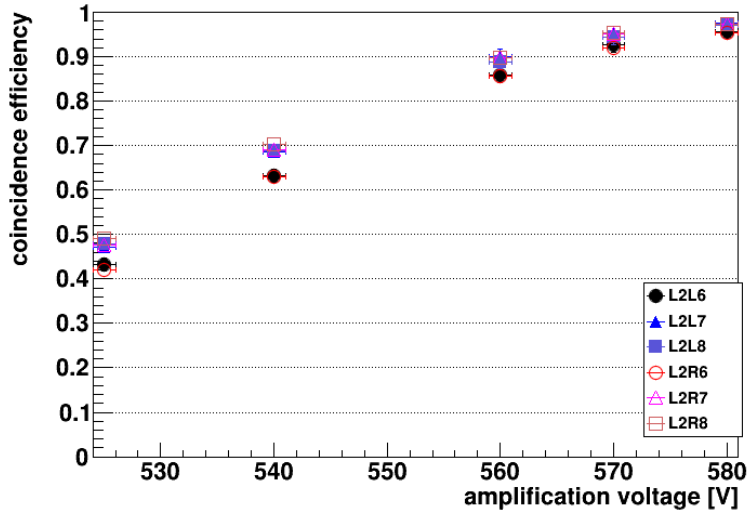
	eta-out	stereo-in	stereo-out
MDT tracks			
internal			

! other y-scale for stereos !

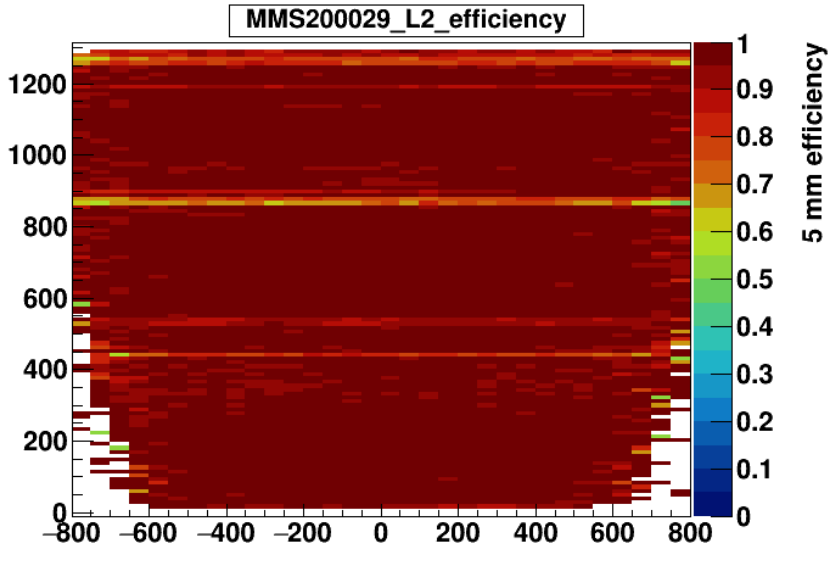
Comparison of External and Internal Efficiency Estimation (e.g. M29, eta-in)

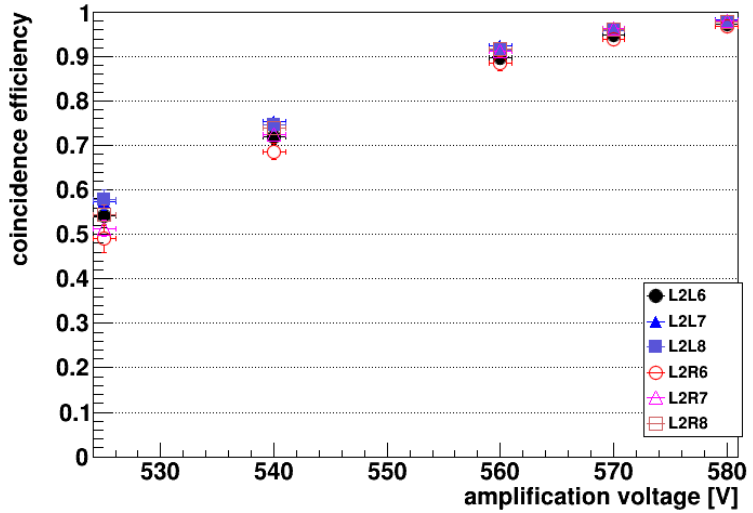
MDT tracks





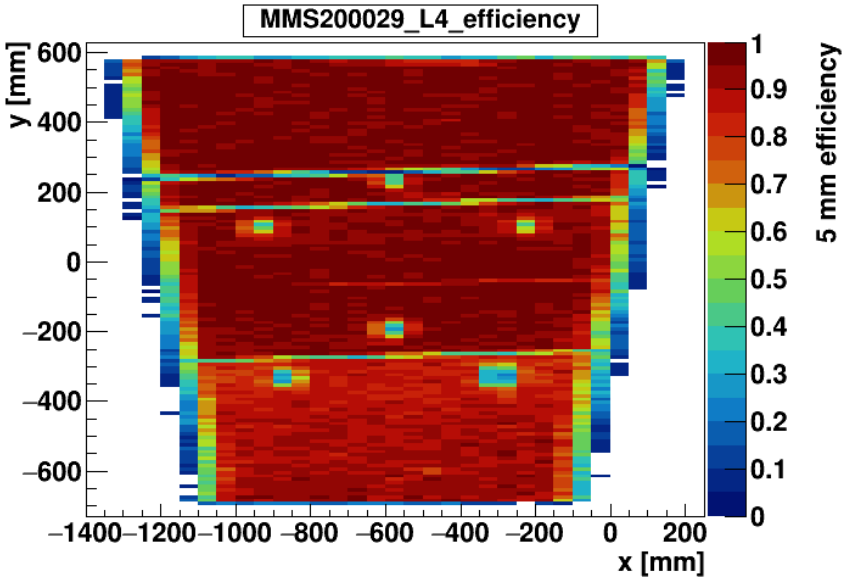
internal

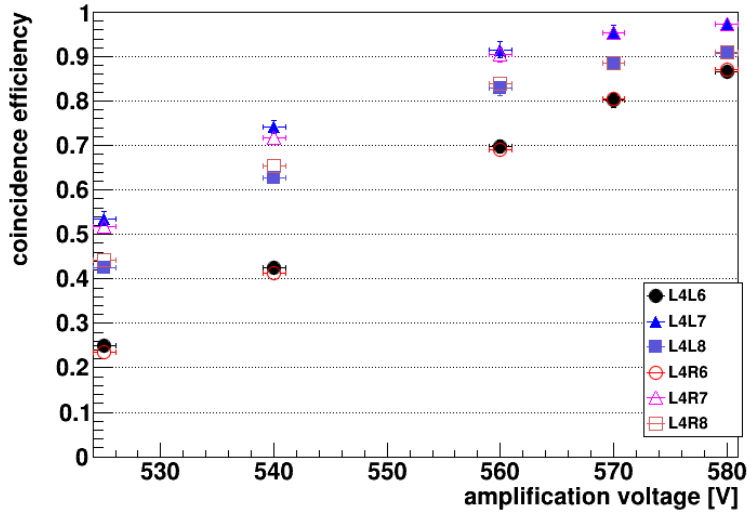




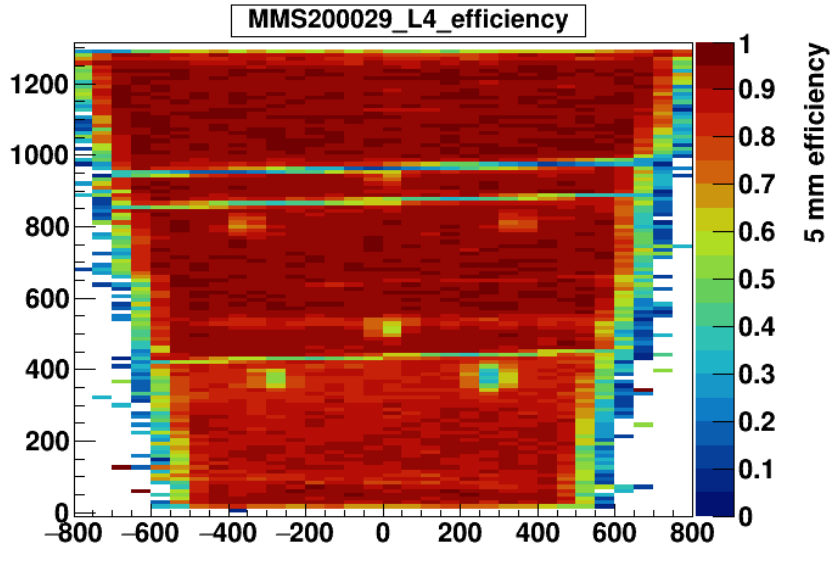
Comparison of External and Internal Efficiency Estimation (e.g. M29, stereo-out)

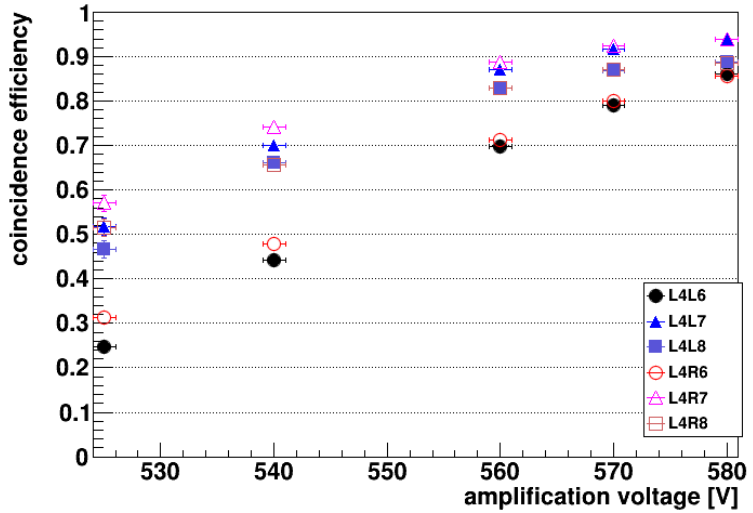
MDT tracks





internal

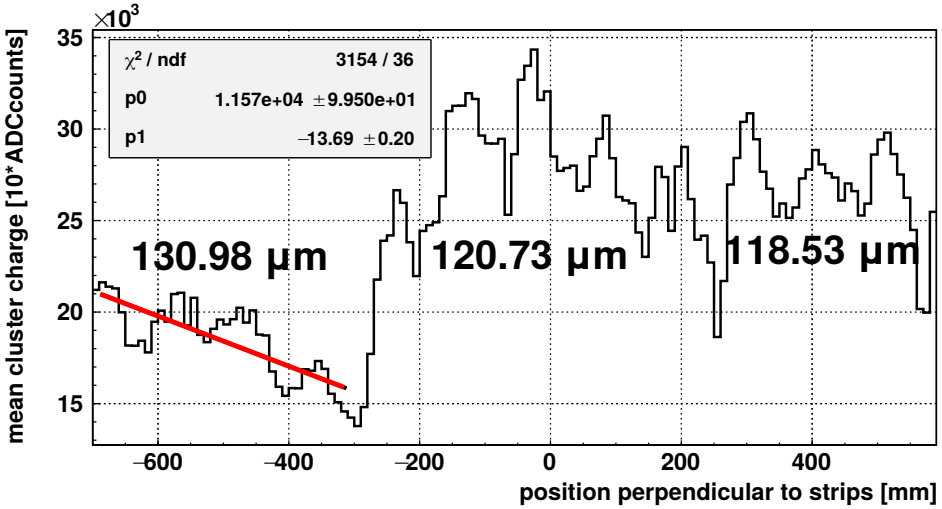




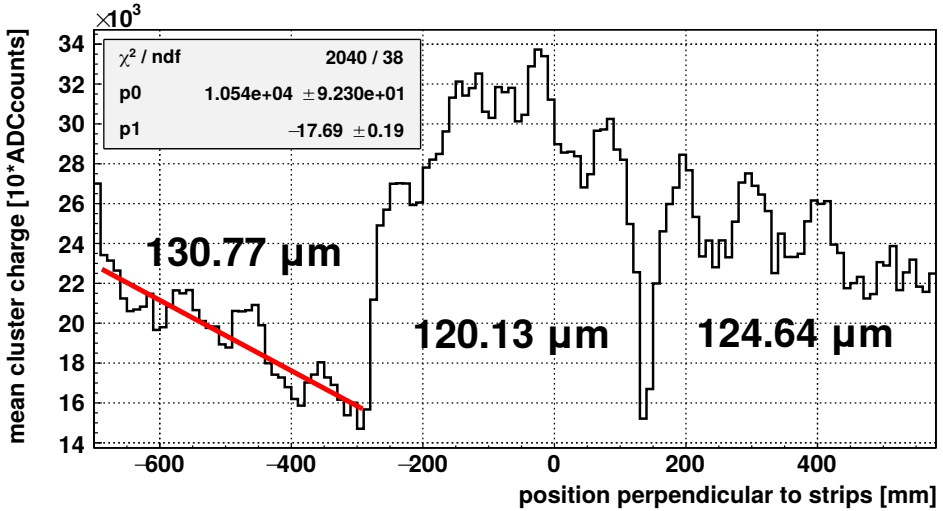
Effect of Pillarheight Trend on Cluster Charge (at 580V)

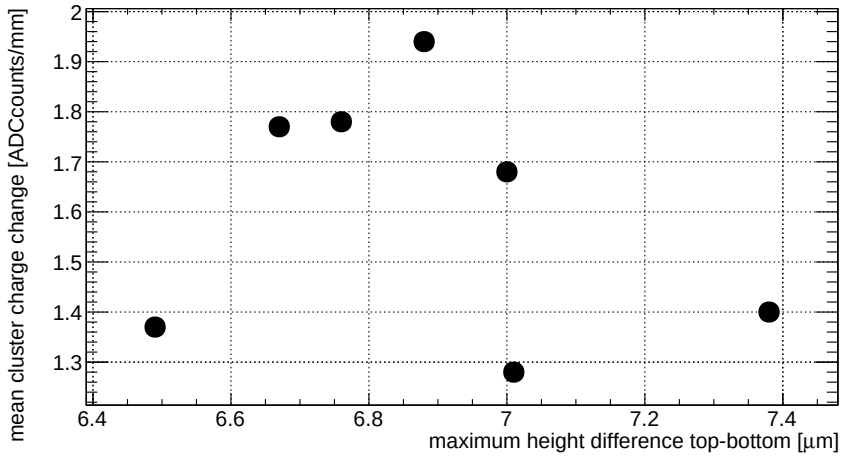
affected PCB of SS6-type ⇒ stereo boards 6 of Modules 29 to 32

M29 stereo-out



M32 stereo-in





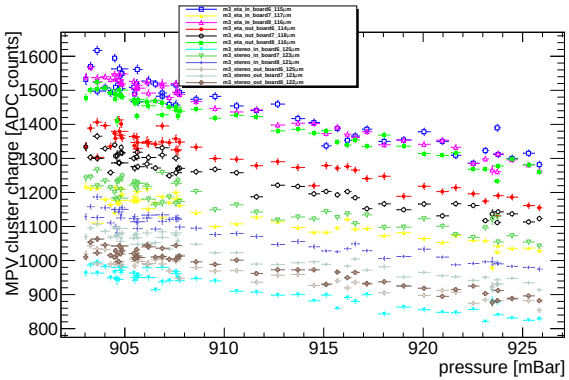
⇒ no clear correlation between height difference and cluster charge change

Pulseheight Dependencies - Pressure and Pillarheight

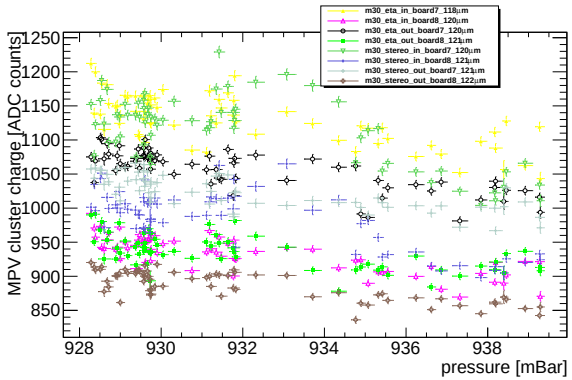
pressure dependence fitted for each readout-board individually
$\Rightarrow$ evaluation as function of pillarheight (linear fit)

570 V

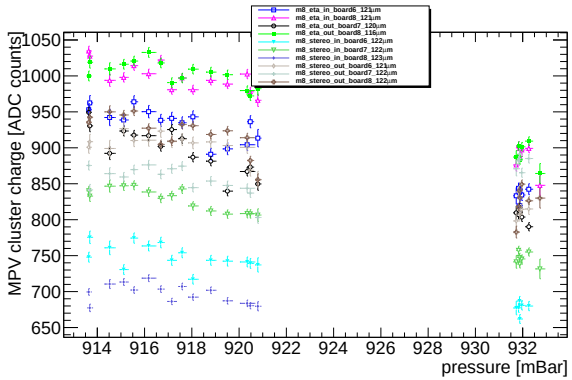
M3



M30

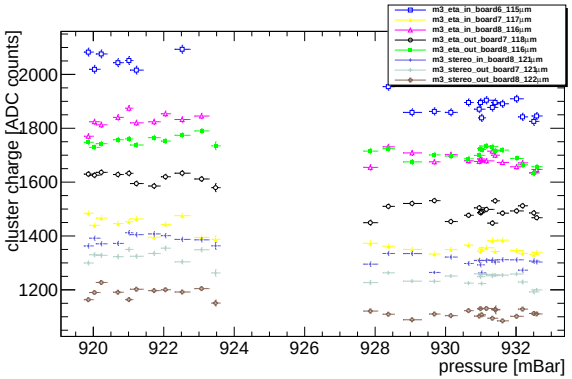


M8

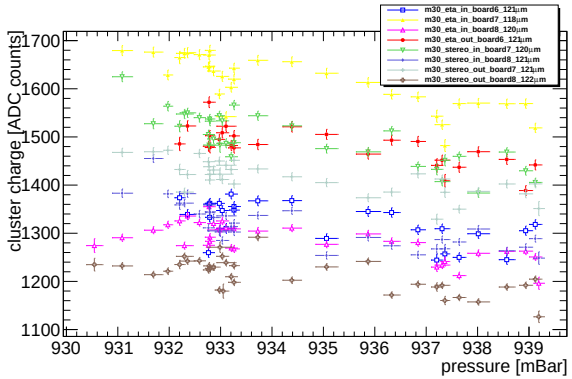


580 V

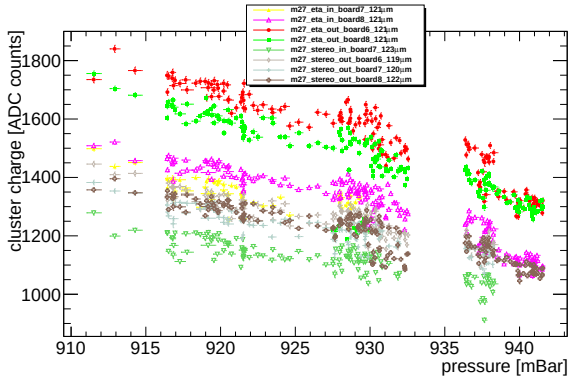
M3



M30



M27



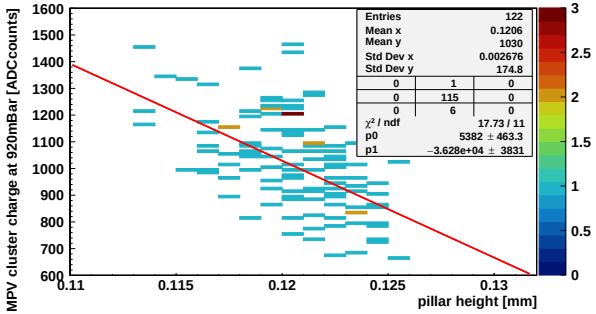
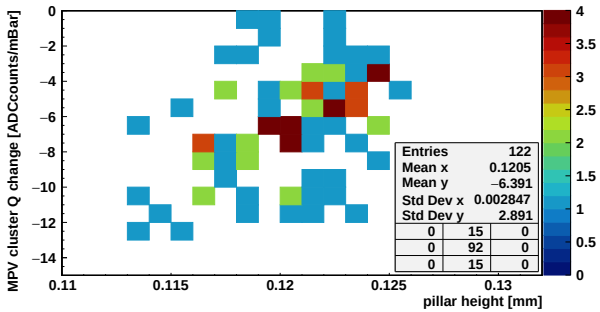
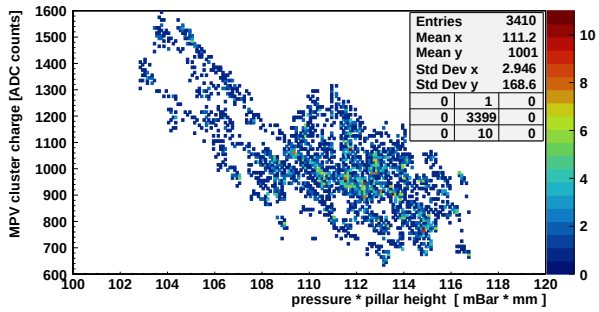
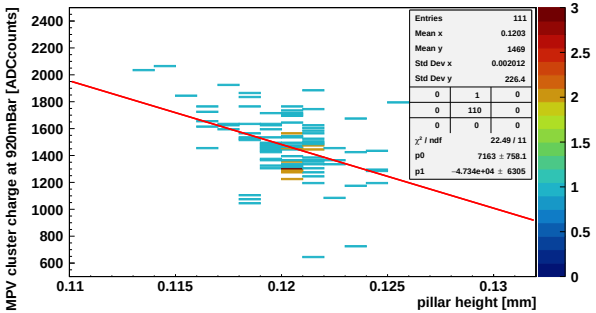
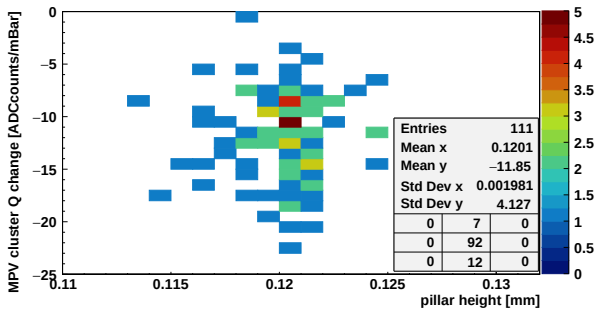
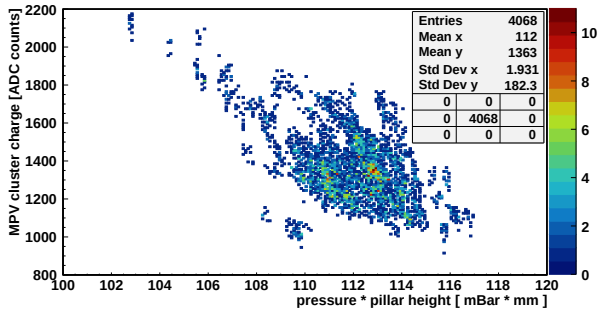
data usable for modules :

570 V : 3 , 4 , 5 , 6 , 8 , 9 , 11 , 12 , 14 , 15 , 19 , 20 , 26 , 30

580 V : 13 , 17 , 18 , 21 , 23 , 24 , 25 , 27

Pulseheight Dependencies - Module Summary

MPV cluster charge ⇒

	at 920 mBar * VS pillar height	pressure dependence (fit slope)	pillar height times pressure
570 V			
580 V			

⇒ relative pulseheight change at 120 µm :

570 V : -3.5 ± 2.0 % / µm

580 V : -3.2 ± 2.1 % / µm

* pressure offset about -30 mBar

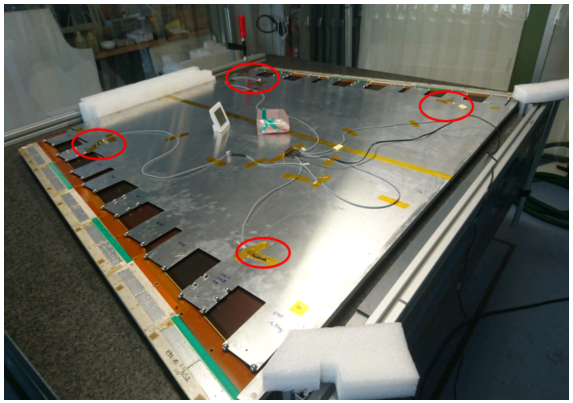
Alignment Analysis by Fabian Vogel (new PhD student)

results of his Masterthesis

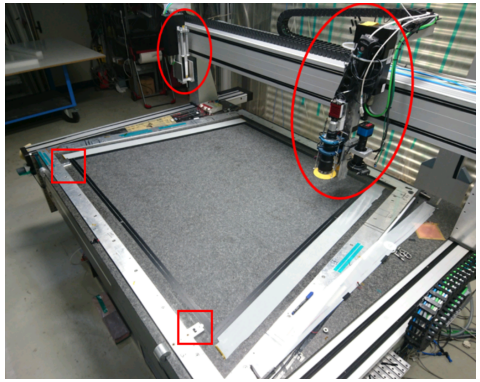
`https://www.etp.physik.uni-muenchen.de/publications/theses/download/master_fvogel.pdf`

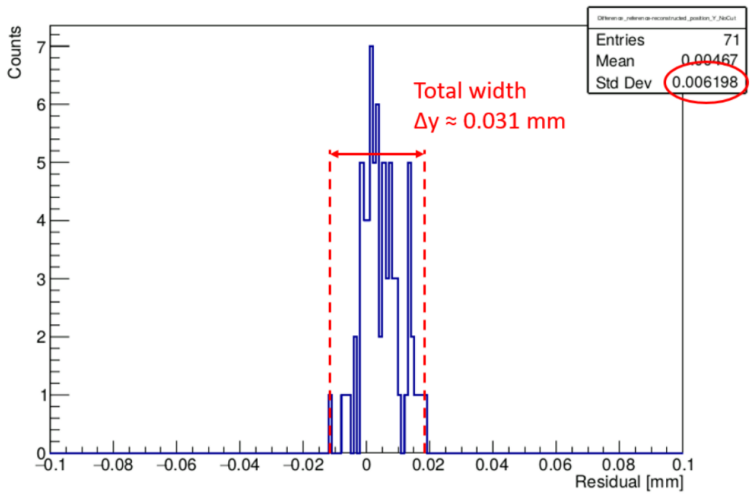
⇒ calibration of jig and CMM using Saclay reference data (panel eta10,stereo11)

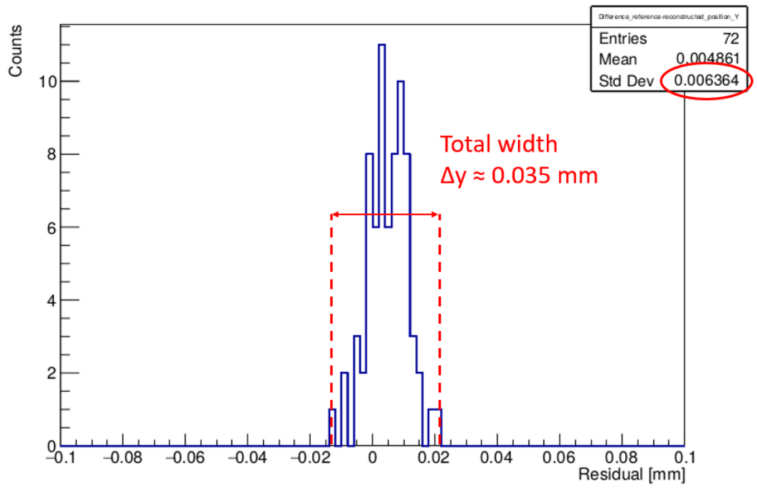
jig



CMM

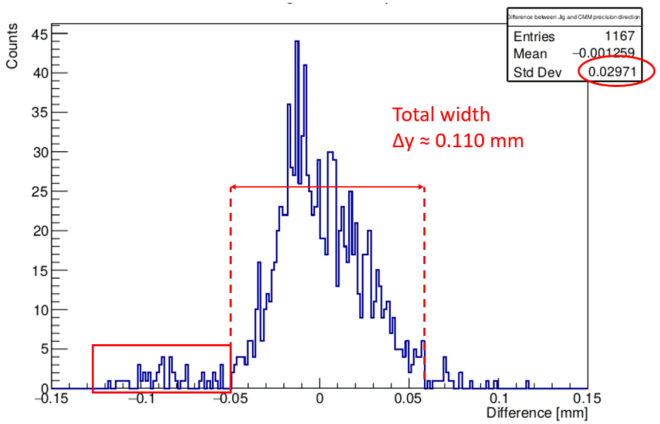




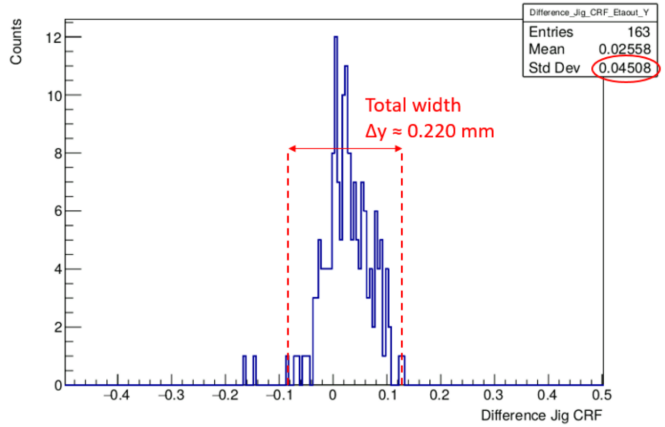


Compatibility Reconstruction of Measurements by Fabian Vogel

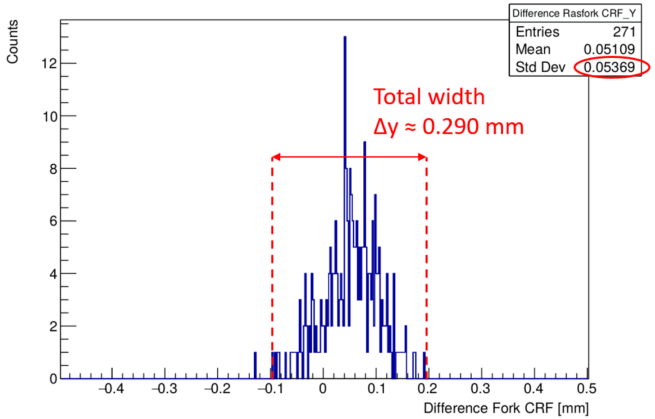
jig - CMM



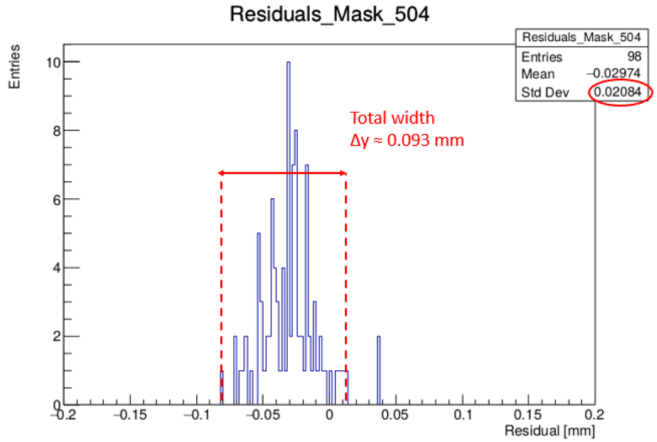
jig - CRF



rasfork - CRF



jig residuals for mask 504



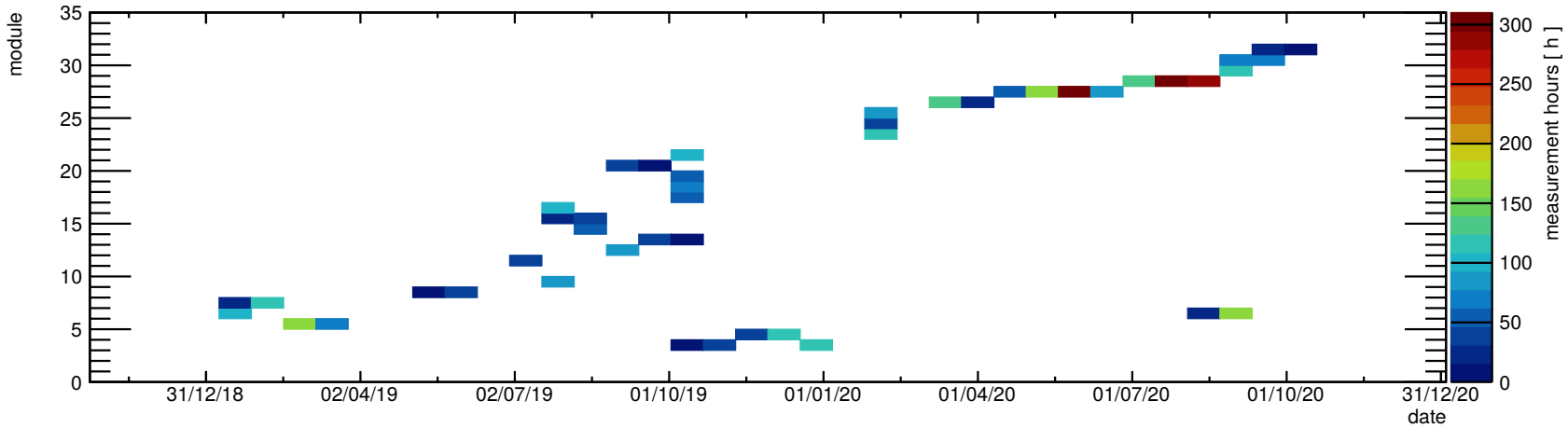
⇒ good agreement between measurements within error estimation

⇒ summary of single mask residuals reconstruct systematics during gluing

Summary

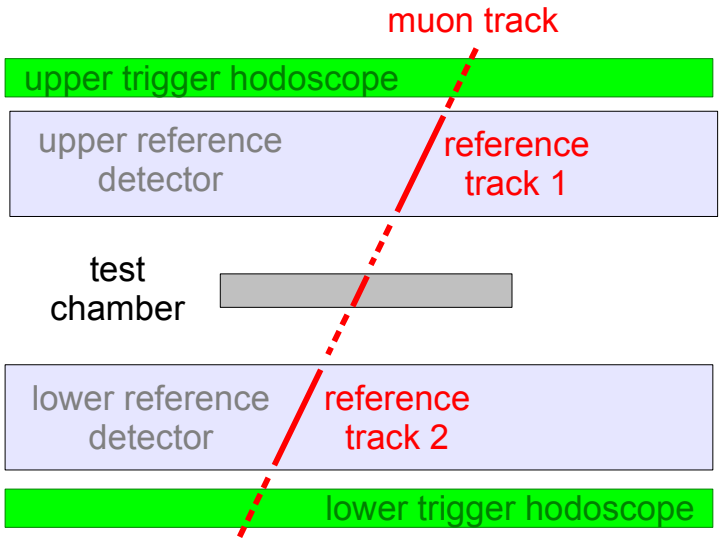
quality control of the full SM2 active area using cosmic muons

- alternative method for tracking implemented to check efficiency reconstruction
  ⇒ compatible results of internal and external tracking
- pulsheight dependencies investigated:
  - pillarheight-trends visible
    ⇒ magnitude not yet correlated
  - pressure-dependence for each PCB individual
    ⇒ pillarheight correlation in the order of -3 % / µm
- improved alignment reconstruction by Fabian Vogel using multiple measurements
  ⇒ calibration of jig and CMM



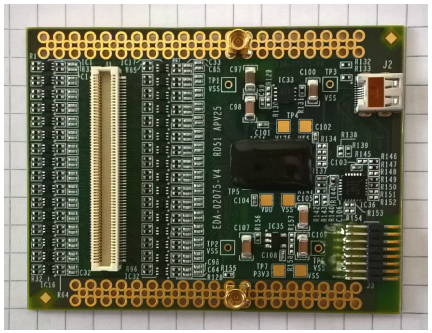
Backup

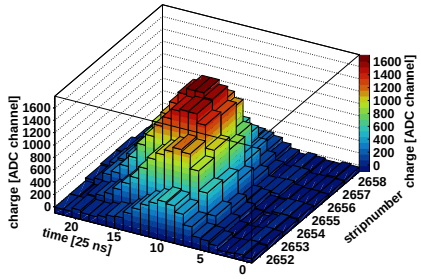
Validation using Cosmic Muons - **C**osmic **R**ay **F**acility

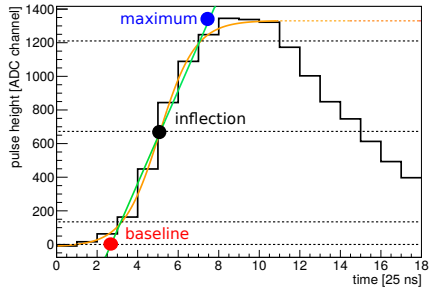


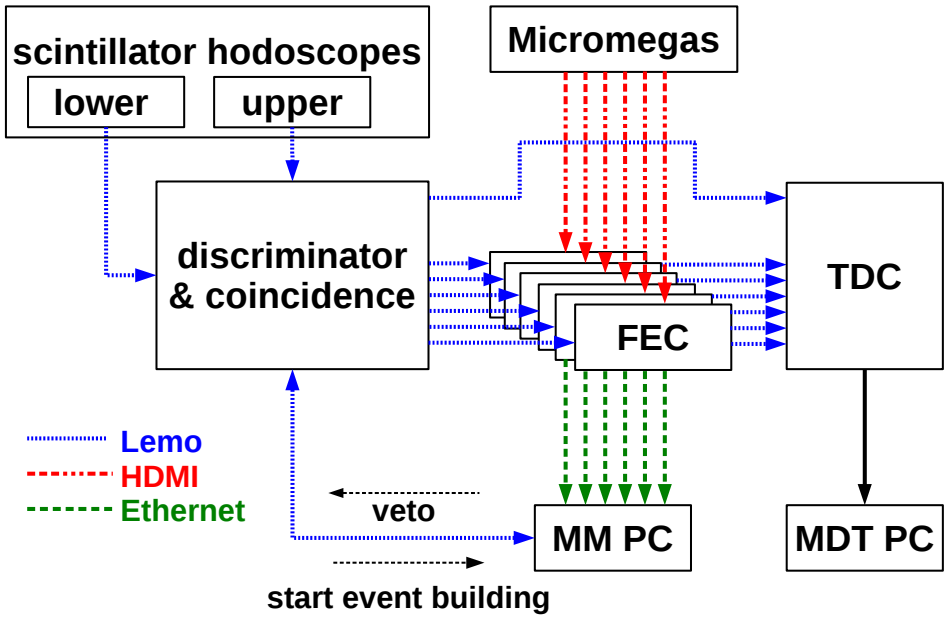
trigger	scintillator hodoscope resolution $\sim$ 10 cm
track reconstruction	Monitored Drift Tubes (MDTs) resolution $\sim$ 0.2 mm
active area	2.2 m $\times$ 4 m
angular acceptance	$\pm$ 30°
energy cut	iron plate $\rightarrow E_\mu > 600$ MeV
readout (full module)	12288 channels
readout rate	100 Hz (online zerosuppression)

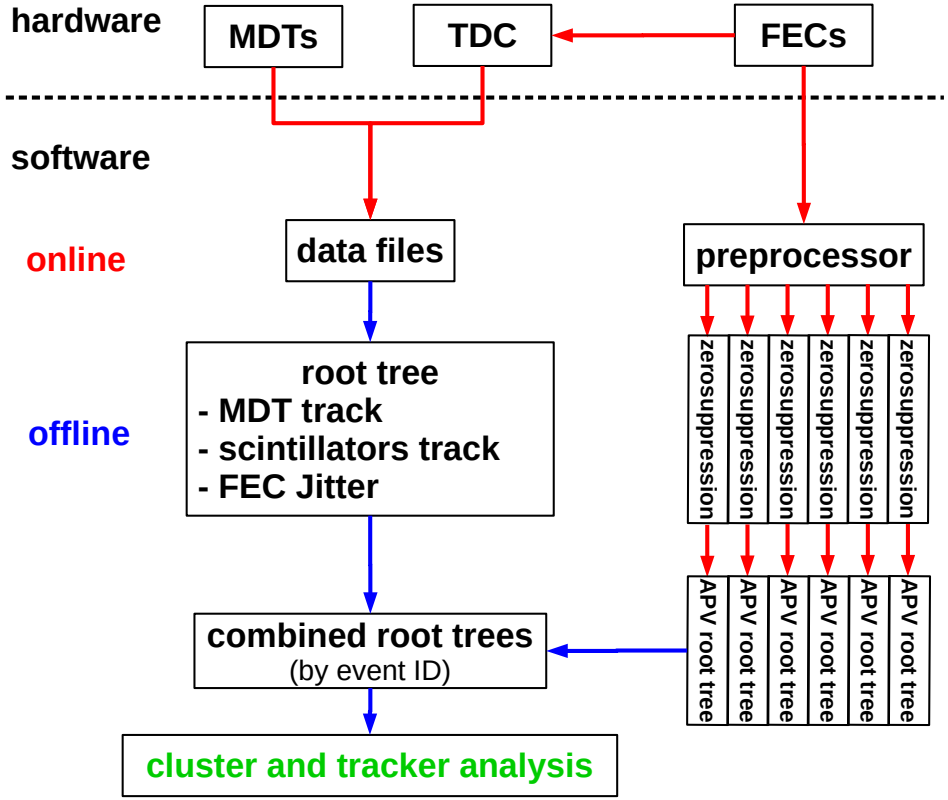
SRS-based Data-Acquisition



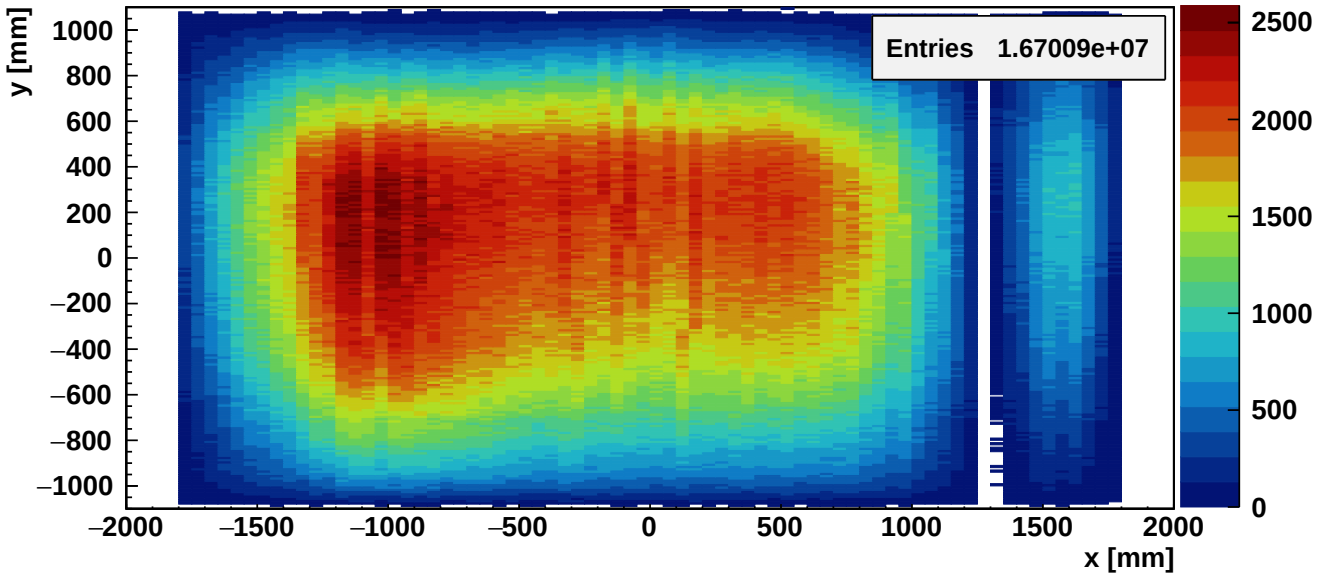




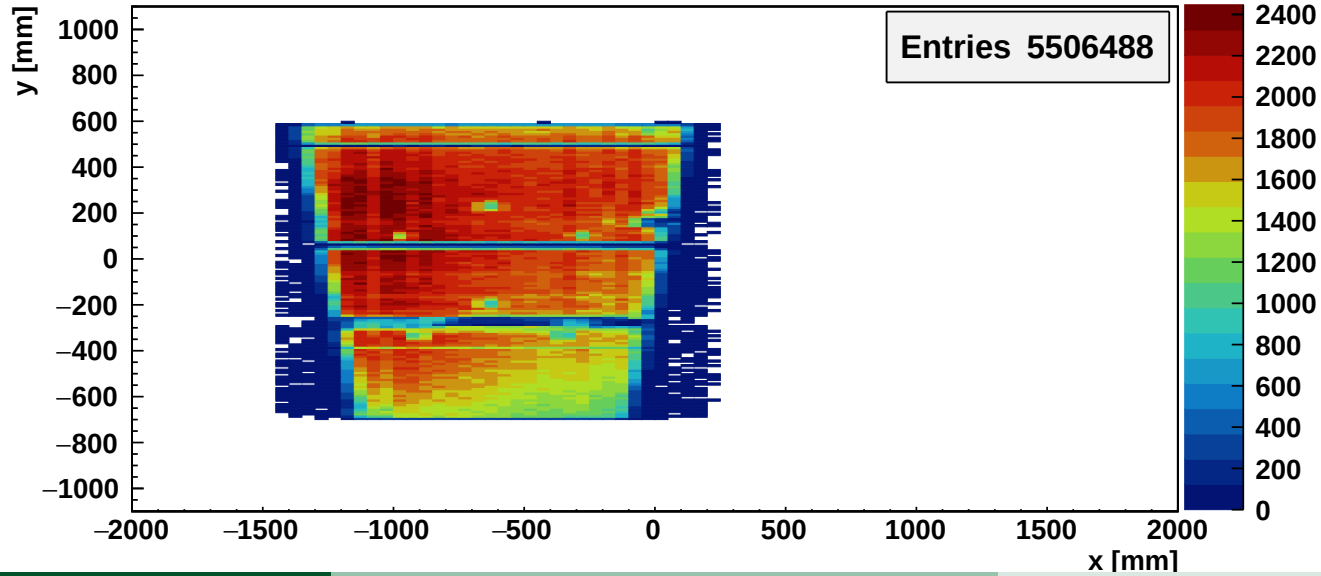




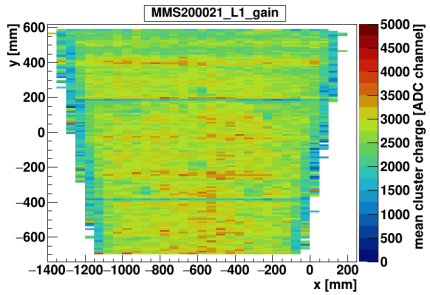
CRF hit distribution

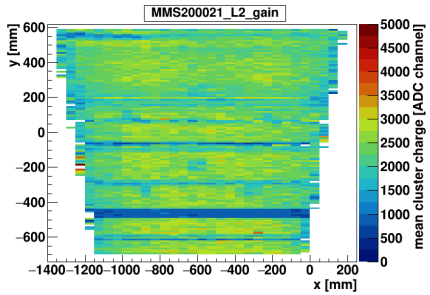


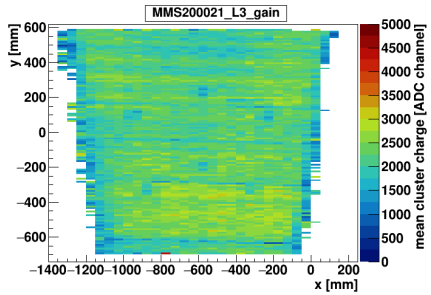
M3 eta_out, 5 mm efficient

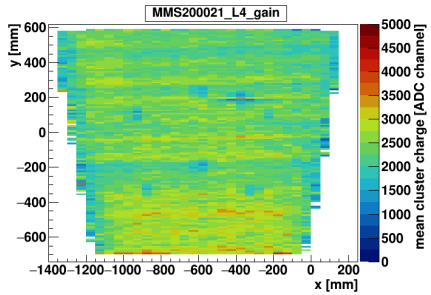


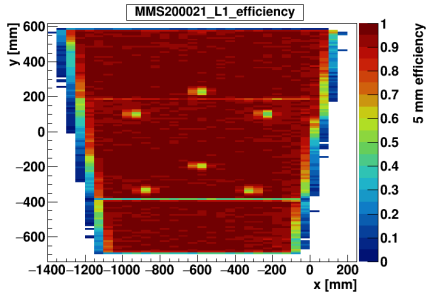
Pulse Height and Efficiency (Ar:CO_2 93:7 vol%) Module 21

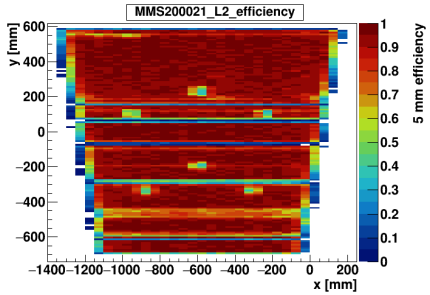


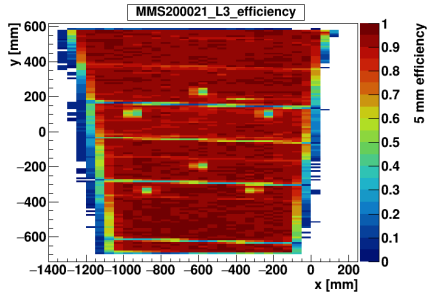


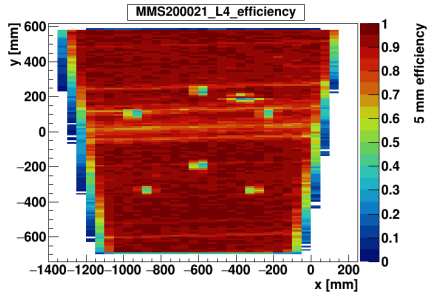


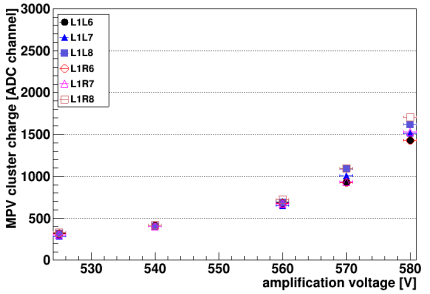


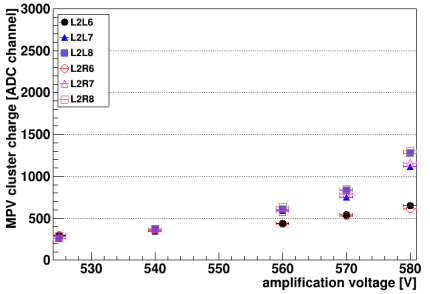


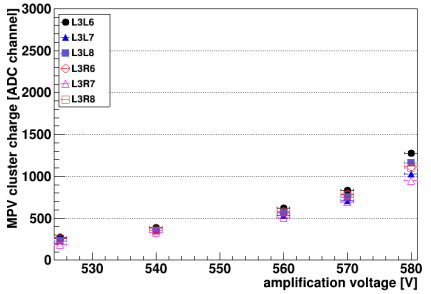


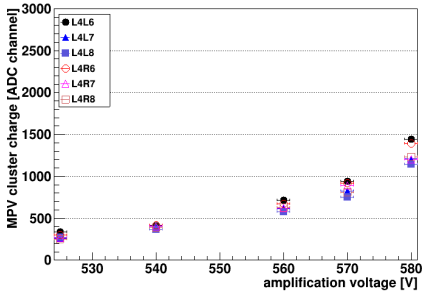


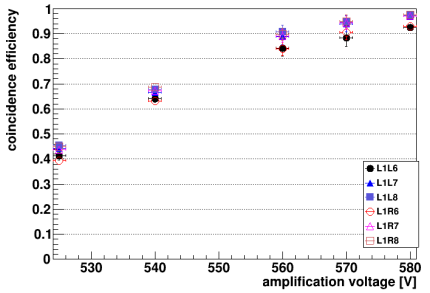


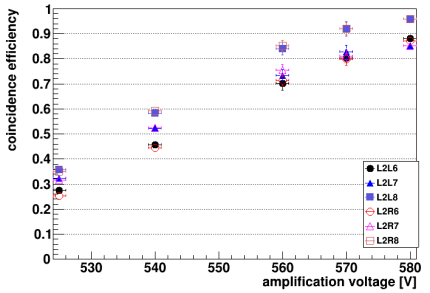


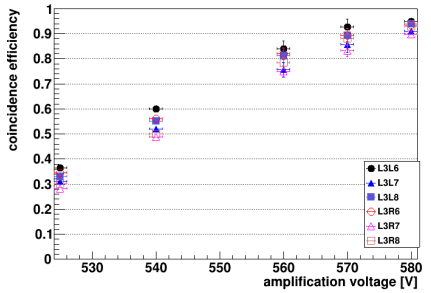


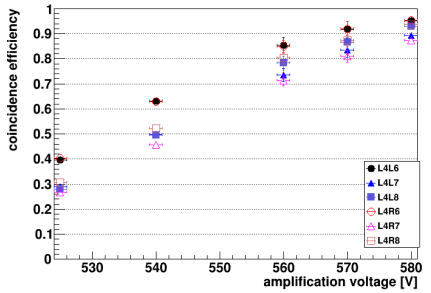






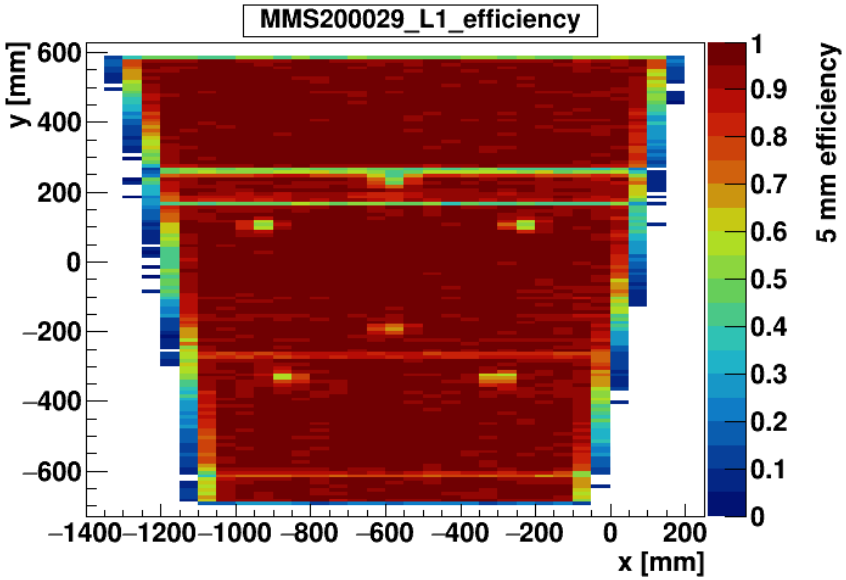


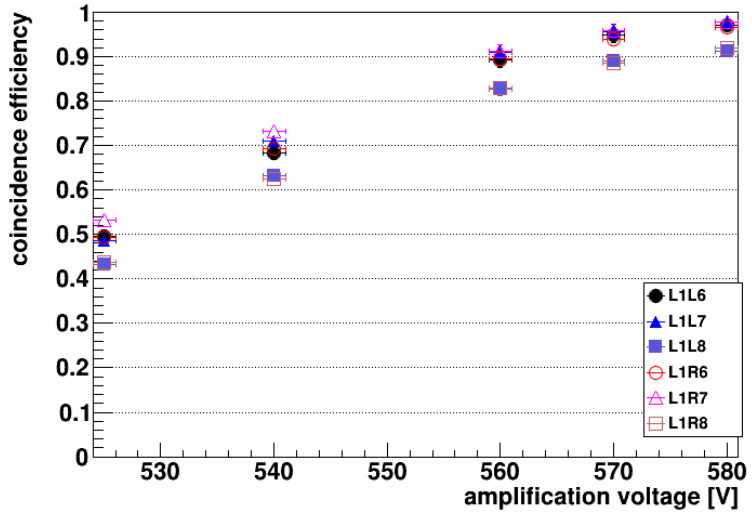




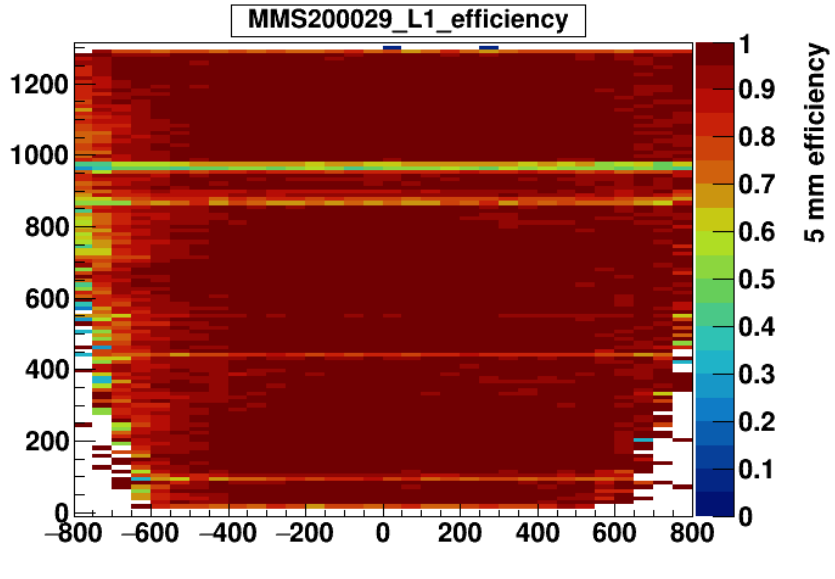
Comparison of External and Internal Efficiency Estimation (e.g. M29, eta-out)

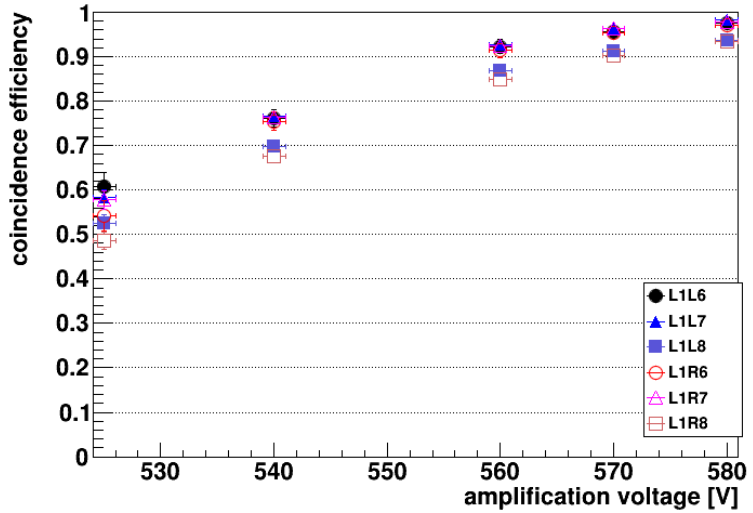
MDT tracks





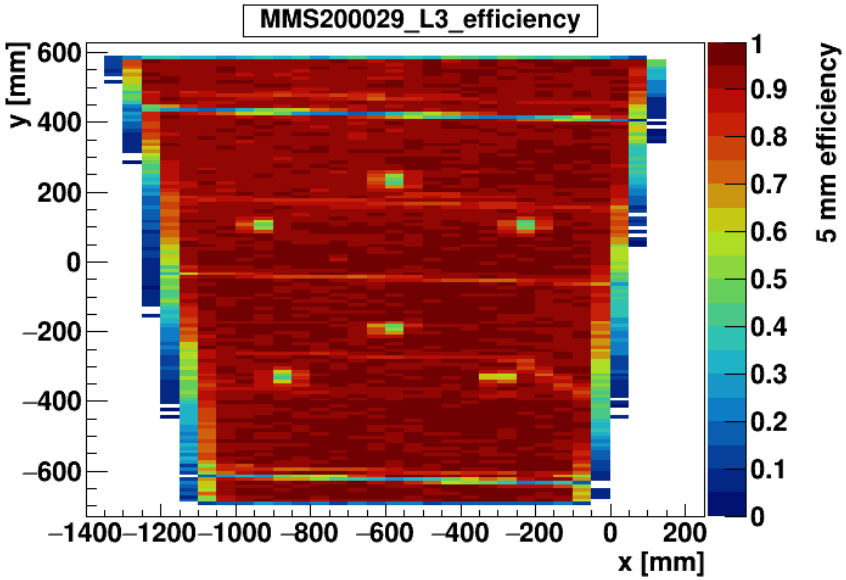
internal

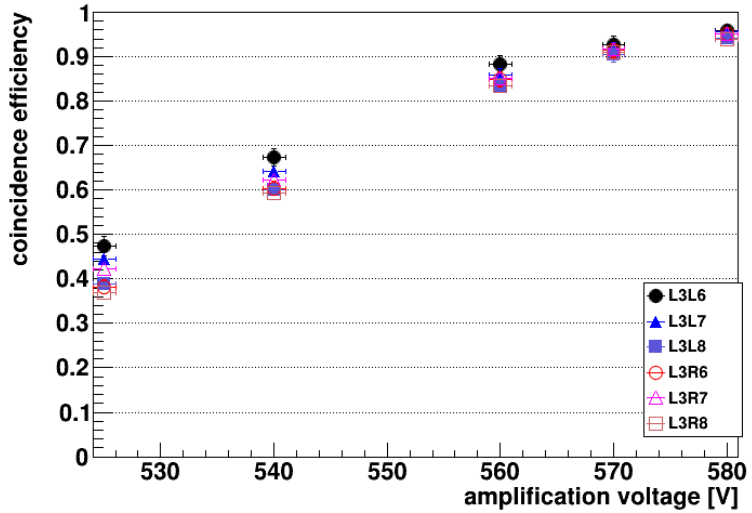




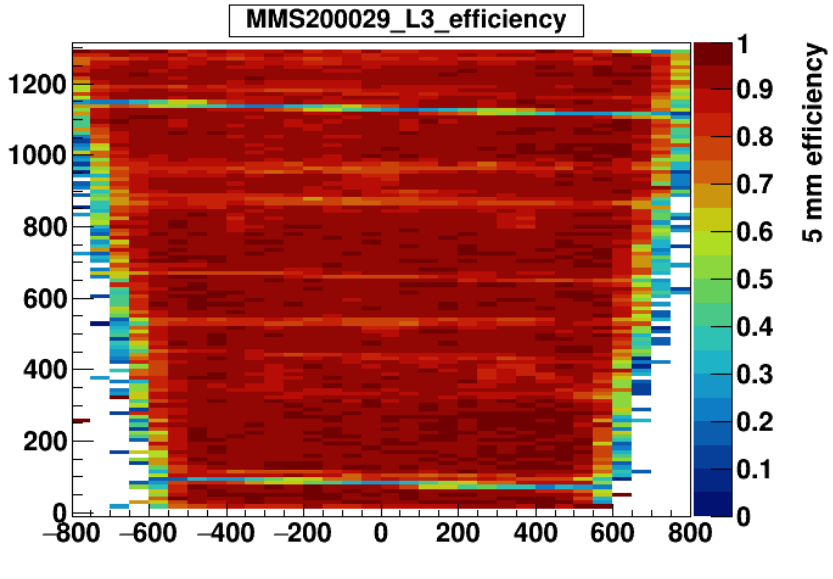
Comparison of External and Internal Efficiency Estimation (e.g. M29, stereo-in)

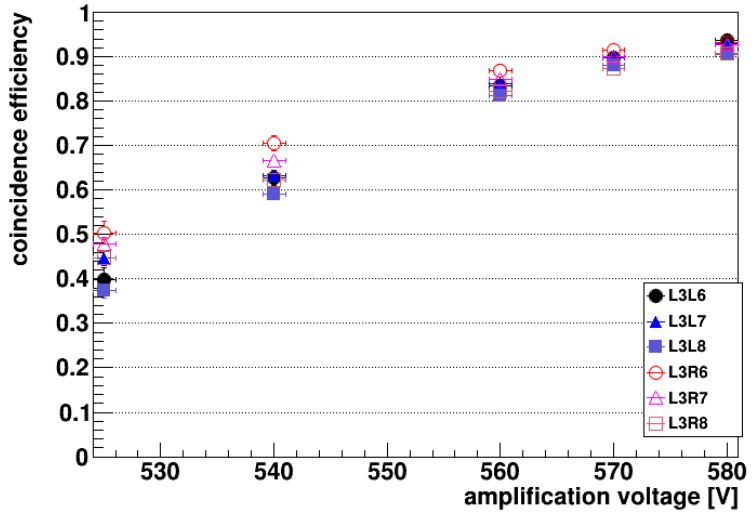
MDT tracks





internal





Theoretical Gain Description

Gain by Townsend (1910) :

$G = \exp\left[\boldsymbol{d} \cdot \alpha\right]$

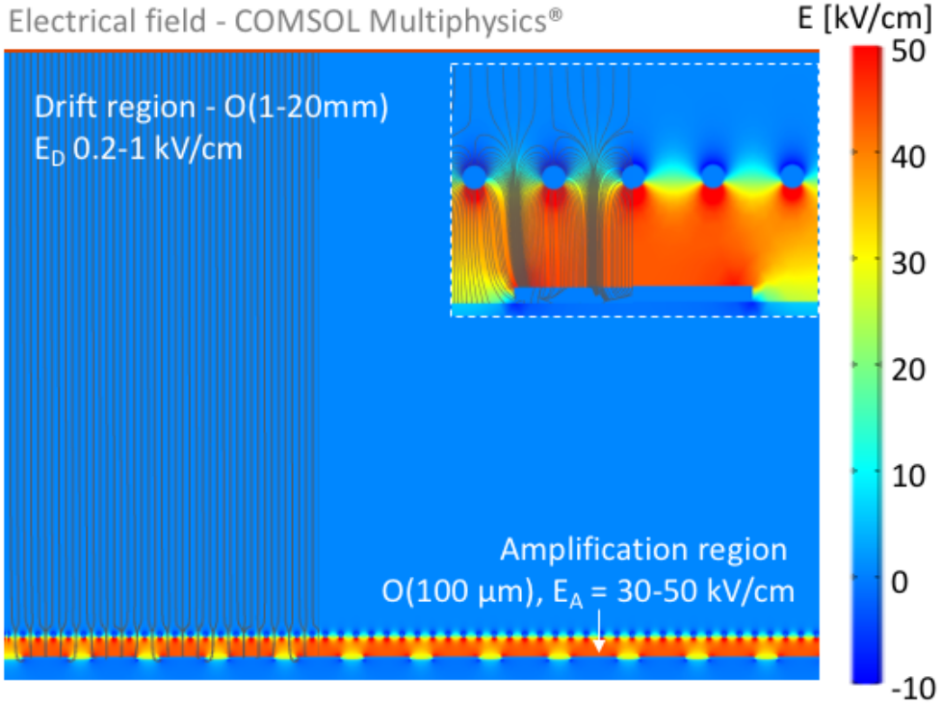
α by Rose and Korff (1941) :

$$G = \exp\left[\; d \cdot \frac{pA}{T} \cdot \exp\left(-\frac{dpB}{TU}\right) \;\right]$$

effective description :

$G = \mathrm{f}\,(dp; U)$

fieldsimulation, Kuger (2017)

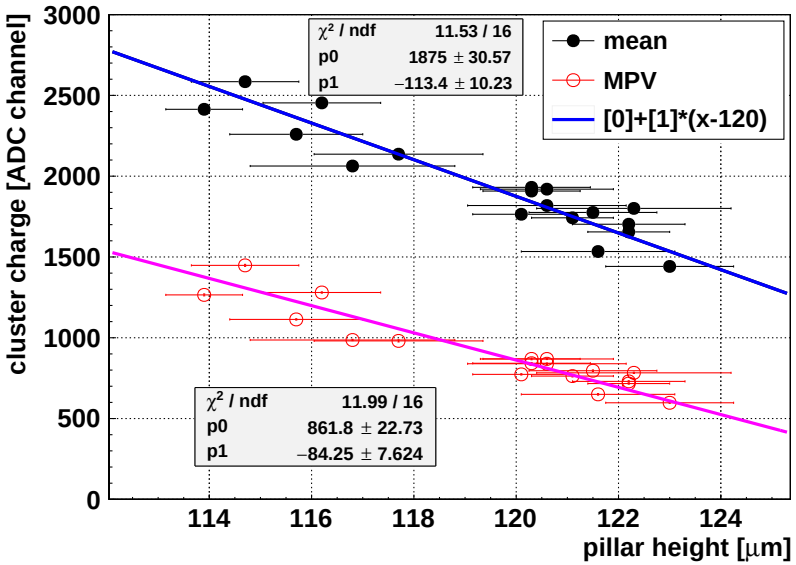


paper by Giomataris mentioning the prospects of a large sample of gap widths ($d \mathrel{\hat{=}}$ pillar heights):

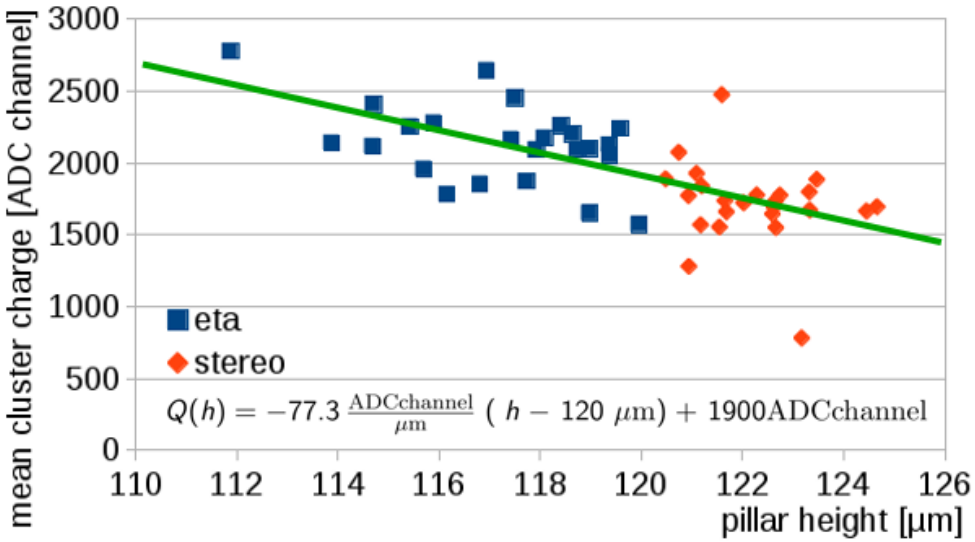
`https://www.slac.stanford.edu/pubs/icfa/fall99/paper1/paper1.pdf`

Pulse-Height Amplification-Gap Dependence

M8 and Eta3-Doublet
(same measurement period)



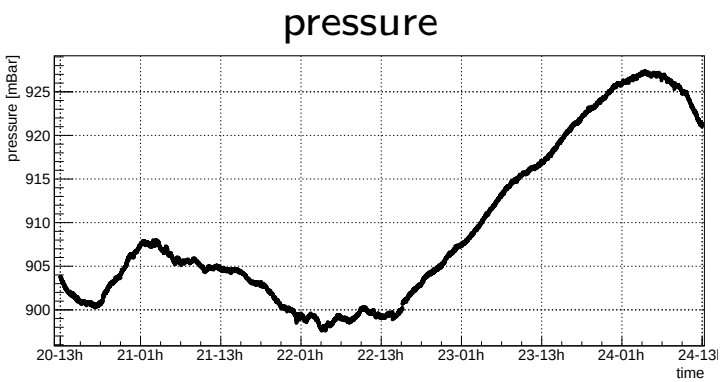
modules 1,3,6,7

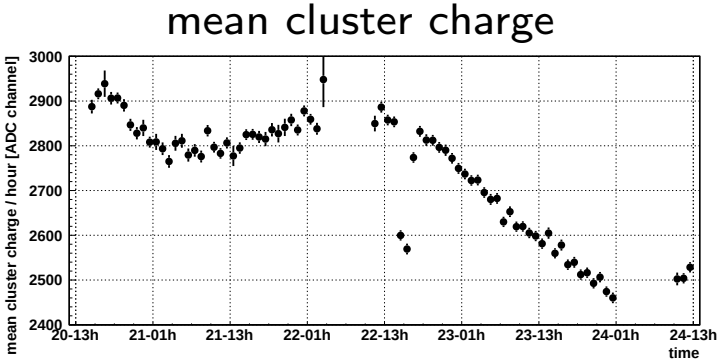


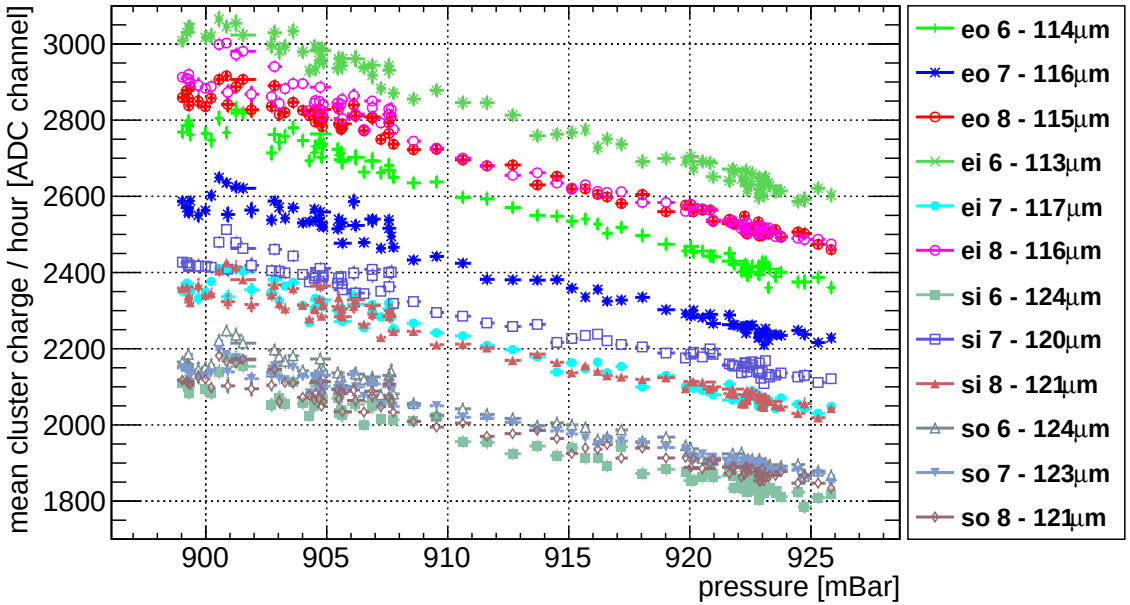
⇒ for a single measurement period a good correlation is given

⇒ comparison of different periods require pressure compensation

Pulse-Height Pressure Dependence (M3 long term test)







$\Rightarrow$ clear pressure dependence, as expected

$\Rightarrow$ dependence on pillar-height NOT straight forward

(pressure biased: offset about 30 mBar)