Performance of the TH2 MicroMegas Chamber

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Introduction

- Resistive strips have successfully been implemented in the MicroMegas layout as spark protection
- Signal obtained on readout strips transmitted through AC coupling with resistive strips
- Studies conducted to investigate if the strength of the signal obtained on the readout strips is affected by two different features in the construction

    1) The thickness of the insulation between the resistive strips and the readout strips

    2) The material of the frame used to enclose the gas-volume

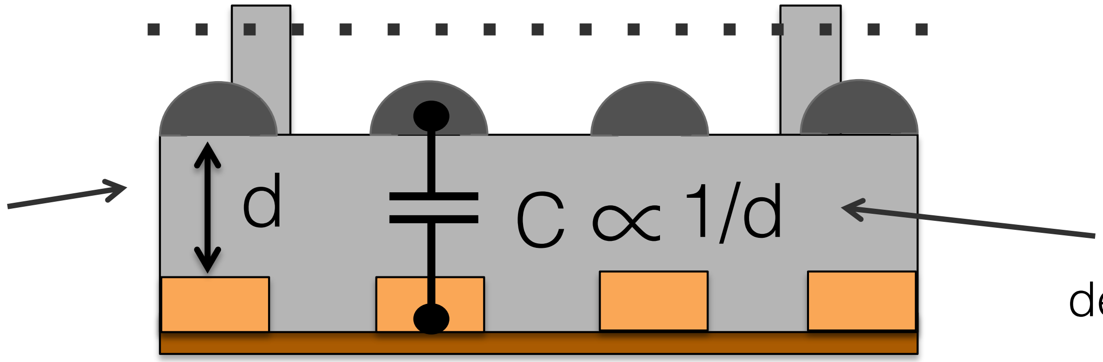
The TH Chambers

- The TH series (TH for *thin*) was developed with the aim of studying if the thickness of the insulation between the resistive and readout strips affects the strength of the obtained signals

- Insulation between resistive and readout strips reduced from ~75 μm to ~24 μm
  → Expect stronger AC coupling between the two strip layers

Sketch of MM perpendicular to strip direction (not to scale)

Insulation:
12 μm kapton
12 μm glue

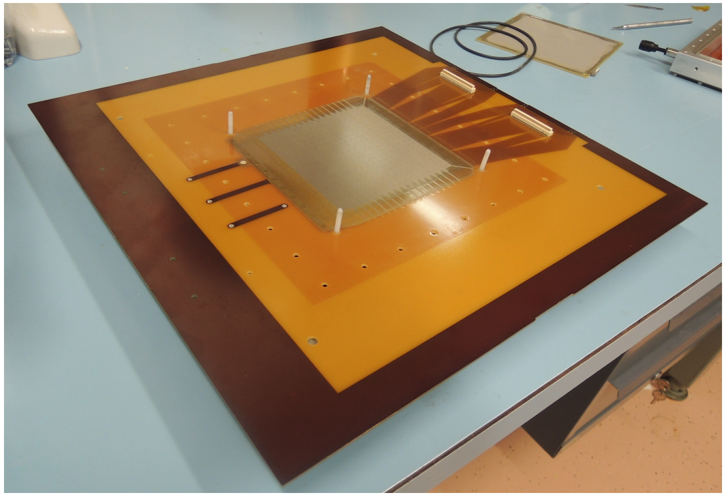


Coupling depends on d

The TH Chambers

- Resistive strips made with screen printing-technique
  - Previously done with deposition of resistive paste

- Studies conducted with the TH2 chamber
  - Resistive bulk →
  - Active area: 10x10 cm^2
  - *x* coordinate read-out
  - 256 strips
  - Strip pitch: 400 μm
  - Strip width: 300 μm

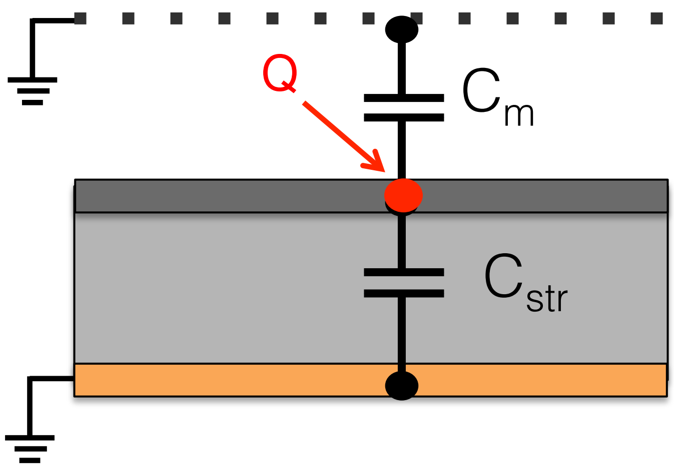


- Response from TH2 to be compared with that of the T3 chamber

AC Coupling Strength

- The charge Q induced on the resistive strips will experience two capacities
  1) C_m - from resistive strips to mesh (ground)
  2) C_{str} - from resistive strips to readout strips (ground)
- The ratio C_{str} / C_{tot} will determine how much of Q will be sensed on the readout strips
- All capacities will be defined by $C = \epsilon A / d$, where A is the area over which the charge is spread

Simplified electrical circuit



AC Coupling Strength

- Assuming the charge spreads over the same area on the resistive strips in the chambers (depends on the resistivity), the capacities will be →

$$C_m = A\,\epsilon_0 / 128\ \mu m \approx \underline{\underline{0.1\ pF}}$$
$$C_{strTH2} = A\,4\epsilon_0 / 24\ \mu m \approx \underline{\underline{2.2\ pF}}$$
$$C_{strT3} = A\,4.5\epsilon_0 / 75\ \mu m \approx \underline{\underline{0.8\ pF}}$$

- The fractional capacitance from the resistive strips to the readout strips will be →

TH2: 2.2 pF / (0.1 + 2.2) pF ≈ 95%
T3: 0.8 pF / (0.1 + 0.8) pF ≈ 89%

- Assuming the induced charge is constant, the signals in TH2 are expected to be a few % larger w.r.t. chambers with “standard” insulation

Measurement Program

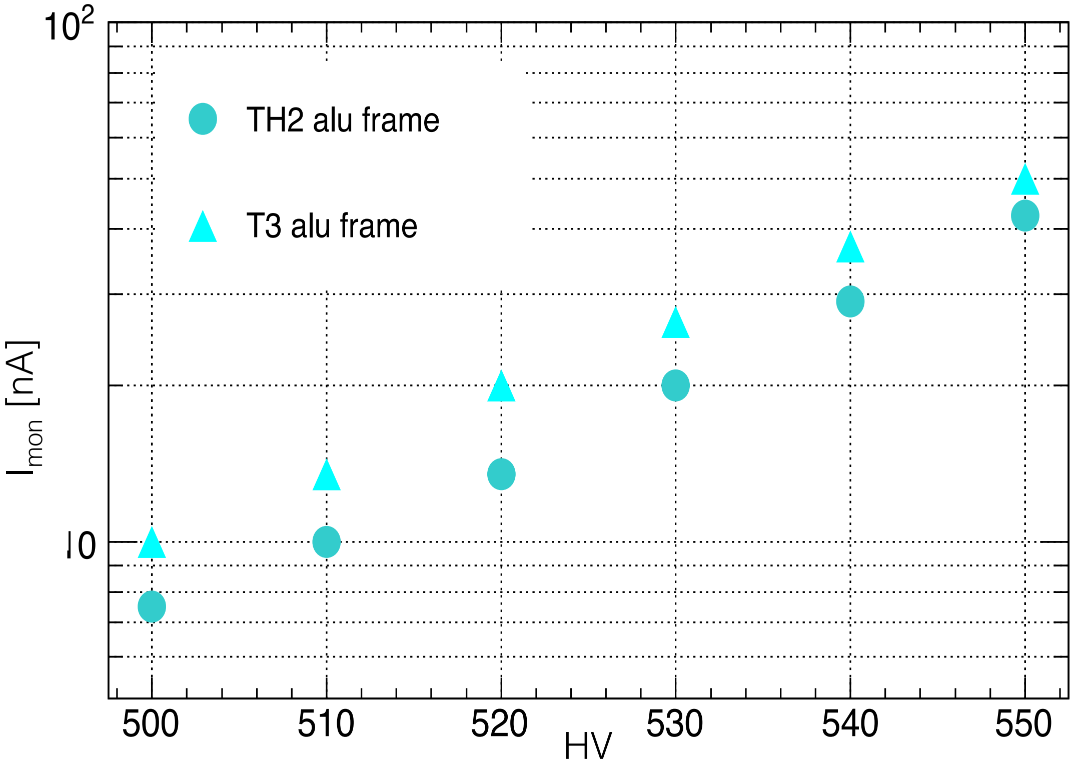
- Compare the strength of the signals from TH2 and T3

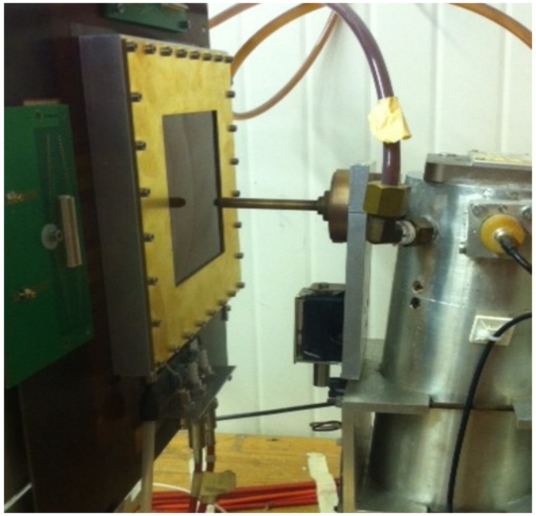
  - Eliminate effects from possible variations in the gas gain
    - Measurements with X-ray allowed to calibrate the gain of each detector

  - Estimate signal coupling from offline analysis of cosmic data taken with APVs

Gas Gain Estimation

- Differences in the gain of the chambers were identified by monitoring the detector current from the HV supply during exposure to 8 keV Cu X-rays





- HV scan performed with TH2 and T3

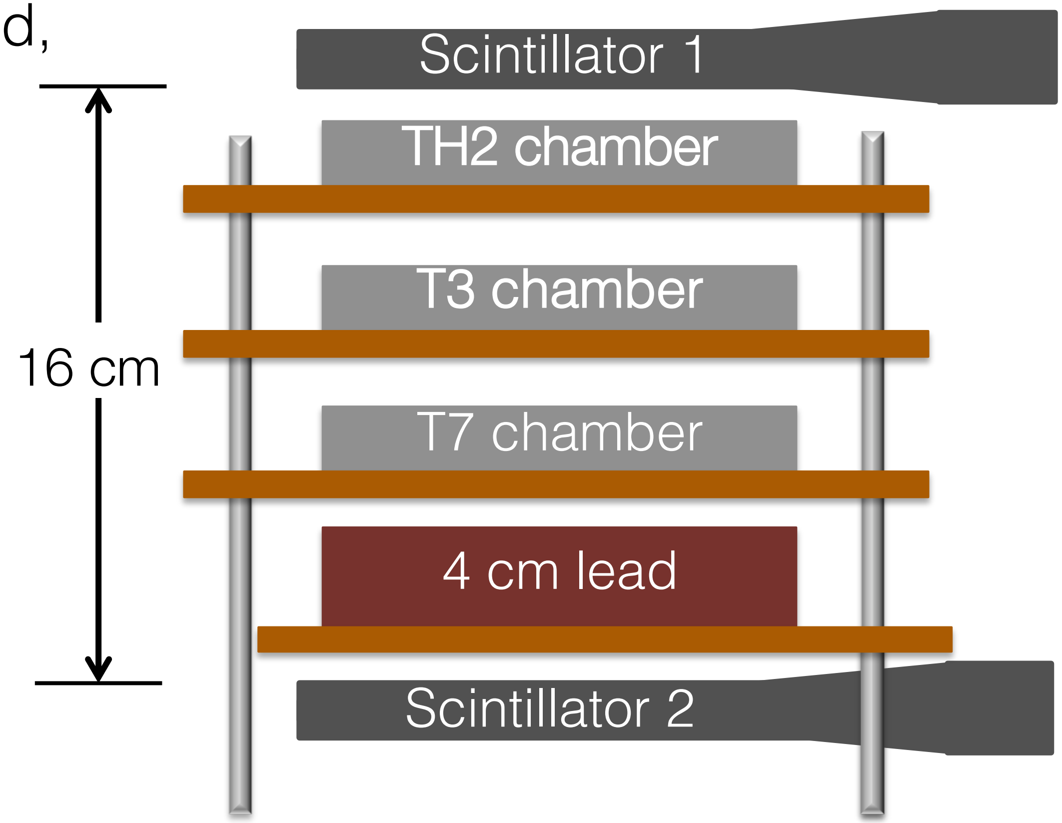
- A constant offset between the two chambers of 10 V was found

Cosmic Stand

- The TH2 and T3 chambers were installed in cosmic stand to evaluate their charge response induced by MIPs

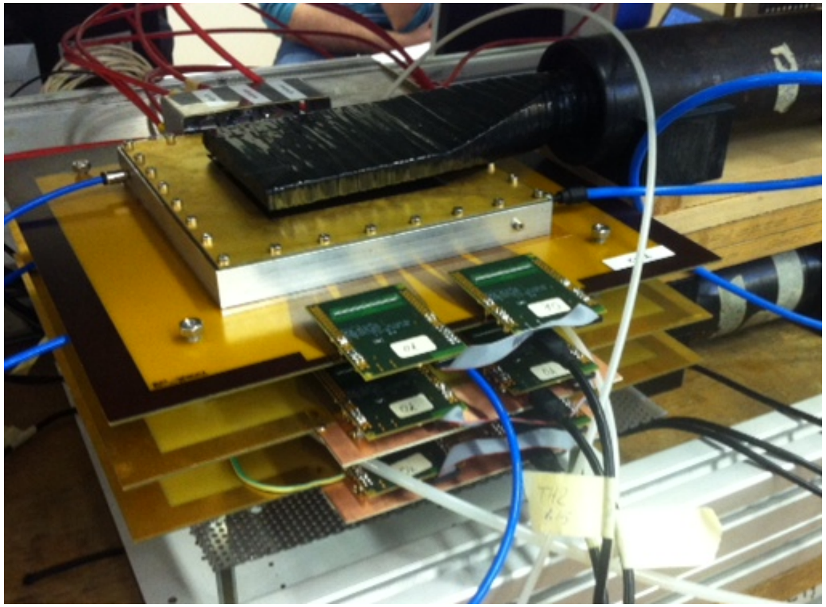
- T7 also installed in the stand, used as a reference to monitor environmental fluctuations

- 4 cm lead inserted to cut out low-energetic cosmics



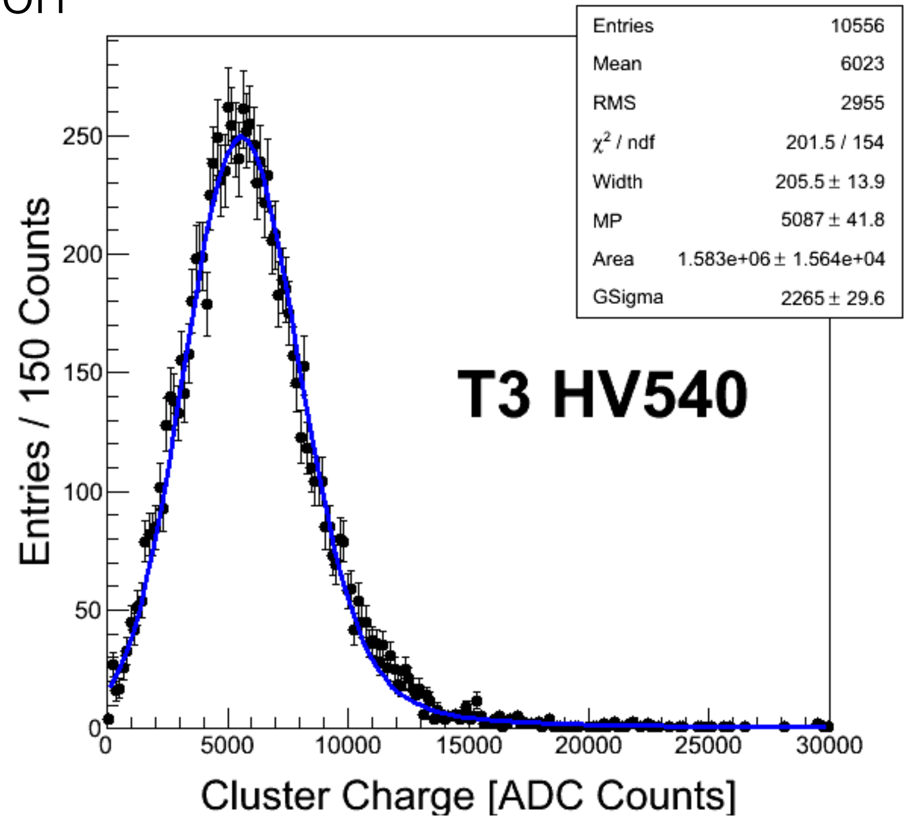
Cosmic Stand

- Each chamber read out with 2 APVs connected to SRS crate
- Trigger on coincidence in the two 10x10 cm^2 scintillators
  - Rate ~0.5 Hz
- Gas mixture: 93% Ar, 7% CO_2
- Events recorded per run: ~5k



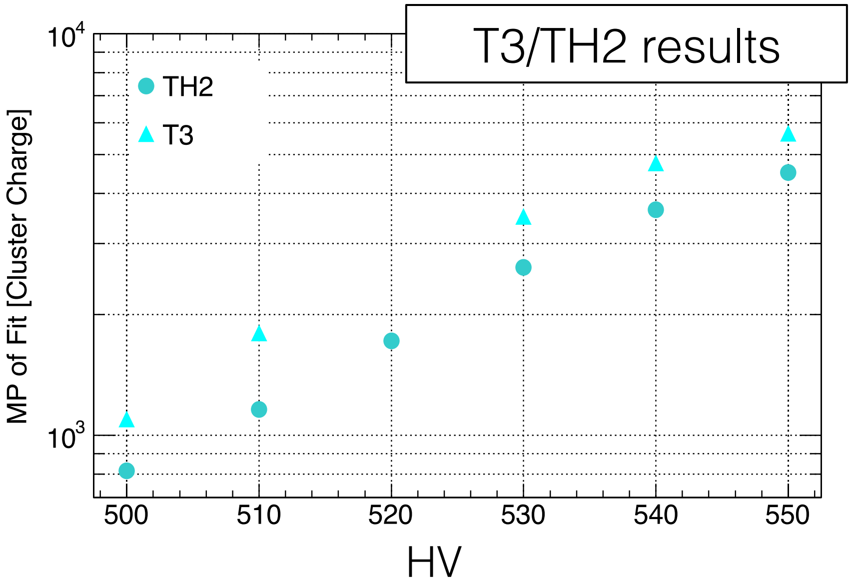
Cluster Charge Distributions

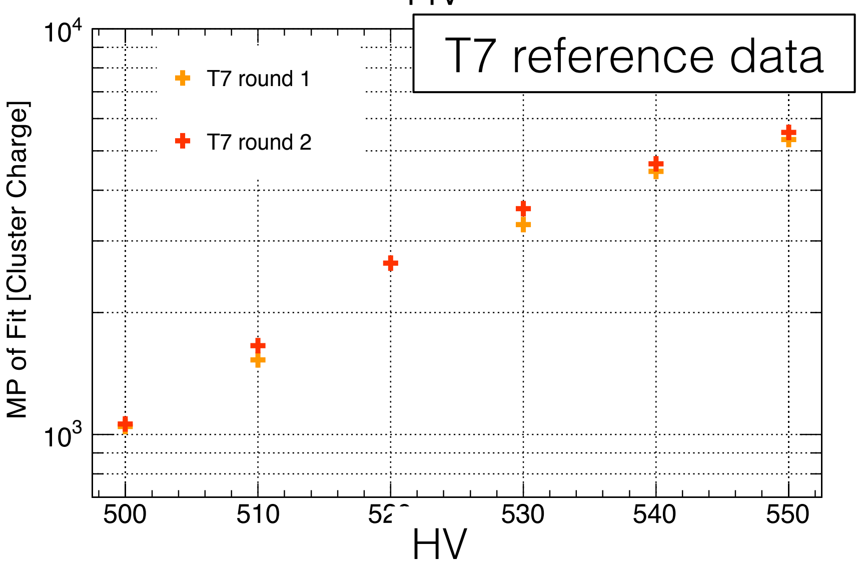
- The distributions of integrated cluster charge were reconstructed in the offline analysis
- Distributions fitted with convolution of Landau and Gauss
- The MPV of the fit will in the following be used to represent the signal coupling



Cluster Charge Distributions

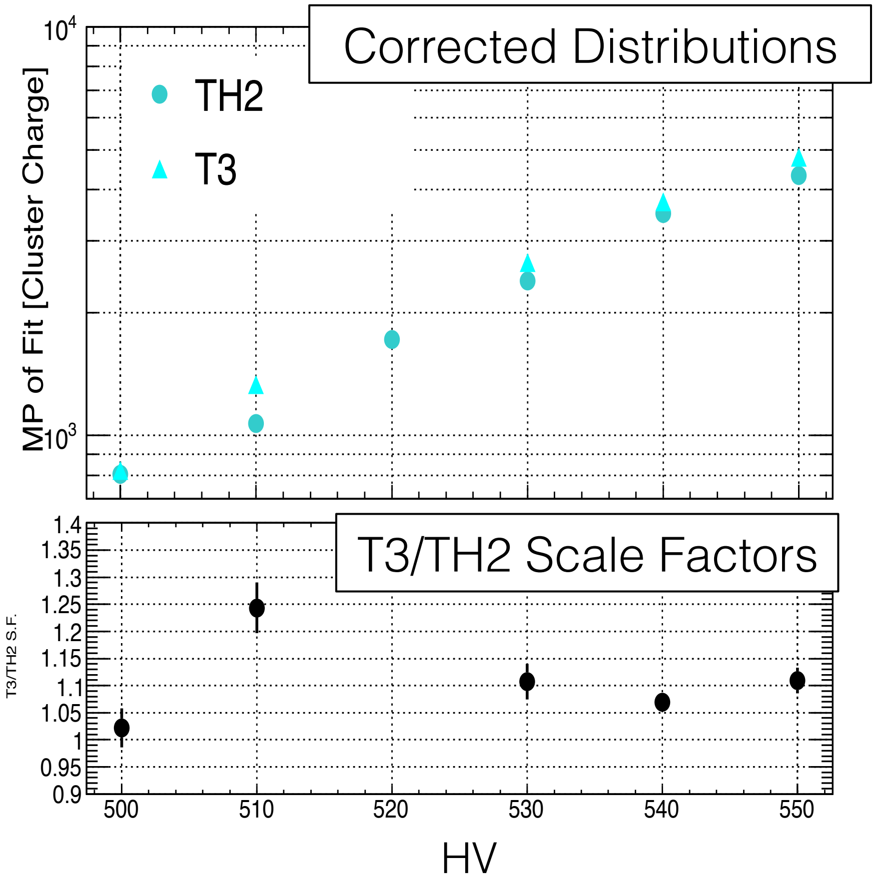
- MPV of cluster charge distributions vs. HV
- 10 V shift seen in the T3/TH2 curves (as observed in the X-ray data)
- Small shift observed in the reference chamber (most likely due to an environmental shift)
- (data point for HV 520 missing)





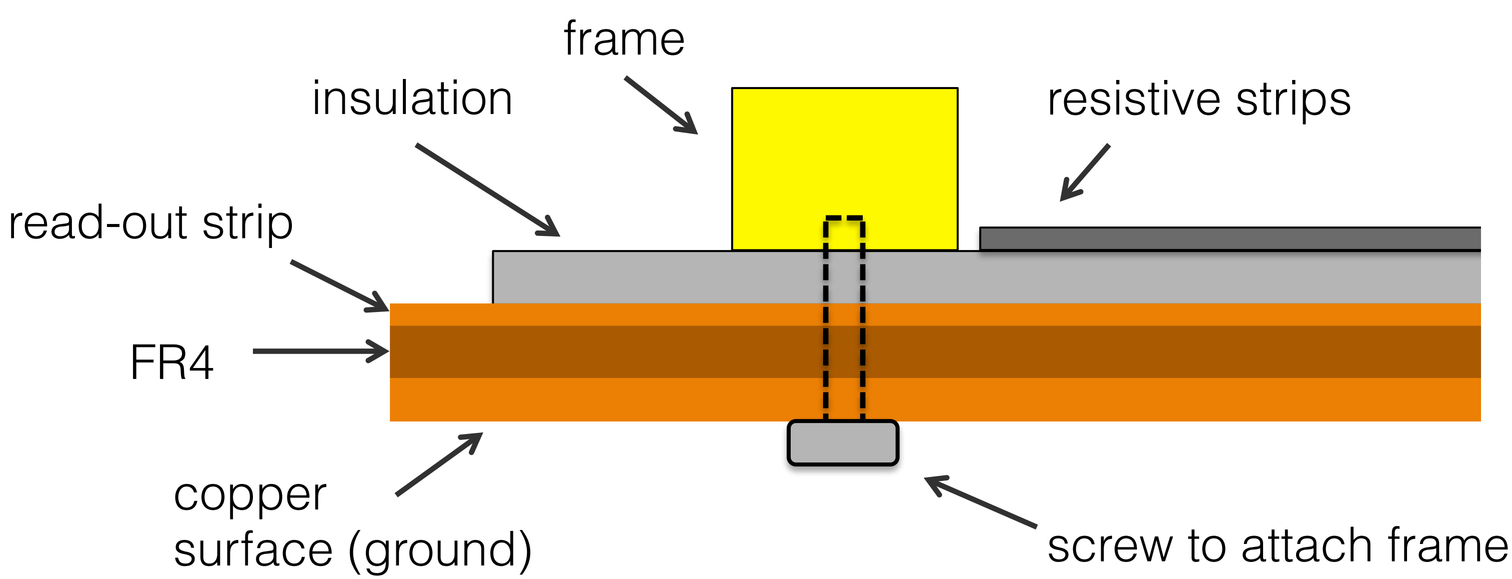
Cluster Charge Distributions

- MPV distributions corrected for
  1) differences in gas gain
  2) T7 reference measurements
- Response from T3 is 5 -15% higher than from TH2 (contrary to the expected)
- A result of differences in the resistivity of the res. strips?



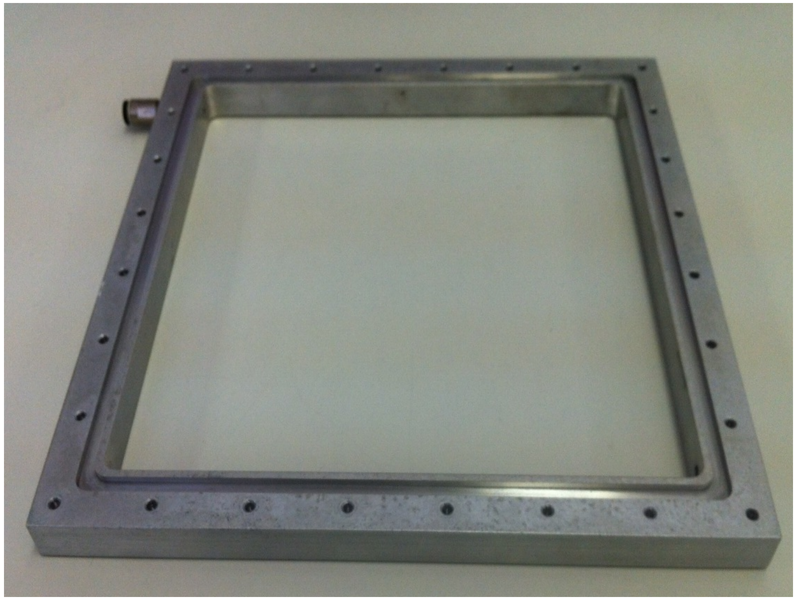
Effects from Frame Material

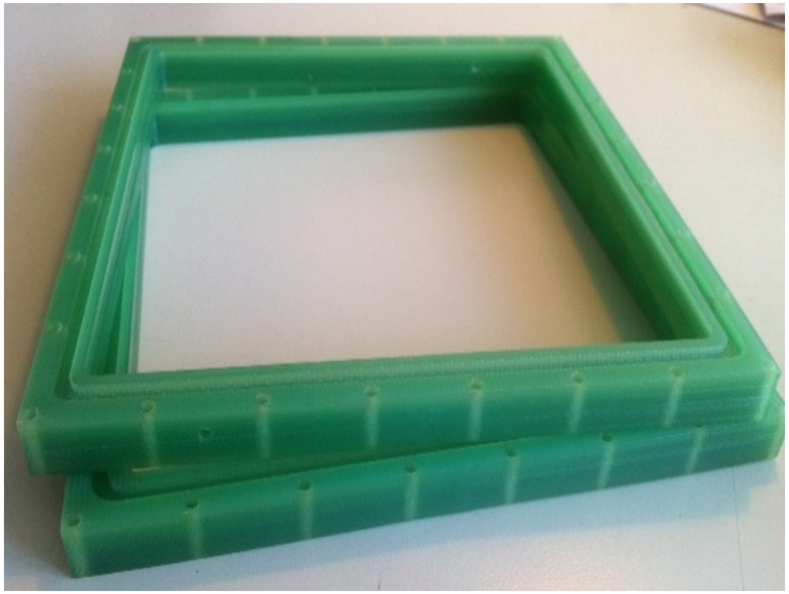
- The choice of material of the frame used to enclose the MM gas-volume might affect the signal strength
- The frame is grounded through the mechanical connections
  → a conductive frame might introduce a parasitic capacitance from read-out strips to ground



Effects from Frame Material

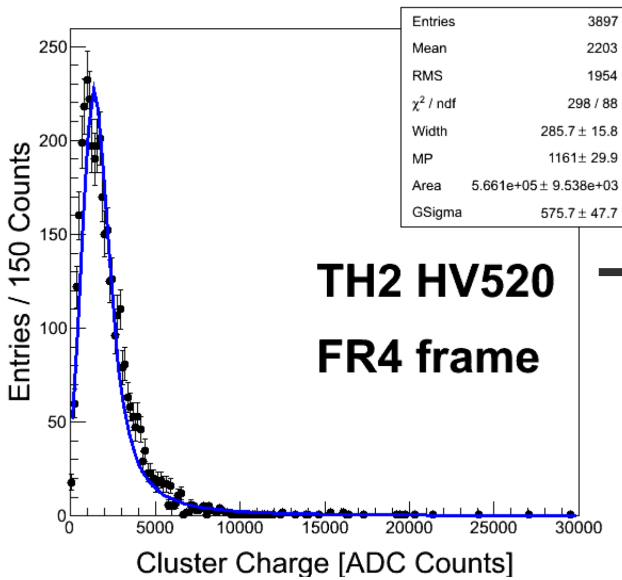
- Previous measurements in cosmic stand performed with two frames of different materials
  - default aluminum frame
  - FR4 frame (non-conducting)

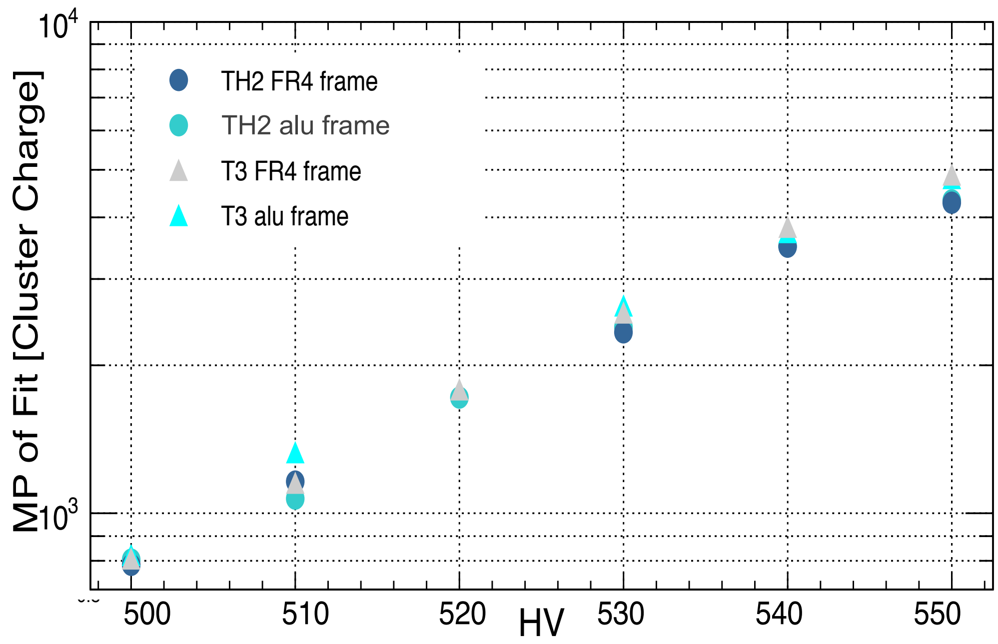




Effects from Frame Material

- Fitted cluster charge distributions examined
- MPV distributions for TH2 and T3 with both frames (corrections applied)
- No noticeable effect imposed by the frame material





Summary

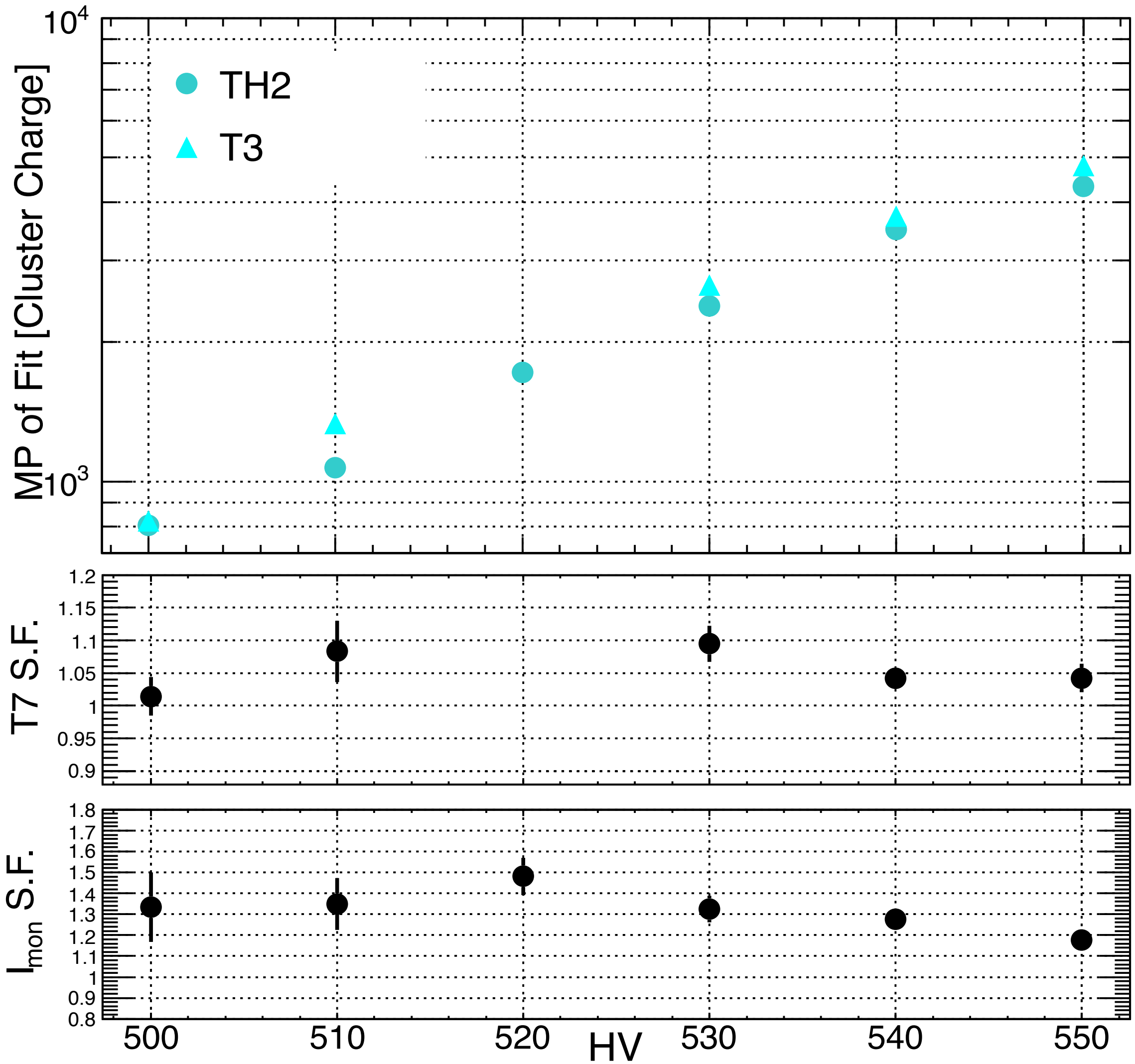
- The influence from the insulation thickness on the signal strength in the TH2 and T3 chambers was studied
  - Calculations showed that a factor 3 reduction of the insulation thickness only should result in a few % difference in the signal strength
  - The signals from T3 were found to be a few % larger than from TH2, most likely because of different value in resistivity of the resistive strips
    - Not fully understood, comments from the community are welcome!

- Effect from the frame material on the signal strength was studied
  - Effect found to be negligible

Thanks for your attention

BACKUP

Backup



TH2
T3
MP of Fit [Cluster Charge]
10^4
10^3
T7 S.F.
1.2
1.15
1.1
1.05
1
0.95
0.9
I_{mon} S.F.
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1
0.9
0.8
500
510
520
530
540
550
HV