High-Resolution Micromegas Telescope for Pion- and Muon-Tracking

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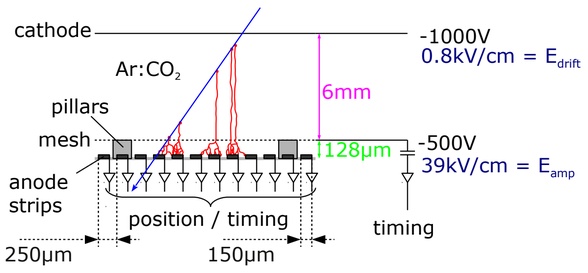
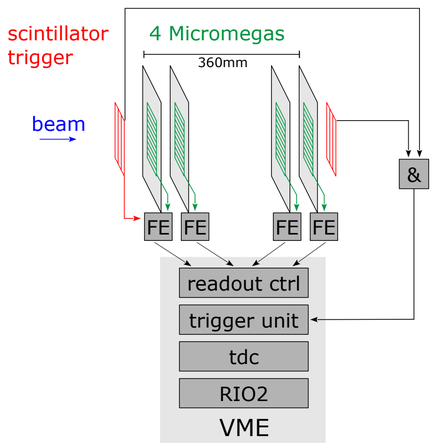
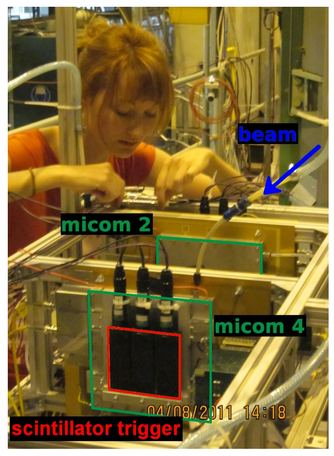
SETUP OF MICROMEGAS TRACKING SYSTEM

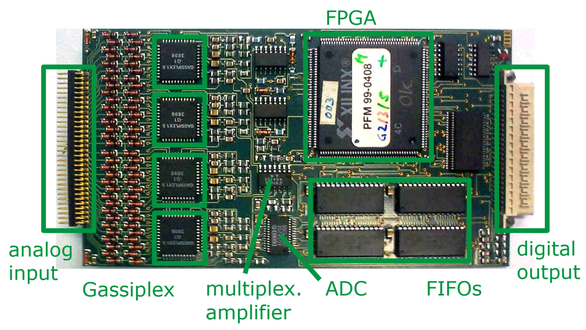
- 4 Micromegas detectors
  - ionization in 6mm drift region
  - amplification in 128µm amplification region
  - 360 copper strips, 250µm pitch, 150µm width, 100mm length
- gas: Ar:CO_2 85:15 & 93:7 @ 1013mbar
- 2 x 3 trigger scintillators, perpendicular to Micromegas strips → 3rd track coordinate
- calibration experiments with 160GeV pions and muons at H6- and H8-beamline at CERN

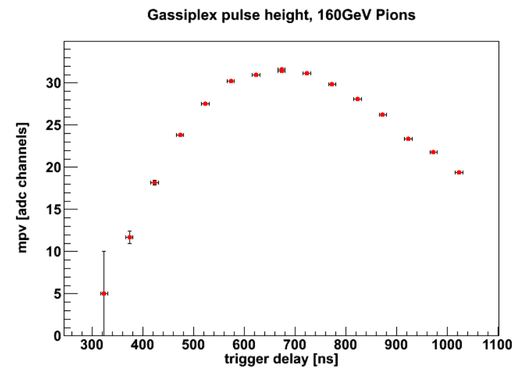






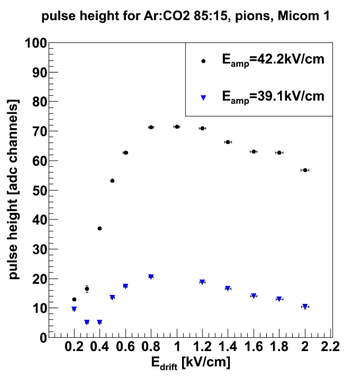
READOUT ELECTRONICS

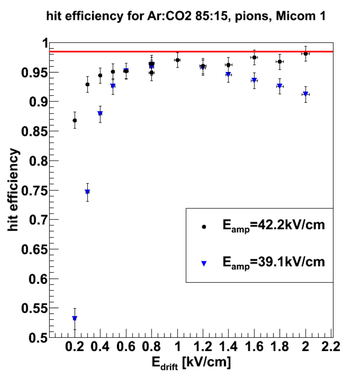




- preprocessing frontend modules
  - 4 charge sensitive 16ch Gassiplex chips → 64 channels/board
  - A/D conversion
  - threshold comparison → data reduction
  - developed for HADES RICH → reconfigured analog section to adapt to Micromegas negative signals and discharges
- Readout Controller (VME)
  - communication with frontend boards
- Detector Trigger Unit (VME)
  - busy handling, trigger handling, channel mapping
- RIO2: VME powerPC
  - readout sequence control
  - data buffering
  - communication with DAQ computer

EFFICIENCY AND PULSE HEIGHT OPTIMIZATION



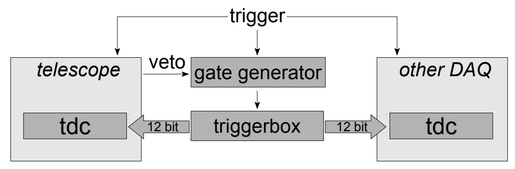


pulse height
low E_{drift}:
- poor separation of ions and electrons
- recombination
- gas dependent

high E_{drift}:
- low electron transparency of the mesh

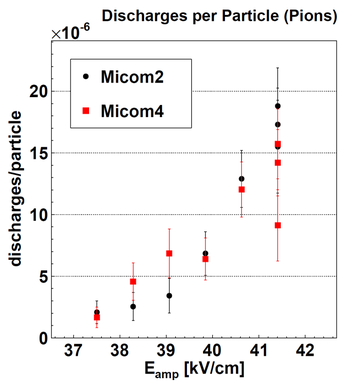
efficiency
- **best measured value: 98.5%**, corresponds to area fraction of mesh supporting pillars

SYNCHRONIZATION OF TELESCOPE WITH OTHER DAQS



- triggerbox
  - 12 bit scaler, counts triggers
  - output: trigger number as 12 bit NIM signal
- ≥12 channel tdc in each DAQ system → record trigger number for each event → offline synchronization possible

DISCHARGES IN HADRON BEAMS



ionization clusters with $>10^4$ electron-ion-pairs can create non-destructive discharges between mesh and anode → ~20ms dead time, data taking not interrupted

without beam/muons:
- discharges dominated by small detector defects
- discharge rate between 1/30min & 1/5min

↔ **<0.04% dead time → completely negligible**

pions:
- particle rate ~22kHz
- discharge rate 0.33Hz

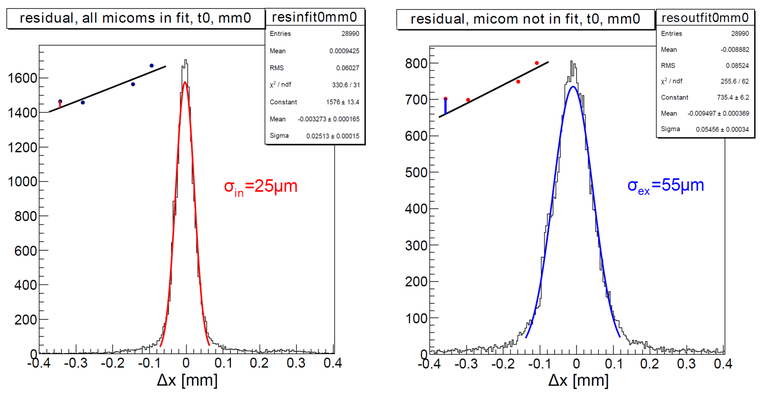
↔ **0.66% dead time → negligible**

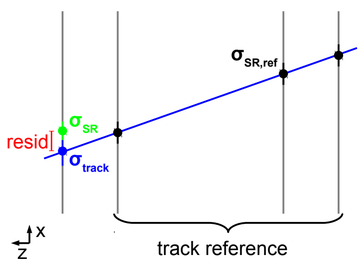
SPATIAL RESOLUTION: ALGORITHM

Calibration of single detector spatial resolution σ_{SR}:

- equal field configuration in all Micromegas
- σ_{in}: all detectors included in track fit → residual too small
- σ_{ex}: detector under study not included in track fit → residual too large
- NIMA 538, 372: $\sigma_{SR} = \sqrt{\sigma_{in} \times \sigma_{ex}}$

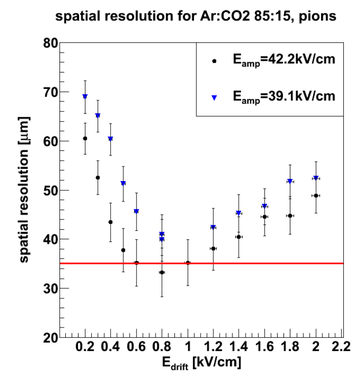
σ_{SR} = (43 ± 2)µm @
E_{amp}=39.1kV/cm,
E_{drift}=0.8kV/cm





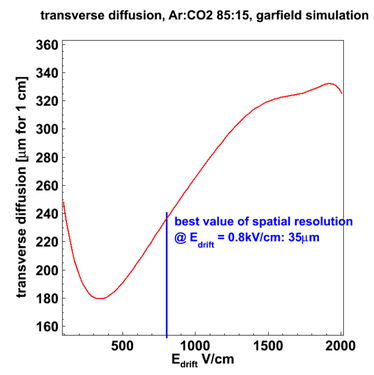
Application: Investigate spatial resolution for varying operational parameters:
- extrapolate track prediction by 2 or 3 detectors with known resolution into the left detector → σ_{track} = (48±3)µm
- measure residual σ_{ex} under different operational conditions
- $\sigma_{SR} = \sqrt{\sigma_{ex}^2 - \sigma_{track}^2}$

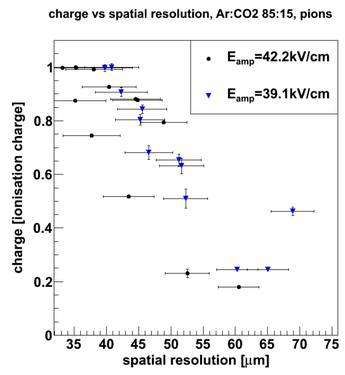
SPATIAL RESOLUTION FOR PIONS IN AR:CO_2 85:15

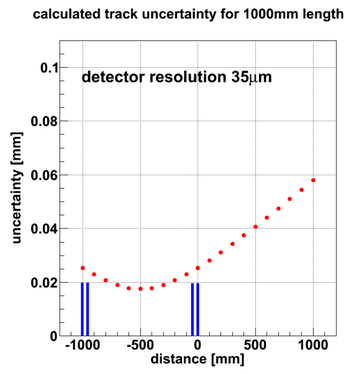


- **best value of σ_{SR} = 35µm**
- **track resolution** using 2 x 2 detectors **<20µm**
- only small effect due to gas gain (E_{amp})
- no clear effect due to diffusion
- resolution follows pulse height behavior

→ spatial resolution dominated by number of electrons, reaching the amplification region







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