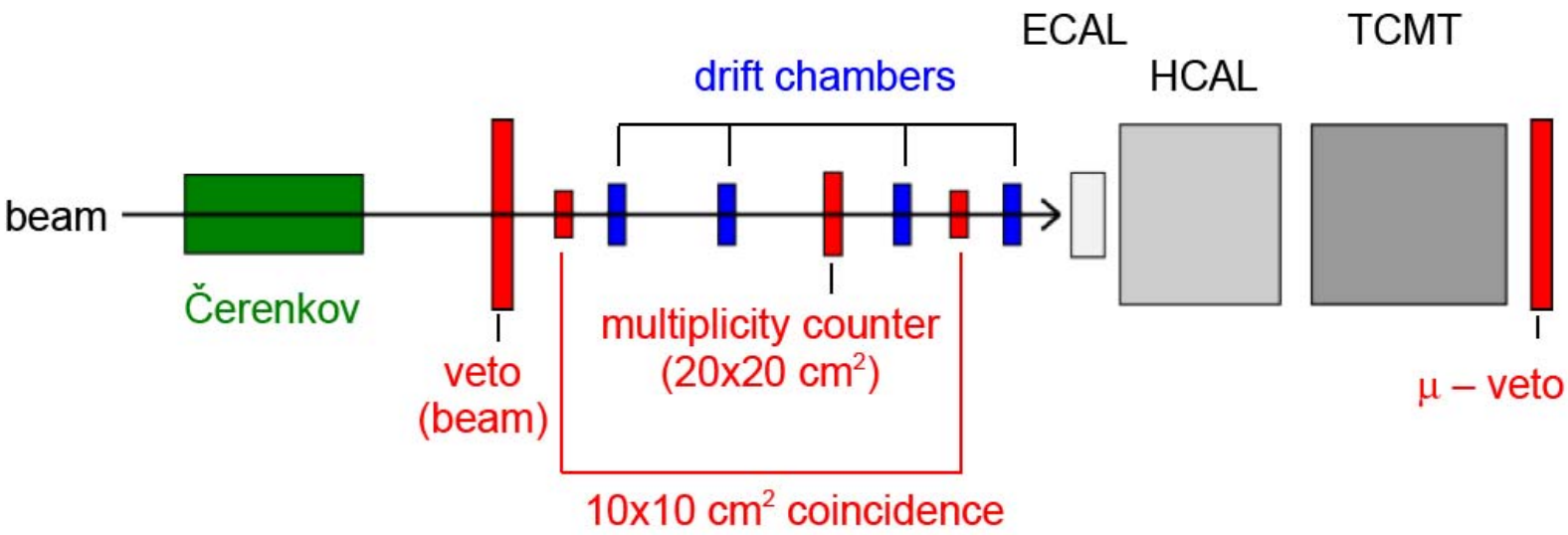
Low energy pion analysis

Erika Garutti on behalf of

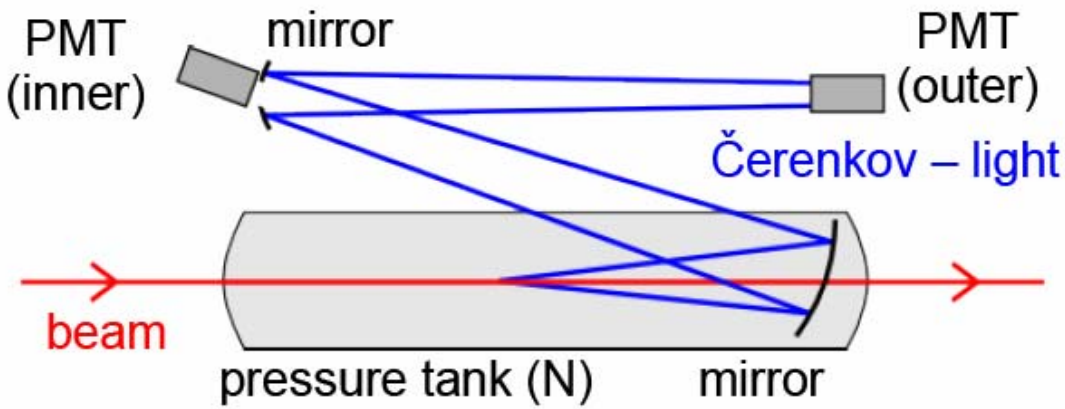
Nils Feege

First look into FNAL data:

- usage of Cerenkov detector
- pion events selection (efficiency/purity at low E)
- all calibrations are still very preliminary !

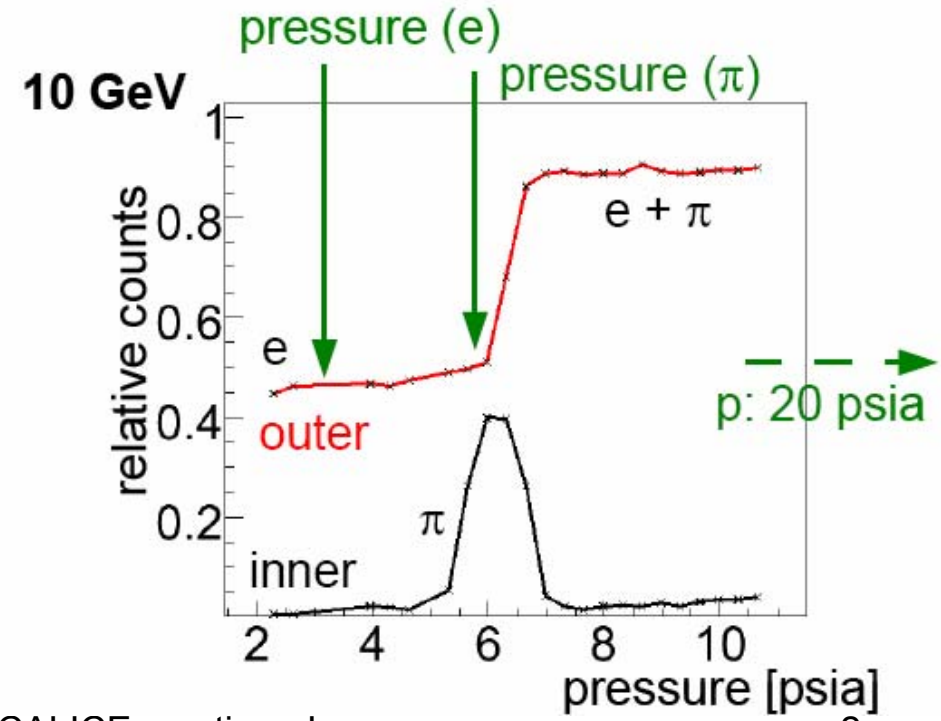


Differential Cerenkov counter



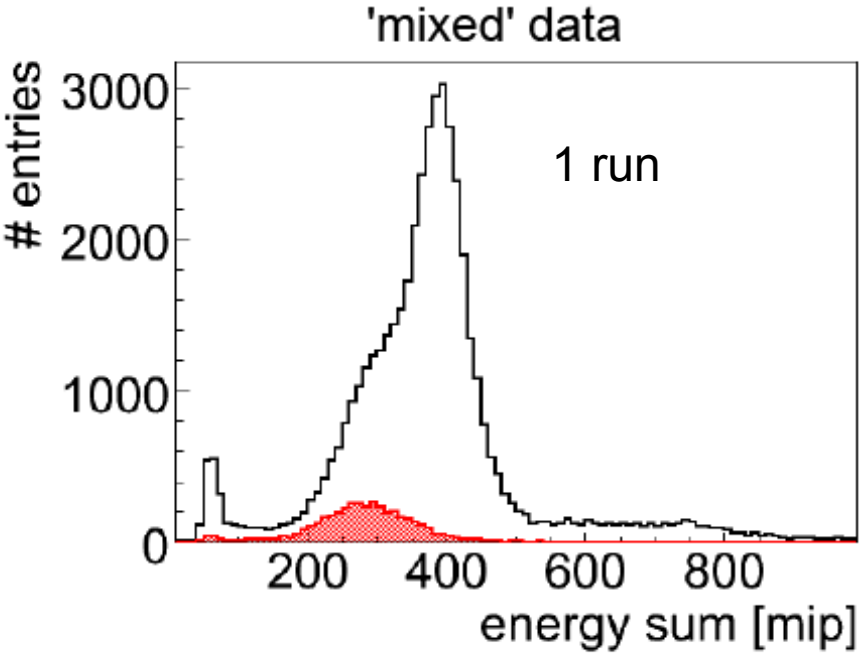
- Triggering on Čerenkov: enhance π / e / p content
- e.g. π content (10 GeV): ~50 % → ~90 %

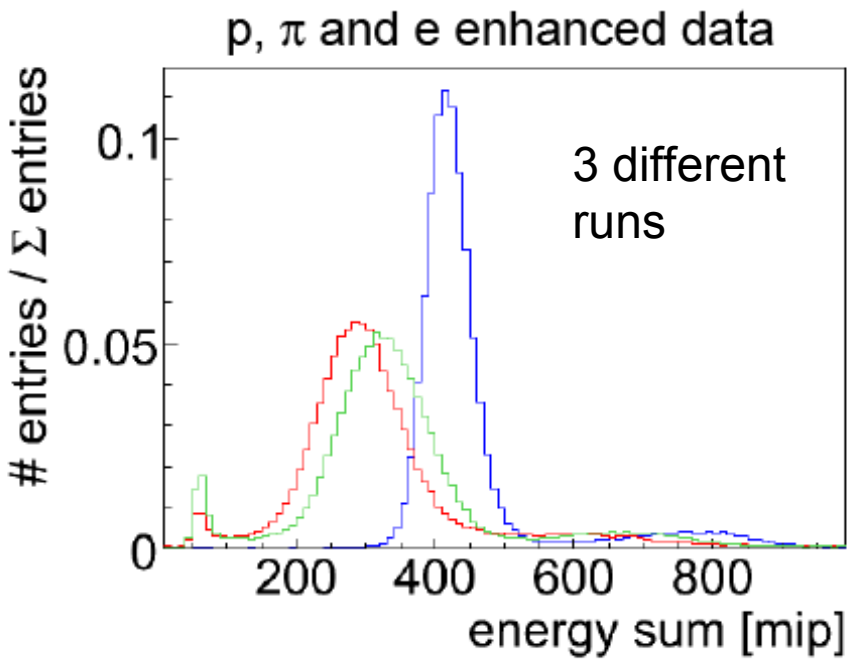
$$\cos\Theta = \frac{1}{n \cdot \beta}, \quad n \sim \text{pressure}$$



Example: enhancing p/π/e content

Beam energy: 10 GeV





- mixed → 10x10
- offline selection of p:
  - 10x10 && !C_{inner} && !C_{outer}
  - < 10 % of collected events

p → 20 psia, 10x10 && !C_{inner} && !C_{outer}

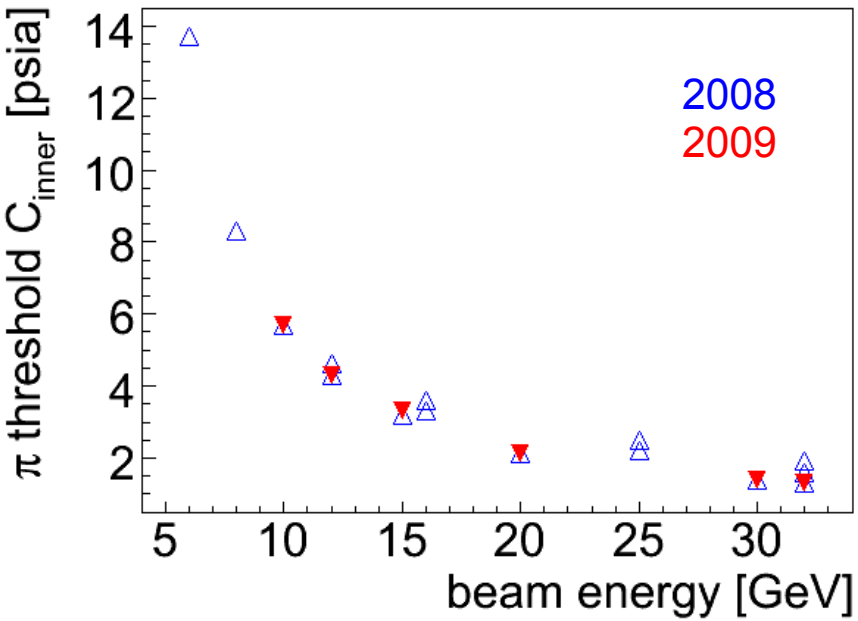
π → 5.7 psia, 10x10 && C_{inner}

e → 3 psia, 10x10 && C_{outer}

Čerenkov Operating Pressure

π (6 – 32 GeV)

- Trigger: 10x10 && C_{inner}



π (1 – 4 GeV)

- Trigger: 10x10 && ! C_{inner} && ! C_{outer}

- **2008**: maximise e detection / rejection efficiency
  → operate at 20 psia

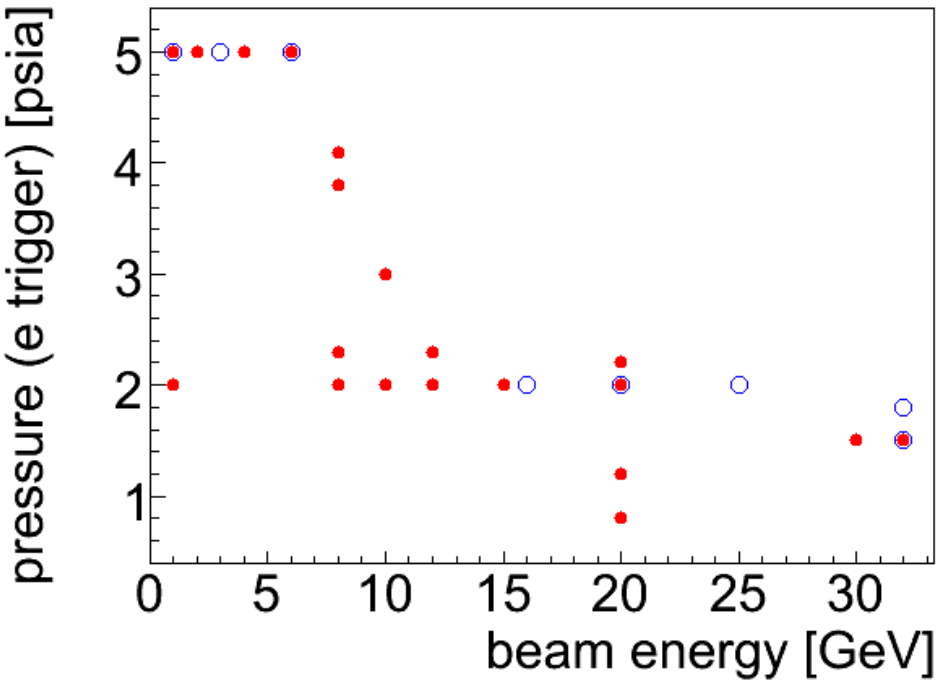
- **2009**: minimise material (gas), multiple scattering and generation of knock – on electrons in Čerenkov to maximise π rate
  → operate at 2-5 psia

- 2009 rates for 2 Gev:
  20 psia → 320 events/spill
  5 psia → 520 events/spill

Čerenkov Operating Pressure

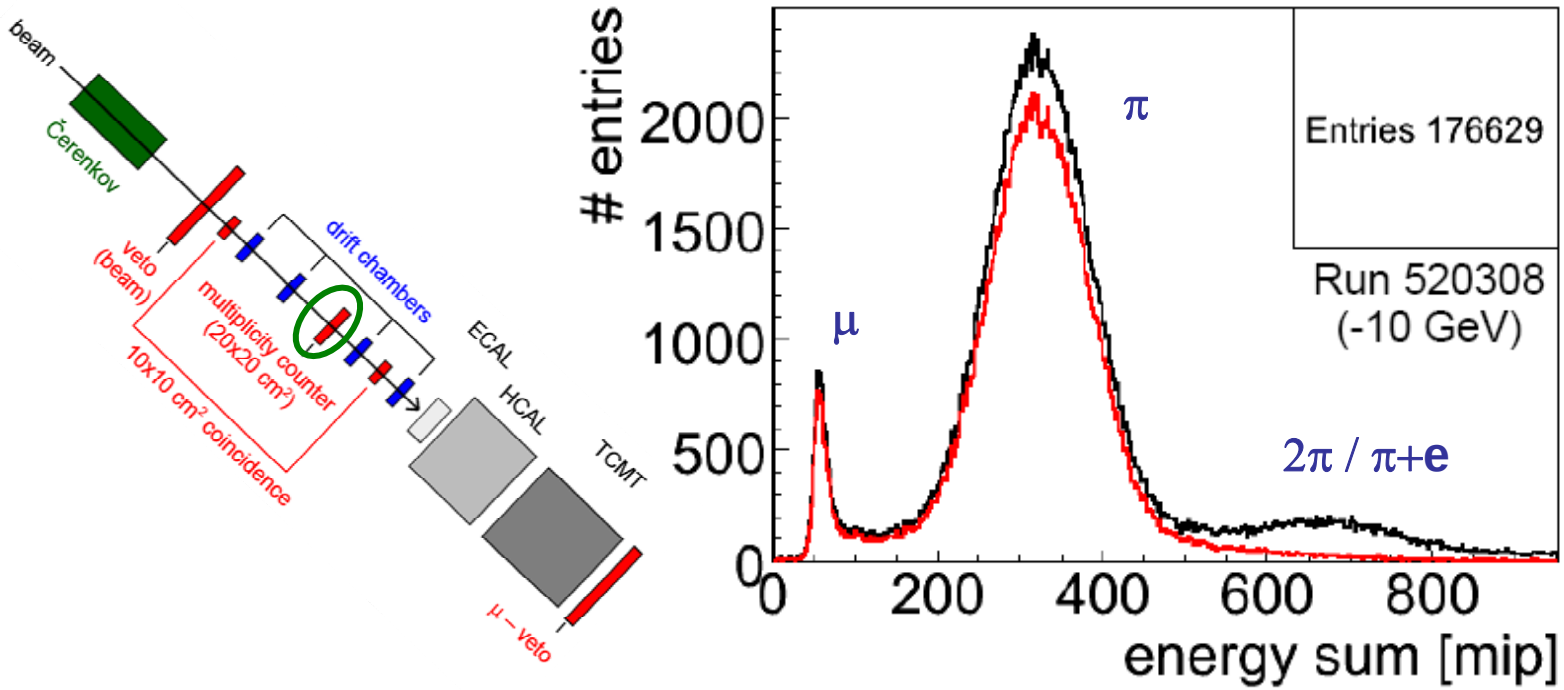
For the analysis record:

e (1 – 32 GeV)



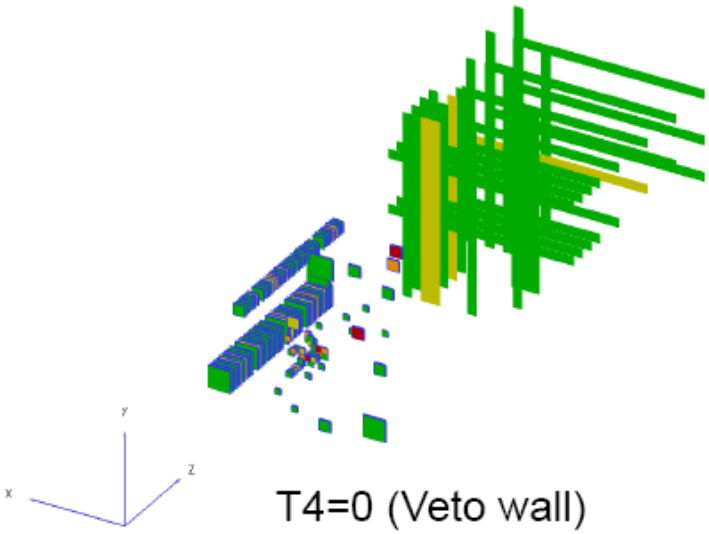
- Trigger: 10x10 && C_{outer}

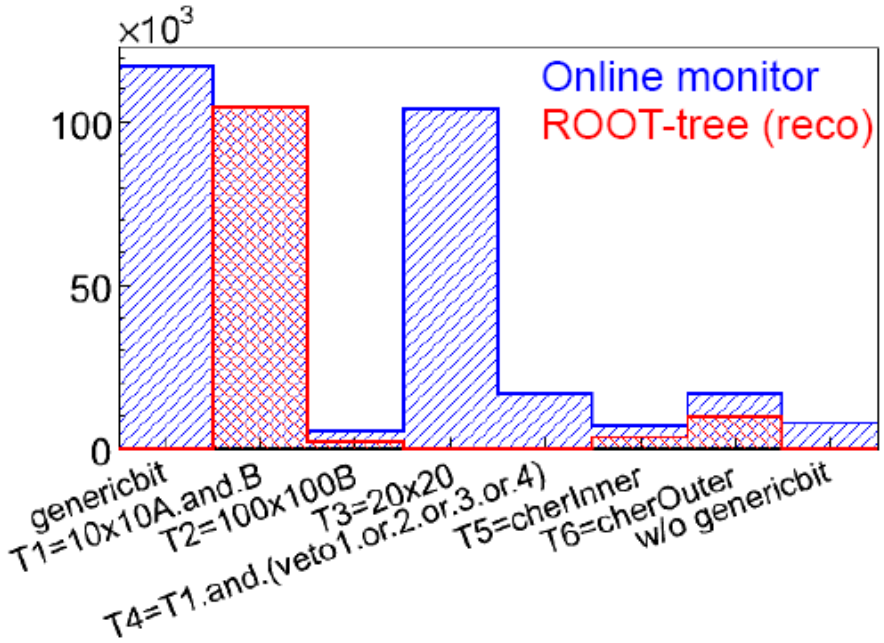
Multiplicity counter

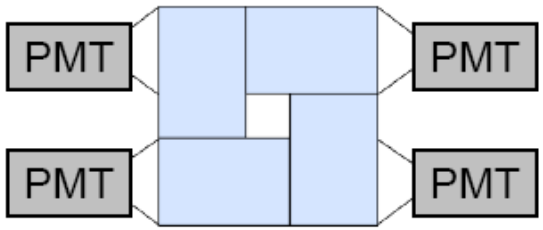


- 20x20 cm^2 scintillator (analog + digital PMT radout)
- cut on analog signal → reject events with >1 particle (all events, signal < 4000 ADC-ch.)
- Processor: vetoBitGenerator (Beni)
  → output: trigger bit → Processor: EventSelector (calice_hh)

Halo rejection using veto-wall







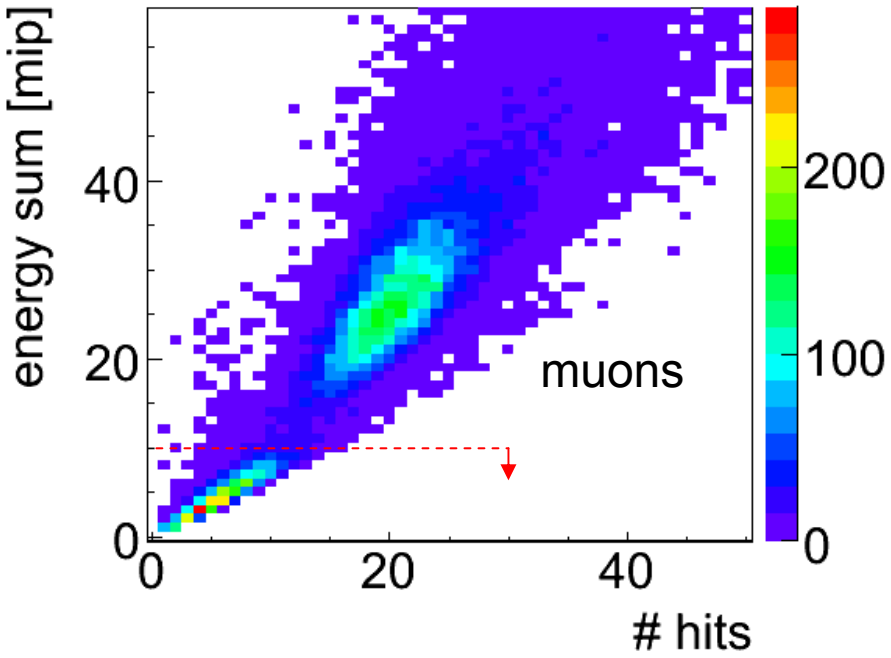
all entries genericbit (OM):	117076
all entries w 10x10A&&B (OM):	104454
all entries (Root):	135477
all entries w 10x10A&&B (Root):	104557

Problem in the decoding of trigger bit info requires investigation
➔ for now the veto-wall info is not reliable

muon rejection ➔ use TCMT

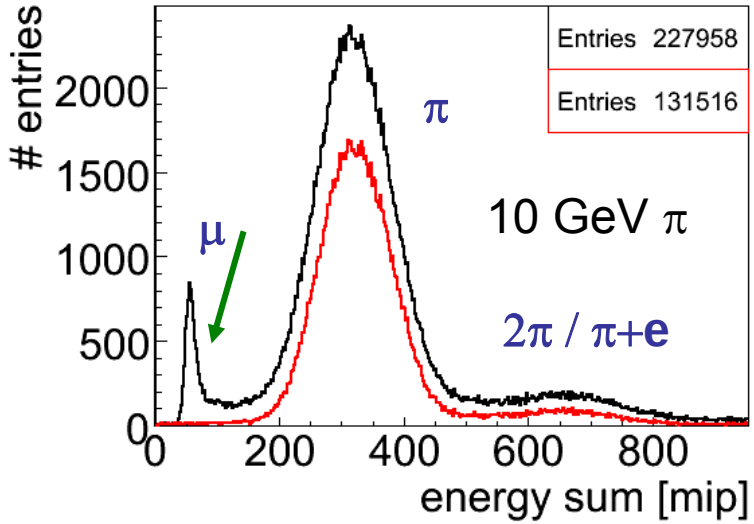
100x100 muon veto scintillator only ~1% efficiency
➔error in Trigger processor / steering?? NOT USED

TCMT signal in run 580156 (-1 GeV):



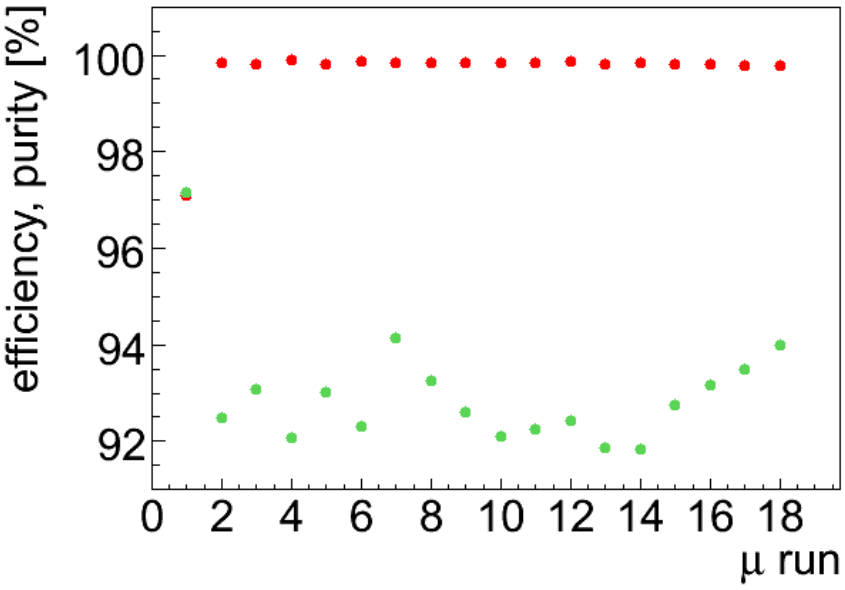
Keep events with E_{TCMT}< 10.5MIP

Effect of TCMT muon rejection



TCMT Cut Efficiency

purity and noise efficiency vs. muon run (2009) for cut ESum ≤ 10.5 mip



mean purity: 99.8
mean efficiency: 92.8

Definitions:

purity = fraction of muon events rejected by cut

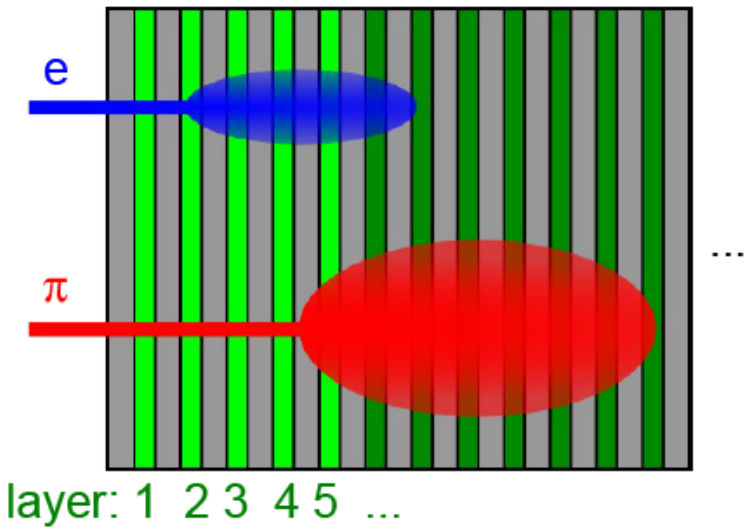
➔ from muon data events with beamBit==1 && ahc_nHits>=30 && ahc_nHits <= 100)

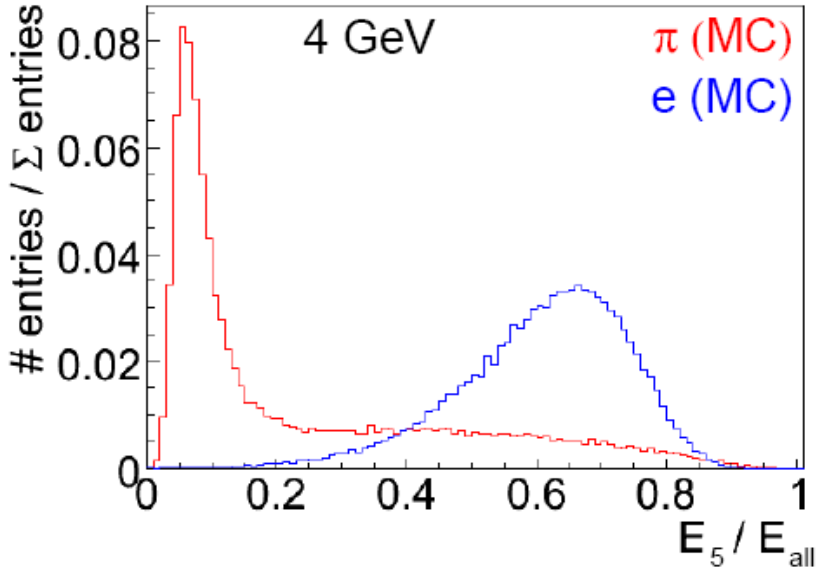
efficiency = fraction of non-muon events not rejected by cut

➔ from pure noise events pedestalBit==1 && calibBit==0 && spillBit==0)

AHCAL: π/e separation

remember: low – energetic pions → no ECAL in front of HCAL to stop electrons





Reject electrons using "shower shape" variable:

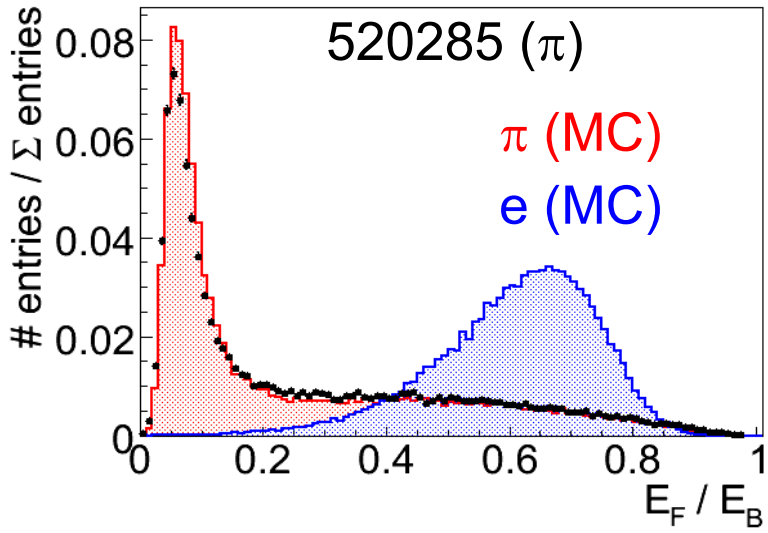
- E_5 = energy sum layers 1 – 5
- E_{all} = energy sum layers 1 – 38

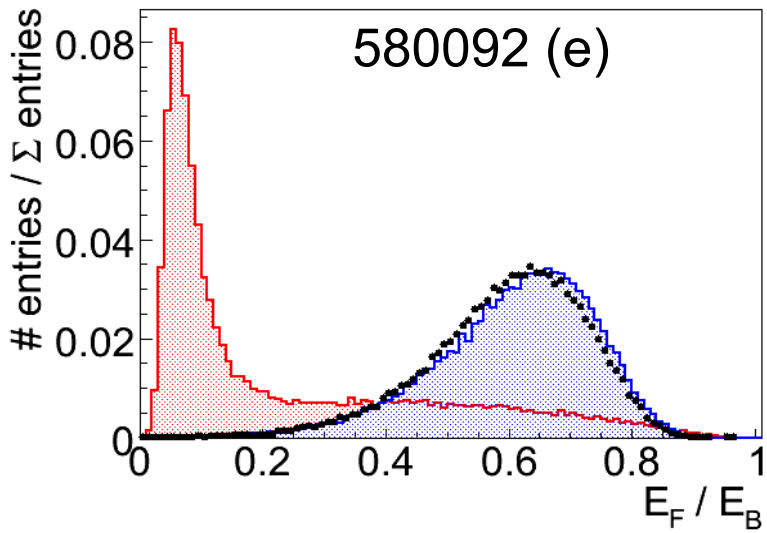
e: ~60% of Etot deposited in first 5 layers

π: <20% of Etot in the first 5 layers +
some events with early charge exchange ➔ cannot use this variable as cut

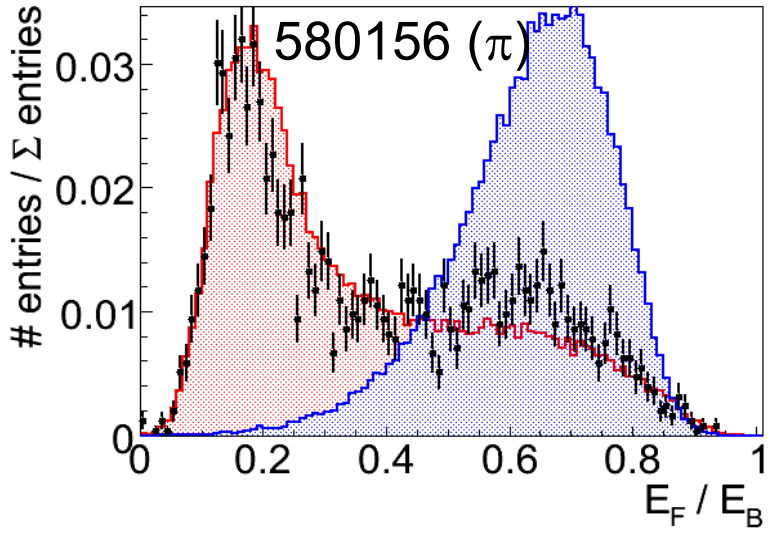
Data / MC comparison

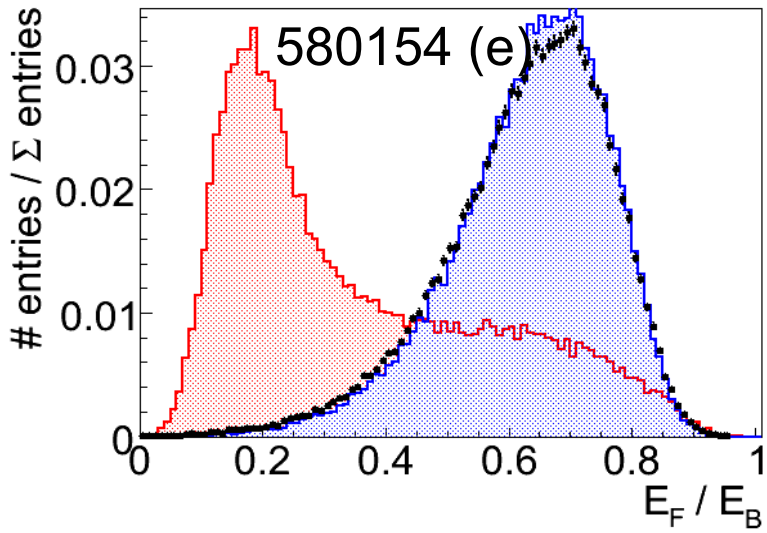
4 GeV





1 GeV

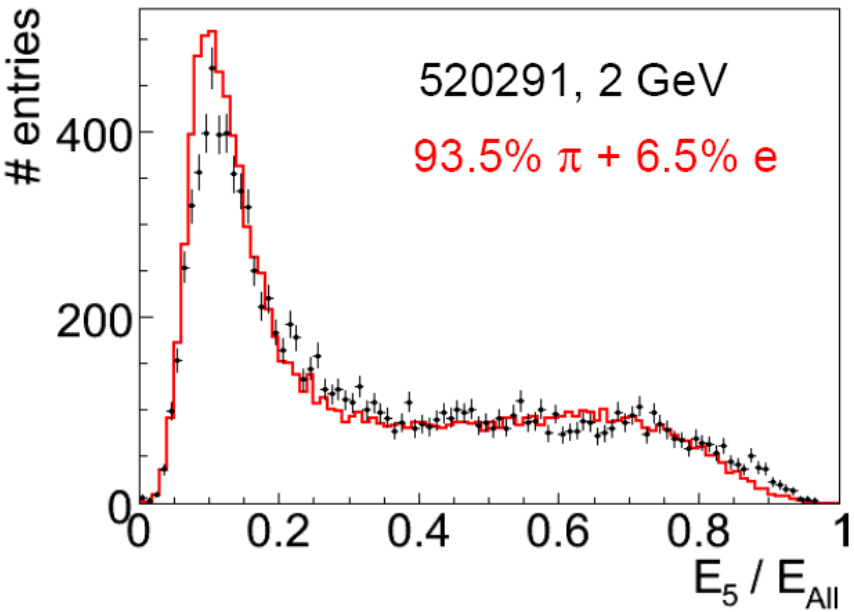


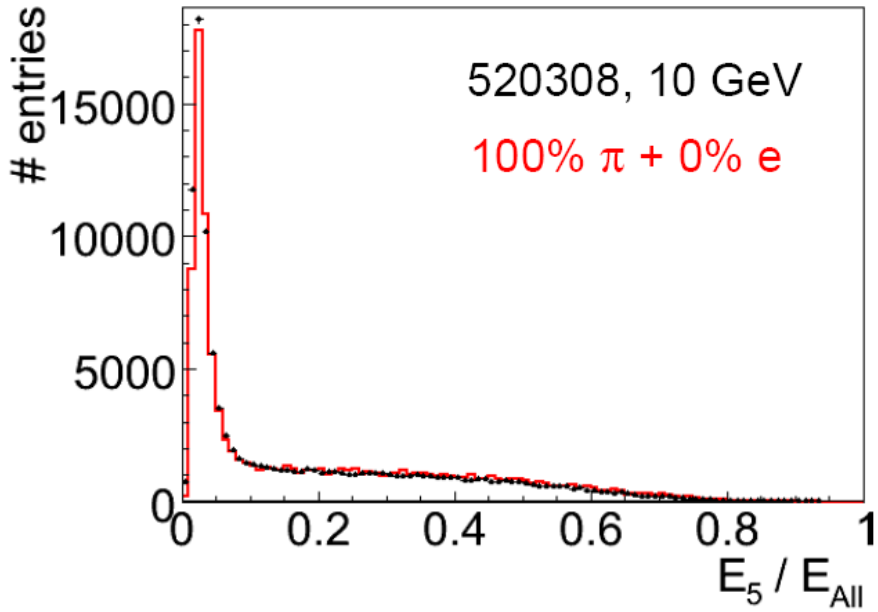


Impressive good agreement of Cherenkov tagged data with MC prediction

Quantifying the e contamination

- TFractionFitter (ROOT): Fits MC fractions to data histogram
  - Input: histograms (data, π MC, e MC)
  - Output: relative contributions of π and e to describe data



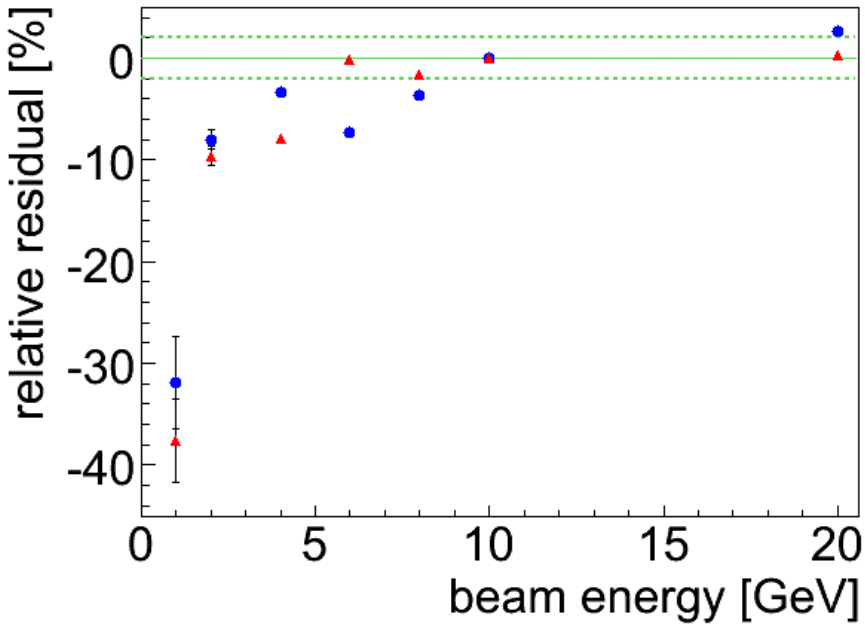


- above 4 GeV: no e contamination!

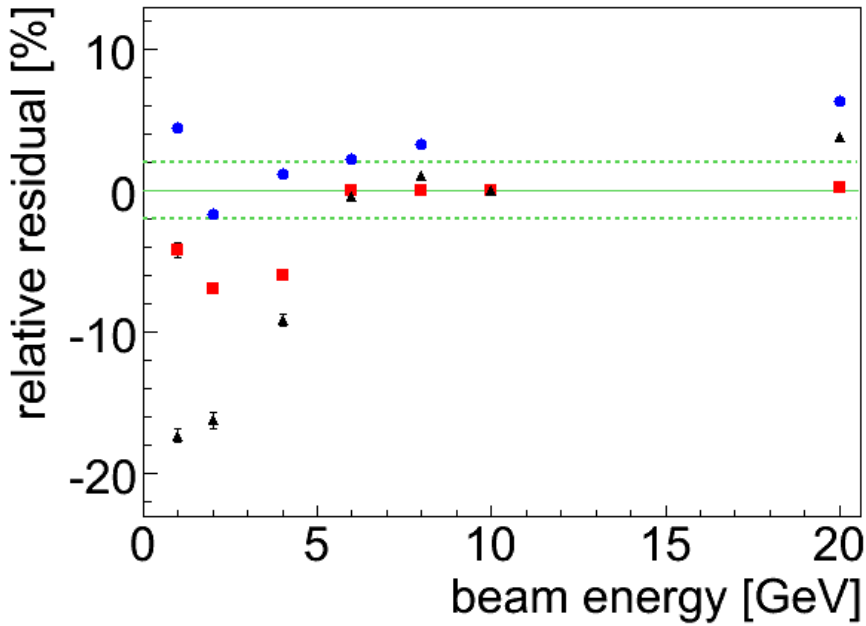
For the moment no further pion selection criteria applied

Calorimeter response 1-20 GeV

w/o correction
after MIP correction
+- 2% band



QGSP_BERT
FTF_BIC
LHEP



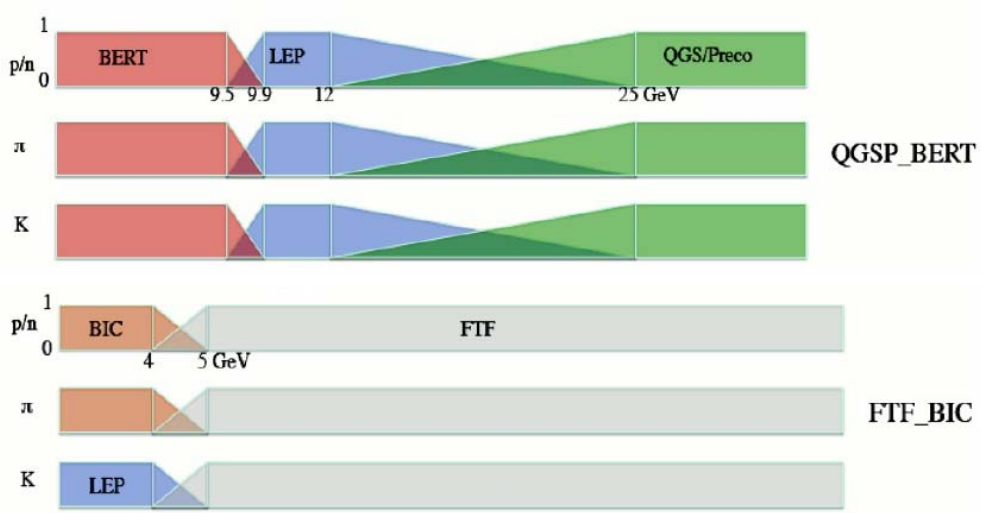
6-20 GeV linear after MIP stab correction layer-by-layer (MPI procedure)
<6 GeV linearity not expected ? ➔ see MC models

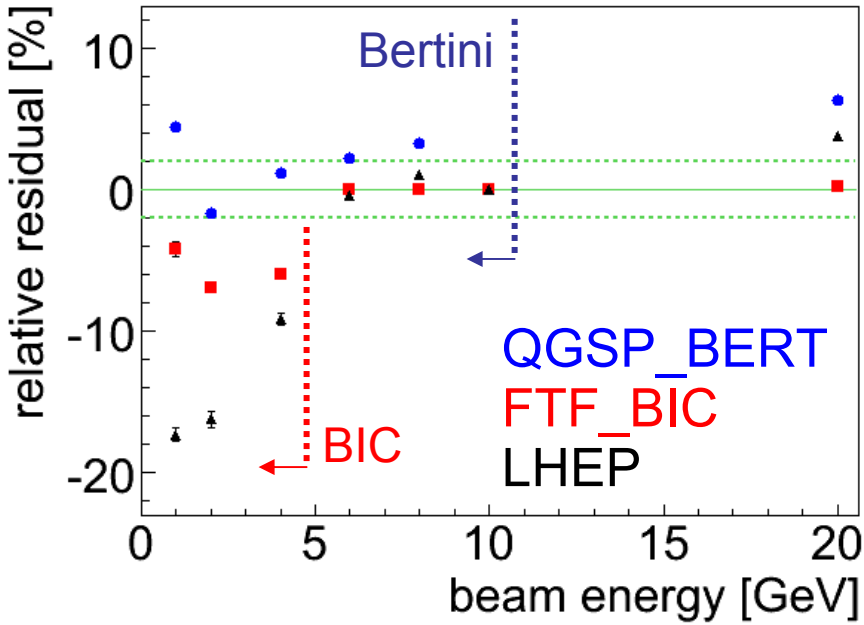
Interesting about the models

Linearity defined fixing 0 and 10 GeV

Change slope in QGSP_BERT before and after 10 GeV

BIC starts below 5 GeV ➔ visible step in linearity





Conclusion

First look at low energy pion data from FNAL

First look at FNAL beam line instrumentation
- important feedback to all analyzers
- processors to be released soon with docu

Analysis in a very preliminary state:
- Still using online calibrations
- No Temperature correction of SiPM response

Very promising physics results to come soon…

TCMT Cut Optimization

muon run 560186