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Activities at Hamburg University

E. Garutti
N. Feege
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I. Marchesini
M. Ramilli

AHCAL Meeting 13/12/2011

New Group at Uni Hamburg!

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AHCAL at University of Hamburg means:
- 1 Professor: Erika Garutti
- 3 post-docs: Nils Feege (soon to be), Ivan Marchesini, Marco Ramilli
- 1 Ph.D. Student: Sebastian Laurien

Research activities:

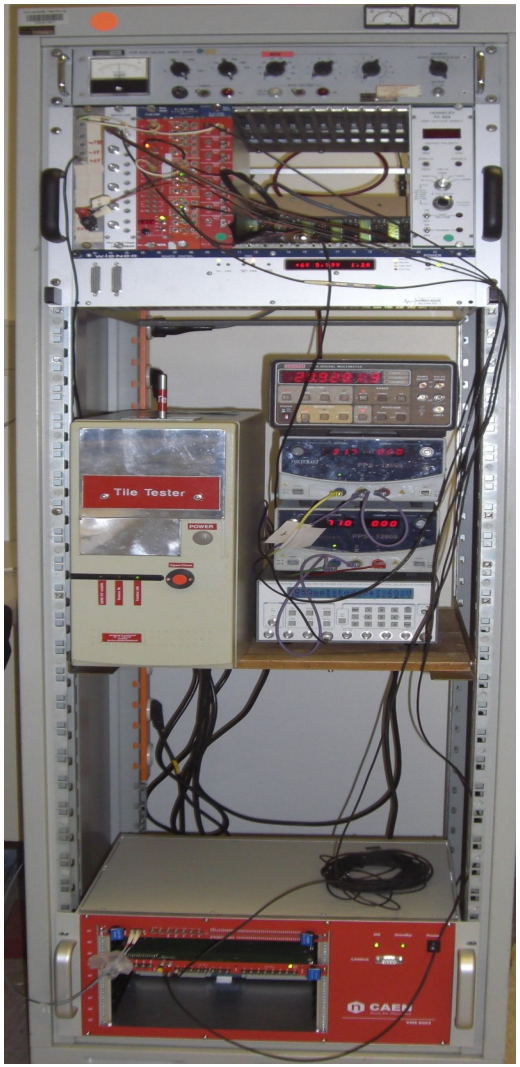
Hardware *(Single Channel Characterization/ Optimization)*

•SiPM characterization (gain, cross-talk, temp. dependance, etc.)
•Tiles coatings, Light Yield measurements, light cross-talk …
•Possible realization of 8 extra HBUs with MPPC

Software:

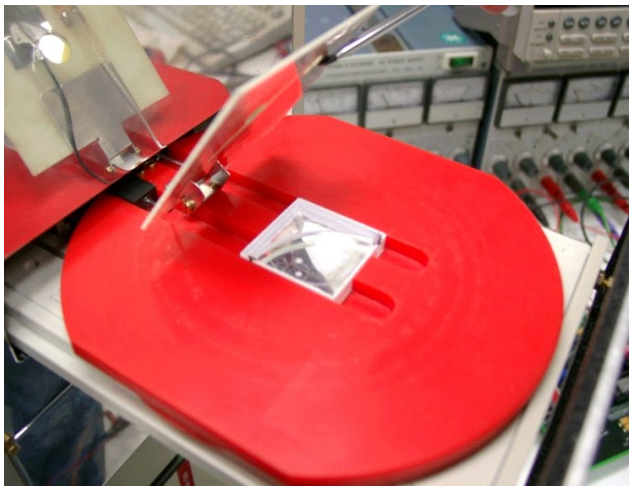
•SiPM simulation (close contact with PET group)
•Errors due to saturation parameters uncertainties
•Tight collaboration with DESY on data analysis and commissioning of AHCAL prototype

Tiletester



450 tiles shipped from ITEP

Test only Gain (for start):
- 125 ns gate
- 1 kHz LED pulse rate
- acquired with CAEN QDC



Overview of the results

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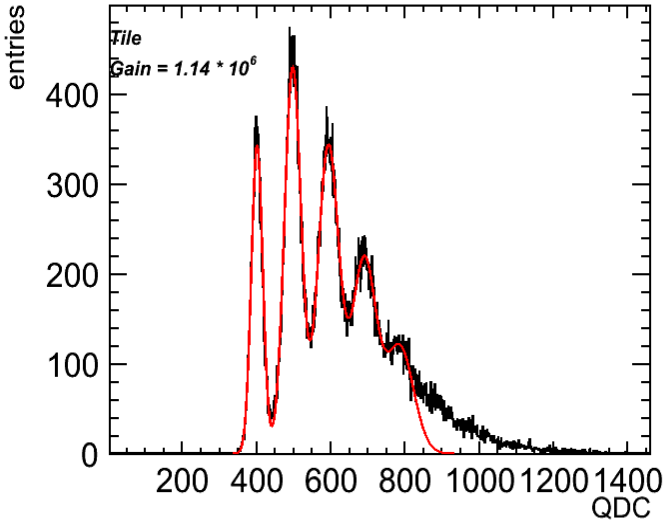
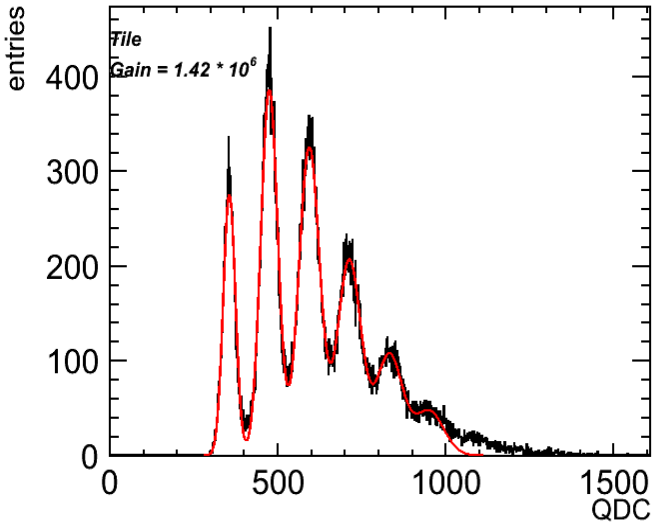
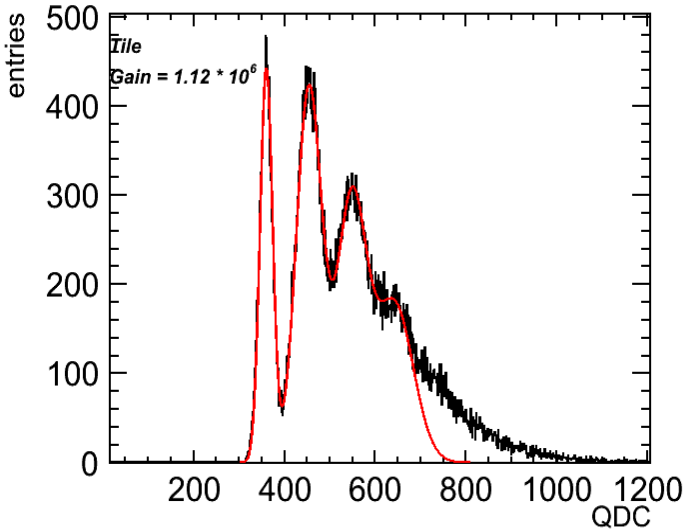
275 tiles tested in three separate sessions

252 well-operating tiles ~ 92. %







Pedestal width analysis

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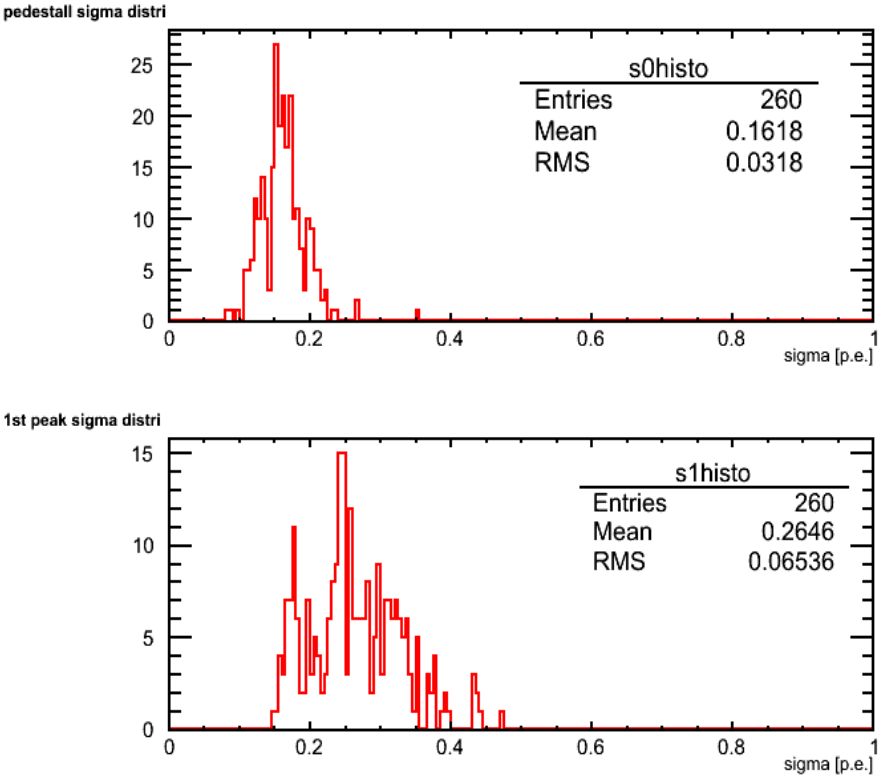
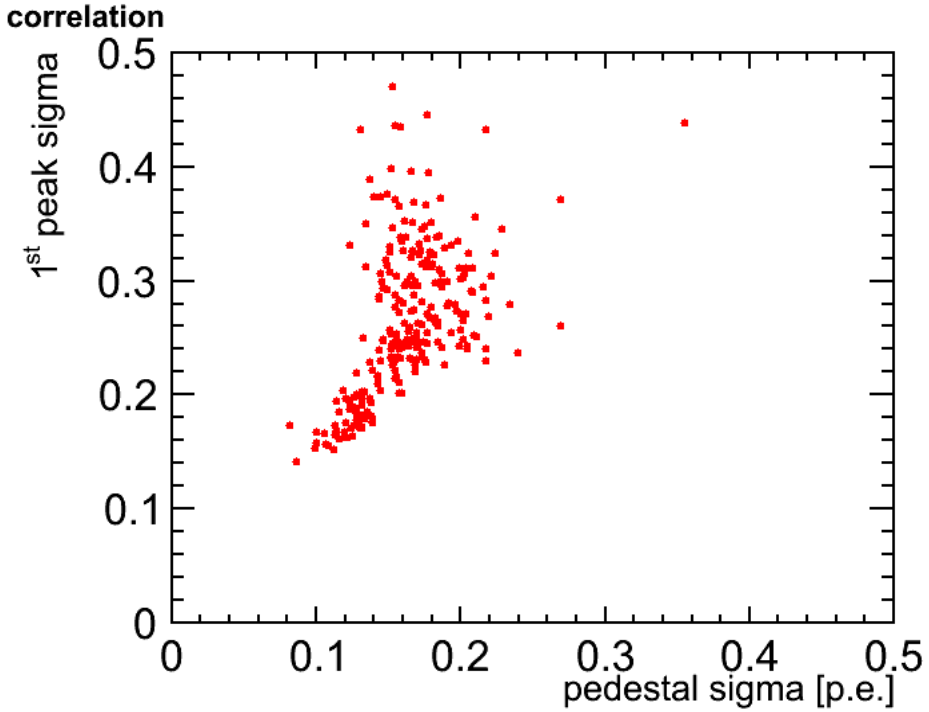
Electronic noise is not dominant in gain determination
S/N ~ 7





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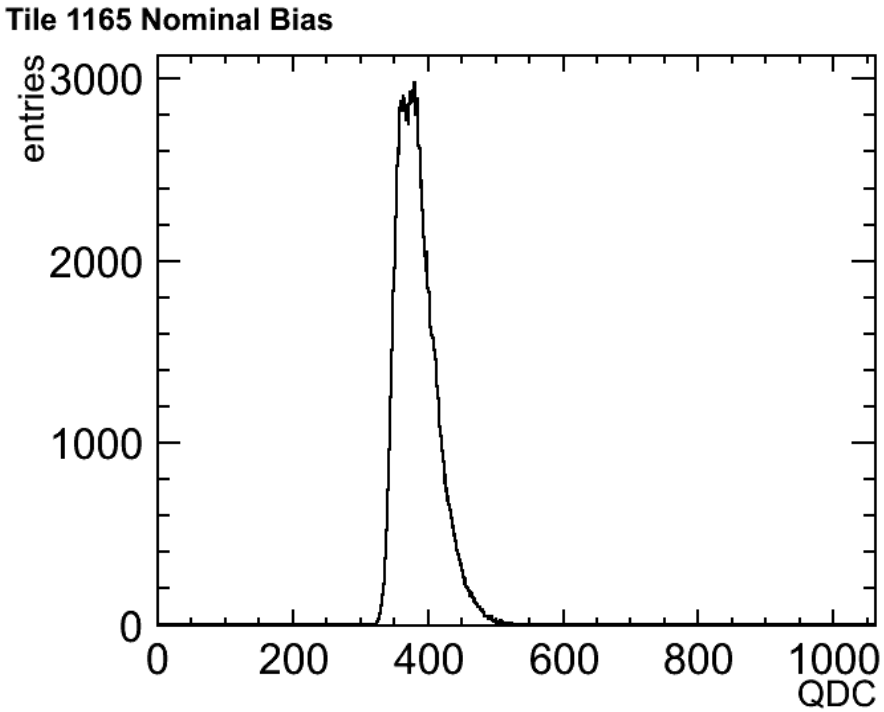
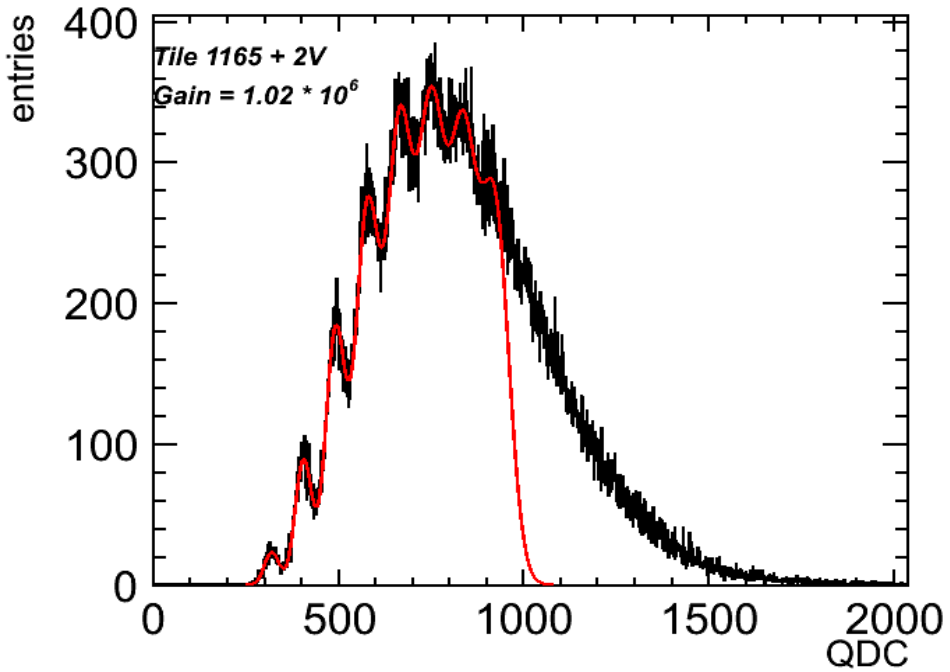
275 tiles tested in three separate sessions

252 well-operating tiles ~ 92. %
3 SiPMs need an higher operational voltage ~1.%





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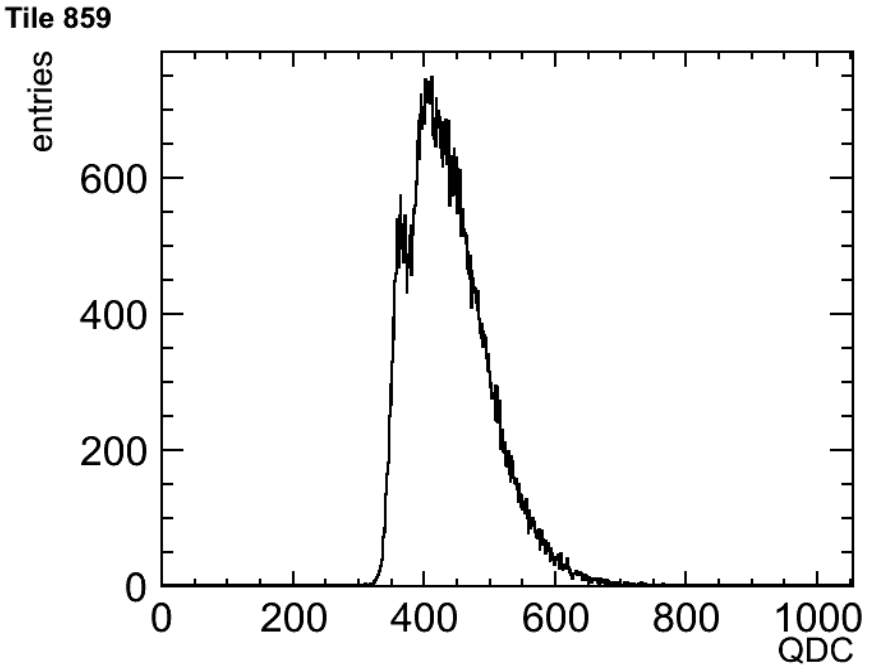
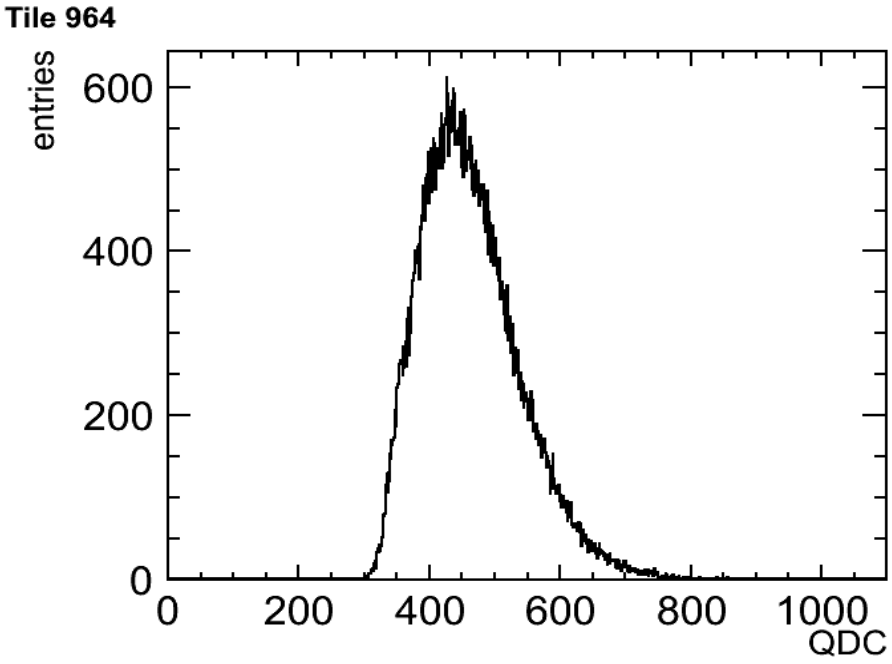
275 tiles tested in three separate sessions

252 well-operating tiles ~ 92. %
3 SiPMs need an higher operational voltage ~1.%
13 badly-operating SiPMs ~4.5%





Overview of the results

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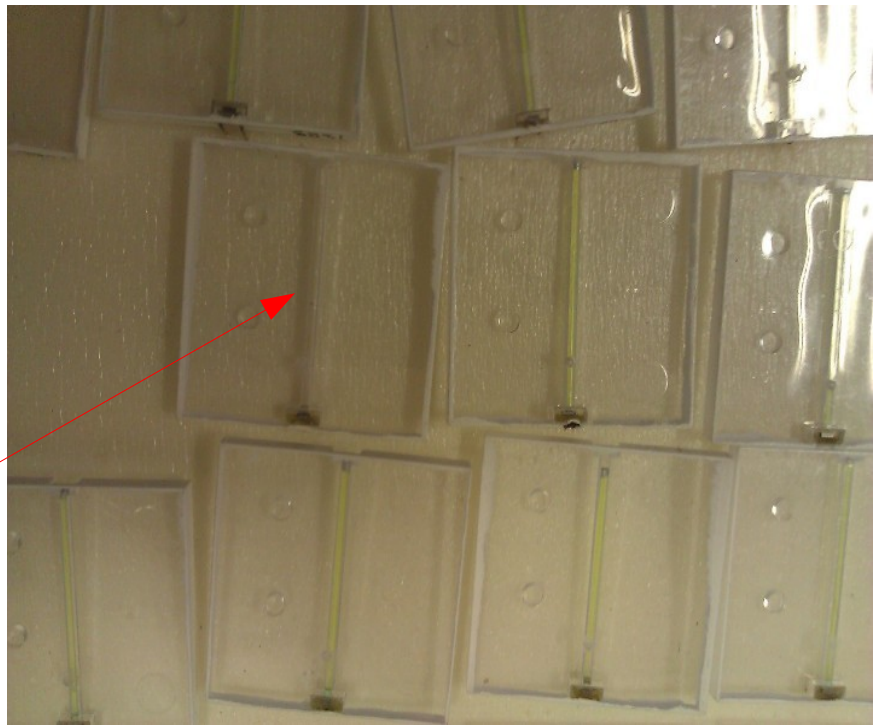
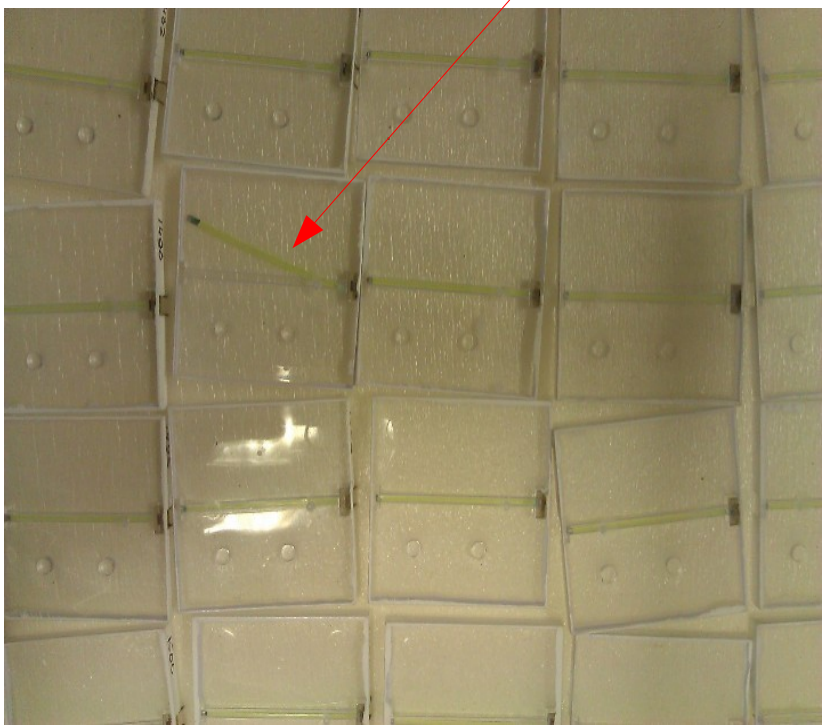
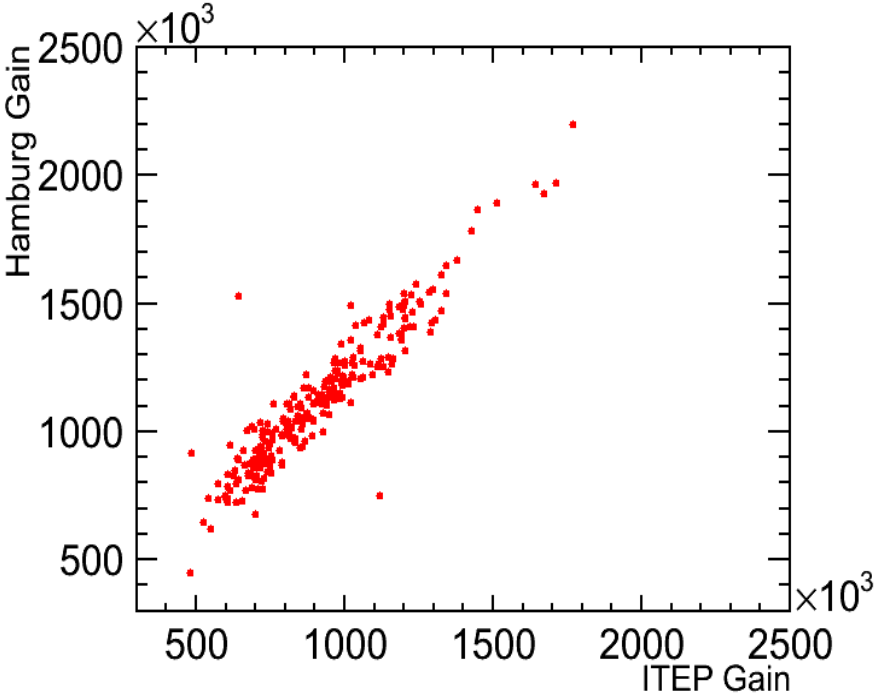
275 tiles tested in three separate sessions

252 well-operating tiles ~ 92. %
3 SiPMs need an higher operational voltage ~1.%
13 badly-operating SiPMs ~4.5%
7 broken items (pin or WLS) ~2.5%





Correlation



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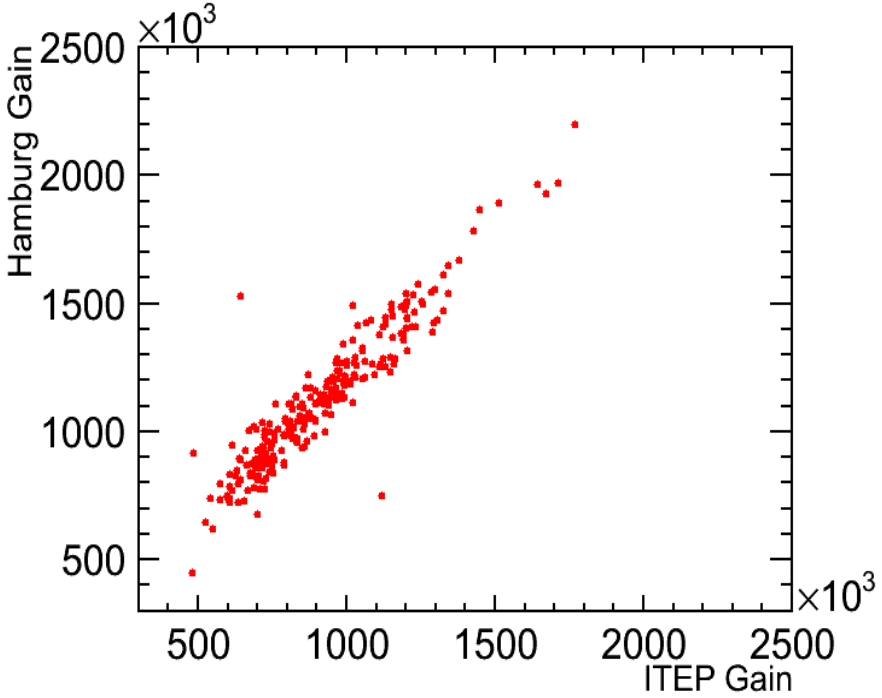
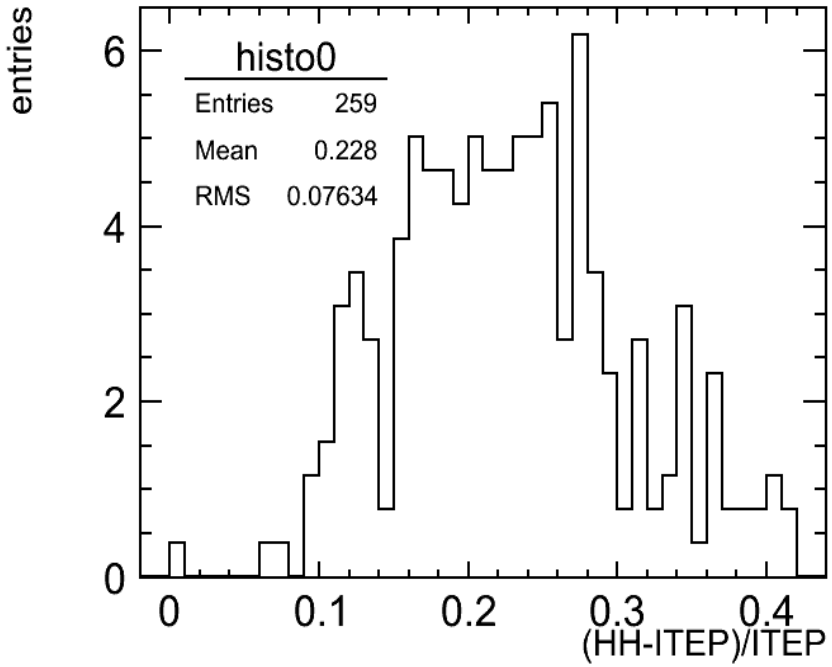
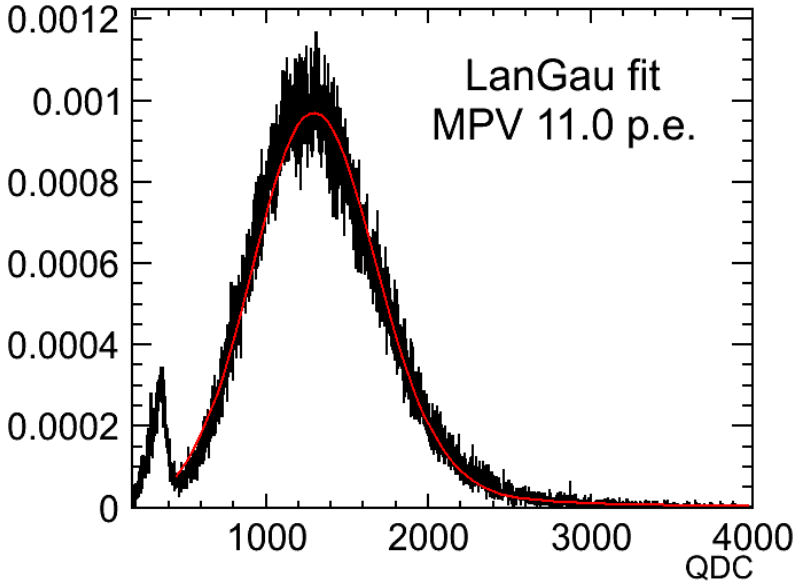
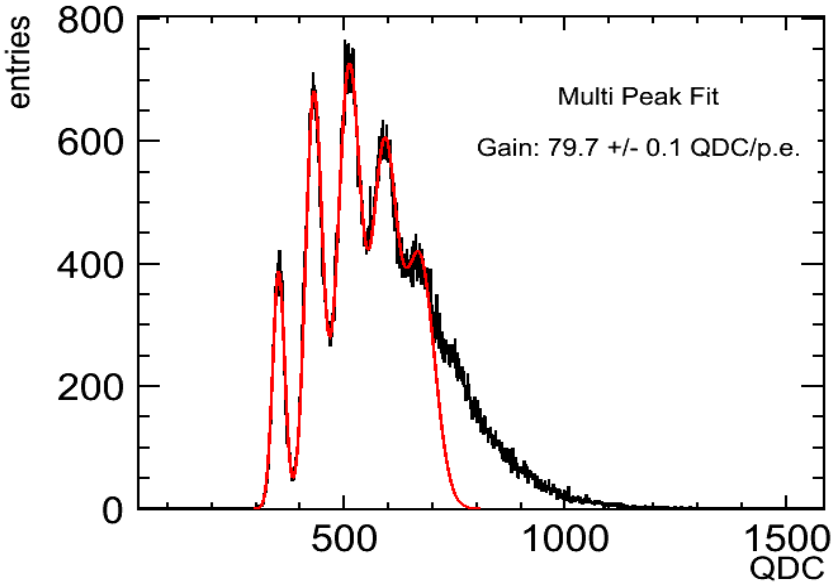


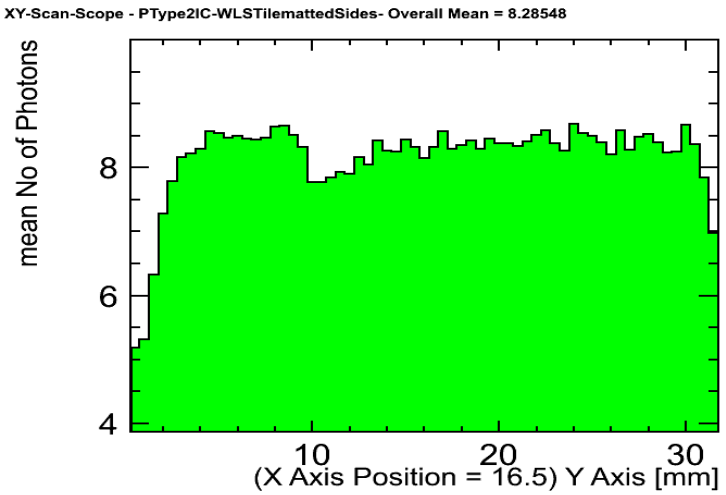


- Correlation spread of 7%
- HH gain overestimated of ~ 20%
- Reason for overestimation still under investigation

LY measurements with TT







Current TT version:
Sr^{90} emission directly on WLS fibers
Assuming ~30% loss due to WLS: LY = 15.7 p.e.

Modification to TT *needed!* (planned for next year)

New tile measurements setups

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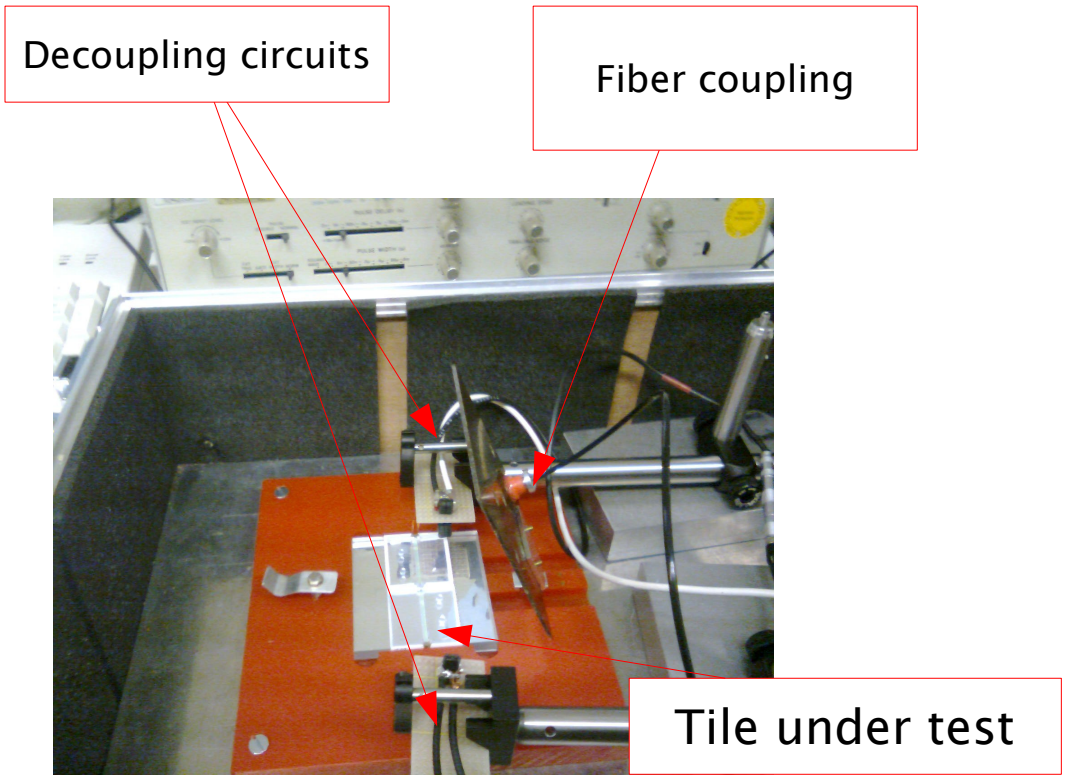
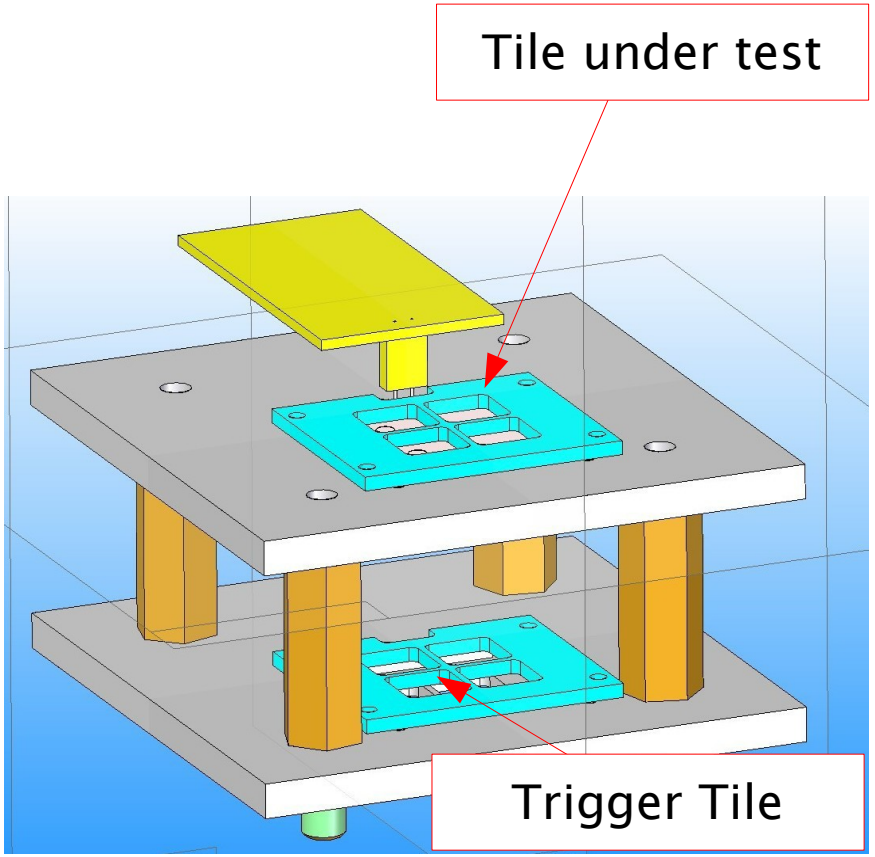
New boxes:
- Light proof
- Temperature stabilized

Light cross-talk setup



LY measurement setup



Saturation Effects

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•Estimate errors on data from a MC study
•Provide systematic error bands for hadron paper

Simulated **pion** Run (QGSP_BERT_HP)

- → Collect Energy per cell E_{hit} [MIP]
- → Convert in N_{in} [p.e.] multiplying by LY
- → Obtain N_m [pixels] measured pixels with normalized Saturation Function:
  - Gain & saturation randomly chosen according to their **spread**

digitization

- → Obtain N_{reco} using the Saturation Correction:
  - Cell parameters randomly chosen according to the **uncertainty**
  - Chosen cell parameter is fixed for all the Events
- → Convert N_{reco} in E_{hit} [MIP] dividing by LY

recostruction

→ end of Run obtain E_{reco}
→ repeat 1000 times changing randomly parameters each time:
  - Uncertainty estimated as E_{reco} spread

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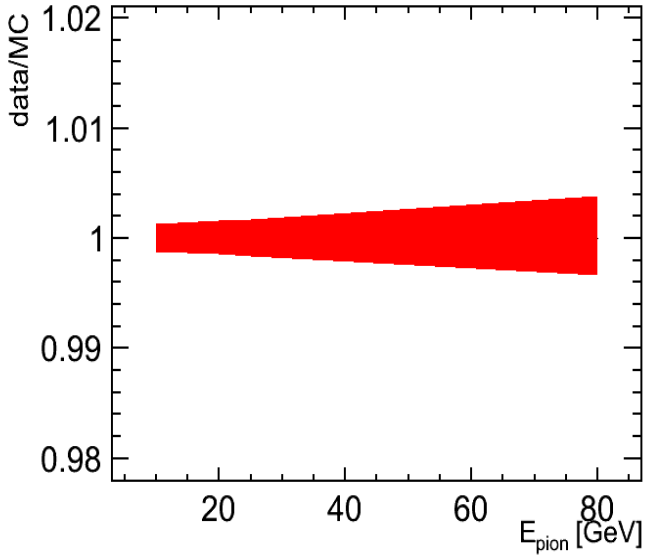
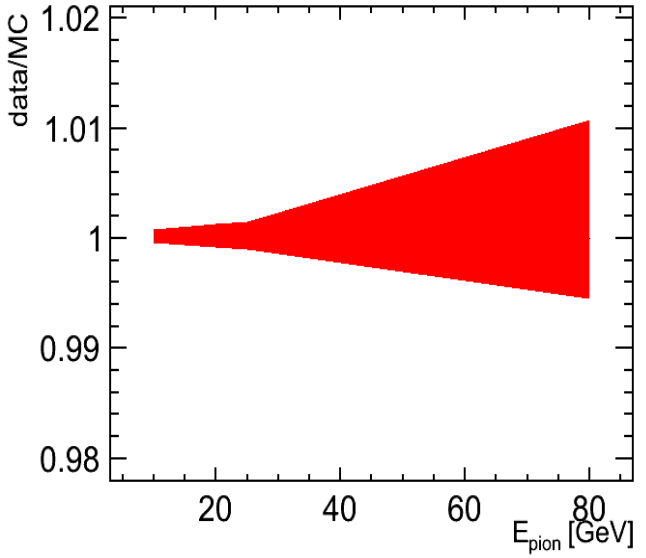
Overview of Results

Assuming MC have NO ERRORS:

2% Gain uncertainty



5% Sat. Point uncertainty



Asymmetric errorbars:
Overestimation of E_{reco} due to non-linearity

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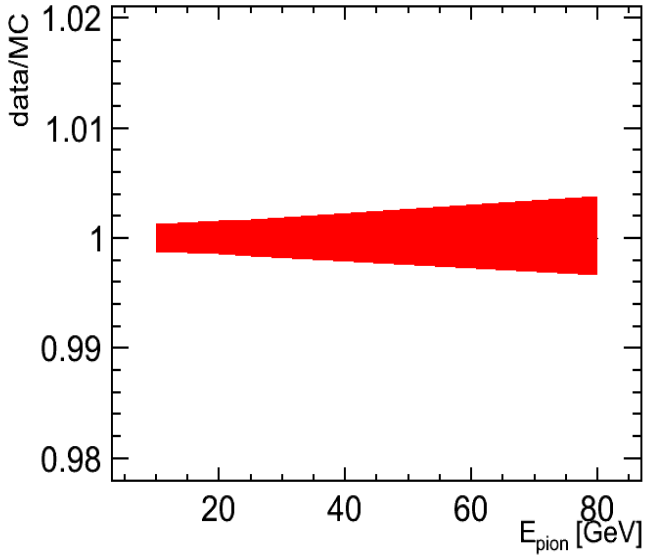

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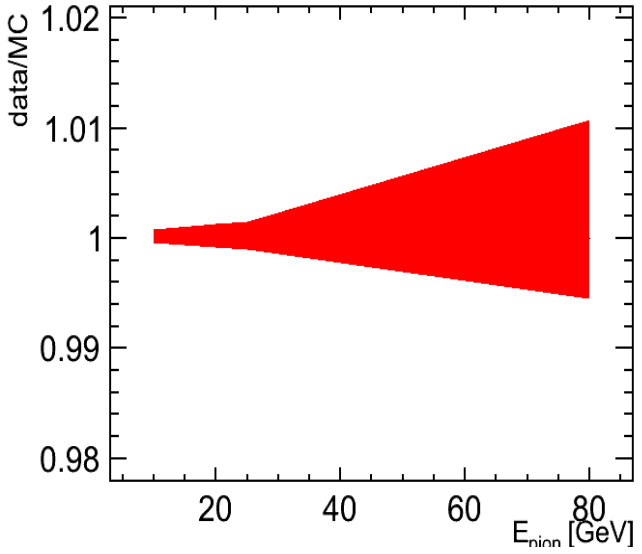
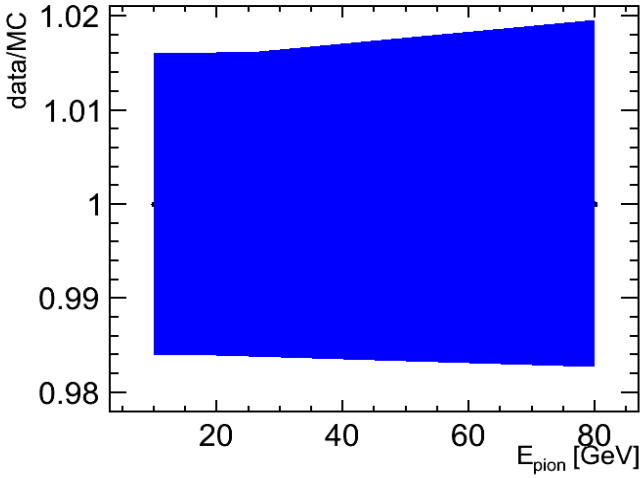


Asymmetric errorbars:
Overestimation of E_{reco} due to non-linearity

Added with 1.6% MIP uncertainty



Conclusions

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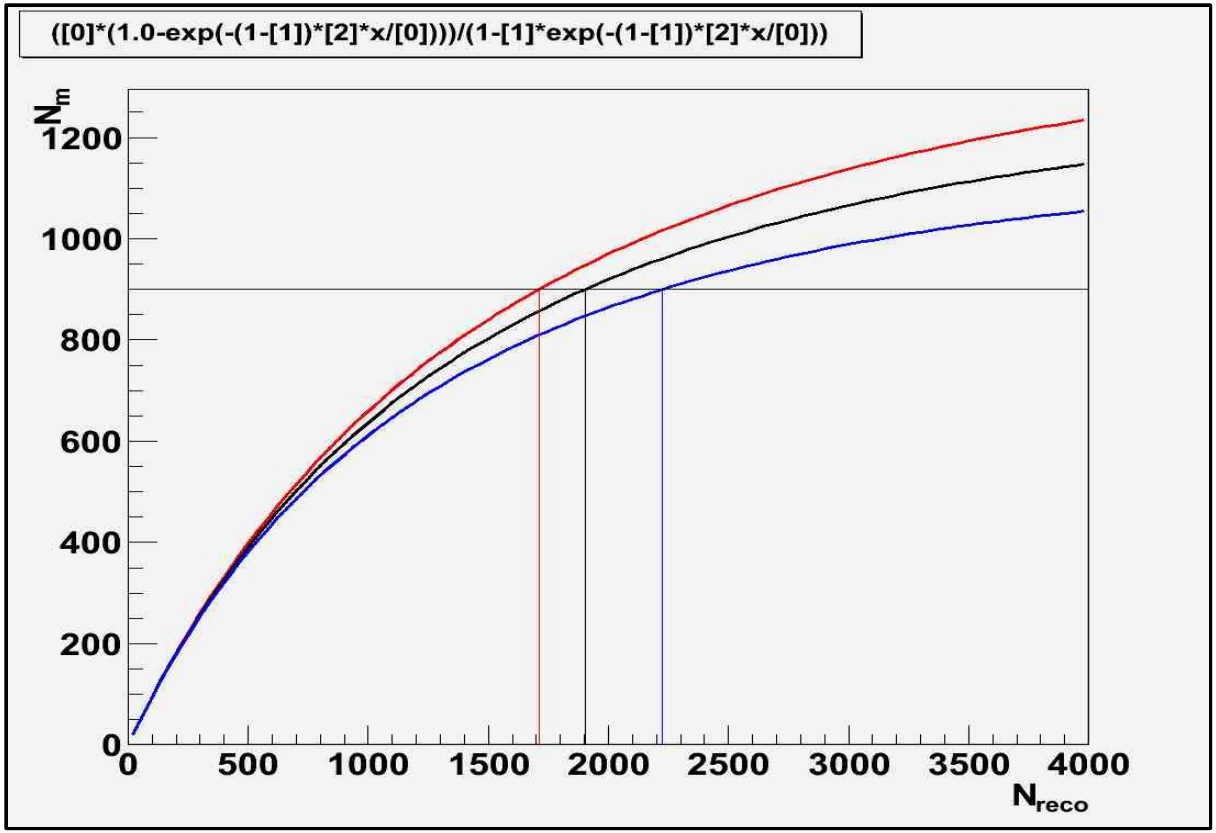
- New Group at Hamburg University
- Focus on Single Channel characterization/optimization
- New experimental setups on the way …
- … in the while, gained expertise cross-checking new tiles gain
- First results from the MC simulations

Now, our operation is small, but there's a lot of potential for "aggressive" expansion.
The Joker (about AHCAL at UniHH)

Backup Slides

Why systematic overestimation?



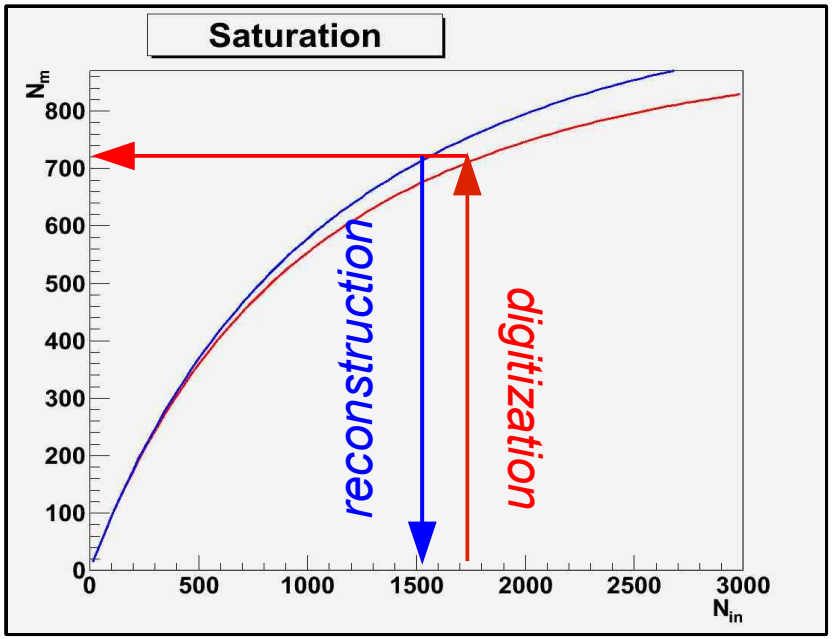
Symmetric variation of Saturation Curves gives larger “excess” values

MC on Impact of Uncertainties

$$E'_{\mathrm{reco}}[\mathrm{GeV}] = \frac{\sum_i E_i[\mathrm{MIP}]}{w[\mathrm{MIP/GeV}]}$$

$$E_i[\mathrm{MIP}] = \frac{A_i[\mathrm{ADC}]}{C_i^{\mathrm{MIP}}} \cdot f_{\mathrm{sat}}(A_i[\mathrm{pix}]).$$

$$N_m = A_i\,[\mathrm{pix}] = A_i\,[\mathrm{ADC}]/G_i\,[\mathrm{ADC/pix}]$$



Goal of this study:

Uncertainties due to $f_{sat}(A_i[pix])$

→Gain

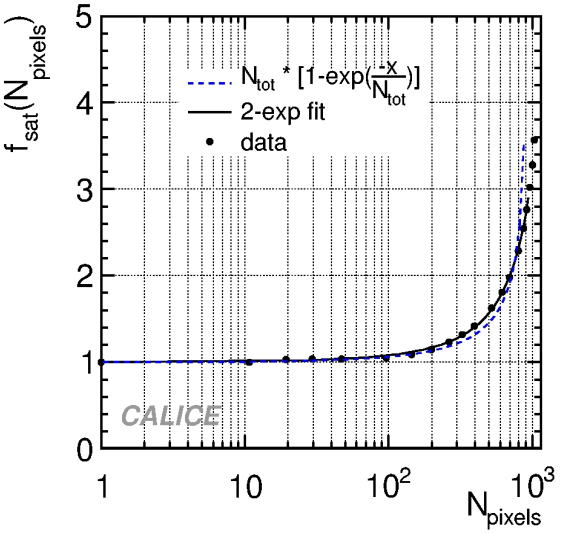
→Saturation Curve shape

→Non-uniformity of tiles

Explicit Function

$$N_m = N_t \left(1 - e^{-a(1-b)Nin\,/\,Nt}\right) / \left(1 - be^{-a(1-b)\,Nin\,/\,Nt}\right)$$

$$N_{reco} = -a\,N_t \ln[(N_t - bN_m)/(N_t - N_m)] / (b - 1)$$



- $N_m \rightarrow N_t$ for $N_{in} \rightarrow +\infty$
- $N_m \rightarrow aN_{in}$ for $N_{in} \rightarrow 0$

N_t – estimation of the total active pixels

a – slope in the limit of low photons (~ 1)
b - "correction" to PDE

80 GeV Pions

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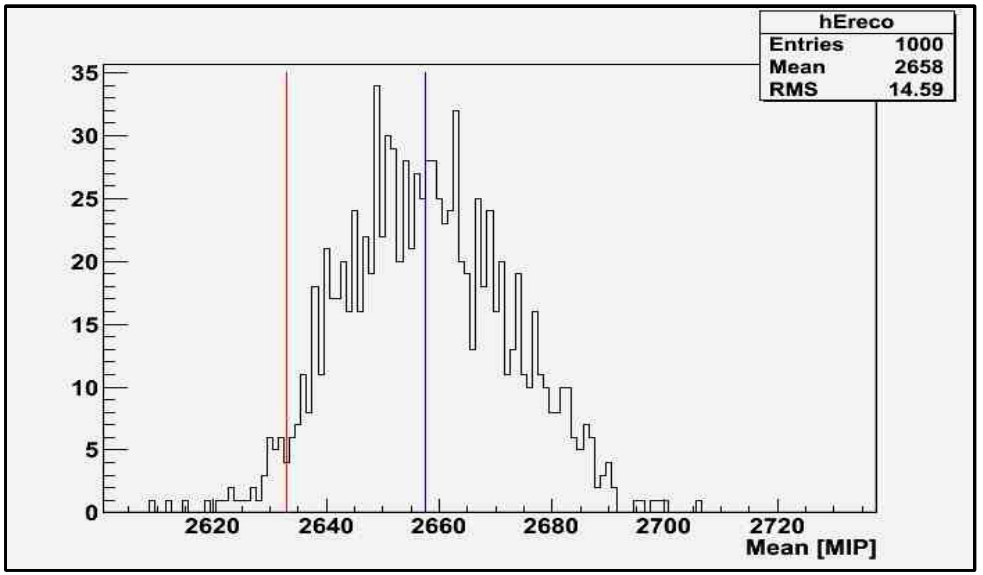
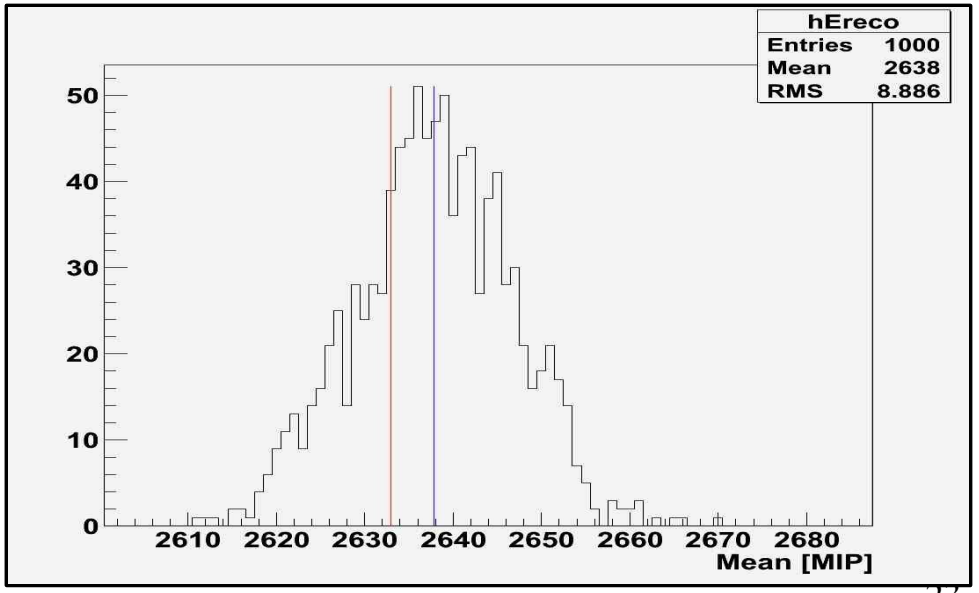
Sat. Point Unc. : 5%
$RMS_{Ereco}/Ereco_{Mean}$ = 0.55%
$Ereco_{Mean}$ = +0.95% E_{mean}



Gain Unc. : 2%
$RMS_{Ereco}/Ereco_{Mean}$ = 0.34%
$Ereco_{Mean}$ = +0.19% E_{mean}



50 GeV positrons

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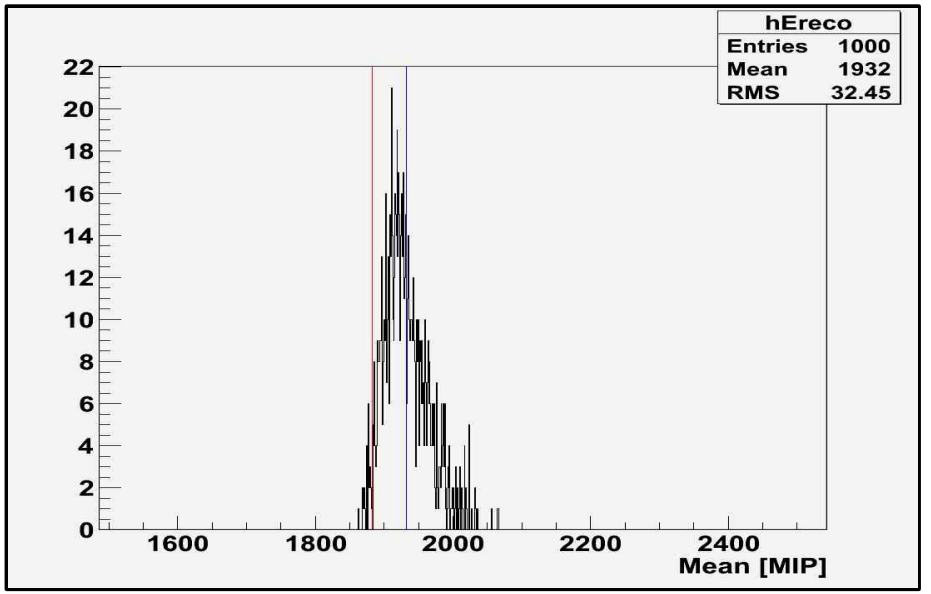
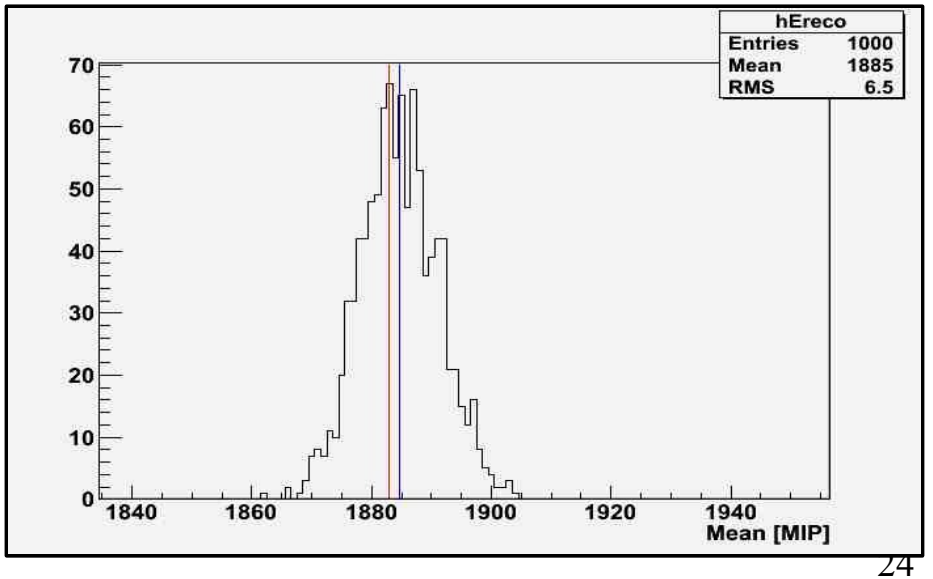
Sat. Point Unc. : 10%
$RMS_{Ereco}/Ereco_{Mean}$ = 1.65%
$Ereco_{Mean}$ = +2.6% E_{mean}

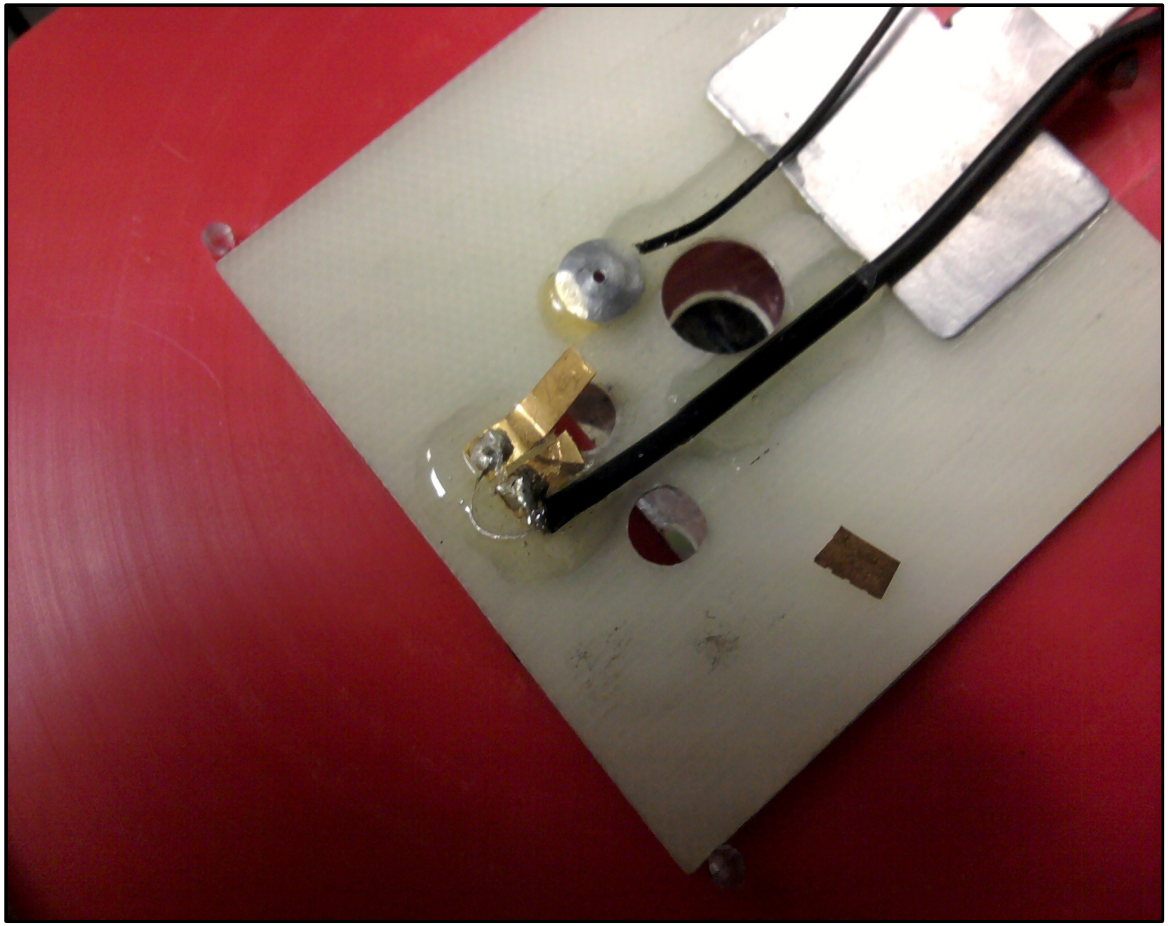


Gain Unc. : 2%
$RMS_{Ereco}/Ereco_{Mean}$ = 0.34%
$Ereco_{Mean}$ = +0.10% E_{mean}



… unfortunately …

…one of the connectors is broken!



…repaired but still unstable…

Better idea:
Ask Karsten a new customized draw