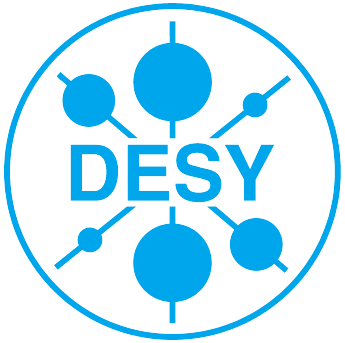


Crosstalk
and
Calibration studies
for the
WHCAL testbeam

Clemens Günter. Janet Dietrich

Hcal main meeting, 13.12.2011

Tile crosstalk study motivation

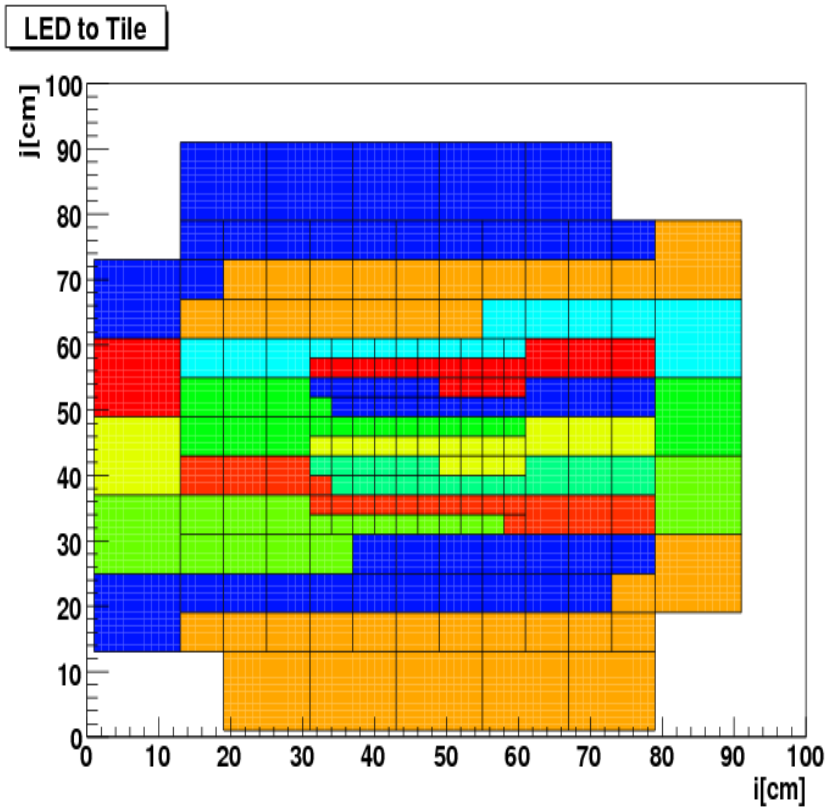
Until now no detailed study of the inter tile crosstalk (X_t) was available

Only a measurement with two tiles was done in the past

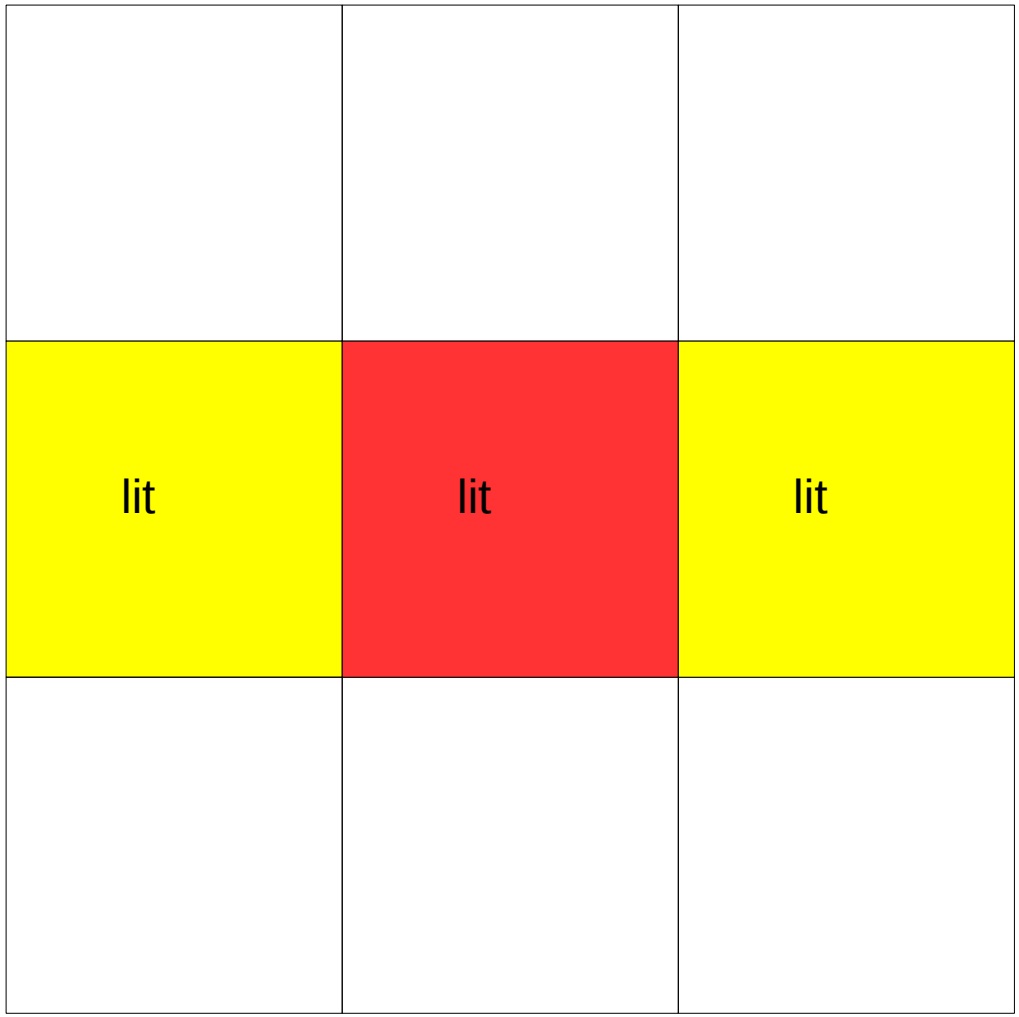
We need the a correct implementation of the crosstalk for simulation (will affect shower radii, etc):

- Current implementation is 10% crosstalk per tile

Three data sets for the calculation of the inter tile crosstalk have been taken. One set at DESY with lying modules and two sets at CERN with standing modules.

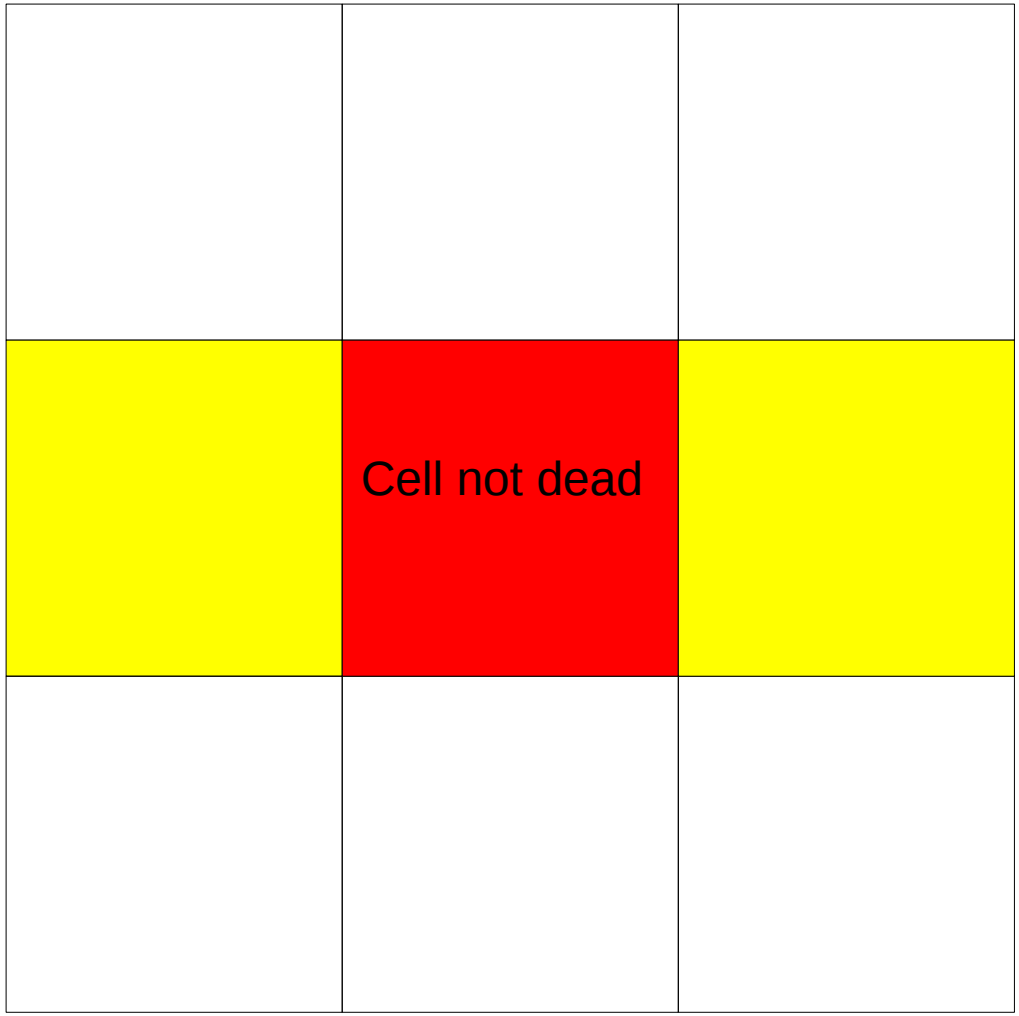


Crosstalk algorithm



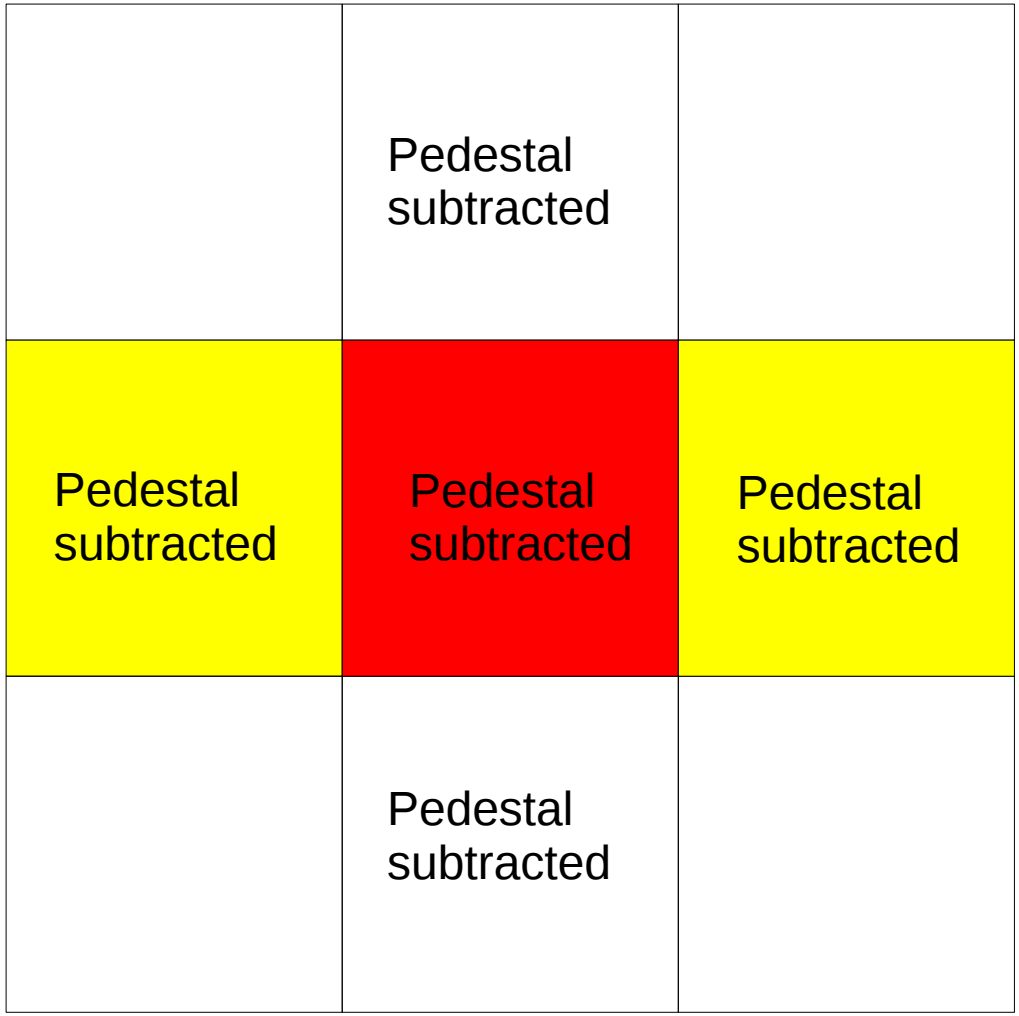
- Just one LED is turned on per module

Crosstalk algorithm



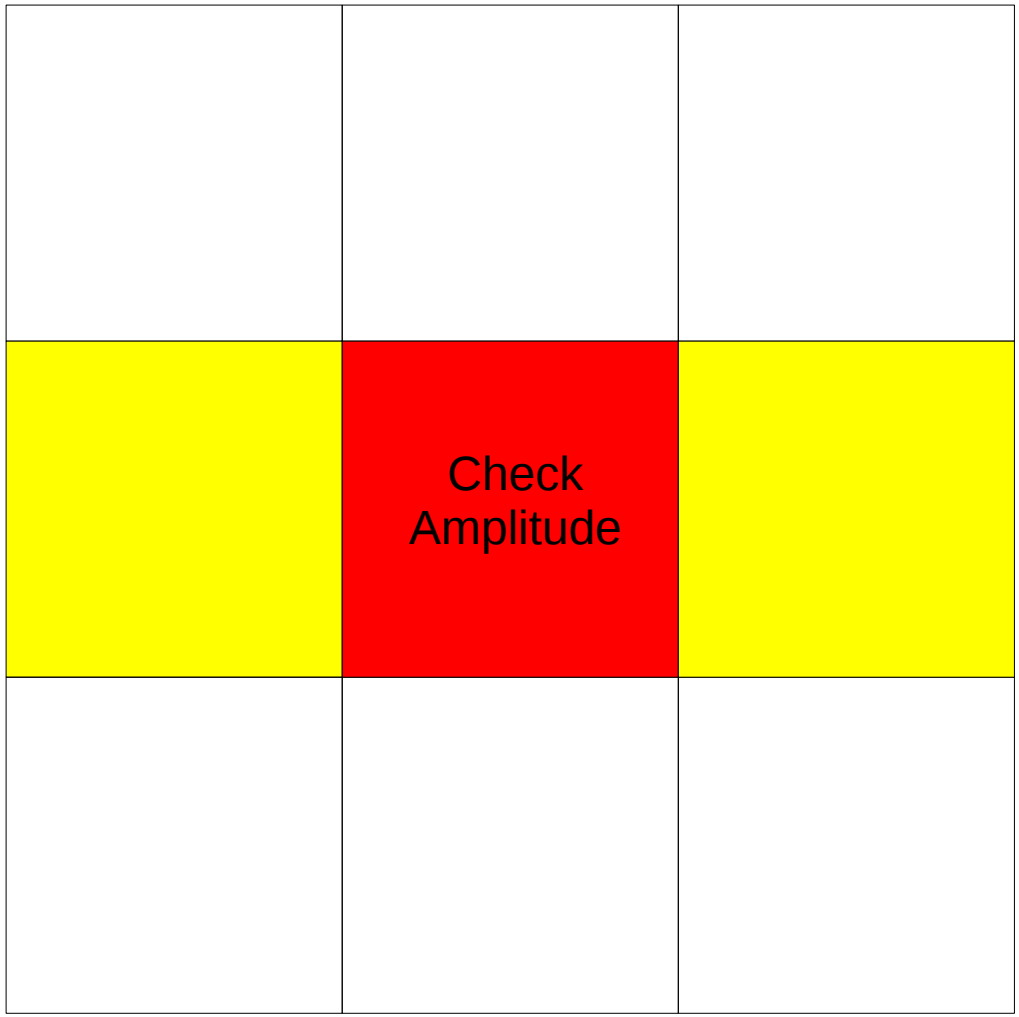
- Just one LED is turned on per module
- Check if cell is not dead

Crosstalk algorithm



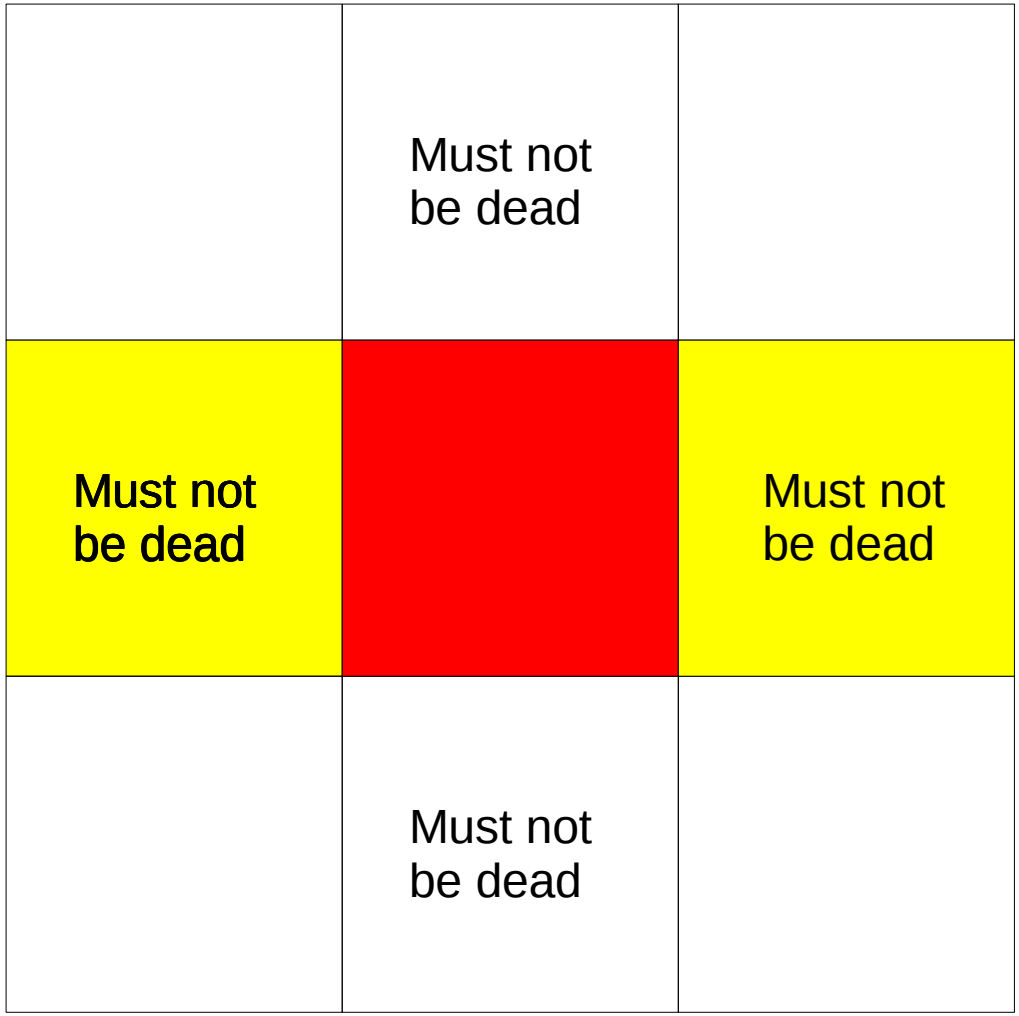
- Just one LED is turned on per module
- Check if cell is not dead
- Pedestal subtraction

Crosstalk algorithm



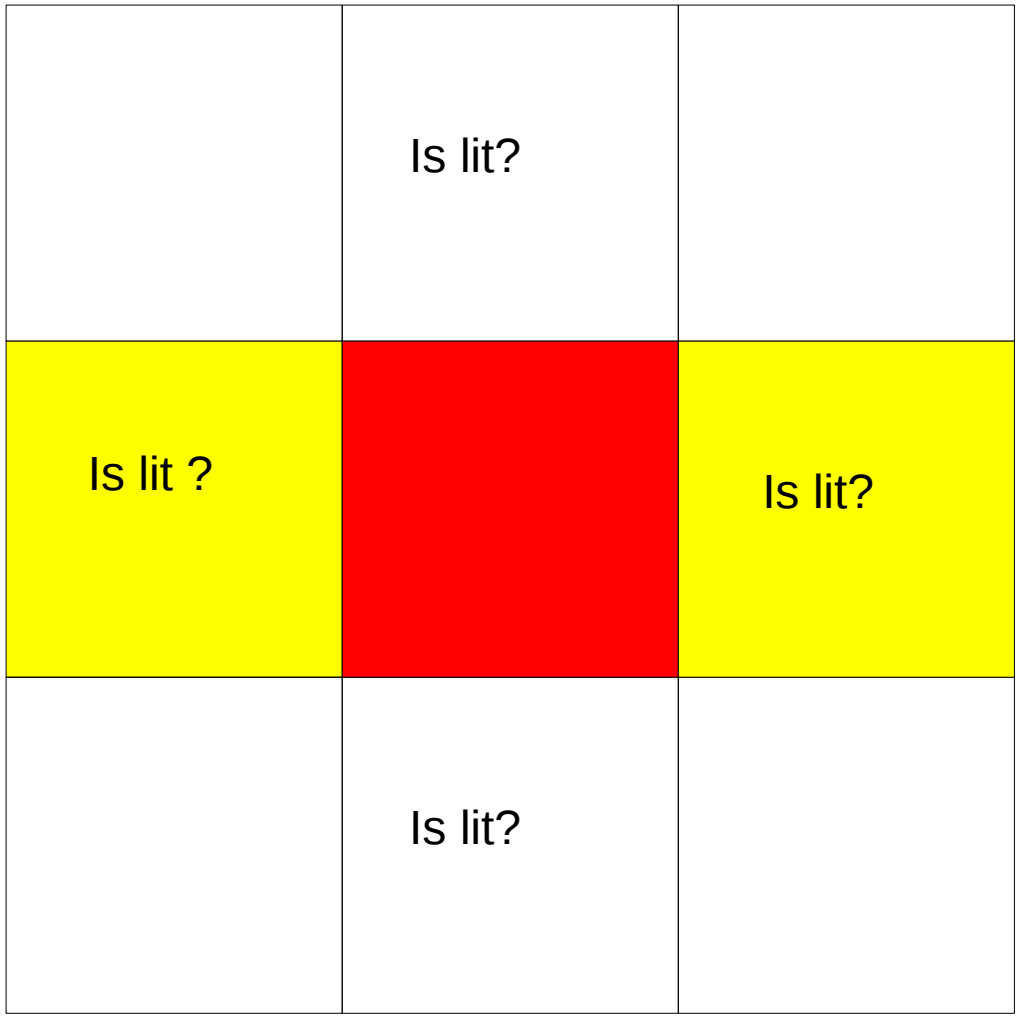
- Just one LED is turned on per module
- Check if cell is not dead
- Pedestal subtraction
- Amplitude cut

Crosstalk algorithm



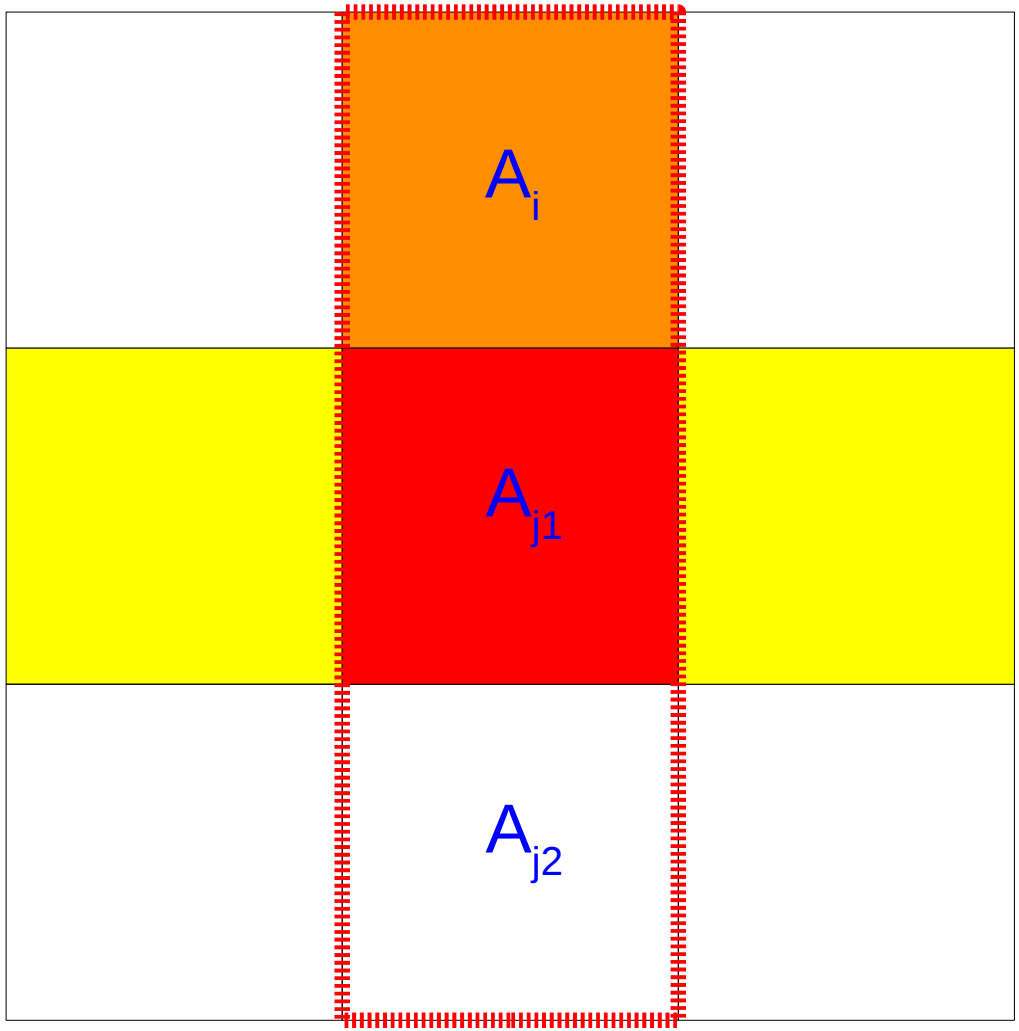
- Just one LED is turned on per module
- Check if cell is not dead
- Pedestal subtraction
- Amplitude cut
- Neighbour cells must not be dead

Crosstalk algorithm



- Just one LED is turned on per module
- Check if cell is not dead
- Pedestal subtraction
- Amplitude cut
- Neighbour cells must not be dead
- Find the non-lit neighbours

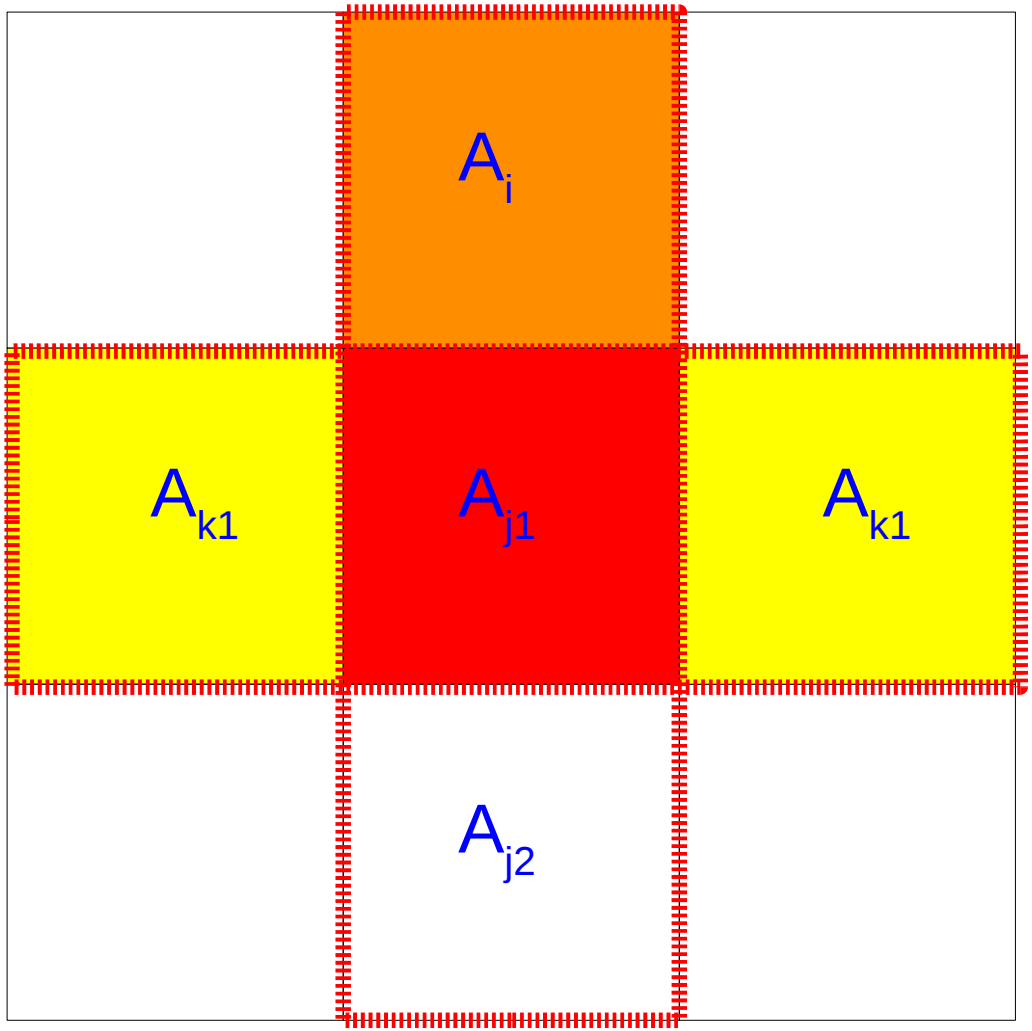
Crosstalk algorithm



Calculate crosstalk 1. iteration:

$$X_t = \frac{A_i[MIP]}{\sum A[MIP]}$$

Crosstalk algorithm



Calculate crosstalk 2. iteration:

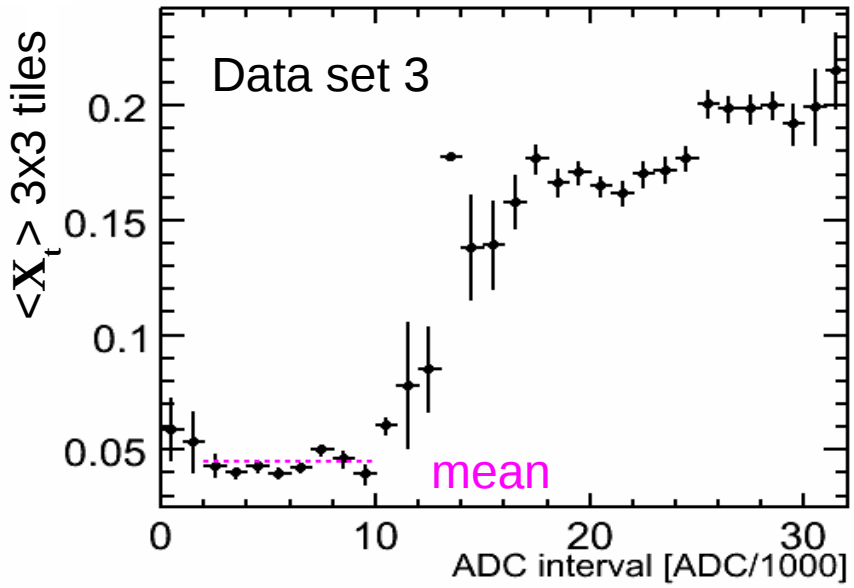
$$X_t = \frac{A_i[MIP]}{A_{Sum}[MIP]}$$

$$A_{Sum} = A_i + \sum A_j - \sum A_k * X_t + 2\,A_{j1} \cdot X_t$$

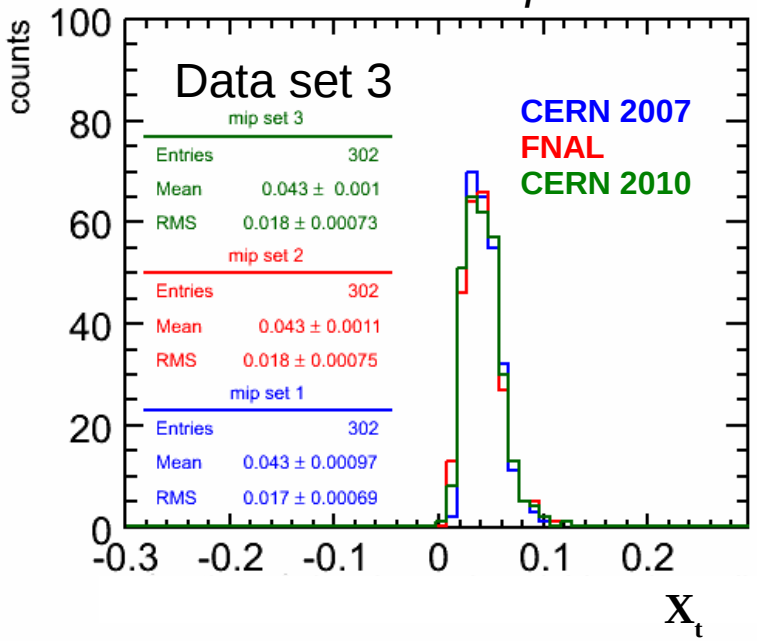
Dependencies of crosstalk results

- Result stable in ADC interval used (3000-10000 ADC counts), but depends on used interval (studies done), uncertainty due to ADC interval start and end goes into error calculation
- Result almost independent of used calibration (also to temperature correction of calibration)
- Result depends strongly on pedestal subtraction (stability checked)

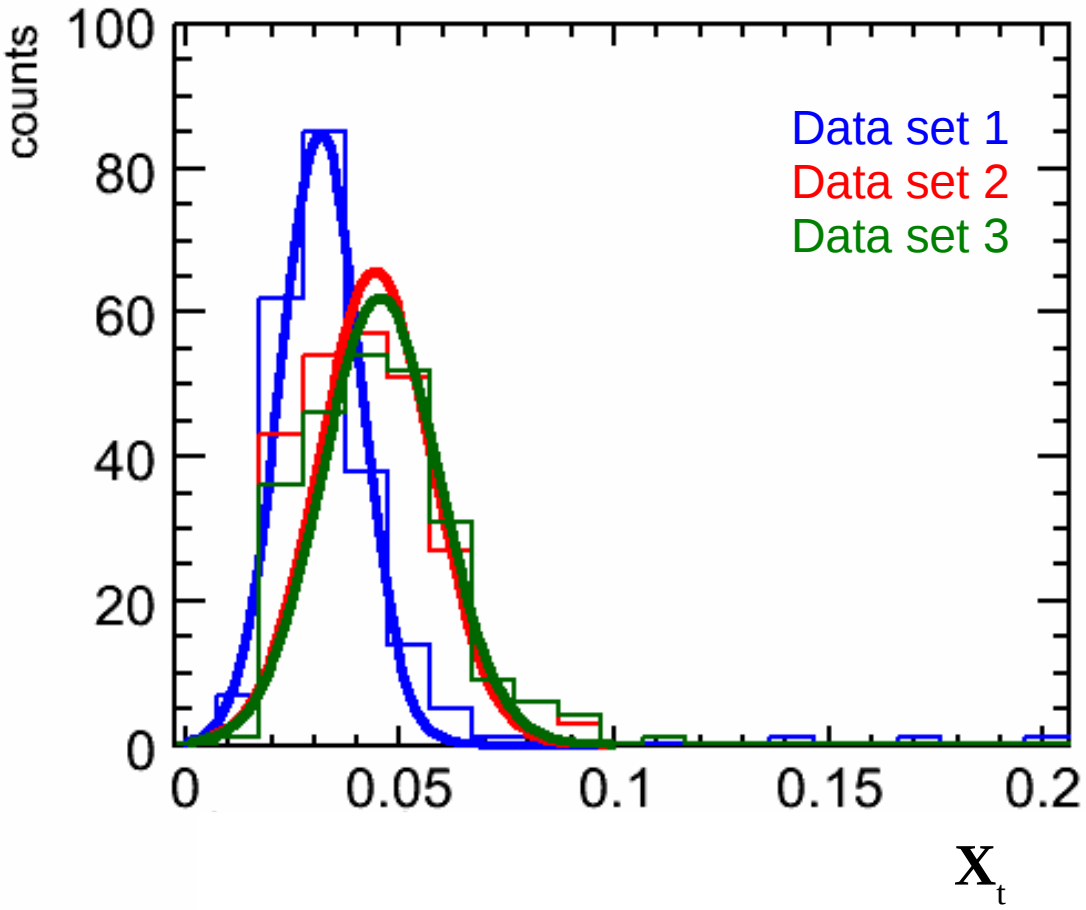
ADC interval dependence:



Calibration set dependence:



Result for 3x3 tiles



Distribution:

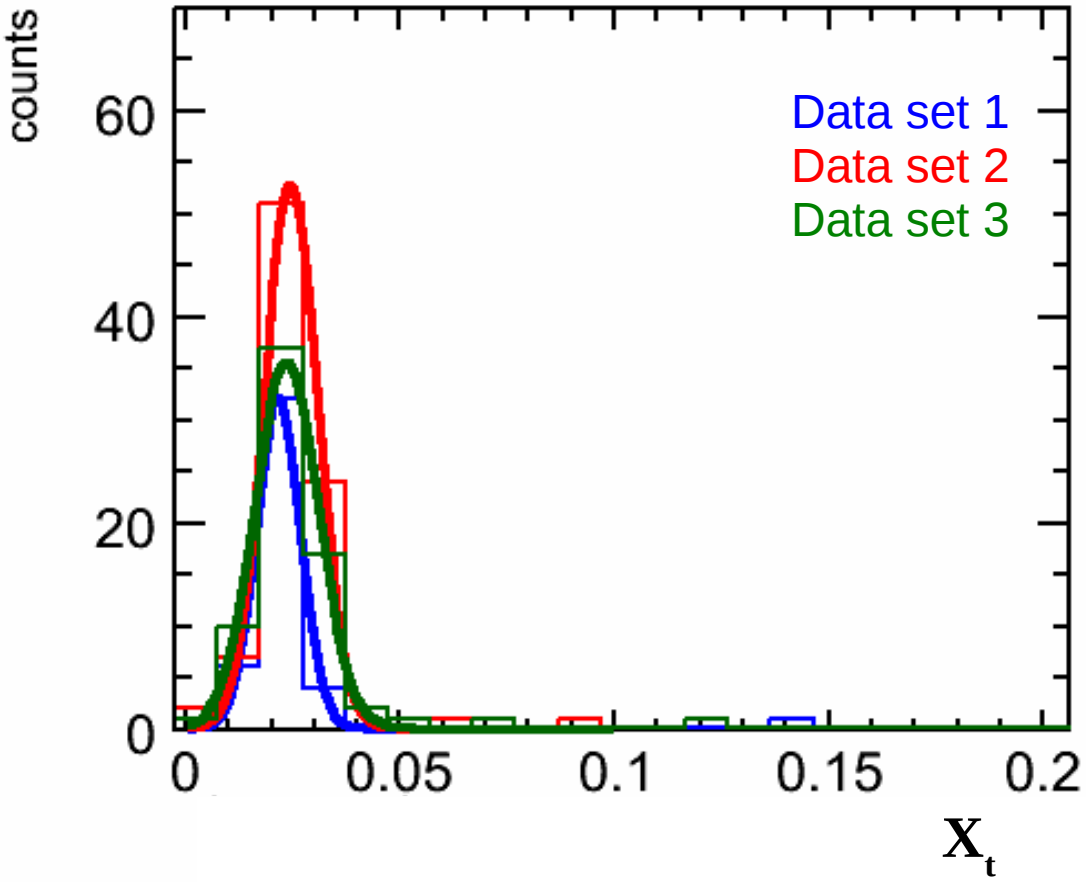
Data set (entries)	mean	rms
1 (219)	0.035±0.001	0.020±0.001
2 (255)	0.044±0.001	0.022±0.001
3 (242)	0.045±0.001	0.017±0.001

Fit:

Data set	mean	rms
1	0.032±0.001	0.009±0.001
2	0.044±0.001	0.013±0.001
3	0.046±0.001	0.014±0.001

- Errors in table are just statistical error, real error estimated: 0.002

Result for 6x6 tiles



Distribution:

Data set (entries)	mean	rms
1 (49)	0.026±0.003	0.020±0.002
2 (93)	0.027±0.002	0.015±0.001
3 (70)	0.026±0.002	0.016±0.001

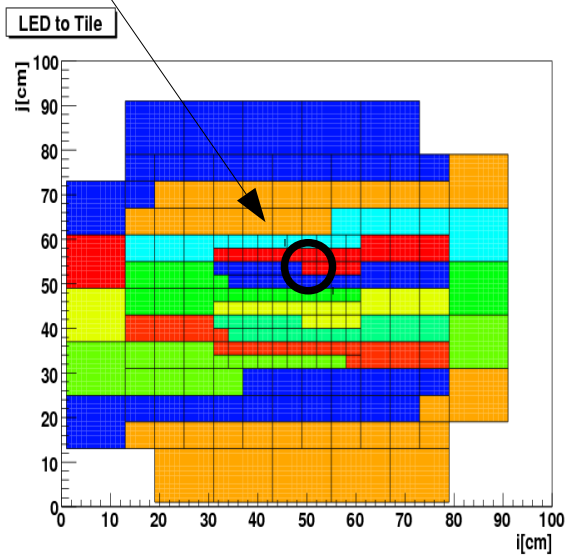
Fit:

Data set	mean	rms
1	0.022±0.001	0.005±0.001
2	0.025±0.001	0.006±0.001
3	0.024±0.001	0.007±0.001

- Errors in table are just statistical error, real error estimated: 0.003 (worse statistics than 3x3 tiles)

Crosscheck with double lit cells

- Some cells have to lit neighbours
- These cells see approximately twice as much light as the single lit



For 3x3 tiles:

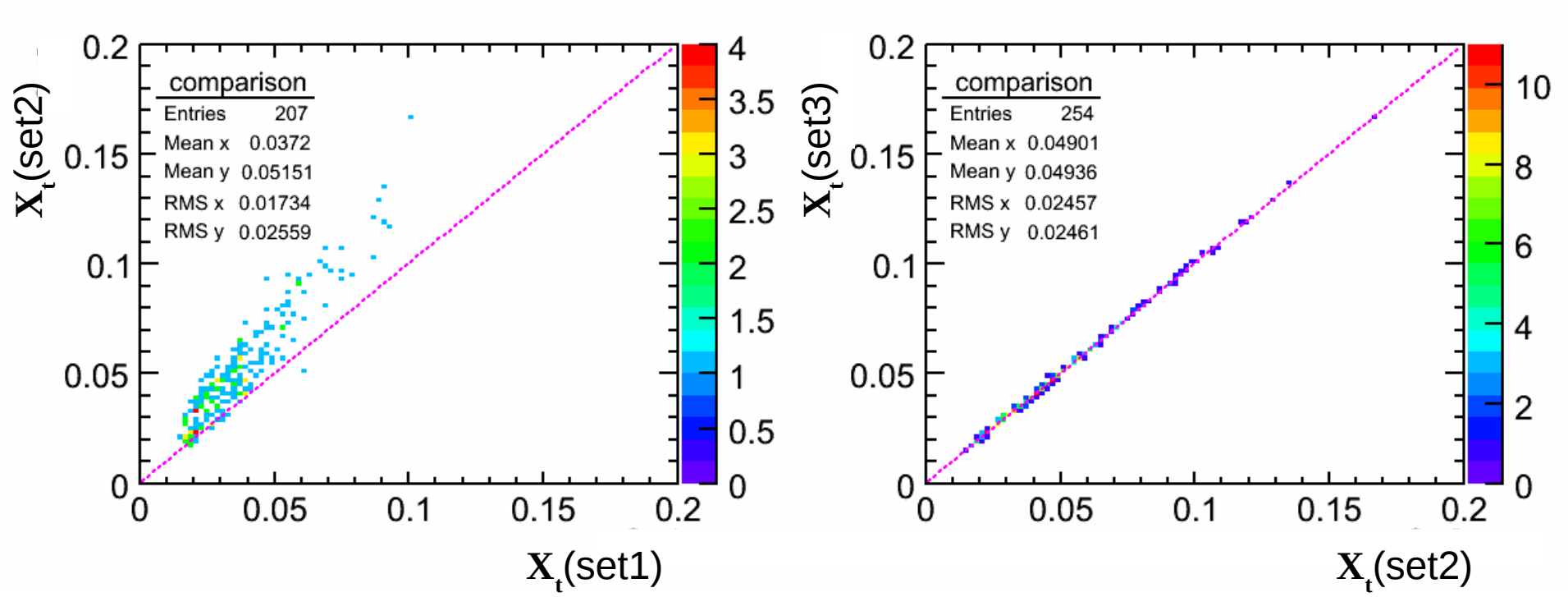
Values for double lit cells	entries	mean	rms
Data set 1	40	0,064 ± 0.003	0.019 ± 0.002
Data set 2	46	0.080 ± 0.004	0.028 ± 0.003
Data set 3	44	0.082 ± 0.005	0.029 ± 0.003

For 6x6 tiles:

Values for double lit cells	entries	mean	rms
Data set 1	4	0.057 ± 0.008	0.016 ± 0.006
Data set 2	14	0.054 ± 0.006	0.021 ± 0.003
Data set 3	12	0.056 ± 0.006	0.019 ± 0.003

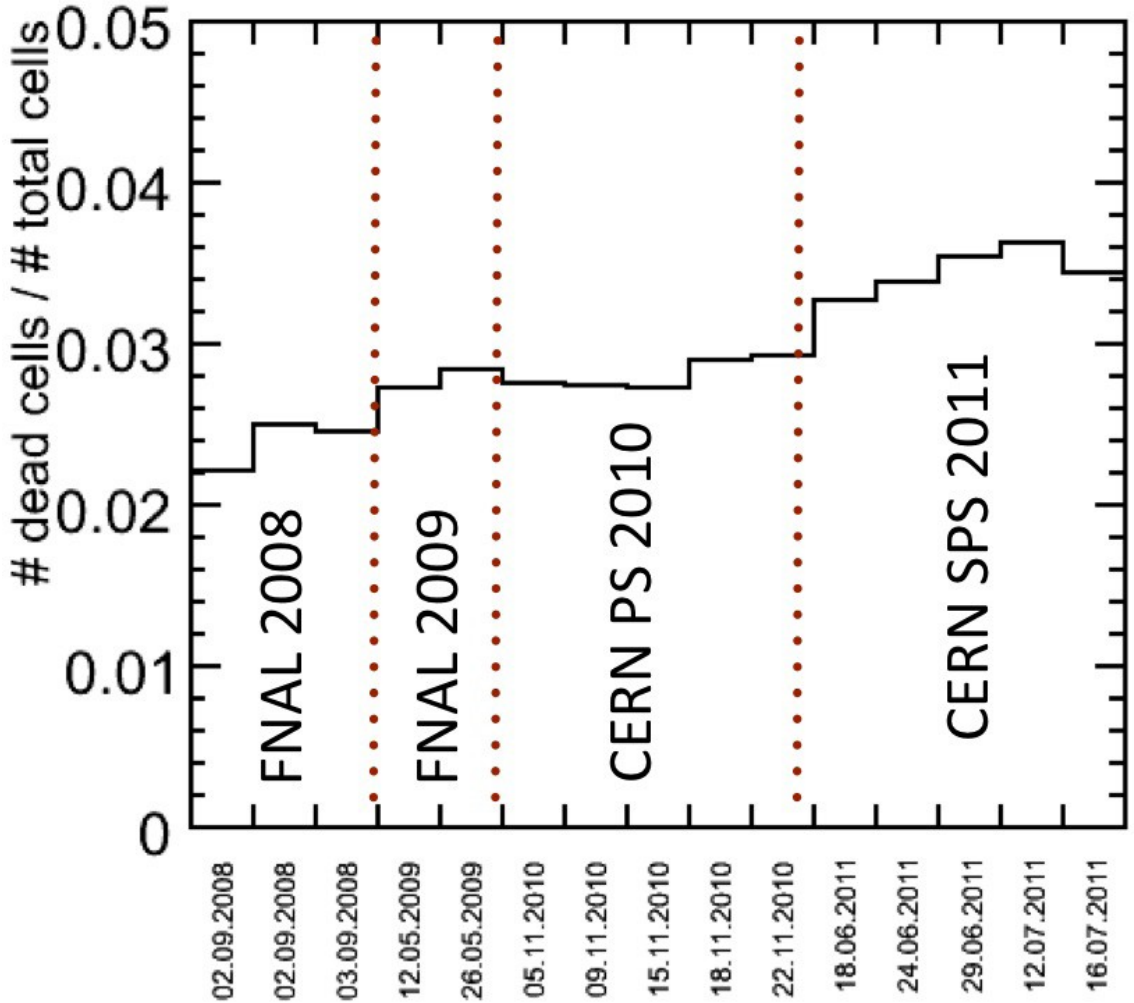
Correlation of results

Compare crosstalk measurement for one tile edge from one set with another set



Data sets 2 & 3 are consistent. But data set 1 gives different values.
But each data set is in itself consistent.

Evolution of the dead channels

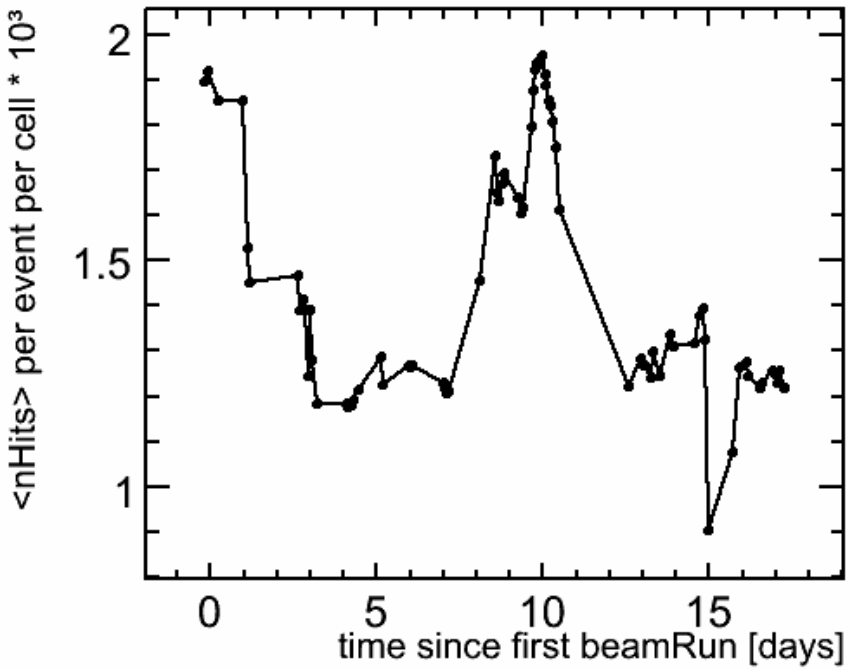


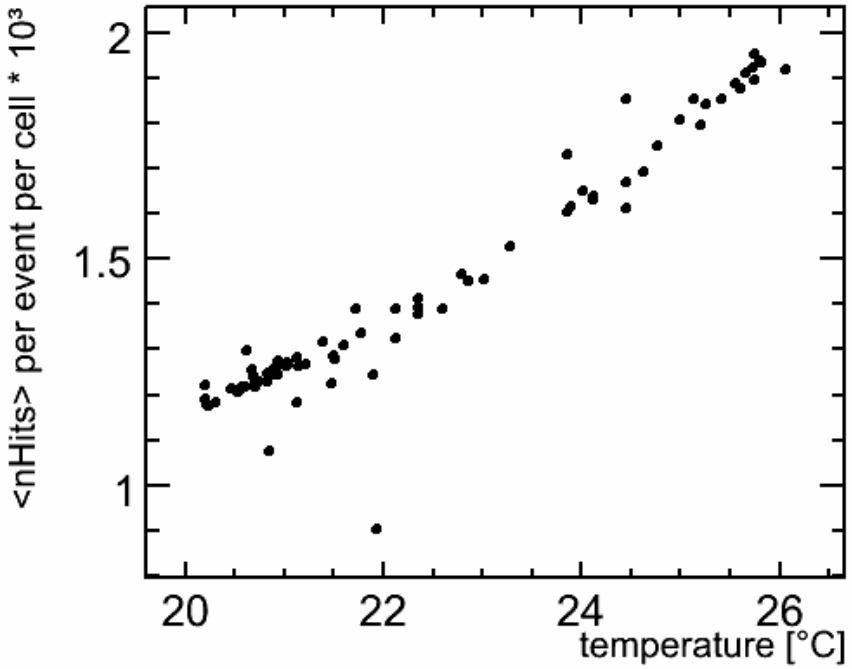
Number of dead channels in individual noise runs

<u>Dead channels:</u>

RMS < 20.5 ADC

Stability of noisehits





Number of hits above 0,5 MIP temperature dependent

Varies from $1.1*10^{-3}$ at 20°C to $2*10^{-3}$ noisehits per events and per cell on average
This translates to ~7 hits (20°C) to ~12 hits (26°C)
(used MIP calibration from Christian Grefe, CERN)

Gain studies

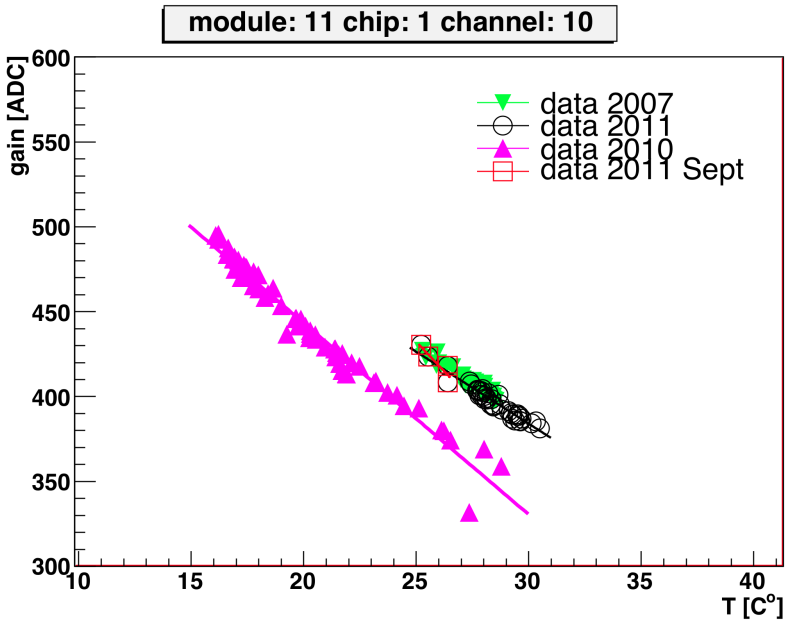
Study combining all the gain measurements from the different testbeam periods

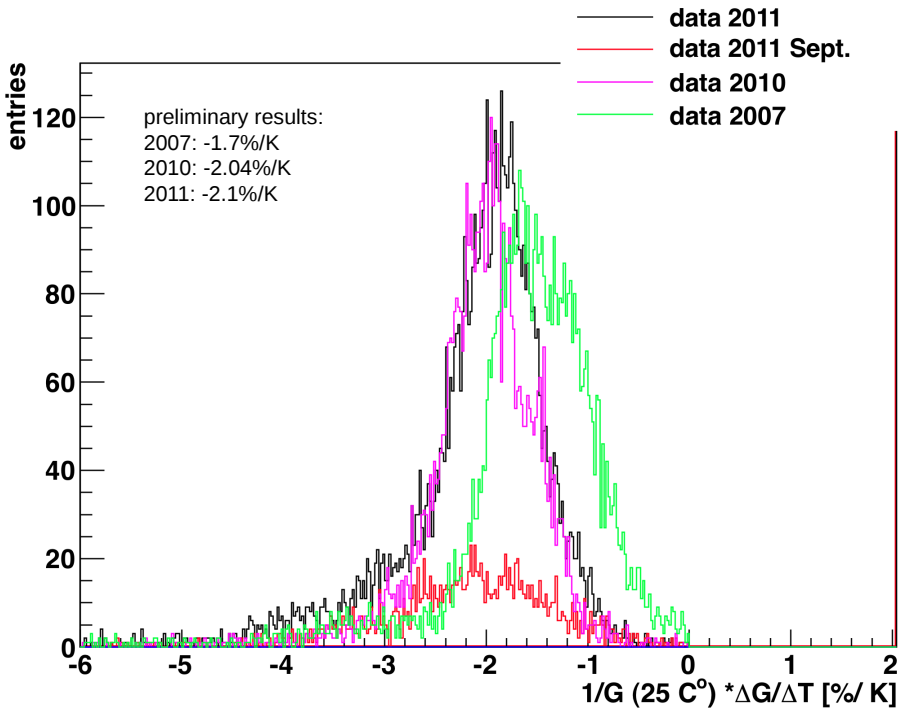
Goal: study the change of gains during the years, study changes of temperature and overvoltage dependence to improve calibration corrections

Study ongoing

Current status:

Differences found in the distribution of the relative slopes, reason unclear





Conclusions I

- 3 data sets for tile crosstalk measurements have been taken and evaluated
- The data set from DESY Hall West gives different results,
  but reason unclear, due to different setup (standing modules vs laying modules, etc.)
- For first data set the tile crosstalk for the 3x3 tiles is 3.1% ± 0.2% per edge, for the other two data sets it is 4.3% ± 0.2% and 4.5% ± 0.2% per edge
- For 6x6 tiles the first data set gives 2.2% ± 0.4% tile crosstalk per edge, data sets 2 & 3 give 2.5% ± 0.3% and 2.4% ± 0.3%
- Data sets 2 & 3 have not only higher cross talk but the distribution has increased width
- Double lit cells see twice as much light as single lit cells

Conclusions II

- The number of dead channels increased from ~2% in 2007 to ~3.5 % in 2011 when looking at individual runs
- Number of hits above 0,5 MIP threshold in pedestal events is temperature dependent
- Number of hits above 0,5 MIP threshold varies from ~$1.1*10^{-3}$ (20°C) to $2*10^{-3}$ (26°C) per cell and event
- Gain study ongoing
- Not shown here: Study on temperature correction of data based on led events

BACKUP

Datasets

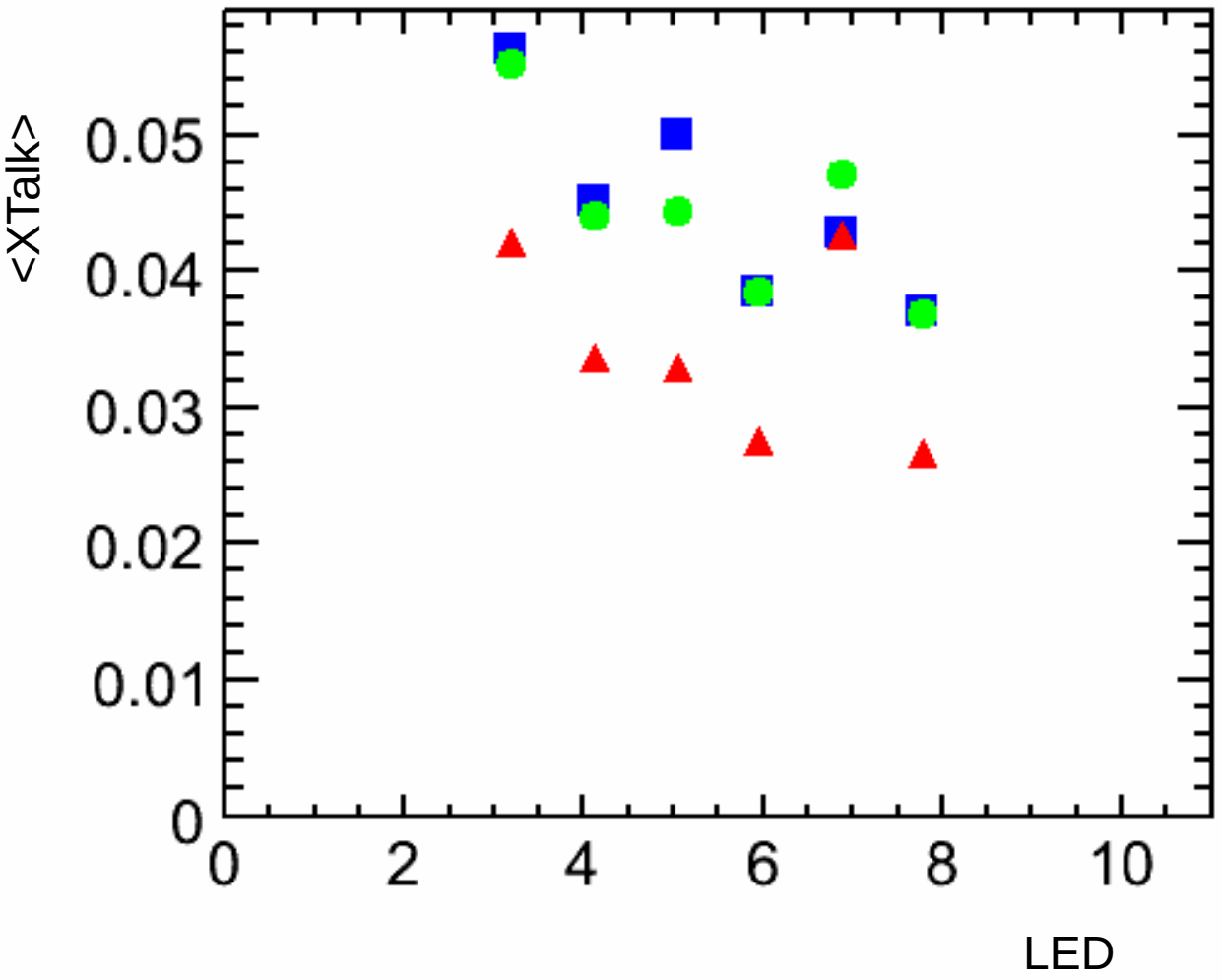
By now 3 datasets. One from 2010 at DESY Hall West(red), two from CERN 2011 (blue):

run	lighted LED
206197	none
206198	0
206199	1
206200	2
206201	3
206202	4
206203	5
206204	none
206205	6
206206	7
206207	8
206208	9
206209	10
206210	11
206211	none

run	lighted LED
361781	none
361782	0
361783	1
361784	2
361785	3
361786	4
361787	5
361788	none
361789	6
361790	7
361791	8
361792	9
361793	10
361794	11
361795	none
361796	even
361797	odd
361798	all on
361799	VcalibScan

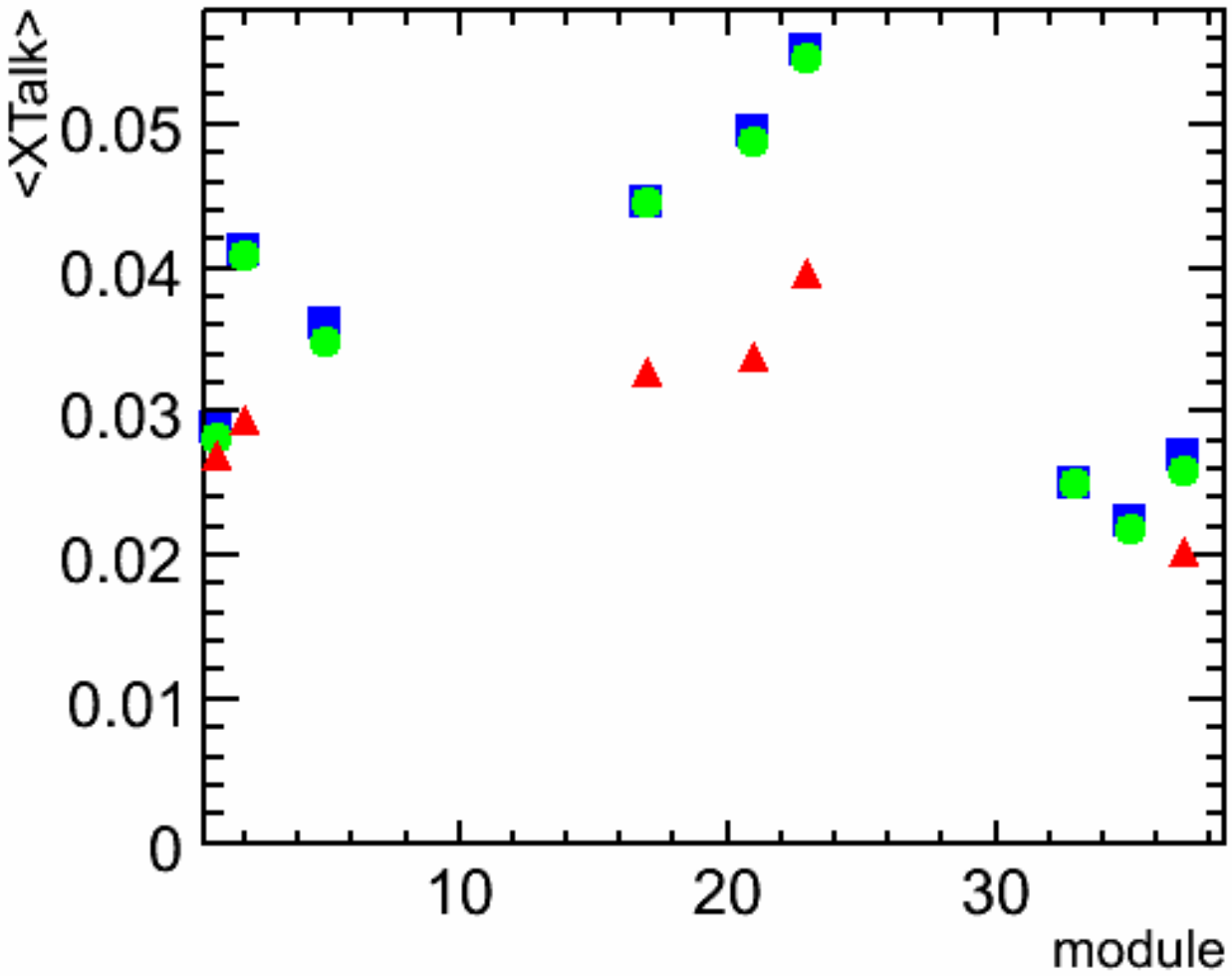
run	lighted LED
361800	none
361801	0
361802	1
361803	2
361804	3
361805	4
361806	5
361807	none
361808	6
361809	7
361810	8
361811	9
361812	10
361813	11
361814	none
361815	even
361816	odd
361817	VcalibScan

XTalk LED wise



Red: data set 1
Green: data set 2
Blue: data set 3

XTalk module wise

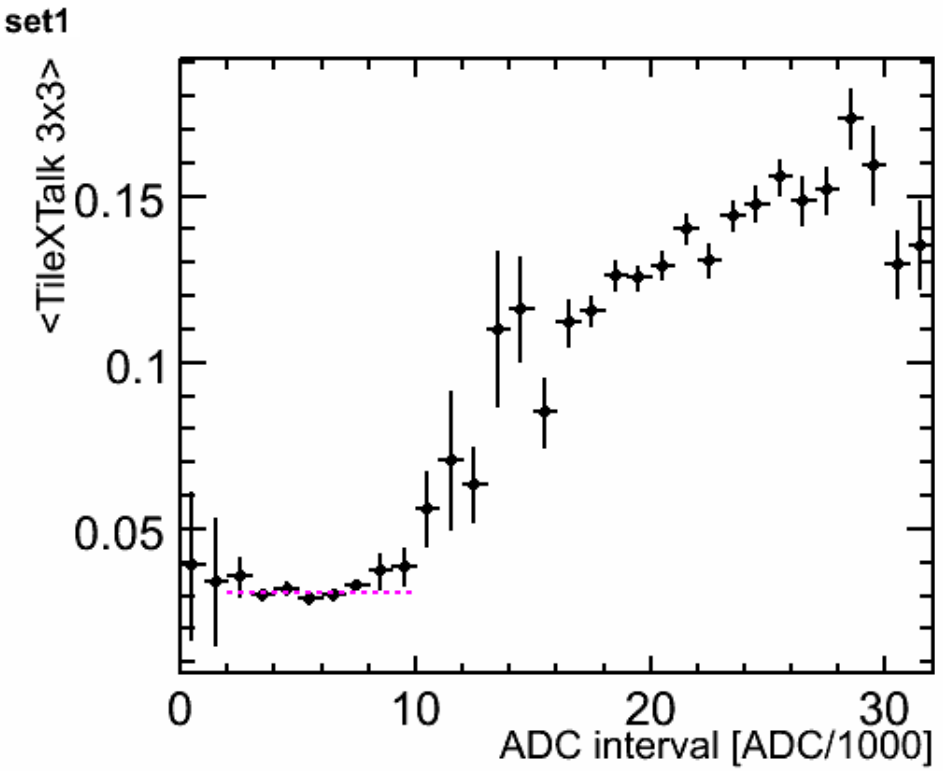


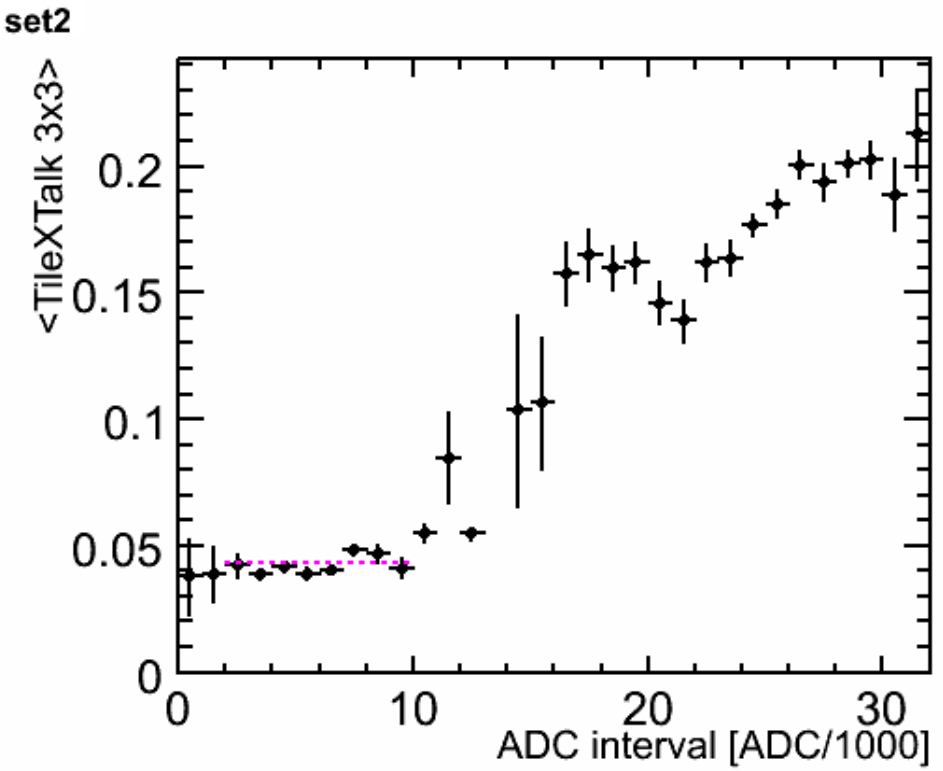
Red: data set 1
Green: data set 2
Blue: data set 3

First dataset has less contributing modules

Only modules >= 5 entries
(3 have 1 entry, 1 has 2)

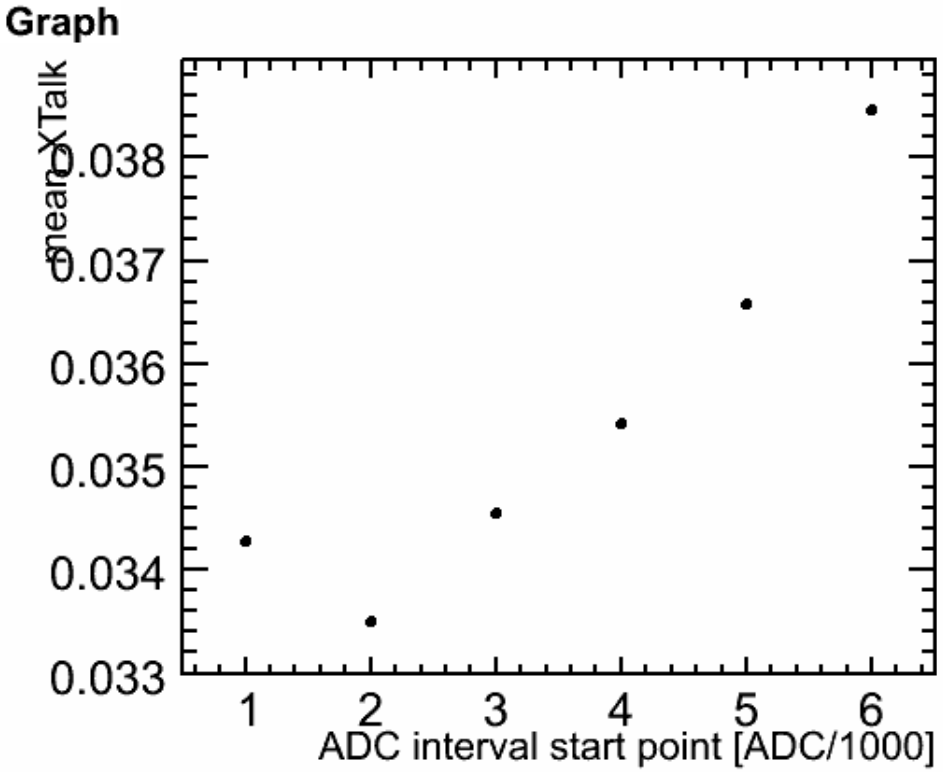
XTalk ADC wise

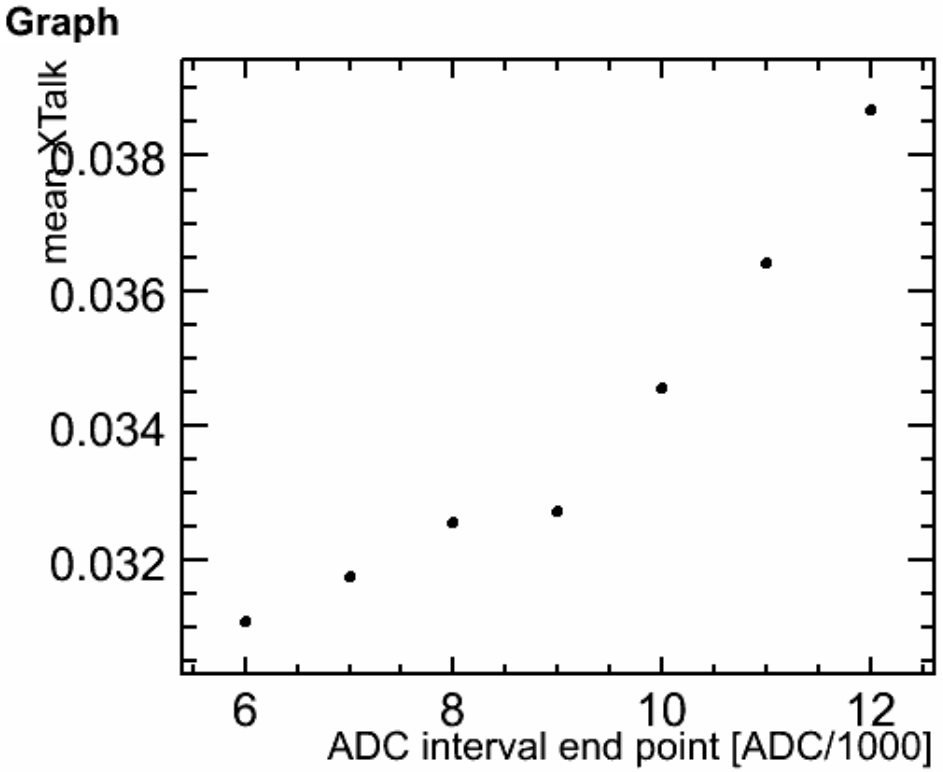




XTalk ADC interval dependency I

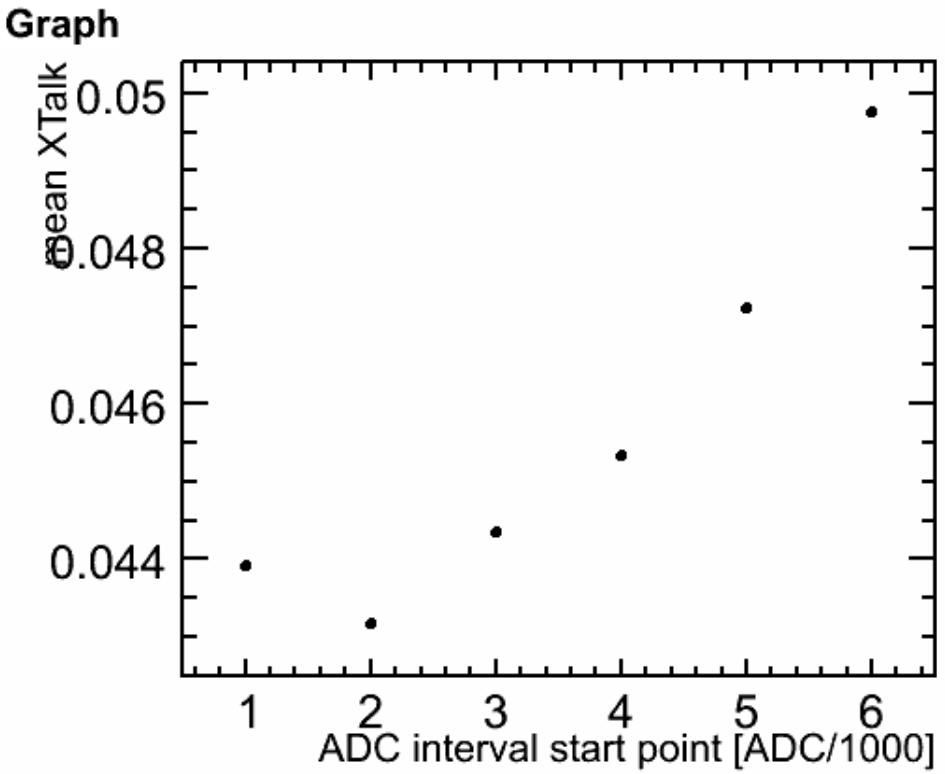
Dataset 1

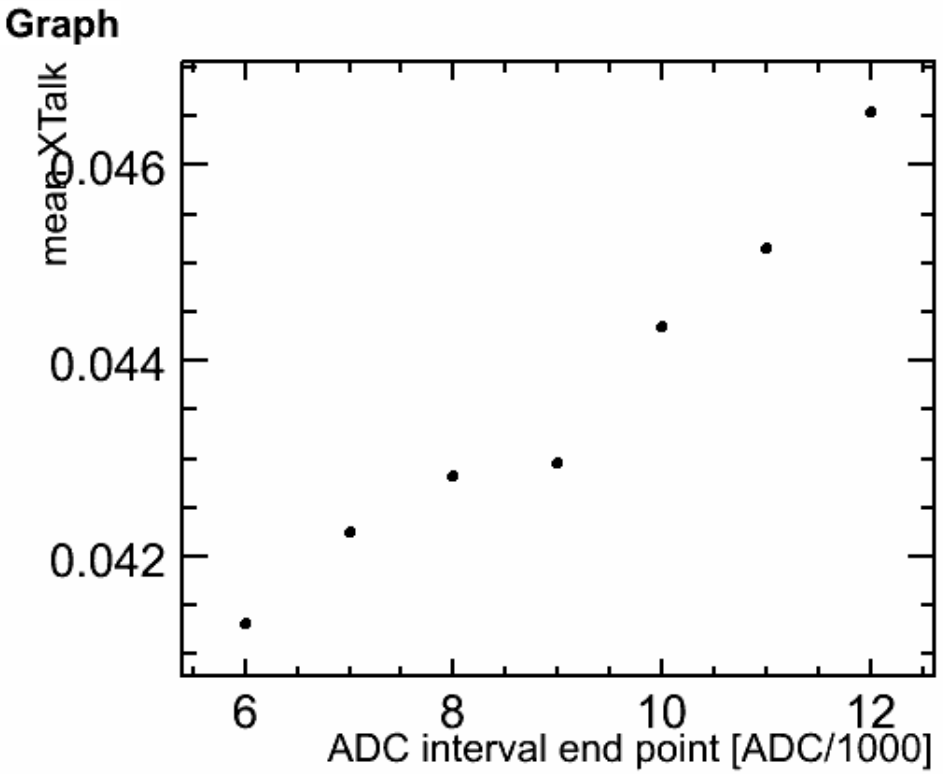




XTalk ADC interval dependency I

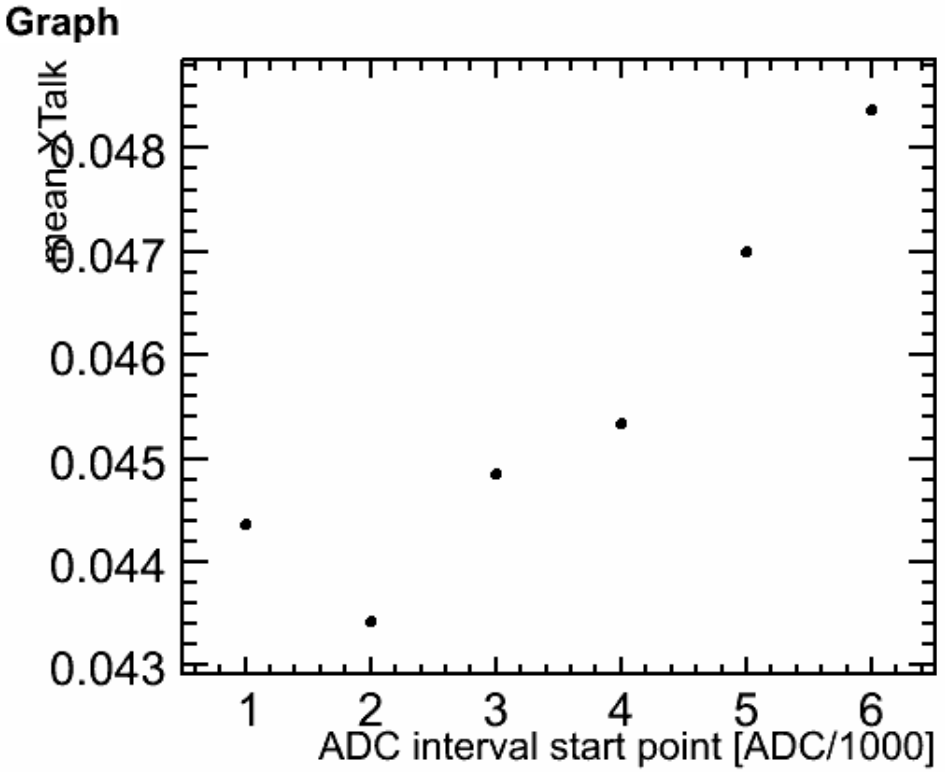
Dataset 2

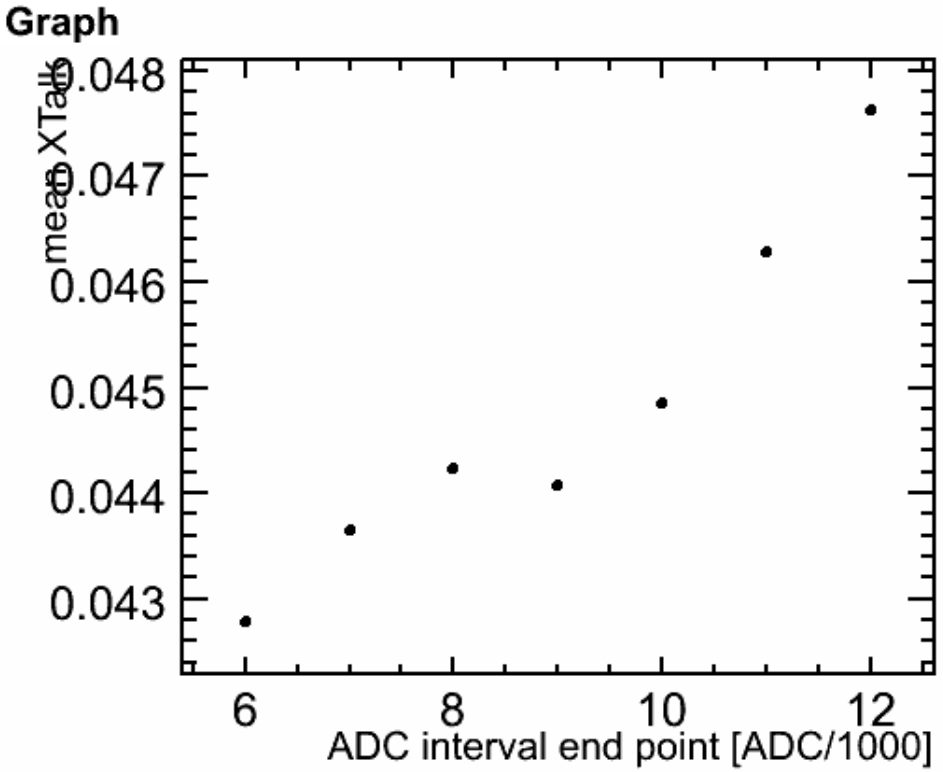




XTalk ADC interval dependency I

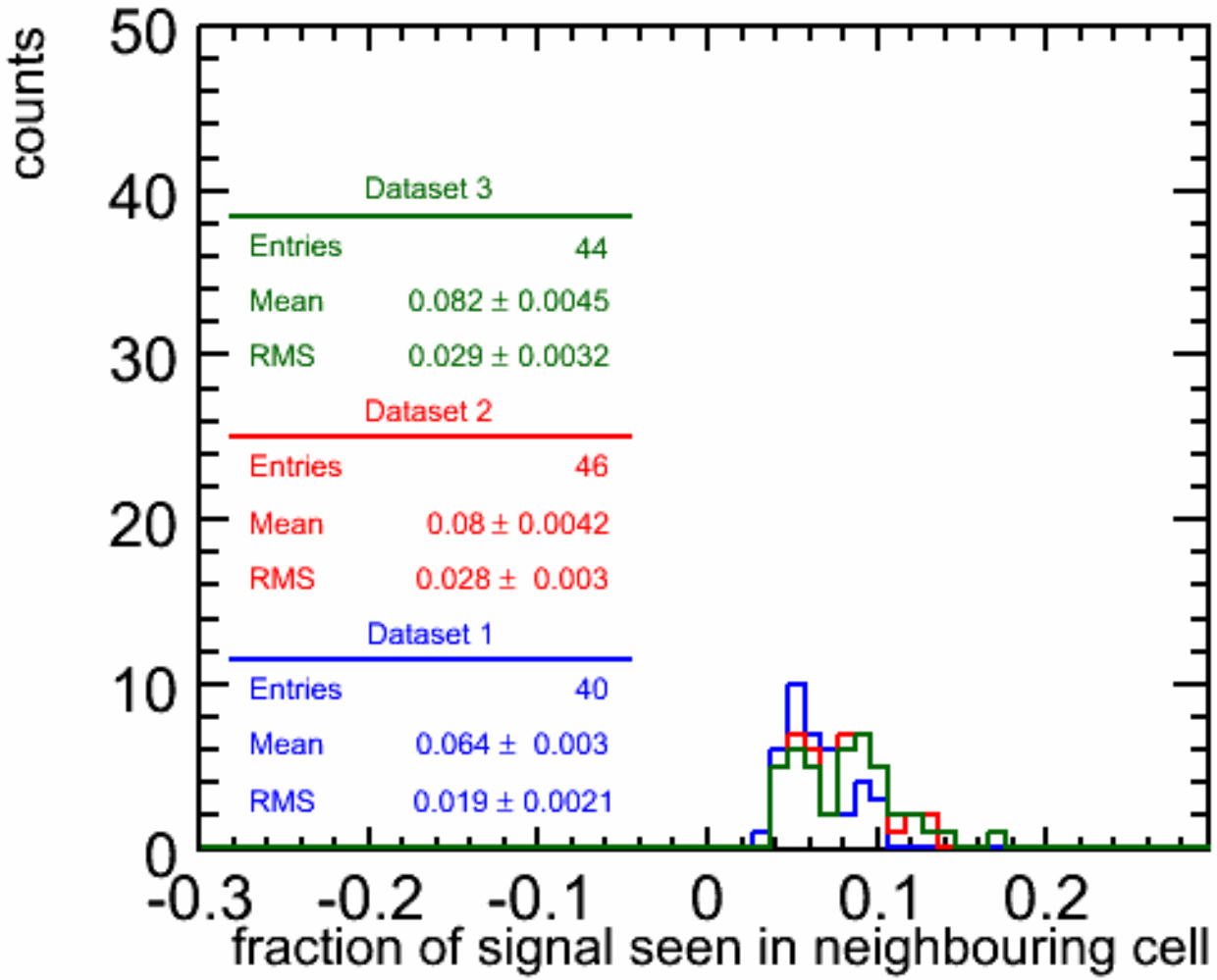
Dataset 3





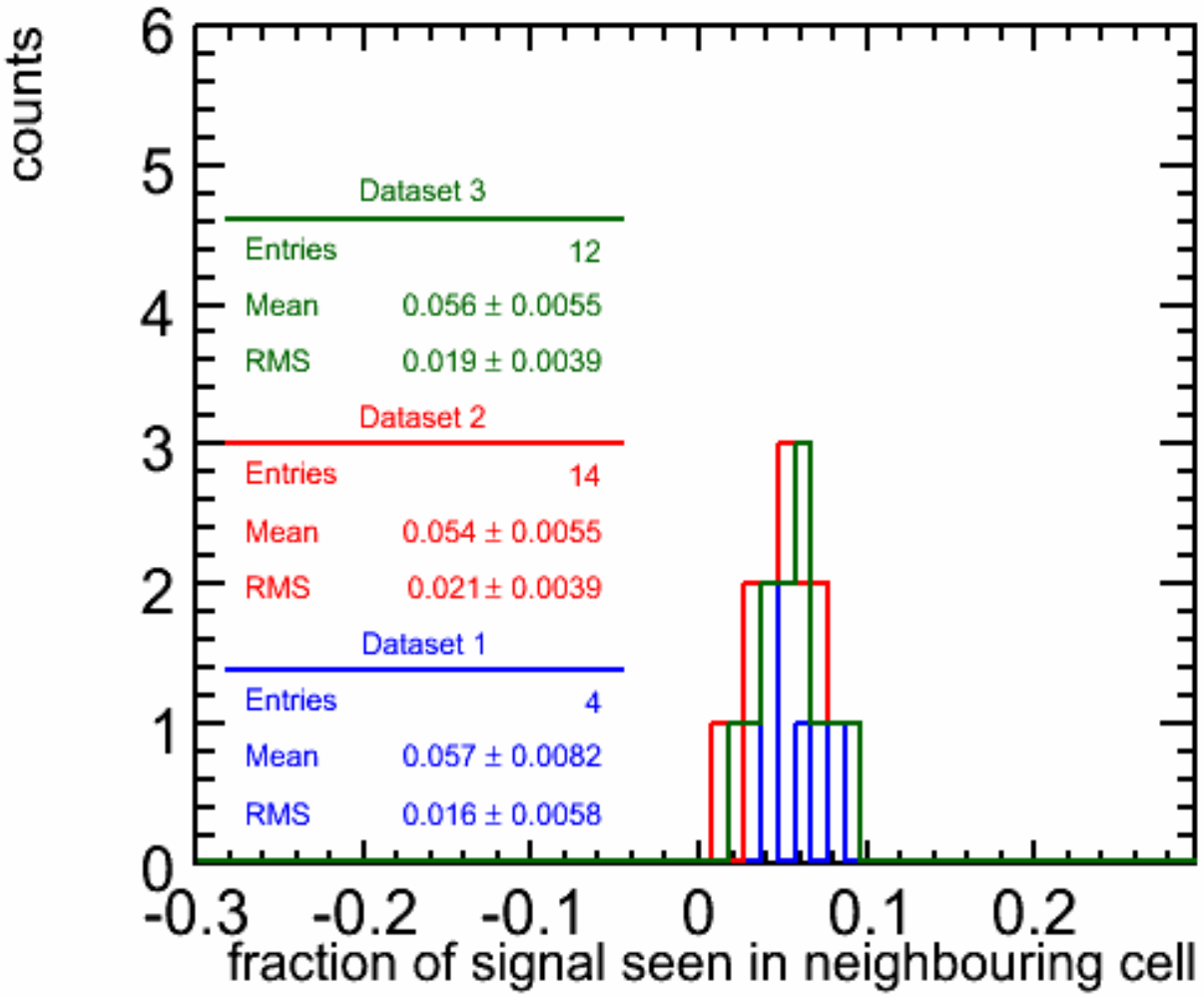
Crosscheck with double lid cells I

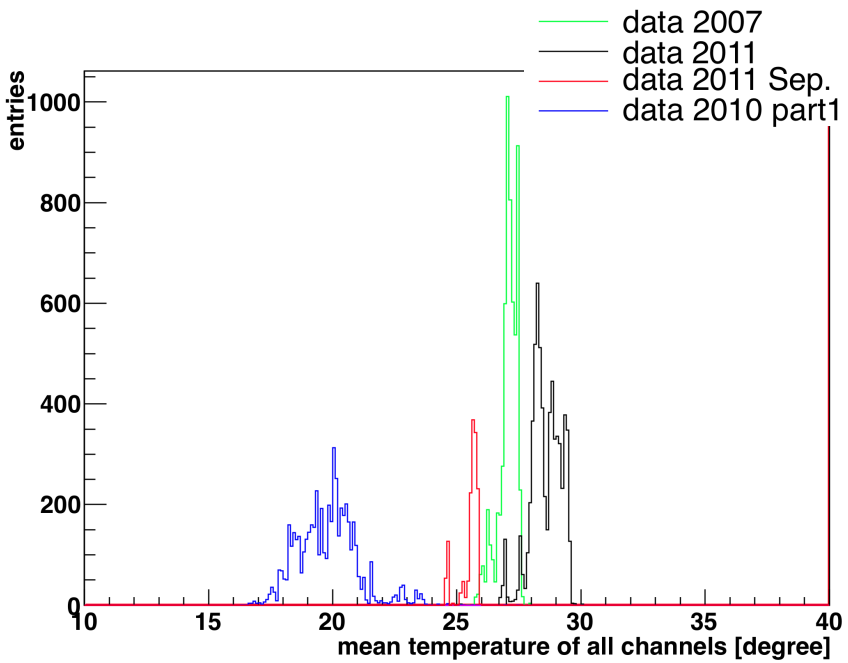
For normal modules:

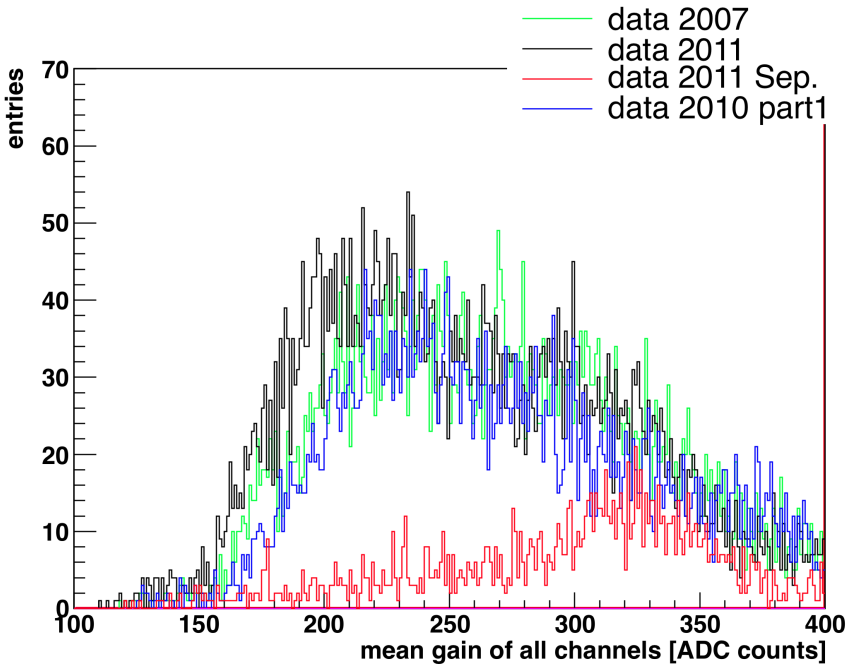


Crosscheck with double lid cells II

For coarse modules:







between 2007 and 2011: temperature differences up to 10 degree

Status:

try to understand the slope (ΔG/ΔT) differences between the different channels (dependence of the position of the chip within the HCAL)

Steps to get the final results

- in order to determine the gain vs. temperature dependence, one has to do the following steps:

1. measure gain values at different temperature; during the measurements a constant bias voltage for the SiPm is assumed
2. perform linear fits to extract the temperature dependence of the gains dG/dT

- SiPm for which available gains do not cover a temperature range of at least 2° are omitted
- fit results with $\chi^2/NDF < 20$ are regarded as good

3. determine the mean result 1/G dG/dT
4. for every channel: the slope dG/dT is divided by the mean gain value G of all gain measurements of this channel at 25 degree