

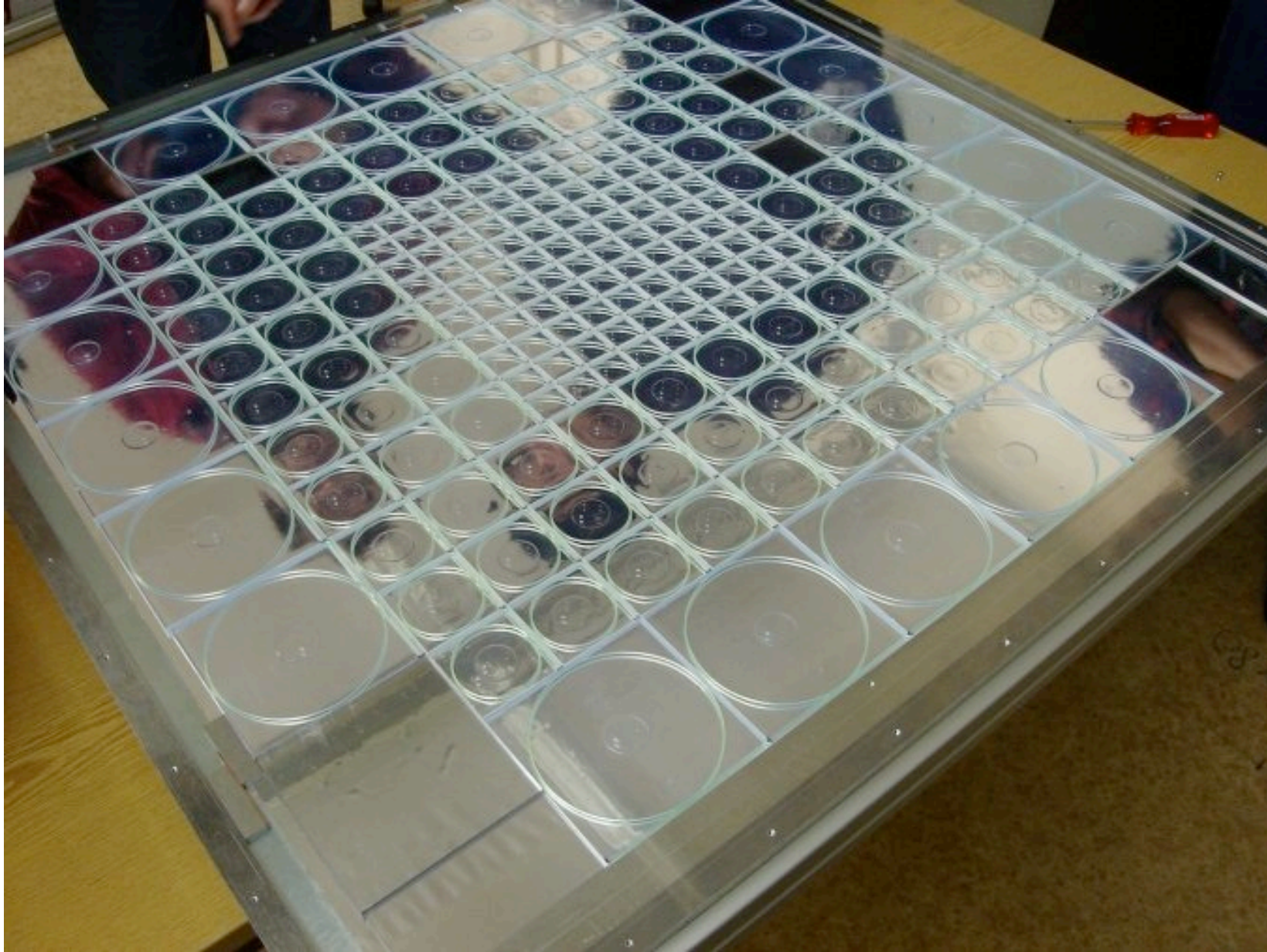
Calibration with hadronic showers

Shaojun Lu

shlu@mppmu.mpg.de

MPI for Physics & Excellence Cluster Universe
Munich, Germany



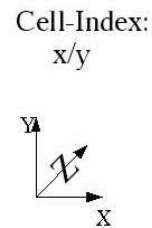


The definition of isolation tiles and track like cluster

Tile Hcal Numbering Scheme I

Fine granulated layer 1-30

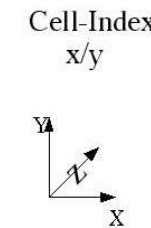
			19/79	31/79	43/79	55/79	67/79				
1/67	13/73	19/73	25/73	31/73	37/73	43/73	49/73	55/73	61/73	67/73	73/73
	13/67	19/67	25/67	31/67	37/67	43/67	49/67	55/67	61/67	67/67	73/67
1/55	13/61	19/61	25/61	31/61	37/61	43/61	49/61	55/61	61/61	67/61	73/61
	13/55	19/55	25/55	31/55	37/55	43/55	49/55	55/55	61/55	67/55	73/55
1/43	13/49	19/49	25/49	31/49	37/49	43/49	49/49	55/49	61/49	67/49	73/49
	13/43	19/43	25/43	31/43	37/43	43/43	49/43	55/43	61/43	67/43	73/43
1/31	13/37	19/37	25/37	31/37	37/37	43/37	49/37	55/37	61/37	67/37	73/37
	13/31	19/31	25/31	31/31	37/31	43/31	49/31	55/31	61/31	67/31	73/31
1/19	13/25	19/25	25/25	31/25	37/25	43/25	49/25	55/25	61/25	67/25	73/25
	13/19	19/19	25/19	31/19	37/19	43/19	49/19	55/19	61/19	67/19	73/19
	13/13	19/13	25/13	31/13	37/13	43/13	49/13	55/13	61/13	67/13	73/13
		13/1	25/1	37/1	49/1	61/1					



Tile Hcal Numbering Scheme II

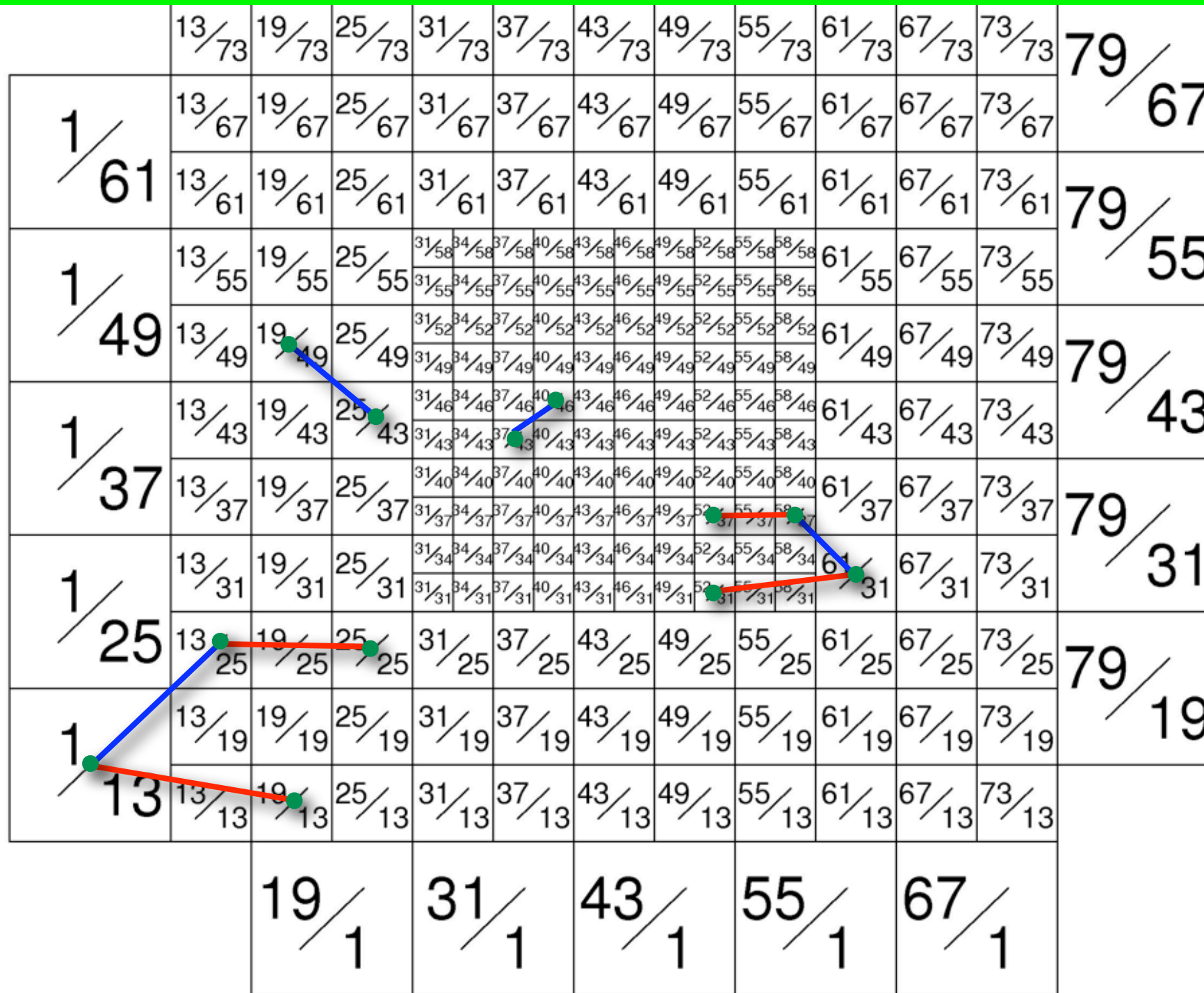
Coarse granulated layer 31-38

			19/79	31/79	43/79	55/79	67/79				
1/67	13/73	19/73	25/73	31/73	37/73	43/73	49/73	55/73	61/73	67/73	73/73
	13/67	19/67	25/67	31/67	37/67	43/67	49/67	55/67	61/67	67/67	73/67
1/55	13/61	19/61	25/61	31/61	37/61	43/61	49/61	55/61	61/61	67/61	73/61
	13/55	19/55	25/55	31/55	37/55	43/55	49/55	55/55	61/55	67/55	73/55
1/43	13/49	19/49	25/49	31/49	37/49	43/49	49/49	55/49	61/49	67/49	73/49
	13/43	19/43	25/43	31/43	37/43	43/43	49/43	55/43	61/43	67/43	73/43
1/31	13/37	19/37	25/37	31/37	37/37	43/37	49/37	55/37	61/37	67/37	73/37
	13/31	19/31	25/31	31/31	37/31	43/31	49/31	55/31	61/31	67/31	73/31
1/19	13/25	19/25	25/25	31/25	37/25	43/25	49/25	55/25	61/25	67/25	73/25
	13/19	19/19	25/19	31/19	37/19	43/19	49/19	55/19	61/19	67/19	73/19
	13/13	19/13	25/13	31/13	37/13	43/13	49/13	55/13	61/13	67/13	73/13
		13/1	25/1	37/1	49/1	61/1					



- Isolated tile: if it has no ‘neighbor’.
- Track like cluster:
 - ▶ consists of isolated hits;
 - ▶ The hits need to be in consecutive layers
 - ▶ The two hits in consecutive layers need to be in tiles with the same I and J coordinates or the neighboring these.
 - ▶ Allow that a layer inside a track may be ‘blank’.

The definition of isolation tiles and track like cluster

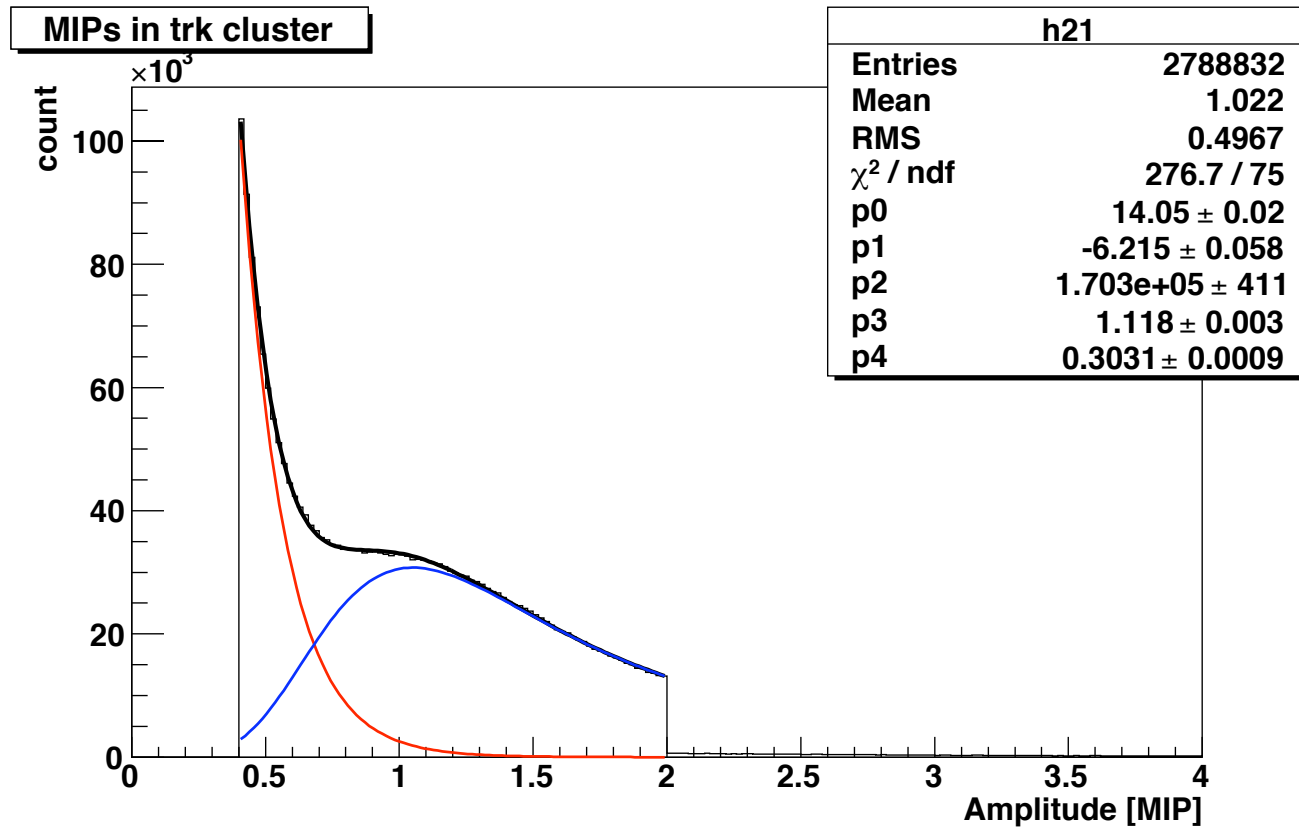


- The red lines show the relevant distances used to determine the isolation criteria for different tiles are marked.
- The blue lines show the neighboring tiles are marked

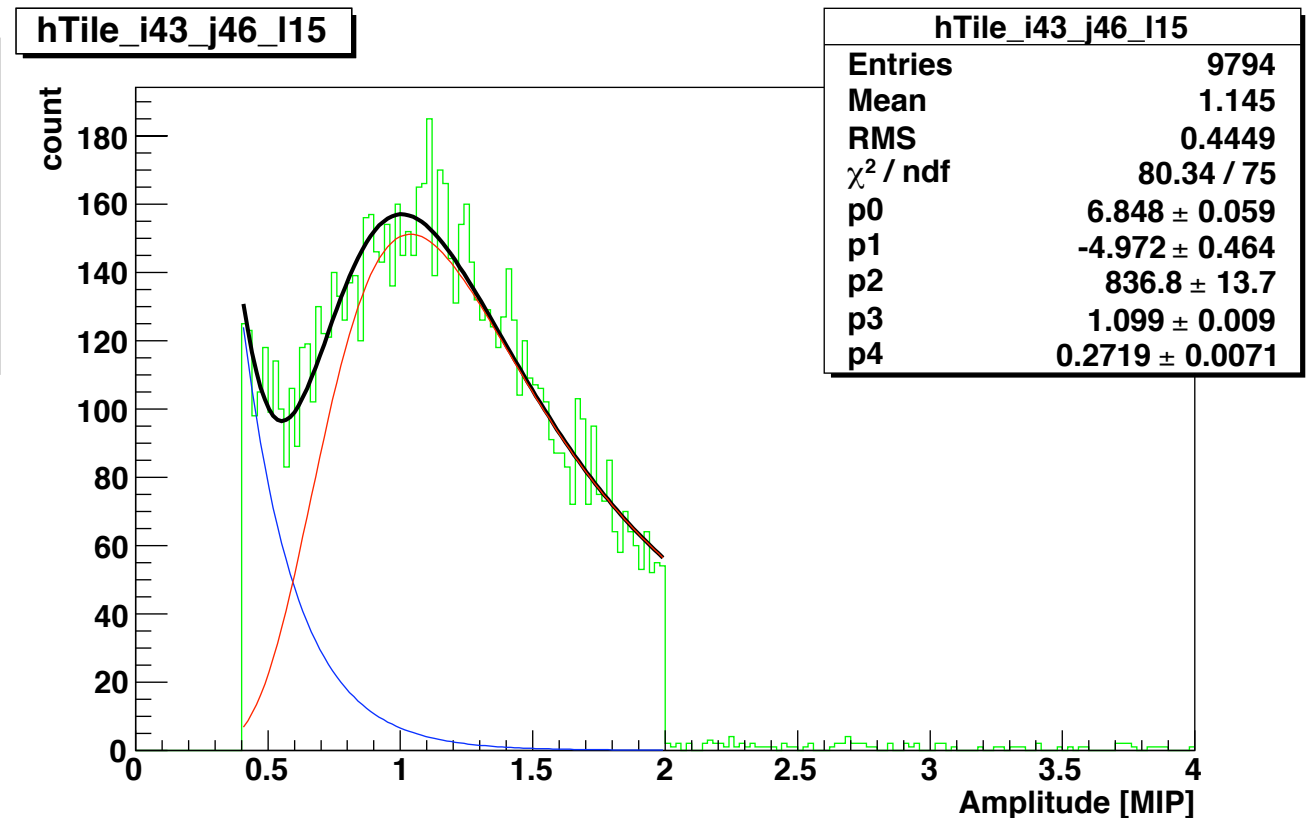
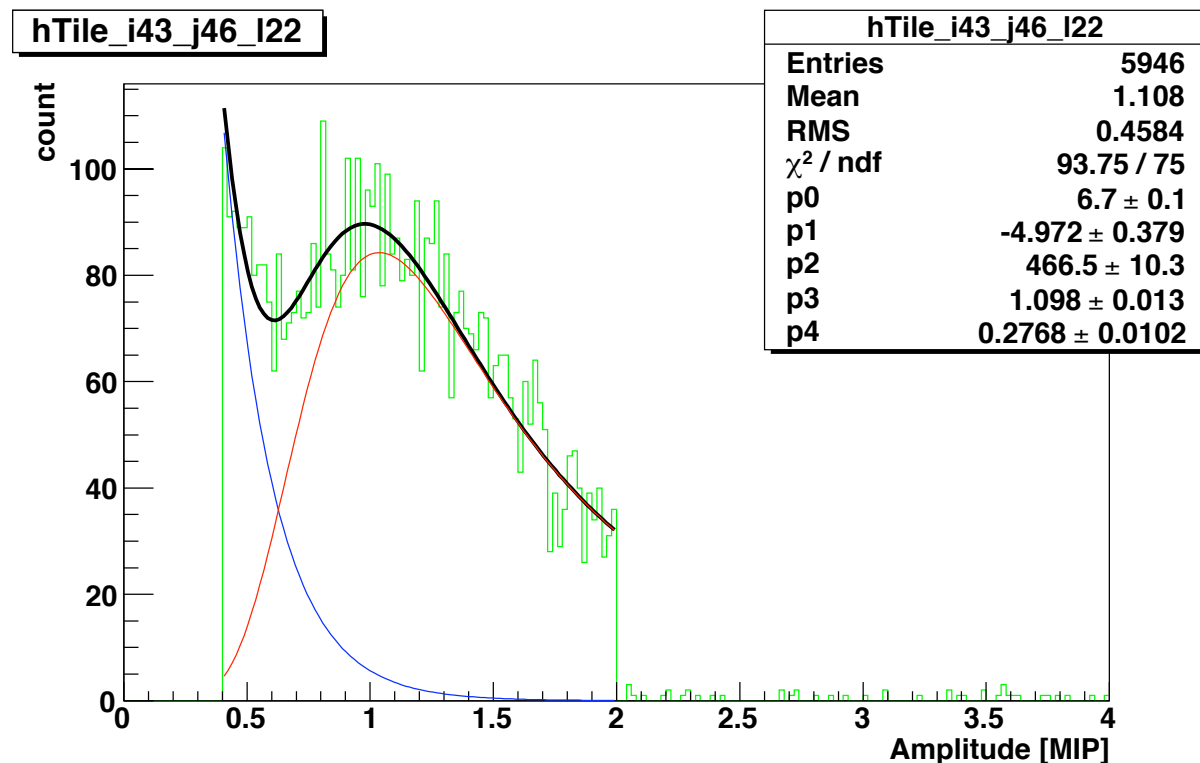
The definition of temperature for isolated tiles

		$\frac{13}{79}$ $\frac{25}{79}$ $\frac{37}{79}$ $\frac{49}{79}$ $\frac{61}{79}$											
		$\frac{13}{73}$	$\frac{19}{73}$	$\frac{25}{73}$	$\frac{31}{73}$	$\frac{37}{73}$	$\frac{43}{73}$	$\frac{49}{73}$	$\frac{55}{73}$	$\frac{61}{73}$	$\frac{67}{73}$	$\frac{73}{73}$	$\frac{79}{73}$
$\frac{1}{61}$	$\frac{13}{67}$	$\frac{19}{67}$	$\frac{25}{67}$	$\frac{31}{67}$	$\frac{37}{67}$	$\frac{43}{67}$	$\frac{49}{67}$	$\frac{55}{67}$	$\frac{61}{67}$	$\frac{67}{67}$	$\frac{73}{67}$	$\frac{79}{67}$	$\frac{67}{67}$
	$\frac{13}{61}$	$\frac{19}{61}$	$\frac{25}{61}$	$\frac{31}{61}$	$\frac{37}{61}$	$\frac{43}{61}$	$\frac{49}{61}$	$\frac{55}{61}$	$\frac{61}{61}$	$\frac{67}{61}$	$\frac{73}{61}$	$\frac{79}{61}$	$\frac{55}{61}$
$\frac{1}{49}$	$\frac{13}{55}$	$\frac{19}{55}$	$\frac{25}{55}$	$\frac{31}{55}$	$\frac{34}{55}$	$\frac{37}{55}$	$\frac{40}{55}$	$\frac{43}{55}$	$\frac{46}{55}$	$\frac{49}{55}$	$\frac{52}{55}$	$\frac{55}{55}$	$\frac{58}{55}$
	$\frac{13}{49}$	$\frac{19}{49}$	$\frac{25}{49}$	$\frac{31}{49}$	$\frac{34}{49}$	$\frac{37}{49}$	$\frac{40}{49}$	$\frac{43}{49}$	$\frac{46}{49}$	$\frac{49}{49}$	$\frac{52}{49}$	$\frac{55}{49}$	$\frac{58}{49}$
$\frac{1}{37}$	$\frac{13}{43}$	$\frac{19}{43}$	$\frac{25}{43}$	$\frac{31}{43}$	$\frac{34}{43}$	$\frac{37}{43}$	$\frac{40}{43}$	$\frac{43}{43}$	$\frac{46}{43}$	$\frac{49}{43}$	$\frac{52}{43}$	$\frac{55}{43}$	$\frac{58}{43}$
	$\frac{13}{37}$	$\frac{19}{37}$	$\frac{25}{37}$	$\frac{31}{37}$	$\frac{34}{37}$	$\frac{37}{37}$	$\frac{40}{37}$	$\frac{43}{37}$	$\frac{46}{37}$	$\frac{49}{37}$	$\frac{52}{37}$	$\frac{55}{37}$	$\frac{58}{37}$
$\frac{1}{25}$	$\frac{13}{31}$	$\frac{19}{31}$	$\frac{25}{31}$	$\frac{31}{31}$	$\frac{34}{31}$	$\frac{37}{31}$	$\frac{40}{31}$	$\frac{43}{31}$	$\frac{46}{31}$	$\frac{49}{31}$	$\frac{52}{31}$	$\frac{55}{31}$	$\frac{58}{31}$
	$\frac{13}{25}$	$\frac{19}{25}$	$\frac{25}{25}$	$\frac{31}{25}$	$\frac{37}{25}$	$\frac{43}{25}$	$\frac{49}{25}$	$\frac{55}{25}$	$\frac{61}{25}$	$\frac{67}{25}$	$\frac{73}{25}$	$\frac{79}{25}$	$\frac{19}{25}$
$\frac{1}{13}$	$\frac{13}{19}$	$\frac{19}{19}$	$\frac{25}{19}$	$\frac{31}{19}$	$\frac{37}{19}$	$\frac{43}{19}$	$\frac{49}{19}$	$\frac{55}{19}$	$\frac{61}{19}$	$\frac{67}{19}$	$\frac{73}{19}$	$\frac{79}{19}$	$\frac{19}{19}$
	$\frac{13}{13}$	$\frac{19}{13}$	$\frac{25}{13}$	$\frac{31}{13}$	$\frac{37}{13}$	$\frac{43}{13}$	$\frac{49}{13}$	$\frac{55}{13}$	$\frac{61}{13}$	$\frac{67}{13}$	$\frac{73}{13}$	$\frac{79}{13}$	$\frac{13}{13}$
		$\frac{19}{1}$ $\frac{31}{1}$ $\frac{43}{1}$ $\frac{55}{1}$ $\frac{67}{1}$											

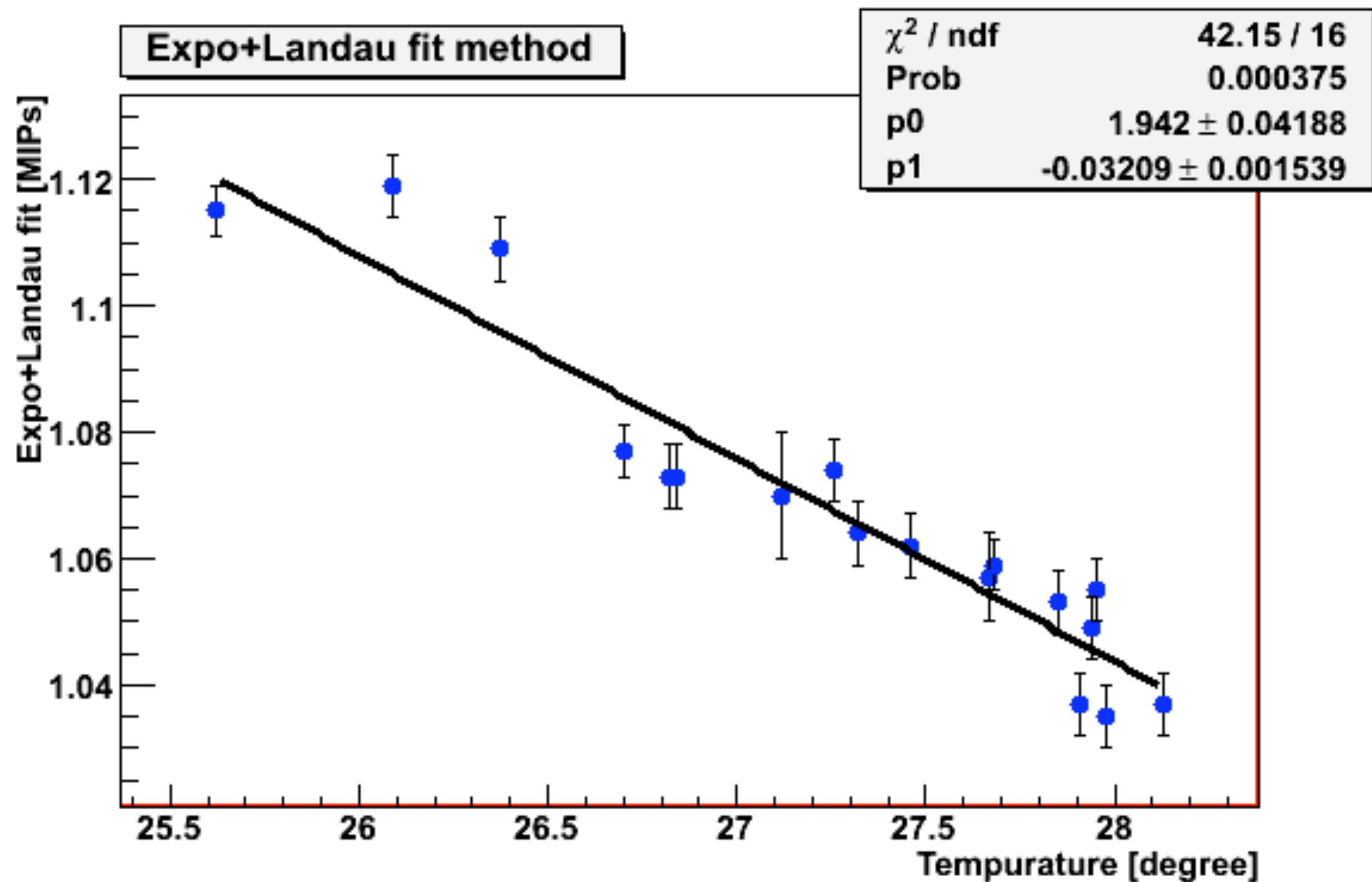
Short review (1)



- Track like cluster from deep analysis code.
- Exponential + Landau fit for the MIPs.

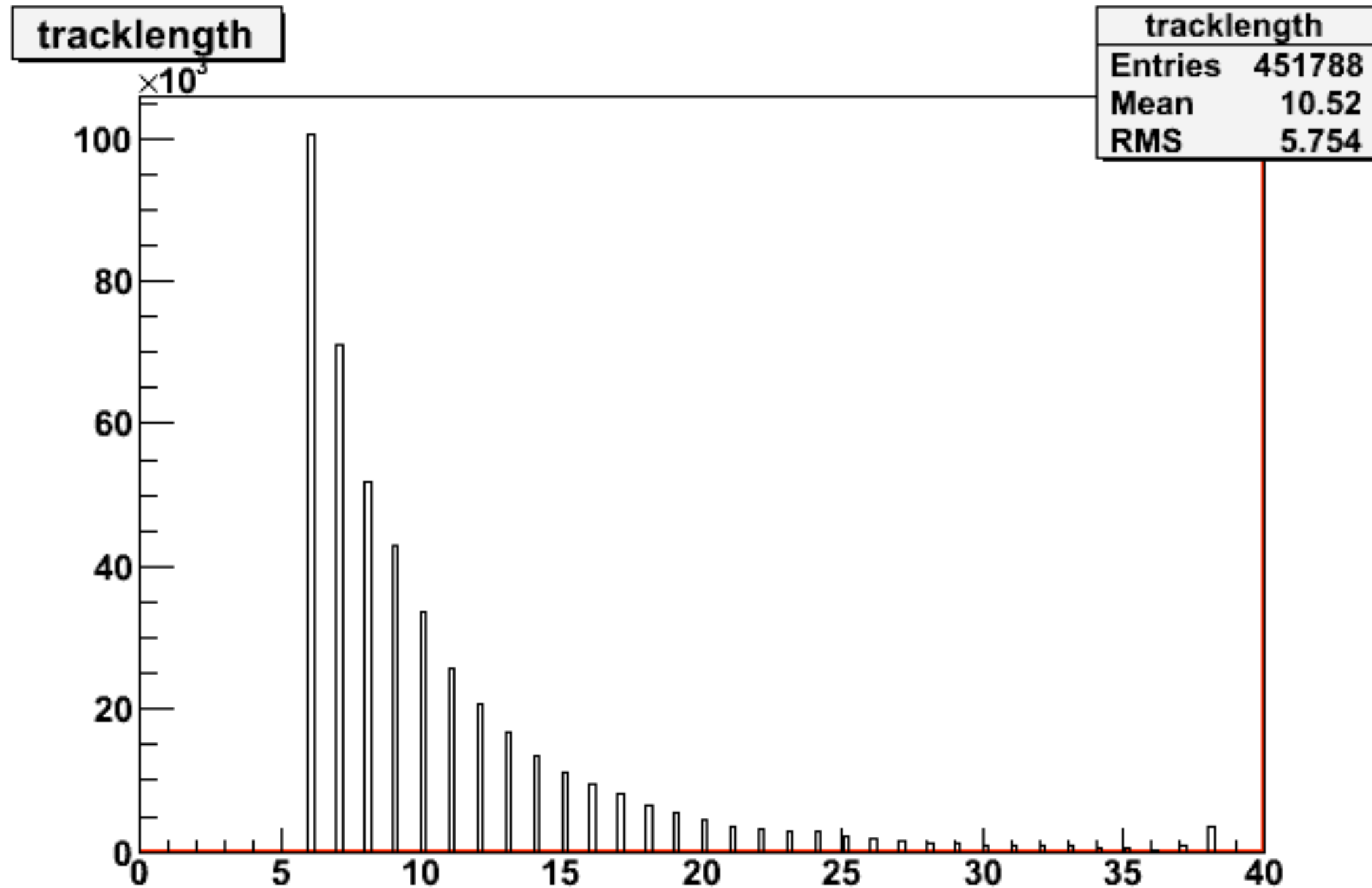


Short review (2)



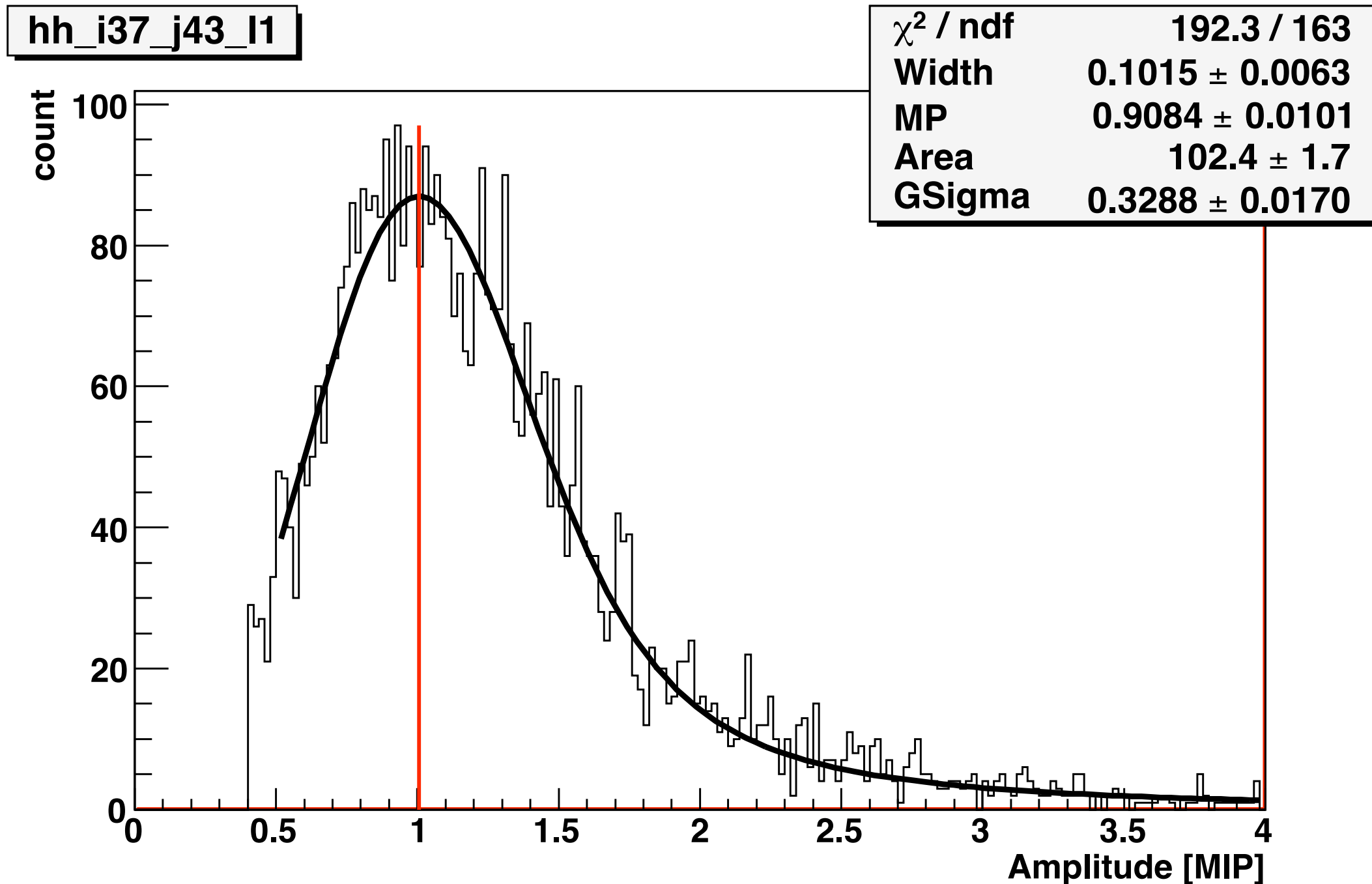
- Mean temperature from all temperature sensors.

The length of track like cluster



- The cut on track length is six tiles.

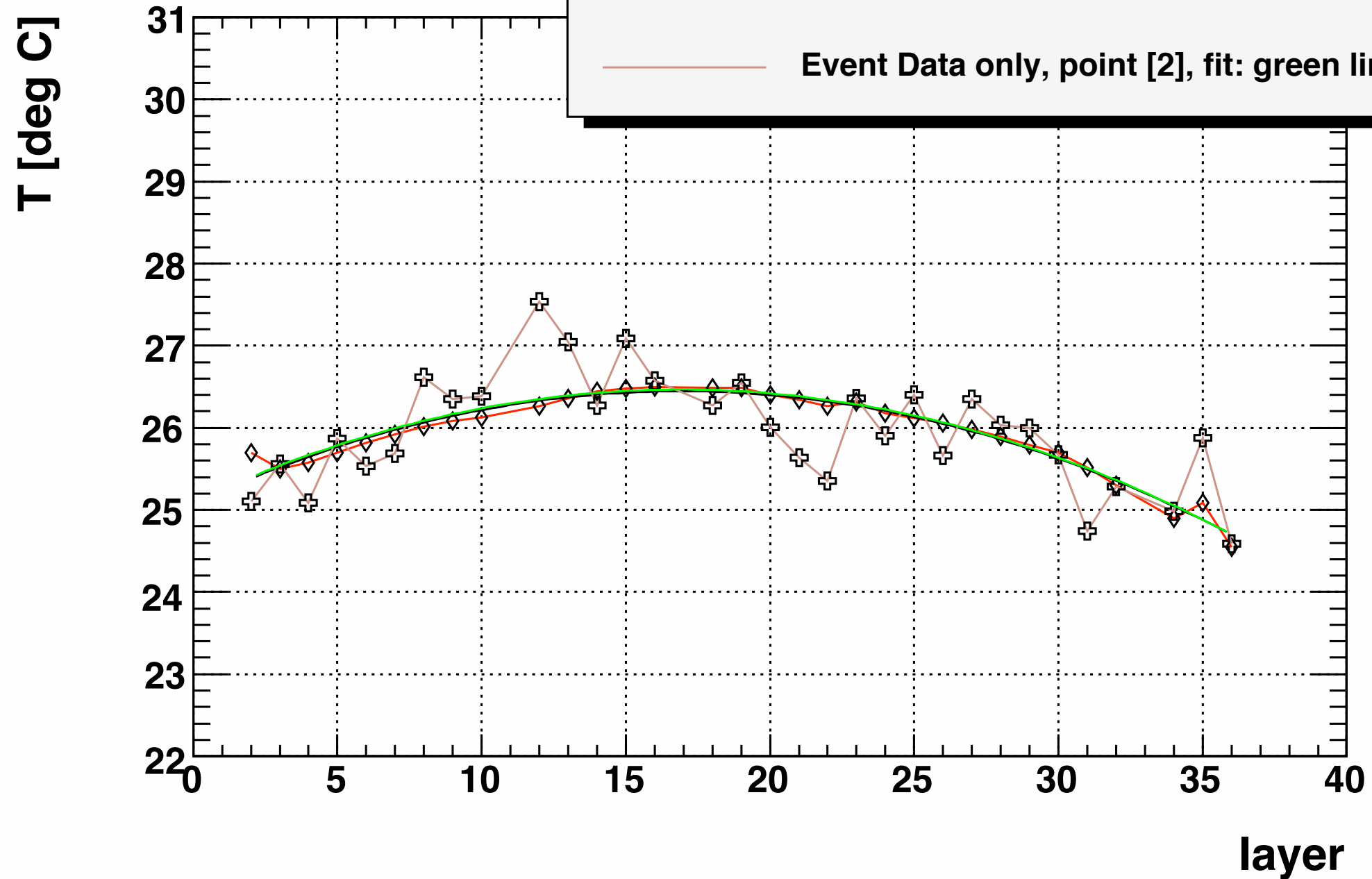
The MIPs of the single isolated tile



- hits in single tile inside the track like cluster from isolation tiles
- fitted with convoluted Landau and Gaussian Fitting Function

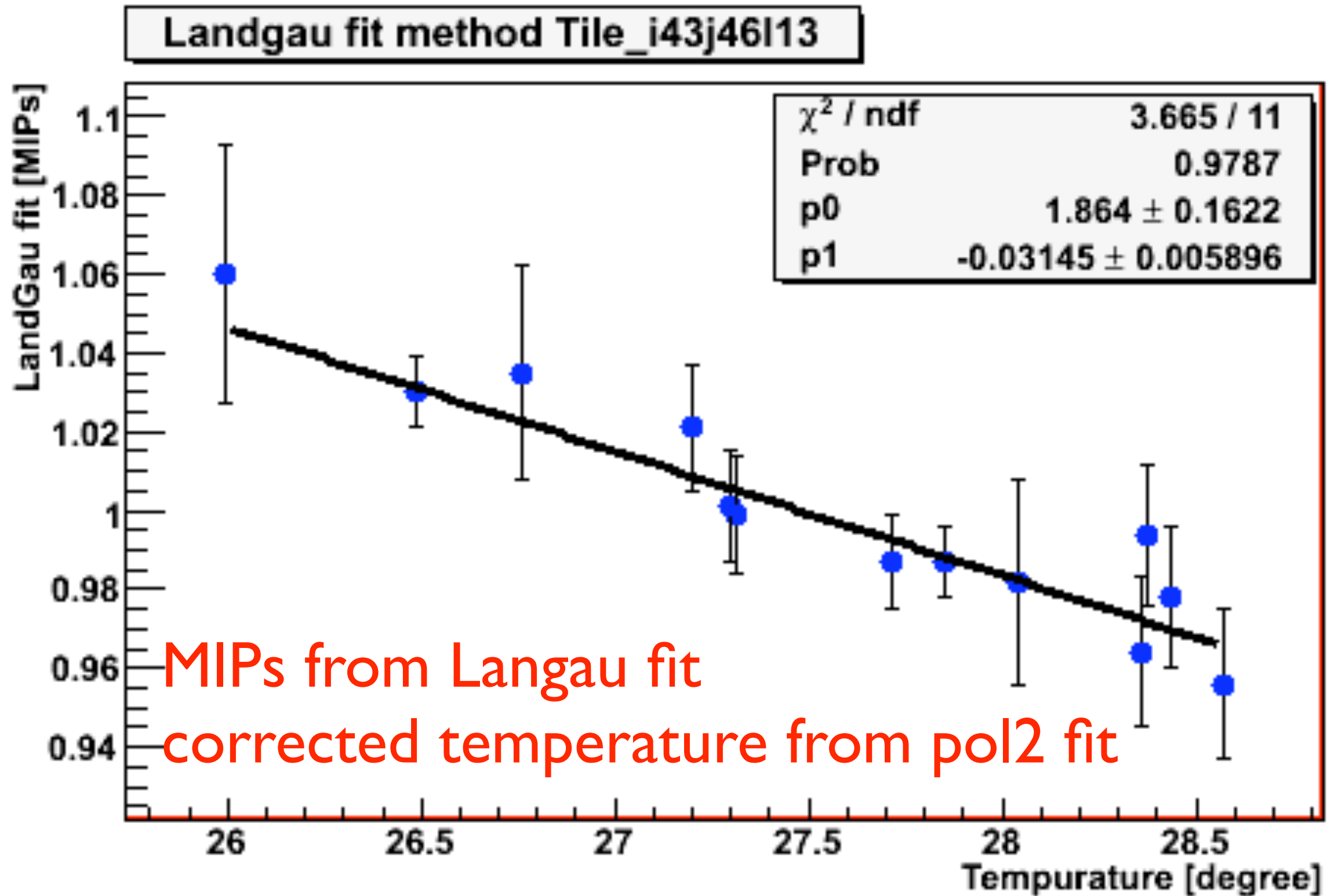
Temperature VS layer

run_number 330921



Temperature correction from pol2 fit is used in this analysis

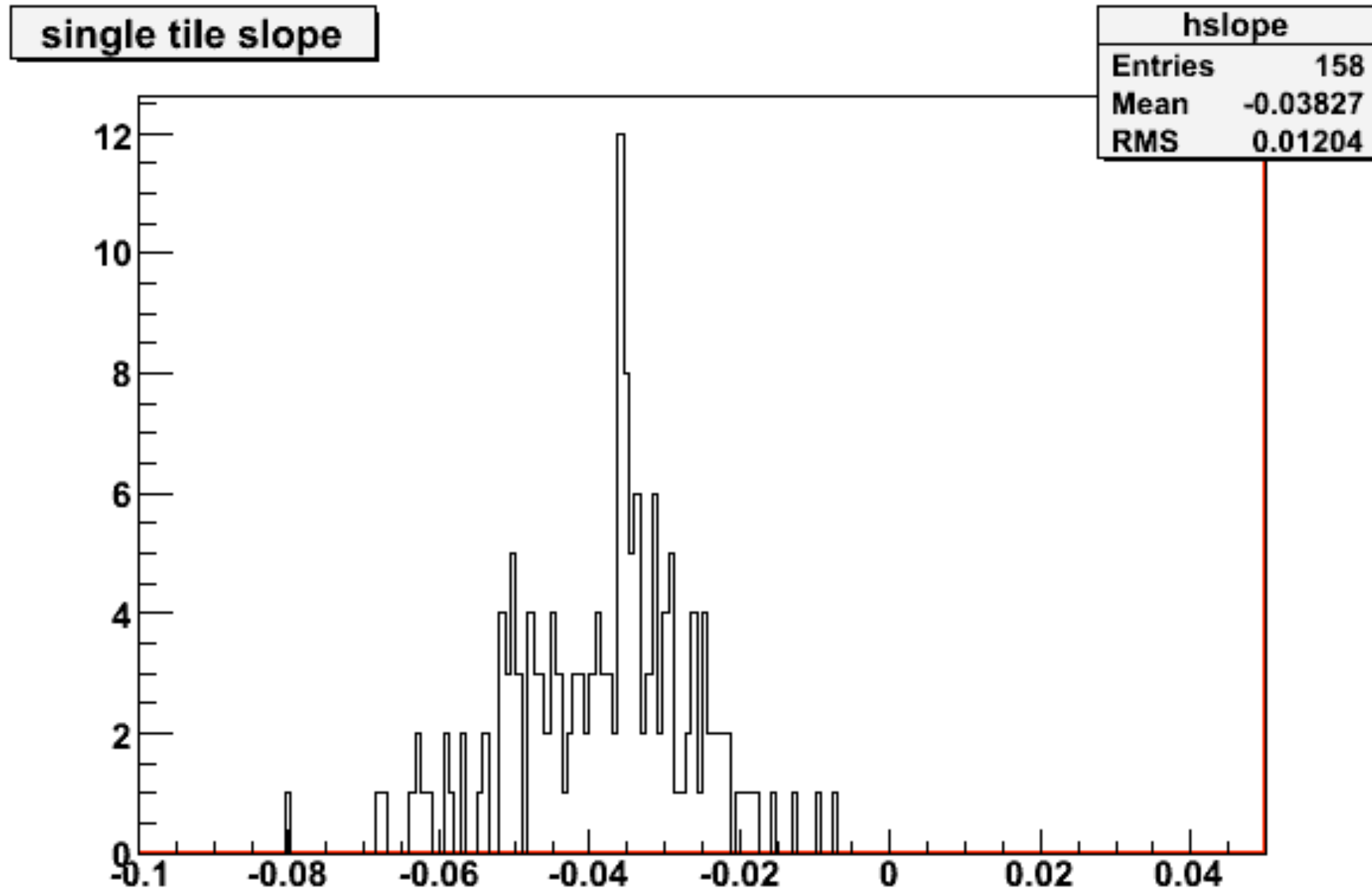
Amplitude VS Temperature



The study in this talk based on

- Amplitude: From single tile
- Track like cluster: From Isolation tile method
- MIPs peak: From convoluted Landau and Gaussian Fitting Function (Langau)
- Temperature: corrected from pol2 fit
- ~7600 Tiles of HCAL in 19 runs have been studied using this method.

The slope distribution



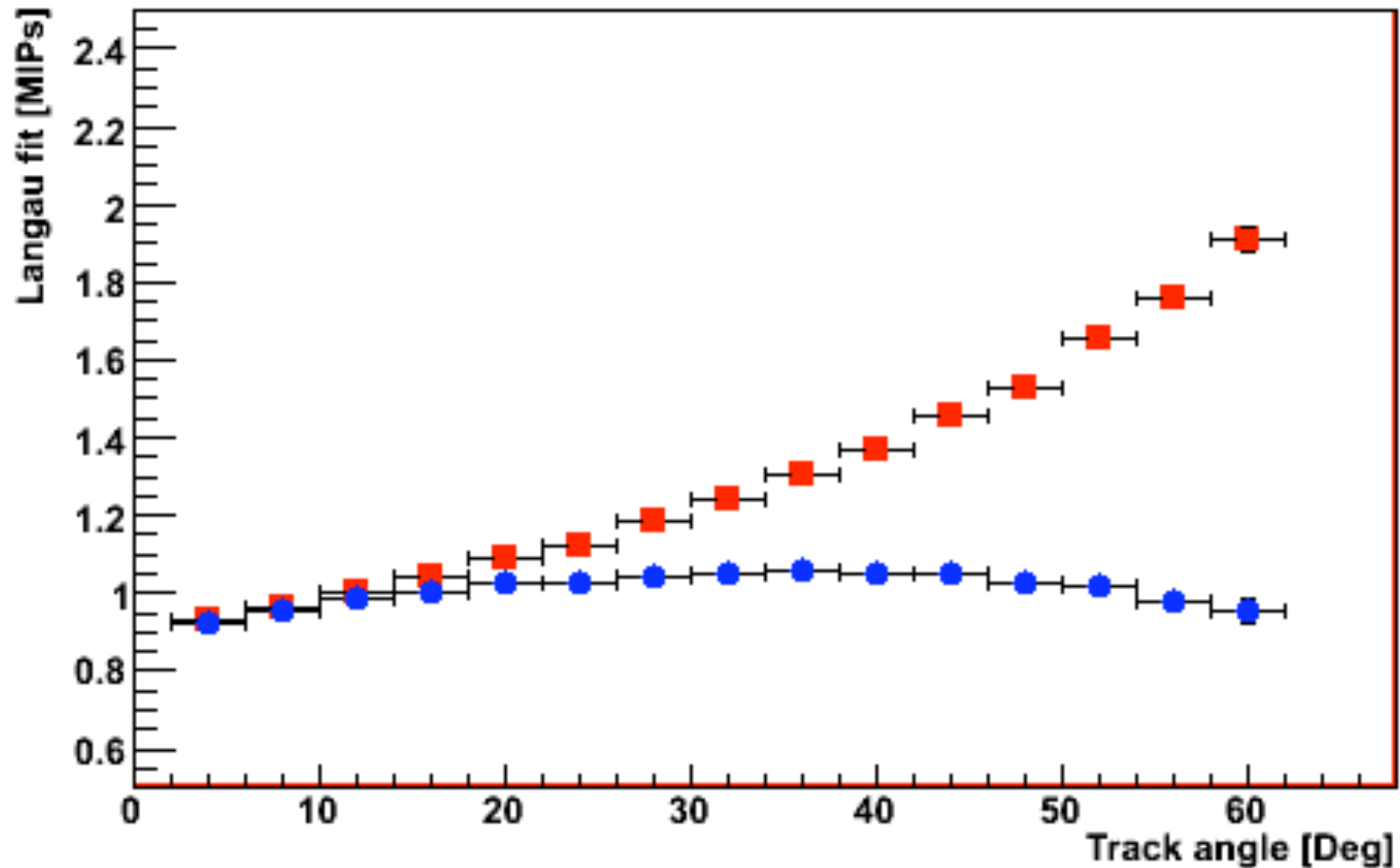
- At least 3000 hits at each temperature point for one tile
- At least six different temperature points are available

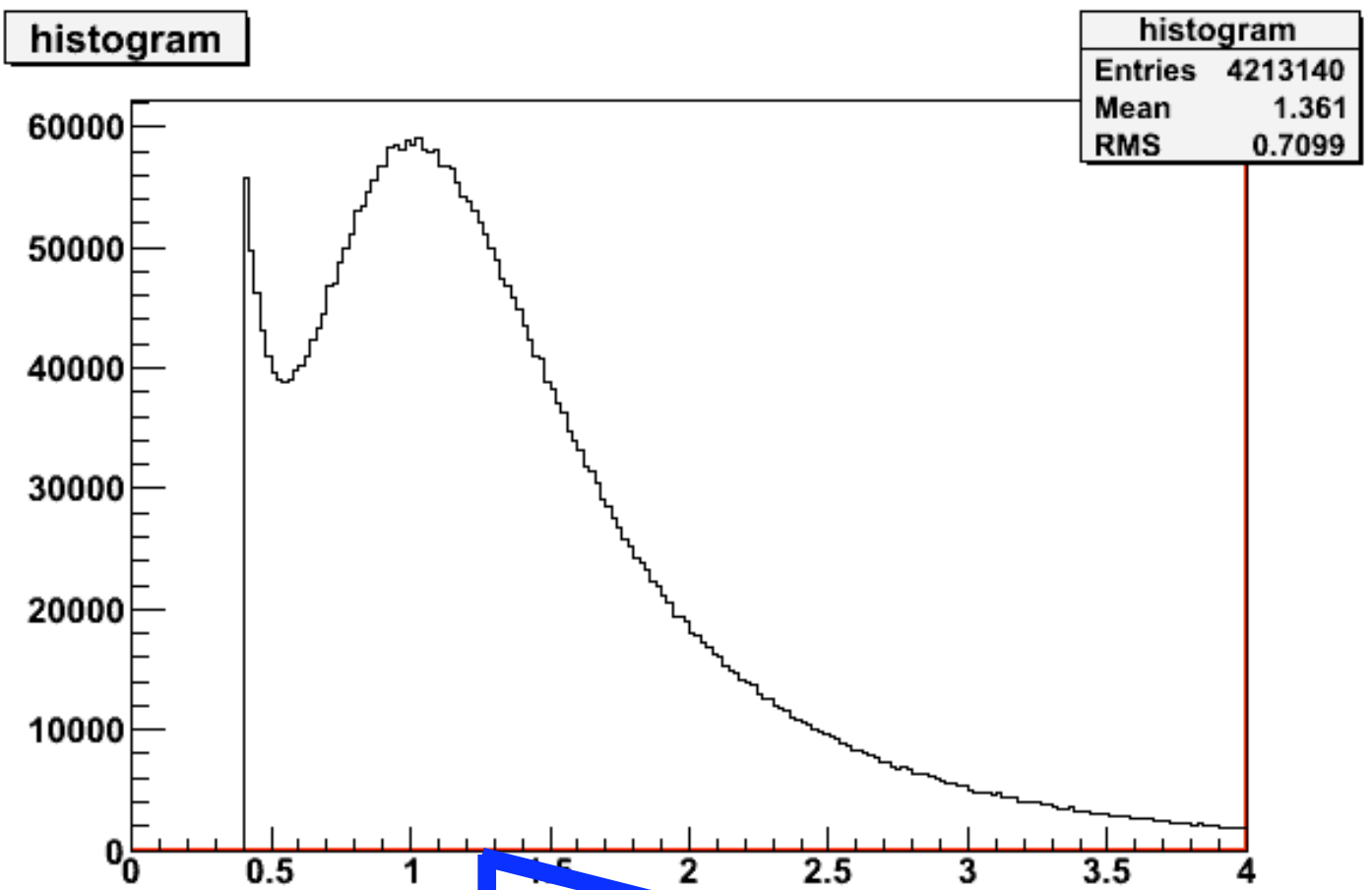
More study on this isolation track method

- Amplitudes difference from the angle of the tracks.
- Amplitudes of all tiles but first and last in a track.
- Amplitudes of the first and the last tile in a track.
- weakened isolation criteria

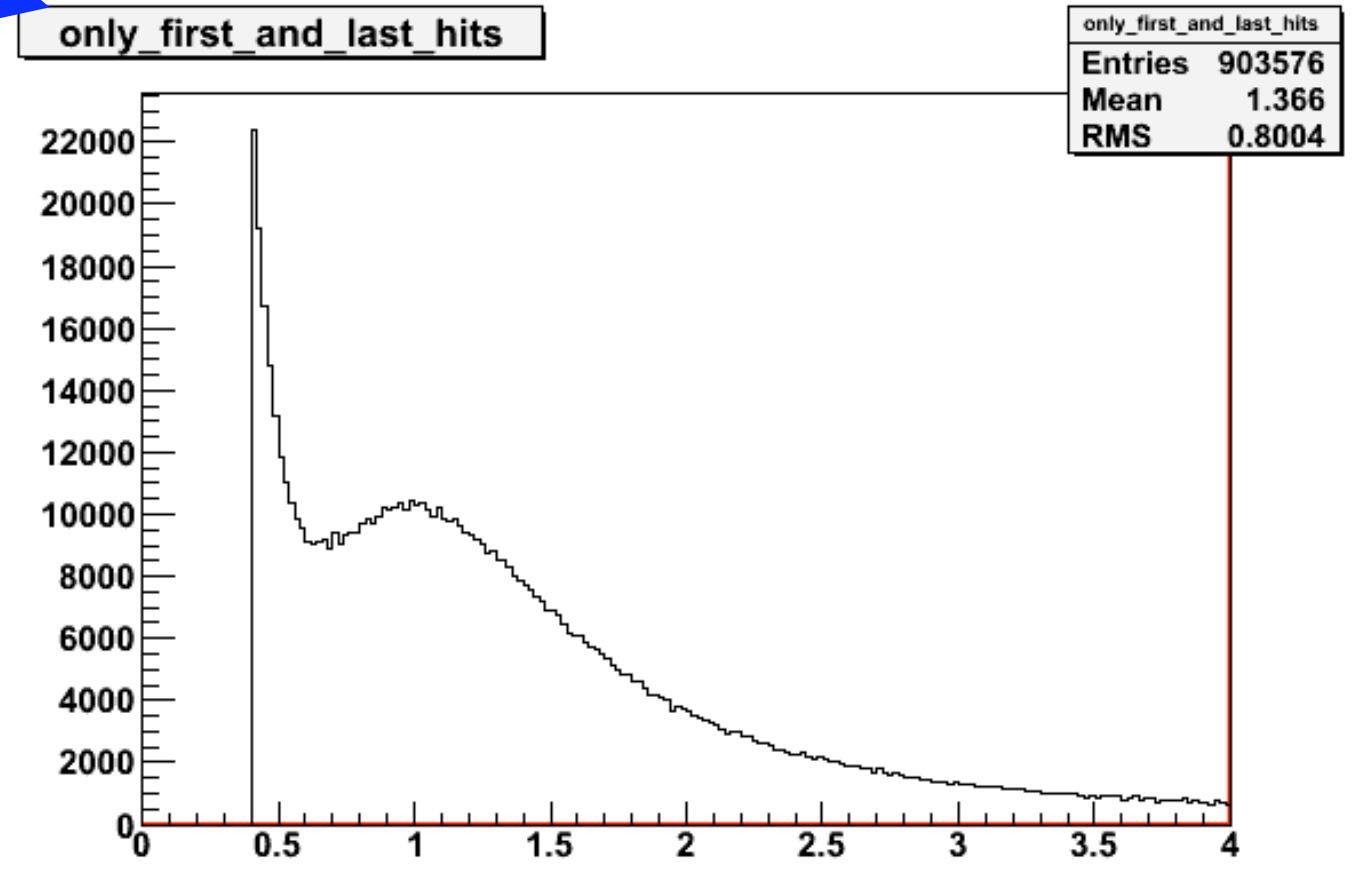
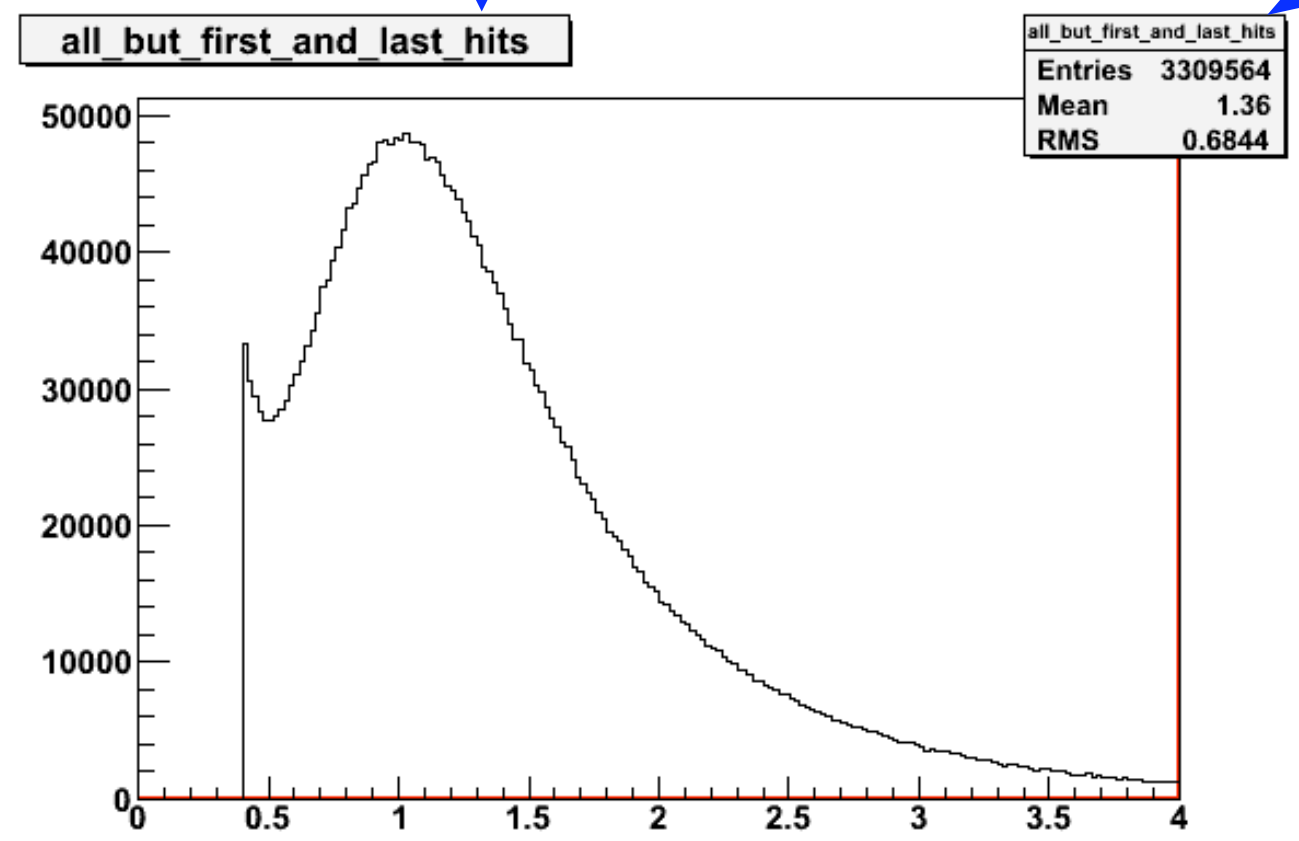
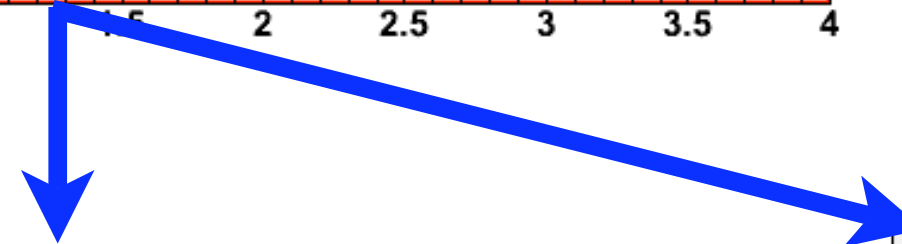
Amplitude VS the angle in the angle track like cluster and correction

MIP peak vs angle

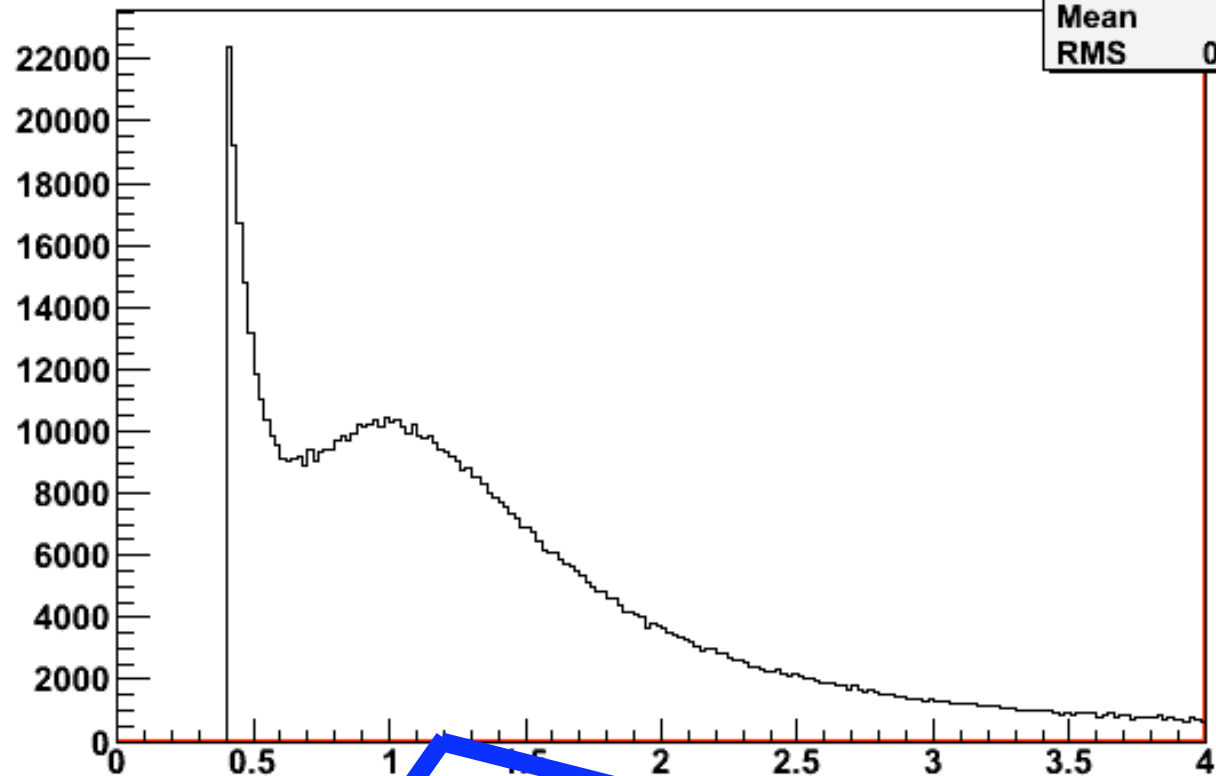




- Inside a track, the first and last tiles have more low energy hits



only_first_and_last_hits

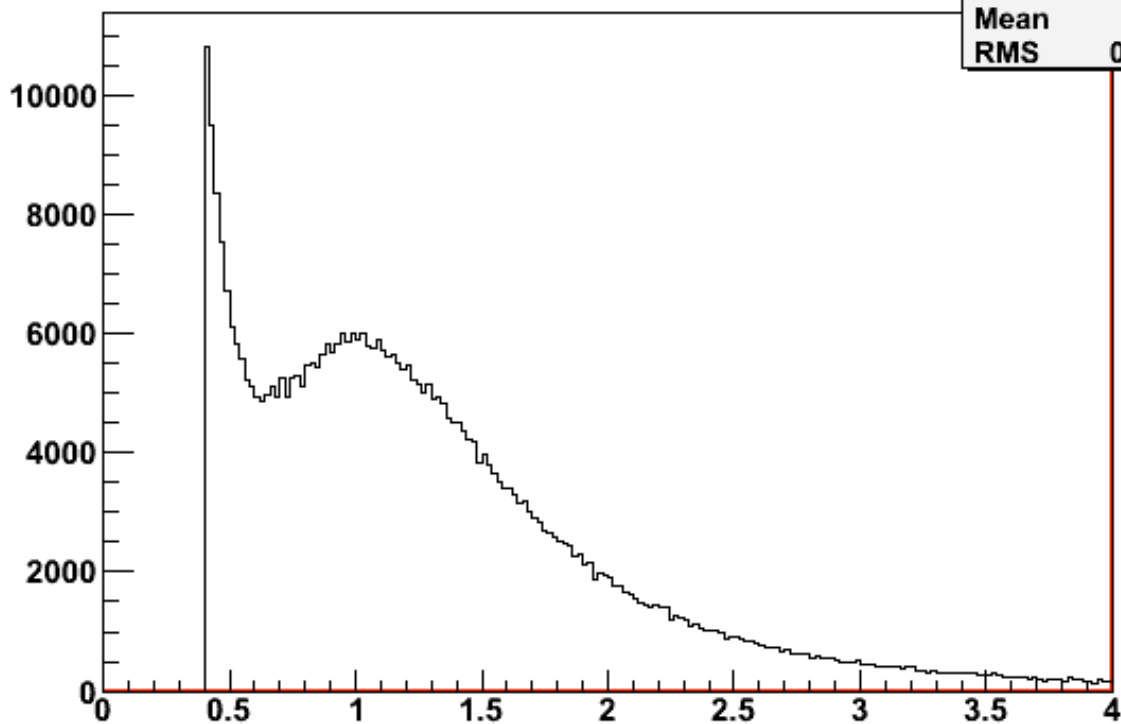


only_first_and_last_hits

Entries	903576
Mean	1.366
RMS	0.8004

- the last tile has more low energy hit than the first one.

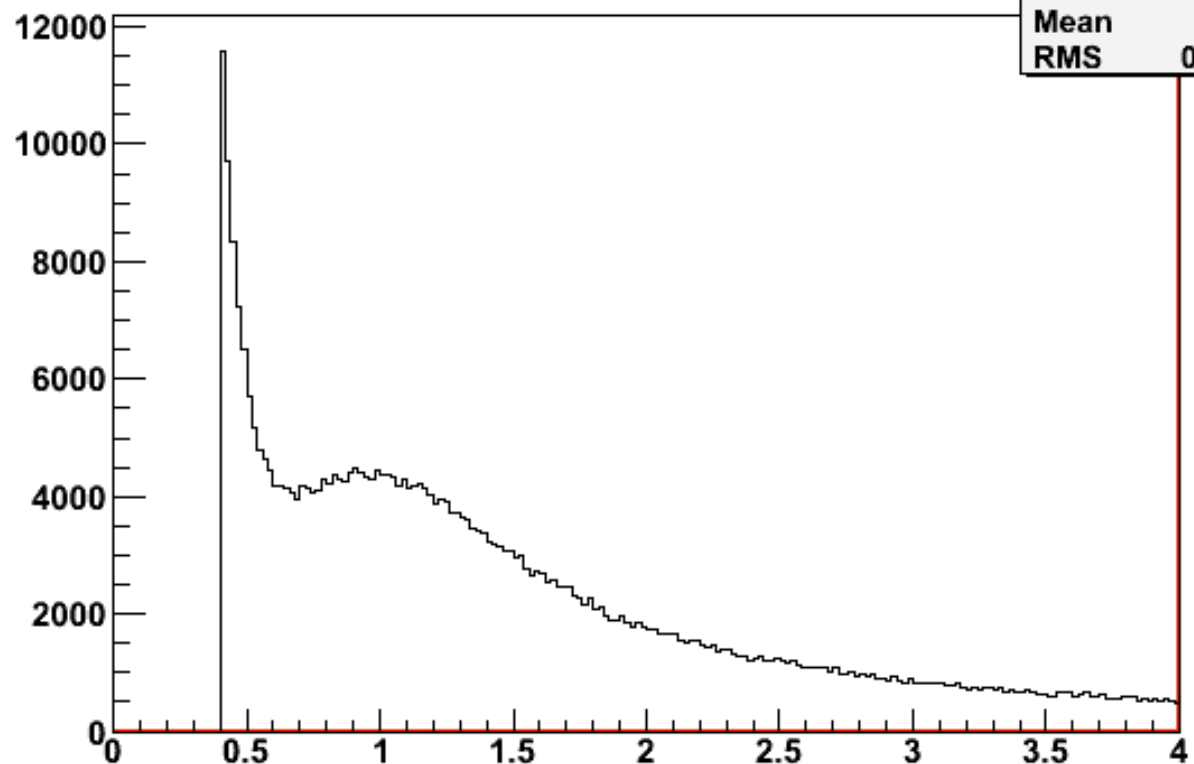
only_first_hits



only_first_hits

Entries	451788
Mean	1.285
RMS	0.7029

only_last_hits

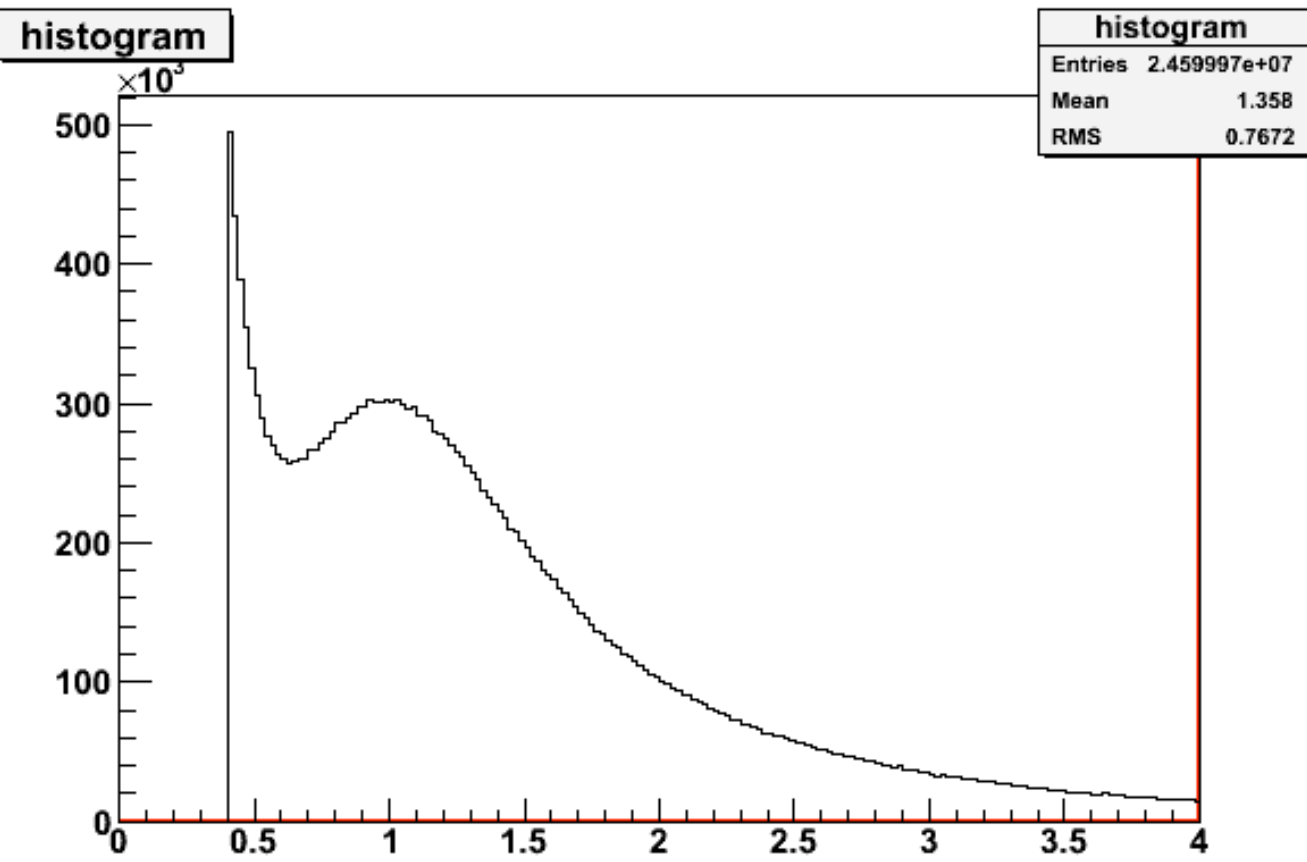


only_last_hits

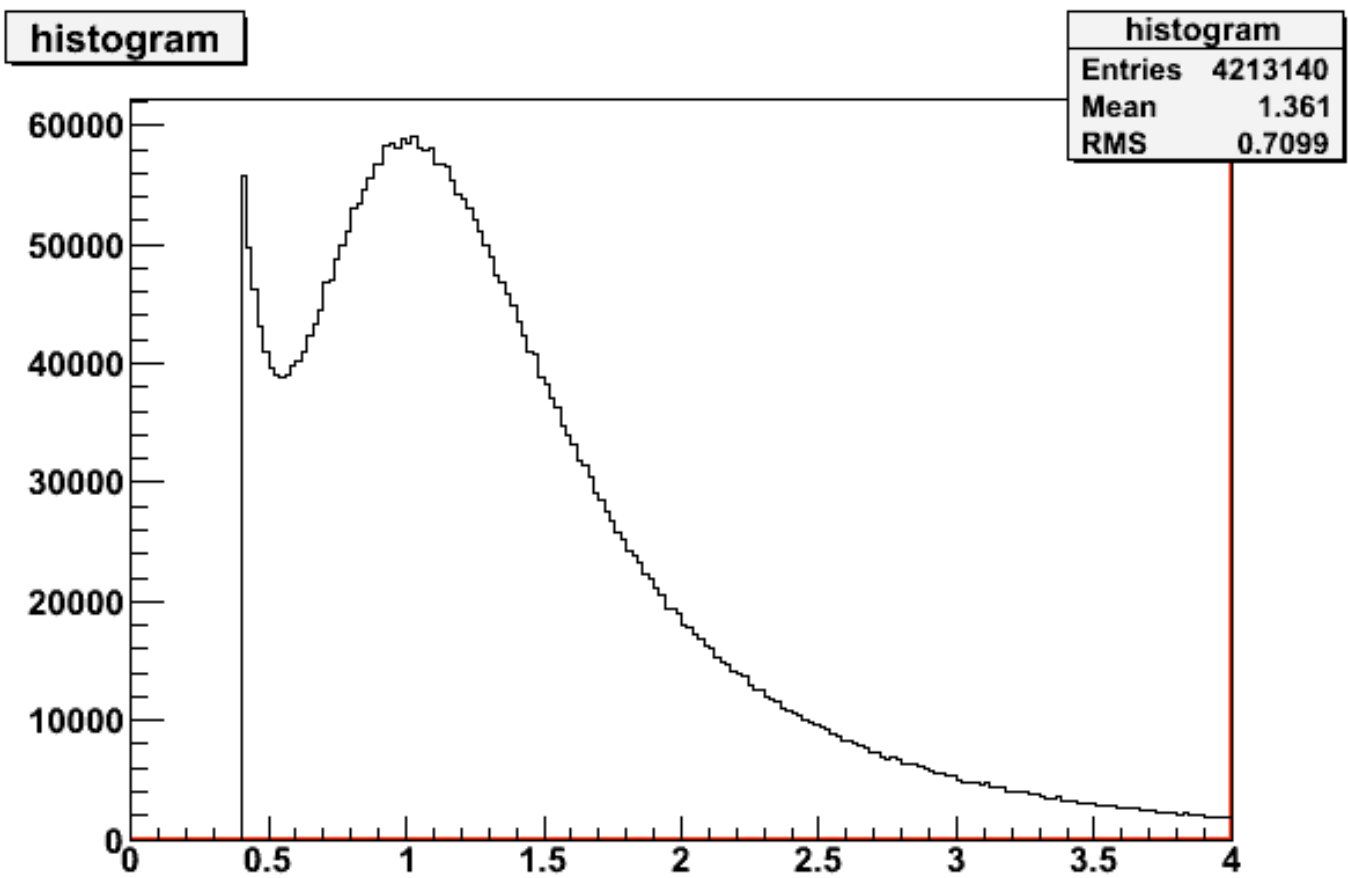
Entries	451788
Mean	1.455
RMS	0.8871

weakened isolation criteria

- If a hit had only one neighbor, it was still considered isolated. (weakened isolation criteria)
- The number of entries in the histograms were expected to increase significantly.
- For the calibration, the larger the amount of data available the better.



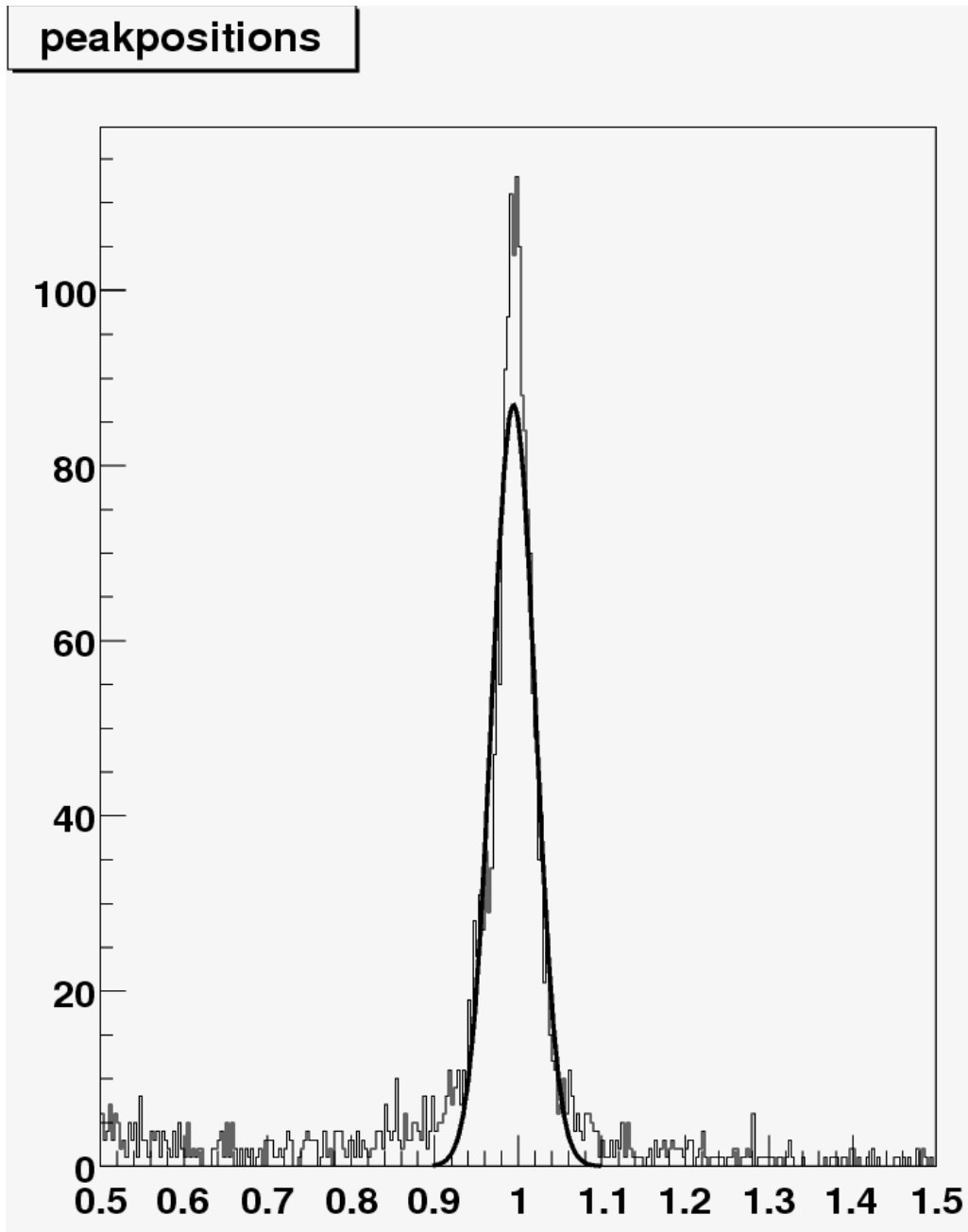
weakened isolation criteria



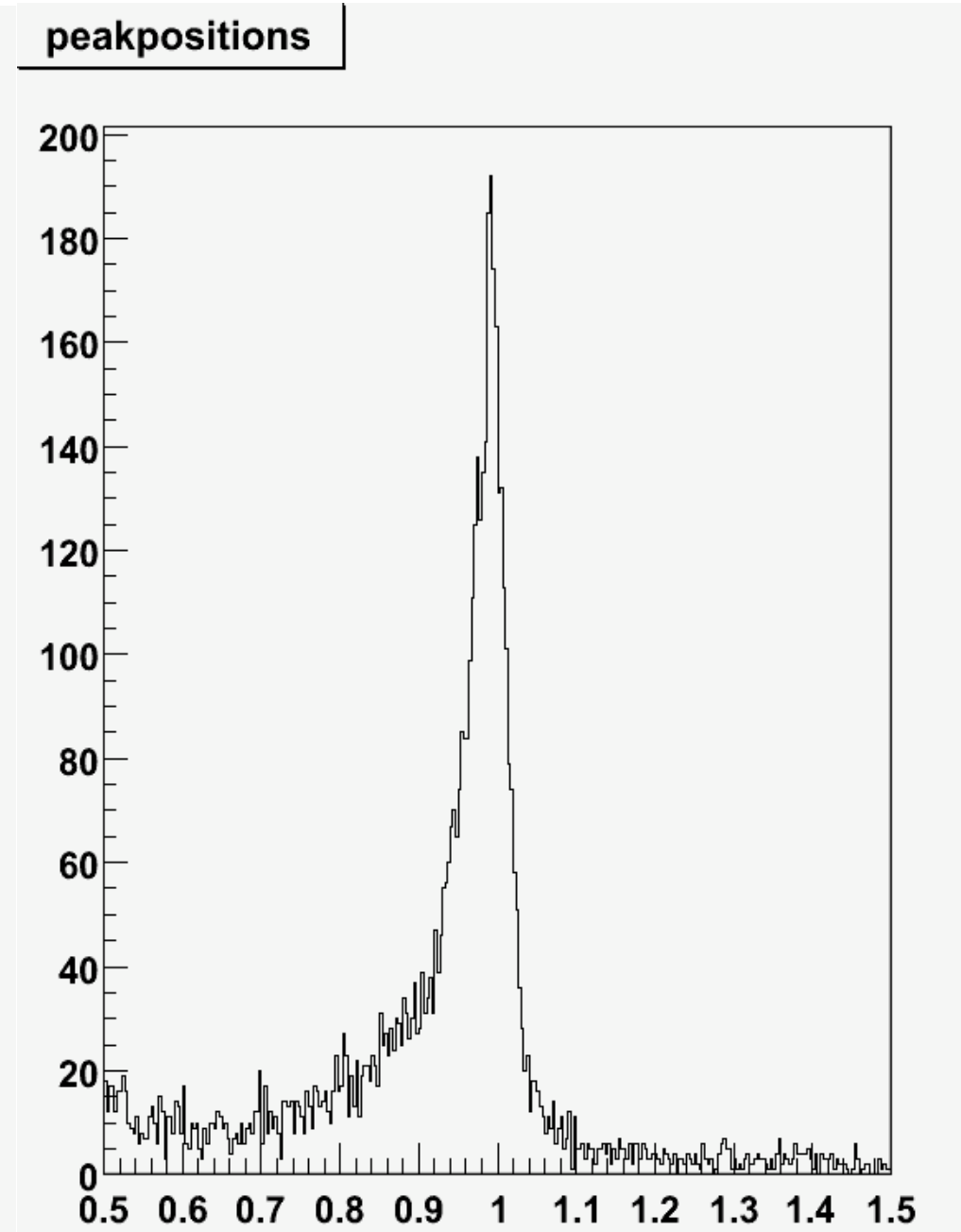
strong isolation criteria

- The number of entries in the histograms were increased significantly with weakened isolation criteria.
- However, the number of low-energy hits showed also a big increase.

MIPs peak position for single tile from two isolation criteria



strong isolation



weakened isolation

Summary

- The temperature and amplitude have been studied with track like cluster from test beam data.
 - ▶ Method 1: tiles inside track like cluster from deep analysis and MIPs peak from exponential + Landau fitting.
 - ▶ Method 2: tiles inside track like cluster from isolated tiles and MIPs peak from convoluted Landau and Gaussian fitting Function.
- The constant result has been got from different methods.