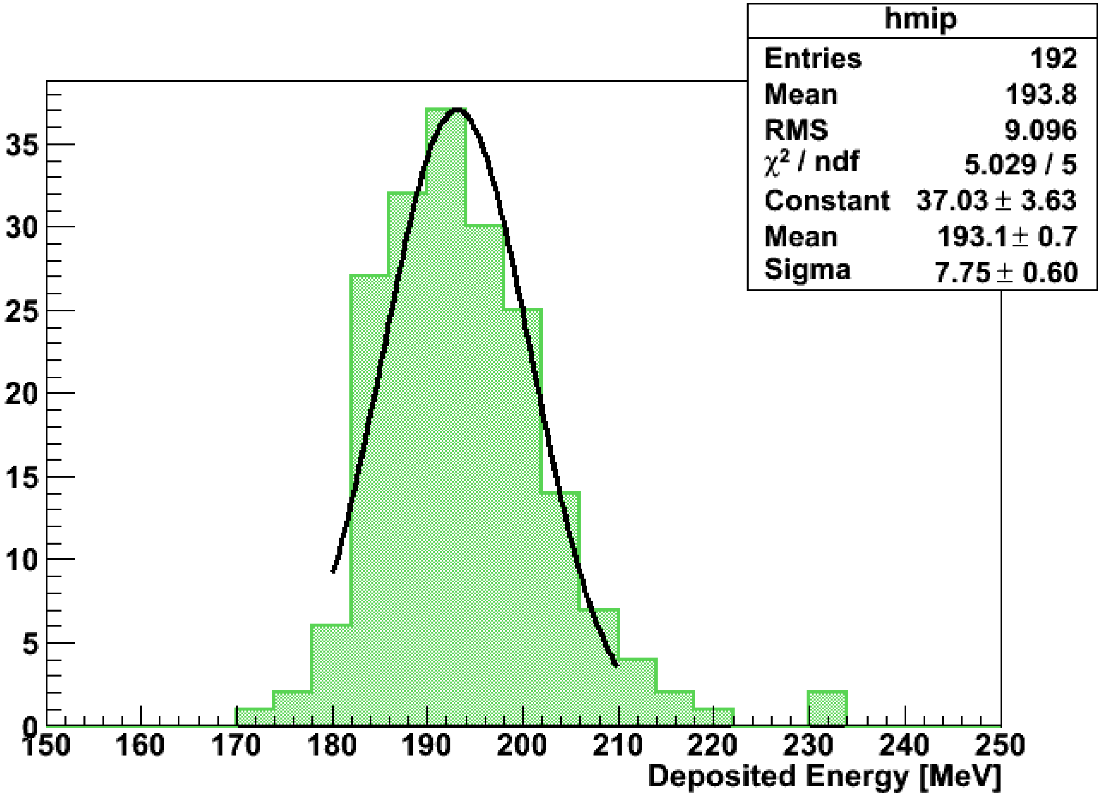
Analysis on mip signals

Mip in the matrix

Minimum ionizing particles give the possibility of studying the single crystal performance;

It is thus possible to disentangle the resolution obtained from several non-trivial effects as the energy leakages or the inter-calibrations;

Stefano has run a simulation by asking mip at the center of one crystal



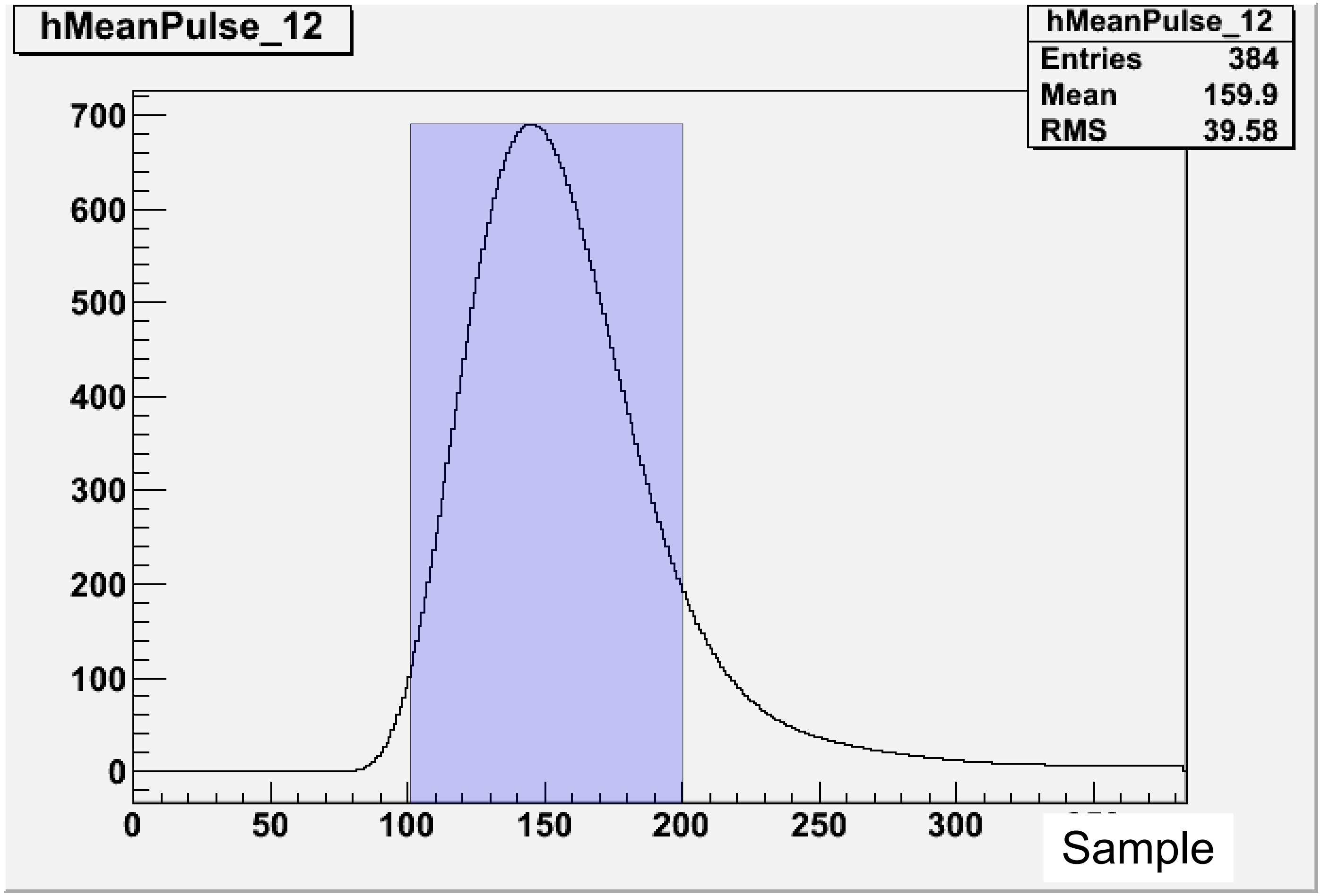
He finds a mean deposited energy of 194 MeV with a spread of about 4%.

In particular we focused on run 437 taken on the 29/10/2010:

- 1.5 GeV;
- 12K events;
- Cherenkov PMT HV raised to 2200 V;
- Rate ~ 3000 Evnts/spill;

In order to isolate minimum ionizing particles we ask for a non-electron in the Cherenkov and signal above the pedestal in the downstream pad;

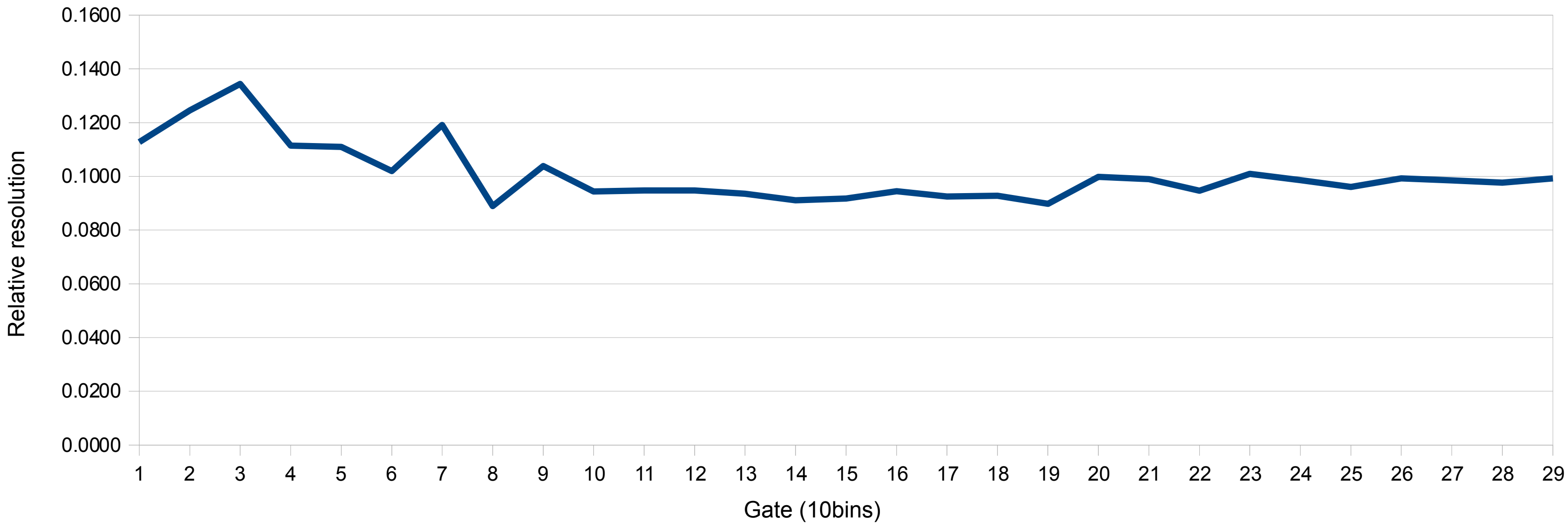
The signal waveform



- In each event we evaluate the signal baseline as the mean value of the first 50 bins;
- After subtracted the baseline, we define the response of each crystal as the integral of the signal waveform performed between bins 100 and 200;

The energy calculation method

In order to optimize the integration gate width, we have tried several different widths around the peak: from 10 bins to 300 bins in 29 steps of 10 bins;



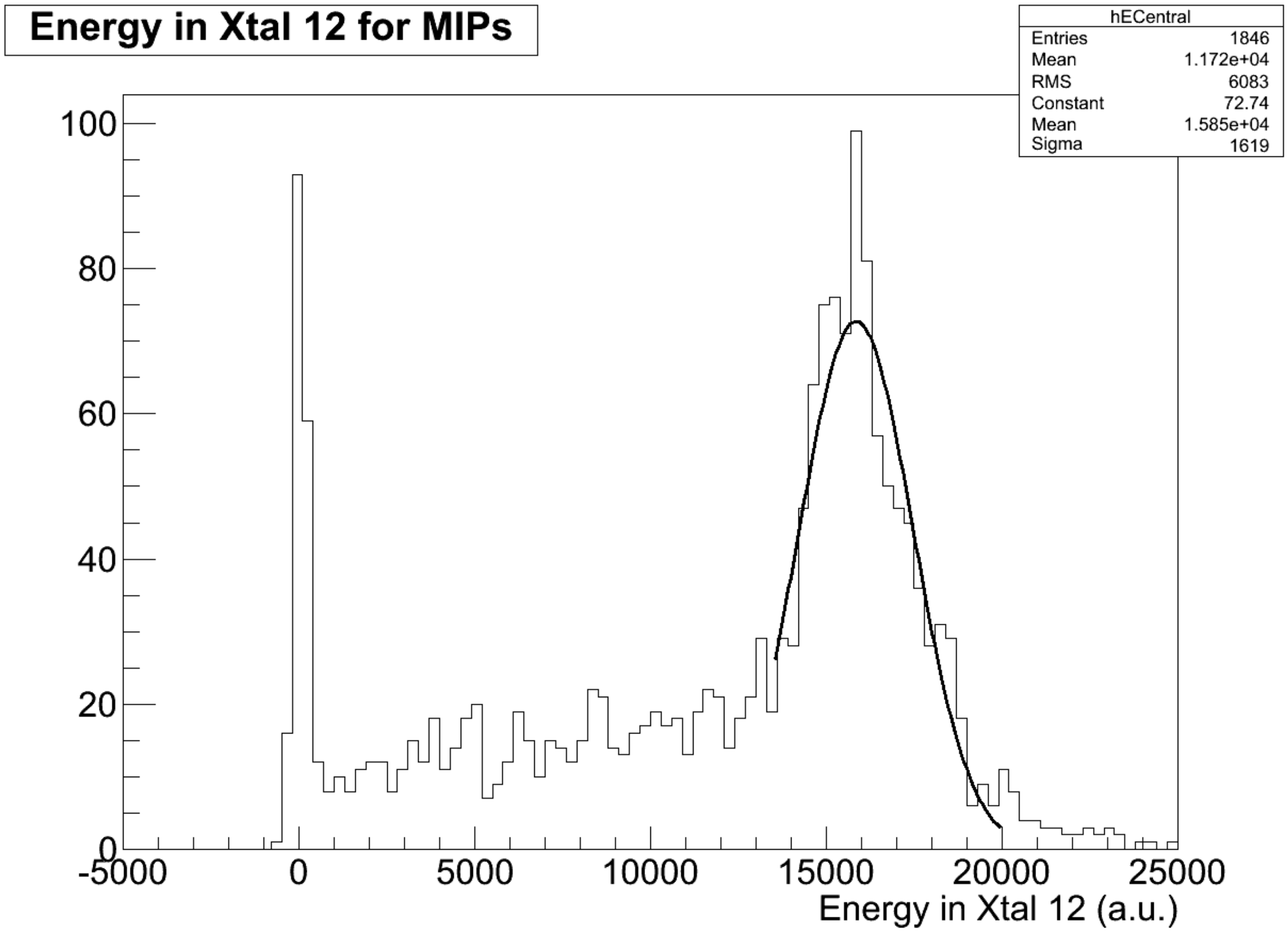
The conclusion is that the resolution is only weakly dependent on the gate width.

Anyway a width between 100 bins and 200 bins is the best we can do;

All the results shown are obtained with a gate 100 bin wide.

The mip spectrum

The response spectrum of the 12th crystal for mip, obtained with a 100 bin gate, is:

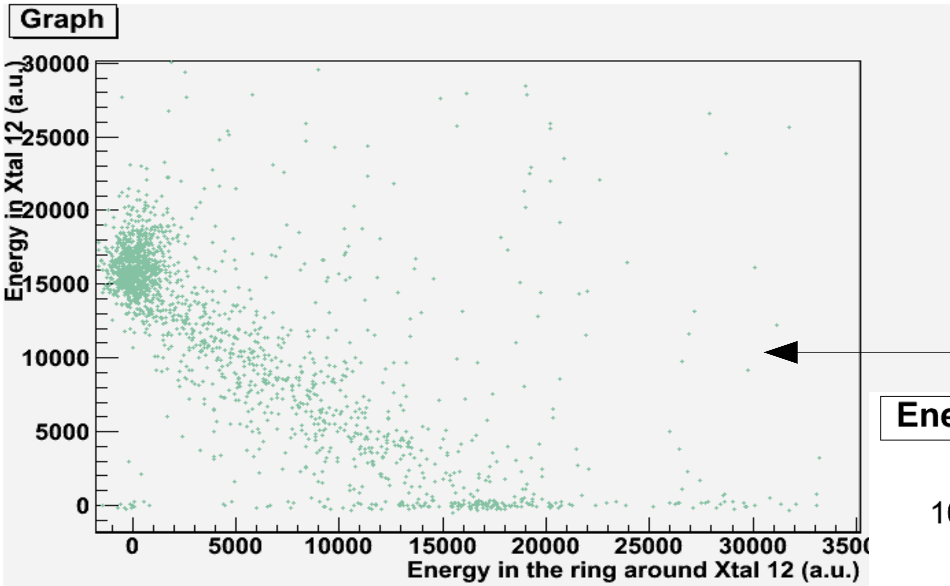


Noise peak has a sigma of 230 bins → 1.4% of the mip peak mean;

Gaussian fit gives a mip energy resolution of 10.2%

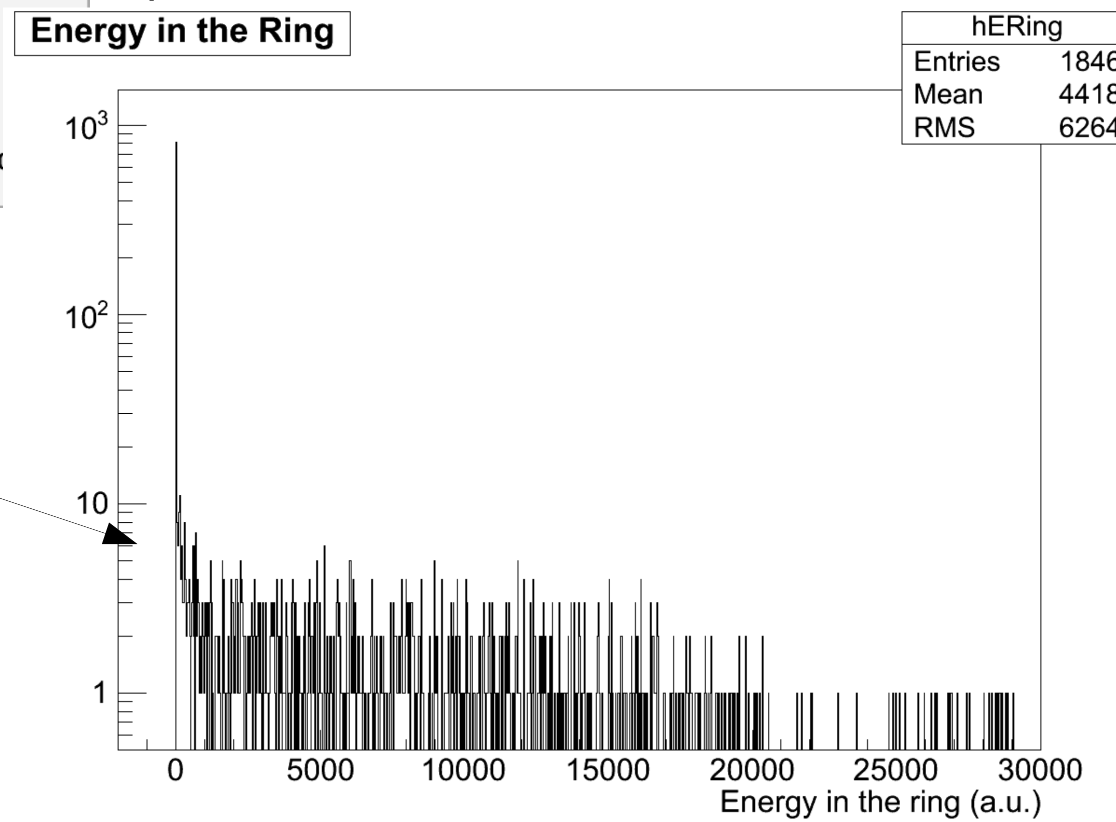
The energy sharing

The energy of the mip is not always contained within only one crystal;



By defining "ring" the 8 crystals surrounding the 12th (6, 7, 8, 11, 13, 16, 17 and 18);

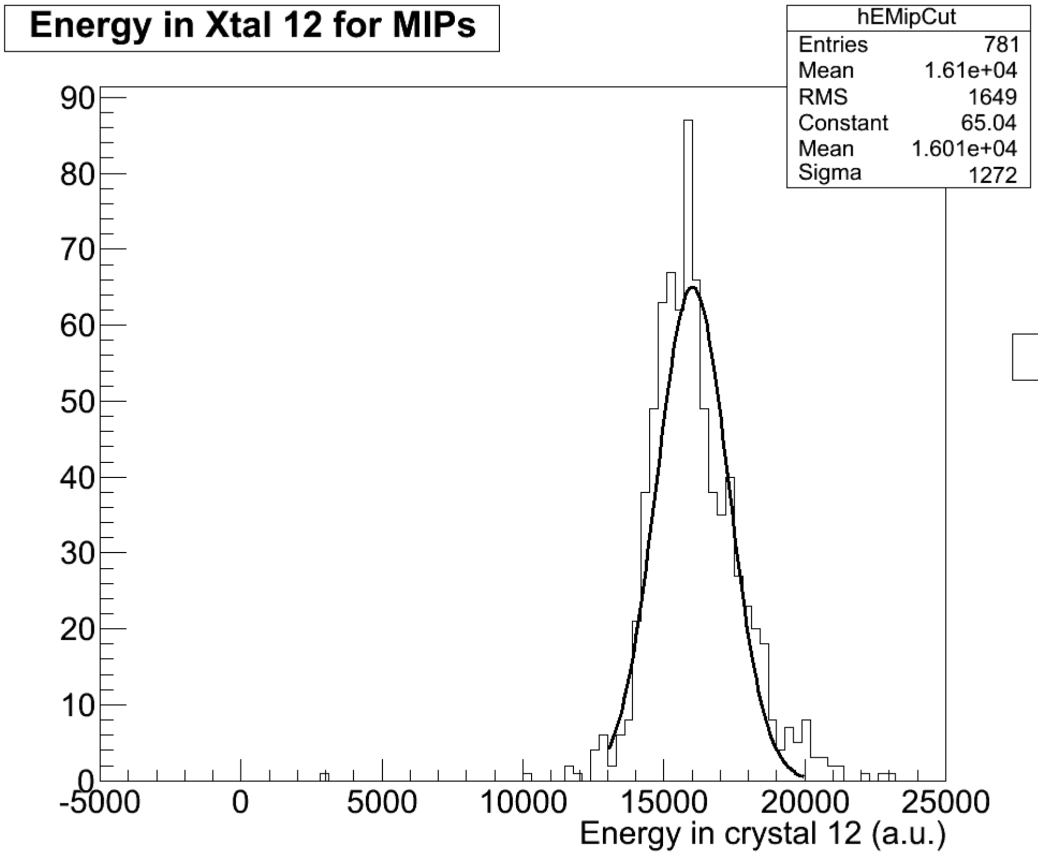
The energy sharing between the central crystal (12th) and the ring is shown in the plot.



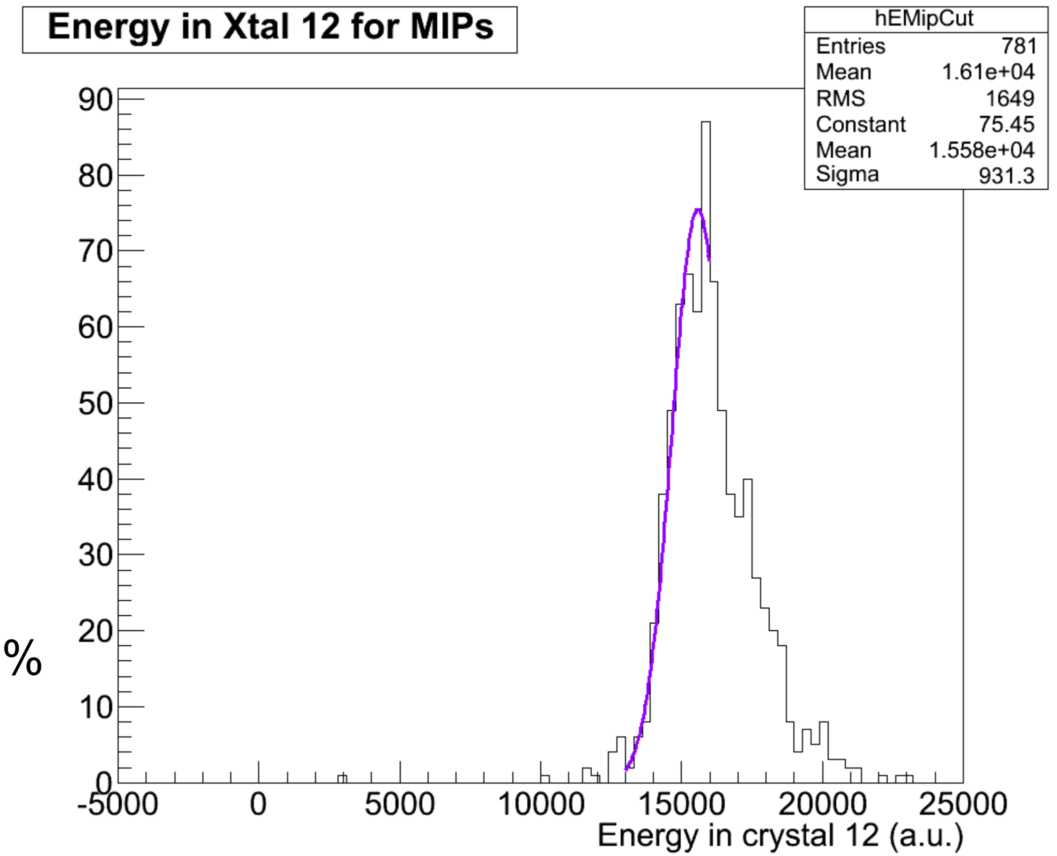
In particular, by adding in the ring only the signals above the pedestals, the Energy in the ring has the shape shown in the plot.

MIP spectrum "clean"

It is possible to ask for contained events by requiring a null energy in the ring;



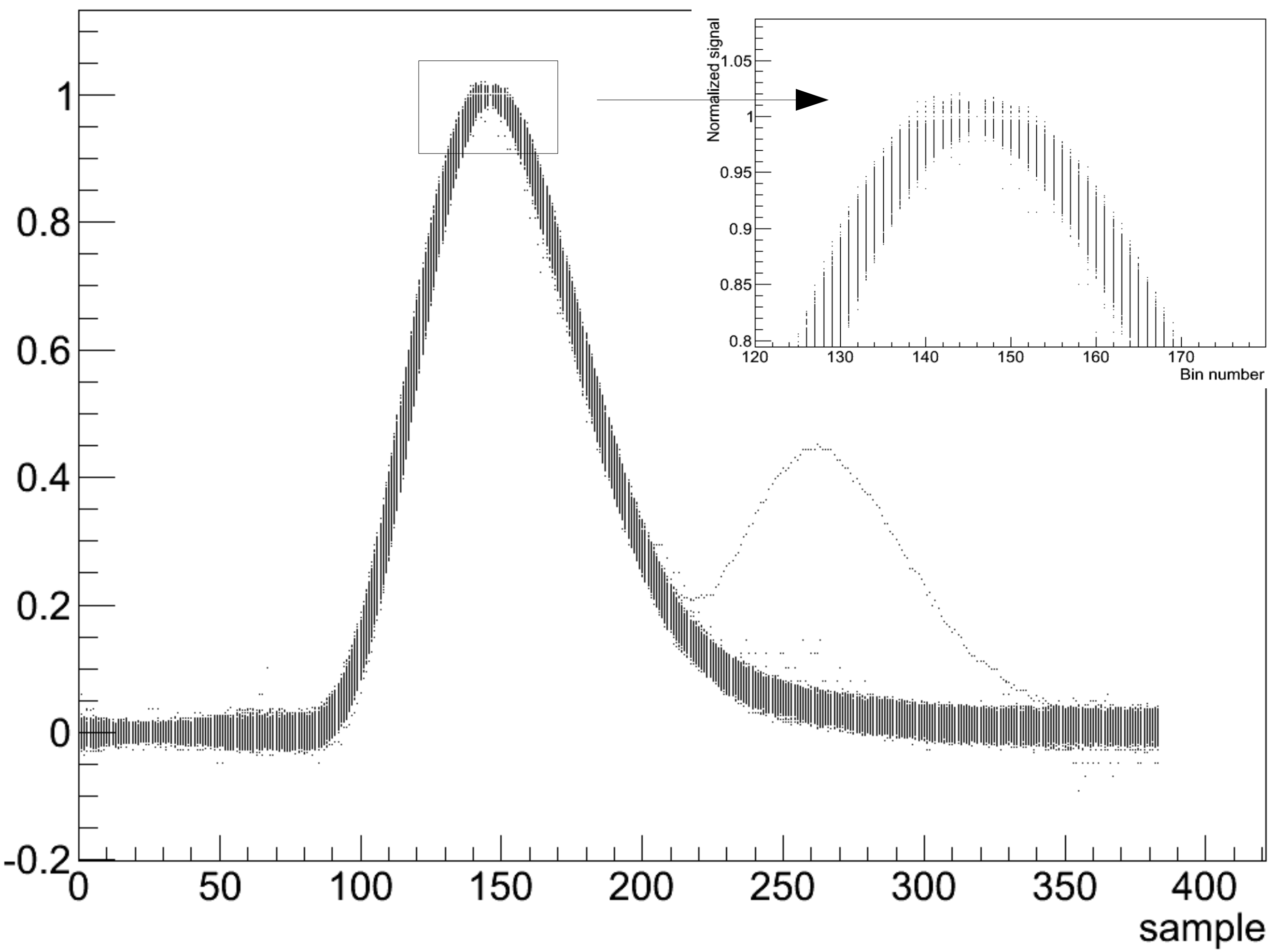
The peak fit gives a resolution of 8%
We are still far from the 4% foreseen by the MC.



A fit only on the left side gives a resolution of 6%

The normalized signal shapes

To try to understand where the cause of a so low resolution is, we studied the waveform of the signals;



The plot shows all the waveforms of Xtal 12th for mip events, NORMALIZED, to the value of bin 146;

The width of the band is a measurement of the noise, the time jitter and of the shaper stability;

The total width of the band is about 4% of the peak height, compatible with the 1.4% rms found on the pedestal.

The noise seems under control and the shaper seems to be stable;

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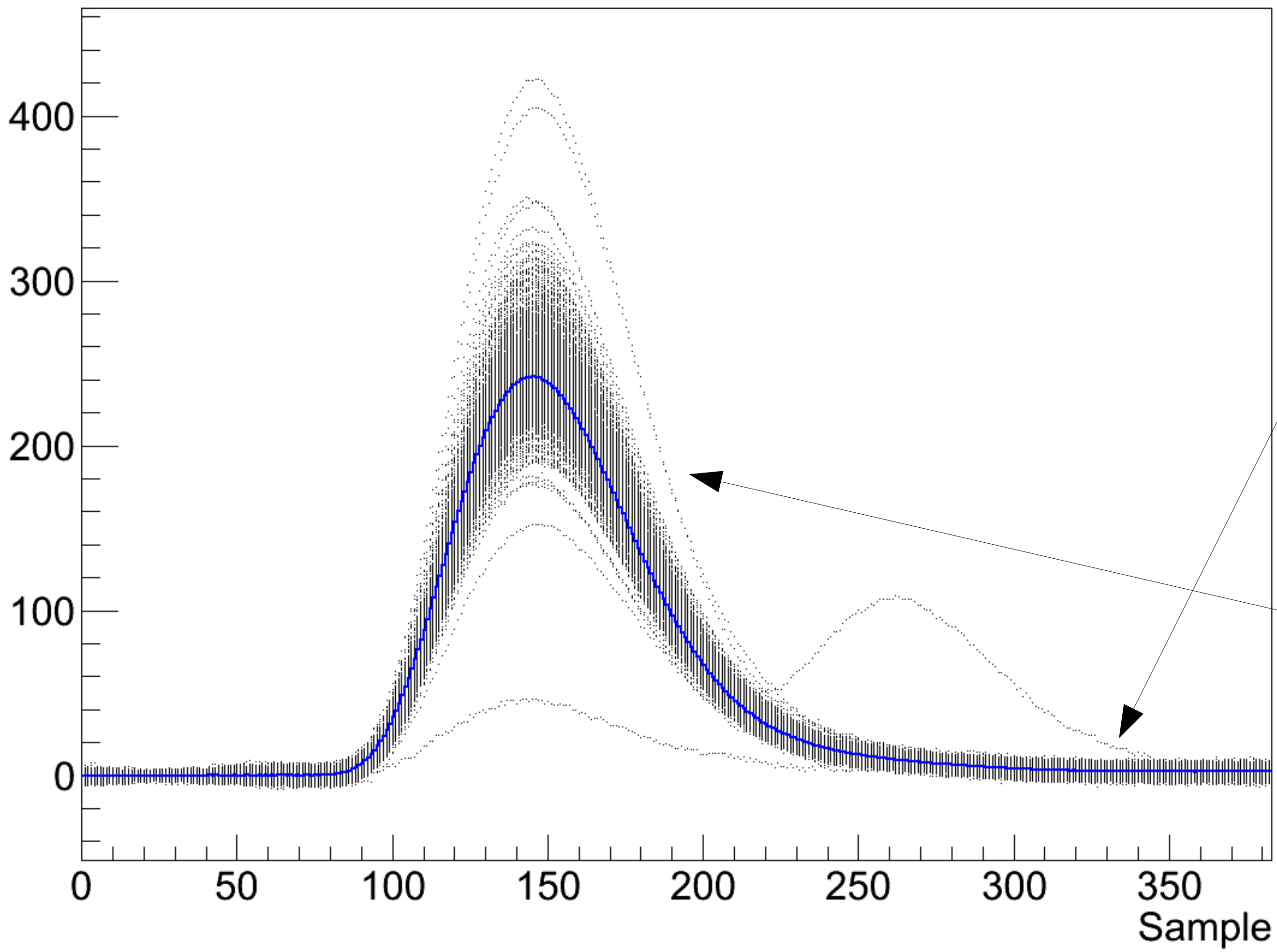
The signal shapes

The plot shows the convolutions of all the waveforms of Xtal 12th for mip events;

The blue line is the average signal for mip events;



The width of the band is related to the energy resolution we have;

Out from the peak signal it is about the 4% of the mean peak height

Event by event the peak height has a jitter of more the 40%.

The latter is what is spoiling our resolution.

Conclusion

On the mip peak we are finding a resolution between 6% and 8%;

This is worst than what it is expected from the MC;

By subtracting the 4% of the MC to the 8% found we have a 7% left;

These fluctuations don't seem to be due to electronic noise nor to shaper instabilities;

Other possible sources are:

- geometrical effects (we are still investigating the possibility of recovering the silicon data);
- real fluctuations of collected crystal signals (light production, transmission and collection fluctuations). If we assume that these scale with the $\sqrt{E}$ we can extrapolate a relative resolution of 3% at 1 GeV.