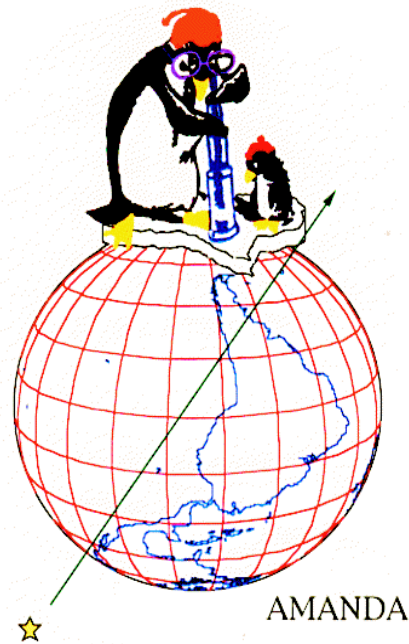


New reconstruction technique using TWR information



Mathieu Ribordy
Thierry Castermans

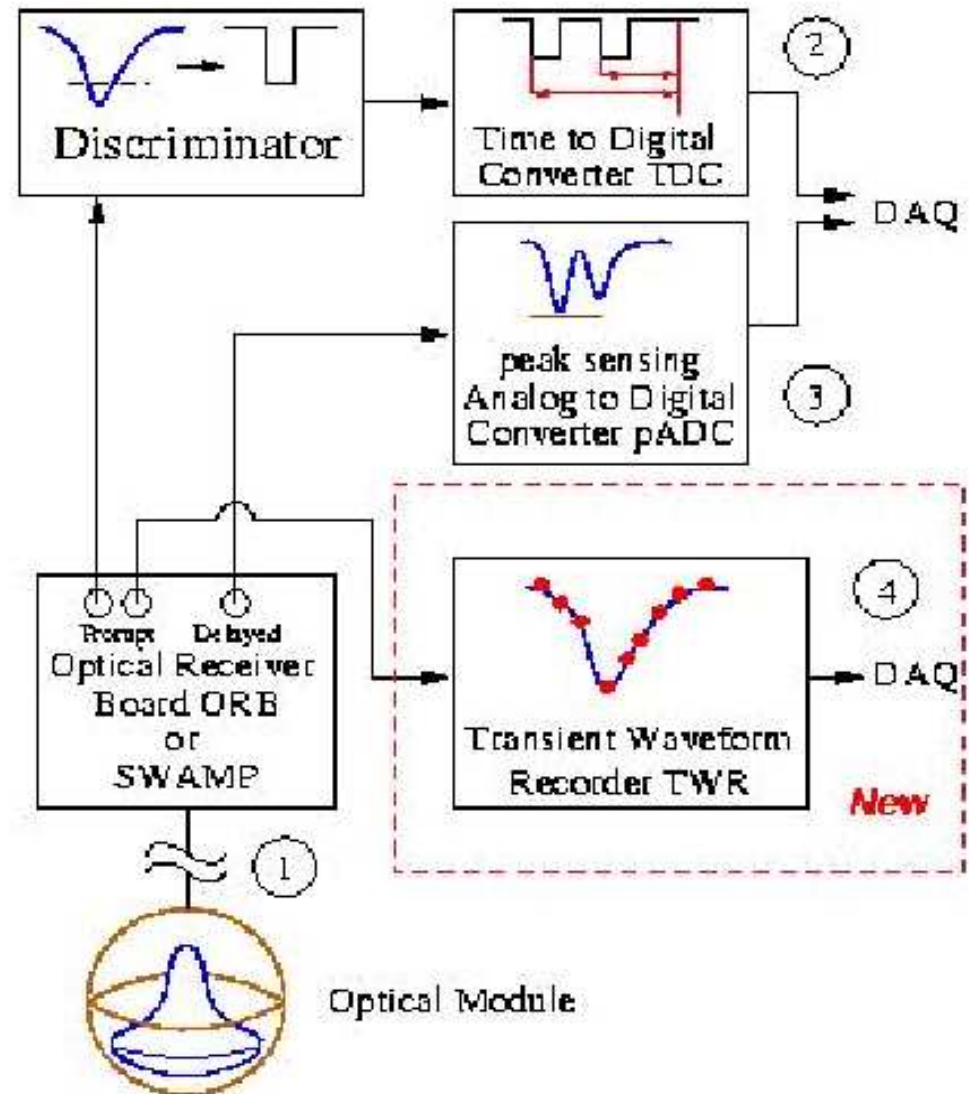
University of Mons-Hainaut, Belgium

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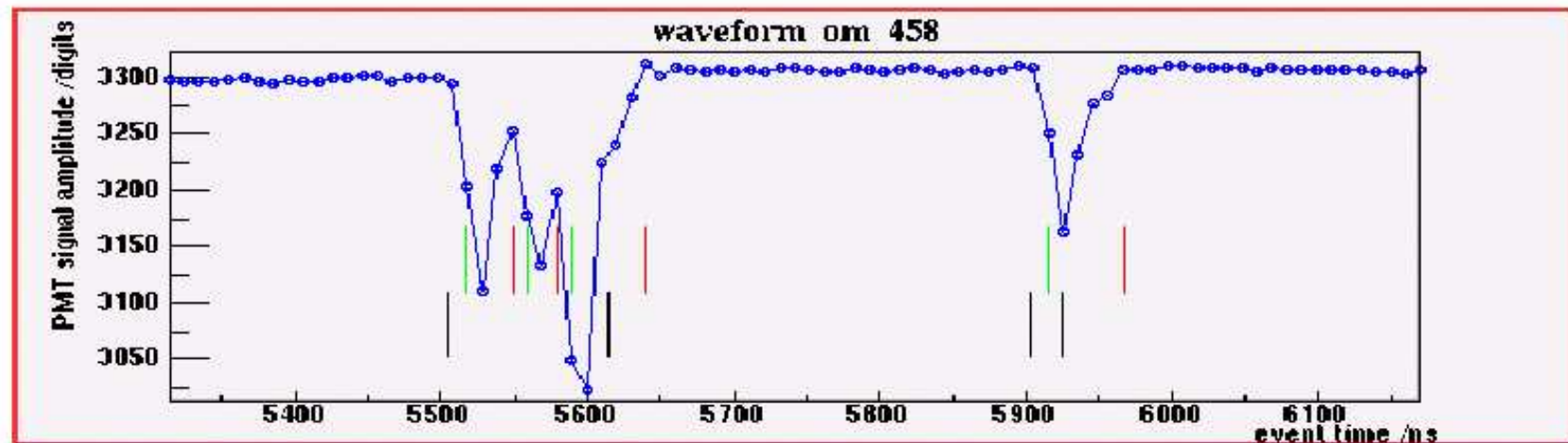
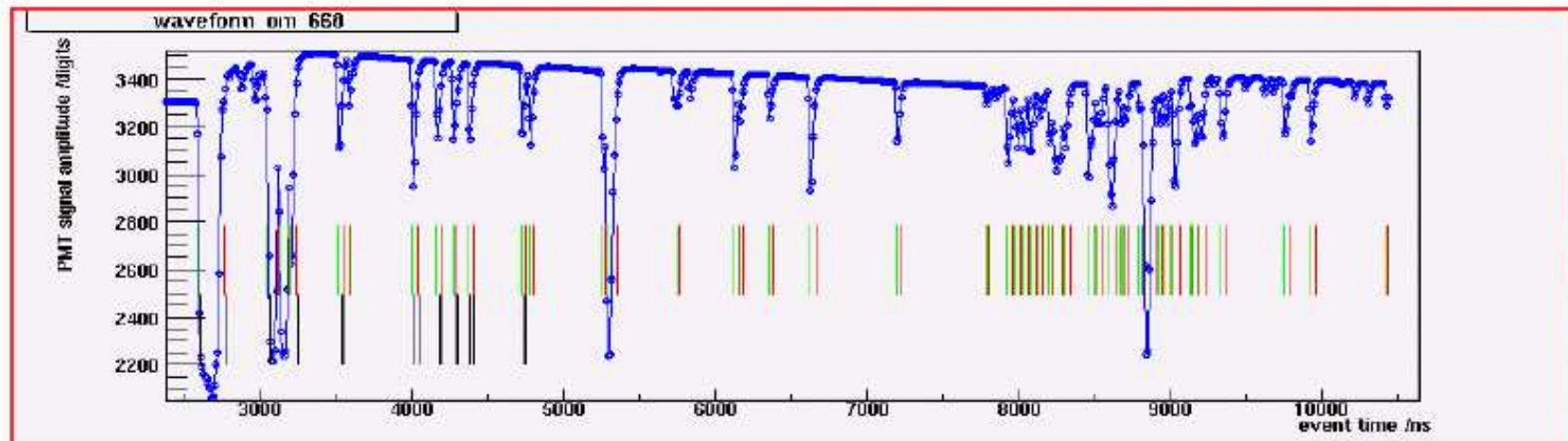
- Introduction
- TWR information
- New reconstruction technique
- A “Toy” Monte Carlo
- Results and comments
- Outlook

Current DAQ system:

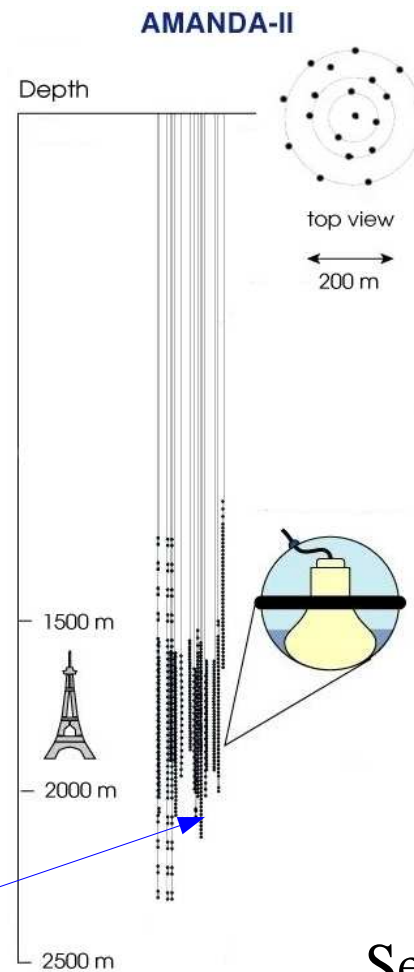
1. PM's pulses transmitted to the surface
2. TDC determines the arrival time of the pulses
3. pADC takes the maximum amplitude in a certain time window
4. Complete waveform sampled using TWR



Typical waveforms



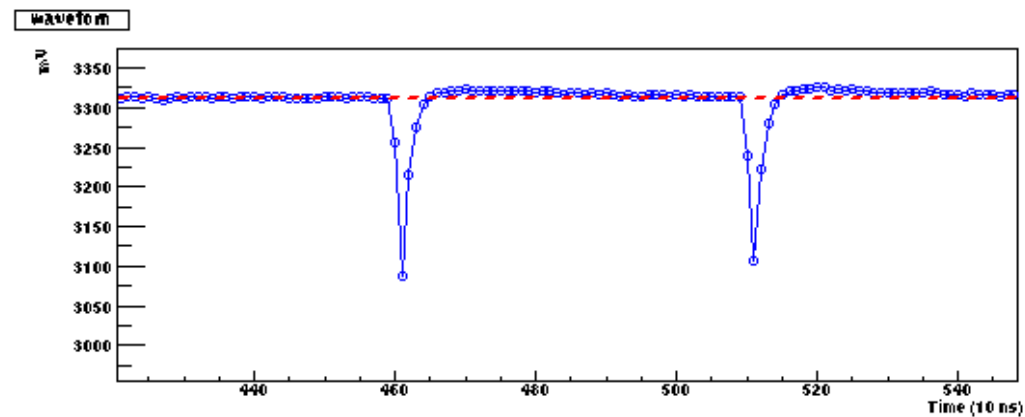
Example: calibration events



Laser source illuminating
the detector

See what happens in the OM's...

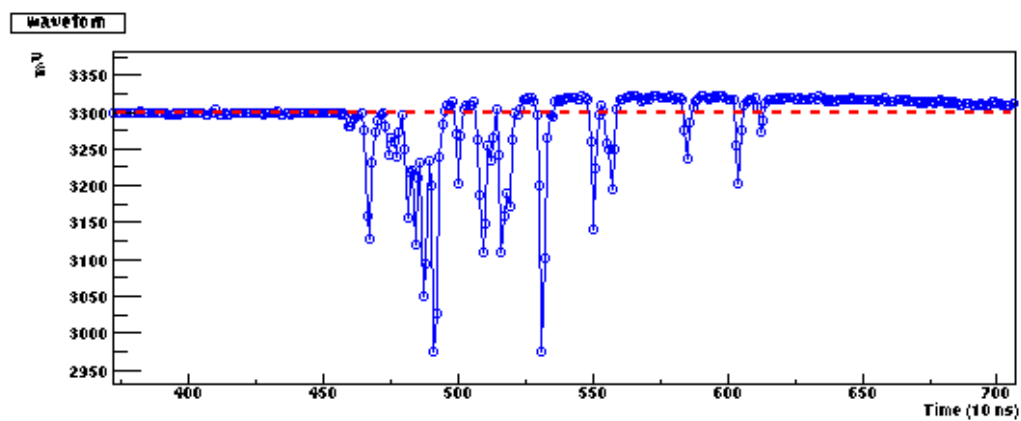
Far from the source: single isolated 1 p.e. peaks...



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distance from laser source: $d=231$ m

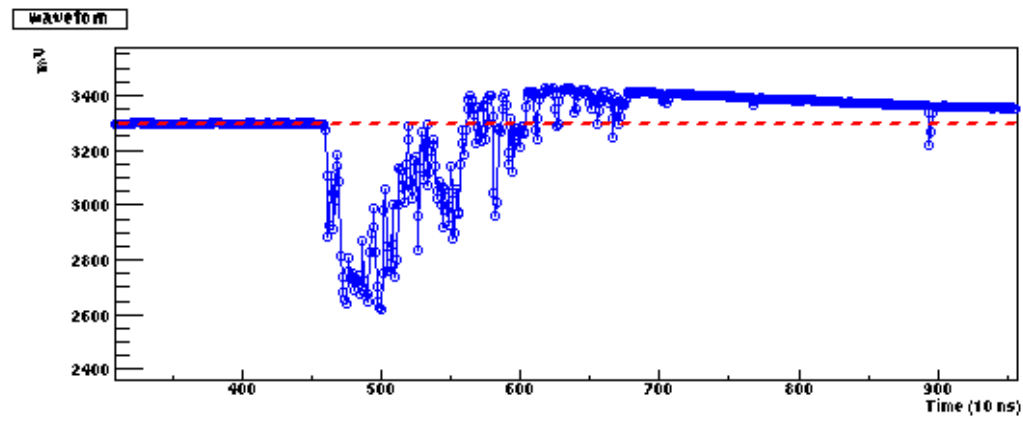
Closer: towards a continuous distribution ?



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distance from laser source: $d=176$ m

Indeed...



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distance from laser source: $d=145$ m

New reconstruction technique

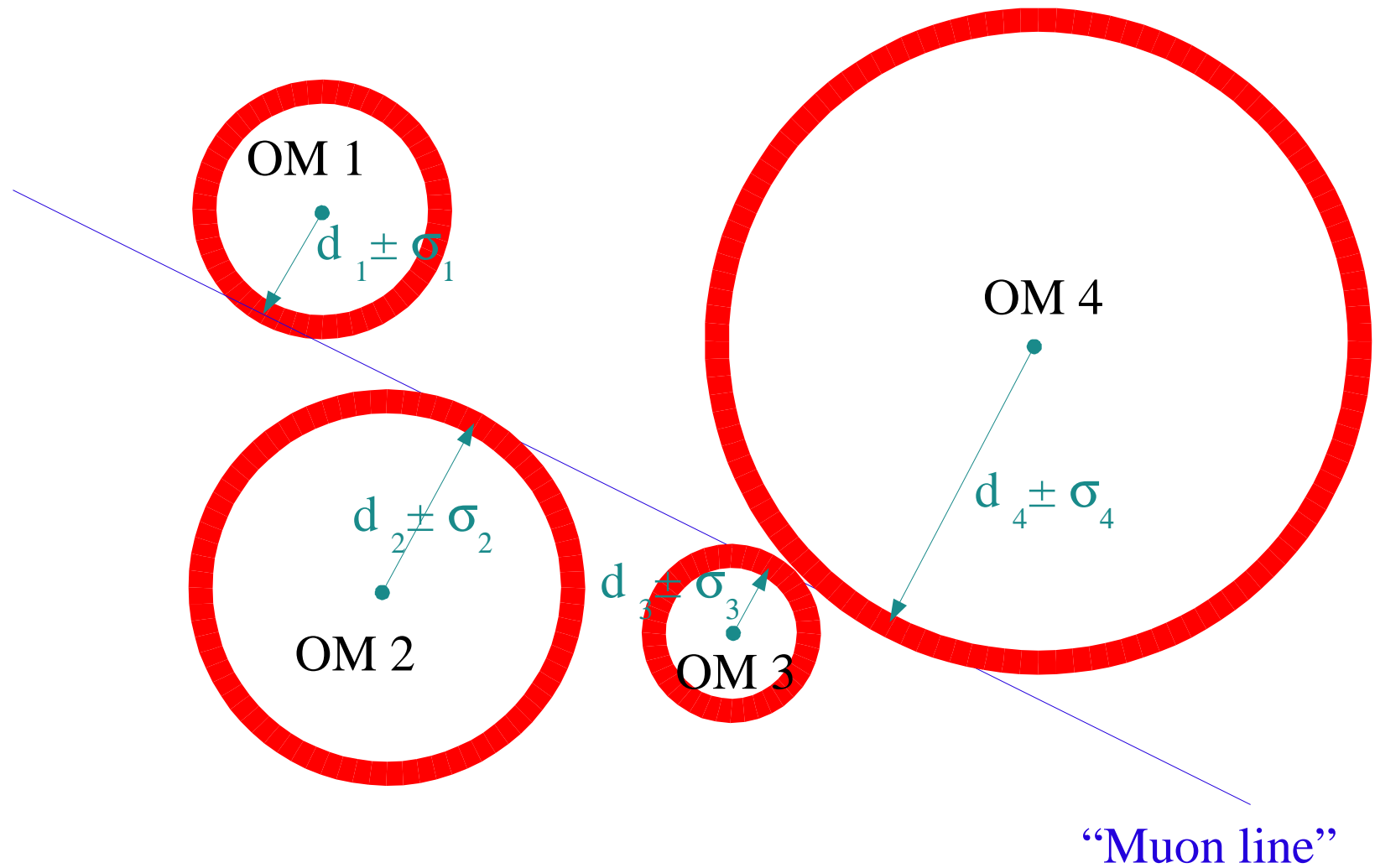
1) For each OM fit the hit distribution time given by the TWR with a Pandel function

==> determine distance, time offset (and their errors)

2) Reconstruct track by minimizing on several OM's (taking into account the errors on distance and time offset)

remark: temporal information is fully exploited !
minimization on only a couple of OM'S

3-dimensional linear regression



\implies minimize $\chi^2 = \frac{\sum [D_i(x_0, y_0, z_0, \theta, \varphi) - d_{i, wf}]^2}{\sigma_{i, wf}^2}$

A “Toy” Monte Carlo

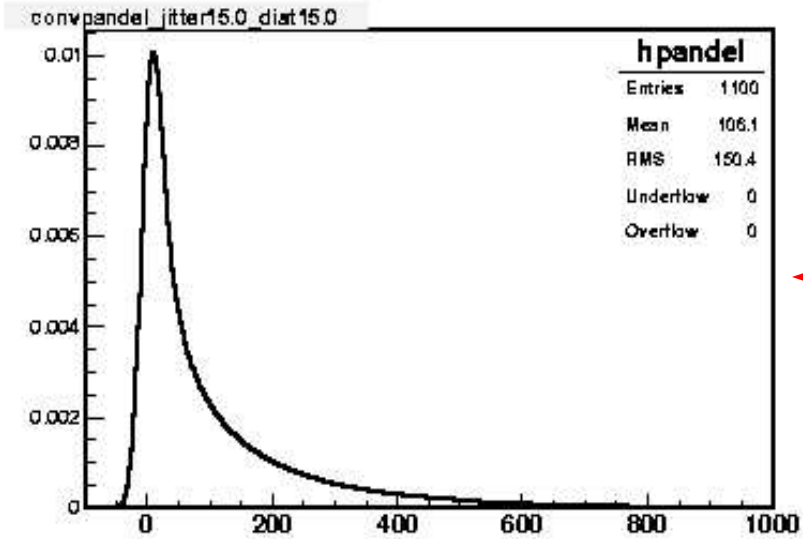
Goal:

Test the idea, the feasibility and accuracy of reconstruction

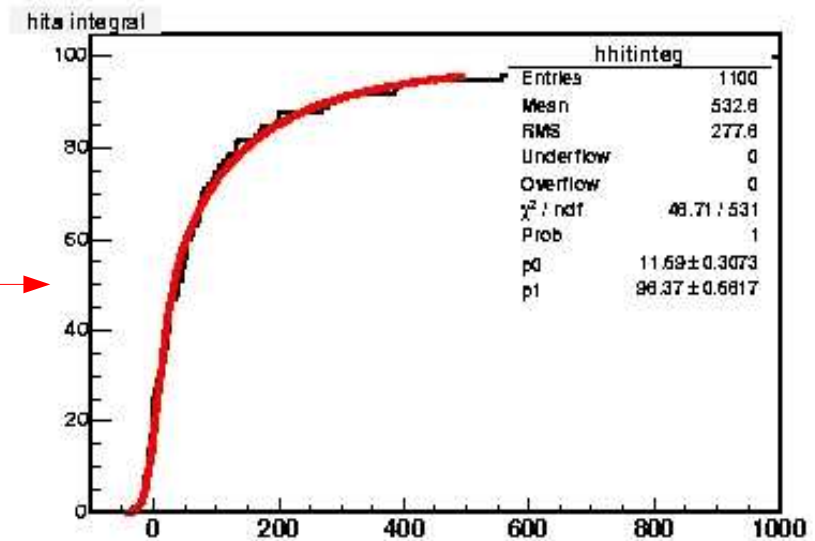
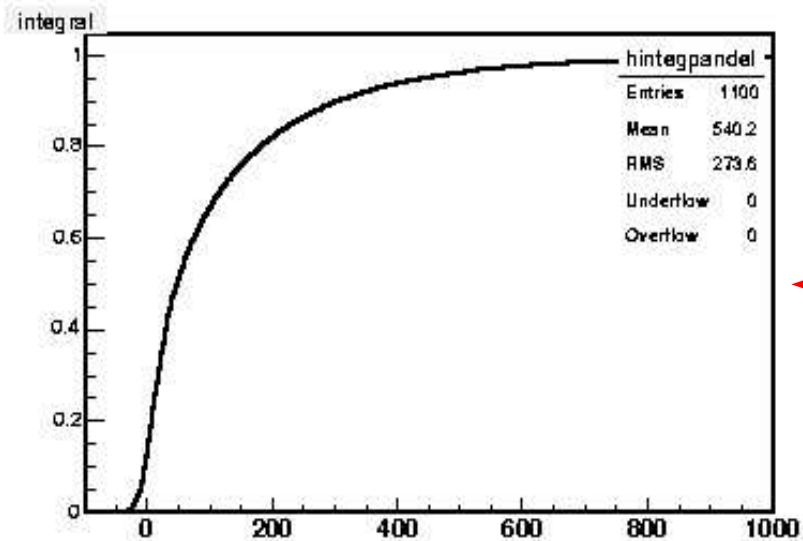
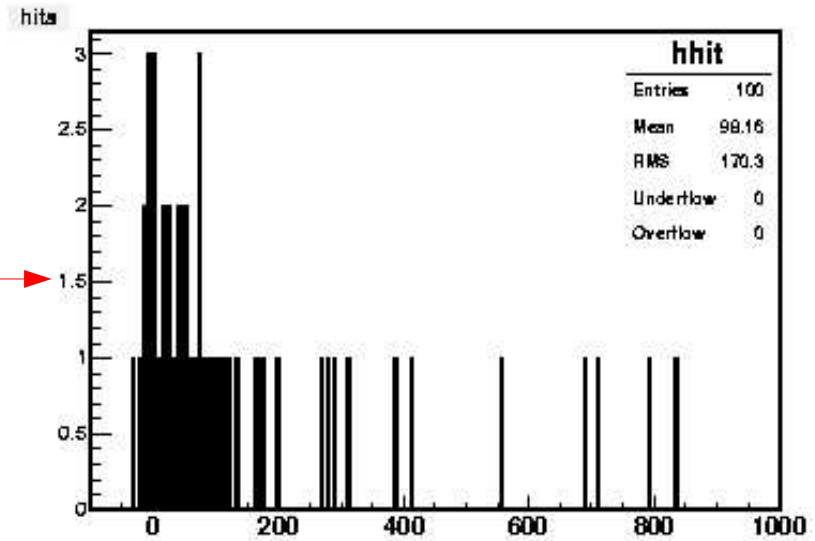
Procedure:

- choose a Pandel function $P(t_{\text{res}}, d)$; fix the distance d
- generate a certain number of hits (randomly distributed, according to the chosen Pandel function)
- fit the distribution of hits with Pandel function to get best value of d
- check that the fitting procedure enables to get a value of distance d close to the one initially chosen

Initial p.d.f.: convoluted Pandel

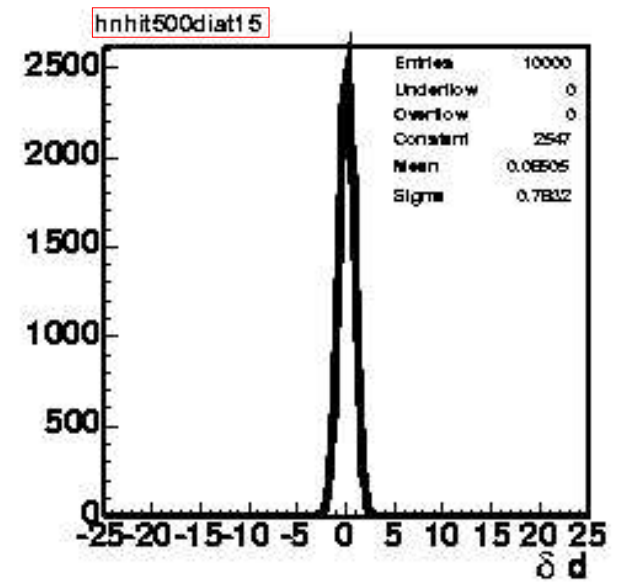
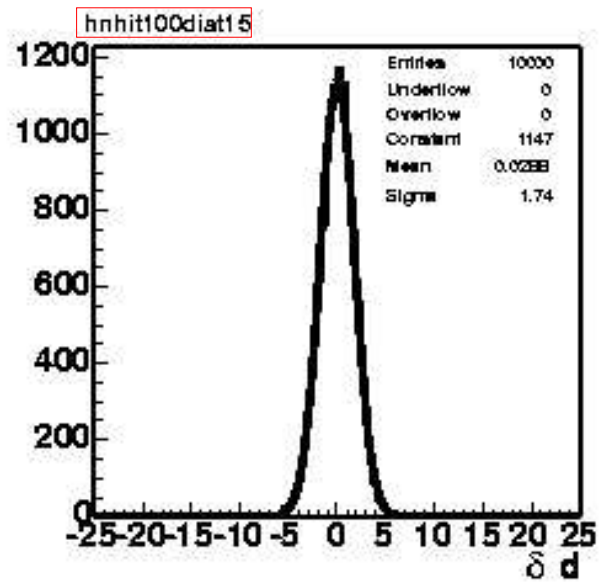
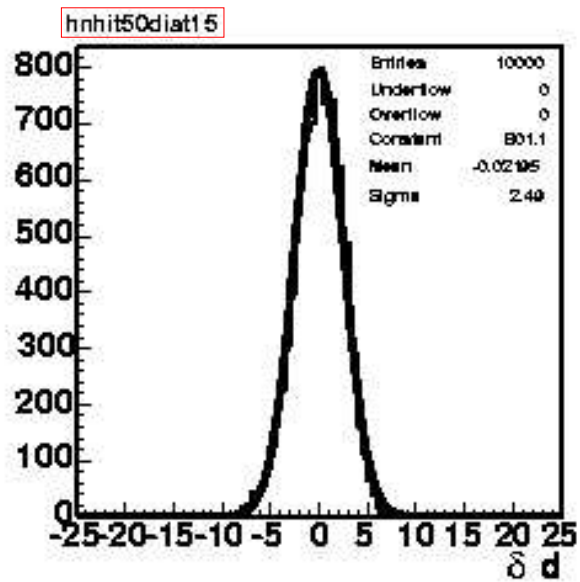
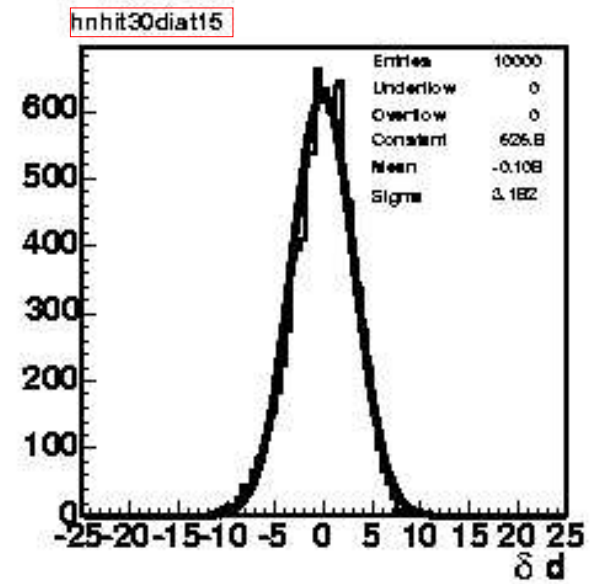
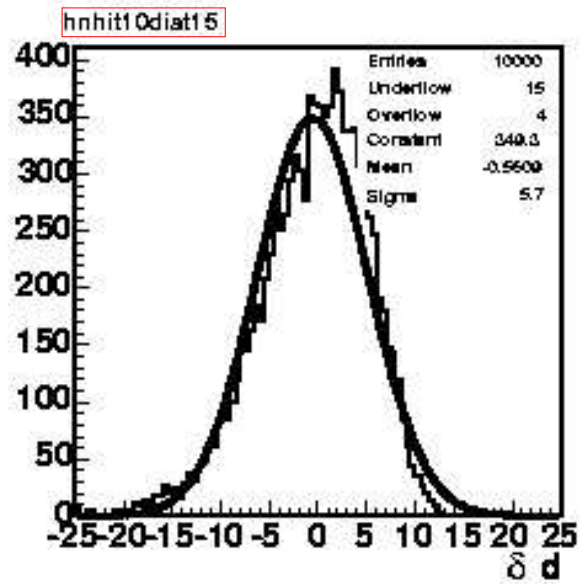
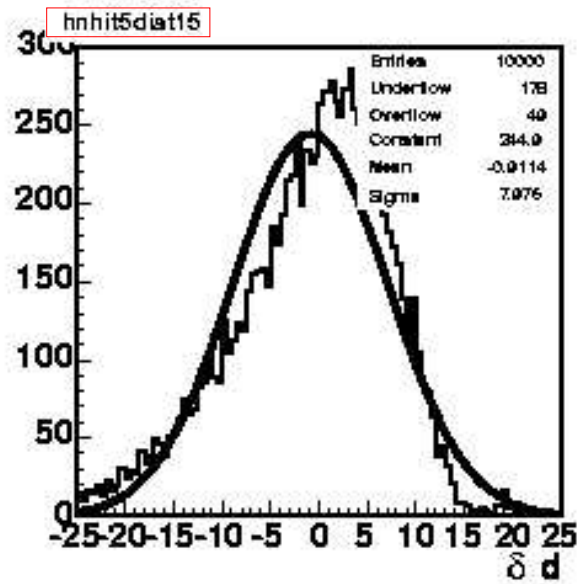


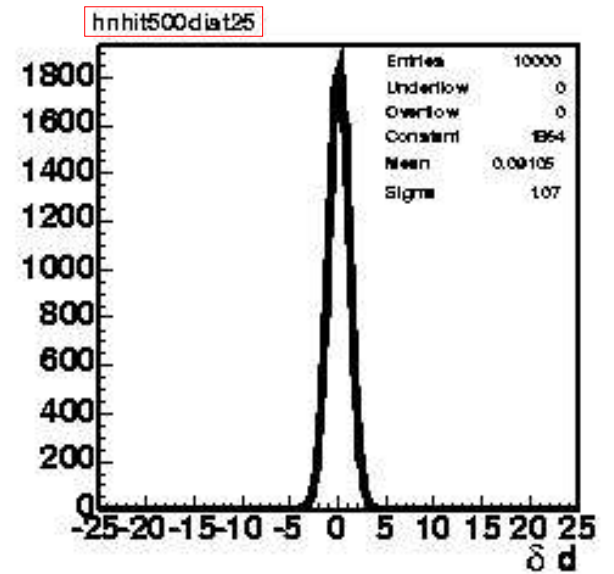
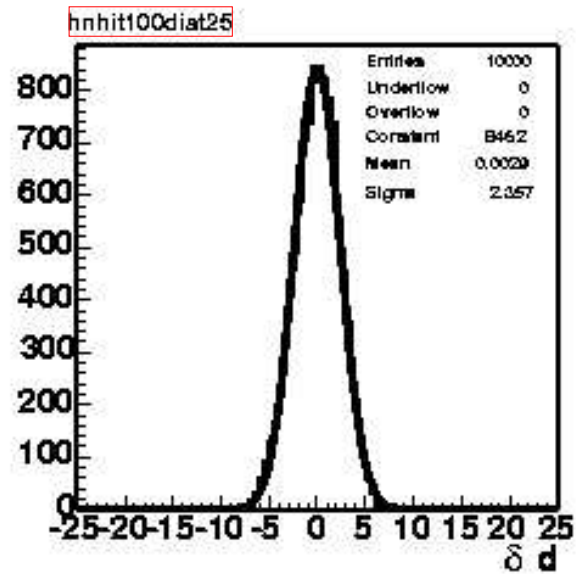
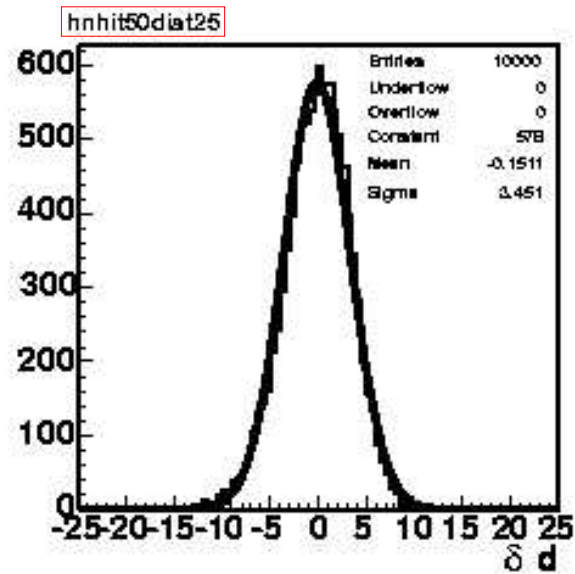
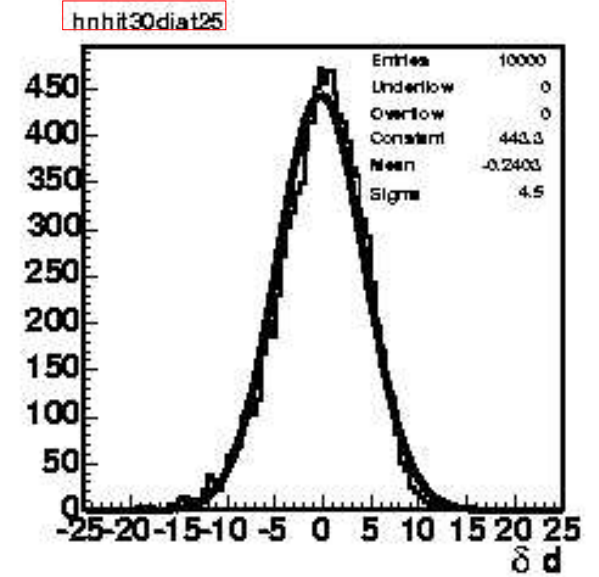
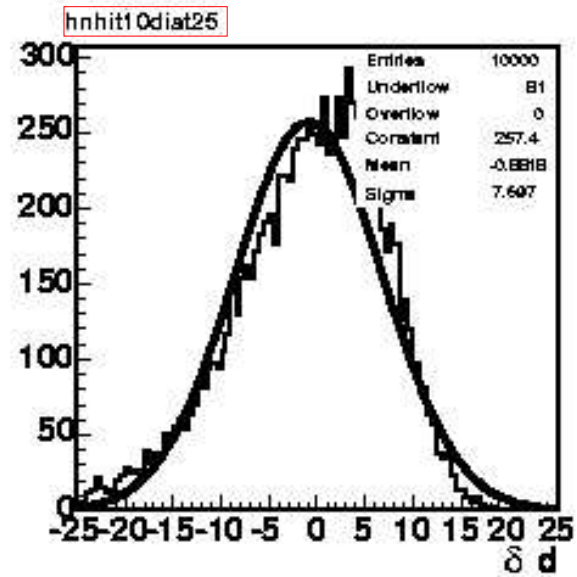
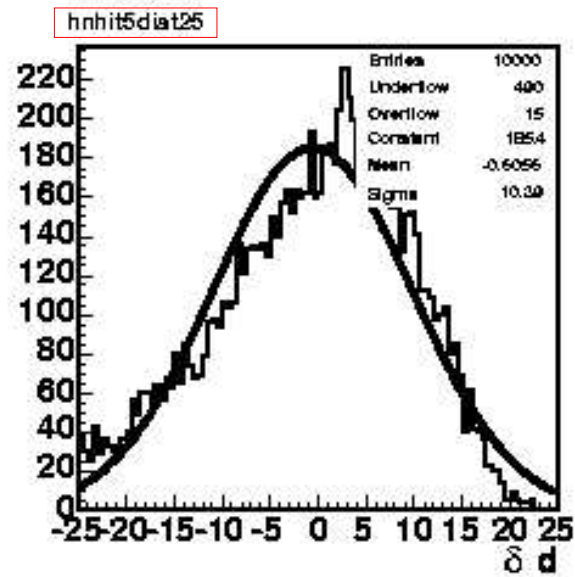
Hits randomly distributed according to the chosen p.d.f. (no noise nor p.e. shape)

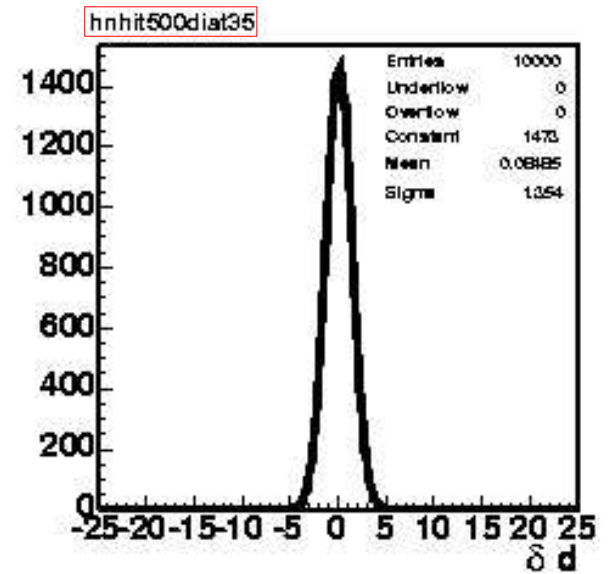
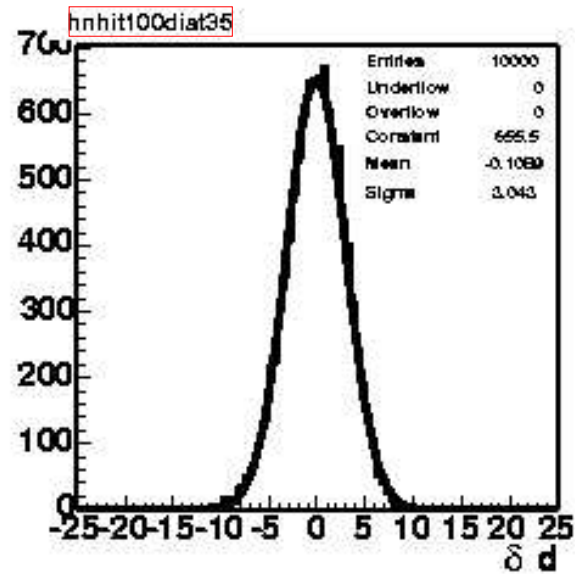
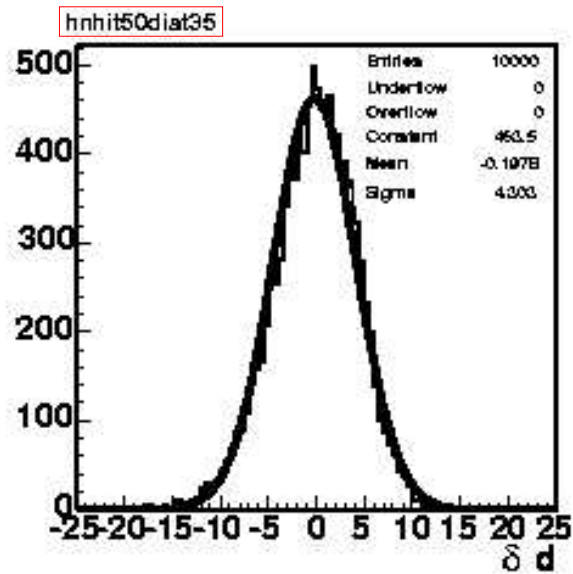
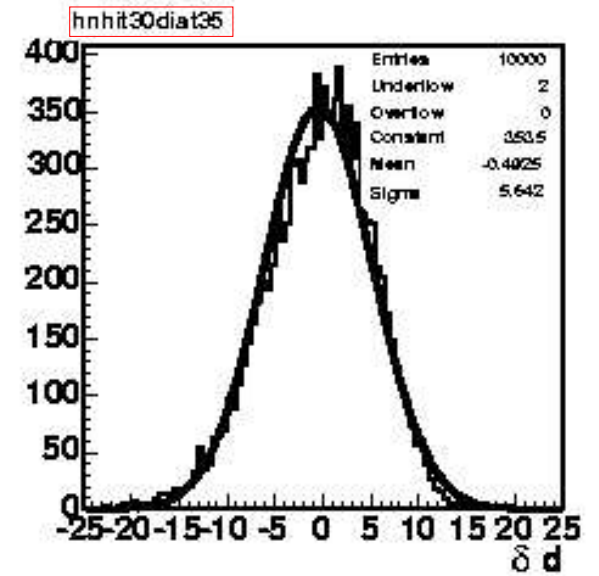
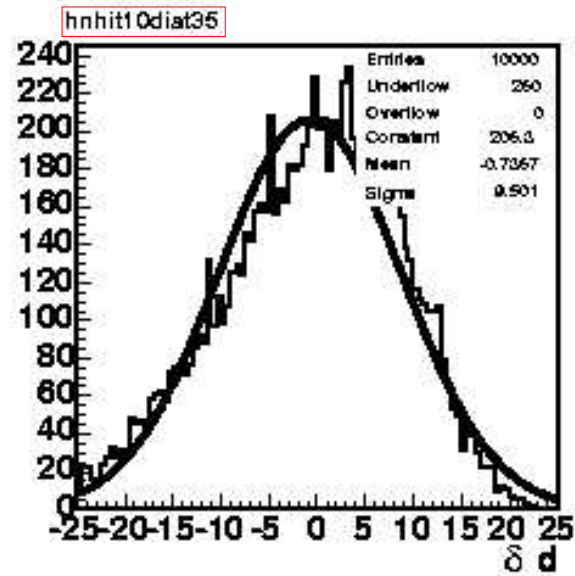
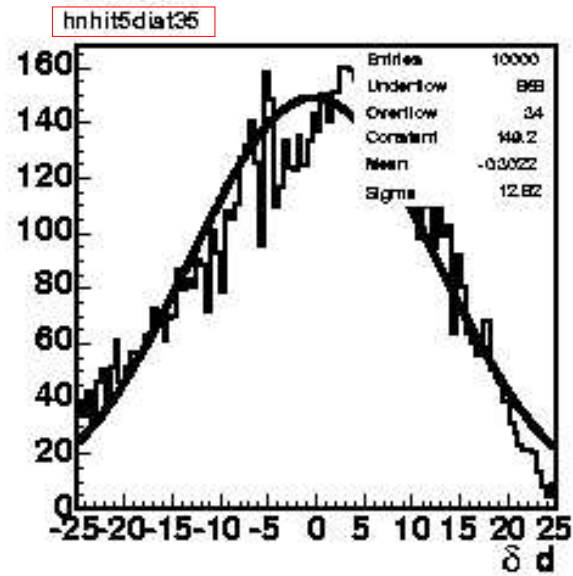


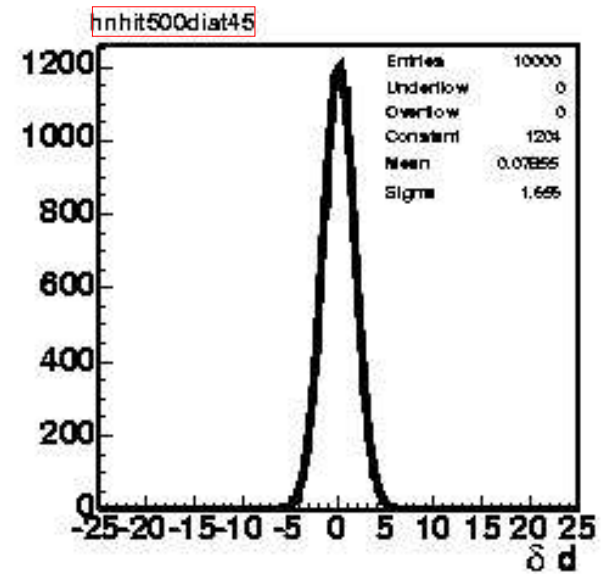
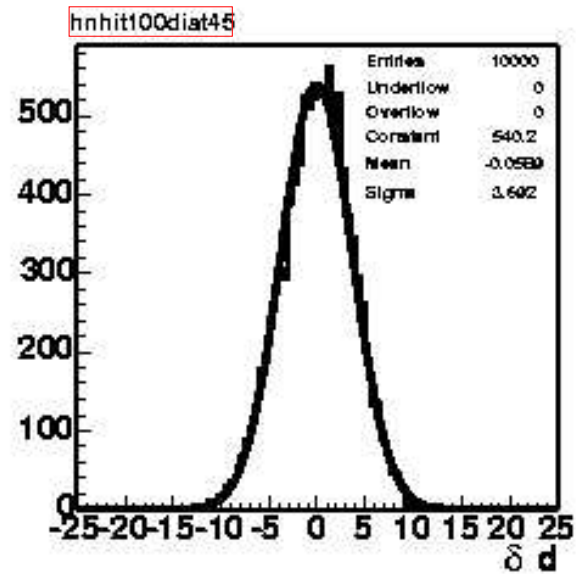
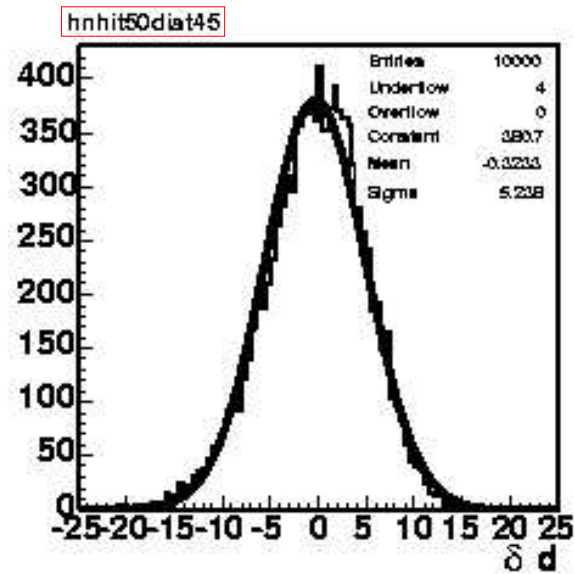
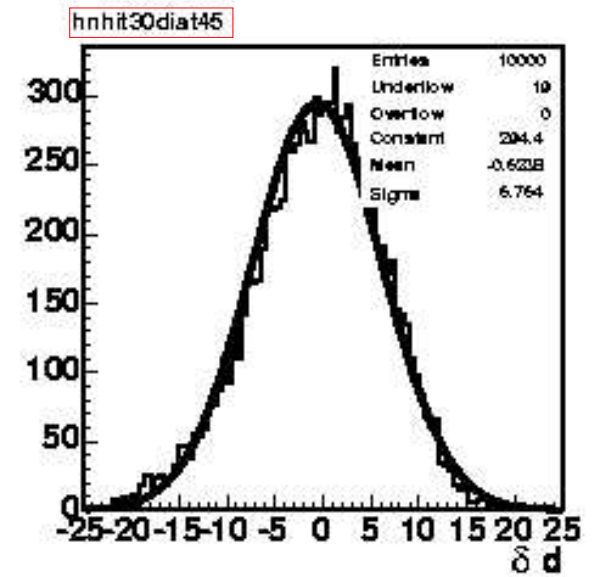
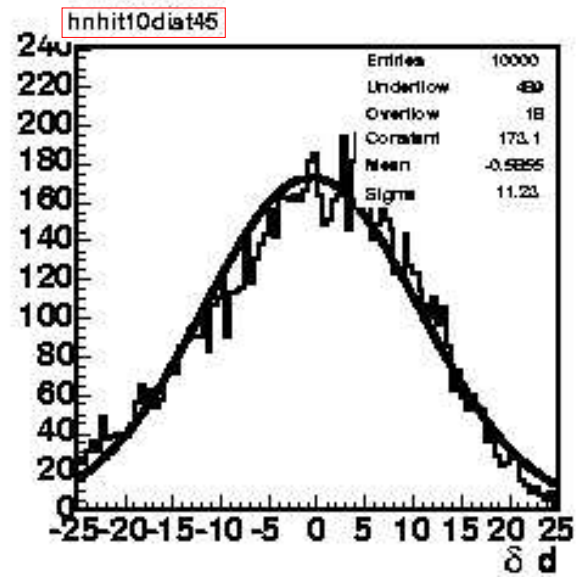
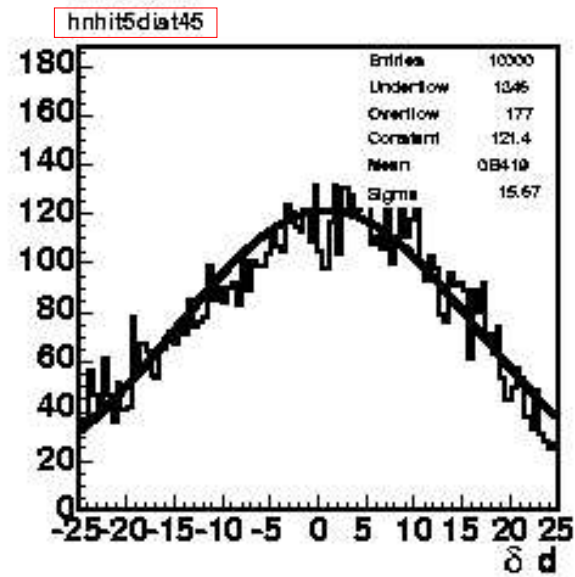
Integrated p.d.f.

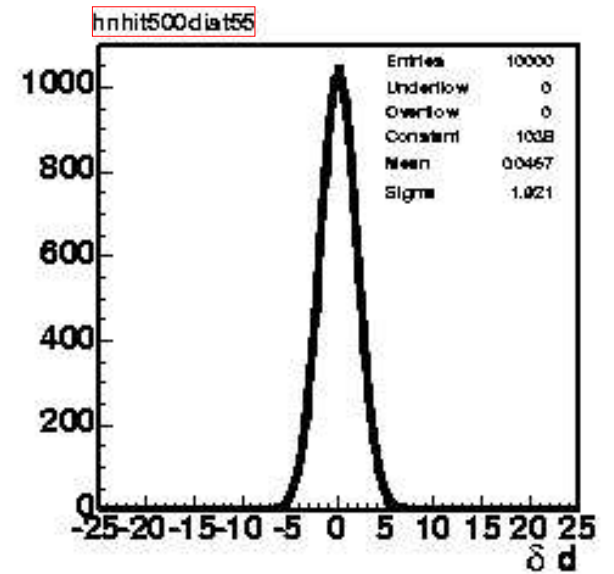
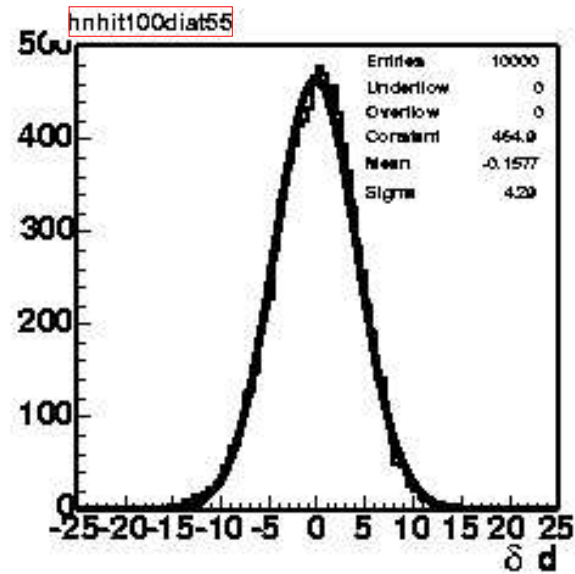
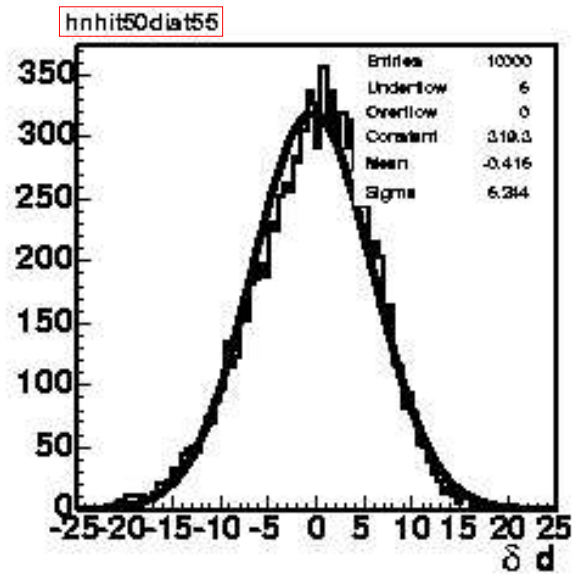
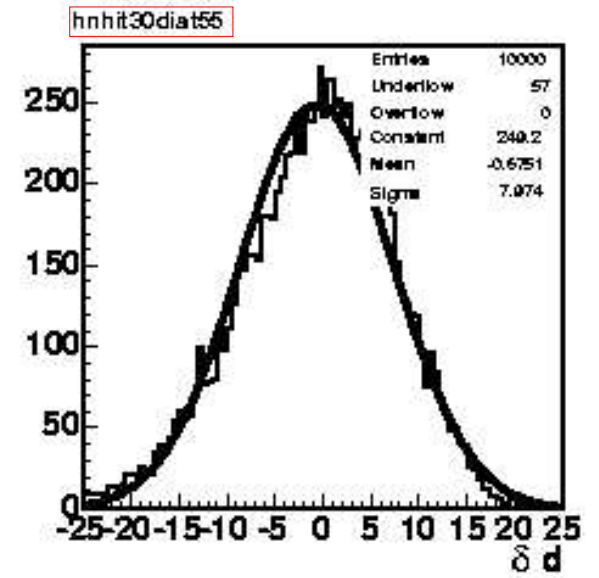
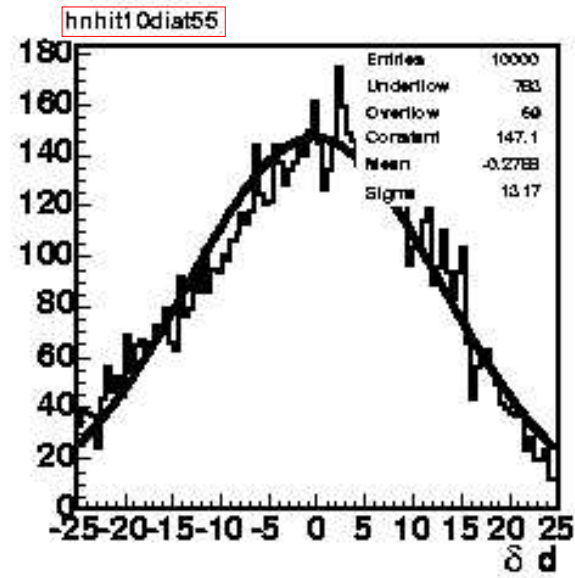
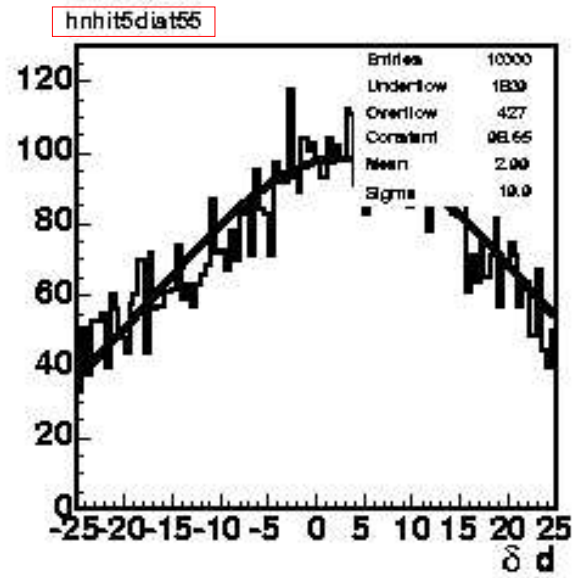
Integrated hits distribution fitted by integrated p.d.f.

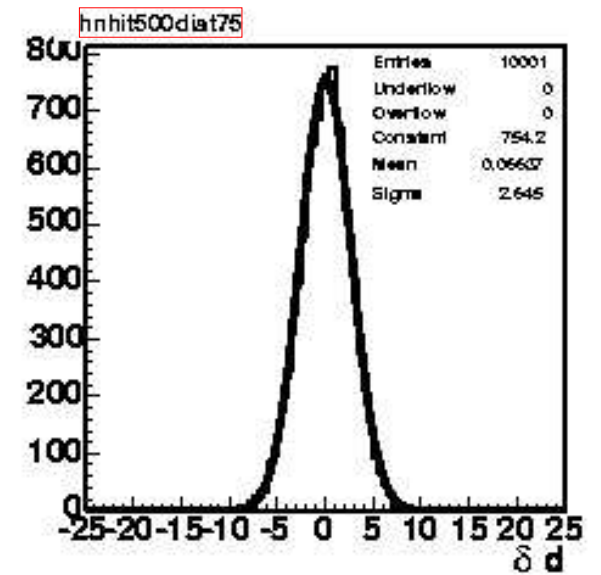
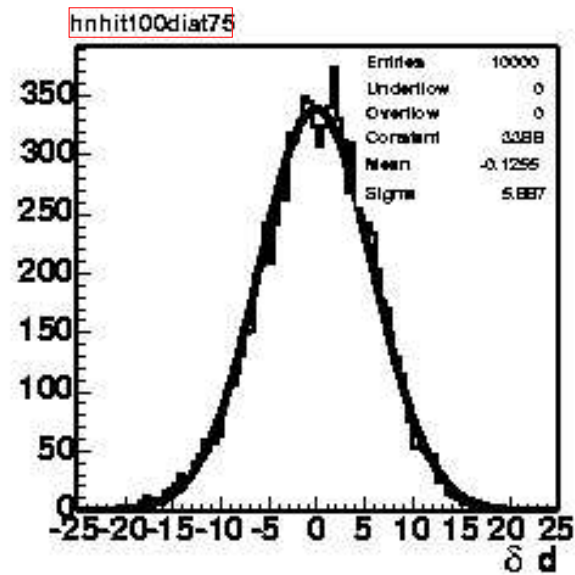
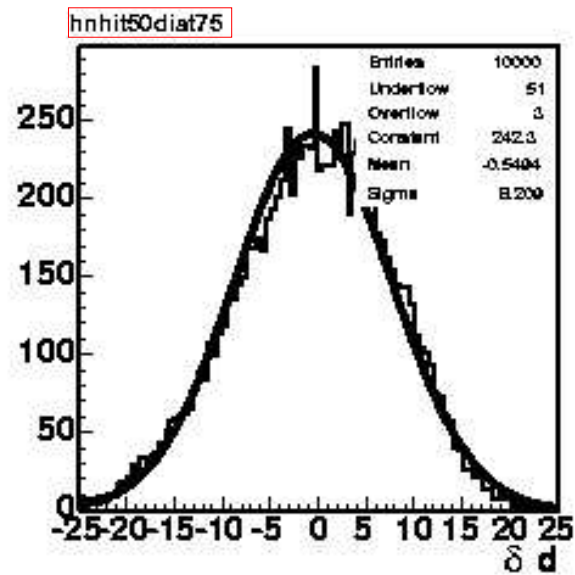
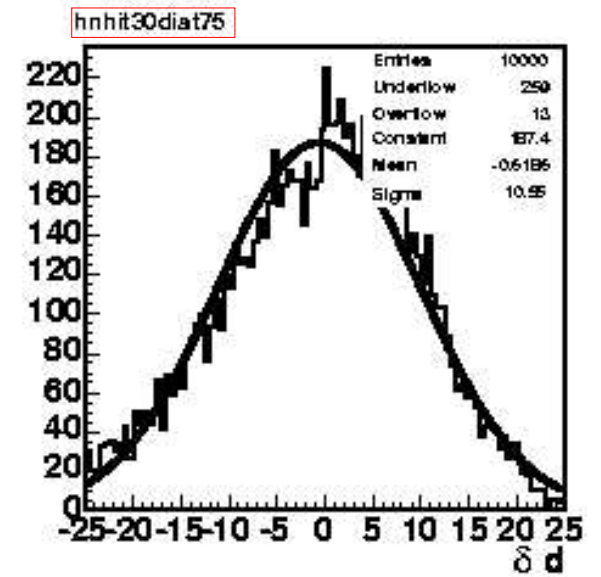
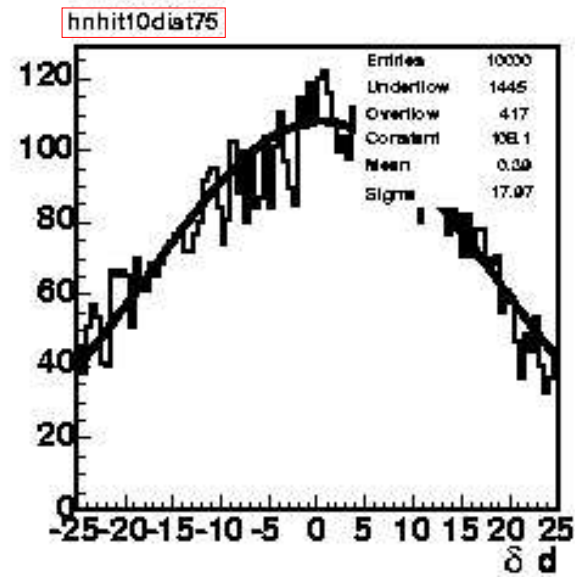
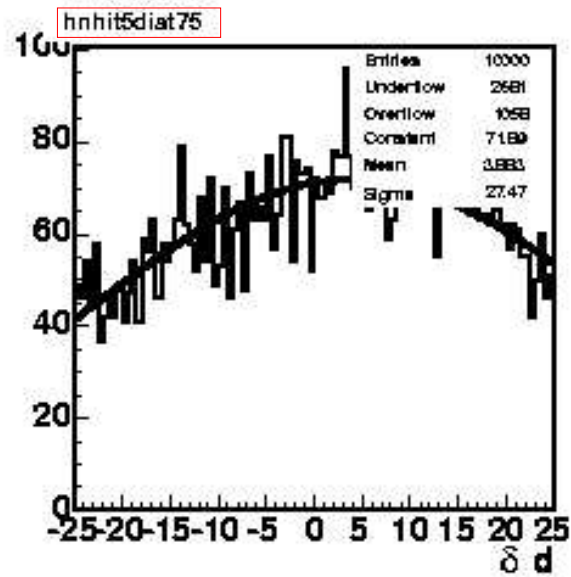




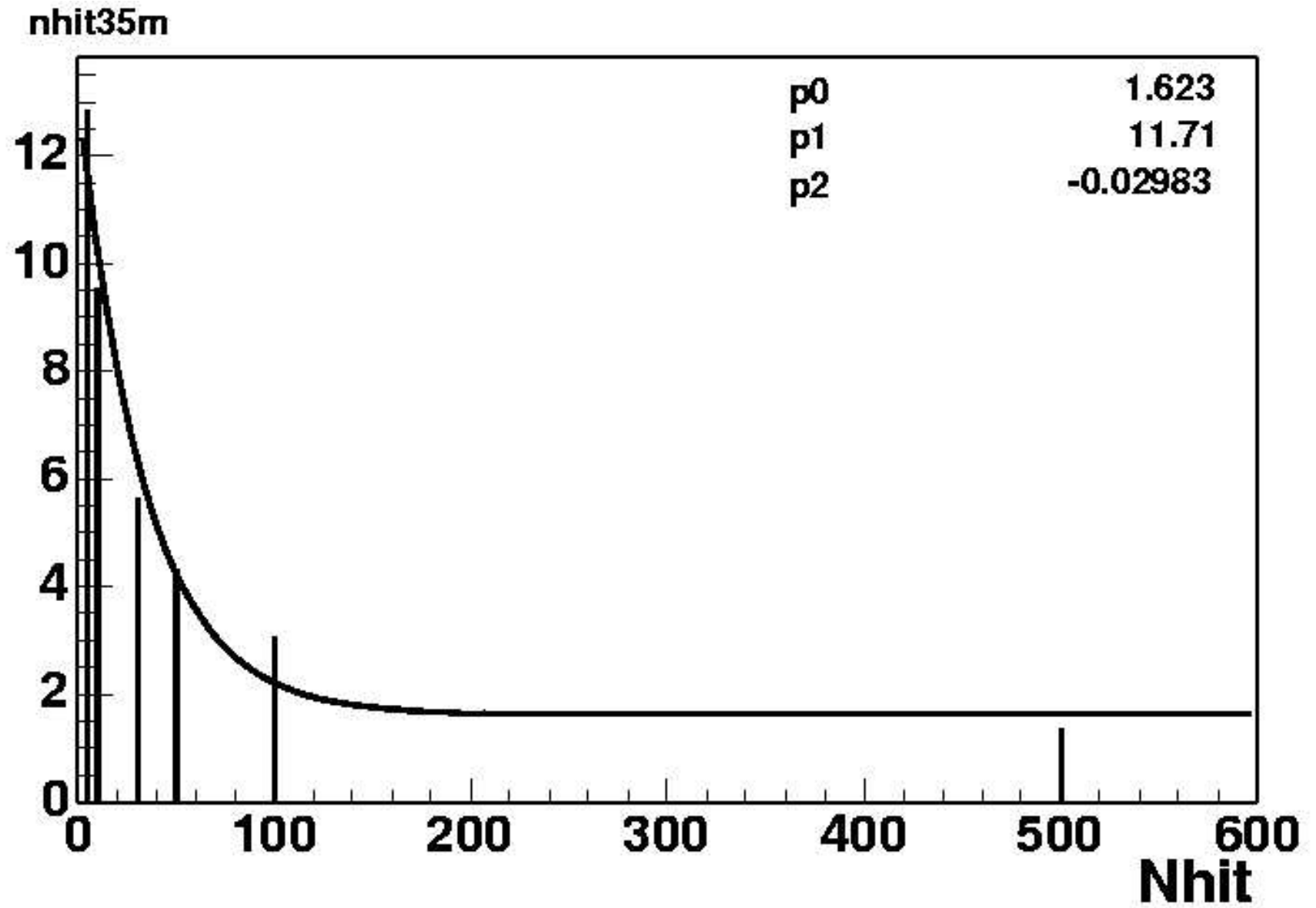




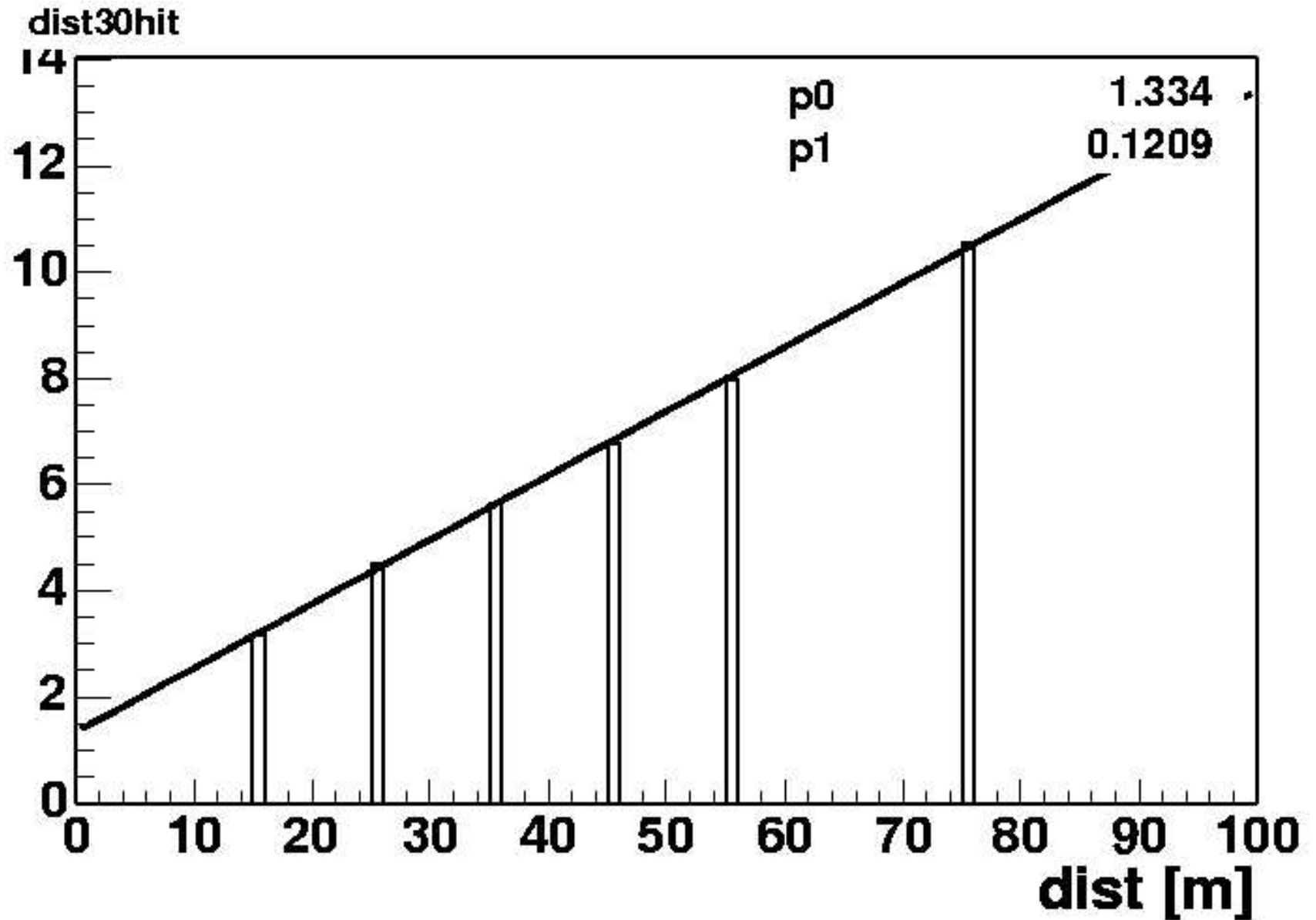


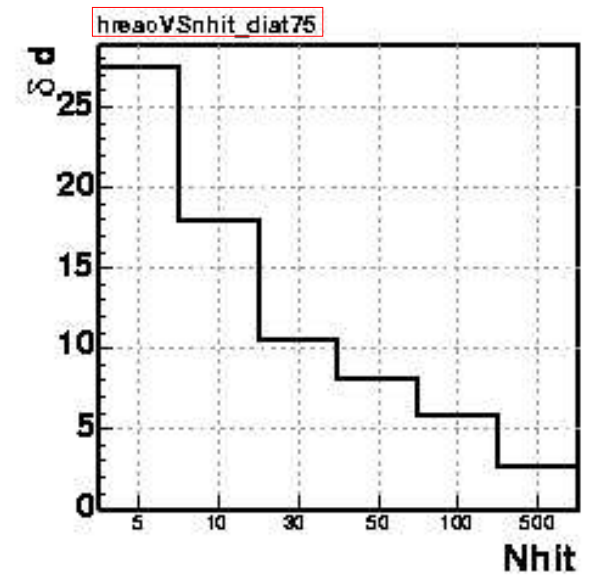
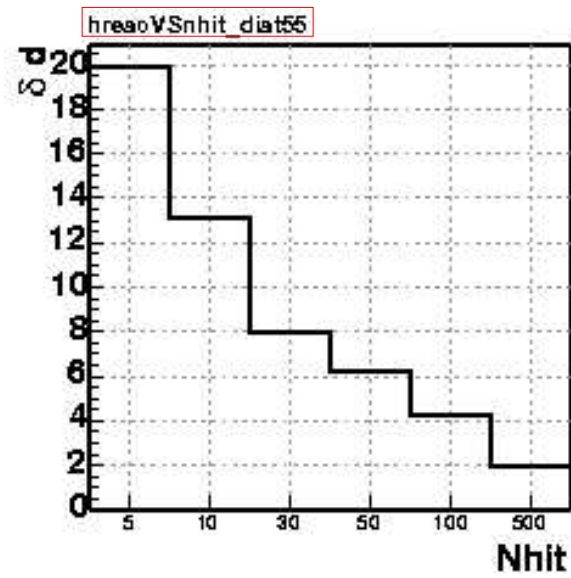
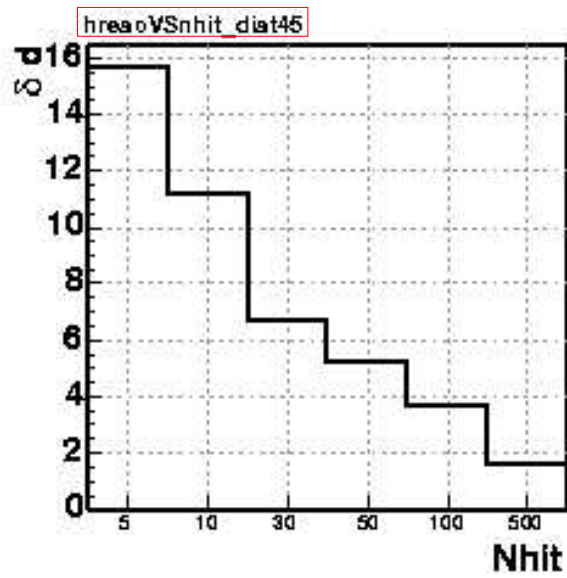
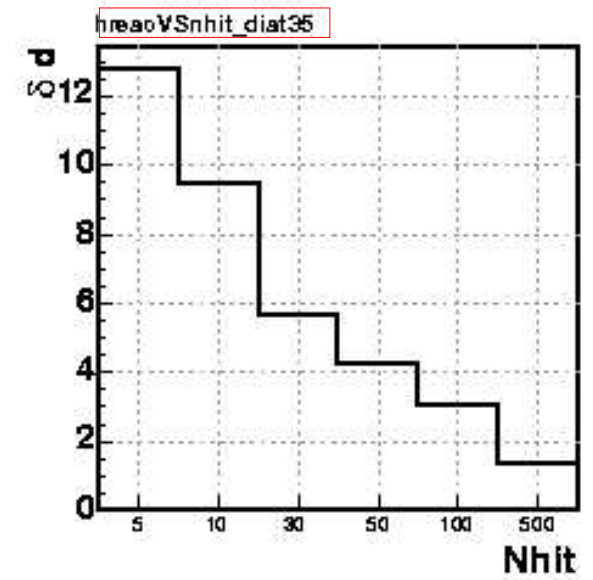
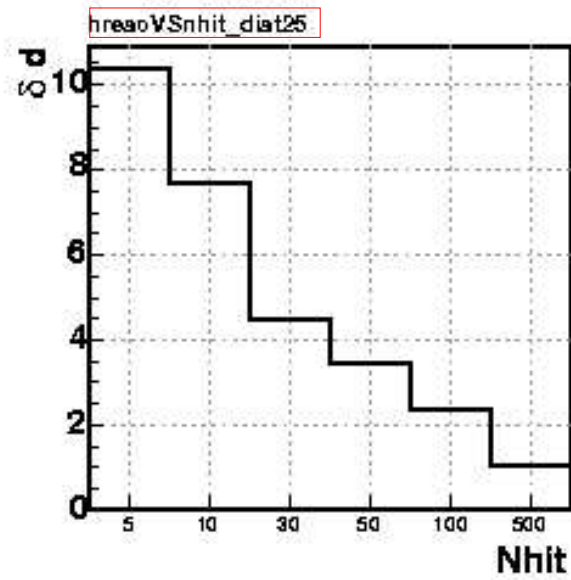
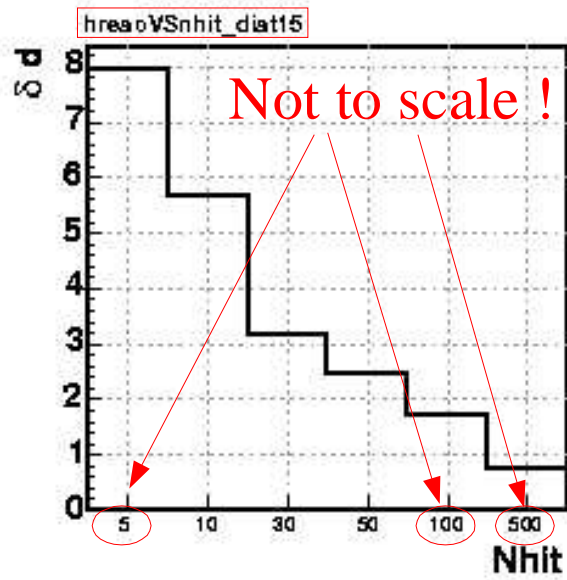


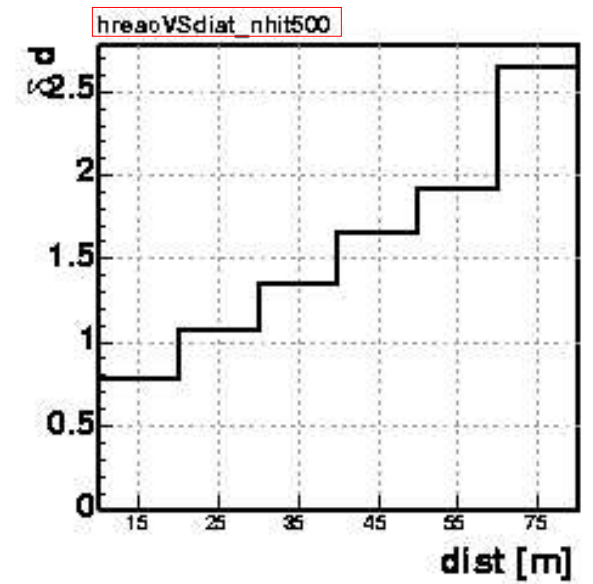
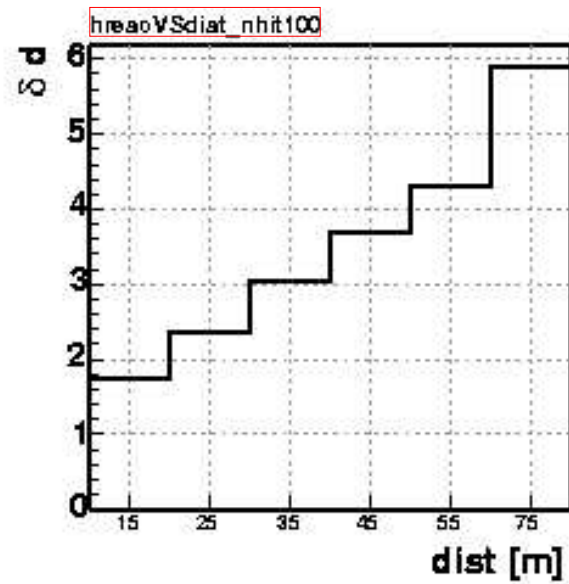
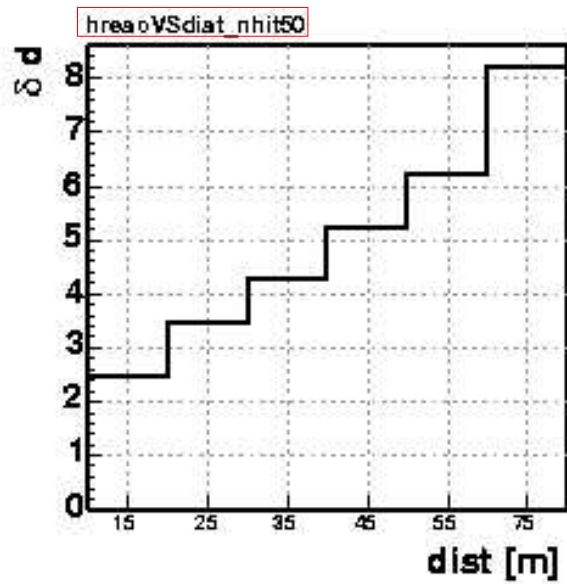
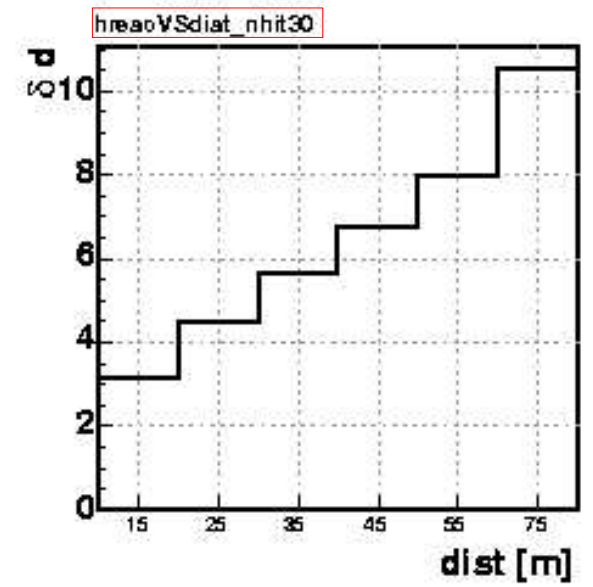
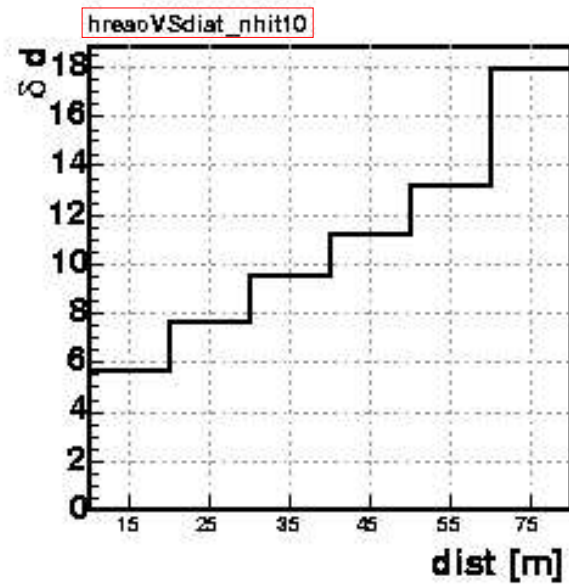
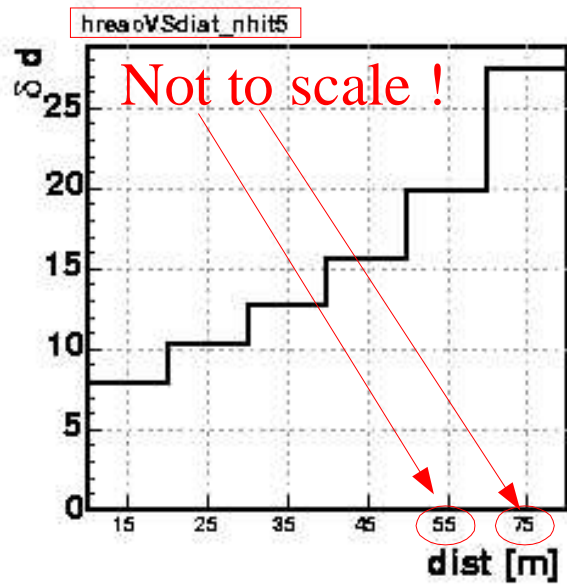
Resolution vs number of hits



Resolution vs distance







Results

- Difference between reconstructed and true distance is gaussian with almost no bias \implies good reconstruction
- Reconstructed distance is good, even when the number of hits is small (5 hits, 15m \implies $\sigma \sim 8\text{m}$... on a lever arm of $\sim 300\text{ m}$ $\implies 1.5^\circ$)
- Resolution:

for a given number of hits \implies LINEAR w.r.t. DISTANCE
for a given distance \implies EXPONENTIAL w.r.t. NHIT

Remarks, open questions and difficulties...

- It is not a reconstruction with minimization on all hits (like the 'standard' reconstruction), but only on a small number of distances between OM's and the track (in 2 steps)

==> much more powerful, faster and more stable for HE

Example: for 10 000 hits

Standard approach

- minimization on all hits for each track hypothesis

==> instable and long

New approach

- determine distances to each OM
- minimize distances to find the track

==> no ambiguity, reliability

Remarks, open questions and difficulties...

- This is a simple Monte Carlo: no noise nor shape accounted for
- Pandel function not realistic \implies extract it from MC/exp (distribution tables – photonics could be the solution) to be better... and faster
- This method could be efficient as a first track guess as well as an optimized reconstruction
- Efficiency as a multi-track reconstruction method (see micro black holes)?

Outlook

- Other tests
- Angular resolution studies
- Introduction of time offset in minimization
- Work with real data: reconstruction of 2003 events
- Comparison with other methods of reconstruction
- ...