

Muon Peaks in the EMC

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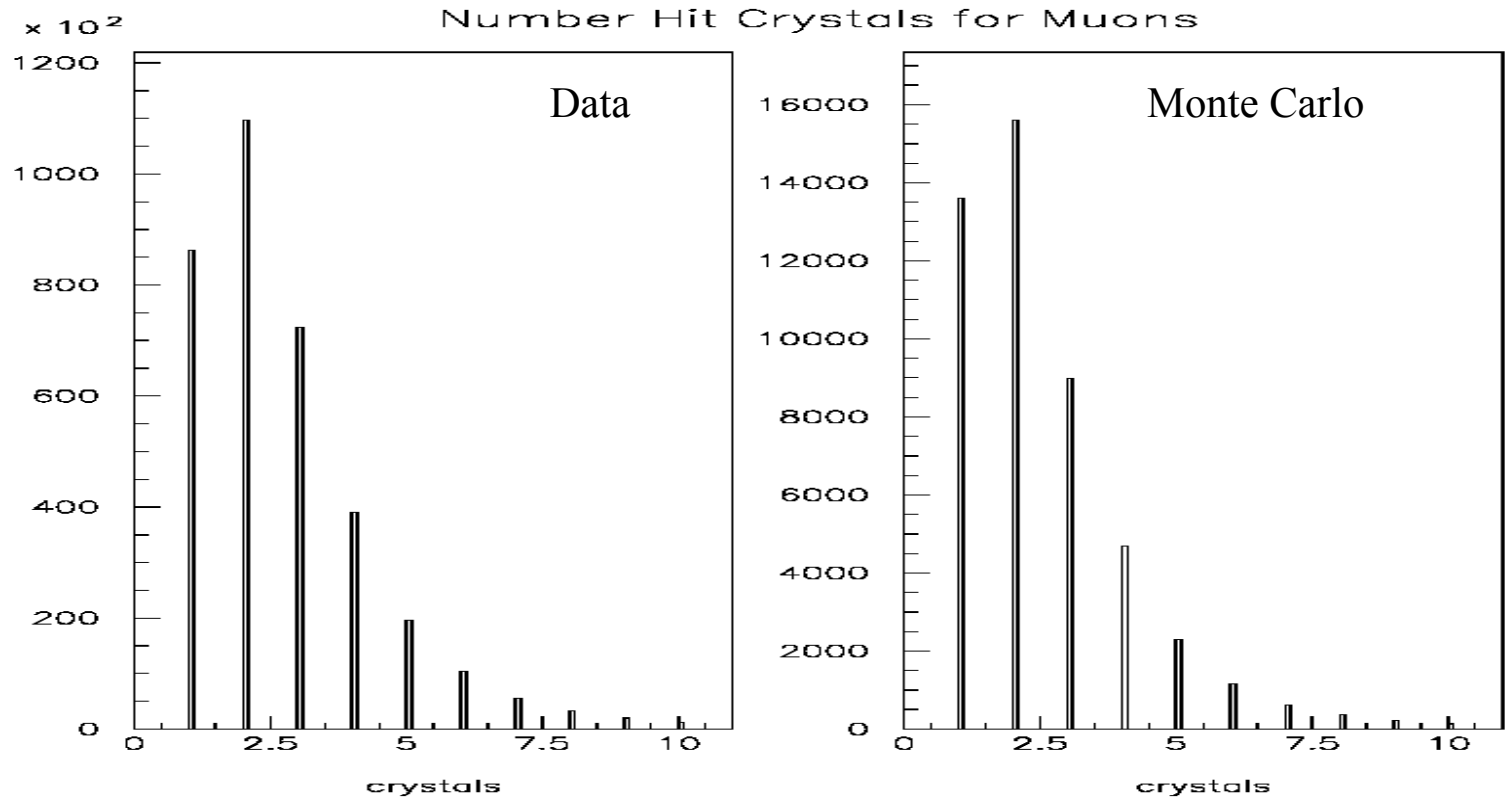
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- Muons are a source of constant energy deposition (about 200 MeV). As a result, they are a check on detector stability.
- Muons deposit energy uniformly along their paths, so they may be affected differently by radiation damage than photons and electrons if the damage is localized (e.g., near the front).
- Previously I showed:
 - Muon peaks for different theta regions vs time.
 - Comparison of data and MC for muons peaks.
- Now I have a first look at muons peaks for single crystals.

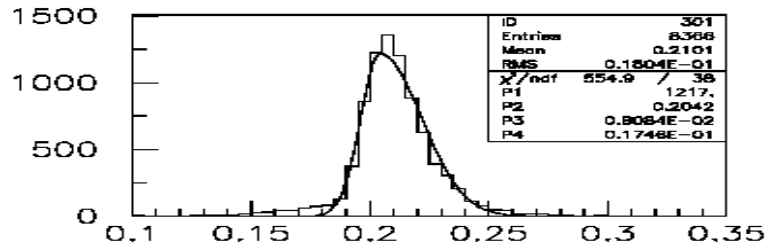
Single Crystal Muon Response

- **Still use Micro**
 - Run Beta job looking at Micro information
- **Select ee $\rightarrow \mu\mu$**
- **Use muons that only hit one crystal (Crystals=1.)**
 - Use rawEnergy()
- **Look at June 2002 data first**
 - good_2002-b1-s3-r10B-on_phys25-26
 - 3.5 fb^{-1} , giving about 1×10^6 muons that deposit energy only in one crystal
- **Fit muon peaks with two half-gaussians**
 - Perform fits for all 6580 crystals
 - Typical errors on the fit value of the peak are 3-4 MeV (about 1.5-2%)

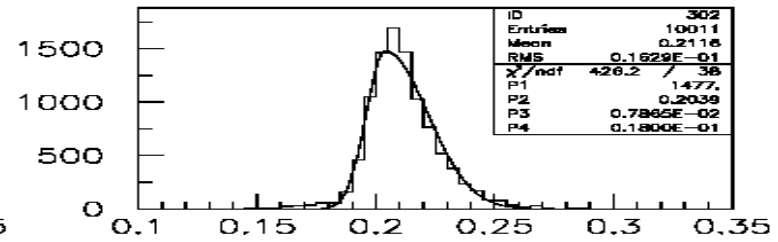


About 20% of muons from $e^+e^- \rightarrow \mu^+\mu^-$ deposit energy in only one crystal.

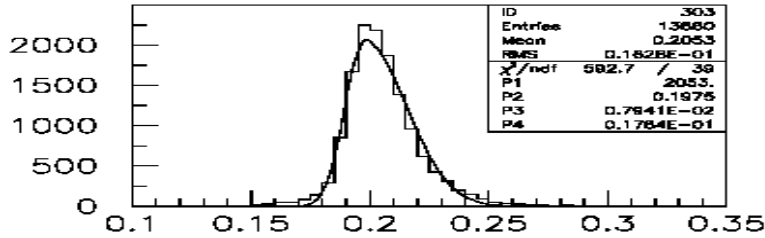
Monte Carlo



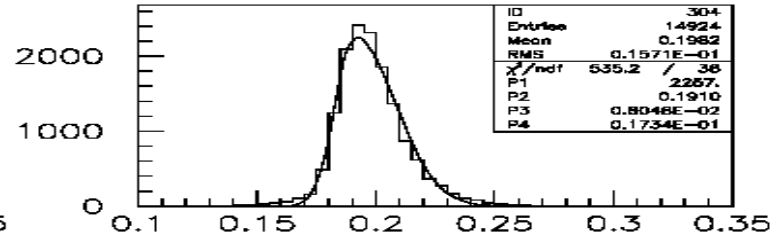
muon energy – endcap



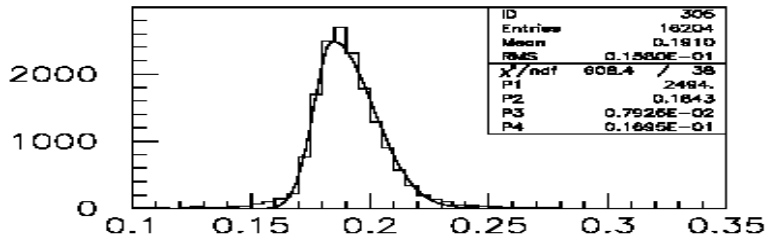
muon energy – forward barrel 1



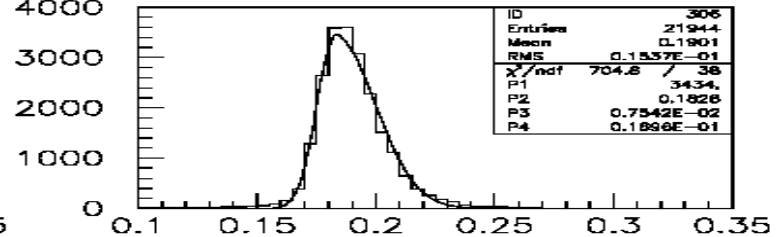
muon energy – forward barrel 2



muon energy – central barrel 1



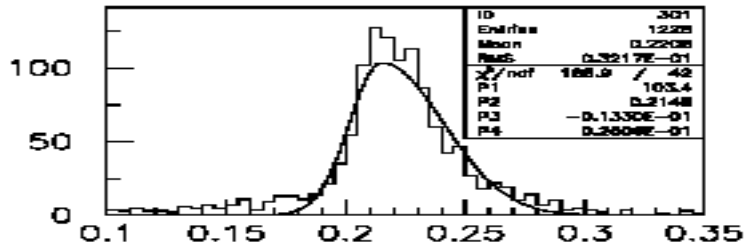
muon energy – central barrel 2



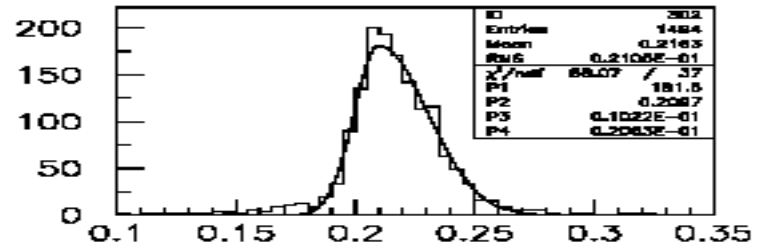
muon energy – central barrel 3

Muon peaks for Monte Carlo with fits.
Fit function is two-half gaussians.

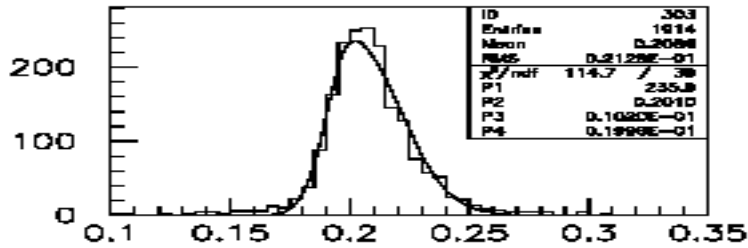
Early June 2002 Data



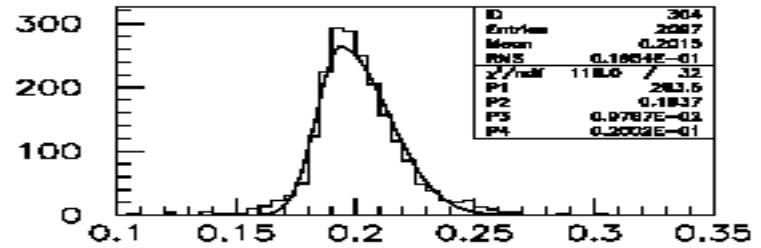
muon energy – endcap



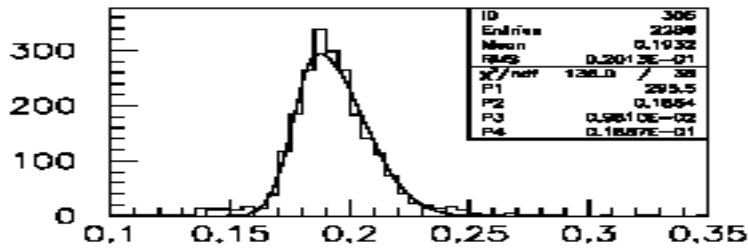
muon energy – forward barrel 1



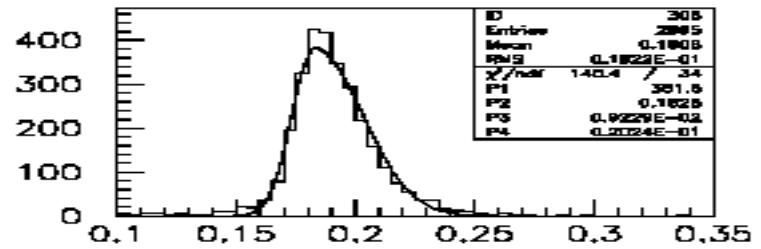
muon energy – forward barrel 2



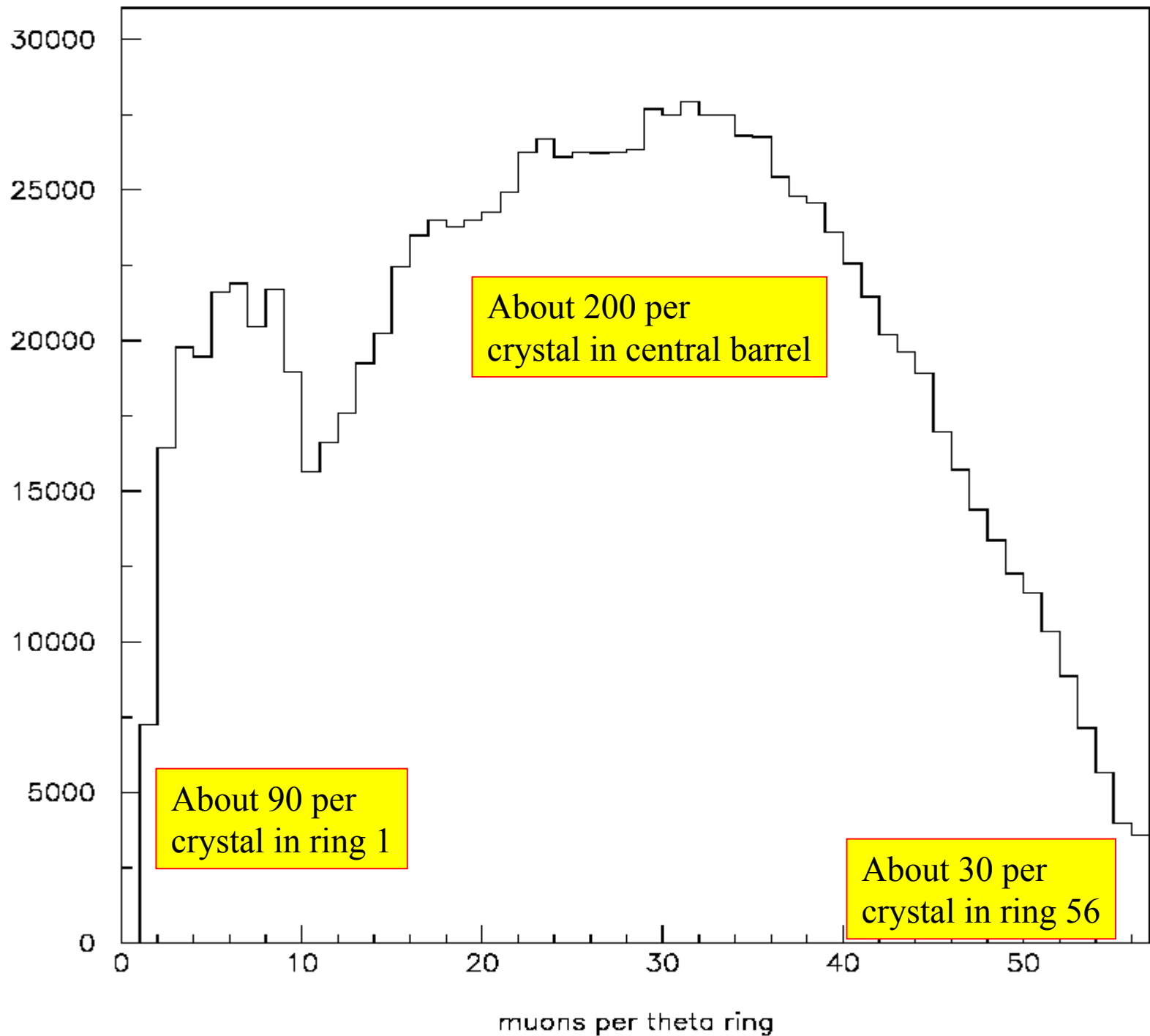
muon energy – central barrel 1



muon energy – central barrel 2

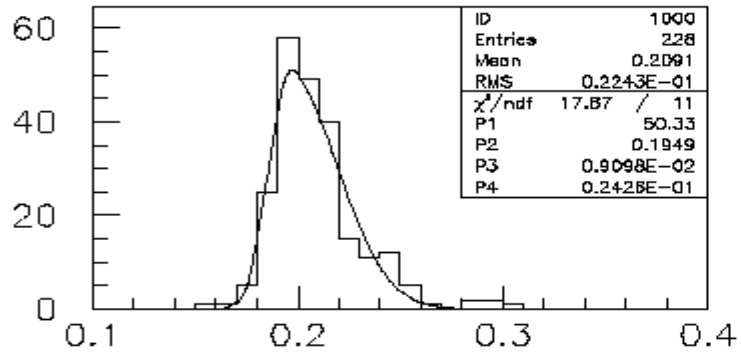


muon energy – central barrel 3

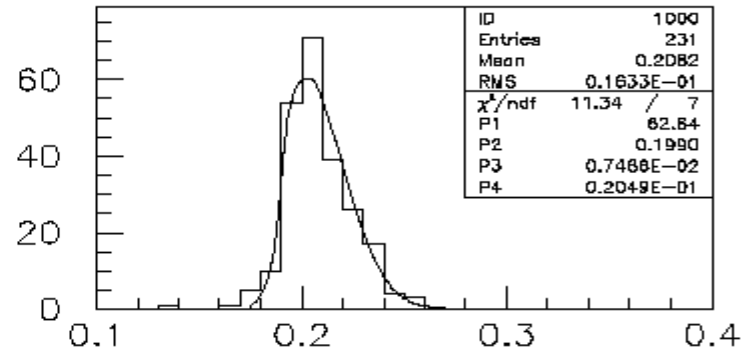


Typical single crystal muon peaks

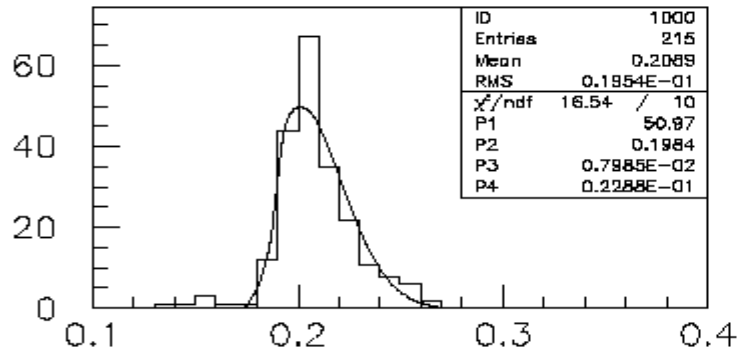
June 2002



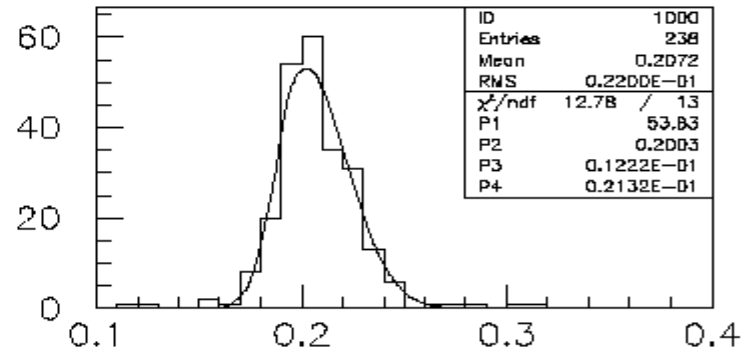
th 19, ph 56



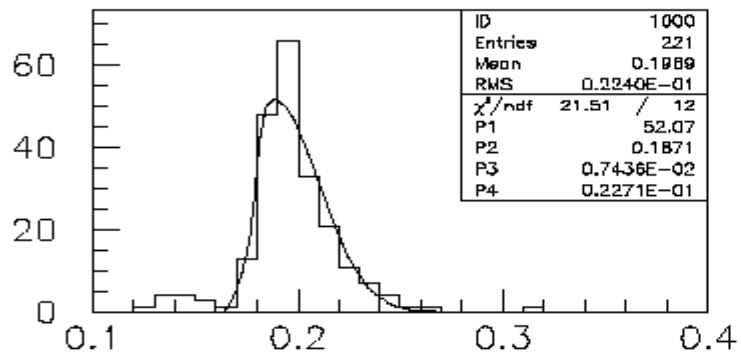
th 20, ph 56



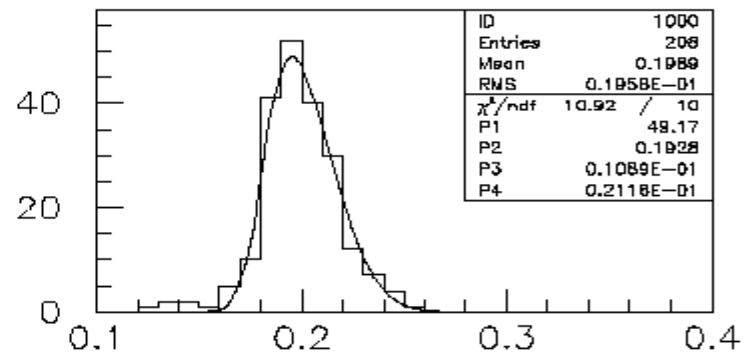
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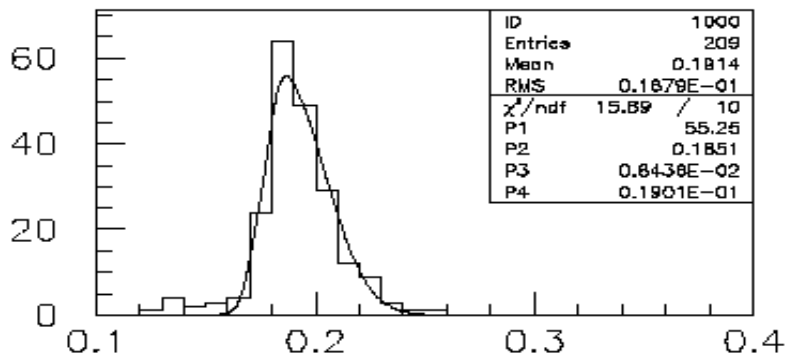
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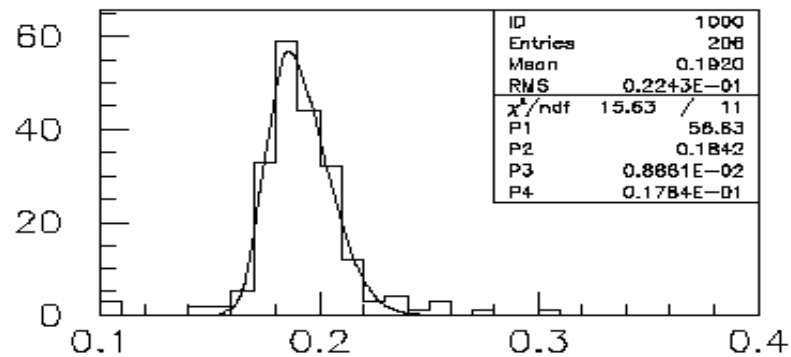
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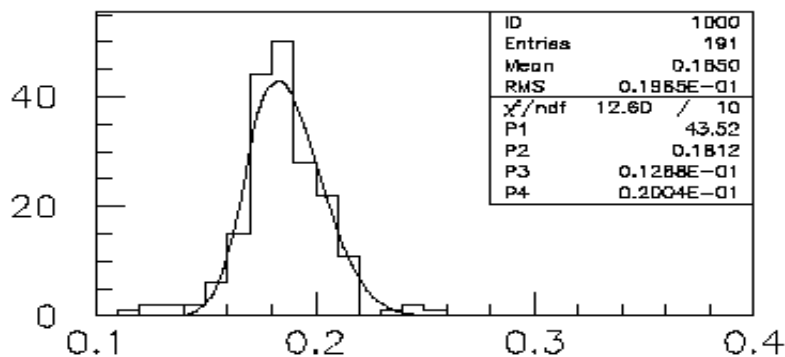
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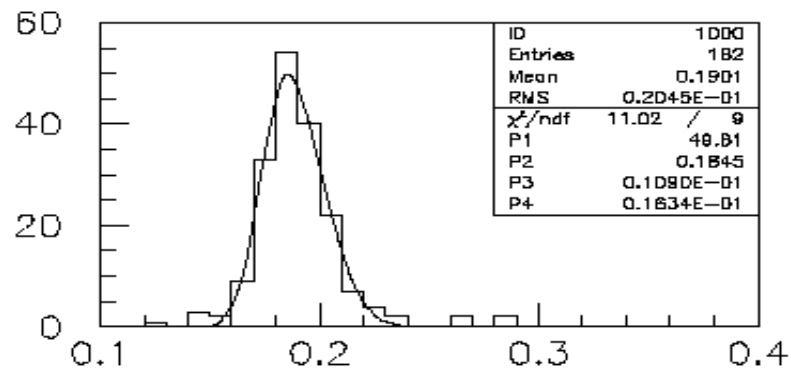
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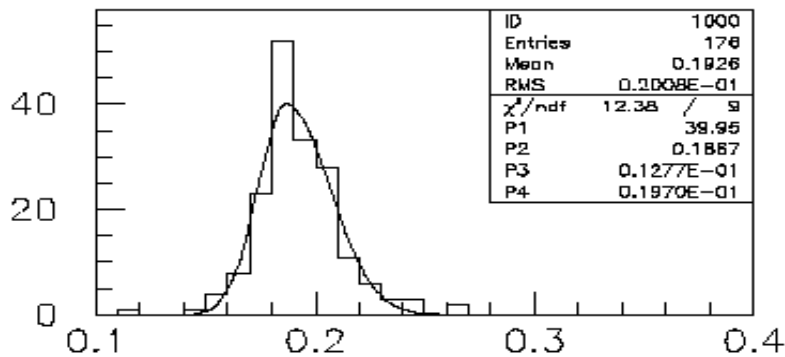
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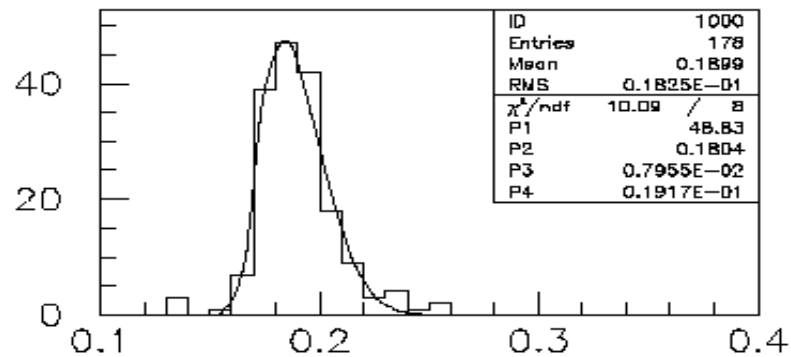
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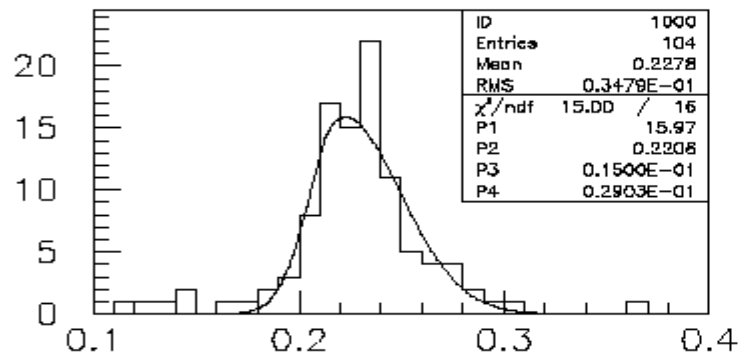
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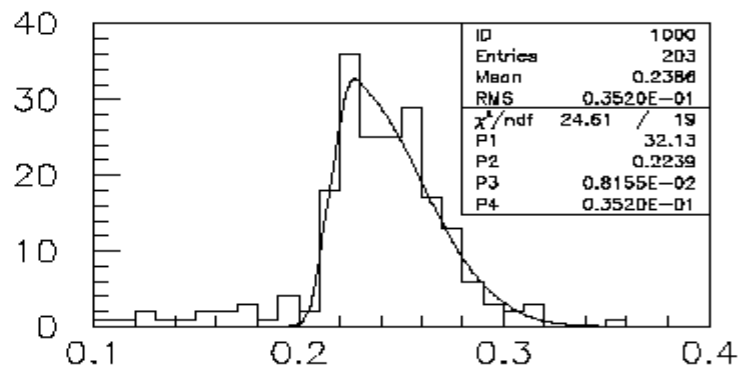
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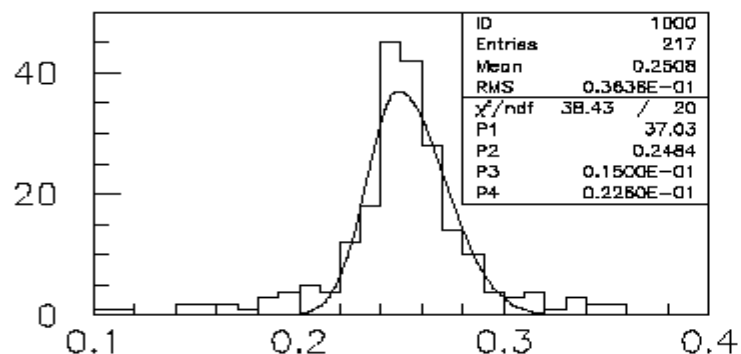
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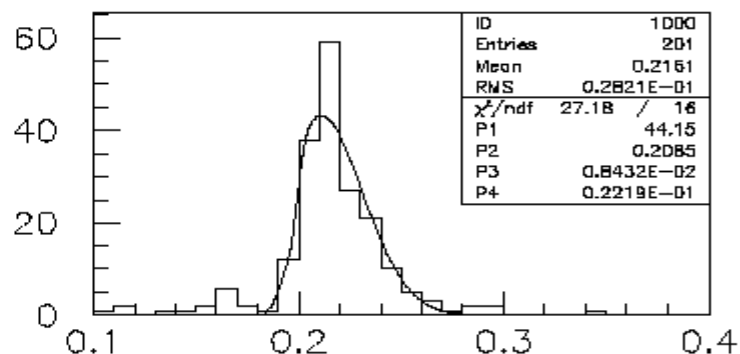
th 1, ph 56



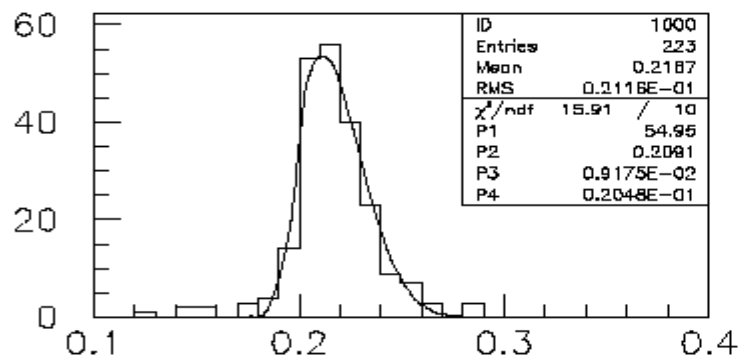
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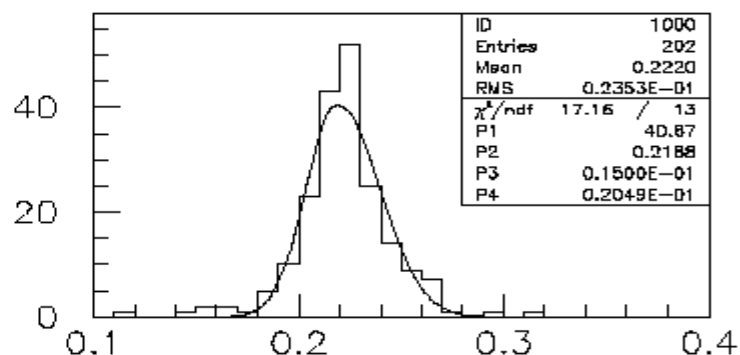
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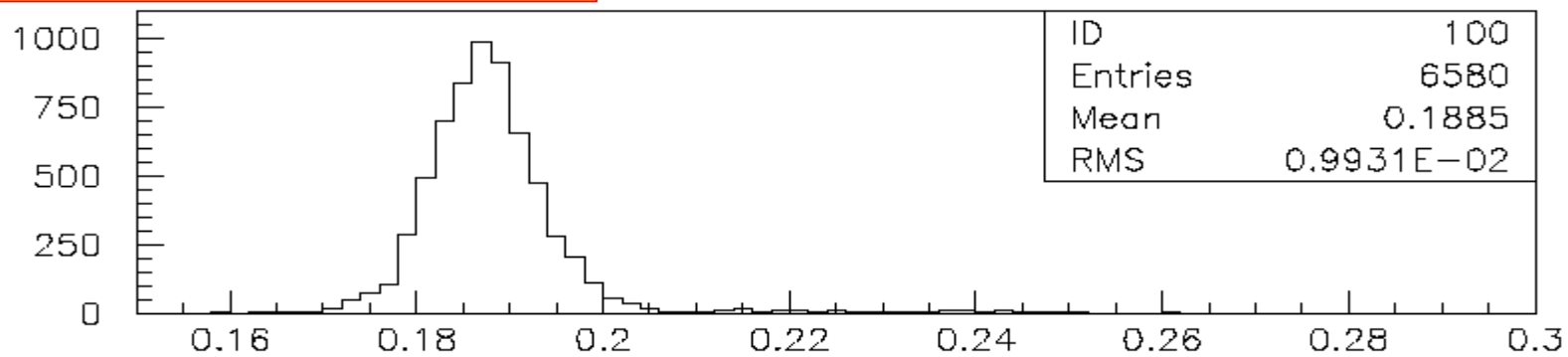
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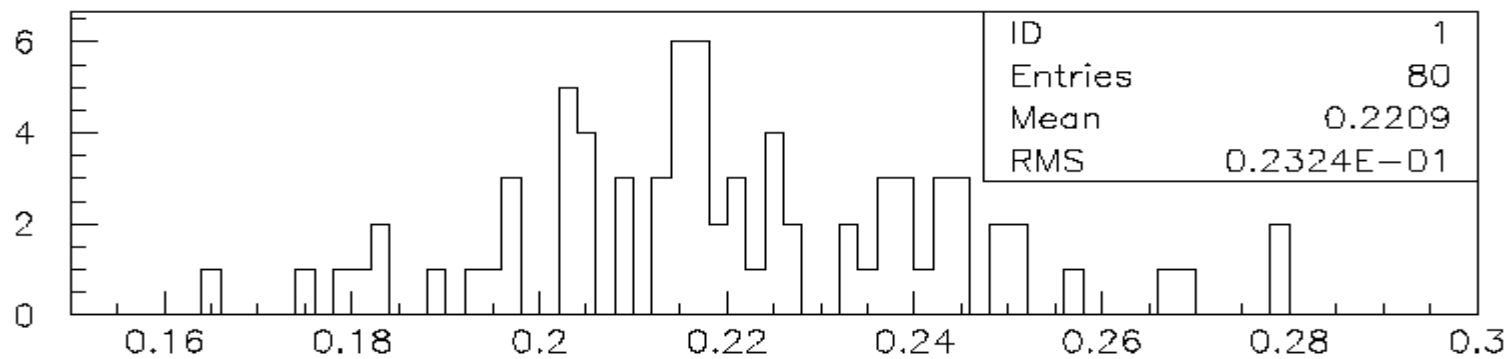
th 5, ph 56



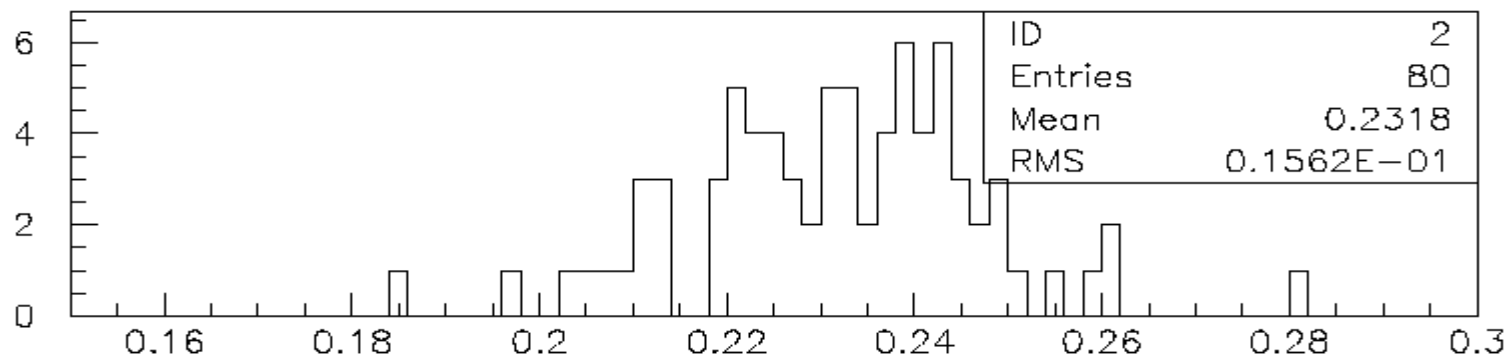
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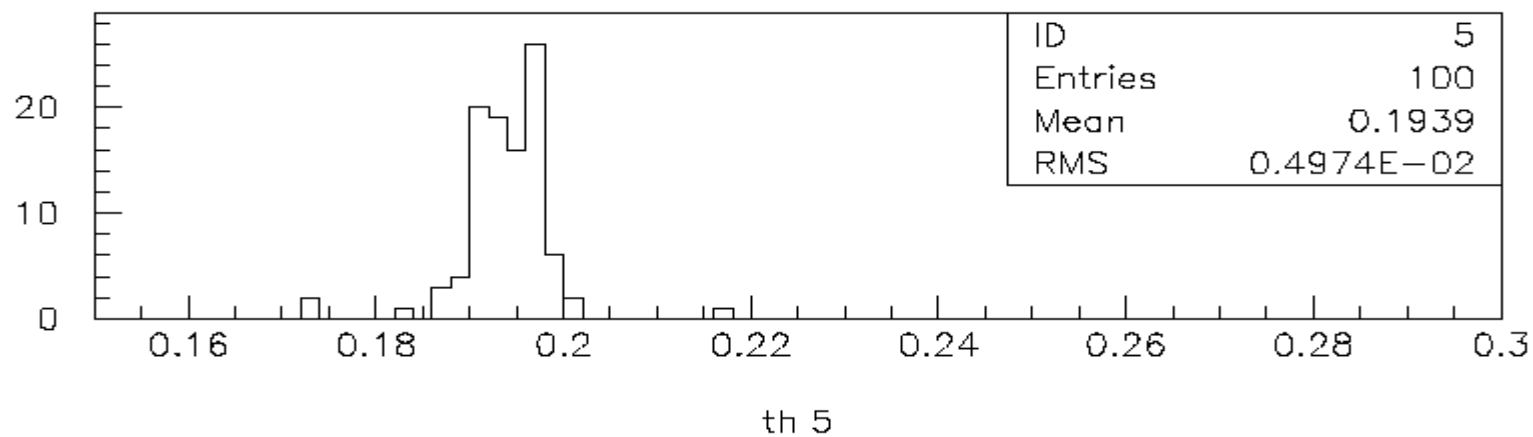
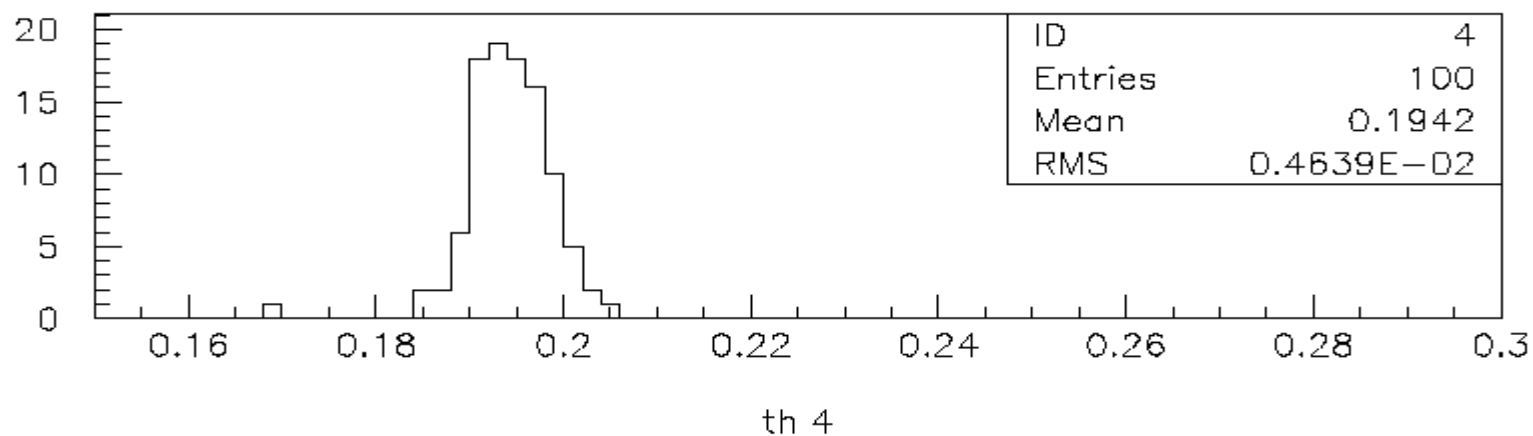
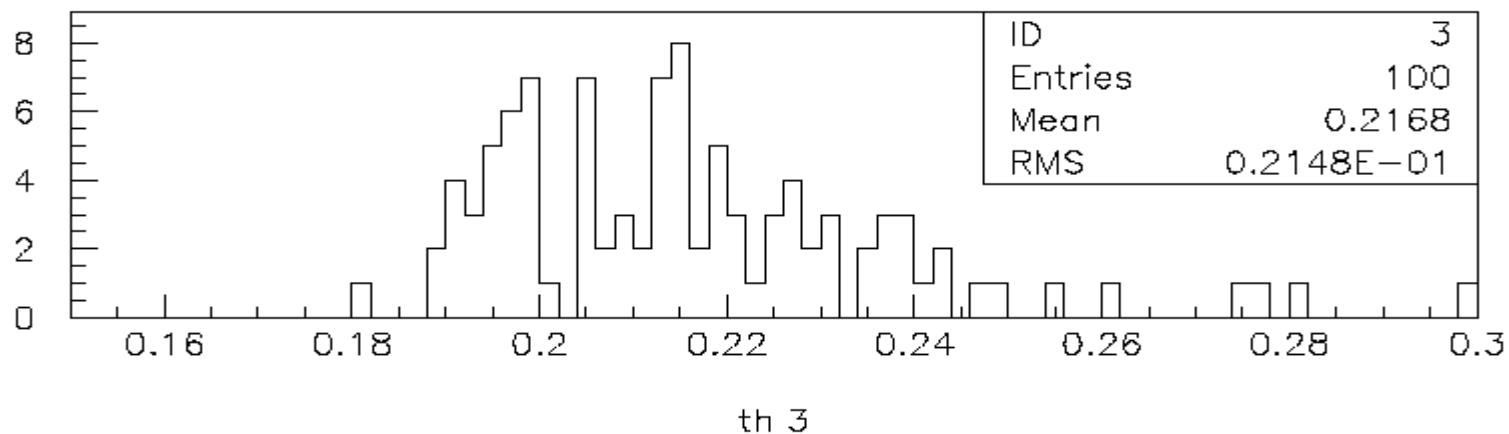
ALL



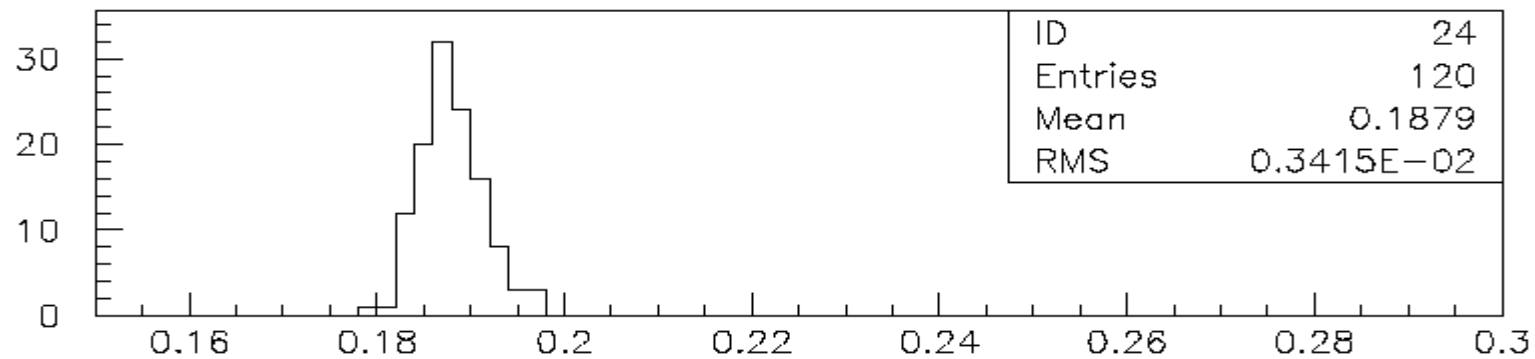
th 1



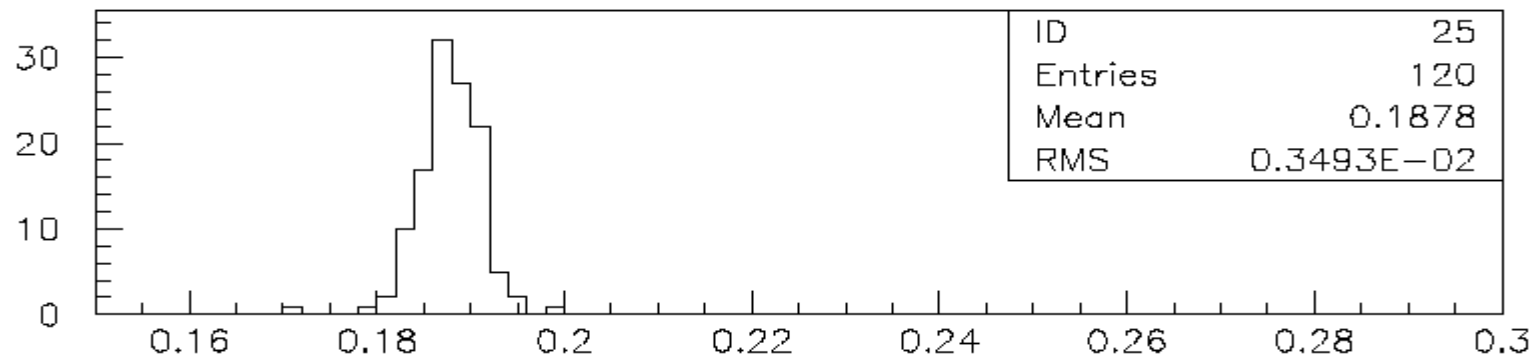
th 2



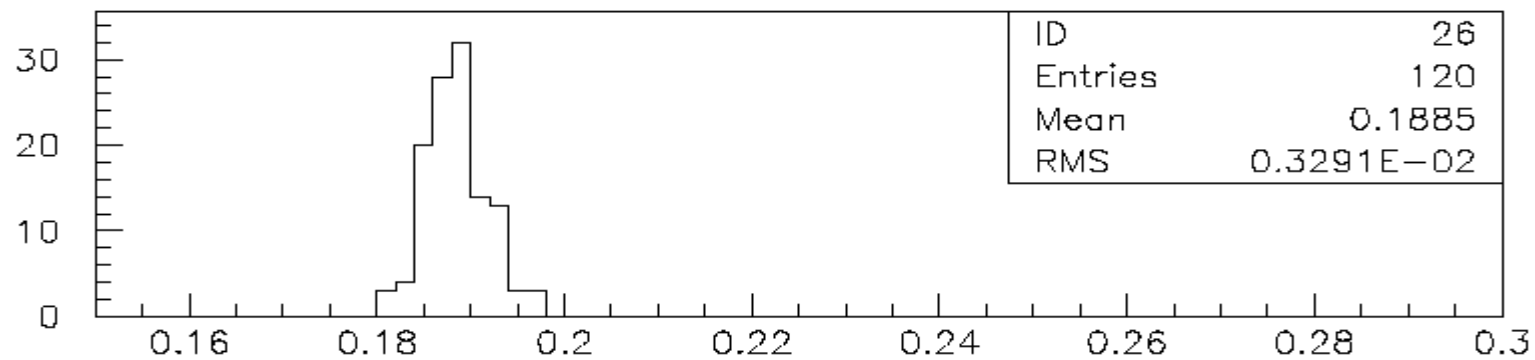
June 2002



th 24



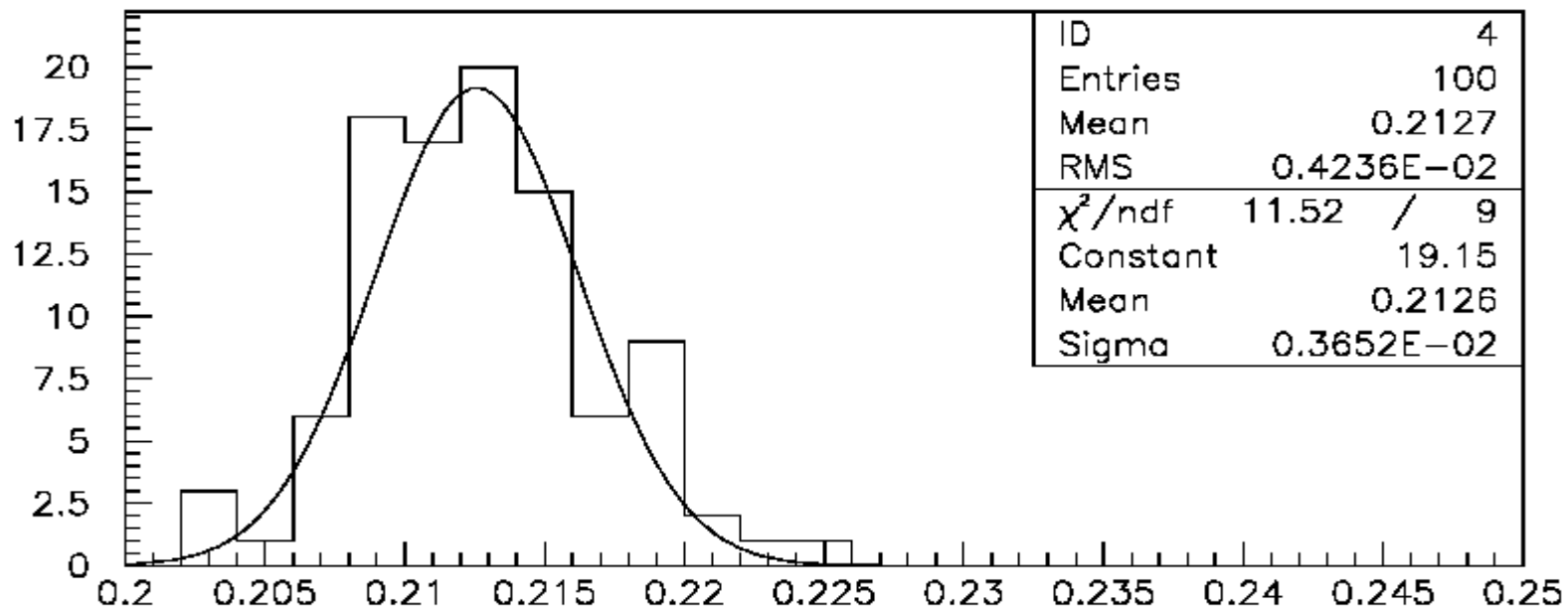
th 25



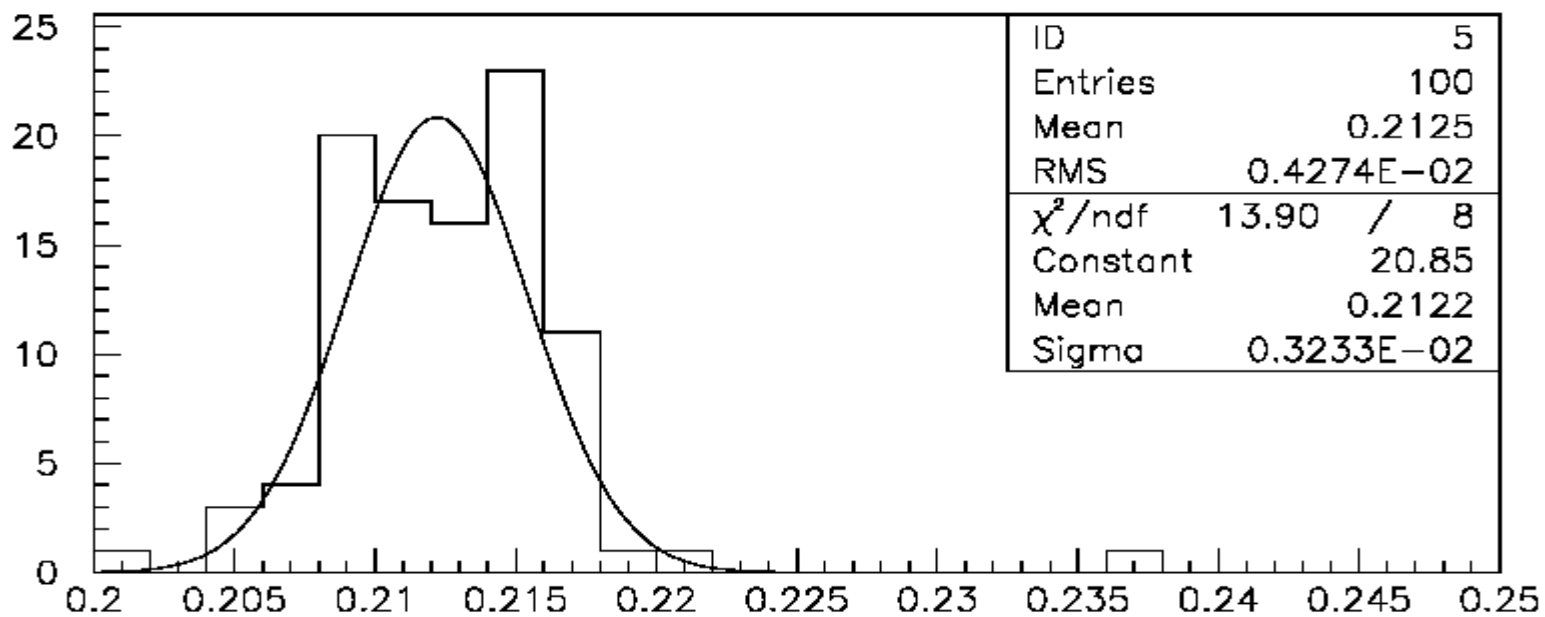
th 26

Can we improve calibration of inner three rings?

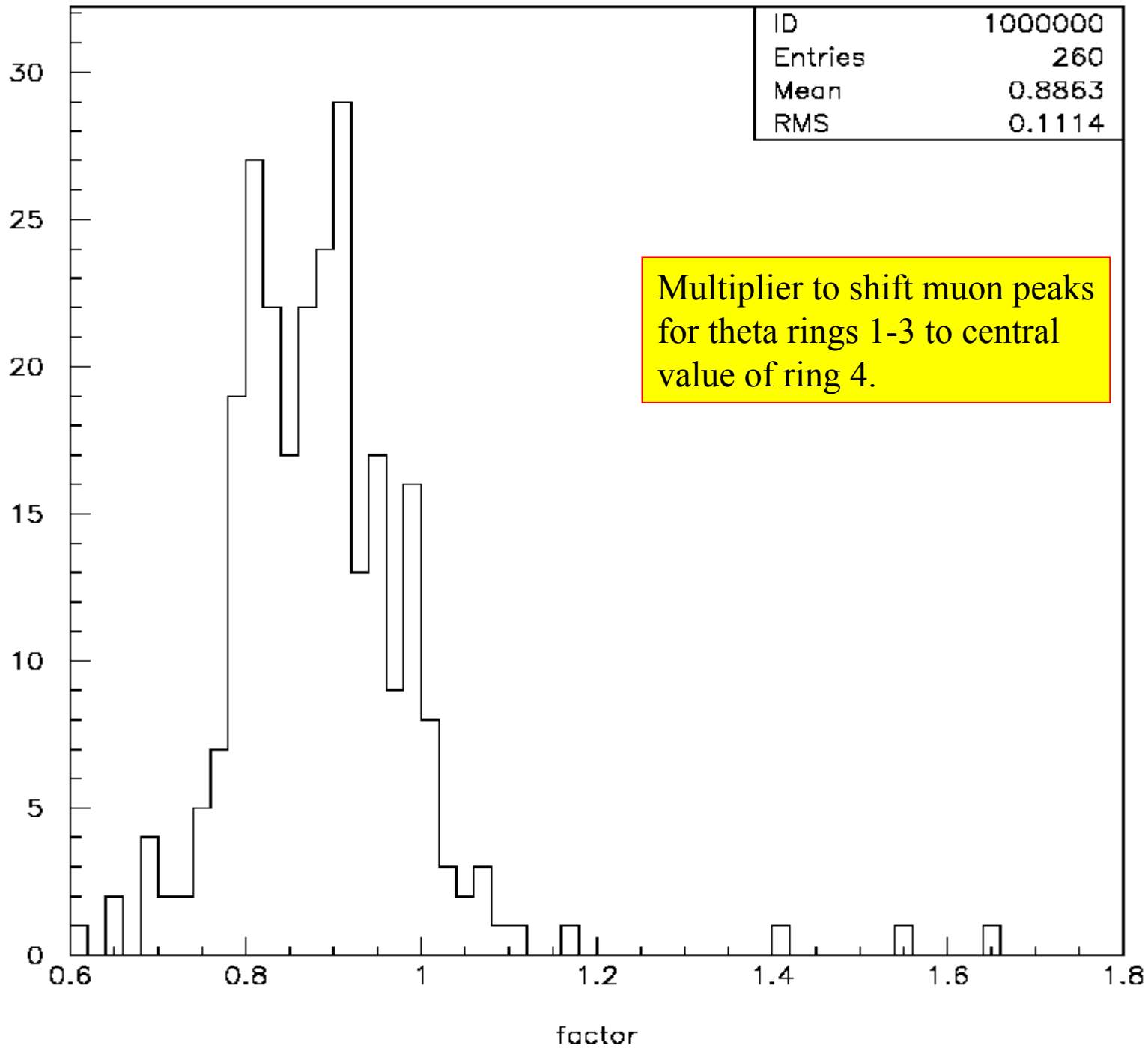
- Since muon energy deposition is a stable reference, it should be possible to use muons to “transfer” the calibration from a good EMC region into the inner three rings.
- To minimize systematics, it is probably best to use ring 4 as the normalization for the calibration (e.g., similar radiation damage and negligible momentum difference for muons).
 - Using muon peaks, determine the central value for ring 4 (simple gaussian fit to the peaks for the 100 crystals).
- Calculate factors for each crystal in rings 1-3 to shift the peak for that crystal to the central value for ring 4.
 - Since ring 1 has shorter crystals, ring 1 is shifted to $(\text{ring 4}) \cdot (16.5/17.5)$
- The precision of this method is limited to the few percent level by the uncertainty in muon peaks for individual crystals, but for rings 1-3, this is a substantial improvement.



th 4 ring



th 5 ring



Summary/Conclusion

- Single crystal muon peaks can be measured to a few percent.
- The first three theta rings have a significant variation in calibration. This can be improved to the few percent level using muon peaks.
 - Correction factors have been generated from June 2002 data. This can be done for other time periods also.
- It should also be possible to compare June 2002 data with earlier data (e.g., early 2000) to recheck that muon light yields track the calibrations for rings with $\theta > 3$. This addresses the question of crystal uniformity due to radiation damage.
- Widths of muon peaks may also provide information on EMC performance.