Muon Peaks in the EMC

Jack Ritchie
University of Texas at Austin
August 28, 2002

• 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:

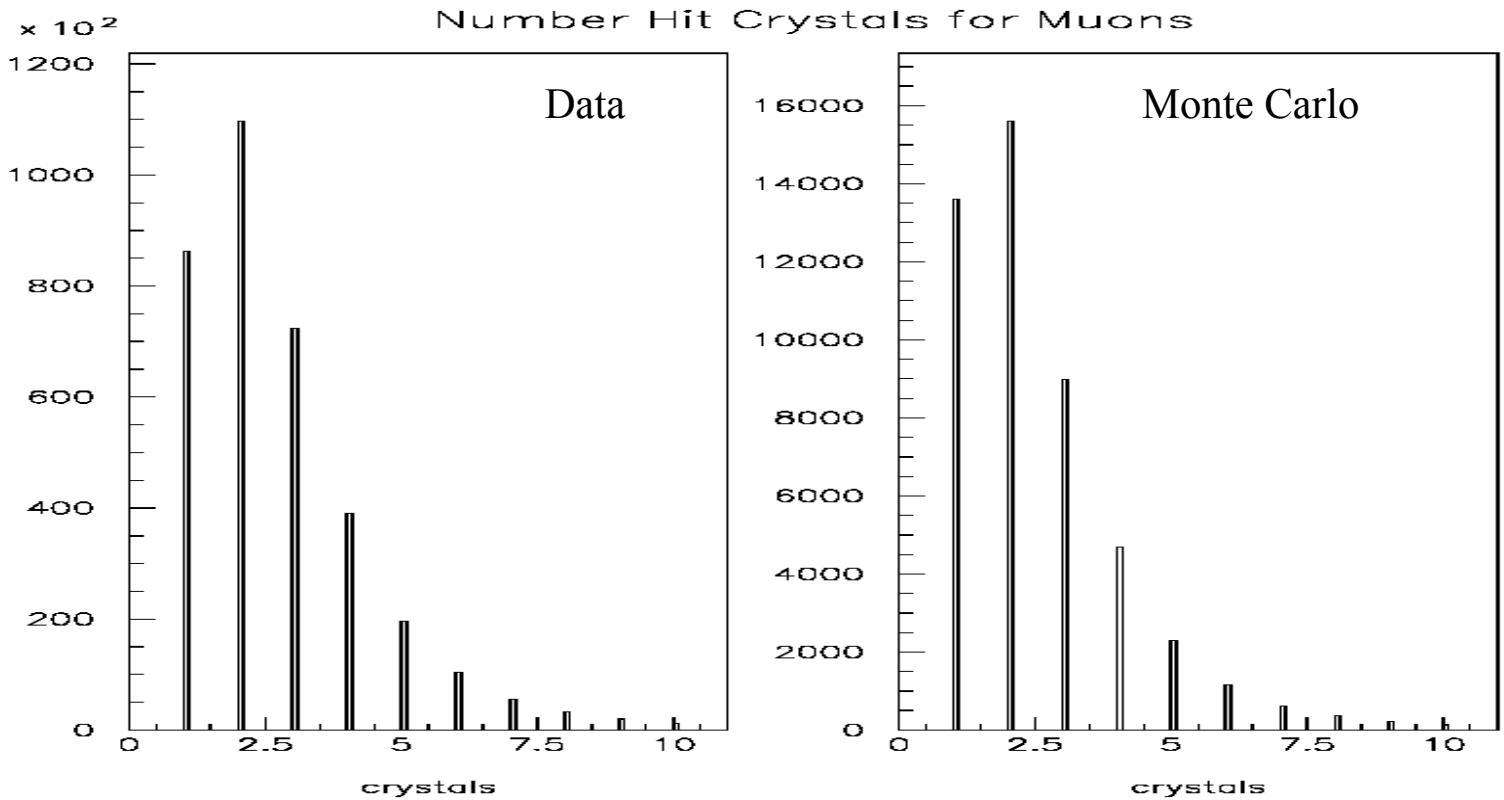
  • Muon peaks for different theta regions vs time.

  • Comparison of data and MC for muons peaks.

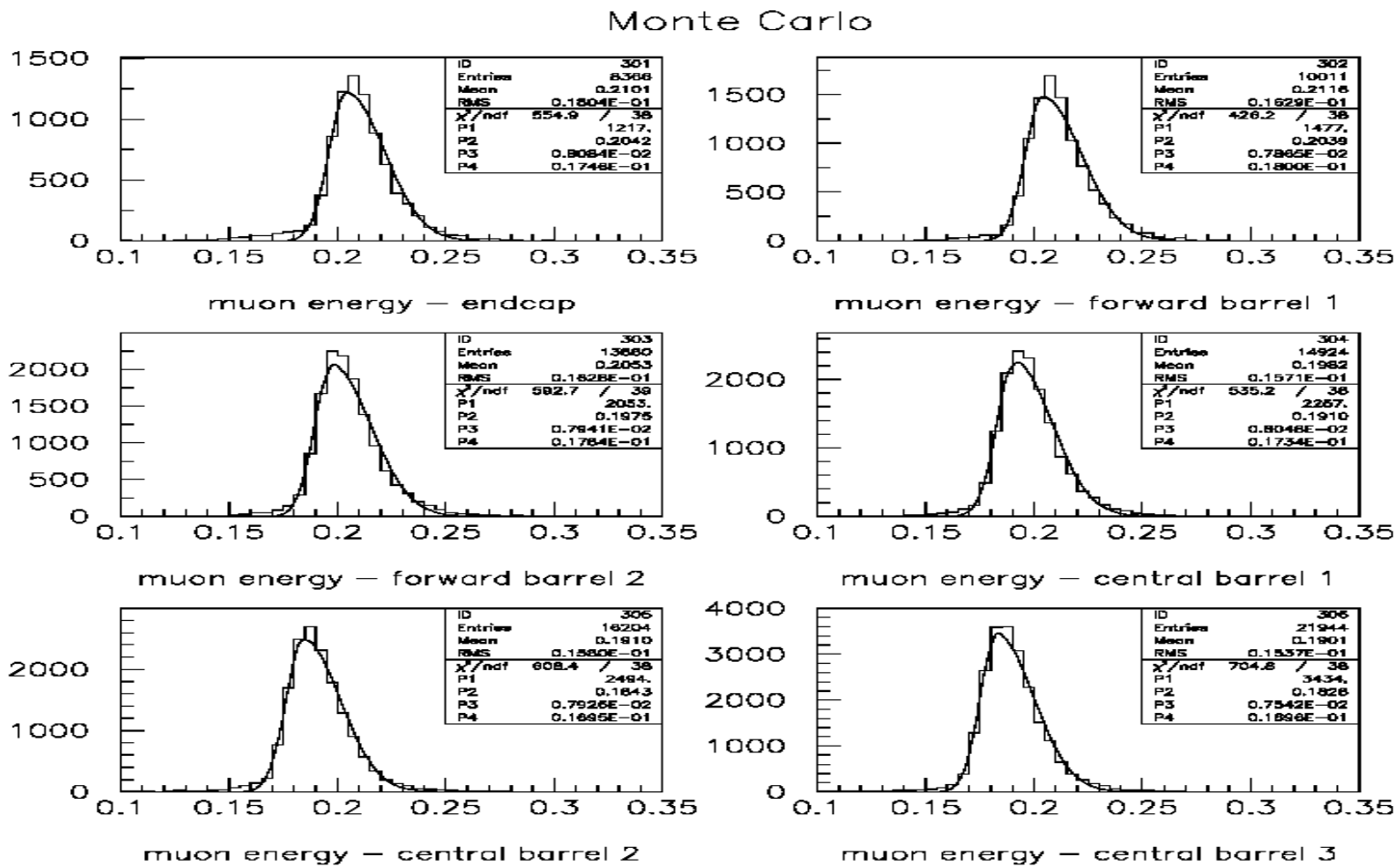
• Now I have a first look at muons peaks for single crystals.

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%)

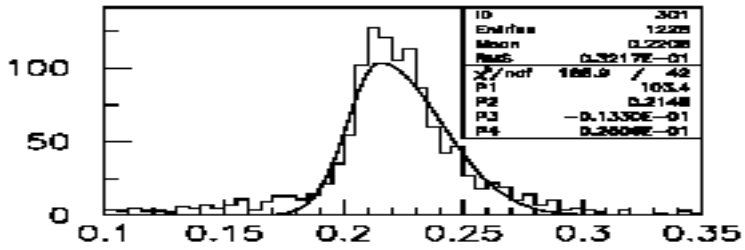


About 20% of muons from $e^+e^- \rightarrow \mu^+\mu^-$ deposit energy in only one crystal.

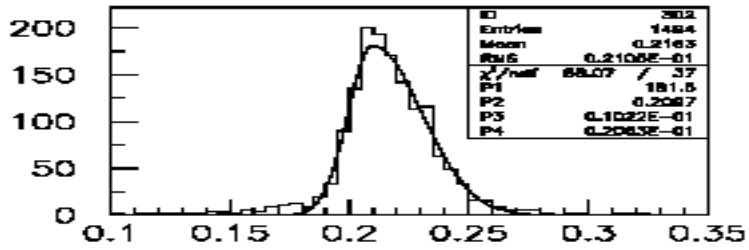


Muon peaks for Monte Carlo with fits.
Fit function is two-half gaussians.

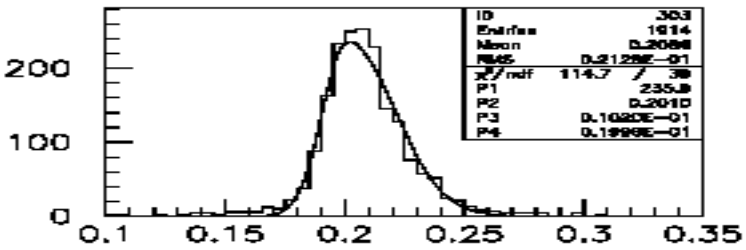
Early June 2002 Data



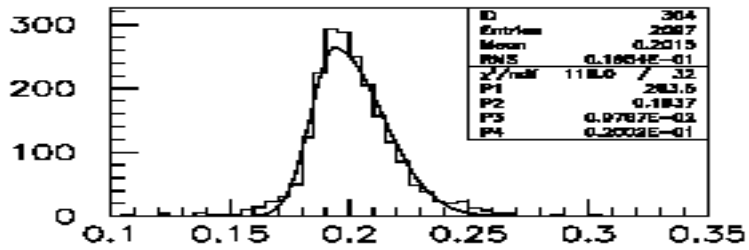
muon energy — endcap



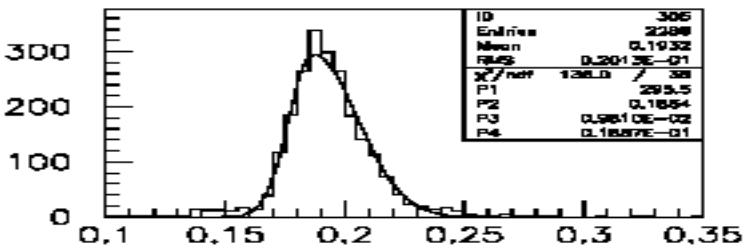
muon energy — forward barrel 1



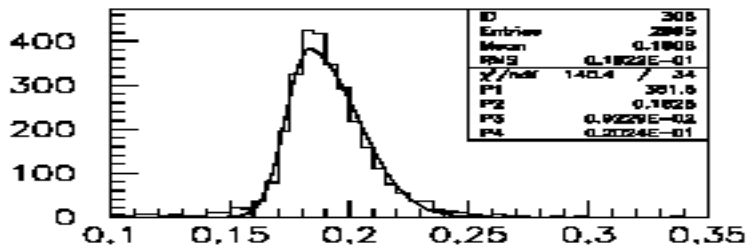
muon energy — forward barrel 2



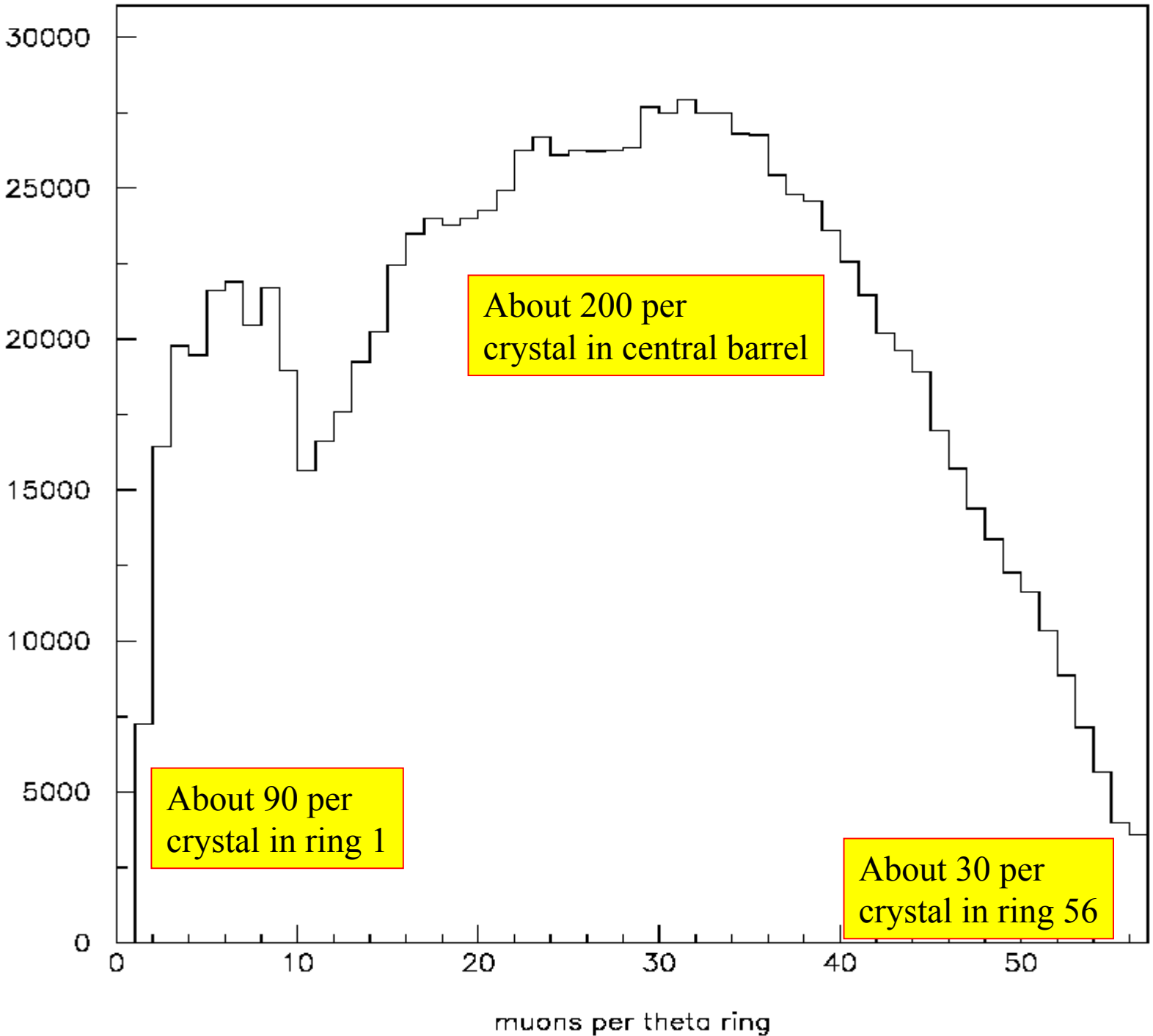
muon energy — central barrel 1



muon energy — central barrel 2

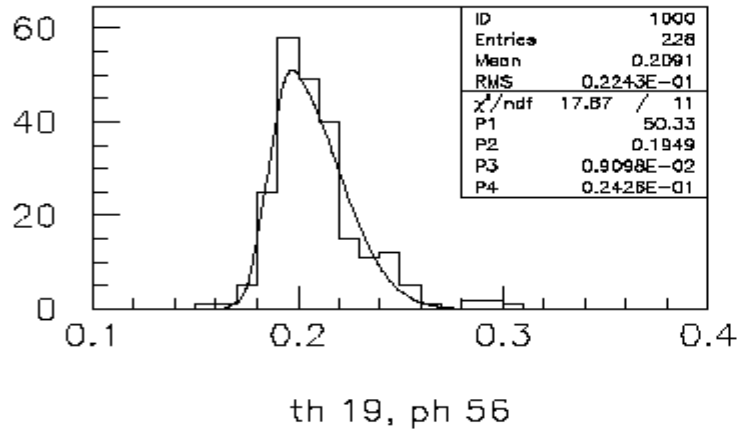


muon energy — central barrel 3

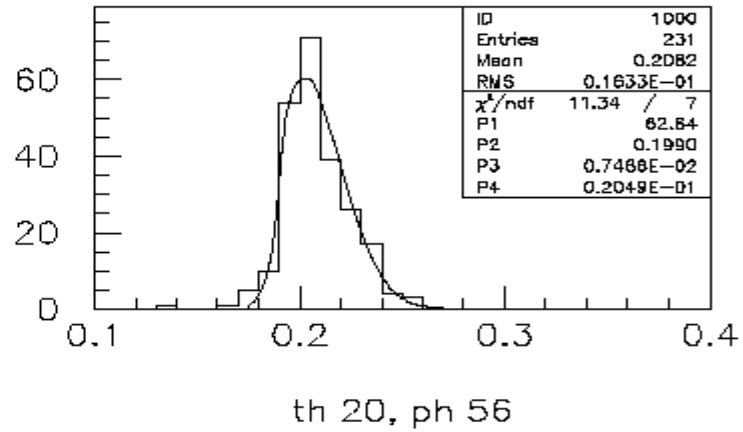

30000
25000
20000
15000
10000
5000
0
0
10
20
30
40
50
About 200 per
crystal in central barrel
About 90 per
crystal in ring 1
About 30 per
crystal in ring 56
muons per theta ring

Typical single crystal muon peaks

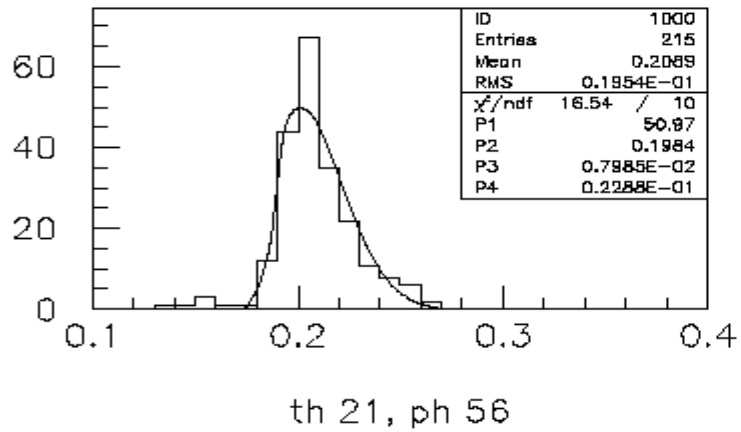
June 2002



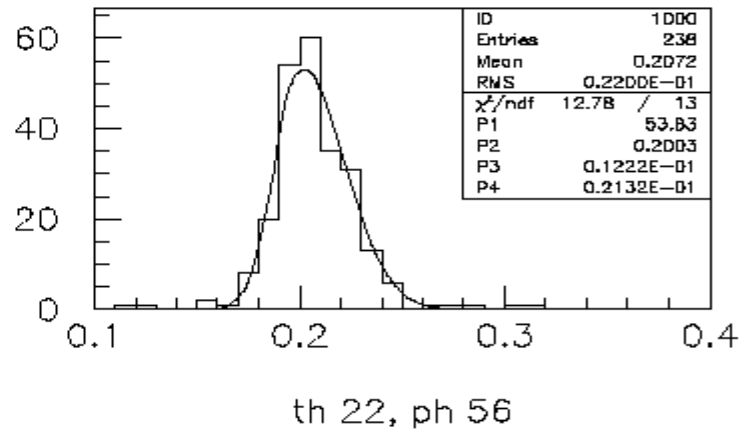
th 19, ph 56



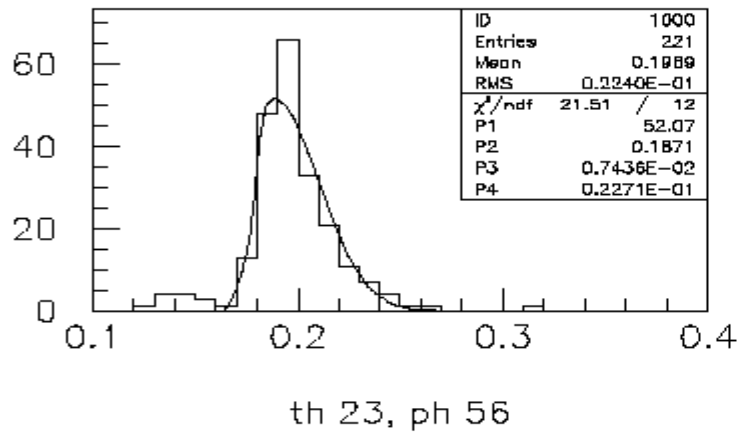
th 20, ph 56



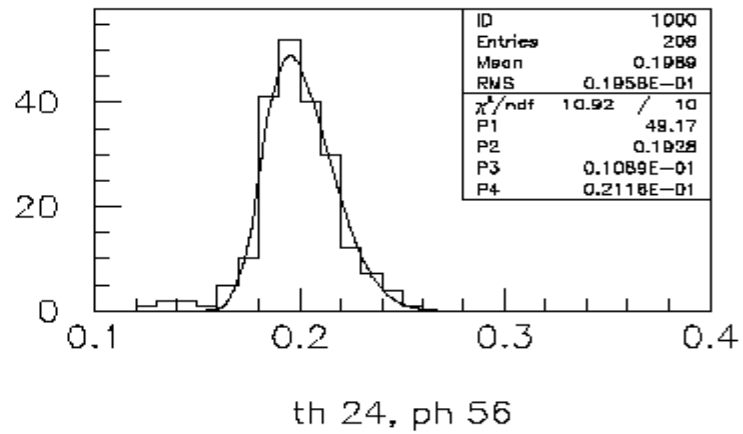
th 21, ph 56



th 22, ph 56

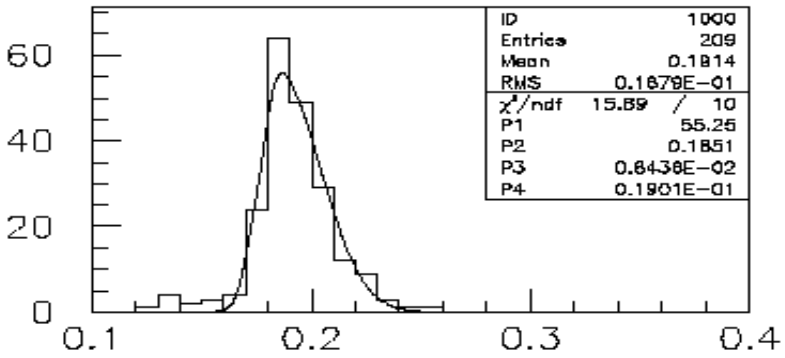


th 23, ph 56

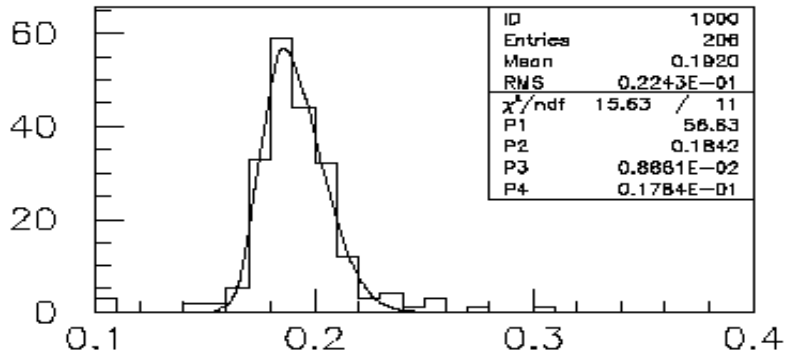


th 24, ph 56

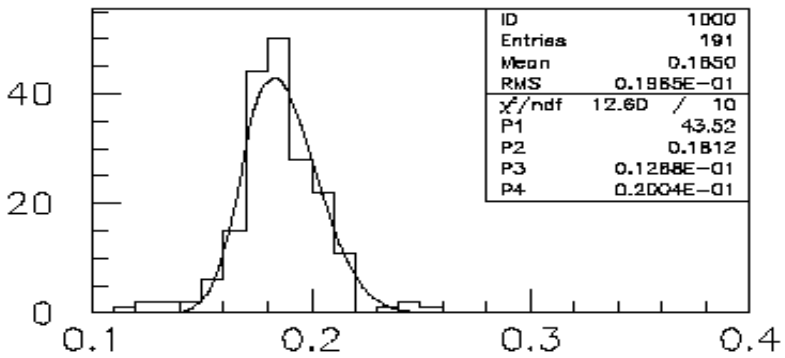
June 2002



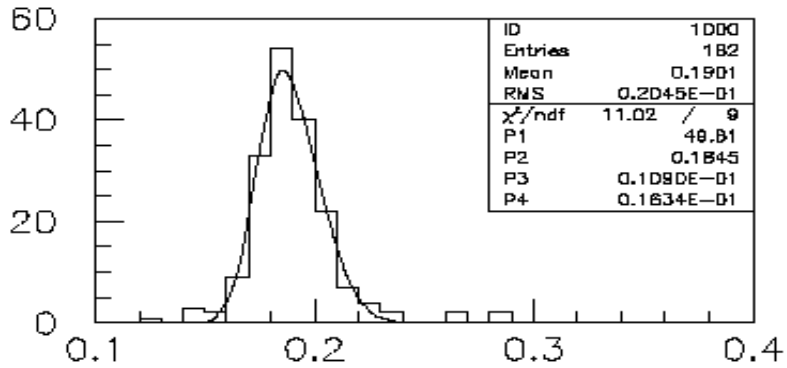
th 37, ph 56



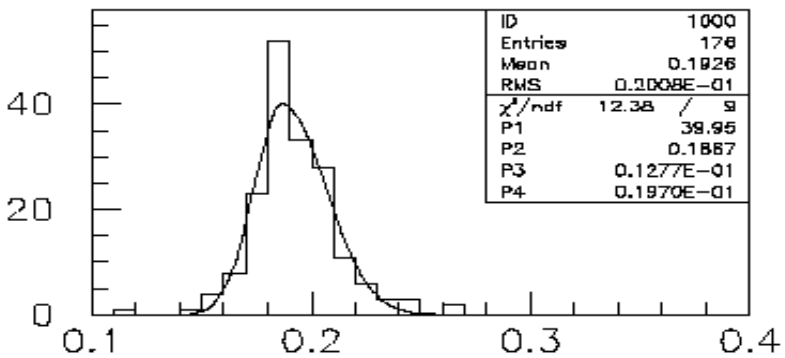
th 38, ph 56



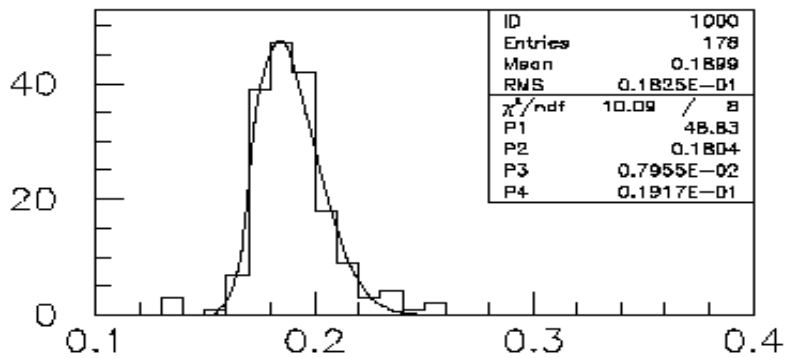
th 39, ph 56



th 40, ph 56

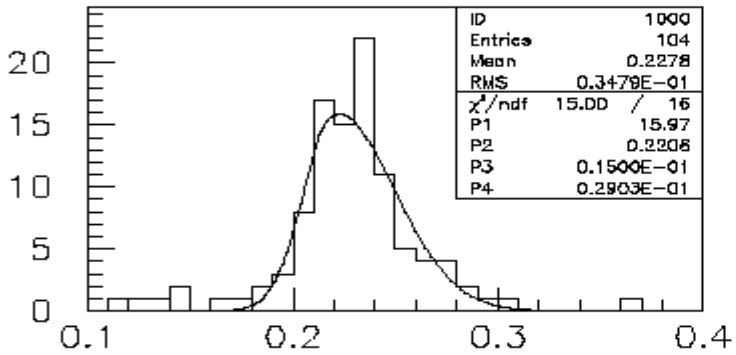


th 41, ph 56

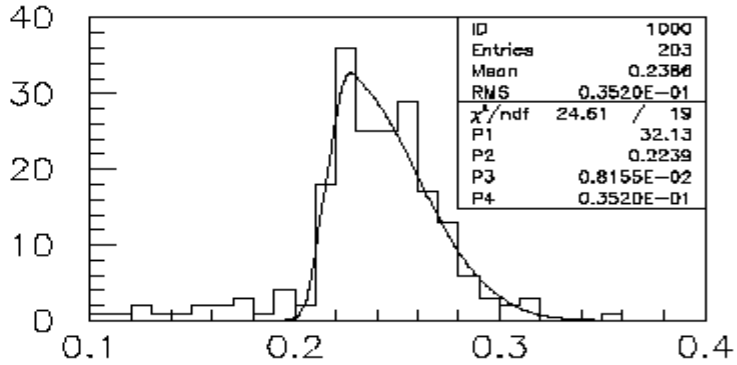


th 42, ph 56

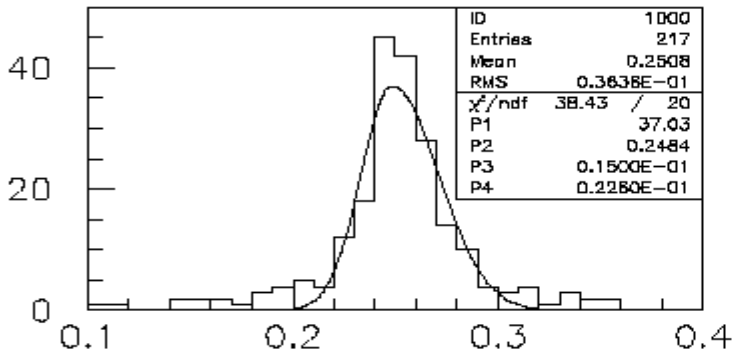
June 2002



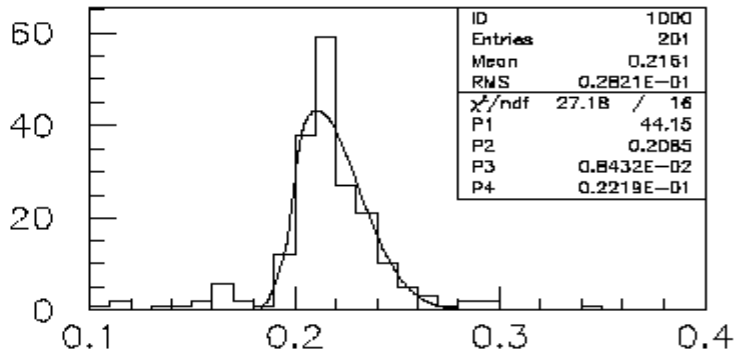
th 1, ph 56



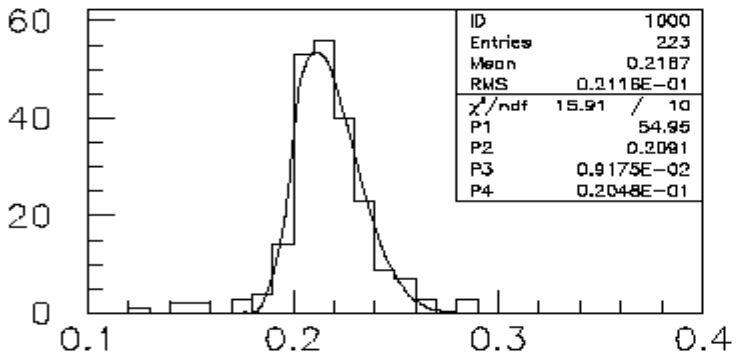
th 2, ph 56



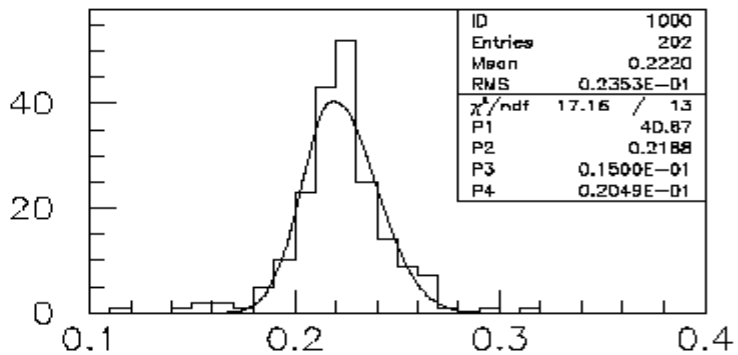
th 3, ph 56



th 4, ph 56

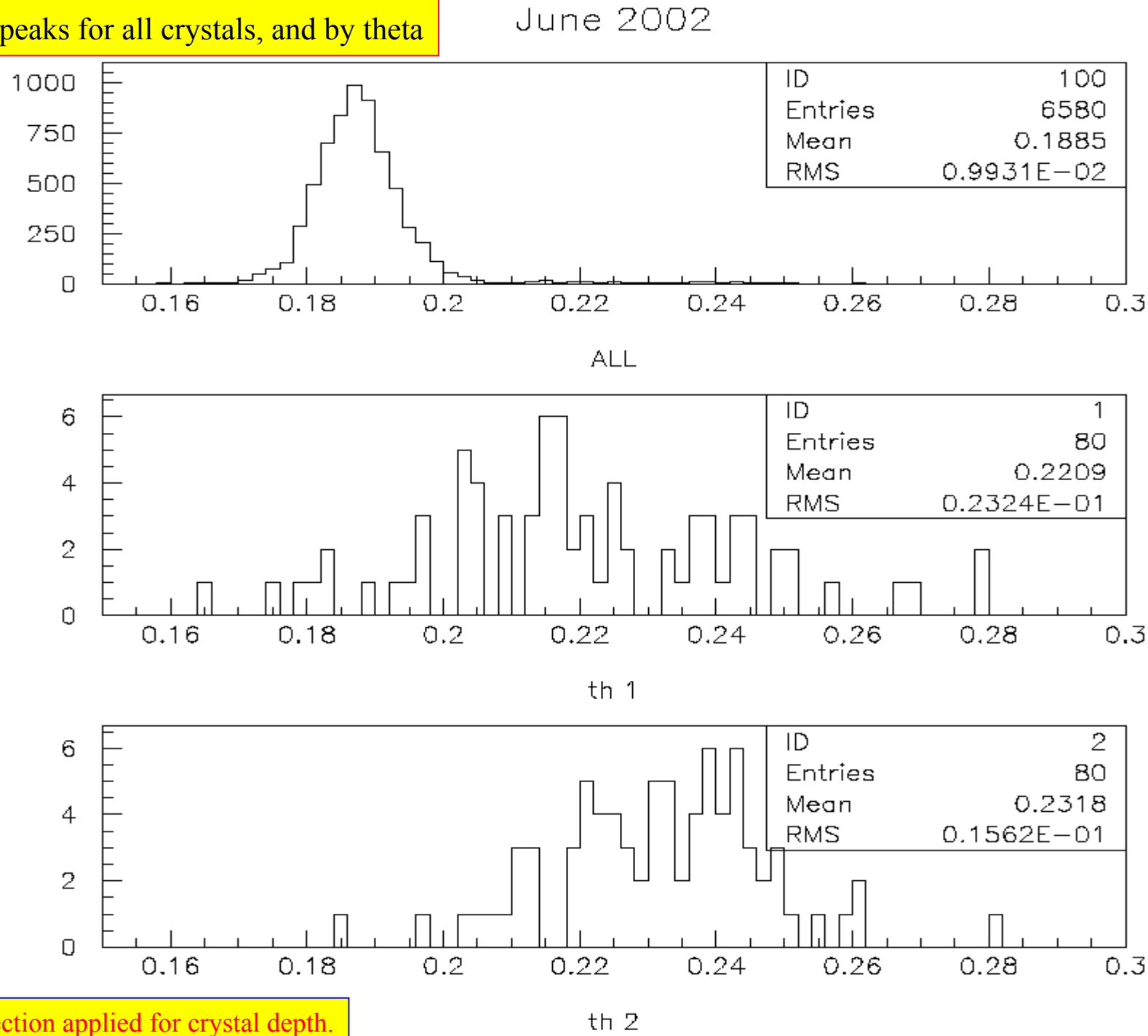


th 5, ph 56



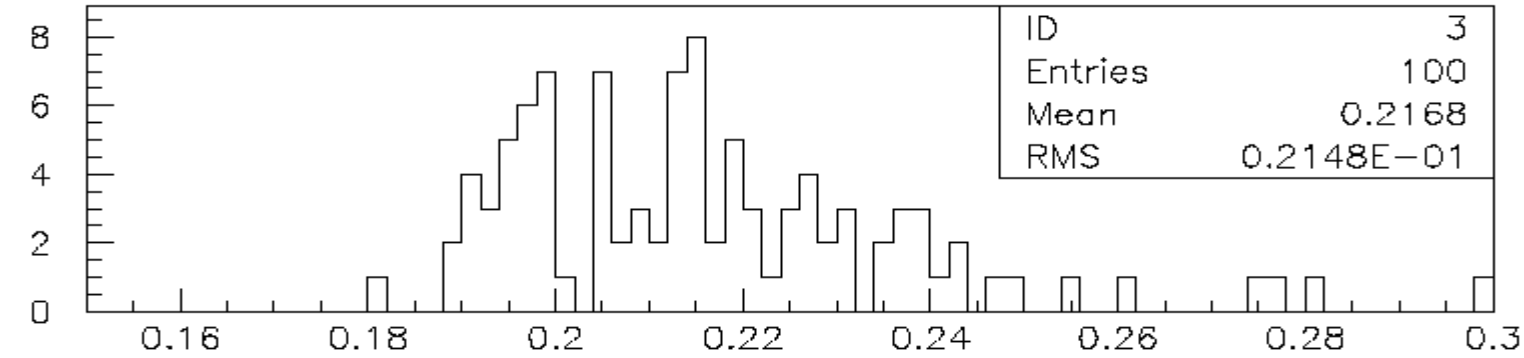
th 6, ph 56

Mu peaks for all crystals, and by theta

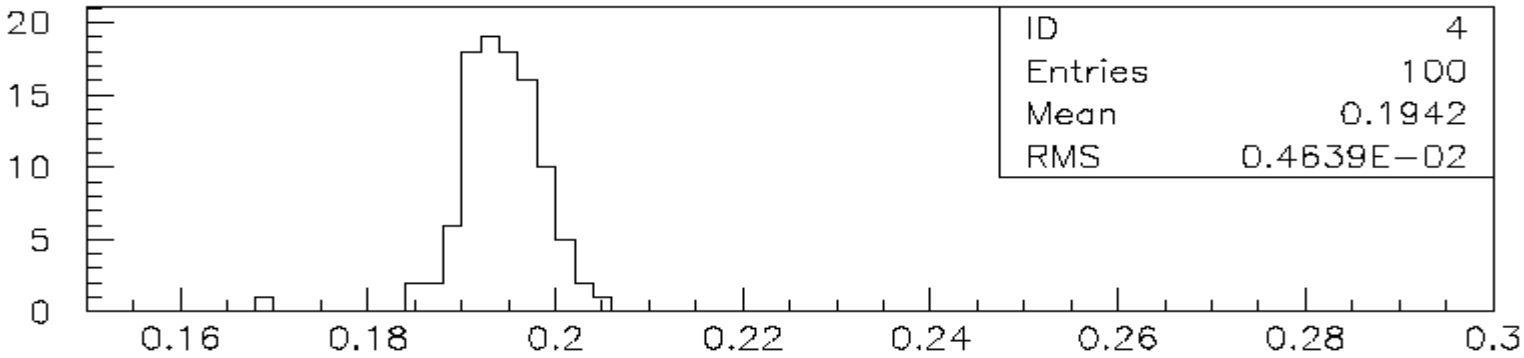


Correction applied for crystal depth.

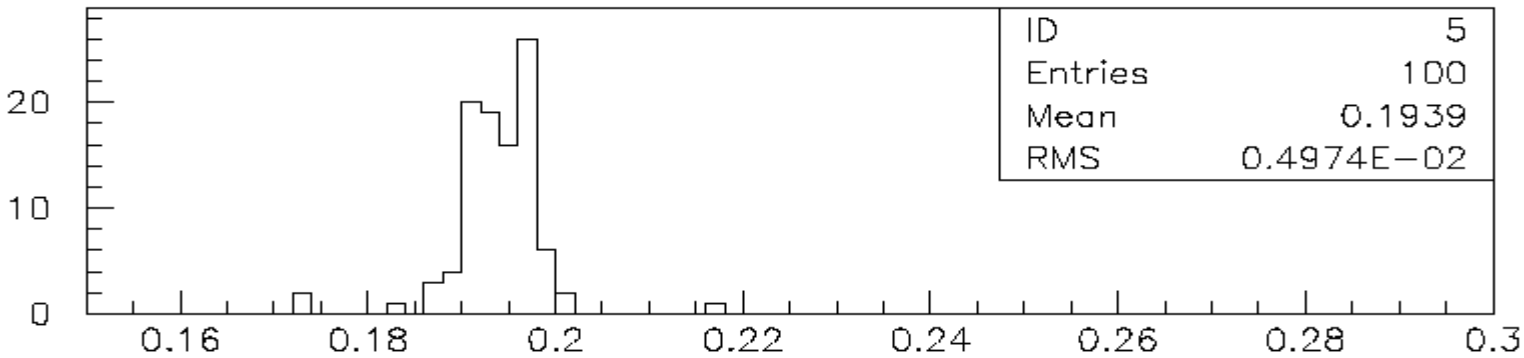
June 2002



th 3

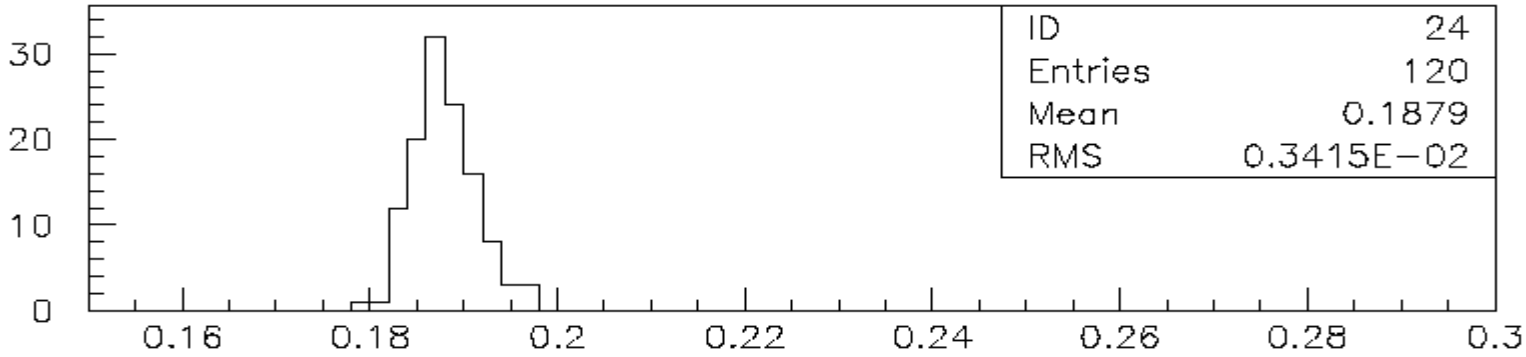


th 4

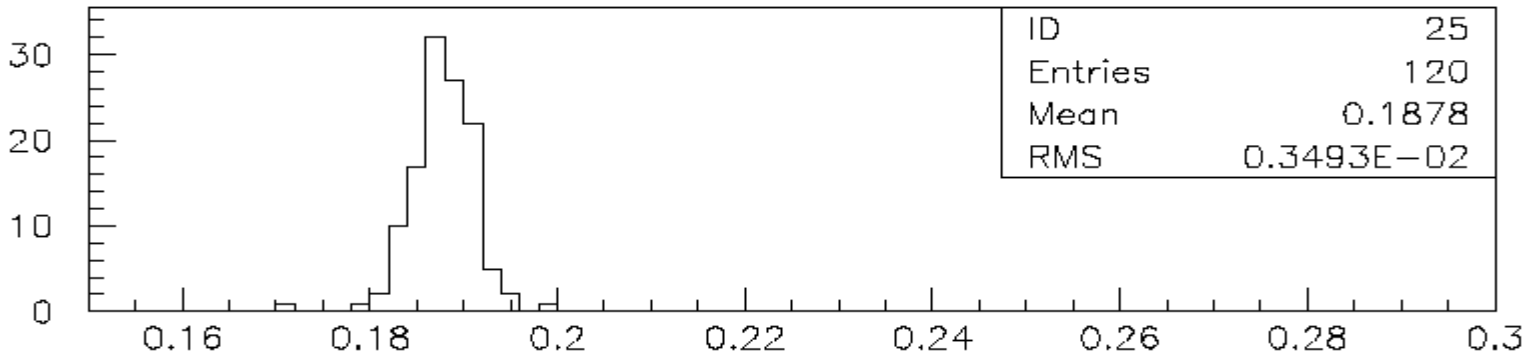


th 5

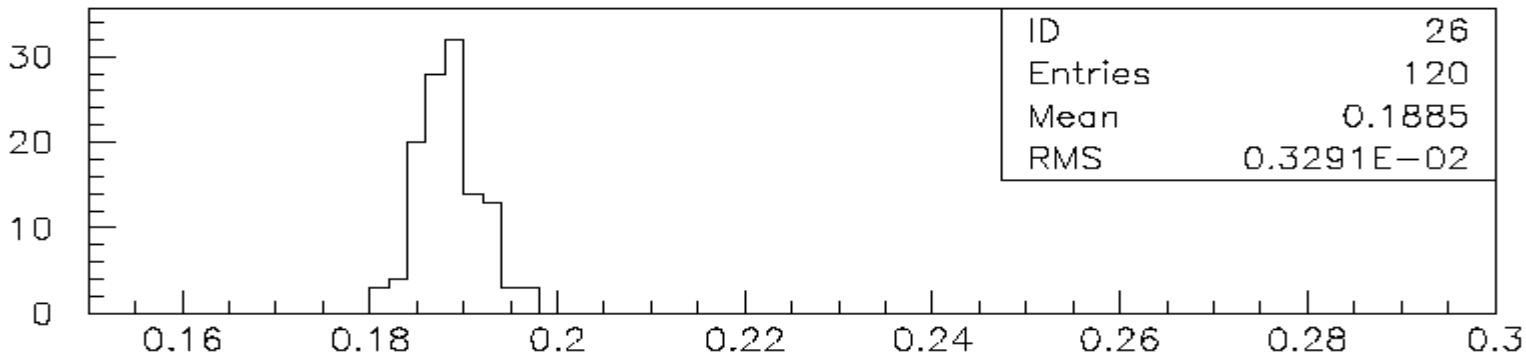
June 2002



th 24



th 25



th 26

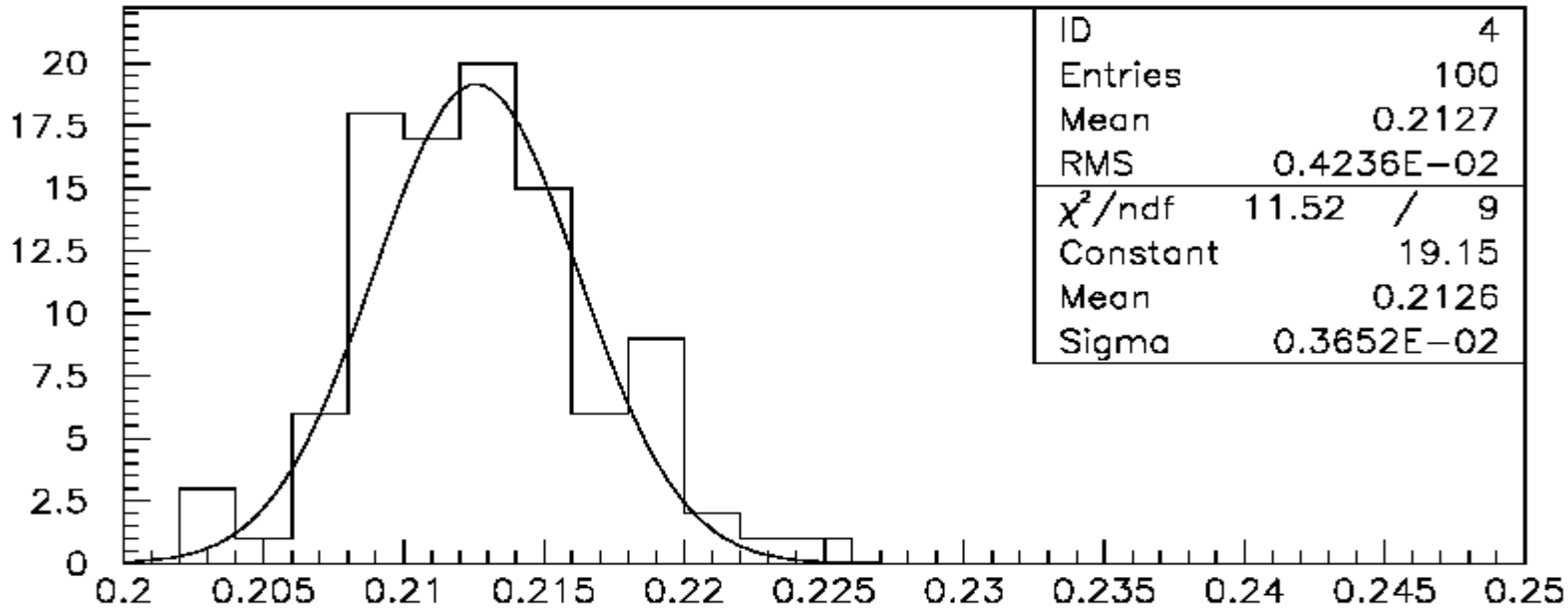
Can we improve calibration of inner three rings?

- 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.

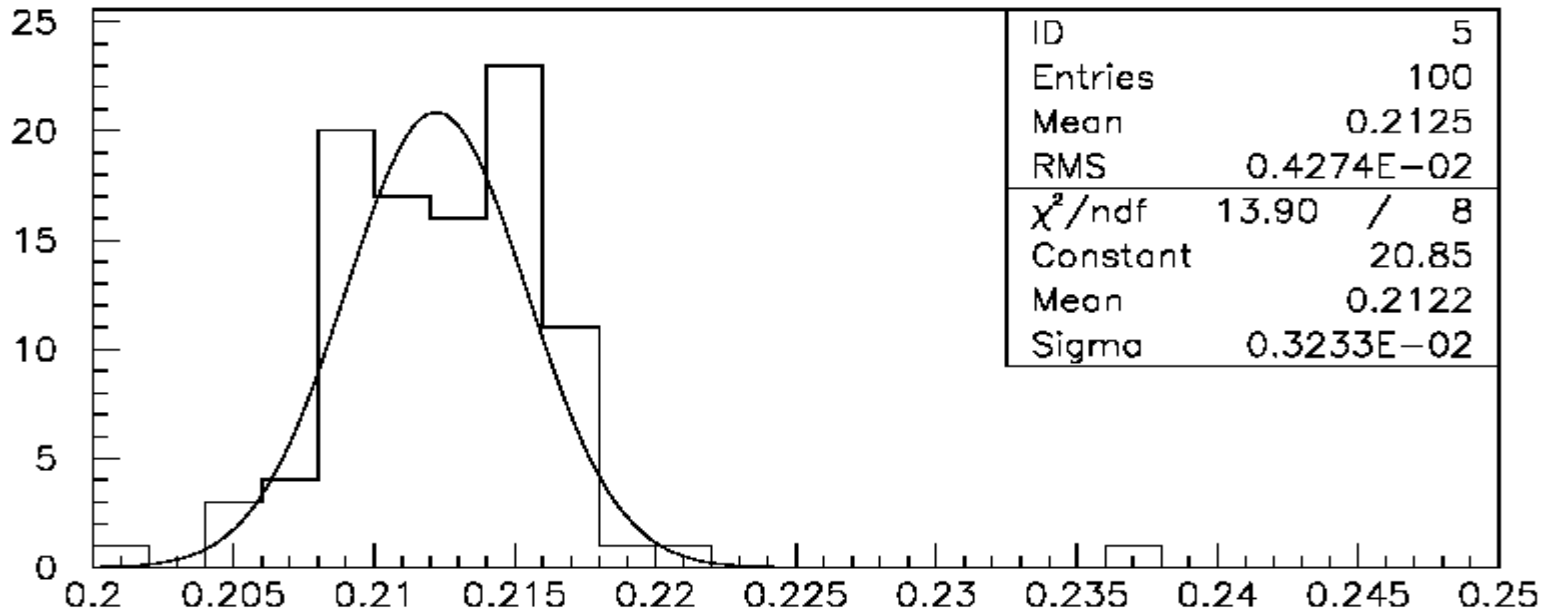
- To minimize systematics, it is probably best to use ring 4 as the normalization for the calibration (e.g., similar radiation damage and negligible momentum difference for muons).
  - Using muon peaks, determine the central value for ring 4 (simple gaussian fit to the peaks for the 100 crystals).

- 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 (ring 4)*(16.5/17.5)

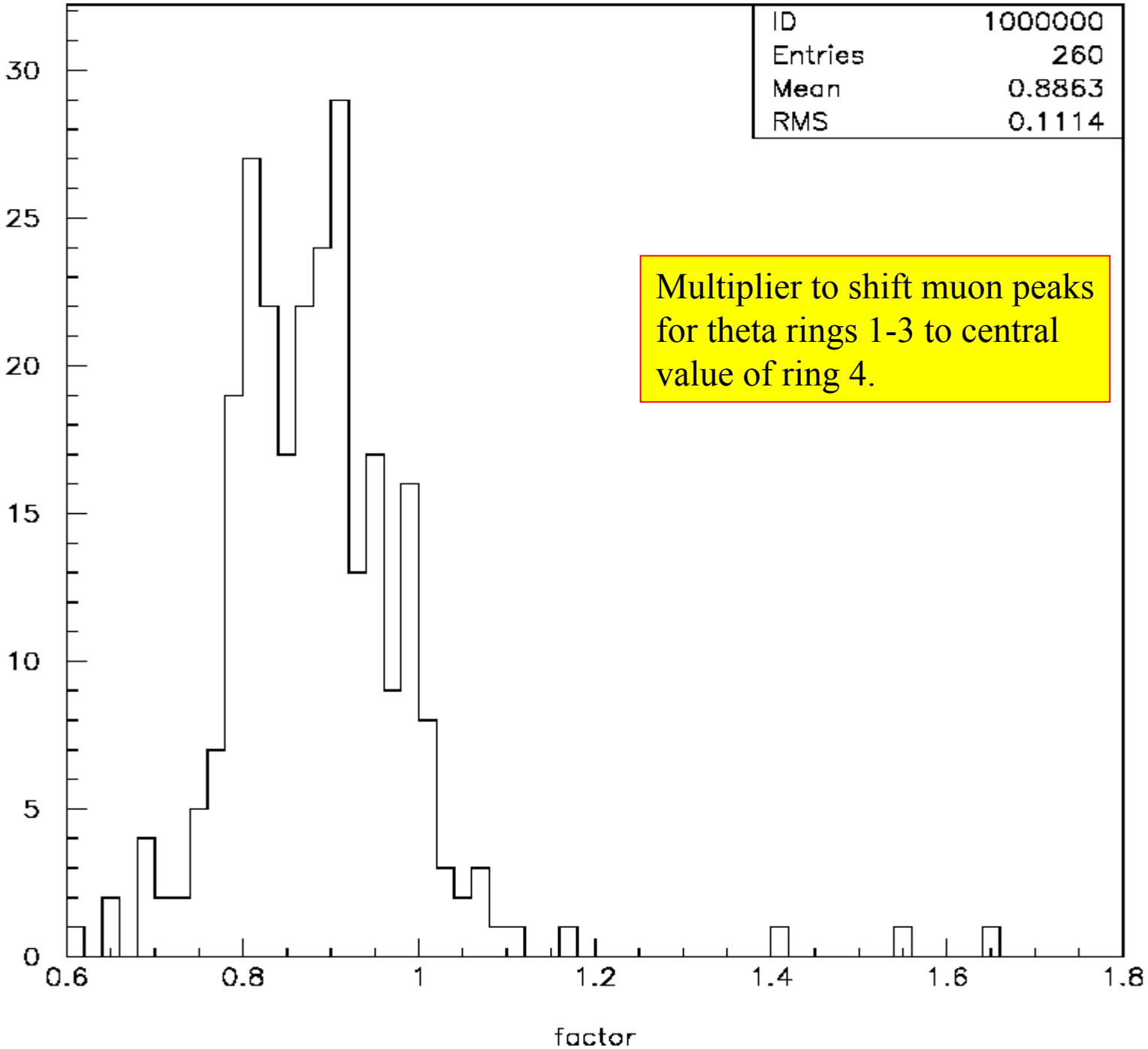
- The precision of this method is limited to the few percent level by the uncertainty in muon peaks for individual crystals, but for rings 1-3, this is a substantial improvement.



th 4 ring



th 5 ring



Multiplier to shift muon peaks for theta rings 1-3 to central value of ring 4.

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.