Tuning response of the central calorimeter to hadrons

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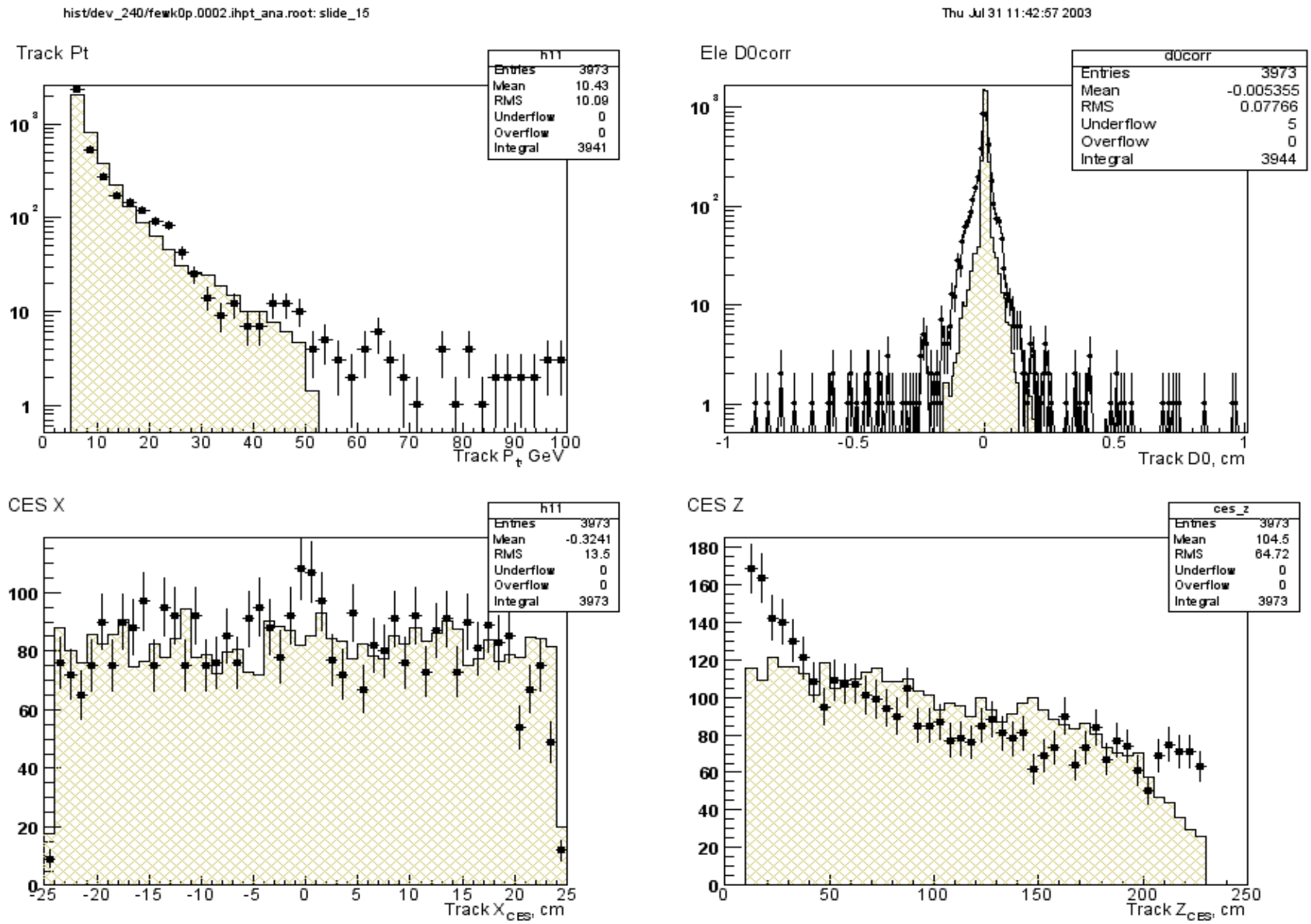
- Parameters to be tuned:
  - Calorimeter scale: response (E/P) for hadronic showers
  - Resolution
  - **Lateral profile**
  - Longitudinal profile
  - Response in the cracks
- In general no simple parameters (compare to resolution in COT), have to vary functions of energy and other parameters
- GFLASH has many parameters varying which leads to correlated effects
- For this study: see what can be achieved by **rescaling** of certain parameters: shower width, resolution, response

Data samples

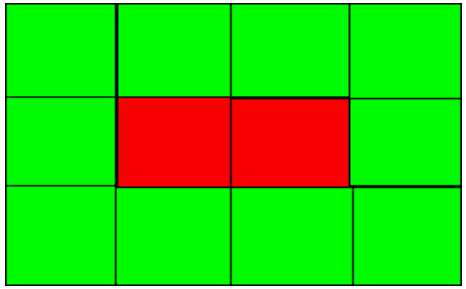
- **Data samples:**
  - Strip from **gjet08/09**: events with high-Pt isolated tracks (Pt > 5 GeV)
  - **GJTC09**: high-Pt isolated L3 track (7 GeV)
  - Strip from **GMBS08/09 (0.8 GeV)**
- **Stripping requirements:**
  - |eta| < 1.2
  - N(axial seg) >= 3, N(stereo seg) >= 3 (segment: ">=6 hits")
  - |D0| < 2 cm
  - In 2D sector of 0.5 there is no other track with Pt > 0.5
  - No other track with Pt > 0.4 extrapolates into the same wedge on the same side
- **Analysis: tighten isolation requirement**
  - No other track with Pt > 0.4 in 2D sector of 0.5
  - no other track with Pt > 0.4 points to the same or neighbouring wedges (on the same side)
  - 9 cm < CES Z <230 cm
  - |CES X| < 25 cm
  - **CES isolation:**
    - no CES clusters with E>0.2 in the neighboring wedges on the same side
    - Only 1 strip / 1 wire CES cluster in the hit chamber with E > 0.2, should be within 5 cm from the track
- Statistics:
  - Gjet08 : 2294 events
  - Gjtc09: 38462 events
  - Gmbs08: 293177 events, but low Pt
  - **Use only Gjet08 and Gjtc09**

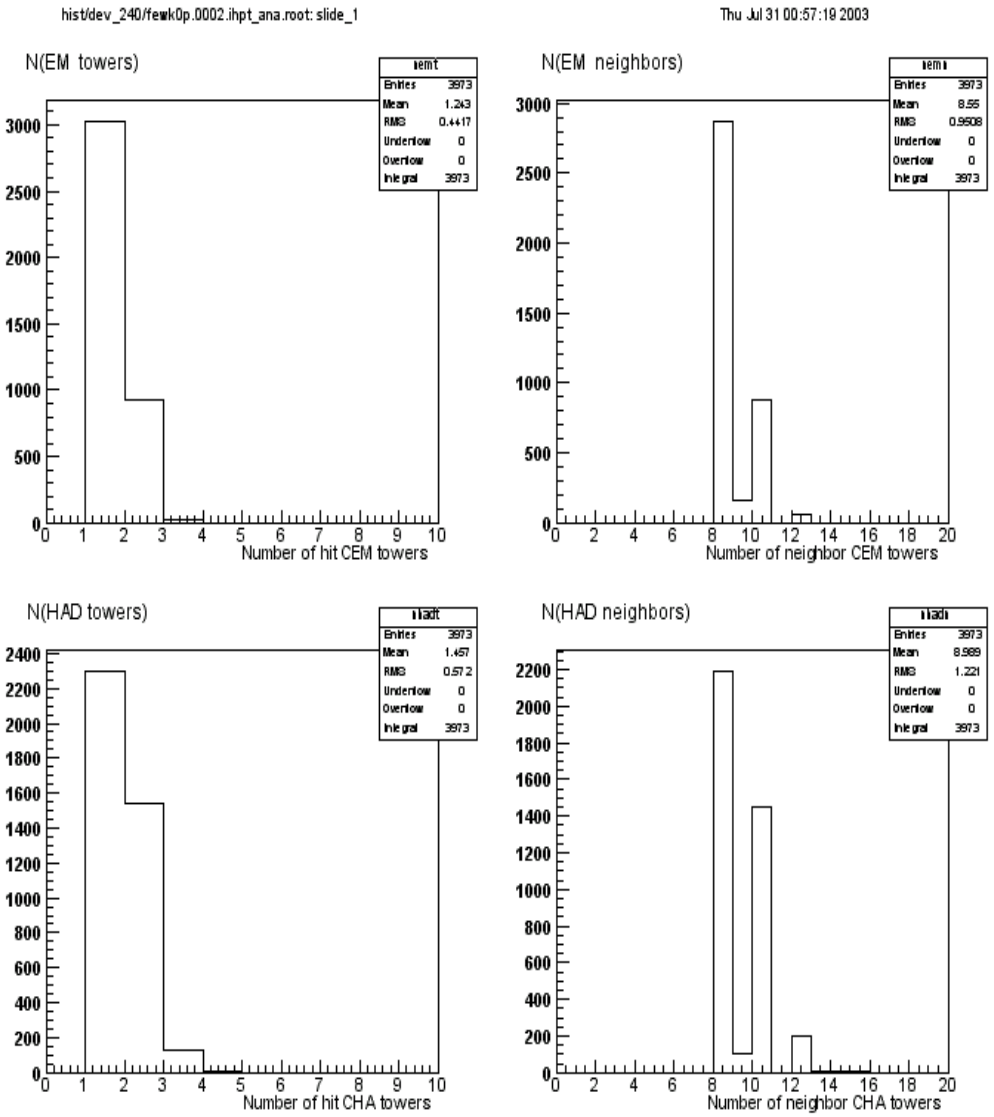
High-Pt isolated track sample, contd



Calculation of the energies

- track energy deposition in the calorimeter:
  - Find hit towers (1,2,3..- red) - in red
  - Determine ring of the neighboring towers - green(8,10,..)
  - Sum energies in the hit and neighboring towers separately
  - sum energy depositions in the central and neighboring wedges (3 of them)
- more sofisticated procedure allows to keep the statistiscs



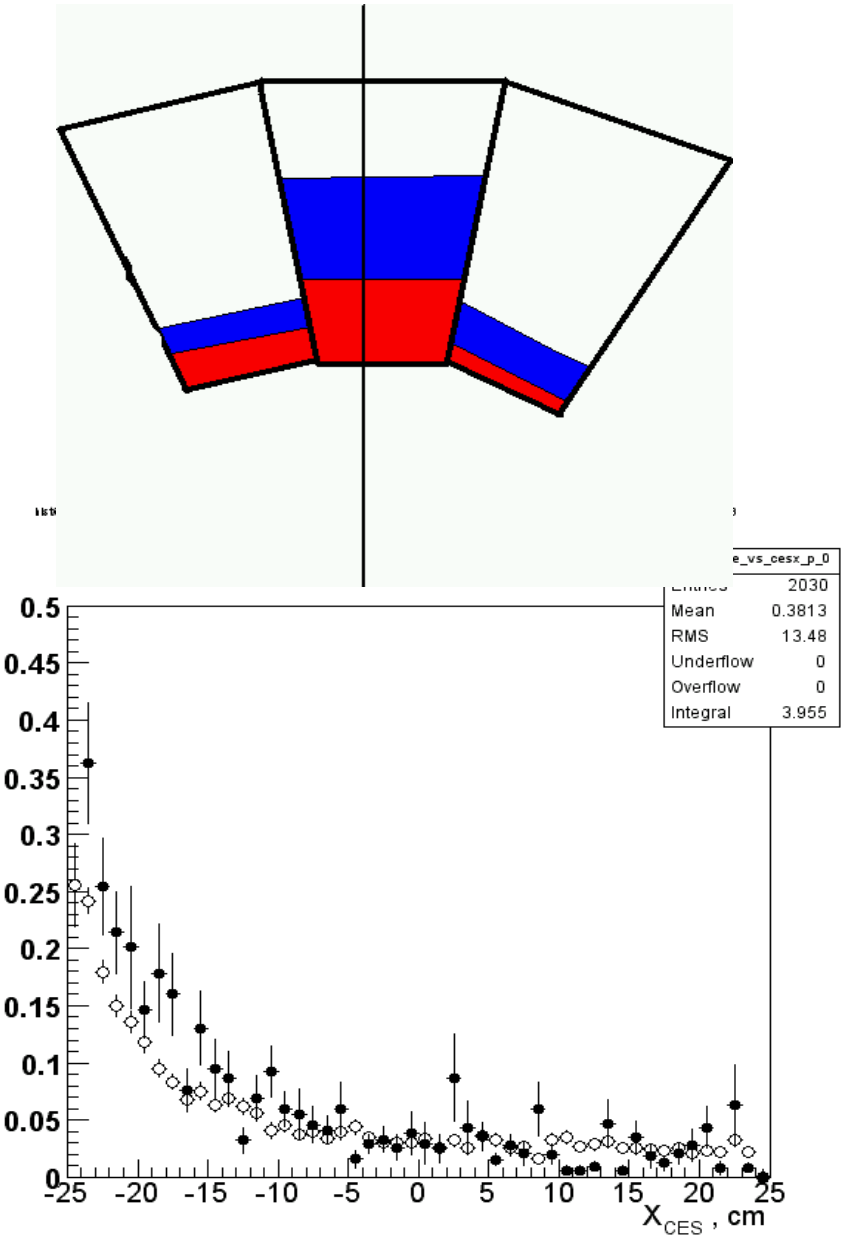


Lateral profiles: distributions to study

- Study energy distributions for the central and shoulder wedges as a function of track position in the central wedge
  - X(CES) and X(eta), the latter normalized to [-1,1]
- Effects
  - Leakage into the neighboring wedge
  - Response in the crack region
  - Energy dependence of above
- To reduce energy dependence use distributions for the fraction of energy deposited in the wedge:

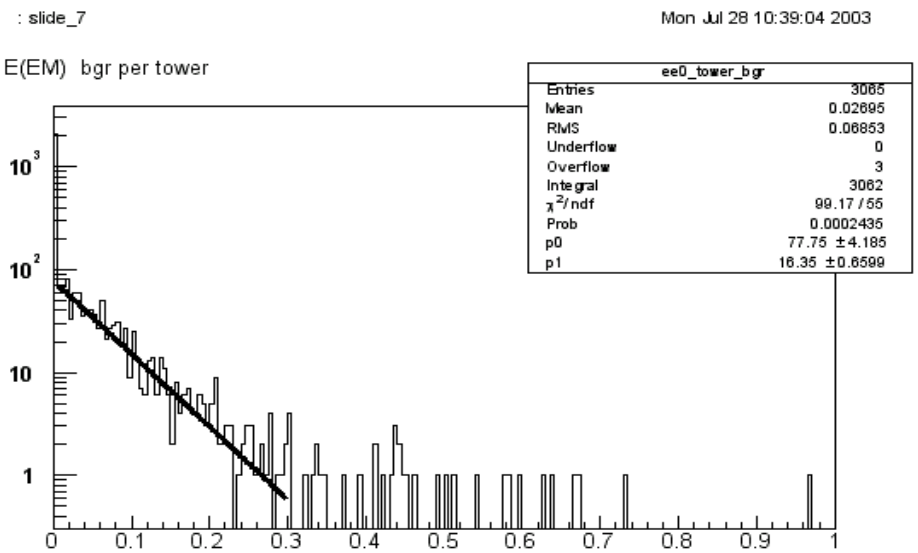
$$F_{EM}(\text{wedge}) = E_{EM}(\text{wedge})/E_{EM}(\text{total})$$

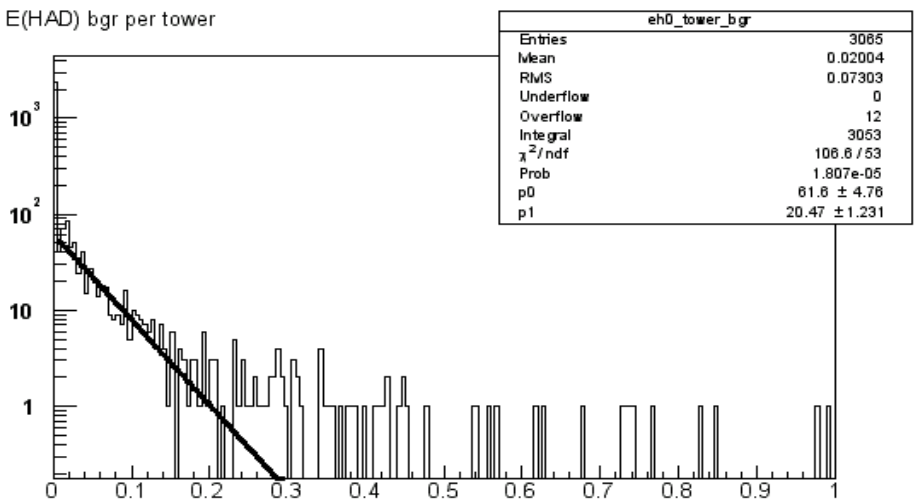
where total is the sum over 3 wedges or 3 towers



Background Parametrization

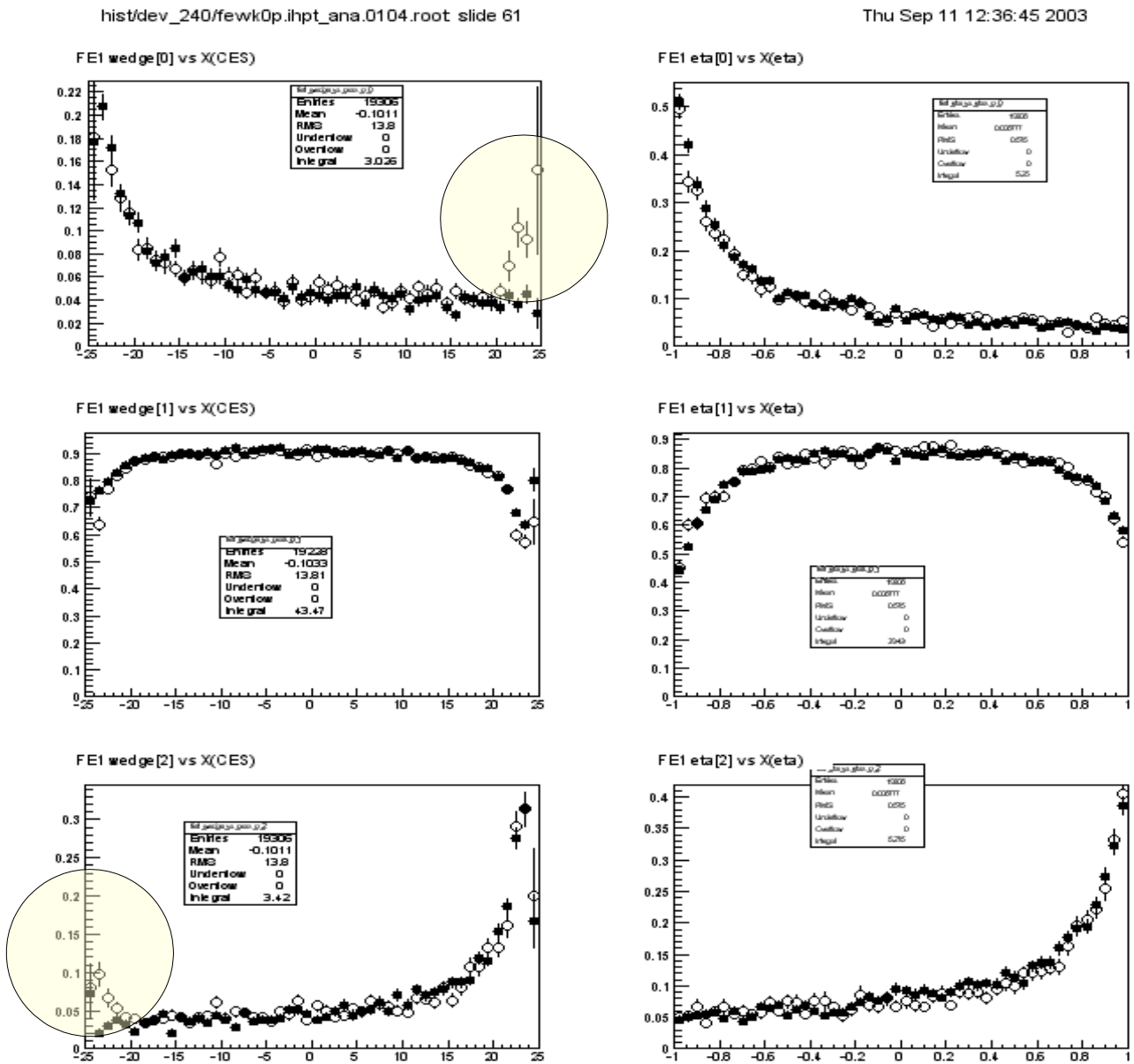
- Determine distribution for the background
  - X(CES) > 5 cm or X(CES) < -5 cm
  - EM and had separately
- 2 inputs :
  - Probability for a tower to have non-zero energy
  - Energy distribution in "non-zero" case
- Fit region 50-300 MeV with the exponential
- EM: 0.65 + 0.35*exp(-16.4*E)
- HAD: 0.76+0.24*exp(-20.5*E)
- Simulate "background" in CEM (CHA) and add it to the MC distributions





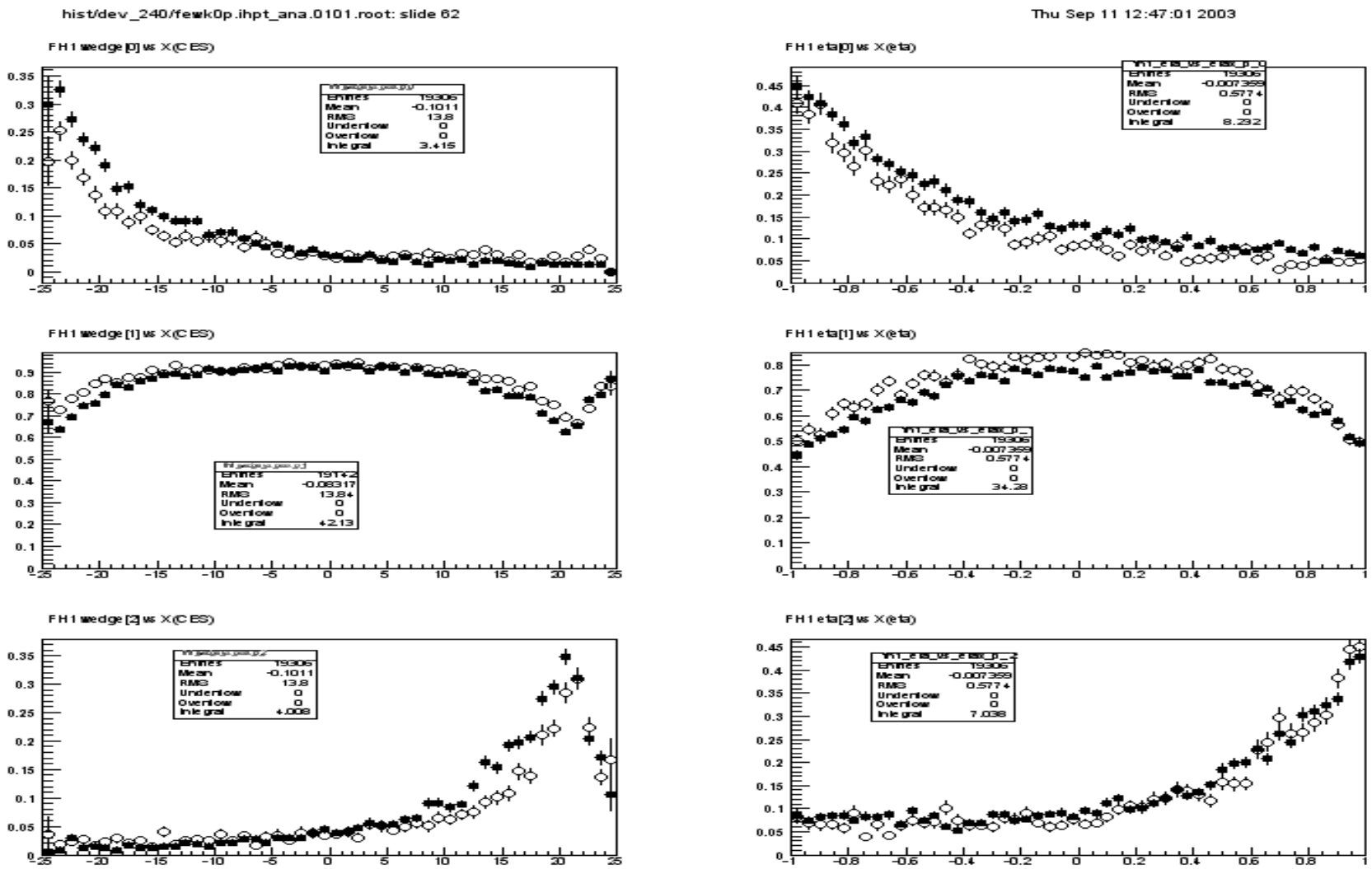
Lateral shower profiles in CEM (GJTC08)

- Good agreement overall, no scaling needed
- MC [most probably] doesn't scale down response for the "far" energy spots when the particle goes into a crack
- effect is seen in phi, but not in eta



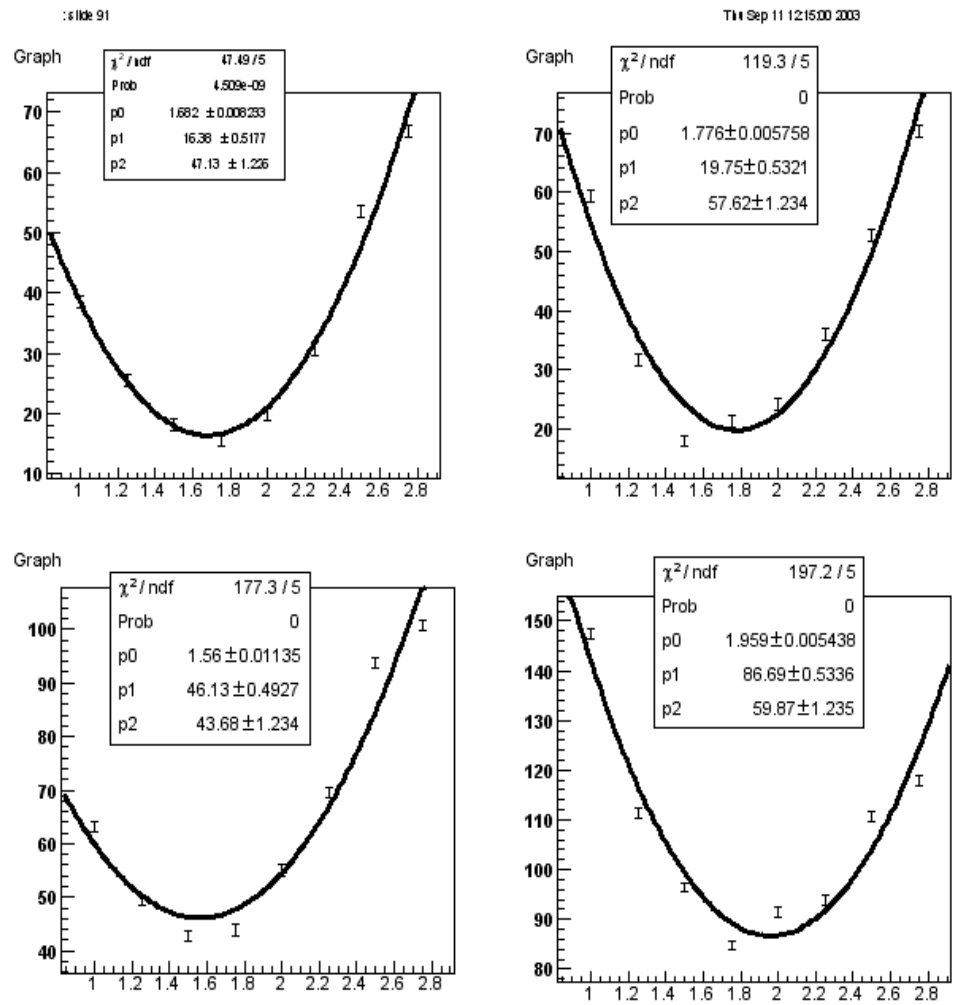
Lateral shower profiles in CHA (GJTC08)

- Systematic effects are clearly seen (plots vs XCES on the left, vs X(eta) on the right)



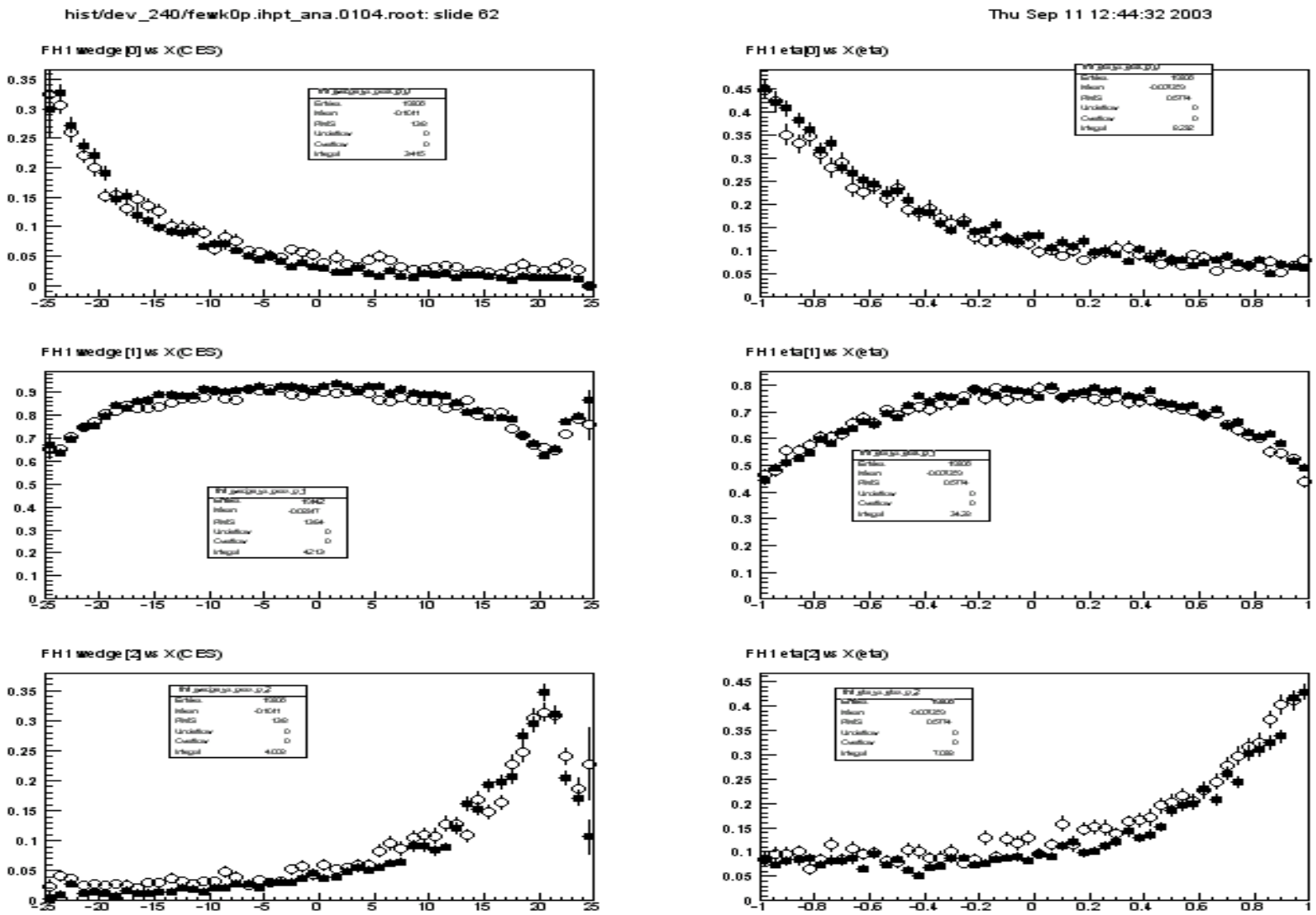
Tuning lateral shower profile in CHA

- Use high-Pt samples only - events from minbias sample have too small E(had)
- Look separately at the leakages in phi and eta
- Generate MC samples for 8 different scale factors applied to the GFLASH parameter, defining "radius" of the hadronic shower in the range of 1-2.75
- calculate chi2 between the data and MC histograms, fit chi2 dependence on the scale factor with the parabola
- **Results**
  - GJTC09 phi : 1.68 +/- 0.008 (stat)
  - GJTC09 eta : 1.776 +/ 0.006(stat)
  - GJET08-HPT phi: 1.56 +/- 0.01(stat)
  - GJET08-HPT eta: 1.96 +/- 0.005(stat)
- **Mean = 1.74 +/- 0.17**



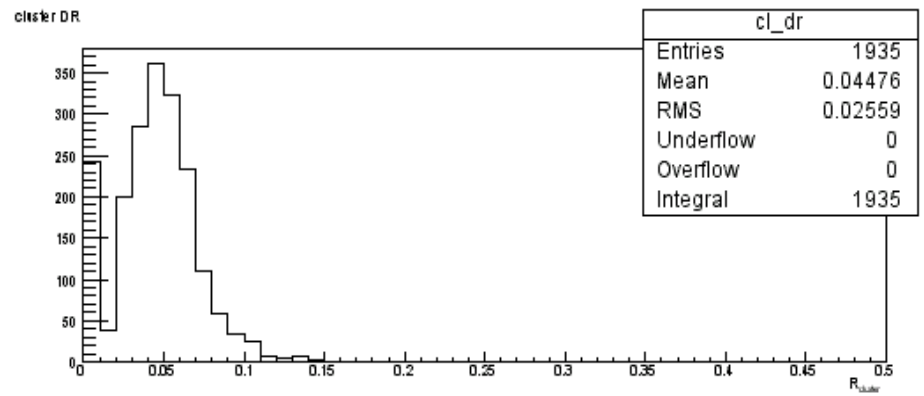
Lateral shower profiles in CHA (GJTC08) – after tuning

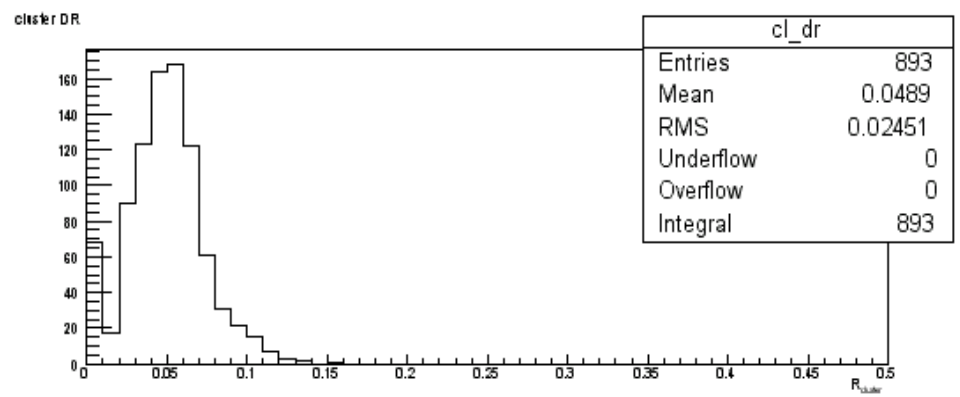
- Good agreement after tuning for both eta and phi directions

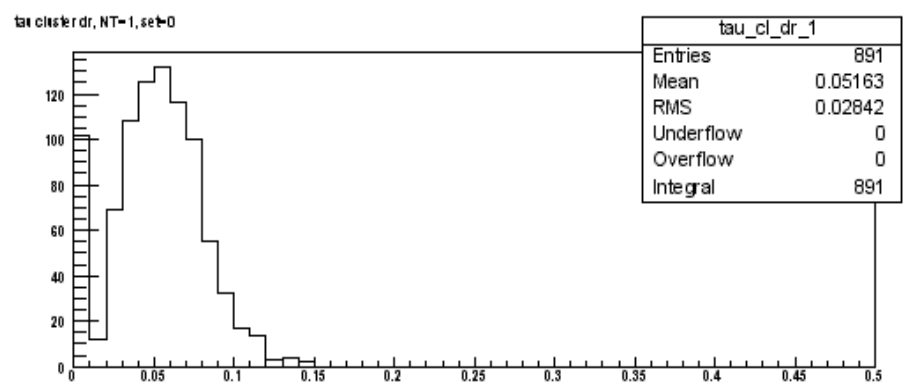


What does tuning change for hadronic tau's ?

- Comparing data to MC:
  - Default MC: <R> = 0.45
  - Tuned MC : <R> = 0.49
  - W->tau nu data: <R> = 0.52
    - MET > 25, no other cone 0.7 jet above 3 GeV
- Tuned MC as expected results in larger radii of the tau clusters (~9%)
- Room for improvement is still available







Summary

- Simulated profiles of the hadronic showers in CHA agree with the data best if the characteristic radius is scaled up by 1.74 +/- 0.17
- No indications that lateral profiles in CEM need to be changed
- Results for 2 independent samples of high-Pt (> 5 GeV) isolated tracks are consistent
- Propose to implement scale factor of 1.75 for CHA in default MC