Improvements in the Calorimeter Simulation

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Jet Energy and Resolution Group Mini-Workshop
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Overview

1) Preliminary results for tuning of the hadronic lateral shower profile:

- central calorimeter
- track momentum range 0.5-24.0 GeV/c
- parametrization in Gflash: see gfinha.F, gfshow.F
- tuning samples:

  data: JET_CALIB (gjtc0d), 16 M events

  MC: FakeEv, 1 track/event, flat spectrum,

  $\pi^{\pm}/K^{\pm}/(p,\bar{p})$=60%/30%/10% , weighted with data spectrum

2) Cross-check of single particle responses:

- data: JET_CALIB vs. Minbias
- MC: FakeEv vs. PYTHIA Minbias (current tuning)

3) Tuning of the plug simulation

4) Conclusions

Track Selection

Quality cuts

- $N_{vtx} = 1$
- $|z_{vtx}| < 6cm$, $|z_0| < 6cm$ (0<p<8 GeV/c)
- $|z_{vtx}| < 60cm$, $|z_0| < 60cm$ (8<p<24 GeV/c)
- 7x7 isolation
- CES isolation

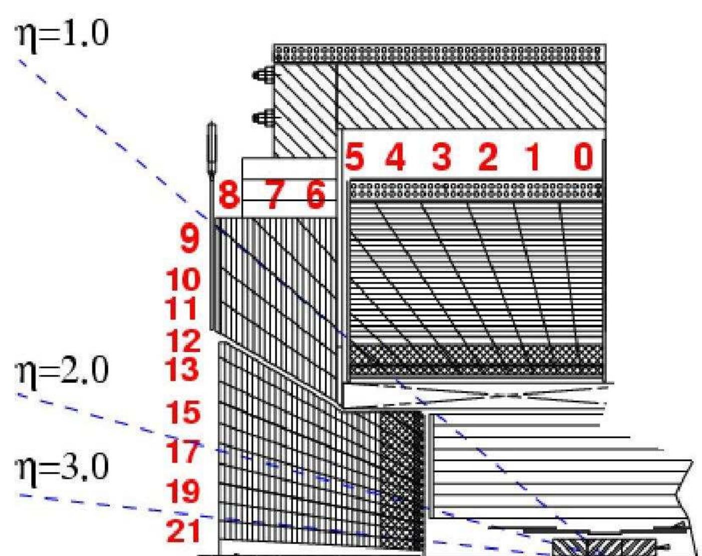
- Number of hits

COT		Silicon	
ax	st	ax	
30	30	-	tower 1-8
25	25	-	tower 9
20	20	4	tower 10-11

tower number	momentum range (GeV/c) ≥ 2	0.5-2	2-3	3-5	5-8	8-12	12-16	16-24	>24
0	101906	329537	11846	64676	16578	8015	629	116	45
1	109072	345385	12726	68439	17704	9262	754	147	39
2	114259	359959	13951	69419	18595	11170	914	169	41
3	115352	365974	15181	65847	19720	13125	1195	245	37
4	114795	366485	16870	59926	21898	14185	1582	280	52
5	118292	380410	20126	53818	26544	15038	2242	463	61
6	119588	388367	23670	47028	30777	14460	2977	597	76
7	126830	427403	30812	42726	34770	13728	3907	802	85
8	96483	445245	38401	26230	21509	7066	2636	566	72
9	55529	439577	38101	14241	2607	444	90	38	7
10	78510	501283	52699	21349	3754	570	94	32	8
11	121194	552756	78114	34826	6926	1050	195	65	13

used for tuning

gjtc0d



- plus contour cut for lateral profile:
  require track within inner 0.6x0.6 of target tower

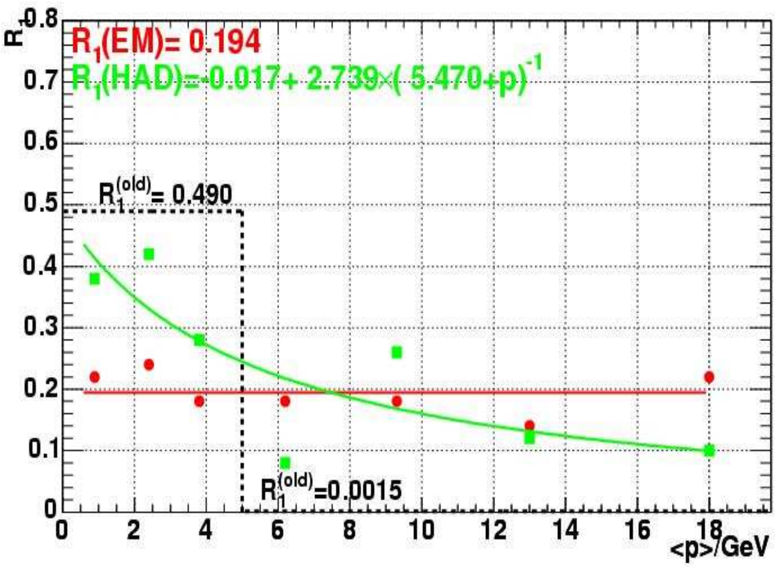
Lateral Profile Tuning Results

Hadronic lateral profile

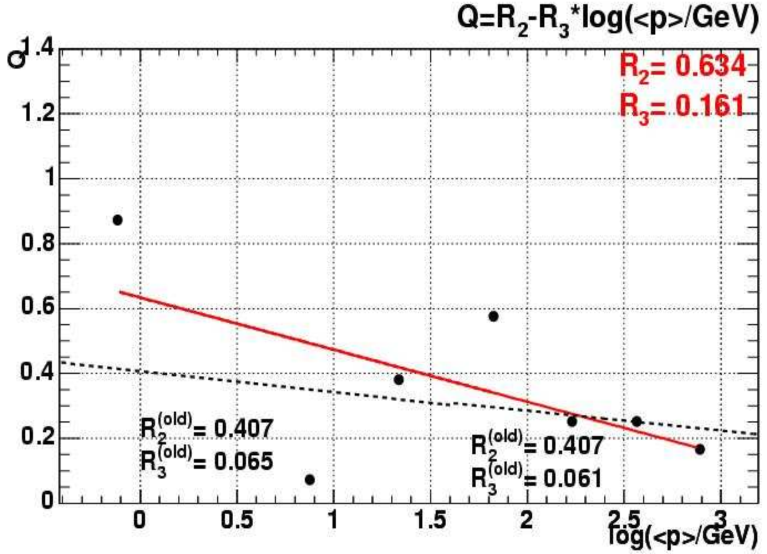
$$f(r)=\frac{2\,r\,R_0^2}{(r^2+R_0^2)^2} \qquad \langle R_0(E,x)\rangle = R_1 + Q\,x \qquad Q = R_2 - R_3 \log(p/\mathrm{GeV})$$

- Tighter vertex cuts (p<8GeV/c) improves tune quality of HAD and agreement between HAD and EM
- Shower core R_1(HAD) at p<2.5 GeV/c roughly consistent with old tune.
- EM and HAD seem to prefer different optimal core values at very low momenta:
  - Shower extrapolation effects? Cutoff artefacts?
- Consistent picture at higher momenta.
- Need to combine green and red curve reasonably.
  - Use average of green and red points at low p and use red points at high p>6GeV/c.
- Subdominant spread term Q(p) is very weakly constrained: need to shift R_1 to higher values (0.35) to extract some reasonable p dependence.

Cutoffs used: $R_0^{max}<1.4$, $x^{max}<2.0$

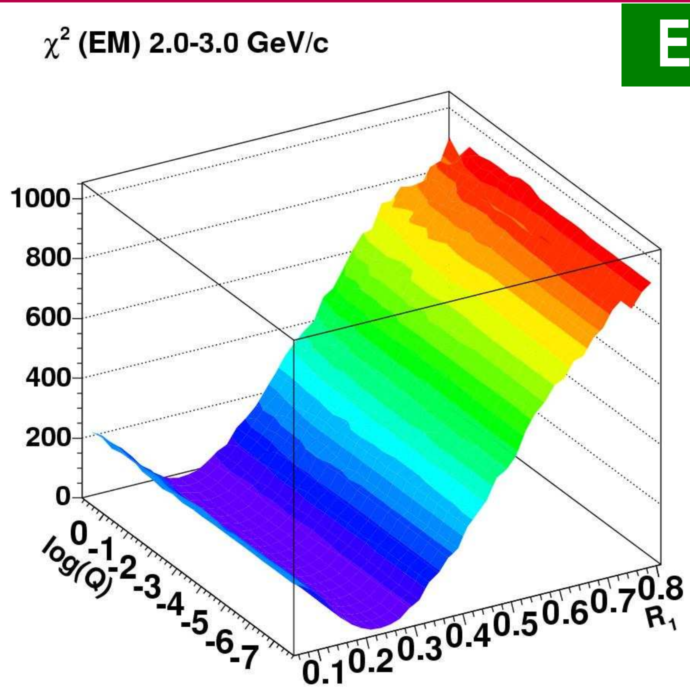


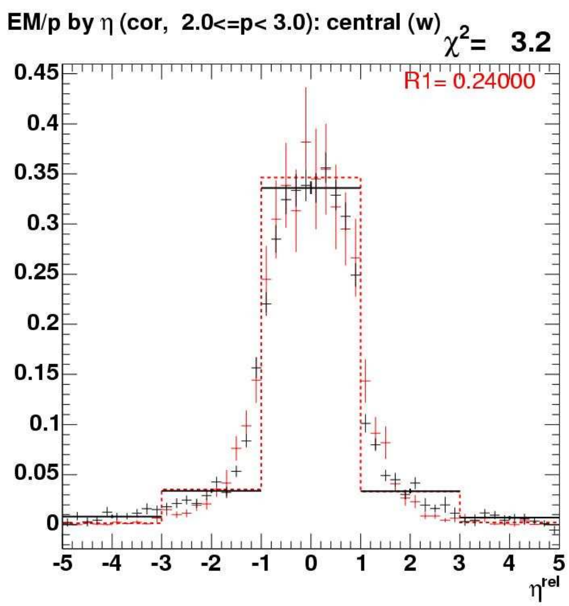
weighted momentum bins



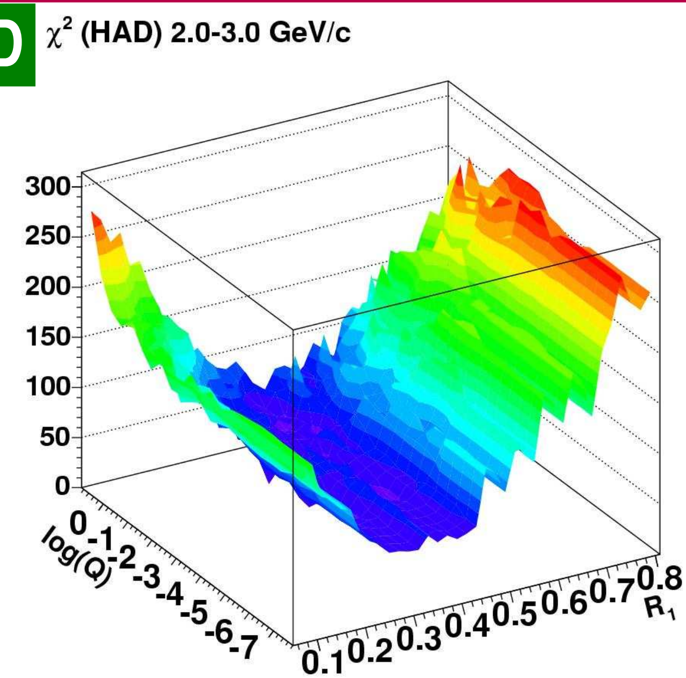
(R1,Q)-Scans 2-3GeV/c

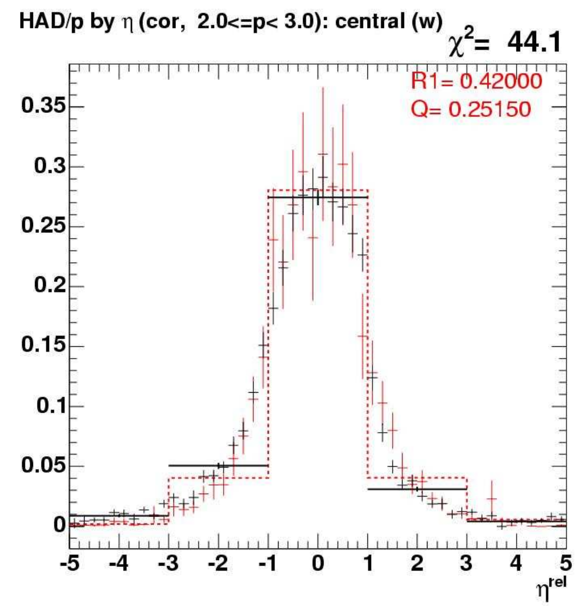
EM





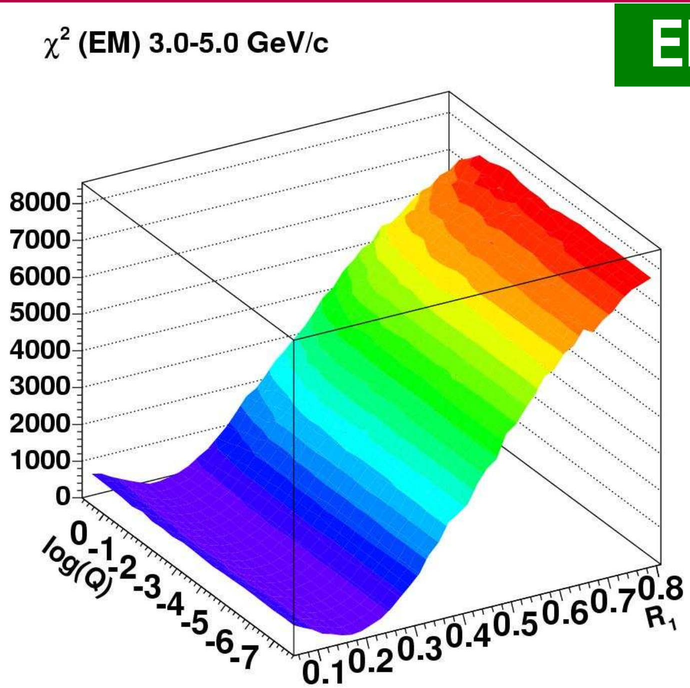
HAD

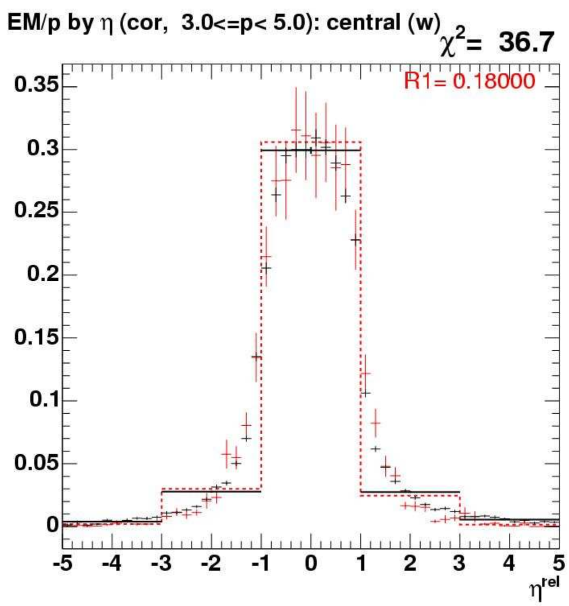




(R1,Q)-Scans 3-5GeV/c

EM





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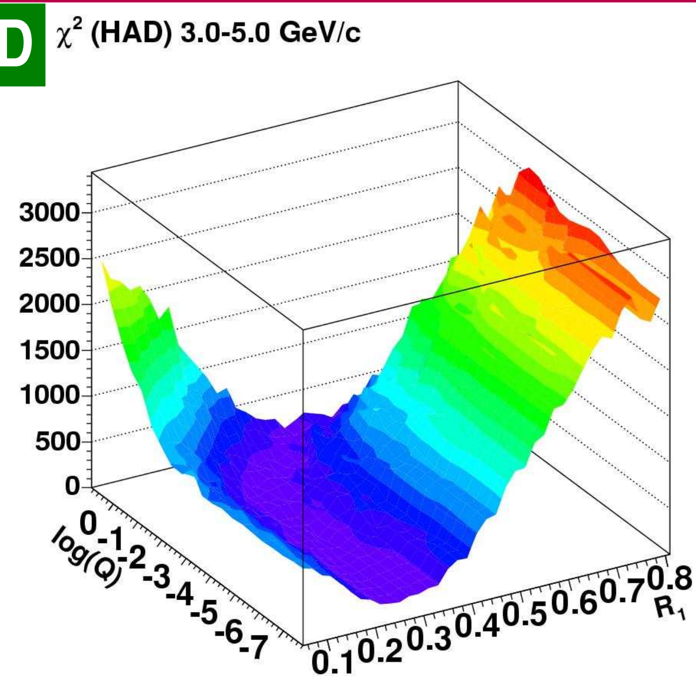
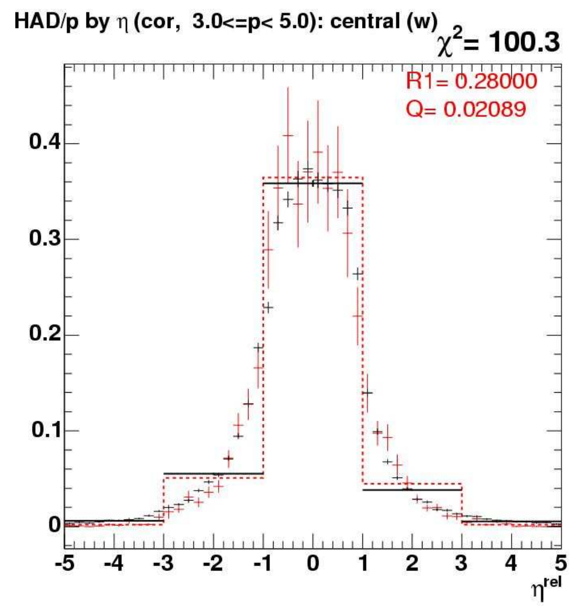
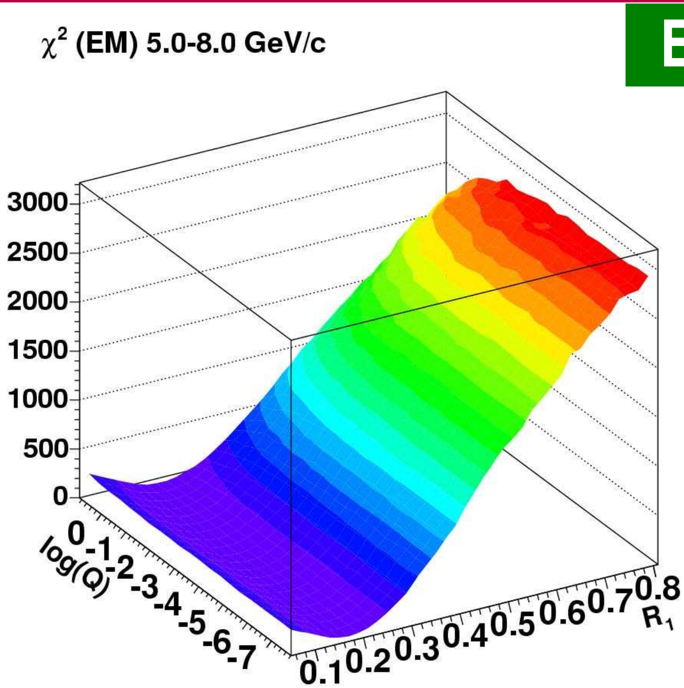
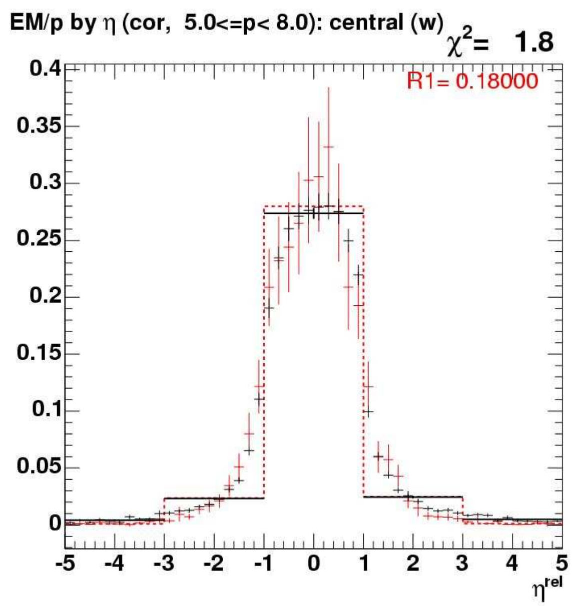




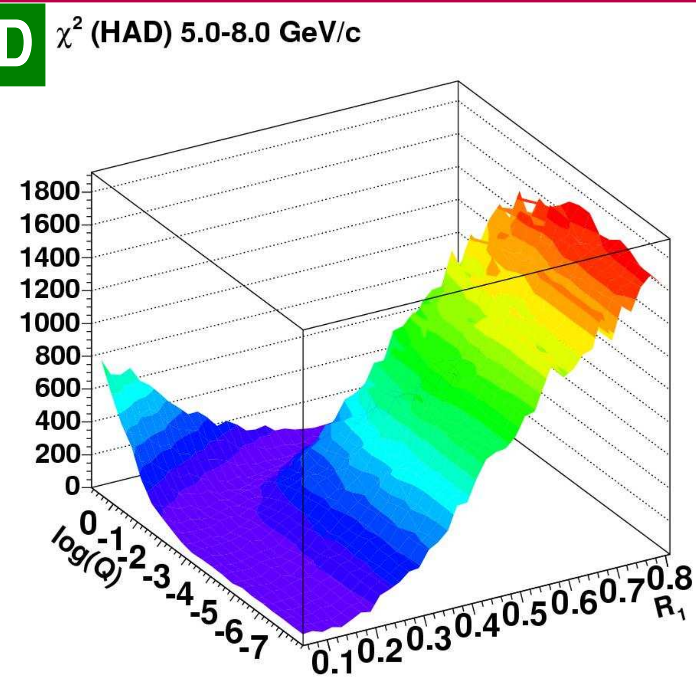
(R1,Q)-Scans 5-8GeV/c

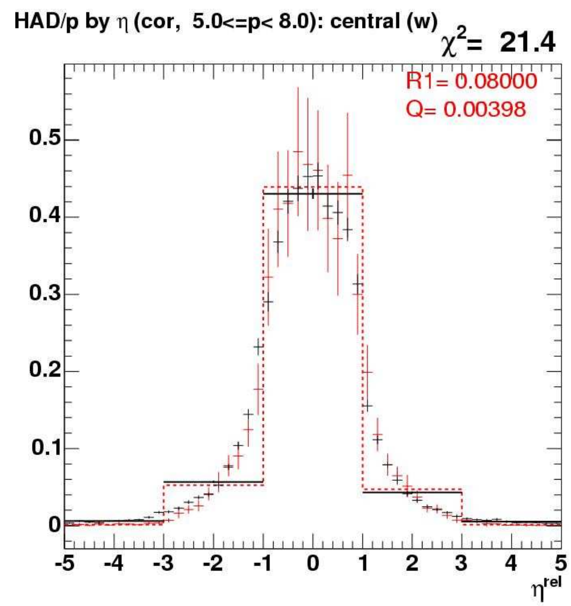
EM





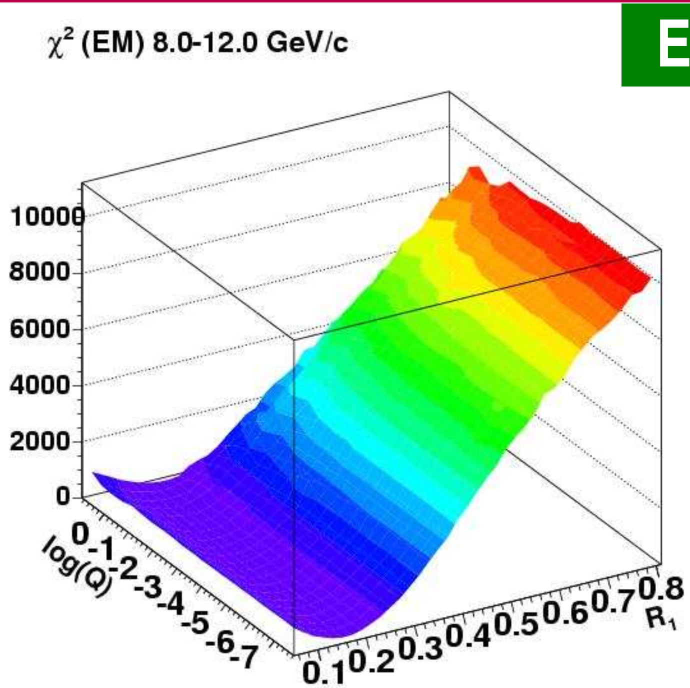
HAD

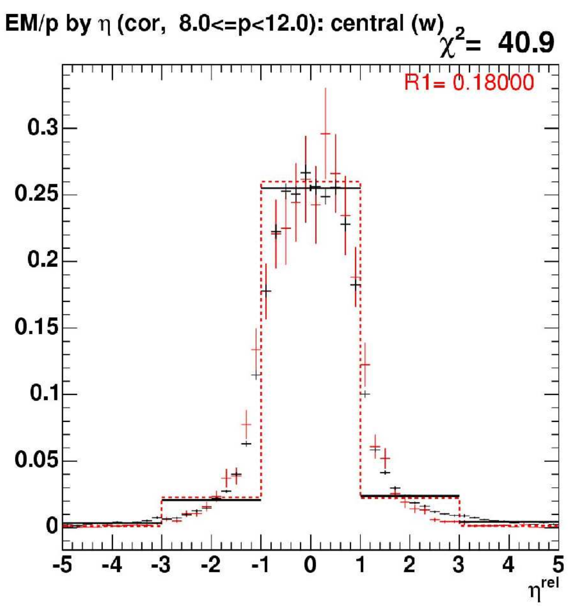




(R1,Q)-Scans 8-12GeV/c

EM





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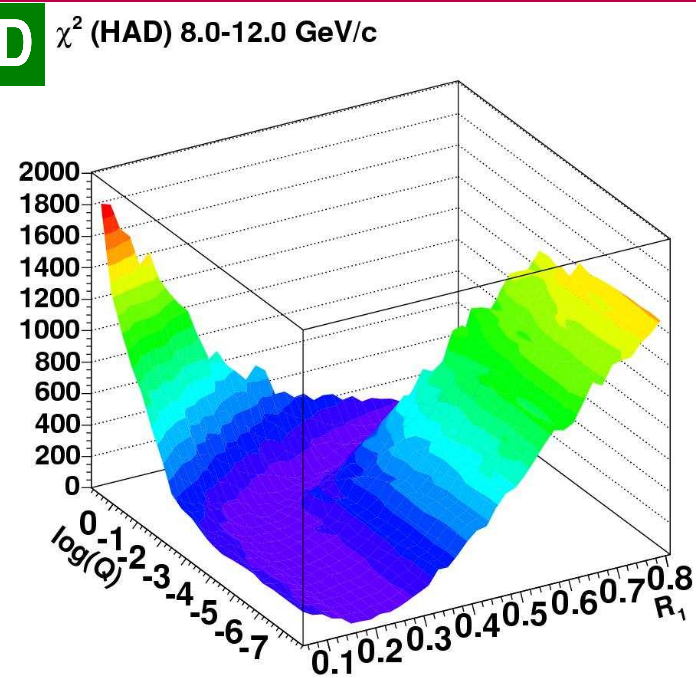
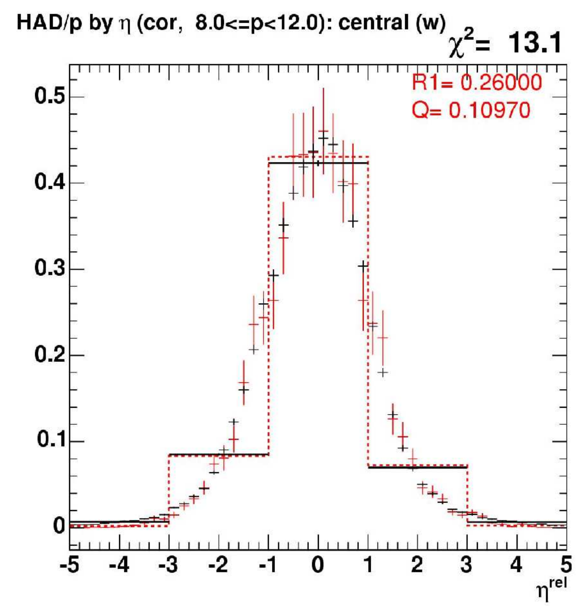
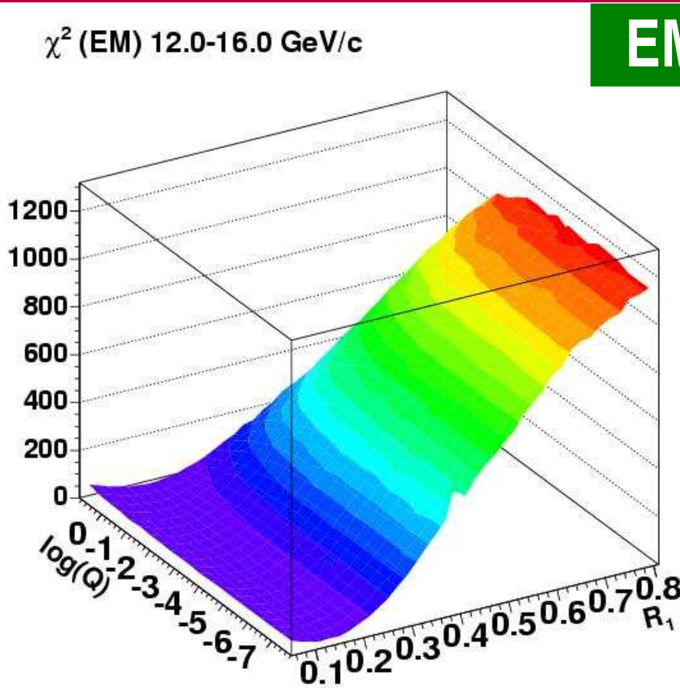
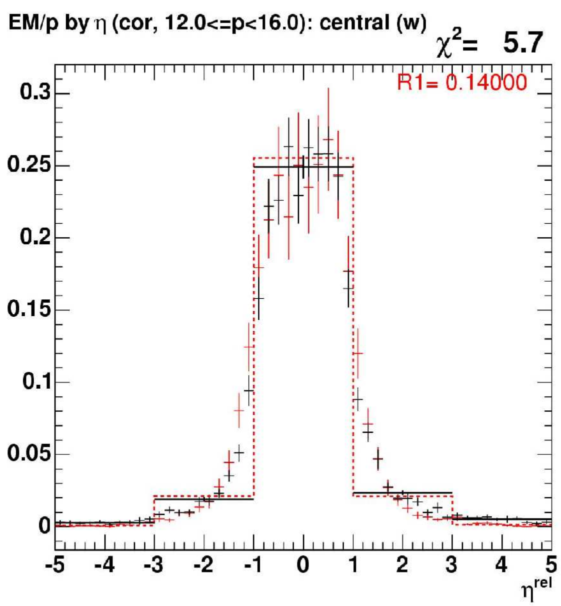




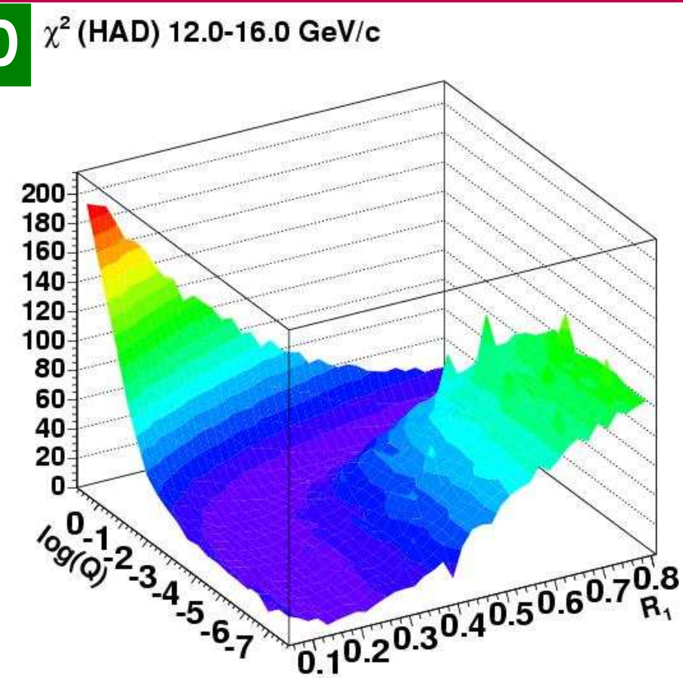
(R1,Q)-Scans 12-16GeV/c

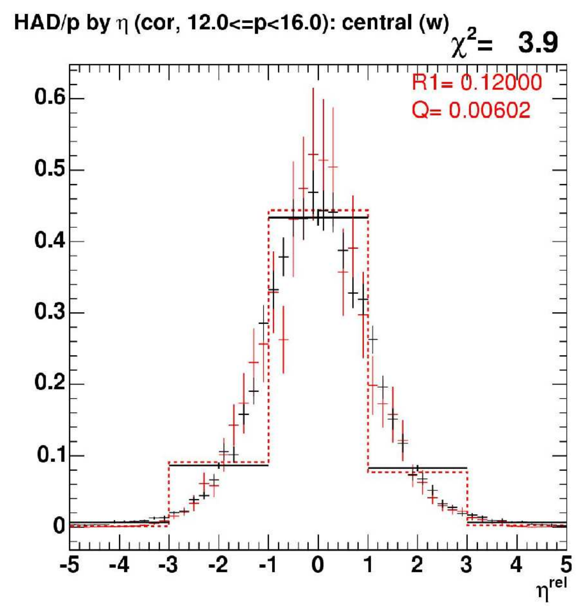
EM





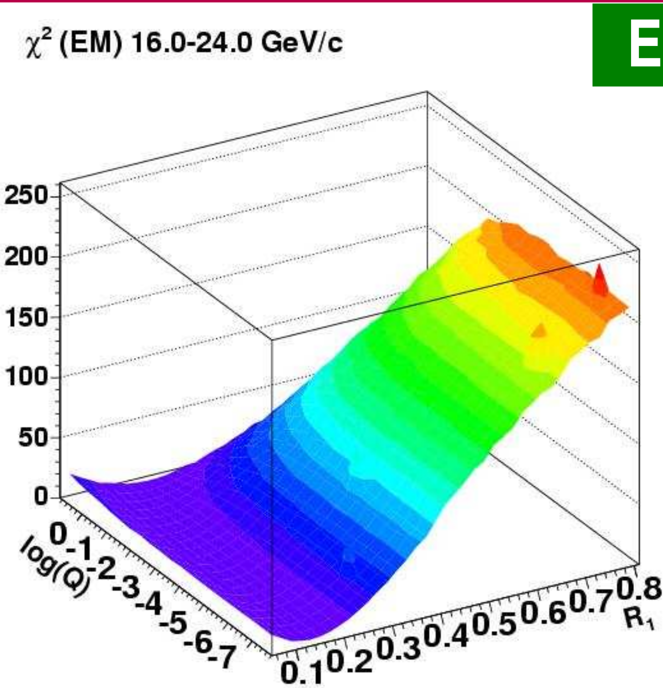
HAD

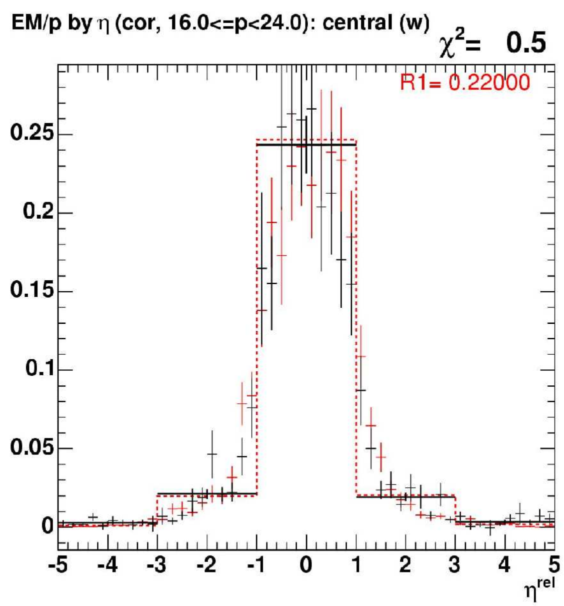




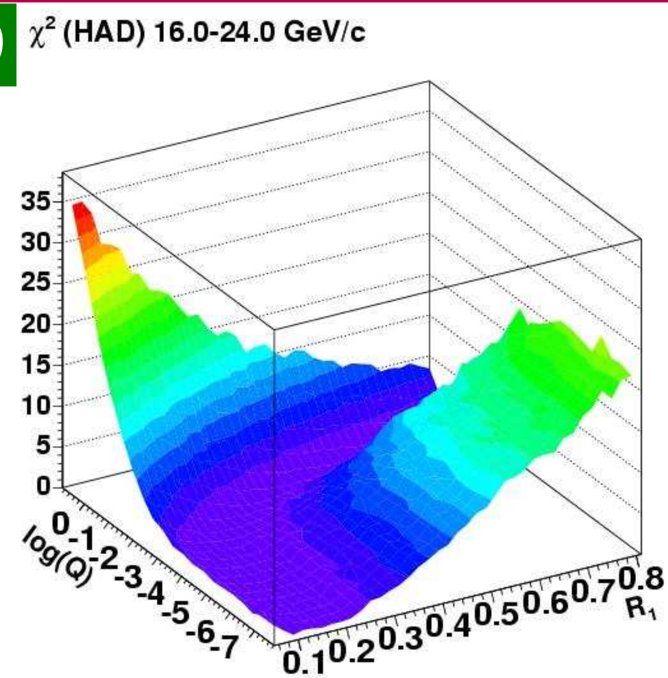
(R1,Q)-Scans 16-24GeV/c

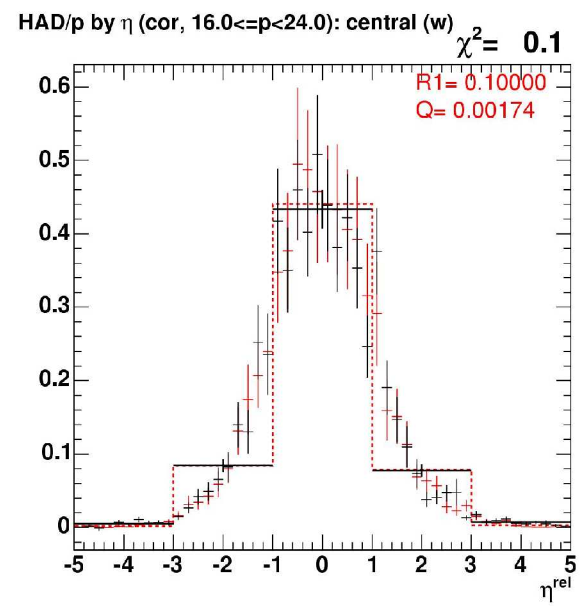
EM



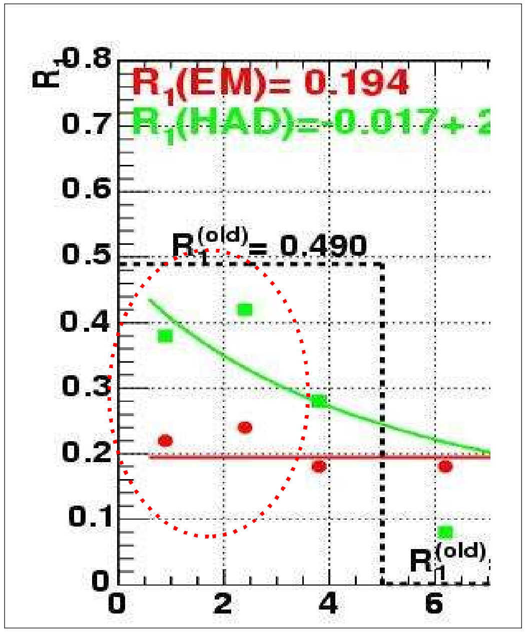


HAD

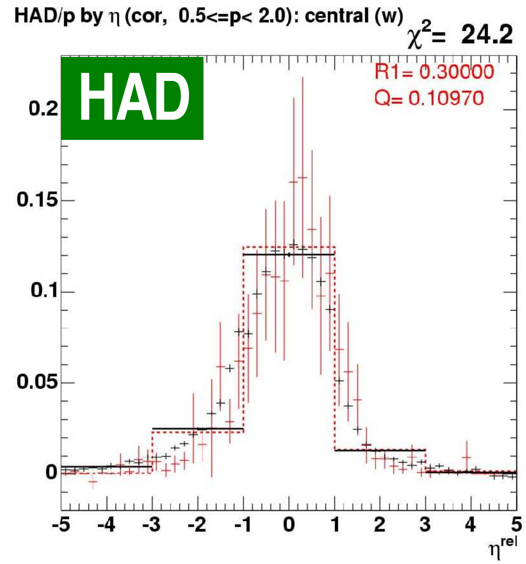


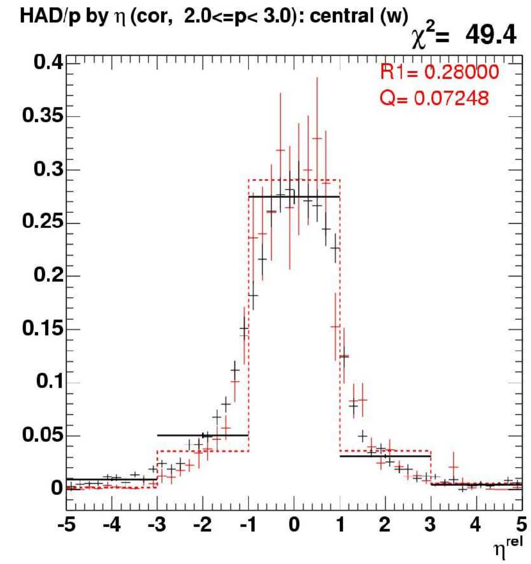


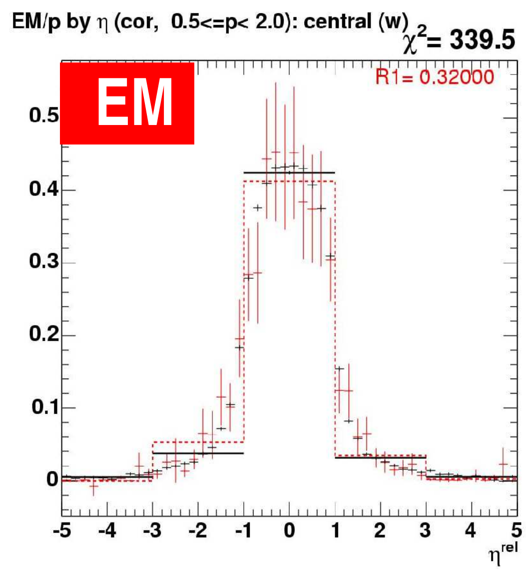
Tuning @ p=0.5-3GeV/c

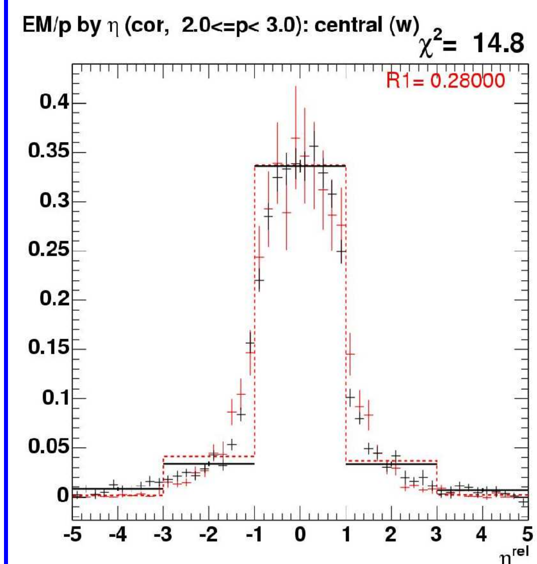


0.5-2.0 GeV/c | **2-3 GeV/c**



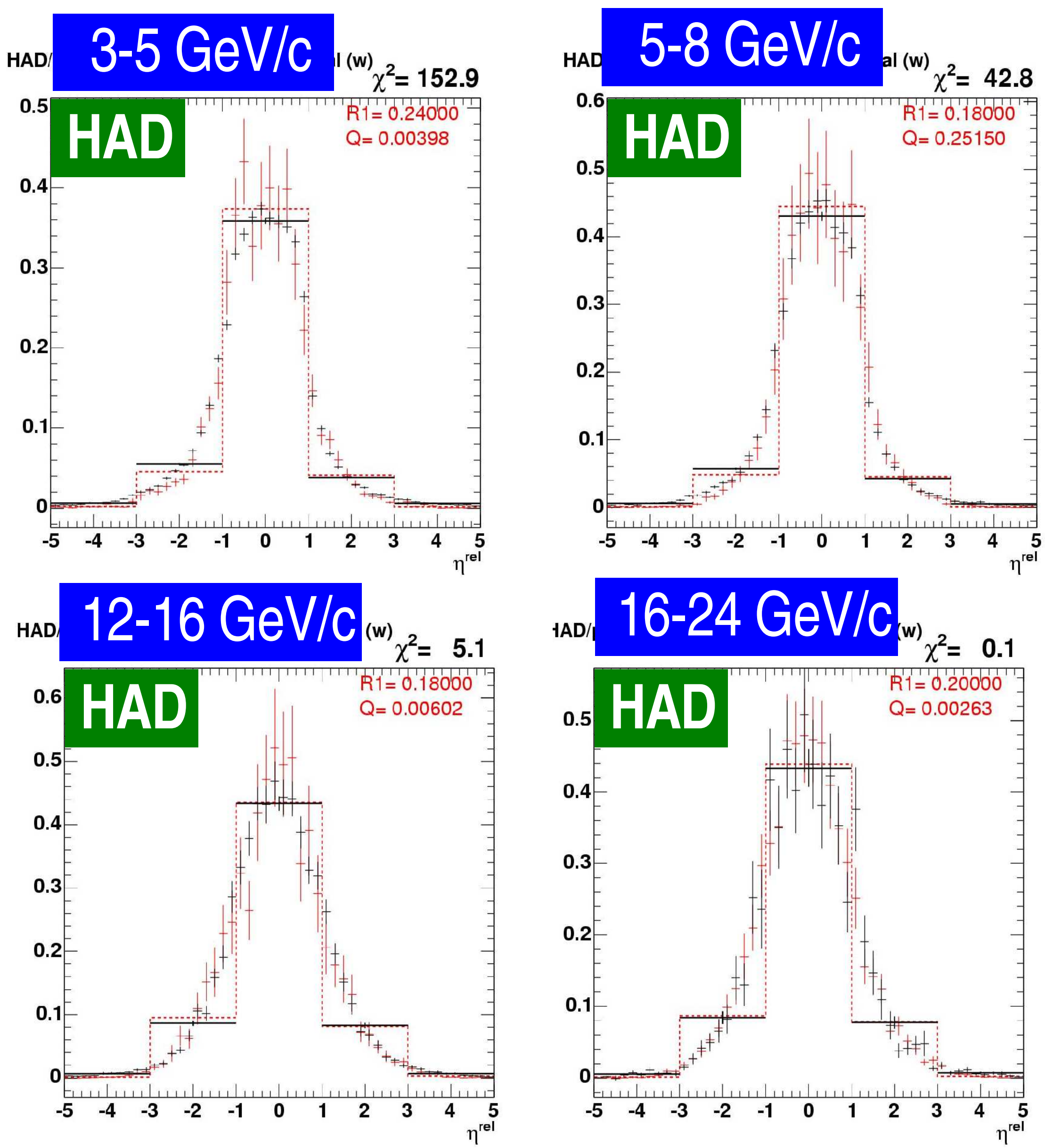






- NB: EM more important at low p.
- Average may be useful: R_1= const ~ 0.3, or a decreasing curve in-between intersecting the red curve at intermediate momenta
- Compromise gives acceptable agreement between data and MC

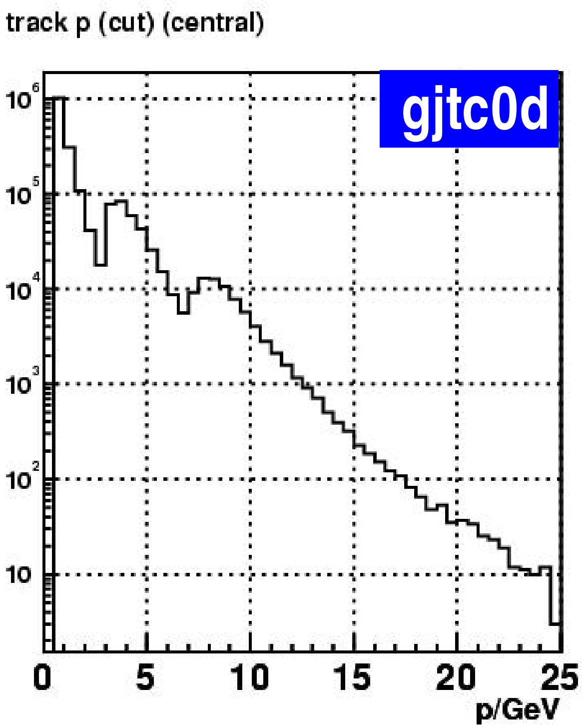
Tuning @ p=3-24GeV/c

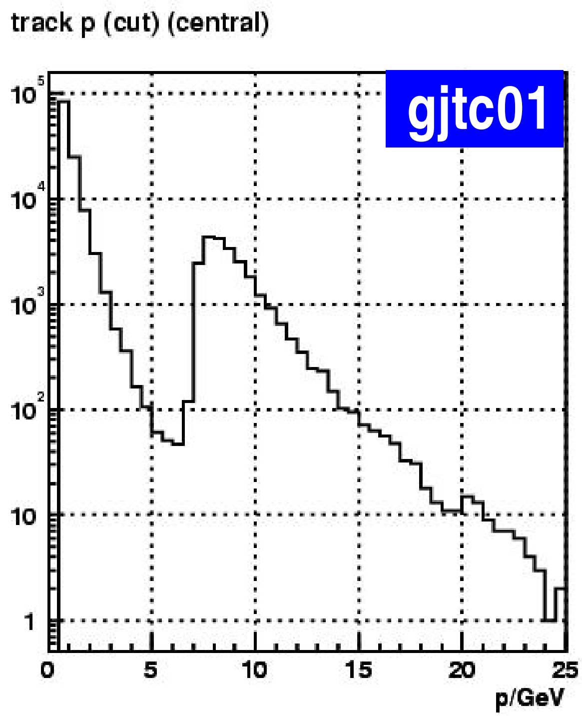


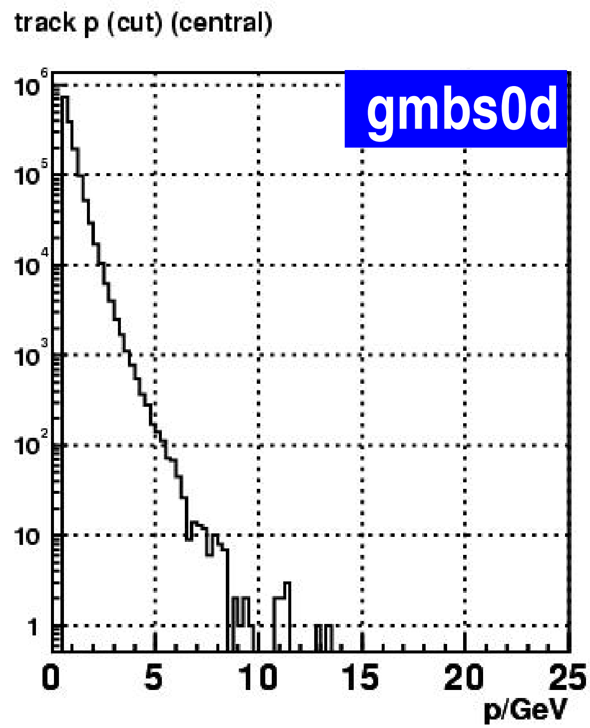
- Fix HAD profiles by more stringent constraint coming from the EM compartment R_1= const = 0.194
- Seems to work reasonable in particular at higher momenta

Cross-Check of Data Samples

Isolated track spectra, central:



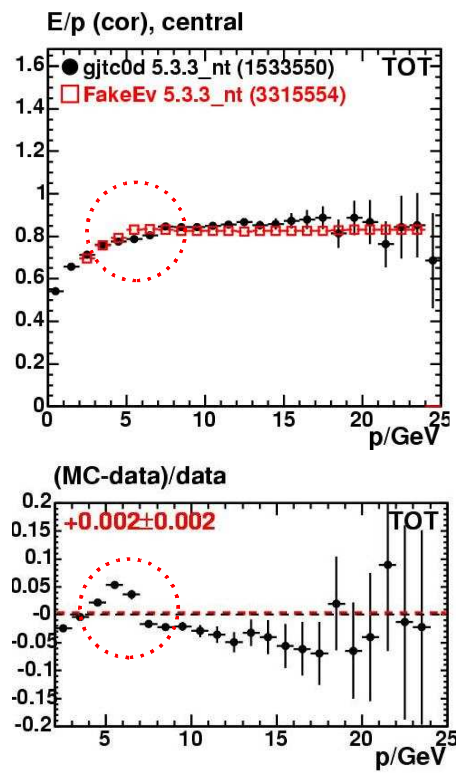




- JET_CALIB and Minbias data
- w/o reweighting discrepancies between data samples around trigger thresholds 4, 7 GeV/c expected

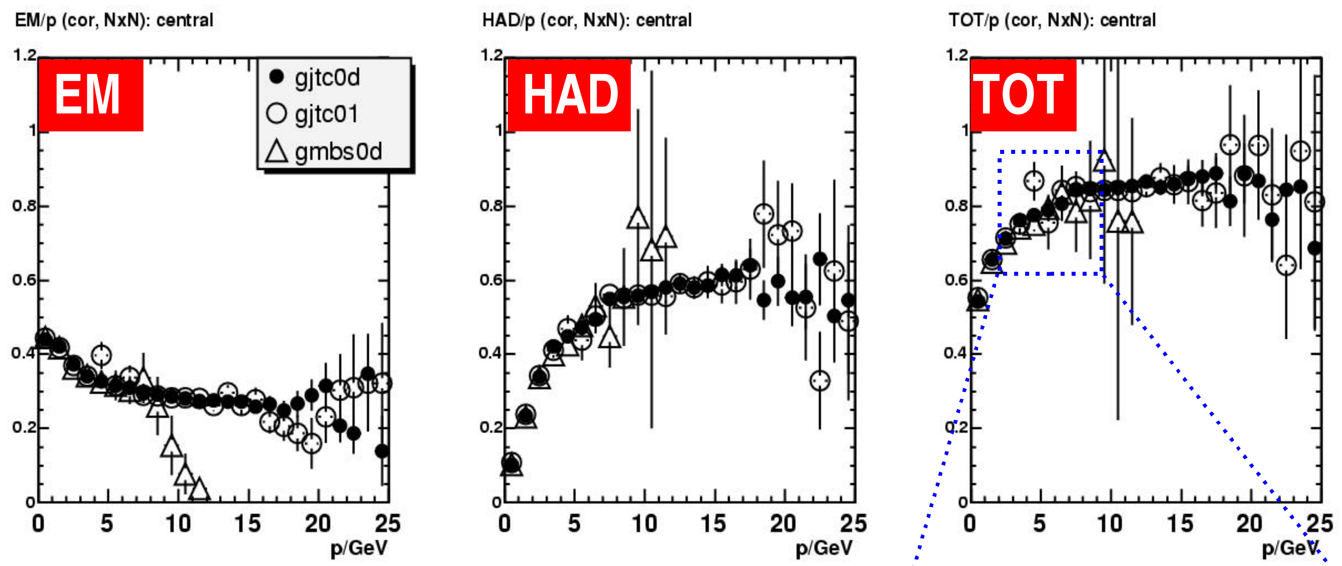
Absolute Response vs. Data Samples

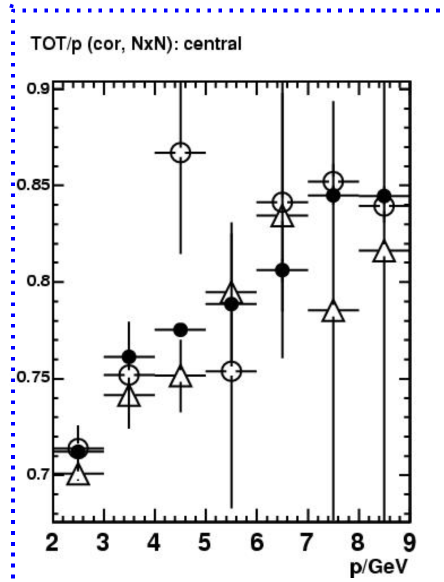
FakeEv / gjtc0d



- Remember: Gen-5 JES uncertainty for p<12GeV/c claimed to be 2%.
- FakeEv does not follow the structure in the data around 6 GeV.

gjtc0d / gjtc01 / gmbs0d



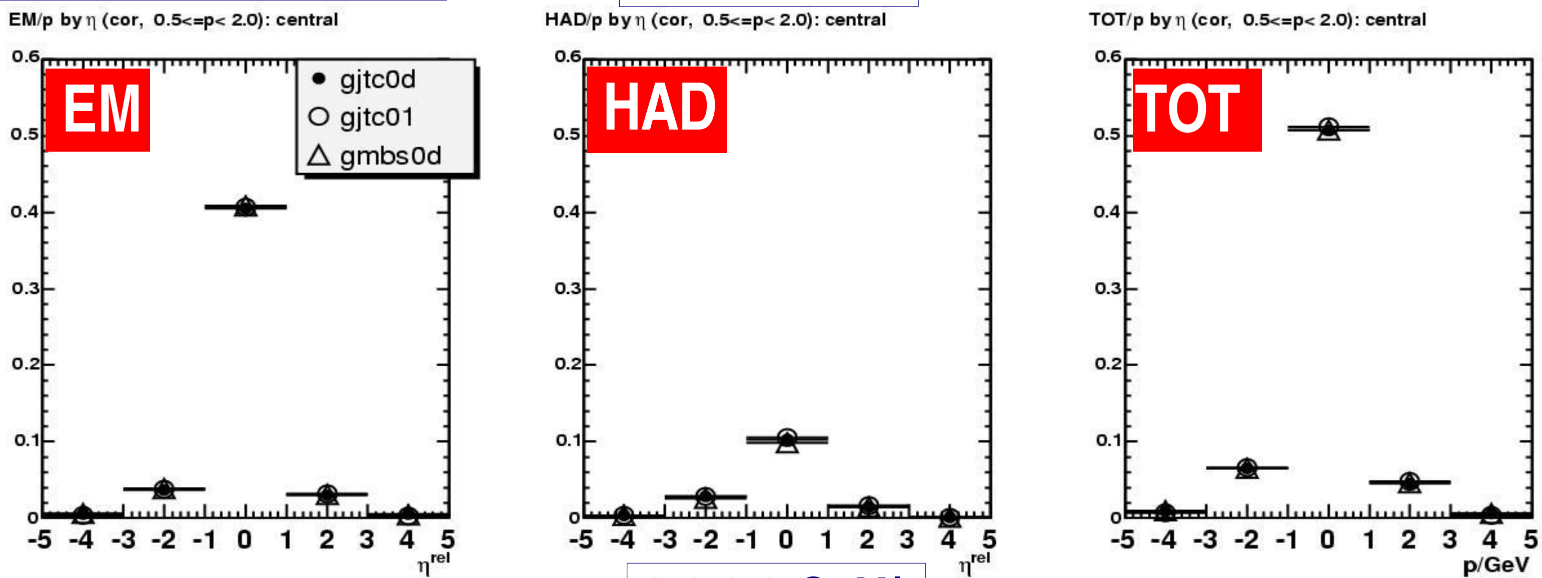


- JET_CALIB: gjtc0d (16M), gjtc01 (1.3M)
- Minbias: gmbs0d (13M of 21M) suffer from too low single track statistics at p>6GeV/c
- Reasonable agreement within statistical uncertainties. Structure in gjtc0d around 6GeV/c "consistent" with other data samples.

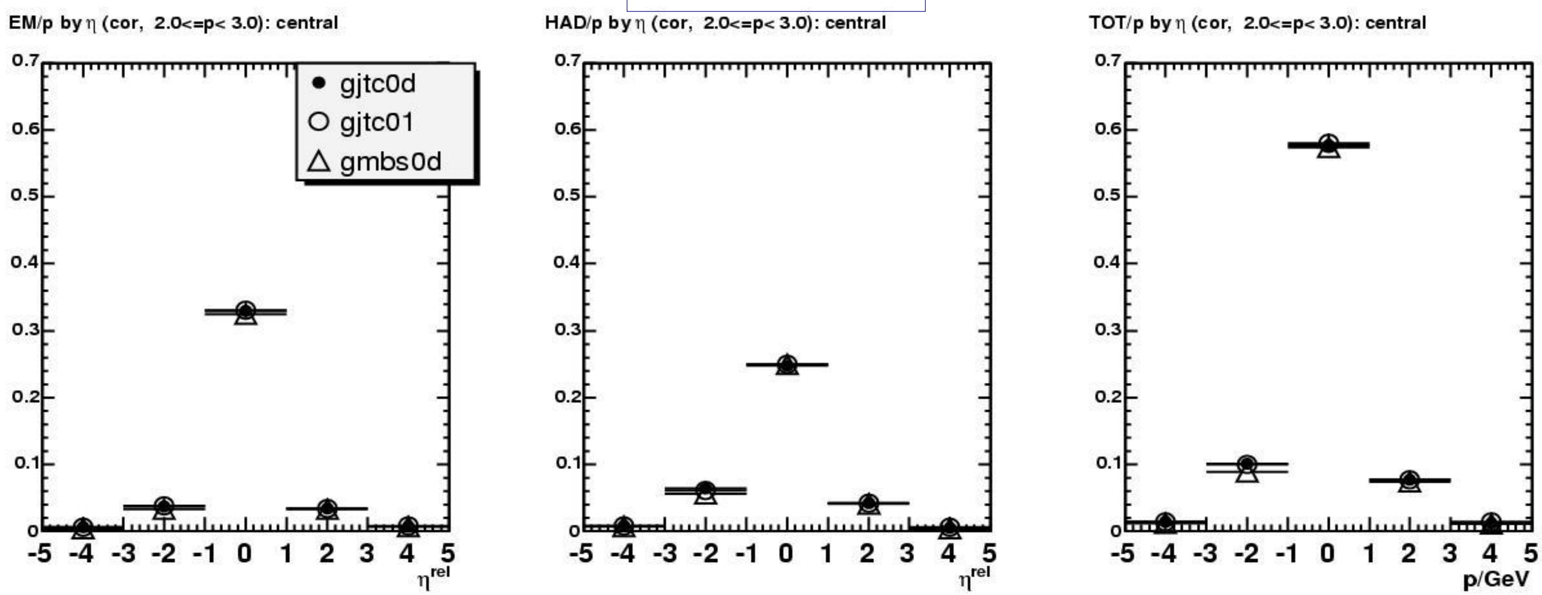
Lateral Profile vs. Data Samples, Central (1)

Unweighted lateral profiles:

0.5-2.0 GeV/c

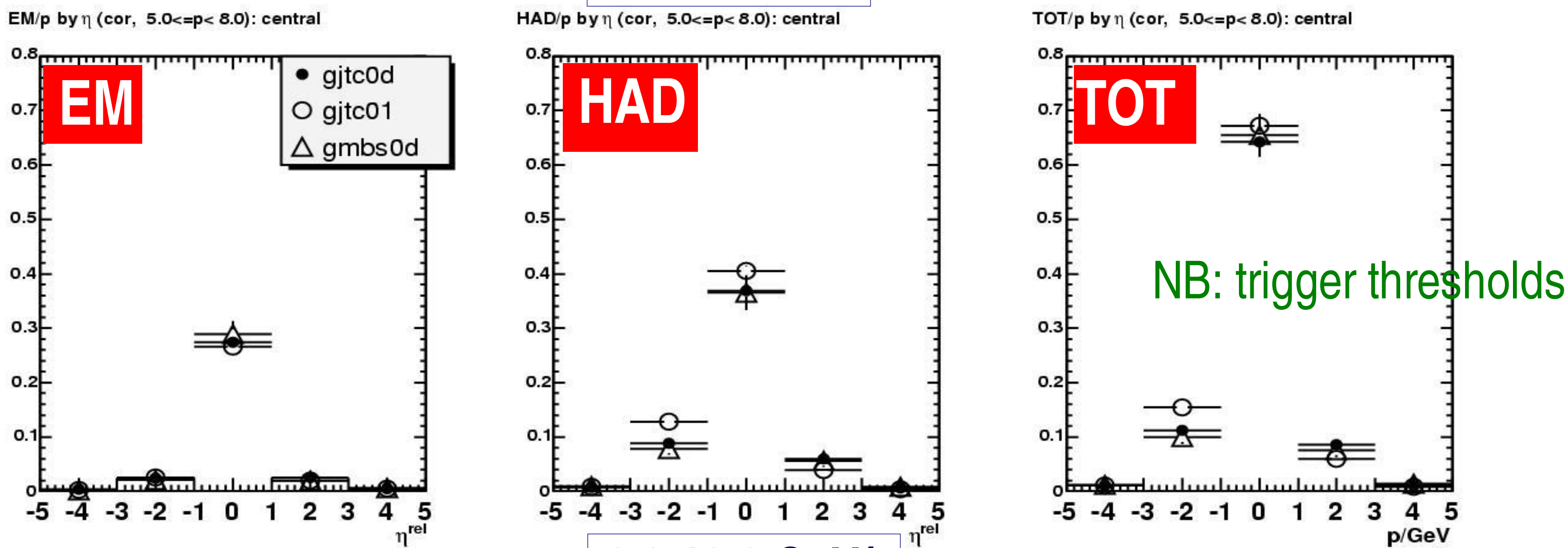


2.0-3.0 GeV/c

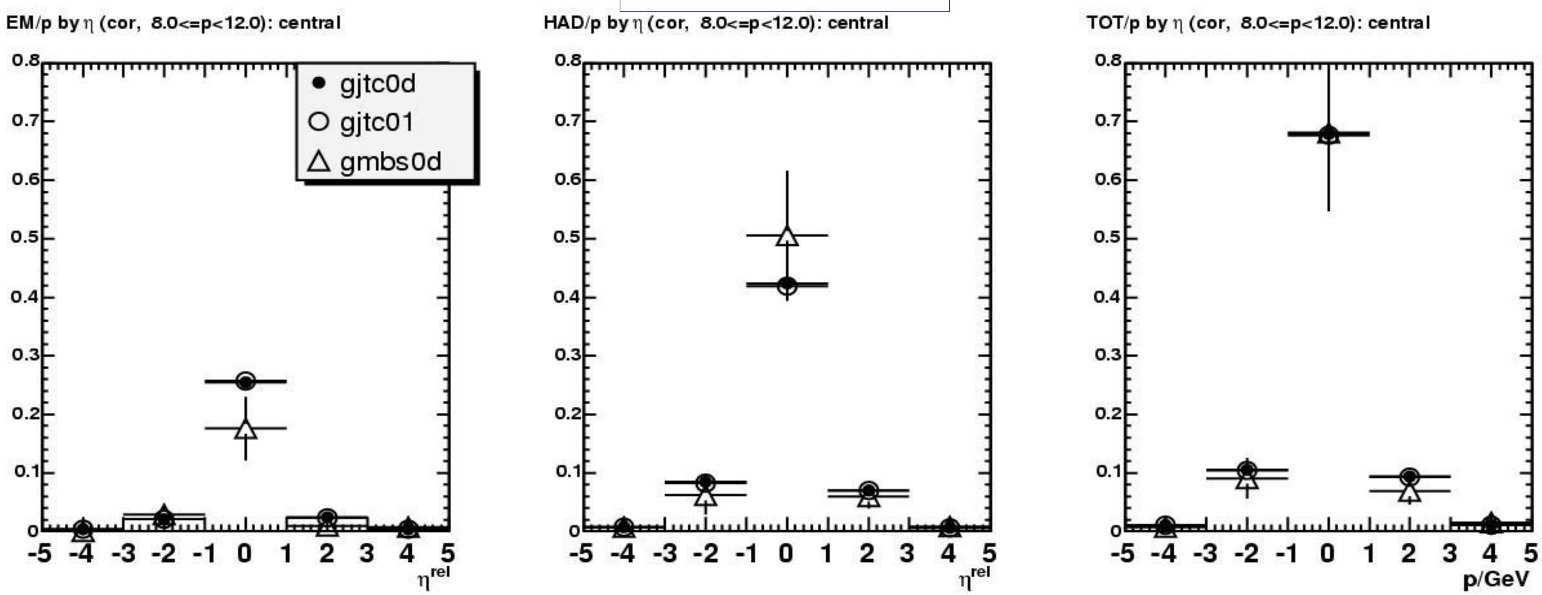


Lateral Profile vs. Data Samples, Central (2)

5.0-8.0 GeV/c

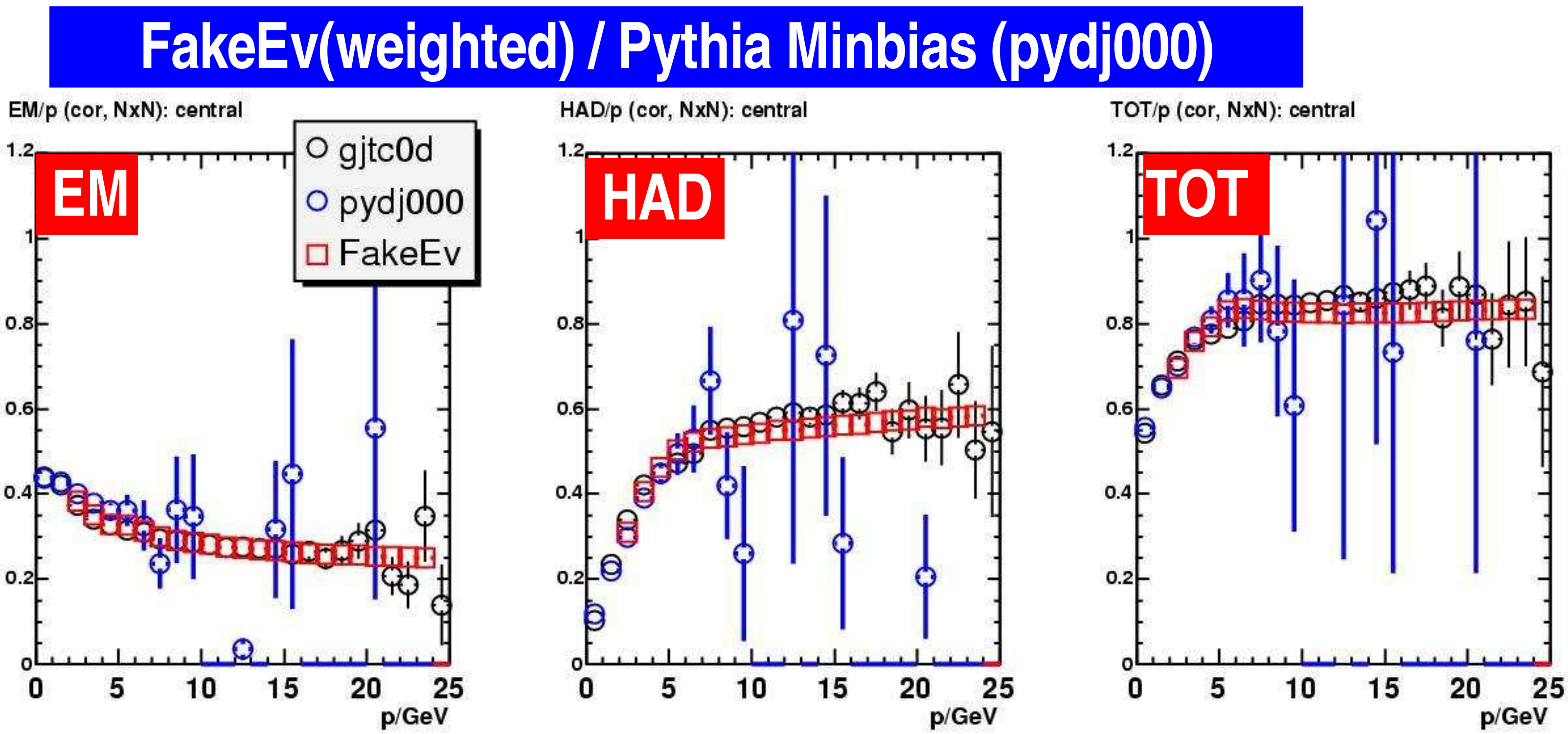


8.0-12.0 GeV/c



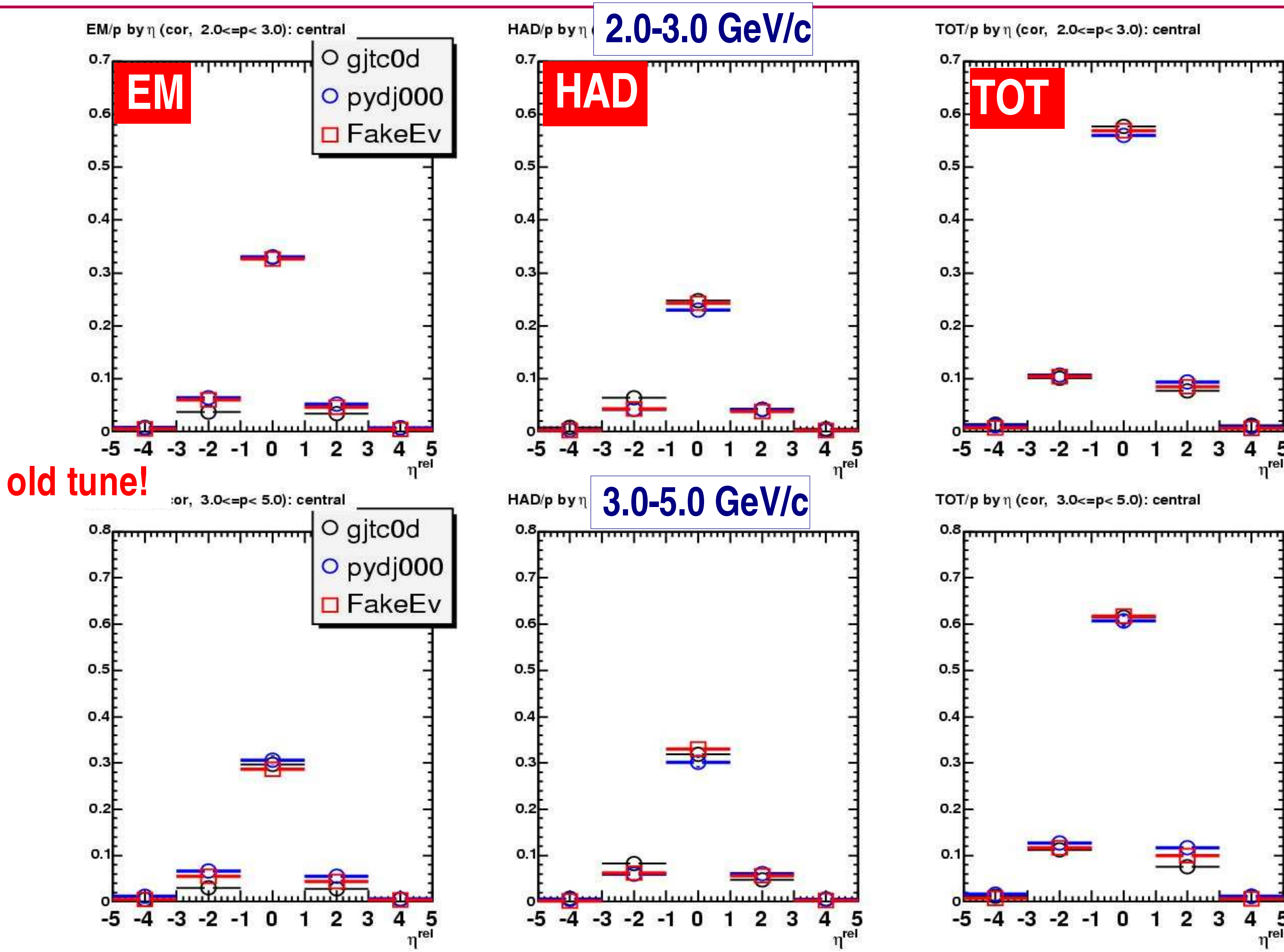
Cross-Check of MC Samples, Central

MC shown in the following are based on old tuning!

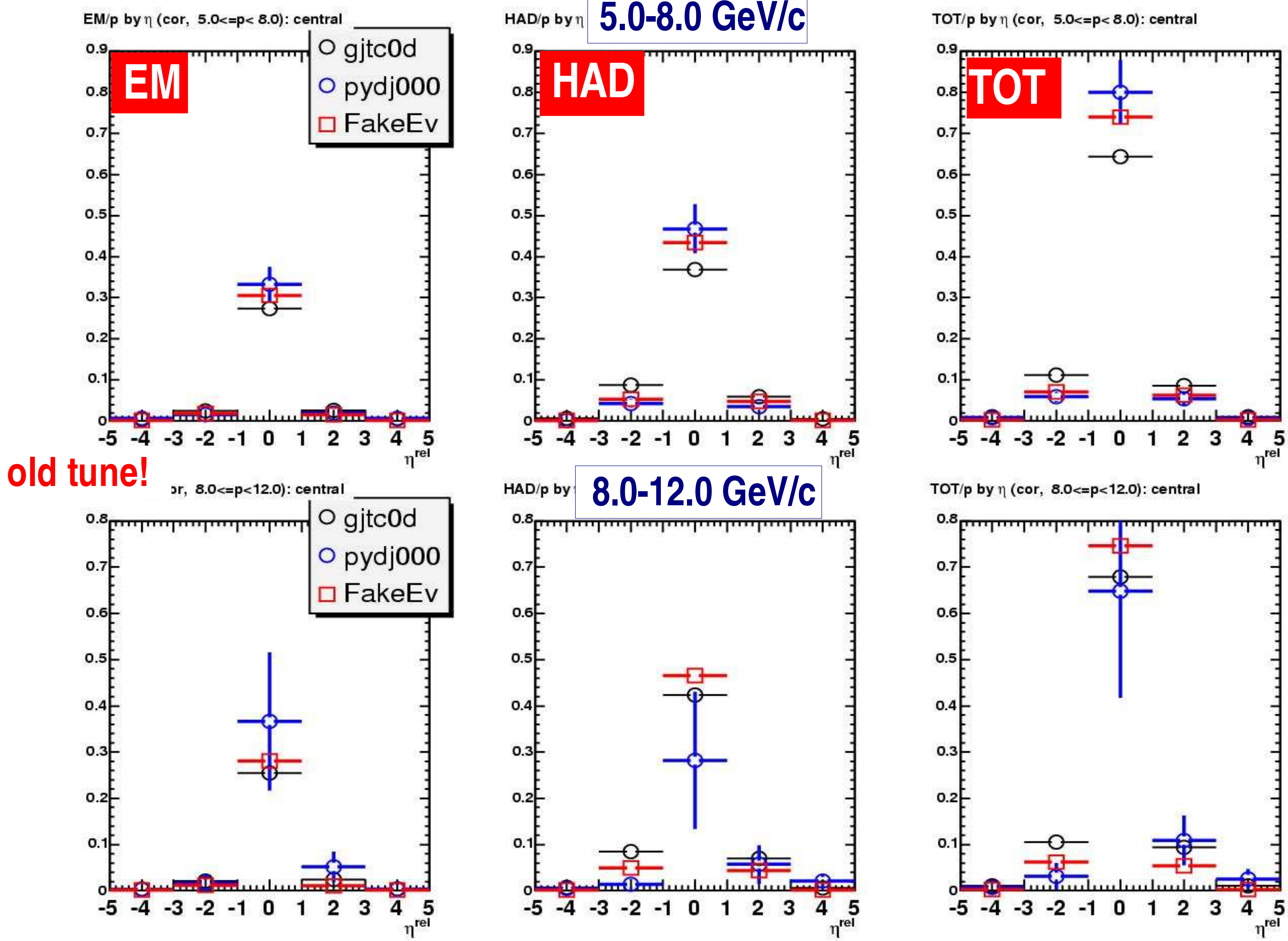


- Reasonable consistency within statistical uncertainties.
- FakeEv somewhat better than Pythia MB (probably due to due to reweighting).
- PYTHIA Minbias sample suffer from too low statistics at p>6GeV/c.

Cross Check of MC Samples, Central (2)



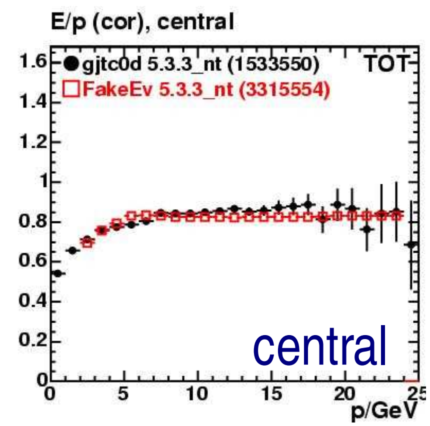
Cross Check of MC Samples, Central (3)



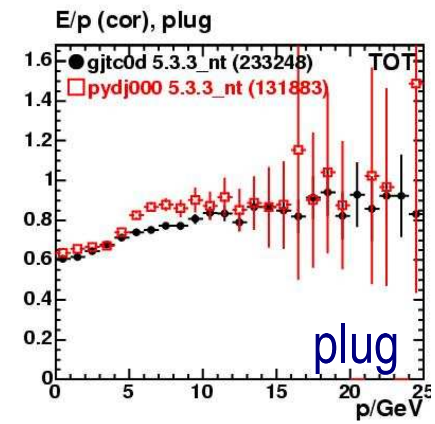
Tuning in the Plug

- We are using IO tracks in the plug to minimize E/p bin migration effects, using target towers 13-15 (see my Simulation Group talk 8/11)
- Central and plug response agree qualitatively.
- Plug tuning in the past was based on Minbias data and MC. We want to switch to FakeEv to have more efficient production of high P tracks.

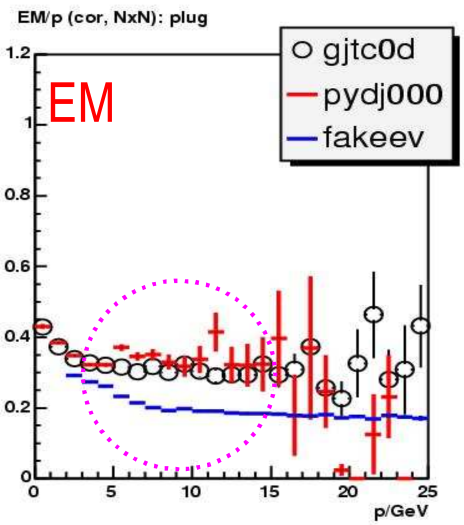
FakeEv vs. JET_CALIB

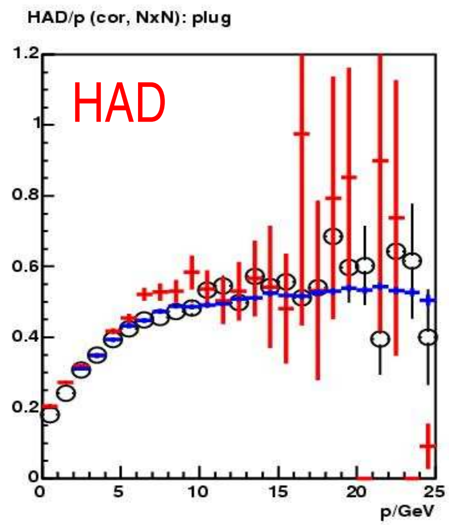


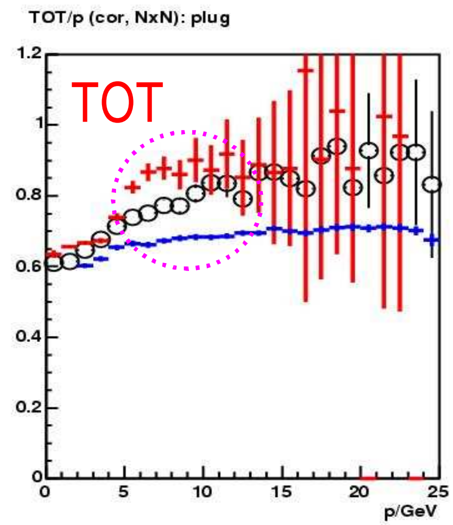
Pythia MB vs. JET_CALIB



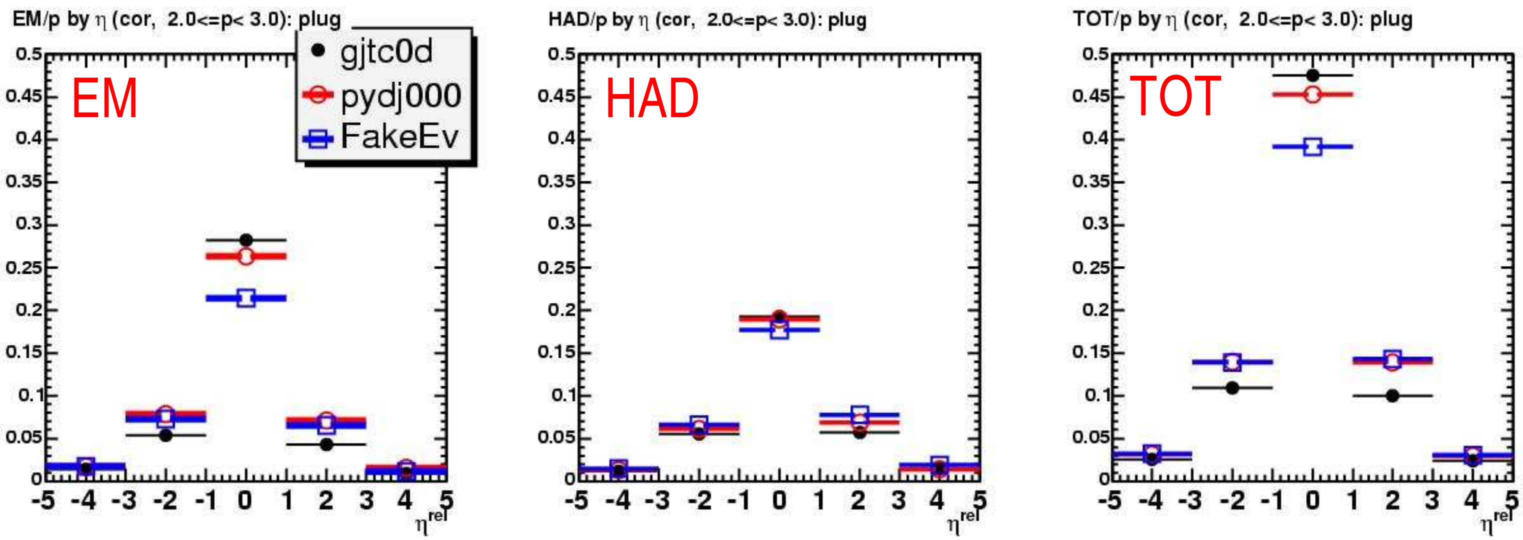
But... FakeEv disagrees with Pythia MB w.r.t. absolute response...





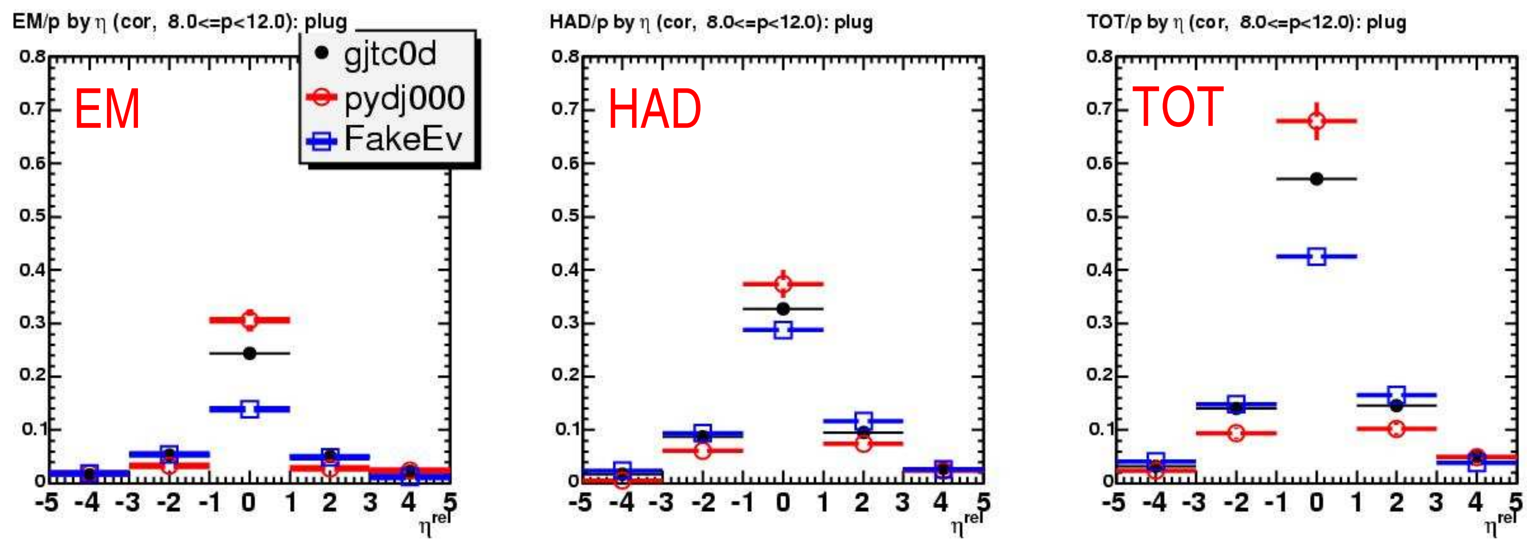


Plug Lateral Profiles: FakeEv vs. Pythia MB



2-3 GeV/c

8-12 GeV/c

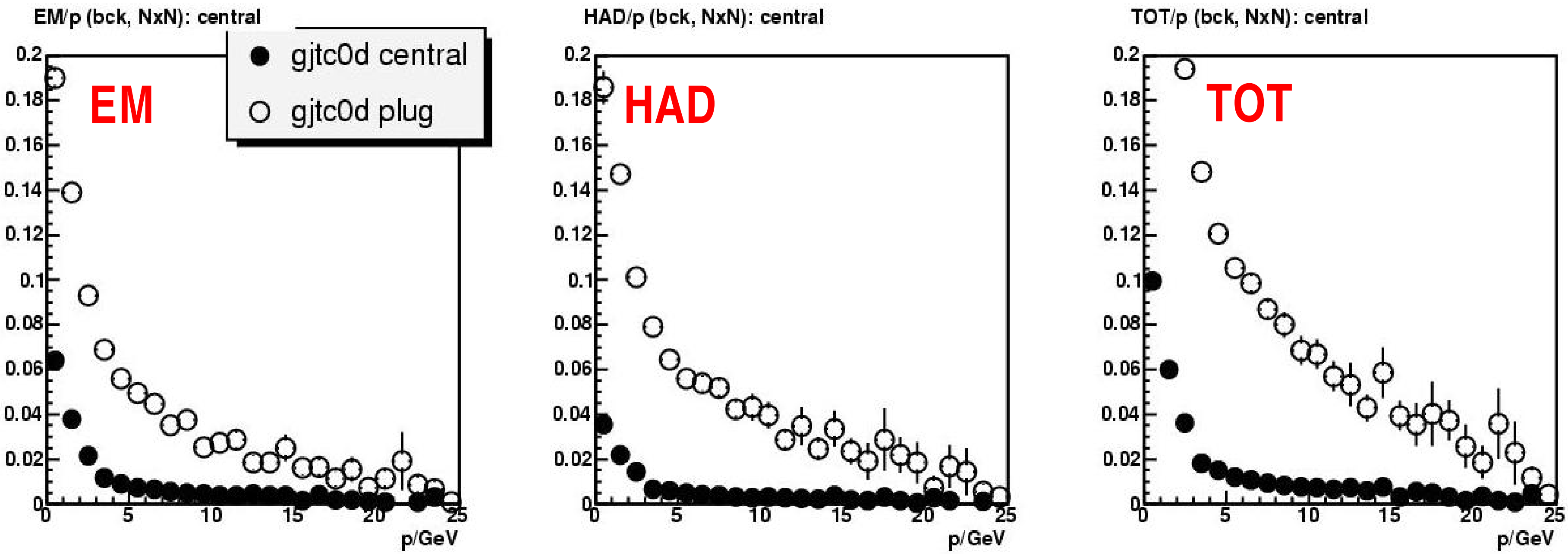


Note that Pythia MB profiles (tuned to p<2.5GeV/c data) are again too narrow at high p.

...and also disagrees w.r.t. lateral response

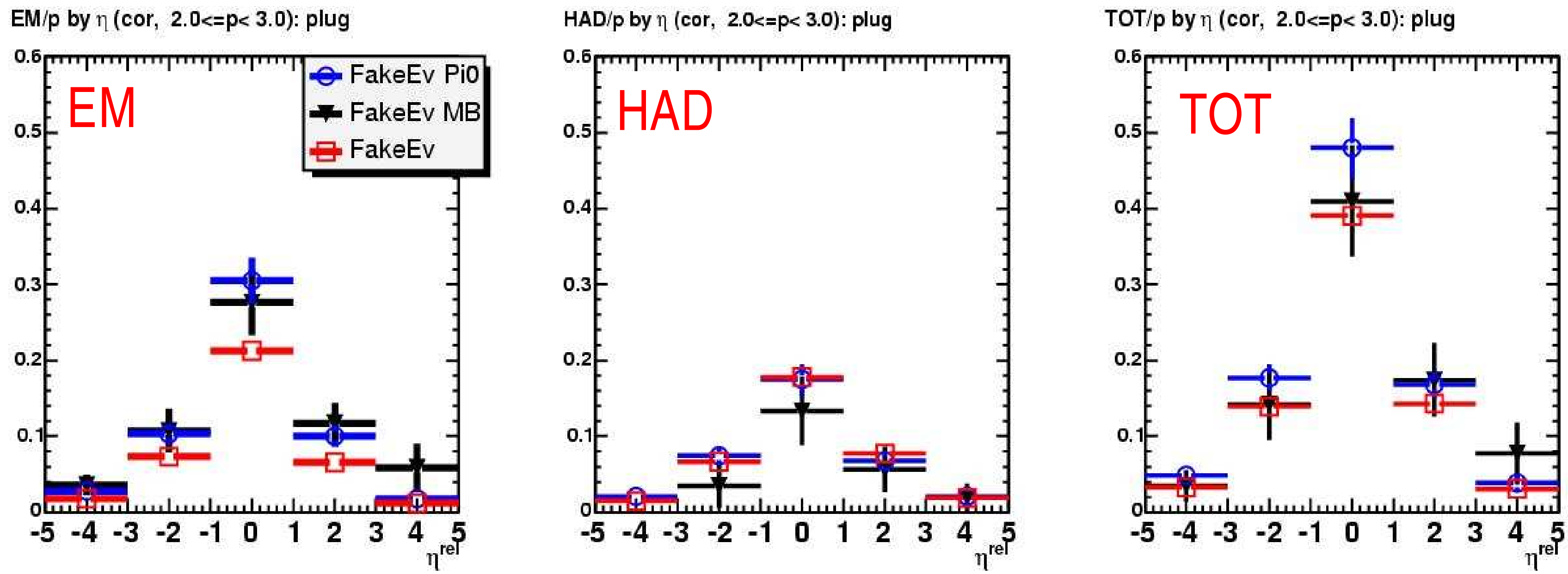
- discrepancy can not be handled by normalization

Plug Backround Response



- FakeEv and Pythia MB have very different background scenario.
- Background contribution in the plug is much larger than in the central!
- Unfortunately we still don't use PES to reduce non-corrigible background (next page).

Plug Lateral Profiles: Background



- Example: Consider three FakeEv versions.

  FakeEv ... plain version with charged particles

  FakeEv MB ... FakeEv + Minbias

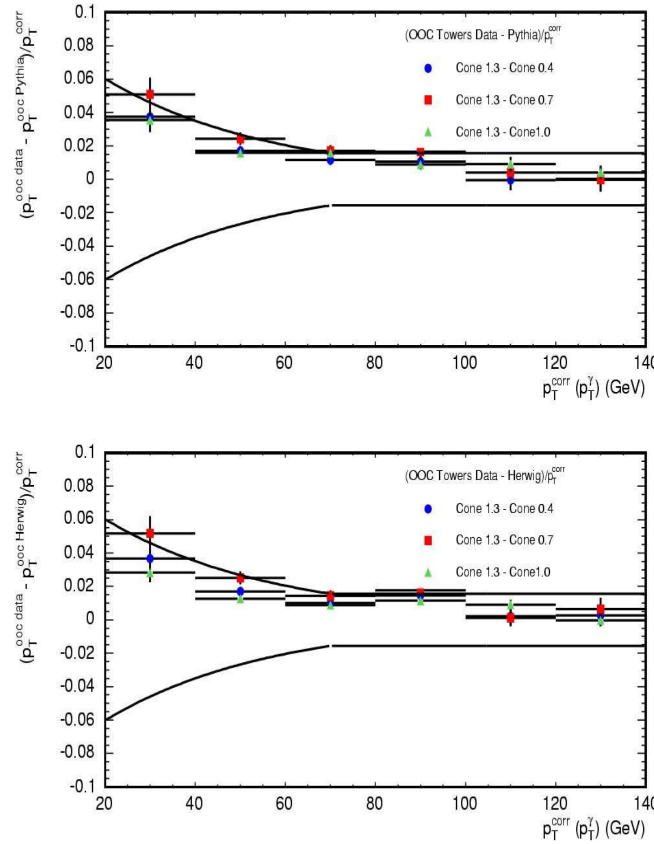
  FakeEv Pi0 ... FakeEv + π^0 component collinear to (1/p^2 spectrum, 30% probability)
- N.B.: the above histograms are <u>corrected</u> lateral responses:

  - background estimate: E/p of "near" and "far" block within same ϕ strip
- By adding background the profile can almost arbitrarily be shaped. Improved PES simulation (Gen-6) is expected to reduce this effect.
- For the plug we should probably use a reasonable physics model that we trust (Pythia MB?)

Conclusions

- Tuning significantly improves simulated lateral response in the central part up to 20 GeV/c.
- New profiles are <u>broader</u> at high momenta. This will help to reduce current OOC uncertainty δ_{OOC}:
  - OOC flow in Gen-5 simulation has <u>deficit</u> w.r.t. data.
  - Sources: modelling of hadronization + shower profile
  - This deficit enters directly into definition of δ_{OOC}.
- Refinements planed for central part (deadline 12/1):
  - Optimize Gflash shower cutoffs.
  - Include recent/ongoing single track trigger data.
  - Introduce η dependence (target towers 0, 1-4, 5-8).

Gen-5 OOC energy flow difference DATA minus MC



- Cross checked E/p responses (absolute, lateral) with different data and MC samples – expectedly no surprises.
- Will start plug tuning soon:
  - Same philosophy but probably using Pythia instead of FakeEv.