Simulated Calorimeter Response in the Plug and at High Momenta

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Outline

1. Update of Gflash lateral hadronic shower profile tuning (central)
   - Re-evaluation after a bugfix
2. Central single particle response up to ~32 GeV/c
   - Inclusion of new single track trigger data
3. Single particle response in the plug
4. Conclusions

1. Gflash Lateral Profile

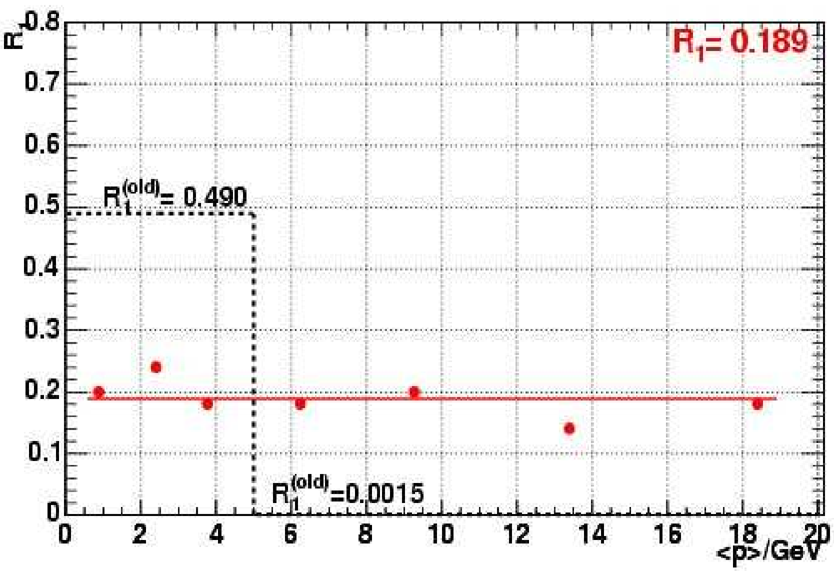
Lateral Profile Tuning Update

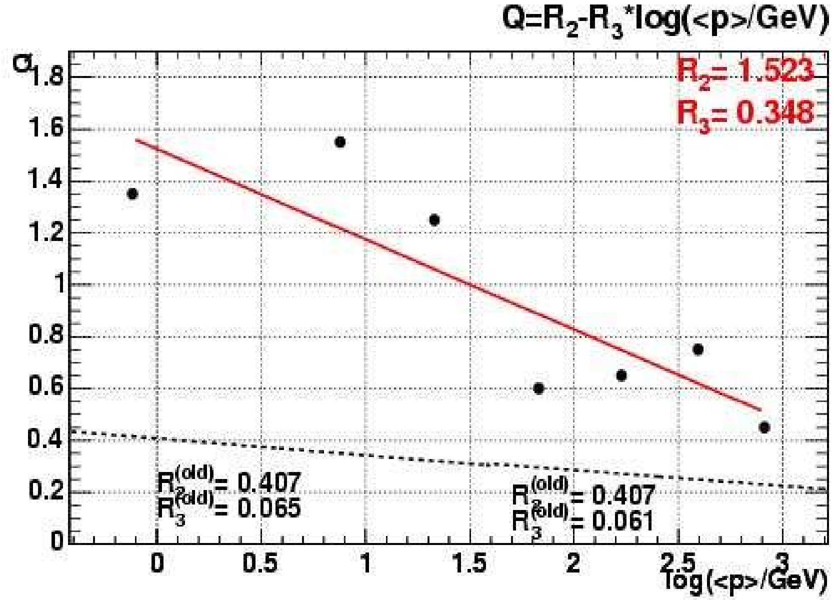
Hadronic lateral profile

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

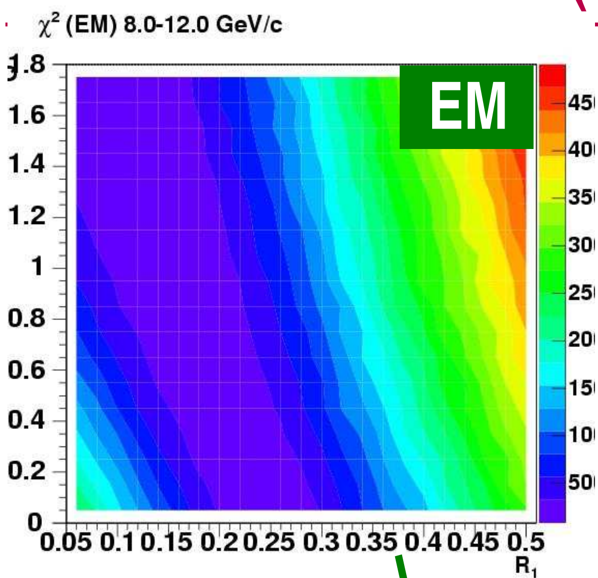
- Tuned FakeEv ($\pi^{\pm}K^{\pm}p$) with single track trigger data sample gjtc0d
- Corrected a bug: some Gflash parameters (passed to simulation via talk-to) were not correctly mapped to a Fortran COMMON block
- Doesn't affect much R_1 but R_2 and R_3

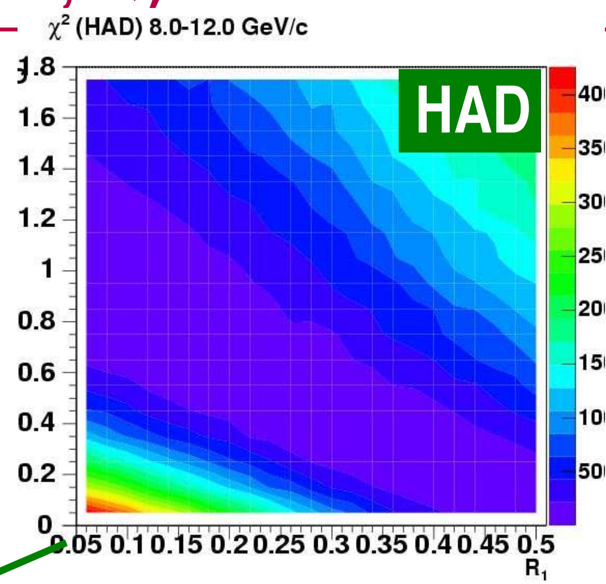
Updated tune values from <u>combined</u> EM and HAD information:

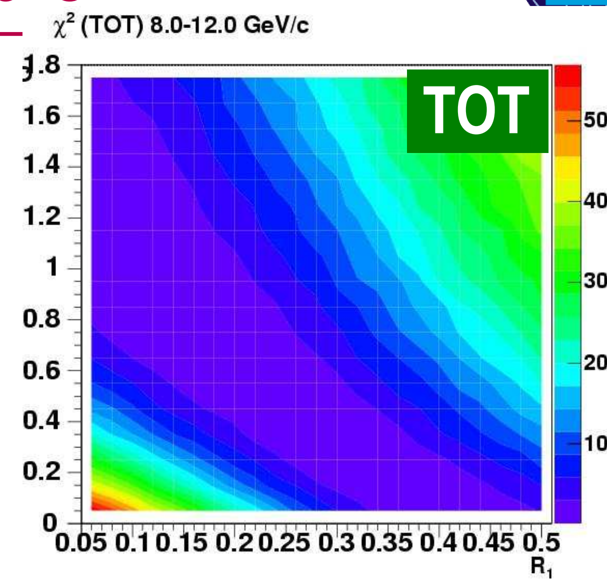


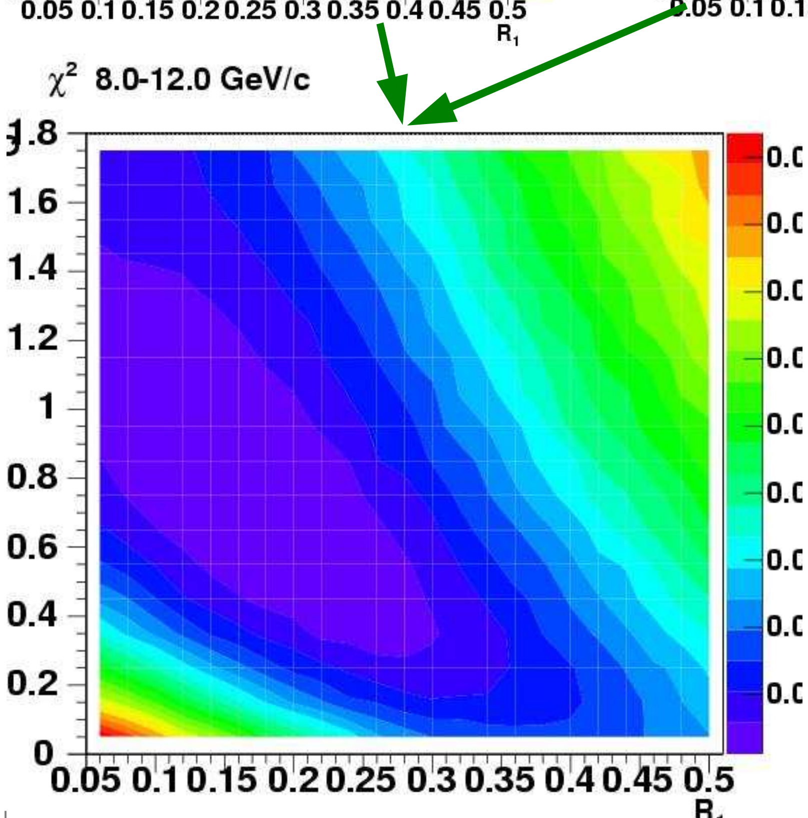


(R1,Q)-Scan Example



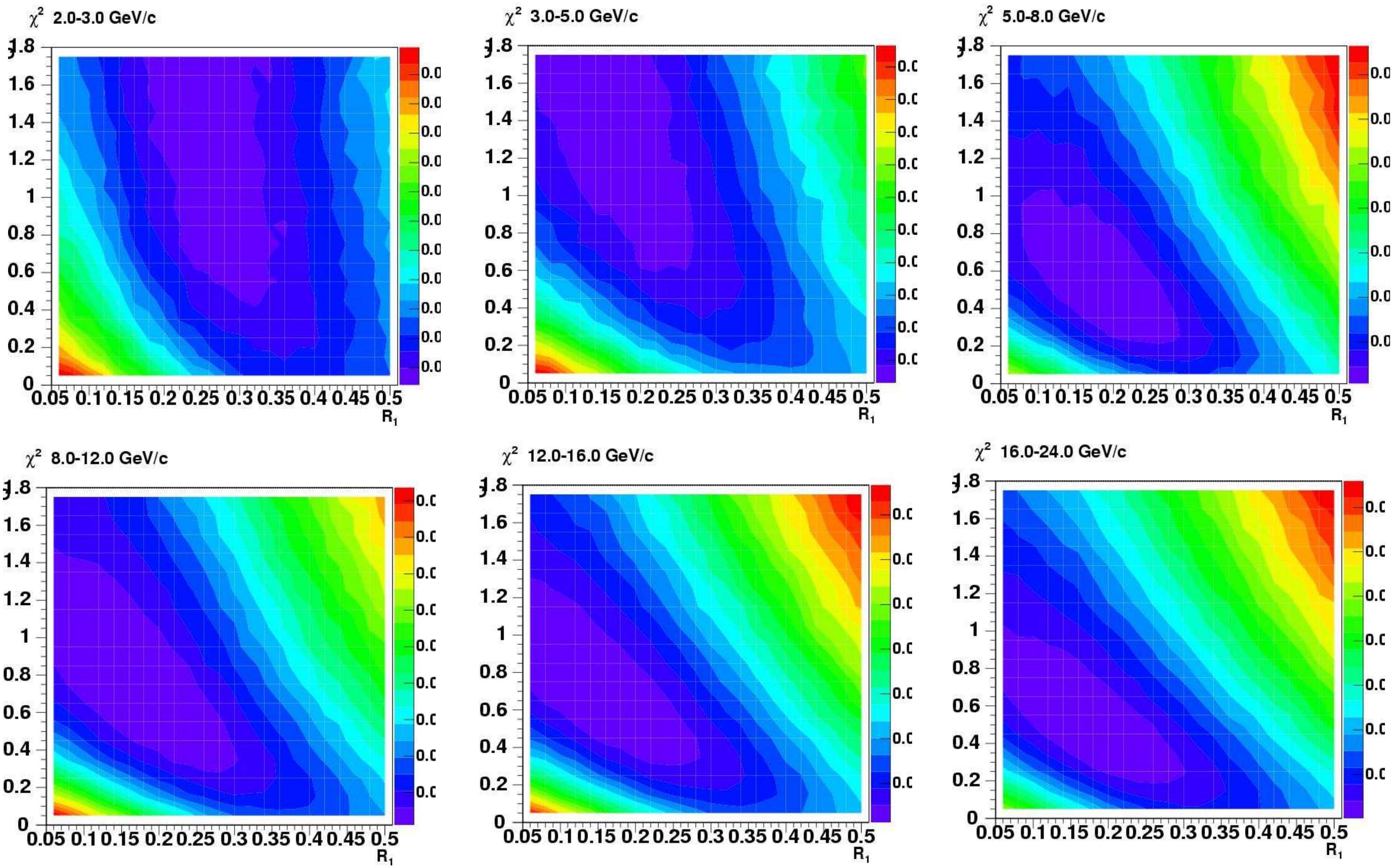






- After bug fix contours are more unambigous.
- As expected, core and spread term appear anticorrelated.
- Use sum of “normalized” χ^2 from EM and HAD for tuning.
- Existence of two different calorimeter compartments provides reasonable constraint at a given momentum.

(R1,Q)-Scans



χ² 2.0-3.0 GeV/c
χ² 3.0-5.0 GeV/c
χ² 5.0-8.0 GeV/c
χ² 8.0-12.0 GeV/c
χ² 12.0-16.0 GeV/c
χ² 16.0-24.0 GeV/c
0 0.2 0.4 0.6 0.8 1 1.2 1.4 1.6 1.8
0.05 0.1 0.15 0.2 0.25 0.3 0.35 0.4 0.45 0.5
R1

2. Central Response up to 32GeV/c

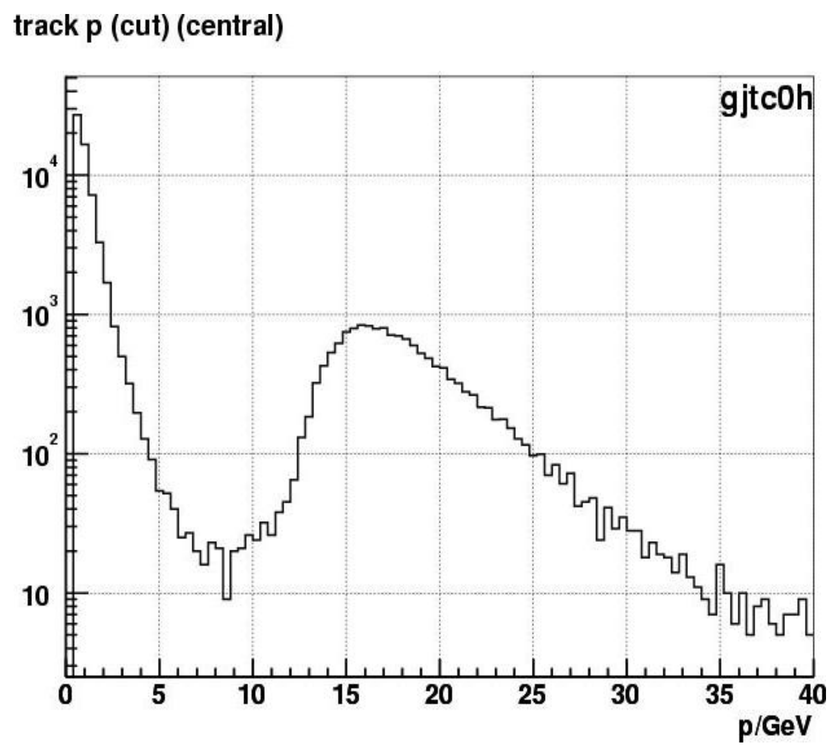
New Single Isolated Track Data

gjtc0h: (from end-of-store runs w/ 15 GeV/c trigger threshold)

tower number	momentum range (GeV/c) ≥ 2	0.5-2	2-3	3-5	5-8	8-12	12-16	16-24	24-32	>32
0	3722	10322	465	160	39	88	1503	1317	111	37
1	4005	10342	523	153	46	78	1536	1475	143	50
2	3907	10538	454	168	43	52	1272	1718	155	45
3	3854	10963	530	172	50	67	903	1870	218	44
4	3801	10799	591	226	44	44	592	1986	240	78
5	3832	11443	707	243	46	36	327	2024	356	93
6	3767	11806	778	313	59	24	169	1844	460	120
7	4152	14190	1026	408	79	37	59	1747	638	157
8	3524	15232	1348	555	112	33	32	885	464	95
9	3517	25281	2222	995	218	50	12	9	7	4
10	3502	17472	2118	1011	294	67	4	5	2	1
11	6701	22020	3865	2122	530	130	18	24	9	3
12	4768	10053	2662	1548	420	93	28	11	4	2
13	12258	12362	5852	4449	1421	347	96	52	28	13
14	15088	9239	6371	5710	2148	595	141	76	23	24
15	6190	2321	2228	2410	1085	312	72	52	17	13
16	74161	53408	33276	26242	10139	3130	667	379	134	158
17	67599	28963	28263	23457	10432	3575	851	531	181	227
18	55721	8501	20407	19206	9773	3837	1093	699	256	342
19	24344	56	5663	8723	5308	2464	856	625	245	351
20	522	0	6	186	139	81	47	30	8	18
21	11	0	0	1	3	3	0	2	1	0
central (1-5)	19399	54085	2805	962	229	277	4630	9073	1112	310
wall	14960	66509	5374	2271	468	144	272	4485	1569	376
crack	10203	39492	5983	3133	824	197	22	29	11	4
plug (13-15)	33536	23922	14451	12569	4654	1254	309	180	68	50
beam	148186	37520	54339	51572	25652	9957	2847	1885	690	938

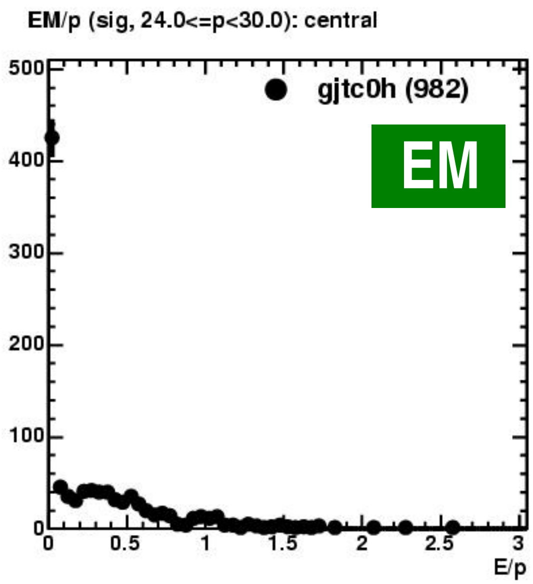
complements scarce data from previous STT runs gjtc0d, gjtc01

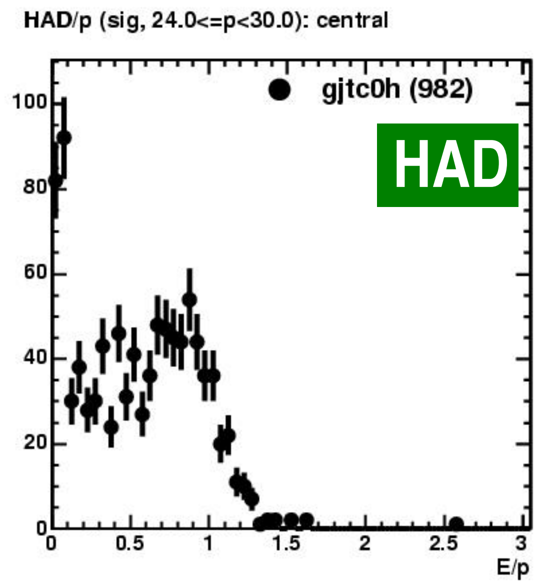
byproduct (IO tracks) usable for plug tuning

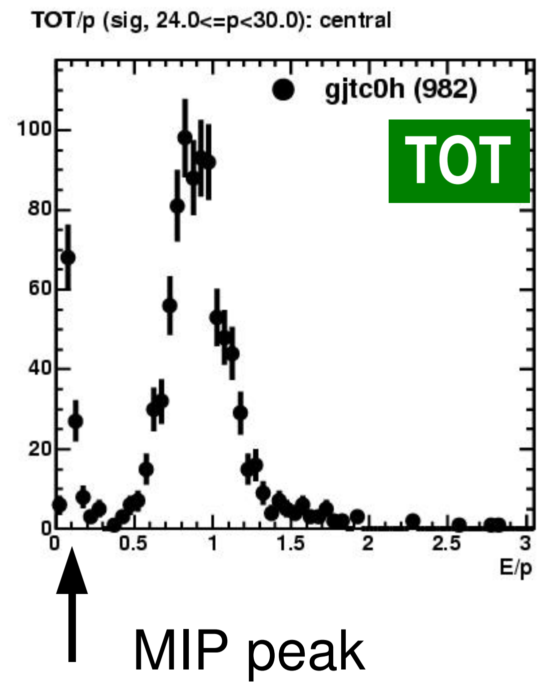


...plus additional contour cuts

Single Particle Response up to ~30GeV/c







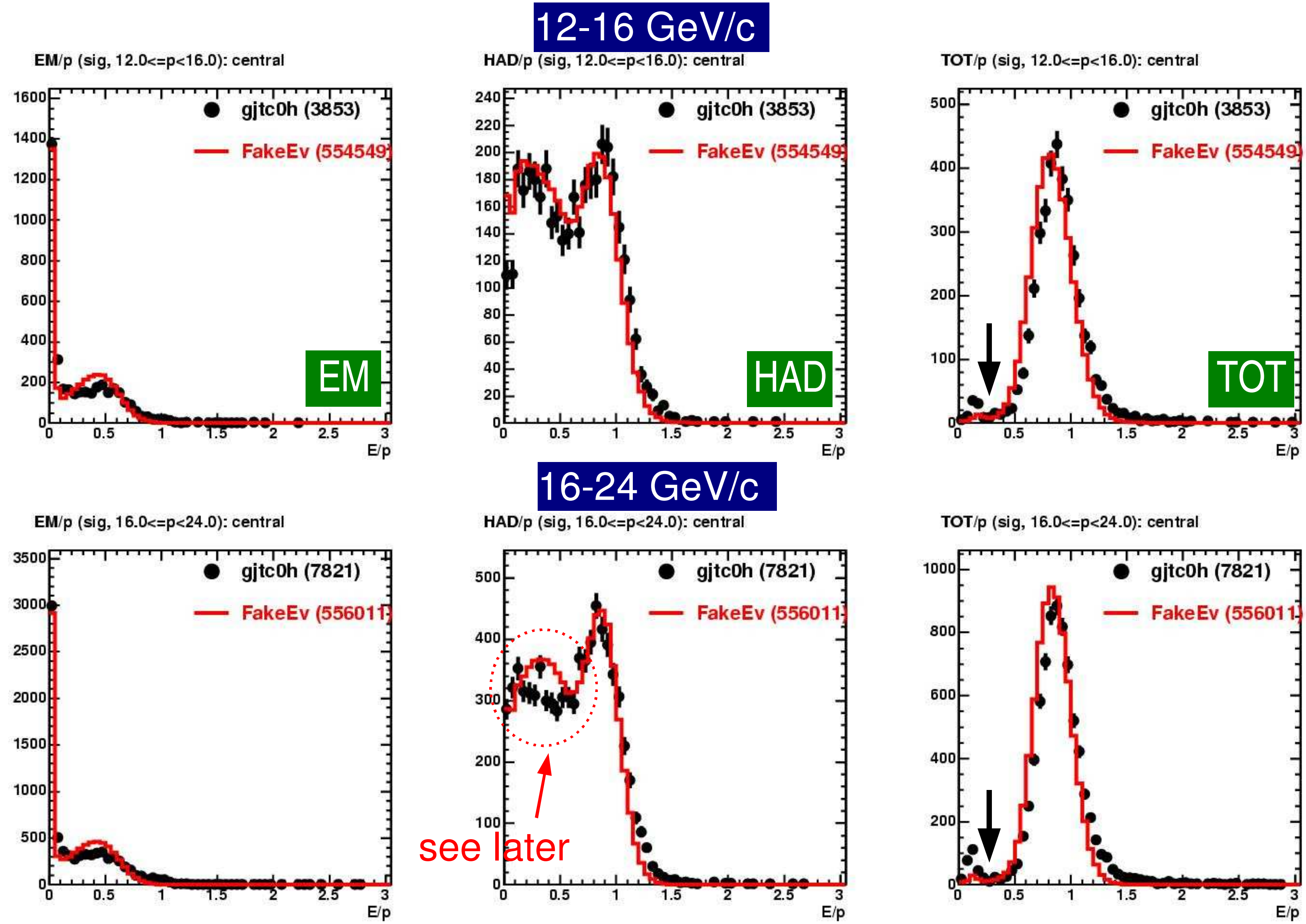
- Use tower groups 1-5 for this study (was 1-4 previously)
- At very high momenta contamination with leptons increases.
- Introduce additional cuts:

  electron veto: $E^{HAD}/E^{EM} > 0.02$

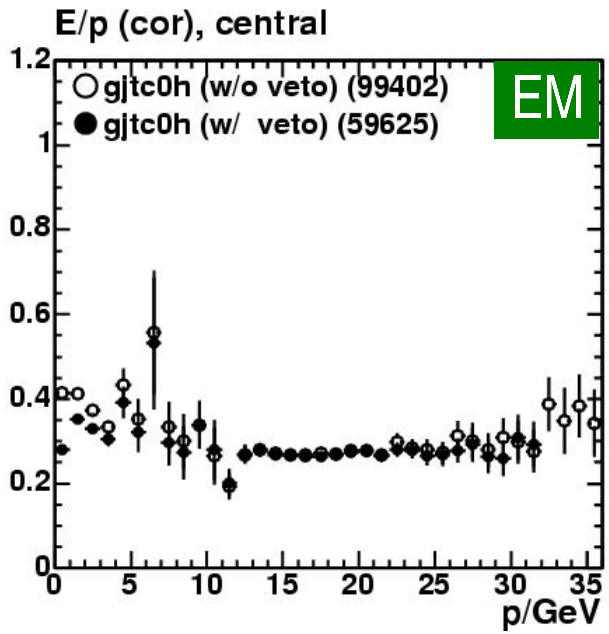
  muon veto: $E^{HAD} > 0.25$ p (for p>8GeV/c)

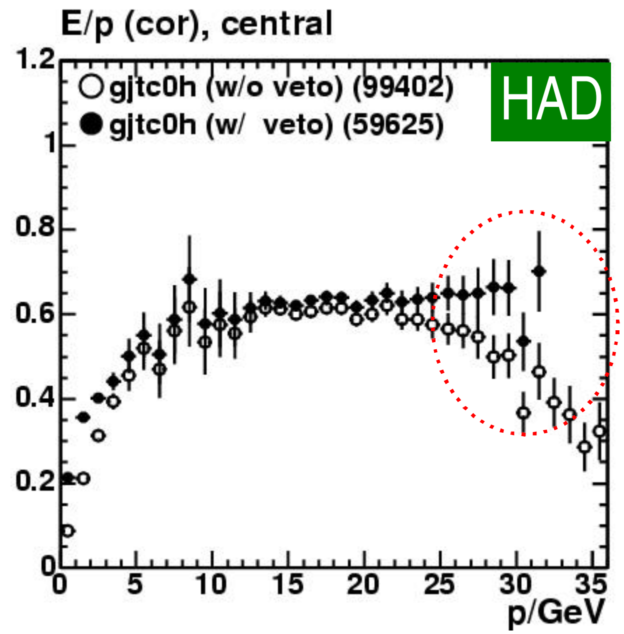
(similar to Soon's initial suggestion)

Comparison with MC (no veto)

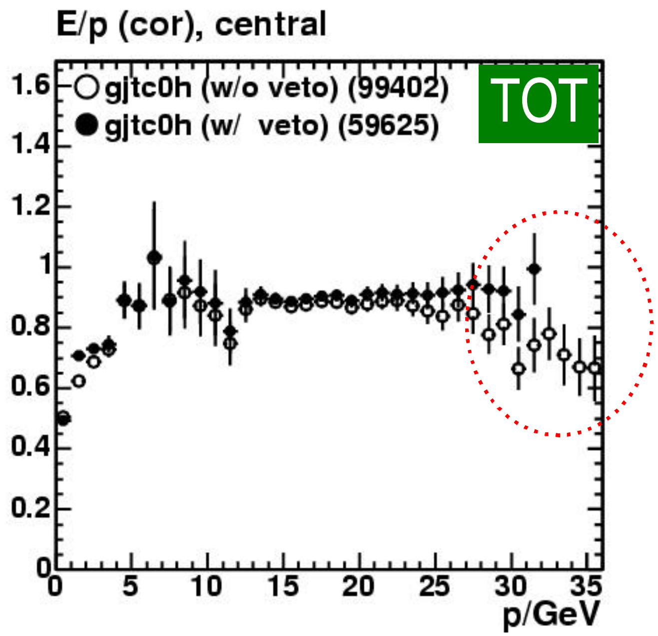


Impact of Lepton Veto on Absolute Response



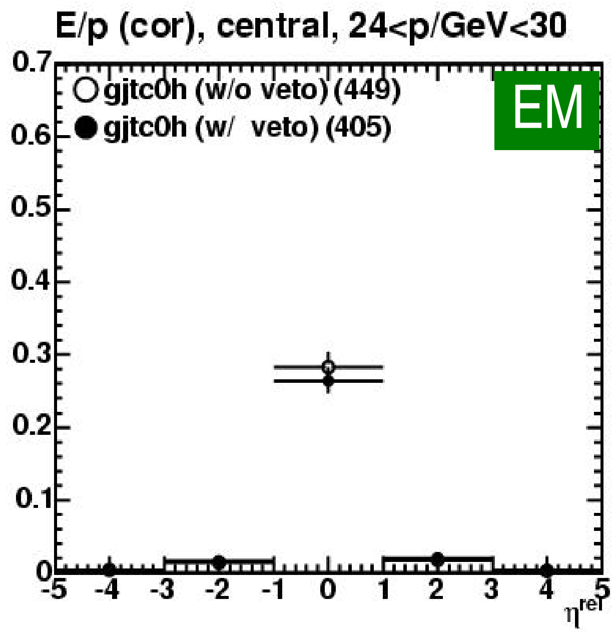


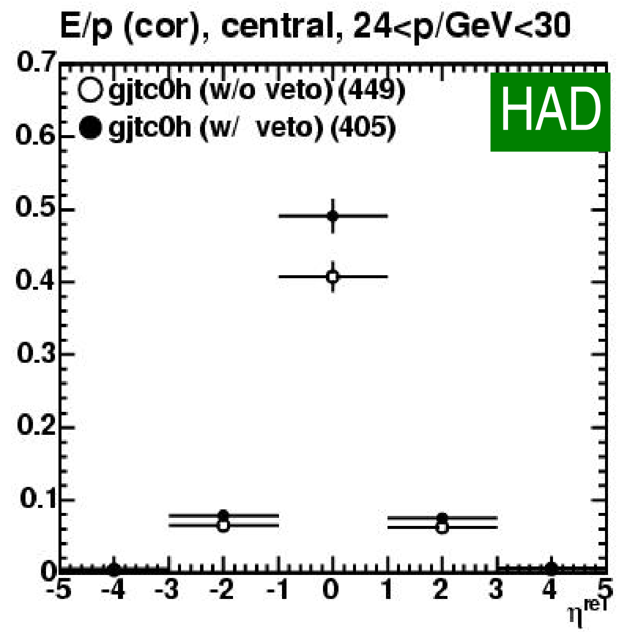
NB: w/ veto histogram ends at 32GeV/c (not a physics effect)

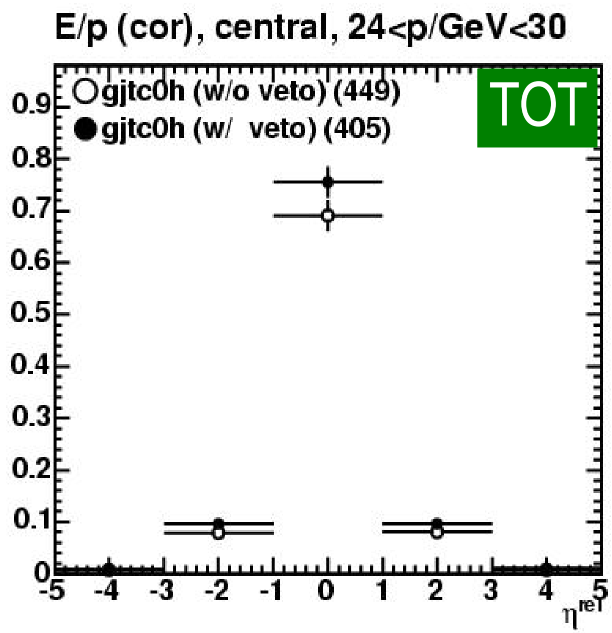


- Presence of MIP particles heavily pull down absolute response at high p

...and on Lateral Profile

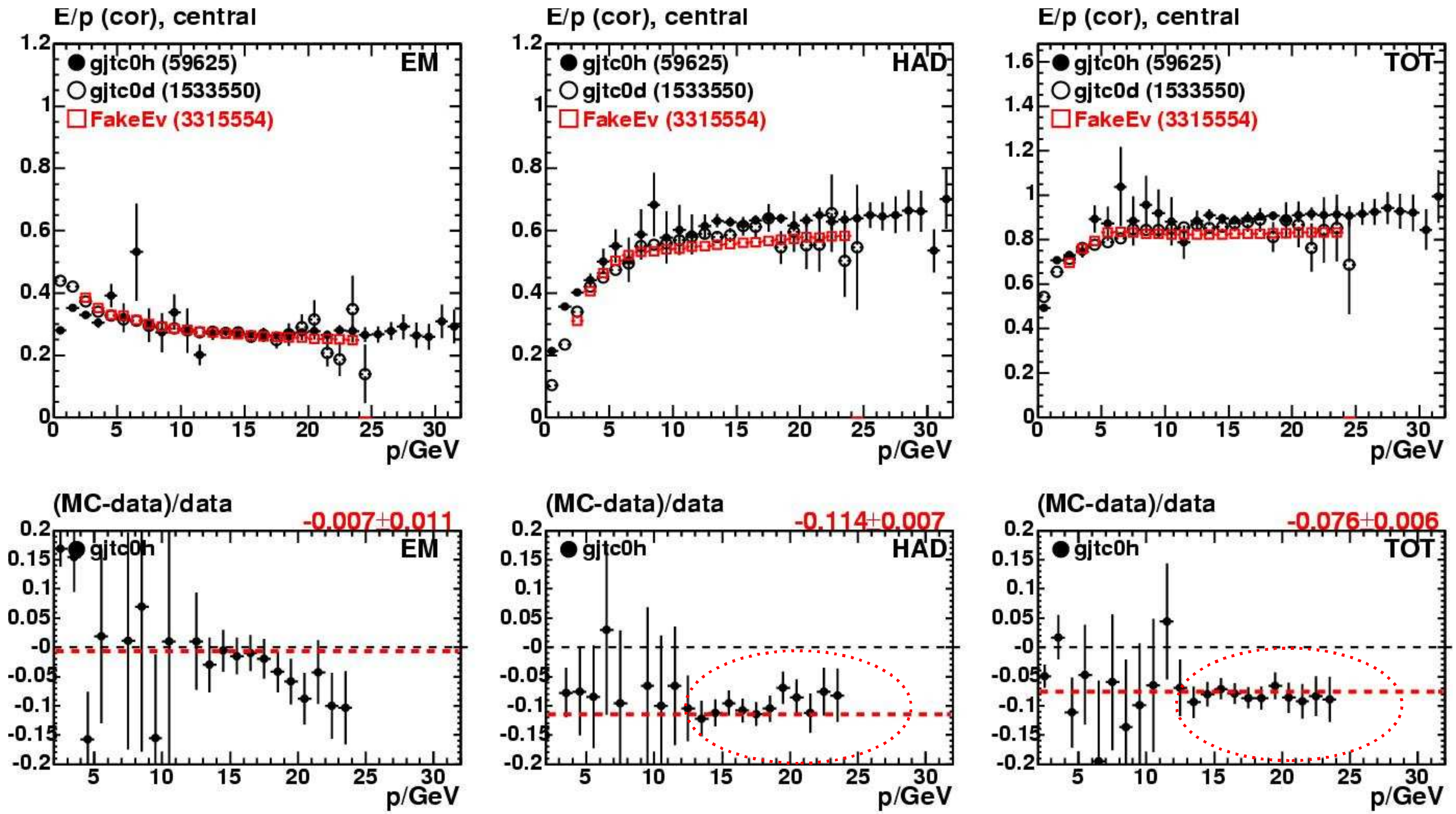






- Has also impact on shape.
- MIP affects mainly target tower.

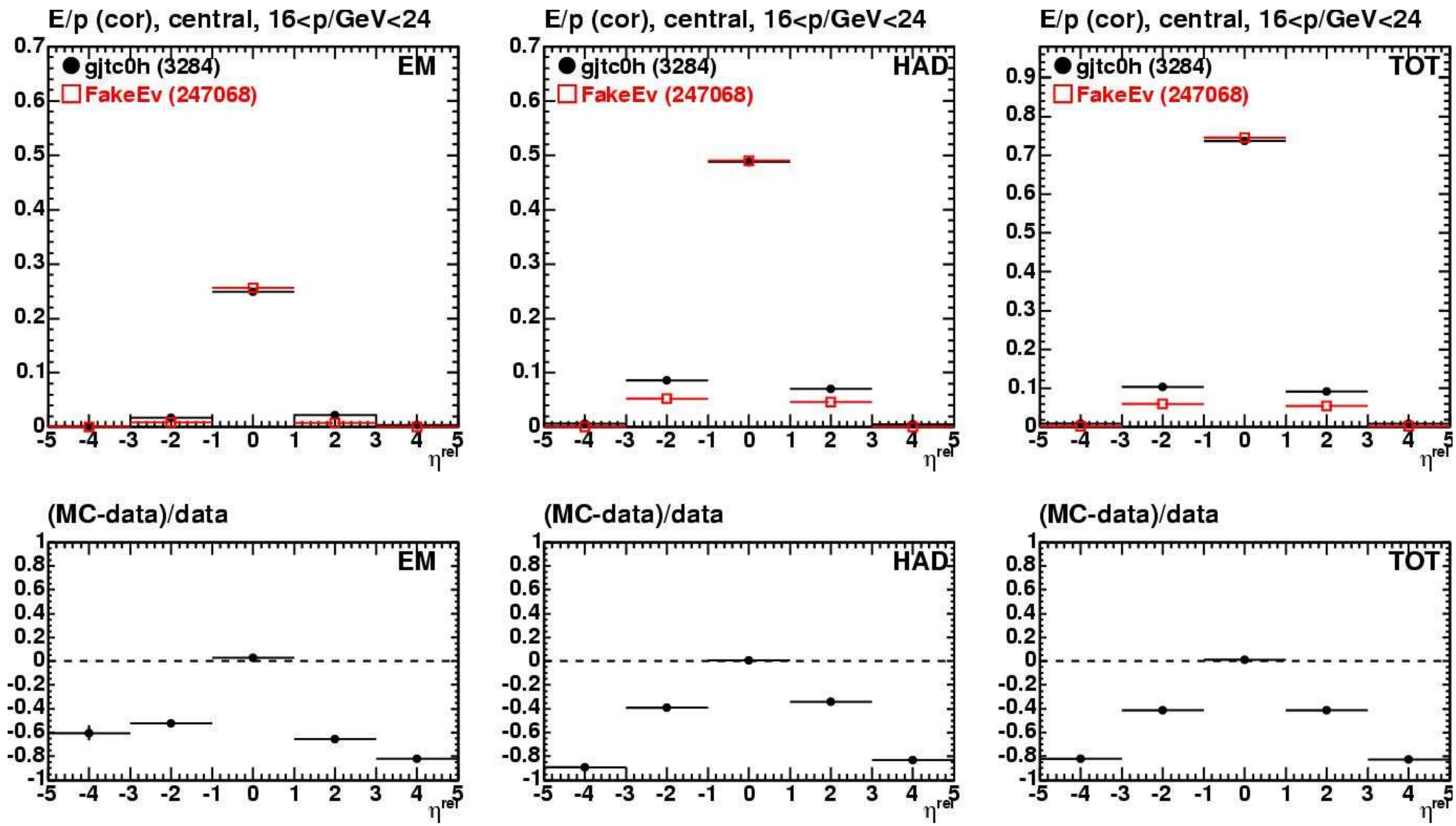
Comparison with MC



Empty symbols: ~ NIM paper
Full symbols: this update

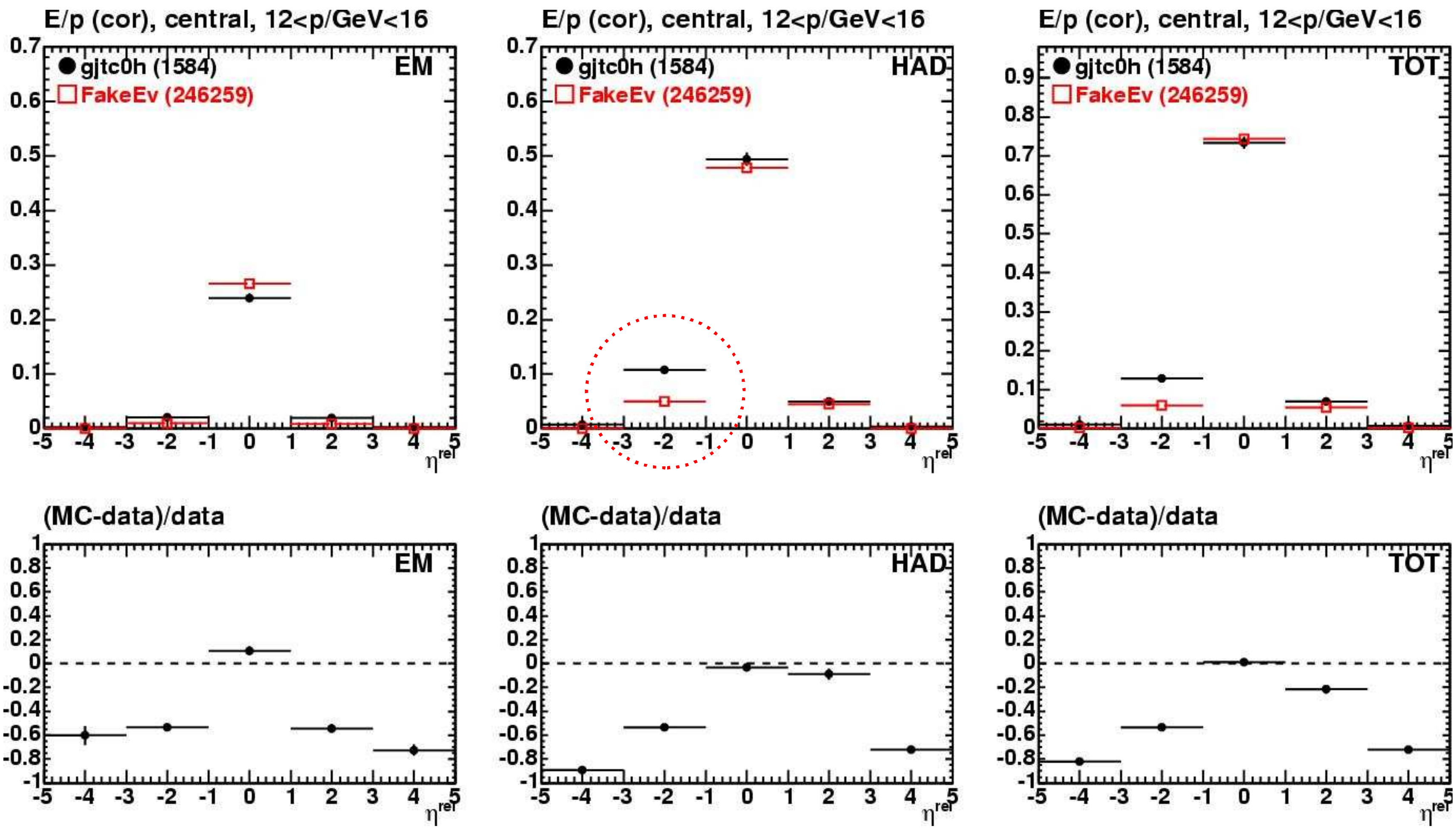
- Data: JETCALIB gjtc0d (no veto), gjtc0h(veto); MC: FakeEv (no veto)
- Clear deficit in simulated absolute HAD response at p>12GeV/c. Discrepancy is larger than stated in the JER NIM paper.

Lateral Profile 16-24GeV/c



- Simulated profiles too narrow, consistent with observation at lower p.

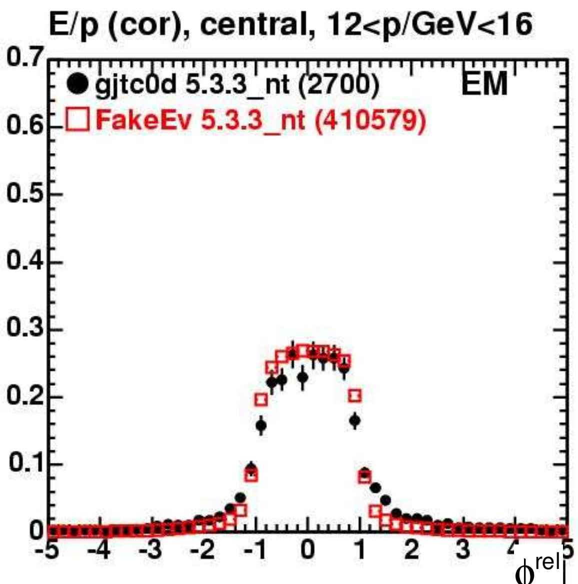
Lateral Profile 12-16GeV/c

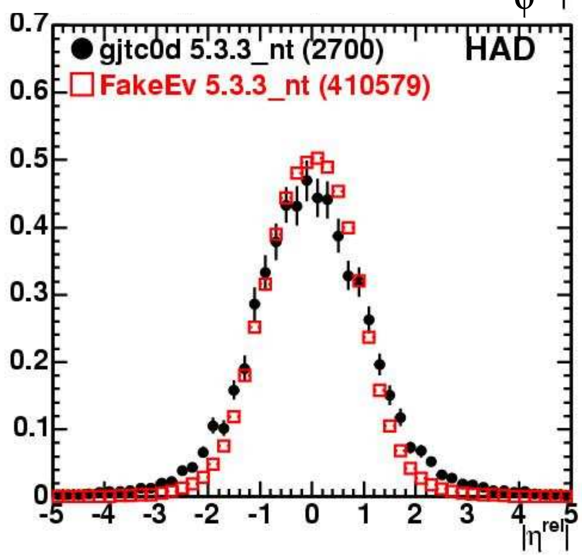


- HAD profile around trigger threshold asymmetric. Why?

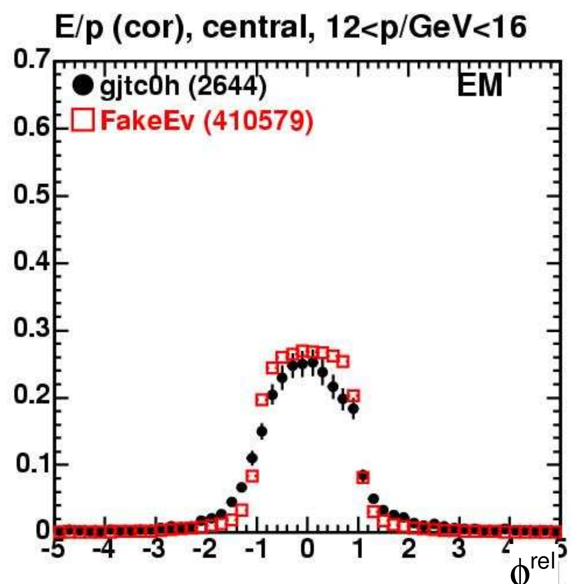
Lateral Profile gjtc0d vs. gjtc0h

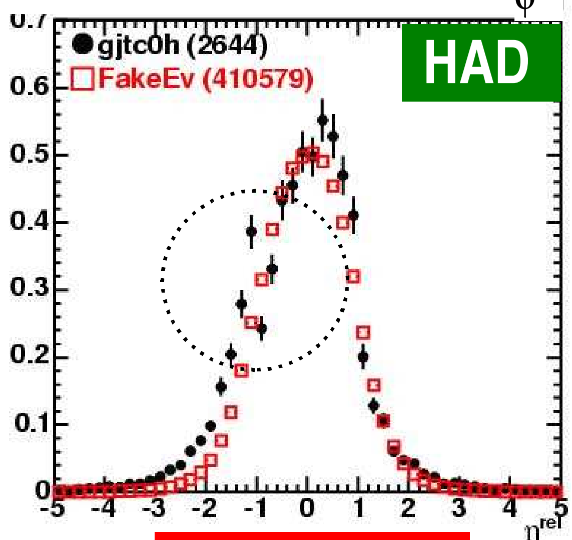
gjtc0d





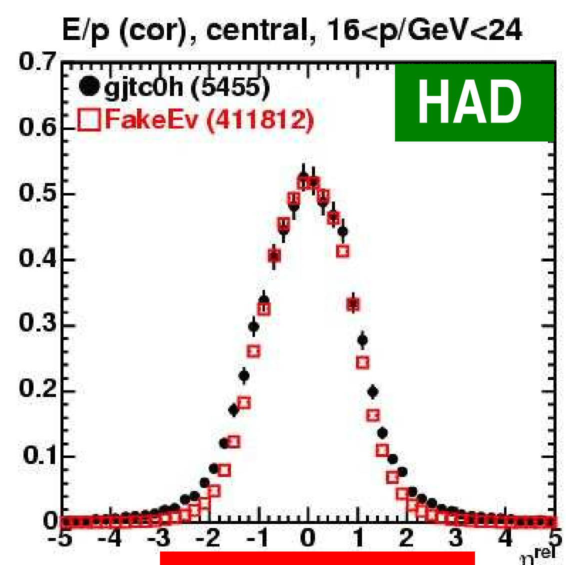
gjtc0h





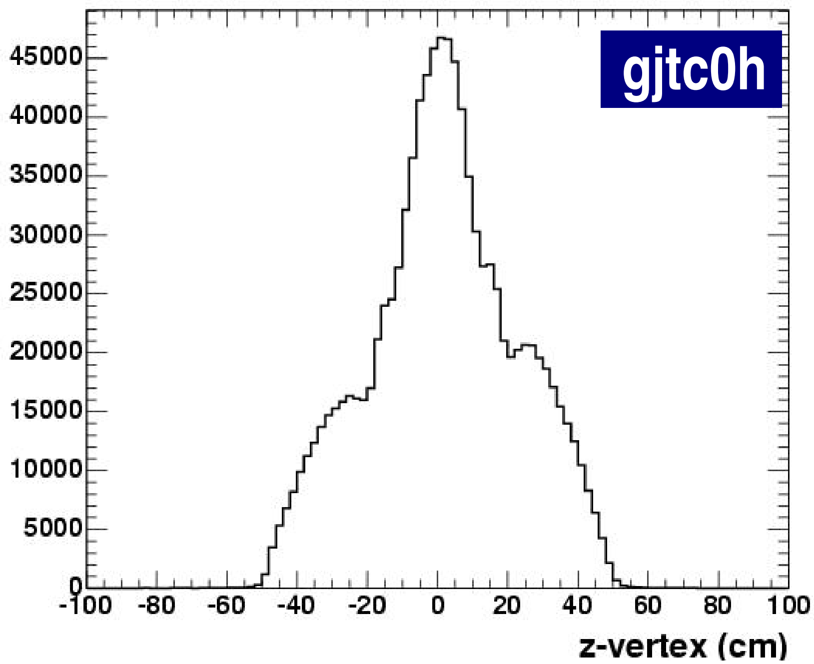
12-16 GeV/c

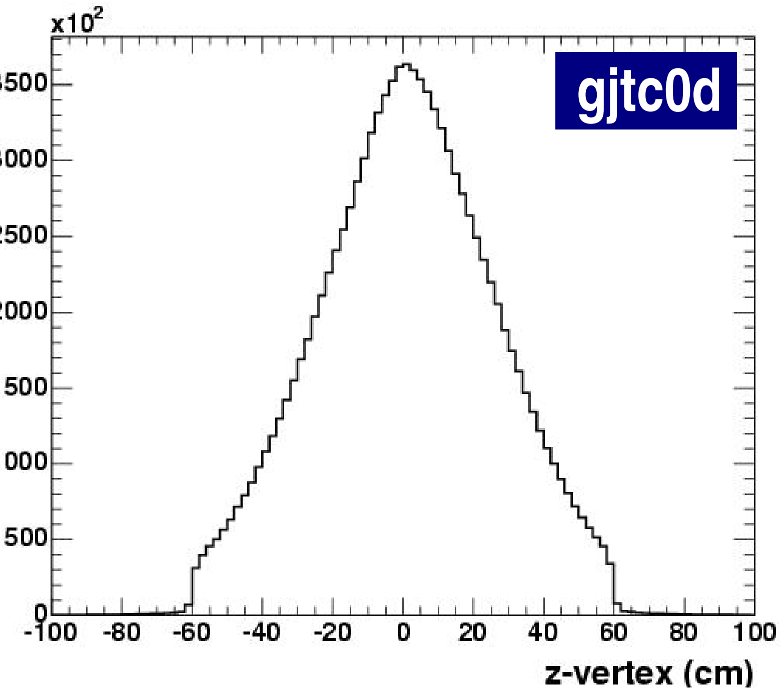
- Pronounced kink at 12-16GeV bin appears in gjtc0h but not in gjtc0d
- Asymetric z vertex distribution?



16-24 GeV/c

Z-Vertices

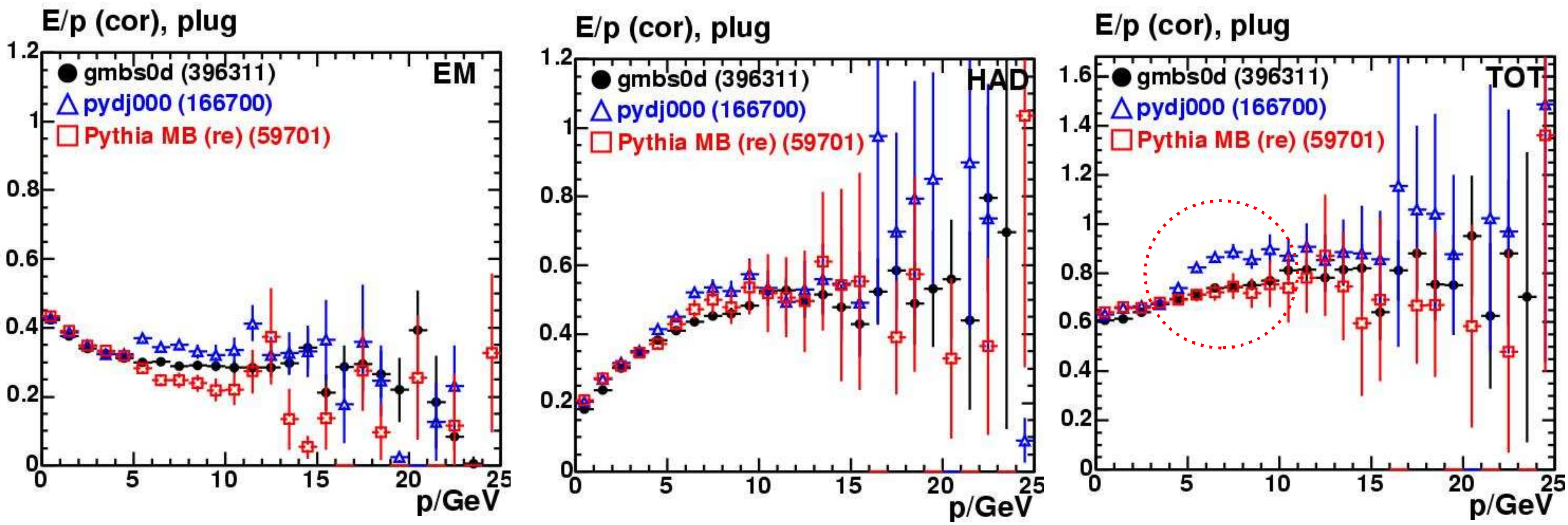




- gjtc0h: L2: XFT track pT>15GeV/c & SVT track pT>15GeV/c
- The three peaks correspond to the SVX barrel centers.
- Asymmetry causes kink in HAD profiles (shower extrapolation effect) and is bad for lateral profile tuning (in particular if p-dependent)
- Currently $|z_{VTX}|<60$cm for p>8GeV/c. Tighter cut at high momenta to reduce kink effect probably not useful due to limited statistics.

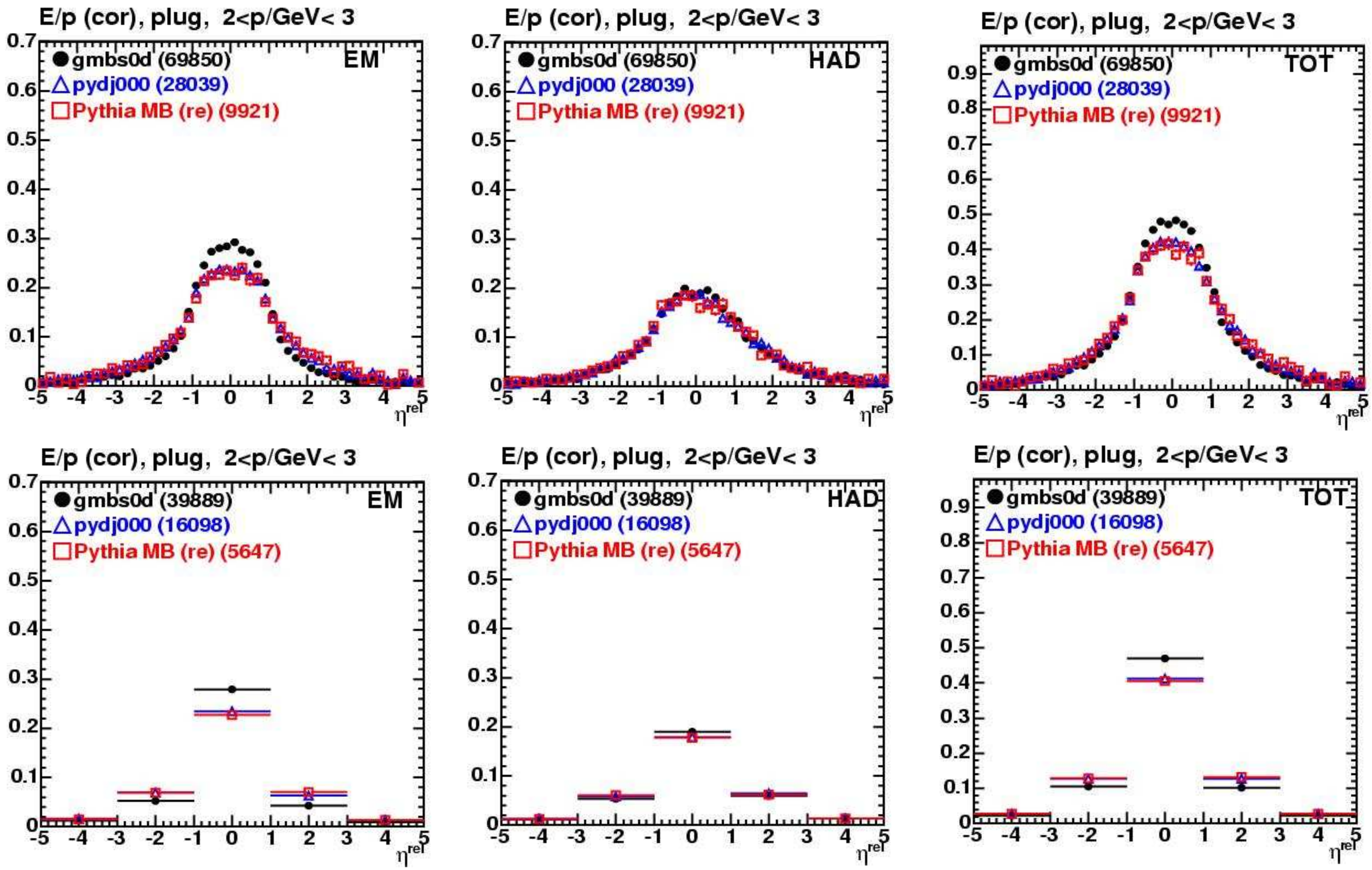
3. Plug Response Simulation

Absolute Response



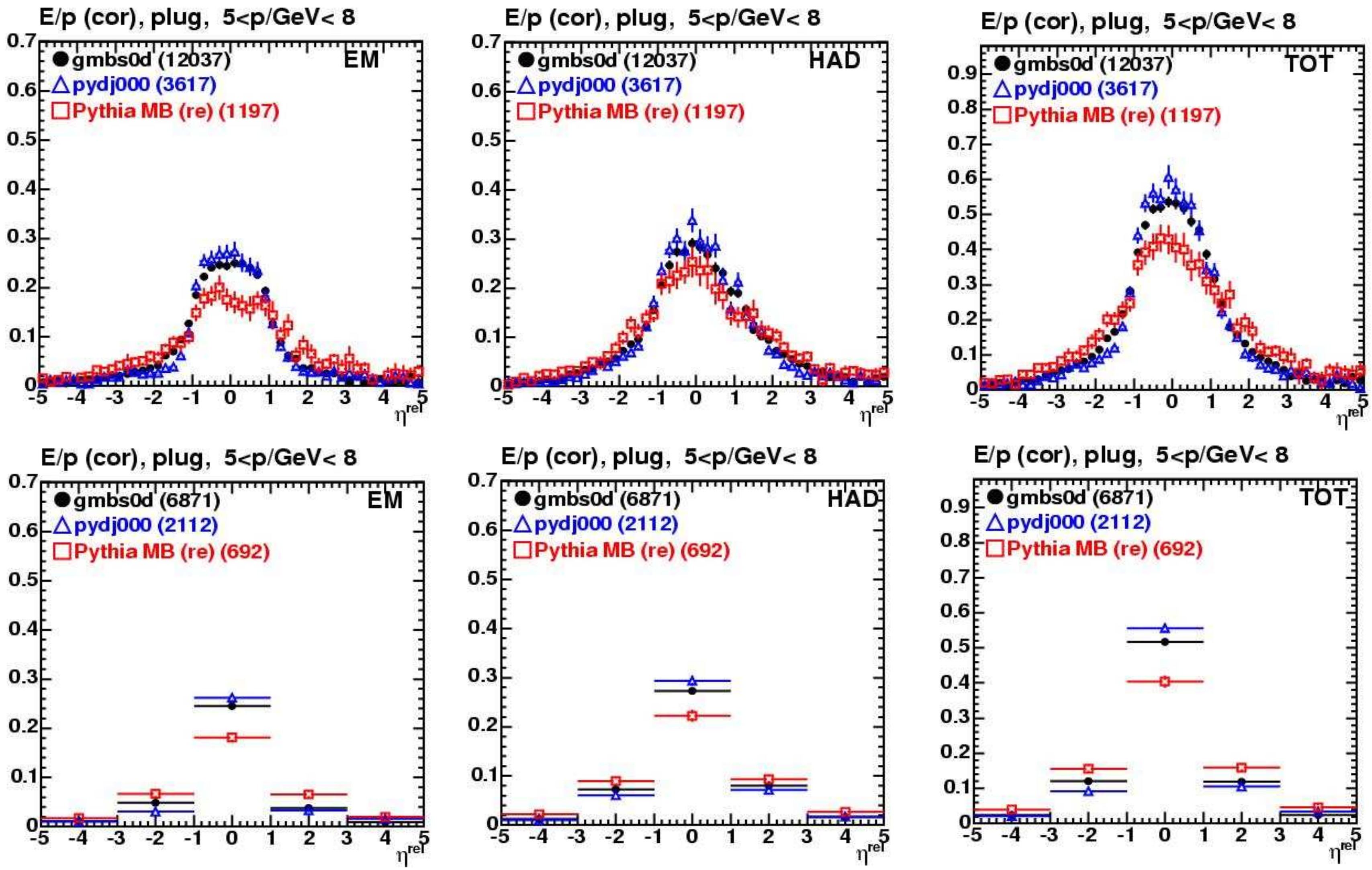
- Tower 13-15, using IO tracks
- Data: gmbs0d (minbias sample)
- MC: blue: Pythia minbias tune A (pydj000) / red: Pythia minbias regenerated by myself
- Cannot reproduce the bump structure seen in pydj000 TOT response
  - same generator + same minbias model + calorimeter simulation parameters
  - only difference: did not use run-dependent scheme which I do not expect to affect E/p much. If this affected the simulated response it in the way observed then something must be wrong with this scheme.
- Red points suggest that the Gflash sampling fractions are suboptimal.

Pythia MB Lateral Response (1)



- MC profiles shown are normalized w.r.t. data absolute response
- pydj000 and Pythia MB (re) profiles agree reasonably but are too wide.

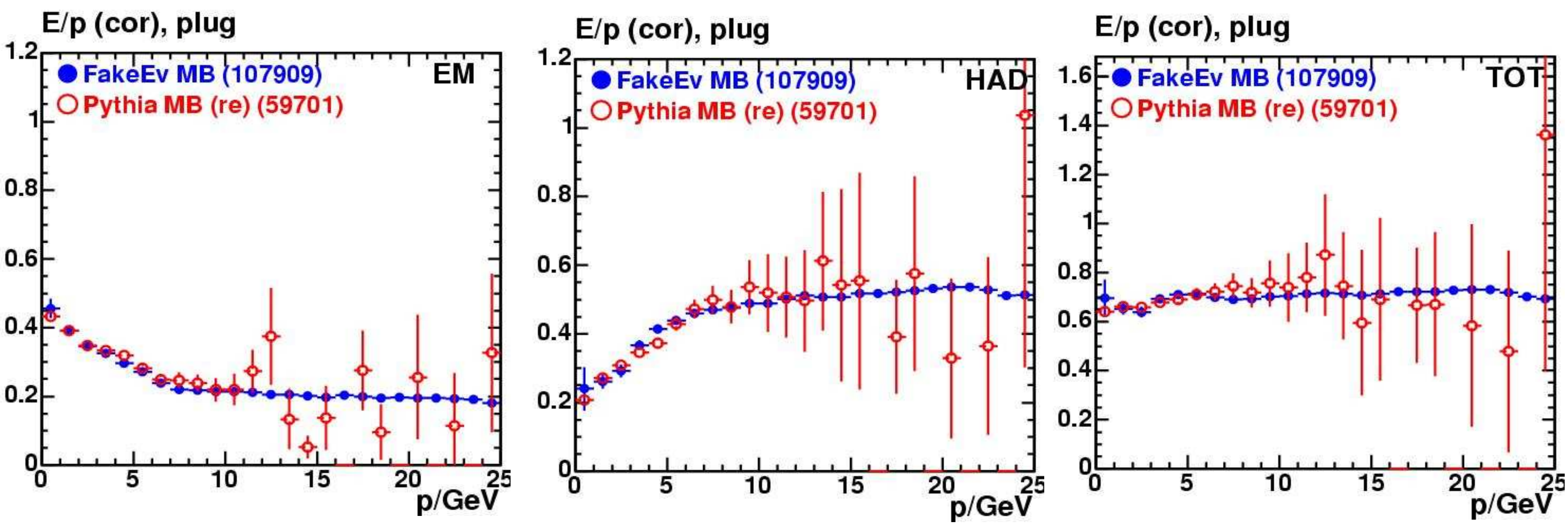
Pythia MB Lateral Response (2)



- pydj000 too narrow, Pythia MB (re) still too wide.

Pythia MB vs. FakeEv MB

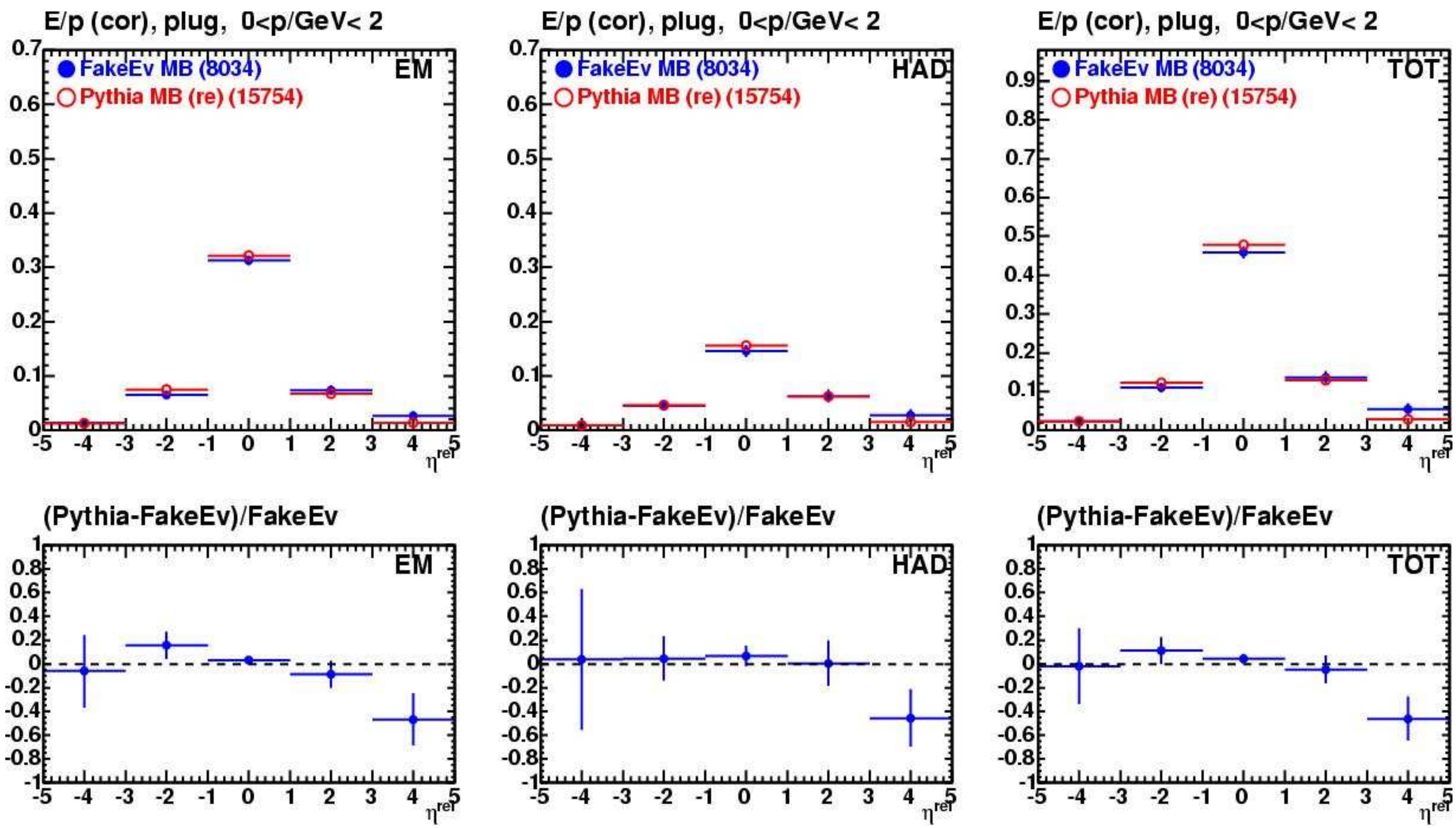
- Run simulation/production in 5.3.3 based on Pythia (ptmin=0) and FakeEv
- Added minimum bias (tune A) events on top of both generators
- Again: Pythia MB (re) mentioned here is <u>not</u> the archived sample



- Both simulation agree reasonably.
- Adding minbias to fake tracks introduces a more realistic background scenario
- Using FakeEv for tuning of absolute response is much more convenient since the momentum spectrum is under better control

Pythia vs. FakeEv Lateral Profiles (1)

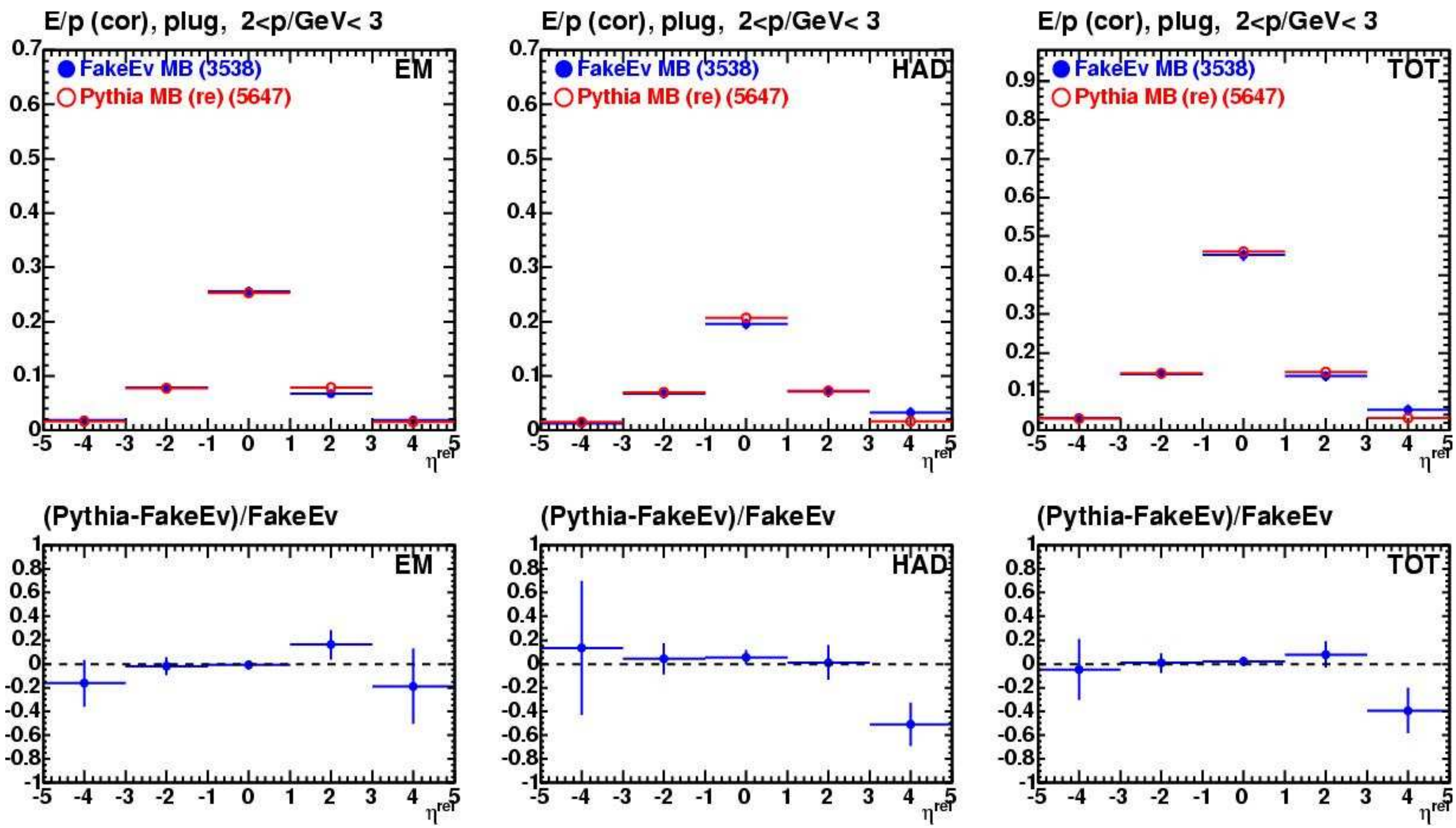
0.5-2.0 GeV/c



- FakeEv profiles are normalized to the absolute Pythia response

Pythia vs. FakeEv Lateral Profiles (2)

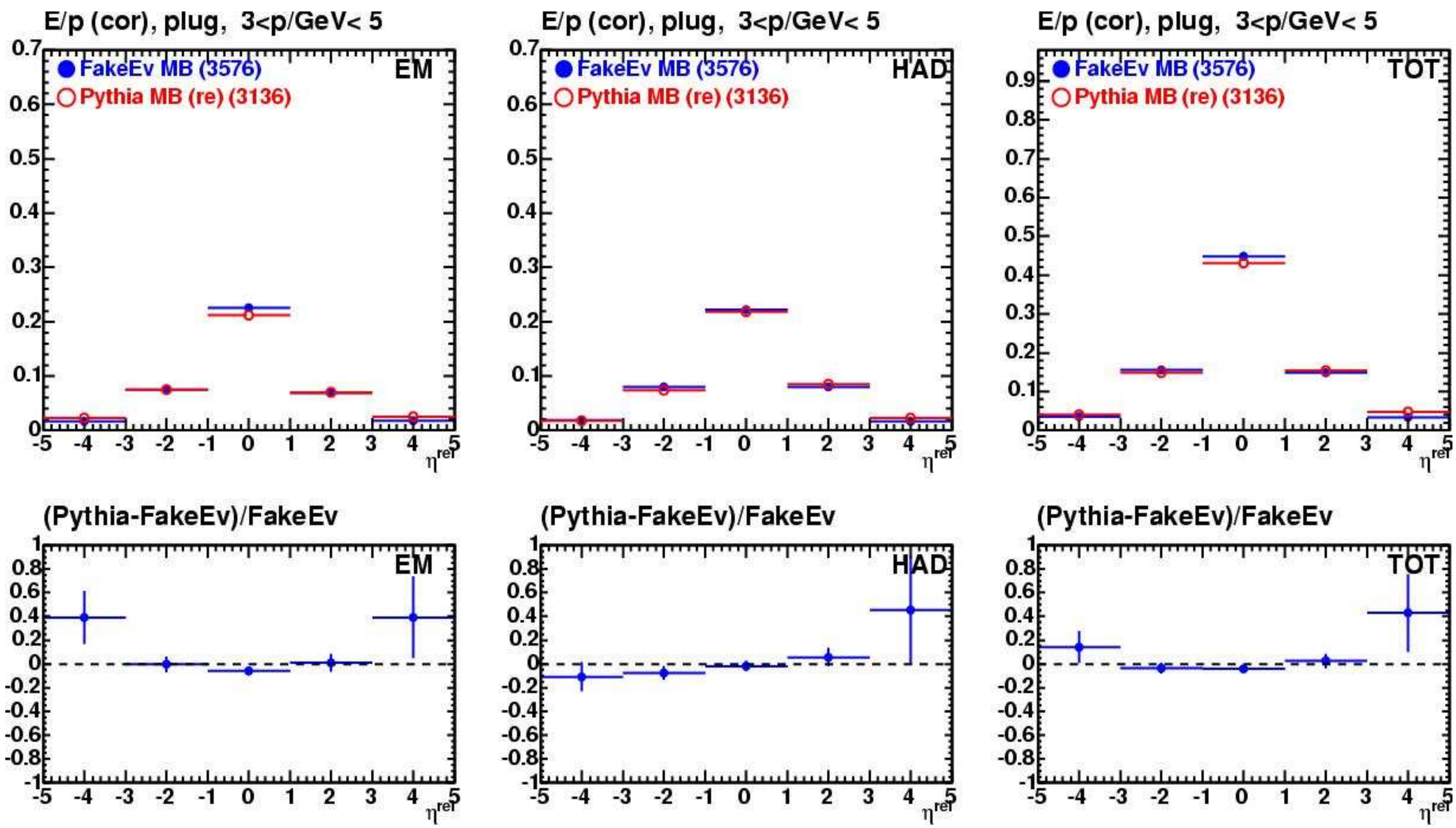
2-3 GeV/c



- FakeEv profiles are normalized to the absolute Pythia response

Pythia vs. FakeEv Lateral Profiles (3)

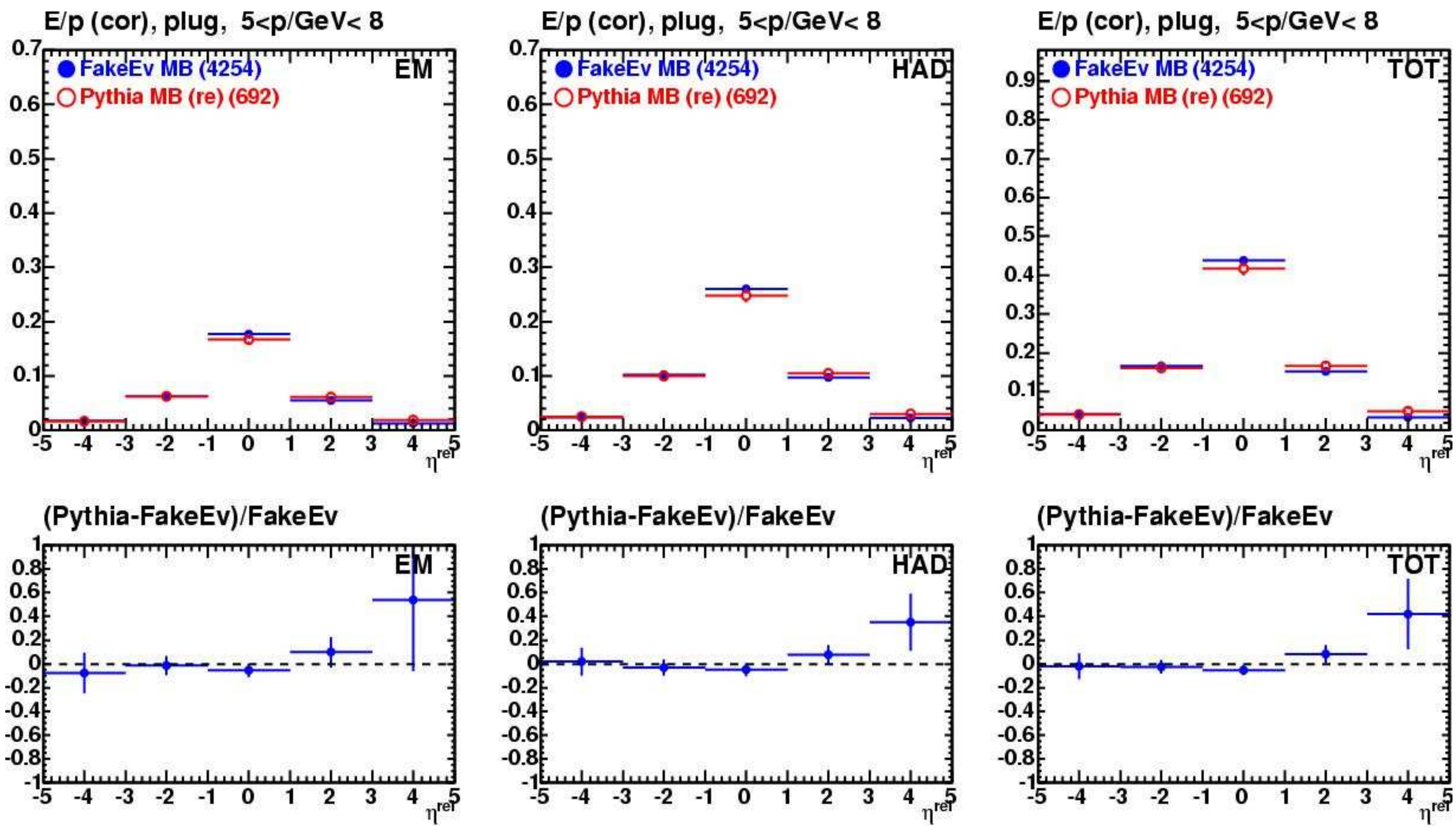
3-5 GeV/c



- FakeEv profiles are normalized to the absolute Pythia response

Pythia vs. FakeEv Lateral Profiles (4)

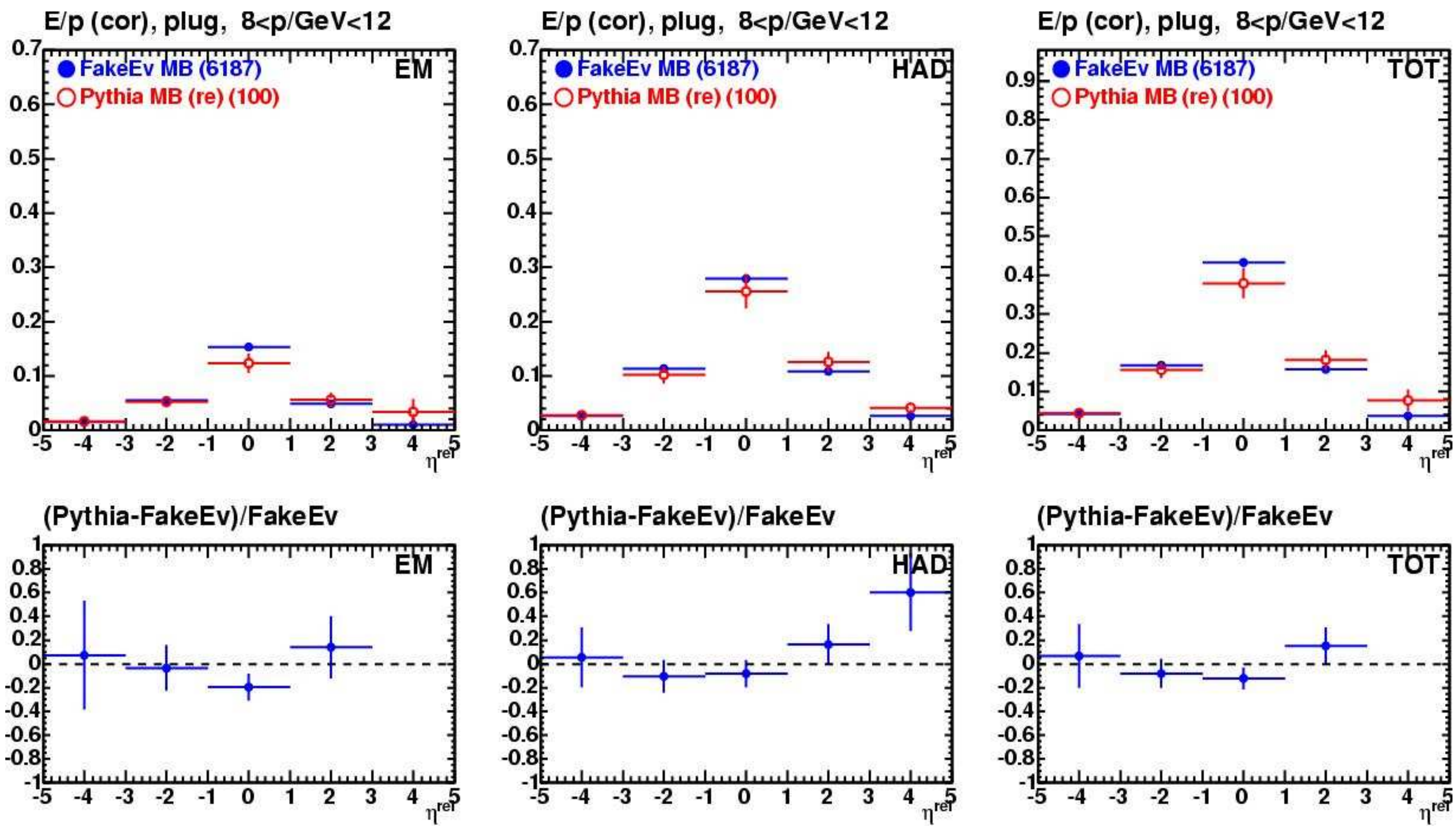
5-8 GeV/c



- FakeEv profiles are normalized to the absolute Pythia response

Pythia vs. FakeEv Lateral Profiles (5)

8-12 GeV/c



- FakeEv profiles are normalized to the absolute Pythia response

Conclusions

- Updated lateral profile tuning in the central part:
  - R_1=0.189 (very stable); R_2=1.528 and R_3=0.348 (less stable)
  - use H1 default for p>79GeV/c
- New single track trigger data (15 GeV/c threshold):
  - Introducing an explicit lepton veto at high momenta is crucial
  - With the better statistics it turns out that Gflash clearly underestimates the HAD response in the central by > 10% at p>12GeV/c! Discrepancy is larger than single particle response uncertainty claimed in the JER NIM paper in that momentum region
  - Absolute EM response seems to be fine
  - Data around trigger threshold probably not usable for lateral tuning due to extrapolation effects in HAD compartment
- Plug response simulation:
  - Nature of excess of absolute response in pydj000 over data still unclear. Is not reproducable by Pythia MC using same old tuning in 5.3.3.
  - Newly generated Pythia MB and FakeEv MB agree perfectly with each other.
  - I see no objection to use FakeEv instead of Pythia for plug lateral profile tuning.