Simulated Calorimeter Response in Central and Plug

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Jet Energy and Resolution Group Mini-Workshop
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Outline

1. Update of the Gflash lateral hadronic shower profile tuning in the central part
2. Simulated absolute response in the central up to ~40 GeV/c
   - Inclusion of new single track trigger data (Shawn's talk)
3. Single particle response in the plug
   - Crosschecks
   - Start of lateral profile tuning
4. Conclusions

1. Gflash Lateral Profile Tuning (Central)

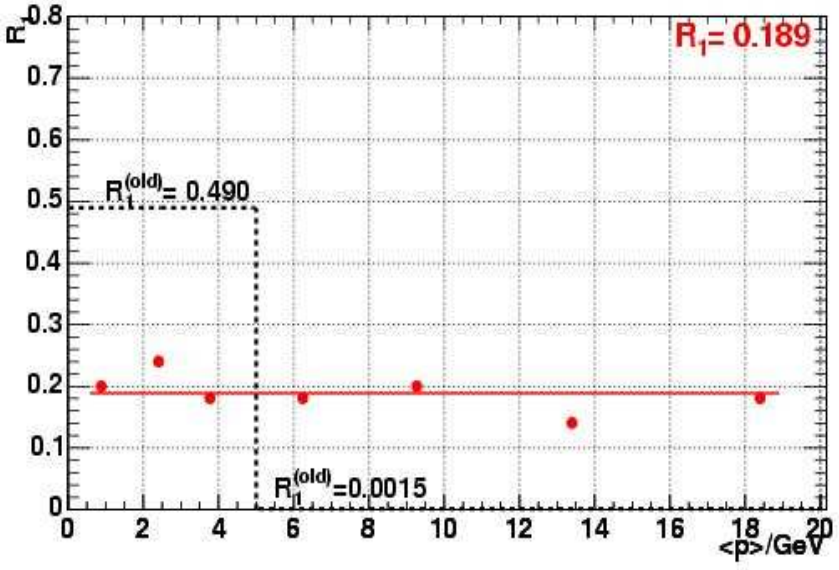
Lateral Profile Tuning Update

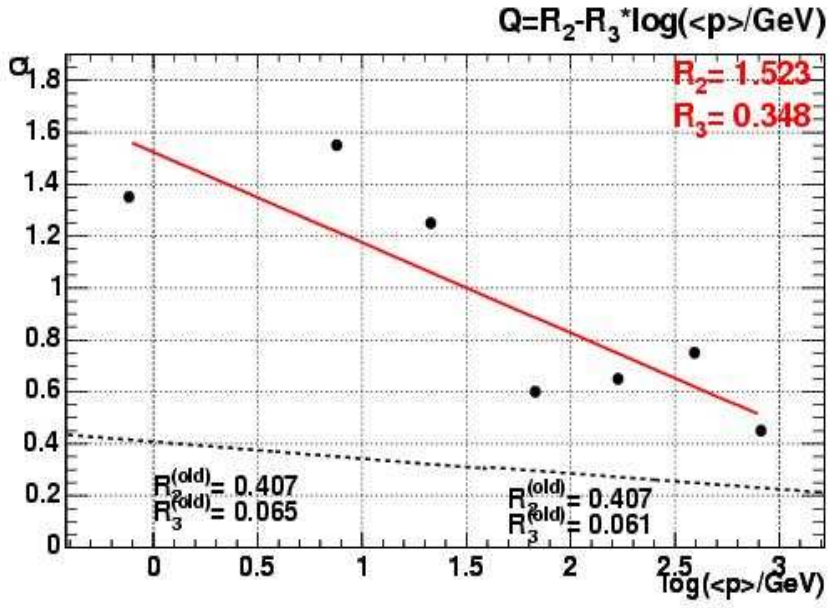
Hadronic lateral profile

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

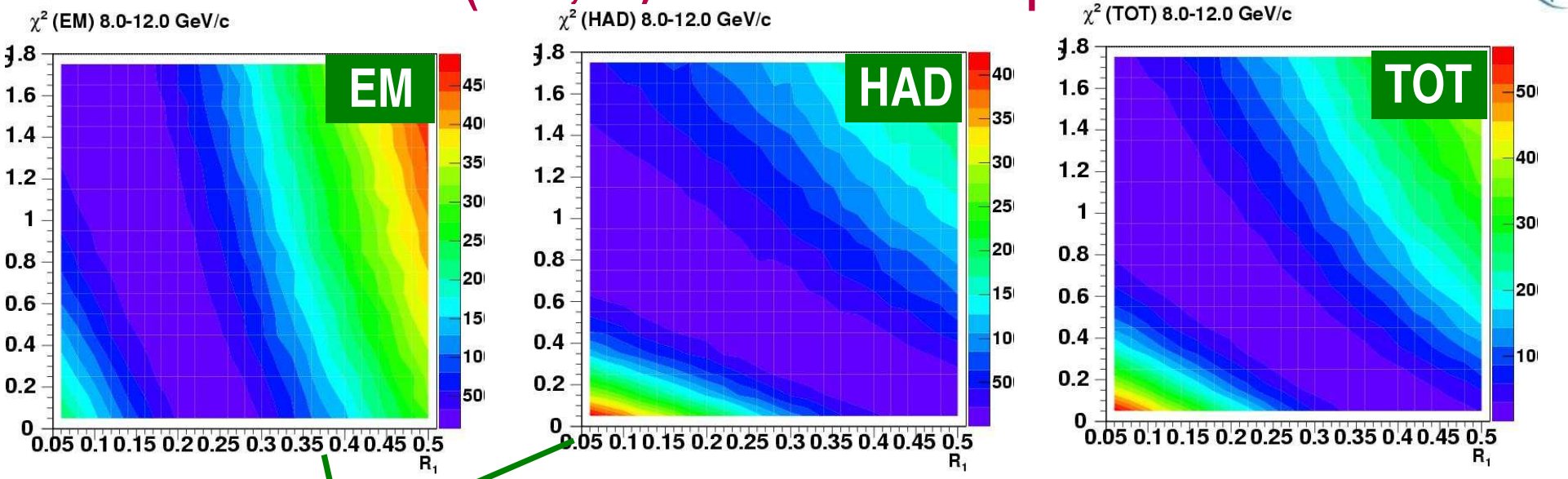
- Tuned FakeEv ($\pi^{\pm}K^{\pm}p$) with single track trigger data sample gjtc0d
- Corrected a bug: some Gflash parameters (passed to simulation via talk-to) were not correctly mapped to a Fortran COMMON block
- Doesn't affect much R_1 but R_2 and R_3

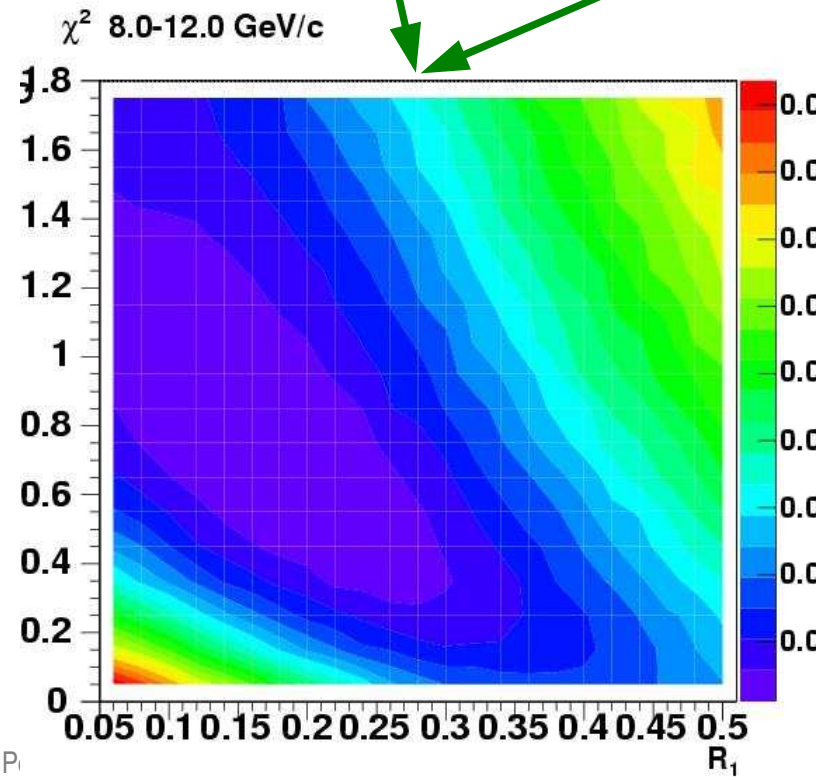
Updated tune values from combined EM and HAD information:





(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.

2. Simulated Central Response

New Single Isolated Track Data

- Special STT with 15 GeV/c threshold
- Complements scarce data from previous STT samples (gjtc0d, gjtc01)
- See Shawn's talk for more details
- Plots shown in the following are based on old tuning!

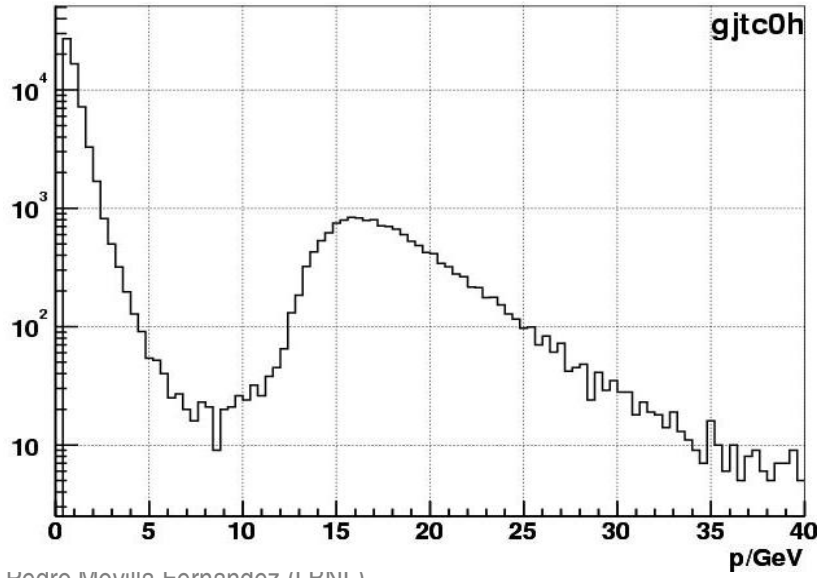
will be included in next lateral tuning iteration

gjtc0h subset (~1/3 of total statistics)

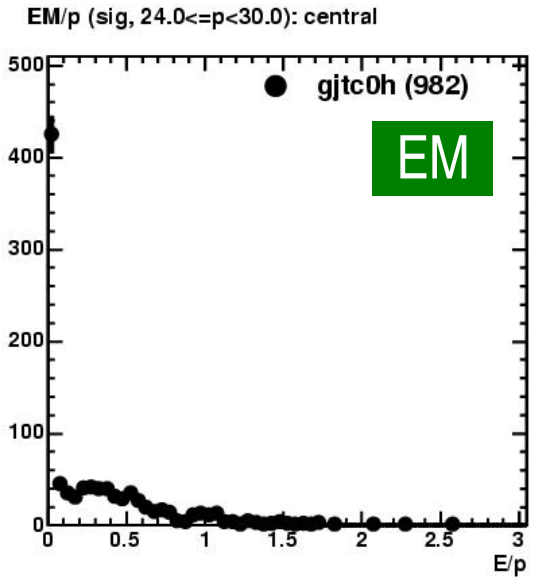
tower number	momentum range (GeV/c)									
	≥ 2	0.5-2	2-3	3-5	5-8	8-12	12-16	16-24	24-32	>32
0	3722	10322	465	160	39	88	1503	1317	111	37
1	4005	10342	523	153	46	78	1536	1475	143	50
2	3907	10538	454	168	43	52	1272	1718	155	45
3	3854	10963	530	172	50	67	903	1870	218	44
4	3801	10799	591	226	44	44	592	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

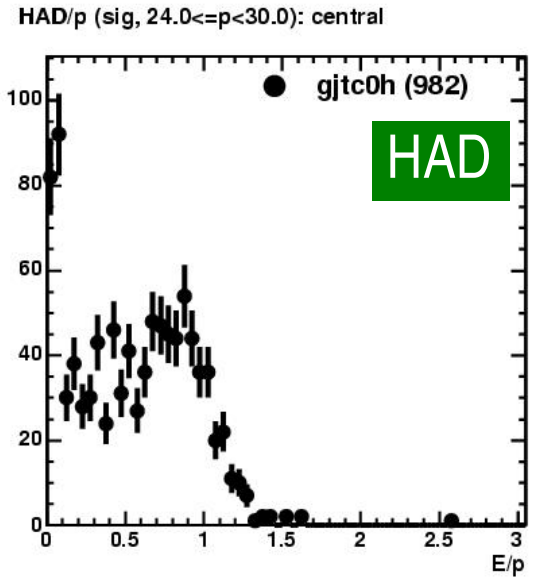
...plus additional contour cuts

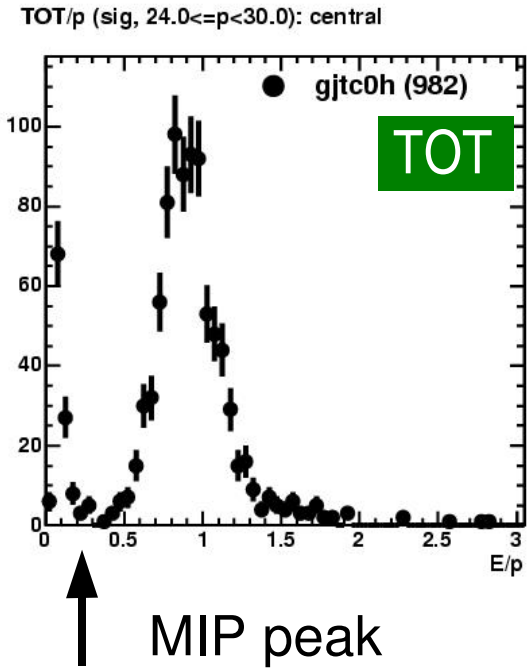
track p (cut) (central)



E/p Distributions







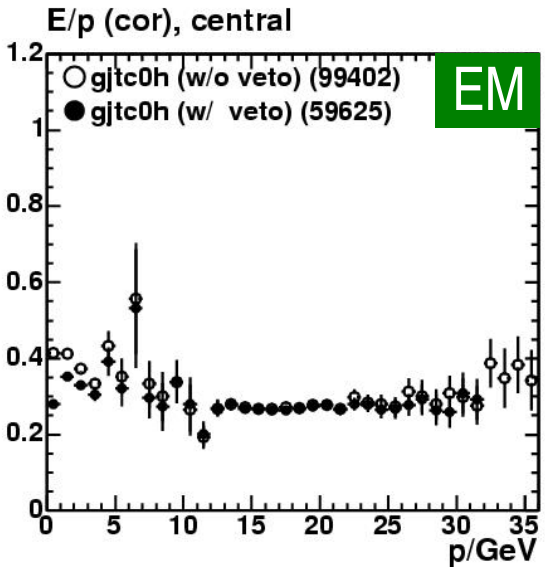
- At high momenta we need to introduce additional quality cuts to reduce contamination from photon conversion and muons from physics processes:

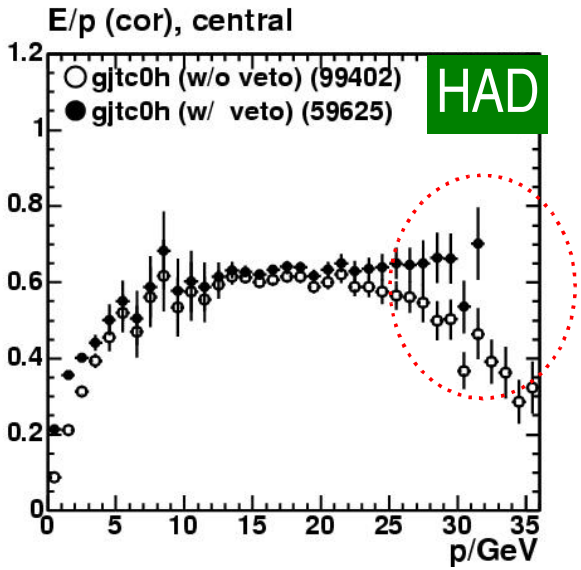
		central (>12GeV/c)	plug (>16GeV/c)	guideline from physics groups:
electron veto:	E^{HAD}/E^{EM}	> 0.02	> 0.02	E^{HAD}/E^{EM}>0.055
muon veto:	E^{TOT}/p	> 0.25	> 0.10	E^{TOT}> 5 GeV/c

(used for the following plots)

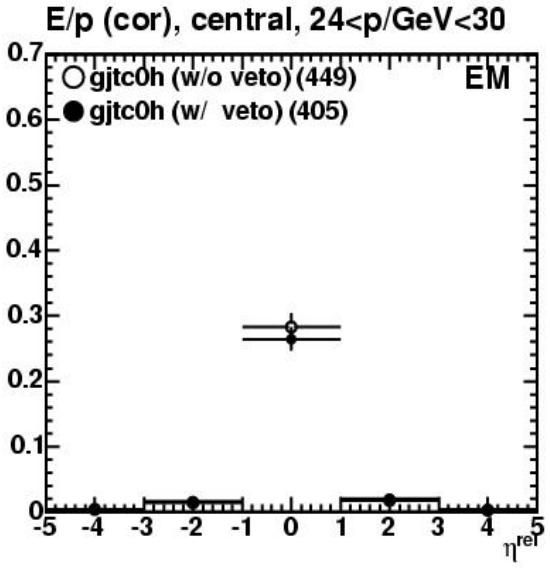
- For coming iteration I am going to use the official lepton veto in the central.
- Threshold and cut values are choosen such that hadronic peak is not truncated.

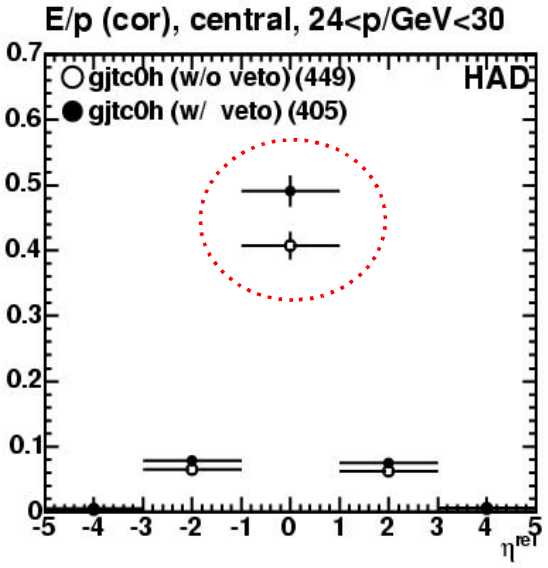
Impact of Lepton Veto





absolute response

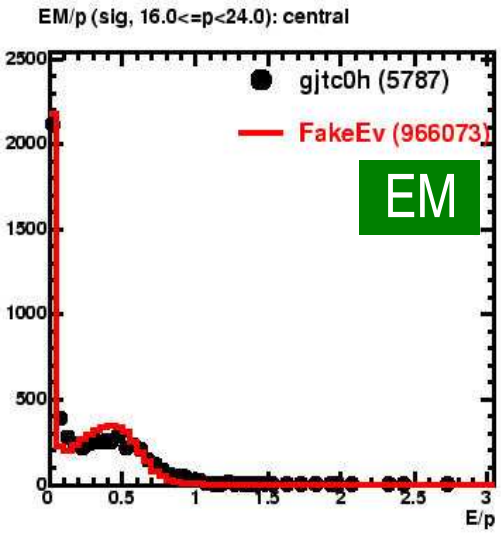


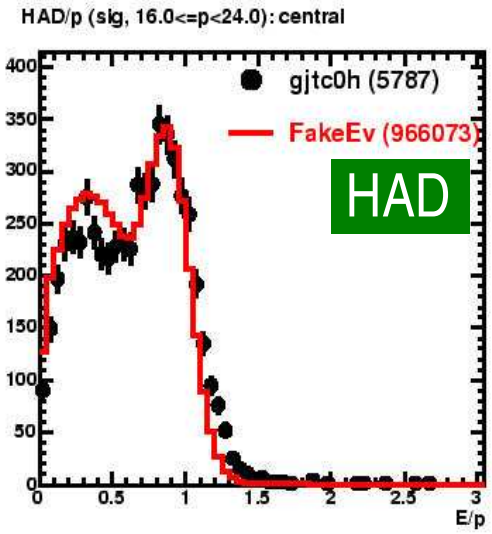


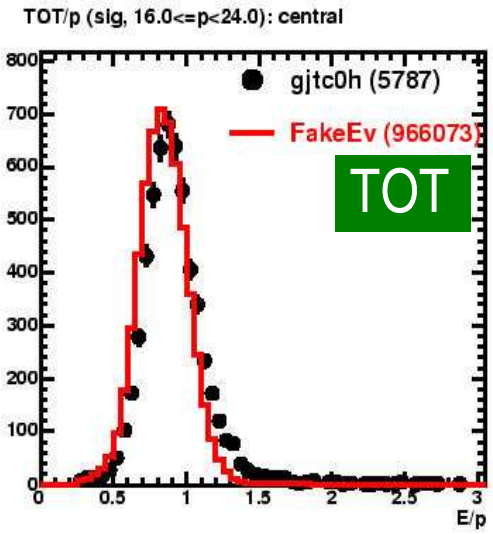
lateral profile

- MIP particles pull down absolute response at high p. Mainly affects target tower in lateral profile.

Comparison with MC (w/ lepton veto)

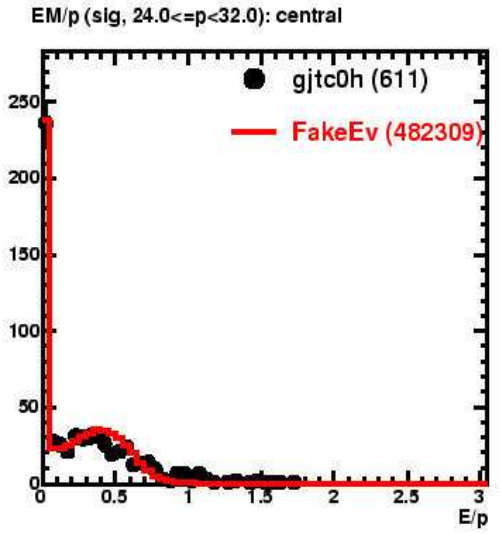


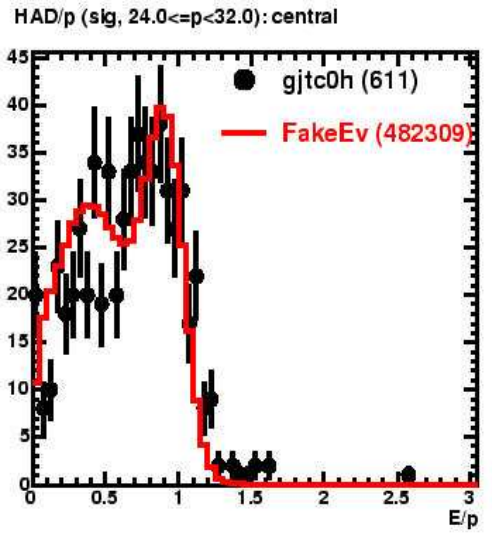


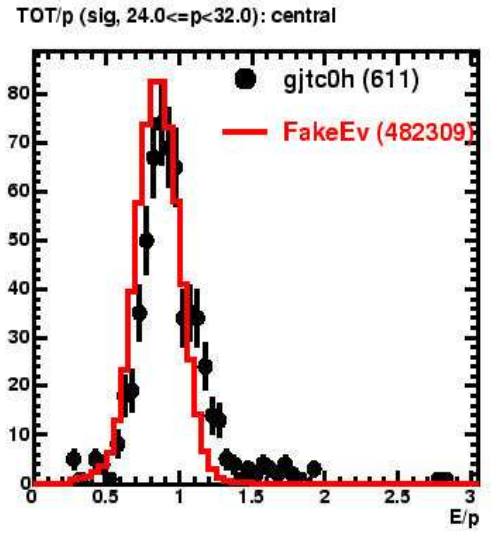


12-16 GeV/c

16-24 GeV/c



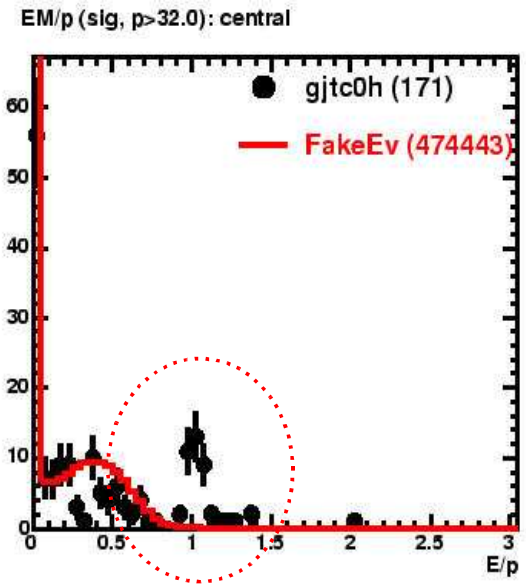


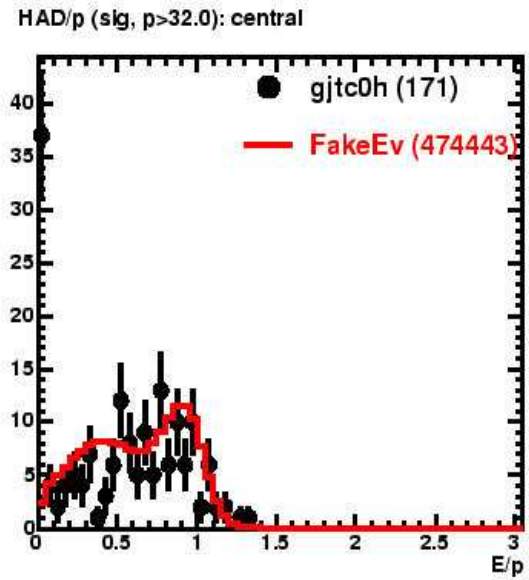


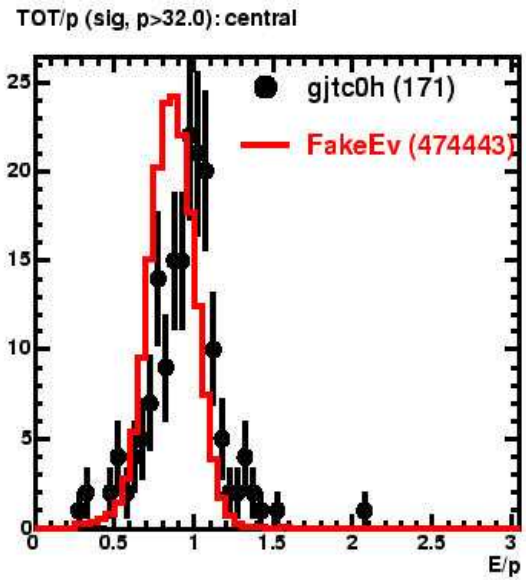
- Momentum bins as used in lateral profile tuning

Comparison with MC (w/ lepton veto)

Data: p > 32.0 GeV/c
MC: p = 32-40 GeV/c

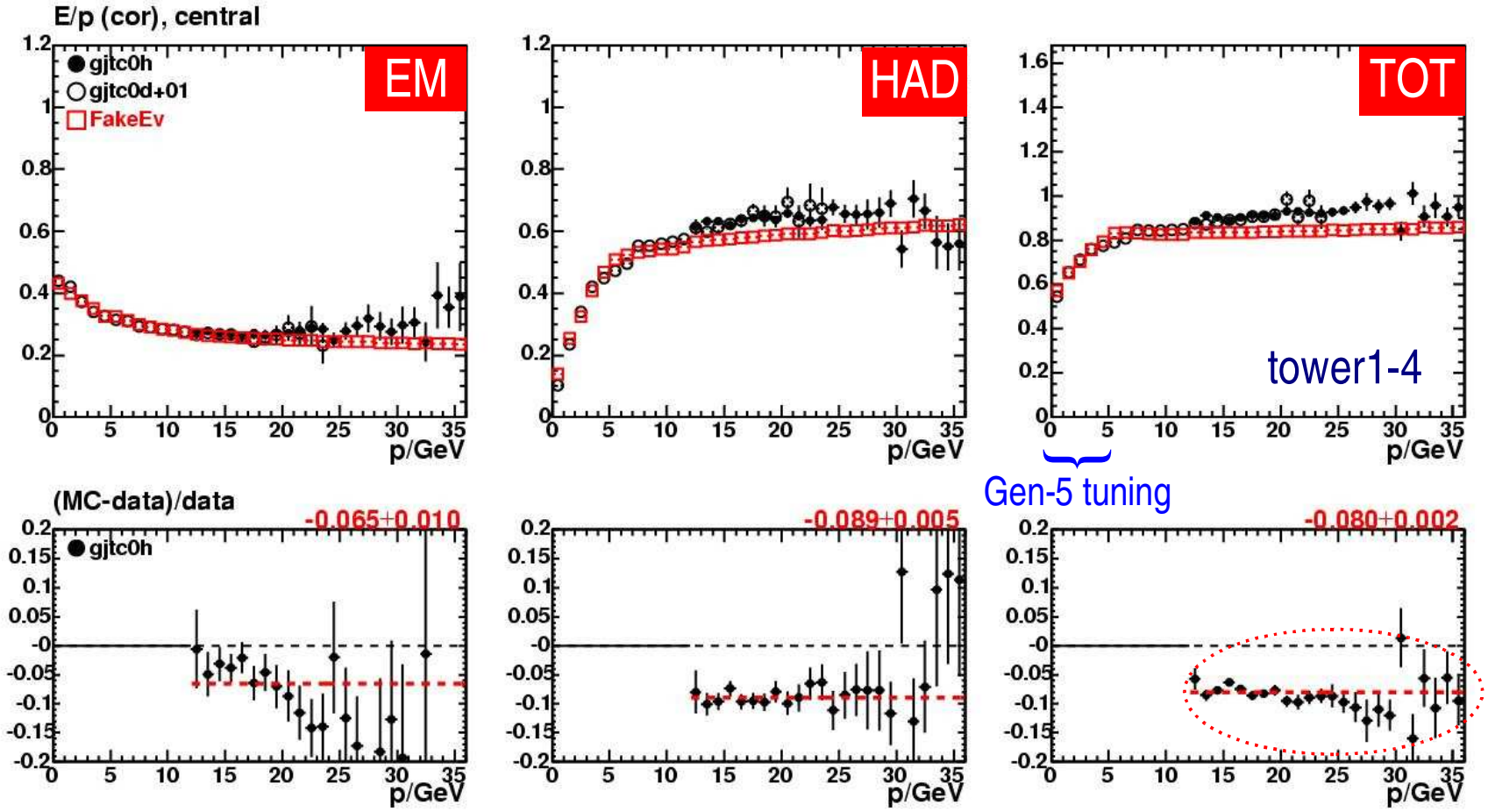






- Indicates that my electron veto is probably not tight enough for highest momenta

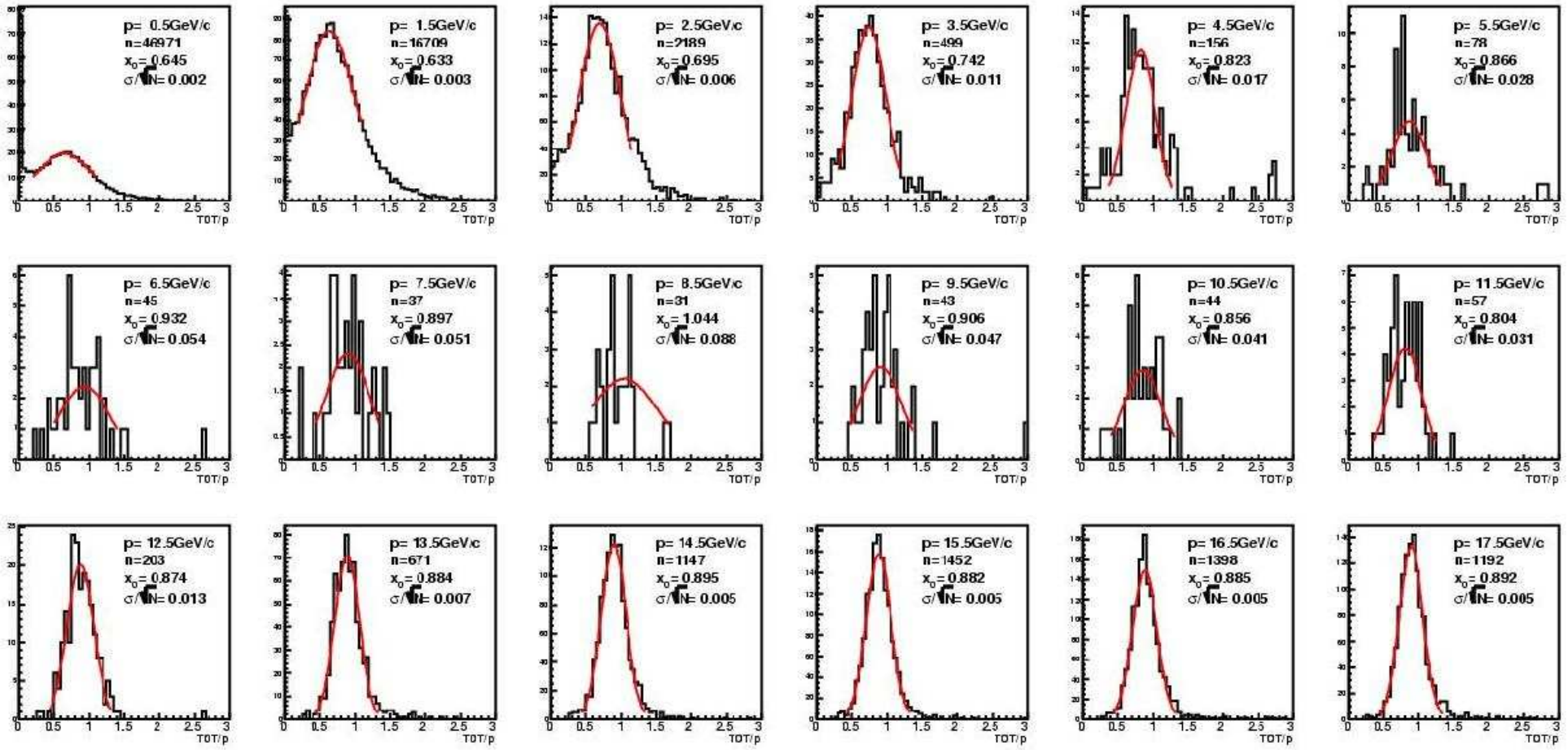
Absolute Central Response



- JETCALIB: gjtc0d+gjtc01(5.3.3_nt), gjtc0h(6.1.2) versus FakeEv (5.3.3_nt)
- Using target tower 1-4 for signal definition in lateral tuning
- EM response simulation pretty good up to 20 GeV/c.
- HAD and TOT ok up to 5 GeV/c, moderate quality up to 12 GeV/c .
- Simulation underestimates TOT/p by ~8% at high p. Discrepancy increases with p.

...using Gaussians (1)

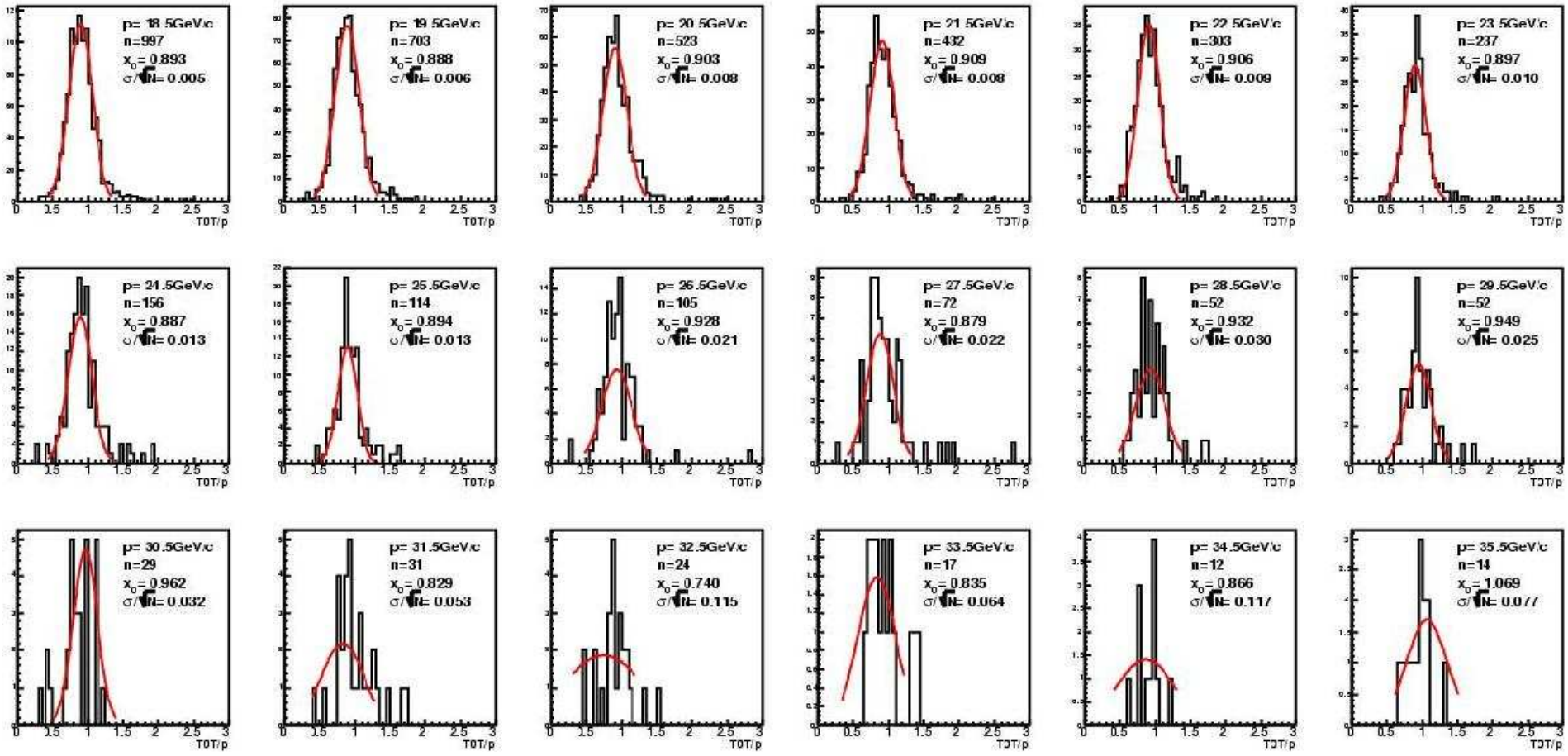
gjtc0h, TOT response, 0.5-18 GeV/c



- Gaussian fits around hadronic peak

...using Gaussians (2)

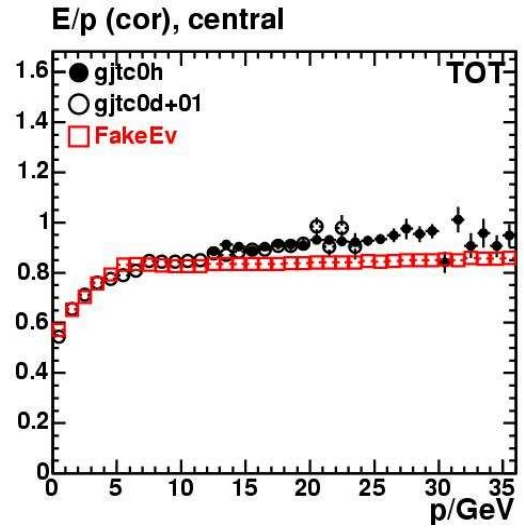
gjtc0h, TOT response, 18-36 GeV/c

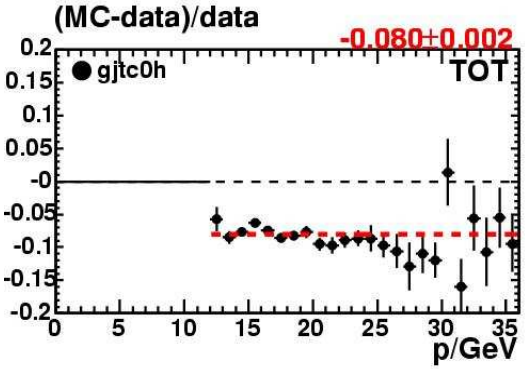


- Gaussian fits around hadronic peak

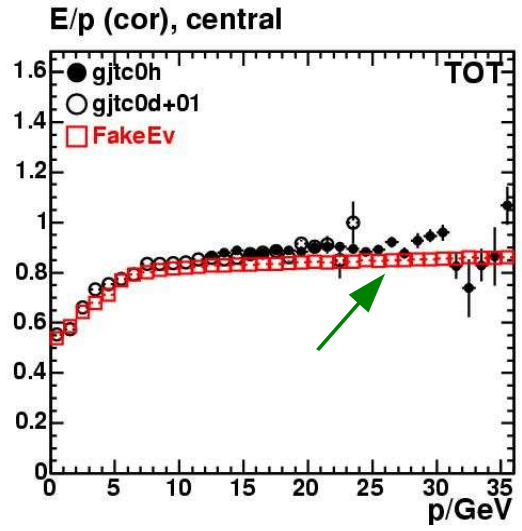
Absolute Central Response (2)

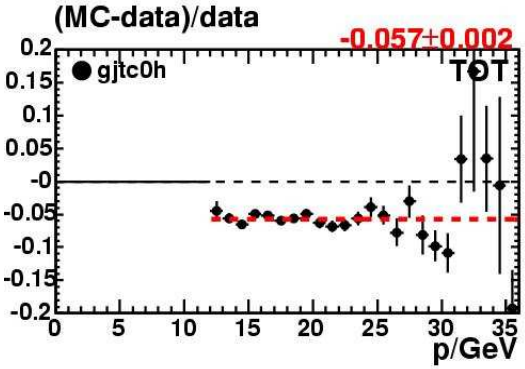
simple mean



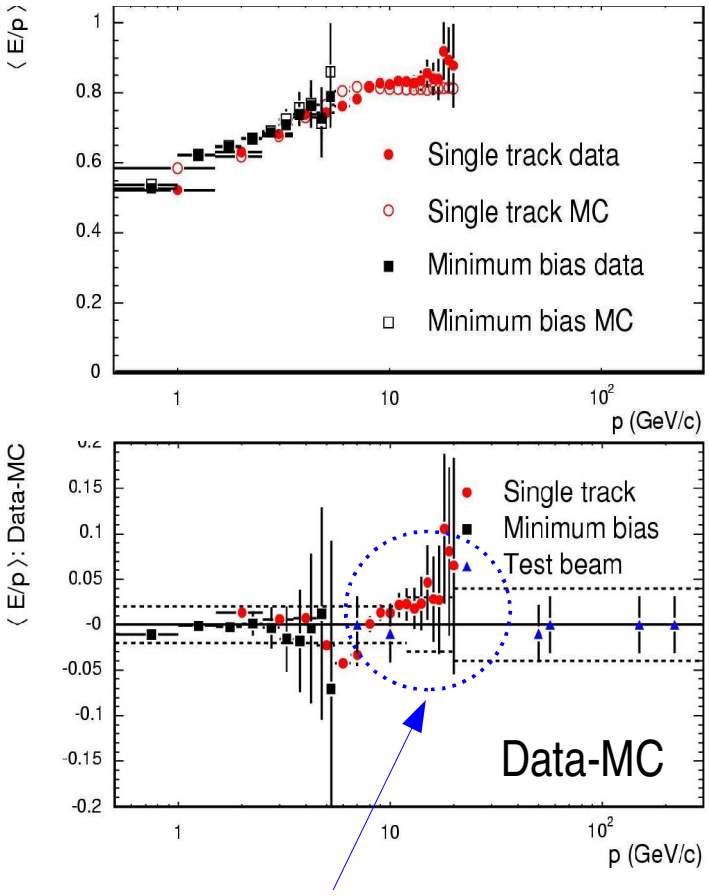


Gaussian mean





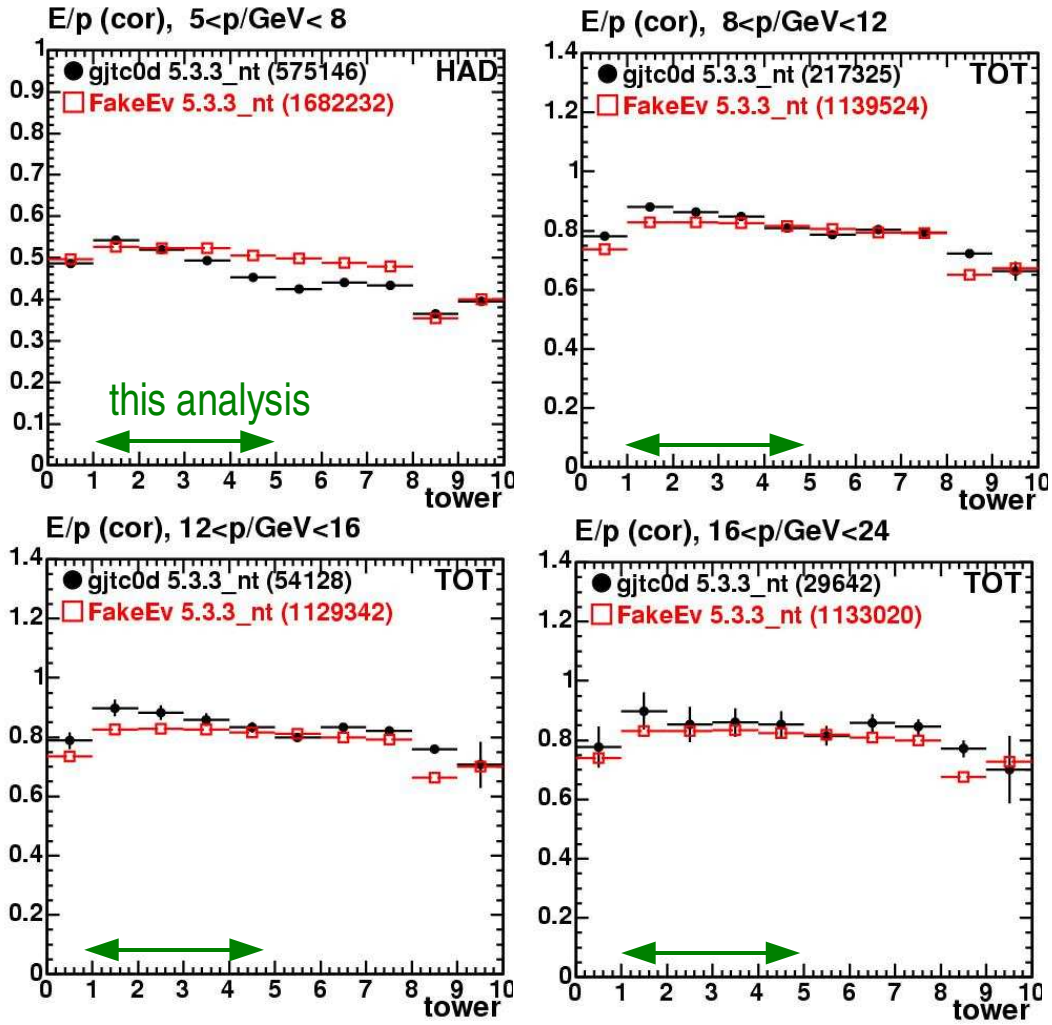
Status JER NIM Draft



- Gaussian means more appropriate for MC/data comparison.
- Much improved p dependence
- Still sizeable average discrepancy of 5.7% at p>12 GeV/c
- NB: - Introducing lepton veto increases the difference
  - Excess of data over MC dependent on tower groups

Claimed uncertainanty for 12-20GeV/c: 3%

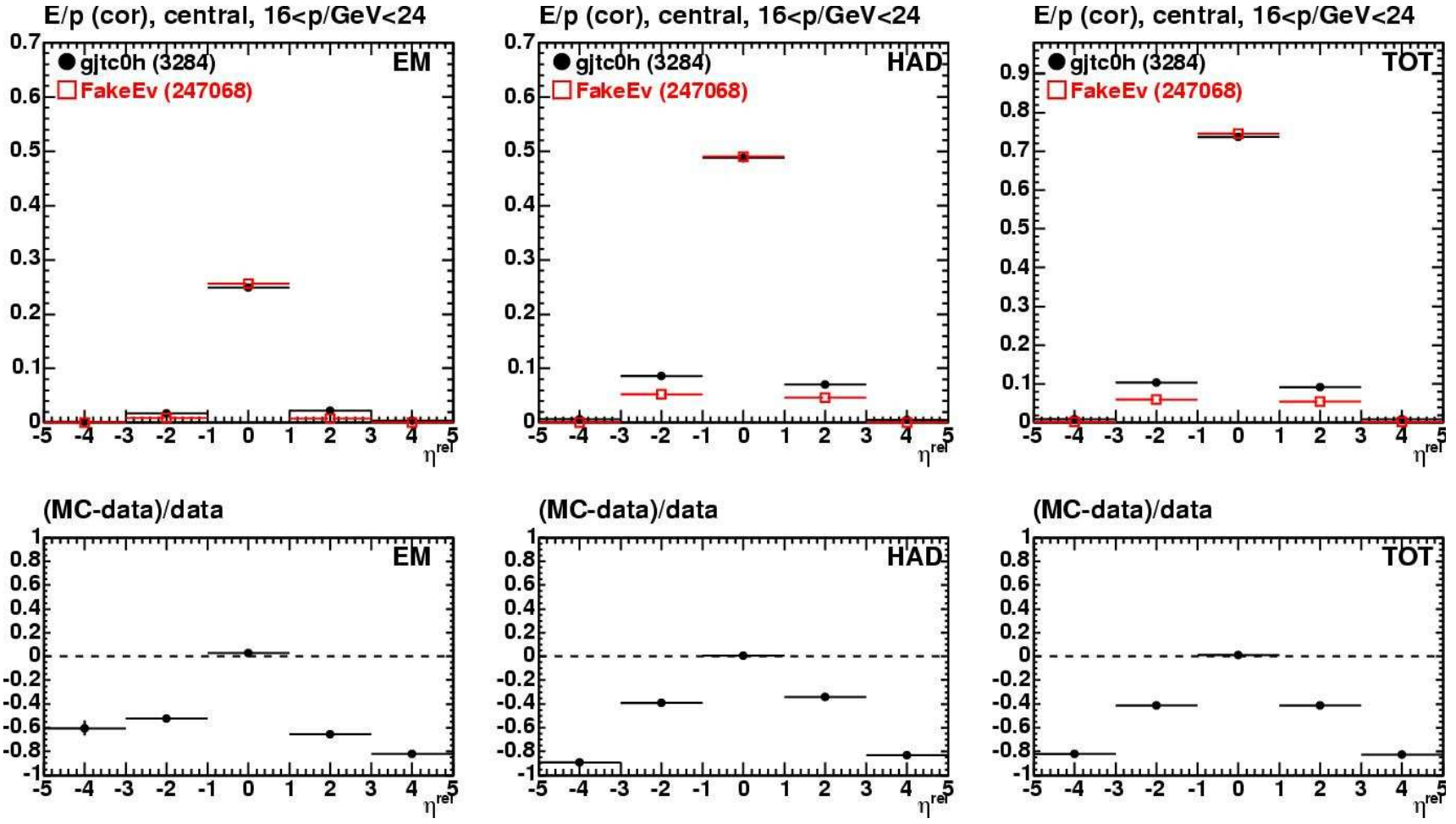
Tower Group Dependence



- Dependence of absolute response on tower is different for data and MC
- For p>8GeV/c, excess of the data over MC decreases towards plug region. Extending tower region would therefore reduce the discrepancy in average absolute response.
- Plug response measurement presented here focuses on target tower group 1-4 (instead of 0-8 in the past)
  - ensures that E/p signal region is well covered by CHA + no adjacent cracks

Simple mean, no lepton veto.

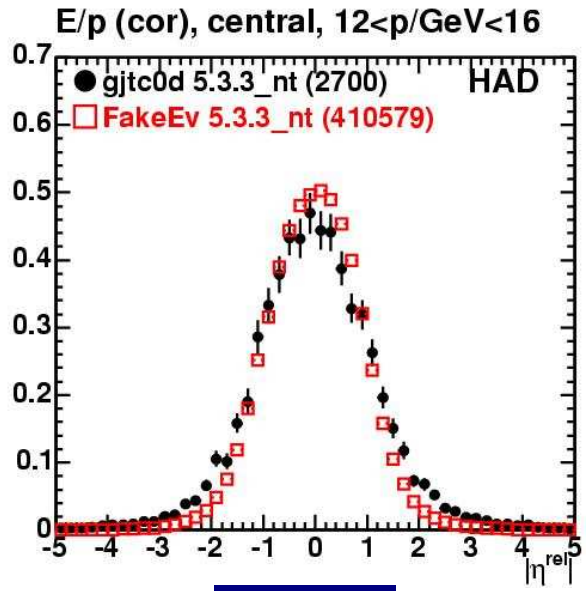
Lateral Profile 16-24GeV/c

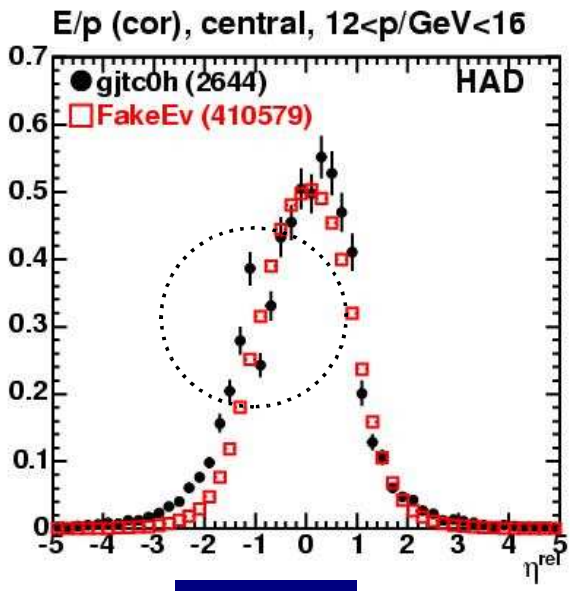


- With Gen-5 tuning, simulated profiles too narrow, consistent with observation at lower p.

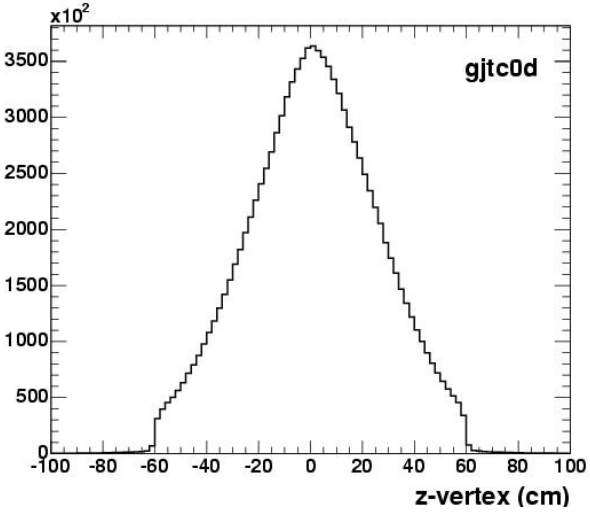
Lateral Profile gjtc0d vs. gjtc0h

12-16 GeV/c

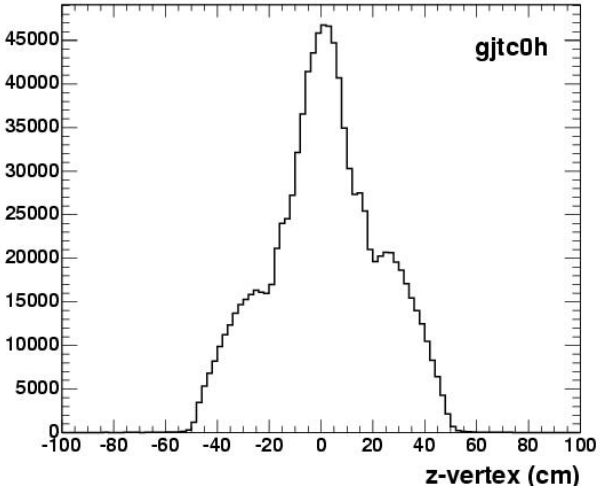




gjtc0d



gjtc0h



- Pronounced kink around trigger threshold 15 GeV appears in gjtc0h but not in gjtc0d. No such kink at higher p.
- gjtc0h: L2: XFT track pT>15GeV/c & SVT track pT>15GeV/c
- 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 $|z_{VTX}|$<60cm for p>8GeV/c. Tighter cut at high momenta to reduce kink effect probably not useful due to limited statistics.
- This momentum bin in gjtc0h probably not useful for lateral tuning

3. Simulated Plug Response

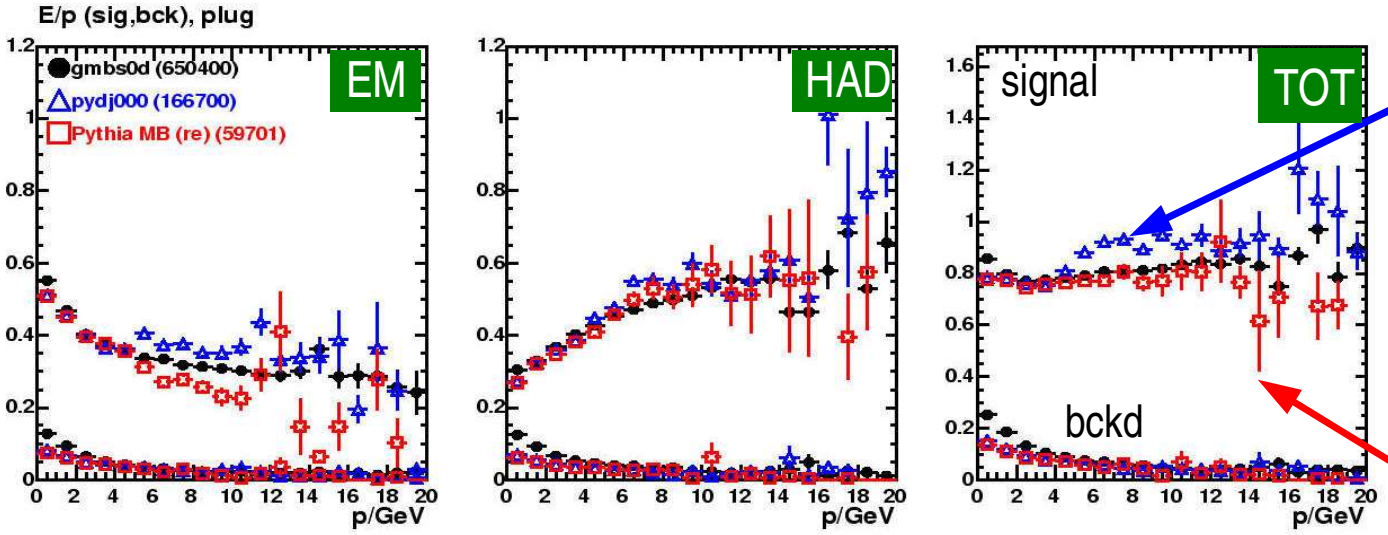
Plug Response Tuning

- Minbias data sample: gmbs0d (~20.5M events)
- Almost same track and event quality requirements as in the central (see Shawn's talk)
  - no PES isolation
  - lepton veto
- For lateral tuning:
  - IO tracks (better resolution)
  - tower 13-15
  - enough statistics up to 16(24?) GeV/c

gmbs0d (full statistics)

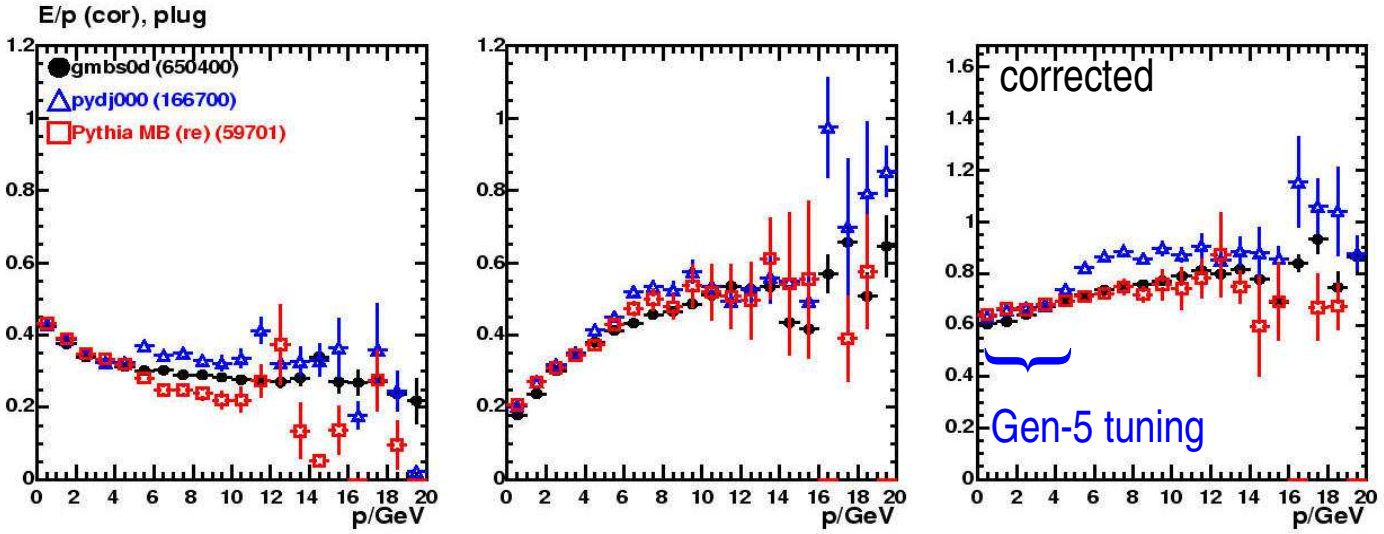
tower number	momentum range (GeV/c)									
	≥ 2	0.5-2	2-3	3-5	5-8	8-12	12-16	16-24	24-32	>32
0	13370	551079	11104	2123	134	7	0	2	0	0
1	14321	572955	11935	2219	156	10	0	0	0	0
2	16319	591695	13443	2682	187	5	1	0	0	0
3	18525	599309	15302	2992	215	14	2	0	0	0
4	21680	596673	17785	3620	257	15	1	1	0	0
5	25779	605169	20815	4573	361	27	3	0	0	0
6	31354	631072	24852	5926	529	45	1	0	0	0
7	39626	654726	31129	7683	764	44	4	1	0	0
8	49339	655646	38130	10115	1015	71	5	1	0	0
9	79190	966805	59989	17228	1770	186	14	2	1	0
10	111003	1043312	81809	25792	3076	298	24	3	0	0
11	170186	1123294	121135	42437	5950	587	61	13	0	0
12	80252	317440	54767	21566	3469	395	41	12	1	0
13	135673	240107	79811	44608	9682	1354	158	55	4	0
14	163351	170835	87105	58508	14949	2352	333	93	6	3
15	64759	40402	30584	24684	7818	1396	217	53	4	2
16	817559	746058	428313	278438	83641	19695	4926	1726	447	353
17	775314	356099	356376	271007	100309	28909	7758	4897	1763	2952
18	639001	89193	251342	226726	101253	34859	10737	6700	2390	3500
19	303229	480	69194	116303	66176	28152	9843	6678	2312	3305
20	13783	0	39	5058	4120	2185	951	688	246	349
21	92	0	0	9	22	19	9	10	5	13
central(1-4)	70845	2360632	58465	11513	815	44	4	1	0	0
wall	199509	2908249	154100	40952	4078	346	24	4	1	0
crack	281189	2166606	202944	68229	9026	885	85	16	0	0
plug(13-15)	363783	451344	197500	127800	32449	5102	708	201	14	5
beam	1731327	445772	676951	619094	271858	94105	29289	18963	6711	10106

Impact of Lateral Profile on E/p



archived Pythia MB dataset (Gen-5 tuning)

Pythia MB with wider profiles using Gen-5 parameters for p<5GeV/c but extended for all p

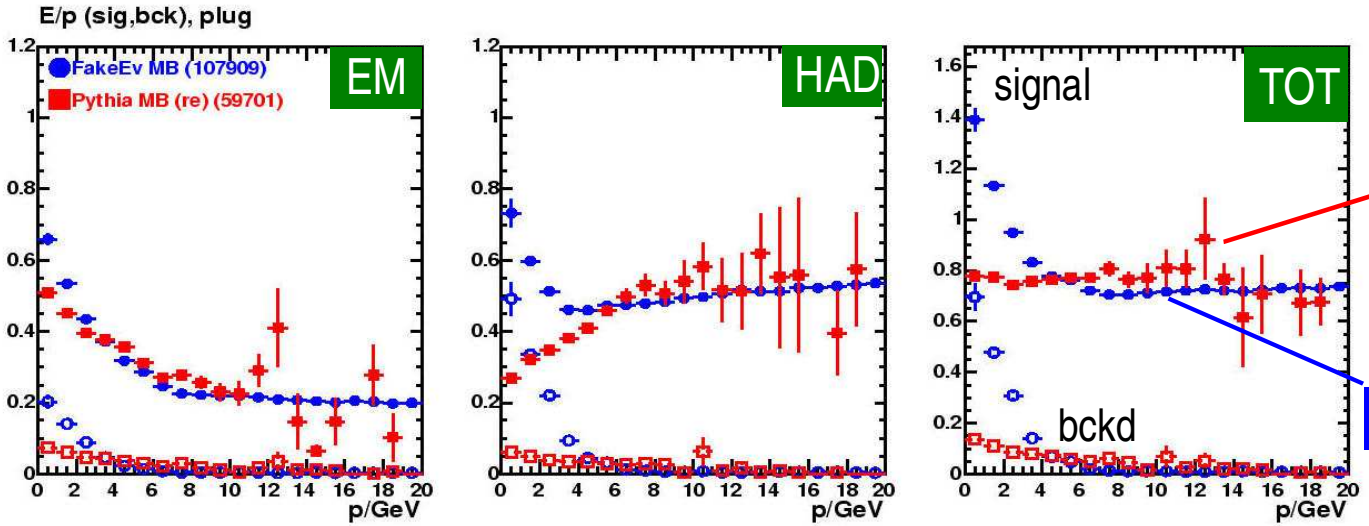


Current situation (Gen-5):

- too narrow profiles at p>5GeV/c
- "bump" in absolute E/p response: partially related to lateral profile mismatch

- Widening the profiles leads to significant additional leckage of shower energy outside 2x2(EM) and 3x3(HAD) signal regions - effect more drastical in plug due to finer granularity
- Need to optimize lateral profiles before starting with tuning of absolute E/p response

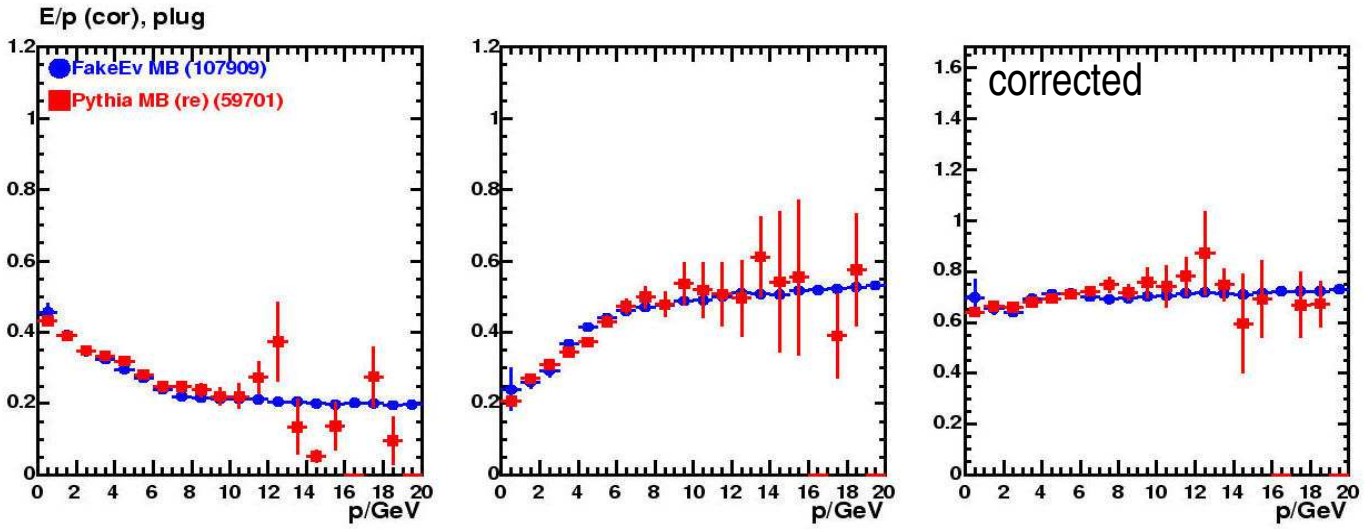
Which Generator for Tuning?



Simple mean, no lepton veto.

Pythia MB

FakeEv MB

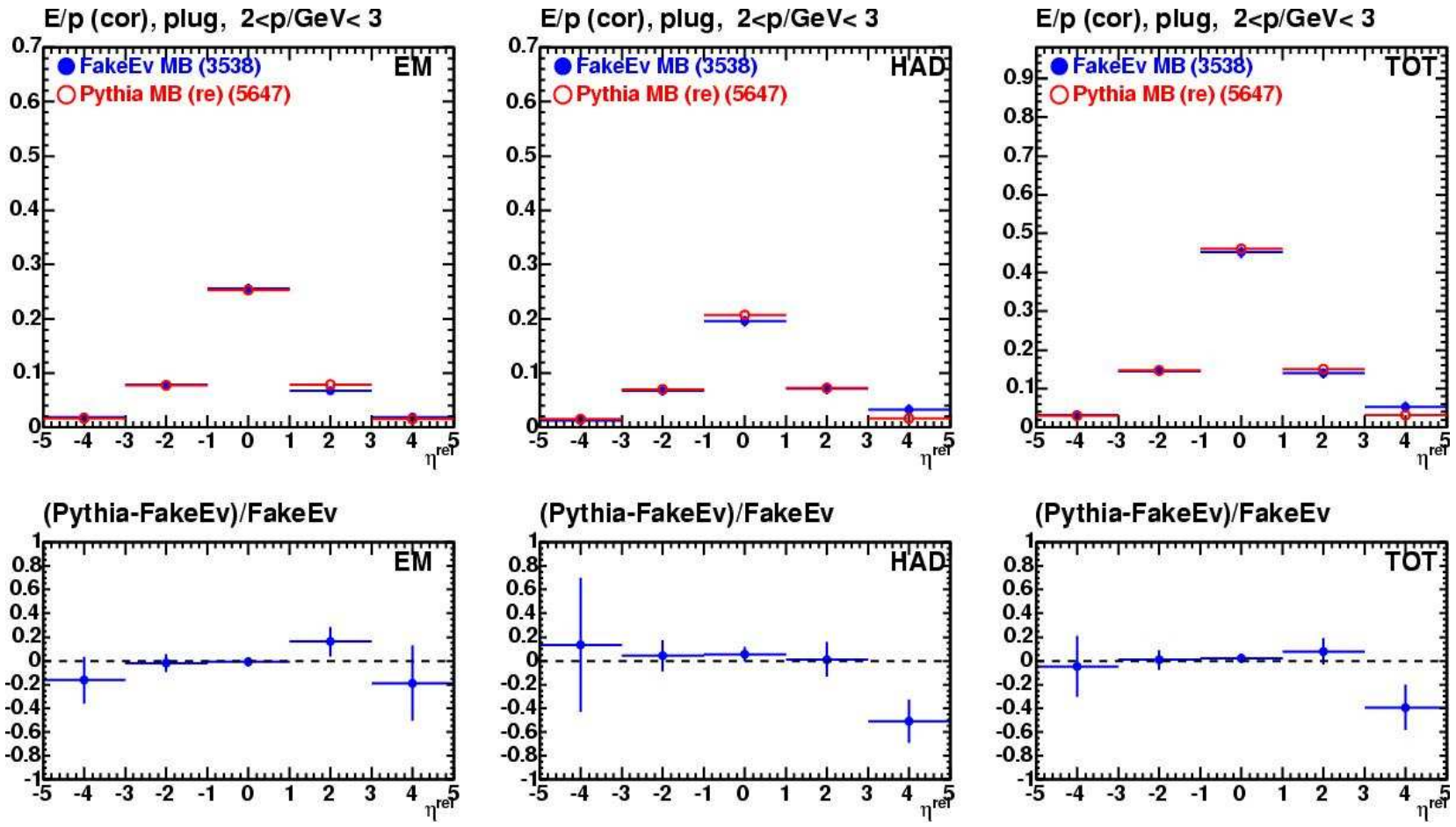


- "FakeEv MB": add minbias on top of fake tracks to introduce a more realistic background scenario (PES not used here)

- Corrected plug distributions for FakeEv MB and Pythia MB statistically compatible
- 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)

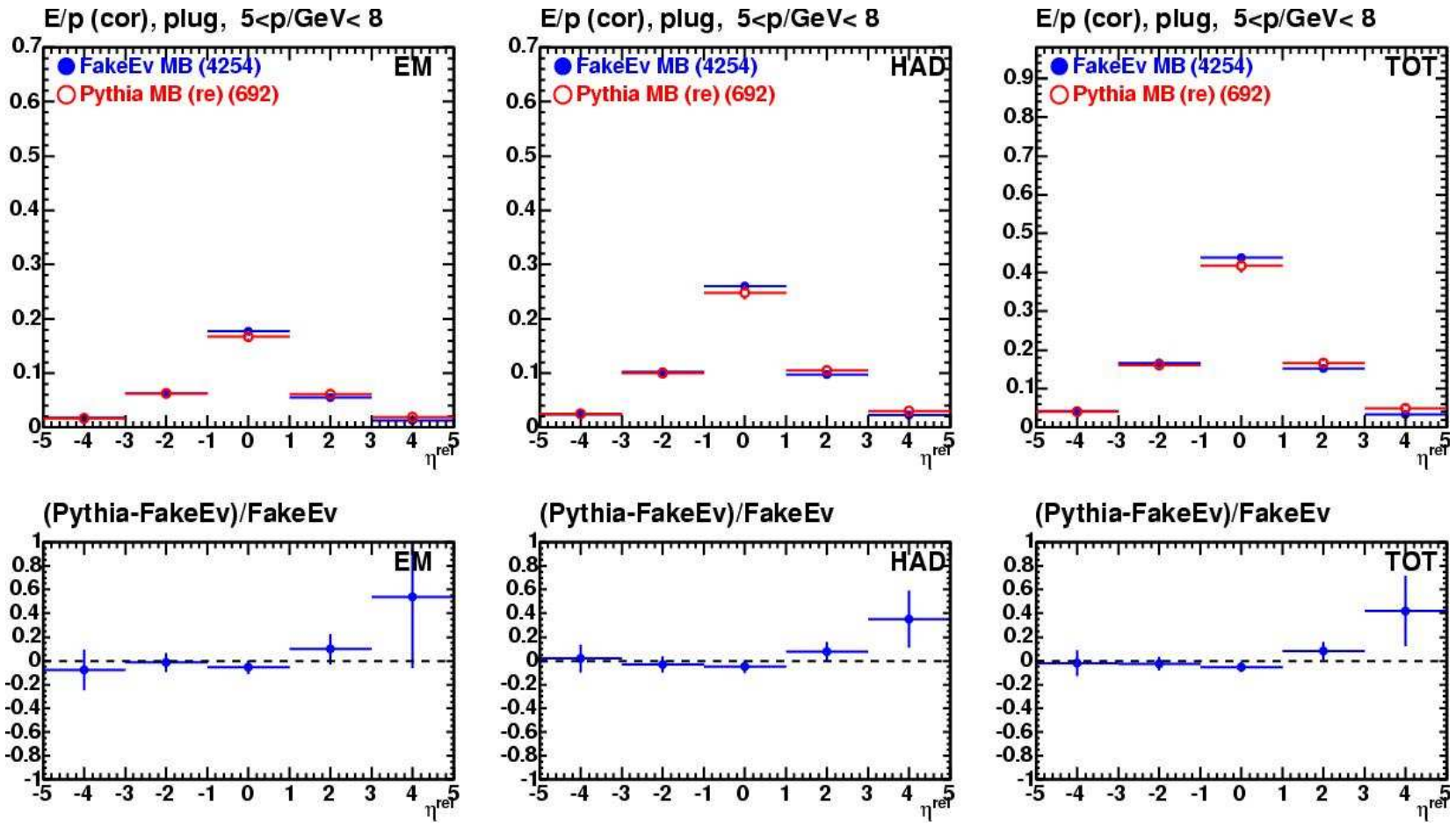
2-3 GeV/c



- FakeEv profiles are normalized to the absolute Pythia response

Pythia vs. FakeEv Lateral Profiles (2)

5-8 GeV/c

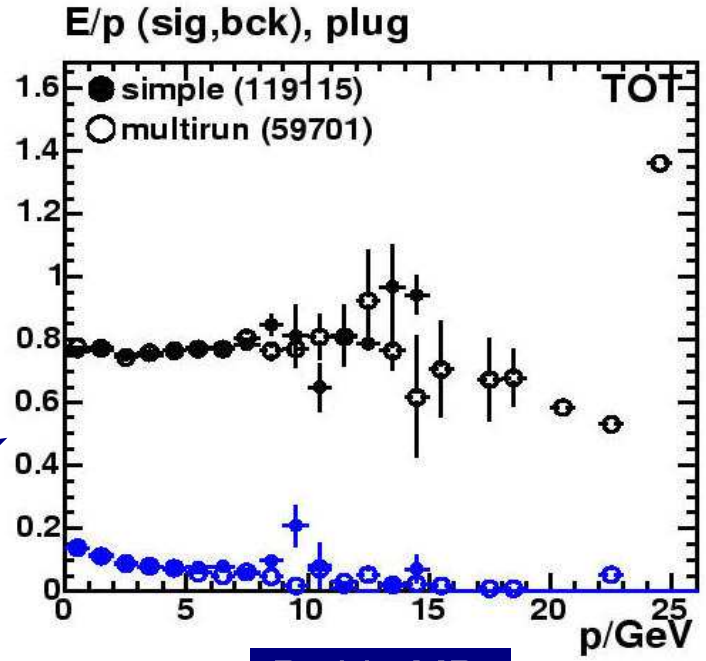


- FakeEv profiles are normalized to the absolute Pythia response

Further Crosschecks

Various cross checks and bug fixes before starting the tuning machinery for the plug

- reproducibility of pydj000
- dependence on data sample (gmbs0d vs gjtc0d)
- impact of background contamination (shows importance of PES)
- dependence on Minbias tuning version
- dependence on multiple run scheme (probably more important in the forward region than in the central)
- impact on calibration passes 13A (pydj000) vs. 17
- tried to optimize fake track multiplicity + η region for tuning jobs (IO track finding much less efficient than in the central)



Pythia MB

Finally I got the confidence that FakeEv can be used in the Plug similarly as in the Central (Pythia MB useful for crosscheck at low momenta).

Lateral tuning machinery for plug is running, will have first results soon.

Conclusion

- New tentative lateral profile parameters for the central included in Gen-6 development release.
- Next tuning iteration includes new STT15 data up to 32 (40?) GeV/c
  -addional track quality cuts
- Probably re-evaluation of Gen-5 data-MC discrepancy in JER NIM draft?
- Lateral profile tuning in the Plug up to 24 GeV/c on the way.
- We should have final result end of this year (projected deadline Dec-1)