Status of the Plug Simulation Tuning

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Overview

- In the Central, the hadronic lateral profile and absolute response are consistently tuned to single isolated track data up to 40 GeV/c
  Level of agreement E/p (MC-Data): 1-2% (status CALOR06)
- In the Plug we are currently using a hybrid tuning:
  Gen-6 Central lateral profile plus Gen-5 absolute response tuning
  - doesn't fit the E/p data well (see SGM talk of 04/06/06)
  - want to improve picture by a new eta-dependent tuning

This talk:

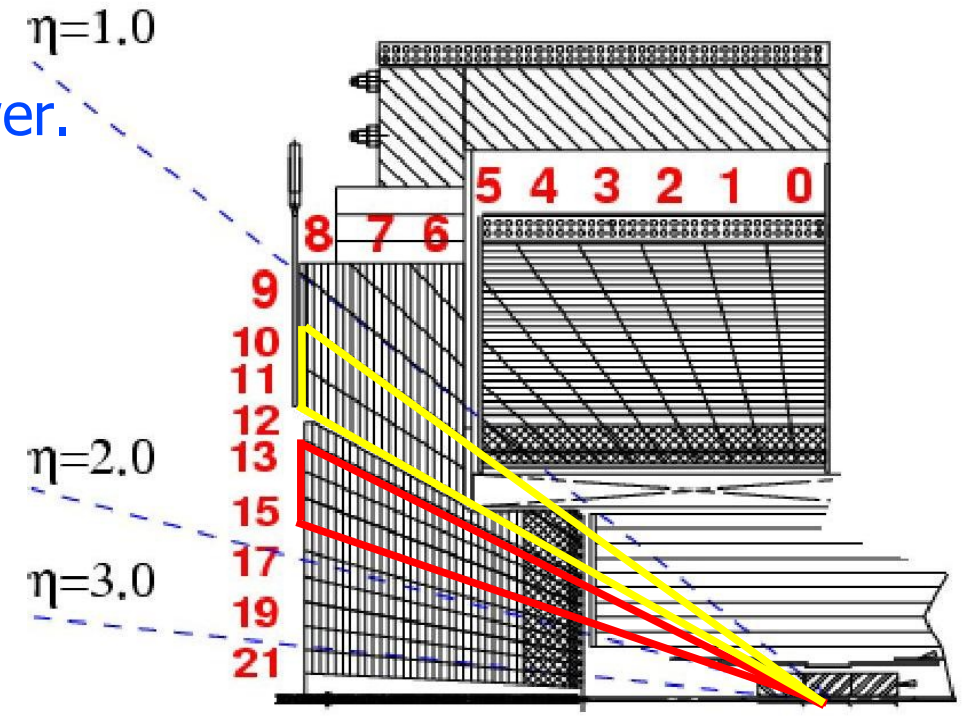
1) Lateral profile tuning update in Plug (almost final).
2) How to use the data for the absolute E/p tuning.
3) Interdependence between lateral and absolute response.

Track Quality Requirements

- Tracks are extrapolated to PES.
- 7x7 block isolation around target tower.
- Hits in COT Silicon

	axial	stereo	axial	stereo	z
Crack:	≥20	≥20	≥4	-	-
Plug:	≥7	≥7	≥4	≥2	≥2

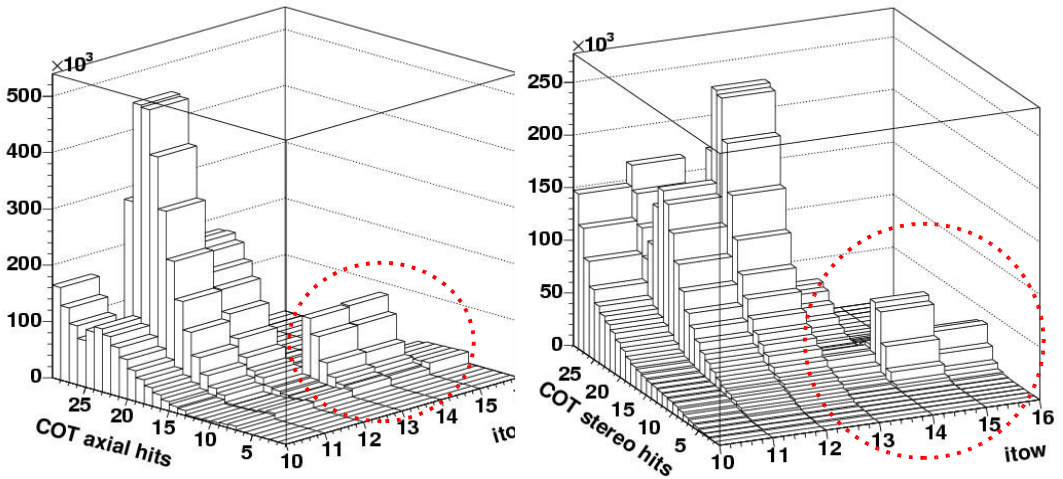
- cut reduces isolated track statistics considerably but is crucial to ensure reasonable E/p measurement.
- target towers >15 not usable



"Crack"= target towers 10+11

"Plug" = target towers 13-15

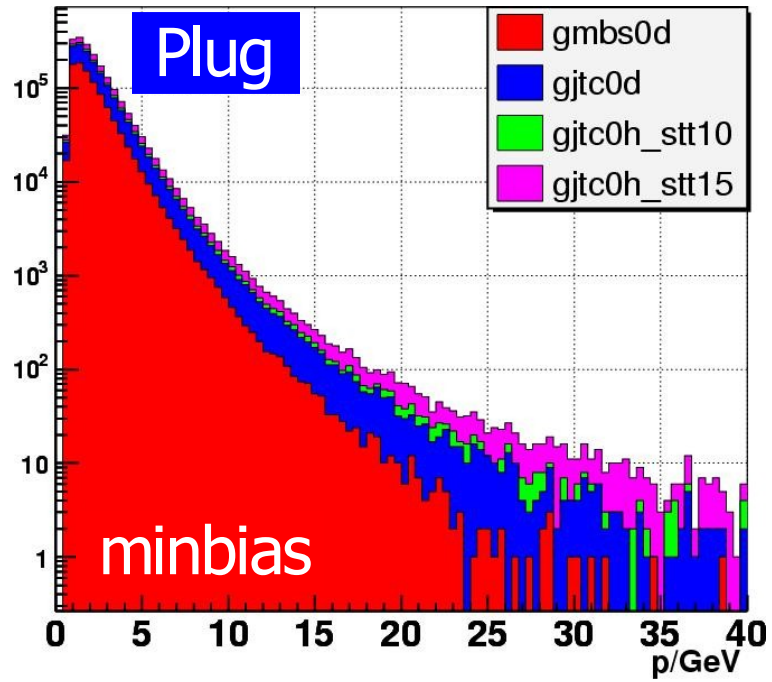
minbias data (gmbs0d)

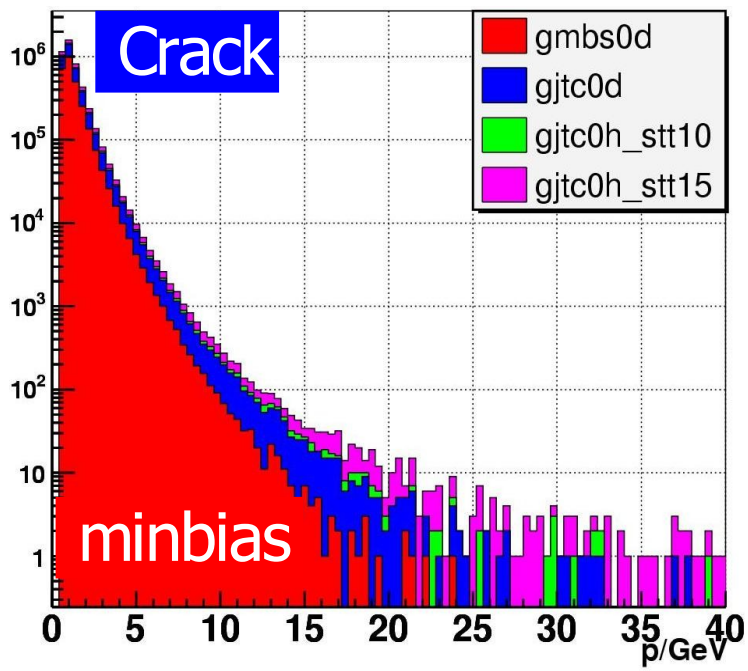


Data Samples

- Minimum bias sample (gmbs0d, ~21M events)
- Single Track Trigger data:
  - 3, 4, 7 GeV/c thresholds: gjtc0d ~16M events
  - 10 GeV/c threshold: gjtc0h_stt10 ~4M events
  - 15 GeV/c threshold: gjtc0h_stt15 ~6M events

...contain single isolated tracks in Plug/Crack as byproduct





Signal Definition

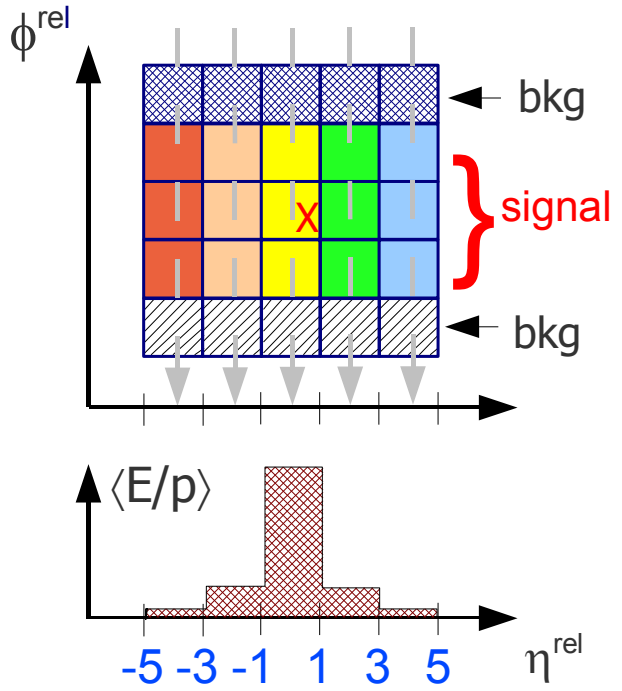
- E/p profile:

sig: ⟨E/p⟩ in 5 tower strips (3x1) adjacent in η

bck: 1.5 x both side towers

cut: $|\eta^{rel}|<0.6$, $|\phi^{rel}|<0.6$

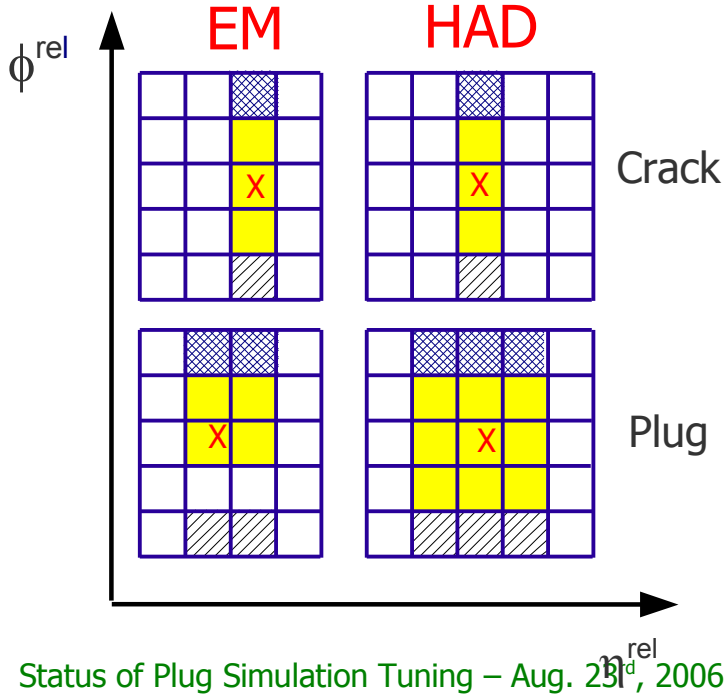
relative η coordinates are normalized to tower boundaries



- Absolute E/p response:

Crack: sig: EM=3x1 strip, HAD=3x1 strip
bck: 1.5 x both side towers
cut: $|\eta^{rel}|<0.6$, $|\phi^{rel}|<0.9$

Plug: sig: EM=2x2 blocks, HAD=3x3 blocks
bck: EM=2x far strip, HAD=3xfar strip
cut: $|\eta^{rel}|<0.9$, $|\phi^{rel}|<0.9$



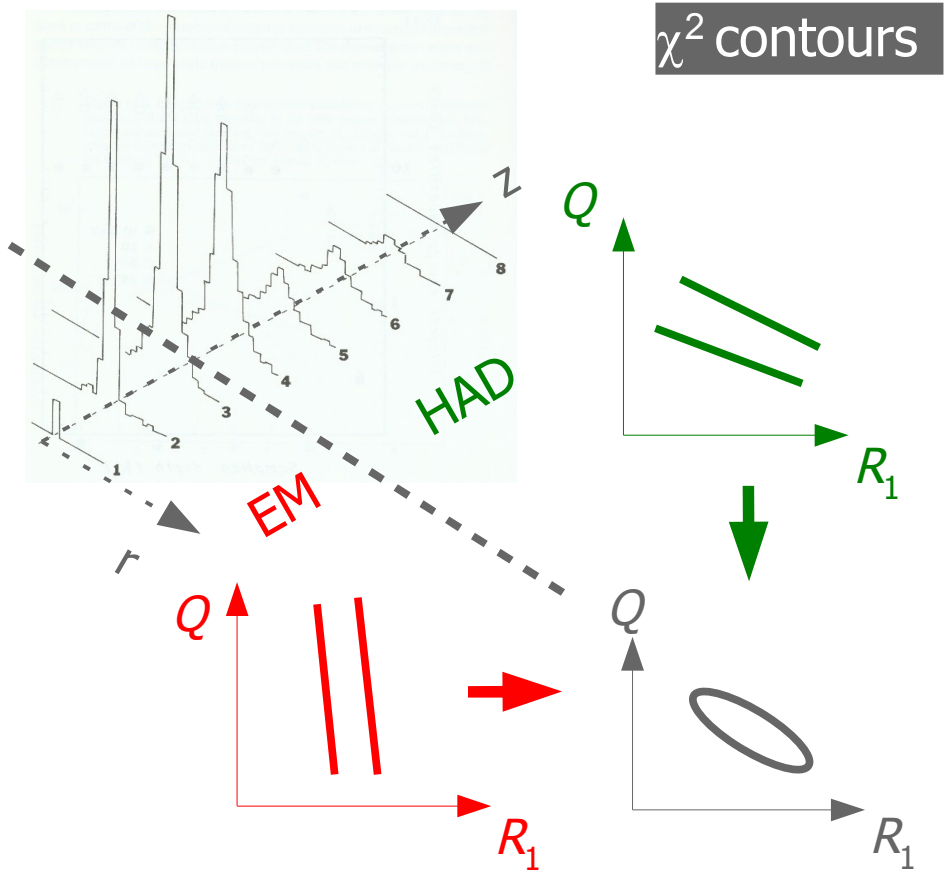
GFLASH Lateral Profile Tuning

$$T(r) = \frac{2\, r\, R_0^2}{(r^2 + R_0^2)^2}$$

- r: radial distance from shower center
- z: shower depth

$$\langle R_0(E_{\text{inc}}, z) \rangle = [R_1 + (R_2 - R_3 \ln E_{\text{inc}})\, z]^n$$

core term R_1 **spread term Q**
- shower depth
- incident particle energy



- HAD and EM compartment provide complementary information about the shower development → useful to constrain R_1 and Q.
- (R_1,Q) is scanned at fixed energy bins and simulated E/p profiles compared with reference data: $\chi^2 = [\, \chi^2(\text{EM})/N_1 + \chi^2(\text{HAD})/N_2 \,]/N$.
- R_2 and R_3 determined from energy dependence of Q using R_1 constraint.

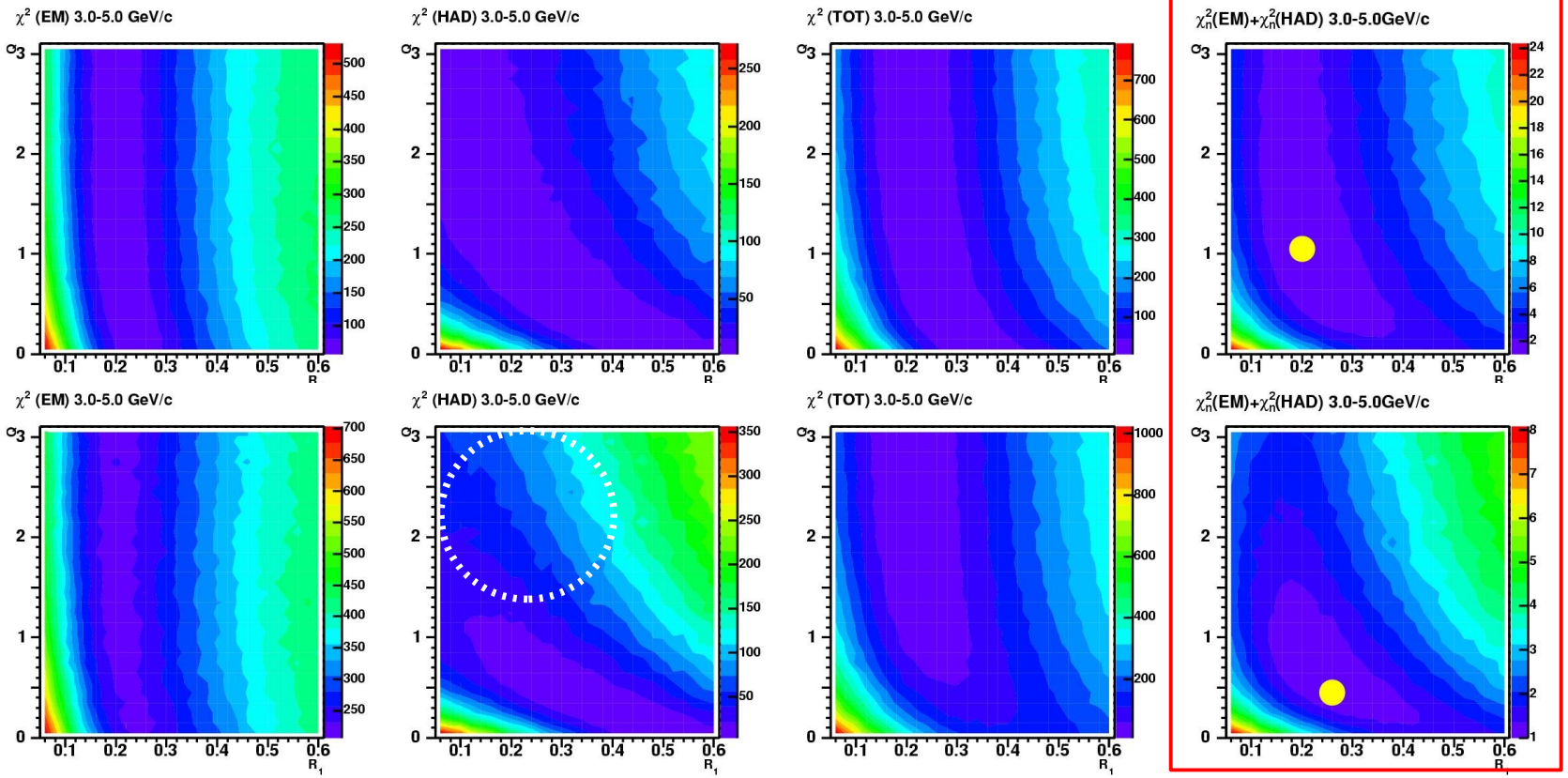
Tuning Details

- Data: Focus on Minimum Bias data.
  - sufficient single isolated IO tracks Plug(Crack) up to 20(14)GeV/c
- Simulation: particle gun (FAKEEV) + cdfSim/ProductionExe 6.1.4
  - 16 particles per event within $|\eta|$=0.3-2.0
  - Pion/Kaon/Proton=.6/.3/.1
  - flat spectrum, momentum weighting of E/p histograms
- For performance reasons no Pythia Minimum Bias events added for background modeling – is ok because...
  - we are looking at the response relative to target tower
  - lateral profiles are normalized to absolute E/p response of data
  - correction procedure for uncorrelated background
- Much higher MC statistics w.r.t. previous iteration and finer scan grid.
- Improved sensitivity by considering E/p profile of five instead of three adjacent towers (for p<8GeV/c):
  - granularity in Plug finer than in Central

Dependence on E/p Profile Definition

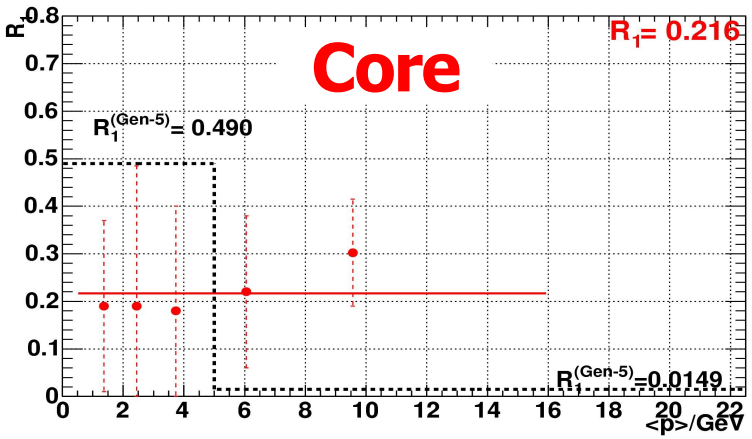
Tower 11
3-5 GeV

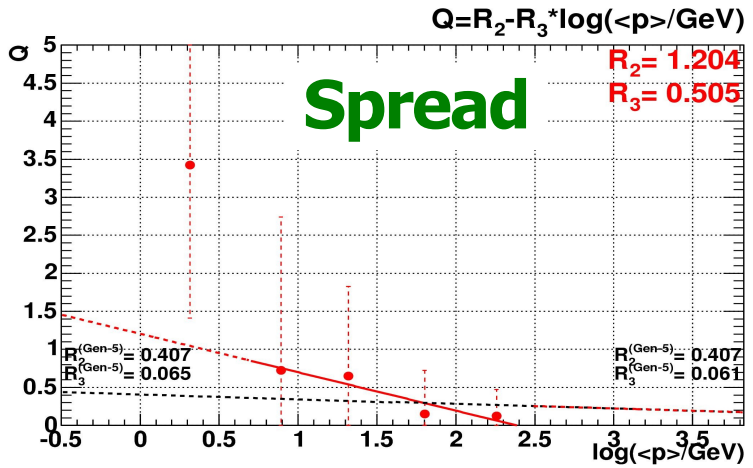
EM | HAD | TOT | EM⊕HAD



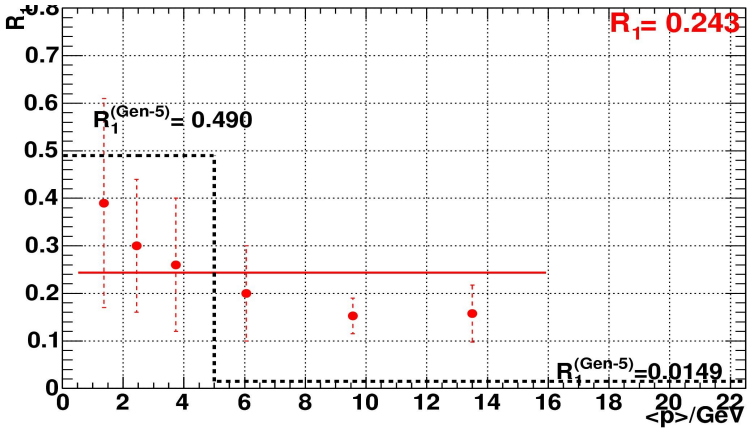
- Extending the experimental profile to 5 tower is useful to reject too high Q values in HAD compartment at low energies .

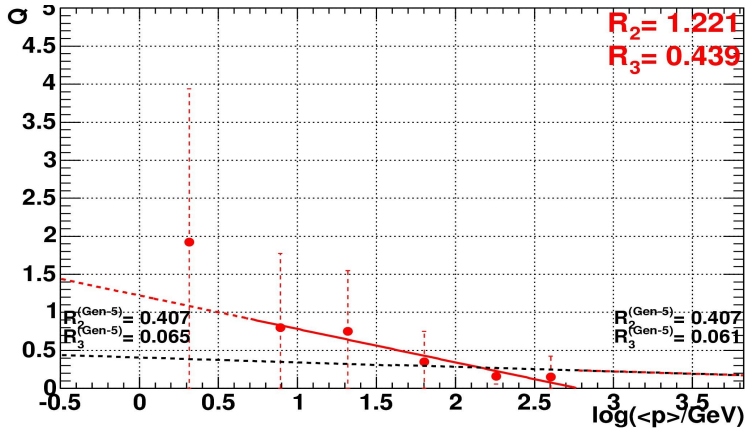
Tuning Results



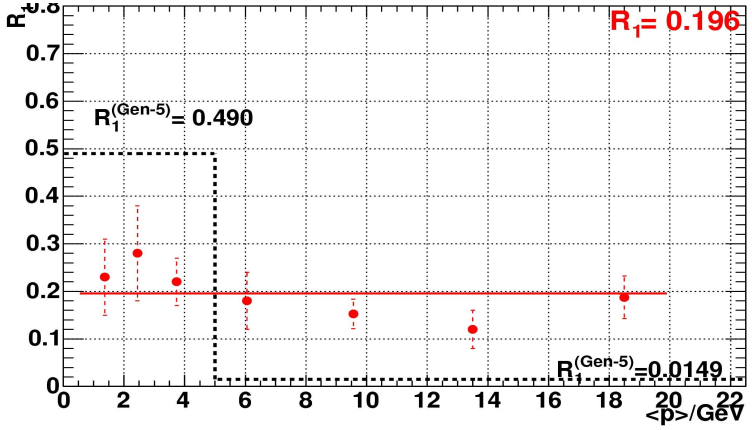


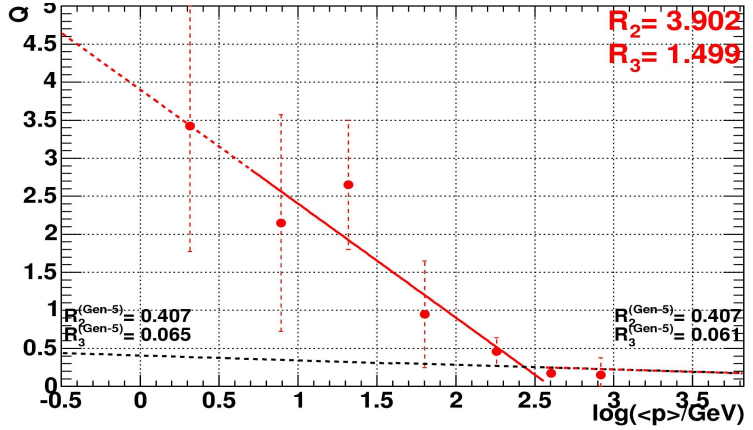
T10





T11

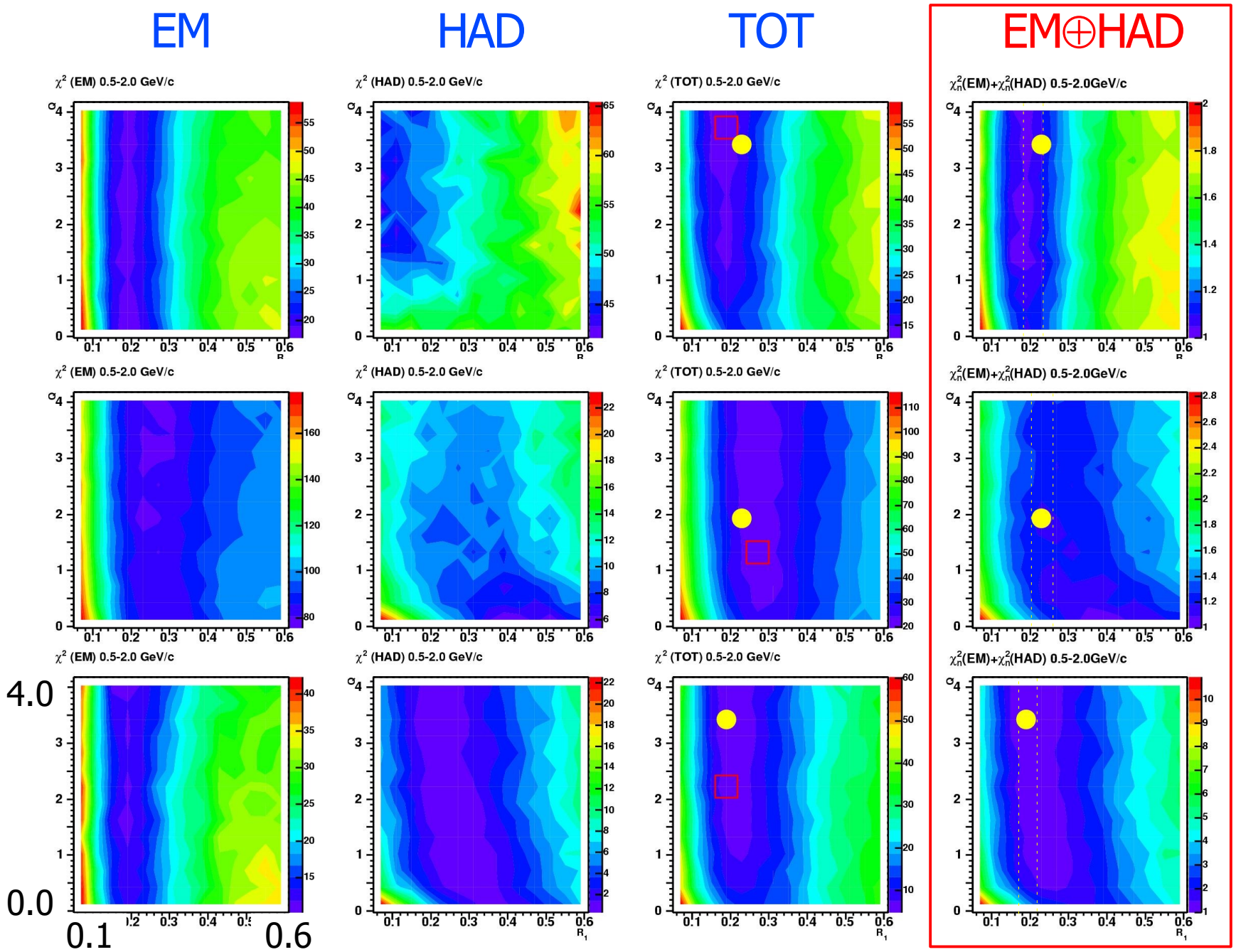




Plug

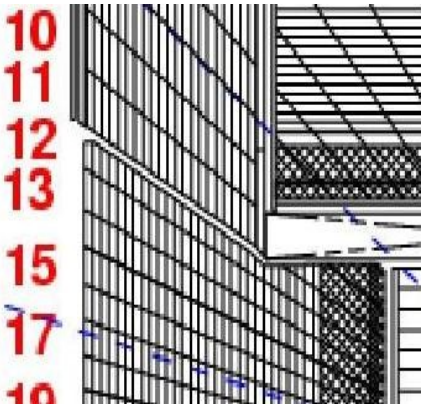
- Consistent core terms, shower spread in Crack towers suppressed w.r.t. Plug

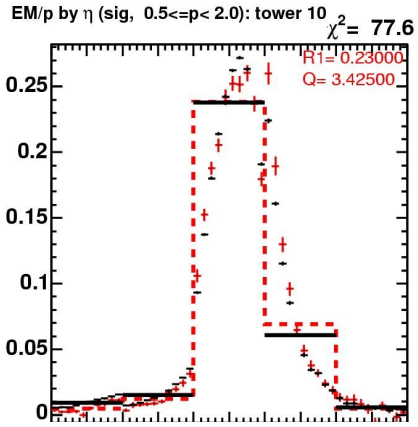
0.5-2.0 GeV/c

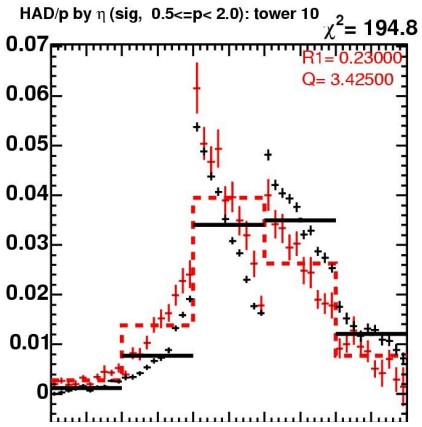

EM
HAD
TOT
EM⊕HAD
T10
T11
Plug
χ² (EM) 0.5-2.0 GeV/c
χ² (HAD) 0.5-2.0 GeV/c
χ² (TOT) 0.5-2.0 GeV/c
χ²n(EM)+χ²n(HAD) 0.5-2.0GeV/c
4.0
0.0
0.1
0.6

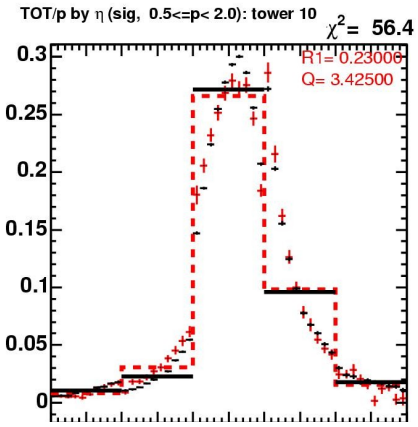
0.5-2.0 GeV

EM HAD TOT

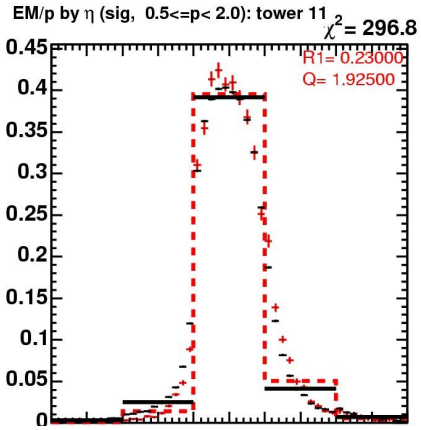


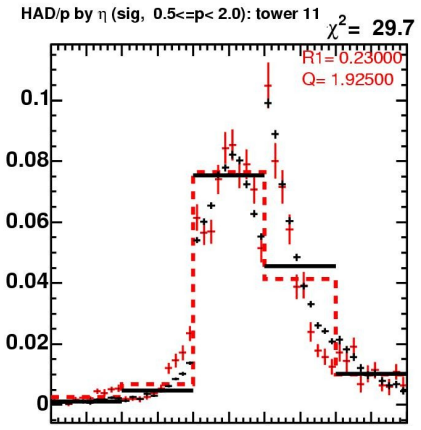


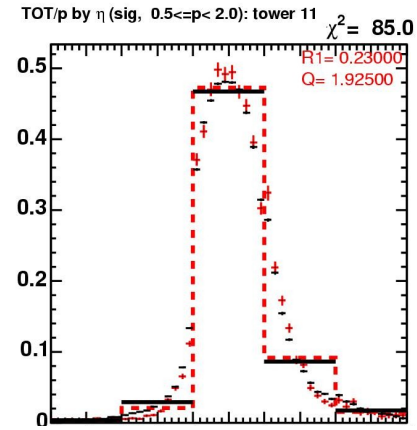




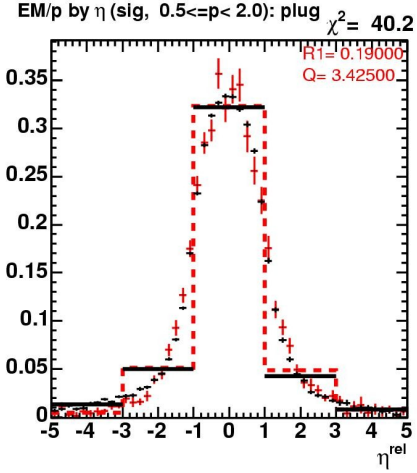
T10

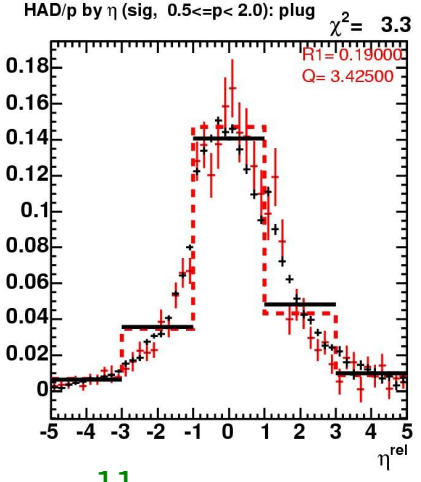


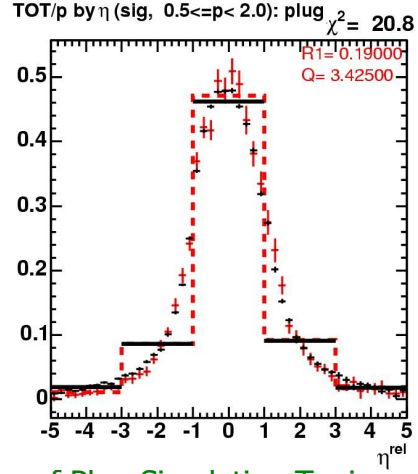




T11

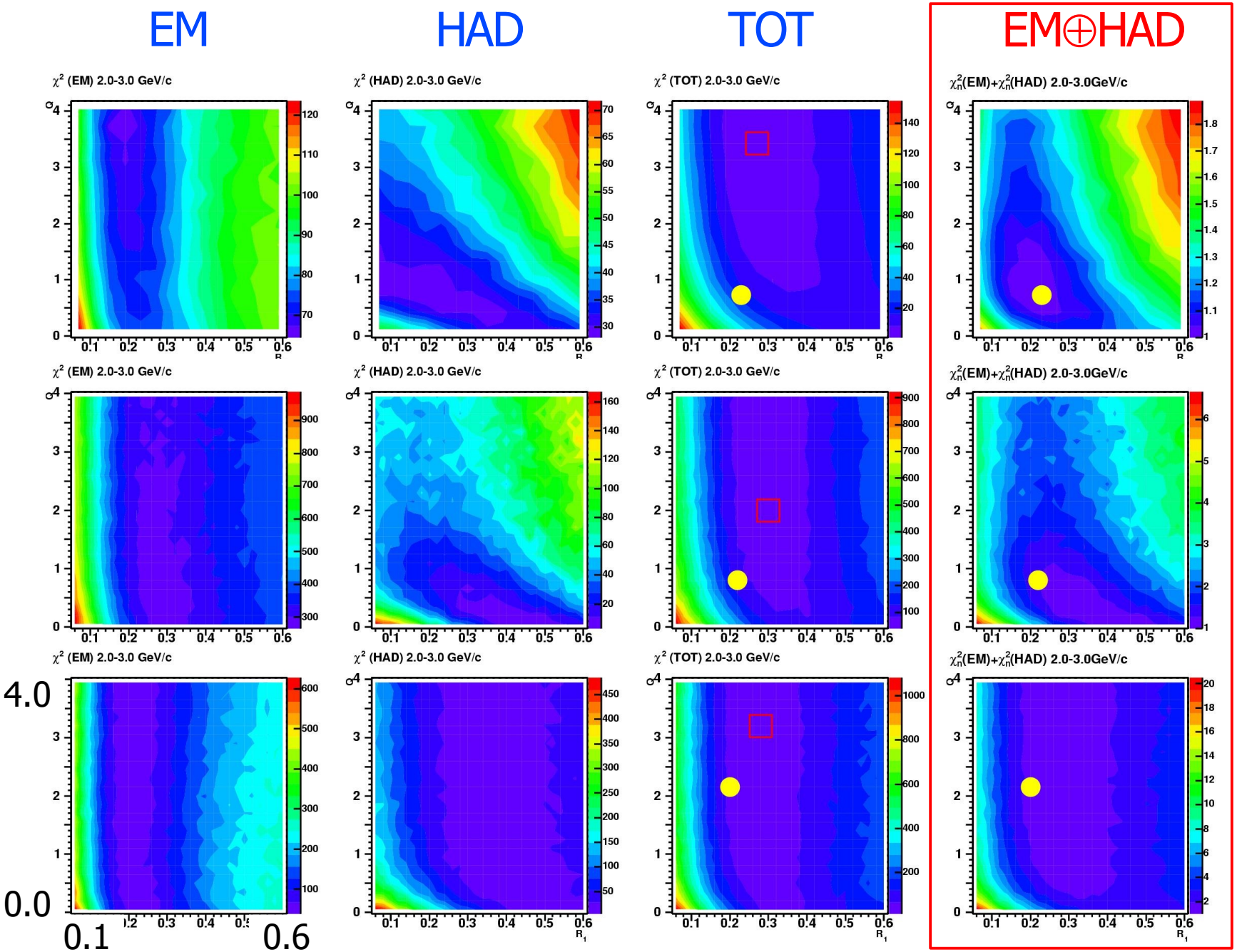




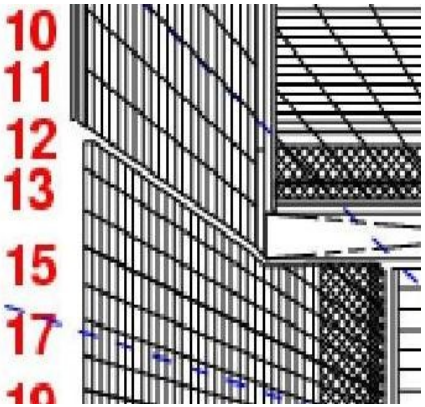


Plug

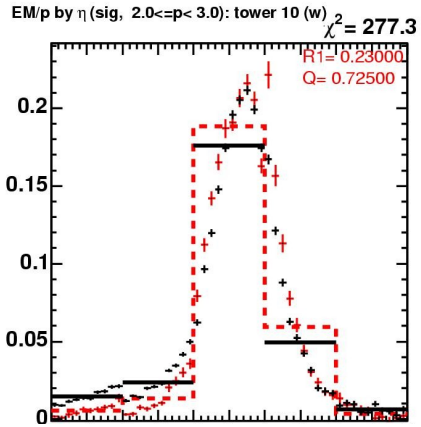
2-3 GeV

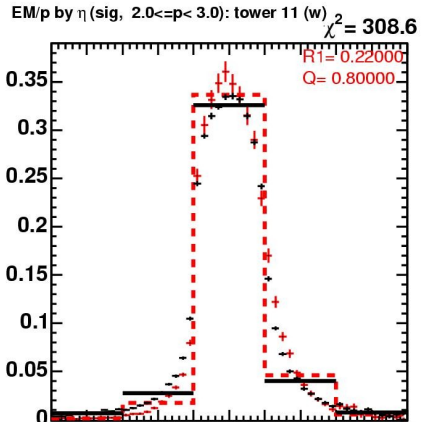

EM
HAD
TOT
EM⊕HAD
T10
T11
Plug
χ² (EM) 2.0-3.0 GeV/c
χ² (HAD) 2.0-3.0 GeV/c
χ² (TOT) 2.0-3.0 GeV/c
χ²n(EM)+χ²n(HAD) 2.0-3.0GeV/c
4.0
0.0
0.1
0.6

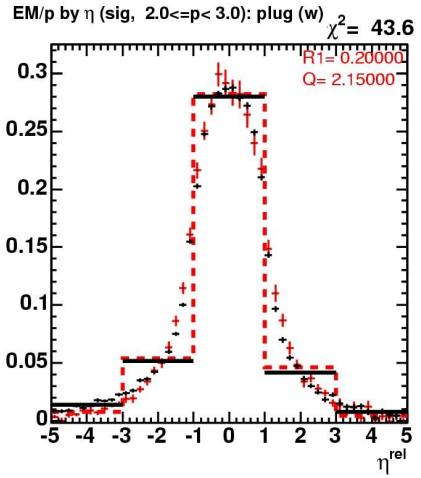
2-3 GeV



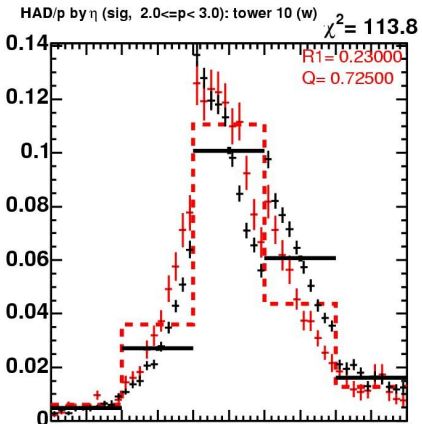
EM

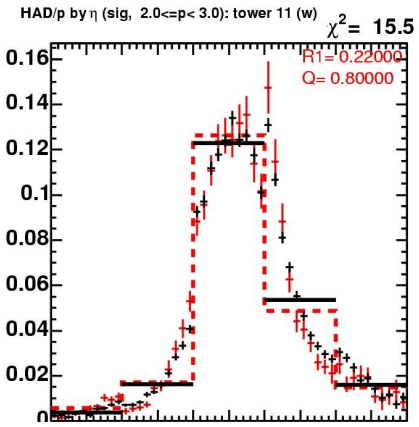


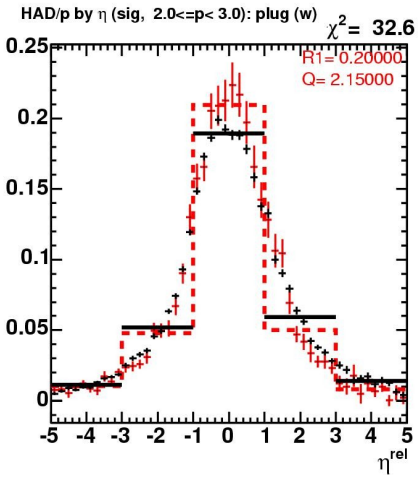




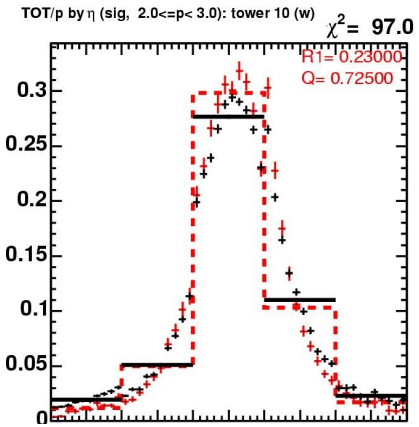
HAD

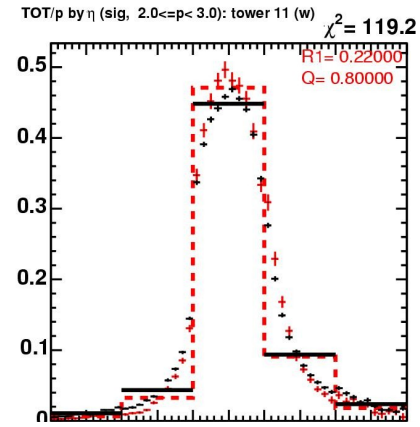


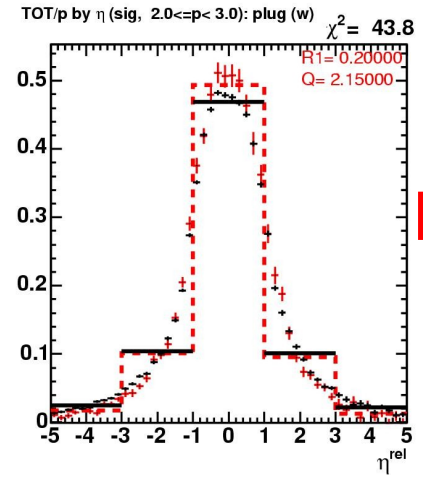




TOT





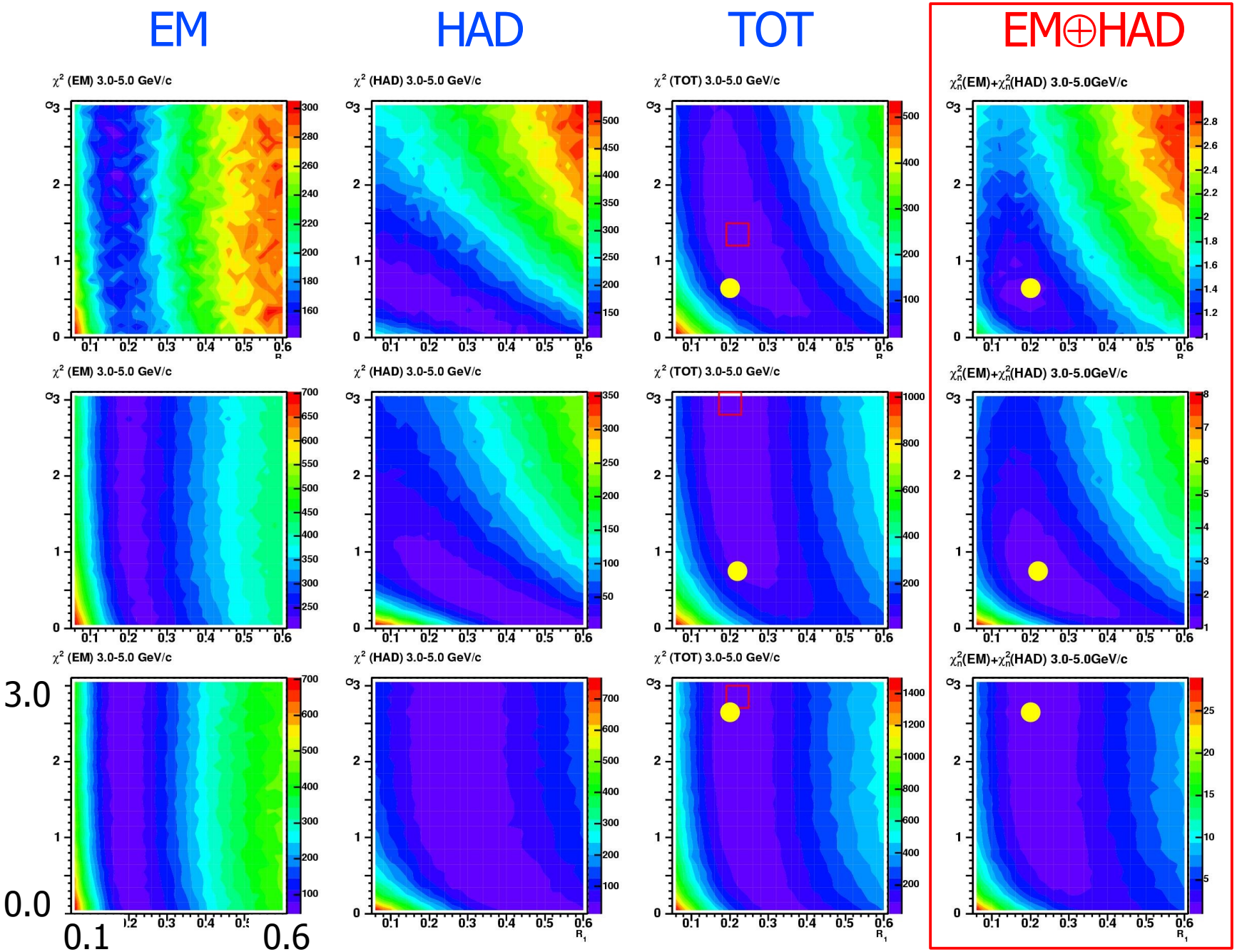


T10

T11

Plug

3-5 GeV

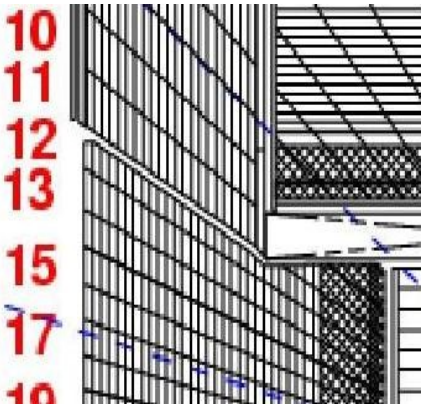

EM
HAD
TOT
EM⊕HAD
T10
T11
Plug
χ² (EM) 3.0-5.0 GeV/c
χ² (HAD) 3.0-5.0 GeV/c
χ² (TOT) 3.0-5.0 GeV/c
χ²n(EM)+χ²n(HAD) 3.0-5.0GeV/c
3.0
0.0
0.1
0.6

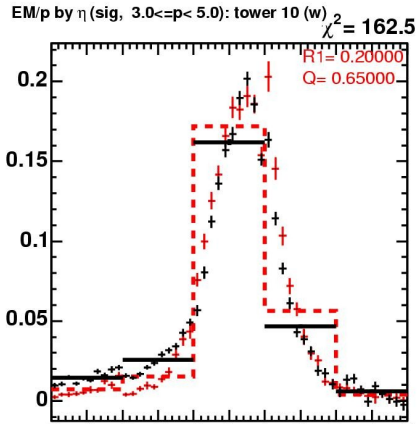
3-5 GeV

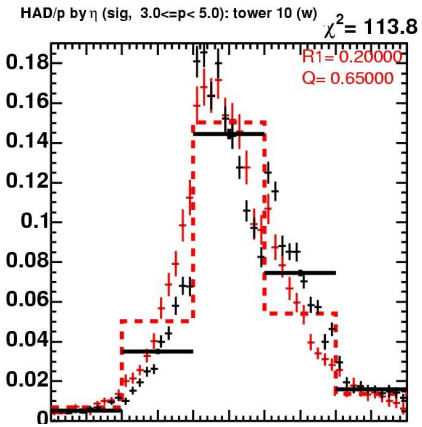
EM

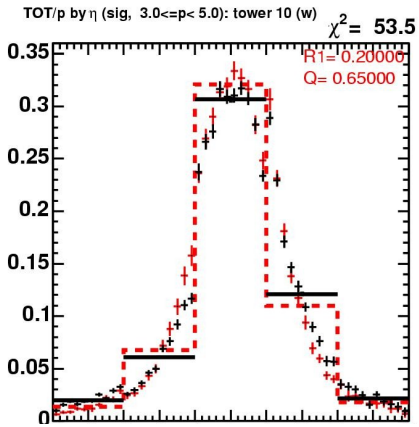
HAD

TOT

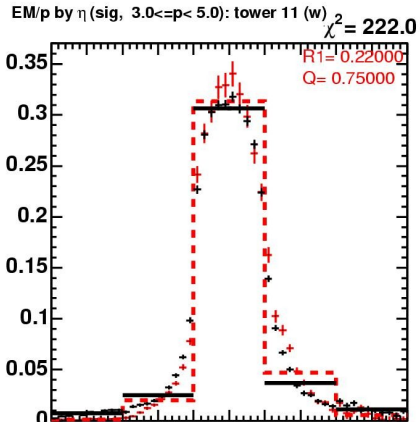


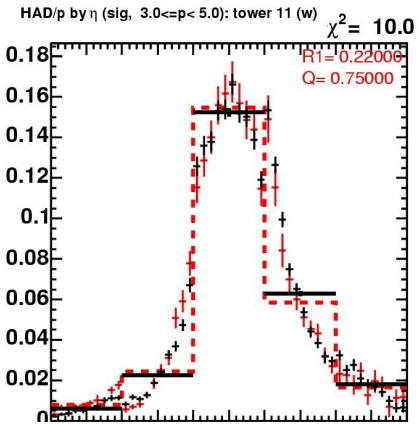


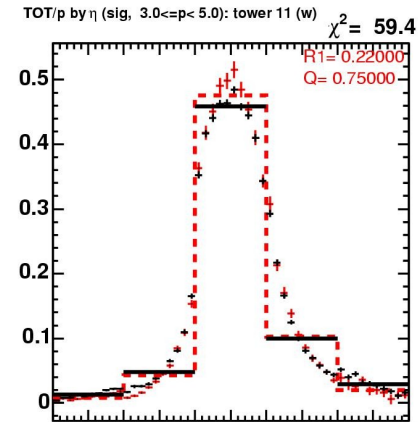




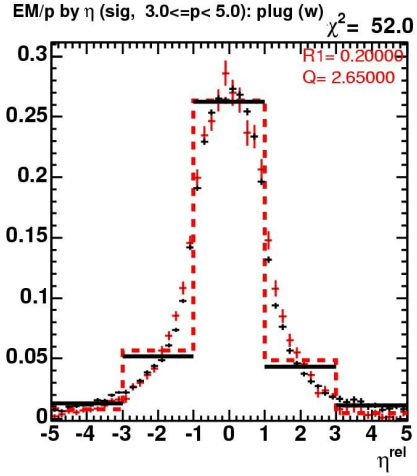
T10

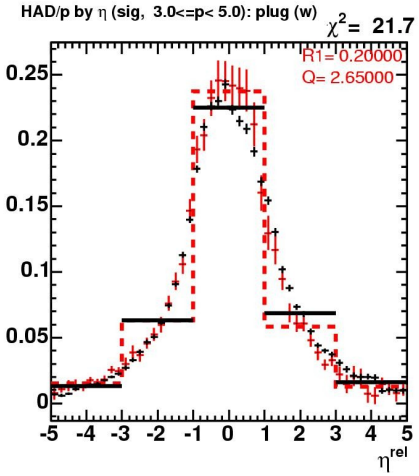


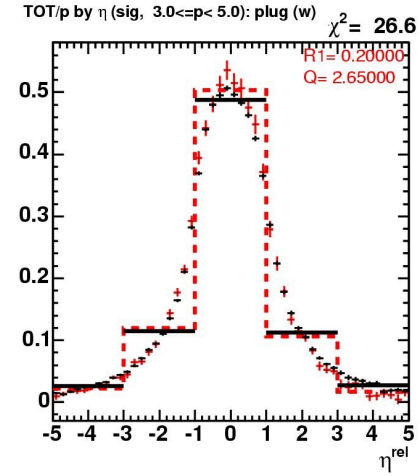




T11

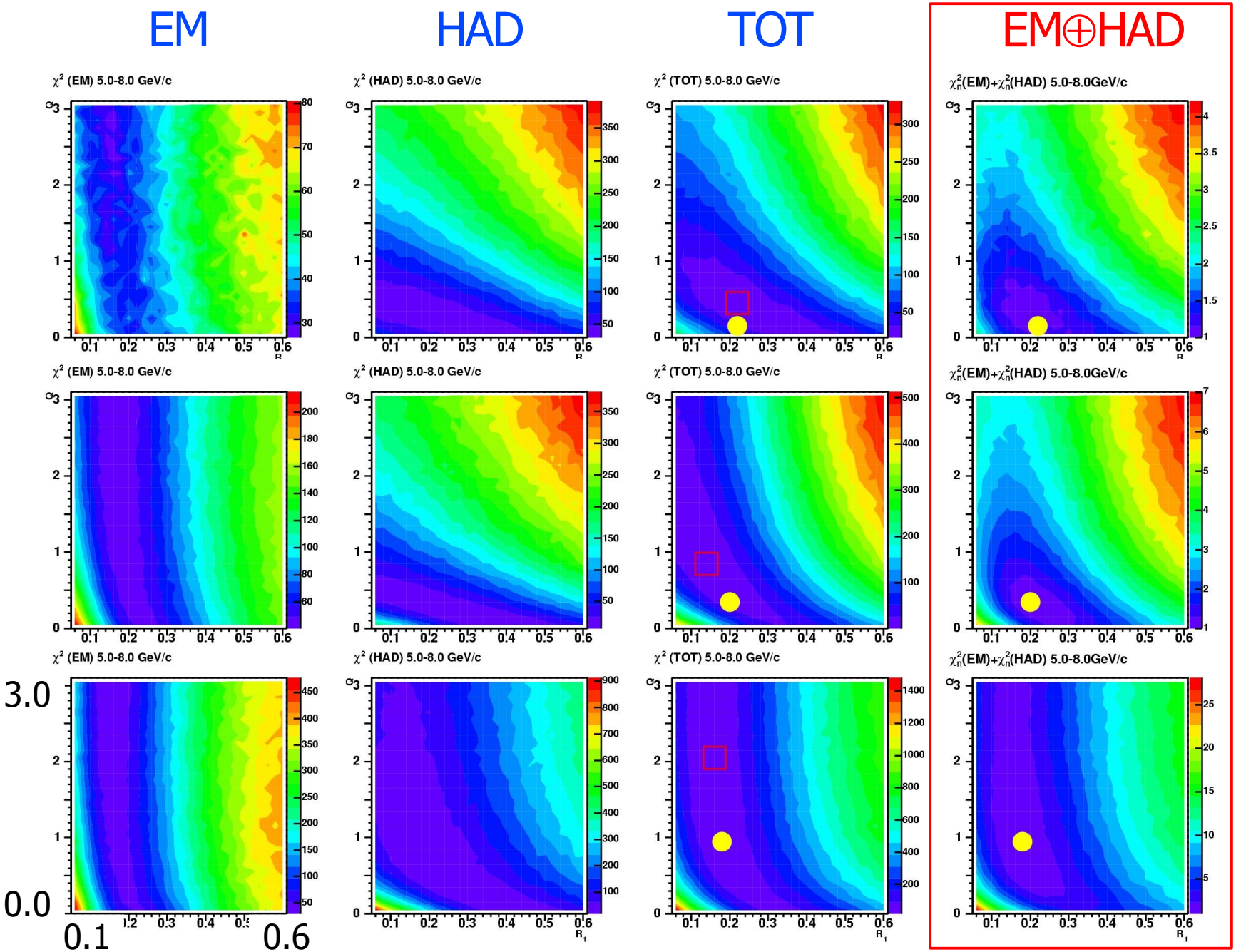




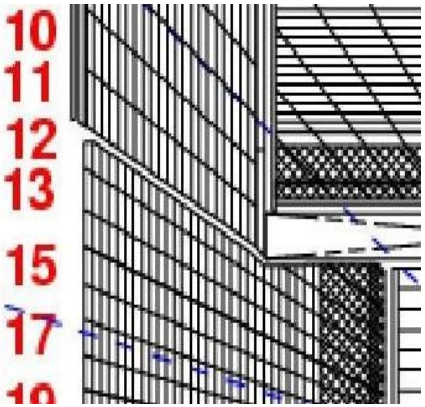


Plug

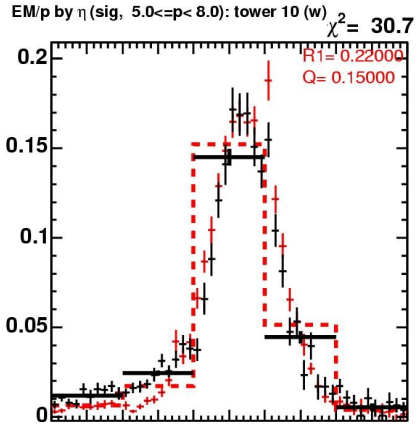
5-8 GeV

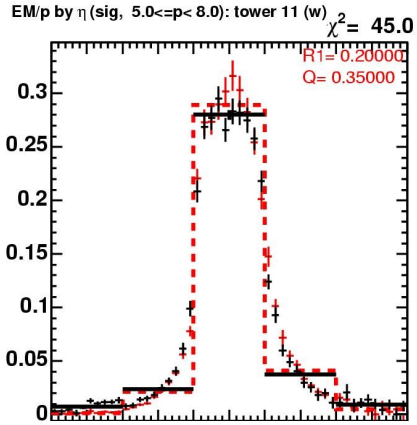

EM
HAD
TOT
EM⊕HAD
T10
T11
Plug
χ² (EM) 5.0-8.0 GeV/c
χ² (HAD) 5.0-8.0 GeV/c
χ² (TOT) 5.0-8.0 GeV/c
χ²n(EM)+χ²n(HAD) 5.0-8.0GeV/c
3.0
0.0
0.1
0.6

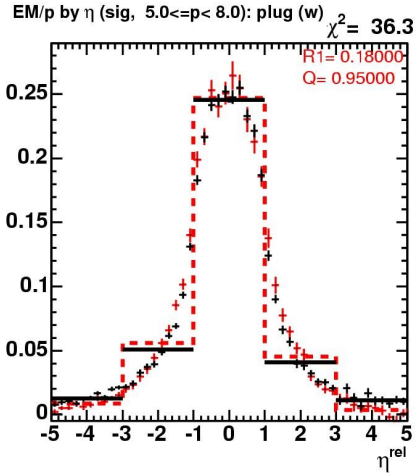
5-8 GeV



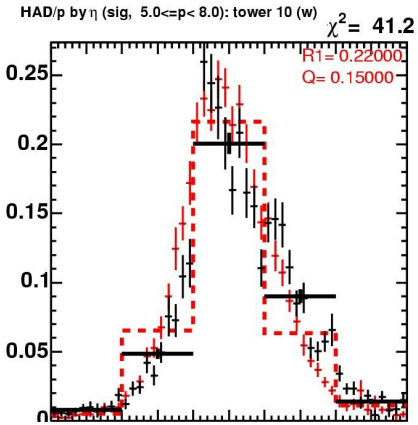
EM

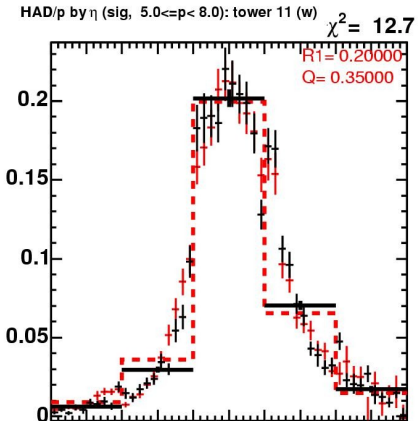


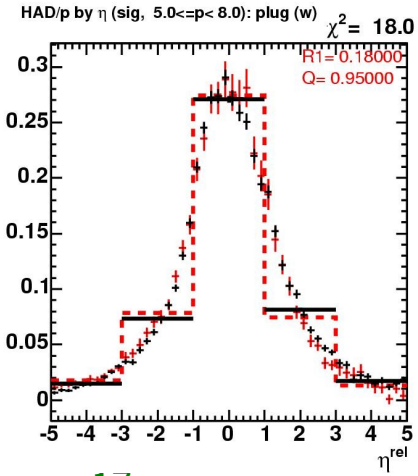




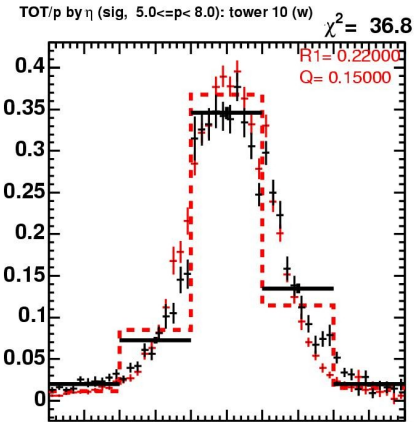
HAD

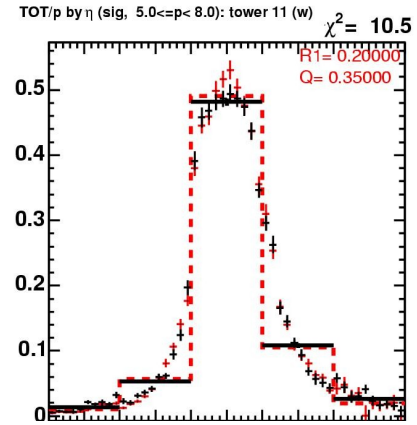


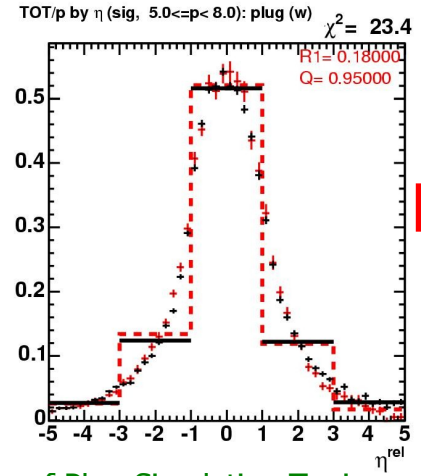




TOT





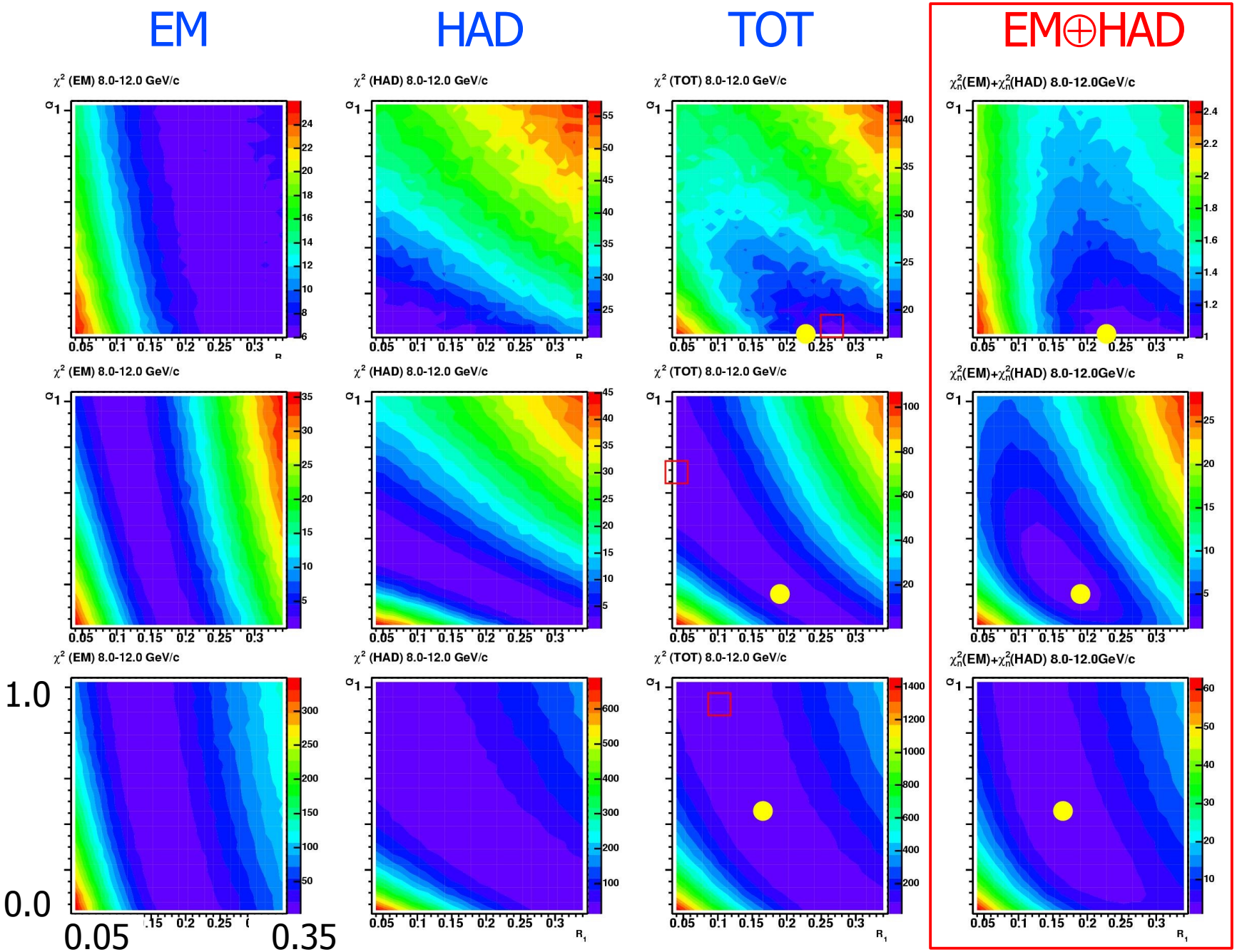


T10

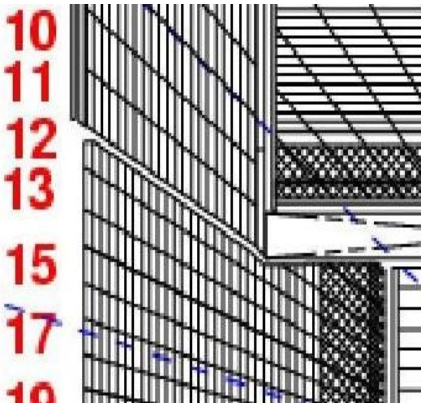
T11

Plug

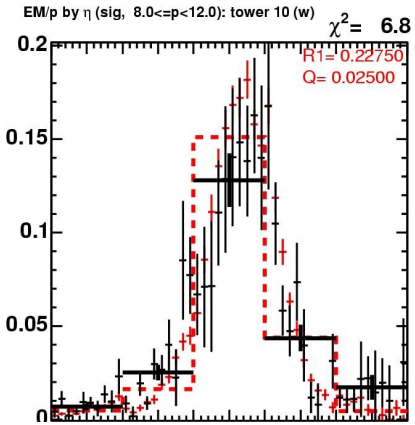
8-12 GeV

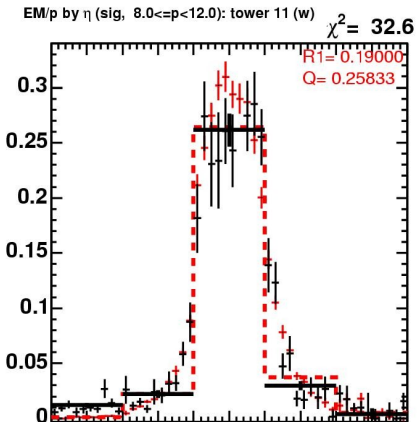

EM
HAD
TOT
EM⊕HAD
T10
T11
Plug
χ² (EM) 8.0-12.0 GeV/c
χ² (HAD) 8.0-12.0 GeV/c
χ² (TOT) 8.0-12.0 GeV/c
χ²n(EM)+χ²n(HAD) 8.0-12.0GeV/c
1.0
0.0
0.05
0.35

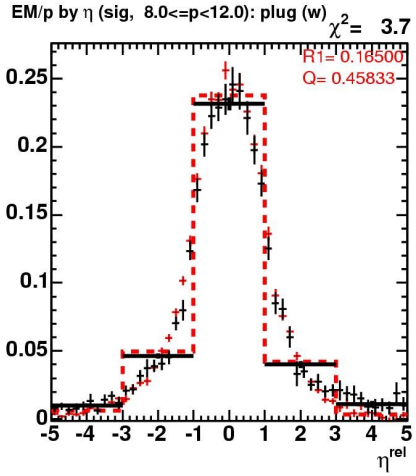
8-12 GeV



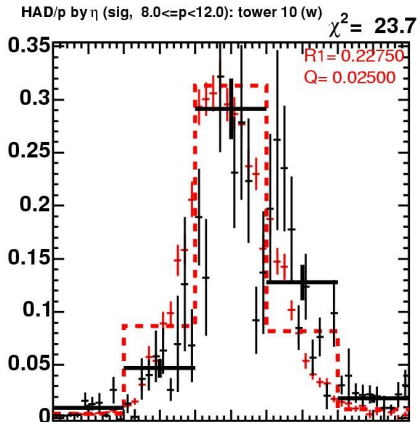
EM

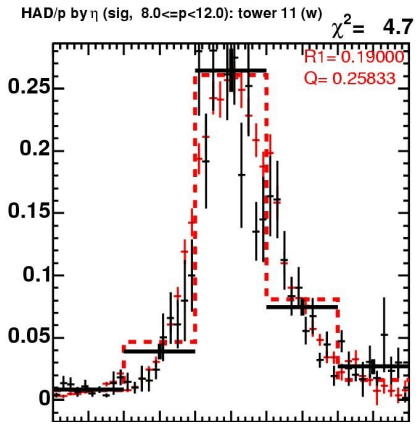


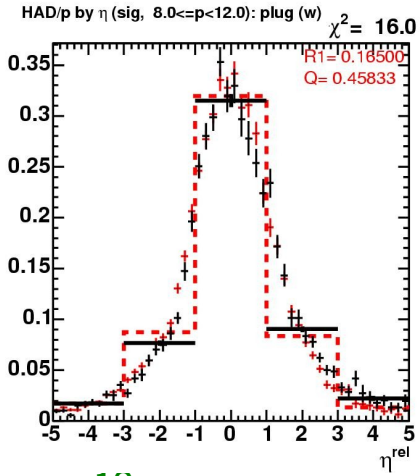




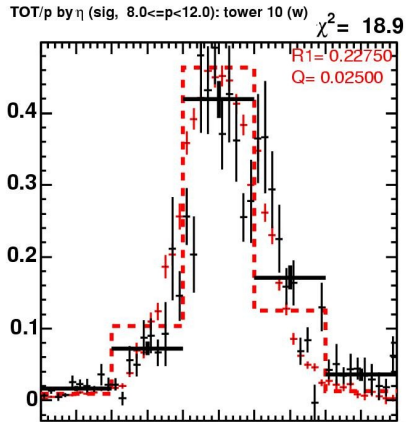
HAD

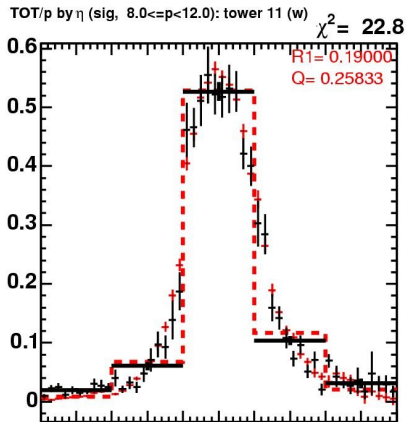


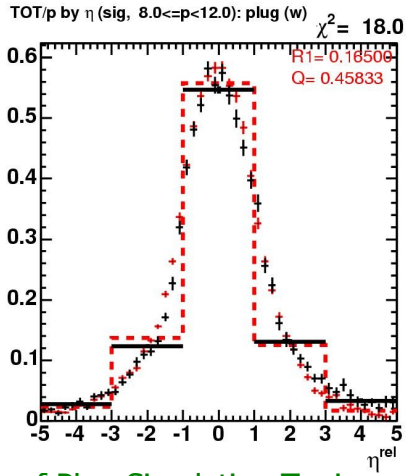




TOT





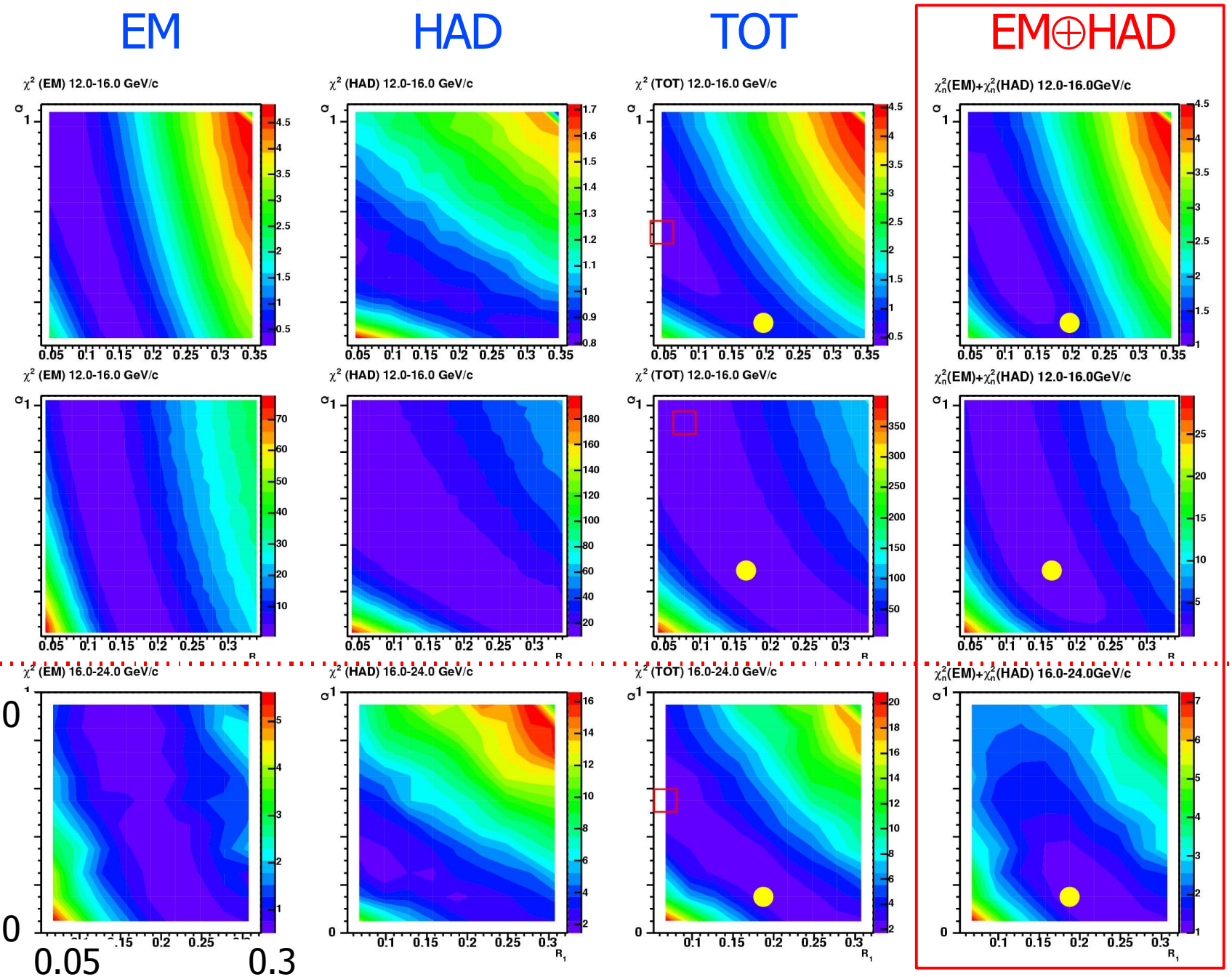


T10

T11

Plug

>12GeV



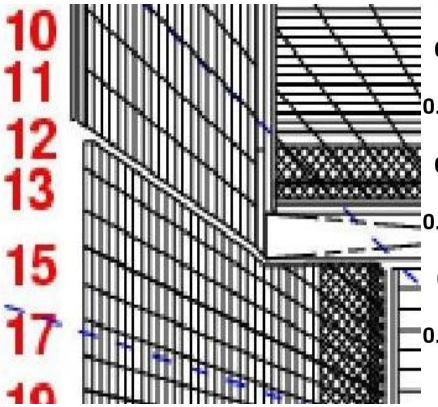
T11
12-16GeV

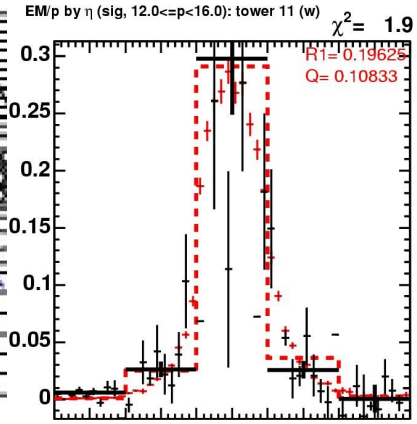
Plug
12-16GeV

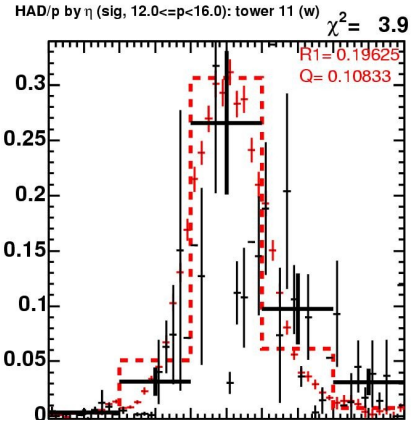
Plug
16-24GeV

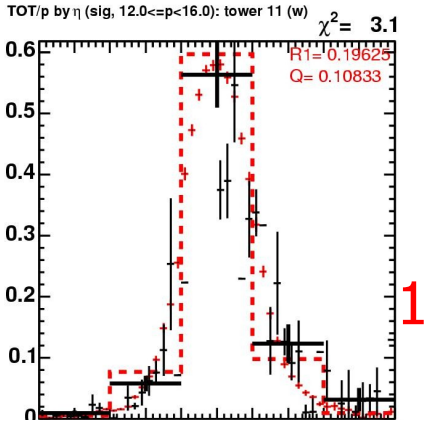
>12GeV

EM HAD TOT

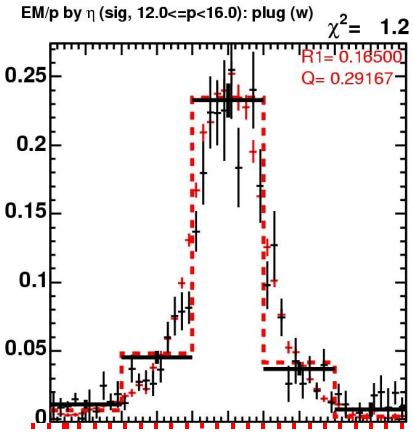


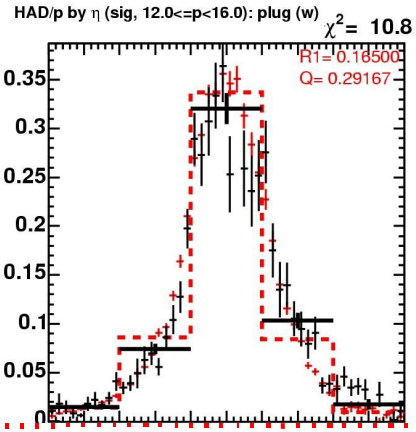


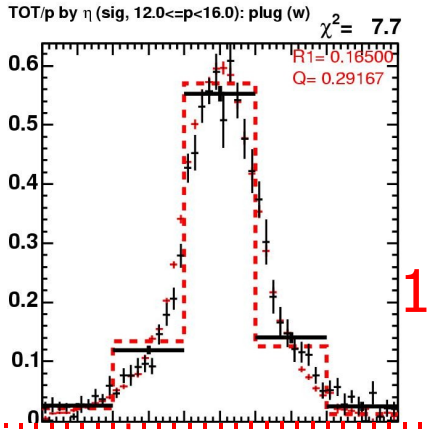




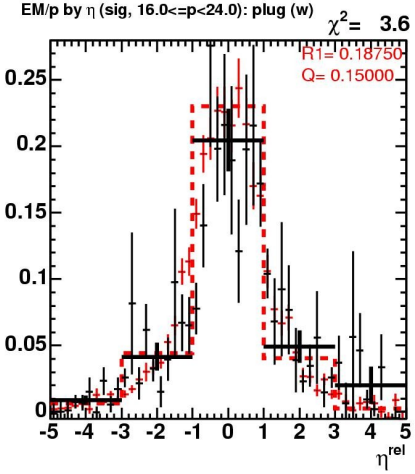
T11
12-16GeV

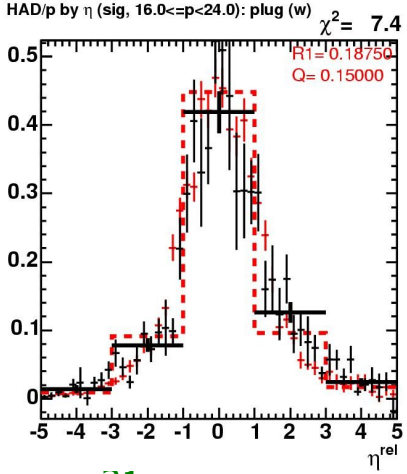


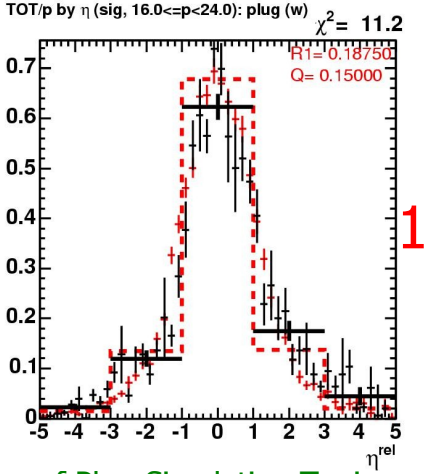




Plug
12-16GeV

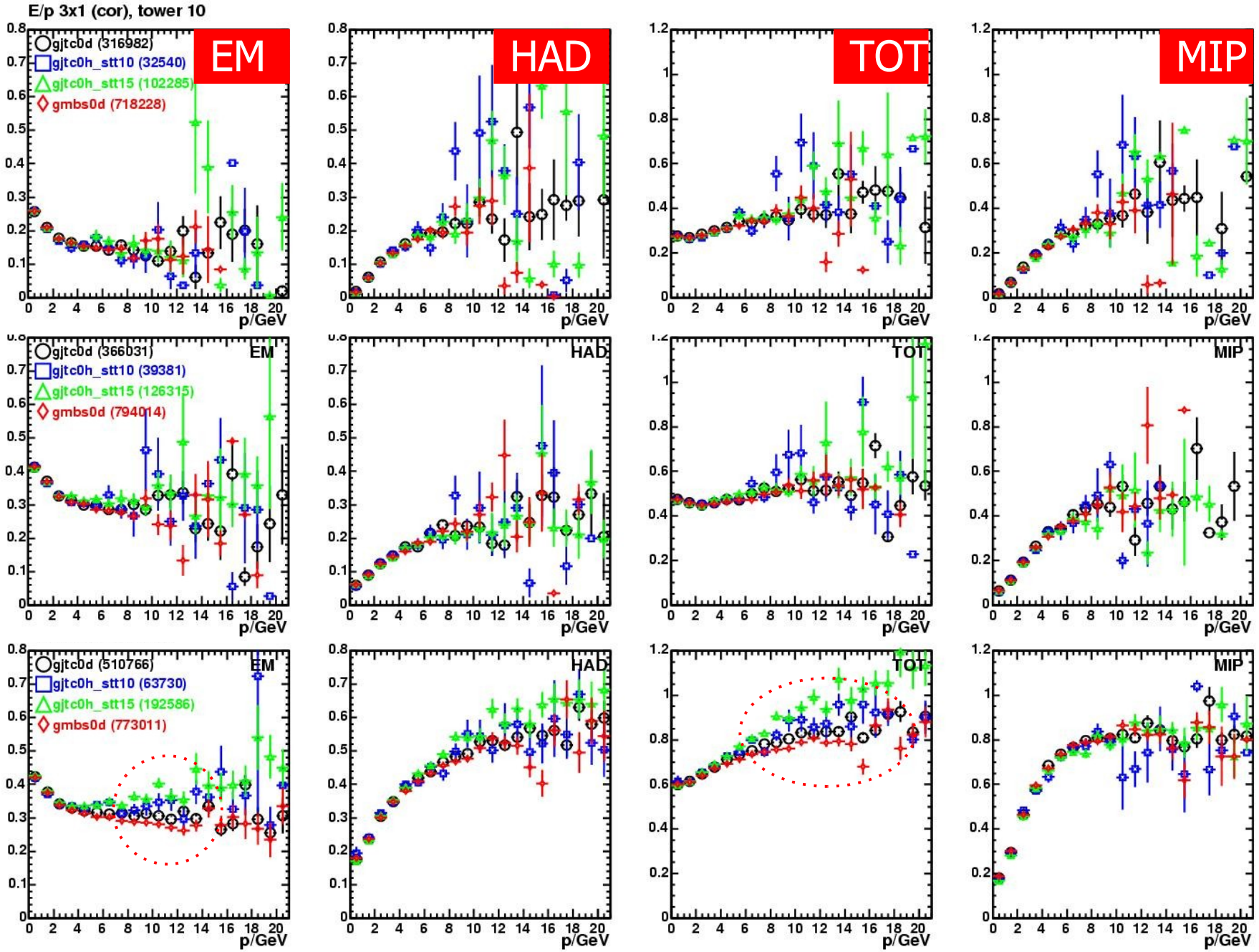




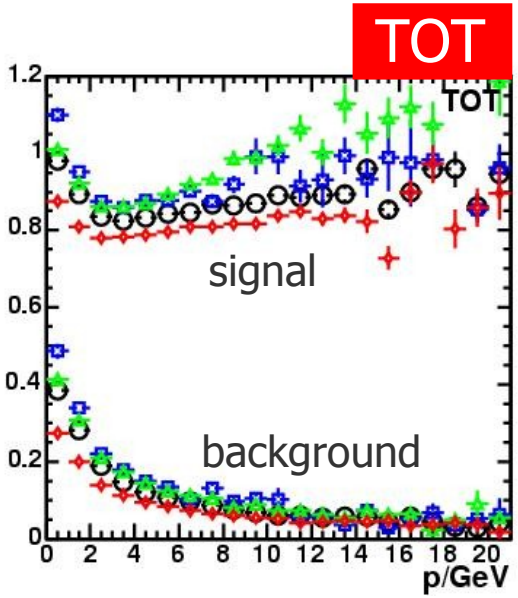


Plug
16-24GeV

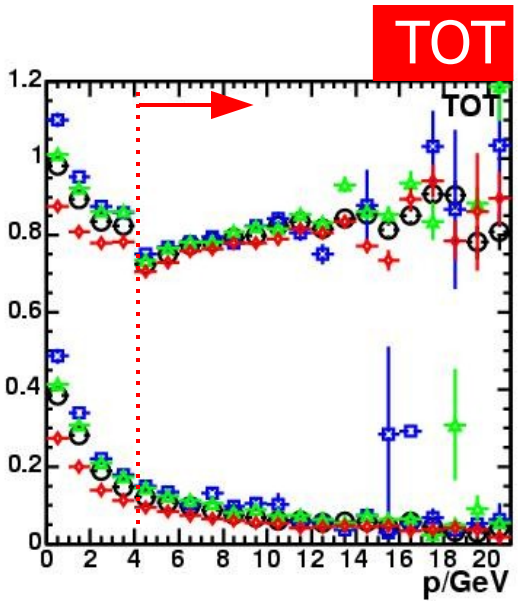
E/p Data for Absolute Response Tuning

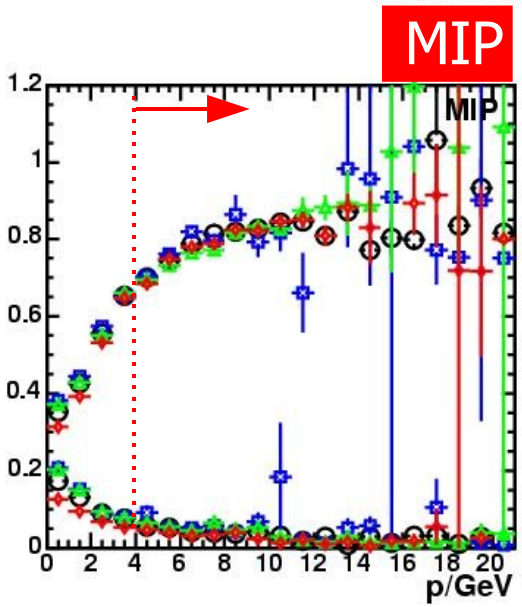


Gaussians vs. Simple Means

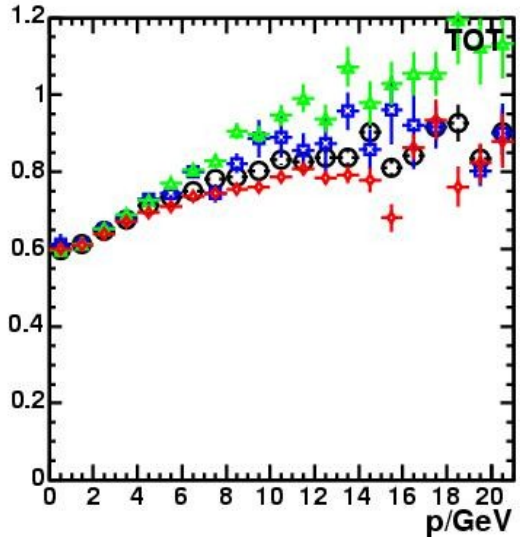


uncorrected



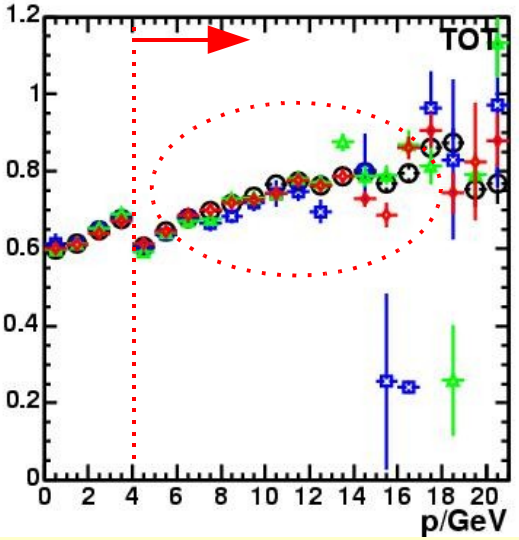


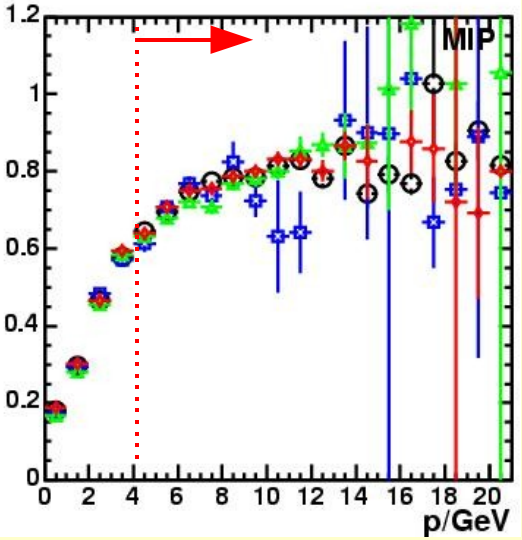
simple means



corrected

Gaussian means

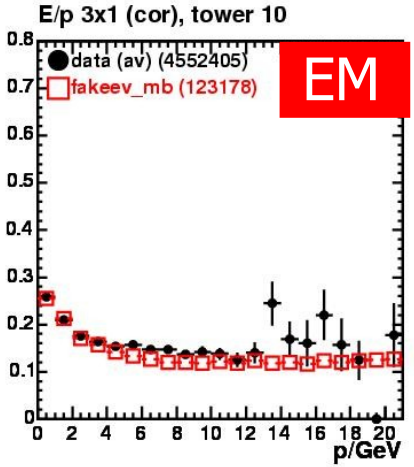


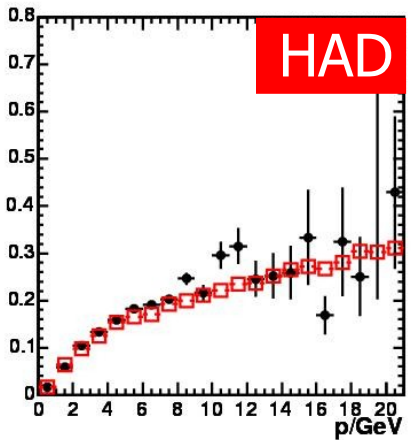


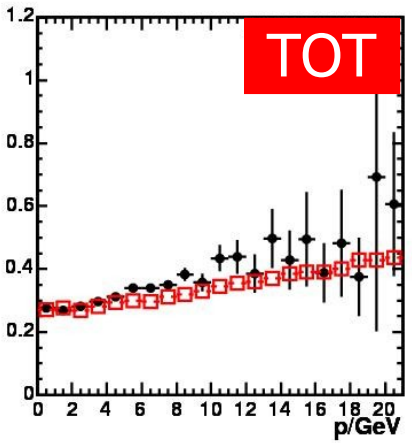
Gaussian means for the TOT and MIP distributions are less sensitive to background uncertainties. Will take weighted averages of samples for absolute response tuning.

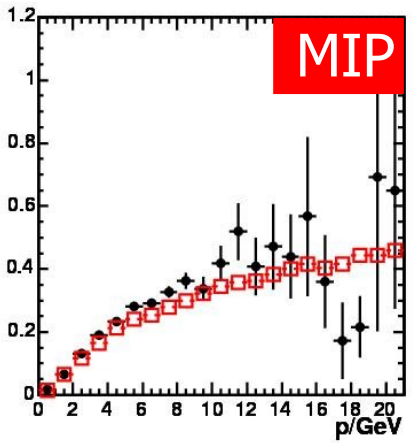
FAKEEV (+Minbias) vs. Data Average in Gen-6

tower 10

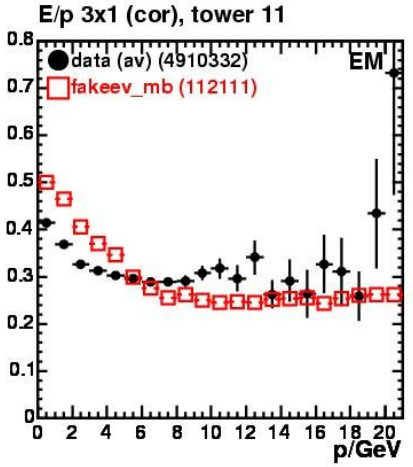


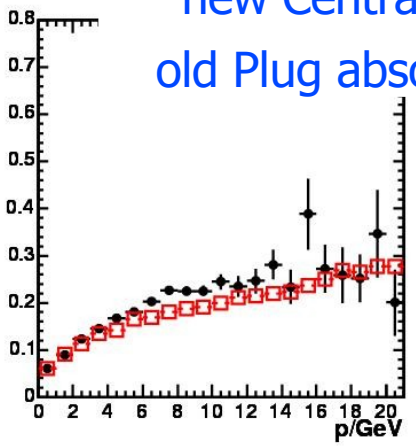


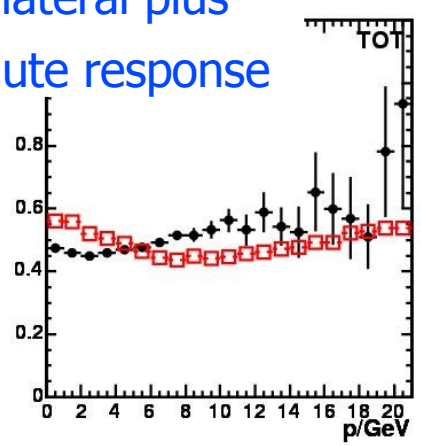


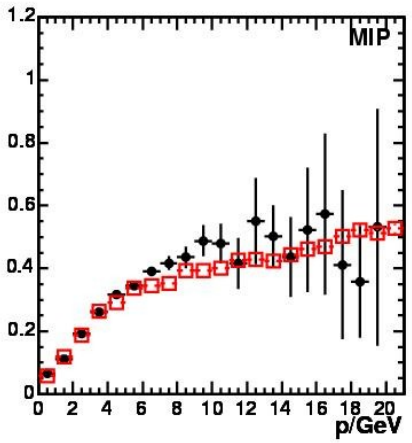


tower 11





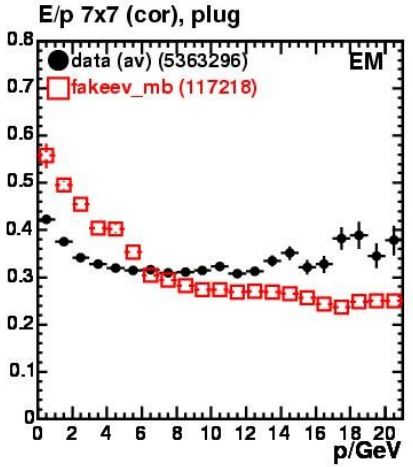


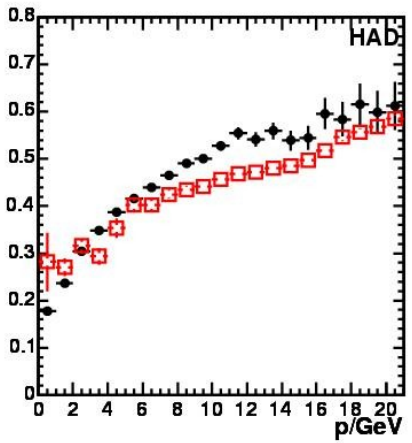


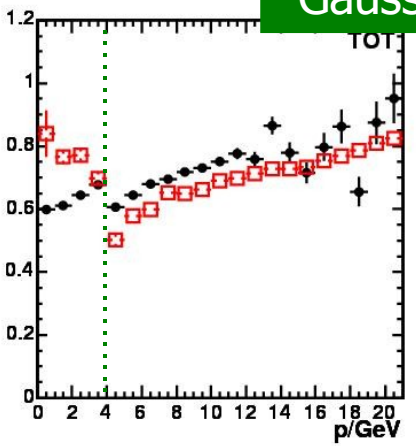
new Central lateral plus

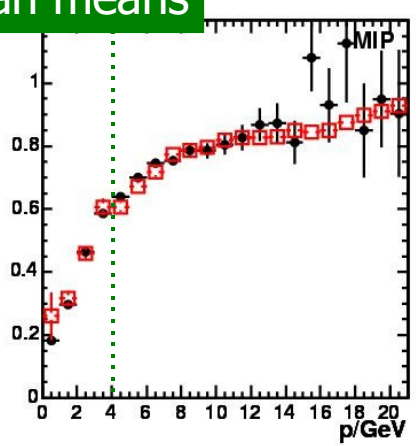
old Plug absolute response

Plug





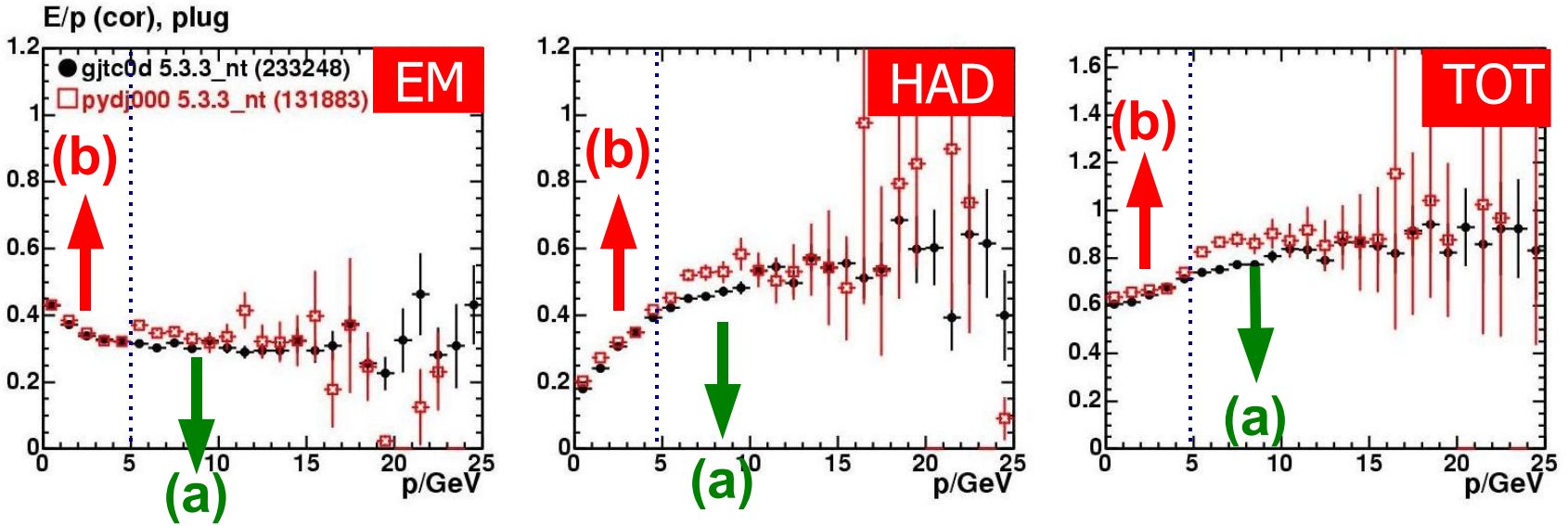




Gaussian means

E/p Dependence on the Lateral Profile

- Limited signal acceptance region causes an interdependence between lateral and absolute response. Effect is moderate in Central but more drastic in Plug/Crack.
- New profiles are narrower at <5GeV and broader at >5GeV
  → **(a)** more leakage **(b)** less leakage



MC/Data comparison in Gen-5

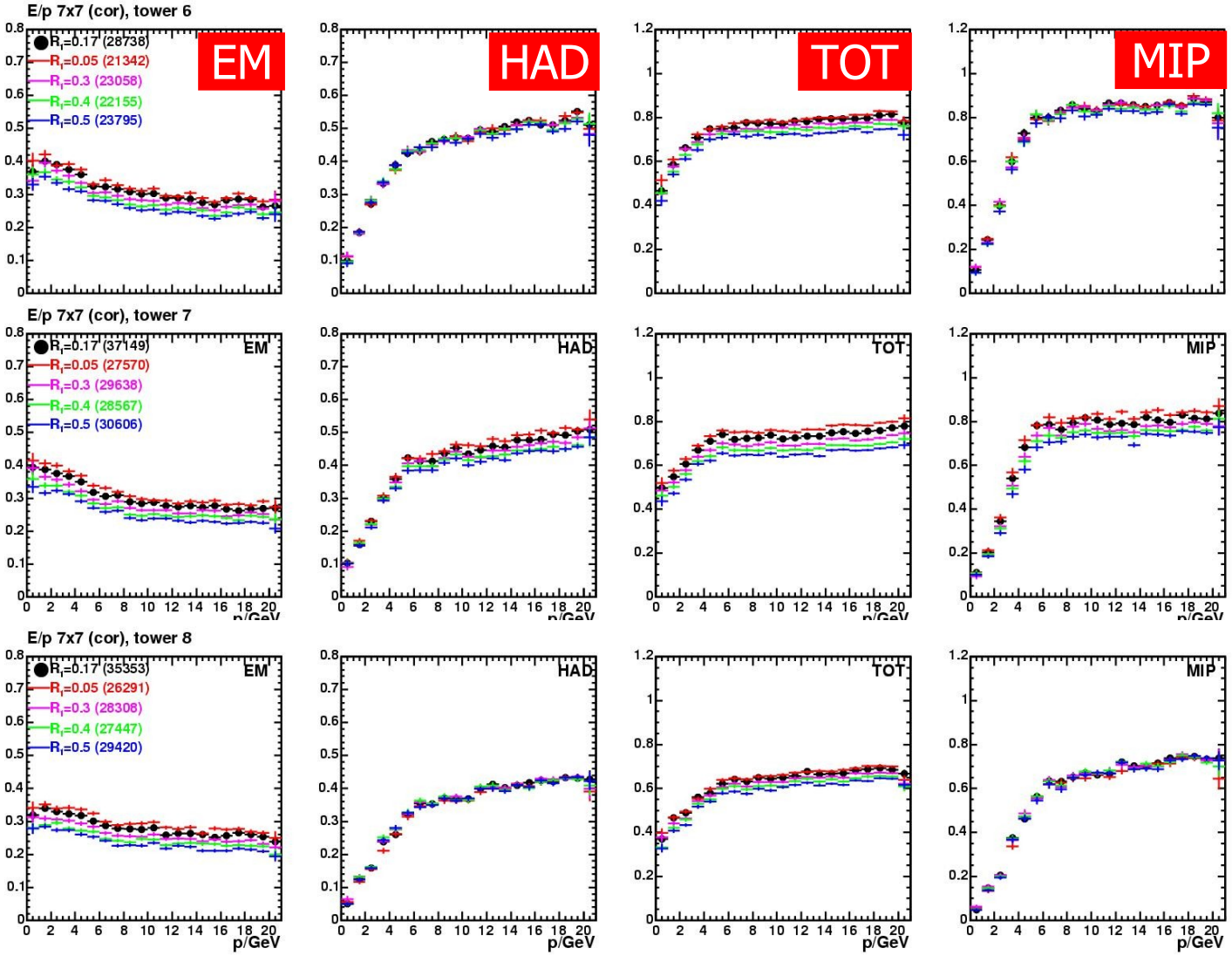
- If Gen-5 assumptions on lateral profile parameters*) are wrong, the simulated energy scale in the plug has perhaps a bias.
  *) derived using SISA tracks up to 5GeV/c + H1 default for >5GeV

E/p Dependence on Lateral Profile (Wall)

tower 6

tower 7

tower 8



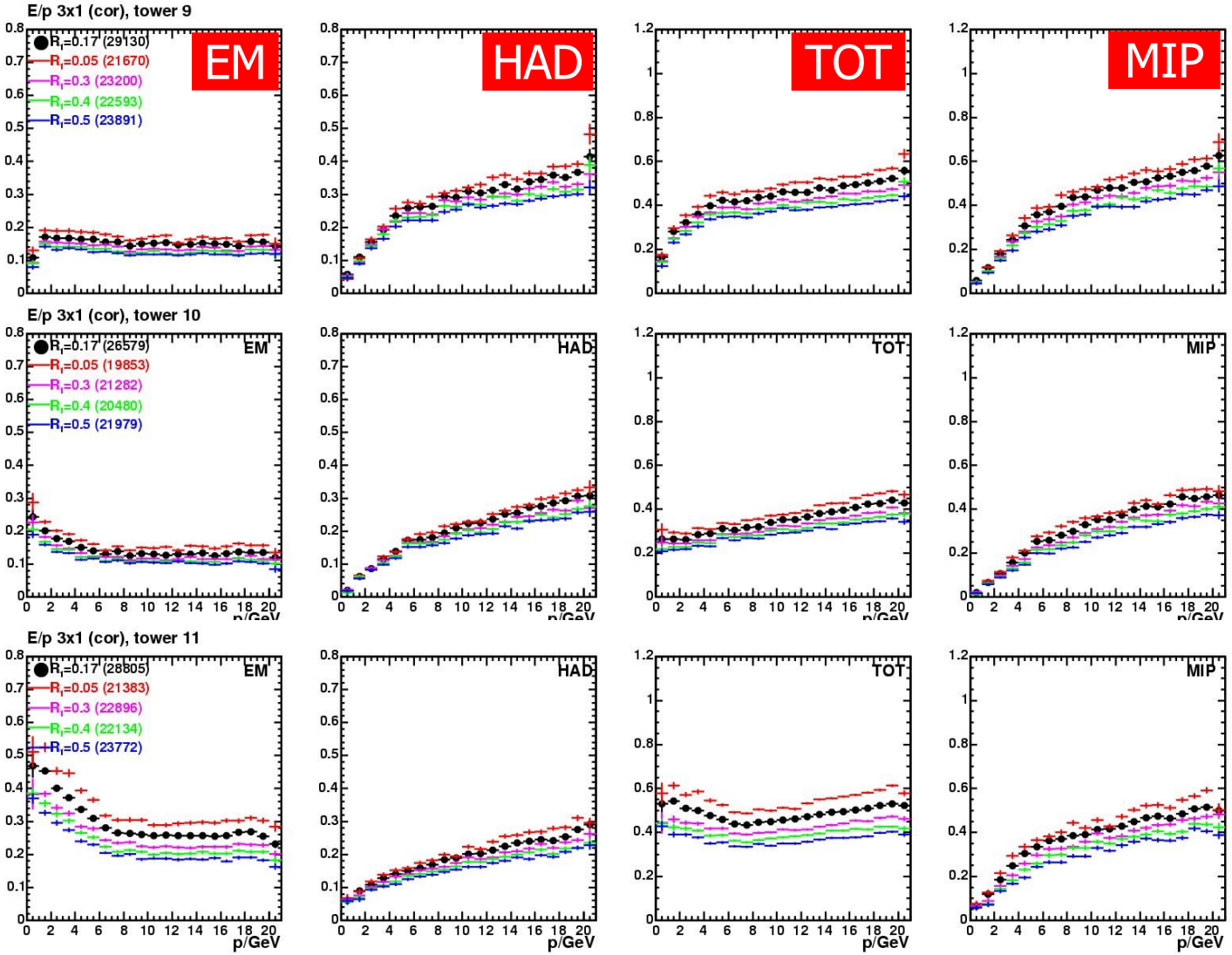
- Effect of varying the lateral profile core parameter R_1 from 0.05 to 0.50.
  NB: R_1 values used in Gen-5: 0.490 (p<5GeV), 0.015 (p>5GeV)

E/p Dependence on Lateral Profile (Crack)

tower 9

tower 10

tower 11



!!!

- Drastically increasing effect starting at tower 11.

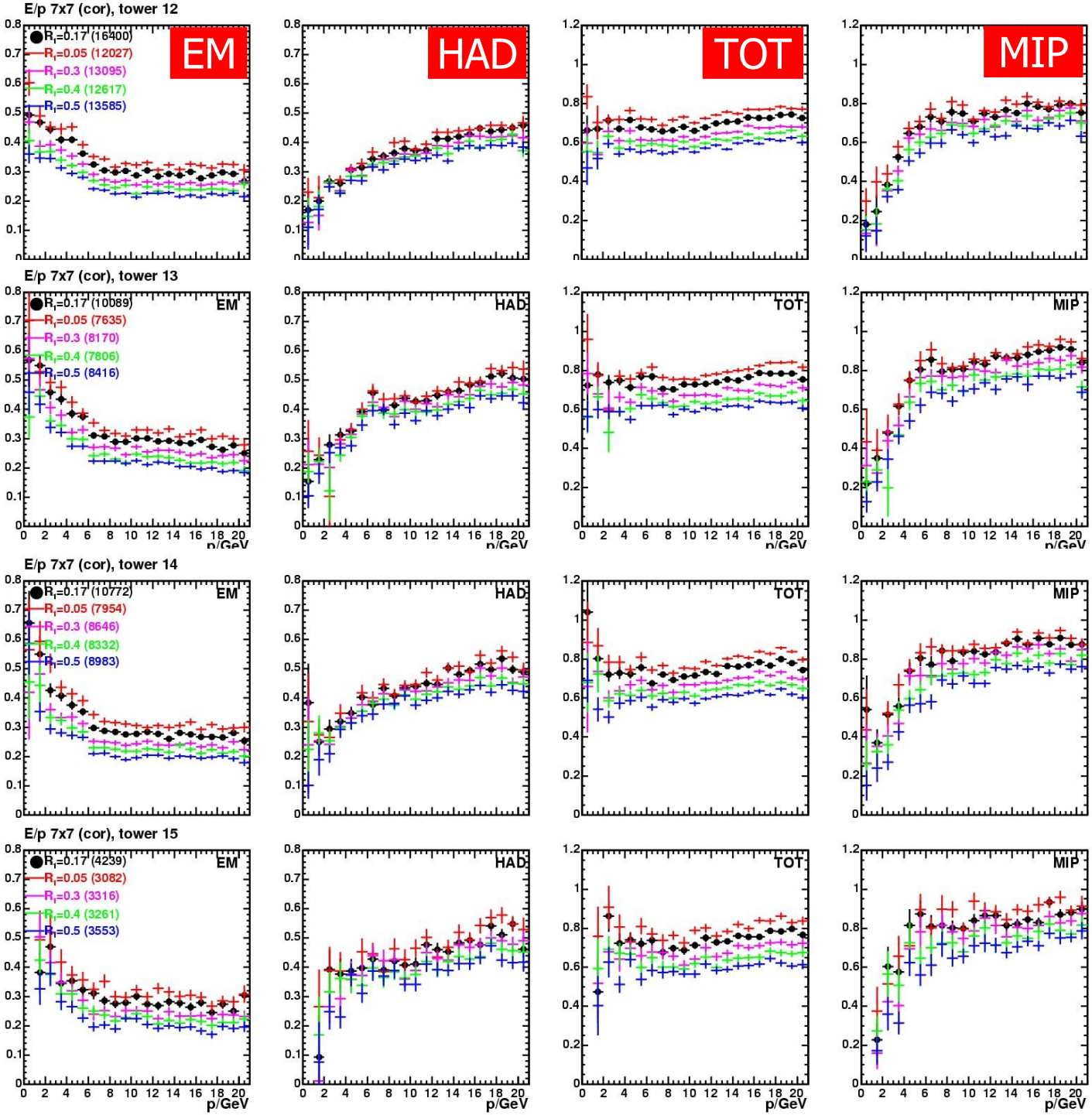
E/p Dependence on Lateral Profile (Plug)

tower 12

tower 13

tower 14

tower 15



Conclusions

- Have (almost) final profiles for Plug.
  - Plug parameters similar to Central values.
  - Lateral shower core consistently at ~0.2.
  - Loosely constrained lateral spread term is set to give a reasonable description of the data.
- Simulated Plug scale in Gen-5/6 probably biased due to former lateral profile mismatch between data and MC.
  - p<5GeV: Need to decrease TOT/p by ~20%.
  - p>5GeV: Need to increase TOT/p by ~15%.
- Absolute E/p tuning for Gen-7 in Plug/Crack in progress...