# Plug/Crack E/p Tuning for Gen-7


Pedro A. Movilla Fernández (LBNL)

Simulation Group Meeting

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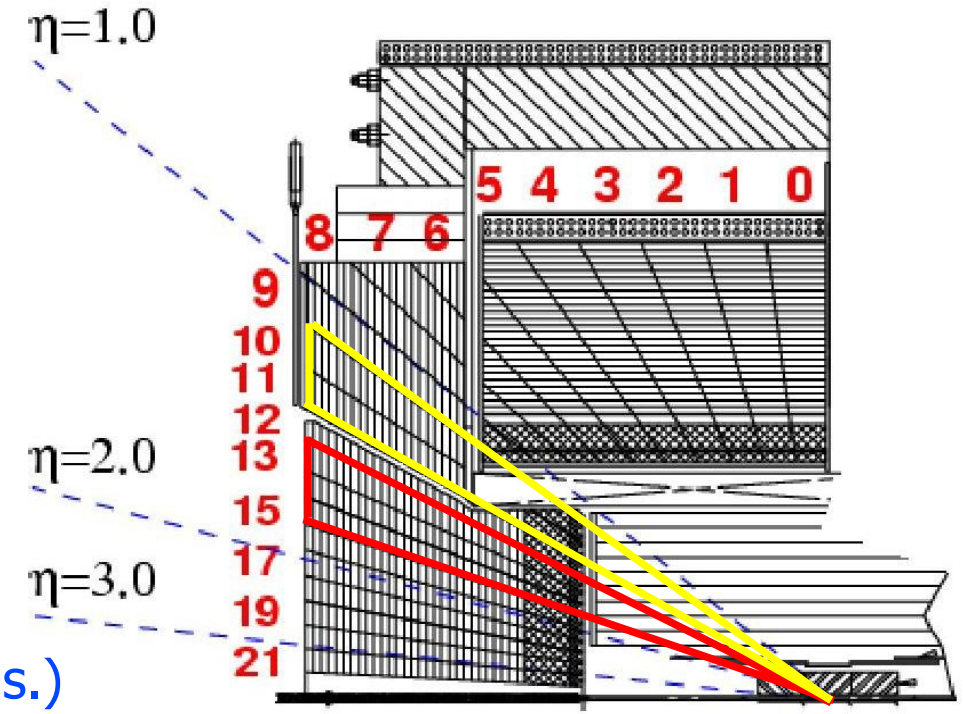
# Overview

## This talk:

- Will present a usable tuning for the simulated absolute ⟨E/p⟩ response in Plug and Crack.
- Main problem in the past was to get the TOT and MIP responses simultaneously right
  ... still not perfect in the tuning presented here

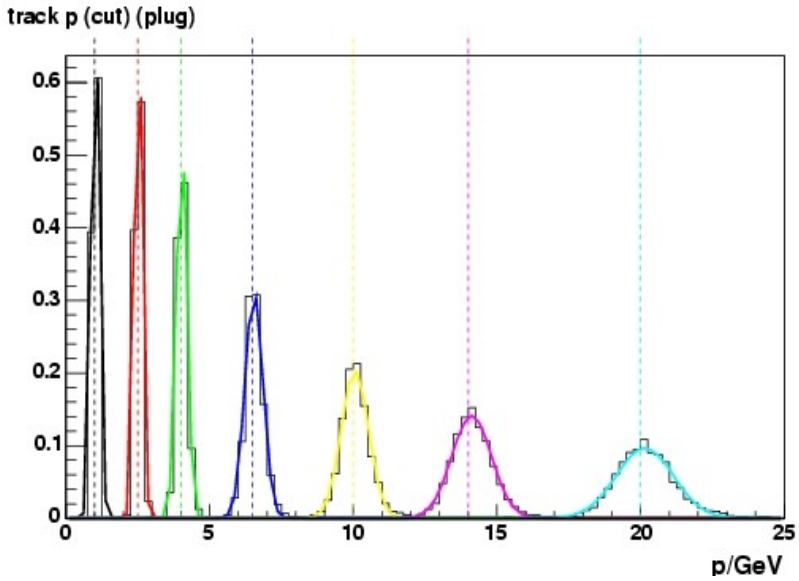
- Basic analysis features:
  - Focus on IO track response;
  - Momentum range: 0-20GeV/c;
  - Towers considered:
    Plug: 13-15
    Crack: 10, 11
  - Data sets used:
    gmbs0d for tuning,
    gjtc0d for additional checks;

(See JER talk of Aug-23 for more details.)



# Changes w.r.t. Previous Iterations

- Focus on simple means for EM/p, HAD/p, TOT/p and MIP/p over the whole momentum region
  - cross check TOT/p, MIP/p using Gaussian means for p>5GeV/c
- Focus on Minimum Bias sample (gmbs0d) for tuning:
  - assume Pythia MB provides a reasonable background description
  - suspect JETCALIB and STT data to introduce bias due to additional background sources
  - cross check TOT/p, MIP/p also with JETCALIB (gjtc0d)
- Use more "realistic" particle spectrum in FAKEEV:
  - limited momentum resolution can introduce a bias of the ⟨E/p⟩ vs. p curves when comparing flat spectra with Minimum Bias spectra



# GFLASH Tuning Basics

- Fractional energy deposition

  FEDP=a+b*tanh(c+d*(P[GeV/c]-e))

  - P: incident particle momentum
  - a,b,c,d,e: tunable parameters

  **GflashSim/gfinha.F**

- Relative sampling fractions

  PBYMIP(1) ... for the PEM

  PBYMIP(2) ... for the PHA

  **GflashSim/gfshow.F**

  - constants

- Crack tower responses:

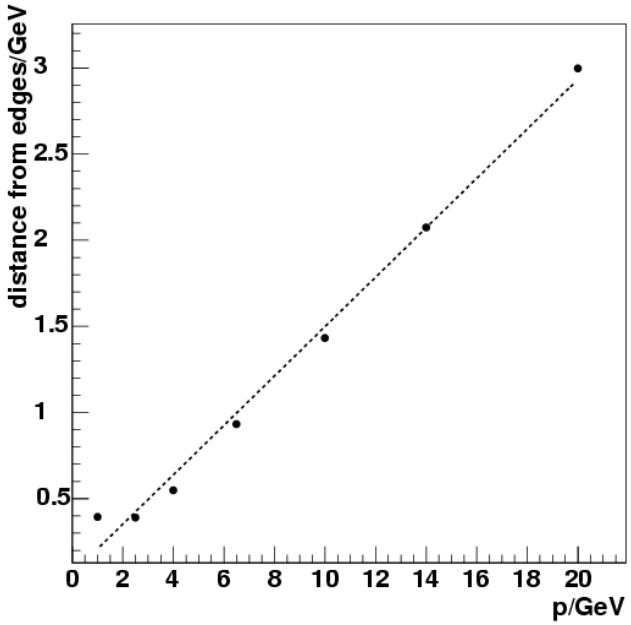
  - constant scaling factors applied to the relative sampling fractions

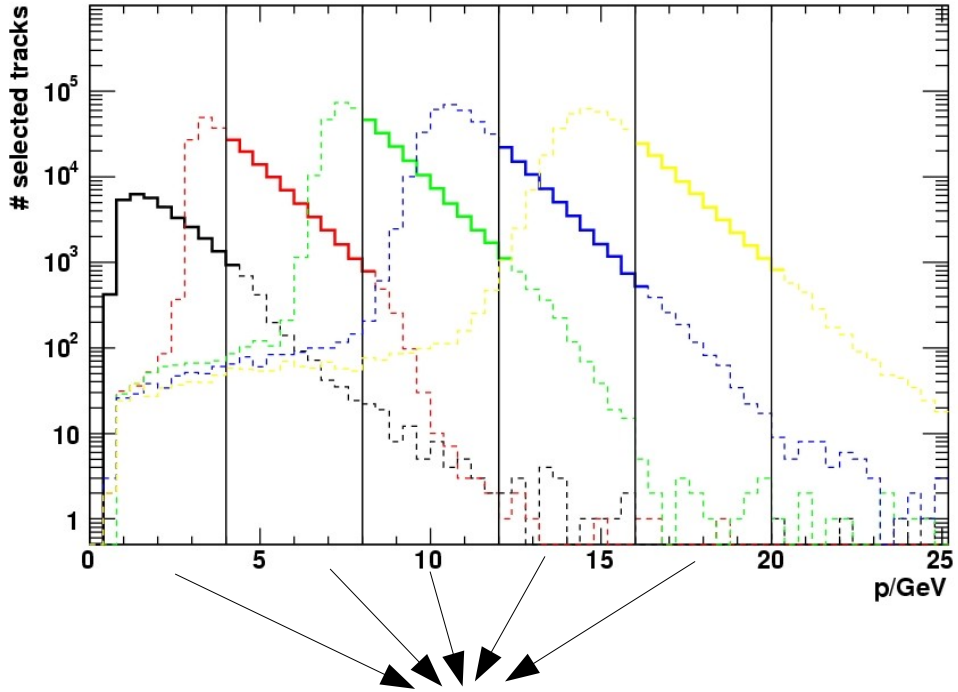
  **GflashSim/gfshow.F**

- No further constraints within 0-20GeV/c.
- Relative sampling fractions kept constant.

# Simulation

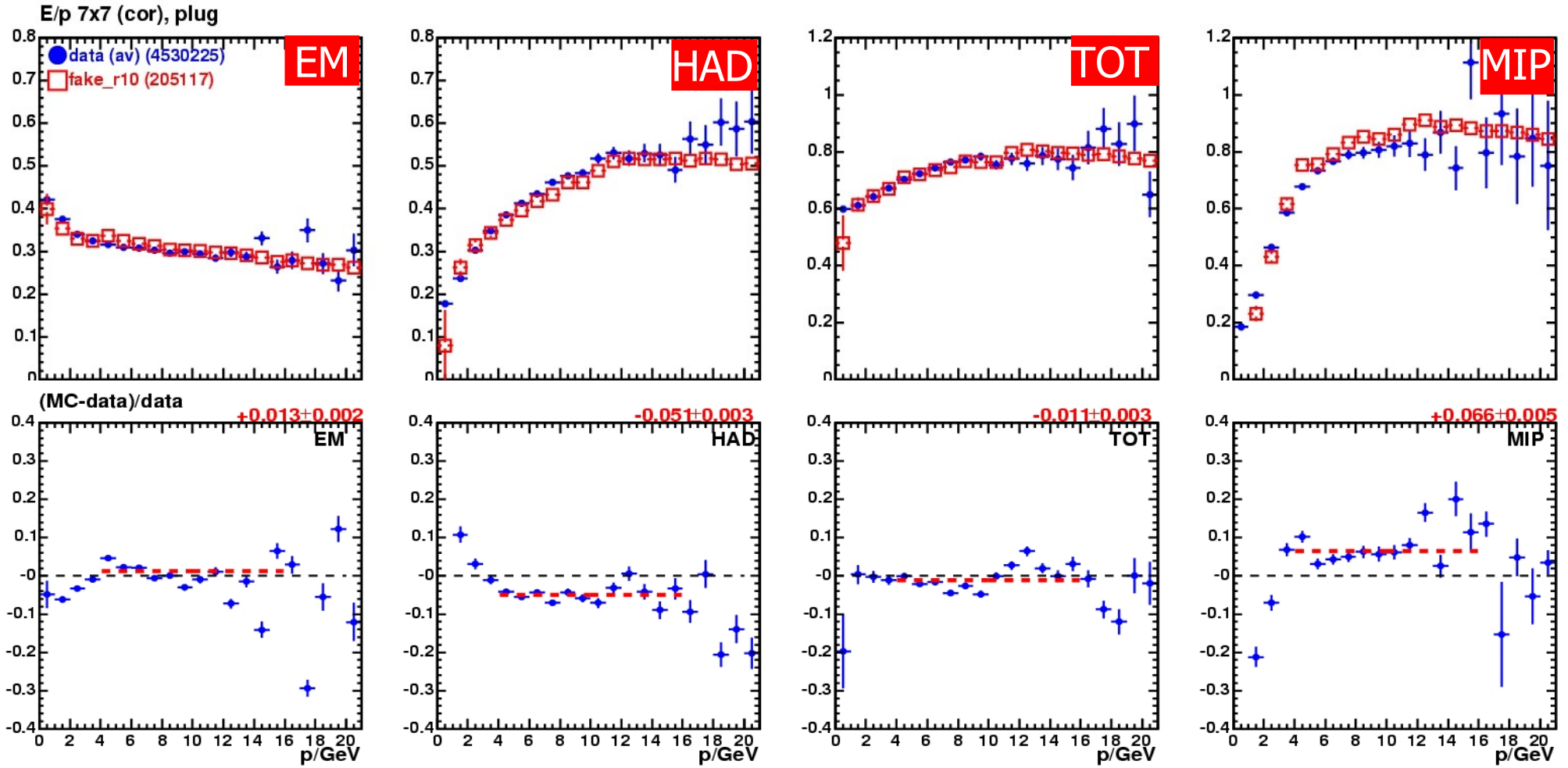
- cdfSim/ProductionExe 6.1.4
- FAKEEV (+ PYTHIA Minimum Bias on top for p<5GeV/c)
- FAKEEV settings:
  - 8 particles per event
  - $|\eta|$=0.72-2.1
  - Pion/Kaon/Proton=.6/.3/.1
  - exponential spectra




- E/p simulated for separate p intervals
- Cut inner part in "safe" distance from edges
- Merge E/p points corresponding to the separate intervals into one histogram

# f5 Tuning used for Validation

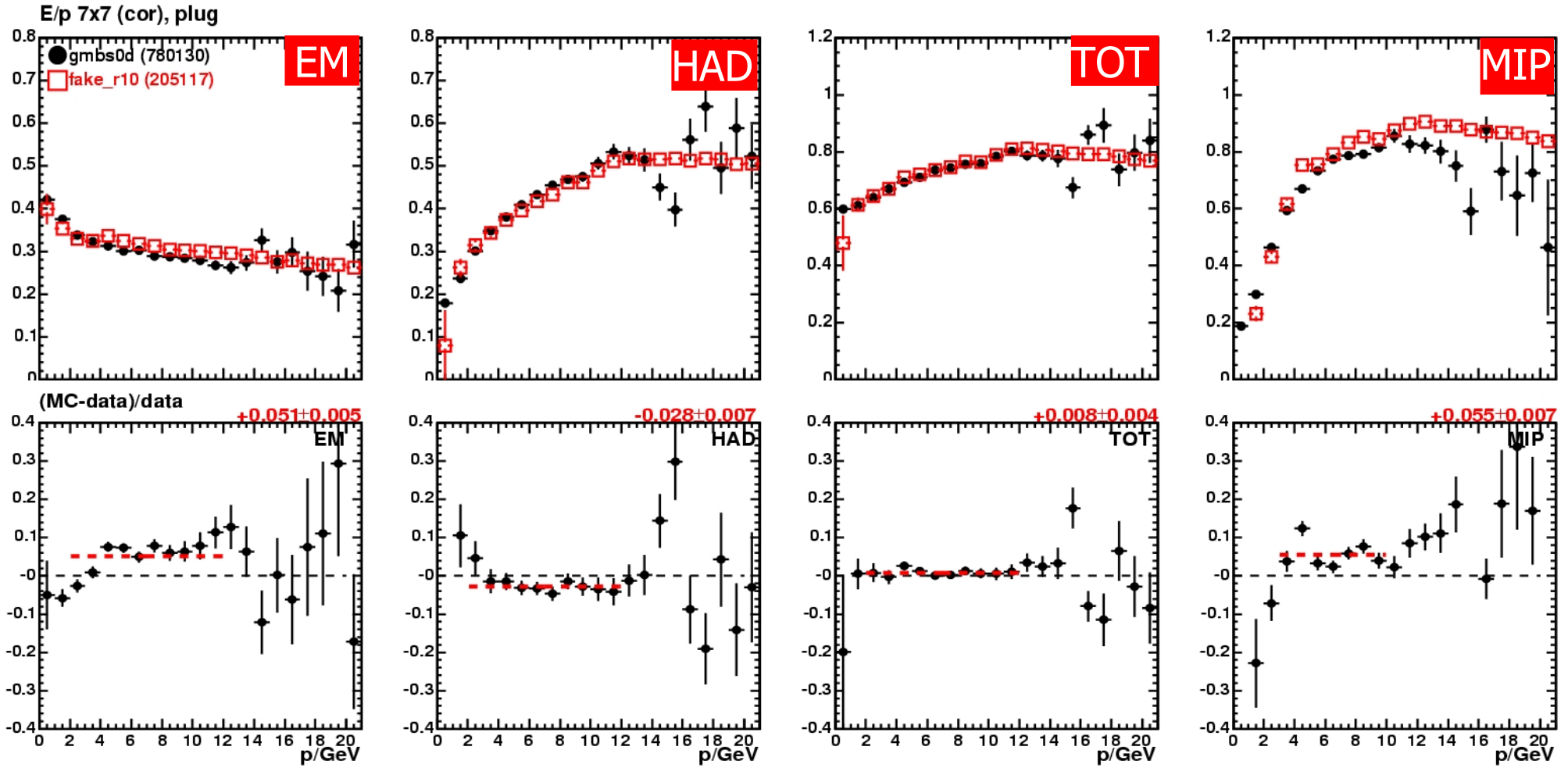



```
PBYMIP(1)= 1.82 - 0.060 * TANH( 8.50 * ( LOG(P) -1.37 ) )
PBYMIP(2)= 2.70 - 0.625 * TANH( 8.50 * ( LOG(P) - 1.37 ) )
FEDP = 0.7071 + 0.1362 * TANH( 2.2600 * ( LOG(P) - 1.2692 ) )
```

R10

- Gaussian means for TOT and MIP at p>10GeV/c
- Combined gmbs0d + gjtc0d sample
- Flat FAKEEV spectrum & non-constant sampling fractions

# f5 Tuning but Different Analysis

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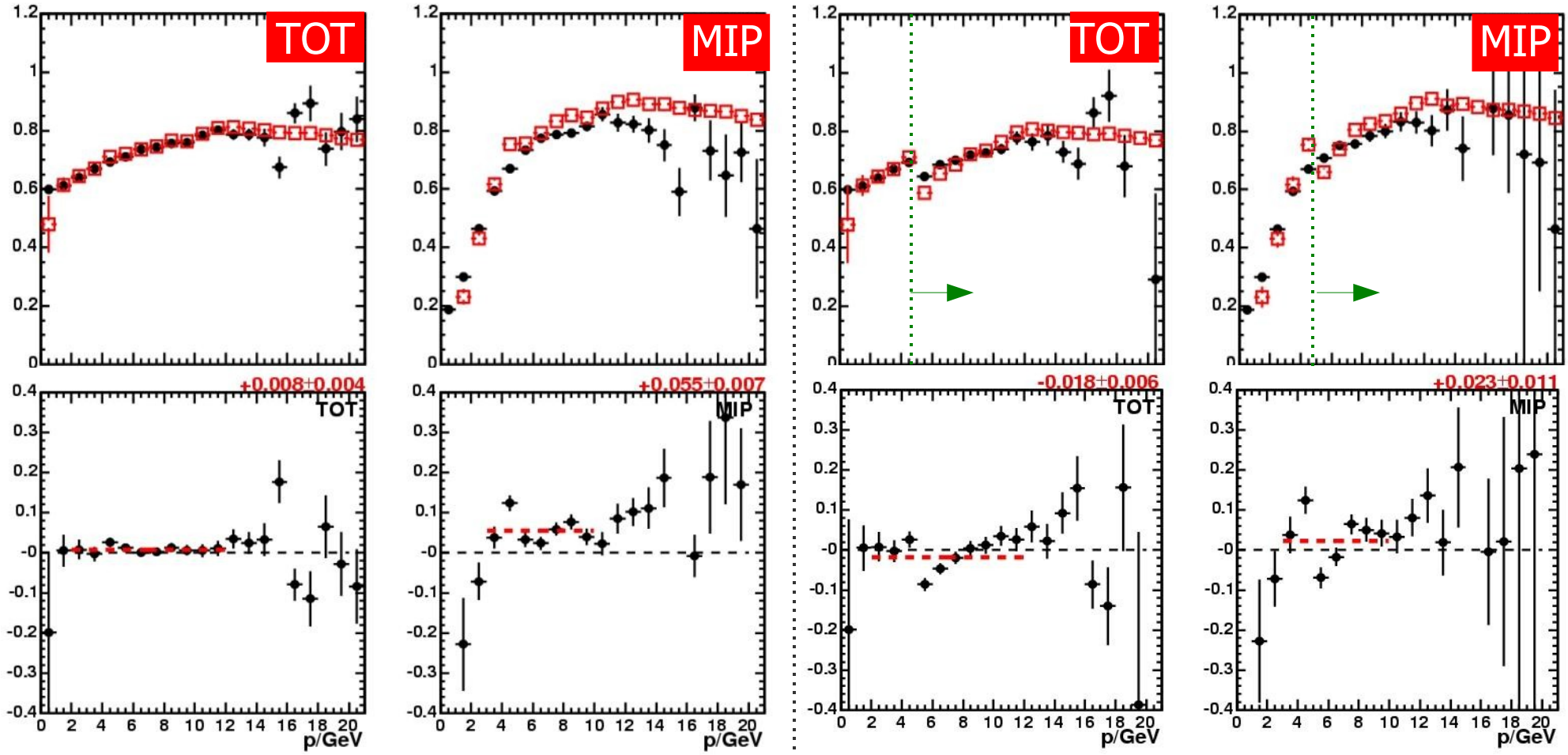
R10

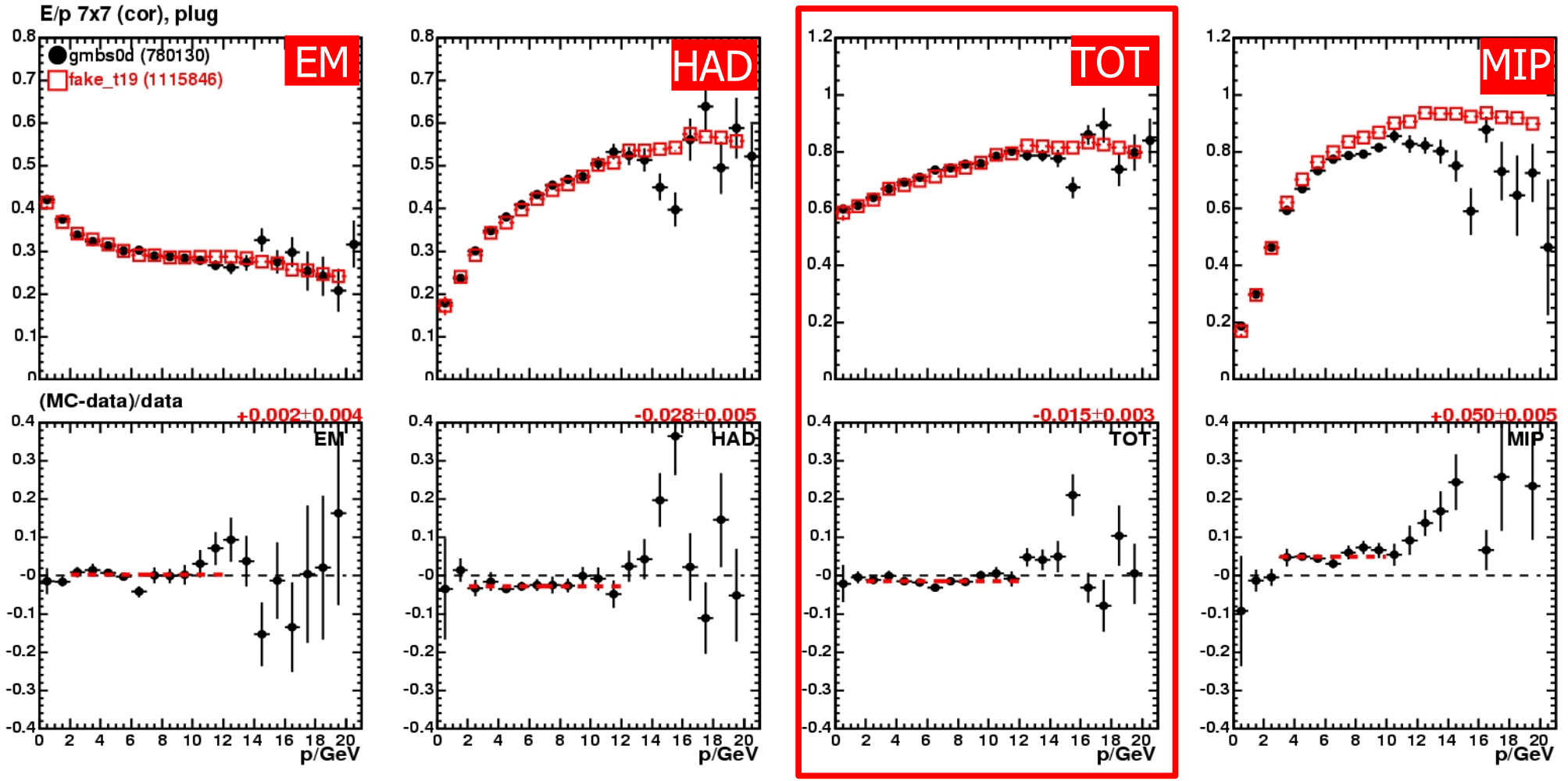
- Simple means for TOT and MIP
- Pure gmbs0d sample
- Flat FAKEEV spectrum & non-constant sampling fractions

# f5 Tuning but Different Analysis (2)




- Simple vs Gaussian means (p>5GeV/c) for TOT and MIP
- Pure gmbs0d sample
- Flat FAKEEV spectrum & non-constant sampling fractions

# **Status**: Latest Tuning Plug

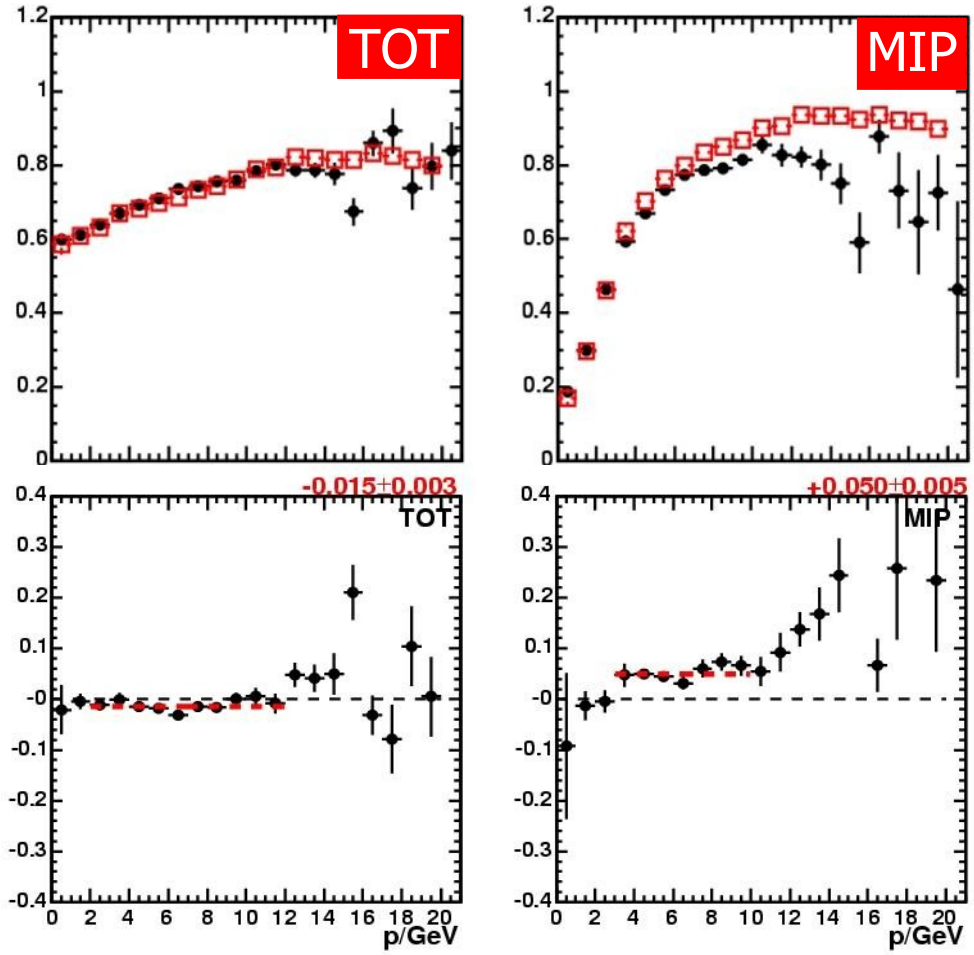



```
PBYMIP(1)= 0.88
PBYMIP(2)= 1.28
FEDP = 0.8719 + 0.0724 * TANH( 1.8459 * ( LOG(p)- 0.9952 ) )
```

T19

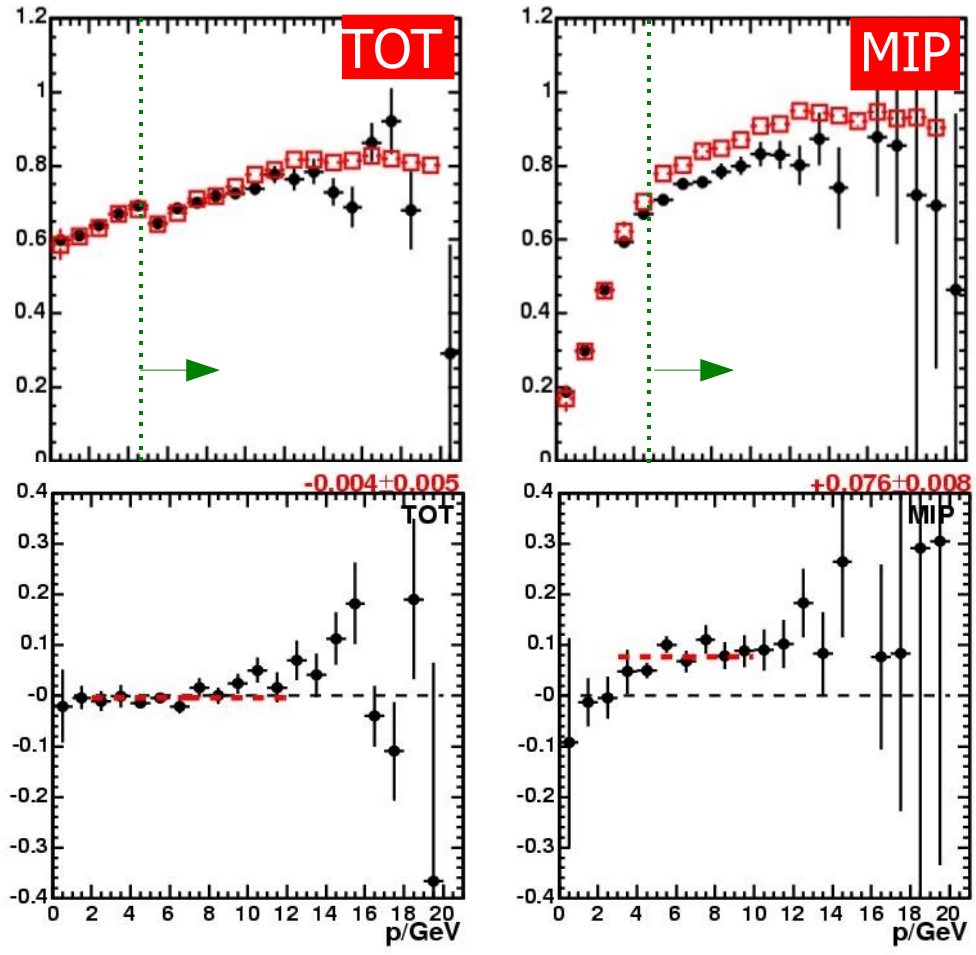
- Simple means for TOT and MIP
- Pure gmbs0d sample
- Exponential FAKEEV spectrum & constant sampling fractions

# **Status**: Latest Tuning Plug (2)




simple means

T19

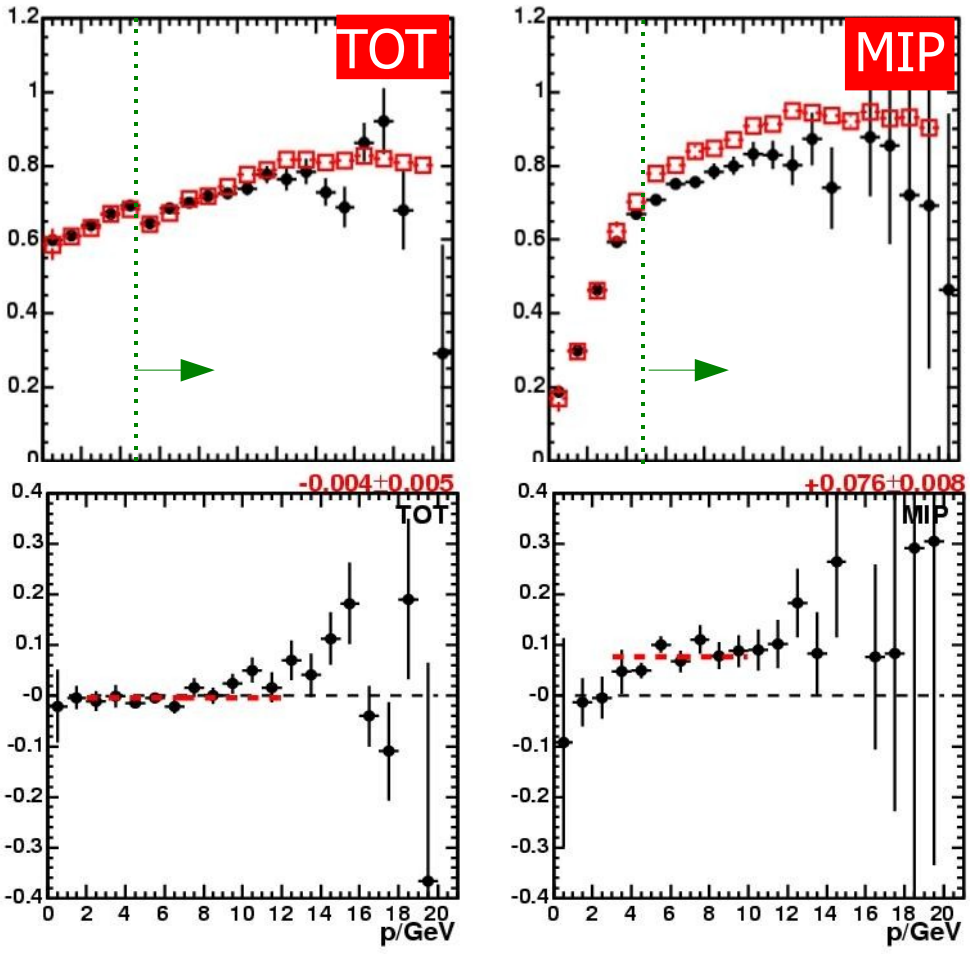



Gaussian means

T19

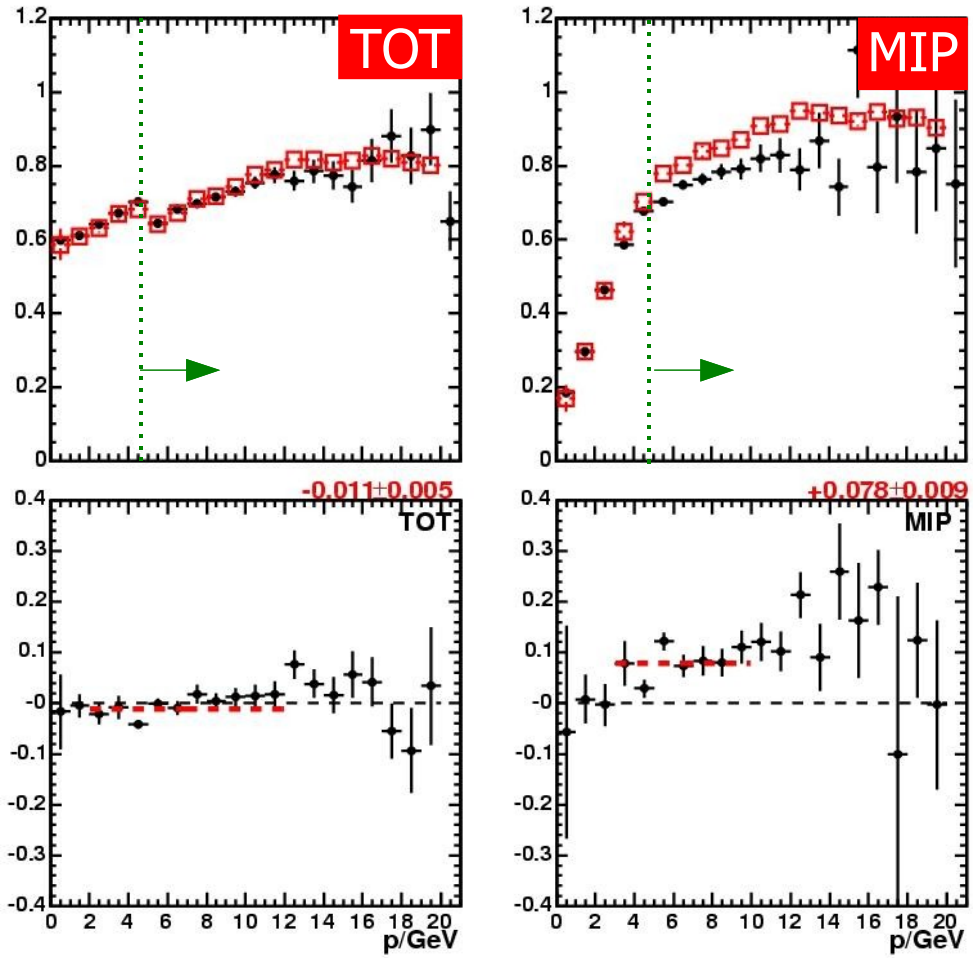
- Simple vs Gaussian means (p>5GeV/c) for TOT and MIP
- Pure gmbs0d sample
- Exponential FAKEEV spectrum & constant sampling fractions

# **Status**: Latest Tuning Plug (3)




gmbs0d
(relevant for tuning)

T19

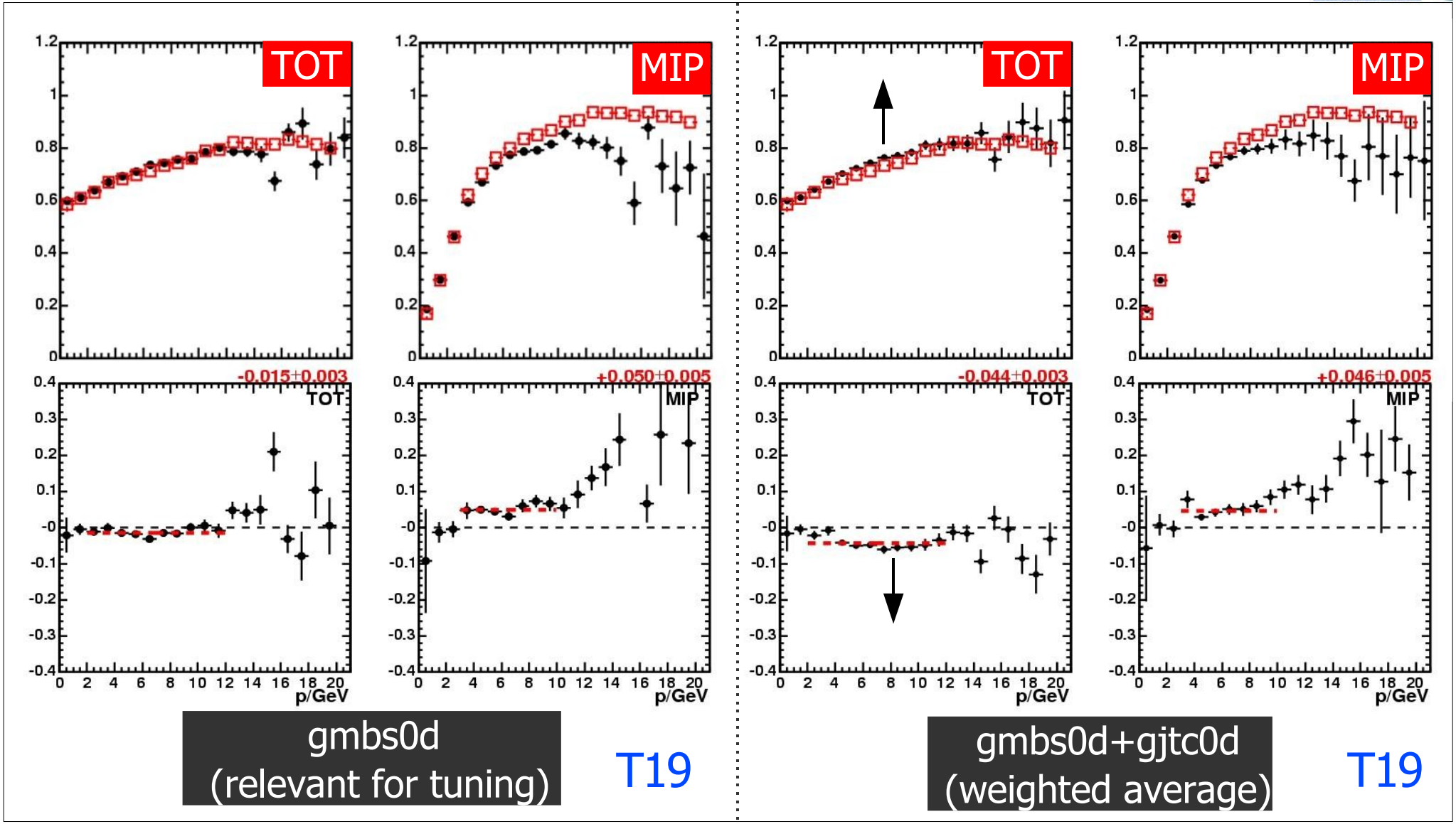



gmbs0d+gjtc0d
(weighted average)

T19

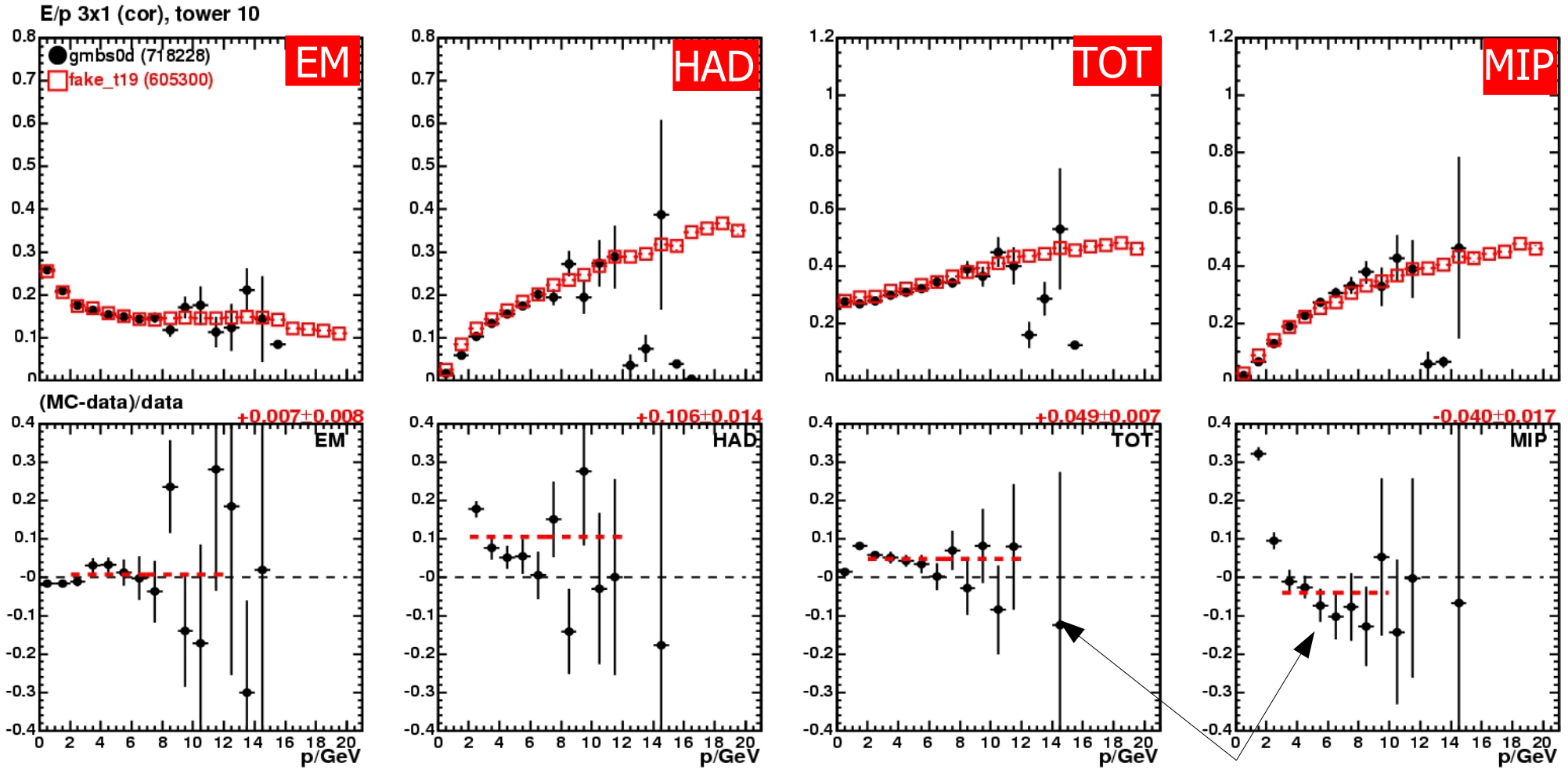
- **Gaussian means (p>5GeV/c)**
- Stable picture...

# **Status**: Latest Tuning Plug (4)




- **Simple means**
- Bias induced by tails at high E/p (similar to STT 0h samples)
  - suspect electron contamination

# **Status**: Latest Tuning Tower 10

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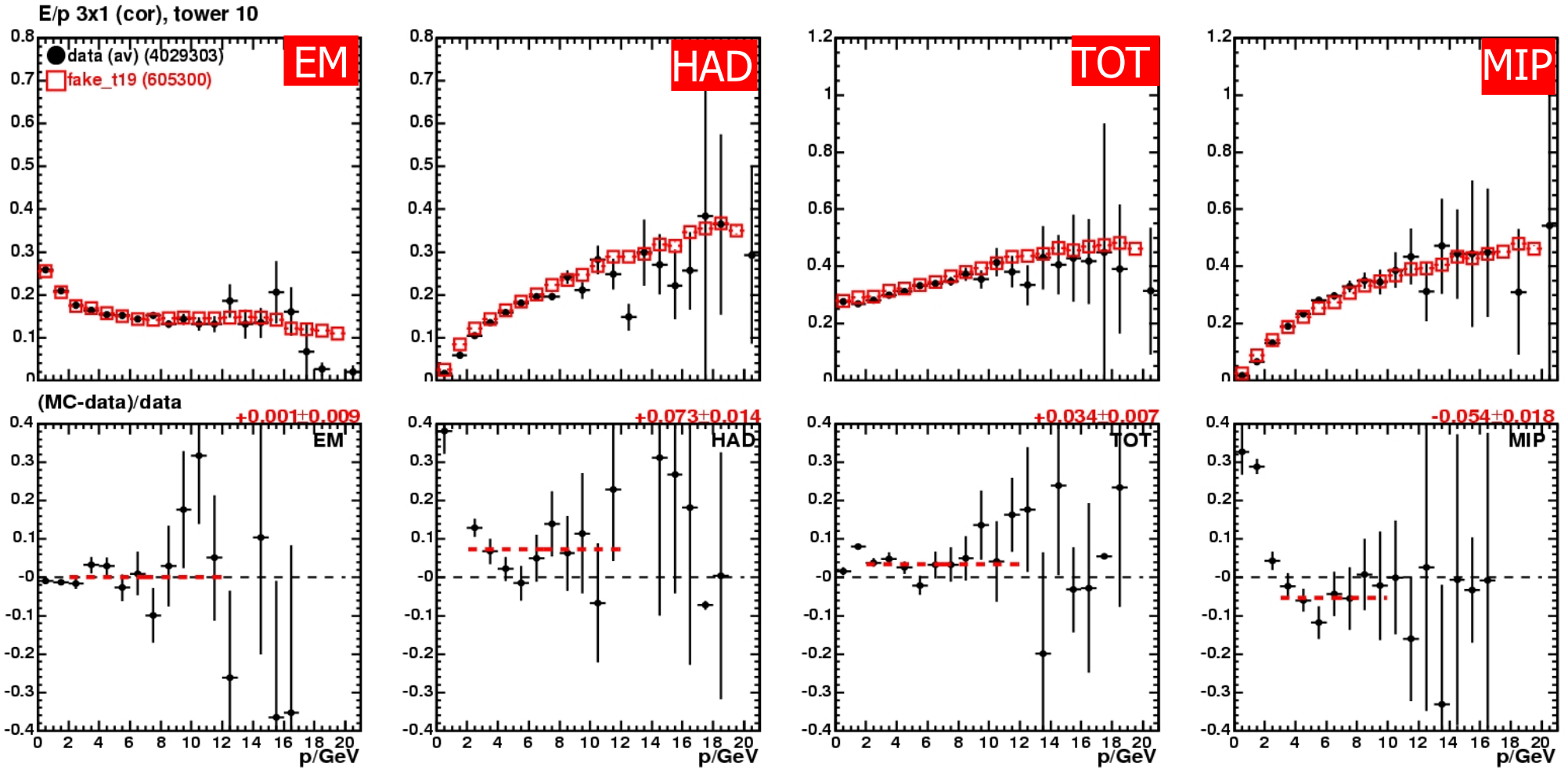
PBYMIP(1)= 0.88
PBYMIP(2)= 1.28
FEDP = 0.8719 + 0.0724 * TANH( 1.8459 * ( LOG(p)- 0.9952 ) )
```

cannot be handled by constant scaling factors

T19

- Simple means for TOT and MIP
- Pure gmbs0d sample

# **Status**: Latest Tuning Tower 10 (2)

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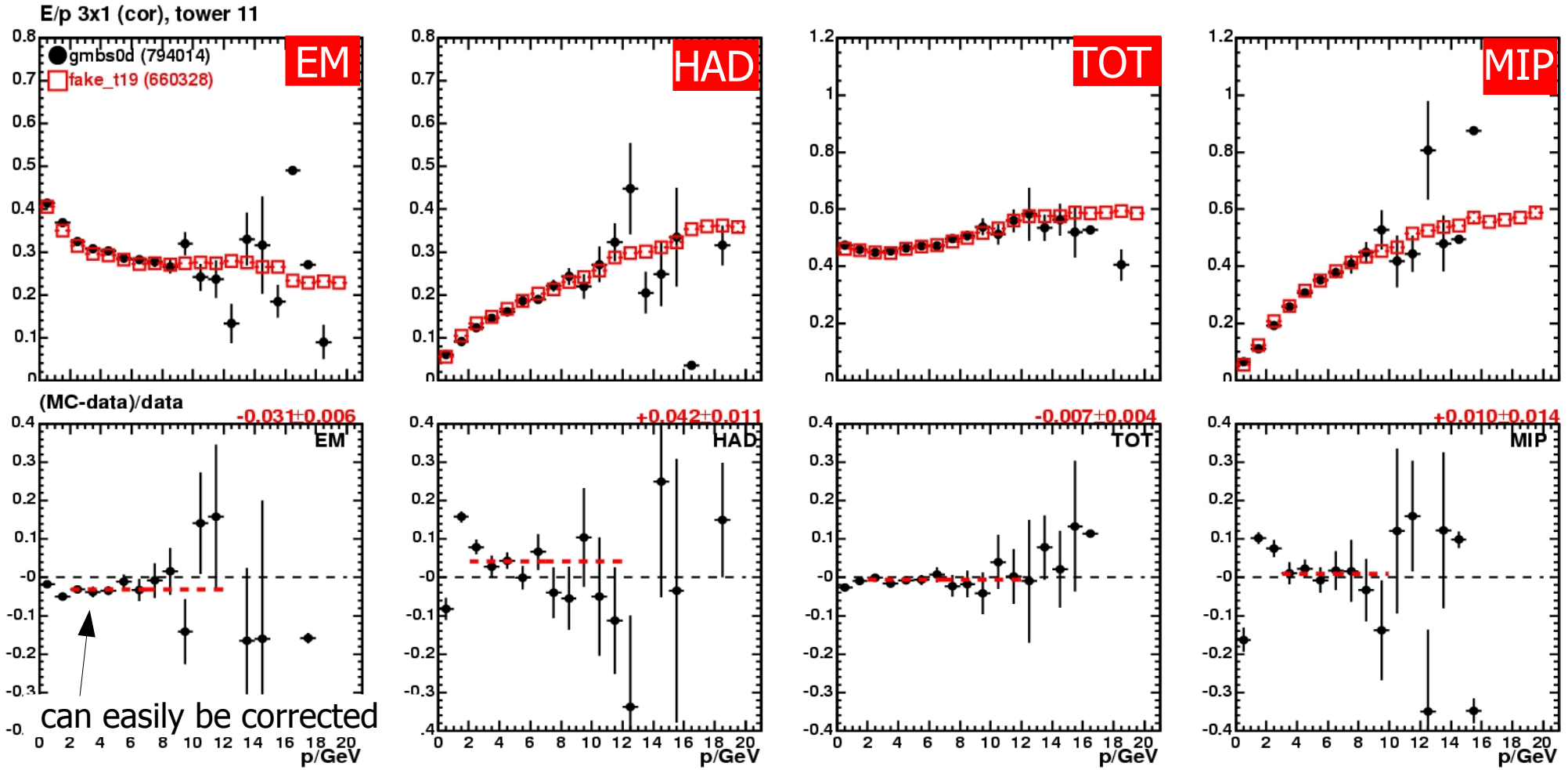
```

T19

- Simple means for TOT and MIP
- Weighted average of gmbs0d & gjtc0d

# **Status**: Latest Tuning Tower 11

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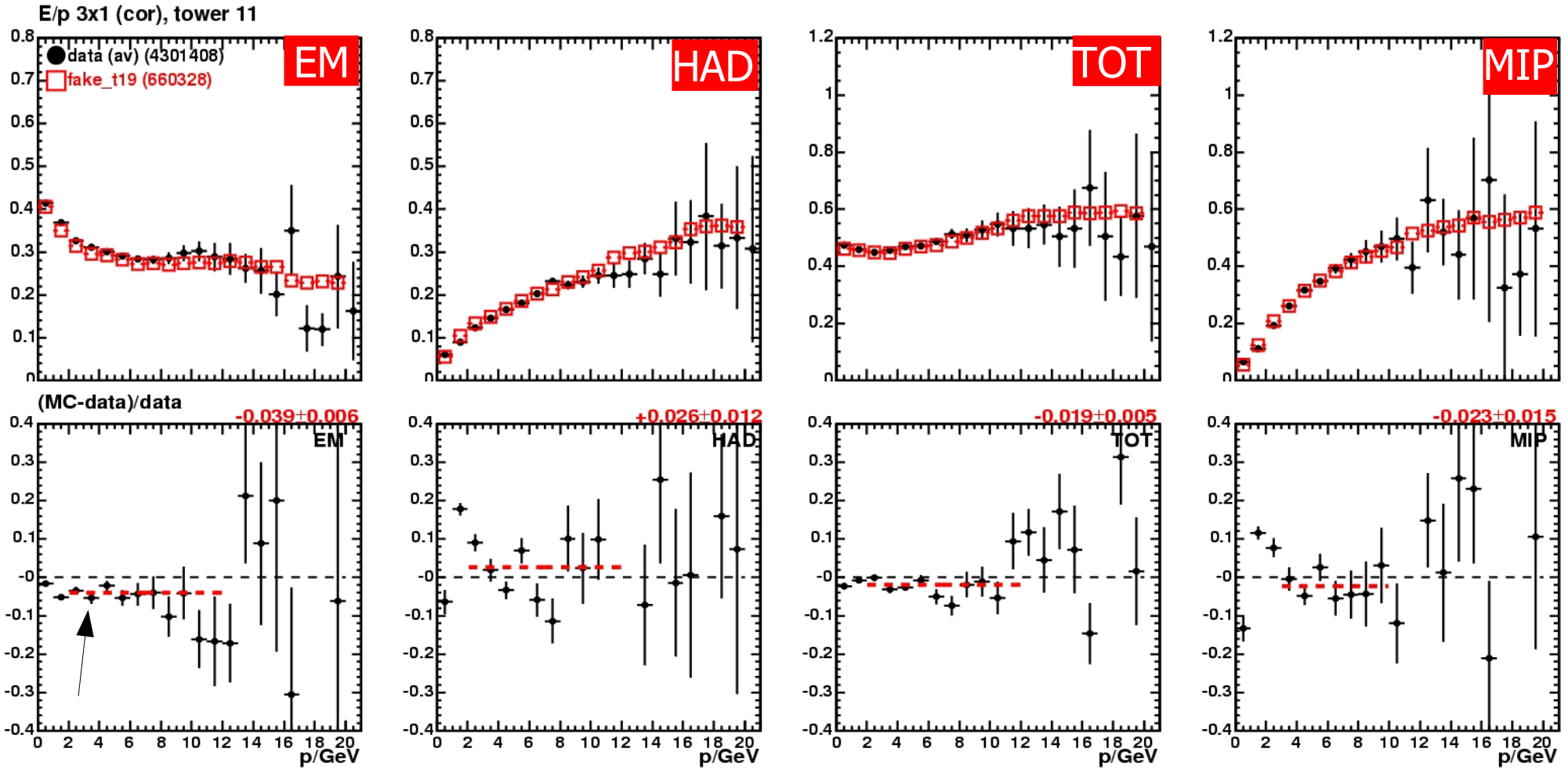
```

T19

- Simple means for TOT and MIP
- Pure gmbs0d sample

# **Status**: Latest Tuning Tower 11 (2)

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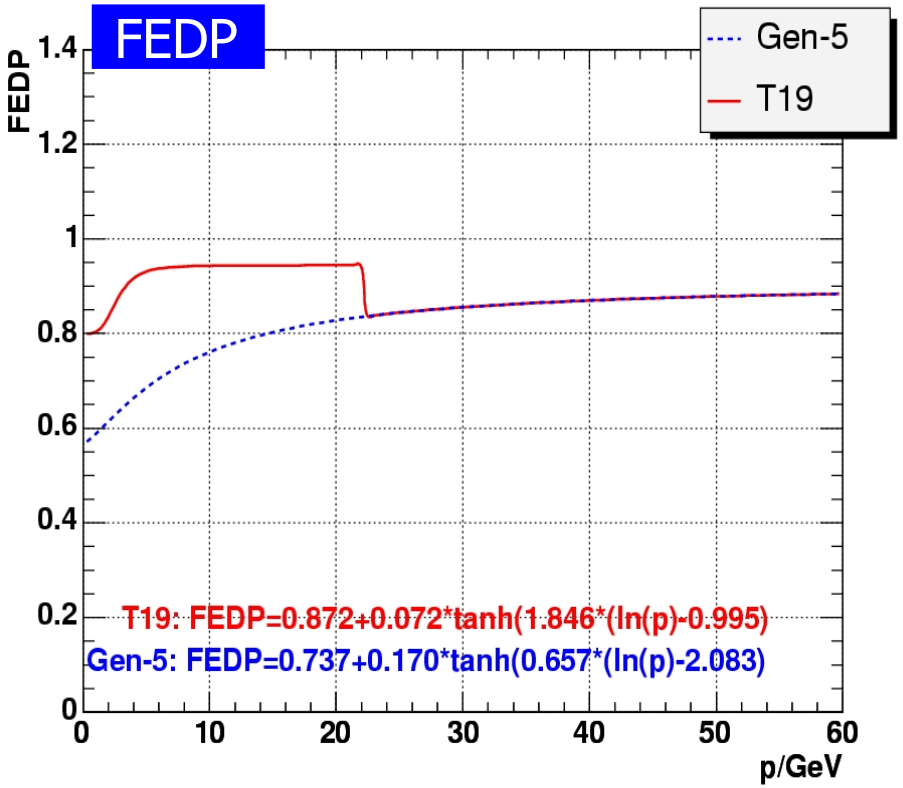
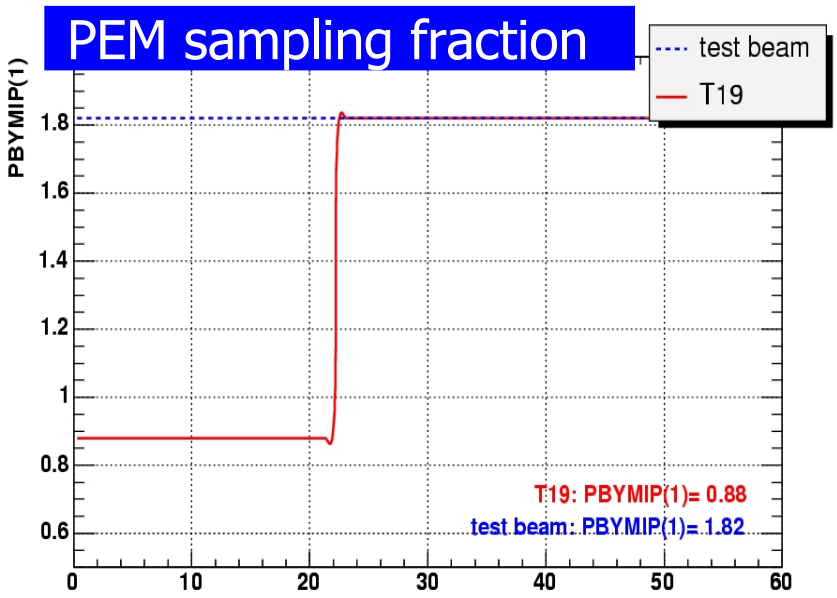
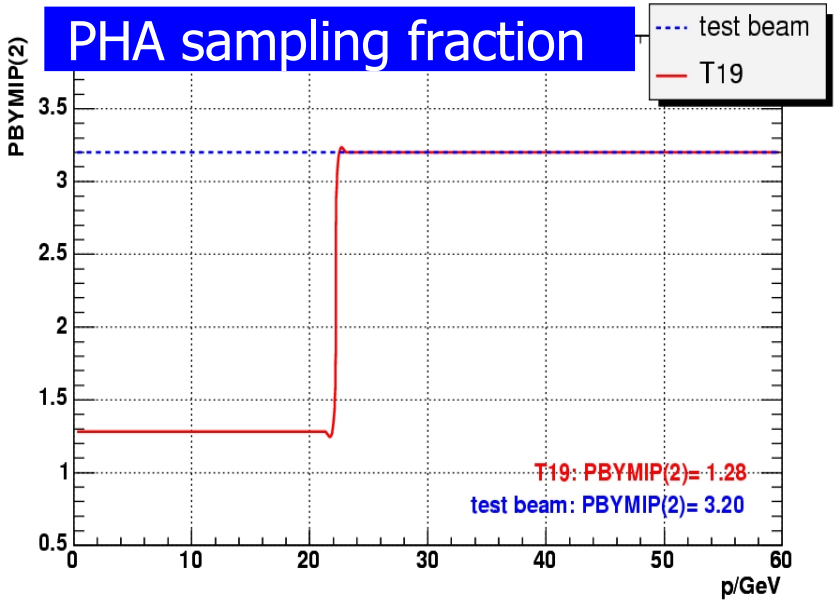
T19

- Simple means for TOT and MIP
- Weighted average of gmbs0d & gjtc0d

# Parameters




- Reducing MIP excess requires enhancing FEDP plateau at low energies.
- Relative sampling fractions far off test beam result.
- Is acceptable because FEDP, PBYMIP(1), PBYMIP(2) are GFLASH-internal quantities for an underconstrained problem.

# Conclusions

- Agreement with minbias data (T19 tuning):

| | | |
|---|---|---|
| TOT: | Plug: | ~2% at p=0.5-12GeV (simple & Gaussian means) |
| | | ~4% at p>12 GeV |
| | Tower 10: | ~5% at p=0.5-10GeV |
| | Tower 11: | ~2% at p=0.5-10GeV |
| MIP: | Plug: | 5-8% excess at p=3-10GeV, higher at p>10GeV |

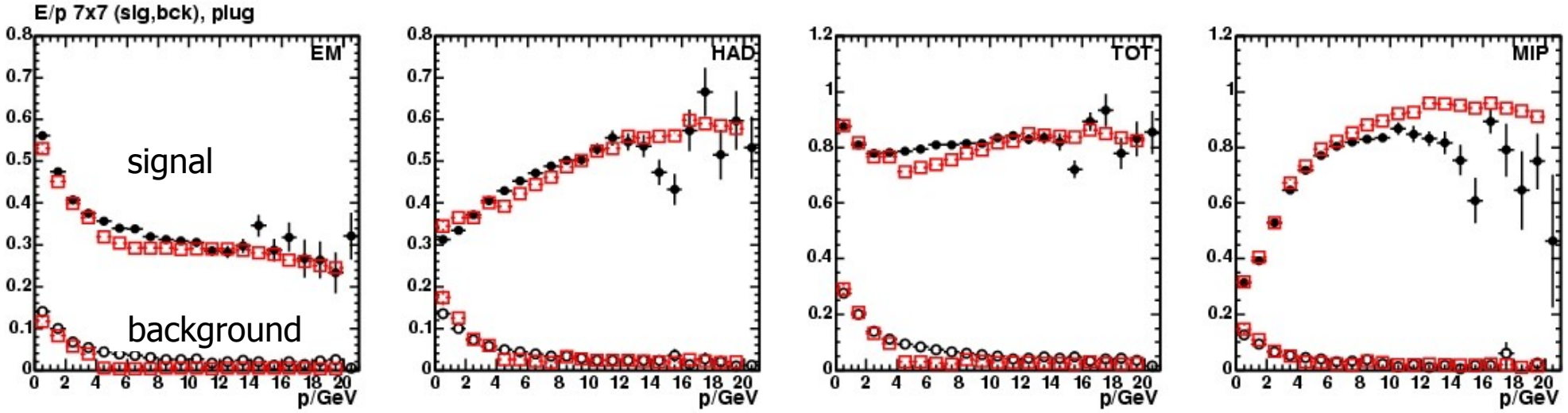
recent CAF downtimes didn't allow to check whether a solution closer to previous R10 (aka f5) reveals smaller excess in MIP response

| | | |
|---|---|---|
| EM: | Plug: | ~2% at p=0.5-12GeV |
| HAD: | Plug: | ~4% at p=0.5-12GeV |

- Additional systematics:
  - Correlated background (we don't use PES); however, we are using a well established physics generator (PYTHIA MB) for background modeling
  - Other data set (looking at Gaussian means): small effect
  - Flavor dependence: small for TOT response, moderate for MIP (CM talk 10/26)
  - Lateral profile / spectrum dependence: should be negligible
- Take test beam tuning used in Gen-5 for p>20GeV
  - Relatively smooth transition in terms of E/p

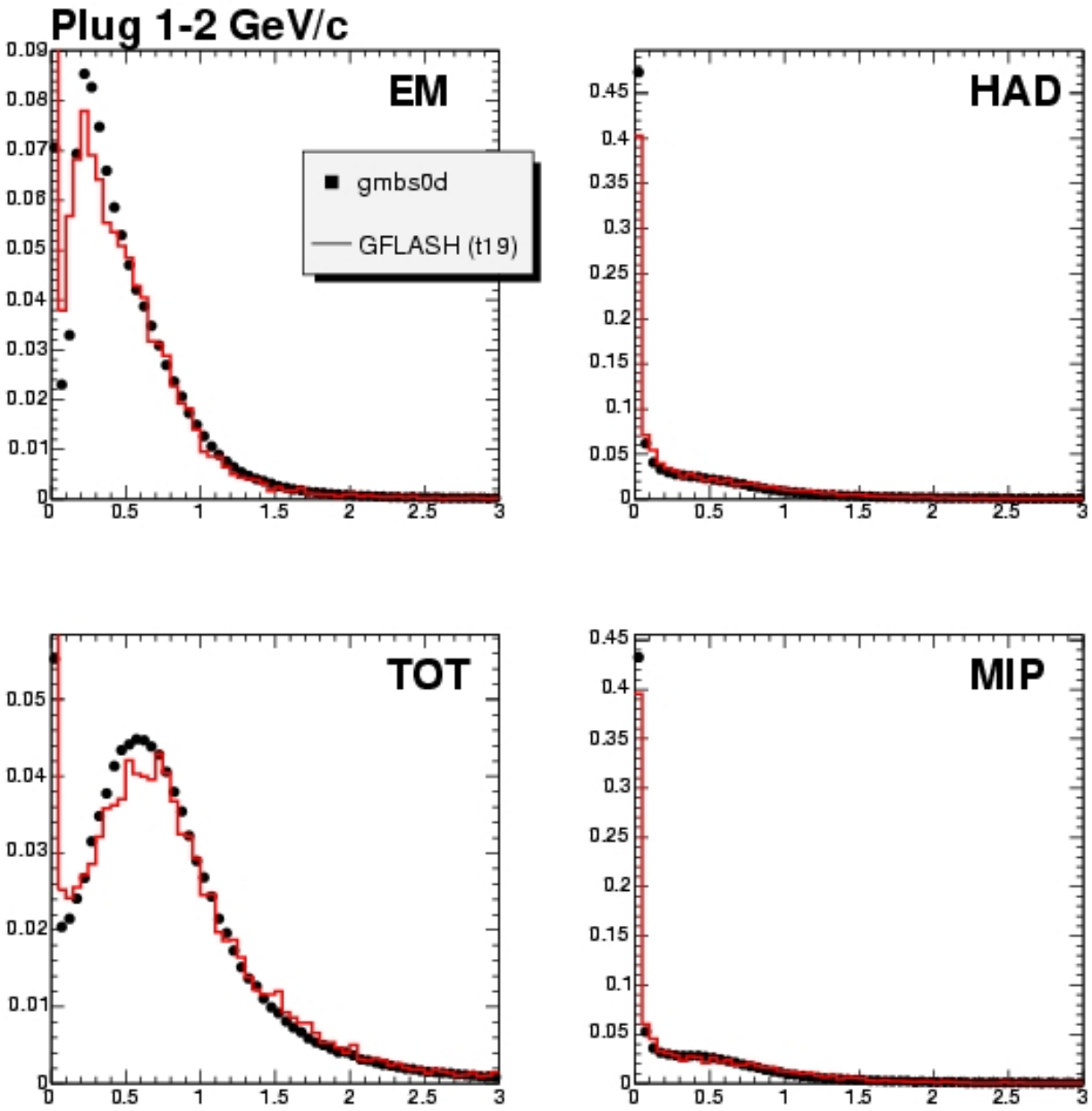
# Appendix: E/p Distributions

# Plug Signal and Background

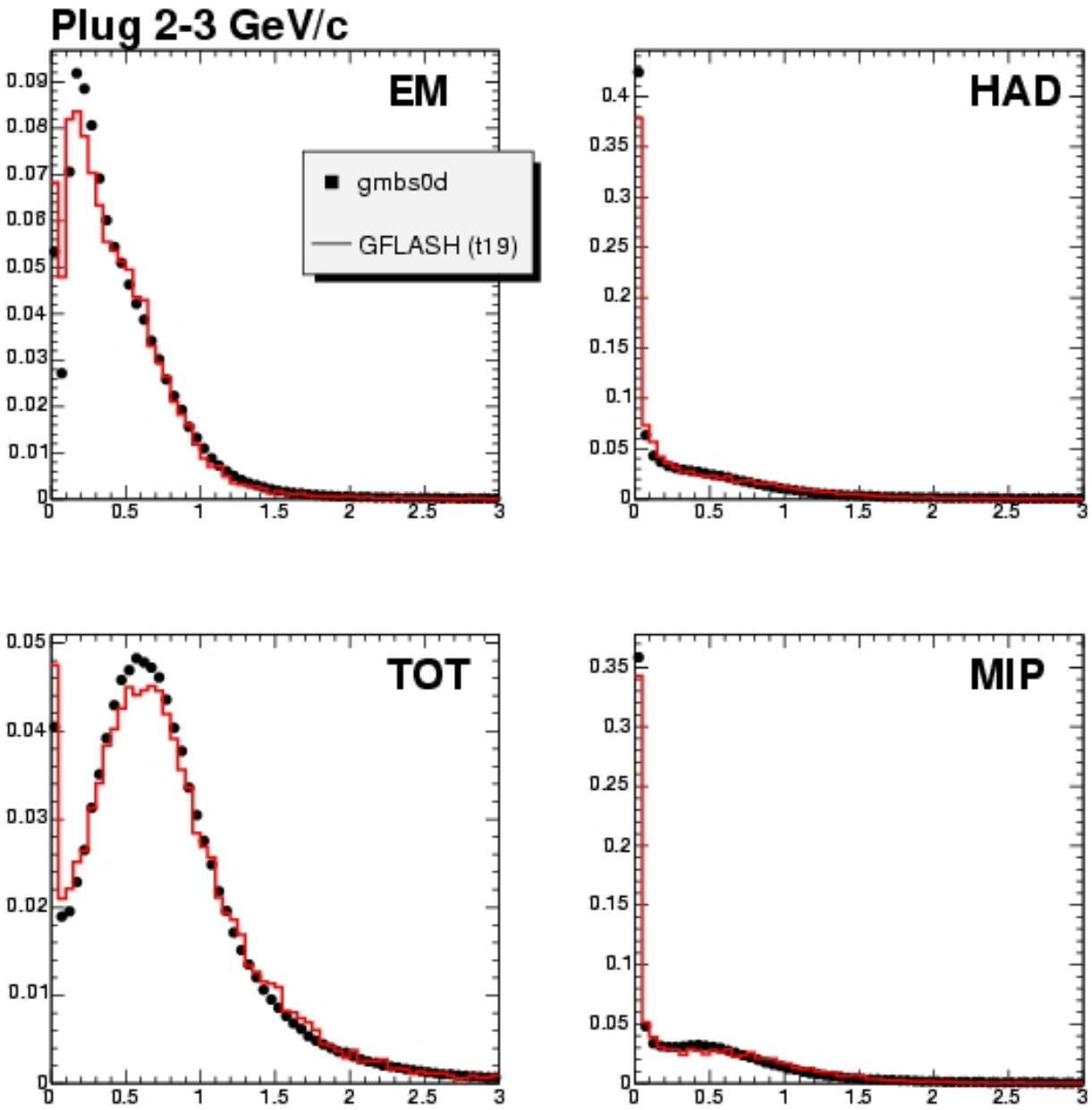



- Following plots show normalized E/p "signal" distributions w/o background corrections
- gmbs0d vs. FAKEEV (+PYTHIA MB)
- In these plots, no MC background modeling for p>4GeV
  - MC/data shift expected according to background differences in the above plots (shape comparison still useful)

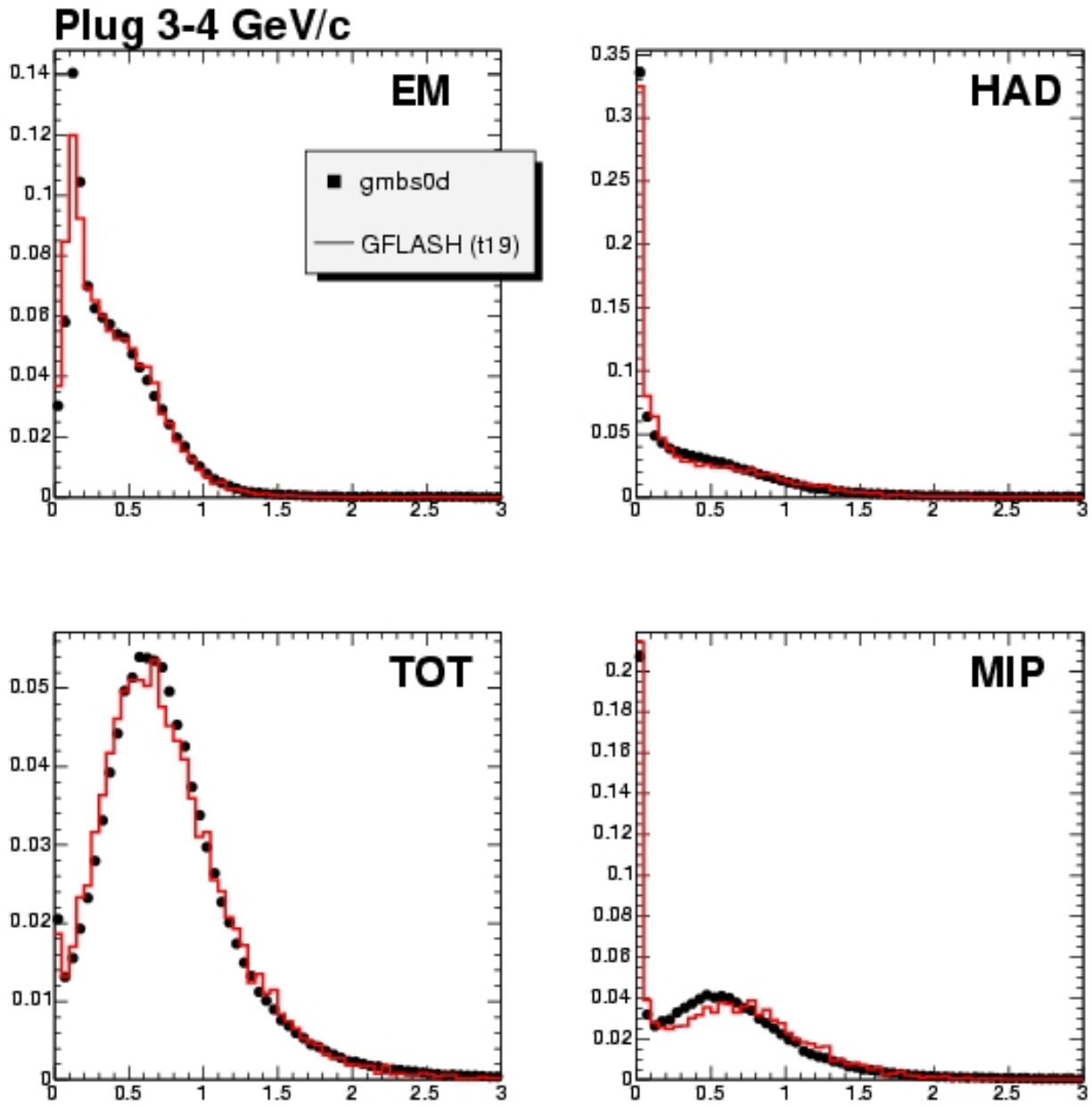
# Plug 1-2 GeV



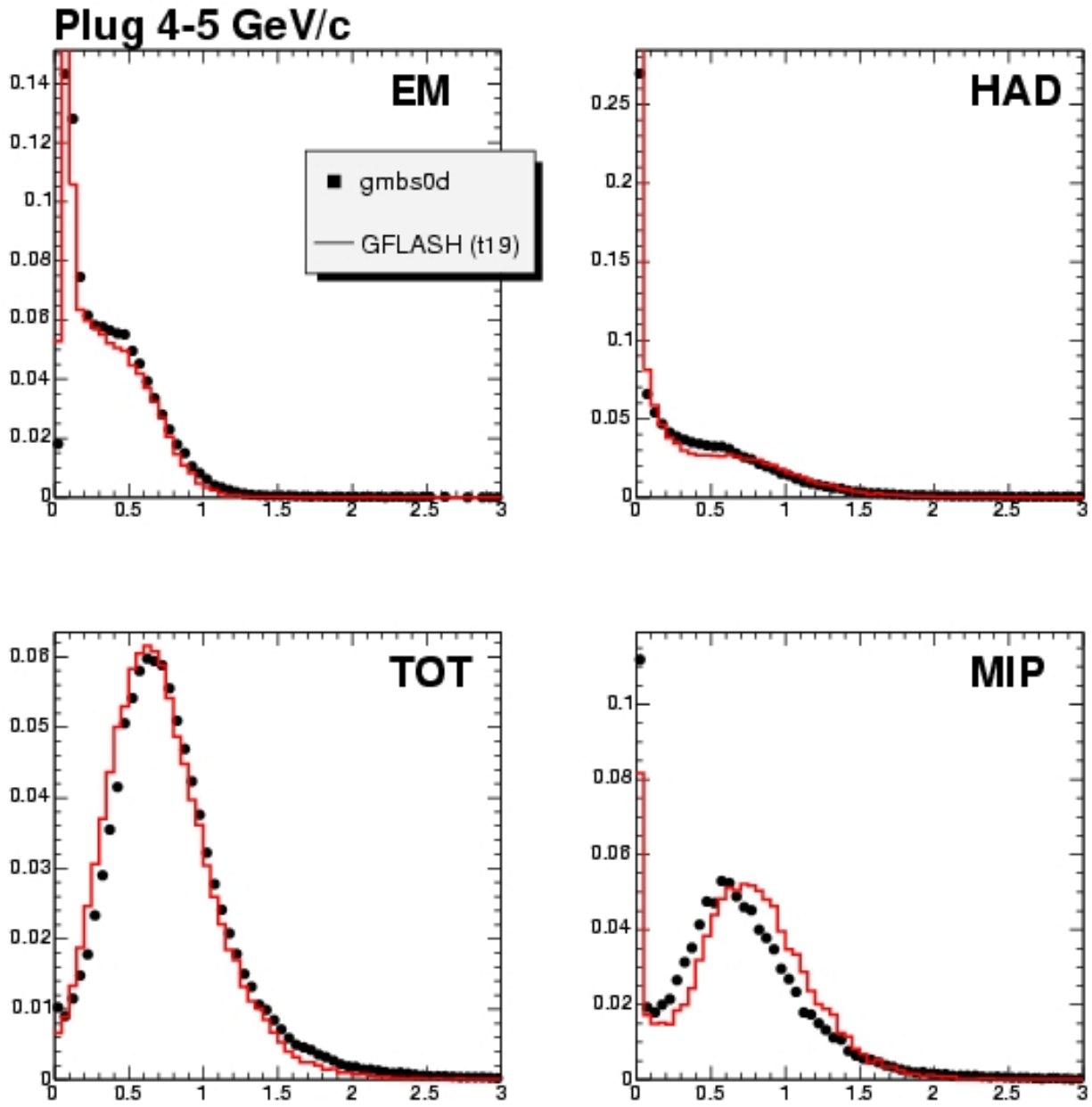
# Plug 2-3 GeV



# Plug 3-4 GeV

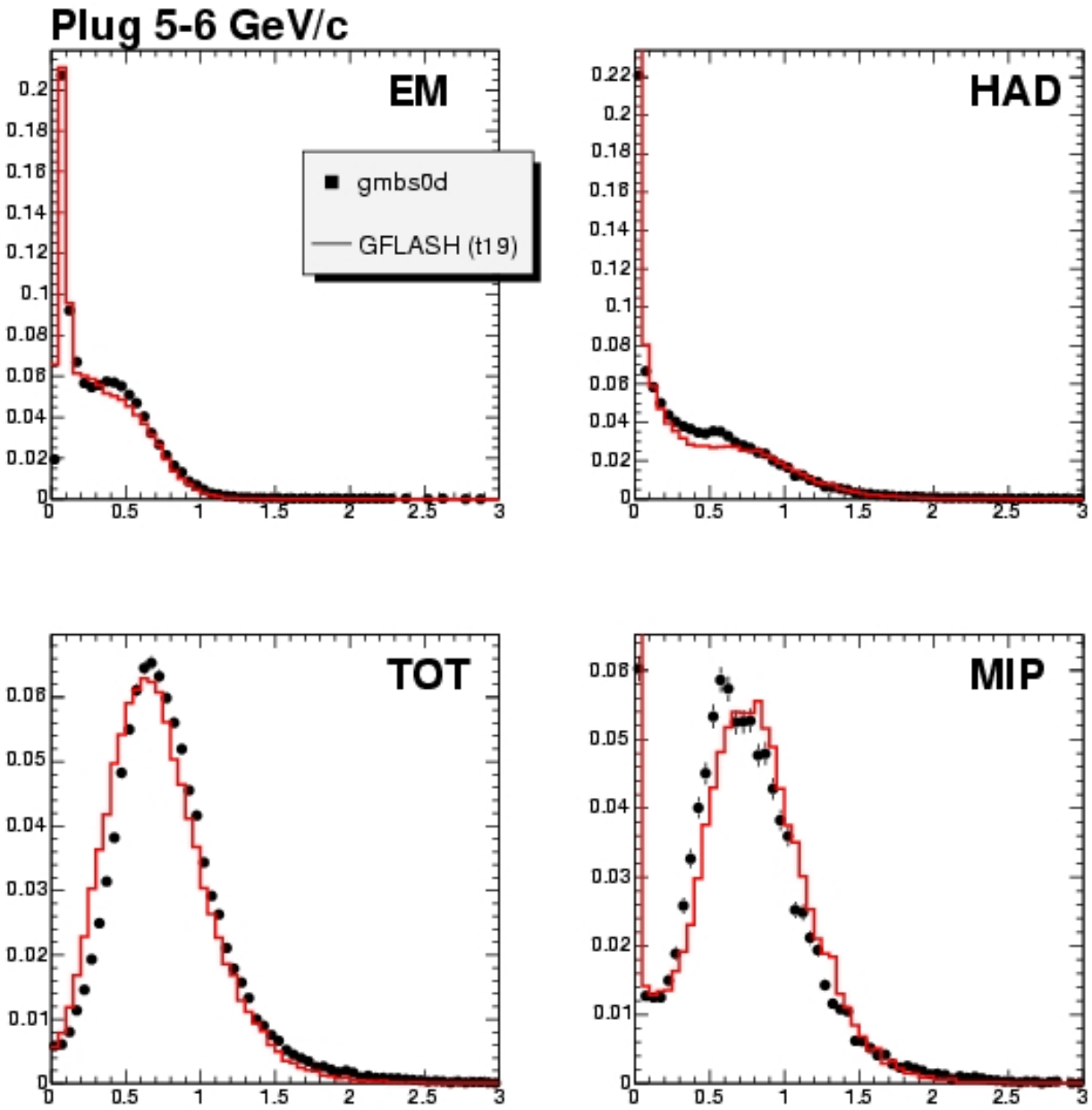


# Plug 4-5 GeV



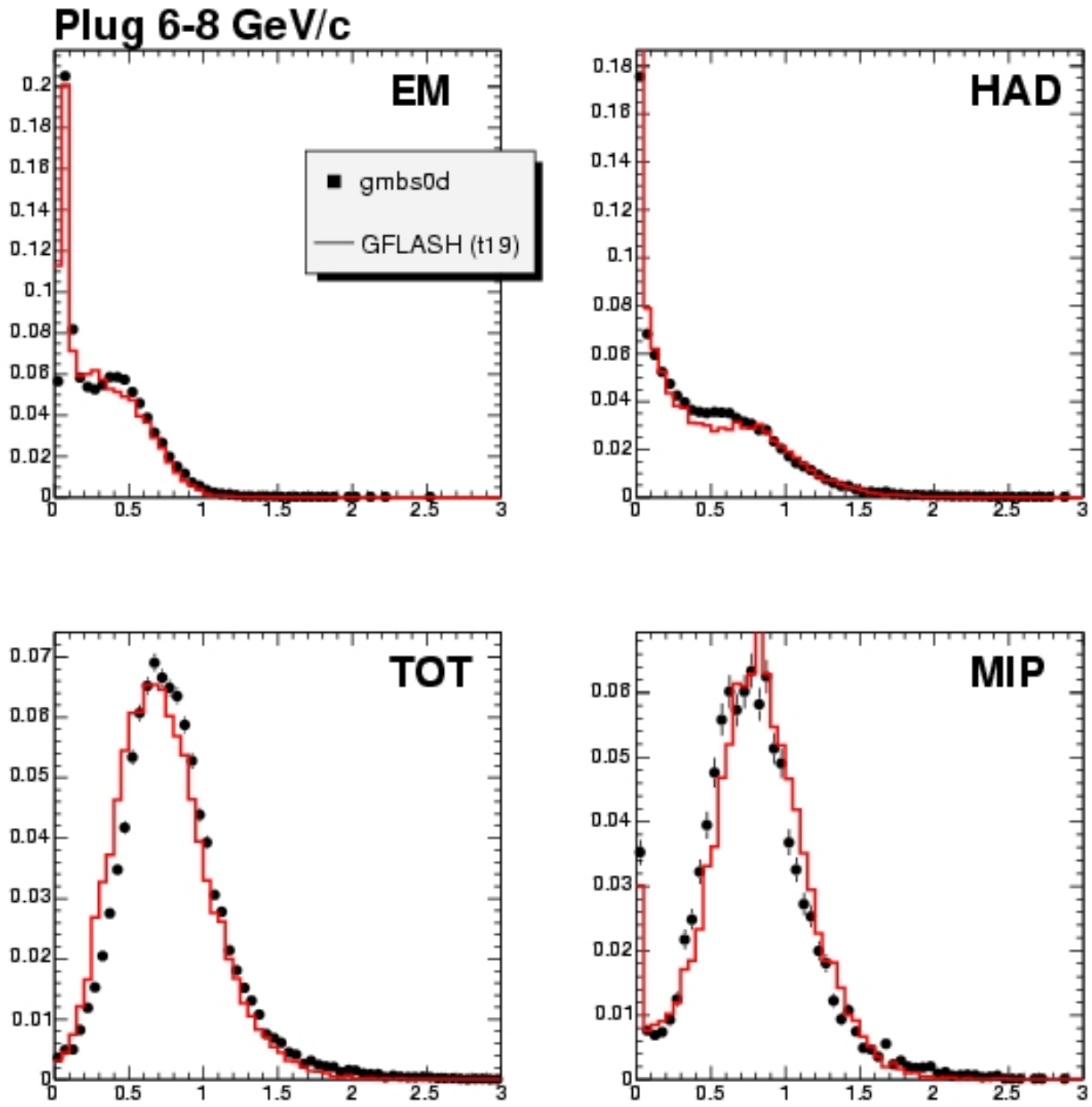

- FAKEEV w/o Pythia MB

# Plug 5-6 GeV



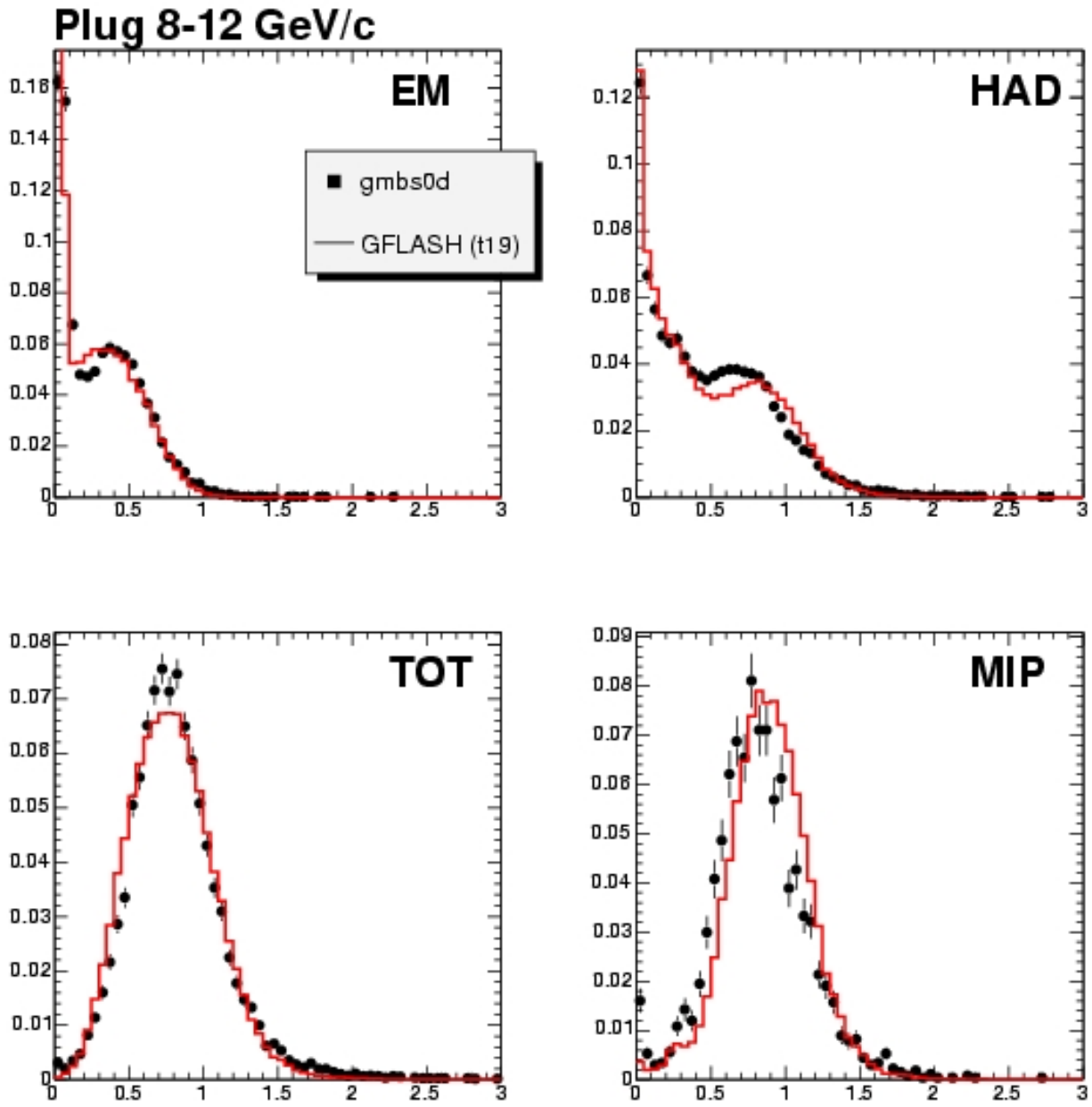

- FAKEEV w/o Pythia MB

# Plug 6-8 GeV



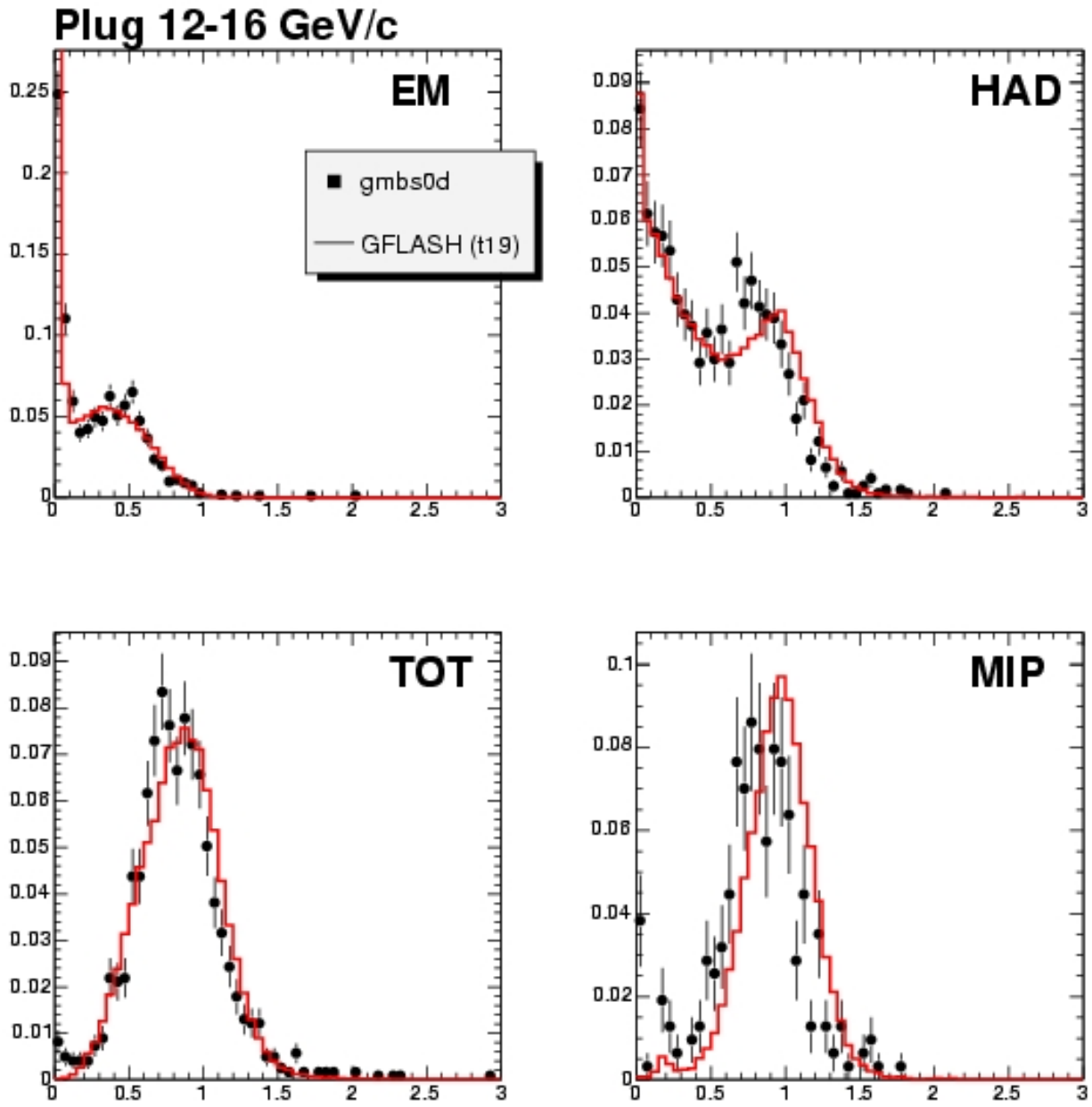

- FAKEEV w/o Pythia MB

# Plug 8-12 GeV



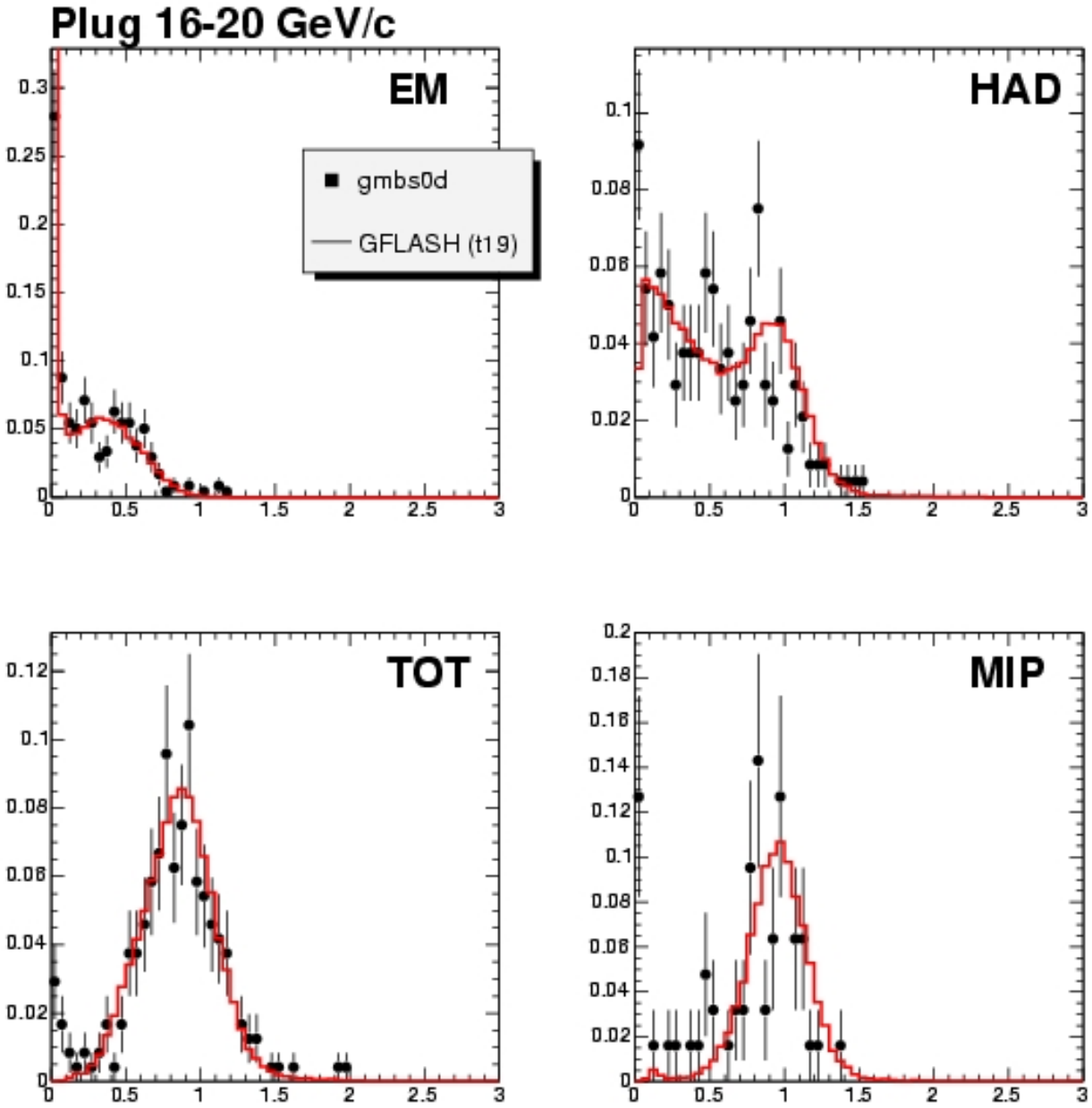

- FAKEEV w/o Pythia MB

# Plug 12-16 GeV



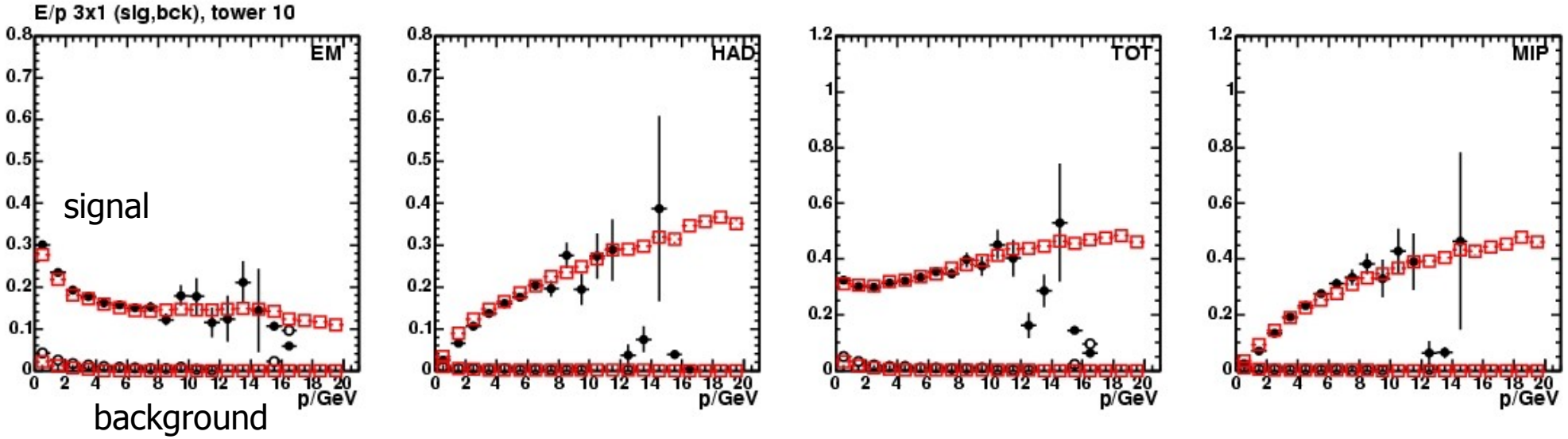

- FAKEEV w/o Pythia MB

# Plug 16-20 GeV

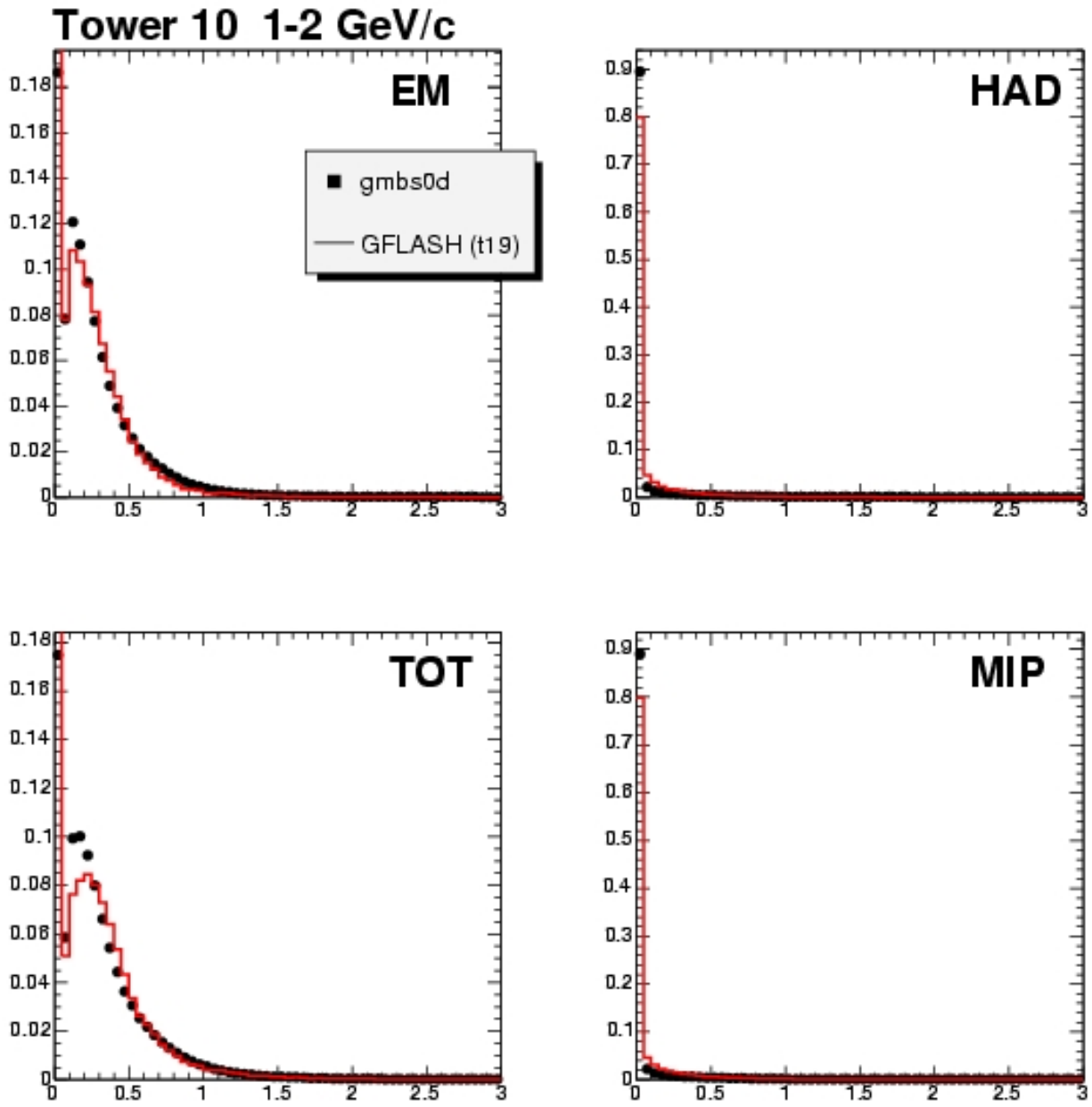



- FAKEEV w/o Pythia MB

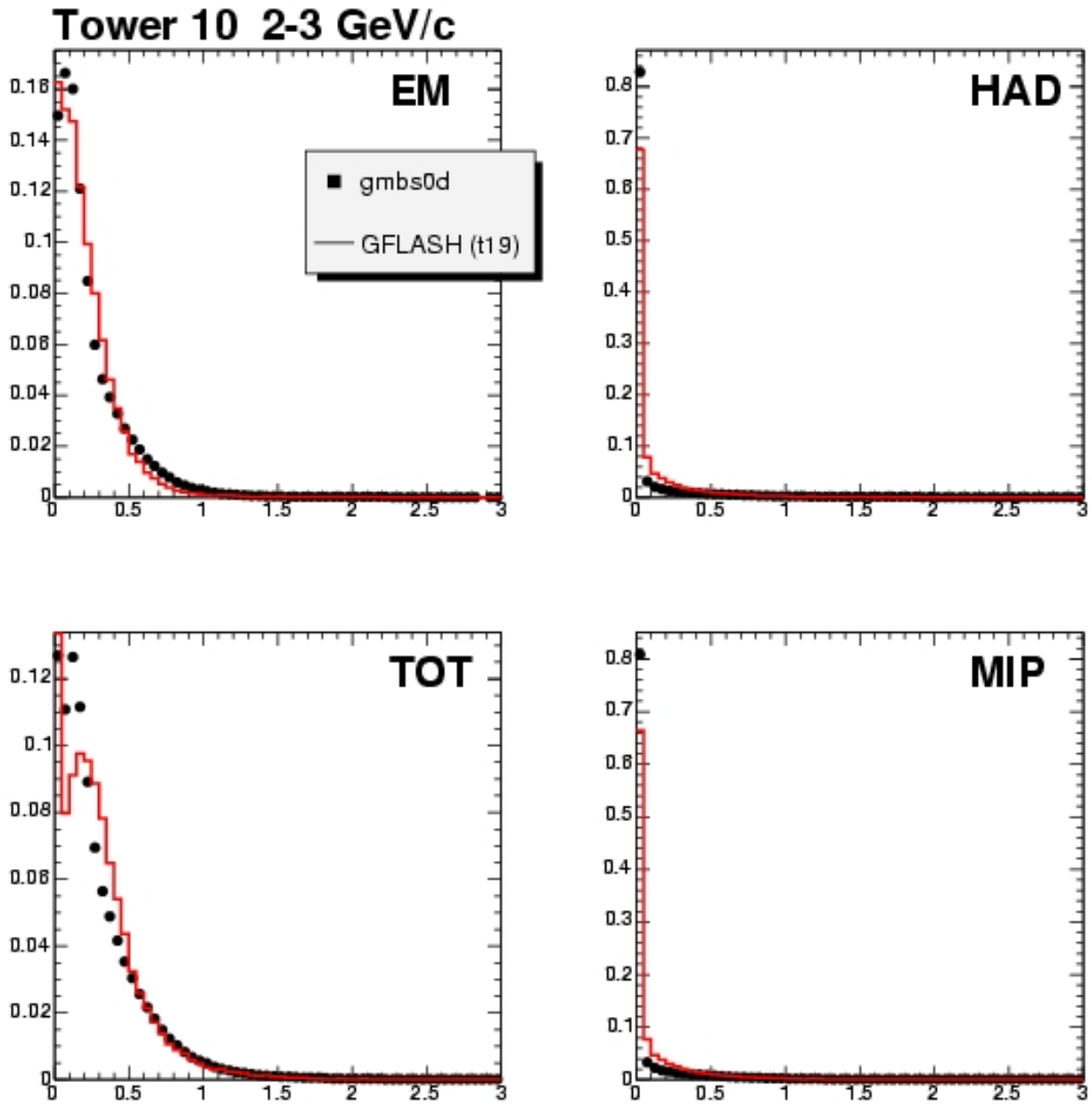
# Tower 10 Signal and Background



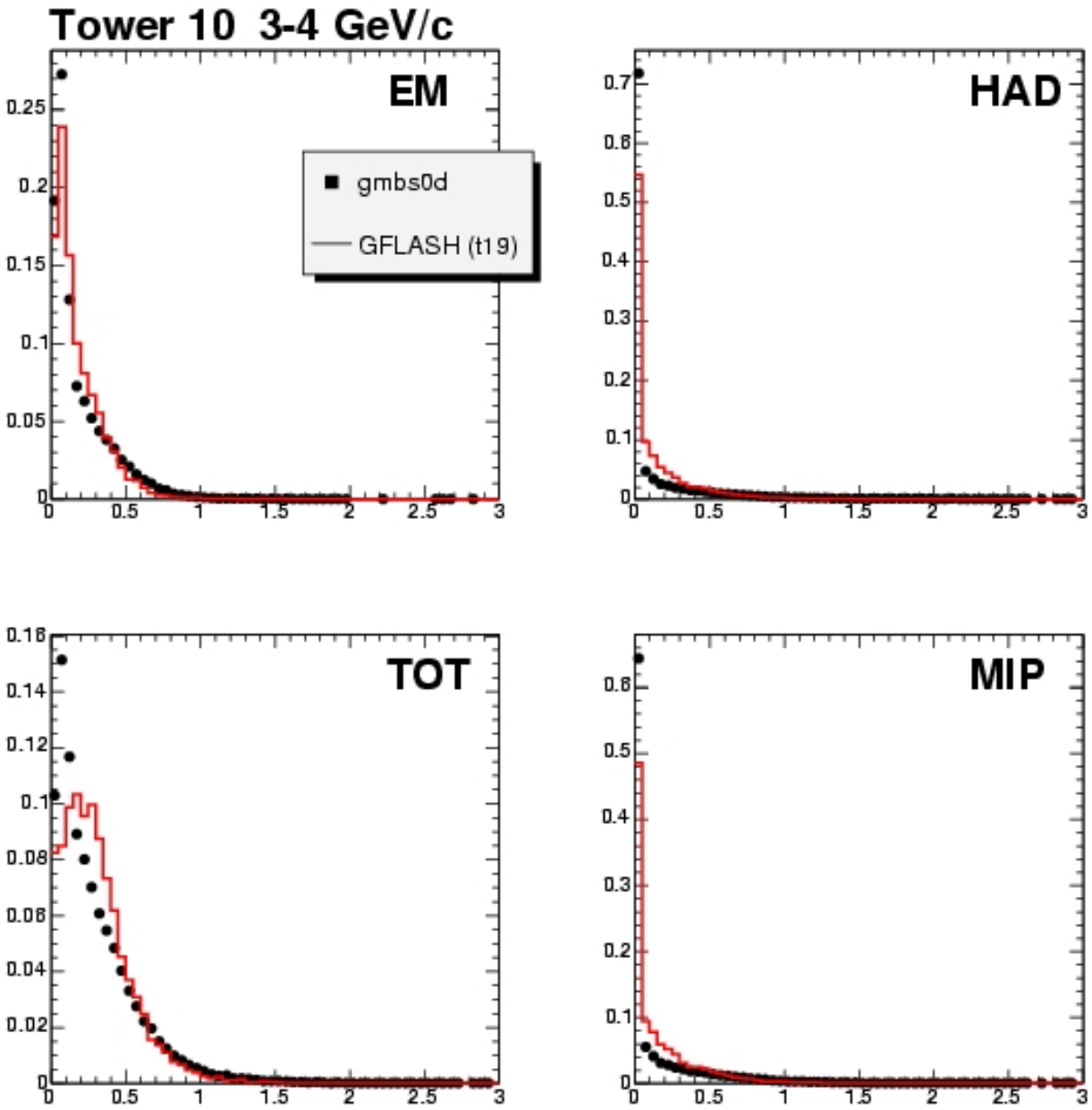
# Tower 10 1-2 GeV



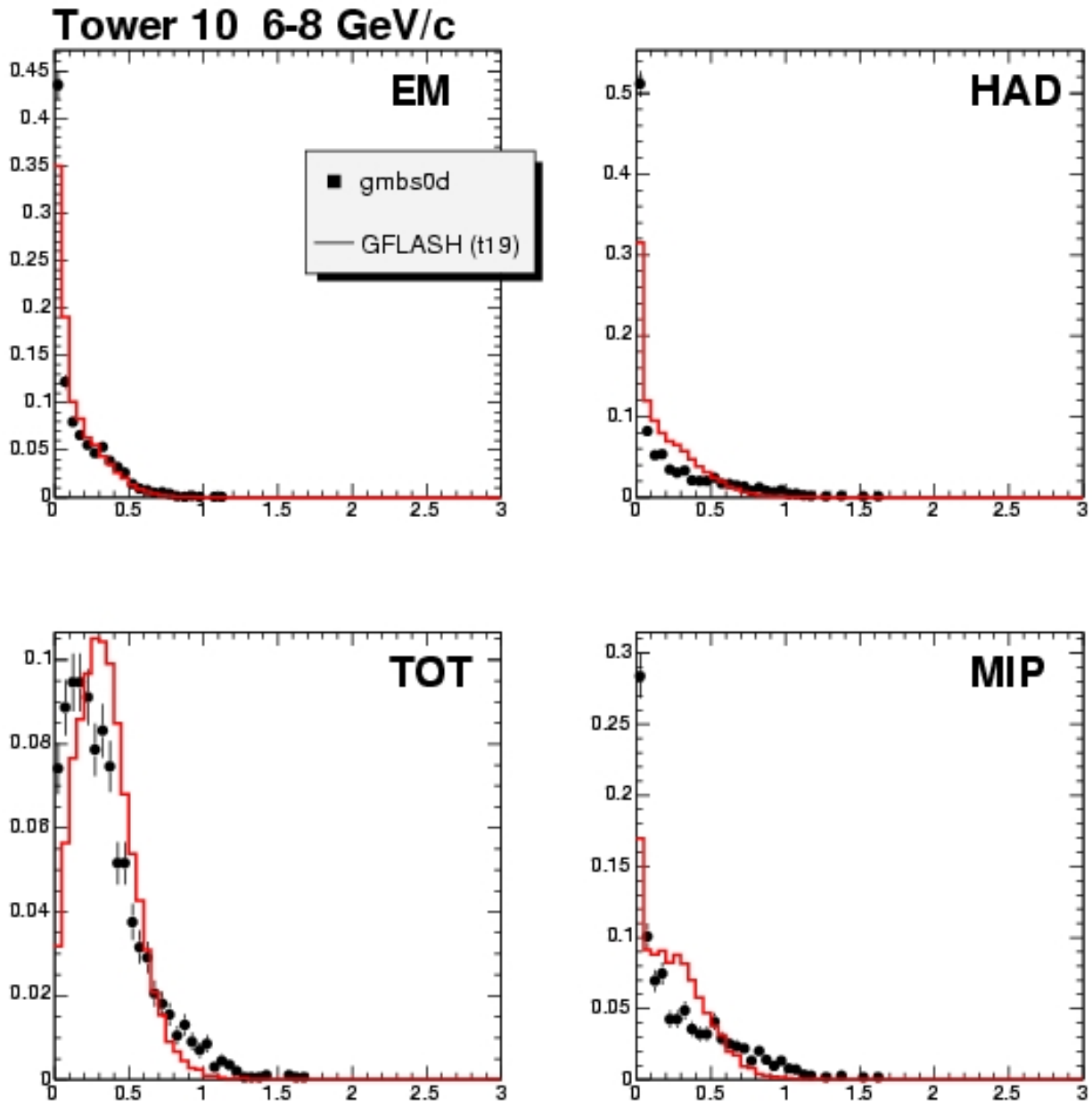
# Tower 10 2-3 GeV



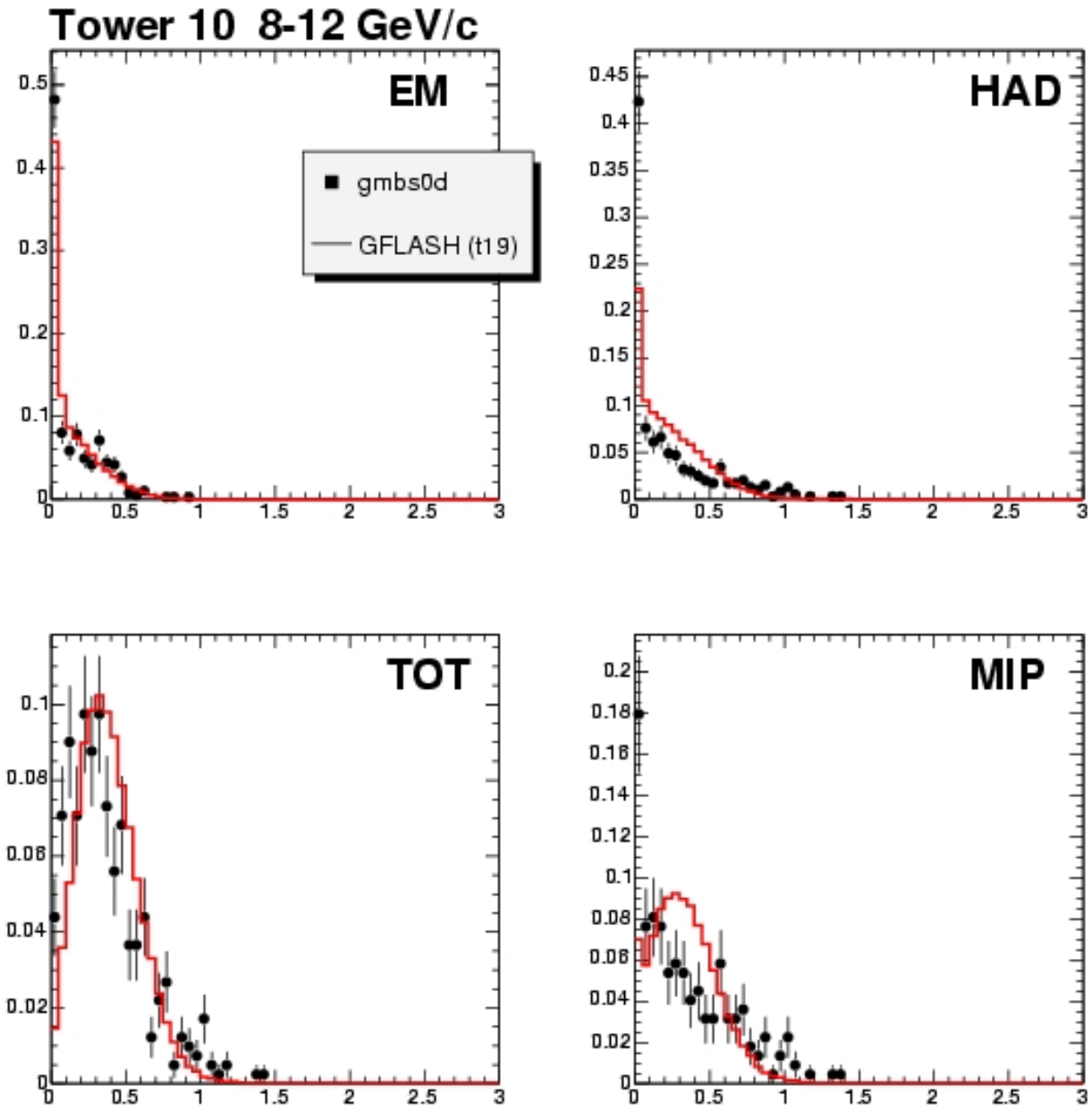
# Tower 10 3-4 GeV



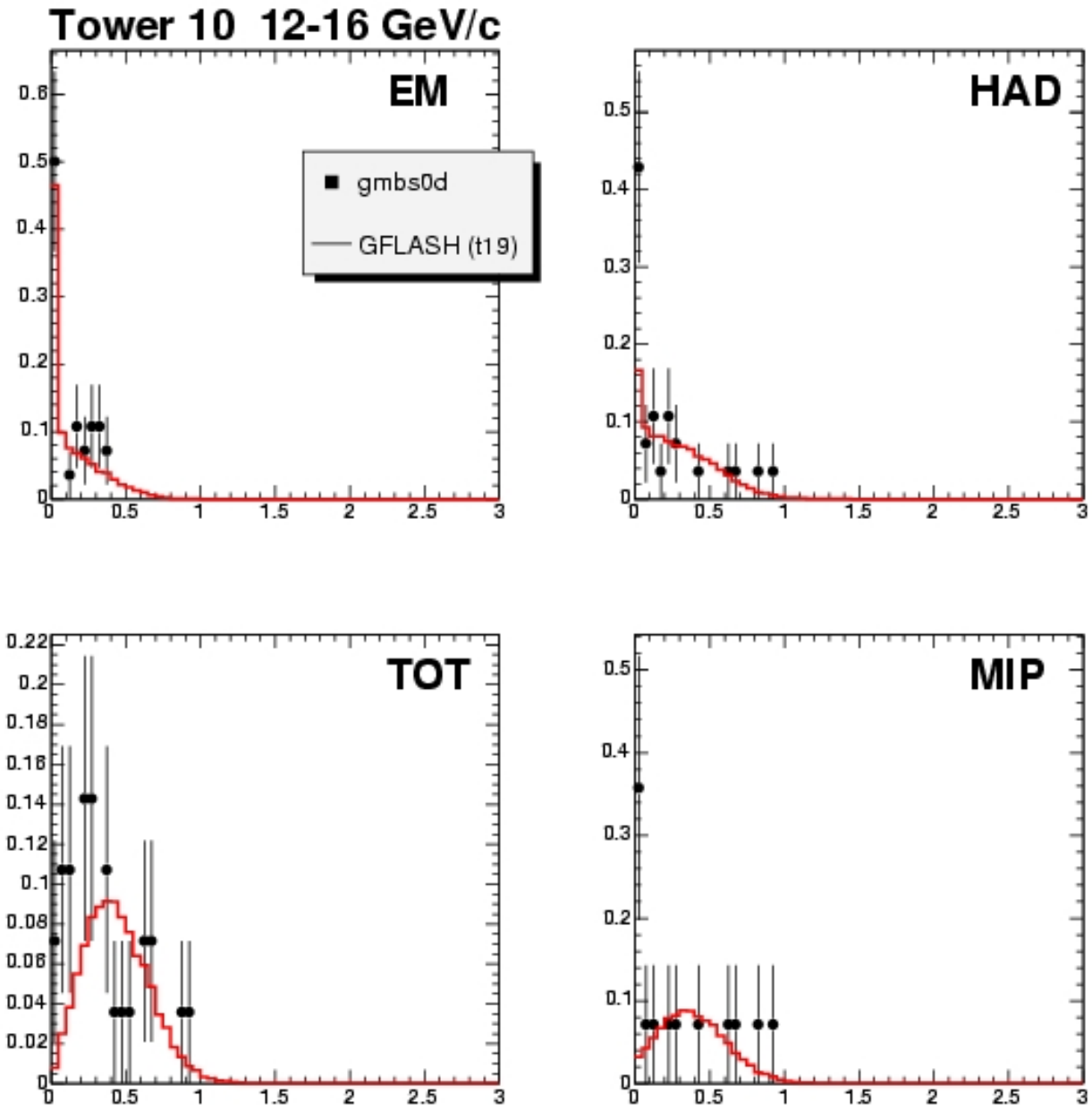
# Tower 10 6-8 GeV



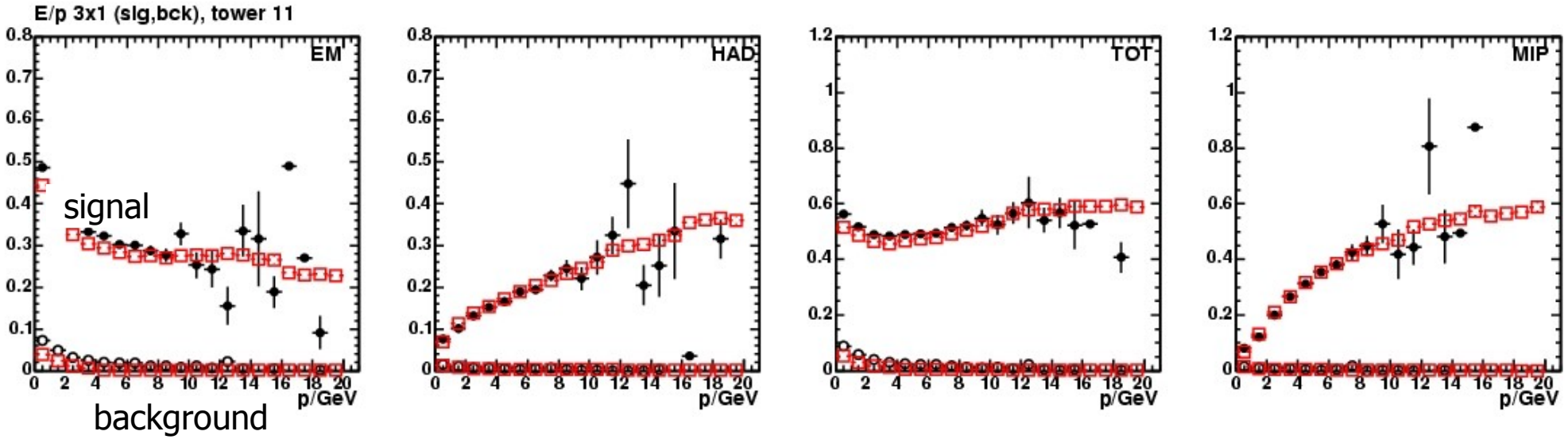
# Tower 10 8-12 GeV



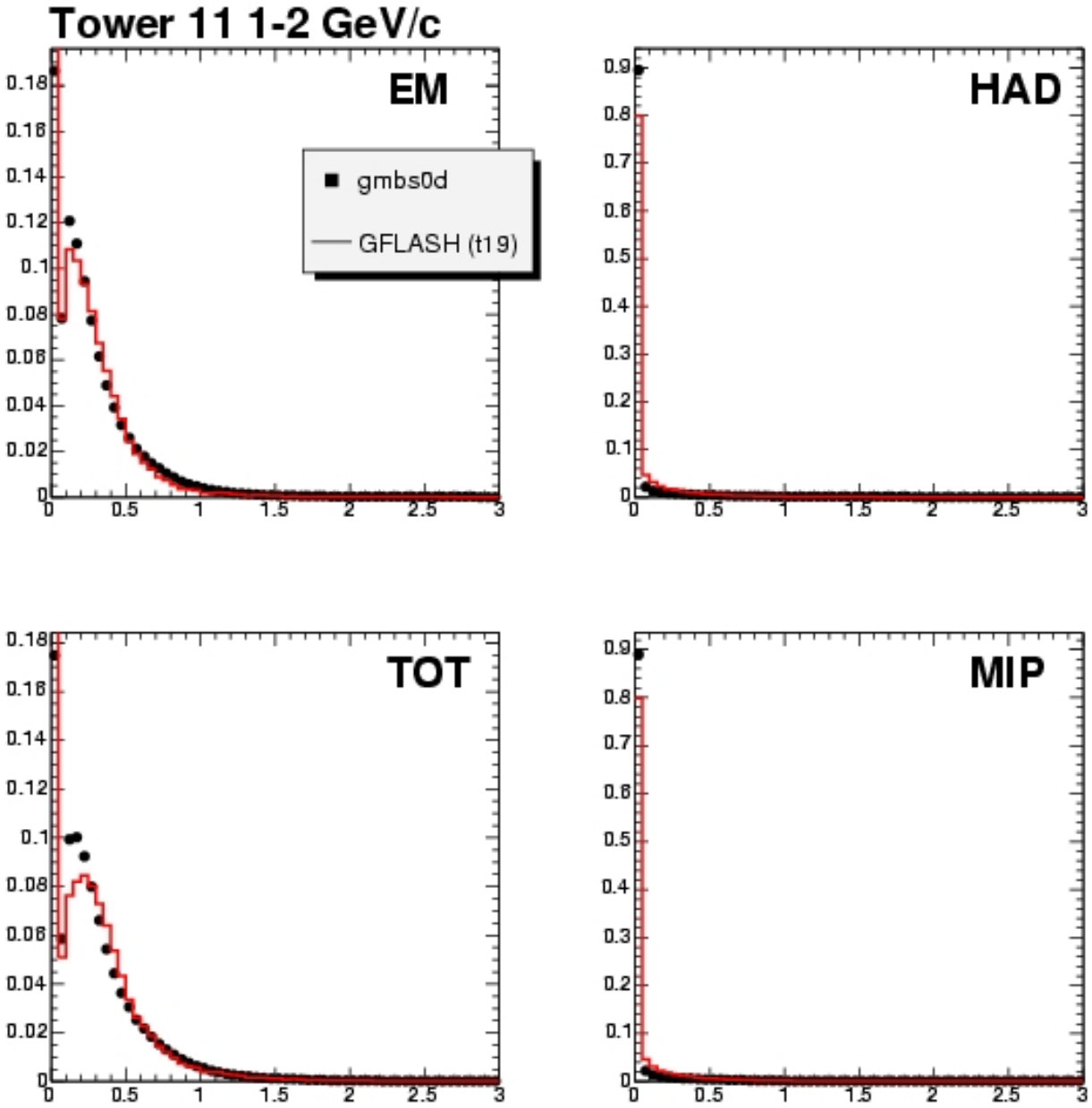
# Tower 10 12-16 GeV



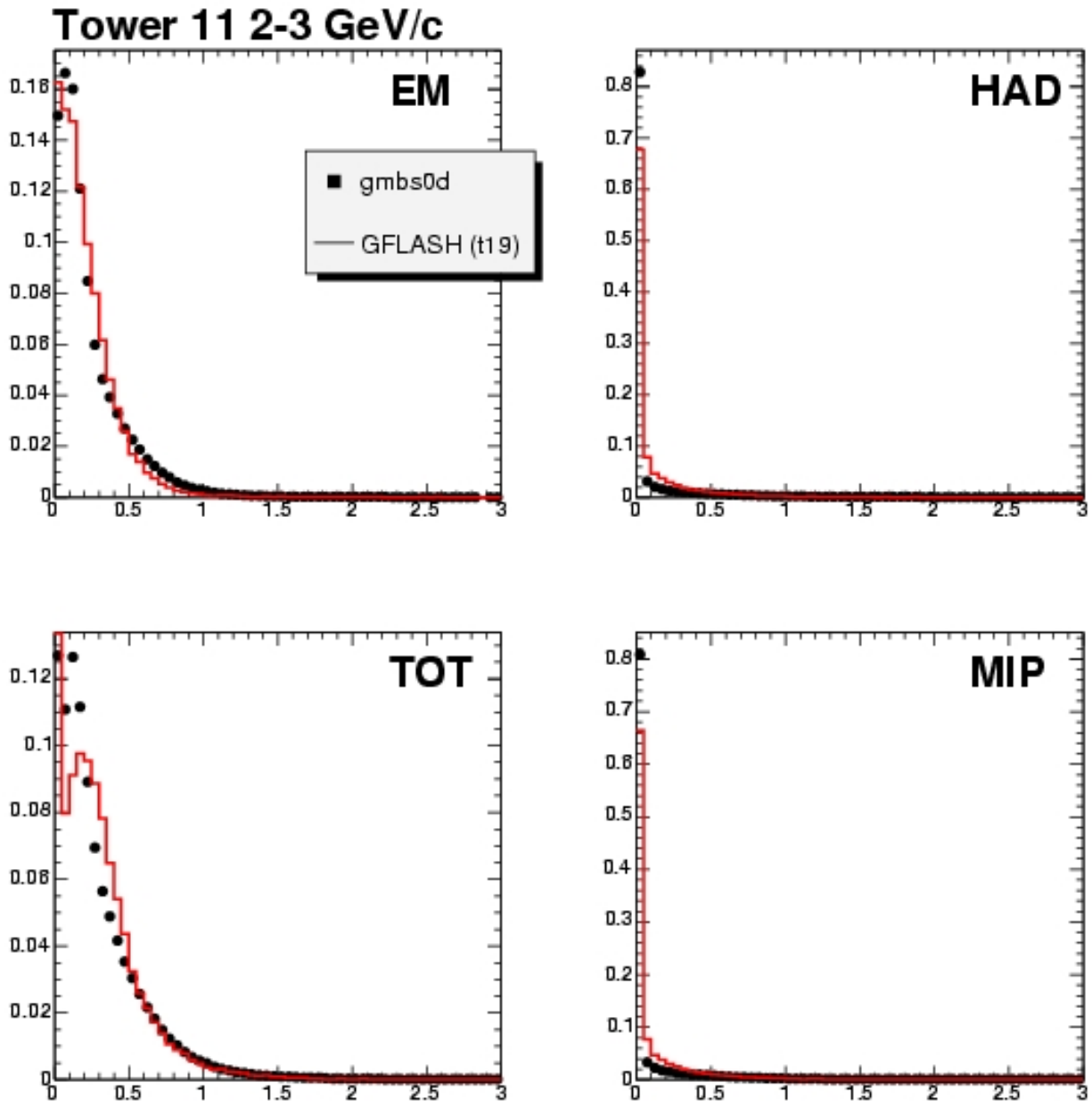
# Tower 11 Signal and Background



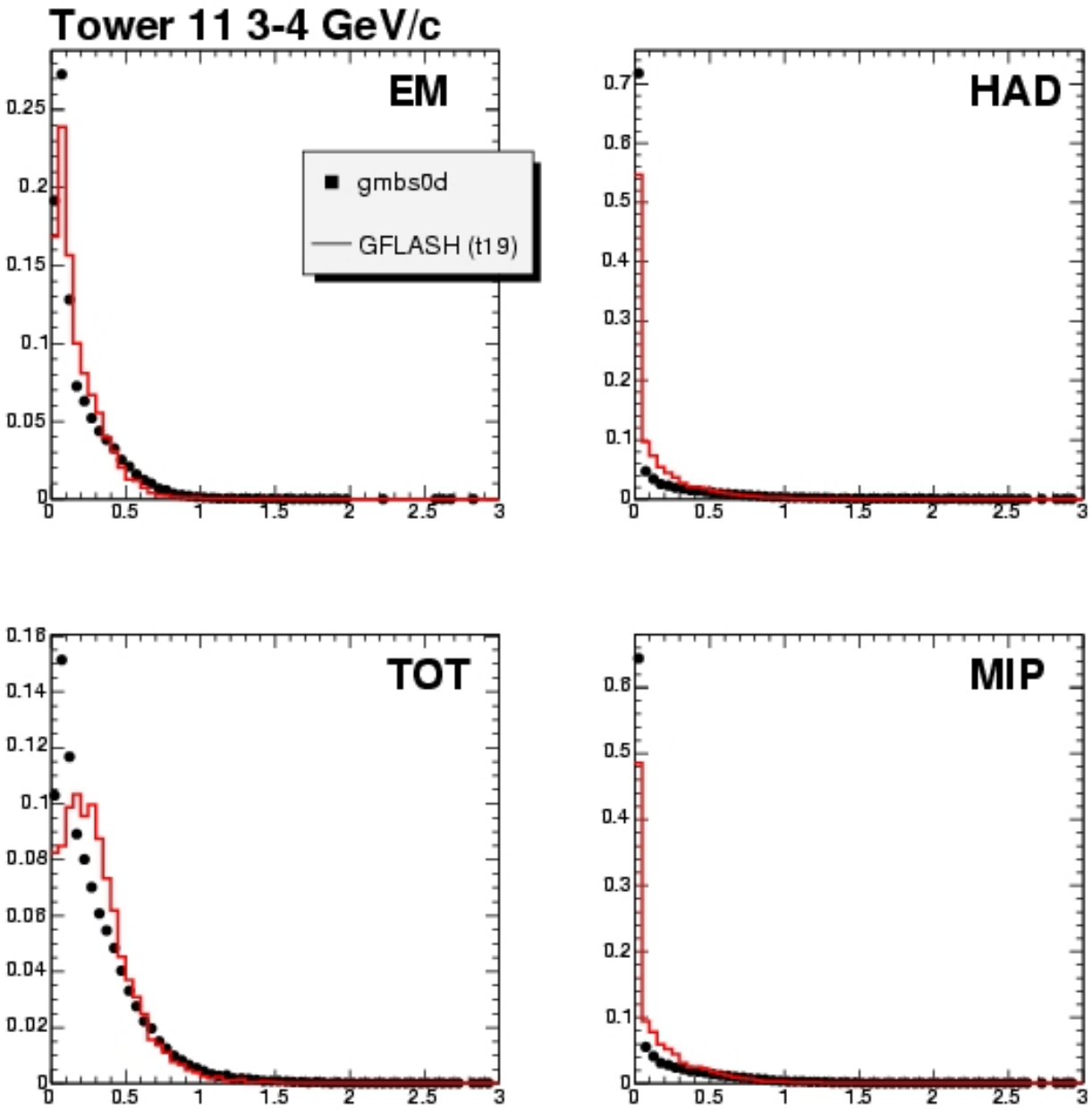
# Tower 11 1-2 GeV



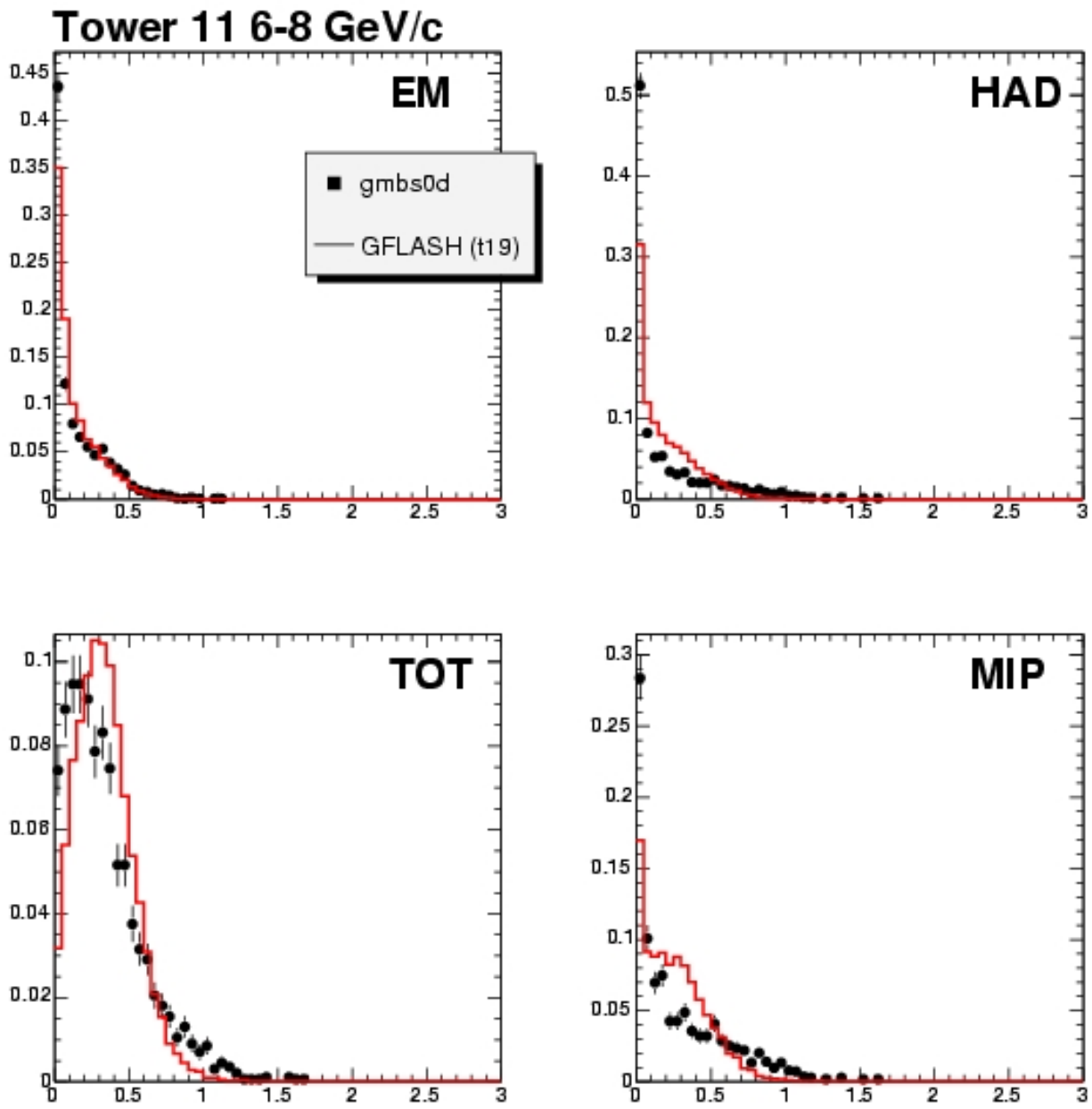
# Tower 11 2-3 GeV



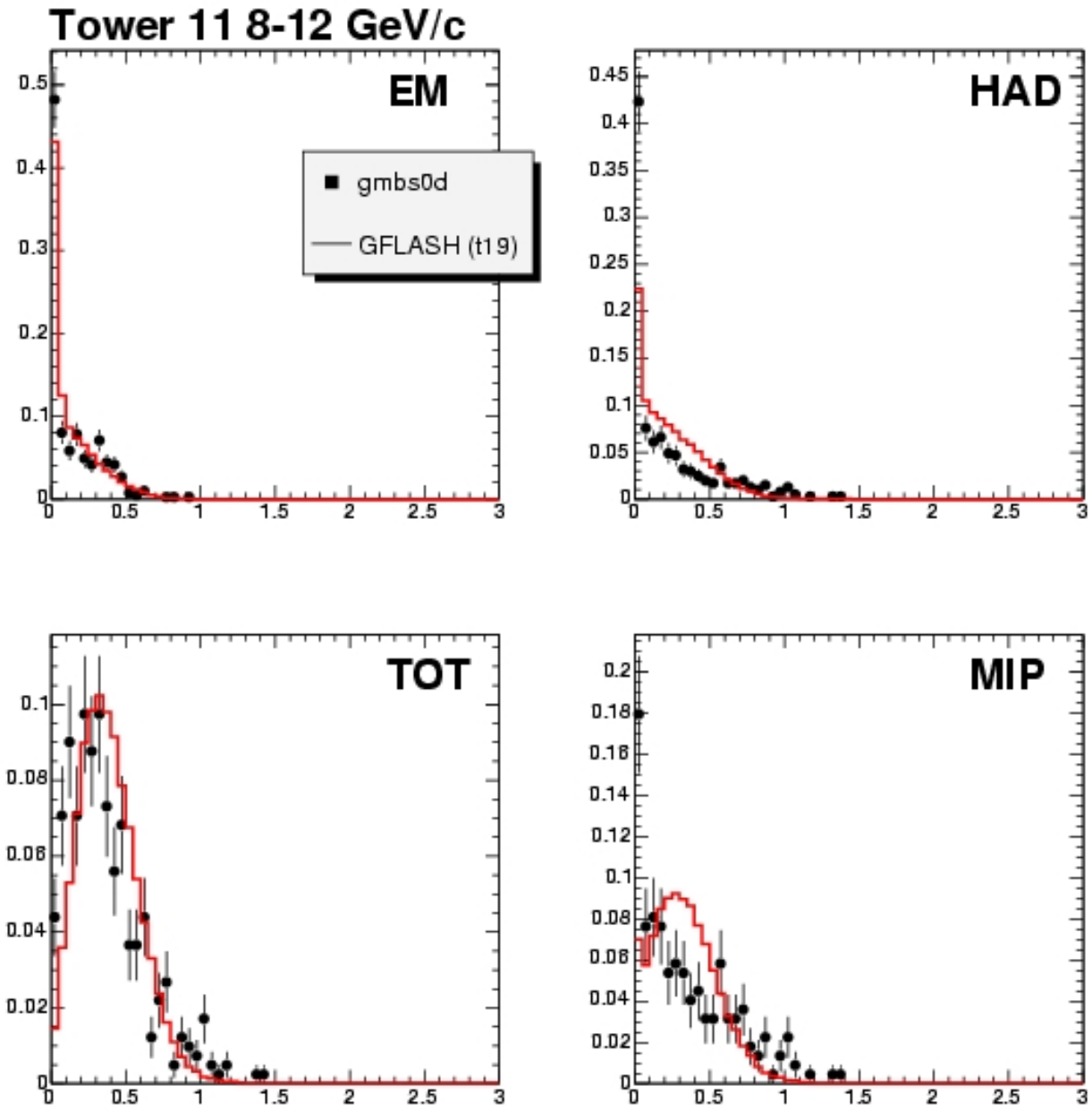
# Tower 11 3-4 GeV



# Tower 11 6-8 GeV



# Tower 11 8-12 GeV



# Tower 11 12-16 GeV