Tuning Pythia6 Z2*lep CDF data

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Input

- Use CDF Tevatron analysis code in rivet
- For tuning: Professor

- **Pythia6 tune Z2*lep**

- generate Minimum Bias QCD events with c_tau > 10 mm stable and no pt cut applied

```
'MSEL=0        ! User defined processes',
'MSUB(11)=1    ! Min bias process',
'MSUB(12)=1    ! Min bias process',
'MSUB(13)=1    ! Min bias process',
'MSUB(28)=1    ! Min bias process',
'MSUB(53)=1    ! Min bias process',
'MSUB(68)=1    ! Min bias process',
'MSUB(92)=1    ! Min bias process, single diffractive',
'MSUB(93)=1    ! Min bias process, single diffractive',
'MSUB(94)=1    ! Min bias process, double diffractive',
'MSUB(95)=1    ! Min bias process'
```

- **center-of-mass energy 300GeV, 900GeV and 1960 GeV**
- PDF CTEQ6L1
- Number of events: 1000000

How to generate files for different $\sqrt{s}$

- Standard config file for Professor and Rivet

```
'PARP(82)=<__PARP(82)__> ! pt cutoff for multiparton interactions',
'PARP(90)=<__PARP(90)__>! Multiple interactions: rescaling power',
'PARP(77)=<__PARP(77)__> ! CR',
'PARP(78)=<__PARP(78)__> ! CR',
'PARP(83)=<__PARP(83)__> ! Multiple interactions: matter distribution parameter',
```

- tuning ranges are given in generator.ranges

```
PARP(82) 1.6 2.2
PARP(77) 0.25 1.2
PARP(78) 0.2 0.6
PARP(90) 0.18 0.28
PARP(83) 0.1 1.0
```

- Create 30 random steering parameters in the directory "mcruns"

```
prof-sampleparams generator.ranges -N 30 -o mcruns -T rivet1960GeV_cfg.py -T rivet300GeV_cfg.py -T rivet900GeV_cfg.py
```

- this creates 30 directories, each with a new config file for all the different cme where the MC paramters are replaced by a random number within the given range.

The MC parameters in each directory are the same for the different cme.

How to generate files for different $\sqrt{s}$

- Run the MC generator with each of the 30 random cfg files for each cme

```
submit_mcpoint.py -r 0-29 -d mcruns -q 06:00:00 -c rivet300GeV_cfg.py
submit_mcpoint.py -r 0-29 -d mcruns -q 06:00:00 -c rivet900GeV_cfg.py
submit_mcpoint.py -r 0-29 -d mcruns -q 06:00:00 -c rivet1960GeV_cfg.py
```

- Be careful: the out.aida files should be named according to the cme that they are not overwritten and submit_mcpoints.py produces a log file which cannot be overwritten (->name it differently)

- Create a list of run combinations

```
prof-runcombs create --m mcruns/ -c 0:1 -o runcombs.dat
```

- Create a weights file including the histograms for the different cme

```
/CDF_Tevatron/d01-x01-y01       1.0
/CDF_Tevatron/d01-x01-y02       1.0

/CDF_Tevatron/d02-x01-y01       1.0
/CDF_Tevatron/d02-x01-y02       1.0

/CDF_Tevatron/d03-x01-y01       1.0
/CDF_Tevatron/d03-x01-y02       1.0
```

How to generate files for different $\sqrt{s}$

- Do the envelope

```
prof-envelopes --mcdir mcruns --datadir . --cl 90 --weights weights --runs runcombs.dat
```

- Interpolate the parameter space

```
prof-interpolate --mcdir mcruns --datadir . --weights weights --runsfile runcombs.dat
```

- Tune the polynomial

```
prof-tune --datadir . --ipoldir ipol --runsfile runcombs.dat --mcdir mcruns --obsfile weights
```

- One can also merge the aida files for the different cme (Albert)

```
aida2flat -m /CDF_Tevatron/d01-x01-y01  1960GeVRun.aida > merged.dat
aida2flat -m /CDF_Tevatron/d02-x01-y01  900GeVRun.aida >> merged.dat
aida2flat -m /CDF_Tevatron/d03-x01-y01  300GeVRun.aida >> merged.dat
flat2aida merged.dat
```

- There is also a scribt available on the Twiki

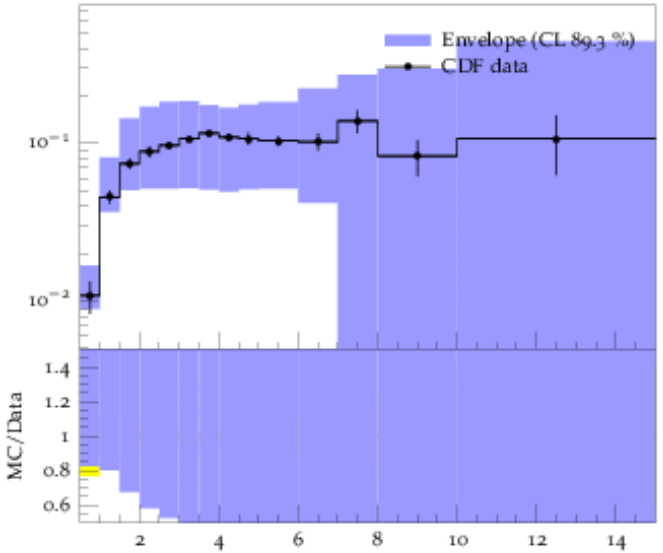
https://twiki.cern.ch/twiki/bin/viewauth/CMS/Professor

Parameters for Tuning

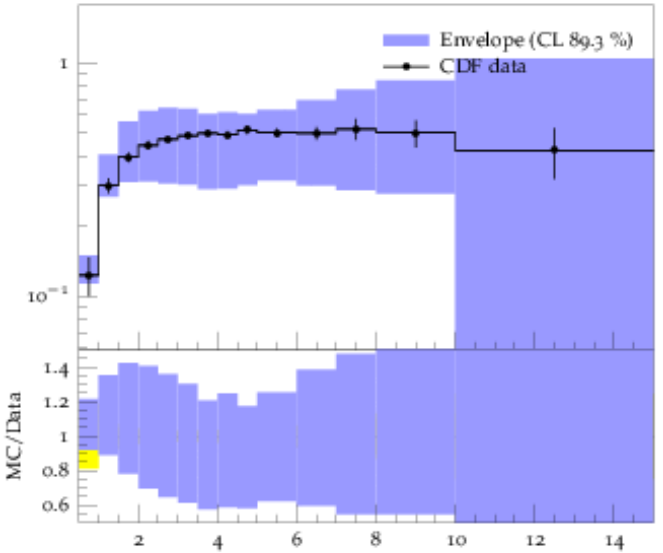
- Increased the range for PARP(77) from 1.15 to 1.2
- Matter distribution is double gaussian
- Oversampling:
  For 5 MC parameters we have 56 free coefficients in a third order polynomial.
  It is advised to use a oversampling factor of 2.5.
  We use **150 MC parameter combination .**

Pythia6 parameter	description	Tuning range	Z2*lep
PARP(82)	p_t^0	1.60 – 2.20	1.924
PARP(77)	Fast string CR	0.25 – 1.2	1.016
PARP(78)	CR strength	0.20 – 0.80	0.538
PARP(90)	p_t^0 $\sqrt{s}$ ev. exp.	0.18 – 0.28	0.227
PARP(83)	matter distribution	0.1 – 1.0	0.356

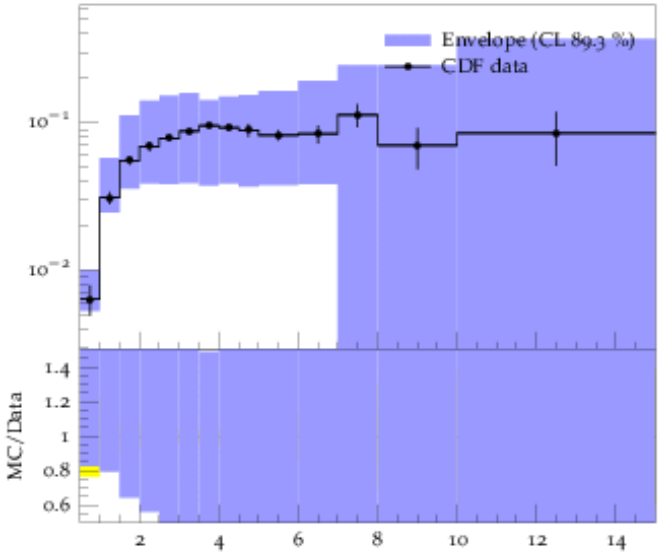
Envelope 300GeV



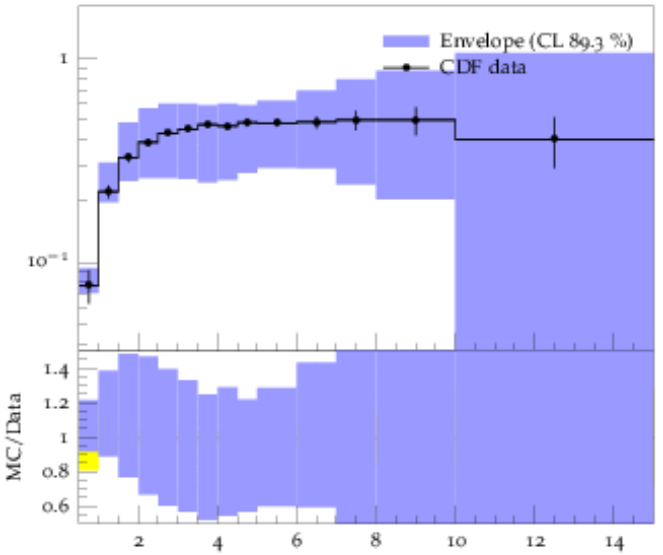
TransMIN charged particle density



TransMAX charged particle density



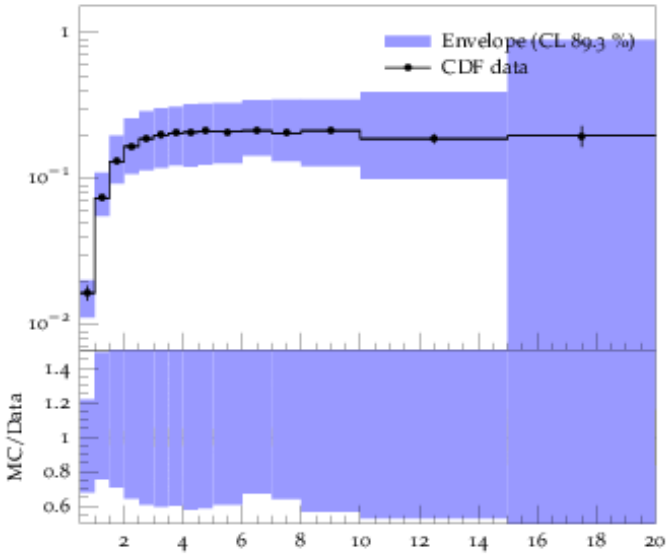
TransMIN charged pTsum density



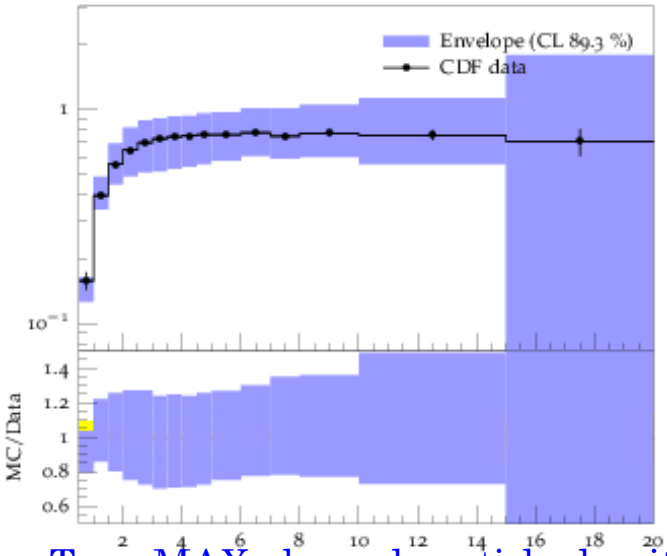
TransMAX charged pTsum density

- Envelope from 150 different parameters
- 89.3% CL
- Data is covered by the envelope

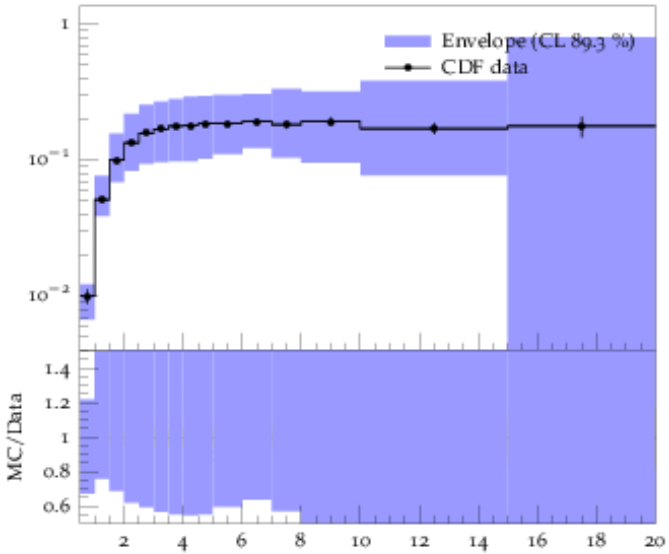
Envelope 900GeV



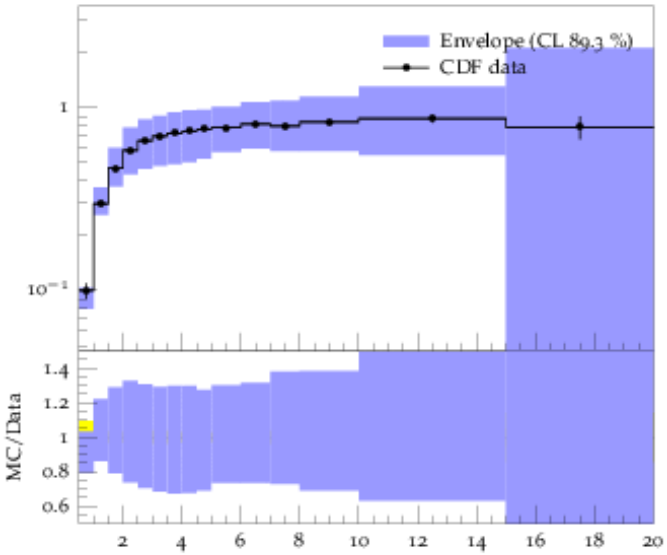
TransMIN charged particle density



TransMAX charged particle density



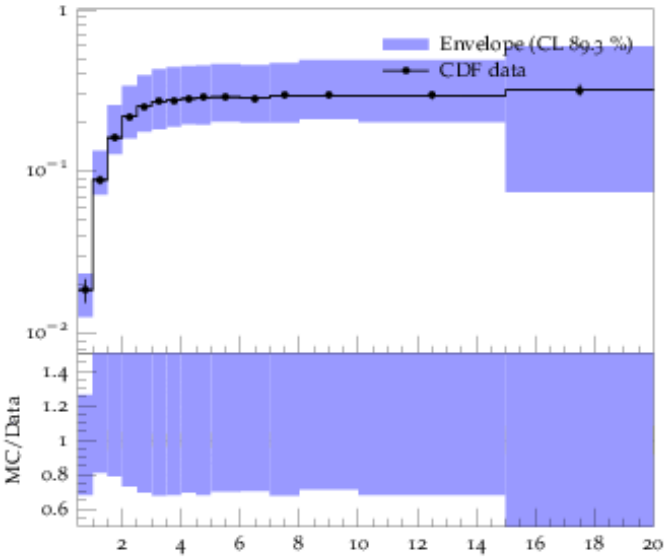
TransMIN charged pTsum density



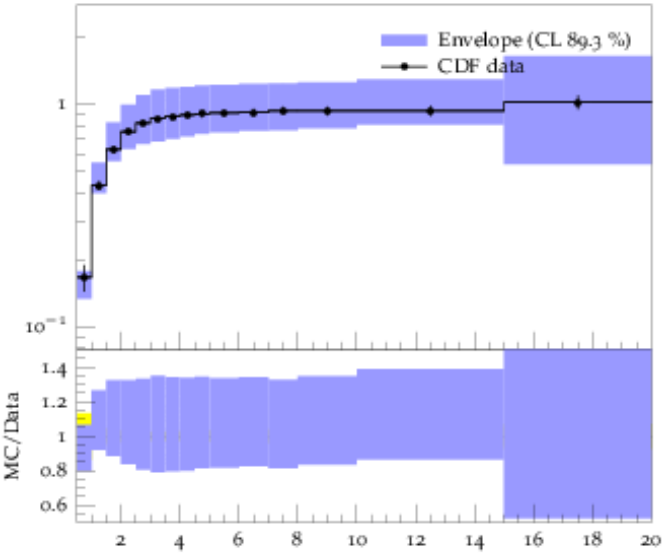
TransMAX charged pTsum density

- Envelope from 150 different parameters
- 89.3% CL
- Data is covered by the envelope

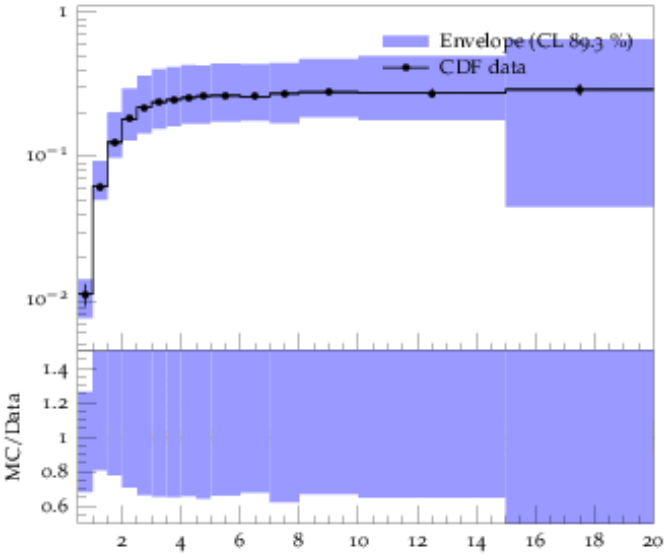
Envelope 1960GeV



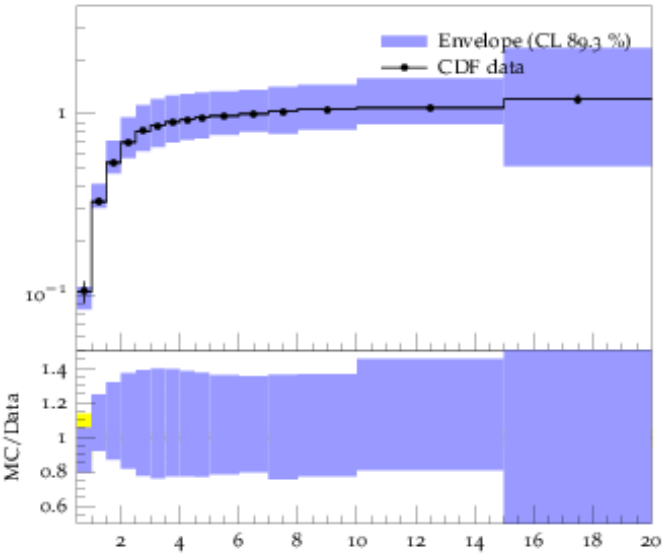
TransMIN charged particle density



TransMAX charged particle density



TransMIN charged pTsum density



TransMAX charged pTsum density

- Envelope from 150 different parameters
- 89.3% CL
- Data is covered by the envelope

Best Fit Tune

Professor output:

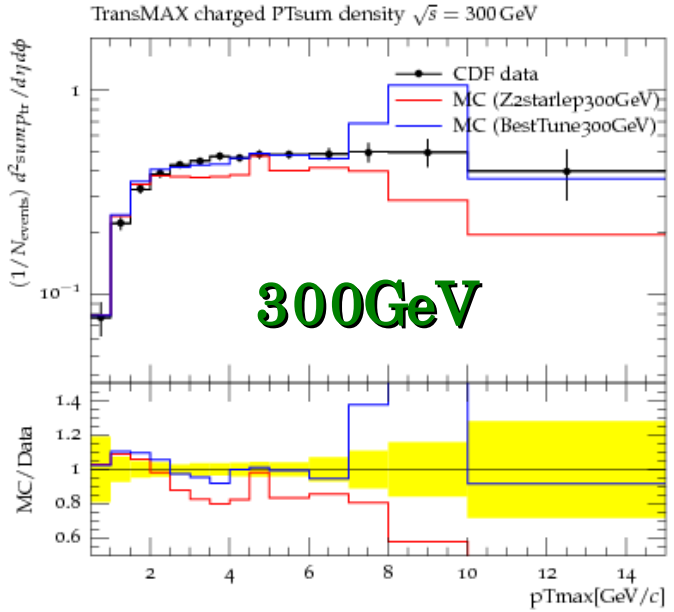
The parameter space given by 150 MC predictions is interpolated with a polynomial.

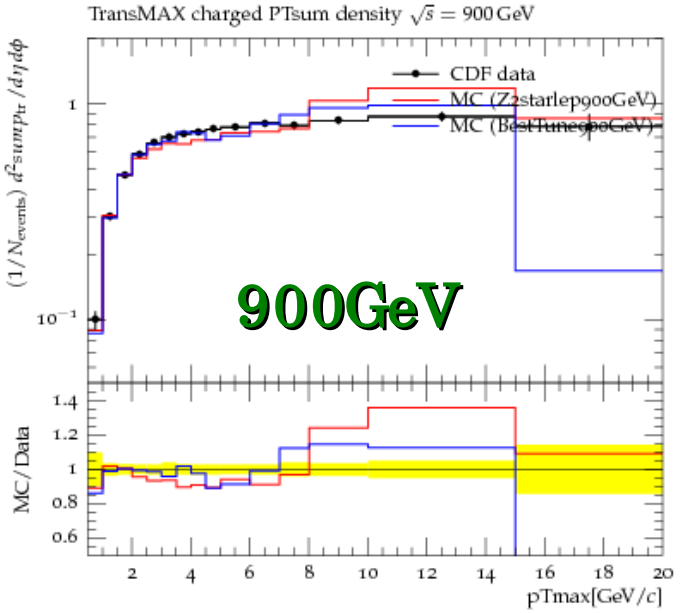
The polynomial is tuned to describe the data, which gives the tuned parameter values.

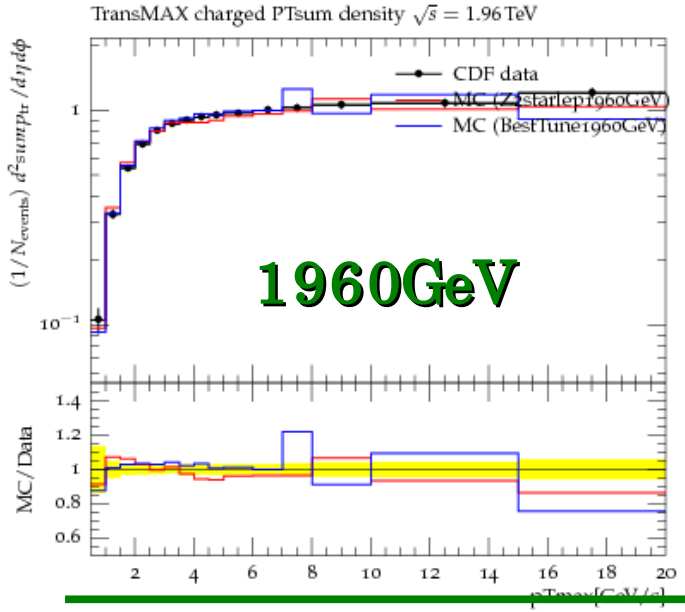
Pythia6 parameter	description	Tuning range	Z2*lep	BestFit Tune
PARP(82)	p_t^0	1.60 – 2.20	1.924	1.926082
PARP(77)	Fast string CR	0.25 – 1.15	1.016	0.3814870
PARP(78)	CR strength	0.20 – 0.80	0.538	0.3398941
PARP(90)	p_t^0 $\sqrt{s}$ ev. exp.	0.18 – 0.28	0.227	0.2416086
PARP(83)	matter distribution	0.10 – 1.0	0.356	0.6315722

Best Fit Tune vs Z2*lep

TransMAX charged pTsum density







— Z2*lep

— best Fit Tune

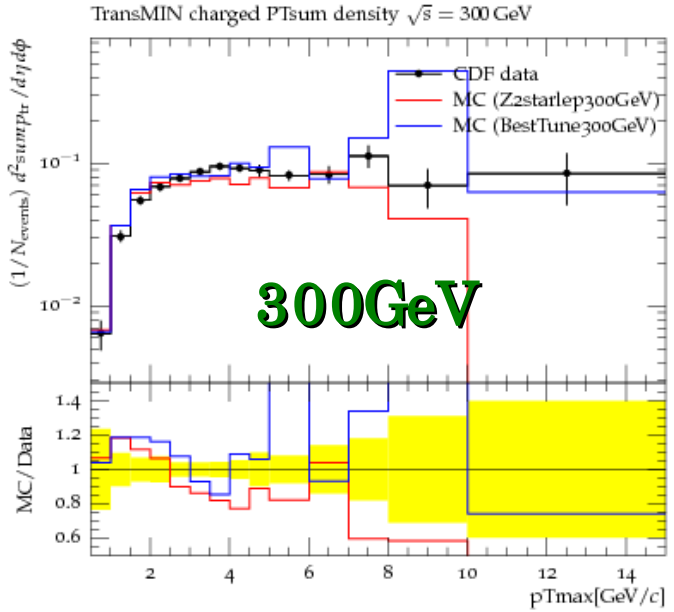
- Dependence in cme is applied

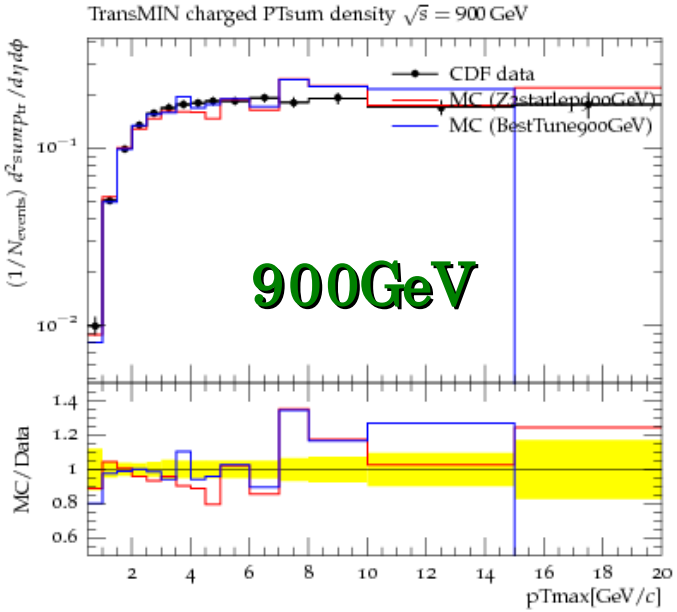
- Better description for Higher cme

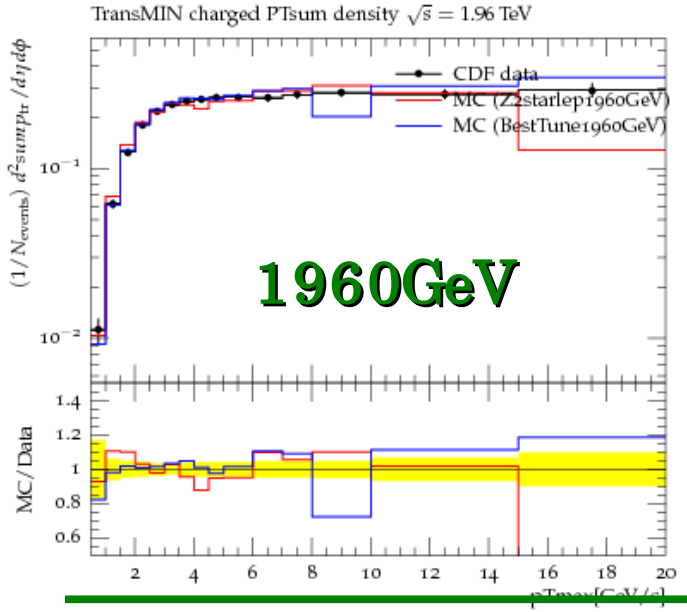
- Need more statistics At 300GeV

Best Fit Tune vs Z2*lep

TransMIN charged pTsum density







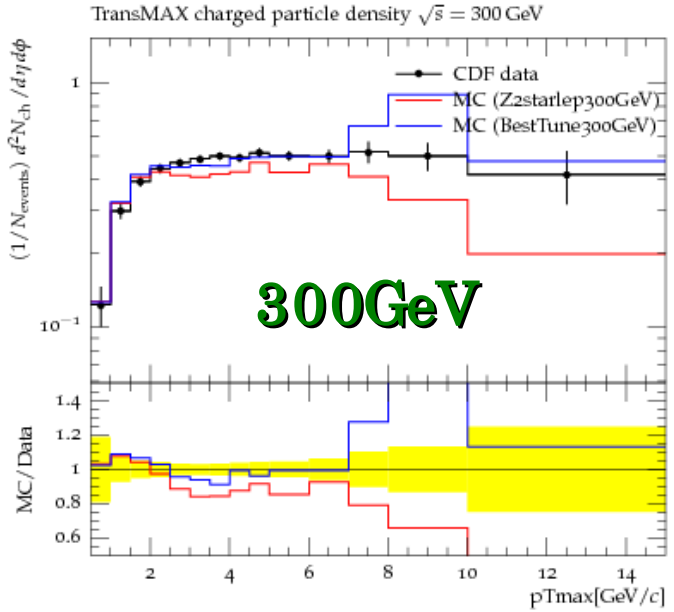
— Z2*lep

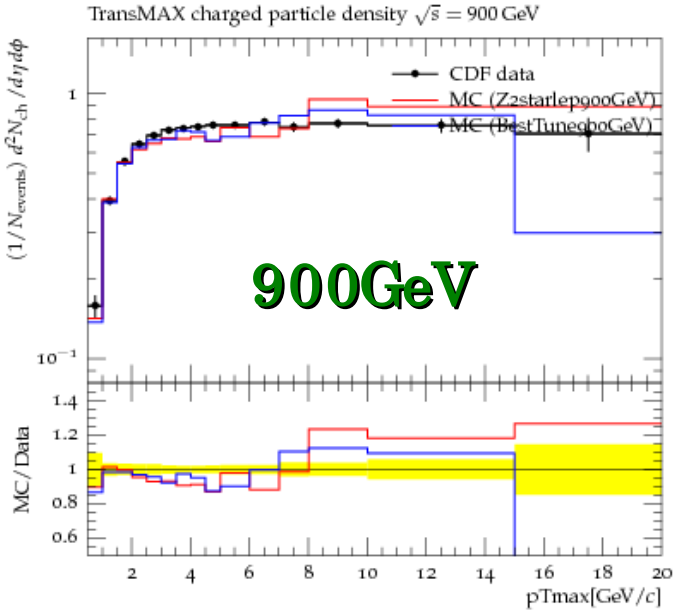
— best Fit Tune

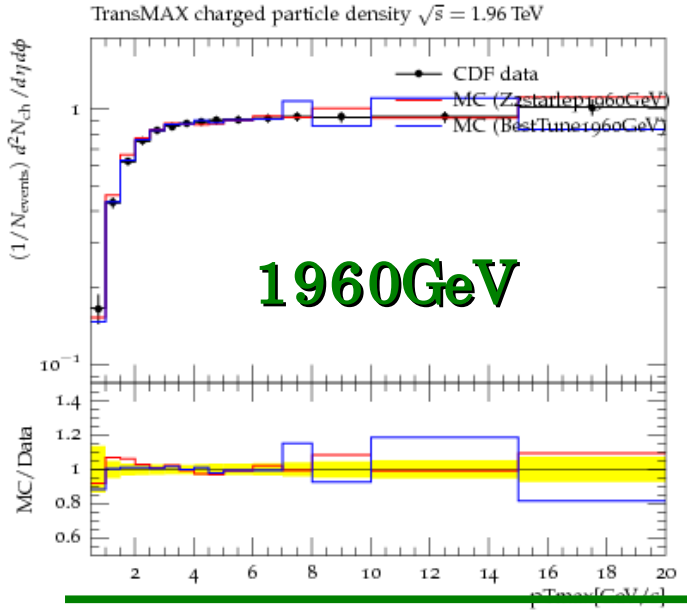
- Dependence in cme is applied

Best Fit Tune vs Z2*lep

TransMAX charged particle density







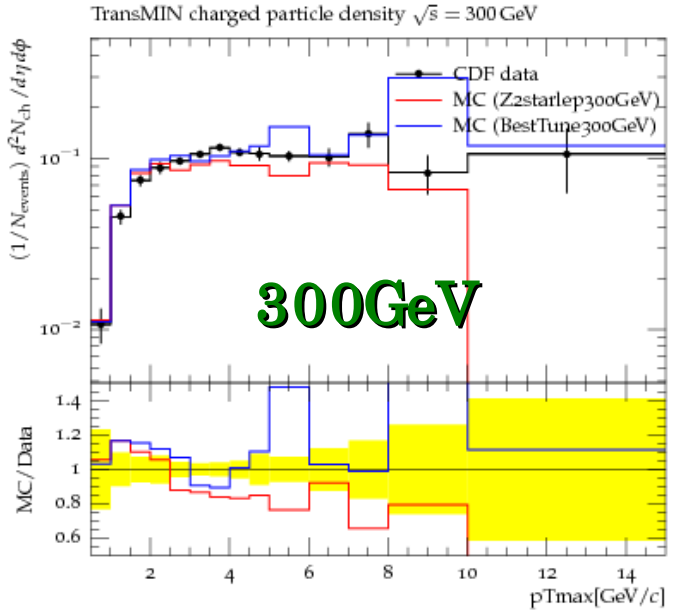
— Z2*lep

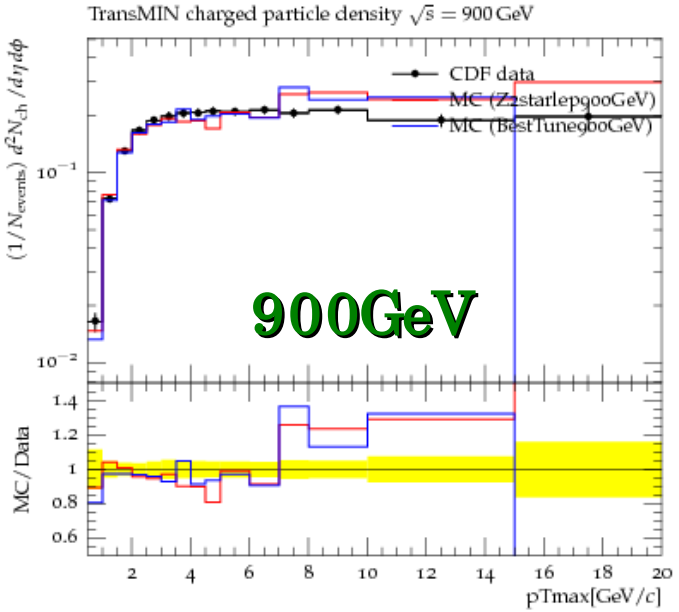
— best Fit Tune

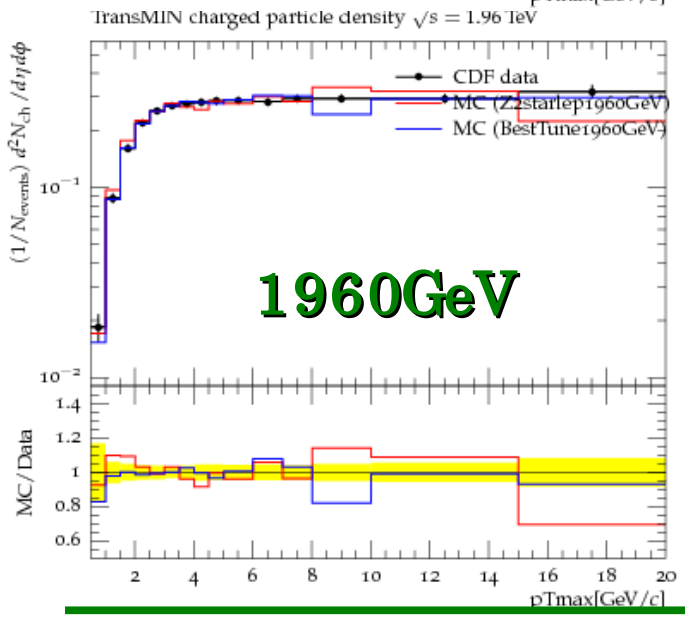
- Dependence in cme is applied

Best Fit Tune vs Z2*lep

TransMIN charged particle density







— Z2*lep

— best Fit Tune

- Dependence in cme is applied

Further Steps

- Check if merging the aida files for different cme gives the same result
- Run with more statistics to get a better discribtion for the 300 and 900GeV
- Just fit the histograms TransMax and TransMin and compare to Ave and Diff (they should be dependent, it is not necessary to interpolate to all)
- Include also different PDF (HERA PDF LO)

Backup

Pyhtia Input Z2*lep

```
'MSEL=0        ! User defined processes',
'MSUB(11)=1    ! Min bias process',
'MSUB(12)=1    ! Min bias process',
'MSUB(13)=1    ! Min bias process',
'MSUB(28)=1    ! Min bias process',
'MSUB(53)=1    ! Min bias process',
'MSUB(68)=1    ! Min bias process',
'MSUB(92)=1    ! Min bias process, single diffractive',
'MSUB(93)=1    ! Min bias process, single diffractive',
'MSUB(94)=1    ! Min bias process, double diffractive',
'MSUB(95)=1    ! Min bias process'
```

```
   'MSTU(21)=1     ! Check on possible errors during program execution',
   'MSTJ(22)=2     ! Decay those unstable particles',
   'PARJ(71)=10 .  ! for which ctau  10 mm',
   'MSTP(33)=0     ! no K factors in hard cross sections',
   'MSTP(2)=1      ! which order running alphaS',
   'MSTP(51)=10042 ! structure function chosen (external PDF CTEQ6L1)',
   'MSTP(52)=2     ! work with LHAPDF',
'PARP(82)=1.921 ! pt cutoff for multiparton interactions',
   'PARP(89)=1800. ! sqrts for which PARP82 is set',
'PARP(90)=0.227 ! Multiple interactions: rescaling power',
   'MSTP(95)=6     ! CR (color reconnection parameters)',
'PARP(77)=1.016 ! CR',
'PARP(78)=0.538 ! CR',
   'PARP(80)=0.1   ! Prob. colored parton from BBR',
'PARP(83)=0.356 ! Multiple interactions: matter distribution parameter',
   'PARP(84)=0.651 ! Multiple interactions: matter distribution parameter',
   'PARP(62)=1.025 ! ISR cutoff',
   'MSTP(91)=1     ! Gaussian primordial kT',
   'PARP(93)=10.0  ! primordial kT-max',
   'MSTP(81)=21    ! multiple parton interactions 1 is Pythia default',
   'MSTP(82)=4     ! Defines the multi-parton model' ,
#Z2star lep
   'PARJ(1) =  0.08 ! HAD diquark suppression',
   'PARJ(2) = 0.21 ! HAD strangeness suppression',
   'PARJ(3) = 0.94 ! HAD strange diquark suppression',
   'PARJ(4) = 0.04 ! HAD vectior diquark suppression',
   'PARJ(11) = 0.35 ! HAD P(vector meson), u and d only',
   'PARJ(12) = 0.35 ! HAD P(vector meson) contains ',
   'PARJ(13) = 0.54 ! HAD P(vector meson), heavy quarks',
   'PARJ(21) = 0.34 ! HAD fragmentation pt',
   'PARJ(25) = 0.63 ! HAD eta0 suppression',
   'PARJ(26) = 0.12 ! HAD eta0 suppression'
```