CMS related tuning activities

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Tunes to UE and forward energy flow data from CMS.
Start up of tuning in CMS.

- **Pythia 6 – the Z2* and Z2f tune**
- **Pythia 8 – the 4C* and 4Cf tune**

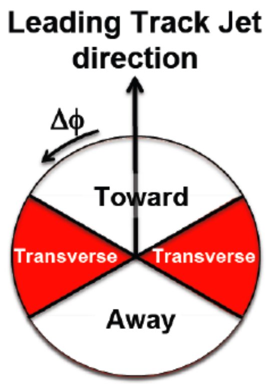
Preliminary results.
Work in progress...
Results not CMS approved.

Data

- **Data for Z2* and 4C*:**

  The **traditional UE measurement** (a la Tevatron), in the central region by CMS at 0.9 and 7 TeV. *(CMS-QCD-10-010)*

  Measurement of activity transverse to the leading charged particle jet.



- **Data for Z2f and 4Cf:**

  The **energy flow in the forward region** (3.15<|η|<4.9) **in bins of rapidity**, measured by CMS at s=0.9 and 7 TeV. *(CMS-FWD-10-011)*

  Measured in both MB and di-jet events.

The Z2 and Z2f*

The Z2, Z2* and Z2f Tunes

- **Z1 – CTEQ5L**
  Based on Professor tunes with ATLAS MB data.
  Manual retune of MI parameters by Rick Field.

- **Z2 – CTEQ6L**
  Manual retune of Z1 for CTEQ6L. By Rick Field.

- **Z2* and Z2f (in this talk) – use automated tuning (PROFESSOR) to retune:**

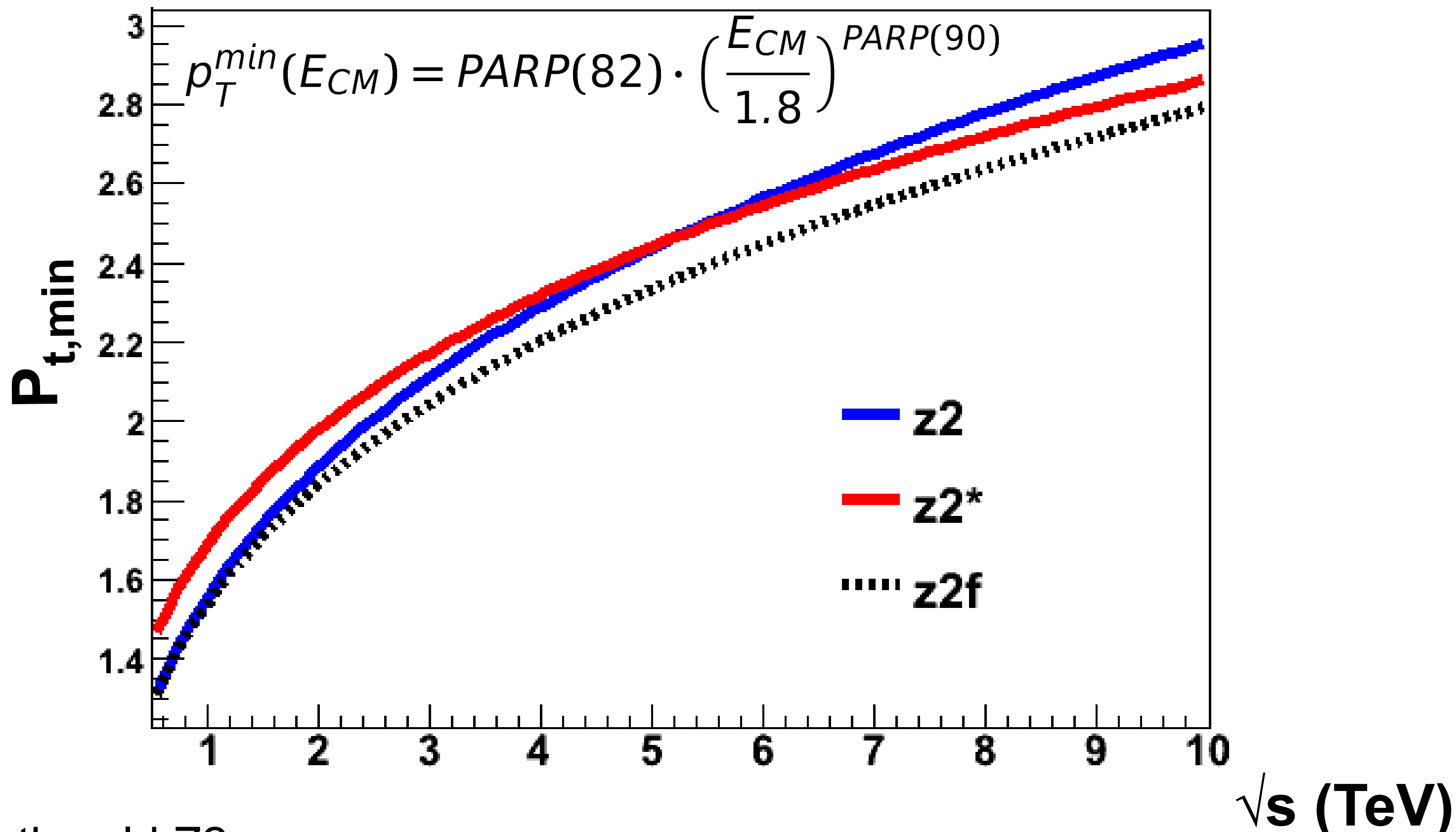
  PARP(82) – Cut off for MPI

  PARP(90) – Extrapolation of energy dependence

$$p_T^{min}(E_{CM}) = PARP(82) \cdot \left(\frac{E_{CM}}{E_{ref}}\right)^{PARP(90)}$$

Results – Z2* and Z2f

	Tuning Range	Z2	Z2* (UE)	Z2f (Forward)
PARP(82)	1.0 - 3.0	1.83	1.93	1.79
PARP(90)	0.0 - 0.4	0.28	0.23	0.26

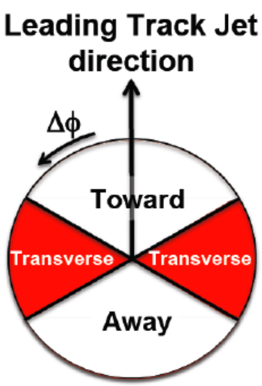


Compared to the old Z2:

- Z2* increases the activity at 7 TeV (lower pt-cut)
  Z2* decreases the activity at 0.9 TeV (higher pt-cut)

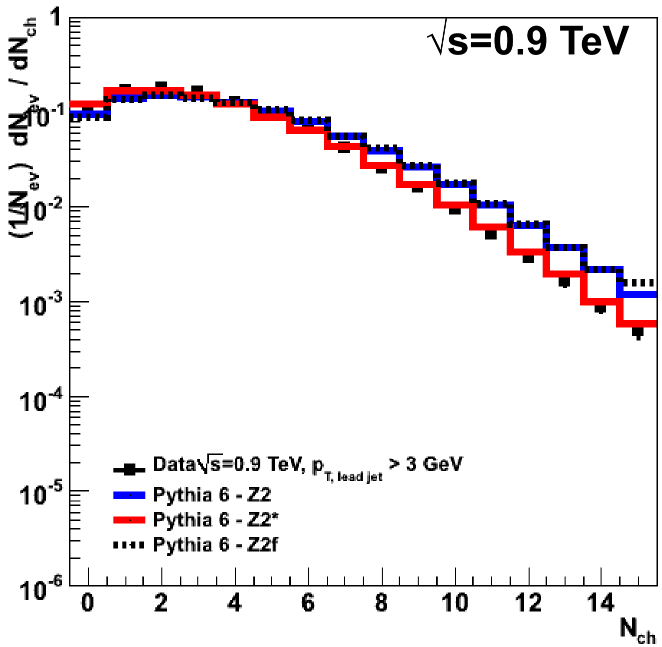
- Z2f does not much at 0.9 TeV, but will increase the activity at 7 TeV.

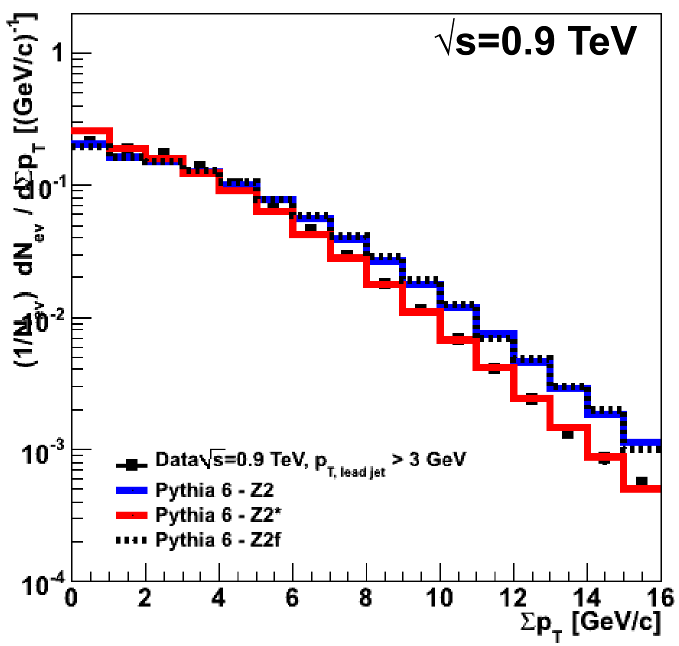
Transverse Particle Distributions – 0.9 TeV

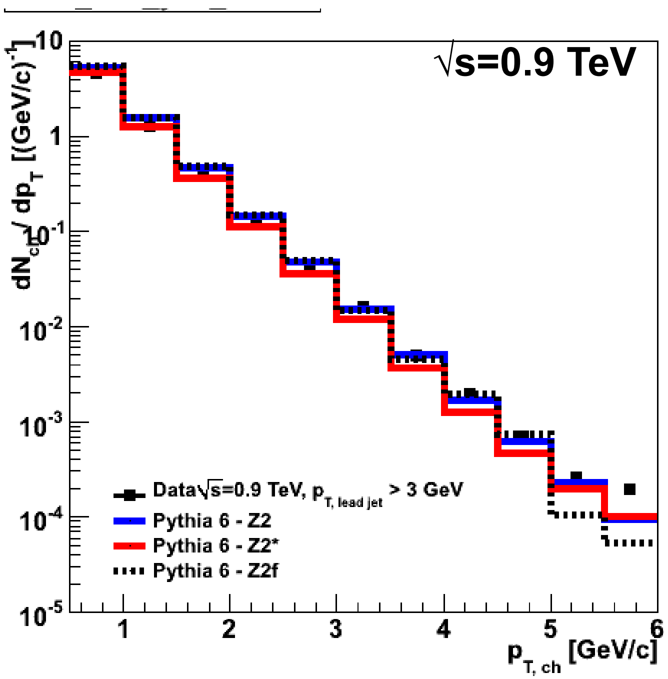


Comparisons ot data used in the Z2* tune....

	Tuning Range	Z2	Z2* (UE)	Z2f (Forward)
PARP(82)	1.0 - 3.0	1.83	1.93	1.79
PARP(90)	0.0 - 0.4	0.28	0.23	0.26







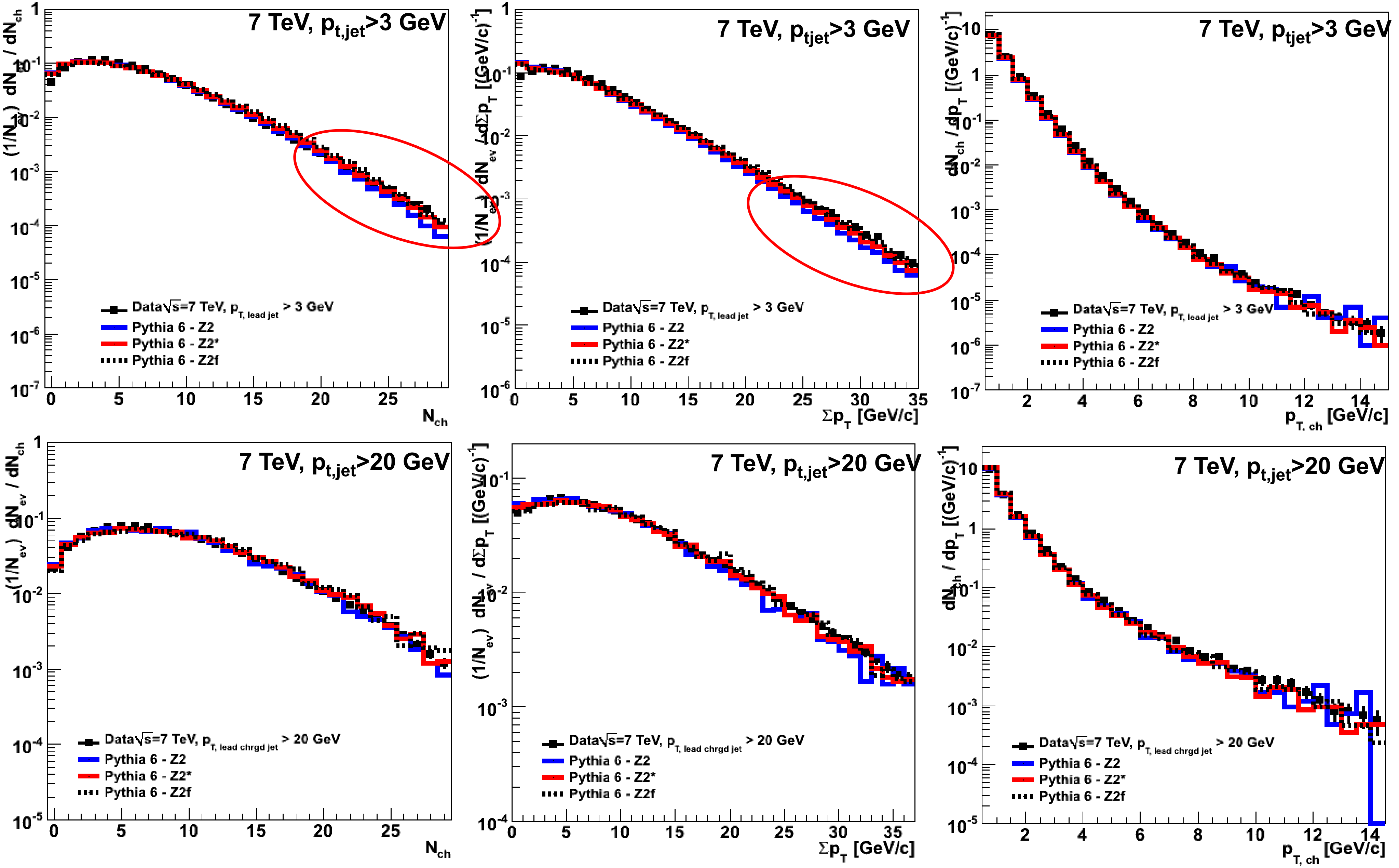
Z2*: Big improvement in the tails of N_{ch} and $\sum p_t$.

Z2f: No big difference to original Z2.

Blue: Z2
Red dashed: Z2*
Black dashed: Z2f

Transverse Particle Distributions – 7 TeV

Blue: Z2 ~~Red dashed: Z2*~~ Black dashed: Z2f



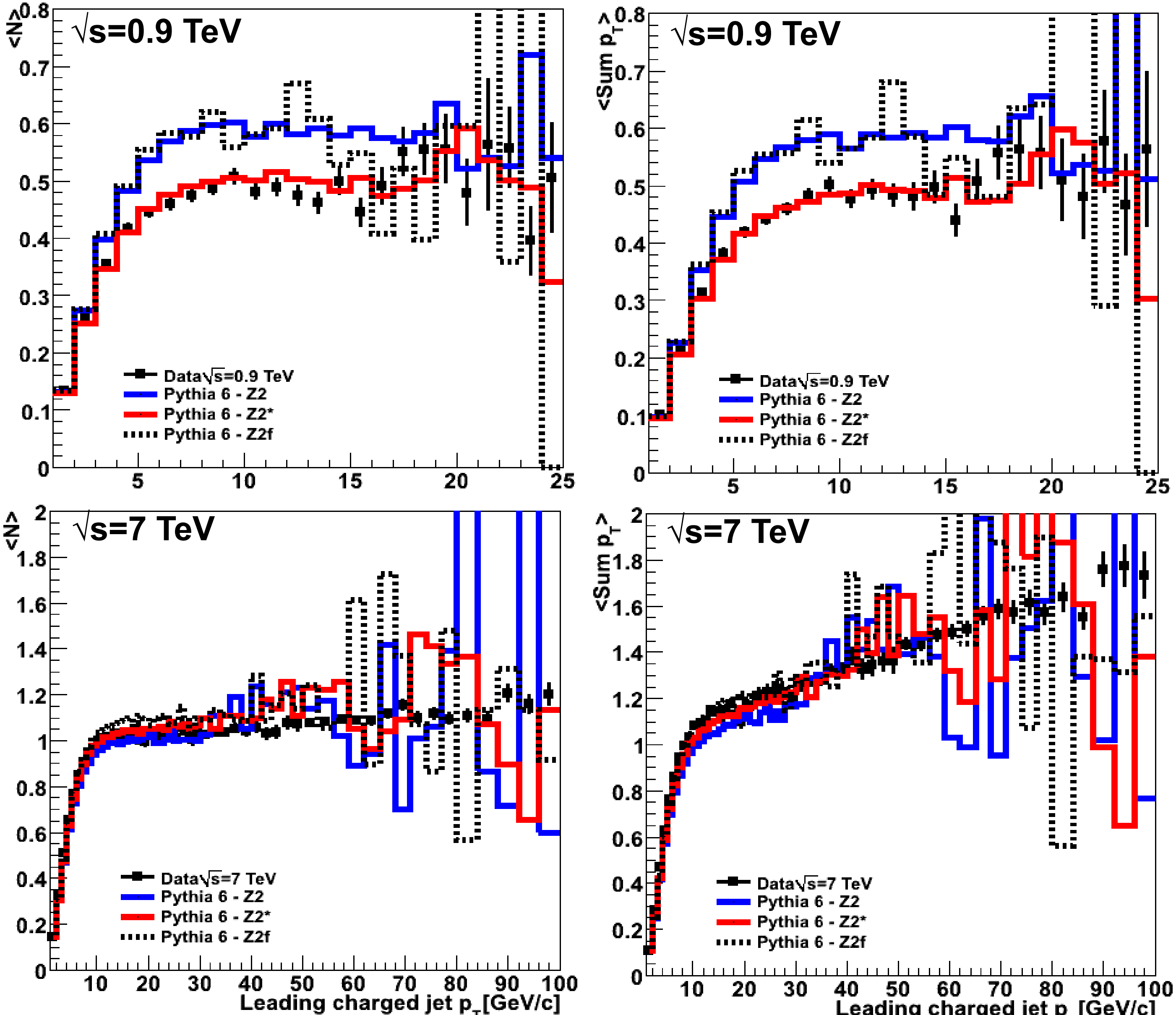
Z2*: Improvement in the tails for the $P_{t,jet}$>3 GeV events.

Z2f: Somewhat higher activity in the tails comp Z2.

Higher activity = lower P_T cut.

Compare 0.9 TeV: Energy dependence...

<N> and Σp_t vs $P_{t,lead}$ – Z2* and Z2f



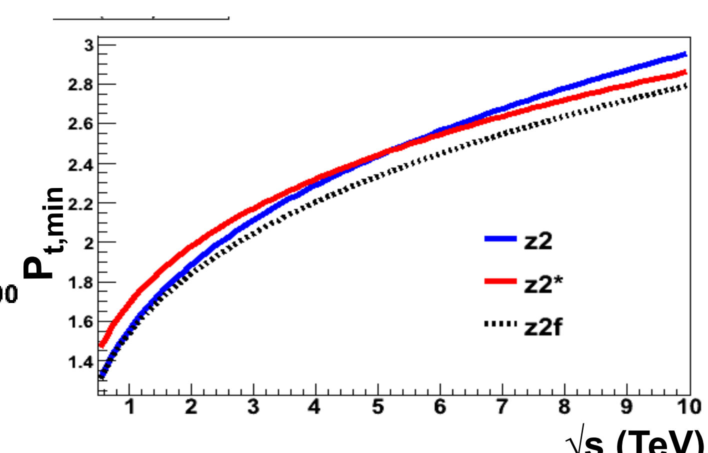
Z2*:
Significant improvement, especially for the 0.9 TeV data.

More activity in the 0.9 TeV data. Somewhat lower activity in the 7 TeV.

Z2f:
No difference for the 0.9 TeV data.

Too much <N> at 7 TeV. Good for Σp_t at 7 TeV.

(Sorry for the low stat, we are working on that.)



Blue: Z2 **Red dashed: Z2*** **Black dashed: Z2f**

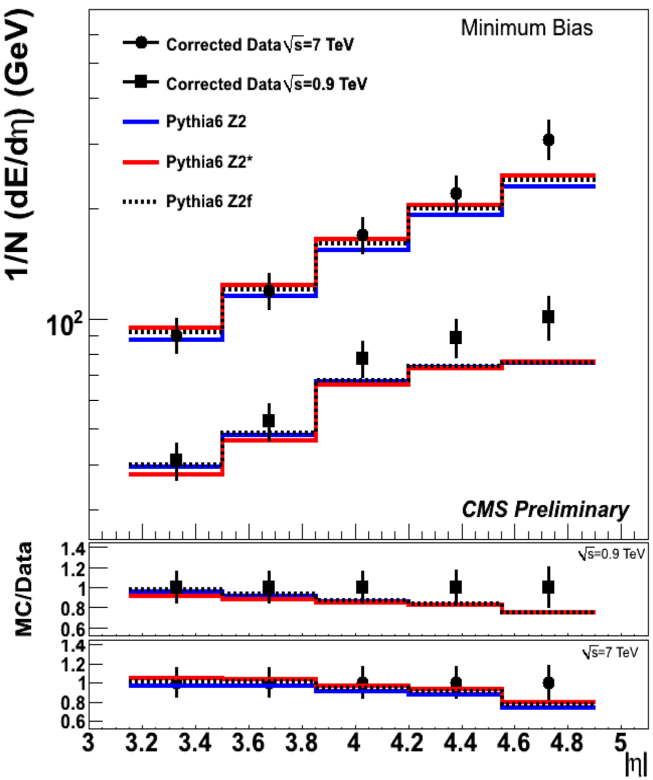
Forward Energy Flow – Z2* and Z2f

Comparison to data used in the Z2f tune.
Energy flow in the forward region (3.14 < |η| < 4.9)

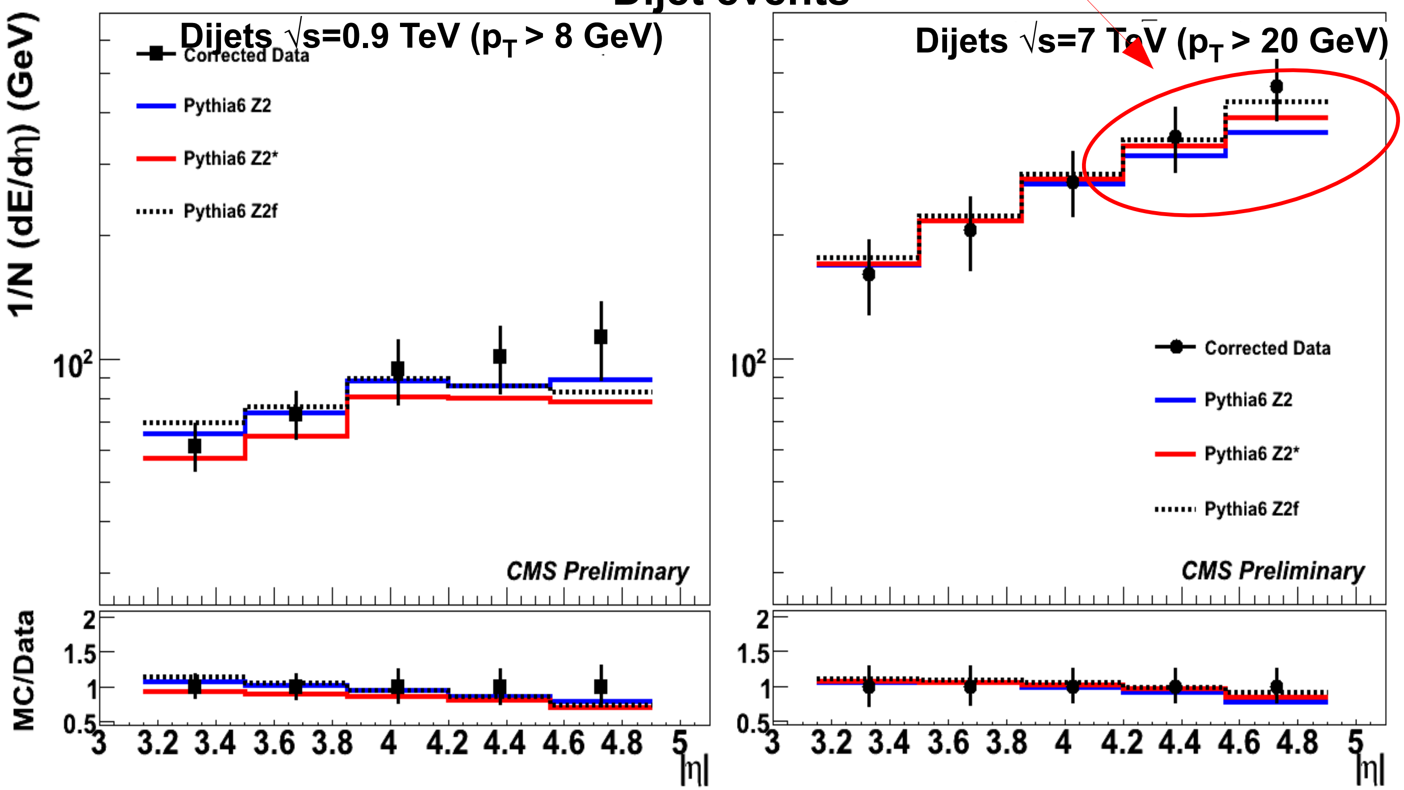
Very little differerence between tunes.

- MB: No difference between Z2, Z2* and Z2f
- Dijets@0.9TeV: Tiny difference between Z2 and Z2f. Z2* somewhat worse.
- Dijets@7TeV: Z2f and Z2* improve data description *little* at high |η|.

MB events



Dijet events



The 4C* and 4Cf tunes

The Pythia 8 – Tune 4C* and 4Cf

- **Tune 2C:** Tune to CDF data. Mix of manual tuning and automated tuning.

- **Tune 4C:** Based on 2C, but with SD reduced data from ATLAS included.
  [Cork, Sjöstrand, arXiv:1011.1759]

- **Tune 4C* and 4Cf (this talk).**
  We use CTEQ6L and CMS data, and retune the following parameters:

- **`MultipleInteractions:pT0Ref`**
  Cut off for MPI (analog to PARP(82) in Py6 Z2* tune)

- **`MultipleInteractions:ecmPow`**
  Extrapolation of energy dependence (analog to PARP(90) in Py6 Z2* tune)

$$p_T^{min} = pT0Ref \cdot \left(\frac{E_{CM}}{E_{ref}}\right)^{ecmPow}$$

- **`MultipleInteractions:expPow`**
  Matter distribution
  Gives the matter overlap between colliding protons. exp(- b^expPow)

- **`BeamRemnants:reconnectRange`**
  Gives the color reconnection probability
  for a system with pT to be merged with a higher pT system
  (probability according to pT0_Rec^2 / (pT0_Rec^2 + pT^2)
  where pT0_Rec = reconnectRange * pTmin)

Results – 4C* and 4Cf

parameter	tuning range	4C	4C* (UE)	4Cf (Forward)
pT0Ref	1.0 - 3.0	2.09	1.95	1.99
ecmPow	0.0 - 0.4	0.19	0.17	0.21
expPow	0.4 - 10.0	2.0	3.2	3.0
reconnectRange	0.0 - 9.0	1.5	4.7	3.05

Somewhat different P_t-cut, but

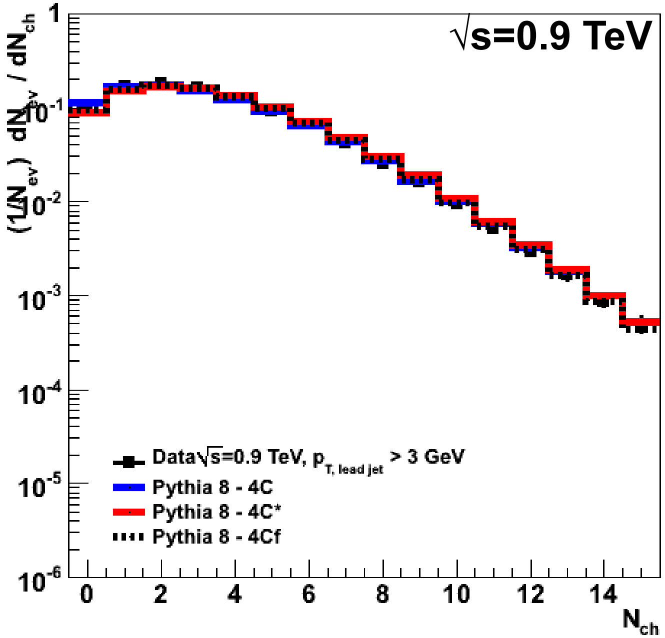
biggest change compared to original 4C is

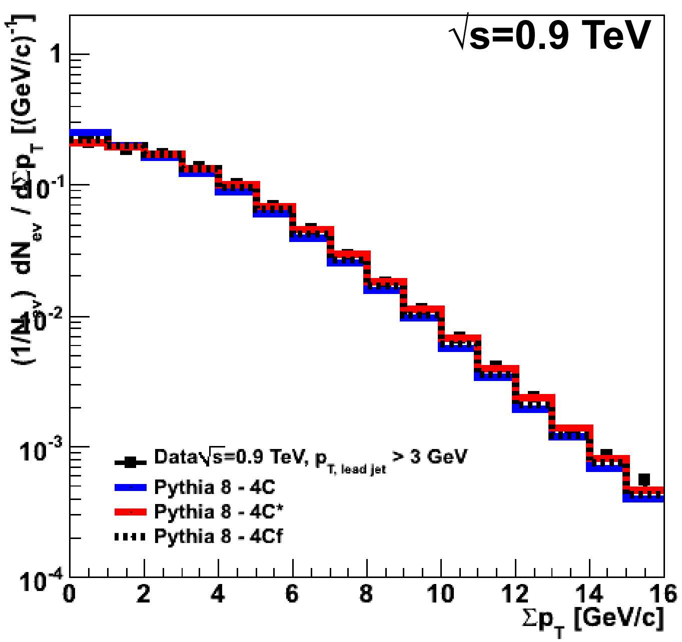
the matter overlap and the color reconnection.

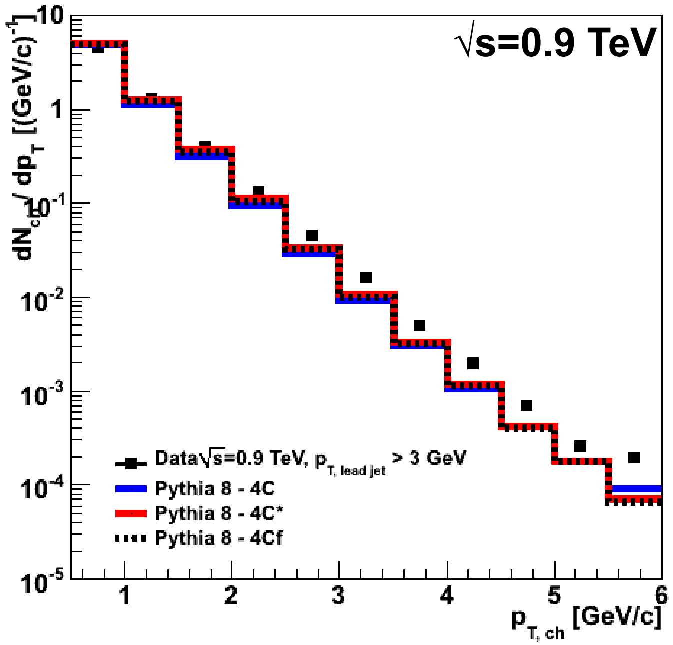
Results – Particle Distributions – 0.9 TeV

parameter	tuning range	4C	4C*	4Cf
pT0Ref	1.0 - 3.0	2.09	1.95	1.99
ecmPow	0.0 - 0.4	0.19	0.17	0.21
expPow	0.4 - 10.0	2.0	3.2	3.0
reconnectRange	0.0 - 9.0	1.5	4.7	3.05

Particle distributions in the regions transverse to the leading track jet.





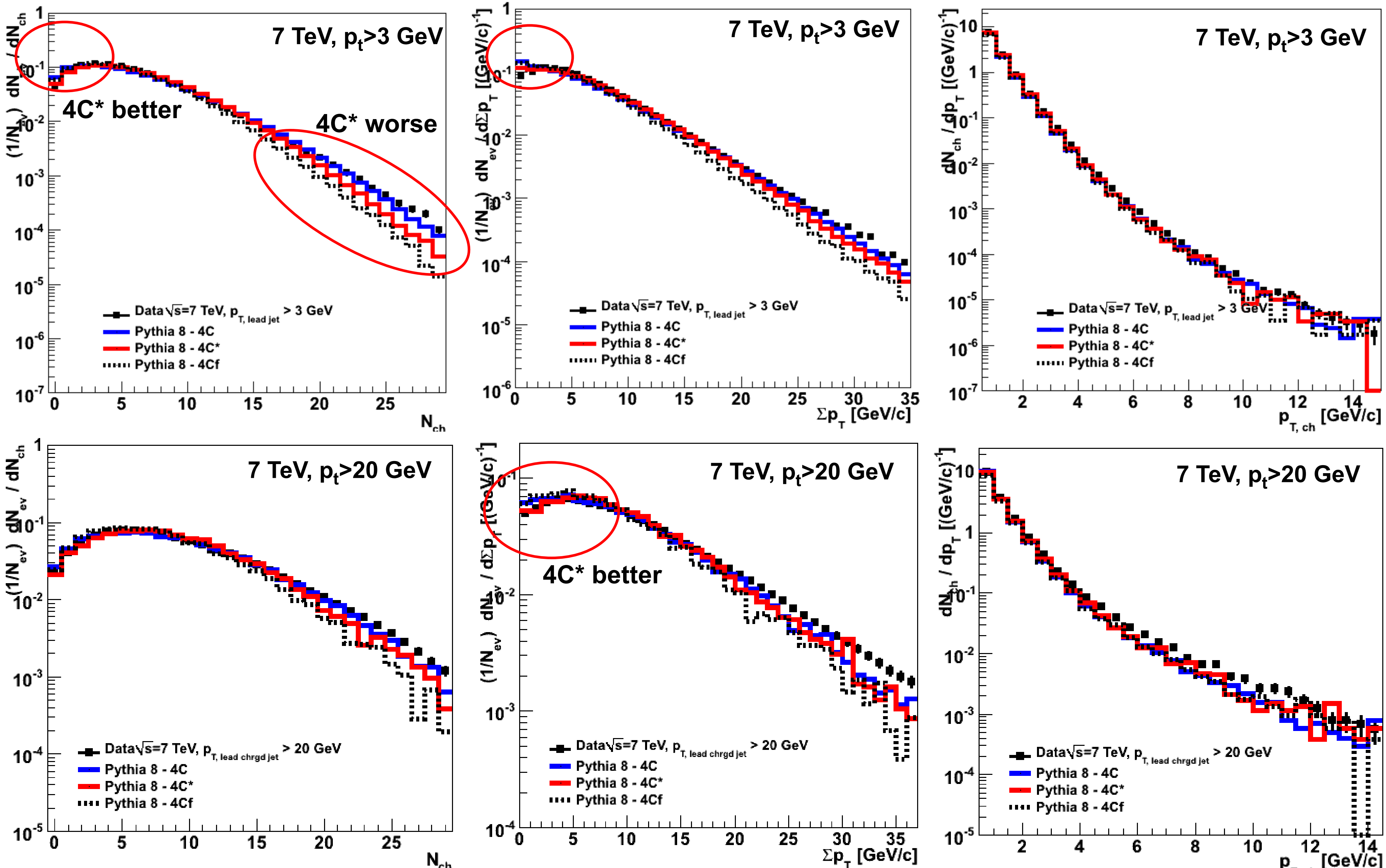


4C* seems to be somewhat better in the tail of $\sum p_t$.
Visually, very small difference between the tunes.

Blue: 4C
Red: 4C*
Black dashed: 4Cf

Results – Particle Distributions – 7 TeV

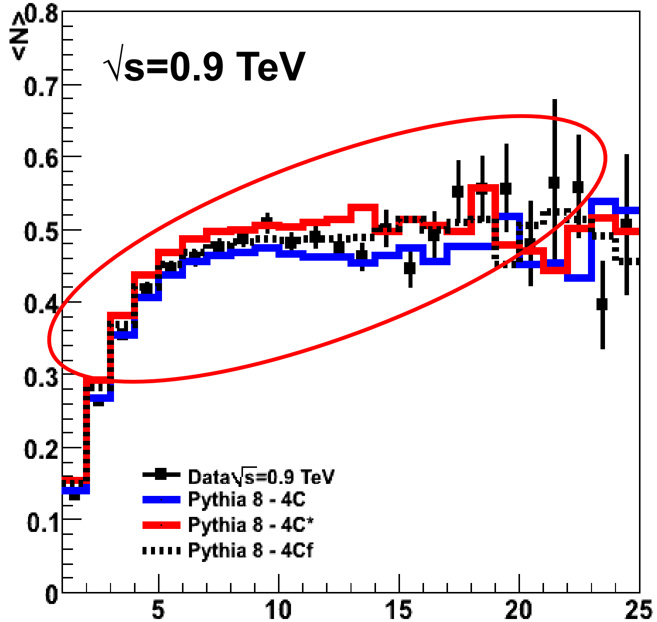
Blue: 4C **Red: 4C*** **Black dashed: 4Cf**

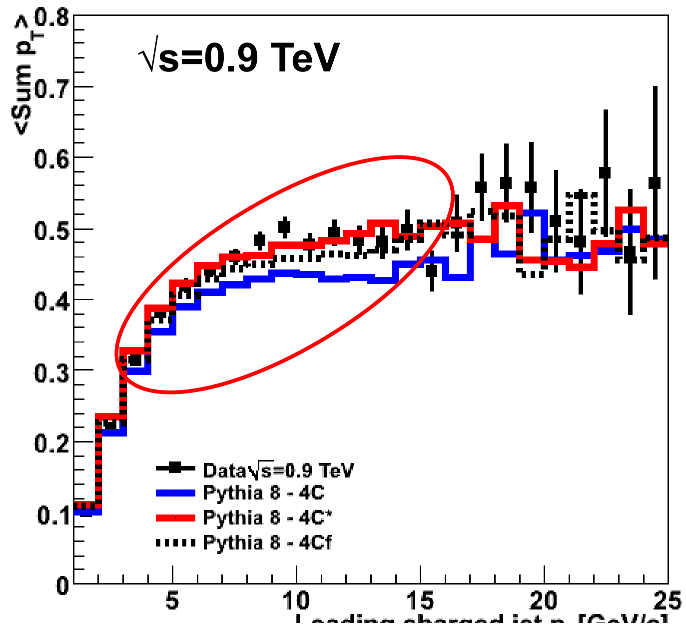


Most significant change is in N_{ch} for low pt jet events. Also at low $\sum p_t$ 4C* makes a difference.

<N> and Σp_t vs $P_{t,lead}$ – Z2* and Z2f

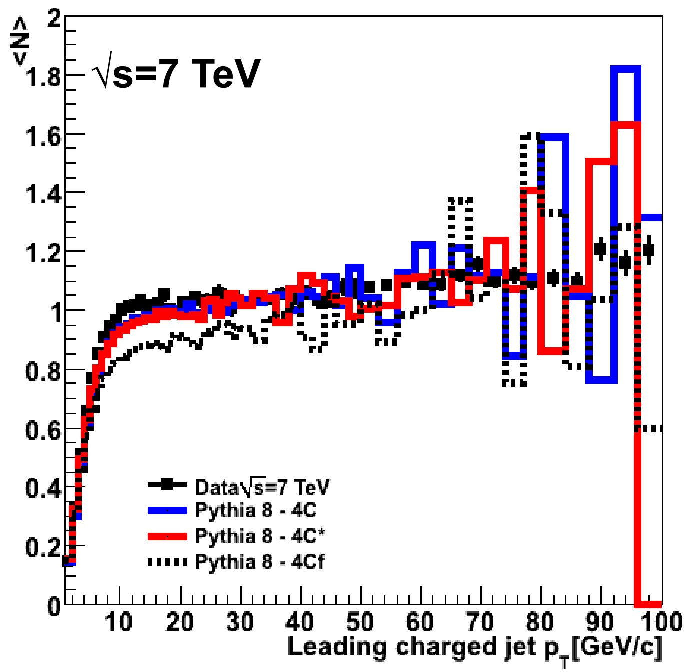
Blue: 4C Red: 4C* Black dashed: 4Cf

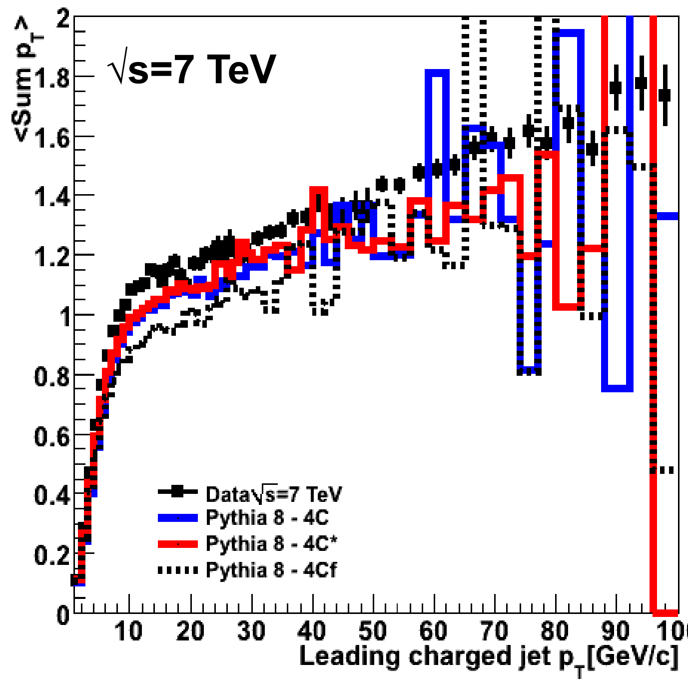




0.9 TeV:

4C* and 4Cf both give increased activity compared to 4C.
This is what we need, but N_{ch} too high in 4C*.





7 TeV:

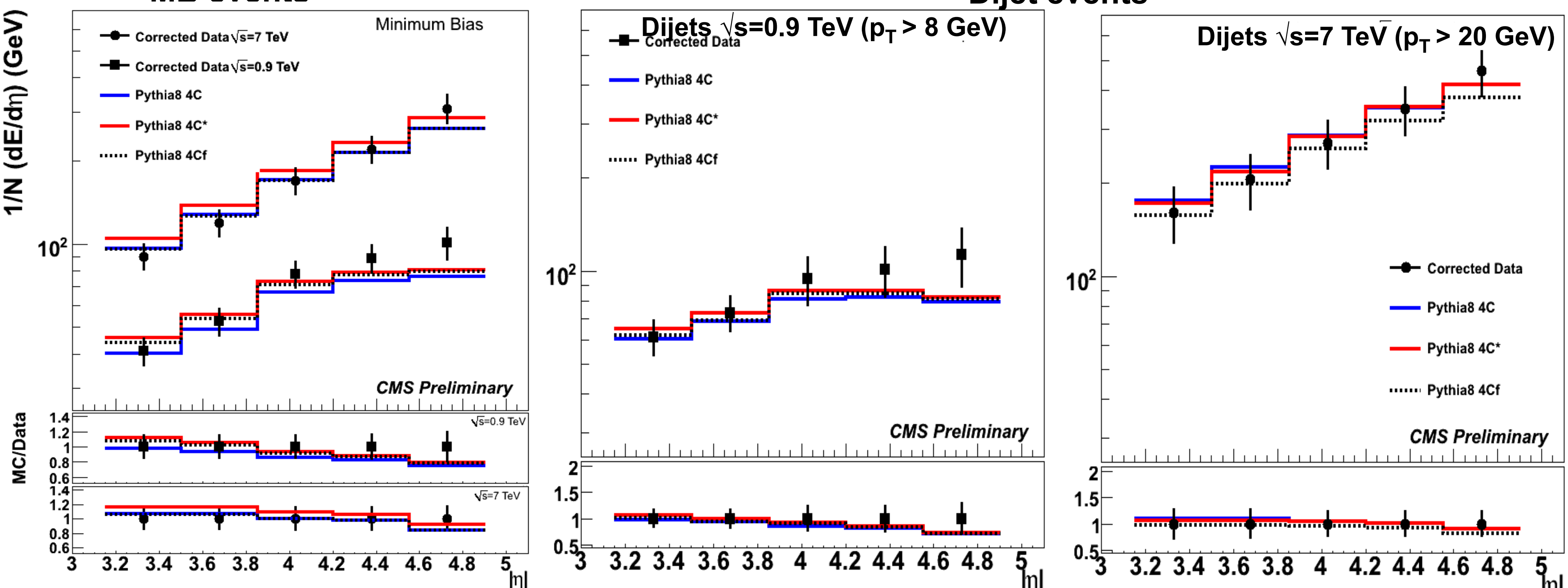
4C* – no improvement over 4C.
4Cf – too low activity.

Comparison to the Forward E-flow

parameter	tuning range	4C	4C*	4Cf
pT0Ref	1.0 - 3.0	2.09	1.95	1.99
ecmPow	0.0 - 0.4	0.19	0.17	0.21
expPow	0.4 - 10.0	2.0	3.2	3.0
reconnectRange	0.0 - 9.0	1.5	4.7	3.05

Very little sensitivity, compard to the UE measurement.
No significant difference.
Only difference comparing 4Cf to 4C is for 7 TeV dijet events.

MB events **Dijet events**



Outlook / Other activities

- Include more parameters, include more data...

- Cross-check tunes with other data (e.g. Les Houches 2011 tune killing criterias)

- Looking for manpower within CMS
  Panos Katsas and Mira Krämer has announced interest...
  E.g. strangeness tuning...

- Tune other generators

- Tuning of **HERWIG++** started at DESY.
  New dipole shower model.
  CMS+theory summer school project.
  Krzysiek Bozek (Supervised by Simon Plätzer and AK)

Summary

- **Tuning activity "within" CMS has started.** (Results not CMS approved.)

- **Pythia 6 Z2* tune to UE measumrent.**
  Clear improvement over the old Z2 tune.
  New energy dependence: Just what we needed (for the UE).
  Less transverse activity for the 0.9 TeV data, more activity for the 7 TeV data.

- **Pythia 8 4C* tune to UE measurement.**
  Improved description of data at low p_t (compared to 4C).
  But improvements not as obvious for the Z2* tune.

- **Forward tunes Z2f and 4Cf tunes to the forward energy flow measurement.**
  Little difference in forward energy flow between new and old tunes.
  Although, Z2f somewhat better description of the energy flow data at 7 TeV.

- **HERWIG++ tuning at DESY**
  New dipole shower model
  Both CMS and ATLAS data used

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Back-up

The Pythia 8 – Tune 4C

Parameter	Tune 2C	Tune 2M	Tune 4C
`SigmaProcess:alphaSvalue`	0.135	0.1265	0.135
`SpaceShower:rapidityOrder`	on	on	on
`SpaceShower:alphaSvalue`	0.137	0.130	0.137
`SpaceShower:pT0Ref`	2.0	2.0	2.0
`MultipleInteractions:alphaSvalue`	0.135	0.127	0.135
`MultipleInteractions:pT0Ref`	2.320	2.455	2.085
`MultipleInteractions:ecmPow`	0.21	0.26	0.19
`MultipleInteractions:bProfile`	3	3	3
`MultipleInteractions:expPow`	1.60	1.15	2.00
`BeamRemnants:reconnectRange`	3.0	3.0	1.5
`SigmaDiffractive:dampen`	off	off	on
`SigmaDiffractive:maxXB`	N/A	N/A	65
`SigmaDiffractive:maxAX`	N/A	N/A	65
`SigmaDiffractive:maxXX`	N/A	N/A	65

Pythia 6 – Tune Z2

PYTHIA Tune Z2

My guess!

Parameter	Tune Z1 (R. Field CMS)	Tune Z2 (R. Field CMS)
Parton Distribution Function	CTEQ5L	CTEQ6L
PARP(82) – MPI Cut-off	1.932	1.832
PARP(89) – Reference energy, E0	1800.0	1800.0
PARP(90) – MPI Energy Extrapolation	0.275	0.275
PARP(77) – CR Suppression	1.016	1.016
PARP(78) – CR Strength	0.538	0.538
PARP(80) – Probability colored parton from BBR	0.1	0.1
PARP(83) – Matter fraction in core	0.356	0.356
PARP(84) – Core of matter overlap	0.651	0.651
PARP(62) – ISR Cut-off	1.025	1.025
PARP(93) – primordial kT-max	10.0	10.0
MSTP(81) – MPI, ISR, FSR, BBR model	21	21
MSTP(82) – Double gaussion matter distribution	4	4
MSTP(91) – Gaussian primordial kT	1	1
MSTP(95) – strategy for color reconnection	6	6

Reduce PARP(82) by factor of 1.83/1.93 = 0.95
Everything else the same!

PARP(90) same
For Z1 and Z2!

Status of CMS Rivet analyses

CMS Rivet Analyses

The following Rivet analyses have been included in the official Rivet release.

- **P_t and η distributions of charged hadrons in pp collisions at √s = 0.9 and 2.36 TeV.**
  JHEP 1002:041,2010, arXiv:1002.0621 (CMS-QCD-09-010)

- **P_t and η distributions of charged hadrons in pp collisions at √s = 7 TeV.**
  Phys.Rev.Lett.105:022002,2010, arXiv:1005.3299 (CSM-QCD-10-006)

- **Charged particle multiplicities in pp interactions at √s = 0.9, 2.36, and 7 TeV.**
  JHEP 1101:079,2011, arXiv:1011.5531 (CSM-QCD-10-004)

- **Strange Particle Production in pp Collisions at √s = 0.9 and 7 TeV**
  JHEP 1105:064,2011,arXiv:1102.4282 (CMS-QCD-10-007)

- **Dijet Angular Distributions and Search for Quark Compositeness at √s = 7 TeV**
  Phys.Rev.Lett.106:201804,201, arXiv:1102.2020 (CMS-QCD-10-016)

More to come soon...