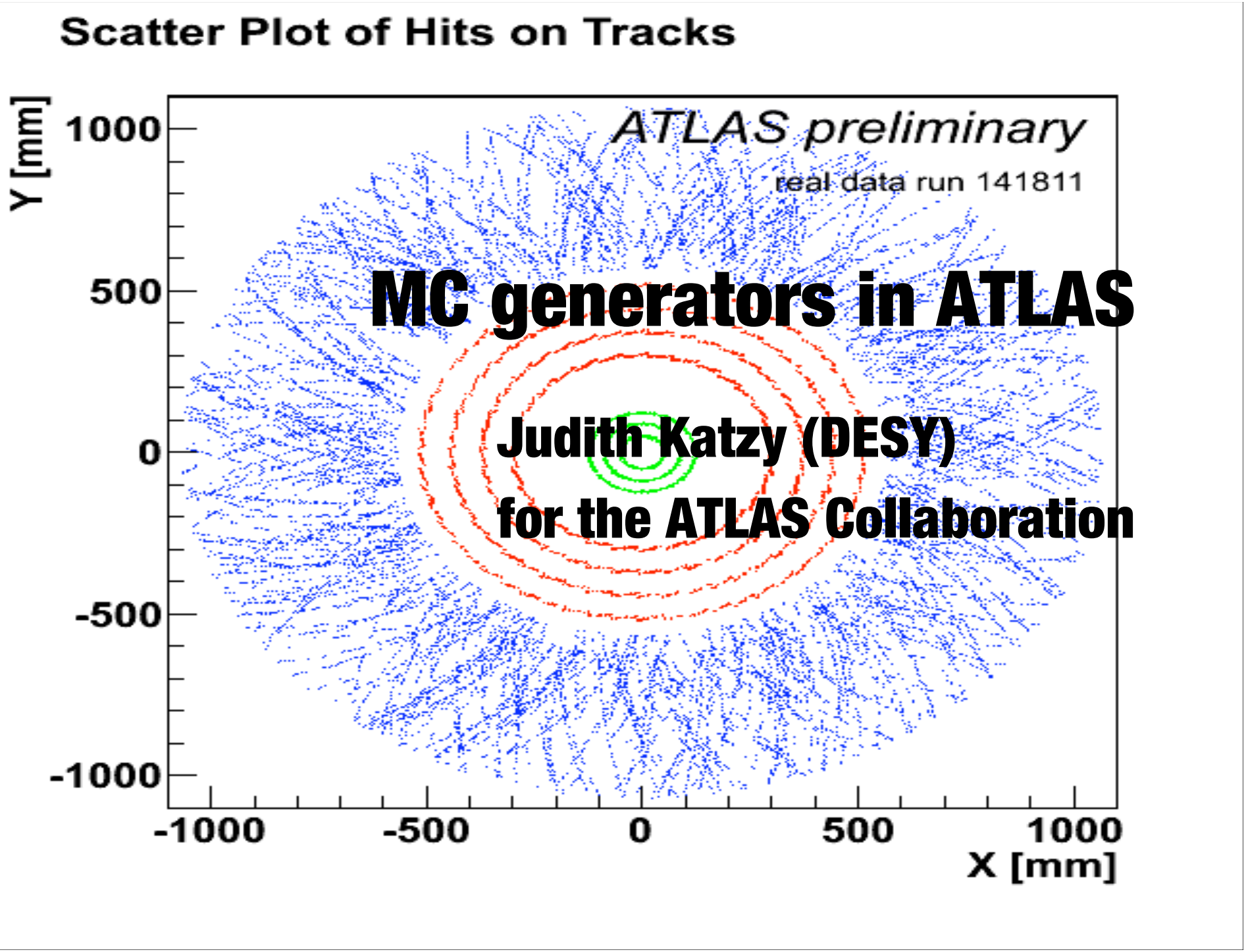
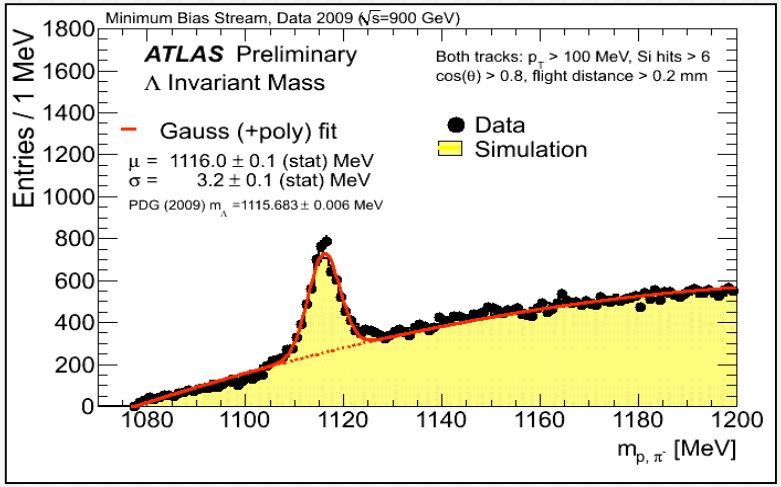


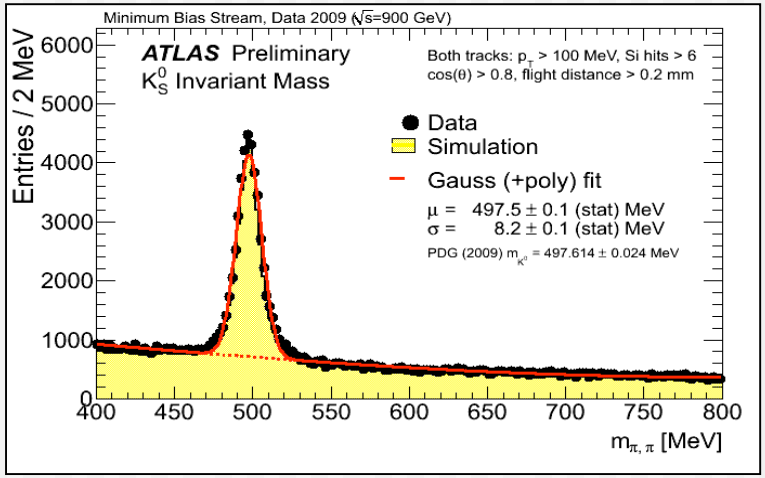
MC generators in ATLAS

Judith Katzy (DESY)
for the ATLAS Collaboration

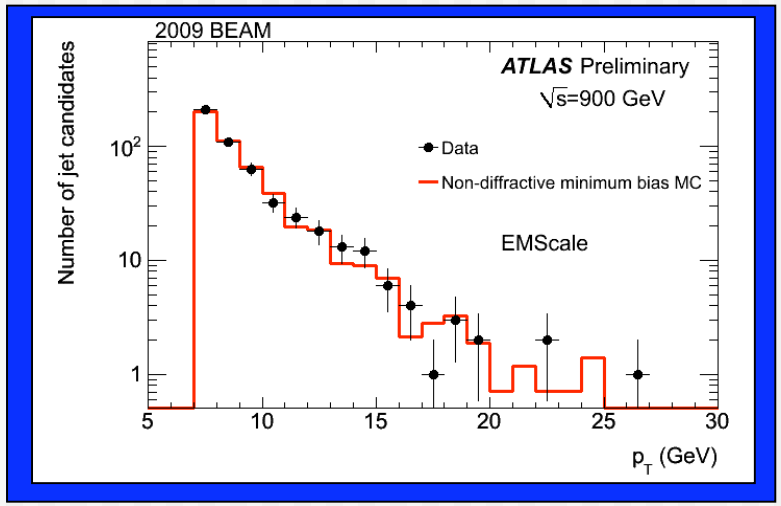

!!! BEAM AT ATLAS !!!
20-11-09 20:47

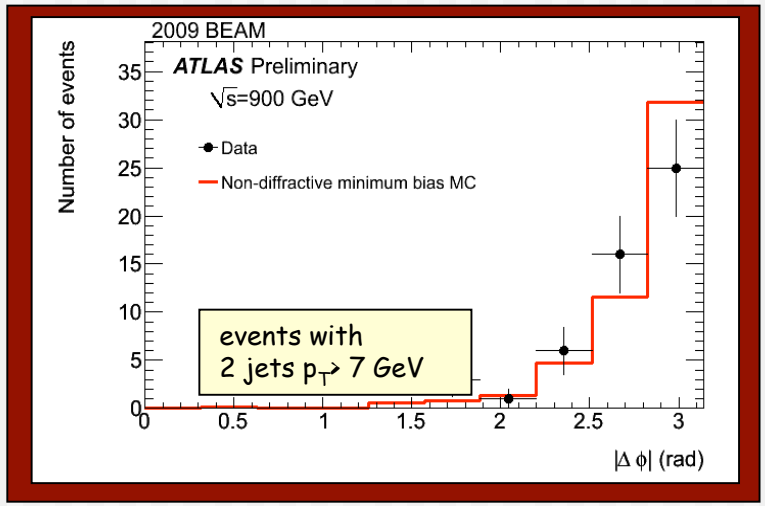
Exciting first data





p_T (track) > 100 MeV
MC signal and background
normalized independently





Uncalibrated EM scale
Monte Carlo normalized to
numb. of jets or ev in data

Outline

- MC generators used in ATLAS
- MC tuning
- New generators
- NLO generators

MC generators used in ATLAS

- General purpose MCs:
  - Pythia, Pythia8
  - Herwig, Herwig++
  - Sherpa
  - Cascade
  - Hijing (using some Pythia tools)
- Parton level MCs:
  - Alpgen
  - AcerMC, Protos
  - McAtNLO, PowHeg
  - ExoGraviton, PythiaExo
  - Charybdis, Madgraph
  - Horace, BaurMC
  - Pomwig, Exhume
  - Winhac
  - CompHep and others

- Specific add-on packages
  - Tauola
  - Photos

Technical Issues

- Use standards helps a lot:
  - Use of LHEF
  - LHA common block
  - Use of LHAPDF
  - Output of HepMC event record
- Code release in GENSER
  - Atlas uses GENSER compiled libs

PDFs

News for MC09 production

- MRST LO* pdf for pythia, herwig/jimmy
- CTEQ6.6 for NLO generators

As LO* pdfs conceptually new, performed validation for wide variety of processes, example: ttbar production

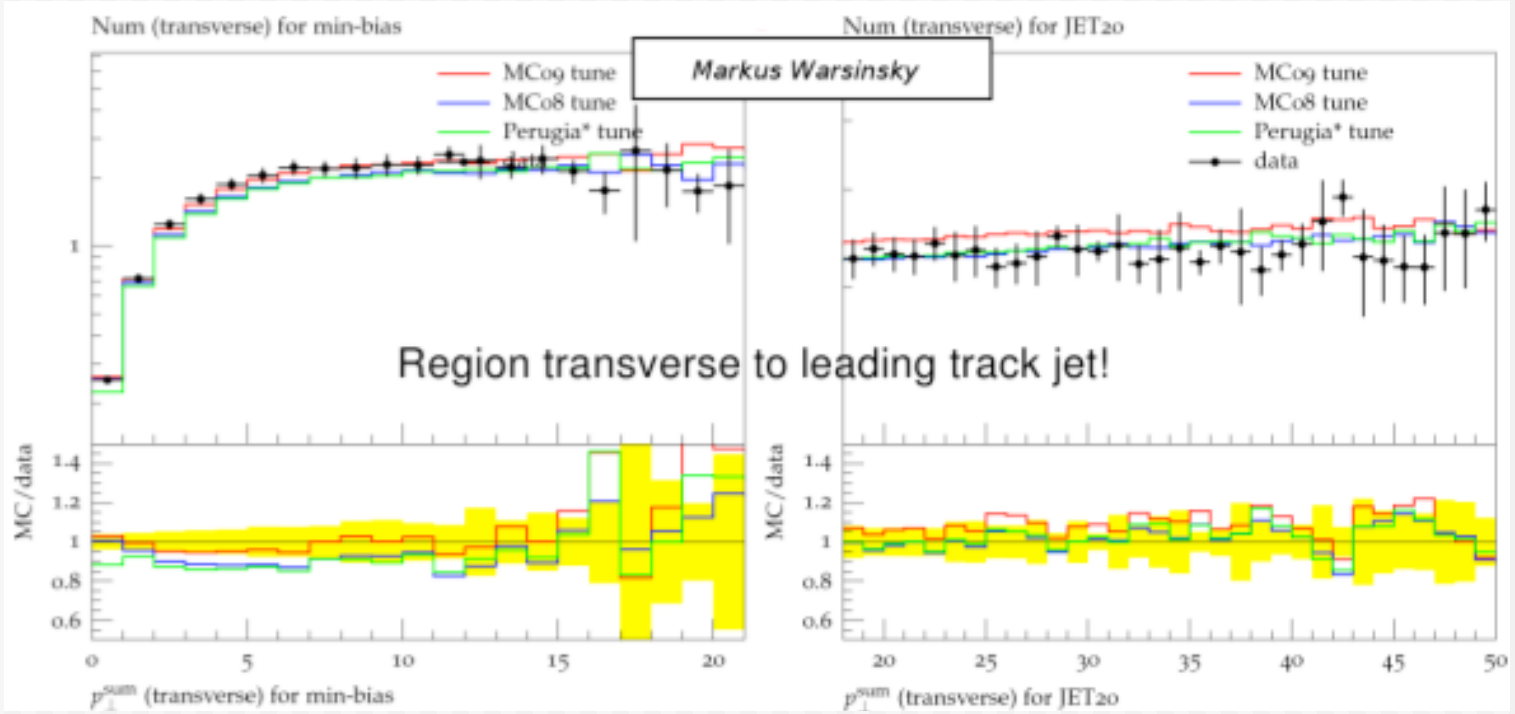
L.Mijovic

generator	PDF set	qq ($\pm$ 0.3%)	σ/σ_{NLO}	K-fact [1]
Pythia 6.4.21	CTEQ6L1	18%	1.9	2.1
Pythia 6.4.21	MRST2007lomod	15%	1.3	1.5
AcerMC 3.6 + Pythia 6.4.21	MSTW2008	19%	1.8	2.0
AcerMC 3.6 + Pythia 6.4.21	CTEQ6L1	19%	1.8	2.0
AcerMC 3.6 + Pythia 6.4.21	MRST2007lomod	16%	1.3	1.4
MC@NLO 3.1 + Herwig 6.510	CTEQ6M	14%	1.0	1.1

- ATLAS developped MC09 tune to adapt pythia and herwig/jimmy for the new pdfs

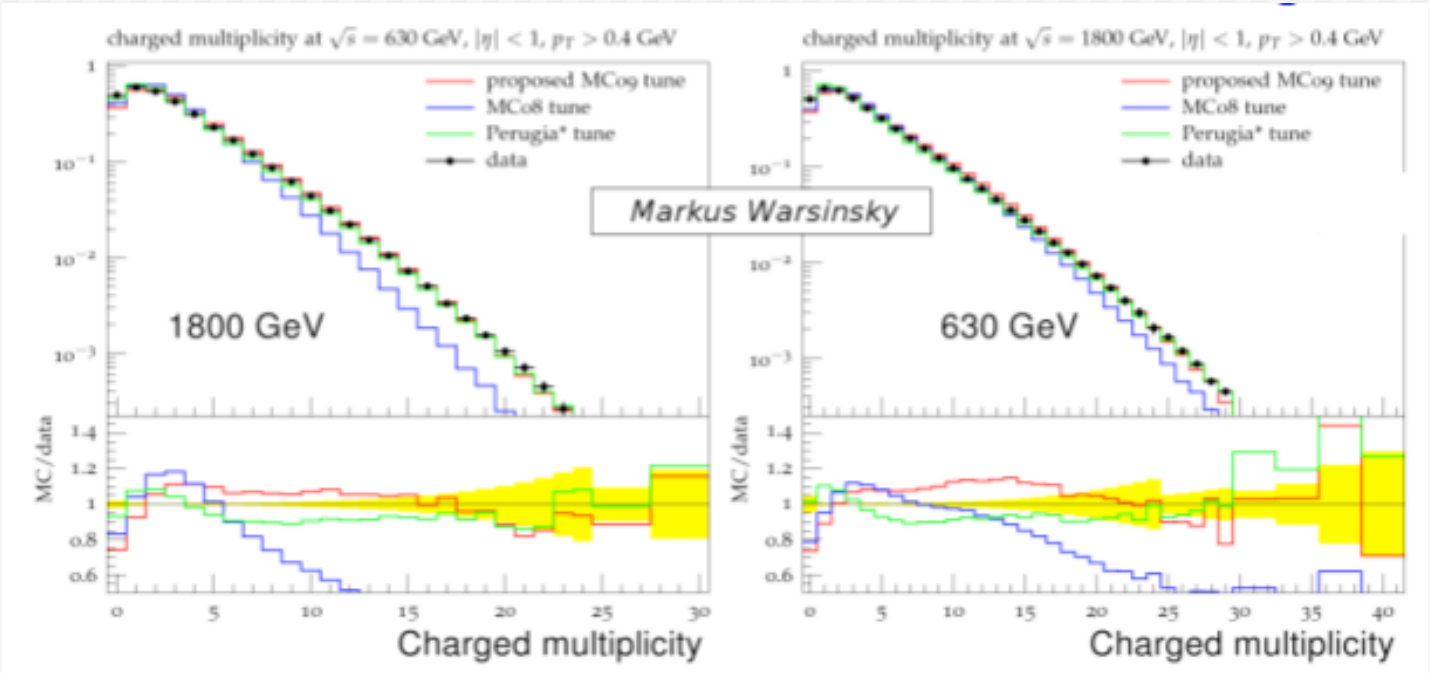
MC09 Pythia6 Tune

- Guideline: adapt pythia for LO* pdfs while keeping the models consistent with MC08



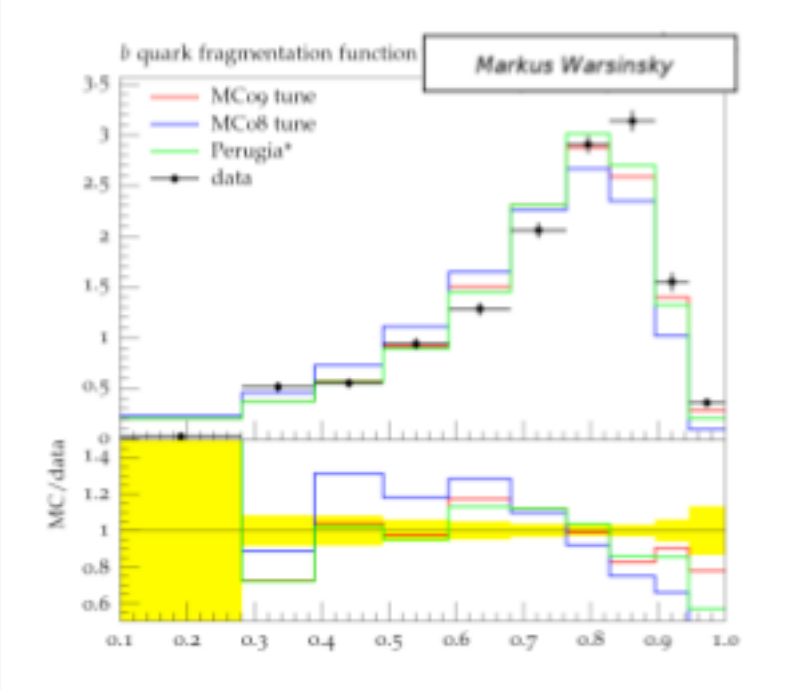
Use CDF leading jet analysis to tune UE
Set cut-off scale in MI model PARP(82) = 2.3 to adjust for new pdf

MC09 Pythia6 Tune



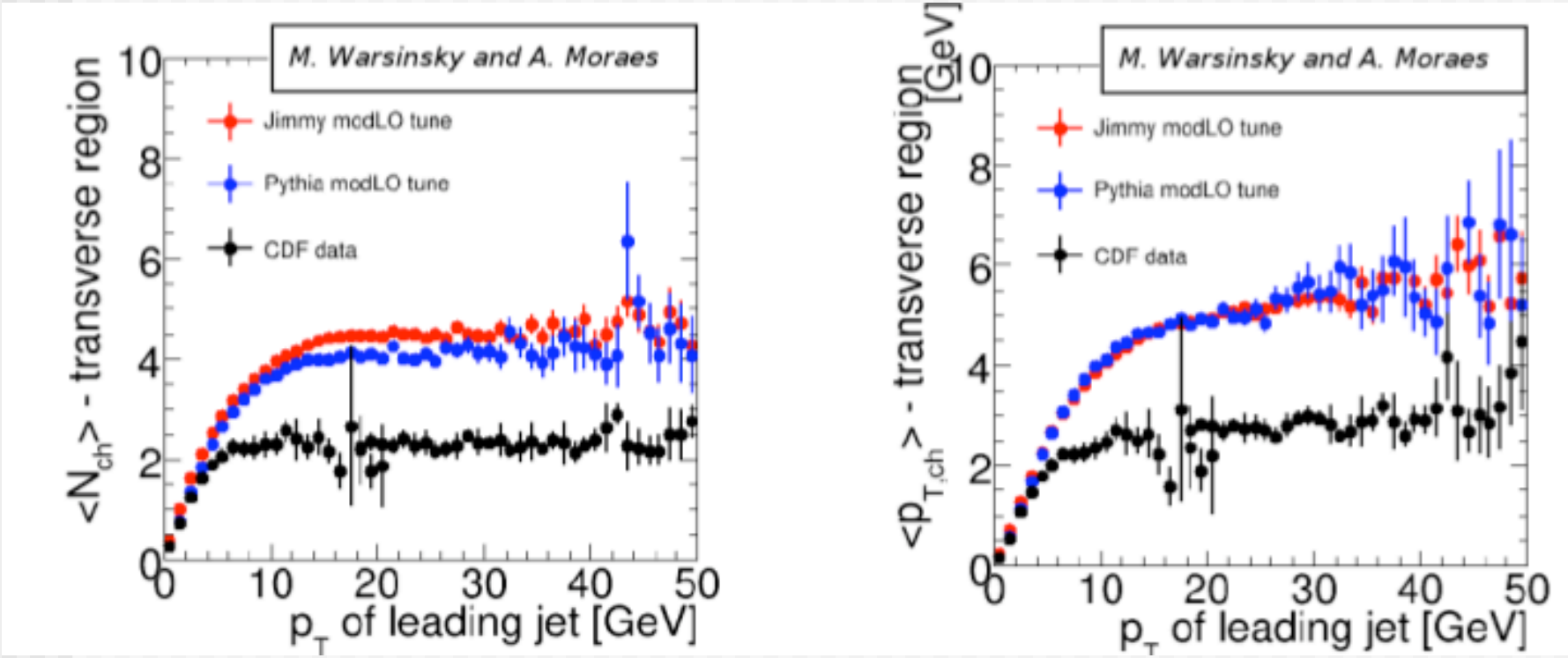
Use CDF min.bias data to tune rescale exponent of energy dependence, I.e. PARP(90)= 0.25

B quark fragmentation in pythia



Switch to Bowler fragmentation for heavy quarks

UE predictions for LHC



PUB note on ATLAS MC09 tunes in prepartion

Tools in ATLAS

- Tuning:
  - Rivet used for most of MC09 tunes
    - Extremly helpful for data comparisons
    - Use of Rivet in the Collaboration encouraged
  - Professor used for official Jimmy CTEQ6.6 tune (Holger Schulz, Andy Buckley)
- Validation:
  - MCTester used for generator comparisons of taus
  - HepMCAnalysisTool used for regression testing

Pythia 6

- Used for SM predictions (min.bias, soft diffraction, Z,W production. …)
- For exotic production, especially thanks to the easiness to include user processes
- As host generator for ME generators

Herwig (fortran)

- SM predictions (QCD, W/Z, diboson,...)
- SUSY
- Higgs
- as host for ME generators (Alpgen, MC@NLO)

Herwig++

- First official production for SUSY submitted
- Validation for SM (Z,W production) currently in process
- Problems with min.bias (this one would be nice to be addressed)
- In general: thanks to the fast-feedback and good Collaboration with authors

Pythia 8

- Used in private analysis (preferred by young people) and in tuning studies
- Appreciate implementation of hard diffraction
- Key question from our side: can the problem with UE in QCD events be constrained to these events?
- Use for official production delayed as we were waiting for an authors pythia8 tune for UE
- Pythia6 and Pythia8: thanks for the fast feed-back of authors on our questions and technical requests

Sherpa

- Version 1.1.3 used in official production for
  - Z + jets (VBF+QCD)
  - W + jets
  - Higgs-Boson signal processes (SM and MSSM)
  - ttbar
- Version 1.2 is currently being validated; hope is to profit from the faster COMIX ME generator
- Feed-back of authors very good & fast

NLO generators

- Recently ATLAS performed mini-workshop on NLO generators and tools
- MC@NLO is used mainly for top
- Start to use Powheg for top and W,Z production
- Powheg + Herwig++ is being validated

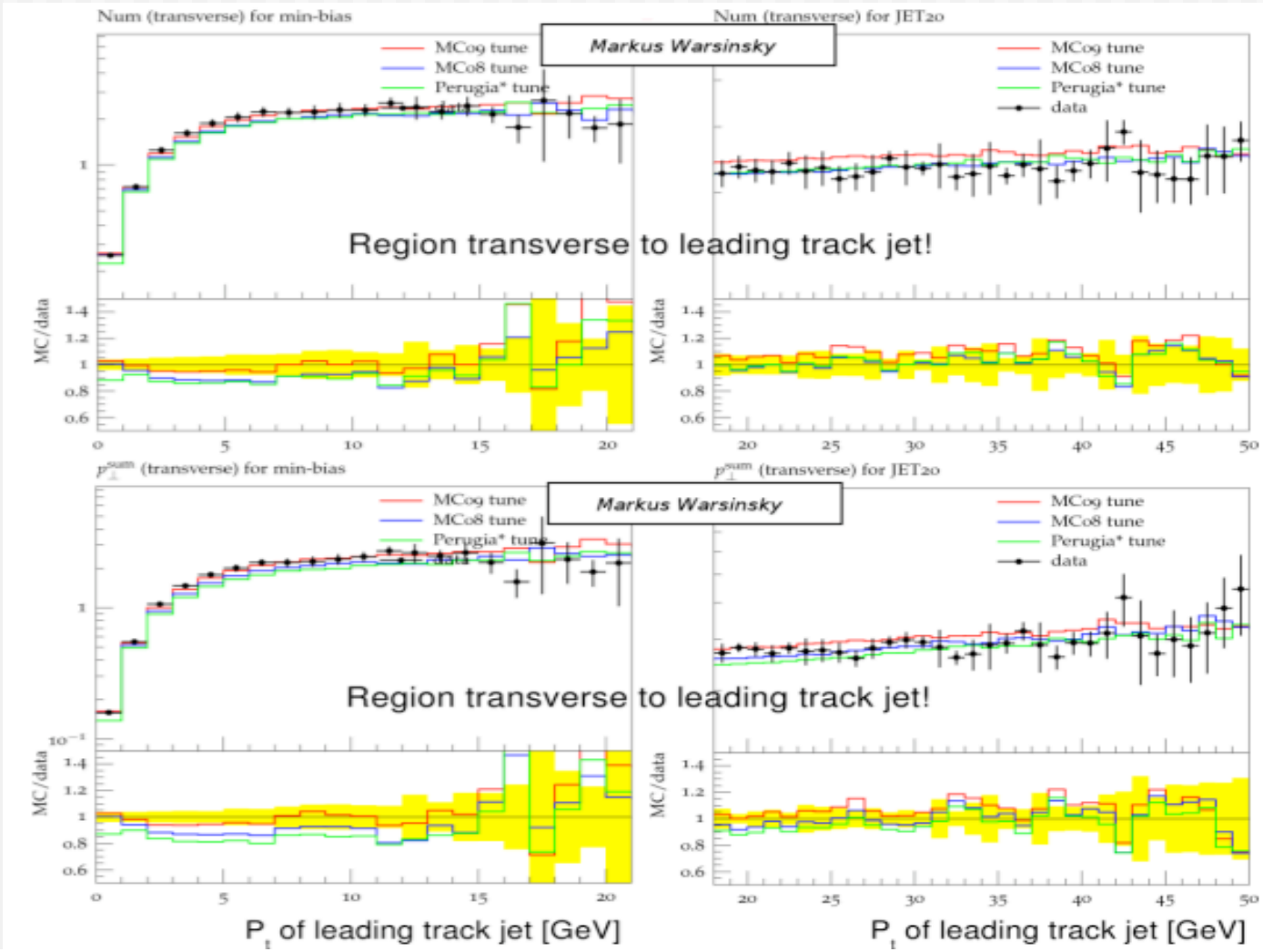
Summary

- ATLAS still uses mainly “old” fortran versions of generators, but C++ generators are coming
- From the new C++ generators, Sherpa

is used most in official production

- New/better physics model best motivation to move to new generators

MC09 Pythia tune



MC09 Pythia tune parameters

ATLAS tune			
PYTHIA Parameter	MC08	MC09	description
General Setup			
PDF	CTEQ6L1	modLO	
PMAS(6,1)	172.5	172.5	top quark mass
PMAS(24,1)	80.403	80.403	W boson mass
PMAS(24,2)	2.141	2.141	W boson width
PMAS(23,1)	91.1876	91.1876	Z boson mass
PMAS(23,2)	2.4952	2.4952	Z boson width
MSTP(128)	1	1	fix junk output for documentary particles
MSTU(21)	1	1	fix junk output for documentary particles
MSTP(81)	21	21	treatment for MI, ISR, FSR and beam remnants: MI on, new model
MSTP(82)	4	4	multiple interaction model: double Gaussian matter distribution
MSTP(70)	0	0	virtuality scale for ISR, separate MI and ISR cut-off modelling
MSTP(72)	1	1	maximum scale for FSR
MSTP(88)	1	1	strategy for qq junction to di-quark or baryon in beam remnant
MSTP(90)	0	0	strategy of compensate the primordial kT
Multi Parton Interactions			
PARP(78)	0.3	0.3	colour reconnection in the final state
PARP(80)	0.1	0.1	probability of colour partons kicked out from beam remnant
PARP(82)	2.1	2.3	cut off scale in MI model
PARP(83)	0.8	0.8	matter distribution, size of inner gaussian
PARP(84)	0.7	0.7	matter distribution, fraction in inner gaussian
PARP(89)	1800	1800	reference scale
PARP(90)	0.16	0.25	rescale exponent for energy dependence
PARJ(81)	0.29	0.29	Lambda value in running α_S
MSTP(95)	1 (2)	6	strategy for colour reconnection
Fragmentation			
MSTJ(11)	3	4	4 : hybrid: Peterson for c/b, symmetric Lund for light quarks; 4: Lund-Bowler for c and b quarks
PARJ(54)	−0.07	-	c hadronization
PARJ(55)	−0.006	-	b hadronization
PARJ(41)	-	0.3	Lund-Bowler a
PARJ(42)	-	0.58	Lund-Bowler b
PARJ(46)	-	0.75	Lund-Bowler rQ
MSTJ(22)	2	2	to make K_S/Λ stable (all with $c\tau > 10$mm)

Table 1: PYTHIA 6 parameters in the MC08 and MC09 tunes.