QCD Measurements (soft QCD, W, Z, photons and jets) at ATLAS

Zdenek Hubacek (Czech Technical University in Prague) On behalf of the ATLAS Collaboration La Thuile 2016 March 9, 2016







- Overview of recent ATLAS measurements of soft or hard QCD phenomena
- Concentrating on the latest Run 2 results from Vs = 13 TeV and the new Vs = 7 and 8 TeV papers
- See also other ATLAS SM related results (A. Solodkov, S. Sacerdoti)

ATLAS Experiment Performance in 2015



- Upgrade and consolidation of the detector for Run 2
 - New beam pipe, new IBL pixel layer, MBTS, 2 level trigger (L1+HLT), ...



- 50ns data taking (Summer 2015)
- 25ns data taking
- ~3.2 fb⁻¹ for analyses
- 5% luminosity uncertainty for full 2015 dataset

Summary of Cross Section Measurements vs √s



A complete list of ATLAS Standard Model results can be found here: https://twiki.cern.ch/twiki/bin/view/AtlasPublic/StandardModelPublicResults

Inelastic cross section



Charged Particle Production @13TeV

- Measure charged particle distributions – n_{ch}, η, p_T,
 <p_T> vs n_{ch}
- Insight into nonperturbative QCD, MC tuning, constraint on multiparton interaction
- 170μb⁻¹, low pile-up
 <μ>=0.005
- Only primary particles, strange baryons excluded
- MB trigger, tracks with p_T>500 MeV, |η|<2.5

ATLAS-STDM-2015-02, arXiv:1602.01633



Charged Particle Production



Charged Particle Production @8TeV

- n_{ch}, η, p_T, <p_T > vs n_{ch}
- Additional phase space regions (n_{ch} > 1, 6, 20, 50, p_T^{min}> 500MeV)
- Most precise MB measurement from Run 1



Charged Particle Production Summary

- EPOS provides the best description for all variables
- Pythia8 A2 & Monash tunes also reasonable
- Herwig++ & QGSJET-II worse
- MC tuned using lower energy regime describes 13 TeV data well!



Charged Particle Production inside Jets @8TeV

- Charged particle distributions studied in dijet system
- Unfolded to particle level
- The difference in average charged particle multiplicity between more forward and more central jets is sensitive to differences between multiplicities in quark and gluon originated jets

ATLAS-STDM-2015-12, arXiv:1602.00988





• Also measured for $p_T^{\text{Jet } p_T [GeV]} > 2 \text{ GeV}$, 5 GeV

- As expected, the extracted gluon-initiated jet charged particle multiplicity is higher than the corresponding quantity for quark-initiated jets
- Significant differences observed with Run 1 MC tunes, but Run 2 tunes improve significantly

ATLAS-CONF-2015-034

ATLAS-PHYS-PUB-2015-016

Jet and Photon Probes @13 TeV



• Preliminary results, test of NLO predictions, PDF in both channels

ATLAS-STDM-2014-09

Inclusive Photon Cross Section @8TeV



- Prompt: either from hard scattering or from fragmentation
- Isolated: to avoid photons from hadronic decays
- 4|η| bins



Inclusive Photon Cross Section



W/Z Production

- Leptonic decay mode (e,µ) easily identifiable
- 85pb⁻¹@13 TeV, <µ>=19

ATLAS-CONF-2015-039

- W: p_T⁻¹>25 GeV, |η|<2.5, E_T^{miss}: p_T^v> 25 GeV, m_T>50 GeV
- $(m_T = \sqrt{2}p_T^{\ \ } p_T^{\ \ } (1 \cos (\phi_I \phi_v)))$)
- Z: p_T^{l} >25 GeV, $|\eta|$ <2.4, 66 < m_{\parallel} < 116 GeV





W/Z Cross Section



Reasonable agreement with theory pred. and with lower Vs measurements

W/Z Production Ratios



Z. Hubacek ATLAS Recent SM Results

Measurement of transverse momentum and ϕ_{η}^{*} in Z->II events @8TeV

- Full vs=8TeV dataset (20fb⁻¹)

 more precise than 7 TeV
 measurement
- φ^{*}_η = tan((π-Δφ)/2)·sin(θ^{*}_η) complimentary to Z p_τ, depends on angles only => more precise than energy variable due to resolution
- Compared to perturbative and resummed QCD calculations



Z p_T and ϕ^*_{η} in 66 GeV<m_{II}<116GeV



More plots available also for lower and higher mass windows

Comparison with MC Predictions

In bins of dilepton mass

In bins of dilepton rapidity



Event Shape Variables in Z->ll Events

ATLAS-STDM-2014-07, arXiv:1602.08980

- Study of underlying event properties √s=7 TeV in Z->ll (leptonic ee,μμ decays)
- Several event shape variables from selected tracks after removal of Z decay products measured in several ranges of Z boson p_T
 - Charged particle multiplicity, sum of transverse momenta, beam thrust, transverse thrust, spherocity, F-parameter
- Restricted 2011 dataset with lower pileup

Event Shape Variables in Z->II Events

Number of charged particles

Sum of transverse momenta of charged particles



Event Shape Variables in Z->II Events

Comparison of MC generators for low and high Z pT bins





Summary

- LHC Run 2 has started
- Number of pp collision studies presented in large energy range of a single experiment √s = 7-13 TeV
- MC tuned using lower energy regime describes 13 TeV data well
- Reasonable agreement with theory predictions
- A complete list of ATLAS SM results can be found here: https://twiki.cern.ch/twiki/bin/vie w/AtlasPublic/StandardModelPubli cResults

