Inelastic proton cross-section at $\sqrt{s} = 13$ TeV

Miroslav Myska, CTU in Prague, Czech Republic
on behalf of the ATLAS Collaboration

Abstract
Poster presents the recent measurement of the inelastic cross-section at 13 TeV with the ATLAS detector, extracted with independent measurements of the rate of inelastic collisions and the LHC luminosity. The result of $79.3 \pm 2.9$ mb has been obtained after extrapolation to the full phase space and is compared with a range of theoretical predictions. In addition, the fraction of diffractive events is estimated using two event selections. The low-luminosity data of total integrated luminosity of 60.1 µb$^{-1}$ recorded in June 2015 was used.

Motivation
- Probes phenomenological models of non-perturbative QCD regime
- Complementar measurement to elastic cross-section connected through optical theorem
- Extends our understanding of the rise of total pp production up at the LHC

Event selection
- At least 2 MBTS counters with a charge above $MC = 0.085 \pm 0.6$ (exp.)
- Used to estimate pile-up at the LHC
- Important for cosmic ray shower models (p+p ↔ p-Air)

Minimum Bias Trigger Scintillators (MBTS)
- Thin polystyrene scintillation counters, the total of 24 counter segments
- Located at ± 3.6 meters between inner tracking detector and calorimeter
- Pseudo-rapidity acceptance: $2.07 < |\eta| < 3.86$
- Sensitive in the kinematical region $\xi > 10^{-6}$ (efficiency above 50% for at least 2 hits)

Results for $\sigma_{inel}$
- Measurement in the fiducial region
  \[ \sigma_{inel}(\xi > 10^{-6}) = \frac{N_{signal} - Nbkg}{\varepsilon_{trig} \cdot L} \cdot C_{MC} \]
  where:
  - $N_{signal} = 4,159,074$ events, $N_{bkg} = 51,187$ events
  - $L = 60.1$ µb$^{-1}$
  - $\varepsilon_{trig} = 99.7$ % = MBTS trigger efficiency
  - $C_{MC} = 99.3$ % = correction for event selection efficiency and migration of events from $\xi < 10^{-6}$ (estimated using Monte Carlo simulations)
  - $\sigma_{inel}(\xi > 10^{-6}) = 68.1 \pm 0.6$ (exp.) ± 1.3 (lum.) mb

Diffractive events
- $\sigma_{inel} = \sigma_{non-diffractive} + \sigma_{diffractive}$
- Fraction of diffractive events $f_D$ of MC generators is compared (fitted) to data
  \[ R_{SB} = \frac{N_{signal \ (one \ side)}}{N_{signal \ (two \ sides)}} = \frac{442,192}{1,459,074} = (10.4 \pm 0.4)\% \]
  MC models vary: 21% < $f_D$ < 31%;
  Best fit: Pythia 8 DL ($\varepsilon = 0.085$) ~ 25.5%
- Pythia 8 with pomeron flux: $SS$ = Schuler & Sjöstrand, $DL =$ Donnachie & Landshoff with tunable parameter $\varepsilon$ or Minimum-Bias RockeffeLer (MBR)
- EPOS LHC and QGIDJET-II ($f_D$ fixed)

Summary
- No pile-up run
- Background only 1.2%
- Low exp. uncertainty
- Result is consistent with selected models within current uncertainties
- 13 vs 7 TeV: increased fiducial phase space, triple larger statistics, smaller uncertainties
- References:
  - ATLAS 7 TeV: Nature Commun. 2 (2011) 463

8 segments in the inner octagonal ring, 4 segments in the outer ring

8 segments of detected particles, $M_X > M_Y$

Proton energy loss: $\xi = \frac{M^2}{s}, \Delta \eta \approx \ln \xi$

Elastic limit: $\xi > 6.10^3$

Elastic limit:

Example graph showing data points and fitted curve.