Inelastic Cross Section Measurements at the CMS Experiment

Melike Akbiyik, Sebastian Baur, Hauke Wöhrmann,
Colin Baus, Igor Katkov, and Ralf Ulrich
for the CMS Collaboration

Karlsruhe Institute of Technology

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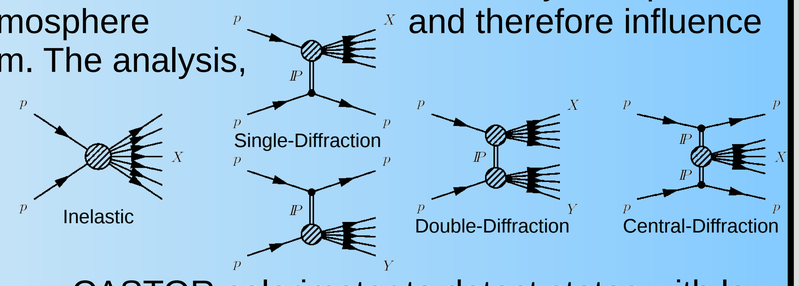
Inelastic cross section in proton-lead (pPb) collisions at 5.02 TeV per nucleon-nucleon pair

In air shower simulations, Glauber calculations and extensions like Regge-Gribov models are widely used to calculate the nuclear cross section using the nucleon-nucleon cross section as input, which has been measured at LHC energies for pp. For the first time the proton-lead cross section was measured at high energies by selecting events with signal in the HF detectors (Fig. 1). It was found that σ(pPb)=2061±80mb [1], where the photo-nuclear contribution has been subtracted (negligible for pAir) and that the Glauber model agrees (Fig. 2).

Diffractive dissociation cross section in proton-proton collisions at 7 TeV

For extensive air showers, diffractive collisions efficiently transport energy within the atmosphere and therefore influence the shower maximum. The analysis, here, is based on particle-flow objects and the acceptance is extended by the CASTOR calorimeter to detect states with low diffractive masses. In the measured range, models show a too small double-dissociation cross section (Fig. 3) and a reasonable shape of the differential cross section (Fig. 4) [2].



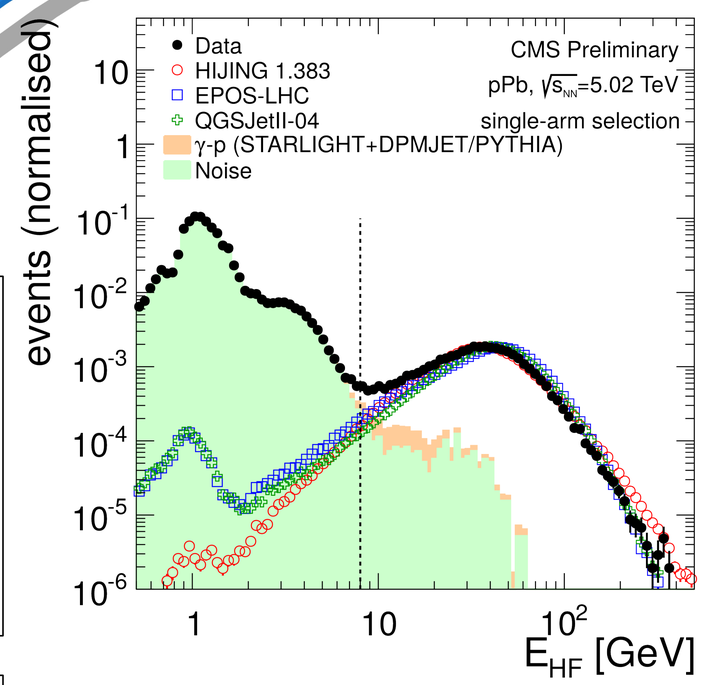


Fig. 1: Energy signal in HF for background (solid areas) and simulated inelastic collisions (open markers) and data (black). The selection threshold is shown as a dashed line.

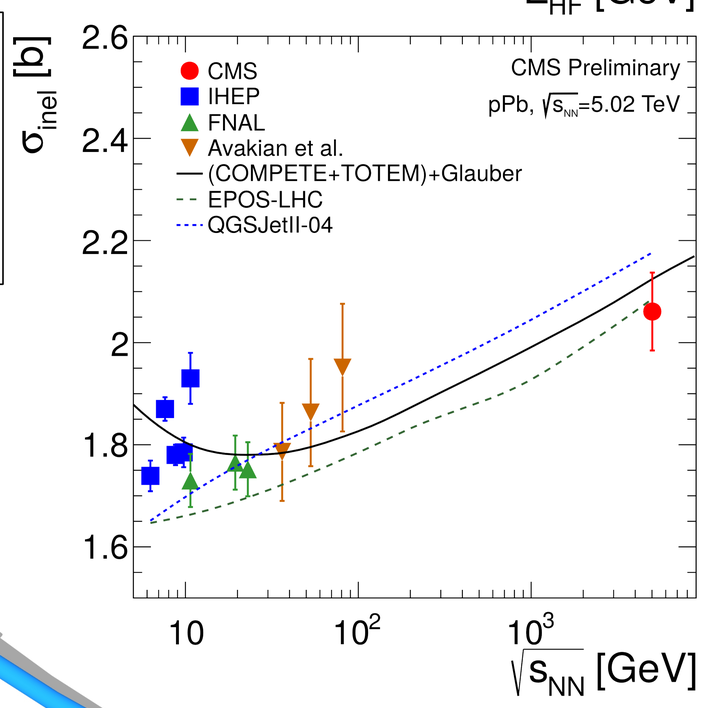
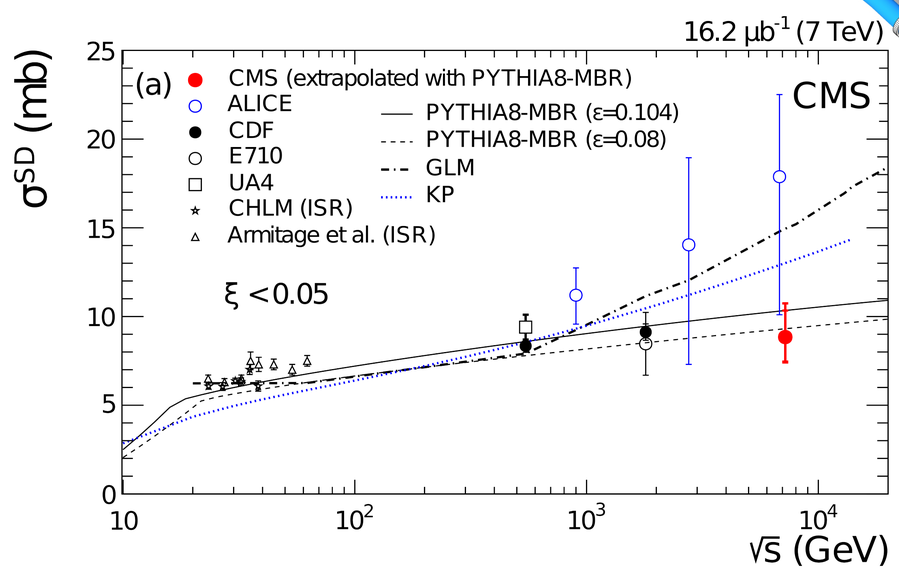


Fig. 2: Inelastic pPb cross section for processes where particle production occurs as a function of centre-of mass energy per nucleon pair.

Fig. 3: Single-dissociation cross section as a function of centre-of-mass energy. The cross section is extrapolated to include the contribution invisible to the CMS detector.



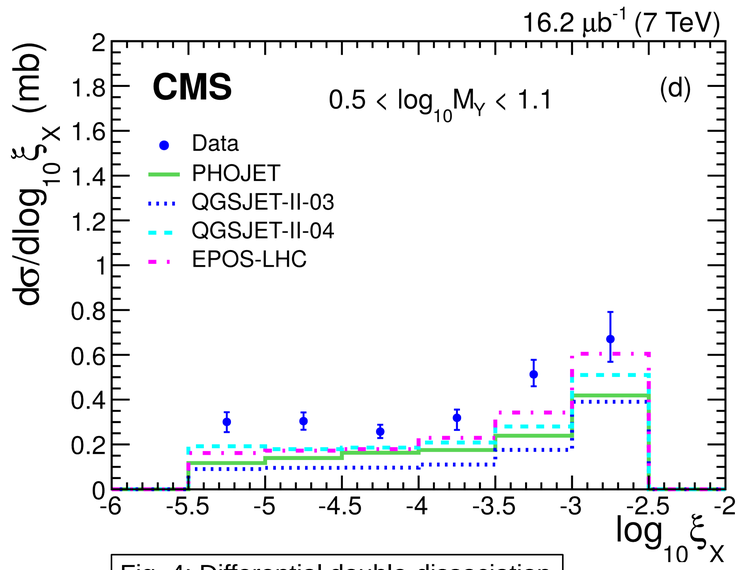


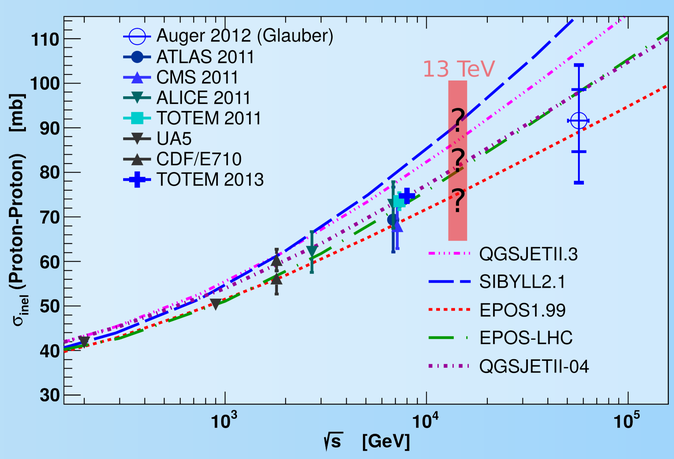
Fig. 4: Differential double-dissociation cross section over longitudinal momentum loss $\xi_X=M_X^2/s$ with the mass of the diffractive system M_X.

The HF calorimeter measures particles in the pseudorapidity range 3<|η|<5 (on both sides)

The CASTOR calorimeter detects EM and HAD particles in the pseudorapidity range -6.6<η<-5.2

Recent 13 TeV Data

In June the LHC restarted after a shutdown during which the detectors were upgraded. Now, the first data at a cms. energy of 13 TeV were successfully taken and are being analysed. The analysis of the number of charged particles at central rapidities has been published by the CMS Collaboration [3]. A measurement of the inelastic cross section will further constrain the extrapolation to ultra-high energies (see Figure to the right).



(courtesy of A. Kuotb)

References

[1] Proton-lead cross section: CMS-FSQ-13-006

[2] Diffractive dissociation cross section: Phys. Rev. D92 (2015) 012003

[3] Charged particles at 13 TeV: arXiv:1507.05915 (submitted to PLB)