



DETERMINING THE INELASTIC RATE FOR THE LUMINOSITY INDEPENDENT CROSS SECTION MEASUREMENT AT TOTEM AT THE LHC

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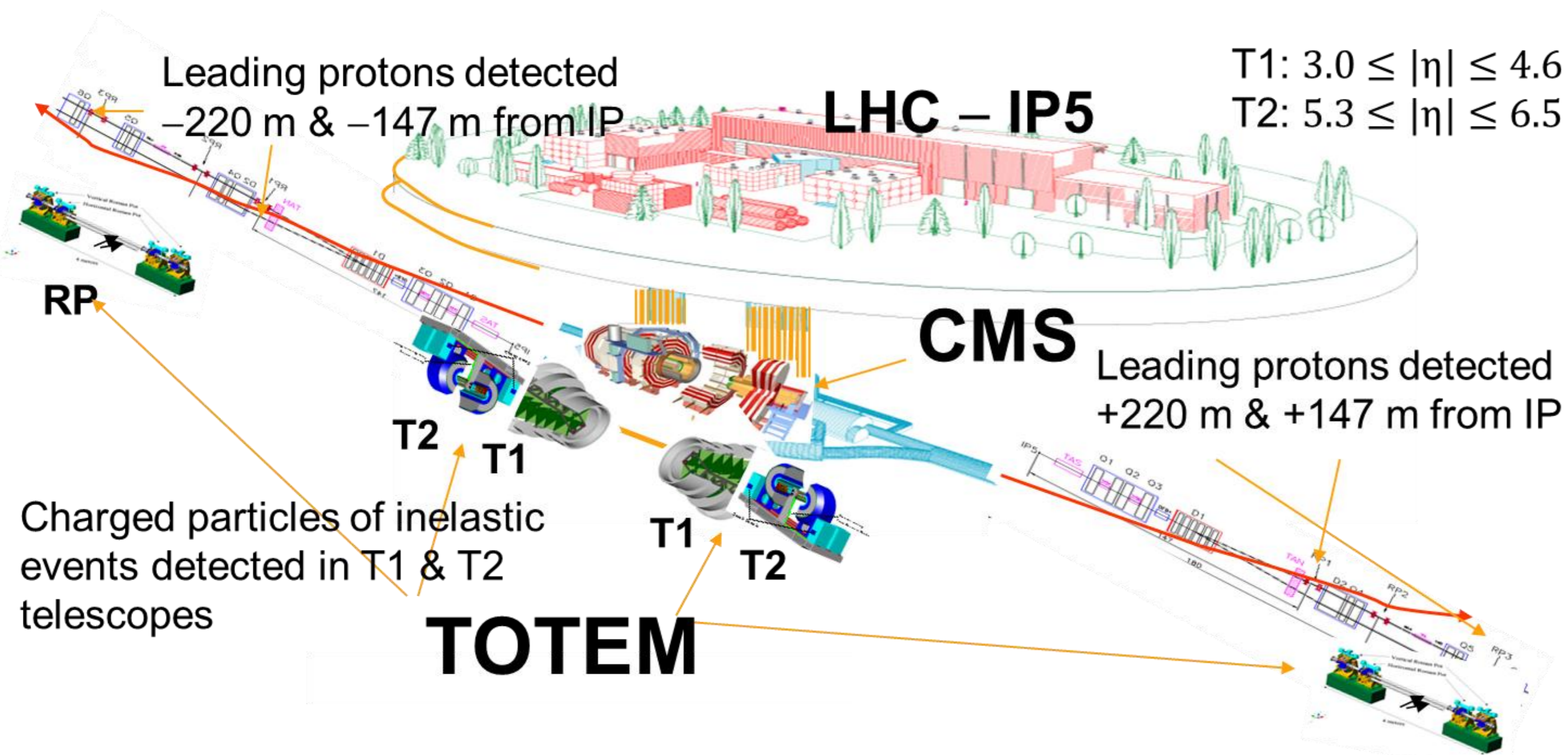


Fig 1. Schematic of the experimental setup of TOTEM showing the locations of the tracking telescopes and Roman Pots

THE TOTEM EXPERIMENT

TOTAL, Elastic and Diffractive cross section Measurement (TOTEM) is at the same interaction point (IP) as Compact Muon Solenoid (CMS).

Main physics goals:

- Total and differential cross section measurements for proton-proton collisions
- Studies of elastic scattering and diffraction

TOTEM detectors:

- Tracking telescopes T1 and T2
- Roman Pots for detecting protons scattered in small angles

CROSS SECTION FROM ELASTIC SCATTERING

A cross section measurement was done by TOTEM looking at the elastic part. The total cross section was obtained by using the optical theorem and the luminosity measurement from CMS. The published results are [1]:

$$\begin{aligned} \sigma_{tot} &= (98.3 \pm 0.2 \text{ stat} \pm 2.8 \text{ syst}) \text{ mb} \\ \sigma_{el} &= (24.8 \pm 0.2 \text{ stat} \pm 1.2 \text{ syst}) \text{ mb} \\ \sigma_{inel} &= (73.5 \pm 0.6 \text{ stat}^{+1.8}_{-1.3} \text{ syst}) \text{ mb} \end{aligned}$$

The main source of uncertainty on the quoted numbers is the luminosity measurement.

DETERMINING THE INELASTIC RATE

Raw inelastic rate is measured through event counting, using T2 as trigger.

Several corrections are needed to obtain the true inelastic rate from this raw rate.

The rates and corrections are divided into three categories based on topology:

- 2h events with reconstructed T2 tracks on both sides of IP (mainly double diffraction and non-diffractive minimum bias)
- 1h+ events with tracks on the positive side (mainly single diffraction (SD))
- 1h- events with tracks on the negative side (mainly SD)

The efficiency and beam gas background corrections are different for these categories; beam gas background is significant only for 1h events.

The corrections leading to the T2 visible cross section $\sigma_{inel,T2vis}$ or rate are:

1. T2 trigger efficiency correction as function of track multiplicity from data triggered on bunch crossing (BX) (see figure 2)
2. Beam gas background correction as function of track multiplicity from T2 triggered events for non-colliding bunches (see figure 3 for correction factor)
3. Pileup correction from BX data using Poisson statistics $(1.4 \pm 0.1 \text{ stat} \pm 0.4 \text{ syst}) \%$
4. T2 reconstruction inefficiency $(1.05 \pm 0.53) \%$ (*)

(*) These Monte Carlo dependent corrections are scaled with the measured ratio of 2h and 1h events (3.54 ± 0.03) to reproduce the diffractive fraction seen in data.

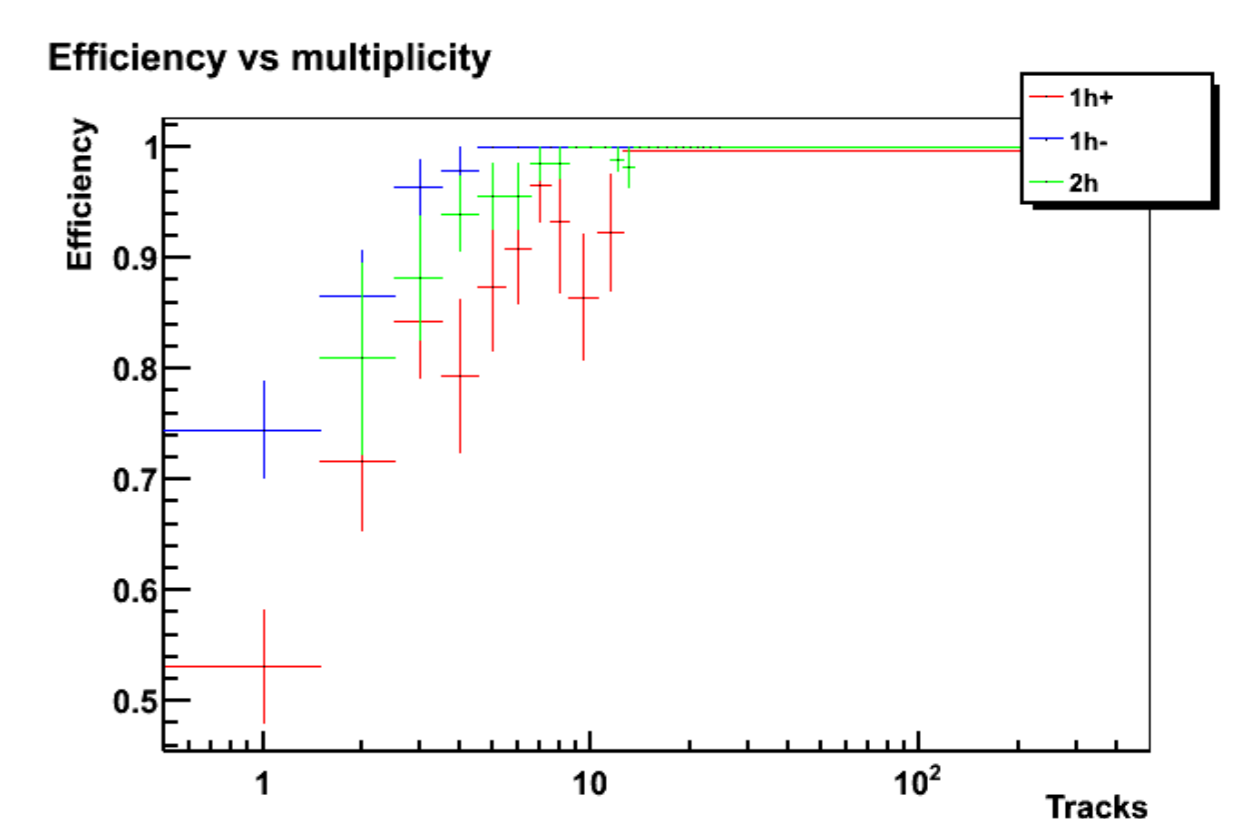


Figure 2: Trigger efficiency correction factor

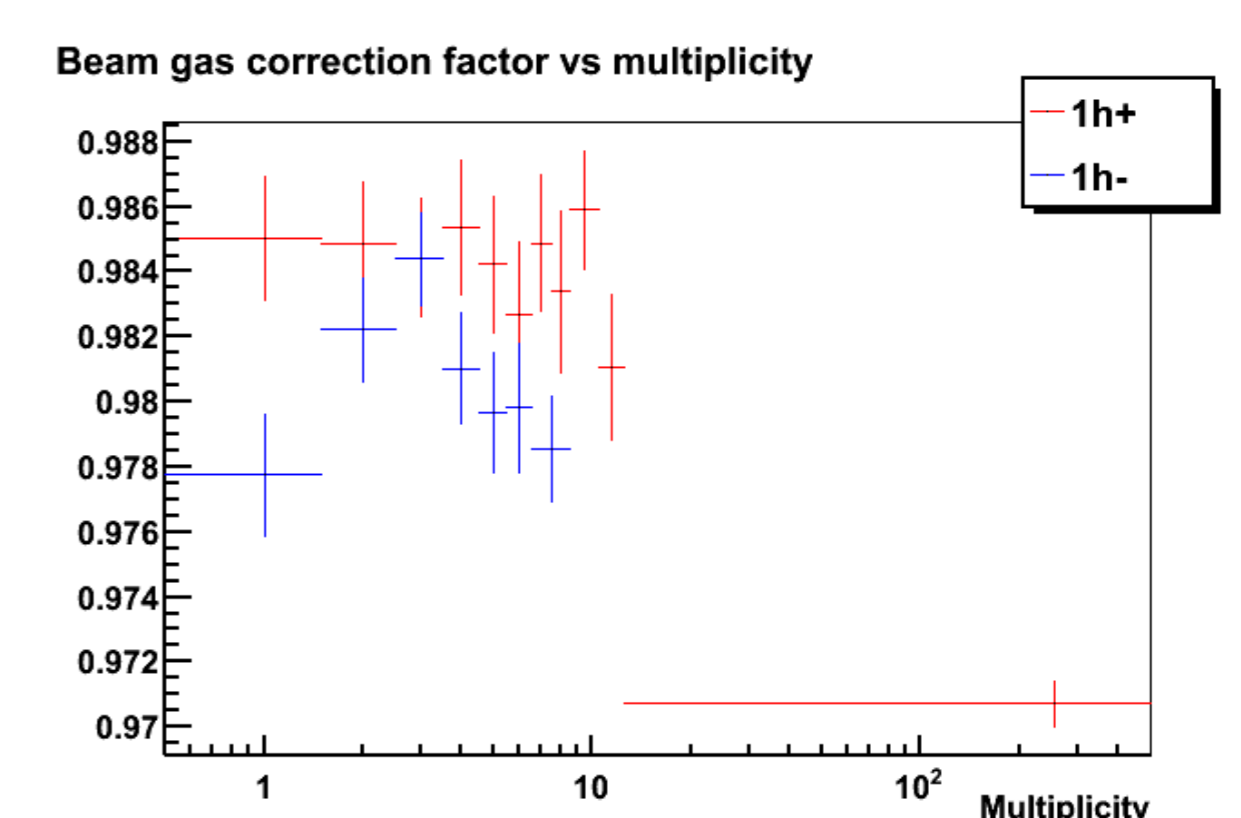


Figure 3: Beam gas background correction factor

Additional corrections for full inelastic rate or cross section:

1. Correction for low mass diffraction (with all particles with higher pseudorapidity than T2 acceptance) from Monte Carlos and models [2] $(4.25 \pm 2.13) \%$ (*)
2. Correction for events with a rapidity gap covering whole T2 $(0.57 \pm 0.11) \%$ (*)
3. T1 only correction, the fraction of events with tracks in T1, but not T2, from BX data $(1.00 \pm 0.51) \%$

FROM RATES TO CROSS SECTIONS

Preliminary inelastic cross sections

$$\begin{aligned} \sigma_{inel,T2vis} &= (69.3 \pm 0.1 \text{ stat} \\ &\quad \pm 1.0 \text{ syst} \pm 2.8 \text{ lumi}) \text{ mb} \\ \sigma_{inel} &= (73.3 \pm 0.1 \text{ stat} \\ &\quad \pm 1.9 \text{ syst} \pm 2.9 \text{ lumi}) \text{ mb} \end{aligned}$$

are obtained from the measured and corrected inelastic rate from 7 TeV proton-proton collisions in October 2011.

The luminosity independent cross section measurement depends on the elastic and inelastic rates N_{el} and N_{inel} and the optical point $dN_{el}/dt|_{t=0}$. The parameter $\rho = 0.14^{+0.01}_{-0.08}$ [3].

$$\sigma_{tot} = \frac{16\pi(\hbar c)^2}{1 + \rho^2} \cdot \frac{dN_{el}/dt|_{t=0}}{N_{el} + N_{inel}}$$

[1] G. Antchev et al., EPL, 96 (2011) 21002

[2] V.A. Khoze et al., Physics Letters B 679 (2009) 56–59

[3] J. R. Cudell et al., PRL, 89 (2002) 201801

