Elastic and Total Cross-Section Measurements by TOTEM: Past and Future

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The TOTEM experiment at the LHC has measured proton-proton elastic scattering in dedicated runs at $\sqrt{s} = 2.76, 7, 8$ and $13$ TeV centre-of-mass LHC energies. The proton-proton total cross-section $\sigma_{\text{tot}}$ has been derived for each energies using a luminosity independent method. TOTEM has excluded a purely exponential differential cross-section for elastic proton-proton scattering with significance greater than 7 $\sigma$ in the $|t|$ range from $0.027$ to $0.2$ GeV$^2$ at $\sqrt{s} = 8$ TeV. The $\rho$ parameter has been measured at $\sqrt{s} = 8, 13$ TeV via the Coulomb-nuclear interference, and at $13$ TeV was found to be $\rho = 0.1 \pm 0.01$. The $\rho$ measurement is a strong evidence of the existence of a 3-gluon bound state, predicted from theoretical models both in Regge-like and modern QCD framework.

Primary author(s) : Dr NEMES, Frigyes (CERN)
Preseuter(s) : Dr NEMES, Frigyes (CERN)
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