Summary of 2019 publications by TOTEM

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on behalf of the TOTEM collaboration

Forward-physics workshop, CERN
16 Dec 2019
First measurement of elastic, inelastic and total cross-section at $\sqrt{s} = 13$ TeV by TOTEM and overview of cross-section data at LHC energies

TOTEM Collaboration

- measurements at 13 and 2.76 TeV (still) compatible with the pre-LHC prediction by COMPETE
First measurement of elastic, inelastic and total cross-section at $\sqrt{s} = 13$ TeV by TOTEM and overview of cross-section data at LHC energies

TOTEM Collaboration

- forward slope: change of behaviour isolated between 2.76 and 7 TeV

$$B = \frac{d}{dt} \ln \frac{d\sigma}{dt}$$
First determination of the $\rho$ parameter at $\sqrt{s} = 13$ TeV: probing the existence of a colourless C-odd three-gluon compound state

TOTEM Collaboration

- consistent $\rho$ results with different approaches – lower than expectations (e.g. COMPETE)
- “partial Coulomb normalisation”: another $\sigma_{\text{tot}}$ determination
  - consistent with 90 m measurement
  - independent from 90 m measurement $\rightarrow$ combination yields uncertainty reduction

<table>
<thead>
<tr>
<th>Data</th>
<th>Method</th>
<th>$\rho$</th>
<th>$\sigma_{\text{tot}}$ (mb)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\beta^* = 90$ m</td>
<td>Ref. [6]</td>
<td>–</td>
<td>$110.6 \pm 3.4$</td>
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<tr>
<td>$\beta^* = 2500$ m</td>
<td>Approach 1</td>
<td>$0.09 \pm 0.01$</td>
<td>$111.8 \pm 3.1$</td>
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<tr>
<td></td>
<td>Approach 2</td>
<td>$0.09 \pm 0.01$</td>
<td>$111.3 \pm 3.2$</td>
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<td>Approach 3</td>
<td>$0.08(5) \pm 0.01$</td>
<td>$110.3 \pm 3.5$</td>
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<td>Approach 3 (single fit)</td>
<td>$0.10 \pm 0.01$</td>
<td>$109.3 \pm 3.5$</td>
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<tr>
<td>$\beta^* = 90$ and 2500 m</td>
<td>Ref. [6] $\oplus$ approach 3</td>
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First determination of the $\rho$ parameter at $\sqrt{s} = 13$ TeV: probing the existence of a colourless C-odd three-gluon compound state

TOTEM Collaboration

- models without important crossing-odd component cannot describe TOTEM $\sigma_{\text{tot}}$ and $\rho$ data
  - below shown for COMPETE models
  - quite general due to dispersion relations

- TOTEM data provide evidence for significant crossing-odd contribution
Elastic differential cross-section measurement at $\sqrt{s} = 13$ TeV by TOTEM

- high statistics ($\approx 10^9$ events) $\rightarrow$ LHC record in large-$|t|$ reach

- no diffractive structures beyond the first dip/bump $\rightarrow$ model exclusion
Elastic differential cross-section measurement at $\sqrt{s} = 13$ TeV by TOTEM

- high statistics ($\approx 10^9$ events) $\rightarrow$ high accuracy

- fine details of the dip-bump structure
Elastic differential cross-section $d\sigma/dt$ at $\sqrt{s} = 2.76$ TeV and implications on the existence of a colourless C-odd three-gluon compound state

- significant dip-bump structure observed (like at 7, 8 and 13 TeV $\rightarrow$ persistent feature)

- significant di/uniFB00erence wrt. $p\bar{p}$ measurement by D0 (green) $\rightarrow$ (another) evidence for strong role of crossing-odd contribution
• extrapolation of TOTEM measurements to D0 energy → closure of energy gap

• elastic scattering at $\sqrt{s} = 900$ GeV → determination of $\rho$ and $\sigma_{\text{tot}}$