Small-x & diffraction

WG5: summary and discussion

10th International Workshop on Multiple Partonic Interactions at the LHC
Perugia, December 10-14, 2018
Soft QCD and small-x

- (not-so) new phase space at LHC
- Improve tunes, measure non-perturbative parts
- Very forward regions down to $x=10^{-6}$
  - Synergy btw pp and pA
  - Top/W/Z production
  - Higgs production
- Experimental limitations?

Parton kinematics

Very forward jet spectra
Open heavy flavour, parton distrib.

- Complementarity for central and low-x regions, for LHC and HERA
- Comparison for HERA/Tevatron/LHC
- Parton densities relevant to NP searches
- Theory predictions with large uncertainties
- Potential to constrain gluon and sea quark PDFs
Jet veto cross section

• Study top quark/etc gap fractions
• Initial discrepancies solved due to MC tuning and QCD model developments
• VBF W/Z+jj
• Better understanding of ISR
• Performance of MC models gives confidence for VBF models
• Differential cross section? etc?

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- TOTEM: total, elastic, inelastic cross sections
- Complete set of measurements
- Anomalies (rho, xsection) may require other models
- Slowing down of xsec? Alternative models? Odderon?
- Look at new data: a factor of 10, high-beta, low luminosity
Diffractive and exclusive

- New results with pp and pA data
- Exclusive dijets/rho/Y, light-by-light scattering
- Comparison to Tevatron results
- Constraints on gluon densities
- Exclusive Y: probe regions of $x=10^{-2}$ to $10^{-4}$
  - Constrain gluon density
- Sensitive to BSM

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Central Exclusive Production

- Many CEP resonances studied at LHCb
- Differential distributions
- Overall good agreement with NLO predictions
- More data collected p-Pb, Xe-Xe, etc to be analyzed
Particle and Astroparticle

- Inclusive energy spectrum in the very forward region
- Understand origin and composition of UHECRs
- Provide constraints on hadronic interaction models at LHC
- Synergy with CR and Astroparticle experiments
Present: LHC as photon collider

- Study photon-photon interactions
- $\gamma\gamma$ dominant at high-energies with two-photon tagged events
- Study anomalous couplings
- Small background, increased sensitivity
- Study rare processes at high luminosity
- Not without challenges
Extended forward coverage

• Cover forward regions to extend sensitivity of LHC experiments: AFP and PPS
• Collected ~110/fb in Run2
• study \( \gamma\gamma \) interactions
• Sensitivity to BSM physics
• Several challenges ahead
• Run3 and beyond?
Future: electron-ion collider

- EIC: high-resolution microscope
- Ion beams colliding polarized (~70%) electrons
- High luminosity, high energy (10-100GeV)
- Proton structure and hadron tomography
- Implications for HEP:
  - High-energy QCD, gluon and saturation
  - Higgs phenomenology and NP searches
  - EWK sector, MPI
  - Reduce PDF and $\alpha_s$ uncertainties
- Study nucleon structure
LHC: from searches to precision

- A hadron collider at full throttle
  - Reaching the energy limit
  - In Run3, collisions at 14 TeV
  - Large datasets

- Moving from searches to precision measurements and rare processes
  - Study backgrounds and reduce uncertainties
  - Understand SM and constrain models
  - Higgs couplings and rare decays
  - Anomalous couplings etc.

- Preparing for High-Luminosity (2026 and beyond) with improved detectors
  - Several technological challenges ahead as complexity increases
BSM searches: resonances, etc.

(defunct) diphotons at PPS

$\sigma \sim 0.3 \text{ fb}$ a few `clean' events with $20/\text{fb}$

Composite Higgs, anomalous gauge-Higgs couplings, excited leptons, technicolor, extra dimensions, axions, heavy exotic states, dark matter candidates, …?