Observations in tests of high-beta at injection energy

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4th Elba workshop on Forward physics
26 May 2018
Motivation for $\rho$ determination at low energy

- no $\rho$ measurements in proton-proton between $\approx 100$ GeV to 7 TeV

- discrimination between models with different energy-dependences of $\rho$

- $\sqrt{s} = 900$ GeV: the lowest (easily) accessible energy at LHC
Tests at $\sqrt{s} = 900$ GeV

- $\rho$ measurement $\Rightarrow$ very low $|t|$ needed $\Rightarrow$ RPs at about 3 $\sigma_{\text{beam}}$
  - special collimation scheme needed
  - beam background can be an issue

- test campaigns
  - campaign 1: 8 Nov 2017
  - campaign 2: 22 Nov 2017
  - campaign 3: 8 May 2018

- test actions
  - many collimation schemes tried
  - RP alignment repeated (to prevent outliers)
  - different bunch intensities tried (to prevent IBS)
  - higher RF voltage tried (to prevent debunching)
  - online background assessment: XY hit distributions at RPs
  - offline background assessment: application of elastic-tagging cuts
Expectable XY distribution for signal

(extracted from campaign 3, DS1, “better diagonal”, after all cuts)
Observed XY distribution: *Comparison between test campaigns*

- best dataset from each campaign (diagonal coincidence required)

  - camp 1/scheme4
  - camp 2/test3bis
  - camp 3/DS1

- two background structures – occurrence and intensity not reproducible neither understood
  - sharp horizontal bands
  - round, beam-halo like
Offline analysis

- example from campaign 3/DS1: one diagonal pessimistic example, the other optimistic one
- gradually applied 8 cuts enforcing the kinematics of elastic scattering
  - black histogram: not cut applied, red: all cuts applied
  - signal expected between the vertical dashed lines ($\pm 3\sigma$)

- top example: dominated by background, bottom example: background few %
Offline analysis: Background bands excluded

- exclude regions affected by background: cut $|y| > 10.5$ mm
- example from campaign 3/DS1: one diagonal pessimistic example, the other optimistic one

- both diagonals: background negligible
Summary

- **horizontal background bands: the show stopper**
  - dominate over signal, concentrated at low $|t|$  
  - cannot be eliminated with conventional cuts  
  - occurred in all 3 test campaigns
    - at different RPs, with different sizes/intensities $\rightarrow$ not reproducible  
    - possible to find a configuration where not present ??
  - consensus: due to non-optimal collimation scheme (detailed source not known)

- **“standard” beam background**
  - can be eliminated with conventional cuts to few-percent level

- **if RP “moved out” by $\approx 3$ mm**
  - background (after cuts) negligible  
  - however reduced acceptance: $|t|_{\min}$ shifts from $3 \cdot 10^{-4}$ to $\approx 7 \cdot 10^{-4}$ GeV$^2$  
  - impact on physics in evaluation/discussion
Backup
Observed XY distribution: *Test campaign 3*

- Only tracks in 4 diagonal RPs required

DS1

- DS1: 1 “good”, 1 “bad” diagonal
- DS2 and DS3: both diagonals “bad”
rates of reconstructed events
  - red: diagonal requirement (4RP), blue: all (8) tagging cuts applied

Campaign 3, DS1: Event rates

- **DS1**:
  - 45b – 56t
  - 45t – 56b

- **DS2**:

- **DS3**:

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Solutions I can see – for discussion

- Collimation experts find a solution
  - currently, to my knowledge they don’t have any idea
  - not much time left, if run to be in 2018

- We move RPs further from beam
  - bands irreproducible → how much to shift?
  - Coulomb normalisation in danger
  - \( \rho \) determination probably possible, if another normalisation method found

- Run at 1.8 TeV
  - background improvement disputable
  - clear loss in turn-around time: needed ramp, de-squeeze, etc.
    - at 0.9 TeV, campaign 3: showed that physics-physics time can be \( \sim 15 \text{ min} \)