S05. Transverse impedance localization measurements in the Booster

Y.Alexahin, N.Biancacci, M.Carlà, J.Eldred

Acknowledgements: H.Bartosik, A.Huschauer, F.Schmidt, C.Bhat, Booster operators crew
Outline

• Summary of the measurements
• Analysis and results
• Conclusions and outlook
Summary of the measurements

Objective:
Identification of unknown transverse impedance sources in the Booster.

Timeline:
28\textsuperscript{th} June 2019: DC mode
- Several pings H, V planes + scan in intensity
- Single ping due to injection oscillations + scan in intensity

2\textsuperscript{nd} July 2019: Ramped mode
- Operational settings: several pings H, V planes + scan in intensity up to 14 turns.
- Optimized settings: several pings during energy ramping + scan in intensity up to 8 turns.
Summary of the measurements

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**Analyzed/ongoing:** priority on V plane analysis (larger effect).
DC mode: BPM data

- V signal example: pings every 500 turns up to 15000 turns.
- Long decoherence (could have been > 500 turns in some cases).
- Data analyzed until 10000 turns (no intensity values or corrupted afterwards).
Phase/tune shift vs intensity

- Turn by turn data recorded at all BPMs
- Tune and phase at average tune computed for each intensity and all BPMs (Sussix [1])
- Typical phase shift pattern of distributed sources (drift along the machine).

[1] R.Bartolini et al., CERN SL/Note 98-017
Reconstruction algorithm

- Reconstruction assuming quadrupole-like effect of the impedance (ok if tune shift is linear).
- Phase beating fitted with analytical response of correctors 1m spaced along the machine.
- Reasonably good fit.
- Main sources in between selected elements (rf, collimators, kickers) -> main bends?
Reconstruction as a function of turns

- Analysis extended up to 10k turns
- Rather constant strength -> expected as in DC mode.
- Some “hot” spots from section 19, otherwise mainly dipole related impedance.
Tune shift: comparison with past studies

- Comparing with [2] the slope is slightly less, likely due to a different bunch length.
- The effective impedance is \( \sim 97 \, M\Omega/m \) (rms bunch length of 4.8 ns).

Tune shift as a function of turns

Tune shift stays within <10% variation, as expected in DC mode (no ramp).
• Decoherence reduces approaching 9000 turns (500 -> 200 turns)
• Only 50 turns above -> not enough accuracy for localization measurements
Phase/Tune shift versus turns

- Tune shift highly reduced (almost a factor 10)
- Reflected as well in impedance localization along the cycle
- Phase shift tends to flatten – no relevant lumped sources.
Comparison with past studies

- Steady tune shift (impedance) decrease measured also by Ng and Huang [3].
- Bunch length evolution needed to compute impedance (in process).

Summary and next steps

• Performed impedance localization measurements both in DC and ramped modes of operation (28/06 and 2/07).

• DC mode:
  – mostly distributed impedance (dipoles)
  – some hot spots after S19

• Ramped mode:
  – good data quality < 9000 turns. Optimization needed above.
  – Impedance lowers, no relevant hot spots detected.
  – Correlation with bunch length to be done.

• Next:
  – Complete analysis of missing scenarios.
Backup

DC mode intensity

![Graph showing DC mode intensity with different lines and labels for various values.](image)
DC mode: bunch length

rms: 4.8ns