Investigations on the crosstalk between the quadrupole circuits and impact on the tune and beta-beat

F. Antoniou, F. Asvesta, H. Bartosik, F. Boattini, G.P. Di Giovanni, T. Prebibaj

16/06/2021
Motivation

- Beta-beating and tune correction needed in the first 5-10 ms after injection.

- Correction function on the Q-strips of QDE3 and QDE14 will be applied for the beta-beating correction.

- Correction function on the Q-strips of the rest QDEs and QFOs will be applied for the tune correction.

- We are interested in the coupling between the different circuits (mainly QDE/QCD, QFO/QCF but also the coupling with the mains)
Currents without fast correction

- **Focusing** quads: 
  \[ MPS14 + QFO + 0.5 \times QCF \]

- **Defocusing** quads: 
  \[ MPS23 + QDE + 0.5 \times QCD \]

- **Defocusing** quads 3/14*: 
  \[ MPS23 + QDE + 0.5 \times QCD_{3/14} \]

- Black dashed line: SET values

*The initial difference reported between the set and the measured currents on the Q-strips was due to a wrong setting that we applied in LSA. After correcting this, the measured current follows the set current as expected.
Currents without fast correction (focusing at injection)

- **Focusing quads:**
  \[ MPS_{14} + QFO + 0.5 \times QCF \]

- **Defocusing quads:**
  \[ MPS_{23} + QDE + 0.5 \times QCD \]

- **Defocusing quads 3/14:**
  \[ MPS_{23} + QDE + 0.5 \times QCD_{3/14} \]

- Black dashed line: SET values
• Correction functions are applied ring by ring and the coupling between the rings is checked

• Correction function applied on the QCD3/14 of R3 between C275-C281:
  • No coupling between QCD3/14 and QDE of R3
Currents with fast correction on QCD3/14 of R3-R4

- Correction functions are applied ring by ring and the coupling between the rings is checked.

- Correction function applied on the QCD3/14 of R3 and R4 between C275-C281:
  - we start to observe some weak coupling between QCD3/14 and QDE of R3.
Currents with fast correction on QCD3/14 of R1-R4

- Correction functions are applied ring by ring and the coupling between the rings is checked.
- Correction function applied on the QCD3/14 of all rings between C275-C281:
  - we observe stronger coupling between QCD3/14 and QDE of R3
QCD3/14 couplings

- Plots show the difference between the measured currents (OASIS) and the set currents in LSA.

- The different colors correspond to:
  - blue: no fast correction applied (natural)
  - orange: fast correction applied in the QCD3/14 of R3
  - green: fast correction applied in the QCD3/14 of R3, R4
  - red: fast correction applied in the QCD3/14 of R2, R3, R4
  - purple: fast correction applied in the QCD3/14 of all rings

- Coupling between QCD3/14 and MPS14: negligible.
- Coupling between QCD3/14 and MPS23: negligible
QCD3/14 couplings

- Plots show the difference between the measured currents (OASIS) and the set currents in LSA.

- The different colors correspond to:
  - **blue**: no fast correction applied (natural)
  - **orange**: fast correction applied in the QCD3/14 of R3
  - **green**: fast correction applied in the QCD3/14 of R3, R4
  - **red**: fast correction applied in the QCD3/14 of R2, R3, R4
  - **purple**: fast correction applied in the QCD3/14 of all rings

- Coupling between QCD3/14 and MPS14: **negligible**.
- Coupling between QCD3/14 and MPS23: **negligible**
- Coupling between QCD3/14 and QFO: **negligible**
- Coupling between QCD3/14 and QDE: ± 0.3 A
- Plots show the difference between the measured currents (OASIS) and the set currents in LSA.

- The different colors correspond to:
  - blue: no fast correction applied (natural)
  - orange: fast correction applied in the QCD3/14 of R3
  - green: fast correction applied in the QCD3/14 of R3, R4
  - red: fast correction applied in the QCD3/14 of R2, R3, R4
  - purple: fast correction applied in the QCD3/14 of all rings

- Coupling between QCD3/14 and MPS14: **negligible**.
- Coupling between QCD3/14 and MPS23: **negligible**
- Coupling between QCD3/14 and QFO: **negligible**
- Coupling between QCD3/14 and QDE: ± 0.3 Å
- Coupling between QCD3/14 and QCF: **negligible**
- Coupling between QCD3/14 and QCD: ±0.1 – 0.2 Å
Currents with fast correction on QCD3/14, QCD and QCF of R1

- Correction functions are applied ring by ring and the coupling between the rings is checked.

- Not only QCD3/14 are used for the beta-beating and tune correction but also the rest QCD and QCF.

- Here, the correction functions are applied on the QCD3/14 and QCD/QCF of R3 between C275-C281.
QCD3/14, QCD, QCF couplings

• Not only QCD3/14 are used for the beta-beating and tune correction but also the rest QCD and QCF.

• Plots show the difference between the measured currents (OASIS) and the set currents in LSA.

• The different colors correspond to:
  - **blue**: no fast correction applied (natural)
  - **orange**: fast correction applied in the QCD3/14, QCD and QCF of R3
  - **green**: fast correction applied in the QCD3/14, QCD and QCF of R3, R4
  - **red**: fast correction applied in the QCD3/14, QCD and QCF of R2, R3, R4
  - **purple**: fast correction applied in the QCD3/14, QCD and QCF of all rings

• Coupling between QCD3/14, QCD, QCF and MPS14: **negligible**.
• Coupling between QCD3/14, QCD, QCF and MPS23: **negligible**.
• Coupling between QCF and QFO: **±0.3 A**
• Coupling between QCD3/14, QCD and QDE: **±0.3 − 0.4 A**
Measurable couplings were observed between the different circuits.

From our current investigations this does not seem to pose a limitation for the beta-beat measurement and correction.

- Tune change because of the current crosstalk: < 0.003
- Beta-beating degradation because of the current crosstalk: negligible