The engima of b4 correction in IR5

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Historical

- The amount to b4 in the IR triplet can be measured via the detuning with amplitude through the beam (Rogelio OMC team)
- Topic discussed few times
  - Ewen in [https://indico.cern.ch/event/821749/](https://indico.cern.ch/event/821749/) (RunIII FiDeL meetings, 2020, 4th February)
  - Ezio in [https://indico.cern.ch/event/872709/](https://indico.cern.ch/event/872709/) (RunIII FiDeL meetings, 2020, 7th January)
  - Ewen in [https://indico.cern.ch/event/874917/](https://indico.cern.ch/event/874917/) (RunII FiDeL meetings, 2019, 21st May)
Octupolar sources in IR

MQXA have a systematic $b_4$ (about 1.3, stdev 0.11 unit) coming from the mechanical structure dipolar symmetry

MQXB have small systematic $b_4$ (about 0.12, stdev 0.14 unit) but their effect is enhanced by the beta functions

Beam screen gives additional 0.12 units, due its dipolar symmetry

Positive in IR1 and negative in IR5, due to installation in H / V direction
Data shown in m^-4 (octupole gradients used in MAD)

- 1 m^-4 corresponds to 1.6 units of octupolar error on MQXA, and zero on MQXB
- Total correction range provided by the corrector octupoles in IR is 2.4 m^-4
- Today measured/simulated correction between half and one fourth of the maximum correction
- Very good agreement for IR1, bad for IR5
SCALEs ARE IMPORTANT

- Shown in a scale going from zero to 65% of the correction
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- Shown in a scale going from zero to 100% of the correction
  - Discrepancy for IR5 is 0.5 m$^4$, corresponding to 20% of the maximum correction
We reconstructed the correction with only contribution of MQXA IR1 and IR5, L and R have approx the same value due to the syst.
Then we added adding MQXB

Some impact since beta functions in MQXB are large, even though systematic is close to zero
Then adding the beam screen contribution

- The beam screen is oriented vertical in IR1, and horizontal in IR5, so the b4 contribution has different signs – gives a change of about 0.3 m⁻⁴
- BS contribution is the difference seen between FiDeL reports (where it is not included) and WISE simulation (initially misinterpreted as a bug)
Ewen observed recently that if you change the sign to the beam screen contribution the same level of agreement is obtained in IR1 and IR5.
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Indeed, it is hard to believe – beam screen cannot have been installed in the wrong direction in IR5 (N. Kos and vacuum group).
CONCLUSION

- We have an agreement between beam measurements and $b_4$ magnetic measurements that is
  - Below 0.1 units of $b_4$ in MQXA only in IR1
  - Around 1 units of $b_4$ in MQXA in IR5
  - Out of a total 1.3 systematic $b_4$ in MQXA

- Changing the contribution of the beam screen in IR5 would bring the precision to less than 0.1 units of $b_4$, but it is not physical according to our present understanding

- Another hypothesis (from Massimo): could CMS giving a octupolar component in MQXA?
THANKS