The engima of b4 correction in IR5

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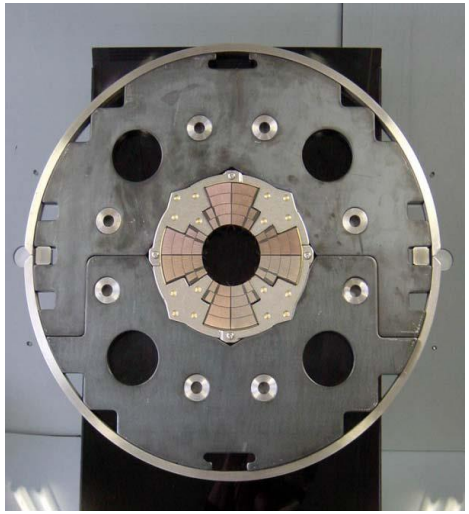
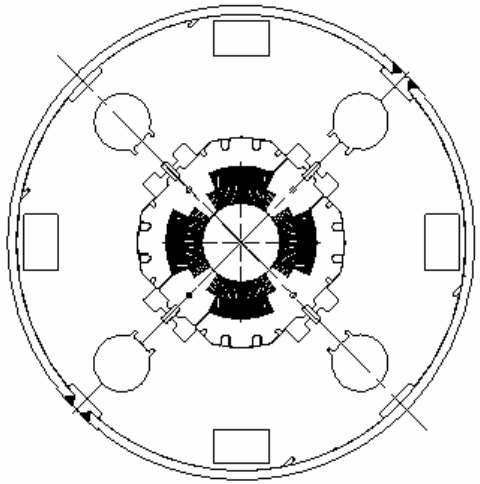
THE B4 ENIGMA

- 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/ (RunIII FiDeL meetings, 2020, 4th February)
    - Ezio in https://indico.cern.ch/event/872709/ (RunIII FiDeL meetings, 2020, 7th January)
    - Ewen in https://indico.cern.ch/event/874917/ (RunII FiDeL meetings,
    - 2019, 21th May)

SOURCES OF B4

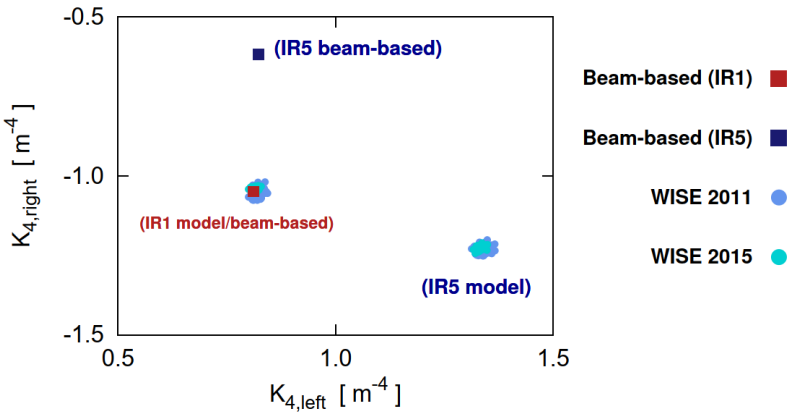
- Octupolar sources in IR
  - MQXA have a systematic b_4 (about 1.3, stdev 0.11 unit) coming from the mechanical structure dipolar symmetry
  - MQXB have small systematic b_4 (about 0.12, stdev 0.14 unit) but their effect is enhanced by the beta functions
  - Beam screen gives additional 0.12 units, due its dipolar symmetry
    - Positive in IR1 and negative in IR5, due to installation in H / V direction





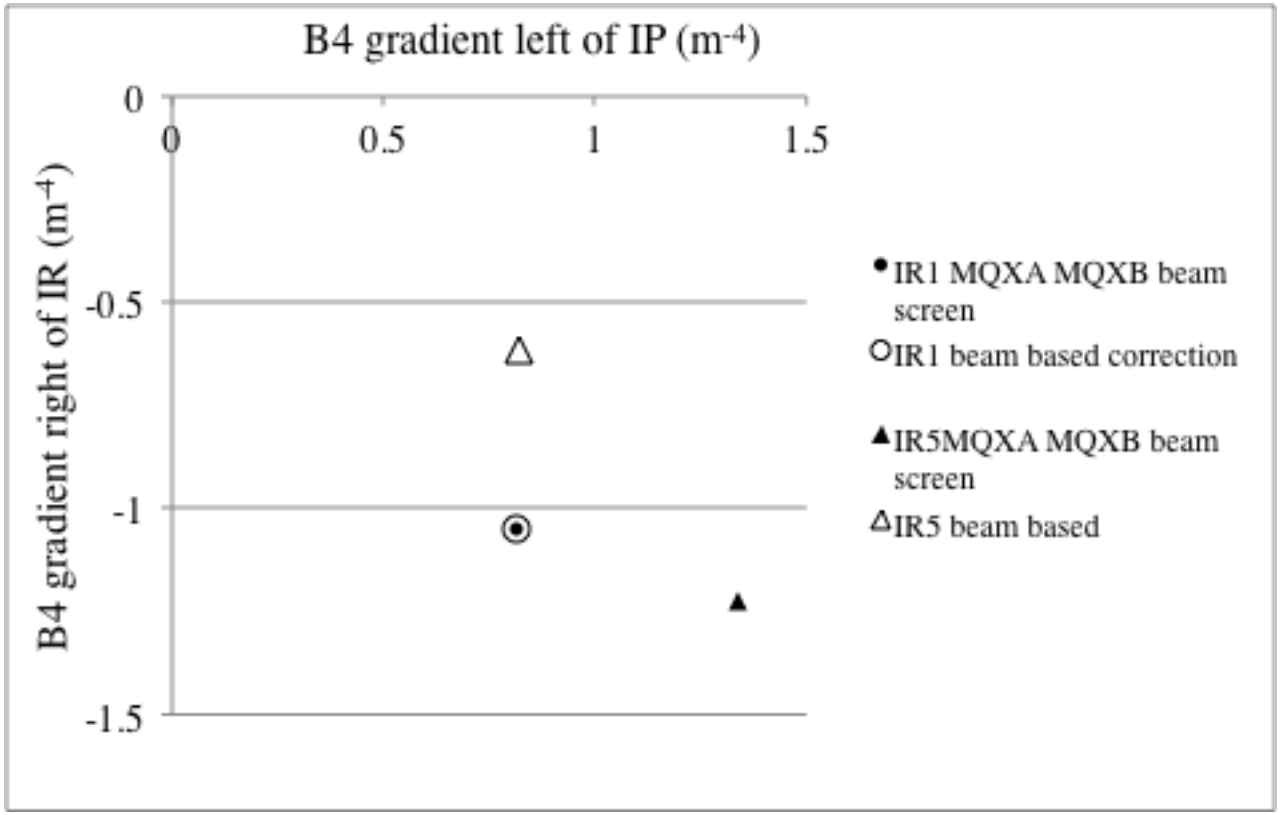
MODEL VS MEASUREMENTS

- 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



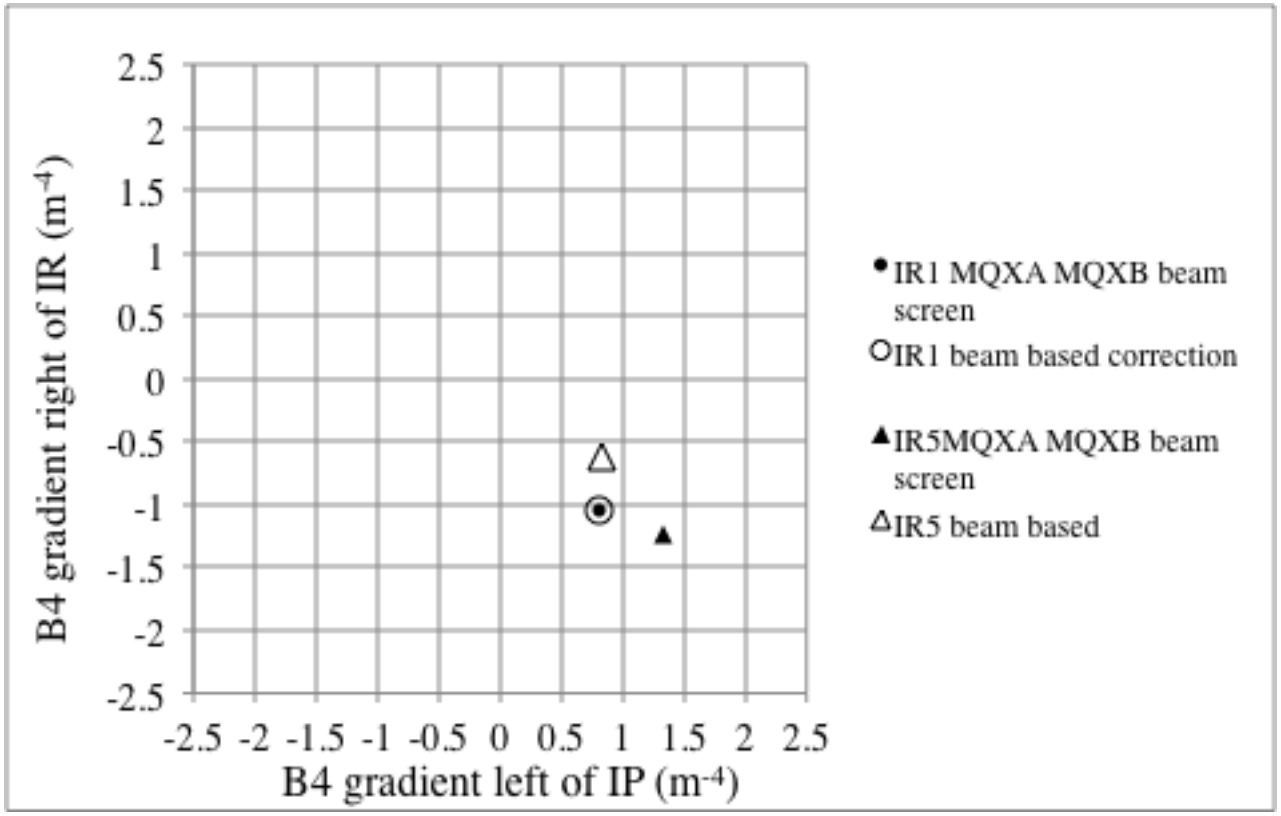
SCALES ARE IMPORTANT

- Shown in a scale going from zero to 65% of the correction



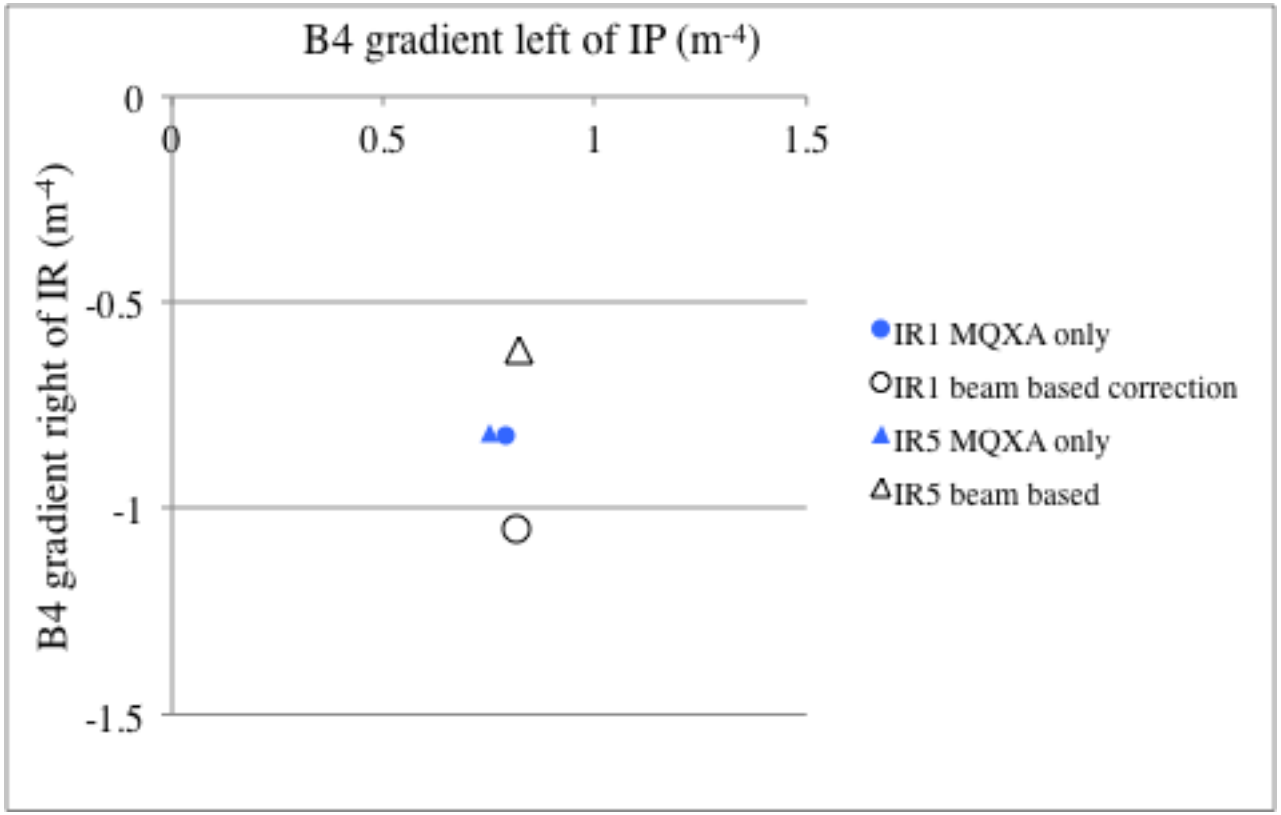
SCALES ARE IMPORTANT

- 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



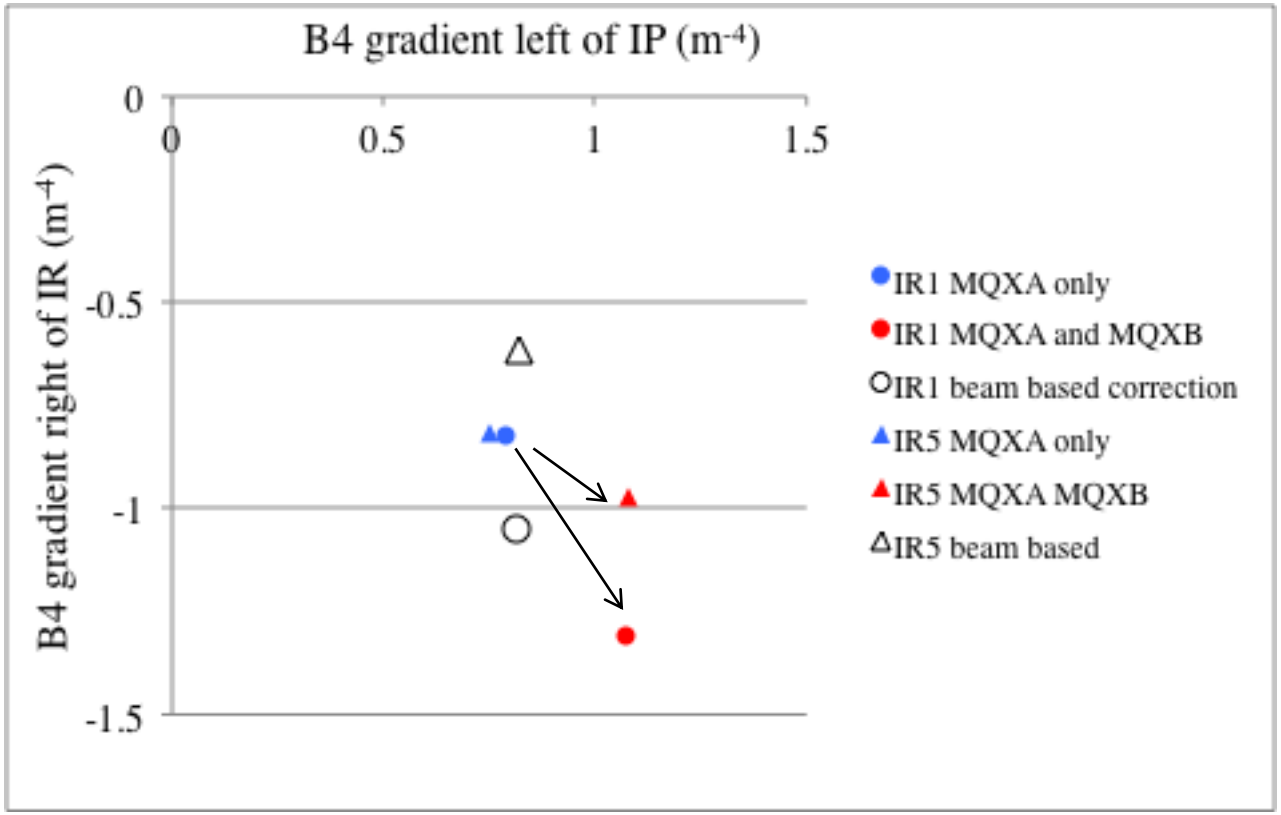
DECOMPOSING THE CONTRIBUTIONS

- We reconstructed the correction with only contribution of MQXA
- IR1 and IR5, L and R have approx the same value due to the syst.



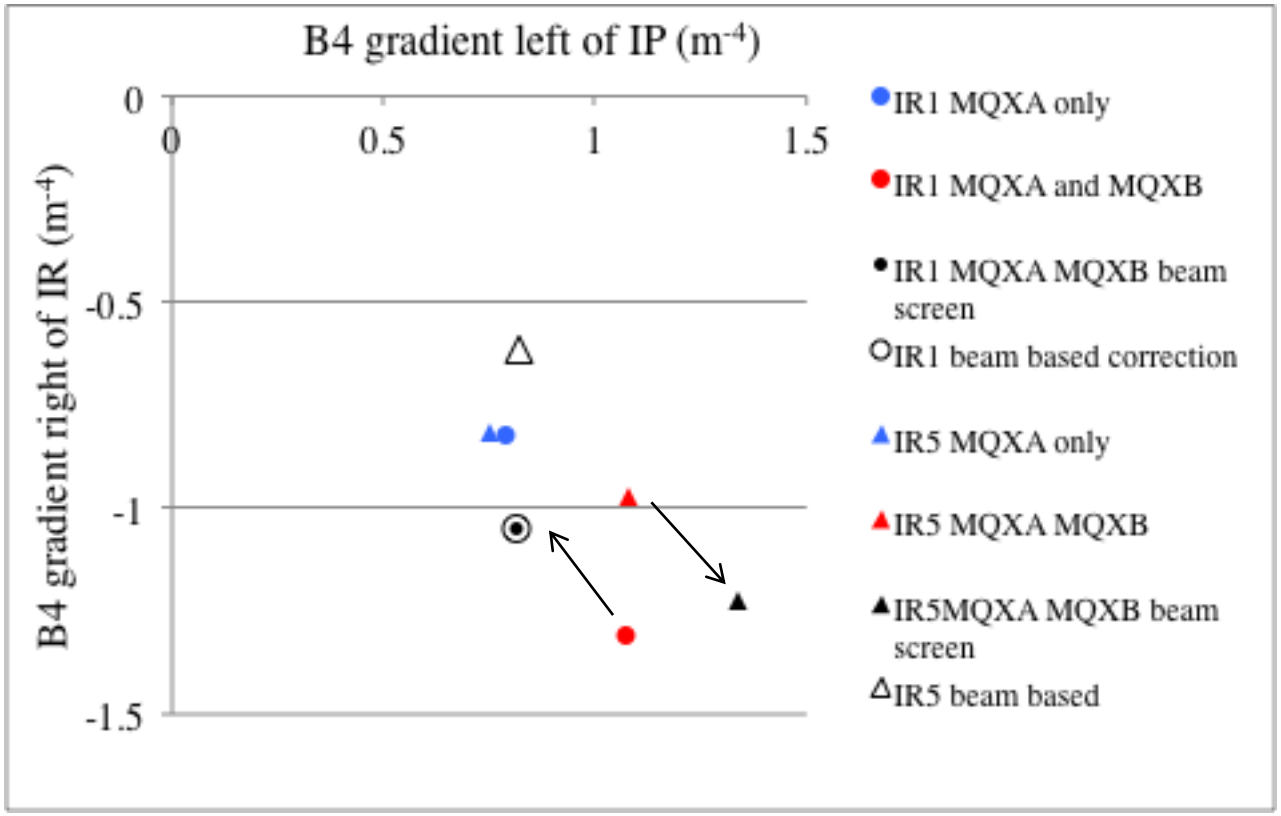
THE IR5 B4 ENIGMA

- Then we added adding MQXB
- Some impact since beta functions in MQXB are large, even though systematic is close to zero



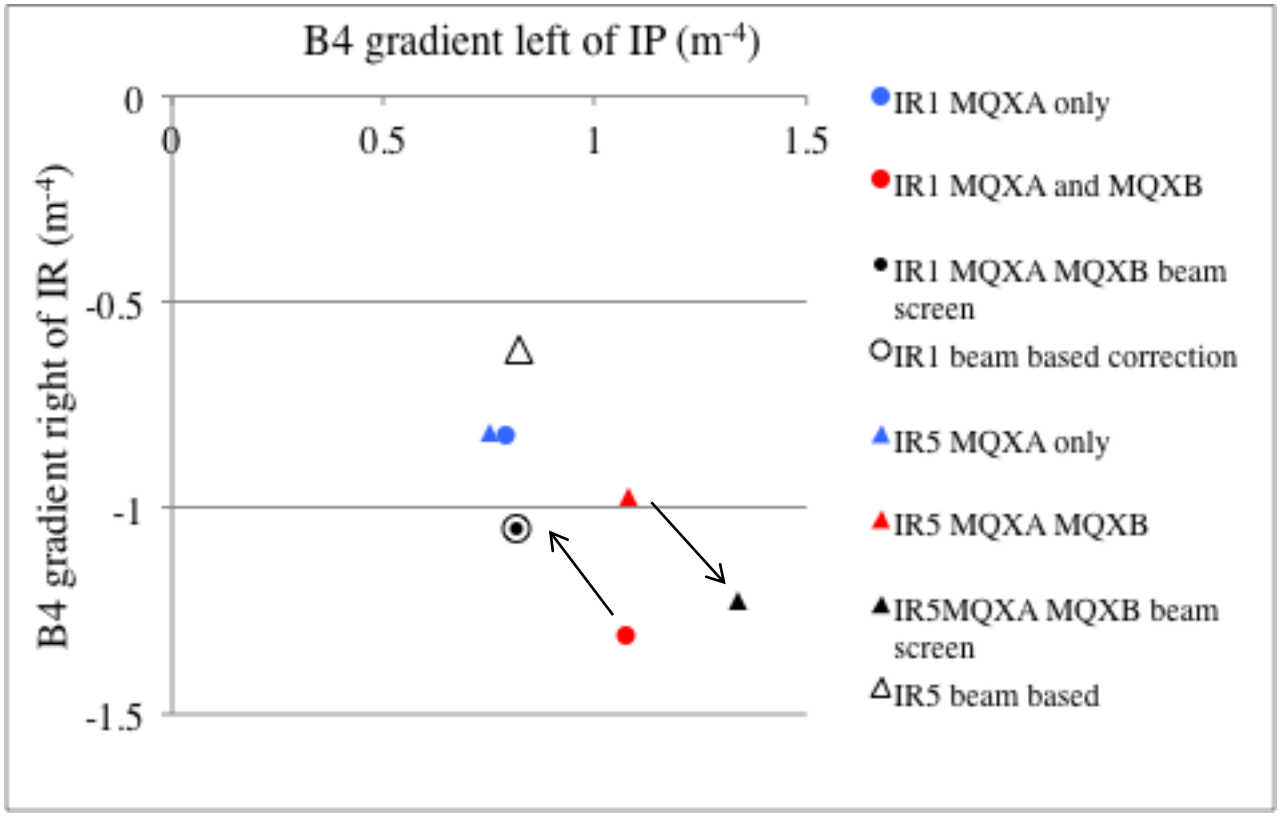
THE IR5 B4 ENIGMA

- 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)



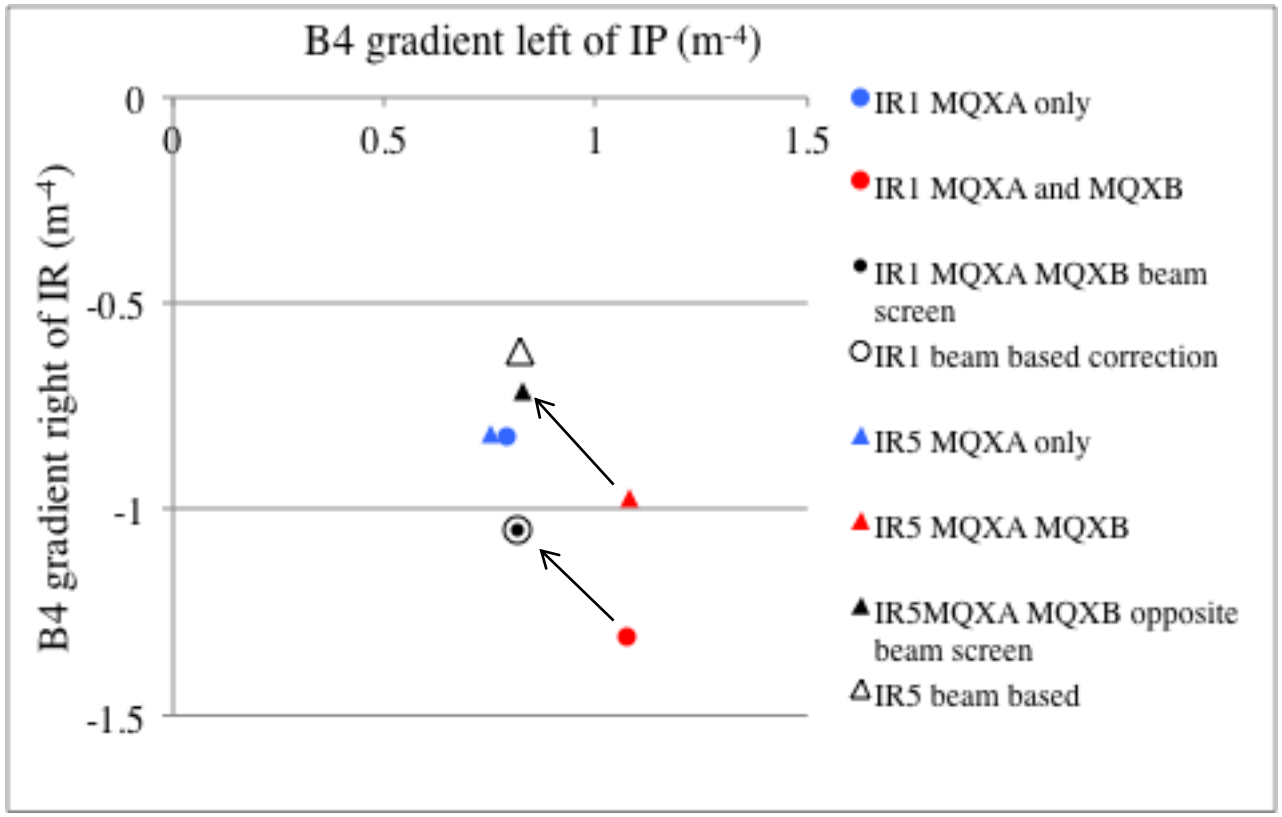
THE IR5 B4 ENIGMA

- 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



THE IR5 B4 ENIGMA

- 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
  - 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 b4 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