Usefulness of a stabilization for ATF2 final focus quadrupoles?

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Introduction

Relative motion tolerance between beam and IP: 10nm
(5% accuracy on beam size measurements)

✓ QDO/QF1FF: induce the most beam deflection at the IP when not perfectly aligned (ground motion)

➔ Studies of stabilization were focused on them

➡ Good ground motion (GM) coherence between QD0/QF1FF and IP

➔ Fixation to the floor: low relative motion between them

✓ Other ATF2 quadrupoles: lower beam deflection

➔ Fixed to the floor even if GM coherence is low (far from IP)

➡ New study: relative motion calculation between beam and IP due to the beam deflection induced by these quads subjected to GM

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Usefulness of a stabilization for these quadrupoles?

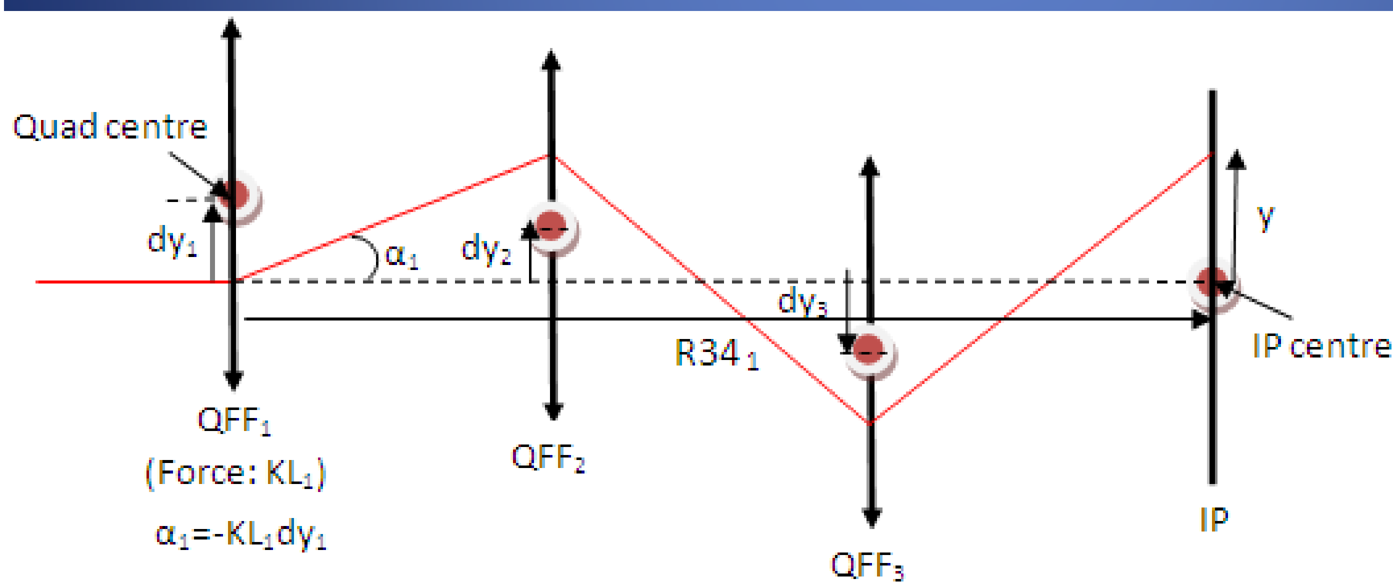
Principle of calculation

1. Use of the ATF2 ground motion generator to have relative motion $dy_i(t)$ of each FF quadrupole QFF_i to the IP (GM coherence incorporated)

2. Beam relative motion to IP due to QFF_i motion: $y_i(t)=-KL_iR34_i\ dy_i(t)$

3. Beam relative motion to IP due to motion of all quads: $y(t)=sum(y_i(t))$

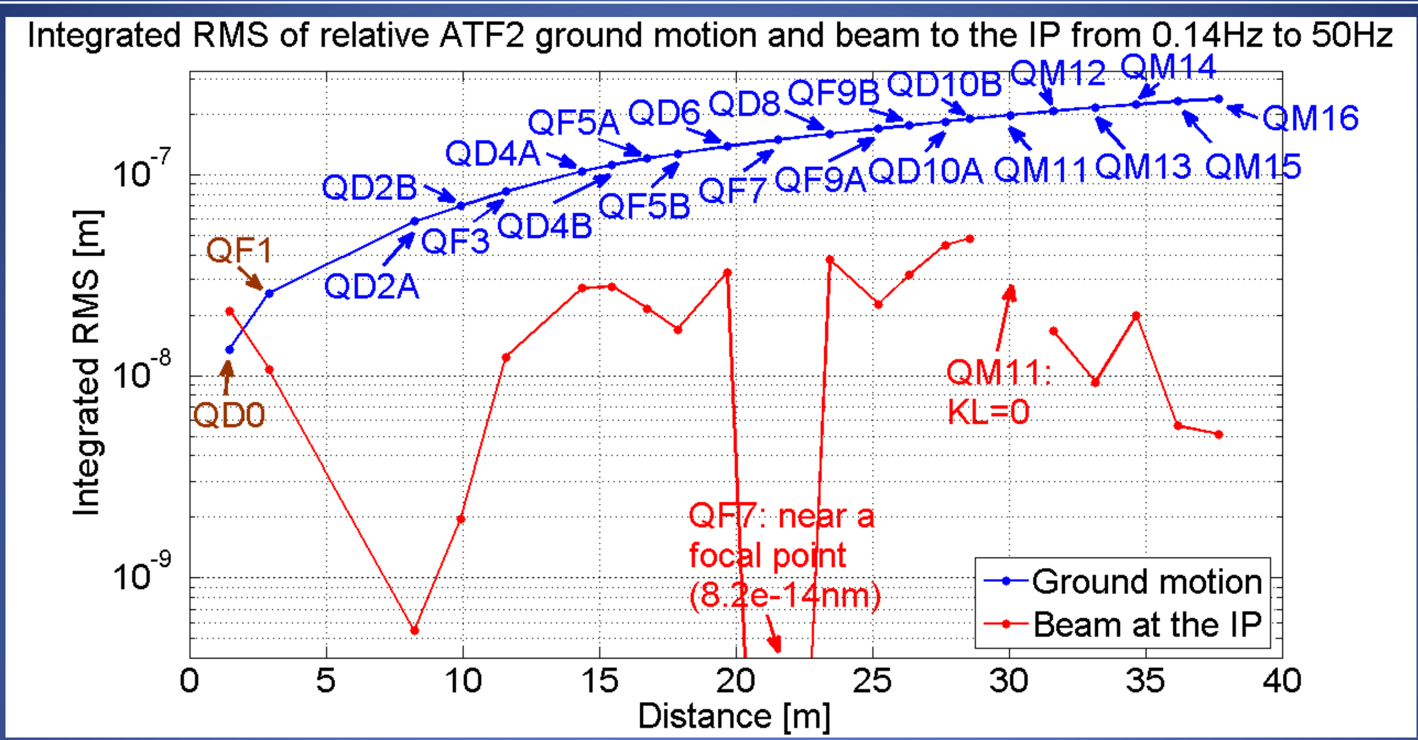
4. Calculation of the integrated RMS of relative motion $Y_i(f)$ and $Y(f)$ to get relative motion from 0.1Hz to 50Hz (sign not given with this calculus)



- ✓ *Sign of KL different for QD and QF*
- ✓ *Sign of R34 varies depending on phase advance*
- ✓ *Sign of dy(t) varies*

Sign of y(t) varies

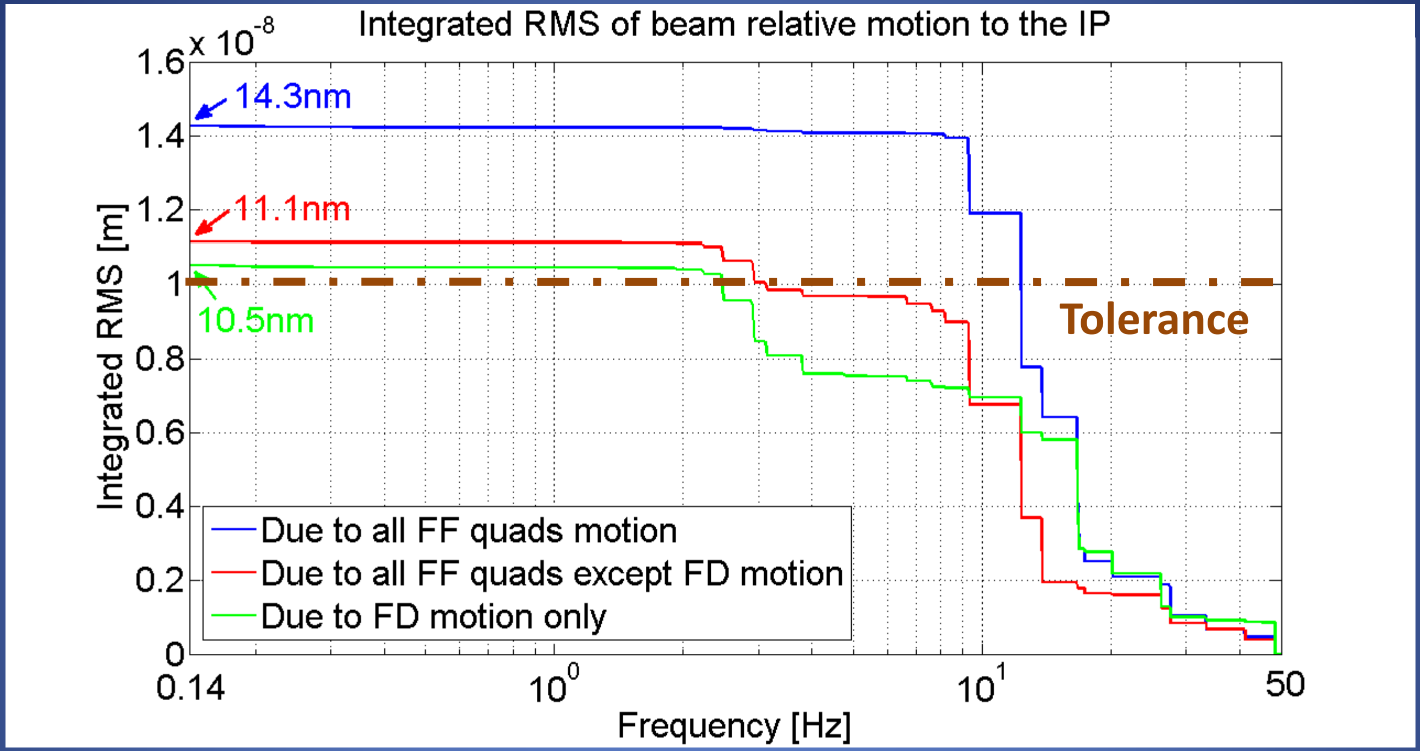
Beam relative motion to IP due to jitter of each QFF_i



- ✓ Increase of relative ground motion to the IP with increase of distance
- ✓ Beam relative motion to IP from 0.1Hz to 50Hz due to motion of:
  - ➢ QD0/QF1FF=21.0/10.7nm: high β but good coherence with the IP
  - ➢ QD10A/B=44.7/48.2nm: very high due to high β/coherence loss

➔ Necessity to look at beam relative motion due to jitter of all quads

Beam relative motion to IP due to jitter of all QFF_i



✓ Beam relative motion to IP from 0.1Hz to 50Hz due to jitter of:
- Both QD0/QF1: 10.5nm (low due to compensation of D and F)
- All FF quads except FD: 11.1nm (low due to lucky compensation)
- All FF quads: 14.3nm (low due to lucky compensation)

Beam relative motion to IP due to jitter of all FF quads almost within tolerances for 5% error on beam size measurements and high ATF2 GM

Conclusion

✓ Jitter of some of FF quads induces separately high relative motion of beam to IP (up to 50nm) due to high β and loss of GM coherence with IP

✓ But due to big luck, sum of these separatly effects well compensated and relative motion of beam to IP is only of 14nm (tolerance:10nm)

- Even much lower in reality because QF1 has a better coherence with the Shintake due to the large support (simulations done on floor)

  ➔ No need of stabilization for the quads of ATF2 beam line!!

Future work: Relative motion measurements between IP and FD with same high GM than for simulations to confirm the achieved tolerance

✓ Warning: for a beam line design different from the present one, compensation could be different (example: longer accelerator)

- Have to be careful for the future linear collider!!