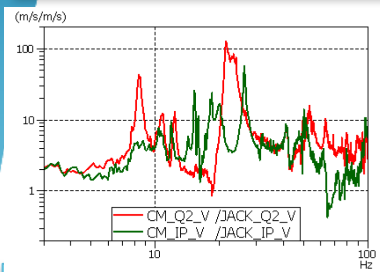
Impact of triplet misalignment:
some preliminary thoughts

D. Gamba

A few slides taken from P. Fessia presentation @Chamonix2017

89th HiLumi WP2 Meeting – 28/03/2017

Introduction



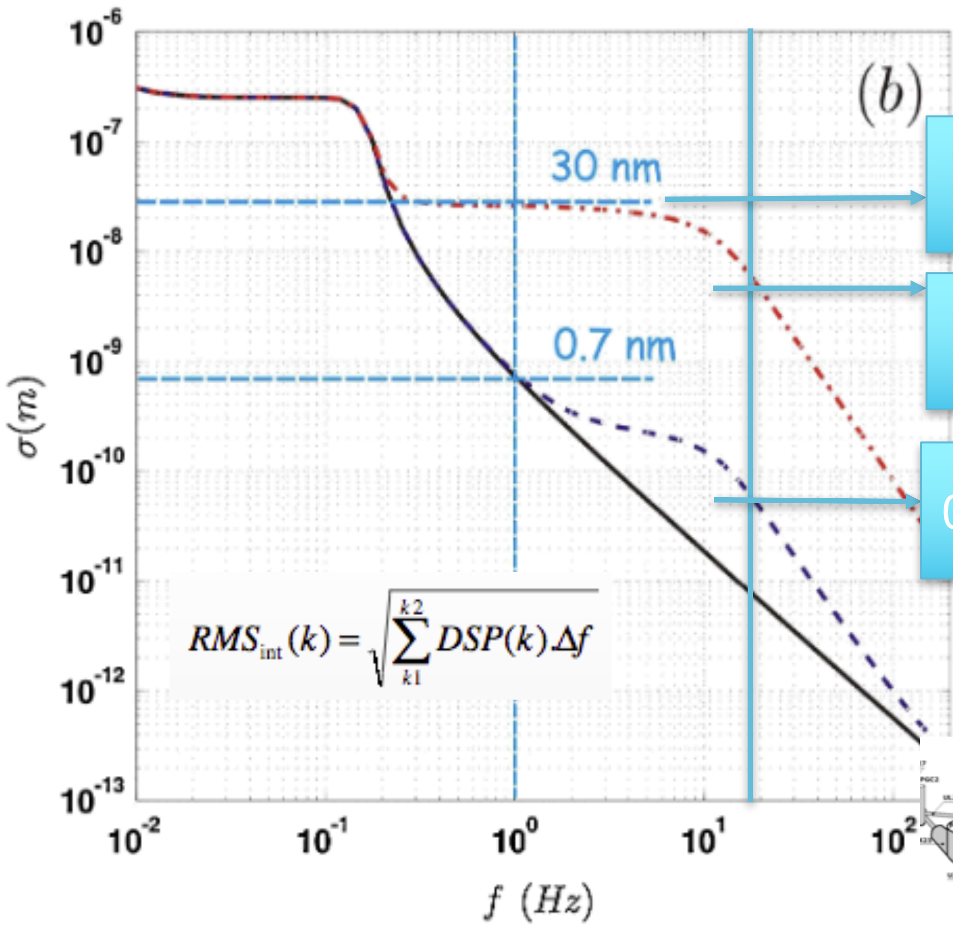
Transfer function ground to CM on spare Q1

- Identification strong modes with amplification ≈100

Vertical modes (21.5 Hz)

Lateral modes 8.4 Hz and 12 Hz

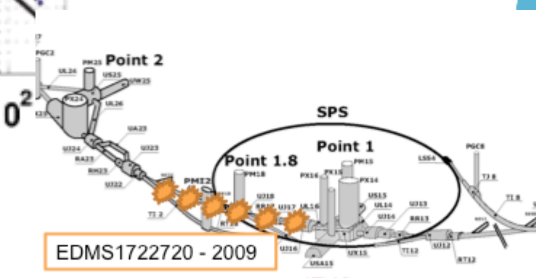
Background noise measured in sector 1-2



$$RMS_{int}(k) = \sqrt{\sum_{k1}^{k2} DSP(k)\Delta f}$$

x 100

30 nm	3 µm
4 nm	0.4 µm
0.04 nm	0.004 µm



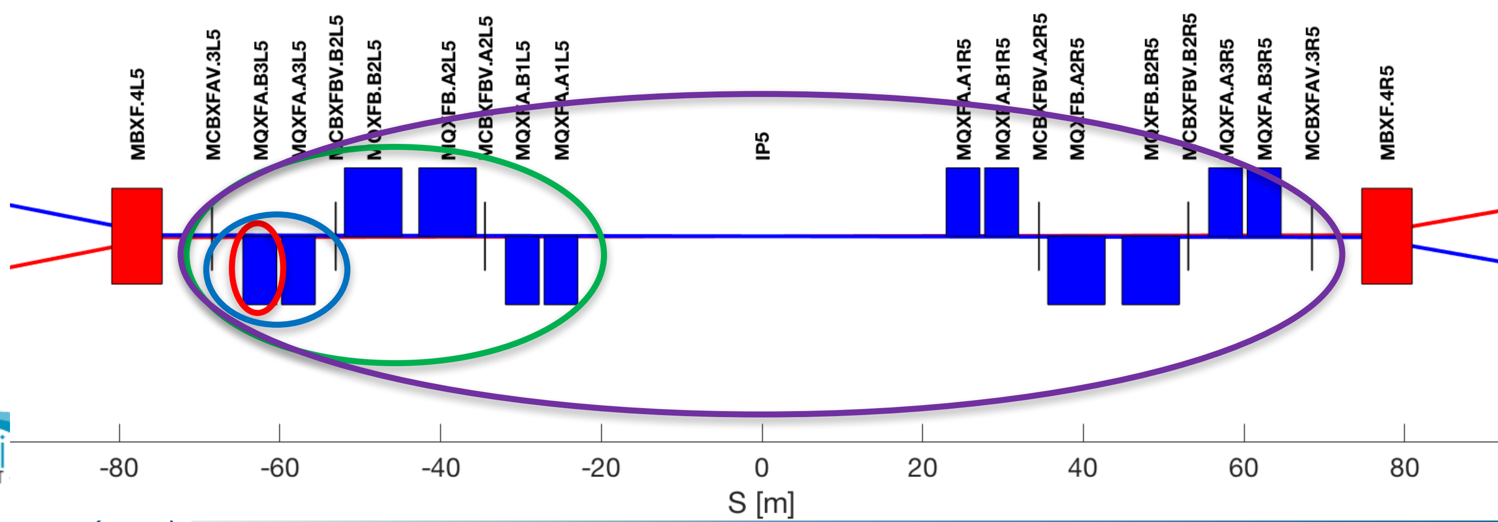
EDMS1722720 - 2009

HiLumi HL-LHC PROJECT

CERN

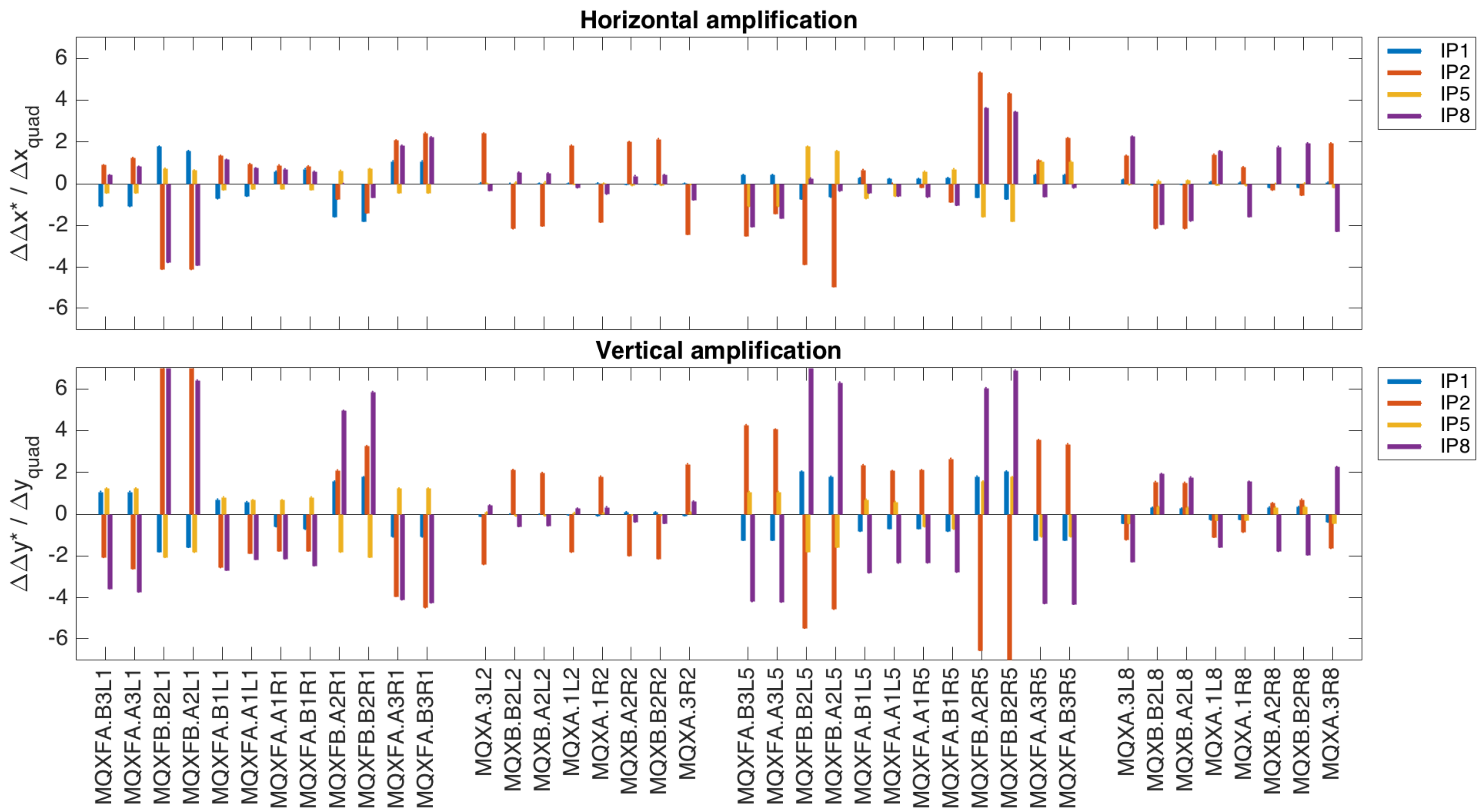
Introduction

- Preliminary study for Chamonix 2017
- Computing closed-orbit **separation** at the IPs under the effect of triplet **transverse** misalignments.
- "**Best case**" scenario:
  - Each element moves independently from the others.
  - **Sum in quadrature of each single element effect**
- "**Worst case**" scenario:
  - The whole IR moves coherently according to the worst mode.
  - **Sum of the absolute effects within each IR, then in quadrature over the 4 IRs**



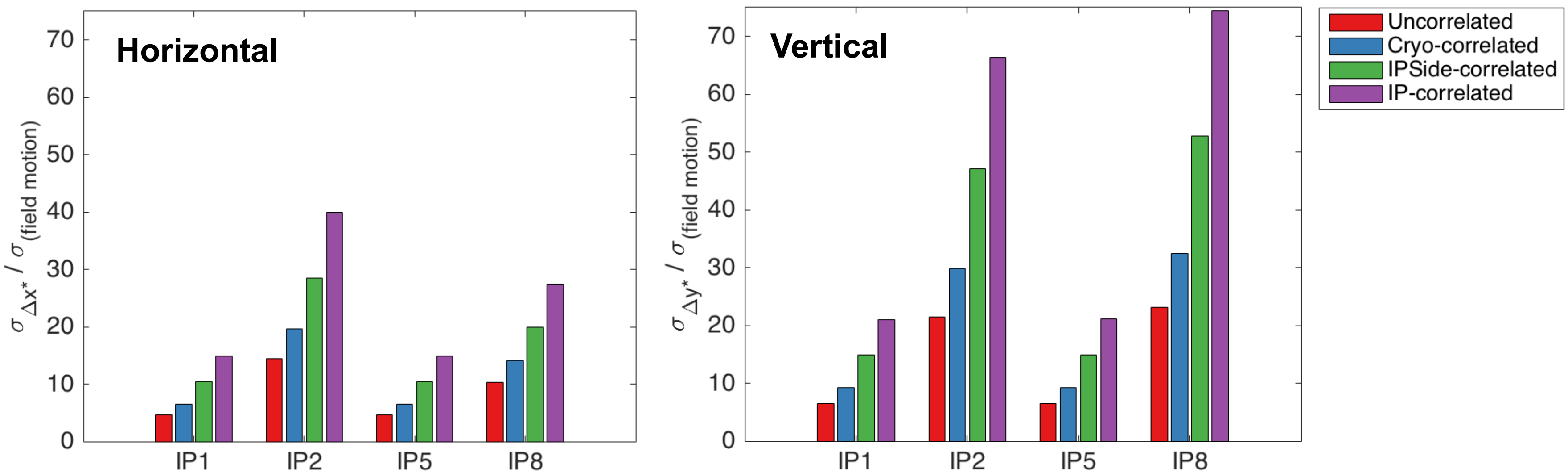
Amplification from triplet to beam motion HL-LHC

Contribution of each single triplet magnet displacement to beam separation:



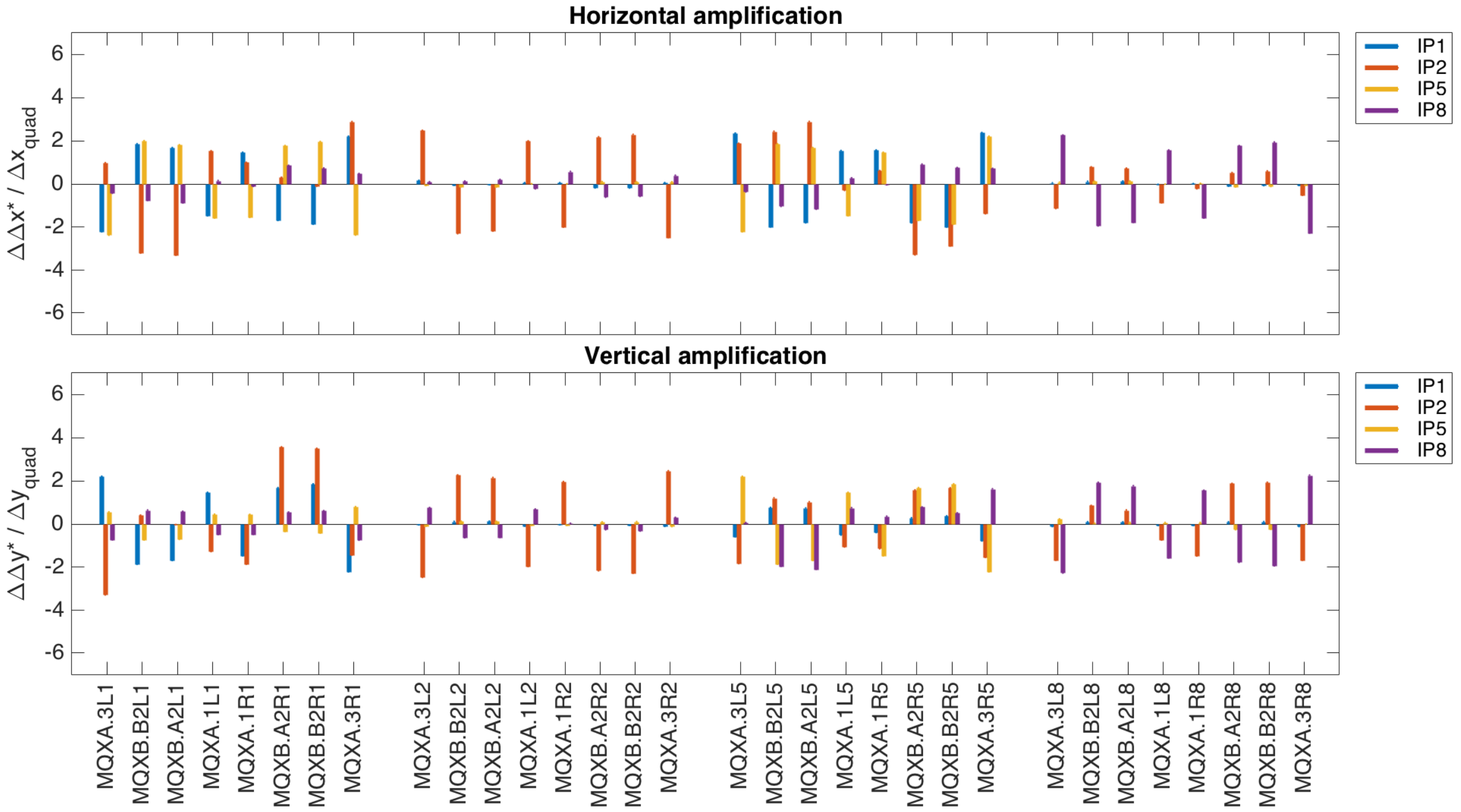
Amplification from triplet to beam motion HL-LHC

- Preliminary estimation using HL-LHC V1.3 round nominal optics (β^* = 15 cm, 2.5 μm ε_N).
- Assuming only transverse vibrations of all MQX magnets in IP1, IP2, IP5, IP8.
- Computing the amplification factor from **magnetic center jitter to closed orbit jitter**.
  - worst correlation scenarios: all (40) quadrupoles uncorrelated (**red**), correlation only within cryoassembly (**blue**), correlation only within all magnets of each side of each IP (**green**), correlation within all magnets of each IP (**purple**).
- A plausible, yet conservative, scenario could be the correlation only within each IP side **(green)**.
- Basic estimation for **IP1/5** where the nominal beam σ ≈ 7 μm:
  - **0.04 ÷ 30 nm** (ground motion jitter) **x100** (amplification by cold mass) **x10 ÷ 15** (from plot below) **≈ 0.04 ÷ 45 μm beam separation jitter ≈ 0.005 ÷ 6.5 beam σ ⇒ luminosity degradation!**
- For **IP8** (beam σ = 32 μm), assuming **x50** amplification, separation jitter up to **4.7 beam σ**.



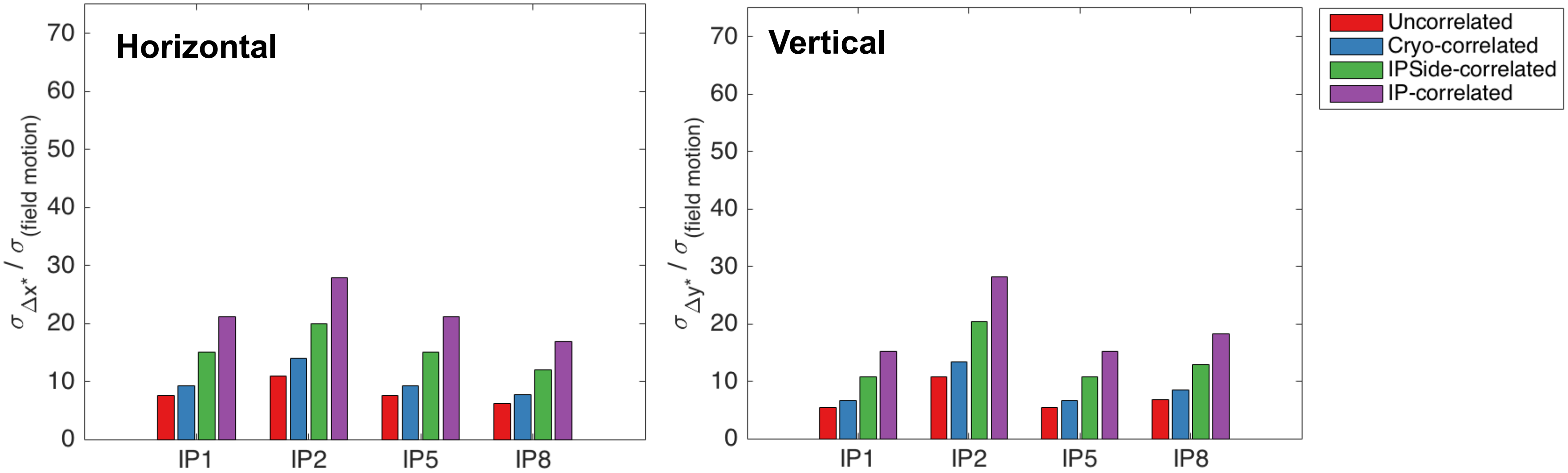
Amplification from triplet to beam motion LHC

Contribution of each single triplet magnet displacement to beam separation:

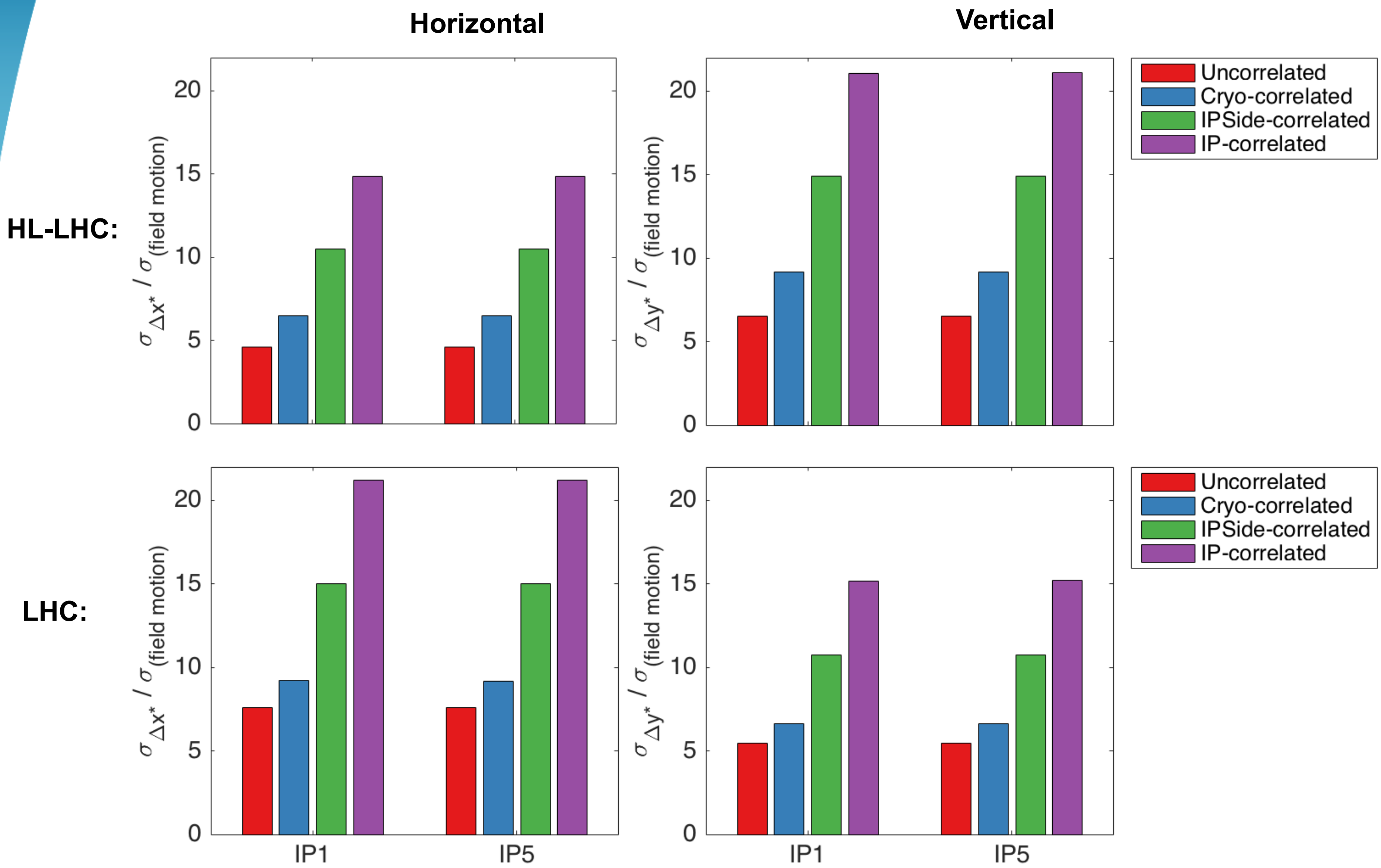


Amplification from triplet to beam motion LHC

- **Same analysis as before, but on present LHC** (β^* = 40 cm, 3.75 µm ε_N).
  - Optics lhc_opt2016_coll400.madx
- The effect at IP1/5 seems to be very similar as for HL-LHC
- Degradation mainly visible in IP2/8
- Basic estimation for IP1/5 where the nominal beam size σ ≈ 14 µm:
  - **0.04 ÷ 30 nm** (ground motion jitter) **x100** (amplification by cold mass) **x10 ÷ 15** (from plot below) **≈ 0.04 ÷ 45 µm beam separation jitter ≈ 0.003 ÷ 3.2 beam σ**
    - **But no luminosity degradation observed (?)**
- In **IP8** (beam σ ≈ 39 µm), assuming **x15** amplification, separation jitter up to **0.9 beam σ**



Same figures, but only IP1/5



--- Thanks for your comments ---