# Correction of ground motion in the CLIC BDS

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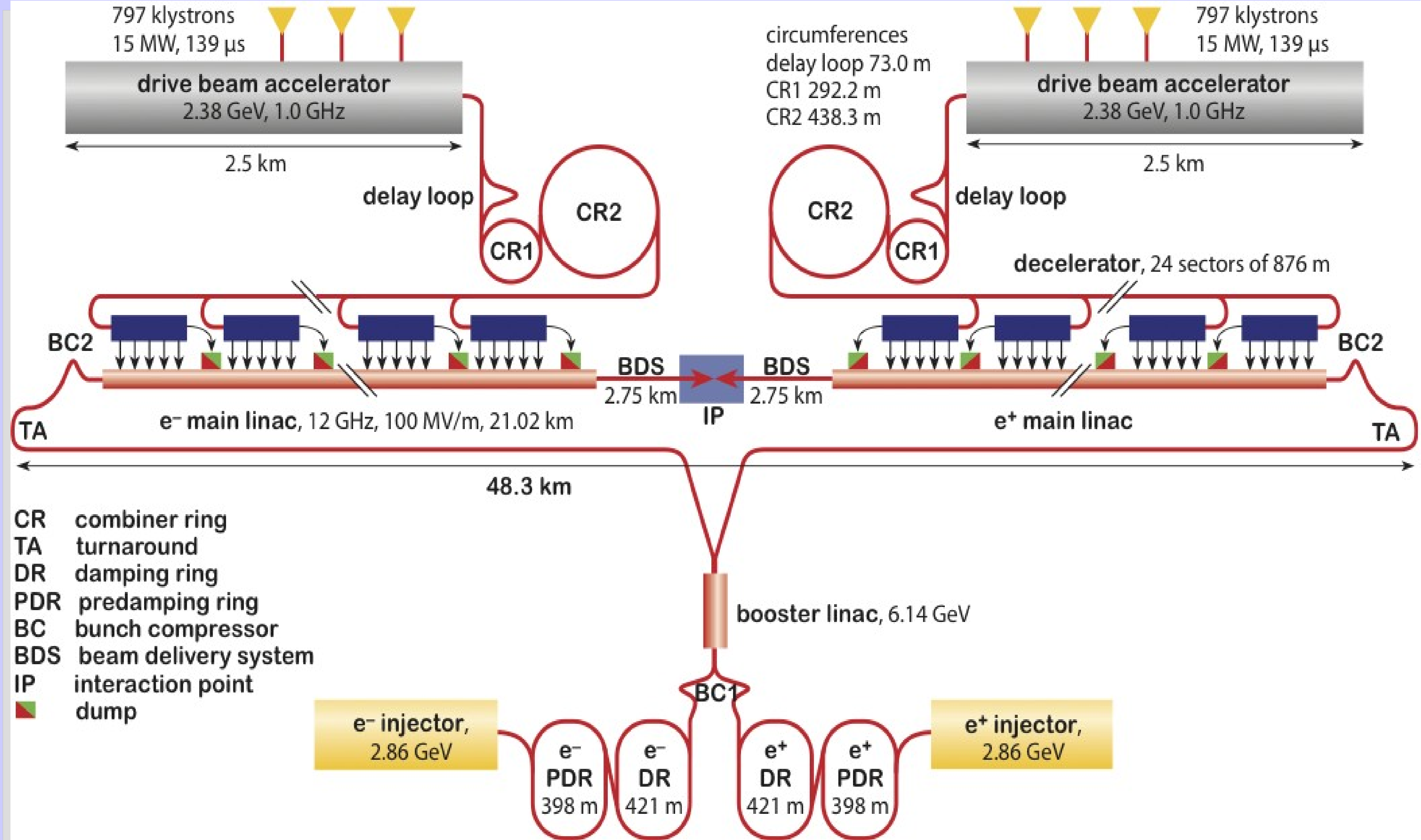
10/20/10

# Outline

- Ground Motion
- Quadrupole offset sensitivity
- Quadrupole stabilisation
- Orbit correction and IP feedback
- Luminosity impact

# CLIC BDS


797 klystrons
15 MW, 139 μs
drive beam accelerator
2.38 GeV, 1.0 GHz
2.5 km
circumferences
delay loop 73.0 m
CR1 292.2 m
CR2 438.3 m
797 klystrons
15 MW, 139 μs
drive beam accelerator
2.38 GeV, 1.0 GHz
2.5 km
delay loop
CR2
CR1
CR2
CR1
delay loop
deceleration, 24 sectors of 876 m
BC2
BDS
2.75 km
BDS
2.75 km
BC2
IP
TA
e⁻ main linac, 12 GHz, 100 MV/m, 21.02 km
e⁺ main linac
TA
48.3 km
CR combiner ring
TA turnaround
DR damping ring
PDR predamping ring
BC bunch compressor
BDS beam delivery system
IP interaction point
dump
booster linac, 6.14 GeV
BC1
e⁻ injector,
2.86 GeV
e⁻
PDR
398 m
e⁻
DR
421 m
e⁺
DR
421 m
e⁺
PDR
398 m
e⁺ injector,
2.86 GeV

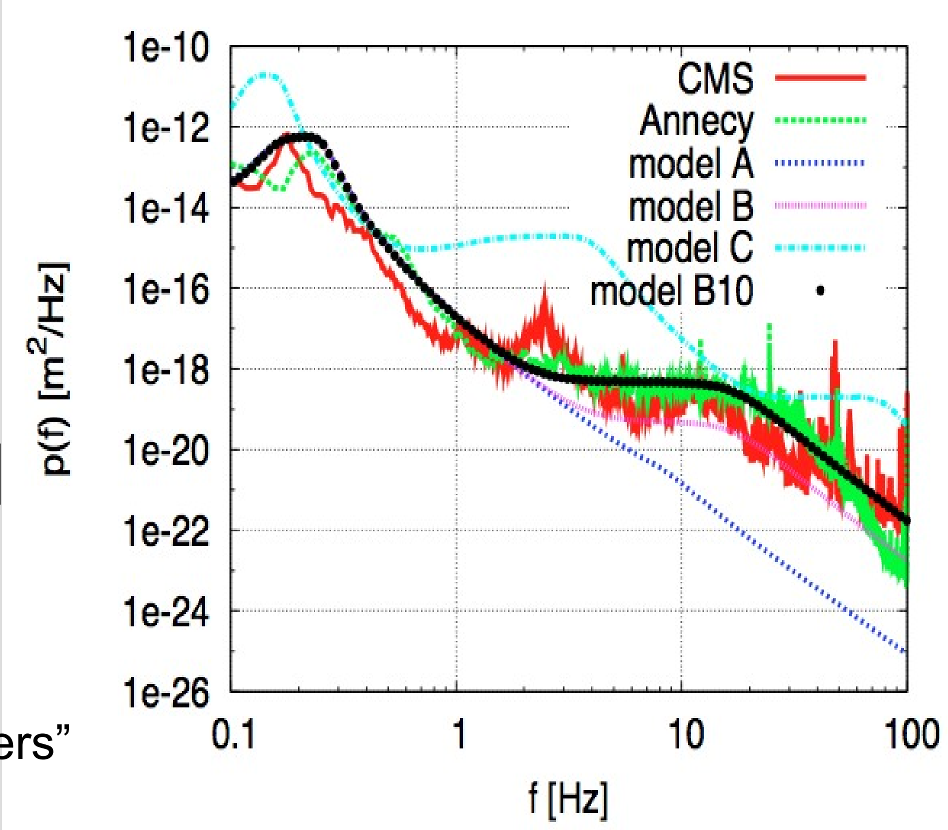
# Ground Motion in BDS

Why should we study ground motion in BDS?

- Main source for dynamic imperfections
  - Serious impact on luminosity
- Puts stringent requirements on stabilisation

# Ground Motion

- Slowly drifting element positions
- Short time scales (< 10 s)
  - A. Seryi models[1] (see figure)
  - Standalone script incorporated into tracking code PLACET
- Long time scales
  - ATL law:
    - Variance ~ A*t*L
- Model B and B10 are used



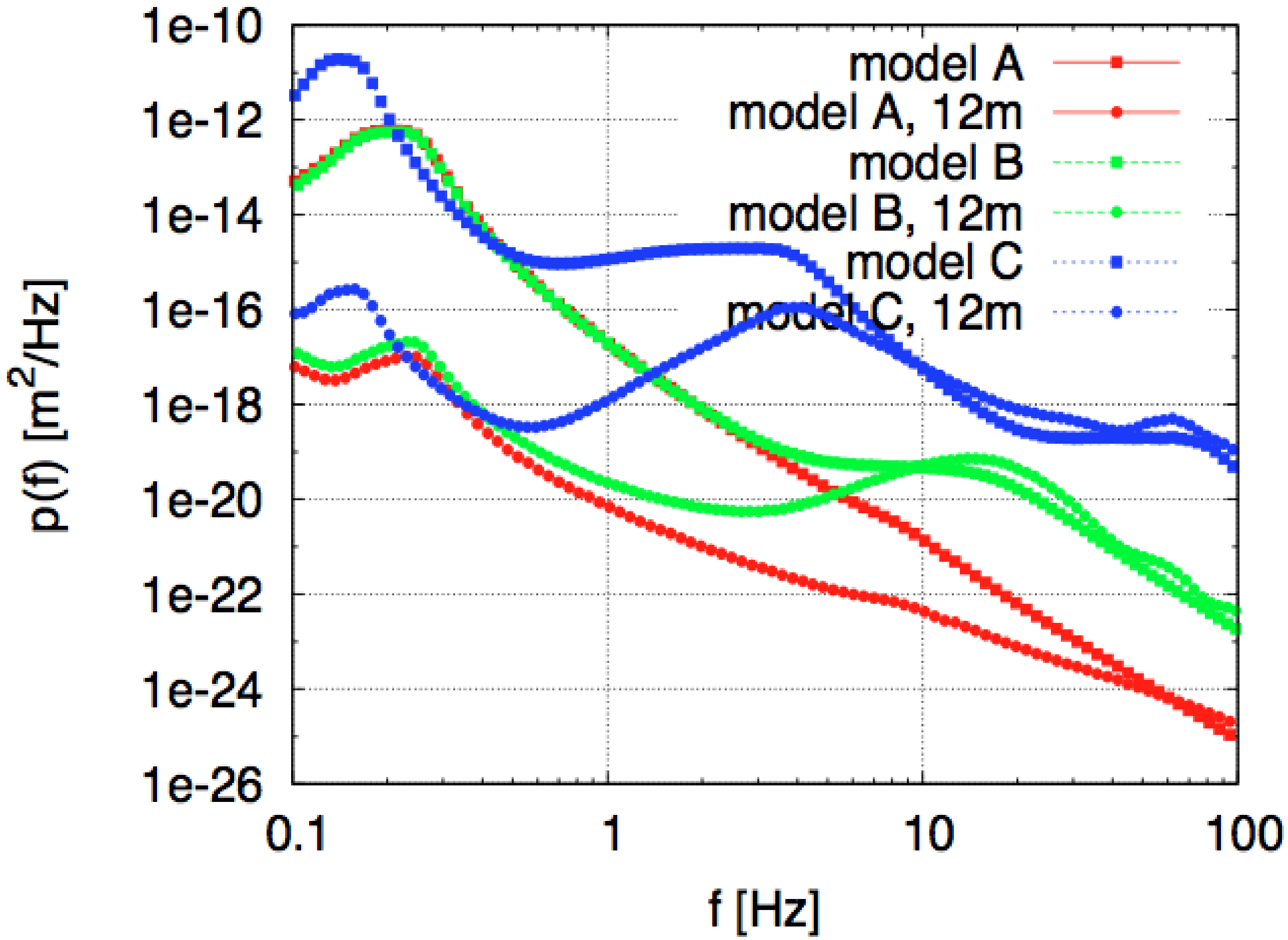

1: “Ground Motion Models for Future Linear Colliders” EPAC2000, Vienna

# Ground Motion

## Ground Motion Correlation

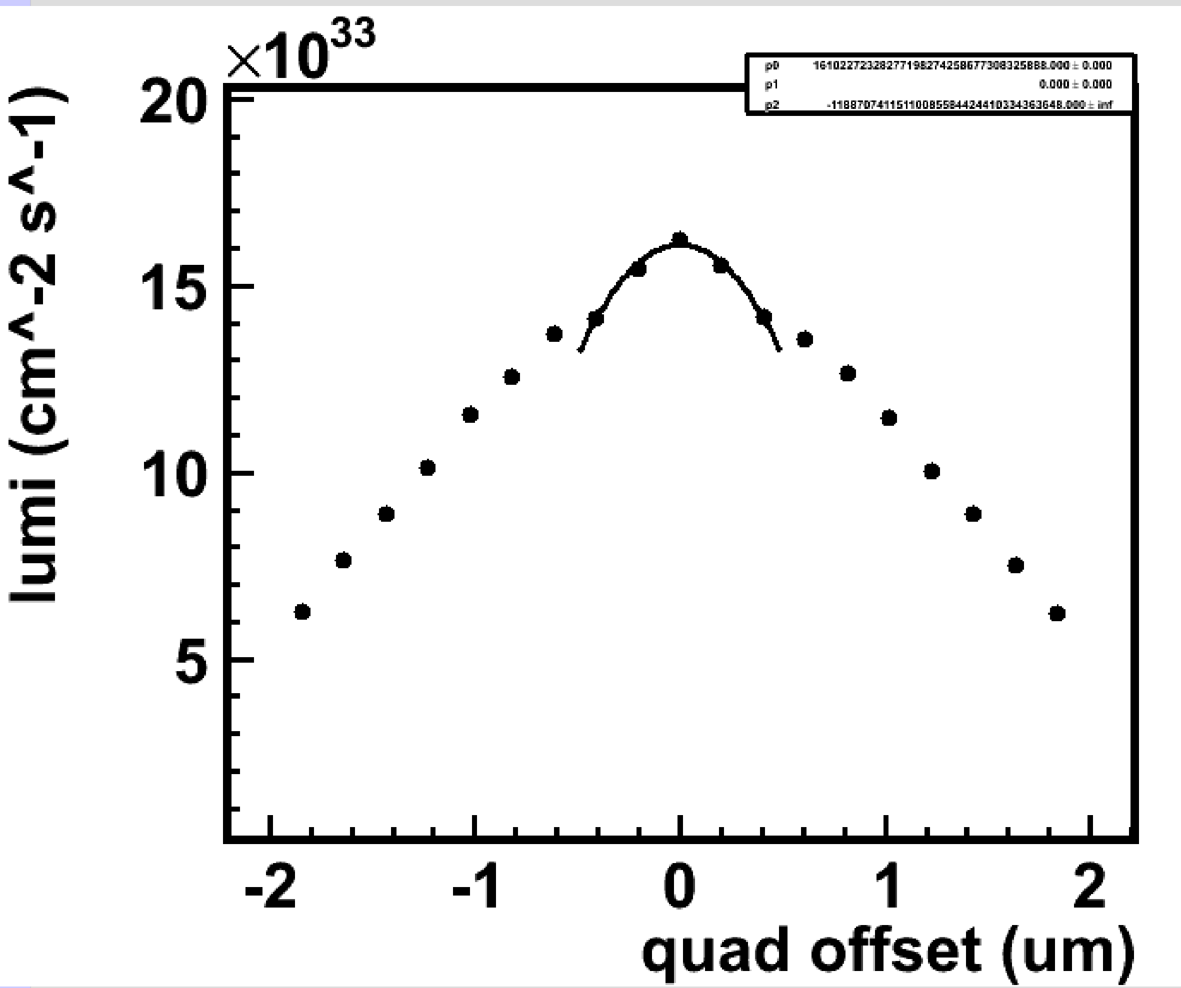
- Ground motion is correlated
- Correlation has an impact on the luminosity performance
  - e.g. relative offsets of final quadrupoles is important (relevant distance $\approx 12\,\mathrm{m}$)

$\Rightarrow$ high frequency part is uncorrelated



# Quadrupole offset sensitivity

Quadrupole 103 (halfway BDS)

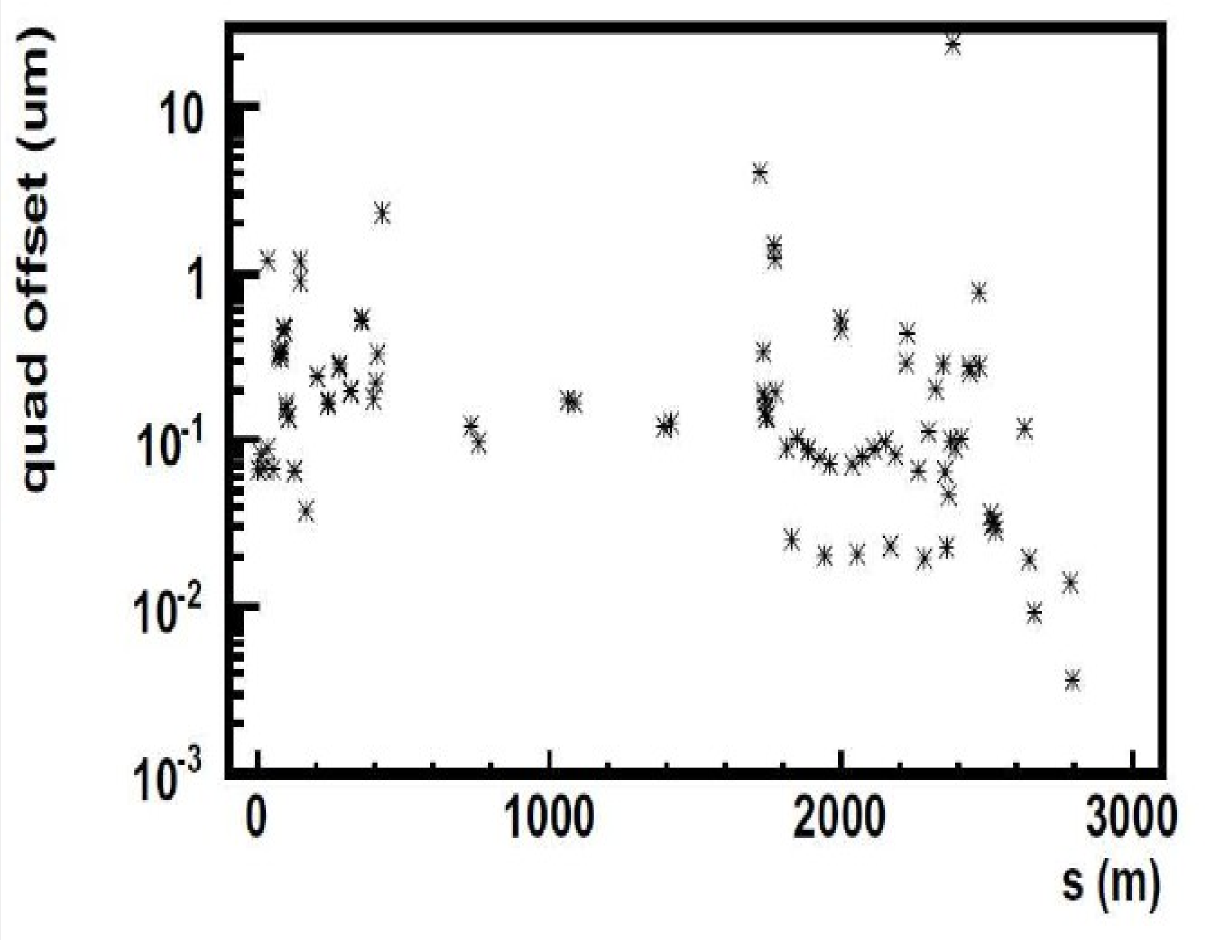



IP corrected

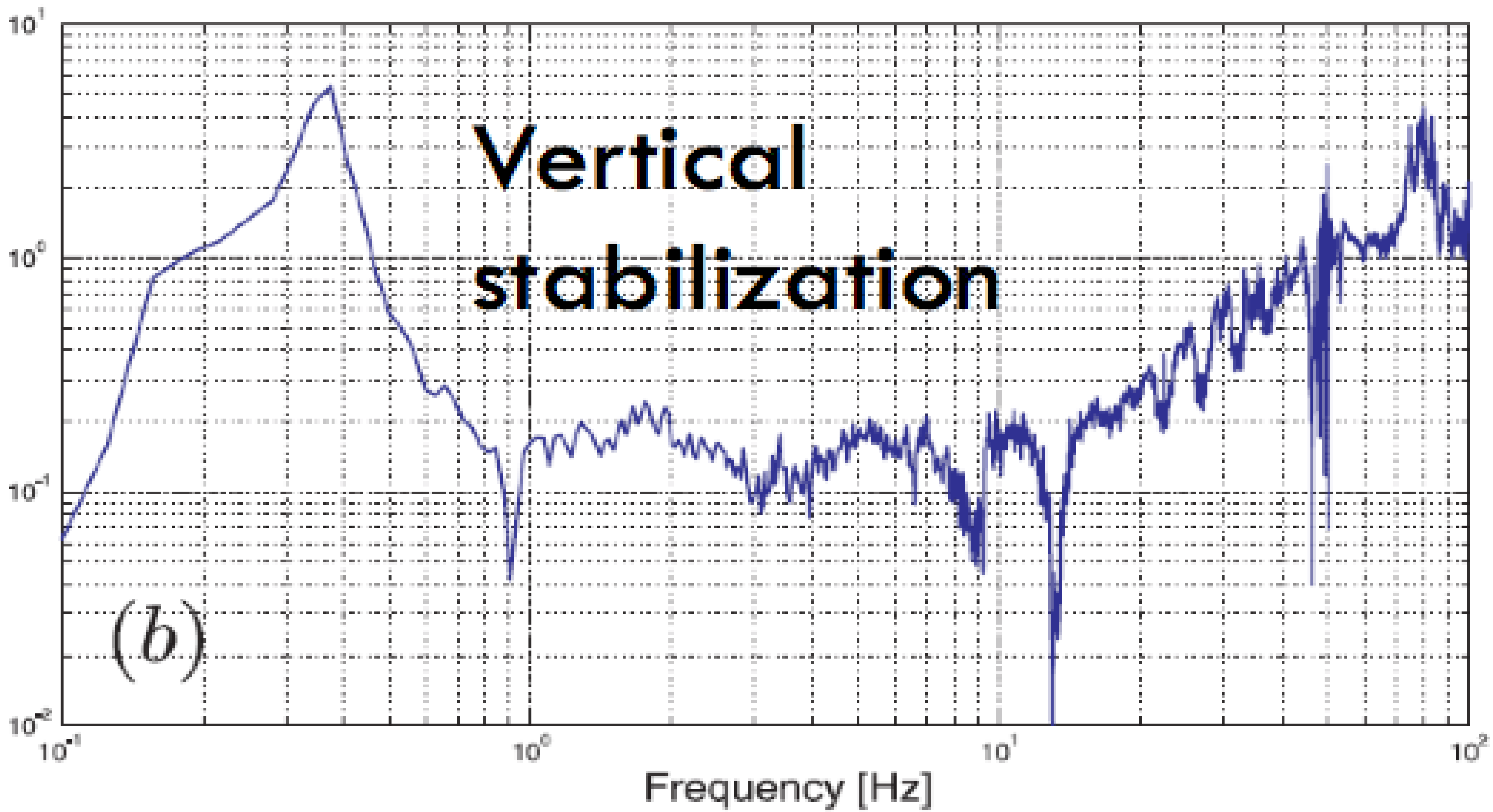
If uncorrected by orbit correction, each misaligned quadrupole induces some luminosity loss

# Quadrupole offset sensitivity

- For every quadrupole in the BDS the offset that corresponds to a 2% has been calculated
- Tolerances of a few nm for the FD quads



# Quadrupole Stabilisation

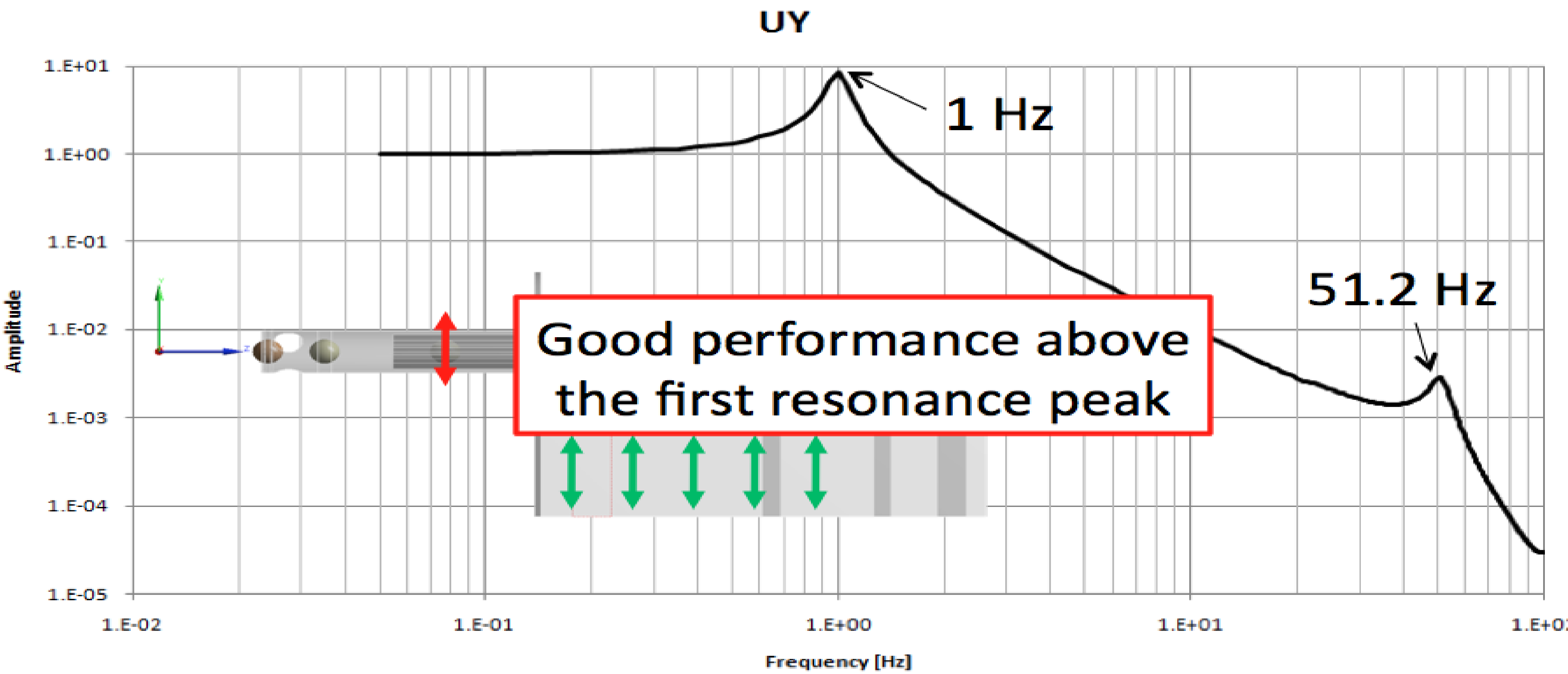



C. Collette for the CERN stabilisation team, see talk tomorrow WG7+8

# QD0 stabilisation

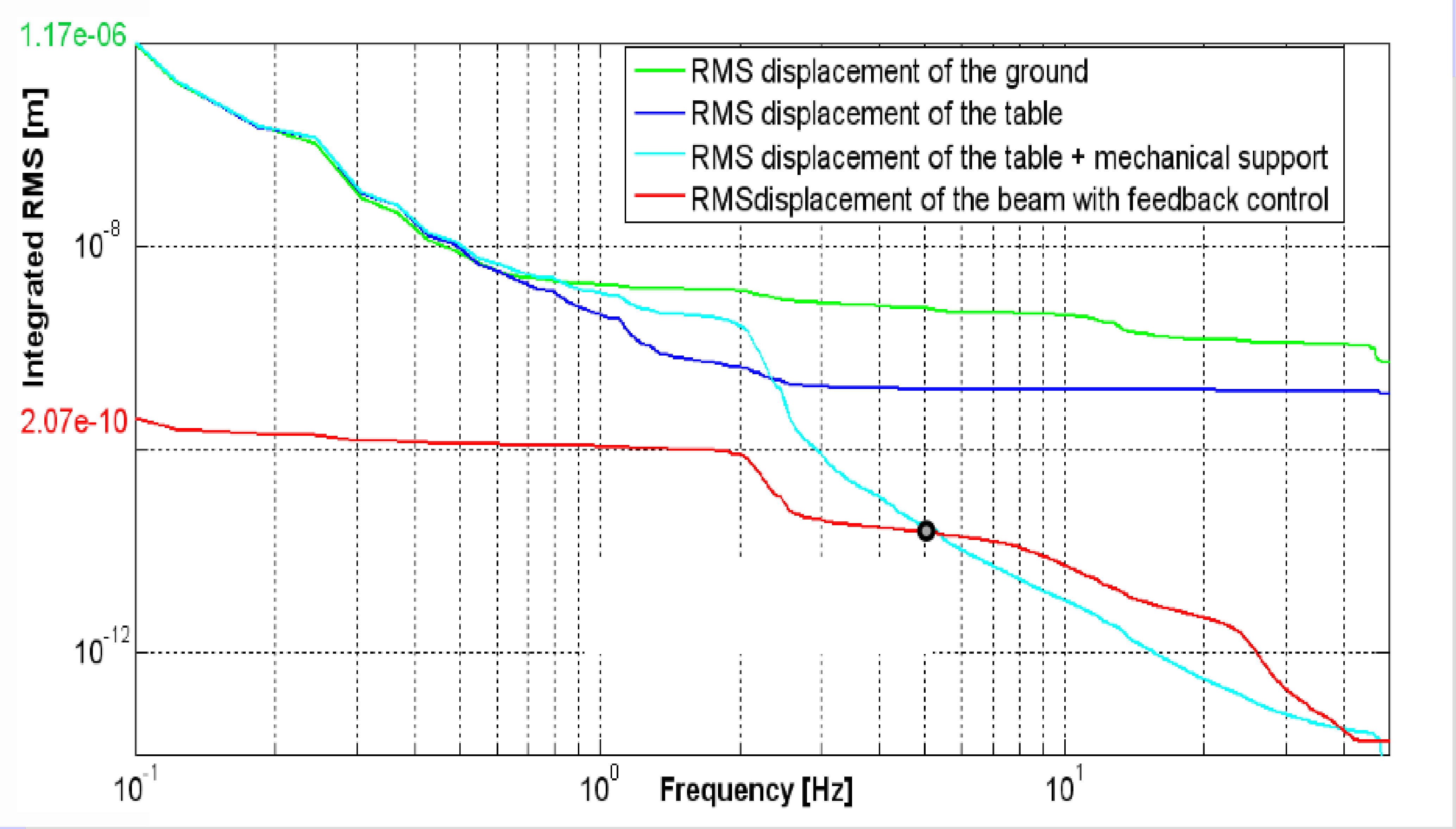
## Harmonic excitation in the vertical direction

Vertical steady-state response at QD0




F. Ramos, A. Gaddi, H. Gerwig, N. Siegrist, see talk tomorrow WG 5+8

# QD0 stabilisation



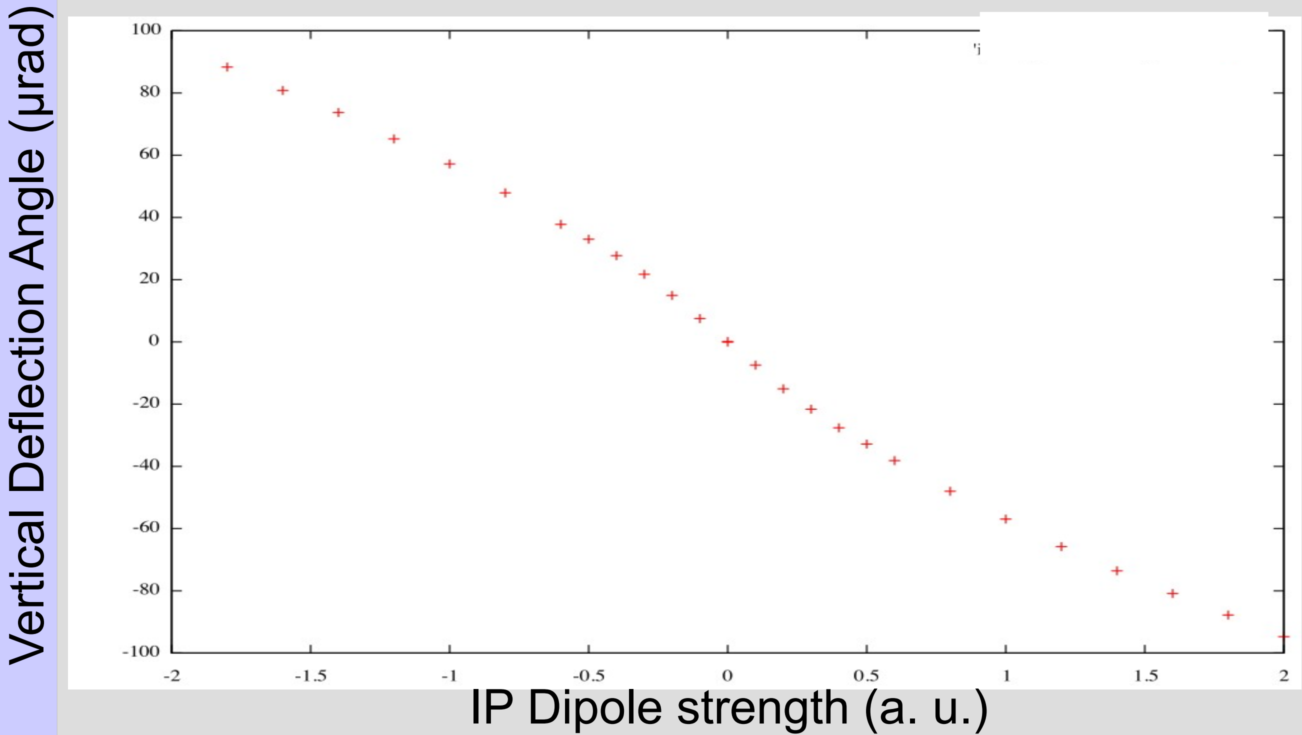

LAPP – LAViSta Project, see talks tomorrow A. Jeremie & G. Balik

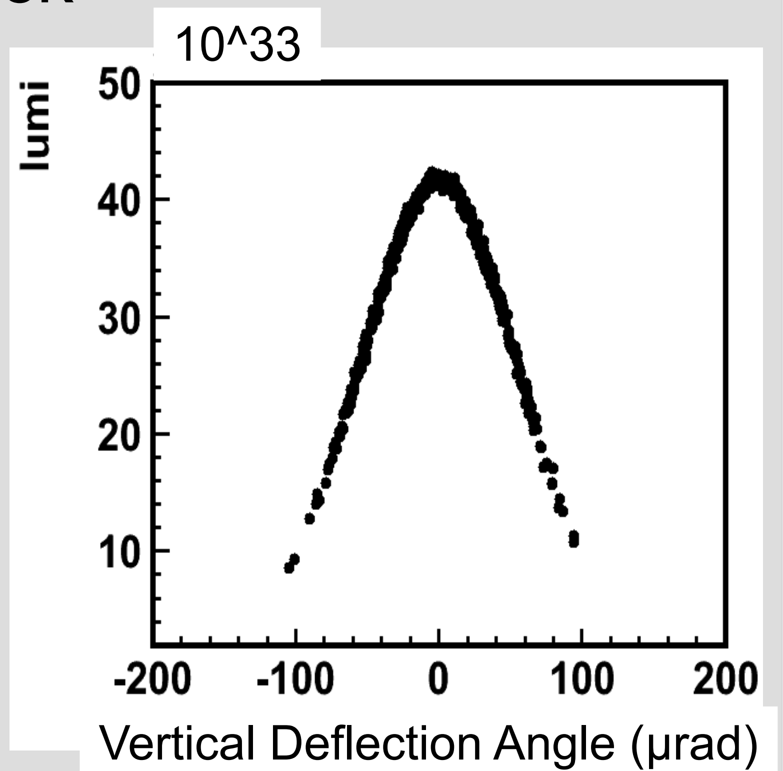
# Orbit correction

- Measure quadrupole offsets with BPMs
  - 79 BPMs (placed after every quad and sextupole)
- Correct BPM positions by dipole kickers
  - 62 kickers
- Minimalise BPM offsets (wrt nominal)
- SVD algorithm
  - see Jürgen Pfingstner talk tomorrow, WG 7
- Simulations performed in PLACET and GUINEA-PIG

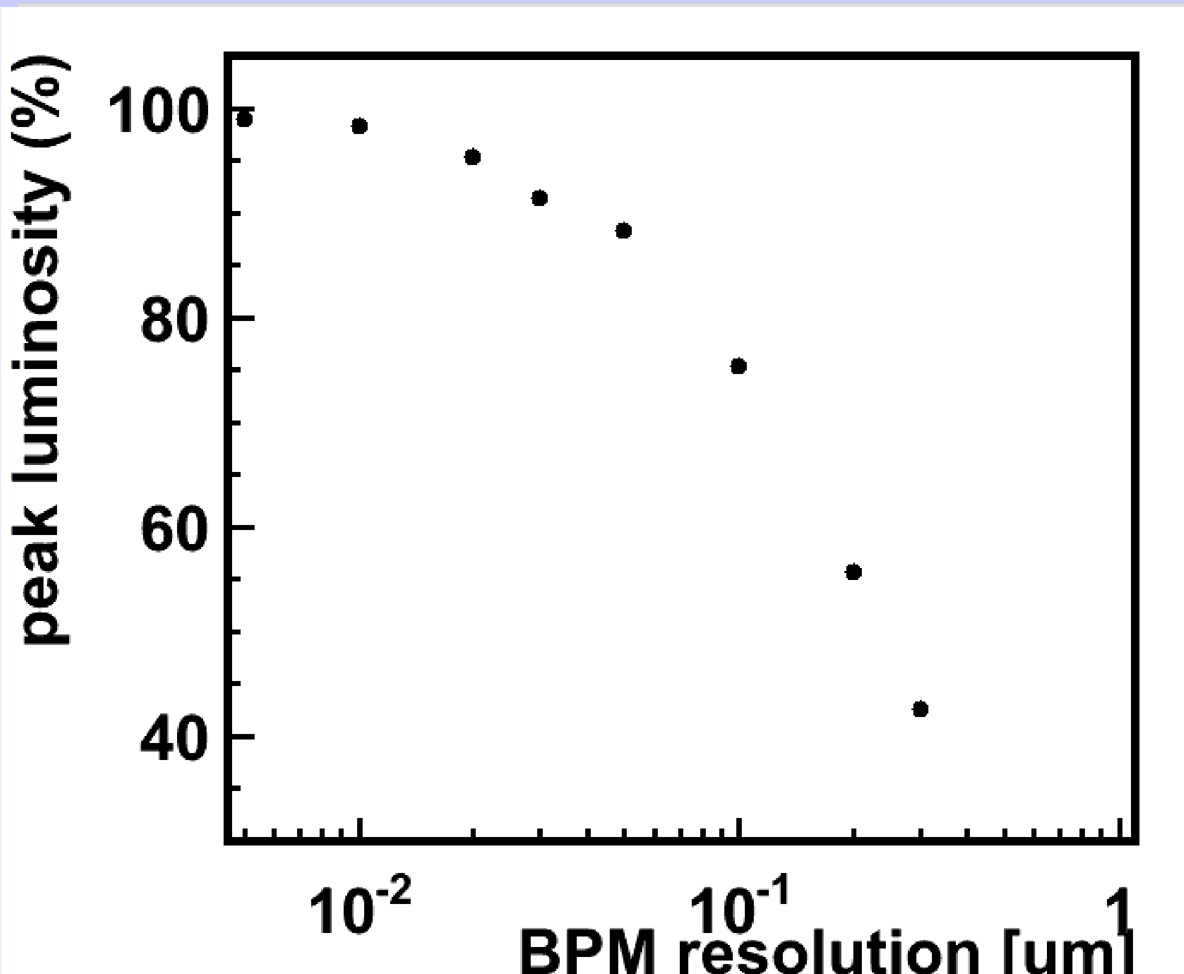
# IP feedback

- IP feedback (beam-beam based):
  - Special feedback of post-collision BPM to last dipole (“IPDipole”)
  - Correct deflection angle for colliding beams
  - Strong correlation with luminosity
  - Possibility for intra-pulse feedback



# BPM resolution




No ground motion,
just BPM meas. errors.

Gain = 1, BPM resolution is less dominant when lower gain is used.

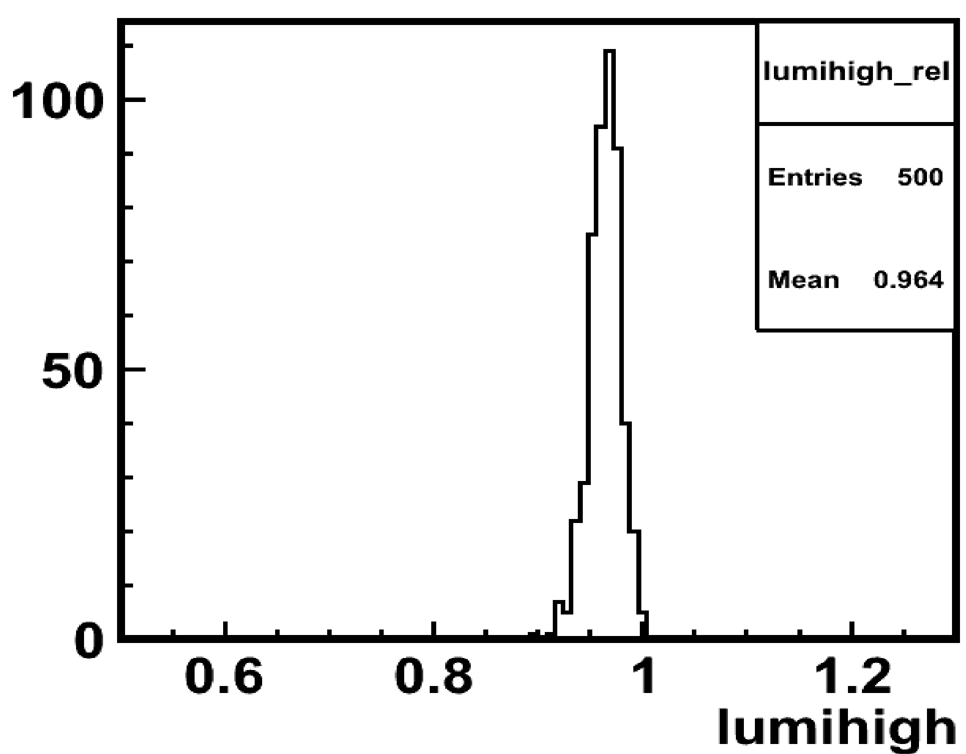
BPMs close to IP are most sensitive.

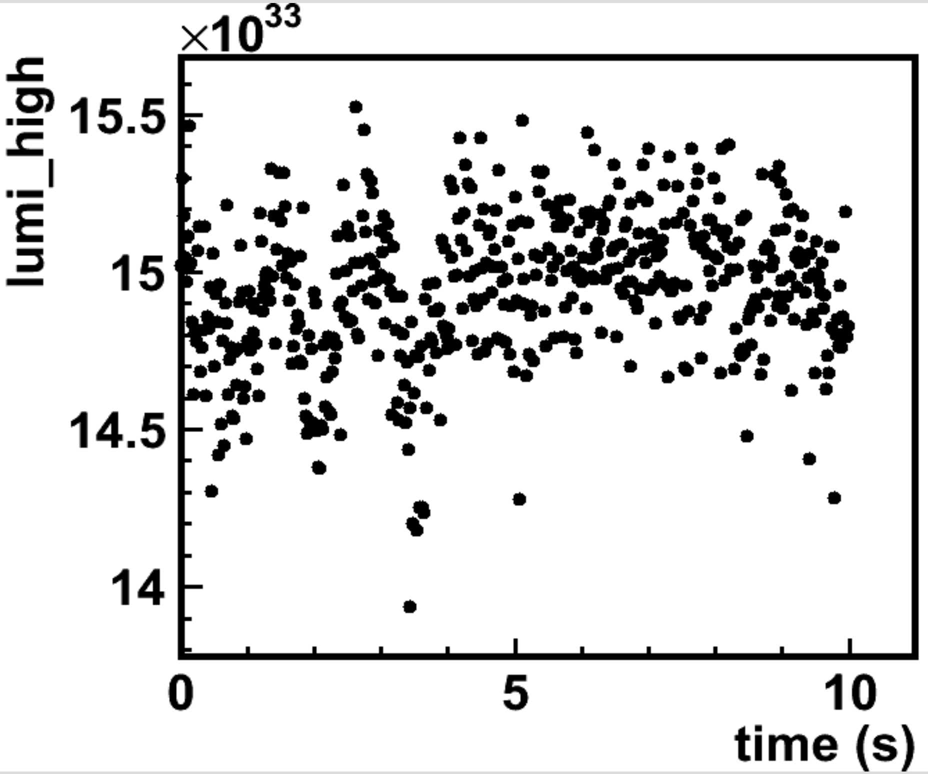
Required BPM resolution for 5-10% loss: 20-50 nm

in agreement with earlier studies by J. Resta-Lopez

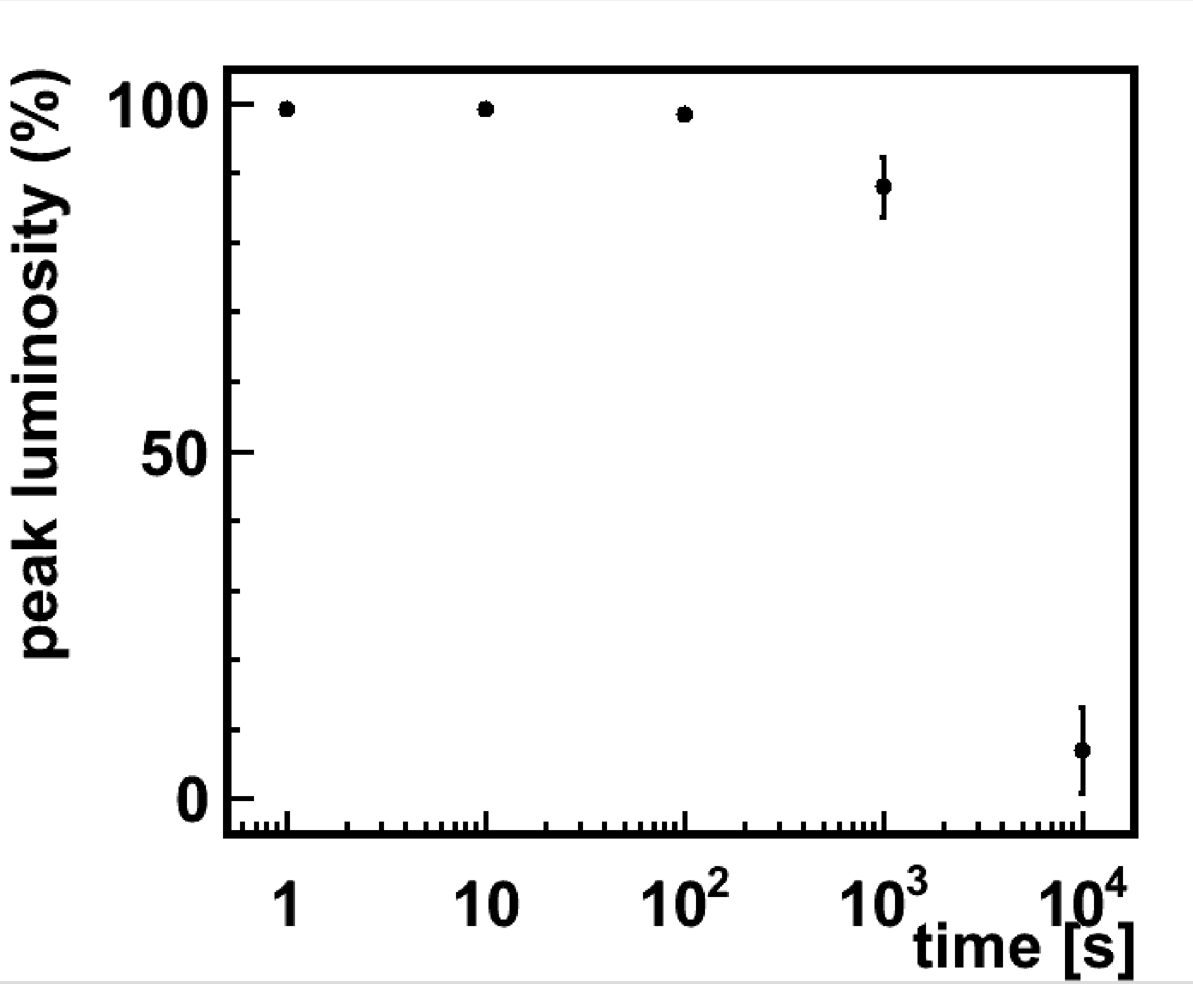
# Adding it all together: Luminosity impact

- lumi distribution plot after several seconds (500 trains with 0.02s distance)
- for both models B and B10 (B10 shown here, but results are similar): 4% lumi loss



# Longer time scales (ATL)




After some period of no active correction. The SVD is not capable to return to nominal luminosity.

Further optimization procedures are required after about half an hour.

# Conclusions and Remarks

- Integrated simulations show promising understanding and performance of the feedback system for dynamic imperfections caused by ground motion in the BDS
- Simulations include ground motion, stabilisation filters, orbit correction
  - Extensions to fully include the main linac are well under way, see Jürgen Pfingstner's talk tomorrow WG 7
- Confirmation of generic results, see Daniel Schulte's talk