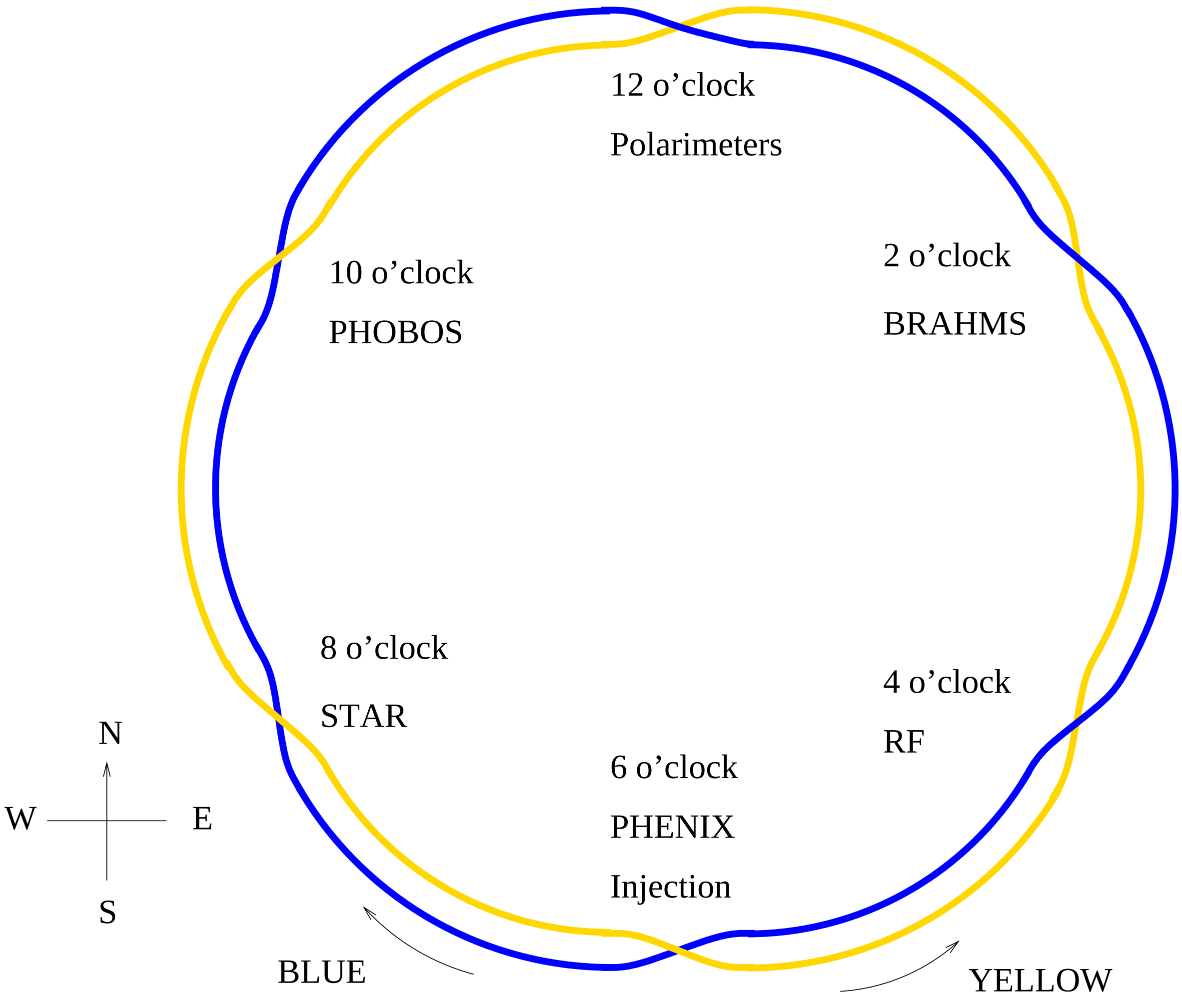
Observation of Mechanical Triplet Vibrations in RHIC

C. Montag, BNL

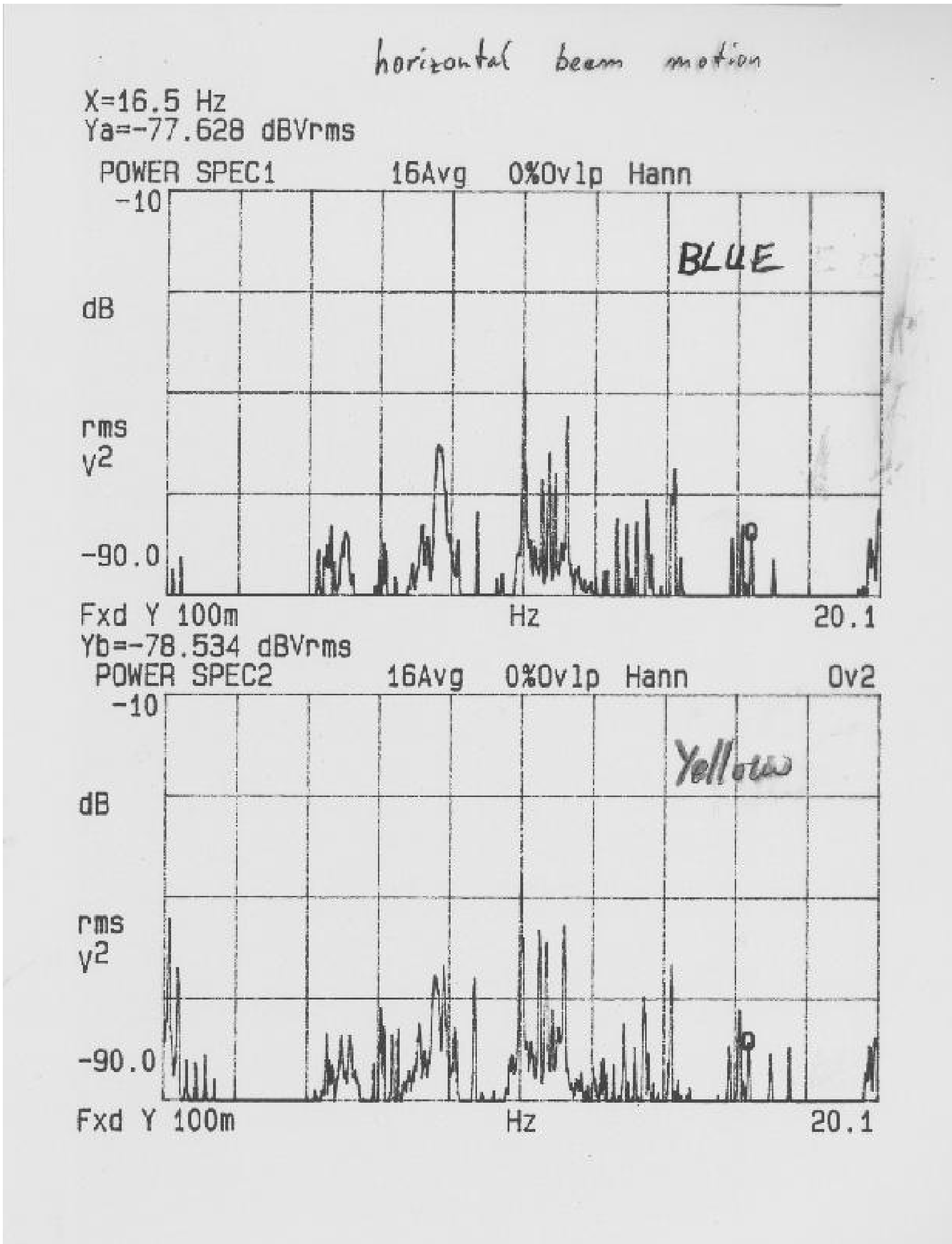
Nanobeam 2002

Overview of RHIC:



Superconducting two-ring heavy ion collider, 3.8 km circumference, $\gamma_{\rm Au} \approx 100$.

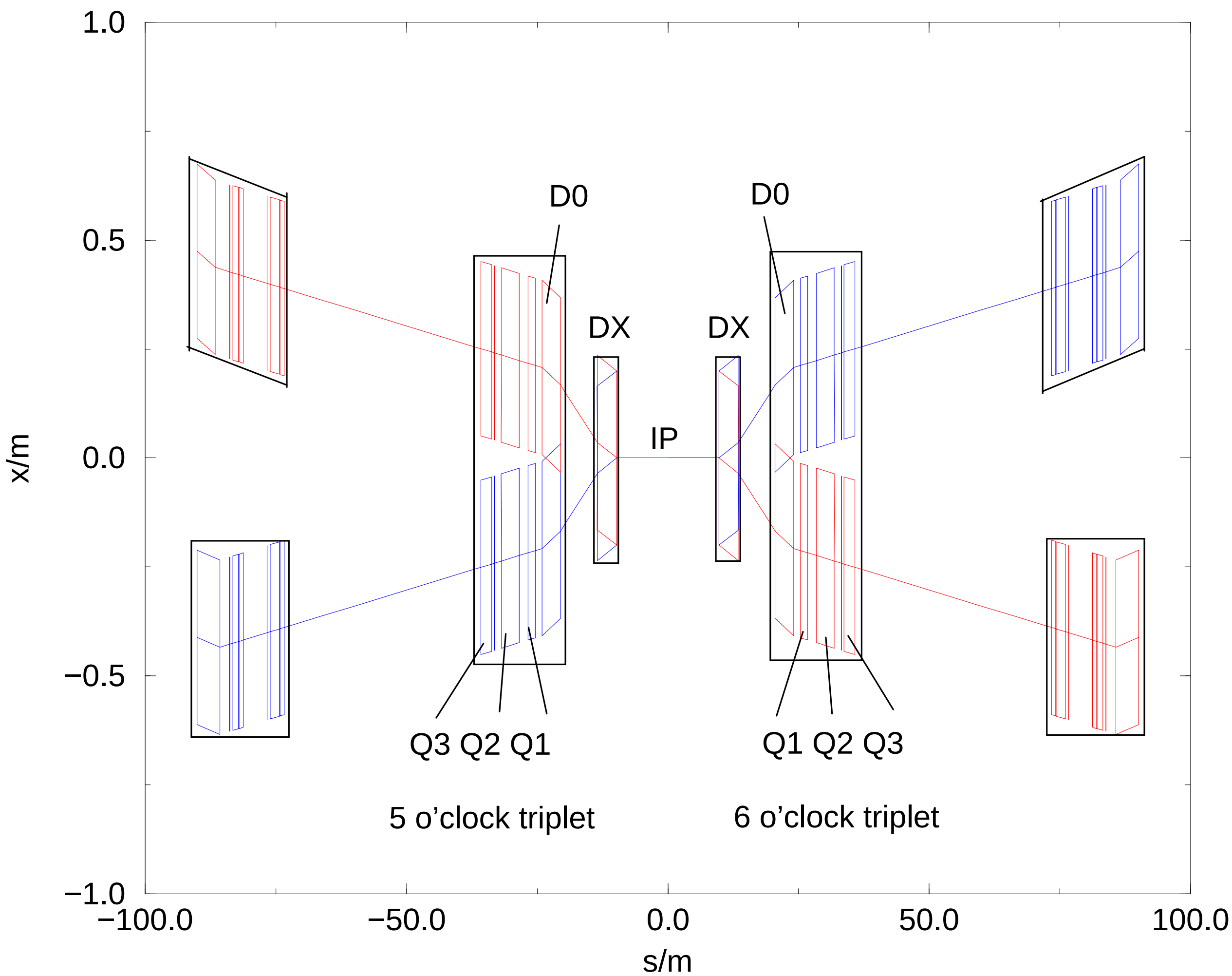
Spectra of horizontal BPM signals in both rings:



Total amplitude corresponds to $\approx 5 \ldots 10\%$ of the rms beam size.

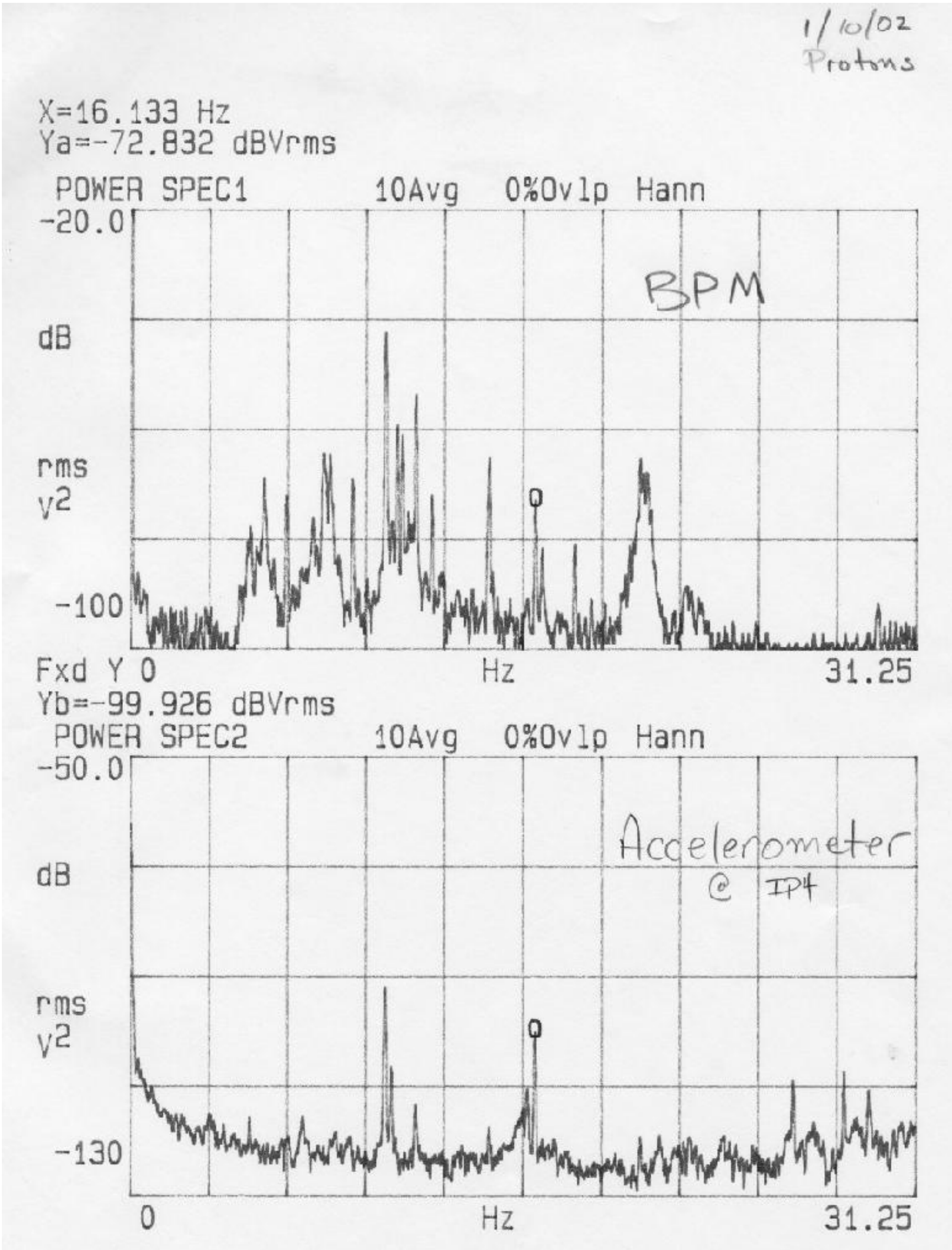
Similar spectra $\rightarrow$ common source.

Schematic overview of a RHIC interaction region:



Triplet quadrupoles share a common cold mass for both beams.

Spectra of horizontal beam and triplet motion (IP 4 triplet):

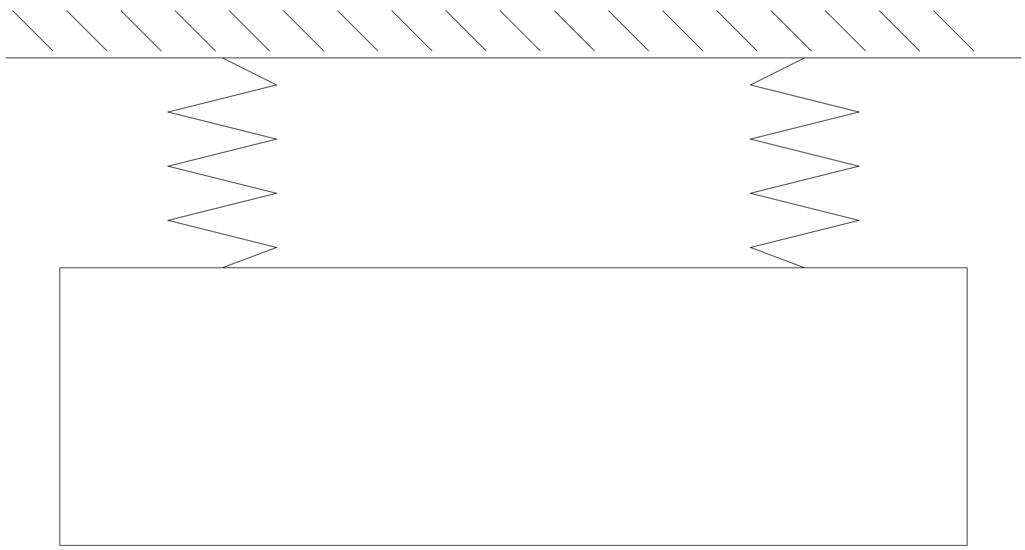


Dominant frequency lines in the horizontal BPM spectrum, and corresponding triplet locations:

Frequency	**Triplet**
7.75	12
8.825	8
10.14	4, 11, 12
10.625	9
10.825	2
11.00	11
11.325	6
12.700	(10)
13.000	1
13.275	unknown
13.55	9, (2)
14.325	2
15.950	2
16.133	4
16.500	8

Mechanical resonance frequencies of the cold masses in the cryostat.

Mechanical model:



Quadrupole	f_d/Hz	f_q/Hz
Q1	21.2	15.8
Q2	14.0	14.3
Q3	15.0	14.1

- Resonance frequencies of this simple model are very close to observed ones.
- Vibrations disappeared when machine was warmed up.

RMS closed orbit distortion:

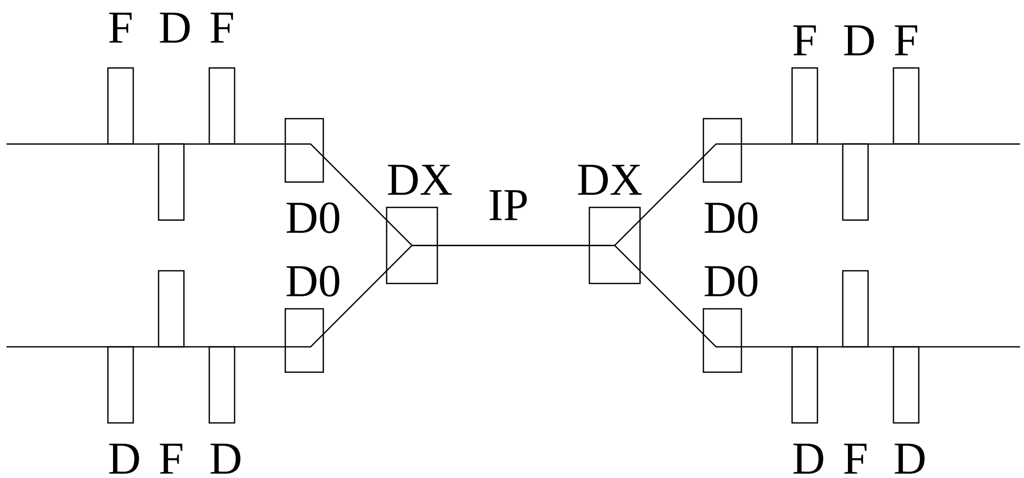
$$\sigma_{\mathrm{co}}(s) = \frac{\sqrt{\beta(s)}\sqrt{\langle\beta\rangle}}{2\sin\pi\nu}\frac{\sigma_{\mathrm{q}}}{|f|}\sqrt{N}$$

Observed rms beam jitter corresponds to rms quadrupole jitter amplitudes of $\sigma_{\mathrm{q}} \approx 0.5\,\mu\mathrm{m}$. For the triplets as a whole, $\sigma_{\mathrm{triplet}} \approx 10\,\mu\mathrm{m}$.

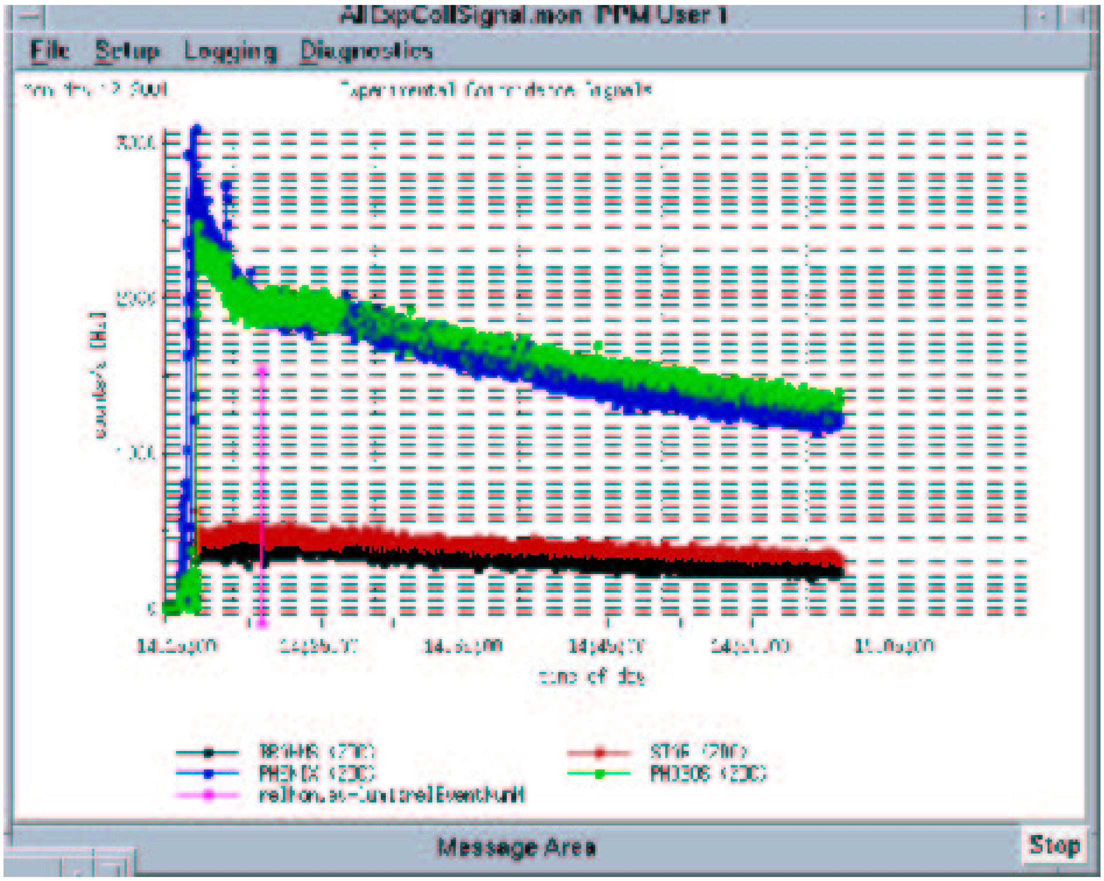
Measured rms amplitudes on triplet cryostats are 200 nm at most.

$\rightarrow$ Beam jitter is caused by vibration of the cold masses within the cryostat, rather than by motion of the entire triplet.

Anti-symmetric IR optics results in relative beam offset at IPs:



Modulated beam-beam interaction may be the source of emittance growth at the begin of each luminosity run:



Simulation studies are in progress to investigate this effect.

Conclusion

- IR triplet vibrations have been identified as source of horizontal beam jitter around 10 Hz.
- Driving force seems to be related to cryo system.
- Measurements inside one triplet beam pipe in progress.
- Plan to permanently attach accelerometers to cold masses in one triplet.
- Modulated beam-beam offset probably causes emittance dilution at the beginning of each luminosity run (needs to be investigated).