Mass drop induced vibration study

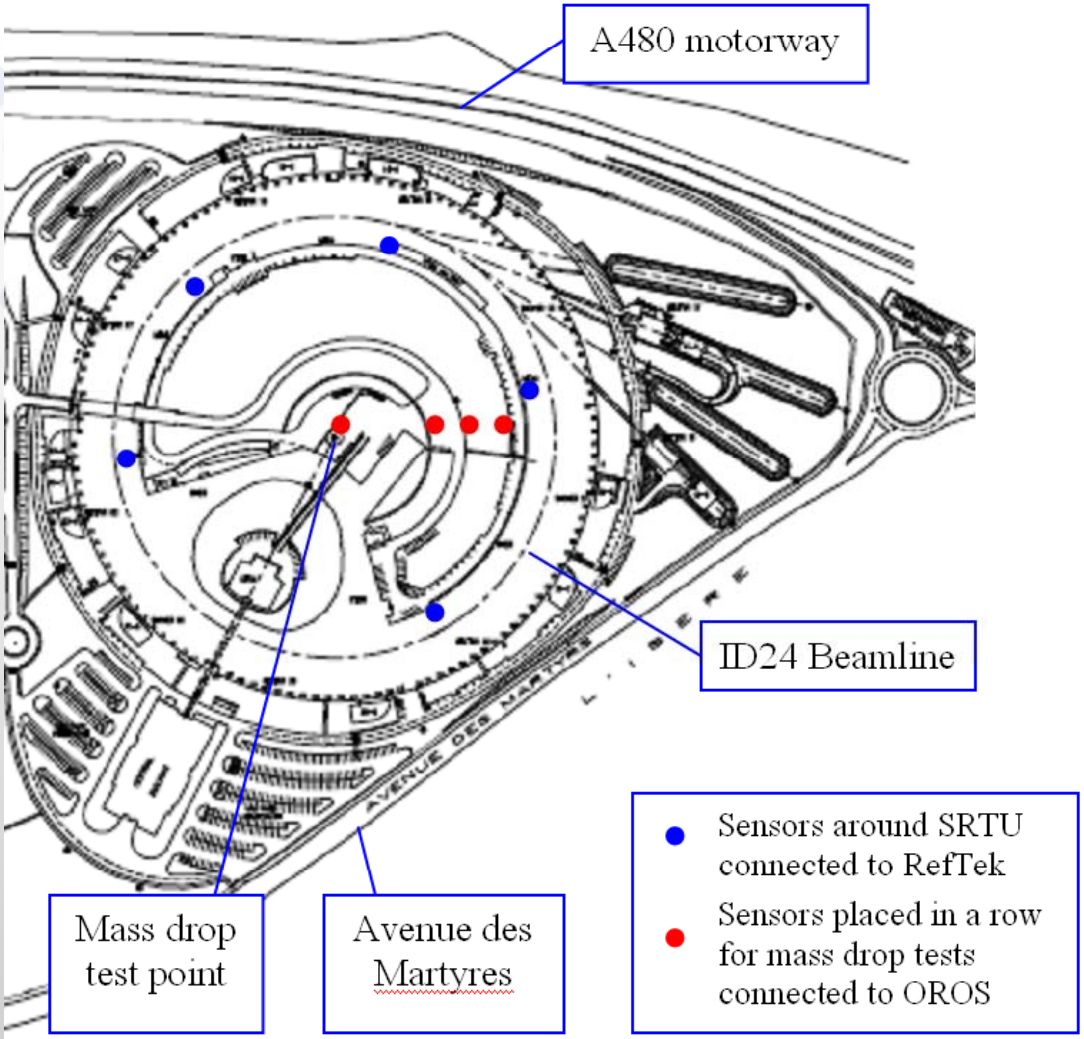
L. Zhang, M. Lesourd, T. Mairs, O. Mathon, J.C. Laidet

- Ground homogeneity
- Vibration propagation
  - From ground via storage ring magnets to e-beam
  - From e-beam to X-ray beam
  - From ground via beamline optics to X-ray beam

Outlines

- Test description
- Ground vibration
- Quadrupole and e-beam vibration
- ID24 beamline stability
- Conclusion

Test description

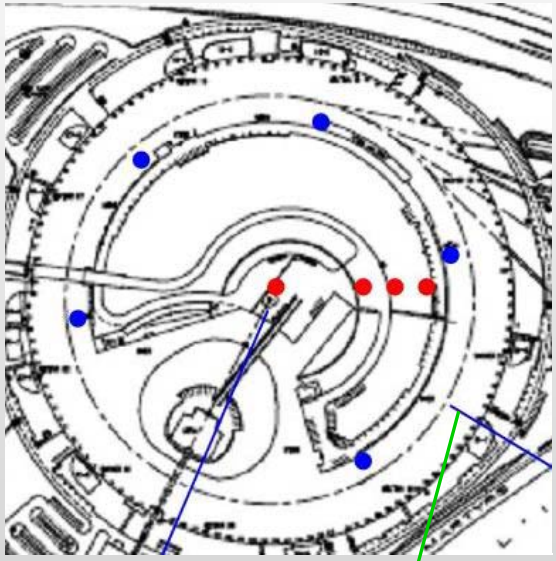


1200 kg mass dropped at 2~3 m height on a 3-cm thick steel plate

Test description - 2

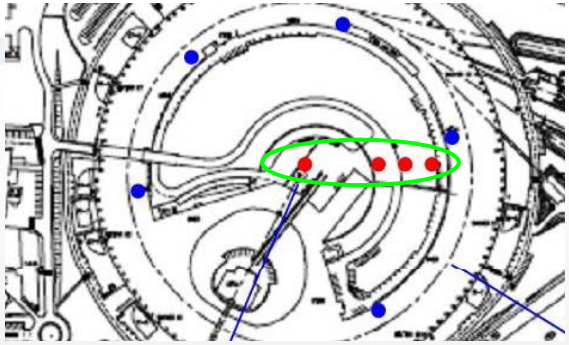
Mass drop tests – vibration measurements of

- the ground with geophones placed
  - at 4 points in a row from the impact point at the centre to the storage ring building
  - at 5 points around the storage ring tunnel (SRTU) in the technical gallery
  - at ID24 beamline optic hutch
- the quadrupole in the storage ring
- the electron beam position with BPMs in cell16 and cell21 in the storage ring, and on ID24
- the mirrors on the ID24 beamline
- the X-ray beam position and intensity



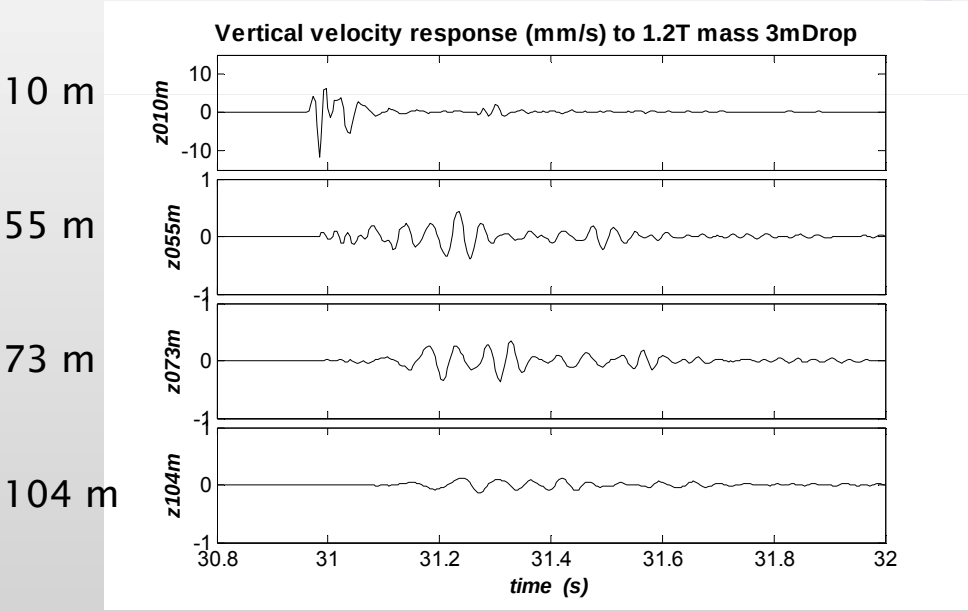
ID24 beamline

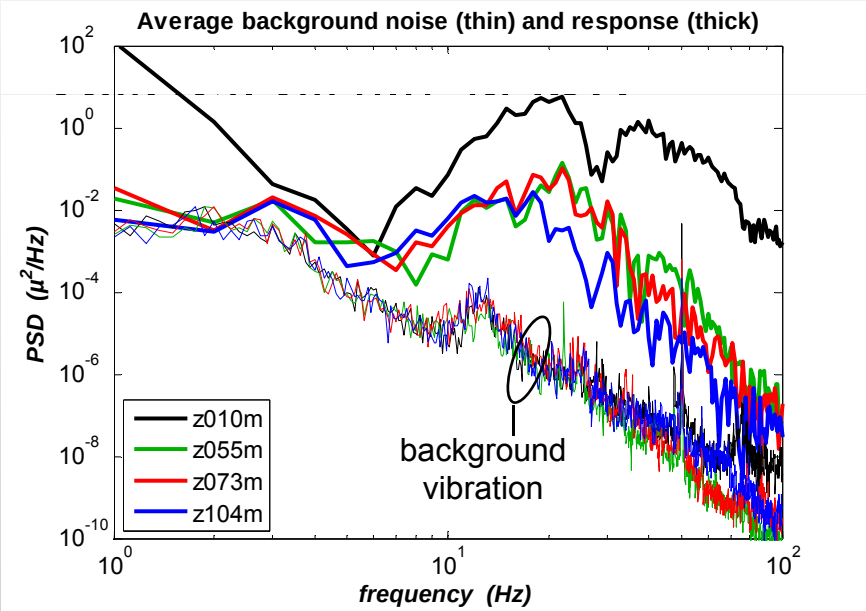
Ground vibration



Mass drop response : distance effects

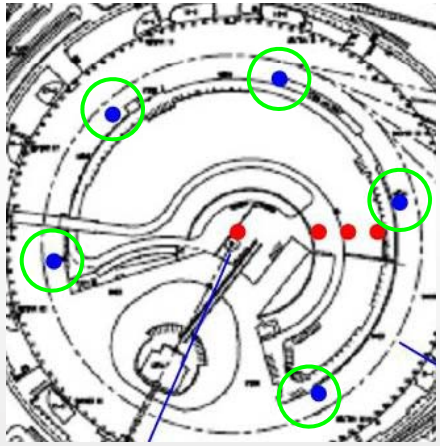
- Vibration propagation
- Vibration attenuation with the distance and time





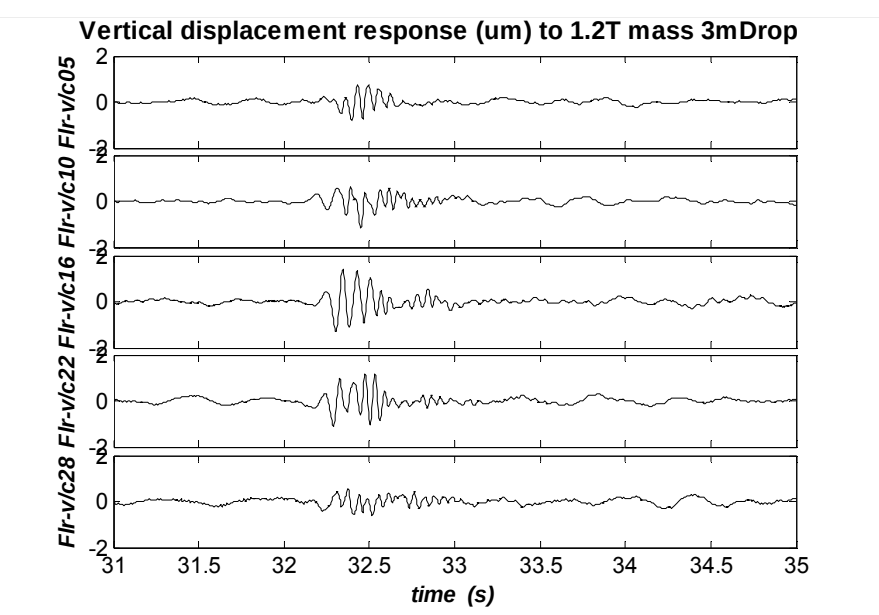
sensors at 4 points in a row from impact point at the centre to the SR building at distances (2) 10, 55, 73, 104 m from the impact point

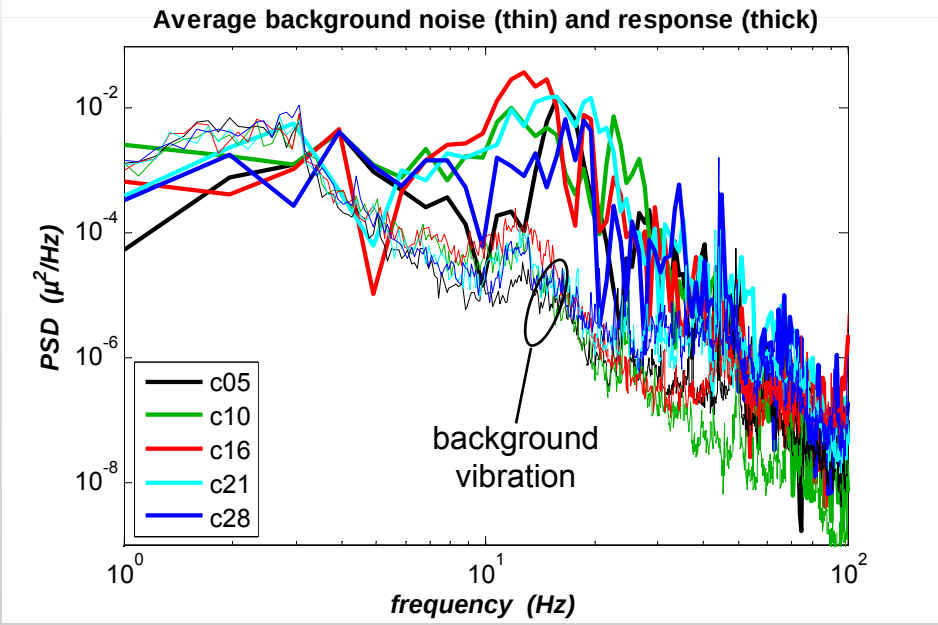
Ground vibration – *some characteristics*



Mass drop response : site homogeneity

- Homogenous wave propagation speed
- Different vibration attenuation
- Pass-band: 10 ~ 30 Hz





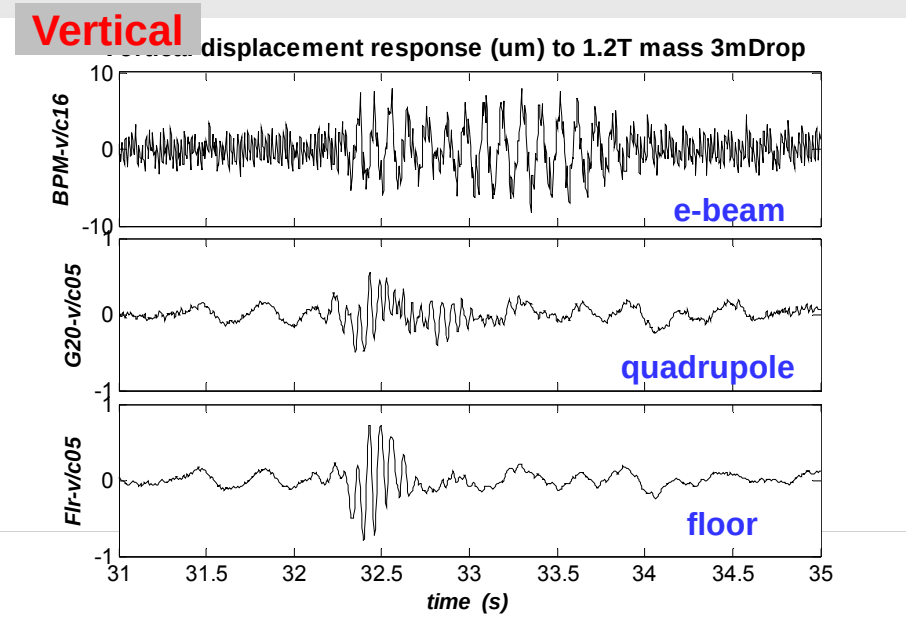
sensors placed at 5 points around storage ring tunnel in the technical gallery

Quadrupole and e-beam vibration:

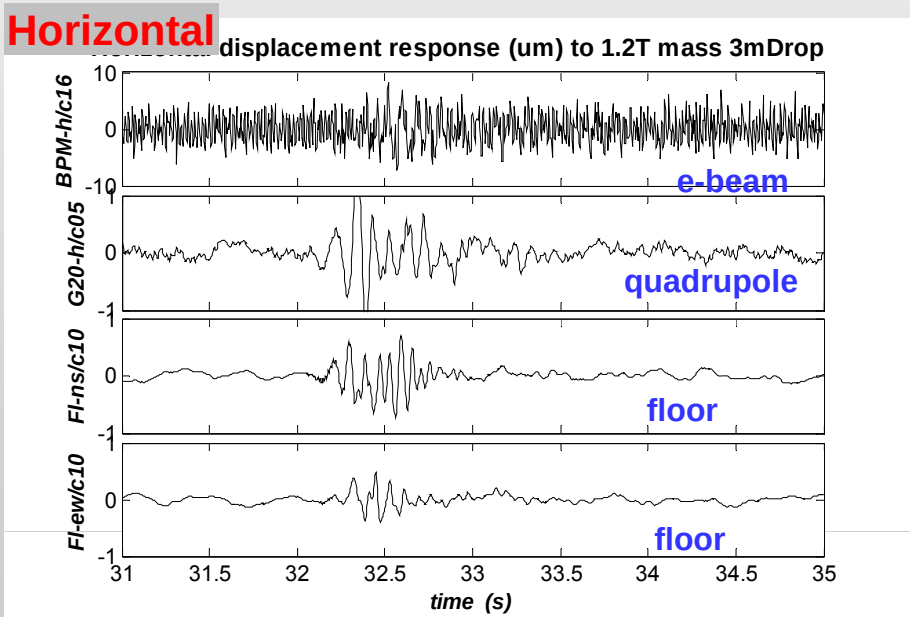
Mass drop response

- Response duration ~1s on the floor and the quad, ~2s on the e-beam
- More significant response of the e-beam in vertical direction

Vertical



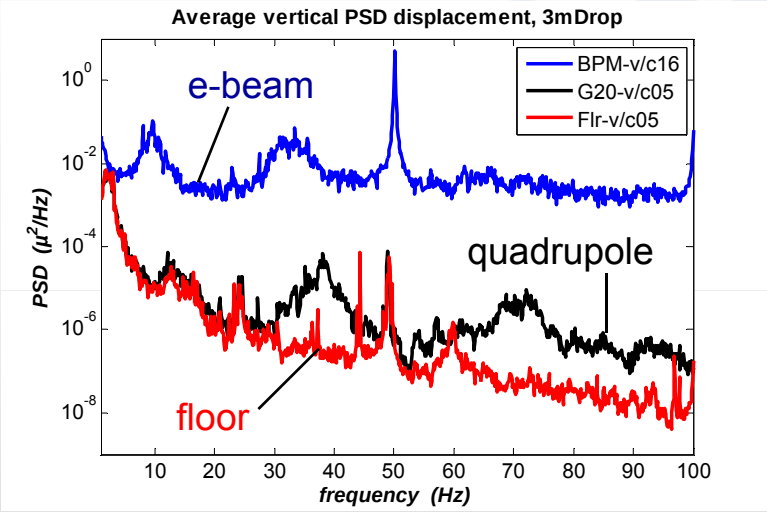
Horizontal

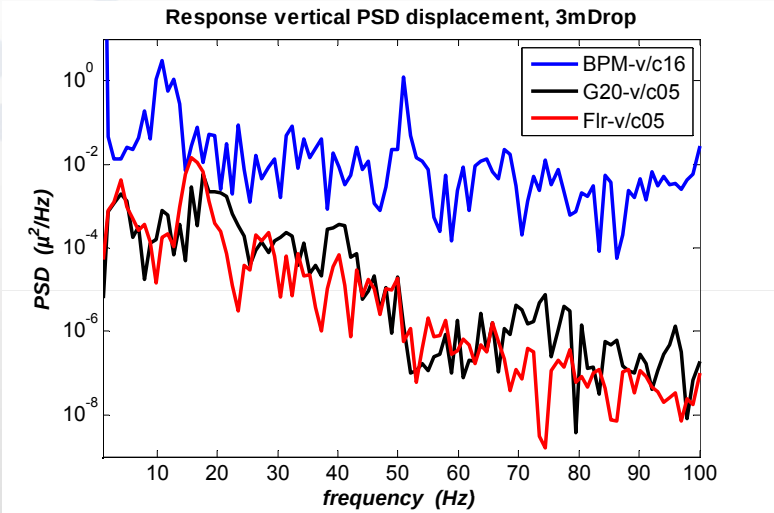


Quadrupole and e-beam vibration: spectral results

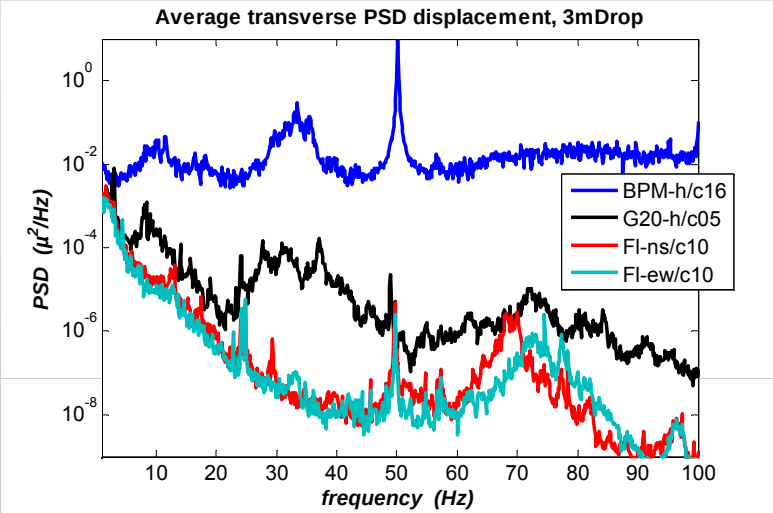
average background vibration | **mass drop response**

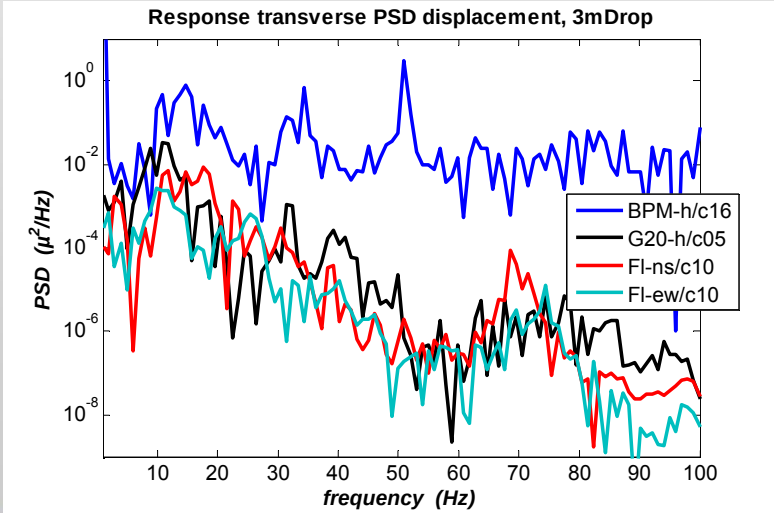
Vertical





Horizontal



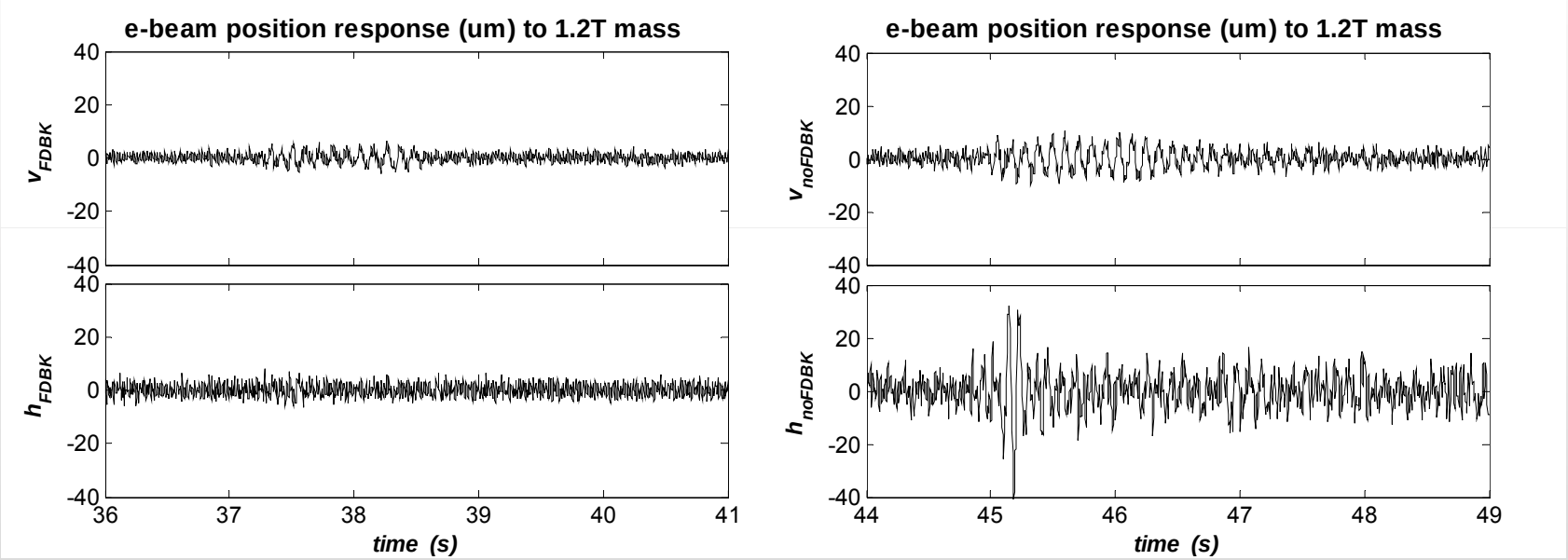


e-beam feedback: Temporal displacement

Feedback ON | **Feedback OFF**

Vertical

Horizontal

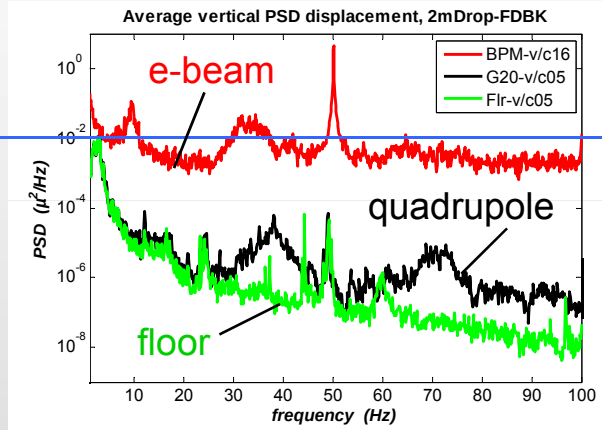


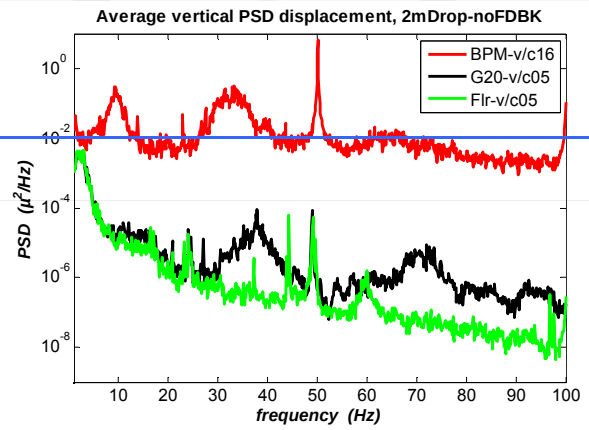
- Feedback is more effective in horizontal direction

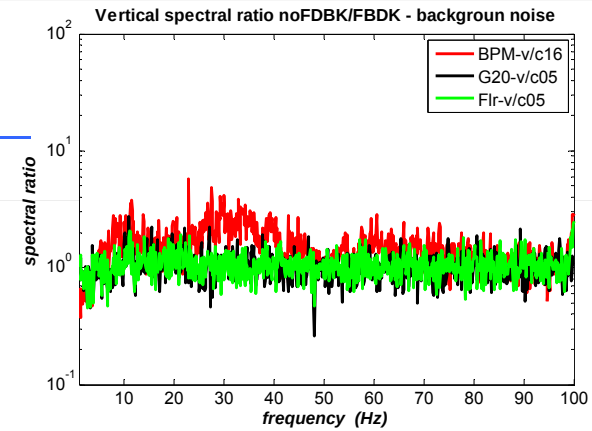
e-beam feedback: PSD displacement and spectral ratio

Feedback ON **Feedback OFF** **ratio** $\sqrt{PSD_{FeedbackOFF} / PSD_{FeedbackON}}$

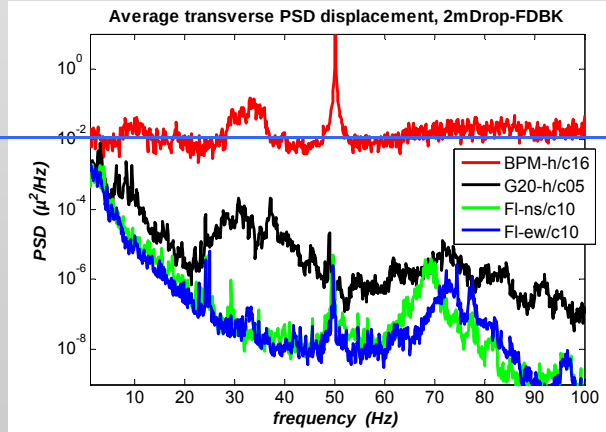
Vertical

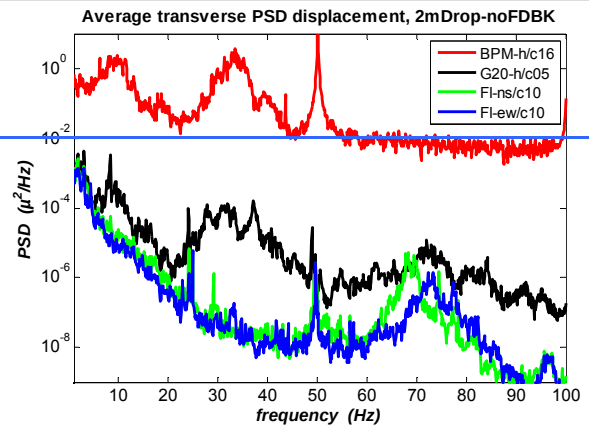


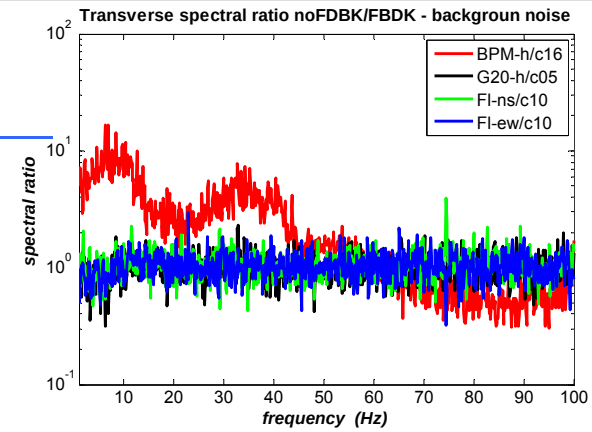




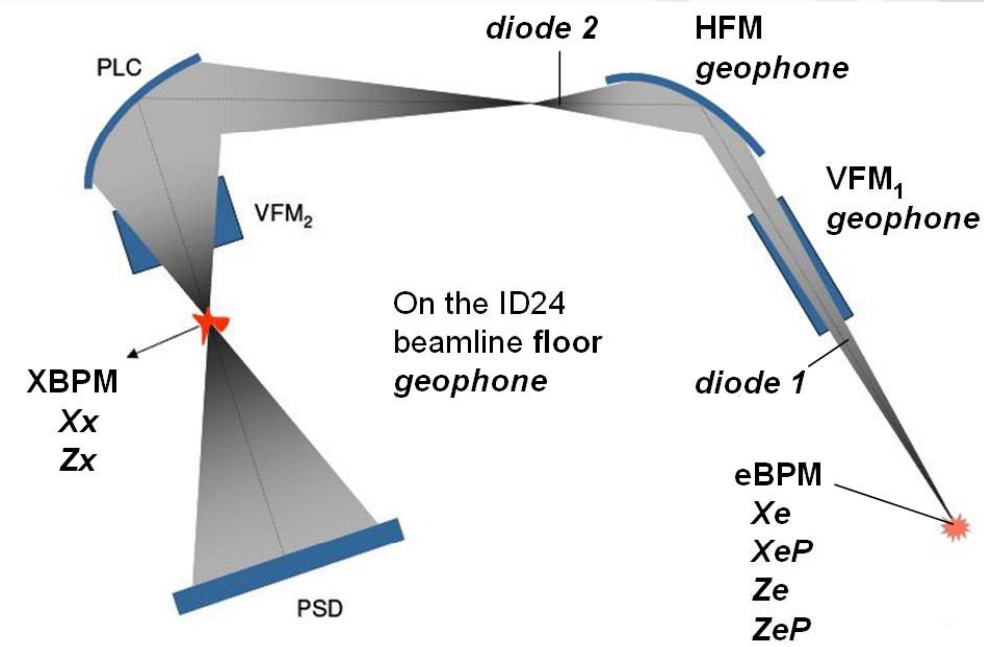
Horizontal

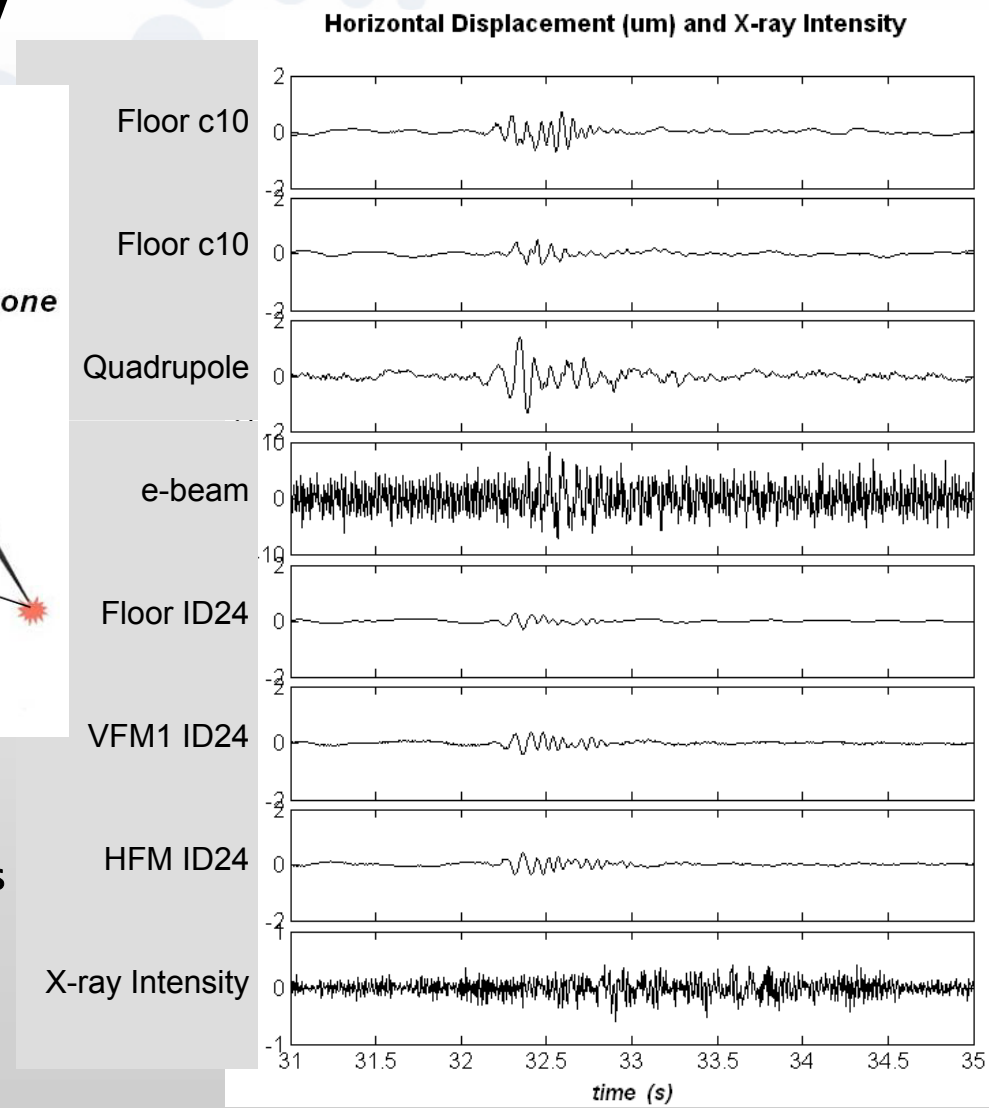






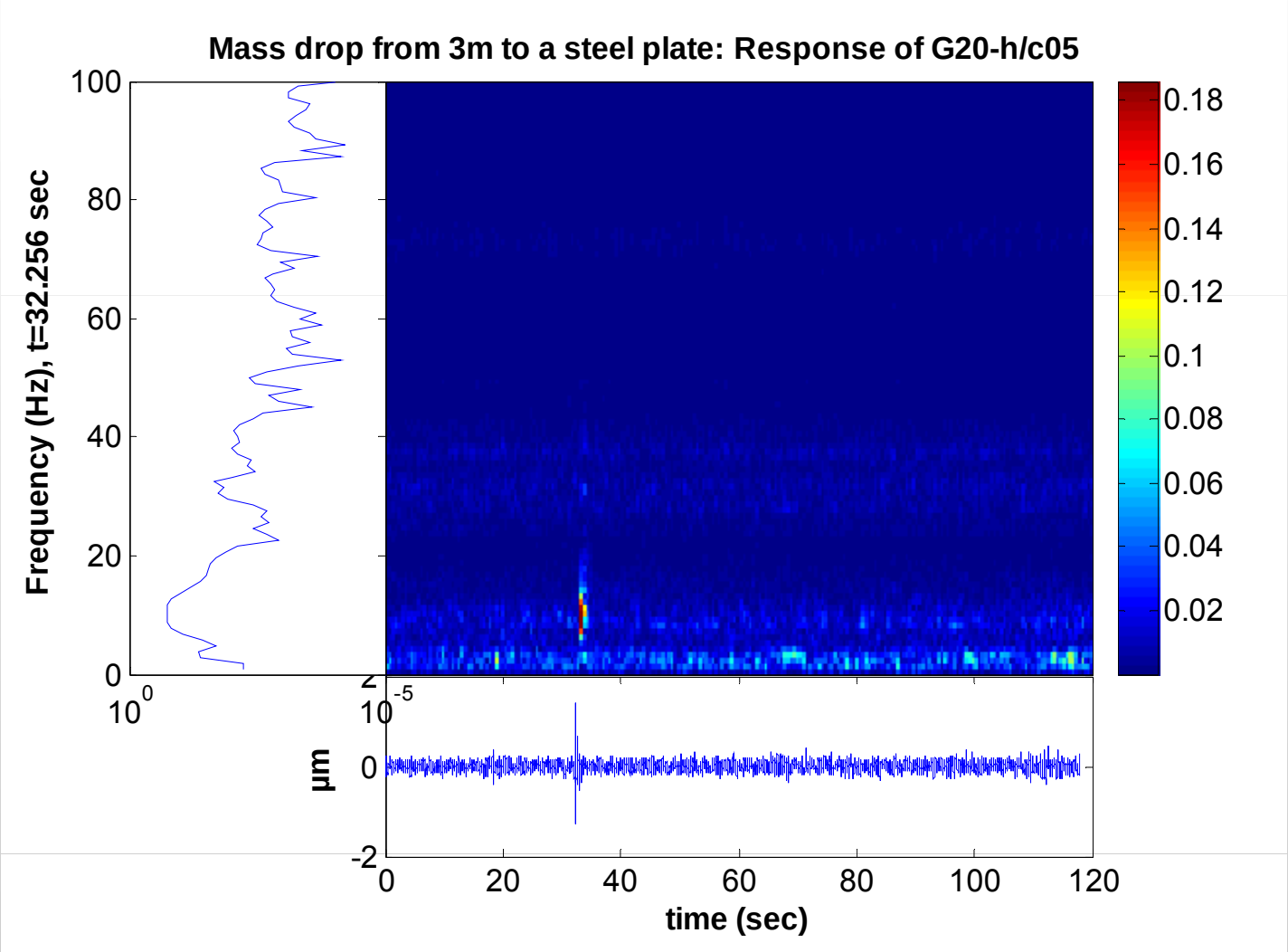
ID24 beamline stability study





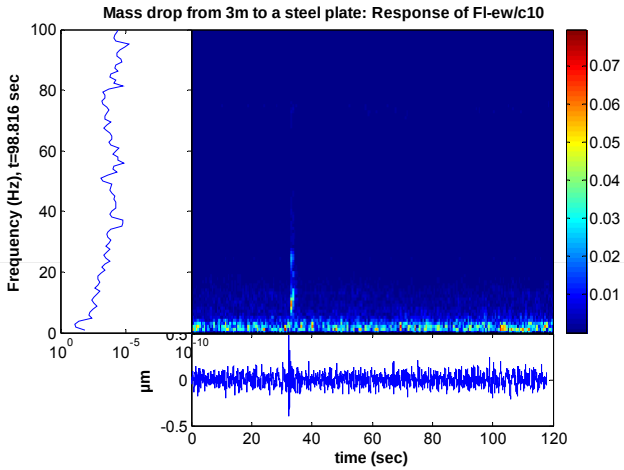
- duration of the response
  - on the floor, mirrors and quadrupole ~ 1s
  - on the e-beam and X-ray beam ~ 2s
- High frequency components on the e-beam and X-ray beam
- Less stronger response in ID24 than in tech. gallery

Vibration response to mass drop - Spectrogram

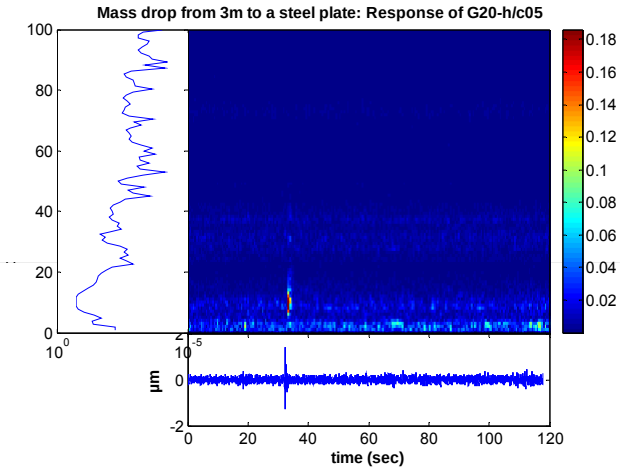


Vibration response to mass drop - Spectrogram

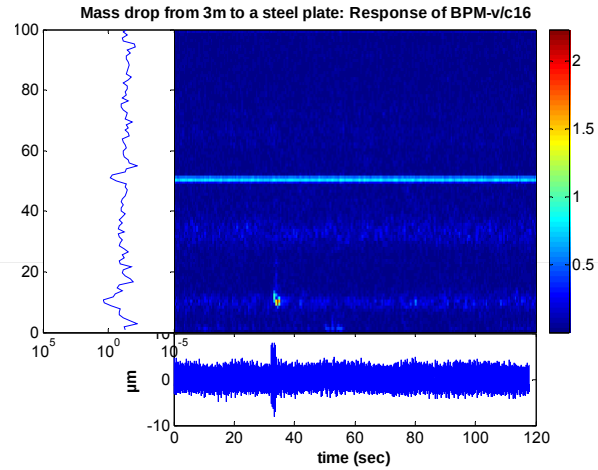
floor around storage ring



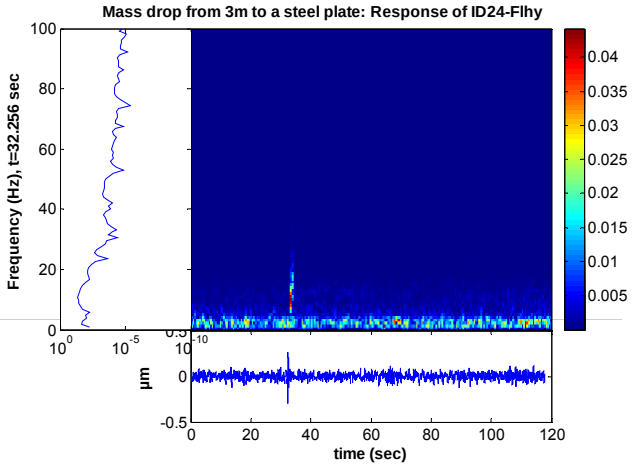
quadrupole magnet



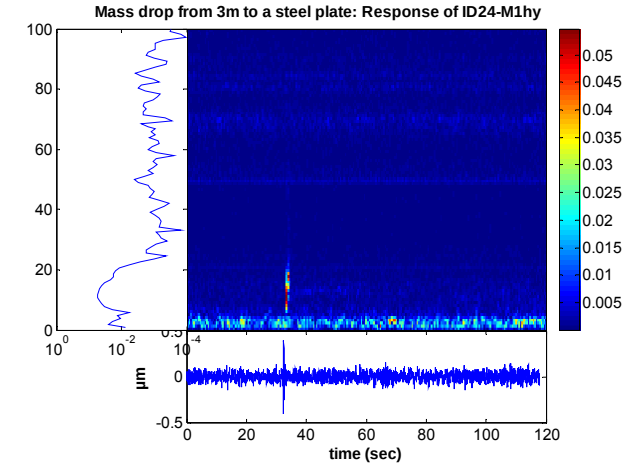
e-beam in horizontal direction



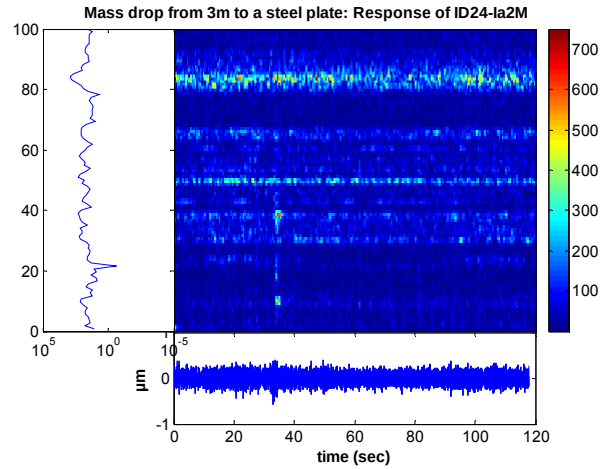
on the beamline floor



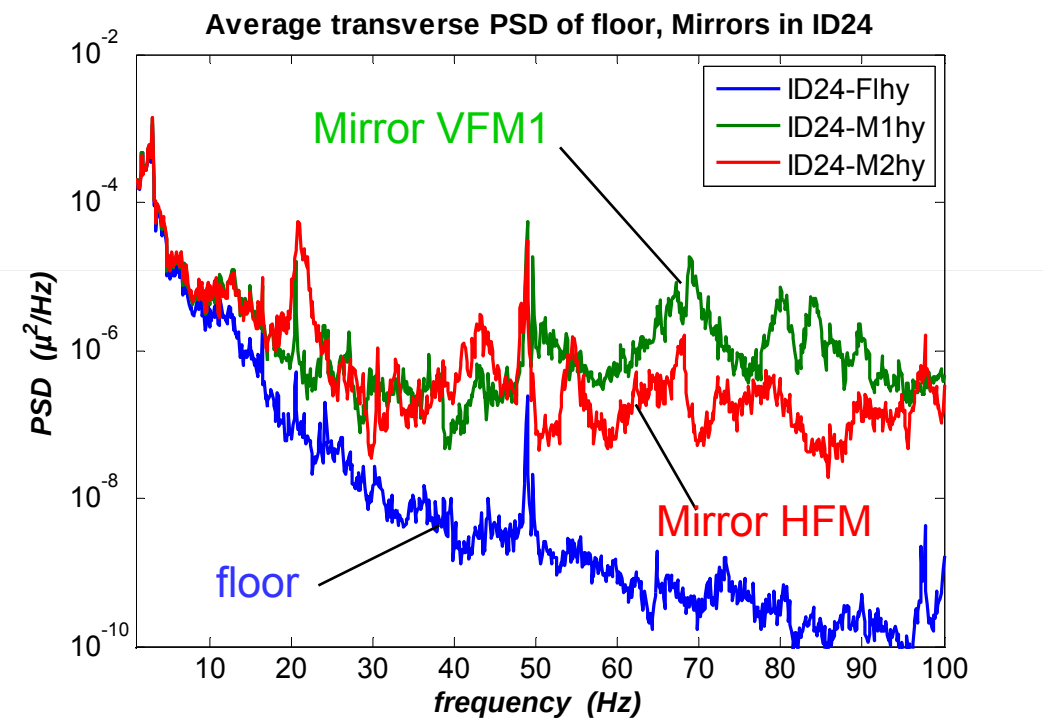
on VF1 mirror



X-ray intensity

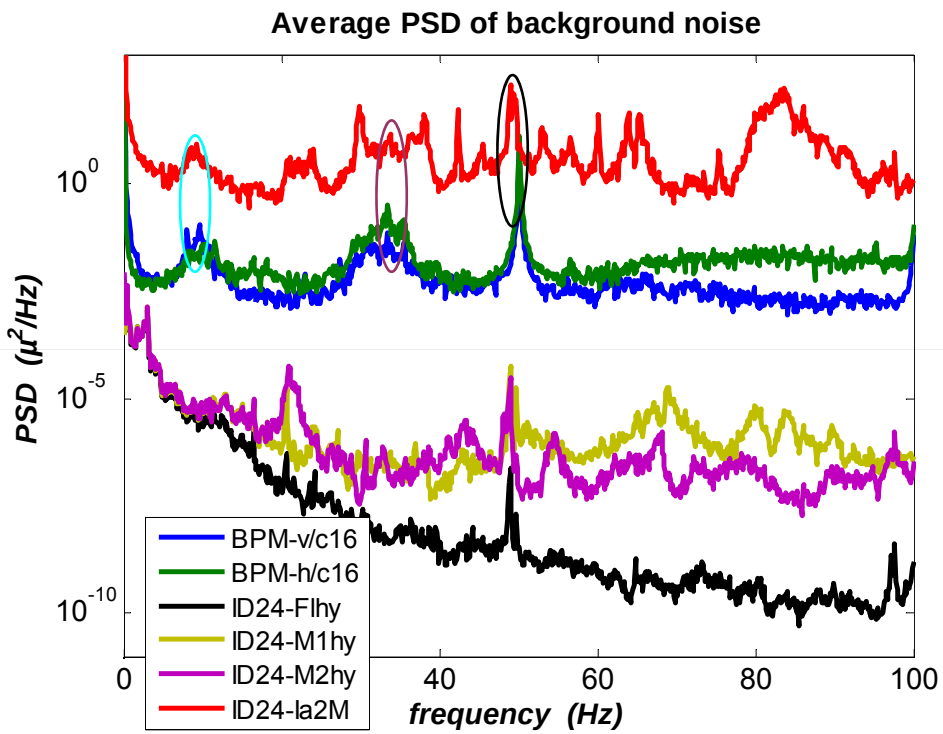


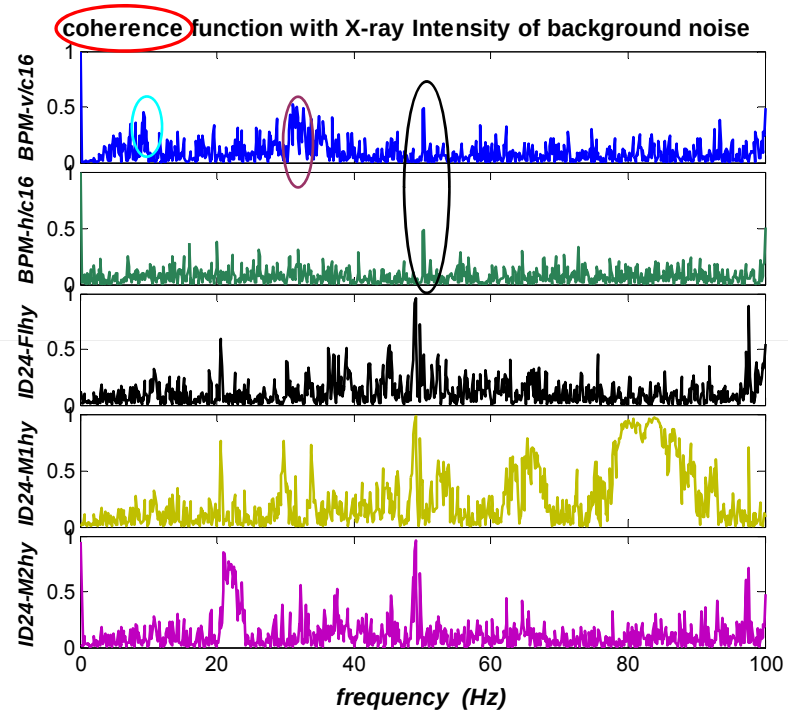
Vibration on the mirror vessel



- The two mirrors significantly amplify the ground vibration above 15 Hz and especially at higher frequencies
- Many peak frequencies: 20,43, 49, 55, 68Hz,…
- Cooling flow induced vibrations (?)

X-ray beam intensity spectrum analysis





Contribution to the X-ray beam intensity instability

- the e-beam vibration at the 2 wide peaks around 8.7 and 33 Hz, partially : coherence ~ 0.5
- the floor and the 2 mirrors on ID24 at the 3 common peaks around frequencies (20~21, 49 and 97.7 Hz)
- Mirror-1 (VFM_1) at 30, 33, 53, 65, 80~85 Hz
- Mirror-2 at 21 and 38 Hz

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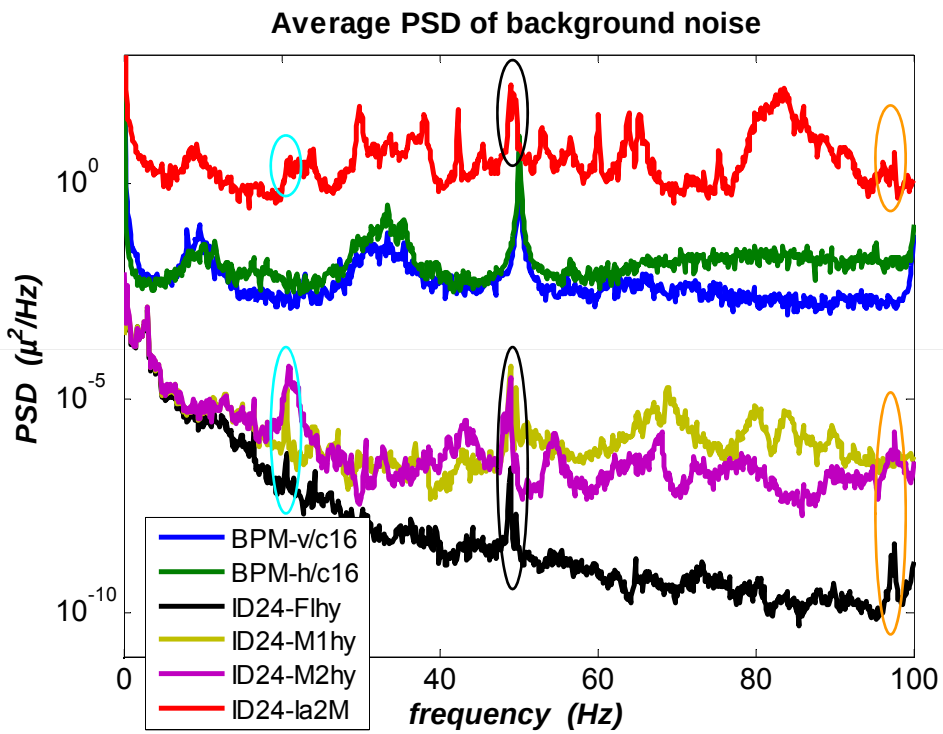

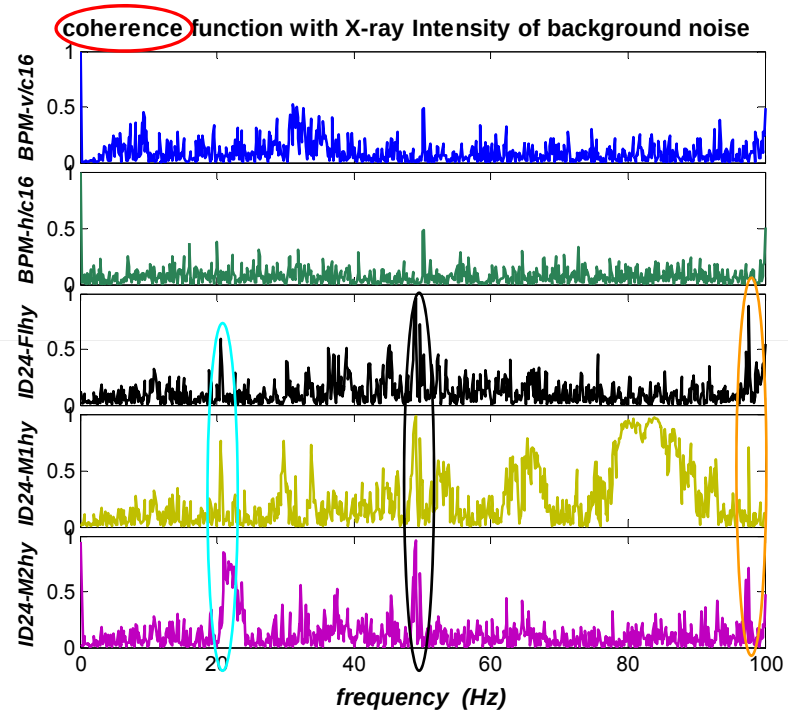

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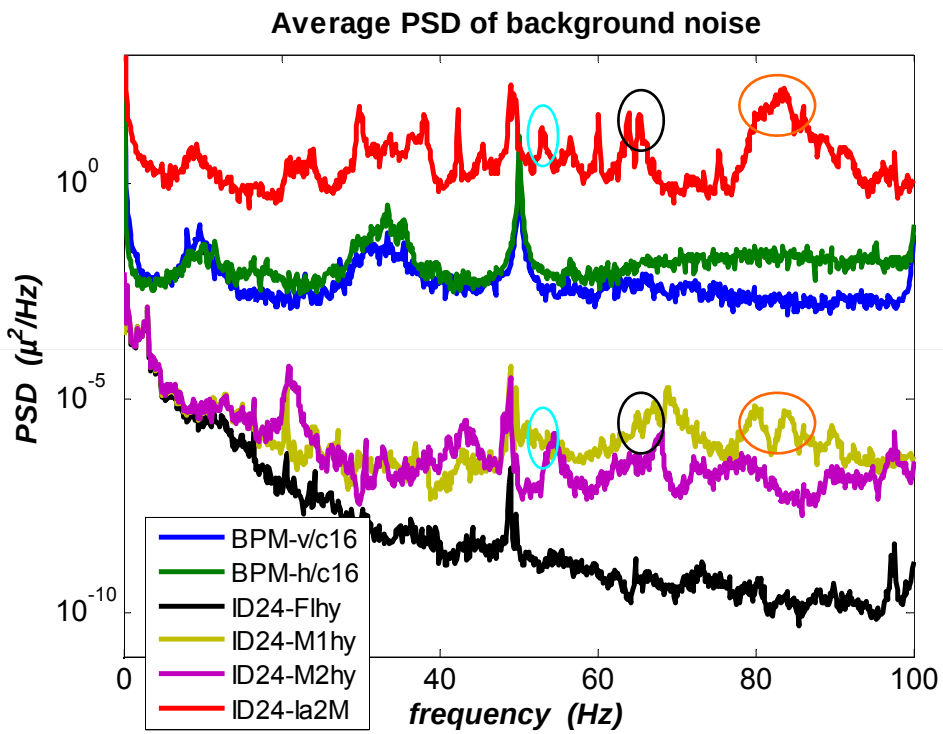

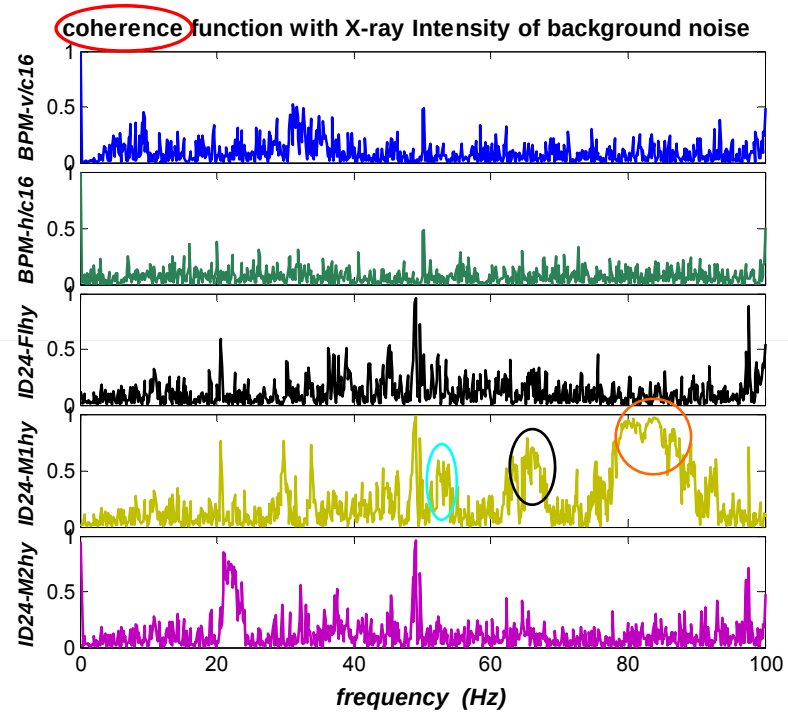

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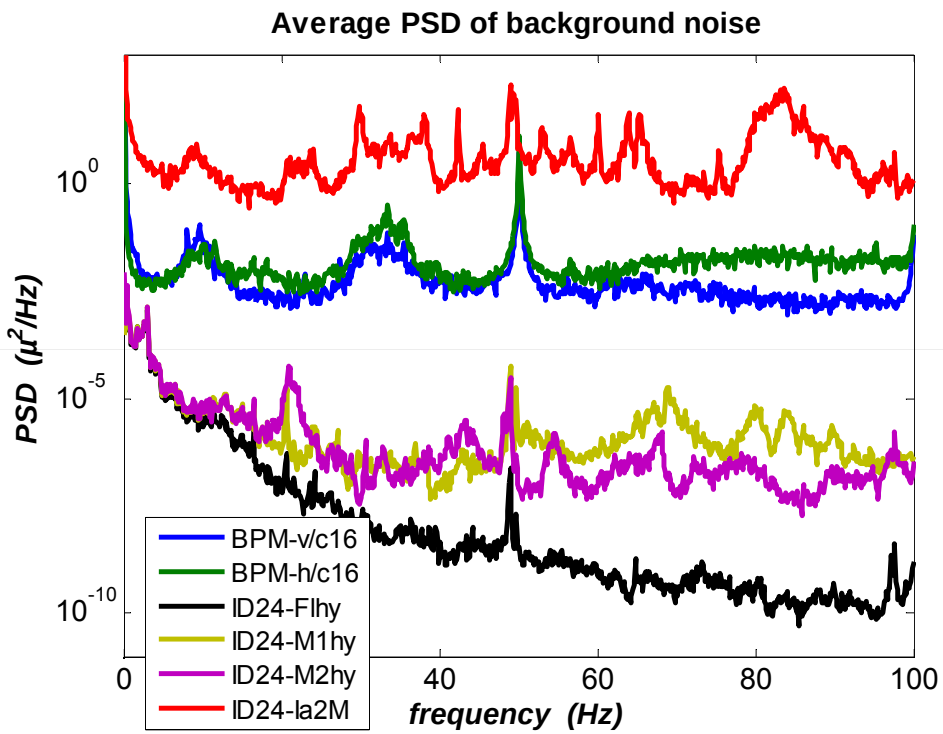

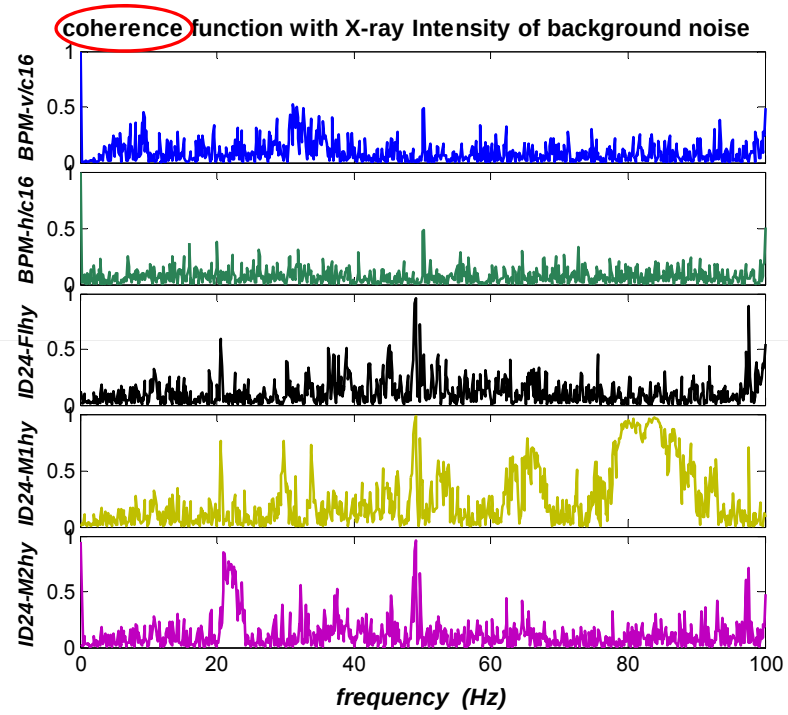

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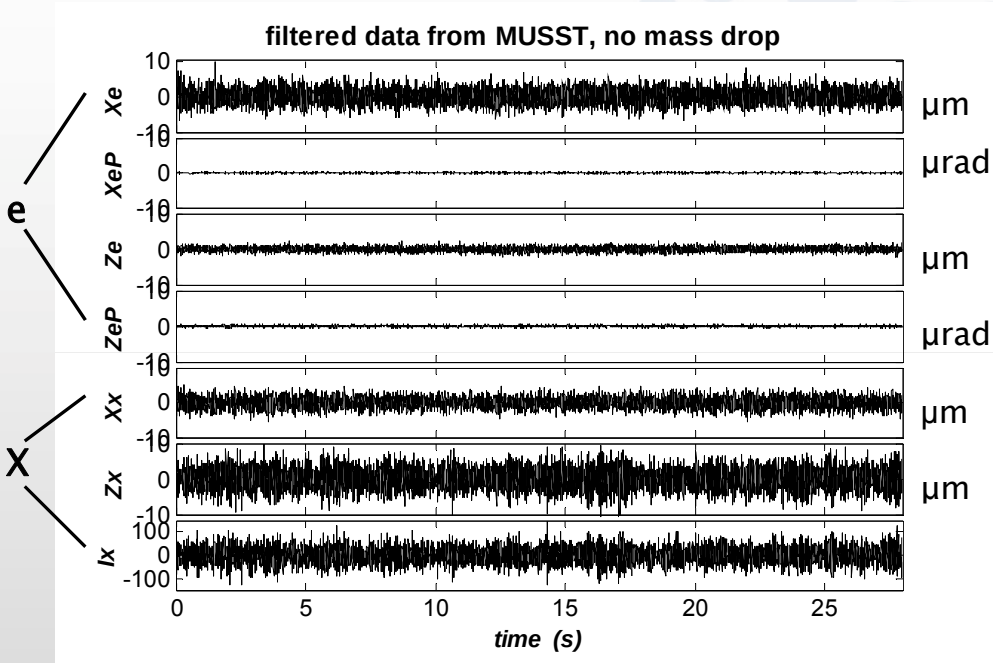
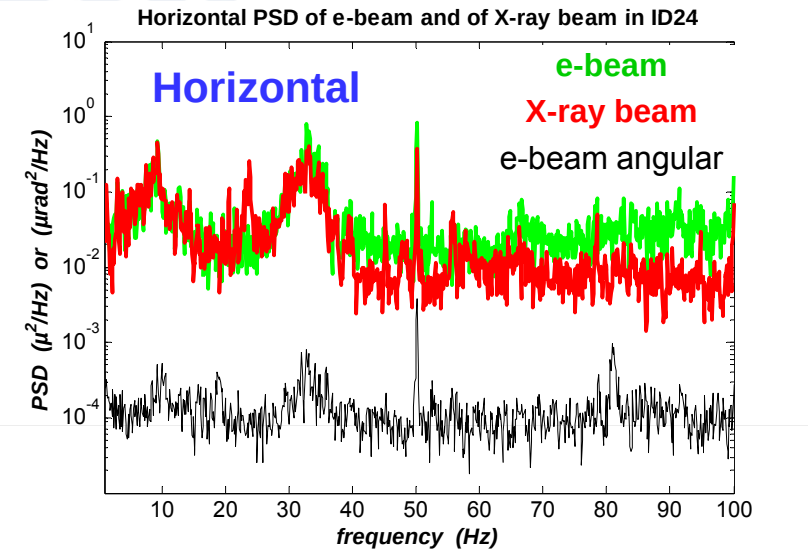
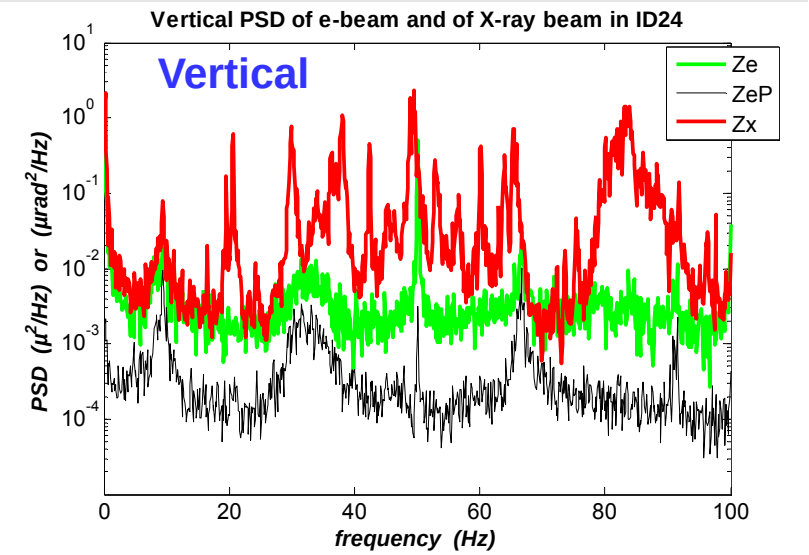
e-beam and X-ray beam position

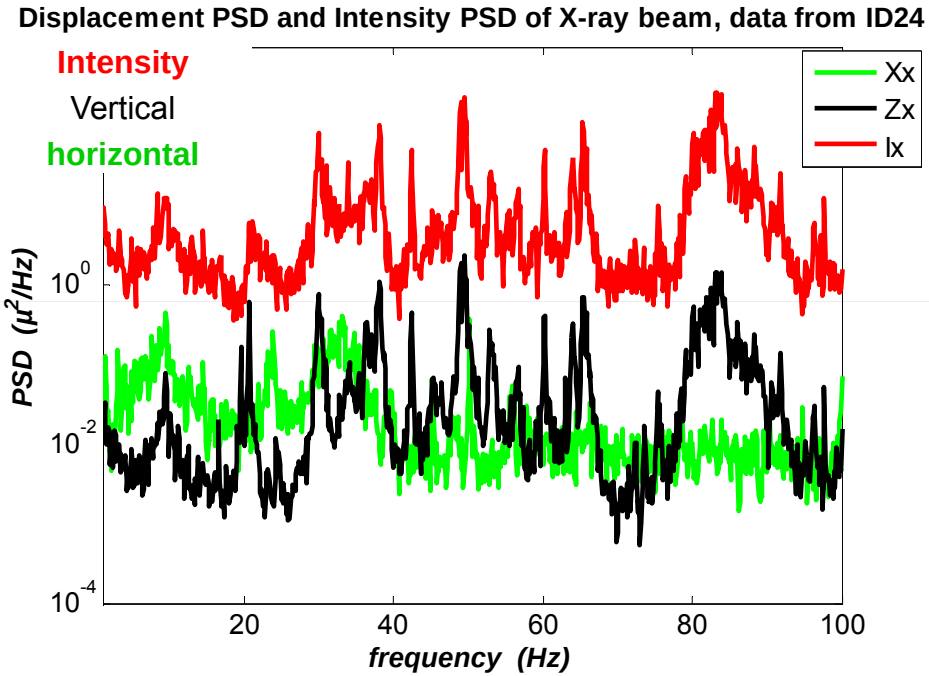


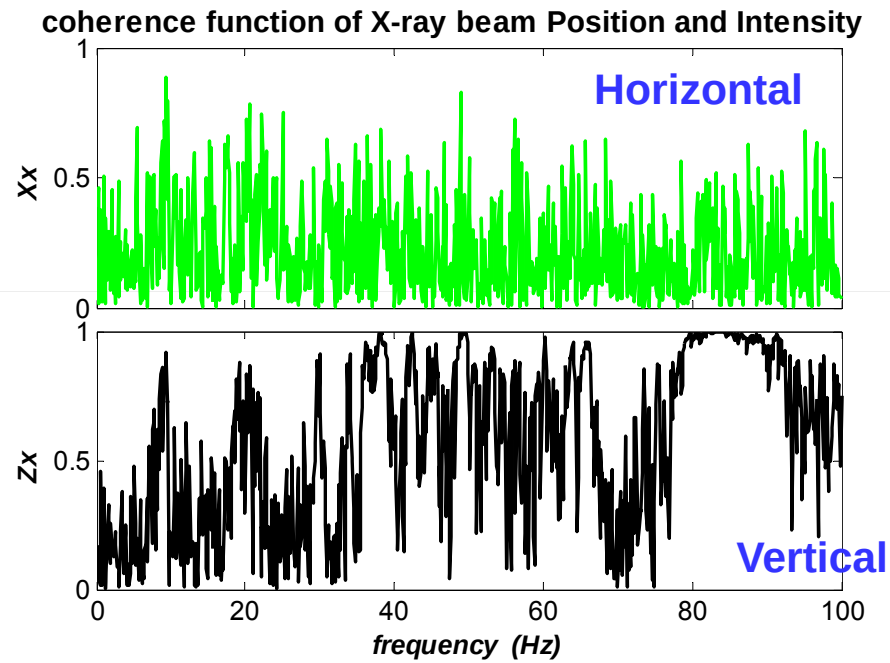




- In horizontal direction, X-ray beam vibration ≅ e-beam vibration
- In vertical direction, X-ray beam vibration > e-beam vibration

X-ray beam position and intensity





- Excellent coherence between X-ray beam intensity fluctuation and vertical position
  - ID24 Optical configuration → X-ray beam more sensitive in vertical direction
- X-ray beam intensity fluctuation is a good indicator of the beam stability

Conclusion

- Ground vibration
  - The vibrations generated by the mass drop strongly attenuated with increasing distance
- Electron beam
  - More sensible to vibration in vertical than in horizontal directions
  - e-beam feedback **more efficient in the horizontal direction** than vertical direction
- X-ray beam stability
  - Influenced by the **optics stability** in a privilege direction depending on the optic configuration
  - Influenced by the **e-beam** position stability
- Good coherence between X-ray beam position and intensity fluctuation
  → photodiode could be a good sensor for X-ray beam instability

Thanks