IWBS 2002
SPring-8, Japan
December 2002

Experience with damping links at E.S.R.F.

(L Farvacque, L Zhang, E.S.R.F)

The Magnet/girder assembly shows several vibration Eigen modes detrimental to beam stability:

- Transverse rocking mode (8 Hz)
- Longitudinal rocking mode (12 Hz)
- Horizontal rotation (14 Hz)

These modes are excited by the ground motion. They were observed on both electron and photon beam motions. Mechanical damping devices were studied to minimise this effect.

Constraints

- Must allow the periodic realignment of the machine
- Must be installed on a running machine
  - Space constraints, easy installation

Preliminary studies

- Tuned vibration absorbers
  - Added weight: 450 kg !
- Damping plates
  - Efficient
  - Difficulty to force the precise positioning of the girder without "shunting" the damping plate.
- Damping links
  - Efficient
  - Possible transverse and vertical displacement by 2mm without degrading the damping performance

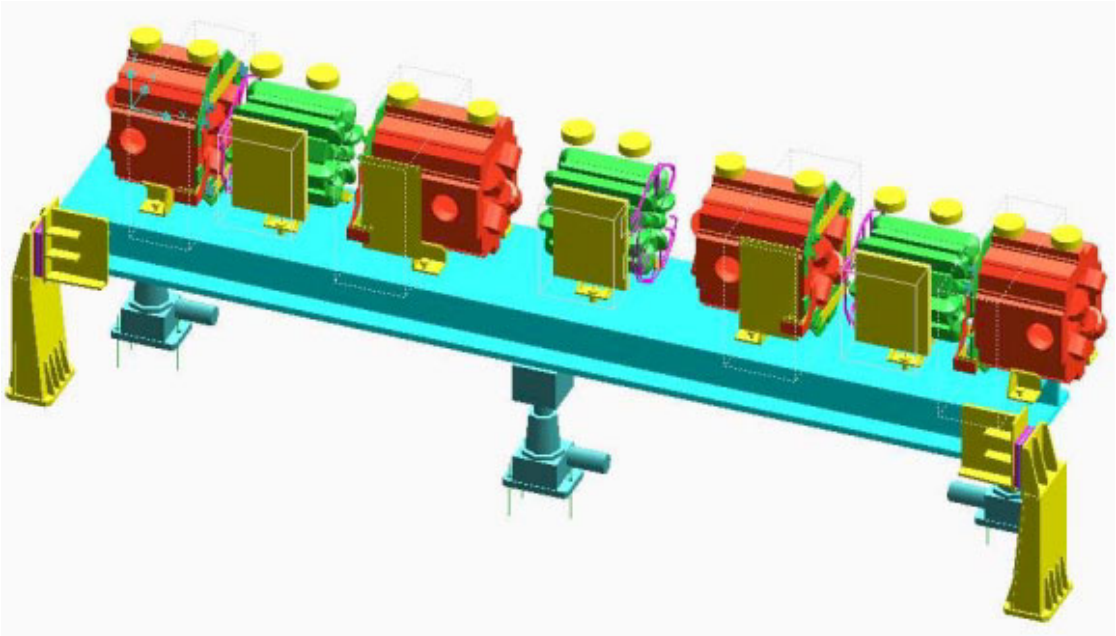
Installation

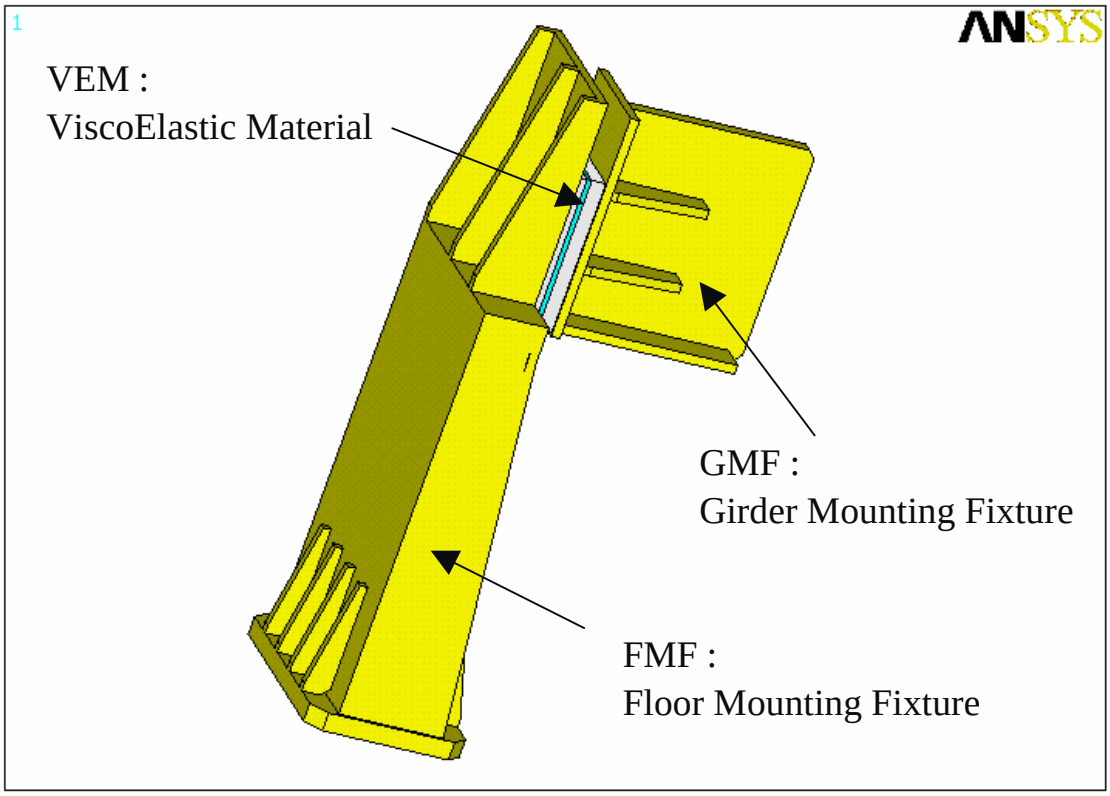
From July 2000 to May 2001

Monitoring with fast BPMs all along the installation:

The beam position is measured at 4.4 kHz. 240 data sets of 1024 samples are averaged every day.

Damping link design

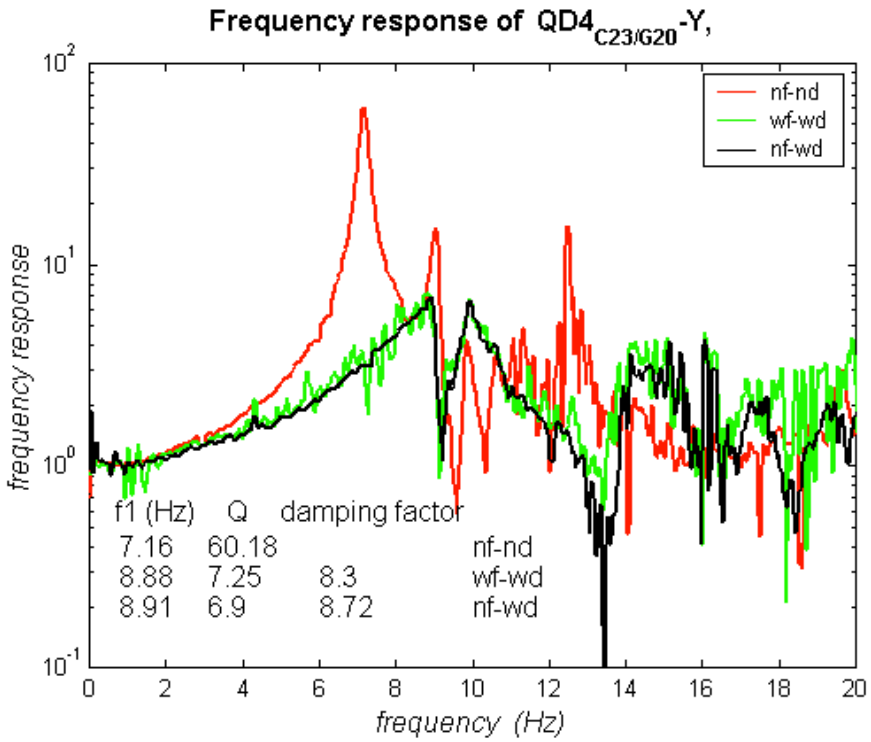




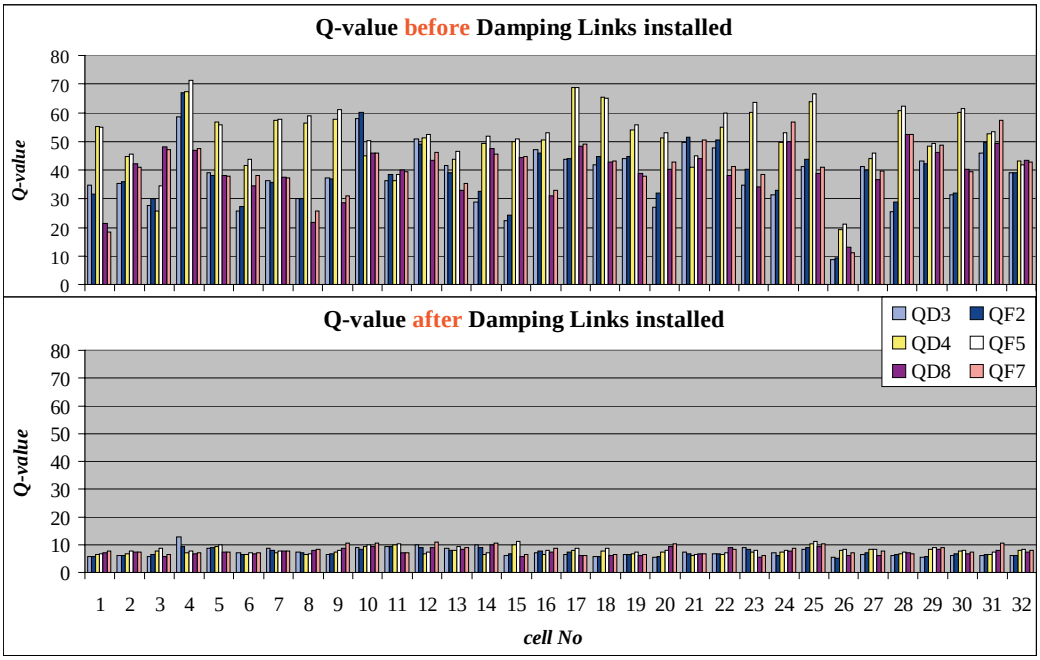
Damping Link : Model_9903BB + 1 Nervure/GMF, z_VEM-35mm

The FMF is glued on the Storage Ring floor

Performance



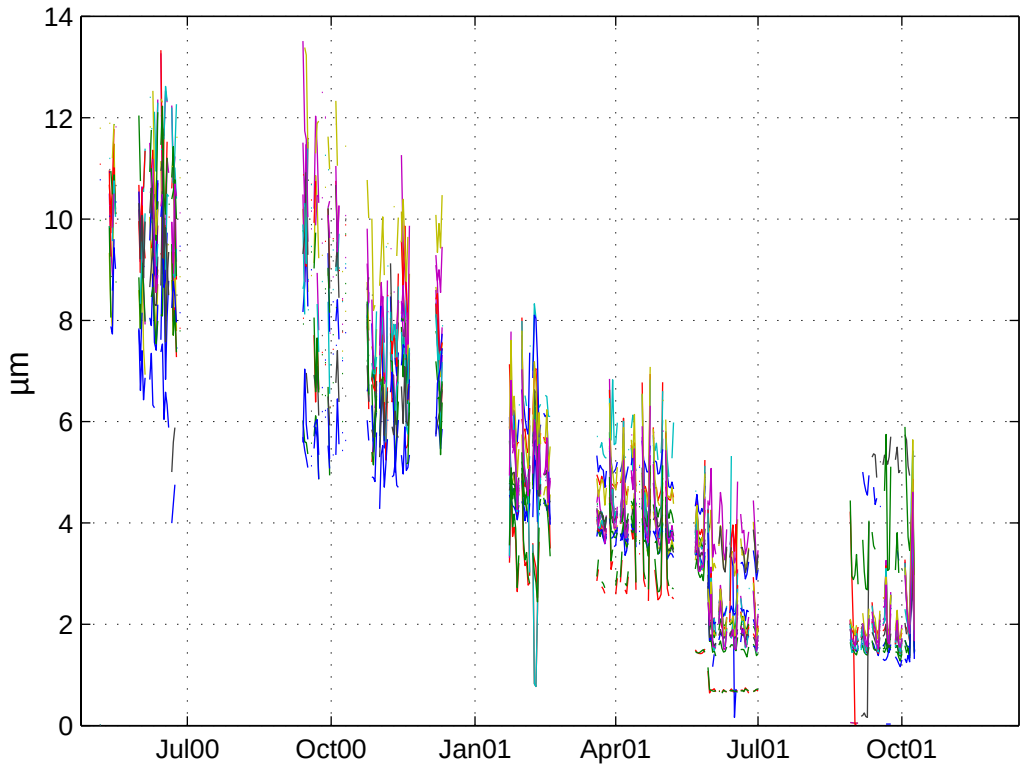
1st mode (transverse rocking motion) and 3rd mode (horizontal rotation) are significantly reduced



Horizontal beam position in high-β straights

Narrow band (4-12 Hz)

- The PSD is computed by averaging 240 data sets per day
- The rms motion is computed from the PSD
- All high-β straight section BPMs are superimposed



Horizontal beam position in high-β straight sections
(4-12 Hz)
(all BPMs superimposed)

In the frequency range where the damping links are designed to be efficient, the improvement with time is clear:

from 10 μm
to 2.7 μm

Broadband (4-200 Hz)

❖ The rms motion is computed again from the PSD

Horizontal beam position in high-β straight sections (all BPMs superimposed)

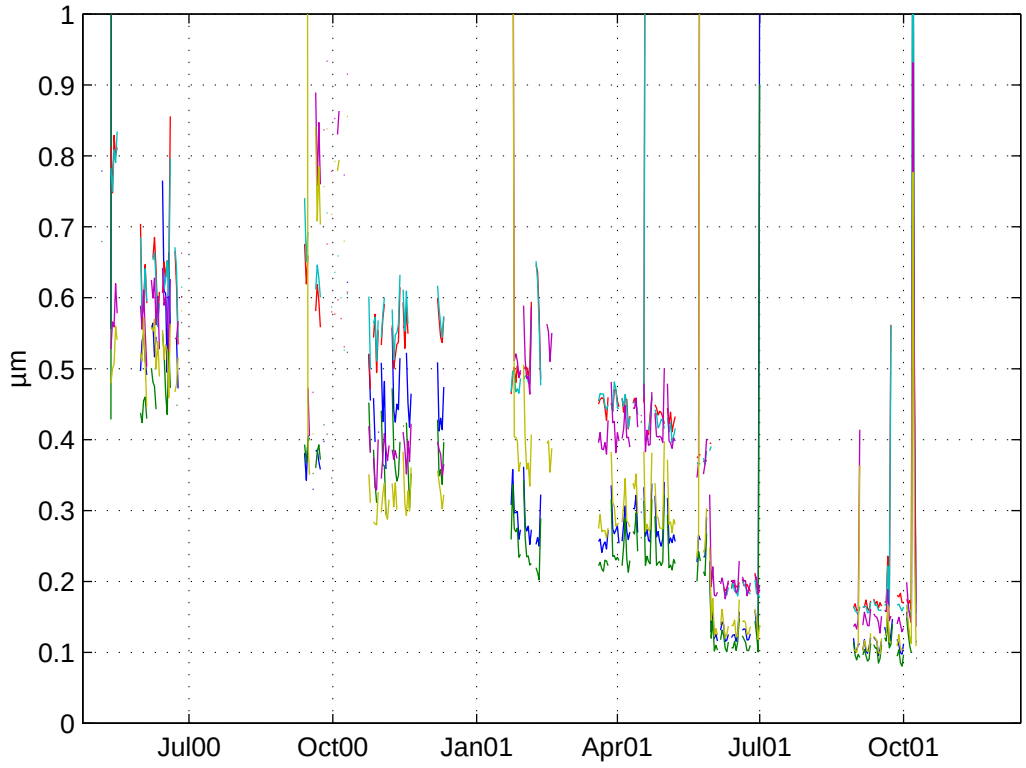
Even in broadband the improvement is still clearly visible:

From 12 μm
To 4 μm

Similar results can be observed in low-β straight sections.

Combination of damping links and feedback

- 3 straight sections were equipped with horizontal local feedback (6 BPMs).
- The improvement is also clear in these straight sections. As long as the feedback system is not limited by the noise level, both approaches can be cumulated.

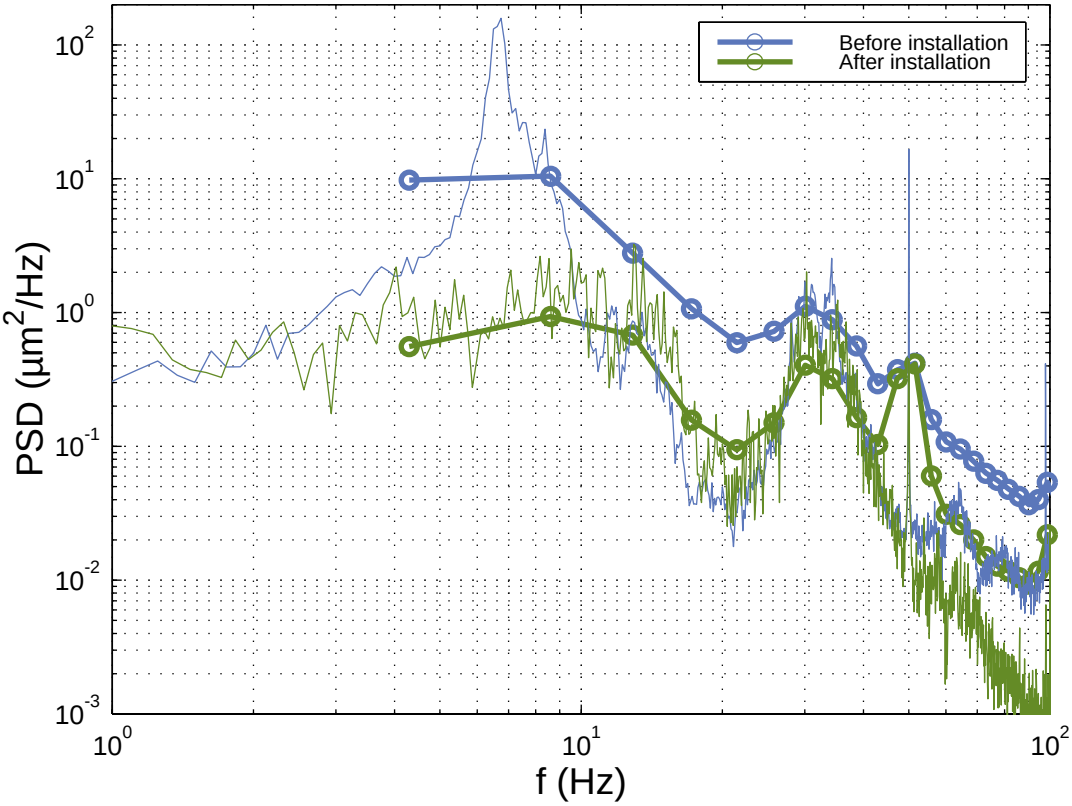


Horizontal beam position in feedback sections (4-12 Hz)

Frequency domain

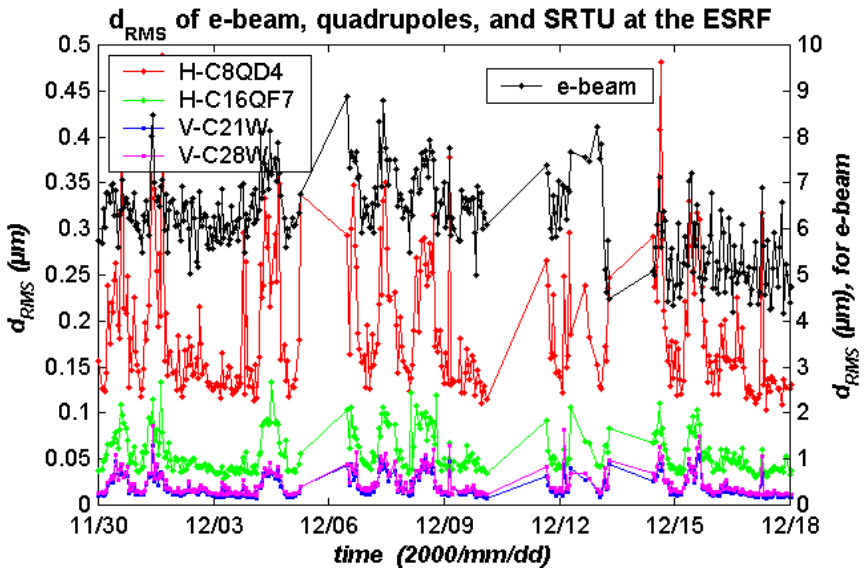
The same BPM signal was processed with two systems

- Standard BPM: 233ms samples + averaging
- High frequency resolution: 30s samples

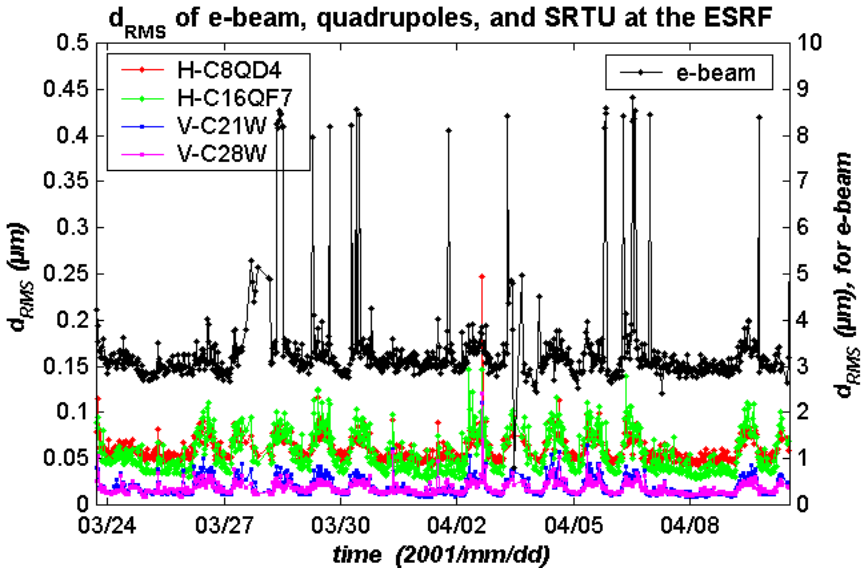


Effect of damping links on the horizontal beam motion

Time domain



Without damping links



With damping links

Conclusions

- The installation of damping links reduced the rms horizontal motion of the electron beam (in the range 4-200Hz) by a factor 3. The improvement was also visible in the vertical plane.
- The mechanical motion is now coming from the individual motion of each quadrupole on the girder (transverse rocking motion again), in the 30Hz range.
- Additional sources of motion are now visible on the electron beam: Booster operation…

Horizontal motion (β_x = 35.4 m)

	4-12 Hz	4-200 Hz
no damping links (μm)	10	12
with damping links (μm)	2.7	4
damping links+feedback (μm)	0.28	1