Orbit Stability at

LNLS

The Brazilian Synchrotron Light Source

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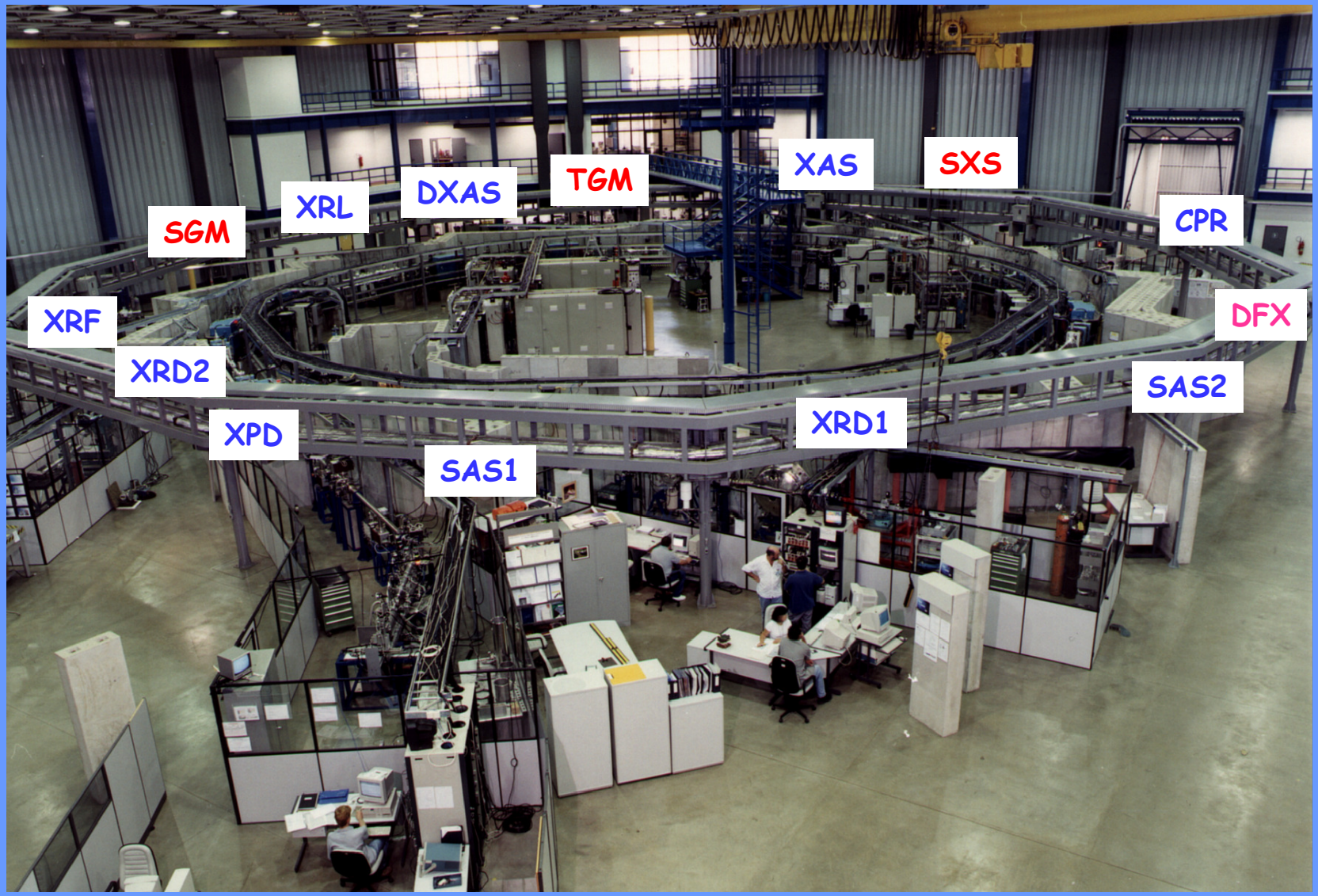
3rd International Workshop on Beam Orbit Stabilization, Grindelwald, December 2004

Where it is located

View of the LNLS campus

Experimental Hall and the Light Source

LNLS Beamlines



Installation of new RF cavity, Dec. 2003

Closing machine tunel with addition of 350 ton of concrete shielding

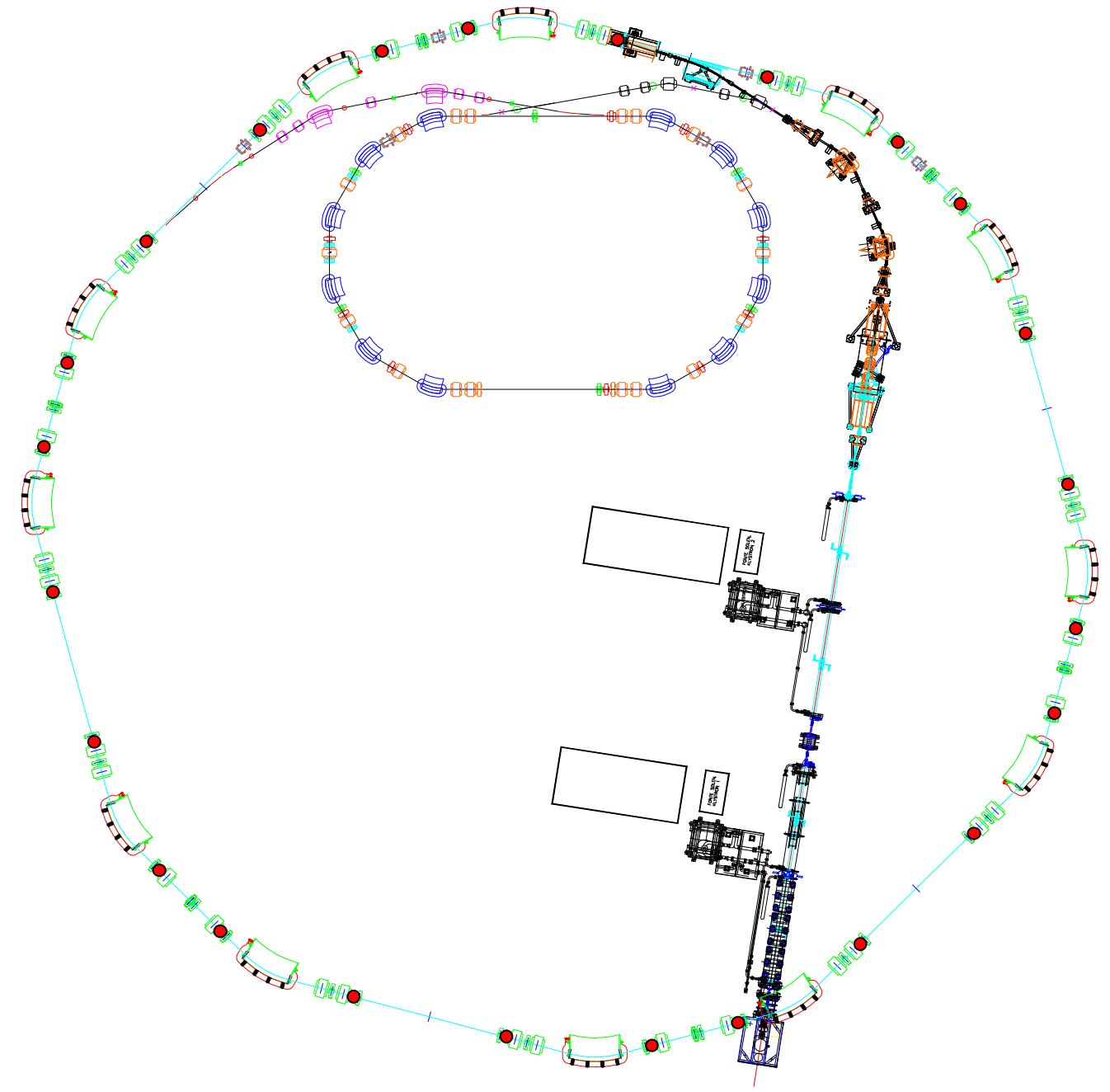
Storage ring parameters

• Operation energy	1.37	GeV
• Injection energy	500	MeV
• Magnetic structure	double-bend, 6 fold symmetry	
• Circumference	93.2	m
• Beam current	250	mA
• RF frequency	476	MHz
• Natural emittance	100	nm.rad
• # of straight sections for IDs	4	
• Horizontal beam size	~ 300	μm
• Vert. beam size (3.5% coup.)	~ 200	μm
• Required vert. orbit stability	± 5	μm

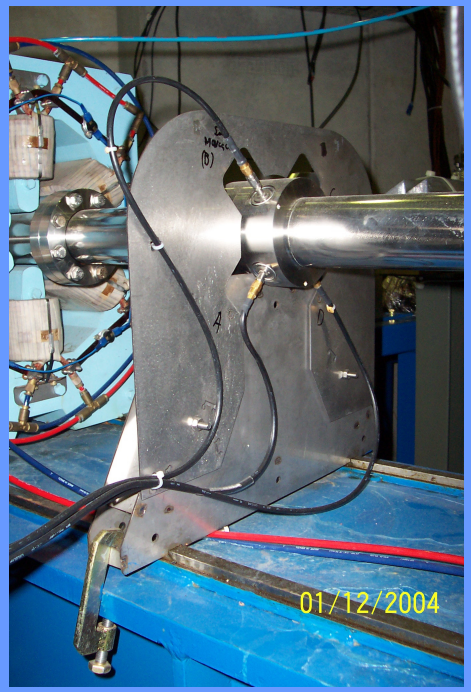
Orbit correction system

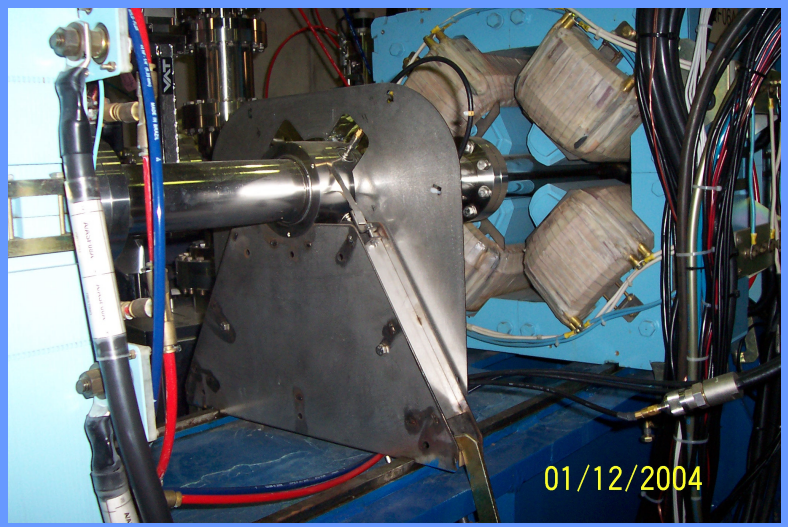
- 24 BPMs ➡ 4.6 per horizontal betatron wavelength.
  11 per vertical betatron wavelength.
- 24 vertical and 18 horizontal correctors.
- Global orbit correction every 24 seconds.
- Correction algorithm: SVD using calculated model response matrix.
- RF stripline BPMs. Commercial electronics.
- Monitors fixed to girders without isolating bellows.
- Thermal stability of magnet cooling water: ± 0.15 ºC.
- Open tunnel (hall) temperature stabilization: ± 1.5 ºC.
- Closed orbit bump at injection.

BPM distribution

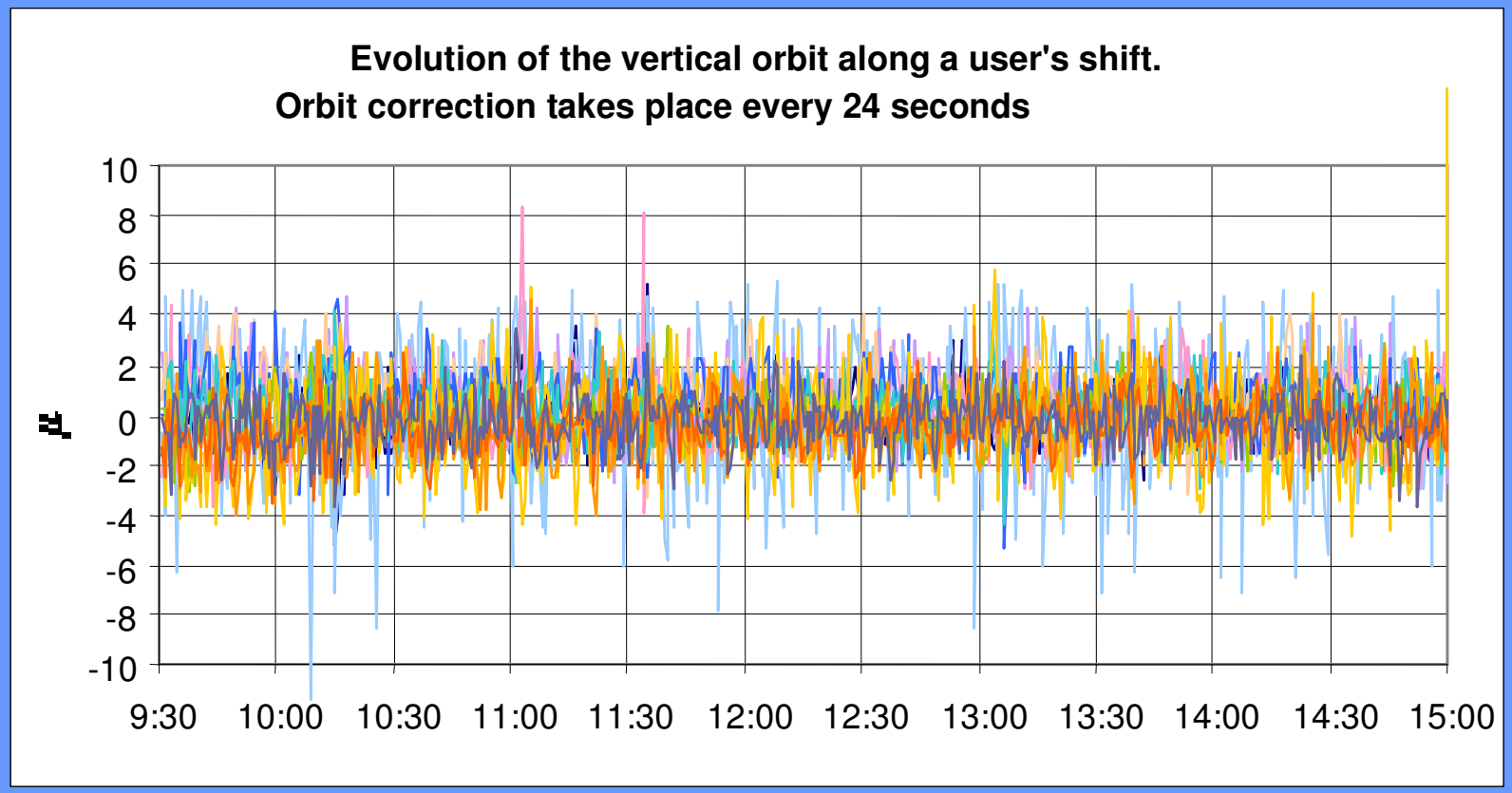


BPMs and electronics



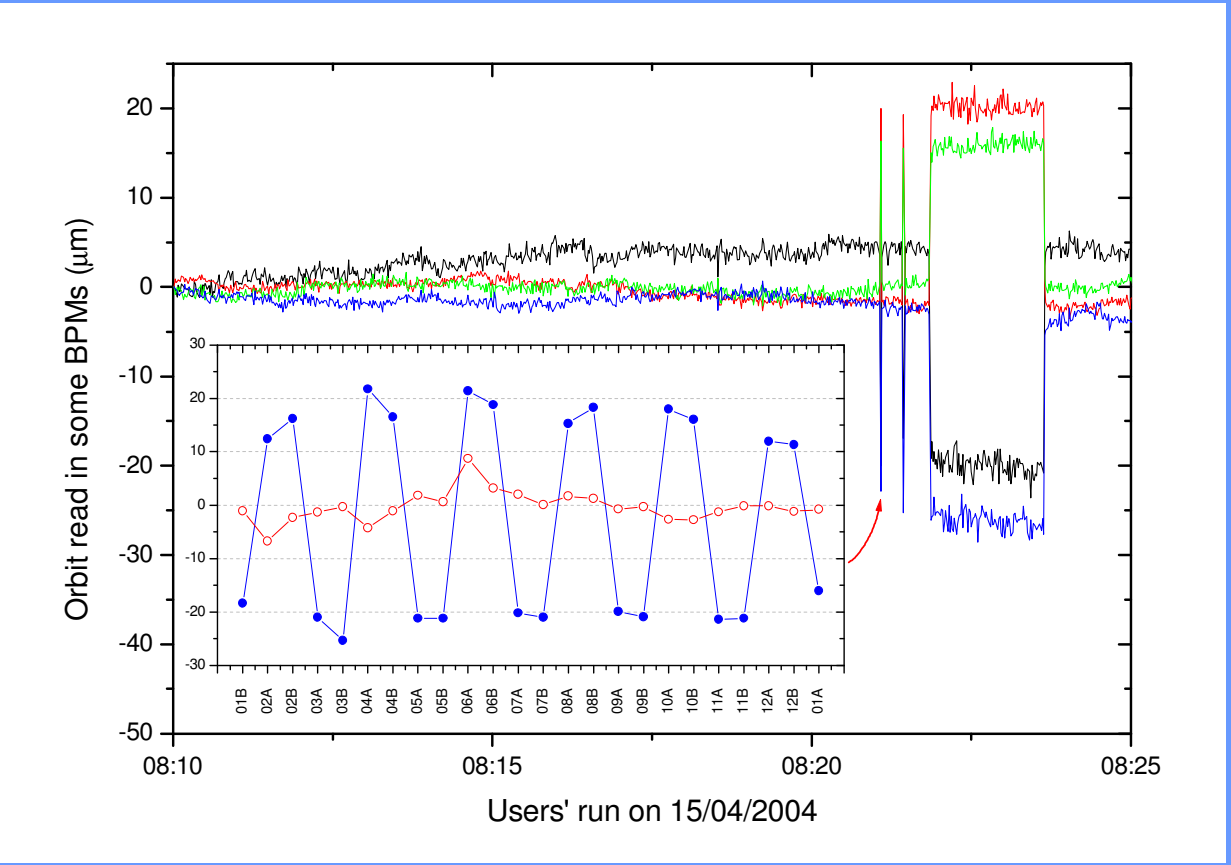


Vertical Orbit Stability



Orbit problems after installation of new RF cavity

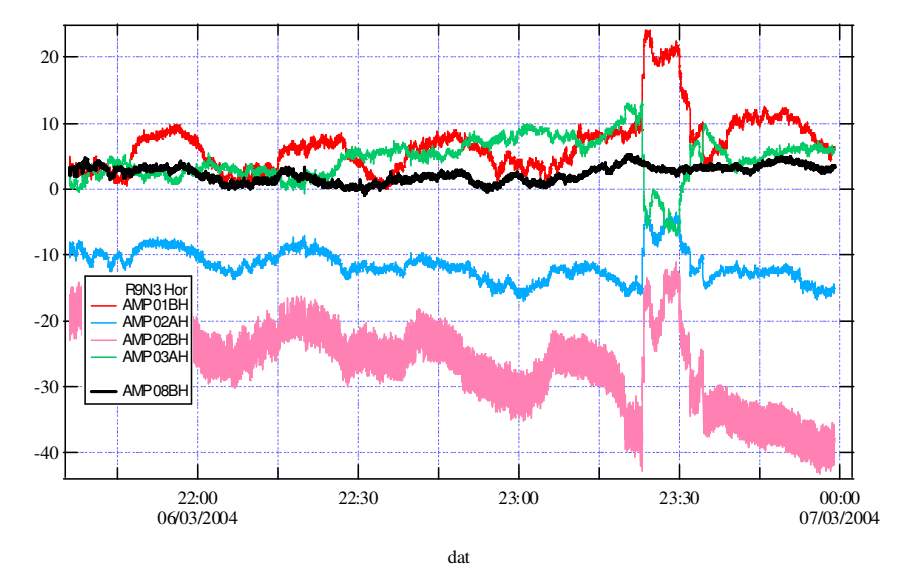
Real orbit displacement with correlation at users experiments.

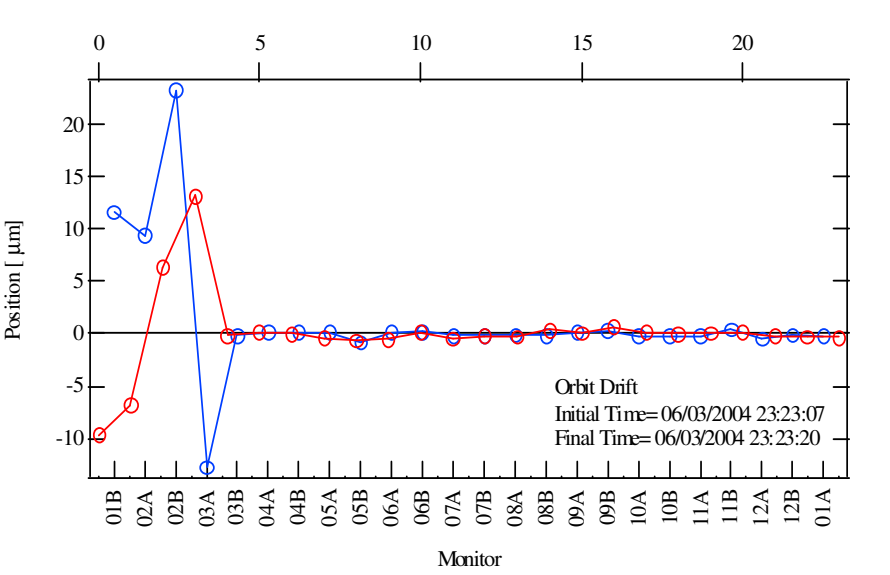


- 6-fold symmetric horizontal orbit distortion appears as a fast transition between 2 states.
- Orbit distortion looks like dispersion function. ➡ Second order dispersion.

Orbit problems after installation of new RF cavity

Problems with BPM readings.





- Variations in a few BPMs. Does not characterize a real orbit oscillation.
- Problems with high level of noise and sudden reading variations.

The 6-fold symmetric orbit instability problem

- The orbit distortions were caused by a longitudinal instability.
- A cavity HOM at ≈ 904 MHz excited large amplitude dipolar energy oscillations in the beam.
- The several tens of kHz oscillation are not seem by the monitors, with response of about 100 ms.

$$x = D_0\,\delta + D_1\,\delta^2 + \cdots$$

$$\delta = \delta_0 + \varepsilon\cos(\Omega t)$$

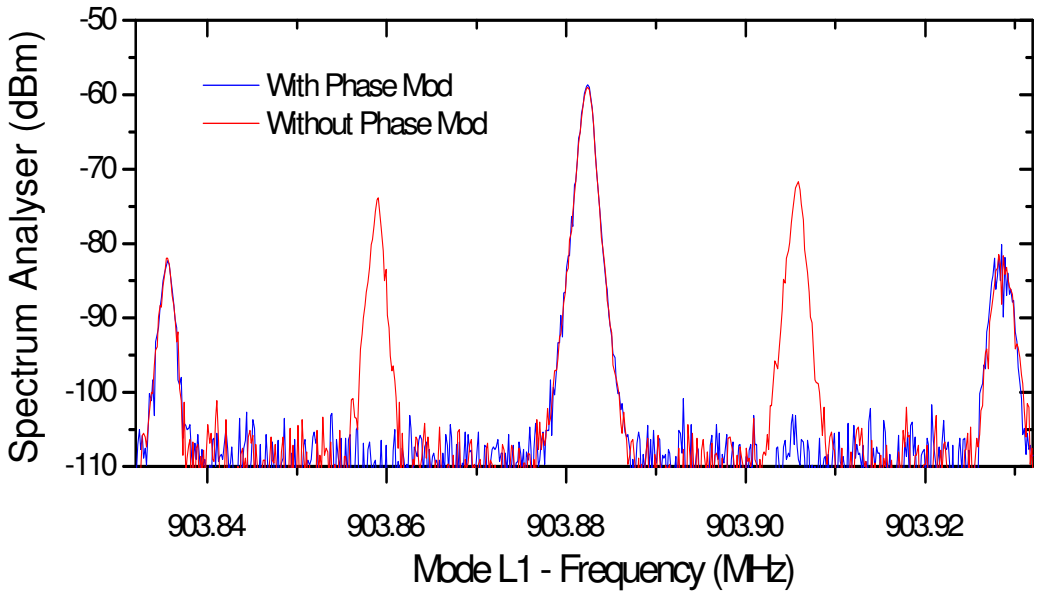
$$\Rightarrow \quad \langle \Delta x \rangle = \frac{1}{2} D_1 \Delta\varepsilon^2$$

Orbit distortion proportional to second order dispersion function.

- The same instability also caused an increase in the beam size.
- Some experiments could notice orbit variations as small as 3 μm.

Cure

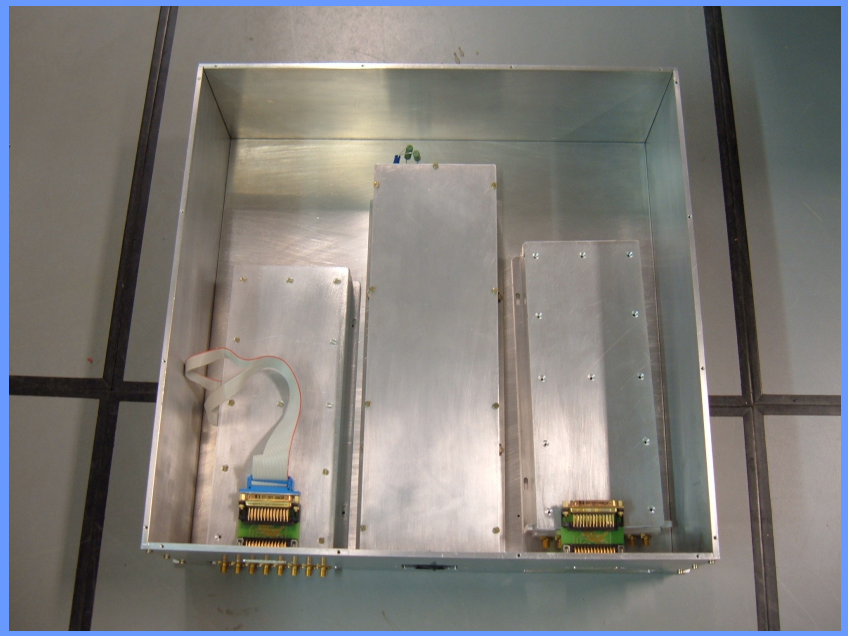
- Attempts to shift the HOM by changing temperature and plunger position were not effective.
- Active solution in the form of a phase modulation of the RF fields at twice the synchrotron frequency was successful.



The BPM reading problems

- Tests made: changing the electronics, cables, control boards. Shielding.
- Results show we need better shielding for the electronics and shorter cables.

New BPM electronics shielding box



Foreseen improvements for the next year

- New BPM electronics shielding and location.
- Increase orbit corrector resolution by using in house developed 20 bit DA converters.
- Improve orbit drift after machine refill by enhancing the temperature stabilization system for magnet cooling water.
- Tests with photon beam position monitors.
- Local orbit correction for insertion devices.
- Machine realignment after addition of 350 ton of concrete shielding around and over the machine.
- New corrector power supplies to allow faster orbit corrections.