Orbit Stability at

LNLS

The Brazilian Synchrotron Light Source

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Where it is located

Campinas
São Paulo
View of the LNLS campus
Experimental Hall and the Light Source
LNLS Beamlines

XRF
SGM
SXS
TGM
SAS1
XRD2
XAS
CPR
XPD
SAS2
XRL
DXAS
XRD1
DFX
Installation of new RF cavity, Dec. 2003

Closing machine tunnel 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 °C.
- Open tunnel (hall) temperature stabilization: ± 1.5 °C.
- Closed orbit bump at injection.
BPMs and electronics
Vertical Orbit Stability

Evolution of the vertical orbit along a user’s shift.
Orbit correction takes place every 24 seconds
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.

\[ x = D_0 \delta + D_1 \delta^2 + \cdots \]

\[ \delta = \delta_0 + \varepsilon \cos(\Omega t) \]

\[ \langle \Delta x \rangle = \frac{1}{2} D_1 \Delta \varepsilon^2 \]

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.
• 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.