Strategies for Achieving Sub-micron Orbit Stability at SLS

- sub-micron - to which level?
- elimination of vibration sources (as far as possible)
- improvements of measurement systems (BPM electronics etc.)
- low gap BPM, matching circuits?
- integration of HLS, HPS, POMS
- integration of X-Ray BPMs
- discrimination of noise sources in storage ring and experiments
- passive and/or active vibration damping at the experiments
Global Position Feedback in SR Sources

Stability Requirements I

**General statement of users:**

Source fluctuations should be one order of magnitude below the resolution and detectivity of experimental stations.

**Experiments have achieved:**

- photon energy resolution of $10^{-4}$ to $10^{-5}$
- detectivity resp. S/N-ratios on the sample of $10^{-3}$ to $10^{-4}$

**This translates into requirements for:**

**Angular Stability:**
(assuming planar crystal monochromator)

Bragg’s law: \[
\frac{\Delta E_{ph}}{E_{ph}} = \frac{\Delta \Theta}{\Theta_B}
\]

with Bragg angle $\Theta_B \sim 5^\circ - 45^\circ$

(90 - 800 mrad)

$\Delta \Theta_{beam} < 1 \mu \text{rad}$

**Position Stability:**
(assuming gaussian beamshapes)

\[
\Delta x_{beam}, \Delta y_{beam} < \sigma / 10
\]

for low $\varepsilon$ and low beta machines: $< 1 \mu \text{m}$

Volker Schlott

EPAC’02
Paris, 03.-07.06.2002
Requirements for Achieving Sub-micron Orbit Stability at SLS

- original requirement: position RMS < 1/10th of $\sigma_{\text{beam}}$

- design:
  1% coupling @ short straight IDs
  $\Rightarrow$ 7 $\mu$m beam size
  $\Rightarrow$ orbit stability < 0.7 $\mu$m RMS

- achieved coupling: 0.3 - 0.7%
  $\Rightarrow$ 4 - 6 $\mu$m beam size
  $\Rightarrow$ orbit stability < 0.5 $\mu$m RMS
Improvements of Readout Electronics

BPM Electronics - RF Front End:

- present hw:
  analogue down-conversion from 500 MHz to IF (36.029 MHz)

- future replacement (?) of RF FE with "passive" module (without mixers)
  ⇒ direct sampling of 500 MHz and digital down-conversion/decimation to base band
  ... to be evaluated

- in general:
  reduce noise sources in RF FE through reduction of active elements (mixers, amplifiers, ...)

T. Schilcher
2nd Workshop On Beam Orbit Stabilisation, Dec. 4 - 6, 2002
Improvements of Readout Electronics

BPM Electronics - Digital Receiver:

- possible upgrade from 12bit ADC to 14 bit
- resolve signal attenuation in digital down converter by internal gain control

- optimize digital filters (bandwidth versus resolution)

\[
\sigma_y = 1.5 \, \mu m
\]
Stability and Dynamic Alignment at SLS

Mechanical Position Monitoring System (POMS)

Deformation of SLS Storage Ring Vacuum Chamber due to Thermal Loads

FEA-simulations indicate movements of up to 2 μm/°K in the transverse plane at the positions of the BPM blocks

POMS System

• Dial gauges sense transverse movements of BPM block in reference to adjacent quadrupole magnets.
• Linear encoders of type Renishaw RGH24Z50A00A with 0.5 μm resolution are used as sensing devices.
• Complete integration into EPICS control system through serial SSI-interface and 32 channel VME-SSI card.

Dial gauges equipped with linear encoders as sensing devices attached to quadrupole magnets

Volker Schlott

ESLS-Workshop 18.-19.11.2002
Stability and Dynamic Alignment at SLS

Vertical BPM Motion at ID-04 as a Function of SR Current

- SR CURRENT [mA]
- "Top-up" operation of SLS storage ring
- "Beam development" shifts with transient beam current

Vertical BPM Motion at Bend-07 as a Function of SR Current

Volker Schlott
ESLS-Workshop 18.-19.11.2002
Stability and Dynamic Alignment at SLS

Horizontal Positioning System (HPS) for SLS Girders

“Train link” over one SR sector

HPS arrangement between adjacent girders

Relative linear encoders with 0.5 μm resolution as sensing devices

Girder Motion at ID04 as a Function of SR Tunnel Temperature

Volker Schlott

ESLS-Wokshop 18.-19.11.2002
Risoluzione vs. Data Rate

Resolution

Current BPM;
FEEDBACK mode

Low Gap BPM:
turn-by-turn
864ns/reading

Transverse Feedback
2ns/reading

89nm, measured
on the beam

M. Ferianis

Riunione Tecnica Settore Acceleratori

20 giugno 2001
Vibration Damping at the Experiments

- separate noise contributions from
  - electron beam
  - mirrors and monochromators
  - experimental stations

spectrum:

\[ \text{freq. [Hz]} \]

\( \text{a.u.} \)

\( \text{monochromator} \quad \text{grid} \)

⇒ passive / active damping of noise sources at experimental setups

(J. Krempasky)