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

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 reqiurements for:

Angular Stability:

(assuming planar crystal monochromator)

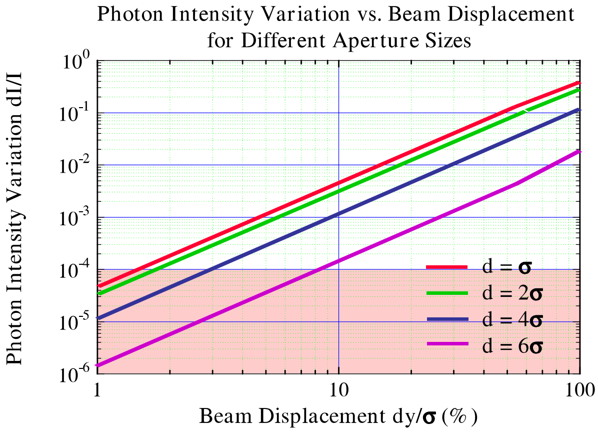
Bragg's law: $$\frac{\Delta E_{ph}}{E_{ph}} = \frac{\Delta\Theta}{\Theta_B}$$

with Bragg angle $\Theta_B \sim 5° - 45°$ **(90 - 800 mrad)**

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

Position Stability:

(assuming gaussian beamshapes)



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

for low ε and low beta machines: < 1 μm

Requirements for Achieving Sub-micron Orbit Stability at SLS

- original requirement:
  position RMS < 1/10th of $_{\text{beam}}$
- design:
  1% coupling @ short straight IDs
  ⇒ 7 m beam size
  ⇒ orbit stability < 0.7 m RMS
- achieved coupling: 0.3 - 0.7%
  ⇒ 4 - 6 m beam size
  ⇒ orbit stability < 0.5 m RMS

Improvements of Readout Electronics

BPM Electronics - RF Front End:

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

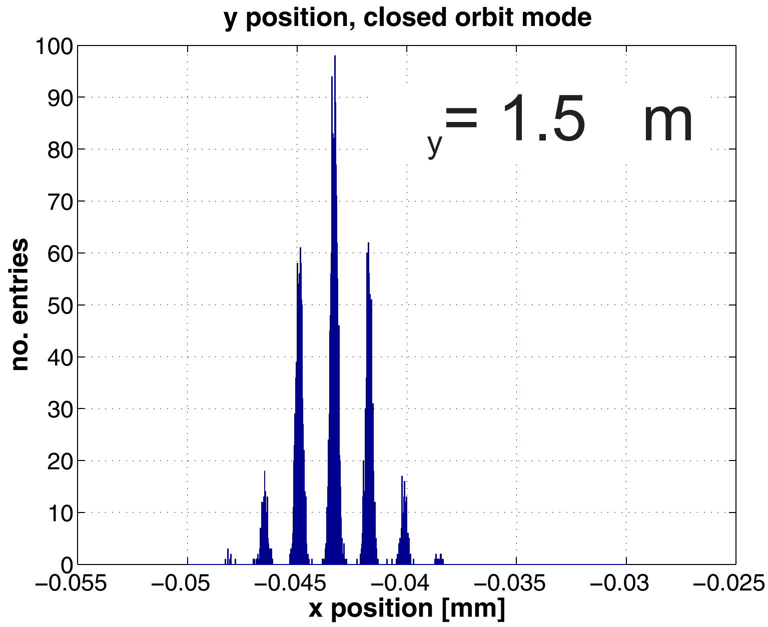
- future replacement (?) of RF FE
  with "passive" module (without
  mixers)
  ⇒ direct sampling of 500 MHz and
  digital down-conversion/decimation
  to base band
  ... to be evaluated

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

Improvements of Readout Electronics

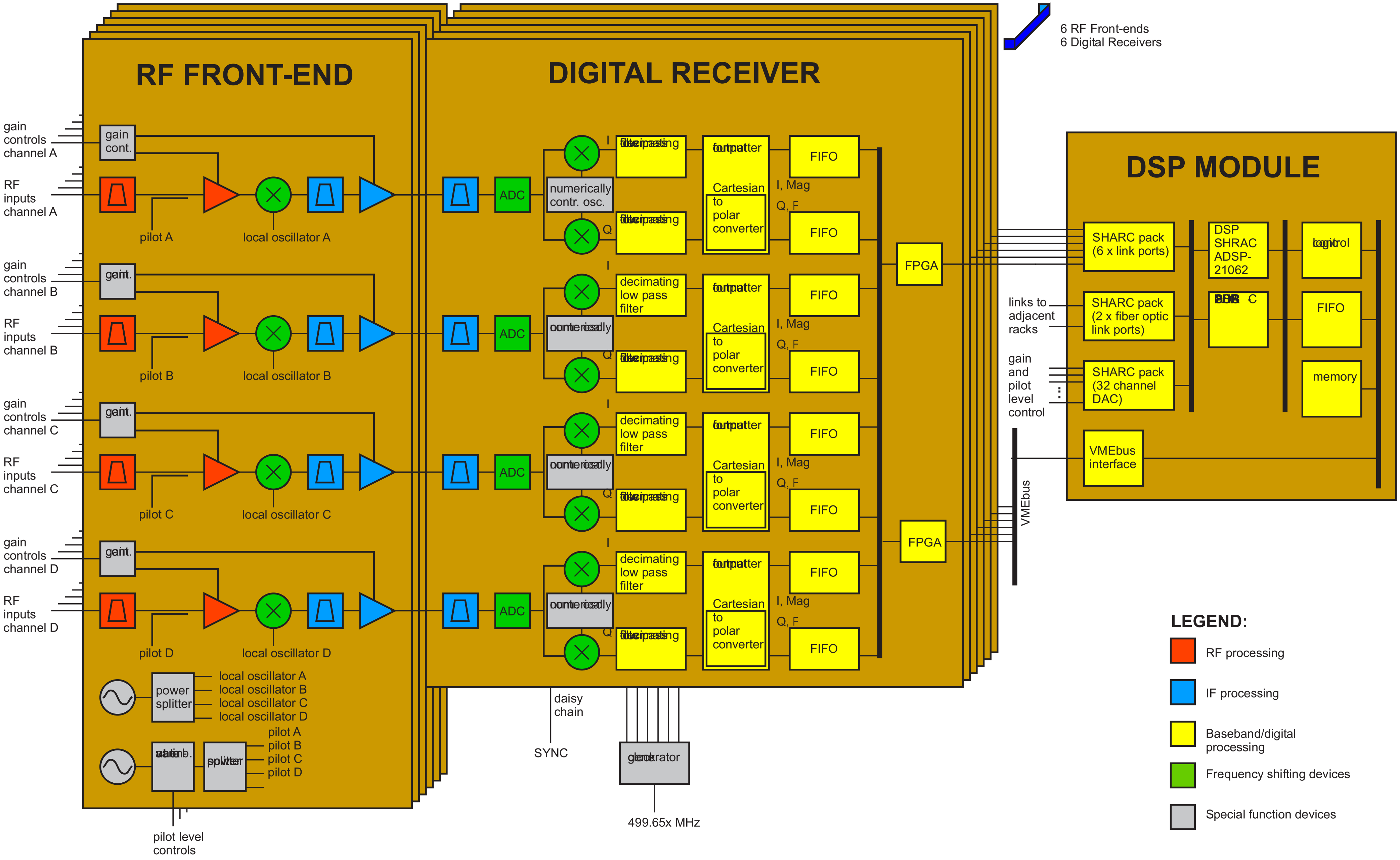
BPM Electronics - Digital Receiver:

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



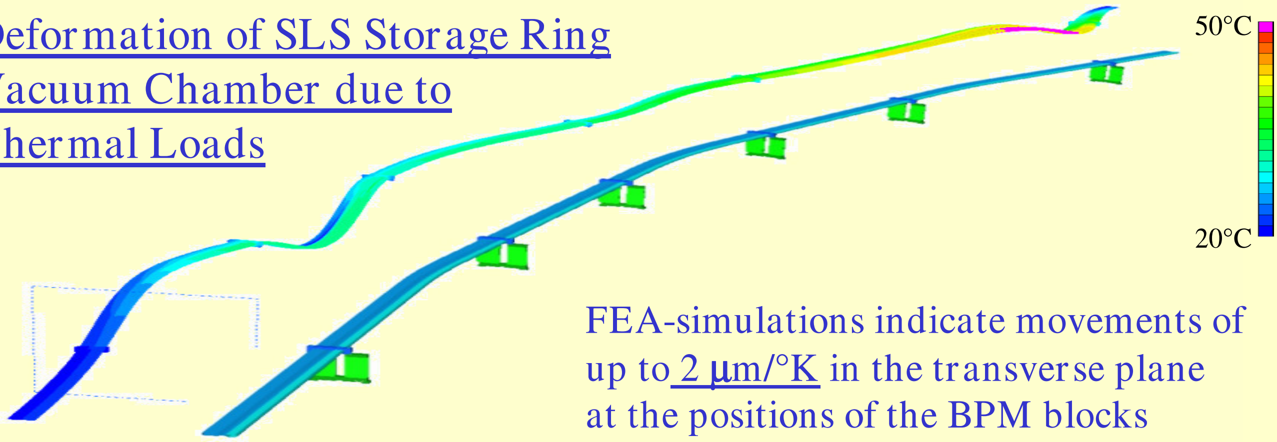
- optimize digital filters (bandwidth versus resolution)

DIGITAL BEAM POSITION MONITORING SYSTEM (DBPM)



Mechanical Position Monitoring System (POMS)

Deformation of SLS Storage Ring Vacuum Chamber due to Thermal Loads

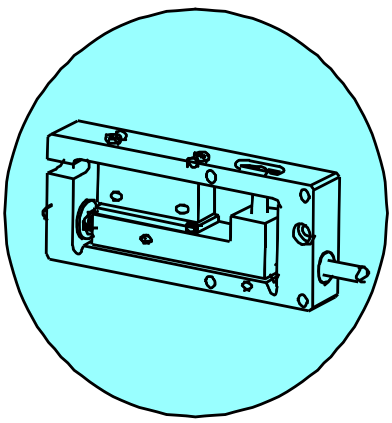


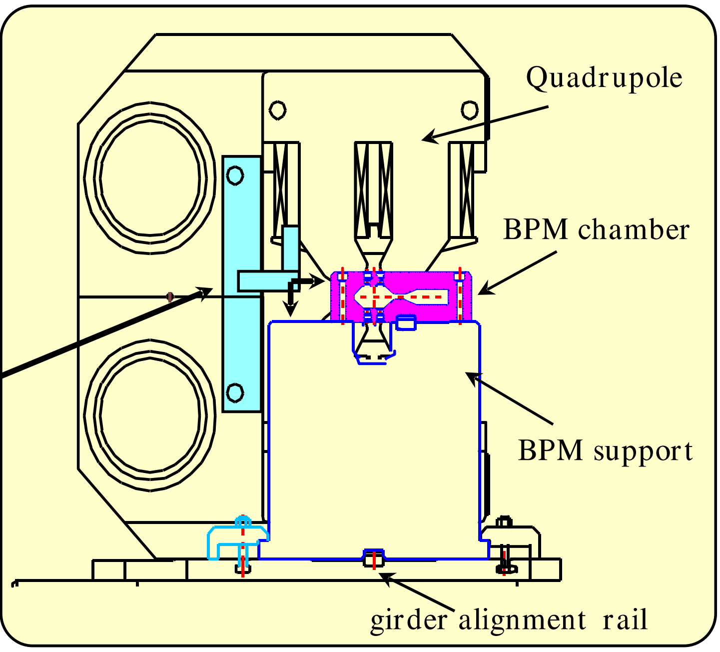
FEA-simulations indicate movements of up to 2 μm/°K in the transverse plane at the positions of the BPM blocks

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.

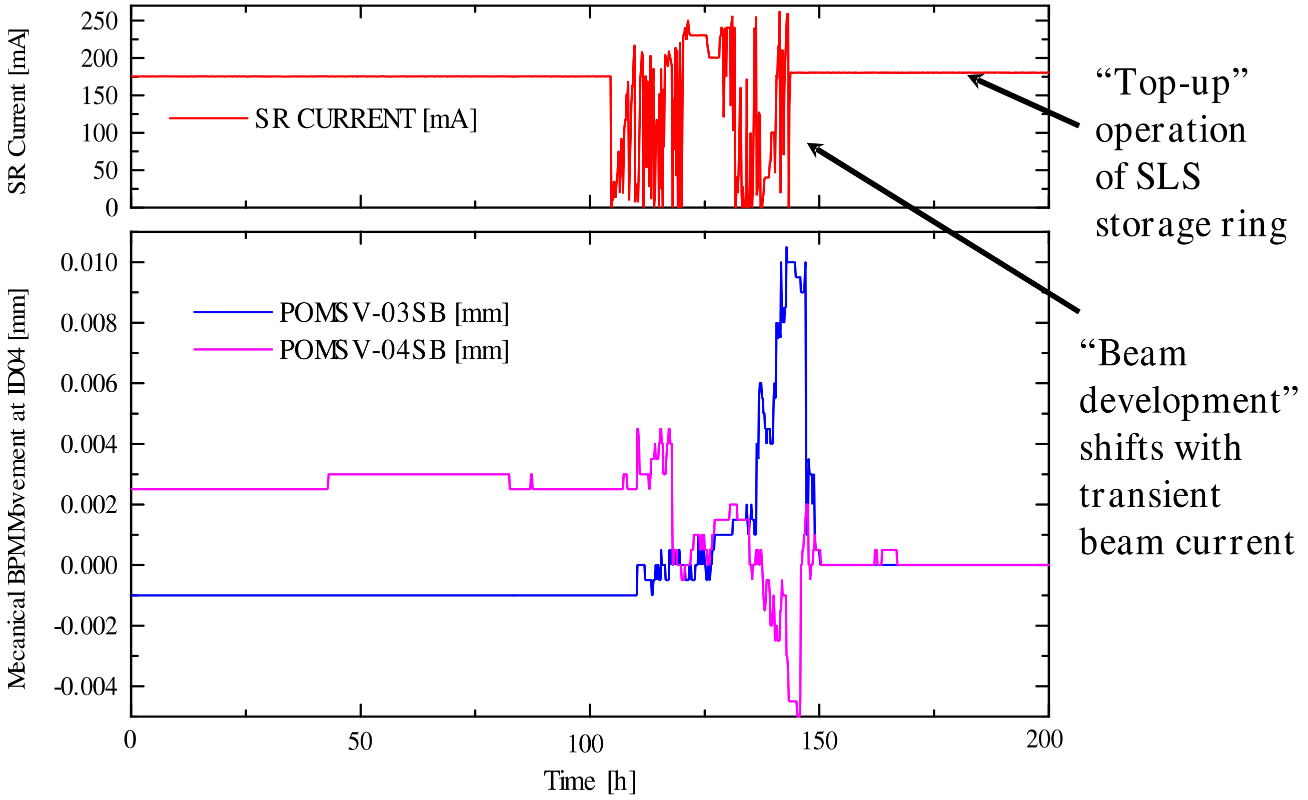
Dial gauges equipped with linear encoders as sensing devices attached to quadrupole magnets



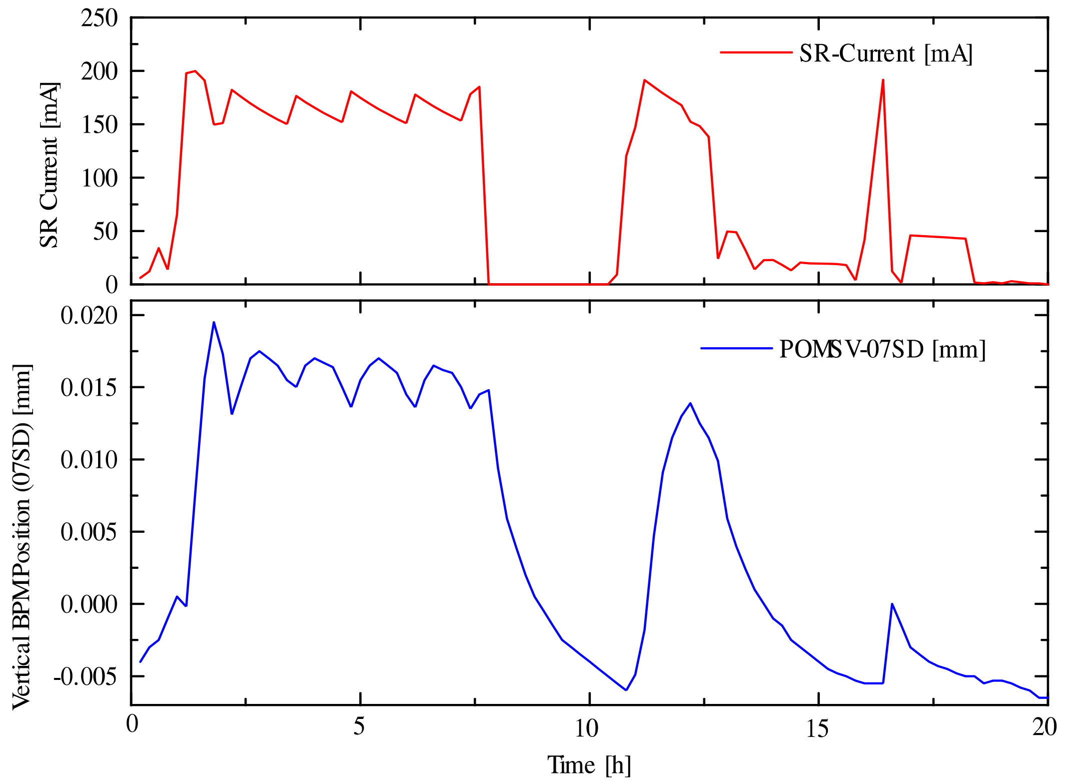


Stability and Dynamic Alignment at SLS

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

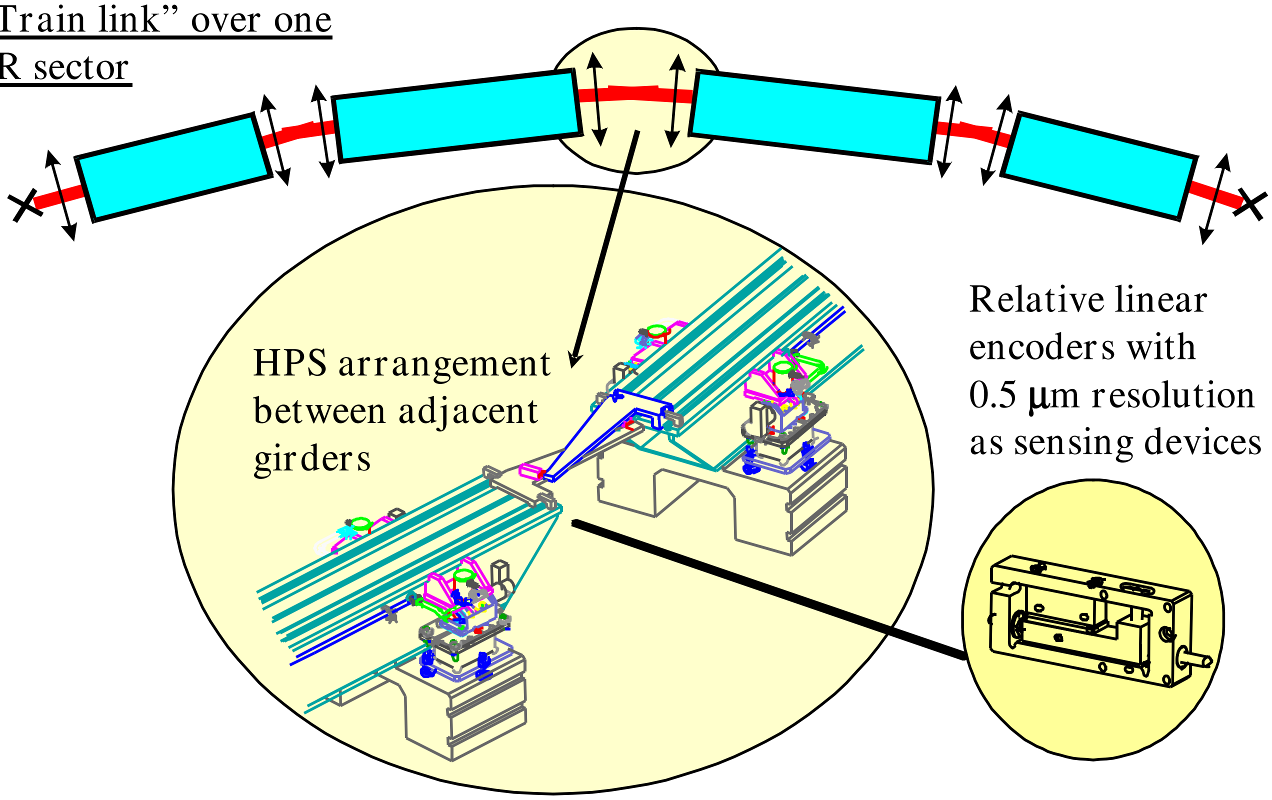


Vertical BPM Motion at Bend-07 as a Function of SR Current

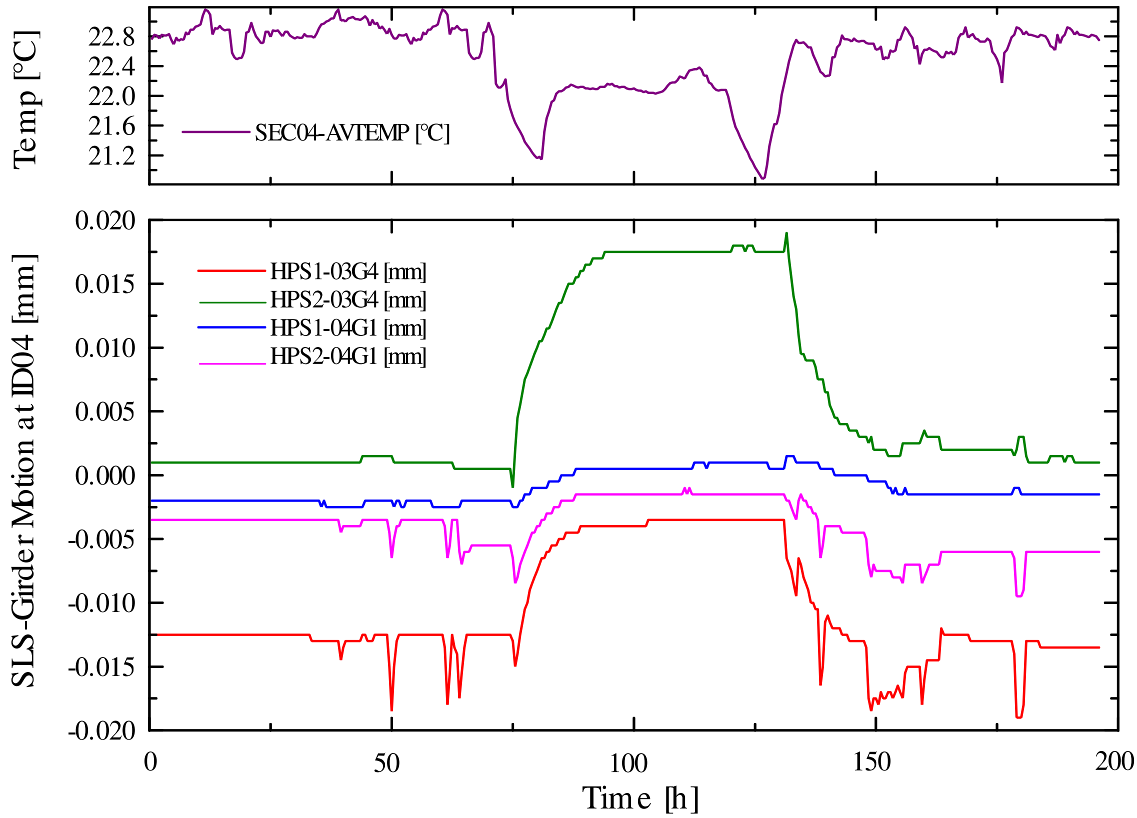


Horizontal Positioning System (HPS) for SLS Girders

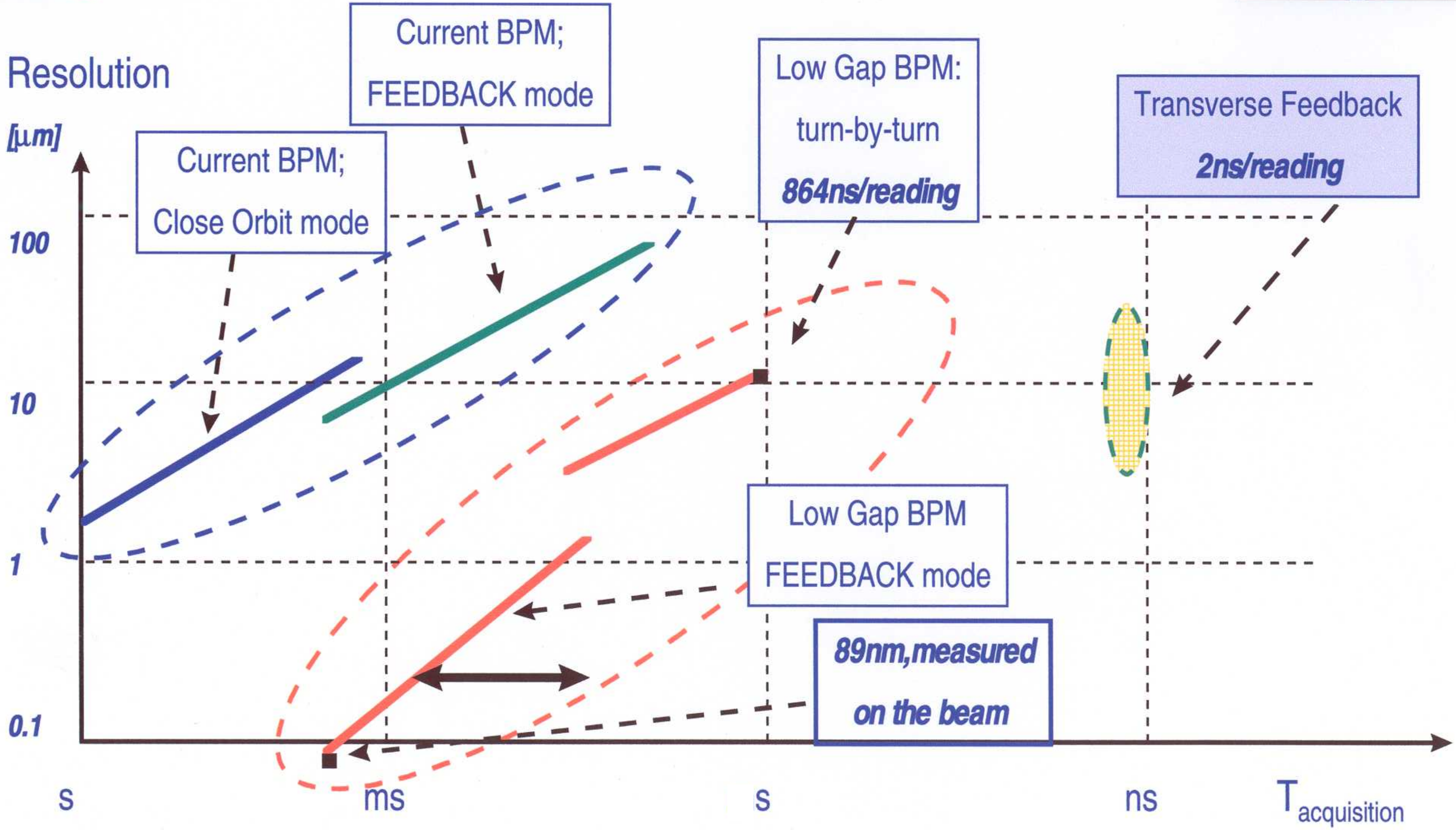
"Train link" over one SR sector



Girder Motion at ID04 as a Function of SR Tunnel Temperature

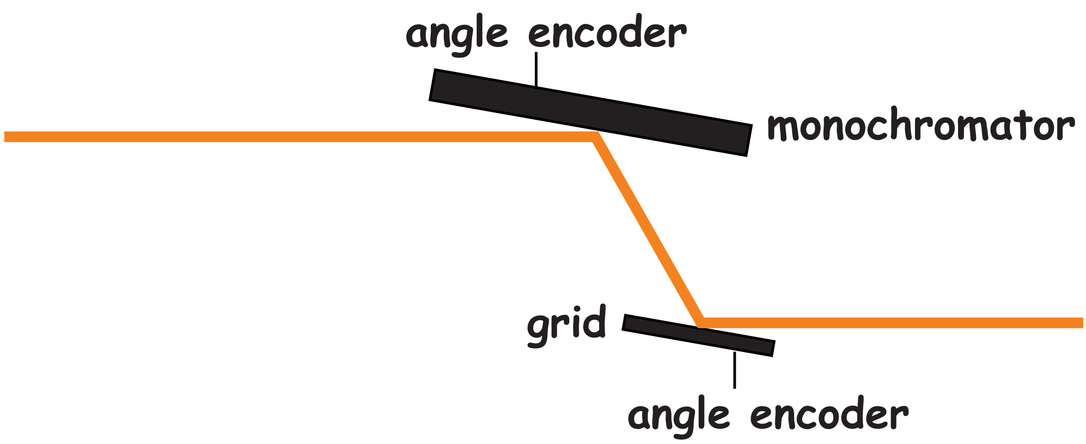


Risoluzione vs. Data Rate

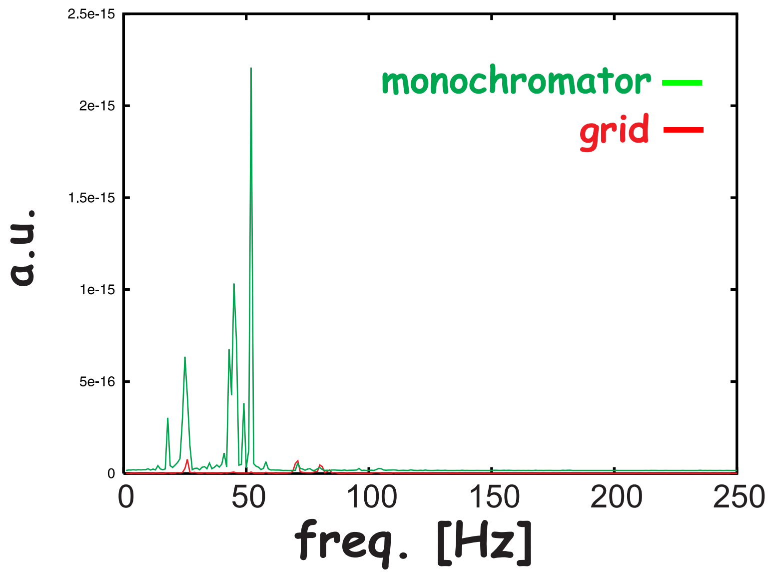


Vibration Damping at the Experiments

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



spectrum:



(J. Krempasky)

⇒ passive / active damping of noise sources at experimental setups