The workshop was held at SLS on September, 9th 2004

It was intended to…

- review the original specifications for beam stability at SLS
- review the performance of the FOFB including all subsystems
- collect experience from users and operators
- define fields for improvements
- to discuss options for improvements
- to re-specify the future requirements for beam stability

The workshop was attended by

- beam dynamics and instrumentation
- users
- operations
- management

*Report on internal „mini-workshop on beam stability at SLS"*

## Original requirements on SLS beam stability (as specified to BPM system in 1998)

- position stability of source point: σ/10 of source size (vertical)
  e.g.: 1 μm at low-β IDs for 1% coupling
- angular stability of source point: ΔΘ < 1 μrad
- long term stability (12 h): ± 2.5 μm (of electron beam)
- reliability: high (but not explicitly specified)

## Achievements of SLS beam stability (since beginning of 2004)

- position stability of source point: ~ σ/30 (vertical, 1-150 Hz)
  < 0.3 μm at low-β IDs (vertical, 1 – 150 Hz)
  ~ σ/250 (@ 5 Hz) vertical
  ~ 0.02 μm global vertical orbit stability @ 5 Hz
- angular stability of source point: ΔΘ < 0.25 μrad (1 – 150 Hz, vertical)
- long term stability (24 h): 2 μm (of electron beam)
- reliability: ~ 1 BPM failure per month (1 failure since September)
  < 3 FOFB subsystem failures per months
  (2 failures since September – user, network)
- signal integrity: data verified by photon BPM readings
  discrimination of electrical (DBPM systematics) and mechanical effects (drifts) through POMS system

# The operations / operators point of view…

- excellent short and medium term performance of orbit feedback (FOFB)

- good DBPM long term stability and reproducibility of "golden orbit" – even after shut-downs

- operators would appreciate easier handling of FOFB – but highly complex systems and the many options and possibilities, which are supported, demand conscious and elaborated use!!!

- maintainability and reliability could be improved in terms of…

| | | |
|---|---|---|
| failure rate of DBPMs | target rate: | < 1 failure per month (achieved since September) |
| faster HW exchange | target: | < 1 hour for electronics exchange |

improved SW support for quick failure detection and analyses

- allow local bumps ("bump-scans") during user run within FOFB application

- calibration of DBPM system for low current operation and different SR filling modes

# The users point of view…

- **beamlines / experiments can obviously be divided into 2 categories:**

**a) “large focus” … ~ 100 µm**
**b) “µ-focus” … < 10 µm (presently)**
**~ 20 nm (planned POLLUX beamline)**

- **category a) beamlines are in general happy with SLS beam stability (performance of FOFB)**

- **category b) beamlines**

**short term stability (hours to 100 Hz) is excellent – except from some occasional spikes (only reported from 06S protein crystallography)**

**top-up injection is visible (due to not perfectly closed injection bump) – gating…?**

**(directly) after shut-down (usually 1-2 weeks) photon beam is “only” back to ~ 10 µm**

**no beamline operation possible without FOFB running !!!**

- **present energy resolution of SIM-beamline ($\Delta E/E \sim 10^{-4}$ to $10^{-5}$) corresponds to ~ 1 µrad beam motion (short term). Future beamlines (ADRESS) will have $\Delta E/E \sim 10^{-4}$ to $10^{-5}$ and will thus need beam motion of < 0.1 µrad.**

# (F)OFB and sub-systems performance and limitations

- for **FOFB performance and orbit correction concept**… see talks from Th. Schilcher and M. Böge

- **(SLS) DBPM-system**

most of the concept is still valid… but keep in mind, the system is "already" 7 years old!

**Pros**
high flexibility of system
HW and SW (almost) debugged
systematics are known and/or eliminated

**Cons**
HUGE effort in SW development
most of the components are outdated
→ difficult repair and upgrade(s)
→ bandwidth and resolution limitations

- **Photon BPMs – white beam diagnostics**

only used for… fixed (smallest) in-vacuum ID-gaps
wigglers and bending magnets

authenticity of data is questionable for… (low energy) undulator beamlines

monitors need calibration, which is non-trivial and time consuming

data need to be integrated in (F)OFB (synchronization!)

- **Mechanical Movements (POMS)**

POMS-data is available for discrimination of electronical drifts and mechanical movements

only used for monitoring since **NO MECHANICAL DRIFTS IN TOP-UP OPERATION**

# Preliminary conclusions and outlook…

- original performance goals have been reached and even exceeded
  → TOP-UP OPERATION REPRESENTS A MAJOR KEY TO BEAM STABILITY !!!

- reliability is pretty high / failure rate is fairly low… but could always be better

- trouble shooting could be improved… but keep in mind complex systems are never easy (to use)

- electronical signal chain has been decoupled from mechanical and thermal effects
  → most of the systematic effects in the electronics (DBPMs) could be eliminated
  → cascaded feedback scheme (including photon BPMs and filling pattern FB) could be applied

- μ-focus beamlines remain a real challenge… and there will be many more in the (near) future

- photon BPMs need more attention… new, better, more reliable monitors ?!
  and should be integrated in (F)OFBs… from the very beginning !!!

- SLS DBPM system is a matured child of it's time… but starting to get old
  → limited possibilities to extend (FEMTO, photon BPMs, etc…)
  → critical HW components are outdated… new concept based on VPC-board (B. Keil)

- beamline data needs to be made available for machine and possibly integrated in (F)OFBs

# Upcoming Session on Orbit Measurement and Correction…

| | |
|---|---|
| **R. Ursic** | **Libera Electron Beam Position Processor** |
| **G. Rehm** | **EBPMs and Orbit Feedback Electronics at DIAMOND** |
| **B. Keil** | **The "Generic VME PMC Carrier Board" – Status and Perspectives of a Common Digital Platform for Beam Diagnostics and Feedbacks at PSI** |
| **T. Straumann** | **Fast Orbit Feedback Electronics for SPEAR3** |
| **R. Steinhagen** | **Large Scale Orbit Correction for LHC** |
| **J. Bergoz** | **Latest Developments and What's to Come in Beam Position Measurement** |

**Expectation…** **what can be expected from industry (present and future systems) as well as upcoming machines (DIAMOND, LHC, SPEAR3) as goal for beam stability**

**to see, where are the achievements and where might be the short-comings**

**Wish…** **to have a lively discussion about the most appropriate way to proceed for future machines and for upgrades of present machines**