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

- position stability of source point: $\sigma/10$ of source size (vertical)
  e.g.: 1 $\mu$m at low-$\beta$ IDs for 1% coupling
- angular stability of source point: $\Delta\Theta < 1$ $\mu$rad
- long term stability (12 h): $\pm 2.5$ $\mu$m (of electron beam)
- reliability: high (but not explicitly specified)

Achievements of SLS beam stability (since beginning of 2004)

- position stability of source point: ~ $\sigma/30$ (vertical, 1-150 Hz)
  $< 0.3$ $\mu$m at low-$\beta$ IDs (vertical, 1 – 150 Hz)
  ~ $\sigma/250$ (@ 5 Hz) vertical
  ~ 0.02 $\mu$m global vertical orbit stability @ 5 Hz
- angular stability of source point: $\Delta\Theta < 0.25$ $\mu$rad (1 – 150 Hz, vertical)
- long term stability (24 h): 2 $\mu$m (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 (ΔE/E ~ 10^{-4} to 10^{-5}) corresponds to ~ 1 µrad
  beam motion (short term). Future beamlines (ADDRESS) will have ΔE/E ~ 10^{-4} to 10^{-5} and
  will thus need beam motion of < 0.1 µrad.
Report on internal „mini-workshop on beam stability at SLS”

(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
  - wiggler 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…**

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**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