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SWISS LIGHT SOURCE

Initiation of turn-by-turn optics measurement at SLS

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Introduction

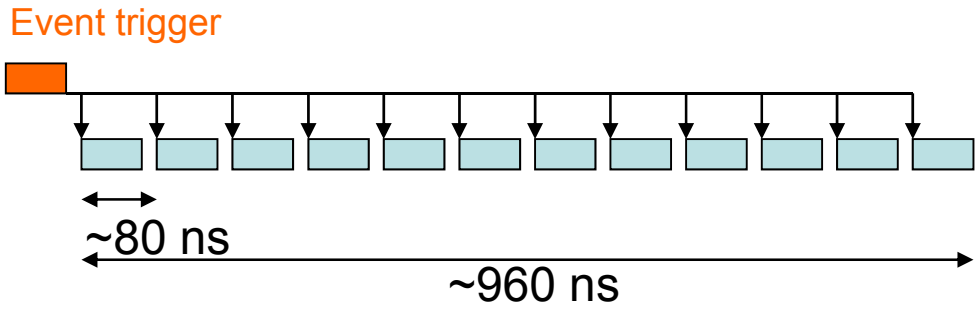
- Status of optics measurement/correction at SLS
  - Beta function with quadrupole variation (Tune response)
  - Linear coupling with orbit response (partial LOCO)
  - Dispersion
    - Hor: No explicit correction (correction through beta correction)
    - Ver: Correction together with coupling.
      Skew Qs at dispersive and non-dispersive section
  - Nonlinear optics with resonance driving term knobs
    - Somehow empirical as looking at beam lifetime
- Motivation for turn-by-turn (TBT) measurement
  - TBT capability has not been fully utilized
    - Used for injection (first few turns) and decoherence measurements
  - Better understanding the optics, complementary to the methods currently used
  - Aiming at even better correction!

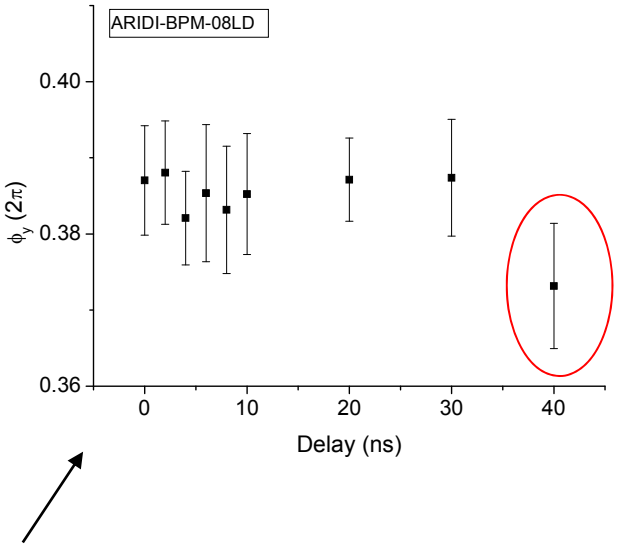
Machine Setup

- Setup for TBT measurement
  - Use pingers to excite betatron oscillation in both planes, oscillation ~1 mm or more
  - Beam current: 50 mA/100 buckets (out of 480 buckets)
    - Avoid collective effects (cf. 400 mA / 390 buckets in user operation)
    - Short bunch train to match pinger pulse length ($<\tau_{rev}$)
    - Side effect: Machine temperature lower than in user operations (see later slide)
  - BPMs: turn-by-turn mode, noise ~20 μm
    - “One click” application to collect and validate ~2000 turns data from all BPMs

Trigger issue/upgrade (1)

- BPM triggering
  - 72+2 BPMs divided into 12 sectors





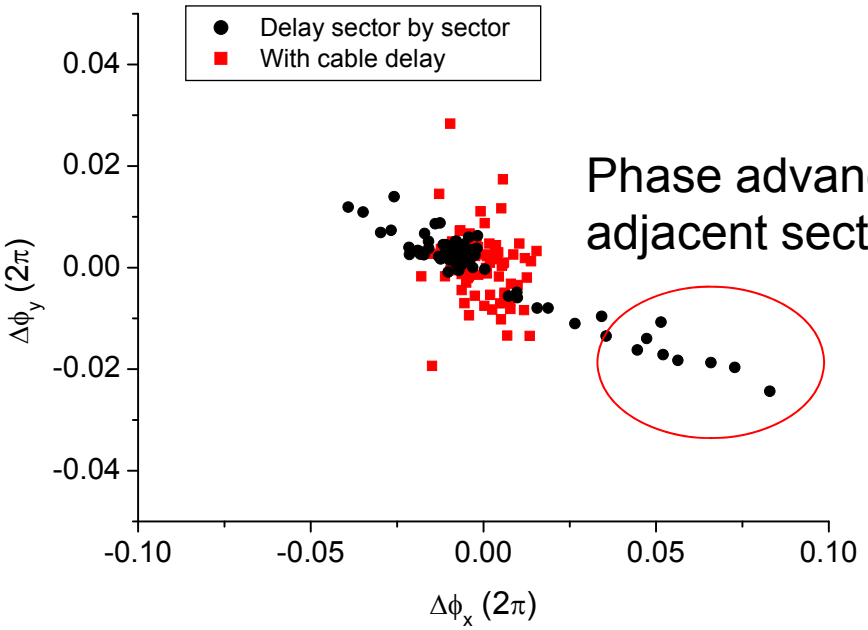
- Issue
  - Artifact in measured betatron phase related with BPM triggering
  - Similar experience at Diamond

    (Ref. R. Bartolini / R. Hrovatin 2nd Nonlinear beam dynamics workshop)

Trigger issue/upgrade (2)

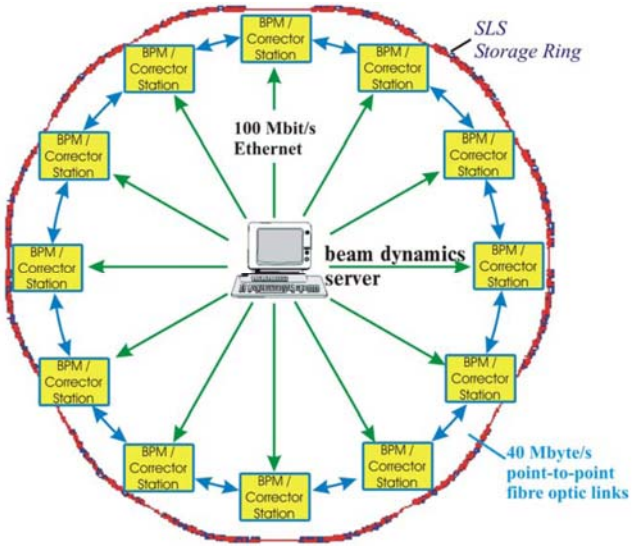
- Upgrade (16/11/2010)
  - Introduce cable delay to adjust triggers at each BPM

Difference phase advance between measured and model



Phase advance over adjacent sectors

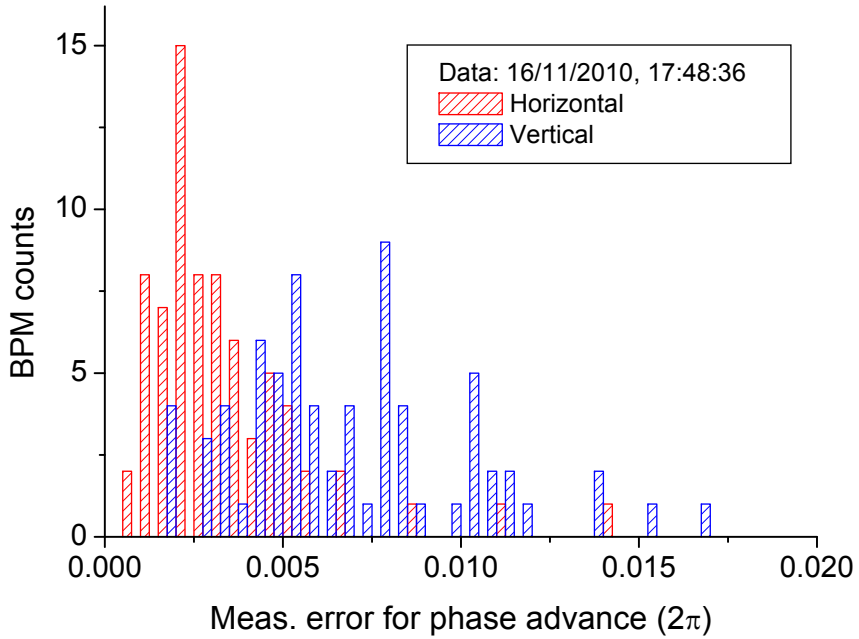
BPM sectors layout



Data quality

- TBT data quality (Statistical error)

Phase advance measurement error



Tunes from all BPM

Hor. σ 6~8×10^{-6}

Ver. σ >10^{-5}

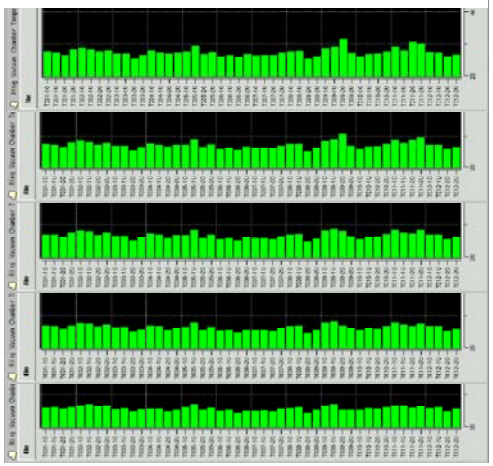
Horizontal: Satisfactory

Vertical: Need understanding

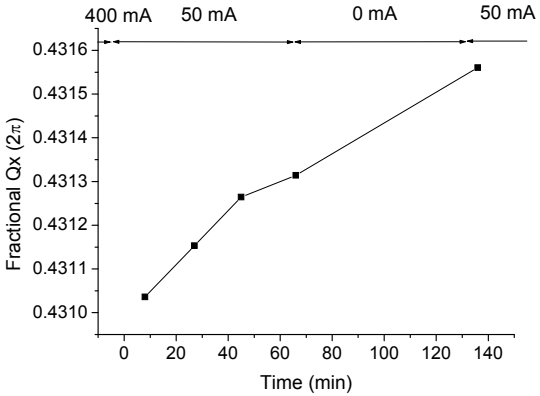
Optics vs. temperature

- Phase measurement following beam dump
  - TBT measurement is fast and capable to take "optics snapshot"

Temperature vs. time

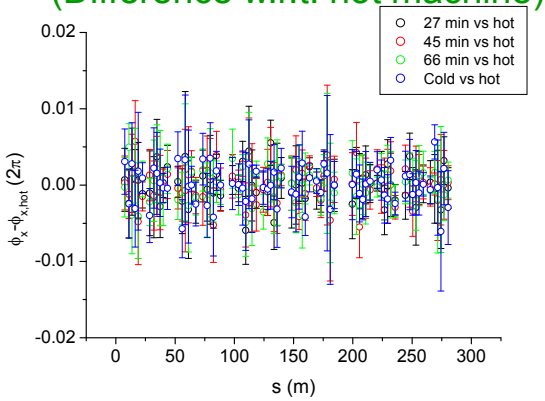


Hor. tune vs. time
(400 mA Beam dump @ t=0)



$\Delta Q \sim 5 \times 10^{-4}$ over 2 hours

Hor. phase advance
(Difference w.r.t. hot machine)



Optics drift < Meas. error

Optics is constant over hot and cold machine, justifying TBT measurement at low current
Optics measurement with Q-variation, ~1 hour with 50~100 mA, as well is OK
Note that the orbit is drifting… (Orbit feedback was off during the measurement)

Summary and Plans

- Summary
  - TBT measurement at SLS has been started
    - BPM trigger adjusted with cables
    - It is revealed that the optics is constant over hot and cold machine, justifying TBT measurement as well as Q-variation
- Plans
  - Comparisons
    - Beta function at quads and BPMs with a reconstructed error model
    - Q-variation, TBT and (Full) LOCO also recently tested at SLS
    - Nonlinear optics optimization, check what is going on with the method currently used (Ref. R. Bartolini et. al., Correction of multiple nonlinear resonances in storage rings, PRSTAB 11, 2008)
  - Coupling correction
    - With resonance driving term
    - With vertical bumps at sextupoles together with vertical dispersion, non-orthogonal knob approach

      (Ref. G. Vanbavinckhove et. al., SPS coupling correction, IPAC10)
  - (Impedance localization)