

New Digital BPM System for the Swiss Light Source

M. Dehler, A. Jaggi, P. Pollet, T. Schilcher, V. Schlott, R. Ursic, PSI, Villigen, Switzerland

R. DeMonte, ELETTRA, Trieste, Italy

Abstract

A new digital beam position monitor (DBPM) system which is currently under development for the Swiss Light Source (SLS) is presented. It is designed to provide sub-micron position data in normal closed orbit, and feedback mode as well as turn by turn information for machine studies and real time tune measurements. The self calibrating four channel system consists of a RF front end, a digital receiver and a DSP module. The same electronics will be used in all sections of the SLS accelerator complex. The system can be reconfigured in real time to perform different kind of measurements like: pulsed for linac and transfer lines, first turn, turn-by-turn, closed orbit, feedback and even tune mode for booster and storage ring. These reconfigurations involve only downloading of new signal processing software and will be performed via EPICS control system. An independent system for monitoring mechanical drifts of the BPM stations will be installed as well. The measured data will be permanently updated in a database and taken into account, when processing the final electron beam positions.

Modes of Operation

Pulsed Mode

Intended for injector and transfer line BPM measurements. Assuming 3 Hz injection, one sample will be taken every 333 ms.

Booster Mode

Each BPM will provide position data throughout the acceleration cycle. Two orthogonal modes are envisioned. First, a single BPM measurement or a group of them is displayed in time domain. This allows tracking of positions as the beam is ramped. Second, booster closed orbit is displayed at selectable time intervals.

Turn-by-Turn

User can select N (1024, ..., 8192) successive measurements to be taken per each sync. cycle. Time as well as frequency domain data formats are selectable.

Closed Orbit

Position measurements are taken continuously. Data is used for closed orbit (CO) display in the control room.

Feedback Mode

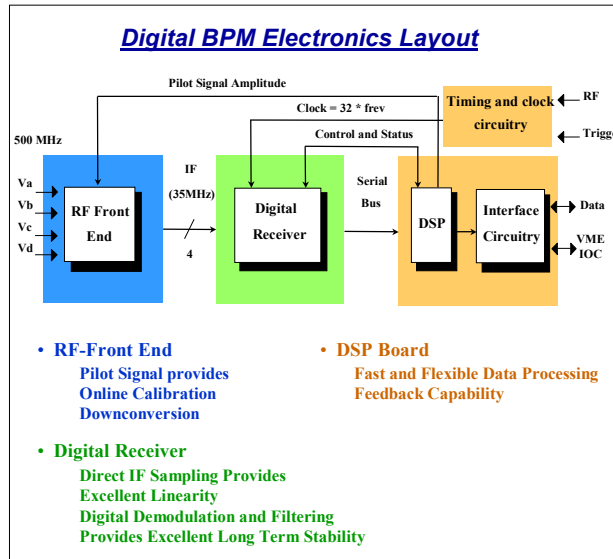
Measurements are taken in the same way as in closed orbit mode and processed continuously to provide position information to global feedback.

Tune Mode

Data are taken in the same way as in turn-by-turn mode. However, software algorithm on DSP will calculate FFT and extract tunes.

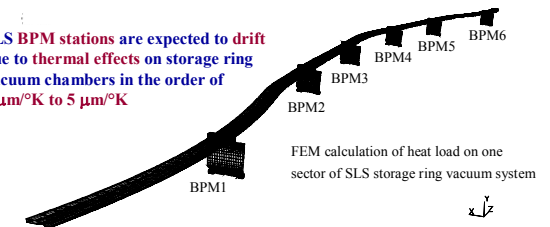
Specifications

Parameter	CO and Feedback	Pulsed and TBT
Dynamic Range	1 - 500 mA	1 - 20 mA
Beam Current Dependence		
Full Range	< 100 μm	---
Relative 1 to 5 Range	< 5 μm	---
Position Measuring Radii	5 mm	10 mm
Resolution	< 1 μm	20 μm
Bandwidth	> 2 kHz	0.5 MHz
RF and IF Frequencies		
Carrier RF	500 MHz	500 MHz
Carrier IF	36 MHz	36 MHz
Pilot RF	498.5 MHz	498.5 MHz
Pilot IF	34.5 MHz	34.5 MHz

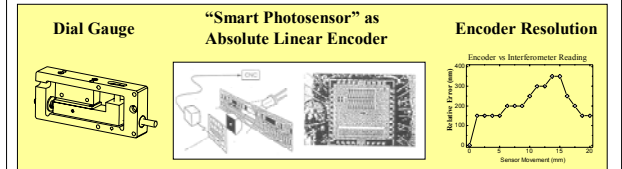


Mechanical Position Monitoring of BPM Stations

SLS BPM stations are expected to drift due to thermal effects on storage ring vacuum chambers in the order of $2 \mu\text{m}/^\circ\text{K}$ to $5 \mu\text{m}/^\circ\text{K}$



After prealignment of BPM centers with beam based alignment, absolute linear encoders will monitor mechanical drifts of BPM stations with respect to adjacent quadrupoles with sub-micron resolution. Any movement will be taken into account, when calculating final electron beam position in DSP part of the digital BPM system.



DBPM Project Status

RF Front End

- Two prototypes are being presently tested in the laboratory.
- Gain discrepancy between four channels is below +/- 0.1 dB.

Digital Receiver

- Under-sampling performance has been demonstrated with AD9042.
- One channel DR has been successfully operated in laboratory.
- Four channel DR has been designed.

DSP and IOC

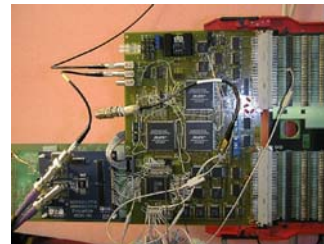
- Data processing routines for closed orbit, feedback and turn-by-turn modes are programmed.
- EPICS interface via IOC ready.

Mechanical Position Monitoring System (POMS)

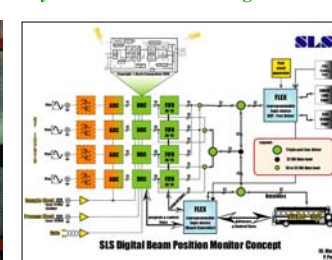
- Interpolation and data transfer electronics tested.
- EPICS interface via memory mapped VME card.
- Sensor prototype tests at ELETTRA successful.

One Channel Digital Receiver

(debugged lab. version)



Layout of Four Channel Digital Receiver



Horizontal and Vertical Drifts of a ELETTRA BPM station, measured with POMS prototype

