DEELS - Diagnostics Experts of European Light Sources

Monday, 3 June 2019 - Wednesday, 5 June 2019

ESRF

Book of Abstracts

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Will we ever stop developping ”BPM-electronics” ?

Authors: Kees Scheidt[1]; Guenther Rehm[2]

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The ESRF has adopted the so-called Spark electronics for its 128 additional BPMs in the new ring. All these units had been installed on real RF-BPM signals for many months in 2018, to verify their reliability & performance (i.e. stability).
These Spark electronics do not use any active compensation scheme (at all) to correct any (relative) drift (between the 4 RF-channels) and yet fulfil our needs.
This presentation (15min, Kees) will show this quickly and comprehensively, and then aims to stimulate an active debate / discussion (45min, moderator Guenther) on what are the real reasons and motivations in the instrumentation community to continue to spend so much efforts in developing their own home-made BPM electronics.

1) is sub-um (mid- and long-term) stability/drift really still an issue for the (existing) BPM-electronics ?
2) are other sources of drift not at least as important, and today largely ignored and/or left aside ?
3) how can we better assess these and then possibly counter-act ?
4) in the end, would X-BPMs not be the ultimate judge, and are collaborations between institutes (diagnostics groups) possible to define, develop and test an X-BPM that focuses on such slow stability issues (only) ?
Related questions :
5) how to handle upgrades during the lifetime of the product ?
6) how to ensure reliability ?
7) ultra-fast data-streams, how far to go ?
8) should BPMs be like: smart phones, or more like self built PCs ?

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Installing a light-source with the beam-lines already in place ...

Authors: Kees scheidt[1]; David Martin[1]

[1] *ESRF*

The ESRF will most probably not be the last light source that will be confronted with a (complete) upgrade of its storage ring, while leaving the existing beamlines in place.
The particular difficulties and challenges with the complete dismantling and disposal of the old storage ring, and subsequent installation of the new ring will be reviewed.
This will also be an introduction talk to the site and tunnel visit planned later that same day, and aims at giving the participants an insight of the complexity of this massive work under very restrained conditions, and to show how solutions were found and applied with success so far.
The first part of this talk (by Kees) will give a general overview of the related logistic challenges, while the 2nd part (by David Martin, head of the ALGE group) will focus on huge work and requirements of the alignment of this new ring.

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Overview of Diagnostics for SLS2.0

Author: Cigdem Ozkan Loch[1]

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In 2023-2024, the SLS storage ring will be upgraded for significantly higher brightness and coherence. The upgrade will require similar diagnostics systems to those already implemented for the current SLS operation. However, the number of devices, their specifications and their technical realizations have to be adapted to the specific requirements of SLS2.0, and the newly available technologies and standardization at PSI.
This talk will provide an overview on the design, technical specifications and implementation of the diagnostic systems (excluding BPMs), which are specific to the upgrade.

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The development and application of digital BPM signal processor at SSRF

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At SSRF, we have been developing digital BPM signal processors (DBPM) for more than 10 years. The DBPM sampling at about 120MHz already applied on Dalian Coherent Light Source, Shanghai Soft X-ray FEL, and SSRF for beam position measurement. Now, we are developing higher performance DBPM running at about 500MHz, which can be used for bunch-by-bunch BPM measurement for SSRF storage ring. The development and status of the DBPM will be introduced.

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ALBA optical fiber BLMs

Author: angel olmos[None]

We've recently started a collaboration project with UB university for the development of BLMs based on scintillating optical fibers and Si photomultipliers (SiPM). A dedicated electronic board takes care

of the counting of photons from the SiPM detectors and hands the results to the control system. Each BLM device will be in charge of up to 8 SiPM detectors and will provide counts of losses and time-of-flight capabilities to localize losses along the fibers. Right now the project is still in its design phase so we'll show the main characteristics of it and some data already taken during preliminary tests with beam.

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The design of HEPS beam diagnostics system

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The High Energy Photon Source (HEPS) is a 6-GeV, 1.3-km, ultralow-emittance storage ring light source to be built in the Huairou District, northeast suburb of Beijing, China. The beam diagnostics as the critical part of the diffraction-limited storage ring light source have many challenges in design and fabrication. This report will present the preliminary design of HEPS beam diagnostics, including the injector and the storage ring. Also the R&D efforts in beam diagnostics will be shown in the talk.

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Calculation of corrected BPM data with polynomials obtained from BpmLab: ESRF and ALBA showcases

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BpmLab is a 2D finite element-based tool for Matlab developed at ALBA and aimed at simulating the electrode response of BPMs of arbitrary geometry to emulated beam excitation. Lately, BpmLab has been thoroughly adapted to EBS BPM geometries to analyze the nonlinear effects and the remedies around them. More complicated situations have as well been studied, e.g. imperfect positioned BPM-buttons. Finally the 2-dimensional geometry-dependent polynomials were calculated to strongly minimize errors and coupling effects that are usually produced by the traditional Delta-over-Sum algorithms for beam position, sum signal and the incoherence (Q) values. Apart from the fast-data streams, all data & buffers of the new EBS will be calculated with such polynomial families, selectable inside the device server of the (Libera and Spark) BPM electronics. Specific beam tests were performed both in ESRF and ALBA to achieve high orbit offsets and study the effects of polynomials on the BPM data to better understand their efficiency.

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Improvements of transverse and longitudinal beam diagnostics in SACLA

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In the X-ray FEL facility SACLA, an electron beam with low slice emittance ($\gamma\varepsilon$ < 1 μm rad), high peak-current (~10 kA) and short bunch length (~10 fs) is required for high quality FEL operations. We initially installed optical transition radiation (OTR) screen monitors for a beam profile measurement. Since the beam profile could not be observed due to intense coherent OTR, we replaced the OTR targets with Ce:YAG scintillator screens. We developed some techniques to separate scintillation light from COTR geometrically and temporally. As a result, COTR is now reduced to a negligible level and the beam profile and beam emittance are appropriately obtained. For the longitudinal diagnostics, one of the key issues was the adjustment of the longitudinal beam profile in the low-energy velocity-bunching section. Therefore, we newly installed a L-band transverse deflector cavity in this section. It helps tuning of the bunch compression in the low-energy part and the reproducibility of the longitudinal beam profile after a long shutdown period is substantially improved. In this presentation, we show the developed techniques and some of the results from the transverse and longitudinal diagnostics.

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Evaluation of a new 500 MHz digitizer at Elettra and Fermi

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A new 14-bit 500 MS/s digitizer was evaluated in ELETTRA storage ring and FERMI linear accelerator. The sampling clock is hard-locked to the Master Oscillator and has a jitter of a maximum 10 ps. The AC coupled version has an analog bandwidth up to 2 GHz and was used to measure the fill pattern. The bunch flat-top is very narrow (10-15 ps). To reach better stability, various external filtering components were used. Bunch-by-bunch beam position was calculated off-line. The DC coupled version was used to sample pulses from the fast current transformer at FERMI. A software interface can configure data acquisition length and fill buffer segments with pre-defined number of triggers. Native TANGO and EPICS interfaces allow for fast integration with CSS and other display tools.

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BPM blocks offset calibration using Lamberson method

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The upgraded ESRF's storage ring comes with brand new BPM. Unfortunately BPM blocks are not ideal and gives the beam position with a random offset coming from mechanical imperfection of the buttons and the vacuum chamber. In order to estimate and compensate for these offsets we measured the button-to-button RF transmission on every BPM block, which can yield to an estimate of BPM

blocks offsets (the so-called Lamberston method). In this talk I will give details on the measurement we performed, and present a statistical analysis of the data which gives useful informations on the errors and reproducibility of this measurement.

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VNA measurements of 6mm buttons in button block

Author: Guenther Rehm[1]

[1] *Diamond Light Source*

The S-parameters of a four button block with 6mm buttons have been measured using a commercial Vector Network Analyser. The quality of the measurement is evaluated with the Lambertson method in mind to determine the gain of the individual buttons.

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High speed Tune Measurement using Phase Following on Multi-Bunch Feedback

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A newly re-implemented feature of the Diamond Multi-Bunch Feedback processor (DLS MBF) uses the ability to measure the betatron/synchrotron tunes using a phase locked loop approach, which produces tune readings at many kHz rate.

This function (which we call Tune PLL) provides insight into the dynamic behaviour of systems affecting the machine tunes.

A new application of the Tune PLL measurement is to simultaneously correct the swept tune measurement for dynamic tune shifts during measurement sweeps, allowing for very high precision measurements of the detailed tune profile. This enables also very slow sweeps allowing the measurement of tunes spectra of extremely weak bunches with high fidelity.

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Measurement of BPM Cable Dependence To Humidity and Temperature Variations

Author: Nicolas HUBERT[1]

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BPM electronics are compensated to cancel local drifts of its electronics components to temperature or humidity variations. However the dependences of the BPM cables to those external parameters are not yet considered or quantified. If the temperature is generally well controlled in the synchrotron

buildings (+-1℃), the relative humidity is not and may vary between 20 to 70 % over a year. In order to estimate the cables dependencies to (large) humidity variations and (small) temperature variations, a climatic enclosure has been rented. Systematic measurements have been performed on different cable types (LMR, CNT) and assemblies (independent or bundled cables).

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The design of bunch-by-bunch beam position monitor

Author: Xinger Zhang[1]

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A bunch-by-bunch beam position monitor is being designed for HEPS. The BPM consists of two parts: Analog Front End (AFE) and Digital Front End (DFE). There are four input ADC channels at 500MS/s,12bit and an adjustable phase clock fanout circuit at AFE. The sampling clock could be free running clock or externally clock locked with beam signal. DFE is designed with the high-performance FPGA/CPU ZYNQ 7100, four-channel raw-ADC data of beam signal can be processed here. The design of hardware has been completed, and bunch-by-bunch raw-ADC data is acquired.
Keywords: bunch by bunch, BPM ,FPGA ,HEPS

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APS Upgrade Beam Diagnostics and R&D Results

Authors: Adam Brill[1]; Bingxin Yang[1]; Dan Paskvan[1]; Glenn Decker[1]; Hairong Shang[1]; Hanh Bui[1]; John Carwardine[1]; Ju Wang[1]; Kent Wootton[1]; Louis Emery[1]; Ned Arnold[1]; Nicholas Sereno[1]; Rob Keane[1]; Robert Lill[1]; Ron Blake[1]; Shifu Xu[1]; Sinisa Veseli[1]; Sirisha Kallakuri[1]; Tom Fors[1]; Tony Pietryla[1]; Weixing Cheng[1]

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Beam position measurement diagnostics required for the APS upgrade (APS-U) are driven by challenging beam stability requirements resulting from the small beam size due to the machine design emittance of 42 pm. Similarly beam size measurements to derive emittance and energy spread are also made difficult by the small beam size. The AC stability specification states that rms beam motion must be corrected to 10 % the rms beam size at the insertion device source points from 0.01 to 1000 Hz. The vertical plane has the tightest rms AC stability requirement of 400 nm which approaches the noise floor of the bpm electronics. In addition long term drift over a period of 7 days is required to be 1 micron or less. The small beam emittance results in beam sizes as small as 1 micron depending on the machine lattice X-ray source and coupling setting. Major diagnostic systems for the APS-U to address beam stability and beam size measurements include rf beam position processing using commercially available fpga based bpm processors, new X-ray beam position monitors based on hard Xray fluorescence from copper, absolute and relative beam size measurement systems that utilize X-ray pinholes and a new feedback system featuring a tenfold increase in sampling rate and a several-fold increase in the number of fast correctors and bpms in the feedback algorithm. We discuss the design of these major diagnostic systems as well as report results from R&D using them.

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Optimisation of the BPM data filtering for the fast orbit correction

Author: Eric PLOUVIEZ[1]

[1] *ESRF*

The scheme of the digital signal processing applied on the beam signal to obtain the position data used by the fast orbit correction in the Libera Brillance is based on the requirement of a standard RF receivers for telecomunication application.
The constraints of the fast orbit correction are different and the optimisation of the filtering based on these specific constraints can lead to a significant improvement of the BPM electronics performance. Beam position data obtained using a Libera with such a modified filtering scheme show that a drastic reduction of the delay in the data processing can be obtained without significant detrimental effect on the quality of the filtering for a fast correction application.

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Offset calibration for single pass BPM

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We present a calibration method for the single pass (SP) BPM using pulsed RF signals. It enables the offset calibration of BPMs necessary to accomplish the beam first turn prior to the start of accelerator commissioning. One of the major factors of the offset is the gain imbalance between BPM channels by uneven characteristics of signal cables and readout electronics. Signal reflections in the cables at bent parts and connectors affect the gain imbalance depending on the measuring mode. In the COD measurement with narrow-bandwidth signal detection, standing waves in the cables caused by reflections impact on the gain balance. The offset calibration using CW RF signals at the detection frequency is necessary in this case. The SP trajectory measurement, however, detects pulsed signals. The delayed signals due to reflections are masked by setting adequate time windows of the readout. The reflections in the cables have smaller effects than the COD measurement. We present here the offset calibration method of SP BPM by pulsed RF signals and the experimental results including the comparisons with results by CW signals.

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SOLEIL New Beam Loss Monitor System

Author: Nicolas HUBERT[1]

[1] *Synchrotron Soleil*

SOLEIL is currently upgrading its Beam Loss Monitor system from pin-diode detectors to plastic scintillators associated with photosensor modules. After preliminary tests, a first set of 20 new BLMs have been installed on 2 cells of the storage ring. Installation setup, calibration procedure and first measurements will be presented.

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Installation of a THz beamline for machine studies and operation @ SOLEIL

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Two beamlines dedicated to users experiments in the infrared to THz range are presently in operation at SOLEIL: AILES and SMIS. A new "short" beamline in the THz range has been installed for machine studies and operation at SOLEIL. It consists, as on the previous beamlines, of a copper slotted mirror which can be inserted in one of SOLEIL's dipole fan to extract radiation from visible to THz range. A toroidal together with a flat mirror, both made of aluminium, enable to transport the radiation to a small diagnostics station located inside the ring tunnel. The radiation focussing was optimized to obtain a small spot size on the diamond window ensuring the vaccuum to air transition. A fast THz diode is implemented on the diagnostics station to monitor the coherent THz radiation intensity, which is emitted in given conditions. This diagnostic will be used for the survey of the femtoslicing experiments and for machine studies at high current per bunch. We present here the installation and first commissioning results of this THz beamline.

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BPM resolution studies at PETRA III

Author: Gero Kube[1]

[1] *DESY*

In order to measure the noise level of a BPM system from beam generated orbit data, the correlated beam jitter has to be removed from the position signals. There exist different ways to extract the BPM noise as the "three-BPM" correlation method or the model-independent principal components analysis (PCA). Both methods will shortly be discussed. Based on a PCA the resolution of the PETRA III Libera Brilliance based BPM system was measured. The results will be presented together with first measurements in view of an updated BPM system for the future PETRA IV project at DESY.

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Scintillating screens issues at the European XFEL

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The European XFEL uses scintillating screens and wire scanners for the transverse beam profile measurements. Mostly there are the scintillating screens (more than 70 along the machine). Nevertheless there are two issues observed during the machine operation.
The first one is an observation of beam shapes with an intensity drop in the center, which reminds OTR but it's not it according to the optics geometry. First investigations revealed that the problem is in the scintillator screen material itself and it's related to the so-called non-proportionality of scintillators. Thus there are further ongoing investigations on scintillator materials and their features in DESY.
The second one appeared on the of-axis screens. The screens are dedicated to the online beam profile measurements and to the measurements with a TDS located right before the screens. In the measurements a single bunch of the bunch train is kicked on the screens to investigate it. The issue is

that the bunch kicked on the screen provokes ionization and charges the screen as a consequence. The next bunches of the bunch train passing by the scintillating screen feel the Coulomb force and deflect. The effect of the deflection is immediately observed at the drop of the SASE level.

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BPM and Global Feedback for Elettra 2.0

Authors: Gabriele Brajnik[1]; Raffaele De Monte[2]; Stefano Cleva[3]; Giulio Gaio[4]; Dario Giuressi[1]

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Elettra is developing a modular eBPM system, based on pilot-tone technique for long-term stability compensation and self-calibration, and it is composed by the analog front end, the 4-channels 16-bit A/D FMC module and the digital carrier board. While the former two have been completely developed and verified, the latter is in testing phase.
In a first prototype the Verilog code for the eBPM processing scheme has been successfully built, now we are focusing on the overall Global Feedback System requirements.
In order to allocate enough computing resources, communication bandwidth, resolution and processing time, we need to plan carefully mandatory and auxiliary functionalities.
Our goal is to have an active discussion with high experienced people about the requirements of the BPM systems and the related Global Feedback in the next generation Synchrotrons.

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New FPGA platform to upgrade the Cavity BPM Systems at Fermi@Elettra

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A new digital FMC carrier board with Altera/Intel Arria 10 FPGA and 10 GbE capability has been developed to support various applications of Elettra-Sincrotrone Trieste laboratories, such as eBPM, PhBPM, Diamond detectors, TDC, etc...
One of these applications is to replace our old uTCA digitizer cards called ADA and ADO that are used in the Cavity BPM system for Fermi@Elettra Free Electron Laser facility. We will describe the new carrier board and the new system topology that plans to replace a complete CBPM uTCA crate.

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Beam diagnostics for fourth generation Russian light source. Concept of the high performance beam position monitoring system.

Author: Dmitry Liakin[1]

[1] *NRC KI*

The fourth generation light sources demand a new level for the performance of the beam diagnostic systems as well as use of stable and proven but renovated devices whenever it is possible. From the other side the nowadays industry gives an opportunity for both ways for the evolution of the diagnostic systems. Here we are considering some concepts (mainly for BPM) proposed for use in ISSI-4 light source.

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Investigation status of amplitude jumps on Libera electronics

Author: Borut Repic[1]

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Some Libera users observed unexpected jumps on amplitudes of BPM. Occurrence of these jumps was totally random and not linked to production batches, operation frequencies and applications. Instrumentation Technologies took these instruments under investigation. The problem was narrowed down to a single component which is common to all analog front-ends and most probably causes the jumps. There were certain actions taken to aviod this behavior in the future.

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ESRF visit

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OASYS overview

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OASYS (OrAnge SYnchrotron Suite) is an open source, user friendly platform which collects all the most relevant software for the simulation of synchrotron radiation, such as XOP, SHADOW, SRW and others. This presentation will provide a quick overview on the software from the point of view of a user.