Libera Brilliance+

Peter Leban, Libera Workshop, October 2012, Solkan

Instrumentation Technologies

Contents

The presentation will cover these topics

- **Libera Brilliance+, the instrument**
- **Libera Brilliance+ visits at world's laboratories in 2011 / 2012**
- **Upgrades and fixes**
- **Extended functionalities**

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Libera Brilliance+, the instrument

High performance electron beam position processor

- **turn-by-turn measurements, first-turn measurements**
- **longterm stability < 100 nm**
- **time domain and frequency domain processing in parallel**
- **trendsetter, reference instrument in lightsources**

Typical performance specification	
Turn-by-turn RMS (@ -20 dBm)	0.35 µm
10 kHz data stream (@ -20 dBm)	70 nm
Beam current dependence (@ -50 dBm)	0.5 µm

Libera Brilliance+, the instrument

References

- **NSRRC TLS**
- **NSRRC TPS**
- **ANL APS**
- **DESY DORIS**
- **KEK-B**
- **IHEP**
- **Abtlus LNLS**
- **(HiSOR)**
- **(MAXLAB MAX-IV)**

Libera Brilliance+ at KEK in 2011

Targets:

- **Upgrade to Super KEK-B**
- **KEK-PF and KEK-PF Advanced Ring upgrades**

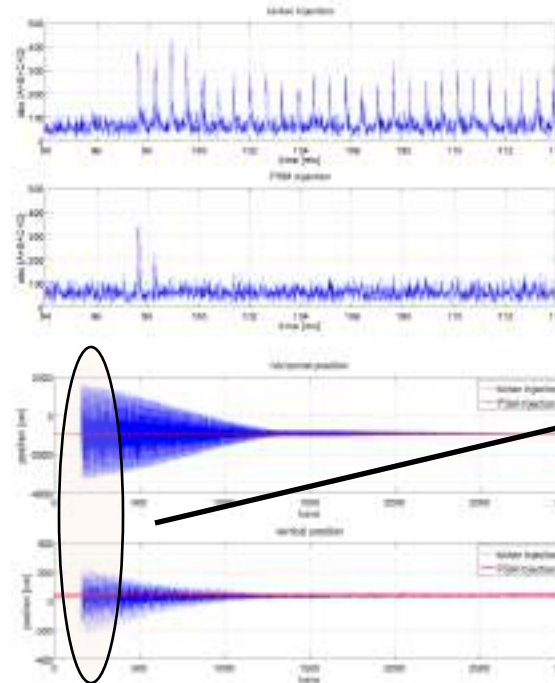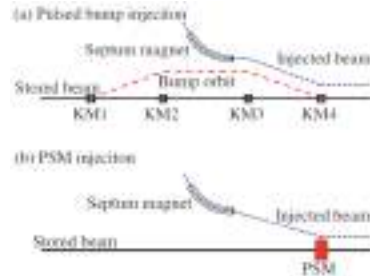Initial tests at KEK Photon Factory:

- **Traditional vs pulsed sextuple magnet injection comparison**
- **First-turn measurement**

KEK 高エネルギー加速器研究機構
物質構造科学研究所　放射光科学研究施設
Photon Factory
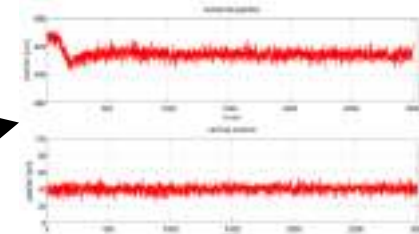

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Initial tests at KEK Photon Factory

Injection at KEK Photon Factory:

The injected beam is captured into the ring acceptance by a kick of the PSM while the stored bean passes through the center of the PSM where the magnetic field is almost zero.

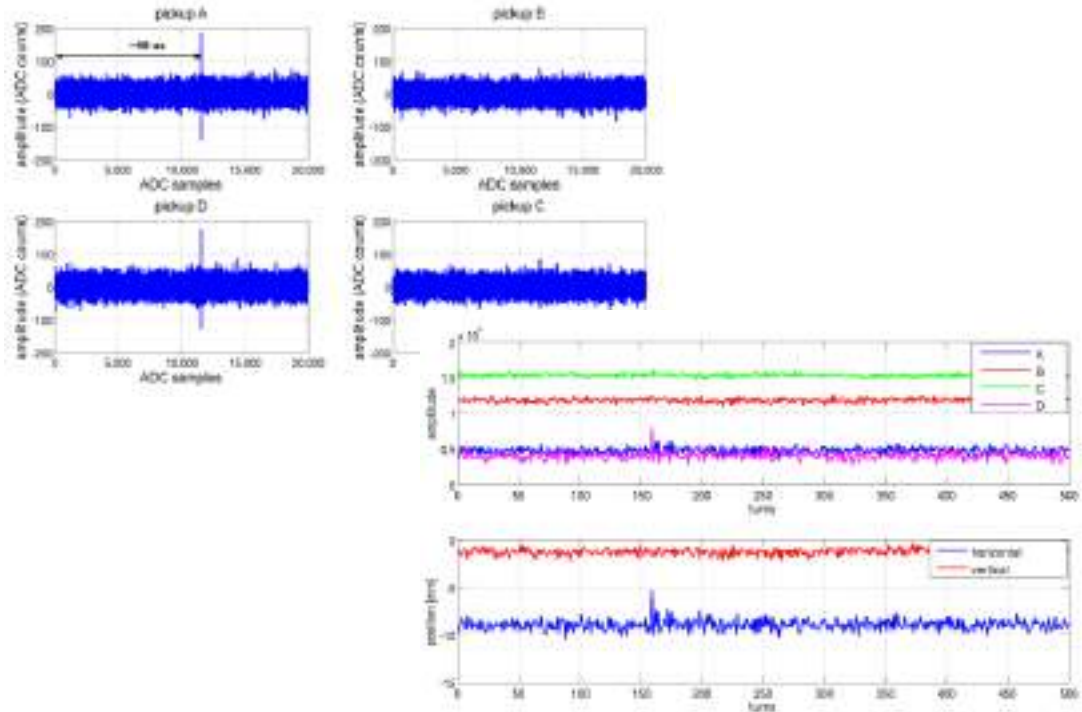www.i-tech.si

Initial tests at KEK Photon Factory

Single bunch – 1 turn:

The bunch charge was 0.1 nC. The input signal was detected at -65 dBm level!

The injection was expected to be seen mostly in the horizontal and very little in the vertical direction.

For these special conditions, the Time-Domain Processing is best choice for turn-by-turn measurements.

www.i-tech.si

Libera Brilliance+ at ANL APS in 2012

Installed at the APS since January 2011

In discussion:

- **Partial upgrade with the Libera Brilliance+**
- **Interlock system improvement**
- **Orbit feedback upgrade:**
  - **General FOFB upgrade (many subsystems)**
  - **20 kHz data rate (~5 kHz bandwidth)**
  - **In house development in the GDX module**
  - **Good progress, data stream available to the existing feedback system**

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Libera Brilliance+ at ANL APS in 2012

In progress:

- **AURORA 2.5 Gbps link with 4-bpm-data (20 kHz data rate)**
- **Duplex communication with CRC to the SP605 development board**
- **Reduced bandwidth and data rate for compatibility with existing feedback system and initial tests**

- **Simulations with using the full 20 kHz data rate and 5 kHz bandwidth:**
  - **electronics noise floor,**
  - **response matrix structure (i.e. choice of bpms and correctors),**
  - **filtering,**
  - **latency, etc.**

(Glenn Decker et al)
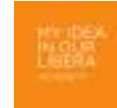
Libera Brilliance+ in Hsinchu and Lund in 2012

Activities in 2012:

- **Fast Orbit Feedback development for Taiwan Photon Source**
  (Check the presentation of the GDX module)
- **Delivery to the Taiwan Photon Source**
- **Agreement for MAXLAB 3 GeV and 1.5 GeV rings**

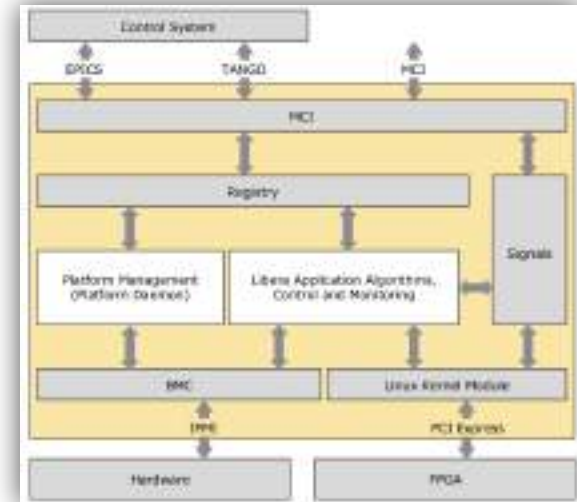www.i-tech.si

Upgrades and fixes

Software developments in the last year:

- **Libera BASE upgrade**
- **libera-ebpm upgrade**
- **Control system interfaces:**
  - **EPICS upgrade**
  - **TANGO device server** (development starts this October)

Targets:

Improve the data throughput and stability.
Share a common platform for easier and efficient maintenance!

Libera BASE upgrade

Libera BASE is a common software framework for the Libera Brilliance+, Libera Single Pass H and Libera Single Pass E.

- **Data on demand refactoring: 10x lower CPU load**
- **sp_b stream generates 45 MB/s @120 Hz trigger rate. CPU load ~7%**
- **Fast Trigger rate support (20 Hz and higher)**
- **Improved data transfer in the Linux kernel module for factor 8**
- **Improved signal distribution in the libera-isig for factor 20**
- **User's benefits: work with more data and consume less CPU ➔ more CPU for applications!**

<u>The latest software version is 2.6</u>

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libera-ebpm upgrade

libera-ebpm is an application daemon for the Libera Brilliance+. Its task is to provide the user the functionalities (turn-by-turn, interlock,…) of the electron beam position processor.

- **New data-on-demand framework**
- **Precision sensor readout (temperatures in the BPM module)**
- **Improved DSC functionality with input data quality estimation**
- **Fixed temperature control functionality**
- **Other smaller improvements (parameter saving, Postmortem control, etc.)**
- **User's benefits: reliable and stable operation, precise health monitoring**

The latest software version is 2.6

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Control system interfaces

The Measurement and Control Interface (MCI) layer has been updated. In addition to EPICS, the TANGO device server is planned.

- **EPICS CA server is replaced by EPICS IOC (input/output controller), 3.14.12-2**
  - **Generic libera-ioc daemon runs against any application in the Libera BASE 2.6**
  - **Flexible database creation by the user**
  - **Intuitive configuration utility (IxeConf)**
  - **Renewed EDM screens will come a bit later**

- **TANGO device server**
  - **Development in cooperation with MAXLAB for Libera Single Pass E and Libera Brilliance+**
  - **Will result as the open-source project in TANGO community**

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Extended functionalities – EvRx module

The Libera Brilliance+ in production from Autumn 2012 includes Event Receiver (EvRx) module as the timing module.

- **MC … Machine Clock input**
- **T0 … Custom connector**
- **T1 … Postmortem input**
- **T2 … Trigger input**
- **SFP … Not used yet**

The EvRx module support for the Libera Brilliance+ units is enabled with firmware upgrade.

(Presentation by Borut Repic)

Extended functionalities – GDX module

The Gigabit Data Exchange (GDX) module extends the real-time data processing to other instrumentation in the accelerator. Main purpose is the fast global orbit feedback application.

- **Virtex6 FPGA**
- **1 GB DDR3**
- **Low Voltage Differential Signalling (LVDS) links to the BPM modules**
- **Direct trigger lines to the EvRX / TIM module**
- **4 protocol & bitrate independent SFP interfaces (Small Form Pluggable)**
- **FPGA development kit provided**

The example application is the TPS Fast Orbit Feedback Application, which will be installed next week at NSRRC.

(Presentation by Ales Bardorfer)

Conclusion

The Libera Brilliance+ community is expanding in Europe and Asia. Next year, expansion is foreseen in the United States.

The software updates bring improved performance for the data throughput and software stability.

EPICS IOC is a better choice than CA server.

The EvRx module allows expansion of functionalities (acting on different events) in the future.

The GDX module is nicely accepted by the laboratories and allows cost-effective solution for the FOFB.