Libera

Measurements with Libera Brilliance+

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Libera

Contents of the Talk

- **Libera Brilliance+: the elements**
- Functionalities
- Tests at labs
- Time Domain Processing
- Future outlook

Why Libera Brilliance+ ?

- To meet the requirements for the latest storage rings
  - Increased buffers' sizes
  - Even better linearity (BCD)
  - EPICS CA server (v.3.14.12)
    can be upgraded to E4, when available

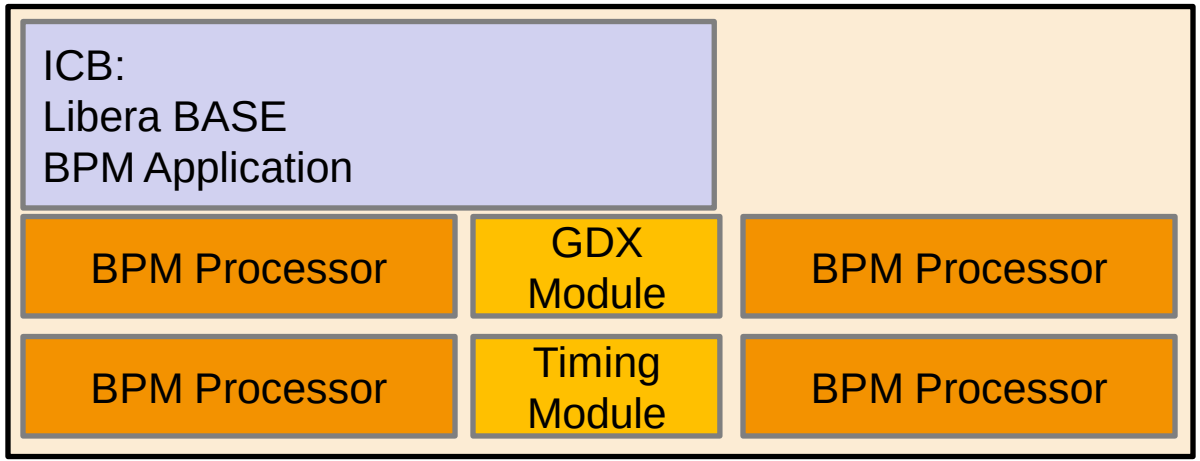
- Use latest technology
  - New Xilinx Virtex 6 chips
  - Intel based computer on module

- New approach for Fast Orbit Feedback Building
  - GDX Module completely available to user: resources, hardware, FDK
  - Utilize GDX Module resources for complete FOFB application
  - Output the magnet corrections directly to power supply controllers

The Elements

- Hardware
  - The chassis & computer
  - The BPM processor
  - The Timing module
  - The GDX module
- Software
  - Libera BASE
  - EPICS casrv
- Application
  - Initial release (2.00)
  - Release 2.20
  - FOFB custom

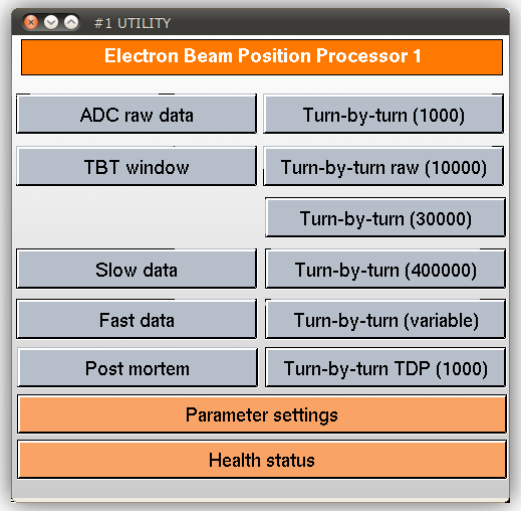
Schematic overview

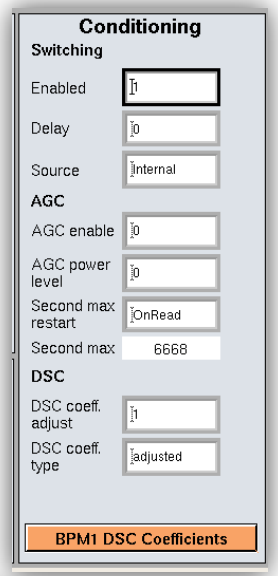


Libera

Functionalities (1)

- ADC, Turn-by-turn, Fast data, Slow data
  - On-trigger, on-next trigger, on demand
  - Acquisition offset
  - Timestamps
- Interlock, Postmortem
  - Physical connectors
  - Software notifications
- Signal conditioning – long-term stability
  - Crossbar switch
  - DSC with full coefficients' monitoring
  - DSC snapshots with predefined store interval (and timestamps)
  - Automatic Gain Control

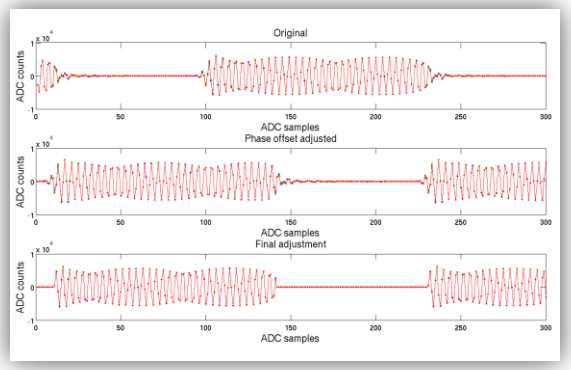




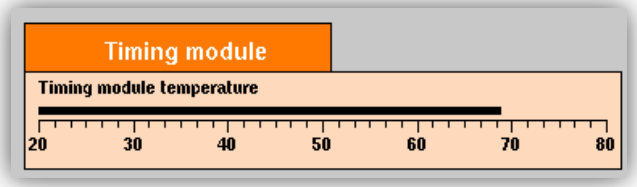
Instrumentation Technologies

Functionalities (2)

- Time-domain processing (TDP)
  - In-depth view of the ADC raw data for position calculation (TBT window)
  - Fine adjustment of the TBT window content (ADC mask array)
  - Phase offset adjustment based on the TBT window data
  - Drastically improves performance with single bunch



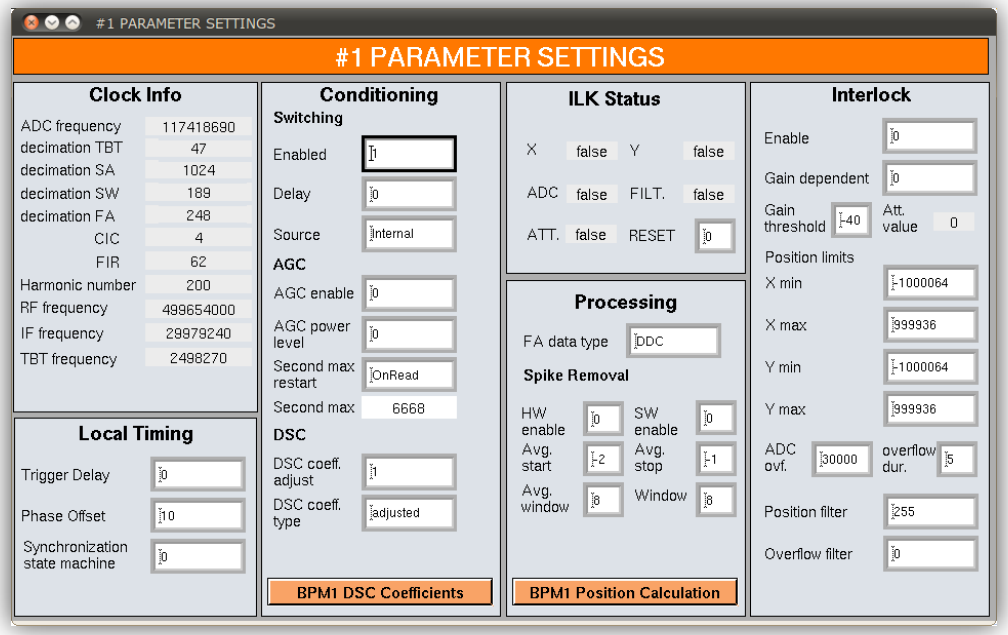
- Health, temperatures, fans
  - Full control over fans' rpms
  - Numerous temperature & voltage sensors on each connected module
    e.g. 2/4 configuration = 70+ sensors!
  - The overall platform daemon logs the health at predefined intervals



- Control system interface
  - EPICS Channel Access server (EPICS base 3.14.12)
  - Interface to support various control systems is foreseen

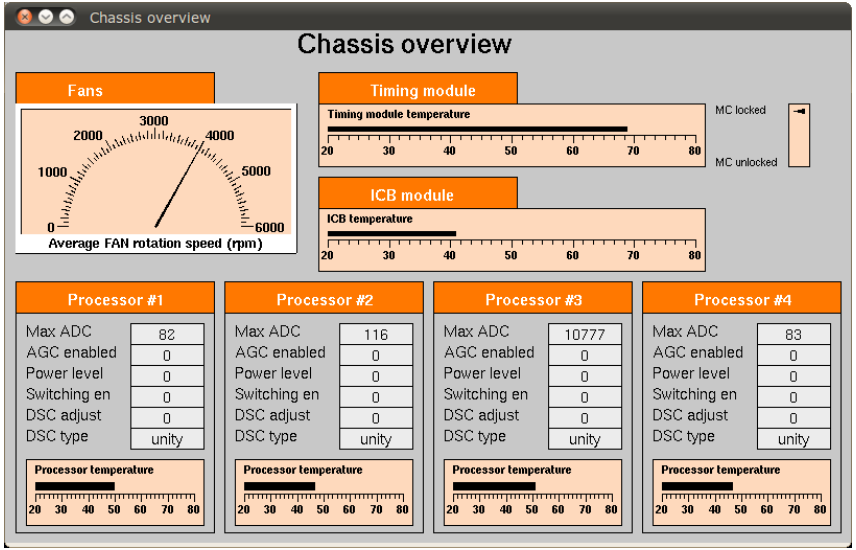
The User Interface

- EDM screens
  - All important machine-related parameters at a glance
  - Buffers, streams acquisitions
  - Parameter value settings
  - Health monitoring and control
- Command line access
  - Full access to all parameters
  - Extra low-level libera utilities
  - Firmware, software upgrades
  - Local access



Simple to Monitor and Control

- **EPICS interface included**
- 90% functionalities covered by enclosed EDM GUI
- **What can it do?**
  - Control the parameters, fans
  - Monitor the health, PLL, other status
  - Fine adjust the offsets, parameters
  - Interlock setting & monitoring
  - Postmortem buffer control & read-out
  - Access to all data streams & buffers



A simple EDM screen to keep the general overview over Libera Brilliance+ chassis at one place.

Initial Tests at Taiwan Light Source, December 2010

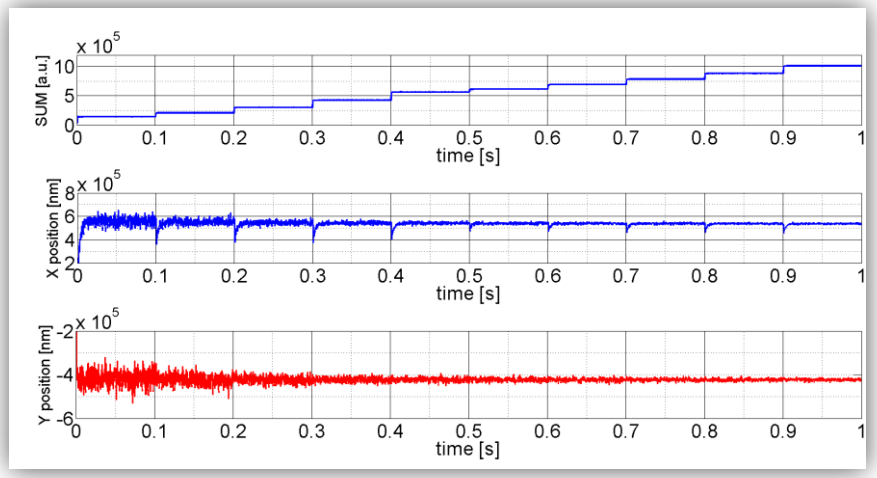
- **Tests were done for the new TPS**
- **The first two Brilliance+ processors**
- All data buffers & streams available

Civil works as of December 8, 2010.

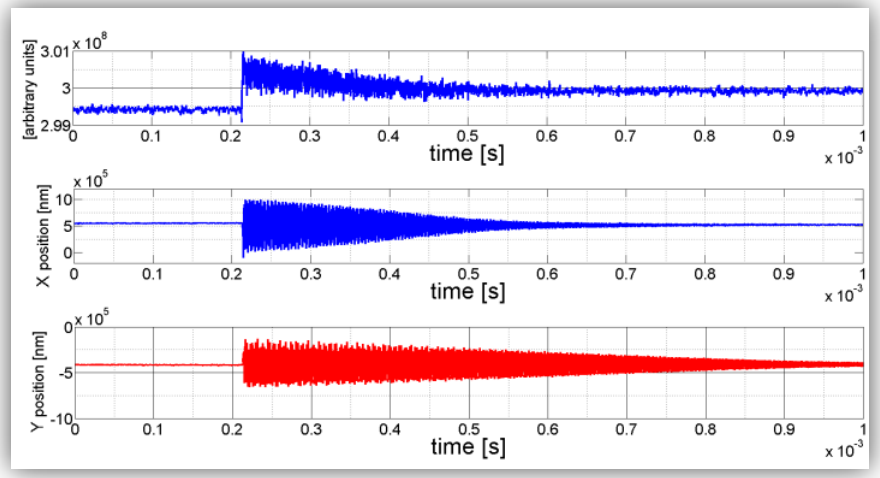
Libera Brilliance+ at TLS

Injection Monitoring

- First 30 seconds of the injection was recorded with FA data
- Detailed look with turn-by-turn data
- No position/current dependence!



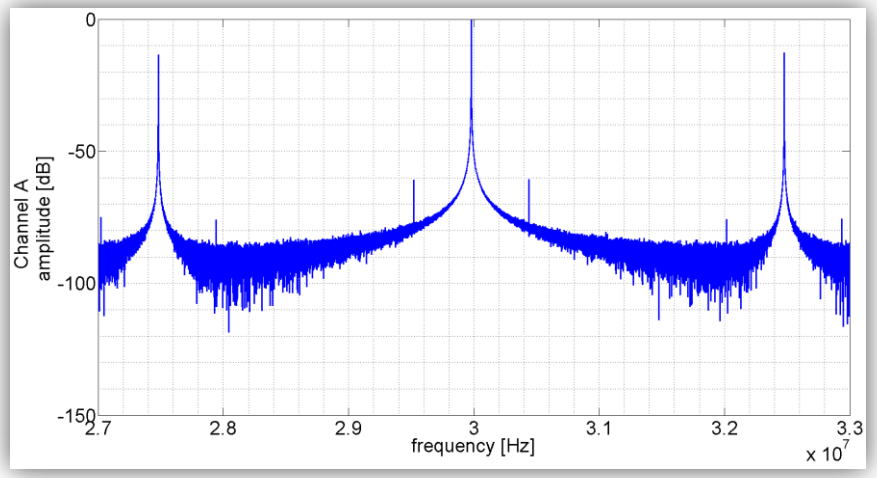
Zoomed-out turn-by-turn data



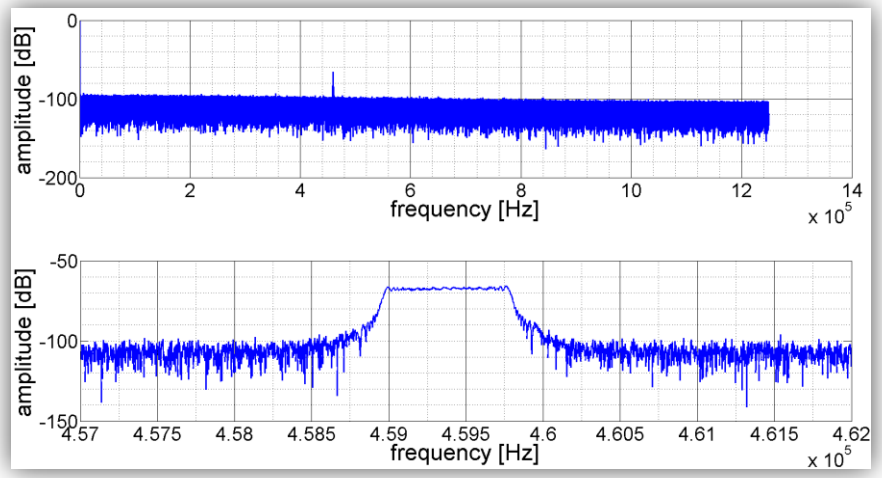
Zoom-in on a single injection

Huge ADC Buffer

- The excitation in the vertical direction at betatron frequency
- 1048576 ADC samples recorded on-trigger (= 22310 turns!)
- FFT from the ADC data with a resolution of 112 Hz!



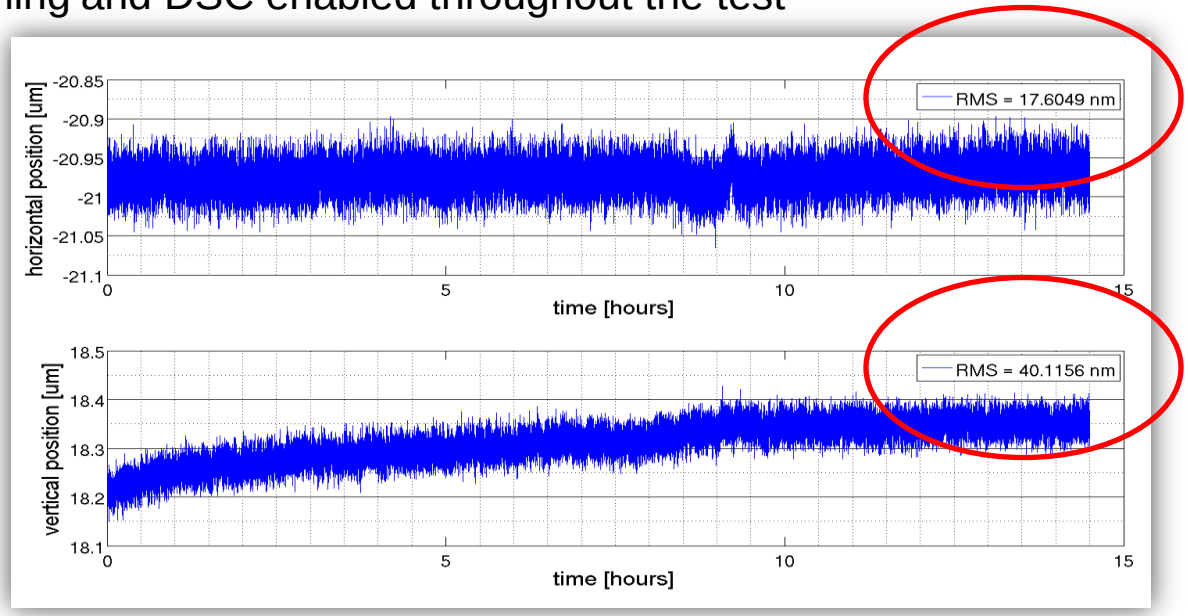
FFT from ADC buffer data: resolution 112 Hz!



FFT from TBT data: resolution 2.38 Hz
Zoom-in at betatron frequency

Long-term Stability Measurements

- ~361 mA current, normal user run, top-up
- Temperature: room temperature, 1 degC p-p, just normal air-conditioning
- Switching and DSC enabled throughout the test



17.6 nm RMS

40.1 nm RMS

Initial Tests at Advanced Photon Source, January 2011

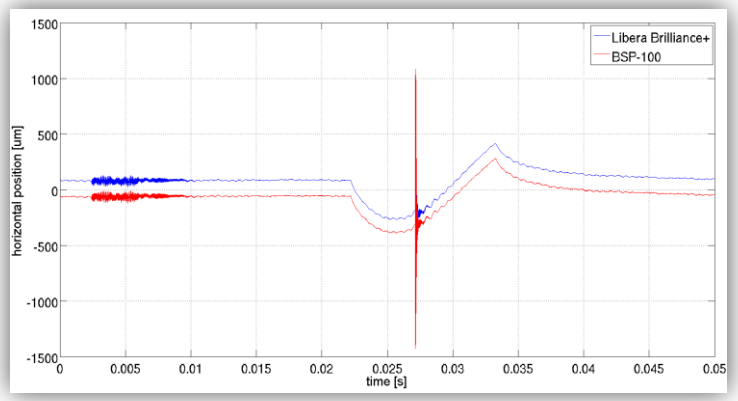
- Calibration of the Libera Photon using Libera Brilliance+ (2 processors)
- FFT spectrum comparison of BSP-100 and Libera Brilliance+
- Simultaneous top-up injection with 3 instruments

Libera Brilliance and Libera Brilliance+ installed in sector 35

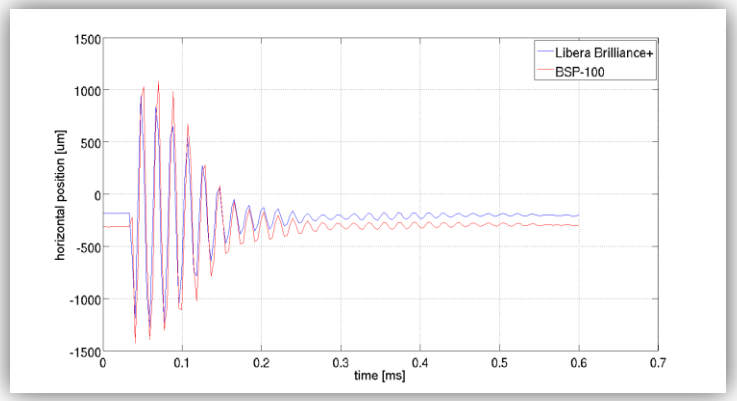
Advanced Light Source in January 2011

Top-up Injection Acquisition

- Comparison of BSP-100 and Libera Brilliance+
- Perfect match of both acquisitions – turn-by-turn data
- BSP-100 could only provide turn-by-turn data in one direction at a time
- Libera Brilliance+ provided access to FA data simultaneously with turn-by-turn data



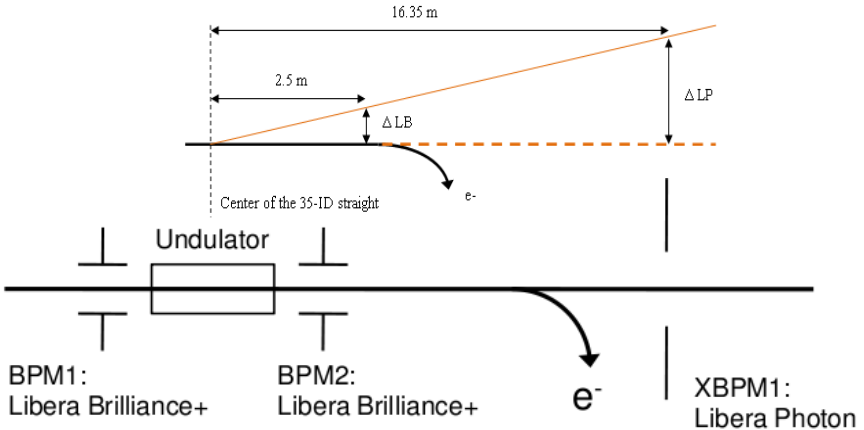
Top-up injection: horizontal direction

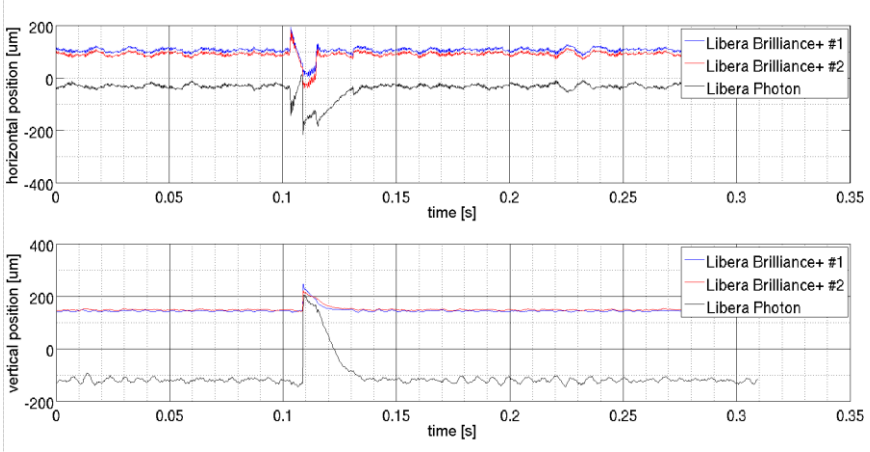


Zoom-in in turn-by-turn data

Simultaneous acquisitions

- Simultaneous acquisition with 2 Libera Brilliance+ processors and Libera Photon (10 kHz data)
- Steps in the horizontal photon beam position most probably made by fast feed forward correction trying to compensate the injection septum transients.



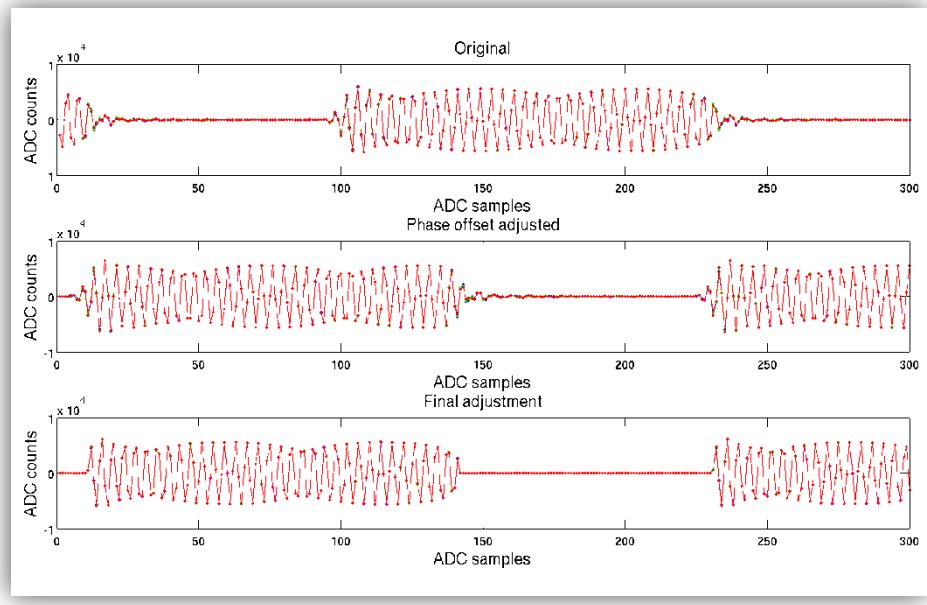


Injection as seen in the electron & photon beam

Time Domain Processing

- Turn-by-turn data path – only in Libera Brilliance+ !
- Fine adjustment of the TBT window
- Fine adjustment of ADC mask

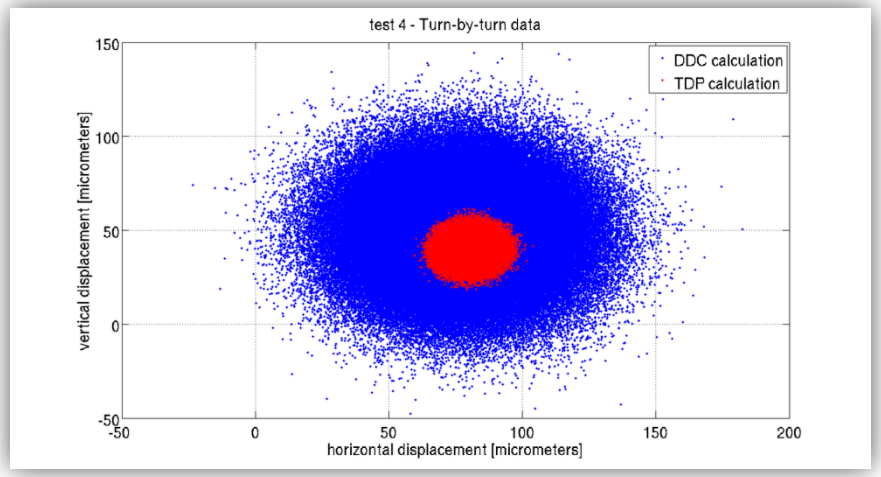
- For special fill patterns:
  - Single bunch
  - Pilot bunch
  - Variable partial fill



Adjusting the TBT window

Time Domain Processing – Results in Lab

- Simulate single bunch with pulse generator (2 ns width @revolution frequency)
- Comparison of the DDC vs TDP turn-by-turn position calculation
- RMS improvement factor is 4-5 in benefit to TDP !

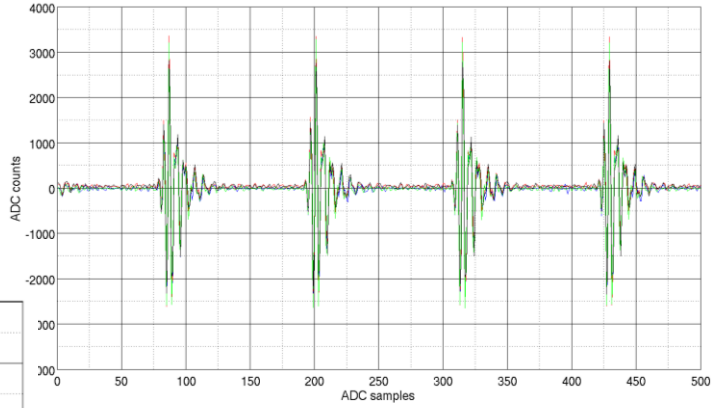


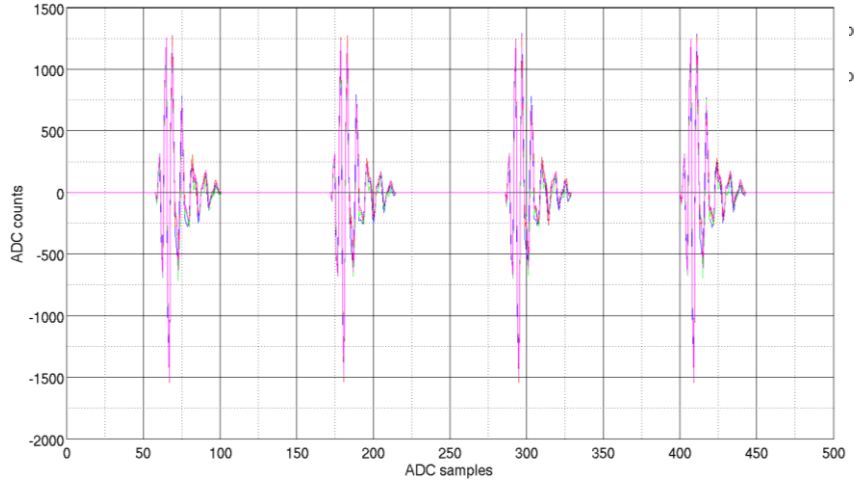
DDC (blue) vs TDP (red) position data (X/Y)

Time Domain Processing – Test at DORIS

- Single bunch fill
- Max ADC = 3500 (low!)
- Power level -44 (low!)
- Switching OFF

Raw ADC data

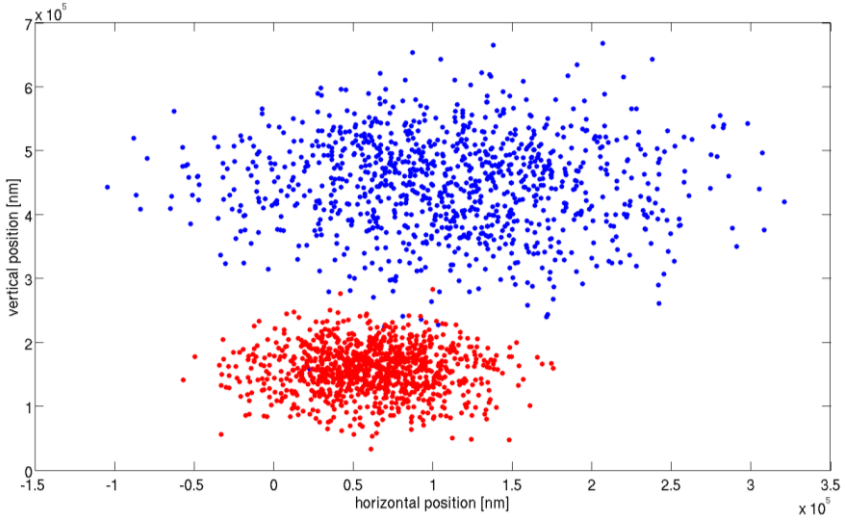




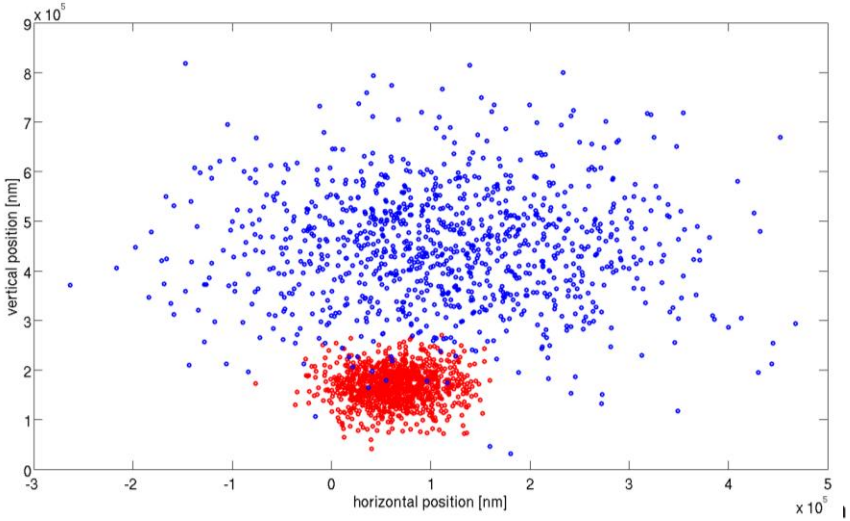
Adjusted TBT window

Time Domain Processing – Results at DORIS

- DDC performance: 118 um / 115 um; 73 um / 70 um
- TDP performance: 35 um / 36 um



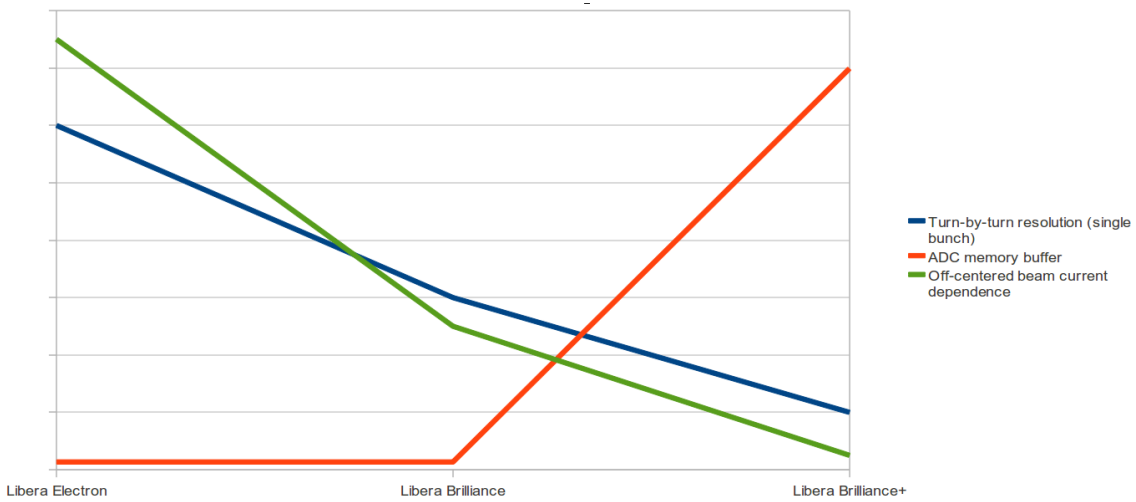
Test 1: Performance improvement factor= 2



Test 2: Performance improvement factor= 3.3

Performance, Functionalities,…

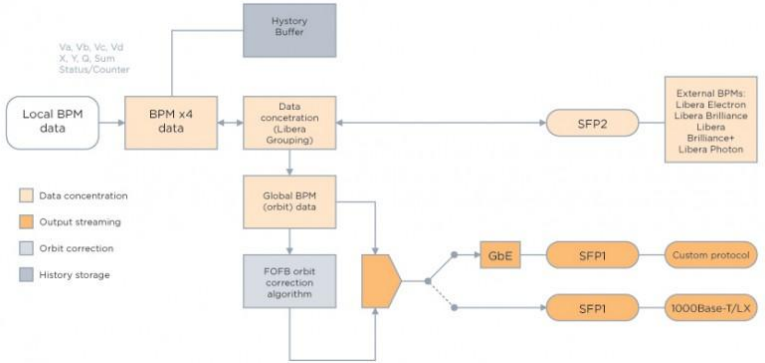
- >1000 times larger ADC buffer
- N-factor improvement for the turn-by-turn data with single bunch
- Significantly better off-centered beam current dependence performance



Future Outlook

- **The Fast Orbit Feedback Application**
  - Implementation in the on-board Virtex6
  - Grouping of the global orbit data
  - Feedback calculation
  - Direct output to corrector magnet power supplies
- **User Application Development**
  - Model the function in Matlab
  - Use signals and parameters provided by Libera BASE
  - Implement the new function in the application using SDK
- **Social networking**

  Libera Brilliance+ does not have a Facebook page… but can
  - Output notifications to Twitter
  - Provide web access
  - Be accessed by a wireless connection



Libera

Conclusion

- Wide range of functionalities
- Excellent long-term stability
- High flexibility for Fast Orbit Feedback Building

Tutorials on Web

See tutorials on
http://www.i-tech.si/accelerators-instrumentation/libera-brilliance-plus/tutorial

… or search for “Libera Brilliance+” on **Youtube**.

Overview and the boot-up procedure

Fan control