Libera Brilliance and Libera Photon Working Together in Fast Orbit Feedback

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Abstract

Libera Brilliance is already a standard Beam Position Processor system, which provides data flows at different sampling rates and bandwidths. It is widely used in the Fast Orbit Feedback (FOF) systems. For this purpose the fast acquisition data flow (FA) at ~10 kHz sampling rate is used. Two standard protocols can be employed for integration, GB Ethernet or DLS Communication Controller, the later being developed at Diamond Light Source. Libera Photon is a new photon beam position processor, which is used with current output based sensors such as blade-based XBPMs. Similar to Libera Brilliance, it provides dataflow at different sampling rates. Sampling frequency of the Libera Photon FA was chosen to exactly match the Libera Brilliance FA. This enables a smooth and simple integration of both devices into the same Fast Orbit Feedback. Since both devices also share the same control system interface, their combination in the same system provides a firm foundation for further stabilization of the beam.

Concept

During last few years, many synchrotron light sources are successfully implementing local and global FOF. Use of Libera Brilliance as electron beam position processor and Libera Photon as photon beam position processor in the same FOF offers several benefits:

- Full and straightforward synchronization of data streams from both devices. The data is automatically synchronized to RF frequency as well.
- Fast data @ ~10 kHz sample rate and 2 kHz 3dB bandwidth.
- The fast data stream can be implemented via two LAN based communication solutions: GB Ethernet protocol or DLS Communication Controller.

Libera Brilliance

Libera Brilliance is well known state of the art instrument for electron beam position processing on synchrotron light sources. Its superb metrological characteristics and supported flexibility in the software have made it the BPM electronics of choice. The specified electron beam position RMS of its FA data stream is 0.25 μm for the input signals above -20 dBm, and is usually kept even lower.

Libera Photon

Libera Photon is a recently developed photon beam position processor for electrical current output based sensors. The Libera Photon is an All-in-one device, it features:

- Current to voltage conversion
- Digitalization of analogue signals
- Digital signal processing

It features three data outputs: raw ADC (@~100kSps, on demand), FA(@~10kSps, streamed) and SA (@10kSps, streamed). For FOF purposes it is important that it shares the same FA data output (2kHz bandwidth) as the Libera Brilliance. Libera Photon performance is being tested on Soleil and ESRF.

The Libera Photon input dynamic range is split into seven ranges. They can be set either manually or automatically.

Input Current ranges

Range	Input Current
0	<2 nA
1	2 nA — 20 nA
2	20 nA — 200 nA
3	200 nA — 2 uA
4	2 uA — 20 uA
5	20 uA — 200 uA
6	200 uA — 1.8 mA

The Libera Photon preliminary position RMS performance was measured at four lower ranges, the setup and the results are outlined below:

Position RMS at lower current range

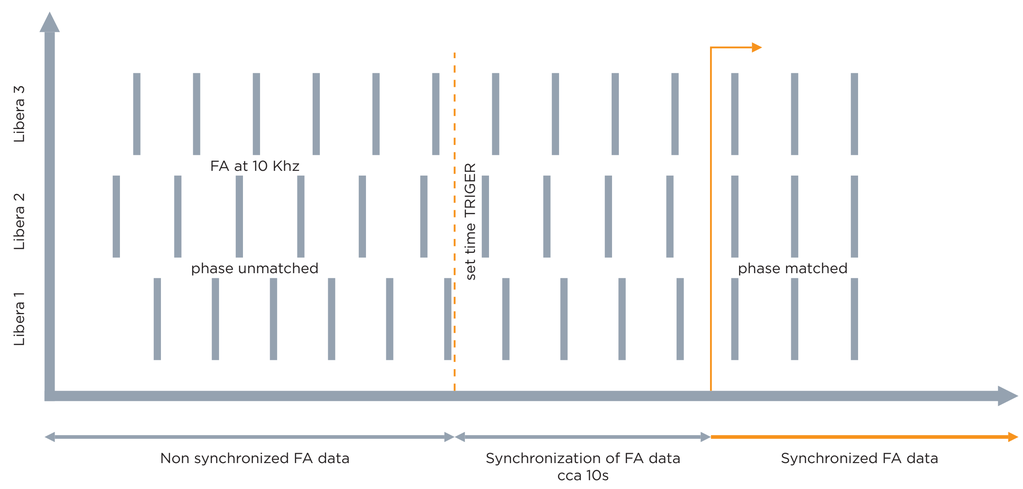
Range	Position RMS [um]		
	ADC	FA	SA
0	1.7	0.75	0.1
1	0.22	0.1	0.03
2	0.13	0.04	0.02
3	0.1	0.05	0.03

Libera Brilliance and Libera Photon working together

Libera Photon and Libera Brilliance are measuring the positions of two totally different types of beam, photon and electron beams. But as the photon beam originates from the electron beam, the measurements on the photon beam can reveal a lot of information of the behaviour of the electron beam. The integration of the Libera Photon into a Libera Brilliance based FOF is just the same as an addition of yet another Libera Brilliance.

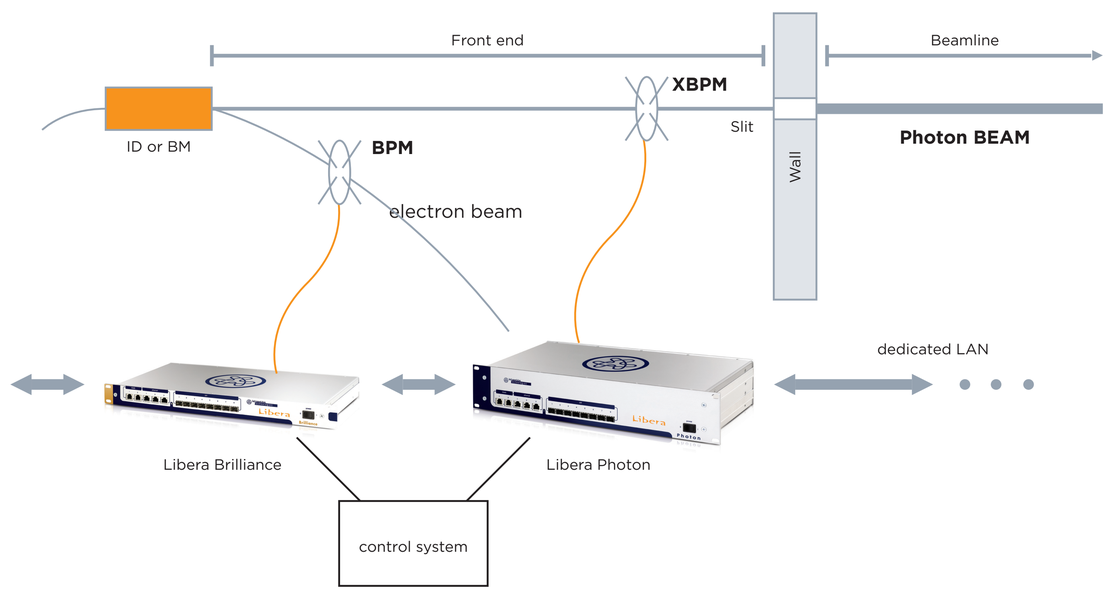
Synchronization in frequency is achieved through the Machine Clock reference. After that, the phase synchronization on set-time trigger is done by tweaking the phase-locked loop.

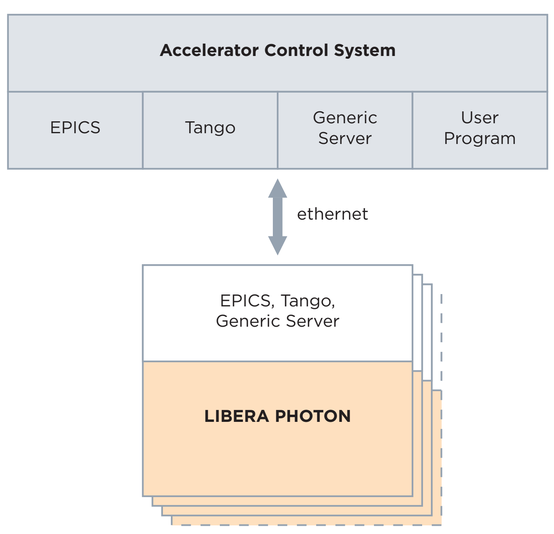
Synhronization of Libera Photon/Brilliance



In addition to perfect synchronization of phase and frequency, the FA data packets are equipped with 16bit counters. These are reset on the set-time trigger to assure that the samples originating from the right moment in time are taken into account for the correction calculation.

To make the FOF containing both devices feasible, a dedicated fast LAN must be in place, connecting all BPM devices around the ring and beamlines. A small sector of the whole installation is depicted in the scheme below.





From the Control System point of view, the devices are very similar and it is thus easy to integrate Libera Photon in the Control system of existing Libera Brilliance user. Below is the schematic of the Libera Control System integration structure.

Conclusion

The addition of Libera Photon to the existing FOF is interesting for users mainly since:

- By having the same data structure in the streams it is very simple to extend the correction matrix of the existing Libera Brilliance FOF.
- Its integration into Control System as well as synchronization is simple as the same principles are used as for Libera Brilliance.
- It helps to improve the global electron beam stability by adding a new dimension into FOF.
- It measures reliably the photon beam position on individual beamlines, which is critical for the quality of the light source.
- Additional DAC outputs on Libera Photon will enable local feedback on the beamline.

Users can also count on Instrumentation Technologies extensive technical support during system planning, setup and commissioning.

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