

**Libera**

**Brilliance Single Pass**  
**Single Pass**

Electron Beam Position Processor  
for Single Pass Machines





## Many instruments. Many people. Working together.

Stability means knowing your machine has innovative solutions. For users, stability means a machine achieving its full potential, enabling them to do more science. For us, stability means synchronized, connected, dynamic state-of-the-art instrumentation, working together as one system.

Because we know that the machine is more than just the sum of its parts.

*Libera Brilliance Single Pass enables beam signal processing for single pass machines. It is recommended for:*

- pulse measurements in the field of FEL machines
- synchrotron light sources: injection diagnostics, beam position monitor applications in LINACs and transfer lines
- pickup buttons and striplines.



## Benefits

### Superior resolution performance

- accurate single-bunch position measurements

### Excellent temperature stability

- negligible temperature-dependent position drifts
- very good RMS results on various long term tests

### Built on the proven and broadly used Libera Brilliance architecture

- platform architecture and reliability of Libera Brilliance proved at several accelerators around the world
- experience and support from the Libera community

### Easy to integrate in the control system as also in the fast feedback and feed-forward system

- well documented and maintained Libera high-level software library (CSPI)
- separates control-system specific knowledge from low level details and logic related to a Libera processor

## Role in the Accelerator

The aim of a single pass position measurement is to resolve the bunch position from the information extrapolated from the very short pulses produced by a single bunch that is crossing the beam position monitor.

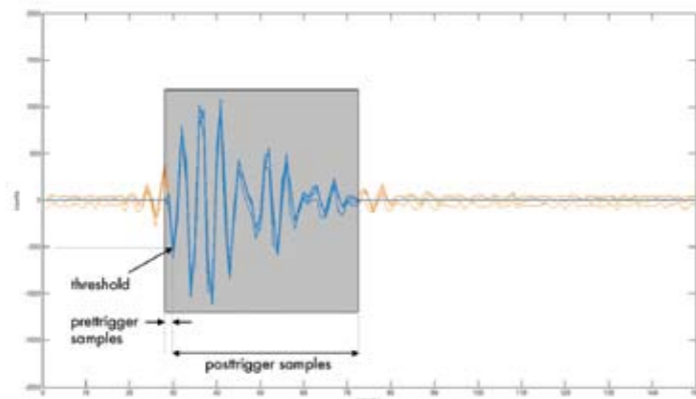
Libera Brilliance Single Pass makes accurate bunch position measurements possible. Together with implemented fast communication protocols (e.g. Gb Ethernet), it represents a reliable and deterministic building block for fast feedback building or fast forward loops and thus enables to achieve higher beam stability.

## How Does It Work?

The signal processing chain on the Libera Brilliance Single Pass is composed of analog signal processing, digitalization on fast ADCs and digital signal processing. The Libera Brilliance Single Pass calculates amplitudes and positions on every trigger - bunch transition. The pickup signal is lengthened to approx. 250 ns due to the relatively narrow (10 MHz width at 500 MHz) bandpass filters on the analog board. The window for position calculation is defined by three parameters:

- threshold level (in ADC counts)
- pre-trigger samples (in ADC samples)
- post-trigger samples (in ADC samples)

Samples taken into account are simply squared and summed, then the square root is applied over the sum. The result is proportional to amplitude. After calculating all four amplitudes, position is calculated using formulas for X and Y.



## Performance Specifications

Estim.Charge [pC]	Measured Peak [mV]	Libera Level Setting	ADC Counts ( $\pm 1000$ )	Required position RMS ( $\mu\text{m}$ )	Typical position RMS ( $\mu\text{m}$ )
280	4400	-10	15000	5	3
98	1560	-19	15000	6	4
31	500	-29	15000	12	9
10	160	-31	7000	35	33

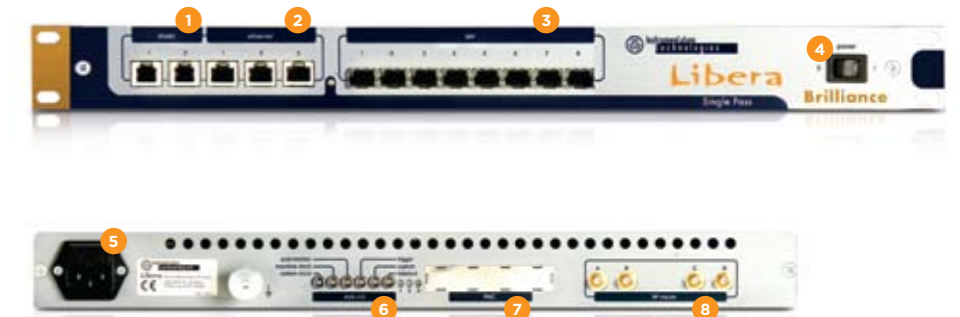
### Front panel

- 1 RS485 ports. Up to 6 RS485 channels.
- 2 10/100 Base-T Ethernet ports used for communication and integration with accelerator control systems. Control and measurement data are exchanged at lower rates. Port 3 standard. Ports 1 and 2 for future use.
- 3 SFP slots, used for fast serial communication. Libera Gigabit Ethernet Interface is available. Multiple other standards are supported.
- 4 On/Off switch

### Back panel

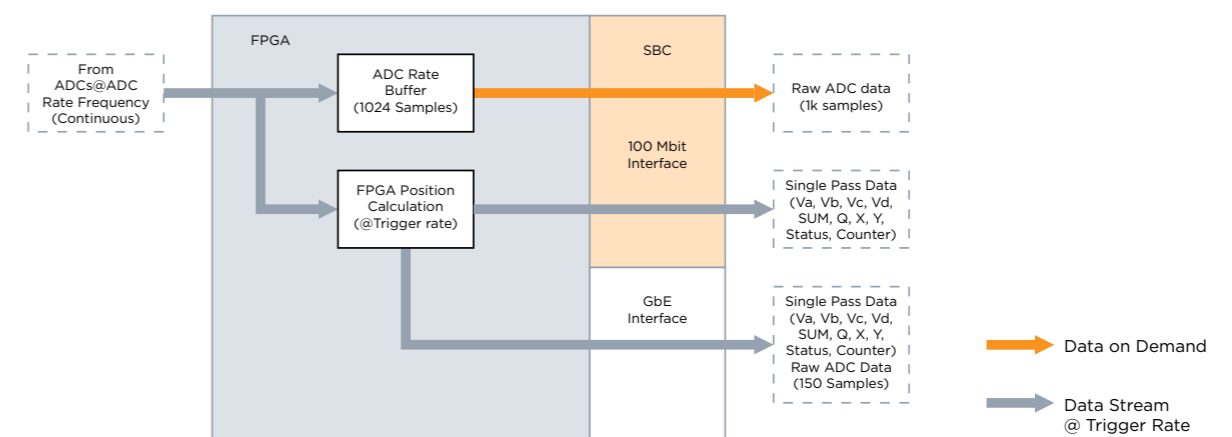
- 5 110/230 V AC mains power supply, 50-60 Hz.
- 6 Fast signal interfaces. In current version only Trigger input is used.
- 7 PMC slot. Standard PMC boards supporter. Due to direct FPGA connection, the interface can be PCI - or user - defined.
- 8 RF inputs. Connect to position pickups.

## Hardware Interfaces

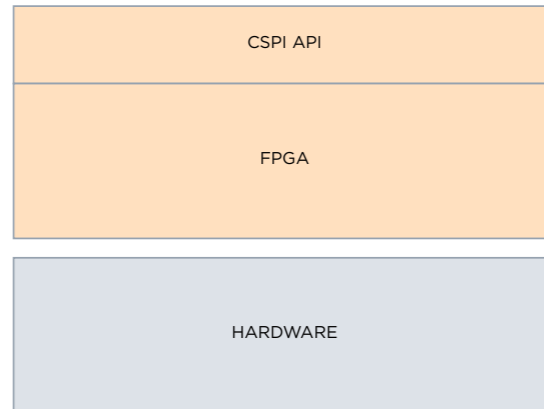


## Data Paths

Libera Brilliance Single Pass provides three main data paths. Acquisitions can be done simultaneously on all three data paths (raw ADC Data, Single Pass Data, Gigabit Ethernet single pass data). Gigabit Ethernet single pass data is available over SFP slot using Gigabit Ethernet protocol.



## High-level Software Architecture



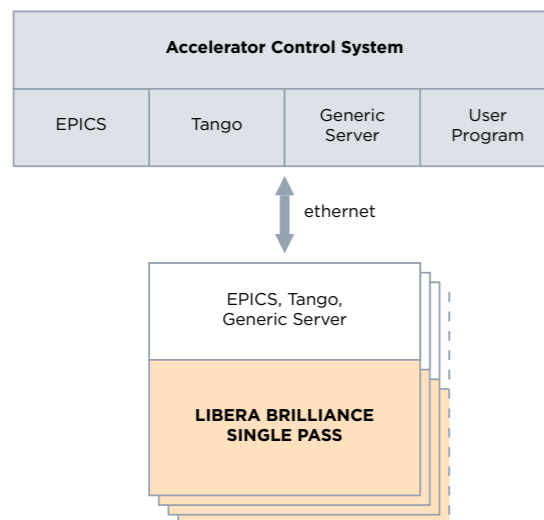
With regard to the hardware architecture that consists of single board computer (SBC) and digital board with Xilinx FPGA device, software architecture is composed of CSPI API (running on SBC) and FPGA software.

CSPI API is a high-level C interface which allows users to implement a range of applications for Libera family. It supports remote access and provides:

- configuration
- data streams
- health monitoring
- event monitoring

The CSPI API is provided to users with GNU GPL license and source code.

## Integration into Control System



There are various possibilities for integration of Libera Brilliance Single Pass units into the accelerator control system. Units can run EPICS, Tango or Generic servers. Data flow consists of:

- data acquisitions
- event delivery
- health monitoring

Integration into control system can be done using the following principles:

- Tango and Generic server:
  - all necessary source code available from Instrumentation Technologies
  - easy implementation based on the "libera utility" example
- EPICS driver for Libera Brilliance Single Pas which is available in lightweight version, based on CSPI API

Future member:

## Libera Single Pass

*Libera Single Pass is a single bunch/ macro pulse position processor for cavity and stripline BPM pickups. It is suitable for new generation linear machines:*

- FELs
- energy recovery LINACs
- multipurpose LINACs



## Benefits

- provides submicron resolution measurements from pulsed signals
- automatic calibration system enables you to maintain accurate measurements
- enables feed forward capability facilitates post mortem analysis

## Parameters

Parameter	Value
Number of input channels	16 (4 per module)
ADC resolution	16 bits
Max. ADC sampling clock frequency	130 MHz
Memory size per module	up to 8 Gbits
Customizable topology	4 BPMs per unit
Customizable RF input	up to 12 GHz

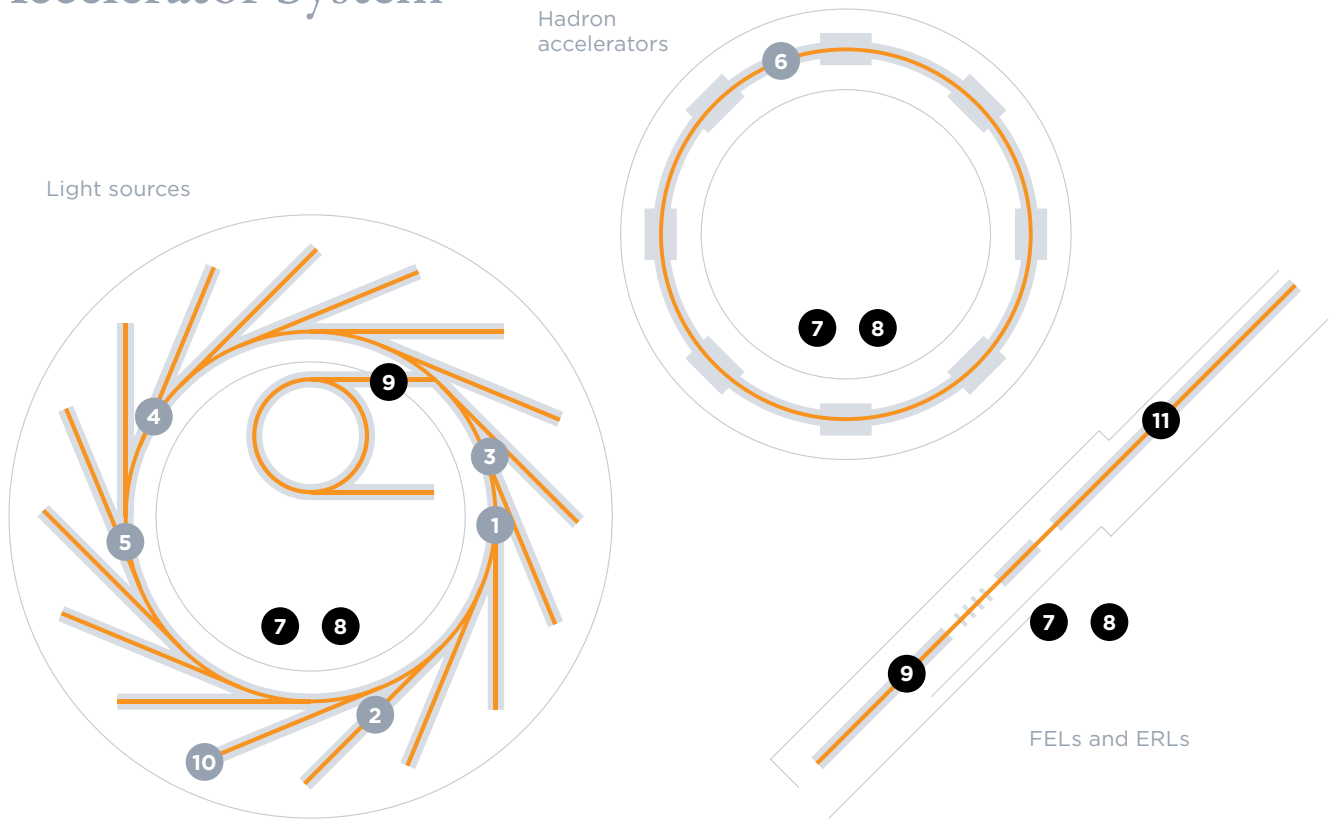
## How Does It Work?

- The pulses are converted to intermediate frequency by means of analog RF chains, then are digitized and processed by the FPGA.
- Low phase noise tunable local oscillators are used to compensate resonant pickup frequency drifts.
- Frequency corrections are computed in real time and applied before the next pulse arrival.
- Temperature drifts in the electronics are compensated by means of a pilot tone signal.
- Up-conversion and distribution to RF outputs.

## Built on the new state-of-the-art architecture and based on the proven Libera technology

- SW based on Libera experience
- shares the platform architecture with Libera LLRF
- high FPGA processing power
- plug-and-play solution
- rich triggering options
- calibration through a pilot signal

# Related Products in the Accelerator System



- 7 Libera LLRF**  
*Digital RF stabilization system*
- 8 Libera Sync**  
*Low-jitter clock distribution system*
- 9 Libera Brilliance Single Pass**  
*Electron beam position processor for single pass machines*
- 11 Libera Single Pass**  
*Single bunch position processor for cavity and stripline BPM pickups*
- +** *See the cover spread for the whole product range*

<b>→ Solution</b>	<b>Building Block</b>
Linac energy stabilization	Libera LLRF + Libera Sync + Libera Single Brilliance Pass (or Libera Single Pass)
Injection efficiency monitor	Libera Brilliance Single Pass (or Libera Single Pass)

## More at [www.i-tech.si](http://www.i-tech.si)

Visit our website to read more about Libera products, download conference papers on the use of Libera at different accelerators around the world, subscribe to the I-Tech Newsletter and learn about the next gathering of the community at the Libera Workshop.

## Technical Support

Prompt and reliable. You can ask for on-site support or we can assist you remotely. You are also welcome to join us at the Libera Workshop training sessions to get the most out of Libera products.



When your users demand stability.