



Instrumentation  
Technologies

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# **Libera Brilliance Single Pass**

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**Libera**  **WORKSHOP**  
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- **Digital signal processing**
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## What is Libera Brilliance Single Pass

- **Beam position processor suitable for single-pass machines**
- **The essential instrument for operators during commissioning and regular operation**
- **Customizable for customer's needs**
- **Simple to integrate into the Control system**
- **Simple to integrate into the Fast Feedback or Feed Forward loops**

## Recommended for

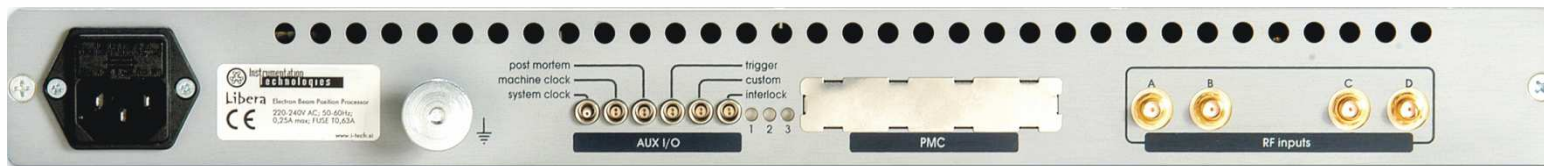
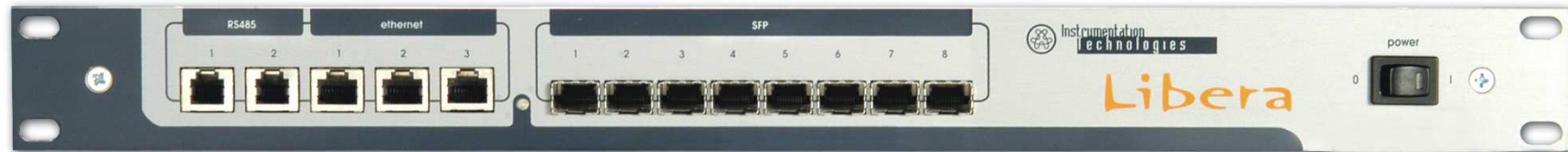
- **Stripline and Button pickups**
- **Field of FEL machines**
  - **Beam position monitor in LINACS**
  - **Charge measurements**
- **Synchrotron light sources**
  - **Injection diagnostics**
  - **Beam position monitor applications in LINACS and transfer lines**

# Connecting Libera Brilliance Single Pass

**Serial connector  
Ethernet connector**



**Fast ports for Fast Feedback  
or Feed Forward loops**



**Trigger input  
Interlock out**

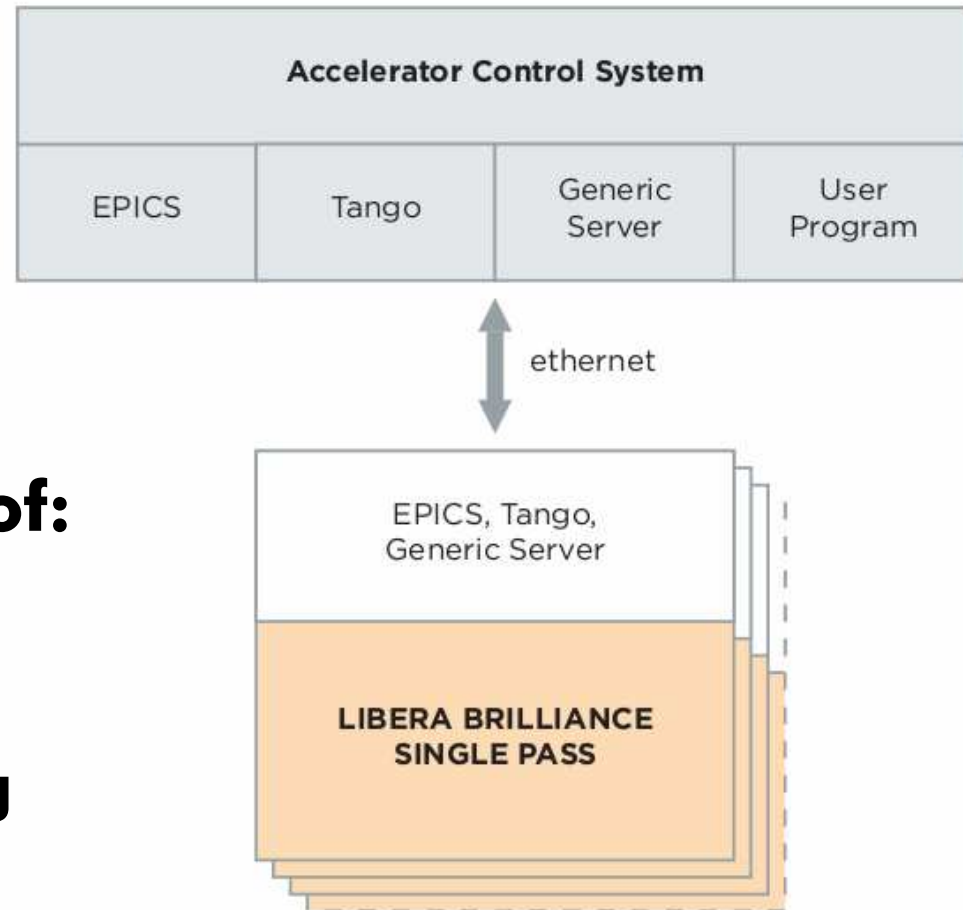


**RF inputs**

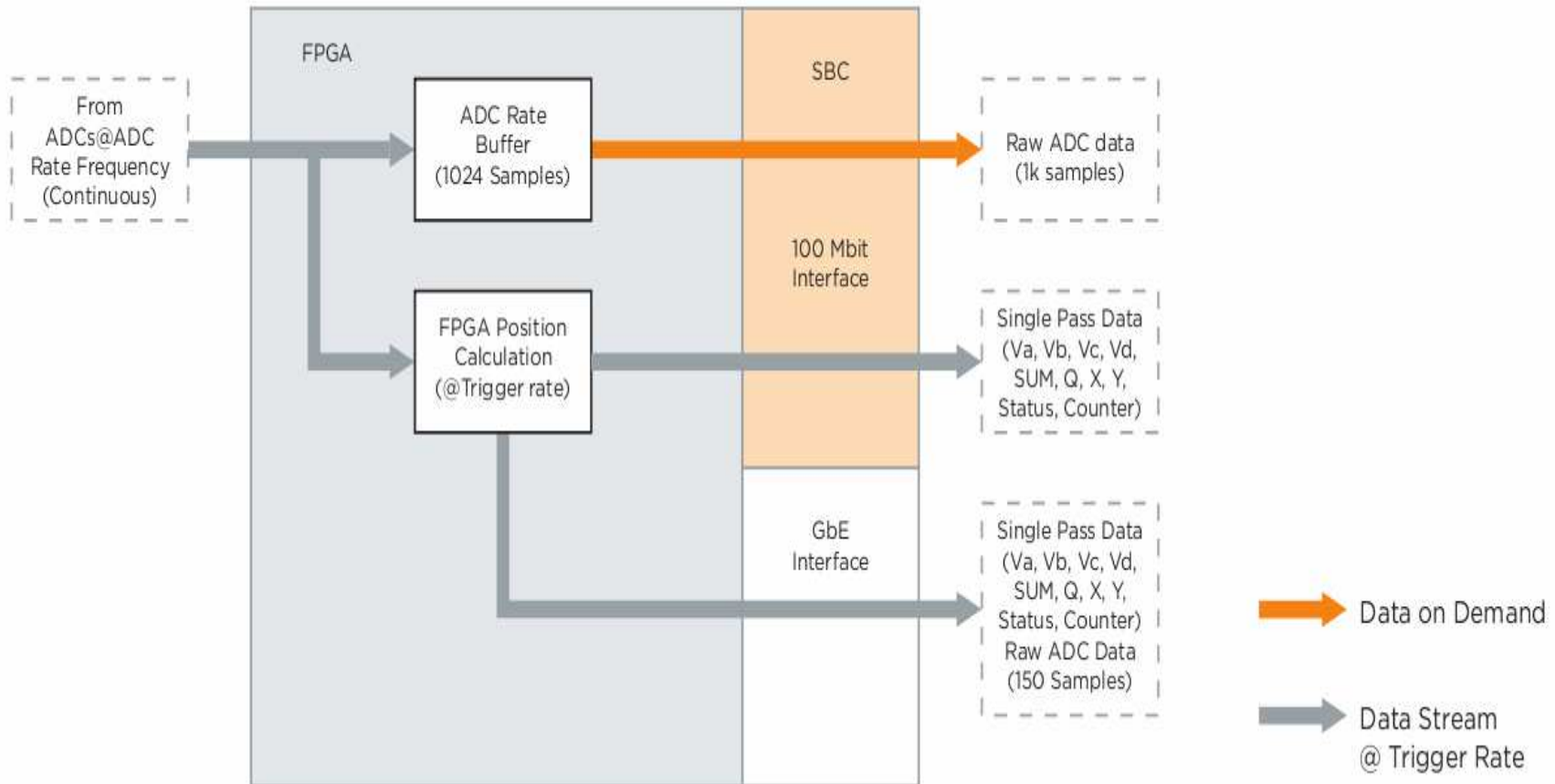


# Control System Integration

- **Principle**
  - **Generic server**
  - **Tango**
  - **EPICS**
- **Data flow consists of:**
  - **Data acquisitions**
  - **Event delivery**
  - **Health monitoring**

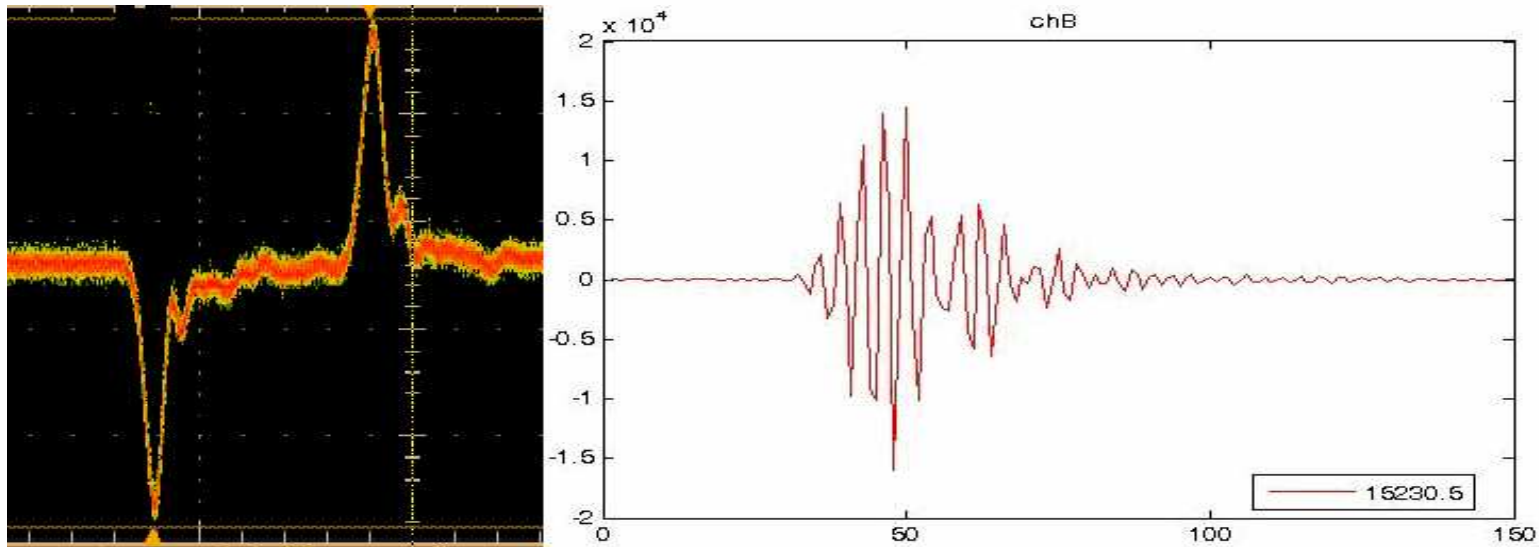


# Dataflow



# Analog Signal Processing

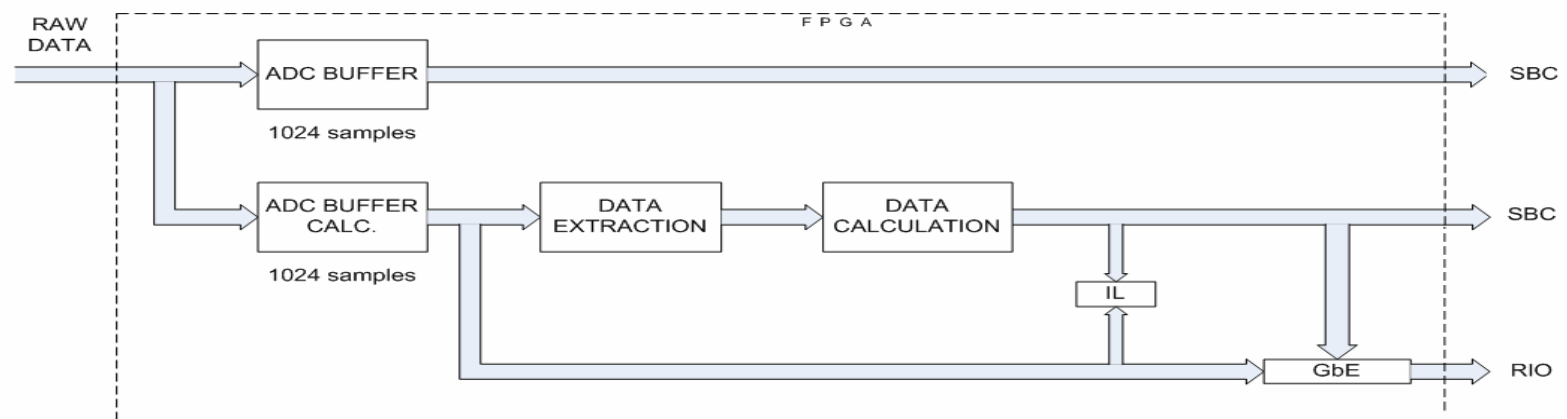
- **4 RF chains**
  - **SAW filters**
  - **Variable attenuators (gain control)**
  - **16 bit resolution**





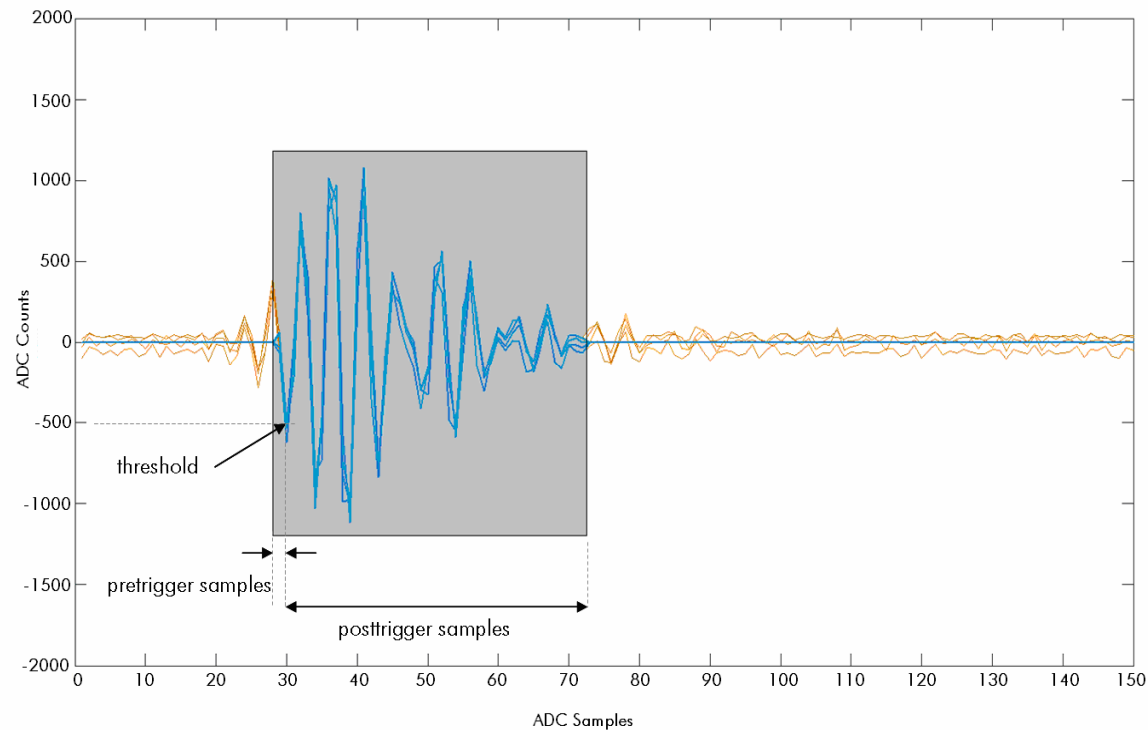
# Digital Signal Processing

- **Works on external trigger (currently limited to 200 Hz)**
- **Implemented in FPGA**
  - **Data acquisition**
  - **Data extraction**
  - **Calculation**

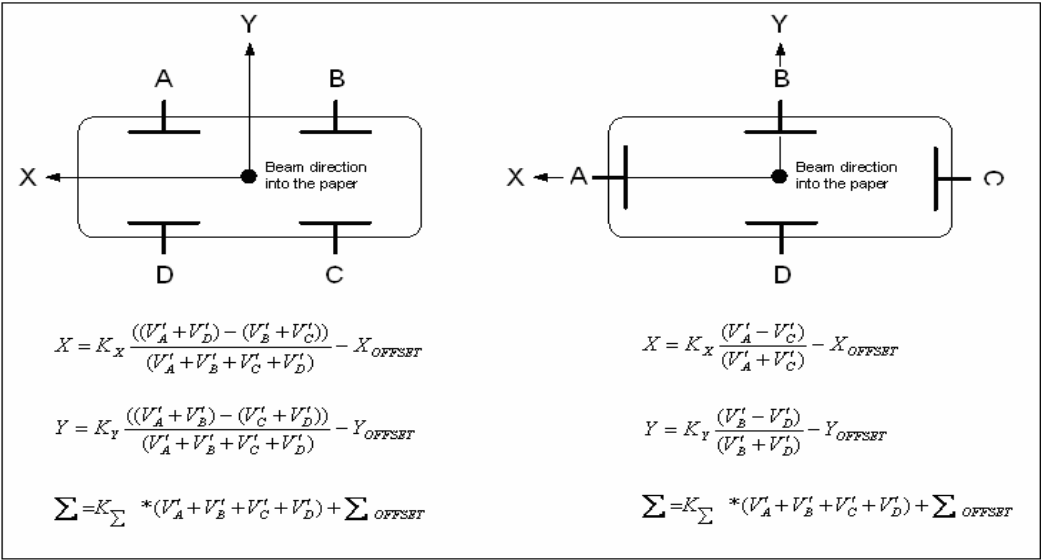
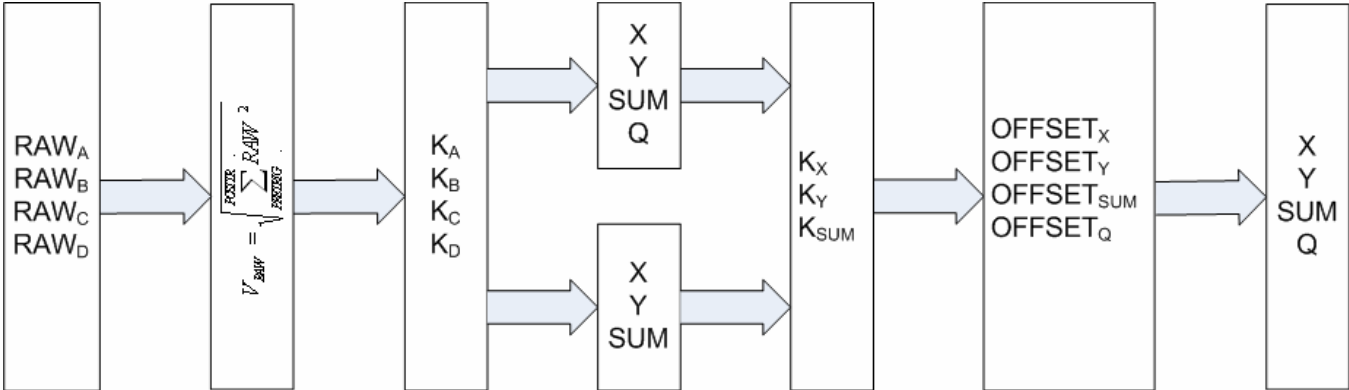


# Data Acquisition and Extraction

- **Threshold (level, below which we consider the signal as noise)**
- **Pretrigger**
- **Posttrigger**

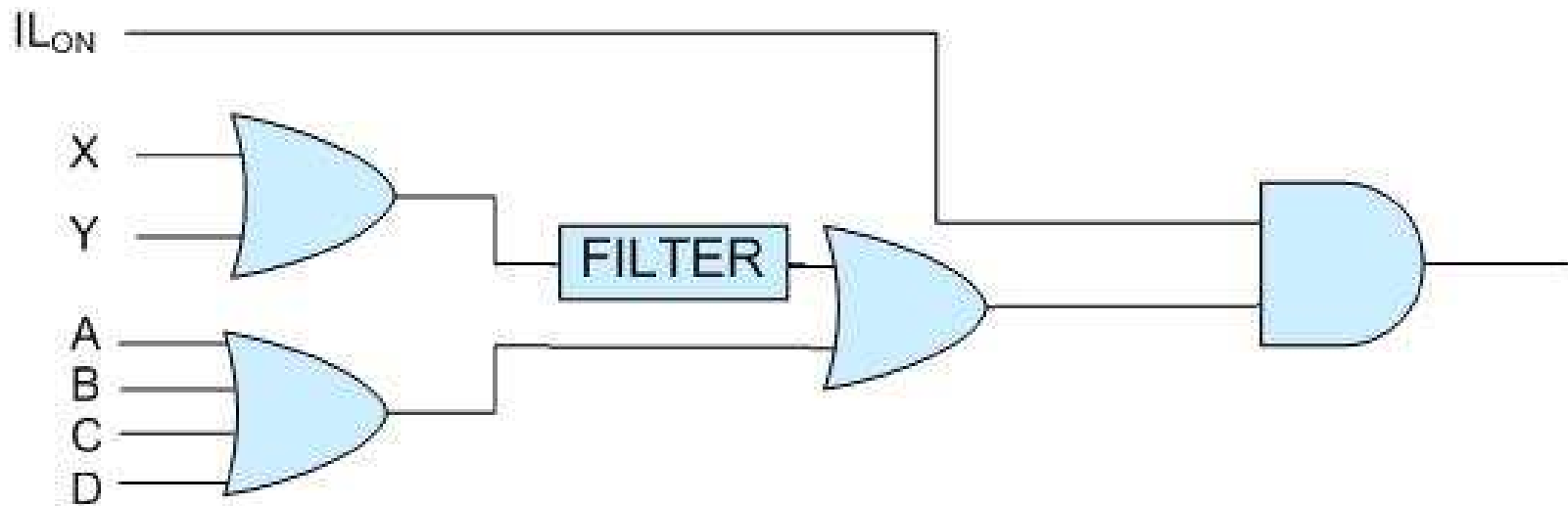


# Position Calculation



# Interlock

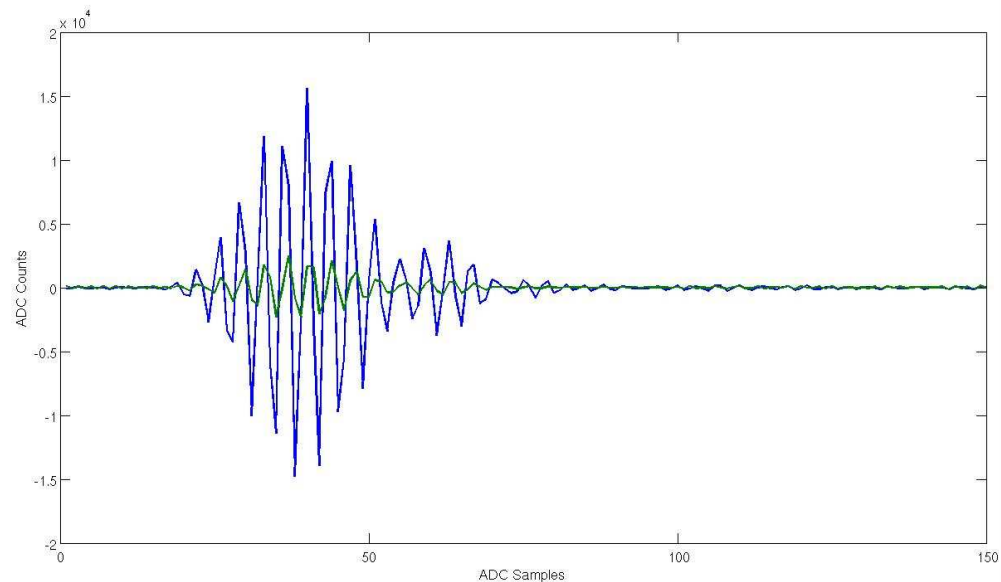
- **Provides continuous monitoring of the beam**
- **Triggers in the following cases:**
  - **X or Y positions exceeds predefined limits**
  - **ADC overflow**



# Manual Gain Control

- **Control the attenuators on analog board**
- **Attenuation from 0 dB to 31 dB, step 1 dB**
- **Predefined attenuation levels are defined in the gain.conf file**

#	P	A1	A2	h	t	X[nm]	Y[nm]
#							
0	31	00	0.5	10	0	0	
-1	30	00	0.5	10	0	0	
-2	29	00	0.5	10	0	0	
-3	28	00	0.5	10	0	0	
-4	27	00	0.5	10	0	0	



## Automatic Gain Control (AGC)

- **Automatically sets the attenuators according to the input signal level**
  - **ADCPEAK** parameter
- **Signal Scan**
- **Speed of AGC is 1 Hz**
- **ADC raw data is used for level calculation**

# Raw ADC Data and Single Pass Data Acquisition

## General conditions and specifications:

- **Trigger connected**
- **Resolution: 16 bit ( $\pm 32767$  counts)**
- **Length: 1kB = 1024 ADC samples**
- **Bunch signal position (Triggerdelay)**
- **Signal level (manual, AGC)**
- **Threshold, Pretrigger, Posttrigger**

Command	Description	Output
libera -3 50	Performs acquisition of ADC Rate Buffer, 50 samples	A, B, C, D
libera -1 50	Performs acquisition of 50 bunches and calculates positions	Va, Vb, Vc, Vd, SUM, Q, X, Y, STATUS, COUNTER

# GbE Single Pass Data Acquisition

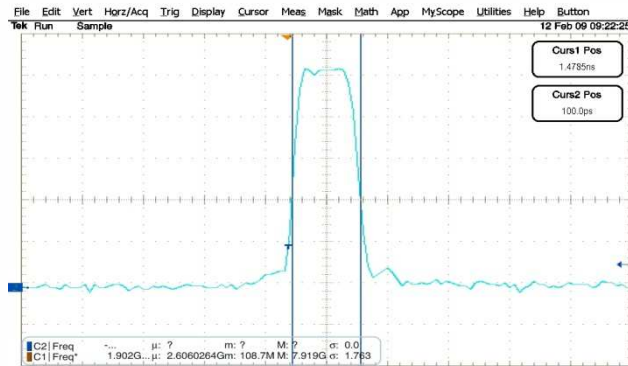
- **Data is available through fast GbE ports**
- **Standard UDP protocol**
- **Configuration file must be edited in the Libera**
- **Test receiver software is needed (fa\_samples)**
- **The data available**
  - **Va, Vb, Vc, Vd, SUM, Q, X, Y, COUNTER, STATUS**
  - **150 raw samples**



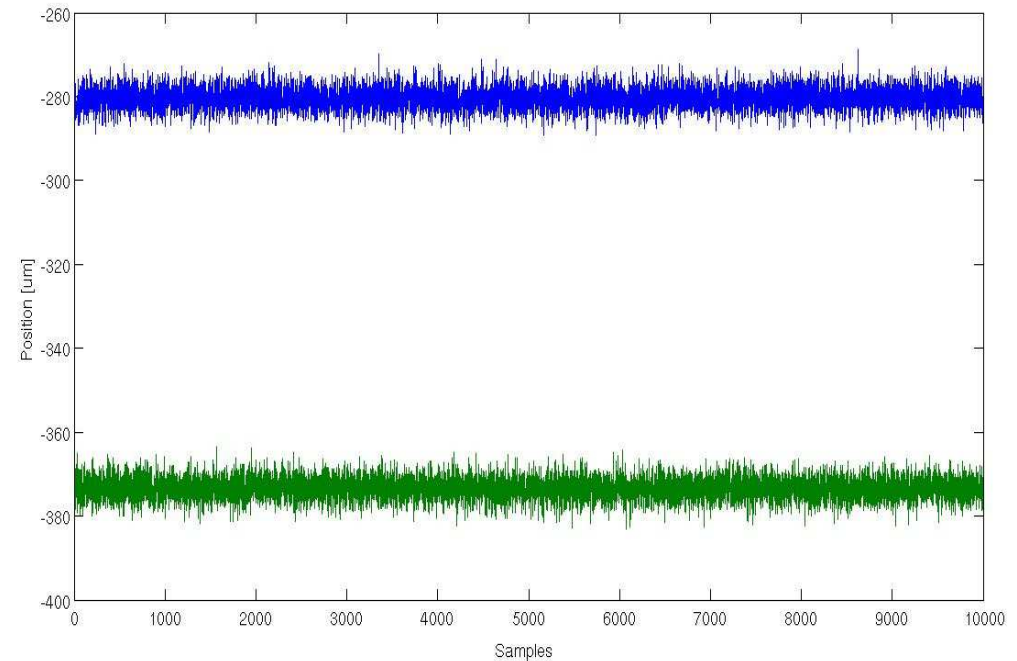


# Laboratory Tests

- **Input signal**

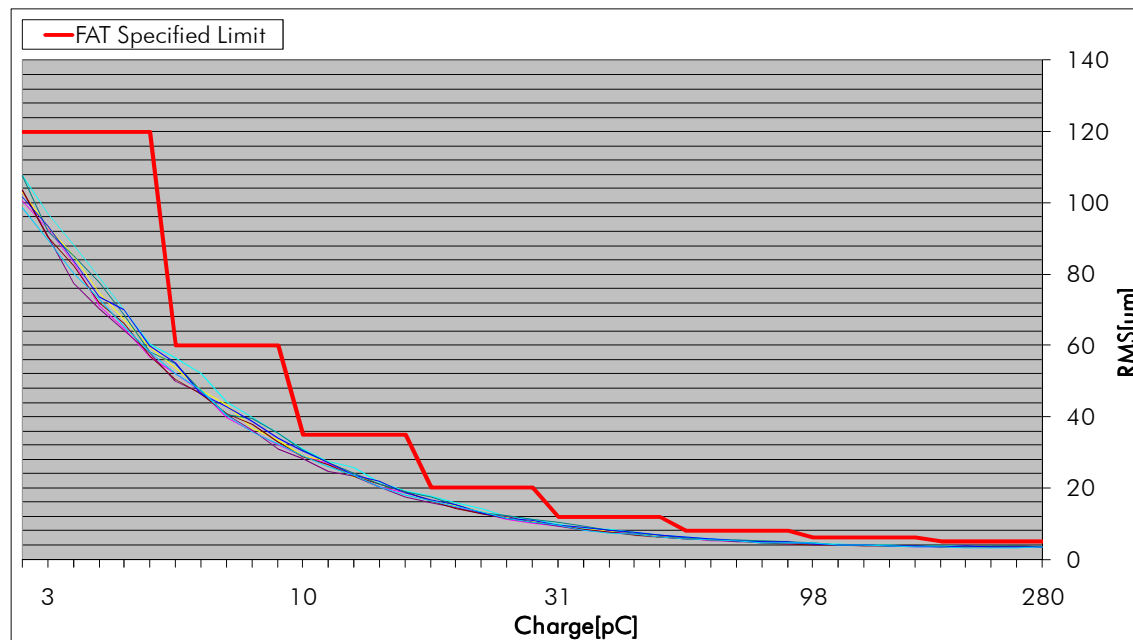


- **Peak = 4500 mV**
- **Xrms = 2.5861 μm**
- **Yrms = 2.6036 μm**



# Position RMS

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



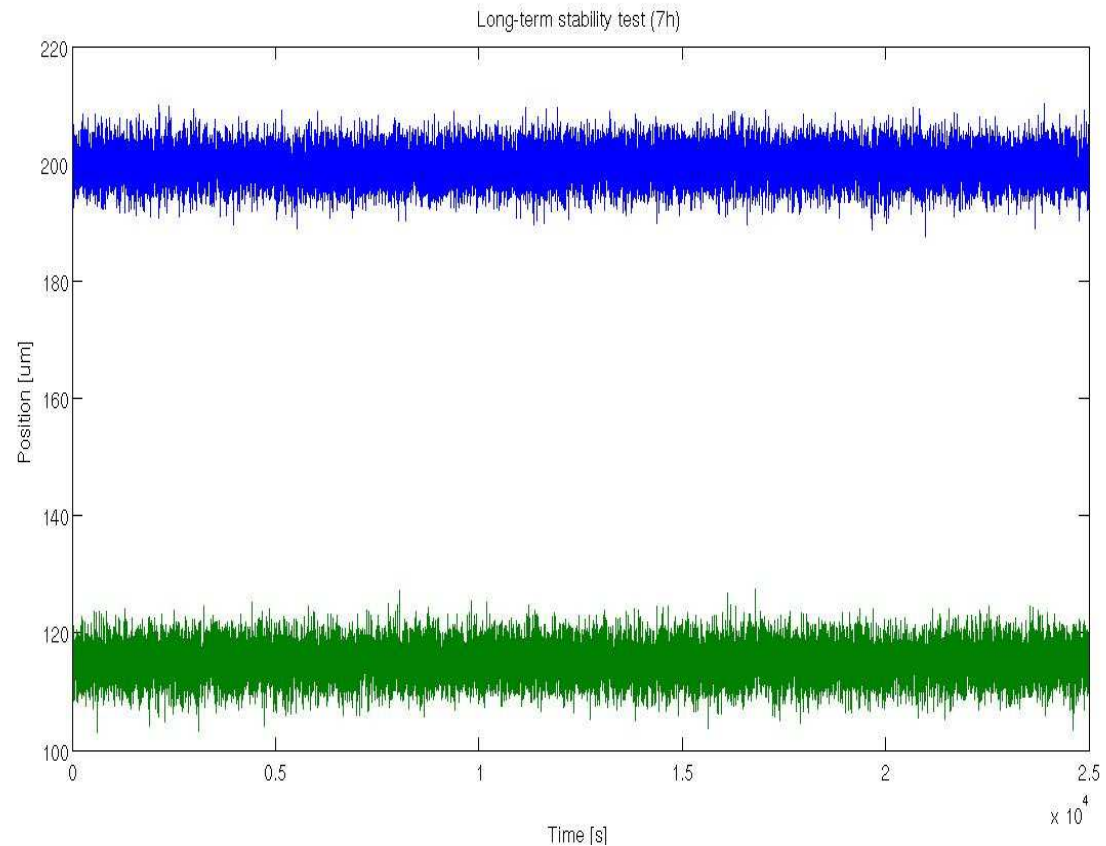
# Long-term Position Stability

**Chamber temperature = 25°C**

**(1) Xmean = 199.7929  $\mu\text{m}$   
Ymean = 114.8667  $\mu\text{m}$**

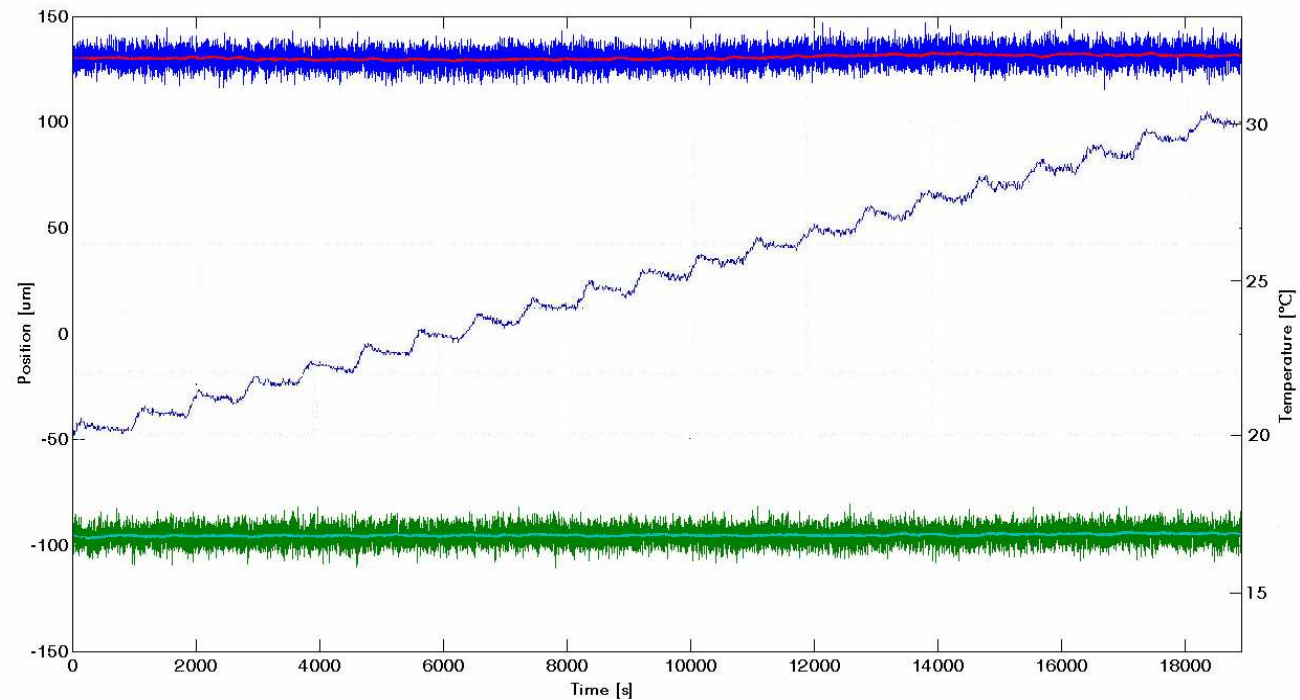
**(2) Xmean = 199.7047  $\mu\text{m}$   
Ymean = 115.1008  $\mu\text{m}$**

**(3) Xmean = 199.7230  $\mu\text{m}$   
Ymean = 115.1928  $\mu\text{m}$**



# Temperature Stability I

- Chamber temperature = 20 - 30°C
- 15 min. intervals



# Temperature Stability II

**Xmean = 130.4766  $\mu\text{m}$**

**Ymean = -95.2049  $\mu\text{m}$**

**Xrms = 3.9509  $\mu\text{m}$**

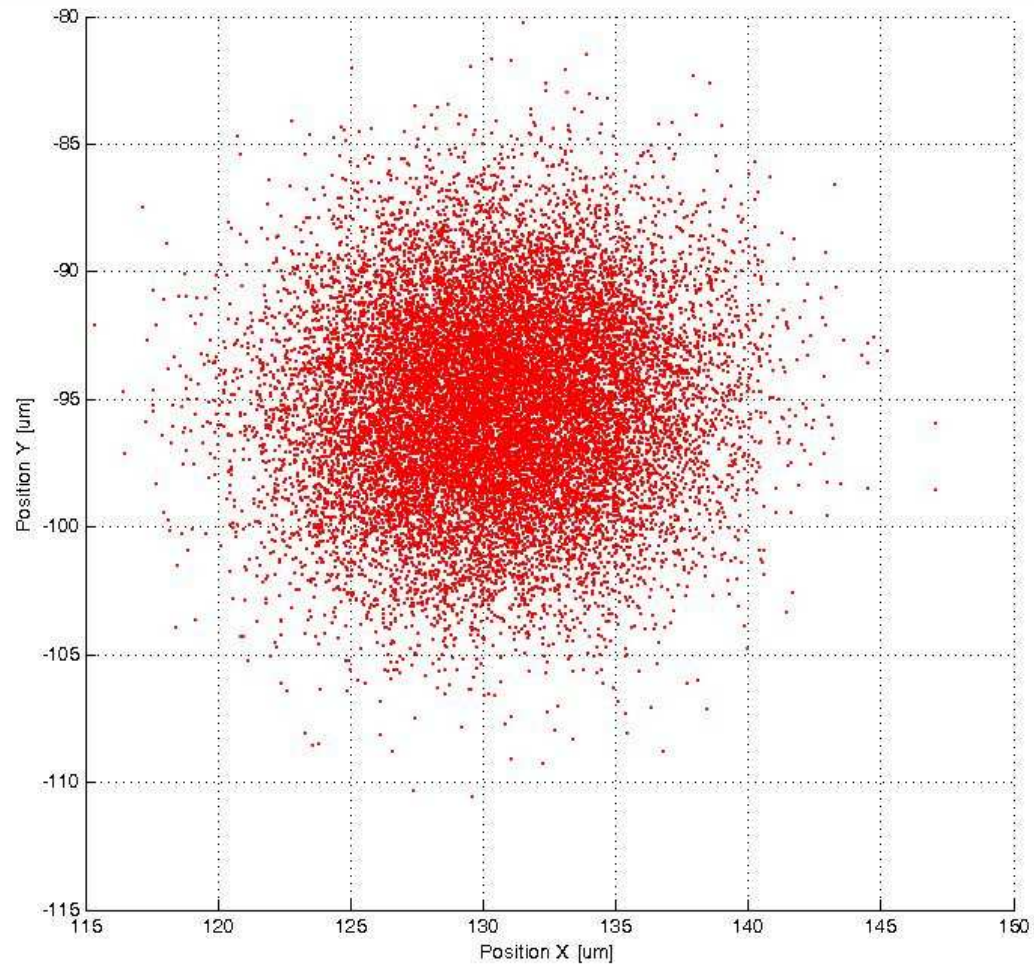
**Yrms = 3.7738  $\mu\text{m}$**

**Xmin = 129.2631  $\mu\text{m}$**

**Xmax = 132.1761  $\mu\text{m}$**

**Ymin = -94.1129  $\mu\text{m}$**

**Ymax = -96.3265  $\mu\text{m}$**



## Live Presentation

- **General**
- **Raw ADC data acquisition**
- **Single Pass data acquisition**
- **GbE Single Pass data acquisition**

# Thanks

- **Team from FERMI for the contribution to the development of this product and various tests**
- **People from INFN who gave us the opportunity for testing the unit on SPARC injector**