Libera

Libera Single Pass H

Borut Baričevič, Libera Workshop, October 2012, Solkan

Outline

- **System overview**
- **Requirements evolution**
- **Latest functionality**
- **Measurements**

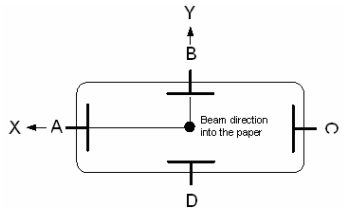
Libera Single Pass H overview

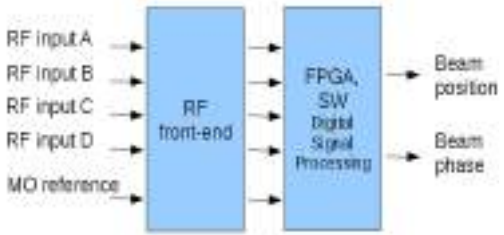
- Intel Dual Core based Computing module
- Beam Phase and Position processing modules
- Processing and Feedback Module (GDX)
- EvRx timing module
- Additional slot availability

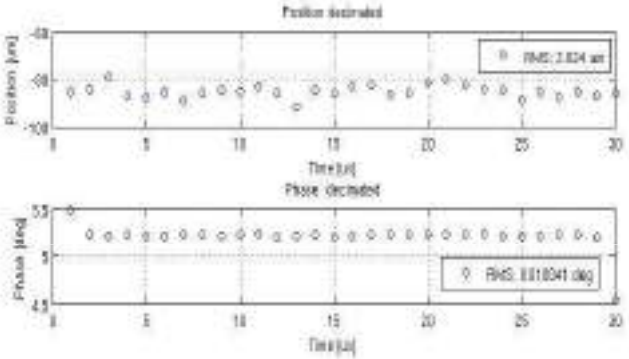
Now EvRx module available: optical event based receiver and timing module

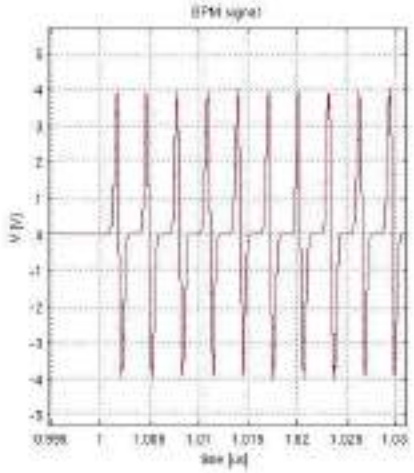
Instrumentation Technologies

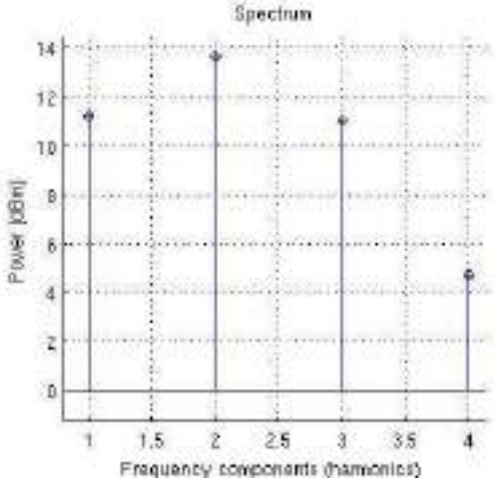
Libera Single Pass H signal processing basics







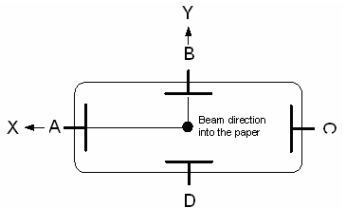


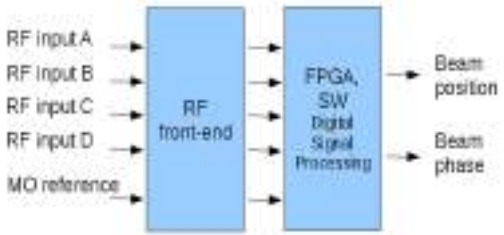


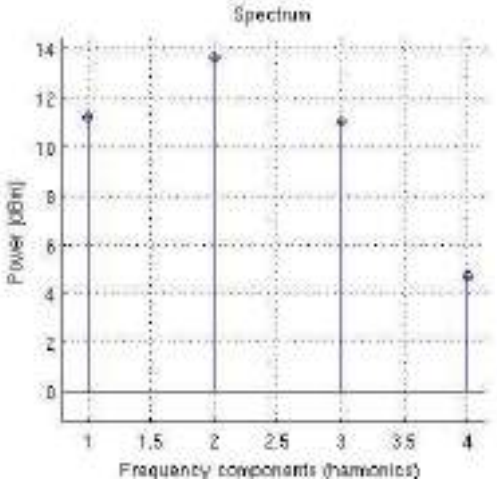
- Input signal: train of pulses at bunch repetition rate
- Output stream: Position and Phase at decimated rate (typically 1 MHz)

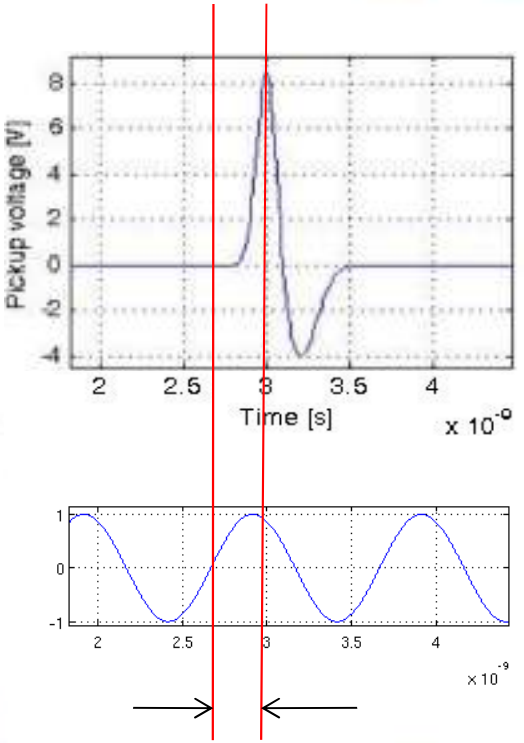
Instrumentation Technologies

Phase measurement principle







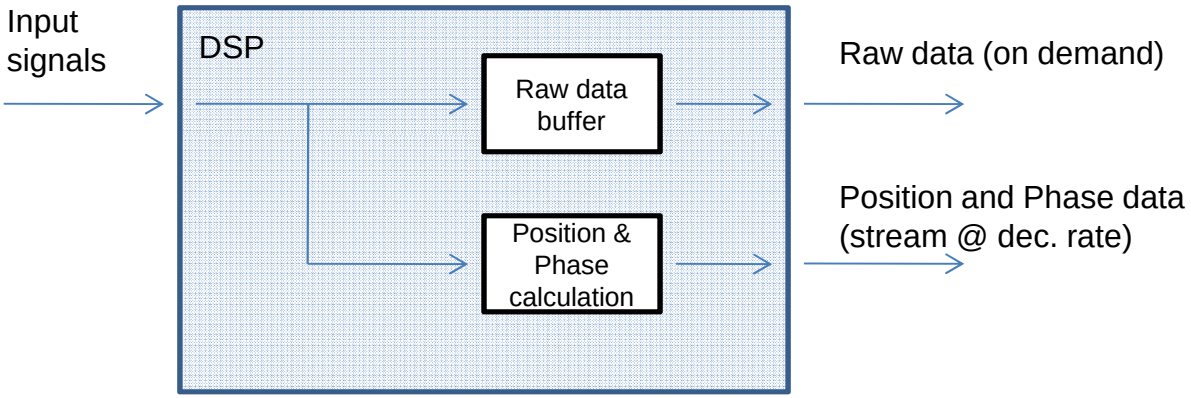


- The periodical nature of the input signal concentrates the pick-up signal power at few frequency components
- The phase relation between a selected frequency component and the simultaneously measured MO reference is used for arrival time measurements.

Beam phase measurement

Instrumentation Technologies

Data paths (basic functionality)



Instrument requirement evolution

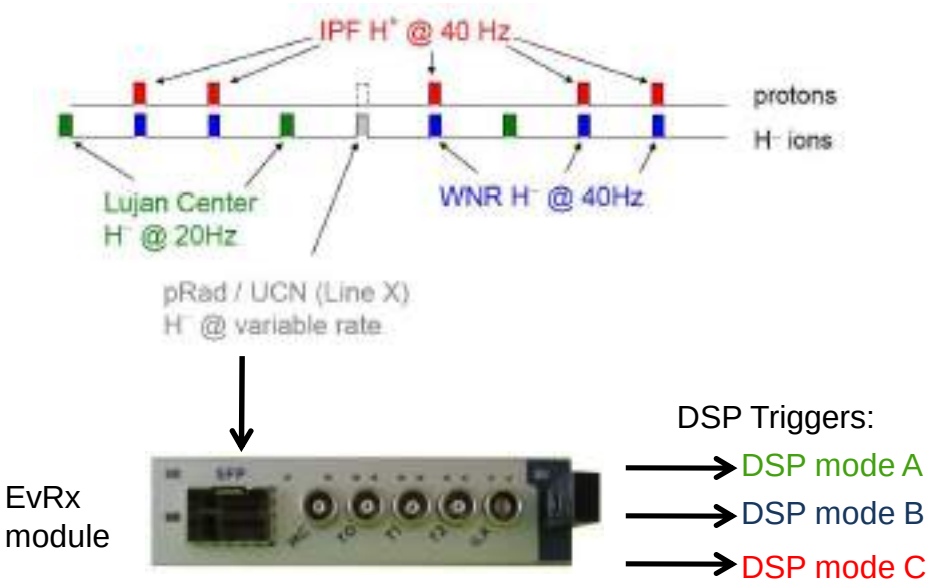
- **Hadron Single Pass Beam Phase and Position Monitor:**
  - **System for processing trains of uniform bunches at predefined bunch repetition rate, limited in duration (macropulses)**
  - **Capability of processing bunch repetition frequency harmonics (to avoid RF system coupling through vacuum pipe)**
  - **Capability of multiple harmonics processing**
  - **Trains of infinite pulses (CW mode)**
  - **Trains of various bunch patterns (LANSCE flavors)**
  - **Single bunch measurements**
  - **Realtime optical event based beam flavor recognition and DSP control (EvRx module)**

System capabilities

- **Capability of multiple bunch repetition harmonics processing:**
  - **Examples of second harmonic usage:**
    - **GSI pLINAC: 650 MHz processing in order to avoid 325 MHz RF cavity leakage through vacuum pipe**
    - **LANL LANSCE: the processing of 402. 5 MHz frequency component improves the measurement performance.**
  - **Measurement performance can be adapted to specific pickup signal characteristics at different machine operation modes (simultaneous processing of two frequency harmonics supported)**

- **Trains of infinite pulses (CW mode):**
  - **A dedicated acquisition mode enables the streaming of further decimated data in order to continuosly track the beam evolution.**

Multiple beam species (flavors) processing

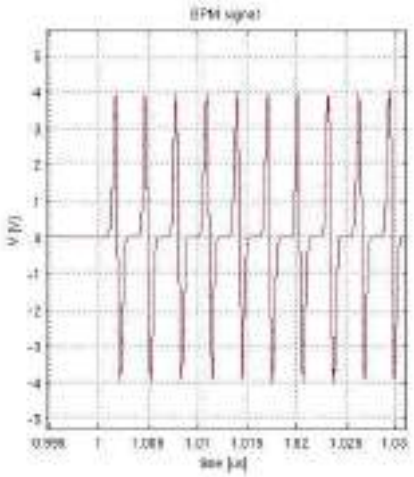


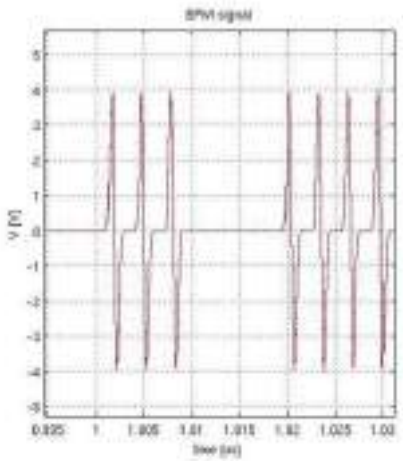
- **Los Alamos LANSCE LINAC: different species are accelerated at 120 Hz repetition rate in order to provide beam to multiple users.**
- **Each flavor requires a specific DSP algorithm**
- **The exact sequence of species is defined by the accelerator timing system distributed as optical events (e.g. MRF timing distribution).**
- **The optically distributed events are received by the EvRx (Event Receiver) module of Libera Single Pass H.**
- **The EvRx module discards the triggers not relevant to the specific application and triggers the suitable real time DSP algorithm, according to the pre-programmed EvRx RTC (Relevant Trigger Coding) tables.**

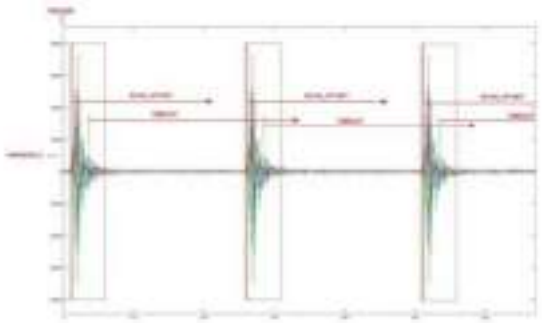
Typical flavor signals

The majority of the LANSCE flavors are processed by 3 different DSP schemes:

- **Classical processing scheme for macropulses defined as uniform bunch trains**
- **Chopped processing scheme for macropulses modulated by a fill pattern frequency**
- **Time domain individual bunch processing scheme**

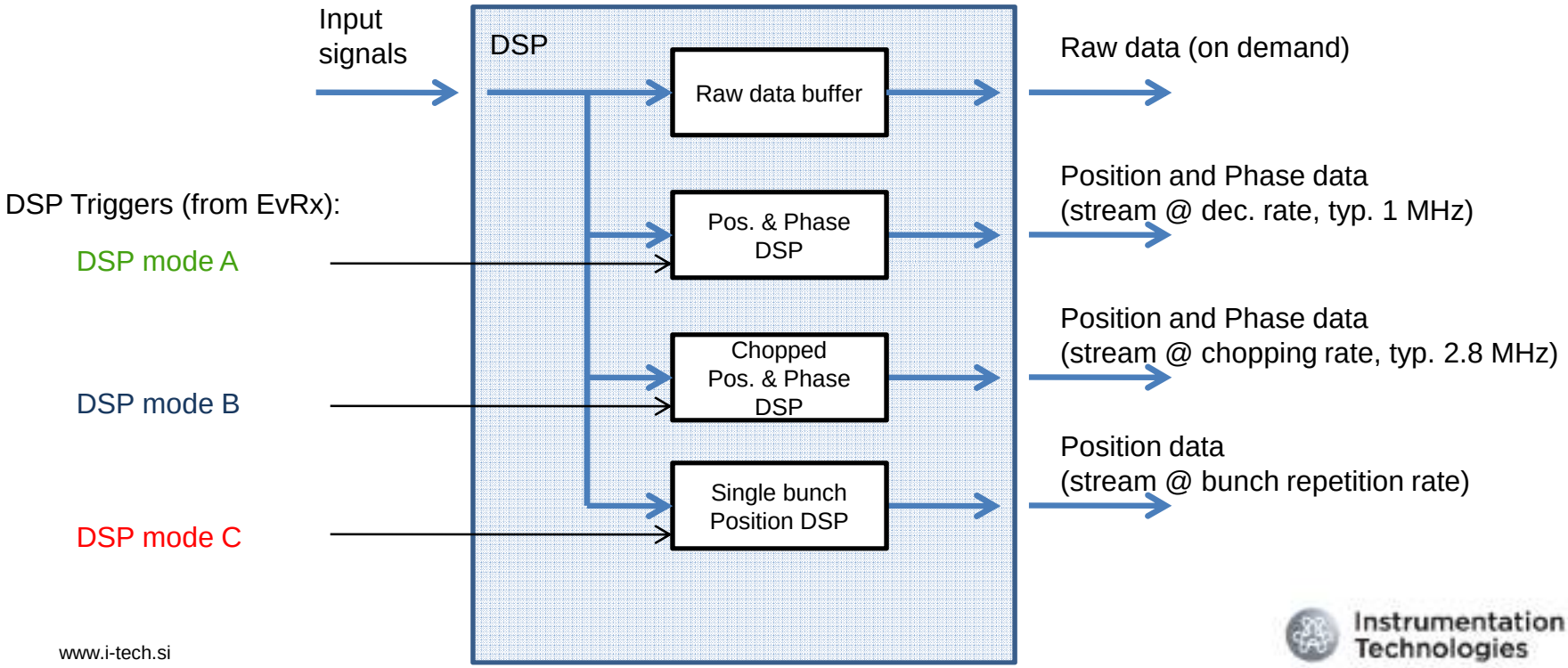






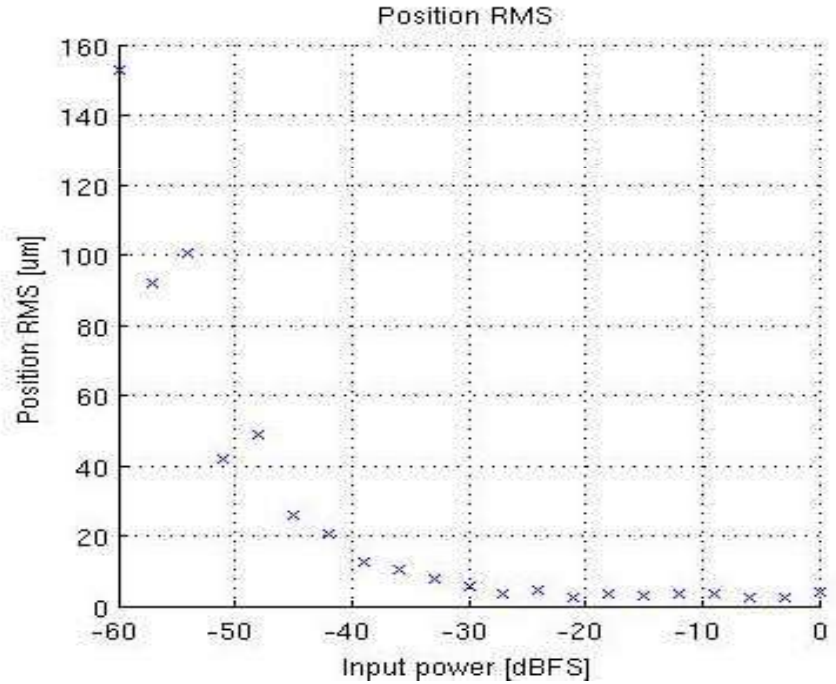
Instrumentation Technologies

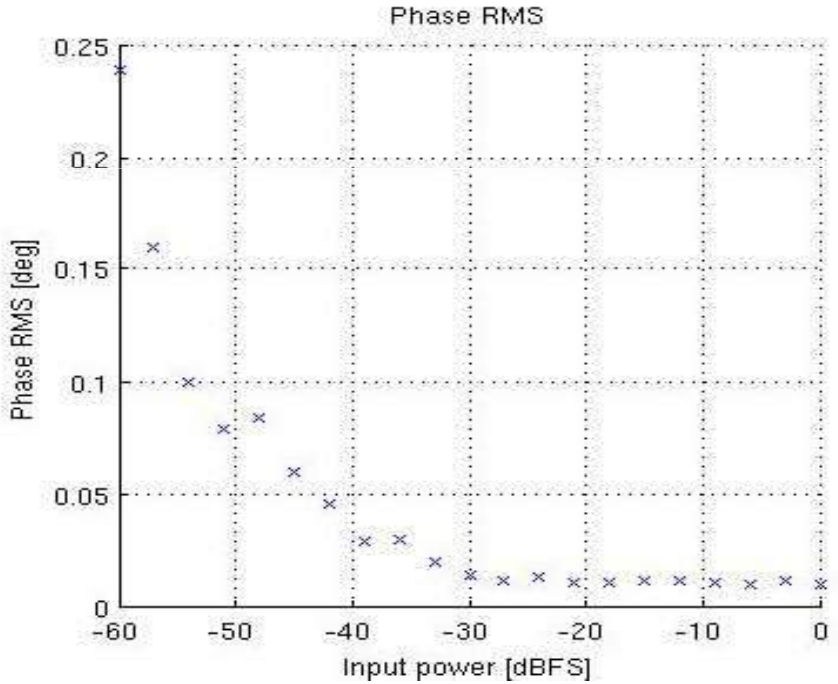
Updated data paths



Some measurements 1/3

Measured position and phase uncertainty in the range of 60 dB at 650 MHz (the GSI pLINAC example). (0 dBFS corresponds to ±4V input.)

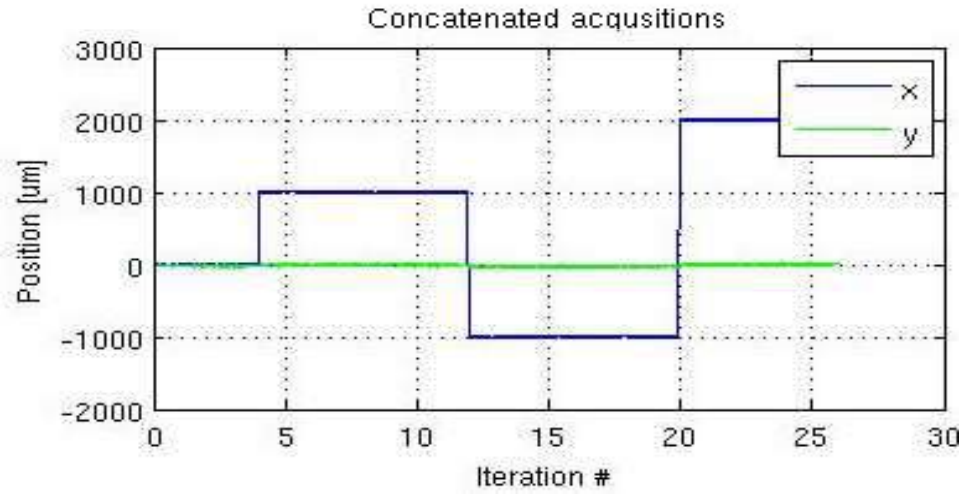


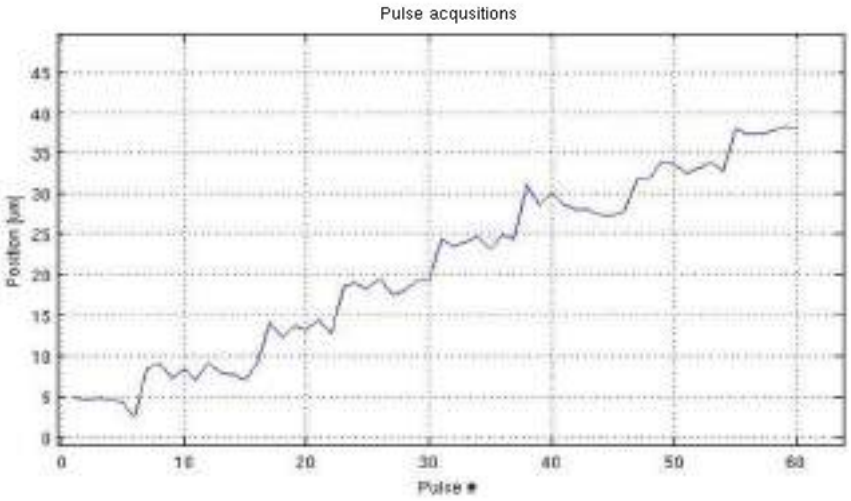


Some measurements 2/3

CIEMAT (IFMIF-EVEDA) testbench measurements:
(bunch repetition frequency: 175 MHz)
Position sweep

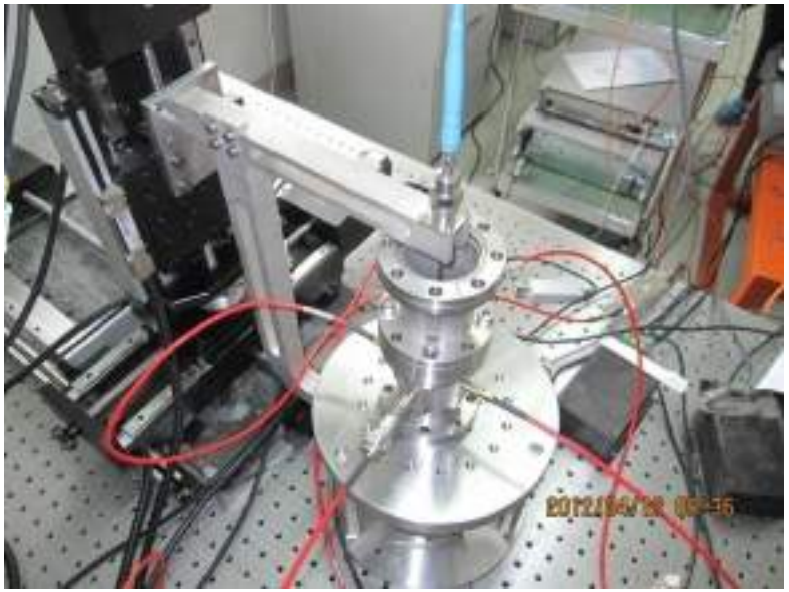
Stepper motor controlled wire BPM testbench.

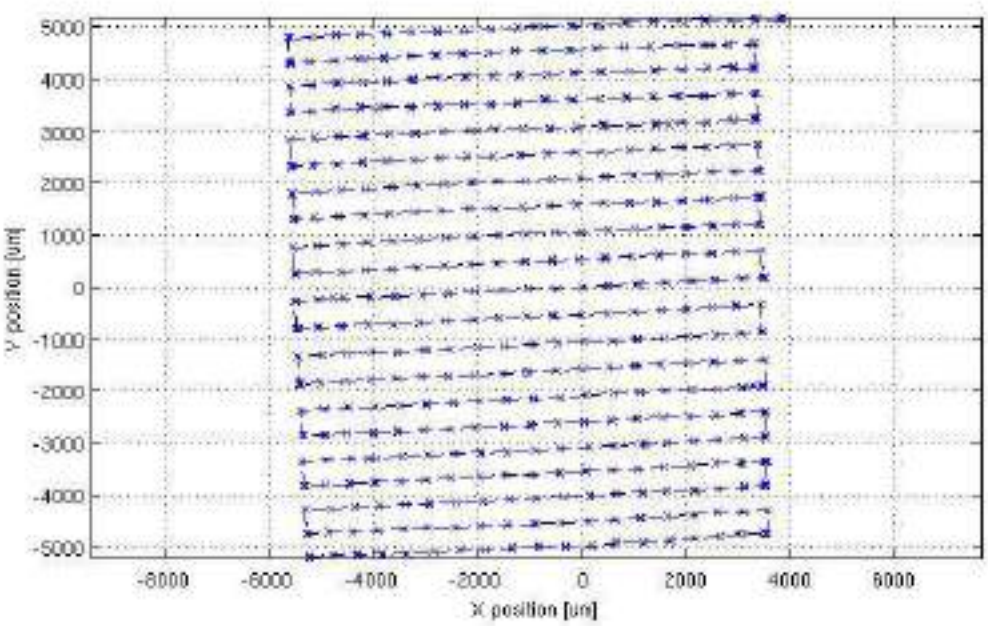




Some measurements 3/3

IMP CAS (HIRFL) testbench measurements (Lanzhou): (bunch repetition frequency: 162.5 MHz)
BPM mapping: ± 10 mm in steps of 500 um.





Conclusion

- **Libera Single Pass H is a high performance beam phase and position measurement instrument**
- **The platform B technologies enable the extension of the instrument functionality:**
  - **Measurements at multiple frequency components can be simultaneously streamed to the user in order to improve the measurement performance.**
  - **The system can be configured for the acquisition of continuos signals.**
  - **The instrument can be interfaced with the accelerator optical system through the EvRx module in order to react in real time to the changing accelerator working conditions.**
  - **Various beam species can be processed with dedicated algorithms.**