

Hadron BPM diagnostics

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Circular machines Hadron BPM diagnostics challenges

Variable revolution frequency

Various interleaved beam species

Different bunch spacing and signal shape

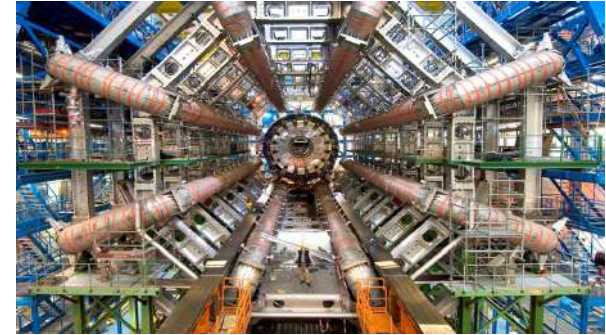
Variable input signal dynamic range (pilot beam)

Various BPM pick-ups (buttons, striplines, shoe-box)

High resolution single bunch position measurements

Integration into accelerator control system

Implementation of feedback systems



LHC CERN

Libera Hadron brief description

Implements high performance analog signal processing and BPM pick-up signal acquisition

Digital Signal Processing:

- bunch detection and tracking over turns

- high resolution measurement

- data streams organization

Provides control system interfacing functionality (MCI, Libera BASE)



Libera Hadron functionality

Basic functionality:

Single Pass – Single Bunch transversal position measurement

Single Bunch precise charge measurements

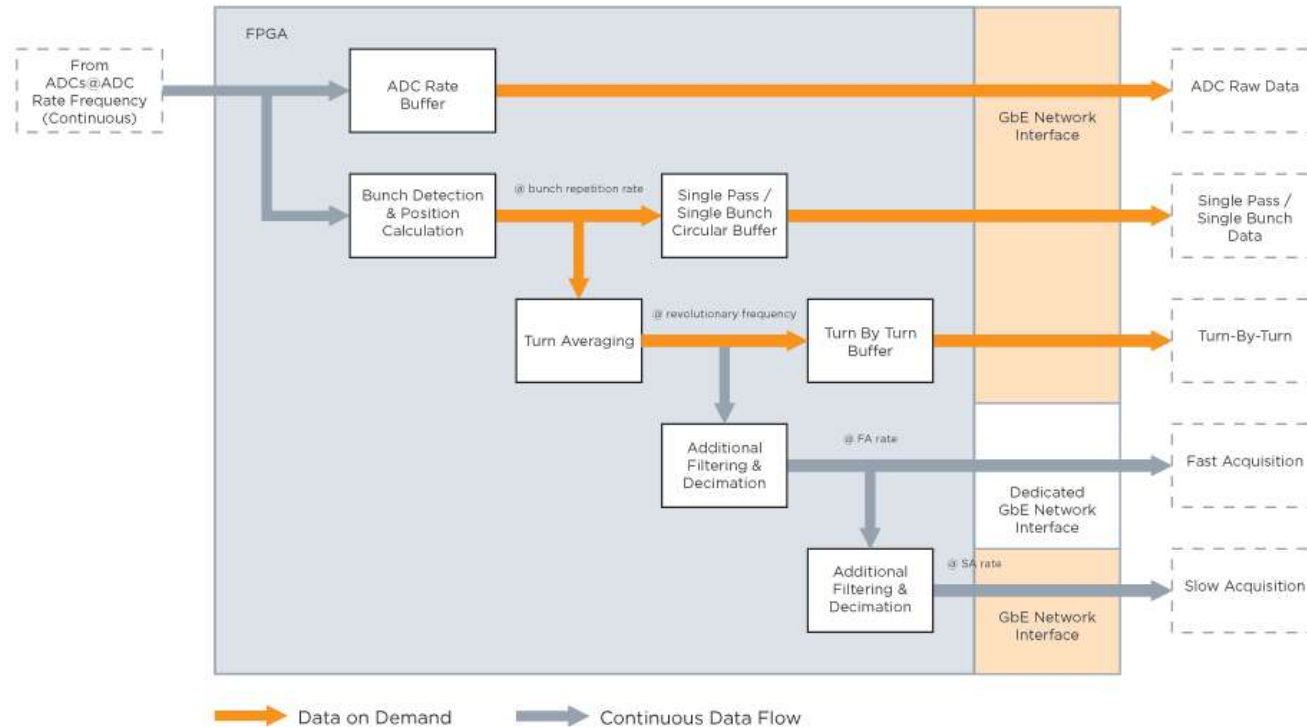
Turn by Turn high resolution beam position and charge measurements

Slow Acquisition beam position monitoring

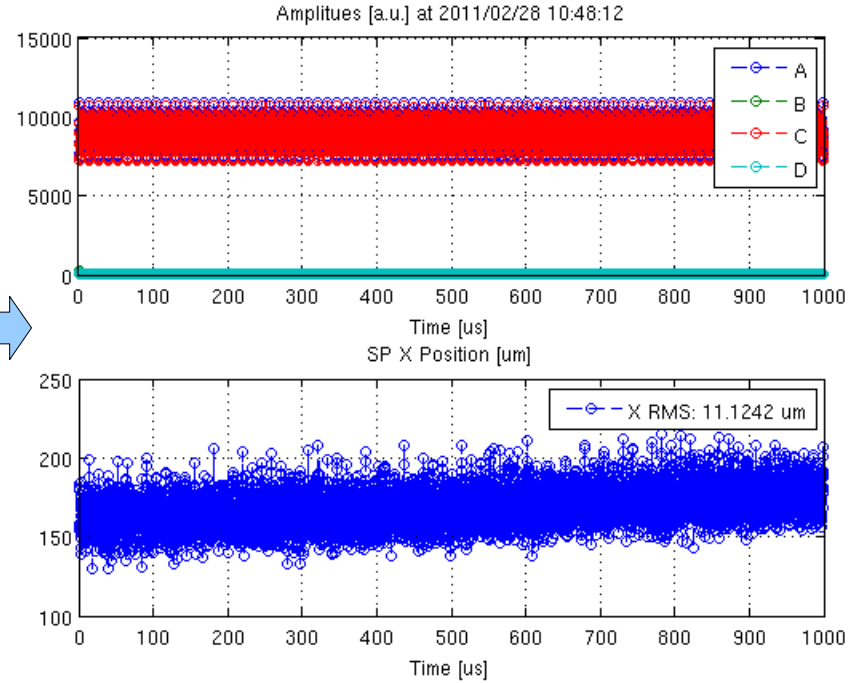
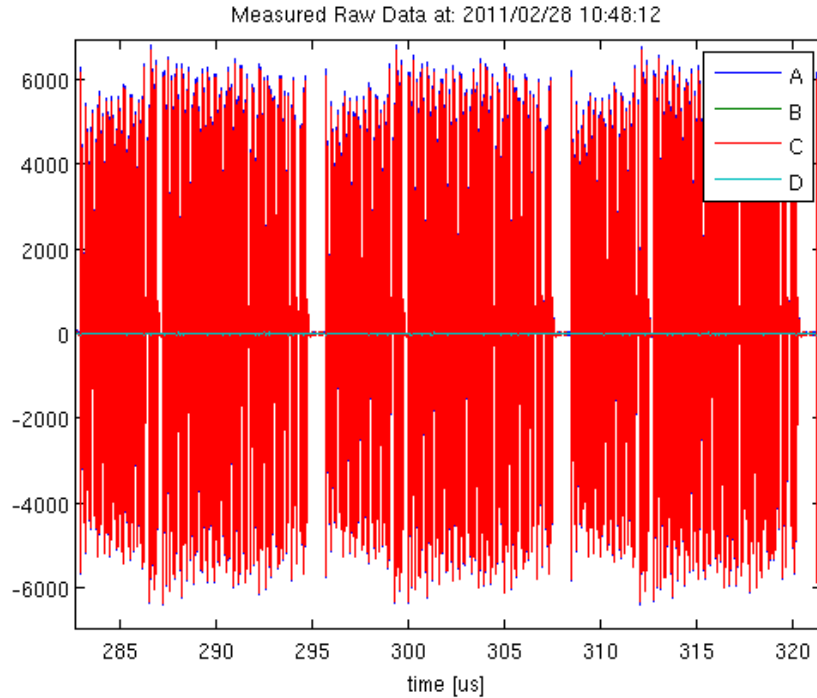
Advanced functionality:

Single Pass – high resolution Bunch Arrival Time

Libera Hadron data paths

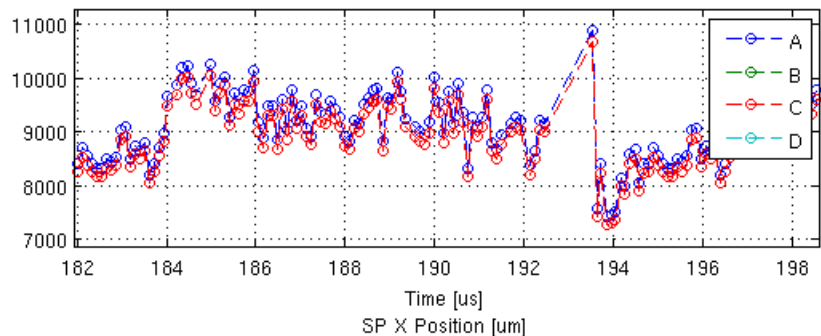
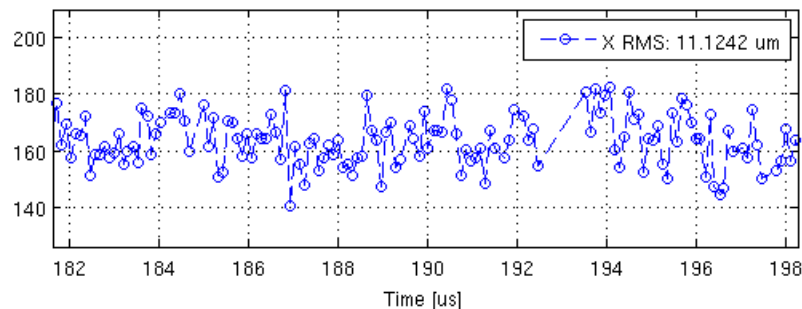


Measurements at RHIC: Raw Data and Single Pass Data

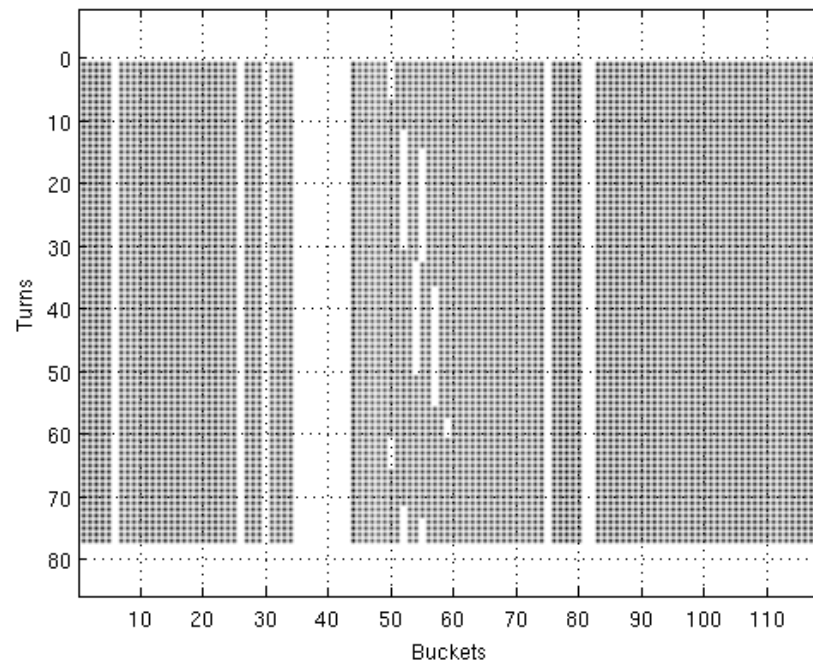


Measurements at RHIC (BNL): details of Single Pass Data

Amplitudes [a.u.] at 2011/02/28 10:48:12

SP X Position [μm]

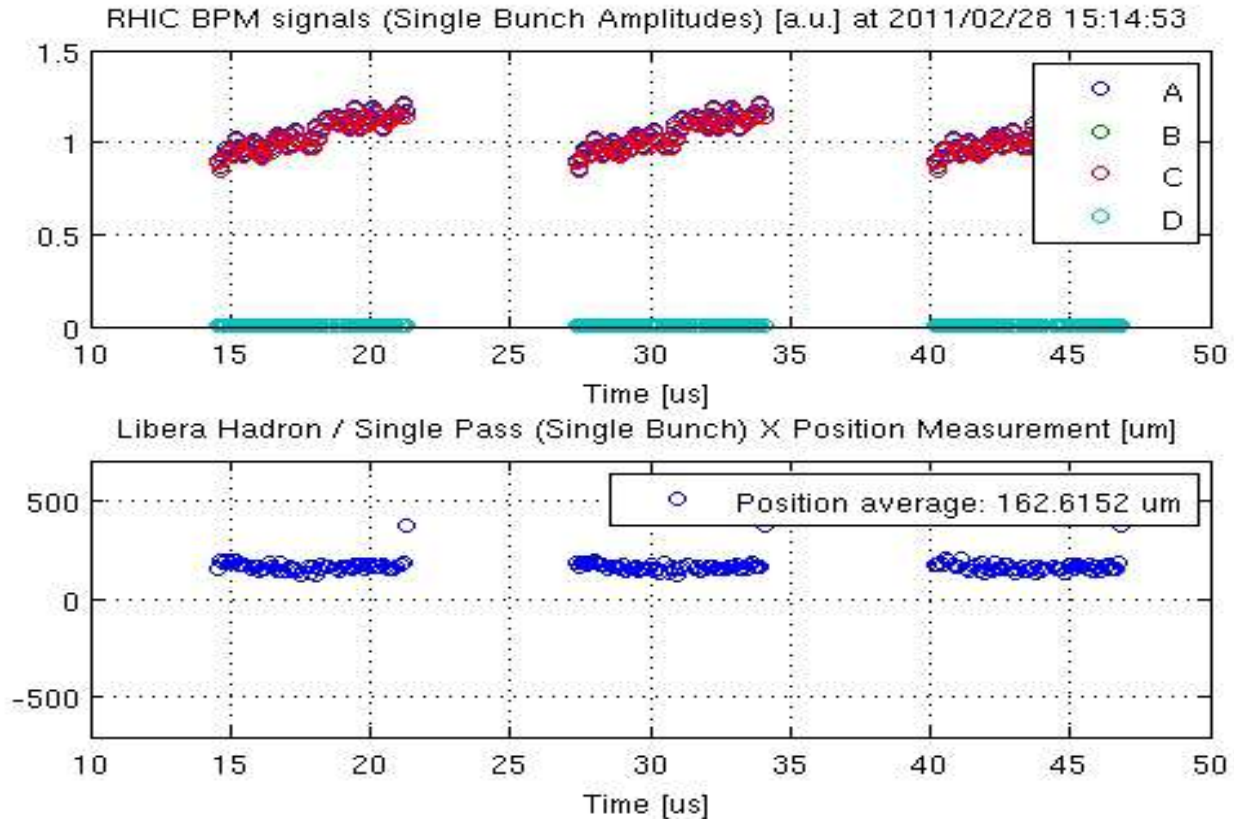
Measured Bunch Map at 2011/02/28 10:48:12



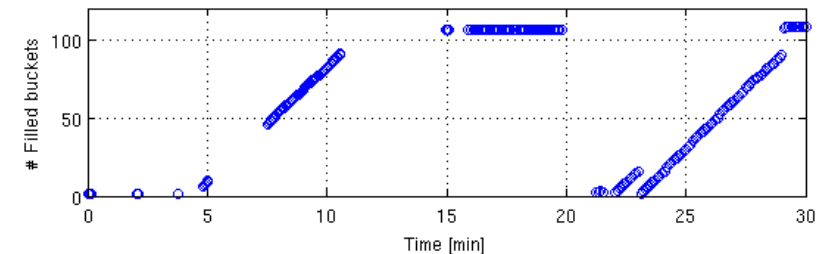
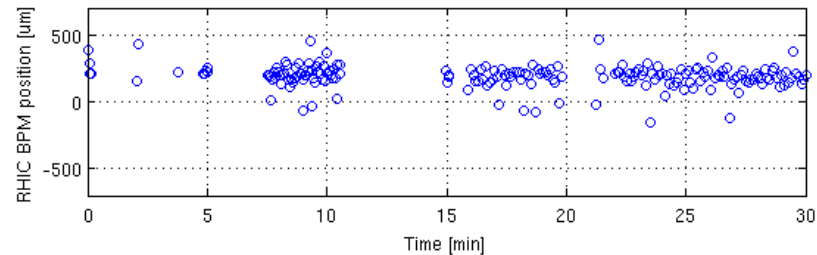
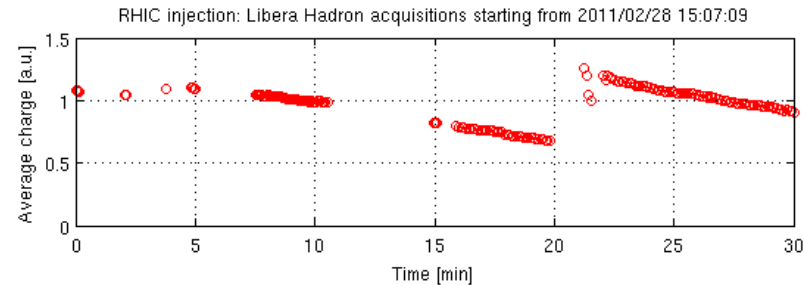
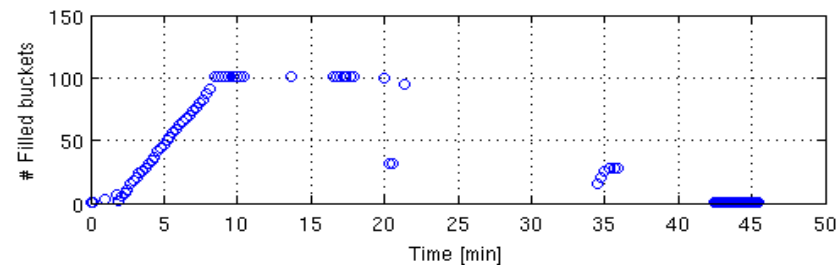
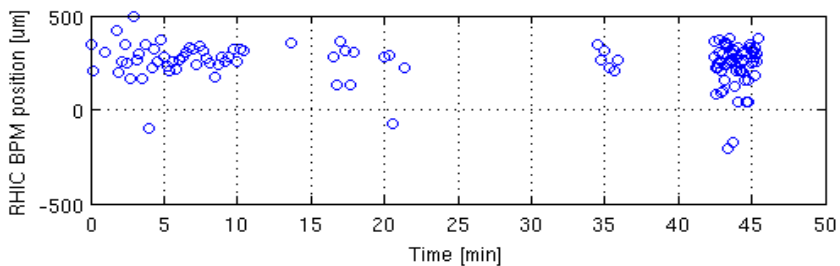
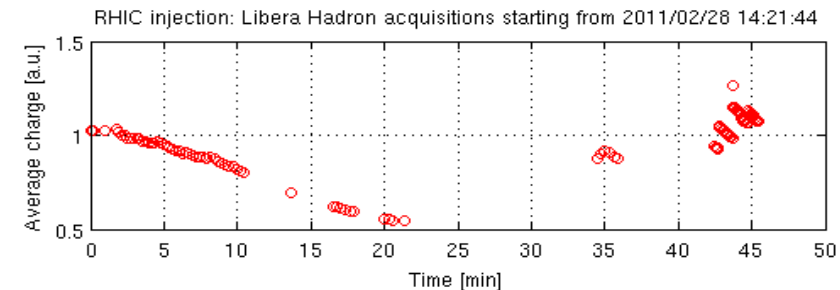
Measurements at RHIC: Injection into RHIC

Hadron BPM diagnostics

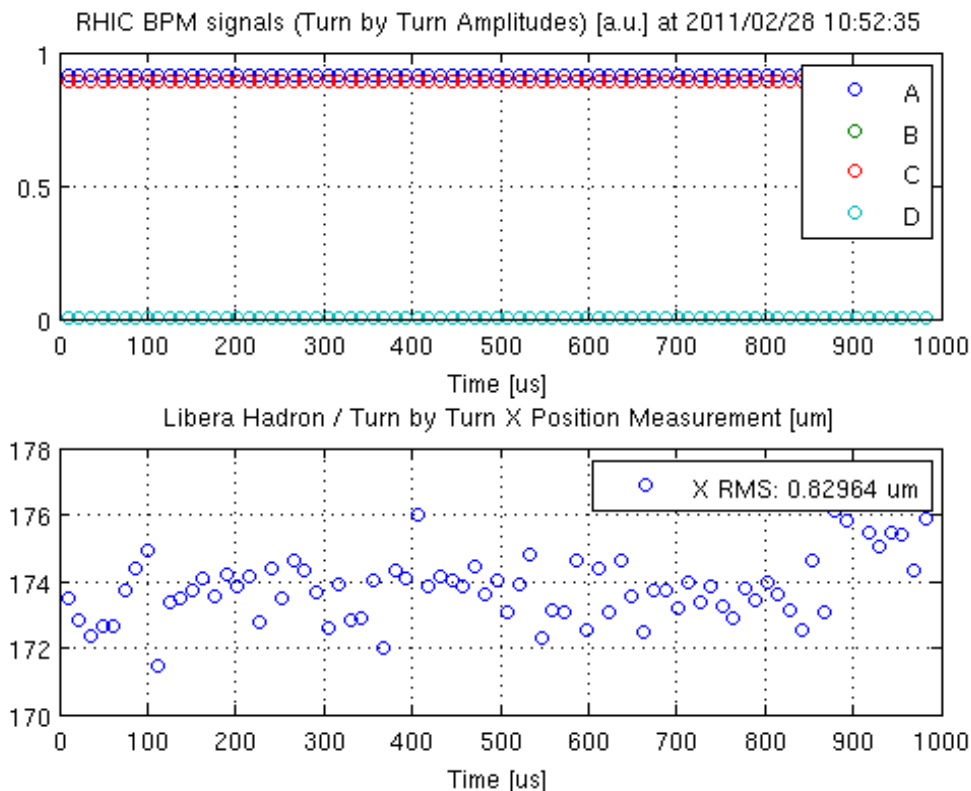
ibera



Measurements at RHIC: Injection summary



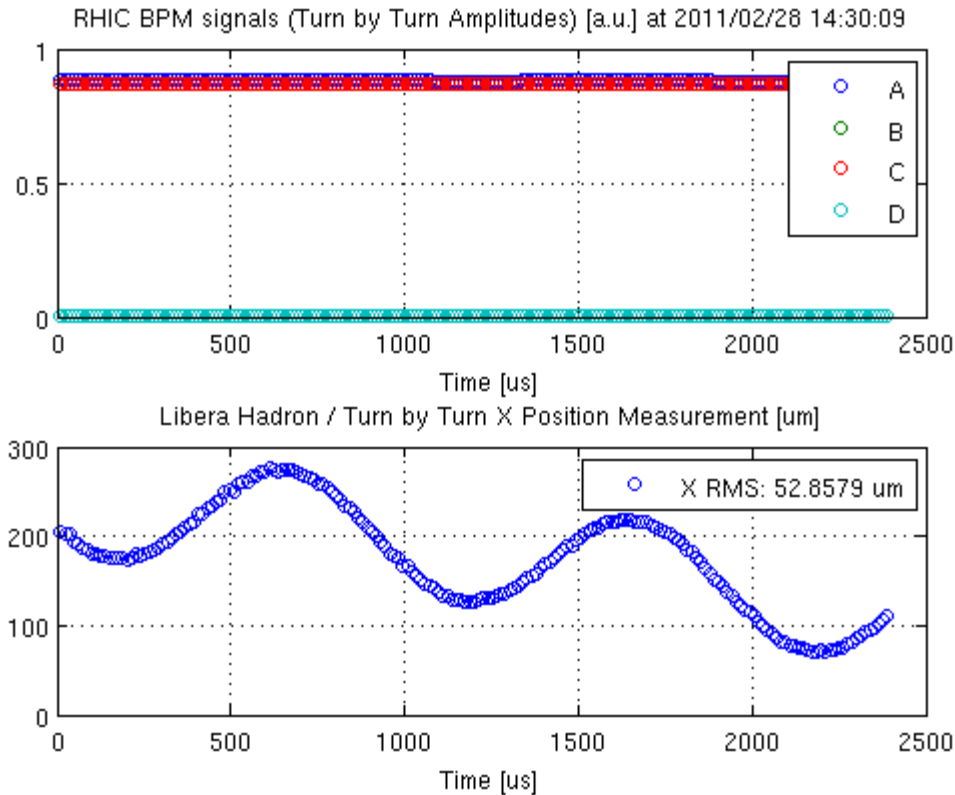
RHIC: Turn by Turn measurements



The Single Bunch position measurement is averaged over one turn.

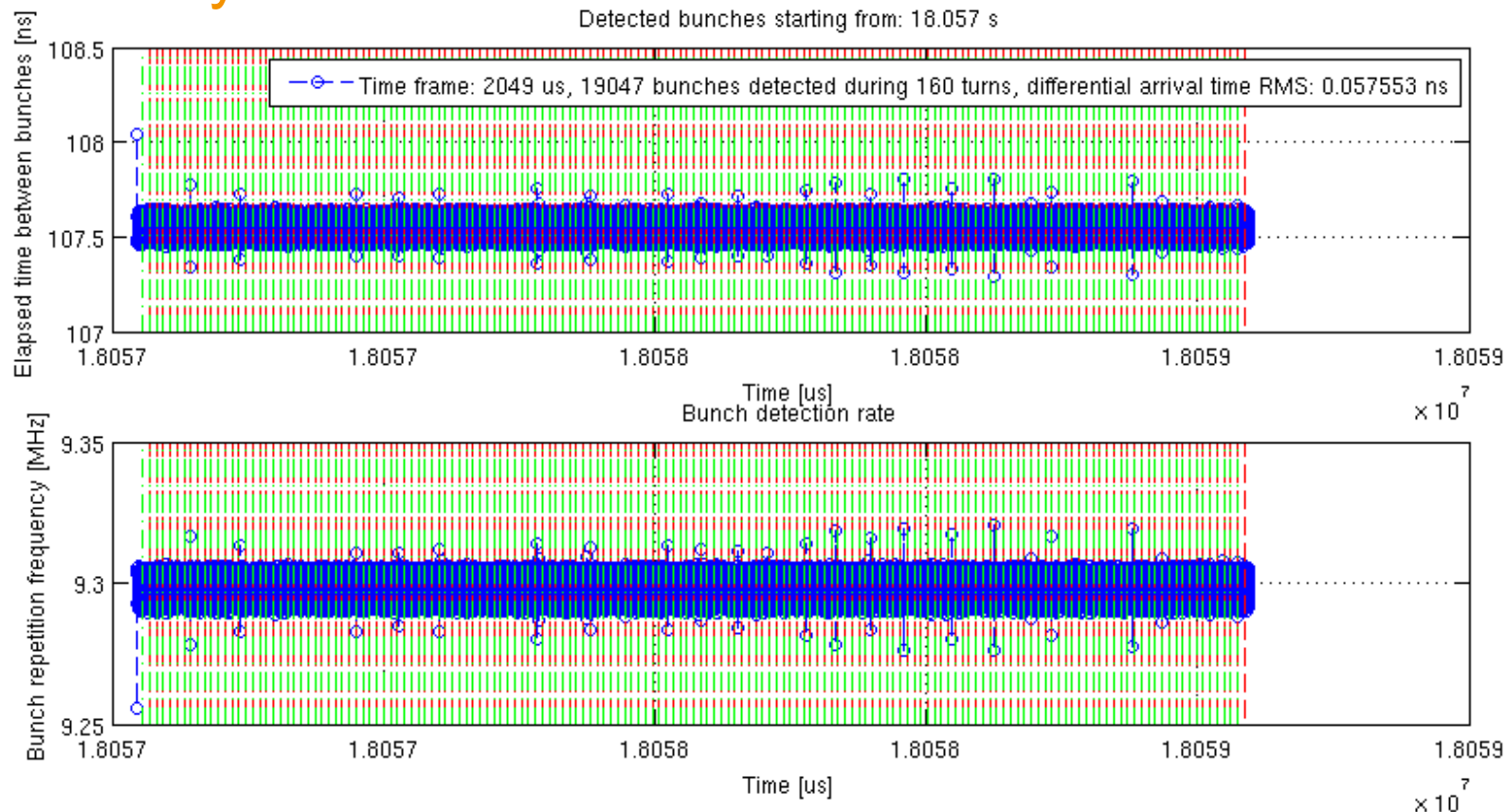
The RHIC revolution frequency is nominally 78 kHz.

RHIC: Turn by Turn measurements (injection)

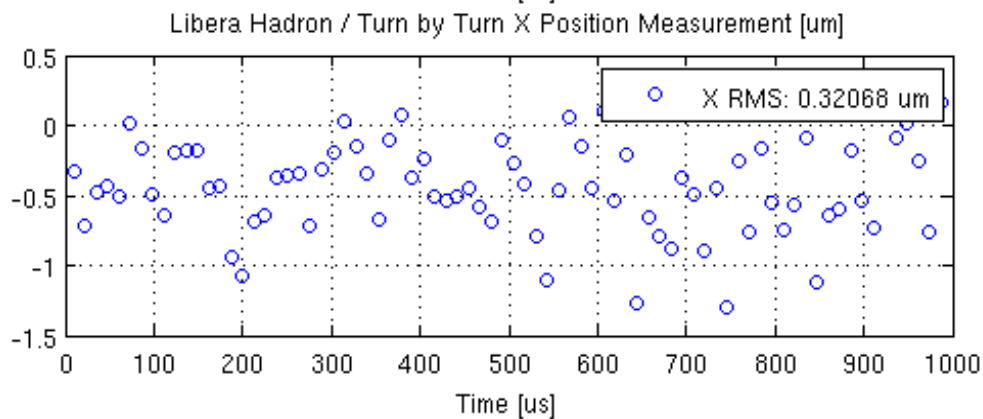
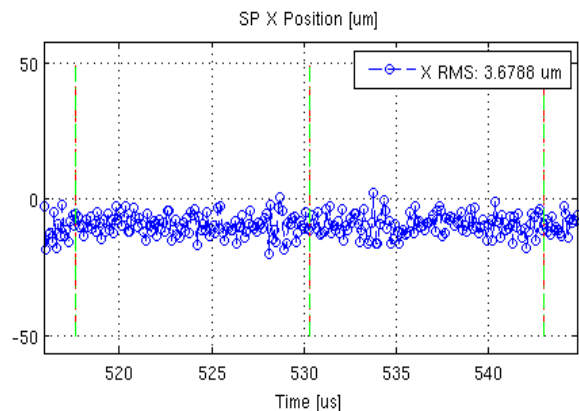
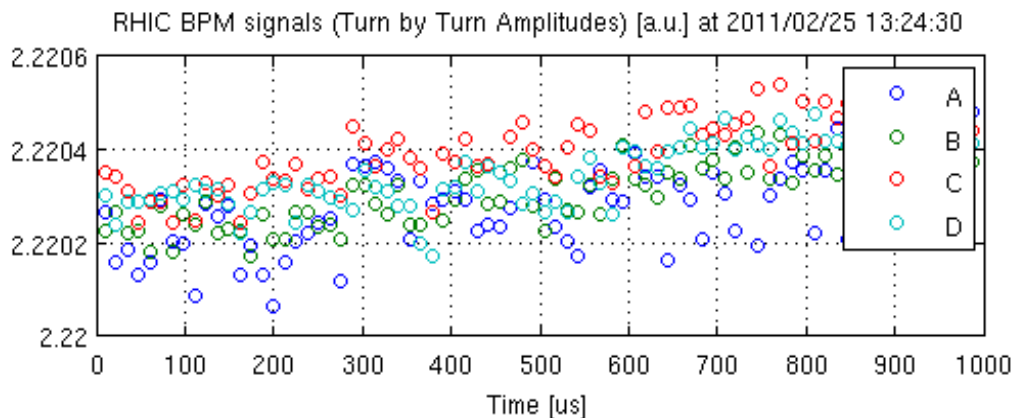
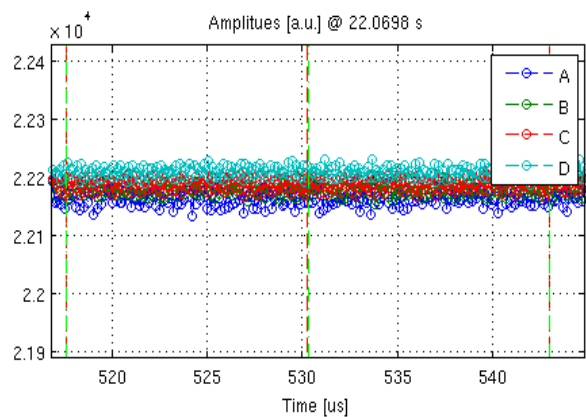


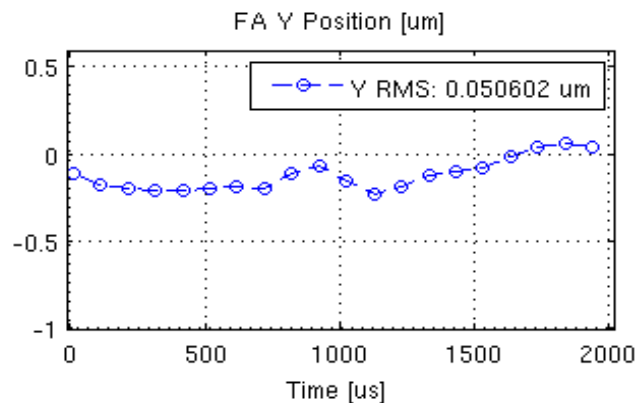
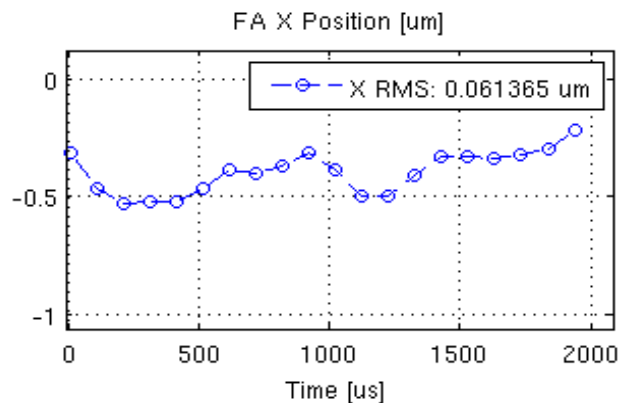
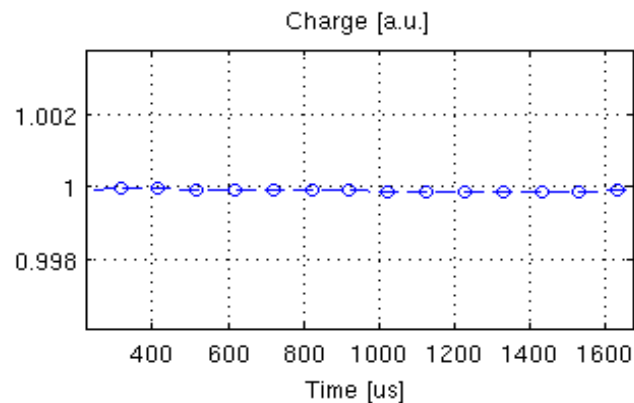
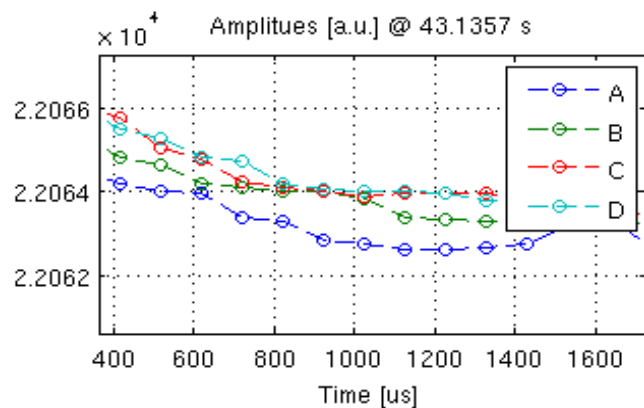
Observed 1 kHz beam position modulation in the transverse plane during injection into RHIC.

Laboratory measurements: Beam Arrival Time



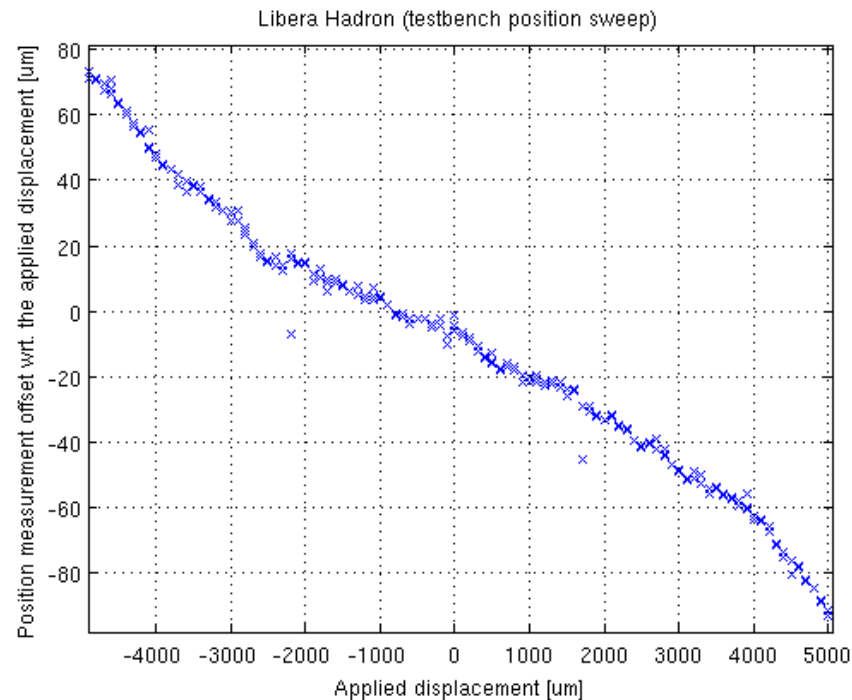
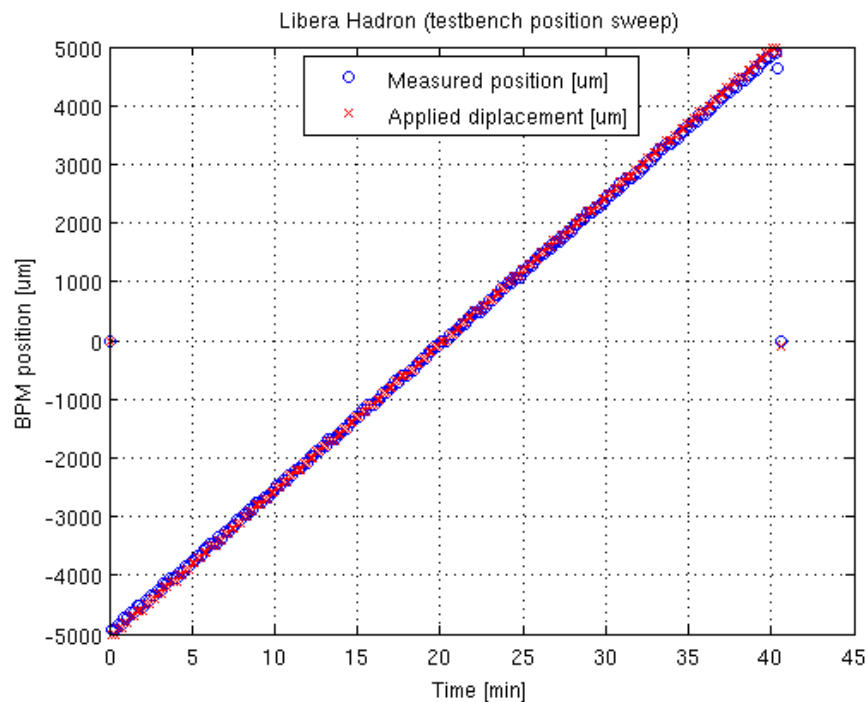
Laboratory measurements: Single Bunch and TBT Libera



Laboratory measurements: Fast Acquisition 10 kHz Libera

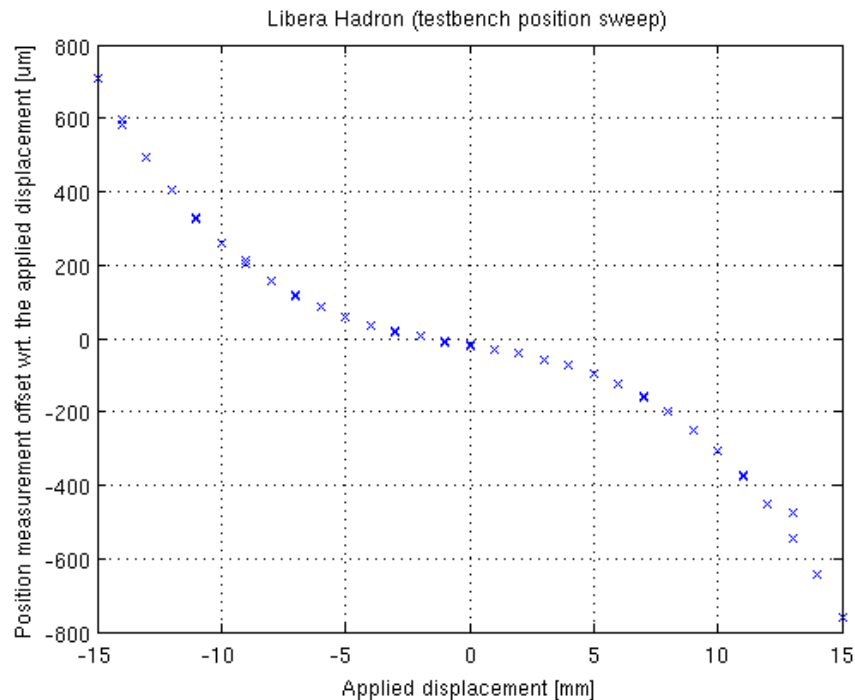
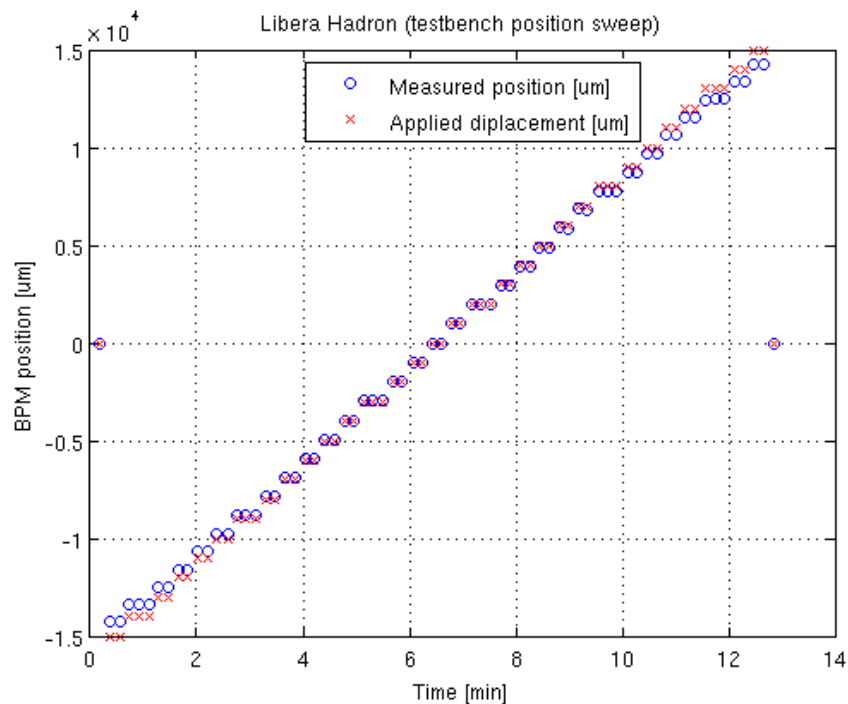
Laboratory wire test-bench measurements 1/2

Position sweep ± 5 mm.



Laboratory wire test-bench measurements 2/2

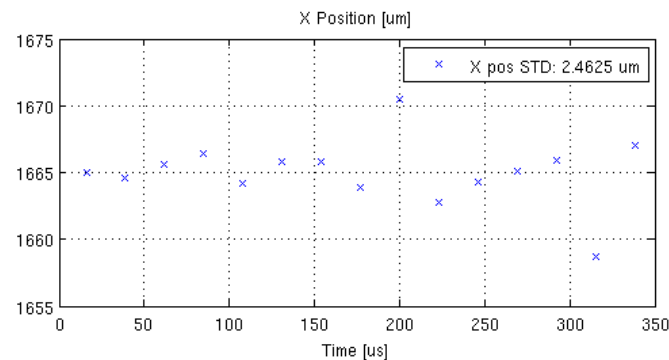
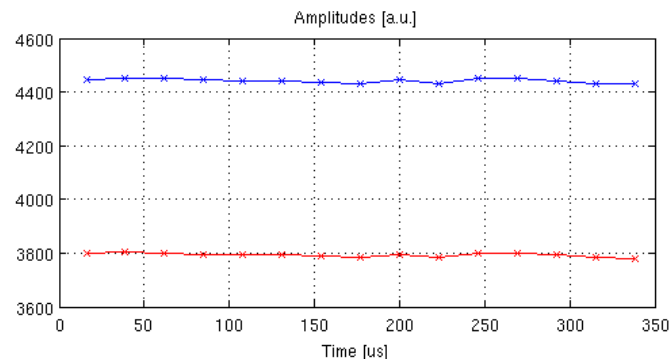
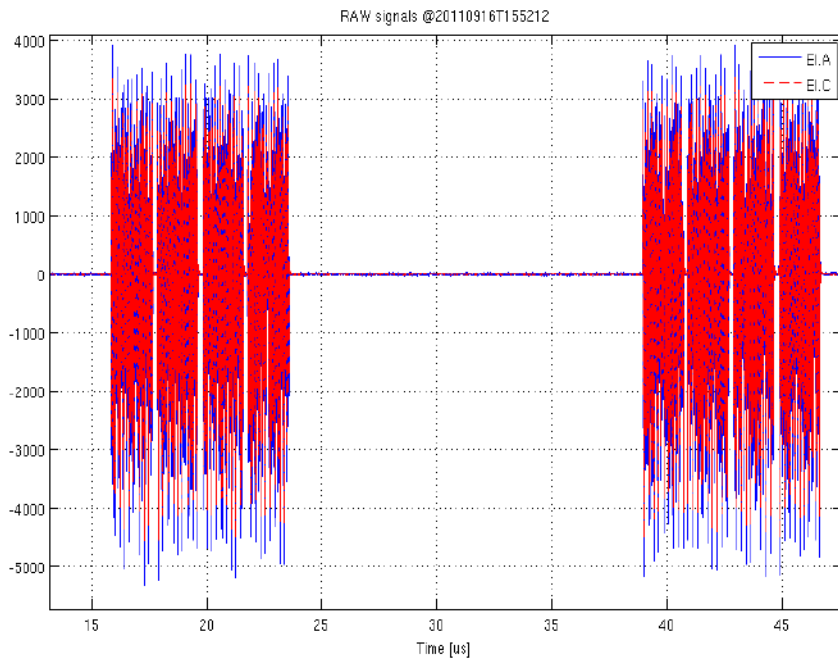
Position sweep ± 15 mm.



Measurements at CERN SPS: during LHC injection

SPS beam RAW data (2 turns, 4 x 36 bunches
@ 50 ns bunch rate)

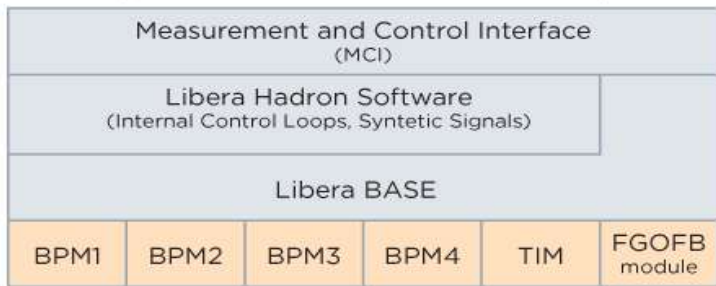
Turn by Turn Acquisition



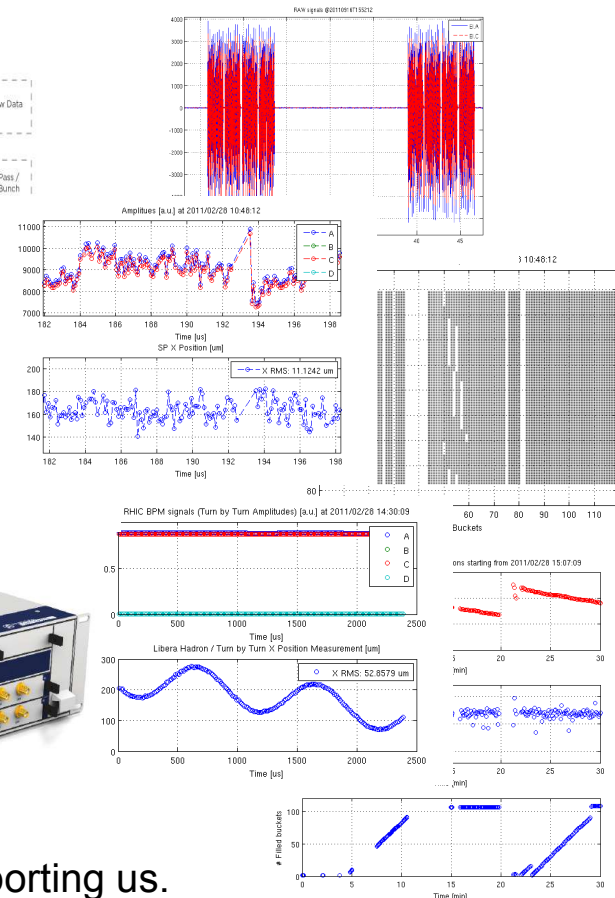
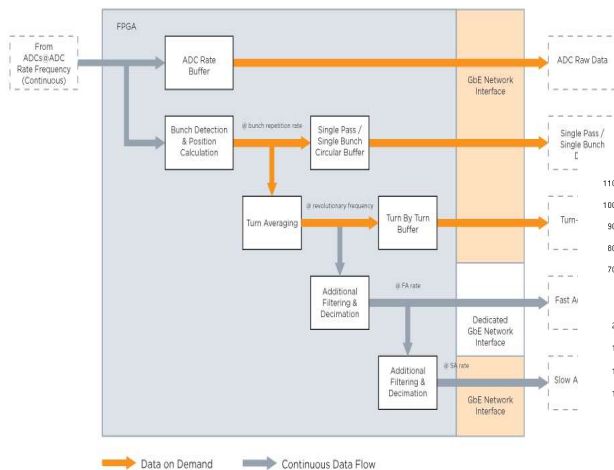
Libera Hadron software structure capabilities

Libera Hadron provides a rich set of basic functions.

The **Libera BASE** software structure simplifies the integration into the control system and the development of advanced functions based on pre-existing high performance measurements.



LIBERA HW GENERATION B



We acknowledge BNL and CERN diagnostics teams for supporting us.