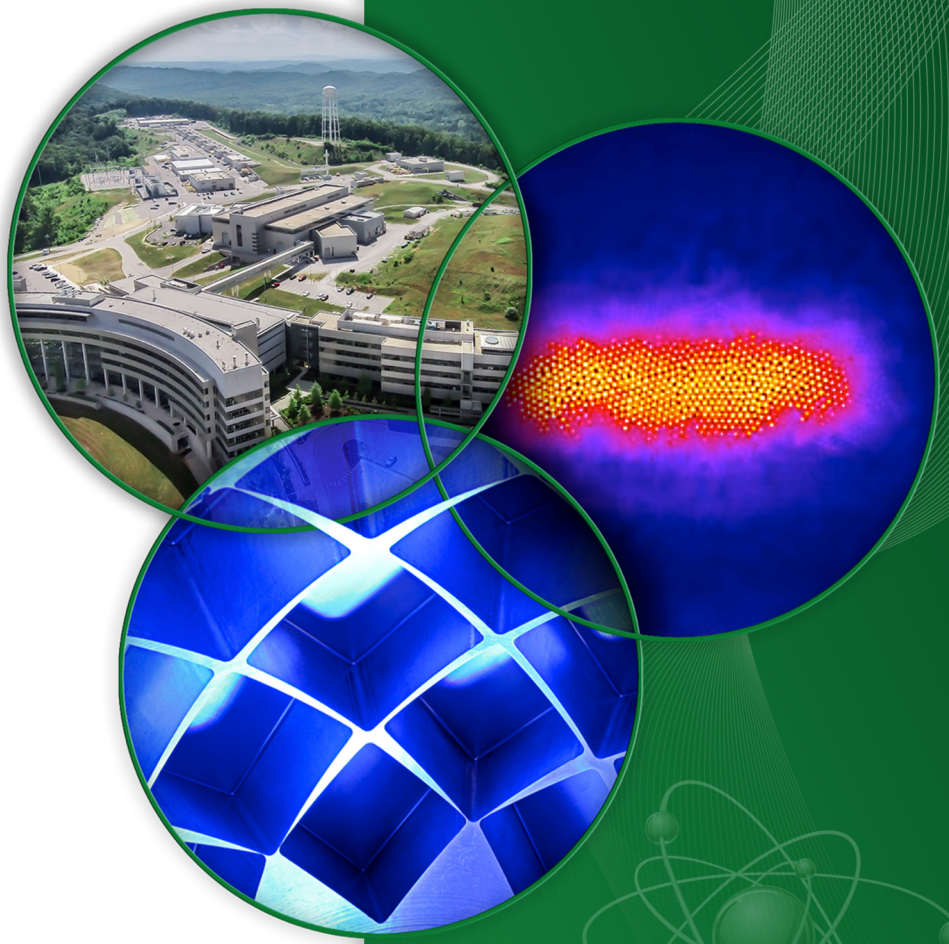
Present Status and Upgrades of the SNS Ion Beam Bunch Shape Monitors



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NAPAC2019

NORTH AMERICAN PARTICLE ACCELERATOR CONFERENCE

Outline

- Overview
- Motivation and goals
- Challenges with existing BSM
- Implementation
- Summary

Overview

- BSM developed at INR (A. Feschenko).
- Used world-wide at many proton machines.
- Examples of BSM at other machines..

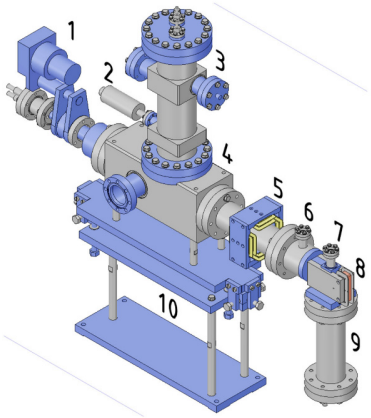


Figure 2: BSM design: 1 – target actuator, 2 – tuner, 3 – RF-deflector, 4 – BSM box, 5 – quadrupole + dipole correcting magnet, 6, 7 – viewports for optical control of e-beam, 8 – bending magnet, 9 – SEM-detector, 10 – support with 3D-adjustment.

FRIB

Bunch Length and Velocity Detector – Linac 3 – Pb27+ @ 4.2 MeV/u

Beam sensitivity - 1uA (peak current) - using 0.1mm wire
Phase Resolution: 0.4 degrees at 101MHz - 10ps
Errors 0.3% on velocity.

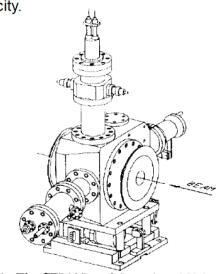


Figure 1. The CERN Bunch Length and Velocity Detector

CERN

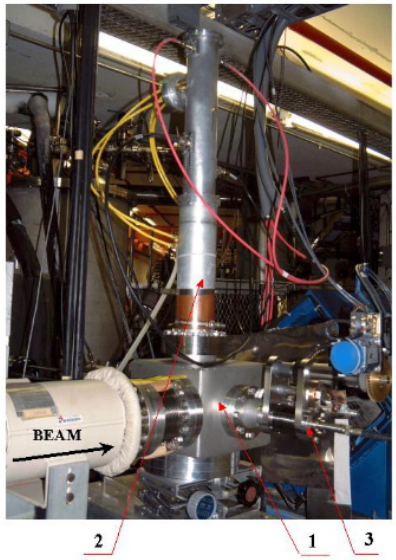


Figure 2: The BSM at the ATLAS beamline.

Argonne

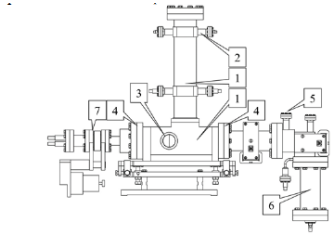
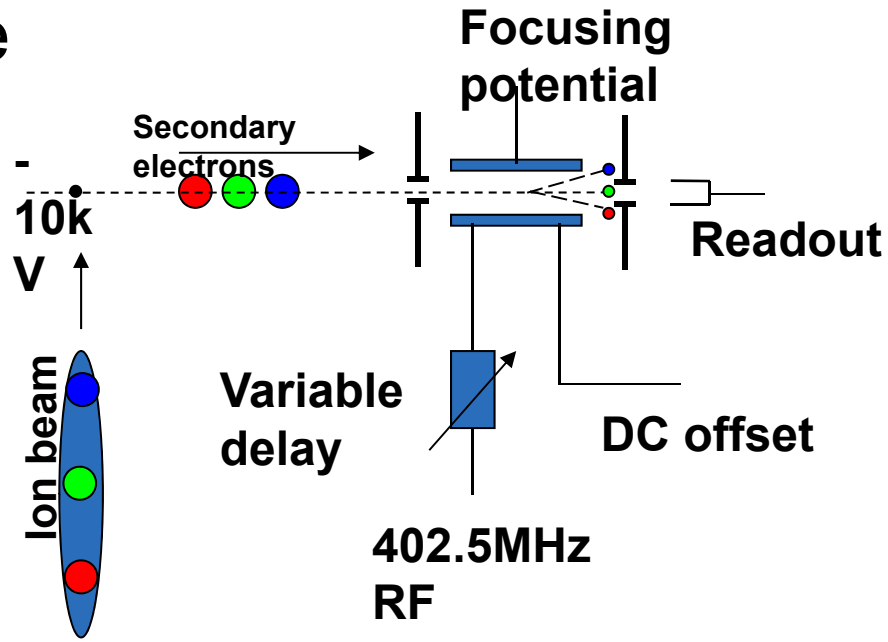


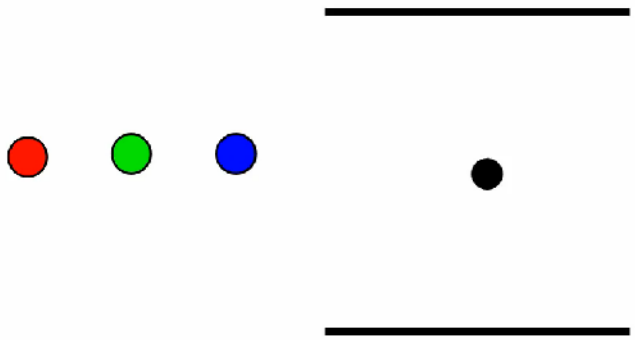
Figure 1: BSM Outline (1-Body and RF deflector, 2-SHV connector, 3-Beam duct, 4-Flange to connect body and pipe, 5-View port, 6-Detector, 7-Actuator).

J-PARC

Overview

- BSM working principle



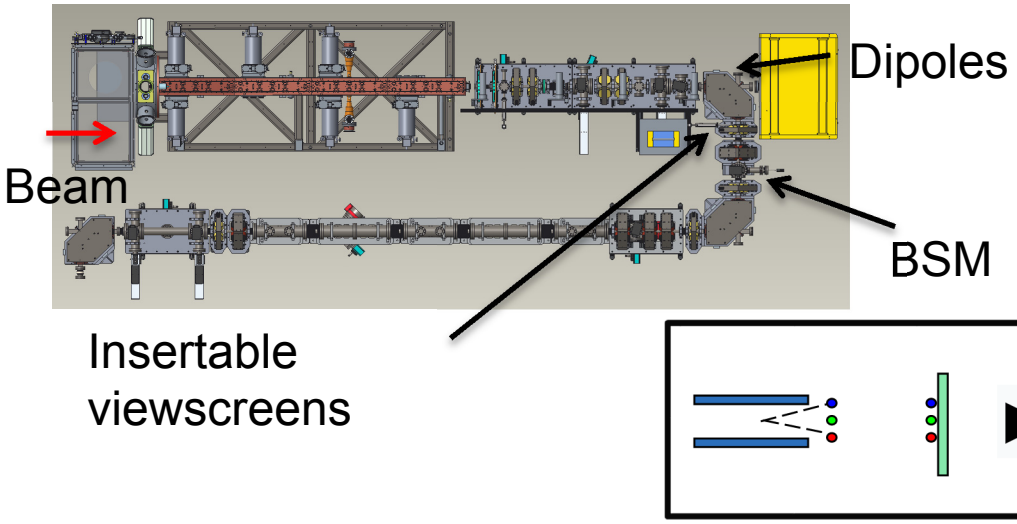


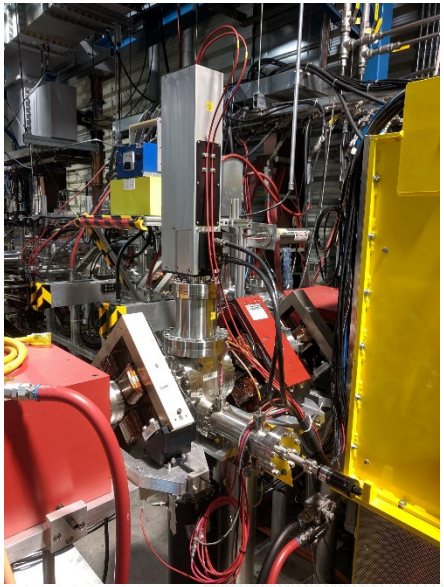
Beam temporal structure to spatial structure

Overview

- SNS BSMs:

  - Focus on BTF BSM
    - Screen instead of Scanning SEM
    - Single shot measurement
    - Bunch length ~ 35 ps



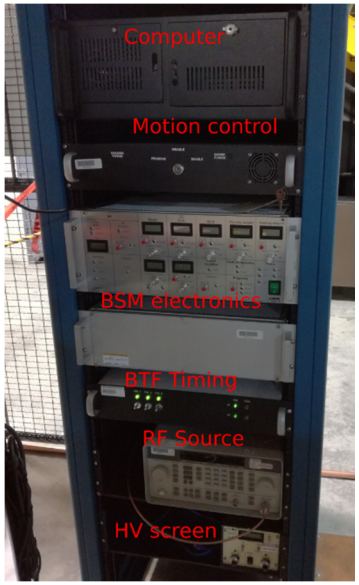


Motivation and goals

- RF amplifier frequent failures (heat load, CW)
- Aged and obsolete components
- Not easy maintenance
- Simpler is better (when possible)
- Modularity
- Easier to use
- In detail:
  - Simplify HV scheme and wire bias
  - Pulsed operation of RF amplifier
  - Simplify auxiliary constant current power supplies
  - Use off the shelf components
  - Custom-made hardware only when necessary

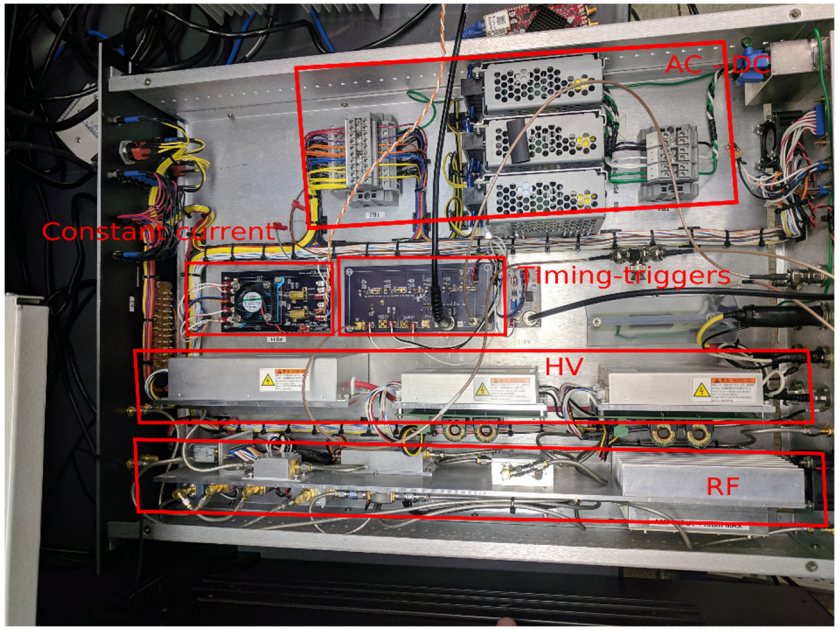
Implementation

Before



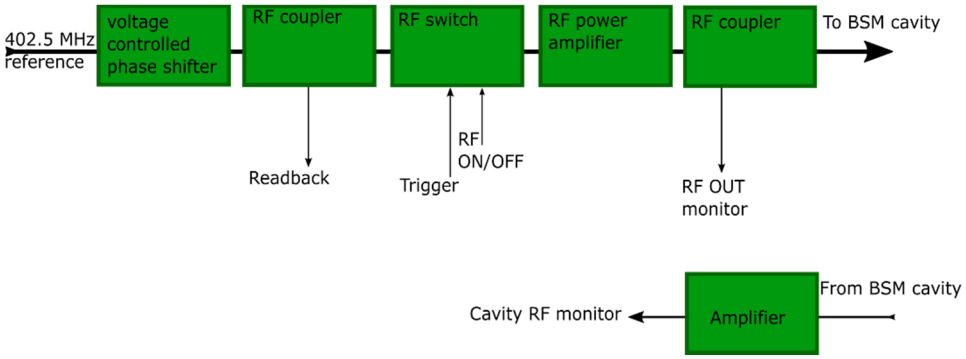
After

New BSM electronics

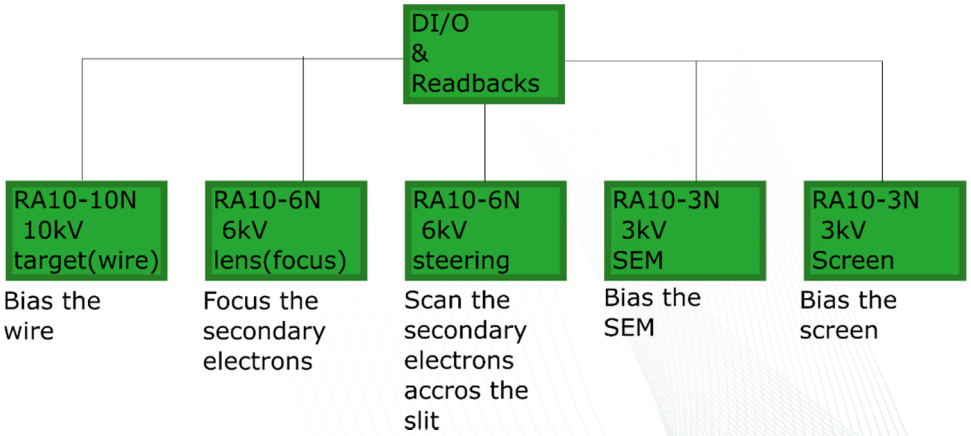


Implementation

- RF Section
  - Mainly off the shelf
  - Custom timing-triggers
  - Pulsed operation

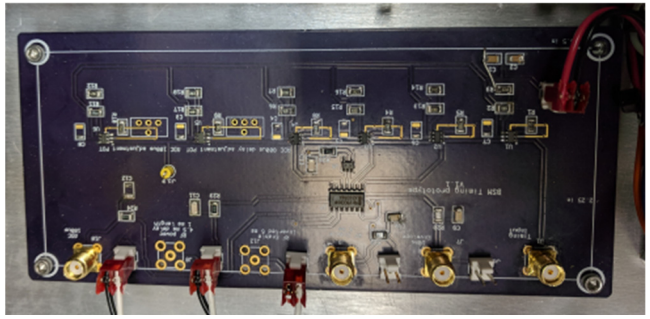


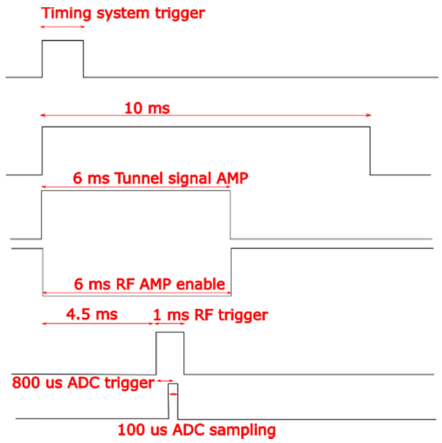
- HV section
  - Off the shelf HV PSUs
  - Very stable and reliable



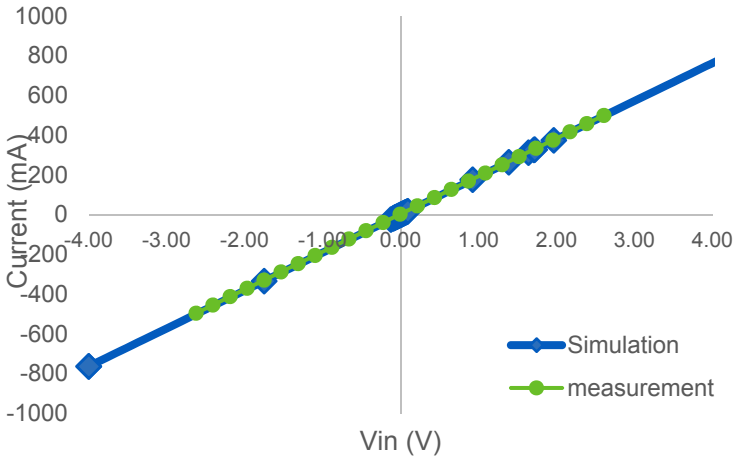
Implementation

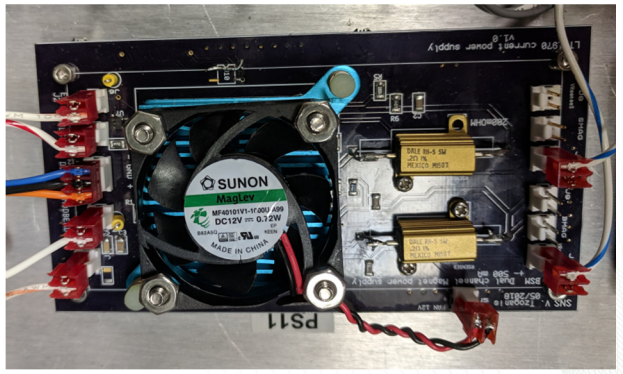
- Timing and synchronization
  - Various triggers
  - Pulsed RF





- Adjustable constant current drivers

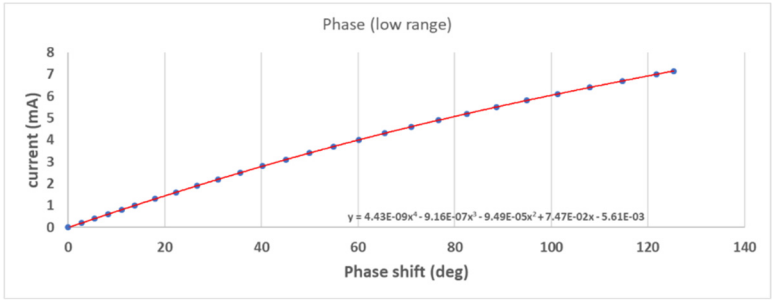




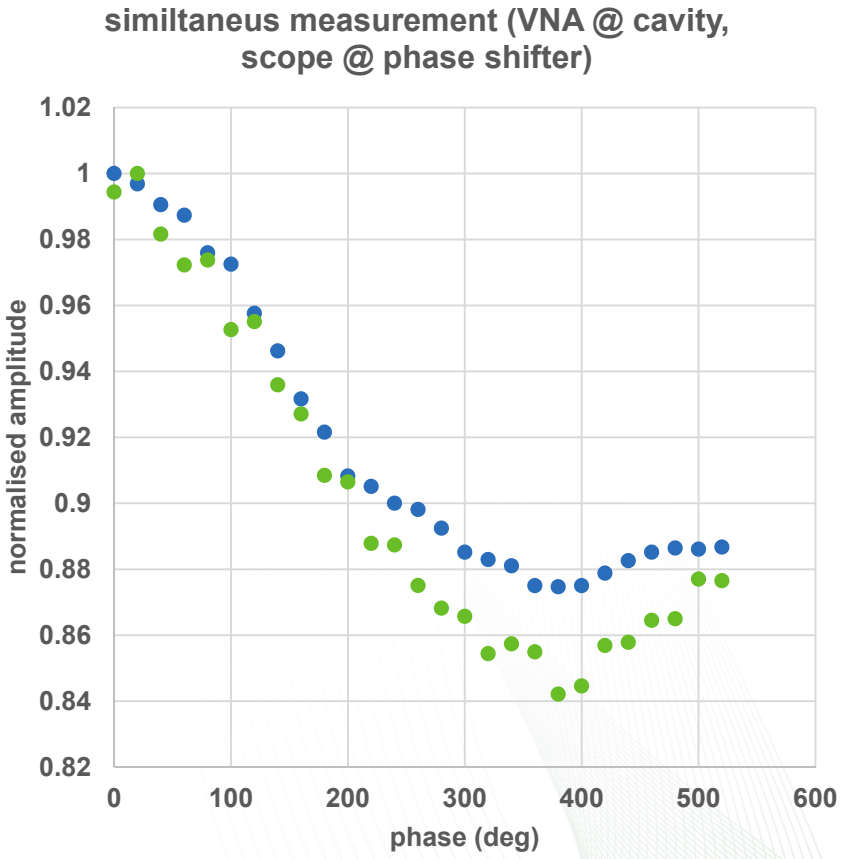
Implementation

Some RF measurements

- Phase shifters non-linear, require calibration
- Calibration valid for different RF amplitudes

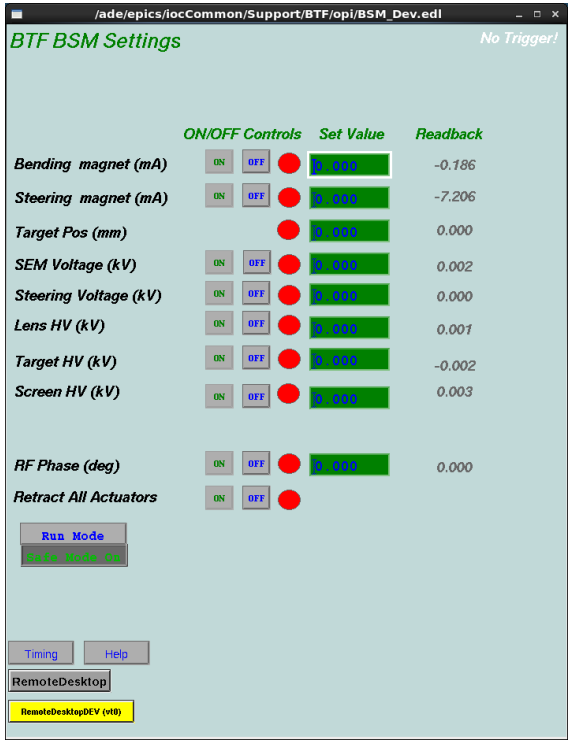


- RF amplitude dependence on phase

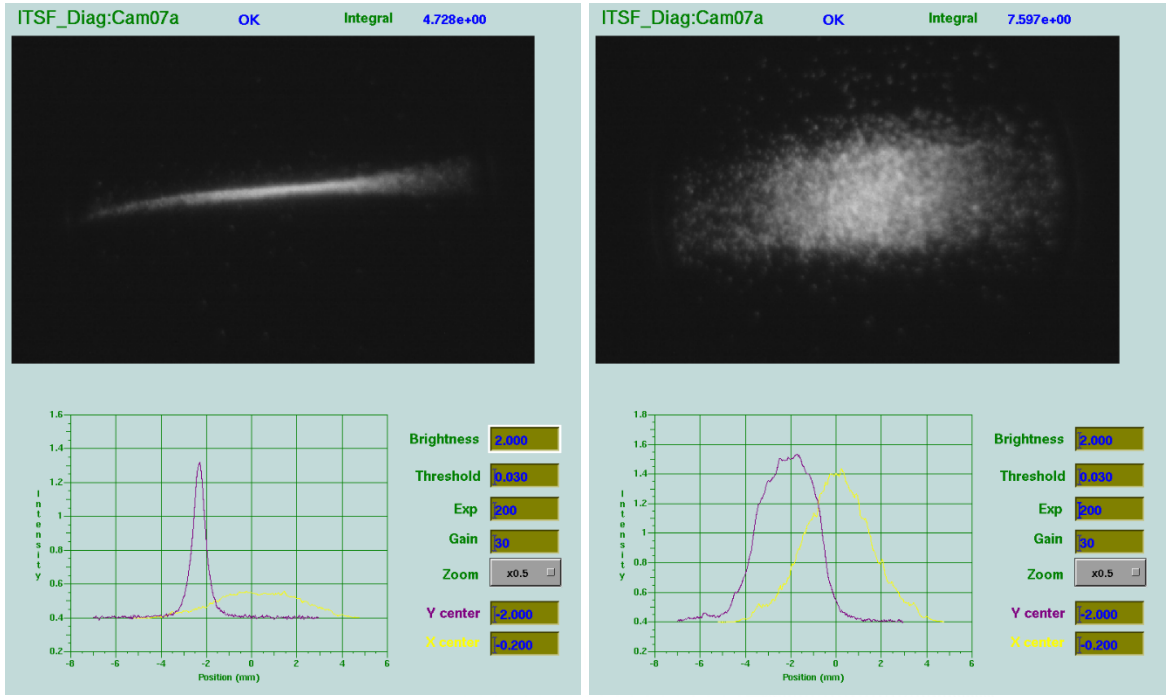


Measurements

Control screen



Sample measurements



Looking forward

- New design for improved light collection
- New design for RF cavity
- Migrate controls to NI-CRIO

Summary

- What have we achieved
  - Modular configuration - ease of maintenance
  - Very good stability - very short setup time
  - High reliability
  - Maintain compatibility with the existing system
  - Tested and characterized the prototype, fixed bugs
  - Ready to deploy to the main accelerator