Bunch Shape Monitor Measurements at the LANSCE linac

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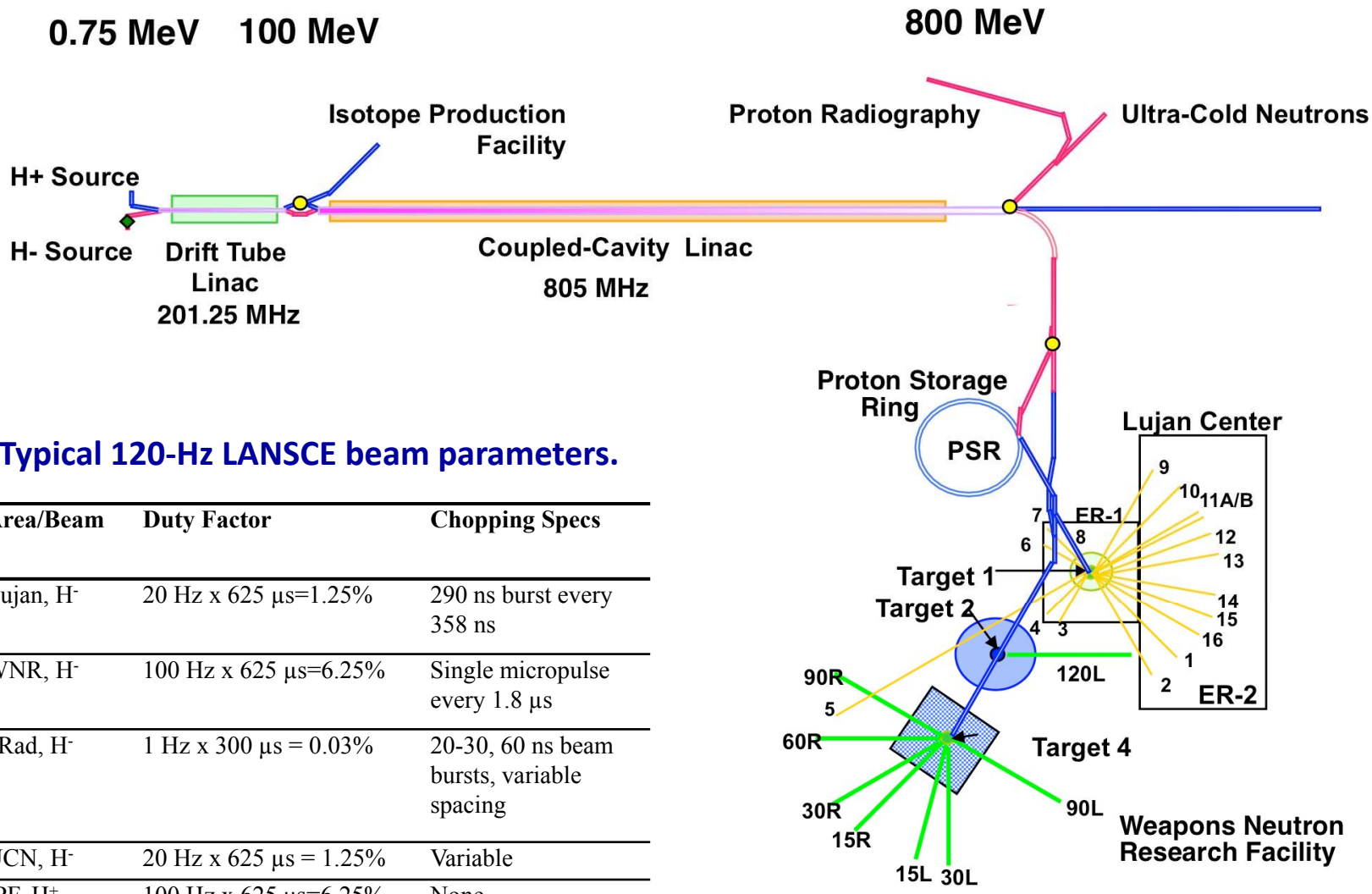
1. Introduction



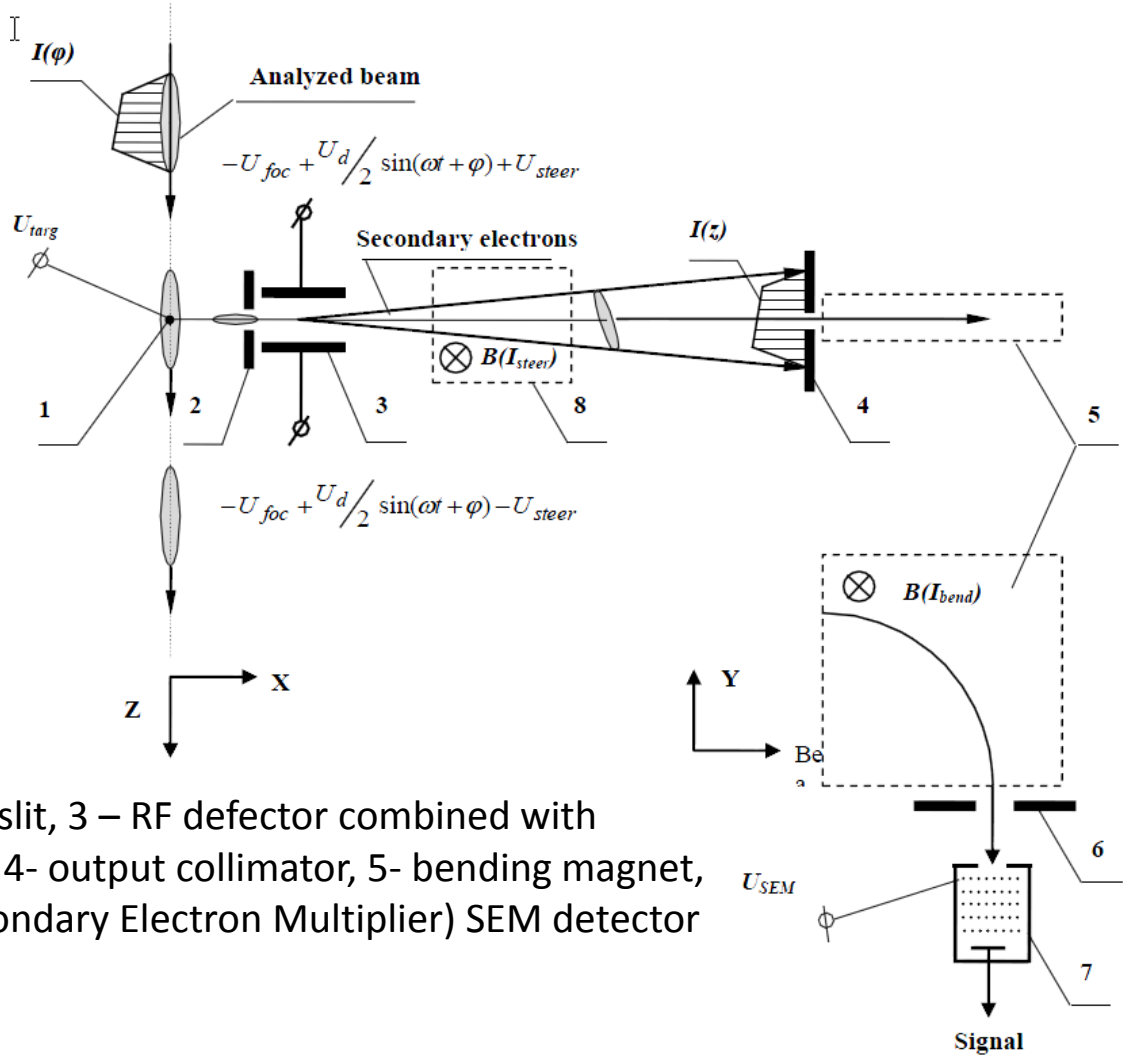
Typical 120-Hz LANSCE beam parameters.

Area/Beam	Duty Factor	Chopping Specs
Lujan, H^-	20 Hz x 625 μs=1.25%	290 ns burst every 358 ns
WNR, H^-	100 Hz x 625 μs=6.25%	Single micropulse every 1.8 μs
pRad, H^-	1 Hz x 300 μs = 0.03%	20-30, 60 ns beam bursts, variable spacing
UCN, H^-	20 Hz x 625 μs = 1.25%	Variable
IPF, H^+	100 Hz x 625 μs=6.25%	None

LANSCE overview

2. Bunch shape monitor description

Working principle of the Bunch Shape Monitor (BSM)

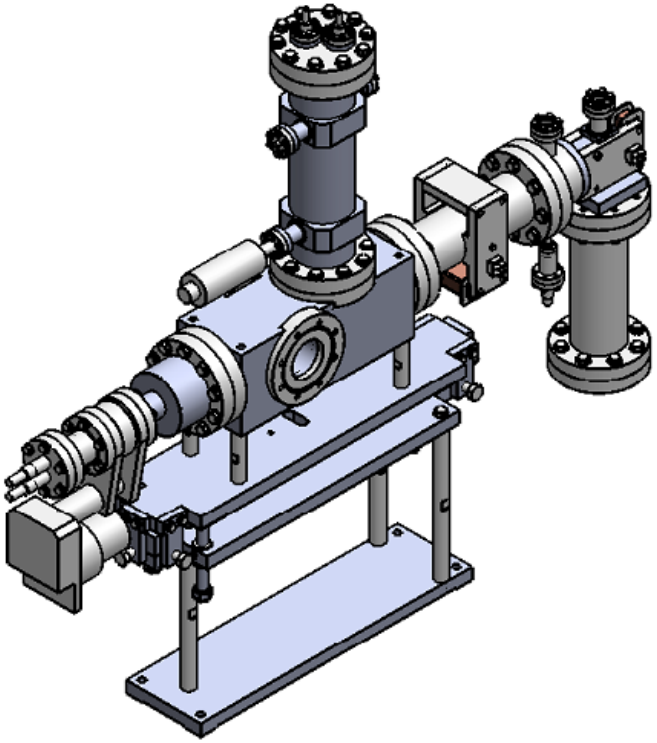


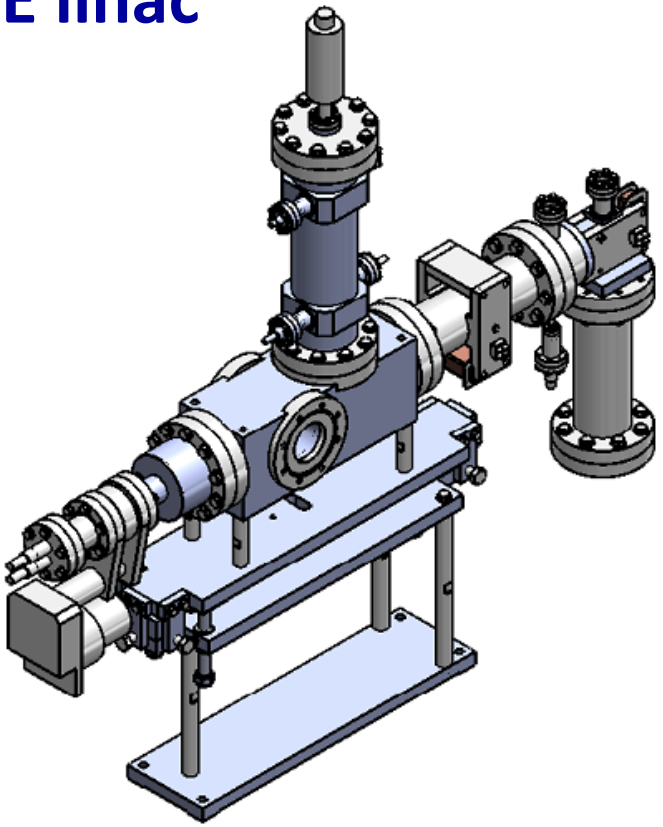
1-Target, 2- input slit, 3 – RF defector combined with electrostatic lens, 4- output collimator, 5- bending magnet, 6-collimator, (Secondary Electron Multiplier) SEM detector

A. Feschenko *"Methods and Instrumentation for Bunch Shape Measurements."* Proc. of PAC 2001, Chicago, IL, USA, pp. 517 - 521.

2. Bunch shape monitor description

BSMs for LANSCE linac





BSM-201

Deflecting frequency – 201.25 MHz

Range of measurements - 180° at 201.25 MHz

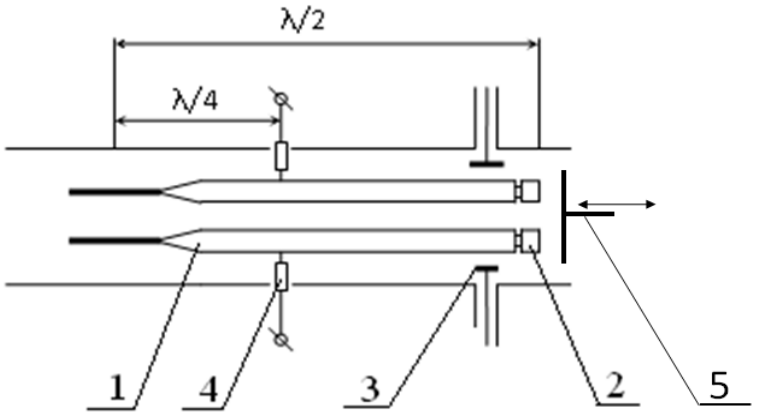
BSM-402

Deflecting frequency – 402.5 MHz

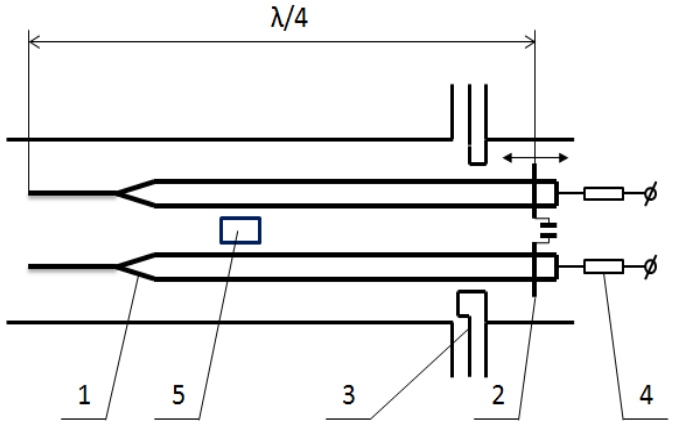
Range of measurements - 90° at 201.25 MHz

2. Bunch shape monitor description

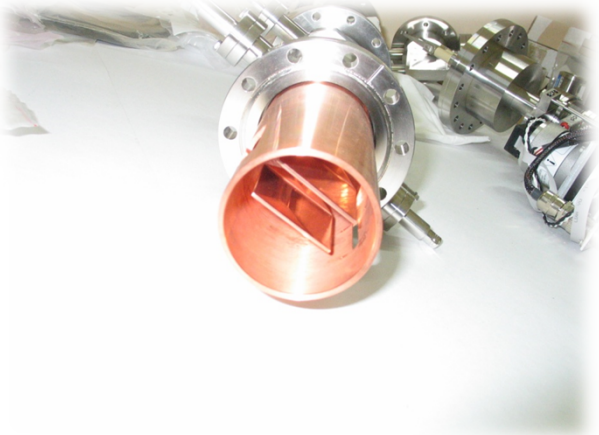
RF deflectors

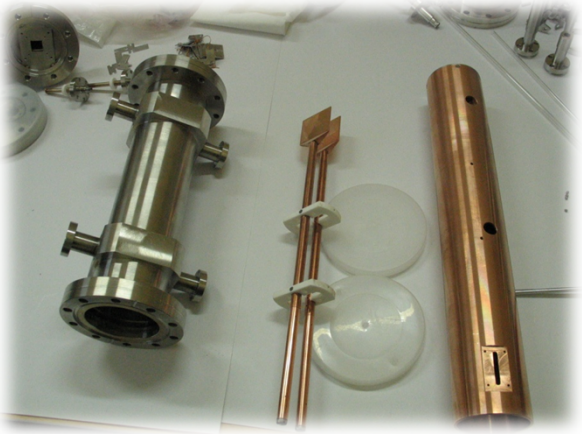


BSM-201 (half-wave resonator)

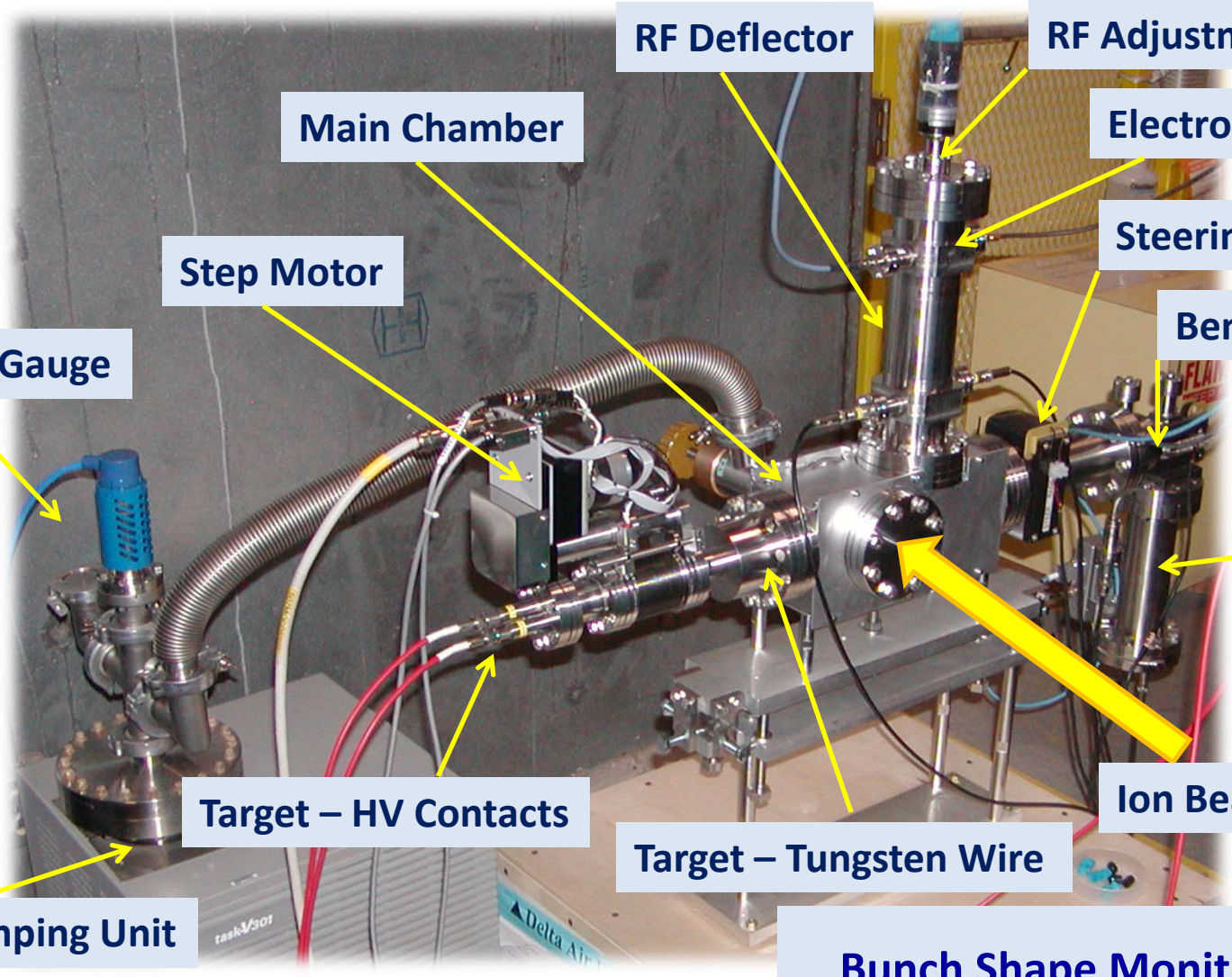


BSM-402 (quarter-wave resonator)



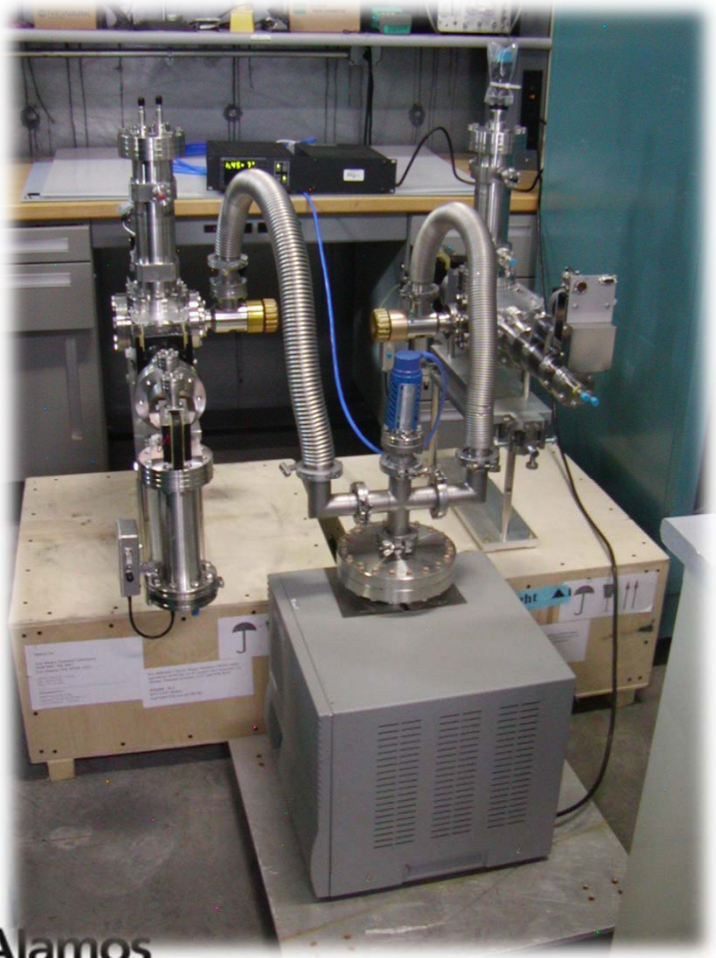


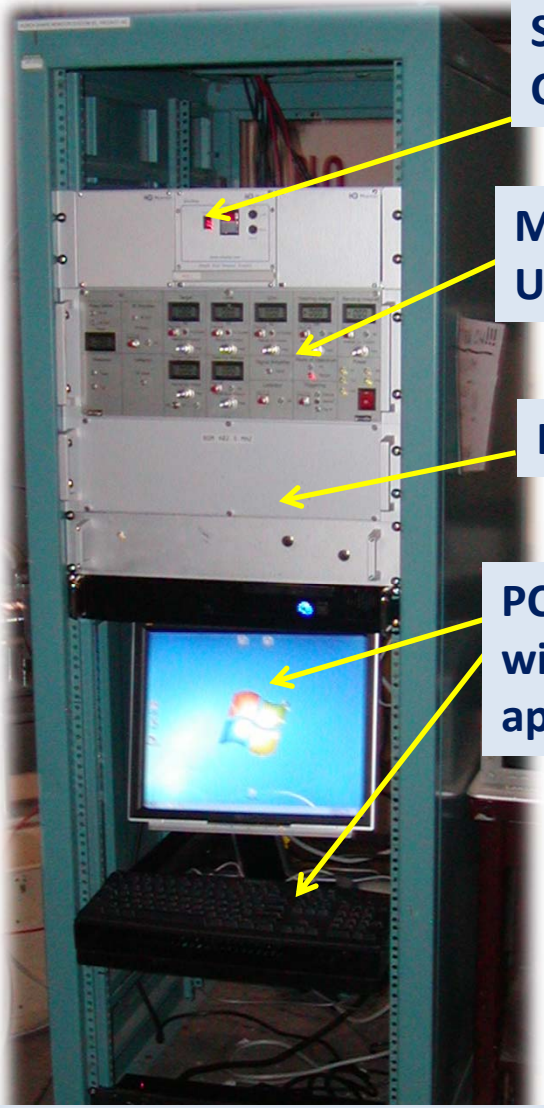
2. Bunch shape monitor description



2. Bunch shape monitor description

BSM 201/402 assembled monitors in RFQ lab during July 2014





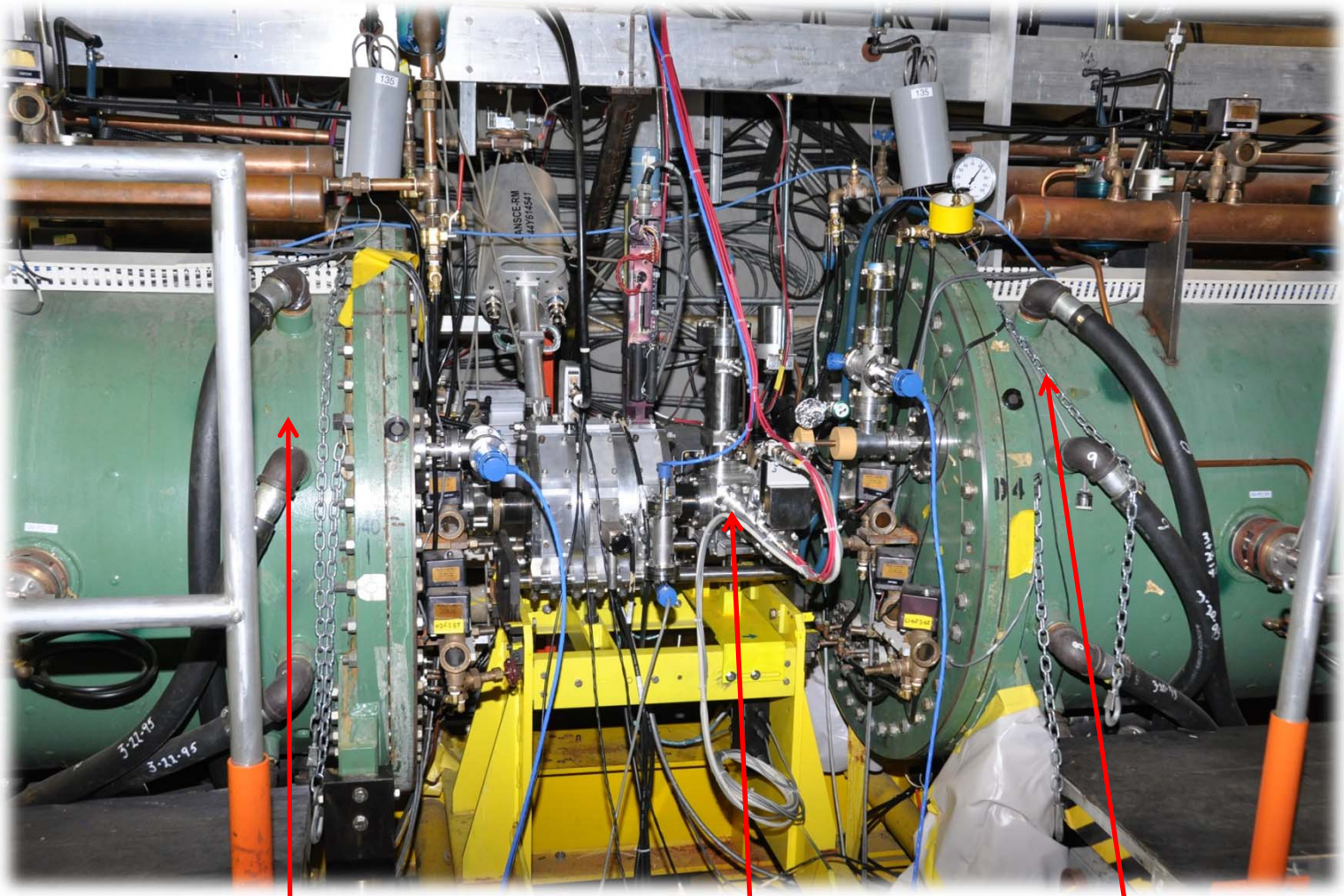
Two BSM racks with electronics

3. BSM 402 installation at the LANSCE linac

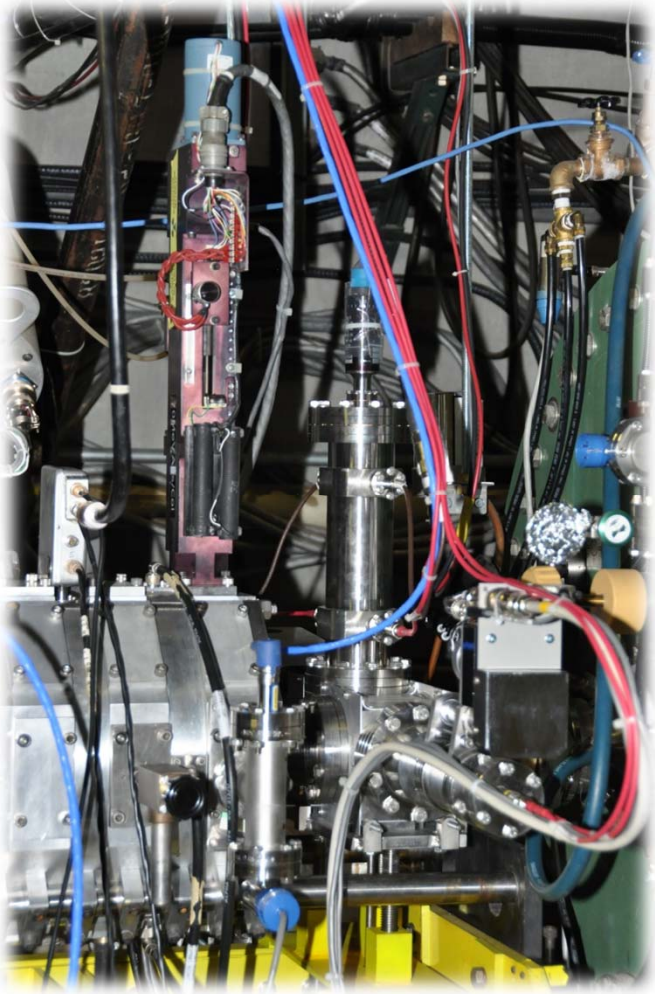
After the project justification review in 2015, the decision was made to install *BSM 402 detector between DTL tanks 3- 4 in next extended maintenance period.*

Locations	TD	DTL T2/3	DTL T3/4	TR ML	IPF	TR CL	TR ST	CCL >M6
Access to all beams	✓	✓	✓	✗	✗	✓	✗	✗
Space Available	✓	✓	✓	✗	✓	✗	✗	✓
Keep existing Diagnostics	✓	✗	✓	✗	✗	✗	✗	✓
Ease of Interpretation	✓	✓	✓	✓	✓	✓	✓	✗
Best bang for the buck	✗	✗	✓	✗	✗	✗	✗	✗

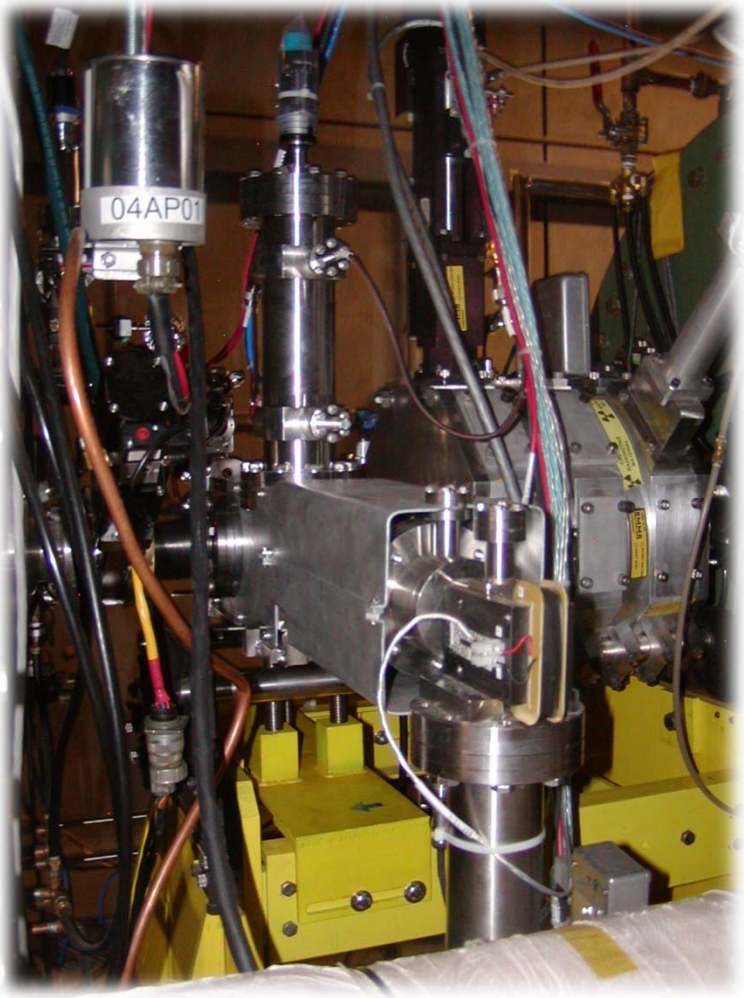
3. BSM 402 installation at the LANSCE linac



3. BSM 402 installation at the LANSCE linac



Right side of BSM

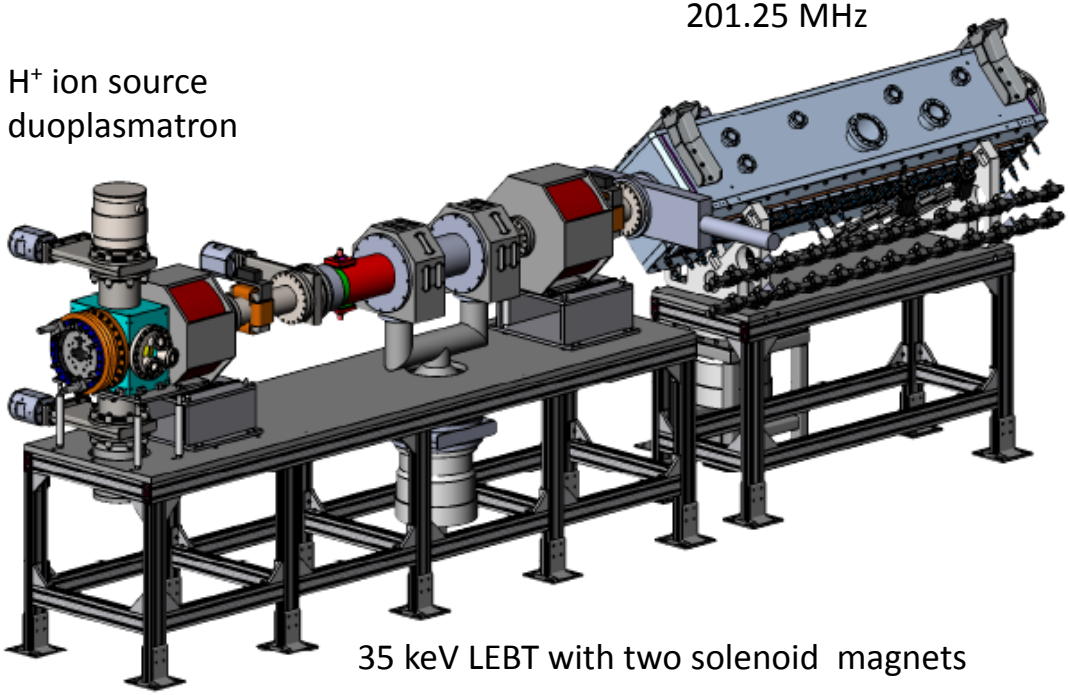


Left side of BSM

3. BSM 402 installation at the LANSCE linac

RFQ accelerator
201.25 MHz

H^+ ion source
duoplasmatron

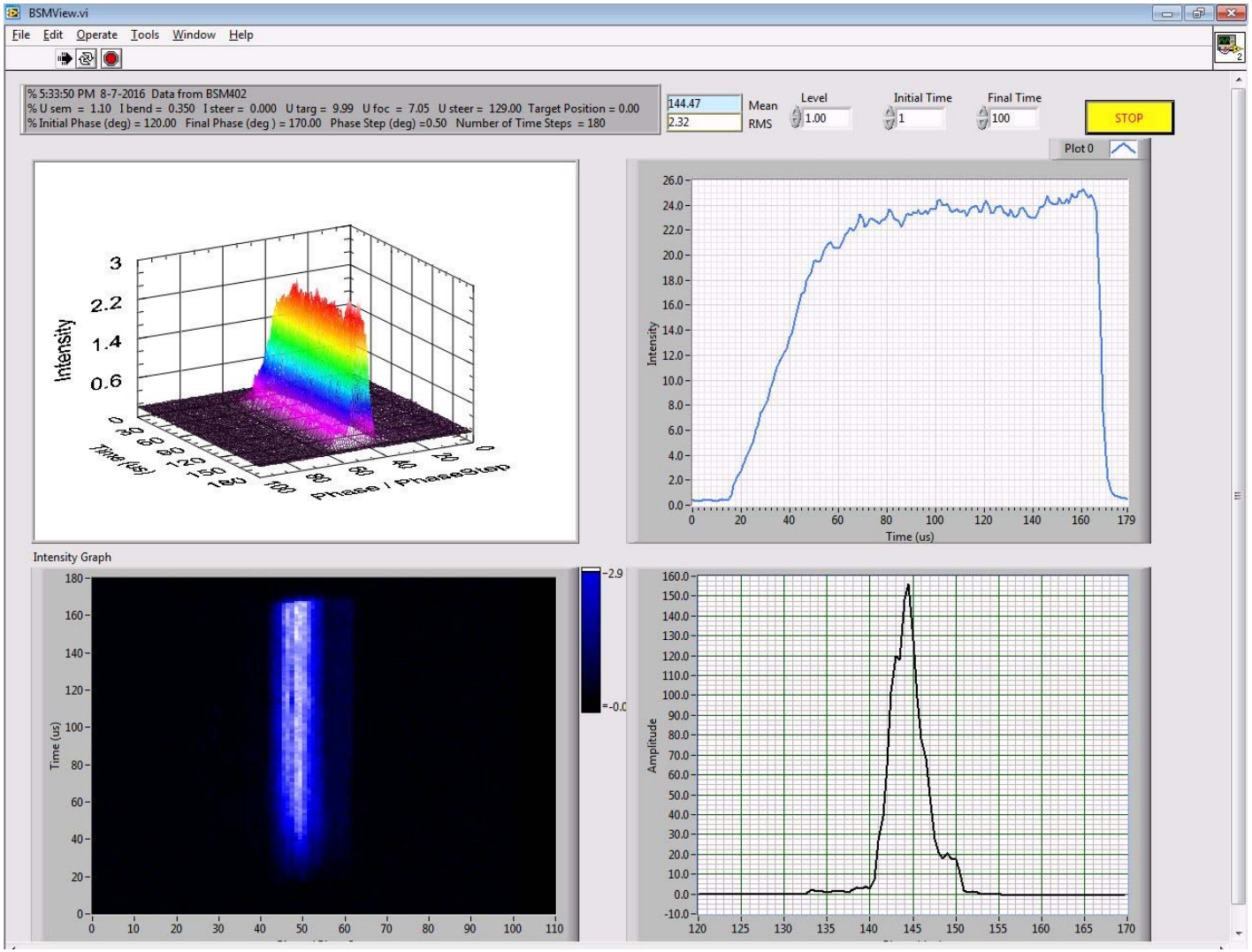


35 keV LEBT with two solenoid magnets

Work on H^+ RFQ accelerator upgrade is in progress.

BSM 201 in the lab for the H^+ RFQ injector diagnostic (750 keV).

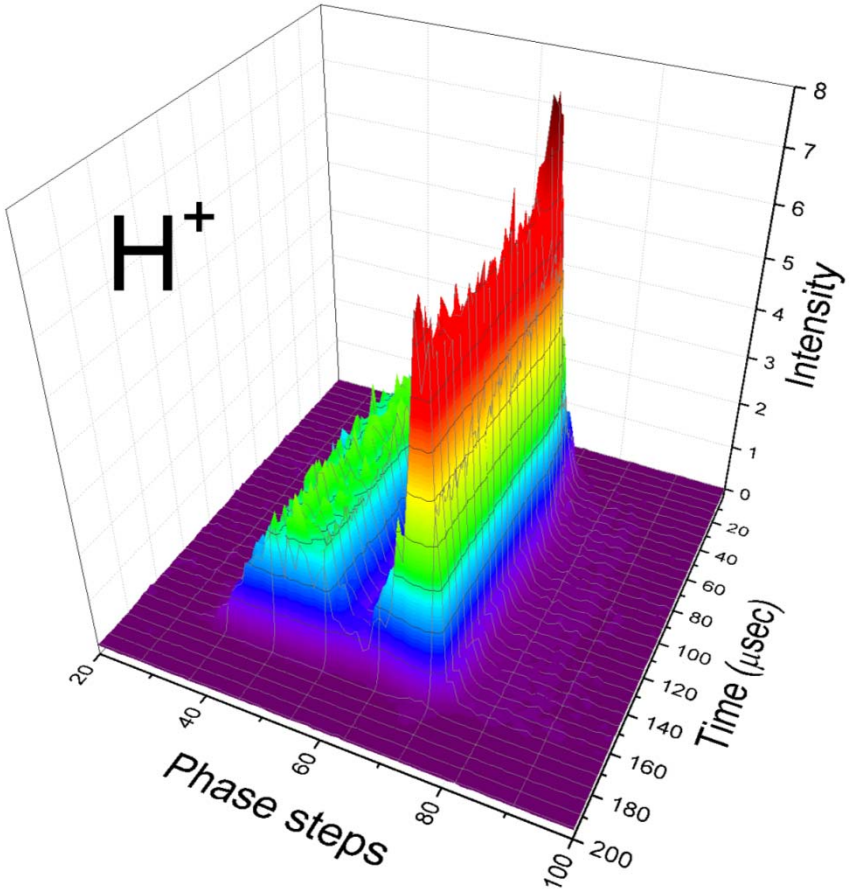
4. First bunch shape monitor measurements

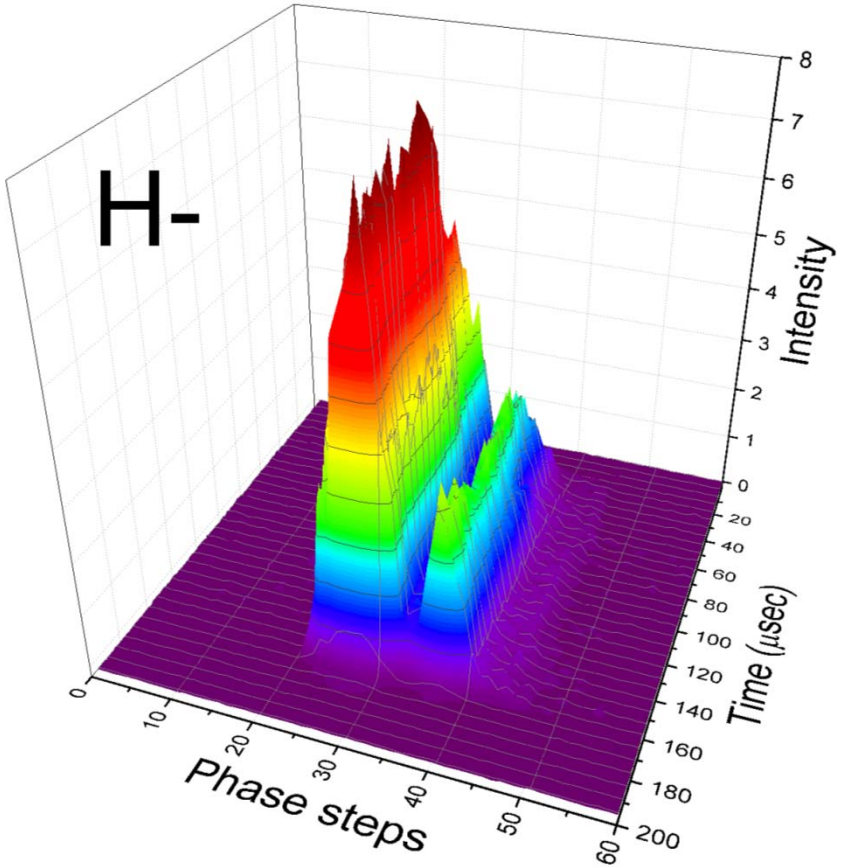


BSM view LabVIEW application

First successfully measured BSM scan H- ion beam, **recorded on August 07 2016**
1 mA beam current ; 1 Hz repetition rate and 150 pulse length

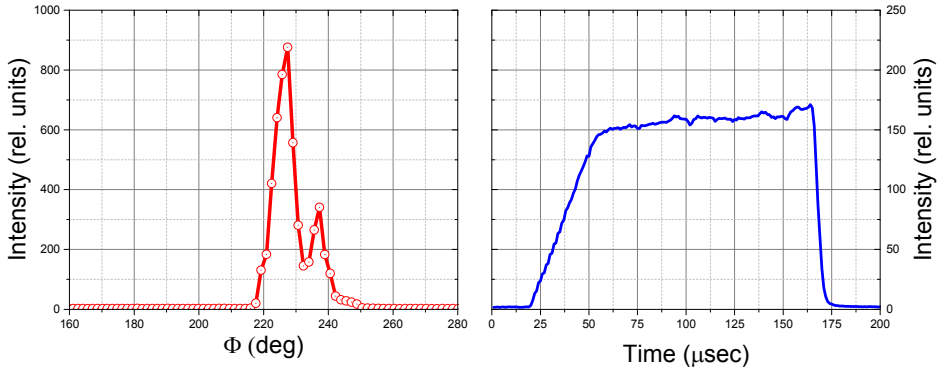
4. First bunch shape monitor measurements





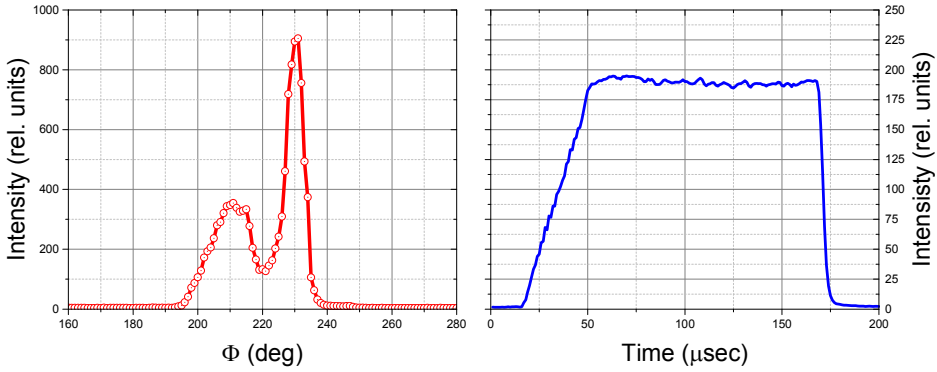
Typical BSM data of H^+ and H^- ion beams.

4. First bunch shape monitor measurements



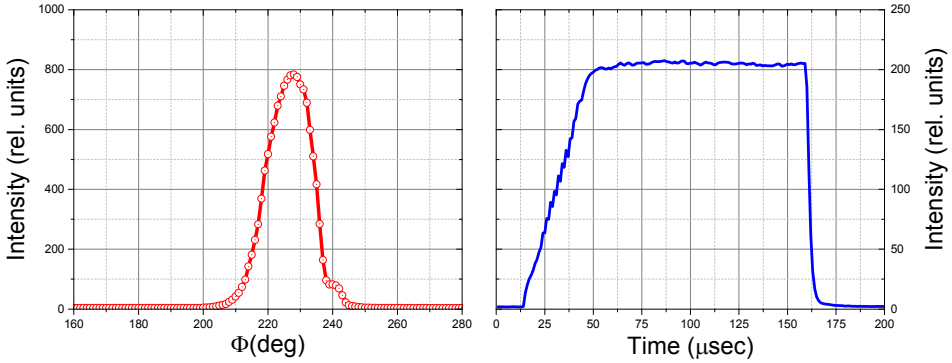
Tuning H⁻ beam (LBEG) – 1 mA peak during startup

Bunch position Φ_{peak}=226.3±0.5°, FWHM=7.3±0.5°



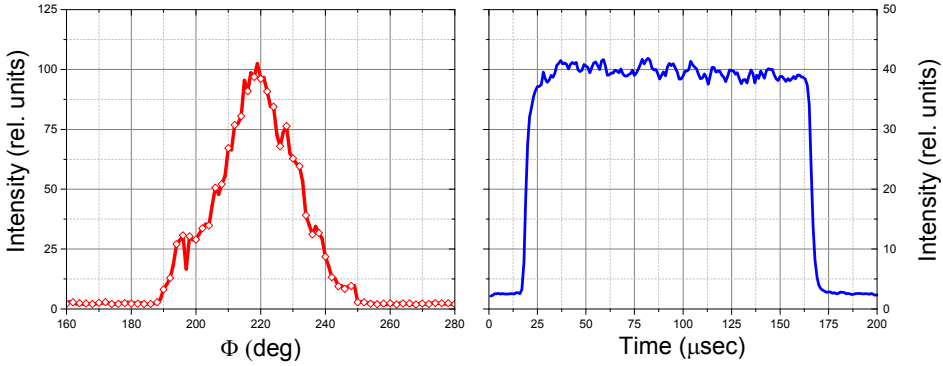
Production H⁺ beam (H+IPF) – 4 mA peak to IPF

Bunch position Φ_{peak}=230.1±0.5°, FWHM=6.4±0.5°



Production H⁻ beam (LBEG) -10 mA peak to PSR

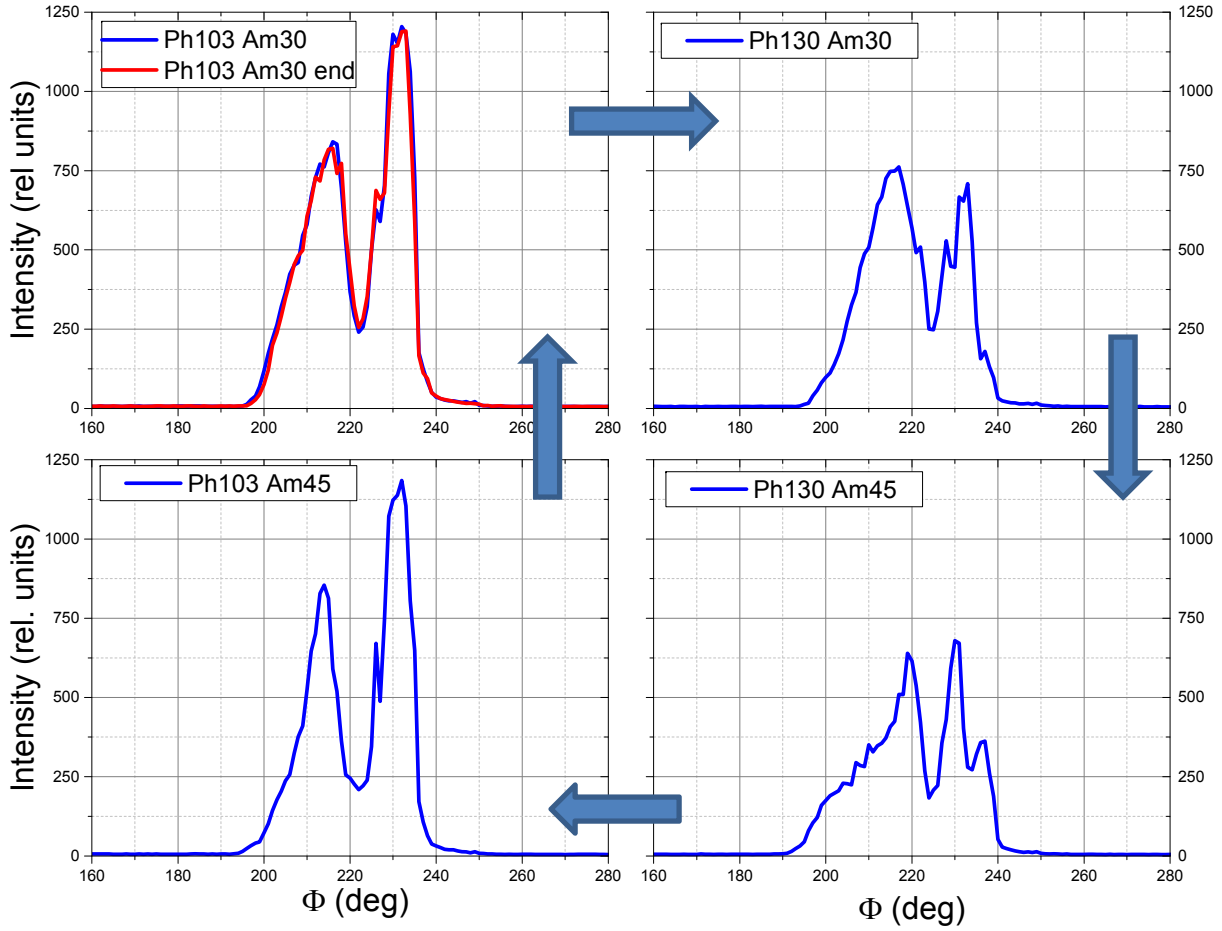
Bunch position Φ_{peak}=226.8±0.5°, FWHM=13.4±0.5°



Production H⁻ beam (MPEG) – 17 mA peak to WNR

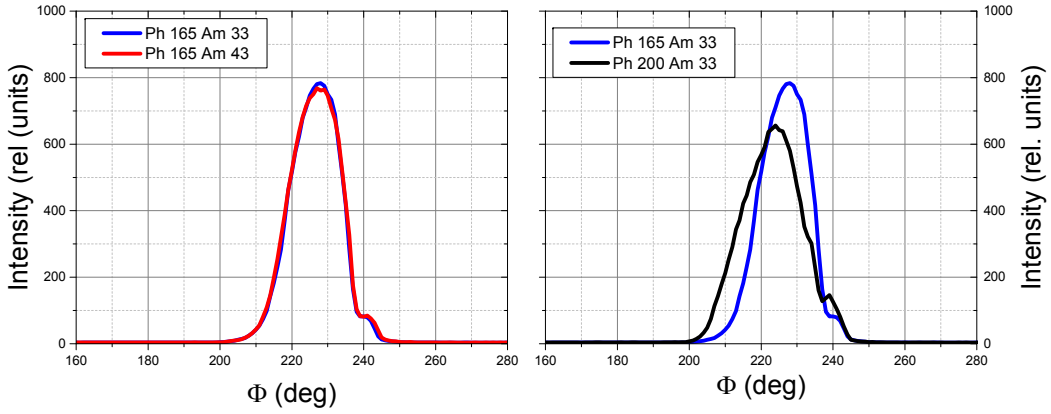
Bunch position Φ_{peak}=219.3±0.5°, FWHM=28.4±0.5°

4. First bunch shape monitor measurements



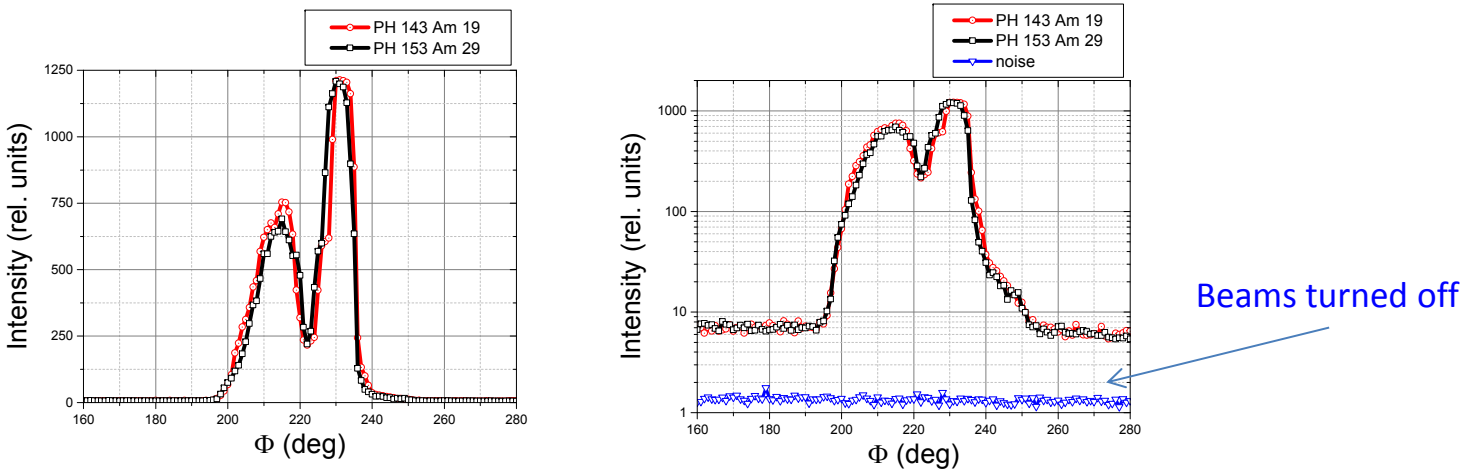
H^+ ion bunch shape changes on variations of prebuncher phase and amplitude.

4. First bunch shape monitor measurements



$\Delta\Phi_{peak}$=-3.6±0.5°,
ΔFWHM=4.3±0.5°

H^- ion bunch shape changes on variations of prebuncher phase and amplitude



H^+ ion bunch shape changes on variations of prebuncher phase and amplitude.

5. Summary

1. The bunch shape monitor (BSM 402) was successfully installed and tested at the LANSCE linear accelerator.
2. The first direct longitudinal profiles of H^+ and H^- ions beams with high phase resolution of 0.5° were measured.
3. New BSM measurements will provide valuable information about the linac tune set points, help with troubleshooting accelerator performances and improve spill reduction.
4. Future applications of BMSs will be to study of longitudinal halo effect, estimate the longitudinal beam emittances and benchmark beam simulation models.