
Highlights of the trip to SNS on May 5-6, 2014

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Introduction

- SNS shutdowns
 - 2 week shutdowns twice a year
 - 8-16 hours shutdowns every 4-6 weeks
 - Determined mainly by replacement of the ion source
- Timed our visit for May 6, a day of IS replacement
 - To be able to enter the front end cage and see IS replacement
- Also, we expected to see RF commissioning of the new RFQ
 - Did not start because Operation Readiness Permit had not been issued

People and places

- People we talked to
 - Sasha Alexandrov - Beam Instrumentation team leader
 - Martin Stockli - Ion Source team leader
 - Wim Blockland – engineer in Beam Instrumentation
 - Yoon Kang – Lead RF engineer responsible for RFQ
 - Charles Peters – SNS operation specialist
 - John Galambos – Head of group (3 teams)
 - Vadim Dudnikov – collaborator from Muons, Inc.
- The main places visited
 - SNS front end IS+ LEPT+ RFQ+ MEPT
 - New RFQ (front end test stand)
 - Ion source test stand
- This talk is our impressions excluding RFQs
 - See Jim's presentation

Operation

- SNS operates at 1.2 MW, with typical beam availability ~ 95%
 - Plan to increase the power to 1.25 MW in May 2014
 - Increase beam energy and duty factor
 - Hope eventually reach the design goal of 1.44MW
- Acceleration gradient drops in cavities where the beam is lost
 - At normal conditions run with one cavity for energy reserve (out of 81)
 - Mainly recoverable by RF conditioning or thermocycling
 - Plan to implement in-situ cavity cleaning by plasma

SNS front end

- SNS front end (down to the end of MEBT) is outside of the tunnel
 - Cage without interlocks; people without radiation training are not allowed to enter
 - Only area with significant radiation is the last bunching cavity (~90 kV)
 - Roped

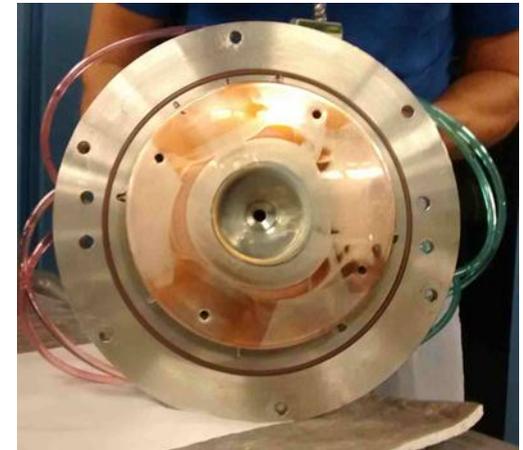


Ion source/LEBT

- Team: M. Stokli + 6 people
- IS/LEBT used to be a big source of downtime
 - Reliability improved significantly
 - RF antenna; procedures
 - Lately no downtime because of IS failure
 - Scheduled periods for IS replacements
 - Last period: 6 weeks; discussing 8 weeks
 - Less stable operation toward the end
 - Have 5 ion sources
 - 3 in rotation for operation
 - 2 for the test stand
- IS replacement
 - 8 – 16 hrs w/o beam for production
 - ~2 min with IS exposed to air
 - Procedure documented in detail



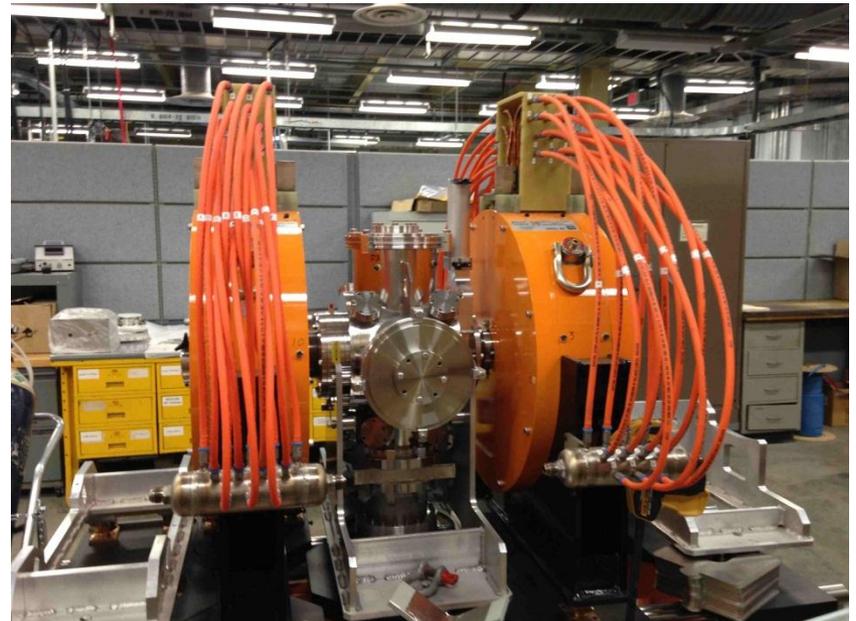
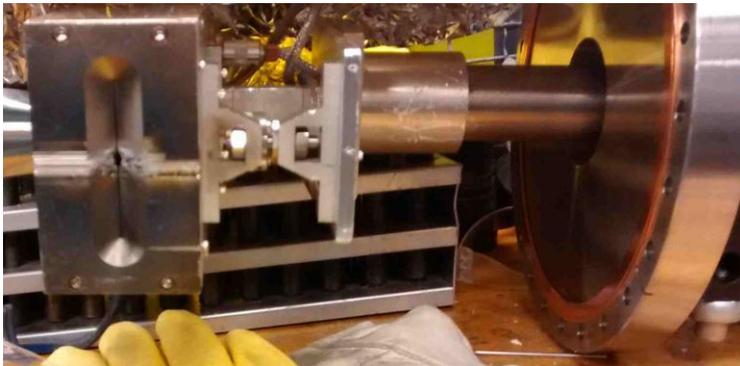
View on LEBT



Freshly removed ion source

Ion source/LEBT: development

- Developing an ion source with an external RF antenna
 - Installed at the ion source test stand
 - So far parameters are below the standard IS'
- The emittance scanner is damaged and not used
- Magnetic LEBT
 - Long time ago in the time of troubles, designed a 2-solenoid LEBT and manufactured 2 solenoids
 - No immediate plans to use



MEBT



- List of installed MEBT elements is similar to PXIE's
 - We are using SNS experience extensively
 - Quads, kicker, target (absorber), diagnostics, scrapers
- Do not use the MEBT chopper
 - Several percent of loss reduction does not justify additional complexity
 - Unreliable kicker electronics

MEBT (cont.)

- A lot of diagnostics
 - RFQ has been characterized with MEBT diagnostics
 - Emittance scanner: slit-harp or slit-slit
 - Dynamic range: 10^5
 - Faraday cup may be at any location, e.g. at the end of the linac
 - The eventual goal is to be able to trace the beam tails in optics simulations
- Two scrapers are important for decreasing the beam loss in SRF
 - Thick carbon tips, not electrically isolated, equipped with a thermocouple
 - Nominal working temperature is $\sim 100\text{C}$, but once glowing was observed
 - Scraping $< 1\%$
- “Beam reducer” is critical for SRF commissioning
 - On one feedthrough: a set of several round holes and a thin foil (for converting the beam into protons)

New test stand

- A new RFQ has been ordered, manufactured, and is under RF commissioning (see Jim's report)
 - Will be moved to the production machine only in a case of catastrophic failure of the present RFQ
- The RFQ will be a part of a test stand
 - IS + LEBT + diagnostics line + beam dump; later 180° bend + user line
 - Official goal: hot replacements for the front end
- Space to install the magnetic LEBT, but will start with electrostatic
- Place to test new diagnostics
 - Example: a movable BPM to measure the beam energy by TOF
 - The phase shift is measured as a function of the BPM shift
 - Simpler; systematic errors are reduced



Machine protection system

- There are clear indications that accidental beam loss in cryomodules results in deterioration of SRF performance
 - Energy deposited by 1 minipulse ($\sim 1\mu\text{s}$) is $\sim 20\text{J}$
- Keep decreasing the reaction time of the MPS
 - From initial $\sim 300\mu\text{s}$ to design $\sim 30\mu\text{s}$ to present $\sim 15\mu\text{s}$
 - The goal to decrease the time to $\sim 5\mu\text{s}$
 - Total time of beam loss, including signal propagation and beam length in the linac
- Beam shut-off
 - Kick beam out with LEBT kicker and turn off RFQ power for the duration of the macropulse
 - If the event is “soft”, operation resumes with the next pulse
 - If “hard”, the ion source timing is shifted to outside of RFQ’s, RFQ is pulsed normally, and the LEBT kicker is turned off so the beam goes into RFQ. Resuming beam operation requires acknowledgement.

MPS: event sensing

- The main tool is Beam Loss Monitors
 - Ionization chamber with analog integrator
- Tested comparison between two toroids
 - Upstream and downstream of SRF linac
 - Worked fine, but presently of one the toroids is removed (ceramics leak)
 - Toroid accuracy is 3-7%. MPS reacts on events with ~20% drop.
- Thinking about using a couple of BPMs
 - Can tap any BPM, but as soon an element becomes a part of MPS, any change (e.g. software change) requires a committee approval