PXIE Ion Source & LEBT Commissioning Update

Lionel Prost

PIP-II Technical Meeting
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Content

• Highlights of main achievements

• Current status: Shutdown

• Plan
Setup

- Last report (7/29): Commissioning in this new configuration had just started
  - In fact, emittance scanner had not been re-installed yet
Setup in picture
(toroid and emittance scanner missing)
Nominal beam

- 5 mA DC with emittance within specs (<0.25 µm)
  - \( \varepsilon_{n,rms} = 0.13 \, \mu\text{m} \) (9/22/14)
  - No direct comparison with 1-solenoid configuration
  - Did not try to ‘match’ the beam to the RFQ input Twiss functions so far
Nominal beam - Pulsed

- 5 mA, 400 μs pulse @ 10 Hz
  - $\varepsilon_{n,\text{rms}} = 0.12 \ \mu\text{m}$ (@ the end of the pulse, 9/22/14)
  - 1-solenoid configuration (best): $\varepsilon_{n,\text{rms}} = 0.10 \ \mu\text{m}$ (6/26/14)
  - Small emittance growth (~20%)
Beam size measurements with Isolated diaphragm #2 in pulsed mode (9/16/14)

- 5 mA, 400 μs pulse
- Data points taken at the end of the pulse
- Procedure and analysis as described in 05/13/14 PIP-II meeting presentation i.e. fit solenoid corrector scan data with corresponding analytical function

- Observed asymmetry between X and Y for the first time
  - Speculating that the permanent magnets inside the extraction electrode have deteriorated
    - Magnetic measurements during shutdown
Maximum beam current

- 10 mA, pulsed (0.4 ms) through toroid (i.e. before Solenoid #3)
  - Beam lost somewhere downstream (1-2 mA)
  - Aperture restriction from Isolated diaphragm in Solenoid #2 limits the range of focusing solutions
    - Will remove it during shutdown

- Up to ~7 mA DC
  - Same issue with losses
Data collection

• A lot of data has been acquired and remains to be analyzed and/or interpreted
  ▪ Optics measurements to *(hopefully)* model the beam line
  ▪ Effect of biasing the diaphragms and/or BPM plates i.e. change degree of neutralization (or neutralization profile)
    ✷ E.g.: attempt was made to measure the ion current going to the BPM plates
  ▪ Optimization of the ion source parameters for various beam currents
Main (operational) issue

• We have not been able to run DC for long period of times (> 2-3 hours)
  ▪ IS sparks/trips
    ✤ Filament PS failed (→ Ordered a spare; we had a loaner from EE support; currently using the PS we bought originally)
  ▪ Restoring operation requires **physically** and **locally** power cycling the HV cabinet !!!
    ✤ Need to build the capability to do this remotely
  ▪ Reason of the sparks is not understood at this point
Shutdown *(started this morning)*

- **Driving tasks**
  - Install chopper assembly & remove Isolated diaphragm #2
  - Relocate solenoid PS to mezzanine (final configuration)

- **Other jobs**
  - Move vacuum control equipment outside the cave (to PLC rack)
  - Fix emittance scanner
    - Developed a short yesterday (top deflecting plate)
    - Also rotate to horizontal position when re-installed
  - Measure magnetic field in the IS extraction region
• Design and build ‘scraper’
  - Part of LEBT/RFQ interface end plate
    - End-plates themselves have been ordered

• Still on-track for RFQ commissioning in Spring 2015
Back-up slides
Cooling water issue

• As of *now*, the cooling water system is **not capable** of keeping the water temperature constant when the RF amplifier is being commissioned (i.e. not in a steady-state)
  - Solenoids are not current regulated at this time
    - Will happen when PS are moved to the mezzanine
  - Leads to large variations of solenoid currents (several Amps), hence very different optics solutions
    - Data logging of solenoid currents had stopped (issue is fixed)
    - Noise on current read backs would not allow for correlations to be established
Cooling water issue (cont’)

Green: FC bottom temperature
Red: FC water return temperature
Cyan: beam current
Bronze: LEBT manifold supply temperature
Purple: LEBT manifold return temperature

No data logging of LEBT manifold temps before here

End of Ralph’s studies

~5°C