PXIE Ion Source & LEBT Commissioning Update

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• Highlights of main measurements
  ▪ Beam size
    ❖ Pulse mode
  ▪ Neutrals

• Operation/hardware remarks

• Shutdown
Setup before shutdown

- Solenoid
- DCCT
- ‘New’ isolated diaphragm a.k.a. donut a.k.a. TID
- Isolated diaphragm connectors
- Bellow
- Faraday Cup
Beam size measurements

- Beam size is obtained by moving the beam across the donut aperture
  - Beam current in FC vs. Solenoid corrector current

- B. Marsh wrote a Java application to speed up data acquisition and improve reproducibility of the measurements
  - Helped a lot!
  - Next step is to implement the computation of the beam size within the program

25-Apr-2014
Current to FC as a function of the solenoid correctors (moved by (1,1) MULT) for 6 solenoid currents, from 168 to 148 A. Data were taken with B. Marsh's program.
Refined beam size measurements analysis procedure

- Fit entire curves assuming a Gaussian distribution being sampled across an aperture

  - Four (4) fitting parameters
    - Beam current
    - Correctors calibration coefficient (i.e. mm/A)
    - Center position
    - Rms beam size

  - For small beam sizes, this fitting gives the same result as “95%-to-95%” procedure used previously
    - Recent data is being analyzed
Solenoid scans in pulse mode

- Carried out scans at various times within the pulse
  - Beam size changes quite significantly between the beginning and the end of the pulse (i.e. DC-like)
    - Likely effect from neutralization

Beam size as a function of the solenoid current at 10, 30, 50 and 100 μs after the start of the pulse

- 5 mA, 200 μs pulse, 10 Hz
- Dashed lines are arbitrary fits to guide the eye
Neutrals ($H_0$)

- With the beam well centered in the donut, its temperature still rises significantly
  - Indicates particles loss

- Constant current from FC and donut when doing beam size measurements
  - Temperature rise very unlikely due to primary beam halo
Estimation of the amount of neutrals

- Thermal characteristic of the donut inferred from heating and cooling measurements
  - Calculate the average deposited power for 5 mA beam = 6.3W
    - If energy is 30keV, it corresponds to 4% of the beam “current”
- From measurements with the solenoid on and off, we find that ~60% of the neutrals bombard the donut
  - Amount of energetic neutrals produce at the ion source:
    4%/0.6 = 7% of the total beam current
- Assuming neutrals distribution to be Gaussian only 10% of these pass through the donut and propagate downstream

Example of heating measurement (5 mA beam, ~no loss)

04/11/14
Current to TID, FC, and TID temperature vs time. TID bias=+40V. Solenoid=160A. The beam is centered in TID.
Operation

- Approved for *remote* operation *yesterday*
  - i.e. don’t have to stand by the machine
  - Warning light indicating ‘HV enabled’ will be installed
    - *Not a requirement from ES&H*
Solenoid current lag (i.e. temperature dependence)

- When changing the solenoid current settings, it takes quite a long time to reach a constant value
  - As much as 5 minutes at turn on i.e. large setting change
  - A couple of minutes for several amps changes
- Present PS are voltage regulated ⇒ Need Current regulation = $$$ (next fiscal year?)

Solenoid current was changed from 0 A to 160 A
Known, large difference between set point and read back in ACNET ⇒ Somewhat fixed now

Stability requirement: 0.1%
Temperature distribution at the bellow

- Installed ‘shield’ on the IS vacuum chamber downstream aperture to prevent the bellow to be irradiated by primary beam
Last week’s shutdown

- Driven by the installation of the emittance scanner
- Other activities *in parallel*
  - Replace bellow shield with one with a smaller aperture (38.1 mm ID ⇒ 34 mm ID)
  - Flip DCCT
Current setup in picture

- DCCT
- Faraday Cup
- ‘donut’ a.k.a. TID
- Gate valve
- Emittance scanner probe
- Turbo pump
Plan

- Finish characterization of the beam through ~1m of the LEBT (**including beam dynamics through one solenoid**)
  - Emittance scanner commissioning

- Installation of the remaining of the LEBT all at once
  - Goal is to start commissioning mid- to late July
    - All solenoids have been delivered and are being measured
    - A lot of the infrastructure is ready or nearly ready (e.g.: water distribution system)
    - Current ‘push’ on the design of the chopper