PXIE LEBT
Status and Startup Plan

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PIP-II Technical Meeting

October 27th, 2015
Outline

- Shutdown activities
  - Ion Source cleaning
- Startup plan
  - Machine Protection System
Last beam line configuration w/o RFQ

- Not shown, Fast Faraday cup between donut and ‘regular’ Faraday cup
Currently, RFQ is blanked off at the interface with the LEBT (just upstream of LEBT scraper assembly)

- In LEBT, region downstream of vacuum valve is at atmosphere
**Shutdown worklist**
*(closely impacting LEBT operation only)*

- IS Filament assembly overhaul
  - More on this in the following slides
- IS Plasma chamber cleaning
- IS magnetic field measurements
- LEBT scraper alignment with RFQ entrance hole & re-balance bellows for smoother motion
- Install new (more powerful) LEBT scraper stepper motor to reduce slippage
- Visual inspection of chopper, LEBT scraper electrode ⇒ Look good
  - Replace emittance scanner broken thermocouple
- Install new DAQ system
  - Some delay; will require us to reuse ‘temporary’ setups
- Purge LEBT LCW system
- Fix noise issue on LEBT scraper LVDT read back
- Install adapting flanges for turbo pumps
  - One is done (out of 3)
- Update/upgrade MPS
  - A. Warner leading

Others to be done when servicing/replacing turbos
Ion source maintenance/repair (I)

- Had planned filament \textit{assembly} overhaul
  - Until then, only replaced filaments

- While preparing for test measurements without beam:
  - Unable to maintain a plasma \Rightarrow
    Discovered short between plasma chamber and plasma electrode

According to TRIUMF experts, discoloration is indicative of a leak (Air? Water?)
Ion source maintenance/repair (II)

- Cleaning done at MDTL under a hood (Donna Hicks from TD helped with HA, chemicals handling...)
  - Arranged by D. Bollinger
  - Linac techs (A. Feld, K. Koch) did the work

![Before Image]

- Back-plate
- Filament holders
- Plasma chamber

![After Image]

- New parts

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Fermilab
Ion source startup

- Already confirmed that the short between the plasma electrode and the plasma chamber is gone after cleaning
  - Established plasma (no extraction) for several hours
- Plan to establish pulsed beam to beam stop
  - Need to verify that the source works properly after overhaul
  - Measure phase space at the ion source exit and compare to the same measurements made before shutting down
- In parallel, work on MPS without beam
  - Need to ensure that no DC beam gets to the RFQ, when vacuum connection is eventually made up
    - Then, can work on the rest of the MPS with beam
Inhibiting DC beam to RFQ

• Current approach is to send beam to the absorber if it is DC and the scraper is not at a given position
  - Build upon NML experience and existing hardware
  - Need to install additional position switches
  - Just need to read back kicker voltage to check functionality

  3-4 weeks

• Alternate protection (needed beyond DC beam inhibition)
  - Implement ion source HV turn off if chopper shows a ‘not ready’ status
    - E.g.: kicker PS off
Plan

• As soon as the jig is ready, measure IS magnetic field in the extraction region
  - Likely sometime this week

• Then, establish beam to beam stop
  - Pulsed and DC at low current
  - Measure phase space for various IS tunes and compare with same measurements before shut down

• Once protection against inadvertently sending DC beam to RFQ has been proven, connect LEBT to RFQ
  - Around Thanksgiving?
  - Run beam to absorber
    - Pulsed and DC
Plan (cont’)

- Work on MPS with beam
  - Use LEBT scraper current read back to inform MPS of the beam structure
    - If pulse is longer than a given value (e.g.: 20 \( \mu \)s), kicker sends beam to absorber (fast) and IS HV is turned off (slower)
      - \textit{HV not crowbarred at this time but HV circuit setup so that it could}
      - \textit{HV turn-off could be made conditional upon the characteristic of the fault}
      - \textit{Some details in ‘additional slides’}
Additional slides
Machine Protection System (MPS)

- Need to ensure pulse length ≤ 20 μs (and 5 mA max peak current)
  - Faraday cups are the limitation for MEBT 1 commissioning
  - First, inhibit beam based on LEBT scraper loss/pulse length
    - Then use pickup ring signal (at 162 MHz) as main device
  - Start with smallest LEBT scraper aperture (3.5-mm diameter vs. 9-mm)
MPS architecture/setup

- Basic MPS setup – No pre-defined beam modes
- Permit line – TTL or close-contact
- Primary beam inhibit – LEBT Chopper (~ 150 ns delay + 110 ns rise time + propagation)
- Secondary beam inhibit – Modulator extractor (~150 ns delay + 250 ns rise time + propagation) and/or High voltage (several ms delay)
- Fast Shut Down signal – 30 MHz carrier (arbitrary)
Preliminary implementation

• Beam loss signal from LEBT scraper
  - 3 different windows of integration
  - Remove permit to chopper if above limit
    - Beam deflected to LEBT absorber
  - “Pulse length limit” trip condition not tried yet

• Beam stop status signal (from PLC vacuum)
  - IS HV is tripped off if beam stop is inserted into the beam line

- Tested successfully but not operational
- Operational

General purpose FPGA Board
- 64 inputs expandable to 162
- 32 outputs
- 405 MHz max for registered logic