PXIE Ion Source & LEBT Commissioning Update

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PIP-II Technical Meeting

July 29th, 2014

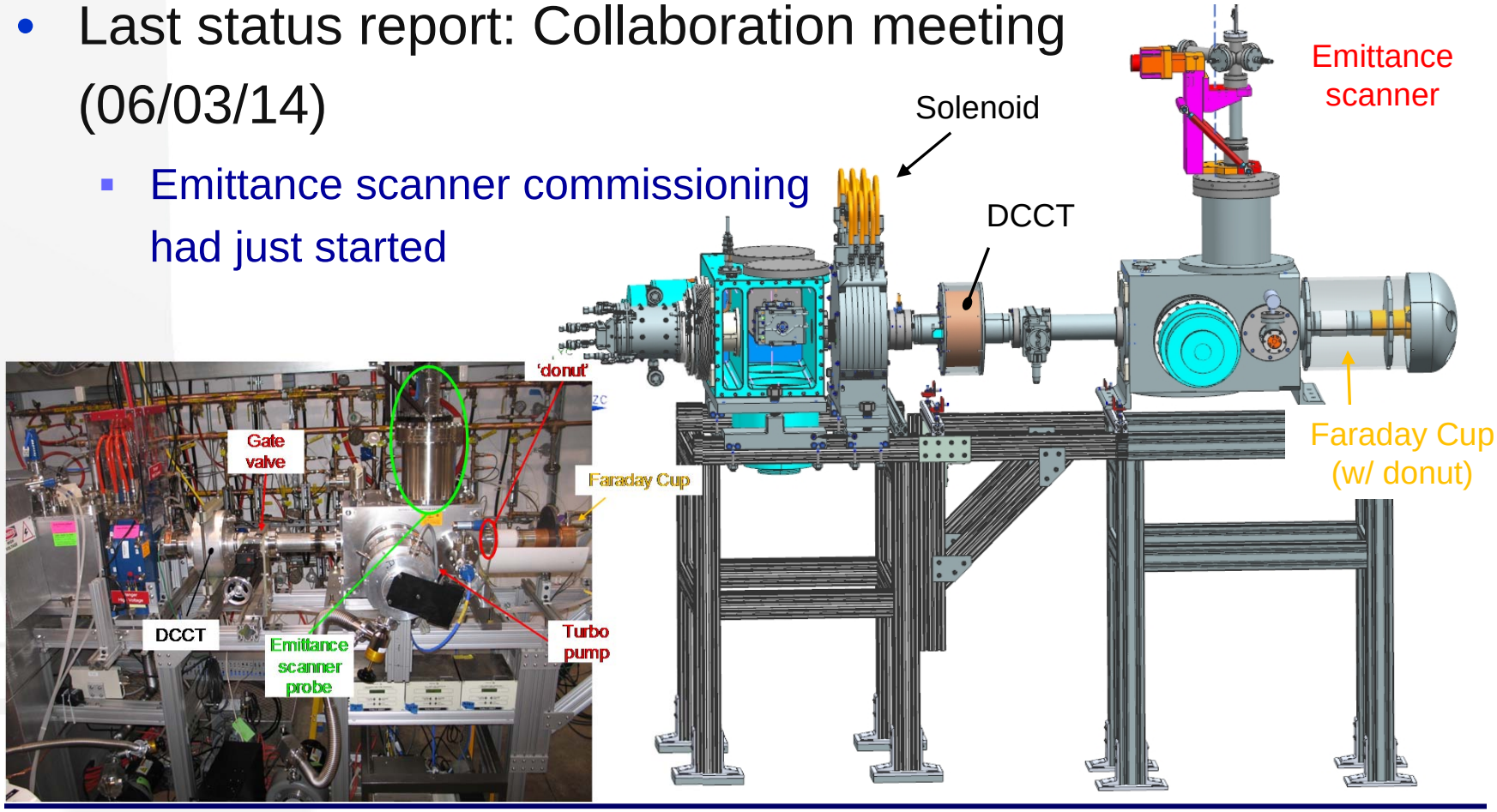
Fermilab

Content

- Highlights of main measurements (*one solenoid configuration*)
  - Beam size/emittance with donut
  - Beam vertical phase space with Allison scanner
- Shutdown
  - Installation of solenoids #2 & #3
- Restart & Plan

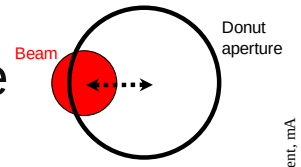
05/12-06/27 setup

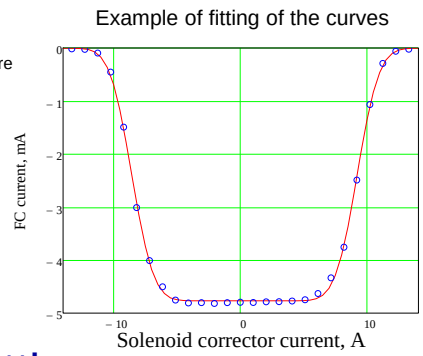
- Last status report: Collaboration meeting (06/03/14)
  - Emittance scanner commissioning had just started



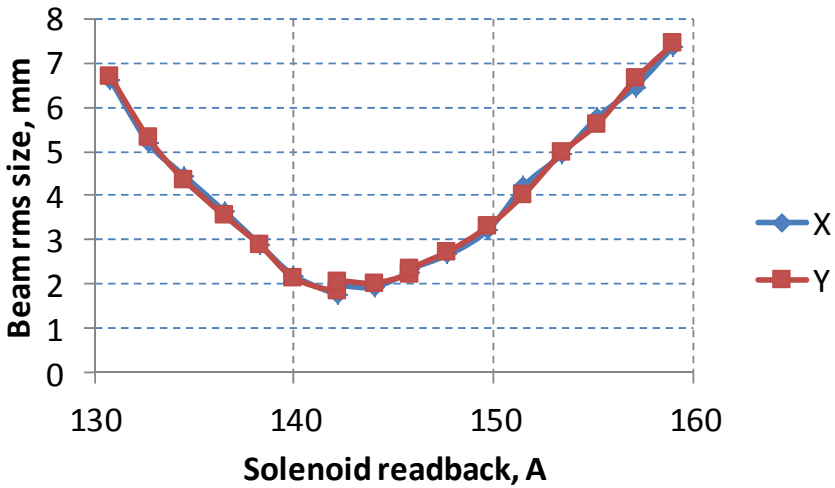
Beam size measurements with ‘donut’ in pulsed mode (6/6/14)

- 2 mA, 400 μs pulse
- Data points taken at the end of the pulse
  - DC-like conditions
- Procedure and analysis as described in 05/13/14 PIP-II meeting presentation i.e. fit solenoid corrector scan data with corresponding analytical function
  - After the solenoid correctors are calibrated, the only fitting parameter is the beam size



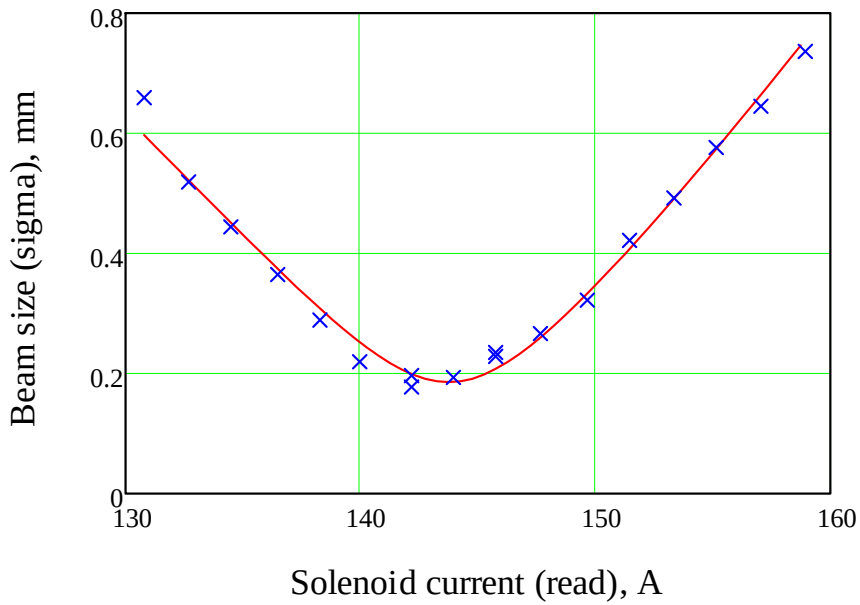


- Checked ‘symmetry’
  - Scans in the X and Y directions give the same results
    - i.e. no large difference between horizontal and vertical emittances



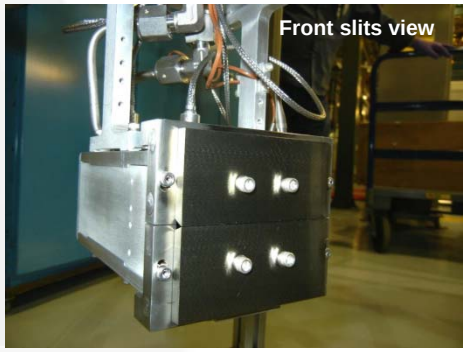
Beam size measurements with 'donut' in pulsed mode (6/6/14) (*cont'*)

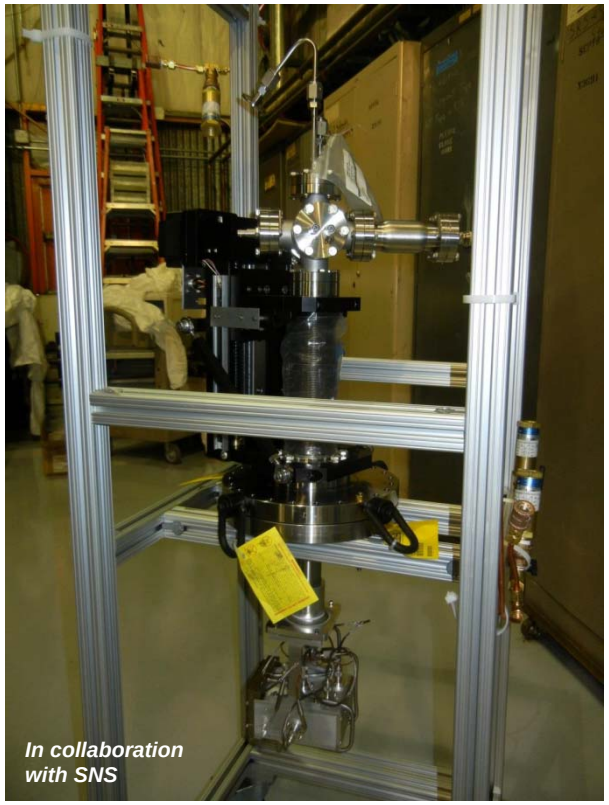
- Solenoid scans to estimate emittance
  - ε = 0.105 μm
  - No obvious emittance growth with the longer drift (~2×) to the measurement location
    - was 0.108 μm for the shorter beam line (05/02/14)
      - Although for higher current (5 mA) and smaller delay within the pulse (100 μs)
  - No contradictions for the fitted beam size and divergence in solenoid #1 between June 6 and May 2 measurements



Emittance scanner commissioning

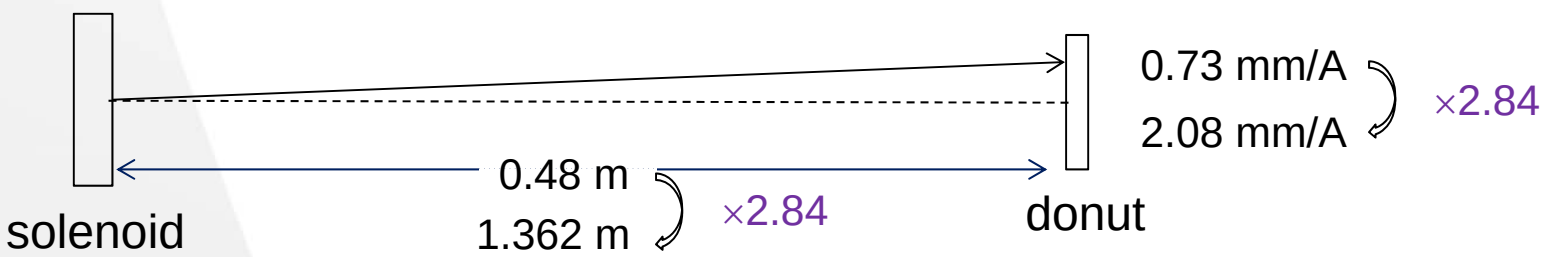
- Typical difficulties associated with commissioning of new complex equipments
  - E.g.: software migration from SNS, stepper motor slippage…
  - Vic S., Andrea S., Richard D'Arcy, Dave Slimmer, Matt Alvarez,
    - With feedback from SNS (W. Blokland, M. Stockli, C. Long)





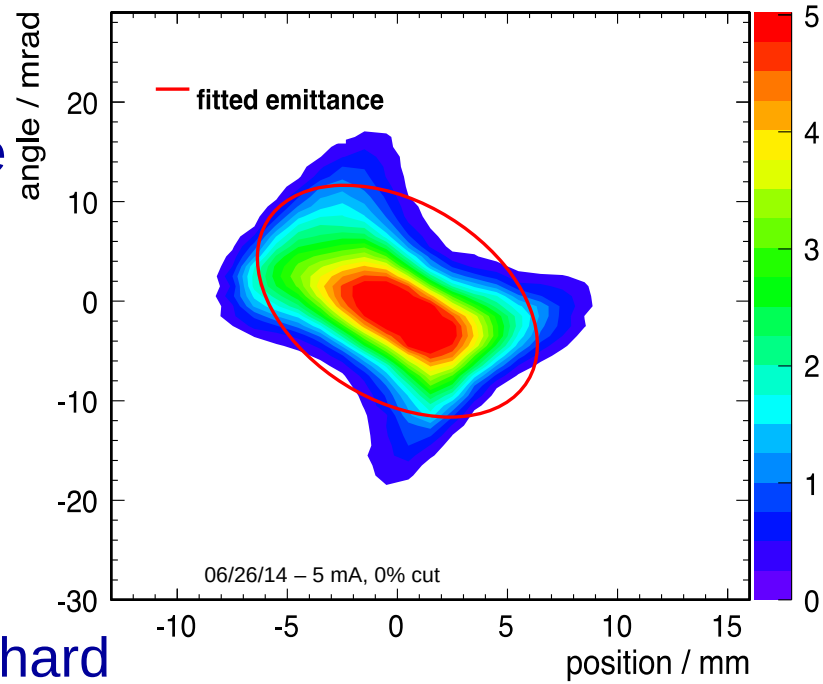
Emittance scanner commissioning (*cont'*)

- Calibration
  - Use solenoid correctors to move the beam at the slit location and record position changes of the beam centroid (in position and angle)
    - Solenoid correctors calibration (mm/A) well-known ⇨ Y/displacement calibration
    - Precise measure of the distance between solenoid, donut and slit ⇨ Y'/angle calibration to $\lesssim$ 5%



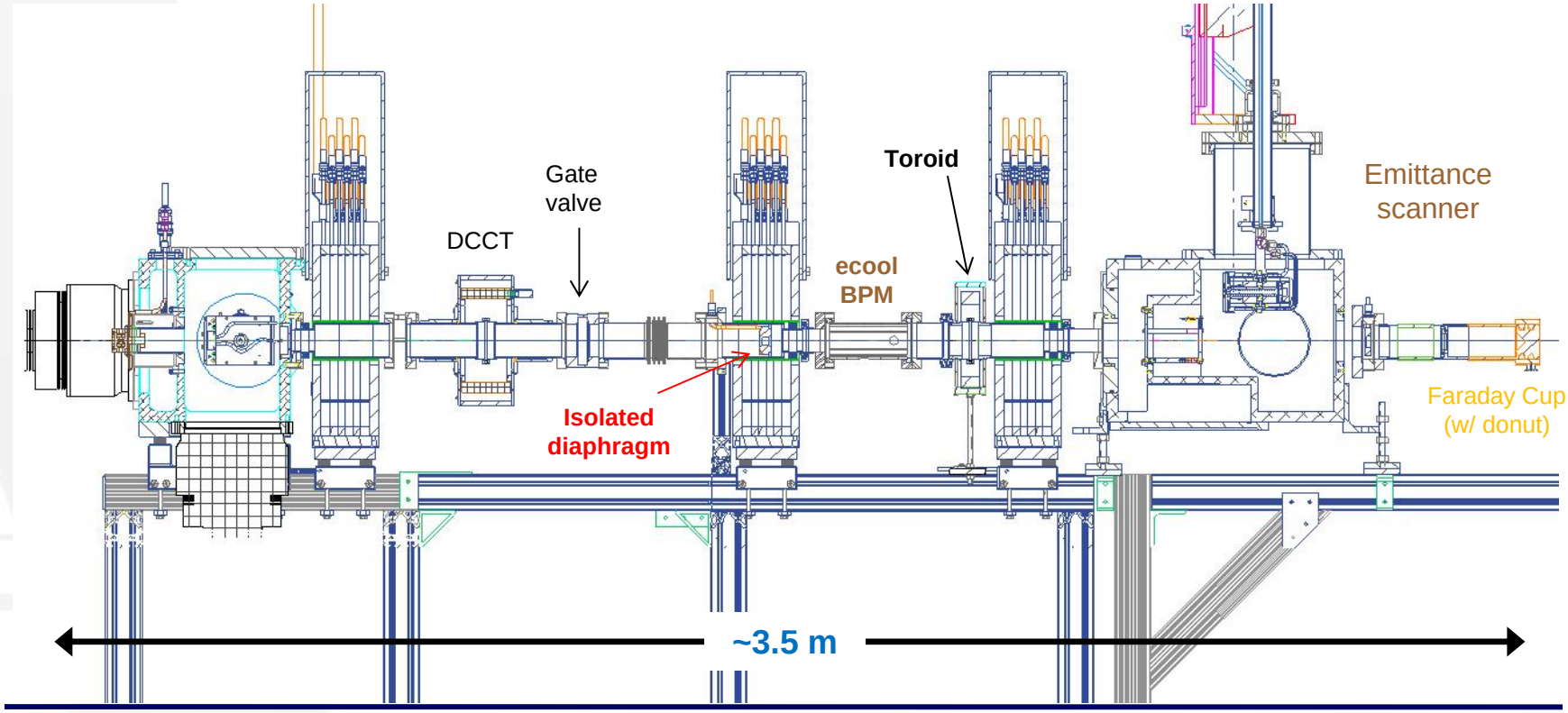
Emittance measurements

- Carried out emittance scans for various conditions
  - Analyses underway
  - Preliminary calculations of the emittance for beam settings similar to those from 6/6/14 (i.e. donut data set) are ~30% higher.
    - More on this next week by Richard



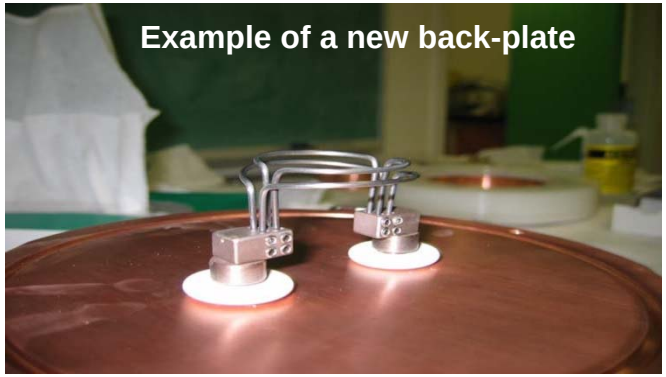
July shutdown

- Installation of the remaining solenoids
  - + ecool BPM as ‘clearing’ electrode until chopper is ready



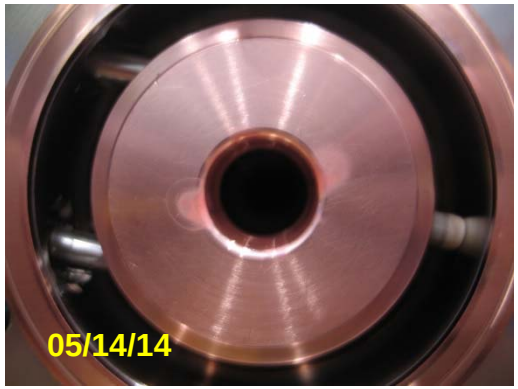
July shutdown (*cont'*)

- Replaced ion source filament
  - After ~555 hours
    - Vs. 300-500 hours estimates from vendor (*depends on beam current*)
  - It had not failed but resistance measurements indicated that *it was getting close*…
- May need to perform 'full cleaning' next time

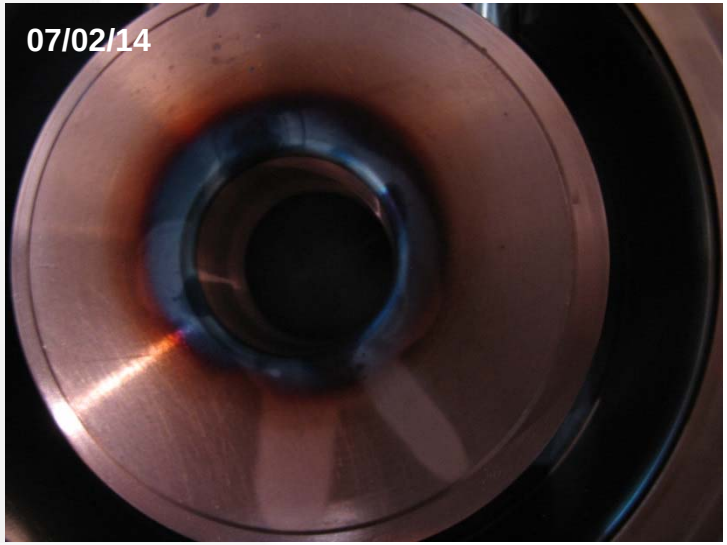


Vacuum contamination ?

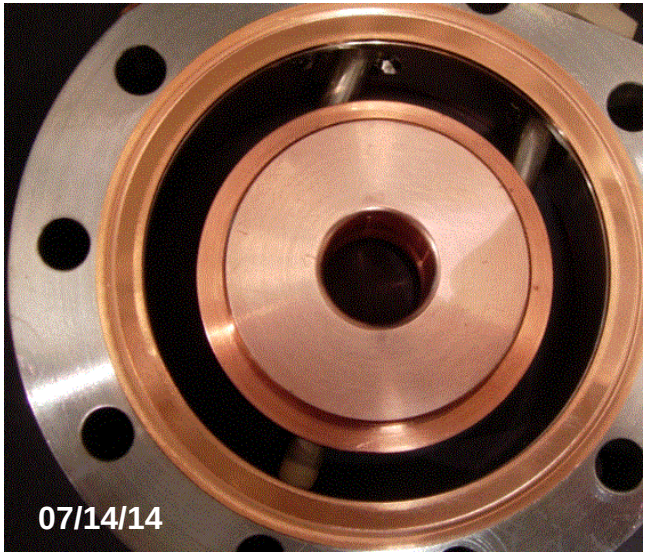
- Black residue on ‘donut’
  - Very different from last opening
    - Before installation of emittance scanner
  - *Easily* removed with white scotchbrite and alcohol



Before cleaning

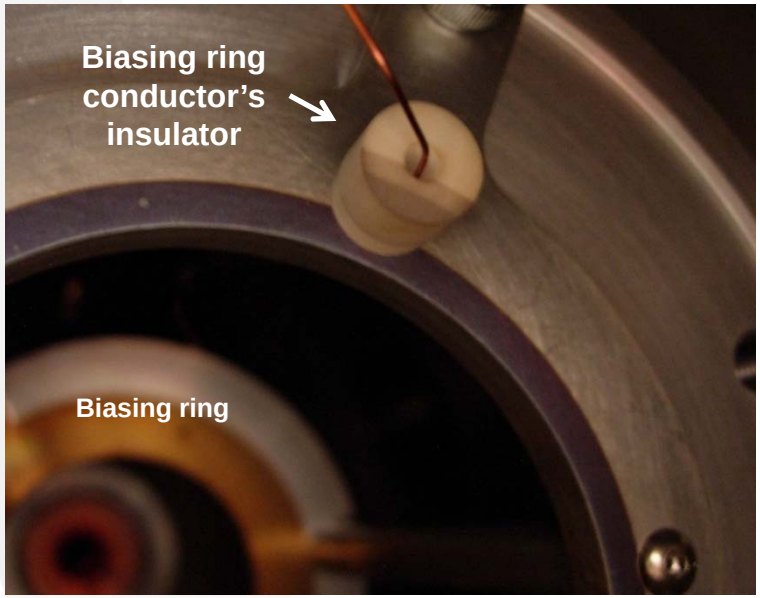


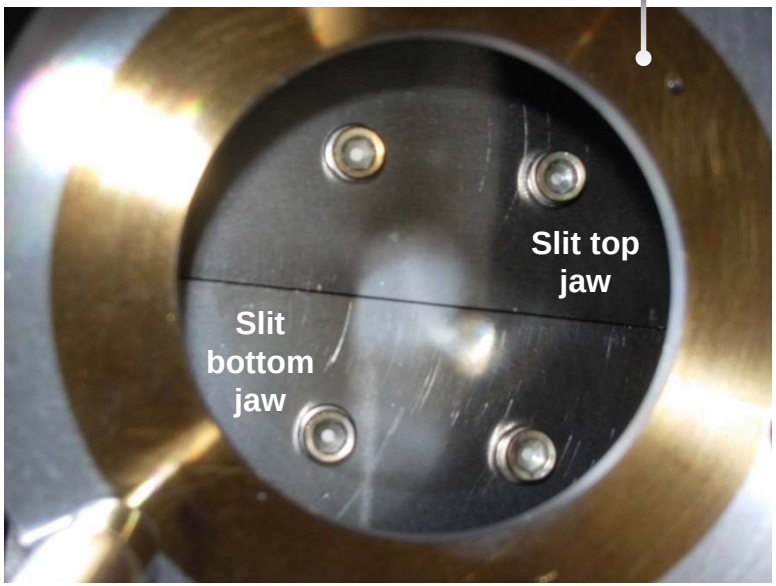
After cleaning



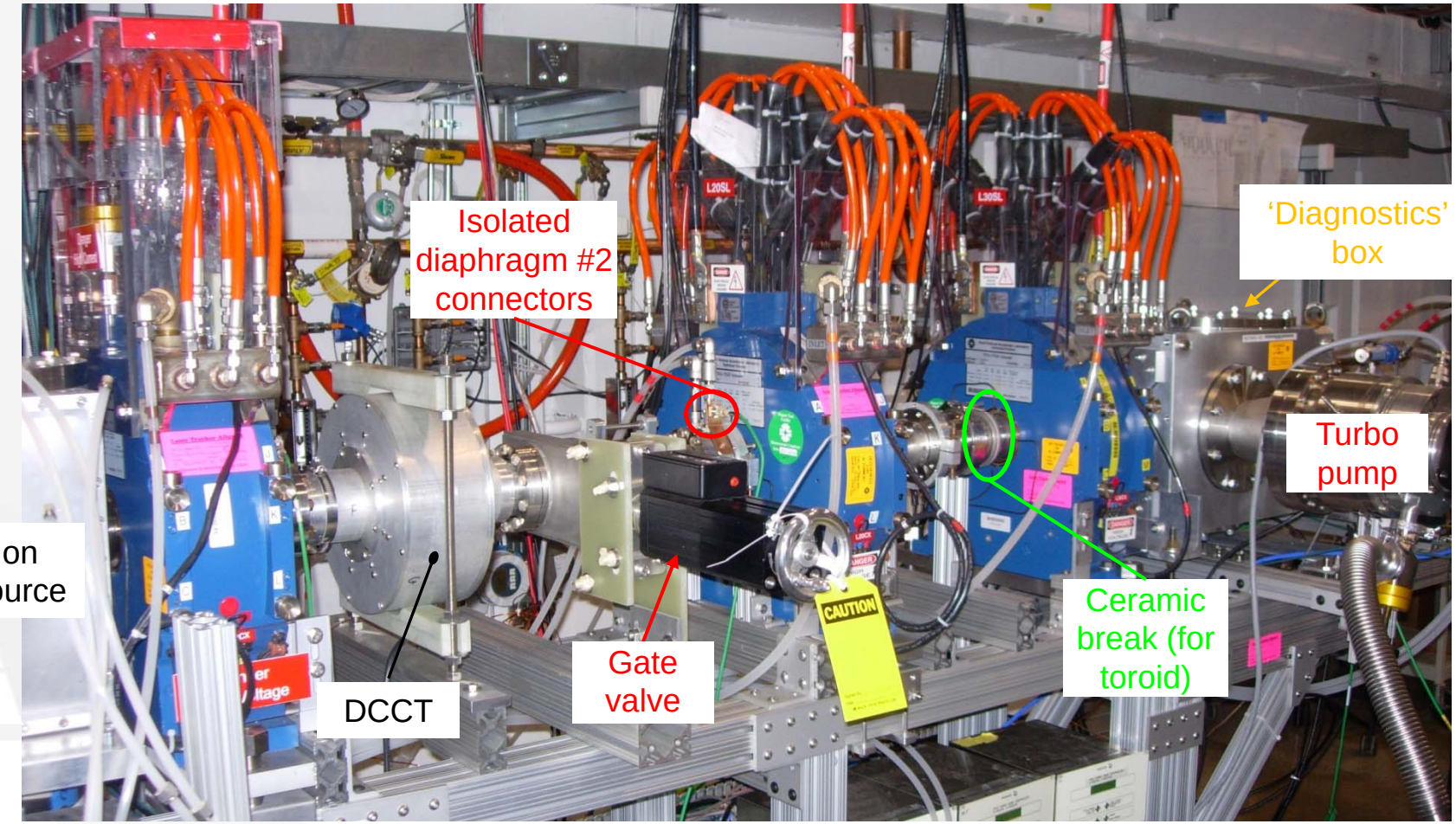
Vacuum contamination ? (cont')

- Similarly on the emittance scanner front slit and *within* the scanner body (*surfaces not exposed to beam*) ?
  - Also black coloration of on some ceramic parts
- Discussing the need of cleaning the entire scanner or not…





Current setup in picture



Status & Plan

- Approved to run with the new configuration late last week
  - Turned on yesterday and achieved up to 4 mA (pulsed) to the Faraday cup with (practically) no loss
- Emittance scanner has not been reinstalled yet
  - End of the week if no additional cleaning
    - At least one more week delay if it is decided that we have to clean it
- Measure solenoids #2 and #3 characteristics and check against expectations (i.e. Solenoid #1)
  - Need to obtain a *predictive* model of the beam line to interpret future neutralization experiments
- Beam size measurements with and without bias on various electrodes

Longer term…

- Expect to install the chopper by the end of September
  - Some fabrication has started (e.g. vacuum chamber)
  - Manpower-limited

- On-track for RFQ commissioning in Spring 2015