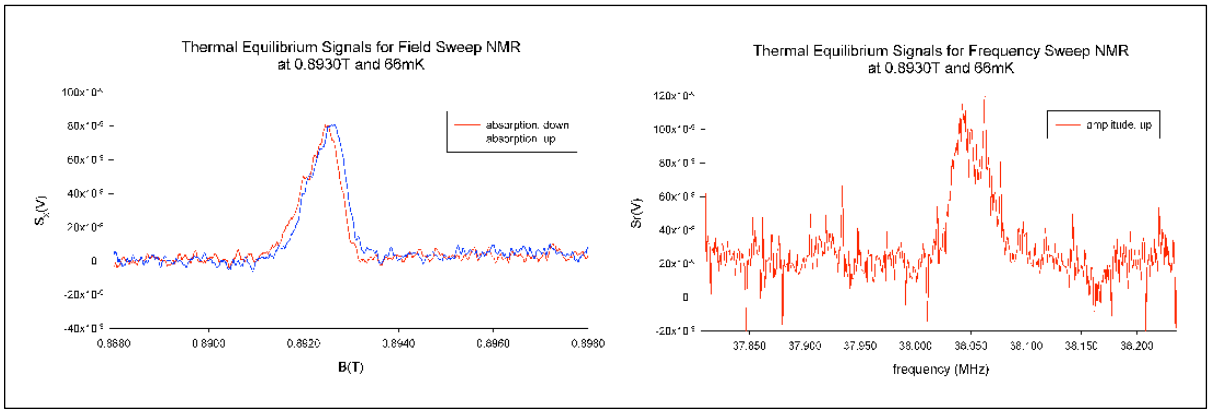
HDice@UITF Run 2 log-summary

last update: Nov 17/20

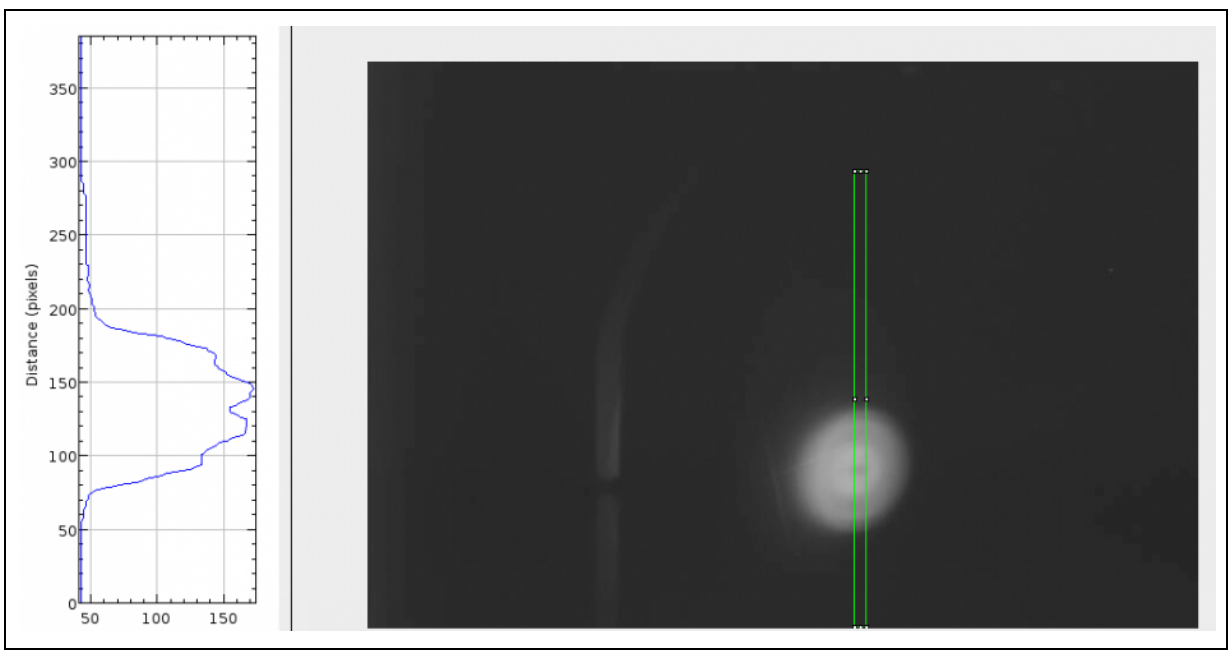
- **Oct 17** - loaded un pol tgt #62 into IBC;
  - Xiangdong runs NMR scans;
  - determines that there is too much noise to scan at 1.1T ⇔ use 3/2 λ line ⇔ 0.9 T



- **Oct 27** - <u>Run 2 starts</u>
  - tested Fernando's Oct 22 WF ☹
  - tested 9.5 vs 9.7 stability and settled on 9.7 MeV/c

- **Oct 28** - tested Fernando's Oct 27 WF ☹
  - tested Bill Gunning's Oct 22 WF – Sombrero1 (hmm !)
  - over-raster to find Kel-F valleys at dump viewer ⇔ verifies method of setting raster size
  - freqSweepNMR run at 0.9020T; current probably ~100 pA
  - tested raster ellipticity
  - find settings for Sombrero1 raster through IBC

- **Oct 29** - tested Luca's HARP detectors – they don't work
  - tested Bill Gunning's Oct 29 WF – Sombrero2 ☺ - https://logbooks.jlab.org/entry/3856040 ⇔ 18 – 39 KHz radius-dependent fundamental x 3 KHz AM



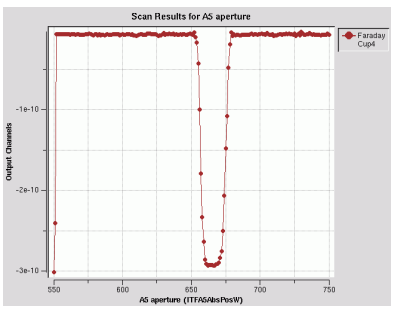
- freqSwNMR bkg runs at various fields - https://logbooks.jlab.org/entry/3856055

- **Oct 30** - HARP *IHAM905* working - https://logbooks.jlab.org/entry/3856142
  - to create circular spot on tgt: https://clasweb.jlab.org/wiki/images/2/26/Raster_V%2CH_ratio_to_create_circle_on_tgt.pdf
    ⇔ HARP scan dimensions: Vharp/Hharp = 1.212
    ⇔ Raster currents: Vpp(H) / Vpp(V) = 1.0716
  - freqSwNMR bkg runs at various fields - https://logbooks.jlab.org/entry/3856156

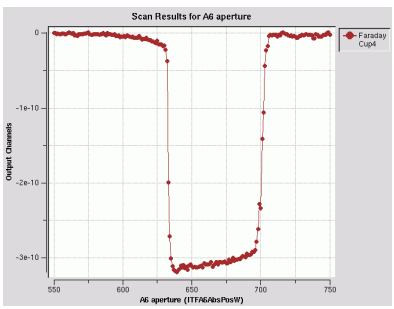
- **Oct 31** - Settled on final Platnimum^3 orbit
  - settled on full Sombrero2 size for [20A, 59A, 320A] magnets
    ⇔ Vpp(H) = 0.1688; Vpp(V) = 0.1575 - https://logbooks.jlab.org/entry/3856228

  - Eloss measurements via Tmix for full raster - https://logbooks.jlab.org/entry/3856234
  - fieldSweepNMR at 1.5 nA and 0.89T, several short (20 sweep) scans
  - Charles studied how to fill tgt at 0.9T. Rastered spot is smaller, due to lower MAIN field; could not find magnetic solution that didn't create other problems; instead, increased raster size by 11/9; but the tail is bigger. https://logbooks.jlab.org/entry/3856239

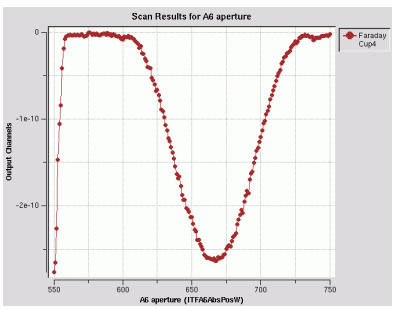
- **Nov 2** - PL^3 Beam-orbit Setup Procedure:
  With 50 pA on FC4:
  - With apertures A5 and A6 out, steer the beam to the reference pts on YAGs M904 and M905 while minimizing the fields in corrector M904A,
    – see https://clasweb.jlab.org/wiki/index.php/HDice@UITF for ref. pts.
  - Scan apertures A5 and A6 vertically (w Stepngraph) and center Apertures on the beam; (1 *step* = 0.1 mm)



A5 scan



A6 scan – Raster OFF



A6 scan – raster ON

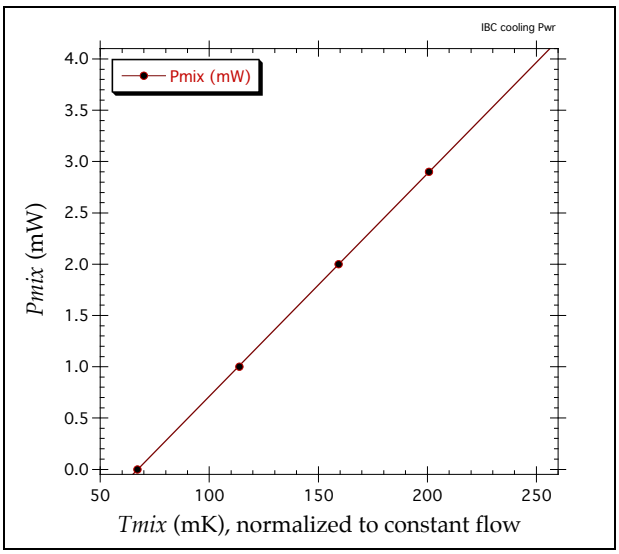
(Images from Nov 6)

  - Now adjust corrector M904_H and M904A_H to center the beam in both A6 and on M905; check with raster OFF and Raster ON.
  - Set corrector M904C (Radiabeam coil) to last reference

  With 50 pA and Raster ON, remove FC4 and send beam through target
  - compare dump viewer MA01A to reference - https://clasweb.jlab.org/wiki/index.php/HDice@UITF
  - adjust M904C to center beam spot using HALO counters

⇔ typical PL^3 viewer walk: https://logbooks.jlab.org/entry/3856444 (Main at 0.9T);
https://logbooks.jlab.org/entry/3856460 (Main at 0.9T & 1.1T)

- IBC cooling pwr data:



- Recheck of Mike's Sept 17/20 results
  - https://logbooks.jlab.org/entry/3850588 ;

  - Adding Pmix heat to mixing chamber (IBC Log 4, p 12-13). Adding Pmix increases flow, which increasing cooling and drops Tmix;

  ⇔ Tmix normalized to flow at base:

  Normalized-Tmix = Tmix x Flow(Pmix)/Flow(b)

- Ie = 0.5 nA, NMR at 0.9T to look for screening for a few hours

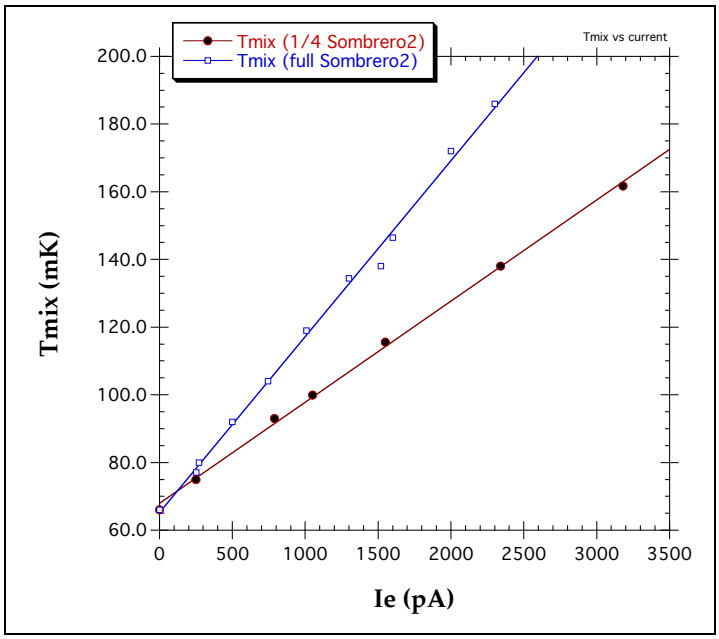
- **Nov 3** - fewer apparent spikes in dump current with +300 V bias; more spikes with +500 V bias
  - NMR at 0.25 nA, full raster, 100 sweeps at 5 g/s, <Tmix> = 77 mK, https://logbooks.jlab.org/entry/3856618

- Tmix measured on Oct 31/20 with full Sombrero2, and magnets [20A. 59A, 320A], https://logbooks.jlab.org/entry/3856234 .

- Tmix measured on Nov 3 with ¼ size Sombrebo2, and magnets [20A, 47A, 320A], are significantly less than with full size, https://logbooks.jlab.org/entry/3856618, and subsequent log entries

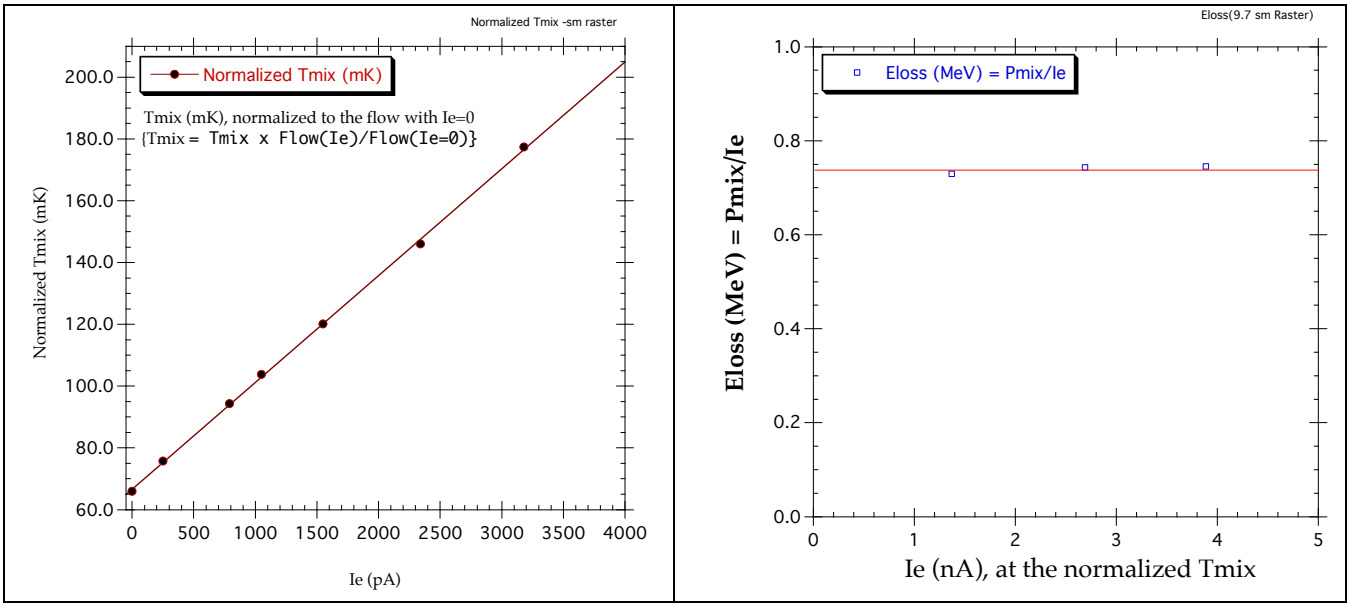
⇒ tails that hit the MIX stop and deposit 20 times the Eloss (ie their full energy)

- Measured Tmix vs current for ¼ size Sombrero2, where tails are small.



- Normalize Tmix: Eloss adds heat, which increases the 3He cooling and drops Tmix
  ⇒ normalize Tmix by Tmix * Flow(Ie)/Flow(base) ⇔ see plot below

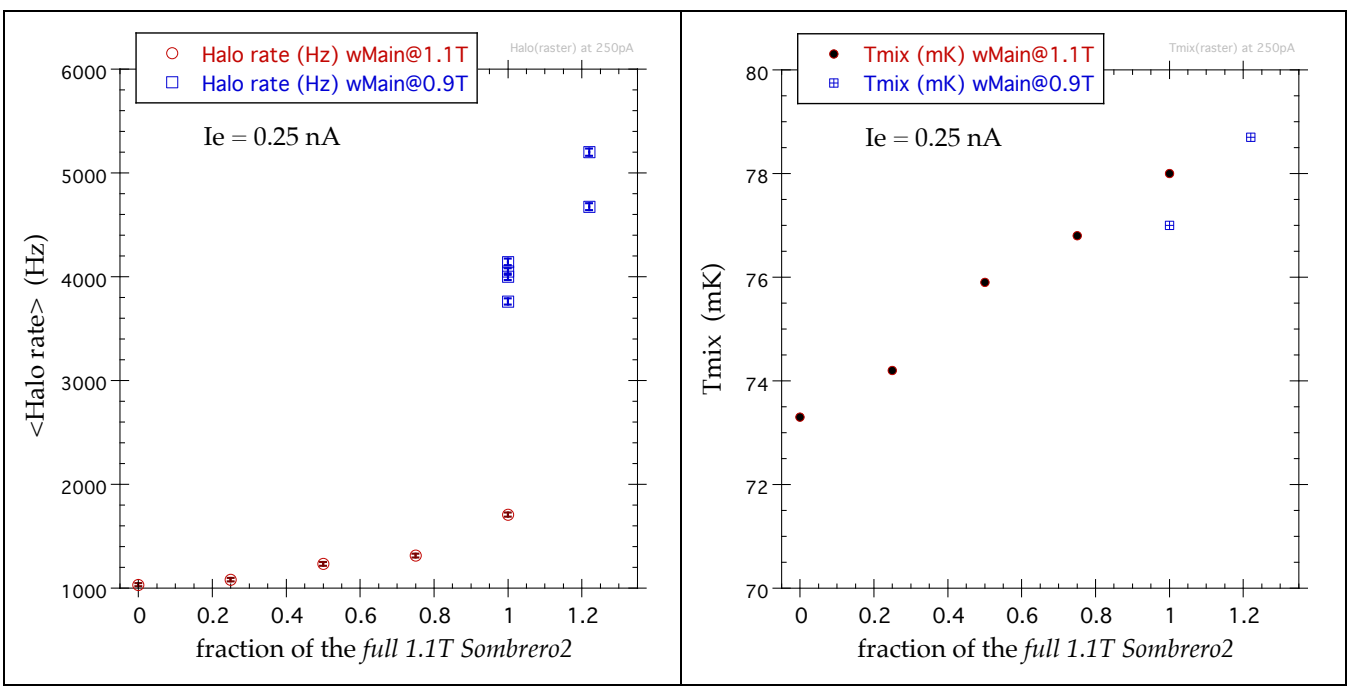
- Eloss per electron = ratio of Pmix (mW) / Ie (nA) at the same normalized Tmix, in mW/nA = MeV-nA/nA, ie in MeV/electron
  ⇔ **Eloss = 0.74 MeV per electron = energy deposited**



- Energy deposition calculation using the NIST *ESTAR* code gives 0.70 MeV for the UITF tgt cell, https://logbooks.jlab.org/entry/3857640 .

Notes: - the ESTAR energy lost in the HD + Aluminum is 0.556 MeV, which agrees with the original calc
- rest, 0.696 – 0.556 = 0.140 MeV is lost in the Kel-F and the wires in front of the HD. Nonetheless, this 0.14 MeV contributes to the heating of the mix chamber.
- the 0.74 MeV deduced from mix heating with a small raster probably still contains some small contributions from electron tails that stop and deposit all their energy in the mix, since the Tmix vs raster size shows no sign of leveling off even when the raster is turned off (see Nov 4 data below).

- **Nov 4** - Measured Halo rates and Tmix variation with raster size
  ⇒ tails on the beam are clearly visible as increased HALO rate and increased Tmix
  ⇒ Charles cannot find magnetic solution with g4BL that fills the target at 0.9T; only solution to avoid under-rastering is to use 11/9 x raster at 1.1 T
  - But this shows up as increased Halo rates, from tails stopping in the mix



- NMR at 0.25 nA for 2 hr, https://logbooks.jlab.org/entry/3856768
- NMR at 0.125 nA for 4 hr, https://logbooks.jlab.org/entry/3856772

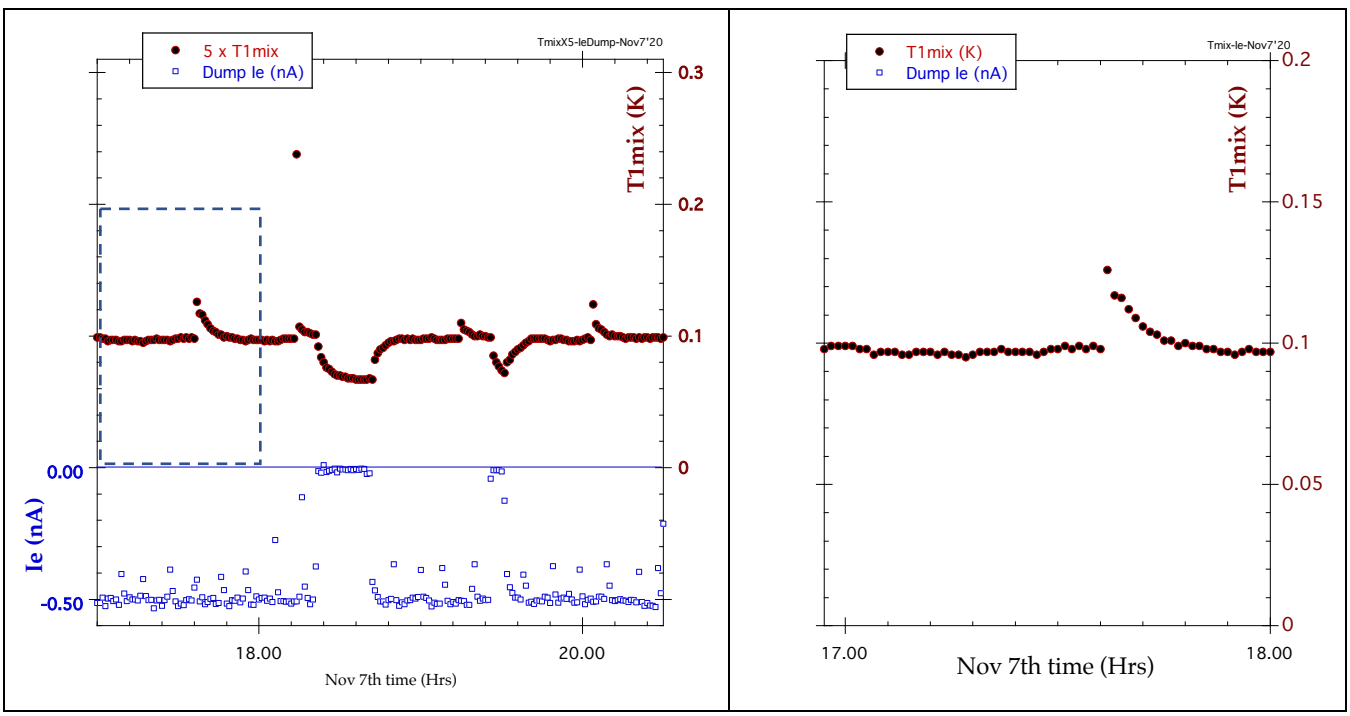
- **Nov 5** - NMR at 0.25 nA, https://logbooks.jlab.org/entry/3856893, https://logbooks.jlab.org/entry/3856919

- **Nov 6** - Tests of Aperture scans with StepNGraph – (results plotted above with Nov 2 log)
  - Tsuneo tests analog DAQ at ¼ nA
  - NMR with Pmix = 0.36 mW to simulate ½ nA heating, https://logbooks.jlab.org/entry/3857006

- **Nov 7** - Calibration of HALO-deduced position with beam displacement with full Sombrero2
  - magnets at 1.1T setting: [20A, 59A, 320A]; 100 pA nad 250 pA
  - moved beam with MATM904 to positions (R2.b), (R2.+j), (R2, -j) & (R2.X_H)
  https://logbooks.jlab.org/entry/3857067

  - repeated calibration checks at 0.9T settings: [20A, 48A, 320A], with 11/9 Raster
  https://logbooks.jlab.org/entry/3857069

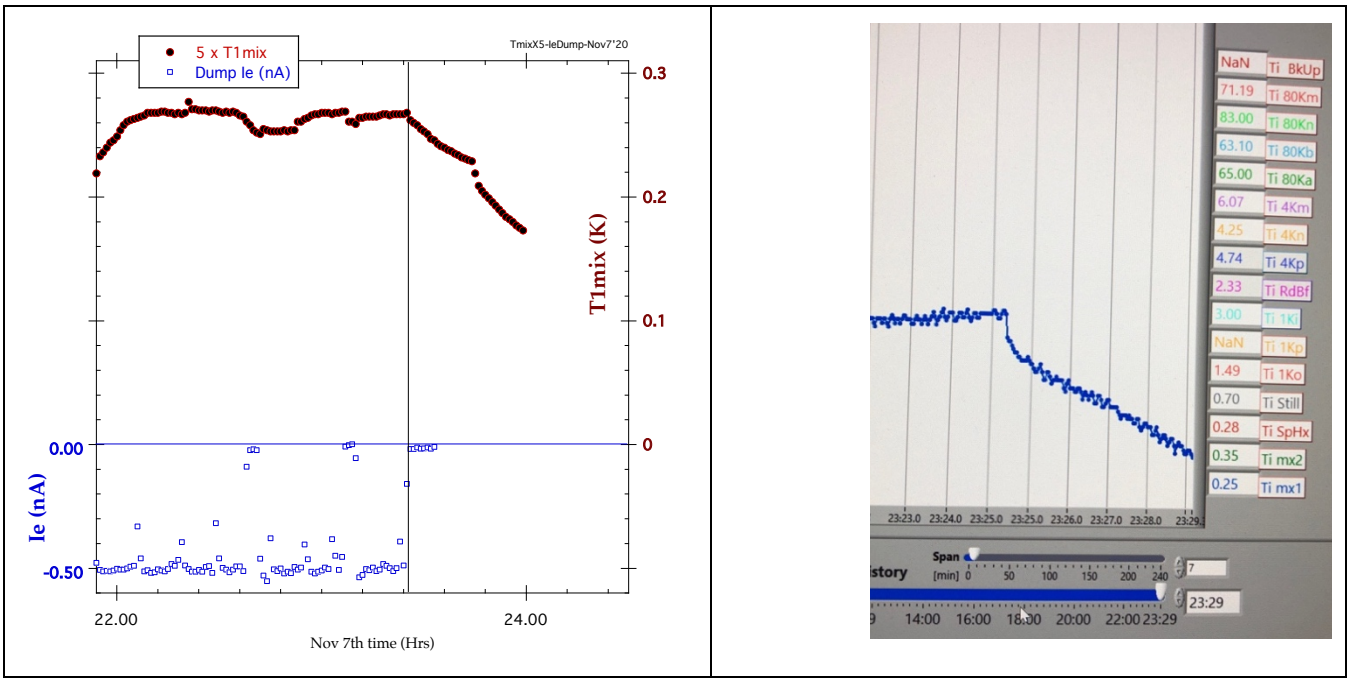
  - NMR at 0.5 nA, 11/9 full Sombrero2, 0.9T Main, Tmix = 98 mK
  – 4 hr, 100 sweeps, 16:30 -to- 20:30
  https://logbooks.jlab.org/entry/3857077 .



- Sudden releases of energy, followed by a slower decay in temperature were observed with a frequency of about once every 45 min with 0.5 nA on target (left panel above). The event at 17:37 on Nov 7, observed while the beam was constant at 0.5 nA, (dashed box in the left panel) is enlarged in the right panel. We interpret these as *recombination flashes*, energy released as dissociated H and D recombine.

- NMR at 0.5 nA, 11/9 full Sombrero2, 0.9T Main
at **elevated Tmix** = 268 mK (Pmix = 2.4 mW w Pstill = 20 mW)
    - 21:55 -to- 23:45
    - Tmix fast recording from 23:21 -to- 23:45 to check fall off when beam goes away.

https://logbooks.jlab.org/entry/3857081



- with Pmix on to elevate the temperature, there appear to be fewer and/or less intense recombination flashes.

- The ½ nA beam was shut down at 23:24 on Nov 7 (the vertical line in the above left panel). Tmix dropped suddenly, but only slightly and then continued a slow decay (as seen in an expanded scale in the right panel). Suggests energy stored in HD dissociation is released as species recombine.

- **Nov 9** - Tsuneo DAQ tests with artificial helicity rigged by Matt
    - More RC#3 studies by Kevin
    - END OF RUN 2

- **Nov 11** - extracted Run 2 target (#62) from IBC and transferred to PD

- Comparison of field-sweep NMR w & w/o beam during Run 2. (These data are taken in field-sweep mode; the two points at each current are the integrated areas of the absorption signals observed during the down and up sweeps of the field.)