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Canada's national laboratory
for particle and nuclear physics
and accelerator-based science

Construction and Commissioning of the Beamline for the UCN Source at TRIUMF

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TRIUMF and University of Winnipeg

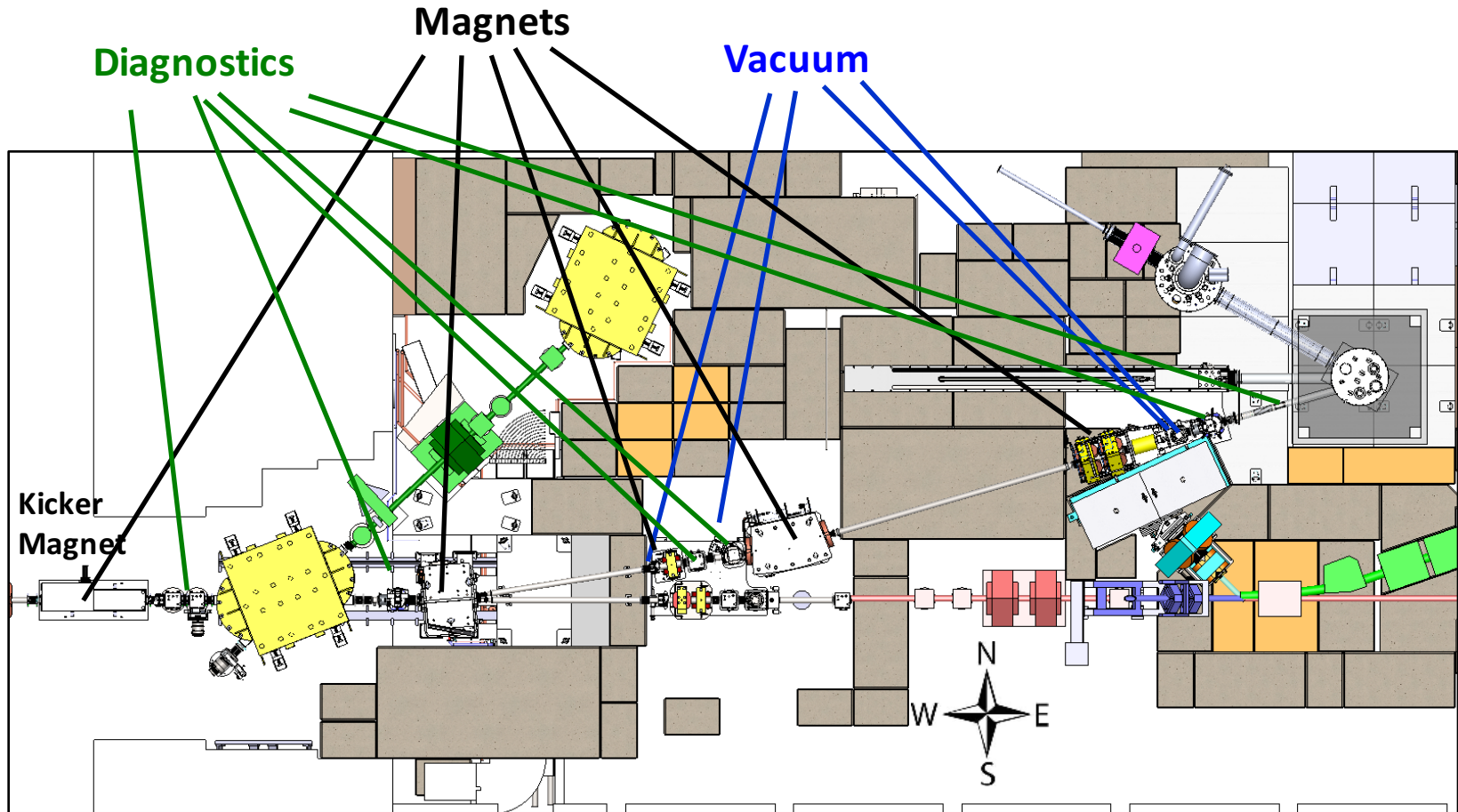
June 1, 2017



- 2016 Accomplishments
 - Completion of Beamline
 - Beamline Commissioning
 - First beam on target
- Ongoing Work
 - Radiation Shielding
 - Machine protection
 - Kicker magnet

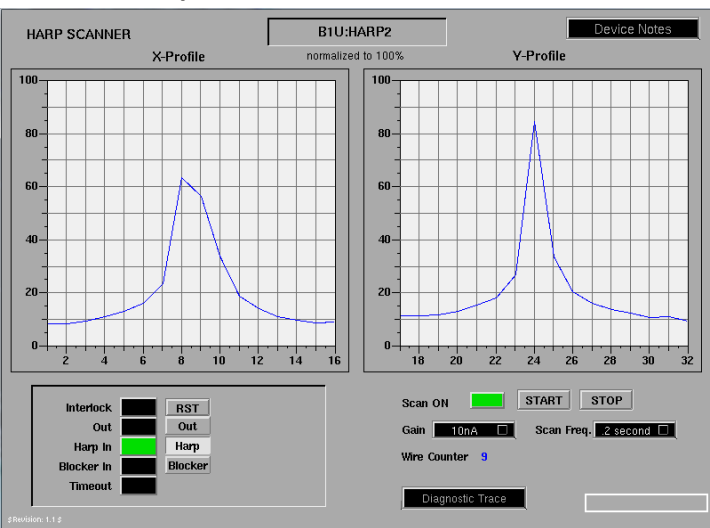
- UCN beamline is new proton beamline that redirects a portion of the 1A beam to the UCN target.
- Constructed and commissioned (mostly) over the past couple years.



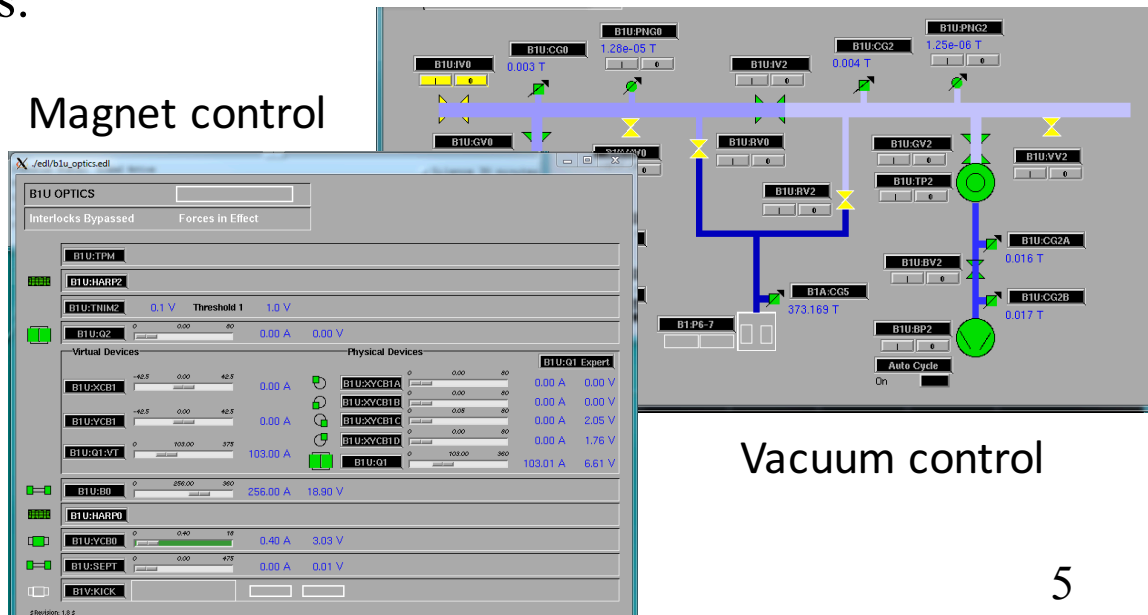


- TRIUMF Controls group provided EPICS control of the beamline elements.
- Challenges:
 - First proton beamline at TRIUMF with EPICS.
 - Cyclotron and beamline 1A controlled with older non-EPICS system; interface issues.

Beam profile monitors



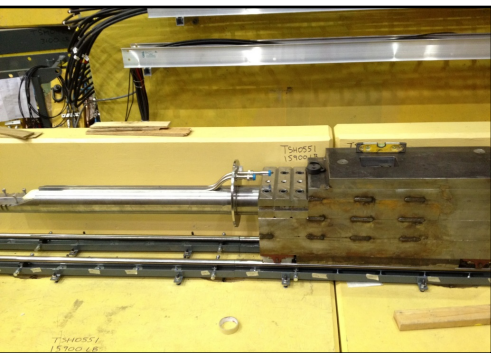
Magnet control



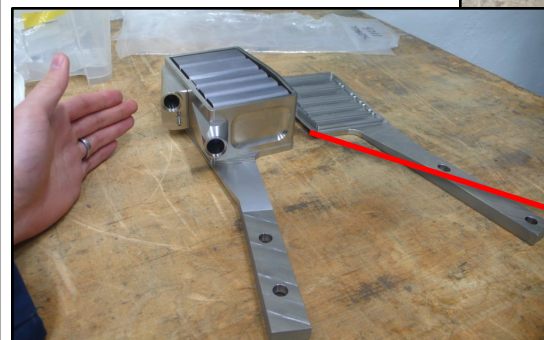
Vacuum control

- UCN target: tantalum-clad tungsten.
- Installed during Winter 2016.
- Water cooling; 14kW of heat to remove (at final power)
 - Need to deal with activated water. Finishing commissioning water package now.
- Have system for remotely removing UCN target

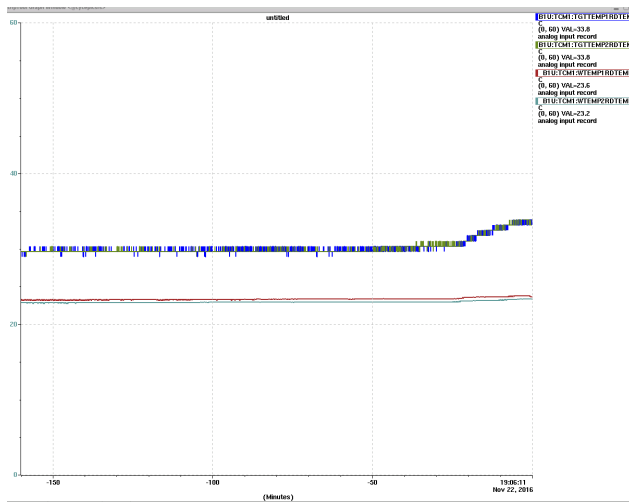
UCN Target Removal System



UCN Target



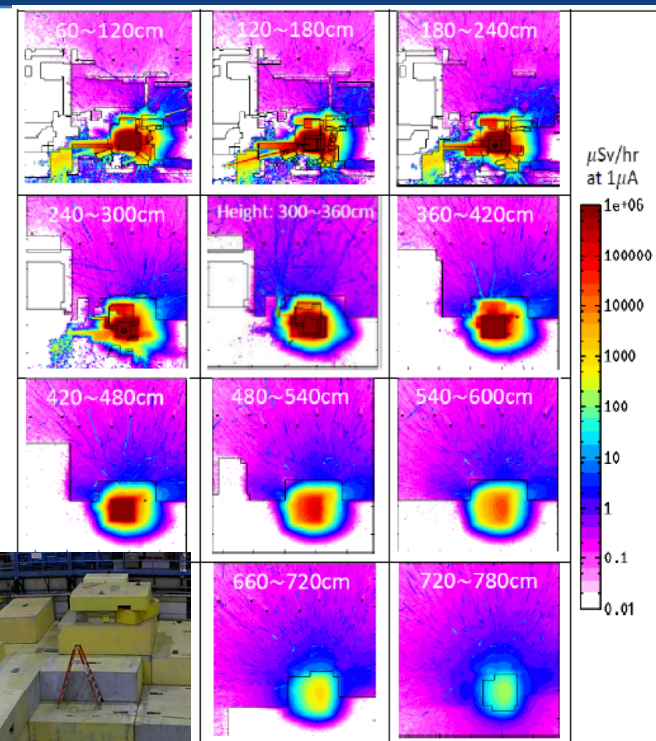
- First beam to UCN target on Nov 22, 2016.
- Thanks to lots of work from many, many different groups at TRIUMF!



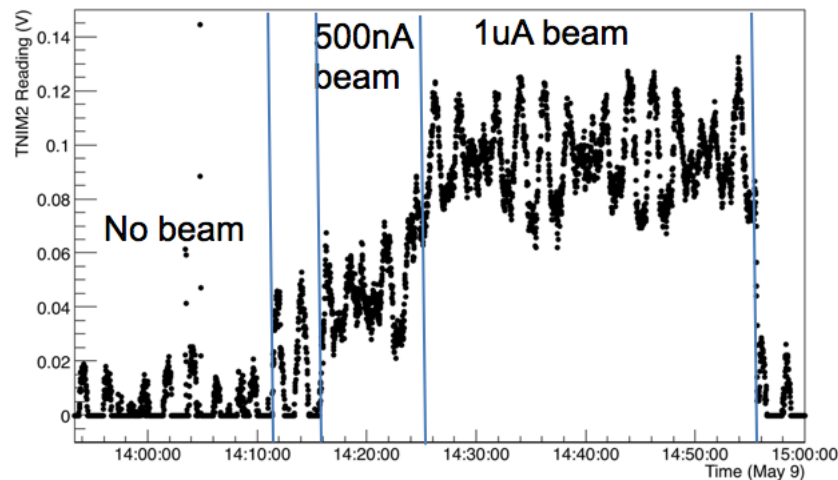
Temperature rise in UCN target cooling water



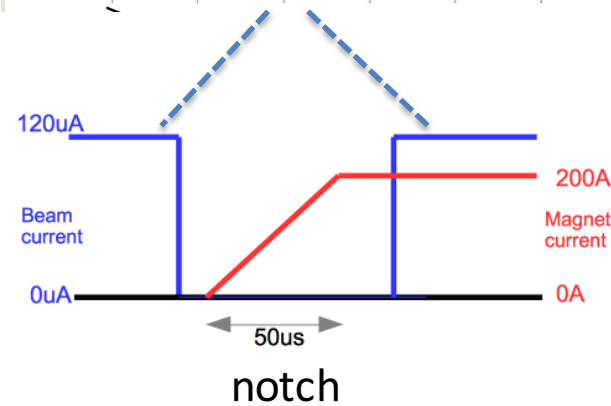
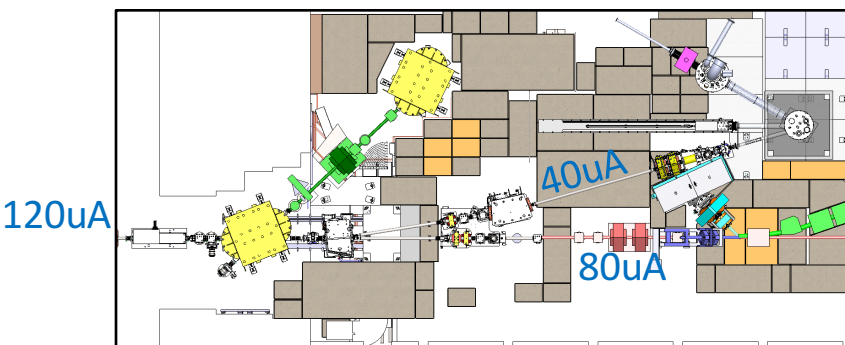
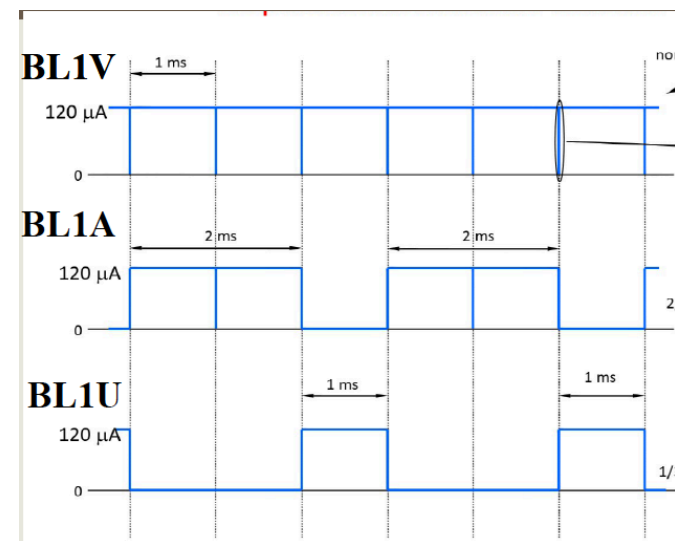
- Extensive work on radiation shielding around UCN target/cryostat. Procedure:
 - Detailed fluka simulation of 1uA
 - Shielding additions to fix weak spots.
 - TRIUMF radiation protection group makes survey during beam tests.



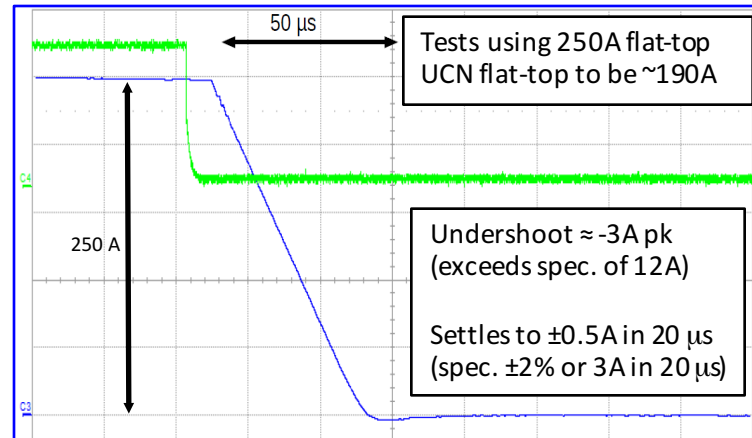
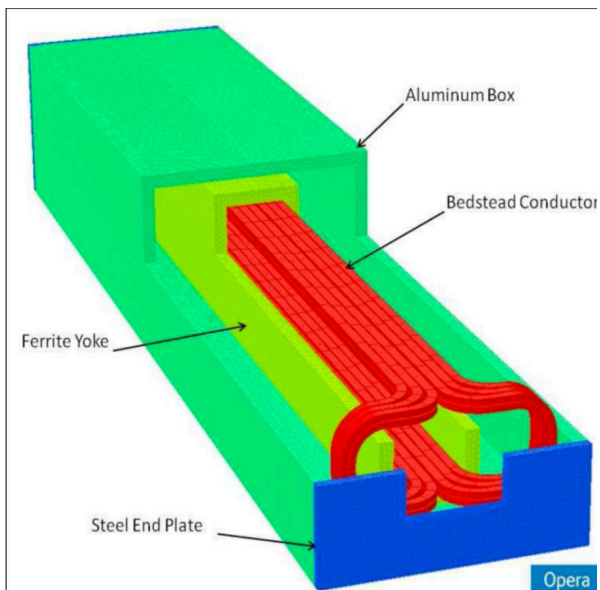
- UCN beamline shielding is currently designed for 1 uA of proton beam; eventually 40uA.
 - Need to develop protection system to automatically turn off beam if beam current exceeds those levels.
- Using Toroidal Non-Intercepting Monitor (TNIM); shaped with analog electronics and readout with PLC. PLC can provide cyclotron interlock.
- Challenge: it is difficult to make accurate measurements at this low current.
- Working on improving probe noise levels, as well as using PLC-based filtering/averaging techniques.



- UCN beamline will run parasitically with TRIUMF beamline 1A (muSR program).
- Cyclotron beam is divided into $\sim 1\text{ms}$ pulses, separated by short notch.
- UCN kicker magnet will ramp up during notch, deliver one pulse to UCN beamline, then ramp down for next N notches ($N = 2$ for $40\mu\text{A}$ to UCN).

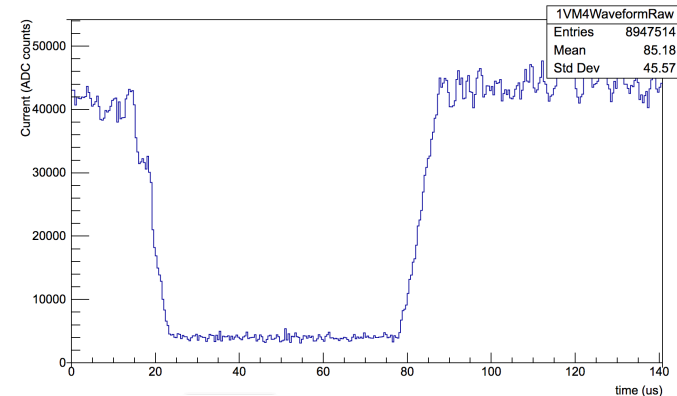


- Kicker Magnet built by Danfysik.
- Installed Feb 2016.
- Magnet meets required $<50\mu\text{s}$ ramp-up and ramp-down.
- Rep rate: 330 Hz.

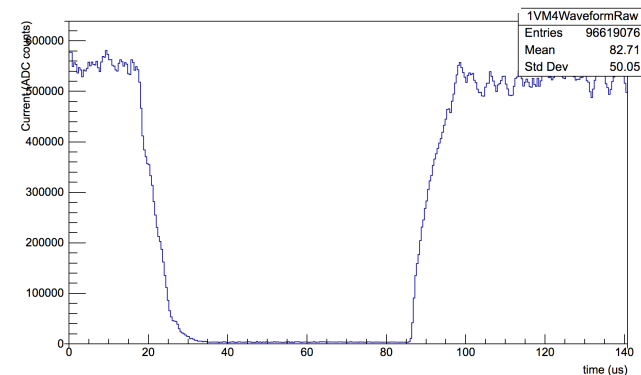


- New capacitive probe on 1 V beamline (just before kicker) to characterize the beam notch position and cleanliness.
 - Beam notch can have residual beam in it, which will spill over the beamline elements.
- Probe is coupled to LC amplifier and digitized by 1GSPS ADC. Allows precision measurement of small beam current.
- Operators already using monitor to optimize notch cleanliness.

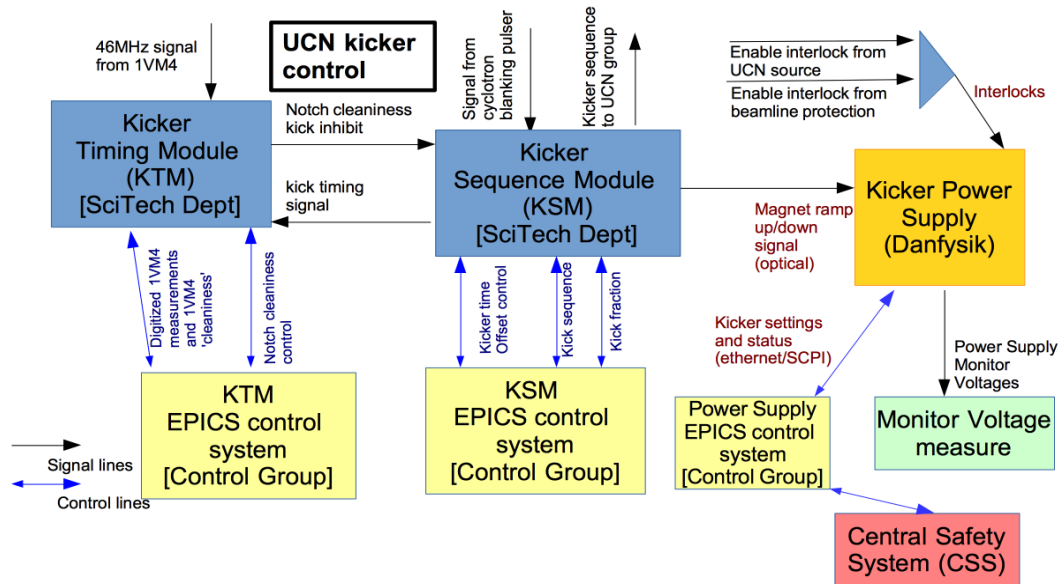
Notch for 10uA Beam



Notch for 100uA Beam



- Developed system for synchronizing the magnet ramps with beam notches.
- Control based on a VME IO board, with special firmware.
 - EPICS control of hardware almost finished.
- First test of the kicker magnet in “kicking mode” on June 6!



- Tremendous progress on the UCN beamline over last couple years.
- Culminated in first beam on target Nov 22, 2016.
- Commissioning of beamline going well.
- First full tests of kicker magnet very soon.



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Thank you!
Merci!

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Carleton | Guelph | Manitoba | McGill | McMaster |
Montréal | Northern British Columbia | Queen's |
Regina | Saint Mary's | Simon Fraser | Toronto |
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- Kicker diverts the beam into septum magnet, which deflect UCN beam by larger angle.

