Introduction to the UCN facility at TRIUMF

Beatrice Franke
nEDM2017 workshop, Harrison Hot Springs, BC Canada

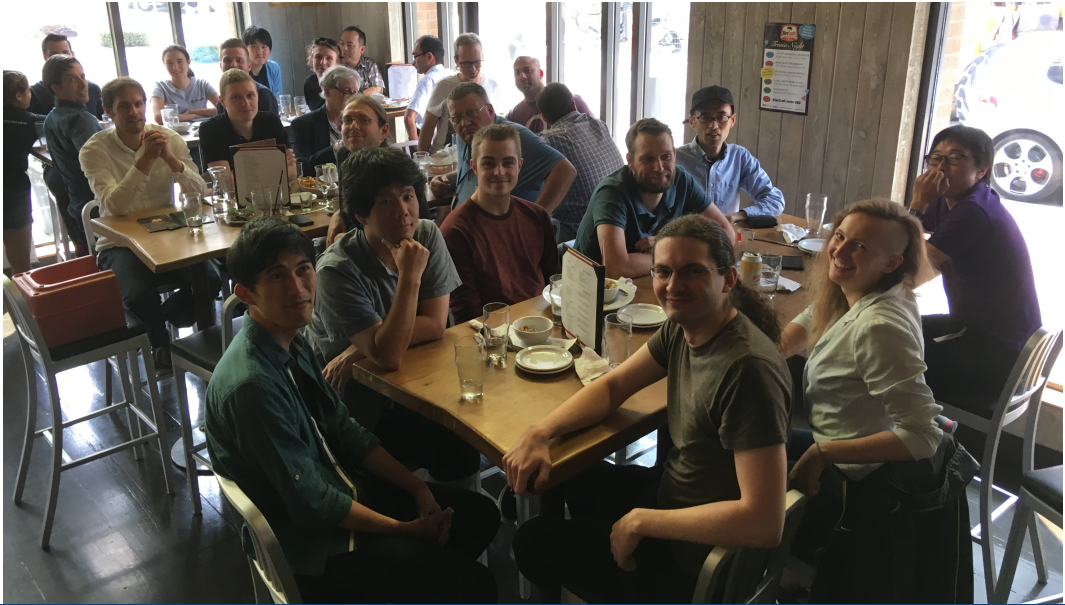
The Japanese-Canadian UCN collaboration
TRIUMF's cyclotron and beamline 1U
Overview of project status

Japanese–Canadian UCN nEDM collaboration

KEK	T. Adachi, S. Jeong, S. Kawasaki, Y. Makida, K. Mishima, T. Okamura, Y. Watanabe
U Nagoya	M. Kiraguchi, H. Shimizu
RCNP Osaka	K. Hatanaka, I. Tanihata, R. Matsumiya, E.Pierre (R.M. & E.P. also TRIUMF)
UBC	E. Altiere, D. Jones, K. Madison, E. Miller, T. Momose, J. Weinands, T. Hayamizu
U Winnipeg	C. Bidinosti, B. Jamieson, R. Mammei (also TRIUMF), J.Martin
U Manitoba	T. Andalib, J. Birchall, M. Gericke, M. Lang, J. Mammei, S.Page, L. Rebenitsch, S. Hansen-Romu, S. Ahmed
TRIUMF	C. Davis, B. Franke, K. Katsika, T. Kikawa, A. Konaka (also UVic and Osaka U.), F. Kuchler, L.Lee, R. Picker (also SFU), W.Ramsay, W.vanOers (also U. Manitoba), T. Lindner (also UW)
UNBC	E. Korkmaz
SFU	J. Sonier

We are an open collaboration and are accepting new membership requests!

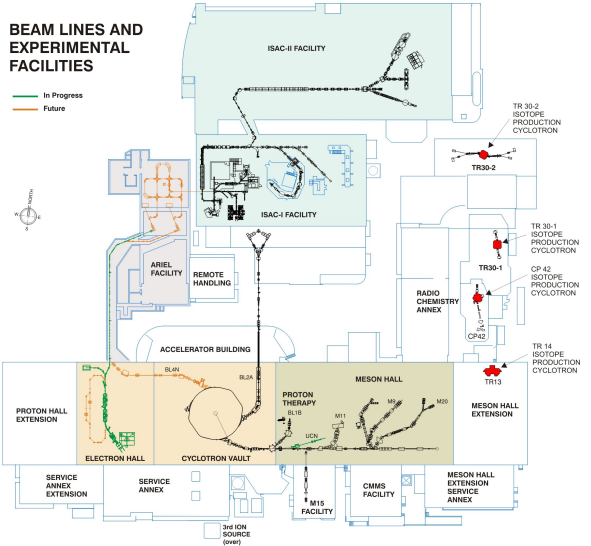
Japanese–Canadian UCN nEDM collaboration



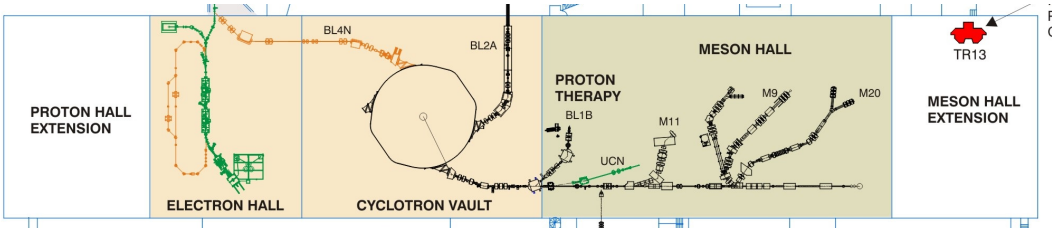
Objective

- Operate world's strongest intensity ultracold neutron (UCN) source at TRIUMF: combination of spallation neutron source and superfluid He converter
- Search for the neutron electric dipole moment (nEDM) to a precision of $10^{-27}\,e$cm
- Establish UCN user facility with a second port & and attract international scientific community

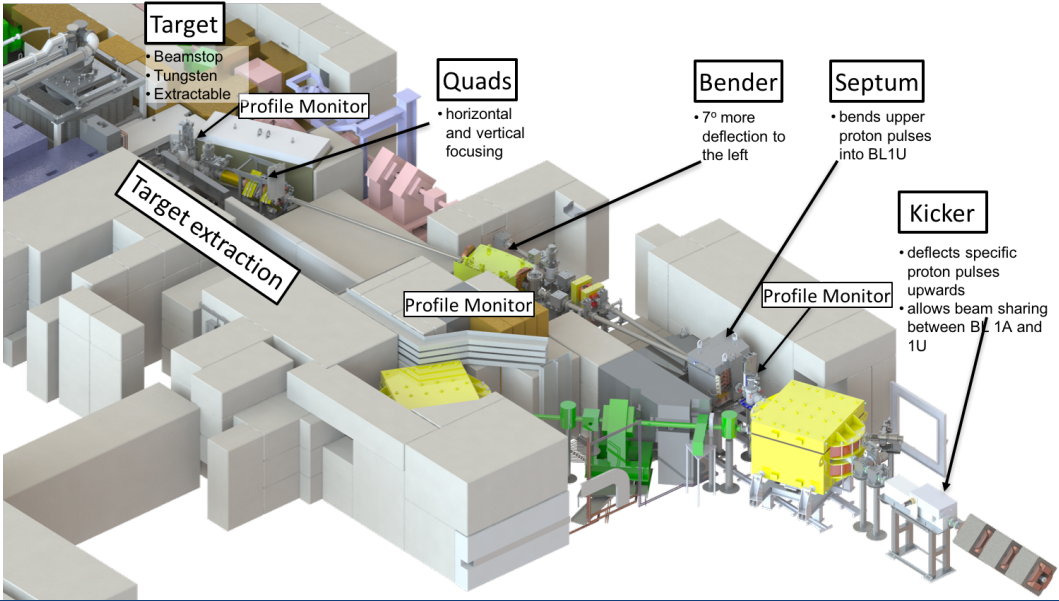

TRIUMF
4004 Wesbrook Mall
Vancouver, B.C.
CANADA V6T 2A3


BEAM LINES AND EXPERIMENTAL FACILITIES
In Progress
Future
ISAC-II FACILITY
TR 30-2 ISOTOPE PRODUCTION CYCLOTRON
TR30-2
ISAC-I FACILITY
TR 30-1 ISOTOPE PRODUCTION CYCLOTRON
TR30-1
CP 42 ISOTOPE PRODUCTION CYCLOTRON
ARIEL FACILITY
REMOTE HANDLING
RADIO CHEMISTRY ANNEX
CP42
ACCELERATOR BUILDING
TR 14 ISOTOPE PRODUCTION CYCLOTRON
TR13
BL4N
BL3A
MESON HALL
PROTON THERAPY
BL1B
M11
M9
M20
UCN
PROTON HALL EXTENSION
MESON HALL EXTENSION
ELECTRON HALL
CYCLOTRON VAULT
SERVICE ANNEX EXTENSION
SERVICE ANNEX
M15 FACILITY
CMMS FACILITY
MESON HALL EXTENSION SERVICE ANNEX
3rd ION SOURCE (over)

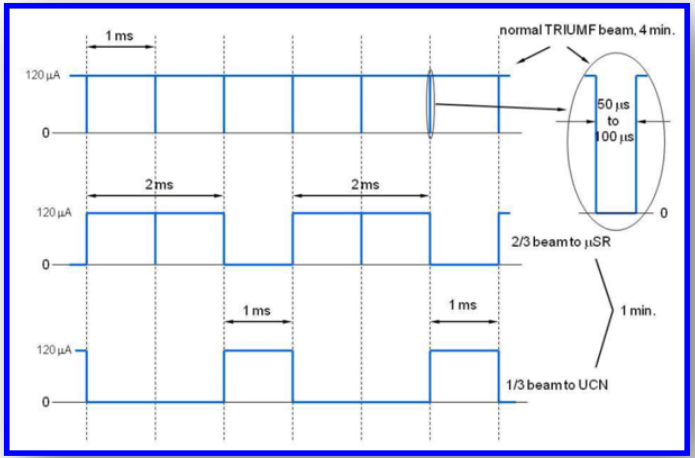
- H- ions are accelerated, and p^+ extracted through stripper foil at $\sim$500 MeV
- Three beamlines can be fed with 120 μA at a time – simultaneous operation of different facilities
- Nuclear Physics, Particle Physics, Life Sciences, Material and Molecular Science, Eye Cancer Treatment via Proton Therapy
- Overview of TRIUMF's scientific program by Jens Dilling this afternoon



Beamline 1U, Meson hall



Beam Structure and Kicker Magnet



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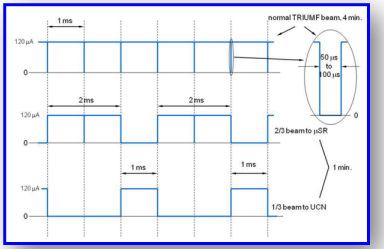

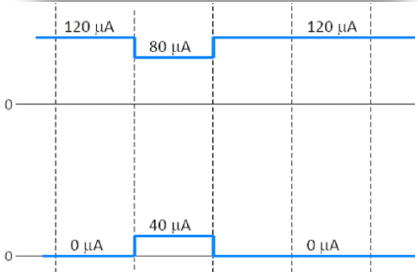

- We need to share the beam with other BL1A users (Center for Materials and Molecular Science, CMMS)
- TRIUMF's beam structure has a 'notch' of zero beam between the 120 μA pulses

  (pulse: 1 ms; notch: 50-100 μs)
- Directing every third pulse to BL1U results in an average of 40 μA

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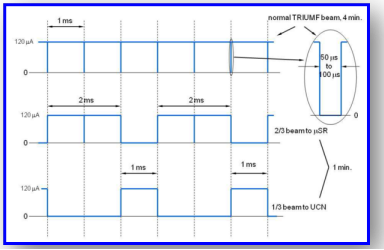

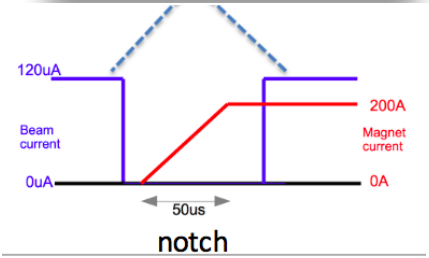

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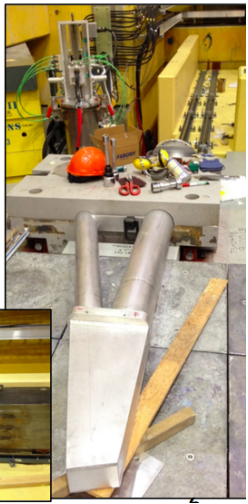
- Directing every third pulse to BL1U results in an average of 40 μA
- Kicker magnet has to ramp within notch!
- Timing of target irradiation:

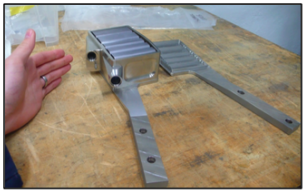
  find optimum between UCN density accumulation, and heat load on cryostat
- difference between sD2 and He-II: UCN lifetime inside converter medium!

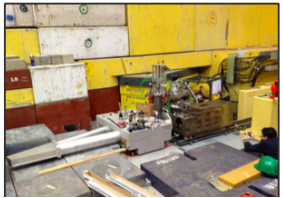
  $\sim$200 ms vs tens/hundreds of seconds
- We aim at an irradiation time of $\sim$ one minute

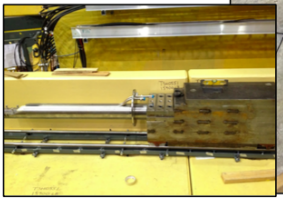
UCN Target

- 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

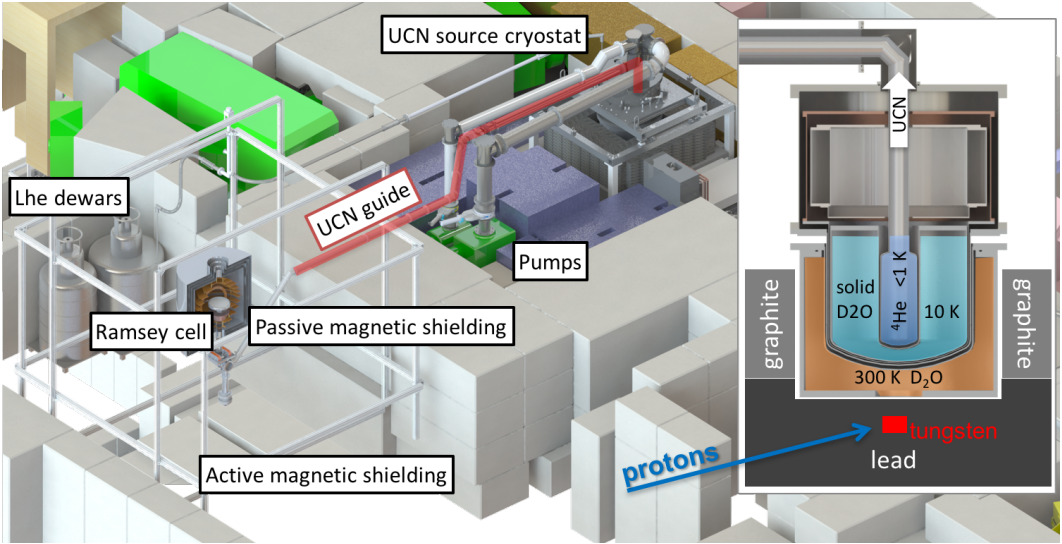








UCN experimental area, Meson hall



Recent progress

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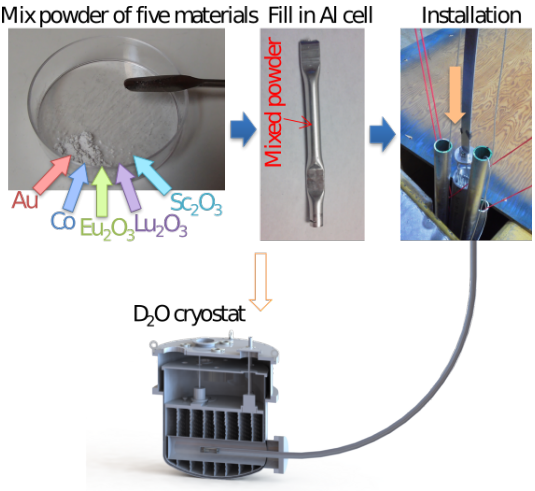

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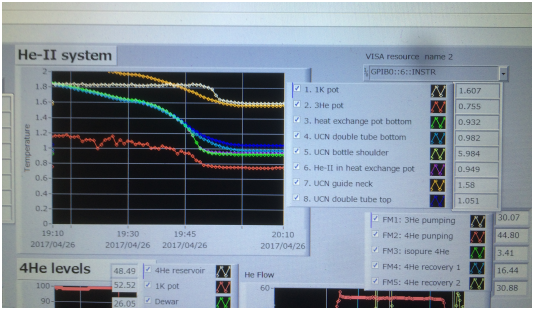

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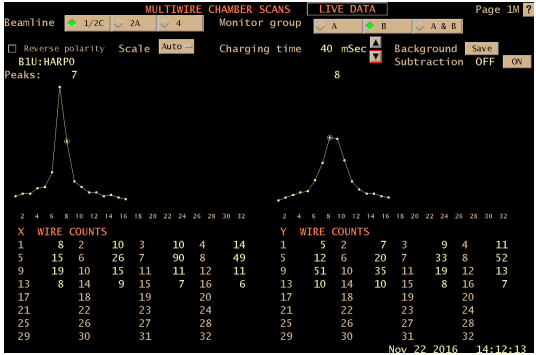

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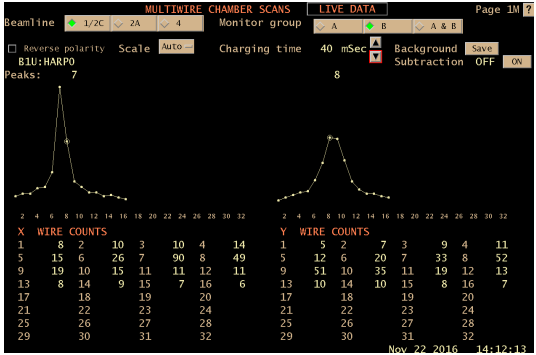
- First cooling test in April: 0.92 K!
- Getting a better understanding and 'practice' in operating the new beamline:
  effects of magnet scans observed on HARP detectors and spill monitors
- Kicker magnet works as expected and is functional
  we are ready to share beam parasitically with BL1A



Current status:

- Previous cooling test had been successful, but that was during shutdown
- Couple of beam times to do beamline and kicker tests
- Two attempts at UCN prod failed
- Next cooldown with Vertical Source starts after this workshop!
- In parallel: development of a new source (Phase 2)
- And: development towards next generation nEDM spectrometer

Conclusion: Overarching schedule

- First UCN production at TRIUMF soon!
- Characterization of Phase 1 UCN source as input for ongoing Phase 2 design (Phase 1: $\sim$handful of UCN/cm^3 vs. Phase 2: $\sim$hundreds of UCN/cm^3)
- Cryostat for Phase 2 expected operational in 2-3 years

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Competitive nEDM measurement at $10^{-27}\,e\mathrm{cm}$ precision:

- Statistics accumulation could be achieved in approximately one year
- Systematic studies: additional $\sim$three years

Thank you for your attention