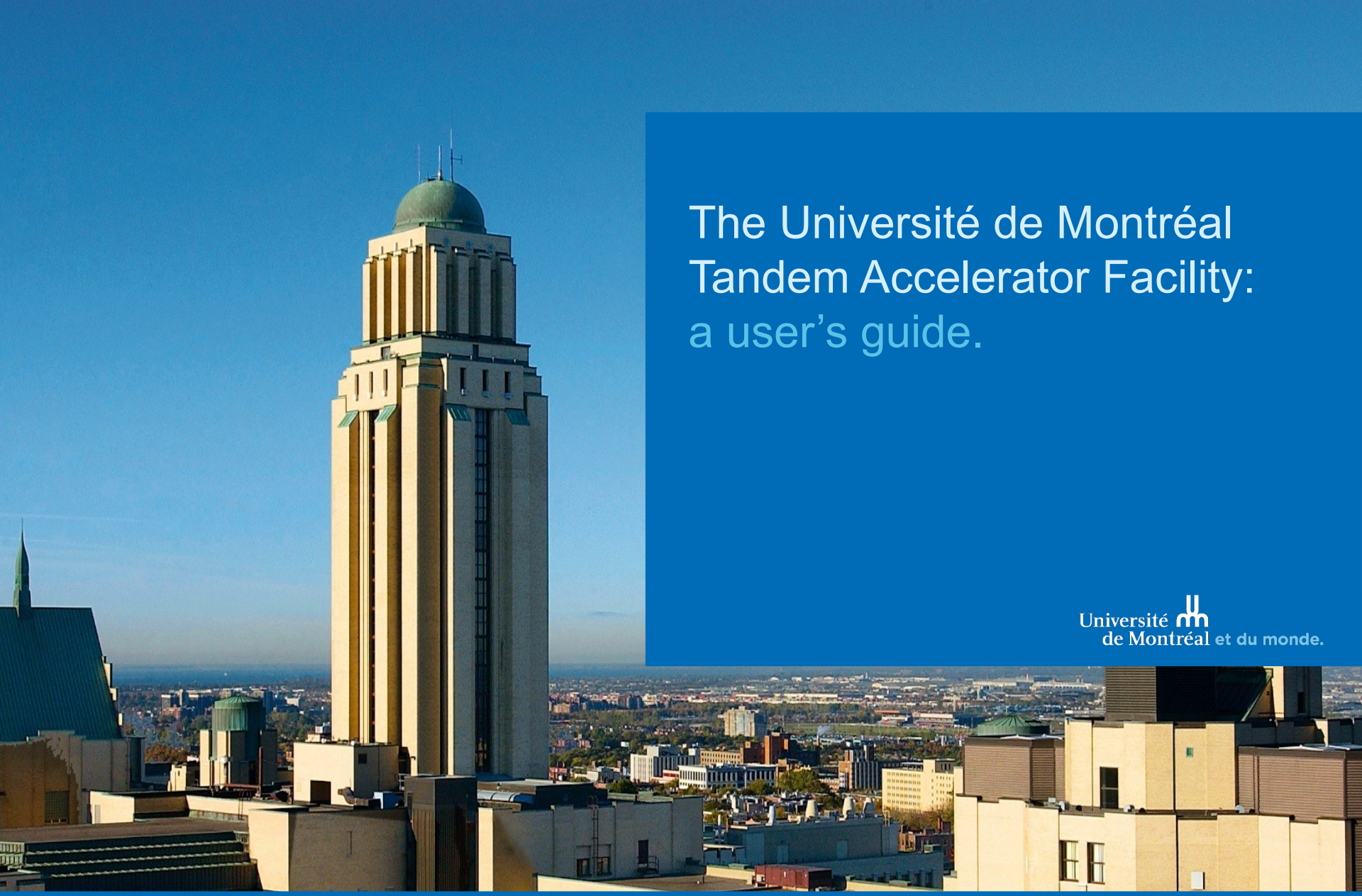

The Université de Montréal Tandem Accelerator Facility: a user's guide.

Université de Montréal et du monde.

Alan Robinson
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12 August 2021

Dark matter problems

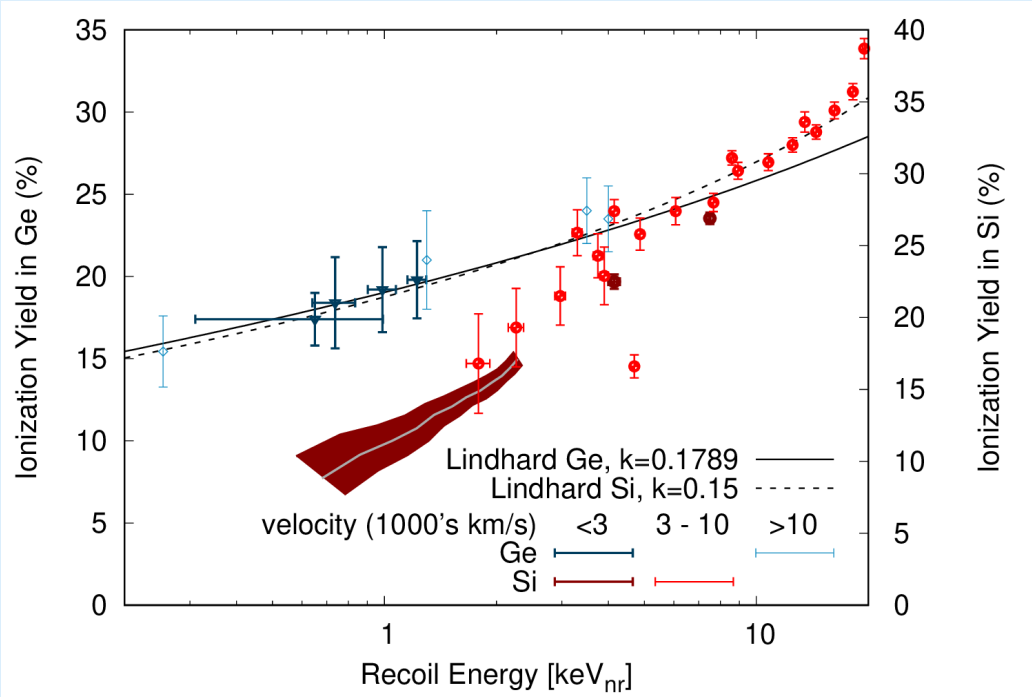
Nuclear physics problems

- Nuclear recoil calibration

  Montréal will soon have the best facility in the world.

- New particle resonances

- Neutron production cross sections

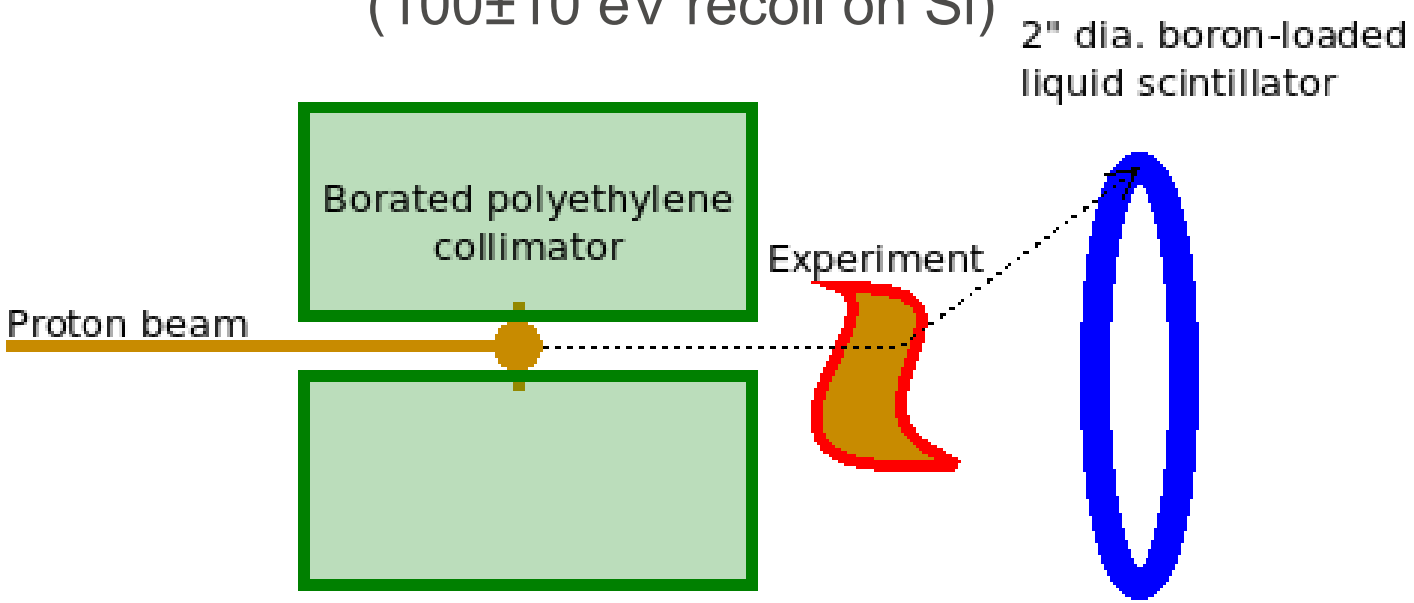


Data from
Chavarria, **AER**, et al., PRD **94** 082007 (2016)
Scholtz, **AER**, et al., PRD **94** 122003 (2016)
and references therein


EN-1 5 MV Tandem
Wide variety of heavy ion beams available.
4 μA of continuous proton current.
< 1 keV energy resolution / stability.

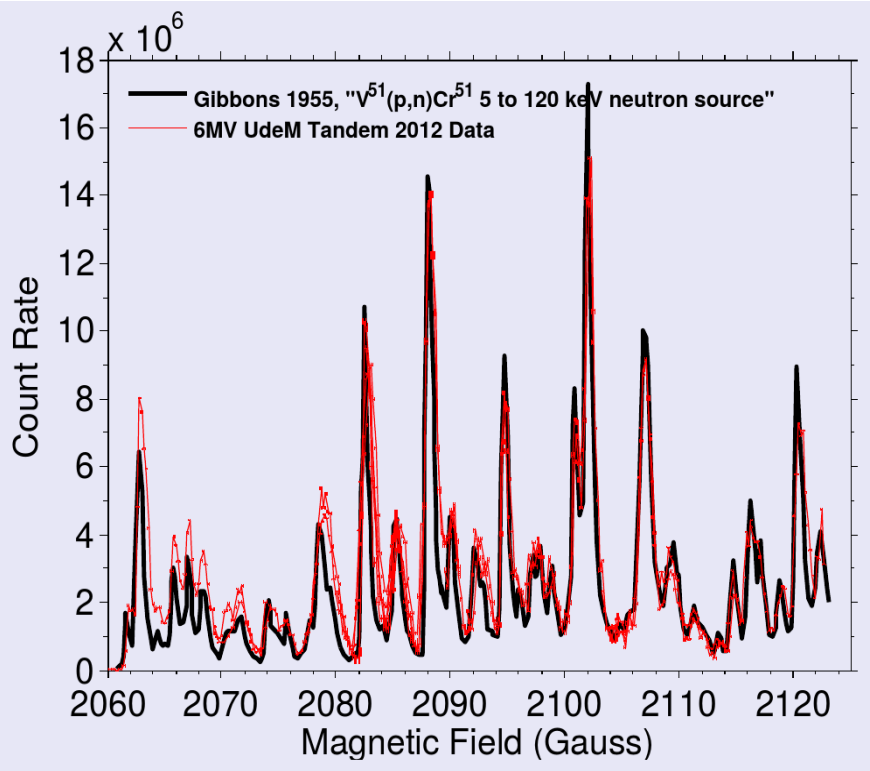
Neutron recoil calibrations

- $E_r \propto E_n \cos\theta$
- Previous PICO calibrations used simulated distribution of θ
- New target station to directly measure scattering angle.
  - 1% acceptance at q=3±0.15 MeV/c
    (100±10 eV recoil on Si)



Monochromatic neutrons

- ^{7}Li(p,n)
  - Large slowly-varying cross-section (~20 mb/sr) for E_n > 70 keV.
  - Centre-of-mass boosted to 30 keV neutron energy.
- ^{51}V(p,n)
  - Resonances as low as 4.8 keV
  - Low uncertainty in neutron energy.
  - Fewer neutrons (0.3 mb-keV/sr) at 4.8 keV resonance



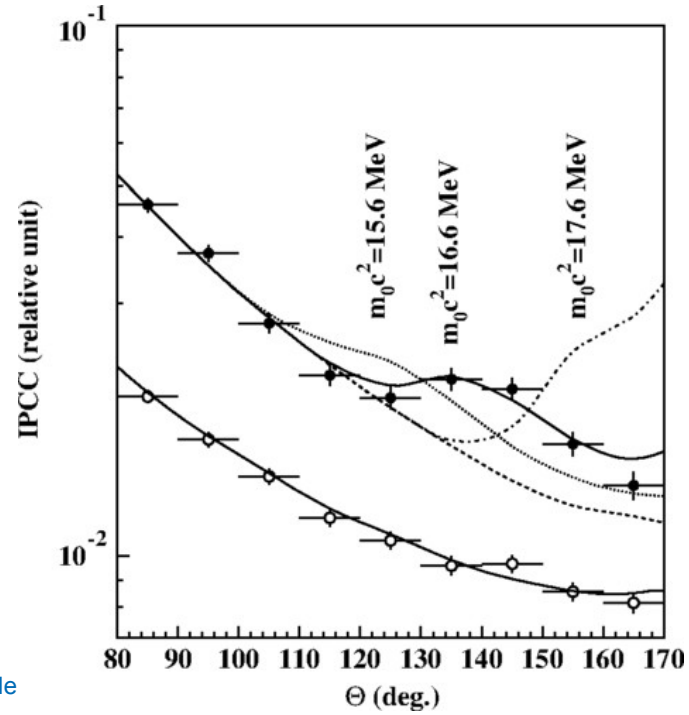
Montreal vs. TUNL – neutron scattering facilities

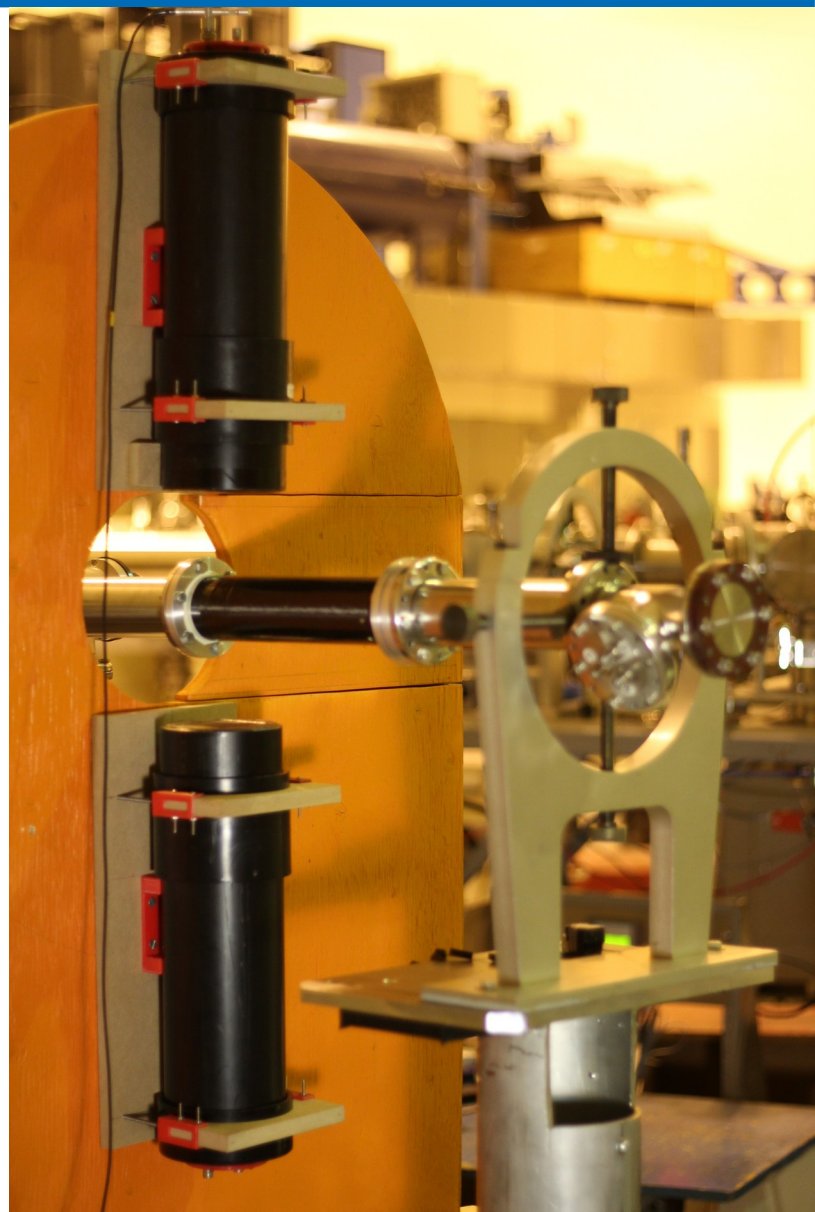
Parameter	TUNL	Montreal
Target used	^{7}Li(p,n)	^{51}V(p,n) or ^{7}Li(p,n)
Minimum usable neutron speed (energy)	3100 km/s (50 keV)	960 km/s (4,8 keV)
Typical beam current on target	0.5 μA	3.5 μA
Neutron flux at target station at lowest speed	2.5 n/cm^2/s/keV	0.4 n/cm^2/s on < 1 keV resonance
Scattered neutron detectors	26 2" x 2" cylindrical liquid scintillator cells	Proposed boron-10 loaded scintillator

- Data collection rate ~1.6 times greater at Montreal.
- Minimum measurable recoil momentum ~6 times lower at Montreal
- Pulsing at TUNL reduces gamma backgrounds by TOF. Better rejection is obtained by B-10 capture at Montreal.

New resonances – X(17 MeV)

- Atomki anomaly – invariant mass resonance in internal pair-production from $^{7}Li(p,g)^{8}Be$ and certain other reactions
  - Verification experiment under construction at Montréal





Neutron production (α,n)

- Boron-loaded scintillator array can be remounted to permit thick-target measurements of (α,n) neutron yields of any vacuum-compatible sample you require.
  - Caveats:
    - Trade-off in yield accuracy / energy precision of measurement.
    - Refurbishment of a power supply for the helium duoplasmatron source.
    - First measurement would require a calibration campaign.

Local facilities support

- MRS supported electronics and machine shops
- Dedicated accelerator / vacuum systems technician
- PVD (evaporator and e-beam) and target characterization (RBS)
- Local McDonald Institute supported engineering resources
- Cleanrooms, detector preparation labs.
- Vacuum, mechanical, and nuclear instrumentation materials on site.
- Easy crane and wide corridor access.
- High beam availability

0° Beamline

Fixed target station.