# **Descendants of Newton's tree**





Fermilab's 1st director, an amateur sculptor, welded 'Broken Symmetry.' Visible from orbit.

One of TRIUMF's 1st directors, Erich Vogt (RIP), took apples each year to his 1st-year physics students.

Also visible from orbit.

# Labs in Main 'Office' Building







Electronics development ceramic/plastic specialty machine shop neutron EDM's HV lab

all stuffed in main office building

# 500 MeV Cyclotron





The main cyclotron came up after maintenance a couple weeks late in April 2020 to make biomedical isotopes like <sup>82</sup>Sr

Why so 'big?' Relativistic  $\vec{E} = \vec{v} \times \vec{B}$  dissociates the H<sup>-</sup> prematurely if B  $\gtrsim$  0.5 Tesla, so the orbits must be big.

## e-linac





High-brilliance 30 MeV beam designed to inject high-energy accelerators

Will make photofission isotopes for nuclear physics  $\sim 2024$ 

## Main (Accelerators) Control Room

#### with **T** mobiles:





The T.A.R.D.I.S. is hidden behind the Enterprise. No worries– it's bigger on the inside.

# $\mu$ spin rotation, ultra-cold neutrons,

#### $\pi ightarrow e u$ should have final result soon





All that concrete is to shield fast neutrons from the 500 MeV proton beam. The crane is now rated for 53

tons– the blocks absorbed  $H_2O$ 

The Governor General of Canada (a Canadian astronaut) is there somewhere. My undergrad was thrilled to meet her.

# **Ultra-cold neutrons**







There have been ultracold (3.5 mK) neutrons at TRIUMF since 2017

Laser-cooled atoms are colder  $\odot.$ 

TRIUMF would like to measure all the EDM's

### **Detector Facility Clean Rooms**







The LHC's ATLAS vertex detector is being assembled at TRIUMF, in one of three cleanrooms. Another has 5-ton crane access and was used for large HERMES detectors and the ATLAS endcap.

Experiments on- or off-site use these development facilities

# $\sim$ 100 Undergrads/year





Over 100 sharp co-op undergrad terms/year from across Canada do research and engineering at TRIUMF. Here T2K is assembling/testing 'multi-PMTs' to improve position resolution. ALPHA-g assembled gas TPC nearby. T2K published in Nature April 2020 near-evidence of *CP* in the  $\nu$  mass mixing matrix TRIUMF would like to help measure other manifestations of *CP* along with all the EDM's

# (some of) Life Sciences



• TR13 sends PET isotopes to UBC hospital by 2 km underground pneumatic tube for diagnostics and research

• Biochemistry hot cells for alpha- and Auger- emitters laser-separated at ISAC

• Developing <sup>225</sup>Ac production from thorium target near 500 MeV beam dump

• Proton therapy cured over 200 eye tumors with 90% success

• Future center under construction: IAMI

## 500 MeV p $\rightarrow$ ISAC







Roughly to scale. The real beamline is longer and aligned better ©.

### **Nuclear Astrophysics**





DRAGON recoil separator measures  $(p,\gamma)$  and  $(\alpha,gamma)$ at energies relevant to novae, stars... Both radioactive and stable beams are used you might want to do that.

You can find pictures with a 2nd Canadian astronaut and Mythbusters

### **Recoil separator insides**





It took people-months to polish the titanium for these 200kV deflectors by hand. EMMA did its first nuclear astrophysics experiment <sup>83</sup>Rb(p, $\gamma$ ) at ISAC II in 2019.

#### "Omnis Experientiae Miraculum (GRIFFIN2)"





While TRIUMF artist-in-residence, Blaine Campbell put this in the Vancouver Art Museum. There's a similar piece in the lobby. There are regular events joint with Emily Carr University of Art.

GRIFFIN helps measure  $V_{ud}$  and nuclear structure

### Laser-polarized beamline





Laser-polarized radiaoactive ion beams do near-surface condensed matter experiments (chat with them about 'spin-echo') test  $\mathcal{T}$  in  $\beta$  decay

nuclear ground-state moments

Polarized beamline should be extended to GRIFFIN in  $\sim$  2 years

# Traps for $\beta$ decay, atomic PNC, masses..







You know what atom and ion trap labs look like...

When a different Nobel Prize winner visited TRINAT, he kindly noted dust bunnies in the cleanroom.

### new ISAC Fun Phys area





This unused lab space is close enough to run an ISAC low-energy beamline to it

You could put 2 or 3 experiments here

# **ISAC II Superconducting Linac**

near the new Fun Phys area on previous page





There's a lot of cryogenics expertise.

That liquid helium pipe over the walkway maintains the 12 foot height clearance of the rest of this area, the main path to the previous slide.