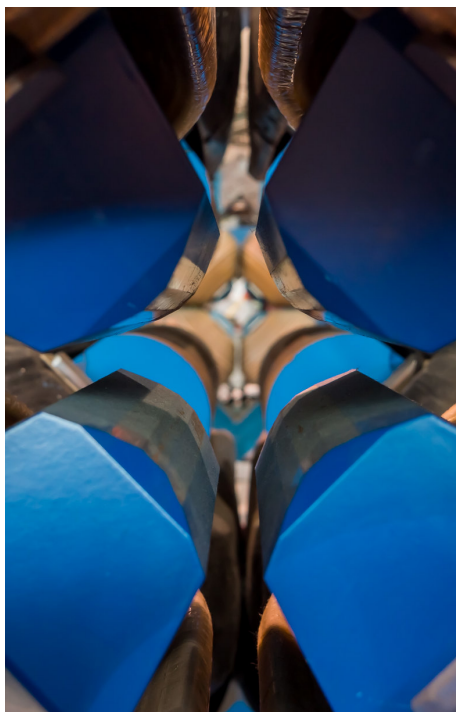




Beam Physics  
for the next 20 years  
and beyond

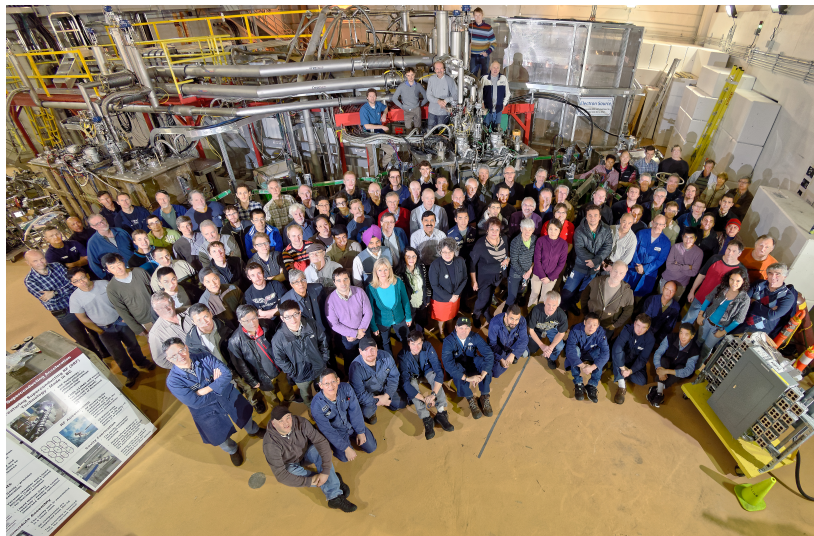
Thomas Planche



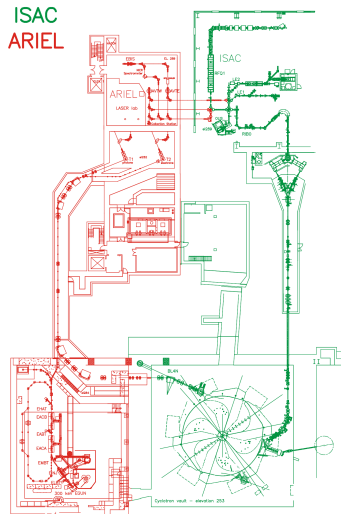
## Not-a-Christmas-Wish-List

- ▶ Electron Complex
- ▶ Integrated Control System
- ▶ Accelerators for High-Energy Physics
- ▶ Excellence in Beam Dynamics Research and Education

# Electron Linac



# High-Power Driver for ARIEL



## High-Brightness THz/IR Photon Source

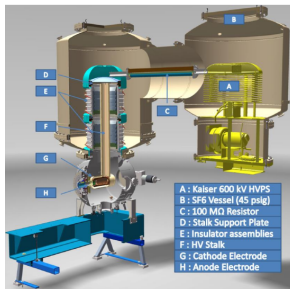
- ▶ Due to its parameters (CW beam, 30 MeV) our e-linac is an ideal driver for a high-intensity THz/IR photon source. There are only a few similar accelerators in the world.
- ▶ The project, lead at TRIUMF by **Victor Verzilov**, is a part of the proposed National IR FEL program leaded by the University of Waterloo.
- ▶ Don't miss the talk from **Scott Hopkins** from the University of Waterloo, tomorrow 8:00.

# High-Brightness THz/IR Photon Source: Stage 1

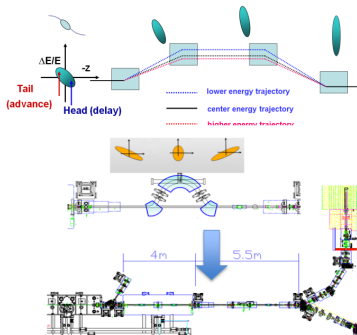
Producing THz light requires sub-mm high-charge electron bunches, and some THz production stations (OTR or synchrotron radiation).

## Major deliverables

DC gun will be based on KEK/Cornell designs.  
Both achieved 500 keV.



Bunch compressor is a well known device.  
Will include a bypass for RIB transport



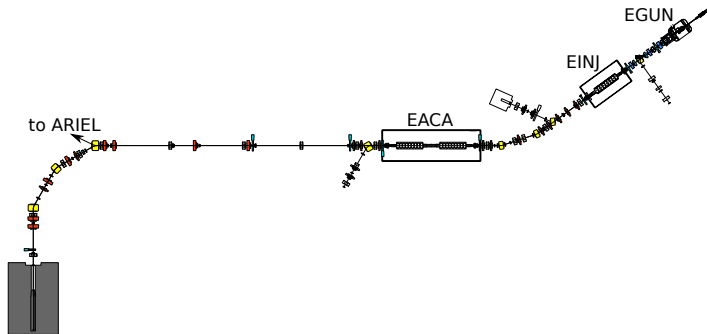
CFI project (proposal), objective: demonstrate production of high intensity ( $\sim$ MV/cm) broadband radiation, and establish a users' community

# High-Brightness THz/IR Photon Source: Beyond

Simultaneous beam delivery to ARIEL and THz-facility:

# High-Brightness THz/IR Photon Source: Beyond

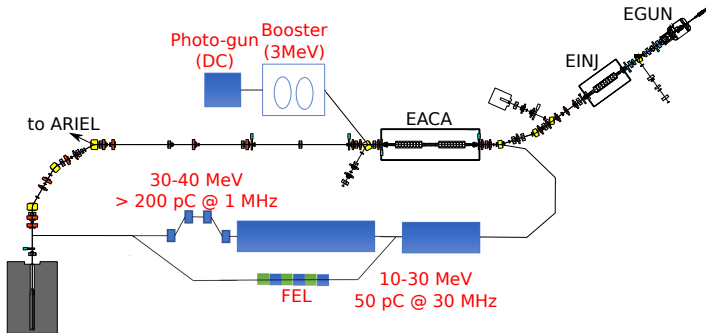
Simultaneous beam delivery to ARIEL and THz-facility:





# High-Brightness THz/IR Photon Source: Beyond

Simultaneous beam delivery to ARIEL and THz-facility:



# TRIUMF Electron Complex

## Minimum Deliverables:

- ▶ High-power electron beam delivered reliably to ARIEL
- ▶ Demonstrated the production high-intensity THz light, and established a community of users

## True Goal:

- ▶ Simultaneous beam delivery to ARIEL and THz-factory

# TRIUMF Electron Complex

## Minimum Deliverables:

- ▶ High-power electron beam delivered reliably to ARIEL
- ▶ Demonstrated the production high-intensity THz light, and established a community of users

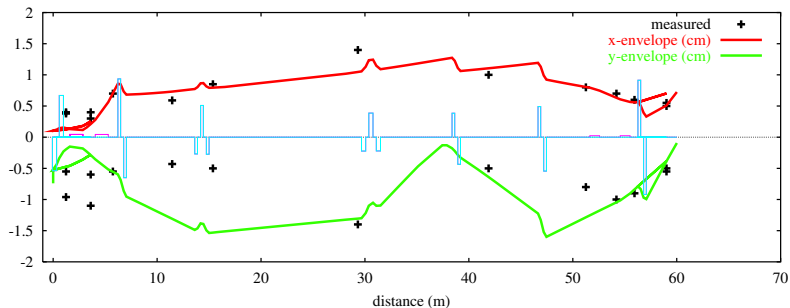
## True Goal:

- ▶ Simultaneous beam delivery to ARIEL and THz-factory
- ▶ Like the octopus: TRIUMF will have 3 hearts!



# The Origin of the 'Knobbing' Culture?

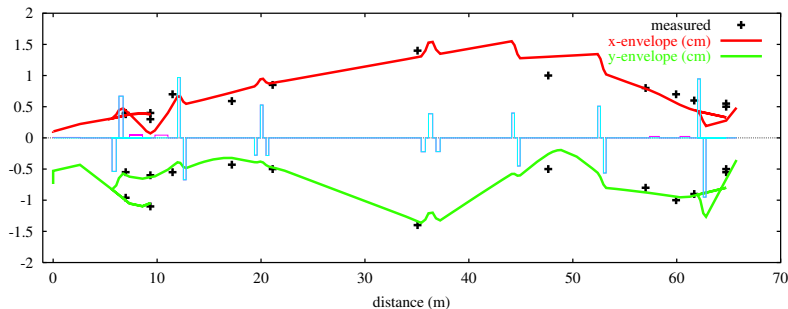
From the origin of the cyclotron to 2005:



BL2A: comparison between measured and calculated beam size along the beamline.

## The Origin of the 'Knobbing' Culture?

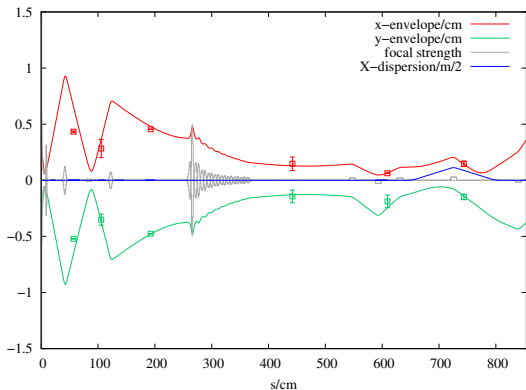
After 2005, when the error in STRIPUBC was found and corrected (Rick and Yi-Nong):



BL2A: comparison between measured and calculated beam size along the beamline.

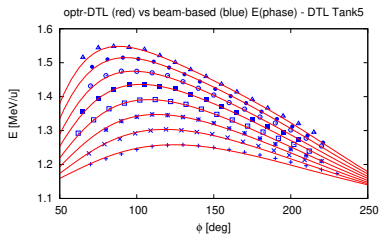
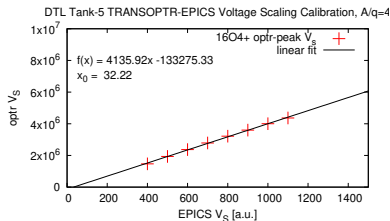
## Model-Based Tuning: Beam Envelope

Model-based tuning (of the optics, not the steerers) has been demonstrated in BL1A, 2A, ISIS, CANREB, and the e-Linac:



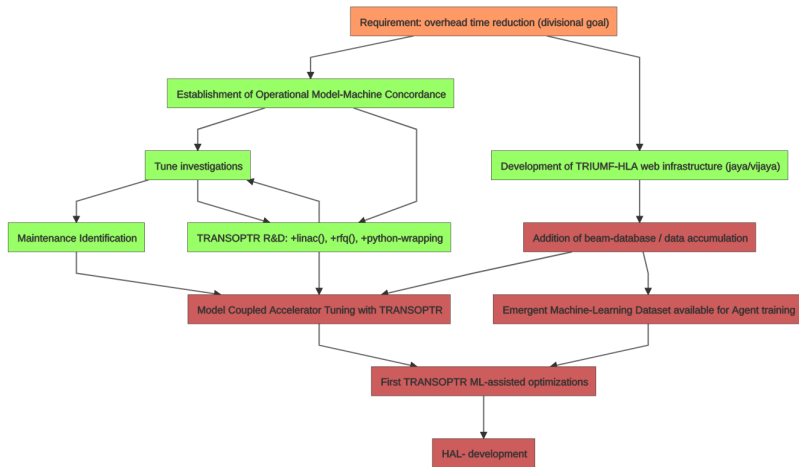
e-Linac EGUN to EMBT: comparison between calculated envelope (lines) and measured  $2 \cdot \text{RMS}$  beam size (squares).

# Model-Based Tuning: ISAC RF



This will mean that we will be able to dial in energy changes (Olivier Shelbaya).

# Model-Based Tuning and Beyond





## 2041: A Controls Odyssey?



# Integrated Control System

Integration of:

- ▶ Beam Physics
- ▶ Instrumentation
- ▶ Operations
- ▶ Data Science
- ▶ with Controls (back end and front end)

# Integrated Control System

## Minimum Deliverables:

- ▶ All of TRIUMF's accelerators and beamlines converted to model-based tuning
- ▶ Explore the possibilities offered by Machine Learning in Accelerator Operations.

## True Goal:

- ▶ HAL in TRIUMF control center?

# International Collaboration Map

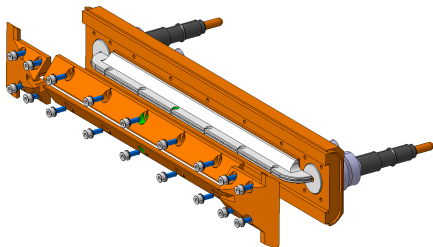
From Bob Laxdal's talk on Monday:



“TRIUMF accelerator scientists are engaged in a number of international collaborations. The international projects aid the community but also nurture our internal expertise while training HQP.”

# High-Luminosity LHC

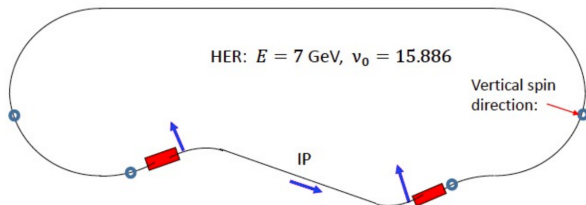
Dobrin Kaltchev developed an effective Hamiltonian to model beam-beam interaction which serves as a theoretical ground to demonstrate the effectiveness of the proposed wire-based compensation:



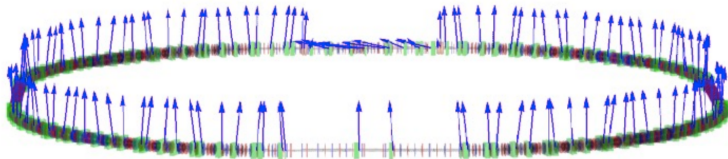
Hardware design of the beam-beam compensation wire

# SuperKEKB

Chiral Belle at SuperKEKB (slide from Michael Roney, UVic):



Spin direction is vertical in the main part of HER. Then it is rotated to the horizontal plane by the set of two solenoids, which are comprising the  $90^\circ$  spin rotator.



From I. Koop, A.Otboev and Yu.Shatunov, BINP, Novosibirsk preliminary considerations on the longitudinal polarization at SuperKEKB

# Accelerators for High-Energy Physics

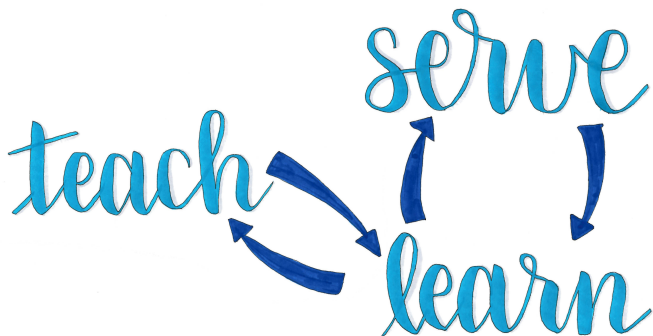
## Minimum Deliverables:

- ▶ The beam physics group will continue to contribute to international projects: LHC, ILC, SuperKEK-B

## True Goal:

- ▶ Make a significant contribution to the accelerator which will be used to make the next Nobel-prize worthy discovery.

# Beam Dynamics Center of Excellence





# Beam Dynamics Center of Excellence

TRIUMF 21 member universities (recent addition: University of Waterloo):



Increase our attractiveness, identify **contact professor**, and recruit accelerator physics grad students from all of them.

# Beam Dynamics Center of Excellence

## Minimum Deliverables:

- ▶ Train, hire, promote diversity.
- ▶ Retain TRIUMF world leading expertise on cyclotrons, beam-beam, space-charge, electrostatic optics, etc.

## True Goal:

- ▶ Contribute to shape the accelerator physics community through our scientific contribution, and through our effort to promote diversity
- ▶ Design and build more radical particle accelerators!  
(Lige's presentation this afternoon on future cyclotrons)



Thank you  
Merci

