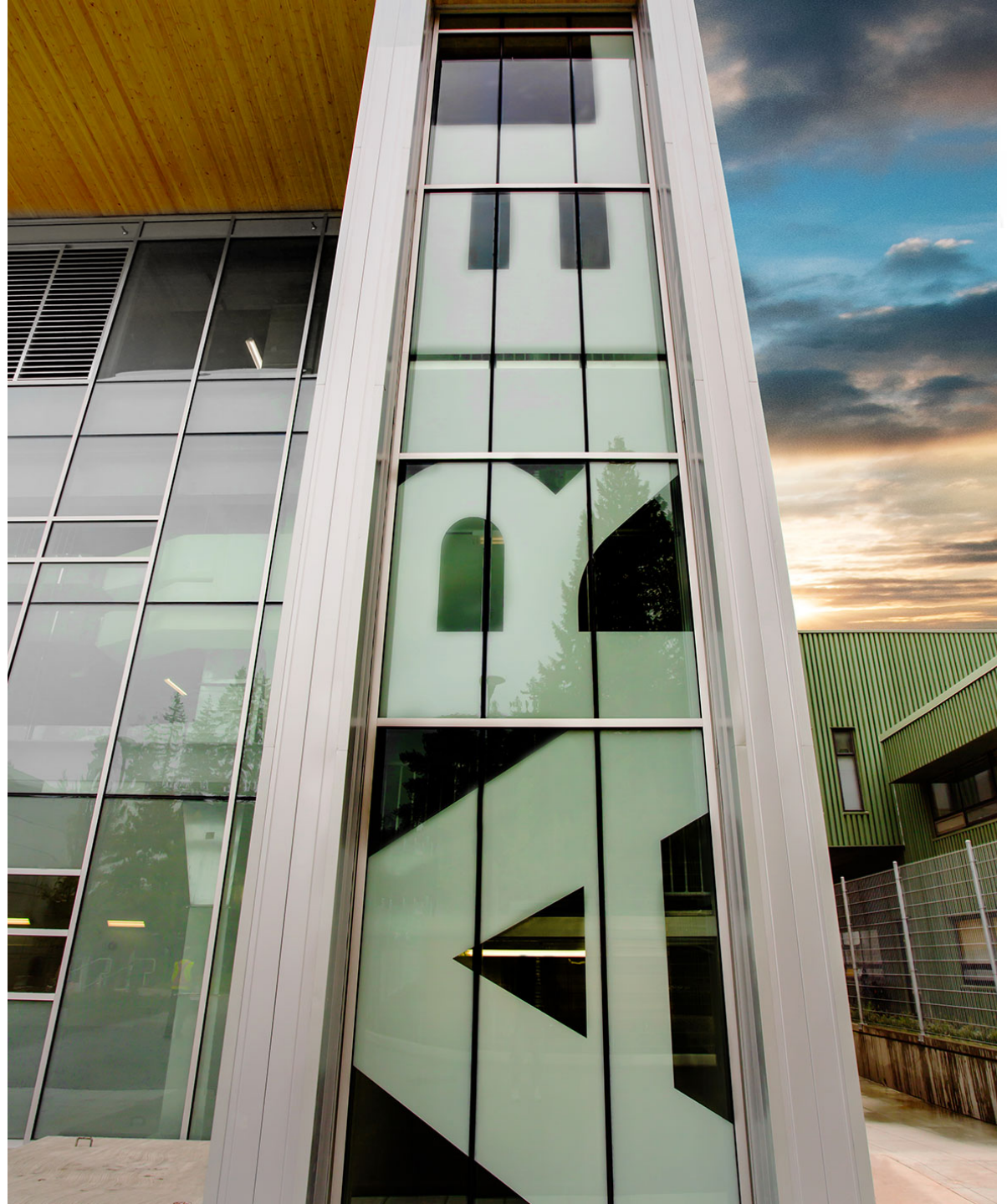
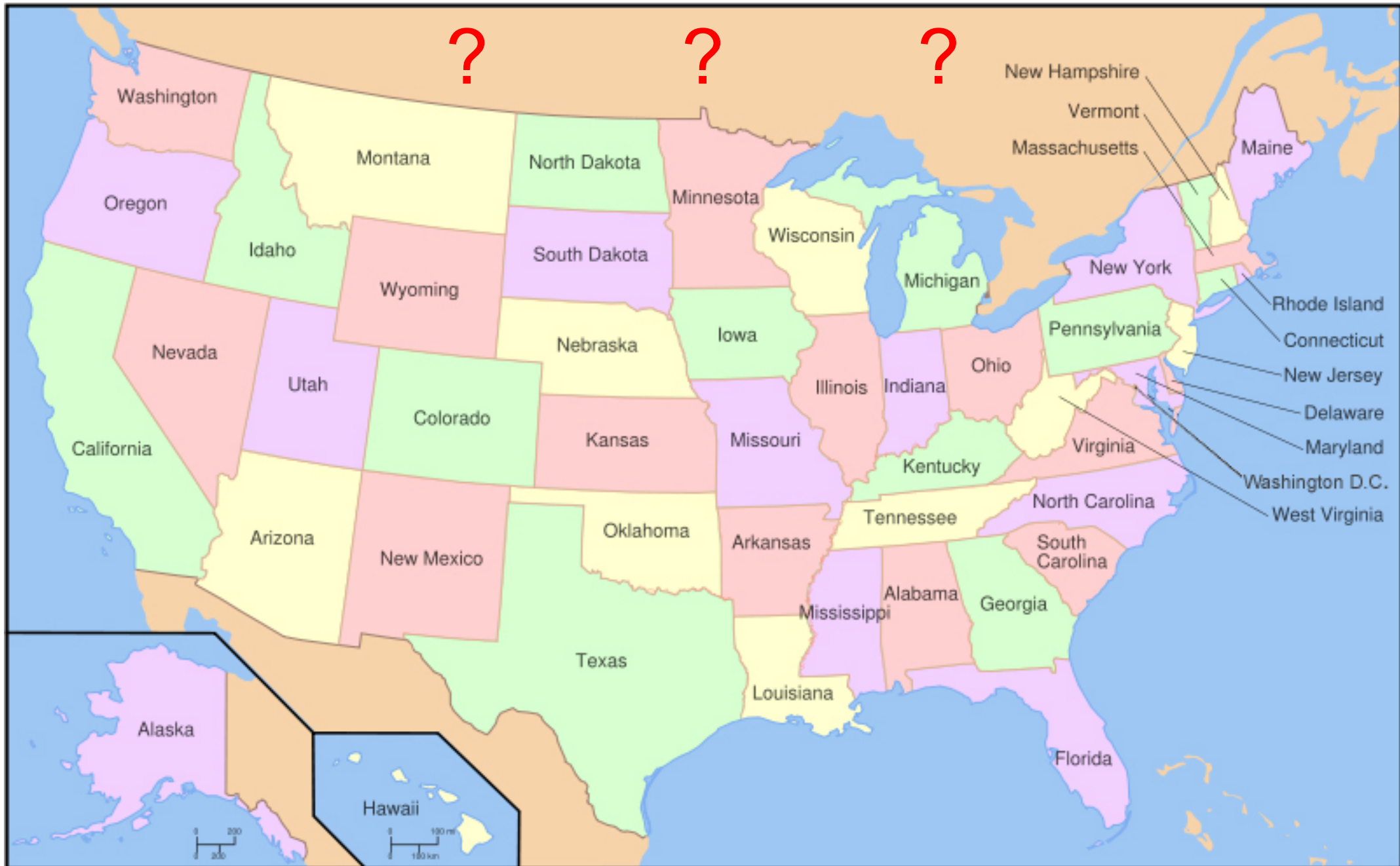


# ELECTRON-ION COLLIDER

## Canadian Perspective

Jonathan Bagger  
Director, TRIUMF







# CANADA / UNITED STATES

	Canada	US
Area	3.8+M sq miles	3.8-M sq miles
Population	36M	325M
GDP	CAD 1.8T	USD 18.6T
Provinces/States	10	50
Territories	3	14

Factor of 10 rule!

## CANADA / UNITED STATES

	Canada	US
Founded	1867	1776
Constitution	1867-1982	1789
Government	Confederation	Federation
Lower House	338 Members	435 Members
Head of Government	Prime Minister	President
Head of State	Queen / GG	President

Canada is a young country, with a very representative democracy and very powerful provinces

# CANADA / UNITED STATES



President  
Donald Trump



Prime Minister  
Justin Trudeau



Governor General  
Julie Payette

# CANADA / UNITED STATES

## Canadian Trade Agreements

- 1992: NAFTA – North America Free Trade Agreement
- 2016: CETA – Canada-EU Comprehensive Economic and Trade Agreement
- 2017: CFTA – Canadian Free Trade Agreement
- 2018: TPP – Trans Pacific Partnership

# CANADA / UNITED STATES

Points where there is (or should be) agreement

- Trade
  - Equal to within systematic errors ( $\pm 2\%$ )
- Border security
  - Joint US-Canada security perimeter
- Defense / Intelligence
  - NORAD, FVEY





# CANADA / UNITED STATES

## Points of difference

- Healthcare
- Guns
- Legalized marijuana
- The letter Z
- War of 1812



# CANADIAN SCIENCE

Trudeau's government has a focus on science

Navdeep Bains, Minister of Innovation,  
**Science** and Economic Development



Kirsty Duncan, Minister of **Science**



Lots of activity

- Innovation
- Fundamental Science

**Opportunity!**

## CANADIAN FUNDING

**TRIUMF:** Operating budget increased by 20%. Funding secured for ARIEL II, Institute for Advanced Medical Isotopes, HL-LHC

**Granting Councils:** 25% increase to NSERC in support of basic research

**Canada First Research Excellence Fund:** CAD 900M in new funding to university centres across all fields of science, including CAD 64M to Queen's University to fund the Canadian Particle Astrophysics Centre, building off the success of SNOLAB

**Canada Foundation for Innovation:** CAD 763M additional for infrastructure funding across all fields of science, supporting proposals from particle and nuclear physics

## CANADIAN FUNDING

However, many players. No Department of Energy. All priorities set from bottom up!

- NRC – National Research Council. Funds TRIUMF's operations
- NSERC – Natural Sciences and Engineering Research Council. Funds individual researchers
- CFI – Canada Foundation for Innovation. Funds 40% research infrastructure, through universities
- Provinces. Fund 40% research infrastructure, through universities

Major projects require large coalitions

## CANADIAN FUNDING: ARIEL

Example: ARIEL, TRIUMF's new rare isotope facility (which will complement and compete with FRIB)

- NRC: ARIEL operations
- NSERC: ARIEL research support
- CFI: 40% of ARIEL construction
- Provinces: Five provinces paid 40% of ARIEL construction through 21 universities
- TRIUMF: 20% of ARIEL construction



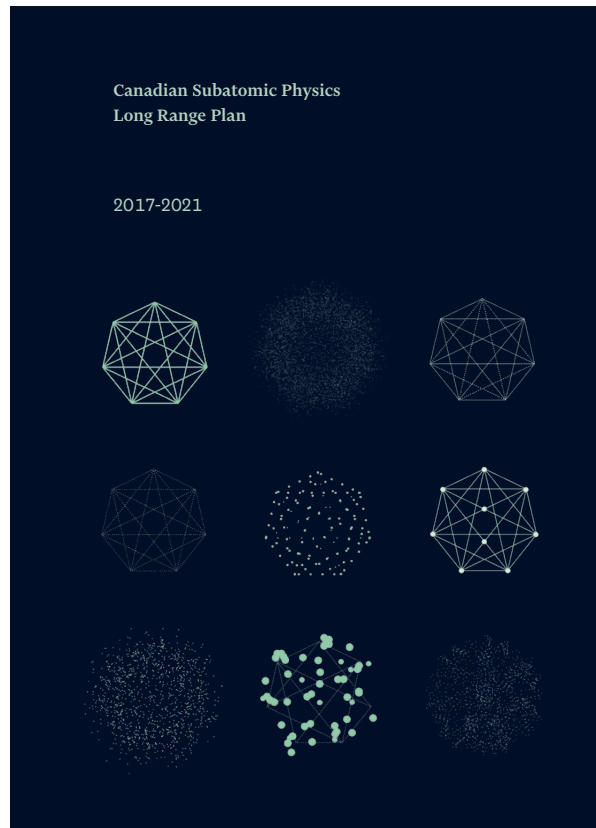
## CANADIAN FUNDING: ATLAS

Example: ATLAS Canada, 40 faculty, 10 institutions,  
4 provinces, 150 people

- NSERC: Base operational and research support
- CFI: Phase 2 HL-LHC upgrades
  - Liquid Argon Calorimeter
  - ITk Silicon Tracker
- CERN: CFI matching requirements met using international contributions to ATLAS
- NRC: Tier-1 Centre operations, through TRIUMF

# CANADIAN PLANNING

How is consensus achieved? Lots of community consultation, captured in two overlapping long-range plans



# TRIUMF FIVE-YEAR PLAN

The TRIUMF Five-Year Plan is being revised as we speak. The new plan will cover the period 2020-2025

The Plan is being organized along three dimensions:

- Science and Technology
- People and Skills
- Innovation and Collaboration

The EIC projects on each of the three axes...





# SUBATOMIC PHYSICS LONG-RANGE PLAN

The community-driven Subatomic Physics Long-Range Plan will be updated in 2019-2020

The SAP LRP is a bottom-up document that captures the hopes and aspirations of the subatomic physics community

- It guides investments by the funding agencies, especially NSERC, but it is not binding
- Its scope includes nuclear and particle physics, at accelerator and underground facilities

# SUBATOMIC PHYSICS LONG-RANGE PLAN

## The Big Questions that drive Canadian Subatomic Physics

- What is the nature of physics at the electroweak scale and beyond?
- What is the nature of neutrino masses?
- What is the nature of Dark Matter in the Universe?
- What structures underlie the forces and matter in the Universe?
- How does the structure of nuclei emerge from nuclear forces?
- How does QCD determine hadrons' properties and the phases of hadronic matter?
- How were the heavy elements formed in the Universe?

The EIC fits squarely into this framework

## SELECTED RECOMMENDATIONS

- **Preamble:** A number of major international facilities and experiments that will further the understanding of the universe will become operational in the coming years. It is important for Canada to engage in such projects to maintain vitality in the field. Furthermore, it is crucial to become active in early stages so that Canadians may take on leadership roles and to ensure success of the projects
- **Scientific recommendation:** [Position Canada for key leadership roles in strategic projects and initiatives by supporting activities in potential future flagship endeavours.](#) Those projects with significant Canadian participation should continue to receive support: ATLAS at the High-Luminosity LHC, Belle II, Hyper-Kamiokande, ILD at ILC, MOLLER and SoLID at JLab, nEXO at SNOLAB, and UCN/nEDM at TRIUMF

## SELECTED RECOMMENDATIONS

- **Preamble:** The Canadian laboratories for subatomic physics are essential for the continued success of subatomic physics research in Canada. They provide the facilities to execute experiments at the laboratories and represent Canada's launchpads to the international network of laboratories in subatomic physics
- **Policy recommendation:** Continue strong support for the Canadian laboratories for subatomic physics: TRIUMF and SNOLAB

## SELECTED RECOMMENDATIONS

- **Preamble:** Canadian participation in decision making for proposed major international facilities, such as the high-luminosity upgrade of the LHC and a future linear collider, requires coordination at a high level. This is a role not currently identified within Canadian government. Federal government involvement is required for discussions with representatives from other international governments and for securing special funding for Canadian components of such new international facilities
- **Policy recommendation:** Identify an office in Canadian government responsible for engaging with the international community in moving forward major new science initiatives

## ELECTRON-ION COLLIDER

“Internationally, there has also been much activity towards the construction of an Electron-Ion Collider (EIC) in the US in the coming decade. Canadian nuclear physicists are taking roles in the planning and prototyping for this new facility, the scientific case for which has been favourably reviewed”

# NEXT STEPS FOR EIC COMMUNITY

- Build on present interest
  - TRIUMF: Accelerator, detector, physics
  - Universities: Detector, physics
- Create a grand coalition – many universities, many provinces
  - “EIC Canada”
  - Already interest from six institutions in six provinces
    - Dalhousie University
    - University of Manitoba
    - McGill University
    - Mount Allison University
    - University of Regina
    - TRIUMF

# NEXT STEPS FOR EIC COMMUNITY

- Ensure that EIC is endorsed by next Subatomic Physics Long-Range Plan
- Engage the EIC UG Institutional Representatives
  - Charles Gale, McGill University
  - Michael Gericke, University of Manitoba
  - David Hornidge, Mount Allison University
  - Garth Huber, University of Regina
  - Swadhin Taneja, Dalhousie University
- Work with Canadian Institute of Nuclear Physics
  - Voice of nuclear physics community
    - Garth Huber, Executive Director
    - ~75 Faculty, 115 Total Membership
  - CINP projected interest in EIC: ~10 Faculty, 25 Total Collaborators. But this could go up – or down...





# CONCLUSION

- The EIC physics is exciting
- The accelerator is challenging
- The community is ready
- So let's get started!



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## An Assessment of U.S.-Based Electron-Ion Collider Science

Committee on U.S.-Based Electron-Ion Collider Science Assessment

Board on Physics and Astronomy

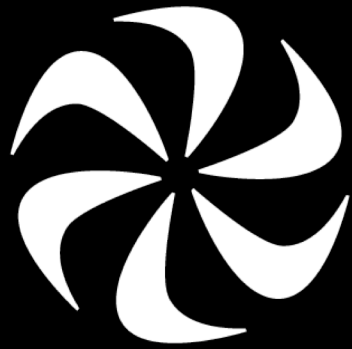
Division on Engineering and Physical Sciences

A Consensus Study Report of

*The National Academies of*  
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# TRIUMF

**50** anniversary  
anniversaire