Big science facilities driving international collaboration

Panel Session: Are we Jupiters' in the celestial field of science?

Organized by: SNOLAB

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Panelists: *:* **Timothy Meyer**, Chief Operating Officer, Fermi National Accelerator Laboratory; *Speakers*: **Johnathan Bagger**, Director, TRIUMF; **Robert Lamb**, Chief Executive Officer, Canadian Light Source; **Dugan O'Neil**, Chief Science Officer, Compute Canada; **Nigel Smith**, Director, SNOLAB

Takeaways and recommendations

- ✓ Big science is a long-term game, with research solutions leading to technological advancement, industry engagement and economic impact
- ✓ Big science facilities encourage international collaboration and leverage benefits for Canadian and foreign participants alike
- ✓ Advanced research computing is essential to collaboration and must be constantly upgraded
- ✓ Significant investment is needed to scale the benefits of big science facilities from individual researchers to society at large
- ✓ Canada is a small country and must identify niches where it can excel and succeed
- ✓ Issues faced by large science facilities can't be addressed by a bottom-up, proposal-driven funding model. It's time for Canada to take a second look at how these facilities are supported.

The policy issue: Canada's big science facilities, despite their cost to build and operate, are critical to international collaboration, scientific advancement and long-term social and economic benefit. Four of Canada's major science facilities – TRIUMF, SNO LAB, the Canadian Light Source and Compute Canada – are significant contributors to the rapidly growing global knowledge base and the interchange of science between research communities and beyond. Their expertise facilitates new avenues of exploration, the training of new researchers and support for cutting-edge industry sectors.

The size and scale of major science facilities is key to their influence and impact, facilitated by astute project management and dialogue between facilities.

"The whole idea is to deliver compelling science. That's really the driver of everything we're trying to achieve. The way you do that is to develop unique tools and infrastructure. There's an element of size and scale here that is not usually accessible to universities themselves but when you collaborate you can develop large infrastructures that can springboard the science forward," said Smith. "It's also the ability to connect to a broader research community internally within Canada and externally. All of these facilities have many external connections which allow Canada and lever the investments and deliver compelling science outputs."

Smith said each of the four facilities represented by the panel are working on world-class niche science projects, from wheat and agriculture and medical isotope production at the Canadian Light Source to isotope research and production for physics and medicine at TRIUMF's ARIEL (Advanced Rare IsotopE Laboratory)—its flagship superconducting electron accelerator.

The options: People are the primary vehicle for transferring research knowledge into practice, making training a critical component for future researchers and engineers. The four big science facilities represented on the panel engage more than 9,000 graduate students and host 15,000 users a year from about 40 countries. Lamb says the circulation of that huge brain trust is integral to Canada's participation and collaboration with researchers worldwide, as well as the communities in which they are located.

"It's like an exclusive club where everyone can join. You have to engage people at every level including those outside who want to know why you'd invest in such a facility," said Lamb. "These national facilities have international networks and they connect into the national facilities … The best way to retain talent is when (students and researchers) get to a certain point they should leave. Then they create their own networks and it's those networks that make these big science facilities happen."

Like all fundamental research, science at big science facilities can generate unexpected, disruptive technologies that have a profound impact on the economy and society at large. Bagger said a key role of laboratory directors is to ensure that the intense creativity at these facilities also benefits Canadians. The unique equipment and instrumentation should be developed in Canada—instead of bought off the shelf—with opportunities to spinout those innovations into the commercial realm.

Bagger says there at least four examples of this transfer of knowledge, starting with the development of TRIUMF's first cyclotron which was contracted to EBCO Industries Ltd. The Vancouver-based companies turned the expertise gained in building the cyclotron into a spin-off company – Advanced Cyclotron System Inc – which is now one of the world's biggest builders of medical cyclotrons. A similar outcome arose from TRIUMF's collaboration with PAVAC Industries Inc., which is a now global leader in hybrid electron beam products and services.

"Real Made-in-Canada technology came from partnering with a national lab," said Bagger. "Put large concentrations of infrastructure in place and use them to attract talented people to solve technological problems … That's how the World Wide Web came out of CERN."

Big science facilities are also a potent generator of multidisciplinary, cross-sectoral research which is increasingly defining many fields of study, including the social sciences and humanities. The ability to access the advanced research computing represented by Compute Canada is essential for fostering such research, said O'Neil. Of the 2,700 faculty members who use Compute Canada services, the largest group is comprised of engineers, computer scientists and mathematicians. But there are also hundreds of users from medicine, biology and bioinformatics, as well as physicists, chemists and environmental chemist, and social scientists.

"At Compute Canada, we have expert staff who know how to support all disciplines and take knowledge from one discipline and apply it to others," said O'Neil. "People in the digital humanities are using sequence alignment technologies that originate in bioinformatics to do text studies … Large science facilities are a fertile ground for people from different areas that come together to solve different problems with similar tools."

Canada's big science facilities are successful despite a less than optimal funding environment. Bagger said that, unlike the United States and other advanced nations, Canada lacks a cohesive funding structure that addresses these facilities holistically.

"We need to look at the connection between capital funding and operations because sometimes it seems a little chancy," said Bagger. "You build these facilities and then put a mortgage on them for 20 or 30 years and this has to be fully understood."