



**CANADA'S NATIONAL LABORATORY FOR  
PARTICLE AND NUCLEAR PHYSICS**

**LABORATOIRE NATIONAL CANADIEN  
POUR LA RECHERCHE EN PHYSIQUE  
NUCLÉAIRE ET EN PHYSIQUE DES PARTICULES**

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15 April 2008

Hon. James Rajotte, M.P.  
Standing Committee on Industry, Science, and Technology, Chair  
House of Commons  
Ottawa, ON K1A 0A6

Dear Mr. Rajotte and Colleagues,

We write to you about “big science” and its role in energizing and employing Canada for a brighter economic future.

Big Science is global science. It has been driven by necessity and is now becoming the norm. Perhaps the most important lesson from the 20th century was the observation that the phenomena that humans experience in everyday life are actually governed by interactions taking place on scales much greater than—as well as much smaller than—that of ordinary human perception. We now know that much of our physiological makeup, which in turns shapes our experience of the world, is governed by biochemistry and genetics at a scale of size that is so small, an optical microscope cannot detect it. We also know that the planet Earth is part of an evolving cosmos whose formation, structure, and destiny can only be deduced by surveys of the entire heavens with telescopes, satellites, and even detectors placed under the surface of the earth. Thus, the 21st century is not just about biology or nanotechnology or the next generation of the internet—it is about seeing the unseen and mapping out its role in our everyday lives. To do so requires Big Science.

Nearly all fields of research are confronting this fact; the frontiers are evolving to use larger, more complex equipment and infrastructure, and scientists in all fields are moving towards working in interdisciplinary, globally connected teams. The days of the lone researcher in a lab are largely gone. Medical doctors, for example, perform research in teams with chemists, biologists, physicists, social scientists, statisticians, and other highly trained technicians. And these teams use microscopes, nanoprobes, radiation, and network studies of human behaviour to do their work. Particle physics has perhaps most visibly blazed the trail for Big Science because of its quest to understand the essential workings of the universe—to understand the building blocks of the building blocks. Modern experiments in particle physics could even be Mega Science projects because they require enormous detectors and hundreds and sometimes

thousands of researchers working in virtual cities of research. Many other fields are adopting a similar global team spirit. Materials scientists, software developers, chip designers, and even aircraft designers all work in research teams distributed around the globe. To be at the forefront of science, then, a country must have a strong commitment to Big Science.

Canada is well positioned to play a role and be amongst the global leaders in Big Science because it is already well connected through its Big Science laboratories, such as TRIUMF, SNOLab, Neptune, and the Canadian Light Source. Each of these laboratories has a scientific and technology focus that makes it unique, but each is also connected to a variety of disciplines and works with a host of partners from academe, government, and industry all around the world.

But what does this have to do with the larger quest for innovation? How does Canada maintain and even improve its high standard of living in this globally connected, fiercely competitive world? Canada is a country blessed with abundant natural resources and with a population of well-educated, innovative, and hard working people. In the modern era, wealth is generated not by making more of a product or by making it 10% less expensive; rather, wealth is created by adding transformative value to a product or by adding value to a natural resource. In serving the public interest, government needs to facilitate the process of adding value and thereby enable the high-paying jobs at home that are the key to future prosperity. The country's educated work force requires a technical infrastructure that promotes the creation of added value. How can government accomplish this feat?

The creation of added value follows from basic research which creates knowledge. The "knowledge advantage" can thus drive many other advantages. This new knowledge is then applied to an existing product to develop an enhanced or more functional product or perhaps a whole new product. An example familiar to Canadians is that of medical isotopes, which are used in nuclear medicine for many procedures ranging from cancer imaging and therapy to establishing the risk for a heart attack. Canada has been a world-leading exporter of medical isotopes for over 40 years. The Canadian domination of this market is at risk not just because of the reliability of the present sources of isotopes for export, but also because other countries will soon develop their own capabilities. Unless Canada innovates new products by adding value to the present ones, our market share will inevitably dwindle as the competition catches up. The added value can come in the form of attaching molecules that target a specific metabolic process in the body, thereby enabling the physician to understand the disease in detail. This rapidly increasing capability of labeling molecules and using them to study disease will drive a revolution in nuclear medicine. Canada is well positioned to play a role in this revolution and others. For instance, the Canadian company MDS Nordion is actively exploring research partnerships with TRIUMF and other "Big Science" partners to exploit these opportunities.

Canada has, through continuous government investment, built up a high-tech infrastructure throughout the country that competes with the world's best. The CANARIE network is another prime example; through high-speed internet, it enables Canadian researchers to exchange data and ideas with one another and their colleagues around the world instantly. These researchers are stimulated by the ideas of their colleagues and vice-versa. The CANARIE network allows Canada to be a part of the world's largest grid of data storage through the ATLAS-Canada Tier-1 Centre at TRIUMF. Members of this grid develop and share the latest software developments in the associated computing technologies. Students recognize these exciting technical projects as

tickets to their future careers. The best students from around the world will come to Canada to be engaged in these high tech opportunities; a good number will move out of academia and into the business world to market their newly acquired knowledge. Thus, the Big Science infrastructure investment has created knowledge and attracted human talent that now permeates Canada's academic and business communities. Since this project is global, these students will naturally think and function globally.

Big Science seeds these types of rewards. Research projects almost always push the limits of technology, whether it is machining, materials, electronics, or computing abilities. Kernels of research activity and excellence, such as TRIUMF, attract and stimulate small specialty companies to provide the "one-off" items needed for cutting-edge research. Once these small companies develop the know-how, they are then able to market it to others. In turn, their businesses not only survive but also expand. By working with a globally-connected research laboratory, their products are guaranteed to be at the cutting edge of technology. Even in today's global economy, a laboratory pushing the limits of technology is better served by having nearby the high-tech business with which they collaborate. The local businesses also interact with one another. These companies, usually run by young entrepreneurs, in turn drive the local economy and attract the best and the brightest. The quality of schools increases and attracts more highly educated people seeking high-paying jobs and who also expect the best health care and the best cultural activities. And so the positive reinforcement cycle continues.

One recent Canadian example is TRIUMF's foray into the science and technology of superconducting acceleration. Working with TRIUMF scientists, a small company in Richmond, B.C., developed techniques for electron-beam welding of solid niobium metal. Their work proved successful and the research and engineering effort is now one of only 4 other companies in the world with this know-how. The company, PAVAC Industries, will market this new technology they have mastered to new customers who need electron beam welders. Through their collaboration with TRIUMF, PAVAC developed added value to their existing product line.

A non-Canadian example is the Paul Scherrer Institute (PSI) in Zurich Switzerland, created around the same time as TRIUMF and with a similar mission. Today, these labs have evolved to have their own areas of expertise. PSI has spurred exponential economic and scientific growth in the immediate area around the lab over the last decade. Simply put, these high-tech activities cluster around each other. Likewise, pharmaceuticals and health related research centers cluster around hospitals, universities, and research institutes.

The formula for success involves merging academia and its associated highly qualified personnel, research laboratories, and businesses in a seamless manner. This merged entity is a science and technology innovation cluster, connected by intellectual pursuits as well as geographical proximity. These clusters are best seeded with an existing core of research excellence, such as with the TRIUMF laboratory in Vancouver and its new company Advanced Applied Physics Solutions, Inc., that will commercialize technologies emerging from subatomic physics research. Pure academia and business do not mix well; the "cultural" barrier can be overcome. A laboratory such as TRIUMF can support an environment that is a mixture of a university and business cultures; it bridges and forms the necessary bonds needed to sustain collaboration. Government must play a key incentivizing role by supporting the laboratory as the "glue" between business and academia.

Clustering university expertise, a national laboratory, and small start-up businesses together naturally pools resources and human talent and is the key to creativity and impact. Everyone brings something unique to the table. These researchers and businesses must also have strong connections to the rest of the research world in order to stimulate new ideas, spurn on creativity, and form new business links. Again, the national laboratory naturally provides these linkages.

Ultimately, a competitive country seeks to add value to its products by seizing upon breakthrough scientific discoveries occurring any where in the world. Big Science connects students, researchers, and businesses to the world and to each other. National involvement in key Big Science opportunities will ensure Canada keeps pace with its partners—and competitors—around the world. Building high-technology clusters around Big Science centres will ensure Canadian businesses generate added value to their products and can compete globally. In this way, Canada will maintain its present high standard of living for additional generations, and continue to use its natural resources wisely and to full advantage.

Thank you for this special opportunity to contribute our thinking to your discussions.

Sincerely,

/s/  
Nigel S. Lockyer

/s/  
Feridun Hamdullahpur

/s/  
Timothy I. Meyer

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#### **About the Authors**

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TRIUMF is owned and operated by a consortium of thirteen Canadian universities. TRIUMF's research is focused on accelerators as applied to nuclear physics, particle physics, nuclear medicine, and materials science. TRIUMF is recognized world-wide for its basic research programs and successful track record of knowledge transfer and commercialization. TRIUMF is supported by the Government of Canada by a contribution through the National Research Council.