



NRC-CMRC

From *Discovery*
to *Innovation...*

Nanotechnology in Canada

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National Research
Council Canada

Conseil national
de recherches Canada

Canada

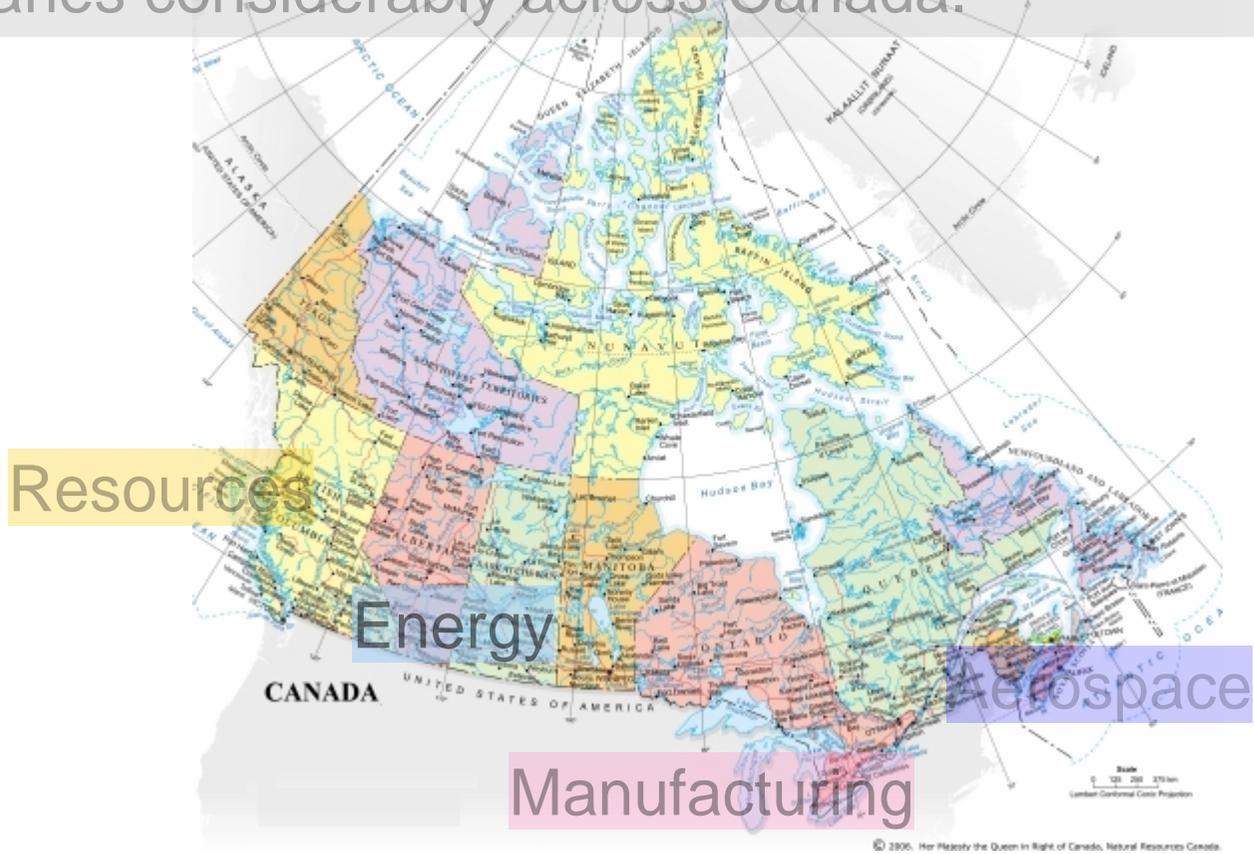
Introduction

- Overview of nanotechnology in Canada
 - provincial and federal programs
 - university research and fabrication facilities
 - National Research Council initiatives



Canada – Regional Economy

The strength of traditional economic sectors such as forestry, mining, manufacturing, agriculture and health varies considerably across Canada.



Canada – Regional Effort

Activities in developing nanotechnology are largely regionally based, with no coordinated national program established at this time.



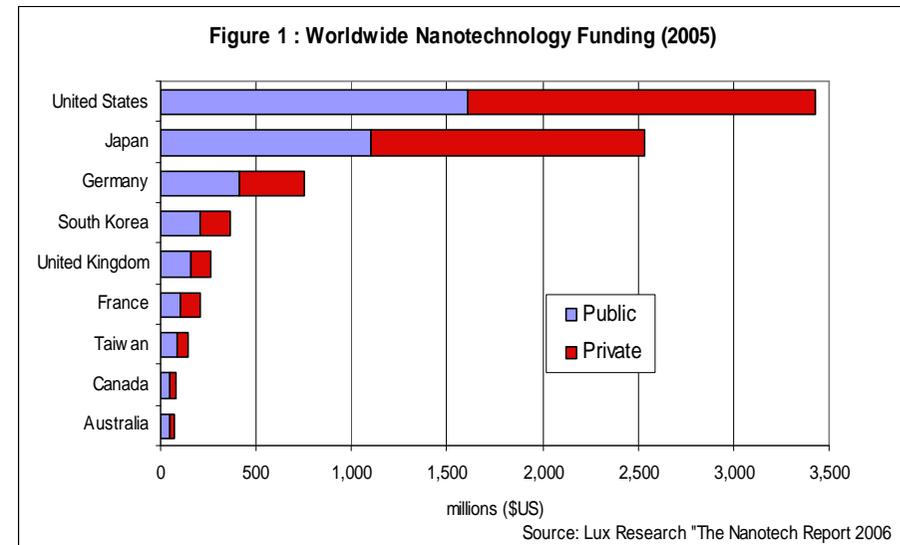
Canada – A Global Player

Canada:

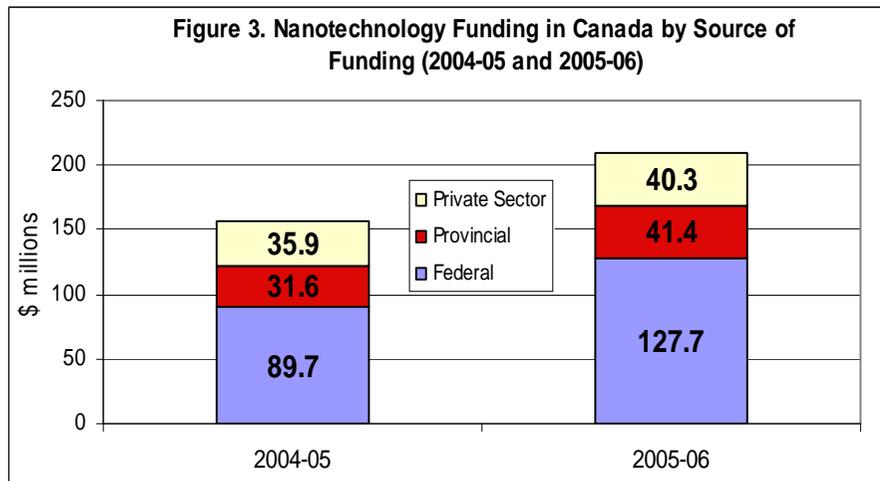
- ~ 2% of global GDP
- ~ 4% of global knowledge creation
- ~ 2% of global federal investments in Nano

BUT:

- < 1% of global private investments in Nano



Provinces: A Significant Contribution



~ 20% from private sector

- Provincial and Private Sector investments are comparable to each other but less than Federal

Compare US:

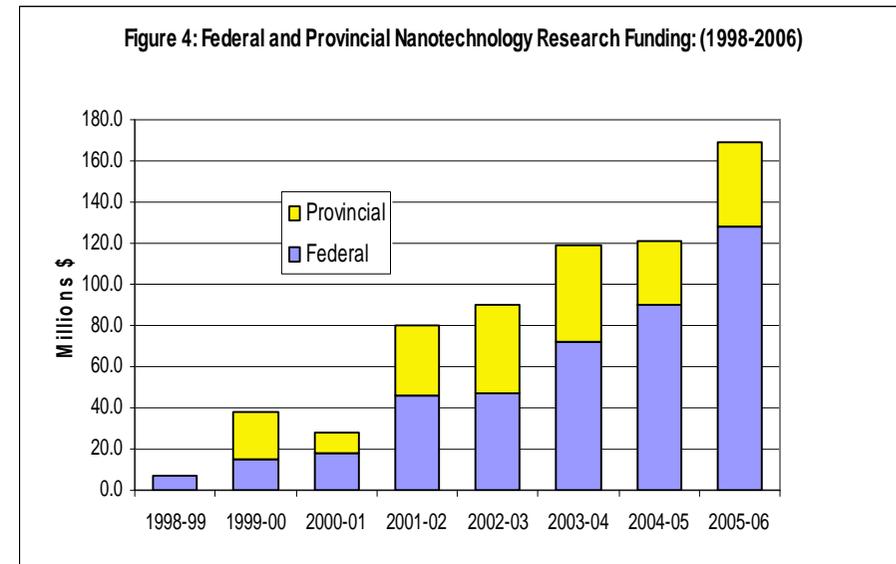
- Federal: ~\$ 1.1B
- States: ~\$ 0.5B
- Private: ~\$ 1.8B

Compare Globally:

- ~ 50% private sector

Canadian Investments: Growing

- Annual investments increase
- Much of the investment is in **infrastructure** (53%)
- Nearly \$300M in operating over 8 years
- Over \$640M total over 8 years



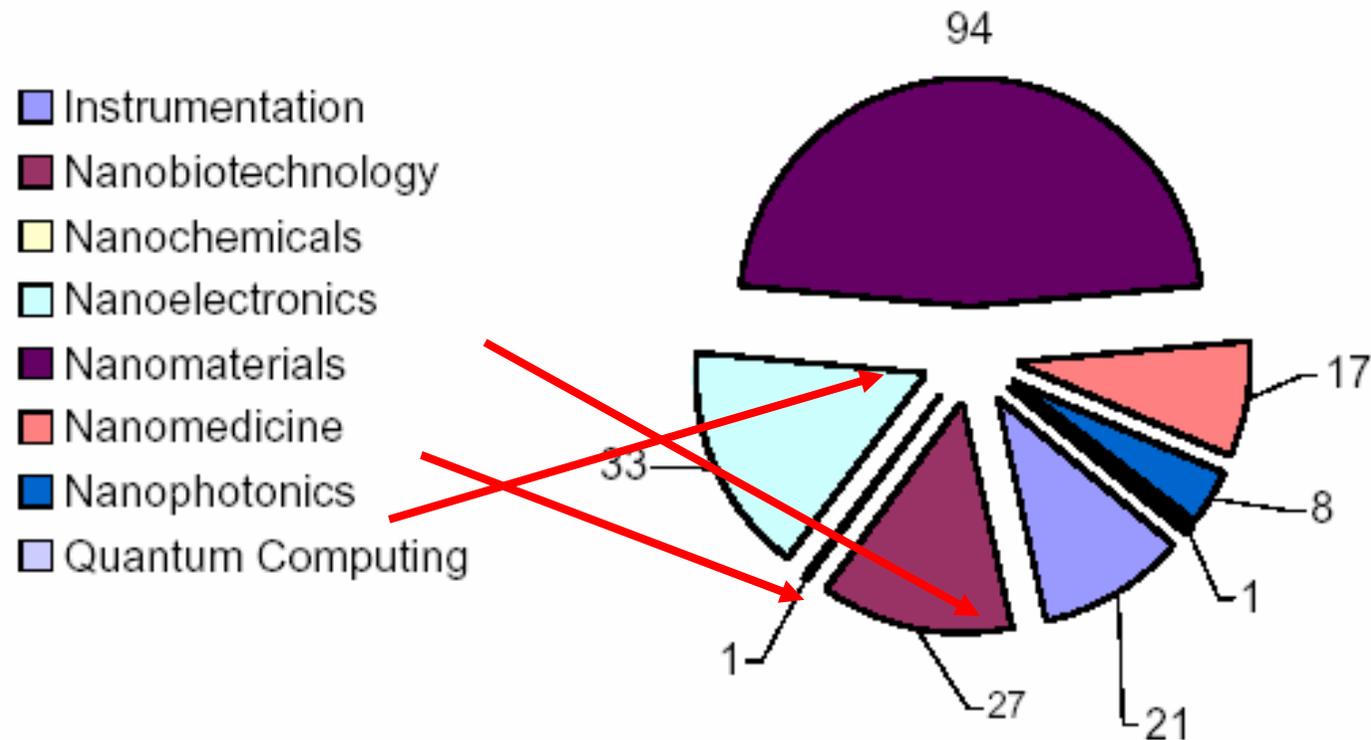
Average: \$ 80M/year
Future: >\$160M/year

Canada is Contributing

	Gov't nano R&D Investment 2005 in \$M	Nano papers 1998- 2003	World ranking by papers	Gov't R&ED efficiency per paper	Nano patents 1984- 2004	World rank by patents	Gov't R&D efficiency per patent
USA	989	25600	1	4	6725	1	1
Japan	864	13339	2	9	2449	2	3
Germany	364	9885	3	3	392	3	7
South Korea	58	3350	8	2	274	4	2
Canada	126	2093	11	7	220	6	6
Switzerland	25	1824	13	1	61	9	4
Taiwan	96	1699	14	6	175	8	5
Israel	60	1230	18	5	45	13	8
Australia	75	1190	19	8	55	11	9

Canadian Nano-Industry: Emerging

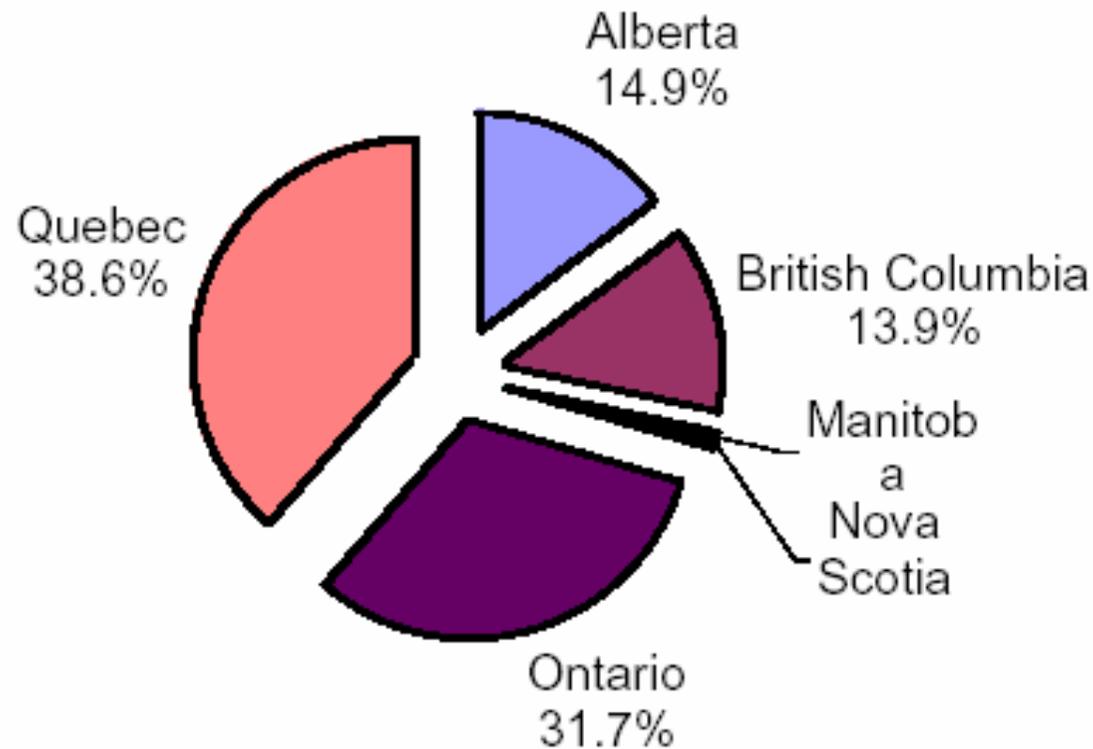
Figure 3: Nanotechnology Companies by Topic



Strong correlation with patent activity

Nano-Industry: Emerging across Canada

Figure 1: Nanotechnology Companies by Province



Québec

- Comprehensive program for nanotechnology in the province of Québec
- nanoQuébec
 - >200 principal investigators
 - >1000 graduate students
 - >\$400Million over 5 years
 - Workshop on Commercialization held on February 7th
- IRSST
 - private non-profit centre
 - workplace safety & security
 - impact of nano on workers

nano
québec
l'avenir des nanos est ici
nanotech's future is here

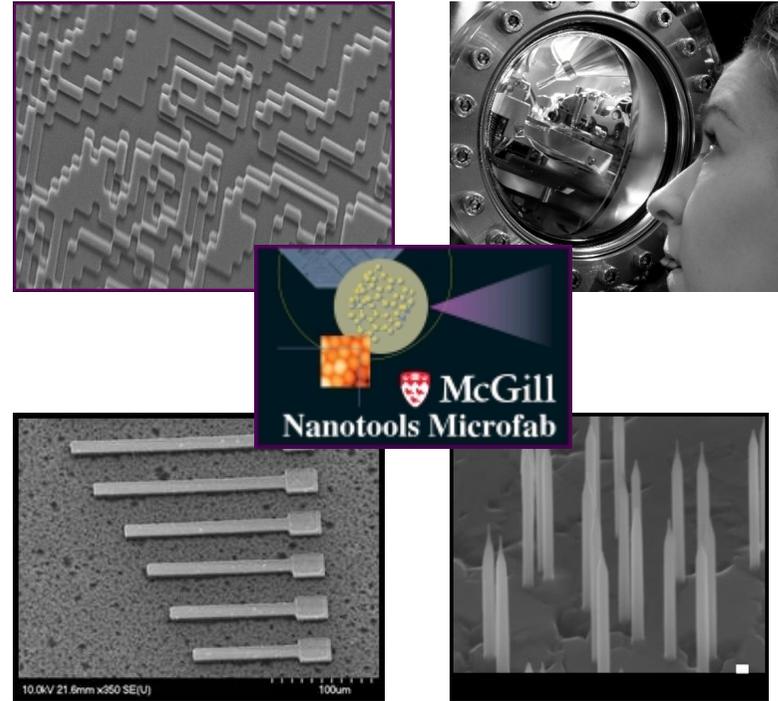


Développement
économique, Innovation
et Exportation
Québec

Canada Economic
Development
for Quebec Regions
Développement
économique Canada
pour les régions du Québec
Canada

Québec : McGill University

- Nanotools Microfab
 - Class 100 Clean Room
 - Photolithography
 - Etch / Deposition
 - Assembly
 - Statistical process control initiative for prototyping
- Research to Innovation strategy leverages both people and facilities

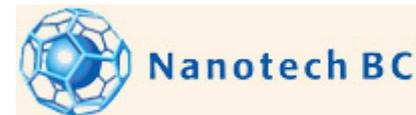


Québec 

nano
québec

British Columbia

- Comprehensive survey of nanotechnology capability in the province of BC (2004)
 - develop asset maps for key commercialization areas
- Nanotech BC
 - joint funding from province and NRC-IRAP program
 - > 12 companies
 - 5 academic institutions
- “Small is Big” Seminar
 - business, industry, research
 - held on February 9th

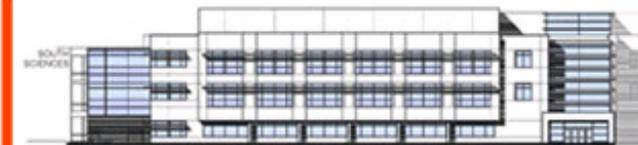
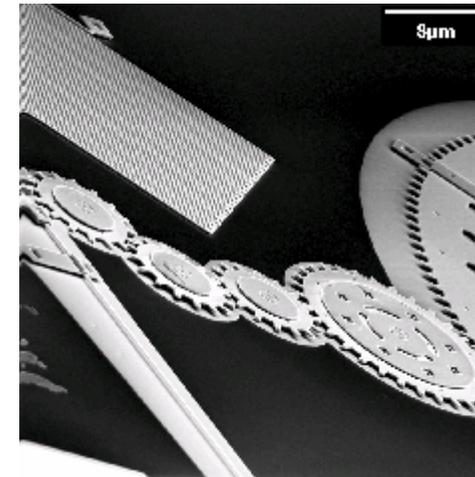


BC : Simon Fraser University

- Four Institutes within the nanoBC initiative:
 - 4D LABS
 - Nano-Imaging Facility
 - Institute of Micromachine and Microfabrication Research
 - Pacific Centre for Advanced Materials and Microstructures
- Design, Development, Demonstration and Delivery of advanced materials and nanoscale devices



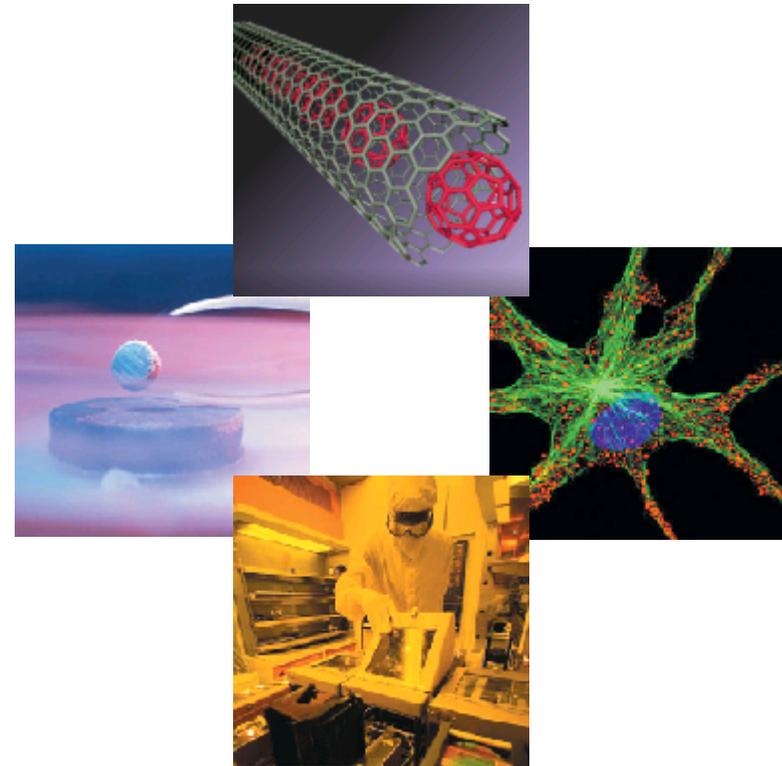
SIMON FRASER UNIVERSITY
THINKING OF THE WORLD



NanoBC

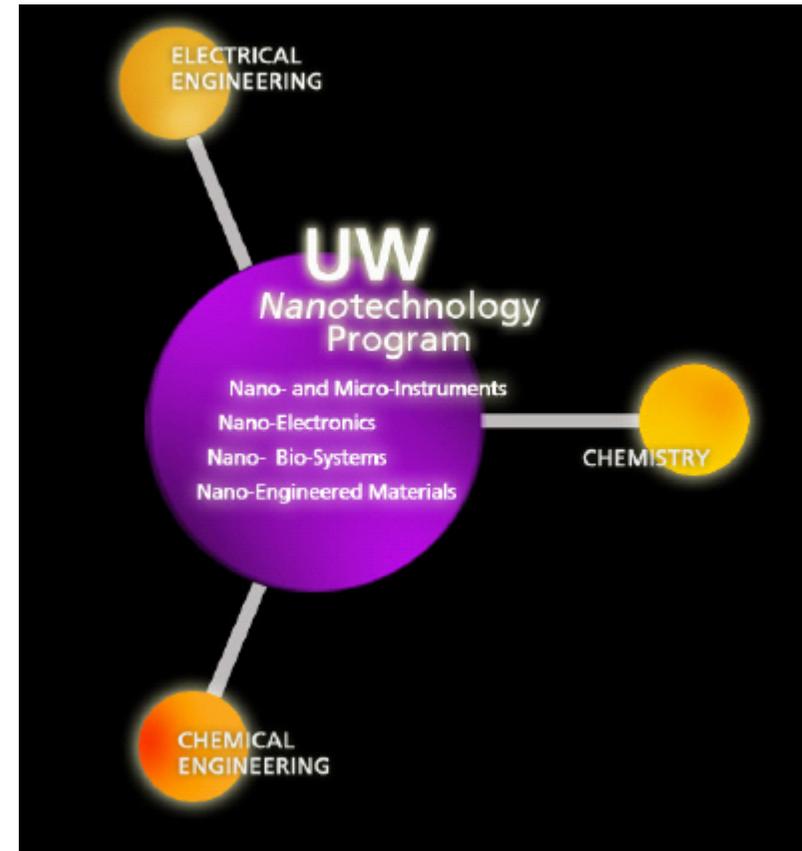
Ontario

- Largest provincial economy in Canada
- Largest university base
- New Ministry of Research and Innovation
 - headed by Premier McGuinty
- Ontario Research Commercialization Fund
 - accelerating transfer of knowledge and technology to the private sector
- New “Ideas to Market” strategy, \$160M program for commercialization



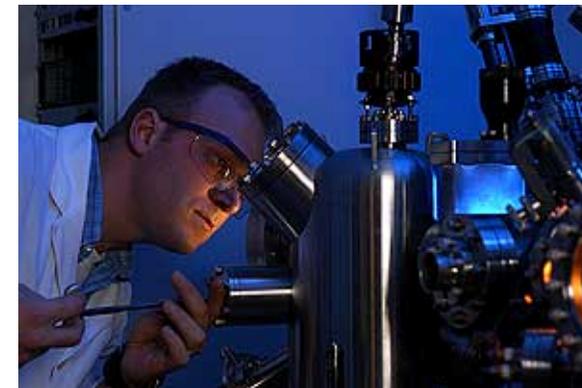
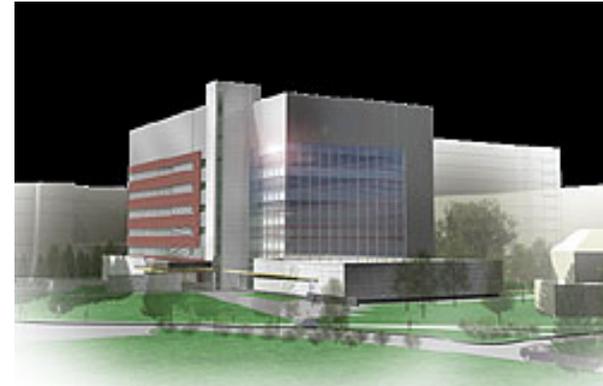
Ontario : University of Waterloo

- New nanotech program
 - unique in Canada
 - growing to 500 undergrads
 - growing to 125 graduates
 - multi-disciplinary engineering
 - includes Metrology option
- New facility being built
 - \$70M Quantum Nano Center to be completed in 2010
 - includes design, fabrication and testing infrastructure

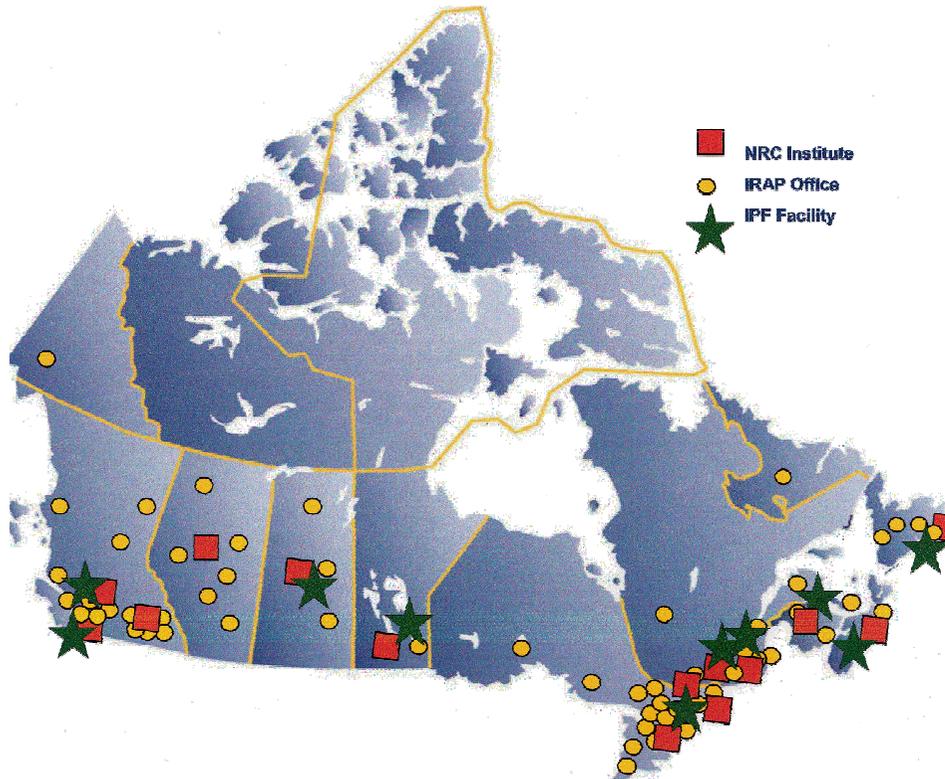


Alberta : National Institute for Nanotechnology

- \$120 million joint venture
 - Governments of Canada and Alberta & U of Alberta
- Multi-disciplinary institute
 - physics, chemistry, engineering, biology, informatics and medicine
- Designed as a catalyst amongst academia and industry
 - accelerate commercialization
 - integration of technologies
 - ethics and regulation issues

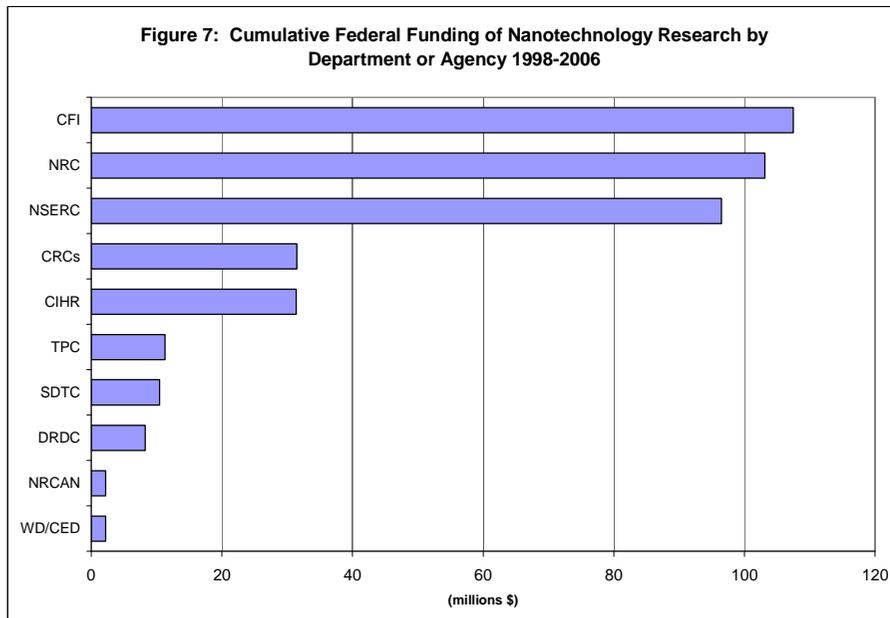


Canada : National Research Council



- National organization, federal government agency
- Provides essential elements of national S&T infrastructure
- 4,200 employees
- 1,500 visiting workers
- Labs and facilities across the country
- 20 Research Institutes
- Total expenditures \$750M

NRC: A Key Player in Canada



NRC (over 8 years):

(Underestimated)

- **25%** of federal investment
- **15%** of Canadian investment
- Majority in **operating** funds

> \$40M invested in nano R&D
~ 260 Full Time Equivalent Researchers

> 40% invested at NINT
> 10% of Canadian investment at NINT

NRC : Multi-Institute Effort



- Institutes for:
 - Nanotechnology
 - Microstructural Sciences
 - Molecular Sciences
 - Biological Sciences
 - Aerospace
 - Environmental Chemistry
 - Research in Construction
 - Fuel Cell Research
 - National Measurement Standards
- Working together on a variety of nanotechnologies
 - new projects in metrology

NRC : Multi-Institute Effort

Institute for Microstructural Sciences (**NRC-IMS**)

- Nano-fabrication and Devices; Quantum Information; Terahertz Devices; Carbon Nanotubes; Bioprobes and Sensors

Steacie Institute for Molecular Sciences (**NRC-SIMS**)

- Confinement effects; Nanoporous materials; Single-walled carbon nanotubes; Nanoscale imaging; Nanoparticles; Molecular Sensing; Nanostructure and microfluidic fabrication in glasses

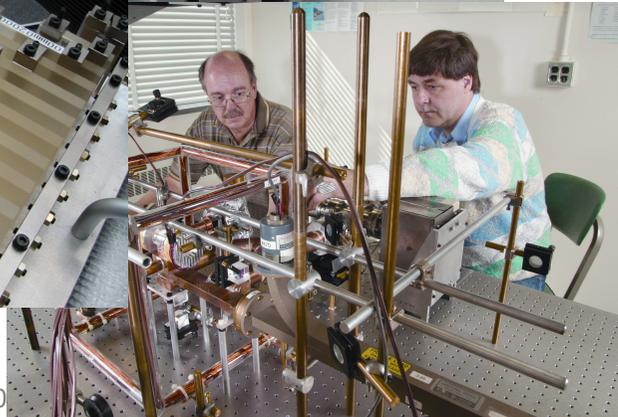
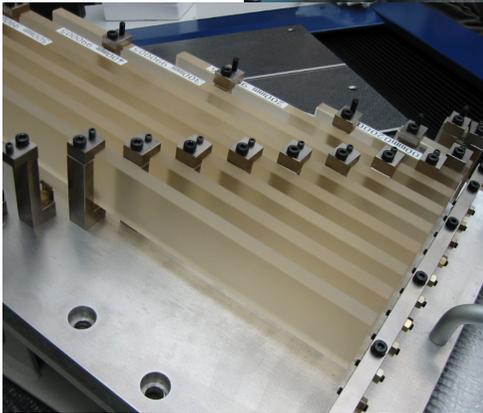
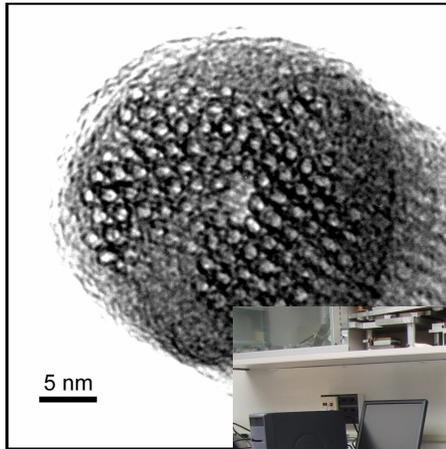
Institute for Chemical Process and Environmental Technology (**NRC-ICPET**)

- Metal nanoparticles as catalysts; Tunable hybrid nanocrystal-polymer films; Thin films for sensors; Natural polymer-clay composites; Laser induced incandescence for nanoparticle measurements; Magnetic core shell particles

Industrial Materials Institute (**NRC-IMI**)

- Polymer nanocomposites; Ceramic coatings; Nanoimprint lithography; Functional polymer surfaces

NRC : Measurement Standards



- Institute for National Measurement Standards
- Supporting development of a variety of nanotechnologies
 - AFM and nanoscale length
 - Nanocomposite dielectrics
 - Quantum photon standards
 - Molecular imaging agents
 - Optical characterization
 - Reference Materials

The Need for Standards and Metrology

- Nanoscience can only evolve into nanotechnology once the measurement problems and metrology are under control
- Economic impacts from product development and commercialization demand standards
- Workplace safety, environment and health are the key drivers during this transition

Canada : Pulling Together

- Efforts to support ISO TC229 have become a natural focal point for activity from all areas
 - Canadian Advisory Committee includes members from academia, industry, government
 - Federal Government playing a strong role
 - NRC-INMS, Environment, Health, Industry, Natural Resources, Food Inspection Agency ...
 - Provincial Governments committed to participate
 - Québec, Ontario, Alberta, British Columbia
- Coalescing participation from all sectors in the absence of a National Strategy is a major benefit of work in Standards Development

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Canada: Helping to Lead

- As Convenor for ISO TC229 WG1, Canada “holds the pen” on terminology and definitions in nanotechnology
 - essential starting point for standards and regulations
- As Chair of the ISO TC229 WG2 Study Group on Metrology, Canada will help coordinate measurement science research programs under way at the National Metrology Institutes of participating countries
 - essential to relate research and reference materials to international standards development activities

Thank you!



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