



Science-Metrix

## **Performance measurement in the context of federal science-based organizations:**

Lessons learned from the evaluation of S&T activities within the  
Minerals and Metals Sector at Natural Resources Canada

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- **Evaluation Context, Scope and Issues**
- **Overview**
  - The Minerals and Metals Sector at Natural Resource Canada
  - **Two S&T Laboratories:** Material Technology Laboratory (MTL) and Mineral and Mining Science Laboratories (MMSL)
- **Main Evaluation Challenges**
- **Selected Approach and Evaluation Methods**
  - Design rationale by method
  - Lesson learned by method
- **Conclusion and Future Perspectives**





# Evaluation Context, Scope and Issues

- The summative evaluation of the science and technology (S&T) activities of the Minerals and Metals Sector (MMS) of Natural Resources Canada (NRCan).
  - Phase I – Evaluation assessment
  - Phase II – Fieldwork and reporting
- Focused on S&T activities of two laboratories:
  - Material Technology Laboratory (MTL)
  - Mineral and Mining Science Laboratories (MMSL)
- This evaluation examined three issues:
  - (1) relevance and rationale
  - (2) results and success; and
  - (3) cost-effectiveness (including design and delivery issues) and alternatives
- Five-year evaluation period: 2002–03 to 2006–07
- Not designed to compare MTL and MMSL → very different organizations.



# The Mineral and Metal Sector at Natural Resources Canada

- NRCan is a large S&T driven organization and manages its S&T programs through four major program activities:

<b>Energy</b> Spending: \$419M FTEs: 1,252	<b>Earth Sciences</b> Spending: \$252M FTEs: 1,531	<b>Sustainable Forest</b> Spending: \$207M FTEs: 892	<b>Minerals and Metals</b> Spending: \$75M FTEs: 645
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- Total NRCan's spending: \$953M (2007-2008)
  - MMS = 8% of spending
- Total NRCan's FTEs: 4,320 (2007-2008)
  - MMS = 15% of FTEs



# S&T in the Mineral and Metal Sector of Natural Resources Canada

- The Minerals and Metals Sector consists of 5 branches, 3 of them S&T based:

**Material  
Technology  
Laboratory (MTL)**

**Mineral and  
Mining Science  
Laboratories (MMSL)**

Explosives Safety and  
Security Branch (ESSB)

- MTL + MMSL have yearly expenditures of approximately \$34.0 million (divided almost equally)
  - 45% of MMS expenditures
- MTL and MMSL had 240 FTEs (divided almost equally)
  - ~ 75% S&T; 25% support and regulation
  - 40% of MMS FTE's
- **MAIN S&T objective at MMS:**

The application of sound science and the development of innovative technologies for the needs of government and industry, as well as for other key stakeholders in the minerals and metals sectors.



# Overview: Resources & Activities of MTL and MMSL

- **Both laboratories have unique expertise, scope and facilities in Canada**
- **Most activities are run on a project basis and most projects are S&T driven**
  - Together, labs typically have 175 to 200 active S&T projects at any time
- **Labs deliver S&T through internally and externally funded projects**
- **Revenue-generation (partial or full revenue generating projects)**
  - Labs are encouraged to put into practice a revenue generation approach to deliver S&T activities
  - Labs now raise 25-40% of their budget from sources outside their operating appropriations (A-base)
  - 80% of S&T projects are revenue generating in nature
  - More than 65% of revenue generating projects have a total value under \$50K
  - This large number of small projects represents only 19% of total revenues



# Overview: Resources & Activities of MTL and MMSL

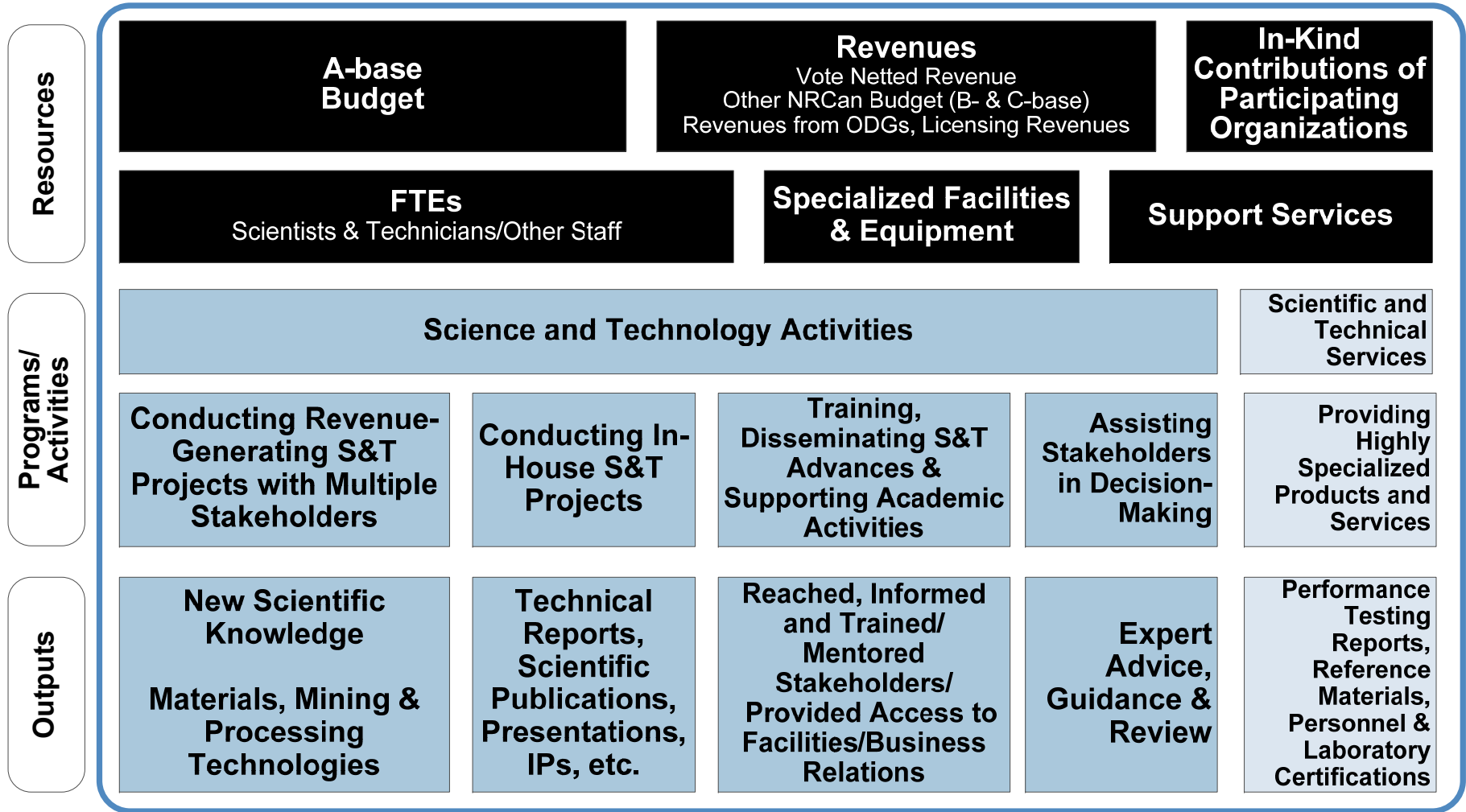
## MTL

- Develops and deploys applied knowledge and technologies that improve all aspects of producing and using value-added products derived from metals and minerals.
- Conducts S&T projects in three industry sectors: transportation, construction, and energy—through five main S&T programs: Advanced Materials, Efficient Metal Production, Infrastructure Reliability, Sustainable Casting, and Advanced Concrete (Discontinued in 2007)

## MMSL

- Develops technological solutions to reduce environmental liabilities and improve worker health and safety in the mining industry.
- Conducts S&T projects in three key areas—mining, processing, and environment—through seven main S&T programs: Ground Control, Mine Mechanization and Automation, Underground Mine Environment, Environment and Processing Programs, Mineralogical and Processing, Metals in the Environment, Mine Effluents, and Mine Waste Management

# S&T Logic Model: Inputs, Activities and Outputs



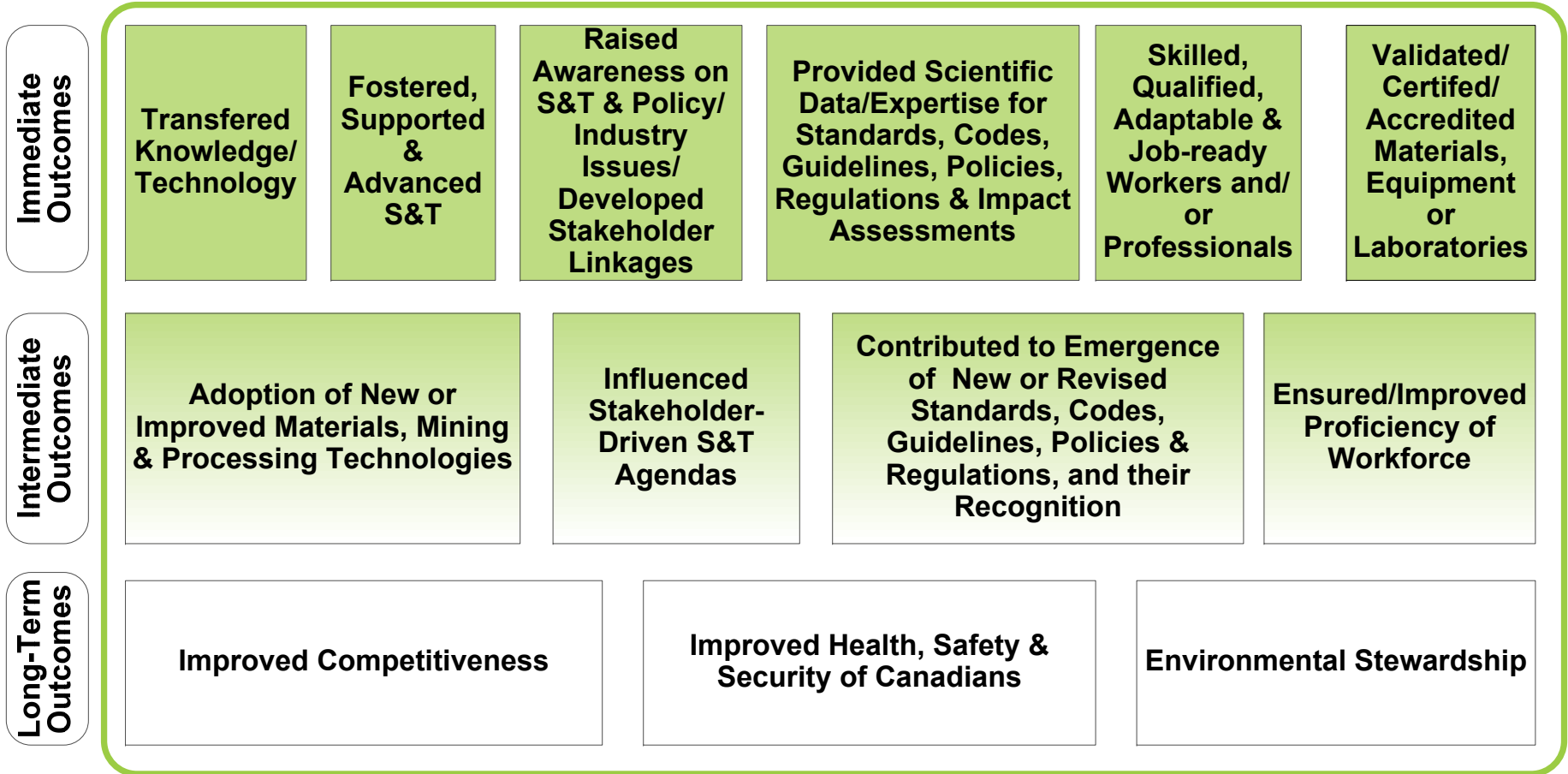


## Overview: Activities to Outcomes at MTL and MMSL

- **Both laboratories commonly maintain a balance between S&T activities that have very different ends:**
  - to support policies/standards and regulations (internally funded projects)
  - to enhance labs core competencies (internally funded projects)
  - to answer clients/partners needs (revenue generating projects)



# S&T Logic Model: Outcomes





# S&T Performance Measurement Challenges

- **Measuring R&D production and S&T in support of programs and regulatory decisions poses many challenges:**
  - Uncertainty of R&D - timeline, cost, results can be difficult to predict
  - Revenue generating projects must also meet the objectives and guidelines of partners (resource alignment and priorities)
  - Accurate attribution of outputs or outcomes is difficult (interdependent projects, multiple-year projects, multiple contributors)
  - Long time frame to achieve expected impacts / benefits
  - Obstacles in determining use of results and overall benefits of client sponsored projects (Follow-up, CR to labs other than \$)
  - Difficulties in quantifying benefits (proprietary, knowledge)



# Global Challenges of the Evaluation of MTL and MMSL

- **First formal and comprehensive evaluation (for the Treasury Board of Canada):** No prior evaluation even though these laboratories have a more than 50 year history.
- **Complex organization/programs:** Evaluation included two organizations and more than 12 programs with 1) different management structure, 2) different objectives and 3) different clients/stakeholders.
- **Performance management:** Absence of a formal results-based performance management / measurement framework.
- **Availability of S&T performance measures:** Limited data on the outputs and outcomes of S&T activities. Some key performance indicators (KPIs) were collected by the laboratories but were not linked to S&T objectives and do not provide a measure of their contribution to MMS and NRCan's outcomes.



### **Use of a multi-faceted approach to help overcome these challenges:**

- (1) Client satisfaction and outreach web surveys
- (2) Interviews with 1) key laboratory individuals and 2) with clients, partners and other stakeholder organizations
- (3) A review of all S&T outputs including a bibliometric analysis of scientific publications
- (4) Detailed project reviews (based on the case study approach)
- (5) Document and file review (performance measurement review)









# Client Consultation: Web Survey and Interviews

- **Rationale:** Collect facts, views and opinions from external sources
  - Complementary tools - survey with close-ended questions to obtain quantitative data (mostly about satisfaction); interviews for in-depth qualitative data
  - 159 survey respondents (response rate: 28%)
  - 30 external interviews (15 per lab)
  
- **Limitations:**
  - Restricted reach - client contact information not readily available and incomplete
  - Bias toward recent clients – new clients or repeat business
  - Mostly clients were interviewed; only few non-client industry stakeholders
  - Inability to link evidence/opinions to specific programs or projects

# Client Consultation: Web Survey and Interviews

## Value/Lessons-learned:

- Web survey is an easy and cost-effective way to gather data from a wide number of individuals
- Both tools (web survey and interviews) complemented each other in many aspects
- Obtain contact information right from the beginning (evaluation assessment)

Thinking about your latest project with the laboratory, how would you rate your satisfaction with the following aspects of this collaboration?	1: Not at all satisfied	2	3	4	5: Very satisfied	Cumul* 
Overall quality of S&T tasks	-	1.9%	11.1%	37.0%	50.0%	
Overall cost-effectiveness/value for money	-	5.7%	17.0%	37.8%	39.6%	
The timeframe of the project	3.6%	16.1%	19.6%	35.7%	25.0%	
Communication / interactions	1.9%	3.8%	13.2%	43.4%	37.7%	
Follow-up/support upon project completion	4.3%	10.6%	19.1%	27.7%	38.3%	



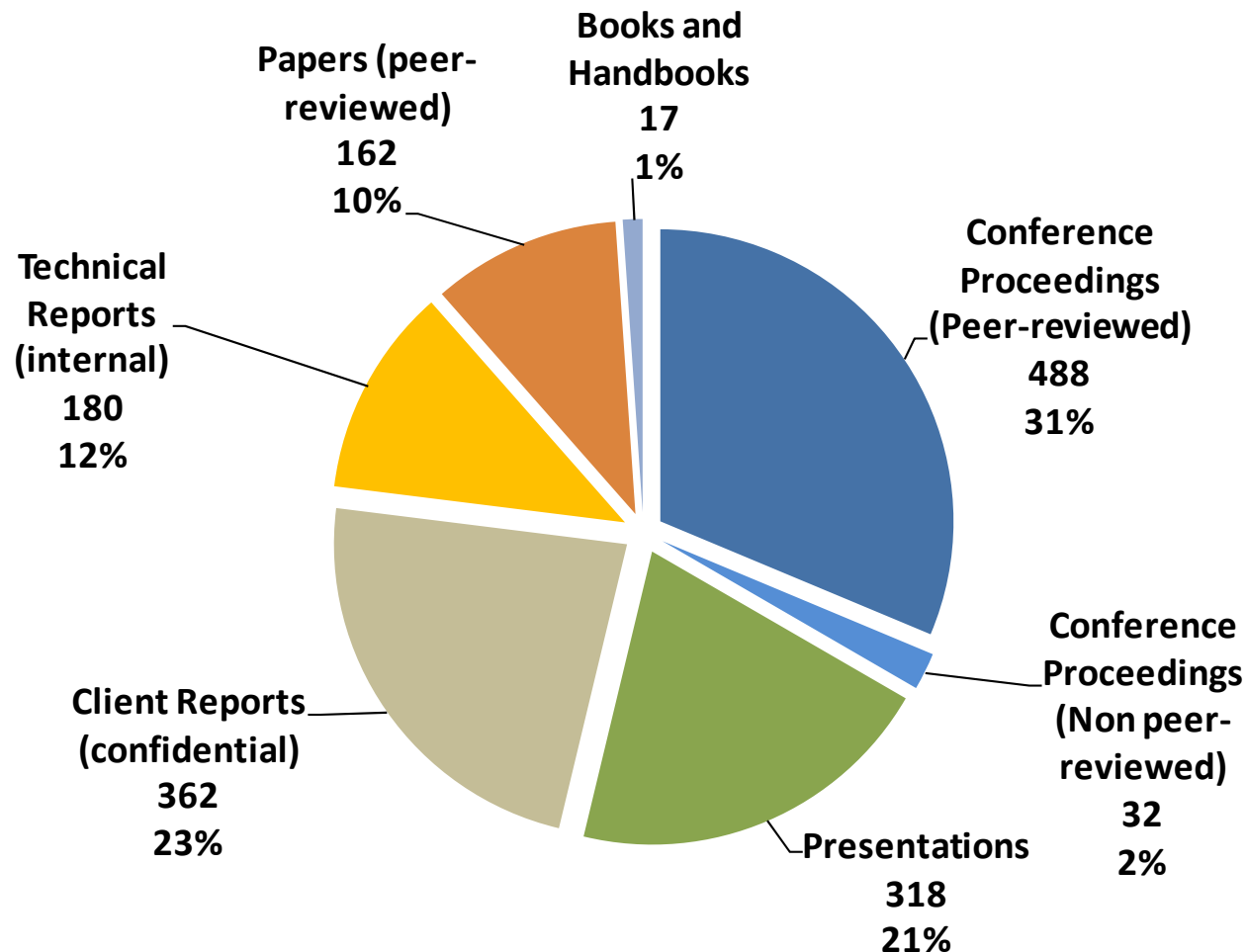
# Review of S&T Outputs

- **Rationale:** Perform an initial mapping of the diverse outputs produced by the labs & measure and characterize using two complementary methods.
  - Publication in peer-review journal is not a priority
  - Comprehensive output review: technical reports, client reports, handbooks, presentations, conferences, etc.
  - Bibliometric analysis (publications in peer-reviewed journals)
- **Limitations:**
  - General view – no link between output and activity/programs
  - No benchmarking with organizations similar in terms of scope, activities or size
  - Bibliometrics focus on scientific community impacts
- **Value/Lessons learned:**
  - Provides a comprehensive view of how S&T is performed, used, and disseminated.
  - Cross-validation between approaches – 95% coverage for peer-reviewed outputs
  - Bibliometrics is a cost-effective method to measure output and uptake (citations)

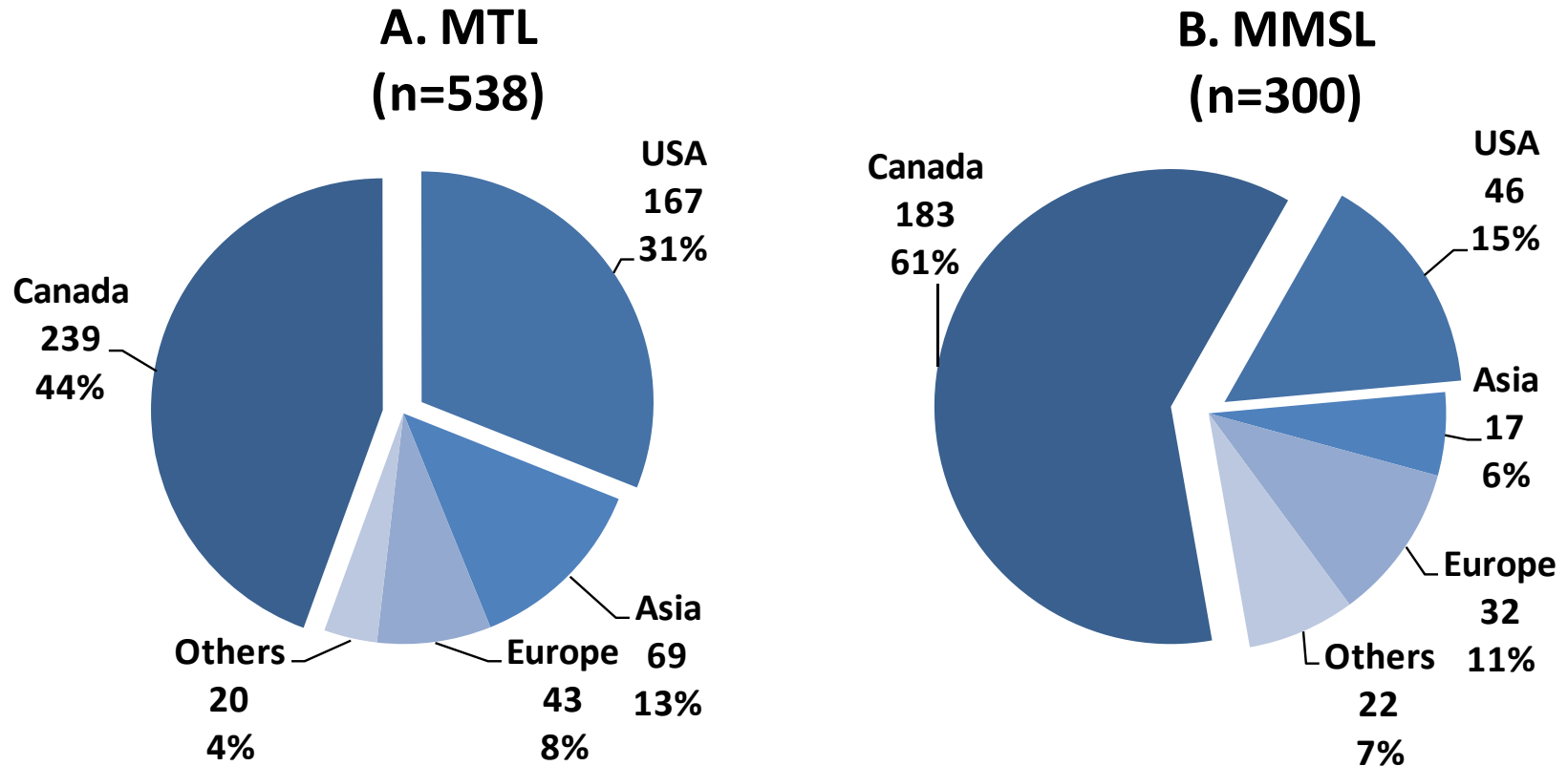


# Review of S&T Outputs: Mapping

**MTL and MMSL S&T Outputs, 2004 to 2006**



## Distribution of labs scientific and technical conferences (proceedings) and presentations by region (2004–2006)

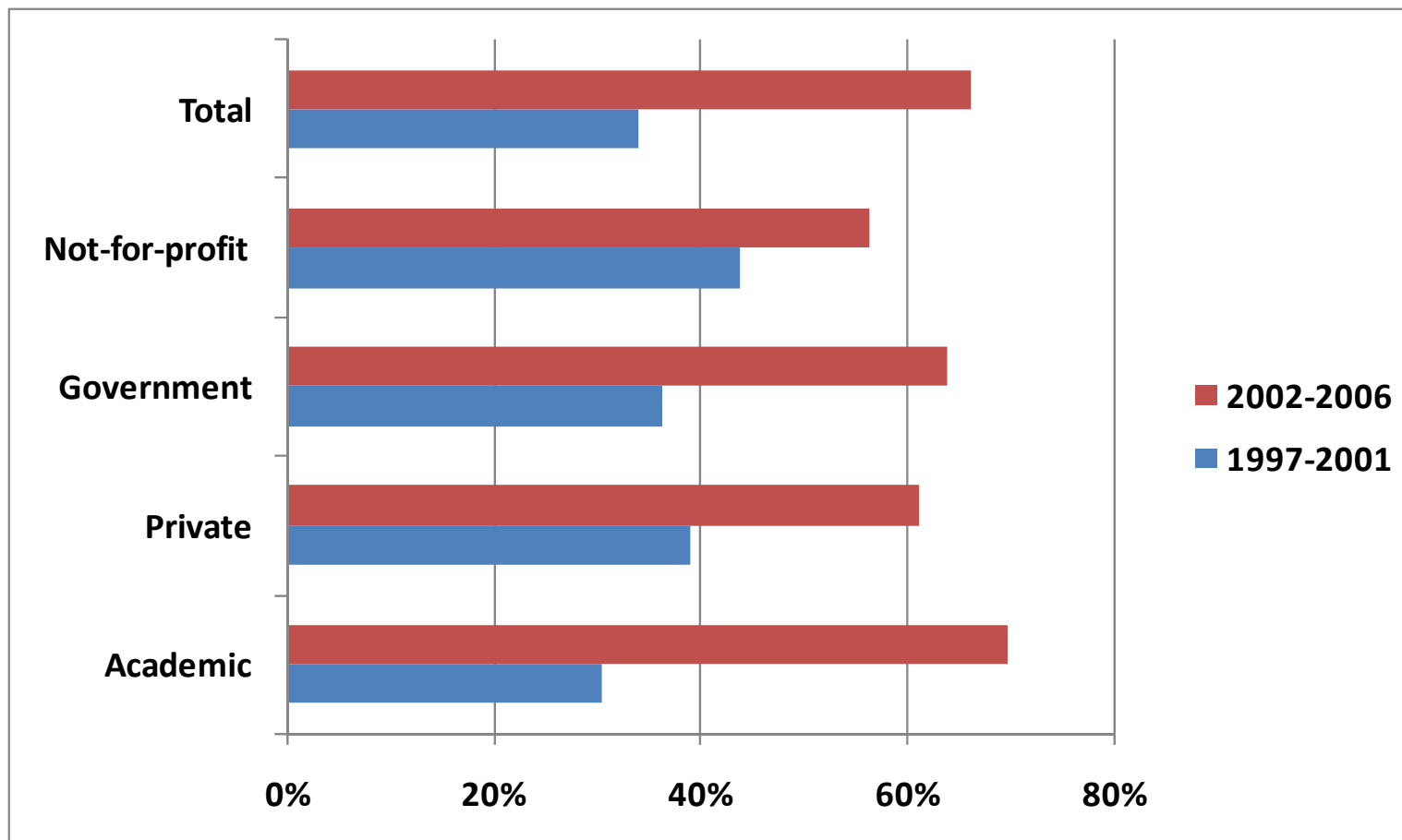


# Review of S&T Outputs: Bibliometrics

**MMS contribution to NRCan's scientific output based on the number of papers and on the citedness of these papers between 1997 and 2006 (Scopus Database)**

Institution	Number of papers*				Average of relative citations (ARC)**		
	1997-01	2002-06	1997-06	%	1997-2001	2002-2006	1997-2006
Geological Survey of Canada	1,204	1,158	2,362	38%			
Canadian Forest Service	961	1,154	2,115	34%			
CANMET-CETC	221	372	593	10%			
Geomatics Canada	232	355	587	10%			
<b>MMS</b>	<b>187</b>	<b>341</b>	<b>528</b>	<b>9%</b>			
<b>CANMET-MTL</b>	<b>109</b>	<b>199</b>	<b>308</b>	<b>5%</b>			
<b>CANMET-MMSL</b>	<b>71</b>	<b>122</b>	<b>193</b>	<b>3%</b>			
<b>CERL</b>	<b>9</b>	<b>23</b>	<b>32</b>	<b>1%</b>	<i>n.s.</i>	<i>n.s.</i>	<i>n.s.</i>
<b>Total</b>	<b>2,814</b>	<b>3,358</b>	<b>6,172</b>	<b>100%</b>			

## Distribution of labs scientific collaborations by sector (1997–2006)





## Detailed Project Reviews (Case Study Approach)

- **Rationale:** Get a better understanding of mode of operations and the contribution of activities and outputs to outcomes.
  - Semi-random selection across labs, project types (internally funded and revenue generating), programs, and value (\$)
  - 14 detailed project reviews based on project documents, and 33 structured interviews with project managers and client representatives
  - Cross-case analysis to identify key delivery dimensions (similarities, best-practices) and evidence on S&T outcomes
- **Limitations:**
  - Restricted view considering the wide diversity of project types/setting/objectives
  - Some use / outcomes may have been missed – multi-partner projects
- **Value/lessons learned:**
  - Was essential to gain operational perspective and evidence on labs' outcomes
  - Provided more detailed accounts of evidence (satisfaction, cost-effectiveness)
  - In-depth look at impact story (insight into impact production; identification of elusive impacts, benefits of CR to core)



# Documentation and File Review

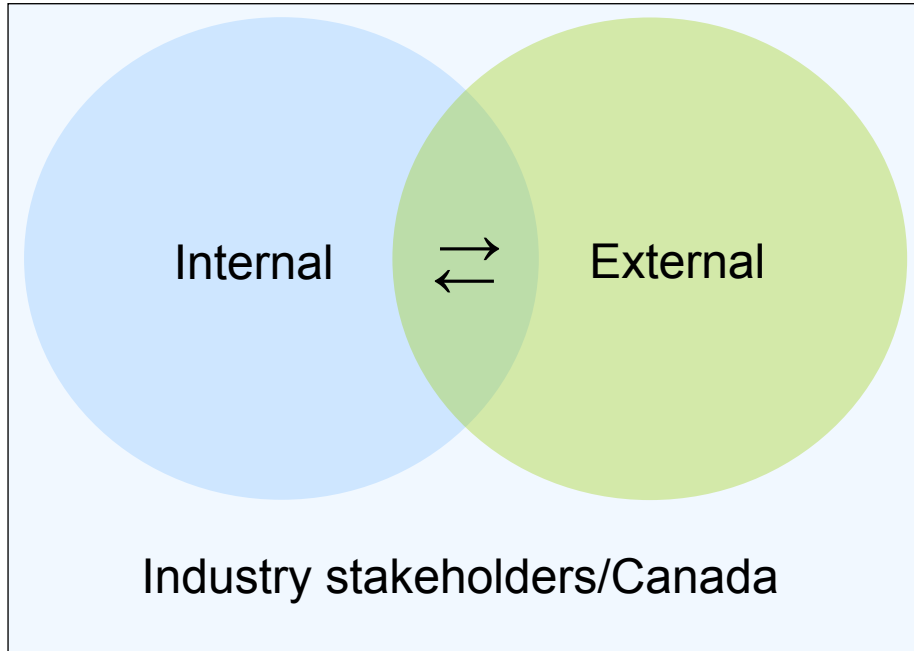
- Considerable documentation was obtained & used to provide evidence across all 3 evaluation issues
- **Limitations:**
  - Important gaps in financial data – no program-level data; incomplete or inconsistent data in the Project Management Information System (PMIS)
  - Lack of performance measurement data and performance management tools
  - Lack of documented procedures on resources allocation/priorities for projects
  - Data on achievements mostly consisted of success stories
- **Sample results:**

Type	#	Median of Project Value	Planned Revenue	Actual Revenue	Surplus/Deficit in Revenue	Planned % CR	Actual % CR
Full CR	163	\$21	\$3,714	\$3,424	-\$290	99%	54%
Partial CR	40	\$80	\$2,993	\$2,943	-\$50	58%	44%

- Other tools provided arguments or evidence to help explain these results



# Documentation and File Review



- Cost overruns on revenue-generating projects are absorbed by the labs
- Strategic decisions to engage in RG projects are made because of other benefits to the labs
- The true challenge is to assess this “grey zone” in terms of mutual / incremental benefits for the labs, the clients and more broadly to industry stakeholders

## ■ Value/lessons learned:

- Provided good lines of evidence particularly concerning rationale & relevance, and results & success
- Financial data did not meet our expectations for cost-effectiveness analysis



# Conclusion and Future Perspectives

- The multi-faceted approach was crucial to thoroughly understand, characterize and answer the evaluation questions especially in consideration of the challenges we faced
- Need to better validate the availability and quality of multiple information and data during the evaluation assessment phase

## **Future perspective:**

- Labs should continue to explore the costs and benefits associated with revenue generating model
- Opportunity to review best practices for revenue generation across NRCan and in OGDs
- Labs should continue to improve their S&T performance measurement capacity
- Opportunity to harmonize S&T output and impact measurement across the sector (MMS) and ultimately across the department (NRCan)



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**Thank you for your time!**

