

Subatomic Physics Long Range Plan

D. Karlen / U. Victoria and TRIUMF
Chair, LRP Committee

CINP/IPP Joint Meeting
Ottawa, June 12, 2016

LRP website: www.lrp2017.ca

LRP Committee

- On behalf of the Canadian community of Subatomic Physicists, I would like to thank all the members for their work on this committee

Committee members:

Name	Institution
Dean Karlen (Chair)	University of Victoria and TRIUMF
Philip Burrows	Oxford University, United Kingdom
Jens Dilling	TRIUMF
Jacques Farine	Laurentian University
Mark Huyse	K.U. Leuven, Belgium
Randy Lewis	York University
Jeffery Martin	University of Winnipeg
Erich Poppitz	University of Toronto
Achim Schwenk	T.U. Darmstadt, Germany
Manuella Vincter	Carleton University
Andreas Warburton	McGill University


LRPC observers

- I would also like to thank the ex-officio members and observers. They provided valuable advice and opinions for our committee:

Ex-officio members and observers:

Name	Institution
Garth Huber (ex-officio)	CINP Executive Director
J. Michael Roney (ex-officio)	IPP Director
Reiner Kruecken (ex-officio)	Head of Science Division, TRIUMF
Nigel Smith (ex-officio)	Director, SNOLab
Adam Ritz (ex-officio)	SAPES, co-Chair 2016
Olivier Gagnon (observer)	Senior Programs Officer, CFI
Sarah Overington (observer)	Team Leader, NSERC

Our Mandate



Based on a broad consultation with the Canadian subatomic physics community, the LRP Committee was asked to:

- Identify subatomic physics scientific ventures and priorities that should be pursued by the Canadian community and that would ensure continuous Canadian global scientific leadership.
- Provide budgetary estimates, including funding ranges for prioritized endeavours.
- Funding ranges should include funding levels that would allow for a restrained, yet efficient, contribution to the ventures, as well as levels that would enable a more extensive contribution.

The plan covers the period 2017-2021 and includes a look ahead to 2026.

Background




The LRP Committee is to take into account the:

- Ever increasing internationalization of projects and collaborations in addressing the fundamental questions of subatomic physics.
- Concurrent requirement to maintain and further develop world-class domestic research programs and infrastructure.
- Established expertise and strengths of the Canadian community.
- Recognition of the fact that the Canadian subatomic physics community cannot be involved in all research endeavours

Deliverable: Final report no later than September 1, 2016.

Broad consultation

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- CINF and IPP briefs:
 - Submissions requested from experiment/theory/accelerator communities
 - Special CINF and IPP sessions at June 2015 CAP Congress
 - Briefs prepared by CINF/IPP councils
 - 200 pages in total – sent to LRPC in early October
 - Survey (November):
 - Distributed to all NSERC-eligible members of SAP community
 - Current/future activities, graduate student supervision and capacity
 - Townhall (December 12):
 - Held at TRIUMF with video conference connection
 - Full day discussion of briefs, survey, and elements of the LRP report
 - Virtual townhall (February 25):
 - Presented draft of scientific and policy recommendations
 - Invited comments at meeting and by email
 - Draft report (May 17):
 - Requested comments by June 6
 - CINF/IPP joint sessions at CAP Congresses (June 2015 and 2016)

Proposed schedule

- As presented at Kickoff meeting (June 2015)

Date	Activities
June 14, 2015	Kick-off meeting
October 1, 2015	IPP and CINP briefs submitted (final draft form, or finalized)
October 24-25, 2015	In-person working meeting of the committee
December 12, 2015	Town Hall meeting
February 23 , 2016 25	Audio conference presentation to community by LRPC: Main recommendations of the LRPC, to be presented to SAP ES on March 8
March 8, 2016	Presentation of main recommendations from the LRPC
May 13 , 2016 17	Draft LRP made available to community. Deadline for comments: June 15 , 2016. 6
June 13 / 18 , 2016 11-12	Report from LRPC to community at CAP congress (Ottawa). In-person working meeting to work on community comments.
July 31, 2016	LRP report finalized and sent for translation and binding.

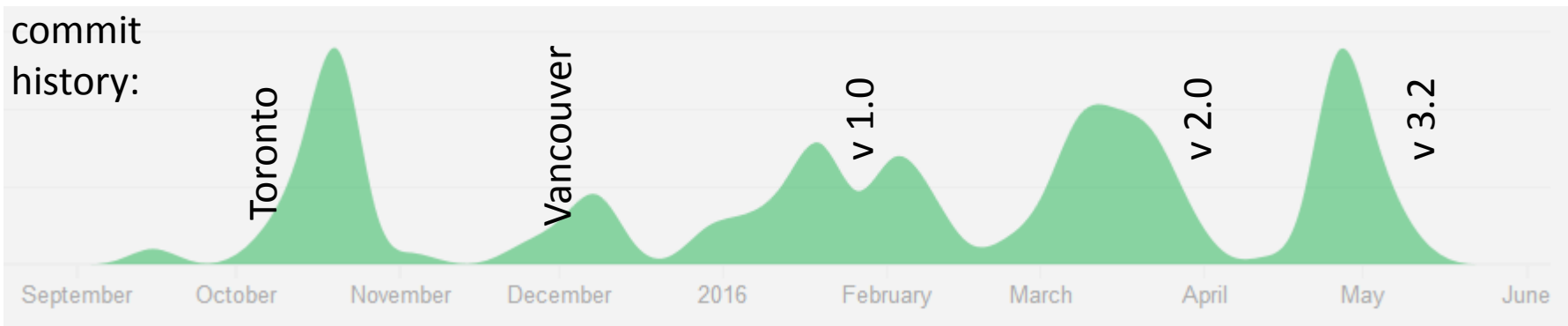
Committee work

Meetings:

- Two face-to-face meetings:
 - October 24-25 in Toronto
 - December 12-13 in Vancouver
- Twenty video-conference meetings (10 full- / 10 sub-committee)

Report writing:

- github repository – write access for all core committee members
- several “freezes” for internal review



Draft report release

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- Draft report released on May 17, with comments due June 6

Some highlights from the report follows:

1. Executive Summary

- Basic introduction, recent awards, guiding principles, summary of scientific and policy recommendations (ordered as appear in report)

2. The “Big Questions” in Subatomic Physics

- Seven questions that encompass most of SAP research in Canada:
 1. What is the nature of physics at the electroweak scale and beyond?
 2. What is the nature of neutrino masses?
 3. What is the nature of Dark Matter in the universe?
 4. What structures underlie the forces and matter in the universe?
 5. How do quarks and gluons give rise to the hadronic properties and the phases of hadronic matter?
 6. How does the structure of nuclei emerge from nuclear forces?
 7. How were the heavy elements formed in the early universe?
- For each: Theoretical aspects → experimental approaches → Canadian roles (theory and experiment)
 - Emphasize strong connections between theory and experiment
 - Avoid dividing efforts into “nuclear” and “particle” physics



3. Canadian Subatomic Physics Plan

- Five broad areas, each with a scientific recommendation (directed particularly to SAP ES):
 - Theory
 - Ongoing Flagship Facilities and Experiments
 - Strategic Smaller-scale Experiments
 - Future Major Projects
 - Look Ahead to 2022-2026



Scientific recommendation on Theory

819 Subatomic physics theorists drive and develop understanding of the “Big Questions”
820 outlined in Section 2. Theory development is essential to answering these questions and
821 to formulating the resulting future research directions. Many in this diverse community,
822 among them world leaders, are addressing these exciting questions by developing theoretical
823 tools and models, ranging from the formal to the phenomenological. The broad range of
824 expertise allows the community to work quickly and efficiently on new directions as they are
825 identified.

826 Experimental work by Canadians benefits significantly from a strong theory community
827 to help interpret results and suggest new paths for discovery. It is therefore essential that
828 the subatomic theory community continues to receive strong support, currently 15% of the
829 NSERC subatomic physics envelope.

92 **Scientific Recommendation:** Maintain strong support for research in theo-
93 retical subatomic physics.

4. The Community of Subatomic Physics Researchers in Canada

- Community profile:

- size (currently 233), education, diversity, renewal

- Between 2010 and 2015:

29 grant holders departed / 29 new hires

4% growth in number of NSERC grant holders in SAP due to those eligible throughout period (more started than stopped receiving support)

Region	departures	new hires
BC	8	8
Prairies	5	5
Ontario	10	12
Quebec	6	3
Atlantic	0	1
Total	29	29

Draft report release

• Research profile:

	2010	redirection		renewal		2015
		in	out	new hire	depart	
Theory	71	2	9	12	12	64
Q1: Beyond SM	17	5	2	3	2	21
Q2: Neutrino mass	0	0	0	0	0	0
Q3: Dark Matter	4	1	2	3	0	6
Q4: Structures	26	3	5	3	4	23
Q5: QCD and hadrons	17	1	6	1	3	10
Q6: Nuclear structure	6	0	2	2	3	3
Q7: Heavy elements	1	0	0	0	0	1
Experiment	146	19	5	16	16	160
Q1: Beyond SM	80	18	7	7	9	89
Q2: Neutrino mass	38	4	5	6	1	42
Q3: Dark Matter	20	3	0	4	0	27
Q4: Structures	0	0	0	0	0	0
Q5: QCD and hadrons	10	0	5	0	0	5
Q6: Nuclear structure	30	8	4	4	4	34
Q7: Heavy elements	16	0	2	1	2	13
Accelerator	6	9	1	1	1	14
All categories	224	21	12	29	29	233

Table shows number of applicants and co-applicants on NSERC grants broken down by categories and the Big Question that the grants are most connected to.

Draft report release

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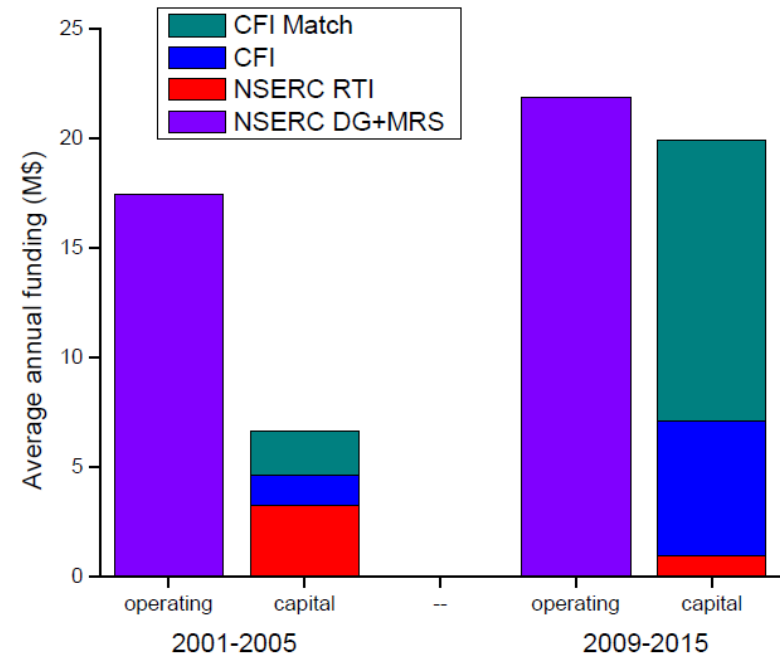
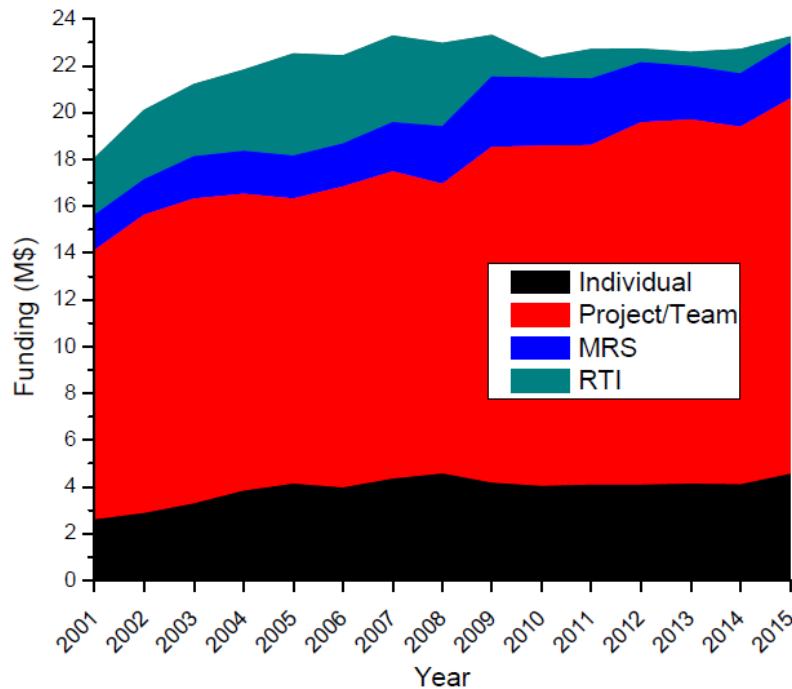
Policy recommendation

1161 Sections 2 and 3 emphasize the important role that theoretical work plays in interpreting
1162 results and defining new directions for exploration. It is therefore important that Canada has
1163 strength in all theory sub-disciplines for which the nation has made significant investments
1164 in experimental infrastructure and Canadians are active on experiments. Table II shows
1165 disproportionately small theoretical activity on Questions 6 and 7, in the areas of nuclear
1166 structure and nuclear astrophysics, for which there is enormous Canadian investment and
1167 experimental activity at TRIUMF. More generally, there is a particular need to strengthen
1168 theoretical studies of non-perturbative aspects of nuclear and particle physics.

1169 **Policy Recommendation:** Institutions and subatomic-physics researchers in
1170 Canada are encouraged to strengthen the theoretical community that supports
1171 substantial Canadian investments in experimental activities.

5. Resources and Support for Canadian SAP Research

- NSERC / CFI – mismatch in operating/capital



Past 15 years:

- SAP received 4% of CFI funding, 2% of NSERC funding (1% of tri-council)
- Excellence in SAP reflected by CFI success – NSERC envelope now insufficient



Policy recommendation on increase to NSERC SAP envelope

	2017	2021
Ongoing research activities	2	2
Ramping up next flagship projects	0	2
New opportunity funding	1	1
Graduate student training	0	2
Total increase	3	7

TABLE III: Recommended increase (M\$) to the subatomic physics envelope at the beginning and by the end of the period of this research plan. Following an immediate increase of \$3M, the envelope should grow linearly by an additional \$4M over the period.

1721 **Policy Recommendation:** Grow the NSERC subatomic physics envelope by
1722 \$7M over the next 5 years.



6. Return on Investment

31 6. Return on Investment

32 6.1. Cultural benefits: Inspiring Canadians

33 6.2. Training highly qualified personnel


34 6.3. Technological benefits: Applications of subatomic physics

35 6.4. Direct economic benefits: Industrial connections

36 6.5. Individual success stories

37 6.5.1. Special page on 2015 Nobel Prize in Physics


Responses to draft

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- Received comments from 15 people:
 - 80 comments in total – committee working through them and will post responses and revised draft in the coming weeks.
 - In addition, a member of the community sent an email to 65 people (primarily in theory community) asking them to object to the theory policy recommendation, with the suggested text:

"I strongly disagree with the NSERC LRPC's recommendation that Canada's theory priority should be to support preferentially theory sub-disciplines which target theoretical studies of non- perturbative aspects of nuclear and particle physics in particular, and experiments in which Canada has significant experimental efforts more generally. I do not think it is the LRPC's role to be intervening in the theory research program in this way."

 - 16 responses generated
 - CINP brief: Recommendation 1: Enhance nuclear theory support.

Summary

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- The LRPC has been very active over the past year
 - Starting to see the light at the end of the tunnel!
 - Thank you for reading the draft and sending your comments
 - A revised draft is forthcoming
 - Please send more photographs/images