Canadian Subatomic Physics
LONG RANGE PLAN 2022 - 26

Community Update

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On behalf of the Subatomic Physics LRP Committee

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subatomicphysics.ca

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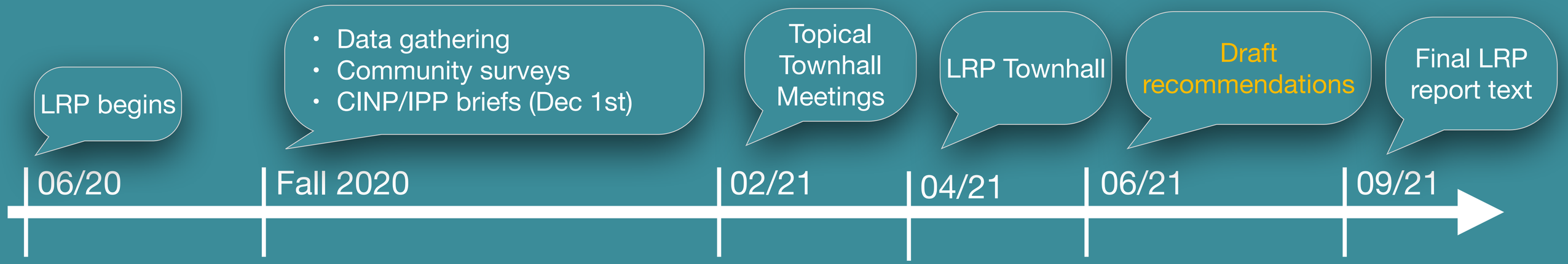
CAP Congress

Overview



<u>Today's presentation</u>

- Research plan portfolio
- Draft recommendations
- Outlook

Research Plan Portfolio

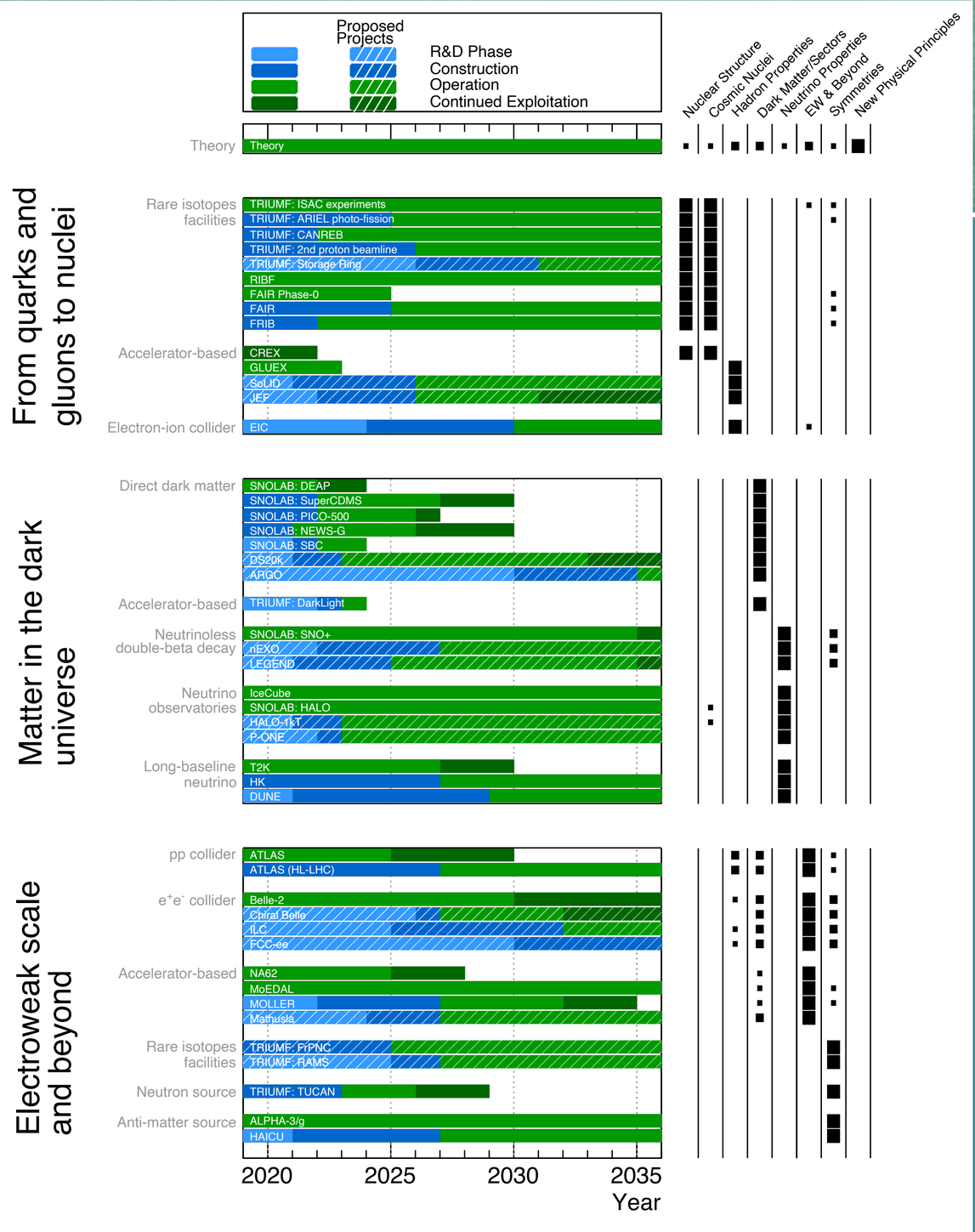
The LRP Committee has discussed the benefits of formulating the research plan as a portfolio of research projects, where an optimum balance among various dimensions would maximize the scientific impact while minimizing risk. [Further details in backup slides.]

A possible representation of this portfolio is shown on the right.

The experimental projects in the portfolio fall into three broad science categories:

- *From quarks and gluons to nuclei*
- *Matter in the dark universe*
- *Electroweak scale and beyond*

These categories will be used to organize some aspects of the Science recommendations to follow.



Recommendations and Statements

- The LRP Committee has identified a number of draft "*recommendations*" and "*statements*" to appear in the LRP report.
  - Statements of value and opportunities:
    - See backup slide
  - Recommendations organized into four categories:
    - Science
    - Funding
    - Policy
    - Community
- Community feedback is welcome.

Draft Recommendations: Science (1/4)

- Topic: High priority Canadian infrastructure
  - We recommend fully exploiting the unique science opportunities provided by SNOLAB and TRIUMF infrastructure, and by the Perimeter Institute, in the pursuit of the science drivers.

- Topic: Theory
  Critical mass and research breadth of the theory community in Canada is vital to maximize the future impact of subatomic physics research.
  - We recommend maintaining strong support to ensure the vibrancy of the theory community over the next decade, both to explore new directions and to support the synergistic interaction between subatomic theory and experiment.

- Topic: Enabling R&D
  - We recommend the support of enabling R&D activities for the future development of accelerators and detector technology, and the development and use of emerging technologies including novel computational and analysis tools.

Draft Recommendations: Science (2/4)

Topic: High priority experimental programs

We recommend pursuit of the following scientific program, which is identified as essential to address the science drivers highlighted in the portfolio:

- From quarks and gluons to nuclei:
  - Explore the structure of hadrons and nuclei using rare isotope and accelerator-based facilities.
- Matter in the dark universe:
  - Search for the existence of dark matter using complementary experimental techniques.
  - Explore the properties of neutrinos through long-baseline experiments, neutrino observatories, and searches for neutrinoless double beta decay.
- EW and beyond:
  - Study matter and its interactions at the highest energy possible both directly and indirectly.

Draft Recommendations: Science (3/4)

Topic: High priority experimental programs *(continued)*

This scientific program is currently implemented through Canadian leadership in a set of flagship projects identified based on their potential scientific payoff, Canadian core expertise, the level of community engagement, opportunities for the scientific and technological training of the next generation, and Canadian investments to date:

- **Flagship projects with broad physics outcomes**
  - From quarks and gluons to nuclei:
    - *TRIUMF ARIEL-ISAC experiments, EIC*
  - Matter in the dark universe:
    - *T2K/HK, IceCube, SNO+*
  - EW and beyond:
    - *ATLAS/ATLAS@HL-LHC, Belle II*

- **Flagship projects with strategic physics outcomes**
  - From quarks and gluons to nuclei:
    - *JLab 12 GeV experiments, Offshore RIB experiments*
  - Matter in the dark universe:
    - *DEAP, PICO-500, SuperCDMS*
  - EW and beyond:
    - *ALPHA/HAICU, MOLLER, TUCAN*

Draft Recommendations: Science (4/4)

Topic: High priority experimental programs *(continued)*

To maximize Canada's future scientific impact, we recommend the support of projects and initiatives within the scientific program (see slide 6) that are under development and have the potential for high impact with significant Canadian participation. In particular, the future program should include pursuit of the following:

- From quarks and gluons to nuclei:
  - The full exploitation of TRIUMF and offshore RIB facilities, as well as JLab programs.
- Matter in the dark universe:
  - The search for dark matter, including via multi-ton scale direct detection.
  - The further exploration of neutrino properties via next generation neutrinoless double-beta decay experiments, long baseline experiments and neutrino observatories.
- EW and beyond:
  - The exploitation of a future Higgs factory, and energy frontier collider.

Potential future projects with ongoing development activities and their timelines are listed in the research plan portfolio (see slide 3).

Draft Recommendations: Funding (1/3)

- Topic: CFI programs
  Support for the development of capital infrastructure through CFI has been highly beneficial for the development of SAP research in Canada.
  - *We recommend continuation of this investment at current annualized levels, as this will be critical for the success of the research plan including many of the proposed future initiatives.*
- Topic: NSERC SAP envelope
  To maximize the impact of current and future investments, and to take advantage of future science opportunities, growth of the NSERC SAP envelope is required for operational support.
  - *The existence of the NSERC subatomic physics envelope structure, and its programs, is highly beneficial for the operational funding of SAP research. We recommend its retention to efficiently support the implementation of the research plan.*
  - *Growth of the envelope is required to maximize the full community capacity for effective HQP training, to ensure that the Canadian programs remain globally competitive, to ensure sufficient availability of funds for small infrastructure projects and to enable future development, and to maximize return on capital investment. As described in the report, we recommend the growth of the envelope by $6M inflation-adjusted [TBC] over the next 5 years.*
  - *We recommend continued support for all the programs available within the NSERC envelope; this includes the MRS technical program which is important for experimental projects in subatomic physics, allowing the efficient collaborative use of unique resources in the development and construction of new instruments, and the RTI program which provides important support for detector and accelerator development.*
  - *We recommend the monitoring and protection of the envelope fraction allocated to theory support. In addition, the minimum award threshold should not be below the level of funding required for sufficient HQP support, analogous to the minimum funding level in other Physics Evaluation Sections.*

Draft Recommendations: Funding (2/3)

In addition to capital and operations funding, support for key infrastructure is required to implement the research plan.

- Topic: Support for Canadian world-leading centers
  Canada's large-scale centers for subatomic physics research have global stature, and provide competitive advantages in pursuing high-priority scientific programs.
  - *We recommend maintaining strong support for Canadian centers (TRIUMF, SNOLAB, Perimeter Institute) so that they remain at the forefront of research worldwide.*
- Topic: IPP Research Scientist program
  The IPP Research Scientist program has had a significant impact on Canada's leadership and contributions to international projects.
  - *We recommend maintaining full support for the IPP Research Scientist program*
- Topic: McDonald Institute
  The existence of the Arthur B. McDonald Institute has added considerable value to the community; its CFREF funding is coming to an end.
  - *We recommend that new funding mechanisms be identified to maintain continuity of the programs provided by the Institute.*

Draft Recommendations: Funding (3/3)

- Topic: Support for Canadian digital infrastructure
  All components of digital research infrastructure (e.g., Compute Canada, Canarie) are critical to the success of subatomic physics research.
  - *We recommend long-term support for the evolving Canadian computing research backbone (including NDRIO) at a level appropriate to address the needs of the subatomic physics research community.*
- Topic: Funding for enabling R&D
  New research opportunities are enabled by the development of novel instruments and technologies. This development relies upon the ability to explore technological frontiers in a non-project specific way.
  - *We recommend that appropriate mechanisms be identified to efficiently fund modest and timely investments in non project-specific R&D activities, that have the potential to address the scientific goals of subatomic physics research.*

Draft Recommendations: Policy (1/1)

- Topic: Coordination of large projects
  - Coordination of the development, capital costs and operational funding over the life-cycle of large-scale (~$100M) projects is difficult within the current system, and we recommend the formation of a new administrative structure to provide this coordination (as articulated, for example in R4.7 of the Naylor Report).

- Topic: Canadian office to engage internationally
  - Subatomic physics research is intrinsically global, and increasingly requires complex multinational agreements. As articulated in LRP2017, we recommend the identification of an office in Canadian government responsible for engaging with the international community with the goal to advance major new science initiatives.

Draft Recommendations: Community (1/2)

- Topic: Equity, Diversity and Inclusion
  There is wide recognition that the Canadian subatomic physics community lacks diversity, as one facet of a broader lack of diversity across other science and technology fields. This lack of representation has many causes, spans the full career range from graduate students to senior faculty, and in itself creates a barrier to entry into the field.

  - *We recommend the pursuit of further sustained actions aligned with the Tri-Council Dimensions Charter, including regular data-gathering and analysis, targeted initiatives to enhance EDI within community activities, and community use of formal EDI committees through the Institutes to support these efforts and/or coordinate with partners.*

  - *We recommend that the subatomic physics community promote balanced representation in high visibility leadership roles, as individuals in these positions are important role models, while recognizing that achieving adequate representation can increase the workload for members from under-represented groups.*

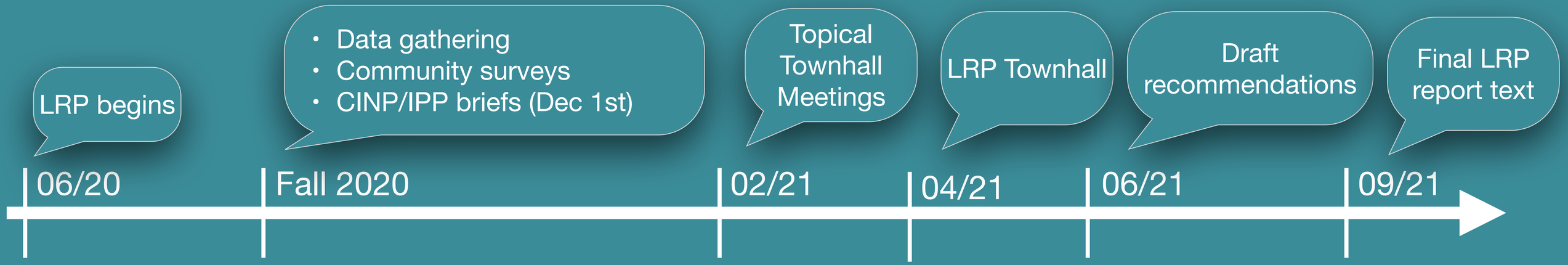
  - *We recommend that the subatomic physics community promote inclusion through acknowledgement of the legacy of colonization in Canada, e.g., with the use of land acknowledgements at events held in Canada, consistent with the spirit of the Calls to Action of the Truth and Reconciliation Commission of Canada (TRC) and of the United Nations Declaration on the Rights of Indigenous Peoples (UNDRIP).*

Draft Recommendations: Community (2/2)

- Topic: Training and career development
  - To enable HQP to receive training that makes use of the national collaborative structure of SAP research, we recommend the coordination and sharing of training opportunities across Canadian centers, institutes and universities.
  - To support early career development, we recommend that Early-Career Researchers (ECRs) be supported to quickly gain knowledge of the Canadian research support and funding ecosystem, and be given opportunities to interact broadly with the community.

- Topic: Communication and engagement with stakeholders
  - We recommend the formalization (e.g. by CINP and IPP) of a subatomic physics community consultation committee for engagement and advocacy to funding agencies and government.

Outlook



- Next step: Release of the first LRP report draft (July) for community feedback.
- Feedback on draft recommendations and portfolio representation is welcome:
  - Email: LRPC@SubatomicPhysics.ca
  - Anonymously, via: https://www.surveymonkey.ca/r/NTHDFMZ

BACKUP SLIDES

Statements

The LRP Committee has identified the following draft statements of value and opportunity that could be included in the report.

- *Description of research plan, using the concept of a portfolio.*
- *Efficient sharing of national research resources and funding, in part through the existence of community-led shared research support (IPP, MRS, etc.)*
- *Value in acquiring broad non-technical skills in SAP physics graduate training.*
- *Acknowledgement of environmental impacts*
- *Global values of international science (government security concerns)*
- *Synergies and opportunities at the boundary with other fields*
- *Value (and uniqueness) of the global SAP lab & collaboration infrastructure and expertise to pivot and address new priorities from genesis to commercialization.*
- *Statement of support for NSERC EDI-focused initiatives.*
- *Statement of appreciation for government and funding agency (e.g. NSERC) COVID-related support for ongoing research.*
- *Statement of the value and importance of the contributions of Canadian centers in enabling Canadian participation to international projects.*
- *Statement of the value of the NSERC Arthur B. McDonald ECR Fellowship program to kickstart the careers of new faculty.*
- *Statement of the value of cross-disciplinary collaborations and exploration of the opportunities that exist at the boundaries between fields.*
- *Statement of the general value of outreach activities (e.g. for society) and the time/effort required for these activities.*
- *Statement of the value of the TRIUMF faculty bridge program.*
- *Statement of opportunity for growth in nuclear physics, given the development of multiple new facilities worldwide.*

Research Plan Portfolio

Objectives: In order to maximize Canada's scientific and societal impact, accounting for the opportunities noted above, the following objectives for the subatomic physics research plan have been identified:

- Focus effort on the most relevant research problems.
- Fully exploit Canada's unique facilities, competitive advantages, and past investments.
- Partner in leading international research projects and deliver on commitments.
- Maintain capacity and flexibility, through R&D support, to explore and develop new scientific opportunities.
- Fully engage HQP in all aspects of scientific research to maximize training outcomes.

Dimensions of the portfolio would include:

- Canadian scientific specialization vs breadth.
- Experimental project lifecycle (R&D and new construction vs operation/science output).
- Guaranteed scientific output vs high-risk/high-reward.
- Project timeline.
- Theory vs experiment.