NSF Perspective on the First Five Years of P5

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NSF

HEPAP Meeting

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NSF / Physics Division Context:

Particle Physics
Project
Prioritization Panel

Particle Physics Project Prioritization Panel

Particle Physics within NSF

- Is just over 1% of the NSF Research & Related Activities (R&RA) line item in the budget
- Is part of a Division that also supports Nuclear Physics, Plasma Physics, AMO, QIS, Physics of Living Systems, and Gravitational Physics
- Can benefit if aligned to NSF Big Ideas ("Windows on The Universe", "Midscale"…)
- Has links to Astronomy Division, Office of Polar Programs, Math Division, DOE
- Funds individual investigators—both experimental and theoretical--at academic institutions

Particle Physics Project Prioritization Panel

Projects within NSF

- Need NSF community support, strong expected scientific impact, broader impacts
- Large projects are funded from MREFC appropriation, requiring multi-year lead time to inform budget formulation
- Proposal-driven NSF-wide Midscale solicitations
- Proposal-driven MRI solicitation
- Proposal-driven PHY solicitation
- Most R&D costs and all M&O costs are the responsibility of individual research programs

Particle Physics Project Prioritization Panel

Prioritization Panel

- Snowmass community input was crucial to P5 subcommittee
- From NSF perspective, P5 did an excellent job answering the DOE/NSF charge
- However, folding NSF proposal-driven approach with long-term and top-down project planning is always a challenge
- P5 outcome included 29 recommendations, not all easily translated or aligned to NSF mission

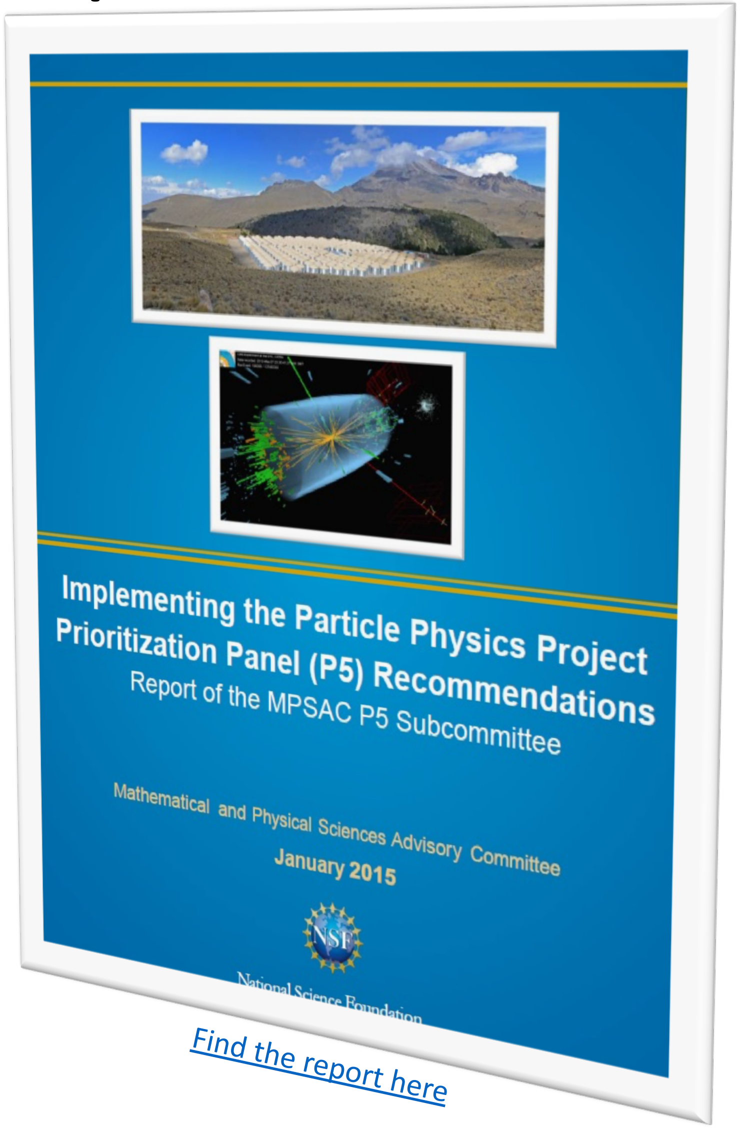
Implementing P5 at NSF

- In order to map these 29 P5 recommendations to the NSF/Physics context, the Physics Division charged the MPS Advisory Committee (MPSAC) to address:
  - Based on the P5 science drivers, how should NSF optimize its investments so that they maximize the impact and visibility of NSF-funded research?
  - What criteria should the Physics Division use to balance support between small-scale, mid-scale, and large projects?
  - How should the Physics Division define a unique role in areas of common interest with DOE?
- A subpanel of NSF MPS AC was formed representing all MPS disciplines, including Materials Research, Chemistry, Mathematics, Astronomy, and Physics. (Chair: Young-Kee Kim, University of Chicago)

MPS Advisory Committee Report

(January, 2015)

- Maintain M&O for ongoing facilities and R&D for future projects at about one-third of particle physics budget
- Use following criteria to balance support between small-scale, mid-scale, and large projects:
    1) Scientific impact
    2) Enables NSF-supported groups to play distinctive and visible roles
    3) Training of next generation of scientists
    4) Significant broader impacts
    5) Feasibility of project execution within budget
    6) Budgetary impact on PI-driven research awards
- Contribute to areas of common interest with DOE when NSF investment:
    - Similar to 1) to 4) above
- “the subcommittee strongly supports NSF investment in the LHC phase-2 upgrades…”



Find the report here

NSF Response to P5 Recommendations

Accepted, implemented or in progress; no further comments

#	P5 Recommendation
1	Pursue the most important opportunities wherever they are, and host unique, world-class facilities that engage the global scientific community.
2	Pursue a program to address the five science Drivers.
7	Any further reduction in level of effort for research should be planned with care, including assessment of potential damage in addition to alignment with the P5 vision.
8	As with the research program and construction projects, facility and laboratory operations budgets should be evaluated to ensure alignment with the P5 vision.
9	Funding for participation of U.S. particle physicists in experiments hosted by other agencies and other countries is appropriate and important but should be evaluated in the context of the Drivers and the P5 Criteria and should not compromise the success of prioritized and approved particle physics experiments.
17	Complete LSST as planned.
20	Support one or more third-generation (G3) direct detection experiments, guided by the results of the preceding searches. Seek a globally complementary program and increased international partnership in G3 experiments.

Accepted, implemented or in progress, and have NSF comments

#	P5 Recommendation	NSF Comment
3	Develop a mechanism to reassess the project priority at critical decision stages if costs and/or capabilities change substantively.	Mechanisms exist for MREFC and midscale projects, such as regular program reviews, reviews by MPSAC and other bodies. In addition, the Physics Division solicitation now includes language that addresses how long-durations efforts will be assessed and how midscale projects will be evaluated.
4	Maintain a program of projects of all scales, from the largest international projects to mid- and small-scale projects.	NSF is pursuing a portfolio of large, mid-, and small projects. Funding mechanisms include MREFC, MRI, Division of Physics midscale funds, and two new FY 2019 NSF-wide midscale programs.
6	In addition to reaping timely science from projects, the research program should provide the flexibility to support new ideas and developments.	New ideas welcome through annual solicitation NSF 18-564
10	Complete the LHC phase-1 upgrades and continue the strong collaboration in the LHC with the phase-2 (HL-LHC) upgrades of the accelerator and both general-purpose experiments (ATLAS and CMS). The LHC upgrades constitute our highest-priority near-term large project.	LHC phase 1 for ATLAS/CMS completed; LHCb phase 1 nearing completion; planning for HL-LHC upgrades for ATLAS/CMS near end. MPSAC validated this recommendation.

Example, Rec. 3: NSF 18-564: Reviews of Long-Duration Activities

The Physics Division solicitation (NSF 18-564) states:

> *"NSF anticipates conducting comparative reviews of selected long-duration efforts on an as-needed basis. The intent of the review is primarily a strategic evaluation aimed at setting long-term scientific priorities… A long-duration effort review report will also provide context for reviews of future proposals from individuals and groups who wish to use associated instrumentation."*

This augments the existing NSF review process with reviews that are conducted on long-duration activities. They are intended to establish priorities for continued investments within the context of a individual program and taking into account the program's resource constraints. <u>As a result of these reviews, NSF support for projects may be phased-out</u>.

Example: Rec. 4, Projects at all scales

Project Cost (approx. in $million)		Funding Source			
From	**To**	**R&D/Planning**	**Construction**	**Operations**	**Scope of Competition**
0	1.0	EPP or PA	EPP or PA	EPP or PA	within EPP or PA
0.2	4.0	n/a	MRI (70%); University (30%)	n/a	PHY (<1.0) NSF (>1.0)
4.0	15	EPP or PA	PHY Division	EPP or PA	PHY
0.6-6.0	20	Midscale RI-1	Midscale RI-1	EPP or PA	NSF
20	70	RI-1, EPP or PA	Midscale RI-2	EPP or PA	NSF
70	--	EPP or PA	MREFC	EPP or PA	NSF

Example, Rec. 10: HL LHC Upgrades

LHC											HL-LHC			
LS12		Run 2				LS2		Run 3			LS3		Run 4	
2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027

NSF Development Timeline

- HEPAP P5 Report released
- NSF MPS AC recommends NSF participate in HL-LHC detector upgrades
- Start Conceptual Design
- CERN/DOE/NSF Experiments Protocol implemented
- CDR
- Start Preliminary Design
- Pre-PDR Reviews
- PDR
- Start Final Design and request construction funding
- Pre-FDR (January 30-31, 2019)
- FDR (September 2019)
- Congress appropriates construction funding (>Oct. 1 2019)
- Budget available to start construction (April 2020)

We are here

Accepted, implemented or in progress, and have NSF comments

#	P5 Recommendation	NSF Comment
11	Motivated by the strong scientific importance of the ILC and the recent initiative in Japan to host it, the U.S. should engage in modest and appropriate levels of ILC accelerator and detector design in areas where the U.S. can contribute critical expertise. Consider higher levels of collaboration if ILC proceeds.	Will evaluate and compete detector R&D with other opportunities once a decision on the future of the ILC is made.
12	In collaboration with international partners, develop a coherent short- and long-baseline neutrino program hosted at Fermilab.	NSF-funded researchers participate in this DOE-led program
13	Form a new international collaboration to design and execute a highly capable Long-Baseline Neutrino Facility (LBNF) hosted by the U.S. To proceed, a project plan and identified resources must exist to meet the minimum requirements in the text. LBNF is the highest priority large project in its timeframe.	NSF-funded researchers participate in this DOE-led program. MPSAC noted that this recommendation should be implemented once LBNF plans were clarified. The MPSAC also noted the value of IceCube to the neutrino mass hierarchy.
15	Select and perform in the short term a set of small-scale short-baseline experiments that can conclusively address experimental hints of physics beyond the three-neutrino paradigm. Some of these experiments should use liquid argon to advance the technology and build the international community for LBNF at Fermilab.	NSF-funded researchers participate in this DOE-led program

Accepted, implemented or in progress, and have NSF comments

#	P5 Recommendation	NSF Comment
18	Support CMB experiments as part of the core particle physics program. The multidisciplinary nature of the science warrants continued multiagency support.	DOE/NSF jointly charged (2016) the AAAC to define a concept for CMS-S4; report released in 2016; agencies are closely coordinating activities through JOG
19	Proceed immediately with a broad second-generation (G2) dark matter direct detection program with capabilities described in the text. Invest in this program at a level significantly above that called for in the 2012 joint agency announcement of opportunity.	DOE/NSF carried out a G2 down-select in 2016 and funding ADMX-GEN2, LZ, superCDMS at SNOlab.
21	Invest in CTA as part of the small projects portfolio if the critical NSF Astronomy funding can be obtained.	NSF/PHY has funded two large MRI awards for telescope and camera development; however, NSF is not formally involved in the project.
23	Support the discipline of accelerator science through advanced accelerator facilities and through funding for university programs. Strengthen national laboratory- university R&D partnerships, leveraging their diverse expertise and facilities.	In 2014, NSF initiated an accelerator science program to focus on basic accelerator science research at universities. The program ran every year for four consecutive years. Decreasing proposal pressure in AS, coupled with increasing budget pressures across the Division, led us to exclude the AS program in the 2019 PHY solicitation. However, NSF continues to accept proposals related to accelerator science through existing programs, such as plasma physics.

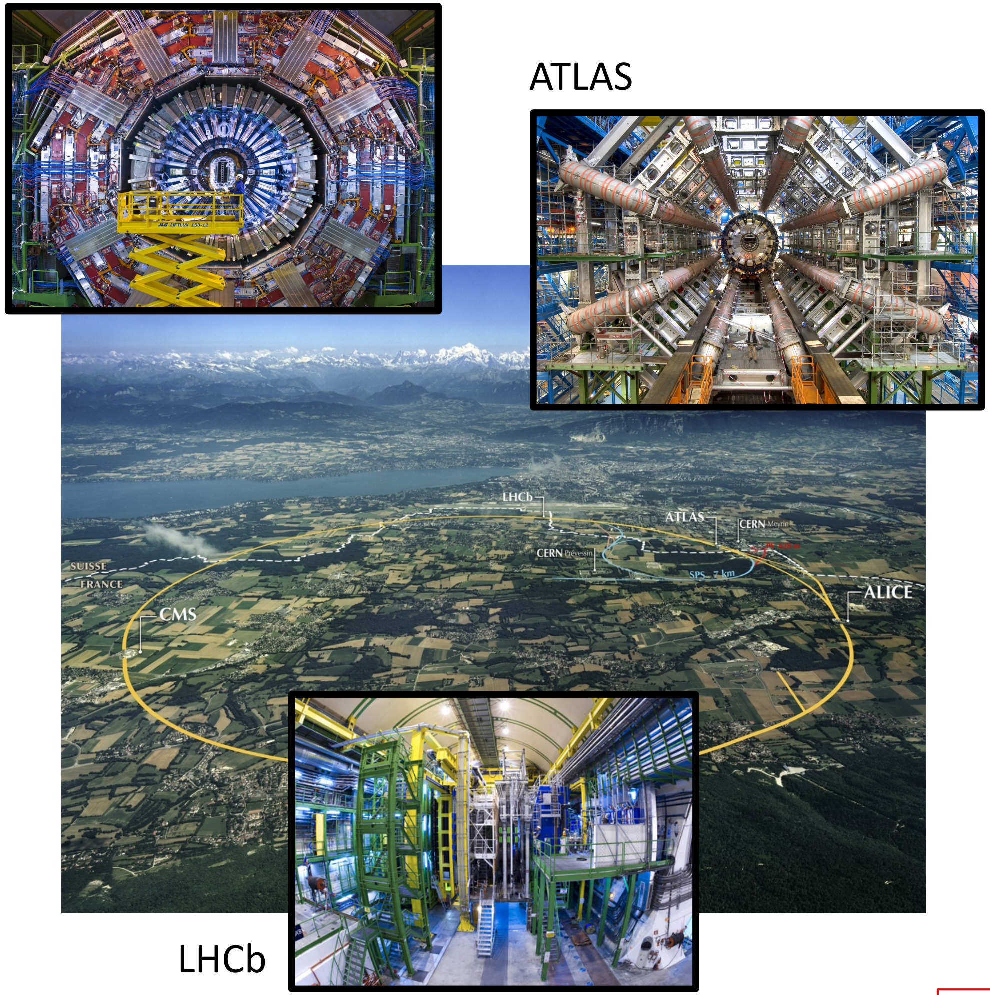
Accepted, implemented or in progress, and have NSF comments

#	P5 Recommendation	NSF Comment
25	Reassess the Muon Accelerator Program (MAP). Incorporate into the GARD program the MAP activities that are of general importance to accelerator R&D, and consult with international partners on the early termination of MICE.	After an assessment and consultation with other funding agencies, NSF support for MICE participation was terminated in 2014.
27	Focus resources toward directed instrumentation R&D in the near-term for high-priority projects. As the technical challenges of current high-priority projects are met, restore to the extent possible a balanced mix of short-term and long-term R&D.	High-priority project (such as ATLAS, CMS, LHCb) funding includes support for directed instrumentation R&D. Proposals for long-term instrumentation R&D are currently competed through the core program solicitation.
28	Strengthen university-national laboratory partnerships in instrumentation R&D through investment in instrumentation at universities. Encourage graduate programs with a focus on instrumentation education at HEP supported universities and laboratories, and fully exploit the unique capabilities and facilities offered at each.	Large ongoing projects (such as HL LHC) provide opportunities for workforce development and education as part of broader impacts.
29	Strengthen the global cooperation among laboratories and universities to address computing and scientific software needs, and provide efficient training in next-generation hardware and data-science software relevant to particle physics. Investigate models for the development and maintenance of major software within and across research areas, including long-term data and software preservation.	NSF has supported software and computing projects that aim to find common cross-domain solutions to data and computing challenges using HEP as a driver. Examples include OSG (open science grid), AAA (data federation), DASPOS (data and software curation), and IRIS-HEP (HEP software institute focused on HL LHC challenges). LSST, an AST-led facility, includes data management in the project.

Example: Rec. 29: Institute for Research and Innovation in Software for High-Energy Physics (IRIS-HEP)

CMS

ATLAS



LHCb

High-Luminosity Large Hadron Collider (HL-LHC) upgrade :

- order of magnitude increase in data analysis complexity
- order of magnitude increase in store and compute cycles
- solutions needed by : HL-LHC : 2025/2026

- Convergence : HPC & Big Data
- Many stakeholders: Collaborations, Agencies, CERN…

IRIS-HEP mission :

- Intellectual hub for community-wide software R&D
- Transform the operational services and computing model
- Address engagement, workforce, education/training

Note: Complements the NSF MREFC for HL-LHC upgrade

$5M/year—PHY co-funding with CISE/OAC

Program Director: B. Mihaila

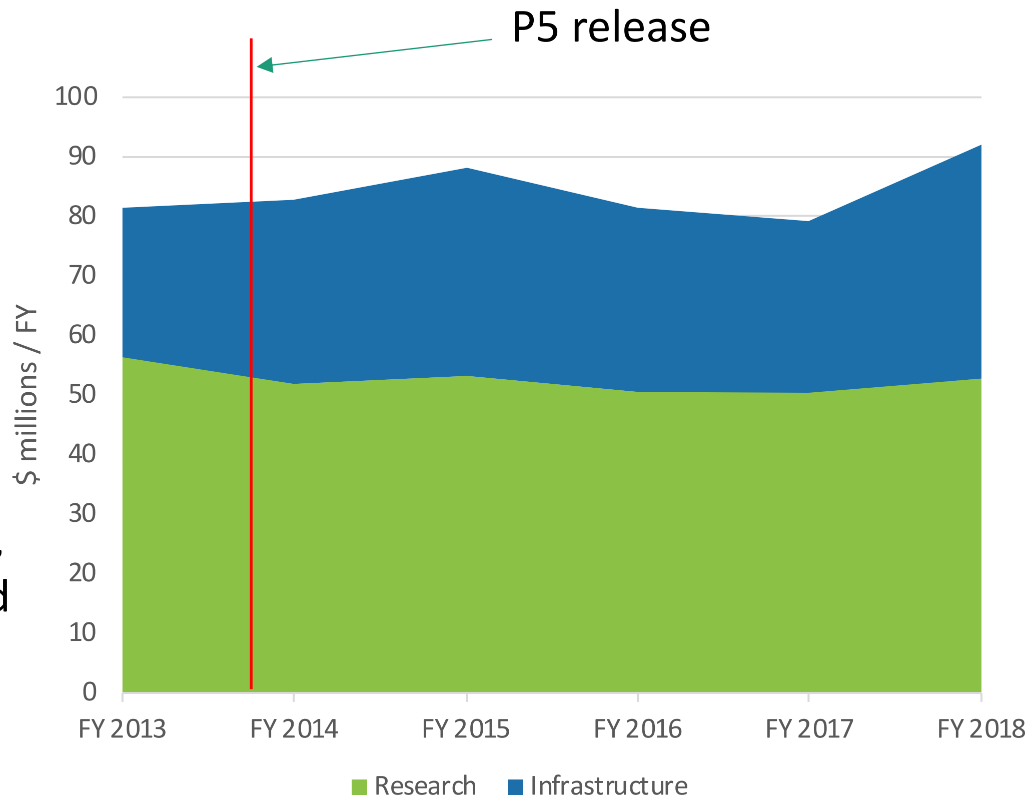
Award 1836650; PI: P. Elmer (Princeton)

Not Applicable to NSF

#	P5 Recommendation	NSF Comment
5	Increase the budget fraction invested in construction of projects to the 20%–25% range.	N/A, although MPSAC panel addressed research/facilities fraction.
14	Upgrade the Fermilab proton accelerator complex to produce higher intensity beams. R&D for the Proton Improvement Plan II (PIP-II) should proceed immediately, followed by construction, to provide proton beams of >1 MW by the time of first operation of the new long-baseline neutrino facility.	N/A
16	Build DESI as a major step forward in dark energy science, if funding permits (see Scenarios discussion below).	N/A
22	Complete the Mu2e and muon g-2 projects.	N/A, although NSF-funded researchers participate in this DOE-led program
24	Participate in global conceptual design studies and critical path R&D for future very high-energy proton-proton colliders. Continue to play a leadership role in superconducting magnet technology focused on the dual goals of increasing performance and decreasing costs.	N/A
26	Pursue accelerator R&D with high priority at levels consistent with budget constraints. Align the present R&D program with the P5 priorities and long-term vision, with an appropriate balance among general R&D, directed R&D, and accelerator test facilities and among short-, medium-, and long-term efforts. Focus on outcomes and capabilities that will dramatically improve cost effectiveness for mid-term and far-term accelerators.	N/A

Particle Physics at NSF during P5

NSF/PHY was able to respond quickly to the P5 report



Infrastructure includes M&O, Planning (R&D), and PHY midscale

Particle Physics Research includes PA, EPP, THY, and excludes Accelerator Science and PFCs

Conclusion

- After five years, the P5 plan continues to guide particle physics at NSF in accordance to the NSF mission and in collaboration with DOE
- All NSF-relevant P5 recommendations have been implemented or are in the process of implementation
- We look forward to the continued impact of P5 in the next five years and to any future planning exercise.