DOE Office of High Energy Physics (HEP) Committee of Visitors 2020

J. Ritchie Patterson, COV chair

Origin

- Mandated by the Office of Science
- Charged by FACA committee (here HEPAP) to assess (1) the efficacy and quality of the processes used to solicit, review, recommend, monitor, and document application, proposal, and award actions and (2) the quality of the resulting portfolio, including its breadth and depth and its national and international standing.
- Report with findings and recommendations are presented to the FACA.

Charge from HEPAP

- Assess operations of HEP Research and Technology Programs in FY 2016, 2017, 2018 and 2019
  - Efficacy and quality of processes to solicit, review, recommend, monitor and document funding actions
  - Quality of the resulting portfolio, including breadth and depth, national and international standing, and progress toward P5 goals.
- Consider: maintenance of sufficient lab and university capabilities and balance among program components.
- Assess progress in addressing the recommendations of the 2016 COV
- Identify issues needing further consideration
- Submit Report in advance of December 2020 HEPAP meeting.

From COV Guidance

Topics to be investigated by the COV *can include but are not limited to* selection of an adequate number of highly qualified **reviewers** who are free from bias and/or conflicts of interest; use of SC merit **review criteria**; adequacy of **documentation**; characteristics of the award **portfolio**; usefulness of **progress reports** on previously funded research; quality of overall **technical management** of the program; relationships between **award decisions, program goals,** and the DOE mission; **significant impacts and advances** that have developed since the previous COV review and are demonstrably linked to DOE investments; and the response of the program to recommendations of the **previous COV review.**

Committee membership

Dan Akerib (SLAC)
Maria Chamizo-Llatas (BNL)
Kyle Cramner (NYU)
Marcel Demarteau (ORNL)
Katrin Heitmann (ANL)
David Hertzog (U Washington)
Andy Lankford (UC Irvine)
Petra Merkel (FNAL)
Mark Messier (Indiana)
Reina Murayama (Yale)
Sergei Nagaitsev (FNAL/U Chicago)
Meenakshi Narain (Brown)
Hiroshi Ooguri (CIT)
Ritchie Patterson, chair (Cornell)
Jamie Rosenzweig (UCLA)
Marc Ross (SLAC)
John Ruhl (Case Western)
Elizabeth Simmons (UC San Diego)
Tim Tait (UC Irvine)
Hirohisa Tanaka (SLAC)
Ron Walsworth (Maryland)
James Wells (U Michigan)

Subcommittees

- Experimental program
  - Energy, Intensity and Cosmic frontiers in a single group (following a COV 2016 recommendation)
- Theory program
- Quantum Information Science
- Accelerator physics
  - Includes GARD, Stewardship, US-Japan, and Traineeship
- Detector R&D
- Computational HEP and Machine Learning
- Diversity

Subcommittee assignments

Experimental Program

Narain
Akerib
Chamizo-Llatas
Heitmann
Hertzog
Lankford
Merkel
Messier
Ruhl
Tanaka

Theory Program

Tait
Ooguri
Simmons
Wells

Computational HEP and ML

Cranmer
Heitmann
Narain
Rosenzweig
Wells

Quantum Information Science

Demarteau
Maruyama
Walsworth

Detector R&D

Demarteau
Akerib
Chamizo-Llatas
Hertzog
Merkel
Ruhl

Accelerator

Nagaitsev
Ross
Rosenzweig

Diversity

Maruyama
Messier
Patterson
Simmons
Tanaka
Tait

Schedule

October 1	Orientation and OHEP overview; conflict of interest
October 13	Presentations on research program by OHEP staff
October 21	Folder review and formulation of questions
October 22	Folder review and drafting of comments, findings and recommendations
November 4	Executive session
November 12	Executive session

Our report

Main body

- Findings, comments, and recommendations

Appendices

- Subcommittee findings and comments

Executive Summary

During the period under review, HEP has

- Attentively managed Research and Technology proposals,
- Strengthened communication with the community, and
- Engaged the community in reviews of programs and operations, targeted workshops, and roadmap study groups.

It is an impressive record, and the resulting program is of high quality.

Executive Summary

Since its release in 2014, the report of the Particle Physics Project Prioritization Panel (P5) has provided a roadmap for High Energy Physics. HEP has largely adhered to the report's guidance, and today, nearly all of the exciting new projects envisioned by P5 are complete or under construction. At the Energy Frontier, ATLAS and CMS implemented their Phase I upgrades and construction of the High Luminosity upgrades is underway. At the Intensity Frontier, Muon g-2 expects initial results soon and Mu2e is under construction. The Long Baseline Neutrino Facility (LBNF) is being excavated for the flagship DUNE experiment and PIP II is finalizing costs. On the Cosmic Frontier, the LSST camera at the Rubin Observatory will soon see first light and begin its survey of the universe, DESI has been commissioned and will begin its studies of dark energy, and plans for CMB-S4 are beginning to take shape. LZ is preparing to begin its search for massive dark matter and SuperCMDS at SNOLAB will follow with sensitivity to low mass. These experiments address some of humankind's deepest questions about nature and each is unique in the world; the ensemble comprises a world-leading program.

Internationalism

High Energy Physics is a global science, and its experiments depend on international collaboration for success. International partnership brings both shared technical know-how and the financial support needed to mount experiments whose extraordinary scale and complexity often put them out of reach for any individual nation.

Going forward, the need for international partnership in HEP will continue, but in an evolving global context that places heightened attention on national security and the ownership of ideas.

HEP will be in the vanguard in adopting new practices that respond to this context, while fostering the prudent exchange of ideas and international cooperation that are required to realize some of humankind's most ambitious endeavors.

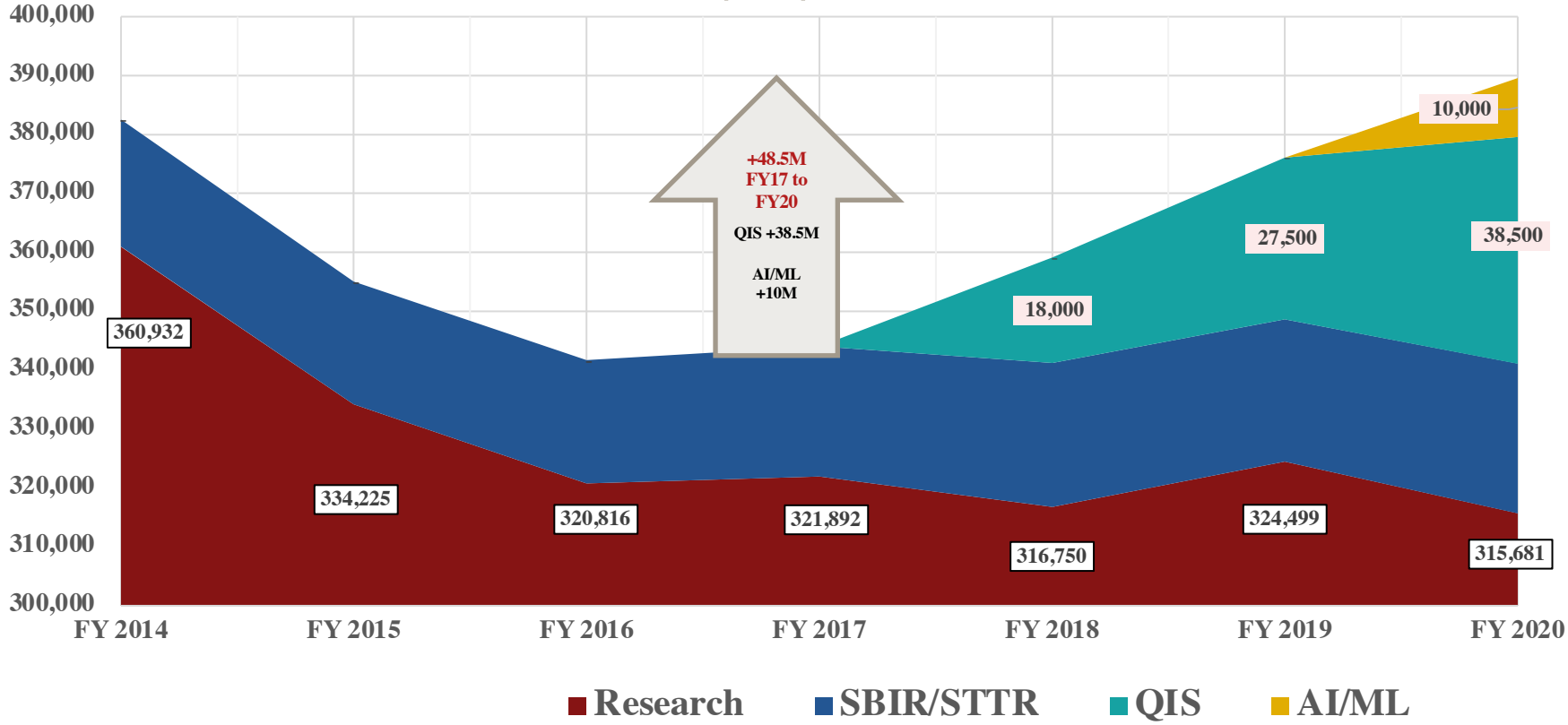
Executive Summary

Comment: Because of the importance of the Research and Technology program for translating the experiments into new understanding of nature and preparing for the future, P5 cautioned against reductions in level of effort (See P5 Recommendation *7*) and adopted an internal guideline of allocating >40% of the HEP budget to the Research and Technology program.

Since the last COV, support has fallen below that level. At the same time,

- The program has expanded to encompass new research into Quantum Information Science (QIS) and Artificial Intelligence & Machine Learning (AI/ML).
- COVID-19 has exacerbated the strain on the research and technology budget largely by delaying several large projects that had recently transitioned to operations.
- In coming years, the pressure on the Research and Technology program is likely to increase because of new operations expenses as additional experiments come online.

HEP Research ($k) FY 2014-2020



Executive Summary

Comment: The ability of the university and laboratory groups to design and build, operate and analyze, and theoretically interpret the experimental data is at risk, and the accelerator and detector R&D needed to enable the next generation of experiments has been sharply curtailed.

If allowed to continue, the consequences will become severe at a time when the Research and Technology program is increasingly central to realizing the P5 program.

Recommendation 1: Increase effort in the Experimental, Theoretical, Accelerator R&D and Detector R&D research programs in order to realize the promise of the portfolio of current and new experiments and to prepare for future endeavors. In the next year HEP should present a strategy to HEPAP for increasing the allocation to these programs by at least 4-5% per year until effort returns to the pre-P5 level, and should strive to return to 40% of HEP expenditures.

Proposal Procedures

Proposal procedures: solicitation

Comment: PI meetings have helped increase proposal quality and reduce the incidence of non-compliant proposals. Furthermore, by increasing the transparency of the process, these meetings have increased the equity of the proposal process and lowered the barriers to entry for new PIs. We commend HEP staff for this success.

Proposal procedures: review

Comment: HEP's processes for comparative proposal and laboratory review are thorough and have increased the quality of the program. This COV, like the last one, commends HEP for its continuation of this important process.

Note: Mail-in reviews are sometimes scant because few people respond to requests.

Example: 14 review requests ➔ 3 received.

COV to community:
Lack of response to review requests lessens review thoroughness and increases the workload for an overburdened staff.

Recommendation 2: Ensure that an adequate number (at least 3) of written reviews is in hand for each PI in advance of the panel review.

Proposal procedures: review

Finding: Lab comparative reviews consist of an in-person meeting with lab presentations.

Comment: Adding mail-in reviews would provide additional expert reviews and increase parity with the university review process.

Recommendation 3: Solicit mail reviews as part of the laboratory comparative reviews. The mail reviewers should include university scientists.

Proposal Procedures: review

Comment: Reviewers vary in their application of the criteria, with some reviewers rating all proposals in the top echelon and others using the full range of ratings. There also appears to be considerable variation in the weightings that the reviewers give to the various criteria.

Inconsistency in the ratings reduces the utility of the reviews and increases the burden on HEP staff

Recommendation 4: Develop guidance for mail-in and panel reviewers about proposal ratings in order to improve consistency.

Proposal Procedures: review

Comments:

- Reviewer assessments based on experience or impressions can be subjective and anecdotal.
- These may hinder PIs from underrepresented groups, either because of unintended biases or because of practical barriers that could reduce PI visibility.
- The COV believes that the reviews should emphasize information contained directly in the proposal.

Recommendation 5: Inform review panels and mail-in reviewers about the impact of biases regarding gender, race, age, and institution.

Recommendation 6: Set clear expectations for mail-in and panel reviewers that proposal evaluation should be based on proposal content and documented information, rather than on impressions or anecdotal information about prior performance by the PI(s).

Proposal Procedures: review

Finding: HEP emphasizes mentorship, but it is absent from the review criteria.

Comment:

- Effective mentorship for students and postdocs has lasting benefits:
  - More successful careers and higher earnings
  - Potentially amplified impact on future advancement of US science and technology.
- Formal mentorship is particularly valuable for students and postdocs from underrepresented groups, who may get less informal advice from other scientists.

Mentorship planning warrants its own merit review category, perhaps following an initial step of including it among the questions that define the existing criteria.

Policies should emphasize the quality of the plan for mentorship and avoid penalizing early career PIs without a mentorship track-record.

Recommendation 7: Promote the importance of effective mentorship as a consideration in the proposal review process.

Proposal Procedures: Review

Finding: The interval between issuing of FOA and the start of the award period is sometimes short.

Comment: Late FOAs can be detrimental because:

- They allow less time for PIs to prepare compelling proposals, especially those PIs who are not "in the know" about pending FOAs. Underrepresented minorities disproportionately fall into this group.
- They can result in a review period for Early Career awards that is insufficient for both mini-panel and super-panel reviews, even though both are valuable.
- Award notification sometimes comes after the start of the funding period.

Recommendation 8: Work with SC for more timely release of FOAs in order to allow adequate time for proposal preparation and review and PI notification before the start of the award period. In the case of the Early Career awards, the timeline should accommodate both mini-panel and super-panel reviews.

Proposal Procedures: Award Implementation

Comment: Notifications to PIs of proposal decisions should be timely, since prompt knowledge of the outcome, whether positive or negative, allows the PI to plan appropriately for students and postdocs.

Recommendation 9: Notify PIs of award decisions promptly, whether positive or negative.

Proposal Procedures: Award Implementation

Finding: The COV saw that some proposals are declined without explanation to the PI.

Comments:

- Useful feedback about the review process allows PIs to improve future proposals and is particularly valuable to PIs whose proposals were declined.
- Comparative review results should contain a clear summary of the panel's reasoning.
- Program Managers should provide an additional summary that (a) explains the final decision if it differs from the mail-in and panel reviews, (b) informs PIs about the opportunity for verbal feedback at their "office hours", and (c) for positive decisions, gives the details of the final award decision and budget guidance.
- While making sure that funded groups have adequate support to carry out their approved scope is important, the precision of the recommended individual award funding levels is less important than overall fairness and balance of the funding decisions.

Proposal Procedures: Award Implementation

Recommendation 10: Provide an explanation of funding decisions to PIs, particularly in the case of declined proposals or those with significant weaknesses.

Recommendation 11: Advise panelists to prioritize feedback to PIs through written reviews and/or summaries of panel discussions over detailed rankings of PIs and proposals.

Diversity, Equity and Inclusion

Diversity, Equity and Inclusion (DEI)

Comments: The COV commends HEP for its considerable effort to address DEI since the prior COV.

The FY21 FOA includes DEI considerations in Proposal Policy Factors.

HEP is aware of the issues and their importance. Nevertheless, policies are needed regarding topics such as:

- Bias mitigation in the review process,
- Consequences for PIs found by their institution to have violated Title IX regulations,
- Policies for managing work-life balance for supported researchers.

While developing such policies will be demanding in the short-term, they will lead to more consistent and sustainable practices.

Diversity, Equity and Inclusion

Finding: While HEP currently offers PIs an opportunity to provide demographic information, many PIs do not respond. Demographic information presented to the COV, for instance on gender of PIs, was generally based upon the assessment of program managers rather than on self-identification by PIs.

Comments: An essential part of a plan to address diversity, equity and inclusion is documenting the demographics of PIs, their groups, and reviewers.

Recommendation 12: Implement measures to improve the collection of demographic data for participants in HEP processes (PIs, personnel supported by grants, reviewers, etc.).

Diversity, Equity and Inclusion

Finding: HEP is coordinating with the Office of Science initiative to address diversity, equity and inclusion (DEI).

- The labs collect demographic data and have developed DEI strategies addressing leadership and accountability, recruiting and hiring practices, employee professional development, and fostering inclusive research environments.
- SC has commenced an external review of the laboratory strategies.
- SC convened a D&I working group that generated 15 recommendations, which are under review by SC leadership. Once approved, there will be an implementation working group.
- DOE has policies prohibiting discrimination and harassment, in accordance with federal civil rights laws, and these are posted on its public website.

Julie Carruthers of SC has presented this effort to HEPAP and met with the COV.

Diversity, Equity and Inclusion (DEI)

Recommendation 13: In consultation with SC, develop and implement strategies and policies to foster diversity, equity and inclusion in supported university groups as well as at the laboratories. The policies should be widely publicized to the community, for example through presentations to HEPAP and at PI meetings.

Portfolio Quality

Portfolio Quality

Comments:

- HEP has managed the Research and Technology program with care and has adhered closely to the P5 plan and the P5 Science Drivers. The resulting program is of high quality with world stature.
- Thanks to vigorous construction spurred by the P5 report, the array of experiments is expanding with exciting opportunities ahead.
- During the last five years, HEP funding has been redirected from research into construction. This has been appropriate and despite the strain on university and laboratory research and technology development, it has had the support of the community. See "HEPAP Assessment of Progress on 2014 P5 Report" (March '20)
- Now, with the new experiments coming online, it is necessary to redirect effort into research and technology in order to take full advantage of the current and new experiments and prepare for the future. This urgent need drives **Recommendation 1**.

Portfolio Quality

Finding: Since the last COV, HEP has taken steps to clarify priorities in several areas:

- Basic Research Needs in Light Dark Matter (2018),
- Basic Research Needs in Compact Accelerator Technology (2019)
- Basic Research Needs in Detector R&D (2019).
- Roadmaps for accelerator R&D in three of five thrusts, and the fourth is underway.

Comment: These initiatives have resulted in critical community-driven guidance.

Finding: Since the last COV, five new elements have been added to the research program:

- HEP-QIS (QuantISED)*
- Small-scale Dark Matter experiments*
- US-Japan Science and Technology Cooperation program (R&D)*
- Accelerator Traineeships*
- Artificial Intelligence & Machine Learning (AI/ML)

* new FOA

Comment: A side effect of the thorough review processes and new program elements is that the burden on the HEP staff has increased to worrisome levels.

Workload puts at risk some high effort tasks, eg small multi-laboratory, multi-agency and multi-partner experiments led by others.

Findings:

- HEP recently hired Dr. Brian Beckford as the new Program Manager for the Intensity Frontier.
  Comment: Dr. Beckford brings significant expertise in intensity frontier physics, most recently on K0T0, and he has worked to increase diversity in physics. The COV is delighted by this development.
- The theory IPA position, which was open at the time of the last COV and was identified in the 2016 COV report as a priority, remains unfilled.
- SC has approved a search for a Program Manager for AI/ML and HEP computing.

Recommendation 14: Fill the open positions for a program manager for the AI/ML and HEP computing program and for a Theory IPA as soon as possible.

Portfolio Quality

Finding: Cross-cutting efforts, eg QIS, are increasing and can advance P5 goals.

Comment: The value of interdisciplinarity to innovation is unquestioned, but realizing it is not trivial. The COV commends HEP for its efforts to coordinate cross-cutting efforts within the office and for reaching out to other offices in the Office of Science. The COV encourages HEP to vigorously continue on the path to bridge divides by, for example:

- Evaluating lowering the barriers to move between projects and frontiers.
- Exploiting connections in computing between operations and research program.
- Building connections between QIS and theory and detector R&D
- Harnessing collaborations with other offices, such as ASCR, BES and NP, to address technical barriers and enhance the fundamental physics research program.

Recommendation 15: Strengthen existing and explore new collaborative, multi-disciplinary efforts that could advance the P5 science goals and increase the science productivity of the field.

Portfolio Quality

Finding: The Accelerator Stewardship program is moving to a new office in SC, Accelerator R&D and Production (ARDAP).

Comments: The COV expresses its strong interest in the outcomes of the new ARDAP office and advises HEPAP to work with HEP and other Offices of Science to ensure a strong accelerator technology basis for its current and future facilities, and also advises HEPAP to actively follow the establishment of ARDAP and to robustly participate in the future advisory process for the new office.

Recommendation 16: Seek an appropriate role for HEPAP in the future advisory processes for ARDAP.

Portfolio Quality

Finding: Detector R&D is currently directed by the needs of current projects and is largely concentrated at the laboratories. A study of Basic Research Needs in Detector R&D was completed in 2020.

Comment: The COV commends the excellent BRN in Detector R&D. This should be the basis to define, together with the high energy physics community, the future roadmap for Detector R&D promoting mid-term and long-term research and development. The roadmap should include a plan for increased participation at Universities.

Recommendation 17: Generate a roadmap for investments in detector R&D based on future research needs of the field, with emphasis on innovation, including a substantial role for university-based R&D.

Portfolio Quality

Finding: HEP initiated the QuantISED program in 2018 as part of the wider SC initiative in quantum information science. Under QuantISED, there were 32 and 21 awards in 2018 and 2019 respectively, primarily in the "Pioneering Pilots" track.

Comments: The COV commends HEP's proactive engagement with the DOE initiative in QIS, which has led to a substantial program.

Important to leverage QIS synergies with traditional particle physics, such as 1) theory, 2)sensor technology, and 3) superconducting cavity technology.

Recommendation 18: Strengthen the HEP QIS program through 1) greater integration of traditional HEP research efforts with the QIS program; 2) clear articulation of QIS goals that capitalize on and advance HEP expertise; and 3) advancing QuantISED pilots that promise to address the P5 science drivers.

Portfolio Quality

Finding: Computing and software account for up to 50% of operations costs, calling for:

- Better exploitation of high-performance computing (HPC) resources
- Strengthened cooperation & exploitation of synergies across experiments

Steps toward this include:

- Collection of information from the laboratories and large experiments (2017)
- Inventory of Computing Needs Roundtable (2018)
- Pilot projects explored more efficient use of HPC resources, the Center for Computational Excellence was renewed, and SciDAC4 funded projects partially addressing these issues.

Comment: A clear plan would facilitate navigating the complex computing landscape.

Recommendation 19: Develop a cross cutting view of the allocations in computing, software, and AI/ML broken down by program and type of cost (e.g., computing facilities, FTE, operations, R&D).

Consistency with P5

Comment: The P5 report was based on projections suitable at the time of writing. Since its release, some of the conditions that affect planning have evolved:

- Project costs have been refined and most have increased
- Budgets have changed
- International landscape has evolved, affecting assumptions about international financial investment in U.S. projects and the outlook for global projects sited elsewhere in the world.

Decisions must be made about how best to adapt the P5 plan, and the community should have a voice in these decisions, especially when the decision will have ripple effects on other activities.

Consistency with P5

Several mechanisms could provide effective community involvement in decisions.

Examples:

- A specially convened HEPAP subpanel could be charged to evaluate the options in a specific case;
- A standing national particle physics advisory committee could address issues as they arise; or,
- The P5 subpanel could continue after the release of its report and meet as needed when significant unanticipated programmatic choices or conditions arise.

Recommendation 20: Establish a mechanism in consultation with HEPAP to advise HEP when a programmatic choice must be made that significantly deviates from the P5 plan or when the context for that choice has evolved significantly from P5 expectations.

HEP response to 2016 COV Report

COV 2020 commends HEP for its overall response to the 2016 COV report, including:

- Continuation of effective comparative reviews
- Establishment of informative PI meetings
- Commissioning several studies of Basic Research needs and roadmaps
- Convening the Facilities panel
- Extensive studies of operations costs
- Lab DEI plans and increased engagement with PIs on DEI issues
- Introduction of mini-panels to review Early Career proposals
- Hiring Dr. Brian Beckford as the Intensity Frontier PM.

Some recommendations are works in progress and have been echoed in this report, eg

- Hiring a Theory IPA
- Fuller explanation of proposal declines
- Need for Diversity, Equity and Inclusion policies

HEP response to 2016 COV Report

COV 2016 Recommendation 1: Continue the comparative reviews of university and laboratory research proposals and activities.

Finding: HEP has continued the comparative reviews.

Comment: This COV concurs with the 2016 COV that the "The review process, with its comparative nature, is an effective tool towards achieving optimal research programs within tightly constrained budgets," and urges HEP to continue the practice.

HEP response to 2016 COV Report

COV 2016 Recommendation 2: Adopt, in consultation with HEPAP, an annual mechanism to determine the best plan of action to implement the P5 vision. In such cases where HEP deviates from the strategic advice, the case should be clearly explained to the community through discussion with HEPAP.

Finding: HEP regularly provides Budget and Program status briefings to HEPAP.

Comment: This COV commends HEP for the briefings, which update HEPAP on the status and health of the program. This COV believes that additional community input is needed in advance of decisions (See **Recommendation 20**).

COV 2016 Recommendation 3: Work closely with the Laboratories and with Project Management and Program Management teams to develop a comprehensive strategic plan, consistent with P5 guidance, that anticipates the needs for future operating funds that will arise from improvement, upgrade and MIE projects. The plan should account for the funding needs not only of accelerator and experimental operations, but also of software, computing, and technical support for the new experimental programs. Develop a similar comprehensive plan for future research program needs, once again taking into account the need for research efforts to maximize the scientific return on improved, upgraded, and new facilities and experiments.

Finding: HEP now folds experiment operating budgets into their projections and presents them to HEPAP.

Comment: The COV welcomes the budgetary information and the HEP planning for operational expenses; however, it notes that HEP generally does not provide forecasts that allow HEPAP to assess the impact of the operating costs on other HEP activities. Because of this omission, other components of HEP portfolio, notably core research, have diminished significantly with little discussion or opportunity for community input. See **Recommendation 20.**

Appendices:
Comments on programs

Appendices on individual programs

Proposal review

- High regard for the work of PMs
- Recommendations for improvement that you've already heard, such as
  - Desire for clearer feedback to PIs, particularly regarding panel summaries
  - Greater guidance on cross program transitions and activities.
    eg between frontiers, or theory/QIS.
  - Need to track # supported personnel at all levels for each program/subprogram
- Some program-specific comments, eg Research Scientists for Experiment

Portfolio quality and adherence to P5 See next slides

Experimental Programs

- Each frontier has an exciting suite of current and new experiments.
- Cosmic Frontier program is clearly world leading. Important to prepare for new experiments coming online and to ramp up CMB-S4.
- Energy Frontier university budgets have declined ~10% since 2016 and redirection of funds into operations and upgrades has further eroded FTEs available for research.

  Effort on physics simulation and detector design for future colliders, eg ILC, FCC, is scant.
- Intensity Frontier funding is flat, with growing need for effort on LBNF/DUNE.
- Further erosion of support will directly impact the scientific workforce needed to meet the project deliverables and will threaten timely delivery of results. (Recommendation 1)

Theory Program

- The current program funds excellent research, thanks to the fair and expert guidance of the program manager.
- The level of funding has shrunk in purchasing power to the point where strong research proposals are being under-supported, especially in the middle tiers, threatening the P5-mandated goal of maintaining a thriving theory program. (Recommendation 1)
- The program manager is highly conscientious and has done an excellent job with the funding made available to the program and in following review recommendations, but this work requires highly intensive effort.

  → Need theory IPA, preferably with university experience. (Recommendation 14)

Accelerator programs

- The roadmaps are quite valuable. Integration will be important and the Accelerator and Beam Physics thrust can help. Snowmass is also a venue for integration.

- In response to P5, GARD funding was reduced from $64M (FY13 actual) to $47.4 (FY19 actual, including a reduction at universities of ~25%). Project-based accelerator studies, mostly at labs, suffered least.

  The GARD program has led past revolutionary developments, eg transformative improvement in cavity cryogenic performance used in LCLS-II and PIP-2, but it has been weakened to the point where another revolution is unlikely. Key activities are subcritical and emerging strong competition in Europe and Asia challenges the traditional leading role played by the US. (Recommendation 1)

- The new ARDAP office is an important opportunity to expand the horizons of accelerator research both inside and outside of HEP. (Recommendation 16)

QIS

Need to encourage continued communication across all boundaries at the QIS/HEP interface (eg theory, accelerator, etc.) and across the SC QIS spectrum. (R15)

Key challenges remain in (i) integrating the QIS effort effectively with other parts of HEP and (ii) defining how the QIS program will achieve continuity and evolve to include new PIs and science thrusts.

The national and international standing of the QIS portfolio elements is strong, in terms of the potential of a set of small, short-term pilot efforts and stature of PIs. Further development of the most successful pilots could result in national and international leadership. (Recommendation 18)

Note: COV didn't comment on QIS centers, which began after the period under review.

Detector R&D

Finding: Nearly 80% of the funding goes towards the national laboratories, of which about ⅔ goes towards research and ⅓ towards operations of facilities.

Successes:

- Leveraging support from synergistic Research Frontier efforts
- The new Graduate Instrumentation Research Award

Three main COV concerns:

- The Detector R&D program has successfully launched P5 projects, despite decreasing budgets. Now we need a sharp pivot toward non-directed, more blue-sky, potentially transformative R&D.
- Heavy tilt towards the labs, leaving little for university-based R&D.
- Nearly sub-critical funding at ≲1.5% of the total HEP budget. New instrumentation is critical to probe nature. (Recommendation 1)

AI/ML and HEP Computing

- INSPIRE, PDG, GEANT4, long-term data repositories, science gateways, etc., help the field exploit data and interpret it theoretically. Some involve global cooperation.

  →A more formal management process is appropriate given that this is crucial infrastructure as part of the portfolio of the CompHEP Program Manager.

- Use of contemporary data science tools and AI/ML is aligned with the national strategic initiatives and workforce priorities but maintaining a sustainable workforce will be challenging given demand in industry.

  →Encourage opportunities to support computing, software, AI/ML through SBIRs.

- Assess software and computing needs and risks across HEP and identify synergies and explore opportunities to bring in expertise or resources from outside HEP. (Recommendations 14, 15, 19)

Thank you to HEP

HEP was very helpful during the review:

- Clear presentations
- Full access to PAMS
- Extensive docs from portfolio reviews, workshops, etc.
- Detailed responses to numerous COV questions

Special shout-out to Christie Ashton who made it all happen

Thank you