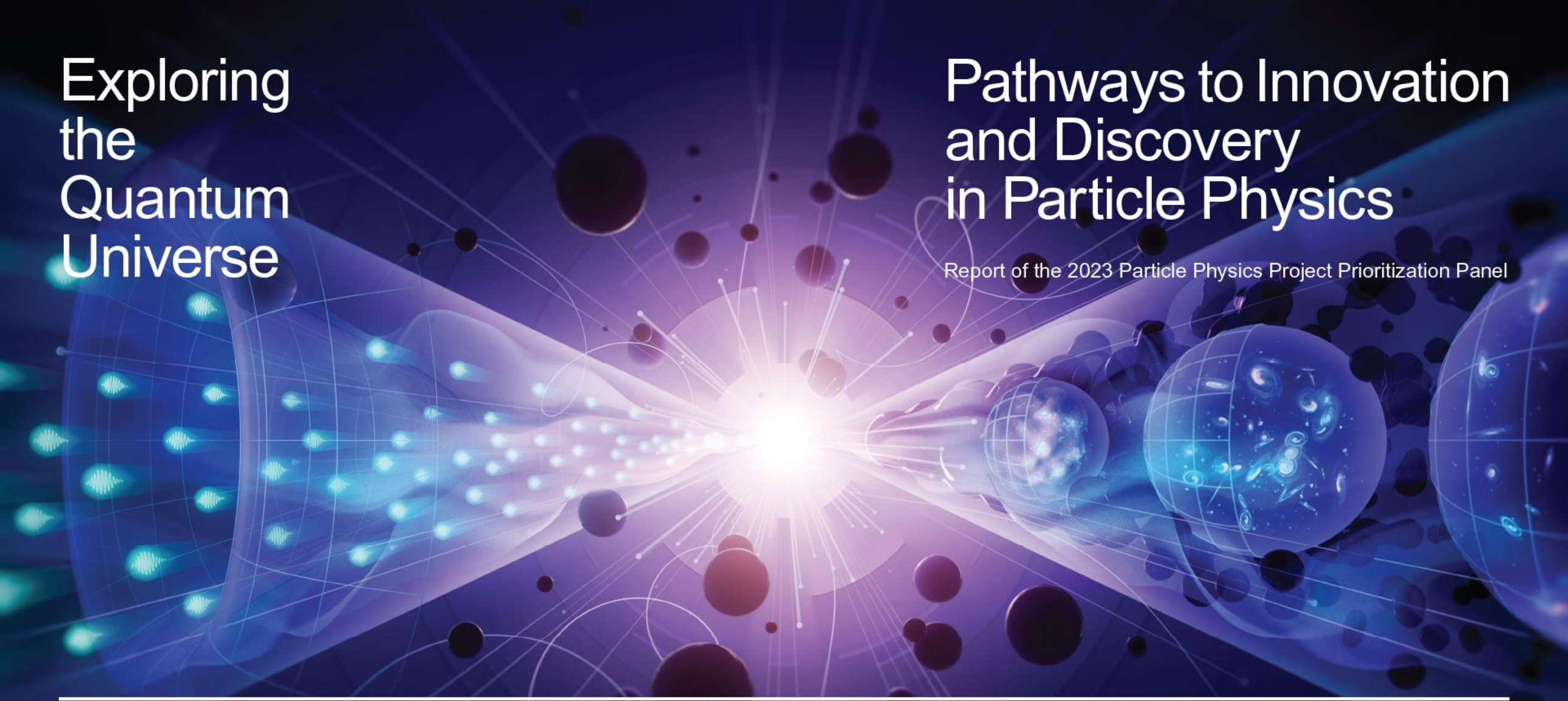


Exploring the Quantum Universe

2023p5report.org

P5 Report Rollout

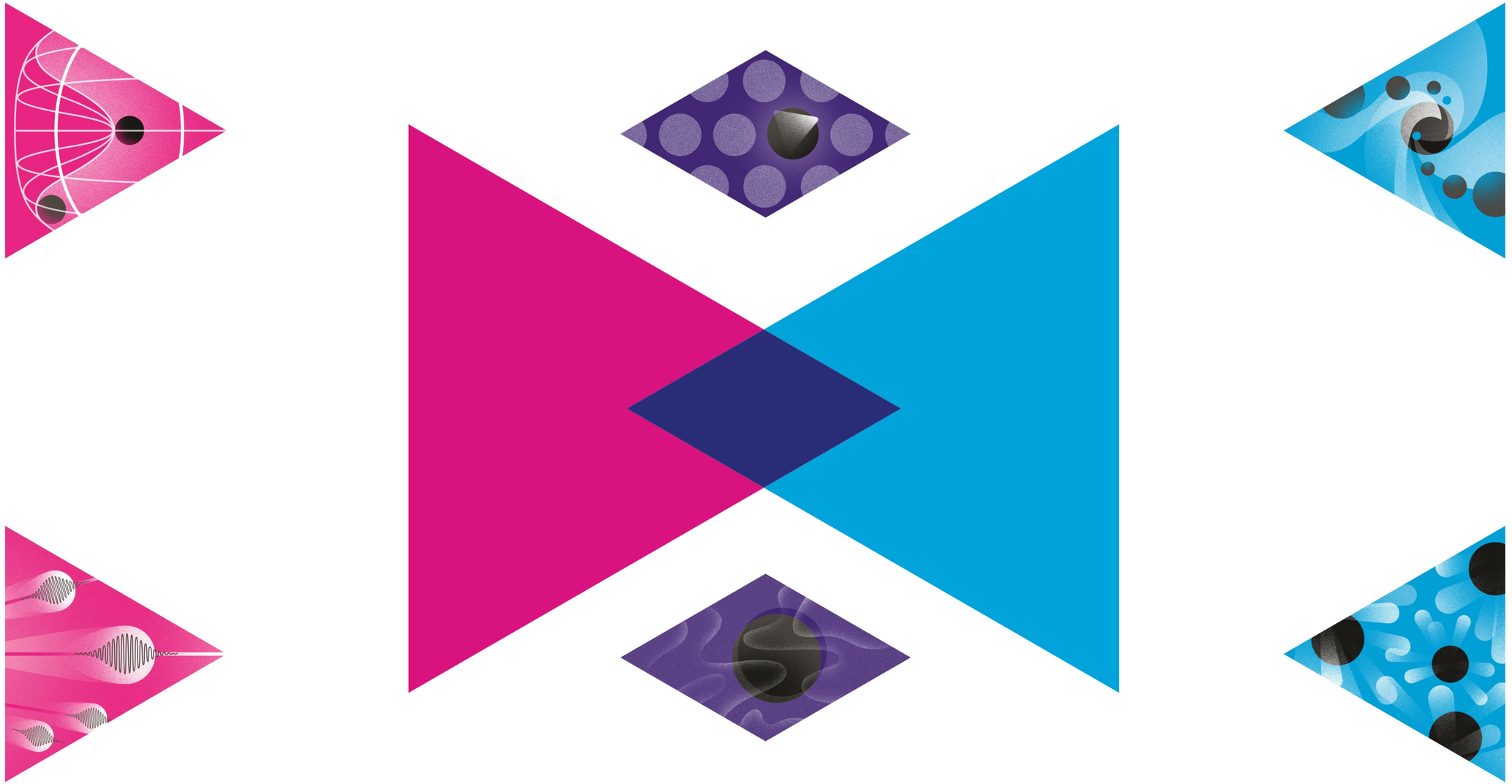
Hitoshi Murayama

HEPAP May 9, 2024

U.S. DEPARTMENT OF ENERGY

NSF

https://usparticlephysics.org/media-assets-library



Final version of the report: http://2023p5report.org

particle physicists dream small

New effort to study the afterglow of big bang heads new decadal to-do list

8 DEC 2023 · 6:10 PM ET · BY ADRIAN CHO

CAREERS COMMENTARY JOURNALS Science

Particle physicists in the United States have released a long-range plan that looks less like a child's wish list and more like a parent's cautious budget. Although some physicists dream of exotic new particle colliders, the report of the ad hoc Particle Physics Project Prioritization Panel (P5) lists just five, mostly smaller projects, only two of which would operate by 2034. That's because the U.S. program, which is supported by the Department of Energy (DOE), is still busy with a massive neutrino project that has greatly exceeded its initially estimated cost and is behind schedule. Still, other physicists are encouraged by the report.

"This is better than I expected," says Daniel Akerib, a particle physicist at SLAC National Accelerator Laboratory. "I'm impressed that even given the constraints, they found a way to fit new things in."

The product of more than a year of deliberation, the new report, presented on 7 December to DOE's standing High Energy Physics Advisory Panel (HEPAP), represents the consensus view of the panel's 31 particle physicists, says Hitoshi Murayama, a theorist at the University of California, Berkeley and P5 chairman. "We never voted on anything," he says.

The report's first recommendation sets the tone, says Regina Rameika, associate director for DOE's high energy physics program, which has a $1.17 billion budget this year. The highest priority, the report says, is to "complete construction of projects and support operations of ongoing experiments." In other words, Rameika says, "We've got to finish what we've started."

Those commitments include a variety of neutrino experiments at Fermi National Accelerator Laboratory (Fermilab), massive underground detectors known as LZ and XENONnT that are striving to detect hypothetical particles of dark matter called weakly interacting massive particles (WIMPs), and a 4-meter telescope to probe the nature of the

The New York Times

Particle Physicists Agree on a Road Map for the Next Decade

A "muon shot" aims to study the basic forces of the cosmos. But meager federal budgets could limit its ambitions.

A tunnel of the Superconducting Super Collider project in 1993, which was abandoned by Congress. Ron Heflin/Associated Press


By Dennis Overbye and Katrina Miller

Published Dec. 7, 2023 Updated Dec. 8, 2023

Dan Garisto
@dangaristo

When Snowmass ended last year, I wondered how particle physicists were ever going to reach consensus that worked within a budget, was still ambitious, and didn't alienate huge swathes of the community. Somehow, the P5 report does all this.

My reporting:

12:22 AM · Dec 14, 2023 · **5,343** Views

1 14 27 4

DECEMBER 13, 2023 | 8 MIN READ

Road Map for U.S. Particle Physics Wins Broad Approval

A major report plotting the future of U.S. particle physics calls for cuts to the beleaguered DUNE project, advocates a “muon shot” for a next-generation collider and recommends a new survey of the universe’s oldest observable light

BY DANIEL GARISTO

Scientific American

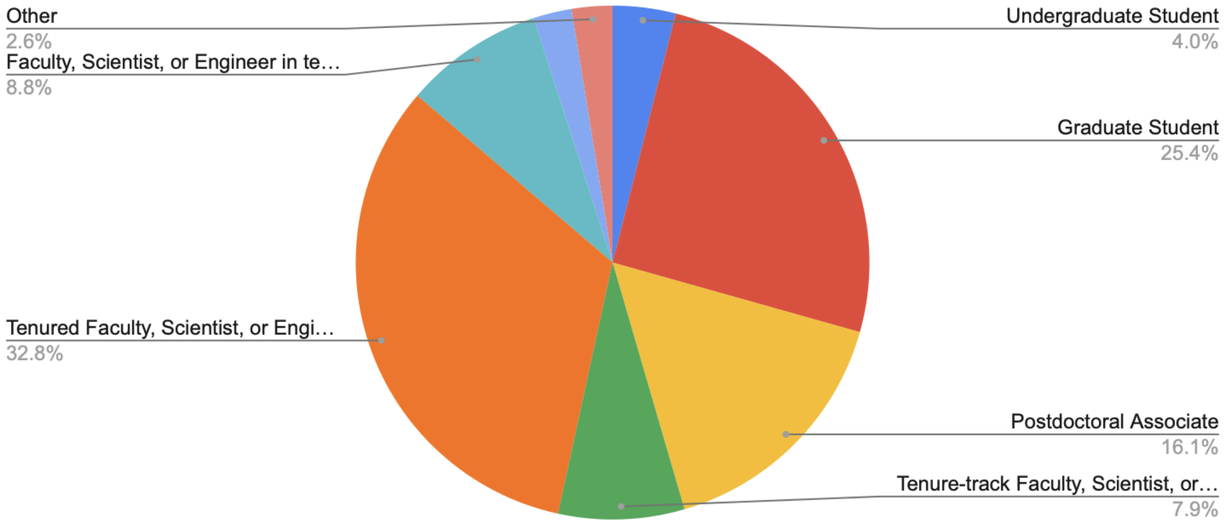
A view from the subterranean excavation for the Deep Underground Neutrino Experiment (DUNE) at the Sanford Underground Research Facility in South Dakota. Credit: Sanford Underground Research Facility

Support the 2023 P5 Report : Statistics

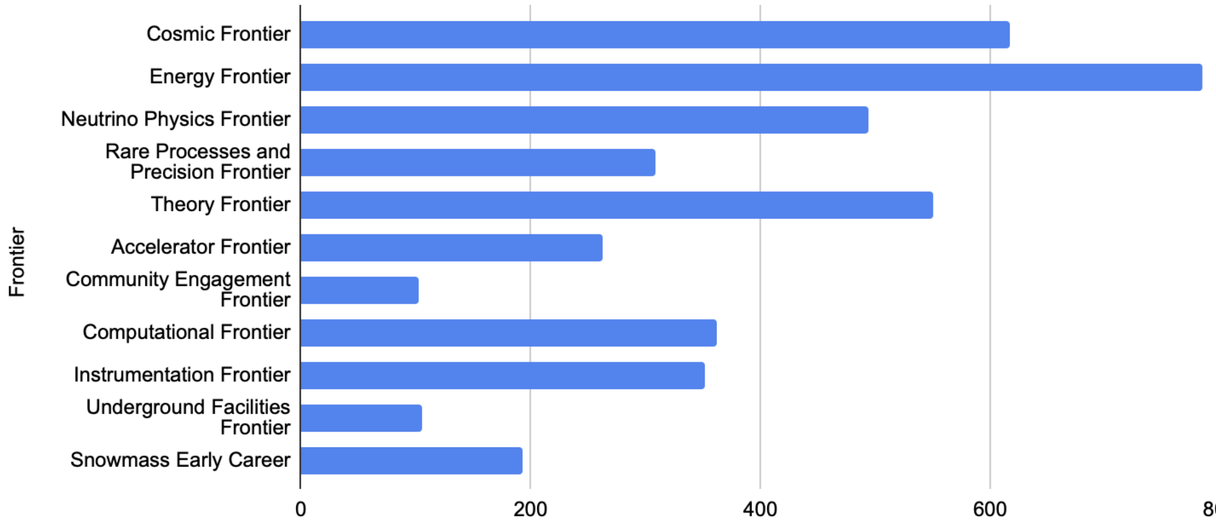
Sekhar Chivukula (DPF)

Number of Endorsements (Total)	Number of Endorsements (US)
3523	3157

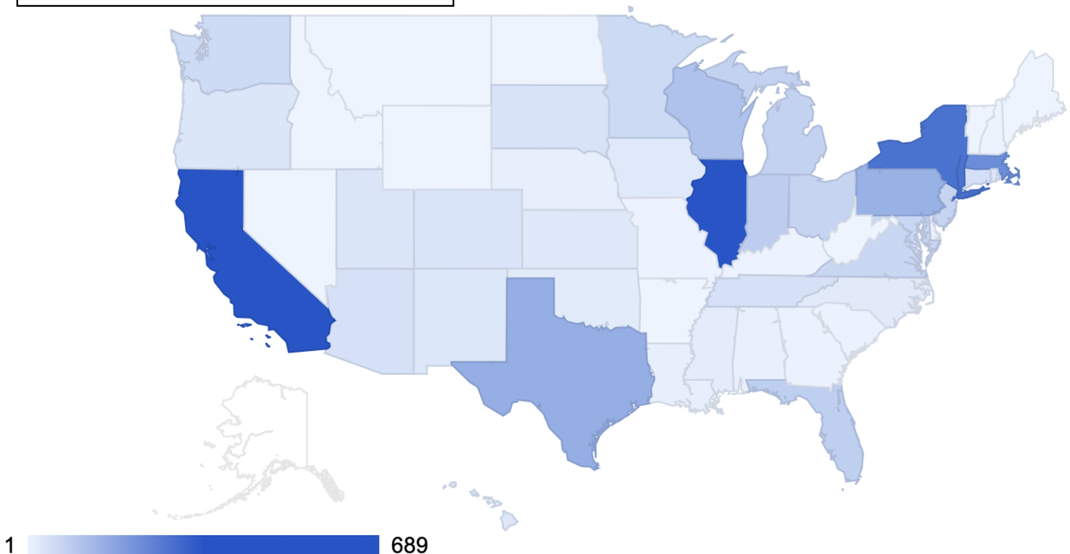
US Endorsements by Career Stage



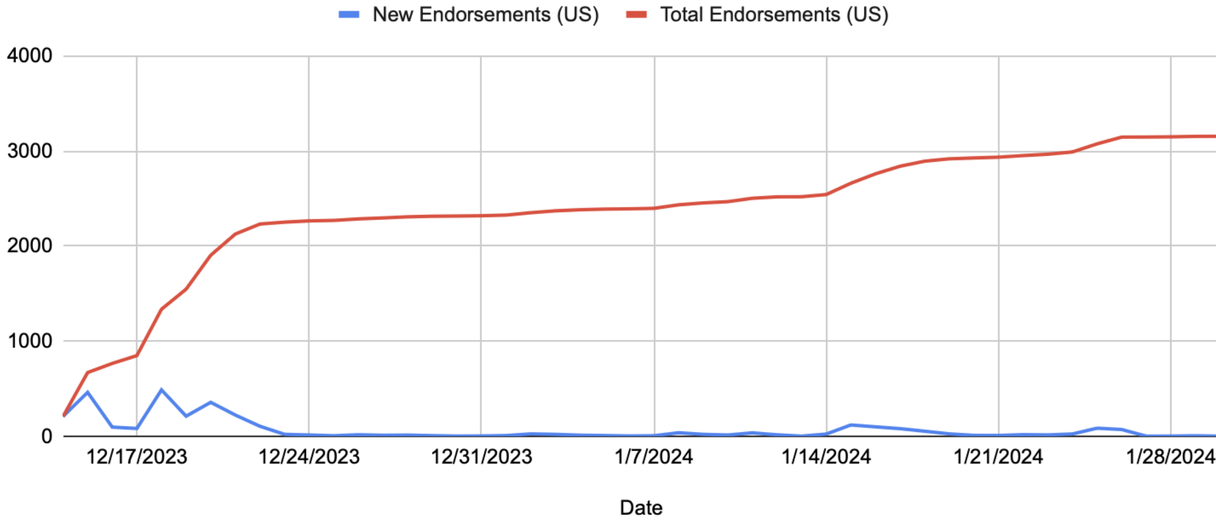
US Endorsements by Snowmass Frontier



US Endorsements by State



US Endorsements vs. Time



American Physical Society
1 Physics Ellipse
College Park, MD 20740

March 29, 2024

The Honorable Patty Murray
Chair
Committee on Appropriations
154 Russell

The Honorable Kay Granger
Chairwoman
Committee on Appropriations
2308 Rayburn

The Honorable Susan Collins
Vice Chair
Committee on Appropriations
413 Dirksen

The Honorable Rosa DeLauro
Ranking Member
Committee on Appropriations
2413 Rayburn

Dear Chair Murray, Chairwoman Granger, Vice Chair Collins, and Ranking Member DeLauro:

As President of the American Physical Society (APS), representing more than 50,000 physicists in universities, industry, and national laboratories, I am writing to reemphasize the importance of long-term, community-driven consensus reports in determining the most effective uses for federal science funding. APS strongly supports the process and purpose of these reports. As you consider future appropriations, we hope that you will continue to consider these documents as roadmaps for ensuring American scientific competitiveness.

These survey and prioritization activities, which typically operate on roughly decade-long cycles, have produced a new round of reports since the start of the 2020s. Community-led prioritization efforts such as those of the National Academies of Science, Engineering, and Medicine (NASEM) and the federal scientific advisory committees (FACAs) represent an important tool to inform appropriations for science, enabling us to pursue our most important scientific questions while also being responsible stewards of public funds. *Exploring the Quantum Universe: Pathways to Innovation and Discovery in Particle Physics* from the high energy physics community, *A New Era of Discovery* from the nuclear physics community, and *Pathways to Discovery in Astronomy and Astrophysics for the 2020s* from the astrophysics community are just a few examples of long-ranges plans published in recent years.

Many of the major programs, instruments, laboratories, and collaborations that enable physics research in the United States are primarily funded by the Department of Energy Office of Science, the National Science Foundation (NSF), and the National Aeronautics and Space Administration (NASA). To ensure that these federal investments reflect the national interest, a variety of physics sub-disciplines are charged with developing long-term strategic plans. APS members are involved at every level in these processes, performing a valuable service for their communities and for the U.S. research enterprise.

Each of these reports is the result of collaborative, democratic efforts, incorporating input from hundreds of physicists in each subfield. The expert panels leading the reports ensure that science is the prime motivator and develop a methodology of prioritization that identifies the most important research areas where substantial progress can be made.

For their decadal surveys, the National Academies organizes committees of experts in each field to incorporate input from their communities. These groups review their fields' recent accomplishments, identifying new opportunities, challenges, and compelling scientific questions. They provide recommendations for infrastructure and programs that secure U.S. leadership in a given research area or, where appropriate, enhance collaboration and coordination internationally. FACAs for areas of research including nuclear (NSAC), basic energy sciences (BESAC), fusion energy sciences (FESAC), and high energy physics (HEPAP), also carry out long-range plans. The resulting reports help inform appropriators, who can then make budgetary decisions knowing that the priorities put forward have the support of the full community in a given sub-discipline.

The suggestions of previous decadal surveys and long-range plans have pushed forward our understanding of the universe by leaps and bounds. These community-consensus projects have resulted in some of our most ambitious infrastructure and most important scientific achievements—from discovering gravitational waves and probing the subatomic realm, to pushing the frontiers of fusion energy and exploring the physical processes of biological life. Importantly, these explorations into fundamental questions have also resulted in cutting-edge applications for national security, medicine, and clean energy, as well as opportunities for STEM workforce development. The 2020 series of planning exercises builds on this heritage of success.

We appreciate the strong, bipartisan support that Congress has shown for fundamental physics research with annual appropriations to the federal science agencies over the years. I hope that you will view the careful consideration inherent in these community-consensus processes as due diligence from the physics community with respect to the resources granted to us. The exploration of fundamental physics and discovery of innovative applications thereof would not be possible without robust and sustained funding for federal science agencies.

Thank you for your time and consideration. If you have questions or would like to further discuss the reports outlined above, please do not hesitate to contact APS Director of Public Affairs Mark Elsesser (elsesser@aps.org; 202.846.8121).

Sincerely,

Young-Kee Kim
President, American Physical Society

Exploring the Quantum Universe

Congressional Staffers on Appropriation Committees

Perry Yates Professional Staff at Subcommittee on Agriculture and FDA, House Appropriations Committee

Scott McKee Democratic Clerk, Subcommittee on Energy & Water Development at U.S. House Committee on Appropriations

Aaron Goldner Professional Staff at United States Senate Committee on Appropriations

Anna Newton Professional Staff Member at United States Senate Committee on Appropriations

	Majority	Minority
House		
Senate		

Harriet Kung: It went exceedingly well

Exploring the Quantum Universe

Office of Science & Technology Policy

Kei Koizumi, Principal Deputy Director for Policy
Cole Donavan, Assistant Director for Research Security and Infrastructure
Joel Parriott, Assistant Director for Federal R&D (on detail from NSF)
Aliya Iftikhar, Special Assistant

Ph.D. Astro Michigan

Harriet Kung: You guys keep getting better! triggered another OSTP meeting with CMB-S4, IceCube, glaciology

United States Senate
WASHINGTON, DC 20510

March 14, 2024

The Honorable Frank Kendall III
Secretary of the Air Force
1670 Air Force Pentagon
Washington, DC 20330-1670

Dear Secretary Kendall,

We write to you regarding the recapitalization of the LC-130H fleet. Flown by the New York Air National Guard's 109th Airlift Wing (AW), the LC-130H is the only ski-equipped heavy airlift aircraft capable of traveling to the Arctic and Antarctica, and the 109th AW is the only US military unit in the world that operates these planes and supports the polar airlift mission set. However, as these planes approach the end of their service life, LC-130H operators and aircrew face a dangerous level of uncertainty during airlift missions. This uncertainty jeopardizes our ability to project power in the Arctic and Antarctic. Therefore, it is imperative that the Air Force recapitalize the entire LC-130H fleet in order to prioritize flight safety and ensure we can effectively meet the requirements of the Department of Defense's (DoD) Arctic Strategy.

US Northern Command (NORTHCOM), which oversees the polar airlift mission, has expressed the urgent need to recapitalize the LC-130H fleet with the newer J model to be able to operate in the Arctic and Antarctic environments. NORTHCOM has also spoken to the unique capabilities that the LC-130H provides, as demonstrated by the 109th AW's participation in annual NORTHCOM-led exercises such as Arctic Edge and Arctic Eagle. The 109th AW provides year-round logistical support for the National Science Foundation's (NSF) polar science research missions in Greenland, Antarctica, and the Arctic, delivering 100% of the materials and equipment for the rebuild of the South Pole Station. These science support missions executed by the 109th AW in turn help enhance DoD's polar mission readiness.

With an impeccable safety record, the 109th AW has executed these critical missions for more than 30 years, and New York is proud to serve as the home to this elite unit and one-of-a-kind capability. However, the majority of the existing LC-130H fleet were built in the 1970s, operate on technology developed in the 1950s, and as a result of being in service for all 12 months of the year, are quickly approaching the end of their service life. Although they have received upgrades, they are constantly suffering reliability issues and high maintenance costs. Additionally, nearly all of the LC-130Hs have parts that require total replacement, but—due to their age and being the only aircraft of its kind—many of those parts are no longer manufactured. With a mission capability rate of roughly 50%, it is apparent that modernization efforts alone are not enough to secure the fleet's long-term sustainability.

Furthermore, it is important to recognize the national security implications of failing to recapitalize the LC-130 fleet. Amid rising global tensions and the rapidly evolving geopolitical landscape, the North and South Poles have grown in their strategic importance to the US's ability to compete with Russia and the People's Republic of China (PRC), both of whom have expanded their presence in the polar regions. As the only ski-equipped aircraft capable of operating in Arctic and Antarctic environments, the LC-130 provides mission critical logistical support to regions that conventional aircraft cannot access. The LC-130 is a centerpiece of US efforts to maintain a strategic advantage in the polar theaters.

For all of these reasons, we urge you to prioritize the recapitalization of the LC-130 fleet. We look forward to your response and are prepared to assist however possible to protect this crucial mission and support the critical contributions of the 109th AW.

Thank you for your prompt attention to this important matter. Please do not hesitate to reach out to our offices with any questions.

Sincerely,

Charles E. Schumer
United States Senator

Kirsten E. Gillibrand
United States Senator

Attempt to improve the South Pole by replacing the LC-130 fleet

Also a letter in the House

Date	Where	talk type	Event	Who requested?	Speaker
12/7/2023	Washington, DC	committee	HEPAP	DOE/NSF	Hitoshi/Karsten
12/11/2023	Fermilab	committee	P5 Townhall	DPF/Fermilab	Hitoshi/Karsten
12/12/2023	DESY	colloquium	Helmhotlz Alliance		Beate Heinemann
12/12/2023	CERN (Meyrin)	committee	CERN SPC	SPC chair	Karsten/Hitoshi
1/12/2024	Edinburgh, Scotland (virtual)	other	LZ collaboration meeting	Sally Shaw	Richard Schnee
12/13/2023	Yale	colloquium	colloquium/discussion	Yale	Karsten/Sarah
12/13/2023	Houston, TX	conference	1st Int. Workshop on Muon-Ion Colliders	Workshop SPC	Mark Palmer
12/15/2023	BNL, Brookhaven NY	seminar	town hall/discussion	BNL	Karsten Heeger
12/15/2023	AAAC	committee	AAAC	NSF	Hitoshi/Karsten
12/18/2023	Asmeret Berhe	briefing	briefing	DOE	Hitoshi/Karsten
12/19/2023	KEK, Tsukuba	seminar	seminar	Masa Yamauchi	Hitoshi Murayama
12/19/2023	BNL, Brookhaven NY	seminar	seminar for ATLAS group	Viviana Cavaliere	Sarah Demers
12/19/2023	Congressional Staffers	briefing	briefing	DOE	Hitoshi/Karsten/Abby
12/22/2023	KEK, Tsukuba	briefing	briefing	Masa Yamauchi	Hitoshi Murayama
12/21/2023	Fermilab	seminar	Colliders of Tomorrow	Sridhara Dasu	Tulika Bose
12/27/2023	MEXT	briefing	Briefing to Research Promotion Bureau	Masa Yamauchi	Hitoshi Murayama
1/5/2024	OSTP	briefing	briefing to Kei Koizumi	DOE	Hitoshi/Karsten
1/9/2024	UChicago	other	KICP/A&A Chalk Talk	Austin Joyce	Abby Vieregg
1/11/2024	University of Hawaii	colloquium	Physics colloquium	John Learned	Jelena Maricic
1/12/2024	LBNL	seminar	Annual LBNL ATLAS Meeting	Kevin Einsweiler	Hitoshi Murayama
1/16/2024	IMCC (virtual)	briefing	IMCC Steering Cmmte.	Steinar Stapnes	Mark Palmer
1/17/2024	UT-Austin	colloquium	Physics Colloquium		Peter Onyisi
1/17/2024	LSST DESC (virtual)	seminar	DESC seminar	LSST DESC spokesperson	Rachel Mandelbaum & Francis-Yan Cyr-Racine
1/17/2024	Multi-lab (virtual)	committee	MDP General Meeting	Georgui Velev (MDP Mgmt)	Mark Palmer
1/18/2024	MDP Management (virtual)	other	MDP Tech. Advisory Cmmte.	Soren Prestemon	Mark Palmer
1/19/2024	Fermilab	other	Accelerator Directorate All-Hands	Alexander Valishev	Bob Zwaska
1/22/2024	University of Washington, Seattle	colloquium	Physics Colloquium	Henry Lubatti	Sarah Demers
1/22/2024	South Dakota Mines	colloquium	Physics Colloquium	Jingbo Wang	Richard Schnee
1/23/2024	University of New Mexico	seminar	Particle/Cosmo Seminar	David Camarena	Francis-Yan Cyr-Racine
1/25/2024	Argonne National Lab	colloquium	Physics Colloquium	Christine McLean	Petra Merkel
1/25/2024	University of Florida	colloquium	Physics Colloquium	Andrey Korytov	Hitoshi Murayama
1/26/2024	William & Mary	colloquium	Physics Colloquium	Marc Sher	Chris Monahan
1/30/2024	Washington, DC	briefing	URA Council of Presidents	John Mester	Hitoshi/Karsten/Sally
1/31/2024	Rutgers	colloquium	Physics Colloquium		Yuri Gershtein
2/2/2024	Annecy	conference	FCC Physics WS	Patrick Janot	Hitoshi Murayama
2/2/2024	CERN (Meyrin)	colloquium	CERN colloquium	Joachim Mnich	Hitoshi Murayama
2/2/2024	LBNL	conference	Physics Division Early Career Strategic Planning Event	Itay Bloch	Hitoshi Murayama
2/5/2024	UK	other	European funding agencies and community	Lia Merminga	Hitoshi/Karsten/Christos
2/5/2024	University of Pittsburgh and Carnegie Mellon	colloquium	CMU/Pitt joint colloquium series	Tao Han	Rachel Mandelbaum
2/9/2024	Wheaton, IL	briefing	NOvA Collaboration	Alex Himmel	Mayly Sanchez
2/12/2024	UChicago	colloquium	EFI Colloquim	Emil Martinec	Abby Vieregg
2/12/2024	SLAC	colloquium	Physics Colloquium	Marty Breindenbach	Hitoshi Murayama
2/13/2024	SLAC	conference	C3 workshop/collaboration	Emilio Nanni	Cameron Geddes
2/15/2024	MIT	colloquium	Physics Colloquium	MIT	Jesse Thaler/Lindley Winslow
2/15/2024	Florida State University	colloquium	Physics Colloquium	Rachel Yohay	Mayly Sanchez
2/22/2024	Wayne State University	colloquium	Physics Colloquium	Gil Paz	Peter Onyisi
2/27/2024	University of Maryland	colloquium	Physics Colloquium	Kaustubh Agashe	Hitoshi Murayama
3/6/2024	Indiana University	colloquium	Physics Colloquium	Hal Evans	Tulika Bose
3/7/2024	Michigan State University	colloquium	Physics Colloquium	Reinhard Schweinhorst	Sarah Demers
3/14/2024	University of Oregon	colloquium	Physics Colloquium	UO	Tien-Tien Yu
3/20/2024		committee	Space Science Week 2024 | National Academies	Kelsie Krafton	Karsten Heeger
3/19/2024	Fermilab	seminar	Accelerator Physics & Technology Seminar	Alexander Valishev	Bob Zwaska
3/24/2024	Aspen Center for Physics	conference	Aspen Winter Conference	Karri DiPetrillo	Hitoshi Murayama
3/25/2024	MIT	conference	FCCee workshop	Christoph Paus	Karsten Heeger
4/3/2024	Sacramento	conference	APS April Meeting		Hitoshi Murayama
4/8/2024	UC Berkeley	colloquium	Physics Colloquium	Christopher McKee	Hitoshi Murayama
4/9/2024	US Congress	briefing	Annual Hill Visit (to last until 4/12)	FRA	Hitoshi/Karsten
4/11/2024	ICFA	briefing	ICFA	Thomas Schörner	Hitoshi Murayama
4/15/2024	UC Davis	colloquium	Department Colloquium	Lloyd Knox	Hitoshi Murayama
4/18/2024	MIT (virtual)	conference	USQCD All Hands' Meeting	Peter Petrezcky	Chris Monahan
4/26/2024	Cornell	seminar	journal club	Anders Ryd	Peter Onyisi
4/26/2024	Arlington, VA	committee	NSAC	Gail Dodge	Sally Seidel
5/3/2024	University of Wisconsin, Madison	colloquium	Physics Colloquium	Sridhara Dasu	Hitoshi Murayama
5/8/2024	NAS Keck Building DC	committee	BPA Spring Meeting	Colleen Hartman	Hitoshi Murayama
5/14/2024	Carnegie Mellon University	public lecture	DPF-Pheno 2024	Manfred Paulini	Hitoshi Murayama
5/9/2024	University of Hokkaido	conference	Hokkaido Workshop on Particle Physics at Crossroads	Ian Low	Mark Palmer
5/15/2024	Jefferson Lab	seminar		Dave Dean	Karsten Heeger
5/16/2024	ORNL	seminar		Marcel Demarteau	Karsten Heeger

international

government

Appropriation committees, OSTP

Annual Visit to the Hill, OMB/OSTP, State

Funding agencies in Europe, Japan

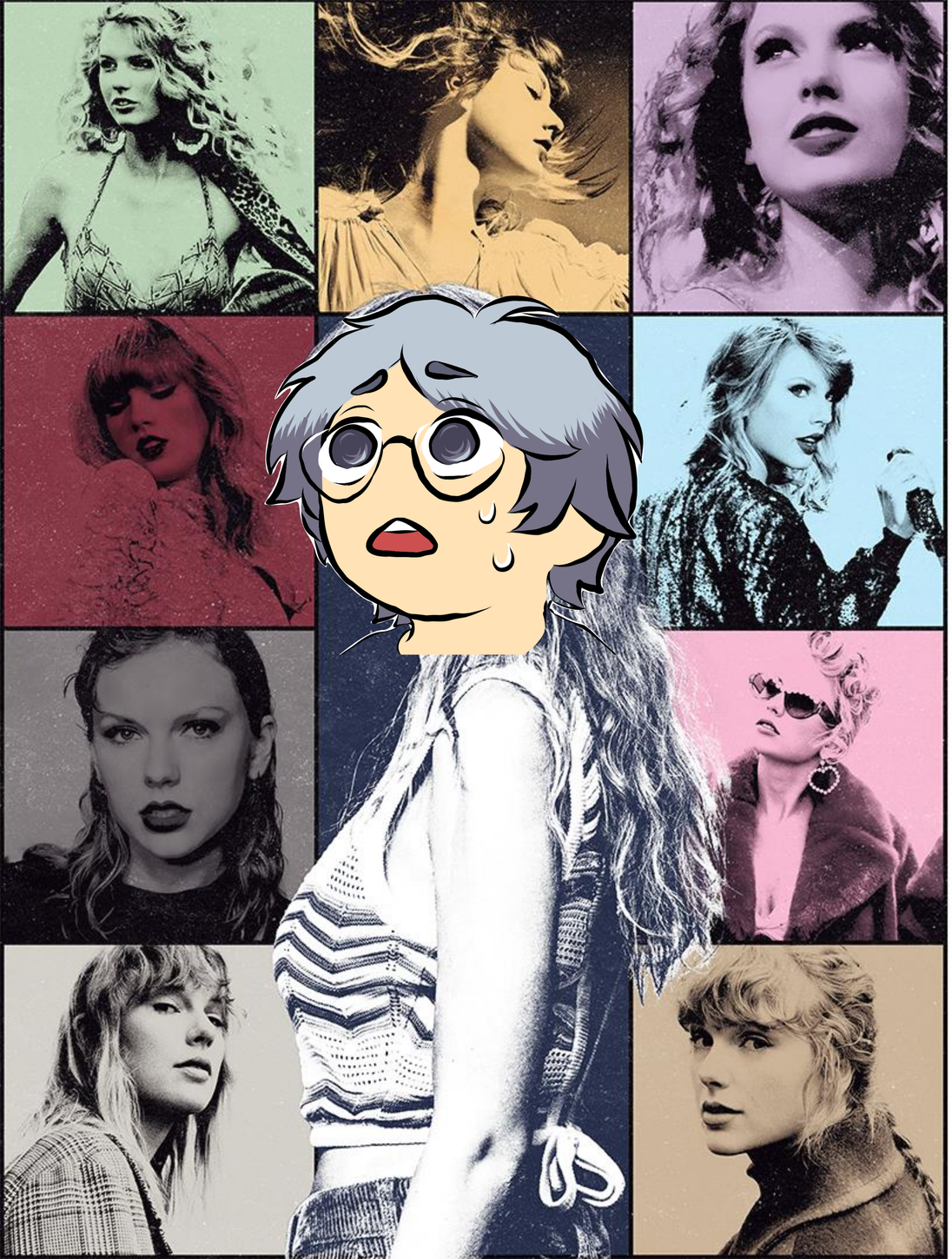
AAAC, NSAC, BPA, URA

FNAL, SLAC, LBNL, BNL, ANL, JLab, ORNL

CERN, DESY, KEK

24 department colloquia

Many other meetings



Particle Physics

THE ERAS TOUR

reached out to 532 offices out of 538

Kevin Pedro <pedrok@fnal.gov>

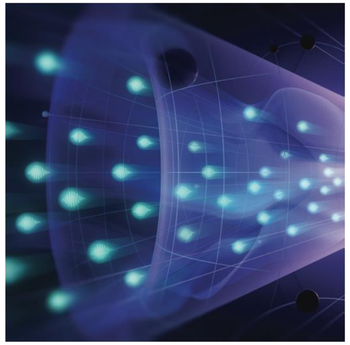
Exploring the Quantum Universe

Pathways to Innovation and Discovery in Particle Physics

A Strategic Plan for US Particle Physics

Particle physics studies the smallest constituents of our vast and complex universe. At such small scales, the fundamental principles of quantum physics prevail. Remarkably, the entire observable universe, now billions of light years across, was once so small as to be quantum in nature. This quantum history of the universe is imprinted on its large-scale structure.

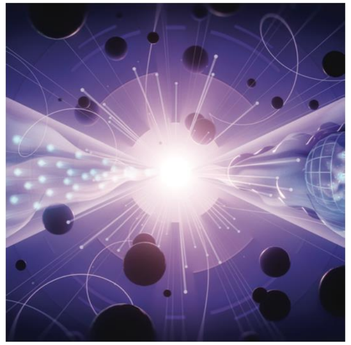
The recommended program describes particle physics in three science themes. Within each of these themes we identify two focus areas, or science drivers, that represent the most promising avenues of investigation for the next 10 to 20 years.



Decipher the Quantum Realm

Elucidate the Mysteries of Neutrinos

Reveal the Secrets of the Higgs Boson



Explore New Paradigms in Physics

Search for Direct Evidence of New Particles

Pursue Quantum Imprints of New Phenomena

Illuminate the Hidden Universe

Determine the Nature of Dark Matter

Understand What Drives Cosmic Evolution

Past successes in particle physics have revolutionized our understanding of the universe and prompted new sets of questions. Collectively, these questions have spurred the construction of state-of-the-art facilities, from particle accelerators to telescopes, that will illuminate the profound connections between the very small and the very large. Recent investments in the High-Luminosity Large Hadron Collider (HL-LHC) at CERN, the Deep Underground Neutrino Experiment (DUNE), and the Vera C. Rubin Observatory (Rubin) have positioned the US to continue its leadership in particle physics. Working with our international partners, we stand on the threshold of harnessing the full potential of these facilities.

Vision of the 2023 Particle Physics Project Prioritization Panel (P5)

We envision a new era of scientific leadership, centered on decoding the quantum realm, unveiling the hidden universe, and exploring novel paradigms. Balancing current and future large- and mid-scale projects with the agility of small projects is crucial to our vision. We emphasize the importance of investing in a highly skilled scientific workforce and enhancing computational and technological infrastructure. Particle physics has a long-proven record of creating new technologies and provides a training ground for a skilled workforce that drives not only fundamental science, but also quantum information science, AI/ML, computational modeling, finance, national security, and microelectronics.

We recommend the following:

1. As the highest priority independent of the budget scenarios, complete construction projects and support operations of ongoing experiments and research to enable maximum science. This includes High-Luminosity LHC, the first phase of Deep Underground Neutrino Experiment (DUNE) and Proton Improvement Plan II, the Rubin Observatory to carry out the Legacy Survey of Space and Time (LSST).

2. Construct a portfolio of major projects that collectively study nearly all fundamental constituents of our universe and their interactions, as well as how those interactions determine both the cosmic past and future.

a. **CMB-S4**, which looks back at the earliest moments of the universe,

b. **Re-envisioned second phase of DUNE** with an early implementation of an enhanced 2.1 MW beam and a third far detector as the definitive long-baseline neutrino oscillation experiment,

c. **Offshore Higgs factory, realized in collaboration with international partners**, in order to reveal the secrets of the Higgs boson,

d. **Ultimate Generation 3 (G3) dark matter direct detection experiment** reaching the neutrino fog,

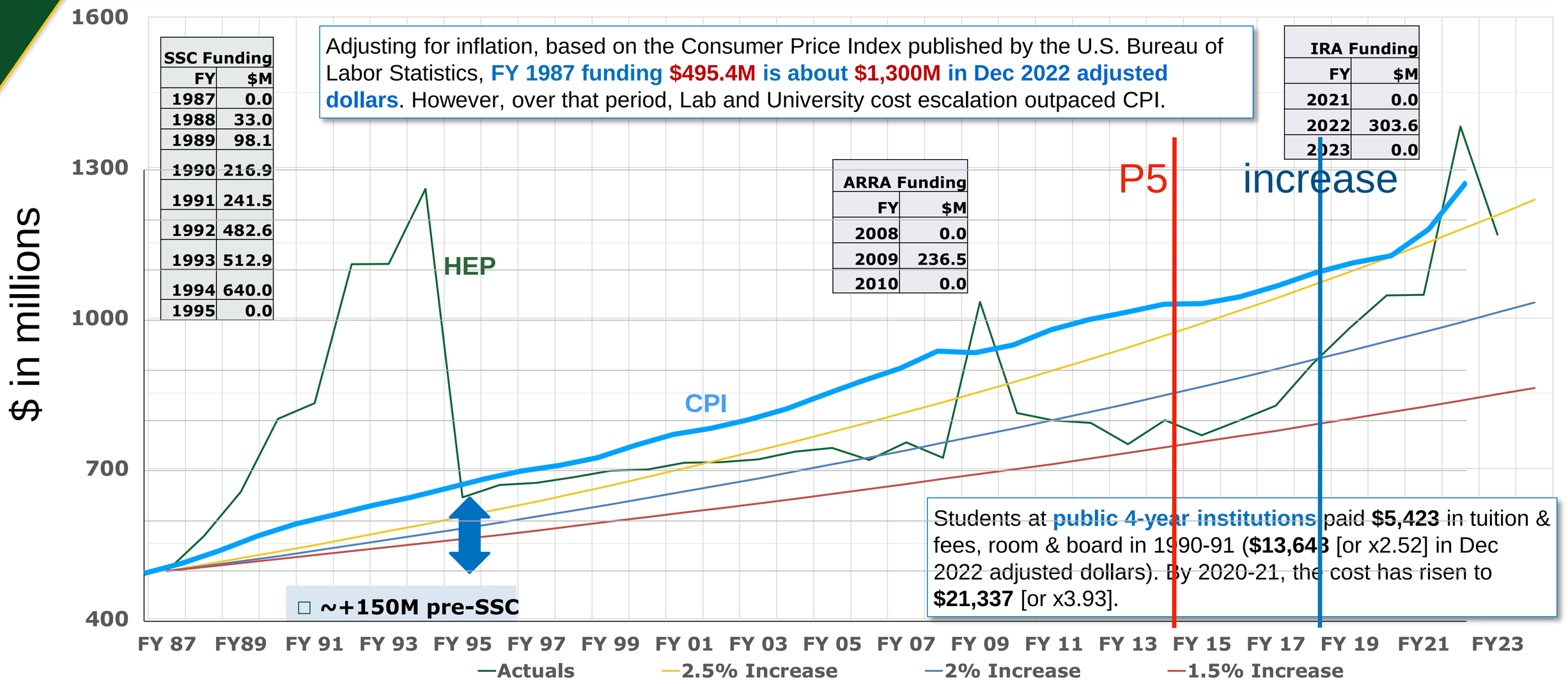
e. **IceCube-Gen2** for the study of neutrino properties using non-beam neutrinos complementary to DUNE and for indirect detection of dark matter.

3. Create an improved balance between small-, medium-, and large-scale projects to open new scientific opportunities and maximize their results, enhance workforce development, promote creativity, and compete on the world stage. The proposed portfolio includes implementing the recommended program, Advancing Science and Technology using Agile Experiments (ASTAE).

4. Support a comprehensive effort to develop the resources—theoretical, computational and technological—essential to our 20-year vision for the field. This includes an aggressive R&D program that, while technologically challenging, could yield revolutionary accelerator designs that chart a realistic path to a 10 TeV parton center-of-momentum (pCM) collider. In particular, the muon collider option builds on Fermilab strengths and capabilities and supports our aspiration to host a major collider facility in the US.

5. Invest in initiatives aimed at developing the workforce, broadening engagement, and supporting ethical conduct in the field. This commitment nurtures an advanced technological workforce not only for particle physics, but for the nation as a whole.

HEP Funding in Historical Context: 1987 to Present



SSC Funding	
FY	$M
1987	0.0
1988	33.0
1989	98.1
1990	216.9
1991	241.5
1992	482.6
1993	512.9
1994	640.0
1995	0.0

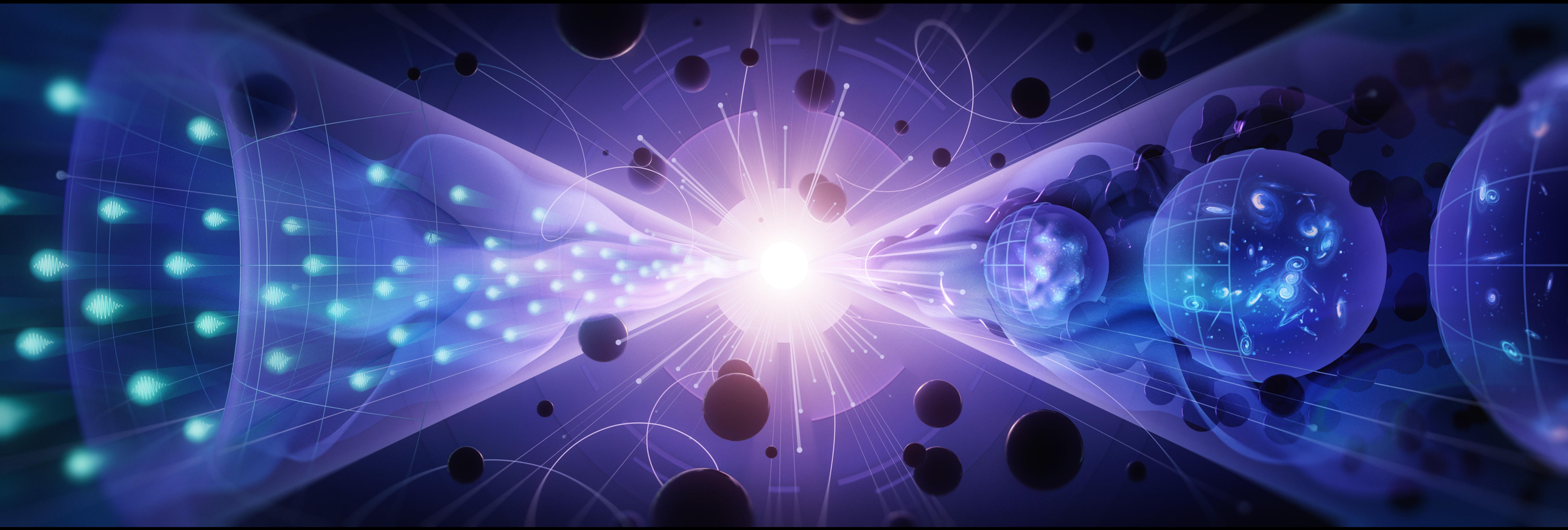
Adjusting for inflation, based on the Consumer Price Index published by the U.S. Bureau of Labor Statistics, **FY 1987 funding $495.4M is about $1,300M in Dec 2022 adjusted dollars**. However, over that period, Lab and University cost escalation outpaced CPI.

ARRA Funding	
FY	$M
2008	0.0
2009	236.5
2010	0.0

IRA Funding	
FY	$M
2021	0.0
2022	303.6
2023	0.0

Students at **public 4-year institutions** paid **$5,423** in tuition & fees, room & board in 1990-91 (**$13,643** [or x2.52] in Dec 2022 adjusted dollars). By 2020-21, the cost has risen to **$21,337** [or x3.93].

Exploring the Quantum Universe



Looking forward to implementation!