Exploring the Quantum Universe

Pathways to Innovation and Discovery in Particle Physics

Report of the 2023 Particle Physics Project Prioritization Panel

US Particle Physics for the Next Ten Years

Exploring the Quantum Universe

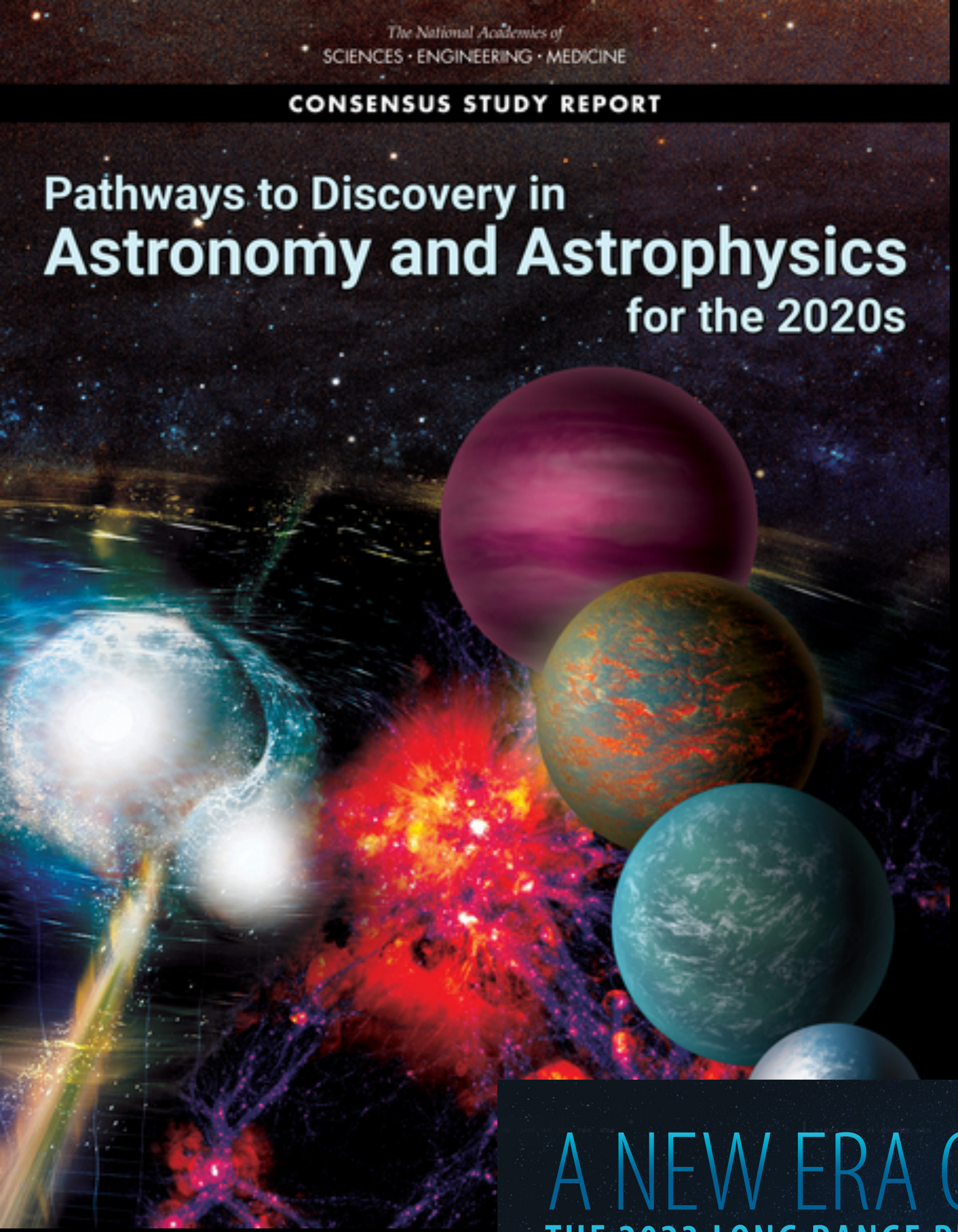
2023p5report.org

Wisconsin 05/3/2024

Hitoshi Murayama, on behalf of P5

U.S. DEPARTMENT OF ENERGY

NSF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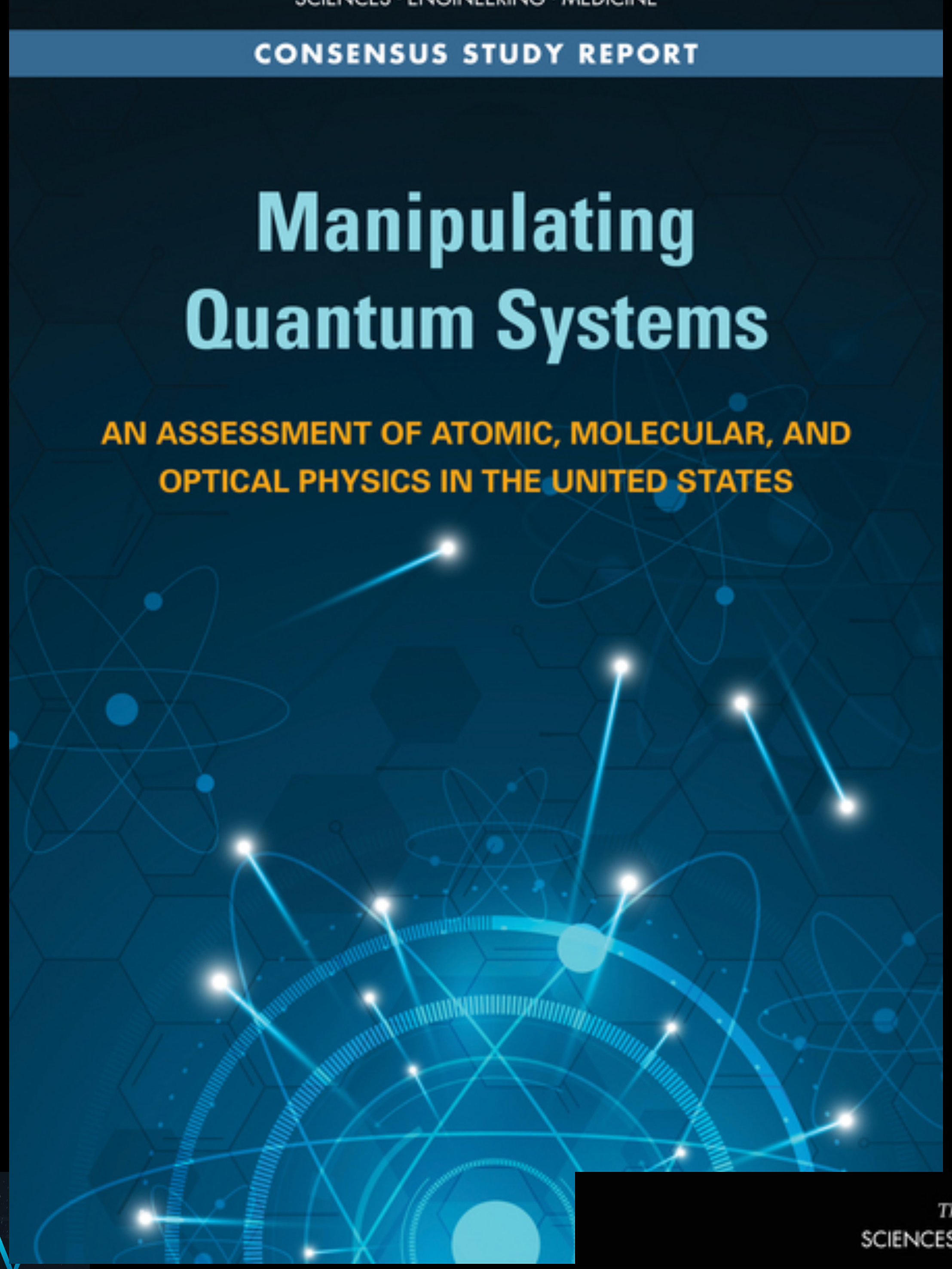
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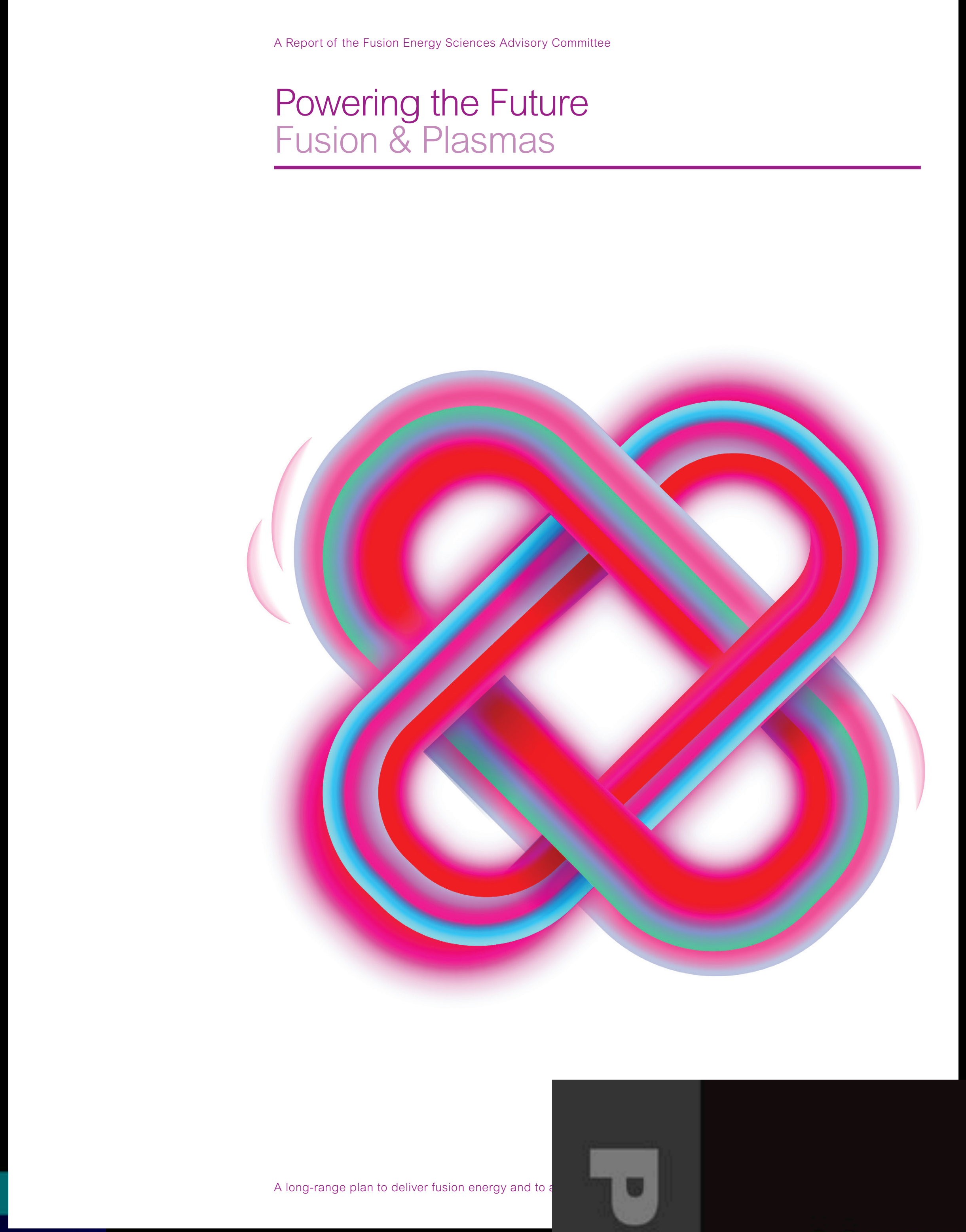
A Report of the Fusion Energy Sciences Advisory Committee
Powering the Future
Fusion & Plasmas


A NEW ERA OF DISCOVERY
THE 2023 LONG RANGE PLAN FOR NUCLEAR SCIENCE
2023 | VERSION 1.1
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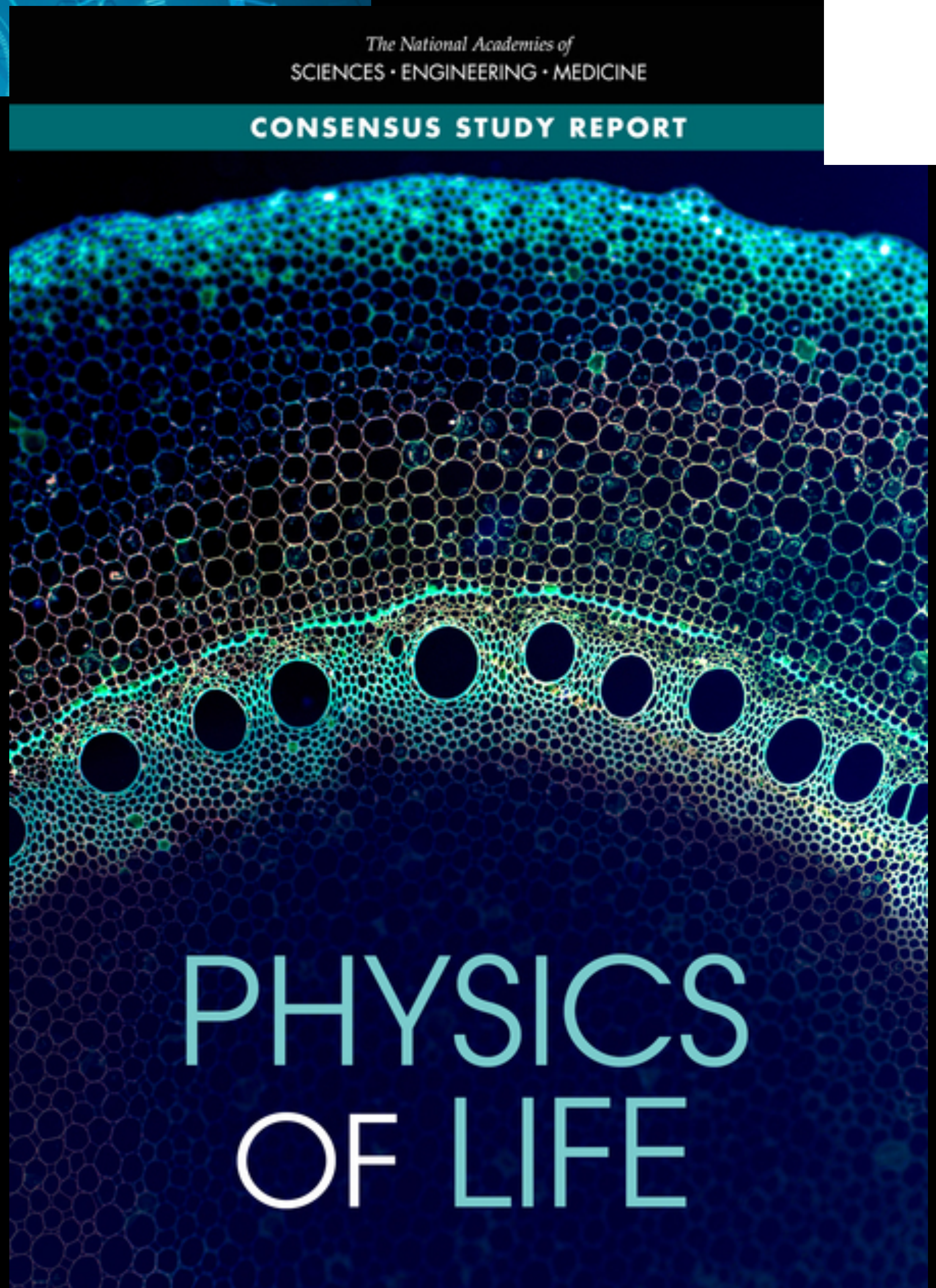
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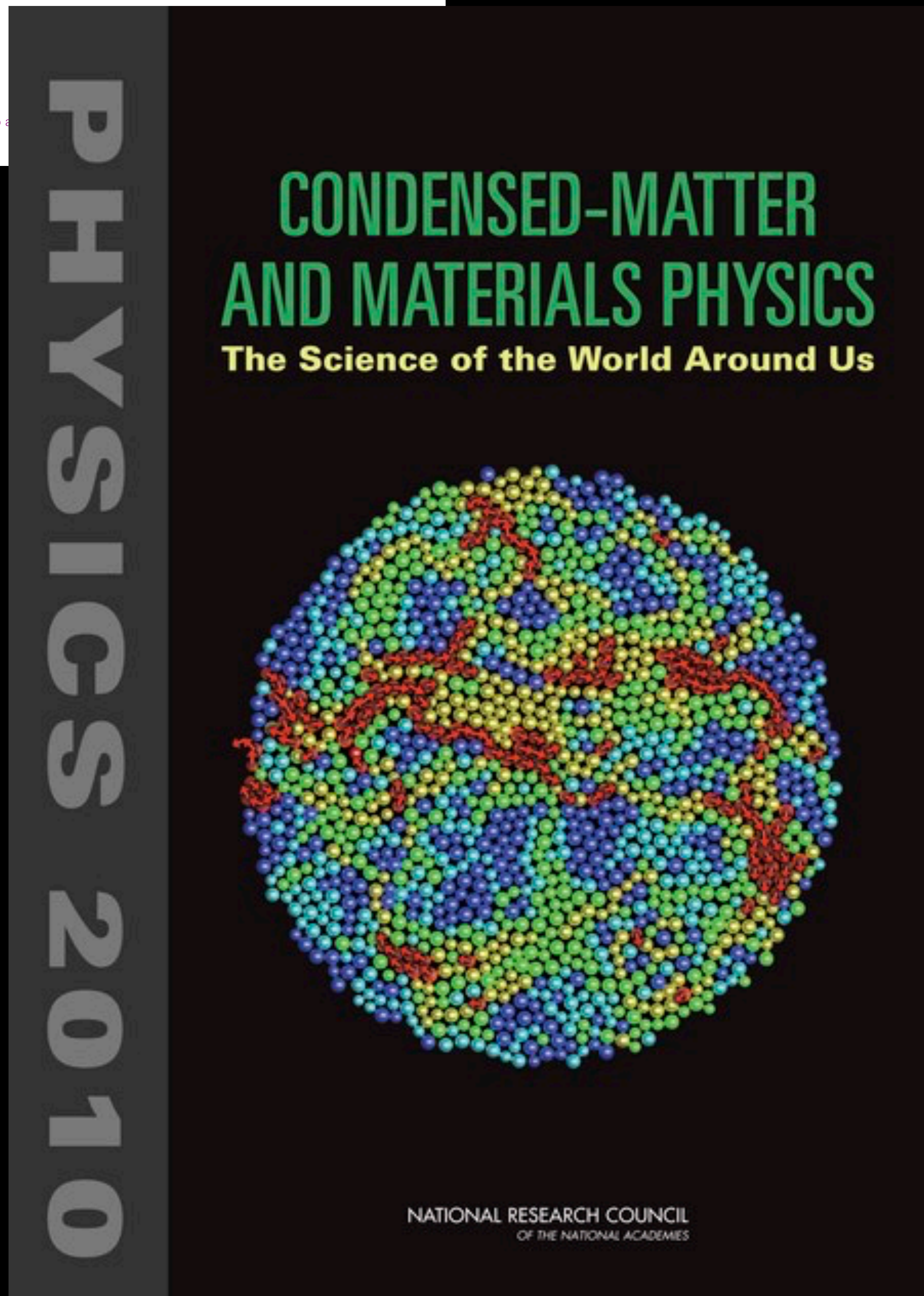
PHYSICS 2010
CONDENSED-MATTER
AND MATERIALS PHYSICS
The Science of the World Around Us
NATIONAL RESEARCH COUNCIL
OF THE NATIONAL ACADEMIES

Future Planning in Particle Physics

Community

"Snowmass" Community Study

Organized by APS / DPF

Snowmass 2021

Organized by High-Energy Physics Advisory Panel (HEPAP)

Particle Physics Project Prioritization Panel (P5)

DOE HEP
NSF PHYS

OMB
OSTP
Congress

Charge
Budget scenario

DOE HEP
NSF PHYS

Final workshop of Snowmass 2021 Community Study
University of Washington, July 2022

Key Elements of a Successful P5

- Well informed by the science community
- Set a grand long-range vision for U.S. particle physics
- Faced budget constraints realistically
  - "Community made tough choices."
- Balanced portfolio
  - Domestic and international
  - Small, mid-scale, and large projects
- Community engagement critical to success
  - "Bickering scientists get nothing."

Harriet Kung, Snowmass in Seattle
Then interim director of HEP
Now interim director for Office of Science

@Snowmass in Seattle


SCARED
TO DEATH

P5 tentative logo

Apologies to Antarctica! CMB and IceCube


Great panel!

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P5 Timetable and Process

Charge issued on Nov 2, 2022 by Dr. Berhe (DOE SC) and Dr. Jones (NSF MPS)

Panel formed by the end of January 2023

Information Gathering Phase

Snowmass Report

Open Town Halls

LBNL: February (513), Fermilab/Argonne: March (797) overlapped with EPP2024

Brookhaven: April (666), SLAC: May (512)

Virtual Town Halls

UT Austin: June (159) with an exclusive session for early career scientists, Virginia Tech, June (119)

All town halls offered live captioning and ASL

Many occasions for community engagement throughout the process

Deliberation Phase

Closed meetings

Austin, Gaithersburg, Santa Monica, Denver, May to August

Additional input from

Agencies Asmeret Berhe, Harriet Kung (DOE), many from DOE/HEP, NSF/PHY, NSF/AST, NSF/OPP

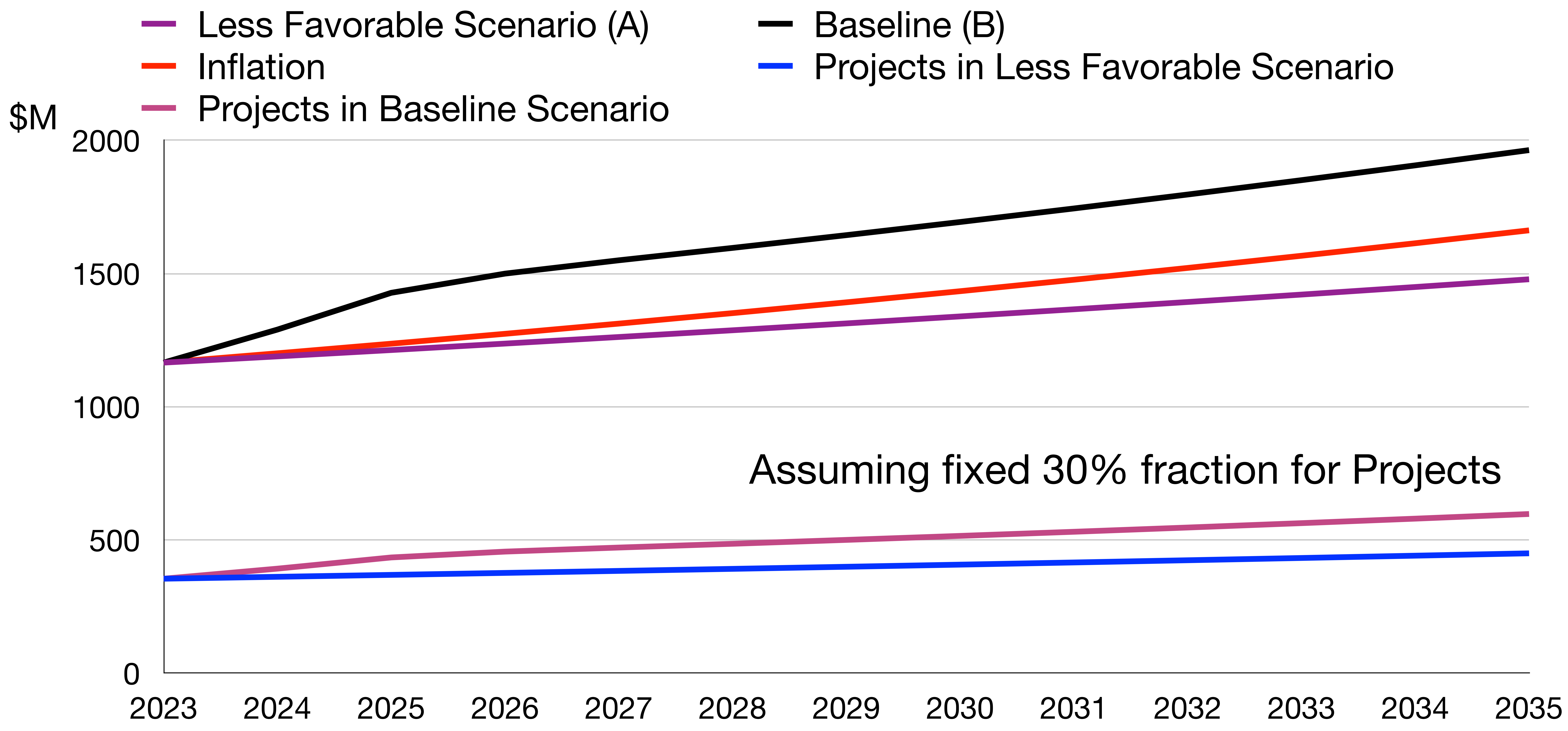
Government Cole Donovan (State, OSTP)

Community

International Benchmarking Panel, computing frontier, DPF leadership, previous P5 (Steve Ritz, Andy Lankford), CoV reports (Ritchie Patterson, Dmitry Denisov)

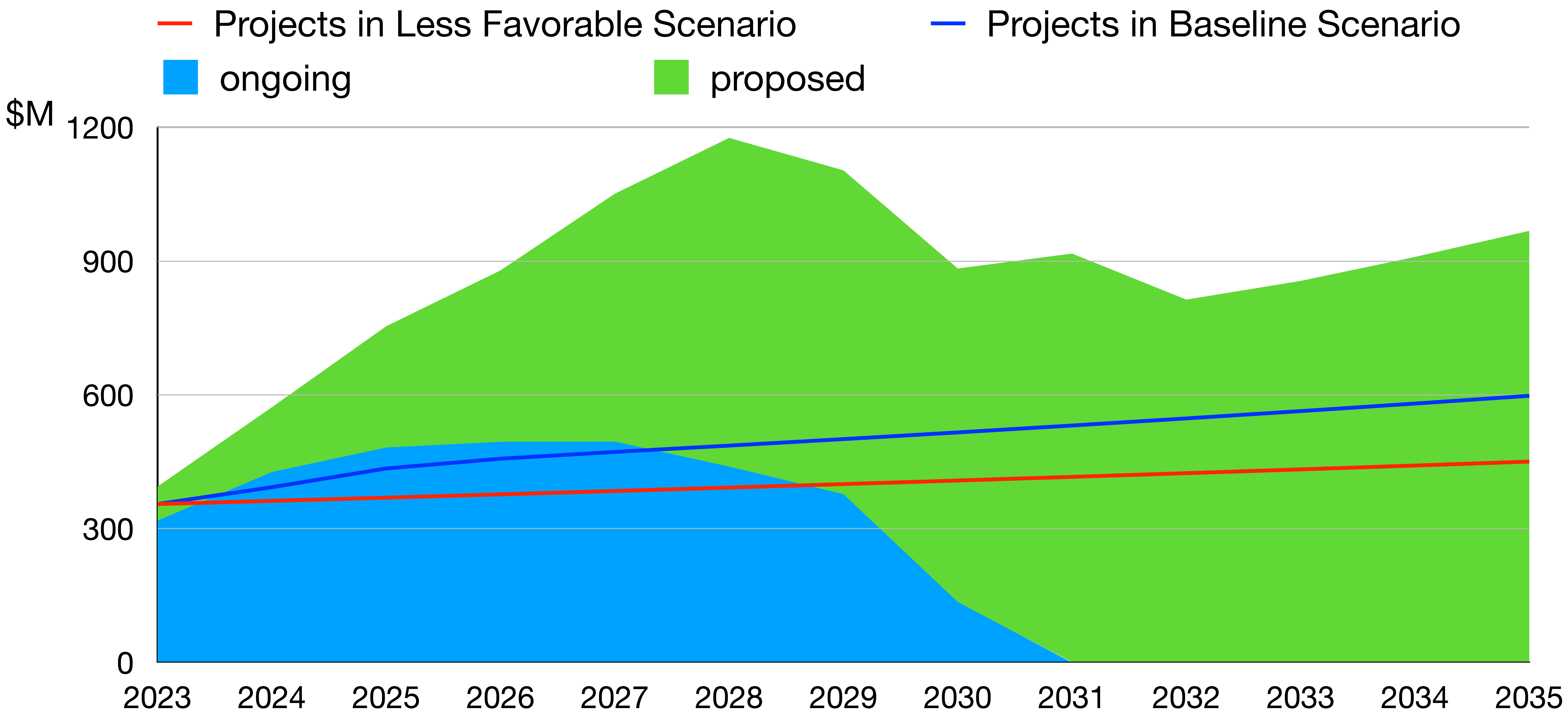
Frequent Meetings by working groups

Budget Scenarios



DOE only

Budget Scenarios and Projects



some multi-billion-dollar projects excluded

DOE only


Most hated man in the community
Credit: Linda Xu

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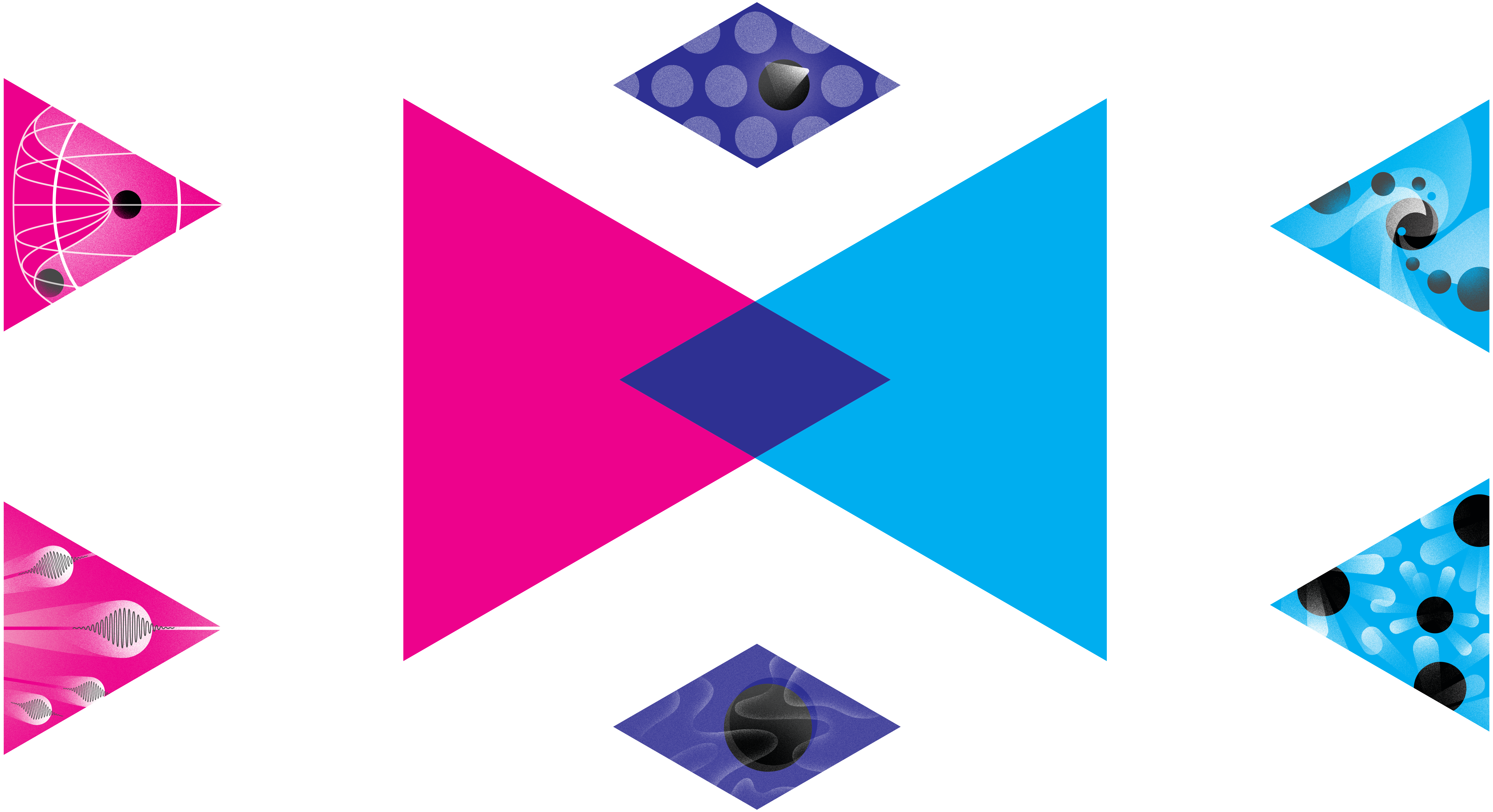
Report Released on Dec 7, 2023



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

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Not Rank-Ordered

Recommendation 1

Reaffirm critical importance of the ongoing projects

As the highest priority independent of the budget scenarios, complete construction projects and support operations of ongoing experiments and research to enable maximum science. We reaffirm the previous P5 recommendations on major initiatives:

a. HL-LHC x10 more data d CMS detectors, as well as Accelerator Upgrade Project) to start addressing why the Higgs boson condensed in the universe (reveal the secrets of the Higgs boson, section 3.2), to search for direct evidence for new particles (section 5.1), to pursue quantum imprints of new phenomena (section 5.2), and to determine the nature of dark matter (section 4.1).

DOE & NSF PHY

b. The first phase of DUNE and PIP-II determines the mass ordering utrinos, a fundamental property and a crucial input to cosmology and nuclear science (elucidate the mysteries of neutrinos, section 3.1).

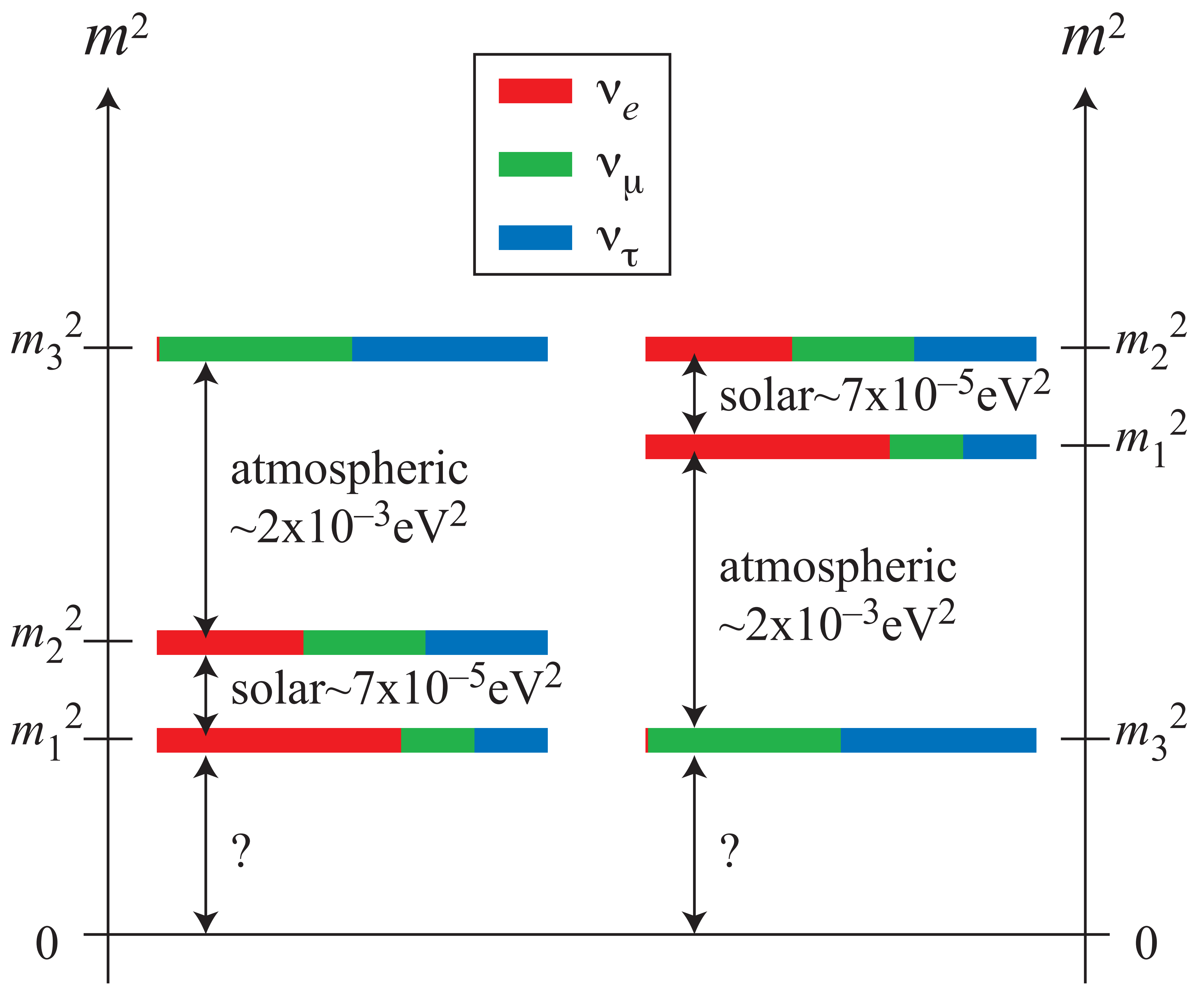
Mostly DOE

c. The Vera C. Rubin Observatory scan the whole sky in every two days y Science Collaboration, to understand what drives cosmic evolution (section 4.2).

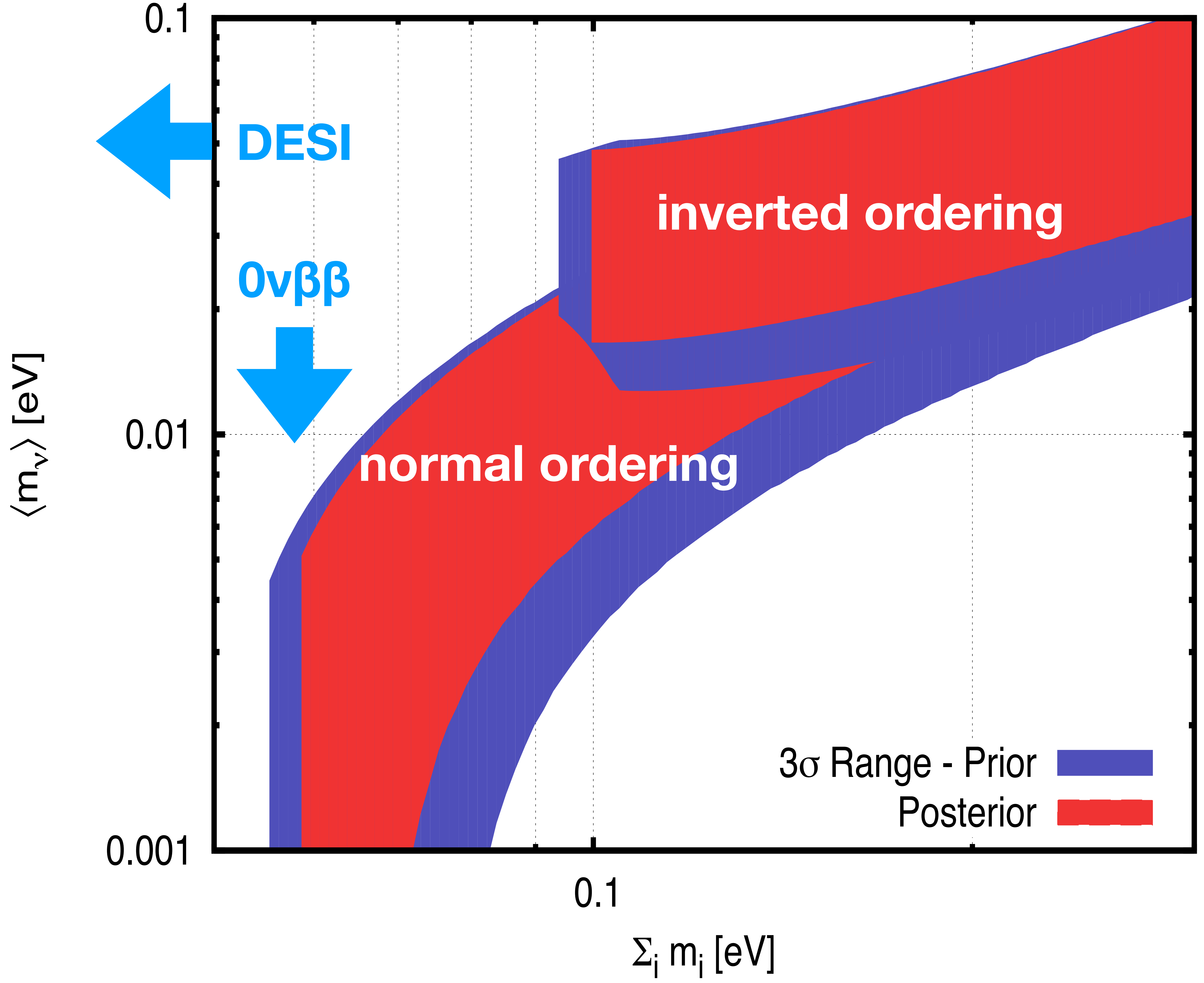
US leadership in key areas of particle physics

DOE & NSF AST

Do we know what happened when the Universe was 1sec old?



determination of mass ordering
JUNO: vacuum oscillation ~3σ
DUNE: matter effect >5σ



Shao-Feng Ge and Werner Rodejohann arXiv:1507.05514

Recommendation 1

Not Rank-Ordered

Reaffirm critical importance of the ongoing projects

In addition, we recommend continued support for the following ongoing experiments at the me… scale (project costs …M for DOE and > $4M for NSF), including completion of c…uction, operations, …search:

NSF

d. **NOvA**, **SBN**, **T2K**, and **IceCube** (*elucidate the mysteries of neutrinos*, section 3.1).

e. **DarkSide-20k**, **LZ**, **SuperCDMS**, and **XENONnT** (*determine the nature of dark matter*. section 4.1). **dark matter direct detection DOE+NSF**

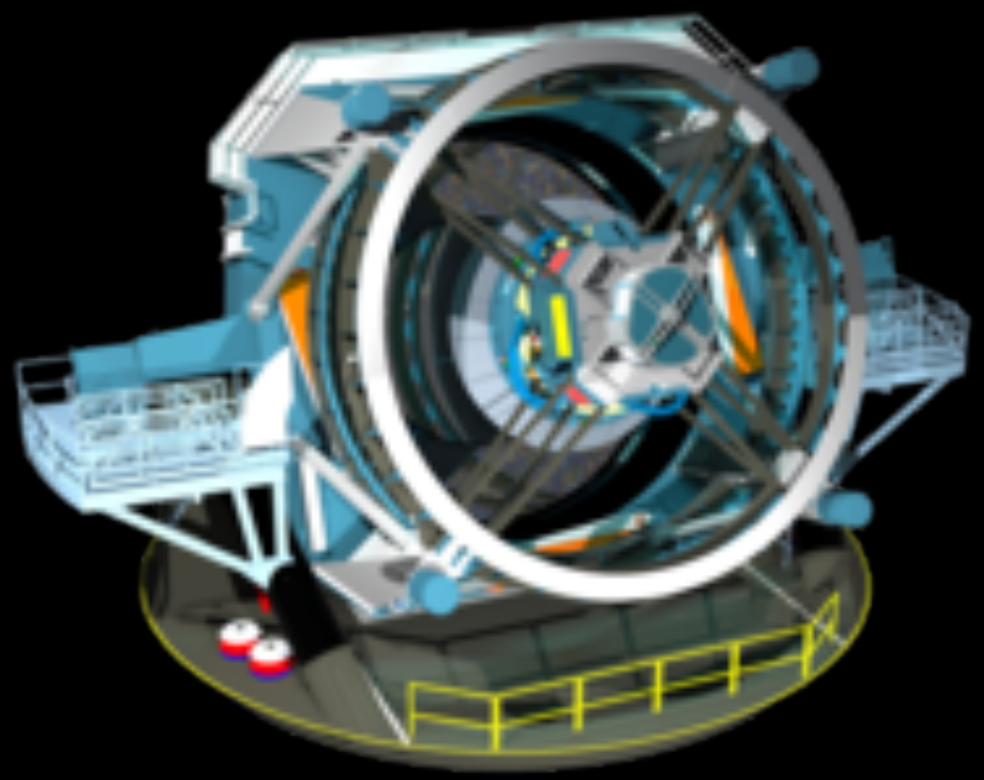
f. **DESI** (*unders… hat drives cosmic evolution*, section 4.2). **DOE but on Mayall 4m Kitt Peak**

g. **Belle II**, **LHCb** … **Mu2e** (*pursue quantum imprints of new phenomena*, section 5.2).

The agencies should work closely with each major project to carefully manage the costs and schedule to ensure that the US program has a broad and balanced portfolio.

Ongoing Projects

Ongoing experiments will provide constraints on cosmic acceleration, and reach back into the weakly matter-dominated era when the expansion was still decelerating. The program will stress-test the standard cosmological paradigm, where CMB surveys can benefit from combinations with space-based datasets.



Rubin Observatory: Legacy Survey of Space and Time (LSST) and the LSST Dark Energy Science Collaboration (DESC)

DESI (a spectroscopic survey)

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Recommendation 2

Rank-Ordered

New exciting initiatives

a. **CMB-S4**, which looks back at the earliest moments of the universe to probe physics at the highest energy scales. It is critical to install telescopes at and observe from both the South Pole and Chile sites to achieve the science goals (section 4.2). DOE & NSF AST

b. **Re-envisioned second phase of DUNE** with an early implementation of an enhanced 2.1 MW beam—ACE-MIRT—a third far detector, and an upgraded near-detector complex as the definitive long-baseline neutrino oscillation experiment of its kind (section 3.1). Mostly DOE

c. **An off-shore Higgs factory**, realized in collaboration with **international partners**, in order to reveal the secrets of the Higgs boson. The current designs of FCC-ee and ILC meet our scientific requirements. The US should actively engage in feasibility and design studies. Once a specific project is deemed feasible and well-defined (see also Recommendation 6), the US should aim for a contribution at funding levels commensurate to that of the US involvement in the LHC and HL-LHC, while maintaining a healthy US on-shore program in particle physics (section 3.2). DOE & NSF PHY

d. **An ultimate Generation 3 (G3) dark matter direct detection experiment** reaching the neutrino fog, in coordination with international partners and preferably sited in the US (section 4DOE & NSF PHY

e. **IceCube-Gen2** for study of neutrino properties using non-beam neutrinos complementary to DUNE and for indirect detection of dark matter covering higher mass ranges using neutrinos as a tool (section 4.1). NSF PHY

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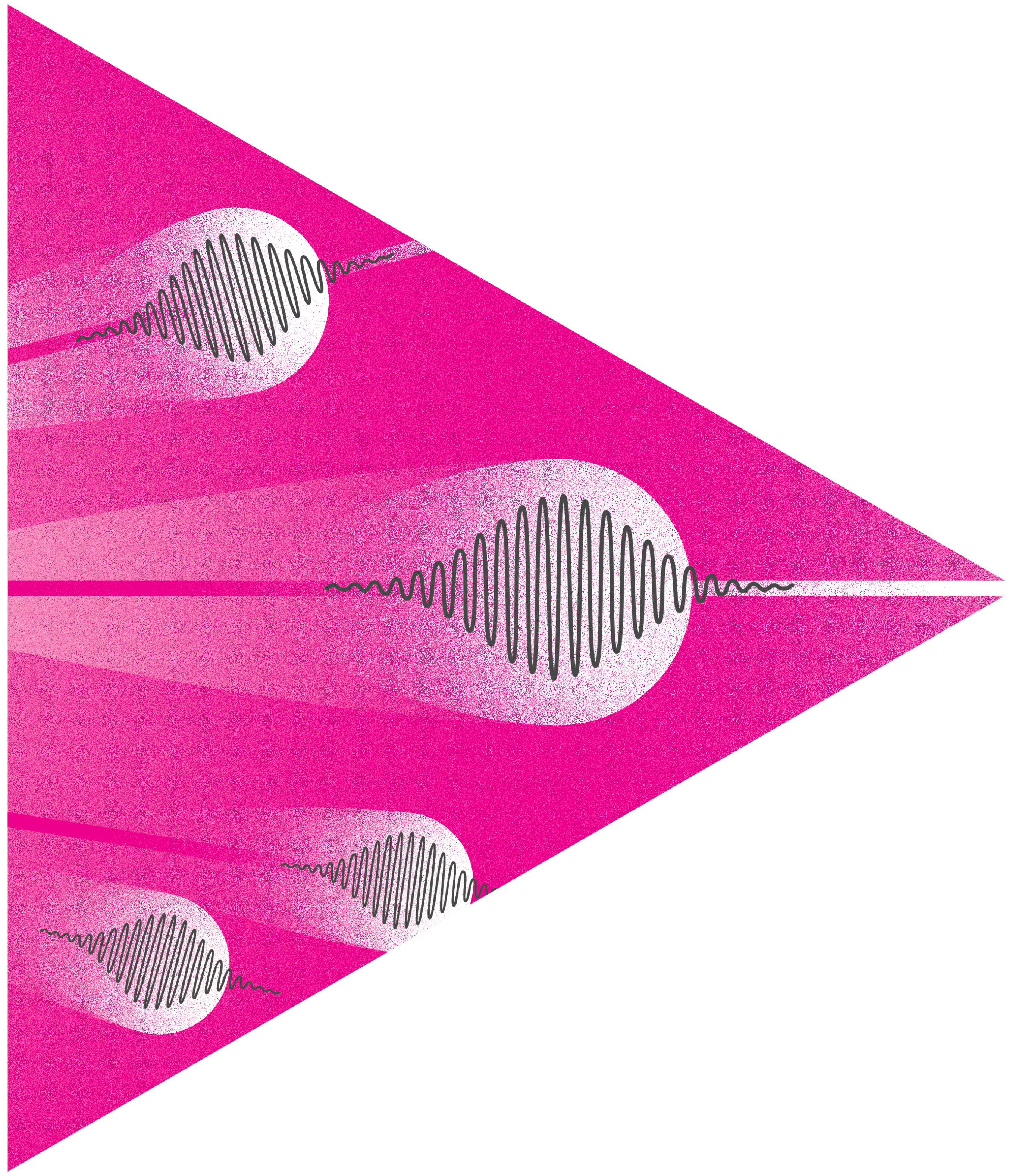
Neutrinos



Beginning of Universe

1,000,000,001

1,000,000,001

matter

anti-matter

Somebody did this

We were saved!

2

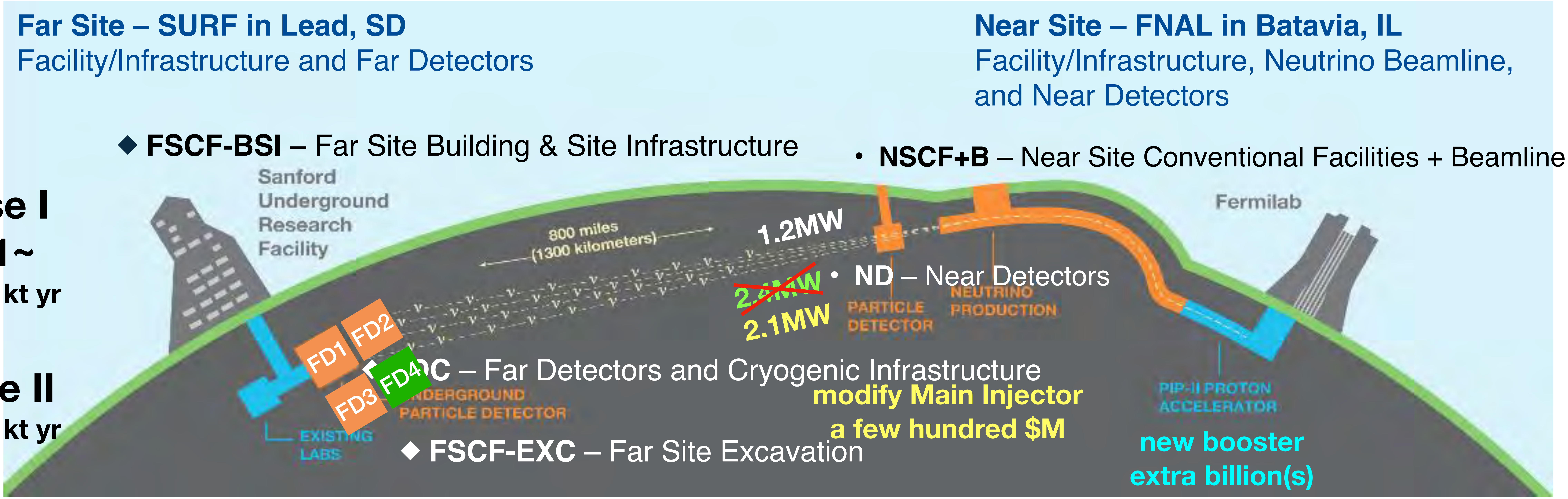
us

matter

anti-matter

Did neutrinos save us from a complete annihilation?

Long baseline neutrino facility (LBNF) and Deep Underground Neutrino Experiment (DUNE)



Phase I
2031~
120MW kt yr

Phase II
600MW kt yr

◆ DUNE is an international science collaboration of more than 1300 scientists from 35 countries plus CERN

- 50 – 50 split between U.S. and non- U.S. collaborators

3.1.4 – Future Opportunities: DUNE FD4, the Module of Opportunity

An upgraded detector module will provide excellent prospects for underground physics, including direct dark matter detection, exotic dark matter searches, and expanded sensitivity to solar neutrinos. R&D for advanced detector concepts should be supported.

…ffice of Science (TPC = $3.2B)
…al particle physics mega-project

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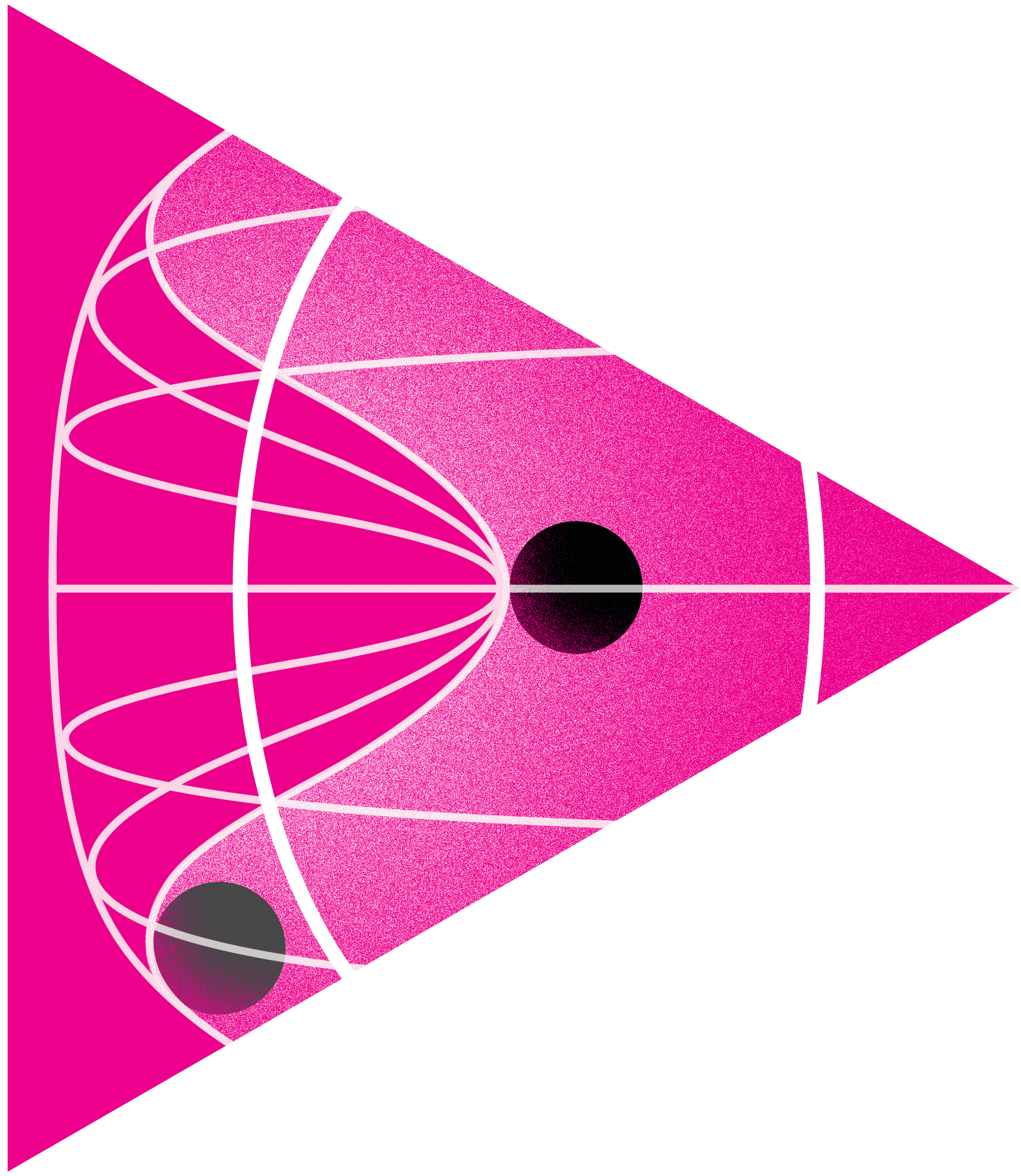
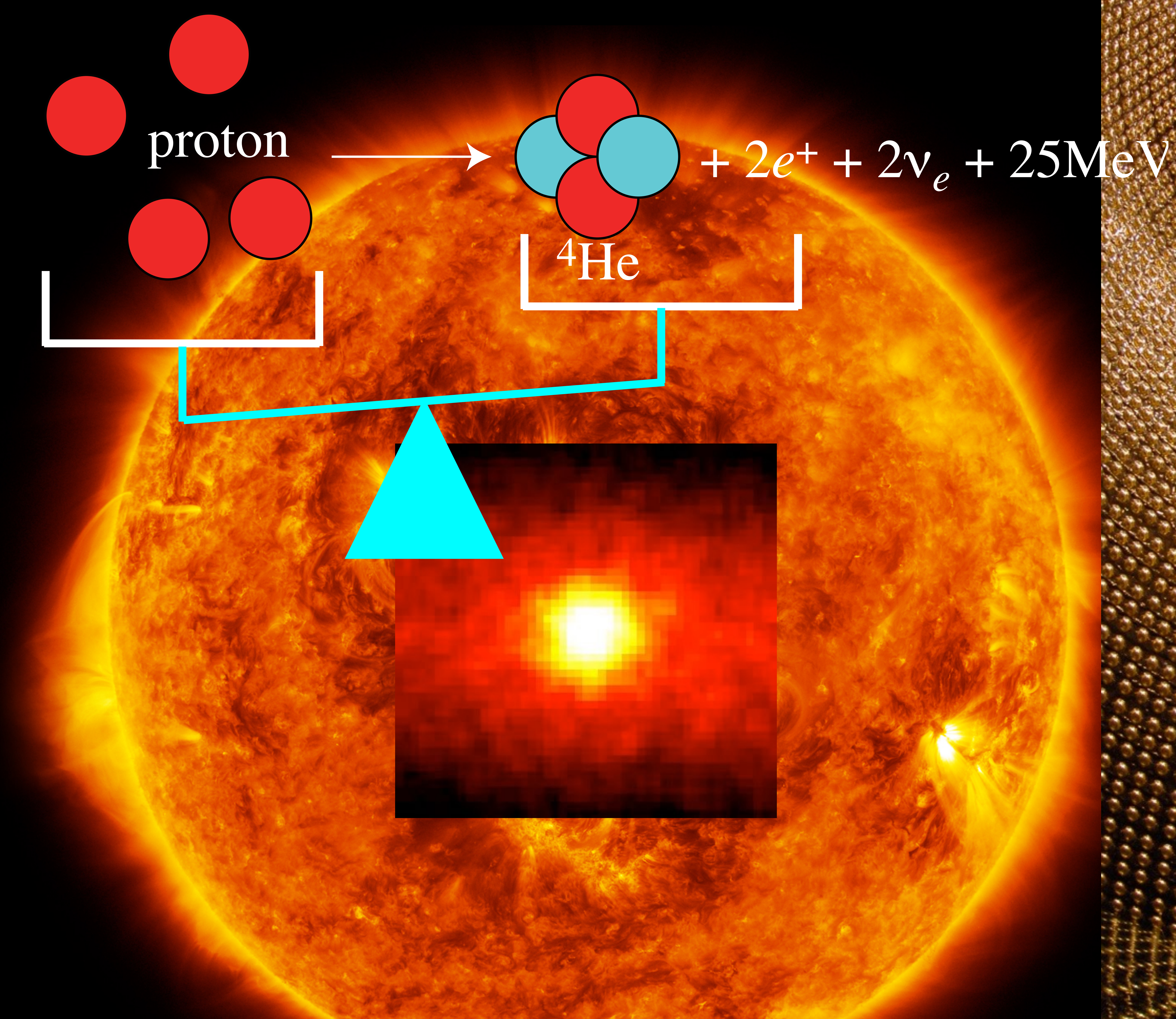
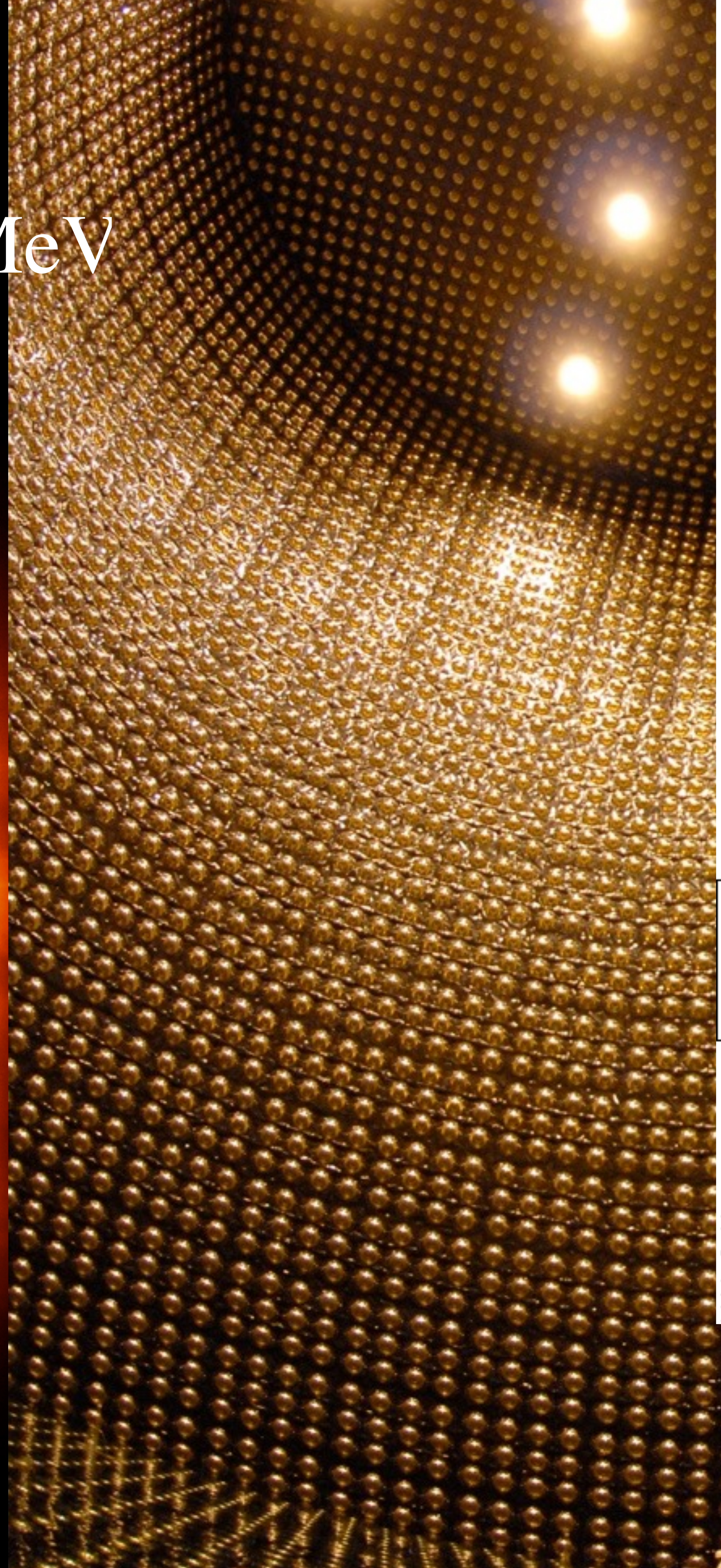
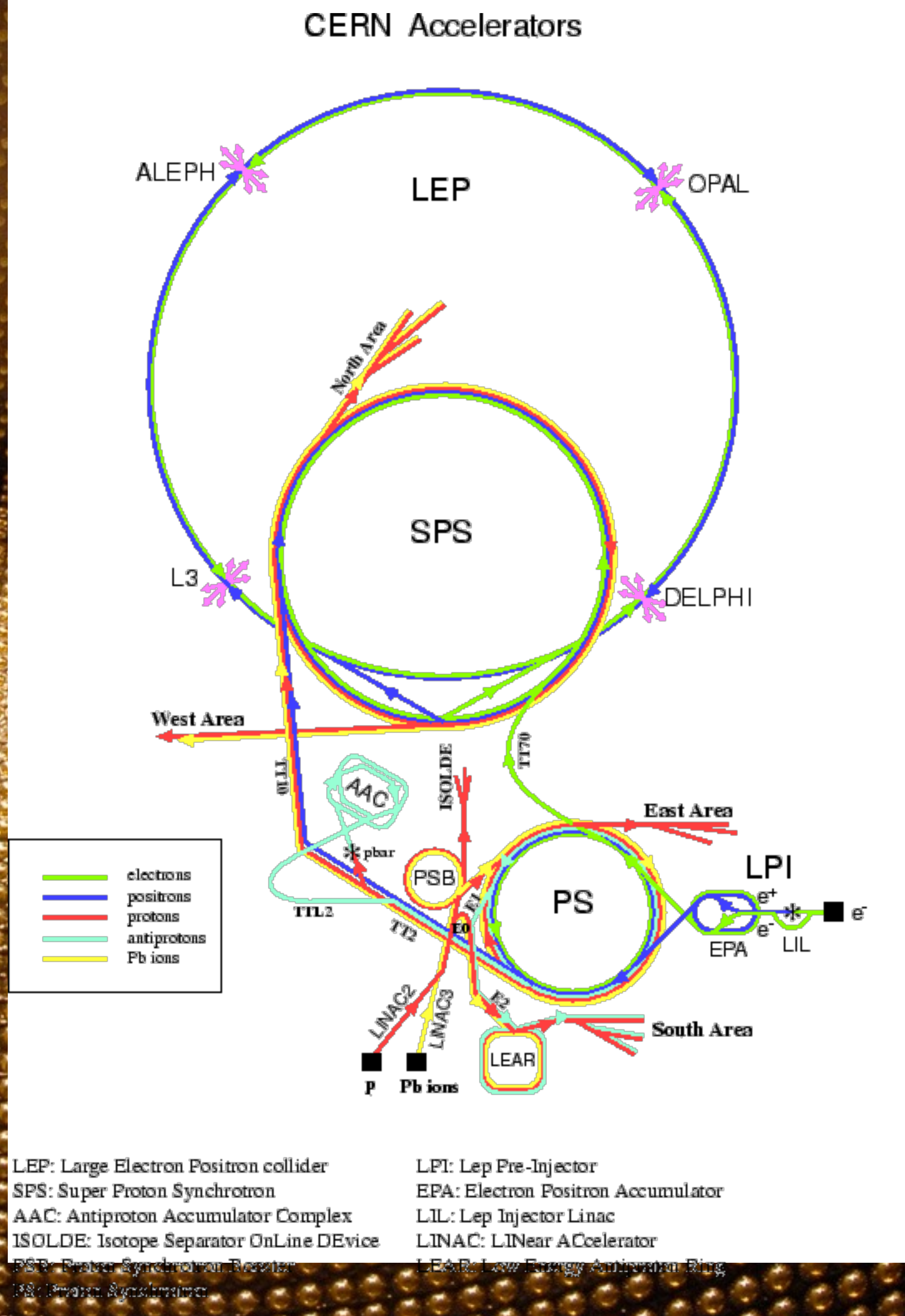
Higgs





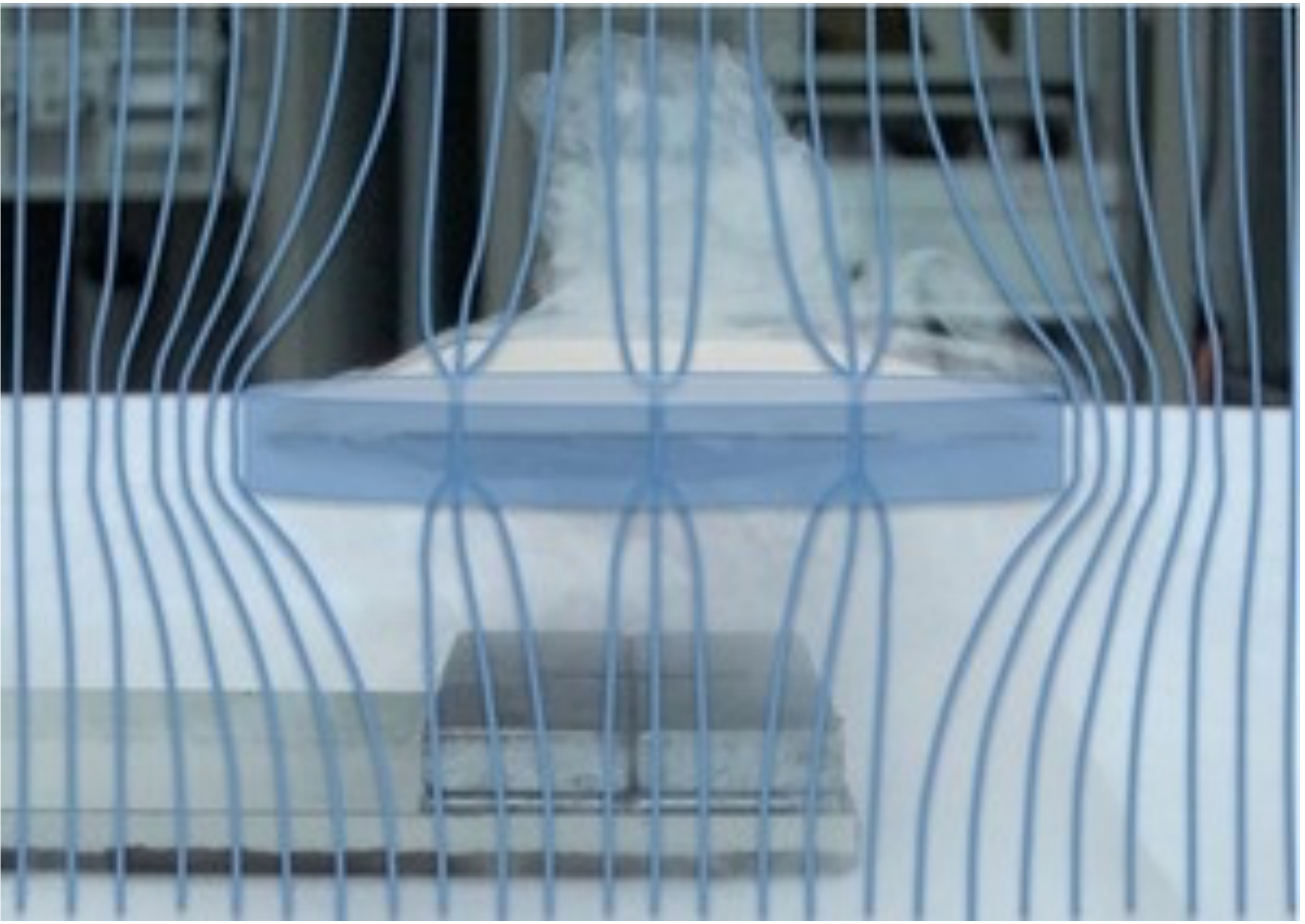




Weak force is exactly the same as electric and magnetic forces
except that it goes over only over 10^{-16} cm
Somehow, it is "just right"!

Why short-ranged?

Magnetic force doesn't go very far in a superdonctor

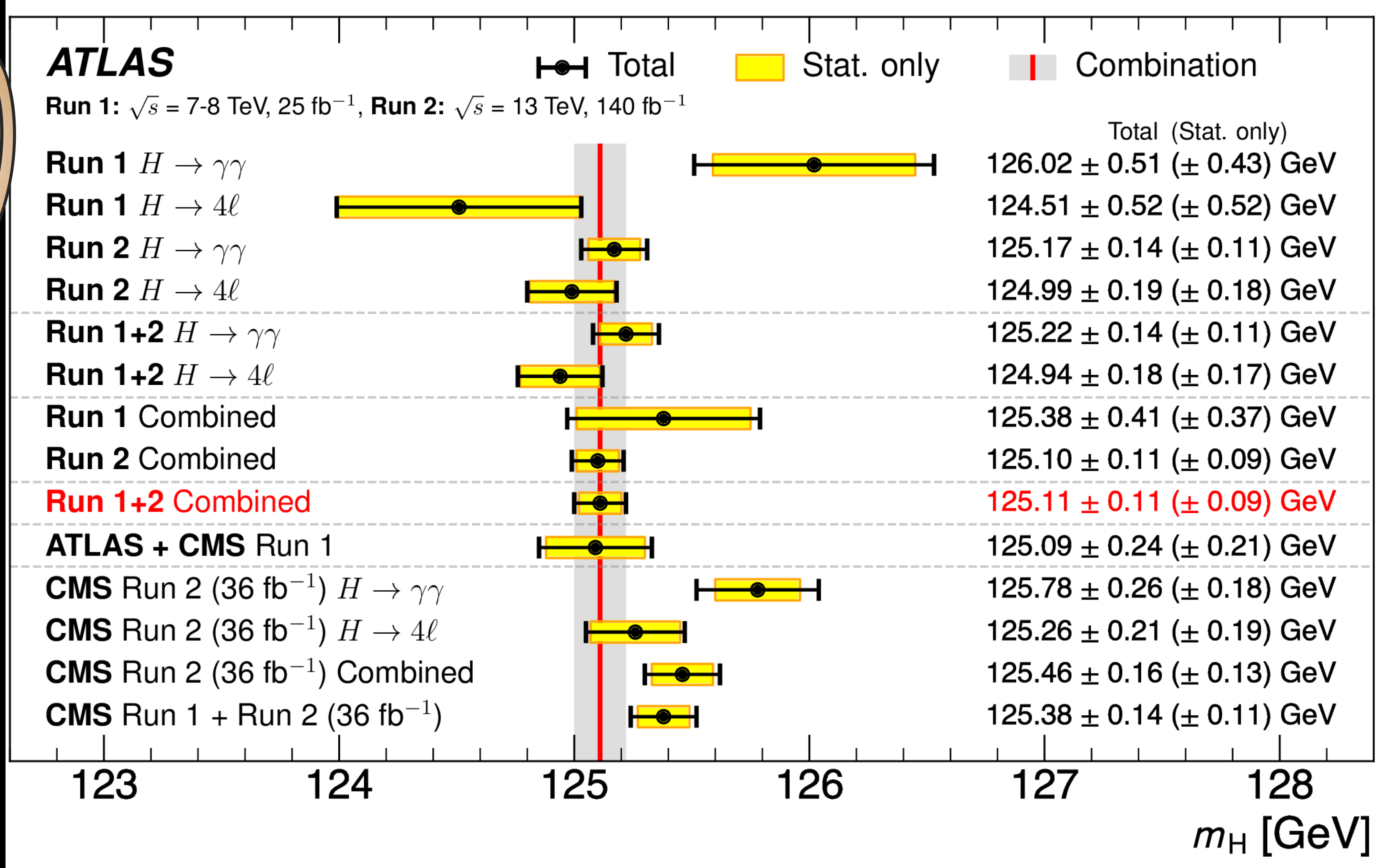


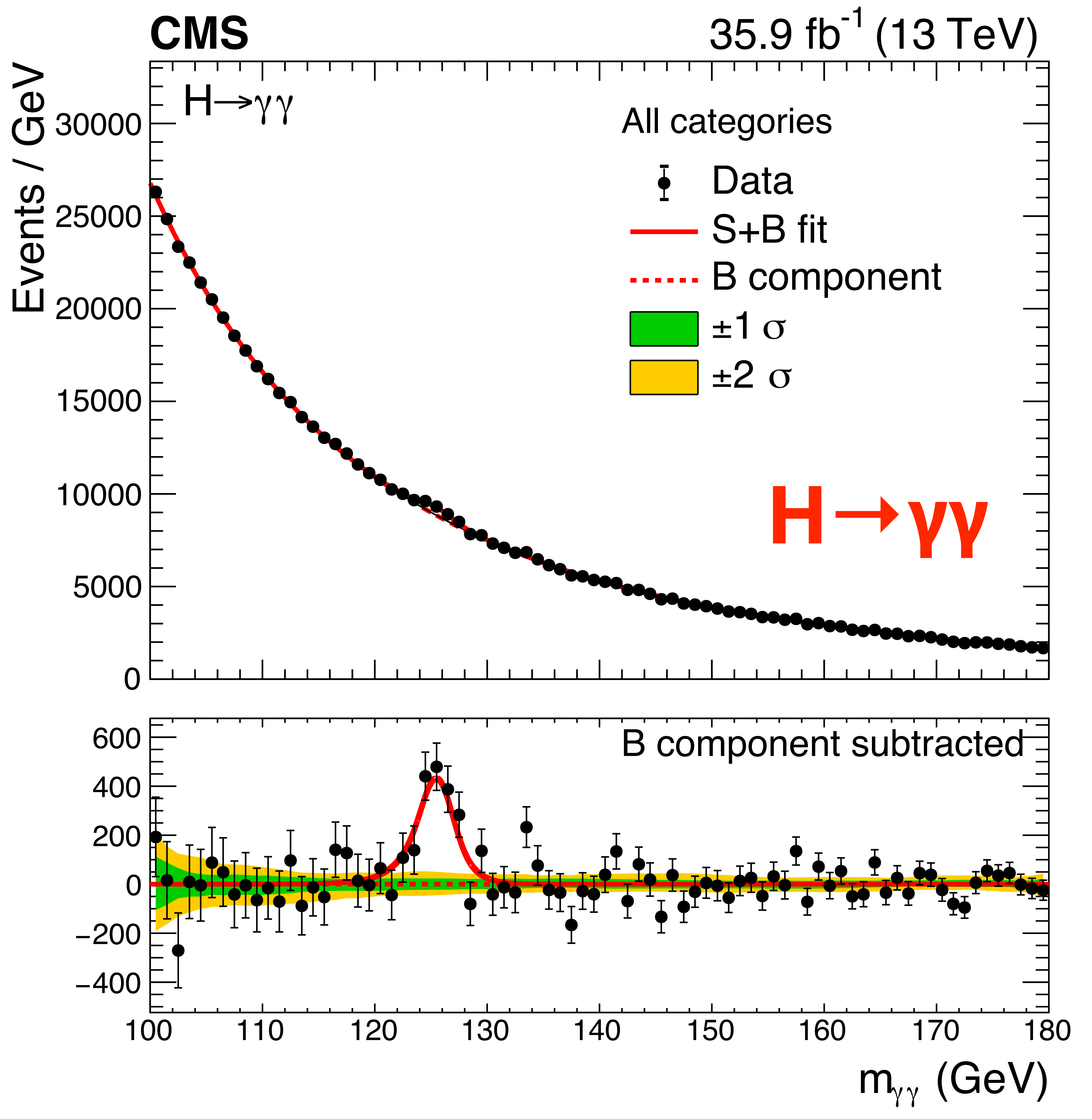
- Suppose you live in a piece of superconductor
- You've figured there is a condensate of charge two that disturbs the magnetic field
- you don't know if the condensate is made of pairs of electrons or elementary particles
- you don't know that phonons are responsible for the condensate
  - you can't swap the universe to a different isotope
- you need to measure its interaction precisely

Ongoing Projects: ATLAS and CMS

Higgs boson measurements

- mass measured to better than 0.2%
- established to have zero spin
- lifetime measurements made using quantum interference effects
- multiple couplings measured to 5-10% precision
- all major production modes observed

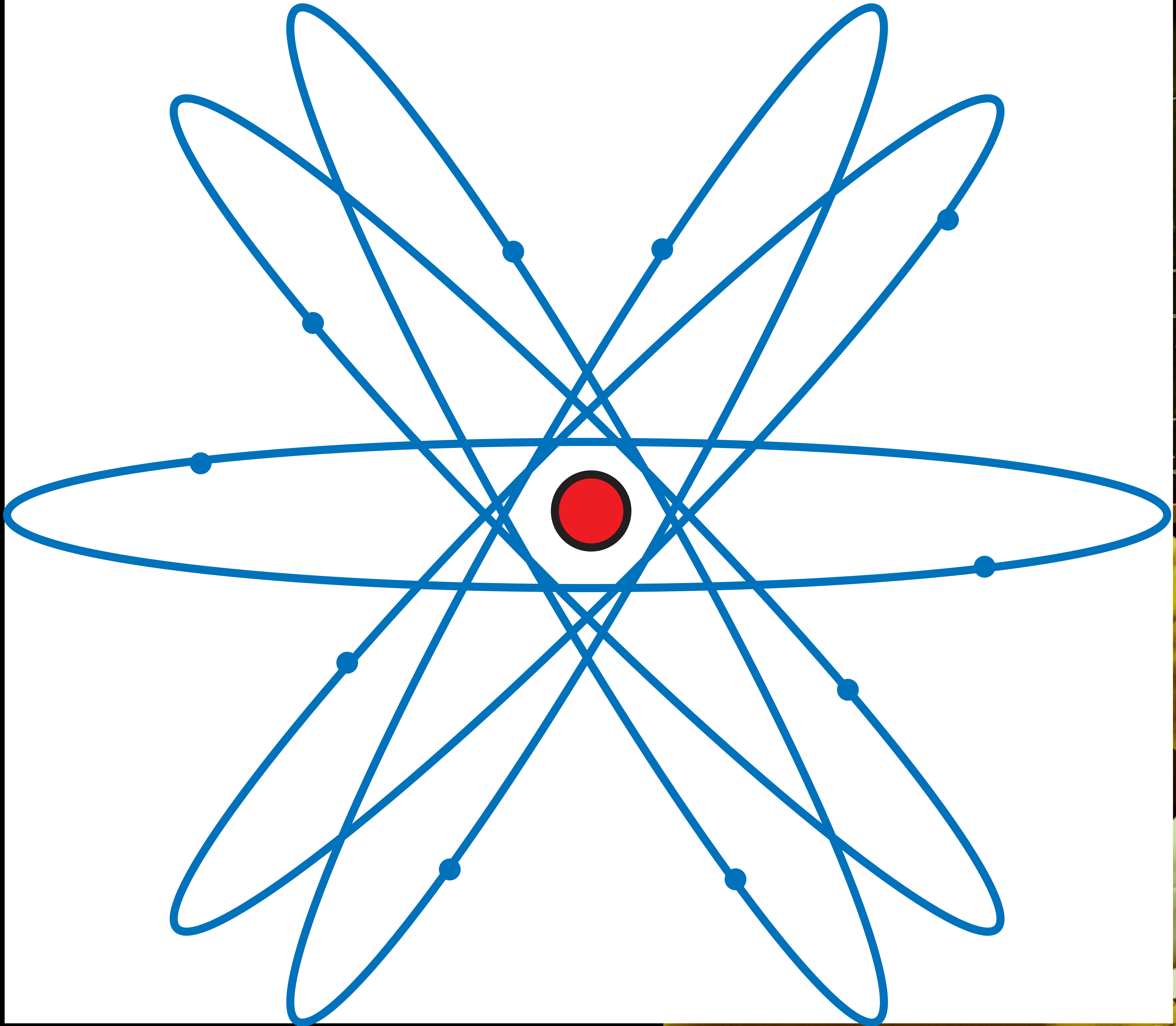




Higgs boson frozen in the Universe

Just the right amount of Higgs boson for us to exist!

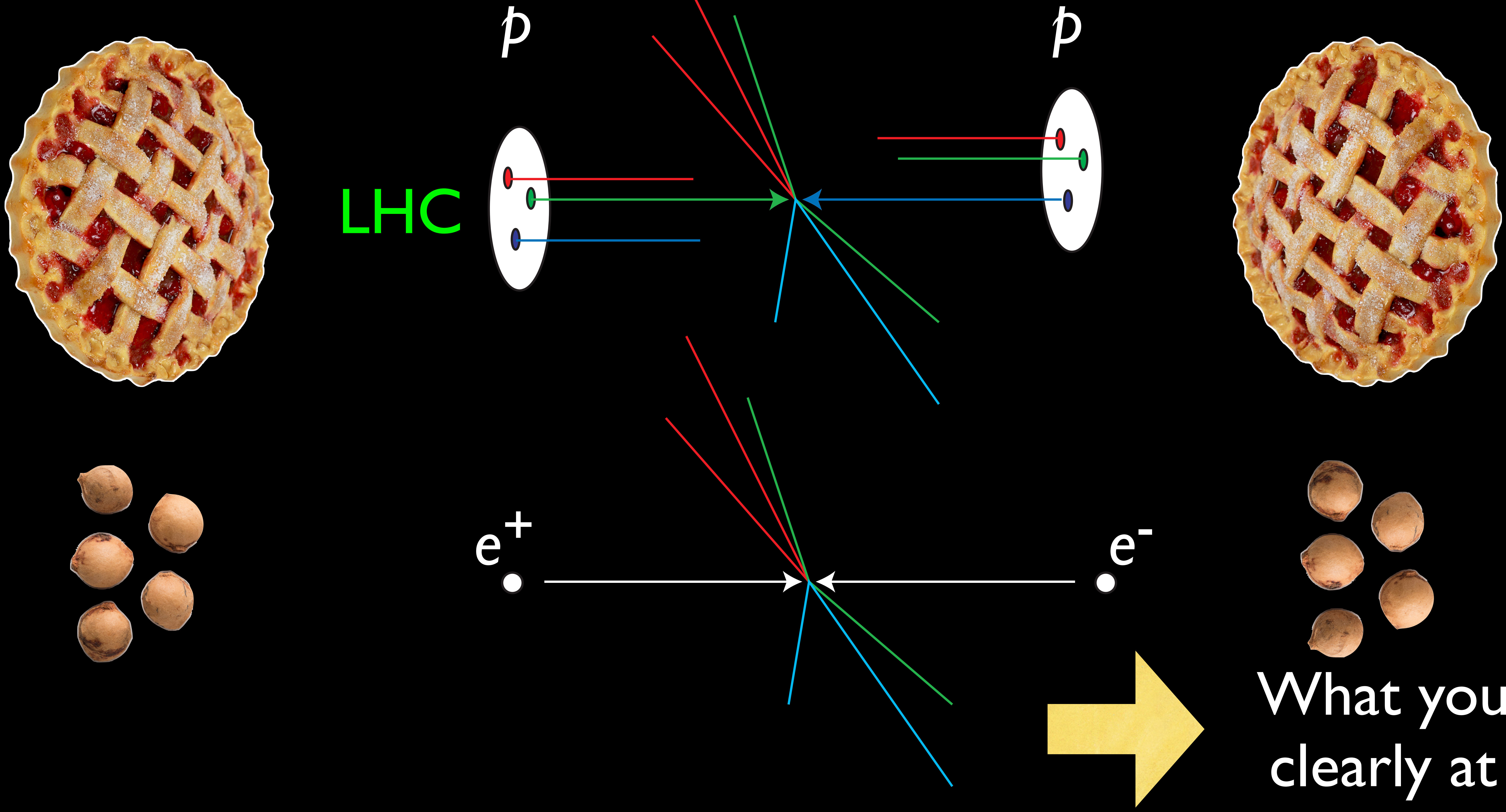
Credit: Newton Japan



Higgs filling up the space keeping us in one piece

https://www.nist.gov/news-events/news/2001/03/implosion-and-explosion-bose-einstein-condensate-bosenova

Pick up interesting ones out of trillions



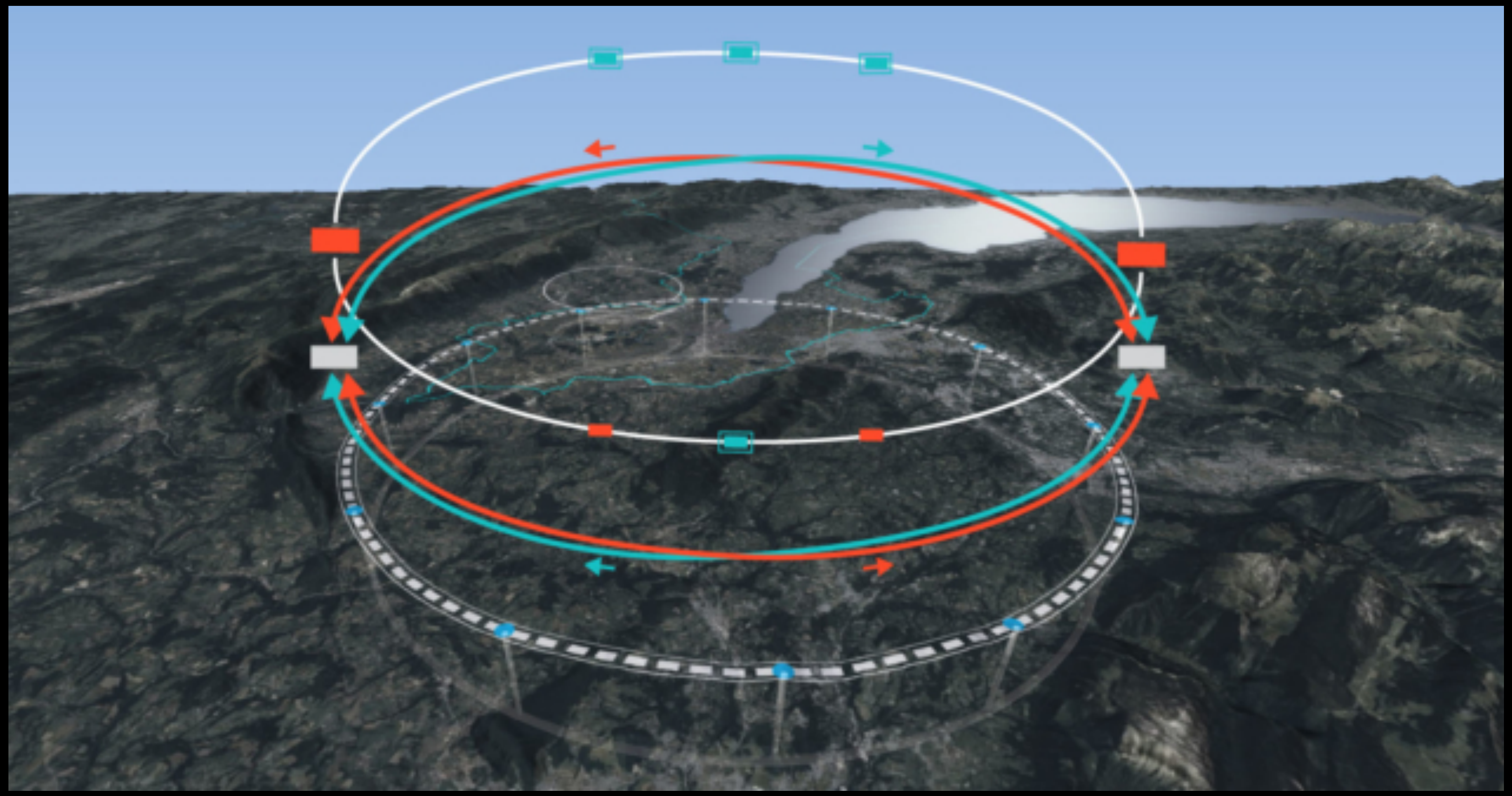
What you can’t see clearly at the LHC

An Offshore Higgs Factory

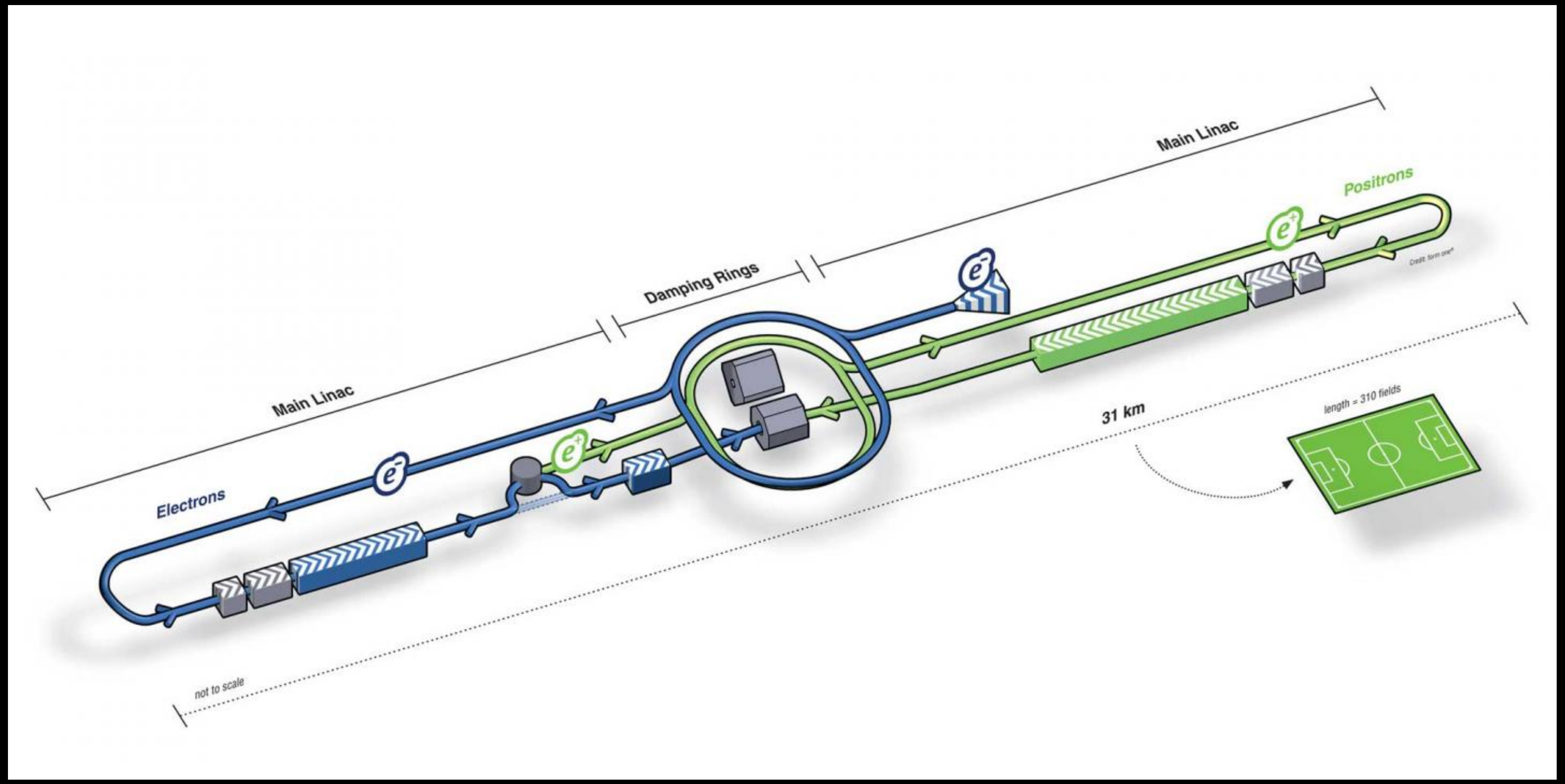
An electron-positron collider covering center-of-momentum energy range 90 - 350 GeV

- Precision measurements of couplings and some production modes
- Order of magnitude improved access to Higgs → invisible decays
- EW sector consistency checks, testing through quantum loops that relate W & Z bosons, the top quark, and the Higgs
- Improve knowledge of coupling to charm quark, potentially provide access to coupling to strange quark

FCC ee



ILC

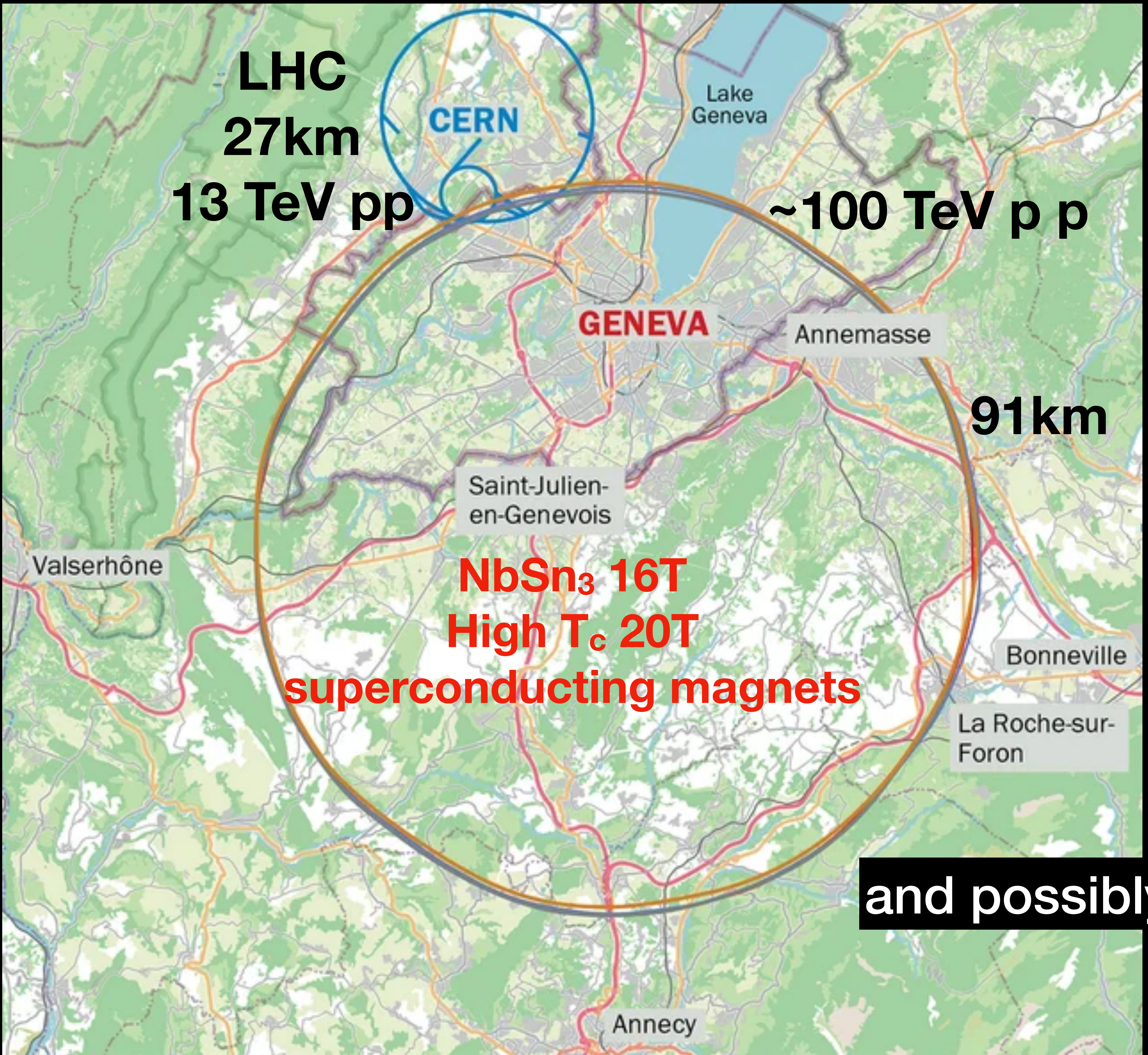


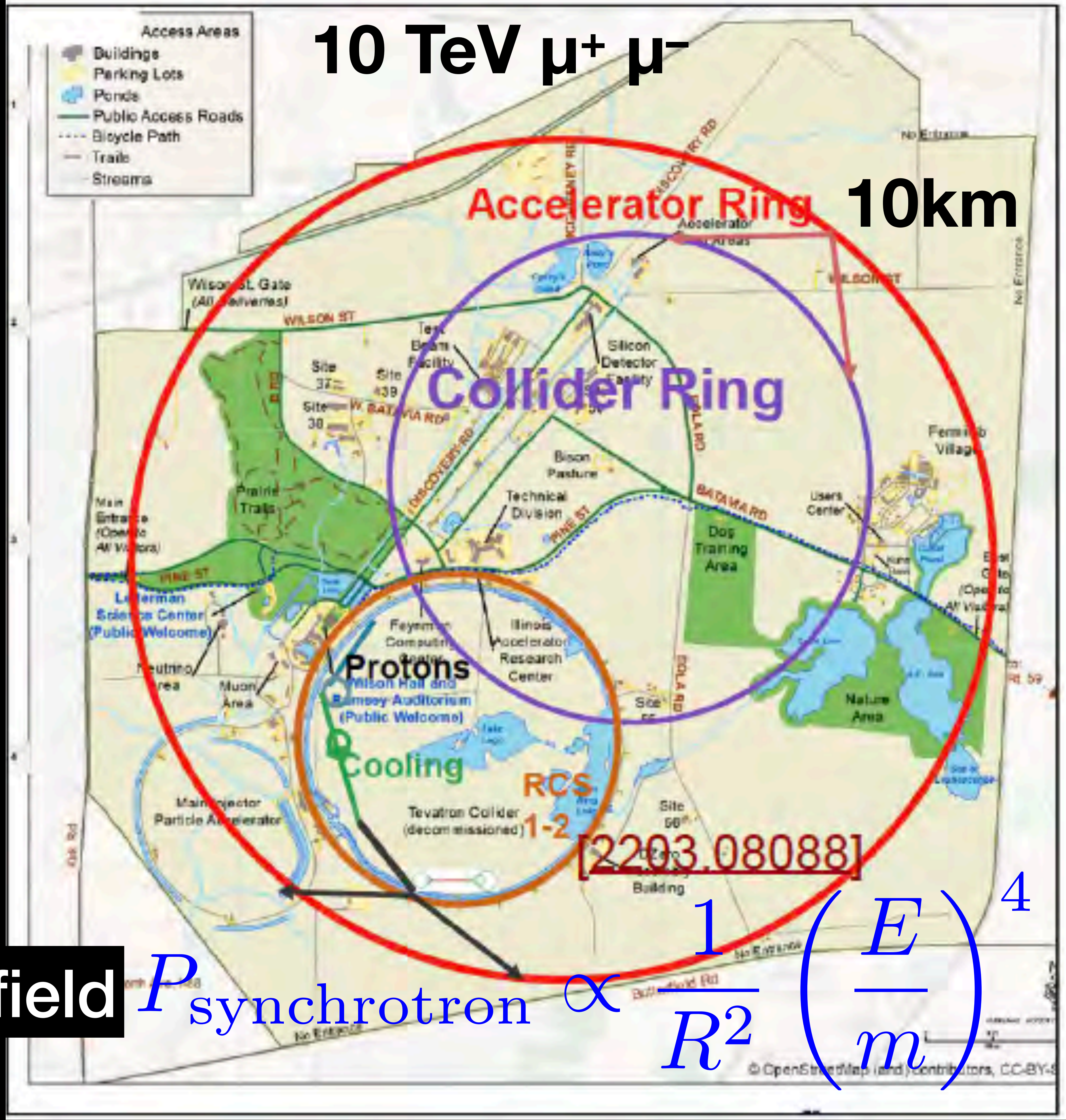
R&D will allow Fermilab to continuously expand the accelerator complex while producing world class science: *our Muon Shot!*

New enabling technologies

5% measurement of Higgs self coupling

Energy 10xLHC
Size 1/3 x LHC
Fits inside the Fermilab site





and possibly wakefield

$$P_{\text{synchrotron}} \propto \frac{1}{R^2}\left(\frac{E}{m}\right)^4$$

Muon production and cooling

Not Rank-Ordered

Recommendation 4

Investment in the future

a. Support **vigorous R&D toward a cost-effective 10 TeV pCM collider** based on proton, muon, or possible wakefield technologies, including an evaluation of options for US siting of such a machine, with a goal of being ready to build **major test facilities and demonstrator facilities within the next 10 years** (sections 3.2, 5.1, 6.5, and Recommendation 6).

b. Enhance research in **theory** to propel innovation, maximize scientific impact of investments in experiments, and expand our understanding of the universe (section 6.1). **$15M/yr increase**

c. Expand the **General Accelerator R&D (GARD)** program within HEP, including stewardship (section 6.4). **$10M/yr increase**

d. Invest in R&D in **instrumentation** to develop innovative scientific tools (section 6.3). **$20M/yr increase**

e. Conduct **R&D** efforts to define and enable new projects in the next decade, including detectors for an e^+e^- Higgs factory and 10 TeV pCM collider, Spec-S5, DUNE FD4, Mu2e-II, Advanced Muon Facility, and line intensity mapping (sections 3.1, 3.2, 4.2, 5.1, 5.2, and 6.3). **$8+9M/yr increase**

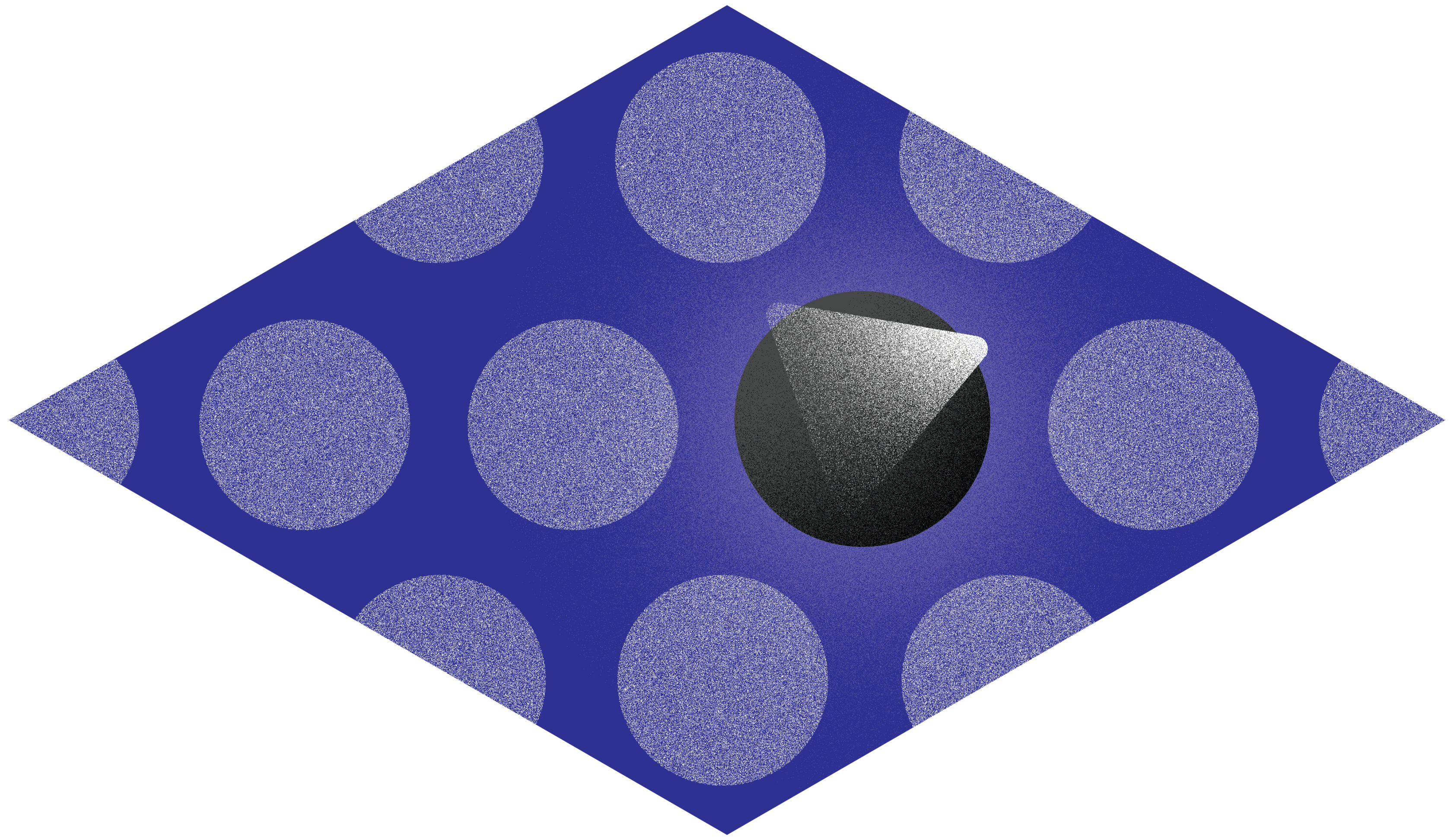
f. Support key **cyberinfrastructure** components such as shared software tools and a sustained R&D effort in computing, to fully exploit emerging technologies for projects. Prioritize **computing and novel data analysis techniques** for maximizing science across the entire field (section 6.7).

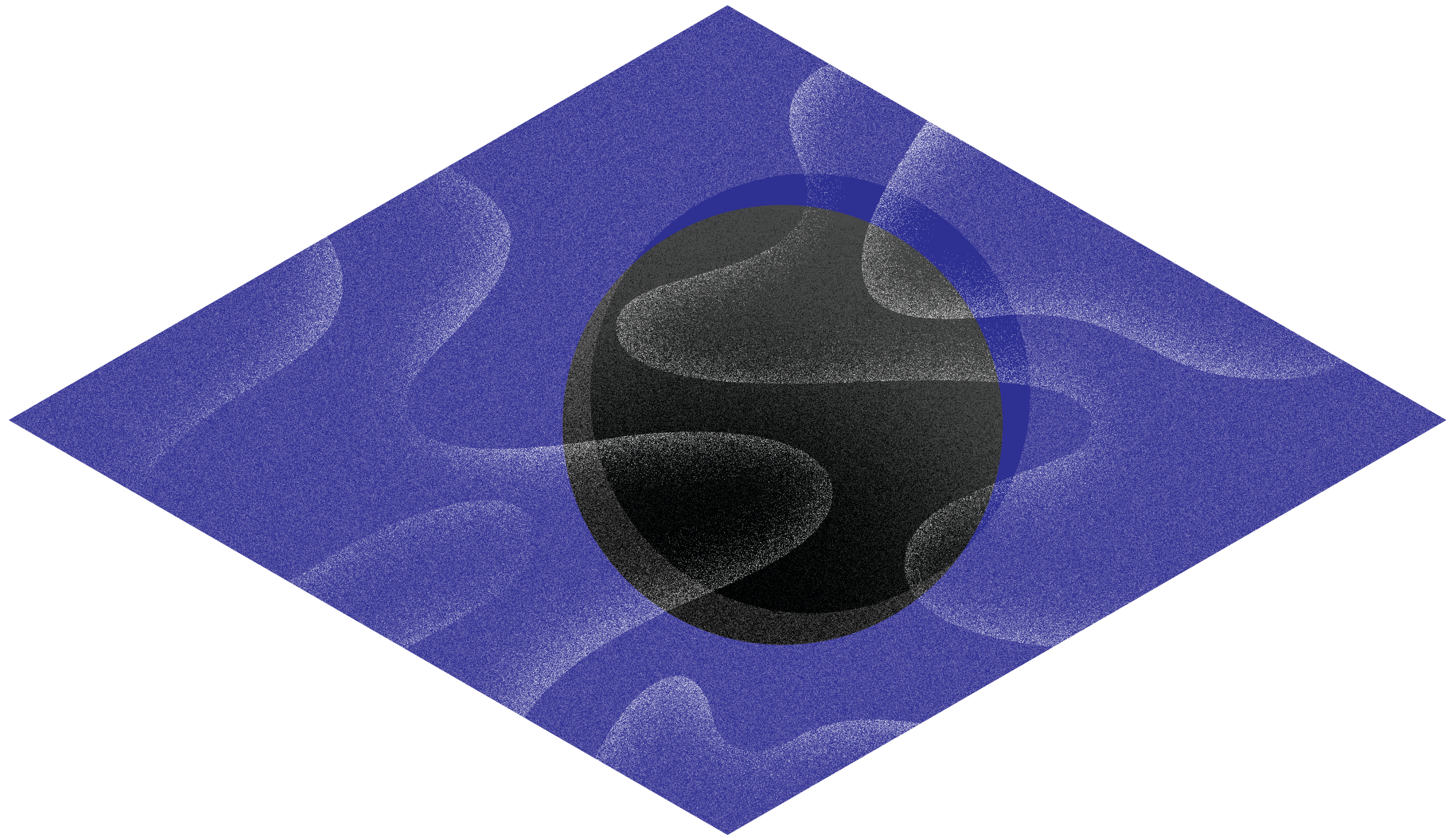
g. Develop plans for improving the **Fermilab accelerator complex** that are consistent with the long-term vision of this report, including neutrinos, flavor, and a 10 TeV pCM collider (section 6.6).

We recommend specific budget levels for enhanced support of these efforts and their justifications as **Area Recommendations** in section 6.

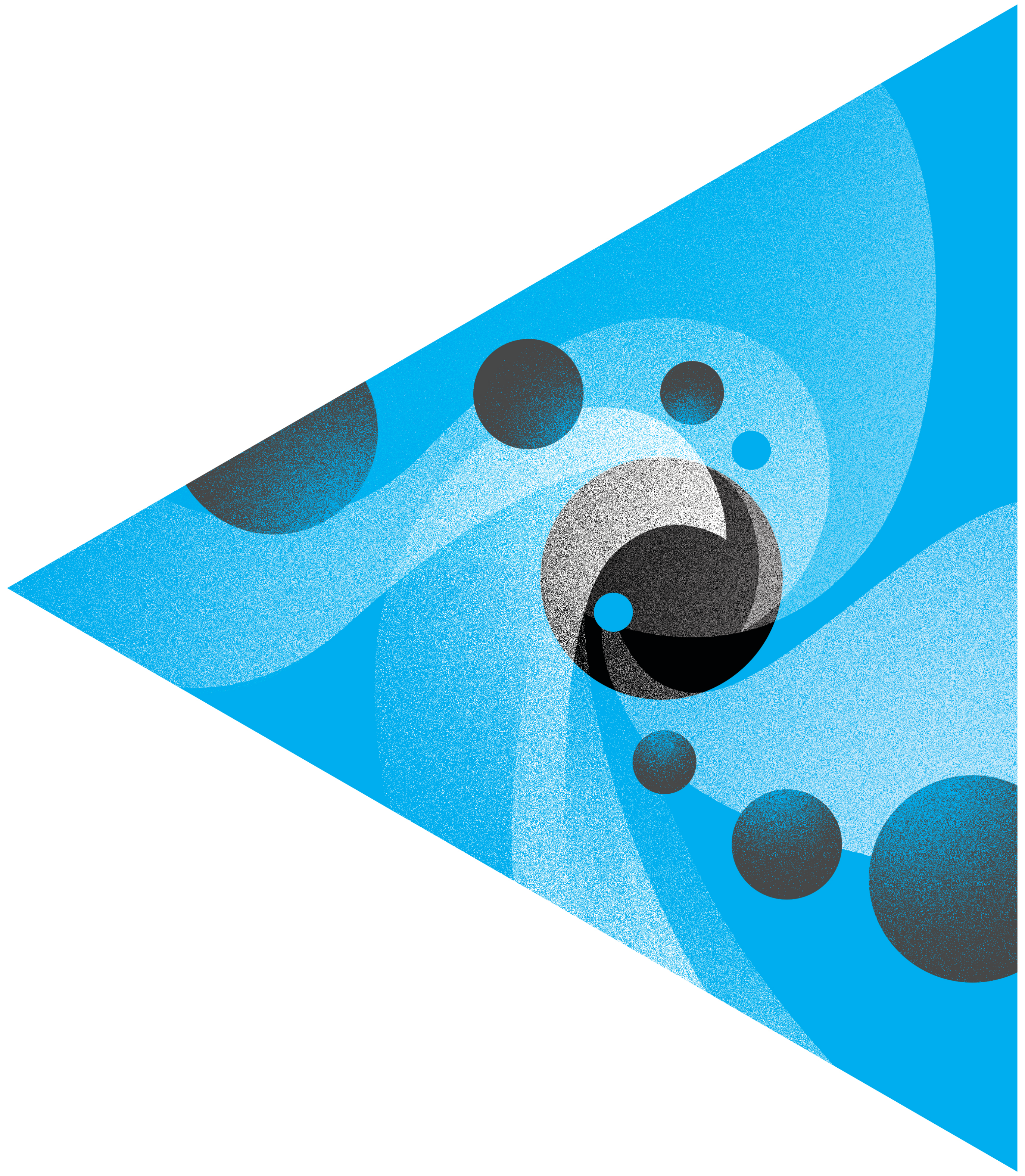
Exploring the Quantum Universe

New Particles, Quantum Imprints



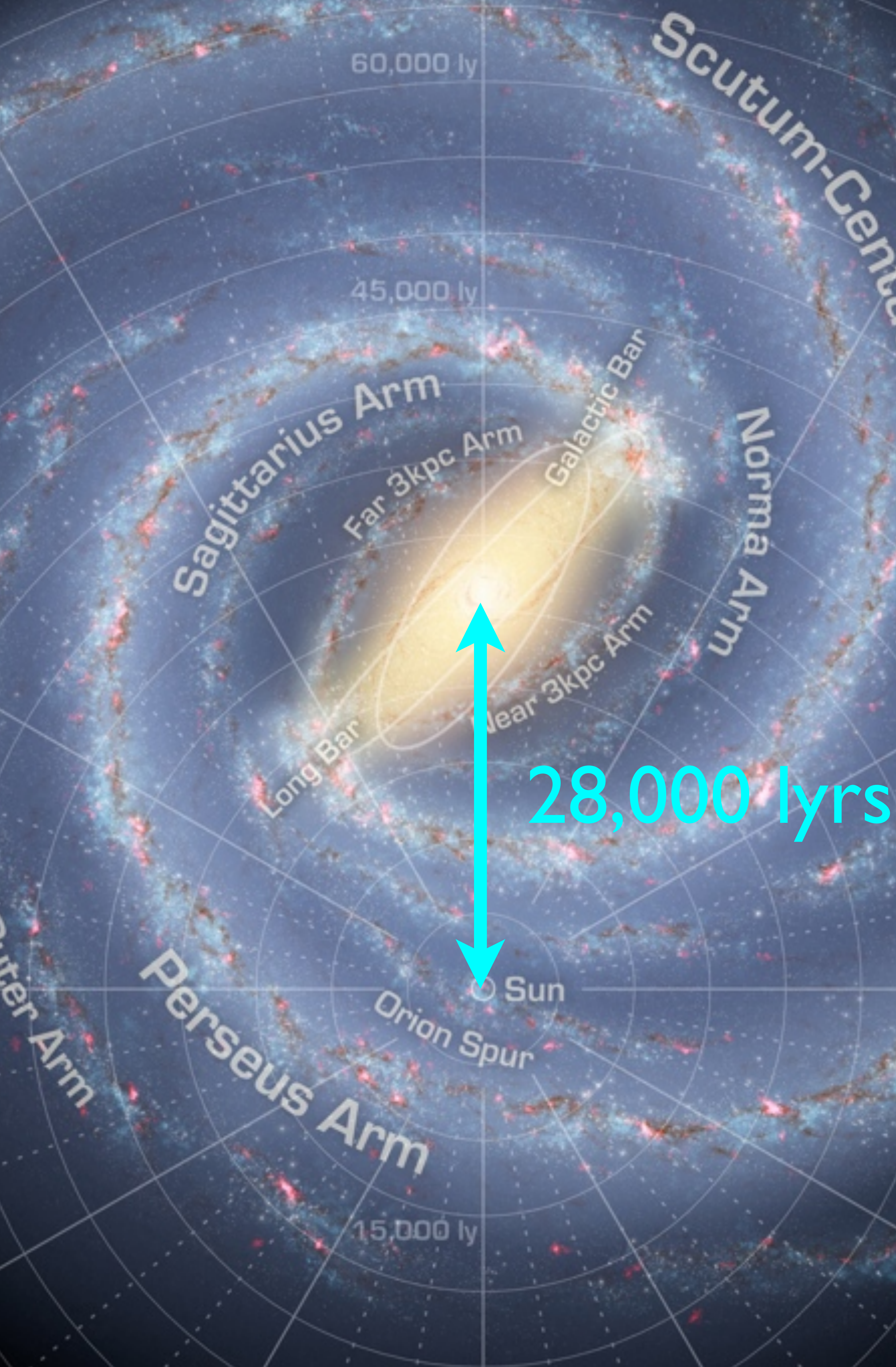


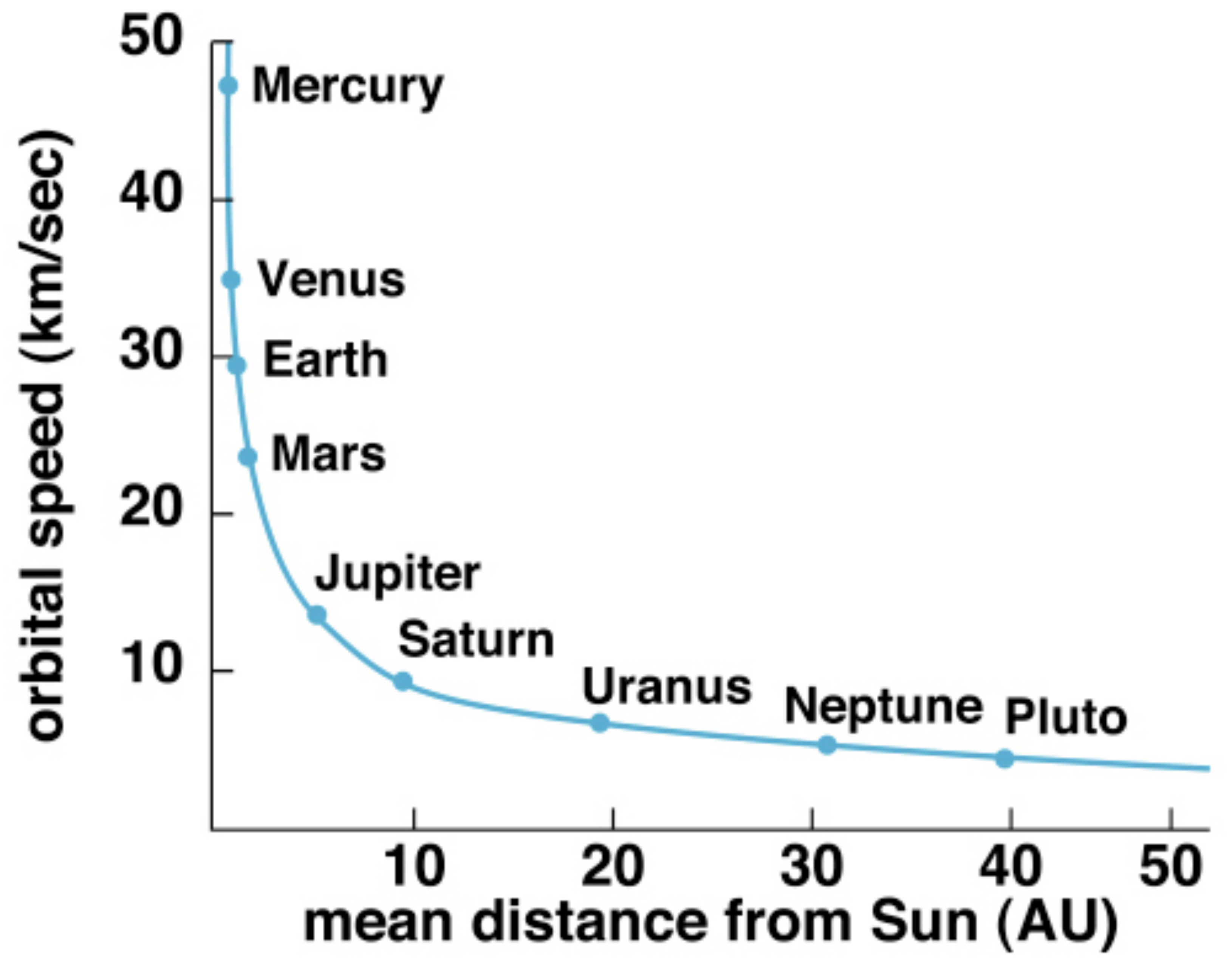
Dark Matter



a hundred billion stars

solar system revolves at 220 km/s
what is pulling us inside?





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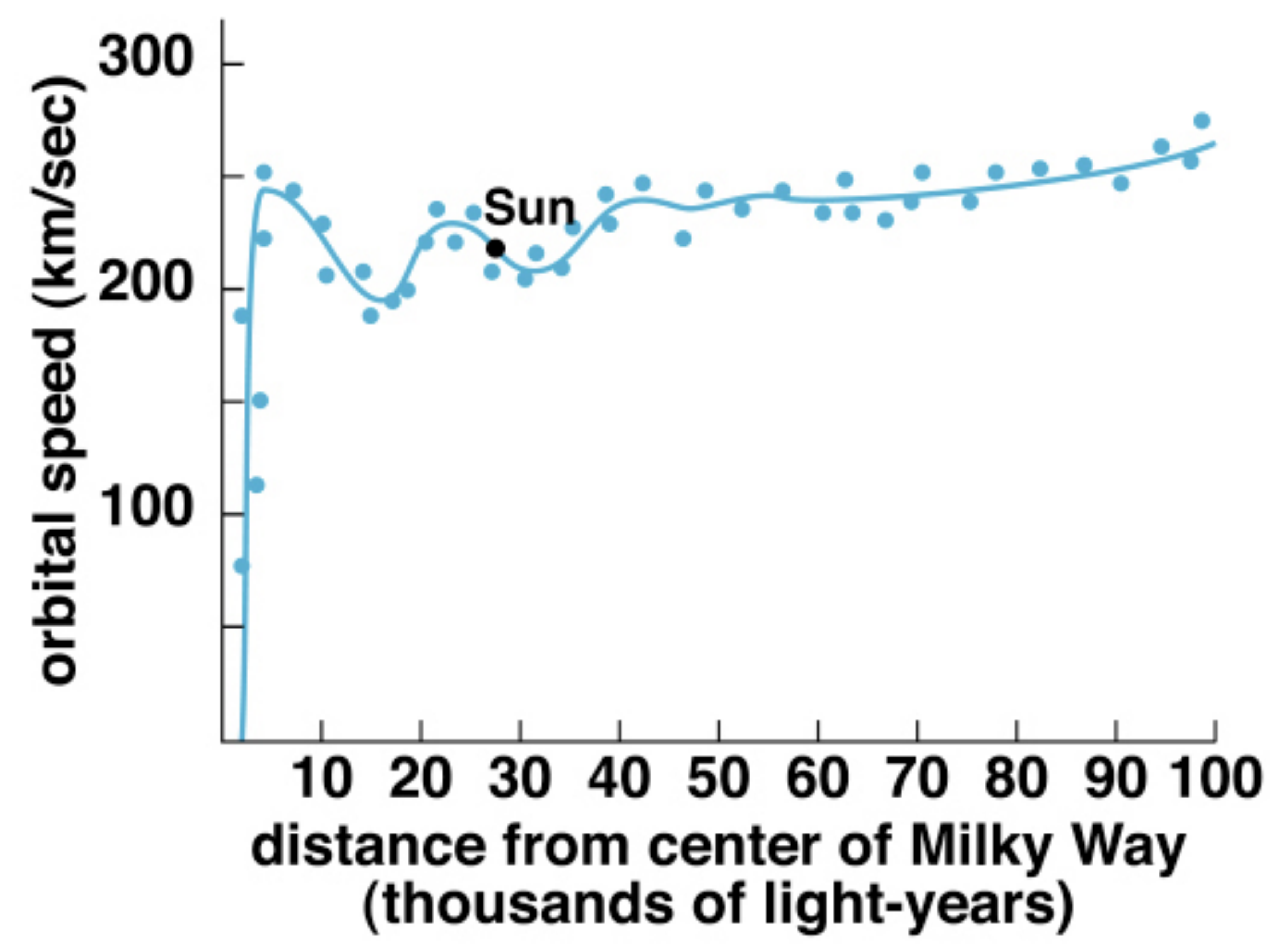
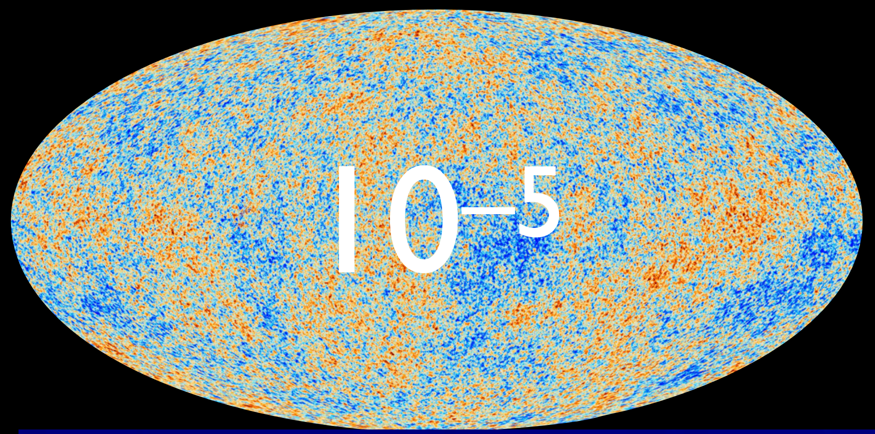


(c)

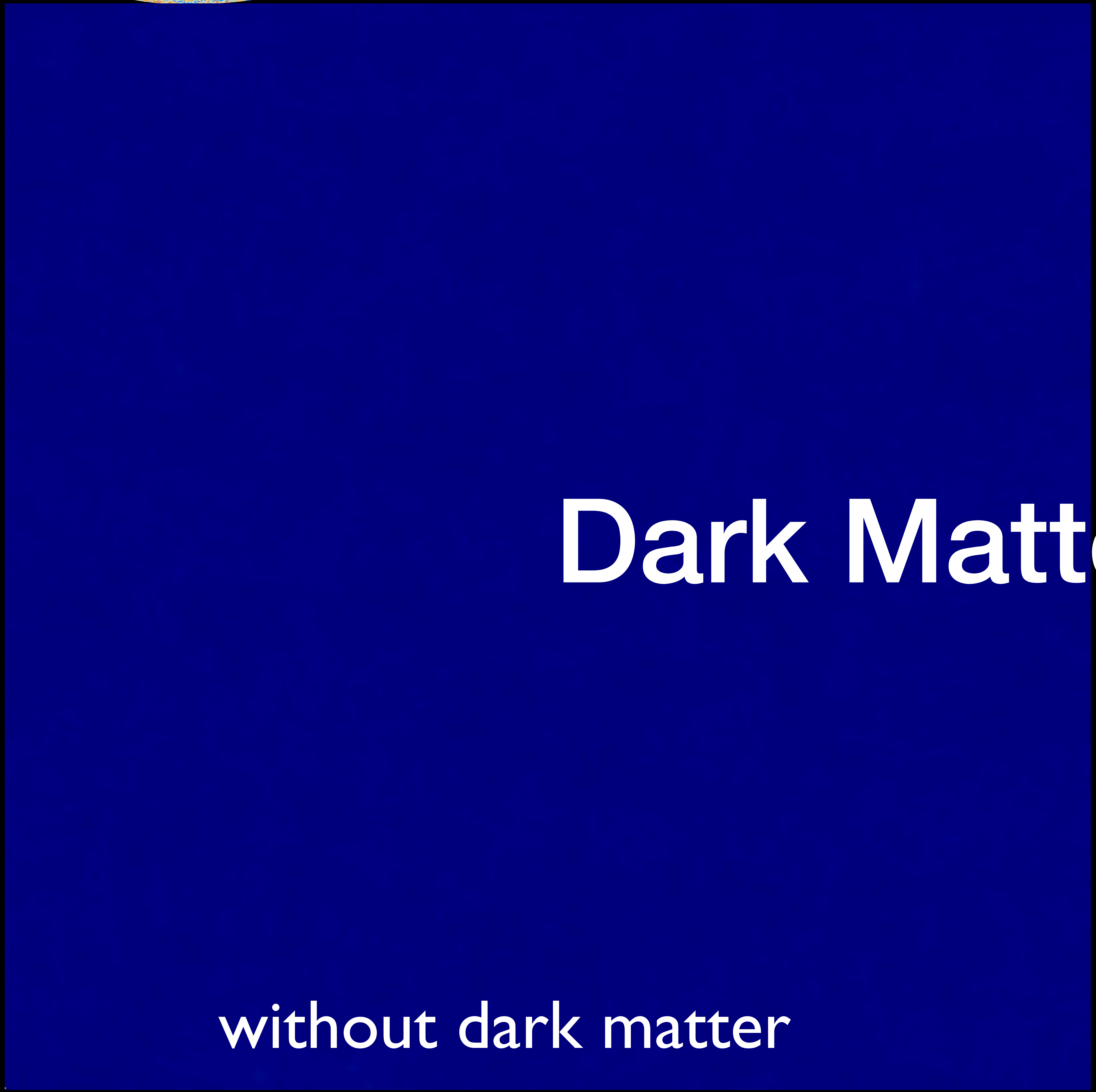
THE WHITE HOUSE
WASHINGTON
NASA
JAMES WEBB
SPACE TELESCOPE
nasa.gov


Credit: NASA
SMACS 0723
4.6Blyr

Credit: Naoki Yoshida



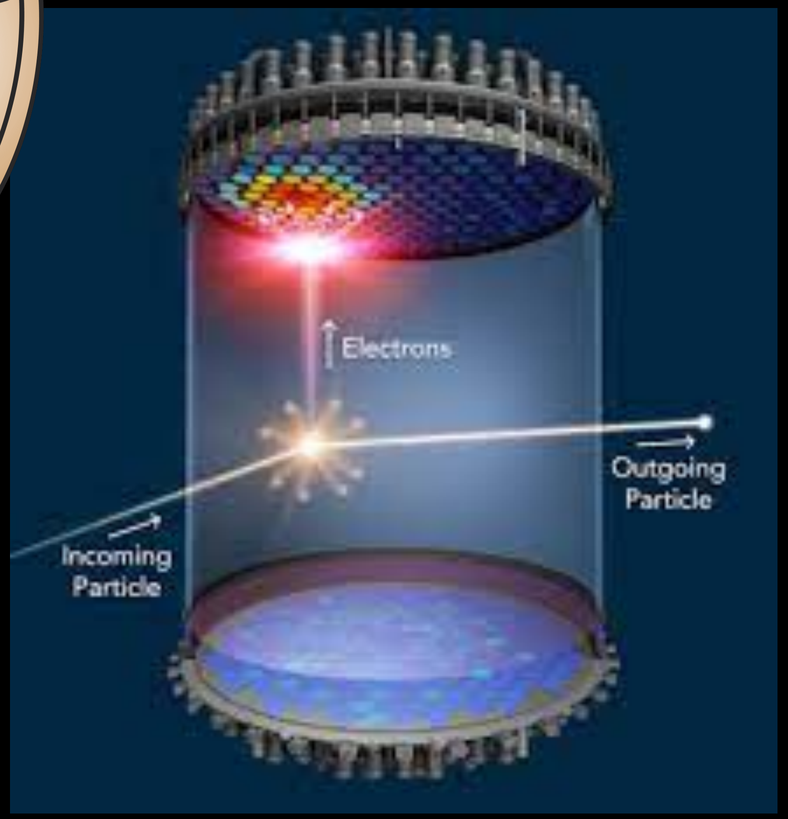
Dark Matter made us



Ongoing Projects

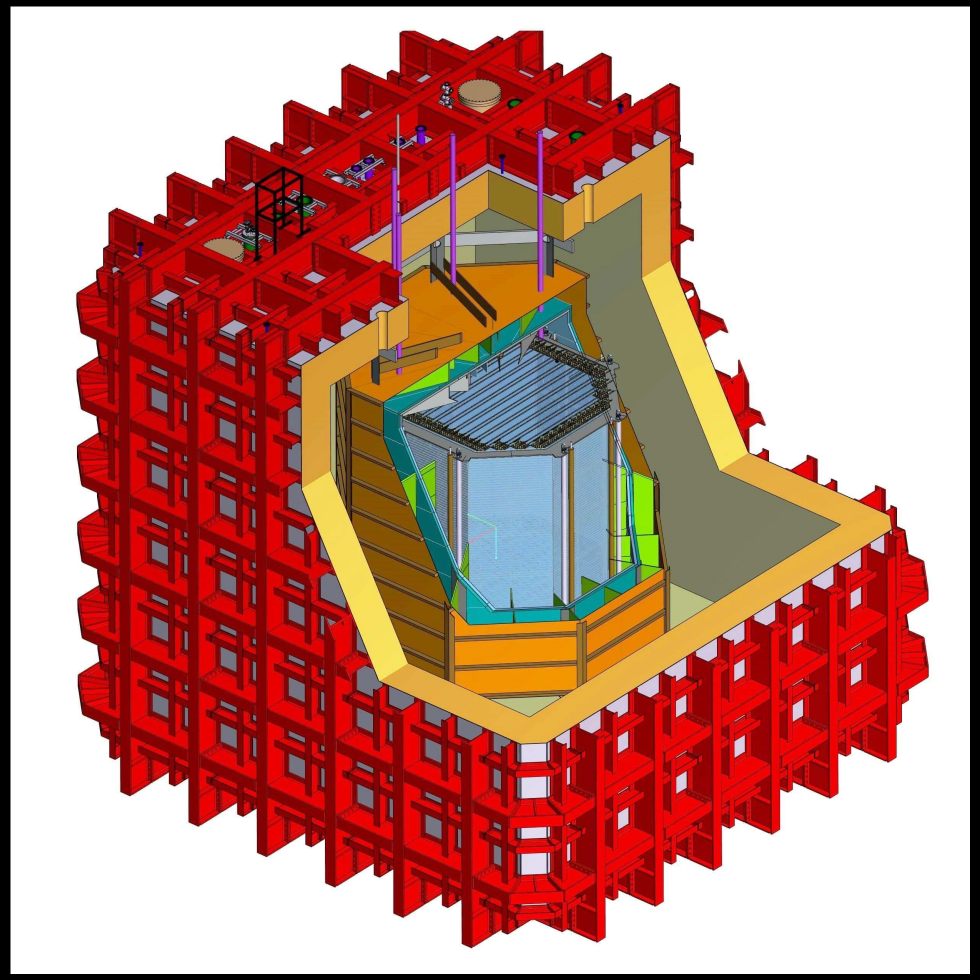
LHC: could produce EW-scale DM

LZ

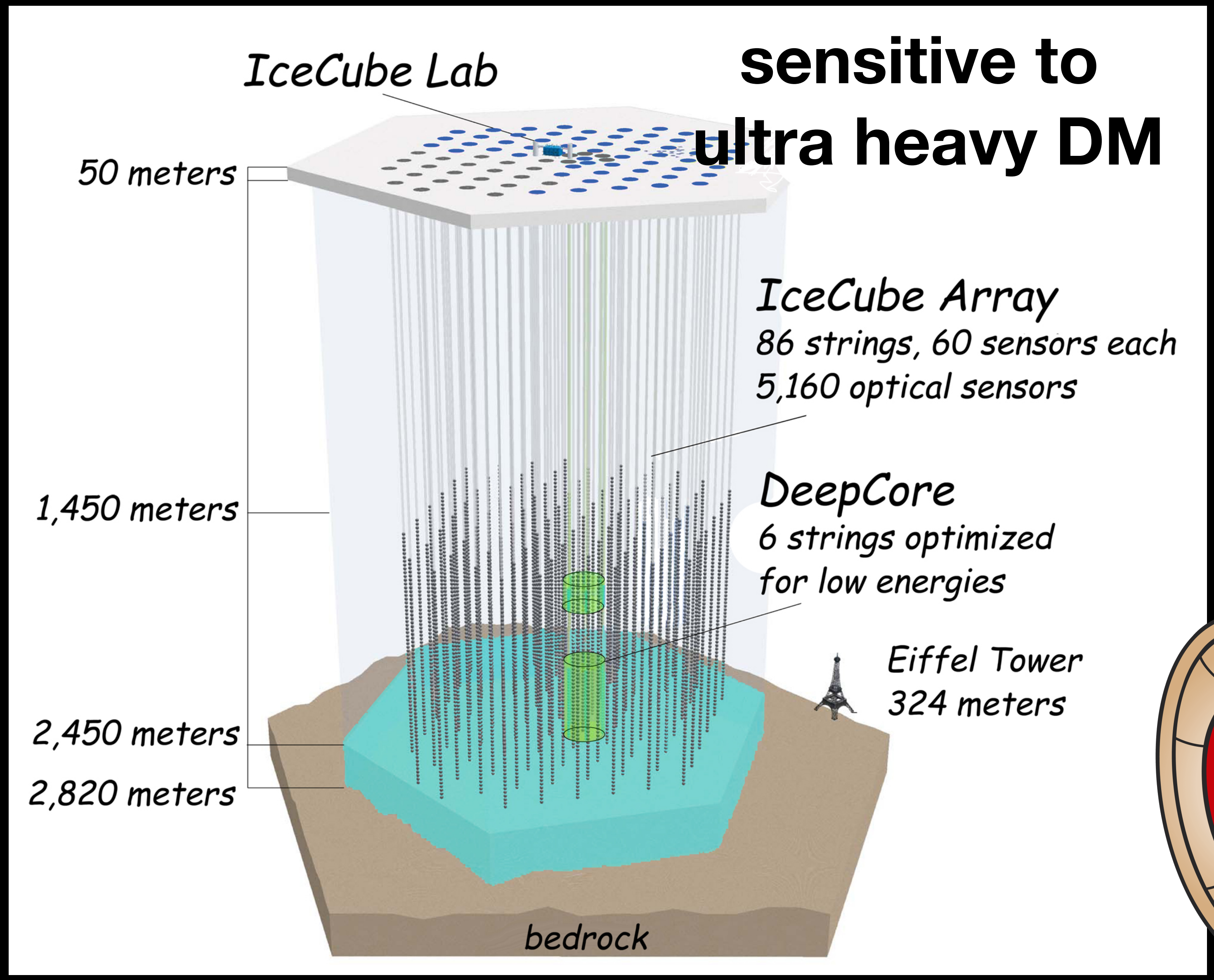


XENONnT

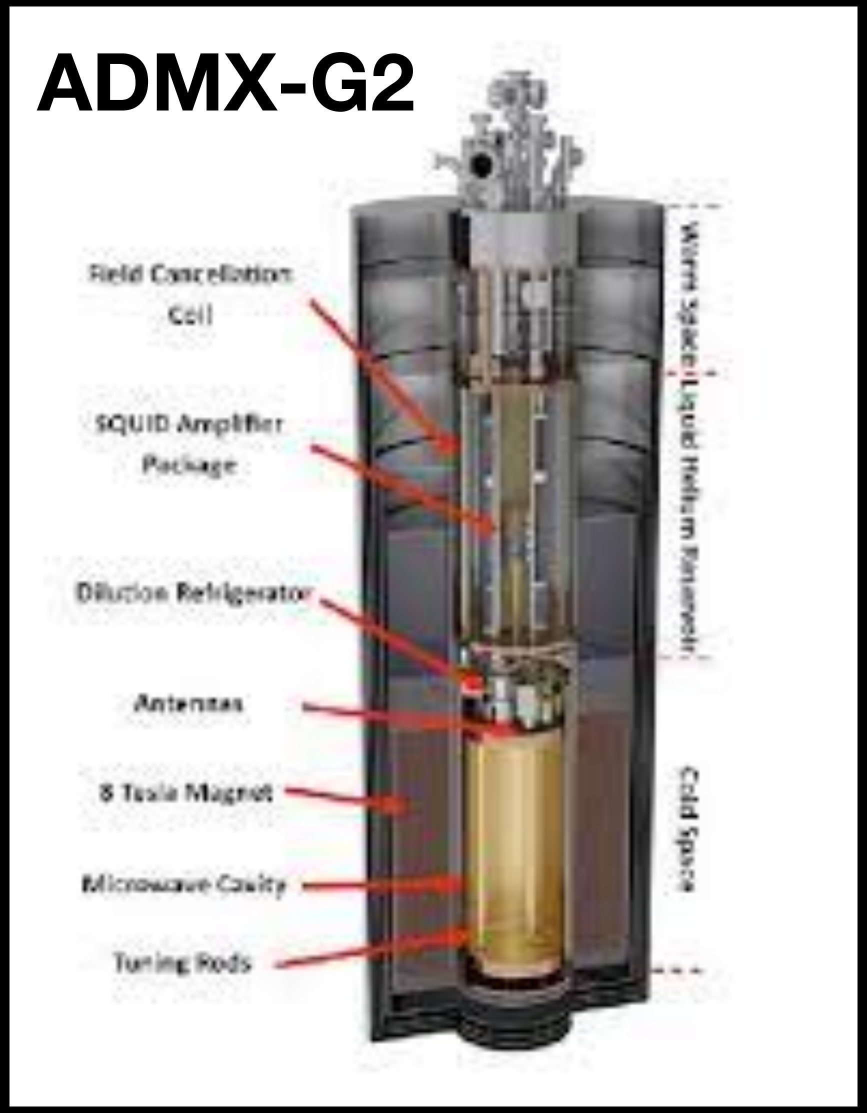
Darkside 20k

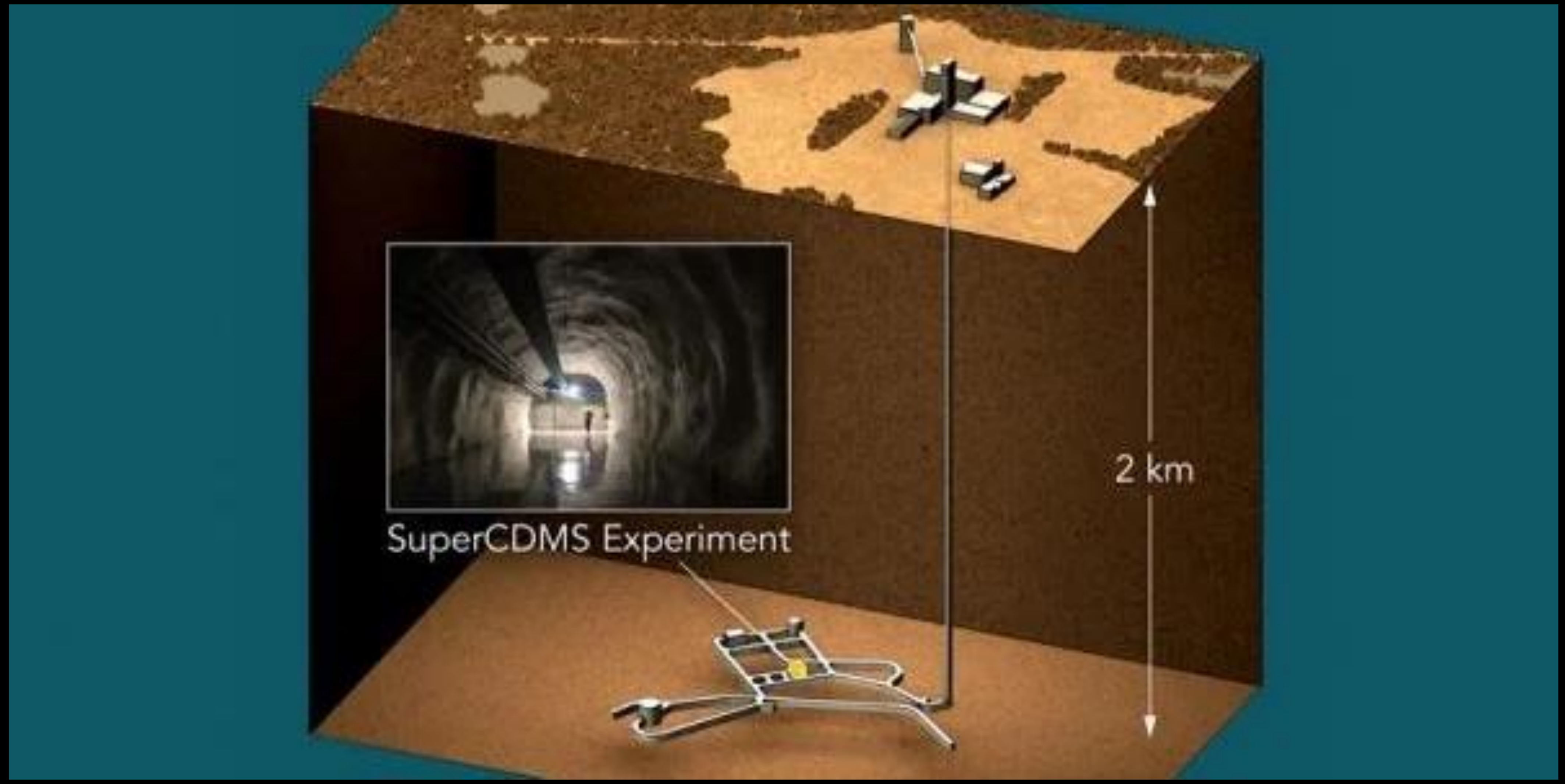


sensitive to ultra heavy DM



ADMX-G2





Dark Matter exists, but **unknown type of matter**

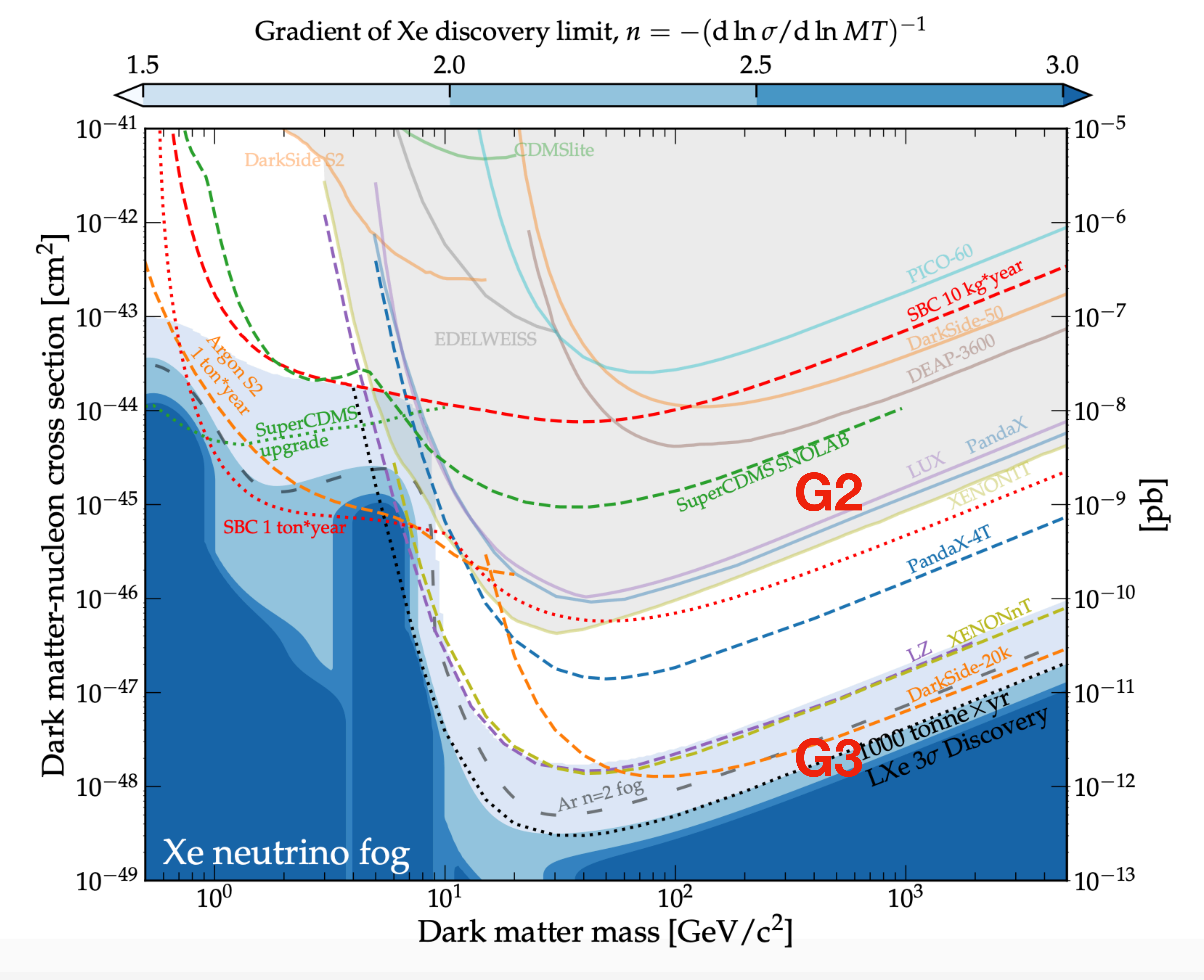
Search so far has been limited to **tiny range of masses**

From G2 → G3: Toward the ν fog

"Ultimate" experiment of its kind

Can be hosted in the cavern made available through the SURF expansion

Sanford Underground Research Facility
South Dakota Science and Technology Authority



Snowmass2021 Cosmic Frontier
Dark Matter Direct Detection to the Neutrino Fog

Exploring the Quantum Universe

Not Rank-Ordered

Recommendation 3

Balanced Portfolio from small to large

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.

In order to achieve this balance across all project sizes we recommend the following: **$35M/yr**

a. Implement a new small-project portfolio at DOE, **Advancing Science and Technology through Agile Experiments (ASTAE)**, across science themes in particle physics with a competitive program and recurring funding opportunity announcements. This program should start with the construction of experiments from the Dark Matter New Initiatives (DMNI) by DOE-HEP (section 6.2).

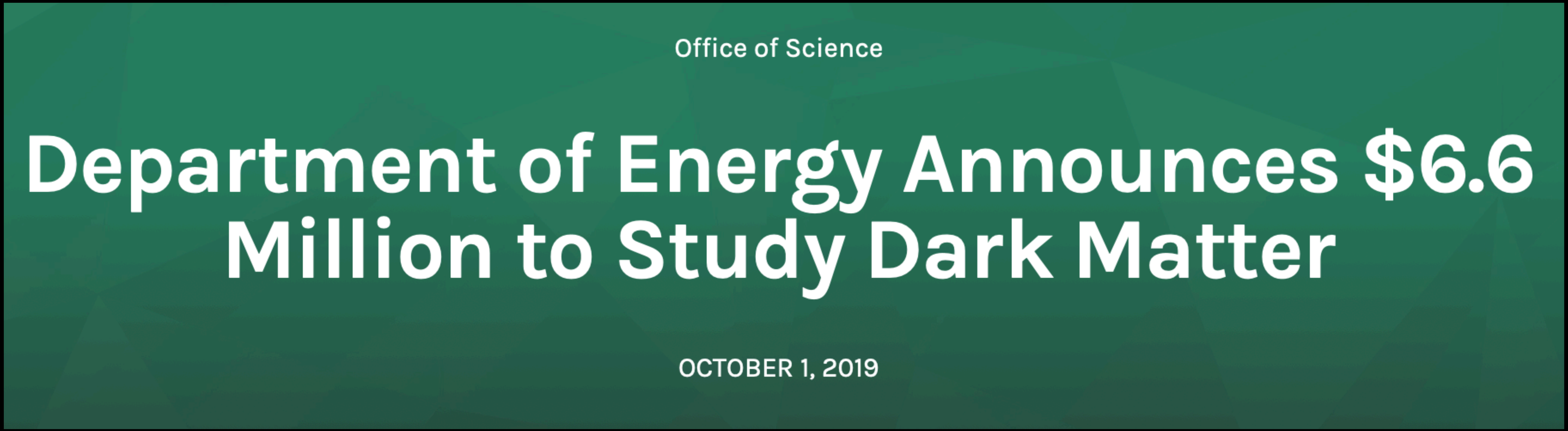
b. Continue Mid-Scale Research Infrastructure (**MSRI**) and Major Research Instrumentation (**MRI**) programs as a critical component of the NSF research and project portfolio.

c. Support **DESI-II** for cosmic evolution, **LHCb upgrade II** and **Belle II upgrade** for quantum imprints, and **US contributions to the global CTA Observatory** for dark matter (sections 4.2, 5.2, and 4.1).

The Belle II recommendation includes contributions towards the SuperKEKB accelerator.

Opportunities this Decade: ASTAE

Advancing Science and Technology through Agile Experiments


Office of Science

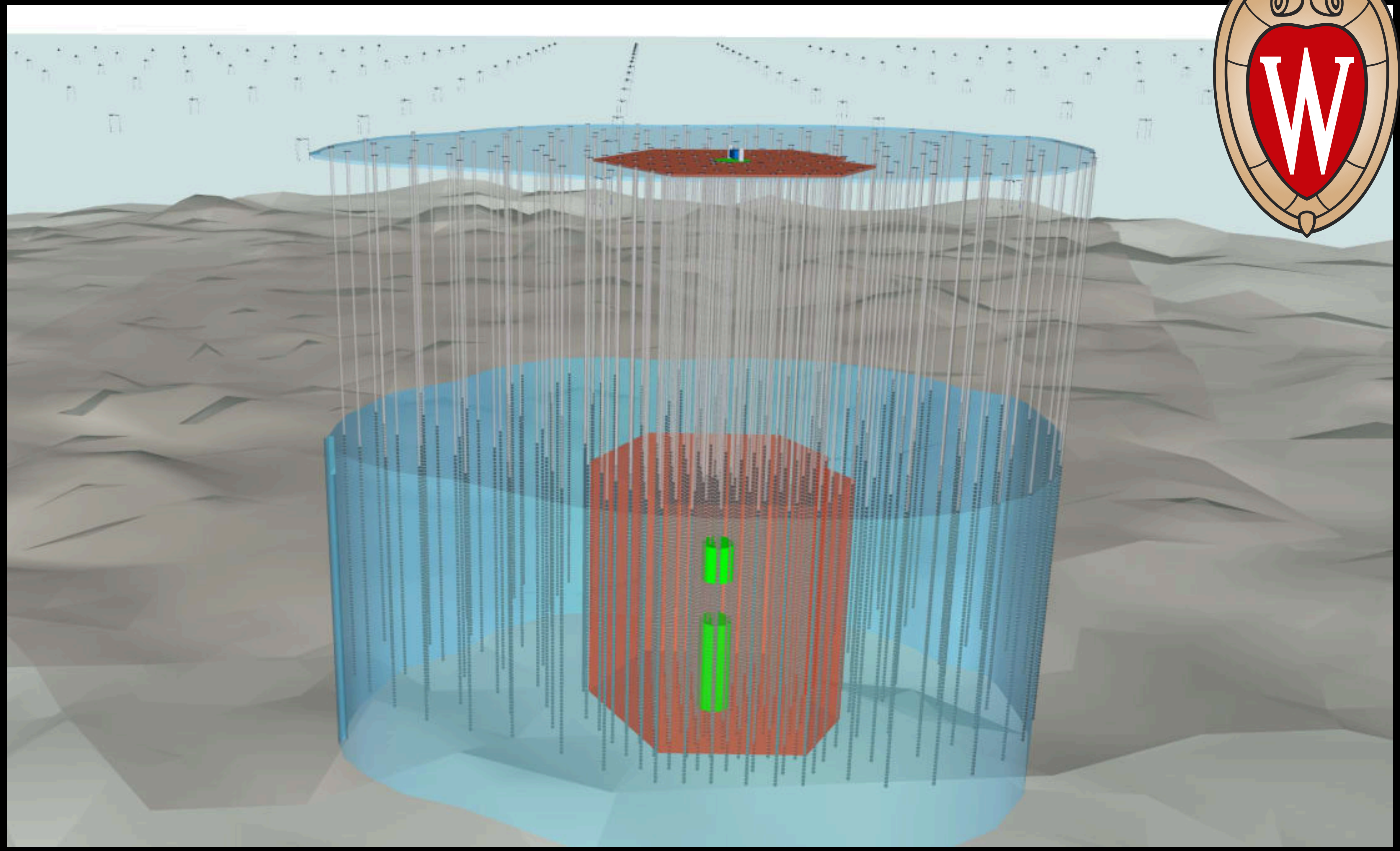
Department of Energy Announces $6.6 Million to Study Dark Matter

OCTOBER 1, 2019

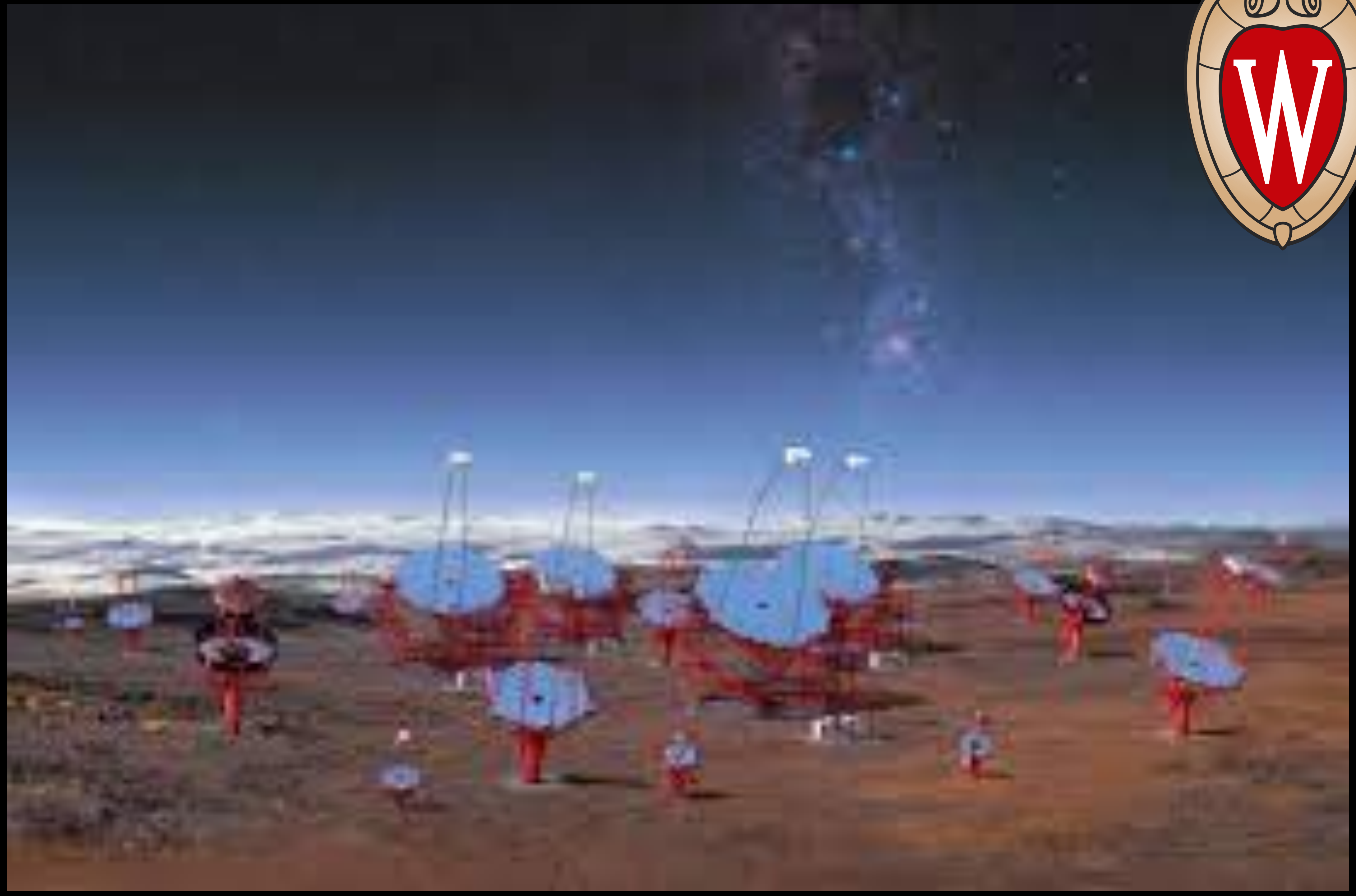
The Dark Matter New Initiatives (DMNI) Program was a huge success. The successful projects now need construction funding!

NSF New Initiatives: IceCube-Gen2 & CTA

IceCube-Gen2: ten-fold improvement in sensitivity to astrophysical neutrinos over IceCube, most sensitive probe of heavy decaying dark matter.

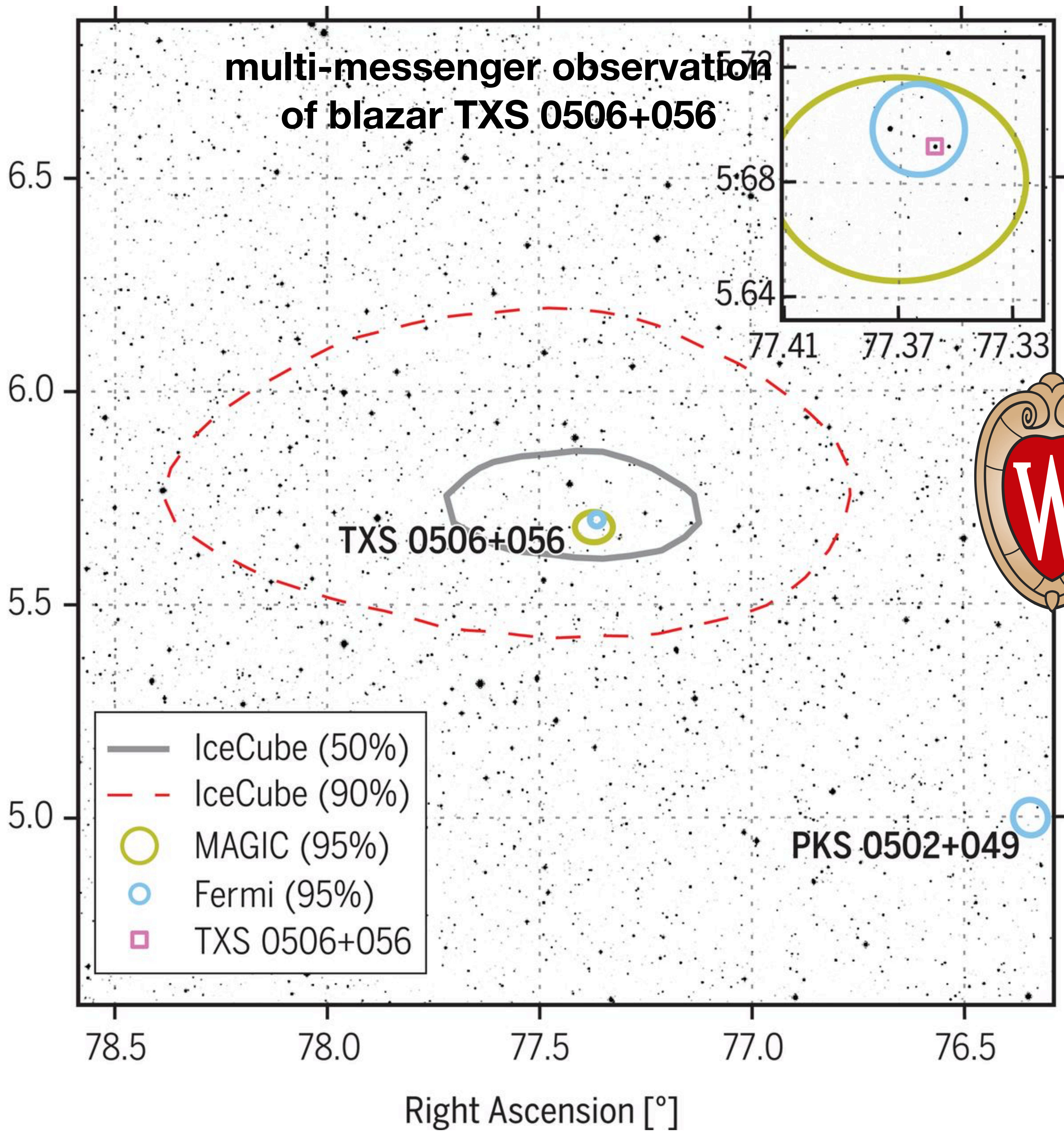


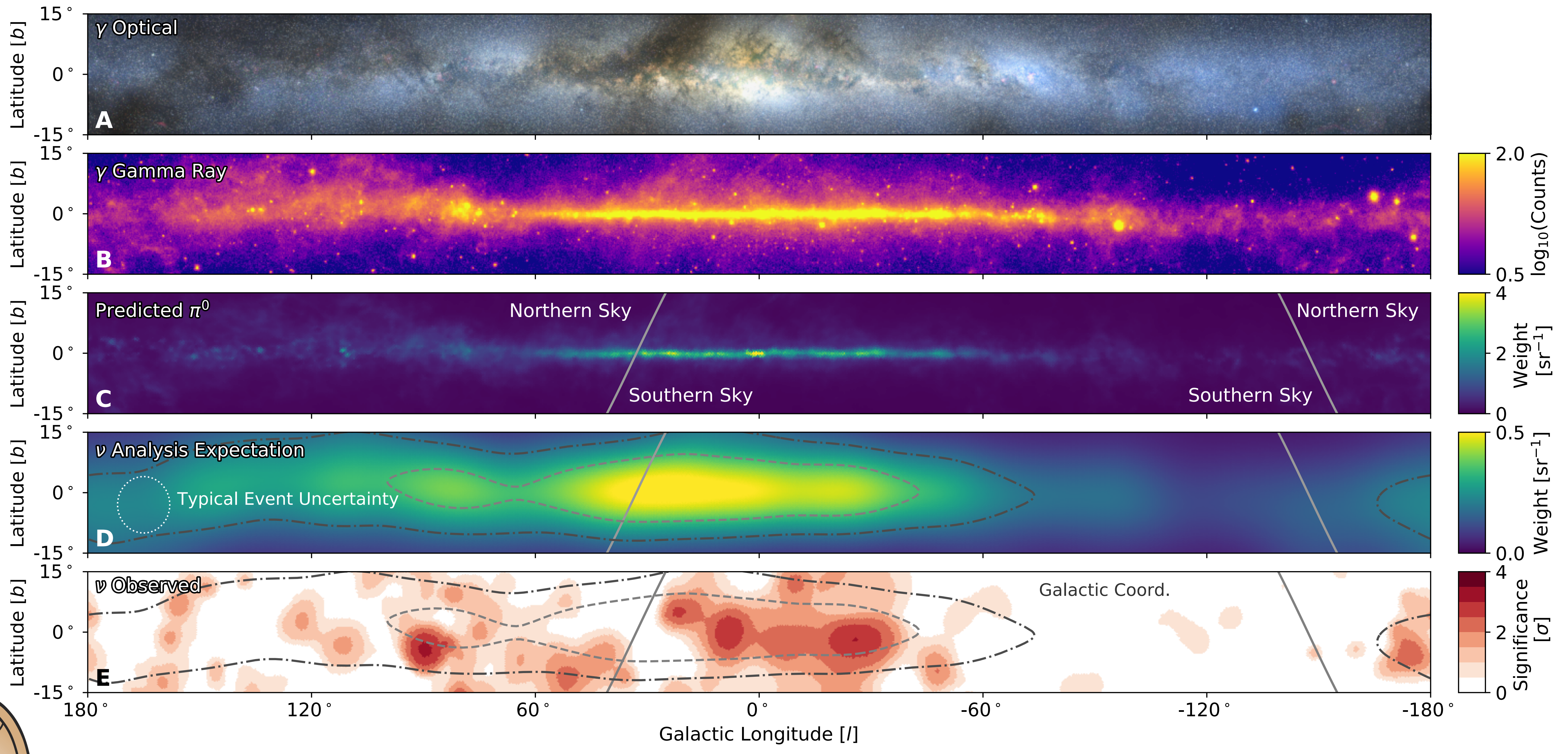
Cherenkov Telescope Array (CTA) provides sensitivity to WIMP thermal targets beyond the reach of G3.



Never has it "taken a village" more than in dark matter… CMB-S4, LSST, DESI-II, and eventually Spec-S5 all play a role

IceCube

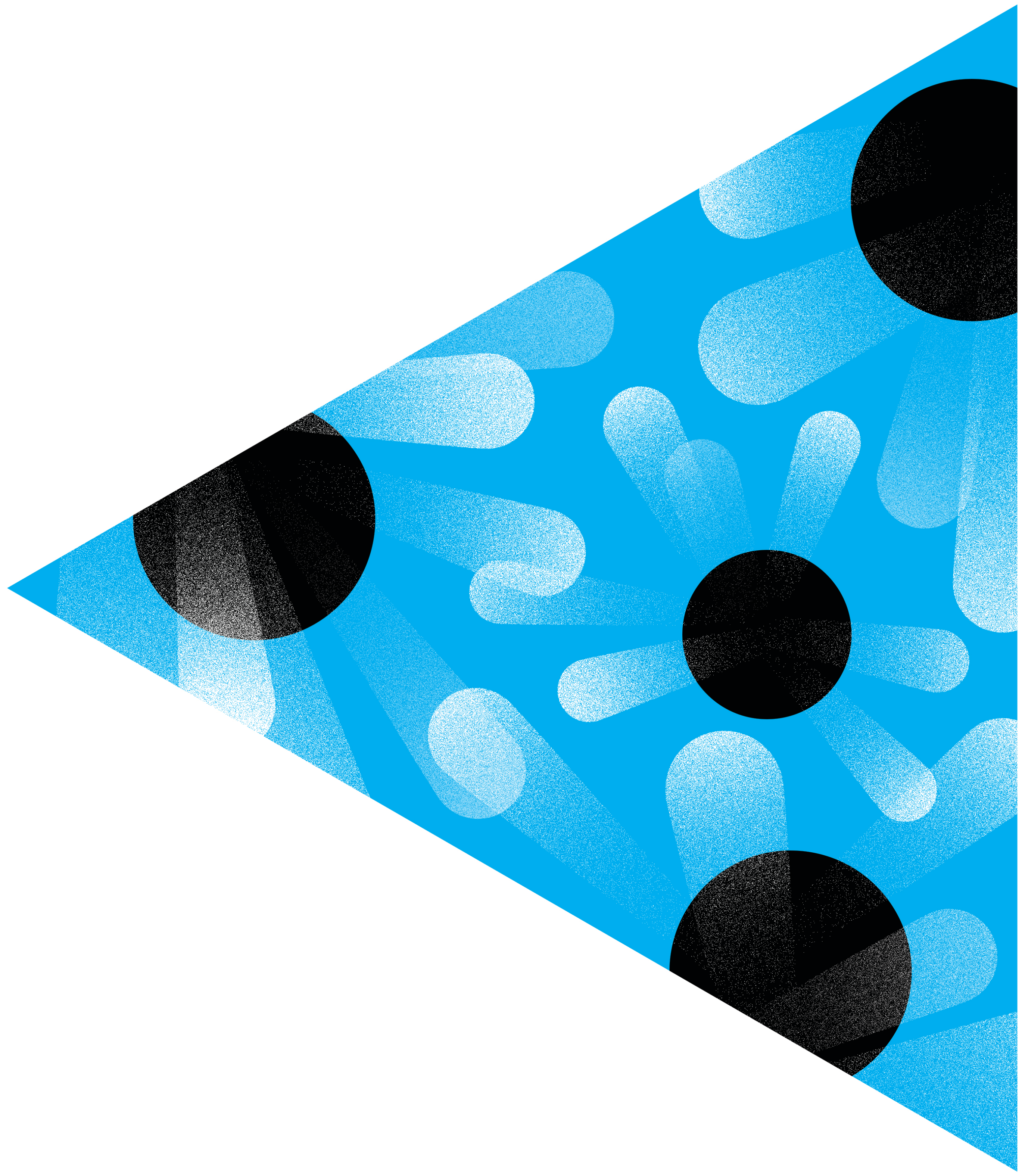




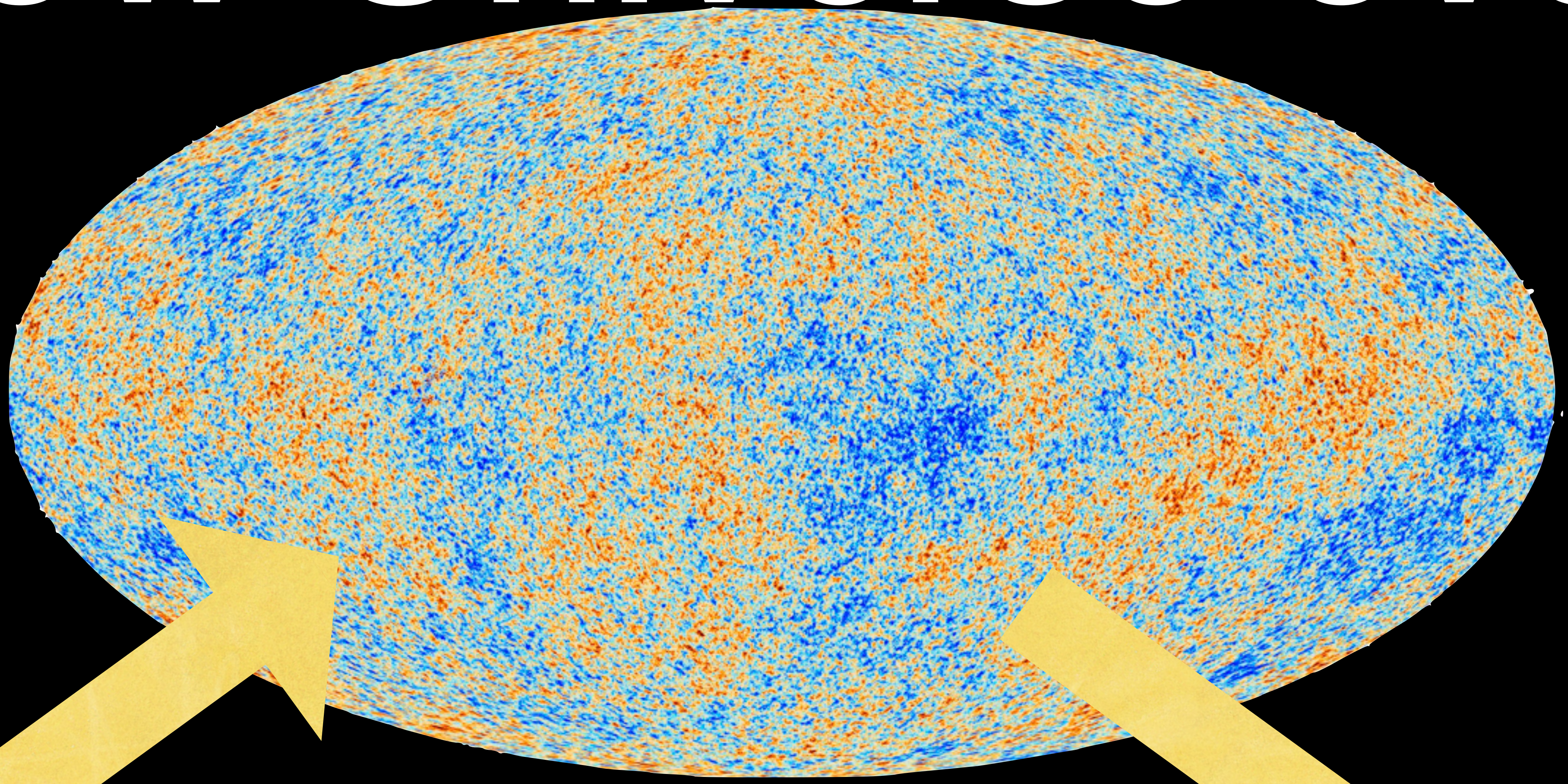
igure 1: **The plane of the Milky Way galaxy in photons and neutrinos.** Each panel is in Galactic coordinates, with the origin being at the Galactic Center, extending $\pm 15°$ in latitude and $\pm 180°$ in longitude. (A) Optical color image (*39*), which is partly obscured by clouds of gas and dust that absorb optical photons. Credit A. Mellinger, used with permission. (B) The integrated flux in gamma rays from the *Fermi* Large Area Telescope (*Fermi*-LAT) 12 year survey (*40*) at energies greater than 1 GeV, obtained from the *Fermi* Science Support Center and processed with the *Fermi*-LAT ScienceTools. (C) The emission template calculated for the expected neutrino flux, derived from the π^0 template that matches the *Fermi*-LAT observations of the diffuse gamma-ray emission (*1*). (D) The emission template from panel (C) including the detector sensitivity to cascade-like neutrino events and the angular uncertainty of a typical signal event (7°, indicated by the dotted white circle). Contours indicate the central regions that contain 20% and 50% of the predicted diffuse neutrino emission signal. (E) The pre-trial significance of the IceCube neutrino observations, calculated from all-sky scan for point-like sources using the cascade neutrino event sample. Contours are the same as panel (D). Grey lines in (C) - (E) indicate the Northern-Southern sky horizon line at the IceCube detector.

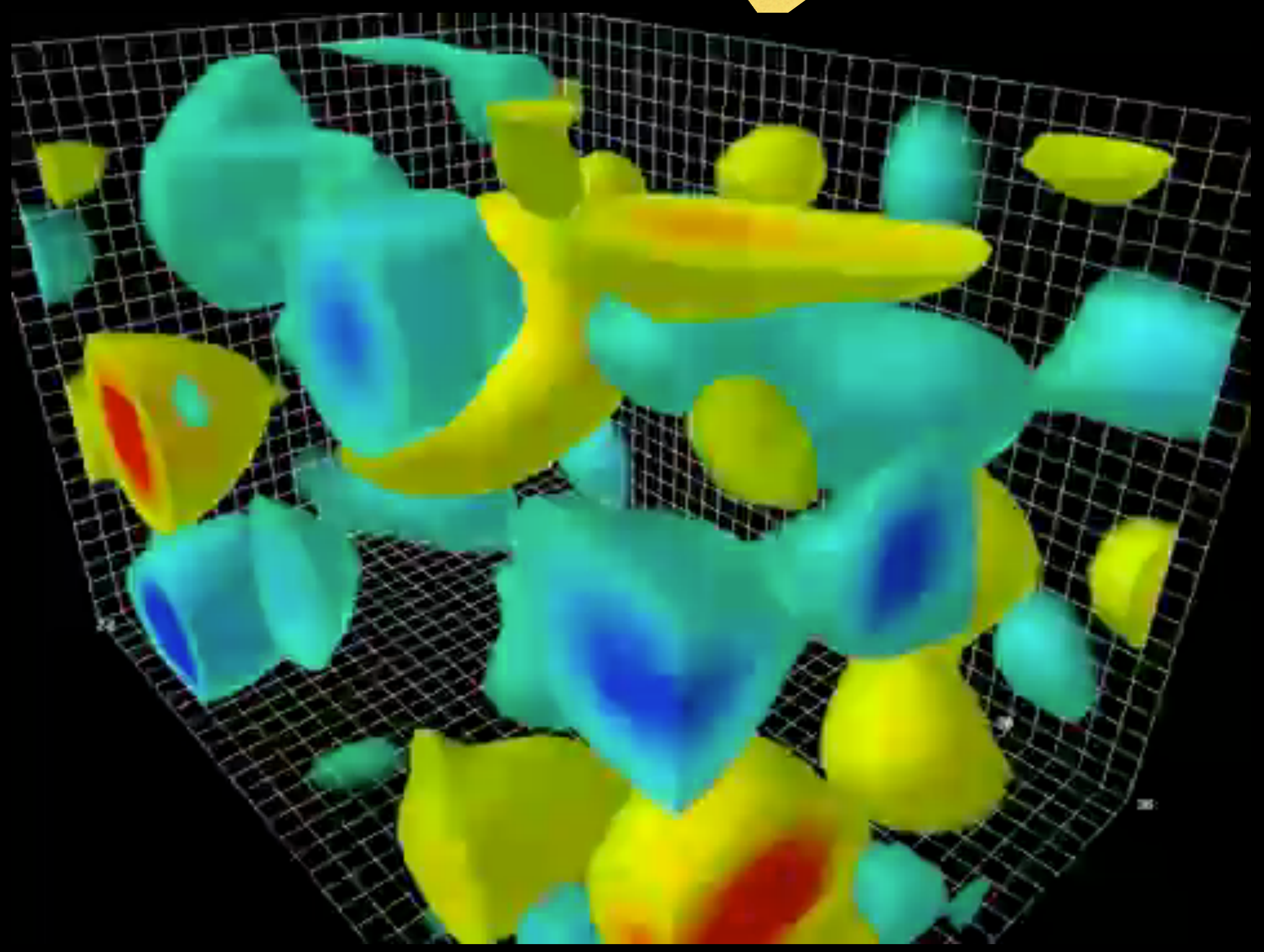
Exploring the Quantum Universe

Cosmic Evolution

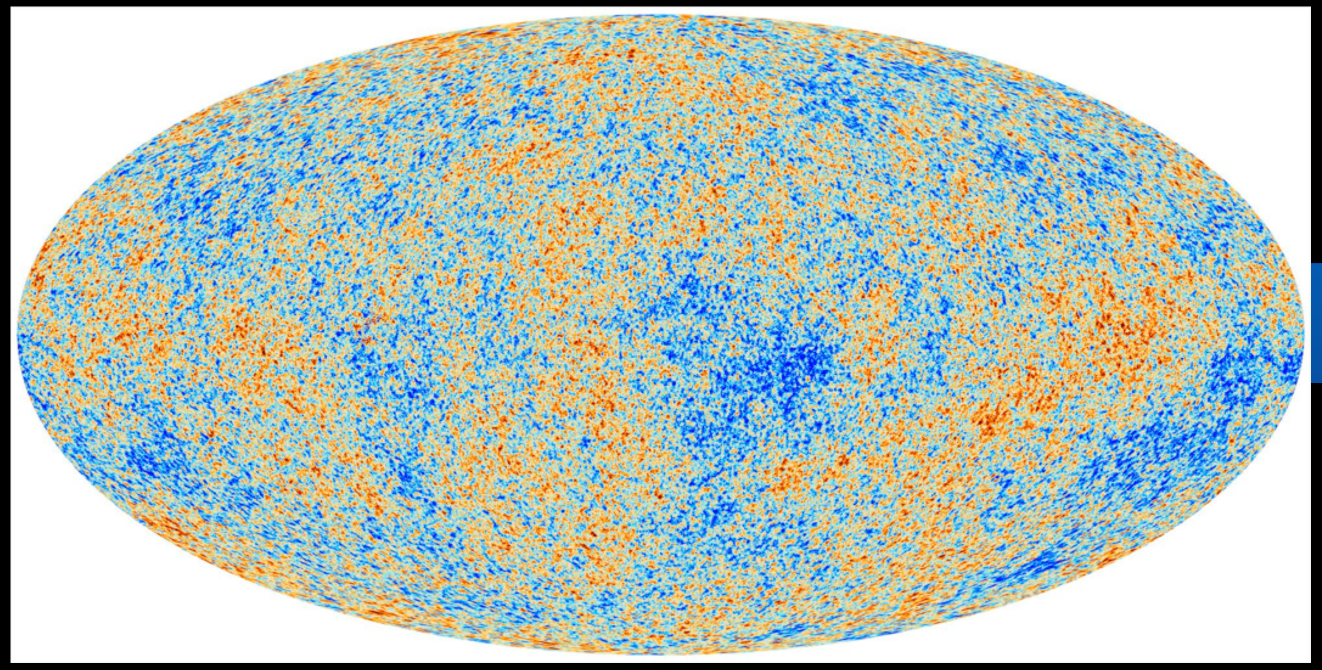


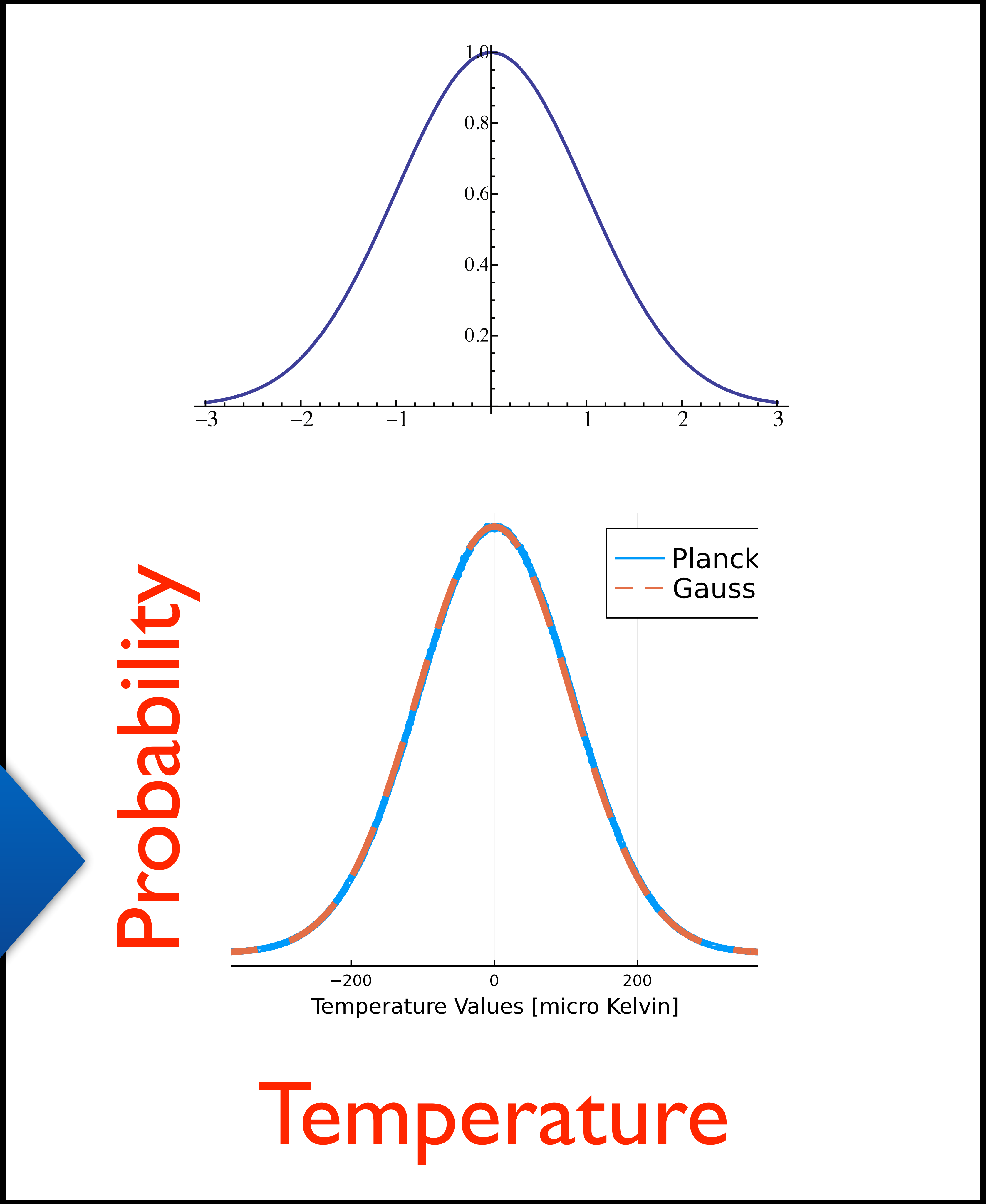
How Universe evolved

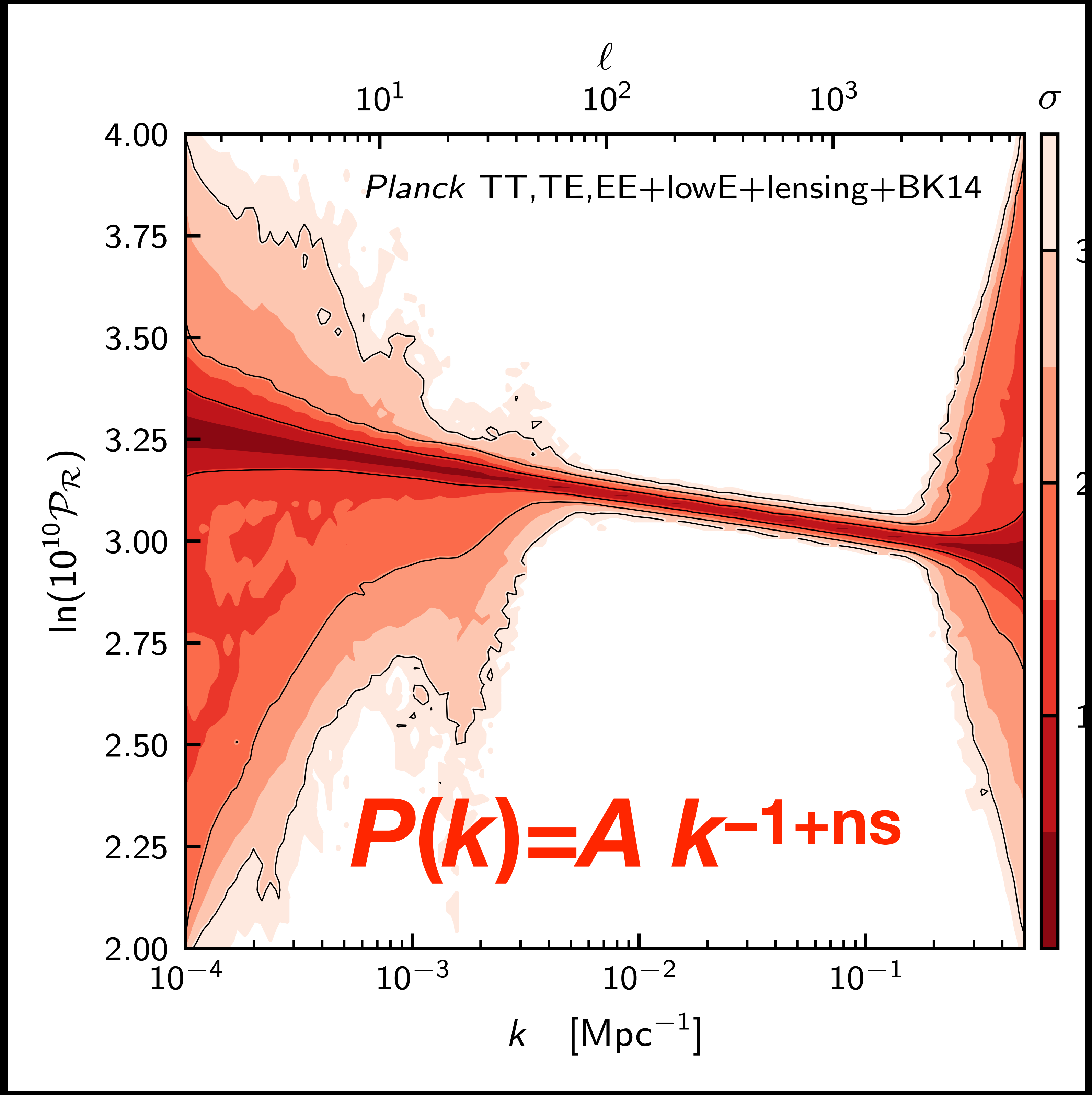




Circumstantial Evidence







Reenacting the Big Bang with Cal Marching Band

Credit:
UC Berkeley

Accelerators
LHC heavy ions
LHC protons
High-energy cosmic rays
Inflation
Big Bang
Size
sible universe
3min
is visible
380k yrs
TODAY
Dark Energy
Rubin, DESI
CMB-S4
Next Generation CMB Experiment
POSSIBLE
TER RELICS
NUCLEI FORM
t = 10^-36 s
E = 10^16 GeV
t = 10^-10 s
E = 10^2 GeV
t = 10^-4 s
E = 10^-1 GeV
t = 10^2 s
E = 10^-4 GeV
t = 3x10^5 y
H:He ~ 3:1 from Big Bang
agrees with observation!
Credit: Particle Data Group

Major initiative: CMB-S4

Constrain the energy scale of inflation, determine the abundance of light relic particles in the early universe, measure the sum of neutrino masses, and probe the physics of dark matter and dark energy…

Site in Chile

Site at the South Pole

Exploring the Quantum Universe

Not Rank-Ordered

Recommendation 5

Diversity, Inclusion, Equity, Relevance to society

The following workforce initiatives are detailed in section 7:

a. All projects, workshops, conferences, and collaborations must incorporate ethics agreements that detail

The inherent curiosity driving our exploration of the natural world is a universal aspect of human nature. This shared curiosity serves as the driving force behind our commitment to strengthening and expanding this workforce, prompting us to actively seek talent from all corners of society, regions of the country, and on a global scale.

c. Comprehensive **work-climate studies** should be conducted with the support of funding agencies. Large collaborations and national laboratories should consistently undertake such studies so that issues can

Treating others with respect requires maintaining a professional work environment, free from harassment and abuse. Discrimination, harassment, or bullying within a scientific collaboration harms individuals, disrupts scientific progress, and is therefore scientific misconduct.

operations and research budgets of experiments. The funding agencies should include funding for the dissemination of results to the public in operation and research budgets.

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.

Share full article 96

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

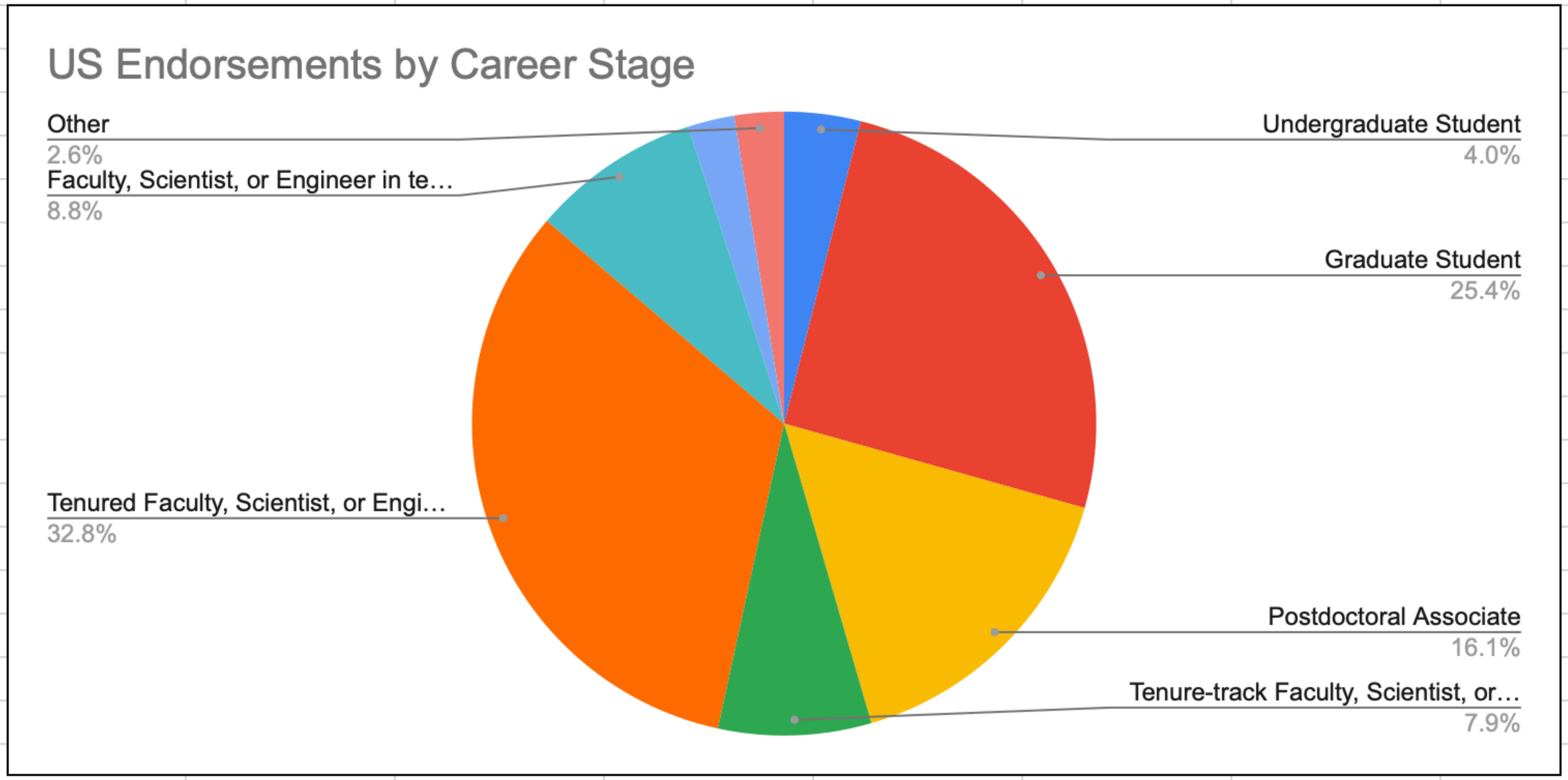
BY DANIEL GARISTO

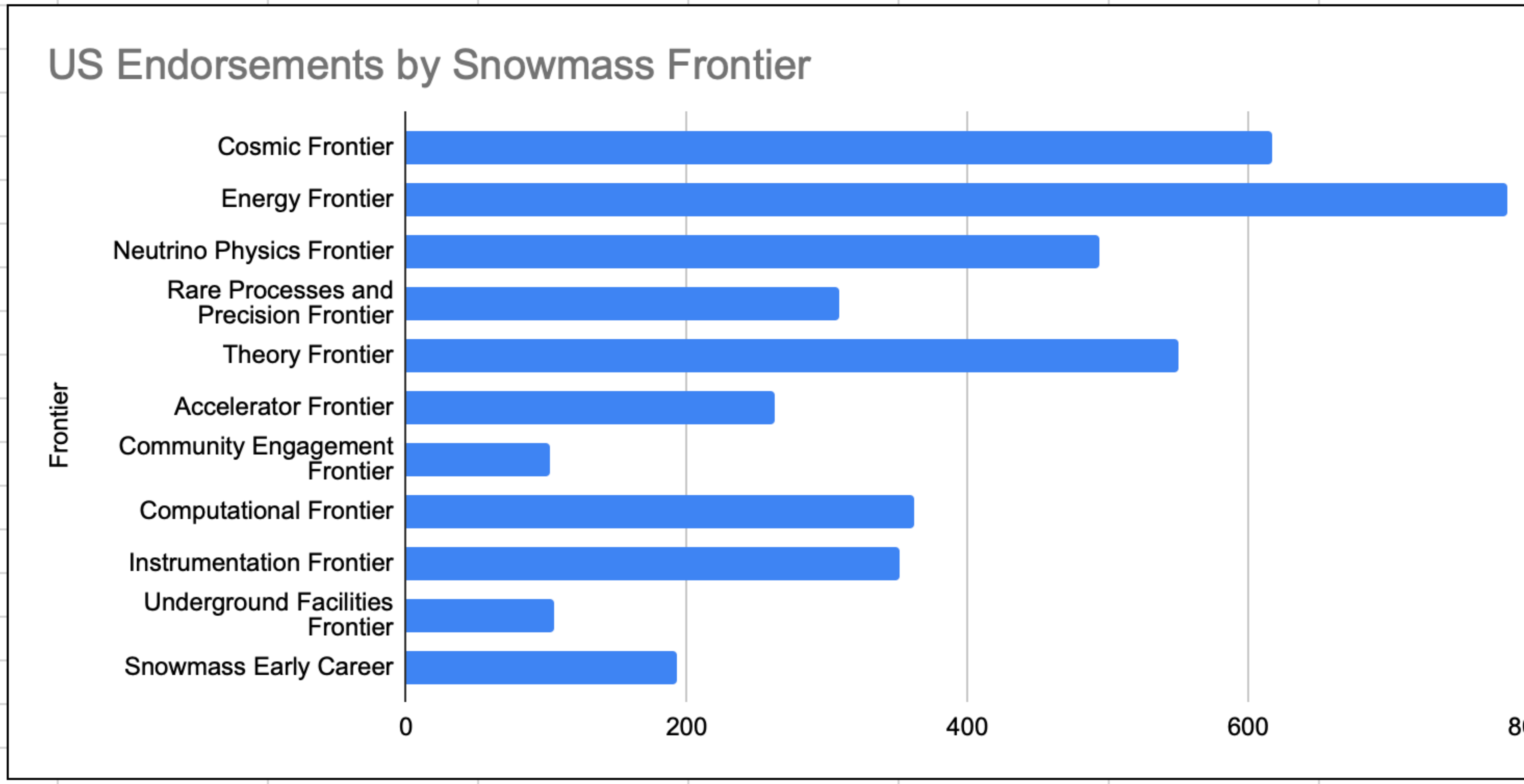
Scientific American

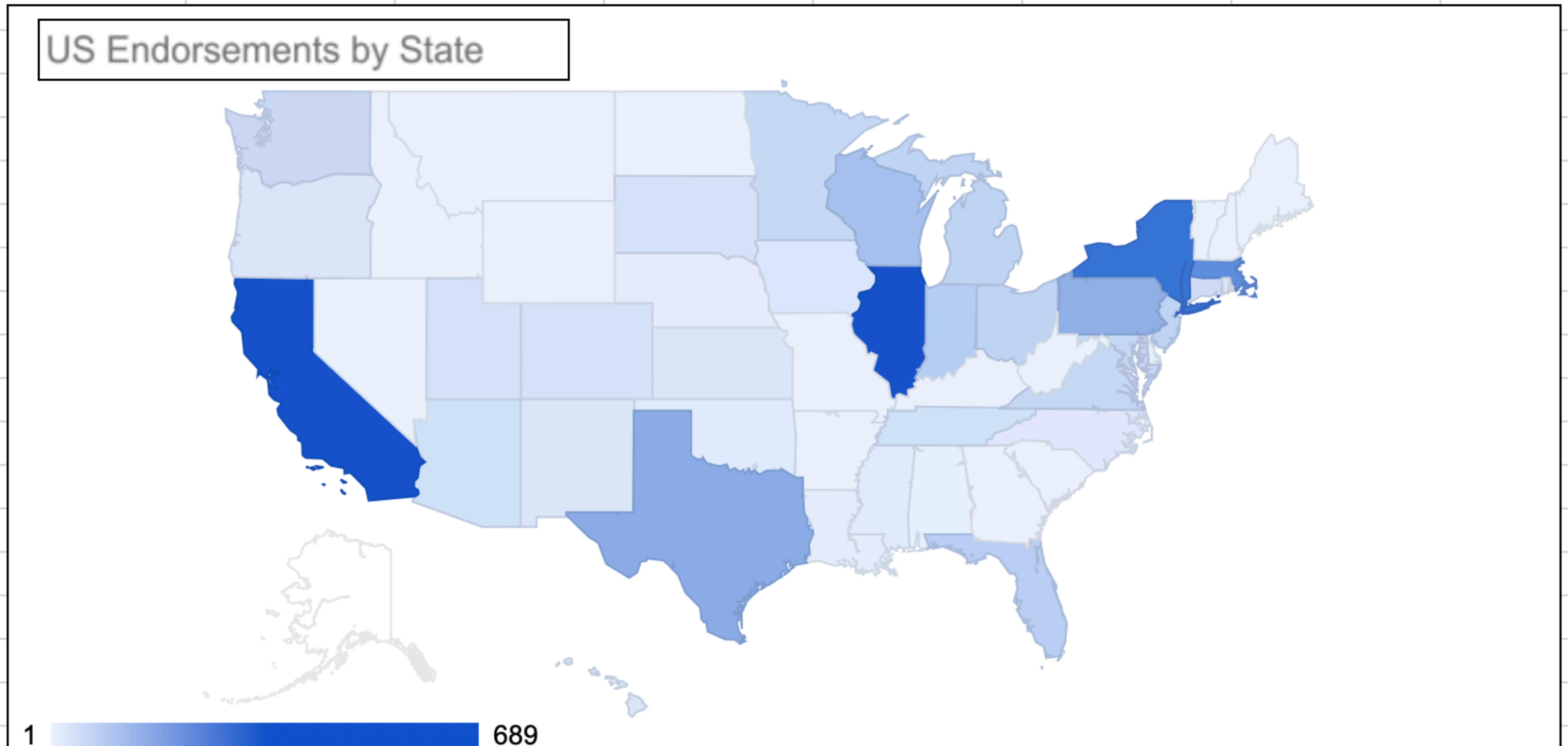
A view from the subterranean excavation for the Deep Underground Neutrino Experiment (DUNE) at the Sanford Underground Research Facility in South Dakota. Credit: Sanford Underground Research Facility

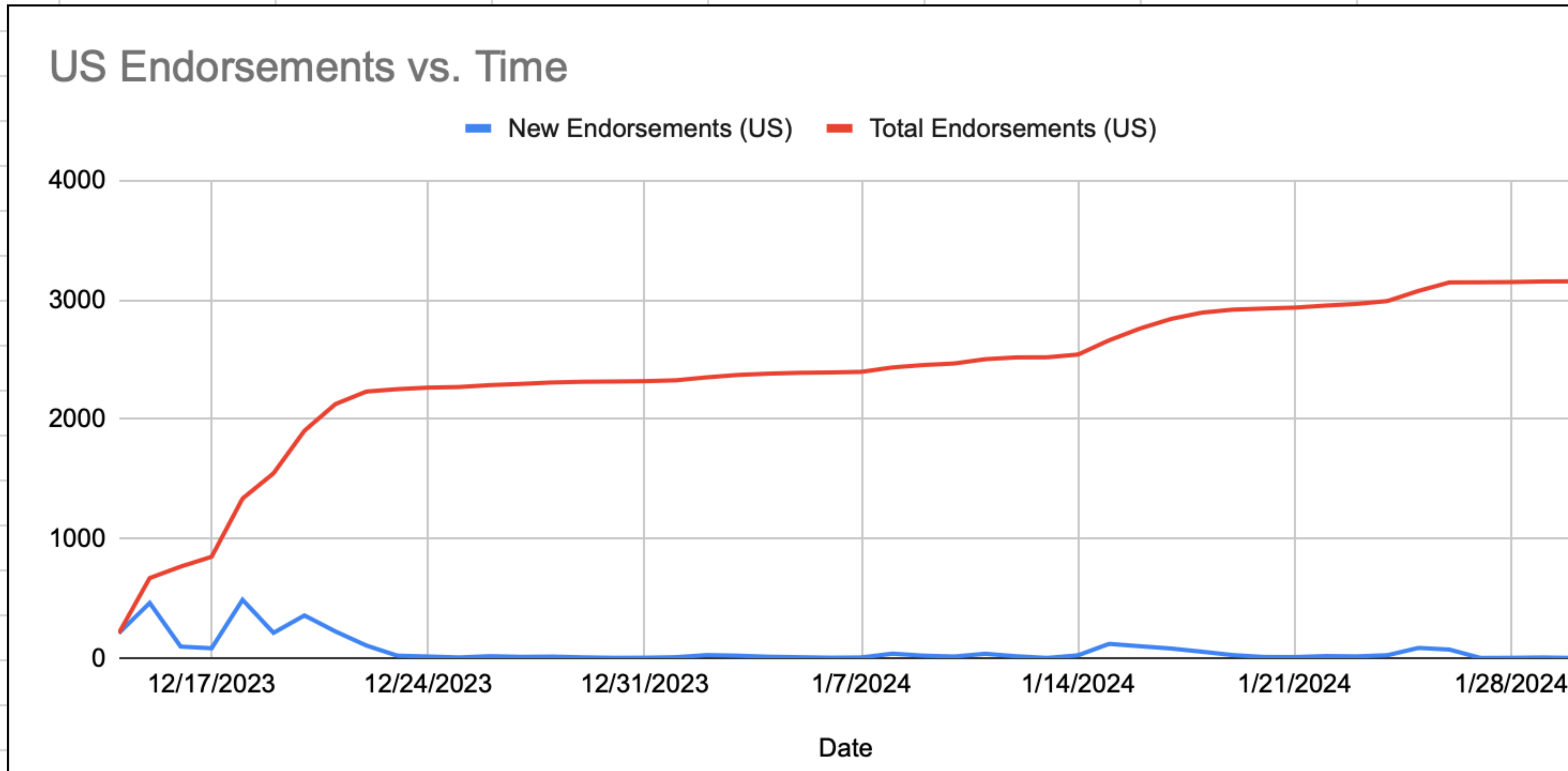
Support the 2023 P5 Report : Statistics

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









Exploring the Quantum Universe

Difficult Choices

Figure 2 – Construction in Various Budget Scenarios

Index: Y: Yes N: No R&D: Recommend R&D only C: Conditional yes based on review P: Primary S: Secondary
Delayed: Recommend construction but delayed to the next decade
† Recommend infrastructure support to enable international contributions
# Can be considered as part of ASTAE with reduced scope

US Construction Cost	Scenarios: Less	Baseline	More	Science Drivers: Neutrinos	Higgs Boson	Dark Matter	Cosmic Evolution	Direct Evidence	Quantum Imprints	Astronomy & Astrophysics
>$3B										
onshore Higgs factory	N	N	N		P	S		P	P	
$1–3B										
offshore Higgs factory	Delayed	Y	Y		P	S		P	P	
ACE-BR	R&D	R&D	C	P				P	P	
$400–1000M										
CMB-S4	Y	Y	Y	S		S	P			P
Spec-S5	R&D	R&D	Y	S		S	P			P
$100–400M										
IceCube-Gen2	Y	Y	Y	P		S				P
G3 Dark Matter 1	Y	Y	Y	S		P				
DUNE FD3	Y	Y	Y	P				S	S	S
test facilities & demonstrator(s)	C	C	C		P	P		P	P	
ACE-MIRT	R&D	Y	Y	P						
DUNE FD4	R&D	R&D	Y	P				S	S	S
G3 Dark Matter 2	N	N	Y	S		P				
Mu2e-II	R&D	R&D	R&D						P	
srEDM	N	N	N						P	
$60–100M										
SURF expansion	N	Y	Y	P		P				
DUNE MCND	N†	Y	Y	P				S	S	
MATHUSLA	N#	N#	N#			P		P		
FPF trio	N#	N#	N#	P		P		P		


Most hated man in the community
Credit: Linda Xu

Credit:
Yurie
Murayama

Particle Phys

THE ERAS TOUR

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	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	
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			Peter Onyisi
1/17/2024	LSST DESC (virtual)	seminar	DESC seminar	LSST DESC	Rachel Mandelbaum & Francis-Yan Cyr-Racine
1/17/2024	Multi-lab (virtual)	committee	MDP General Meeting	Georgui Velev (MDP	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,	colloquium		Henry Lubatti	Sarah Demers
1/22/2024	South Dakota Mines	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		Christine McLean	Petra Merkel
1/25/2024	University of Florida	colloquium		Andrey Korytov	Hitoshi Murayama
1/26/2024	William & Mary	colloquium		Marc Sher/W&M	Chris Monahan
1/30/2024	Washington, DC		URA Council of Presidents	John Mester	Hitoshi/Karsten/Sally
1/31/2024	Rutgers	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	Carnegie Mellon University	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		Marty Breindenbach	Hitoshi Murayama
2/13/2024	SLAC	conference	C3 workshop/collaboration	Emilio Nanni	Cameron Geddes
2/15/2024	MIT	colloquium		MIT	Jesse Thaler/Lindley Winslow
2/15/2024	Florida State University	colloquium		Rachel Yohay	Mayly Sanchez
2/22/2024	Wayne State University	colloquium		Gil Paz	Peter Onyisi
2/27/2024	University of Maryland	colloquium		Kaustubh Agashe	Hitoshi Murayama
3/6/2024	Indiana University	colloquium		Hal Evans	Tulika Bose
3/7/2024	Michigan State University	colloquium		Reinhard	Sarah Demers
3/14/2024	University of Oregon	colloquium		UO	Tien-Tien Yu
3/20/2024		committee	Space Science Week 2024 | National Academies (meeting last until 3/20)	Kelsie Krafton	Karsten Heeger
3/19/2024	Fermilab	seminar	Accelerator Physics & tTchnology 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		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
4/26/2024	Cornell	seminar	journal club	Anders Ryd	Peter Onyisi
5/3/2024	University of Wisconsin,	colloquium		Sridhara Dasu	Hitoshi Murayama
5/8/2024	NAS Keck Building DC	committee	BPA Spring Meeting	Colleen Hartman	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

government

international

Today

Exploring the Quantum Universe

We are all very excited!