

Towards the next Strategic Planning in the Americas (U.S. + Canada + Latin America)

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KAIST-KAIX workshop for future colliders
July 8 – July 19, 2019

Americas: Particle Physics Scientific Drivers

Great promise for discovery over the next 10-20 years

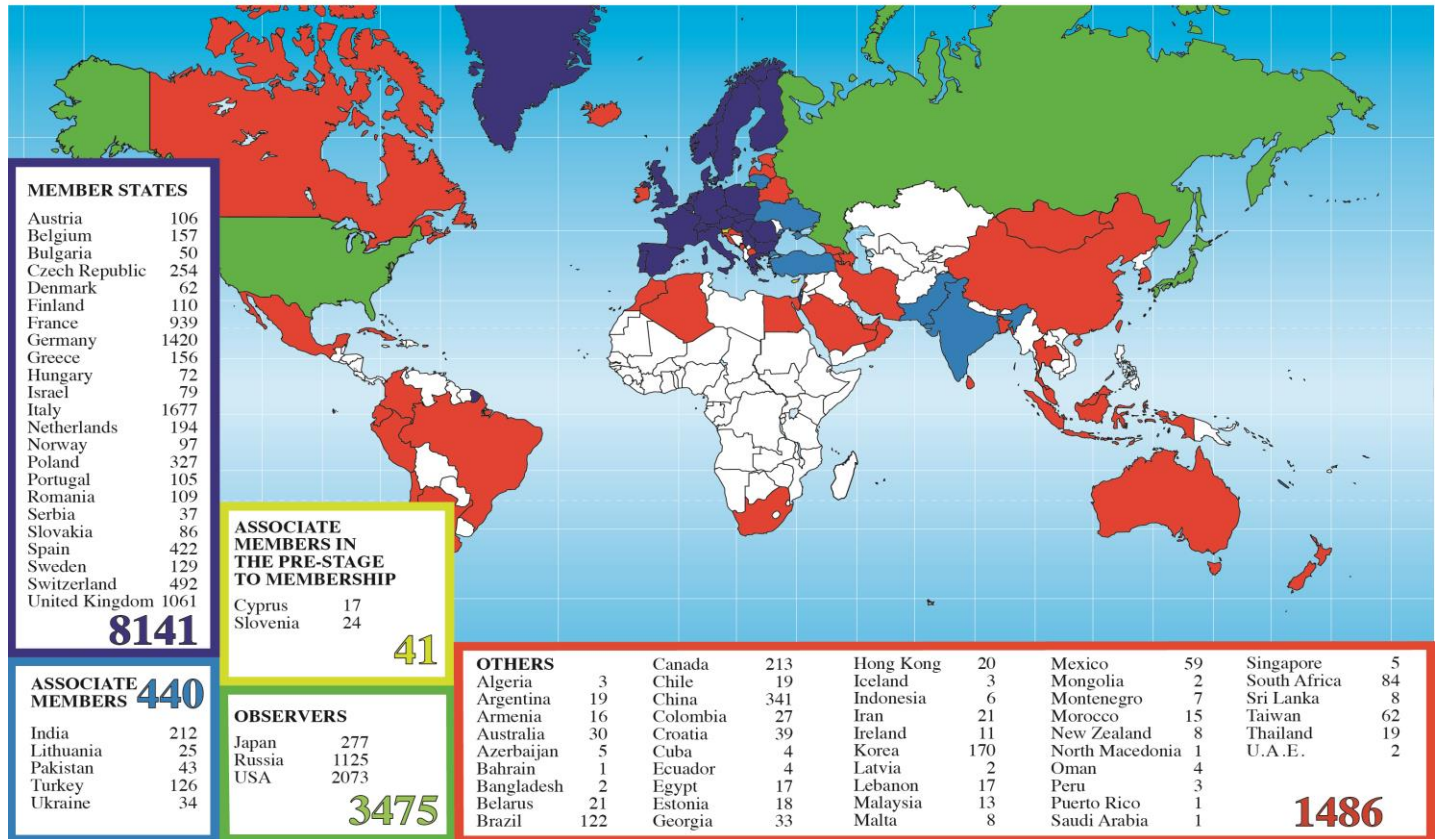
- Use the Higgs boson as a new tool for discovery
 - Explore the unknown: new particles, interactions, and physical principles
 - Pursue the physics associated with neutrino mass
 - Identify the new physics of dark matter
 - Understand cosmic acceleration: dark energy and inflation
- What is the nature of physics at the electroweak scale and beyond?
 - What structures underlie the forces and matter in the universe?
 - What is the nature of neutrino masses?
 - What is the nature of dark matter in the universe?

Particle Physics is Global

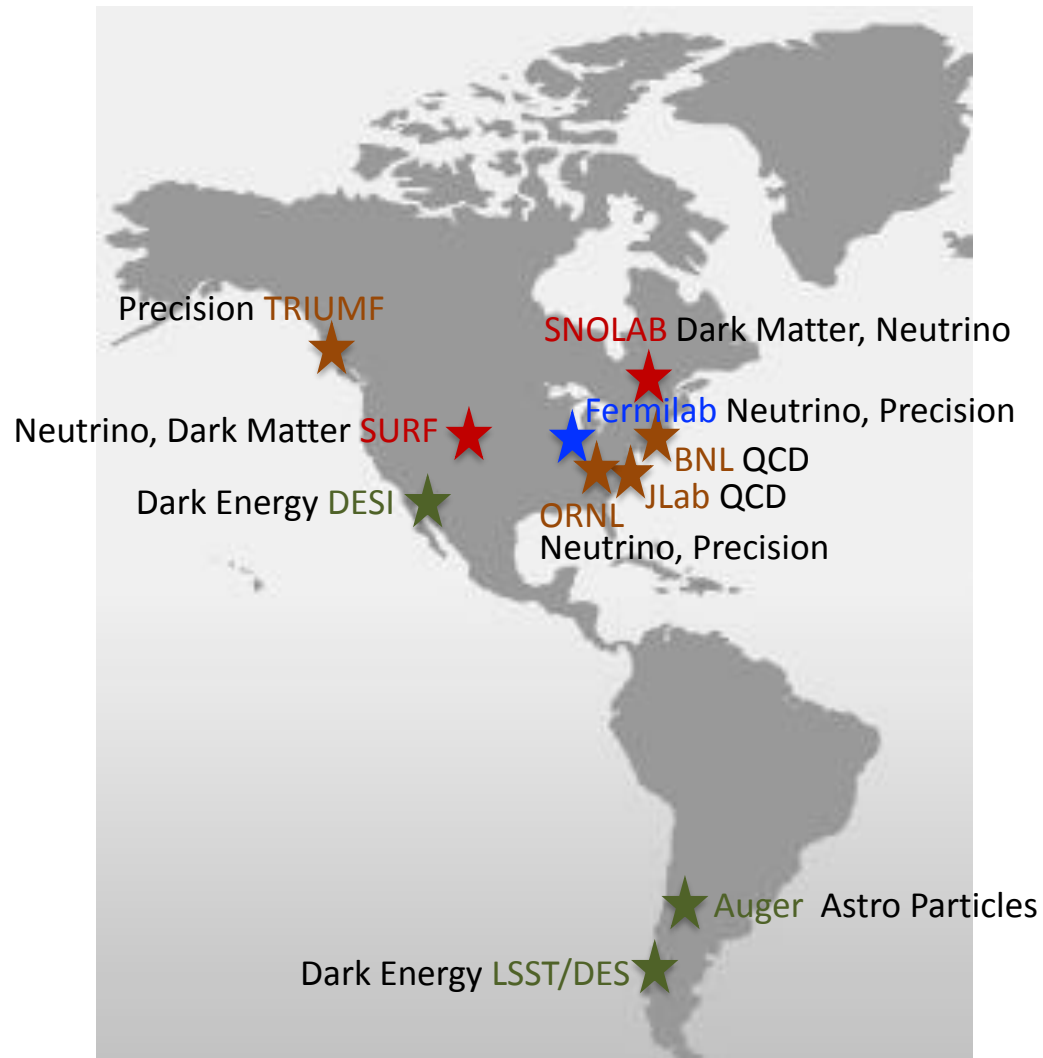
CERN



Distribution of 13,583 CERN users by location of institution (78 countries)



Facilities in Americas for the World Community



Facilities for accelerator science + R&D in U.S.
ATF (BNL), FAST (FNAL), FACET (SLAC), BELLA (LBNL), AWA (ANL)

U.S.: Fermilab

Short- & long-baseline neutrino program
Muon program



More than 4,000 users from 52 countries

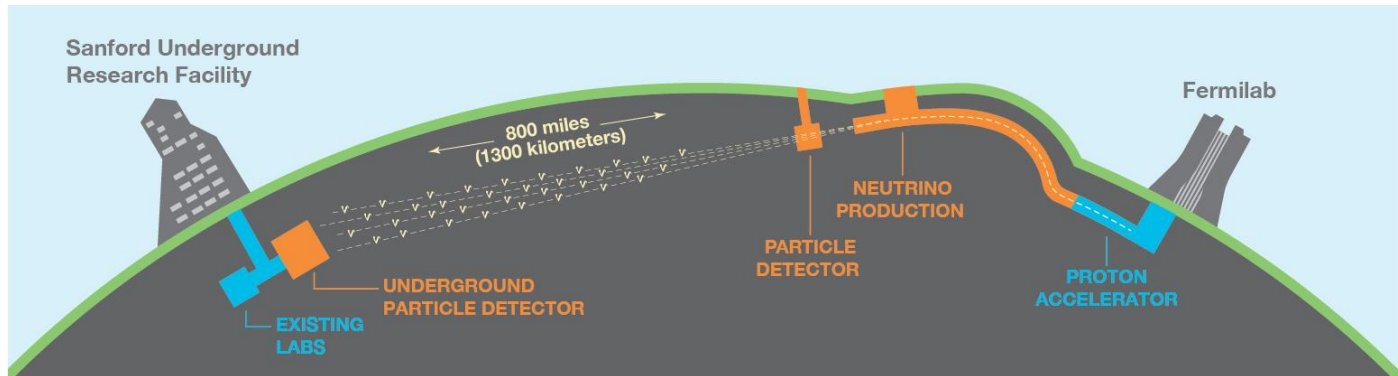
- Africa: 3
- Americas: 12
- Asia: 7
- Middle East: 4
- Europe: 26

More than 100 nationalities



NOV 2018

U.S.: SURF



Dark Matter and Neutrino

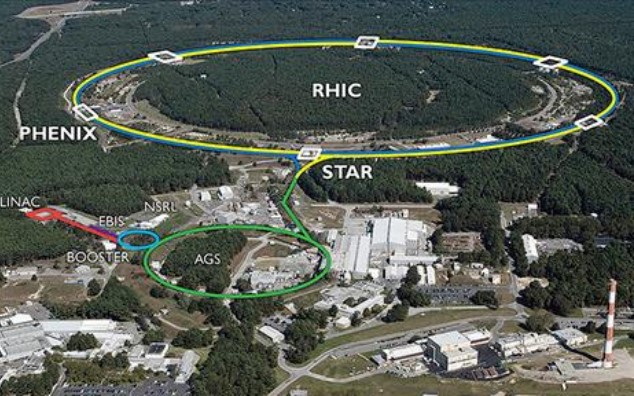
LZ: ~250 collaborators
37 institutions in 5 countries

DUNE: ~1,000 collaborators
179 institutions in 30 countries plus CERN



U.S.: BNL and JLab

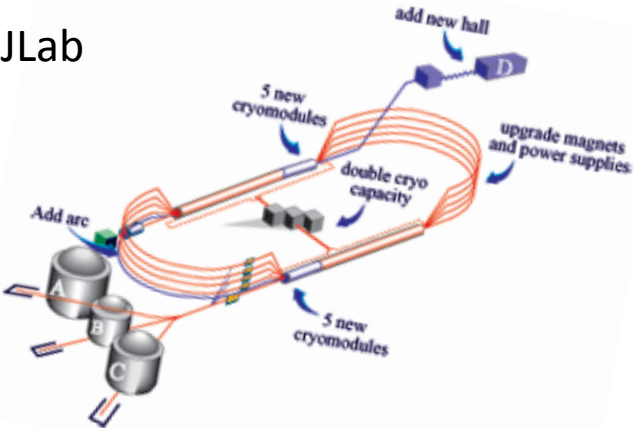
BNL



RHIC heavy ion collider



JLab

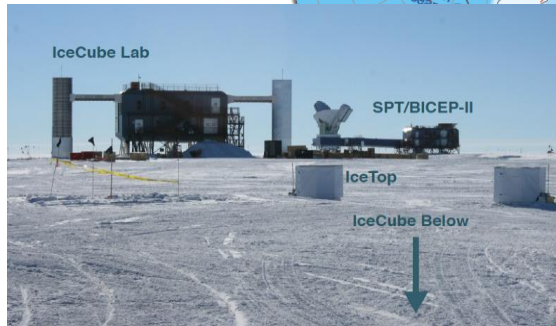


Electron accelerator



Other U.S. Facilities

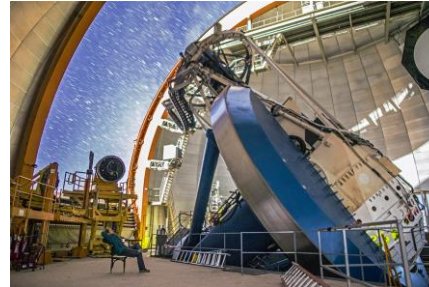
Neutrinos



IceCube Neutrino Observatory in Antarctica

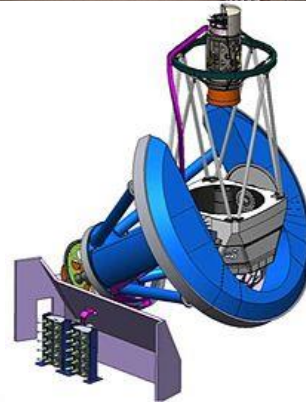
- ~270 scientists
- 49 institutions
- 12 countries: US, Germany, Belgium, Sweden, Australia, Canada, Denmark, Japan, New Zealand, South Korea, Switzerland, UK

Dark Energy



DES at CTIO, Chile

- ~400 scientists from 26 institutions
- 7 countries: U.S., Australia, Brazil, Germany, Switzerland, Spain, UK



DESI at Kitt Peak, U.S.

- 450 scientists from 73 institutions
- 11 countries: U.S., Australia, Brazil, China, France, Germany, Korea, Mexico, Spain, Switzerland, UK

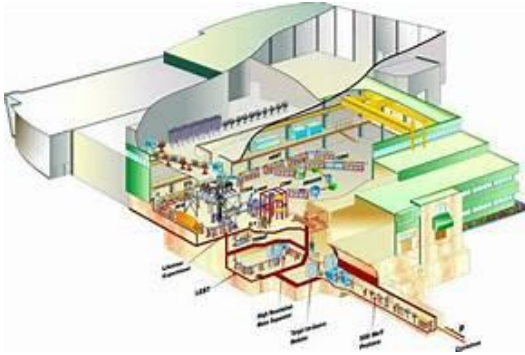


LSST, Chile

- Material contributions from U.S., Brazil, Chile, France

Canada: TRIUMF and SNOLAB

TRIUMF



Radioactive beam facilities
Fundamental symmetry



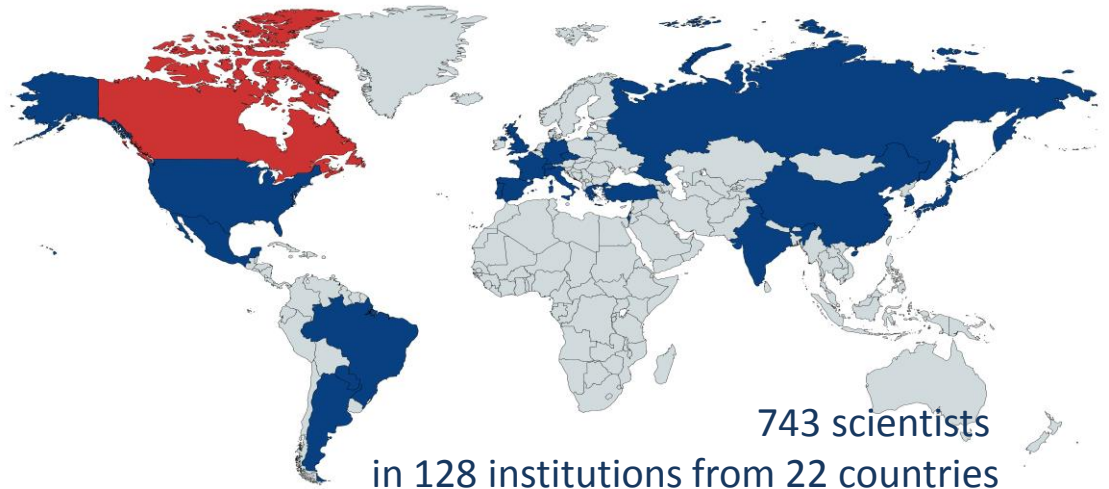
SNOLAB

Dark Matter and Neutrino



DEAP, SNO+
SuperCDMS

Global Argon Dark Matter Collaboration



The worldwide particle physics community can together address the full breadth of the field's most urgent scientific questions with each major player hosting a unique world-class facility at home and partnering in high-priority facilities hosted elsewhere.

Planning in the Global Context

Strategic Planning Process and Execution

Latin America

Canada

U.S.

Latin America

Many nations have growing particle physics communities

October 2018: Ministers + Heads of state approve creation of LASF4RI (Latin American Strategy Forum for Research Infrastructure) and pilot projects HECAP (High Energy, Cosmology and AstroParticle Physics) is a pilot project

Latin American Strategy for HECAP next steps:
Multi-National Scientific Community Based Effort



Argentina's planning (Feb. 12, 2019)



Latin America's planning (April 30-May 1 2019)

<http://www.ictp-saifr.org/workshop-on-the-latin-american-strategy-forum-for-research-infrastructure/>

Latin America: HECAP Landscape Analysis

Initial list of current experiments and facilities in/with Latin American participation

Gravitation and cosmology	<ul style="list-style-type: none">• LIGO, QUBIC• DES/DESI/LSST/SDSS
Colliders	<ul style="list-style-type: none">• ATLAS, CMS• LHCb, ALICE
Astroparticles	<ul style="list-style-type: none">• AUGER, LAGO• HAWC, ALPACA, SGSO
Neutrinos	<ul style="list-style-type: none">• DUNE• NOvA
Infrastructures	<ul style="list-style-type: none">• ANDES (proposed underground lab)• LNLS:SIRIUS (Brazilian Synchrotron Light Source)

<https://sites.google.com/view/lastrategyforum/home>

At this stage, intended to document, not to prioritize

- Significant capacity building in LA over the last decade enhancing hardware capabilities and leadership → Stronger LA presence in European experiments
- LA considers crucial to have a cutting-edge accelerator-based experiment running all the time, not only for the great/unique theoretical and experimental progresses, but also for keeping the best students within our field and also within Science.

Canada

- Long Range Plan (LRP): 2017 – 2021
 - Drafted by committee of 11 subatomic physicists (nuclear + particle)
 - Appointed by NSERC (funding agency)
 - Members: 1/3 non-Canadians
 - Observers: 7 from IPP(Institute of Particle Physics), CINP(Canadian Institute for Nuclear Physics), TRIUMF, SNOLAB, CFI(Canada Foundation for Innovation), NSERC
 - LRP Committee Mandate:
 - Identify subatomic physics scientific ventures and priorities
 - that would ensure continuous Canadian global scientific leadership covering the period 2017-21 and look ahead to 2026
 - Provide budgetary estimates (funding ranges for prioritized endeavors)
 - Extensive and broad input
 - Documents from IPP/CINP (particle/nuclear physics communities)
 - Surveys of Canadian subatomic physicists
 - Two town hall meetings.

Canadian Long Range Plan: 2017 – 2021

- Research in theoretical subatomic physics
- Ongoing flagship facilities and experiments
 - TRIUMF radioactive beam facilities and experiments
 - SNOLAB and its experiments
 - ATLAS experiment
 - T2K experiment
- Strategic smaller-scale efforts giving breadth
 - ALPHA, JLab and offshore rare isotope beam experiments, IceCube
- Projects operational in the coming years
 - ATLAS at HL-LHC, Belle II, Hyper-K, ILD at ILC, MOLLER and SoLID at Jlab, nEXO at SNOLAB, and UCN/nEDM at TRIUMF
- Generic accelerator and detector R&D

United States

- Snowmass
 - 2012-2013: “Snowmass” community-wide studies
 - Organized by DPF (Similar to the European PPG process)

Until 2005: ~a thousand physicists gathered for three weeks to talk about the future of particle physics in the U.S. / the rest of the world



Snowmass (2012 – 2013)

Year-long Snowmass Study

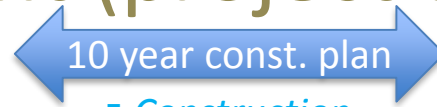


Final meeting (1 week) of Snowmass at Minnesota (Summer 2013)

United States

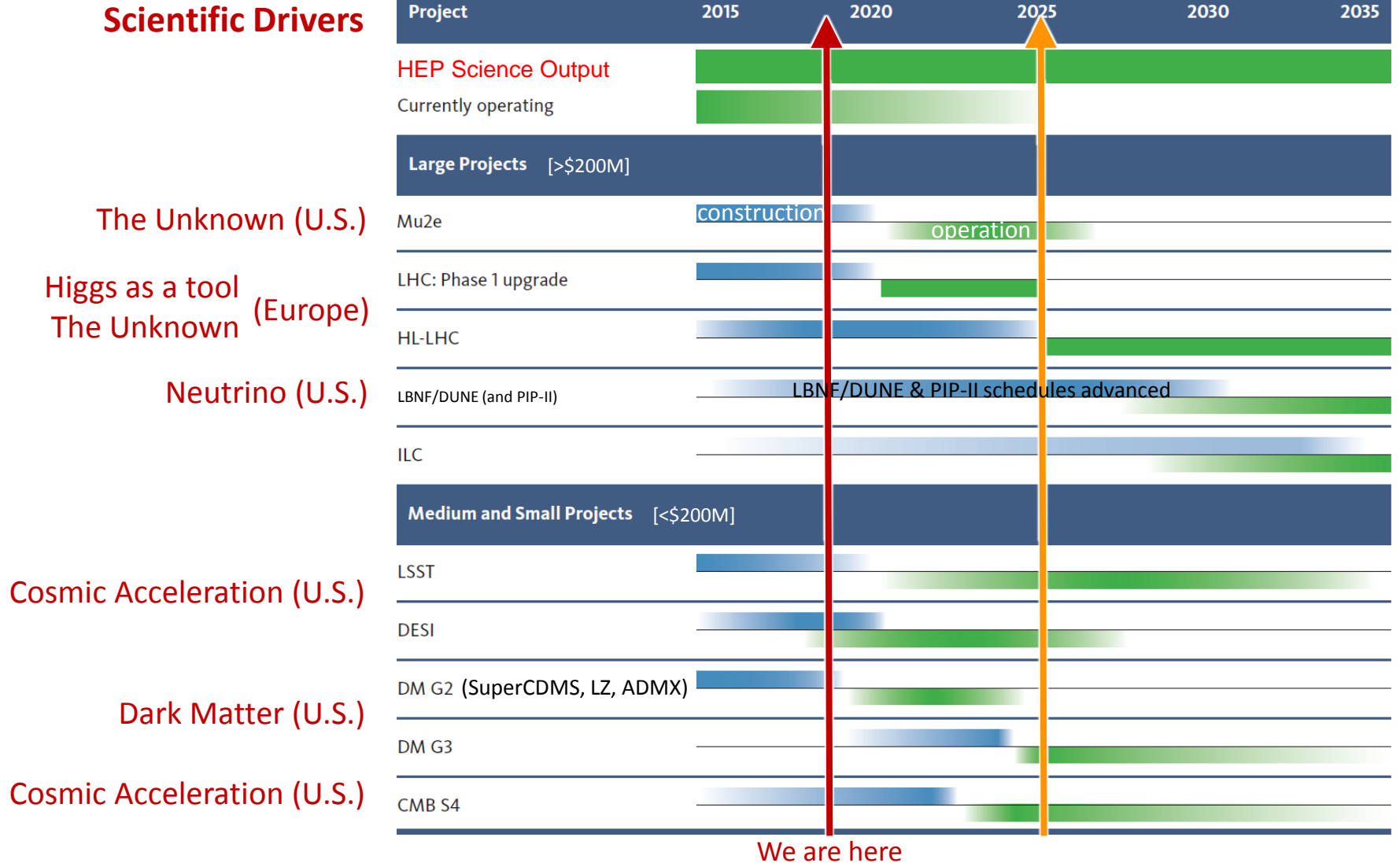
- Snowmass → P5 Strategic Plan
 - 2012-2013: “Snowmass” community-wide studies
 - Organized by DPF (Similar to the European PPG process)
 - 2013-2014: P5, Particle Physics Project Prioritization Panel
 - Subpanel of HEPAP, High Energy Physics Advisory Panel for DOE and NSF funding agencies
 - P5 takes the scientific input from Snowmass and formulates a strategic plan to address the science within specified funding constraints
 - 10 year plan in the context of a 20-year vision
- Long-Range Plan for Nuclear Science (2015)
 - Funded by Nuclear Physics Offices of funding agencies
 - Fundamental Symmetries and Neutrinos
 - QCD: Structure of Hadrons and Phases of Strongly Interacting Matter
- Decadal survey on Astronomy and Astrophysics (2010)
 - Dark Energy
 - Cosmic Microwave Background

P5 2014: U.S. investment (project construction)



■ Construction

■ Operations / Physics



Scientific Drivers

The Unknown (U.S.)

**Higgs as a tool
The Unknown (Europe)**

Neutrino (U.S.)

Cosmic Acceleration (U.S.)

Dark Matter (U.S.)

Cosmic Acceleration (U.S.)

U.S.: Other Important Programs

Scientific Drivers

- Neutrino • Neutrinoless double beta decay
 - LNGS: CUORE, CUPID
 - WIPP: EXO
 - SURF: Majorana, GERDA
 - SNOLAB: SNO+, nEXO

- Neutrino • Long- & short-baseline and solar neutrinos / neutrino interactions
 - Fermilab: NOvA, MicroBooNE, SBND, ICARUS
 - T2K, Super-K
 - LNGS: BOREXINO
 - ORNL: COHERENT, PROSPECT



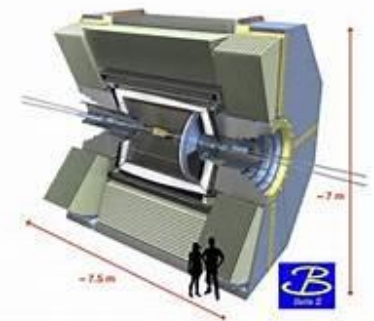
SNOLAB, Canada

- Dark Matter • Dark Matter
 - LNGS: DARKSIDE, SABRE, XENON
 - SNOLAB: DEAP, PICO
 - Y2K: COSINE
 - Beyond the WIMP Paradigm



LNGS, Gran Sasso, Italy

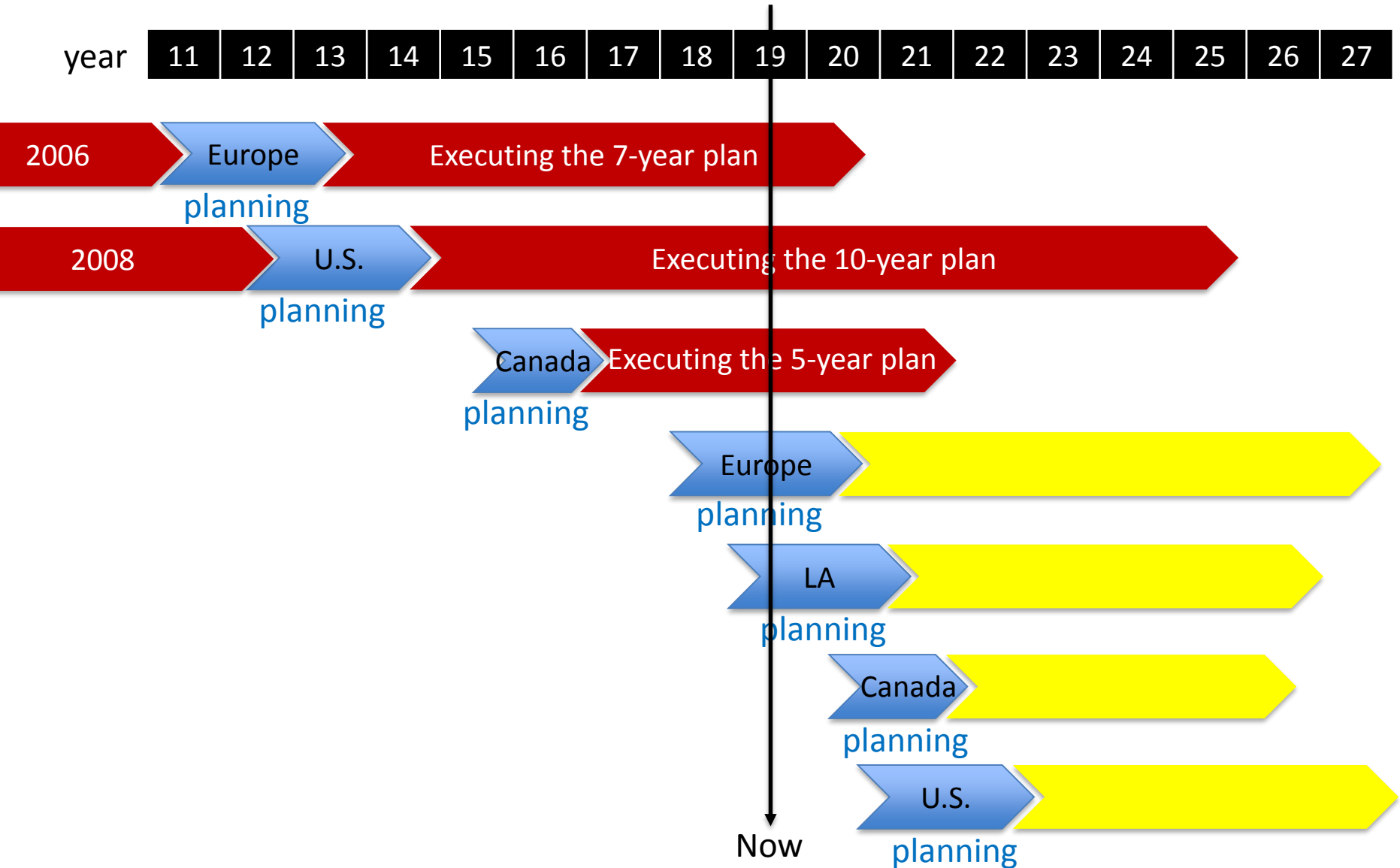
- The Unknown • Flavor
 - Fermilab: Muon g-2
 - KEK: Belle-II at SuperB
 - KEK: KOTO at J-PARC
 - IHEP: BES-III at BEPC



KEK, Japan

- The Unknown • Fundamental symmetries
 - EDMs

Planning and Executing



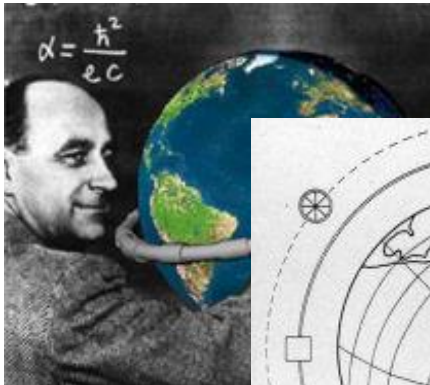
For discussions in this workshop

How to put more brains into Accelerator Science?

Breakthroughs
In Accelerator



Breakthroughs
in Particle Physics



Fermi's
Globatron



40,000 km in 1954

1 TeV accelerator with then technologies

x10,000 smaller

6 km in 1985
Achieved!



For discussions in this workshop

How to put more brains into Accelerator Science?

Breakthroughs
In Accelerator



Breakthroughs
in Particle Physics

~6,000 ATLAS+CMS + many more



US:
~15 Accelerator Ph.D.s / year

BES-III: 20 Ph.D.s / year