U.S. High Energy Physics Program: HEPAP View

JoAnne Hewett
US – Japan Collaboration
40th Anniversary

SLAC NATIONAL ACCELERATOR LABORATORY

U.S. HEP Strategic Planning Process

The U.S. High Energy Physics program is guided by the strategic plan laid out in the 2014 P5 report

- Community Driven Strategic Process
  - "Snowmass" 2013: a year-long community-wide study of science opportunities, organized by the Division of Particles and Fields of the American Physical Society
  - Particle Physics Project Prioritization Panel (P5) 2014: HEPAP subpanel, prioritized scientific opportunities outlined in the Snowmass study within a budget framework
- Dovetailed with
  - 2010 Astronomy & Astrophysics Decadal Survey
  - 2013 European Strategy for Particle Physics

Process defines strategic plan for U.S. HEP for the decade

Particle Physics Project Prioritization Panel (P5)

Scientific advisory panel (subpanel of HEPAP) tasked to develop a strategic HEP plan to be executed in 10-yr timeframe, in the context of a 20-yr global vision for the field

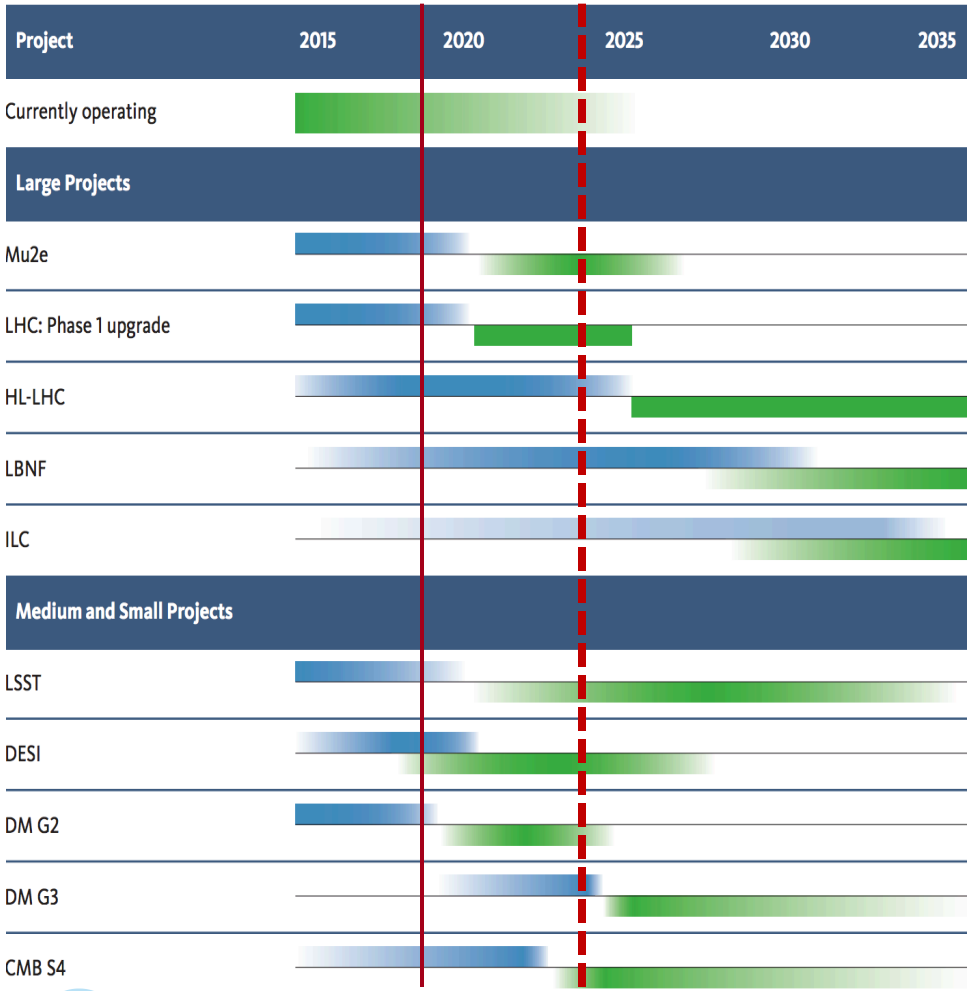
- Examine current, planned and proposed research capabilities and assess
  - Role & potential for scientific advancement
  - Uniqueness & scientific impact in global context
  - Time & required resources to achieve stated goals
- Provided with 3 budget scenarios to work within
  - Necessitated hard choices
- Community “Snowmass” study served as invaluable input

Signals that time was right for a new P5

- Physics landscape changed
  - Higgs discovered at relatively low mass
  - Key neutrino mixing angle measured to be large
  - New technology & innovative approaches
  - 3 Nobel prizes: CKM, Higgs, Dark Energy
- These demonstrate importance of diversity of topics and scale
- Programmatic Changes
  - Tevatron and B-Factory ceased operations
  - Budgets more constrained than considered by last P5 (2008)
  - International considerations
- Success of 2013 “Snowmass”

Context important when considering next P5

The P5 plan in one glance: Building for Discovery



Particle Physics is Global

Centered on 5 Science Drivers

- Higgs Boson is a tool for discovery
- Physics Associated with Neutrino Mass
- Identify the Physics of Dark Matter
- Understanding Cosmic Acceleration
- Exploring the Unknown

Mix of projects of all scales

Balance Research, Operations & Projects

P5: Where are we today?

The P5 plan has endurance

- Broadly accepted by the community
- Followed by the funding agencies
- Accepted in Congress

  The FY19 DOE Congressional Budget Request states: The FY 2019 Request will focus support for HEP research on the laboratory research programs that are critical to executing the P5 recommendations, and on world-leading R&D efforts that require long-term investment.

Plan requires a delicate balance

- breadth and mix of project scale
- healthy theory program
- enablers
- balance between research, operations, projects

U.S. Administration supports the P5 Plan

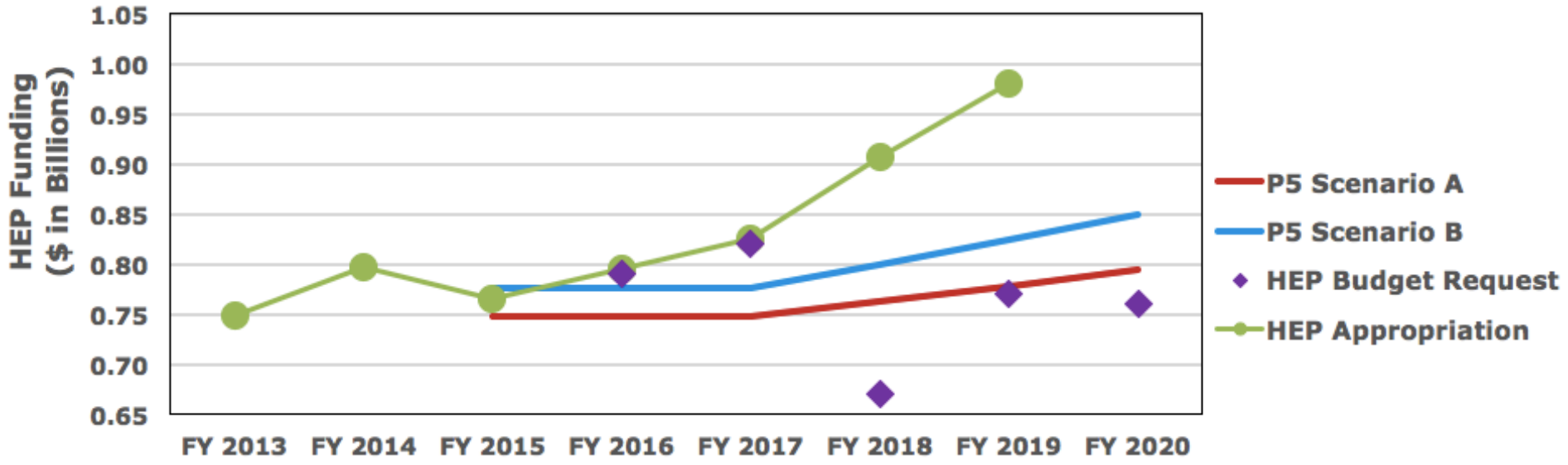
- U.S. – CERN Agreement, May 2015 in D.C
  - U.S. Secretary of Energy Ernest Moniz, CERN Director General Rolf Heuer, U.S. National Science Foundation France Cordova
  - Aligns European and American long-range strategic plans for HEP
- UK – U.S. Science & Technology Agreement, signed Sep 2017 in D.C.
  - UK Science Minister JO Johnson and U.S. Acting Assistant Secretary of State for Oceans and International Environmental and Scientific Affairs Judith Garber
  - 1st major project under this agreement is UK investment of Lbs 65M ($88M) in LBNF/DUNE
- DOE-DAE (India) Project Annex II on Neutrino Research signed Apr 2018 in New Delhi
  - U.S. Secretary of Energy Rick Perry and India's Atomic Energy Secretary Sekhar Basu
  - Expands accelerator science collaboration to include science for neutrinos

U.S. Congress Supports P5 Plan

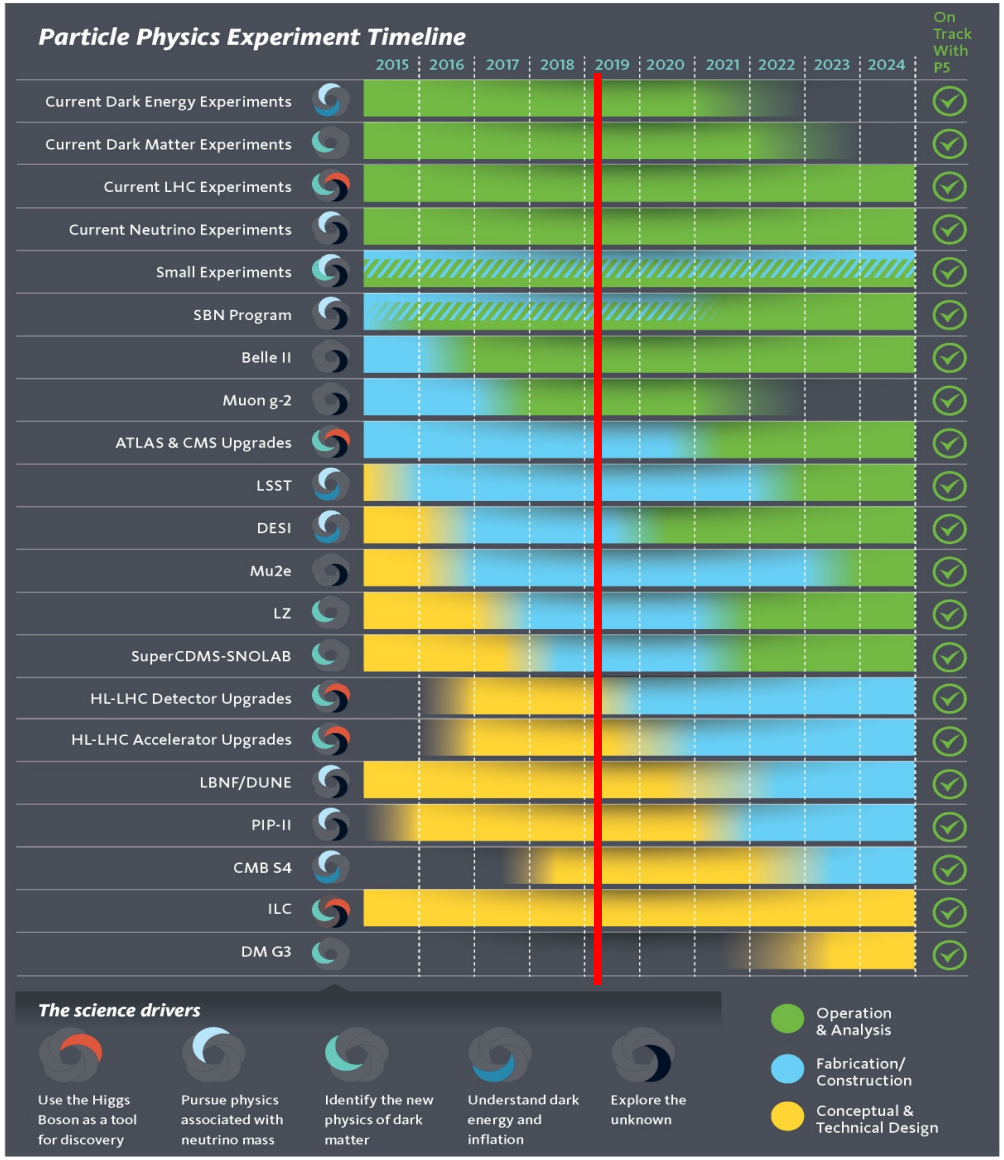
FY19 Senate Energy & Water Development Appropriations

Report: "The committee strongly supports the Department's efforts to advance the recommendations of the Particle Physics Project Prioritization Panel Report [P5], which established clear priorities for the domestic particle physics program…."

"...Four years into executing the P5, the Committee commends the Office of Science and the high energy physics community for acheiving significant accomplishments and meeting the milestones and goals set forth in the strategic plan..."



P5 Plan in 2019



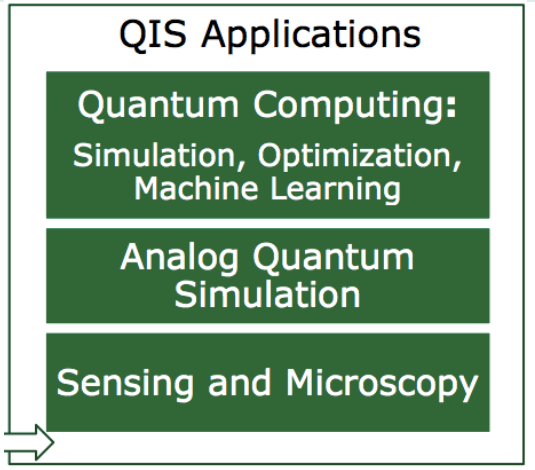
All projects on budget & schedule

- Projects fully funded as of FY19
  - Muon g-2: 1st beam 2017
  - LHC detector upgrades: on track for 2019/20 installation
  - Mu2e : 1st data in 2020
  - LSST: full science operations 2023
  - DM-G2 (superCDMS & LZ): 1st data 2020
  - DESI: 1st light on April 1, 2019
- HL-LHC accelerator and detector upgrades started on schedule
- LBNF/DUNE & PIP-II schedules advanced due to strong support by Administration & Congress
- CMB S4: developing technically-driven schedule to inform agencies, NAS Astro 2020 Decadal Survey
- DM-G3: R&D limited while fabricating G2
- ILC: cost reduction R&D while waiting for decision from Japan
- Broad portfolio of small projects running

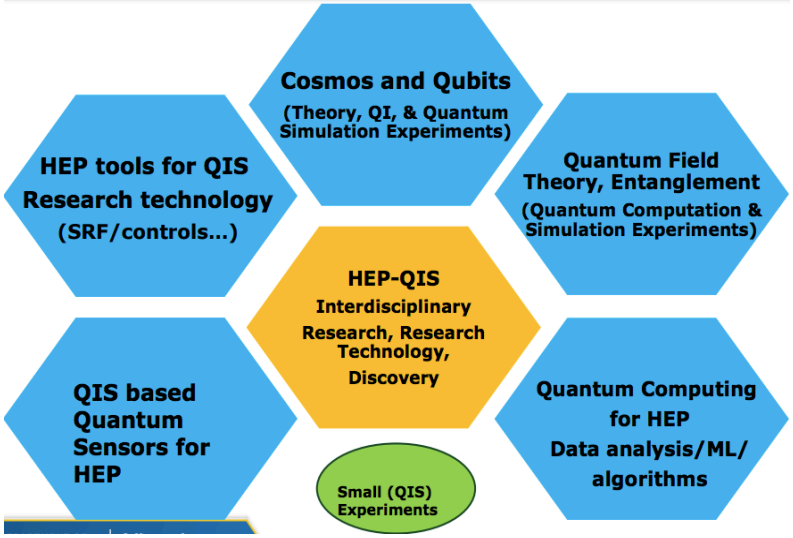
What's new since P5?: I

Quantum Information Science

- Congressional launch of a National Quantum Initiative: "to create a 10-yr National Quantum Initiative aimed at increasing America's strategic focus on quantum information science and technology development"



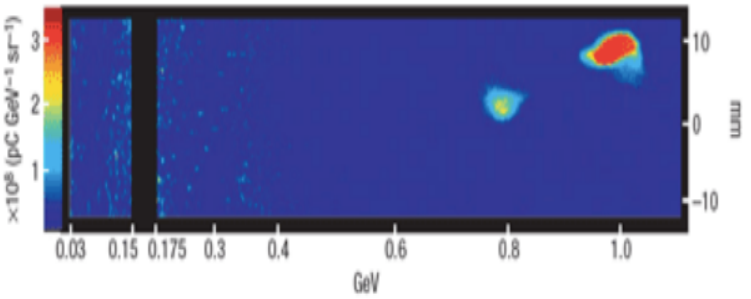
- HEP QuantISED program
  - 1st awards FY18
  - HEP QIS strategy aligned to Office of Science QIS strategy & National Initiative
  - large response from community
  - proposals ranged from GARD R&D to Holography.



What's new since P5?: II

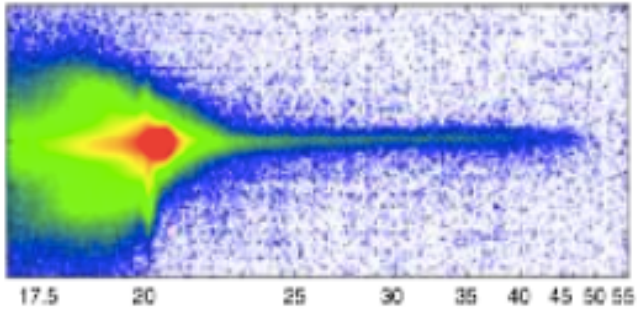
Accelerator R&D Facilities

Demonstrate new acceleration techniques to change cost/capability curve

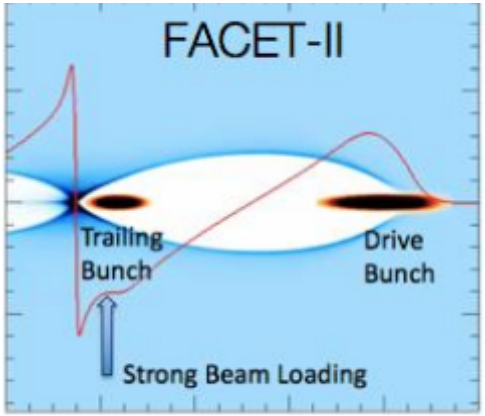


Electron beam facilities:

- Bella: Laser Driven Acceleration
  - National facility to advance development of laser-driven plasma acceleration
  - Milestons
    - 10 GeV/meter with high quality electron beams
    - Demonstrate coupling of acceleration stages



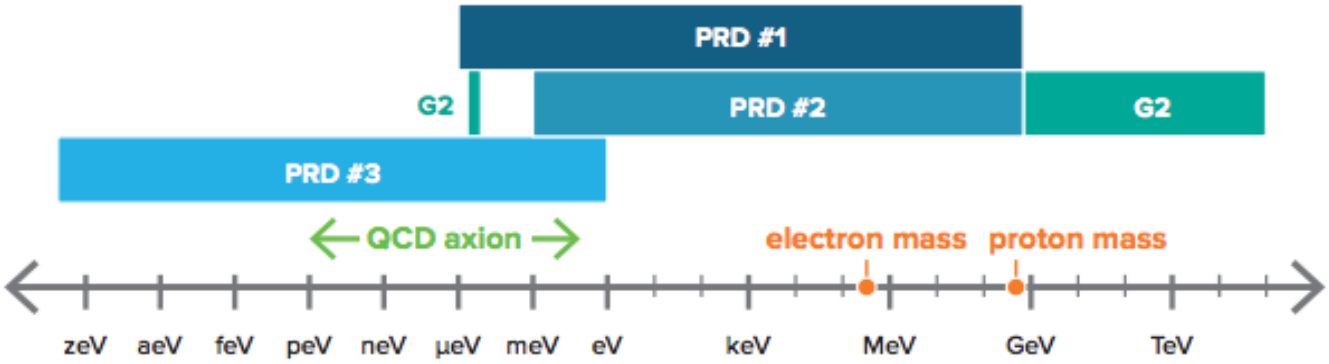
- FACET: Plasma Wakefield Acceleration
  - National user facility based on High energy electron (and eventually positron) beams to realize the promise of PWFA technology
  - Milestones
    - High brightness beam generation, preservation, characterization
    - e^+ acceleration in e^- driven wakes



What's new since P5?: III

Basic Research Needs Workshop Series – Dark Matter

- Initiate small portfolio of Dark Matter experiments
- Investigating low-cost, high impact experiments



Priority Research Directions identified

1. Create and detect dark matter particles and associated forces below the proton mass, leveraging DOE accelerators
2. Detect individual galactic dark matter particles below the proton mass through interactions with advanced detectors
3. Detect wave dark matter using innovative technologies with emphasis on the QCD axion

FOA announced soon for experimental R&D proposals

HEP Strategic Planning Process – Next Round for U.S.

- U.S.
  - Community Study ("Snowmass") – ~2021/2022
    - Ideas for facilities & experiments bubble up from community
    - Feasibility studies & physics reach evaluations
  - National Academies of the Sciences Study - TBD
  - Particle Physics Project Prioritization Panel (P5) – ~2022/23
    - HEPAP subpanel, prioritizes science within a budget framework
  - Astronomy & Astrophysics Decadal Survey – 2020
    - NCR & NAS
- European Strategy for Particle Physics
  - White papers submitted by community – 2018
  - Open Symposium - 2019
  - Panel report - 2020

DPF organized whitepaper from the U.S.

Summary

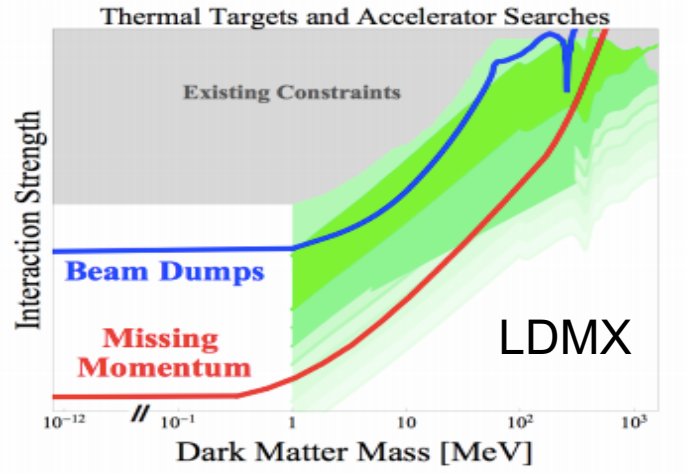
- The P5 plan is an amazingly diverse array of exciting science with enormous discovery potential
- It is progressing well so far
- Time to commence preparation for next planning cycle
  - Need for generation of ideas for major new projects

U.S. is on a good track – keep up the momentum!

Dark Matter small experiments are “shovel ready”: Examples

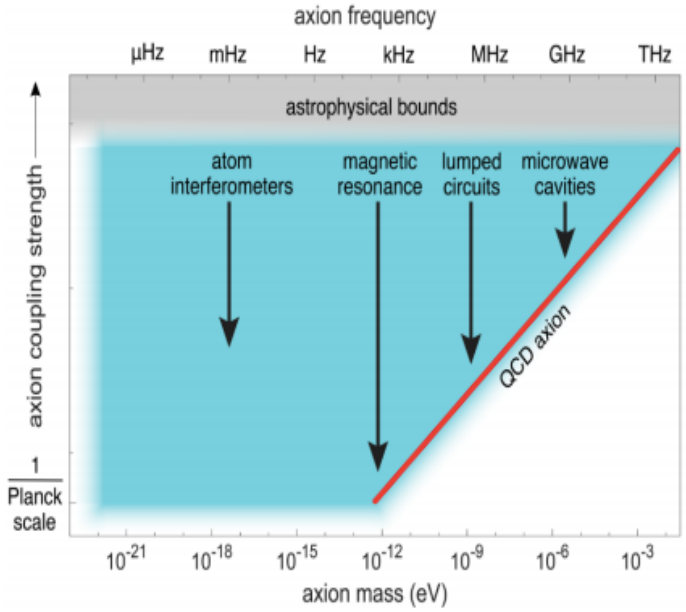
PRD1: Accelerator based fixed target search for sub-GeV Dark Matter

- Mature detector concept
  - Light Dark Matter Experiment
  - International collaboration



PRD2: Quantum sensor technology to search for QCD axion

- Several experiments to cover full mass range
  - CASPER, Dark Matter Radio, ADMX, Haystac
  - Quantum techniques make these feasible in finite timeframe



2013 Community Summer Study – "Snowmass"

Community driven process organized by the APS Division of Particles and Fields

- Goal: Identify compelling science opportunities over an approximately 20-yr timeframe
  - Not a prioritization, but made scientific judgements
- Year-long process
  - Several working group meetings to study individual opportunities
  - Synthesis in Minnesota with ~1000 participants
- Deliverables
  - 7 working group reports
  - ~100 subgroup reports
  - ~1000 individual contributed whitepapers
  - Set of 11 compelling scientific questions

P5 Program Optimization Criteria

- Science impact
- International context
- Sustained productivity
- Timing
- Cost vs value
- History and dependencies
- Feasibility
- Roles

Many things to consider at once
- Science impact comes first