U.S. DEPARTMENT OF ENERGY

OFFICE OF SCIENCE

# DOE Office of High Energy Physics (HEP) Status Report to the AAAC February 3, 2014

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**Office of High Energy Physics**
**Office of Science, U.S. Department of Energy**

# Budget

# FY14 HEP Budget Overview

| Budget in $M | FY2012 actual | FY2013 actual | FY2014 President's request | FY2014 Initial plan in CR | FY2014 House mark | FY2014 Senate mark | FY2014 Final Approp. |
|---|---|---|---|---|---|---|---|
| HEP available | 770.5 | 727.5 | | | | | |
| SBIR/STTR (~ 3%) | 20.3 | 20.8 | | | | | |
| **HEP Total** | **790.8** | **748.3** | **776.5** | **748.3** | **772.5** | **806.6** | **797.5** |
| Office of Science (SC) | 4,874.6 | 4,621.1 | 5,152.7 | | 4,663.0 | 5,152.7 | 5,071.0 |

**The FY2014 HEP budget has been approved and is up $21M from the President's Request (with specific guidance for the $21M).**

➔ **Program planning in this budget environment is very difficult due to not having a stable budget.**

# FY14 HEP Budget

**In the last few years, the HEP budget philosophy has been to enable new world-leading HEP capabilities in the U.S. through investments on all three frontiers**

**- To be accomplished through ramp-down Research (~ -6%) & existing Project operations**

**FY 2013 Budget:**

We were not able to start new Major Item of Equipment (MIE) projects, including the Large Synoptic Survey Telescope camera project (LSST-camera) or Belle-II.

**FY 2014 Budget Appropriations & Guidance:**

Projects Approved:

- LSST-camera MIE-fabrication start - we can provide full planned funding ($22M in FY14)
- Belle-II MIE-fabrication start
- Muon g-2 MIE-fabrication start
- Muon to Electron conversion (m2e) experiment Project Engineering & Design (PED) and Construction funds approved

Other

Specific guidance in approved Budget for the additional $21M provided over the Request:

- Long Baseline Neutrino Experiment (LBNE) – $26M in R&D & PED funds **($16M in PED over Request)**
- Homestake Mine Operations - $15M provided **(specific guidance was $5M over Request)**

# HEP Budget - Cosmic Frontier

| Cosmic Frontier (in $K) | FY2012 actual | FY2013 actual | FY2014 President's request | FY2014 Approp. – current plan |
|---|---|---|---|---|
| Research – university + labs | | | 46840 | 49271 |
| Research - university | 12881 | 12233 | | |
| Research - labs | 34962 | 36448 | | |
| Experimental Operations | 8505 | 10111 | 7500 | 9615 |
| Future project R&D (includes DM-G2, DESI, etc) | | 9659 | 13494 | 8900 |
| Small project fabrication | 5891 | | 1200 | |
| MIE R&D - LSST camera | 5500 | 8000 | | 3000 |
| MIE fabrication - LSST camera | | | 22000* | 19000 |
| MIE fabrication – HAWC (ended in FY13) | 1500 | 1500 | | |
| **TOTAL** | **69239** | **77951** | **91034** | **89786** |

* This is a REQUEST

# Strategic Planning

# Strategic Plan & Budget

- **The U.S. HEP program is following the strategic plan laid out by the previous HEPAP/P5 studies (2008)**
  - Recent results provide compelling evidence that the science focus is shifting "Beyond the Standard Model."
  - We are adapting the program to the science opportunities.
- **Though some of the boundary conditions have changed, we are still trying to implement the 2008 strategic plan within the current constraints**

- **We are currently actively engaged with community in developing new strategic plan through Snowmass/P5 process (2013-2014)**
- **Increased emphasis on broader impacts via accelerator stewardship**
- **Maintain leadership**
  - Focus on areas where US can have leadership
  - High impact science as opposed to incremental advances
- **P5 report will come out in May 2014**

# Cosmic Frontier – Planning

**At the Cosmic Frontier: US HEP has a leading role in a competitive, multidisciplinary environment.**

**→We follow PASAG criteria: Make contributions to select, high impact experiments:**

- That directly address HEP science goals
- That will make a significant, visible or leadership contribution
- Where HEP community contributions /expertise is needed – instrumentation, collaborations, analysis techniques etc.

PASAG criteria - Used for considering projects as well as research activities

**Current Planning - Projects**

- Dark Matter: working with NSF-PHY on planning one or more DM-G2 experiments
- Dark Energy: LSST camera fabrication project approved in FY14 (partnership NSF-AST); planning DESI (in coordination w/NSF-AST)
- Cosmic-ray, Gamma-ray: HAWC ending fabrication and full operations starts in FY14 (w/NSF-PHY); considering SPT-3G

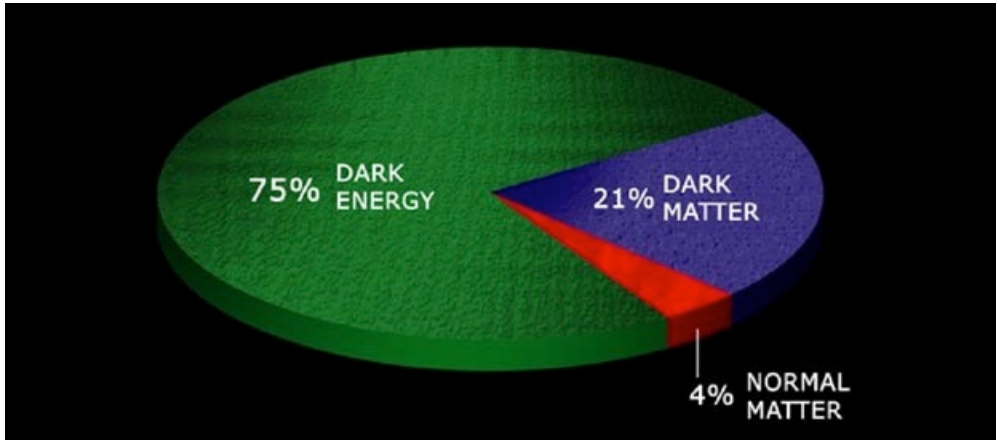
**Path Forward – Awaiting guidance from P5 on projects currently in the planning phase as well as other possibilities**

- DM-G2, DESI
- Cherenkov Telescope Array (CTA) contributions, Stage 4 CMB experiment (CMB-S4)

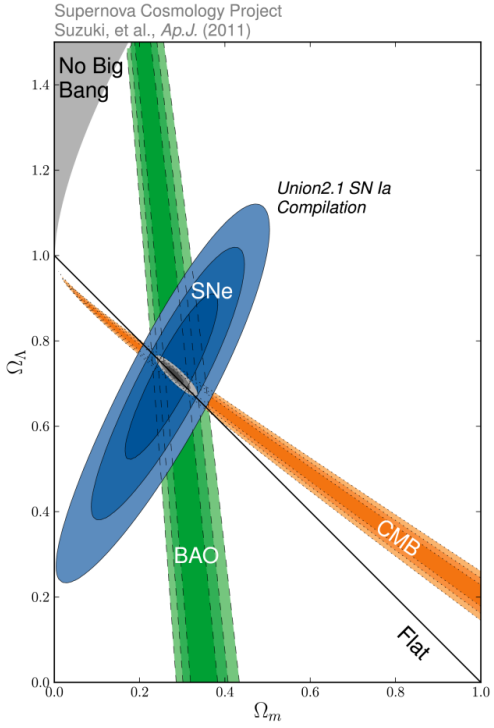
**→ Will further develop and optimize program following the Snowmass/P5 process.**

# Program Status →Cosmic Frontier

# Dark Energy Program - status




Have continuing balanced, staged program of Stage III → Stage IV experiments that use imaging or spectroscopic surveys to explore the nature of dark energy using complementary methods. Different methods probe different parameter space. Weak lensing will allow differentiation between cosmological constant or modification to General Relativity.



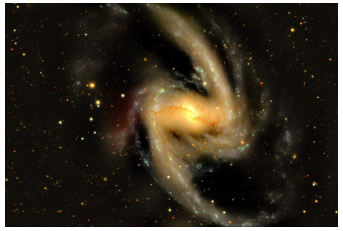

**Operating**

• Baryon Oscillation Spectroscopic Survey **(BOSS)**

Stage III spectroscopic survey using Baryon Acoustic Oscillation (BAO) method; 5 year operations completes in FY14

• Dark Energy Survey **(DES)**

Stage III imaging survey; 5 year ops started Sept 2013; partnership with NSF-AST; Joint Oversight Group (JOG) meets monthly



• Supernova surveys continue operations

# Dark Energy Program - planning

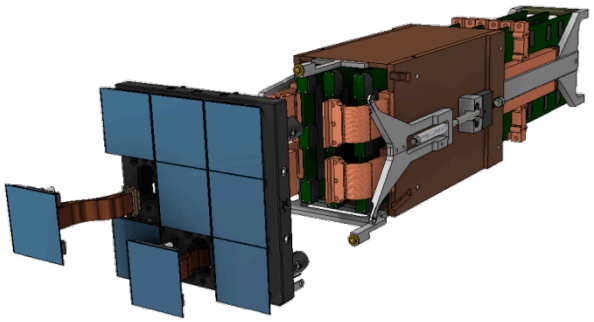
**Fabrication phase**

- Large Synoptic Survey Telescope **(LSST)**

Stage IV imaging survey

➔FY14 fabrication start for LSST-camera **approved!**

- Partnership with NSF-AST; MOU in place
- JOG meets weekly; brief OSTP regularly
- CD-3a review in May 2014; CD-2 review in 2015



**LSST - Science Raft Tower, Part of the DOE deliverables**

**Planning**

- Dark Energy Spectroscopic Instrument **(DESI)**

Stage IV spectroscopic survey to use BAO and Redshift Space Distortion (RSD) methods

- planning in coordination with NSF-AST
- Sept. 2012 CD-0 approved
- Jan. 2013 statement of agency principles signed
- April 2014 CD-1 review scheduled
- FY14 R&D support continuing

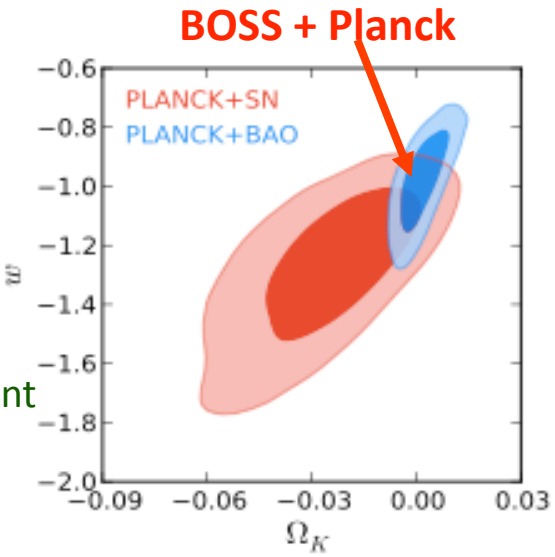
- extended BOSS **(eBOSS)** operations being considered

**Science effort,** but no "project" plans:

- WFIRST NASA Science Definition Team
- Euclid (ESA/NASA) space mission

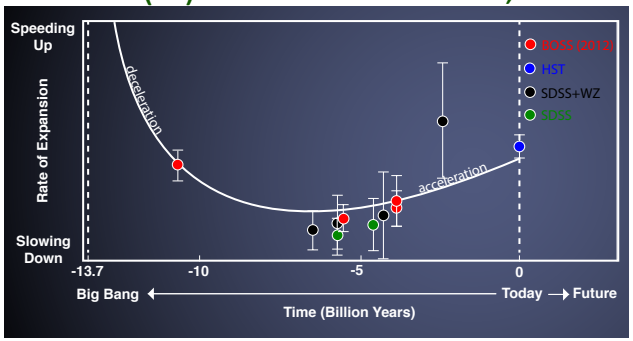
# Baryon Oscillation Spectroscopic Survey (BOSS)

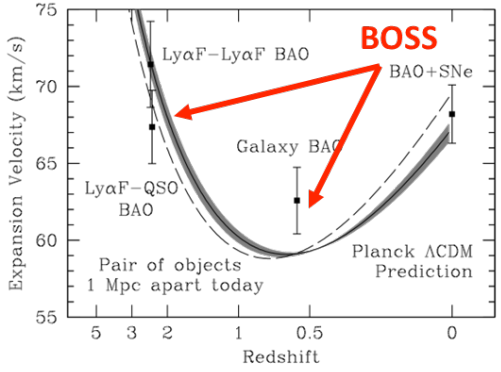
Dark Energy using Baryon Acoustic Oscillation (BAO) method
- first Stage-III dark energy experiment; 5 year survey completes in July 2014
- flagship survey on Sloan Digital Sky Survey (SDSS) Phase III at Apache Point Observatory in New Mexico; DOE funded spectrograph upgrade
- Mapping 3-D positions of 1.5 million galaxies & line-of-sight to 160,000 quasars using Lyman-alpha forest.
- Pending proposal for extended-BOSS (eBOSS) survey




**January 2014**: 1.0% distance measure from galaxy survey at z=0.55 is consistent with Einstein's Λ
- Supersedes all previous BAO results combined
- better than the accuracy of local measurements of the Hubble constant

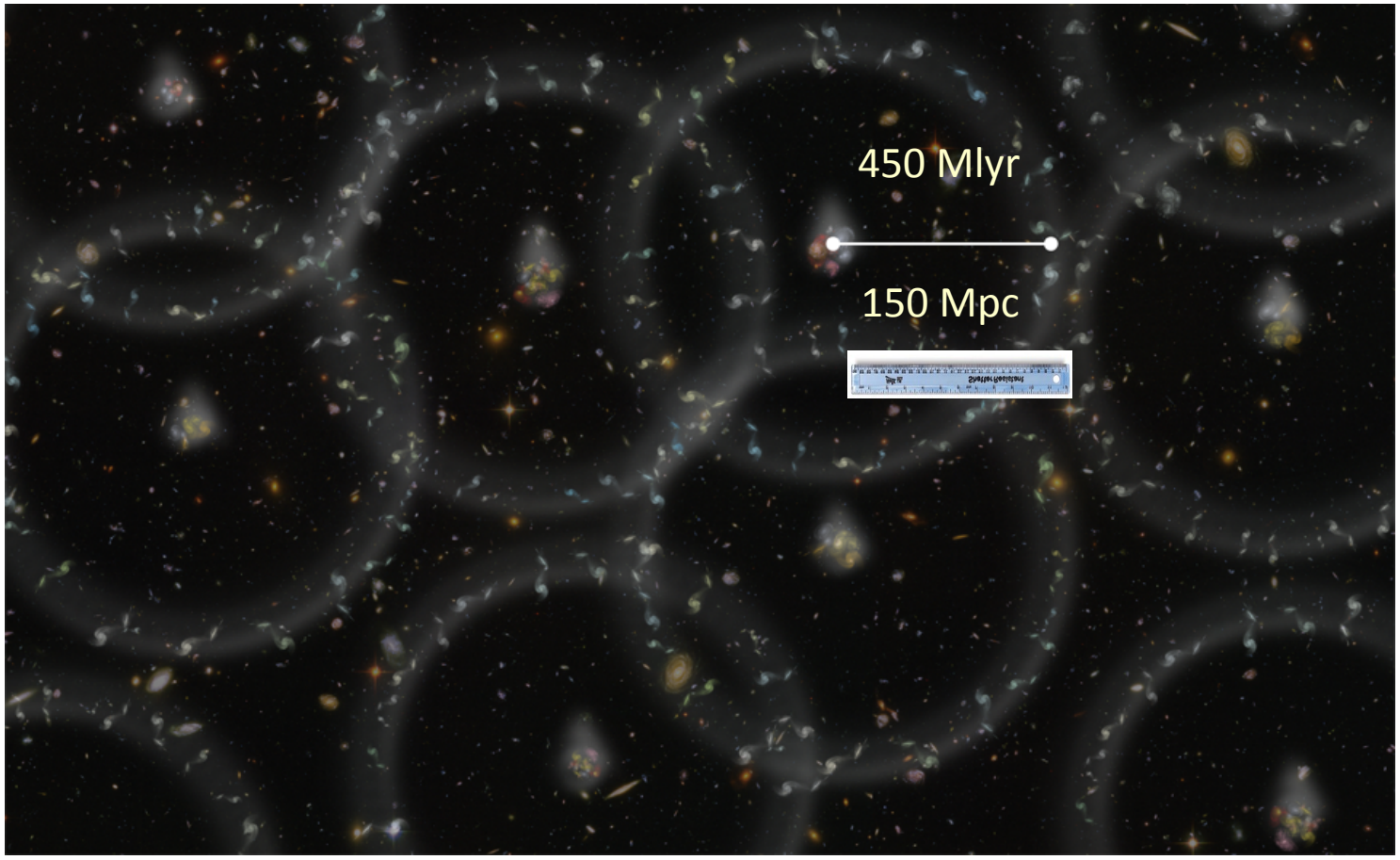
**November 2012**: 3% distance measure at z=2.3 from newly-demonstrated Lyman-alpha technique from distant quasars; results from 3X more data in prep. for **April 2014**
- First measurement showing the universe is decelerating ~ 10 billion years ago.
- Dark energy equation of state (*w*) measured to 10%, consistent w/Einstein's Λ



# Baryon Oscillation Spectroscopic Survey (BOSS)

**"BOSS measures the universe to 1% accuracy" using the BAO standard ruler**
**Pairs of galaxies more likely to be separated by 450 million light-years**



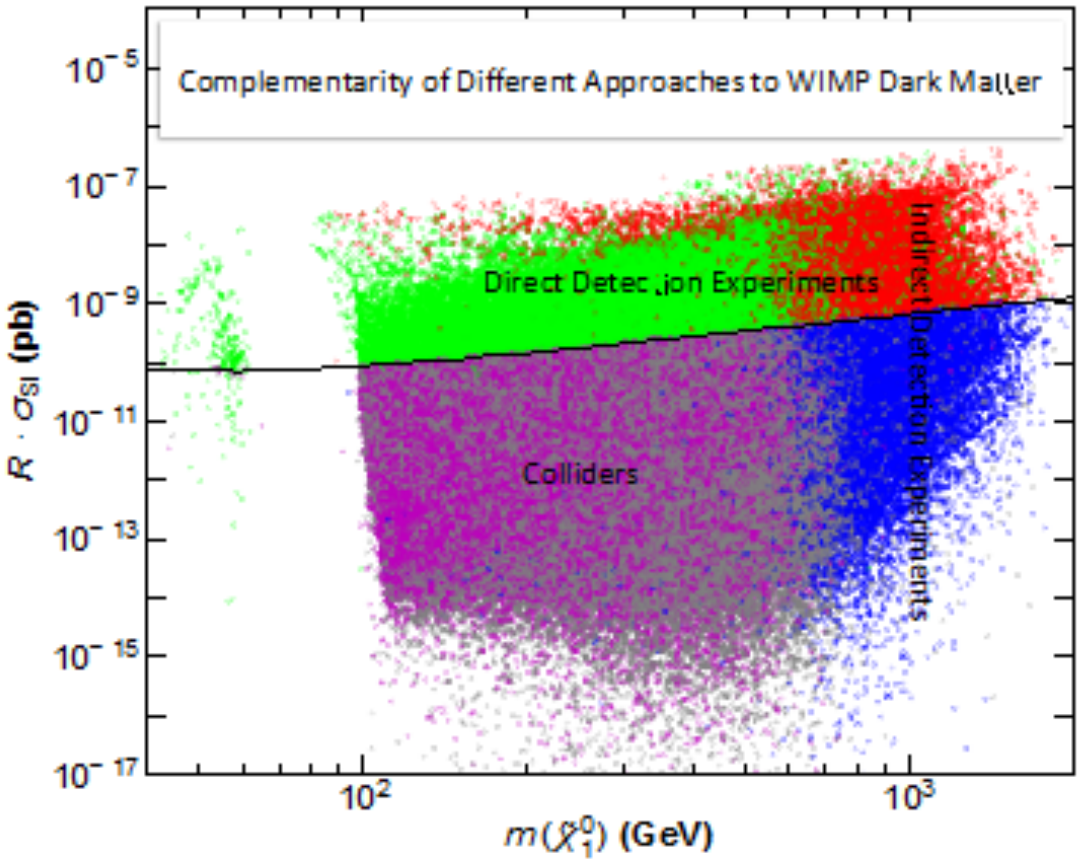

**Artist conception of baryon acoustic oscillations (BAO) from the early universe, imprinted on the distribution of galaxies. Credit: Z. Rostomian; Jan 2014 press release, http://www.interactions.org/cms/?pid=1033541**

# Complementary Methods for Dark Matter Detection

**Direct Detection**: Deep underground experiments directly measure interactions with DM WIMPs. These provide the most information on the nature of DM if detected.

**Indirect Detection**: Measure cosmic-ray byproducts of WIMP annihilation in the Galaxy.

**Particle Accelerators**: Production of new particle species in collisions; cannot determine if they are the DM, however.




These three methods cover all the possible ways of detecting WIMP dark matter.

# Dark Matter – Direct Detection Program Status

**→Have balanced, staged program of experiments w/multiple technologies in the near term.**

- **Done in coordination with NSF-PHY**

**Dark Matter "Generation 1" (DM-G1)**

**→current generation of commissioning or operating experiments will determine which of several promising technologies are best for larger searches.**

**Weakly Interacting Massive Particle (WIMP) searches:**

- **SuperCDMS-Soudan: cryogenic germanium**
- **LUX: liquid xenon**
- **DarkSide-50: liquid argon**
- **COUPP-60: bubble chamber fluids**

**Nature Magazine - 2013 in Review→LUX was rated the top story of the year.**

**Axion search:**

- **ADMX-2a: search for axions – dark matter candidates predicted in certain QCD models; would interact with strong magnetic fields to produce detectable photons**

# Dark Matter – Direct Detection Program Planning

➔Have a path forward for next phase of direct detection dark matter experiments

Dark Matter Generation 2 (DM-G2) experiments

Select the best technologies for dark matter searches that will be over an order of magnitude more powerful than those of Generation-1.

Sept. 2012 – approved Critical Decision 0 (CD-0) for DM-G2 experiment(s)

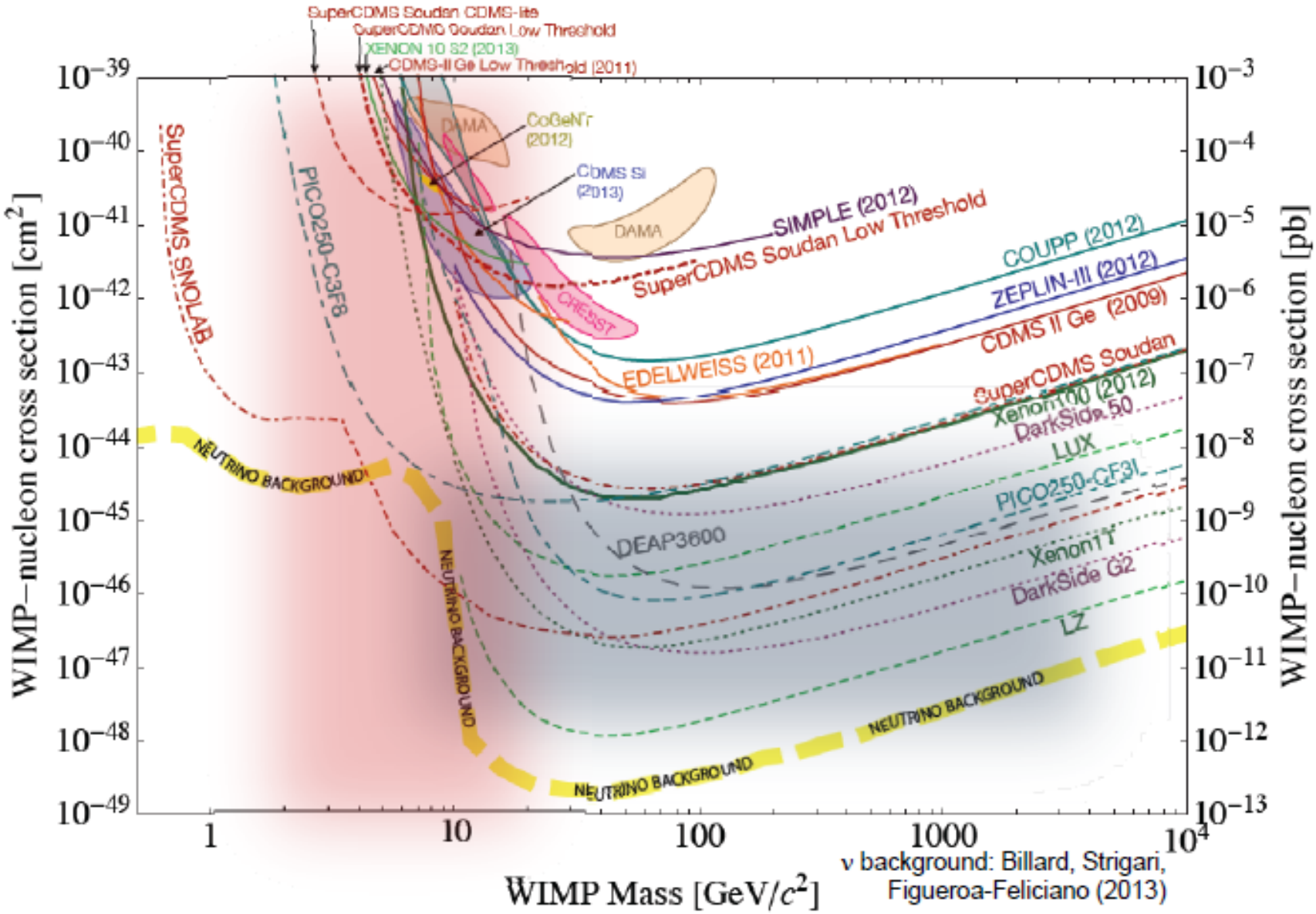
FY2013 (and continuing part-way through FY14)
– based on Sept 2012 review, R&D funding provided to:
SuperCDMS-SNOLab, LZ, DarkSide-G2, PICO-250, ADMX-G2

Dec. 2013 - down-select review for 1 or more DM-G2 experiments to move to the fabrication phase – results will be announced later in 2014

DM-G3 experiments

- G3 R&D and planning continues at a low level

# CURRENT STATUS AND FUTURE PROSPECTS




ν background: Billard, Strigari, Figueroa-Feliciano (2013)

# High Energy Cosmic-ray, Gamma-ray experiments

➔**Experiments measuring properties of high energy cosmic-rays & gamma rays; can also explore acceleration mechanisms and do indirect searches for dark matter candidates.**

**Operating**

**Alpha Magnetic Spectrometer – cosmic ray observatory in space**

**Pierre Auger - cosmic ray observatory in Argentina**

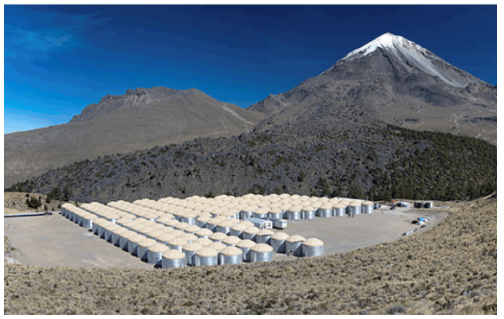
**Fermi Gamma-ray Space Telescope – gamma-ray observatory in space**

- Origin of Cosmic Rays (FGST) one of Science magazine's Top 10 Science Breakthroughs of the Year

**VERITAS – gamma-ray array in Arizona**

**Fabrication**

**HAWC – gamma ray array in Mexico; now partial operations with full operations starting August 2014**



**Construction on schedule and on budget: 194 of ~300 tanks are constructed (2/1/14)**

**Future Planning:**

- community planning on Cherenkov Telescope Array (CTA); will be considered by P5

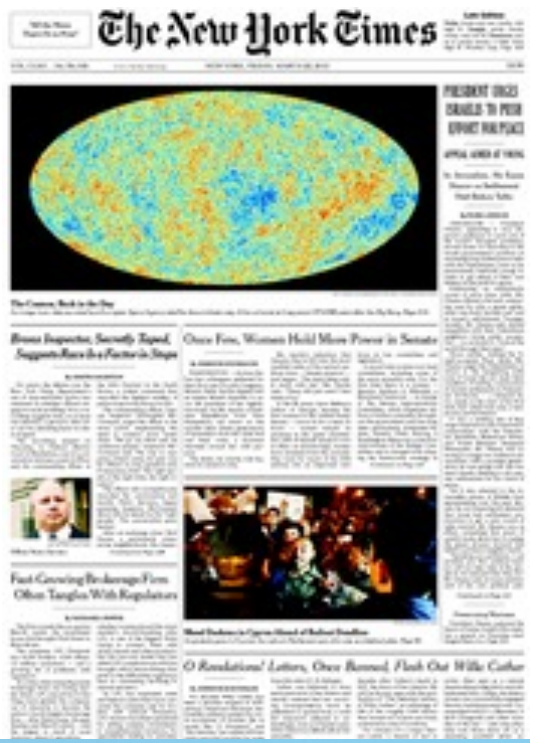
# Cosmic Frontier – Cosmic Microwave Background (CMB)

**CMB experiments:**

**HEP currently has small contributions to:**

- South Pole Telescope polarization (SPTpol)
  - HEP provided outer-ring detectors
- Planck
  - supercomputing resources for data analysis at NERSC (DOE & NASA MOU)

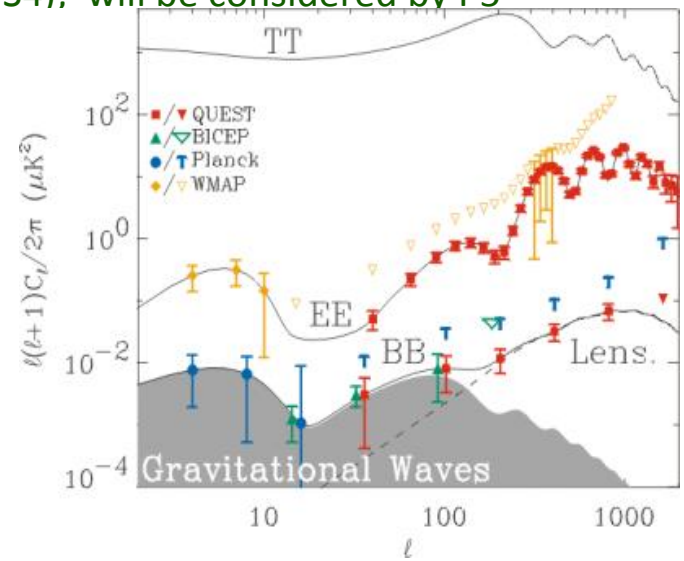
Planck →




**Future Planning**

SPTpol-3G – HEP considering participation in major upgrade to replace the camera with a larger focal plane with 2539 multi-chroic pixels (total of 15,234 detectors) to greatly increase sensitivity

CMB Future: Community is developing science case and concept for a Stage-IV CMB experiment (CMB-S4); will be considered by P5




SPT is the first CMB telescope to measure "B-mode" polarization in the CMB

# Grants Process – FY14

# Cosmic Frontier – Research Model & Opportunities

**Considerations for Research Support**

**➔can use same PASAG criteria and considerations in program model**

- Priority is to support efforts in our program, where we have responsibility for experiment
- People working in HEP collaboration model – long term commitments, responsibilities, % effort
- Increasing university involvement in dark energy, dark matter
- Change distribution between thrusts as we go forward to support changing program

**Reviews - for Research Funding Opportunities**

Sept. 2013 – Cosmic Frontier comparative review of Lab research programs (held every 3 years)
Nov. 2013 – Cosmic Frontier comparative review of Grant Proposals
Jan. 2014 – Comparative review of Early Career lab & university proposals

# Cosmic Frontier: Research Grant Statistics

## Statistics on Received/Funded grants

| | FY12 | | | FY13 | | |
|---|---|---|---|---|---|---|
| | Amount | #proposals | # PI's | Amount | #proposals | # PI's |
| Request | $3.3M | 11 | 21 | $7.7M | 28 | 53 |
| Funded | $1.6M | 5 | 12 | $3.4M | 20 | 28 |
| **Success rate** | **48%** | **50%** | **60%** | **44%** | **71%** | **53%** |

**FY14: Still in process so funding rate is TBD**

| | FY14 | | |
|---|---|---|---|
| | Amount | #proposals | # PI's |
| Request | ~$7-8M | ~ 30 | ~ 40 |
| Funded | | | |
| **Success rate** | | | |

# Full Funding of Multi-Year Grants

- **Beginning FY14, DOE/SC will transition to full funding of multi-year grants and/or cooperative agreements received from academic institutions with total cost less than $1M.**
  - **"Full funding" implies funds for the *entire award* for the project period is obligated at the time the award is made, instead of funding year-by-year.**
- **Logistics on full funding:**
  - **Process for full funding applies to new, renewal, or supplemental grant awards that are made after the merit review process.**
  - **Transition is planned over the course of five years.**
  - **Grants and cooperative agreements with total cost of $1M or more – integrated over the project period approved for the proposal – are exempt from the transition.**
- **During the submission of a proposal along with conducting its merit review and making decisions on the award:**
  - **There will be no change to how an applicant applies for a grant or cooperative agreement.**
  - **There will be no change to the merit review process.**
  - **There will be no change to DOE Program Managers requesting revised budgets from PIs.**
- **DOE Program Managers (PM) will continue to have oversight of the research program by requiring PIs to submit an annual research performance progress report that must be approved by the PM prior to any funds being accessed by the PI the following year.**
- **SC program offices, including HEP, will aim to carry out the transition in a way that minimizes impacts on the scientific community and the mission needs served by the office.**

# Summary

# Awards & Recognition

FGST:  Cosmic Particle Accelerators Identified
http://www.sciencemag.org/content/342/6165/1438.1.summary

Planck results #3 in Science News Top 25 of 2013
https://www.sciencenews.org/article/top-25-science-stories-2013-microbes-meteorites

Nature Magazine: 2013 in Review. The LUX dark matter search result was rated the top story of the year.
http://www.nature.com/news/no-sign-of-dark-matter-in-underground-experiment-1.14057

The South Pole Telescope's detection of b-mode polarization in the CMB made the top ten results of 2013 in Physics World:
http://physicsworld.com/cws/article/news/2013/dec/13/cosmic-neutrinos-named-physics-world-2013-breakthrough-of-the-year

**Roger Blandford (SLAC/Stanford) – KIPAC Director**
**- He was *awarded* with the Gold Medal of the *Royal Astronomical Society* in 2013.**

**Josh Frieman (FNAL/U.Chicago) - DES Project Director**
**- He was named honorary fellow of the Royal Astronomical Society (UK)**

# Summary

**Cosmic Frontier: Lots of results coming out or expected soon in all areas.**

**Have plan forward & working to implement it:**

- Dark Energy: LSST-camera (approved!), DESI
- Dark Matter: DM-G2
- Other possibilities: awaiting P5 report (May 2014)

# Backups

# FY14 HEP Budget -Guidance

- **FY 2014 Appropriations Conference Act 1/13/14**
  - **Within available funds, the agreement provides . . . $26,000,000 for the Long Baseline Neutrino Experiment (LBNE), to include $10,000,000 for research and development and $16,000,000 for project engineering and design. The agreement includes no funds for long-lead procurements or construction activities for the LBNE project.**
  - **Within available funds, the agreement provides $15,000,000 to support minimal, sustaining operations at the Homestake Mine in South Dakota . . .**
  - **Within available funds, the agreement provides . . . $9,931,000 for Accelerator Stewardship . . .**
  - **Per the funding table in the report, $35,000,000 is provided for the Muon to Electron Conversion Experiment.**

# FY14 HEP Budget Planning

**In the last few years, the HEP budget philosophy has been to enable new world-leading HEP capabilities in the U.S. through investments on all three frontiers**

**- To be accomplished through ramp-down Research (~ -6%) & existing Project operations**

**FY 2014 Request:**

- Muon g-2 experiment was the only requested new start in HEP that was not requested in FY13
- LSST-camera and Belle-II were requested again in FY14

This upsets several major features of our budget strategy:

- Strategic plan : "trading Research for Projects"
  - Several new efforts are delayed and continue in R&D phase (some funded in Research): Large Hadron Collider (LHC) detector upgrades, Long Baseline Neutrino Experiment (LBNE), 2nd Generation Dark Matter (DM-G2) detectors, Dark Energy Spectroscopic Instrument (DESI) experiment
- Implementation of facilities balanced across Frontiers
- Leveraging strategic partnerships with domestic and foreign agencies

# FY14 HEP Budget – Approved

**FY 2014 Budget Appropriations & Guidance:**

Projects Approved:

- LSST-camera MIE-fabrication start - we can provide full planned funding ($22M in FY14)
- Belle-II MIE-fabrication start
- Muon g-2 MIE-fabrication start
- Muon to Electron conversion (m2e) experiment Project Engineering & Design (PED) and Construction funds approved

Other

Specific guidance in approved Budget for the additional $21M provided over the Request:

- Long Baseline Neutrino Experiment (LBNE) – $26M in R&D & PED funds **($16M in PED over Request)**
- Homestake Mine Operations - $15M provided **(specific guidance was $5M over Request)**

| Projects & Other info in Budget (in $M) | FY14 President's request | FY14 Final Approp. |
|---|---|---|
| MIE Belle-II | 8 | 8 |
| MIE Muon g-2 | 9 | 9 |
| MIE LSST camera | 22 | 22 |
| Line item R&D - LBNE | 10 | 10 |
| Line item PED - LBNE | 0 | 16 |
| Line item Const - m2e | 35 | 35 |
| Operations: Homestake Mine | 10 | 15 |

# Snowmass – community scientific input

- **Snowmass 2013 process – community input on science directions:**
  - ✓ **What are the most compelling science questions in HEP that can be addressed in the next 10 to 20 years and why?**
  - ✓ **What are the primary experimental approaches that can be used to address them?**
    - **are they likely to answer the question(s) in a "definitive" manner *or* will follow-on experiments be needed?**
  - ✓ **What are the "hard questions" (science, technical) that a given experiment or facility needs to answer to respond to perceived limitations in its proposal?**


**These topics are covered in the Snowmass reports and White Papers**

- **P5 will use these reports and white papers as its starting point.**
- **Draft Summary Working Group Reports available on the P5 webpage: *http://www.usparticlephysics.org/p5***

# P5 Strategic Planning Process
## http://www.usparticlephysics.org/p5/

- **P5 will assess and prioritize HEP projects over a 20-year timeframe within reasonable budget assumptions and position the U.S. to a be a leader in some (but not all) areas of HEP.**
  - **Identify priorities with 10-year budget profiles but may well extend past the next decade**
    - **consider technical feasibility as well as fiscal plausibility of future projects that can be executed in a 20-year timescale.**
  - **Scenario A: FY 2013 budget baseline: flat for 3 years, then +2% per year.**
  - **Scenario B: FY 2014 President's budget request baseline: flat for 3 years, then +3% per year.**
    - **difference between Scenarios A and B integrated over the 10-year period: ~$540M**
  - **Scenario C: Unconstrained budget scenario. Beyond A and B, prioritize *"… specific activities … … needed to mount a leadership program addressing the scientific opportunities identified by the research community."***
  - **This will include an explicit discussion of the necessity (or not) of domestic HEP facilities in order to maintain such a world leadership position.**
  - **Consideration of possible international partnerships will be required.**
  - ***Charge: "[P5] report should articulate the scientific opportunities which can and cannot be pursued and the approximate overall level of support that is needed in the HEP core research and advanced technology R&D programs to achieve these opportunities in the various scenarios."***

**P5 Reports: Final P5 report due by May 1, 2014 (interim March 1)**

# Customized Implementation Strategies

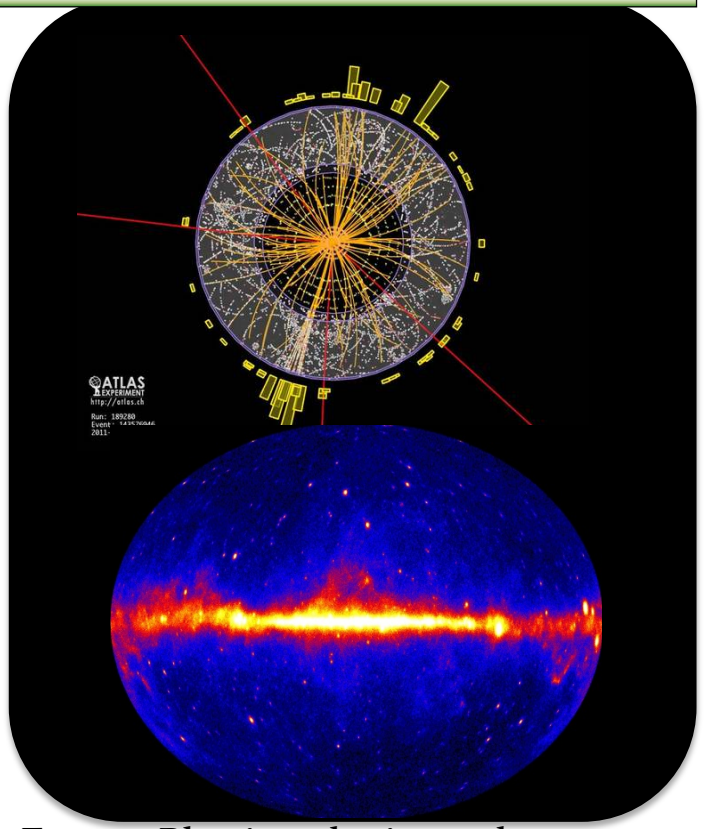
- **Energy Frontier**
  - US has a leading role in LHC physics collaborations but is not the **driver**
    - The issue is the scope and scale of US involvement. Requires US-CERN negotiation.
    - Could also be true for Japanese-hosted ILC but requires *deus ex machina*
- **Intensity Frontier**
  - US is a (the?) world leader and needs new facilities and/or upgrades of existing facilities to maintain its position
    - Has the potential to attract new partners to US-led projects if we can get going
    - Portfolio of experiments and science case is diverse. This complicates the case. The scale of the projected investments is a big challenge
- **Cosmic Frontier**
  - US HEP has a leading role in a competitive, multidisciplinary environment
    - Technologies are diverse but HEP physics case is simple and compelling. Only question is how far one needs to go in precision/setting limits.
    - DOE is a technology enabler, not a facilities provider (see NSF, NASA)
      - Analogous to LHC but the HEP physics goals are not those of the facility owners
    - DOE supports particle physics goals and HEP-style collaborations
      - Astronomy and astrophysics is not in our mission nor our *modus operandi*

# From Deep Underground to the Tops of Mountains, HEP pushes the Frontiers of Research

**RESEARCH AT THE ENERGY FRONTIER —** HEP supports research where powerful accelerators such as the LHC are used to create new particles, reveal their interactions, and investigate fundamental forces, and where experiments such as ATLAS and CMS explore these phenomena.

**RESEARCH AT THE INTENSITY FRONTIER —** Reactor and beam-based neutrino physics experiments such as Daya Bay and LBNE may ultimately answer some of the fundamental questions of our time: why does the Universe seem to be composed of matter and not anti-matter?

**RESEARCH AT THE COSMIC FRONTIER — Through ground-based telescopes, space missions, and deep underground detectors, research at the cosmic frontier aims to explore dark energy and dark matter, which together comprise approximately 95% of the universe.**




**THEORY AND COMPUTATION —** Essential to the lifeblood of High Energy Physics, the interplay between theory, computation, and experiment drive the science forward. Computational sciences and resources enhance both data analysis and model building.

**ACCELERATOR SCIENCE —** Supports R&D at national labs and universities in beam physics, novel acceleration concepts, beam instrumentation and control, high gradient research, particle and RF sources, superconducting magnets and materials, and superconducting RF technology.

# HEP Program Model

**DOE Office of Science: We are a science mission agency**

- Provide science leadership and support to enable significant advances in specific science areas
- Lab environment with a variety of resources needed to design, build, operate selected facilities & projects
- Lab infrastructure, including computing facilities (NERSC, SCiDAC program etc)
- Encourage scientific teams with expertise in required areas to participate in all phases → science results.
- Partnerships as needed to leverage additional science and expertise (e.g. use other agency's facilities)

**High Energy Physics**

- **We develop and support a specific portfolio of selected facilities & experiments to obtain the science**

-- support a science collaboration in all stages, leading to the best possible science results

**Cosmic Frontier:**

Design and build instrumentation; led by scientific collaborations; bring other resources (e.g. computing, operations) & use other agency's facilities (e.g. telescopes) when needed.

**→ Our model also brings significant new capabilities in terms of instrumentation, and coordinated computing, simulation and analysis efforts that provide impacts & resources to the astronomy community.**

**Model has been very successful:**

See http://science.energy.gov/about/honors-and-awards/doe-nobel-laureates/

# HEP Program Guidance

**FACA panels & subpanels – official advice:**

- **High Energy Physics Advisory Panel (HEPAP)**
  - reports to DOE and NSF; provides the primary advice for the program
  - Subpanels for detailed studies (e.g. PASAG, P5)

- **Astronomy and Astrophysics Advisory Committee (AAAC)**
  - reports to NASA, NSF and DOE on areas of overlap

**Other:**

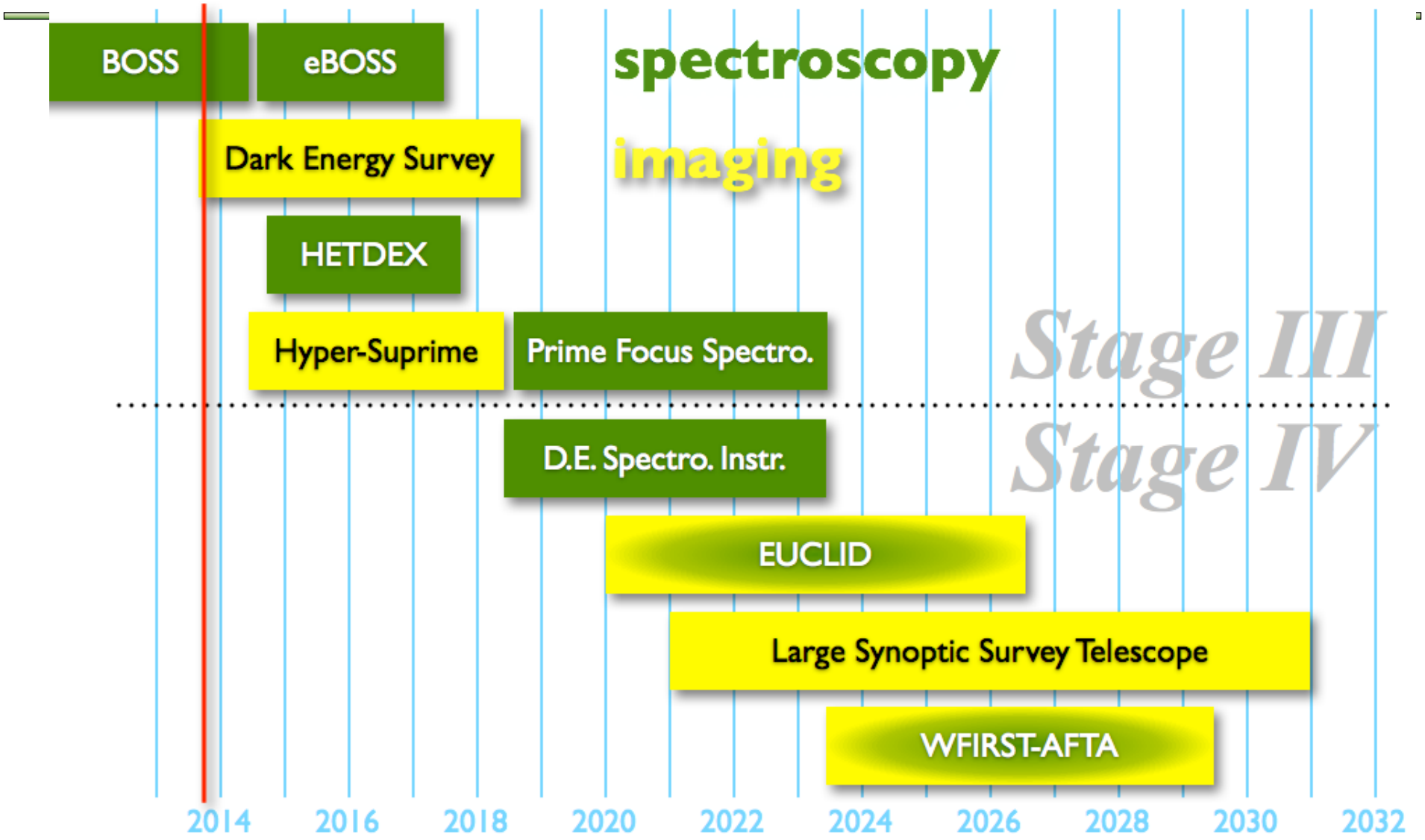
e.g. National Academies of Science studies, community science studies, reviews, etc.

**Strategic Program Planning → Have been following the 2008 P5 program plan**

**→Recently embarked on new strategic planning process:**
**Snowmass + P5 (May 2014 reports)**

# Recent Major Accomplishments : Cosmic Frontier

- **April 2013: The Alpha Magnetic Spectrometer (AMS) on the International Space Station observes structure in the cosmic ray positron spectrum that is consistent with Dark Matter annihilation in our Galactic halo.**
  - If the source really is a Dark Matter particle, its mass would be > 500 GeV
  - Need several more years of operation to achieve an "indirect detection," or determine if the origin is instead from "conventional" astrophysics (e.g., pulsars)
- **April 2013: The Cold Dark Matter Search (CDMS) team observes 3 events in their underground detectors that appear to be DM particles, but the significance (99.8% confidence level) is too low to claim a discovery.**
  - If the source really is a Dark Matter particle, its mass would be ~10 GeV.
  - If it is Dark Matter, would expect to confirm and learn about its particle properties in the Second-Generation set of DM experiments.


BOSS
eBOSS
spectroscopy
Dark Energy Survey
imaging
HETDEX
Hyper-Suprime
Prime Focus Spectro.
Stage III
D.E. Spectro. Instr.
Stage IV
EUCLID
Large Synoptic Survey Telescope
WFIRST-AFTA
2014
2016
2018
2020
2022
2024
2026
2028
2030
2032

# Baryon Oscillation Spectroscopic Survey (BOSS)

**Science:** Dark Energy using Baryon Acoustic Oscillation (BAO) method. The data is also of use to the wider astronomical community. This is the first Stage-III dark energy experiment

- Mapping 3-D positions of 1.5 million galaxies & line-of-sight to 160,000 quasars using Lyman-alpha forest.
- All data made public in a freely-available, user-friendly database.

**Description**:
BOSS is the flagship survey on the Sloan Digital Sky Survey (SDSS) Phase III at Apache Point Observatory in New Mexico; DOE funded the SDSS spectrograph upgrade needed for BOSS

**Partnership**: DOE, NSF, the Sloan Foundation, and private and foreign institutional contributions
**Collaboration**: ~ 160 scientists from ~ 15 US institutions and UK, Brazil, Germany, France, Japan
**HEP funding**: LBNL (project office), BNL, Utah, Yale, OSU, Michigan, UC-Irvine

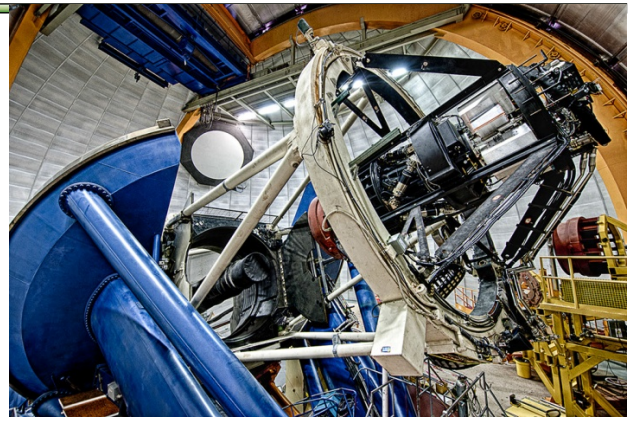
**Status:**

- 5-year survey of 10,000 sq deg will complete in July 2014
- Pending proposal for extended-BOSS (eBOSS) survey

Status – Feb 2014

# Dark Energy Survey (DES)

**Science**: Stage-III dark energy experiment using imaging survey

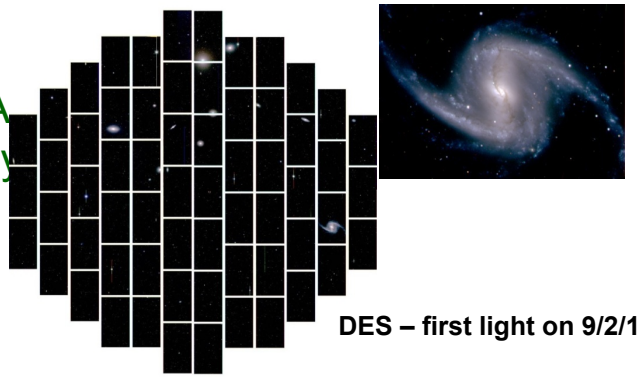


**Description:**

• HEP supported fabrication of Dark Energy camera (DECam), managed by Fermilab, now installed on Blanco telescope at CTIO (Chile), and supporting survey operations
• NSF supporting telescope operations and data management

**Partnership**: DOE/NSF partnership + private & foreign contributions; JOG meets monthly

**Collaboration**: 4 DOE labs (FNAL lead, ANL, SLAC, LBNL), NOAO, CTIO, NCSA, 20 universities from US, Spain, UK, Brazil, Germany, Switzerland

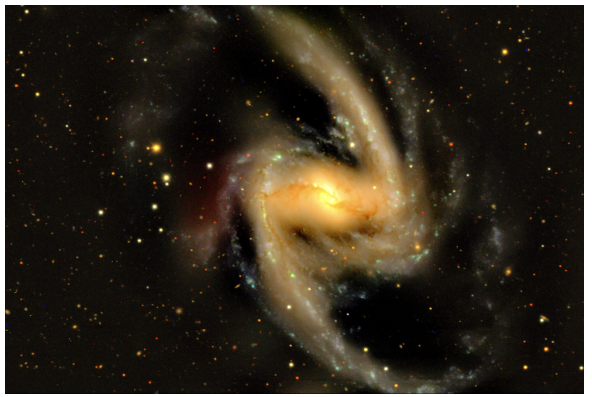


DES – first light on 9/2/12

**HEP funding**: FNAL, ANL, SLAC, LBNL, BNL, Illinois, Michigan, Penn, OSU, UCSC

**Status**:

- first light 9/12/12; Science Verification Nov. '12-Feb. '13
- first season of 5-yr survey Aug. 31, 2013-Feb. 9, 2014 went well
- first science results (from Science Verification) coming out this year



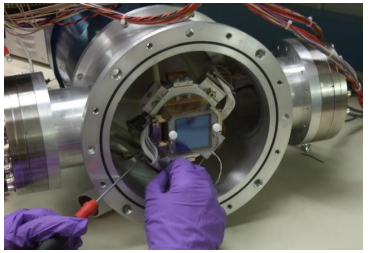
# Future Planning →
# Large Synoptic Survey Telescope (LSST)

**Science:**

- DOE's interest is the nature of Dark Energy, causing the expansion of the universe to accelerate.
- The data will also be used by the wider community for a variety of astronomical measurements.
- The optical/NIR imaging survey will be used for a variety of dark energy methods, especially weak lensing.

**Project:**

- New 8.4 m telescope facility and associated instrumentation on Cerro Pachon (8,800 ft) in Chile.
- NSF is the lead-agency, responsible for telescope & data management;
- DOE is responsible for the 3-billion pixel imaging camera (LSSTcam), managed by SLAC.

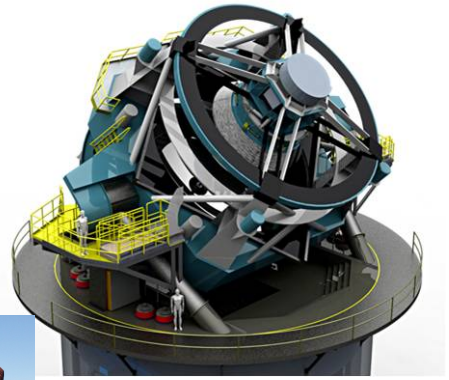


**Partnership:** DOE & NSF (MOU July 2012), with contributions from private and foreign institutions
-DOE/NSF Joint Oversight Group (JOG) meets weekly

**Science Planning:** Dark Energy Science Collaboration (DESC) formed to start preparations for precision analyses.
- Started in 2012 and will continue to grow; collaboration with mix of expertise needed to plan for data analysis to get precision dark energy results

**Status (LSST Project)**

- Critical Decision 1 (CD-1) approved for LSST-camera in Feb. 2012
- FY 2013 – DOE wasn't able to get a fabrication-start approved for LSSTcam
- FY 2014 President's Request budget for DOE includes fabrication start for **LSSTcam**
- FY 2014 President's Request budget for NSF includes MREFC funds for LSST construction
- NSF Final Design Review in December to support going to the NSB in 2014



On Cerro Pachon

Status – Feb. 2014

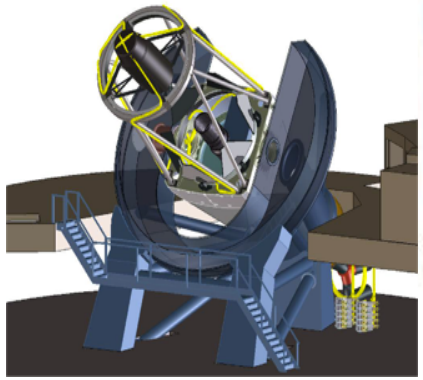
# Dark Energy Spectroscopic Instrument (DESI)

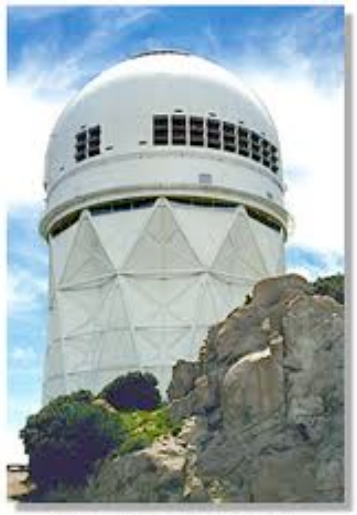
**Science**:

HEP community dark energy science plan (August 2012) identified a wide-field spectroscopic survey to carry out a Stage IV dark energy program using the Baryon Acoustic Oscillations and Redshift Space Distortions methods as a high priority medium-scale project to maintain US leadership in this area.
- DESI will complement the DES → LSST imaging surveys

**Description**:

- Proposed Project will build a new spectrograph for existing telescope
- HEP would provide operations support for use of the telescope facility





Mayall 4-Meter Telescope

**Partnership:** DOE, with foreign and private contributions

**HEP funding**: LBNL (Project Office) + SLAC, FNAL, ANL, BNL, Ohio State, U Michigan, Yale, Pittsburgh, CMU,Utah, Irvine , etc

**Status:**

9/18/12 -- Critical Decision 0 (CD-0) for MS-DESI experiment approved
Jan. 2013 – DOE and NSF signed a statement of agency principles
Dec. 2013 – NSF to defer decision on new partnerships for Mayall until after P5 reports
Apr. 2014 – Lehman review for CD-1
FY14 – R&D support continuing

Status – Feb. 2014

# CDMS – Cryogenic Dark Matter Search

**Direct Detection WIMP search by enhanced phonon production by drifting ionization electrons in stronger electric field.**

**Partnership: DOE and NSF, with contributions from Canada**
**Collaboration: 80 scientists from 13 US universities & 2 labs, plus institutions from Canada and Spain.**

**Status:**

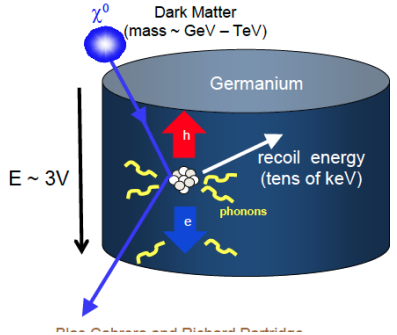
- **CDMS II (4 kg Ge) operated at Soudan in 2004-2009**
- **SuperCDMS-Soudan: (9 kg Ge) taking data in 2012-2014+ in Soudan mine (Minnesota)**
- **SuperCDMS-SNOLab: (200kg Ge) – awarded FY13 DM-G2 R&D funding; awaiting down-select review results; for installation at SNOLab (Canada)**

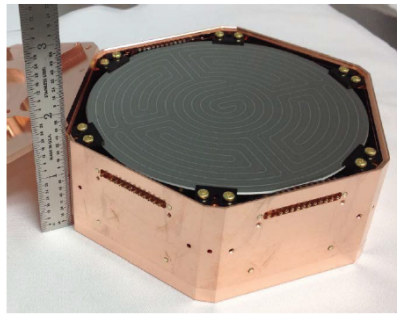
**Recent News:**

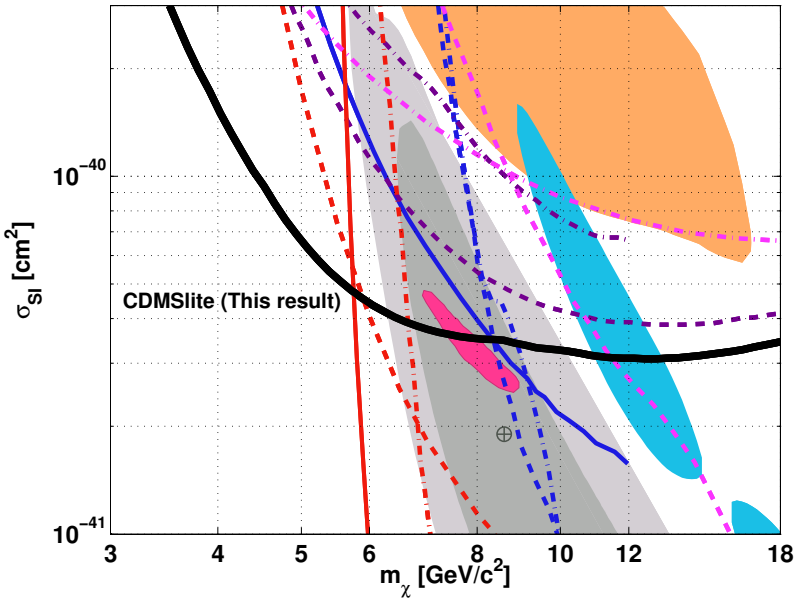
**Sept 12, 2013: The CDMS collaboration demonstrated a new way of operating their detectors with a higher voltage bias (CDMSlite) and produced the world's best limits on light-mass dark matter particles.**

## Searching for Dark Matter with CDMS

- CDMS has pioneered the technique of searching for dark matter in cryogenic Ge crystals that detect both ionization and phonon signals to achieve nearly "0-background" sensitivity

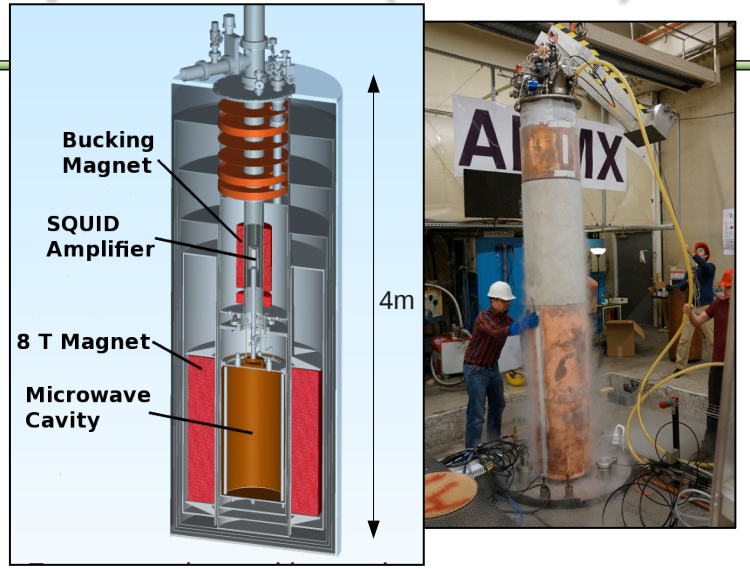




Status – Jan 2014

# Axion Dark-Matter eXperiment (ADMX)




→Detector consists of a cryogenically-cooled microwave cavity within the bore of a large superconducting 8 Tesla magnet (at Univ of Washington)

-The field and cavity induce nearby halo dark-matter axions to convert into microwave photons, which are then detected by an ultra-low-noise SQUID-based microwave amplifier/receiver.

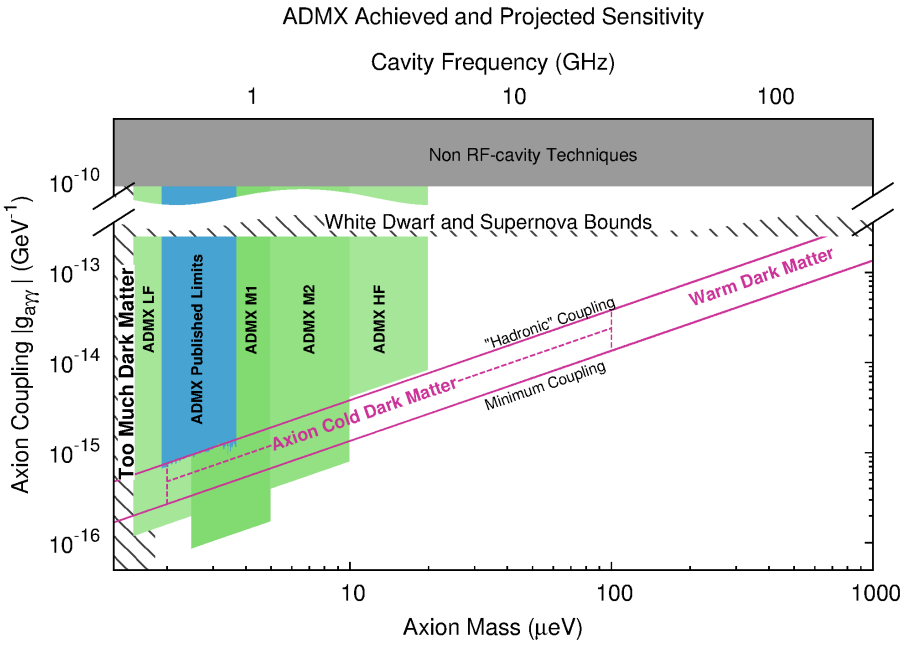
**ADMX-2a: Spring 2014 - install $^3$He cooling and continue data-taking, which ends ~ fall 2014.**

**ADMX-G2:**

- Received FY213 R&D funds; Awaiting downselect results of Dec. 2013 to determine next steps.
- Will include a large flow-rate dilution refrigerator which will deliver quantum-limited sensitivity, plus multi-mode parallel receiver chains for a very rapid search.
- This would be the "definitive axion search", with enough sensitivity to either detect the QCD dark-matter axion or reject the hypothesis at high confidence.

**Partnership: US (major DOE support), UK contributions w/ contributions from the U.K.**

**Collaboration: 23 scientists from 2 countries**

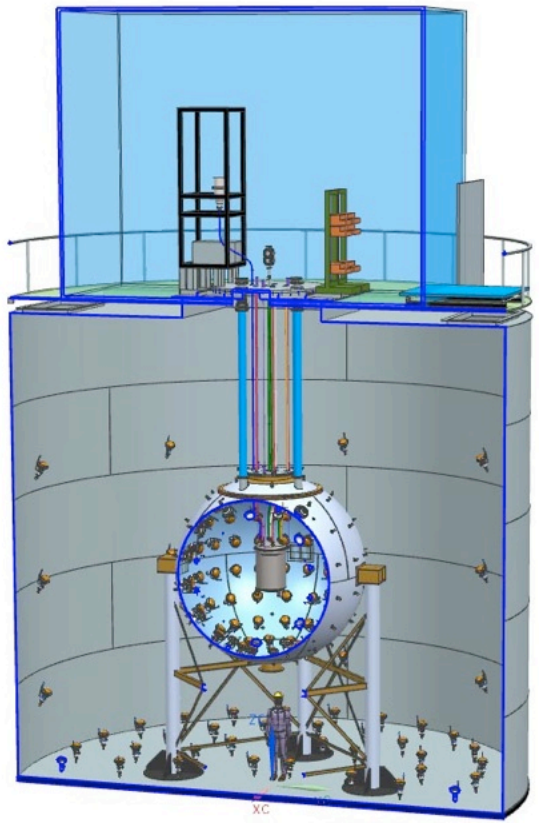


Status – Jan 2014

# DarkSide

## DarkSide-50kg:

- low radioactivity liquid Argon two-phase LAr time projection chamber (TPC), inside a 4m spherical Neutron Scintillator Veto, inside an existing 10m x 11m cylindrical water tank underground at Laboratori Nazionali del Gran Sasso (LNGS), Italy
- Aimed at sensitivity of $10^{-45}$ cm$^2$ for 100 GeV WIMP in 3 year run
- Currently taking data; 3 year run planned

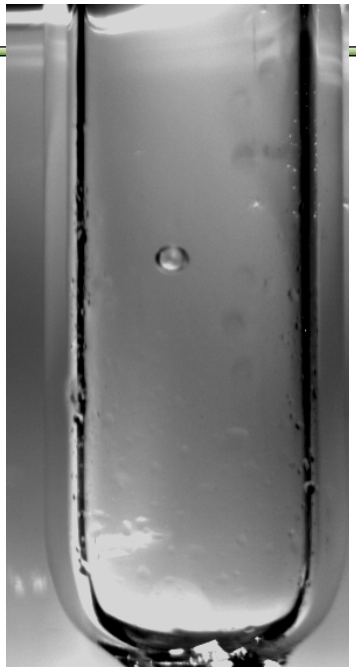


Collaboration: ~60 scientists at 26 institutions from China, France, Italy, Russia, Poland, Ukraine, US
Partnership: US (DOE, NSF) with major contributions from INFN

## DarkSide-G2

- 5 tons; sensitivity near x $10^{-47}$ cm$^2$ for 100 GeV WIMP
- FY13 R&D funds awarded; awaiting results of G2 downselect

# COUPP- Chicagoland Observatory for Underground Particle Physics + PICASSO → PICO



**Science: sensitivity to WIMPs scattering via either spin-dependent or spin-independent scattering on nuclei.**

**he detectors are continuously sensitive bubble chamber, with several target liquids ($CF_3I$, $C_3F_8$). Thermodynamic conditions for bubble nucleation are manipulated to make chambers insensitive to gamma backgrounds.**

**Partnership: DOE, NSF, Canada; located at SNOLab**
**Collaboration: recently joined with PICASSO → now PICO**

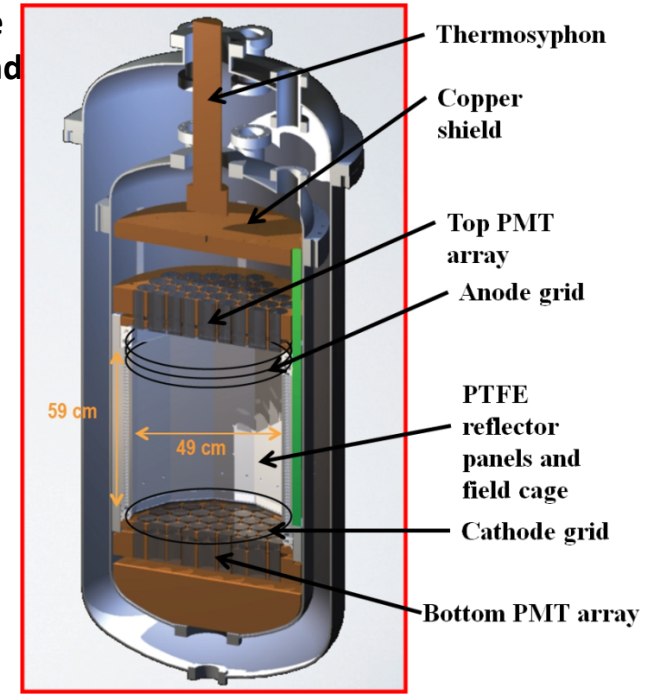
**Status:**
**COUPP-60kg: Installation at SNOLAB in 2012; data-taking started May 2013.**

**PICO-250L: Awarded FY13 DM-G2 R&D funding; awaiting results of DM-G2 downselect review**

Status – Jan 2014

# Large Underground Xenon (LUX) + ZEPLIN → LZ

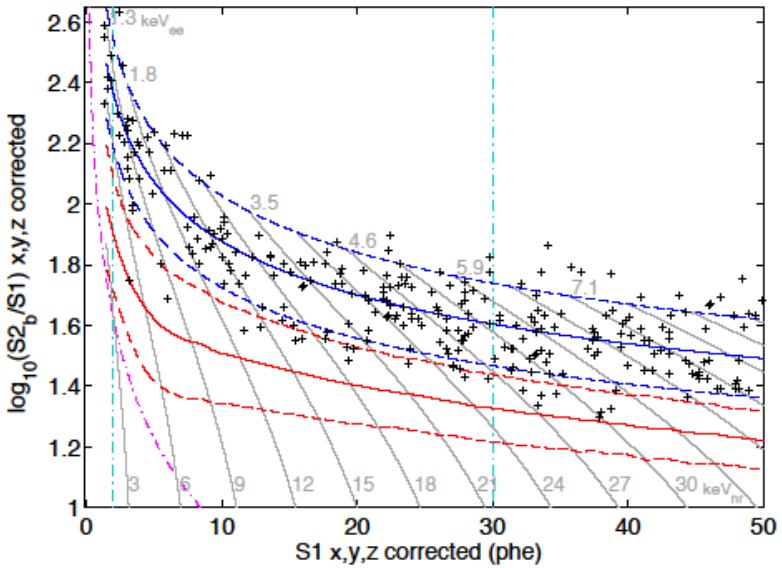
**LUX is the world's largest dual-phase Liquid Xe detector (350 kg); installed at the Sanford Underground Research Facility (SURF) in Davis cavern 4850' underground**
**-Will reach sensitivity to WIMP (60 GeV) of ~ 2 x $10^{-46}$ $cm^2$.**
**- 85 live-day run completed and results published**
**- next run starting ~ summer 2014**




Partnership: DOE & NSF partnership, contributions from UK, Portugal, Russia(LZ)
Collaboration: LUX: 19 institutions. LZ: 27 institutions

**LZ (LUX-ZEPLIN): 7 tons of Xenon and sensitivity near x $10^{-48}$ $cm^2$**

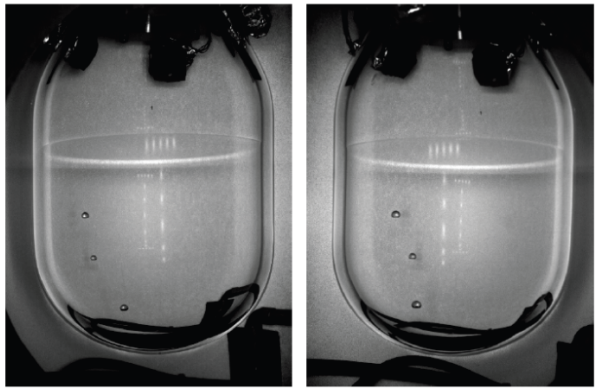
- **Awarded FY13 DM-G2 R&D funding; awaiting results of DM-G2 downselect review**



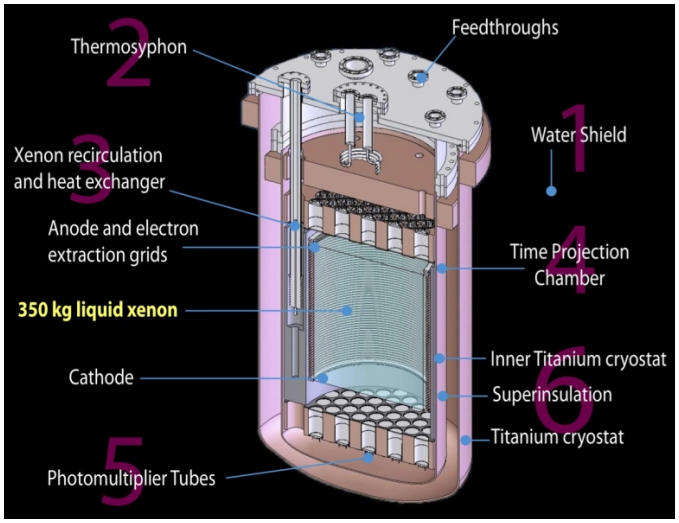

The LUX WIMP signal region. Events in the 118 kg fiducial volume during the 85.3 live-day exposure are shown. Vertical dashed cyan lines showing the 2-30 phe range used for the signal estimation analysis.

**Nature Magazine - 2013 in Review.**
**→LUX was rated the top story of the year.**

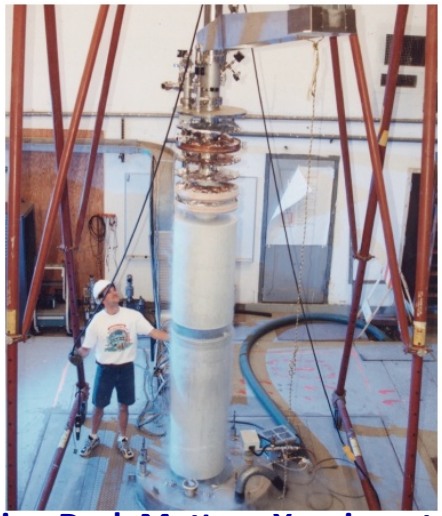
# Direct-Detection Dark Matter – Current "Generation 1" (DM-G1)



COUPP --PICO Bubble Chambers–SNOLAB
- Commissioning --operating




Large Underground Xenon (LUX) detector – Sanford Lab, Homestake mine – now operating, currently the world's most sensitive direct-detection DM detector.



Cryogenic Dark Matter Search (CDMS) at Soudan mine - germanium detectors
- operating

Axion Dark Matter eXperiment (ADMX) Phase-2a at U.Washington -commissioning; start science run in summer

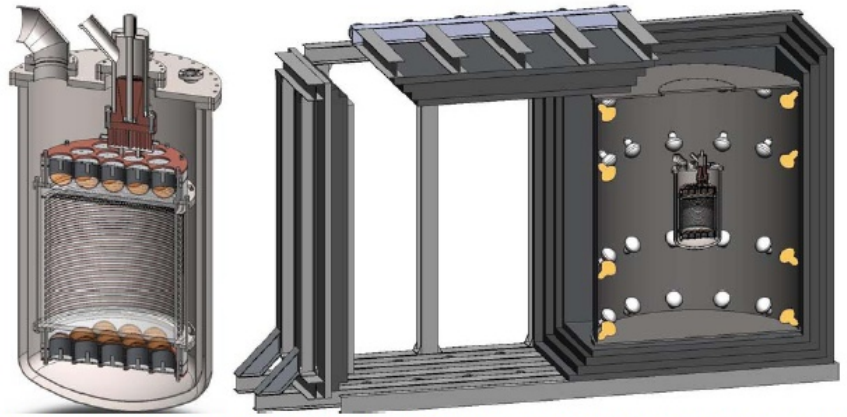


FIG. 5: (a) The DarkSide-50 internal detector. (b) The DarkSide-50 detector within the active liquid scintillator neutron veto and the passive shield.

DarkSide-50 – Dual-Phase liquid argon TPC at LNGS Gran Sasso; commissioning

# High Energy Cosmic-ray, Gamma-ray experiments

➔**Experiments measuring properties of high energy cosmic-rays & gamma rays; can also explore acceleration mechanisms and do indirect searches for dark matter candidates.**

**Operating**

**Alpha Magnetic Spectrometer – cosmic ray observatory in space**
**Pierre Auger - cosmic ray observatory**
**Fermi Gamma-ray Space Telescope – gamma-ray observatory**
**VERITAS – gamma-ray array in Arizona**

**Fabrication**

**HAWC – gamma ray array in Mexico; now partial operations with full operations starting August 2014**

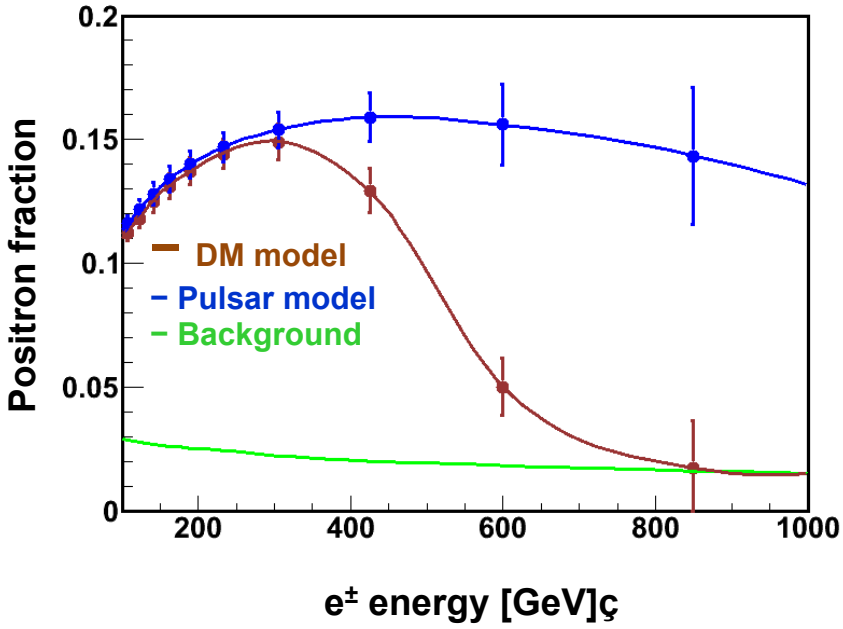
**Future Planning:**

- community planning on Cherenkov Telescope Array (CTA)

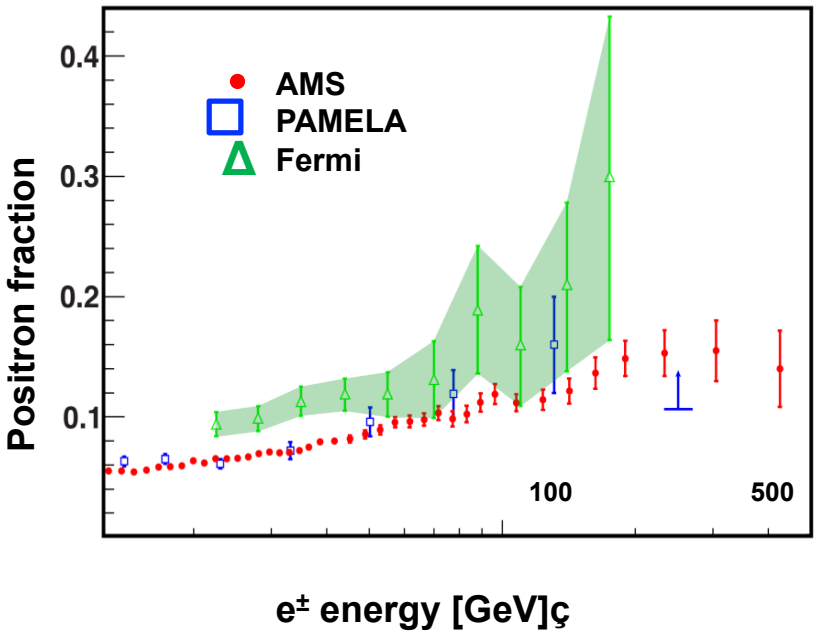
# AMS today

# AMS: Searching for Dark Matter in Space

**Positron Fraction at High Energy Predicted**

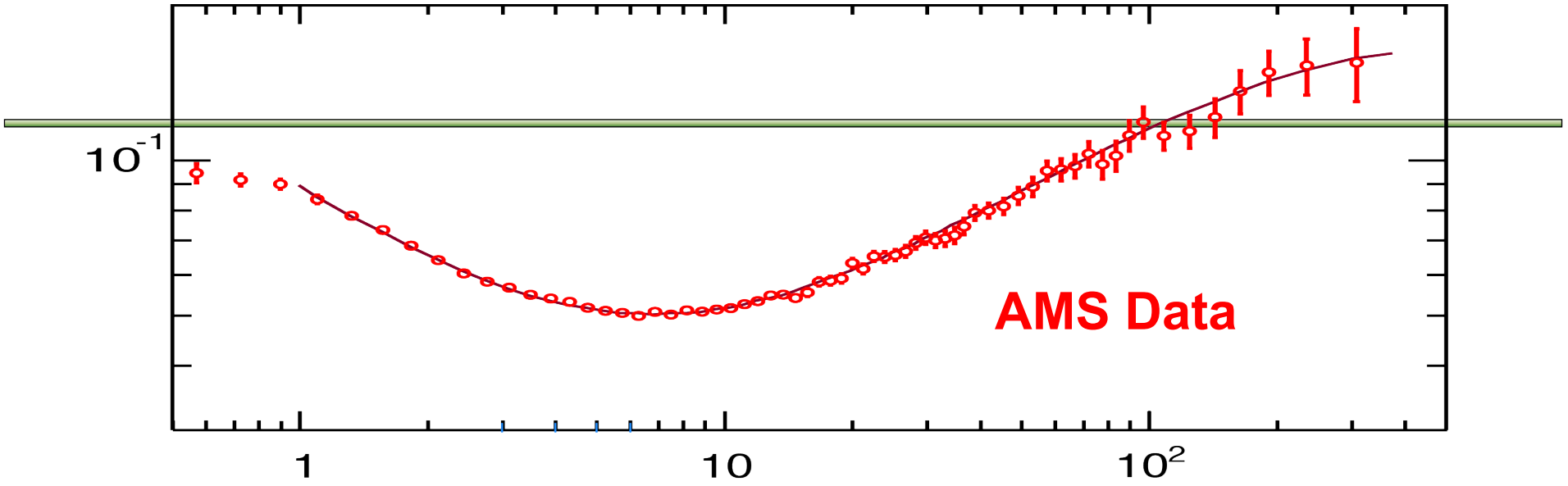


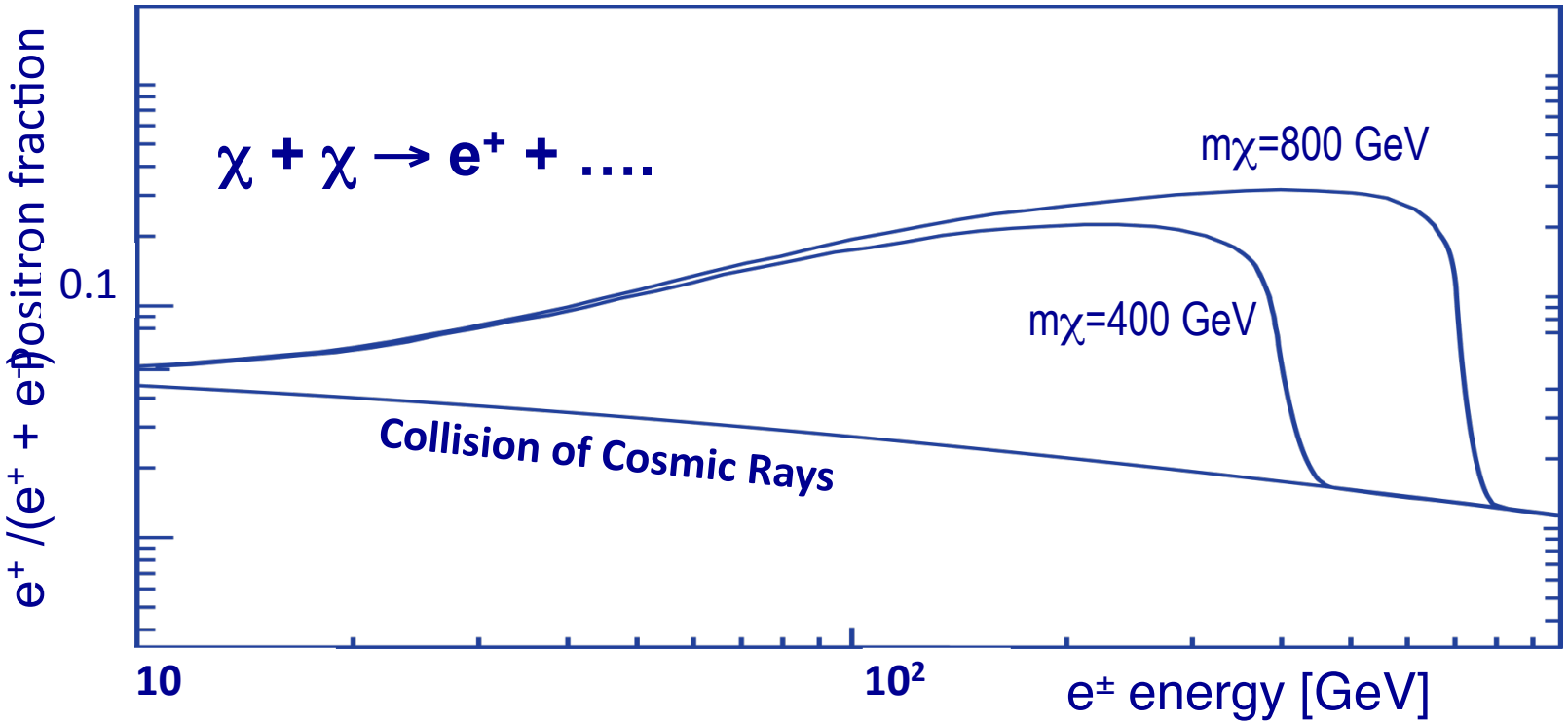

**Positron Fraction at Higher Energy Observed**

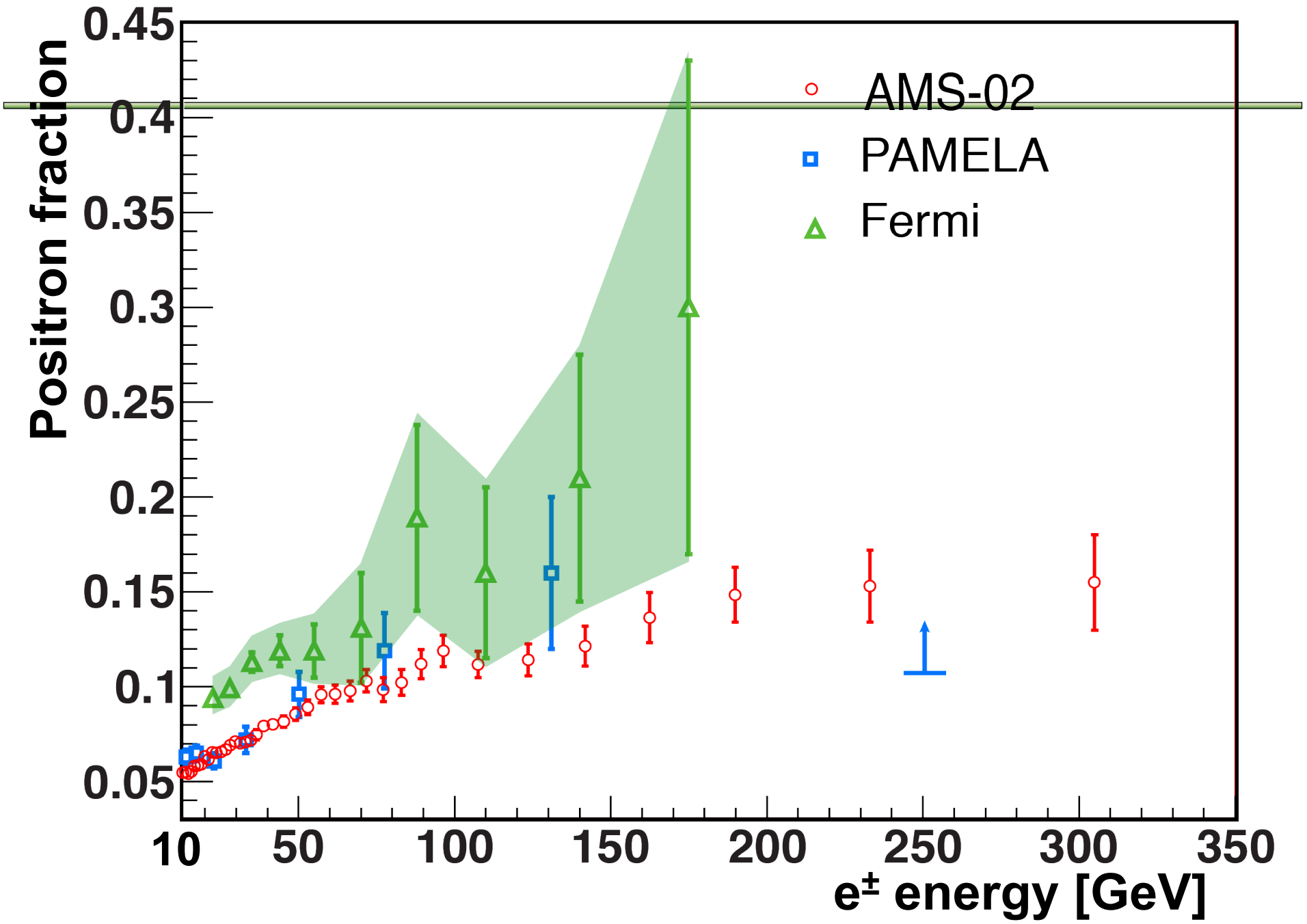



- The Alpha Magnetic Spectrometer located on the space station is making high precision measurements of high energy positrons that may be from dark matter.

- AMS has significantly greater precision and energy reach than its predecessors.


$10^{-1}$
AMS Data
1
10
$10^2$


$\chi + \chi \rightarrow e^+ + \ldots$
$m\chi$=800 GeV
$m\chi$=400 GeV
Collision of Cosmic Rays
$e^+/(e^+ + e^-)$ positron fraction
0.1
10
$10^2$
$e^\pm$ energy [GeV]


Positron fraction
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
10
50
100
150
200
250
300
350
e± energy [GeV]
AMS-02
PAMELA
Fermi

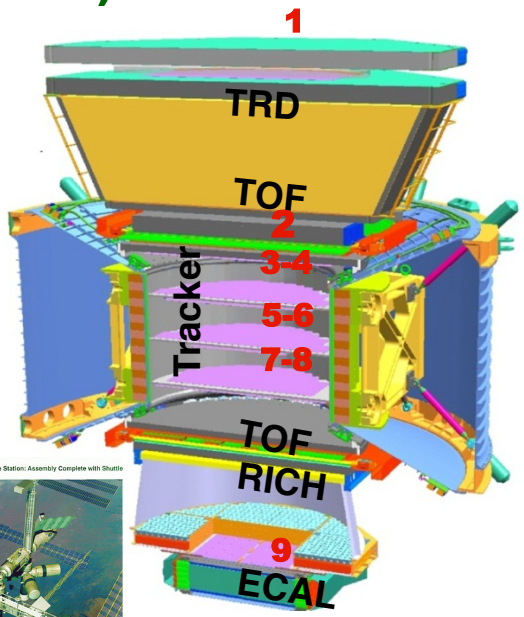
# Alpha Magnetic Spectrometer (AMS)

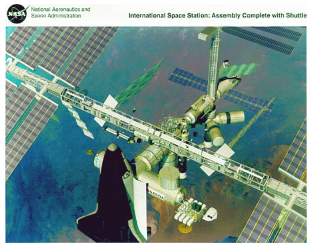
**Science: Search for antimatter, dark matter, missing matter in space.**

**Description:**

• A TeV, precision multi-purpose spectrometer; the most precise cosmic-ray detector ever flown in space.

• A major challenge of operating on the International Space Station (ISS) is the extreme thermal environment – has to be continually monitored and adjusted.



**Partnership & Collaboration:**

AMS is a U.S.-DOE-led international collaboration (led by Prof. Sam Ting, MIT) of 16 Countries, ~600 Physicists.

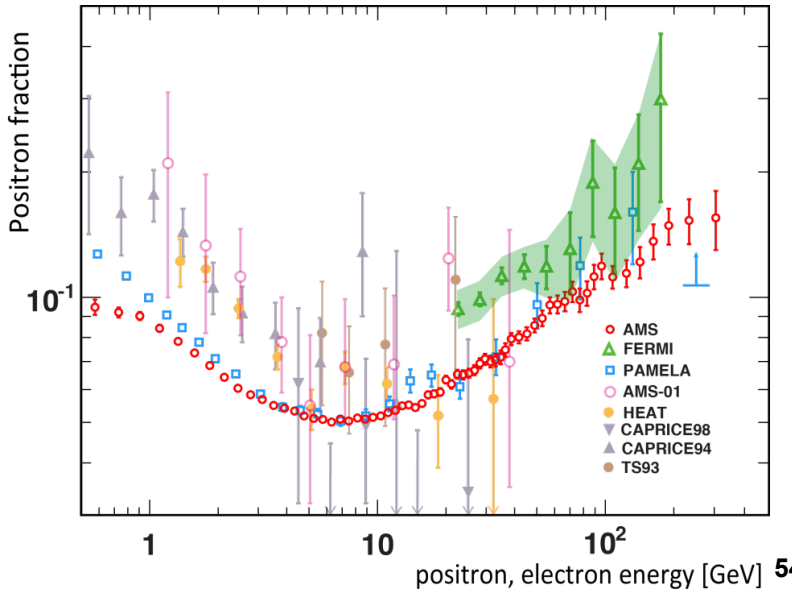
- 95% of ~$2B construction costs from Europe and Asia .
- NASA provided dedicated Space Shuttle flight, use of the ISS resources (power, data, …) and mission management.
- CERN hosts the AMS Payload Operations Control Center (POCC).

**Status:**

Launched on May 16, 2011, (STS-134); installed on ISS

- Has collected over 25 billion events in first 18 months of operations, including 6.8 million electrons or positrons.
- Operations continuing

**April 3, 2013: First Results announced! The data show that the positron fraction is steadily increasing from 10 to ~ 250 GeV, but from 20 to 250 GeV the slope decreases by an order of magnitude.**



# Pierre Auger Observatory

**Science:** observe, understand and characterize the Ultra High Energy (UHE) cosmic rays and probe particle interactions at UHE.

**Observatory:** installed over a 3000 km$^2$ site in Argentina with 24 fluorescence telescopes & 1600 surface Cherenkov detectors (2008);

-- Has since been enhanced with 3 high elevation fluorescence telescopes, 60 infill detectors, muon counter array, Auger Engineering Radio Array (AERA), Microwave (AMBER, MIDAS, EASIER)

**Collaboration:** Large international collaboration of 18 countries, 463 collaborators

Project leadership transitioning from Fermilab to Germany in 2013.

→ International Finance Board meets annually

**Operations Status:** Data taking started in 2004.

Full array completed in 2008; Collaboration has commitments to run through 2015; planning another 10 years.

**Future Plans:** Working on proposal for upgrade to submit in 2014 → to determine if the features of the spectrum at high energy are dominated by energy-limited heavy primaries or by a dramatic change in hadronic interactions of light particles at these energies.

Energy Spectra multiplied by E$^3$ (ICRC 2013)

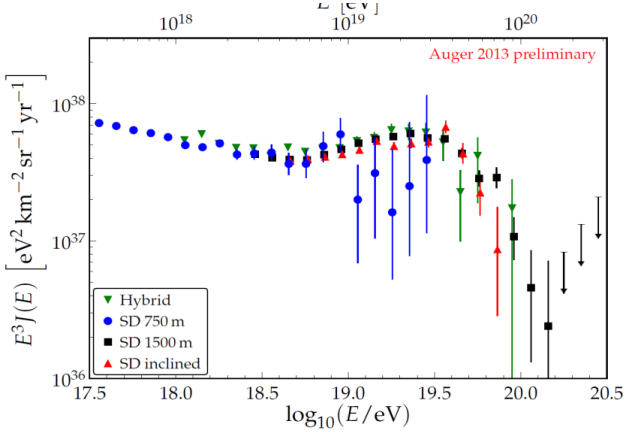



**Figure 4**: Energy spectra, corrected for energy resolution, derived from SD and from hybrid data.

# VERITAS

Status – Jan 2014

(Very Energetic Radiation Imaging Telescope Array System)

**Science:**

- Studies high energy (50 GeV - 50 TeV) gamma-rays

**Project:**

- Located at the Whipple observatory in Arizona
- An array of four 12-meter Cherenkov telescopes

**Partnership:** NSF, DOE, Smithsonian (managing agency)

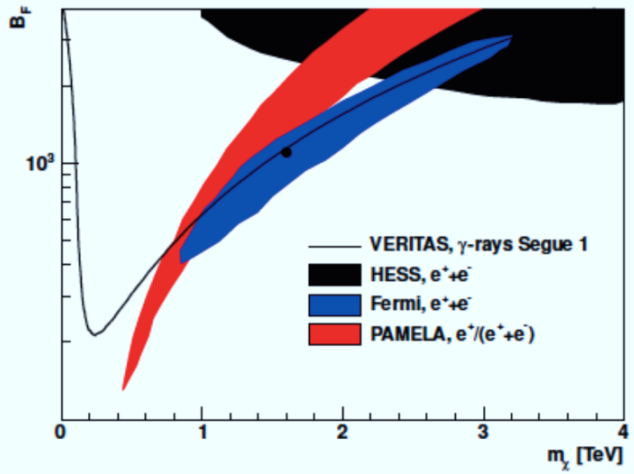
**Collaboration:** ~100 scientists from US (DOE,NSF,SAO), Canada, Ireland and Germany

**Status:**

- Operating since Fall 2007; ~60 publications so far
- Emphasizing dark matter searches for a large fraction of time
- NSF-funded upgrade completed summer 2012
- NSF and DOE funded 3-year grants for operations starting FY13
- Collaboration requesting to continue into FY19

**Recent Highlights:**

- VERITAS DM limits from dwarf galaxy Segue 1
- Discovery of most distant VHE emitting galaxy (with cosmological implications)
- Deep study of the active galaxy 1ES 0229+200 (constraints on cosmic rays, the intergalactic magnetic field and other aspects of cosmology)
- Discovery of unexpected VHE emission from the Crab Pulsar




Limits on boost factor in leptophillic DM models (region above line excluded); arXiv:1202.2144, Phys. Rev. D 85, 062001 (2012)

# Fermi Gamma-ray Space Telescope (FGST)

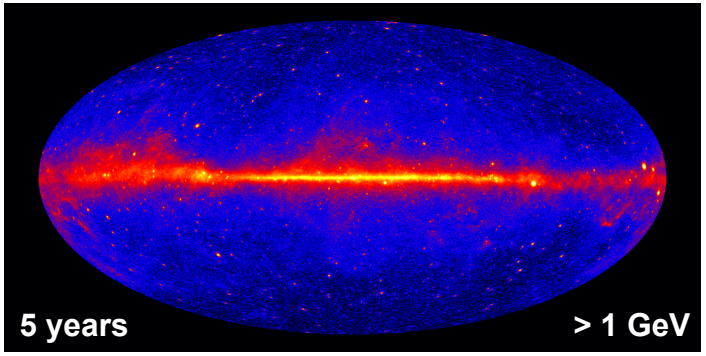
**Science :**

- study high-energy (~20 MeV->300 GeV) gamma rays using particle physics detector technology in space
- Indirect dark matter detection; high energy acceleration mechanisms, etc

**Partnership:**

- DOE, NASA and 4 international agencies partnered on Large Area Telescope (LAT); NASA leads the mission.
- DOE supports SLAC's Instrument Science Operations Center (ISOC)

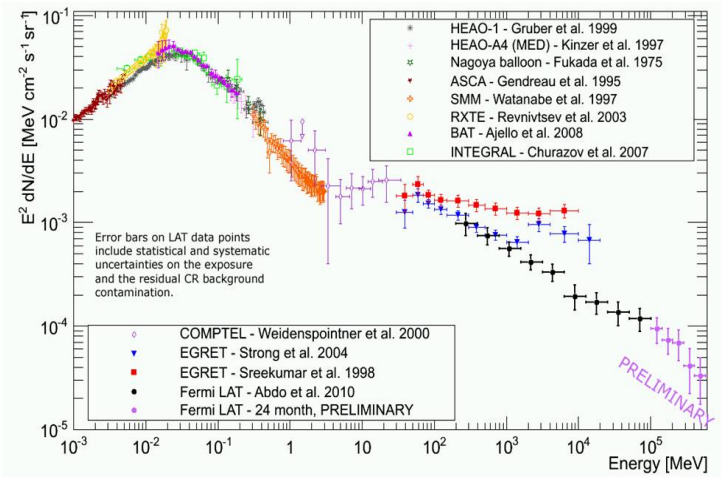
→ International Finance Board meets twice a year




**Gamma-ray sky**
**More than 2500 sources, ~30% unidentified**

**Recent highlights include:**

- ~1300 papers since 2008 , >160 PhD
- Brightest gamma ray burst in 20 years on 27 April 2013.
- Search for dark matter in gamma-ray spectrum, ~ 135 GeV bump
- -- systematics under careful investigation; more statistics will answer the question




**Status:**

- Launched June 2008 with 5 year prime mission, currently recommended for extension through FY2016, want to run through at least 2018 (NASA senior review in spring 2014)
- Upgrade of event reconstruction and analysis ("Pass 8") to be released in 2014; will further improve instrument performance

**Origin of Cosmic Rays (Fermi GST) was chosen as one of the Top 10 Science Breakthroughs of the Year by Science magazine (AAAS)**

# High Altitude Water Cherenkov (HAWC) Gamma Ray Observatory

**Science:**

Sky survey 100 GeV to> 100 TeV gamma-rays

- indirect dark matter search using gamma-ray annihilation
- quantum gravity effects on propagation of gamma-rays
- particle acceleration in extreme magnetic and gravitational fields; transient objects, GRBs, supermassive black holes in AGNs

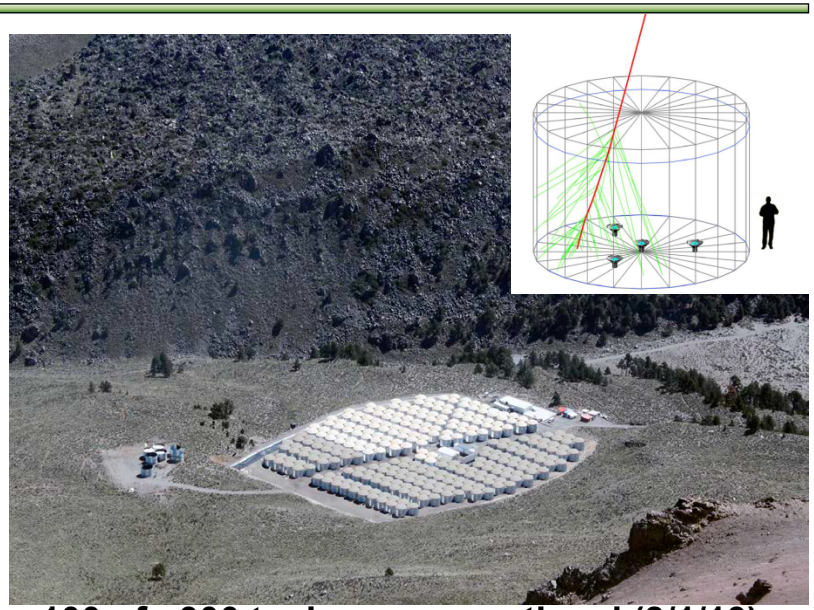
**Project:**

- Air Shower Detector with ~300 Water Cherenkov Detector tanks covering 20,000 $m^2$ at 4100 m in Sierra Negra Volcano, Mexico. Exposure to half of the sky during a 24-hour period.

**Partnership:**

NSF (lead), DOE, Mexico (CONACyT)

→Joint Oversight Group meets quarterly



**100 of ~300 tanks are operational (8/1/13)**

**Status:**

- **2011-2014: fabrication**
- **Aug 2013: started operations with 100 tank array**
- **Aug 2014: projected start of operations with full array**

# CTA
# The Cherenkov Telescope Array

**Science:**

- CTA is a next-generation ground-based Ultra-High Energy telescope array with plans for northern & southern sites
- 2010 Astronomy & Astrophysics Decadal Survey recommended US contribution in higher budget scenarios (4th on list of ground-based experiments) and that funding be split approximately 2/3 NSF and 1/3 DOE; total US contribution ~ $100M

**Observatory:**

- Variety of telescopes with different apertures and field-of-views:
  23 12m medium size telescopes (MST), 4 23m telescopes (LST), 32 5-6m telescopes (SST)
- US collaboration proposing to add 28 2-mirror MST's for enhanced resolution & wide field of view, and 2-3X sensitivity gain

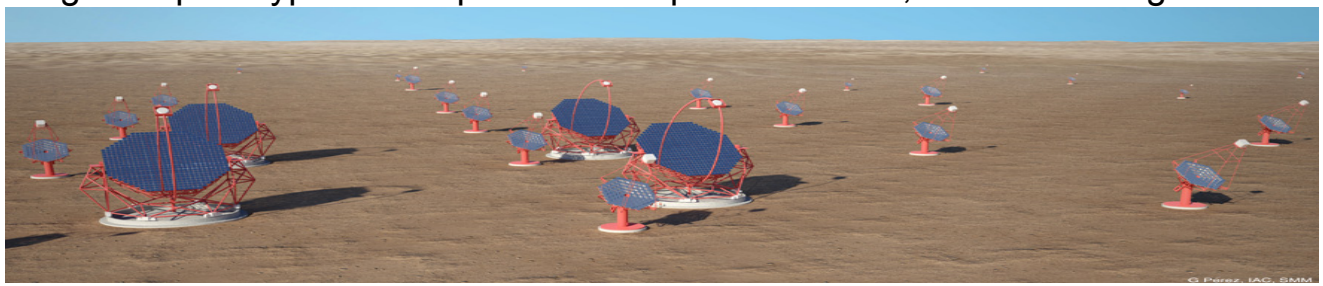
**HEP Guidance**: to US collaboration from Jim Siegrist's August 2012 HEPAP talk

- Following the Astro2010 recommendation, we consider NSF to be in the lead for considering the project
- HEP has no funding identified for CTA contribution in the foreseeable future; therefore don't plan to fund R&D for prototypes or the project but is supporting science simulations and design studies effort

**→Further consideration awaiting Snowmass/P5 process**

**Status – R&D**

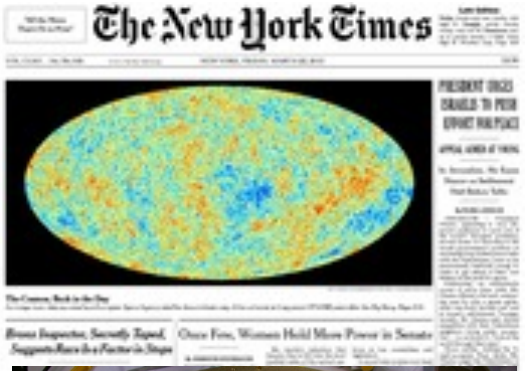
NSF MRI funding for a prototype telescope to be completed in 2014; commissioning with VERITAS in 2015

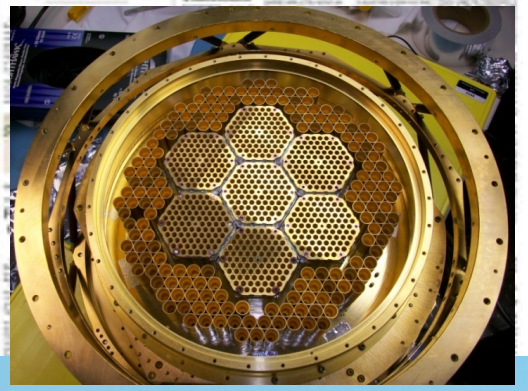


# Cosmic Frontier – Cosmic Microwave Background (CMB)

**CMB experiments: HEP currently has small contributions to:**

- South Pole Telescope polarization (SPTpol)
- Planck – DOE signed an MOU with NASA for interagency cooperation on providing supercomputing resources for data analysis at NERSC; also supports small science effort



**SPTpol**

- NSF-led experiment
- HEP provided outer-ring detectors, fabricated at Argonne National Lab (ANL) and is currently supporting operations and research for ANL activities
- Experiment is currently in operations phase which lasts through 2015.
- **Recent results: first ever detection of lensing B-mode polarization!**

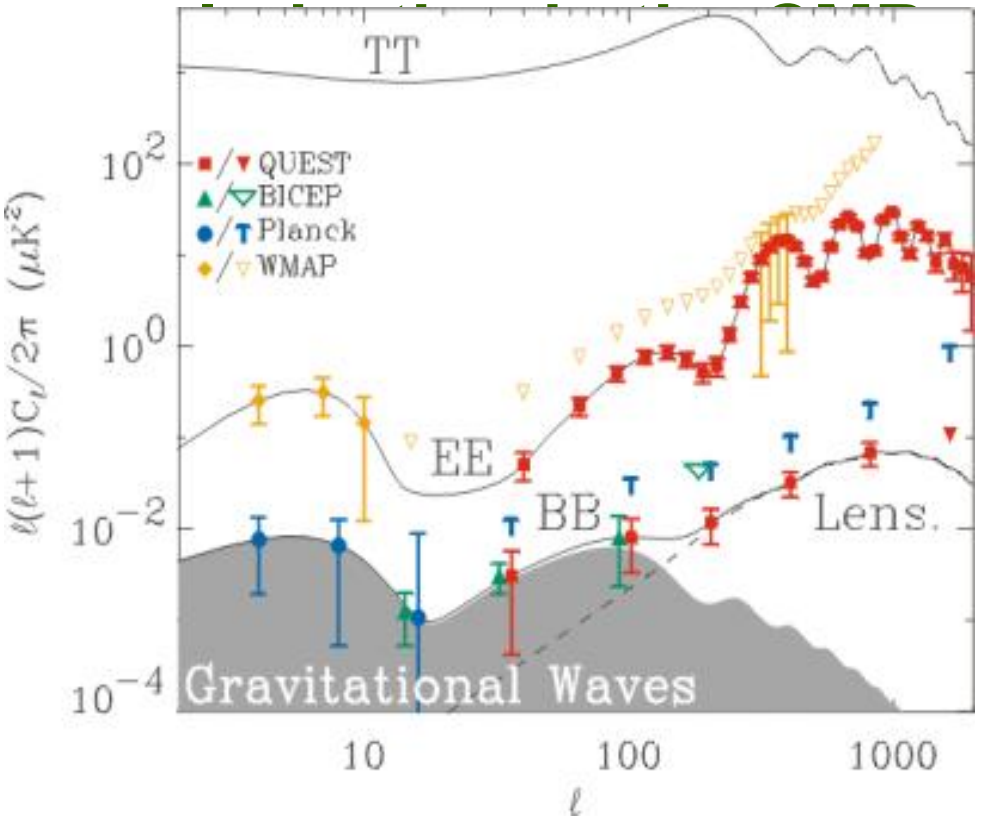
**SPTpol-3G**

- Collaboration is starting major upgrade to replace the camera with a larger focal plane with 2539 multi-chroic pixels (total of 15,234 detectors) to greatly increase sensitivity
- NSF funded; have requested DOE project participation (in consideration)

**CMB Future:** Community is developing science case and concept for a Stage-IV CMB experiment (Snowmass); will be considered by P5

# Polarization of the Cosmic Microwave Background (CMB)

**South Pole Telescope is the first CMB telescope to measure "B-mode"**




**The B-mode signal seen by SPT is due to gravitational lensing.**

**The Holy Grail: Detection of B-modes due to the imprint of primordial gravitational waves that are predicted by inflation.**

# Cosmic Frontier – Research Model & Opportunities

**Considerations for Research Support**

**➔can use same PASAG criteria and considerations in program model**

- Priority is to support efforts in our program, where we have responsibility for experiment
- People working in HEP collaboration model – long term commitments, responsibilities, % effort
- Increasing university involvement in dark energy, dark matter
- Change distribution between thrusts as we go forward to support changing program

**Reviews - for Research Funding Opportunities**

Sept. 2013 – Cosmic Frontier comparative review of Lab research programs (held every 3 years)
Nov. 2013 – Cosmic Frontier comparative review of Grant Proposals
Jan. 2014 – Comparative review of Early Career lab & university proposals

# Cosmic Frontier: Research Grant Statistics

## Statistics on FUNDED grants

| | FY10 | | FY11 | | FY12 | | FY13 | |
|---|---|---|---|---|---|---|---|---|
| | Amt $K | # grants | Amt $K | # grants | Amt $K | # grants | Amt $K | # grants |
| Research - Bridge renewals | | | | | 669 | 6 | 691 | 9 |
| Research - conference | 3 | 1 | 3 | 1 | 20 | 4 | 9 | 2 |
| Research - NEW | | | 258 | 3 | 1,605 | 5 | 3410 | 18 |
| Research - Renewal | 3,415 | 16 | 5,919 | 7 | | | | |
| Research - Continuations | 7,705 | 19 | 5,726 | 24 | 10,137 | 28 | 7510 | 17 |
| Early Career FY10 (ARRA funds) | 0 | 2 | 0 | 2 | 0 | 2 | 0 | 2 |
| Early Career FY11 | | | 150 | 1 | 150 | 1 | 150 | 1 |
| Early Career FY12 | | | | | 300 | 2 | 300 | 2 |
| Early Career FY13 | | | | | | | 150 | 1 |
| **TOTALS** | **11,123** | **38** | **12,056** | **38** | **12,881** | **48** | **12,200** | **52** |

## Statistics on Received/Funded grants

| | FY12 | FY12 | FY12 | FY13 | FY13 | FY13 |
|---|---|---|---|---|---|---|
| | Amount $K | #proposals | # PI's | Amount $K | #proposals | # PI's |
| Received | 3319 | 11 | 21 | 7731 | 28 | 53 |
| Funded | 1605 | 5 | 12 | 3410 | 20 | 28 |
| **Success rate** | **48%** | **50%** | **60%** | **44%** | **71%** | **53%** |

# FY14 Comparative Review (I)

- ~~FY14 Comparative Review Funding Opportunity Announcement (FOA) issued: June 14, 2013~~
- Final application deadline: Sept. 9, 2013 by 11:59 pm Eastern Time
  - 134 applications submitted for review among 6 different HEP subprograms
    - Energy, Intensity, and Cosmic Frontiers
    - HEP Theory, Accelerator Science and Technology R&D, and Particle Detector R&D
  - In Sept. 2013, after the FOA-deadline, all applications were pre-screened for compliance to FOA:
    - verification of senior investigator status
    - compliance with proposal requirements: *e.g.,* page limits, appendix material, use of correct DOE budget and budget justification forms, …
    - responsive to subprogram descriptions
- For review process, experts of panelists selected and convened during Nov. 12-22, 2013
  - Panel deliberations discussed *each* proposal and *each* senior investigator, provided additional reviews for proposal(s), and for comparative evaluation of proposals and PIs

| Subprogram | Panel Deliberations | # of Total Proposals [includes proposals containing multiple subprograms] |
|---|---|---|
| Intensity Frontier | November 12-13, 2013 | 26 |
| HEP Theory | November 13-15, 2013 | 33 |
| Accelerator Science and Technology R&D | November 14-15, 2013 | 31 |
| Particle Detector R&D | November 18-19, 2013 | 14 |
| Energy Frontier | November 19-20, 2013 | 20 |
| Cosmic Frontier | November 20-22, 2013 | 28 |

# FY14 Comparative Review (II)

- Reviewer proposal assignments and input for reviews managed through DOE's Portfolio Analysis and Management System (PAMS)
  - Use of PAMS framework for the review process is new to DOE/HEP
  - First large-scale FOA within DOE/SC that was managed using PAMS
- In addition to reviewing merits of the senior investigators, the merit review process addressed 5 criteria items:
  - Scientific and/or Technical Merit of the Project
  - Appropriateness of the Proposed Method or Approach
  - Competency of Research Team and Adequacy of Available Resources
  - Reasonableness and Appropriateness of the Proposed Budget
  - Relevance to the mission of the Office of High Energy Physics (HEP) program
- Post-Panel review (currently in process: December 2013 – early January 2014)
  - Assess reviews at DOE OHEP on *each* proposal and *each* senior investigator in order to develop guidance and funding levels
    - in addition to reviews, solicit input from other DOE Program Managers & Grant Monitors
- January – April 2014:
  - By ~mid-January 2014, PIs will be given guidance and funding levels with request to submit revised budgets and justifications
  - Route proposal procurement packages through DOE/SC and DOE Chicago Operations Office
- Funded grants to begin 1st year: on or about May 1, 2014