U.S. DEPARTMENT OF ENERGY

OFFICE OF SCIENCE

DOE HEP Program Status

AAAC Meeting
May 2, 2013

Kathy Turner (kathy.turner@science.doe.gov)
Office of High Energy Physics
Office of Science, U.S. Department of Energy

FY 2014 High Energy Physics (HEP) Budget
(in $K)

Description	FY 2012 Actual	FY 2014 Request	Explanation of Change
Energy Frontier Exp. Physics	159,997	154,687	Ramp-down of Tevatron
Intensity Frontier Exp. Physics	283,675	271,043	Completion of NOvA (MIE), partially offset by FermilabOperations
Cosmic Frontier Exp. Physics	71,940	99,080	Ramp-up of LSST
Theoretical and Computational Physics	66,965	62,870	Continuing reductions in Research
Advanced Technology R&D	157,106	122,453	Completion of ILC R&D
Accelerator Stewardship	2,850	9,931	FY14 includes Stewardship-related Research
SBIR/STTR	0	21,457	
Construction (Line Item)	28,000	35,000	Mostly Mu2e; no LBNE ramp-up
Total, High Energy Physics	**770,533***	**776,521**	**Down -1.8% after SBIR correction**
Office of Science	**4,873,634**	**5,152,752**	

***The FY 2012 Actual has already been reduced by $20,327,000 for SBIR/STTR.**
The FY 2014 Request will be reduced by SBIR/STTR.

DOE HEP Budget

FY 2013

- The FY 2013 President's Request Budget (PRB) was for $776 million but the final amount is expected to be less due to the Continuing Resolution, Sequestration and other issues.
- The PRB included a request for a Major Item of Equipment (MIE) fabrication start for the LSST-camera, which was not approved. Therefore, long-lead procurements cannot be made in FY 2013.

FY 2014

- The FY 2014 PRB is $776 million, which will be above the FY 2012 if approved.
- FY2014 budget philosophy was to enable new world-leading HEP capabilities in the U.S. through investments on all three frontiers
  - Accomplished through ramp-down of existing projects and Research
  - When we were not able to fully implement this approach, converted planned project funds to R&D: Research → ~~Projects~~ → Research
  - Therefore the FY14 Request shows *increases* for HEP Research which are driven by this R&D "bump", while Construction/MIE funding is decreased relative to FY12
- The PRB includes MIE fabrication start for the LSST-camera and Muon g-2 experiment. It also includes LBNE and Mu2e construction funding.
- The PRB does not include MIE fabrication start for LHC-upgrades, Dark Matter 2nd Generation (DM-G2) or Mid-Scale Dark Energy Spectroscopic Instrument (MS-DESI) experiments. **→R&D funding is planned to continue for these experiments in FY2014**

Cosmic Frontier (Experimental) Program - Funding

Cosmic Frontier Funding (in $K)	FY 2012 Actual	FY 2014 Request
Research – university	**11,815**	**11,775**
Research – lab	**34,937**	***47,065**
Experimental Operations	7,415	7,500
Future project R&D	3,100	1,494
Small project fabrication	2,538	1,200
MIE – LSST	5,500	22,000
MIE – HAWC	1,500	0
DM-G2 R&D	0	0
TOTAL	**66,805**	**91,034**

MIE = Major Item of Equipment

DM-G2 = Dark Matter Generation 2

* FY14 lab research includes $12M for DM-G2 R&D, The FY13 amount was $7M.

Budgets:

Research: scientists and their expenses

R&D, Fabrication, Operations: covers technical, engineering, computer professional, management, other personnel & expenses, M&S, computers, utilities, common funds, etc.

DOE-HEP Strategic Planning

The HEP budget puts in place a comprehensive program across the three frontiers. In five years,

- NOvA,Mu2e, g-2 will be running on the Intensity Frontier.
- The CMS and ATLAS detector upgrades will be installed at CERN.
- DES will have completed its science program and new mid-scale spectroscopic instrument and DM-G2 should begin operation
- The two big initiatives, LSST and LBNE, will be well underway.

Strategic Planning - Need to start planning now for what comes next.

- The American Physical Society Division of Particles and Fields (APS-DPF) "Snowmass" community planning process will conclude in August 2013
  - Will identify compelling HEP science opportunities over an approximately 20 year time frame.
  - Not a prioritization but can make scientific judgments
- Following this, we are planning a process (via a HEPAP "P5" subpanel) to develop a new strategic plan and project priorities for HEP in various funding scenarios, using the DPF/Snowmass and other inputs.

DOE Office of Science Statement on Digital Data Management

- DOE Office of Science is developing a policy for digital data management that is consistent with recent Office of Science and Technology Policy (OSTP) guidance on "Increasing Access to the Results of Federally Funded Research" (2/22/2013)
  http://www.whitehouse.gov/blog/2013/02/22/expanding-public-access-results-federally-funded-research
- This policy will come into effect October 1, 2013.
- The focus of the policy is sharing and preservation of *digital research data*– the data required to validate research findings.

Requirements

- All proposals submitted to the Office of Science for research funding are required to include a Data Management Plan (DMP). The DMP should address data sharing and preservation and the validation of research results.
- Research data displayed in publications must be made digitally accessible at the time of publication.
- Researchers that plan to work at an Office of Science User Facility as part of the proposed research should consult the published data policy of that facility and reference it in the DMP.

http://science.energy.gov/~/media/hep/hepap/pdf/march-2013/2013_Spring_HEPAPBriefing_v3_NoBackup_LBiven.pdf

DOE HEP - Cosmic Frontier Status

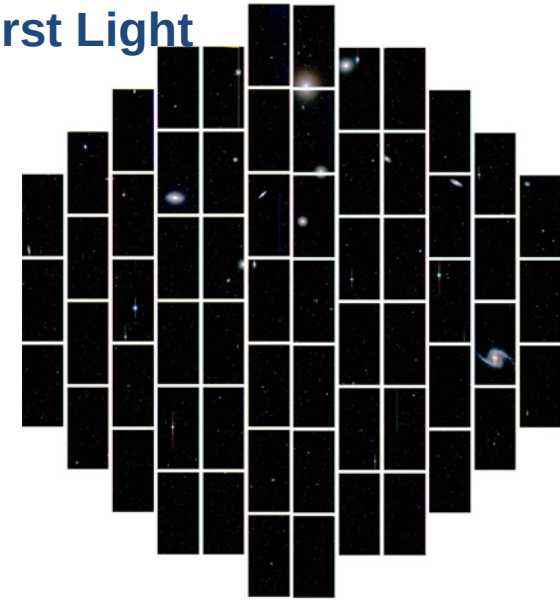
Current program

- Several operating experiments studying high-energy cosmic and gamma rays: **Fermi/GLAST, Veritas, Auger, AMS**
- Several 1st generation (G1) dark matter direct detection experiments operating: **ADMX, LUX, CDMS-Soudan, DarkSide, Xenon**
- Several dark energy experiments are operating: **BOSS, supernova surveys**
- **Dark Energy Survey (DES)** commissioning & science verification completed; starting 5-year survey in Sept. 2013
- Science studies on WFIRST, Euclid
- Other areas: **SPTpol (CMB), Holometer**

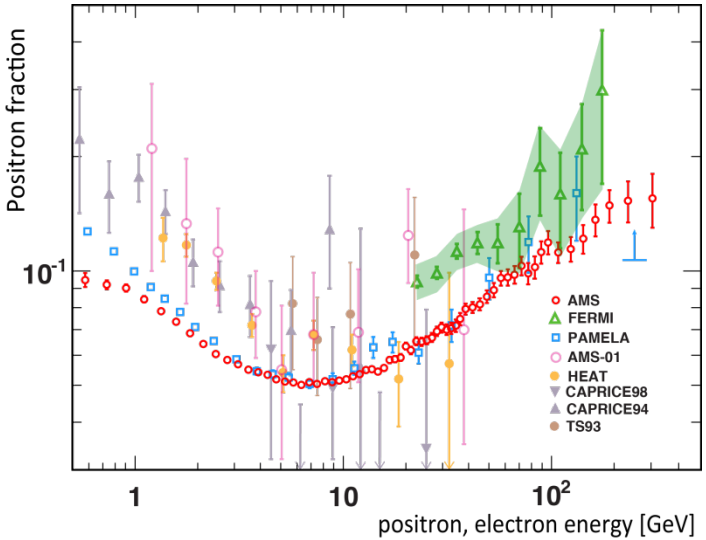
Planned program

- **2nd-Generation Dark Matter** experiments to probe most of preferred phase space
- **Large Synoptic Survey Telescope** will make definitive ground-based Stage IV Dark Energy measurements using weak lensing
- **Mid-scale Dark Energy Spectroscopic Instrument** to complement DES/LSST with Stage IV measurements using baryon acoustic oscillations
- **High Altitude Water Cherenkov (HAWC)** starts operations in 2014
- **Other projects to be considered by HEPAP/P5 following the DPF/Snowmass process**

DES First Light



AMS First Results



Dark Matter – results and planning

Dark Matter 2nd-Generation (DM-G2) experiments

- Will probe most of preferred phase space
- Program in coordination with NSF
  - CD-0 approved in September 2012
  - FY13 R&D awards announced at March HEPAP meeting:
    ADMX-Gen2, LZ, SuperCDMS-SNOLab, DarkSide-G2, COUPP-500
  - Down-selection for experiments to move to fabrication phase planned for late 2013.
  - FY14 President's Request: R&D continues

Dark Matter – Two recent "Non-Discoveries"

April 3: 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.

- Dark Matter particle mass would be > 500 GeV
- Need several more years of operation to achieve an "indirect detection," or determine if the origin is instead from pulsars

April 15: The Cryogenic 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.

CDMS – Cryogenic Dark Matter Search

Science: Direct Detection of Weakly Interacting Massive Particles (WIMPs) that may make up Dark Matter, with sensitivity to:

- 'Conventional' WIMP candidates (MSSM, Kaluza-Klein)
- 'Dark sector' particles (low-mass WIMPs)
- Axions from the sun and/or the galaxy
- Lightly-ionizing particles

Agencies: DOE and NSF, with contributions from Canada
Collaboration: 80 scientists from the US and Canada

Status:

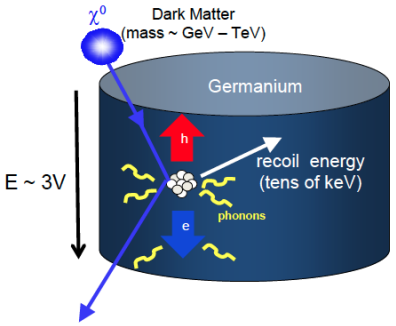
- CDMS II (4 kg Ge) operated at Soudan in 2004-2009
- SuperCDMS Soudan (9 kg Ge) operating in 2012-2013 (FNAL management); Results will be factor of 5 improvement over CDMS-II

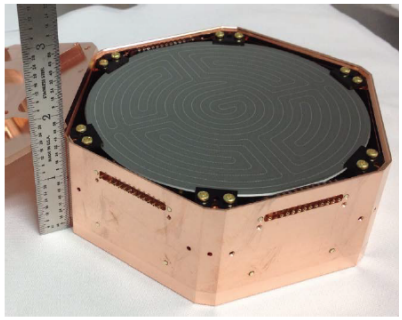
Recent News:
April 15, 2013: The CDMS collaboration observed 3 dark matter candidate events, but the significance (99.8% confidence level compared with background) is too low to claim a discovery; Dark Matter particle mass would be ~9 GeV.

Future:
SuperCDMS SNOLab (FNAL/SLAC management) awarded FY13 R&D funding as part of Dark Matter Generation 2 program
- With 200 kg of Ge, it will provide another order of magnitude improvement in WIMP sensitivity

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

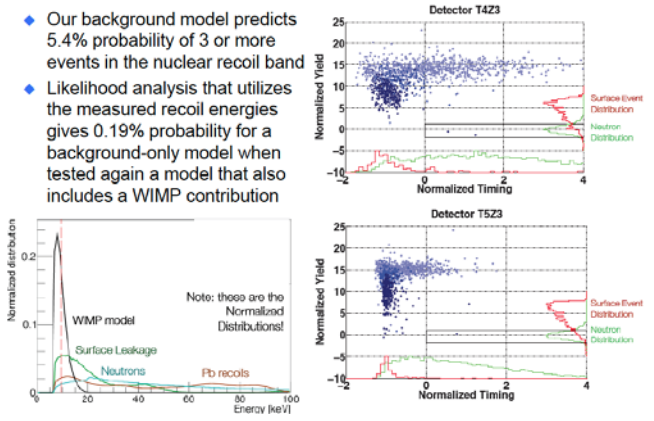




Blas Cabrera and Richard Partridge 3

3 Events Pass All Data Quality Checks

- Our background model predicts 5.4% probability of 3 or more events in the nuclear recoil band
- Likelihood analysis that utilizes the measured recoil energies gives 0.19% probability for a background-only model when tested again a model that also includes a WIMP contribution



Status – May 2013

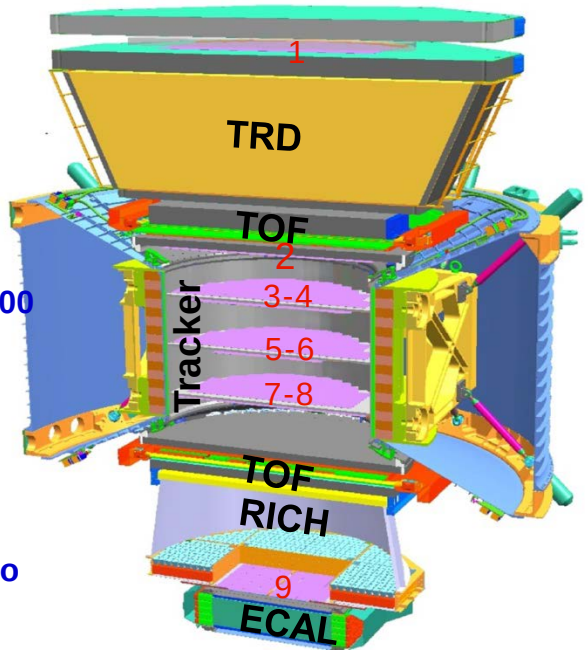
Alpha Magnetic Spectrometer (AMS)

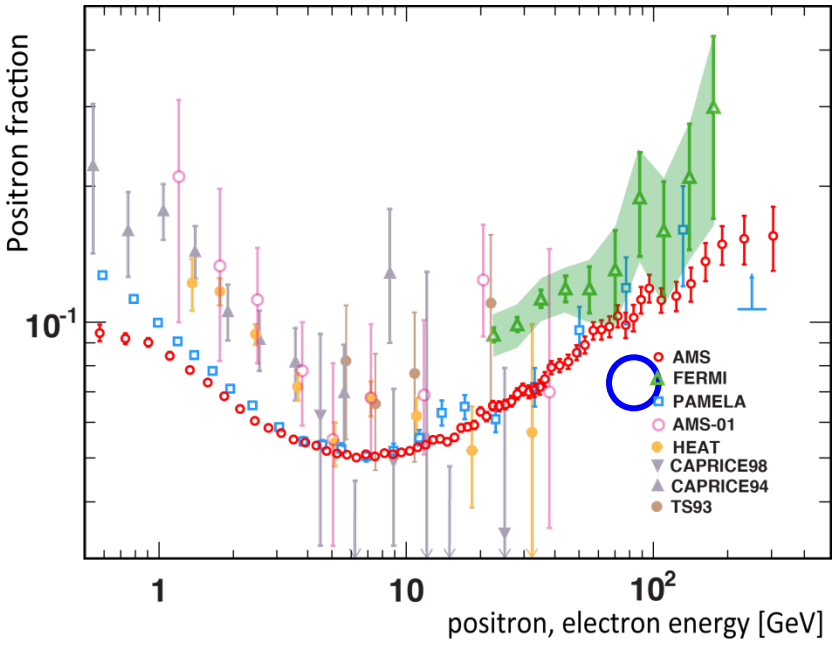
Launched on May 16, 2011, (Endeavor, STS-134); installed on ISS
- Has collected over 25 billion events in first 18 months of operations, including 6.8 million electrons or positrons.

AMS is a U.S.-DOE-led international collaboration of 16 Countries, 60 Institutes and 600 Physicists.

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

A major challenge of operating on the ISS is the extreme thermal environment – has to be continually monitored and adjusted.

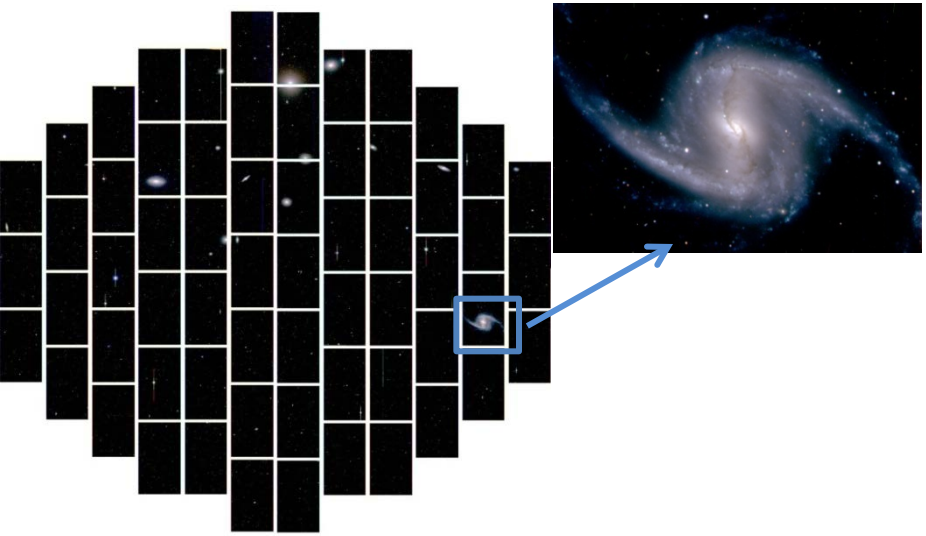




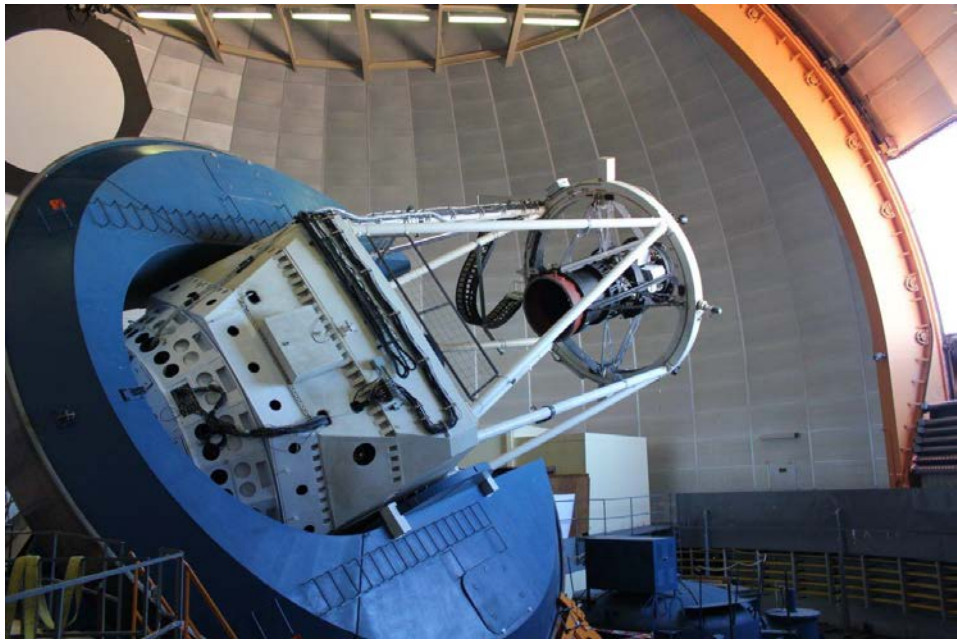
April 3, 2013: First Results announced! The data show that the positron fraction is steadily increasing from 10 to ~ 250 GeV, but from 20 to 250 GeV the slope decreases by an order of magnitude.

Dark Energy Survey (DES)

Fornax cluster with close-up of the galaxy NGC 1365



DES – first light on 9/2/12



- DOE/NSF partnership with private and foreign contributions
- DOE/NSF Joint Oversight Group (JOG) meets monthly
- HEP supported fabrication of the Dark Energy camera (DECam), managed by Fermilab, which was installed on Blanco telescope in Chile
- NSF supporting telescope and camera operations and the data management system
- Status: commissioning & science verification completed; camera working well, telescope performance improved; **will start the 5 year science survey in Sept. 2013**
- April 2013: Panel review of DES pre-operations status and 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.

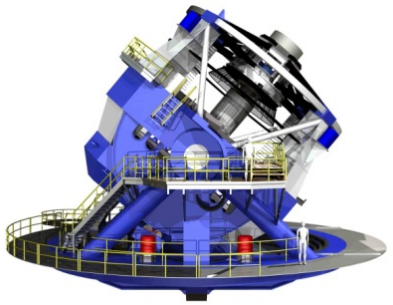
- Dark Energy Science Collaboration (DESC) formed to start preparations for precision analyses.

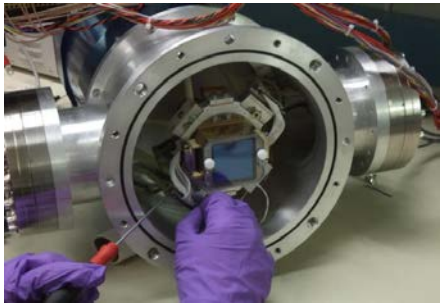
Project:

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

Status:

- Critical Decision 1 (CD-1) approved for LSST-camera in Feb. 2012
- FY 2014 President's Request budget for DOE includes fabrication start for LSST-camera
- FY 2014 President's Request budget for NSF includes MREFC funds for LSST construction
- Planning DOE "Lehman" status review of LSST-camera in June





Camera: fully functional prototype sensors

Dark Energy Future
Mid-scale Dark Energy Spectroscopic Instrument (MS-DESI)

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.

9/18/12 -- Critical Decision 0 (CD-0) for MS-DESI experiment approved
The CD-0 statement calls for the development of new instrumentation to be operated in the time gap between other dark energy experiments (i.e. DES & LSST).

DOE & NSF having regular talks (at least biweekly) about possible opportunities, constraints and models for the experiment and use of a telescope facility.

January 2013: HEP and NSF-AST signed a statement of agency principles
• HEP goal is to do the survey in 3-5 years with 70-100% of the dark time and is willing to pay operating costs; HEP would like to make the site selection asap to meet the envisioned schedule.
• NSF is interested in identifying a suitable telescope to support MS-DESI; Mayall is likely to be available for usage and a decision could be made ~ April 2013; Blanco not known yet to be available and decision is not likely possible in the April 2013 time frame.

May 2013: MS-DESI project office sent HEP a science alternatives analysis report in response to request for studies to support HEP's decision-making process in selecting a preferred telescope facility. **DOE is preparing a letter to send to NSF with preferred site and to work with NSF to determine if the preferred site can be made available for MS-DESI.**

DOE effort on Planck

ESA's Planck satellite mission was launched in 2009 to make the most precise measurement yet of the temperature and polarization of the cosmic microwave background (CMB) - the remnant radiation from the big bang.

3/21/13: ESA and NASA, a major partner in Planck, released preliminary cosmology results based on Planck's first 15 months of temperature data. It made the front page of the NY Times on 3/22/13 (above the fold!)

Strength in data analysis is a major U.S. contribution and was made possible in part because of the DOE and NASA interagency cooperation for supercomputing resources.

A DOE and NASA MOU in 2007 provided Planck with a multi-year allocation of NERSC resources which has so far amounted to tens of millions of hours of massively parallel processing, plus the necessary data-storage and data-transfer resources.

With the guaranteed allocation, the U.S. Planck Team was also able to base its dedicated computational resources at NERSC and take advantage of NERSC's global file-system capability and systems administration expertise.

The JPL-based US team includes scientists in LBNL's Computational Cosmology Center (C^3) who are responsible for using NERSC supercomputers to generate the thousands of mission simulations needed to analyze the flood of data from Planck.

Comprising 250,000 maps, this is the largest simulation set ever fielded in support of a CMB mission, but still only 10% of the set needed for the full Planck analysis.

NY Times – 3/22/13

Cosmic Frontier – Summary

Dark Matter & Dark Energy:
Have path forward for next steps

Other areas:
-- Science case and role of other particle astrophysics areas needs to be better articulated through DPF/Snowmass process

→Will further develop and optimize program starting with input from the DPF/Snowmass process, followed by the HEPAP P5 prioritization process.

Lots of results coming out or expected soon in all areas. Future is looking bright!!