LA-UR- 10-01072

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Title: Nuclear and Particle Physics, Astrophysics and Cosmology (NPAC) Strategic Capability Planning

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Intended for: LANSCE Nuclear and Particle Physics, Astrophysics and Cosmology (NPAC) Strategic Capability Planning Review Committee

Los Alamos NATIONAL LABORATORY
EST. 1943

Nuclear and Particle Physics, Astrophysics and Cosmology (NPAC)
Strategic Capability Planning

J. Carlson (T-2), D. Rej (SPO-SC), T. Vestrand (GS-PO), S. Wilburn (P-25)

Abstract

At the request of LANL ADTSC and ADEPS, a strategy is proposed for a balanced, high-quality, relevant, and sustainable NPAC capability at LANL. Recommendations and comments are presented in a form that can be readily translated into long-term strategic goals. Recommendations are based upon the following criteria: (1) relevance to LANL mission; (2) relevance to National community strategies; (3) alignment with sponsors' interests and plans; (4) credible transition plans when taking on new scope; (5) leveraging opportunities; and (6) sustainability.

Nuclear and Particle Physics, Astrophysics and Cosmology (NPAC) STRATEGIC CAPABILITY PLANNING

Findings, Comments, & Recommendations

Prepared for
Alan Bishop & Susan Seestrom

by
J. Carlson (T-2), D. Rej (SPO-SC), T. Vestrand (GS-PO), S. Wilburn (P-25)

February 24, 2010

Outline

- Objective of this Exercise
- Planning Committee Charge
- Process
- Background Materials Examined
- Evaluation Criteria
- Findings
- Comments
- Recommendations

Objective

- Propose a strategy for a balanced, high-quality, relevant, and sustainable NPAC capability at LANL.
  - To be proposed by a committee comprised of three technical leaders from TSC, GS, EPS, chosen and commissioned by ADTSC & ADEPS
    - J. Carlson (T-2)
    - T. Vestrand (GS-PO)
    - S. Wilburn (P-25)
      - D. Rej (SPO-SC, Committee Chair)

Committee Charge from ADEPS & ADTSC

- Deliverable:
  - Proposed strategy to Alan Bishop and Susan Seestrom, with findings, recommendations, and priorities for a balanced, high-quality, relevant, and sustainable NPAC capability at LANL.
- Recommendations to be based on following guidance & assumptions
  - No increases in current LDRD-DR NPAC investments
    - Also consider a reduced investment scenario (by one DR Project)
  - Realistic external sponsors budgets, plans, and interests

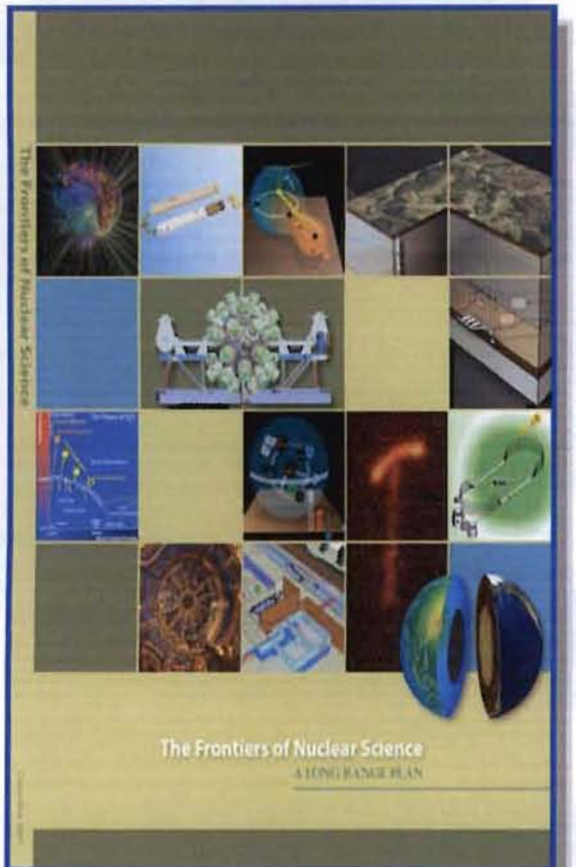
Committee Charge from ADEPS & ADTSC

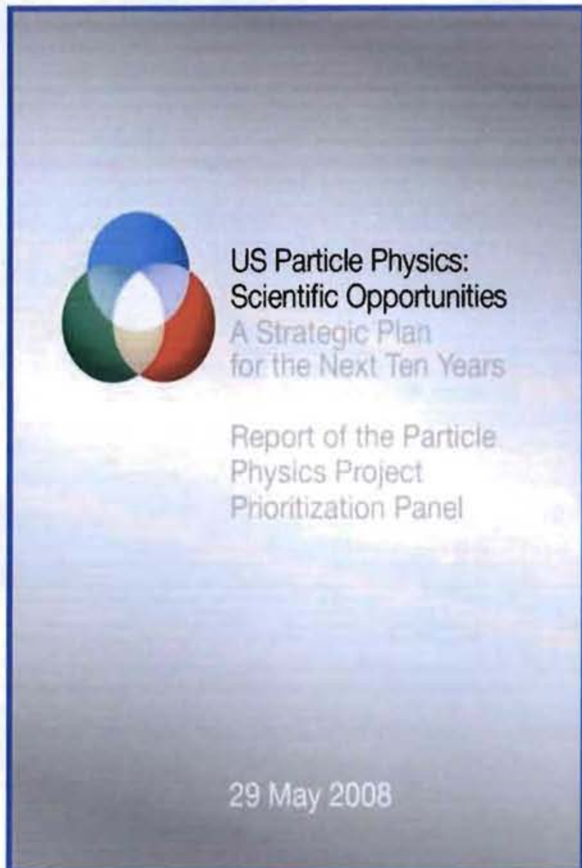
- Recommendations to be based on following prioritization criteria:
  - Relevance to LANL Mission
  - Relevance to National community strategies
  - Alignment with sponsors' interests and plans
    - Include SC, NASA, NSF
    - Consider LANL's reputation with particular sponsors, based on quality, relevance and performance, to date
  - Credible transition plans when taking on new NPAC scope
  - Leveraging opportunities
    - *e.g.,* ability to fold in matching funding from elsewhere
  - Sustainability
    - Ability to rapidly and effectively communicate importance of the NPAC portfolio to variety of changing stakeholders
      - *e.g.,* during management transitions

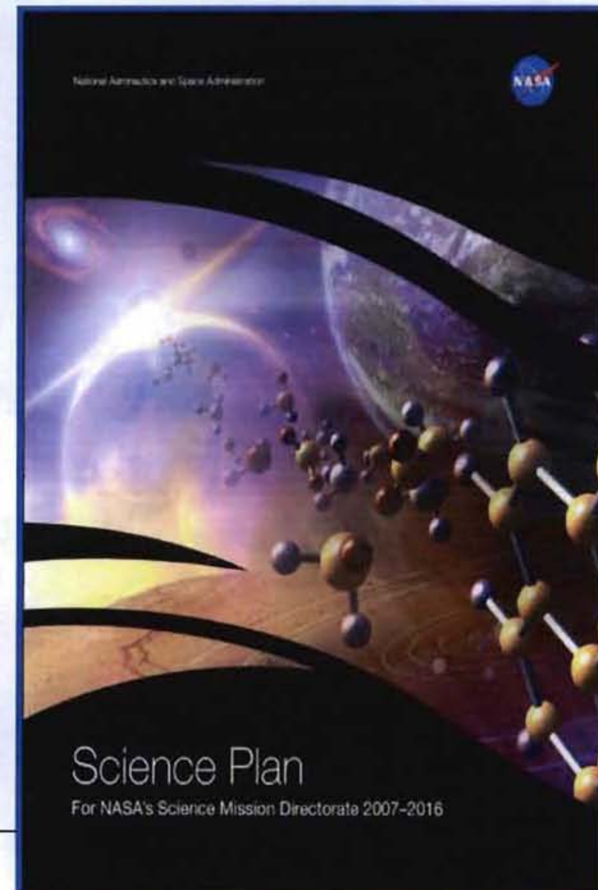
Thrusts & Capabilities Examined

- Accelerator Neutrinos
- α-dot
- Astroinfomatics (*e.g.,* SkyDOT)
- Astrophysics Theory
- CLEAN
- Computational Cosmology
- FNPB Neutron Nuclear Phys
- FRIB Technology R&D
- γ-ray/ Neutron Detection for National Security
- HAWC
- Heavy Ions at CERN
- Heavy Ions at RHIC
- High Energy Physics Theory
- High-Energy Astrophysics (*e.g.,* Swift, GLAST)
- Isotope Production
- JDEM
- Low-E Neutrinos
- LSST
- Muon Tomography
- New Technology for Fast Access to Space (*e.g.,* microsats)
- NIF Nuclear Diagnostics
- Non-FRIB Isotope R&D
- NTS Archiving
- Nuclear Astrophysics Experiment (LANSCE & FRIB)
- Nuclear Physics Theory
- Nuclear Structure & Reactions & Nuclear Data (Theory & Experiment)
- Nucleon Spin & Medium E
- NW Design
- NW Radiochemistry
- Plasma Astrophysics
- Proton Interrogation
- Proton Radiography
- Radio/mm Astronomy (*e.g.,* LOFAR)
- Sub-Critical Materials Testing
- Sub-Orbital Technology
- Theoretical Particle Astrophysics & Cosmology
- Thinking Telescopes Technology
- Ultra Cold Neutrons

Background Materials Considered: Community & Sponsor Plans

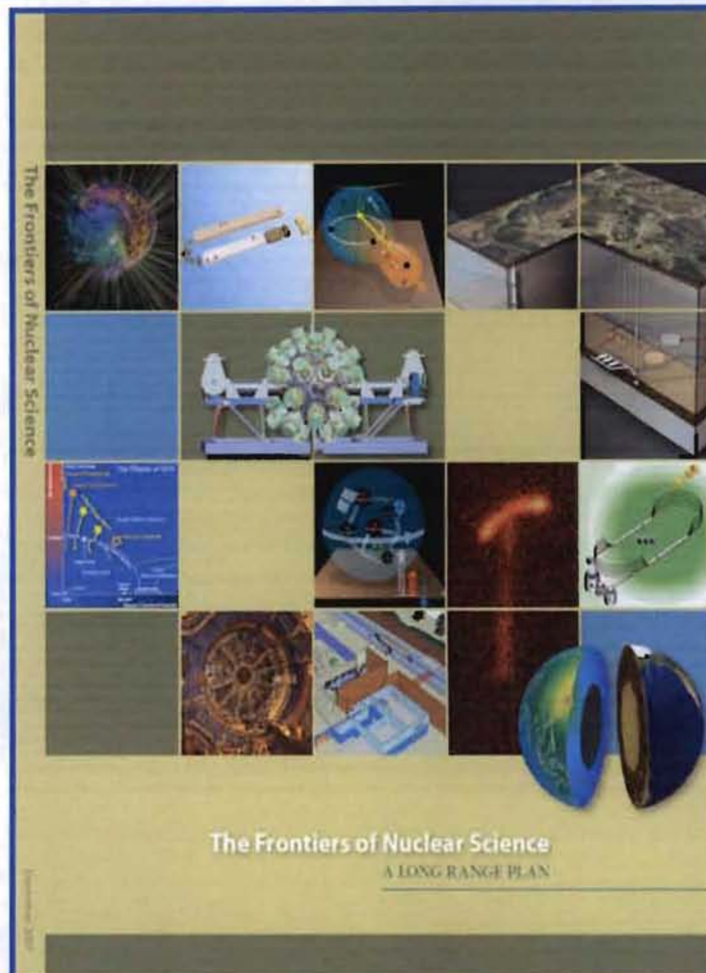






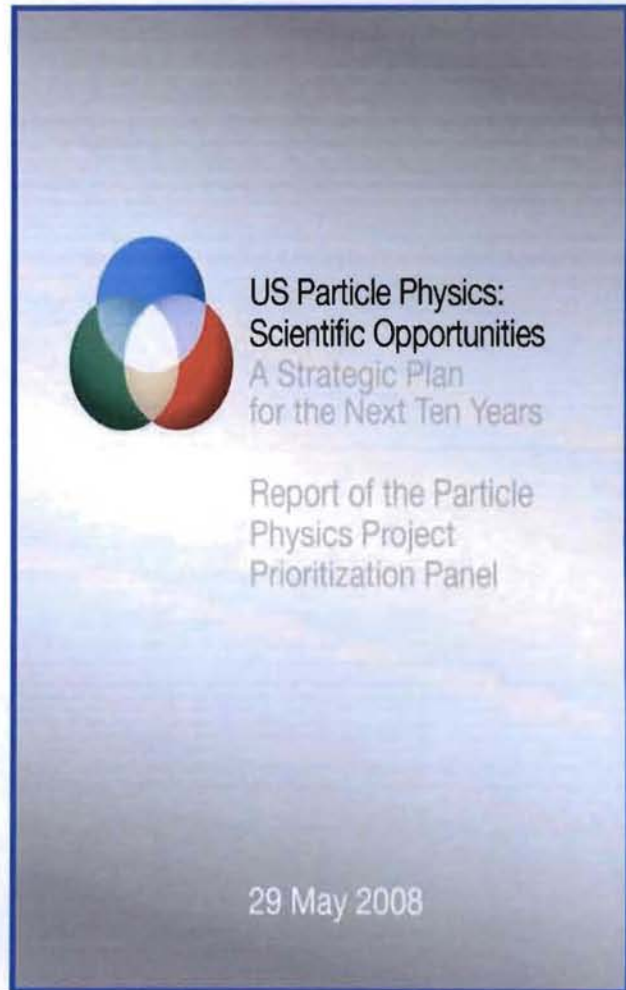
Recommendations from the NSAC Long-Range Plan (Dec. 2007)

- Complete the 12 GeV CEBAF Upgrade
- Construct he Facility for Rare Isotope Beams (FRIB)
- A targeted program of experiments to investigate neutrino properties and fundamental symmetries.
  - Construction of a DUSEL is vital to U.S. leadership in core aspects of this initiative.
- Implementation of the RHIC II luminosity upgrade & detector improvements
  - to determine properties of quark-gluon plasmas
- Initiatives meriting special consideration
  - Nuclear Theory
  - Accelerator R&D
  - Gamma-Ray Tracking



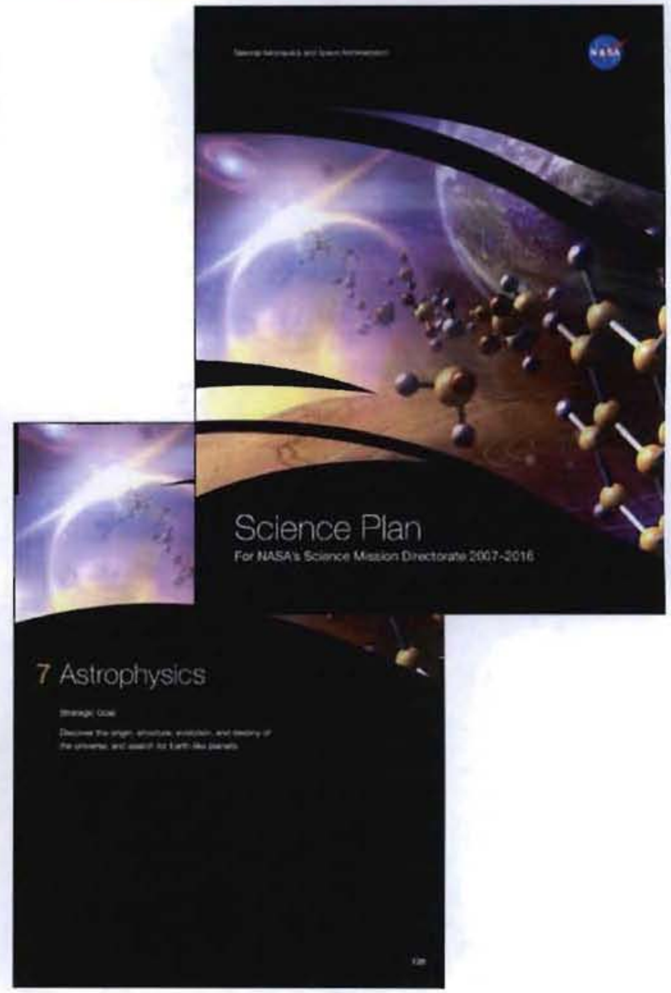
Recommendations from the HEPAP "P5" Report

- The Energy Frontier
  - Continue support Tevatron Collider program.
  - Support US LHC program
  - Broad accelerator & detector R&D for lepton colliders
- The Intensity Frontier
  - World-class neutrino program as a core component of US program, with long-term vision of a large detector in the proposed DUSEL and a high-intensity neutrino source at Fermilab.
  - DOE & NSF work together to realize a particle physics program at DUSEL.
  - Measurements of rare processes, to an extent depending on the funding levels available
- The Cosmic Frontier
  - Study of dark matter & dark energy as an integral part of the US particle physics program
  - DOE support the space-based JDEM, in collaboration with NASA
  - DOE support for the ground-based LSST program in coordination with NSF
  - Joint NSF & DOE support for direct dark matter search experiments
  - Limited R&D funding for other particle astrophysics projects & recommends establishing a PASAG



NASA Decadal Plan for Astrophysics: Objectives & Targeted Outcomes through 2016

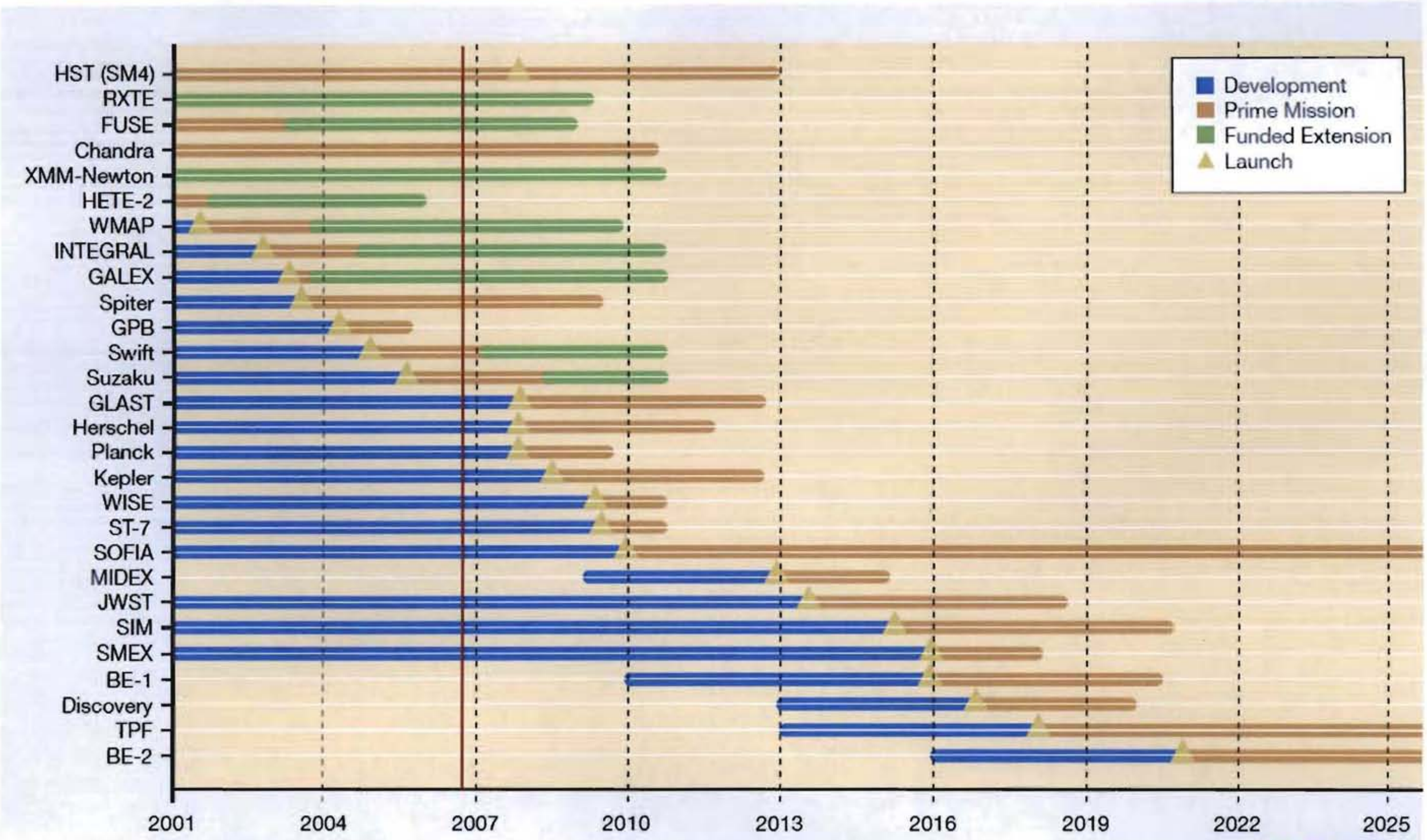
What are the Origin, Evolution, and Fate of the Universe?	How Do Planets, Stars, Galaxies, and Cosmic Structures Come into Being?	When and How Did the Elements of Life and the Universe Arise?	Is There Life Elsewhere?
Test the validity of Einstein's General Theory of Relativity. Investigate the nature of spacetime through tests of fundamental symmetries (e.g., is the speed of light truly a constant?). Test the inflation hypothesis of the Big Bang. Precisely determine the cosmological parameters governing the evolution of the universe. Improve our knowledge of dark energy, the mysterious cosmic energy that will determine the fate of the universe.	Investigate the seeds of cosmic structure in the cosmic microwave background. Measure the distribution of dark matter in the universe. Trace the filamentary cosmic web of atomic matter in the universe. Discover the first stars, galaxies, and quasars (black holes). Determine the mechanism(s) by which most of the matter of the universe became reionized. Determine the history of cosmic star formation and the assembly of galaxies. Study the birth of stellar and planetary systems. Uncover the connection between galaxies and supermassive black holes.	Discover when complex organic molecules, the precursors of biology, first appeared in the universe. Measure the metal enrichment of the diffuse intergalactic and interstellar media. Improve our understanding of supernovae and their nucleosynthesis of heavy elements needed for life.	Determine the frequency with which planets are found within the habitable zones of other stars and characterize their physical properties, such as mass, diameter and orbital parameters. Determine what properties of a star (such as metallicity) are most strongly correlated with the presence of habitable Earth-like planets.



NASA Decadal Plan for Astrophysics: Future Mission Summary

Program	Mission	Objective (See Table 2.1)				Mission Objectives and Features
		1	2	3	4	
Flagship	James Webb Space Telescope (JWST)	•	•	•	•	Infrared successor to the HST; 6.5 meter telescope with four infrared instruments at L2; partnership between NASA, the European Space Agency (ESA), and the Canadian Space Agency.
Flagship	Hubble Space Telescope - Servicing Mission 4 (HST-SM4)	•	•	•	•	Enhance Hubble's range and dramatically increase both the survey power and the panchromatic science capabilities. Space Shuttle servicing to add two instruments: Cosmic Origins Spectrograph operating at near ultraviolet wavelengths and Wide Field Camera 3 (WFC3) operating at near infrared wavelengths.
Strategic mission	Gamma-ray Large Area Space Telescope (GLAST)	•	•	•		Observations of celestial high energy gamma-ray sources. Joint NASA/DOE mission with a large area telescope for an all sky survey in the highest-energy gamma rays.
ISSC	Herschel Space Observatory)		•	•		Completely cover the peak of the spectrum of galaxies and of star-forming regions out to redshifts of six. Fills wavelength gap between JWST and Spitzer. ESA mission with NASA contribution.
ISSC	Planck Surveyor	•				The third-generation space mission to measure the anisotropy of the cosmic microwave background radiation. An ESA mission with major contributions from NASA.
Discovery	Kepler				•	Monitor 100,000 stars continuously for four years to detect Earth-sized planets using transit photometry. Discovery PI-led mission; sensitive detectors capable of detecting a change in a star's brightness as small as 20 parts-per-million.
Explorer	Wide-field Infrared Survey Explorer (WISE)		•	•		Survey the whole sky in four mid-infrared bands to sensitivities 500 or more times better than previous all-sky surveys. The survey will provide an important catalog for JWST. Explorer MIDEX PI-led mission; 40 cm telescope continuously scanning spacecraft with scan mirror to freeze images on arrays for 8.8 second exposures.
Flagship	Stratospheric Observatory for Infrared Astronomy (SOFIA)		•	•	•	Infrared and submillimeter observations of stellar and planet-forming environments. Joint NASA/DLR (Germany) airborne 2.5-meter telescope on a Boeing 747; nine first-generation instruments.
Explorer	Explorer (MIDEX)	o	o	o		Competitively selected PI mission; could address any of the first three objectives.
Explorer	Explorer (SMEX)	o	o	o		Competitively selected PI mission; could address any of the first three objectives.
Navigator	Space Interferometry Mission (SIM)		•	•	•	Detect and characterize other planetary systems; measure the mass of planets and stars; measure the internal dynamics and external motions of galaxies in the Local Group and beyond; investigate quasar physics and establish the successor to the International Celestial Reference Frame. A 9-m baseline interferometer in Earth-trailing solar orbit.
BE	Constellation-X (Con-X)	•	•	•		X-ray imaging and spectroscopy for the study of black holes, dark matter, dark energy and neutron stars. Single spacecraft carrying a constellation of four telescopes placed in an L2 orbit with a combined collecting area of 1.5 square meters.
BE	Joint Dark Energy Mission (JDEM)	•				Measure the cosmological parameters of the expanding Universe. Joint NASA/DOE mission; three mission concept studies (ADEPT, DESTINY, SNAP) have been selected by NASA to examine differing mission implementations.
BE	Laser Interferometry Space Antenna (LISA)	•	•	•		First measurement of low-frequency gravitational waves. Three independent, free-flying, drag-free spacecraft provide for three-arm interferometry of a variety of astrophysical sources. Collaboration with ESA.
BE	Black Hole Finder Probe (BHFP)	•				Conduct a thorough census of black holes in the universe.
BE	Inflation Probe (IP)	•				Provide a stringent test of inflationary cosmology, the physics of the universe at less than a trillionth of a second after the Big Bang. This is a PI-class mission that will be selected by competition.
Navigator	Terrestrial Planet Finder–Interferometer (TPF)		•	•	•	*Interferometer*—Detect and characterize all components of other planetary systems, including terrestrial planets, gas-giant planets, asteroid belts; search for signs of life in terrestrial planets. Four 3-4 m passively cooled telescopes on separate formation flying spacecraft feeding light to a nulling interferometer on a fifth spacecraft; Proposed joint project with ESA's Darwin mission. *Coronagraph*—Image Earth-like planets, giant planets, and zodiacal dust around nearby stars; search for signs of life on Earth-like planets; carry out general astrophysics observations probing dark energy and dark matter. Single telescope at L2 with a narrow-field coronagraph and spectrometer to observe planets 10[illegible] as bright as their stars, and a wide-field camera for general astrophysics in the visible and near-infrared.

NASA Decadal Plan for Astrophysics: Timeline of Missions



Projects at the Cosmic Frontier naturally exist at boundary between particle physics & astrophysics

- HEPAP chartered a PASAG to assess:
  - Dark matter
  - Dark energy
  - Cosmic particles (high-energy cosmic rays, gamma rays, neutrinos)
  - Cosmic microwave background
- Recommendations for most pessimistic budget scenario (FY08 level w/3.5% annual escalation) include:
  - Dark matter
    - Two G2 experiments and the 100-kg SuperCDMS-SNOLAB experiment
    - Technology selection for the G2 experiments should occur soon enough to allow the construction of at least one G2 experiment to start as early as FY13.
    - No G3 experiments can be started in this decade. Progress will be slowed, risking loss of U.S. world leadership. However, due to the risk of picking the wrong technology, this is preferable to descoping to only one G2 experiment.
  - High-energy cosmic particles
    - Only VERITAS upgrade and HAWC are possible.
    - Even in this very lean scenario, the diversity offered by these two projects is a priority, and their impacts are large for a relatively small investment.
    - Auger North and AGIS are not possible.
      - This would be a retreat from U.S. leadership in high-energy cosmic rays and high-energy gamma rays.

Report of the HEPAP Particle Astrophysics Scientific Assessment Group (PASAG)

20 October 2009

DRAFT v1.12a

Background Materials Considered: External, Independent Program Reviews

Office of Nuclear Physics

Department of Energy
Office of Nuclear Physics Report

on the

Low Energy Subprogram Review

of the

Los Alamos National Laboratory
Low Energy Nuclear Physics Group

May 16-18, 2007

Office of Nuclear Physics

Department of Energy
Office of Nuclear Physics Report

on the

Medium Energy Review

of the

Los Alamos National Laboratory
Medium Energy Neutrino Gr

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on the

Medium Energy Review

of the

Los Alamos National Laboratory
Hadron Research Group

Los Alamos National Laboratory
Heavy Ion Research Group Review

A review was conducted by the Office of Nuclear Physics of the research activities of Heavy Ion groups at the national laboratories based upon submitted material and presentations made at DOE Headquarters in Germantown on January 29-30, 2004. The purpose was to evaluate the quality, performance, and significance of the ongoing and planned laboratory programs. In carrying out this charge, reviewers were asked to evaluate and comment on four criteria: (1) scientific significance and/or technical merit of the laboratory's past and proposed research; (2) demonstrated competency and future promise of personnel; (3) feasibility of the plans for the proposed research, cost-effectiveness and reasonableness of the requested funding; and (4) effectiveness of the support and infrastructure of the laboratory.

This report contains an executive summary and the findings of this review for the four review criteria with a copy of the charge letter and the excerpts of the reviewers' comments as appendices.

Executive Summary

Accomplishments/Competency: The construction and installation of the muon arms for the PHENIX experiment were major accomplishments and the group continues to provide significant operational support for these detectors. However, the micro vertex detector (MVD) was not completed in a timely fashion and has yet to produce useful results. The LANL group has built a strong analysis effort with ORNL and French groups. First observation of the J/ψ sig… leading role in the muon … laboratory, especially LD… The LANL group is judg…

Department of Energy

NOV 17 2008

Department of Energy

Dr. Scott Wilburn
Group Leader
Physics Division
Los Alamos National Laboratory
P-25, P. O. Box 1663
Los Alamos, New Mexico 87545

Dear Dr. Wilburn:

Enclosed is the report of the review of the Los Alamos National Laboratory (LANL) Nuclear Theory Group. This report contains an executive summary, comments upon past achievements, merit of the proposed program, role of the research in the national program, and quality of the research staff. It also provides programmatic and funding guidance. Excerpts from the reviewers' comments are included in the document. Overall, this review finds that the LANL Nuclear Theory Group is performing at an excellent level.

Please feel free to contact George Fai or myself if you have questions, or would like clarification on any issue. We thank the members of the LANL nuclear theory group for their effort in preparing and participating in this review. We trust the enclosed material will be helpful for guiding and strengthening the future nuclear theory program at LANL and look forward to progress in response to the review toward making an excellent program even stronger.

Sincerely,

Timothy Hallman
Associate Director of the Office of Science
for Nuclear Physics

Background Materials Considered: External LANS Capability & Grand Challenge Reviews

LANS Capability Review

Nuclear Physics, Astrophysics, Cosmology and Particle Physics (NPAC)

9-11 May 2007

Document Number: FM-07-01-NPAC

Revision: Final

Date: 31 August 2007

Chair: Robert Rosner

Reviewed by:

PAD

DIR

LANS, LLC

LOS ALAMOS
National Security LLC

Functional Management Assessment of the Beyond the Standard Model Grand Challenge

30 June 2008 – 2 July 2008

Document Number: POFMA 2007-6140

Revision: Final

Date: August 22, 2008

Team Leader: Michael Turner, University of Chicago

Reviewed By:

PAD: Terry Wallace, PADSTE

LANS, LLC: Joe Scarpino, LANS, LLC

DIR: Jan Van Prooyen, DIR

LANS Capability Review

Earth and Space Sciences

21-23 August 2007

Document Number: FM-07-04-ESS

Revision: Final

Date: 17 September 2007

Chair: Thomas Prince

Reviewed by:

Sensors, Remote Sensing, and Sensor Review Committee Report

May20-22, 2008

Document Number: POFMA 2007-4495

Revision: 0

Date: 05/12/2008

Team Leader: Raymond J. Juzaitis

Reviewed By:

PAD:	Terry Wallace	Date
DIR:	Michael Anastasio	14Aug08 Date
LANS, LLC:	Joseph A. Scarpino	15Aug08 Date

Summary Description of Issues Reviewed:

Recommendations from the Rosner Report

- "Hard decisions will need to be made soon
  - ambitions exceed funding projections
  - buy-in' from the troops is essential."
- "A sustainable & stable funding plan for basic research aligned with the Lab's mission needs to be found & implemented."
- "Needs to formulate an implementation plan for the BSM Grand Challenge in a timely manner
  - e.g., winnow down to the program that matches the Lab's mission and is financially sustainable."
- "Lab needs to make the difficult choices on which (Astrophysics & Cosmology) projects to pursue, commensurate with the core competencies, synergy with Lab Mission, and ability to sustain."

LANS Capability Review

Nuclear Physics, Astrophysics, Cosmology and Particle Physics (NPAC)

9-11 May 2007

Document Number: FM-07-01-NPAC

Revision: Final

Date: 31 August 2007

Chair: Robert Rosner

Reviewed by:

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LANS, LLC

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National Security LLC

Excerpts from the Turner Report

- Recommendations:
  - "Further refine BSM strategy & develop priorities, based upon quality of science, connection to programs, and match to the Lab's technical and human assets."
  - "Develop performance metrics that measure the success and progress of BSM GC (e.g., sustainable funding for projects, integration of young scientists into programs, scientific and technical milestones)."
  - "Opportunities exceed what can be realistically and effectively achieved; hard decisions will need to be made."
  - "Establish a mentoring program for young scientists to guide them into stable funding within Laboratory programs, or to move them onto other career paths."
- Comments:
  - "Since nearly half of the support for nuclear physics comes from LDRD, the BSM/GC is effectively determining the future direction of Nuclear Physics at the Lab. Given this reality, strategic decisions are realized through the BSM/GC and it is essential that there be a well formulated global strategic plan."
  - "The cosmology theme of the BSM/GC has a 3-prong strategy in place: direct dark matter detection; computational cosmology; dark energy surveys. This strategy is the most well developed of the BSM/GC strategies and is well matched to the Lab's assets (high-performance computing, strong experimental nuclear physics) and the most exciting scientific opportunities (e.g., dark matter and dark energy)."

Functional Management Assessment of the
Beyond the Standard Model Grand Challenge

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DIR: Jan Van Prooyen, DIR

Excerpts from the Prince Report

- "LANL's capabilities in space physics directly contribute to and are relevant to the mission of the Laboratory.
  - "LANL's capabilities in space physics are critically important for space-based nuclear detonation detection and non-proliferation treaty monitoring from space.
  - "LANL's capabilities in space physics provide a critically important and unique contribution to space situational awareness, a rapidly growing area in national security space; space situational awareness is specifically listed in the U.S. National Space Policy (2006)."

LANS Capability Review

Earth and Space Sciences

21-23 August 2007

Document Number: FM-07-04-ESS

Revision: Final

Date: 17 September 2007

Chair: Thomas Prince

Reviewed by:

PAD

DIR

LANS, LLC

Background Materials Considered: Internal LANL Community Planning & Analysis

LANL Nuclear Physics Long Range Plan
October 2008

Strategic planning is an organization's process of defining its strategy, or direction, and making decisions on allocating its resources to pursue this strategy, including its capital and people. Various business analysis techniques can be used in strategic planning, including SWOT analysis (Strengths, Weaknesses, Opportunities, and Threats) and PEST analysis (Political, Economic, Social, and Technological analysis). -Wikipedia

HEP – Activities, Funding and Opportunities

HEP National Priority Alignment (P5 Panel and Report):

DOE HEP (Energy)	DOE HEP (Intensity)	DOE HEP (Cosmic)	NSF	NASA
LHC Fermilab ILC	SM & BSM ν @ Accelerators Mu e conversion	Dark Matter Dark Energy JDEM, LSST Cosmology HE γ-rays	DUSEL HE γ-rays DE (LSST)	JDEM

HEPAP P5 Charge to the Panel (and representing DOE and NSF):
Develop a 10 year plan for US Particle Physics under the following four DOE funding scenarios:
A. Constant effort at the FY2008 level (688 FY08 M$ DOE)
B. Constant effort at the FY2007 level (752 FY07 M$ DOE)
C. Doubling of budget over 10 years starting with FY2007
D. Additional funding above the previous level, associated with specific activities needed to mount leadership

2000-2005 HEP investment profile (for both people and projects):
Energy Frontier (57%),
Intensity Frontier (32%)
Cosmic Frontier (11%)

Funding Opportunities in HEP and related areas:

DOE HEP	DOE NP	NSF	NASA
SM & BSM Theory ν@Accelerators Mu e Conversion Dark Energy Dark Matter Cosmology(Th) Gravity Astroparticle	LHC Heavy Ion Neutrons FRIB Neutrinos	DUSEL Dark Matter HAWC Dark Energy	JDEM Astrophysics(Th) Cosmology (Th)

SciDAC:
Astrophysics
Cosmology
Nuclear
Lattice QCD

Ongoing and Future Programs & Capabilities Examined With Respect to Eight Factors

Relevance & Significance to Mission, Community, & Sponsor

1. Relevance to LANL National Security Mission (*i.e.,* NW, Global Security, & Energy)
2. Relevance to National basic science community strategies
3. Alignment with sponsors' interests and plans

Reputation of People & Team with Sponsor & Community

4. LANL's reputation with particular sponsors, based on quality, relevance & performance to date
5. Talent Management

Sustainability of Effort: Leverage, Transition, Stakeholder breadth

6. Leveraging opportunities (*e.g.,* existing infrastructure, ability to fold in matching external funding from thrust sponsor)
7. Credible transition plans when taking on new NPAC scope
8. Ability to rapidly and effectively communicate importance of the NPAC portfolio to variety of changing stakeholders (*e.g.,* during management transitions).

Consideration 1:

Relevance to LANL National Security Mission

Low: Notional connections to LANL National Security Mission (*e.g.,* some capability overlap).

Moderate: 2-way communication

Connection identified, but not proven. Mission Program Mangers are engaged with PIs and their divisions; key team members knowledgeable of Mission programs.

High: 1-way personnel, idea, and technology transfer demonstrated

Technology and technique spin-offs, several former staff now leading major National Security thrusts.

Very High: 2-way personnel, idea, and technology transfer demonstrated

Strong, continued, and sustainable connections demonstrated: PIs and other key staff regularly contribute concurrently to a NPAC basic science thrust and National Security programs, regular and continuous transfers of innovation and technologies between programs. Peer reviewed publication in journals outside the principal field indicating broad impact.

Consideration 2:

Relevance to National Science Community Strategies

Low: Notional connections to community strategies and collaborations.

Moderate: Connection identified but not widely accepted

LANL thrust fits well within a leading strategy and is competitive, but strong community engagement and support not yet attained; strong collaborations with world-class organizations under discussion/negotiation .

High: Clear connections demonstrated

Priorities developed in major reports (*e.g.,* NAS level) include LANL thrust by name; staff asked to speak to Academy or equivalent panels to discuss further research directions; while competitive, significant results from LANL not yet realized; strong collaborations with world leading organizations and PIs formally established. Strong peer review comments in all relevant areas.

Very High: Strong, continued, and sustainable connections demonstrated

Priorities developed in major reports (*e.g.,* NAS level) cite specifics of LANL ideas by name; staff lead Academy or equivalent panels; this work changes or will likely change the direction of research fields; high impact LANL publications (in prestigious journals, high number of citations, important positive publicity); LANL is highly competitive and principals are the world leaders in the field; strong collaborations with world leading organizations and their PIs formally established; work changes the way the research community thinks about a particular field; team is recognized by the research community as the leader for making the science case for a new program/facility; resolves critical questions and thus moves research areas forward; results generate huge interest/enthusiasm in the field .

Consideration 3:

Alignment With Sponsors' Interests and Plans

None: External interest unlikely

LANL's return on investment is in fame, not fortune .

Low : Notional connections with sponsor's plans

Cognizant LANL program managers engaged

Moderate: Connection identified but not proven

Sponsor has been briefed, is engaged, and has provided positive feedback.

High: Clear connections demonstrated

Sponsor strategic plan priorities include thrust by name; LANL in a position to credibly compete for a significant role; significant results by LANL not yet realized; principal collaborators are already funded by sponsor; competition likely within 3 years; reviews repeatedly confirm potential for scientific discovery in areas that support the Department's mission, and potential to change a discipline or research area's direction.

Very High: Clear connections demonstrated

Sponsor strategic plan priorities include thrust by name; LANL in a position to credibly compete for a significant role; significant results by LANL not yet realized; principal collaborators are already funded by sponsor; competition likely within 3 years; reviews repeatedly confirm potential for scientific discovery in areas that support the Department's mission, and potential to change a discipline or research area's direction.

LANL reputation with particular sponsors, based on quality, relevance & performance to date

None: Sponsor unaware of LANL, or has serious issues with LANL that must be confronted and resolved

A number of projects have not met expectations for quantity, schedule, &/or quality; peer reviews identify significant deficiencies that have negatively impacted overall program/project

Low: Sponsor is acquainted with LANL and has a mixed opinion

Most program/project goals and/or milestones are met on schedule and within budget; overall program/project and/or mission objective(s) are met; minor delays, overruns, and/or deficiencies are minimized and/or have little to no adverse impact the overall program/project.

Moderate: Sponsor views LANL as a credible player based on a history of previous work directly for sponsor

Key researchers are known by name and respected by sponsor; peer reviews are largely positive, with only a few minor deficiencies and/or slightly negative responses noted; minor deficiencies and/or negative responses have little to no potential to adversely impact the overall program/project; program/project goals and/or milestones are primarily met on schedule and within budget.

High: Sponsor fully satisfied with LANL previous performance and key personnel

as evidenced by peer reviews that are universally positive, sustained funding, and recognition; program/project and/or mission objective(s) are fully meet and are fully responsive to sponsor guidance; development of tools and techniques that become standards or widely-used in the scientific community.

Very High: Sponsor delighted with LANL previous performance and key personnel

as evidenced by best-in-class peer reviews, increased market share of funding, and awards. Sponsor and independent experts and/or peers laud work results; output(s) exceeds the amount and/or quality typically expected for an excellent body of work; program/project goals and/or milestones are met well ahead of schedule and/or well under budget; demonstrated willingness to take on high-risk/high payoff/long-term research problems *accompanied by* evidence that the team "guessed right" in that previous risky decisions proved to be correct and are paying off.

Consideration 5:

Talent Management

Low: Qualified staff in place but critical hires needed

Moderate: Thrust a proven attractor of qualified post docs and critical hires; quality staff retention and collaboration satisfactory.

Initial signs of success are evident.

High: Thrust is a recruitment magnet, as evidenced by many Director and Named Postdocs; mid-career award winners, and Lab Fellows who continue to contribute to intellectual leadership.

Strong performers in most areas; some aspects of programs are world-class; development and maintenance of strong core competencies that are cognizant of the need for both high-risk research and stewardship for mission-critical research; attracting and retaining scientific staff that are very talented in all programs .

Very High: Internationally-renown leadership

There are significant, major award winners in field); group is trend-setter in their field with invited talks, citations, making high-quality data available to the scientific community; attraction and retention of world-leading scientists; recognition within the community as a world leader in the field.

Leveraging opportunities *(e.g.,* ability to fold in matching external funding from thrust sponsor)

Low: Notional opportunities identified.

New LDRD-DR needed to initiate thrust and likely needed to extend beyond 3 years.

Moderate: Opportunity clearly identified.

New LDRD-DR needed to initiate thrust not likely to extend beyond 3 years.

High: Matching LDRD funds in hand and likely not needed after current LDRD project(s) ends.

Very High: Stable, matching (or greater) programmatic funds in hand.

May need LDRD-ER to expand or enhance capability breadth and depth.

Consideration 7:

Credible transition plans when taking on new scope

Low: Initial, notional planning evident.

Moderate: Key personnel staffing, facility, and infrastructure plans developed; over commitment and infrastructure/facility gaps identified.

High: Staffing, facility, and infrastructure plans for key personnel developed; plans in place to fill identified over commitment and infrastructure/facility gaps.

Very High: Staffing, facility, and infrastructure plans for key personnel developed; no major over commitment and infrastructure/facility gaps evident.

Consideration 8:

Ability to rapidly and effectively communicate importance of the NPAC portfolio to variety of changing stakeholders

Low: Notional connections. Need to collect and document thoughts.

Moderate: Compelling communication packages *e.g.,* white papers, brochures, briefings) for non-specialist decision makers written, distributed, and regularly communicated

High: Multiple stakeholders understand and support thrust, and capable of effectively representing thrust.

Very High: Multiple stakeholders serve as champions for the thrust, and regularly represent the thrust in presentations and documents. Thrust is an Institutional priority.

Findings: Nuclear Physics

Nuclear science, both basic & applied, continues to be one of our most important capabilities to ensure that we can reduce nuclear risk.

- Then:
  - LANL was founded to develop nuclear explosives. Its most notable founding scientists were world renowned nuclear physicists: Oppenheimer, Teller, Bethe, Dirac, and Fermi.
  - Strong interaction between our core mission and basic nuclear science resulted in the only Nobel Prize ever awarded for work at a weapons laboratory, the discovery of the neutrino.
- Now:
  - Nuclear physics has remained one of our most important core competencies to today, and the interaction between basic science and the core programs has demonstrated continued vitality.
  - Scientists from our basic science program have recently developed new techniques being used in the core weapons program such as proton radiography. They are providing important cross section measurements that are needed for mining the underground test data base.
  - LANSCE, which started as a nuclear science facility is now being used for many material science applications that are helping to steward the aging nuclear stockpile, and is the cornerstone for our next signature facility, MaRIE.
  - In addition to weapons applications, nuclear science techniques are contributing to other mission areas, including homeland security, for example: low field nuclear magnetic resonance imaging for high explosive detection, cosmic ray muon tomography for nuclear explosive detection, new techniques for active interrogation using muons and high energy protons, and improved radiation detection techniques.

Findings: Nuclear Physics
LANL nuclear physics program is of high quality

- Emphasis on neutrinos, fundamental symmetries, neutrino and nuclear astrophysics, nucleon spin, and the physics of the QGP. The first three have been raised in priority in the most recent Nuclear Physics Long-Range Plan.
- LANL is significantly involved in new high-profile experimental projects, *e.g.,* nEDM and Majorana.
- Project management reputation from our work on RHIC PHENIX FVTX is high.
- Theory program is strong, *and*
    - can be further strengthened by taking advantage of LANL facilities (*e.g.,* high-performance computing), and tying to Laboratory and DOE/NP national program priorities;
    - can provide an important connection to, and leverage for, theoretical particle and astrophysics initiatives.

Findings & Comments: Nuclear Physics
Top prospects for program development are off-site

- LANL-based facilities and experiments are not considered to be a high priority by ONP (and HEP) sponsors.
  - 12-GeV CEBAF Upgrade, FRIB, FNPB are top new ONP facility priorities.
  - Community support is likely needed to attract major external facility investments at LANL.

Comments: LANL should perform the best science at the best facilities; nevertheless, the lack of a significant local facility is not entirely healthy for LANL. Some expertise is necessarily tied to the facility host laboratory and is lost when only pursuing offsite experiments, as are integration opportunities with our National Security mission. While ONP terminated support of LAMPF operations in the 90's, they began supporting operations of the LANSCE IPF in 2009. There may be other opportunities to renew ONP stewardship of research facilities at LANSCE. It is unlikely that large-scale ONP experimental facilities could be hosted by LANL; however, there are intermediate-scale facilities at LANL worthy of a national lab, that could grow, *e.g.*, UCN, nuclear astrophysics, isotopes.

Findings & Comments: Nuclear Physics
Basic BSM & Applied program integration is uneven

There is close coupling between BSM physics and applied nuclear physics (*e.g.,* in NW, GS, NE) in some areas, and gaps in others.

- There is strong overlap between scientists working on fundamental neutron physics and pRad and GS activities.
- Development of large-area, state-of-the-art silicon detectors for ONP heavy ion experiments has proven to be an effective gateway for staffing Global Security Programs.
- Theoretical and experimental nuclear data programs provide crucial support to LANL National Security mission (*i.e.,* "deterrence by capability").

Comment: The gap between BSM physics and applied nuclear physics could be bridged by starting or enhancing a program aimed at FRIB nuclear structure/reactions, nuclear astrophysics, fundamental symmetries; however, present staffing level is insufficient to pursue a leading role at FRIB. While early career scientists at LANL are highly capable, there is a need for mid-career experimentalists who could lead such an effort.

Nuclear Physics: Recommendations & Comments

Comment: Experimental & theoretical nuclear physics is a critical part of many future directions for LANL and its health should be a top priority.

Recommendations:

1. Deliver on current obligations & transitions to new efforts

   Comments: Average program peer reviews result in status quo, while above-average program reviews are required for credible program development and portfolio growth. Construction projects (FVTX, nEDM,) are especially important and must to be managed with discipline and rigor. Special attention is needed for Majorana as it transitions from R&D to project phase & as mature experiments reach their conclusions.

2. Plan, promote, and establish the next major LANL thrust to follow the successful conclusion of our commitments on RHIC

   Comment: LHC and/or JLab are viewed as our most promising near-term prospects at this time. A leading role in the Electron-Ion Collider should be evaluated as a longer-term goal. Re-evaluate this position once the future of RHIC and the EIC become clear; we should position ourselves for a technical leadership role, and as neutral brokers that may inform facility decisions.

3. Make a concerted effort to plan, attract community support, market, and sell world-class, intermediate-scale National user facilities at LANL

   Comment: Targets of Opportunity include:(1) Expanding the IPF mission to provide isotopes to the research community; (2) utilizing UCN at full capacity; and (3) exploring potential of WNR to support National nuclear data community and FRIB physics. Reevaluate options and position after assessing community support and sponsor reaction to that support.

Findings: Particle Physics
Opportunities exist for new OHEP program starts

- For the first time in many years, LANL has significant prospects for increasing external OHEP support because of the close ties of the nuclear program with particle physics.
  - "The U.S. is uniquely positioned for a world-leading (HEP) program in neutrino physics" – W. Brinkman Feb. 1, 2010.
  - LANL experience at FNAL in neutrino physics has resulted in a unique opportunity to play an important role in future long-baseline experiments.
  - LANL reputation in HEP neutrino theory is high.
  - HEP environment will continue to be highly competitive.
- DEEP/CLEAN experiment is a strong candidate for OHEP support because of its ability to scale to large detector sizes at reasonable cost.
- LANL theoretical HEP program is subcritical, and found to be at risk if not corrected by the next DOE Theory review in 2011.
  - HEP theory peer reviews indicate a need to take advantage of national laboratory infrastructure (*e.g.,* high-performance computing, on-site collaborations with major experiments).

Comments: Particle Physics

- Our theoretical HEP program could be strengthened by
  - Playing a significant role in large-scale simulations, *e.g.,* those supported by DOE-SC-ASCR.
  - Connecting to the experimental programs in both nuclear and particle physics, and in cosmological grand challenges.
- Fermilab (FNAL) appears to be a natural HEP partner for LANL
  - FNAL is "OHEP's Lab."
  - Experiments are opening new opportunities in the interface between NP and HEP.
  - Grass roots collaborations have sprung up in AOT, ISR, MPA, P, T Divisions that provide nucleation sites for a longer-term, strategic partnership.
  - FNAL, particularly in conjunction with the DUSEL, currently has an abundance of outstanding scientific opportunities.
  - FNAL is actively seeking LANL contributions to their new OHEP initiatives.

Particle Physics: Recommendations & Comments

Recommendations:

1. Form a strategic partnership with Fermilab.

Comments: There is an excellent opportunity to build upon success achieved by the LANL accelerator and theoretical neutrino groups. Being the FNAL strategic partner of choice would provide leverage to obtain increased DOE OHEP support and develop NPAC science in new directions.

2. Invest and support the strongest integrated experimental and theoretical prospects with DOE OHEP.

Comments: The Mini-CLEAN Project is viewed as our most promising major experimental program development opportunity at this time, and worthy of full support as a top Institutional priority, up until the selection of the 2nd-Generation (G2) Experiment. Re-evaluate this position after first results from Mini-CLEAN are achieved and the G2 decision in FY13.

A focused effort is needed to establish a sustainable theory program, integrated with LANL experiments.

Findings: Astrophysics & Cosmology
LANL's breadth touches most areas of this discipline

- Key threads running through many LANL thrusts are high-energy and nuclear processes, and cosmic explosions.
- LANL strengths include
  - Cross-disciplinary approaches and expertise (nuclear physics, astrophysics, equation of state physics, plasma physics, modeling and computing) provide a competitive advantage, *e.g.,* the new ONP Collaborative Center for Dense Matter & Neutrinos, and Laboratory expertise for measuring key nuclear cross-sections.
  - Measuring x-rays, gamma-rays, and neutrons both in space and on the ground
    - Storied history of space-based performance from VELA through SWIFT
    - New ground-based efforts at the proposed HAWC Observatory are now being supported, following strong endorsements from the NSF/DOE-SC HEPAP PA-SAG.
  - Distributed robotic instrumentation, real-time knowledge extraction, data mining, and the curation of peta-scale datasets.
    - Application of this capability to both open science and Global Security problems like Space Situation Awareness is important and a rapidly growing thrust across the laboratory.
- Programmatic & science mission relevance continues to be high
  - LANL Weapons Program established an Astrophysics Center in 2000 that co-located X & T Div personnel, hired postdocs, and provided a recruiting portal. Center was disbanded in 2004 after ASC funding cuts.
    - There has been renewed NNSA interest in establishing an Astrophysics Center in recent years to provide a recruiting portal.
  - Programmatic and science mission relevance of astro-informatics is high and traction is rapidly growing.
    - Other major research institutions are copying LANL.
  - ASCR/HEP extreme scale computing panel lists large-scale structure simulations as the #1 computational cosmology priority.

Findings: Astrophysics & Cosmology
Our NASA reputation has been consistently high, but..

- Swift, the Lunar/Mars missions, & Space Environment IBEX missions all 1st-rate
- There is much commonality in LANL interests and future NASA missions
  - LANL Director offered to visit NASA to promote & partner at executive level
- LANL's significant space expertise is recognized by NASA and the programmatic side of DOE, *but:*
  - LANL's decades of experience do not appear to be fully appreciated by DOE-SC, who in the future may be embarking on serious investments in a space-based dark energy mission.
  - Given the limited available funds, SC has supported their currently funded particle physicists, before funding scientists at NNSA Labs with space experience.
- There appear to be insufficient investments to position LANL for sustained leadership with NASA.

Comments: Astrophysics & Cosmology

- Current programmatic capability needs and discovery science opportunities warrant re-examination of a viable Computational Astrophysics & Cosmology Center at LANL, building upon the lessons learned & best practices from previous attempts.
- Depth and breadth of theory and experimental and observational capability for the study of extreme astrophysical environments is one the scientific "crown jewels" at LANL. We need to develop a plan for astrophysics at LANL that integrates tailored strategies for the primary customers --- NASA, NNSA, & SC.
- Efforts like the Astroinformatics Signature Facility is a natural way to both demonstrate and to grow the distributed robotic instrumentation, real-time knowledge extraction, data mining, and curation of peta-scale datasets capability.
- While our reputation at NASA is high, we must position ourselves for sustained leadership by investing in development of new space instrumentation, technologies, and PIs. Sub-orbital payloads and mini/micro-satellites are an excellent means to grow new leaders and new test new technologies.

Astrophysics & Cosmology: Recommendations & Comments

Recommendations:

1. Successfully execute externally-sponsored and LDRD programs that exercise cross-disciplinary computational capabilities needed for astrophysics and cosmology. Integrate these efforts into a single high-visibility, sustainable Center where the whole is greater than the sum of the parts, making strong contributions to both programmatic and basic science work, and with strong connections to leading experiments and observations.

   Comments: Objectives of a Center could include: (1) maintaining a sustainable world-class capability; (2) demonstrating strong "push" from NNSA, SC, NASA, and other programs; (3) effectively exploiting LANL's cross disciplinary strengths (people and infrastructure); (4) promoting strong, daily communication and career mobility between programmatic and discovery science researchers, including established intellectual leaders and early career staff; (5) serving as a recruiting portal; (6) developing & executing the overall LANL strategy for Computational Astrophysics & Cosmology.

   In addition to programmatic work scope, sustainability would be enhanced by strategic collaborations with major discovery science experimental facilities such LIGO, FRIB, DUSEL Observatories, LSST, and the JDEM Great surveys, where a Computational Center supports both the mission design and interpretation of observations.

2. Support the strongest program that: (1) produces marquee impact science; *and* (2) make significant programmatic contributions; *and* (3) fosters & demonstrates major LANL capabilities.

   Comment: Astroinformatics is viewed as our most promising experimental program development opportunity at this time; it exploits LANL's considerable strengths in information science, real-time knowledge extraction, computation, and robotic instrumentation.

3. Promote LANL's growing astrophysics & cosmology portfolio to DOE –SC.

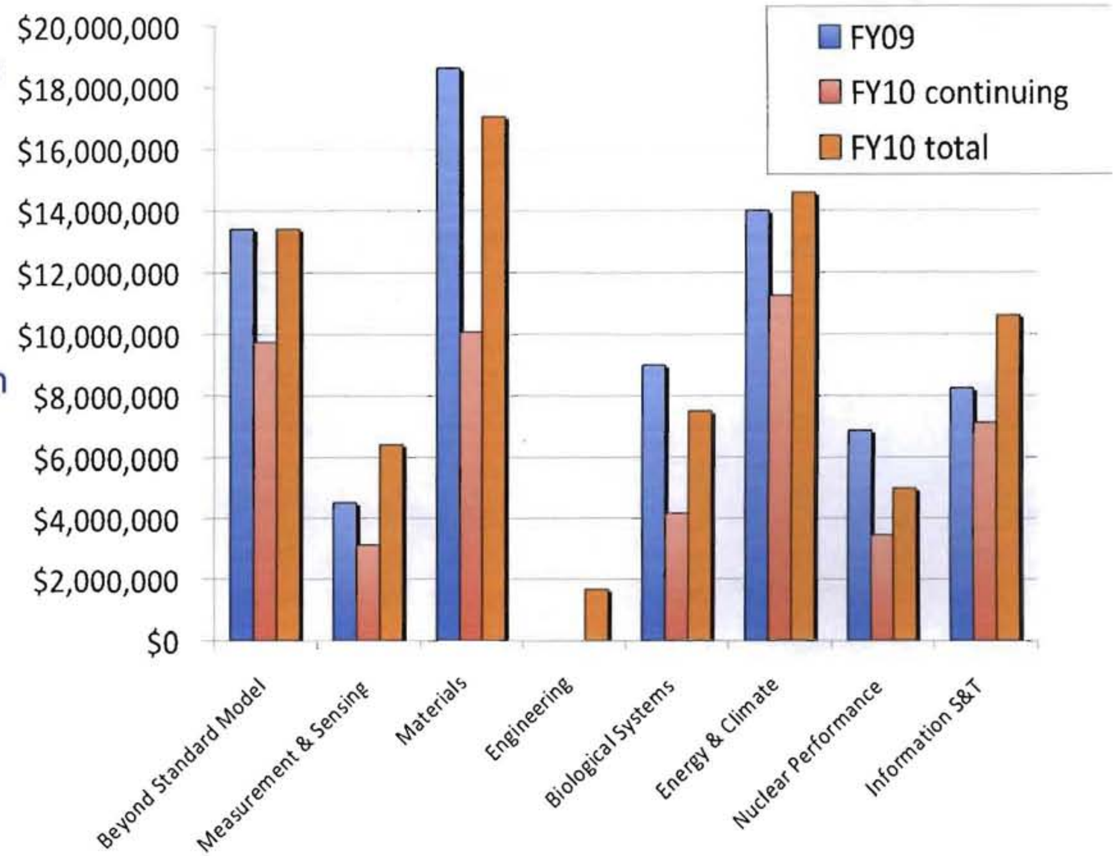
   Comment: Recent PASAG endorsement of HAWC is an excellent first step.

4. Develop & execute a LANL decadal & beyond strategy for enabling a DOE-NNSA programmatic, DOE –SC and NASA partnership to conduct a LANL-led Space Mission in High Energy Astrophysics.

   Comment: Current theoretical & computational efforts, such as cosmic explosions and nuclear astrophysics, and experimental efforts, such as CFE, should drive this effort.

General Findings:

- LDRD investments are critical to develop sustained programs on the NPAC frontier
  - FVTX, nEDM, UCN
  - SciDAC
  - Space Situation Awareness
- Staffing levels for projects are often subcritical
  - "Ambitions exceed funding projections"
  - Limited planning for timely staffing when taking on new work, while delivering on existing program obligations
- Operational barriers present a vulnerability for sustainable program
  - Is science productivity considered when making operational decisions, e.g., scientific computing, Foreign National access?



LDRD investments in the Beyond the Standard Model Grand Challenge have been significant, corresponding to ~ 10% of total portfolio

General Comments

- We are pursuing many opportunities at DOE-SC right now; this is a sign of a healthy program and the right approach, *but:*
  - We must realize that many of the new initiatives ultimately will not prove successful;
  - LANL must be prepared to cut off projects which will not be supported by DOE/SC or other agencies.
- Waiting for funding to arrive before developing a staffing plan results in substantial project schedule risks.
  - Failing on early project deliverables adversely affects reputation, relationships, momentum, and productivity.
  - Consider best practices and lessons learned from LANL BES programs.
- All strategic programs should be forward looking, with regular self-assessments, and investments to refresh, as needed.

General Recommendations & Comments

Recommendations:

1. **Improve the correlation between community relevance, sponsor alignment, and stakeholder management.**

   Comments: Stakeholders should be aware of and able to champion programs. In cases where community relevance exceeds sponsor alignment, work with the scientific community through planning documents, publications, and peer review to enhance sponsor alignment. In cases where sponsor alignment is high, use this political capital to pursue the highest-quality science in that research area.

2. **Develop and implement integrated staffing plans for existing and proposed thrusts**

   Comments: A staffing plan for each existing and proposed project (FTE numbers, names, and schedule) that documents needs, personnel gaps, recruiting priorities, and partnering preferences. Working without these plans or on an *ad-hoc* basis threatens our ability to deliver on commitments.