U.S. DEPARTMENT OF ENERGY | Office of Science

Office of Nuclear Physics Program Update

DOE/NSF Nuclear Science Advisory Committee Meeting

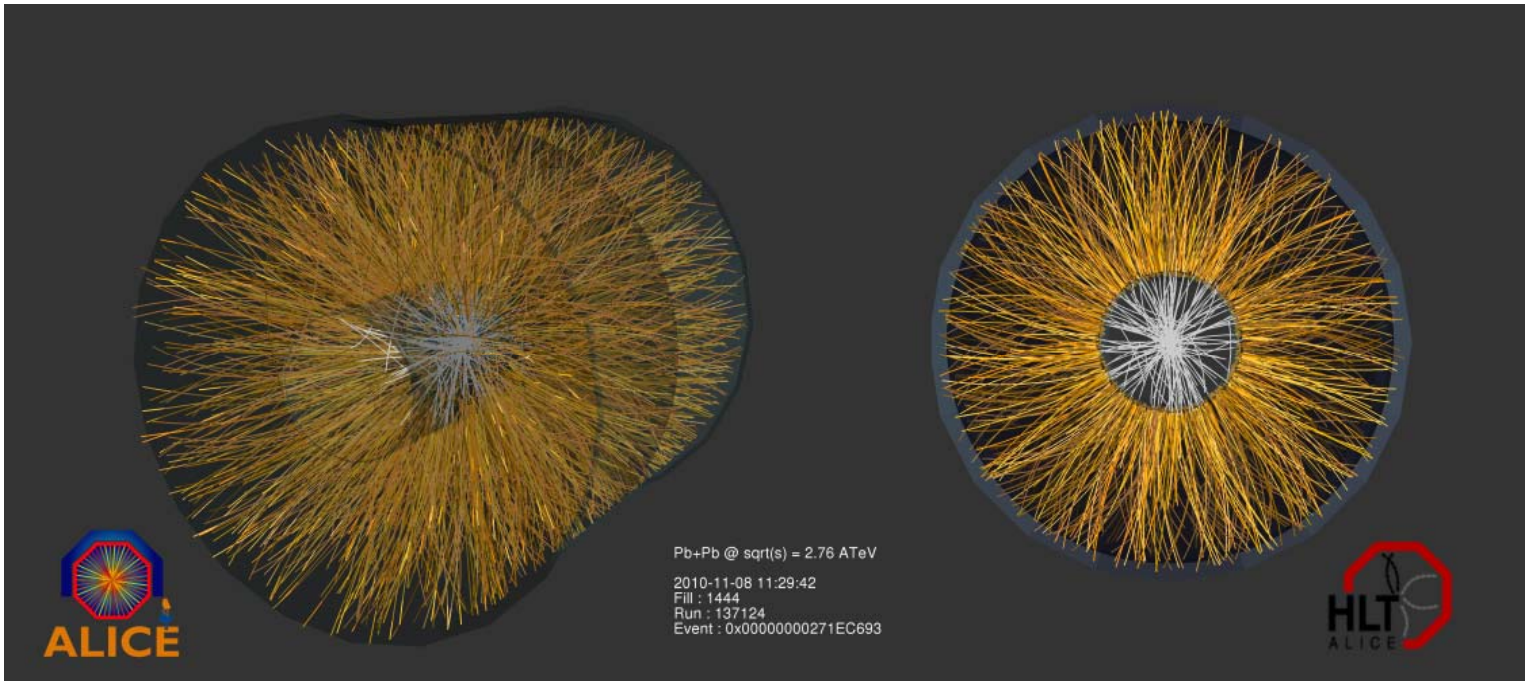
December 8, 2010

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

Outline

- Selected highlights
- FY2011 Appropriation
- FY 2012 Request
- Office of Nuclear Physics News
- Future Challenges

Opening a new science horizon at the Large Hadron Collider



One of the first events from lead-lead collisions at a centre-of-mass energy of 2.76 TeV per nucleon pair.

(Reconstructed event from the High Level Trigger (HLT), showing tracks from the Inner racking System (ITS) and the Time Projection Chamber (TPC) of ALICE.)

Selected Highlights

New two-particle correlations observed in the CMS detector at the LHC

September 21st 2010

The CMS Collaboration at CERN released today a paper entitled "Observation of Long-Range Near-Side Angular Correlations in Proton-Proton Collisions" that details signs of a new phenomenon in proton interactions.

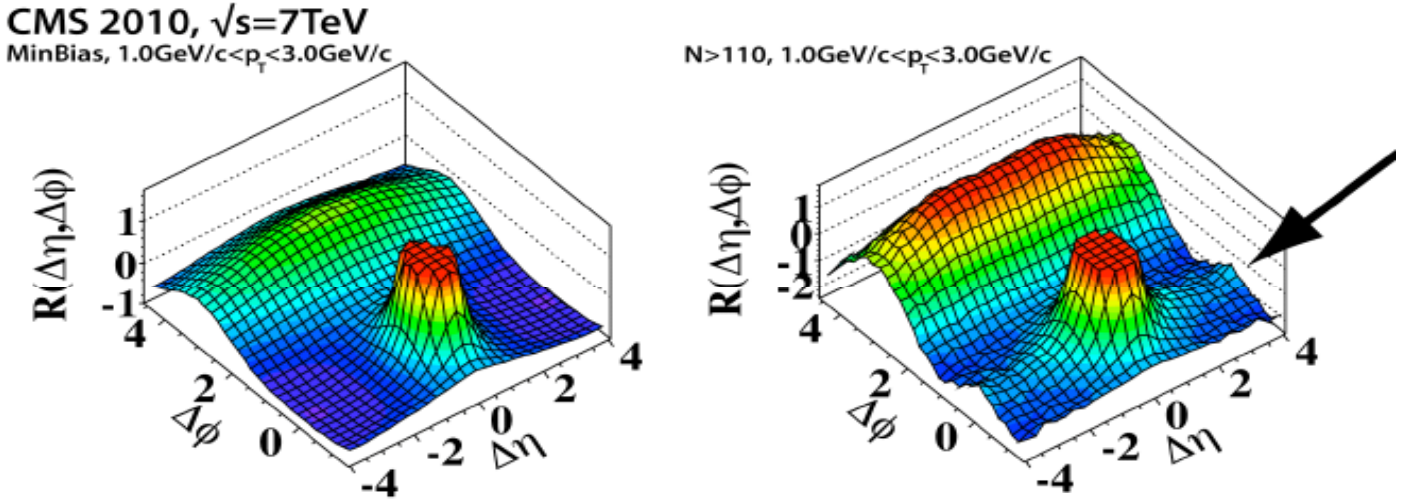
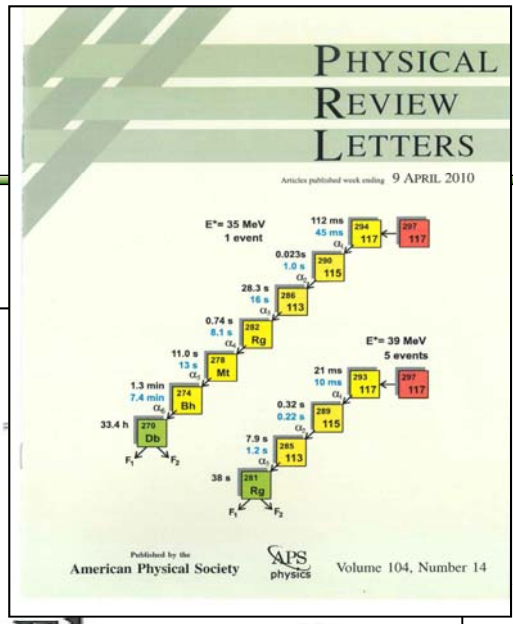


Figure 2: The variation of R with Δη and Δφ, for proton-proton collisions in CMS. Left: for minimum bias collisions; Right: for collisions that produced at least 110 charged particles.

The most notable difference between the two images is the curious addition of an elongated ridge at Δφ=0 for all Δη. This means that particles in some pairs at large Δη are receding from each other at close to the speed of light, but are oriented along the same φ angle – as if the particles were somehow associated together when they were created at the point of collision.

Selected Highlights



April 6, 2010

Scientists Discover Heavy New Element

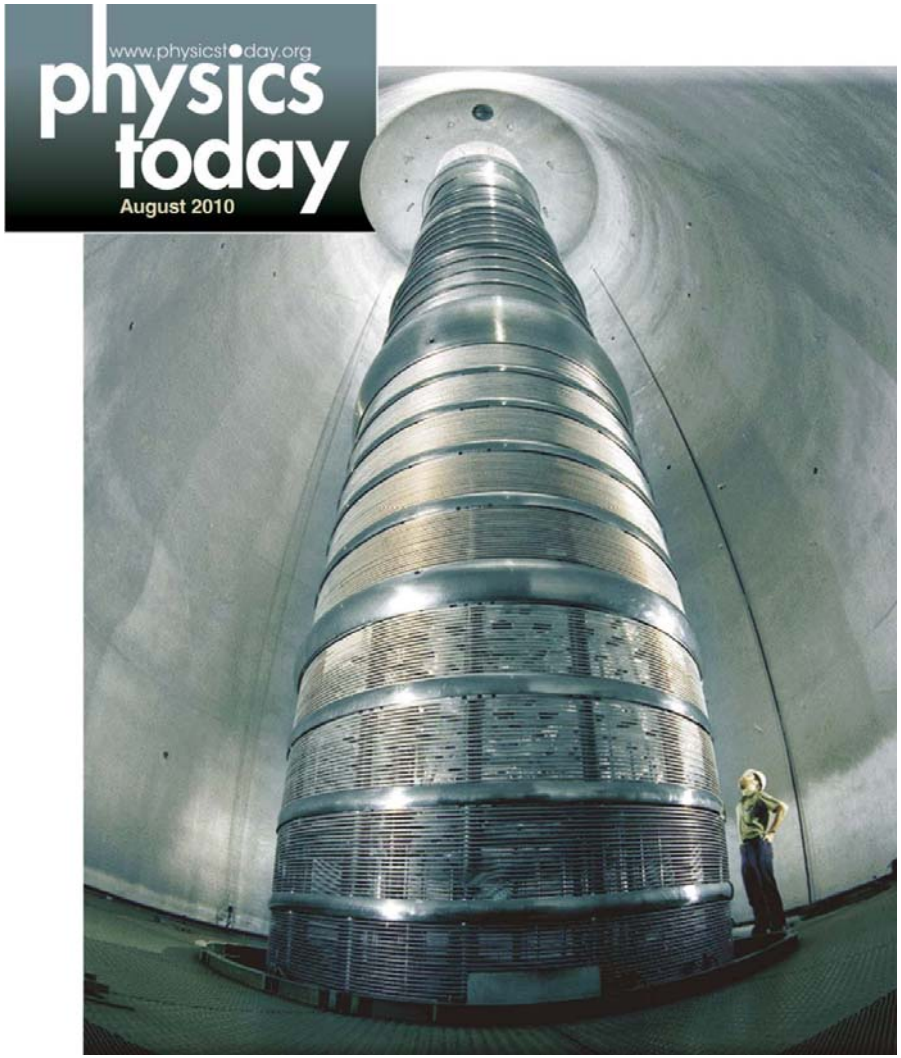
By JAMES GLANZ

A team of Russian and American scientists has discovered a new element that has long stood as a missing link among the heaviest bits of atomic matter ever produced. The element, still nameless, appears to point the way toward a brew of still more massive elements with chemical properties no one can predict.

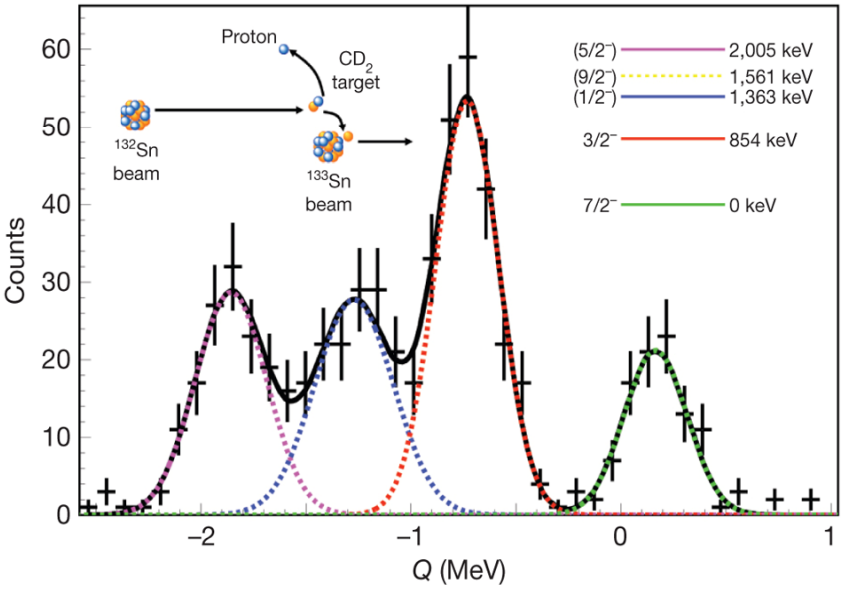
Six New Isotopes of the Superheavy Elements Discovered

A team of scientists at the U.S. Department of Energy's Lawrence Berkeley National Laboratory has detected six isotopes, never seen before, of the superheavy elements 104 through 114.

Selected Highlights



Discovery of a new doubly magic nucleus at HRIBF



Doubly magic shell game (Sn 132)

How much ^{82}Sr radioactivity is really in the Sr-Rb PET generator?

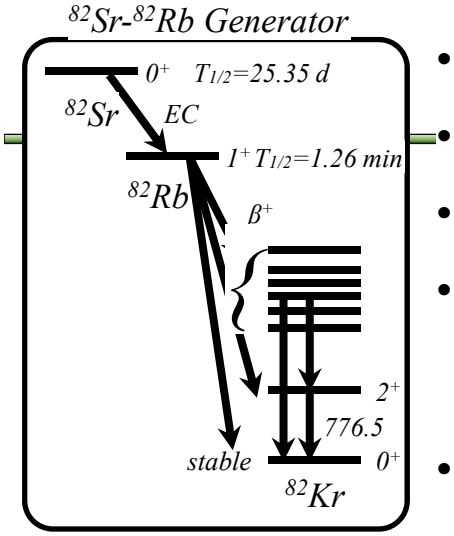
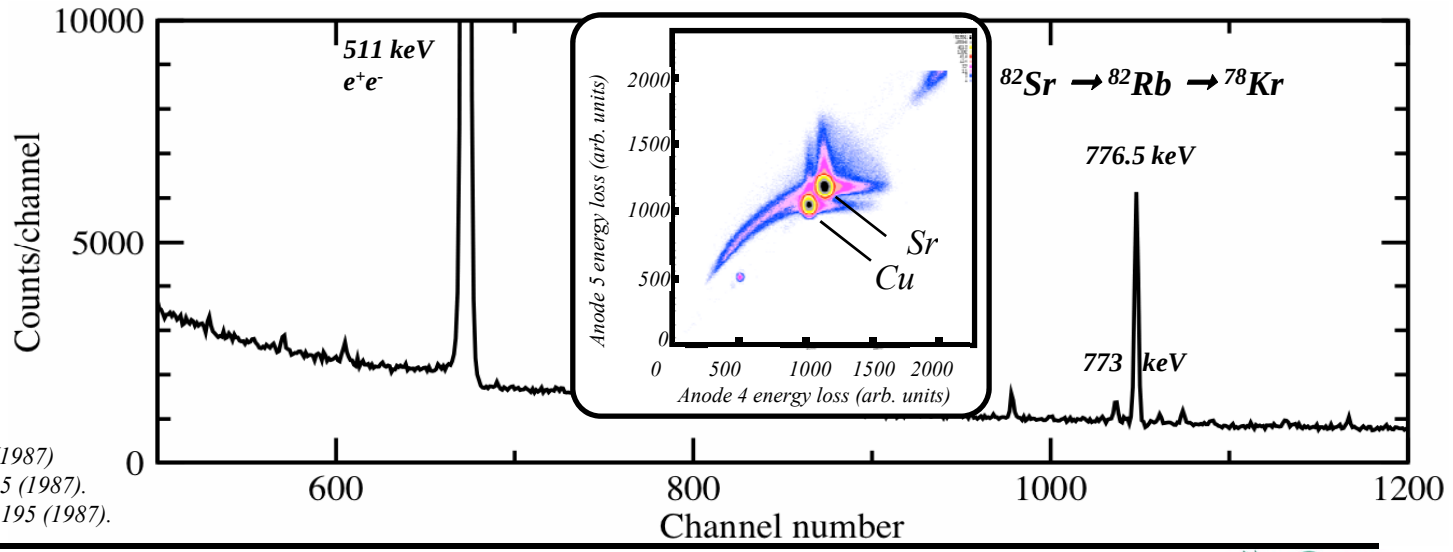


Fig. 1 - ^{82}Sr-^{82}Rb-^{82}Kr decay process.

- ^{82}Rb is most widely used radionuclide for PET assessment of the heart muscle.
- Due to1.26 min half-life, must be obtained locally by extraction from an ^{82}Sr-^{82}Rb generator.
- Question arose on how much ^{82}Sr needed to extract a given amount of ^{82}Rb.
- Determined by measuring the number of the 776.5 keV γ-rays arising from the β-decay of ^{82}Rb to stable ^{82}Kr per 100 decays of ^{82}Sr. (initially measured to be 13.41(47) [1] . The weighted average of two later measurements is 15.08(16) [2,3].
- At HRIBF, strontium ions implanted in thin aluminum foils.
- Acceleration energy analysis removed most of a copper impurity
- Preliminary result: 14.93(37) 776.5 keV γ-rays for every 100 decays of ^{82}Sr in the ^{82}Rb generator, in agreement with references[2,3].

Fig. 2 - The γ-ray spectrum obtained from 4 samples with a total of $7.26(3)\times10^{8}$ atoms of ^{82}Sr implanted. The inset shows the energy loss of the beam in the fourth and fifth anodes of the ionization chamber. Sr ions are clearly identified. Colors indicate a logarithmic intensity scale with black (blue) the most (least) intense. The beam intensity during the experiment was typically 2300 ions per second (66% ^{82}Sr); pile-up and data acquisition live time were kept below 1% and above 90%, respectively.



References

*[1] H.-W. Muller, Nuclear Data Sheets, **50**, 1 (1987)*
*[2] S.M. Judge et al., Appl. Radiat. Isot. **38**, 185 (1987).*
*[3] D. D. Hoppes et al., Appl. Radiat. Isot. **38**, 195 (1987).*

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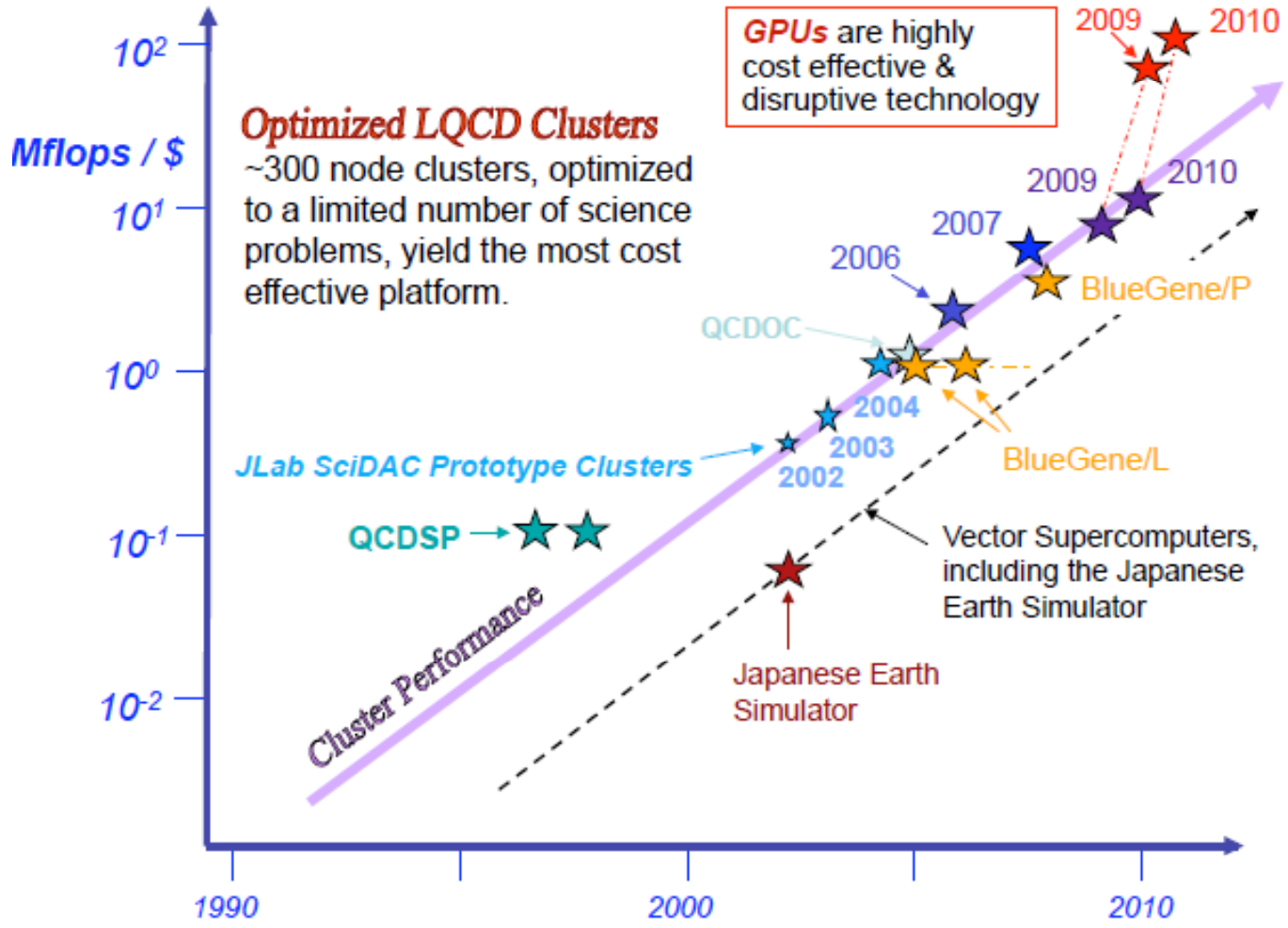
*Research sponsored by the U.S Department of Energy, Office of Nuclear Physics

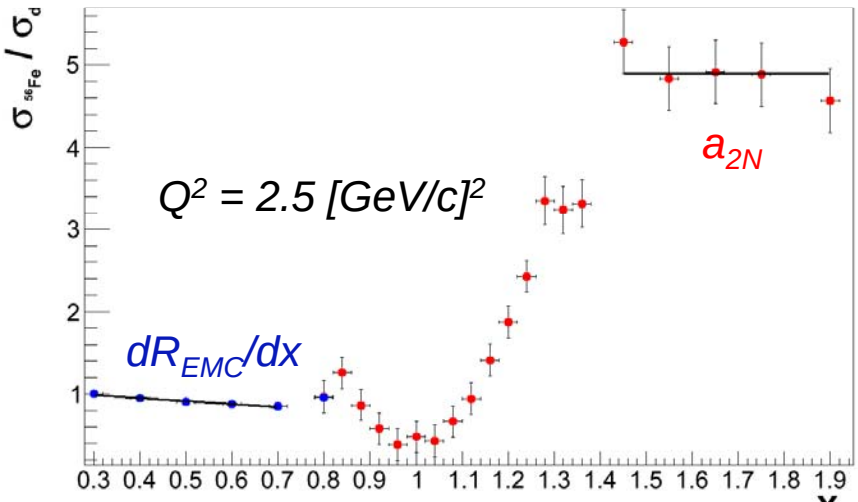
OAK RIDGE National Laboratory

Selected Highlights

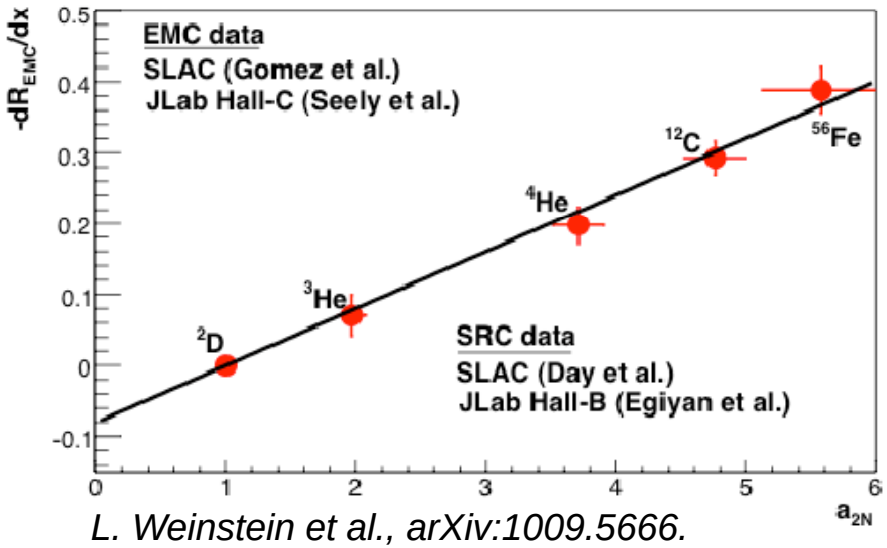
Advancing Science per dollar for LQCD applications at TJNAF



New Clues to EMC Effect Origin



D. Higinbotham et al., arXiv:1003.4497.



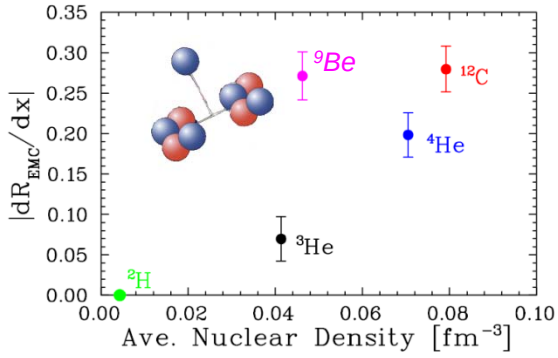
L. Weinstein et al., arXiv:1009.5666.

- x_B>1.5 scaling plateaus (a_{2N}) are due to two-nucleon short-range correlations (SRC)

  R. Subedi et al., Science **320** (2008) 1476-1478.

- EMC slopes (x_B<0.7) and a_{2N} (x_B>1.5) show a striking correlation
- Results from independent experiments with $Q^2 > 1$ [GeV/c]^2
- Consistent with local density EMC effect seen in light nuclei

  J. Seely et al., Phys. Rev. Lett. **103** (2009) 202301.



Selected Highlights

UNEDF SciDAC Collaboration

Universal Nuclear Energy Density Functional

UNEDF One-Page Highlights

On this page are links to one-slide summaries of UNEDF-related research accomplishments, plus notes giving contacts and references along with brief explanations of the technical details. All are in pdf format. See also the "UNEDF Highlights" page.

- Nuclear excitement [notes]
- Proton halo in fluorine-17 as a fragile 17-body quantum state [notes]
- UNEDF-TOPS eigensolver collaboration: Breakthrough nuclear science [notes]
- Microscopic description of nuclear fission [notes]
- Building medium-mass atomic nuclei from scratch: coupled cluster [notes]
- Computing masses of atomic nuclei [notes]
- Discovering the secrets buried in theories [notes]
- The uNclear Nuclear Pairing [notes]
- For atomic nuclei, three's a crowd: Enabling microscopic calculations of nuclei [notes]
- Building the UNEDF from the ground up [notes]
- Towards improved cross sections on medium and heavy unstable nuclides [notes]
- High-performance code for nuclear level density [notes]
- Predictions for Proton-Dripping Fluorine-14 [notes]
- Ab initio no-core shell model (NCSM) and resonating-group method (RGM)

State-of-the-art Cryomodule for ATLAS

- Benefit to experiments with both stable and radioactive nuclear beams at ATLAS
- Increases maximum beam energy by ~30%
- Incorporates innovative features:
  - Separate cavity vacuum from insulating vacuum
  - Cancels beam steering effects due to RF fields
  - Cleaning techniques achieve low-particulate cavity surfaces
  - Higher accelerating fields and cavity voltages—better than other Transverse ElectroMagnetic (TEM) mode cavities around the world

Cavity string suspended from the lid, ready to be dropped into the vacuum vessel.

Selected Highlights

100 MeV γ-rays Produced at the High Intensity Gamma Ray Source

Ying K. Wu, on behalf of the accelerator physics group at Duke FEL Laboratory, TUNL*

October 20, 2010

TUNL accelerator physicists at the Duke Free Electron Laser Laboratory produced circularly polarized gamma rays between 70 and 100 MeV for the first time at the HIGS facility. This achievement opens new opportunities for studies of the internal structure of the nucleon. PAC approved experiments

- New Electron Beam Ion Source completed on time and on schedule at RHIC
- Excellent progress on 12 GeV upgrade construction
- Commissioning of CARIBU with 100 mCi source
- New research on alpha emitting radioisotopes

Implementing the recommendations of the Long Range Plan

With the completion of the 12 GeV CEBAF Upgrade, researchers will address:

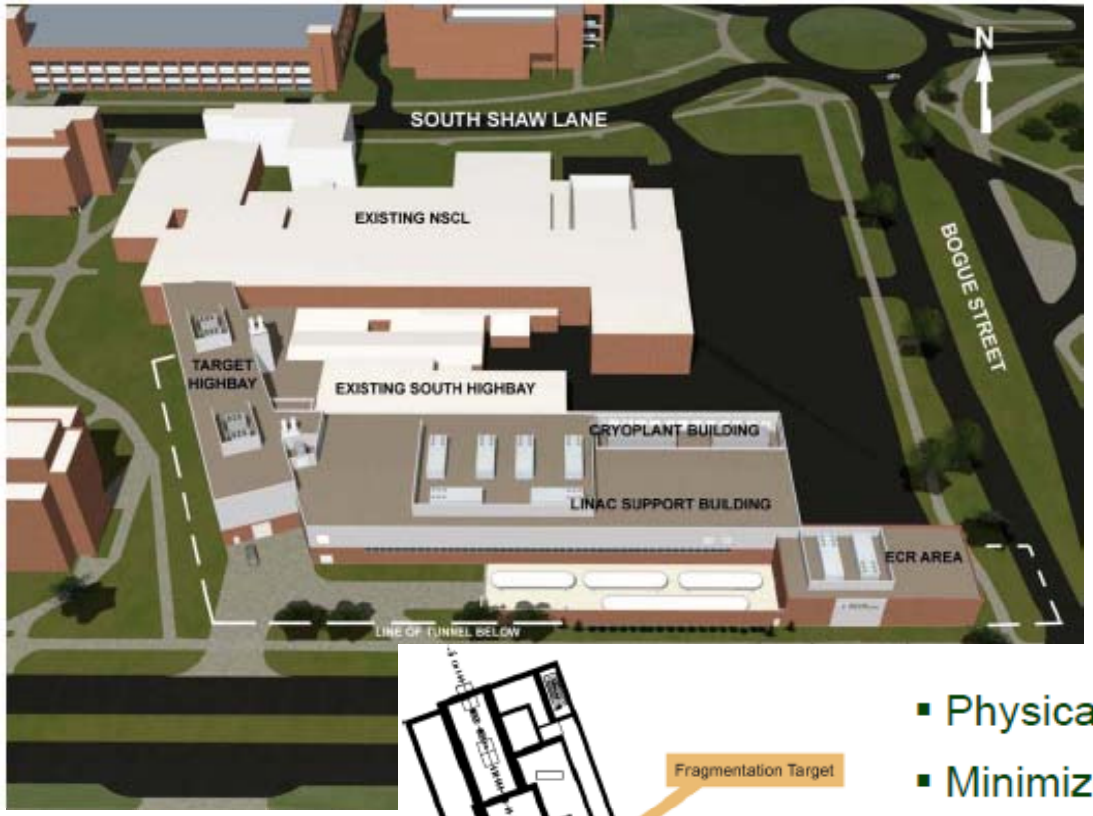
- The search for exotic mesons—a quark and an anti-quark held together by gluons, but unlike conventional mesons, the gluons are excited
- Physics beyond the Standard Model via high precision studies of parity violation
- The spin and flavor dependence of valence parton distributions—the heart of the proton, where its quantum numbers are determined
- The structure of atomic nuclei, exploring how the valence quark structure is modified in a dense nuclear medium
- Nuclear tomography to discover and explore the three-dimensional structure of the nucleon

Pouring the foundation for the Hall D complex.

Implementing the recommendations of the Long Range Plan

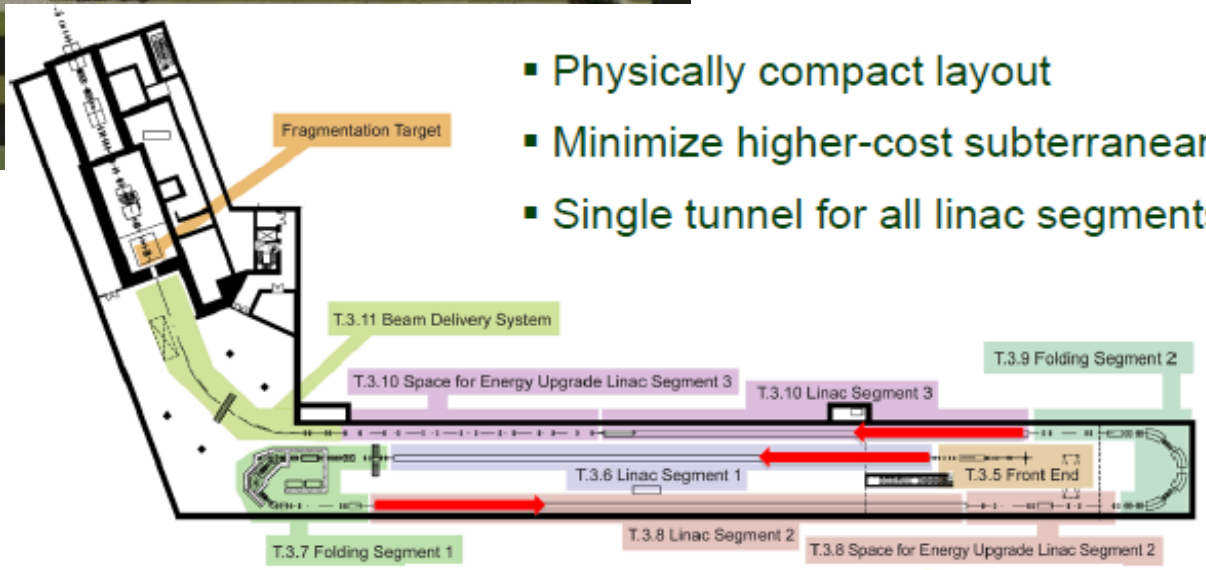
November 2010

Implementing the recommendations of the Long Range Plan: FRIB



FRIB CD1,
September 2010

Steady progress towards CD2



- Physically compact layout
- Minimize higher-cost subterranean structures
- Single tunnel for all linac segments

Applications of Nuclear Science & Technology (ANS&T)

Funds	FY09	FY10	FY11 (Pres. Req.)
Base	3,000	3,694	3,236
ARRA	19,440	-	-

Applications		
Received > 200 (FOA 09-13)		
Funded	FY09	FY10
	22	5

Current Efforts	FY09	FY10
Measurements (astrophysics, medicine, homeland security, advanced fuels, reactor physics, nuclear forensic, material damage)	6	-
Instrumentation (accelerators, isotope beams, advanced fuels, medicine, homeland security, nuclear non-proliferation, environmental science, earth science)	10	4
Nuclear Data (advanced fuel cycles, reactor physics)	6	1

- *New FOA in progress for FY11*
- *ANS&T program expected to continue in the future*

Isotope Program

Developments in Isotope Program continue….

- Research on alpha-emitting isotopes and stable isotope production continues
- All three Isotope production/processing capabilities within the program have been peer reviewed for performance. Starting second rounds of reviews.
- New solicitation for Isotope R&D will be coming out in December.
- New solicitation for new isotope production at existing and new sites will be coming out in early CY 2011
- New solicitation for letters of interest for commercial partnerships in a dedicated isotope facility planned for early CY 2011
- Completed joint IP/NNSA review of re-establishing Am-241 production capability in U.S.
- John Pantaleo has retired- expect to hire a Deputy/Program Manager in 2011.
- National Isotope Development Center has appointed a new lead to the Isotope Business Office at ORNL: Mitch Ferren

Nuclear Physics
FY 2011 Congressional Request

	FY 2009 Approp.	FY2009 ARRA	FY 2010 Approp.	FY 2011 Request	FY11 Request vs. FY10 Approp. $	FY11 Request vs. FY10 Approp. %
Medium Energy Nuclear Physics	116,873	+15,390	127,590	129,610	+2,020	+1.6%
Heavy Ion Nuclear Physics	194,957	+12,669	212,000	218,435	+6,435	+3.0%
Low Energy Nuclear Physics	94,880	+29,667	114,636	113,466	-1,170	-1.0%
Nuclear Theory	37,776	+17,237	41,574	44,709	+3,135	+7.5%
Isotope Program	24,760	+14,837	19,200	19,780	+580	+3.0%
Subtotal, Nuclear Physics	469,246	+89,800	515,000	526,000	+11,000	+2.1%
Construction	31,061	+65,000	20,000	36,000	+16,000	+80.0%
Total, Nuclear Physics *	**500,307**	**+154,800**	**535,000**	**562,000**	**+27,000**	**+5.0%**

* *SBIR/STTR for FY 2009 was $11,773k. Comparable NP total w/SBIR/STTR in FY 2009 is $512,080k.*

SC:

House Mark: $4,900 million ($221 million below President's Request) (- $8M for NP)

Senate Mark : $5,012 million ($109 million below President's Request) (- $23.4M for NP + BER Medical Imaging Scope and $$)

Continuing Resolution to Dec. 18. Senate mark? House Mark? House & Senate Conference Mark? Omnibus? Full Year CR?

We can only wait and see

Other News

- As a result of funding constraints in any foreseeable scenario, a number of RIB Science Initiatives have been declined
- The FY2012 budget is in the hands of OMB; pass back is expected soon
- Early Career Research Program applications closed Nov 9th; ~1150 applications are undergoing merit review by SC Offices; notification of awards is anticipated in March 2011
- Solicitation for FY2011 graduate fellows on hold pending budget outcomes, but is anticipated soon; the size of the program is under consideration
- Office of Science is assessing recent news on DUSEL and what various options may be available

Office of Nuclear Physics Staff News

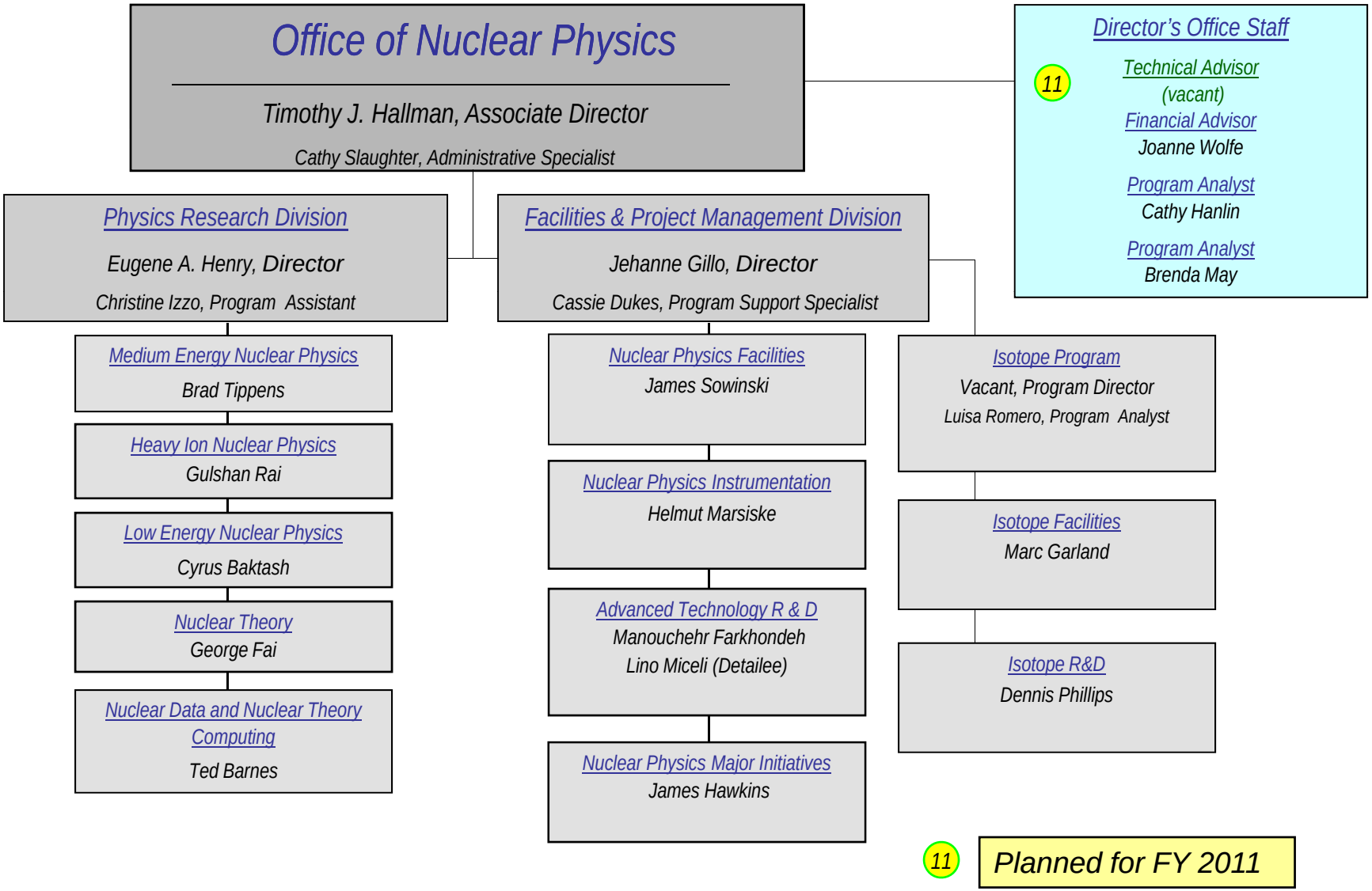
Changes in Office of Nuclear Physics

- Program Manager for NP National User Facilities – Position filled, James Sowinski
- Program Manager for Nuclear Data and Computing – Position Accepted, Ted Barnes
- Program Manager for Isotope Facilities – Position Filled, Marc Garland
- John Pantaleo, Isotope Program Manager has retired

Detailee / IPA Positions

We do have openings - please contact myself, Jehanne Gillo or Gene Henry

Office of Nuclear Physics



December 2010

Outlook

- Nuclear science continues to deliver discovery science and forefront advances in technology
- The highest priority opportunities for ground breaking research are being addressed
- Training and advancement of the next generation of scientists is supported
- National needs for production and R&D on high priority rare isotopes for research, medicine and national security are being addressed
- New advanced research tools that will provide new capability and maintain US leadership are being constructed

The Challenge Going Forward:

- More than ever, every nuclear scientist has (at least) two important tasks:

  Continuing to deliver groundbreaking science and important applications

  Articulate to whoever will listen how what you do contributes to the nation (economic security national security, advancing knowledge, etc.)