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| Title: | Los Alamos National Laboratory  A National Science Laboratory |
| Author(s): | Chadwick, Mark B. |
| Intended for: | CEA Meeting: Annual meeting of the steering committee for the international agreement on cooperation in fundamental science supporting stockpile stewardship, 2012-07-25 (Washington, District Of Columbia, United States) |

# Los Alamos National Laboratory

# A National Science Laboratory

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For
Paul Dotson
Associate Director Theory, Simulation, and Computation (acting)
Fundamental Science Agreement Technical Coordinator

July 2012

# LANL Mission & Vision

**Our mission as a DOE national security science laboratory is to develop and apply science, technology, and engineering solutions that**

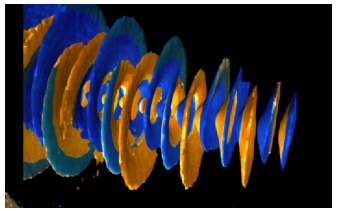
- Ensure the safety, security, and reliability of the US nuclear deterrent
- Protect against the nuclear threat
- Solve Energy Security and other emerging national security challenges

**Our vision is to be the premier National Security Science Laboratory**


**People → Capability → Mission Impact**

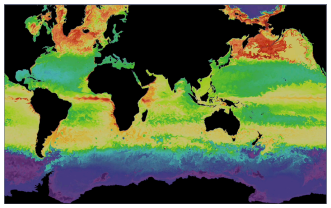
Los Alamos NATIONAL LABORATORY EST. 1943

# Capabilities serve Programs



Computational Physics & Applied Mathematics

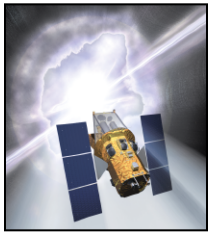
Accelerators & Electrodynamics



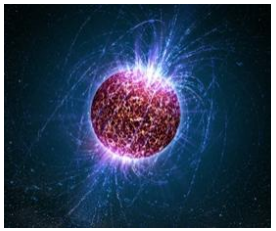
Information Science & Technology

Computer & Computational Sciences

Weapons Science & Engineering

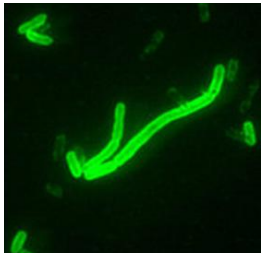


Science of Signatures

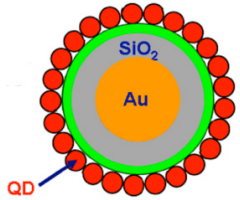



Nuclear Physics, Astrophysics & Cosmology

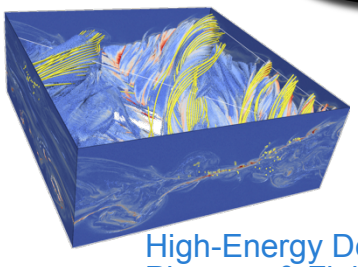
Nuclear Engineering and Technology



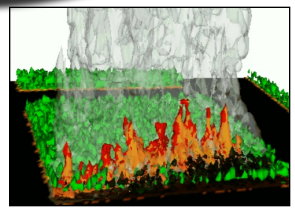
Biosciences



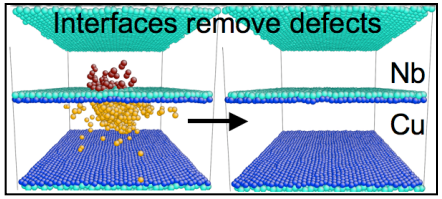

Chemical Science



High-Energy Density Plasmas & Fluids



Earth & Space Sciences




Materials

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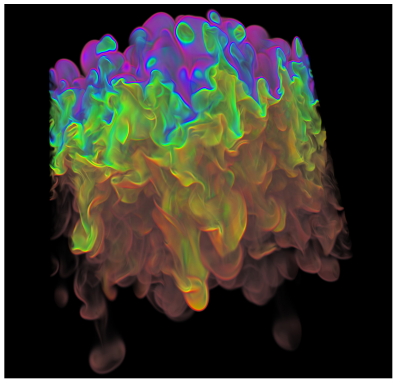
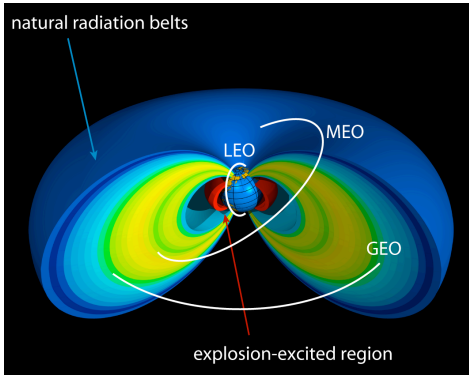
# Science and Engineering at Los Alamos National Laboratory

## Stockpile Stewardship



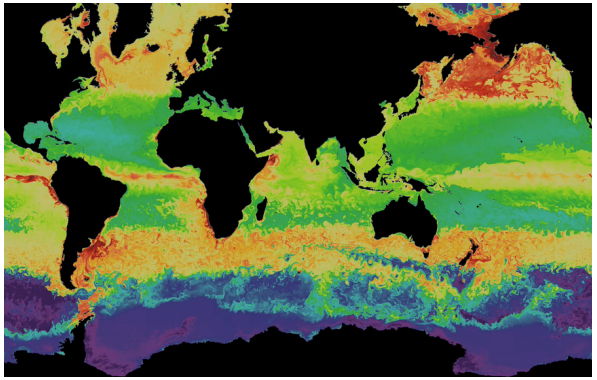
**Hydrodynamics:** Turbulence

## Global Security

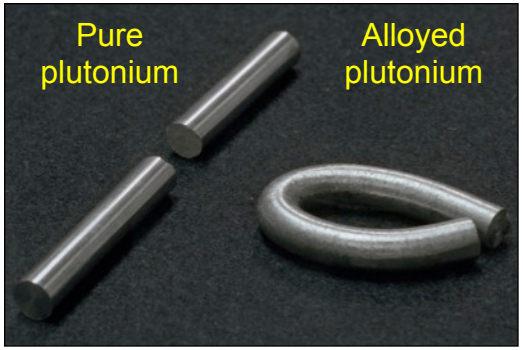



**Threats from Space:** Dynamic Radiation Environment Assimilation Model

## Energy Security

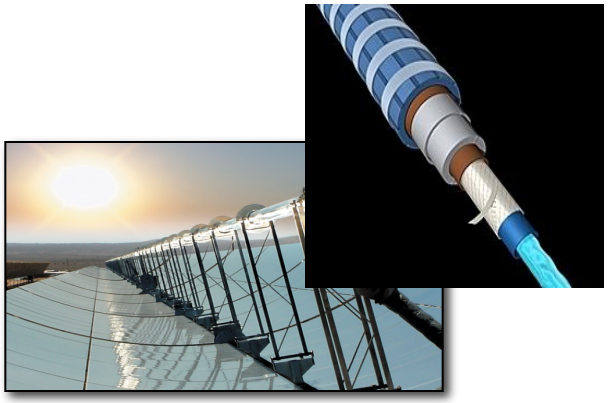


**Climate/Energy Impacts:** Measurement, simulation, prediction




**Plutonium Science:** Metallurgy

**Sensors:** Thinking Telescopes



**Materials:** Energy generation & transmission

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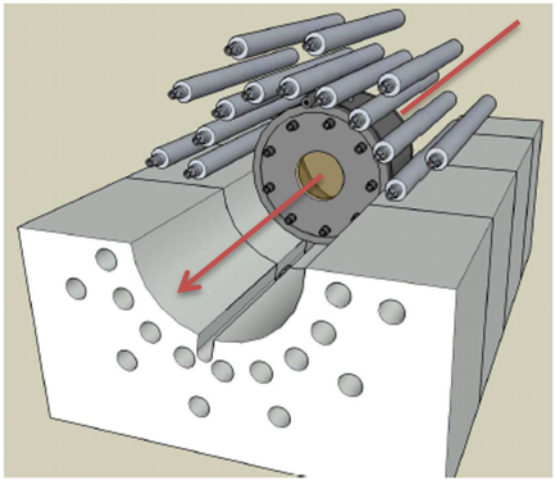
# P104: Measurements of fission mass yields and neutron multiplicity

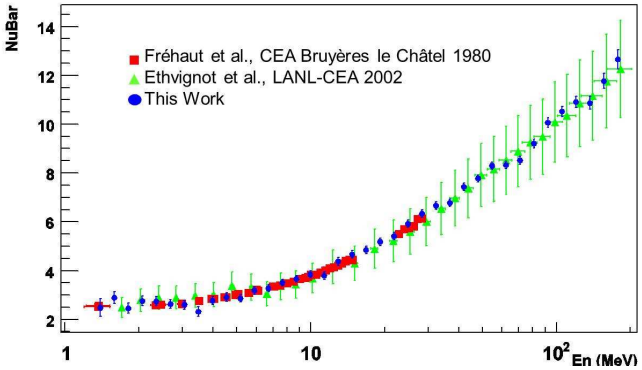
- Fission fragment yields are relevant to basics science and to nuclear applications
  - Fission fragments mass yields are intimately related to the internal mechanisms involved in the fission phenomenon.
    - New advances in the theoretical modeling of the fission process show promise for predicting fission mass yields
    - However, accurate measurements are needed to validate those model
  - Fission product yields of the major actinides are very important data for the defense program
    - They provide an important diagnostic tool
    - Data for fast neutrons are scarce, and the energy dependence is not well understood
- Experiments at LANSCE are providing measurments of mass yields and neutron multiplicites as a function of incident neutron energy
  - A double Frisch-gridded ionization chamber is used to measures fission fragment masses
  - The neutron multiplicity is measured with a neutron counter consisting of 30 3He neutron detectors arranged in two concentric rings within a polyethylene block for neutron moderation
  - The LANSCE white neutron source provides neutrons from 0.1 to 200 MeV

# Current results

- Experiments were performed in 2009 and 2010 at LANSCE
- Data for both the mass yields and neutron multiplicities for U-238 were obtained
- The statistic accuracy on the mass data was limited, and needs to be improved

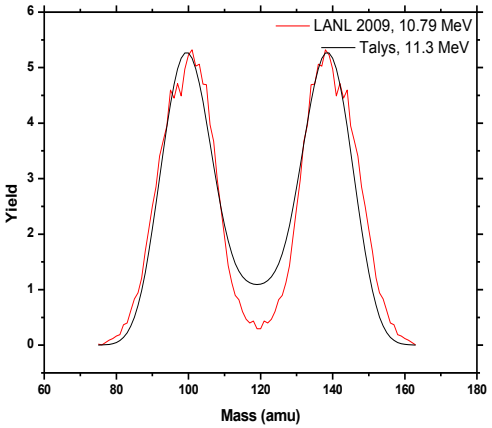


Drawing of the experimental setup with the DFGIC surrounded by the 3He counters. Only one half of the polyethylene blanket is represented. The arrow corresponds to the incident neutrons trajectory.




Neutron multiplicity from U-238 (n,f) as a function of incident neutron energy

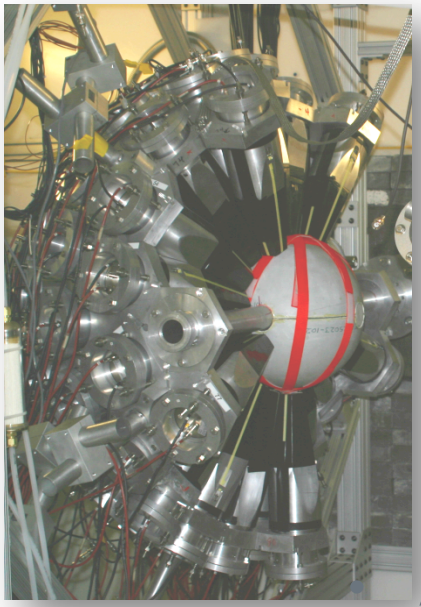
Measured mass yields from U-238(n,f) for 11 MeV neutrons compared to calculations with the Talys code.



# Future plans

- The statistical accuracy needs to be improved to accurately determined the fission mass yields
  - Dedicated beam time at LANSCE has been allocated in November of 2012
  - New experiments will be optimized for high statistics
- Other major actinides will be investigated
  - Pu-239 and U-235 should be measured
- The fission Time Projection Chamber (TPC) will be used as a complementary tool to measure mass yields
  - This instrument is currently being developed for high precision fission cross section measurements, but can be used to determine fission fragment yields
- An new instrument, SPIDER, will provide higher resolution mass yields
  - However, the lower efficiency will limit the ability to measure the energy dependence
  - The ionization chamber measurements in combination with SPIDER data will provide high resolution *and* high efficiency data

# P162: DANCE experiments on Lu isotopes: $^{175,176}$Lu



$^{175,\ 176}$Lu targets

- Lu targets with high purity
  - in particular,
  - $^{176}$Lu target, 99.95%, 1mg/cm$^2$
  - enriched at SIDONIE (Orsay, France)

## November 2007 : $^{175,176}$Lu(n,g) @ DANCE

Absolute measurement from thermal to keV neutron energy

- New or more precise resonance parameters determination for more than 50 resonances
  - Publications

*O. Roig et al., Proceedings of NIC10 (2008)*

*O. Roig et al., Proceedings of CNR09 (2009)*

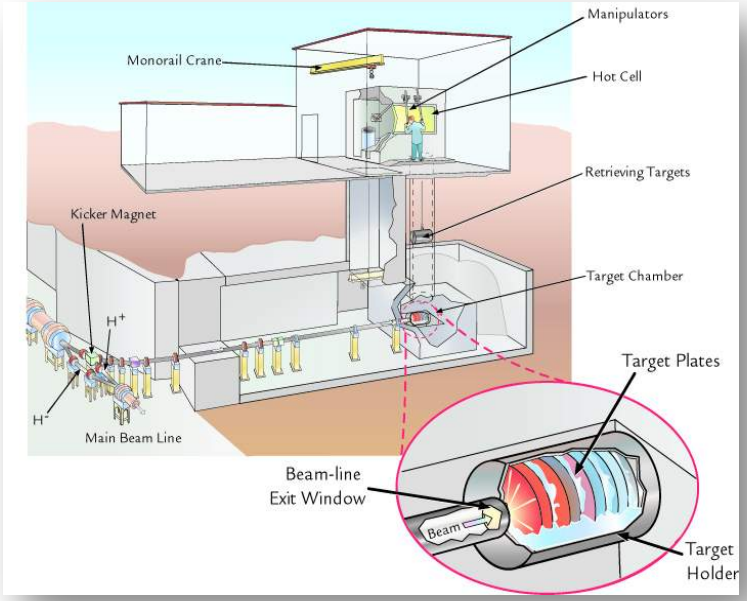
*O. Roig and A.J. Couture, Proceedings of Varenna (2009)*

*O. Roig et al., Proceedings of CGS14 (2011)*

***O. Roig et al., Phys. Rev. C, to be submitted (2012)***

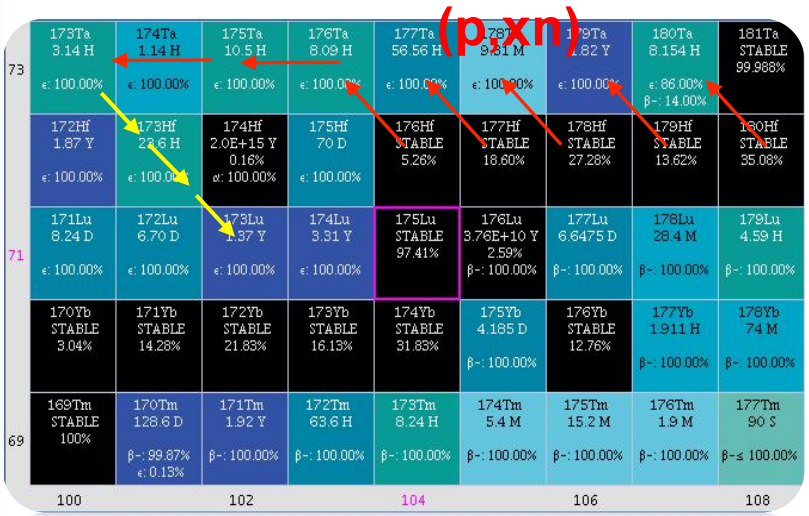
# P162: DANCE experiments on Lu isotopes: $^{173}$Lu

## Very challenging target production




- at IPF, using $^{Natural}$Hf(p,xn) reactions

*F. M. Nortier, LANL*



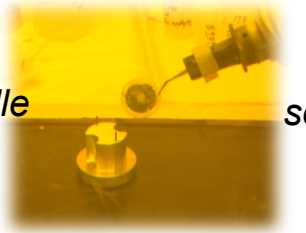

- at CNR (LANL) Using Hf/Lu and Yb/Lu chemical separations

*W. A. Taylor, LANL*

*hot cell*

*electrodeposition*

*handle*



*set up*

50 g Hf

60 µg $^{173}$Lu

W. A. Taylor, R. S. Rundberg, E. M. Bond, F. M. Nortier and D. J. Vieira, "*Production of a $^{173}$Lu target for neutron capture cross section measurements*", **J. Rad. Nucl. Chem., 282, pp. 391-394 (2009)**

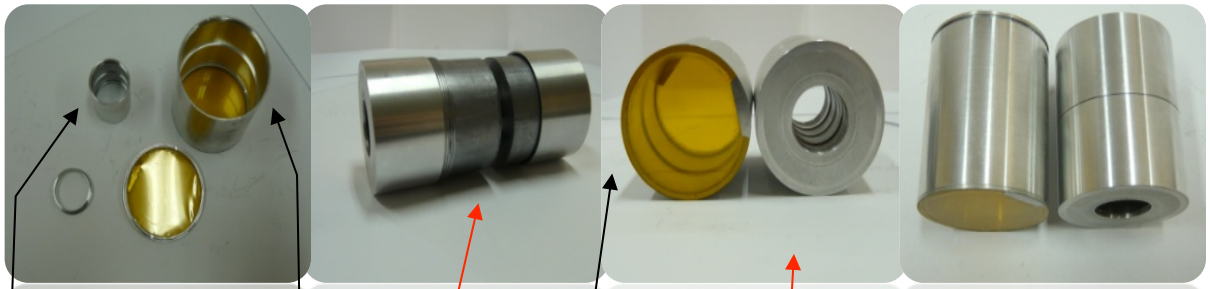
# P162: DANCE experiments on Lu isotopes: $^{173}$Lu

## December 2011 : $^{173}$Lu(n,g) @ DANCE

- 23 days of acquisition data in december 2011
  - very high counting rate in DANCE
- Pb liner to avoid too high counting rate (+ mini-RTH)
  - 30 $BaF_2$ detectors off
  - PMTs' HV decreased

60 µg $^{173}$Lu

**3,2 $10^9$ Bq**




60 µg $^{173}$Lu

**~2 $10^7$ γ/s**

# P162: DANCE experiments on Lu isotopes: $^{173}$Lu

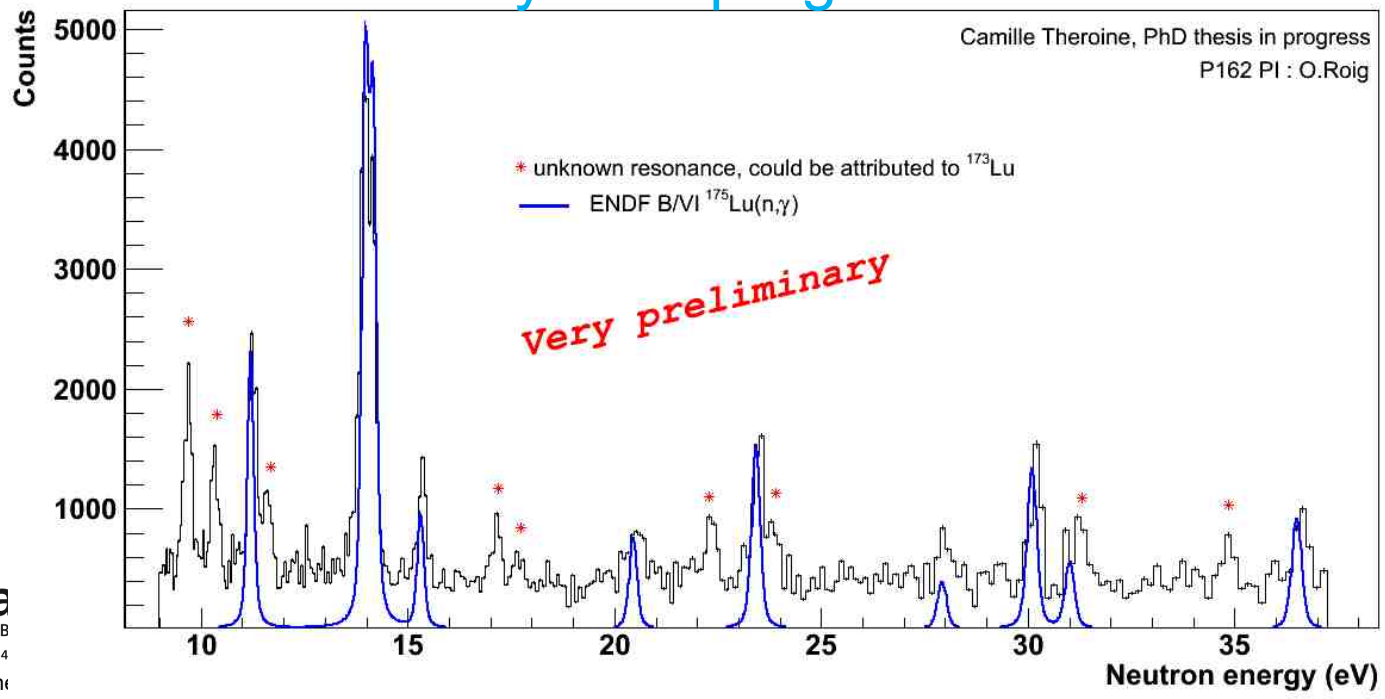
- Very promising set of data with the highest radioactive $^{173}$Lu target used at DANCE

  New resonances

  (not referenced in literature: *S.F. Mughabghab, Atlas des résonances, 2007*)

  Energies and level density seem to be really similar to $^{175}$Lu.

- Analysis in progress at CEA



# P168: Computational Radiography Improvements and Cross Code Comparison

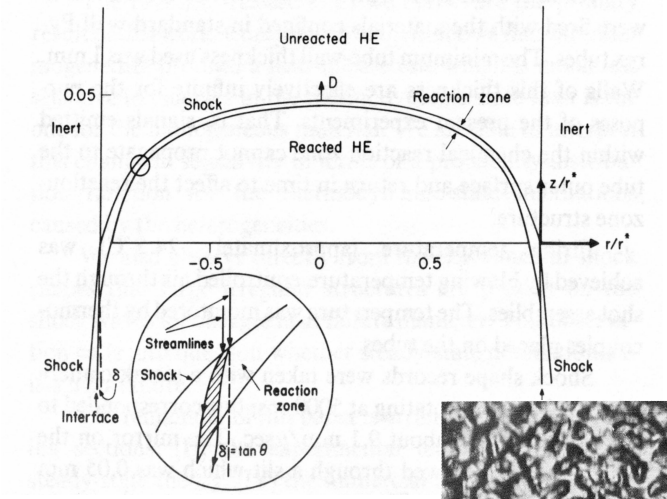
- Purpose: To improve the accuracy and efficiency of simulated radiography of DOE and CEA radiography simulation tools.
- 2011-2012:
  - Presented one conference presentation

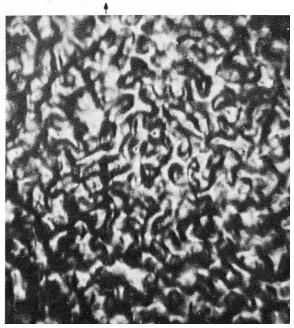
    S. Lemaire, et. al, "Neutron and Photon Next-Event Estimator Benchmarks for Intercode Comparisons", Tenth Internation Conference on Monte Carlo and Quasi-Monte Carlo Methods in Scientific Computing, Sydney, Australia, Feb. 2012.
  - Finalized one internal publication on cross-code comparison benchmarks.
- Future Plans:
  - Extend the charter of P168 to include cross-code comparisons of electron transport benchmarks, including low-energy electron/ photon transport.
  - Implement the last-event estimator mythology (radiography simulation), in MCNP (DOE/LANL) and benchmark with current capability in DIANE (CEA).

# P113-Experimental measurement and analysis of 2-D/3-D detonation fronts and flows

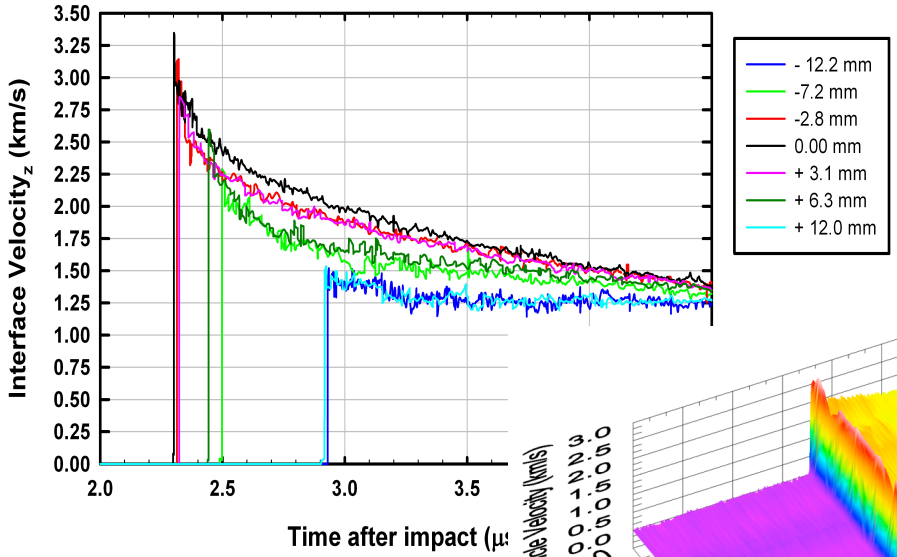
Principal investigators: Arnaud Sollier, Laurent Soulard (CEA); Dana Dattelbaum, Stephen Sheffield (LANL); Marcia Cooper, Wayne Trott (SNL)

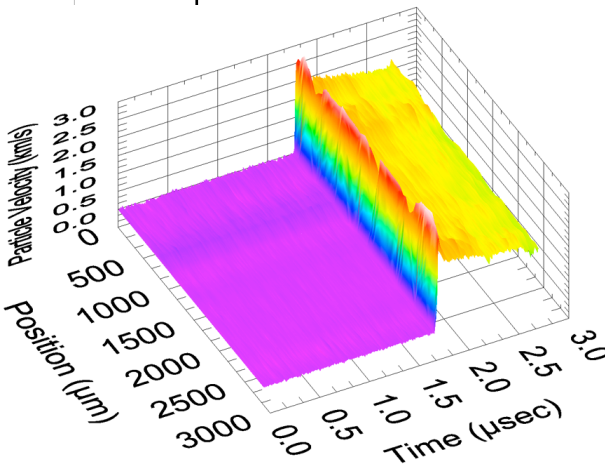
**Objective:** to define experimental methods to measure dynamical properties of 2-D flow



Detonation fronts can be highly curved and may contain heterogeneous structures




We are applying embedded gauges, PDV and ORVIS to measure 2-D and 3-D flows.

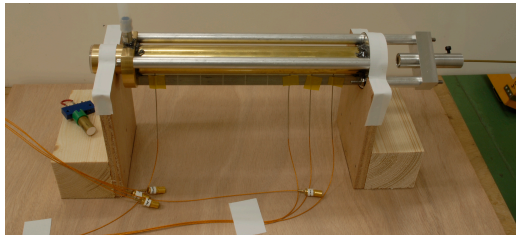
**Results:** We have performed experiments employing embedded gauges, multipoint PDV and ORVIS to 2-D flows in detonating nitromethane, HMX, TATB and TNT explosives. New gauge design prepared for CEA.

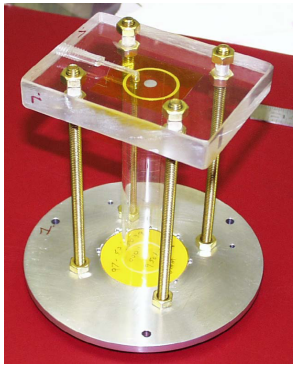
- 3 inter-lab visit with additional visit planned for August (Dattelbaum, CEA)
- FOCUS article published jointely

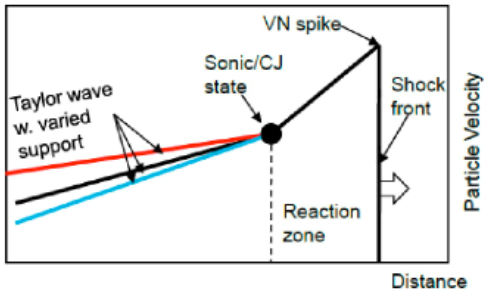
# P159-Experimental study of the reaction zone of explosives

Principal investigators: Viviane Bouyer, Arnaud Sollier (CEA); Dana Dattelbaum, Stephen Sheffield (LANL); Marcia Cooper, Wayne Trott (SNL)

**Objective:** to compare and further develop experimental diagnostics for quantifying the chemical reaction zone in detonating explosives

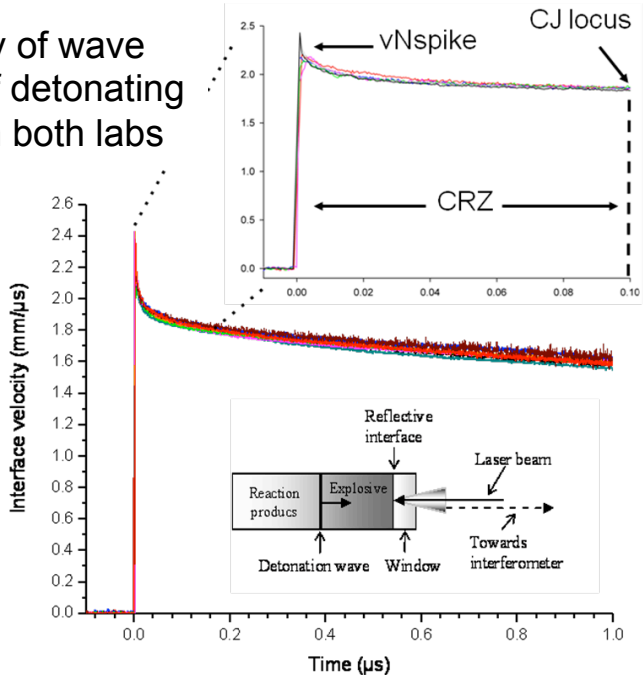







Joint experiments at CEA and LANL

Overlay of wave profiles of detonating NM from both labs

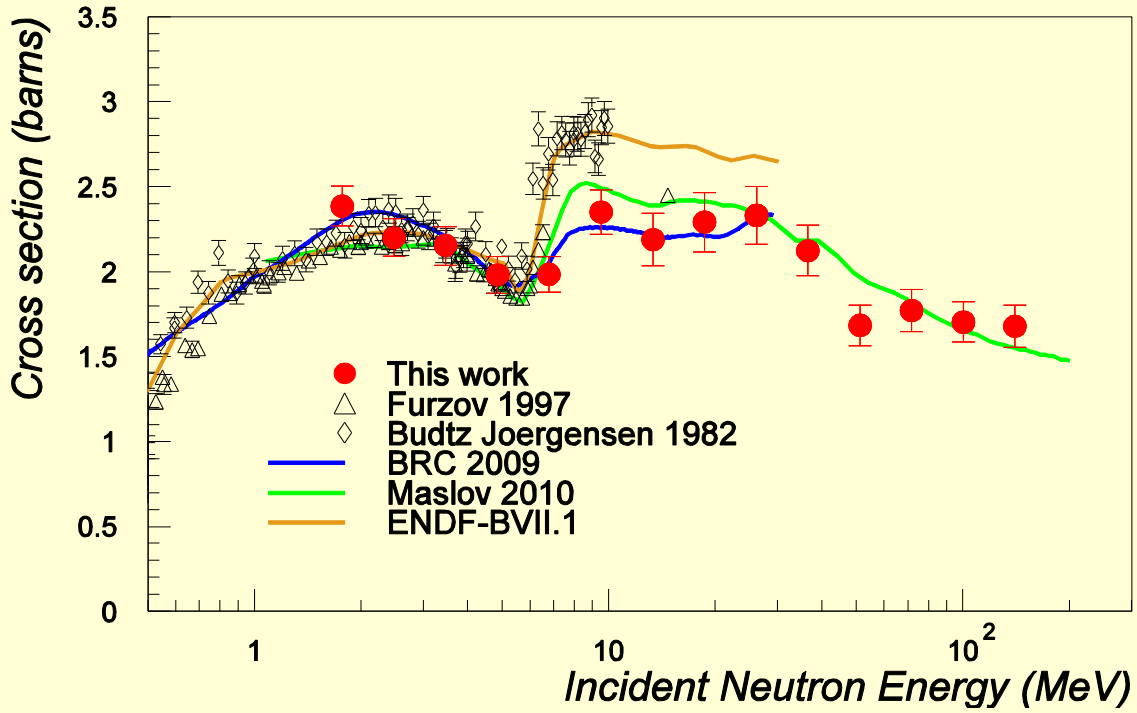



**Results:** We have performed joint experiments employing VISAR, PDV and ORVIS to measure reaction zones in nitromethane, TATB and TNT with excellent agreement.

- 3 inter-lab visits occurred recently, with 1 additional planned for August
- 1 paper and 1 FOCUS article published jointely

# Measurement of the $^{238}$Pu(n,f) Cross Section (P103)

- New measurements of the $^{238}$Pu(n,f) cross section using a CEA cylindrical fission ionization chamber at LANSCE
- Preliminary results have been obtained and presented – differences exist between surrogate reaction results and ours
- Work is proceeding to finalize the results for publication



# Technical Scope within the Agreement

- Technical discussions in most recent General Meeting (Mar 2009)

| Topical Area | Reports | New Proposals |
|---|---|---|
| Nuclear Physics | 11 | 4 |
| Atomic Physics | 1 | 0 |
| Shock Physics | 6 | 2 |
| Materials | 3 | 0 |
| High Explosives | 2 | 1 |

- We have discussed the desire and opportunity for more collaboration in a broader array of Materials projects
- Supporting sciences relevant to Nuclear Energy (materials, nuclear reactions and cross sections); Global Security (attribution-relevant nuclear physics, materials, etc); others
- This was discussed at the Mar 2009 meeting, and will be taken up by the Steering Committee (May, 2010)

# Looking Forward

- LANL values our collaborations with the CEA in this basic science arena
- We have not been taking full advantage of the opportunities that this agreement presents
- Propose to continue to collaborate heavily in nuclear physics, find ways to enhance the collaborations in plasma and atomic physics, and to extend our collaborations in condensed matter and materials

| Project | Title | PIs | Status | Highlights | Future Plans | Pubs |
|---|---|---|---|---|---|---|
| P103 | Measurement of the neutron induced fission cross section of 238Pu | Nelson/ Granier | Active | Data acquired on 238Pu(n,f) preliminary results obtained and presented at conferences. | Analyze remaining data, resolve issues with backgrounds and normalizations and publish. | 0 |
| P104 | Prompt neutron and photon emission measurements in fission | Tovesson/ Haight/ Nelson | Active | Experiments have been performed at LANSE in 2009 and 2010 which produced data for mass yields and neutron multiplicities for U-238, however accuracy on the mass data was limited. New experiments to optimize statistics are planned for the future with one at LANSCE set for November 2012 which will measure Pu-239 and U-235. | An instrument called the fission Time Projection Chamber (TPC) is currently in development for use of high precision fission cross section measurements. The ionization chamber measurements in combination with a new instrument called SPIDER will produce high resolution and high efficiency data. | 0 |
| P163 | Neutron-Induced Reaction Cross Section Measurements on Fission Products | Nelson/ Granier | Active | data acquired on<br>•86Kr, 93Nb, 100Mo, 112,124Sn, 127I, 130Te, 136Xe, 138Ba - application of some of this data to neutrinoless-double-beta-decay experiments | Continue analysis, finalize results and publish. | 0 |

| Project | Title | Pis | Status | Highlights | Future Plans | Pubs |
|---|---|---|---|---|---|---|
| P140 | Collaborative exchanges of nuclear reaction modeling codes and data | Chadwick/ Bauge | Active | CEA staff joined LANL and LLNL staff and others at Los Alamos for a workshop on nuclear fission physics. | Future collaborations, including verification code comparisons of predictions, will be useful. | 1 |
| P141 | Uncertainties and covariances in nuclear data and application to Yttrium | Kawano/ Delaroche | Active | Summarize 2 methods at LANL and CEA on evaluating the covariances of nuclear reactions on Yttrium. This paper highlights advantages & disadvantages of methods (Bayesian statistics at LANL and a Monte Carlo procedure at CEA). Reasonable agreement of the calculated uncertainties in the nuclear data was obtained. | The covariance evaluation technique should be applied to generate a covariance data file, which will be used by nuclear data users. | 0 |
| P161 | Evaluation of neutron cross sections on prompt fission products | Kawano/ Hilaire | Completed | A significant comparison of the fission product average cross section was performed, with different model codes and model parameters. Calculated the fission product averaged cross sections of neutron capture, (n,2n), and (n,3n) reactions with TALYS (CEA), EMPIRE (BNL, IAEA), GNASH (LANL), and CoH (LANL). | A new project should be initiated to pursue this challenge: improvement of predictive capability for nuclear reactions on the unstable nuclei. | 1 (accepted) |

| Project | Title | PIs | Status | Highlights | Future Plans | Pubs |
|---|---|---|---|---|---|---|
| P171 | Theory of post entrance channel fission physics | Chadwick/ Bauge | Active | Important peer review activity chartered by senior LANL/ LLNL mngt on fission product yields that has led to rebaselining. | CEA and LANL will continue to discuss fission product yields and try to understand differences between the Laurec (CEA) measurements and those of others (LANL-ILRR, NIST-ILRR, Maeck etc). | 1 |

| Project | Title | PIs | Status | Highlights | Future Plans | Pubs |
|---|---|---|---|---|---|---|
| P168 | Radiography and Next-event Estimators Cross Code Comparison | **Sweezy/ Toccoli** | Active | To date the project has focused on two major areas: 1) improving the next-event estimator methodology, and 2) improving photon data and photon data treatment. The two code teams have exchanged the results of a computation radiographic benchmark problems and simple transport problems to test photon and neutron next-event estimators. As of 2012, the results of MCNP and DIANE compare well for the radiographic test problem and for most of the simple transport problems. | we plan to submit a proposal to modify the charter of Project 168. We propose to extend the charter to include cross-code comparisons of electron transport benchmarks, including low-energy electron/ photon transport. We expect the electron transport benchmarking effort to be the thrust of the work performed under Project 168 during the remainder of 2012 and 2013. | 2 |
| P162 | Dance experiments on LU Isotopes | Bredeweg | Active | | | 2 |

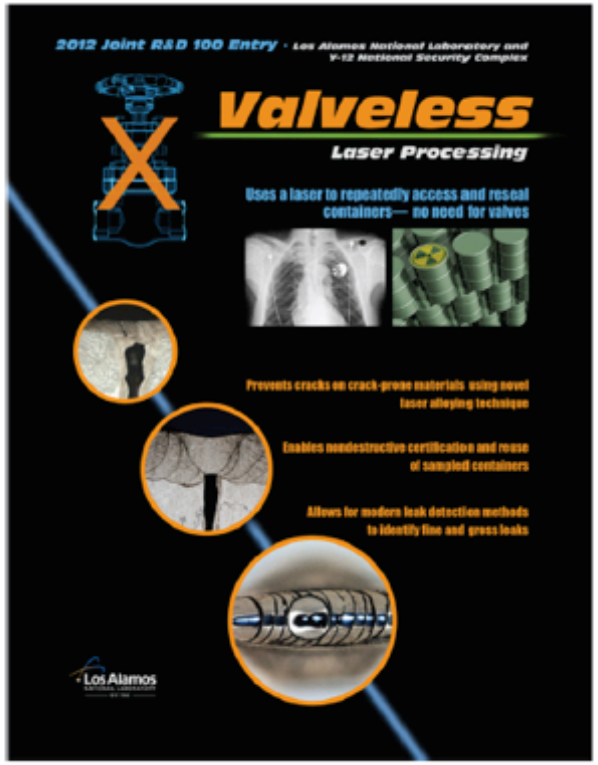
| Project | Title | PIs | Status | Highlights | Future Plans | Pubs |
|---|---|---|---|---|---|---|
| P176 | Validating the surrogate technique | Bredeweg | Inactive | Unable to make any progress this year due to funding and programmatic constraint. | | 0 |

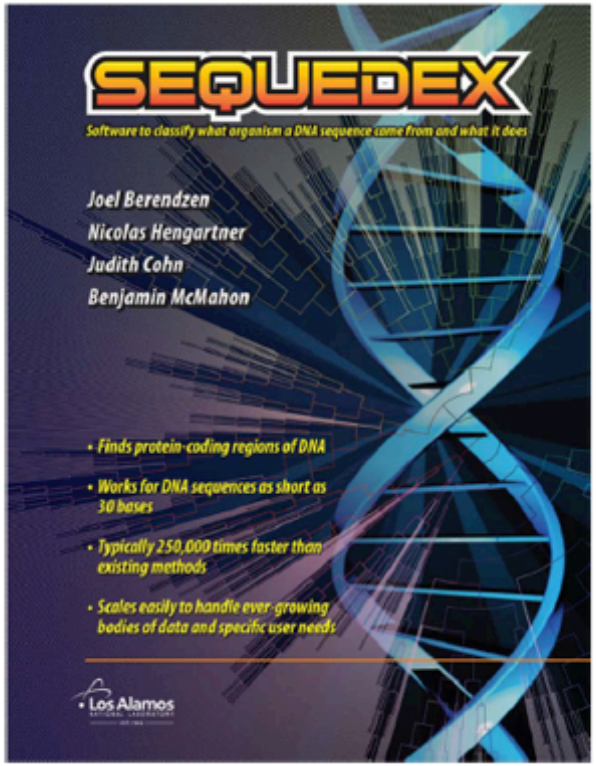
| Project | Title | PIs | Status | Highlights | Future Plans | Pubs |
|---|---|---|---|---|---|---|
| P113 | Experimental measurement and analysis of 2-D/3-D detonation fronts and flows | Sheffield/ Sollier | Active | We have performed experiments employing embedded gauges, multipoint PDV and ORVIS to 2-D flows in detonating nitromethane, HMX, TATB and TNT explosives. New gauge design prepared for CEA. | 3-4 more expts at LANL, then write a joint paper, which will complete the project. | 1 |
| P159 | Experimental study of the reaction zone of explosives | Sheffield/ Bouyer | Active | We have performed joint experiments employing VISAR, PDV and ORVIS to measure reaction zones in nitromethane, TATB and TNT with excellent agreement. | | 2 |
| P116 | Experimental study of Shock Induced Chemistry in Explosives | Moore/ Hebert | Active | In the previous year, we have added UV/ visible spectroscopy capability to our ultrafast dynamic ellipsometry (UDE) experiments at Los Alamos to be used to measure species evolution as a function of time after the shock. In parallel, at Le Ripault we are using time resolved UV/ visible spectroscopy to observe laser-induced decomposition at high pressures and temperatures in a diamond anvil cell. In addition, we are developing at Le Ripault a laser shock / spectroscopy capability in the nanosecond regime to bridge the gap between the Los Alamos "first half nanosecond" experiments and more traditional plate impact experiments. | The collaboration between Los Alamos and Le Ripault on the shock induced chemistry of simple molecular liquids is continuing, with work foreseen at Le Ripault both at high static pressure and temperature as well as nanosecond time resolved laser shock/spectroscopy. At Los Alamos we plan to obtain molecular species specific information on the products of the shock induced reactions using coherent Raman spectroscopic methods. | 0 |

| Project | Title | PIs | Status | Highlights | Future Plans | Pubs |
|---|---|---|---|---|---|---|
| P165 | Diagnostic Development and Code Validation on Low Shock Melting Point Materials | Holtkamp/ Roy | Suspended | Unable to make any progress this year due to funding and programmatic constraint. | | 0 |
| P152 | Electronic Correlations effects in Pu | Albers/ Bouchet | abandoned | Insufficient interaction. | | 0 |
| P107 | Integral measurement of 235U isomer activation by unelastic neutron scattering | | | | | |

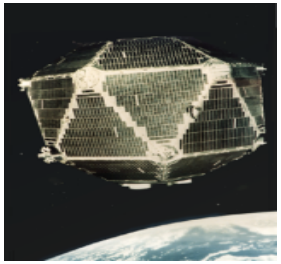
# Backup Slides

# Laboratory wins three more R&D 100 awards

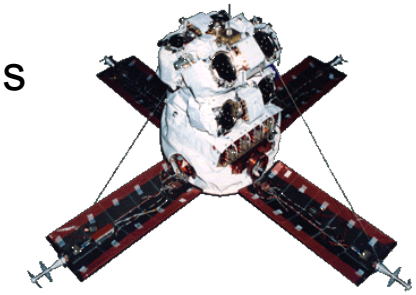
# LANL has a long history of success in space



VELA

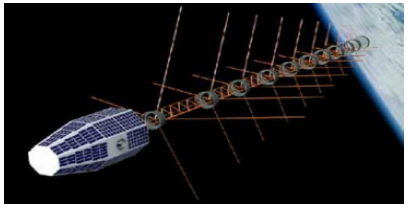
Science => Mission Design => Instrumentation => Testing => Launch => Operations => Analysis

***50+ years of experience***



ALEXIS

DSP

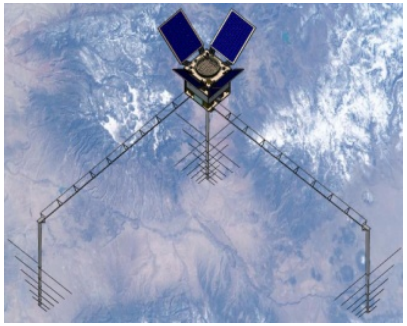


FORTE

MTI

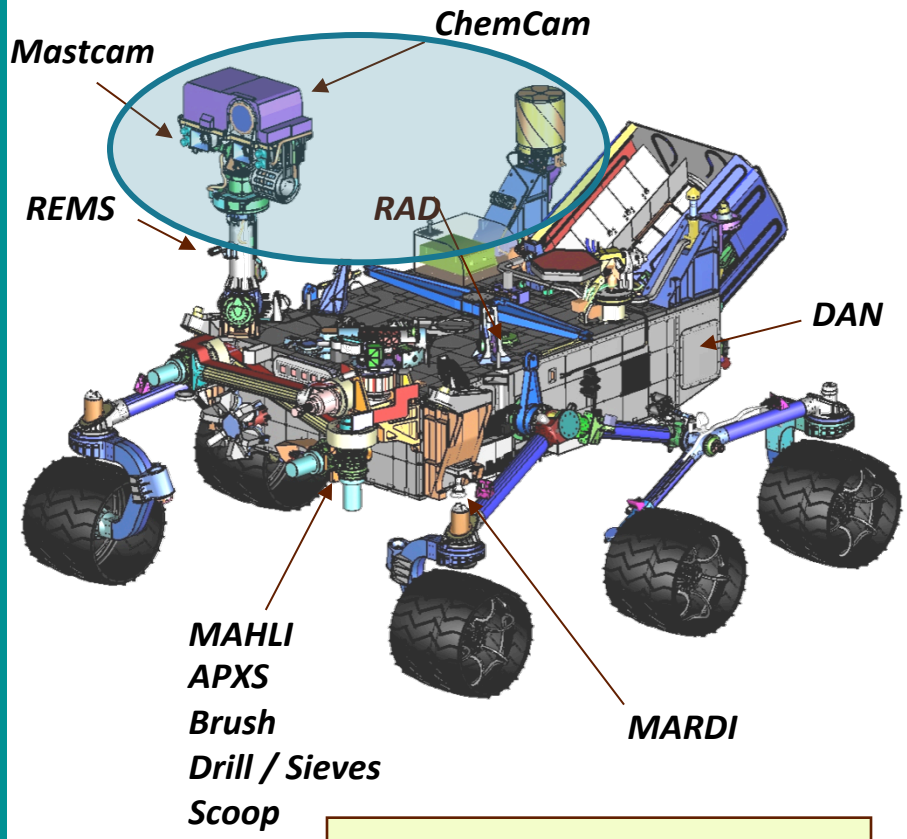
GPS

**~1400 sensors**
**on**
**~400 instruments**
**on**
**~60 satellites**



CFE

# Mars Science Laboratory (MSL)
# Curiosity Rover Science Payload




| | |
|---|---|
| **Rover Width:** | **2.8 m** |
| **Height of Deck:** | **1.1 m** |
| **Ground Clearance:** | **0.66 m** |
| **Height of Mast:** | **2.2 m** |

## REMOTE SENSING

**Mastcam** (M. Malin, MSSS) - Color and telephoto imaging, video, atmospheric opacity

**ChemCam** (R. Wiens, LANL/CNES) – Chemical composition; remote micro-imaging

**CONTACT INSTRUMENTS (ARM)**

**MAHLI** (K. Edgett, MSSS) – Hand-lens color imaging

**APXS** (R. Gellert, U. Guelph, Canada) - Chemical composition

**ANALYTICAL LABORATORY (ROVER BODY)**

**SAM** (P. Mahaffy, GSFC/CNES) - Chemical and isotopic composition, including organics

**CheMin** (D. Blake, ARC) - Mineralogy

**ENVIRONMENTAL CHARACTERIZATION**

**MARDI** (M. Malin, MSSS) - Descent imaging

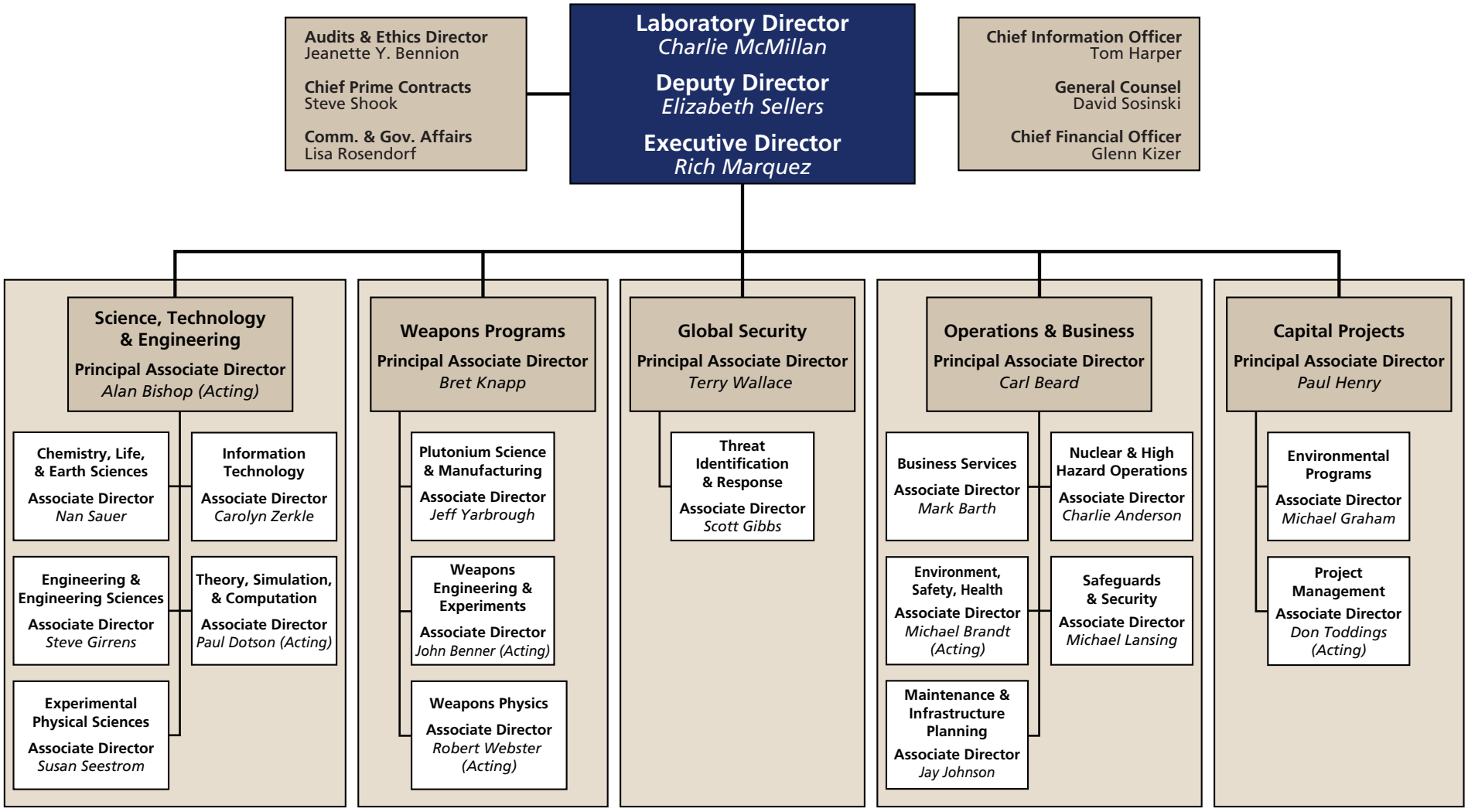
**REMS** (J. Gómez-Elvira, CAB, Spain) - Meteorology / UV

**RAD** (D. Hassler, SwRI) - High-energy radiation

**DAN** (I. Mitrofanov, IKI, Russia) - Subsurface hydrogen

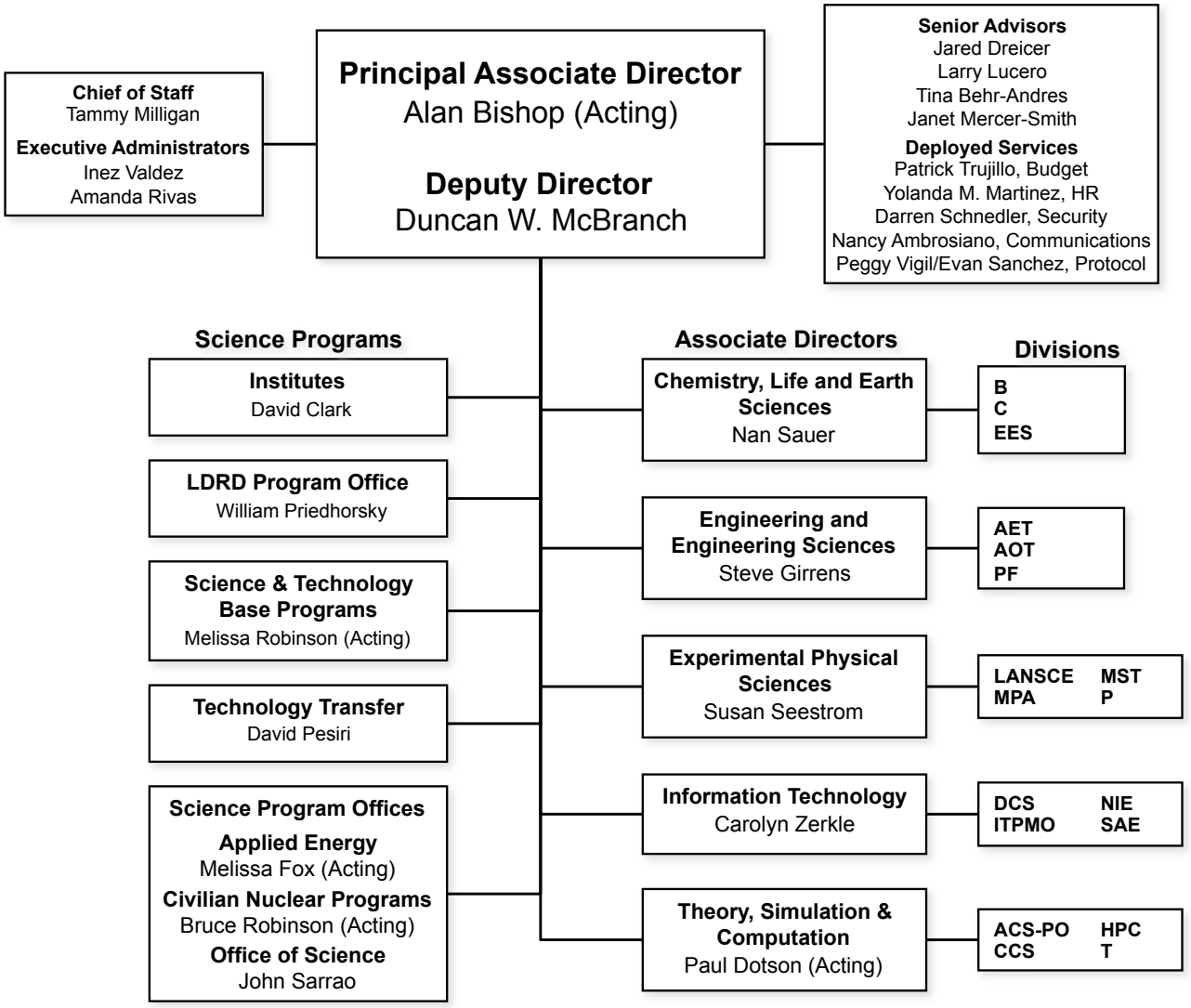
Global Security

Los Alamos NATIONAL LABORATORY EST.1943


Audits & Ethics Director
Jeanette Y. Bennion
Chief Prime Contracts
Steve Shook
Comm. & Gov. Affairs
Lisa Rosendorf
Laboratory Director
Charlie McMillan
Deputy Director
Elizabeth Sellers
Executive Director
Rich Marquez
Chief Information Officer
Tom Harper
General Counsel
David Sosinski
Chief Financial Officer
Glenn Kizer
Science, Technology & Engineering
Principal Associate Director
Alan Bishop (Acting)
Chemistry, Life, & Earth Sciences
Associate Director
Nan Sauer
Information Technology
Associate Director
Carolyn Zerkle
Engineering & Engineering Sciences
Associate Director
Steve Girrens
Theory, Simulation, & Computation
Associate Director
Paul Dotson (Acting)
Experimental Physical Sciences
Associate Director
Susan Seestrom
Weapons Programs
Principal Associate Director
Bret Knapp
Plutonium Science & Manufacturing
Associate Director
Jeff Yarbrough
Weapons Engineering & Experiments
Associate Director
John Benner (Acting)
Weapons Physics
Associate Director
Robert Webster (Acting)
Global Security
Principal Associate Director
Terry Wallace
Threat Identification & Response
Associate Director
Scott Gibbs
Operations & Business
Principal Associate Director
Carl Beard
Business Services
Associate Director
Mark Barth
Nuclear & High Hazard Operations
Associate Director
Charlie Anderson
Environment, Safety, Health
Associate Director
Michael Brandt (Acting)
Safeguards & Security
Associate Director
Michael Lansing
Maintenance & Infrastructure Planning
Associate Director
Jay Johnson
Capital Projects
Principal Associate Director
Paul Henry
Environmental Programs
Associate Director
Michael Graham
Project Management
Associate Director
Don Toddings (Acting)

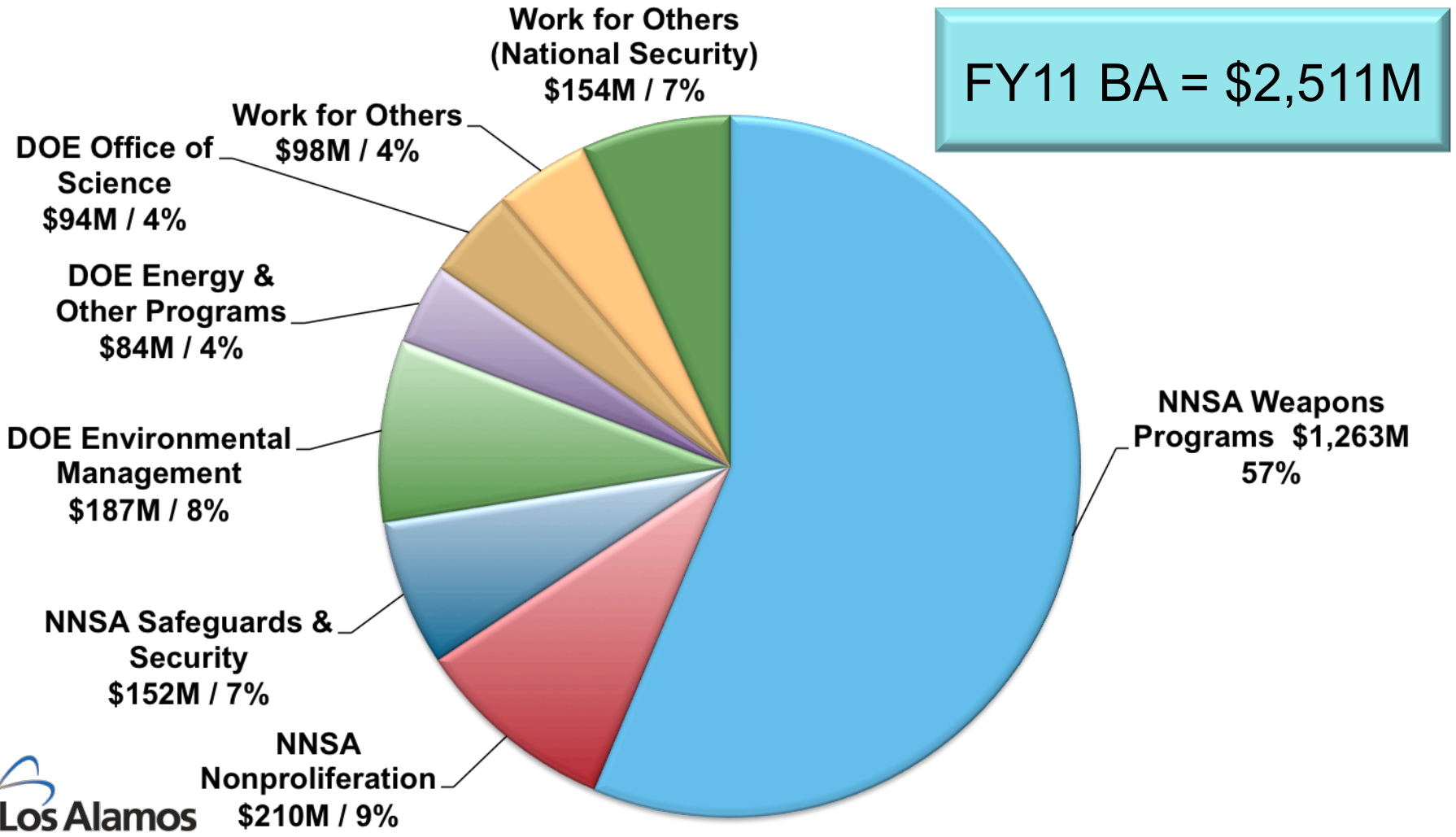
05/21/12

# Science, Technology and Engineering

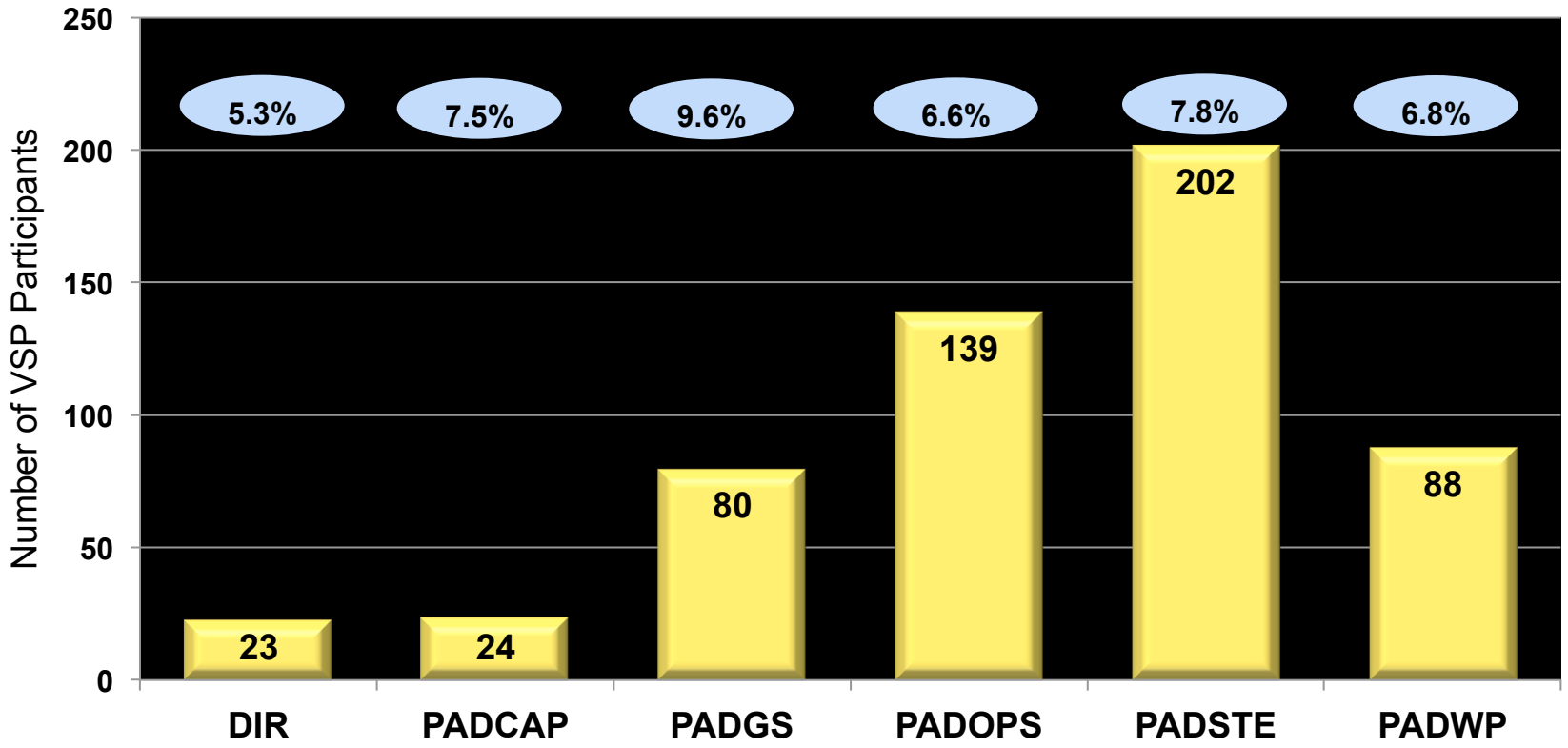



06/06/12

# FY12 estimated LANL budget authority is $2,242M



# LANL VSP Results: April 2012




- Severely limited hiring in FY12/FY13
- Requires re-prioritizing scope & schedule for many programs
- Maintaining skills pipeline