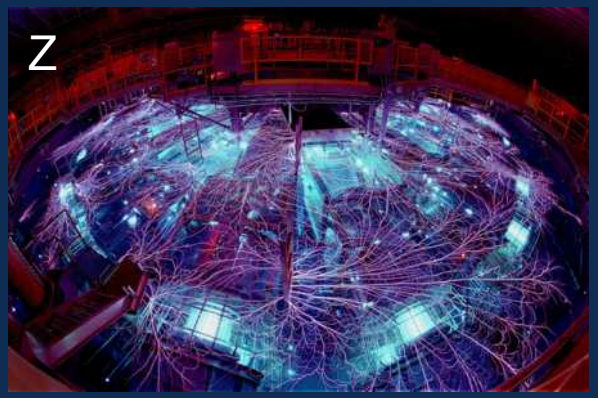
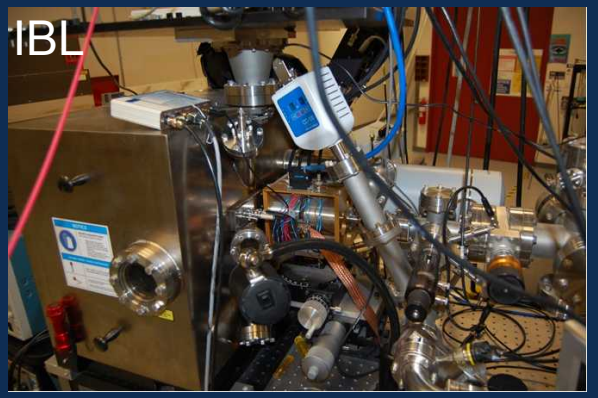
Exceptional service in the national interest

SAND2013-4008C

Sandia National Laboratories



Reflex Triode



Radiation Effects & High Energy Density Science Research Foundation Overview

Keith Matzen

REHEDS RF Director Lead

Director, Pulsed Power Sciences Center

Radiation Effects and High Energy Density Sciences Research Foundation External Review, May 14-16, 2013

U.S. DEPARTMENT OF ENERGY | NNSA

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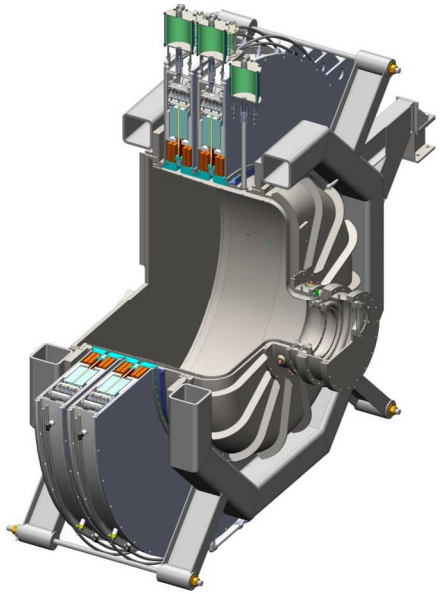
Executive Summary / Outline

- **The Radiation Effects and High Energy Density Sciences (REHEDS) research foundation is delivering important results for the stockpile stewardship and modernization programs**
- **Sandia has played a significant role in the development of the National ICF and HEDS path forward**
- **FY13 Sequestration and FY14 President's Budget Request result in significant funding challenges to this research foundation**
- **Our REHEDS strategy continues to evolve**
  - **Focus on maturing the Radiation Effects Science Strategy**

We are excited about advances: … in the Z facility and LTD research

Sandia National Laboratories

- **Multiple hardware and operational improvements were implemented that increased the Z shot rate**
  - **We performed 177 shots in CY12, a factor of 2 more than in the refurbished Z's first year of operation**
- **We developed and are installing a next-generation laser-triggered gas switch with 2x reduction in timing jitter**
  - **This is a major step on the path to 95 kV operation**
- **We commissioned a new X-ray Thomson scattering diagnostic**
  - **This instrument will enable measurements of temperature, ionization, and phase in dynamic material experiments**
- **We commissioned Mykonos II, a megampere-class LTD module**
  - **We conducted 2000 shots at 160 GW with a standard deviation of 1%**



We are excited about advances: … in the Science and ICF Campaigns

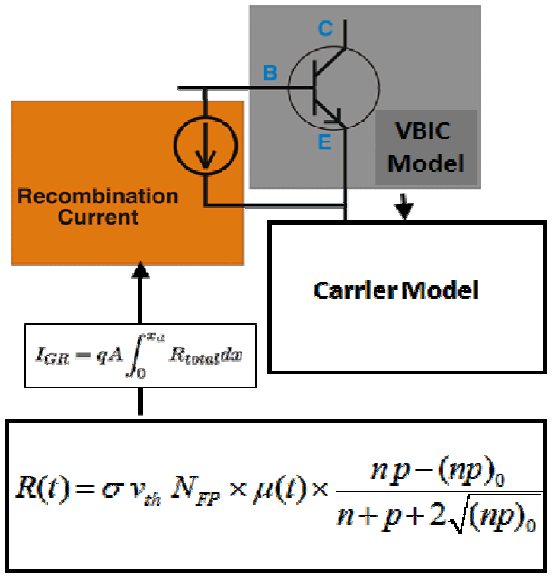
Sandia National Laboratories

- **Radiation Effects Sciences:**
  - Tested advanced concepts that gave world record x-ray yields >10 keV on Z
  - Deployed gas puff capability on refurbished Z enabling record argon x-ray yields
- **Dynamic material properties:**
  - Safely performed 4 plutonium EOS experiments
  - Obtained authorization to perform Pu experiments at 16 MA:
    - ~ doubling the pressures that can be obtained
  - Successfully diagnosed cylindrical ramp compression experiments using internal PDV probe:
    - May increase ramp pressures on Z to 10-20 Mbar from 5 Mbar currently
- **Radiation physics:**
  - Made detailed comparison between classified opacity measurements and calculations in collaboration with LANL
  - Supported unique radiation flow experiments on Z in collaboration with LLNL
- **Pulsed Power Fusion:**
  - Commissioned an independent applied magnetic field capability on the Z facility and demonstrated > 10 Tesla applied-B fields for Z experiments
  - Successfully performed first magnetized implosions on the Z facility and obtained radiographs showing nature of instabilities changed with an applied field
- **Radiography:**
  - Enabled high quality images of Gemini experiments at NNSS
  - Developed a path to more penetrating radiographs in U1a should it be needed

We are excited about advances: … in radiation effects science

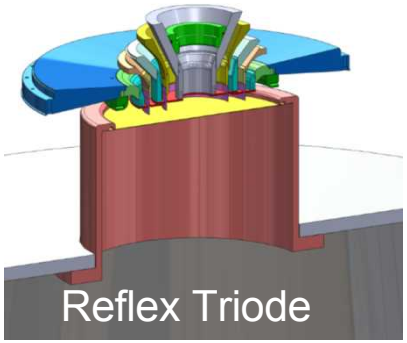
- QASPR PnP compact models delivered to circuit designers in Phase 6.3 of W88Alt370

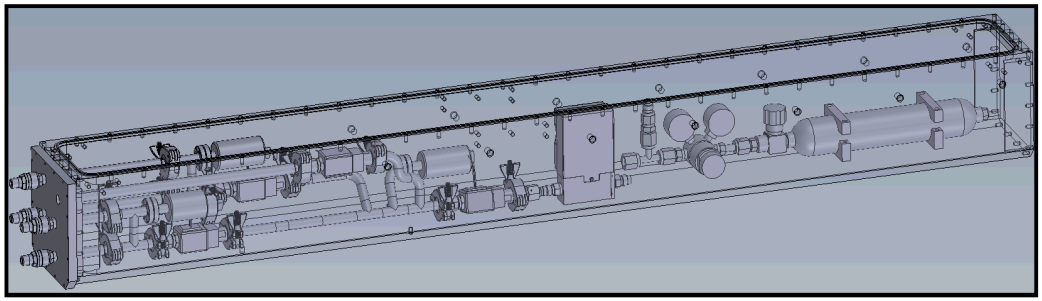
- Developed WSMR-based approach for continued QASPR validation experiments while ACRR has been off-line



Xyce III-V HBT compact model

- Demonstrated initial operation of new reflex triode radiation source producing higher dose rate high fidelity spectrum on Saturn – supports Box IEMP testing





- Designed & constructed gas handling system that fits within NIF's tight requirements; preparations on track for Q4FY13/Q1FY14 SGEMP shots on NIF

Technical and financial challenges, and the path forward

- The National Ignition Campaign (NIC) did not achieve ignition
  - ICF National Program developed a Path Forward Plan for ignition
- NIF and Z have both unique and complementary roles in the stewardship program
  - Science of extreme environments is important for national security
  - Some critically important issues require at least two independent approaches
  - We must avoid technology surprise
- There is significant budget pressure on nuclear weapons S&T
  - LEP / ALT / CAPE
  - Assessed and communicated the impacts to Sandia and NNSA leadership

The highest yield NIF experiment remains >500x below the fusion yield defined to be ignition on NIF

Sandia National Laboratories

- National Ignition Campaign
  - NIF laser met its performance specifications
  - ~60 sophisticated diagnostics are routinely fielded
  - Major milestones not achieved:
    - Fusion yield for alpha heating low by >3 (fusion self-heating > hydro energy deposited in fuel)
    - Fusion yield for ignition low by factor of >500 (fusion energy > total laser energy)
  - Simulation codes are inadequate
  - Path to ignition with NIC indirect-drive baseline is challenging
- The ICF Execs delivered to NNSA a draft report that responds to the Senate Energy and Water Development (SEWD) and House Armed Services Committees (HASC)
  - Explains the scientific and technical barriers to achieving ignition
  - Describes the steps NNSA will take to achieve ignition on a revised schedule
    - Balanced path forward for Indirect Drive (IDI)
      - Integrated implosion experiments
      - Focused experiments to isolate and understand key physics issues
      - Alternate x-ray driven implosions
    - Pursue alternative drive concepts of Polar Direct Drive (PDD) and Magnetically-Driven Implosions (MDI)

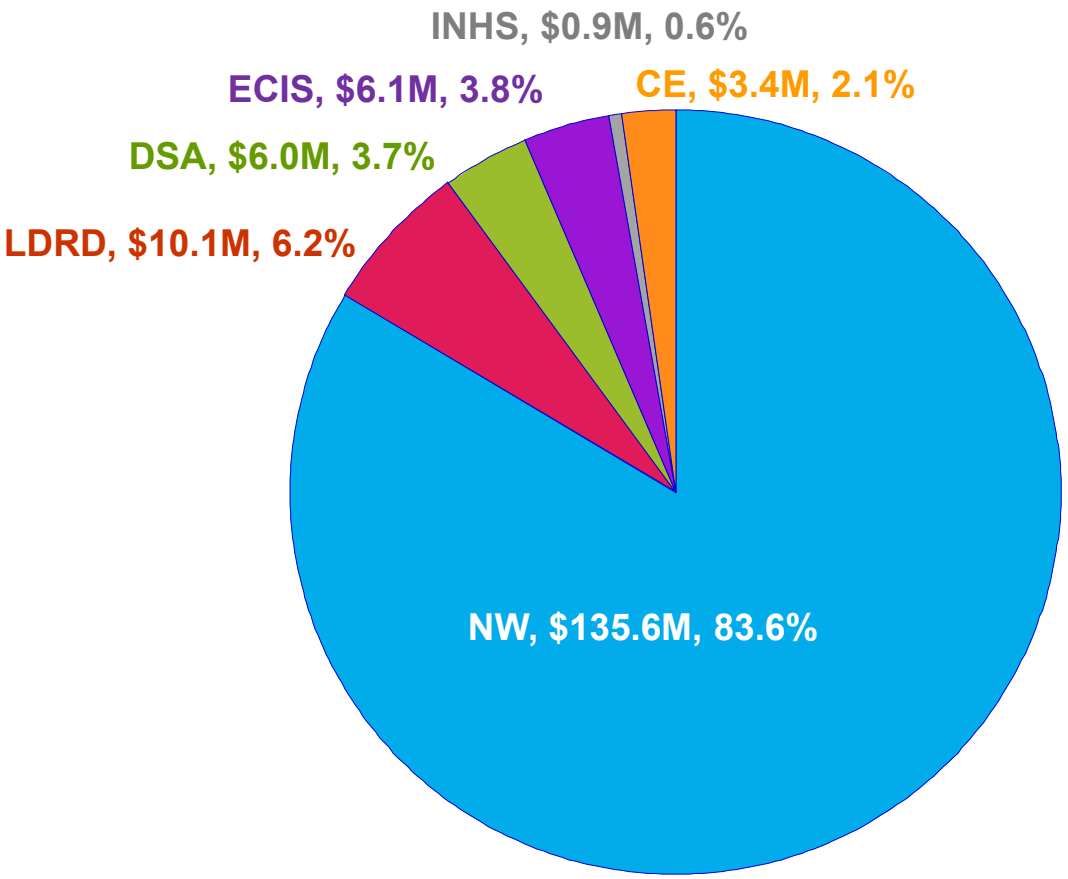
"Understanding why ignition has not been achieved is important, both to guide the experimental program and because it could have implications to the physics models and codes used in the SSP."

Sequestration reductions are significantly impacting Sandia's Science, ICF, and ASC Campaign funding

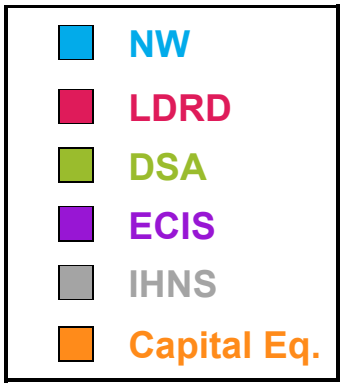
	FY12 Budget Authority	FY13 PBR	FY13 "present" post-sequestration	FY14 PBR	FY14 PBR w/ sequestration estimate
ICF	$ 49,460	$ 55,000	$ 47,873	$ 48,197	$ 43,377
Science	$ 39,991	$ 31,500	$ 29,076	$ 30,832	$ 27,749
Engineering	$ 75,943	$ 84,084	$ 63,274	$ 86,185	$ 77,567
ASC	$ 130,877	$ 136,851	$ 118,901	$ 127,757	$ 114,981
RTBF	$ 166,942	$ 214,061	$ 165,329	$ 186,483	$ 167,835
Total	$ 463,213	$ 521,496	$ 424,453	$ 479,454	$ 431,509

REHEDS FY12 NW expenditures = $135.6M

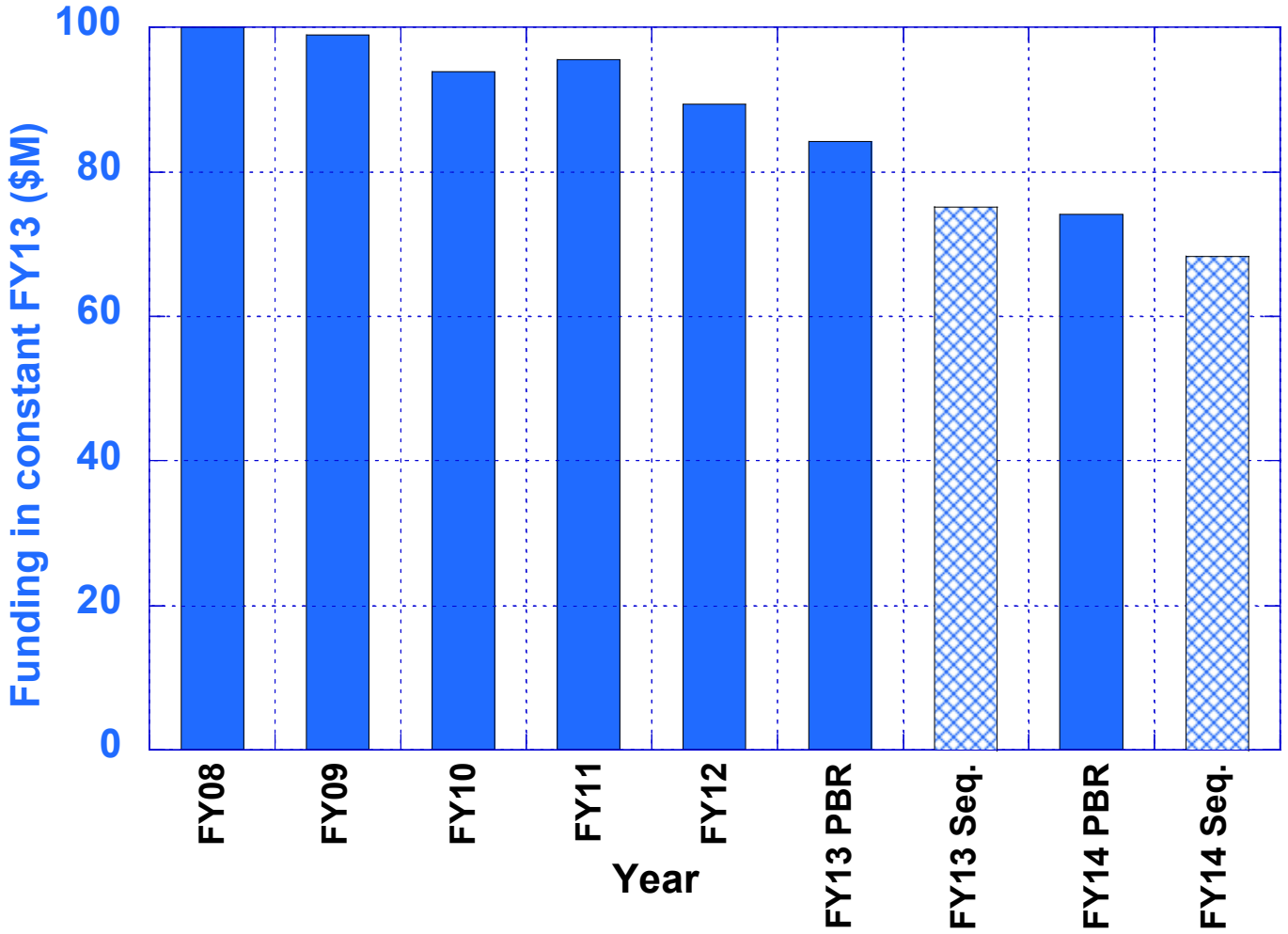
REHEDS financial overview
FY12 expenditures (actuals) = $162.2M



Pulsed Power Sciences	$105.1M
Radiation Sciences	$48.3M
Physical, Chemical, & Nano Sciences	$3.5M
Other Centers	$5.3M



Sandia's total ICF + Science Campaign* funding has decreased by ~25% since FY2008



*Capabilities for Nuclear Intelligence funding not included in FY11-FY14 funding

Implementation of the Budget Control Act (sequestration) has had a significant impact

Sandia National Laboratories

- The ICF and Science Campaign funding was reduced at mid-year from $86.5M (FY13 PBR) to $75.1M (modified authorized financial plan)

- Reduction was managed through several Z program changes
  - Selected high priority shots for the remainder of the year to maintain progress in key areas (DMP and RES)
  - Implemented extended Z maintenance periods
  - Reduced purchase of Z shot hardware sets by 20%
  - Reduced development of diagnostics and experimental platforms
  - Reduced staffing costs
  - Placed several FY13 milestones at risk

- Funds in ASC, Engineering, and RTBF were de-obligated last week
  - Impact is being assessed

The FY14 President's Budget Request will significantly slow the rate of Z experiments, increase integrated costs, and have a significant negative impact on our ability to execute Pu experiments

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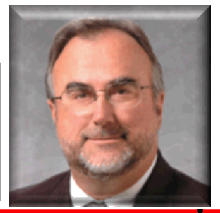
- **Pu program requires a sustained investment; each Pu experiment is extraordinarily complex and requires a new experimental platform and many supporting shots**
  - **New capabilities and a new containment system are needed to obtain the highest impact Pu data**
  - **These advances will not be possible given the FY14 PBR**
- **FY14 PBR will eliminate or significantly delay Z work supporting stockpile modernization and the assessment of pulsed power fusion as an alternate approach to ICF**
  - **Must preserve, but significantly slow materials, radiation effects, and fusion**
  - **Must eliminate radiation physics**
- **NNSA has directed that Z experiments for the Fundamental Science Program will be subject to full cost recovery**
  - **"NNSA will not permit shots on the NIF or on Z for academic users unless the users pay the full shot costs"**
  - **Effectively eliminates these collaborations with our academic colleagues**

Line and Nuclear Weapons program management of the principal research areas within the REHEDS RF

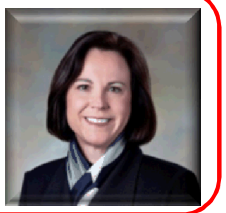
Sandia National Laboratories

Executive Office

Paul Hommert
President &
Labs Director



Jerry McDowell
Dep Lab Dir & EVP
Natl Sec Prog



Kim Sawyer,
Dep Lab Dir
& EVP for
Mission Support

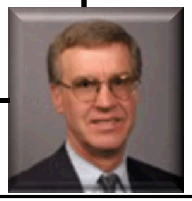
Julia Phillips,
acting VP
Chief Technology
Office

(LDRD)

Steve Rottler, VP
NW S&T;
California
Laboratory

(NW Program)

(WS&T) (SWPR)



Bruce Walker, VP
Weapons Engineering
& Product Realization

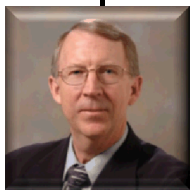
Wendy Cieslak and
Jay Jakubczak
Principal Program Directors
Nuclear Weapons Program

Duane Dimos,
acting VP
Science &
Technology

(Line)

Charles Barbour, Director
Physical, Chemical, &
Nano Science

Jim Lee, Director
Radiation Sciences Center



Keith Matzen, Director
Pulsed Power Sciences Center
REHEDS RF Chair

We have realigned the Group structures and are reorganizing the Pulsed Power Sciences Center

Sandia National Laboratories

New Pulsed Power Science Group Structure

Material Properties

Radiation & Fusion

Z Facility R&D

Pulsed Power S&T

Radiography

Keith Matzen

Pulsed Power Sciences Center

Mark Herrmann

High Energy Density Science

John Porter

Z Operations & Engineering

Larry Schneider

Pulsed Power, Electromagnetics, & WFO Programs

May 3

Electromagnetics + Electrical system & device physics

Jim Lee

Radiation Sciences

Grant Heffelfinger

Radiation Effects Sciences & Applications

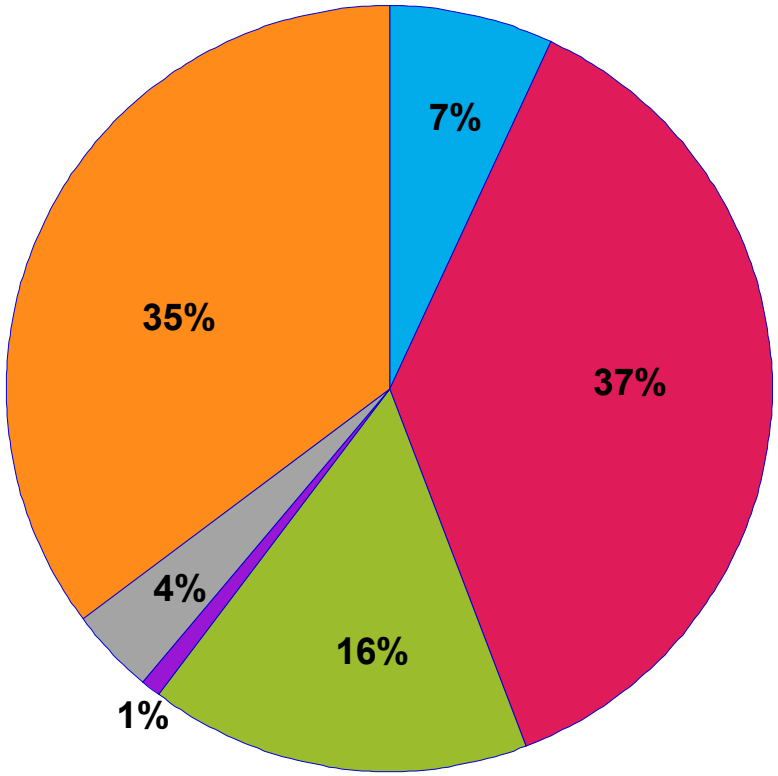
Paul Raglin

Nuclear Facilities & Applied Technologies

Larry Schneider

Electrical Services

FY13 Staffing Overview: 505 presently on-role



Staffing in Core Centers

Pulsed Power Sciences	282
Radiation Sciences	201
Physical, Chemical, & Nano Sciences	22

Recent PhD hires

FY11	9
FY12	7
FY13	2

This year's REHEDS review will emphasize our Radiation Effects Science strategy

Sandia National Laboratories

- **Jim Lee and the RES team will address the following four recommendations:**
  - **RECOMMENDATION: Sandia should conduct an assessment of its radiation effects strategy to determine the best overall scientific approach to accomplish the mission objectives**
  - **RECOMMENDATION: We strongly recommend that Sandia develop a roadmap that clearly shows when RES research efforts must be ready to guide decisions on weapon components and systems.**
  - **RECOMMENDATION: Sandia should develop a formal documented and peer-reviewed process for qualifying the performance of various weapon components under the radiation effects requirements.**
  - **RECOMMENDATION: The panel recommends that Sandia step up to provide national leadership in radiation effects.**
- **Mark Herrmann will address your fifth recommendation on our fusion strategy:**
  - **RECOMMENDATION: Sandia should conduct a classified workshop with NNSA's support to evaluate future program directions for its fusion efforts and then develop an appropriate strategy to pursue on Z and other facilities.**

Review Agenda: May 14

Tuesday, May 14			
8:00	15	Welcome and introductions, panel charge	Charles Barbour
8:15	30	REHEDS Research Foundation overview	Keith Matzen
8:45	15	U.S./UK transmissibility briefing	Luis Paiz
9:00	30	Overview of Radiation Effects Sciences	Jim Lee
9:30	*20*	*Break*	
9:50	40	Radiation Effects Sciences strategy update	Grant Heffelfinger
10:30	45	Stratcom Radiation Effects Sciences perspective	Pat Griffin
11:15	45	Sandia and the Redbook	Charlie Nakhleh
12:00	*60*	*Working Lunch (Panel meets in three groups with managers, senior staff, and junior staff)*	*Review Panel & staff*
1:00	45	W88/MK5 Alt 370 program overview and hostile environments qualification	Dave Fordham
1:45	45	Ferro-electric neutron generator qualification to nuclear environments in the post-UGT era	Scott Jones
2:30	*30*	*Break*	
3:00	30	NuGET applications overview	Russell DePriest
3:30	15	QASPR overview	Len Lorence
3:45	25	Validation hierarchy strategies to support the W88 Alt	Joseph Castro
4:10	20	QASPR W88 Alt hostile qualification circuit metrics	Chuck Hembree
4:30	*90*	*Panel Executive Session*	*Review Panel*
6:00	*120*	*Catered dinner on site–Panel and specific REHEDS RF managers*	
8:30	*120*	*Adjourn and depart to hotel*	*Review Panel*

Review Agenda: May 15

Wednesday, May 15			
8:00	45	Science-based qualification of SGEMP effects	Keith Cartwright
8:45	45	High Energy Density Science overview and strategy	Mark Herrmann
9:30	30	Pu experiments and plans	Marcus Knudson
10:00	*30*	*Break*	
10:30	30	Cylindrical platform for ramp loading experiments to 10-20 Mbars on Z	Ray Lemke
11:00	30	Integration of QMC/DFT/QMD modeling and experimental efforts	Thomas Mattsson
11:30	*90*	*Working Lunch: Poster Session in 960/1001*	*Review Panel & some staff*
1:00	30	RES source development on Z	Mike Cuneo
1:30	30	Pulsed power ICF progress and plans	Dan Sinars
2:00	*30*	*Break*	
2:30	30	Mix diagnostics for fusion plasmas	Stephanie Hansen
3:00	30	Sandia radiographic support for scaling and surrogacy	Bryan Oliver
3:30	30	Recent progress in linear-transformer-driver technology	Brian Stoltzfus
4:00	*120*	*Panel Executive Session*	*Review Panel*
6:00		*Adjourn and depart for restaurant*	*Review Panel*
6:30		*Working Dinner*	*Review Panel*
8:30		*Adjourn and depart to hotel*	*Review Panel*

Review Agenda: May 16

Thursday, May 16			
7:30	*195*	*Panel Executive Session, including breakfast*	*Review Panel*
10:45	*15*	*Break*	
11:00	**30**	**Outbrief**	**John Browne**
11:30		*Working Lunch – Panel*	*Review Panel*
12:00		*Adjourn*	
After-noon		*Optional tours of REHEDS facilities (IBL, Sphinx/Saturn, HERMES III, RITS-6, ACRR)*	*Review Panel*

Poster Session List	
Wednesday, May 15 – 960/1001	
Cavity SGEMP experiments at Z and at the NIF	Tim Flanagan
Saturn, HERMES III and SPHINX recapitalization in preparation for stockpile modernization	Ray Thomas
HERMES short pulse simulation source development	Vic Harper-Slaboszewicz
Diagnostic developments for dynamic material experiments	Dan Dolan
Beryllium Liner Implosion Experiments on Z for MagLIF and DMP	Ryan McBride
QASPR: Radiation effects in semiconductors	Jonathan Custer
Potential evidence for post-irradiation defect evolution	Ed Bielejec

Background Information

- Center organizational structures
- Sandia National Laboratories
  - Mission Areas
  - Research Foundations
- Radiation Effects and High Energy Density Science Research Foundation
  - Strategic intent and objectives
- REHEDS LDRD overview
- Awards and Leadership

Management Structure
Pulsed Power Sciences

Sandia National Laboratories

Keith Matzen

Pulsed Power Sciences Center

Robert Petro

Center 1600 Business Services

Keith Matzen (acting)

Pulsed Power Program Mgmt & Integration

Mark Kiefer

Center Conduct of Operations

Mark Herrmann

High Energy Density Science

Thomas Mattsson

HEDP Theory

Mike Cuneo

Radiation & Fusion Experiments

Charlie Nakhleh

ICF Target Design

Dawn Flicker

Dynamic Material Properties

Gordon Leifeste

Solid Dynamics Experiments

Dan Sinars

High Energy Density Experiments

Keith Matzen (acting)

Pulsed Power Science & Technology

Mark Kiefer

Adv. Radiographic Technologies

Dan Bozman

Nevada Support

John Porter

Z Operations & Engineering

Bill Stygar

Advanced Accelerator Physics

John Porter (acting)

Laser Operations & Engineering

Michael Jones

X-Ray Measurements & Controls

Greg Rochau

Imaging and Spectroscopy

Randy McKee

Pulsed Power Engineering

Greg Rochau (acting)

Diagnostics & Target Physics

Finis Long

Load & Diagnostics Engineering

Mike Lopez

Z Operations

Management Structure
Radiation Sciences

Jim Lee

Radiation Sciences

Robert Petro

10616
Center 1300 Business Services

Grant Heffelfinger

Radiation Effects
Sciences & Applications

Len Lorence

Radiations Effects Theory

Ray Thomas

AGT Accelerator Operations

Fred Hartman

Radiation Effects
Experimentation

James Bryson

Radiation Effects Research

Larry Schneider

Electrical Services

Bryan Oliver

Electromagnetic Theory

Steven Glover

Electrical Science & Experiments

Scott Hutchinson

Electrical Models & Simulation

Steven Wix

Component & Systems Analysis

Paul Raglin

Nuclear Facilities
& Applied Technologies

Matthew Burger

Nuclear Facility Operations

David Wheeler

Nuclear Quality &
Requirements

James Dahl

Nuclear Safety Analysis

Kenneth Reil

Applied Nuclear Technologies

Paul Helmick

Nuclear Engineering &
Maintenance

Warren Strong

Nuclear Materials Management

Michael Spoerner

Non-Reactor Nuclear Facilities

Management Structure
Physical, Chemical,
& Nano Science

Charles Barbour

Physical, Chemical,
& Nano Science

Rick McCormick

Rad, Nano & Optical Sciences

Jonathan Custer

Radiation-Solid Interactions

Carlos Gutierrez

Nanoscale Science

William Seng

Laser, Optics
& Remote Sensing

Jerry Simmons

Semiconductor & Optical Sciences

Daniel Barton

Quantum Phenomena

Jonathan Wierer

Semiconductor Material
& Device Sciences

Robert Biefeld

Advanced Materials Sciences

Neal Shinn

Integrated Nanotechnologies

Jeffrey Nelson

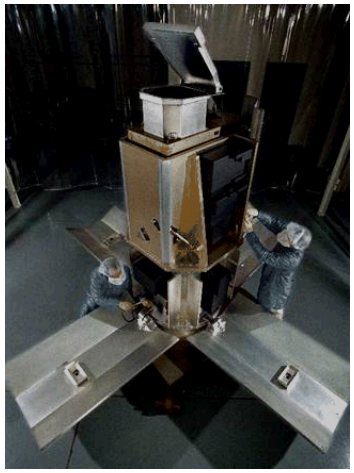
Nanostructure Physics

Sean Hearne

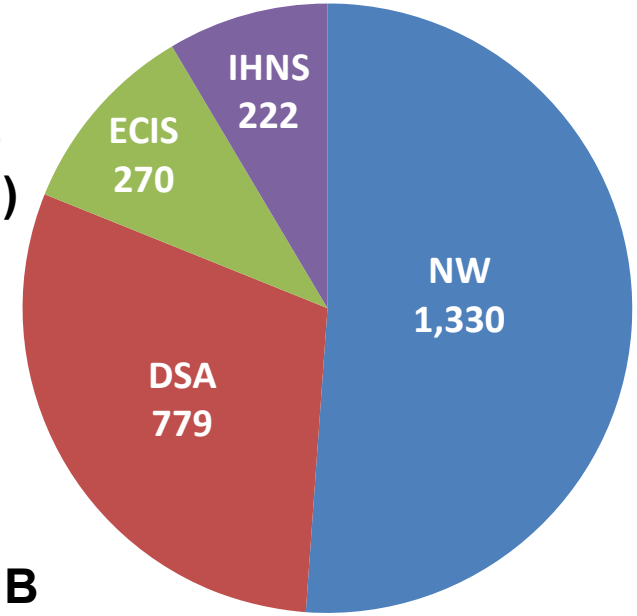
Nanosystems
Synthesis/Analysis

Sandia's Four Mission Areas (Strategic Management Units)

- Nuclear Weapons
- Defense Systems & Assessments (DoD and Intelligence)
- Energy, Climate, & Infrastructure Security
- International, Homeland, and Nuclear Security



FY12 SMU total revenue breakout ($M)



Total - $2.601B

Sandia Research Foundations

Julia Phillips
Chief Technology Officer

- Bio Science and Technology
- Computer Science and Math
- Engineering Sciences
- Geosciences
- Materials Science and Technology
- Microsystems Science and Technology
- Radiation Effects and High Energy Density Science

Research Leadership Team: Directors of >20 technical research organizations and/or business area leads

Radiation Effects & High Energy Density Science Research Foundation

Sandia National Laboratories

Strategic Intent: Our Vision

Meet Sandia's unique national security mission needs in radiation effects and high energy density science,

fulfill our role as the Nation's steward of fast pulsed power science and technology, and

utilize the best available facilities to advance our capability to create and understand extreme radiation, pressure, and temperature environments.

REHEDS Strategic Objectives

- **Objective 1: Deliver on our stockpile commitments and expand efforts to support annual assessment and certification reviews, the life extension of weapons, and modernization of weapons components and subsystems.**

- **Objective 2: Advance our facilities, capabilities, and foundational science, technology, and engineering to meet national security needs.**

- **Objective 3: Attract and retain a world-class workforce as the Nation's stockpile stewards.**

Radiation Effects & High Energy Density Science Research Foundation

Sandia National Laboratories

- **Radiation Effects Science (RES):** Ensure that engineered systems are able to operate as intended in radiation environments
  - Radiation resistant technologies
  - Understanding the effects of radiation
  - Assessing the performance of the stockpile
- **High Energy Density Science (HEDS):** Explore and strengthen science concepts that are important for our national security missions
  - Dynamic material properties
  - Soft x-ray source development
  - Radiation physics
  - Pulsed-power fusion
- **Pulsed Power Science and Enabling Technologies:** Enable the construction and effective operation of terawatt to petawatt pulsed-power systems
  - Z facility improvements and optimization
    - 50% increase in energy to target; Z-Beamlet/Z-Petawatt
  - Linear Transformer Driver (LTD)
    - Cygnus replacement; Z-300; SPARC

LDRD funds strategic investments in REHEDS capabilities

- **Radiation Effects & High Energy Density Science LDRD strategy:**
  - **The call each year reflects program gaps in the 3 – 10 year horizon**

- **REHEDS LDRD funding ($M):**
  - **funding levels by year**

2008	2009	2010	2011	2012	2013	2014
8.39	8.70	9.30	9.30	9.30	7.86	7.97

- **REHEDS LDRD Call for FY14:**

  Radiation Effects Science, High Energy Density Science, and Enabling Technologies:
  - **Innovative approaches to address the gap between potential environments and conditions currently achievable on existing facilities**
  - **Pulsed power drivers and platforms that could produce warm x-rays**
  - **Develop technologies, techniques, computation and theoretical studies, and diagnostics that could scale to higher energy drivers**
  - **Understand and mitigate current loss in pulsed power experiments**
  - **Develop new techniques to access hard-to-measure physical processes of programmatic interest**

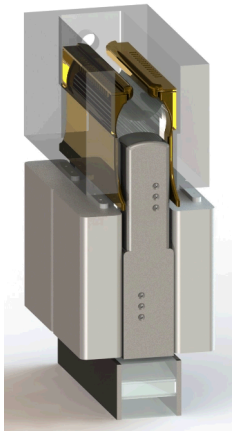
Current LDRD Projects Address Strategic Issues

Ensure systems operate as intended in high radiation environments

- Develop New DFT techniques to tackle point defects of III-V ternary compounds to radiation (impact to QASPR and Alts/LEPs)
- Develop new radiation resistant materials (potential impact to future Alts/LEPs)
- Develop techniques to assess electron transport in electromagnetic fields to accommodate transport in EM fields inside materials. Current techniques limited to vacuum
- Develop sources to produce warmer x-rays (enable highly relevant tests of engineered systems in radiation environments)

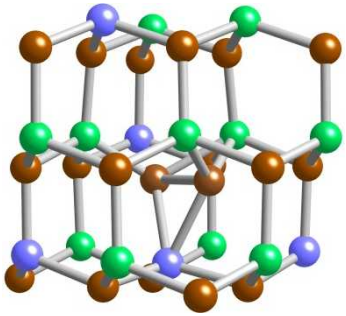
Foundations for future pulsed power high energy density science

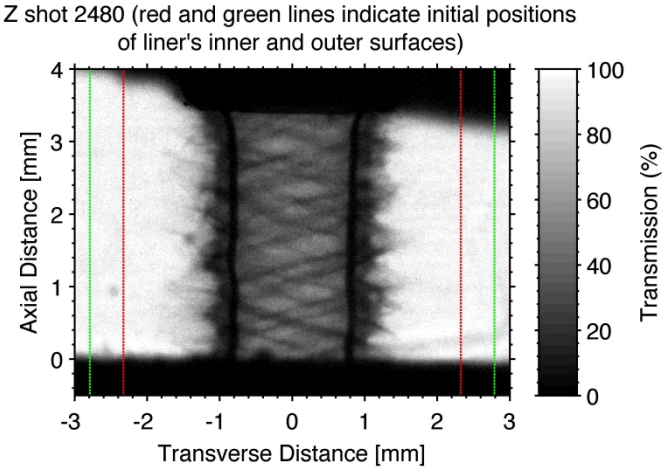
- Implement and diagnose magnetic flux compression on Z
- Advance pulsed power technology for next generation LTD's (new switches & magnetic core materials)
- Develop temperature diagnostics appropriate for ramp compression experiments
- Model ion tail depletion to improve predictability in ICF simulations



LTD brick with a rail-gap switch

$In_{0.5}Ga_{0.5}As$





Applied B field leads to helical MRT pattern

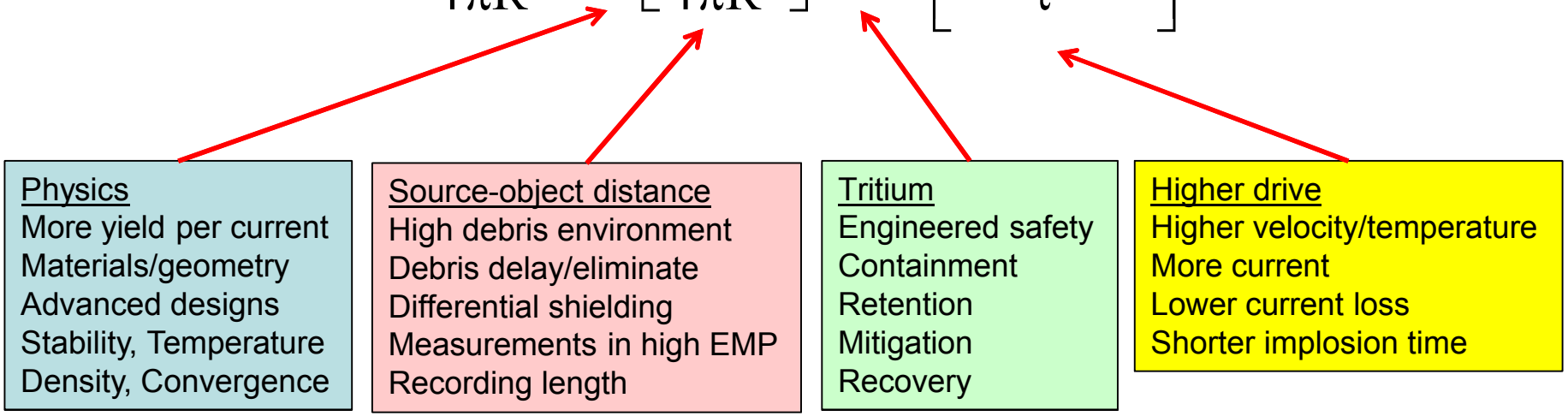
To answer fundamental science questions for increasing neutron or x-ray fluences to threat levels on Z, a Grand Challenge LDRD has been proposed for FY14 thru FY16

- **The x-ray and neutron fluences scale with the following factors (among others)**
- **There are significant scientific and engineering risks and challenges to impact each factor**

$$F = \frac{\xi Y}{4\pi R^2} \sim \chi\left[\frac{\xi}{4\pi R^2}\right]\langle \sigma v \rangle_o \left[\frac{\left(I - I_{loss}\right)^{\beta}}{\tau^{\alpha}}\right]$$

$$\beta \sim 2-4$$

$$\alpha \sim 0-2$$



Our staff are leaders in RES, HEDS, and Pulsed Power S&T

Sandia National Laboratories

- **Peer recognition**
  - 2012: HEART Conf. Peter Haas Award and Meritorious Paper Award, IEEE NPSS Early Achievement, ANS Robert L. Long Training Excellence Award, Quality New Mexico Performance Excellence Award for Nuclear Facilities & Applied Technology, Fusion Power Associates Fusion Engineering Award, Young Alumni of year Univ. Nevada Reno
  - 2013: IEEE Igor Alexeff Outstanding Student in Plasma Science Award
  - Fellows: 25 since late 1980s: 11 APS, 8 IEEE, 3 AAAS, 1 AIAA, 1 National Academy of Engineering, 1 Hypervelocity Impact Society
- **DOE, DoD recognition and contributions**
  - 2 Defense Programs Awards of Excellence (to Uranium Experiments Team and to Sandia Pulsed Reactor facility Critical Experiments Project Team)
  - Presidential Early Career Award for Scientists and Engineers (2012)
  - Secretary of Energy Achievement Award, NNSA IBL Project (2012)
  - NNSA Bronze Award to former Director of Pulsed Power Sciences (2013)
  - Fusion Energy Sciences Advisory Committee (2010-2013)
  - Technical advisors, Defense Science Board Task Force on Survivability
  - Editor in chief, FY 2013 & FY 2014 *Stockpile Stewardship and Management Plans*
- **Publications**
  - Journal papers: 78 in 2010, 81 in 2011, 86 in 2012
  - Proceedings papers: 17 in 2010, 44 in 2011, 4 in 2012
- **Professional Service**
  - Participation on advisory groups, review panels, and editorial boards
  - Leadership positions in more than 10 professional societies
  - Chairing or assisting in organizing numerous conferences and workshops