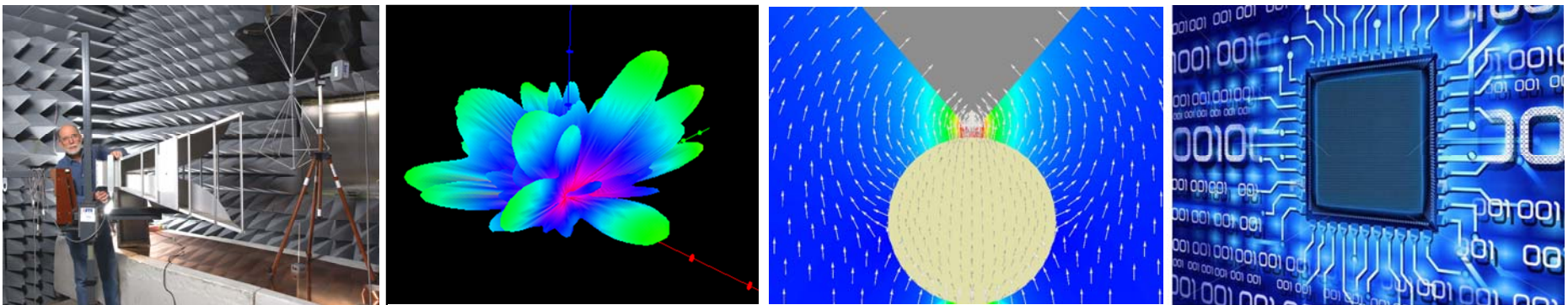


Exceptional service in the national interest



Consolidation of Electrical Sciences at Sandia

Presented to the FY14 ESRF External Advisory Board

March 25, 2014

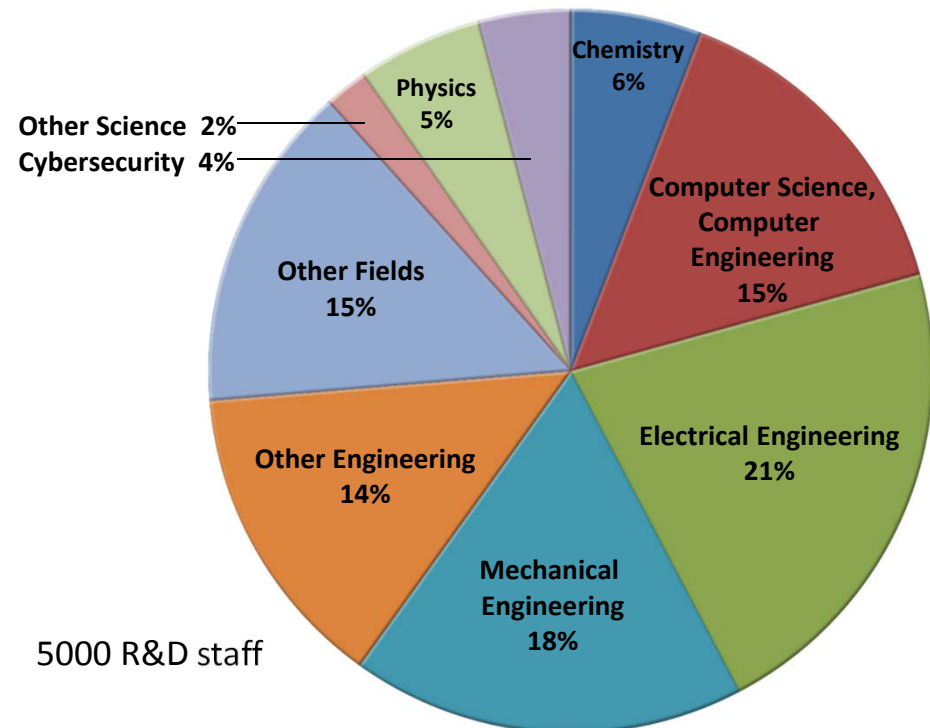
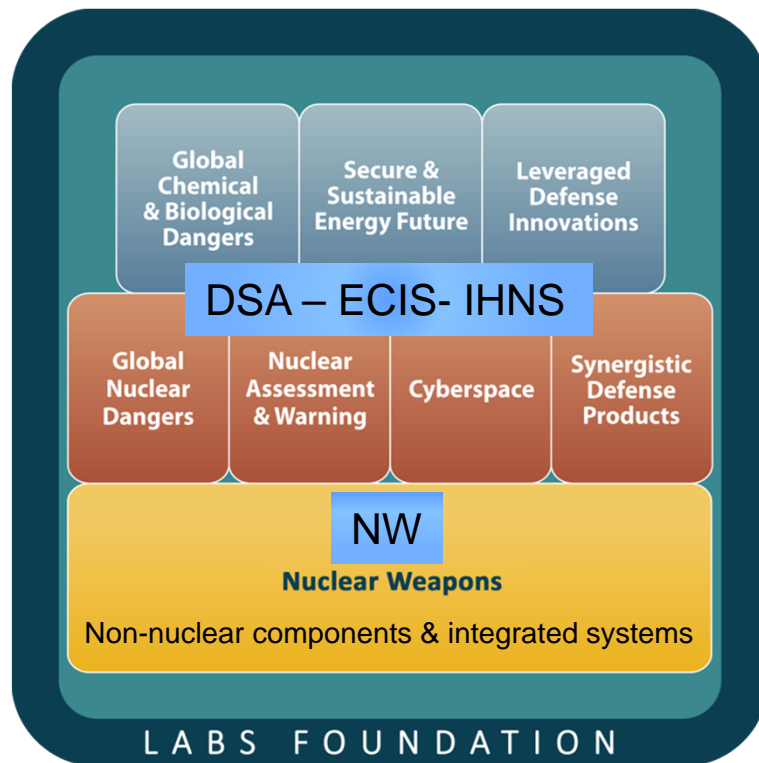
Larry Schneider, 1350 Senior Manager



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Expertise in Electrical Engineering/Sciences is needed throughout Sandia's mission space

Sandia is the engineering arm of the U.S. nuclear weapons enterprise entrusted to ensure the U.S. nuclear arsenal is safe, secure, and effective.



These highly complex technical challenges require a multi-disciplinary approach of systems engineering supported by deep science

Mission area concerns with Electrical Sciences were identified by a multi-division working group



- **No clear stewardship or line POC for an integrated set of capabilities to solve electrical problems requiring a more science-based approach**
 - Develop clear capability requirements and stable, adequate funding sources.
 - Improve clarity on science role and priorities
 - Improve responsiveness to mission customers
 - Improve impact on design, surveillance, analysis and qualification
- **Need for an improved capability to perform predictive electrical simulation (both physical and computational)**
 - Circuit sciences, mod/sim, and experimental capabilities too dispersed
- **Gaps in technical capabilities and specific services**

The initial scope of Electrical Sciences was defined



■ In Scope:

- Electrical circuit code development including device and material models
- Physical and computational electrical circuit simulation
- Circuit modeling capability coupled to environments
- Electromagnetic/plasma physics code development and mod/sim
- NW qualification in Normal, Abnormal and Hostile electromagnetic environments
- Support to NW qualification in Hostile radiation environments

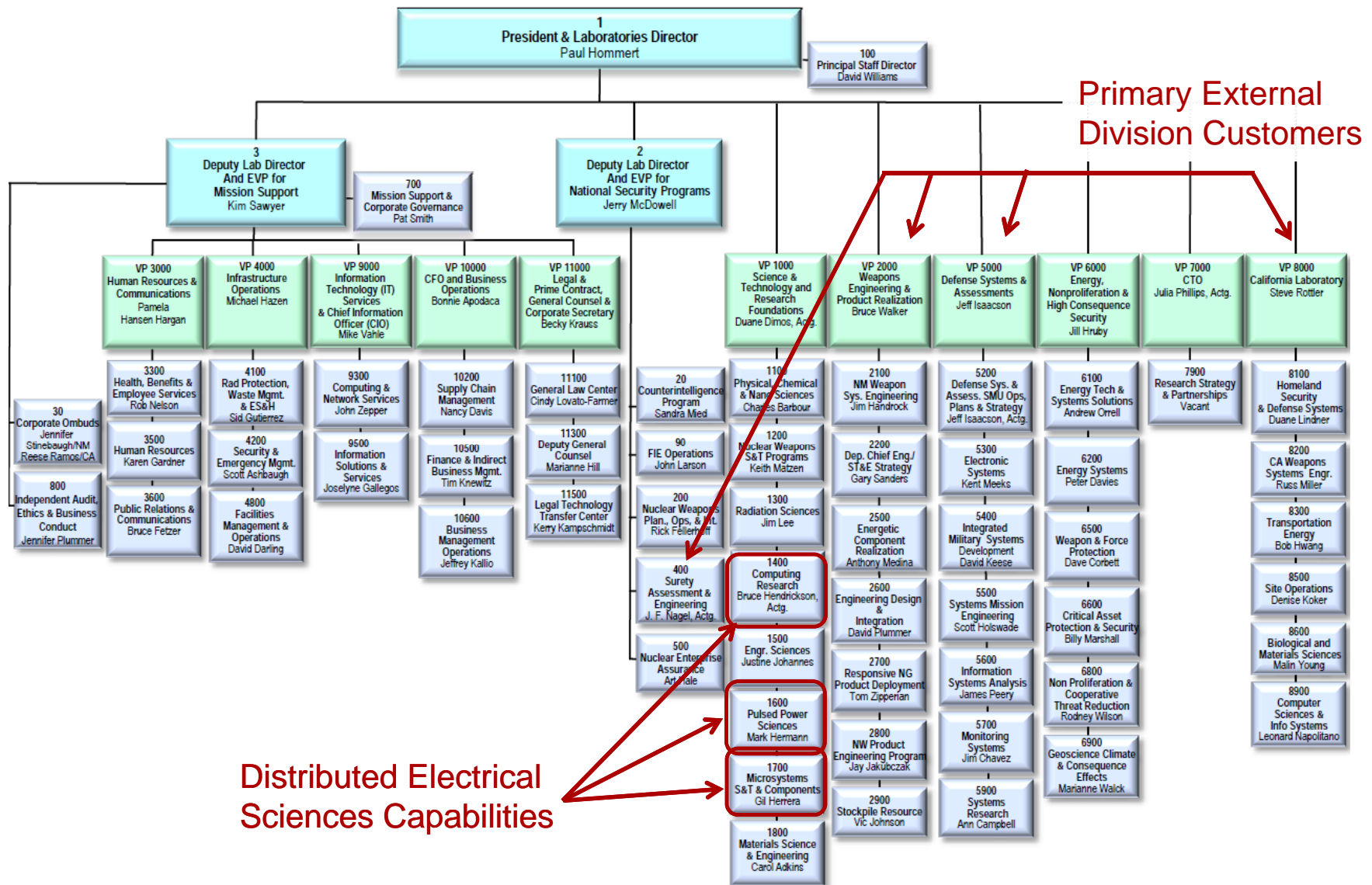
■ Out of scope:

- Radiation sciences and NW qualification in Hostile radiation environments
- Material science/physics
- Electrical circuit and system products/hardware design and delivery
- Circuit analyses and experimentation that must be embedded in the mission organization for successful mission execution
- Independent assessments

An Electrical Sciences Strategic Vision & Mission statement was developed

Advance the science and engineering tools needed to predict and control the generation, transport and interaction of electrical energy in complex engineered systems. Verify that NW systems will operate safely and reliably in electromagnetic environments.

Electrical Sciences resources were distributed across three Centers in the S&T Division

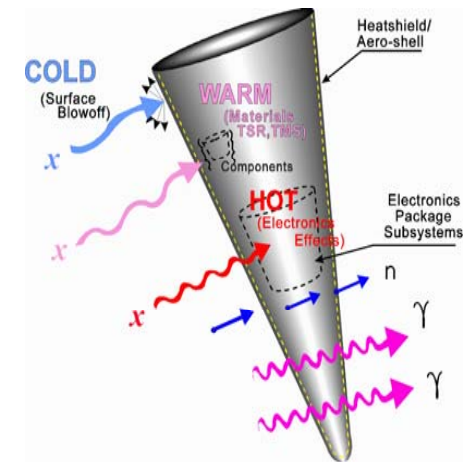


Radiation Effects Science Center was one of several candidate homes for Electrical Sciences

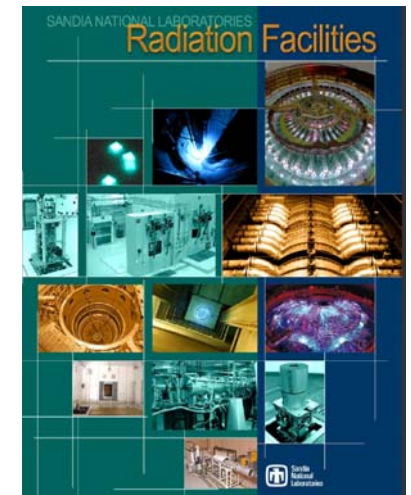


Radiation Effects Sciences (RES) Center mission was to ensure that engineered systems are able to operate as intended in radiation environments

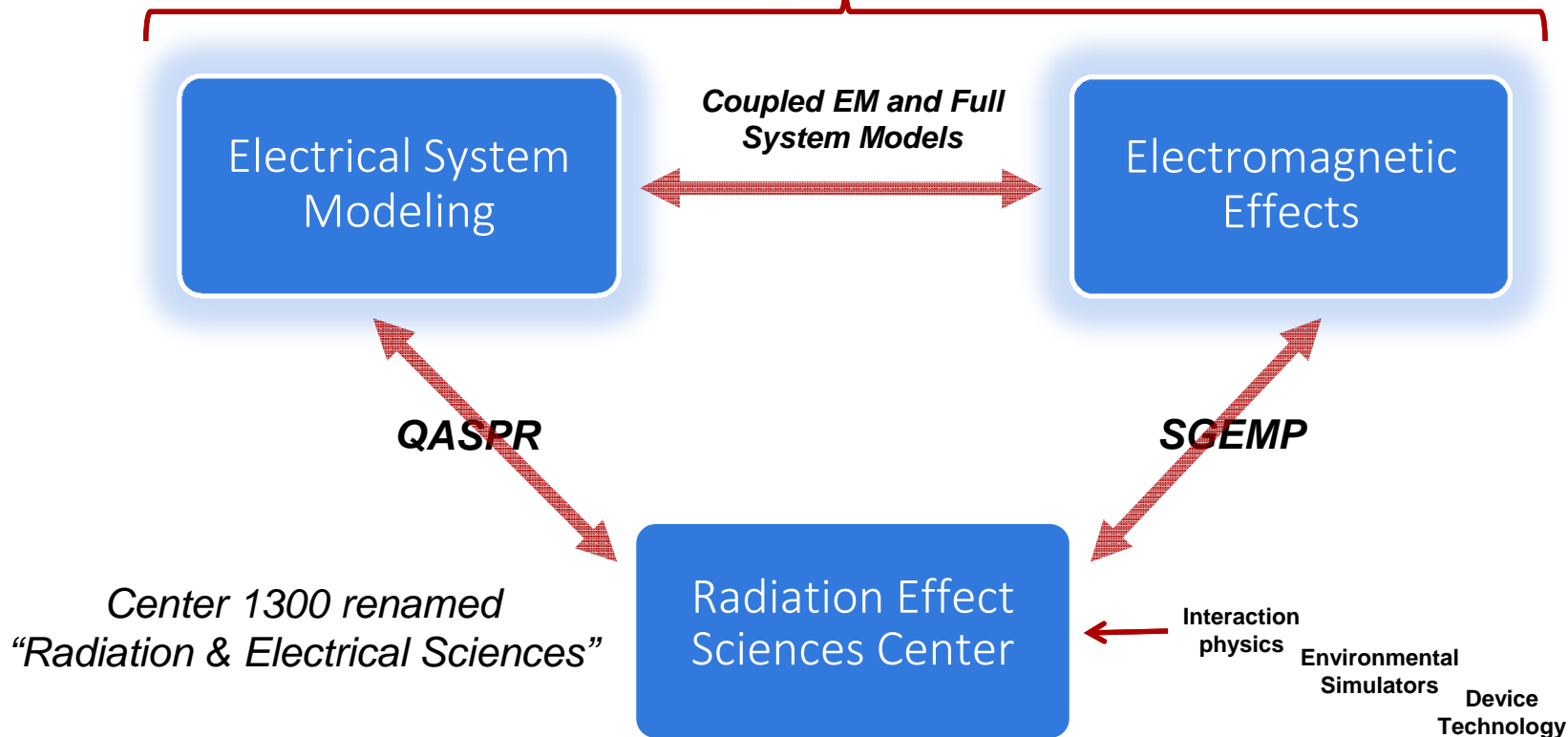
- Develop the scientific understanding and capabilities to certify in the absence of underground nuclear testing
 - QASPR program (Qualification w/o SPR pulsed reactor)
 - SGEMP (hostile rad/electrical response)
- Maintain and operate major radiation environment simulators
- Support development of radiation resistant technologies
- Assess the performance of the stockpile
- NW Qualification in radiation environments



Hermes III
Saturn
Sphinx
ACRR
GIF



EM/Circuit Sciences were consolidated into the RES Center in May 2013 for several compelling reasons



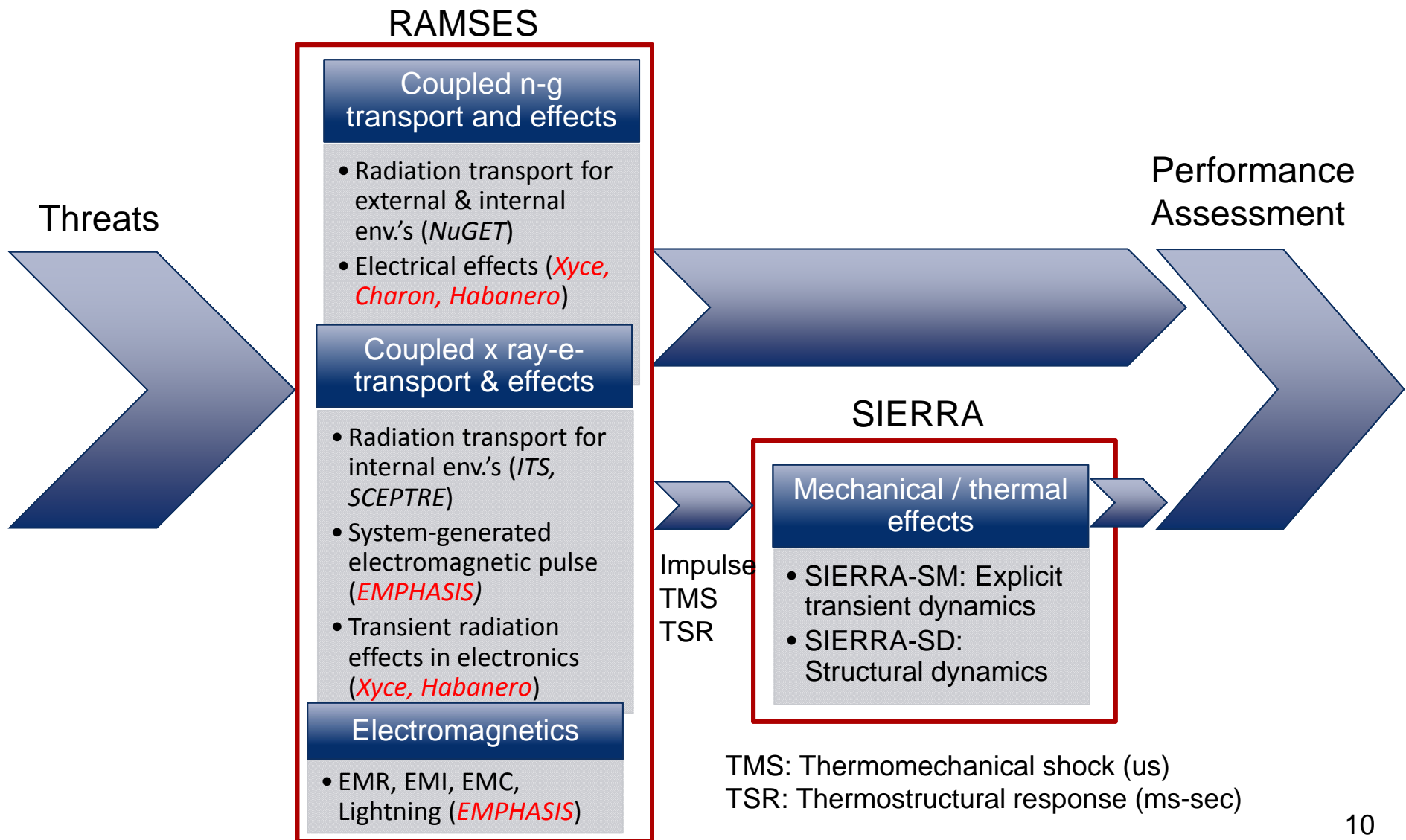
The consolidation drew in key elements of circuit sciences that were previously distributed, strengthened bonds between RES and EM/Circuits and linked EM and Circuits

The ES consolidation colocates responsibility for half the NW Stockpile-to-Target-Sequence environments

Environment	EM / Electrical	Radiation	Thermal	Mechanical
	<div>1300</div> <div>←→</div>		<div>1500</div> <div>←→</div>	
Normal	EMR ESD Nearby Lightning DeGauss		Climate	Shock Vibration Acceleration acoustic
Hostile	EMP SREMP SGEMP	IEMP Neutrons Gammas X-rays		Blast Shock
Abnormal	Lightning External Power		Jet-fuel, propellant fire	Shock Crush

Trust

The RAMSES code suite also consolidates into Center 1300, similar to the 1500 model for SIERRA

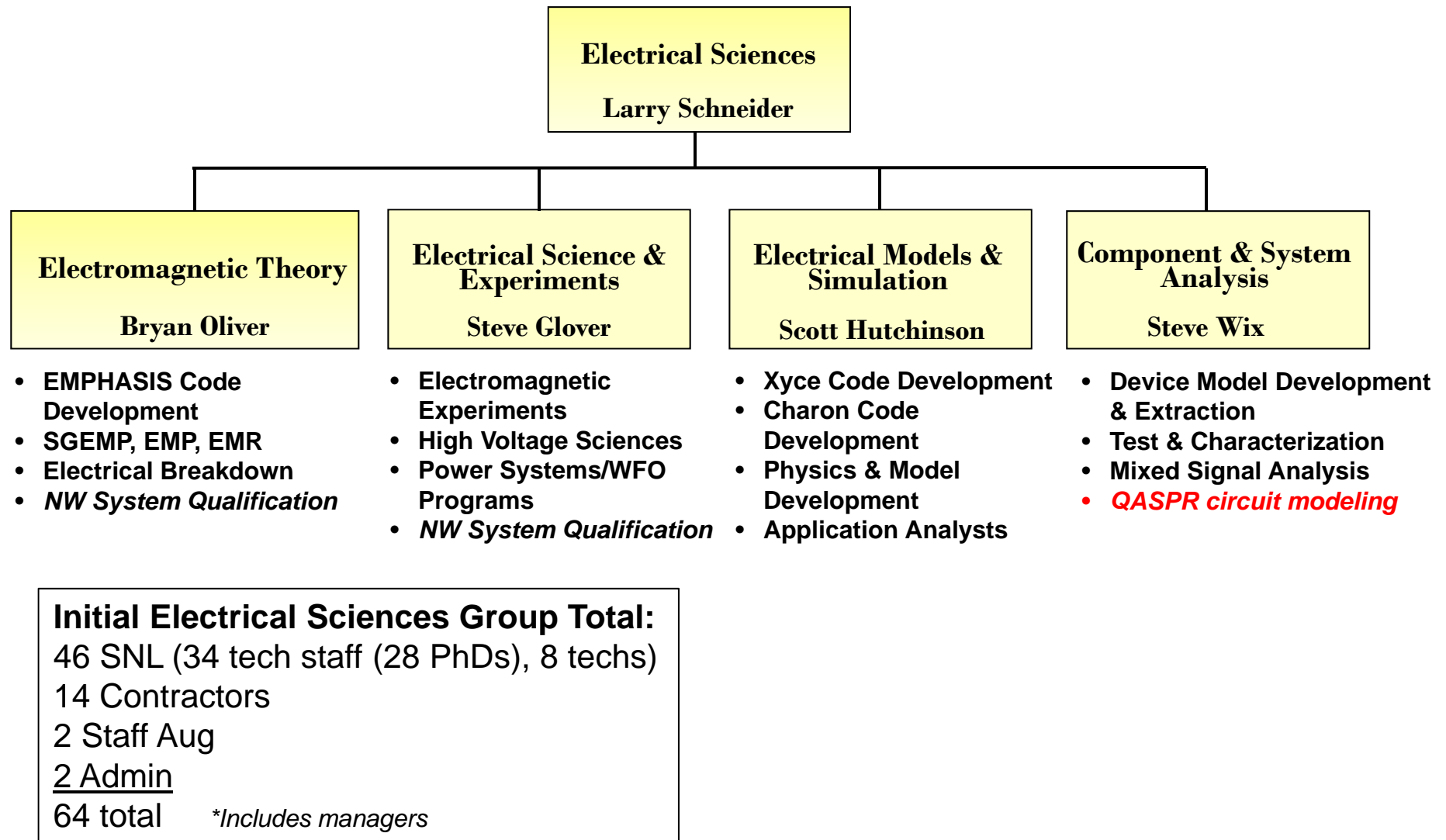


RAMSES consolidation improves integration and development across several areas



- RAMSES supports rad-transport, EM, plasma and circuit effects for Hostile environments *and* Normal and Abnormal electromagnetic environments for design, qualification and surveillance across all stockpile systems
 - Development engages multiple departments outside of Electrical Sciences
 - Impacts hostile environments design for W88 alt 370 , W78 LEP initial studies
 - Impacts electromagnetic environments qualification capability (e.g. W88 alt 370, B61 LEP)
- ES Road Map forward for EMPHASIS, Xyce, Charon, Habanero includes:
 - Supporting new technologies and advanced analysis (*e.g., higher frequency capabilities, RF circuits, III-V devices, new electronic technologies*)
 - Simulation support for higher levels of integration towards system-scale capabilities
 - Usability & Integrated Workflow to expand user community

The initial ES structure sets a solid foundation



Electrical Sciences core technical areas

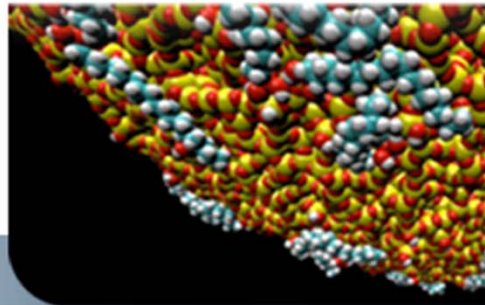
- **Linear electromagnetics**
 - Modeling, simulation & analysis of EM coupling and interactions in complex geometries supporting design, qualification and surveillance in normal, abnormal and hostile electromagnetic environments
- **Plasma physics**
 - Electromagnetic kinetic (monte-carlo and particle-in-cell) modeling and simulation of pulsed power; SGEMP, gas and vacuum discharge physics supporting NW design, experiments, and qualification
- **High voltage sciences**
 - Physics of high voltage electrical breakdown, Lightning burn/blast through, electrostatic discharge supporting design, qualification and surveillance in normal and abnormal environments
- **Circuit and device simulation, device model development**
 - Analog, digital and RF circuit simulation as well as TCAD device simulation supporting NW electrical systems design, surveillance and qualification
 - Physics based device models development (coupled environments, aging), device model extraction, V&V and calibration supporting full lifecycle NW electrical systems
- **Power systems and electronics**
 - Modeling, simulation of power systems/microgrids and advanced control and optimization, power electronics, development of advanced solid-state switching for ECIS and WFO programs

Electrical Sciences supports and is reviewed under three Science and Engineering Foundations

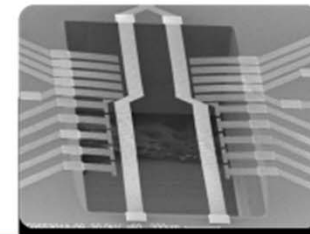
Computing and information science



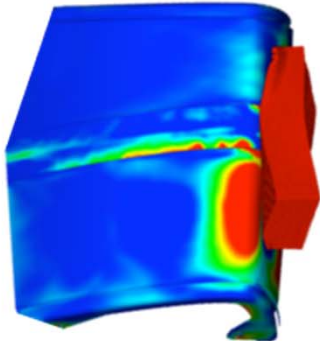
Materials science



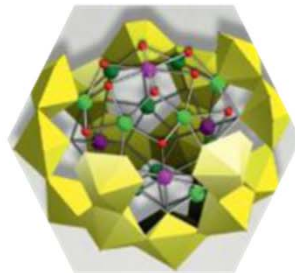
Nanodevices and microsystems



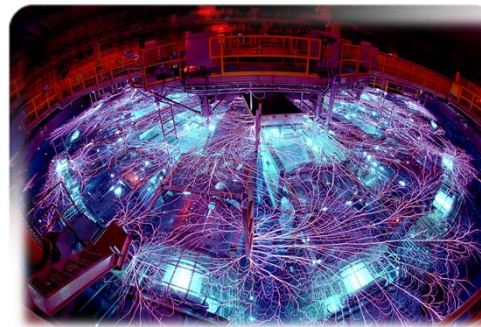
Engineering sciences



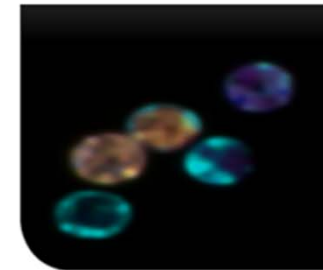
Geoscience



Radiation effects and high- energy density science



Bioscience



Consolidation status

- **Staff transitions and acquisition of colocated office and lab space went smoothly thanks to buy in across impacted Centers***
- **Progress has occurred in virtually all the areas of concern**
 - QASPR circuit modeling consolidating into ES, new staff hired (*more analysts*)
 - SGEMP program management transferred to ES, new staff hired (*responsiveness & integration*)
 - Xyce/Charon development consolidated into ES (*dispersed capabilities*)
 - Improving support for code workflow including (*code use by customers*):
 - Integration with commercial tools
 - Model management and interfaces
 - Data management & archiving
 - Interface with DART workbench
 - Full system electrical modeling roadmap completed (*enable full systems analysis*)
 - Integrating experimental and computational support of EMP effects on circuits under DTRA/NNSA MOU (*EM effects on circuits*)

*Radiation Effects Sciences, Pulsed Power Sciences, Microsystems S&T, Computing Research

Consolidation status (cont.)

- **Although there have been some challenges, NW community support has been strong and other opportunities arose**
 - Consolidated computing/software development support in two Centers into ES (*opportunity to integrate/work more effectively*)
 - Securing funds for new EM test capability (high fidelity *GTEM cell for EMR/EMP*)
 - NW component work/data analysis walk-in work (*experimental capability*)
 - Bandwidth to reach out to NW (*improve integration with NW/responsiveness*)
- **Three new technical staff added, five additional pending this FY, DMTS promotion for Eric Keiter (Xyce Technical Lead)**
- **Future focus will center on:**
 - Expanded support to QASPR program
 - Code Workflow and code use by customers
 - Action on full system modeling roadmap
 - Expand experimental capabilities
 - Qualification of W88 alt 370 & B61 LEP
 - Support to other non-NW mission customers



All-in-all, a surprisingly good start