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SDRD Metrics and Success Indicators: Holistic View from Above

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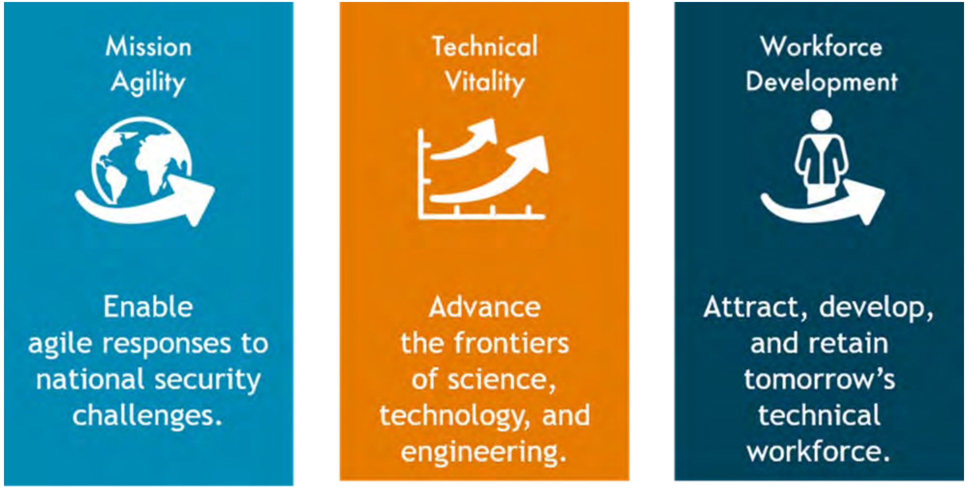
Assessing Impact and Return on Investment

Our main objectives are foundational tenets with outcomes we hope to achieve



qualitative ⟷ quantitative

Long-term success stories demonstrate that investments in both Technical Vitality and Workforce Development provide the foundation for our agile responses to national security challenges

Amenable to both short- and long-term numerical metrics and both short- and long-term success stories

Highly amenable to numerical, short-term metrics and quick-turnaround project highlights; indicative of the activating power of technical achievements

Background and Motivation for Measuring SDRD Results

- SDRD as part of the NNSA LDRD group we follow DOE O413.2c and NNSA Roles, Responsibilities and Guidance (the RRG document)

- NNSA RRG for the NNSA Laboratories (2.4.11):
  - Maintain a set of short- and long-term performance indicators for evaluating the success of LDRD projects and to inform planning activities at the Laboratory

- Over the past decade Dept. of Energy LDRD has been the subject of number of Congressional reviews and assessments
  - The May 2017 DOE ASCAC review was particularly important and relevant:

"U.S. Department of Energy Advanced Scientific Computing Advisory (ASCAC) Committee Subcommittee on LDRD Review recommendation:

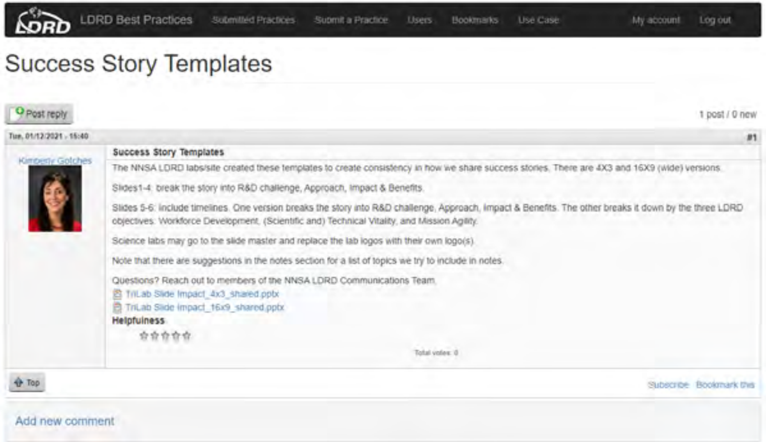
Document and highlight the longer-term (>5 year) impact of LDRD as a national asset. For example, a consistent process to track and understand the impact of projects so that it is clear which LDRD projects led to subsequent beneficial activities"

Other useful background information

- "Review of Best Practices for Assessing Science and Technology Performance," by Terry Land with Tri-Lab ST&E Metrics WG (June 2019, LLNL-AR-773577)
- Findings validated in subsequent discussions

  --June Yu, Executive Director, National Laboratories Programs, UC Office of the President

  --LLNL Workshop, "Getting Innovation Right in the Strategy for Long-Term Competition" 16-17 April



LDRD best practices website
https://bestldrd.labworks.org/

The NNSA labs and NNSS agreed on a set of consistent metrics (while also continuing to collect their own institution-specific metrics)

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At the NNSS our SDRD program keeps track of many metrics/performance indicators; both quantitative and qualitative

- Standard metrics as agreed upon with NNSA
- Enhanced institutional capabilities
- New scientific and technical knowledge
- New IP
- New products
- New customers
- New programs
- Follow on proposals
- Follow on funding

- Technology adopted by programs
- Long-term impacts (success stories)
- Cost avoidance
- Risk reduction
- Technology transfer
- Recruitment and retention
- Career development
- Awards (internal, and external such as NNSA, PECASE, RD100)

It's a balancing act!

SDRD strives to provide technology to programs as quickly as possible

- Approximately 1 in 3 SDRD projects produces technology that is subsequently adopted by a direct NNSS program
- SDRD strives to provide new technologies to key programmatic efforts as quickly as possible; one of our biggest success stories was the fast-TRL-track MPDV
- Centers of Excellence and strategic plans emphasize meeting forward-looking needs integrated with achieving long-term goals

SDRD Program Performance Metrics

	FY16	FY17	FY18	FY19	FY20
Number of projects	27	30	28	28	29
Invention disclosures	5	4	2	4	2
	19%	13%	7%	14%	7%
Patents	3	4	2	--	2
Technology adopted by programs	10	8	9	11	9
	37%	27%	32%	39%	32%

Publications increased significantly in FY20 and engagement of postdocs and interns is growing

- Researchers continue to address technology gaps at a high percentage
- A smaller but healthy percentage of projects are helping grow NNSS expertise in new areas
- Publications increased by a factor of 2.4, from 10 in FY19 to 24 in FY20
- The NNSS Technology Needs Assessment describes gaps in and challenges facing mission areas, and the Broad Site Announcement contains detailed information on strategic initiatives keyed to the Centers of Excellence vision; both guide proposers

SDRD Program Performance Metrics

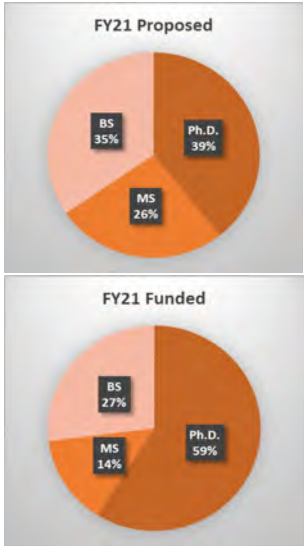
	FY16	FY17	FY18	FY19	FY20
Number of projects	27	30	28	28	29
Gap or need addressed*	10	13	11	14	12
	37%	43%	39%	50%	41%
"Emerging Area & Special Opportunity" effort*	3	5	6	3	6
	11%	17%	21%	11%	21%
Postdocs	2	1	2	2	2
Journal Publications	7	8	8	10	24

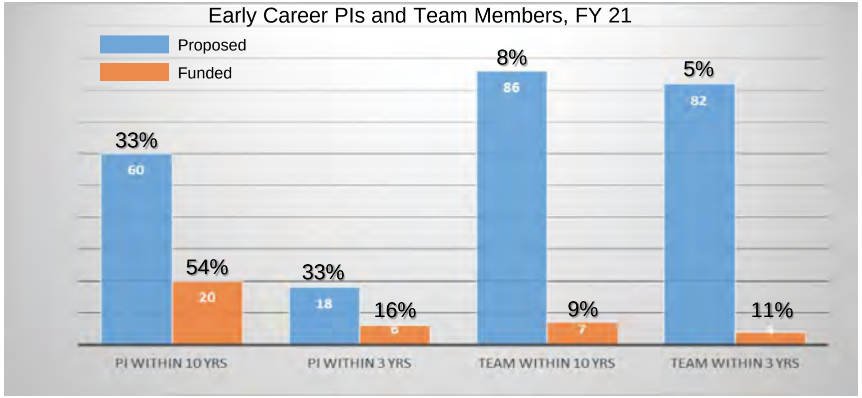
* per NNSS Technology Needs Assessment

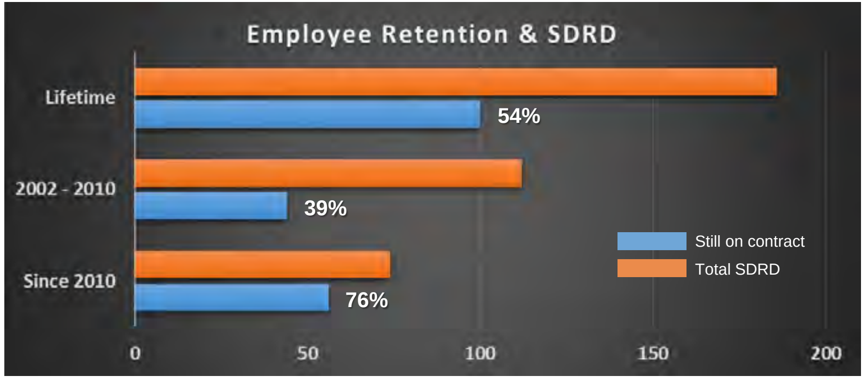
The SDRD program attracts early career scientists and engineers and is a factor in workforce retention

- Early career staff find a home in SDRD
- Research teams led by early career PIs contain an increasing number of early career members
- Marylesa Howard received a PECASE award in 2019
- The SDRD program welcomed its first postdoctoral PI in 2015, attracting eight postdocs and interns since
- Six postdocs or interns have converted to full-time staff
- 76% of PIs who had funded SDRD since 2010 are still with the company

PIs by Degree, FY21







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Multiplexed Photonic Doppler Velocimetry (MPDV) Stockpile Stewardship Paradigm Shift

SDRD SITE-DIRECTED RESEARCH & DEVELOPMENT

R&D CHALLENGE

A better, faster, and more economical way of diagnosing nuclear weapon performance and avoid underground testing

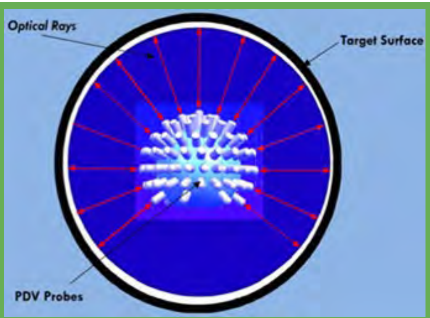
Historical testing utilized electrical pins with very limited data. A 21st century approach was lacking for modern stockpile diagnostic to verify and validate high performance computing codes.

APPROACH

Utilize SDRD innovations in photonic Doppler velocimetry and optical "domes" for unprecedented data fidelity

Fiber optic domes combined with ability to multiplex large numbers of velocimetry data channels using photonic Doppler velocimetry

IMPACT & BENEFIT



A new paradigm for nuclear weapon performance certification at much lower cost and circumventing the need for underground nuclear testing

>100,000x increase in data, 100x less expensive and most important data yet obtained to validate nuclear weapon codes and performance. We can now achieve more information in one shot than all previous SCEs combined.

2010 – ***SDRD starts investigating technology concepts***

2011 – ***Proof-of-principle demonstrated for large numbers of channels***

2012 – ***Gen-1 system completed / fielded on qualification shots***

2012 R&D 100 50th ANNIVERSARY

2012 – ***First major SCE (U1a)***

2013 – ***Gen-2 systems developed and proliferating MPDV designs***

2014/2015 – ***BLR springboard off MPDV/ multiple SCEs***

2017 – ***MPDV systems fielded at LANL DARHT and other sites***

2019 – ***New SCEs and future planned beyond***

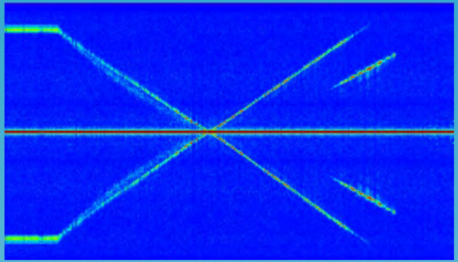
SDRD (2010–2012) → ***Programmatic*** (2012 onward)

Broadband Laser Ranging (BLR)
The Next Level of Dynamic Material Diagnostics

R&D CHALLENGE

Traditional velocimetry that is routinely implemented in shock physics experiments does not always return a reliable position of a moving surface.

APPROACH



A repetitive broadband laser pulse reflected off a surface is interfered with a reference, giving an interferometric measure of position as a function of time.

IMPACT & BENEFIT

This new diagnostic is integrated alongside traditional velocimetry (MPDV) and has been implemented and fielded at numerous NNSA facilities.

- **Apr. 2014** — *Feasibility study awarded to bench-test a BLR idea*
- **Aug. 2014** — *Dynamic/explosive test of technique*
- **2015** — *Tri-lab plus NNSS BLR team formed*
- **Dec. 2015** — *2-channel BLR fielded on hydrodynamic shot at Site 300*
- **2017** — *Fielded 8 points on Gemini series of subcritical experiments (U1a)*
- **2020** — *Fielded 16 points on Red Sage series of subcritical experiments (U1a)*
- **2020** — *Fielded 16 points on 3687 experiment (DARHT)*
- **2020** — *48-point BLR installed at Site 300*

SDRD (Apr. 2014 – 2015) | ***Programmatic*** (Dec. 2015 – 2020)

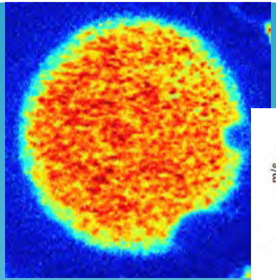
Critical Research Infrastructure Development
Propellant Launcher for Dynamic Material Experiments

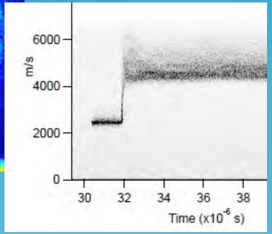
R&D CHALLENGE

Diagnostic development within NNSA slowed by programmatic experiments

NNSA dynamic platforms are dedicated to Stockpile Stewardship science program schedules. Developing diagnostics at these facilities can be difficult given the high priority core mission activities. Diagnostics development can be slowed by this constraint.

APPROACH

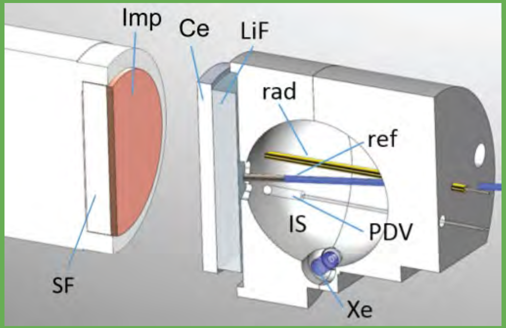




Built a powder gun dedicated to diagnostic development activities

A gun facility allows NNSS scientists to host developmental campaigns with NWL collaborators to rapidly test new design concepts and push diagnostic maturity forward at a high rate.

IMPACT & BENEFIT



Novel pyrometry technique developed / implemented and expanded customer base

The STL powder gun facility has been outfitted with a suite of diagnostics to support and develop new techniques. It is a collaborative research site, with a team skilled at rapidly realizing complex ideas.

2015–16: *SDRD starts 3-yr materials project – gun acquired and assembled*

2016: *Platform commissioned*

2017: *Tin melt boundary mapped with new temperature diagnostic*

2018: *Multi-pulse radiography, high-speed imaging, high-resolution spectroscopy integrated*

2019: *Shallow bubble collapse concept demonstrated in LANL collaboration*

2019–20: *New reflectivity diagnostic used to map cerium EOS*

2020: *New foil sensors validated in double-shock ejecta studies*

2021: *Shot #100*

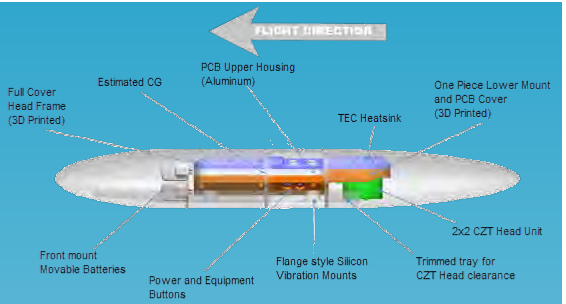
ChemBioRadNucExplosive (CBRNE) SuperDrone Unmanned Aerial Autonomous System

SITE-DIRECTED RESEARCH & DEVELOPMENT

R&D CHALLENGE

Harness UAS for CBRNE detection, environmental monitoring, remote sensing, aerial mapping, and meteorology

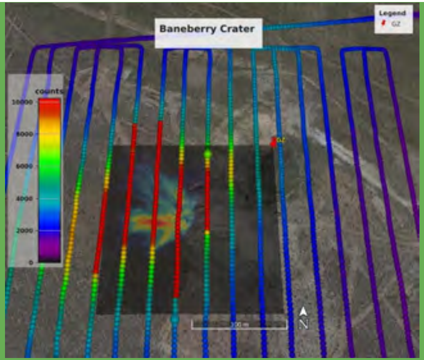
APPROACH



New hybrid heavy lift platforms combined with advanced detectors enables multitude conduct of operations. CRADA with H3D allowed new research and development of critical sensor technology.

2020 R&D 100 FINALIST

IMPACT & BENEFIT



Combined effort has pushed aerial radiation detection and measurement, emergency response, and consequence management into the UAS era

2015	*NNSS strategic initiative to develop UASs as a new capability begins*
2017	*Rotary & fixed wing radiological source detection demonstrations at Desert Rock Airfield (NNSS)*
2017-2018	*Fixed wing chemical & radiological source detection (Montana); rotary UAS chemical & spectroscopic sensors mission (Wisconsin)*
2018	*Fixed wing radiation survey proof of concept at Desert Rock Airfield (NNSS)*
2019	*Sandstorm BVLOS flights at JIFX 19-4 (Camp Roberts)*
2020	*Two BVLOS rotor wing rehearsal flights at JIFX 20-1 (Camp Roberts)*
2020	*Crater survey of Palanquin, Cabriolet, Sedan, and Baneberry (NNSS)*
2021	*GPS-denied tunnel flight (Irvine, CA)*

Summary, Lessons Learned, and Moving Forward

- Working in concert the NNSA LDRD/SDRD programs were able to develop long-term success indicators that had common applicability and utility
  - ***Mission Agility, Workforce Development, and Technical Vitality***
- Numerical metrics and success stories are both useful performance indicators
- Each institution may have a different set of specific preferred metrics that works best for them
- Performance is a moving target especially when it comes to research and development investment!

THANK YOU!

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