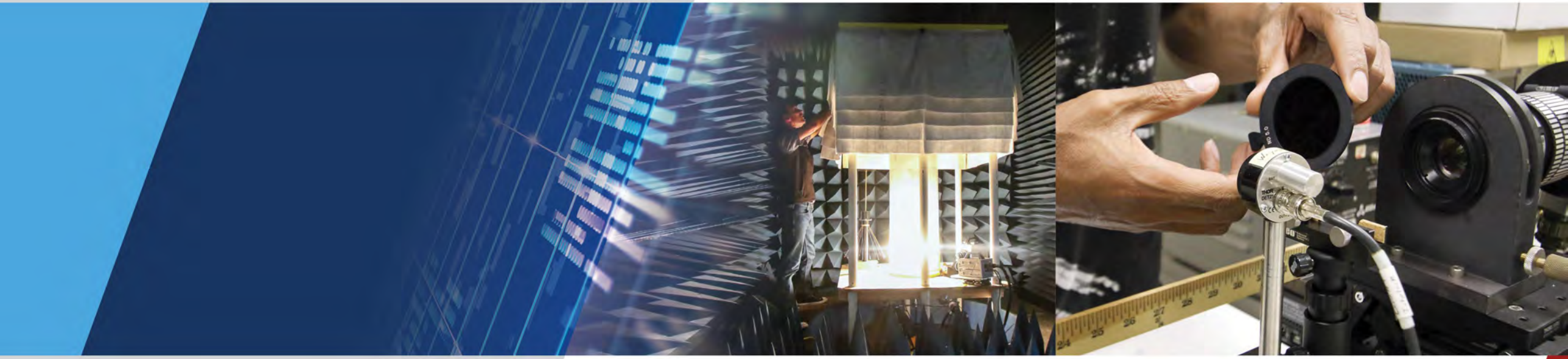
NEVADA NATIONAL NNSS SECURITY SITES

WE SECURE AMERICA'S FUTURE

State of the SDRD Program

February 1, 2024



SDRD SITE-DIRECTED RESEARCH & DEVELOPMENT

Paul Guss

Program Manager

Nevada National Security Sites is managed and operated by MSTS under contract number DE-NA0003624.

This work was done by Mission Support and Test Services, LLC, under Contract No. DE-NA0003624 with the U.S. Department of Energy, the NNSA Office of Defense Programs, and supported by the Site-Directed Research and Development Program. DOE/NV/03624--1868.

SDRD
SITE-DIRECTED RESEARCH & DEVELOPMENT

Introduction

Budget News: 2024 Outlook

Staffing

Return on Investments

Publications

Invention Disclosures

Highlights

NEVADA NATIONAL SECURITY SITES
NNSS
WE SECURE AMERICA'S FUTURE

Site-Directed Research and Development

The Site-Directed Research and Development program is an essential element of the NNSS technical enterprise. The SDRD program has become our premier science and technology venue and primary source for new discovery and innovation for our national security missions; the program has no equal and provides unparalleled return on investment. Leading with an adept vision of the technologies needed for the future, SDRD is uniquely poised to respond to the evolving missions of stockpile stewardship and global security.

SDRD allows us to stay . . .
"ahead of our time by design."

NEVADA NATIONAL SECURITY SITES
WE SECURE AMERICA'S FUTURE

SDRD Realignment into Mission-Focused Thrust Areas is a Focused, Long-Term Technical Investment

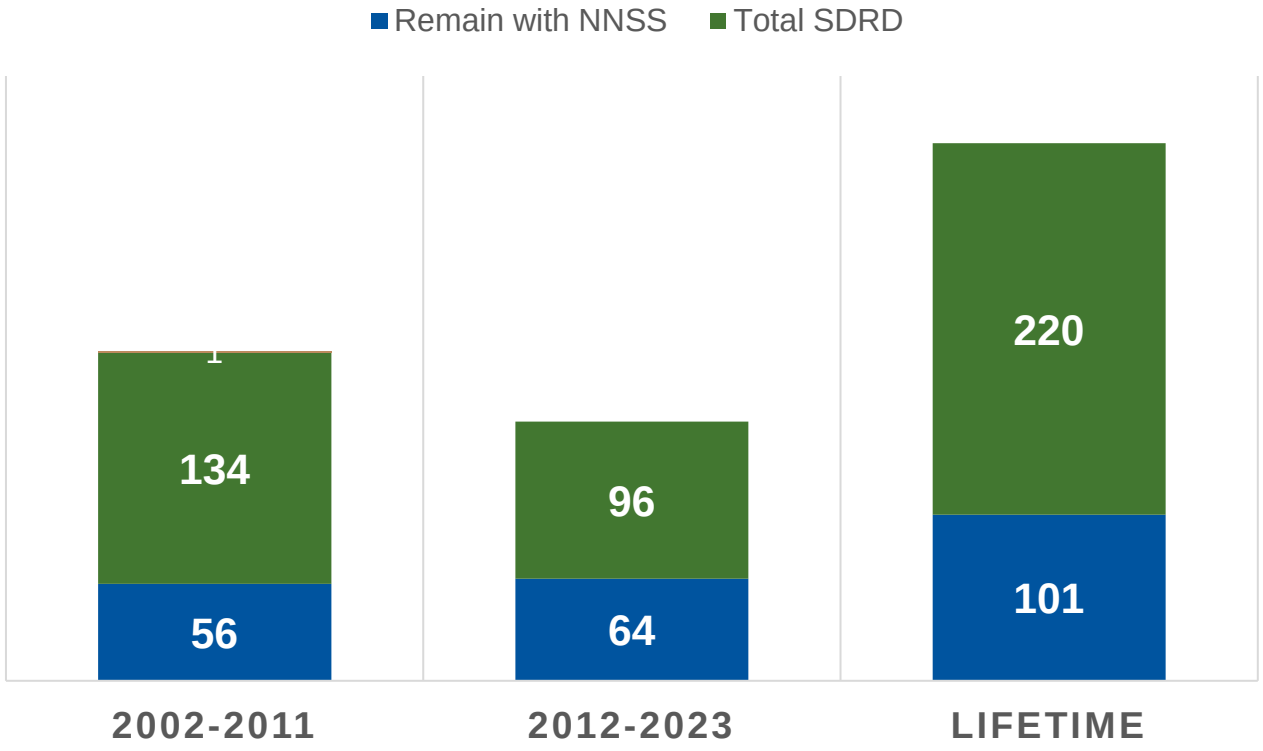
- **Objectives for the STTAs**
  - Strengthen technical capabilities in the near term
  - Enhance readiness of our core competencies in the long term
  - Make us more agile and adaptable to new global threats
- **Strengthen existing and develop new technical capabilities throughout the NNSS in support of future NNSA-10/20/80 missions**
  - Align SDRD investments to better support NNSA missions
  - Focus programmatic R&D efforts with a goal of enhancing or enabling new capabilities
  - Deepen our scientific and engineering benches within these focused areas
- **SDRD Alignment to the STTAs**
  - Focus areas for Exploratory Projects
  - Strategic initiatives

Strategic Response toward NNSS Future Technology Preparedness

SDRD Performance at a Glance

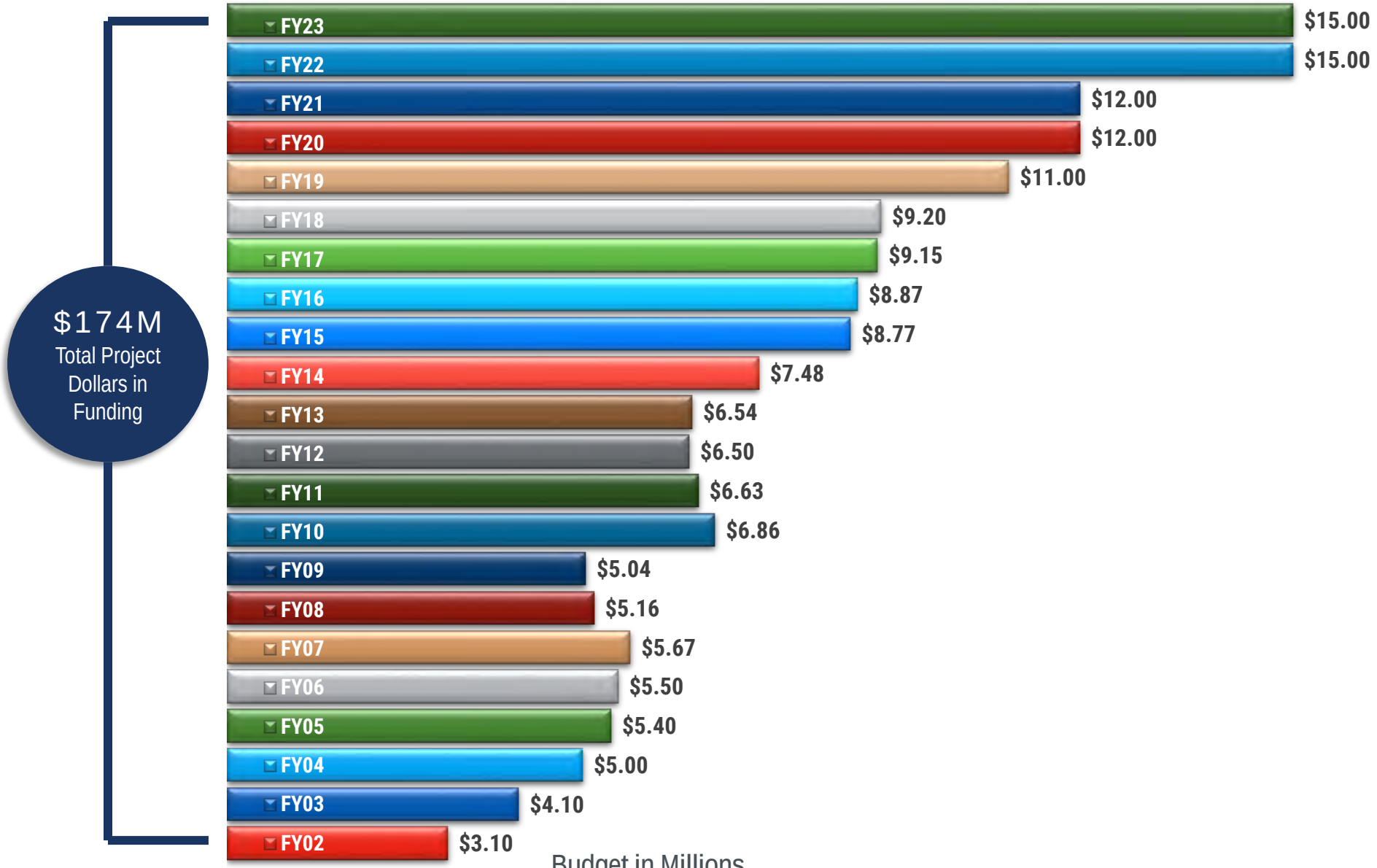
$15M	$290K	47	21
Total Program Cost	Median Project Size	Total SDRD Projects	New Projects in FY23

EMPLOYEE RETENTION



Publications	5
Technologies Adopted by Programs	11
Gaps or Needs Addressed	29
Invention Disclosures and Patents	7
Postdocs	4

SDRD Trends FY 2002–2023



2027
- Total Proposals

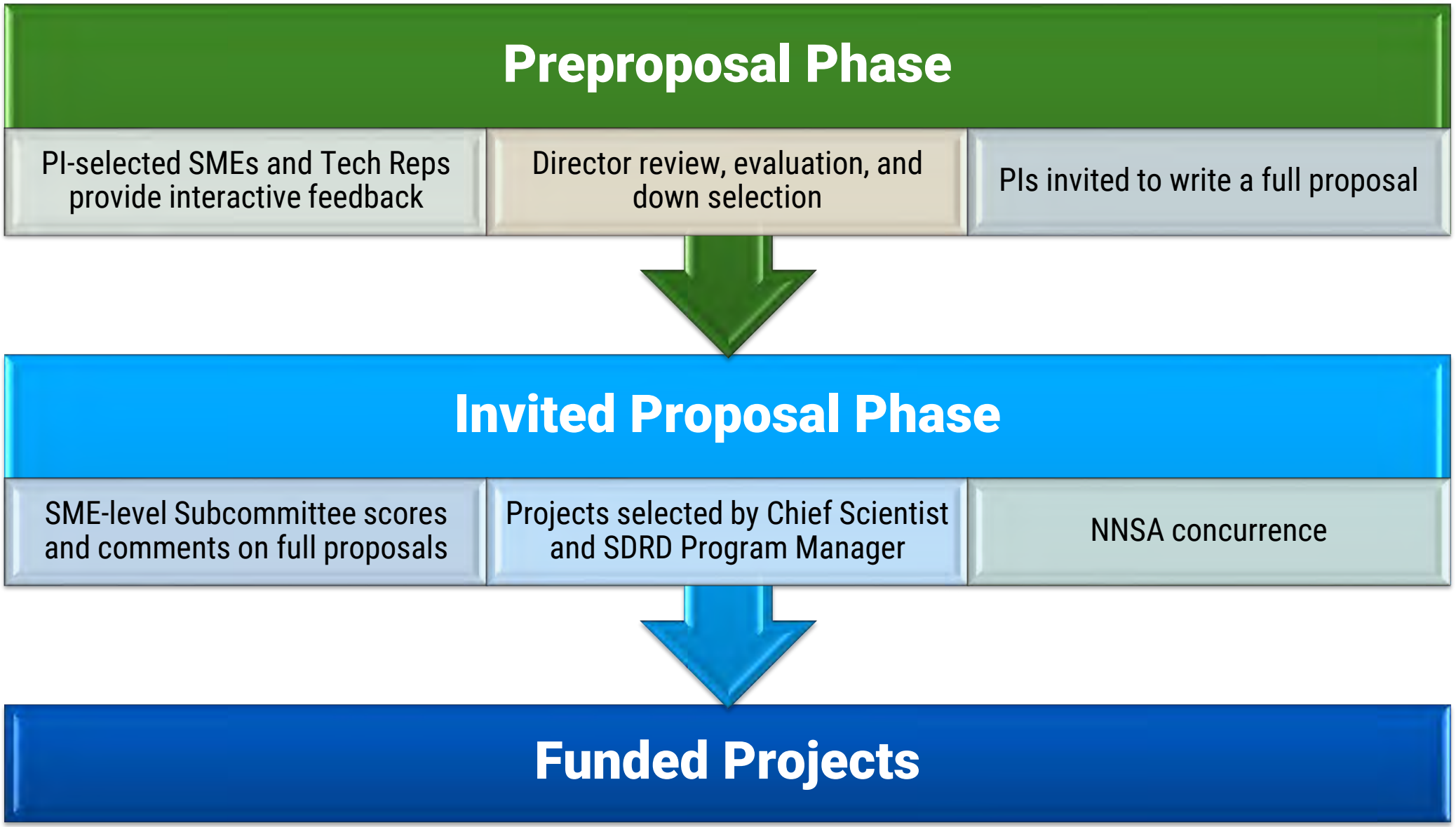
767
- Total Projects

393
- Total principal investigators with projects

314
- Gaps or Needs Addressed

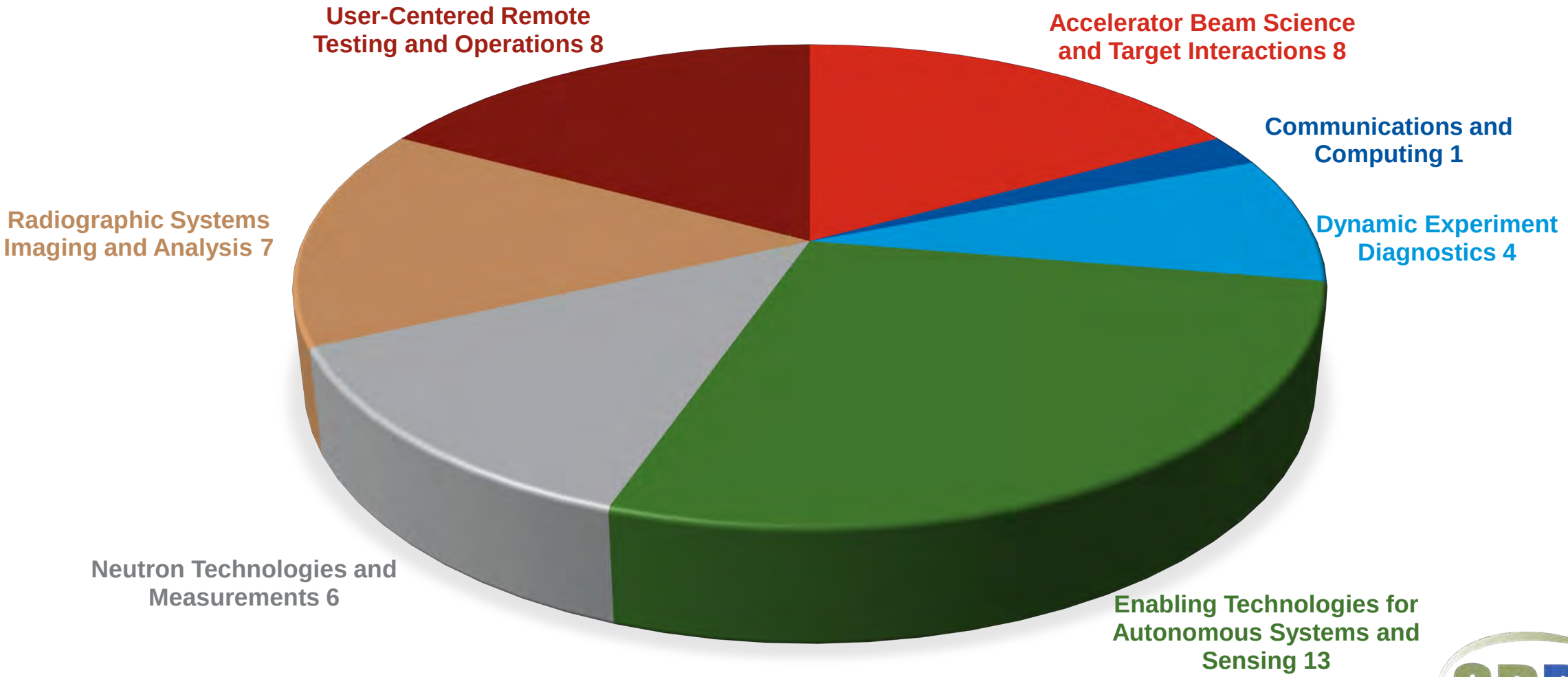
227
- New technologies deployed to programs

SDRD Proposal Process



The SDRD proposal process is informed by NNSS strategic guidance, NNSA mission need, and underwritten by comprehensive peer review.

SDRD FY 2023


User-Centered Remote Testing and Operations 8
Accelerator Beam Science and Target Interactions 8
Communications and Computing 1
Dynamic Experiment Diagnostics 4
Radiographic Systems Imaging and Analysis 7
Neutron Technologies and Measurements 6
Enabling Technologies for Autonomous Systems and Sensing 13

SDRD Performance Metrics
FY 2018 to FY 2024

SDRD Program Performance Metrics: FY 2018 to FY 2024

Metric	FY18	FY19	FY20	FY21	FY22	FY23	FY24*
Number of Projects	28	28	29	39	54	47	**33**
Records of Invention	2	4	4	3	0	6	**0**
	7%	14%	14%	8%	0%	11%	**0%**
Patents	2	—	—	1	2	1	**0**
Technology Adopted by Programs	9	11	9	13	9	11	**11**
	32%	39%	31%	33%	16.7%	23%	**33%**
Gap or Need Addressed	11	14	12	18	27	31	**29**
	39%	50%	41%	46%	50%	66%	**88%**
Emerging Area and Special Opportunity	6	3	6	18	11	10	**9**
	21%	39%	21%	46%	20.4%	21%	**27%**
Postdocs	2	2	2	12	4	4	**1**
Journal Publications	8	10	24	21	16	5	**6**

SDRD
SITE-DIRECTED RESEARCH & DEVELOPMENT

Introduction

Budget News: 2024 Outlook

Staffing

Return on Investments

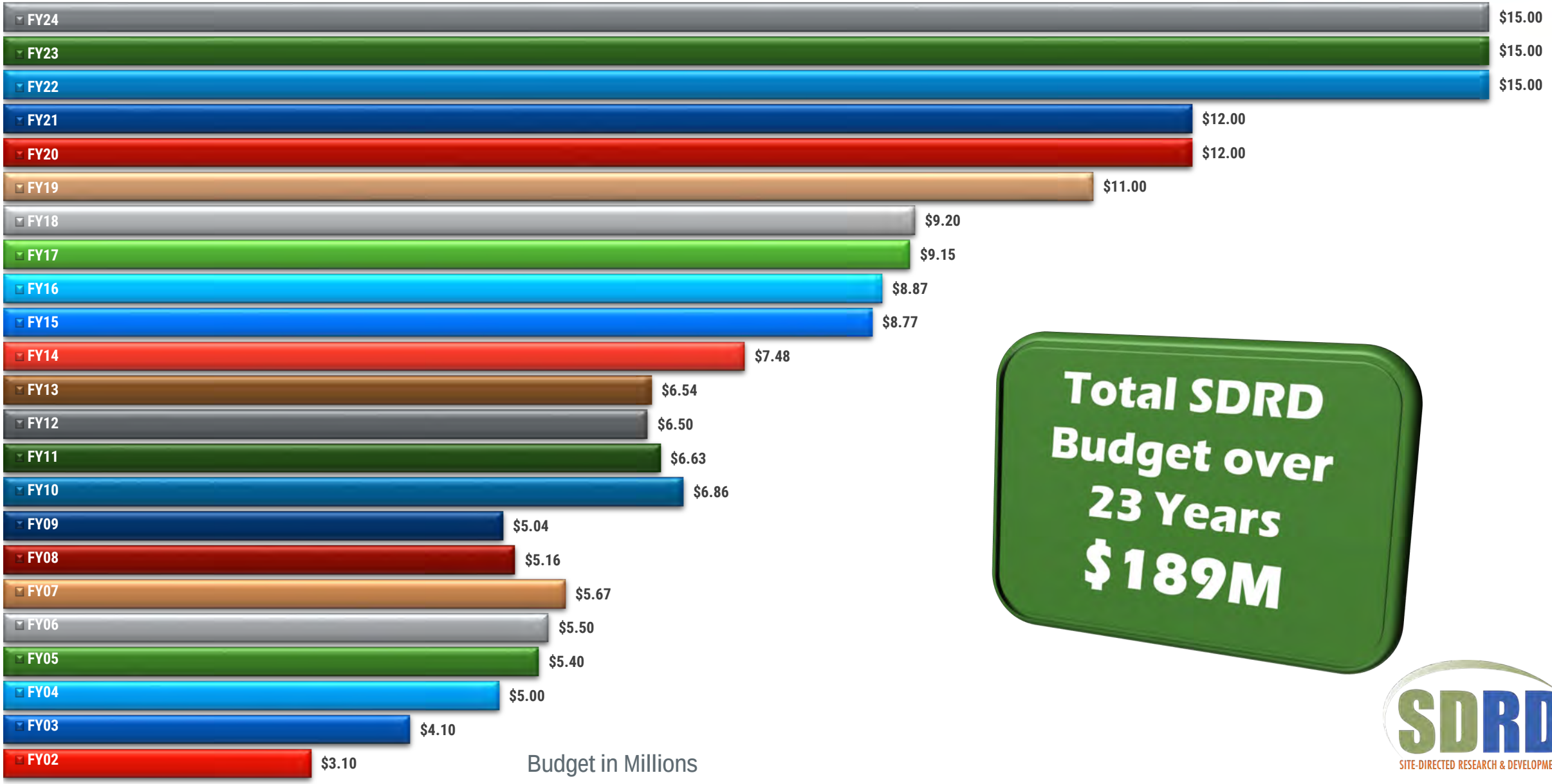
Publications

Invention Disclosures

Highlights

NEVADA NATIONAL
NNSS
SECURITY SITES
WE SECURE
AMERICA'S FUTURE

SDRD Annual Budget



Total SDRD Budget over 23 Years $189M

Science and Technology Updates

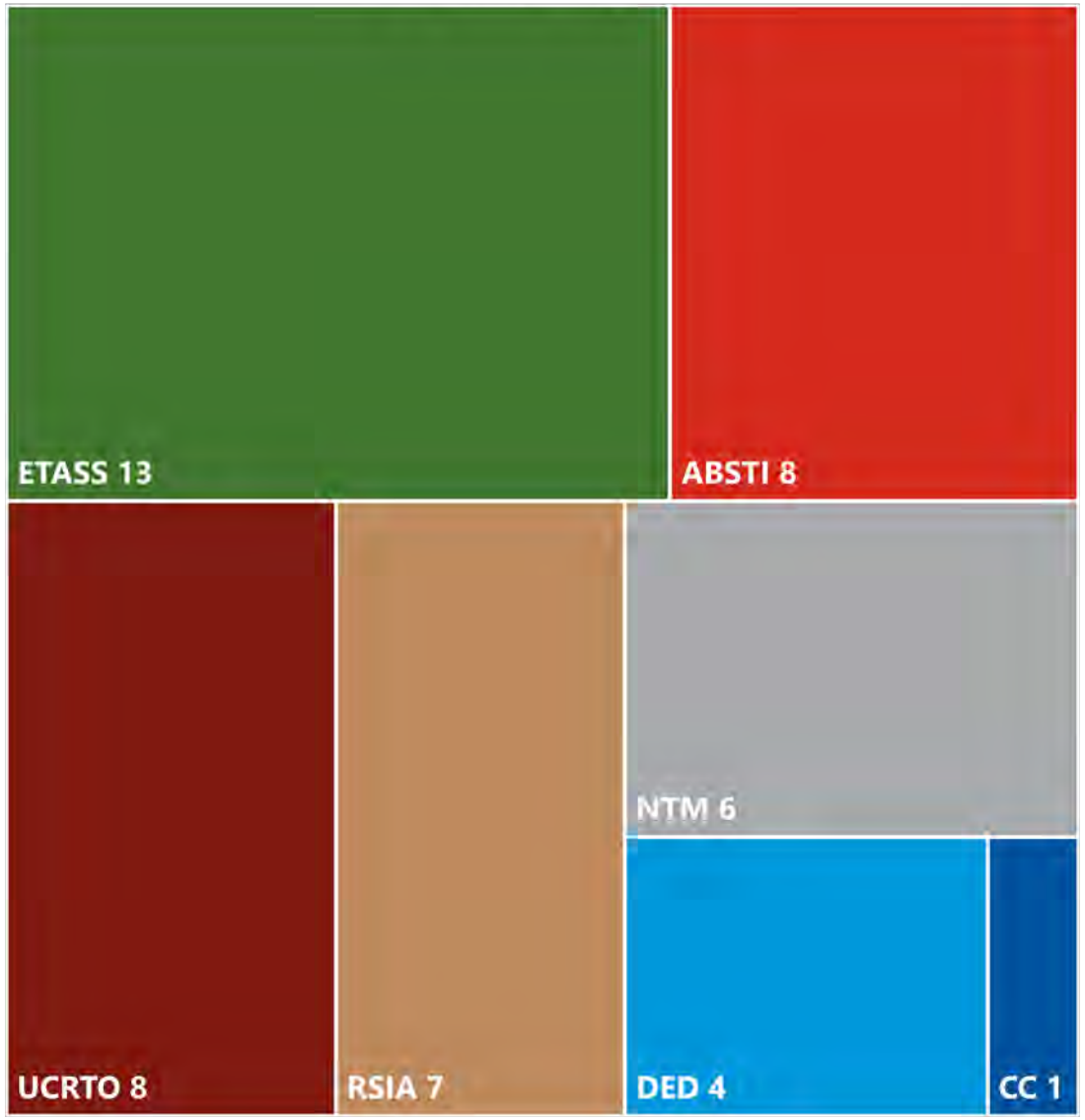
- SDRD Annual Program Review September 26–28
- SDRD Overview- FY23 vs. FY24
  - Same total budget: $15M
    - Reinstated Strategic Initiatives
    - New Continuing Project Review Process
    - Monthly Phase Gate Reviews for Feasibility Studies

SDRD Projects	FY23	FY24	FY23	FY24
Exploratory Research	**39**	**32**	**$11,980K**	**$10,768K**
Feasibility Studies	**2**	**0**	**$328K**	**$0**
Mid-Year Feasibility Studies	**6**	N/A	**$682K**	N/A
Strategic Initiatives	**0**	**1**	**$0**	**$1,401K**

Projects by STTA	Exploratory Research		Feasibility Studies		Strategic Initiatives	
Science and Technology Thrust Area	**FY23**	**FY24**	**FY23**	**FY24**	**FY23**	**FY24**
Accelerator Beam Science and Target Interactions	6	2	2	N/A	0	1
Communications and Computing	1	1	0	N/A	0	0
Dynamic Experiment Diagnostics	4	4	0	N/A	0	0
Enabling Technologies for Autonomous Systems and Sensing	12	10	1	N/A	0	0
Neutron Technologies and Measurements	6	4	0	N/A	0	0
Radiographic Systems Imaging and Analysis	7	5	0	N/A	0	0
User-Centered Remote Testing and Operations	5	6	3	N/A	0	0

SDRD Projects by STTA

FY 2023 Projects



Science and Technology Thrust Areas (STTAs)

Accelerator Beam Science and Target Interactions (ABSTI)

Communications and Computing (C&C)

Dynamic Experiment Diagnostics (DED)

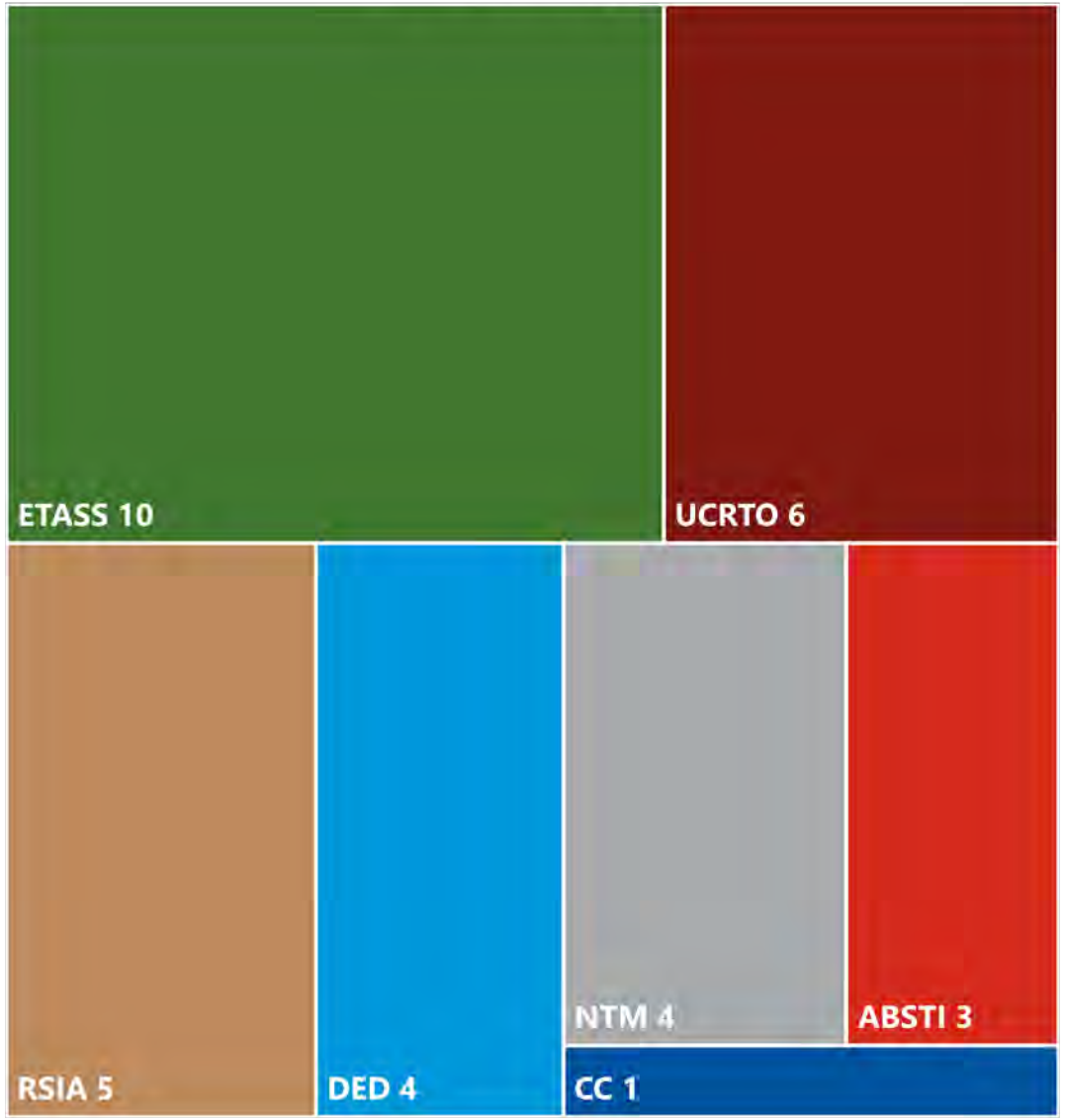
Enabling Technologies for Autonomous Systems and Sensing (ETASS)

Neutron Technologies and Measurements (NTM)

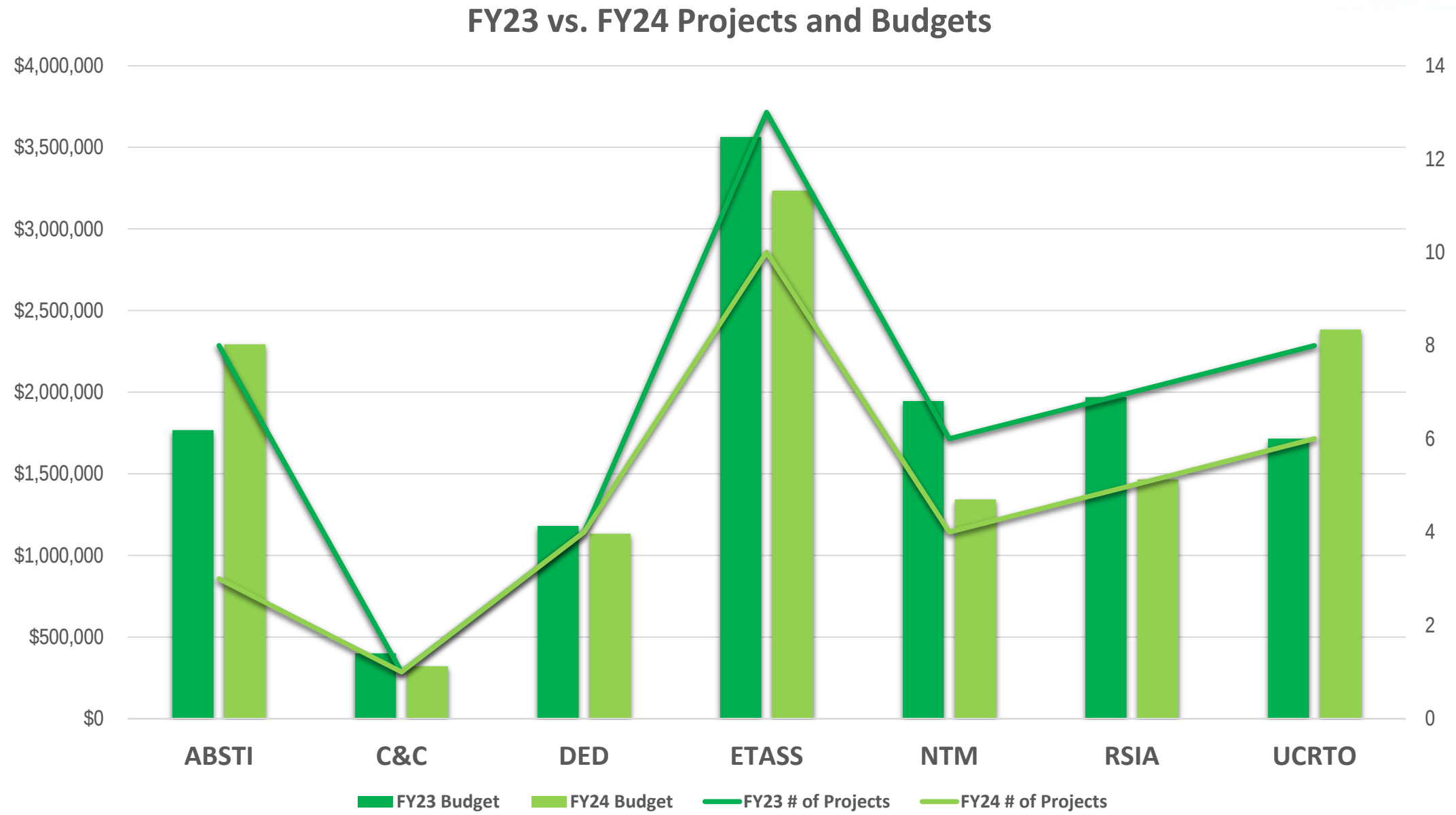
Radiographic Systems Imaging and Analysis (RSIA)

User-Centered Remote Testing Operations (UCRTO)

FY 2024 Projects



SDRD Project Summary by STTA



Science and Technology Thrust Areas (STTAs)

Accelerator Beam Science and Target Interactions (ABSTI)

Communications and Computing (C&C)

Dynamic Experiment Diagnostics (DED)

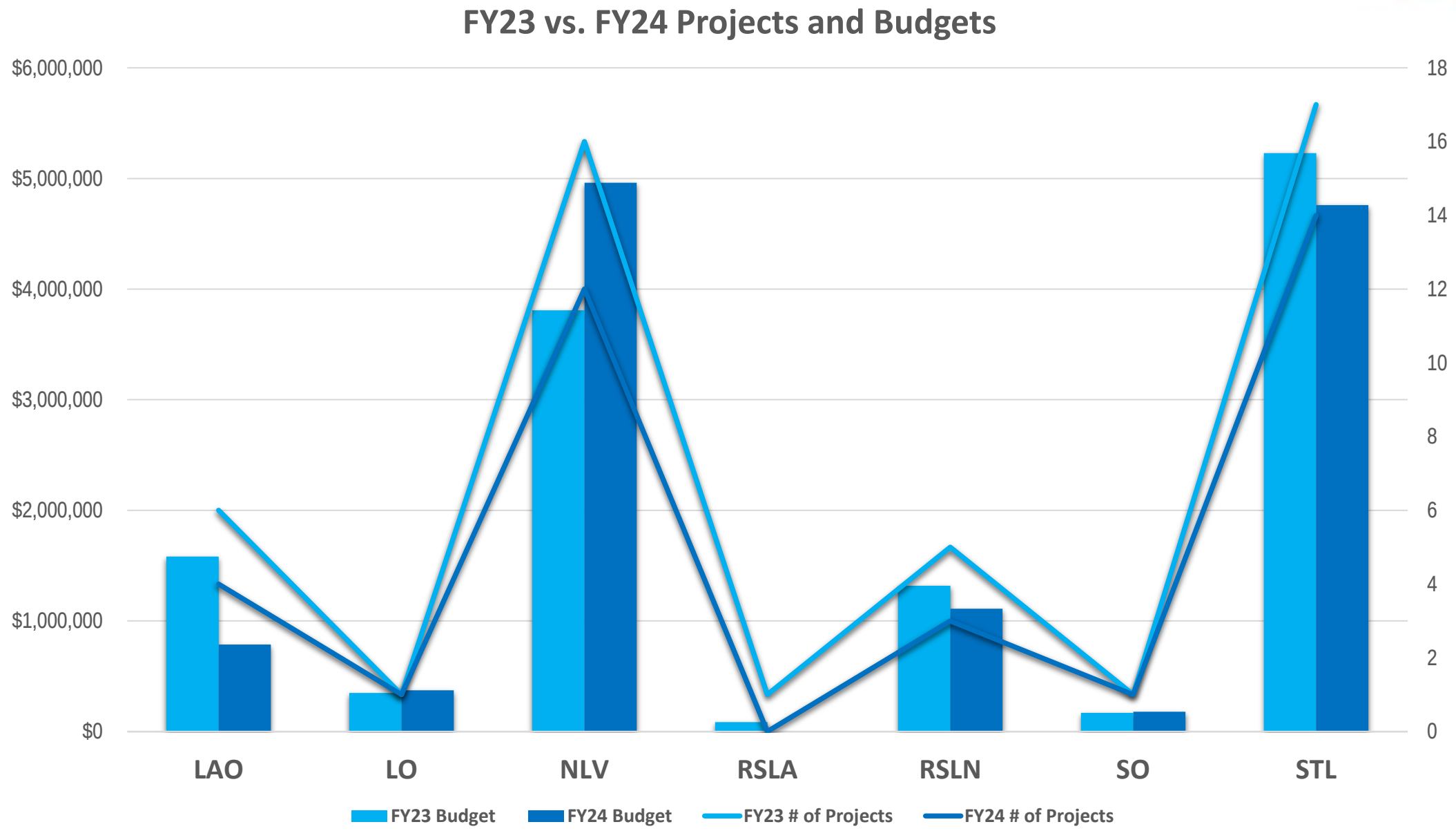
Enabling Technologies for Autonomous Systems and Sensing (ETASS)

Neutron Technologies and Measurements (NTM)

Radiographic Systems Imaging and Analysis (RSIA)

User-Centered Remote Testing Operations (UCRTO)

SDRD Project Summary by Location



Locations

Los Alamos Operations (LAO)

Livermore Operations (LO)

North Las Vegas (NLV)

Remote Sensing Laboratory, Nellis (RSLN)

Remote Sensing Laboratory, Andrews (RSLA)

Sandia Operations (SO)

Special Technologies Laboratory (STL)

SDRD
SITE-DIRECTED RESEARCH & DEVELOPMENT

Introduction

Budget News: 2024 Outlook

Staffing

Return on Investments

Publications

Invention Disclosures

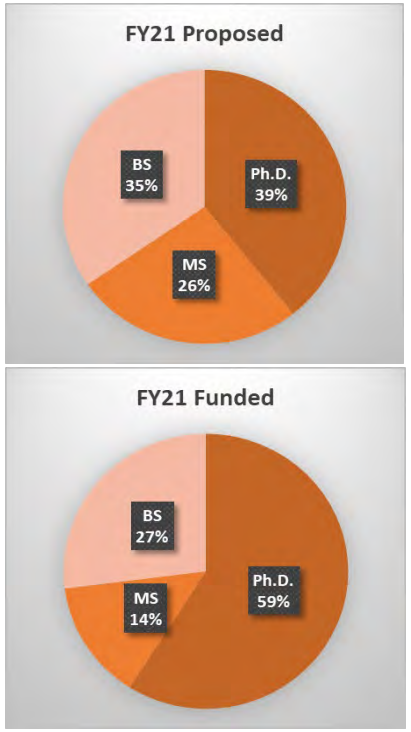
Highlights

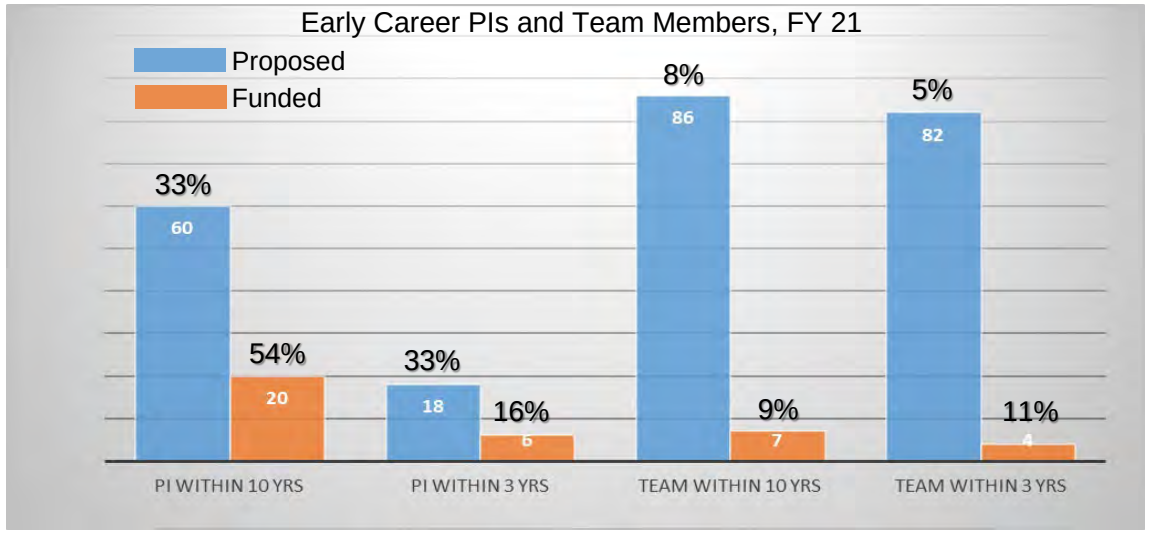
NEVADA NATIONAL
NNSS
SECURITY SITES
WE SECURE
AMERICA'S FUTURE

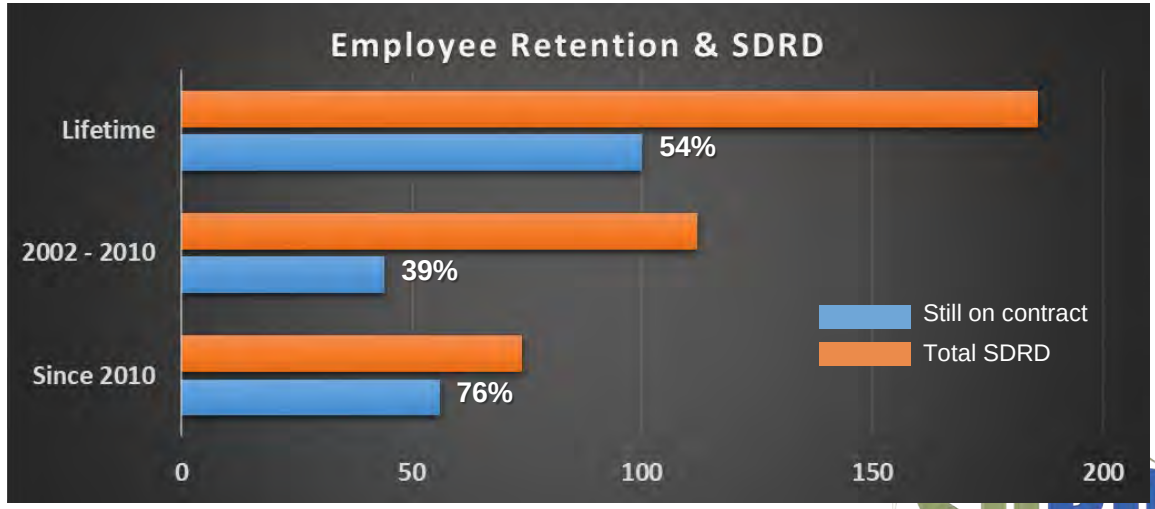
The SDRD Program Attracts Early Career Scientists and Engineers and Is a Factor in Workforce Retention

- 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







SDRD
SITE-DIRECTED RESEARCH & DEVELOPMENT

Introduction

Budget News: 2024 Outlook

Staffing

Return on Investments

Publications

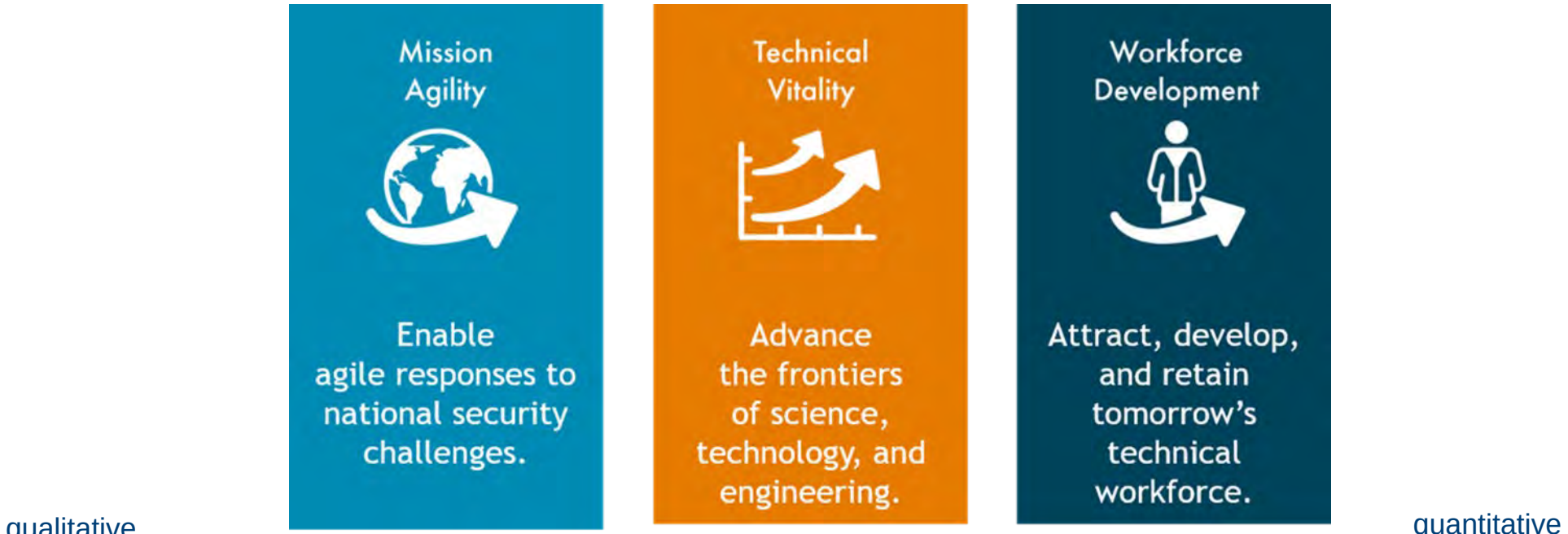
Invention Disclosures

Highlights

NEVADA NATIONAL
NNSS
SECURITY SITES
WE SECURE
AMERICA'S FUTURE

Assessing Impact and Return on Investment

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

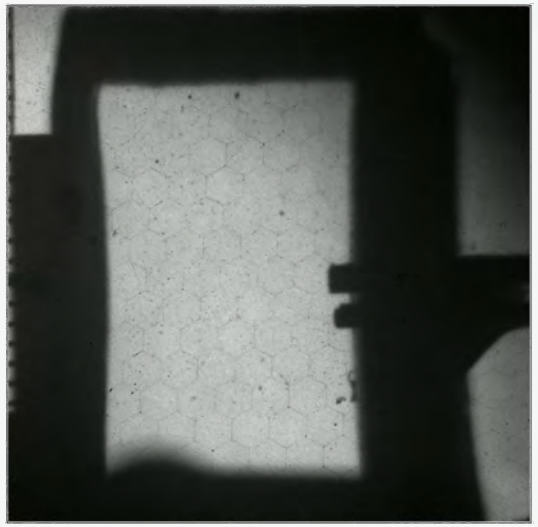


Long-term success stories demonstrate that investments in both Technical Vitality and Workforce Development provide the foundation for our agile responses to national security challenges

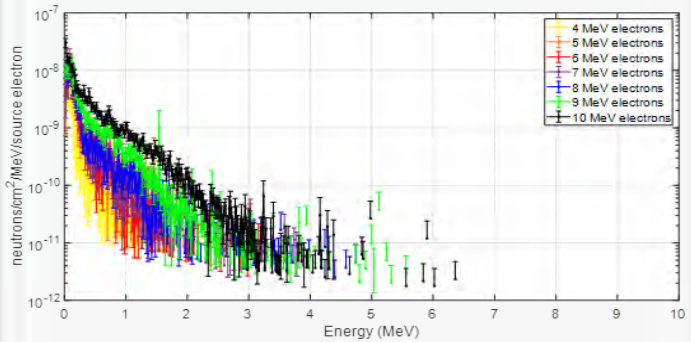
Amenable to both short- and long-term numerical metrics and both short- and long-term success stories

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

Strengthened the NNSS's Science and Technology Capabilities through High-Risk and High-Reward Research and Development



Bubble collapse in nitromethane gas during a supported shock experiment



An electron driven photoneutron source is being investigated to enable neutron radiography capabilities on Scorpius

- **Submitted two R&D 100 Award applications**
  - Amber Guckes – "Multi-Layered Avalanche Diamond Detector for Fast Neutron Applications."
  - Dale Turley – R&D 100 Leader of the Year for "Study of Bubble Collapse in Optically Transparent High Explosive as a Method to Probe the Detonation Process."
    - *Gaining national recognition for our Site-Directed Research and Development (SDRD) accomplishments*
- **Identified 8 new and 25 ongoing SDRD projects for funding in FY24**
  - Tried a new approach of embedding Continuing Project Reviews within routine Quarterly Reviews to improve efficiency. This new process resulted in findings and lessons learned that will serve to improve the process of future years.
  - A strategic initiative focused on developing the NNSS's critical skills in Accelerator Science and Beam Physics was identified for funding.
    - *SDRD is the proving ground for innovations that advance national security technologies*
- **Supported 23 interns through the MSTS Student Program**
  - SDRD projects based at the NNSS and NLV are required to support at least 1 intern for every $350k of funding, and projects based at remote NNSS and non-NLV sites are required to support at least 1 intern for every $250k funded.
    - *Exposing university students to high-risk, high-reward R&D to train the future workforce*

University Partners for FY24

- *Arizona State University*
- *California Polytechnic University*
- *Idaho State University*
- *Imperial College London*
- *Massachusetts Institute of Technology*
- *New Mexico Institute of Mining and Technology*
- *Portland State University*
- *University of Rochester*
- *Texas A&M University*
- *Texas Tech University*
- *University of California, Los Angeles*
- *University of California, Santa Barbara*
- *University of Nevada, Las Vegas*
- *University of Nevada, Reno*
- *University of Oregon*

Introduction

Budget News: 2024 Outlook

Staffing

Return on Investments

Publications

Invention Disclosures

Highlights

Advanced Science and Technology by Pursuing Copyrights, Patents, and Publications

NNSS authors published and presented high-risk, high-reward R&D in prominent journals and conferences

View of the FIBLS apparatus at TEMU, from Scheussler et al.'s presentation at the LasPhys 23 Conference

- **Disclosed two new records of invention that derived from SDRD projects (May 18 and 22)**
  - AR/VR solution for first responders – copyright will be pursued.
  - Inorganic scintillators for increased X-ray absorption, scintillation, and reactivity – patent will be pursued either by MSTS or university partner.
  - 8 records of invention have been completed this year, 6 of which derived from SDRD projects.
    - *Our high-risk R&D is generating new intellectual property with potential for future technology transfer*
- **Continued strong record of publishing research at the NNSS**

Journal/Conference	Date
SPIE Hard X-Ray, Gamma-Ray, and Neutron Detector Physics	October 2022
Journal of Applied Physics	January 2023
Spectrochimica Acta Part B: Atomic Spectroscopy	April 2023
JACoW International Particle Accelerator Conference	May 2023
Communications Physics (Nature)	June 29, 2023
LAsPhys23 Conference	July 6, 2023
SPIE Optics and Photonics	August 21, 2023
Physical Review B	N/A (manuscript submitted)

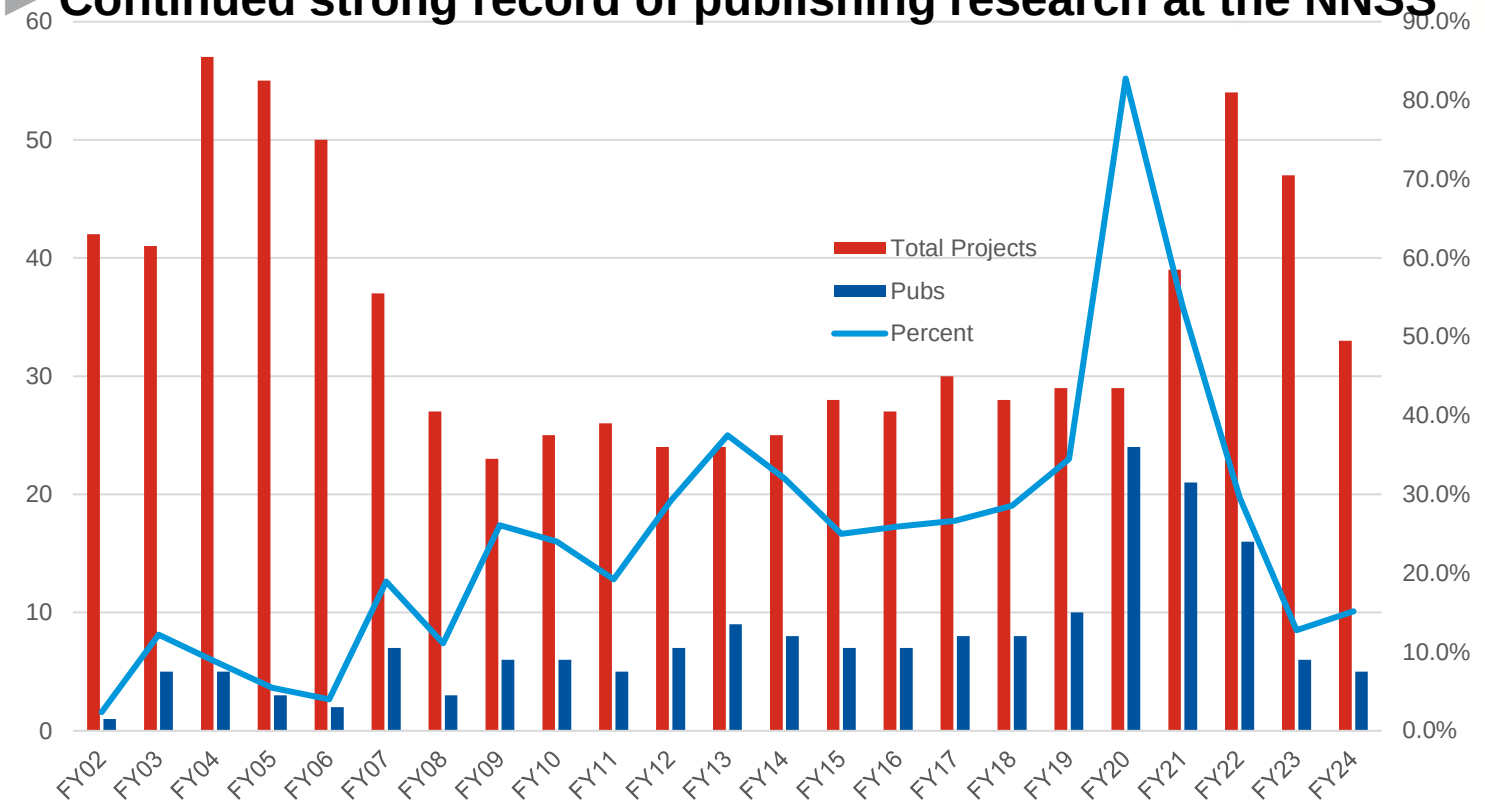
  - *The NNSS executes and publishes peer-reviewed science*
- **Finalized new and progressed in current CRADA partnerships**
  - Finalized Umbrella CRADA with UNLV and sent to NFO for review, comment, and approval (May 25), which will provide a pathway for further collaboration with our UNLV partner (e.g., joint appointments to supervise theses, sharing of equipment).
    - *Enhancing university and commercial collaborations develops STEM and technology transfer pipelines*

Advanced Science and Technology by Pursuing Copyrights, Patents, and Publications

NNSS authors published and presented high-risk, high-reward R&D in prominent journals and conferences

View of the FIBLS apparatus at TEMU, from Scheussler et al.'s presentation at the LasPhys 23 Conference

Continued strong record of publishing research at the NNSS



Journal	Pub Date
Proc. SPIE 12241	10/4/2022
J. Appl. Phys.	1/12/2023
Optimization and Control arXiv	3/15/2023
Proc. SPIE 12696	10/3/2023
Phys Review B	10/6/2023
Nature's Scientific Reports	10/16/2023
Journal of Chemical Physics	11/2/2023
Chemical Communications	11/3/2023
Results in Physics	1/16/2024

The NNSS executes and publishes peer-reviewed science.

SDRD SITE-DIRECTED RESEARCH & DEVELOPMENT

SDRD
SITE-DIRECTED RESEARCH & DEVELOPMENT

Introduction

Budget News: 2024 Outlook

Staffing

Return on Investments

Publications

Invention Disclosures

Highlights

NEVADA NATIONAL SECURITY SITES
NNSS
WE SECURE AMERICA'S FUTURE

Multi-Layered Avalanche Diamond (MAD) Detector

Above: *From left to right, Amber Guckes, Allan Ortiz, Andrew Green, and Dave Schwellenbach outside of the Idaho State University Idaho Accelerator Center.*

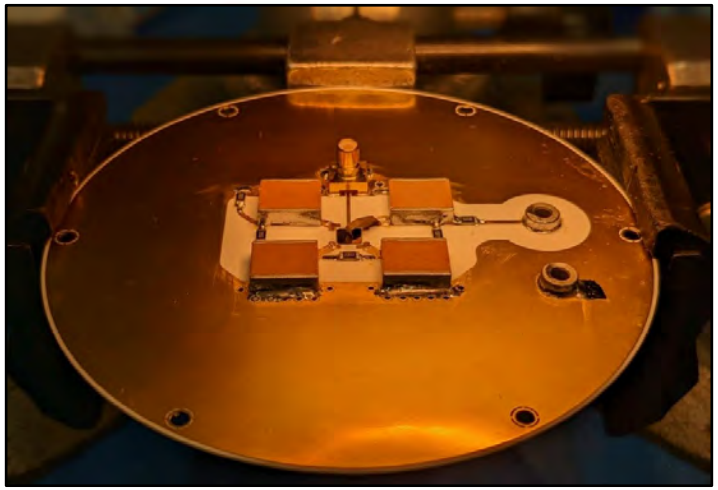
Below: *Intern Christine Evans works on part of the MAD Detector SDRD project.*

"Multi-Layered Avalanche Diamond Detector for Fast Neutron Applications"

Amber Guckes (PI), Robert Buckles, Andrew Green, Adam Wolverton, in collaboration with Applied Diamond, Inc.

Researchers funded by the Site-Directed Research and Development (SDRD) Program are developing a multi-layered avalanche diamond (MAD) detector suitable for radiation detection applications. This work builds upon and extends research that was done with charged particles, but not with neutrons. Diamond can efficiently detect neutrons and reject gamma ray interactions, a quality important to the success of high-flux neutron source experiments across the DOE complex, including Neutron Diagnosed Subcritical Experiments (NDSE) at the NNSS.

Initial MAD detector work has resulted in the submission of a video presentation and manuscript to *SPIE Optical Engineering + Applications* conference and has fostered a strong working relationship with Applied Diamond, Inc. MAD detector was also submitted to the R&D 100 awards for 2023.



Above: *Close-up of MAD detector prototype.*

Below: *James Mellott and others work on the MAD Detector project.*

SDRD
SITE-DIRECTED RESEARCH & DEVELOPMENT

Introduction

Budget News: 2024 Outlook

Staffing

Return on Investments

Publications

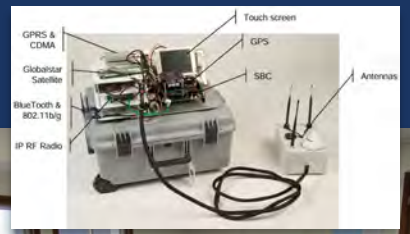
Invention Disclosures

Highlights

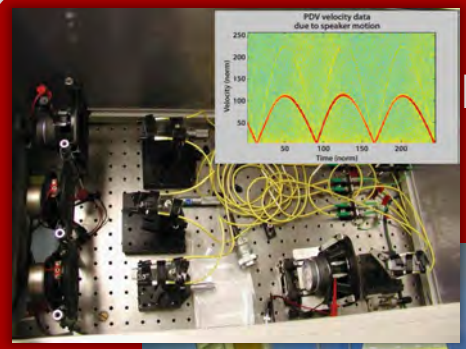
NEVADA NATIONAL SECURITY SITES
NNSS
WE SECURE AMERICA'S FUTURE

Key Technologies Rooted in SDRD

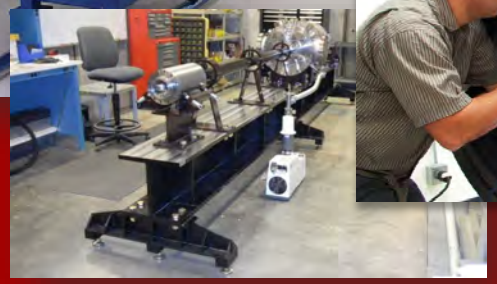
Dense Plasm Focus (DPF) 2004



Multi-Path Communication Device (MPCD) 2005

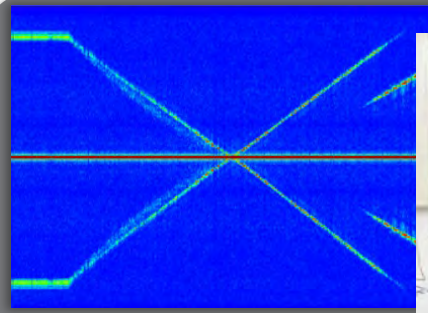


Multiplexed Photonic Doppler Velocimetry (MPDV) 2008



Powder Gun 2015

For more than 20 years, technologies essential to our National Security mission have originated from SDRD projects.



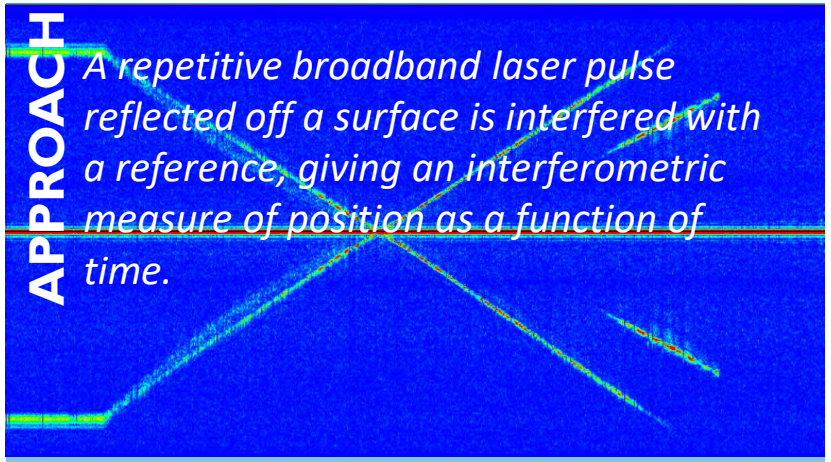
Broadband Laser Ranging (BLR) 2016

Broadband Laser Ranging
The Next Level of Dynamic Material Diagnostics

R&D CHALLENGE

Traditional velocimetry that is routinely implemented in shock physics experiments doesn't 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.

2014 — *Feasibility study awarded to bench-test a broadband laser ranging idea* (SDRD)

2014 — *Dynamic/ explosive test of technique* (SDRD)

2015 — *Tri-lab plus NNSS BLR team formed.* (SDRD)

2015 — *2-channel BLR Fielded on hydrodynamic shot at Site 300* (Programmatic)

2017 — *Fielded 8 points on Gemini series of subcritical experiments (U1A)* (Programmatic)

2020 — *Fielded 16 points on Red Sage series of subcritical experiments (U1A)* (Programmatic)

2020 — *Fielded 16 points on 3687 experiment (DAHRT)* (Programmatic)

2020 — *48-point BLR installed at Site 300* (Programmatic)

SDRD

Programmatic

Tri-Lab Working Group

- *Lawrence Livermore National Laboratory*
- *Los Alamos National Laboratory*
- *Sandia National Laboratories*
- *Nevada National Security Sites*

Los Alamos
NATIONAL LABORATORY

Sandia
National
Laboratories

NEVADA NATIONAL
NNSS
SECURITY SITES

Lawrence Livermore
National Laboratory

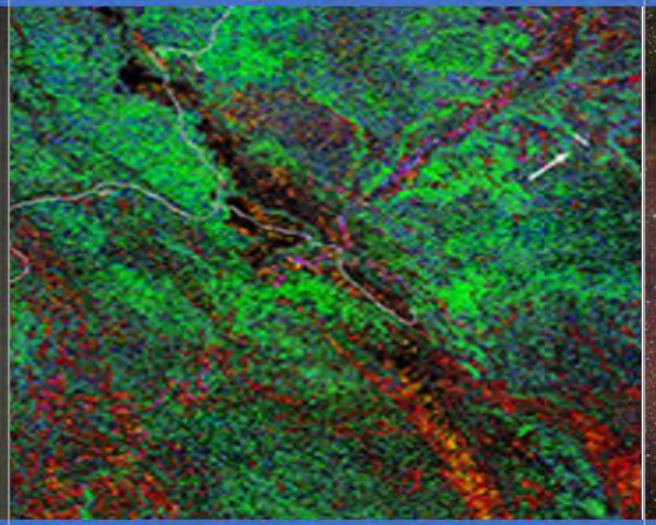
These S&T Thrust Areas Impact All of NNSS Missions: NA-10, NA-20, NA-80 as well as SPP/SIPP

NEVADA NATIONAL NNSS SECURITY SITES

NNSS Science and Technology Thrust Areas

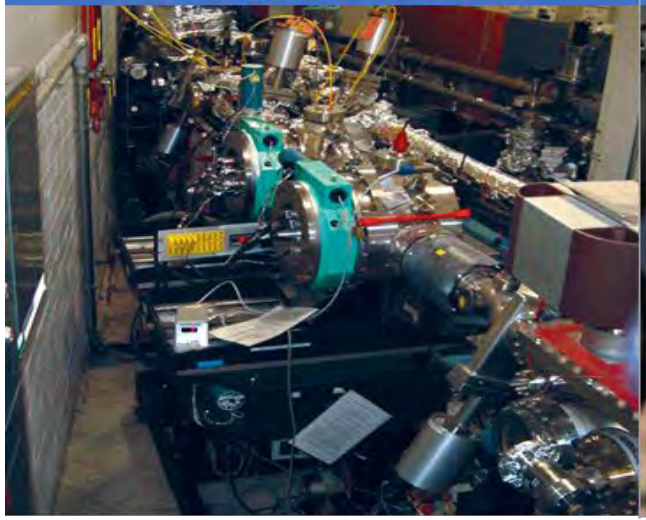
Radiographic Systems Imaging and Analysis

User-Centered Remote Testing & Operations



Neutron Technologies and Measurements

Accelerator Beam Science and Target Interactions



Enabling Technologies for Autonomous Systems & Sensing

Dynamic Experiment Diagnostics

Communications and Computing

Summary, Lessons Learned, and Moving Forward

- Numerical metrics and success stories are both useful performance indicators
- Performance is a moving target especially when it comes to research and development investment!
- Continuing Project Review system led to more continuations and fewer new starts
- Procurement and IT are significant challenges
- Funding disruption can have immense impact on SDRD

SDRD
SITE-DIRECTED RESEARCH & DEVELOPMENT

Thank you for listening!

Any questions?

NEVADA NATIONAL
NNSS
SECURITY SITES
WE SECURE
AMERICA'S FUTURE