



U.S. DEPARTMENT OF  
**ENERGY**

Office of  
Science



**BERKELEY LAB**

# Laboratory Directed Research and Development (LDRD) at Berkeley Lab

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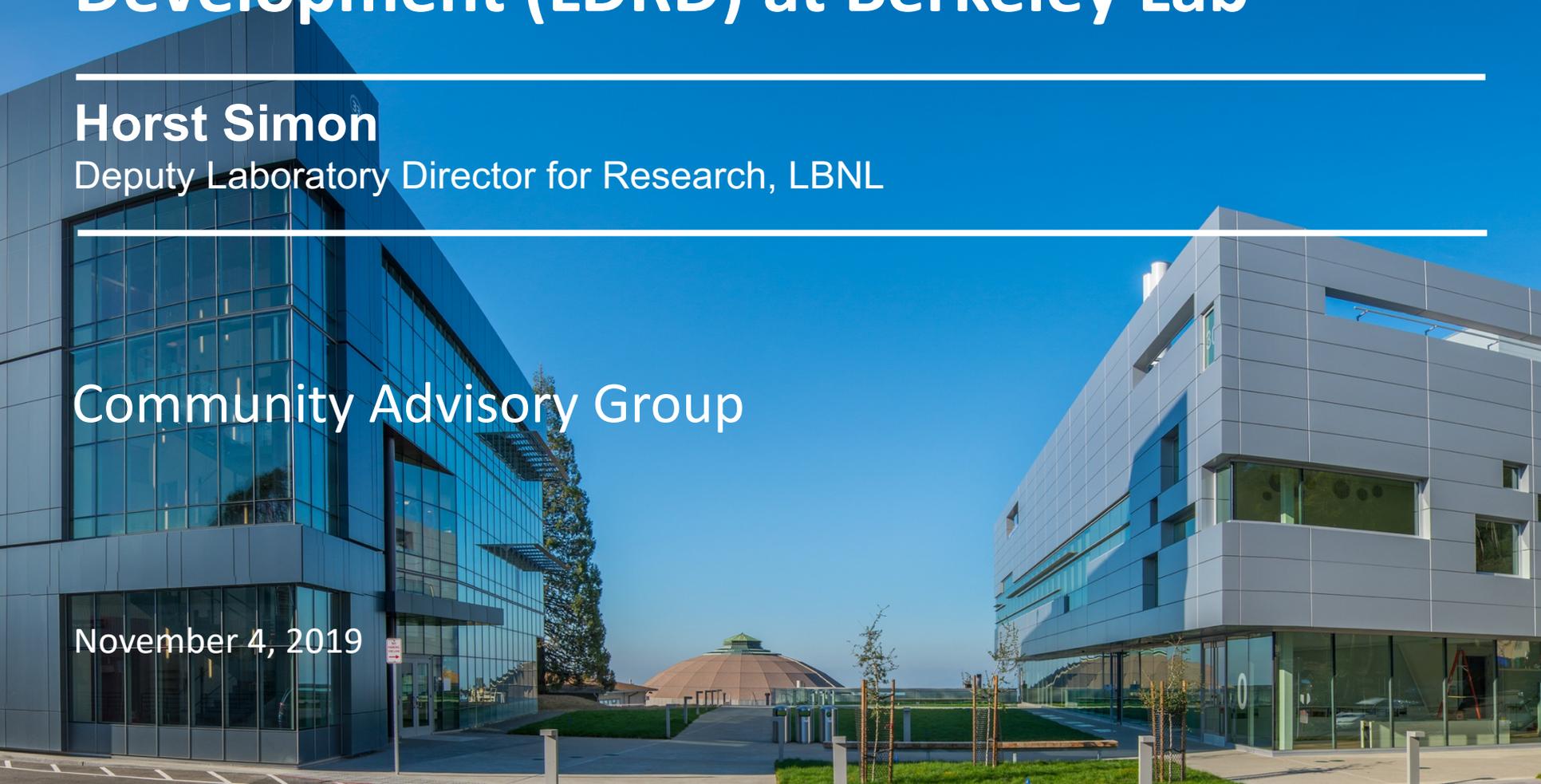
**Horst Simon**

Deputy Laboratory Director for Research, LBNL

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Community Advisory Group

November 4, 2019



“Lawrence was obliged to seek new funding sources. He was as adept at fundraising as at building new devices and despite the grim Depression environment, he found donors for his next machine.” (AIP History Project)



# LDRD at National Labs

Fosters science and innovation  
Strengthens S&T workforce

DOE Order 413.2B  
Establishes and Sets Guidelines  
for LDRD



**U.S. Department of Energy**  
Washington, D.C.

**ORDER**  
**DOE O 413.2B**

Approved: 4-19-06  
Admin. Chg 1: 1-31-11  
Certified: 7-9-11

**SUBJECT: LABORATORY DIRECTED RESEARCH AND DEVELOPMENT**

- OBJECTIVE:** To establish Department of Energy (DOE) requirements for laboratory directed research and development (LDRD) while providing the laboratory director broad flexibility for program implementation. The objectives of the LDRD program are to—
  - maintain the scientific and technical vitality of the laboratories;
  - enhance the laboratories' ability to address current and future DOE/NNSA missions;
  - foster creativity and stimulate exploration of forefront science and technology;
  - serve as a proving ground for new concepts in research and development; and
  - support high-risk, potentially high-value research and development.
- CANCELLATION:** DOE O 413.2A, *Laboratory Directed Research and Development*, dated 01-08-01. Cancellation of an Order does not, by itself, modify or otherwise affect any contractual obligation to comply with the Order. Canceled Orders that are incorporated by reference in a contract remain in effect until the contract is modified to delete the references to the requirements in the canceled Orders.
- APPLICABILITY:**
  - DOE Elements:** The provisions of this Order apply to all DOE elements responsible for laboratories with approved LDRD programs. (Attached list of all DOE elements as of the approval date of this Order. This Order automatically applies to DOE elements created after it is issued.)  
The National Nuclear Security Administration (NNSA) Administrator and NNSA employees and contractors comply with their respective responsibilities under this Order.
  - DOE Contractors:** The Contractor Requirements Document (CRD), Attachment 1, sets forth requirements that are to be applied to contractors operating laboratories that conduct LDRD programs approved by the appropriate cognizant Site Officer (CSO)/Deputy Administrator, NNSA.
  - Exclusions:** None.

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DOE O 413.2B  
4-19-06

5 (and 6)

- The National Nuclear Security Administration Act, Title XXXII of P.L. 106-65, as amended, which established a separately organized agency within DOE.
- Homeland Security Act of 2002, P.L. 107-296, 6 U.S.C. 189(f), which directs that funds authorized to be used for LDRD must benefit the homeland security mission.
- FY 2006 Energy and Water Development Appropriations Act, P.L. 109-103, Section 311, raises the maximum LDRD funding level to 8 percent and makes all the DOE laboratories eligible for LDRD funding.

7. **CONTACT:** Questions covering this Order should be addressed to the Office of Laboratory Policy and Evaluation, Office of Science, 202-586-5447.

BY ORDER OF THE SECRETARY OF ENERGY:

 CLAY SELL  
Deputy Secretary

# LDRD: High Impact, Innovative Science

- Advanced study of *hypotheses, concepts, or innovative approaches* to scientific or technical problems
- Experiments and analyses directed toward *proof-of-principle* or early determination of the utility of new scientific ideas, technical concepts, or devices
- Conception and preliminary *technical analysis* of experimental facilities or devices
- Support *high risk, high value* projects

# LDRD Funds Award Winning Science from the Ground Level

Saul Perlmutter wins 2011 Nobel  
Prize for Discovery of  
Accelerating Universe



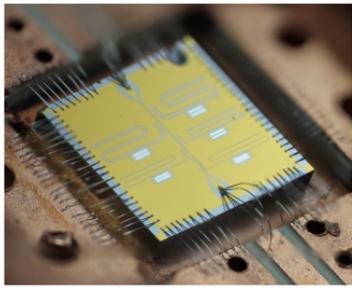
Postdocs hired by George Smoot and  
Perlmutter for their 1990s LDRDs are  
now leading the Computational  
Cosmology Center (Nugent, Borrill)



# LDRD: Three Categories at Berkeley Lab



**Labwide Initiatives:** Foster the development of new teams and activities in fields that directly support the *high level strategic goals* of the laboratory



**Area Initiatives:** Introduce *new research activities* in one of the six areas of the lab



**Early Career:** Develop the *future scientific workforce* at the laboratory and prepare early career PIs for a successful scientific career

# Lab-wide and LDRD Strategic Research Initiatives 2018-19

## Lab-wide Initiatives:

- Electron Microscopy
- Microbes to Biomes/BioEPIC Science
- Quantum Information Systems

## LDRD 2020 Lab-wide Initiatives:

- Energy Efficient Microelectronics and Computing Architectures for Beyond Moore's Law
- Genetically Encoded Composites
- Machine Learning for Science
- Solid State Energy Storage
- Water-Energy Resilience
- Early Career LDRD track

Today's Berkeley Lab is the result of strategic use of LDRD. We use LDRD to:

Initiate new capabilities

BERKELEY LAB  
MOLECULAR  
FOUNDRY



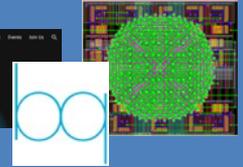
JBEI



Reduce technical risk for major projects

Integrate across programs

Machine Learning for Science



Develop scientific leaders for the future



2019 Early Career LDRD cohort

# Machine Learning for Science

Over 100 projects at the Lab are using or developing machine learning.



Lab LDRD Initiative

Summer School

"Data" Conference

Website: <https://ml4sci.lbl.gov>

# Scalable Dimensionality Reduction for Interpretable Feature Extraction from Noisy Data

*John Wu (CRD), Jonathan Ajo-Franklin (EGD), Michael Mahoney (EECS/UCB)*

- **Project Objective**

- Enhance interpretability of learning algorithms
- Develop more efficient learning algorithms for large applications

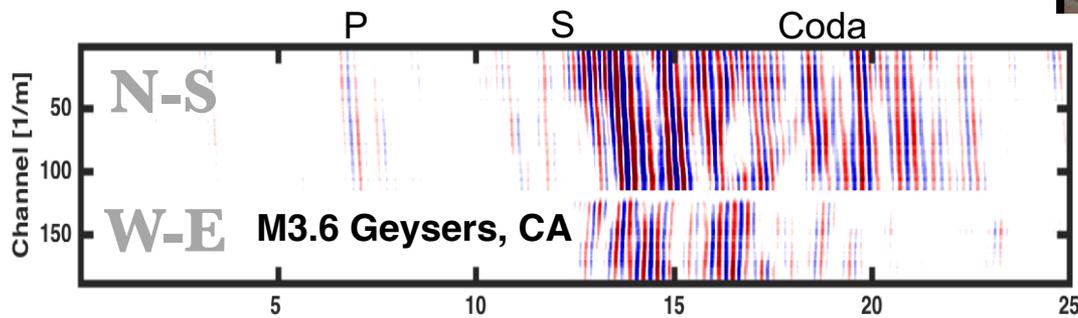
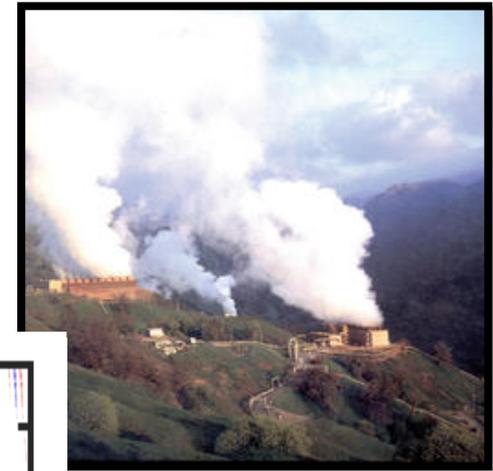
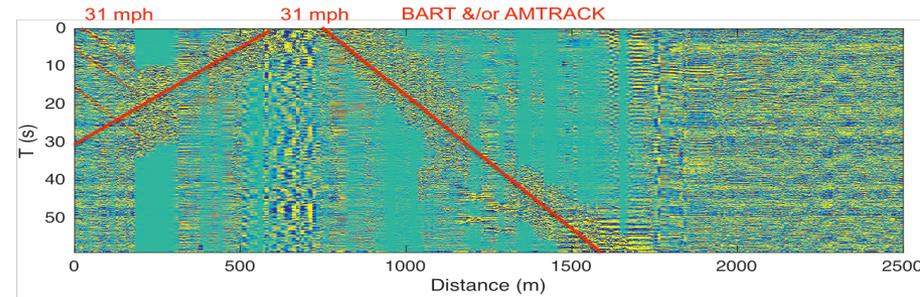
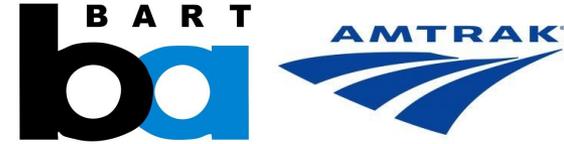
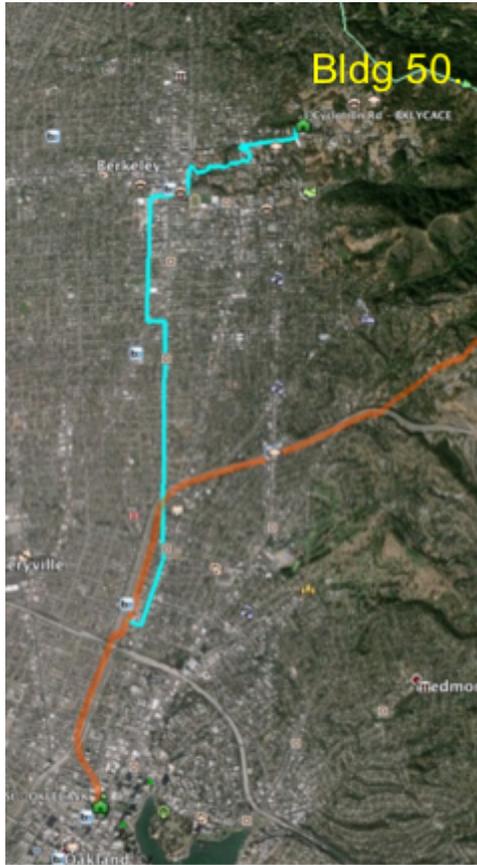
- **Overview of Approach**

- Employ statistical mechanics to improve interpretability of learning procedures
- Accelerate the convergence of optimization in learning algorithms
- Scale algorithms on HPC systems for large data analysis

- **Impact of Project**

- Unique scalable machine learning tools for big science
- Addressing the challenges in experimental and observational data identified in DOE Computing's long-term plan

# Application Driver: Massive Seismic Datasets on Fiber



# Early Career LDRD – Esther Singer

Improving bioenergy yield under drought stress from field to lab



GOAL: Submission to DOE ECRP



# Summary

- **“Success” = quantitative (\$) + qualitative (all else)**
- **LDRD highly successful for Lab**
- **Significant contributions to DOE and the Nation**
- **Long-term investments**

# Thank You