Laboratory Directed Research and Development Program at Lawrence Livermore National Laboratory

Presented to the Global Climate & Energy Project Workshop on Design for Breakthrough Research in an Academic Setting

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Topics for discussion

- A brief discussion of the Laboratory’s history and mission
- The Laboratory Directed Research and Development (LDRD) Program
- LDRD successes—Examples
- Summary and comments
LLNL was established in 1952 as the second physics design Laboratory

- Owned by the Department of Energy
- About 8000 employees
- Annual budget ~ $1.7 billion
- 1.2-square-mile main site
- Capital investment and infrastructure is about $4.0 billion
- Experimental test site near Tracy
The Laboratory is managed by the University of California for the DOE National Nuclear Security Administration (NNSA)

• **Laboratory Strategic Vision**
  – A multidisciplinary science and technology laboratory dedicated to national security in the **global context**

• To meet our missions, we undertake extremely large and complex S&T efforts that typically press beyond the range of established feasibility

• Laboratory strength stems from a focus on
  – Anticipating national needs
  – Innovating integrated solutions
  – Delivering “products”

> The day when the scientist, no matter how devoted, may make significant progress alone and without material help is past. ... the attack on the atomic nucleus has required the development and construction of great instruments on an engineering scale.”

E.O. Lawrence, February 29, 1940
LLNL national security mission has continued to evolve

• Our core mission is to
  – Ensure that the nation’s nuclear weapons remain safe, secure, and reliable and to prevent the spread and use of weapons of mass destruction worldwide

• To meet this national security mission we are pursuing challenging programs for
  – Stockpile stewardship
  – Fusion ignition in the laboratory by 2010
  – Nonproliferation, arms control and international security
  – Homeland security

• As well as supporting programs in
  – Energy and environmental security
  – Biosciences

• The Laboratory serves as a resource to U.S. government
  – In partnership with academia, industry and other national and international
Core capabilities and a long-term perspective has been applied to meet other national needs.

**Bioscience**
- chromosome painting
- genome sequencing

**Atmospheric Science**
- global circulation models
- climate change
- atmospheric releases
- WMD incident response

**Geoscience**
- seismic monitoring
- nuclear waste disposition
- environmental cleanup
- CO₂ sequestration

**Fallout concerns**
- bioagent detectors
- healthcare technologies
National security activities dominate our FY 2005 budget of $1.7 Billion
# LLNL Organization

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*Acting
In summary, LLNL provides an important resource to the nation

- National security—our core defining mission
- Innovative applied science and technology—our core contribution

Our internally-funded R&D Program has been an essential driver for creativity and innovation in support of our national security mission

- Talented people—our greatest asset
Topics for discussion

- A brief discussion of the Laboratory’s history and mission
- The Laboratory Directed Research and Development (LDRD) Program
- LDRD successes—Examples
- Summary and comments
LDRD is the Lab’s most important resource for fostering excellence in our science and technology

If U.S. taxpayers are to get the most return from their support of R&D, government laboratories must have sufficient discretionary funding for independent research and development. Almost every laboratory has found that the most important innovation often comes from the scientists’ independent ideas or actions. Thus, the productivity of the U.S. R&D establishment depends on a vigorous independent R&D program.”


• LDRD funding history
  — Established by Congress
  — Began in 1985 as an IR&D Program at 2% of the Laboratory total budget
  — In 1993, was raised to 6% of the total budget and renamed as LDRD
  — Our FY2005 budget was about $70M
LDRD is the Lab’s most important resource for fostering excellence in our science and technology

• LDRD funds creative and innovative basic and applied research activities
  – Focus primarily on mission-related, long-term, high-risk R&D activities

• LDRD supports research projects that
  – Enhance the Laboratory’s core strength and drive the scientific and technical vitality of the Laboratory
  – Create new capabilities that enable us to meet evolving DOE and national security needs
  – Attract and retain the most qualified scientists and engineers
  – Promote scientific collaborations: academia, industry, national laboratories

• Provide a management investment tool for both programmatic and disciplinary organizations to look 5 to 10 years ahead
Several goals are considered to ensure a high impact R&D program

- Focus on our mission and strategic vision
- Ensure that proposals are addressing a long-term goal, addressing current and future needs and contributing to the vitality of the Laboratory
- Demand the highest S&T standard
- Attract and retain the most qualified scientists and engineers
- Implement well communicated, fair and robust peer-review processes (on par with federal science agencies)
- Pay special attention to the leadership
  - We often bet on individuals’ track record
  - Train future leaders
- Make sure that all relevant expertise are available
- Encourage cross-disciplinary collaborations and exchange of ideas

More importantly, we structured the program to address a spectrum of laboratory needs and to encourage innovations at all levels of the organization
The LLNL LDRD Program consists of four components

**Institution**
- **Strategic Initiatives (SIs)**
  - Support the Laboratory’s strategic vision
  - Focus on major challenges requiring large multidisciplinary team
  - Develop future programs and programmatic leaders

**Organizations**
- **Exploratory Research (ER)**
  - Exploratory Research in the Directorates (ERD) are
    - Aligned both with the strategic R&D needs of the Directorates, and the Laboratory S&T Plan
  - Exploratory Research in the Institutes (ERI)
    - Promotes strategic and effective collaborations with academia

**Individual PIs**
- **Laboratory-Wide competition (LW)**
  - Emphasizes innovative PI-driven research from LLNL staff
- **Definition/Feasibility Studies (D/F)**
  - Provide flexibility for exploring the feasibility of new ideas quickly throughout the year
  - Less than $75K and 12-month duration
Three committees are selected by the Director to support the proposal screening process

• SI Oversight Committee
  — Consists of senior S&Es and high-level managers

• ER Oversight Committees
  – Consists of senior S&Es and technical managers

• LW Research Committee
  — Consists of about 20 scientists and engineers representing all Laboratory directorates

• We also make extensive use of internal and external subject matter experts

The Committees’ review processes are specifically tailored for each LDRD category
LDRD proposal solicitation and review processes are “fair and robust” and are well communicated

- Clearly communicated strategic vision and R&D needs
- Clearly articulated proposal-evaluation criteria
  - Quality of research team
  - Quality of proposed R&D
  - Potential return to Lab; “exit strategy”
  - Strategic alignment to LLNL Programs and S&T Plans
- Review Committees represent cross section of the entire Laboratory
  - Members of the committees work closely with the PIs to strengthen and increase chances of success
- Retrospective assessments: publications, awards, new programs, new staff
- Ongoing examination, redesign analyses and process improvement

Our review and selection processes ensure that all LDRD projects are of high quality and responsive to DOE and LLNL strategic needs
Topics for discussion

- A brief discussion of the Laboratory’s history and mission
- The Laboratory Directed Research and Development (LDRD) Program
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LDRD resulted in many patents and publications, and provided support for students and post-doctoral researchers

• Though LDRD is only 6 percent of the Lab budget it is responsible for
  • Over 40% of the patents issued for LLNL research
  • About 30% of our annual publications
  • Over 40% of laboratory R&D 100 awards

• Award winning science and scientists

• LDRD also support about 70% of our Post Docs and students
  • Many of the Post docs converted to career are typically funded by LDRD
LDRD has catalyzed broad university collaborations, including NSF S&T Centers

- NSF Center for Adaptive Optics
- NSF Center for Biophotonics Science and Technology
- NSF Center for Magnetic Self-Organization in Laboratory and Astrophysical Plasmas
- NCI National Cancer Center at UC Davis
LDRD investments enabled us to address a nearly impossible environmental restoration problem

- Visalia Pole Yard was a heavily contaminated site owned by Southern California Edison
- It would have taken ~2000 years to clean using the conventional pump-and-treat approach
- Using Dynamic Underground Stripping and a host of sensors and analysis techniques, the site was closed in two years
- LDRD investments enabled discovery, development and staffing of the many technologies (most were developed for other purposes)
  - Discovery and development of the hydrous pyrolysis oxidation process
  - NUFT modeling for process design
  - Well protection and packer techniques
  - Noble Gas tracers for process verification
  - Electrical Resistance tomography for process control
  - On-site chemical analysis via MS and GC for compliance data

The Visalia site is now closed
Our Biodefense technologies are the culmination of decades of prior work and excellent example of spinoffs.

**HEALTH BENEFIT**
- outbreak of plague
  - Hoof and Mouth
  - Exotic Newcastle Pre-symptomatic diagnosis

**S&T INNOVATIONS**
- Microfabrication of silicon (1970s)
- DNA sequencing/ Human Genome Project (1987)
- Miniaturized PCR (1997)
- Signatures, Assays and Bioinformatics

**BIODEFENSE**
- HANAA
- BASIS at the Olympics (2002)
- Advanced Pathogen Detection in DC Metro
- Sentinel for pathogen detection
LDRD investments enable a wide array of new programs and science with broad sponsorship – e.g. Adaptive Optics

- Ultrahigh-bandwidth communications
- LDRD investment in Laser Guide Star adaptive optics
- Surveillance for Homeland Security
  - raw image
  - enhanced image
  - range: ~1 km
- DOE Vision Program
- NSF Science and Technology Center
- DARPA Coherent Communications Imaging and Targeting Program
- Forefront adaptive optics for astronomy and vision science
- 1024-pixel MEMS spatial light modulator
- High energy laser beam control
- uncorrected beam
- corrected beam
- air-to-space
- space-to-air
- ground-to-space
LDRD is the Laboratory’s most important resource for fostering excellence in our science and technology

- LDRD is essential to the Laboratory’s scientific and technical vitality—especially in support of DOE/NNSA goals
- LDRD enables LLNL to attract and retain the best and brightest to support future national security needs and to maintain scientific collaborations with academia and other national laboratories
- LDRD projects have been generating scientific and technological breakthroughs—major awards, patents, and publications
- Previous investment enabled rapid deployment of laboratory technology in the post-September 11 response
- The review-and-selection processes and DOE oversight ensure compliance with DOE regulations

Year-to-year stable LDRD funding ensures continued scientific and programmatic excellence
Contact

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