SAND2012-6146P

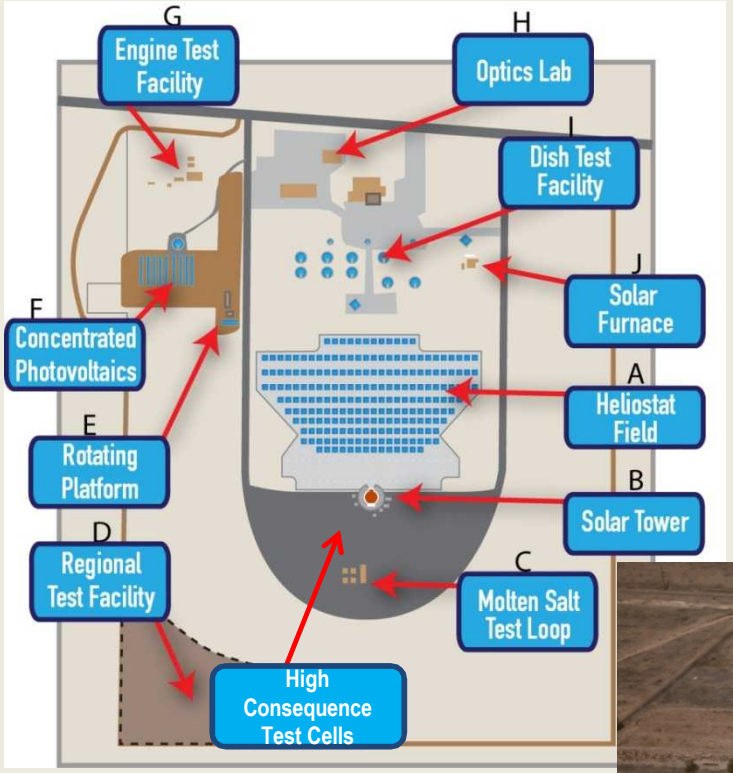
Core Facilities at the DOE National Solar Thermal Test Facility (NSTTF)

Cheryl Ghanbari (PI) -SNL
William Kolb (Co-PI) – SNL
David Gill (Co-PI) - SNL

FY13 Budget Request	$1,500K
FY14 Budget Request	$1,500K
FY15 Budget Request	$1,500K
Total Budget Request	$4,500K

Sandia National Laboratories is a multi-program laboratory managed and operated by Sandia Corporation, a wholly owned subsidiary of Lockheed Martin Corporation, for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000

NSTTF Facility Overview



NSTTF Mission

Support CSP and industry partners to reduce cost, increase performance and increase reliability of all CSP components and ultimately reduce LCOE

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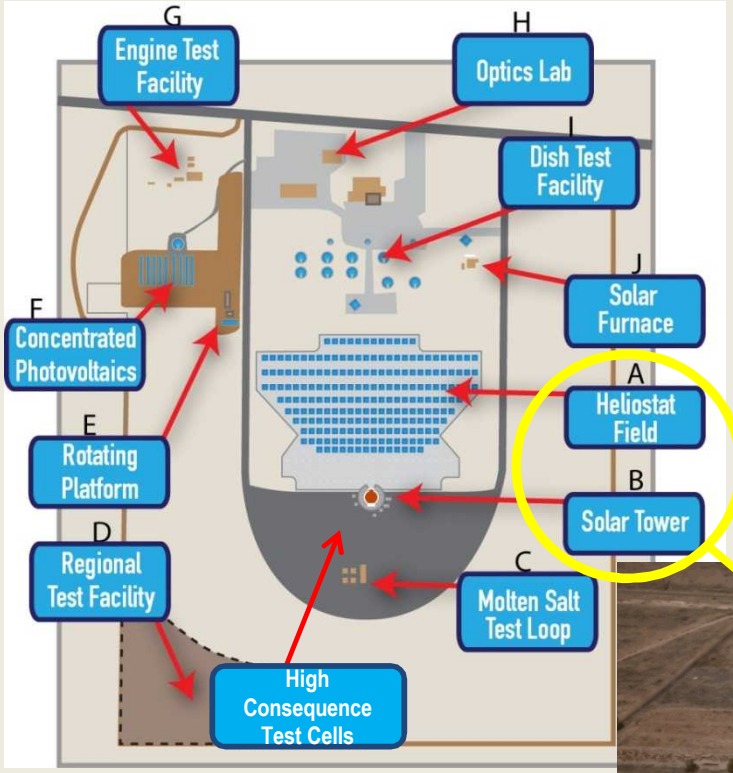
NSTTF Facility Overview



Site Capabilities Supporting SunShot Goals

Nooter Eriksen receiver shroud under test

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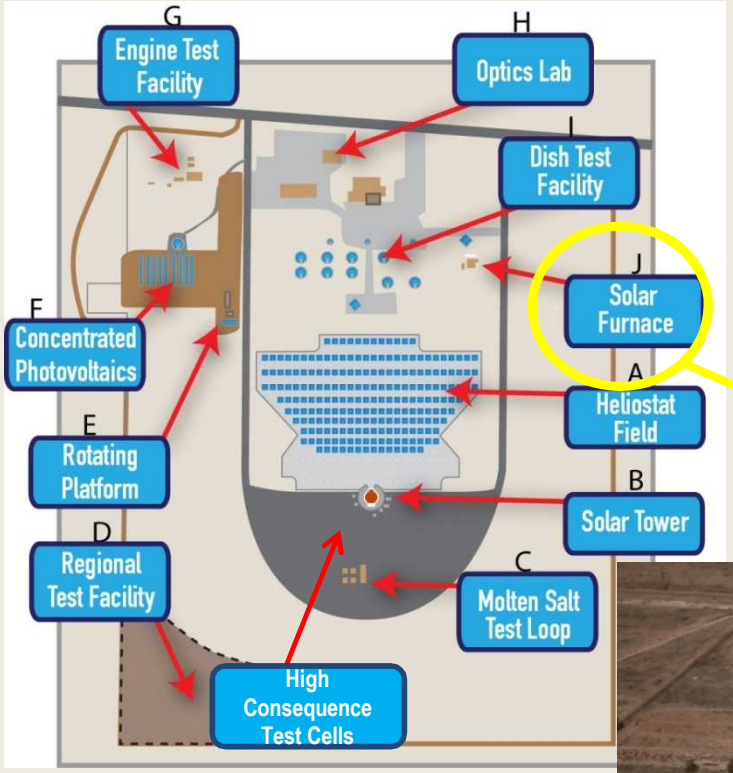
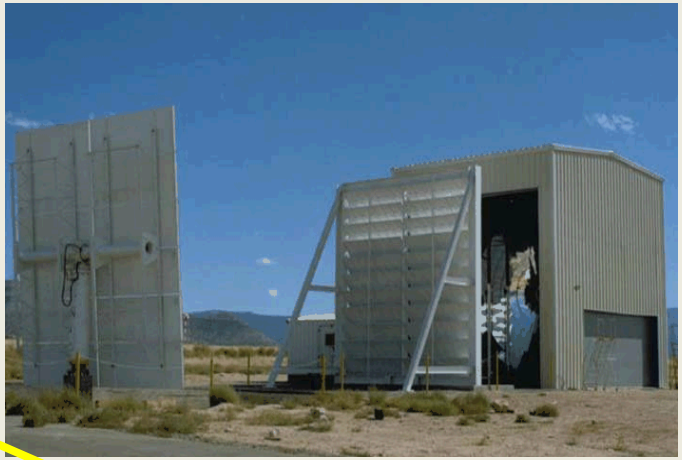
NSTTF Facility Overview



Site Capabilities Supporting SunShot Goals

Solar Furnace for Materials Testing On-Sun



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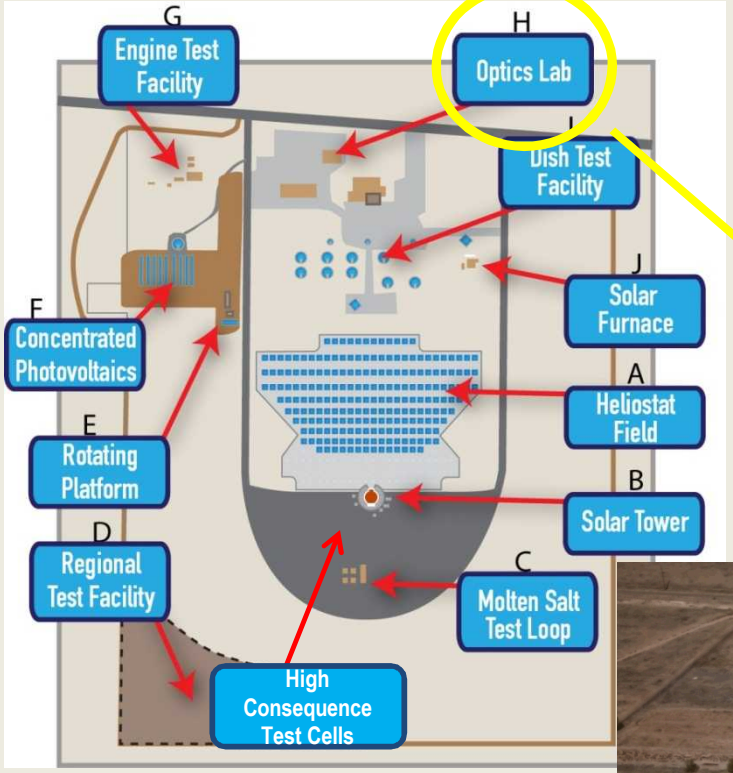
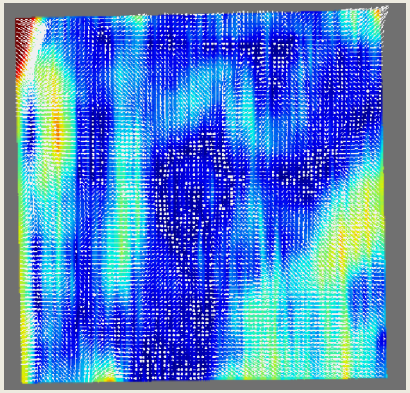
NSTTF Facility Overview



Site Capabilities Supporting SunShot Goals

NSTTF heliostat facet imaged with SOFAST



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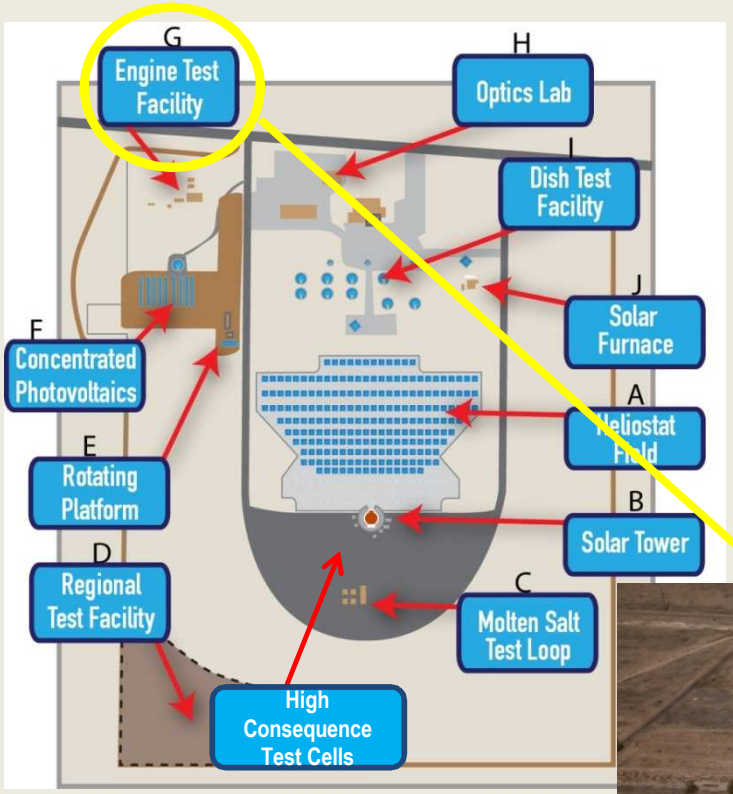
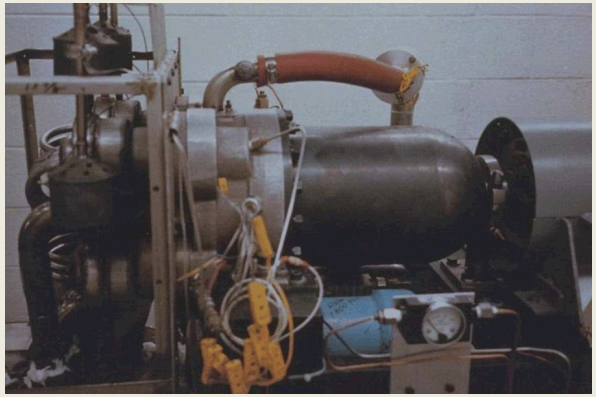
NSTTF Facility Overview



Site Capabilities Supporting SunShot Goals

STM engine under test on ETF dynamometer



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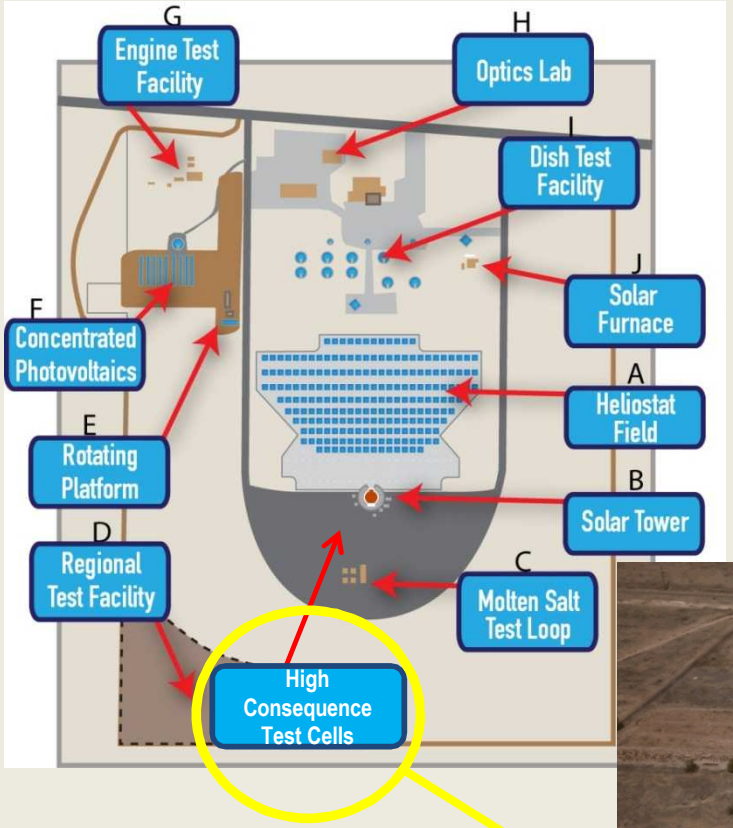
NSTTF Facility Overview



Site Capabilities Supporting SunShot Goals

700C Salt Pot for Corrosion Testing of High Temperature Metals and Salts

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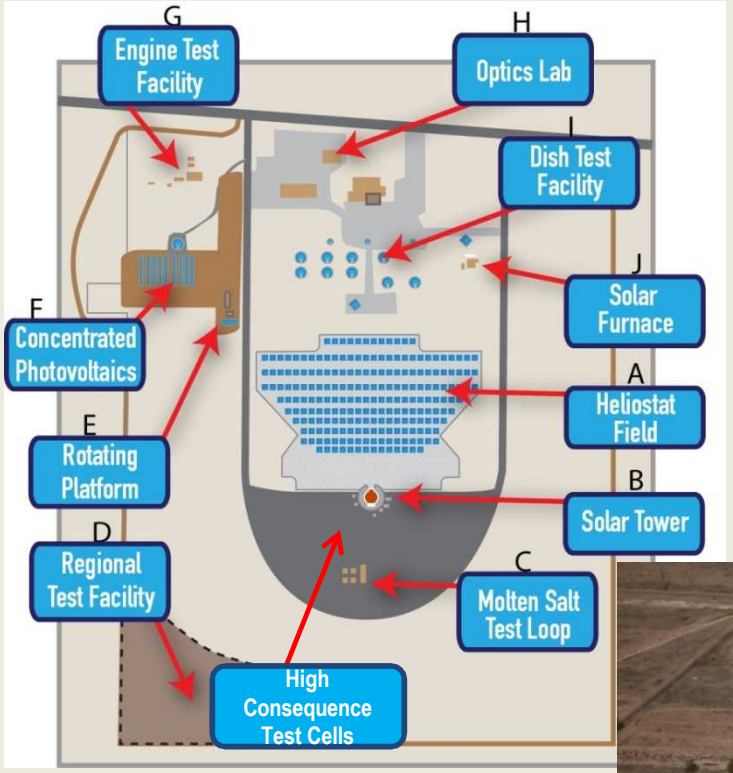
NSTTF Facility Overview



Site Capabilities Supporting SunShot Goals

Long Range Heliostat Target Tower for mobile flux measurement at any distance

Long Range Heliostat Target

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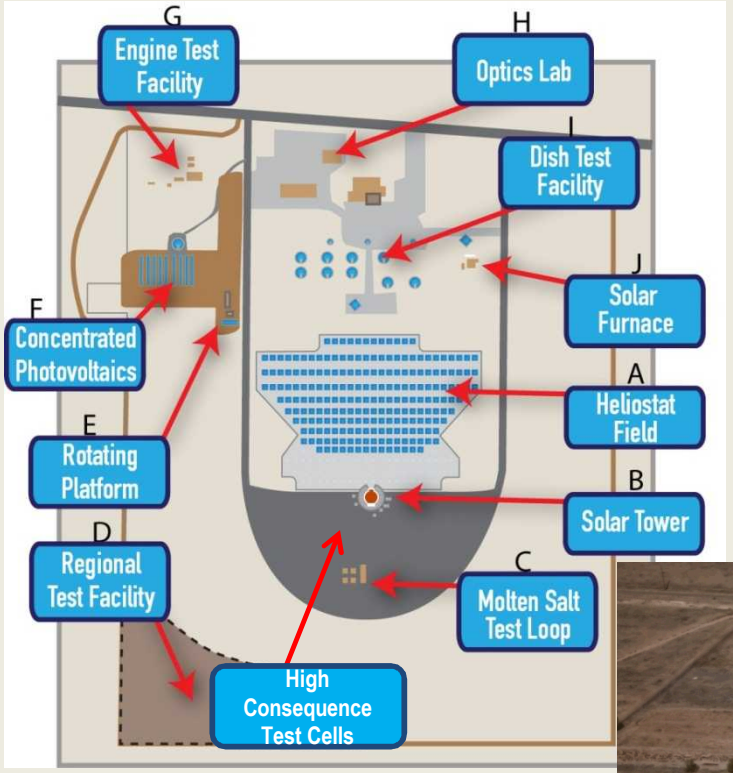
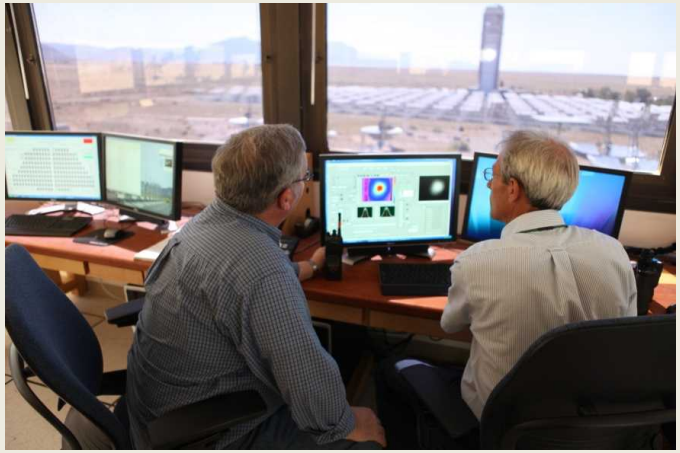
NSTTF Facility Overview



Site Capabilities Supporting SunShot Goals

Beam Characterization from the Control Room



Portable BCS

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NSTTF Facility Overview

Recent DOE Funded Projects Supporting SunShot Goals

Heliostat facet replacement – peak flux increase of 27%

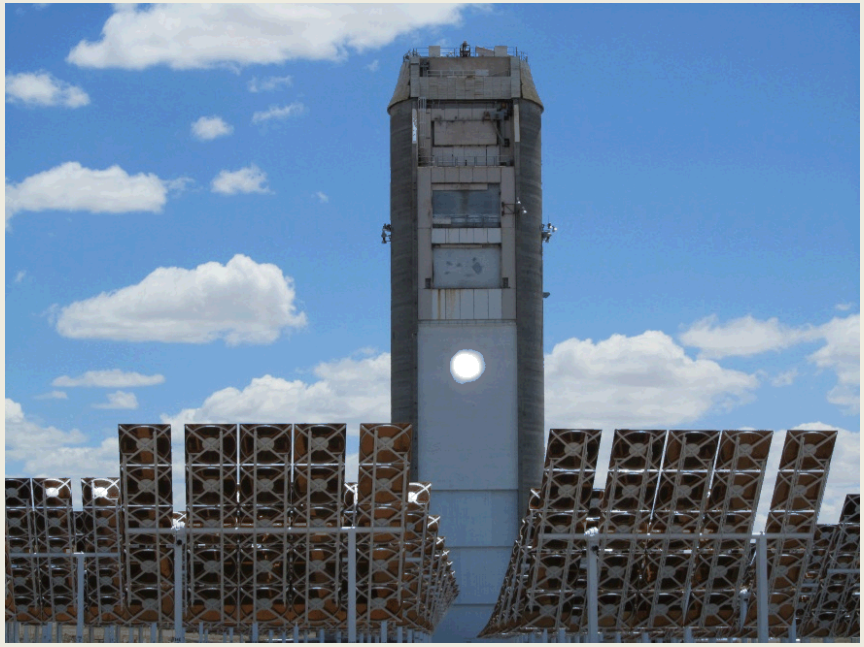
Heliostat field controls upgrade

Dedicated optics lab and test equipment

Tracking corrections

Heliostat field modal analysis

Long range heliostat target



Heliostat facet replacement increased flux by 27% as seen with one heliostat on the tower

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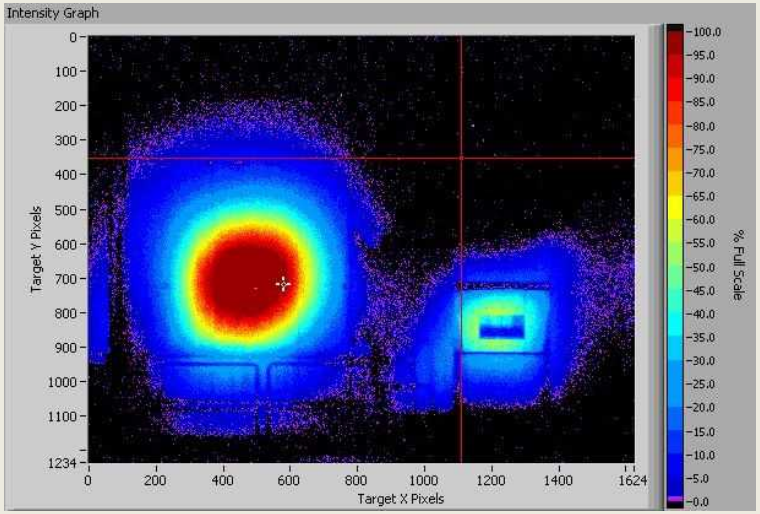
Prior Accomplishments

How NSTTF supports SunShot Goals of DOE CSP Program

Objective - Speed deployment of proven technology using this world class test facility – providing tested systems and components, valuable lessons learned, and best practices to research partners

- **Solar receiver on-sun testing**



Flux map of Sierra Nevada on-sun test of a volumetric air receiver

With calibration beam shown on left

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Prior Accomplishments

How NSTTF supports SunShot Goals of DOE CSP Program

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- Solar receiver on-sun testing
- **Heliostat evaluation and cost reduction; provided data for Loan Guarantee to SolarReserve**

Diverse heliostat designs installed for testing

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Prior Accomplishments

How NSTTF supports SunShot Goals of DOE CSP Program

Objective - Speed deployment of proven technology using this world class test facility – providing tested systems and components, valuable lessons learned, and best practices to research partners

- Solar receiver on-sun testing
- Heliostat evaluation and cost reduction; provided data for Loan Guarantee to SolarReserve
- **Advanced solar material development**

Materials Test Set-up at the Solar Furnace

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Prior Accomplishments

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- Solar receiver on-sun testing
- Heliostat evaluation and cost reduction; provided data for Loan Guarantee to SolarReserve
- Advanced solar material development
- **Dish technology advancement**

Diverse Dish Designs Installed for Testing

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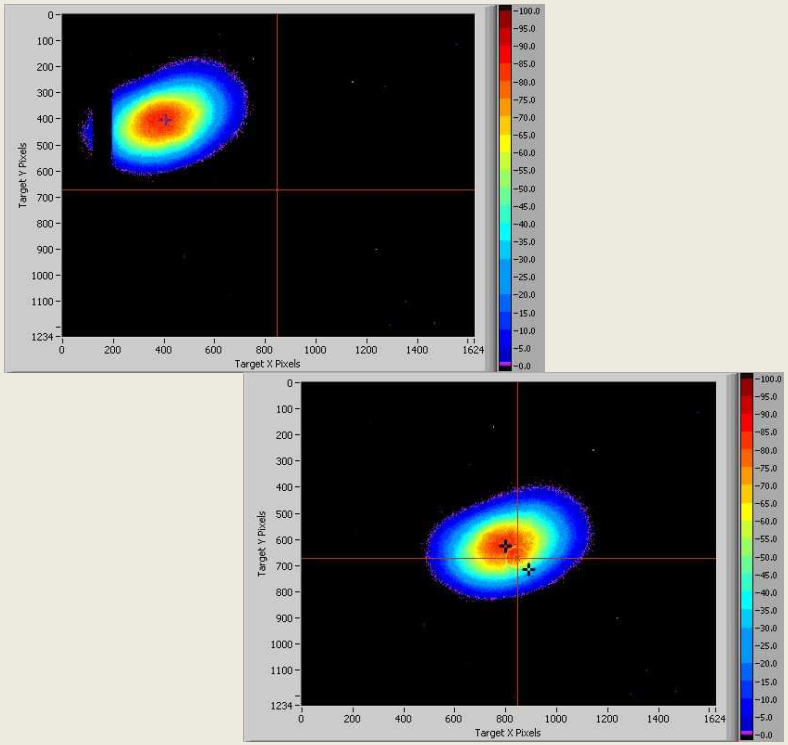
Prior Accomplishments

How NSTTF supports SunShot Goals of DOE CSP Program

Objective - Speed deployment of proven technology using this world class test facility – providing tested systems and components, valuable lessons learned, and best practices to research partners

- Solar receiver on-sun testing
- Heliostat evaluation and cost reduction; provided data for Loan Guarantee to SolarReserve
- Advanced solar material development
- Dish technology advancement
- **Heliostat tracking correction**



BCS Images of heliostat before and after tracking correction model applied

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- Advanced solar material development
- Dish technology advancement
- Heliostat tracking correction
- **Improved Thermal Storage**

Molten Salt Thermal Storage Test Facility

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Prior Accomplishments

Game Changing Technology Adopted by Industry

Technologies Developed at NSTTF	Impacted Companies & Projects
First Molten Salt Receiver Tested On-Sun	Solar 2, Torresol Gemasolar, SolarReserve Crescent Dunes
First Steam Receiver	Solar 1, BrightSource Ivanpah
First Long-shafted Pump Testing	Solar 2, Torresol Gemasolar, SolarReserve Crescent Dunes
Original Test-Bed for Prototype Heliostat Testing	All Tower Plants
Use of Molten Salt Proven (includes extensive corrosion and component testing)	Solar 2, Torresol Gemasolar, Solar Reserve Crescent Dunes, Abengoa Solana, many trough plants in Spain

Many of the Key Technologies of the SolarReserve Crescent Dunes Plant Were First Proven at the NSTTF

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Prior Accomplishments

Recent Accomplishments

- Dish Stirling solar-to-electric efficiency world record - 31.25%

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- Tested first large scale solid particle receiver on-sun

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- First on-sun test of 3M SMF1100 reflective polymer film for heliostat applications

Prior Accomplishments

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- First full-field dynamic modal testing of heliostats for increased reliability

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- Molten salt corrosion testing / materials compatibility – all plant HTF containment material choices based on DOE supported testing at NSTTF

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- Molten salt corrosion testing / materials compatibility – all plant HTF containment material choices based on DOE supported testing at NSTTF
- Long Range Heliostat Target – Only known mobile beam profile and flux measurement target up to 1 mile away

NSTTF Business/Financial Structure

Proposal Request Breakdown of Costs		
Category	**Annual Cost ($K)**	**Description**
Technical Personnel	$1,212	Labor including site engineering, electrician, technologist and training coordination, support for facility maintenance & operation
Vehicles	$139	Operation and maintenance of vehicles Includes: two pickup trucks, three forklifts, two man lifts
General Purchases	$74	This includes small equipment and supply/service purchases based on average of previous years' costs (see back-up slide 1)
Computer Support	$40	Includes: site-specific software (LabView) and computing equipment (heliostat micro processors) necessary for facility operations
Site Specific Training	$35	Training to operate site-specific equipment (e.g. heliostat field & furnace) and manage hazards (e.g. manlift, fall protection, molten salt handling) unique to NSTTF work
Total	$1500	

NSTTF Business/Financial Structure

Required Research and Support Staff	
Role	**FTEs Required**
Electromechanical Heliostat Technician	0.9
Software/Controls Engineer	0.7
Electrician	0.8
Mechanical Technician	0.3
Work Planner	0.8
General Site Support Technician	0.5
Training Coordinator	0.75
Site Engineer/ Coordinator	0.5
Total FTEs	5.35

Although NSTTF Site is 36 years old;
it continues to provides state-of- the-art testing

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NSTTF Business/Financial Structure

Total annual cost of NSTTF operation and maintenance is $3.4M

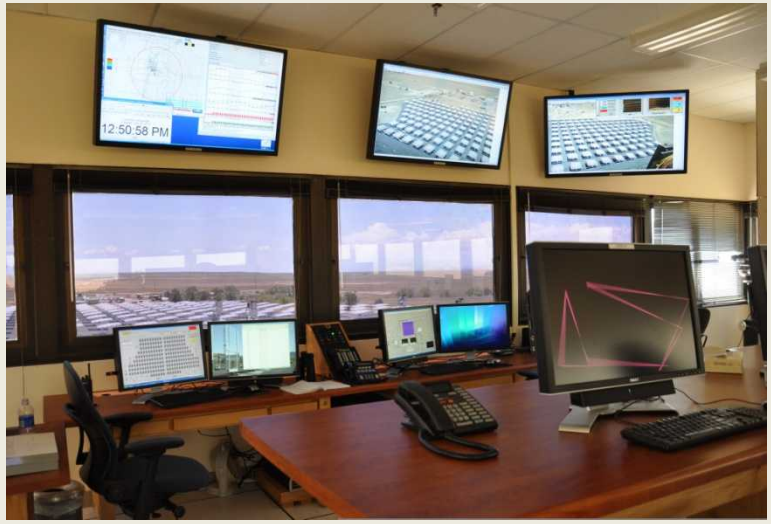
Sandia's annual contribution to total facilities cost is $1.9M

Sandia's contribution includes:

- Building & site maintenance
- Utilities
- Secretarial / Custodial /Portion of managerial support
- Equipment calibration, Site inspections
- Badging and site access

Recent NSTTF cut backs

- Reduced number of site vehicles by 2
- Staff using personal vehicles
- Cancelled contracts
  - porta-potties, rags/coverall cleaning contract, DI water



The control room where on-sun testing of experiments and heliostats are conducted

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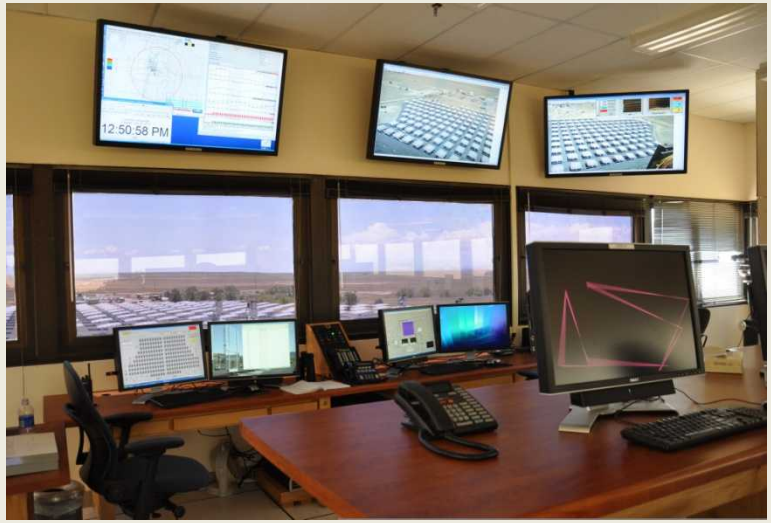
NSTTF Business/Financial Structure

Total annual cost of NSTTF operation and maintenance is $3.4M

Without requested funding

- NSTTF achievement of SunShot goals potentially impaired
- Will lose hundreds of labor-years of test knowledge and important systems-level implementation experience
- Test programs in jeopardy
  - 3M reflective film
  - SolarReserve
  - NREL
  - PWR
  - Thermata
  - Brayton Energy



The control room where on-sun testing of experiments and heliostats are conducted

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NSTTF Business/Financial Structure

Plans to Reduce Reliance on DOE funding

- Sandia will carefully study all aspects of becoming a DOE User Facility in FY13
- Meanwhile pursuing
  - DoD
  - LDRD
  - California Energy Commission
  - Sandia internal research
  - DOE Hybrid and other potential FOA's
- Current Contracts
  - AREVA
  - SolarReserve
  - 3M
  - SunPower
  - Abengoa (pending)
  - PWR (pending)
  - Boeing, NASA

SolarReserve's Mark Speir telling Secretary Chu about the importance of the collaboration between industry and Sandia

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Impact of NSTTF for Achieving SunShot Goals

Impact Description	Capability Utilized
One-of-a-kind on-sun test capabilities in U.S to validate heliostat and receiver developments	Solar tower, heliostat field
Provides test platform for selective absorber on-sun testing, up to 500W/cm2	Solar furnace
Optical performance analysis for reduced cost heliostats, facets, and dishes	BCS, Long Range Heliostat Target, Optics Lab
Allow mid-scale testing – provides path from bench-top to deployment of components	ETF, solar furnace
Utilizing NSTTF reduces deployment risk, thus reducing financial rates and cost	All
Ensure partners meet technical and business goals	All

Unique world class test facility validating new concepts for meeting SunShot Goals

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Impact of NSTTF for Achieving SunShot Goals

Industry Comments from SunShot Grand Challenge Summit

- SolarReserve, eSolar, BrightSource, and AREVA stated in Deep Dive session that testing of components, hardware, and processes at Sandia ***are extremely valuable***

- Company leaders and venture capitalists stated during CSP session that they did not want to implement or invest in technologies "out in left field"

Industry and investors want concepts
that leverage <u>tested</u> or <u>proven</u> technology
… a capability that the NSTTF provides.

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Acknowledgement

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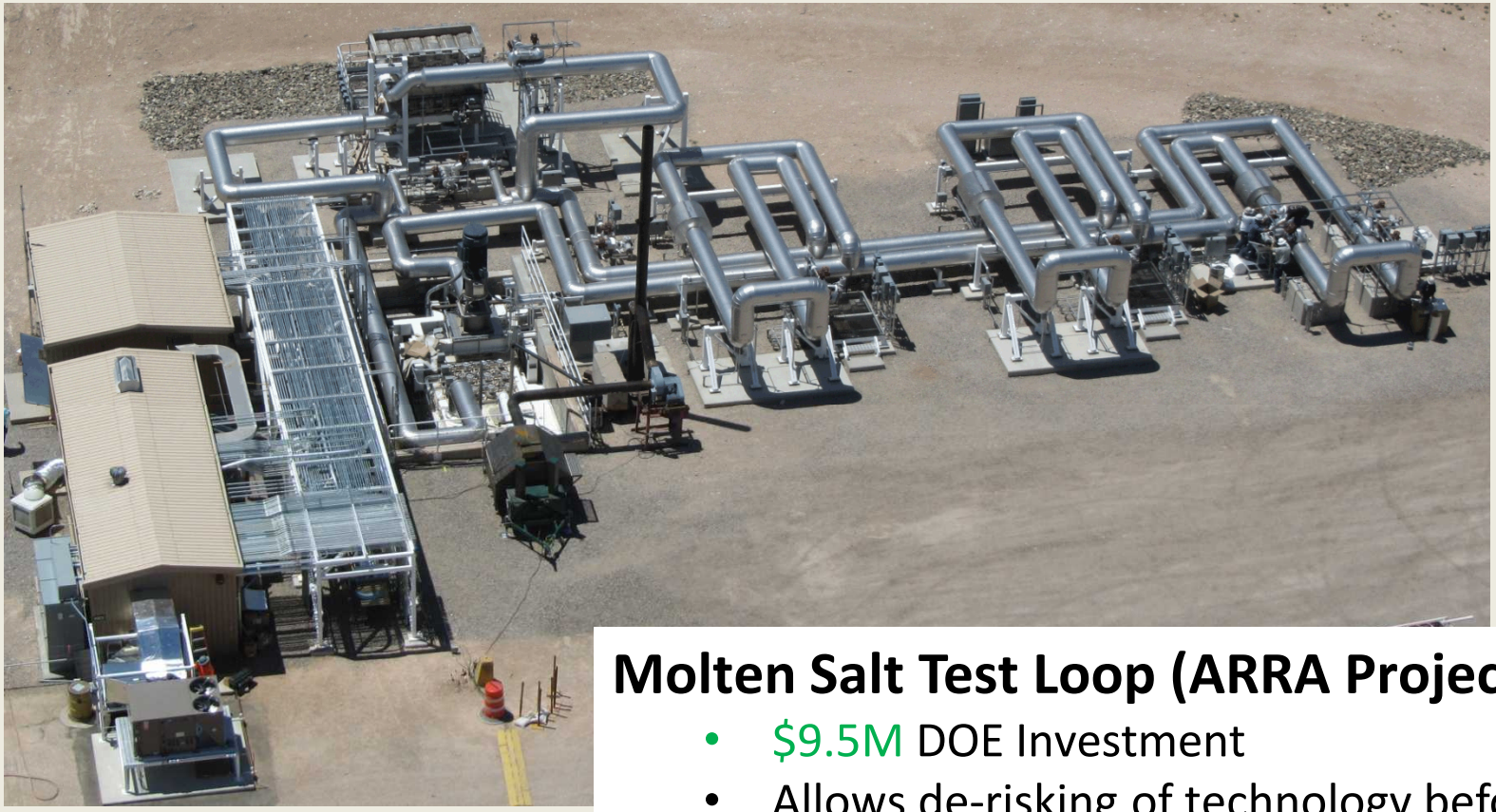
Back-up Slide 1

Purchases

- Power supplies for heliostat field
- Replacement covers for heliostat facets
- Gas/Diesel for vehicles
- Welders, welding rod, gases, set-up tools
- Metal, piping, hardware for repair and fabrication
- Machine tool supplies, repairs, and componentry
- Heliostat drive fluids & components
- Heliostat controller modules, connectors, pins, sockets, cables
- Facet repair equipment, cleaners, adhesives
- Fuses, batteries, thermocouples, extension wire, & connectors
- Heat trace controllers, heat trace, insulation, weather covers
- Safety shoes, safety glasses, Nomex fire (and salt) protection gear
- Hard hats, fall protection harnesses, extreme weather gear

Back-up Slide 2



Molten Salt Test Loop (ARRA Project)

- $9.5M DOE Investment
- Allows de-risking of technology before deployment
- Provides flowing molten nitrate salt up to 600gpm, 600psi, 585C, with 3 test loops

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Back-up Slide 3

Required Research and Support Staff		
Role	Responsibilities	FTEs Required
Electromechanical Heliostat Technician	• Maintains and repairs all hardware for heliostats, dishes, furnace • Maintains and repairs control equipment, including motors, encoders, electronic boxes, and cabling	1.0
Software/Controls Electrical Engineer	• Maintains software and operation of the heliostats • Is integrally involved in diagnosing control problems • Ensuring that the control software is sufficient to meet the many varied needs of customer researchers.	0.7

Electrician	• Supports electrical repair and maintenance of
	  ○ Heliostat field and the solar tower
	  ○ 480V heliostat power
	  ○ Test equipment in the tower with a variety of voltages from 120-480
		0.8

Mechanical Technician	• Tower and site equipment requires periodic equipment inspection, maintenance and calibration for SunShot researchers • Equipment includes; cooling pumps, blowers, control valves, pressure relief valves, generators and air compressors, solar insolation, and flux measuring equipment.	0.3

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Back-up Slide 4

Role	Responsibilities	FTEs Required
Work Planner	• Insures that the basic required work controls and safety documentation are in place to operate the facility. Documents include: • NEPA, emission permits, hazard assessments, Air Force lease documentation, Technical Work Documents, etc.	0.8
General Site Support Technician	• Supervises distribution and maintenance of on-site radios • Orders and coordinates delivery of equipment and supplies (welding gases, hard hats, safety glasses, basic tools, etc.) • Coordinates vehicle and equipment inspection and maintenance.	0.5
Training Coordinator	• Insures that workers meet all of the DOE/SNL- required site-specific training.	0.75
Site Engineer/ Coordinator	• Coordinates all hardware activities on-site and helps to coordinate technician support for each project • Additional duties include space allocation for various projects and insuring operational tools for each activity. Interacts with potential customers in activities including testing assessments, equipment scheduling and assignment, and all contracting paperwork.	0.5

Facilities/Software Overview

- Describe the facilities/software as they are now.
- Provide some background on the work/funding that has gotten the facility/software to the state it is at currently.

Prior Accomplishments

- Goal: In two or three sentences or bullets, clearly and concisely present the research that the facility/software has been used for within the past 5 years.
  - Clearly identify what accomplishments this facility/software has made possible that no or few other facilities/software packages would allow.

Prior Accomplishments

- Clearly identify what accomplishments this facility/software has made possible that no or few other facilities/software packages would allow.

NSTTF Business/Financial Structure

- Describe the research and support staff needed to maintain these facilities/software.
- Describe what the operating cost and capital equipment, if appropriate, are needed for the facility/software.
- Describe plan to reduce reliance on DOE funding through user fees for the facility/software.

Impact of NSTTF for Achieving SunShot Goals

- Describe the impact that the proposed facilities/software maintenance/upgrade will have on enabling the achievement of SunShot goals.

NSTTF Business/Financial Structure

Operating Cost and Capital Equipment Requirements

Brian

- **Site technical personnel** ($1212K, with an annual increase of 4% for inflation)– Includes: site engineering, training coordination, and electrician and technologist support to maintain the facility and keep it in working order to support R&D projects.

- **Site specific training** ($35K) – This includes training to operate site-specific equipment and manage hazards unique to the work performed at the NSTTF.

- **Vehicles** ($139K) – Operations and maintenance of vehicles to support R&D and daily activity at the NSTTF; includes two pickup trucks, three forklifts, two manlifts, and similar transport equipment.

- **Computer support** ($40K) – This includes support of site-specific software and computing equipment necessary for R&D operations at the NSTTF.

- **General site purchases** ($74K) – This includes small equipment and supply/service purchases necessary for site operations and maintenance.

Expand – justication Examples