SAND2021-12098C

SOLAR ENERGY TECHNOLOGIES OFFICE
U.S. Department Of Energy

HelioCon: US Heliostat Consortium to advance low-cost, high-performance heliostat technologies with optimized operation and maintenance (OM).

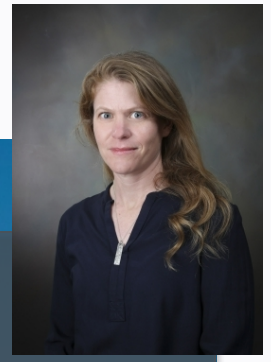
Guangdong Zhu, NREL

Margaret Gordon, Sandia National Labs

Plenary: Solar Field Optimization

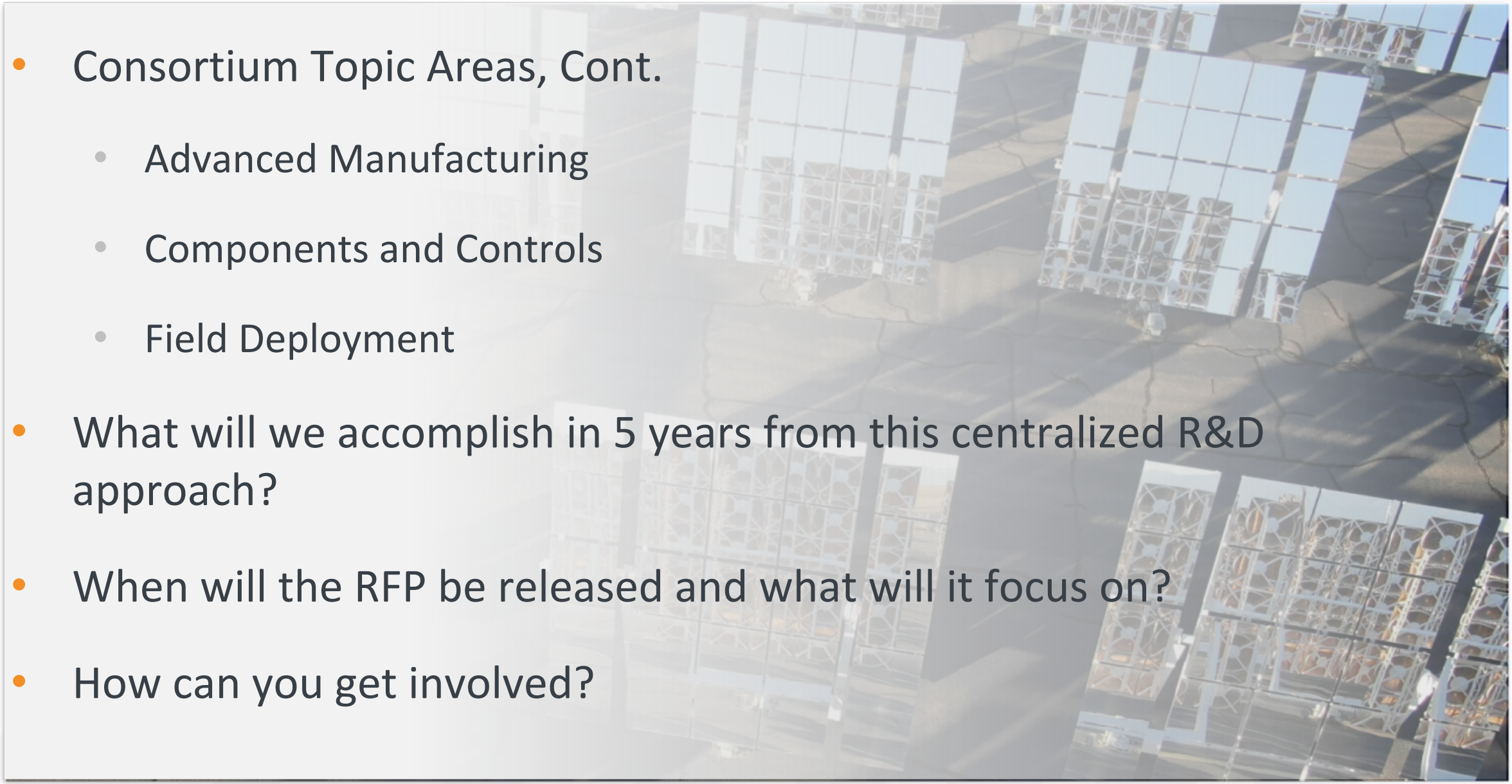
SolarPACES 2021

Introducing – Sandia HelioCon Lead



- Dr. Margaret Gordon
  - Manager of the NSTTF at Sandia
  - PhD Inorganic chemist from Northwestern University, work in hydrogen separation zeolitic membranes, photocatalytic materials, methane hydrates, sorbents, negative thermal expansion materials, composites for photovoltaics
  - Former deputy director of DuraMAT – the PV materials consortium.

Outline, cont.



- Consortium Topic Areas, Cont.
  - Advanced Manufacturing
  - Components and Controls
  - Field Deployment
- What will we accomplish in 5 years from this centralized R&D approach?
- When will the RFP be released and what will it focus on?
- How can you get involved?

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HelioCon – Advanced Manufacturing

Lead: Randy Brost (SNL), Co-Lead: Parthiv Kurup (NREL)

- Manufacturing efficiency is one key to achieving high economic performance.
- Manufacturing and field deployment are tightly integrated.
- Product design is the best opportunity to influence manufacturing cost.
- Design ⇒ process, so multiple designs ⇒ multiple processes.
- Metrology and process control are key to high-quality, high-productivity manufacturing.
- The diversity of heliostat designs make this a hard problem:

Rigid Mirror

1 Jemalong

Discrete Pads

2 Coalinga

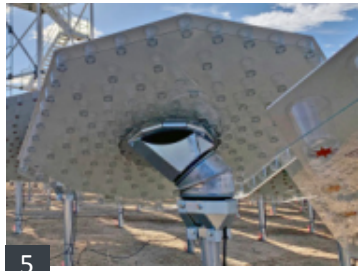
Strut Lattice

3 Luneng Haixi

Stamped Back

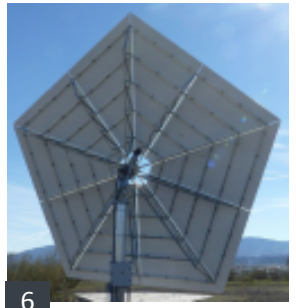
4 Crescent Dunes

Glass Sandwich



5 Heliogen

Radial



6 Hami

Roadmap Year 1 goal: Conduct heliostat manufacturing gap analysis

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1. ABC News. Jemalong Solar thermal Station CSP Project, Jemalong, New South Wales, Australia. 2019. https://www.abc.net.au/news/2019-06-06/solar-power-energy-renewable-coal-vast/11177714?nw=0. Accessed Aug. 2020.

2. Bright Source Energy. Coalinga Enhanced Oil Recovery, Coalinga, CA. http://www.brightsourceenergy.com/image-gallery#.VvBBbNIrK71. Accessed Aug. 2020.

3. CSP Focus, SolarPaces. Luneng Haixi 50MW Molten Salt Tower CSP Project, Haixi, Qinghai Province, China. 2019. https://www.solarpaces.org/china-connects-its-5th-csp-project-in-climate-push/. Accessed Aug. 2020.

4. Alec Ernest, Chris Clarke, KCET. Crescent Dunes Solar Energy Project, Tonopah, NV. 2017. https://www.kcet.org/redefine/video-offers-a-compelling-look-at-nevadas-largest-solar-plant. Accessed Aug. 2020.

5. Evwind. Heliogen Lancaster Tower, Lancaster, CA. 2020. https://www.evwind.es/2020/02/13/self-aligning-heliostats-arrive-to-slice-concentrated-solar-power-costs/73563. Accessed July 2020.

6. Pfahl, et al. Progress in Heliostat Development. *Solar Energy* **152**, pp. 3-37, 2017. Figure 31.

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HelioCon – Advanced Manufacturing

HelioCon Lead: Randy Brost (Sandia), Co-Lead: Parthiv Kurup (NREL)

- **What are the key outstanding problems in heliostat manufacturing?**
- **What parts/processes are not well supported?**
- **What can HelioCon impact?**
- **What is the most productive use of automation?**
- **Are there any key fundamental manufacturing processes that are bottlenecks for heliostats?**
- **Are there any products or components that would enable improved manufacturing?**

Your input is welcome!
heliostat.consortium@nrel.gov

HelioCon: Component & Controls

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Lead: Ken Armijo (SNL) Co-lead: Matt Muller (NREL)

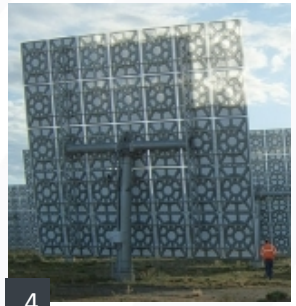
- Reliability of components and controls is critical for favorable financing, operation, maintenance
  - Environmental (wind loading, repetitive motion, rain/snow/hail, dust, UV, temperature cycles) safety, security, repeatable accuracy
  - Requires validated accelerated testing → → →
    - Design & Reliability standards do not exist for Heliostat components and Controls

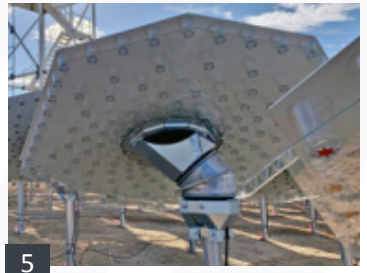
- Components and Controls are tied to manufacturing, optical metrology, and field deployment.
- Opportunity for advanced controls: remote operation, next-gen control algorithms
- Component and materials list is extensive; control systems are custom to each field:

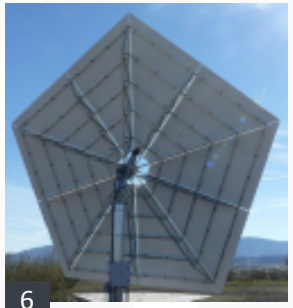

1 Jemalong


2 Coalinga


3 Luneng Haixi


4 Crescent Dunes


5 Heliogen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Topic Area Year 1 goal: Conduct industry survey of components and controls

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HelioCon – Components and Controls

Lead: Ken Armijo (SNL) Co-lead: Matt Muller (NREL)

- **What are the key outstanding problems in component operation?**
  - **Control system operation?**
- **What parts/processes are not well supported?**
- **What can HelioCon impact?**
- **What is the most productive implementation of automation, wireless controls, etc.?**
- **Are there any key fundamental failures in components/controls that cripple heliostat operation?**
- **Are there any key fundamental failures in components/controls that cause a significant safety issue?**
- **Are there any missing capabilities in controls that would enable improved operations?**

Your input is welcome!

HelioCon – Field Deployment

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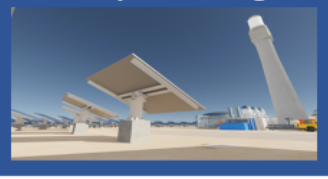
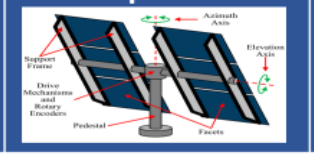
Lead: Mark Speir (SNL), Co-Lead: Alex Zolan (NREL)

- Field Deployment strategies vary widely across all commercial scales
  - Deployment periods over two years are common!

Heliostat Development Cycle	Conceptual Design:	Heliostats Components:	An Integrated Heliostat:	Mass Production of Heliostats:	A Heliostat Field:
					
	• Solar Field optimization • Design guidelines and standards • Resources of past design lessons • Catalog of conditions for size and geo-type	• Prototyping and engineering • **Component installation/ deployment** • **Foundation and installation** cost/time reduction	• Heliostat test protocol & standards • **Simultaneous design of product & installation process** • Full heliostat reduction tech.	• Mass field deployment • **Optical field validation** • High Volume low cost foundation for various soils	• Site layout • Site geo type • **Operation & Maintenance optimization** • **Efficient, low cost installation and initial calibration** • High fidelity site survey

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HelioCon – Field Deployment

Lead: Mark Speir (SNL), Co-Lead: Alex Zolan (NREL)

- **What are the key outstanding problems in field deployment?**
  - **What stages are not well supported? Are field installation time and field calibration time high priorities? What else?**
- **How could automated and semi-automated methods affect field layout and installation, cable/trenching vs wireless, heliostat assembly, initial calibration, commissioning, repair (including in-situ recalibration)?**
- **How could we** Improve predictability of life-time performance models of commercial deployment?
- Optimize O&M, including component replacement, re-canting (if needed), re-calibrating, washing, routine performance monitoring?
- **Adding sensing for real time feedback, fill in unknowns,…..**

Topic Area Year 1 goal: Conduct solar field deployment gap analysis

Your input is welcome!

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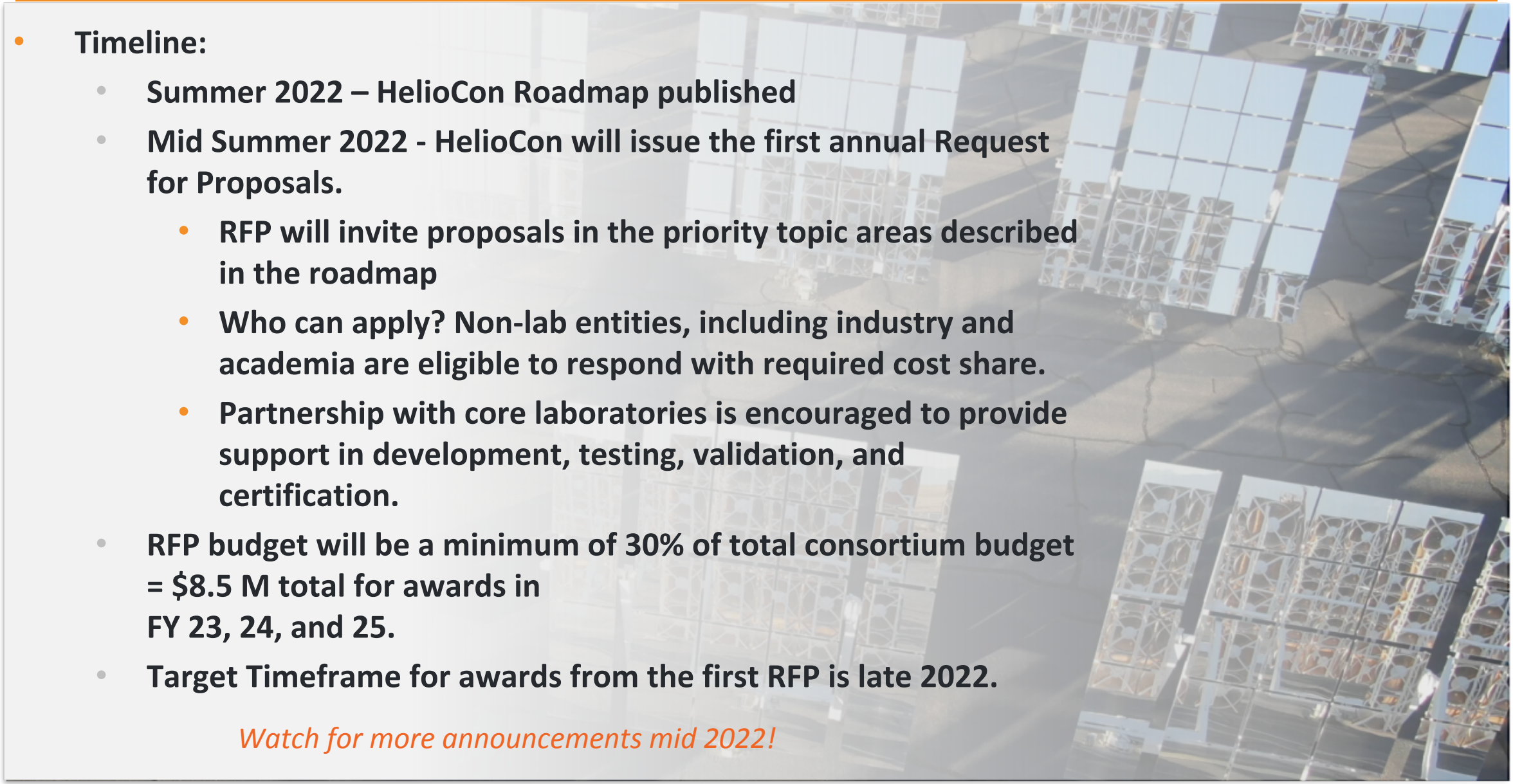
HelioCon Request for Proposals



- **Timeline:**
  - **Summer 2022 – HelioCon Roadmap published**
  - **Mid Summer 2022 - HelioCon will issue the first annual Request for Proposals.**
    - **RFP will invite proposals in the priority topic areas described in the roadmap**
    - **Who can apply? Non-lab entities, including industry and academia are eligible to respond with required cost share.**
    - **Partnership with core laboratories is encouraged to provide support in development, testing, validation, and certification.**
  - **RFP budget will be a minimum of 30% of total consortium budget = $8.5 M total for awards in FY 23, 24, and 25.**
  - **Target Timeframe for awards from the first RFP is late 2022.**

Watch for more announcements mid 2022!

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HelioCon Goals

Why employ a centralized research consortium?

- **HelioCon will link researchers and stakeholders advancing the state of the art in Heliostats – webinars, workshops, etc.**
- **HelioCon will fund research projects that will realize low-cost, reliable, high performing heliostats.**
- **HelioCon will develop specialized capabilities at the core labs to support the heliostat industry**
  - **a full list of accessible capabilities will be on the HelioCon website**
  - **test infrastructures with specifications including working principles, performance metrics, licensing options.**
- **HelioCon will streamline partnership agreements and tech transfer opportunities → transition IP developed in HelioCon to the private sector**
- **HelioCon will make available a public database summarizing heliostat related resources, training and education materials**
- **Annual and Final Reports will summarize research achievements and future perspectives on heliostat research, development, and validation**

Your involvement is welcome!

Questions?
Thank you!

www.nrel.gov **csp.sandia.gov**

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