Characterization of Convective and Particle Losses in High-Temperature Particle Receivers

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Clifford K. Ho
ckho@sandia.gov
Sandia National Laboratories
CPS# 33869

FUNDING PROGRAM: **GEN3 CSP SYSTEMS AND LAB SUPPORT**

PROJECT OVERVIEW

- PI: Cliff Ho, Sandia National Laboratories
- Partners: University of New Mexico, AirPhoton
- DOE Funding: $1.03M (2 years)

SUMMARY STATEMENT

- **Problem statement:** Particle and heat losses occur from the open aperture of a falling particle receiver
- **Resulting solution:** Develop in-situ imaging methods to quantify particle and heat losses; perform exposure assessments to determine inhalation hazards
- **Critical capability:** Sandia has the nation's only solar tower test facility and falling-particle receiver test loop that can be used to test the imaging methods and perform particle exposure assessments

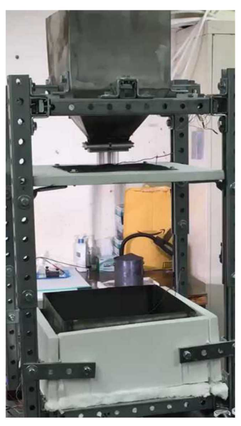
KEY ACTIVITIES

- **Task 1:** Develop imaging methods to characterize particle and heat losses emitted from the aperture of a high-temperature particle receiver
  - Perform bench-scale tests to evaluate imaging methods and develop algorithms
  - Perform on-sun tests of imaging methods
- **Task 2:** Quantify particle emissions using standard air monitoring procedures and compare to OSHA standards (15 mg/m^3)

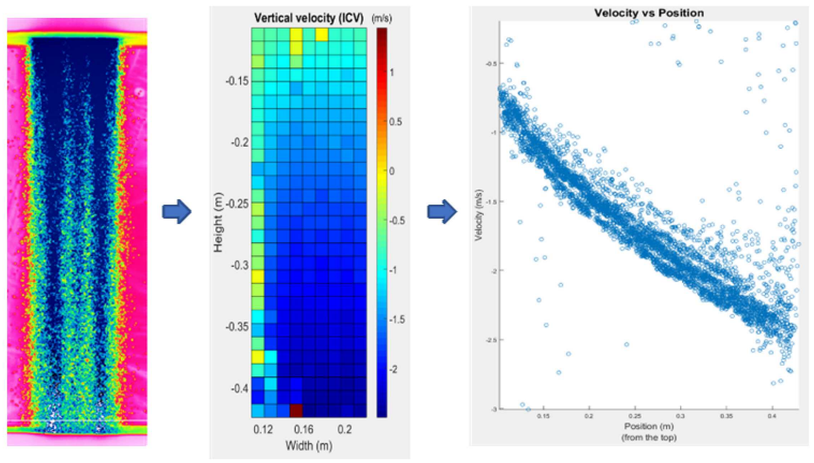
KEY OUTCOMES AND IMPACT

- Identified tools and imaging methods to assess particle and heat losses from receiver aperture
- Performed preliminary imaging tests to extract particle velocities and temperatures
- Performed on-sun test of particle sampling for exposure assessment
- Particle exposure << 15 mg/m^3 (OSHA)
- Identified particle attrition rate and mechanisms
  - PM10 production rate from shaking/fluidization ~1x10-5 % of particle mass flow rate
  - Particle generation due to deagglomeration of pre-existing particles (<1 micron) and mechanical fracturing or abrasion (~8 – 10 microns)

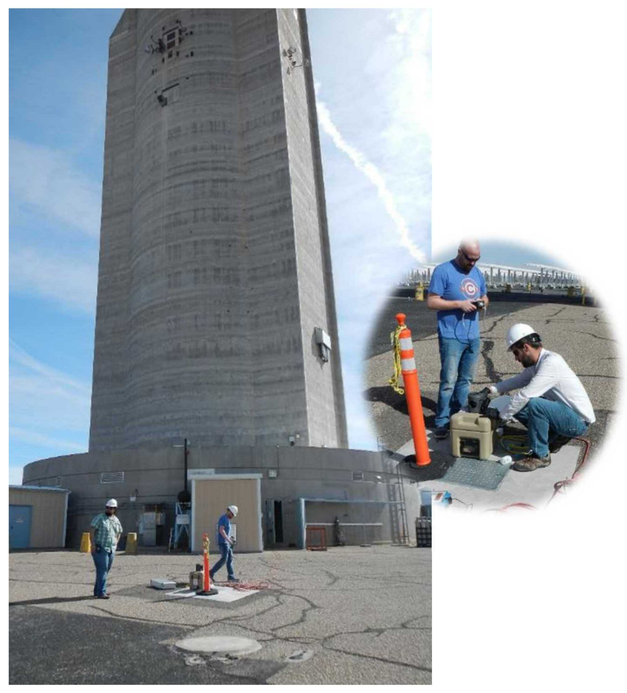
➢ Results will improve and enable safe operation of advanced particle receiver designs to meet DOE goals

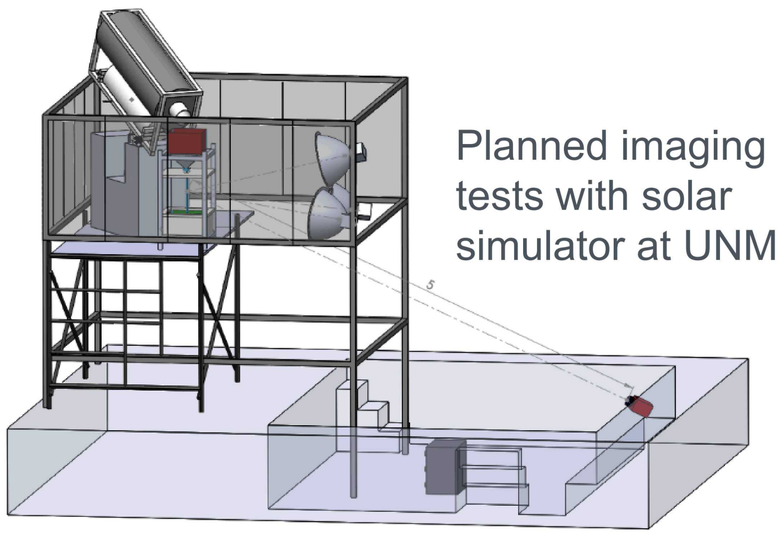


Infratec High-Speed IR Camera (left) and bench-scale test

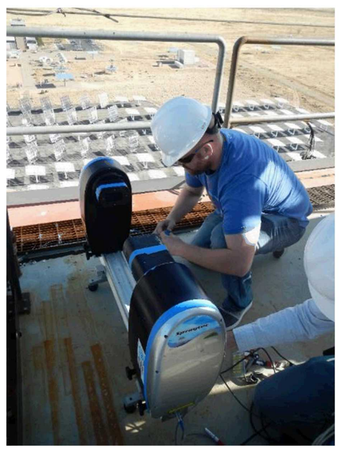


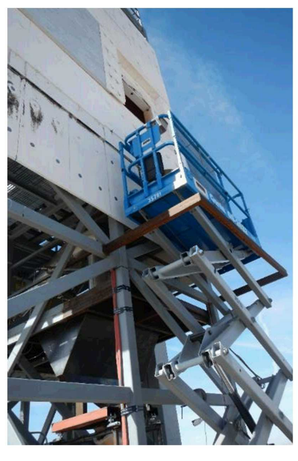
Left: false-color instantaneous image of the curtain. Center: Velocity distribution obtained by image correlation velocimetry. Right: Raw velocity data as a function of downstream distance.

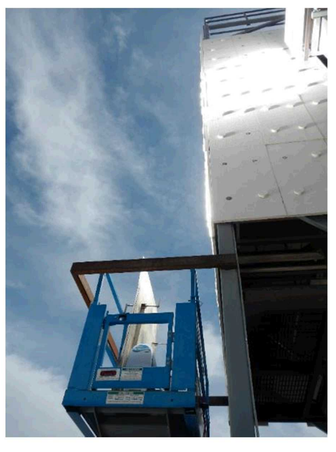




Planned imaging tests with solar simulator at UNM







Left and above: Particle sampling during on-sun particle-receiver tests on top of Sandia's 200-ft tower in 2018

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