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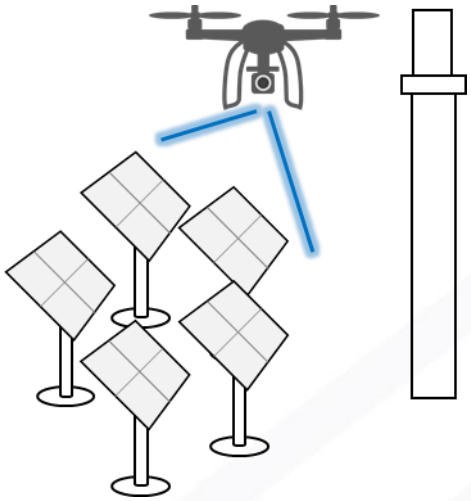
SOLAR ENERGY TECHNOLOGIES OFFICE

SETO CSP Program Summit 2019



Development of a UAS-Driven Universal Field Assessment, Correction, Enhancement Tool Adopting Non-Intrusive Optics

CPS # 3..., 3...

Partners: CU-Boulder, Tietronix

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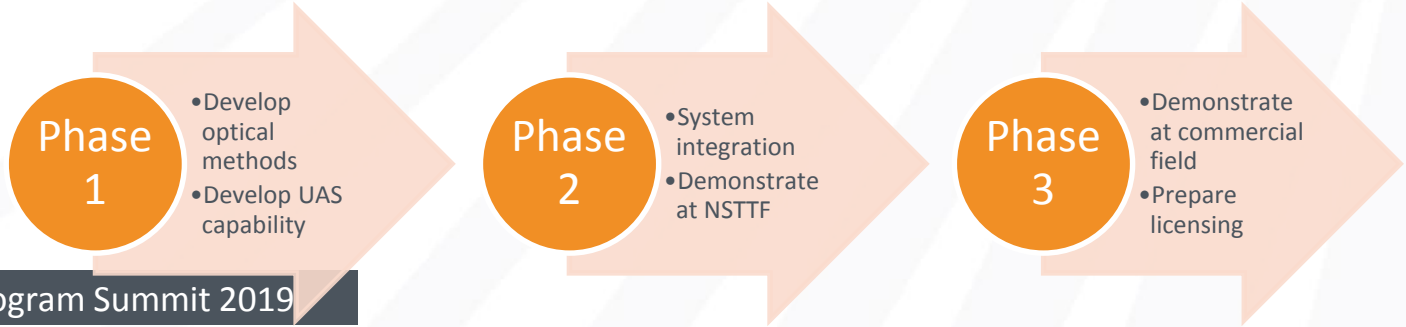
Outline

- Introduction
- Purpose
- Technology Overview
- Optical Methods
  - Near-Field Target Imaging
  - Far-Field Target Image
- Conclusion

Introduction

- The project aims to develop a first-of-a-kind airborne, non-intrusive optical characterization tool for heliostat fields
  - Develop data collection and analysis methods to assess optical performance of heliostat collector fields: slope error, canting error, tracking error
  - Develop capability for airborne assessments using an unmanned aerial system (UAS)
  - Demonstrate at NSTTF and then at a commercial field
  - Advance the concept from TRL3 to TRL6



Purpose

- No tool currently exists that will assess multiple optical errors in a heliostat field efficiently and accurately
- Benefits:
  - Assess heliostat field for optical errors, identify low performing heliostats, and make corrections to those heliostats
  - Frequent monitoring of the heliostat field
    - Quickly identify issues
    - Quantify temporal effects on optical performance
  - Ensure high performance from the heliostat field
    - Consistently achieve needed high temperatures for Gen3 power towers
  - Reduce O&M costs
    - Efficiently and accurately assessing the heliostat field using UAS technology

Technology Overview

Develop flight paths for UAS

- Apply constraints to optimize flight paths

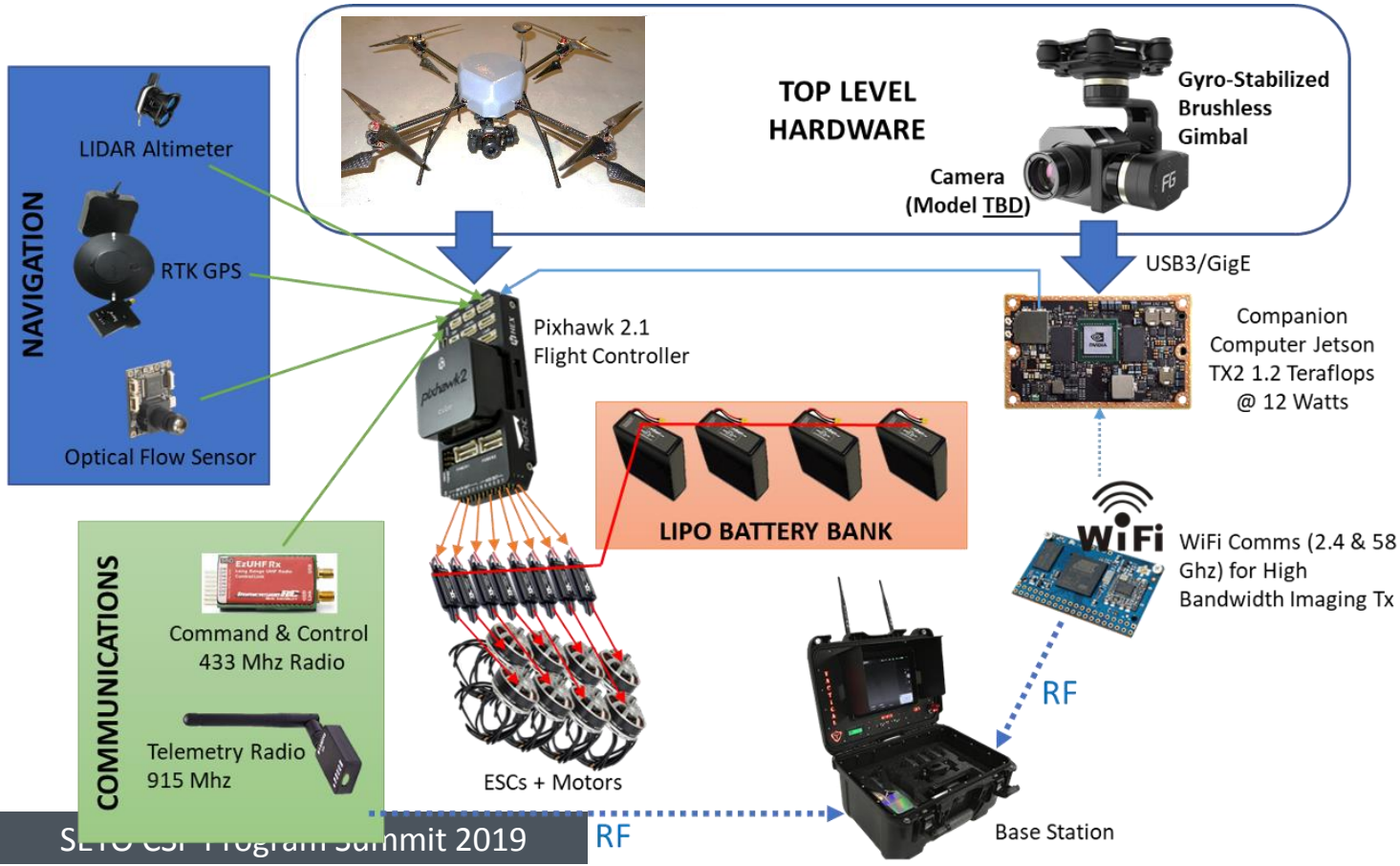
Assess field for optical errors using far-field targets

- Slope error
- Tracking error
- Canting error

Correct canting using near-field target imaging

- Use live video with theoretical target mapping as overlay to provide feedback
  - Stretch Goal – autonomously ID specific correction plan in real-time

UAS Imaging Platform



Criteria

- Positional accuracy
- Stability
- Flight time
- Payload

UAS

- Flybycopters (frame, motors, ESC, props, RTK GPS)

Camera

- 10-12 Mpix

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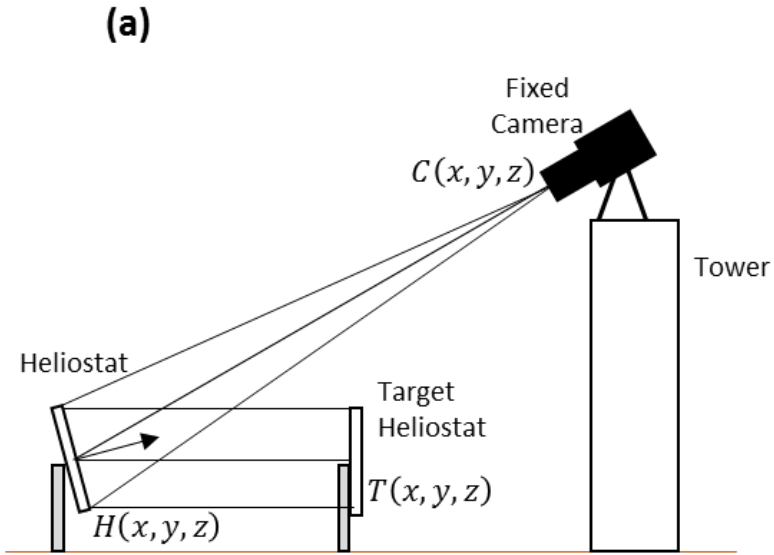
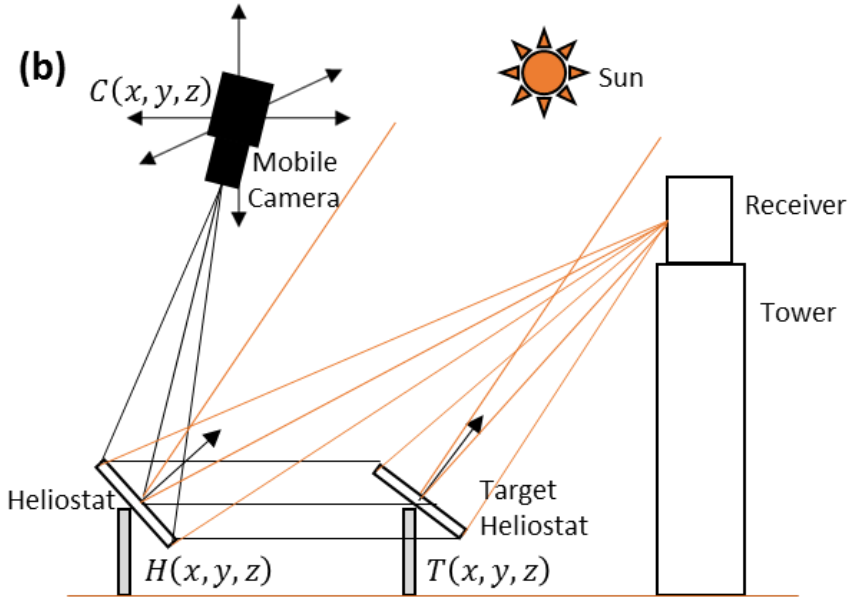
Near-Field Target Imaging (HFACET → UFACET)

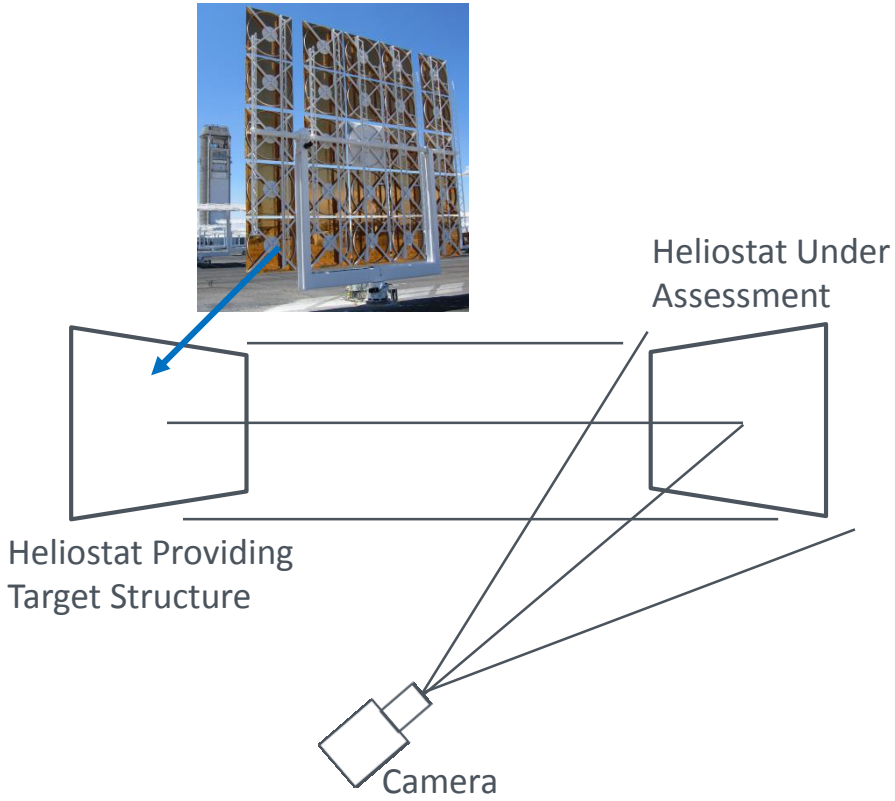


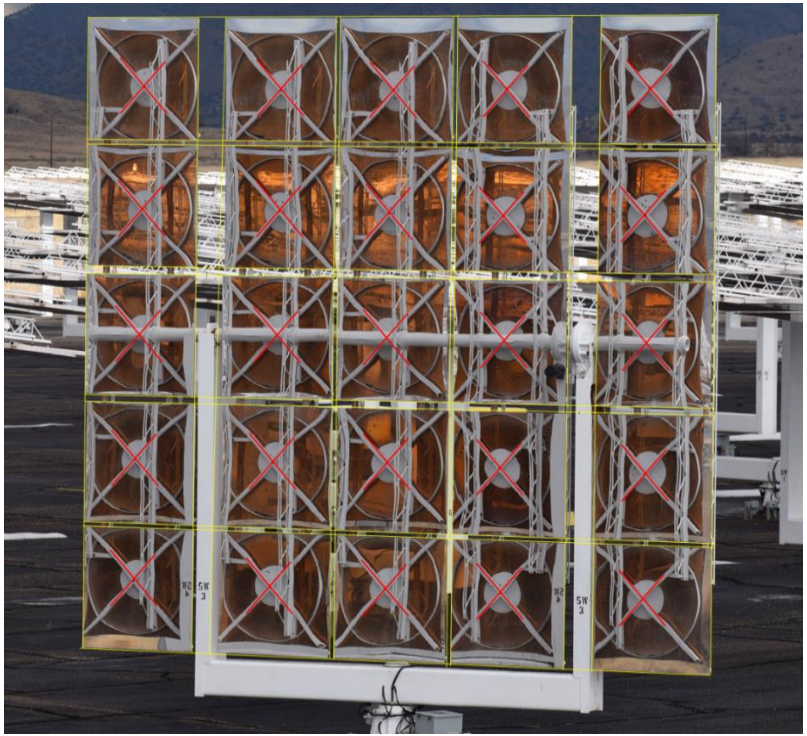
Camera on Fixed Platform – Heliostats Off-Line



Camera on Mobile Platform – Heliostats In-Situ

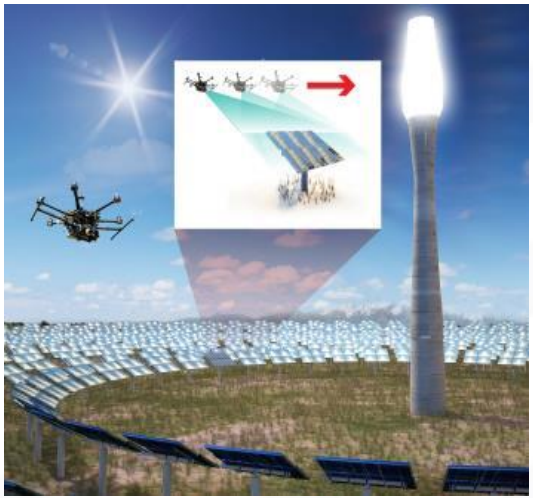
UFACET Analysis





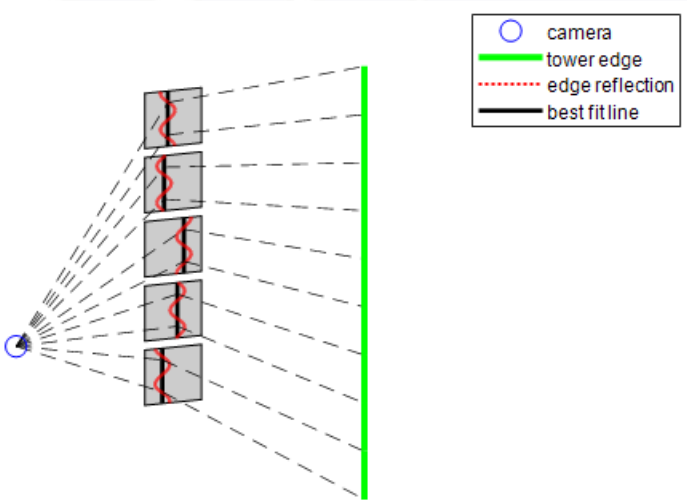
Non-Intrusive Optics Approach (1/2)

- Develop a flexible and non-intrusive optical (NIO) characterization methodology and tool to efficiently survey a utility-scale field without interrupting plant operation



Non-Intrusive Optics Approach (2/2)

- Given a series of images of a heliostat, compare the reflected tower edge in each facet with that of a reference facet with known canting
- Distortions and misalignments of the reflected edge can be measured to calculate optical errors



Conclusions

- Sandia and NREL are developing a UAS-based imaging system to assess heliostats for optical errors using far-field targets
  - Slope errors
  - Tracking errors
  - Canting errors
- Correct canting errors using near-field target imaging for feedback

Questions

Thank you!

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