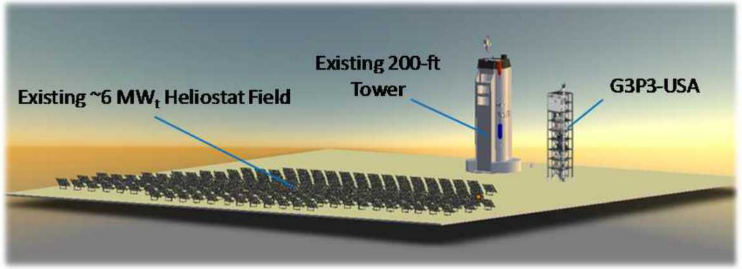
*Presented at the 26th SolarPACES Online Conference*
*September 28 – October 2, 2020*

SAND2020-10216C

# Receiver Design and On-Sun Testing for G3P3-USA

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SAND2020-XXXX

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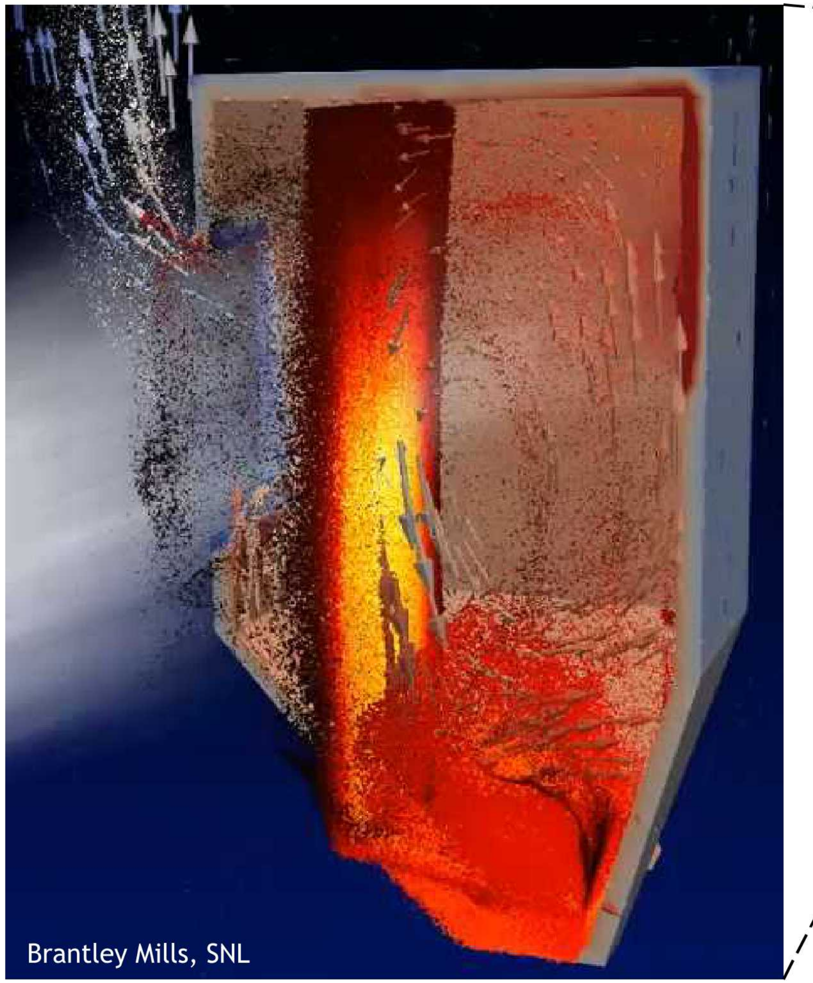
# Overview

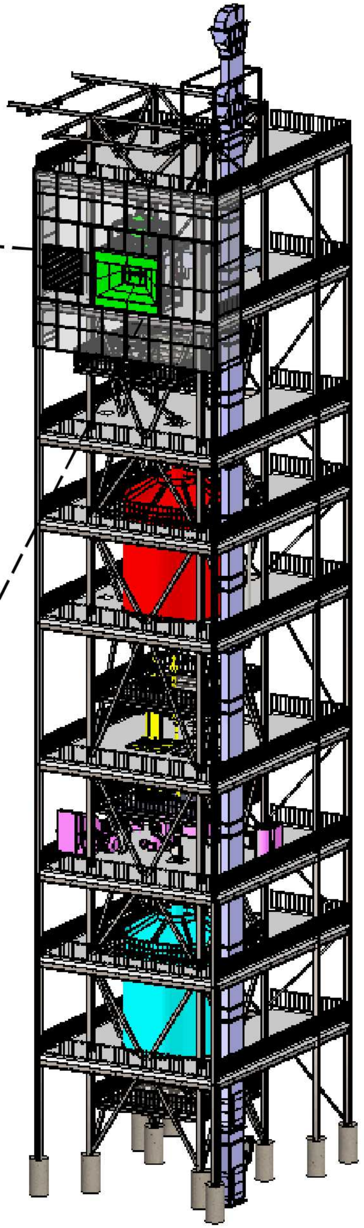
- Introduction and Objectives
- Receiver Design
- On-Sun Testing
- Next Steps

# Introduction

High-Temperature Falling Particle Receiver



Brantley Mills, SNL



K. Albrecht, SNL

**Gen 3 Particle Pilot Plant**

- ~1 – 2 $MW_t$ receiver
- 6 $MWh_t$ storage
- 1 $MW_t$ particle-to-$sCO_2$ heat exchanger

# Objective

- Develop new design features to improve receiver thermal efficiency
- Perform on-sun testing to evaluate performance of new design features and obtain operational experience

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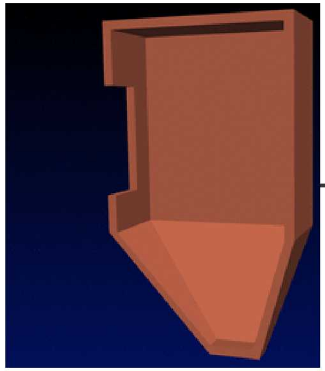
# G3P3-USA Receiver Design Evolution

2015 – 2018

NSTTF
1 $MW_{th}$ FPR



Design Challenges
- Low thermal efficiency
- Sensitivity to wind

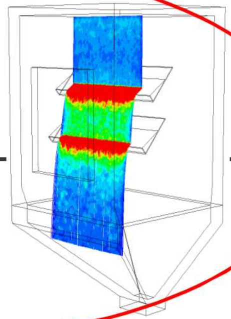
FPR = Falling particle receiver

**Feature evaluation**

- Hood/Tunnel
- Quartz Half Shells
- Active Air Flow
- Multistage
- Optimized Cavity

Reduced volume with SNOUT

StAIR Receiver



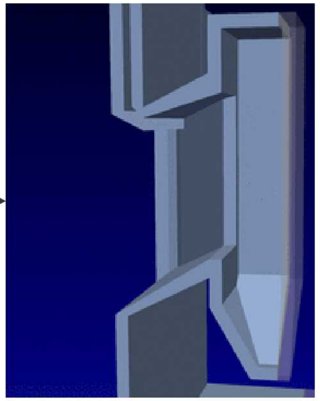
**Design refinement**

- Receiver Chimney
- Ray Tracing Analysis

2020

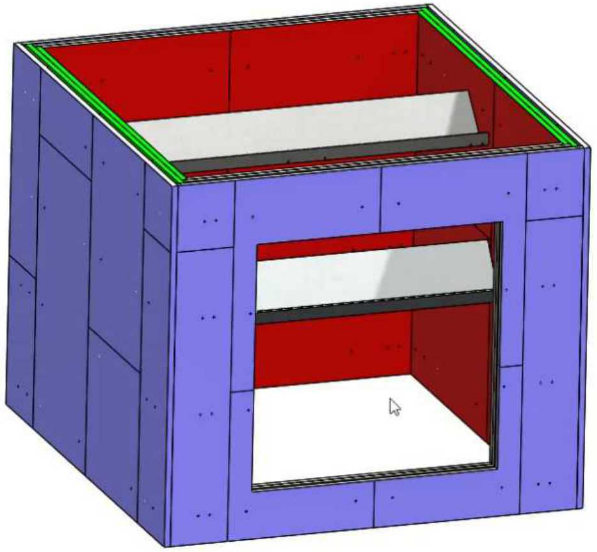
**Design evaluation**

Optimized G3P3 FPR



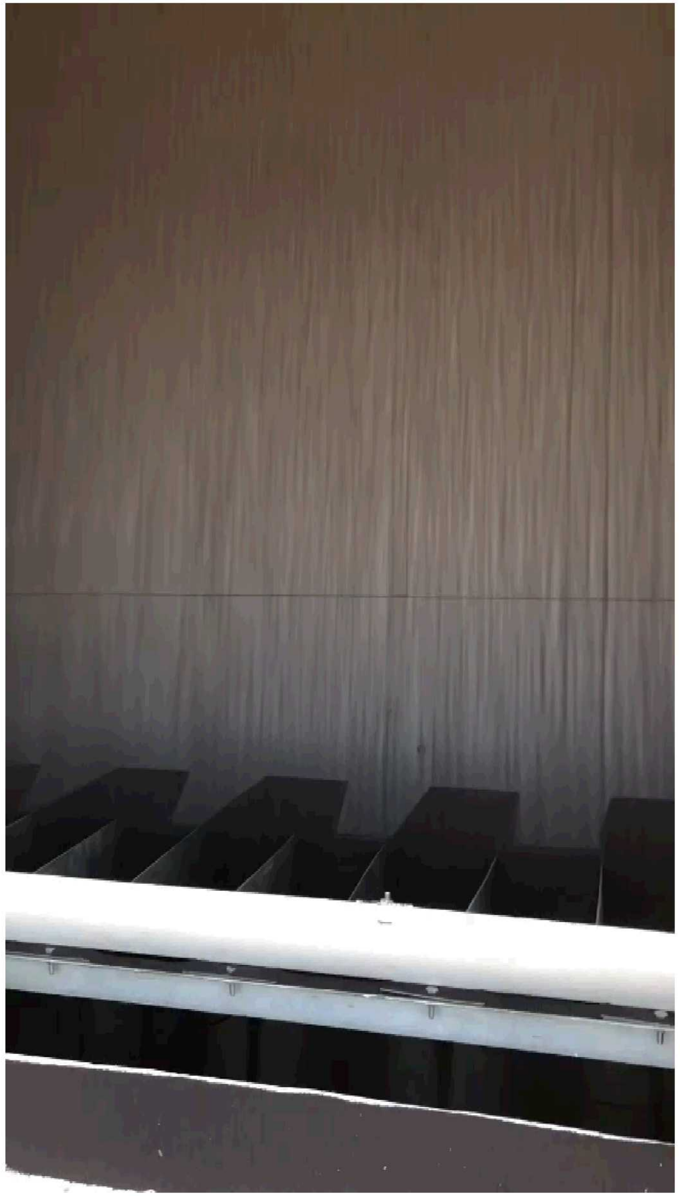
Pathway
- Wind Evaluation
- Ground Testing
- On-sun Testing
- Model Validation

# Stair Testing

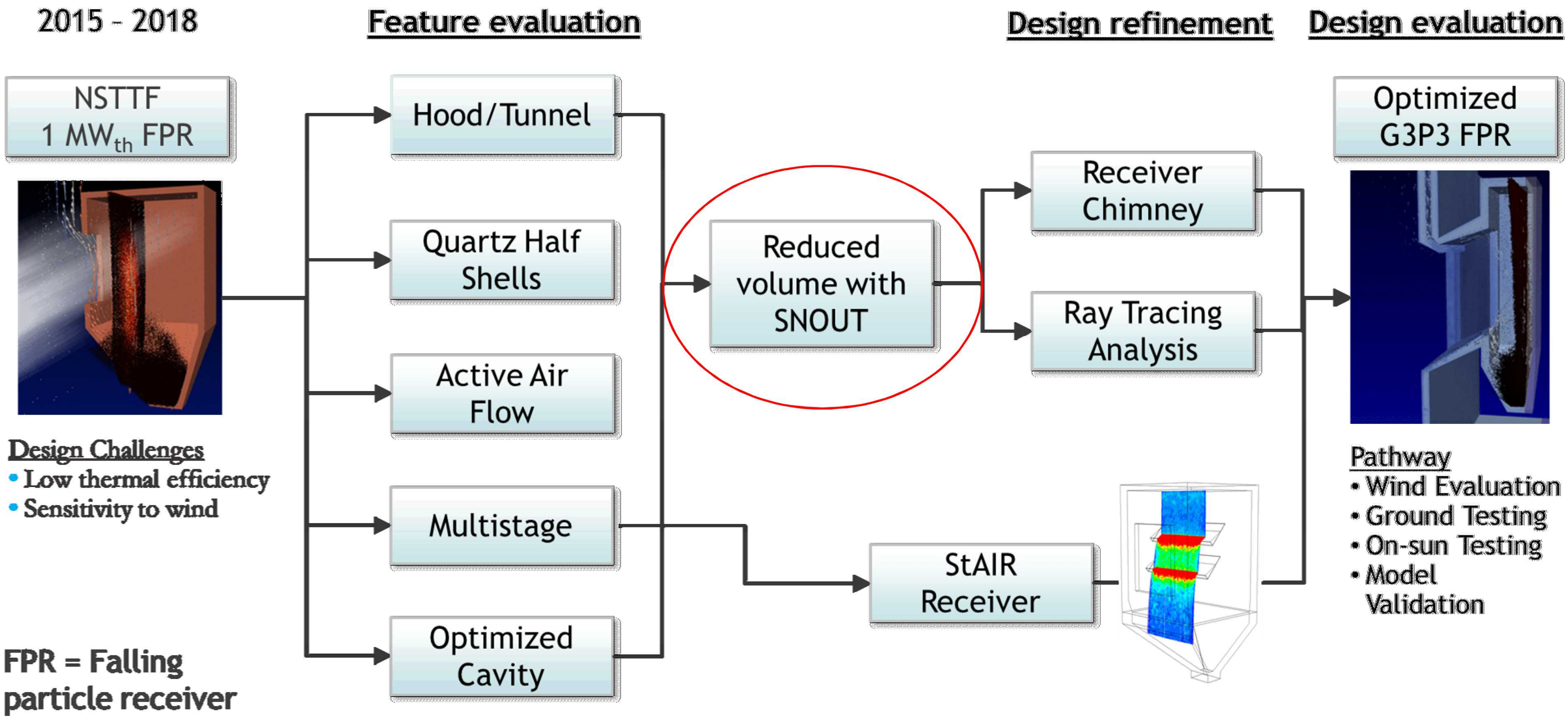


Drawing of “stairs” in receiver cavity

Particle flow over two-stair configuration (5 – 10 kg/s)



# G3P3 USA Receiver Design Evolution

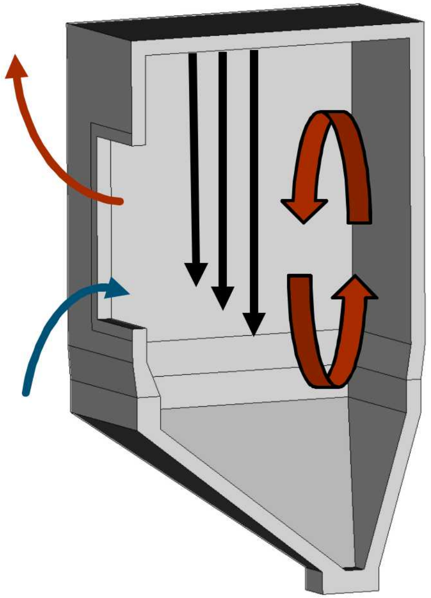


# SNOUT and Reduced Volume Receiver

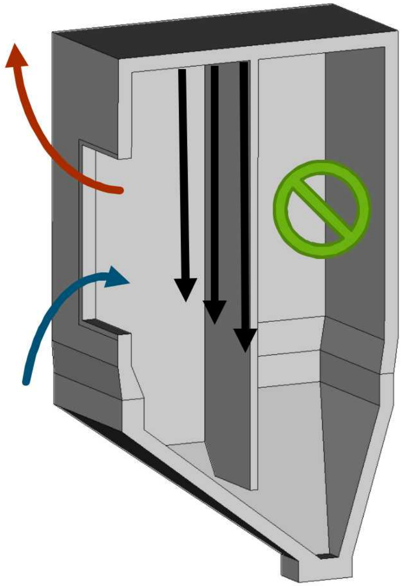
Baseline

SNOUT

Baseline



Reduced volume receiver



Experiment

Simulation

SNOUT and reduced-volume reduced advective heat loss by ~20 – 25%

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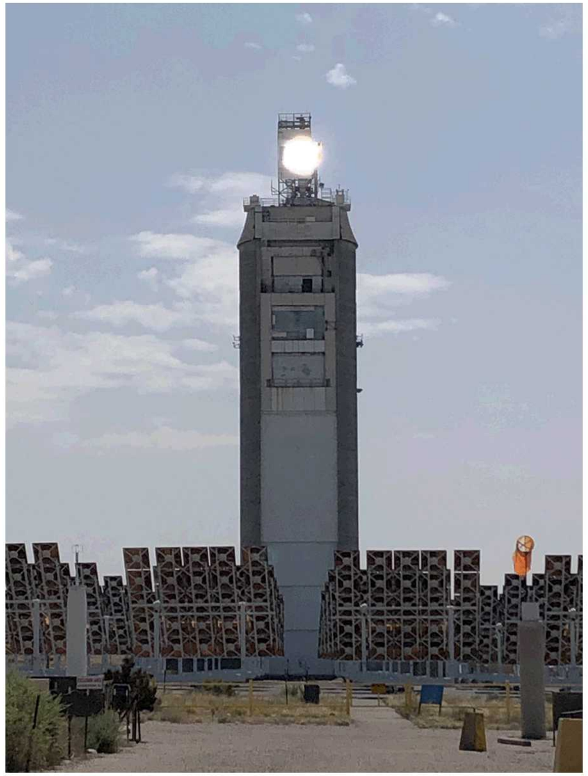
# Control Room and On-Sun Testing

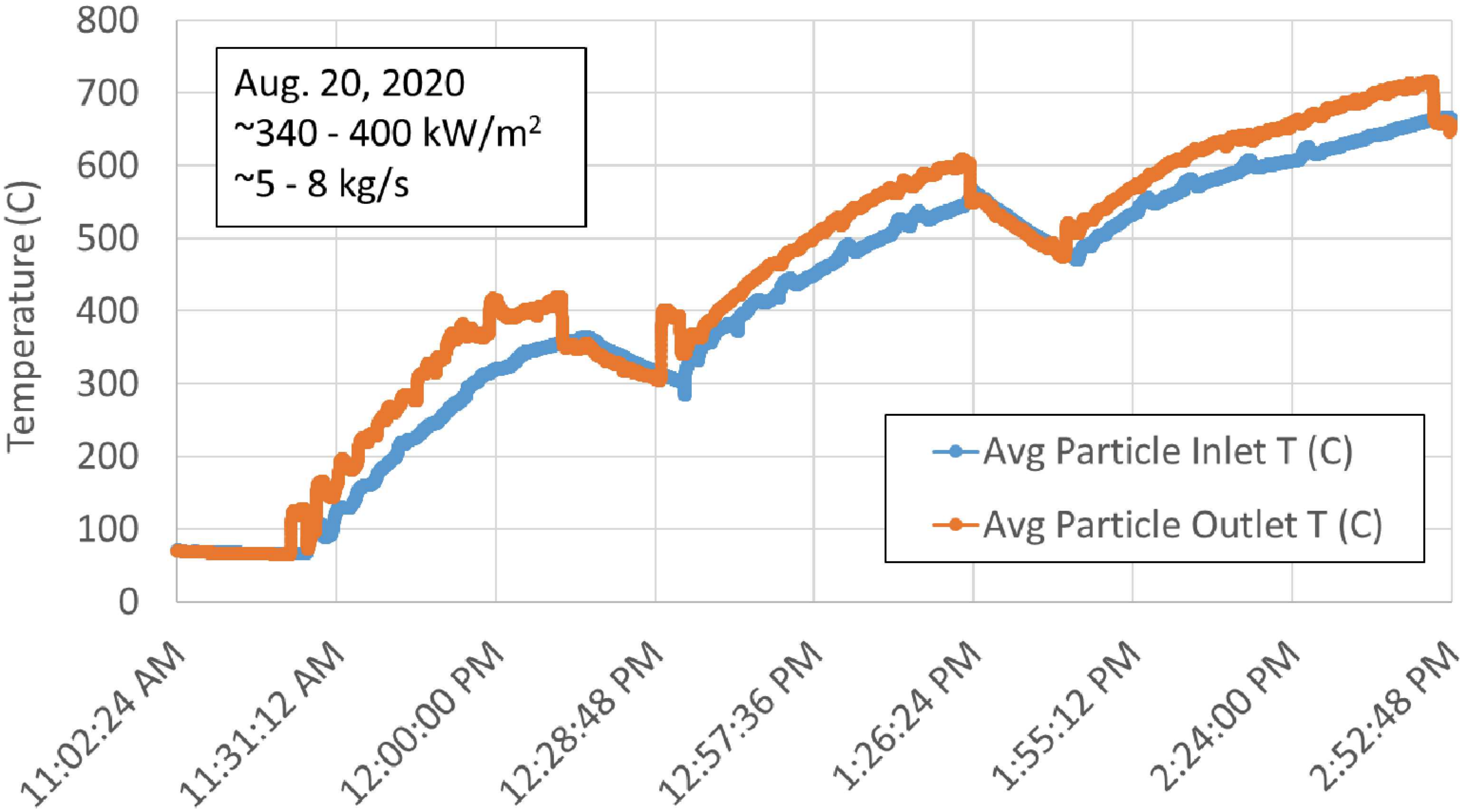



On-sun testing of particle receiver with StAIRs and reduced volume

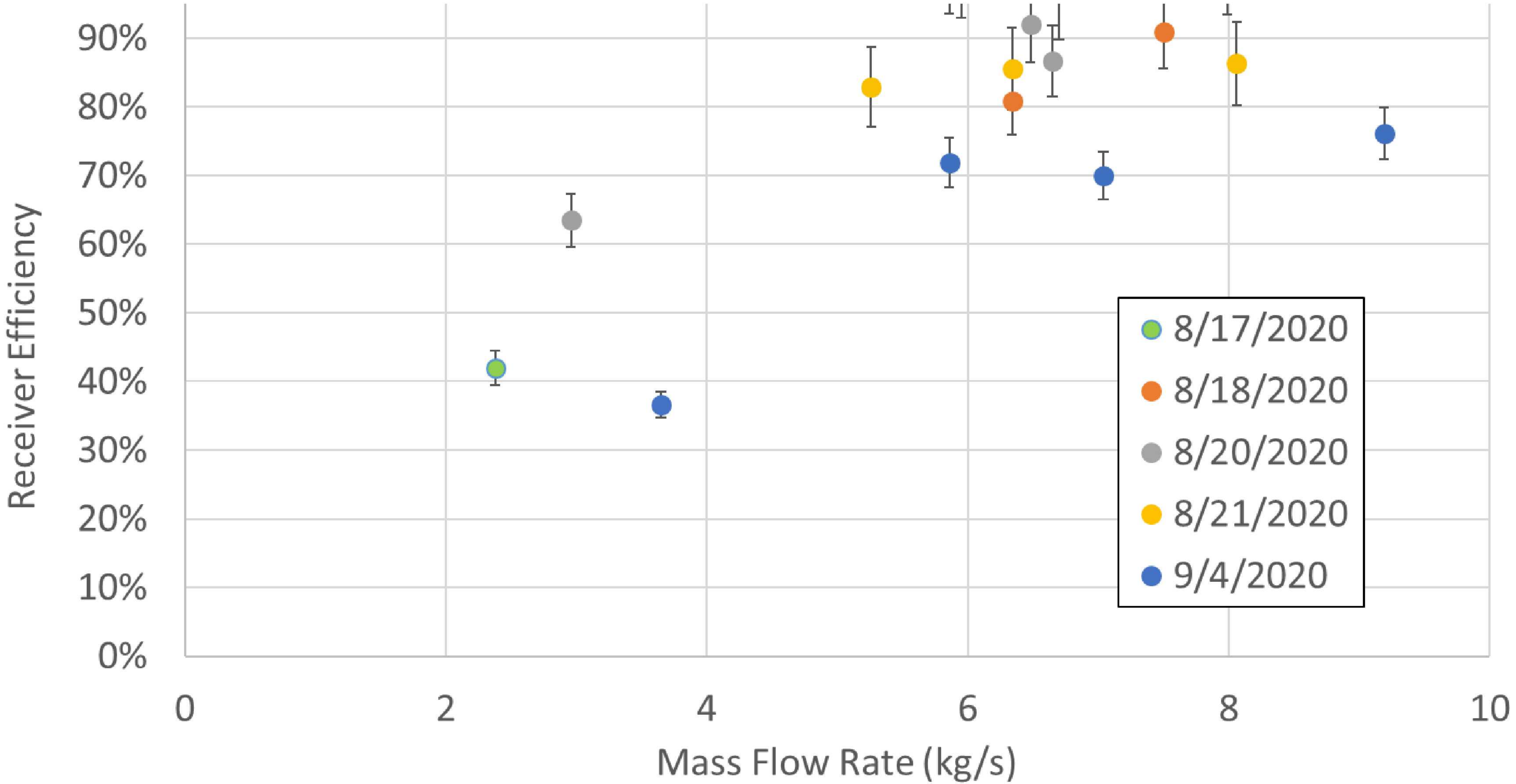
# Summary of Tests (until Sep. 4)

| Date | Start | End | Description | Weather |
|---|---|---|---|---|
| 17-Aug-20 | 11h00 | 14h30 | Receiver testing 500°C and 700°C, peak flux of 60 and 115 W/cm^2, two stairs | Very windy afternoon, Some cumulonimbus clouds |
| 18-Aug-20 | 11h00 | 14h30 | Receiver testing 500°C and 700°C, peak flux of 60 and 115 W/cm^2, two stairs | Hazy from smoke |
| 20-Aug-20 | 10h30 | 15h00 | Test load cells, 50 W/cm^2, 500-600 °C, test single stair, top stair only | |
| 21-Aug-20 | 10h30 | 14h00 | Receiver testing, load cell troublehooting, single top stair | Hazy from smoke, low DNI |
| 4-Sep-20 | 10h30 | 15h00 | Receiver test day, 500C @ 5kg/s and 10 kg/s, with 50 W/Cm^2<br>700C @ ±5kg/s and 50 W/cm^2<br>700C at 108W/cm^2 | Good DNI clear skies |

# On-Sun Particle Temperatures



# Preliminary Receiver Efficiencies



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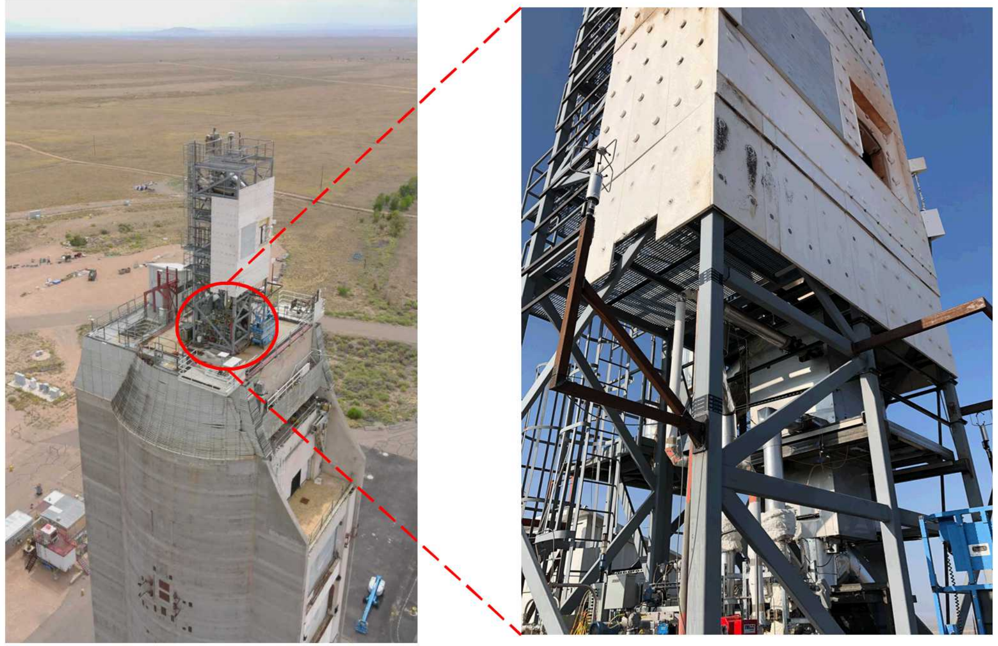
# Next Steps

- Perform additional on-sun tests with clear days and more reliable mass flow rates
- Evaluate impact of wind speed & direction
- Evaluate impact of reduced-volume receiver and stairs
- Process on-sun data for world's first particle-to-$sCO_2$ heat exchanger



# Acknowledgments

SOLAR ENERGY
TECHNOLOGIES OFFICE
U.S. Department Of Energy


- This work is funded in part or whole by the U.S. Department of Energy Solar Energy Technologies Office under Award Number 34211
  - DOE Project Managers:  Matthew Bauer, Vijay Rajgopal, and Shane Powers