# Particle Challenges and Characterization Needs for CSP

## Gen 3 Particle Pilot Plant (G3P3) for Concentrating Solar Power

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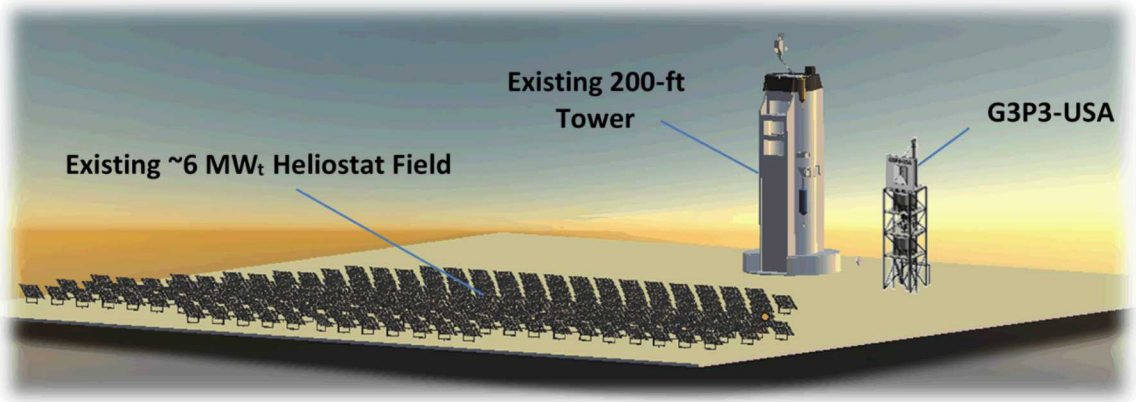
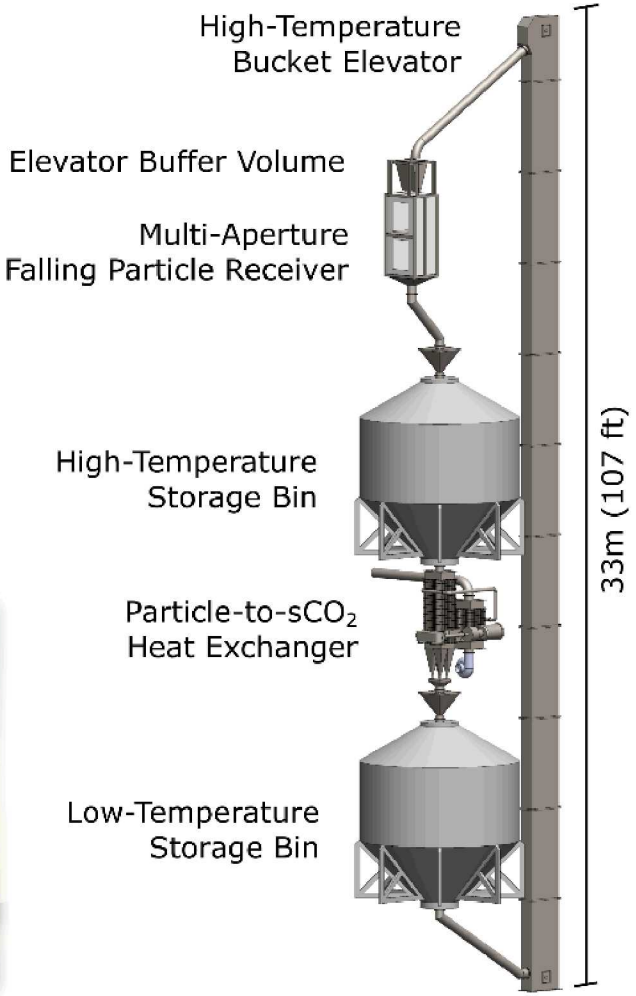
# Gen 3 Particle Pilot Plant (G3P3)

- Received funding for first 2 years of potential 5-year project
  - ~$10M for FY19 – FY20 (R&D, de-risking)
  - Possible ~$25M for FY21 – FY23 (construction and operation of pilot plant)



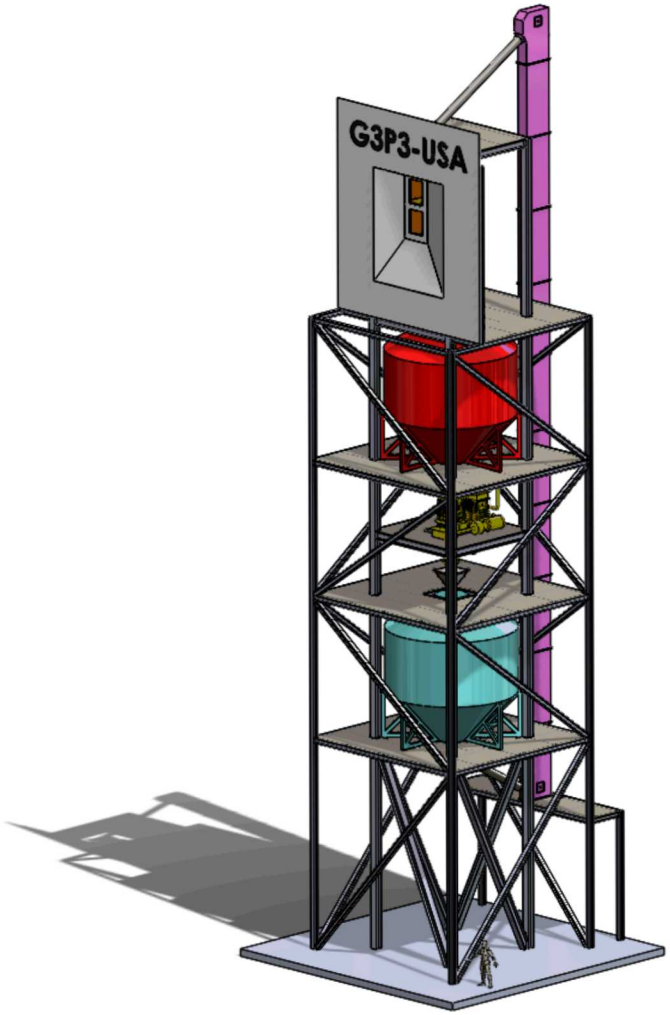

Sandia's National Solar Thermal Test Facility



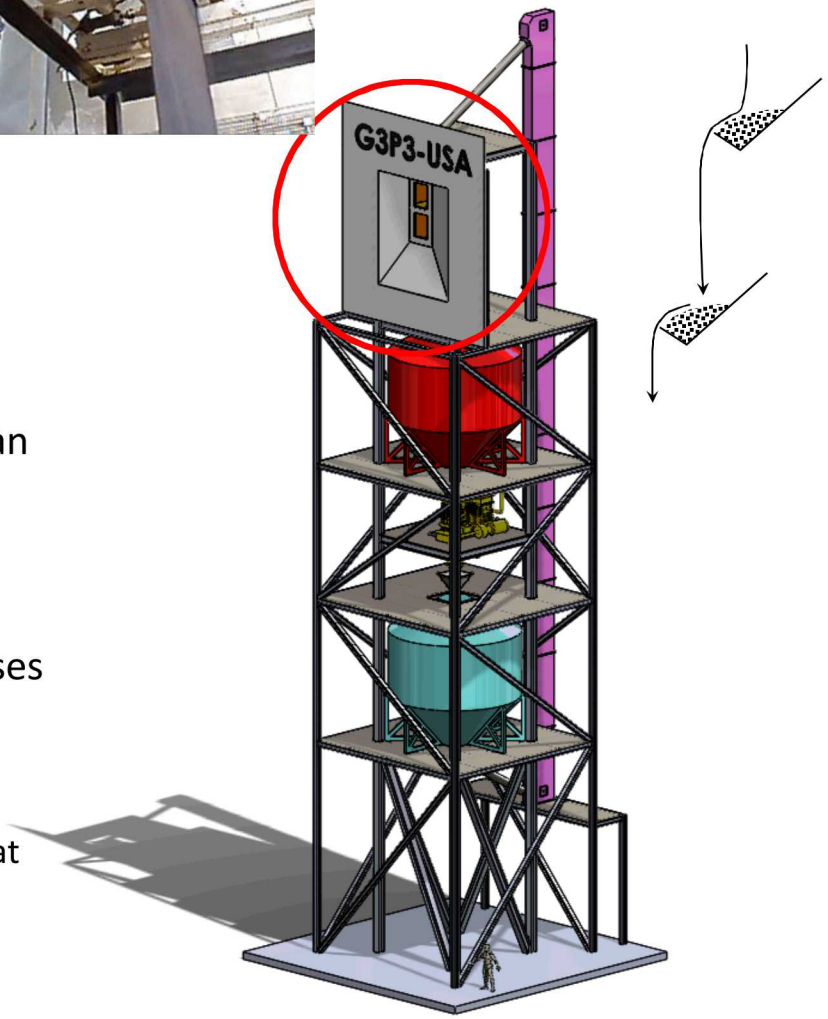

**Proposed G3P3 System**

# Subsystem Components

- Particle Receiver
- Particle Storage
- Particle Heat Exchanger
- Particle Lift & Conveyance



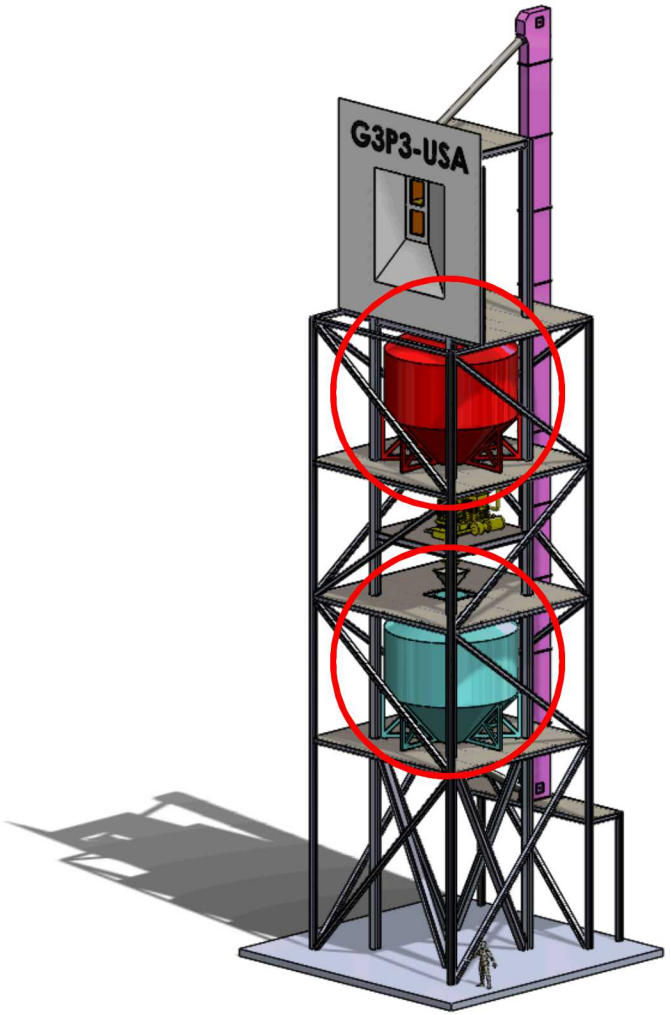
# Particle Receiver




- Mechanical
  - Particle attrition and fines generation
  - Particle coefficient of restitution at elevated temperatures and of different materials
    - Particle/metal, particle/refractories, particle/particle
    - Particles bounce off obstructions and can be lost through aperture
  - Erosion of materials impacted by particles (Tulsa U.)
  - Measurement of particle and convective losses from aperture
- Radiative
  - Particle solar absorptance and thermal emittance at elevated temperatures
  - Light scattering
    - May be relevant for imaging particle and convective losses using IR cameras; interference from concentrating light

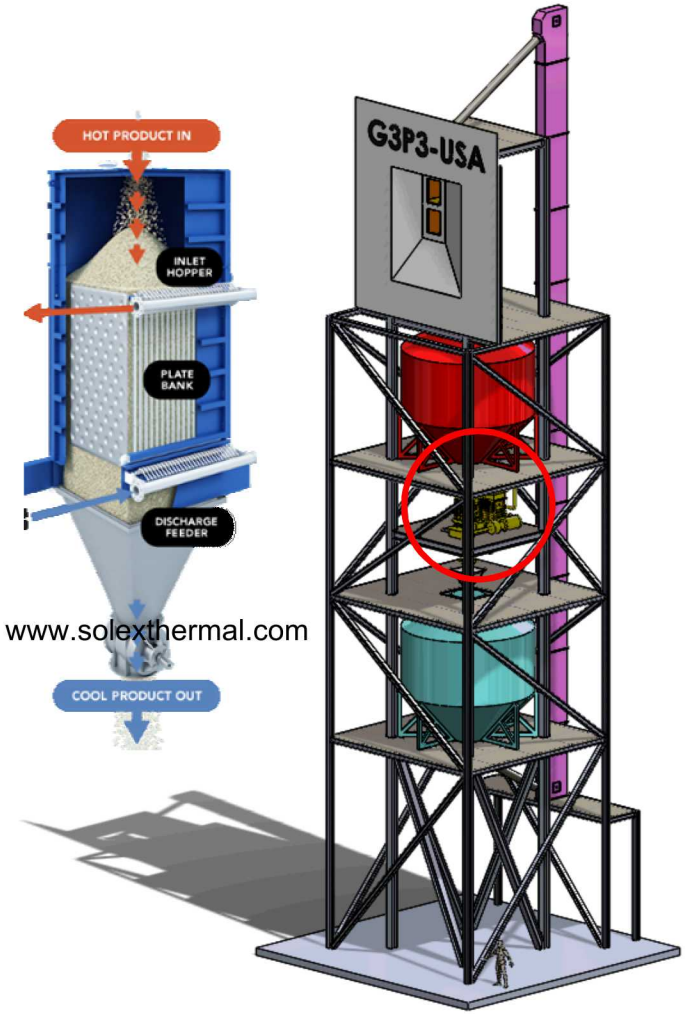
# Storage System

- Particle flowability
  - Particle/wall and particle/particle friction coefficients at elevated temperatures
    - Evaluate different materials
    - Temperatures up to 800 C
- Particle level sensing
- Erosion of refractory insulation by particles (Tulsa U.)
- Particle sintering under expected particle head (Jeter)
- Particle thermophysical properties at elevated temperature
  - Calculation of heat loss



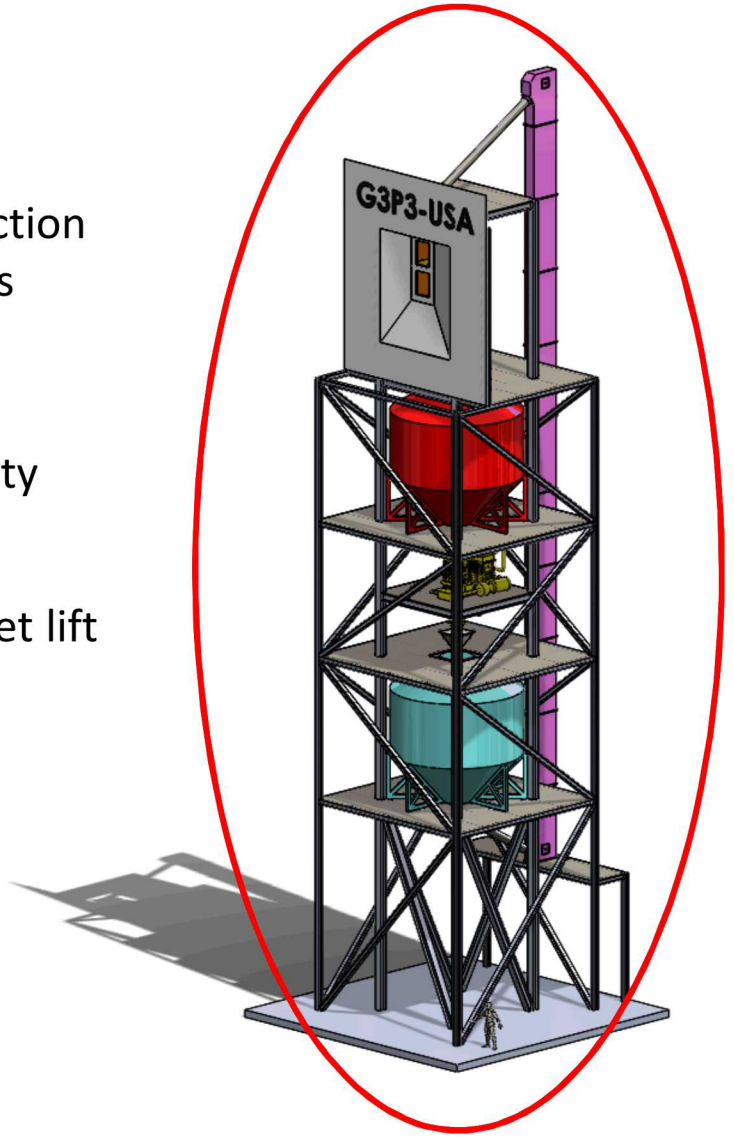
# Particle-to-$sCO_2$ Heat Exchanger

- Particle-side heat-transfer coefficient
  - Measurement/correlation of particle shape/size to heat-transfer coefficient
- Impact of radiation on effective particle thermal conductivity at elevated temperatures up to 775 C
  - Measurement of effective particle thermal conductivity
- Erosion caused by particles (Tulsa U.)
  - Velocity is slow (mm – cm per second)
- Particle flowability and uniformity in narrow channels (Sandia)
  - Debris and clogging

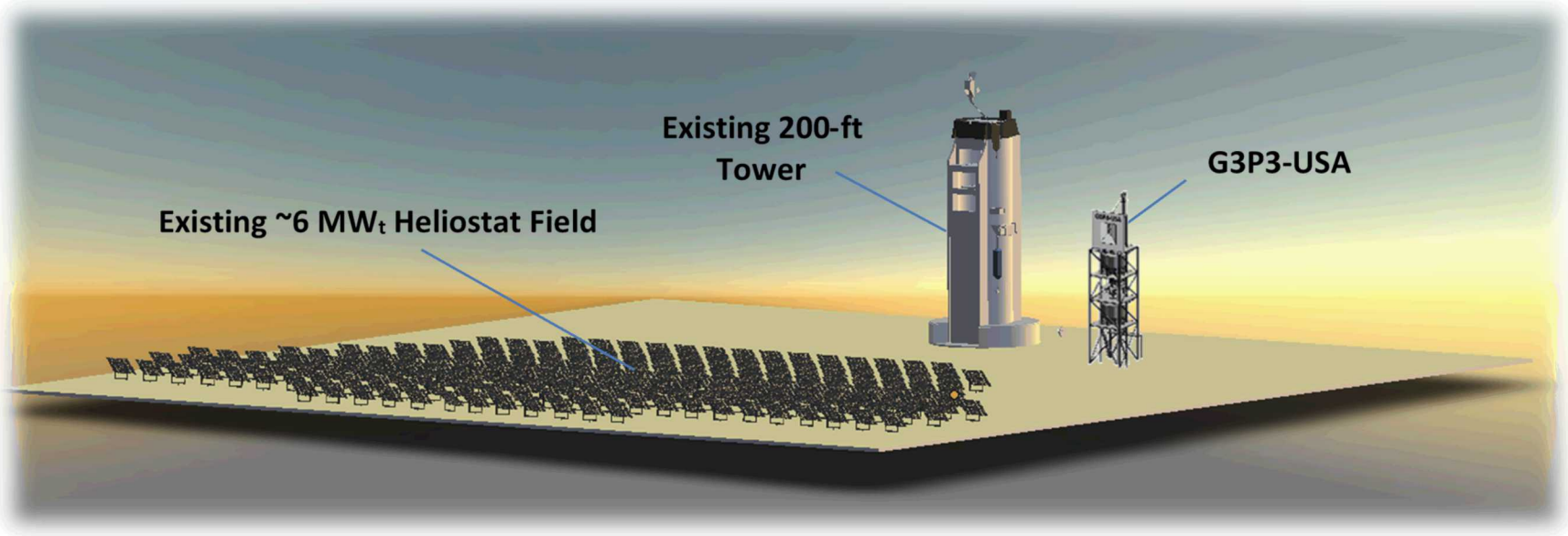


# Particle Lift and Conveyance

- Particle flowability
  - Particle/wall and particle/particle friction coefficients at elevated temperatures
    - Evaluate different materials
    - Temperatures up to 800 C
  - Correlation of shape/size to flowability
- Particle attrition
  - Mechanical abrasion caused by bucket lift
- Erosion of duct materials



# Thank you!

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# CSP and Thermal Energy Storage

- **Hot fluid can be stored as thermal energy efficiently and inexpensively** for on-demand electricity production when the sun is not shining