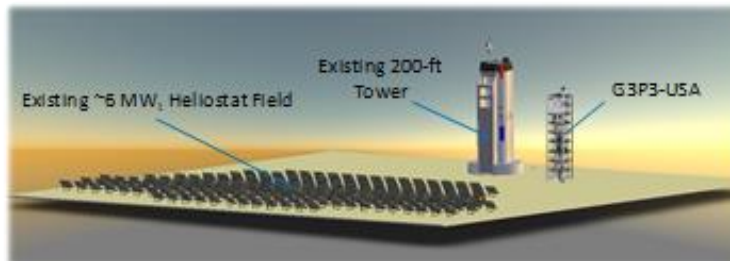


Overview of the Gen3 Particle Pilot Plant (G3P3)



PRESENTED BY

Clifford K. Ho

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Contributors:

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Others: Georgia Tech, King Saud U., SEC, DLR, ANU, CSIRO, U. Adelaide, CNRS-PROMES, CARBO Ceramics, SolarDynamics, EPRI

SAND2021-10301 PE



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Gen 3 CSP Program (FY19 – FY24)



Achieve higher temperatures, higher power-cycle efficiencies, and lower LCOE

Brayton Energy

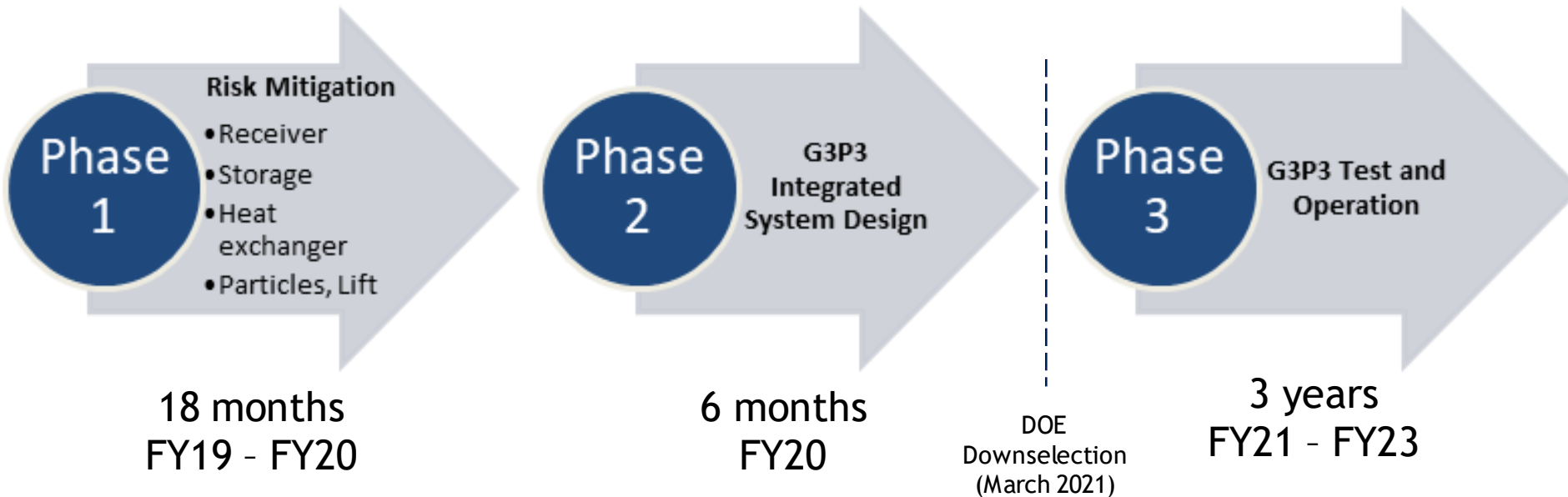
Gas Phase Pathway

NREL

Liquid Phase Pathway

Sandia

Solid Phase Pathway

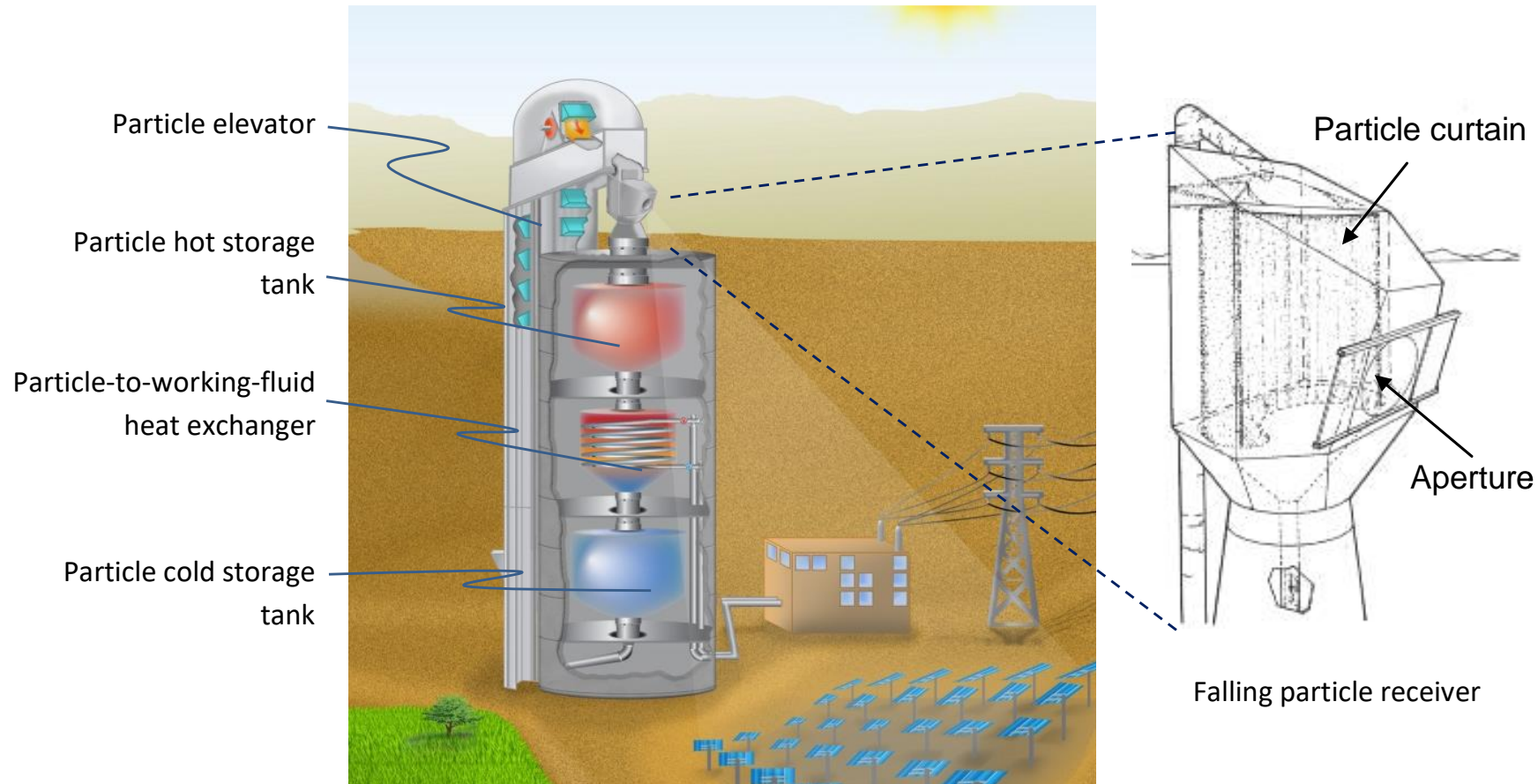


Introduction to the Team



Role	Team Members	
PI / Management	<ul style="list-style-type: none">Sandia National Labs (PI, PMP, financial, facilities)	
R&D / Engineering	<ul style="list-style-type: none">Sandia National LaboratoriesGeorgia Institute of TechnologyKing Saud UniversityGerman Aerospace Center	<ul style="list-style-type: none">CSIROU. AdelaideAustralian National UniversityCNRS-PROMES
Integrators / EPC	<ul style="list-style-type: none">EPRIBridgers & Paxton / Bohannon Huston	
CSP Developers	<ul style="list-style-type: none">SolarDynamics	
Component Developers / Industry	<ul style="list-style-type: none">Carbo CeramicsSolex Thermal ScienceVacuum Process EngineeringFLSmidth	<ul style="list-style-type: none">Materials Handling EquipmentAllied Mineral ProductsMatrix PDM
Utility	<ul style="list-style-type: none">Saudi Electric Company	

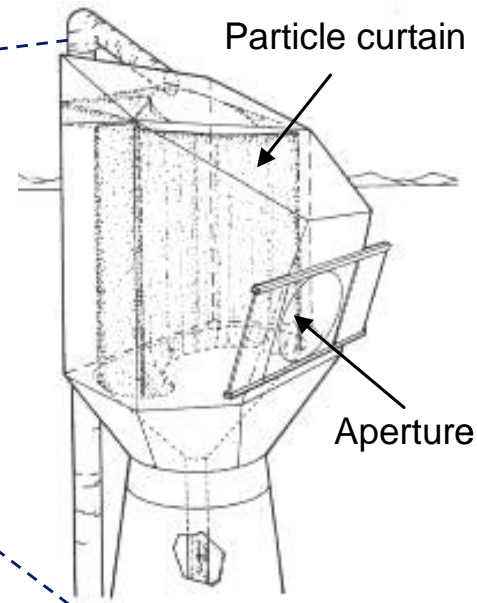
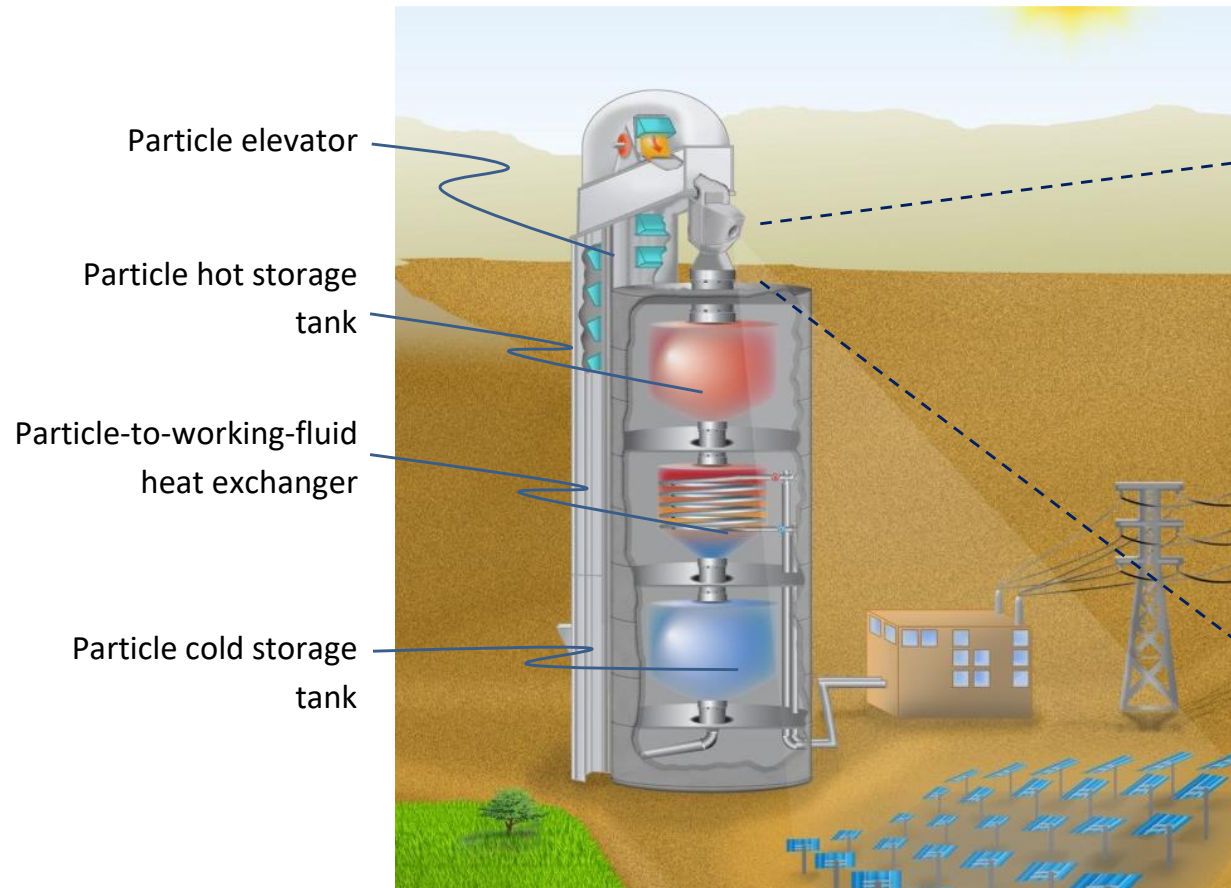
High-Temperature Particle-Based CSP



Background and Value Proposition



High-Temperature Particle-Based CSP

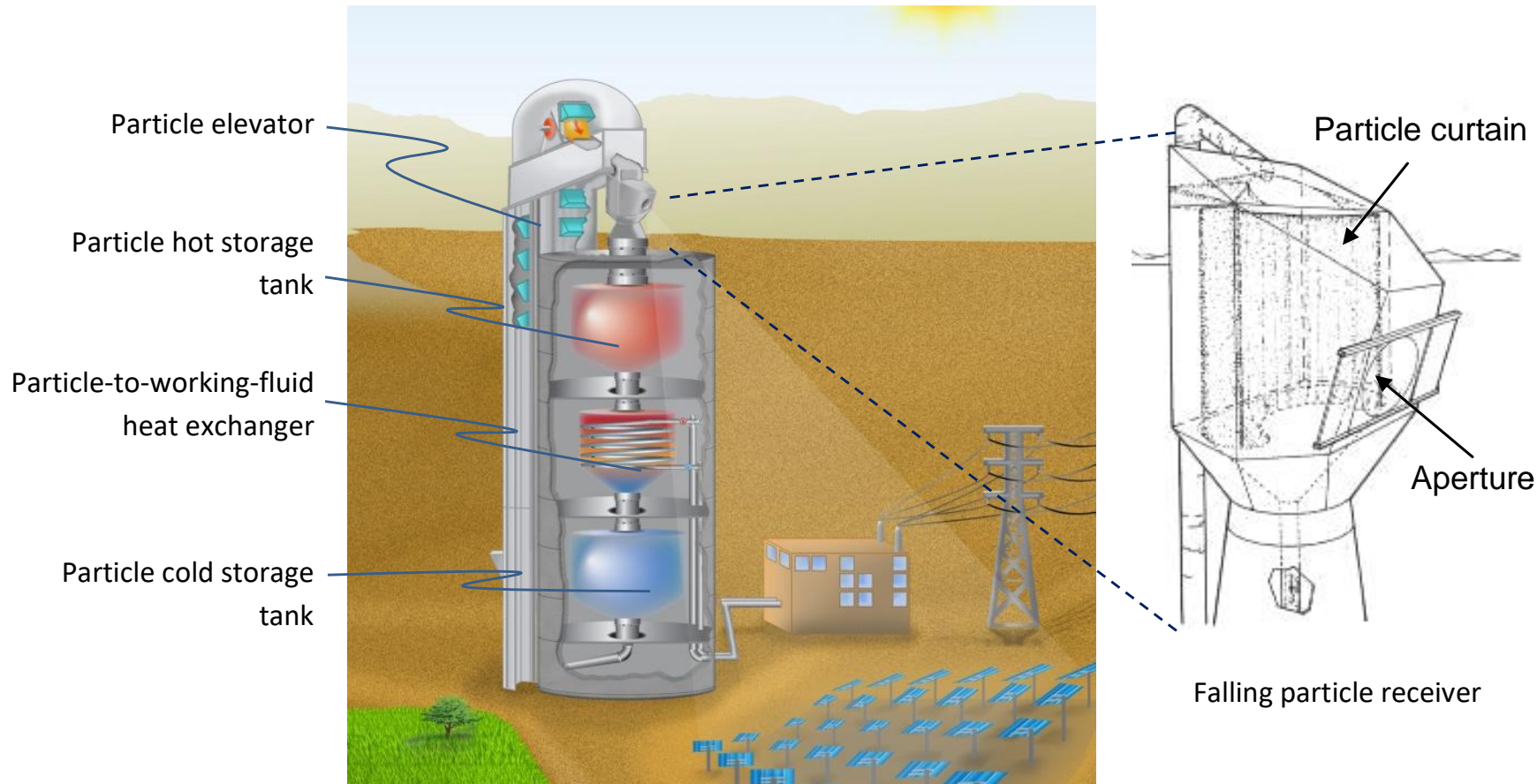


Falling particle receiver



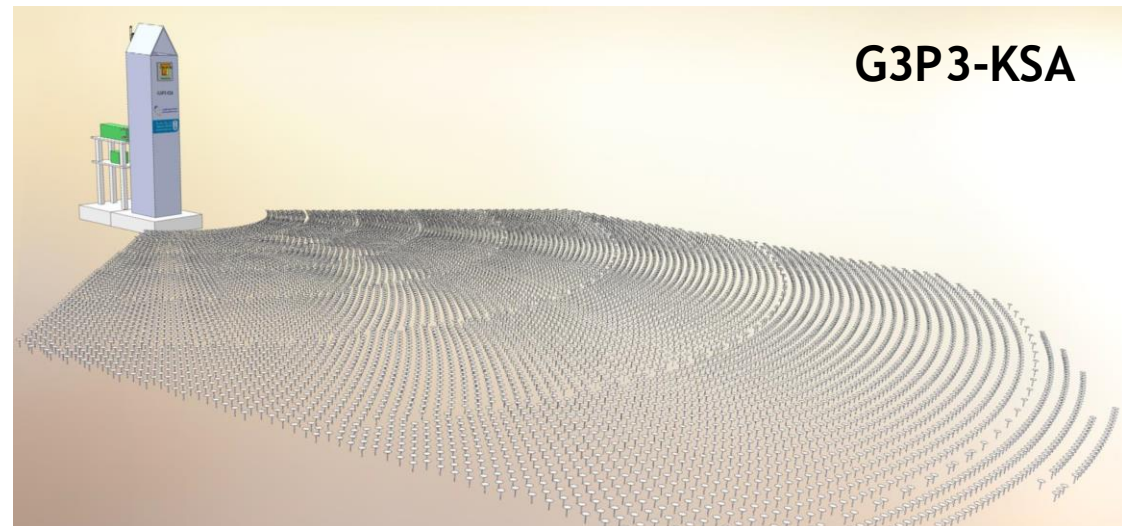
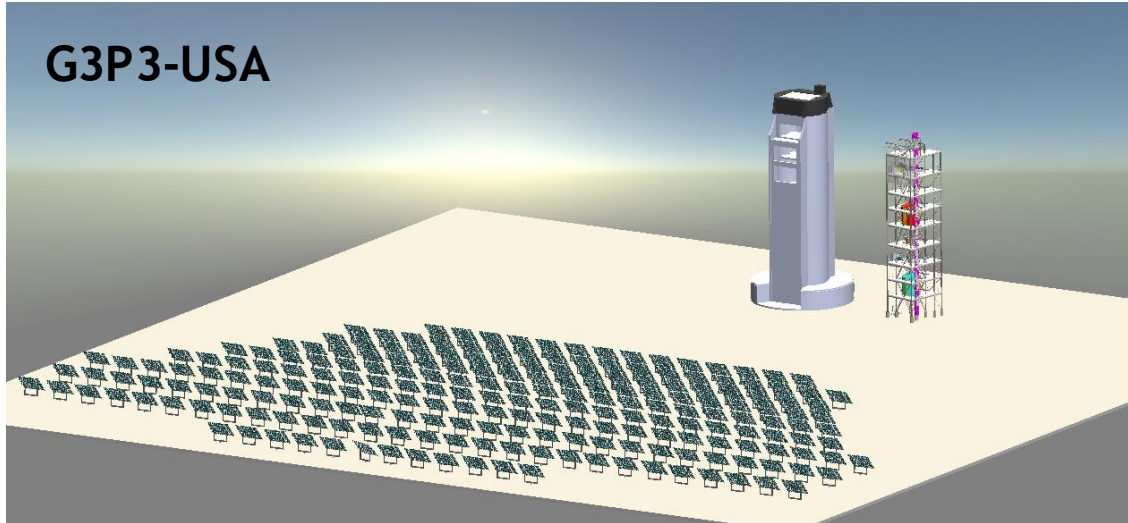
National Solar Thermal Test Facility
Sandia National Laboratories

High-Temperature Particle-Based CSP



- Higher temperatures ($>1000\text{ }^{\circ}\text{C}$) than molten nitrate salts
- Direct heating of particles vs. indirect heating of tubes
- No freezing or decomposition
 - Avoids costly heat tracing
- Direct storage of hot particles

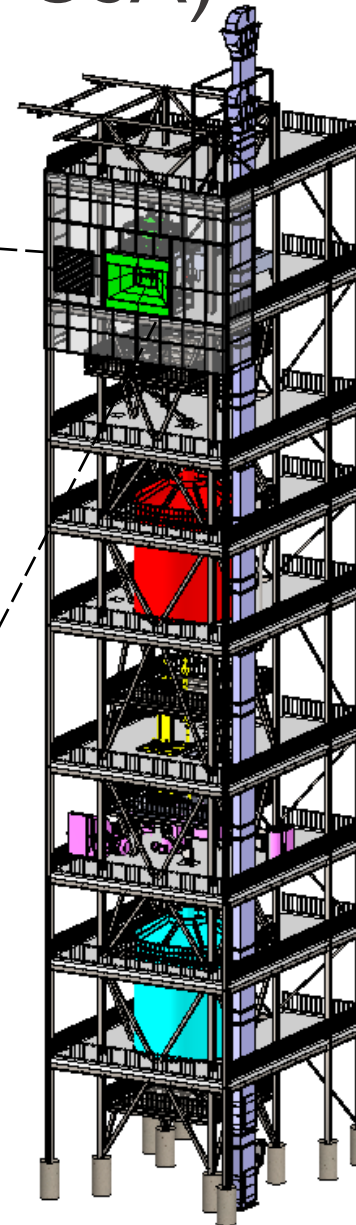
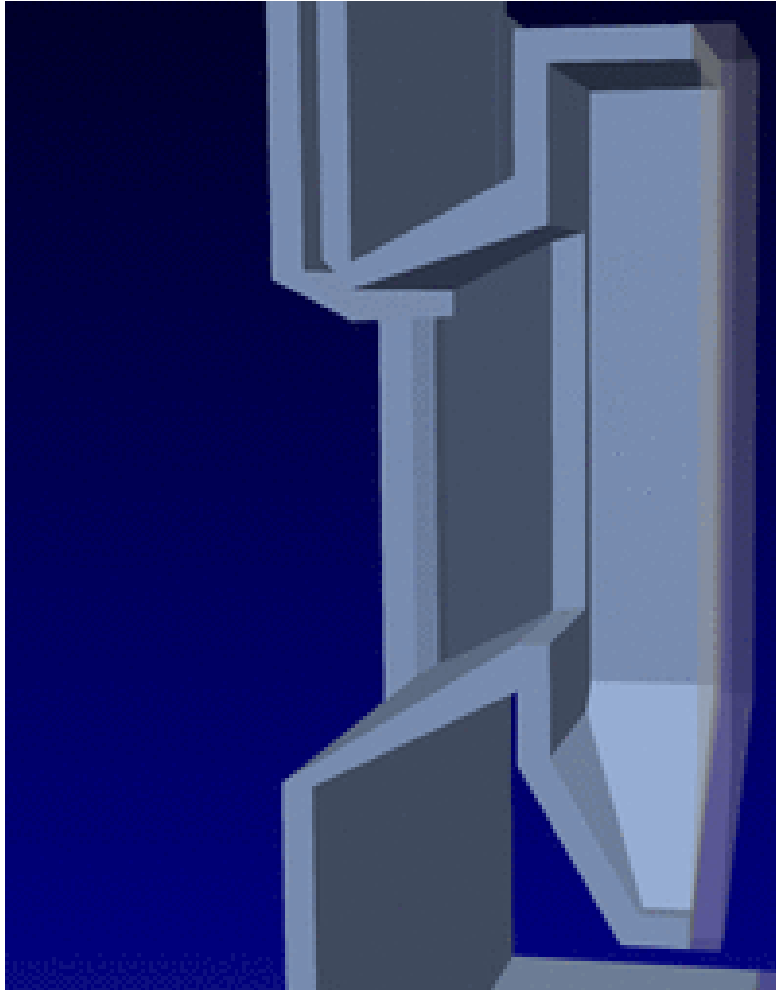
G3P3-USA and G3P3-KSA



Gen3 Particle Pilot Plant (G3P3-USA)



Next-Generation High-Temperature Falling
Particle Receiver



Gen 3 Particle Pilot Plant

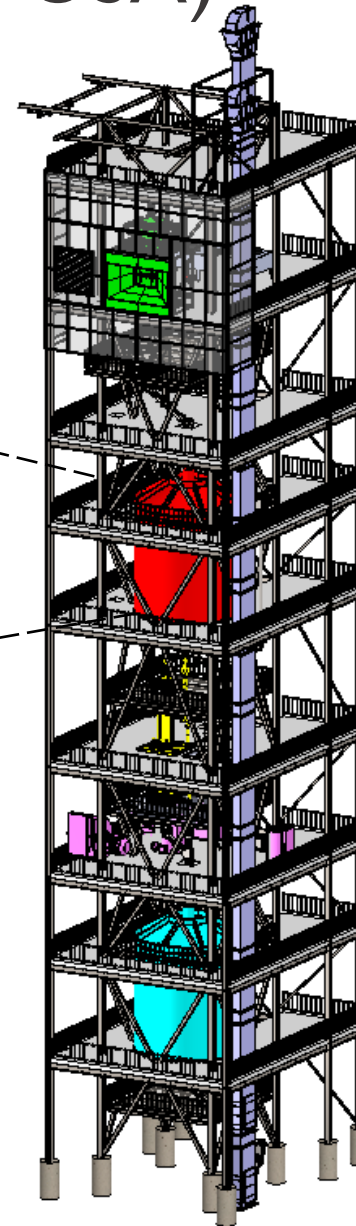
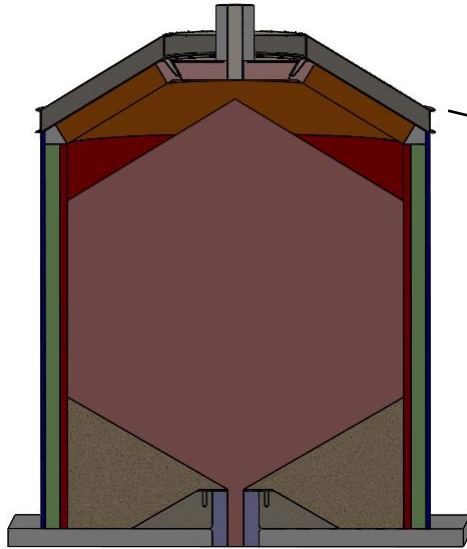
- ~1 - 2 MW_t receiver
- 6 MWh_t storage
- 1 MW_t particle-to-sCO₂ heat exchanger
- ~300 - 400 micron ceramic particles (CARBO HSP 40/70)

K. Albrecht, SNL

Gen3 Particle Pilot Plant (G3P3-USA)

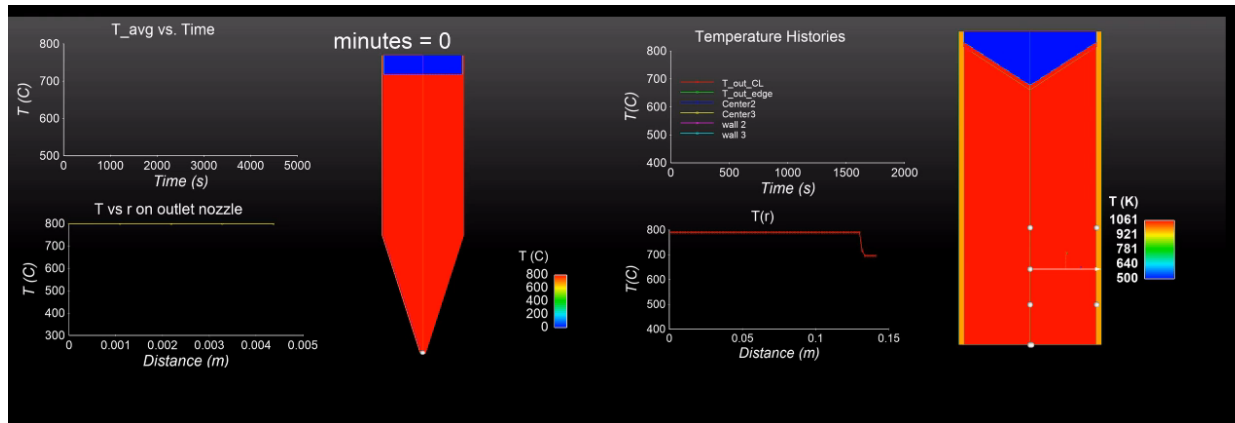


High-Temperature Particle Storage Bin
(Allied Mineral Products, Matrix PDM, Sandia)



Gen 3 Particle Pilot Plant

- ~1 - 2 MW_t receiver
- 6 MWh_t storage
- 1 MW_t particle-to-sCO₂ heat exchanger
- ~300 - 400 micron ceramic particles (CARBO HSP 40/70)

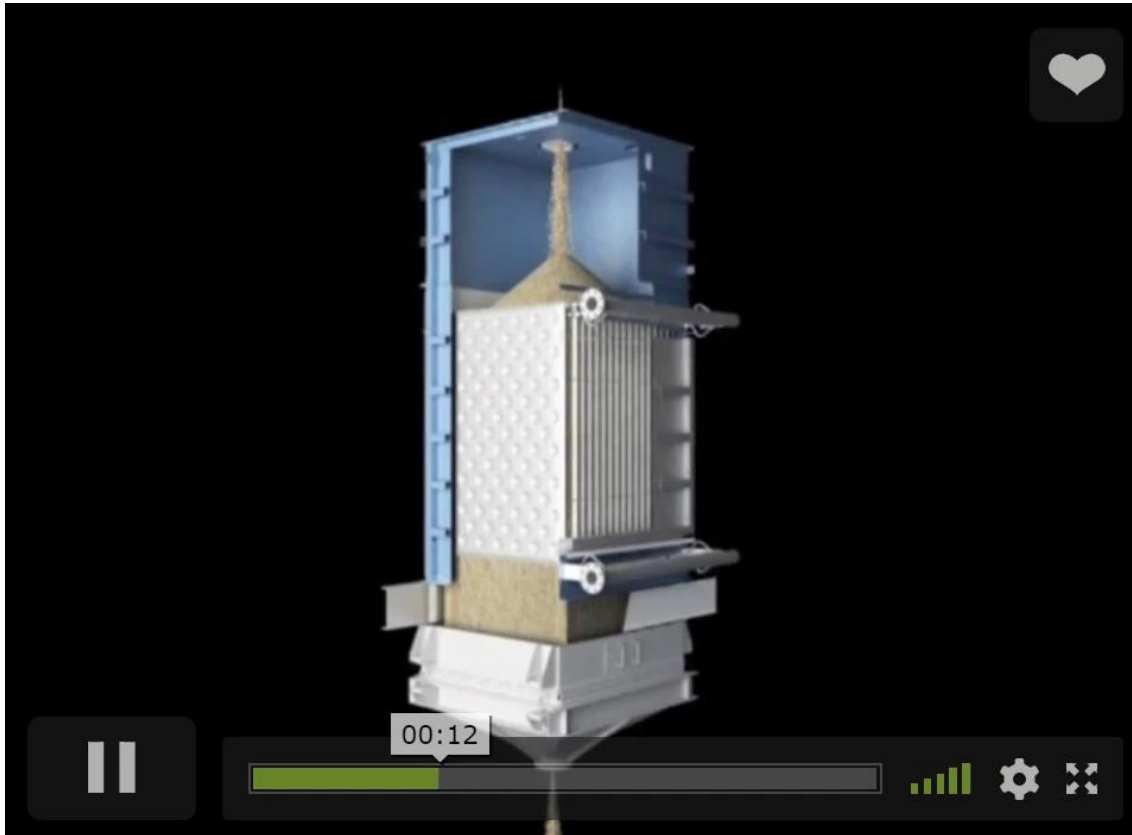


K. Albrecht, SNL

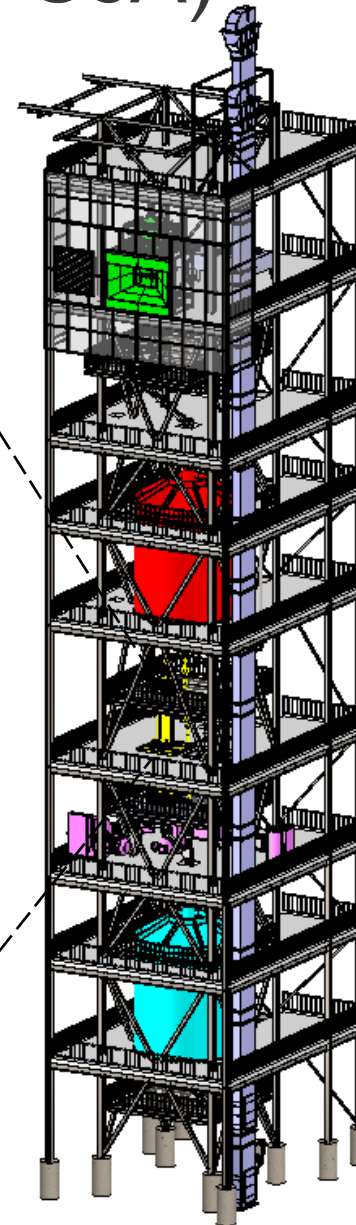
Gen3 Particle Pilot Plant (G3P3-USA)



High-Temperature Particle-to-sCO₂ Heat Exchanger
(VPE, Solex, Sandia)



<https://www.solexthermal.com/our-technology/cooling/>



Gen 3 Particle Pilot Plant

- ~1 - 2 MW_t receiver
- 6 MWh_t storage
- 1 MW_t particle-to-sCO₂ heat exchanger
- ~300 - 400 micron ceramic particles (CARBO HSP 40/70)

K. Albrecht, SNL

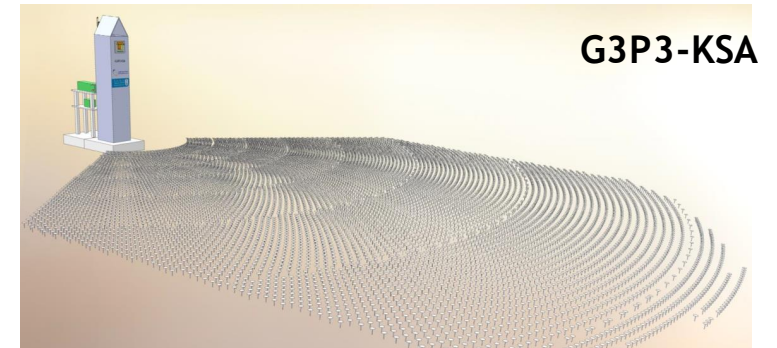
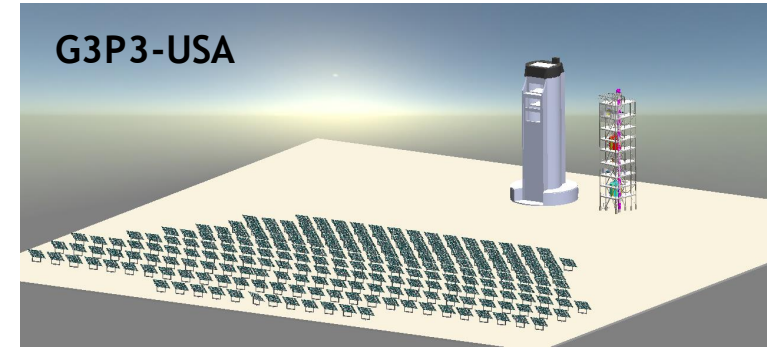
Summary



Summary



- G3P3-USA and G3P3-KSA being developed
- Key components evaluated in G3P3 Phases 1 & 2
 - Receiver
 - Particle-to-sCO₂ heat exchanger
 - Storage
- Key risks of G3P3
 - Particle and heat loss from open-aperture receiver
 - Heat loss from storage and bucket elevator
 - Low particle-side heat-transfer coefficients in heat exchanger
 - High cost of diffusion-bonded heat exchanger
- Contingencies
 - Fluidized-bed heat exchanger (Babcock & Wilcox, SandTES TU Wien)
 - Skip hoist for particle lift
 - Tower-integrated particle storage bins



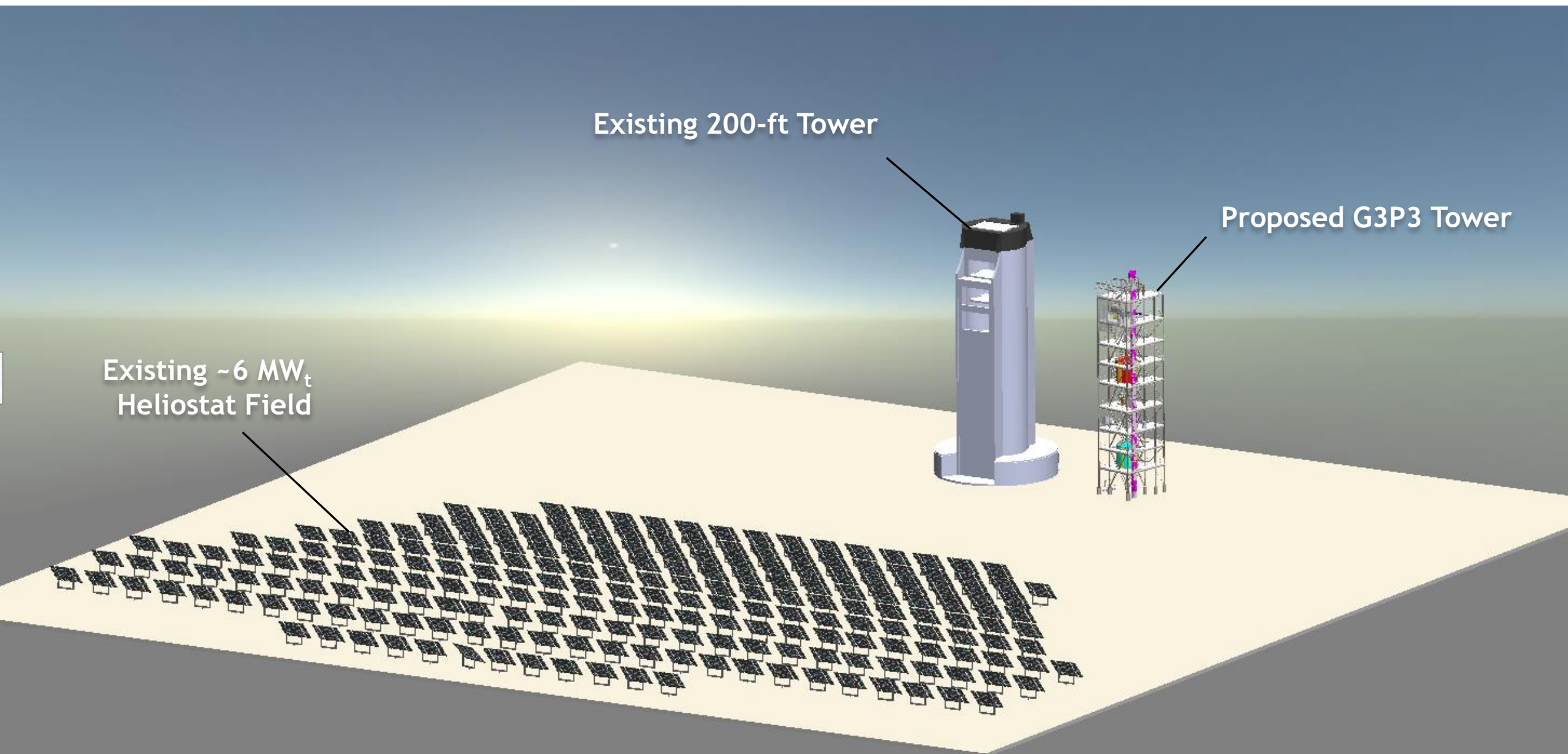
Acknowledgments



- 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, Shane Powers, Vijay Rajgopal, Levi Irwin, Andru Prescod, Mark Lausten, Avi Shultz

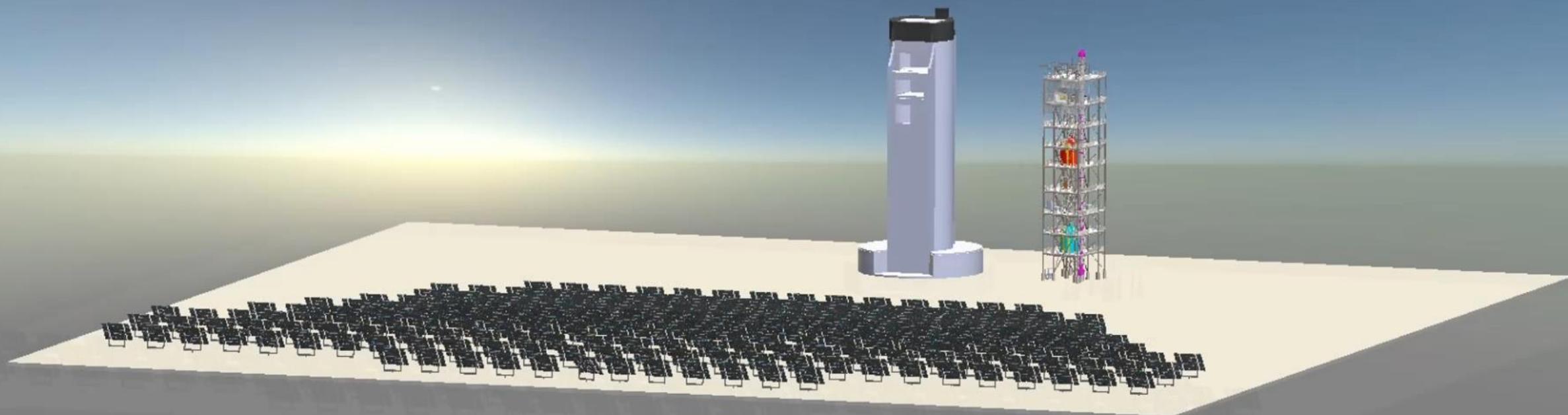
G3P3-USA

National Solar Thermal Test Facility (NSTTF), Albuquerque, NM



G3P3-USA

National Solar Thermal Test Facility (NSTTF), Albuquerque, NM



Backup Slides



High-T, High-P Particle-to-sCO₂ Heat Exchanger



100 kW particle-to-sCO₂ heat exchanger



~100 kW sCO₂ flow loop

On-sun testing of integrated system with falling particle receiver

Integration of heat exchanger and sCO₂ flow loop in tower

