



**Jet Propulsion Laboratory**  
California Institute of Technology

# JPL Ocean Worlds Lab

Overview & Highlights

Kevin Peter Hand & Team

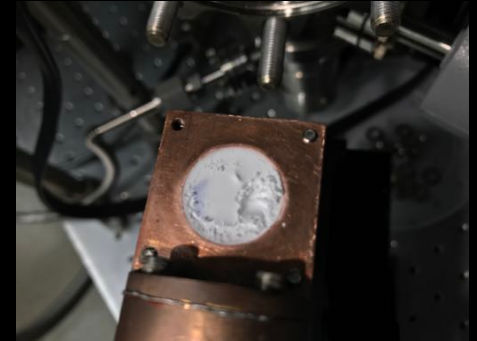
# Ocean Worlds Lab

## Creating ocean worlds surface ice in the lab

- Europa/Enceladus in a Can: High fidelity, small sample
  - 1-10  $\mu\text{m}$  sample (vapor deposited or placed onto cold-finger)
  - Europa/Enceladus Temp and Pressure (100 K, 1e-9 torr)
  - Radiation: Electron gun/Ion gun
- Stockpots: Low fidelity, large sample, ‘rapid prototyping’
  - 20 cm thickness, 40 cm diameter
  - Earth to Europa/Enceladus processes
  - T down to -30 C, P <1 torr
  - Stationary lamp (halogen)
- Ark: High fidelity, large sample
  - 30 cm thickness, 60 x 120 cm ‘bathtub’
  - Diurnal scan platform with vis/ir leds for solar spectrum
  - Europa/Enceladus T and P
- Cutting chambers – now migrated to new building

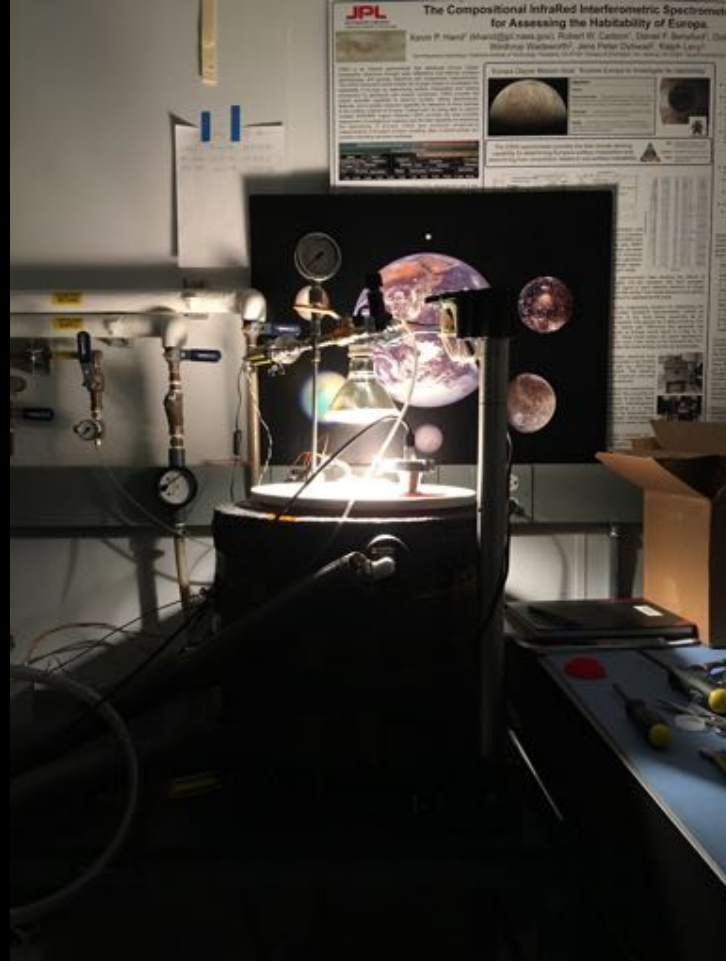
# Ocean Worlds Lab

## Europa/Enceladus in a Can (Minos Chamber)

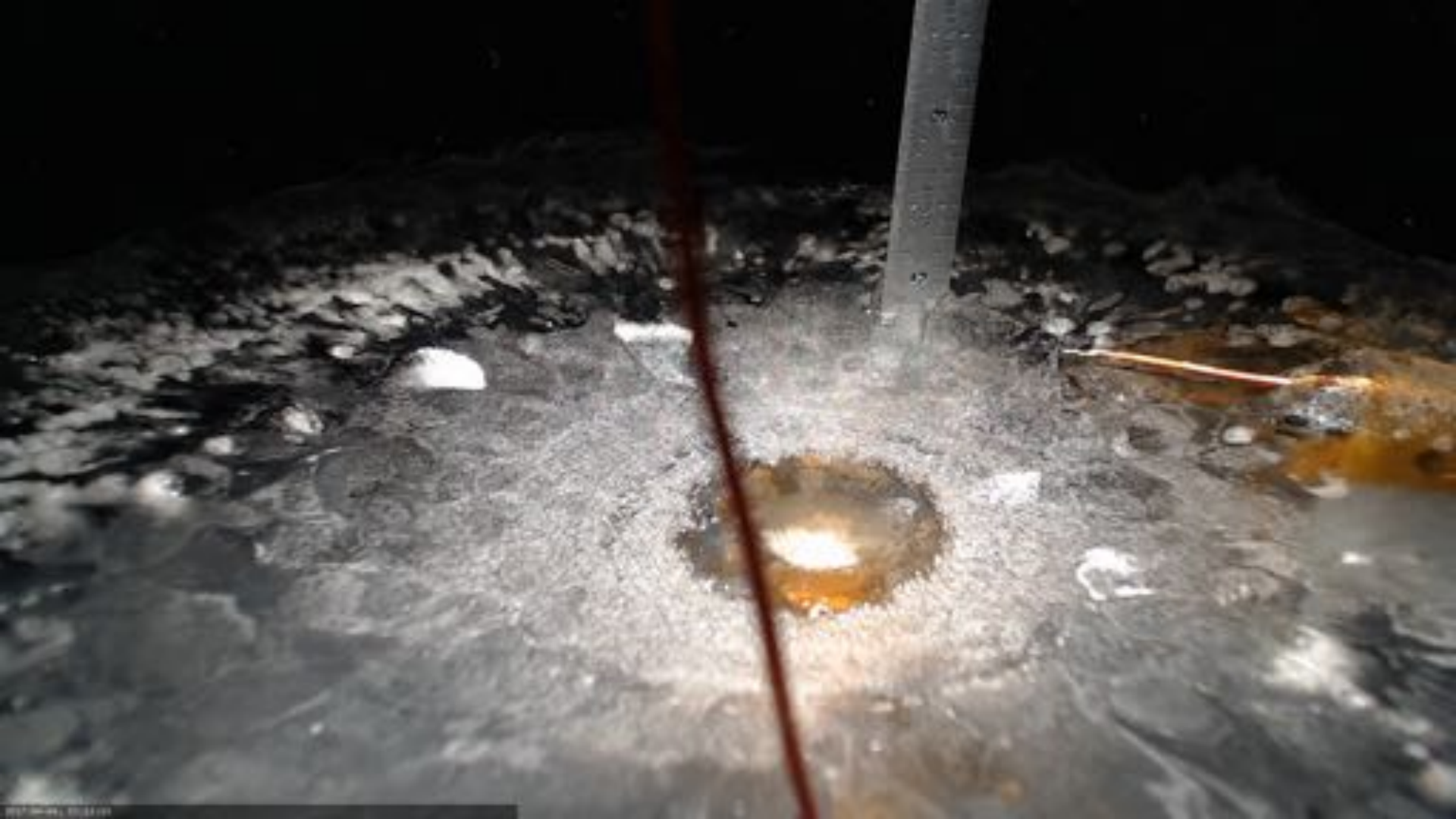


# Ocean Worlds Lab

## Stockpots







Penitentes:  $T = -15\text{ C}$ ,  $\sim 1\text{ torr}$



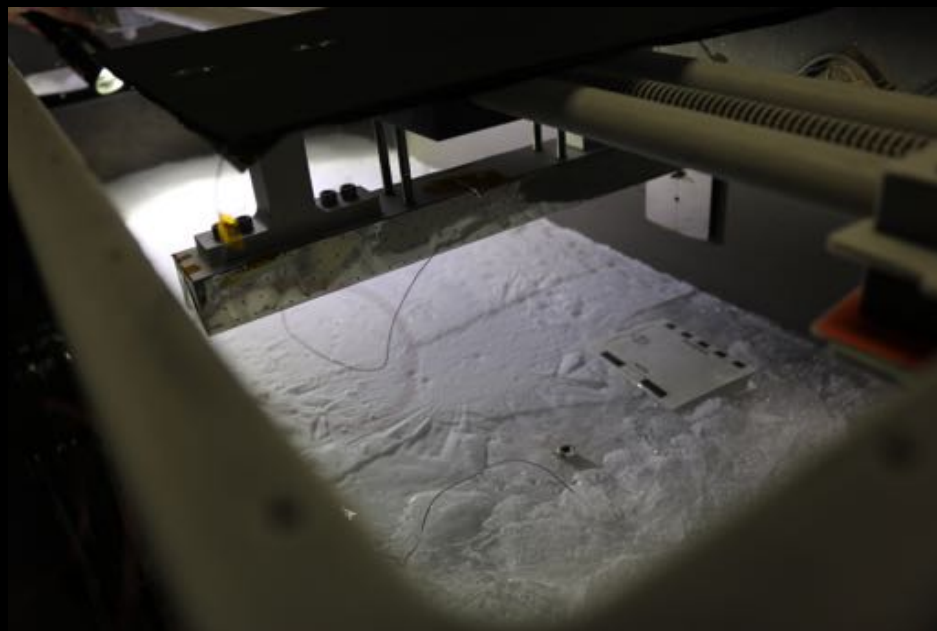






# Ocean Worlds Lab

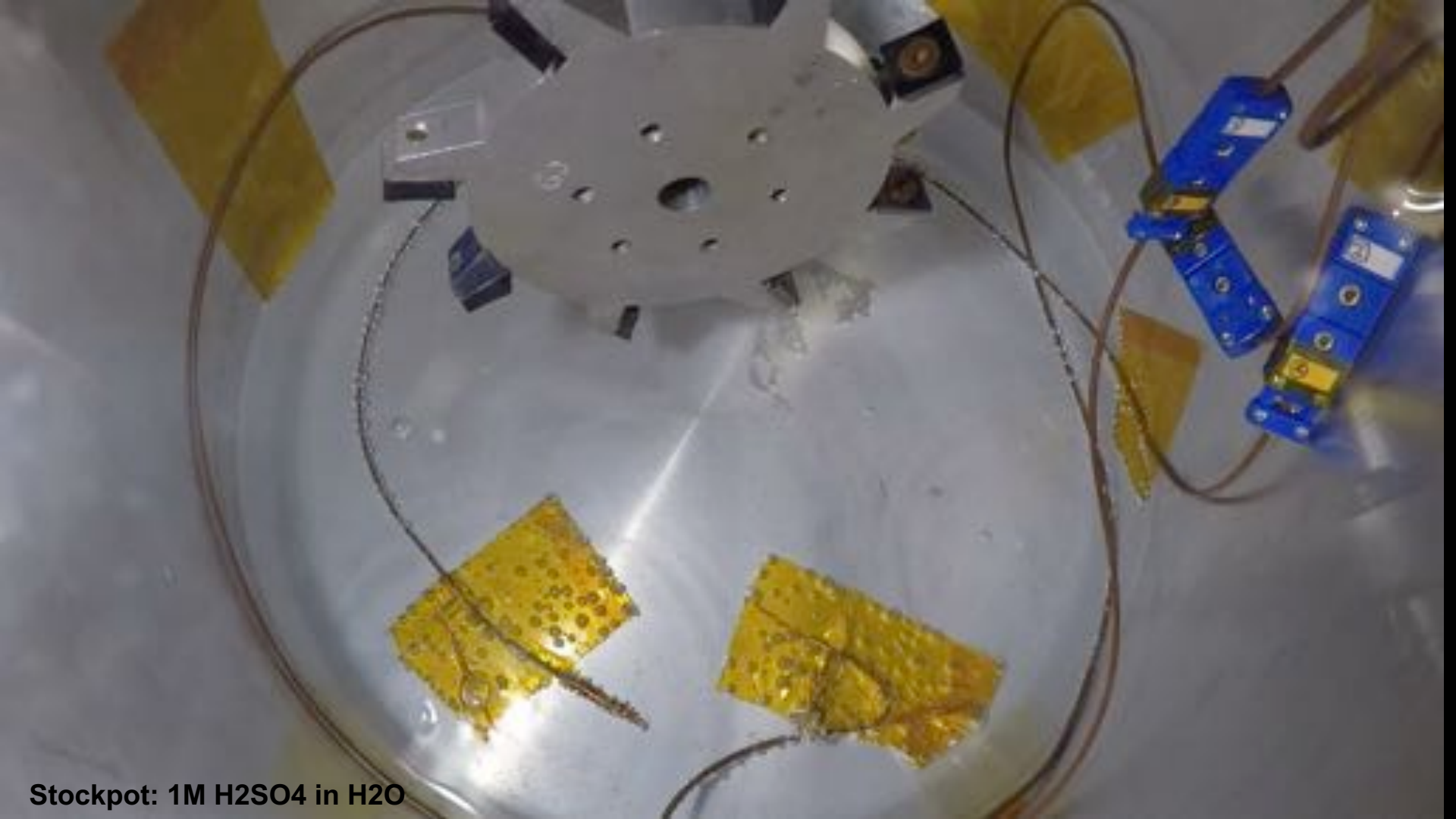
## The Ark











Stockpot: 1M H<sub>2</sub>SO<sub>4</sub> in H<sub>2</sub>O



# Working to Define Materials and Topographies for V&V

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*“Hard to cut” is relative – each material has its own challenges associated with it*





# Early Testing Performed with Hand Tools and Low-Fidelity Testbeds

Hand Tools:

Stockpot







# Early Testing Performed with Hand Tools and Low-Fidelity Testbeds

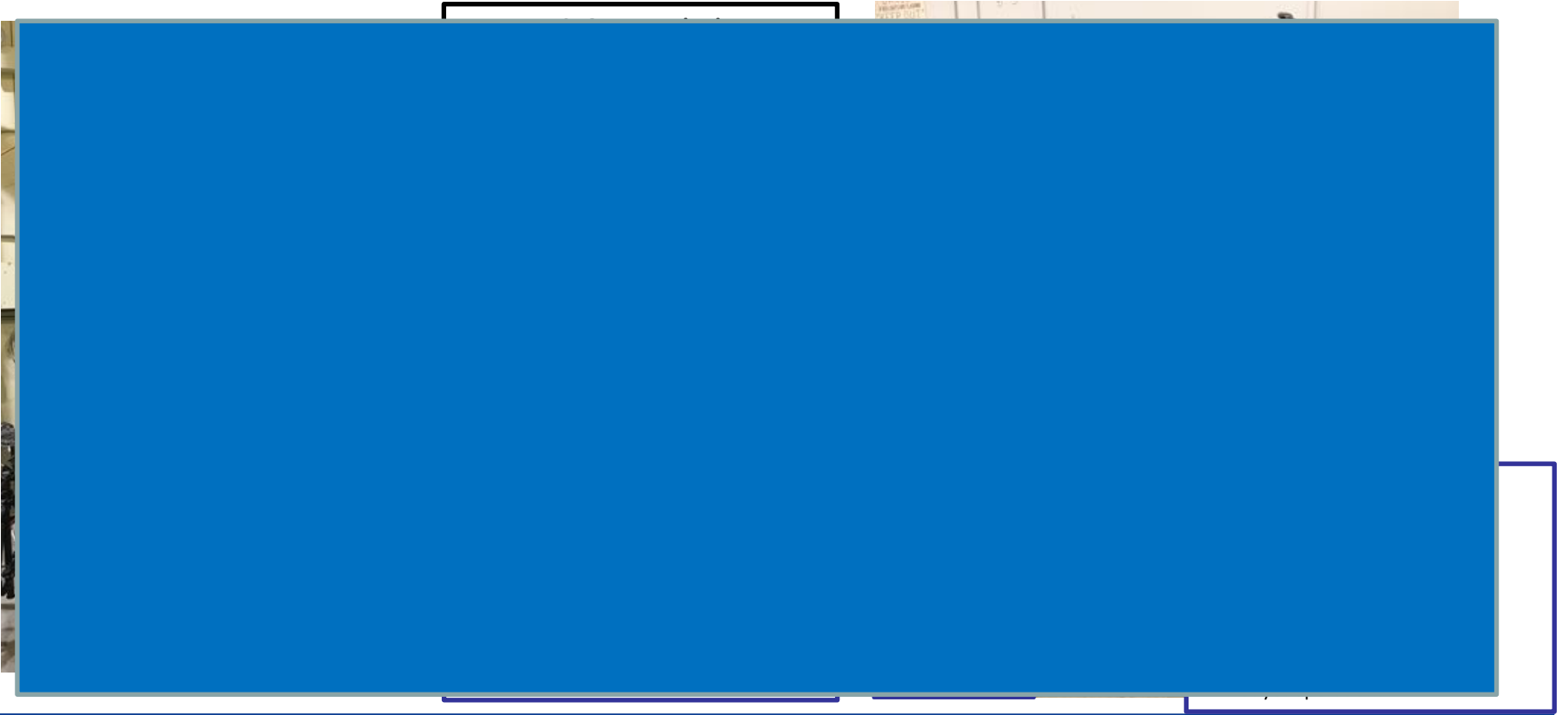
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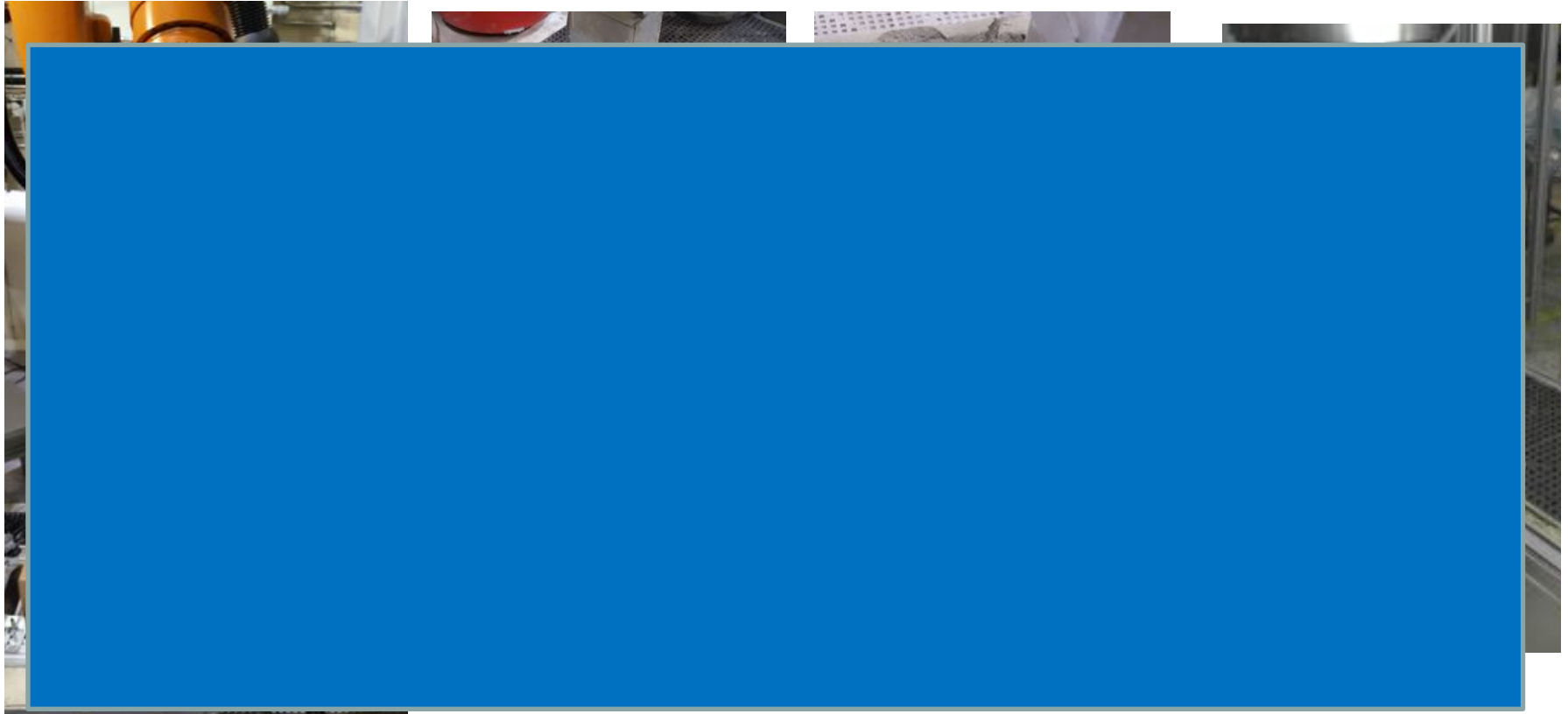
# Significant Progress Has Been Made Building High-Fidelity Test Infrastructure

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# Sampling System Excavation Tools: V-Saw (baseline) and Right-Angle





# Excavation with Data Collection





# Terrain Excavation Videos





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