

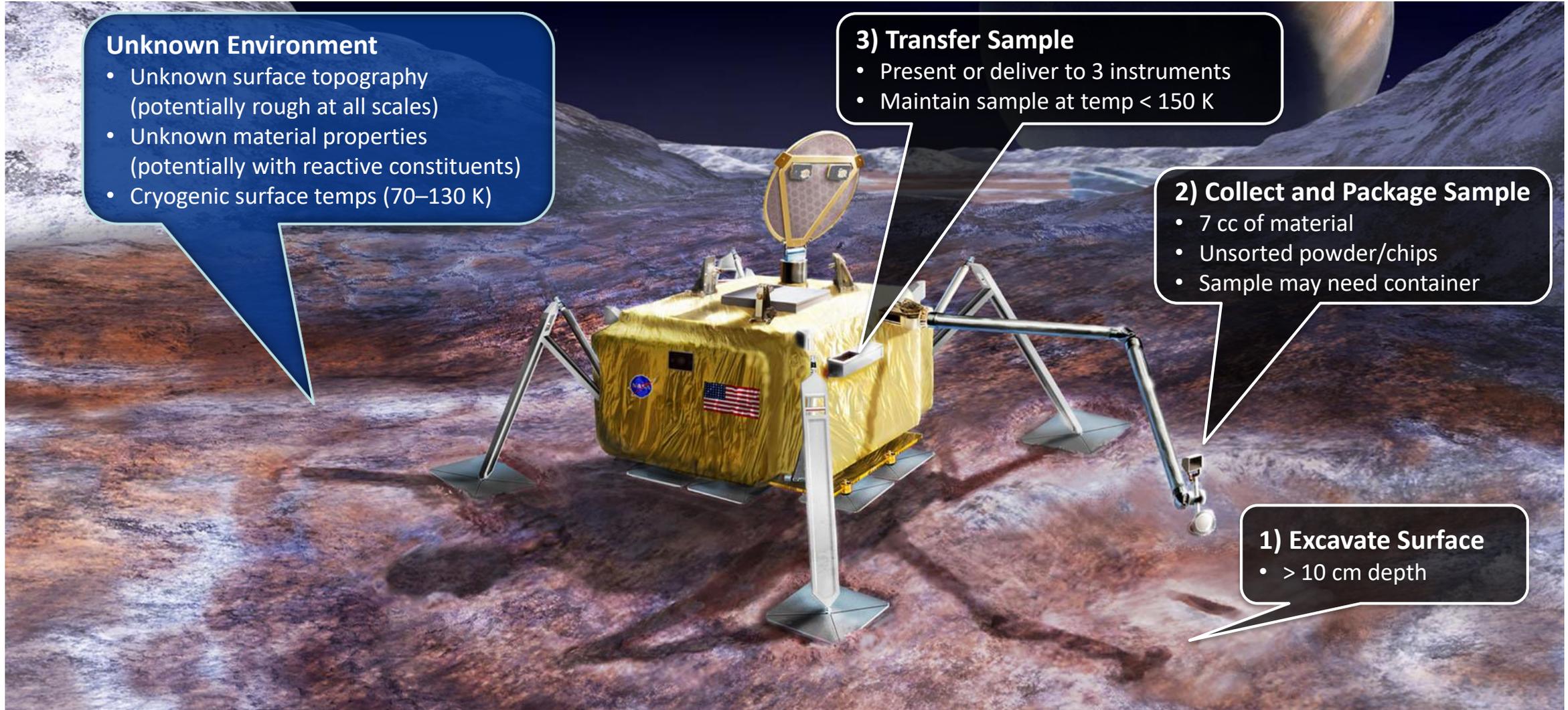
Sample Acquisition

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The Europa Lander Sampling System Mission Concept





Design Philosophy

- **Study the end-to-end sample handling chain in the correct environment as early as possible**
- **Robustness to all scales of topographies & material strengths**
- **Leveraging lessons learned from Phoenix, MSL, M2020, & other sample handling missions & studies**



Capabilities-Based vs. Requirements-Based

Topographical roughness presents different challenges at different scales

TOPOGRAPHY



Salt Flats



Beach



Gravel Bed



Cobblestone Street



Devil's Golf Course



Chilean Penitentes

"Hard to cut" is relative – each material has its own challenges associated with it

MATERIAL COMPOSITION

											
MMS Dust	Minus 30 Sand	Loose Ice	Comet Simulant	Grill Brick	Lake Koehn Evaporite	250 K	190 K	123 K	Saltwater Ice	Composite Cryogenic Ice	Kramer Massive Mudstone
<ul style="list-style-type: none"> Granular and loose materials Low to high bulk density Moderate to high angle of repose 			<ul style="list-style-type: none"> Porous to "granular" solids Low density Low compressive strength 			<ul style="list-style-type: none"> Crystalline to fractured and refrozen Zero to saturated salinity 			<ul style="list-style-type: none"> Uniform to composite solids High toughness 		

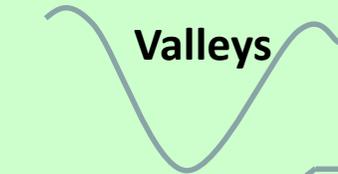
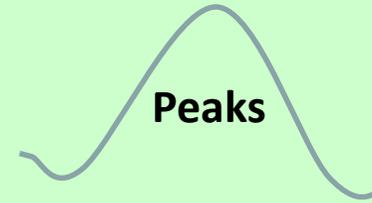


Robustness to Topography We Can't See from Orbit



Devil's Golf Course: "Rough at all Scales"

Basic Elements



Scales

Lander
1m

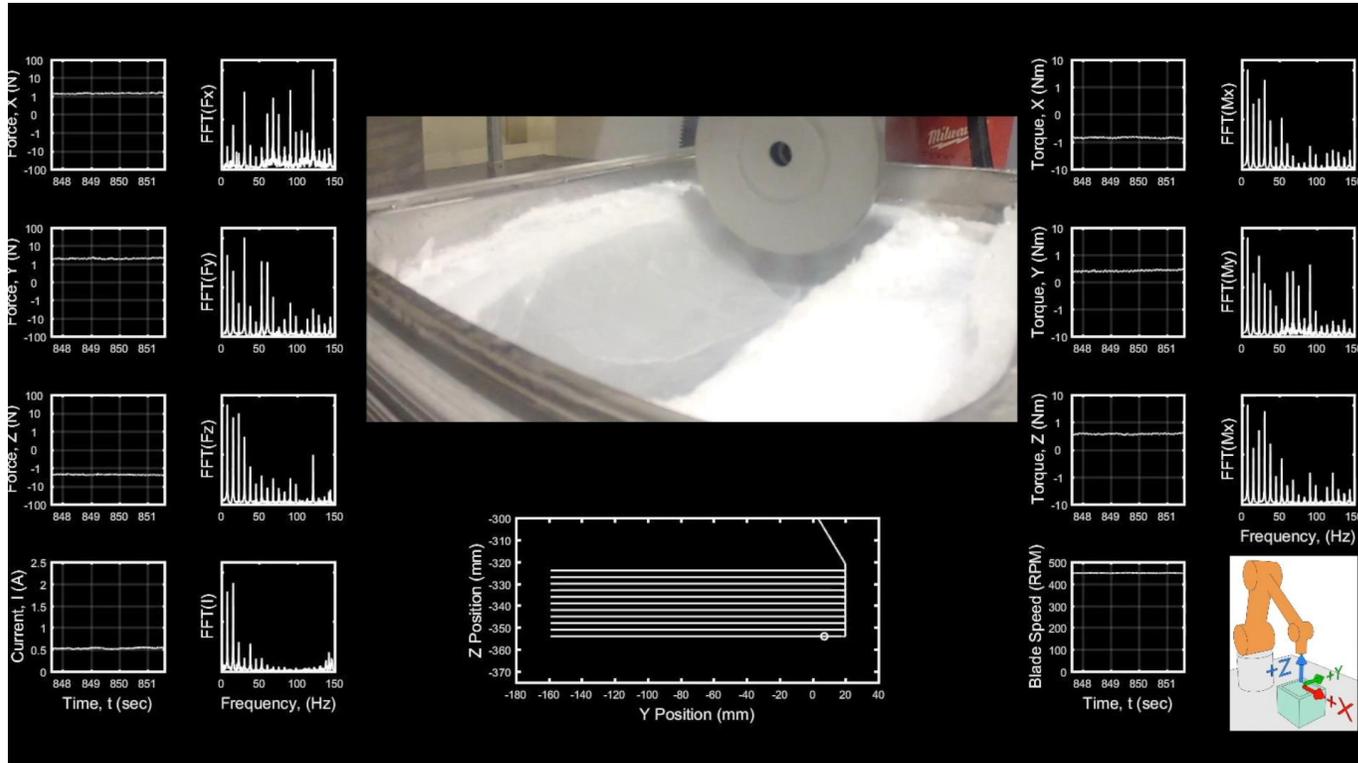
Appendage
500 mm

Tool
100 mm

Sub-tool
10 mm



Robustness to Material Strengths



300% **Square-Tooth Blade (Shaving)**

MgSO₄ Ice 100K

Relative Power to Excavate

250%

200%

150%

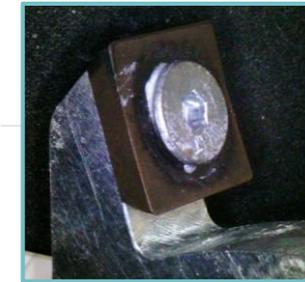
100%

50%

0%

Water Ice 100K
MgSO₄ Ice 190K

Cotton Ice 190K
Water Ice 190K



Undercutting-Toothed Blade (Shaving + Fracturing)



MgSO₄ Ice 100K

MgSO₄ Ice 190K

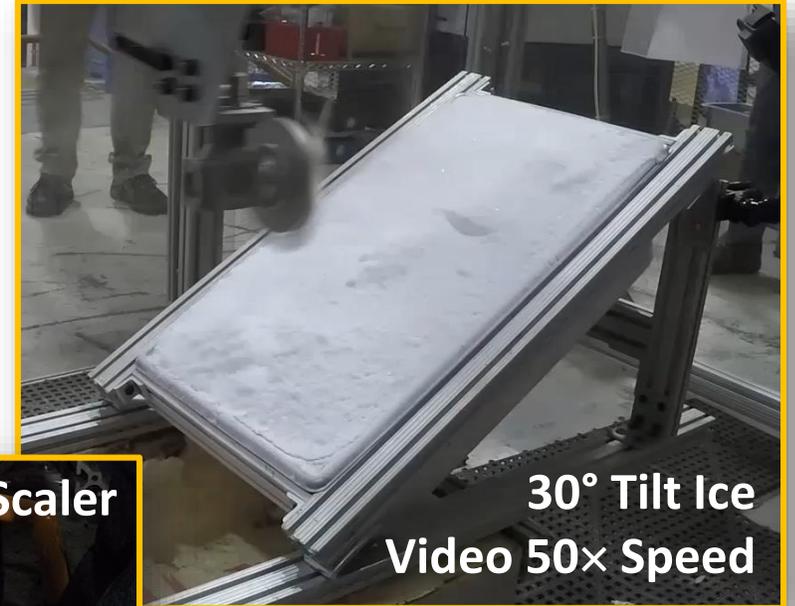
Cotton Ice 190K

Water Ice 100K

Water Ice 190K



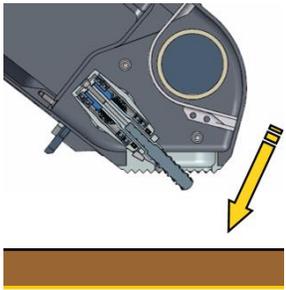
Terrain Interaction Tests





Some Collection Tool Concepts

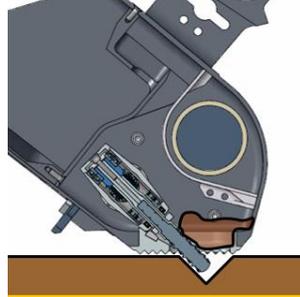
Approach
Trench Floor



Load into
Surface



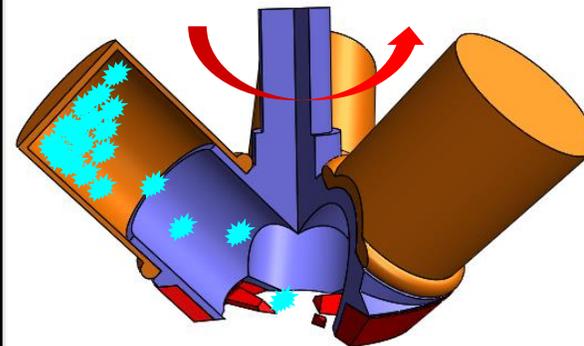
Spin Rasp Bit to
Acquire Sample



Phoenix Rasp Testing



Centrifugal Collector Testing



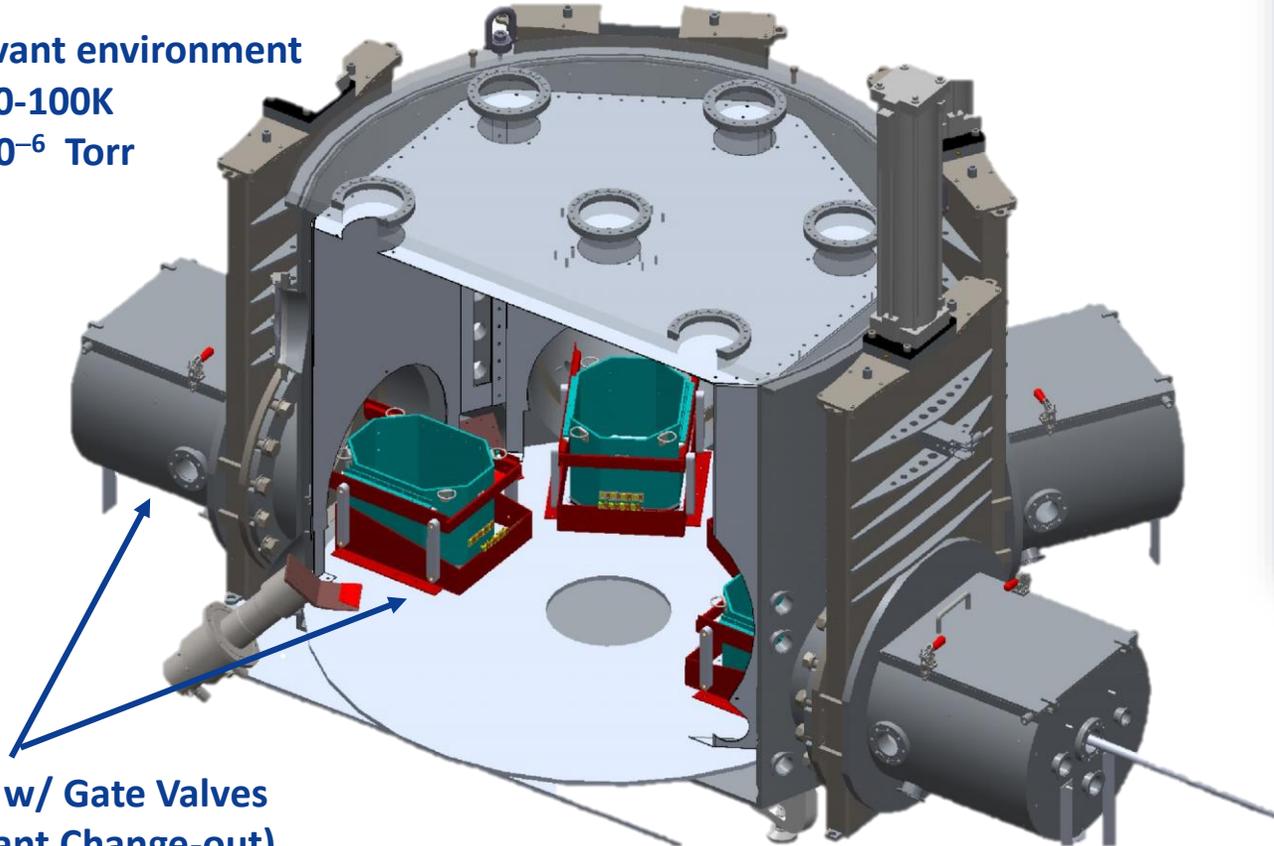


Future Testing: Europa Environment

Europa relevant environment

T = 70-100K

P = 10^{-6} Torr



4x Load Locks w/ Gate Valves
(Europa Simulant Change-out)

Robotic Manipulator (not
shown) for Tool-Ice Interaction



Early Test Objectives:

- Sample Thermal Integrity Testing
- Collection Tool - Ice Interaction & Chip Dynamics
- Sample Handling Chain
- Initial material & component shakeout

*Facility Upfits Underway
Commissioning Begins Spring '18*