



## Europa Lander/ICEE-2 Status

Earl Maize Joel Krajewski

Outer Planets Advisory Group 03 Feb 2020



**Jet Propulsion Laboratory**  
California Institute of Technology

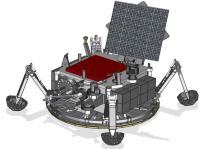
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# Europa Lander pre-Project Current Status

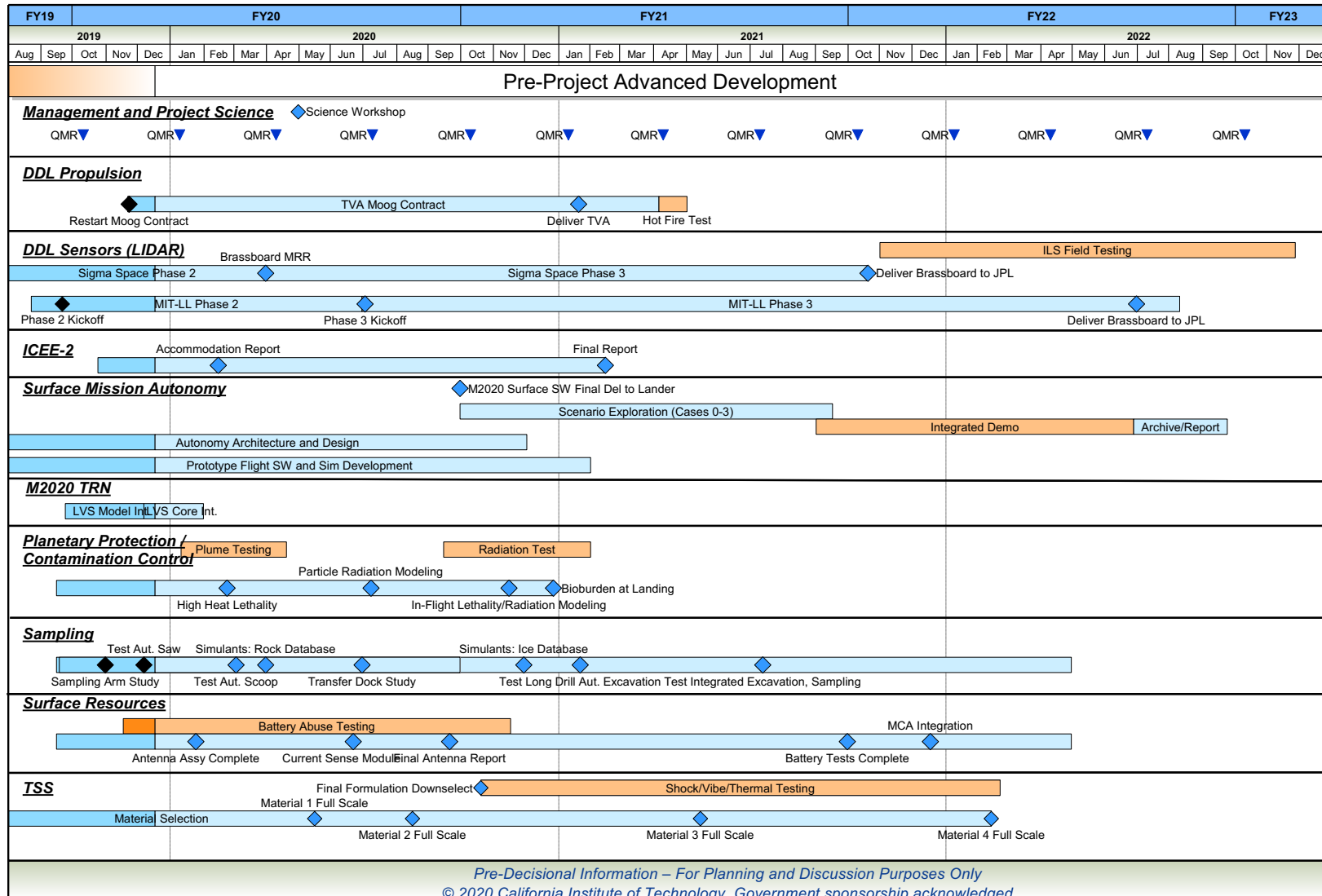
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- Competed new baseline of all advanced development activities
  - 18 high-priority spacecraft/payload advanced development/maturation tasks
    - Some efforts collaborative with Mars 2020
  - Some tasks extend into well into 2022 (schedule next page)
  - Resources adequate for integrated plan
- Partnerships
  - Actively engaged with MSFC, GSFC, and Sandia NL
  - All major sub-contracts are in place
  - Developed a strategy to partner with JPL R&TD for advanced avionics
- Development on all fronts is well underway

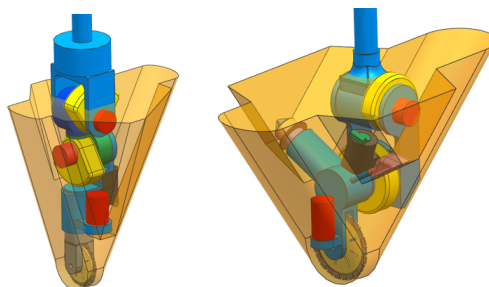
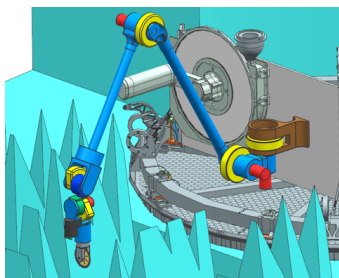
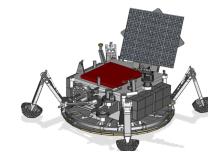


## Europa Lander Advanced Development Schedule





# Surface Sampling Recent Accomplishments



Excavation studies



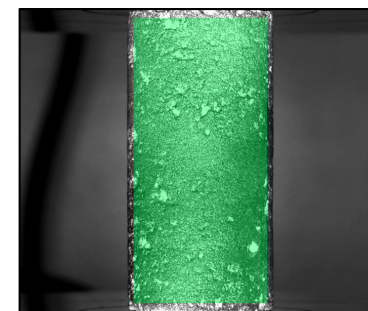
Material	Peak Force [kN]	Mean-Failure Height [mm]	Mean-Failure Energy [J]
AC Failed	1.09		
AC Intact	1.15	47.05	2.43
TI Failed	4.01		
TI Intact	5.45	113.33	6.89
RG Failed	5.58		
RG Intact	6.66	93.75	4.84
CB Failed	4.46		
CB Intact	4.68	37.14	1.92
SB Failed	12.57		
SB Intact	15.77	192.22	9.93



Pneumatic transfer  
Dock and delivery assembly prototype



Cutter sample acquisition  
prototype tests

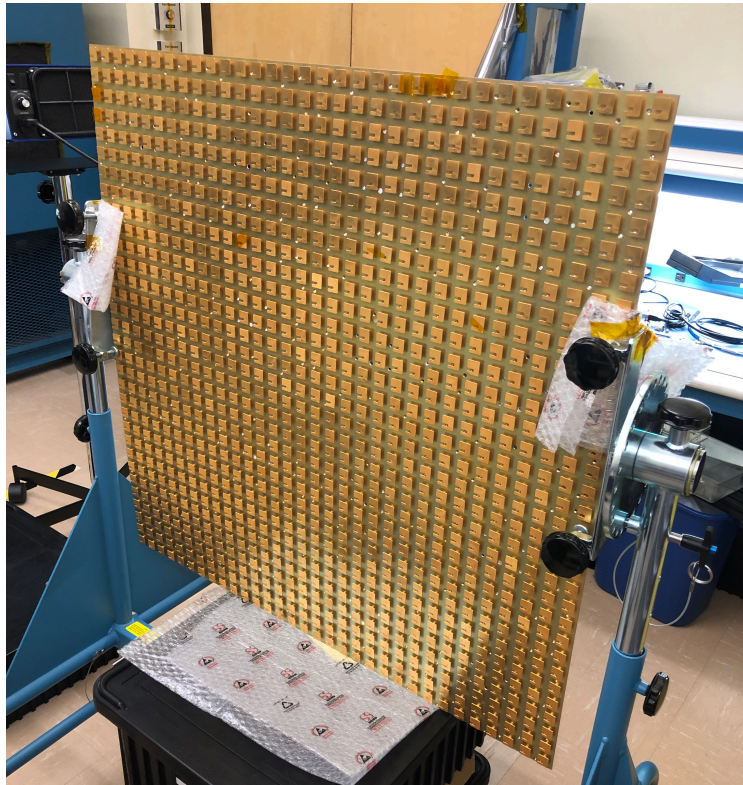
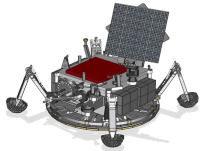


Impact tower material  
properties testing

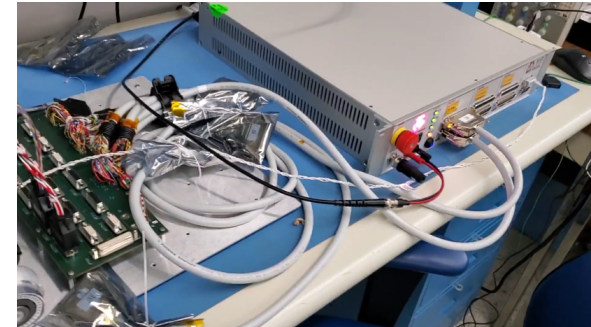




# Surface Resources Recent Accomplishments



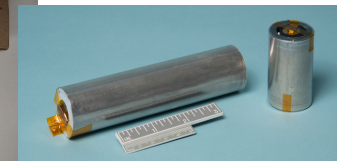
32 x 32 High Gain Antenna



Standalone GSE rack

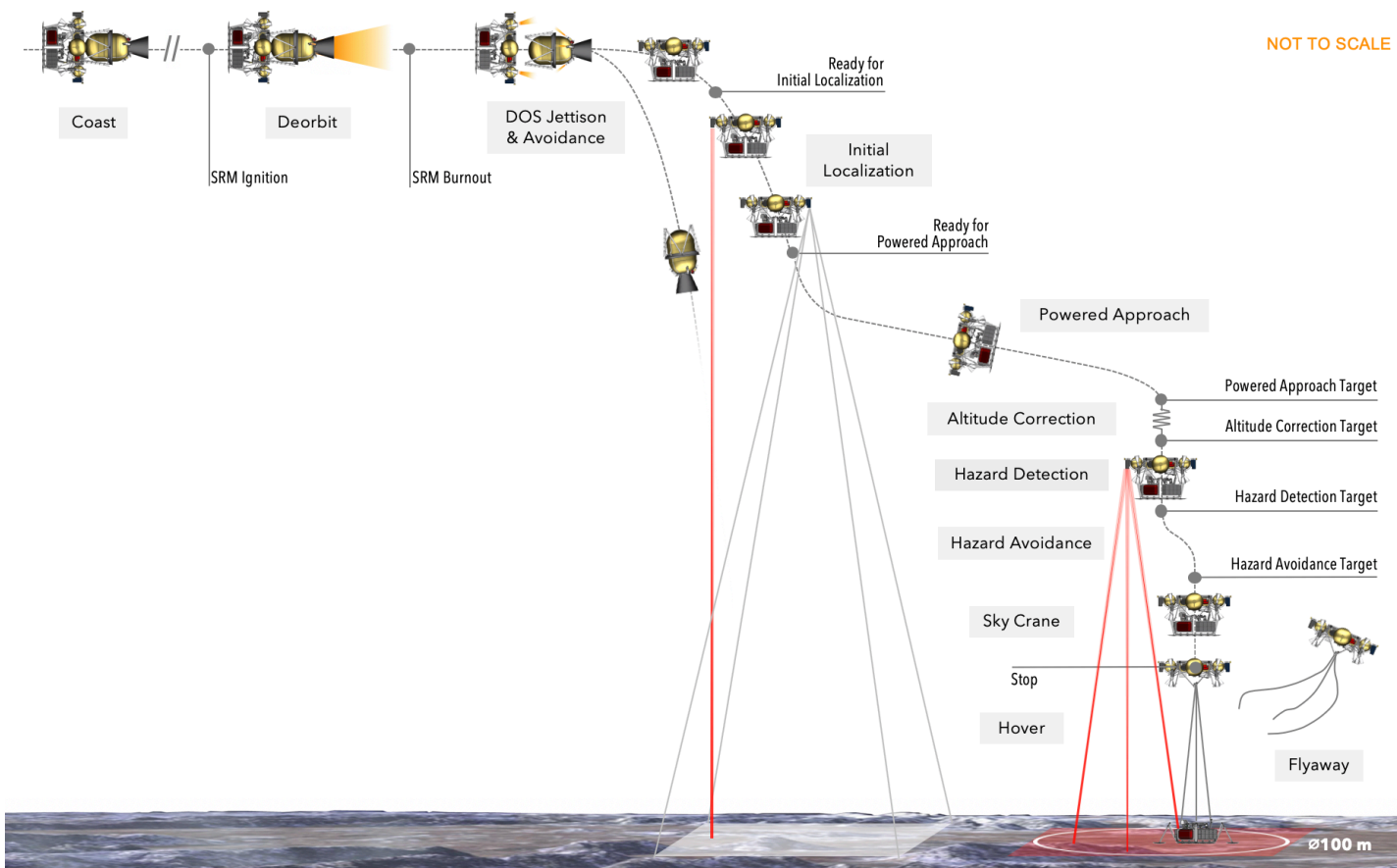
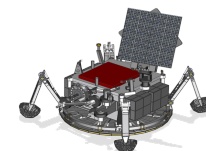


6 month (irradiated) Li-CFx Cell Testing





# Intelligent Landing System Recent Accomplishments

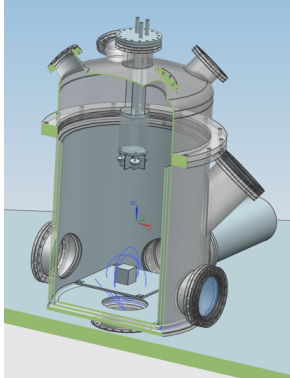
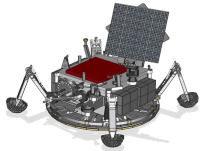


- Lidar/TRN and velocimetry field test
  - Held kick-off meetings at MIT/Lincoln Labs and Sigma Space
  - Held readout ASIC design PDR and DDR
- DDL ConOps study

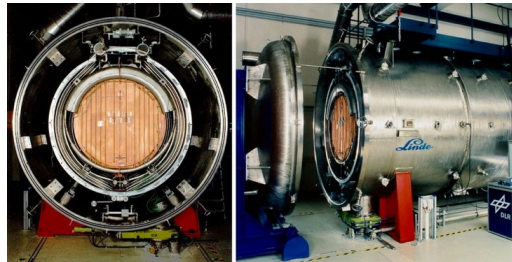




## Contamination Control & Planetary Protection Recent Accomplishments



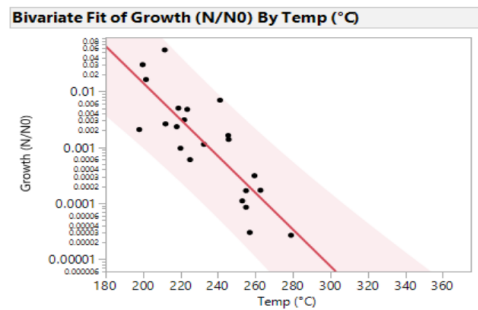
Materials radiation characterization test chamber preliminary design



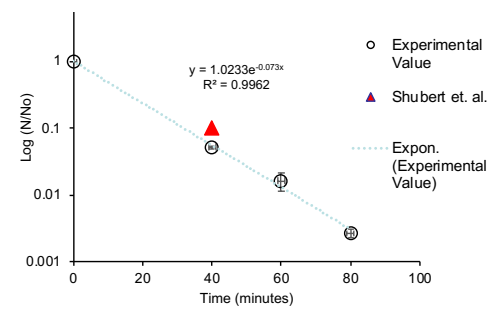
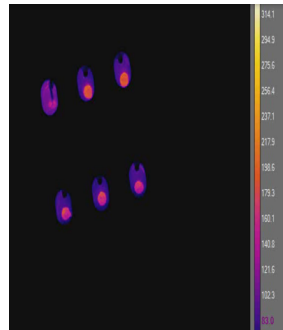
DLR STG-CT facility



Energetic Material #1 ignition test



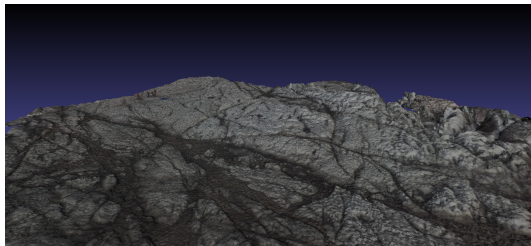
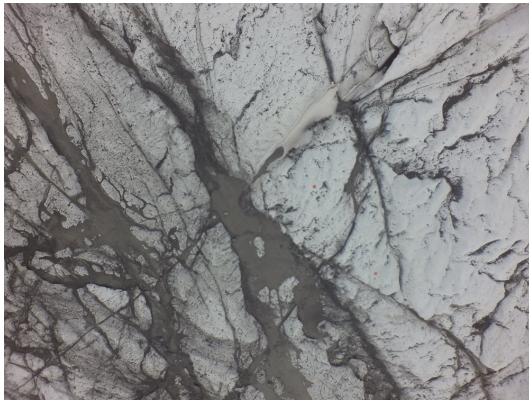
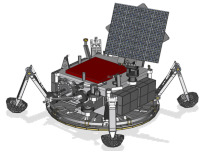
Heat-resistance of spores



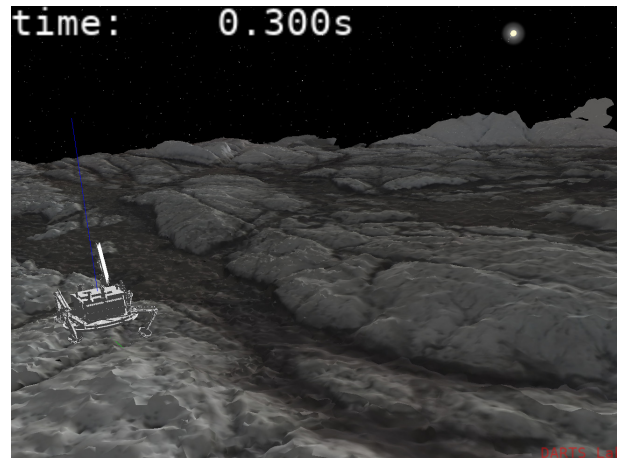
PRA work for PP workshop



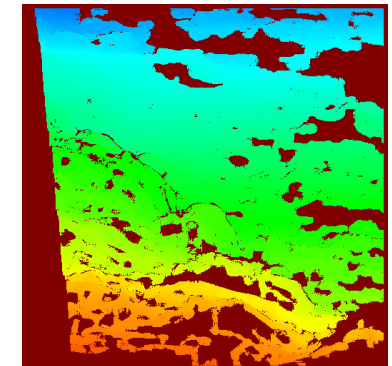
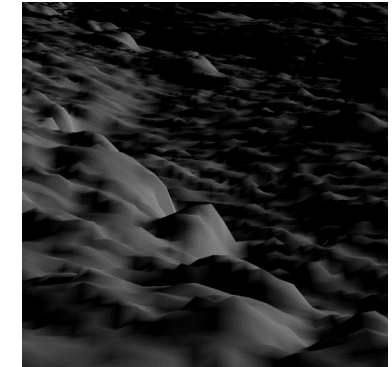
# Sampling Autonomy – Vision Simulator



3D terrain reconstruction using drone images or LIDAR survey (pictured: Matanuska Glacier)



Europa Lander simulation in DARTS on reconstructed terrain

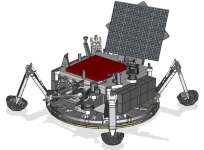


Extracted simulated camera image and disparity image





# 2020 In Situ Science & Instrumentation Workshop for the Exploration of Europa and Ocean Worlds



- April 28-30<sup>th</sup> 2020
- Primary Location: Ramo Hall at CalTech, Pasadena, CA
- ~340 people registered; registration now closed
- JPL/APL providing student support
- <https://www.europa-insitu.caltech.edu/>



**Europa In Situ Workshop**  
April 28-30, 2020

[Home](#) [Registration](#) [Program](#) [Location](#) [Hotels](#)

## 2020 In Situ Science and Instrumentation Workshop for the Exploration of Europa and Ocean Worlds

Dates of Workshop: April 28-30, 2020  
Location: JPL, Pasadena, CA

The Europa Lander Mission Concept team invites you to join us for a workshop open to all scientists and engineers interested in science and instrument concepts for the in situ (landed) exploration of Europa and other ocean worlds. It will be an extended, in depth version of the previous workshop held at the Astrobiology Science Conference (AbSciCon) in June, 2019, with opportunities to have focused discussions and interactions on topics of interest to the Europa and other ocean worlds in situ exploration community.



## ICEE-2 Status for OPAG

Joel Krajewski, Payload Manager, Europa Lander PreProject  
February 2020



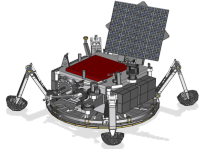
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02/03/20

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## ROSES ICEE-2 Program

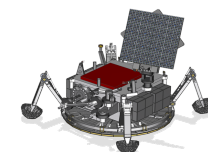


- Award Date: 8 Feb 2019 to 14 awardees; 2-year execution
- Deliverables
  - Biannual: Briefings via telecon with NASA program managers
  - End of Year 1: Report on detailed spacecraft accommodation
  - End of ICEE-2 Task: Final Report (< 10 pages); Final Briefing at NASA HQ
- ROSES Call:
  - “...advance both the technical readiness and spacecraft accommodation of instruments and the sampling system for a potential future Europa lander mission ... to TRL 6 in the 2021/2022 timeframe.”
  - “...close interaction (including face to face) between the NASA-JPL pre-project lander study team and ICEE 2 selectees.....collaborative discussions of issues and solutions regarding instruments, the sample acquisition and delivery system, and the landed element”





# ICEE-2 Awardees



## Organic Analyzer

**CORALS:** Characterization of Ocean Residues and Life Signatures  
PI: Arevalo, Ricardo D, U. Maryland, College Park

**MASPEX-ORCA:** MAss Spectrometer for Planetary Exploration  
-ORganic Composition Analyzer for Europa Lander  
PI: Glein, Christopher R, Southwest Research Institute

**MOAB:** Microfluidic Organic Analyzer for Biosignatures  
PI: Mathies, Richard A, UC Berkeley

**EMILI:** European Molecular Indicators of Life Investigation  
PI: Brinckerhoff, W. B., Goddard Space Flight Center

## Vibrational Spectrometer

**CIRS:** Compact Integrated Raman Spectrometer  
PI: Lambert, James L., Jet Propulsion Laboratory

## Microscope

**ELM:** Europa Luminescence Microscope  
PI: Quinn, Richard, Ames Research Center

## Seismometer

**SIIOS:** Seismometer to Investigate Ice and Ocean Structure  
PI: Bailey, Samuel Hop, University Of Arizona

**ESP:** Europa Seismic Package  
PI: Panning, Mark P, Jet Propulsion Laboratory

## Sample Handling

**CADMES:** Collaborative Acceptance and Distribution  
for Measuring European Samples System  
PI: Malespin, Charles A, Goddard Space Flight Center

## Imager

**C-LIFE:** Cold-Lightweight Imagers for Europa  
PI: Byrne, Shane; Univ. Of Arizona

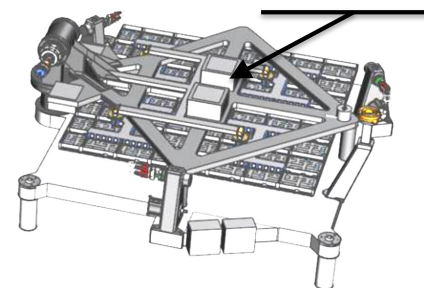
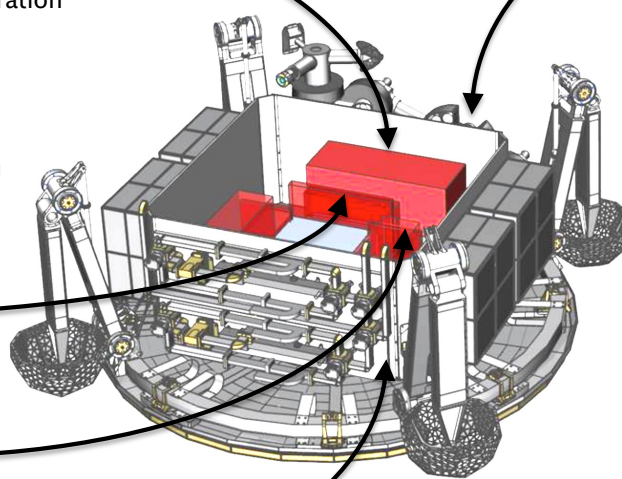
**ELSSIE:** Europa Lander Stereo Spectral Imaging Experiment  
PI: Murchie, Scott L, JHU/APL

## Other Potential Instrument Types

**MICA:** Microfluidic Icy-World Chemistry Analyzer (Inorganic)  
PI: Ricco, Antonio J, Ames Research Center

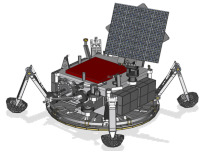
**MAGNET:** Radiation Tolerant Magnetometer for Europa Lander  
PI: Moldwin, Mark B, U. Michigan, Ann Arbor

**EMS:** Europa Magnetotelluric Sounder  
PI: Grimm, Robert E., Southwest Research Institute





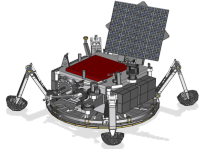
## ICEE-2 Accommodation Support Progress since August 2019



Planned	Notes
Design of sample cups and handoff mechanism	<ul style="list-style-type: none"><li>Achieved each PI concurrence with cup point-designs to be used in CADMES cup handling/transfer testing</li><li>Defined Cup Fill Station design interfaces between CADMES and Sampling teams</li></ul>
Sample cup-fill testing (ambient)	<ul style="list-style-type: none"><li>ID'd instrument-specific Cup design features key to fill testing</li><li>Initiated adapting ambient test equipment</li></ul>
Sampling instrument "front end" thermal accommodation	<ul style="list-style-type: none"><li>Initiated effort to scope out thermal requirements and accommodation approaches to Instrument sample-ingestion interface</li></ul>
Instrument sample vent accommodation	<ul style="list-style-type: none"><li>ID'd likely path locations to reach vault exterior</li><li>Initiated volatiles transport analysis</li></ul>
Individual ICEE-2 instrument accommodation	<ul style="list-style-type: none"><li>Responded to various PI questions</li><li>Initiated creation of material to feed the 1-year individual accommodation assessments required by ICEE-2</li></ul>



## Wrap Up



- Continued good progress working with ICEE-2 PI's and their teams
- April Workshop will be a good venue to engage the wider community
  - “2020 In Situ Science and Instrumentation Workshop for the Exploration of Europa and Ocean Worlds”
  - <https://www.europa-insitu.caltech.edu/>
- Joel Krajewski, Payload Manager ←primary point of contact for ICEE-2 accommodation
  - [Joel.a.krajewski@jpl.nasa.gov](mailto:Joel.a.krajewski@jpl.nasa.gov)
  - 818-354-5808 (office); 818-687-9829 (cell)