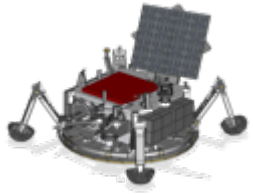
Mini-workshop on Instrumentation for the In Situ Exploration of Europa and Ocean Worlds

Europa Lander Pre-Project Science and Engineering teams

June 26, 2019

Jet Propulsion Laboratory
California Institute of Technology

Mini-workshop Agenda



Time	Topic	Person(s)
12:20-12:35 (15 min)	Welcome and Introduction to Instrumentation for the In-situ Exploration of Europa and Ocean Worlds	Kevin Hand Cynthia Phillips Trina Ray Mitch Schulte
12:35-1:20 (45 min)	Europa Lander (including current mission architecture)	Grace Tan-Wang Steve Sell
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1:35-2:10 (35 min)	***Flash talks (1 min) from Instrument Providers***	Attendees – give 1 slide/image to: Morgan Cable
2:10-2:30 (20 min)	Icy and cryogenic sample collection: Progress and prototypes.	Kristopher Kriechbaum, Cambria Logan, Matt Shekels, Brett Kennedy
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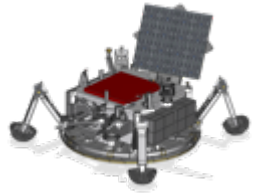
3:25-4:00 (35 min)	Q&A and next steps.	All

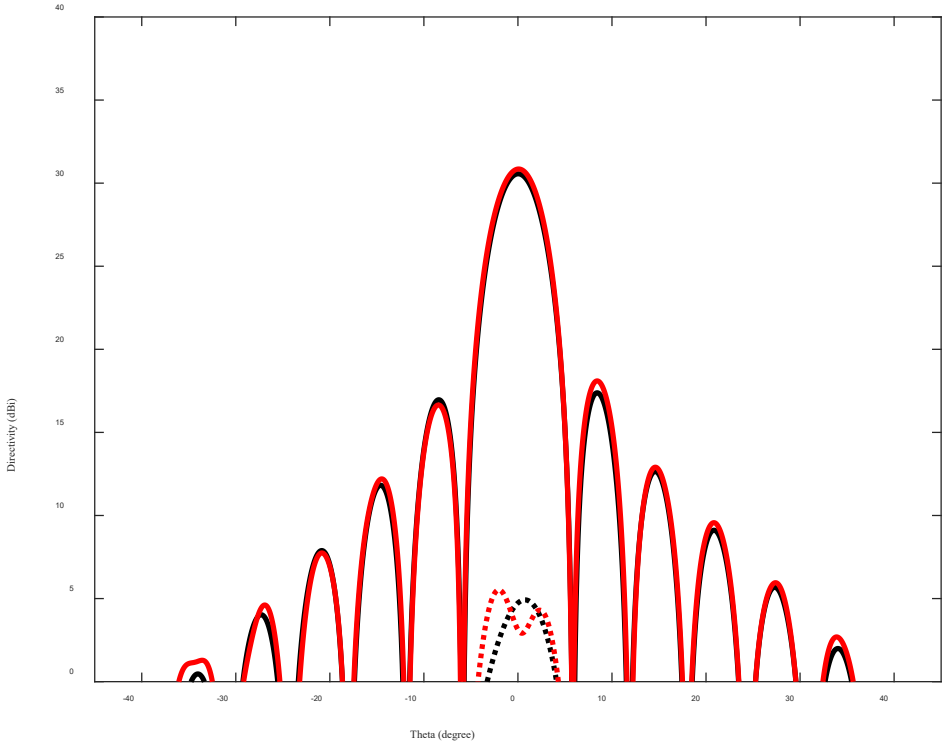
Technology Development
Direct-to-Earth Antenna



From TRL-1 to TRL-5 in 5 months

16x16 antenna

f = 7.19GHz

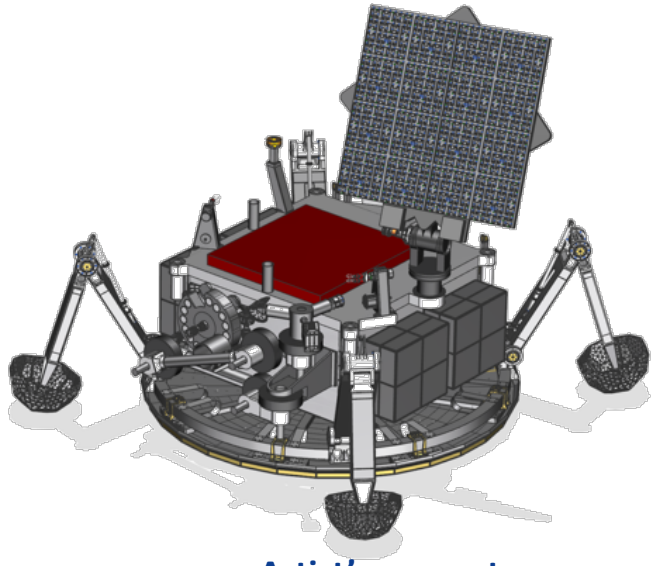


Gain = 29.6dBic

η = 75%

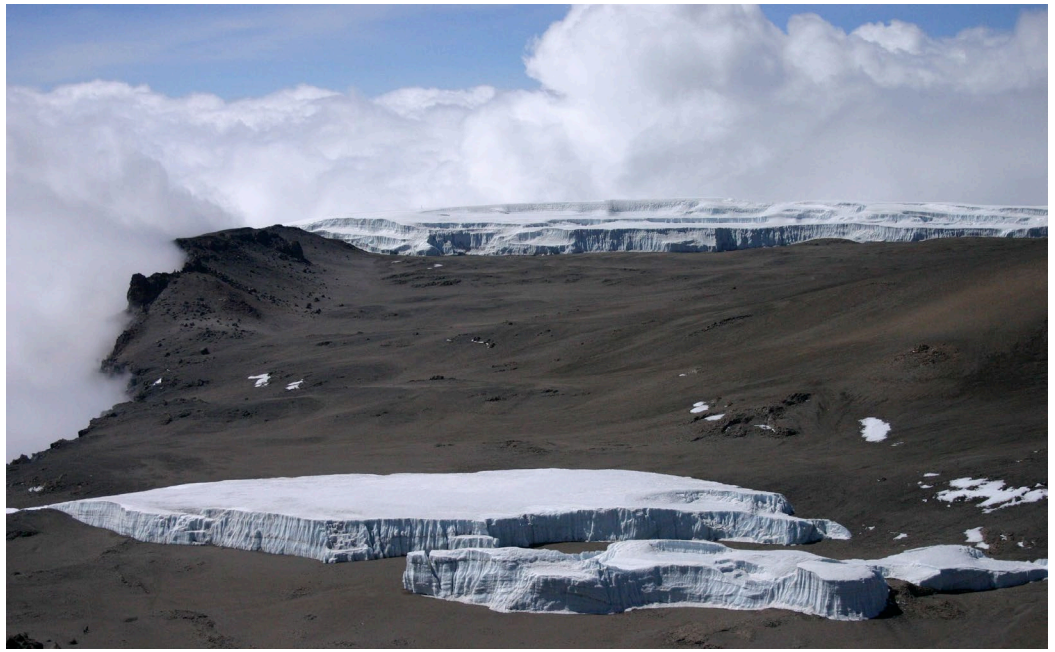
— Calc.
— Meas.

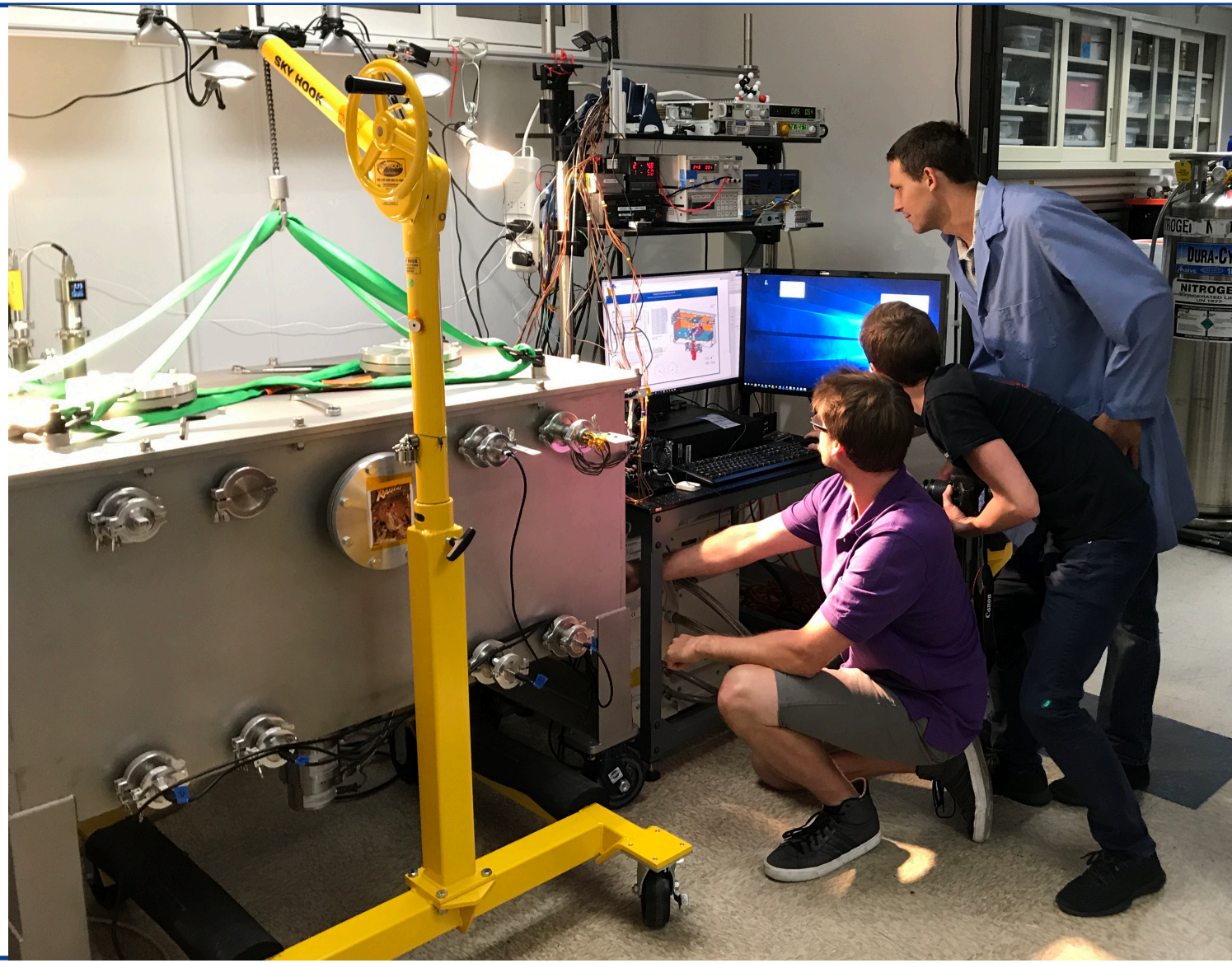
16x16 element performance



Artist's concept

What does the surface of Europa look like?





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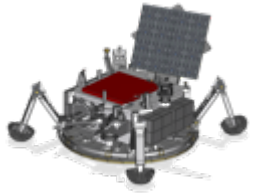
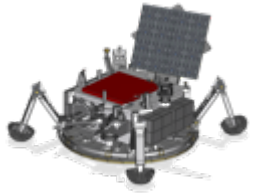
Europa Lander: Common Questions/Misconceptions



- ***To be clear***: Europa Clipper does not have a lander as part of the mission.
  - Clipper orbits Jupiter and makes ~45+ flybys of Europa.
  - Launch date: ~2023. Arrival at Jupiter: mid- to late-2020's.
- "We do not know where to land."
  - Even if we transitioned today to Phase A there would be over 3 years for landing site selection using Europa Clipper data.
    - **Result:** Science team will have lots of time to deliberate on landing sites.
- "Its not safe to land until we have data back from Clipper."
  - Europa Lander mission concept was designed with Clipper data in mind.
  - The highest resolution Clipper data is ~0.5 m/pix and is insufficient to change the architecture and mechanical design of the lander (also minimal impact on cost).
    - **Result:** We would need to change Clipper payload if the above is taken as a true statement.
  - Landing close in time with respect to reconnaissance data reduces risk.
    - **Result:** Land as close in time relative to the recon data as you can.

Europa Lander Status

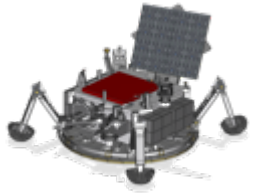


- Europa Lander pre-Project status
  - Held delta-Mission Concept Review (MCR) in Nov. 2018
    - "The review board (chaired by Bobby Braun) cannot recall a pre-phase A planetary science concept at this advanced level of fidelity"
  - FY19 budget signed, but near-term budgets unlikely to include funding levels required for new start
- NASA selected 14 potential instruments for maturation under Instrument Concepts for Europa Exploration 2 (ICEE-2) @ ~$2M each for 2 years
  - Funded out of FY18 budget
- High-priority Advanced Development maturation tasks have begun
  - Funded out of FY19 budget
  - Reduces flight development risk
  - Many tasks applicable to projects beyond Europa Lander

Europa Lander Next Steps

- Transition to Phase A halted.
- Decisions likely deferred until next decadal survey (~2023).

Mini-workshop Agenda



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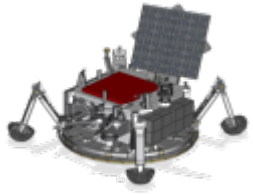
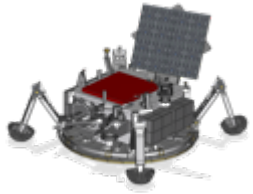
Advanced Development Activities



- Update launch opportunities and perform flight system impact assessment
  - Launch Period Survey and Interplanetary Trajectories
  - Navigating 3-body arrival with a short period
  - Support to Clipper Reconnaissance Focus Group
  - Assess DDL/Nav trade space

- De-orbit, Descent, and Landing (DDL)
  - DDL sensors
    - Reduce sensor hardware and algorithm development risk
  - Landing
    - Prototype and test landing system (legs, feet, bellypan) concepts for very rugged terrain
  - Propulsion
    - Prototype and test low-thrust throttleable engine
    - Environmentally test solid rocket motor propellant and ignition system

Advanced Development Activities



- Surface
  - Sampling
    - Prototype and environmentally test excavation, acquisition, and sample transfer techniques
      - Interact with ICEE-2 selectees to conduct rapid-prototype evaluation of interfaces
    - Develop approaches to maintain samples <150K
  - Autonomy: Develop and test concepts for highly autonomous operations
    - Develop software simulation and hardware testbed for development of autonomy designs
    - Mature autonomy sensing, closed-loop control, and computational requirements
  - Resources (size/weight/power/life/computation)
    - Develop and test lightweight, low-power motor controller
    - Continue radiation and life testing of primary batteries
    - Develop and test full-scale High-Gain Antenna
  - Planetary Protection/Contamination Control
    - Conduct planetary protection/bioburden analyses to mature payload and flight system requirements
    - Continue development of Terminal Sterilization System
    - Evaluate outgassing properties of radiation-exposed materials
    - Assess plume product interaction and alteration with cryogenic ices