



**Digital Twins for Solar System Exploration:
Enceladus**

**Date November 4-8, 2024
Overview Schedule**

**Monday, November 4, 2024
Broad 100 (Rock Room), Broad Center for Biological Sciences - Caltech**

**Short Course: Digital Twins for Solar System Exploration
Introductory Lectures - Open to all interested students, researchers and faculty**

Time	Event	Speaker
8:15 - 8:45	Coffee and Refreshments	
8:45 - 9:00	Logistics / Introduction	Harriet Brettle Team Lead
9:00 - 10:00	Short Course Lecture #1: End-to-End Example of A Digital Twin	Terry Hill
10:00 - 10:30	Break	
10:30 - 11:30	Short Course Lecture #2: Overview of Planetary Mission Formulation	Karl Mitchell
11:30 - 12:30	Short Course Lecture #3: Lessons from Europa Clipper	Erin Leonard
12:30 - 1:30	Short Course Ends: Informal Lunch is provided outside Broad 100	

**Invitation-Only Workshop Begins
Keck Center - Think Tank, Room 155**

1:30 - 1:45	Walk to Keck Center, pick up badge and welcome packet, find seat in the Think Tank	
1:45 - 2:15	Workshop Logistics and Introduction to KISS	Harriet Brettle
2:15 - 2:45	Participant Introductions	Harriet Brettle
2:45 - 3:30	Study vision and goals for the workshop	Team Leads
3:30 - 4:00	Break	
4:00 - 4:15	Introduction to KISS Breakout Groups	Harriet Brettle
4:15 - 5:00	Breakout Session 1: Defining Digital Twins for Planetary Missions	Groups
5:00 - 5:30	Report Outs from Breakout Groups (10mins each)	Groups
5:30 - 6:00	Solicitation of Lightning Talks	All
6:00 - 6:30	Walk to dinner	All
6:30	Dinner - informal dinner at Green Street Restaurant	

Tuesday, November 5, 2024 - Keck Center - Think Tank, Room 155

Time	Event	Speaker
8:00 - 8:30	Institute Opens - FREE THINK TIME	
8:30 - 9:00	Coffee and Refreshments at Keck Center	
9:00 - 9:15	Logistics and Team Lead Goals for the Day	Harriet Brettle and Team Leads
9:15 - 10:00	Special Topic Talk/Discussion: Summary of published Enceladus concepts and various science traceability matrices (STMs)	Mark Simons
10:00 - 10:30	Lightning Talks - Instrumentation Modelling 101 - Diana Blaney - Where is interesting on Enceladus beyond the South Pole - Erin Leonard	Diana Blaney Erin Leonard
10:30 - 11:00	Break	
11:00 - 12:30	Breakout Session 2: - What are the physical and chemical (and biological?) processes that a Digital Twin should consider scientifically? - What instruments should an initial Digital Twin for Enceladus include? - What aspects should be considered for defining a Concept of Operations (ConOps) for these instruments/measurements?	All
12:30 - 2:00	Group Picture and Lunch at the Athenaeum	
2:00 - 2:45	Report outs from breakout groups (15 mins each)	Groups
2:45 - 3:15	Lightning Talks - Computational hypergraphs for Digital Twin Design - Pau Batlle - What is the closest to a Digital Twin of Enceladus that we have now - Eitan Rapaport	Pau Batlle Eitan Rapaport
3:15 - 3:45	Break	
3:45 - 5:30	Breakout Session 3: Revisiting the definition of a digital twin for planetary missions	Groups
5:30 - 7:30	POSTER SESSION and Informal dinner at the Keck Center (dinner starts at 6:30 pm)	

Wednesday, November 6, 2024 - Keck Center - Think Tank, Room 155

8:00 - 8:30	Institute Opens - FREE THINK TIME	
8:30 - 9:00	Coffee and Refreshments at Keck Center	
9:00 - 9:15	Logistics and Team Lead Goals for the Day	Harriet Brettle and Team Leads
9:15 - 9:45	Report Outs from Breakout Groups (10 mins each)	Groups
9:45 - 10:30	Convergence on defining Digital Twins for planetary missions	All
10:30 - 11:00	Break	
11:00 - 11:45	Special Topic #2 Talk/Discussion: Approaches to Verification, Validation, and Uncertainty Quantification (VVUQ) and addressing trust in Digital Twins	Amy Braverman
11:45 - 12:30	Plenary Discussion: Role of AI and Machine Learning	Alphan Altinok
12:30 - 2:00	Boxed Lunch provided at the Keck Center - explore Caltech or get a head start to Huntington	
2:00 - 4:00	Walk and Talk at the Huntington Library and Gardens	All
4:00 - 4:30	Return to Keck Center	All
4:30 - 5:00	Group Pulse: What have you gained so far? What do you want to accomplish by Friday?	
5:00 - 6:00	Plenary Discussion: Given what we now know, how do we want to proceed to achieve our DT goals? Selection of Day 4 Lightning Talks & Breakout Groups	All
6:00	Workshop Day #3 Ends	All
6:00	OPTIONAL: No-Host Dinner in Pasadena	

Thursday, November 7, 2024 - Keck Center - Think Tank, Room 155

8:00 - 8:30	Institute Opens - FREE THINK TIME	
8:30 - 9:00	Coffee and Refreshments at Keck Center	
9:00 - 9:15	Logistics and Team Lead Goals for the Day	Harriet Brettle and Team Leads
9:15 - 10:30	Lightning Talks: - Best Practices for collaborating across different organizations on complex models - Michael Aivazis - Combining unique datasets - what is the art of the possible? - Terry Hill <i>Followed by Plenary Discussion</i>	Michael AivazisTerry Hill
10:30 - 11:00	Break	
11:00 - 12:30	Breakout Session 4: Habitability Objectives and Instruments	All
12:30 - 2:00	Lunch on your own	
2:00 - 2:45	Report outs from breakout groups (15 mins each)	TBD by participants
2:45 - 3:00	Lightning Talks: - How can we abstract models as emulators, examples from weather/climate modeling - Dev Niyogi	Dev Niyogi
3:00 - 3:30	Plenary Discussion: Next Steps	All
3:30 - 4:00	Break	
4:00 - 5:30	Breakout Session 5: 1. Plume Provenance 2. Thermal budget - ice shell thickness 3. Nutrients - ocean density	Groups
6:00	Closing Dinner at the Athenaeum	

Friday, November 8, 2024 - Keck Center - Think Tank, Room 155

Time	Event	Speaker
8:00 - 8:30	Institute Opens - FREE THINK TIME	
8:30 - 9:00	Coffee and Refreshments at Keck Center	
9:00 - 9:15	Logistics and Team Lead Goals for the Day	Harriet Brettle and Team Leads
9:15 - 9:30	Lightning Talk: What do the plumes tell us? Lucas Fifer	Lucas Fifer
9:30 - 10:00	Breakout Groups Report Out	All
10:00 - 10:30	Synthesis - are there fundamental commonalities / differences / significant incompatibilities between the products of the three breakout groups?	All
10:30 - 11:00	Break	
11:00 - 12:30	Report Drafting - discussion and writing sprint	All
12:30 - 2:00	Lunch at the Keck Center	
2:00 - 3:30	Open Discussion of Path Forward to the Second Workshop - action items assigned, etc.	
3:30 - 4:00	Break	
4:00 - 5:00	Workshop Closeout	Harriet Brettle
5:00	Institute Closes	