Jet Propulsion Laboratory
California Institute of Technology

Science Intent Capture Architecture

for Science Planning on The Mars 2020 Mission

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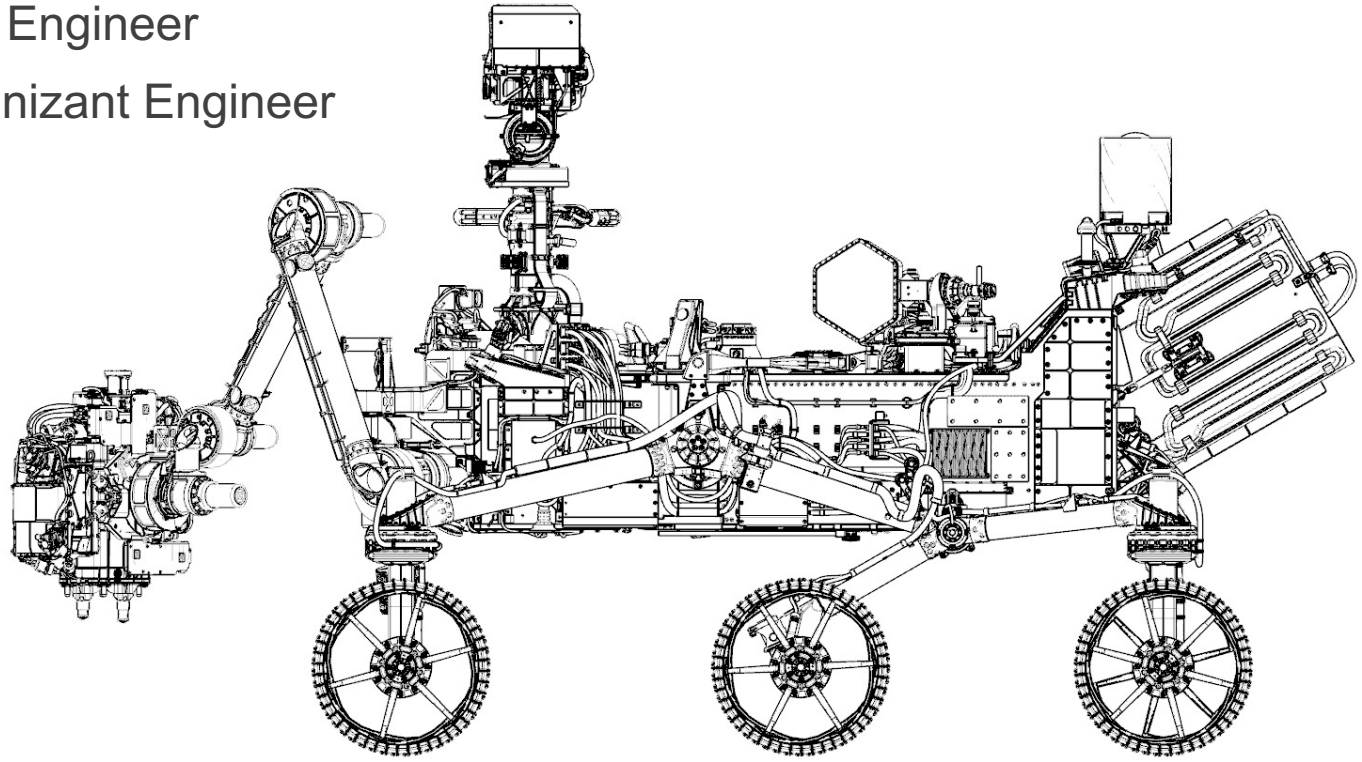


MARS 2020
PROJECT

M2020 Science Intent Architecture Overview

Mission Objective: Identify opportunities for, and acquire rock and soil samples during its mission.

Challenge: The different levels of science planning, from high-level strategic mission planning to daily tactical planning, needs to be more closely coordinated than on previous Mars surface missions in order to ensure that the sampling objectives of the mission in Jezero crater are accomplished.

Strategy: Facilitate alignment of the science team around the objectives of the mission so that collaborative decision making can be most efficient and strategic

Solution: A cross-cutting software architecture that links the science objectives for each Campaign to all the pertinent planning and analysis tools so that these objectives are present as guideposts to the Science Team throughout the Science Planning processes.

Priority Challenges

There are 11 key challenges to accomplishing the M2020 mission from a science planning perspective. The approach outlined here is intended to address these from the perspective of tracing science intent.

Strategic > Tactical Interface

1. Balancing having a well-defined plan with improvisation based on new information
2. Tactical has more current data while strategic has more context on big picture goals
3. Large potential mars surface area to explore, small area that can actually be explored during prime mission
4. More time to analyze and reflect during strategic, less time during tactical, when the decisions are most critical

Sol > Sol Handoff

1. Continuity of plan rationale at sol>>sol handoff (what, where, how, why)
2. Density of current state of information at sol>>sol handoff (report update effort, report review effort)
3. Informal, human process at sol>>sol handoff
4. Accumulation of understanding from sol>>sol of multiple science investigations, with transparency to all teams
5. Getting at the most relevant information for decisions each sol, quickly and easily

Analysis > Plan Updates

1. Analysis processing is not always fast enough to effectively inform tactical planning
2. Analysis is not easily accessed across teams, from sol>sol, and location to location

Science Intent Solution

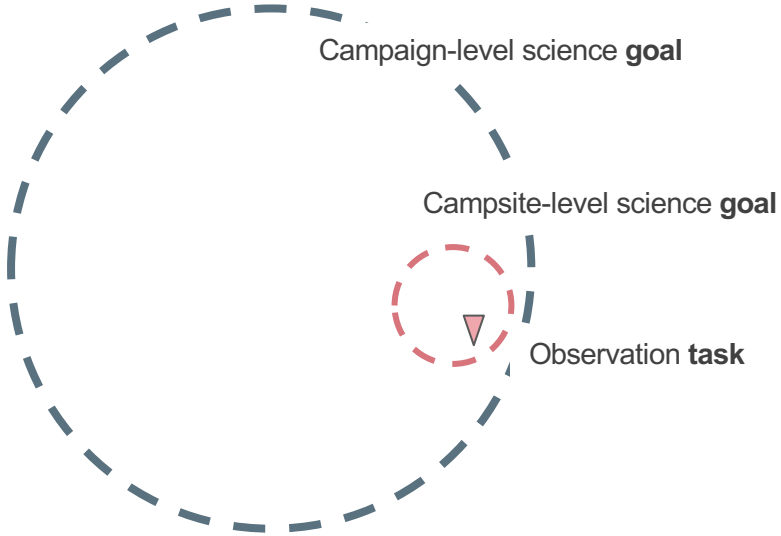
Keep our entire science team, through all planning phases, aligned on what we are doing next, and why, via tools and process.

This solution includes:

- Continuity of science intent capture and communication in planning and analysis workflows
- Close coordination of the science team at all planning phases
- Consistent visibility into goals for each campaign, and how they trace to rationale for observations
- Systematic tracking and communication of ongoing progress towards science goals

…all integrated into existing tools and processes

Science Intent - Goals and Tasks



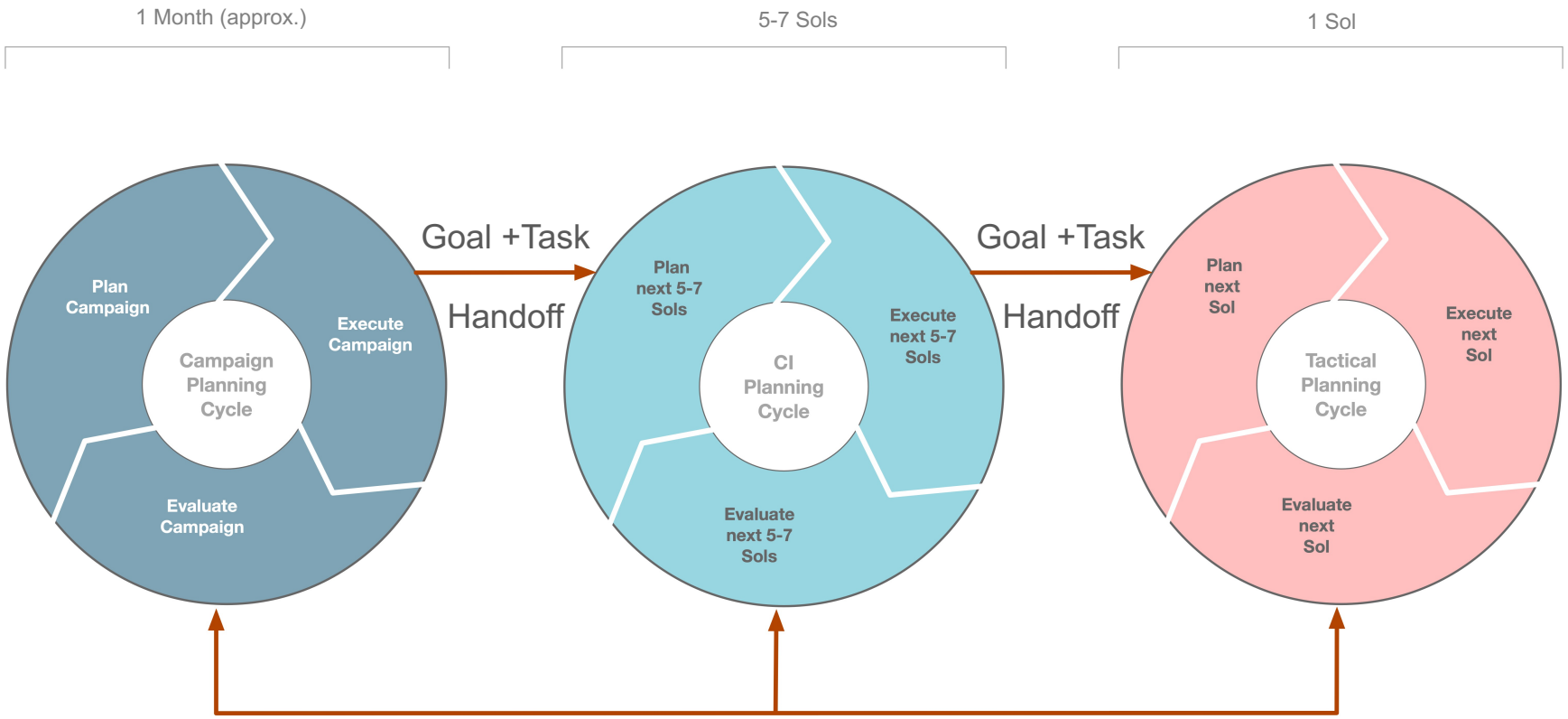
Goal
High-level science objective that is addressed via observation outcomes.

Task
Investigation of a specific aspect of a Goal, via one or more observations.

Goals – ***written at campaign and campsite scales***
These statements describe the higher-level science questions we want to address at a location, and are used to define the science that will be done at that location.

Tasks – ***written for the scale of observations***
These are a defined set of more granular objectives that, when carried out, will inform our understanding of the broader science question that a Goal describes. Each Task should lead to one or more observations, and tell you the "what" and the "why" – what feature are you observing, with what technique, and why does this help us address the relevant Goal?

Science Intent – Planning Phase Iteration



Goal and Task Iteration Informed by Other Processes

Science Intent – Planning Phases Iteration

Iteration Cycle Context for Goals and Tasks

There is iteration in all phases of the planning processes, happening simultaneously in each phase:

- During **Campaign Planning**, a set of Goals and notional Tasks is be defined for the campaign.
- As a product of **Campaign Implementation**, relevant Goals are identified for the next few sols, and a set of Tasks are identified and/or created to address these Goals at this location. New insights from the previously executed Tasks inform each Goal, and also inform the definition of new Tasks if needed.
- On the **Tactical Shift**, the set of Tasks notionally provided by CI is reviewed and mapped to actual Activities and Targets in the plan. As the team makes progress on accomplishing these Tasks and Goals, this progress is documented and accessible, via the tools, in all of the processes so that each planning group has the most recent information to revise their plan.

Science Intent Architecture Primary Goals

- **Decision making**
  Capture science rationale for observations as relates to the broader objectives for each rover location in the team's planning tools. This will help facilitate decision-making about priorities, observation design, and to provide transparency to the team around these rationale.

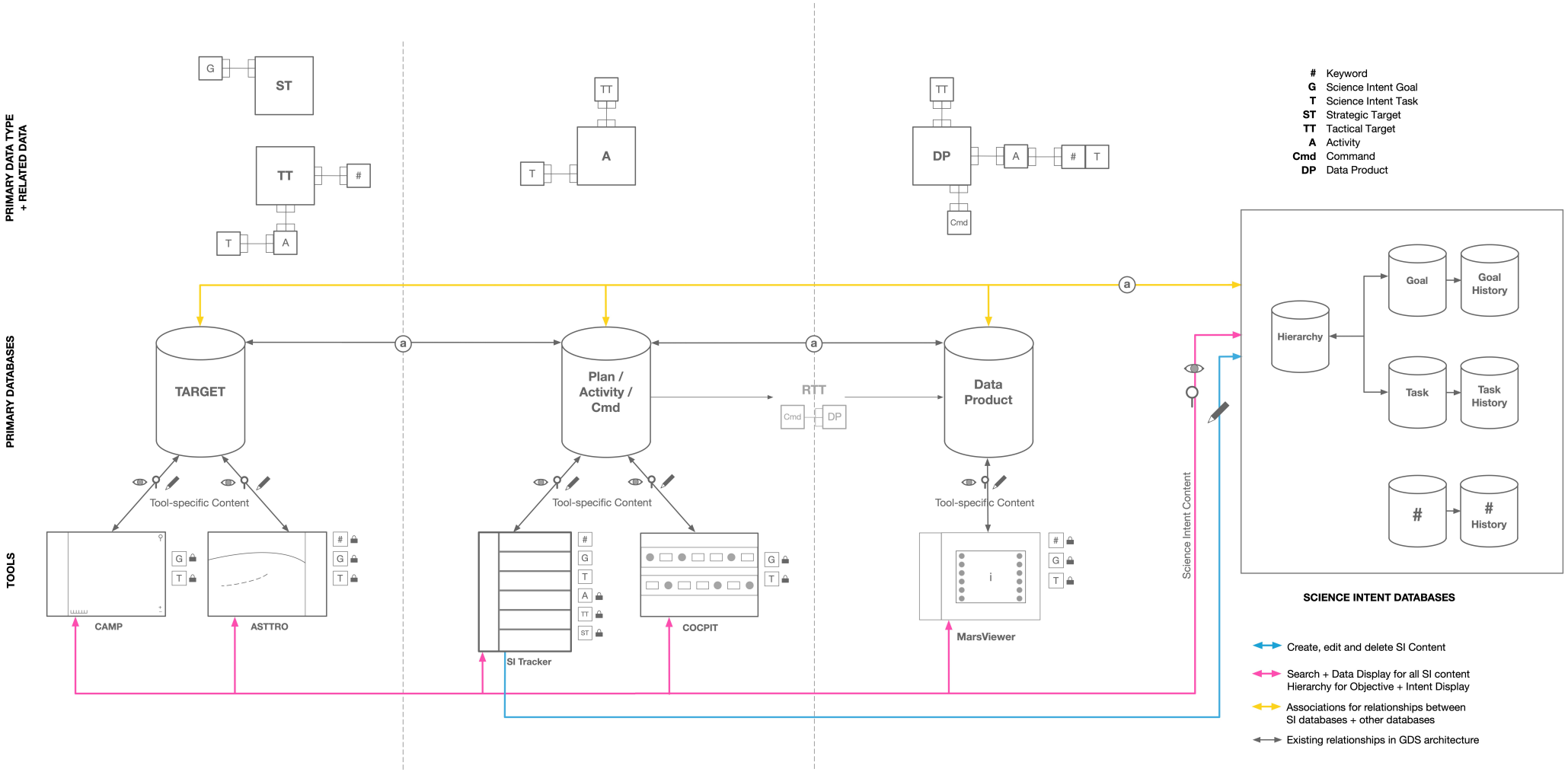
- **Handoff sol to sol and process to process**
  Provide a mechanism for consistent and accessible guidance

- **Tracking Progress**
  To provide a central science intent tracking tool to manage and understand the team's progress towards accomplishing science goals at each rover location with links to related targets, plans, and data products

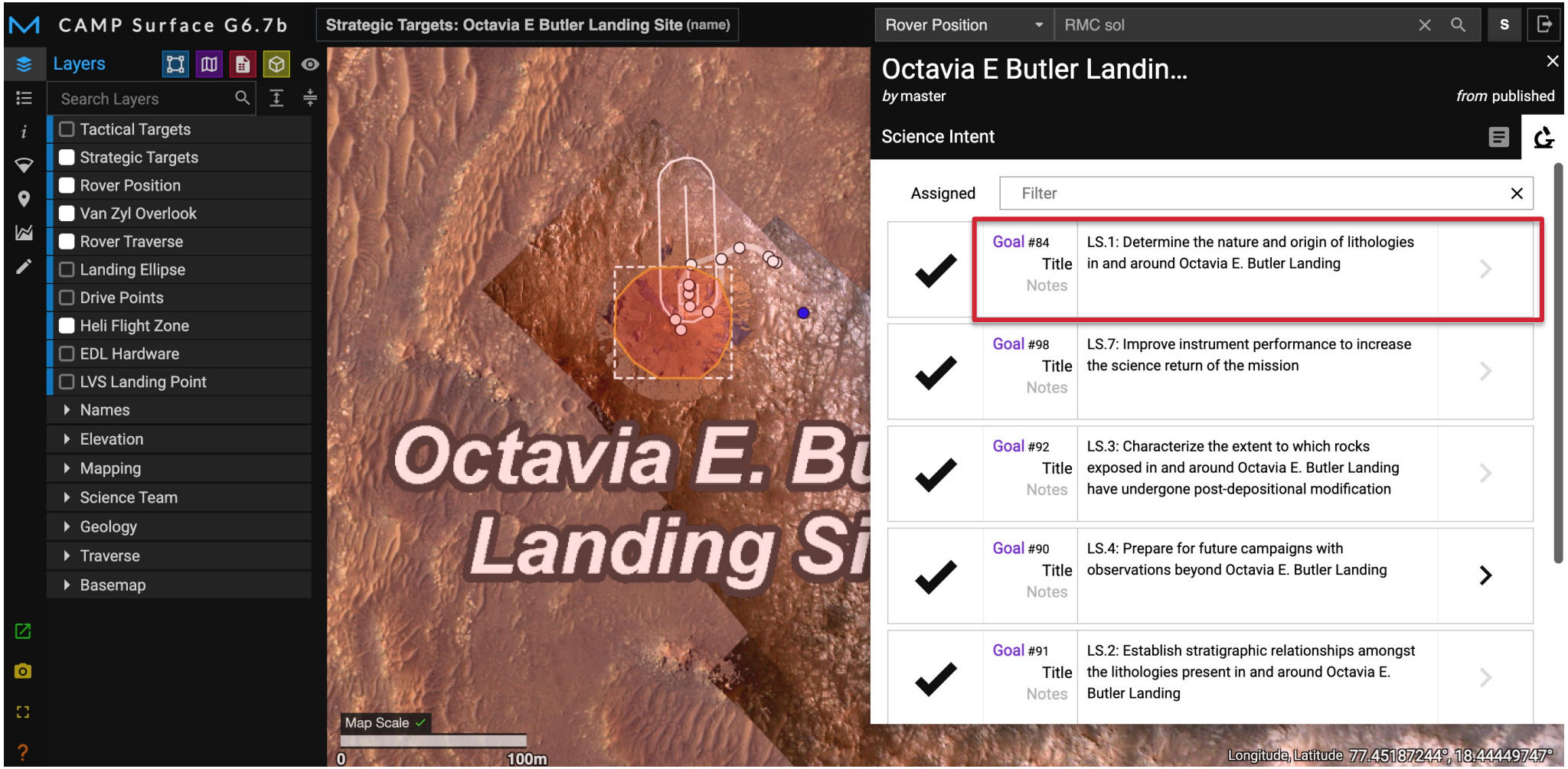
- **DL Analysis context**
  Enhance Downlink Analysis of science data by linking science rationale for observations with their associated data products

- **Searchable historical archive**
  Record of science rationale mapped to observations at each campaign

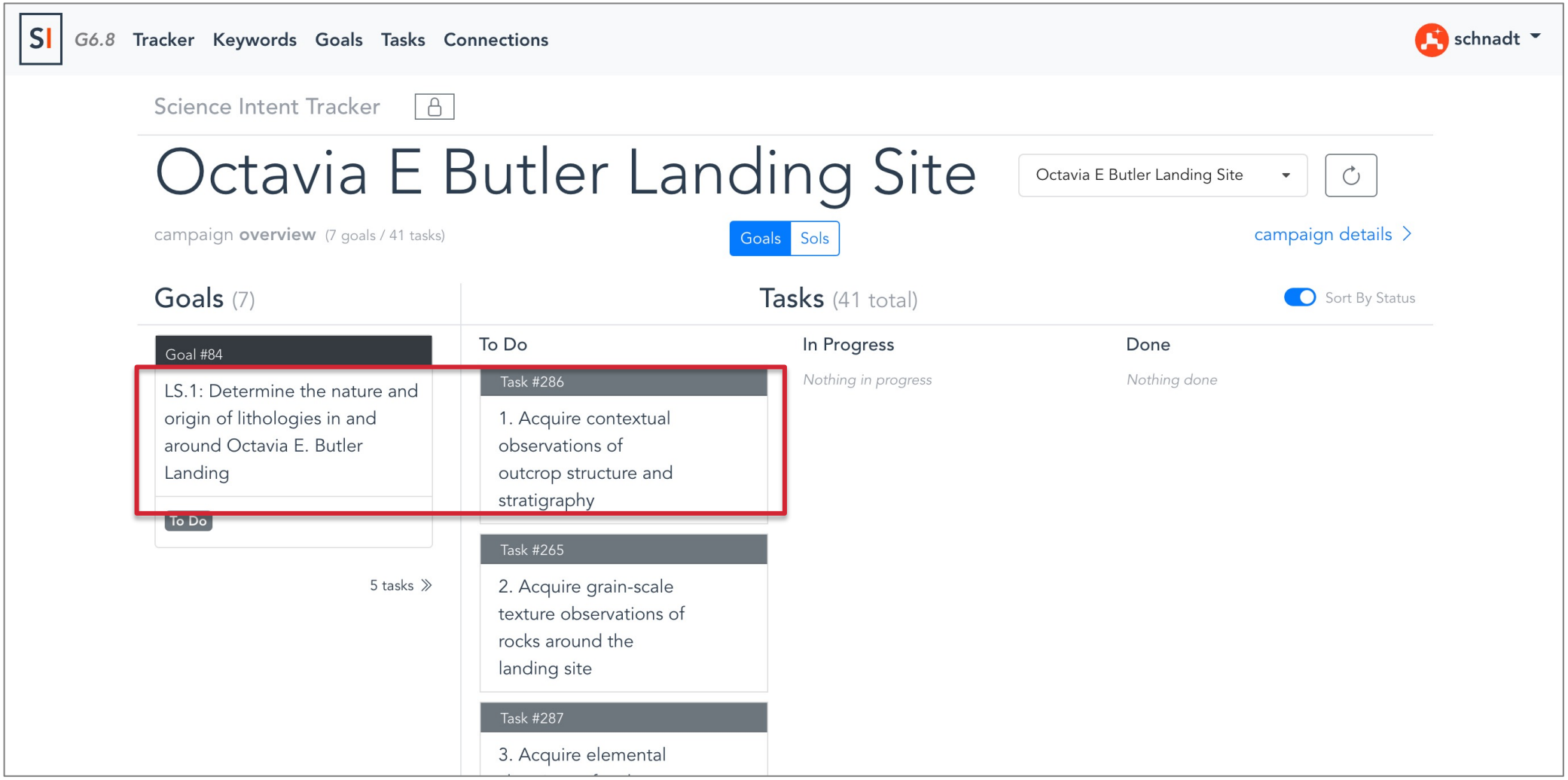
Science Intent Architecture



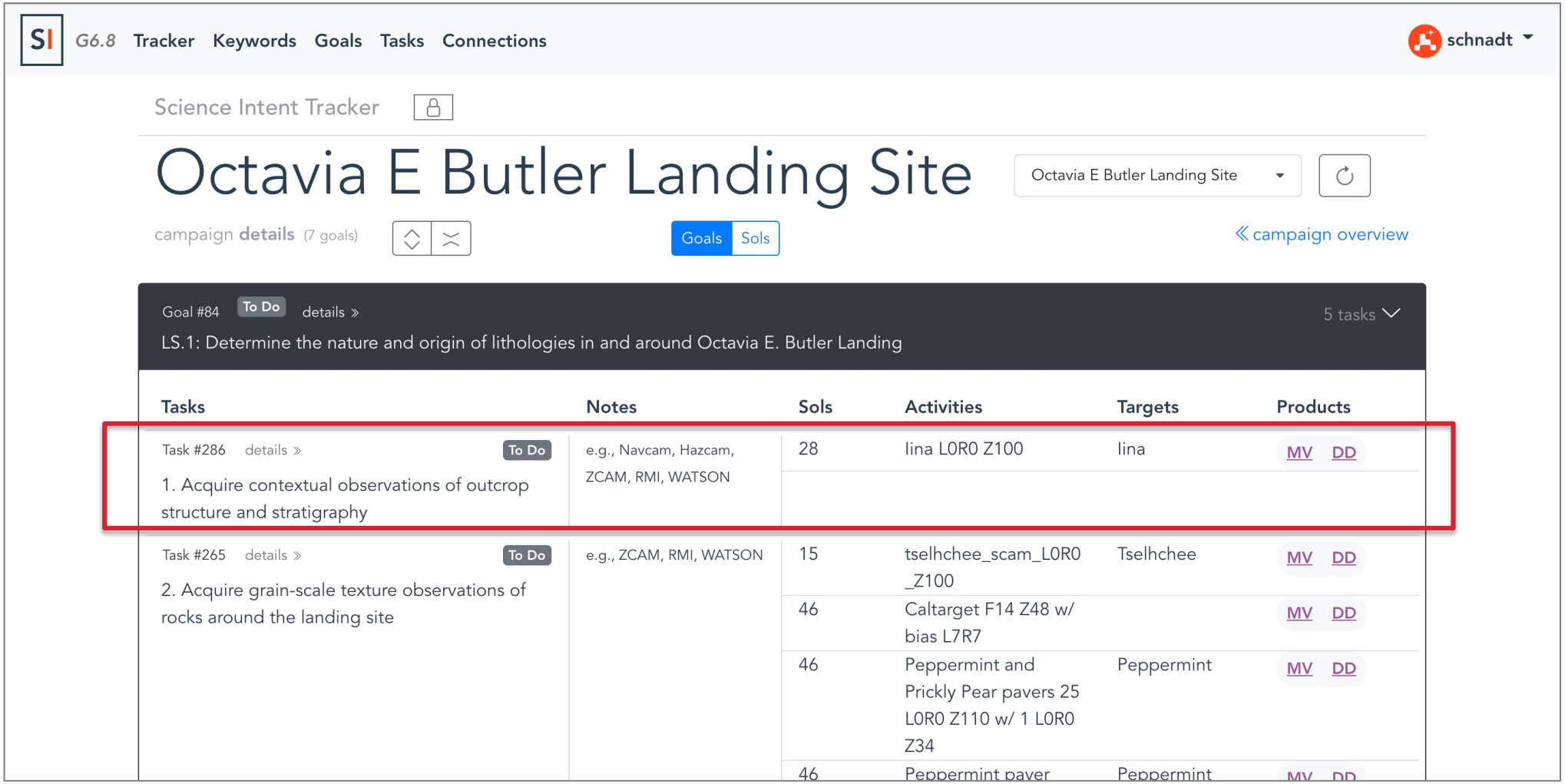
CAMP – Goals for a Campaign



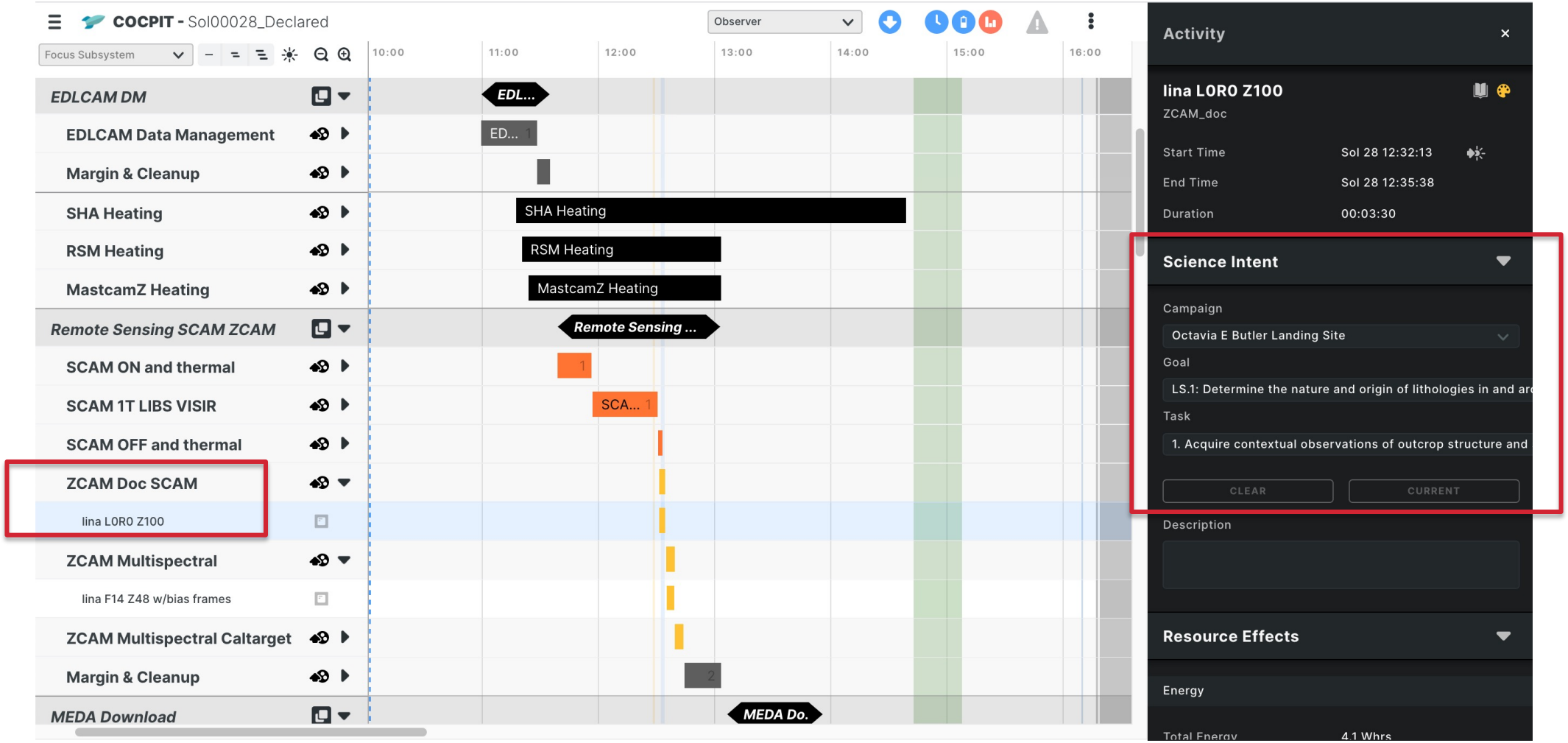
SI Tracker – Goal + Task Tracking View



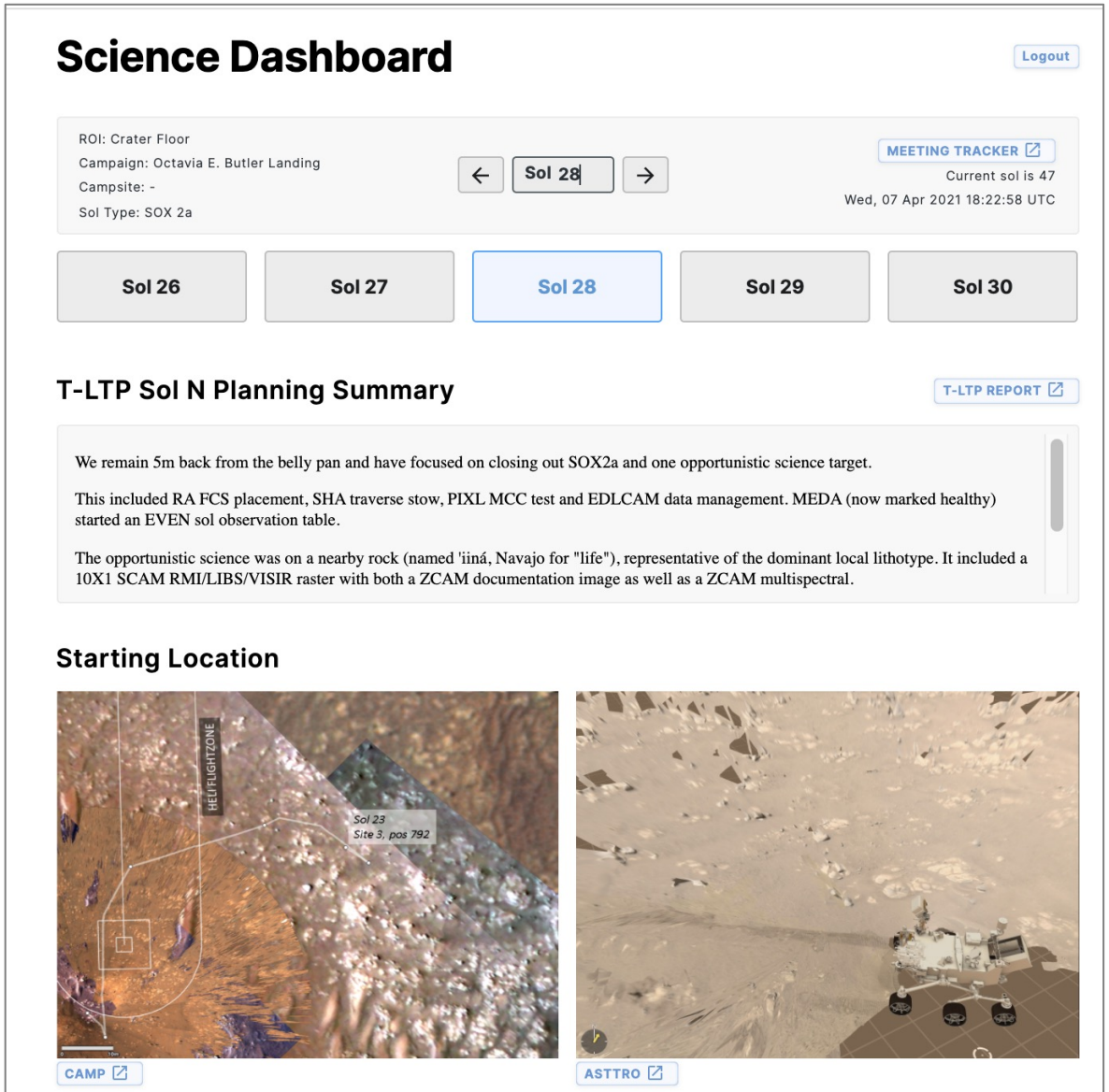
SI Tracker – Detail View



COCPIT – Goal +Task Associated to an Activity



Science Dashboard – Sol-based Context



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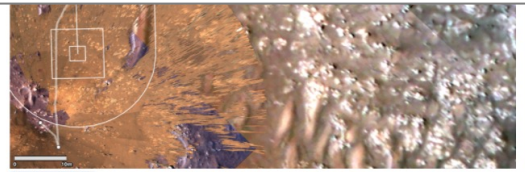
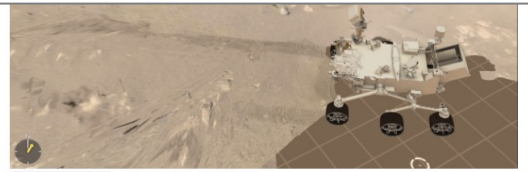


CAMP



ASTTRO

Planned Activities

Sol00028_Tactical OPEN PLAN IN COCPIT Last Refresh: Wed, 07 Apr 2021 18:22:25 UTC Refresh

		331a1fd92844	rocks around the landing site	
SCAM OFF and thermal	-	-		DD MV
lina L0R0 Z100	lina	696571fd-f5b5-481c-9333-331a1fd92844	1. Acquire contextual observations of outcrop structure and stratigraphy	DD MV
lina F14 Z48 w/bias frames	lina	696571fd-f5b5-481c-9333-331a1fd92844	4. Acquire mineralogy and/or hydration of rocks around the landing site	DD MV
ZCAM caltarget F14 Z48 w/bias frames	unassigned		4. Acquire mineralogy and/or hydration of rocks around the landing site	DD MV
MEDA Data Download and OT reactivation	-	-		
FHAZ	-	-		DD MV

Science Reports

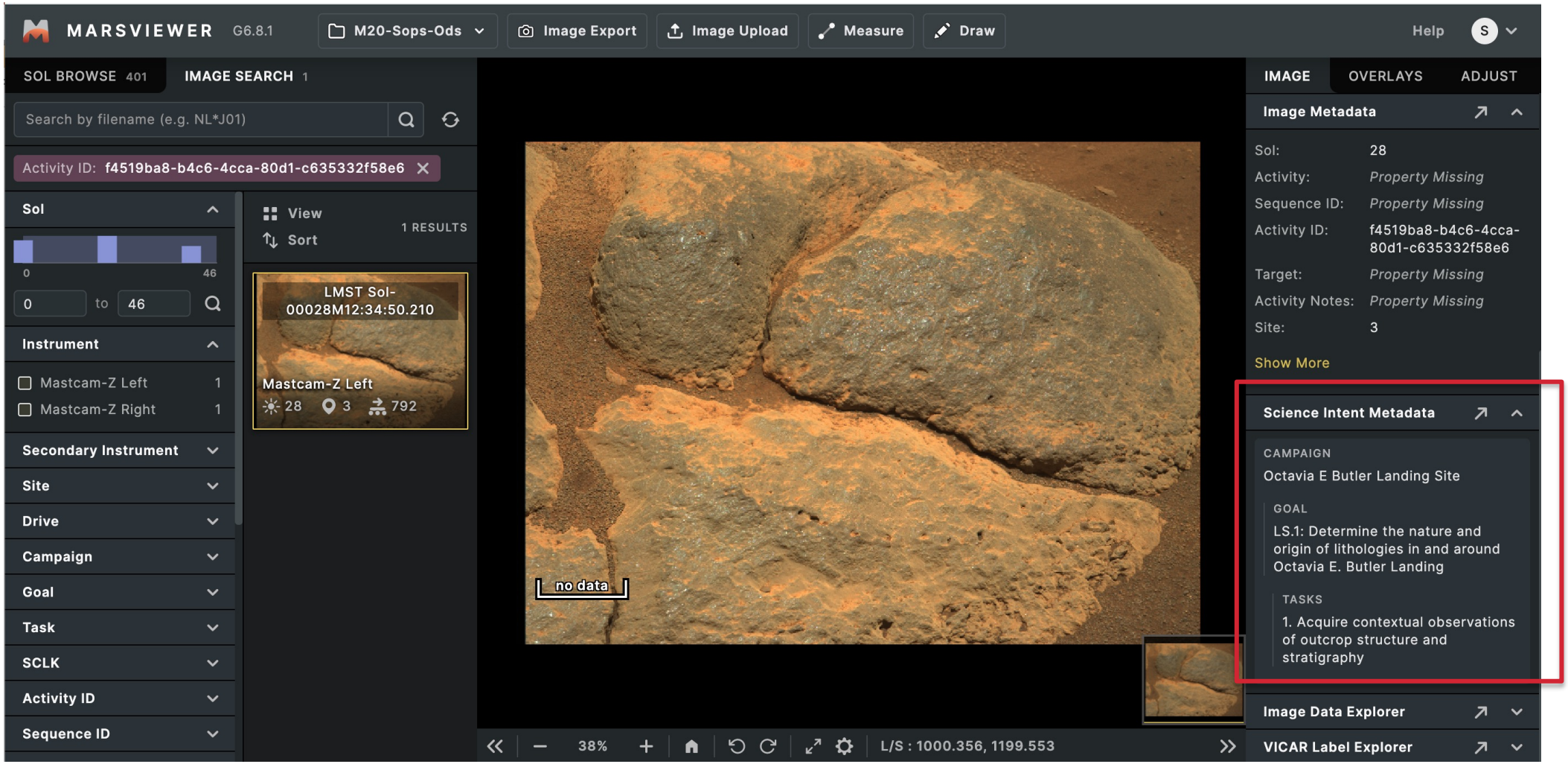
Tactical Reports

T-Doc TSL T-LTP PILOT/T-SEL T-RSS Mapping Specialist

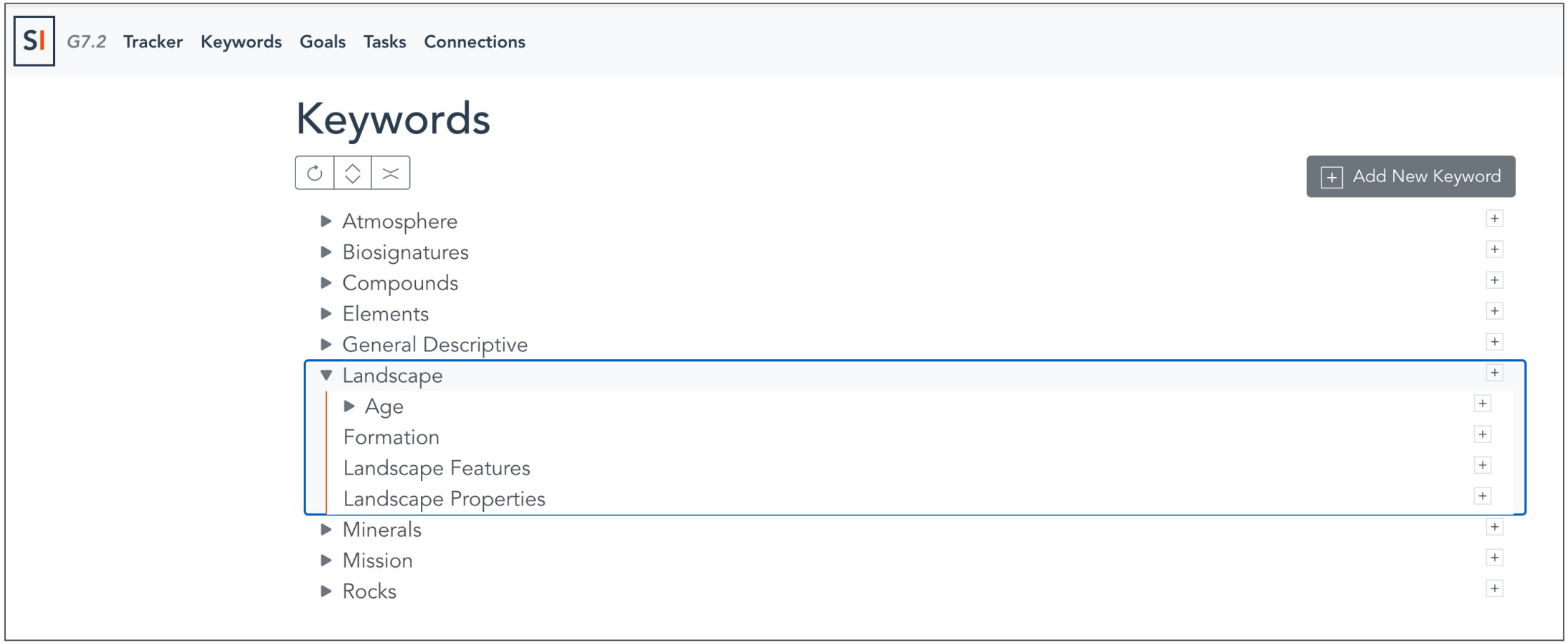
CI Reports

CI Science Report CI-SEL CI-RSS

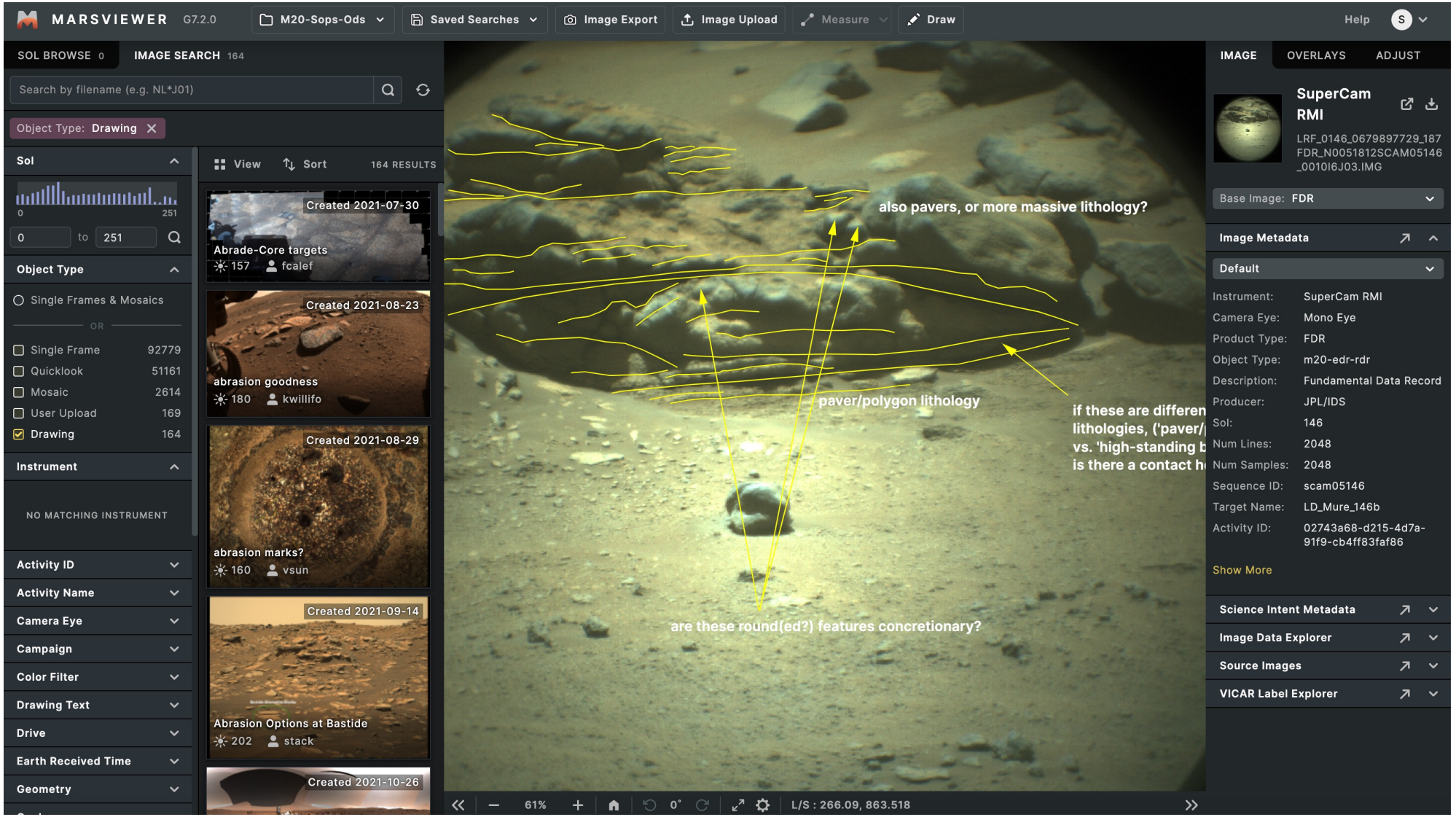
MarsViewer– Goal + Task Metadata on Image



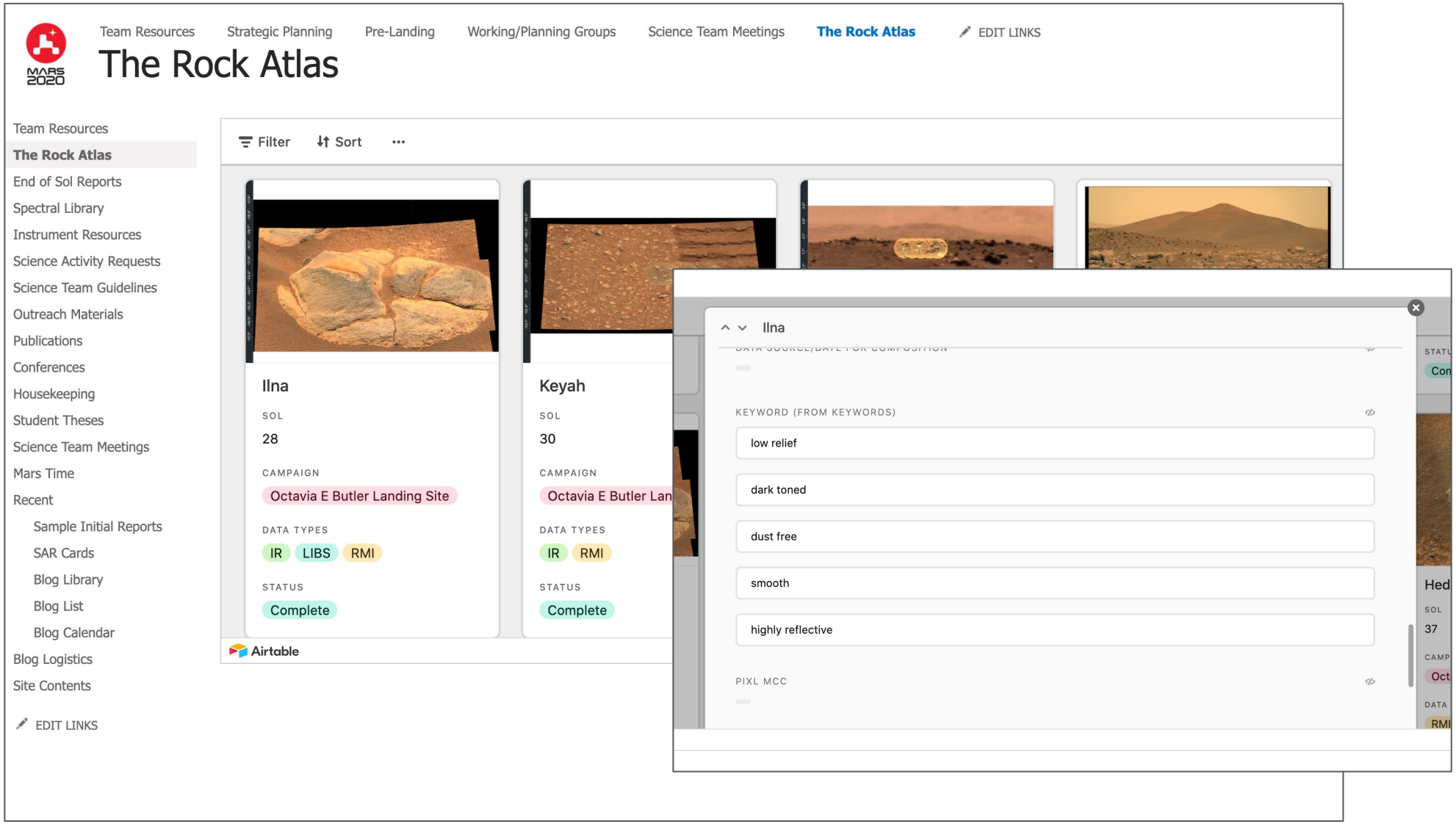
SI Tracker – Keywords Creation + Management



MarsViewer– Annotations, Keywords on Image



Rock Atlas – Catalog of features w/ Keywords



How Goals and Tasks are Working So Far

Socialization and inclusion in science processes is going well!
Goals and Tasks are being used for:

Identified Goals:
- Decision making
- Handoff sol to sol and process to process
- Tracking Progress
- DL Analysis context
- Archive

Also for:
- Guidance and governance
- Documentation of how plans correspond to mission objectives

"The Goals and Tasks are like the sign posts and fundamental guides for the kinds of activities that are in scope, and they are combined with understanding of what has happened so far and what kinds of observations we haven't done yet (towards the Goals and Tasks) to define priorities for upcoming sols."

Science Planner