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Science Intent Capture Architecture

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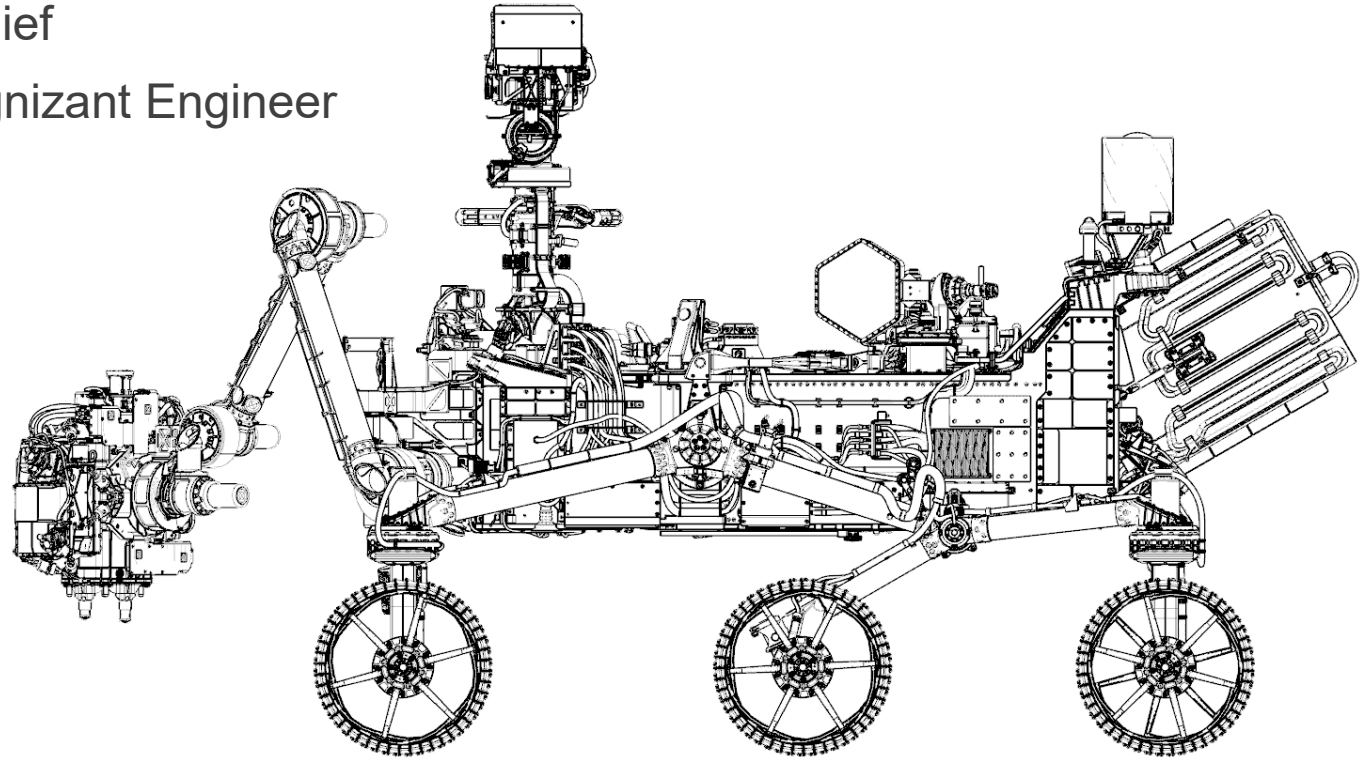


MARS 2020
PROJECT

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 in order to improve collaborative decision making, and help it to be more 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.

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 can help facilitate decision-making about priorities, observation design, and to provide transparency to the team around these rationale.

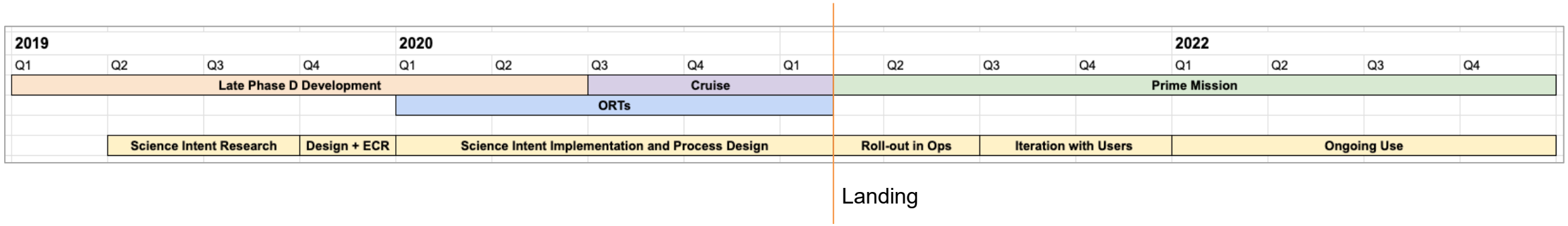
- **Handoff sol to sol and process to process**
  Provide a mechanism for consistent visibility into science intent as part of handoff guidance

- **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.

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

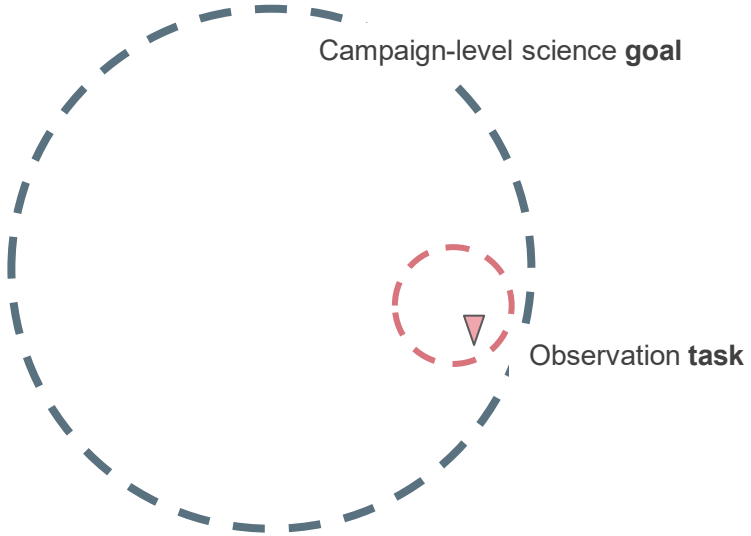
- **Searchable historical archive**
  Record of science rationale mapped to observations at each campaign (included in the PDS as of release 4)

Development and Rollout Timeline



- Began work in late phase D
- Added Science Intent Architecture design to existing near-complete GDS
- ECR-ed work into mission Oct 2019, 15 months before landing
- Built out solution and associated process design in time for landing
- Incorporated use in science team procedures and included in Strategic, mid-range and Tactical Planning
- Iterated on design during the first year of operations
- Continued use for second year of prime mission, and ongoing

Science Intent - Goals and Tasks



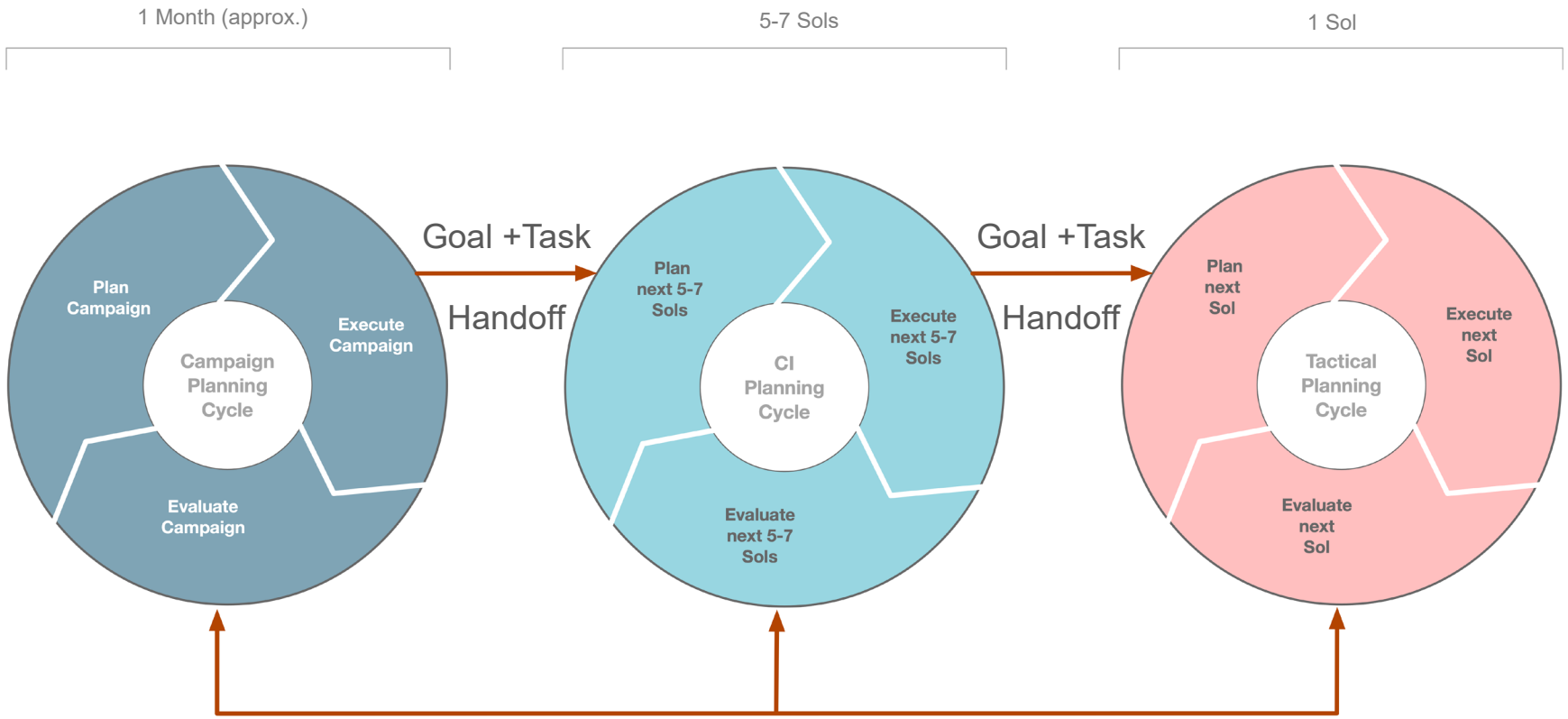
Goal
High-level science objective that is addressed via observation outcomes.

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

Goals – ***written at campaign scale***
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



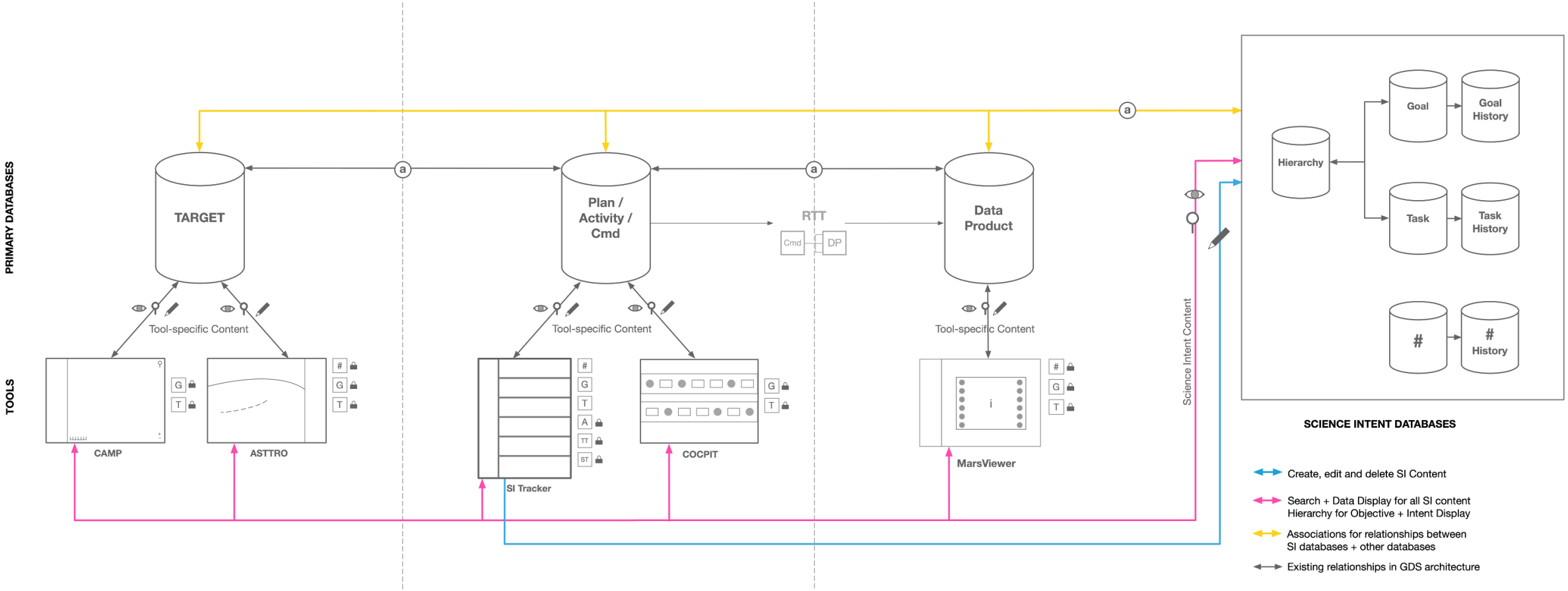
Goal and Task Updates Informed by Other Processes

Science Intent – During Planning Phases

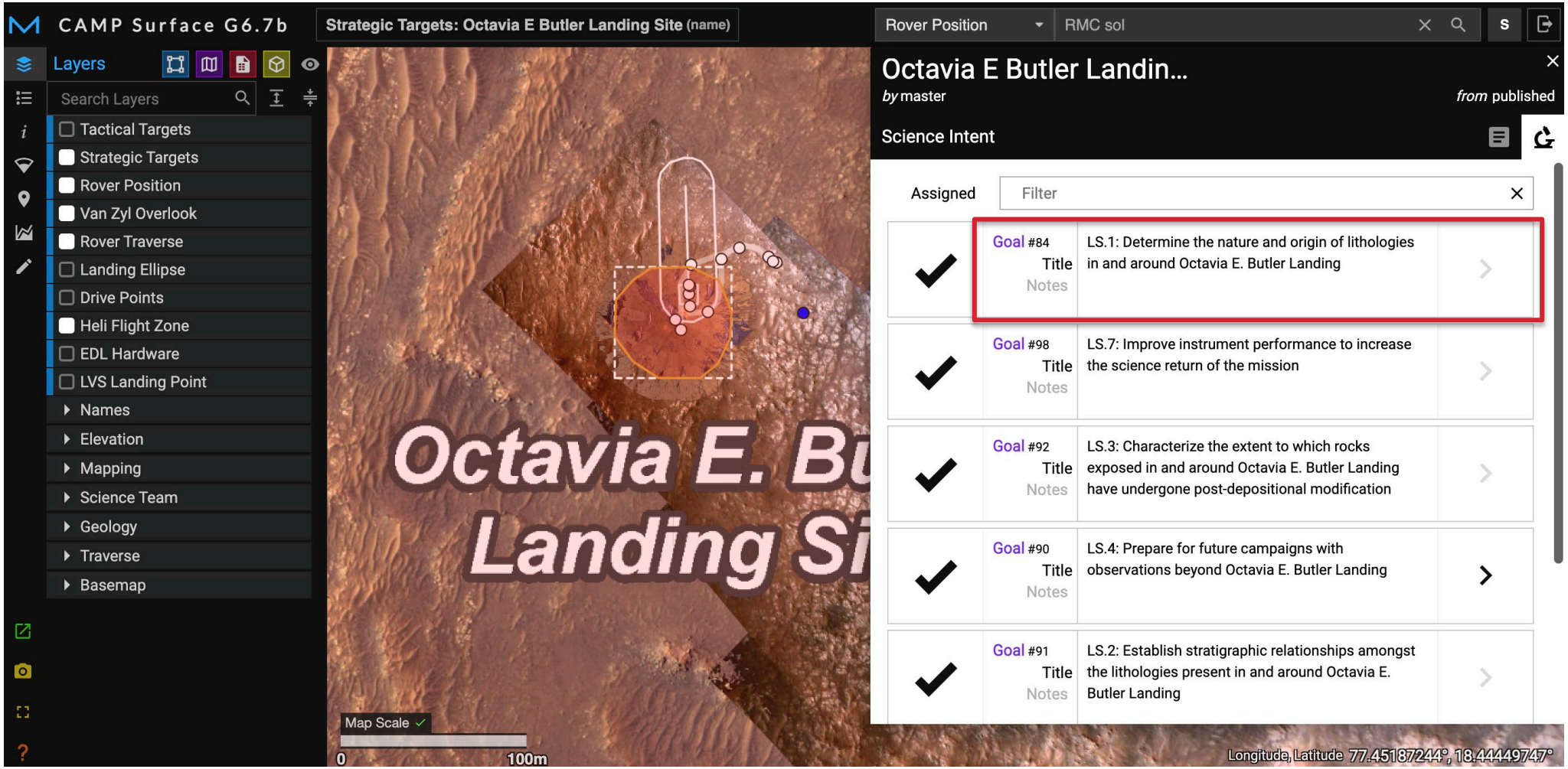
Goals and Tasks in the Planning Phases

- During **Campaign Planning**, a set of Goals and notional Tasks is 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.

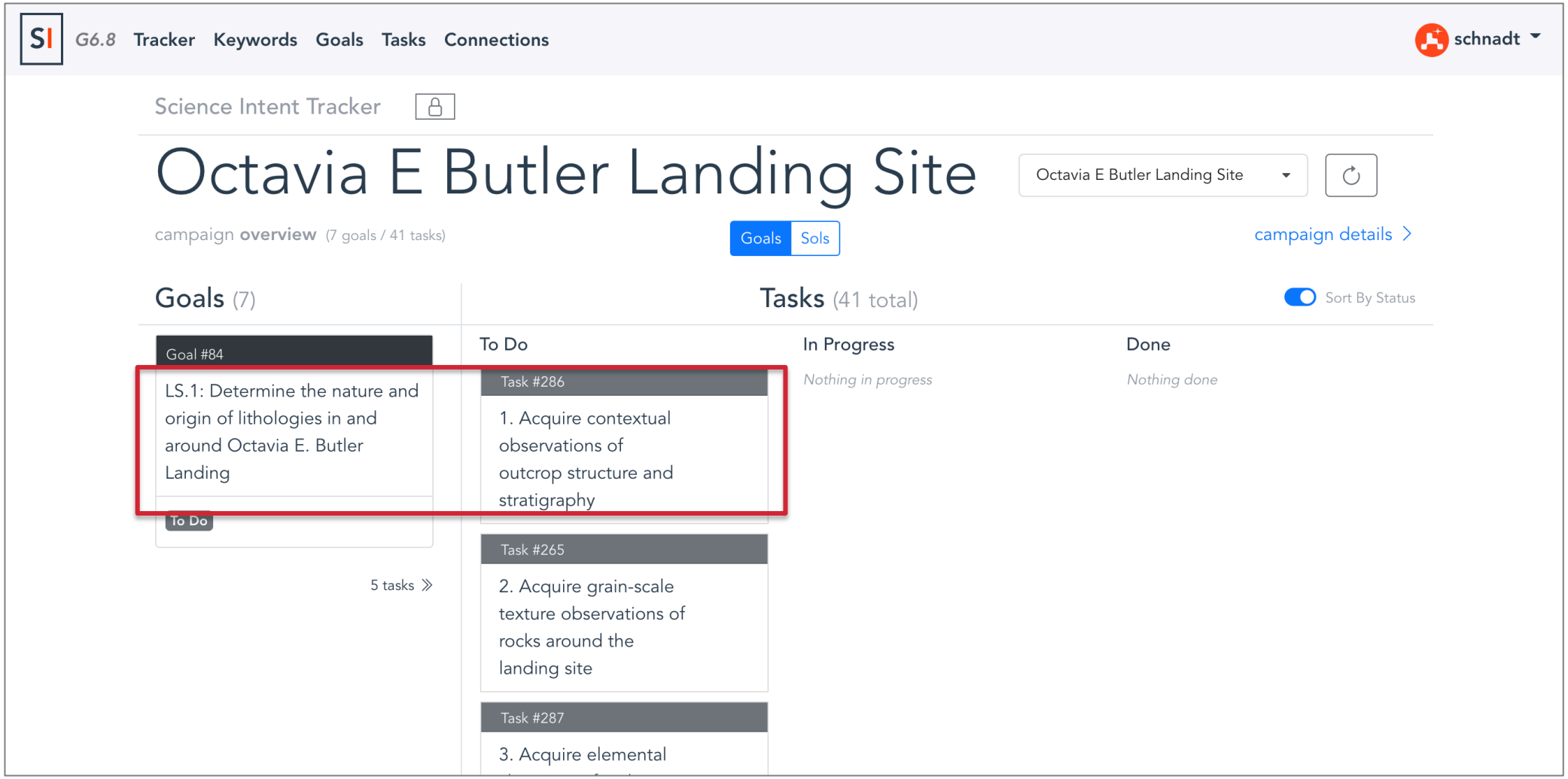
Science Intent Architecture



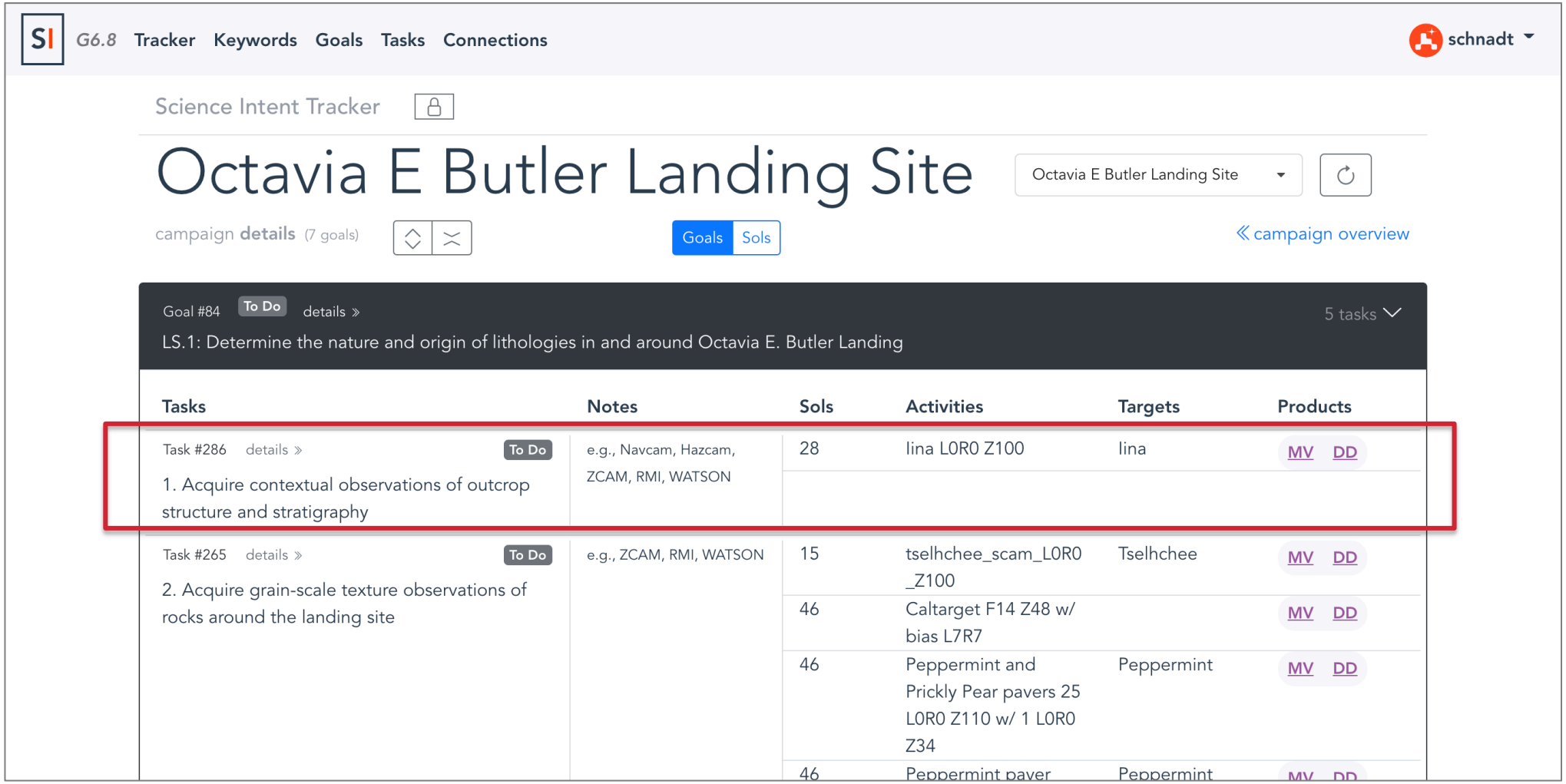
CAMP – Goals for a Campaign



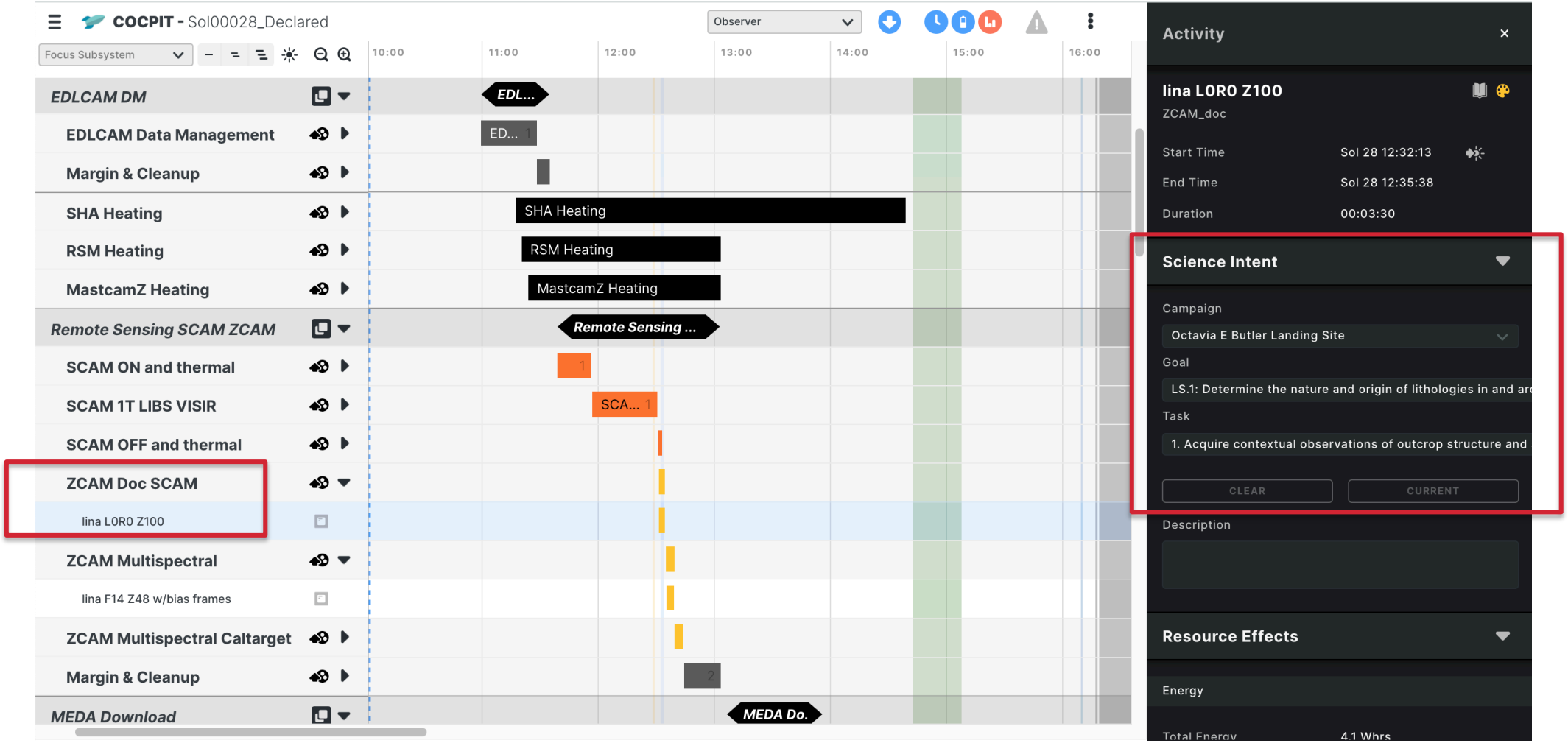
SI Tracker – Goal + Task Tracking View



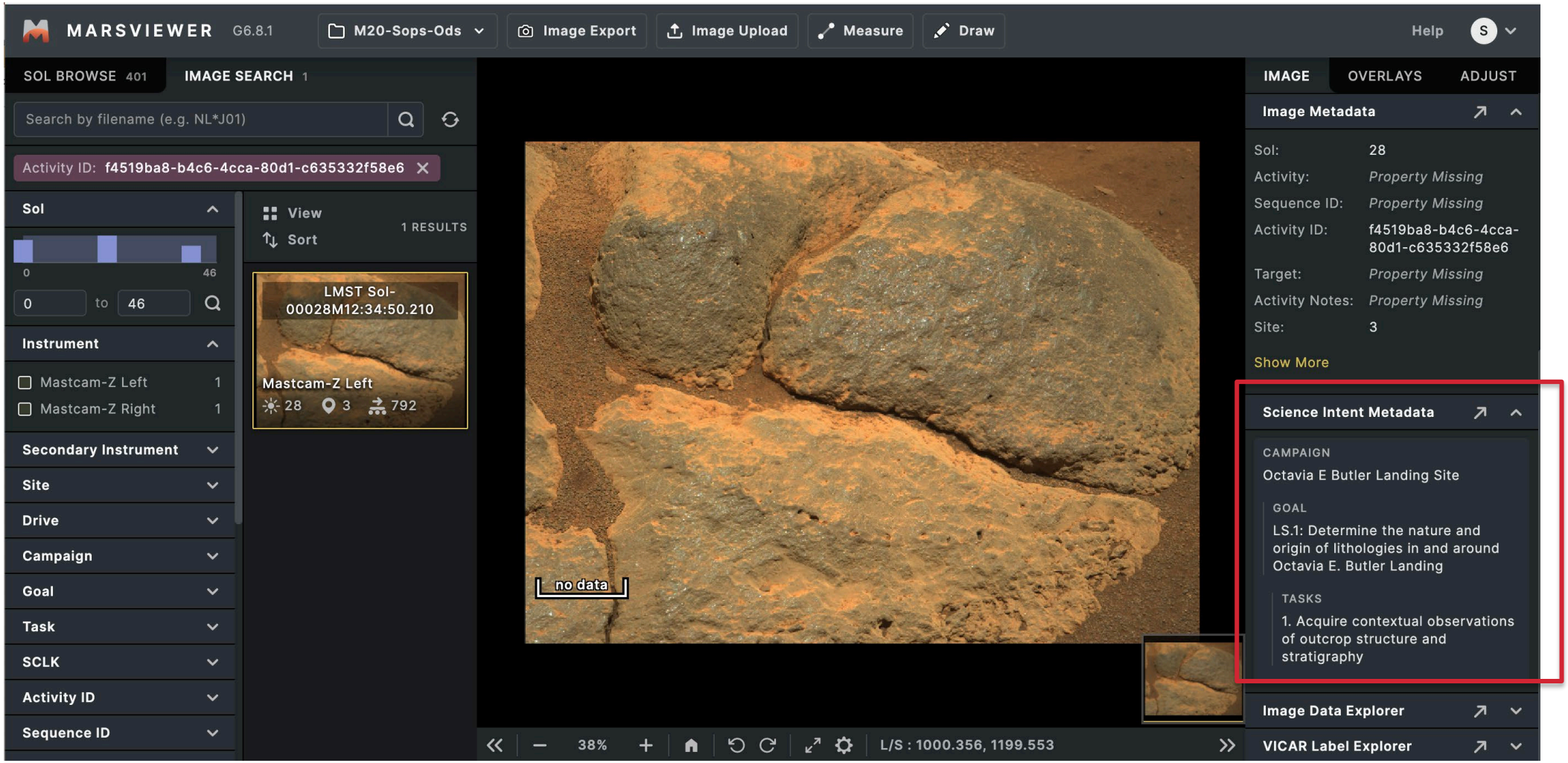
SI Tracker – Detail View



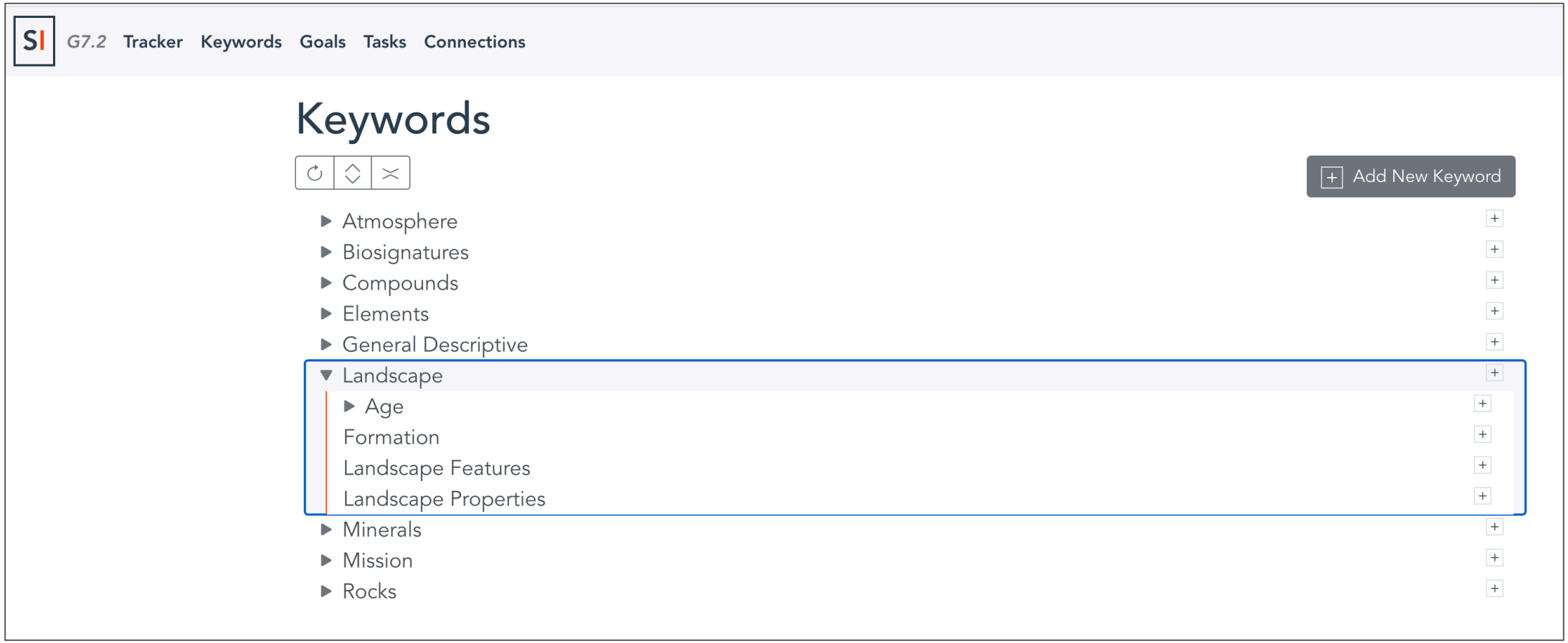
COCPIT – Goal +Task Associated to an Activity



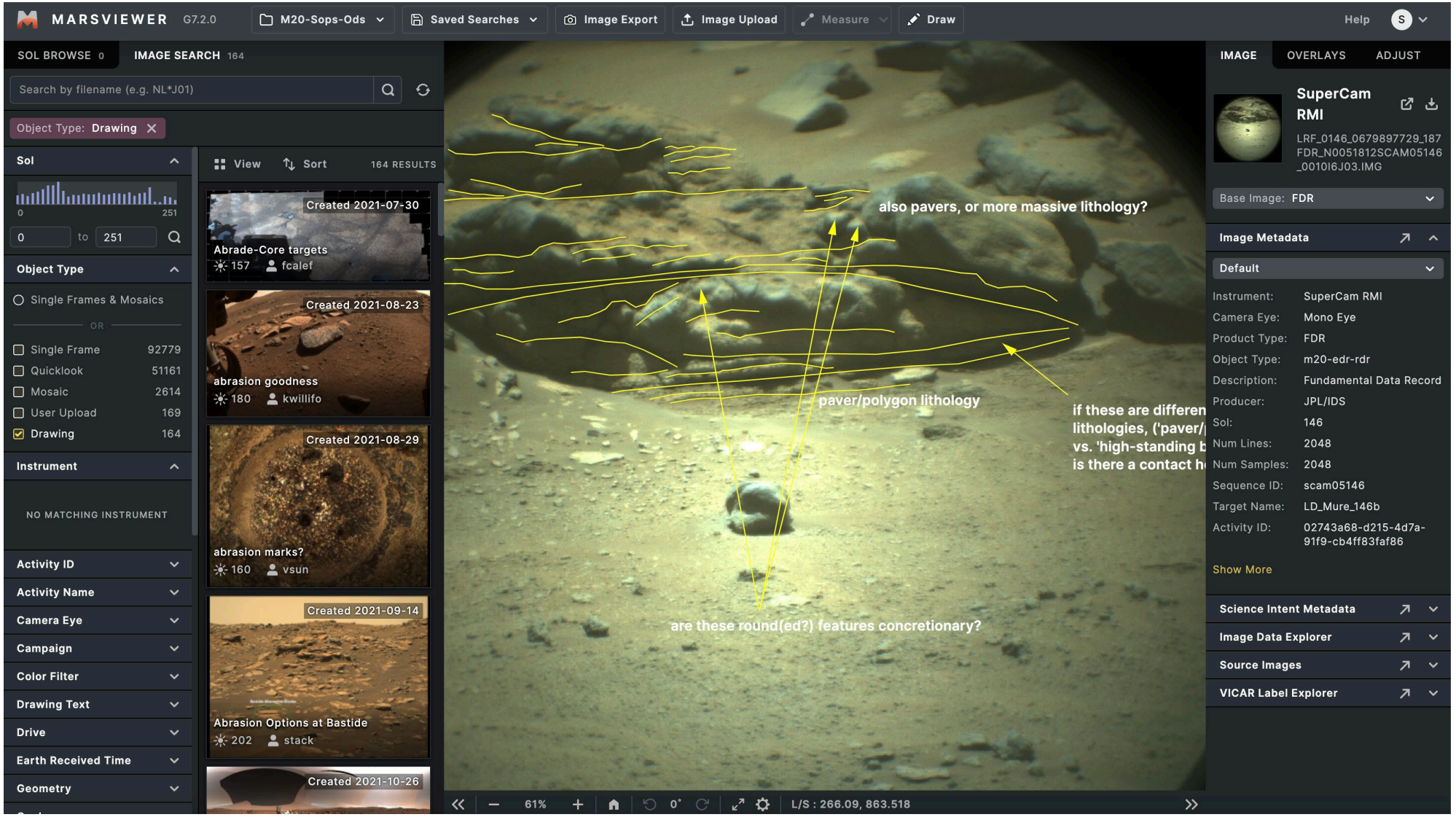
MarsViewer– Goal + Task Metadata on Image



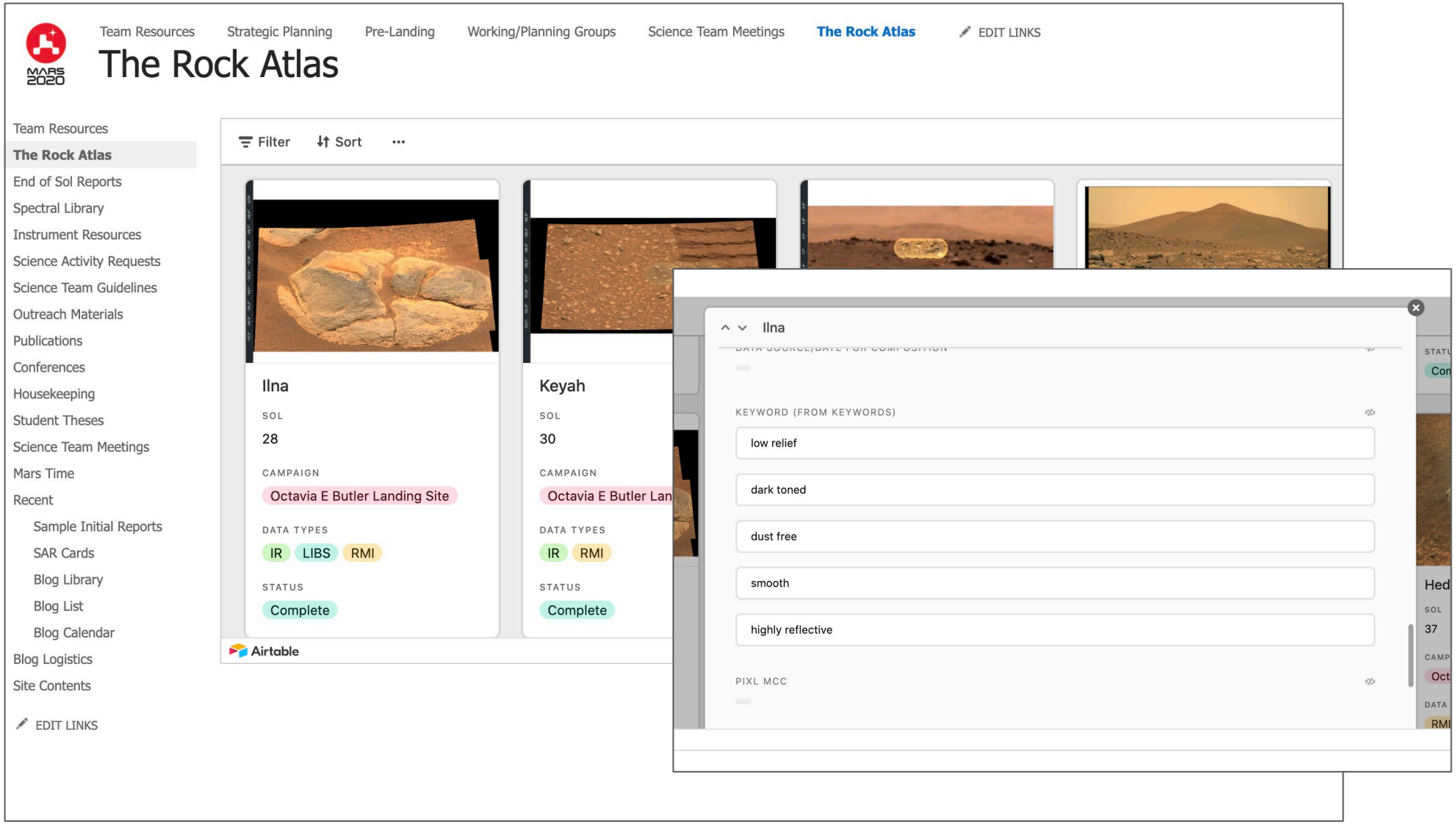
SI Tracker – Keywords Creation + Management



MarsViewer– Annotations, Keywords on Image



Rock Atlas – Catalog of features w/ Keywords



Development + Roll-out Challenges

- The science intent solution, and also the processes that it supports, were new
- Work began late in phase D when all other GDS tools had been built, tool budgets had been allocated, and the GDS architecture was complete
- The overall mission science operations processes were being designed in parallel to this architecture
- These processes, as they matured in early operations, addressed the core need for more strategic science intent alignment, decision making and planning than on the previous mission. This was a significant evolution from MSL processes (whose use cases informed the science intent architecture).
- The architecture includes an interface with the mission's uplink plan-building tool, which (due to lack of time for performance testing of the architecture prior to landing) caused the core science intent tool to load slowly in early operations
- Since the new operations process provided an alternative to using the science intent architecture, the architecture was fragile to loading issues for user adoption

What We Actually Accomplished

- **Decision making**
  Is addressed primarily through process and definition of a key new role present in all planning processes – the Long Term Planner (LTP). However the LTPs do use science intent to inform their decision-making and governance of what proposed activities are in scope

- **Handoff sol to sol and process to process**
  Is addressed primarily through process and LTPs guidance, as well as robust use by the science team of real time chat tools. Some context from science intent is included in handoff reports.

- **Tracking Progress**
  Science Intent is used in strategic and campaign planning along with other planning approaches. However the core Science Intent tool, SI Tracker, is not used for tracking campaign progress as designed.

- **DL Analysis context**
  Science Intent statements are present with downlinked science data products to provide some context. However much context also comes from other solutions including science team presentations and detailed documentation in reports

- **Searchable historical archive**
  Science Intent is available with science data products as part of the mission's Planetary Data Systems delivery

Lessons Learned

- Designing an architecture for a new process comes with significant uncertainty, and the outcome may vary widely from the initial plan.
- When your solution is not on the team's critical path, it is particularly vulnerable to early mission adoption issues
- When you collaborate on design with key mission operations staff, expect them to be otherwise occupied once prime mission begins
- Testing with realistic data volumes and processes prior to operations is important