HiRISE

High Resolution Imaging Science Experiment

uahirise.org

UA SCIENCE
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The HiRISE Science Operations Planning Approach

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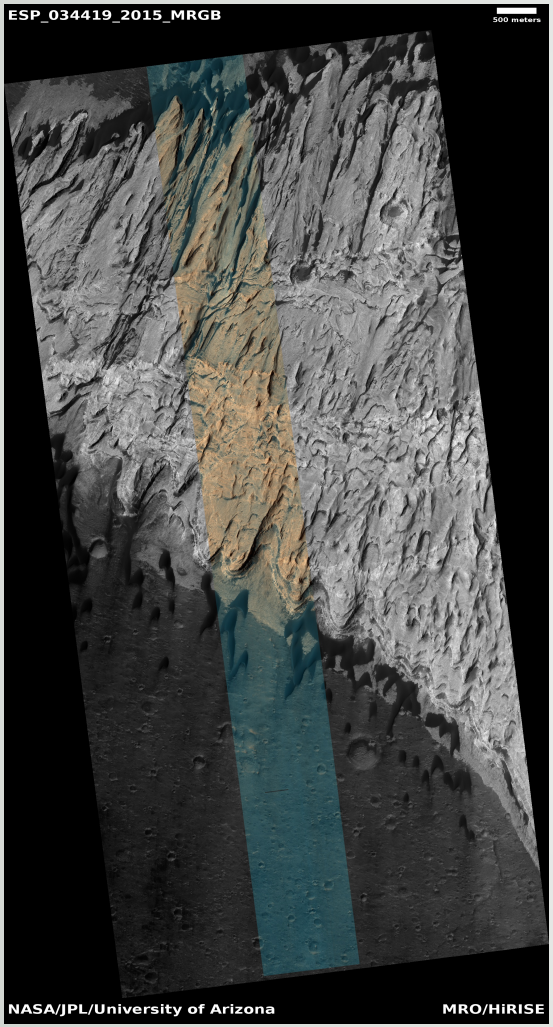

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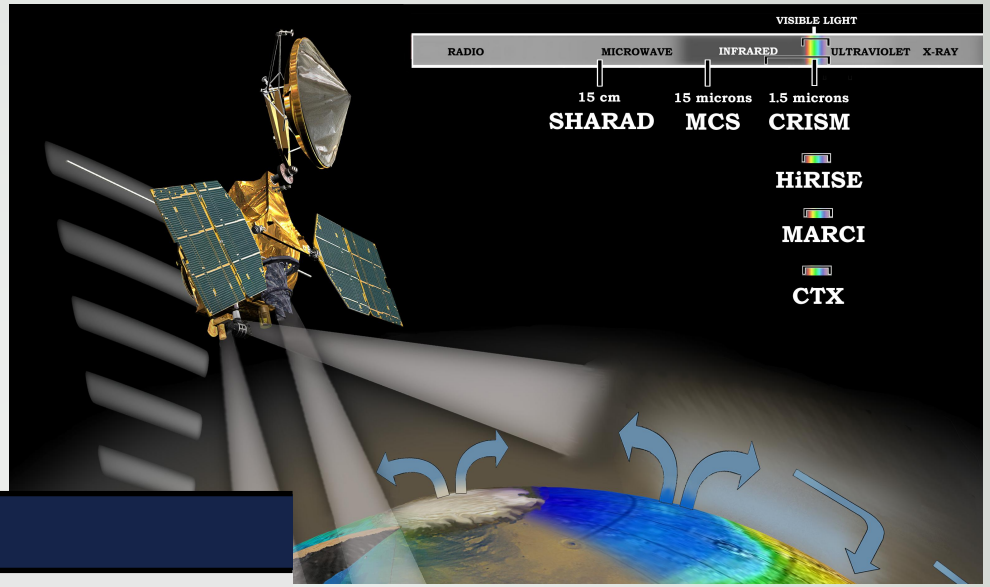
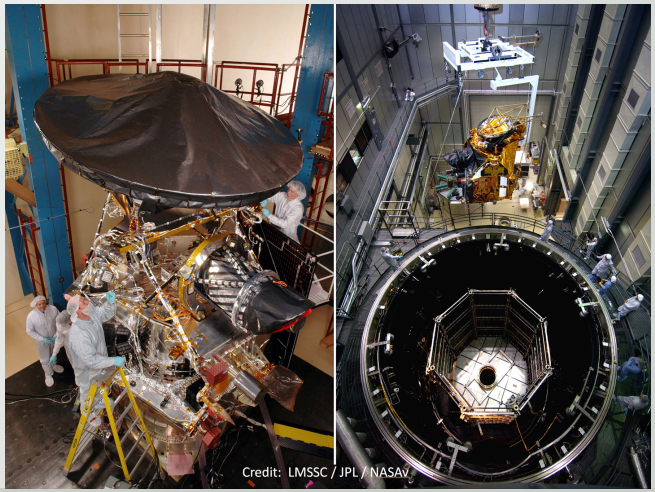
Mars Reconnaissance Orbiter (MRO)

- Launched 2005
- ~300km altitude, sun-synchronous ~3pm LMST orbit
- ~113min orbital period
- ±30° off-nadir rolls
- Built by Lockheed-Martin, managed by JPL



MRO Instruments

HiRISE	High Resolution Imaging Science Experiment	Imager, ~30cm/pix res
CTX	Context Camera	Imager, ~6m/pix res
MARCI	Mars Color Imager	Imager, ~km/pix res
CRISM	Compact Reconnaissance Imaging Spectrometer for Mars	Imaging spectrometer in VNIR, IR
MCS	Mars Climate Sounder	Sounder in thermal IR
SHARAD	Shallow Radar	HF radar, ~10m vertical subsurface res
Electra	telecom package	Relay



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High Resolution Imaging Science Experiment (HiRISE)

- Designed and built by Ball Aerospace
- Operated by University of Arizona Lunar and Planetary Lab, Alfred McEwen, Principal Investigator
- 50cm telescope aperture
- 14-CCD array with 1.0 μrad IFOV
- ~30 cm/pix max resolution
- Pushbroom imager
- Line integration timing matched to orbital ground speed ~3.2 km/s

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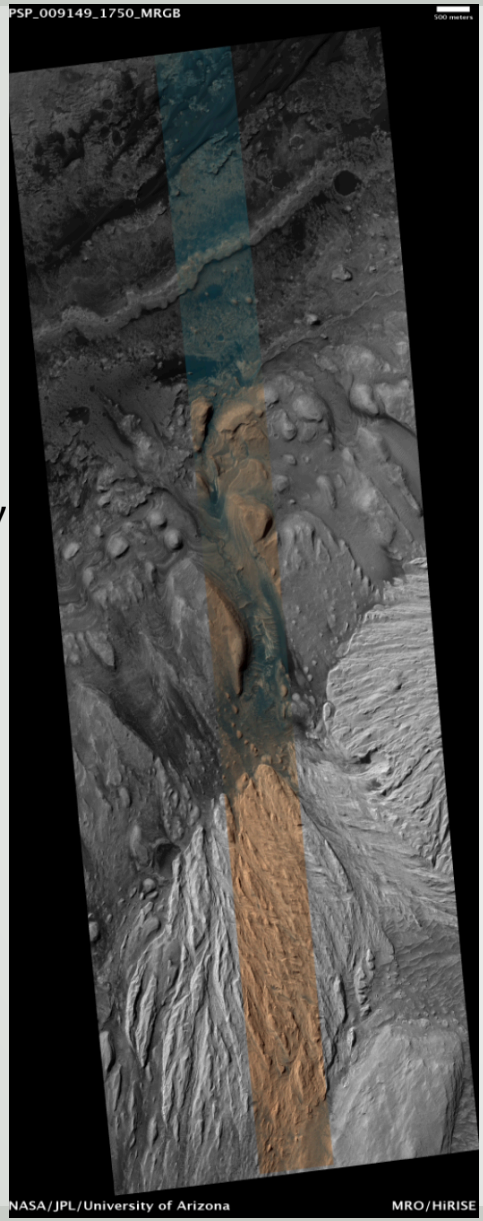
High Resolution Imaging Science Experiment (HiRISE)

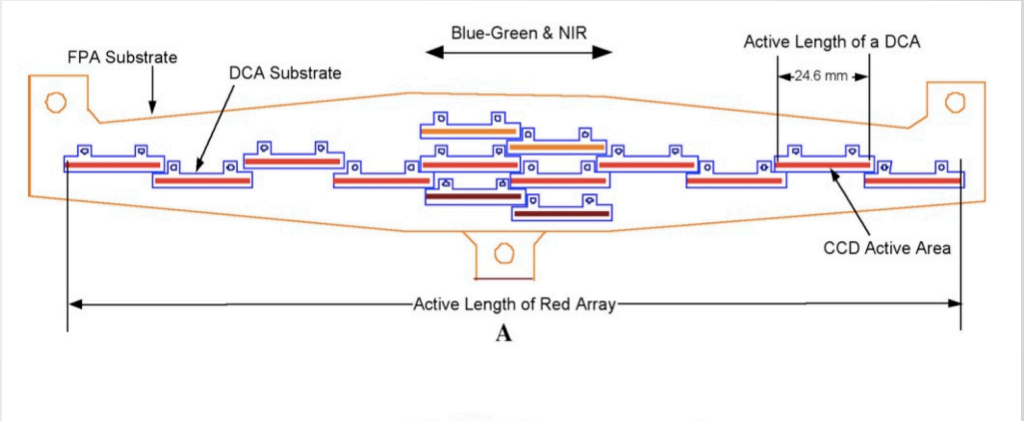
Downtrack sub-satellite (nadir) velocity

Crosstrack direction, 20000 pix max



HiRISE focal plane has:

- 10 Red (550-850nm) CCDs which span full width
- 2 NIR (800-1000nm) CCDs in the center
- 2 BG (400-600nm) CCDs in the center



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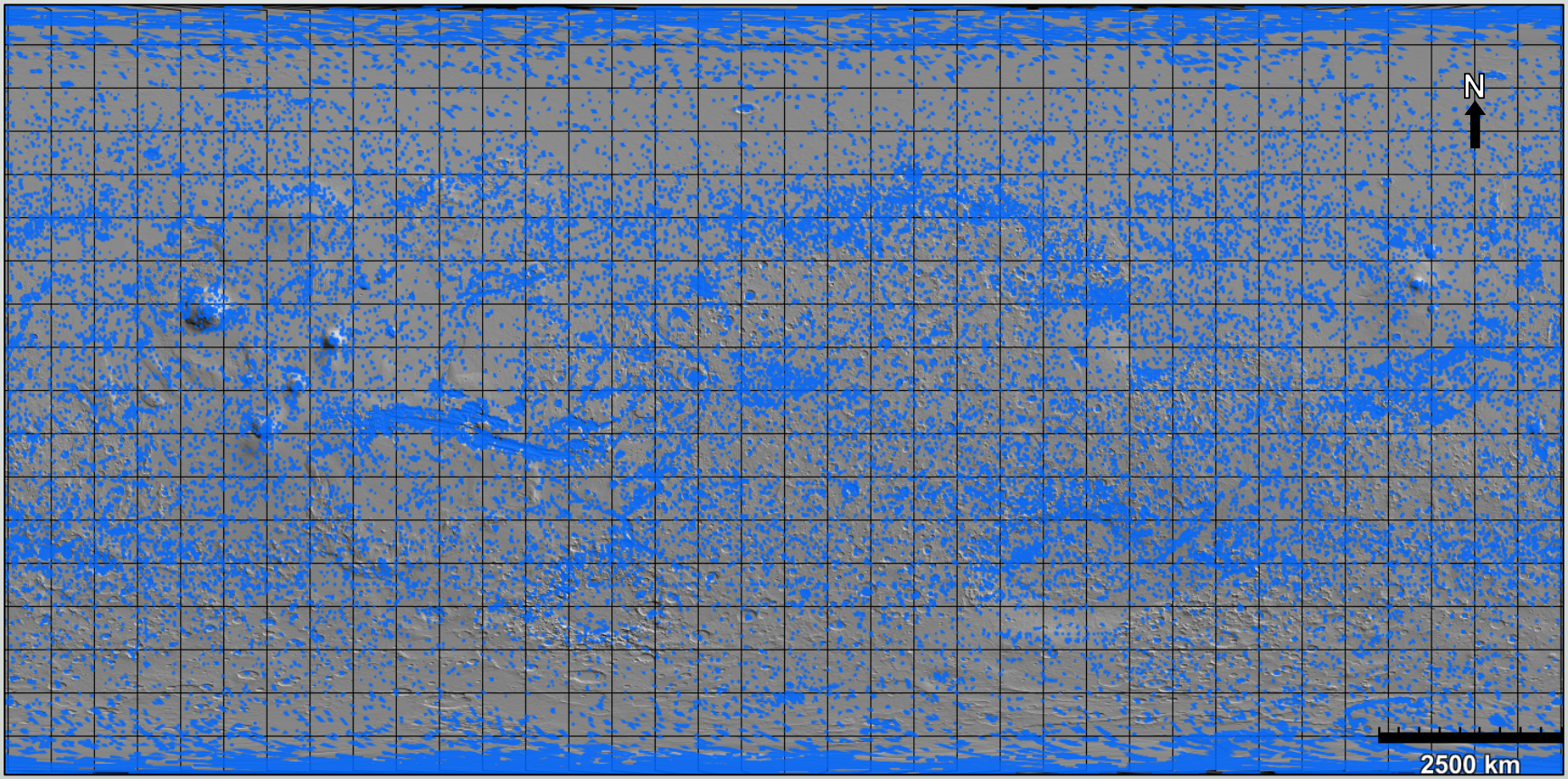
HiRISE science return

As of April, 2019 HiRISE has completed:

- **>62,000 observations**
- total of > **39,800 Gigapixels** or **39 Terabytes** of raw data
- covering an area of >**5,000,000 km²**
- the equivalent of **~3.4% of the Martian surface**



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MRO planning process

- MRO executes observations in two-week cycles
- Planning begins ~3 weeks prior to execution for ~4 weeks of activity

Planning week	Activities	
1	JPL, flight, systems block out relay passes and spacecraft activities for both cycle weeks	
2	Science Operations Teams plan rolled observations for both cycle weeks	
3	Science Operations Teams plan nadir observations for cycle week 1	
4	Science Operations Teams plan nadir observations for cycle week 2	Cycle week 1 executes on board
5		Cycle week 2 executes on board

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HiRISE planning team

Small, fixed ops group based at UA LPL HiRISE Operations Center (HiROC):

- **Operations Engineers in the Uplink group (~4.5 FTE) provide most nominal cycle planning**
- Smaller Downlink group, assisted by undergrads
- Some overlap between HiROC groups: Software, Health and Safety, DTM production, …

Large, distributed science team serving on a rotating basis:

- **Co-Is provide science guidance for each cycle on a rotating basis**
- Post-docs train up to serve as Co-Is for cycles
- Science Theme Leads each responsible for 1 of 18 areas of Mars science expertise (polar science, volcanism, etc.)

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HiRISE observation targets

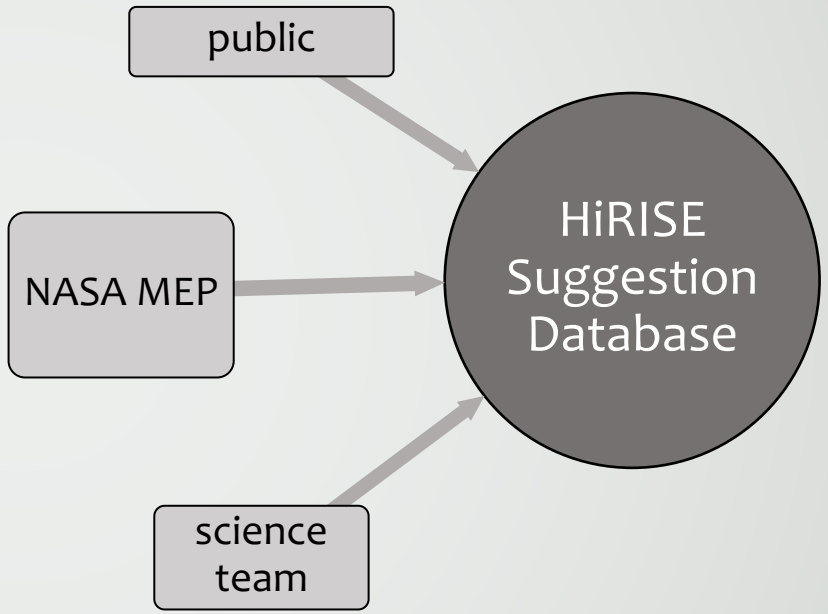
On a rolling basis:

Suggestions are added to our database by members of the public, other mission personnel, HiRISE science team

- suggestions require justification, other info
- uahirise.org/hiwish

Science Theme Leads and Co-Is organize and prioritize

Every prioritized suggestion has a science justification and has been examined by a science team member



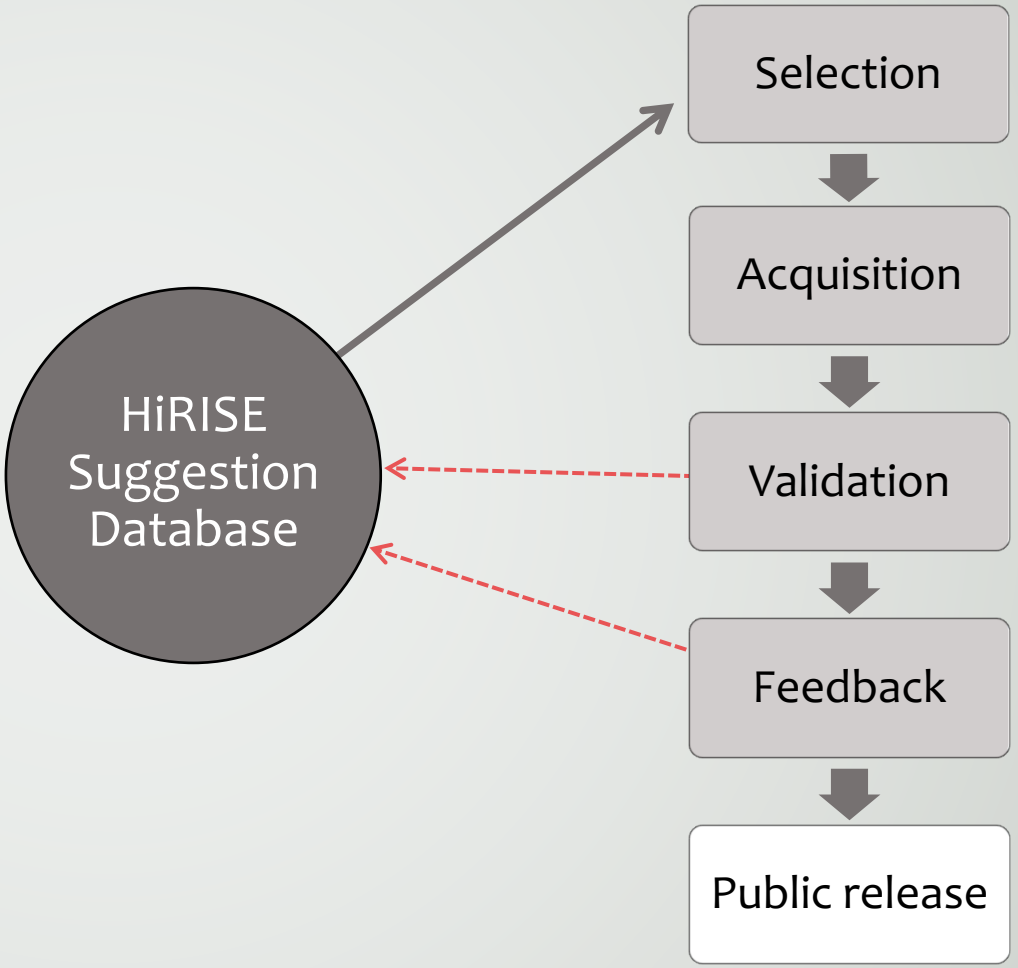
HiRISE observation targets

For each planning cycle:

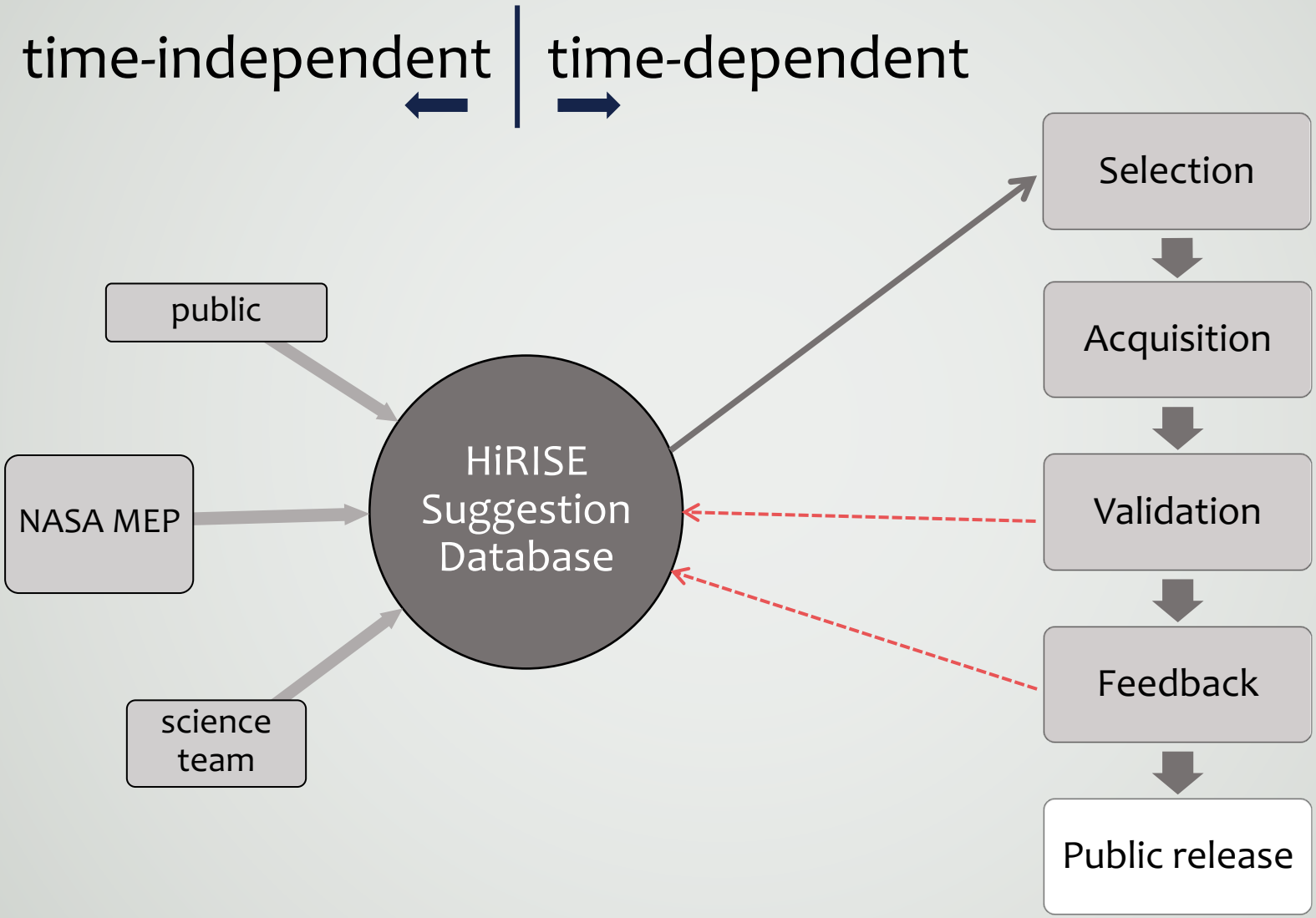
One **Operations Engineer** works with one **Co-I** to develop a science focus and strategy for suggestions to be acquired

- **Operations Engineer** provides targeting, image planning, sequence generation, commanding
- **Co-I** provides science goals and focus, prioritization of targets, initial image parameters

Every cycle has a science focus and guiding science goals, determined by the Co-I



HiRISE observation targets



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HiRISE cycle planning process

Planning week	Activities	
1	Operations Engineer determines viewable suggestions, Co-I prioritizes based on science goals	
2	Operations Engineer submits rolled observations for both weeks, Co-I provides ideal image settings	
3	Operations Engineer finalizes image settings based on current conditions and plans nadir observations for week 1	
4	Operations Engineer finalizes image settings and plans nadir observations for week 2	Cycle week 1 executes on board
5		Cycle week 2 executes on board

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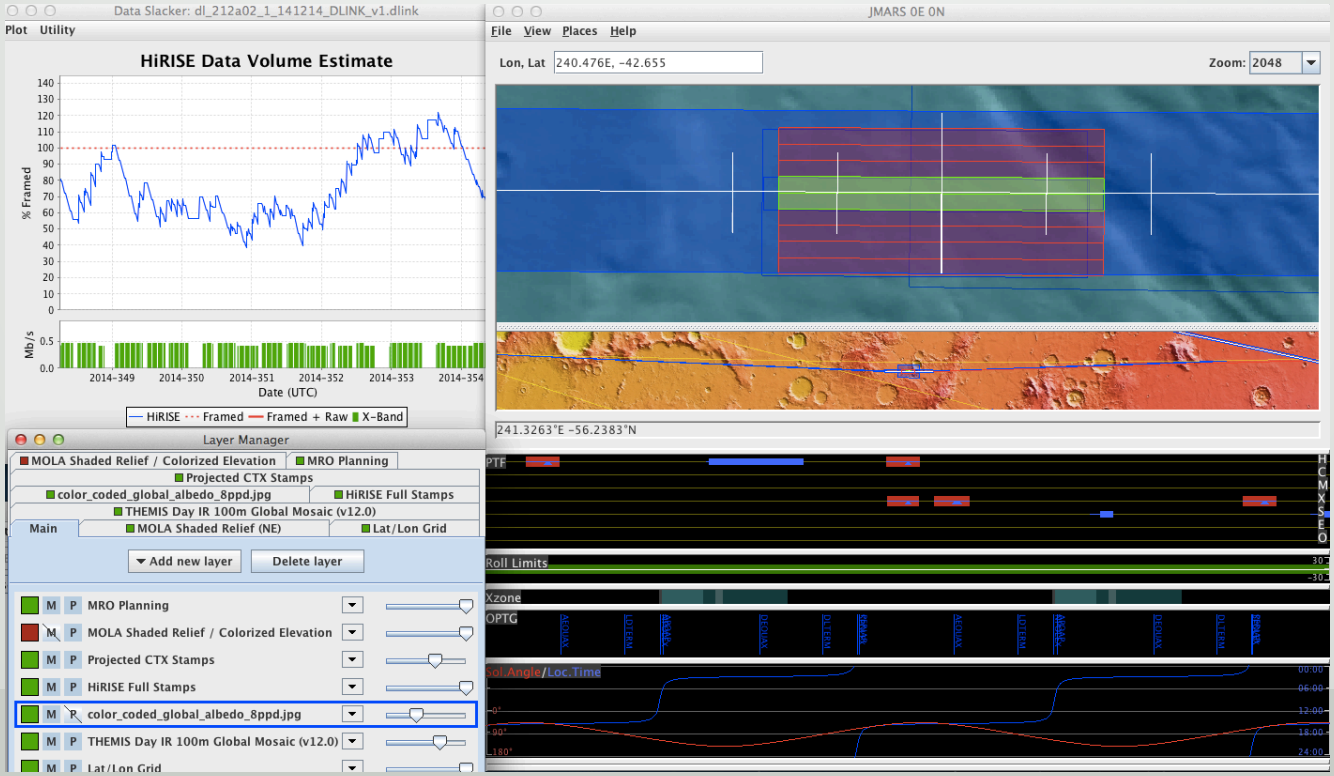
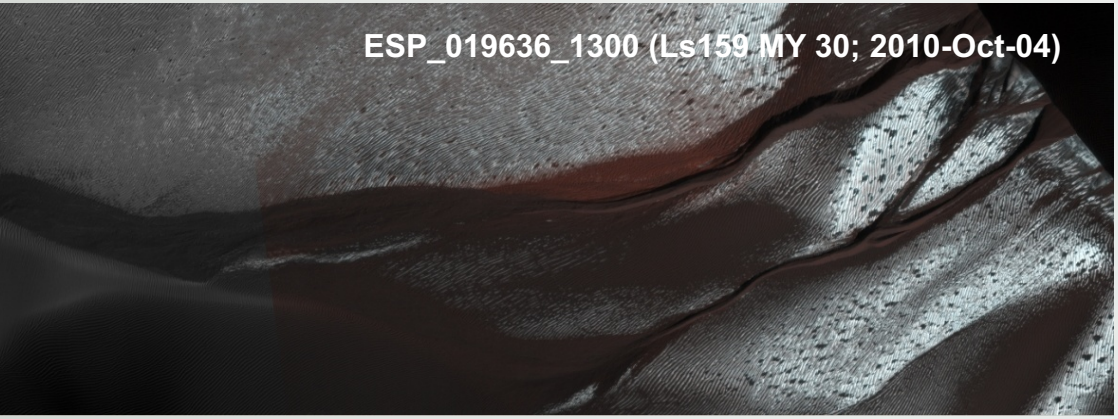
Imaging decisions

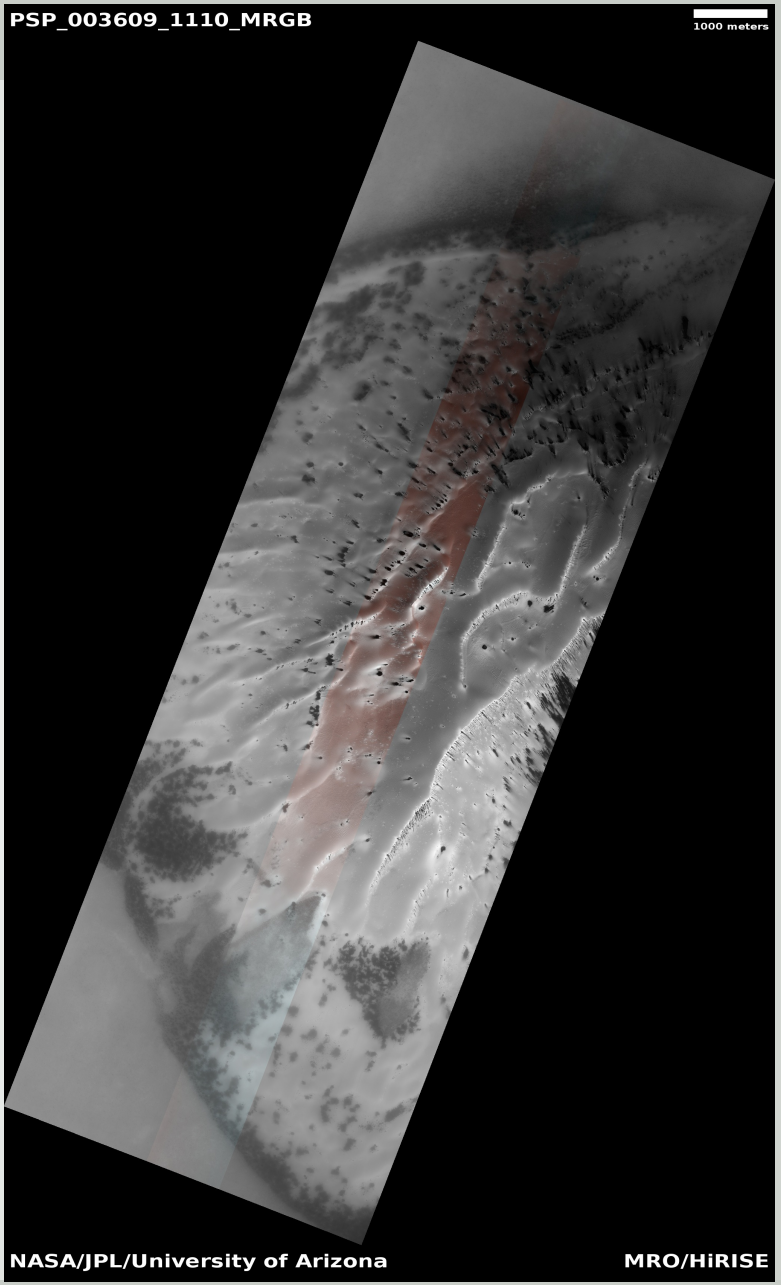
- Prioritization
  - Which images do we want to take *now*?
  - Programmatic, seasonal change, public outreach, stereo opportunities, repeats
- Image mode (CCD selection) and binning
  - Resolution vs finite data volume
- Length
  - Terrain coverage vs instrument temperatures
- Photometry
- Adding coordination with other MRO instruments
- Adding nadir imaging opportunities

→ 100-400 images each two-week cycle



Imaging decisions





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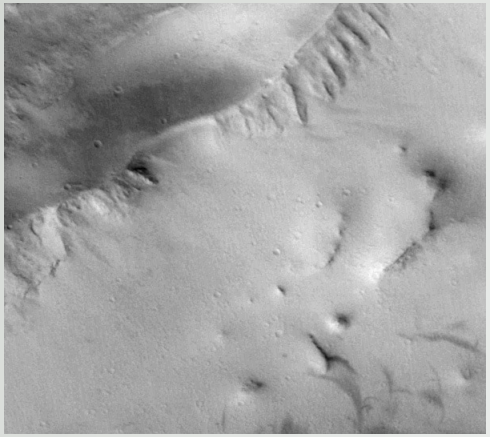
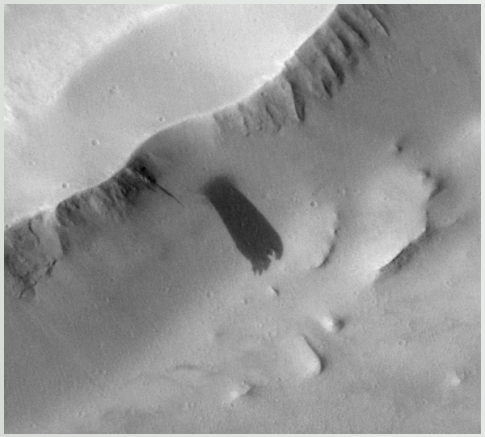
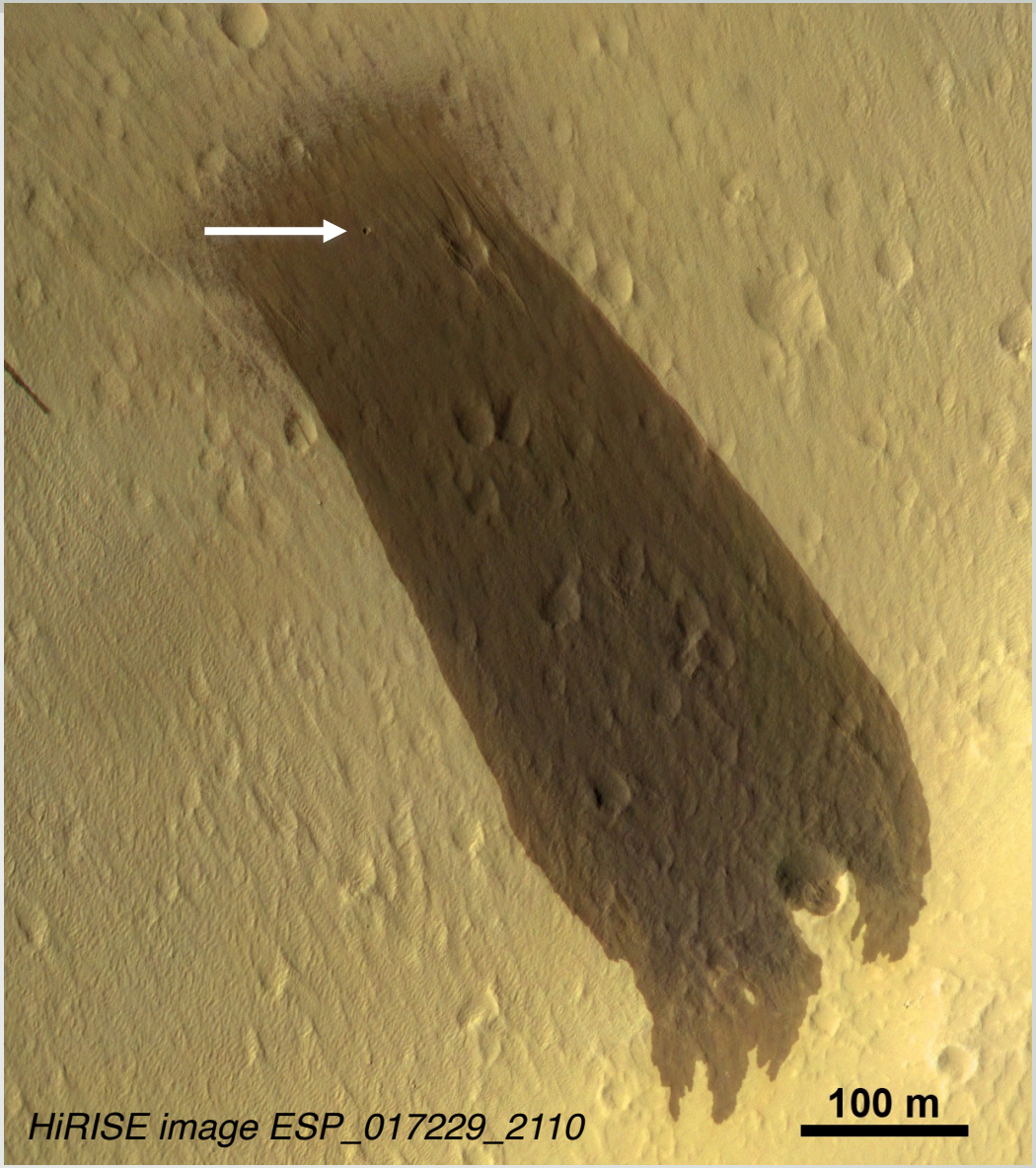
Imaging decisions



CTX image P13_006153_2133_XN_ 33N141W_071118



CTX image B18_016662_2087_XN_ 28N140W_100214



HiRISE image ESP_017229_2110

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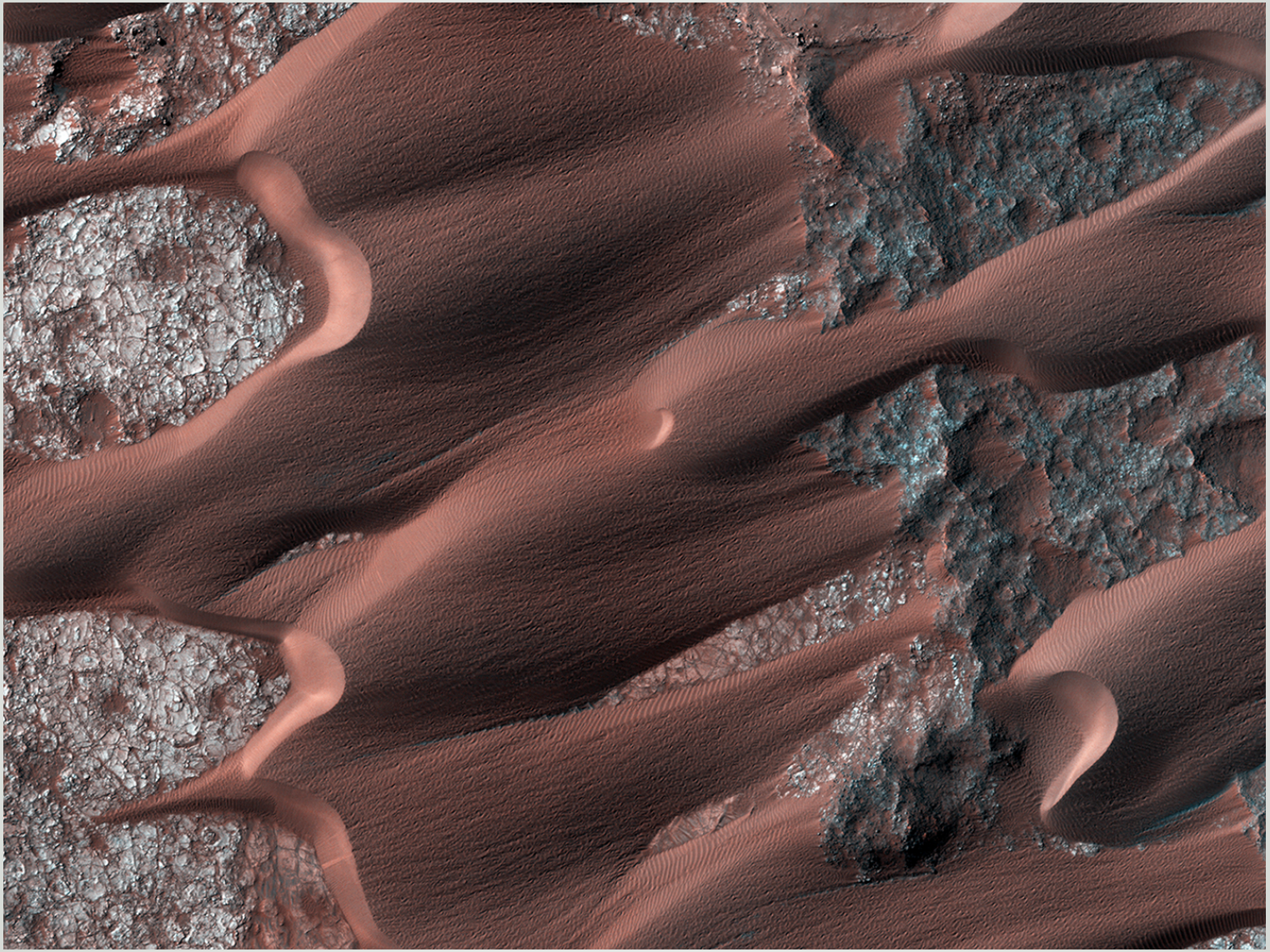

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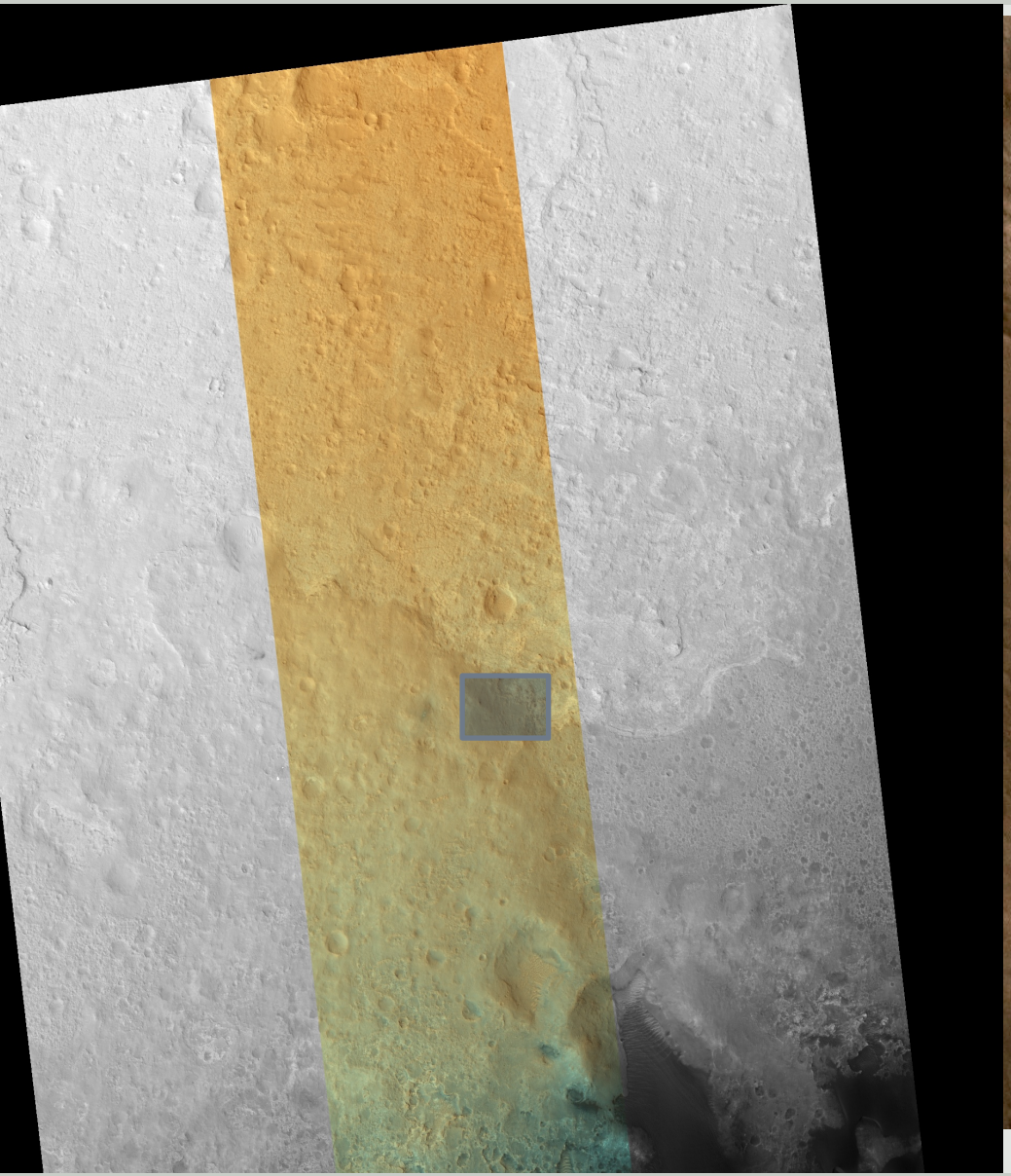

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Factors for success

- Operations Engineers are knowledgeable about planetary science
  - Independently advance suggester and Co-I goals
  - Weigh decision cost to science
- Large science team provides interest/expertise across breadth of Mars science
  - Rotation of Co-I duties prevents narrowing of science focus
  - Co-Is can facilitate coordination with their other projects (InSight, CaSSIS)
- Image suggestions are considered for science potential
  - Time-independent and time-dependent basis
- Planning process was designed for a widely distributed team
  - Remote workstations, planning software support
  - Extensive wiki
  - ITAR-friendly resources for international Co-Is
- Team values the public involvement in the process
  - Hobbyists, elementary homerooms, independent researchers, you
  - HiRISE as a "community facility instrument"

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Acknowledgments

- Contributors: Singleton Thibodeaux-Yost, Nicole Bardabelias, Operations Engineers; Nicole Baugh, Uplink Lead; Christian J. Schaller, GDS Lead

- The University of Arizona is a Hispanic-Serving Institution (HSI)

- The University of Arizona resides on the traditional land of the Tohono O'odham

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