Solar Probe Plus

A NASA Mission to Touch the Sun

Integrated Science Investigation of the Sun
Energetic Particles

Preliminary Design Review
05 – 06 NOV 2013

Risk Status

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ISIS SE (SwRI)

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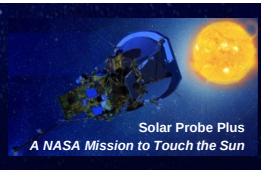
Outline

- Risk Mitigation Plan Overview
- Team Member Roles
- Risk Management Plan Flow
- Risk Analysis Score Card
- Risk Summary
- Progress on Top Risks
- Tracking the “life cycle” of one of the top risks
- Summary

Risk Mitigation Plan Overview

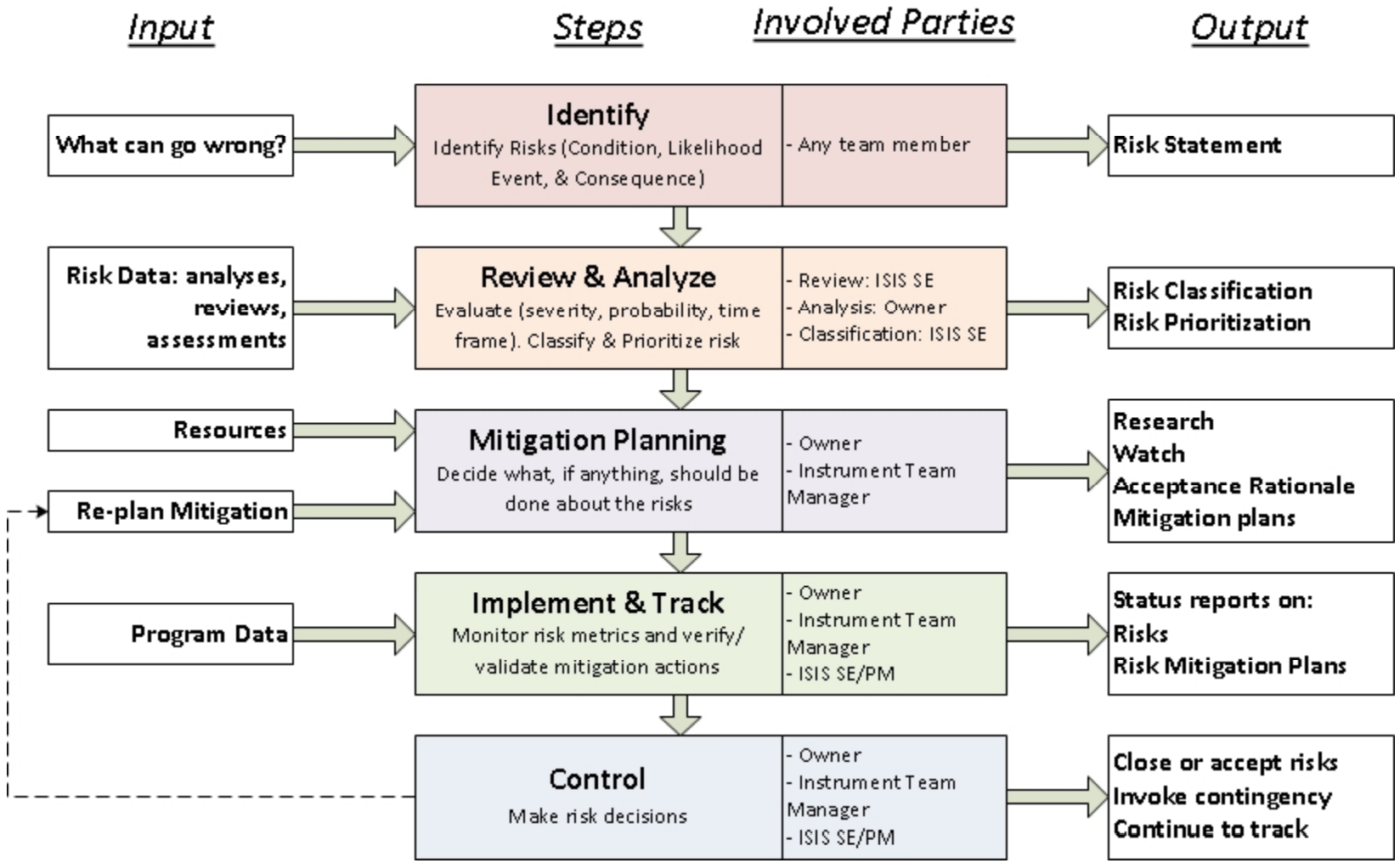


- Team members constantly weigh potential risks
- Team members can suggest a risk at any time
- With team member input, SE enters risk into PIMS
- Instrument leads generate risk mitigation plan including potential cost and schedule, technical, and safety impacts
- SE assesses probability and consequences of risks
- Once a mitigation strategy is selected by team and confirmed by SE/PM, it is executed
- SE ensures risks are handled by assigning and tracking action items
- Team members review risks in weekly meetings
- PM and SE will continuously monitor and audit risk list
- PM elevates risks that impact other instruments or ISIS resources to SPP Project in PIMS system (web-based tool, open to SPP)
- PM and SE consensus is required for risk closure with SPP Project concurrence as needed

Team Member Roles

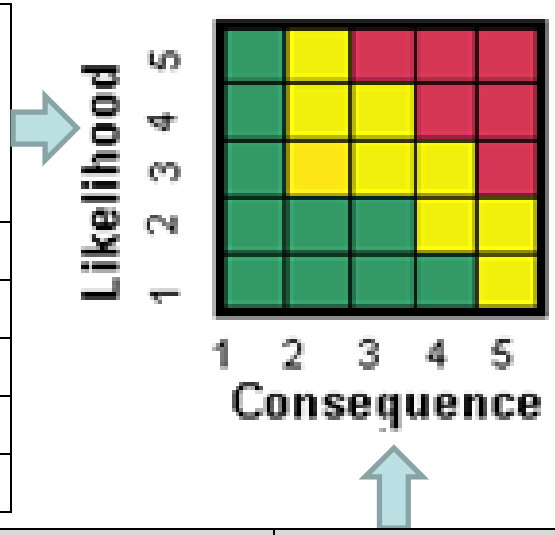
- Bottoms-up approach
- All team members
  - Assess threats to determine if any are risks
  - Provide risk details to SE for entry into PIMS
  - Analyze identified risks
- Instrument Team Leads (Wiedenbeck/Cummings and McNutt/Seifert)
  - Manage and report on instrument risks
  - Determine mitigation strategies
  - Determine how risks might affect the SPP mission
- ISIS SE (Dickinson)
  - Assist ISIS PM as needed, especially with technical input and analyses
  - Review mitigation plans
  - Address concerns from SPP Project Office
  - Ensures risks are documented as appropriate
- ISIS PM (Weidner)
  - Oversee and manage risk list
  - Work with SE and instrument teams to determine risk mitigation plans
  - Report major risks to SPP Project in Monthly Risk Status Reports

General RMP Flow



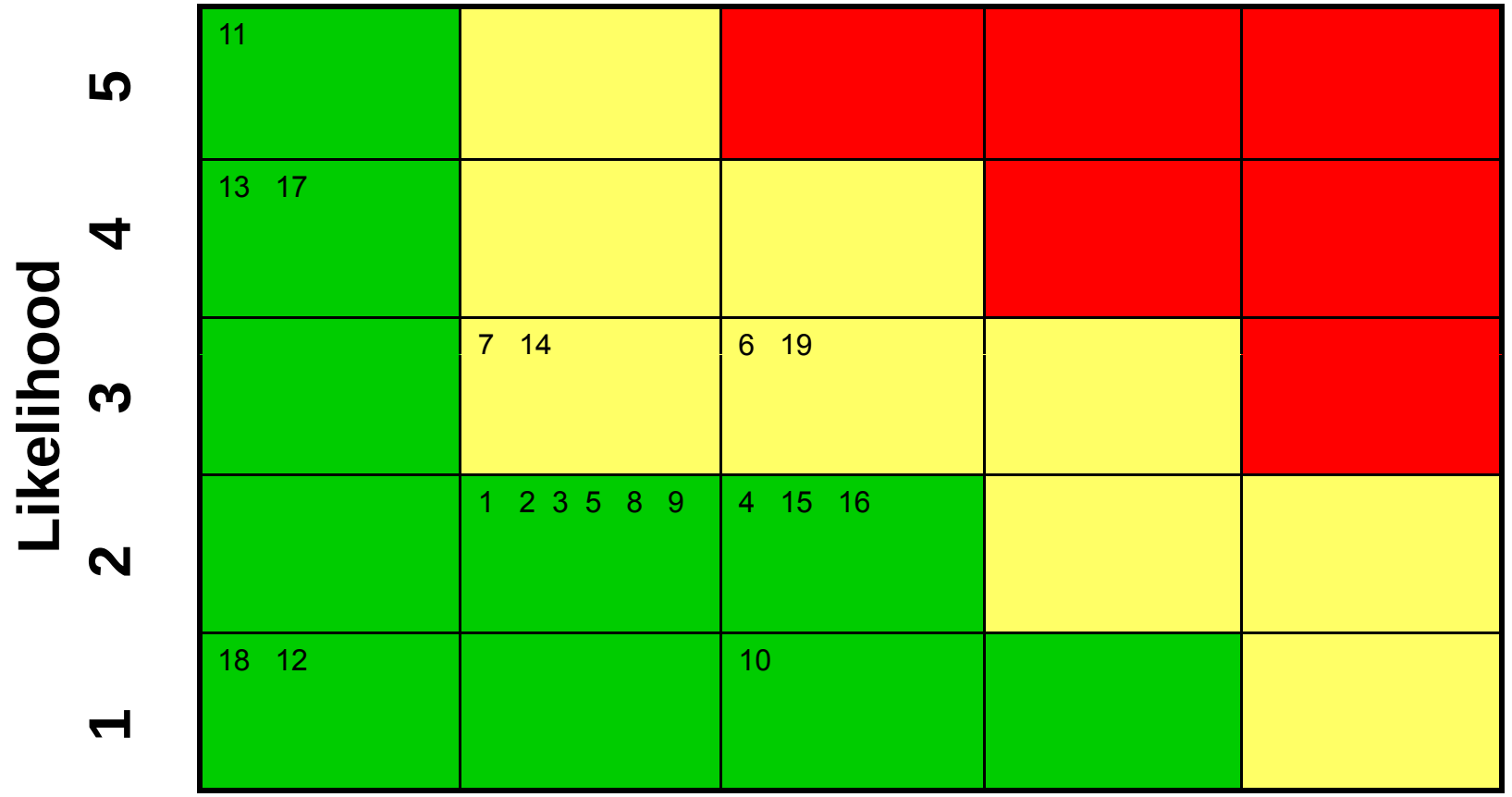
Risk Analysis Score Card

Likelihood Bins	Safety (likelihood of safety event occurrences)	Technical (Estimated likelihood of not meeting mission technical performance requirements)	Cost/schedule (Estimated likelihood of not meeting allocated Cost/Schedule requirements or margin)
5 Very High	($P_s > 10^{-1}$)	($P_T > 50\%$)	($P_{CS} > 75\%$)
4 High	($10^{-2} < P_s \leq 10^{-1}$)	($25\% < P_T \leq 50\%$)	($50\% < P_{CS} \leq 75\%$)
3 Moderate	($10^{-3} < P_s \leq 10^{-2}$)	($15\% < P_T \leq 25\%$)	($25\% < P_{CS} \leq 50\%$)
2 Low	($10^{-6} < P_s \leq 10^{-3}$)	($2\% < P_T \leq 15\%$)	($10\% < P_{CS} \leq 25\%$)
1 Very Low	($P_s \leq 10^{-6}$)	($0.1\% < P_T \leq 2\%$)	($P_{CS} \leq 10\%$)

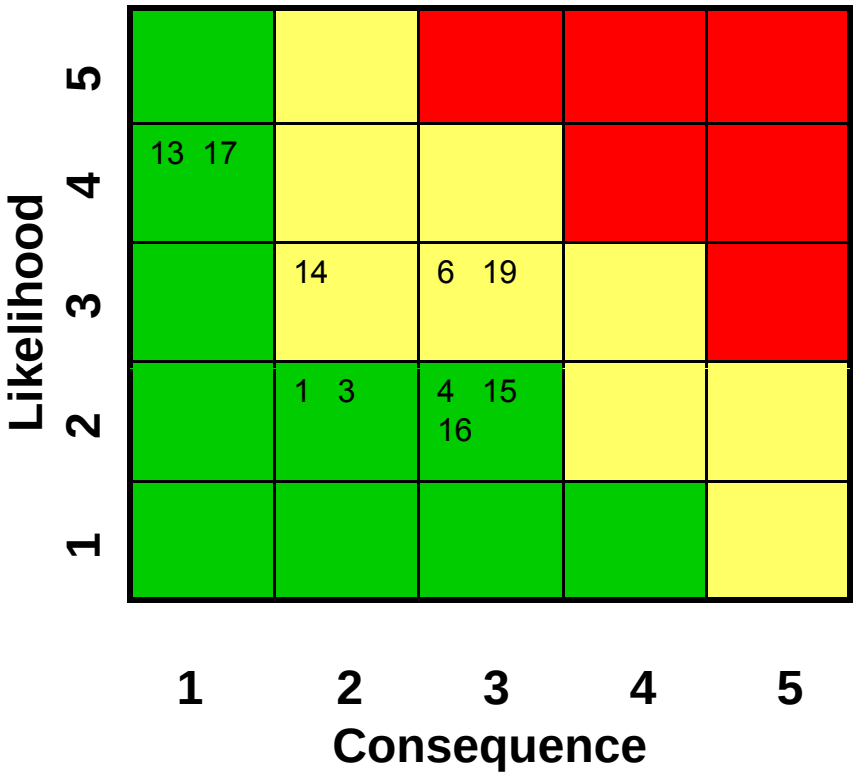


LEVEL	Minimal (1)	Minor (2)	Medium (3)	Major (4)	Very High (5)
Safety	Negligible safety impact	Minor injury with no lost work time	Injury with lost work time	Severe injury	Death or permanent disabling injury
Technical	Negligible technical impact	Decrease in instrument capability/margin. But all instrument requirements met, or need for requirement definition or design/implementation workaround	Major loss of instrument capability	Loss of Instrument (EPI-Hi or EPI-Lo)	Loss of one or more Level-1 science requirements
Cost	ISIS Project cost overrun of less than 1% of allocated	ISIS Project cost overrun between 1% to 3% of allocated	ISIS Project cost overrun between 3% to 10% of allocated	ISIS Project cost overrun between 10% to 20% of allocated	ISIS Project cost overrun of greater than 20% of allocated
Schedule	Negligible schedule slip	Schedule slip not on critical path	Schedule slip affecting critical path but not launch or post-launch critical event	Schedule slip of 1 to 3 months	Schedule slip of greater than 3 months

Risk Summary



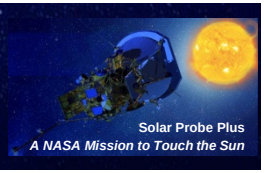
Progress on Top Risks



Criticality	L x C Trend	Approach
High	⇩ Decreasing (Improving)	M - Mitigate
Med	⇧ Increasing (Worsening)	W - Watch
Low	⇨ Unchanged	A - Accept
	□ New Since Last Period	R - Research

Rank	Trend	Risk ID	Approach	Risk Title
1	⇨	6	R	ISIS Vibration Levels
2	⇩	19	R	ISIS Increased Autonomy
3	⇨	14	R	ISIS Shock Testing
4	⇩	4	R	EPI-Lo Dust Impact Susceptibility
5	⇩	15	R	ISIS Increased Ground Software Demands Due to Autonomy
6	⇩	16	R	ISIS Increased Instrument FSW Demands Due to Autonomy
7	⇩	13	R	ISIS Time Tagged Commands
8	⇩	17	R	Configuring ISIS Based on Solar Distance
9	⇩	1	R	EPI-Hi Thin Detector Availability
10	⇩	3	R	EPI-Hi LET Thin Windows and Dust Impact Susceptibility

RISK: EPI-Hi LET Thin Windows and Dust Impact Susceptibility

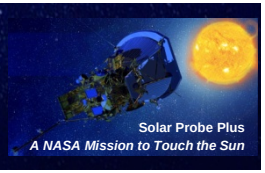


Description ID: 3	**Given that thin windows are fragile and the mission dust environment could be harsher than initially expected; there is a risk that dust impacts could result in damage to the windows during flight,**
Consequence	which will result in a compromise in the resolution of the EPI-Hi telescopes.
Overall Status: Accepted(Active)	Consequence: 2 Likelihood: 2
Status Message	EPI-Hi windows survived Heidelberg dust testing and showed stacked window configuration is effective at mitigating dust penetration to detectors. Even holes produced by penetrating particles result in very limited access of UV light to detectors.
Mitigation Plan 1 Status: Completed Trigger Date: 01 May 2013	Title: Perform Dust Testing Description: The integrity of the windows in a stacked configuration will be tested in a dust environment to determine the efficacy of the windows in protecting the detectors from dust and maintaining structural integrity to block UV light.
Mitigation Plan 2 Status: Not Started Trigger Date: 01 Nov 2013	Title: Baffling for Dust Protection Description: If risk of catastrophic damage due to dust impacts does not appear acceptably low, EPI-Hi could increase the baffle size to limit the affected angle of dust on the detectors. Trade: mass is used to buy down damage risk.
Backup Mitigation Plan Status: Not Started Trigger Date: 01 Nov 2014	Title: Significant Thickness Increase Description: If risk of catastrophic damage due to dust impacts does not appear acceptably low, EPI-Hi could use significantly thicker window for LET2 (single ended) telescope. Trade: measurement quality is reduced to buy down catastrophic damage risk.

Process: Initiation

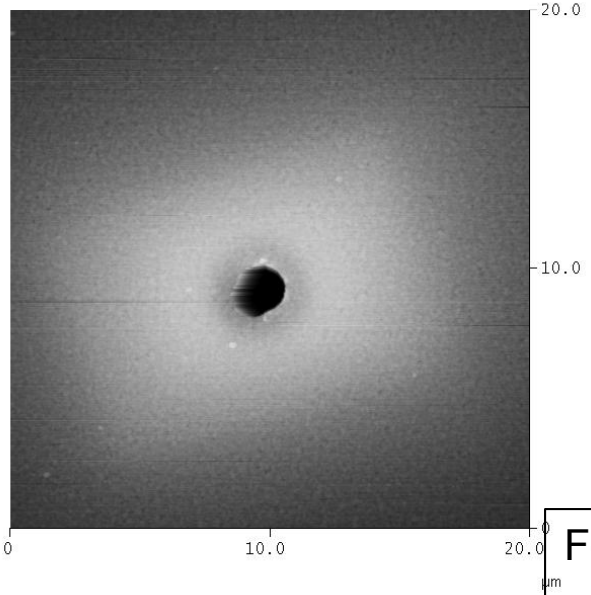
- Initial concerns about dust
  - The SPP dust environment is not known
- There are sensitive apertures on the ISIS instruments
  - SSDs sensitive to UV light contamination (background noise)
- The need for detector protection was known
  - Windows were required to protect the detectors from UV light
  - Various materials were allowable, so long as they were light-tight, had an outer surface with low α/ε
- Realization that windows are sensitive
  - While protective windows were expected in the design, it was not known what configuration would be required or adequate to mitigate the dust environment
- A risk was written to capture the progress of this concern

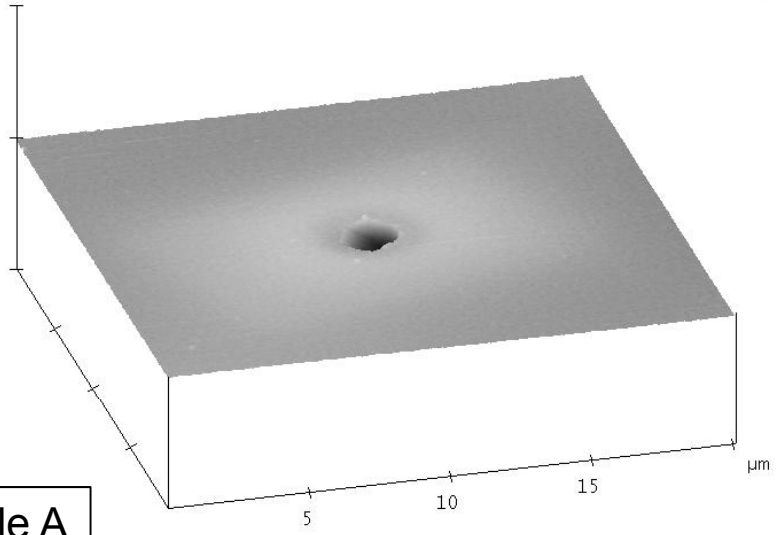
Process: Mitigation Approach



- In order to mitigate the risk, more information was needed about the environment, the window configuration, and the response of the windows to dust impacts in the environment
- ISIS worked with Doug Mehoke and the project to refine dust models
  - ISIS actively participated in early discussions of the most appropriate dust model to apply to the mission
  - Project ran simulations on the environment accounting for ISIS geometry to produce impact statistics
- ISIS established a plan for testing of candidate windows at Heidelberg dust impact facility
  - Few dust accelerator facilities in the world
  - Dust impact plan was established
  - Eric Christian travelled to Heidelberg with the samples to perform the test
- ISIS used dust impact results to determine a viable window configuration

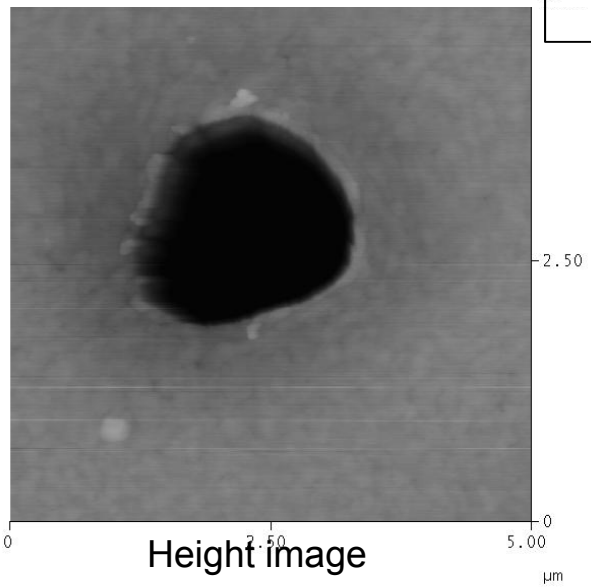
Process: Mitigation - Dust Testing



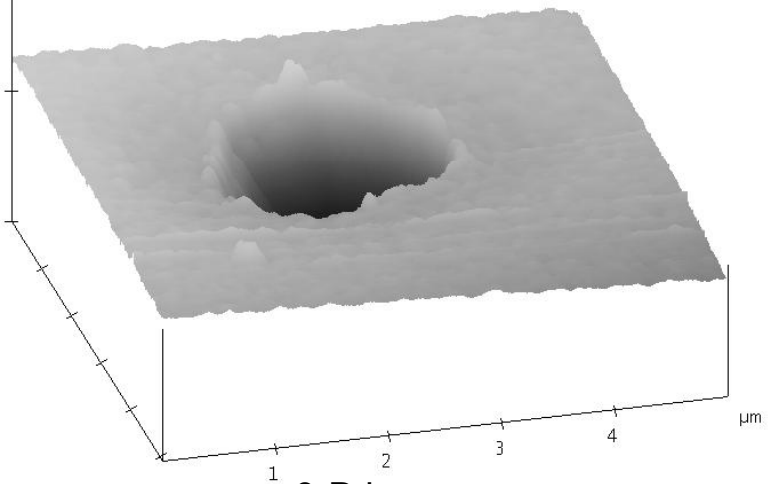


Foil #1, Hole A
Top Shown

The diameter of the hole: ~2.1 µm



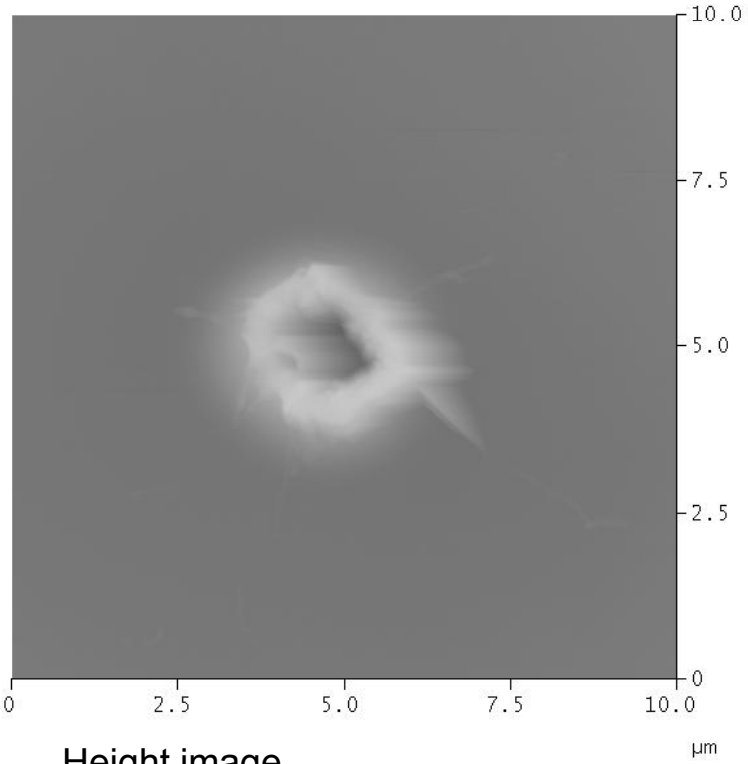
Height image



3-D image

Process: Mitigation - Dust Testing

Foil #1, Hole A Bottom Shown



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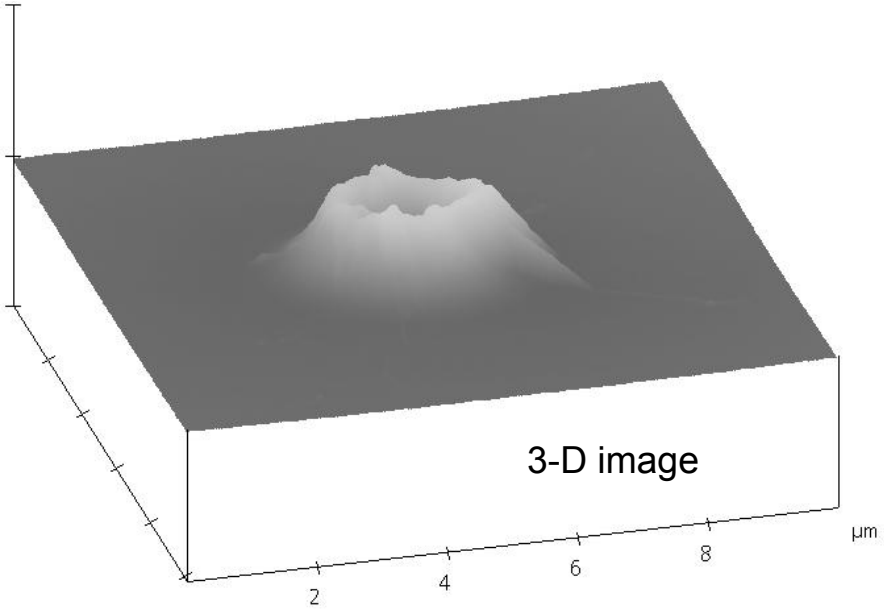
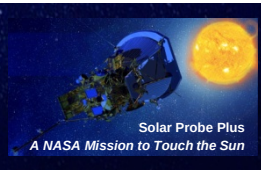


The height of the crater: ~0.9 µm

Note that there are some artifacts in all AFM images due to AFM tip shape and scanning speed

Process: Analysis and Results

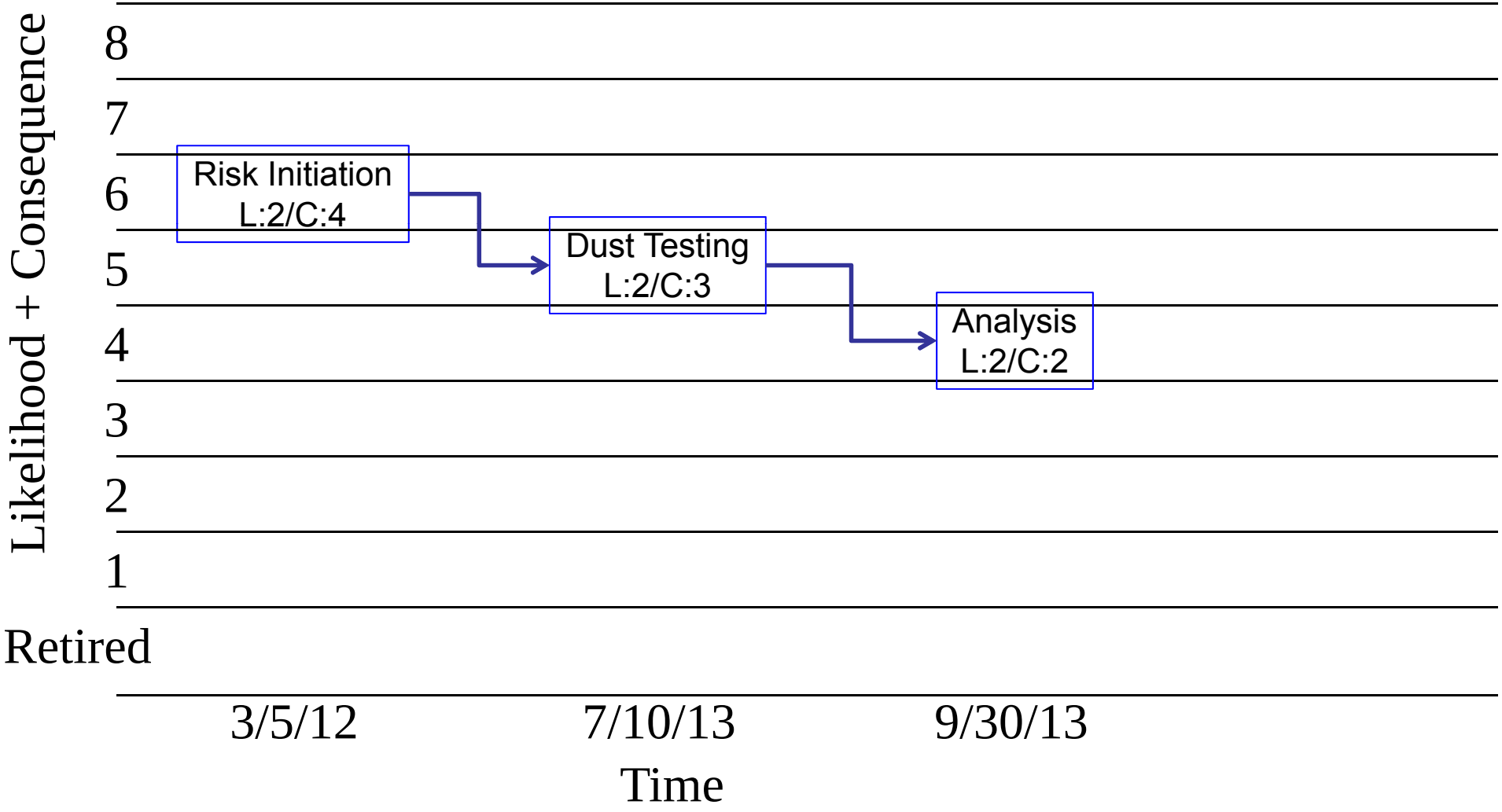


- Tests showed the Windows performed as we had hoped

- Dust impacts did not propagate into large-scale tears
- Affected regions remained on the order of the particle size
- Triple stack of Windows effectively stopped lower energy particles (in some cases first two Windows were penetrated, but third was only dented)
- Even when full penetration occurs, collimation provided by the stack of Windows limits UV background

- Risk level was lowered through a combination of test and analysis

Process: Road Map



Summary

- ISIS risk process is effective and active
- Excellent coordination between SPP Project Team and ISIS in making analyses and running tests to reduce risk
- ISIS has made good progress in driving down and mitigating early risks during Phase B
- New risks will continue to be identified, and this process will be used to systematically work these risks down