Jet Propulsion Laboratory
California Institute of Technology

SITUATIONAL AWARENESS

The Glue of Mission Planning and Operations

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The research was carried out at the Jet Propulsion Laboratory, California Institute of Technology, under a contract with the National Aeronautics and Space Administration.

What is Situational Awareness?

- The perception of environmental elements and events
  - with respect to time or space,
  - the comprehension of their meaning,
  - and the projection of their future status
- More simply, it's knowing what is going on around you.

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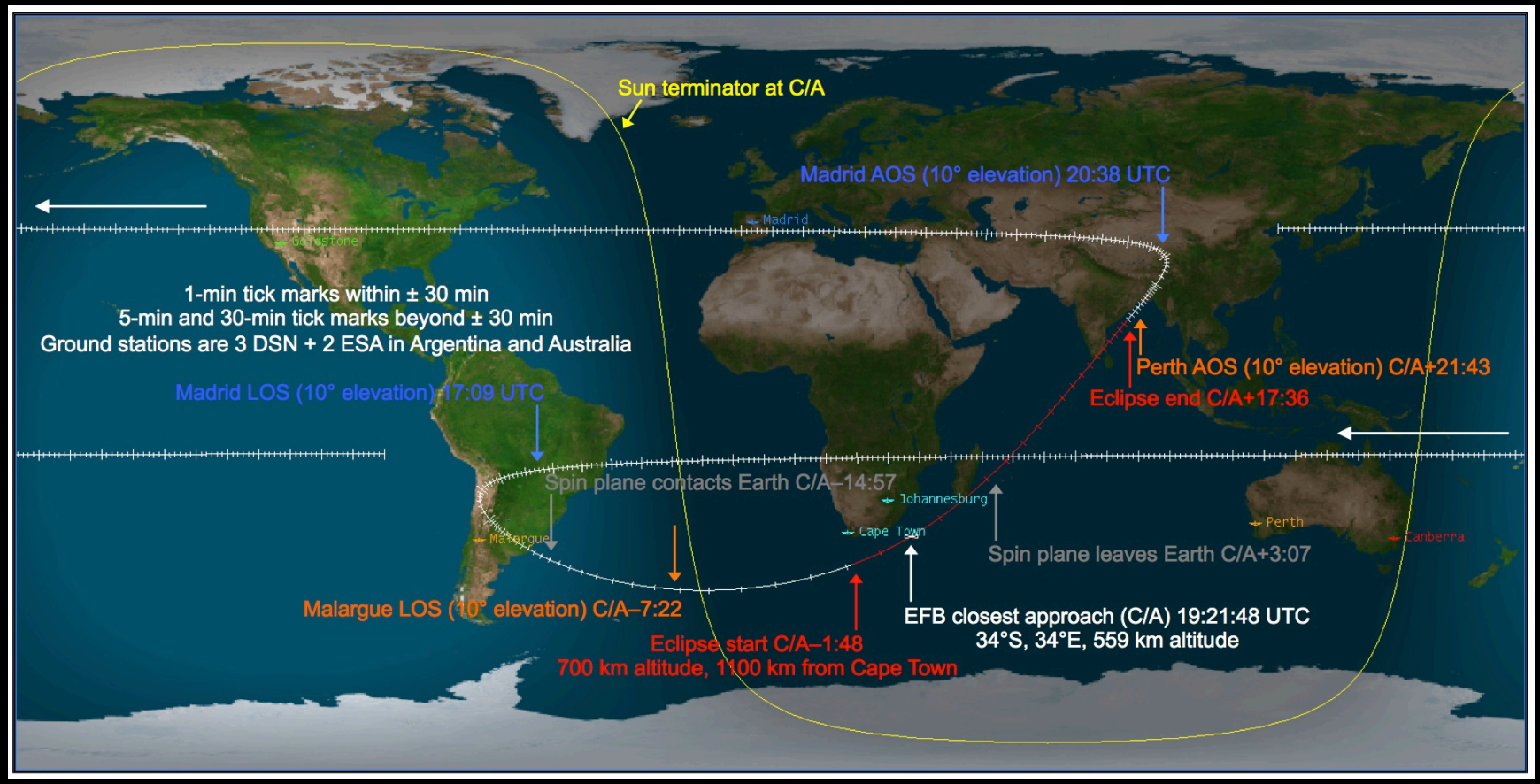
Lights Out



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Lights Out (1)

- Communication among the teams on the project regarding the battery management was in terms of state of charge
- Further, the work was managed as battery state of charge
- During eclipse state of charge drops from 50% to 46% over about 20 minutes
  - Understood that 38% SOC was the fault protection trigger point

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Lights Out (2)

- In reality, fault protection triggers on battery voltage at 28.7 volts
  - We entered eclipse at 29.3 volts as planned
  - With no power from the solar arrays and full load the battery dropped 0.4 volts to 28.9 volts.
  - It continued to drop past the safe mode entry point
- We didn't properly analyze the situation based on this difference and underestimated the margins – a proper analysis was available

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To Sweep or not to Sweep

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To Sweep or not to Sweep (1)

- MER ACE and Flight Director, in conversation with an off-project but trusted technical resource, decided to change existing procedure in the middle of the shift and not do the uplink sweep before commanding.
- This was not what the routine procedure said & changing it required testing. Double due to the fact that we were in critical ops.
- Why was sweeping important?

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To Sweep or not to Sweep (2)

- Inside each commanding pass, we could not be sure when the rover would wake, so we needed to treat each command as the only one in the pass, thus, the sweep had to be done.
- The frequency on the SDST is temperature related and so we had to sweep for each command as we couldn't be sure what frequency the rover would respond on, thus, the sweep had to be done.

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To Sweep or not to Sweep (3)

- As commanding was compressed into the “last 10 days”, the ACEs were asked to do longer and longer shifts. They noted they were tired but did not seem to communicate the full seriousness of the issue.
- MER ACE & FD decided to change the procedure “as a test.” They did not request approval first.
- Had they done it right, would it have been a success? We will never know.

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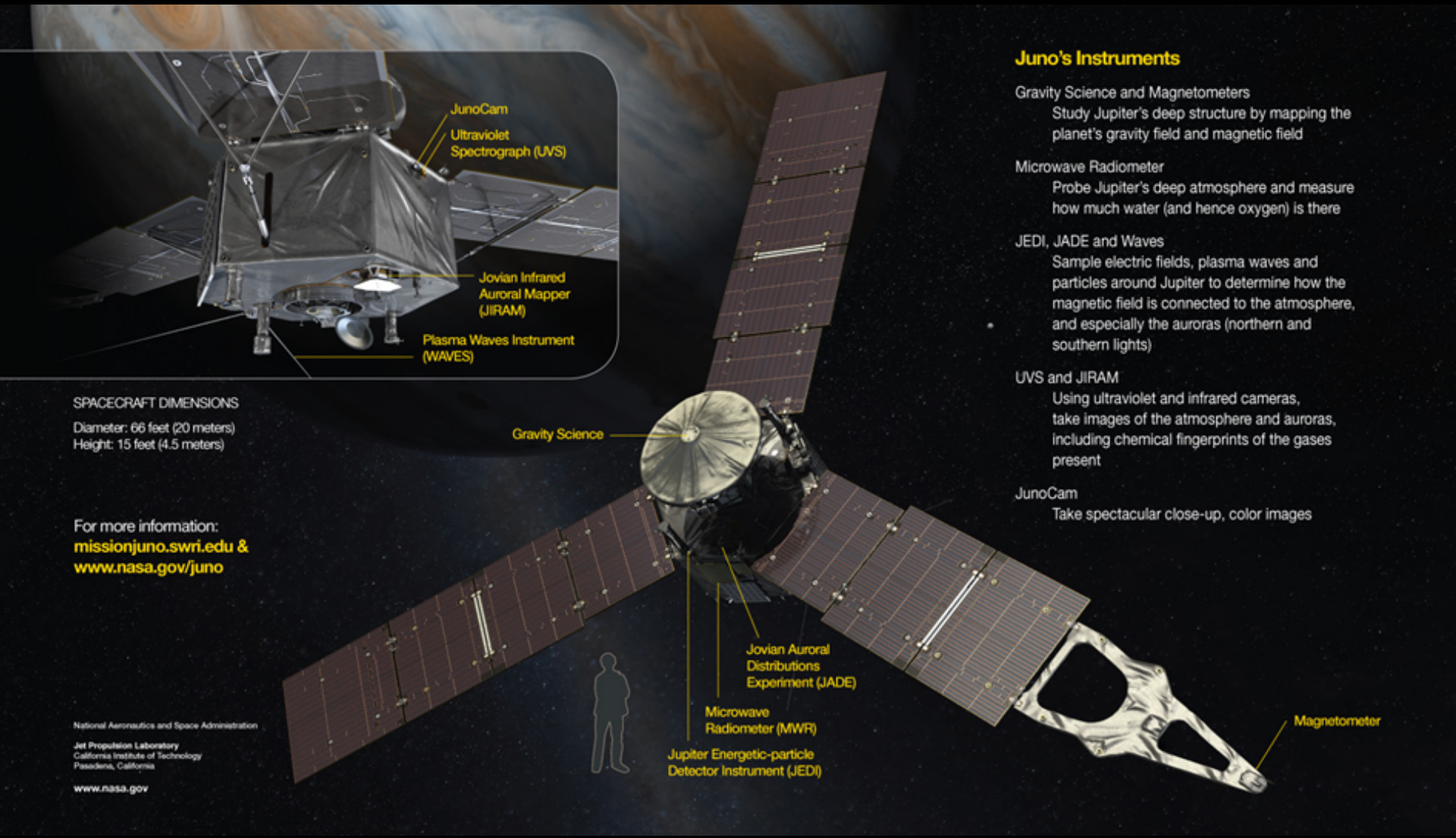
May the Force be with You



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May the Force be with You

- Initial discussion of the exercise involved raising the HV for 10 days and then lowering to zero.
- Using the repoint commands in the implementation of the exercise resulted in the HV only lowering to 100, not zero.
- The test was successful throughout the 10-day period, and no harm was done by leaving the HV at 100 since that is a safe voltage level.
- Though the test was successful and safe, it was a CFE due to lack of situational awareness.

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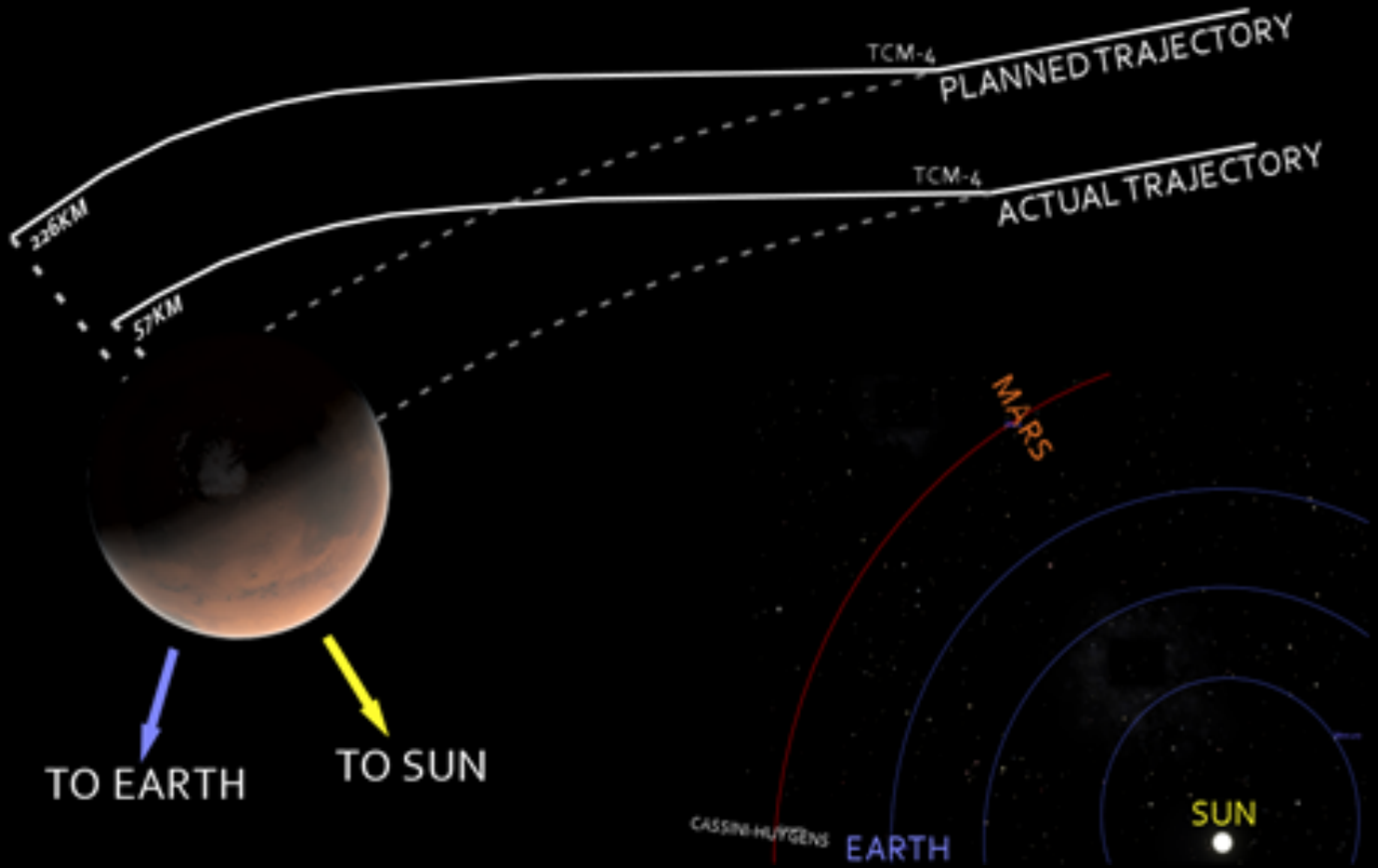
A Really Bad Day

MARS CLIMATE ORBITER ENCOUNTER DIAGRAM



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A Really Bad Day

- The loss of mission occurred when the MCO entered the Martian atmosphere because the spacecraft approached at an incorrect trajectory.
- The trajectory error was caused by errors in small forces modeling. The modeling error occurred because small forces information was delivered in pounds-force seconds, instead of the required Newton-seconds.

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Conclusion

- Situational Awareness means knowing what's going on around you and maintaining an attitude in your behavior and exactitude in your performance that enables you to approach reaching the ideal level of performance.
- While some errors cause by a lack of Situational Awareness may be benign, they can just as easily be catastrophic.

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