Collecting and Analyzing Surface Material from Permanently Shadowed Regions on the Moon Using an Orbiting Dust Telescope

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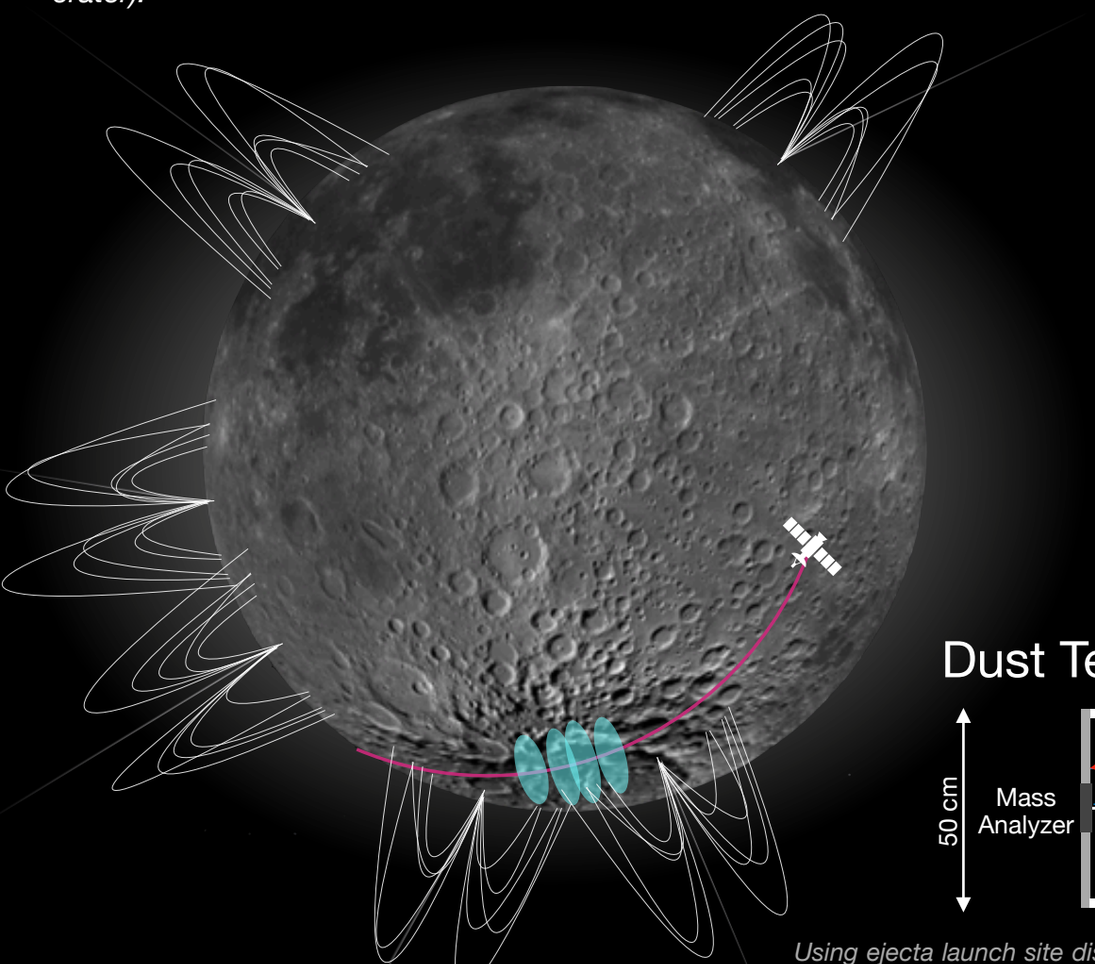
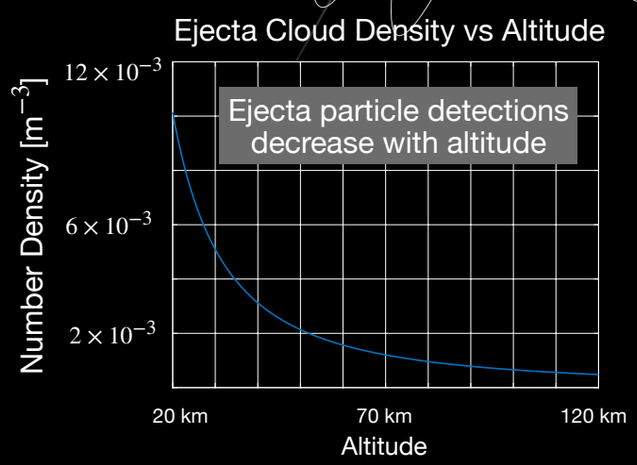
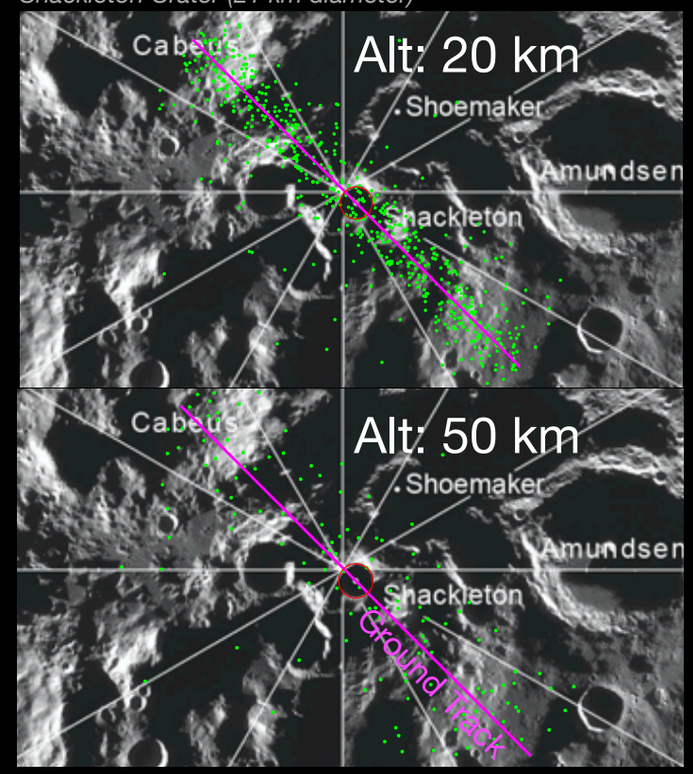
Interplanetary micrometeoroids bombard the surface of the Moon kicking up material creating a cloud of ejecta surrounding it[1,2,3]. Ejecta particle sizes range from hundreds of nanometers to a few microns. A dust telescope aboard an orbiting spacecraft can sample ejecta particles, analyze their chemistry (e.g. detect water ice), and map their site of origin on the surface in order to associate composition with geological features (e.g. Shackleton crater).

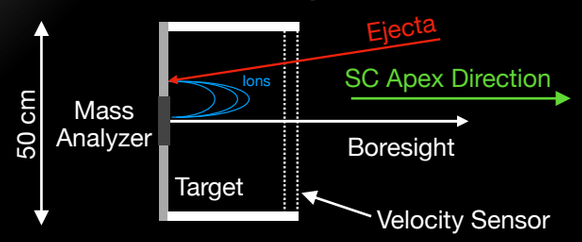




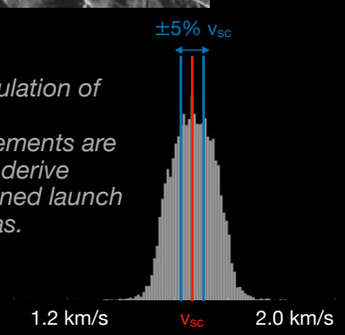
Monte Carlo generated ejecta launch sites (shown below as green points) for detected ejecta during a single flyby over Shackleton Crater (21 km diameter)



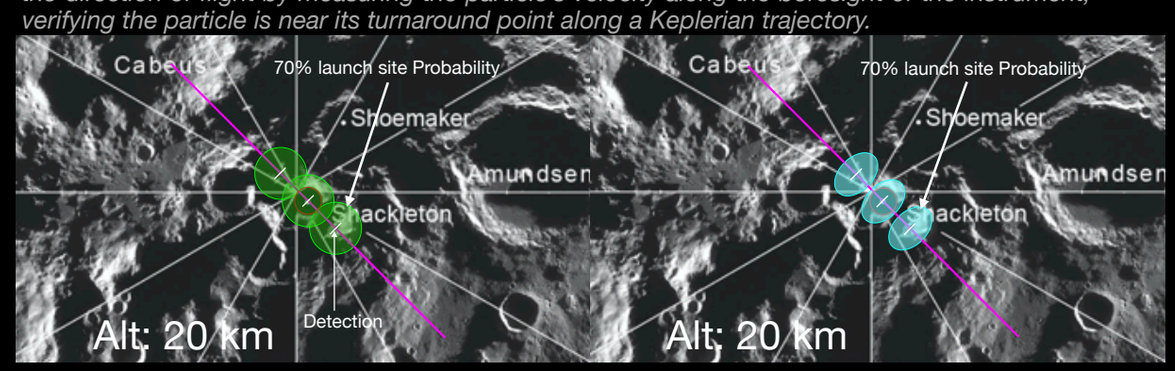
Dust Telescope



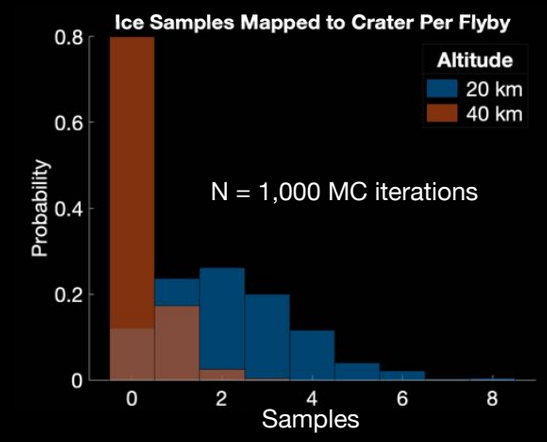
MC simulation of velocity measurements are used to derive constrained launch site areas.



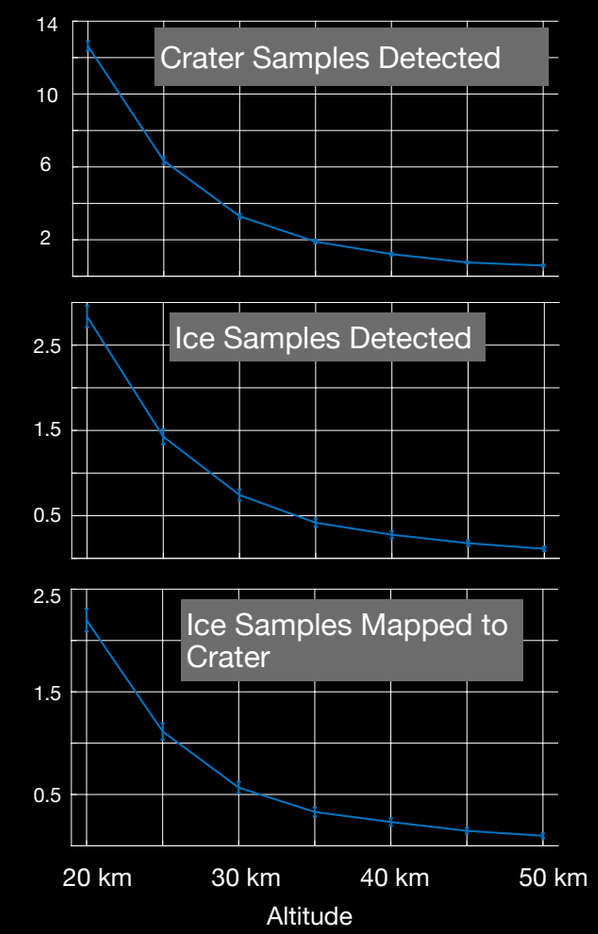
Using ejecta launch site distributions derived by Monte Carlo simulations, the area of probable launch sites are shown by projected ellipses on the surface corresponding to 3 example detections along the flyby. The circular areas on the left correspond to mapping without taking velocity measurements. The elliptical areas on the right increase the mapping resolution along the direction of flight by measuring the particle's velocity along the boresight of the instrument, verifying the particle is near its turnaround point along a Keplerian trajectory.



Expected Ice Detections Per Flyby Given Surface Material is 22% Ice within Shackleton Crater[4]:



Expected Detections for Single Flyby over Shackleton:



References:

1. Krivov et al., *Planet. Space Sci.*, **51**, 2003
2. Horanyi et al., Nature, **522**, 2015
3. Szalay et al., JGR: *Planets*, **124**, 2019
4. Zuber et al., *Nature*, **486**, 2012