**Comets are small primordial icy planet-building bodies** formed in the PPD. Older than Earth and no longer stable in the inner system, they are stored in two populations: the Kuiper Belt at the edge of the original PPD, and in the Oort cloud, a large spherical halo extending out to the gravitational edges of the present solar system (SS). Low inclination KBOs, scattered inward over Kyr by giant planets encounters, supply the population of short period comets, 5 of which have now been encountered by s/c. Oort comets, formed 4.56 Gya in the outer disk and scattered outwards into the Oort Cloud in near-miss attempts to accrete onto the giant planets, are on Myr period orbits with high inclinations and have never been closely observed. Thus our only detailed knowledge of SS planet-forming icy planetesimals comes from *in situ* flybys of thermally processed nuclei from the edges of the PPD.

On 19 Oct 2014, circa 1630 UT, this will change. The nucleus of **Oort Cloud Comet C/2013 A1 (Siding Spring)** will pass within 138,000 km of Mars, on its first passage inside the $H_2O$ ice line since its formation. We can expect significant planet-planetesimal interactions, as Mars will be within the comet's coma and the comet will be well within the Martian Hill sphere ($R_{Hill} = 1.5\times10^6$ km). During this close flyby, the highly dynamic comet will be the subject of an intense ground & s/c based observing campaign to determine its size, composition, behavior, and effect on Mars. E.g., MRO/HiRISE will to be able to resolve its nucleus, the first time ever for an Oort Comet; *MAVEN and Chandra* will measure any gas input into the Martian atmosphere; the Mars Rovers will search for impacting meteors; *Spitzer & SWIFT* will measure $CO_2$ and $H_2O$ outflow. Right after C.A., the comet will pass through the K2 Campaign 2 field, allowing Kepler to obtain highly accurate lightcurves (lc's) unobtainable from any other observatory. We propose a custom aperture to obtain detailed 30min cadence Kepler lc's of the $V_{nucleus} \sim 12$ magnitude comet over more than 25 hrs. This timespan will ensure us extensive sampling over a day/night rotation of the comet, allowing us to measure rotation & dust outflow rates as well as variability due to jets, morning outbursts, and solar or tidally induced fragmentation events. The resulting lc will also be critical for placing snapshot observations of the comet by *HST, Chandra, Spitzer*, and the NASA/ESA Mars s/c fleet onto an absolute scale, phased for the comet's rotation.

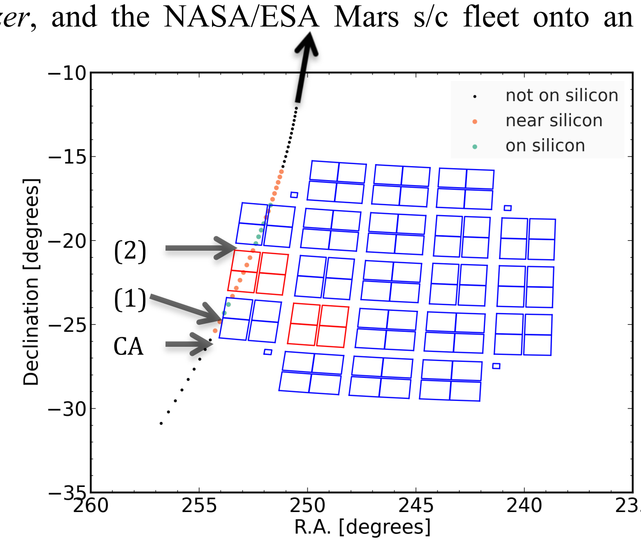


Fig 1 - Track of Comet Siding Spring across the K2 Campaign 2 field centered at (RA=16:24:31.2, DEC= -22:27:00) using JPL's #46 ephemeris (version 31Mar2014) for the comet. Mars C.A. occurs just off silicon at -26 $^{o}$ DEC. Each tick is 12 hrs. (1) The comet is observed at -24$^{o}$ DEC by K2 for 25 hrs over a ~1020 pixel-long track from 20 Oct 2014 1000 UT to 21 Oct 2014 1100 UT. (2) It is observed at -20$^{o}$ DEC for 41 hrs over a ~1200 pixel-track from 25 Oct 2014 1200 UT to 27 Oct 0500 UT.

**In Campaign 2, K2** has two opportunities to observe Siding Spring: (1) the 1st for a 25 hr continuous stretch starting 15 hrs after Mars closest approach, and (2) 5 days later for a longer 41 hr stretch. To obtain high precision photometry for this centrally peaked, but extended, target moving at 130 – 160"/hr (32 - 40 K2 pixels/hr), we will need to monitor all on-silicon pixels along the comet's track and use HST maps of the comet's morphology. Simulations using Mar 2014 HST Siding Spring data show we should be able to recover < 1%, ~5 min cadence photometry in post-processing. Because of the pointing uncertainties of K2, we will need an aperture 10 CCD pixels wide to ensure the comet is observed. **Our first preference is for Custom Aperture (1) at -24$^{o}$ DEC**, which will yield 25 hrs of measurements as close to the time of Mars flyby as possible. Custom Aperture (2) at -20$^{o}$ DEC will provide us a 41 hr observing baseline, but many days after the Mars encounter.