Kepler update to focus on flight segment performances

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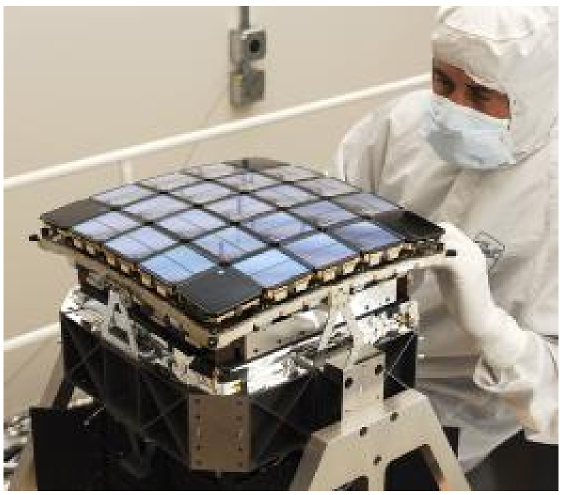

A focal plane assembly with all 21 science modules and four fine-guidance sensors, one in each corner, installed. The Kepler focal plane is approximately one foot square. It's composed of 25 individually mounted modules. The four corner modules are used for fine guiding and the other 21 modules are used for science observing. Each of the 21 CCD science modules are covered with lenses of sapphire. The lenses flatten the field of view to a flat plane for best focus. Sapphire is highly refractive and is strong, so a thin, light lens can be used and still be durable. Sapphire is also very resilient to extremes of hot and cold and is radiation resistant- that is, its optical properties don’t degrade significantly with radiation impact. Note that the four fine guidance modules in the corners of the focal plane are much smaller CCDs than the science modules. Each module and its electronics convert light into digital numbers that is analyzed for planet transits. Image credit: NASA/Kepler mission

(PhysOrg.com) -- At the May 23 press event, held at the 218th Meeting of the American Astronomical Society in Boston, the Kepler team provided a progress report on the mission. How is Kepler performing while trailing Earth around the sun?

The health of the spacecraft and photometer, the instrument used to measure changes in the brightness of distant stars, is excellent and has recorded more than two months of routine operations in this quarter. The observing efficiency in Quarter 9, which is April through June 2011, has been above 97 percent due to two very efficient monthly science data downlinks in April and May-- 16.6 hours and 15.2 hours, the quickest yet! Coupled with no unplanned breaks in collecting science data, it has been a strong quarter so far.

The monthly downlinks are planned science breaks where science data collected since the previous monthly contact is retrieved. Any data missed in the previous month's downlink is retransmitted. Kepler is NASA's first mission to use Ka band, a microwave band of the electromagnetic spectrum within the 26.5 to 40 GHz range, for routine science data downlinks. Prior to launch, it was estimated that up to 25 percent of each downlink would need to be retransmitted at the next monthly contact. This could be as a result of unforeseen interference with ground-based antennas or the spacecraft during the contact. However, performance of Ka band downlink between the spacecraft and the Deep Space Network ground stations has been excellent. Greater than 99 percent of science data reaches the ground on the first attempt. To ensure no data is left behind, 100 percent of the downlink is collected during the following month's contact.

Downlinking science and engineering data typically accounts for about six hours of a monthly contact. The remainder of the time is spent collecting calibration data and maneuvering the spacecraft to point the high-gain antenna (HGA) at Earth for the downlink. Once the downlink is complete, the photometer is returned to science attitude, resuming data collection and regular maintenance. For example, during the monthly contact in May, the team completed a file uplink to the spacecraft to mitigate the root causes of the anomalies encountered during Quarter 8 operations.

The duration of the science downlinks will increase over the course of the mission as the range between the spacecraft and Earth increases. Kepler is in a heliocentric orbit, slowly drifting further behind Earth each year as it orbits the sun. As the range increases, a lower downlink rate will need to be configured to maintain the link between the spacecraft and the ground. To date, the downlink rate operates at the maximum Ka band rate of 4.3 Mbps.

Kepler is currently 36.7 million kilometers from Earth. At the end of the nominal 3.5-year mission it will be almost 69 million kilometers away. For a mission extending beyond 3.5 years, the number of stellar targets would either be reduced so there are less data to return or have the same amount of targets and take longer to downlink to compensate for the growth in distance.

Last month, the first reaction wheel passed one billion revolutions. This means the spacecraft is on target to meet the goal of fewer than two billion revolutions during the nominal 3.5-year science mission. Reaction wheels are the primary actuators for controlling the attitude of the spacecraft. The wheels rotate faster or slower to maneuver the spacecraft, or just maintain science attitude, while compensating for external torques like solar wind. The number of revolutions is driven by how much external torque the wheels need to counteract. This will determine the rate at which the wheels change speed, and how long before the reaction control system thrusters are needed to desaturate, or unwind, the wheels. This will determine the maximum speed reached. The latest estimates show the spacecraft is equipped with enough propellant for the thrusters to last for an additional eight years. Two billion revolutions in the 3.5-year mission is a goal and would not limit the spacecraft from continuing to collect data.

While the reaction wheels are the actuators that point the spacecraft, the sensors used while collecting science data are the fine guidance sensors. There are four CCDs, or charged coupled devices similar to those in a digital camera, on the corners of the photometer's focal plane array. The CCDs take measurements of 40 guide stars while in fine point, the attitude required for collecting science data. The Kepler Science Operations Center (SOC) takes a set of reference pixels from the science CCDs that are collected once per day and monitors the pointing of the focal plane, ensuring the spacecraft is precisely pointed at the stellar targets. The most recent estimate from the SOC shows that while the spacecraft drifted four to five millipixels over the quarter, it is currently less than half of a millipixel away from where it started collecting science this quarter. That means the light from the stars Kepler is monitoring falls on the same part of the science CCDs, which is required to obtain the precision necessary to detect planet transits. A science CCD pixel covers four arcseconds of the field-of-view. The spacecraft is only two milliarcseconds away from where it was pointing at the beginning of the quarter. An arcsecond is 1/3,600 of a degree or 1/1,296,000 of a circle. A change of two milliarcseconds is like looking at a laptop screen in New York City from San Francisco, and after two months the line of sight is now an inch and a half from the center of the screen. That's impressive staring!

Kepler is performing well and is delivering an abundance of data capturing over 5.5 billion brightness measurements over its first two years of science operations. The galactic stare down continues...

Provided by JPL/NASA