

TES / AURA

Mission Operations Working Group Report

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Aura MOWG
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Overview

- Instrument status
- Instrument downtime
- Instrument faults
- Issues, Concerns and Other Items

Instrument Status

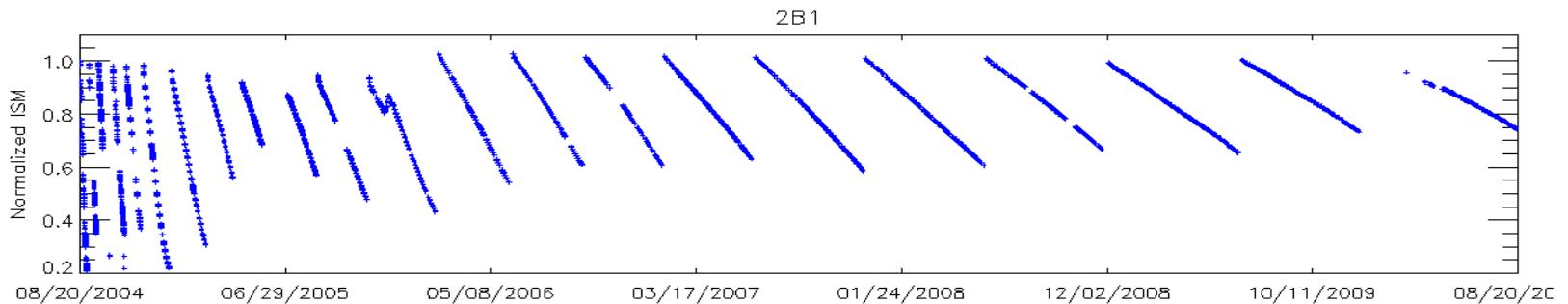
- The TES instrument is again in nominal operations, but showing signs of aging
 - Global Survey regularly scheduled every other day
 - Special Observations scheduled during ‘off’ days
 - PCS (Pointing Control Subsystem) investigation & fault recovery
- 84 Global Surveys gathered YTD
 - 945 Global Surveys since launch
 - Global Survey modified 07/08, 4/10 to reduce ICS travel
 - Global Survey calibration modified in response to PCS issue
 - Extensive downtime due to PCS anomaly
- 130 Special Observations gathered YTD
 - 2478 Special Observations since launch
 - SO campaigns reduced in light of instrument aging

Tropospheric Emission Spectrometer

Instrument Status – Scheduled Downtime

- Scheduled Instrument downtime this year:
 - Three day De-ice cycle commanded January, October '10
 - Periodic de-ice necessary to restore signal

Integrated Spectral Magnitudes as Function of Days
16 pix/20 scan Averaged, Normalized to the 1st Measurement. Target: On-Board Blackbody



- Coordination with Goddard FOT has reduced the number of conflicts between TES scheduling & instrument maneuvers

Instrument Status – Unscheduled Downtime

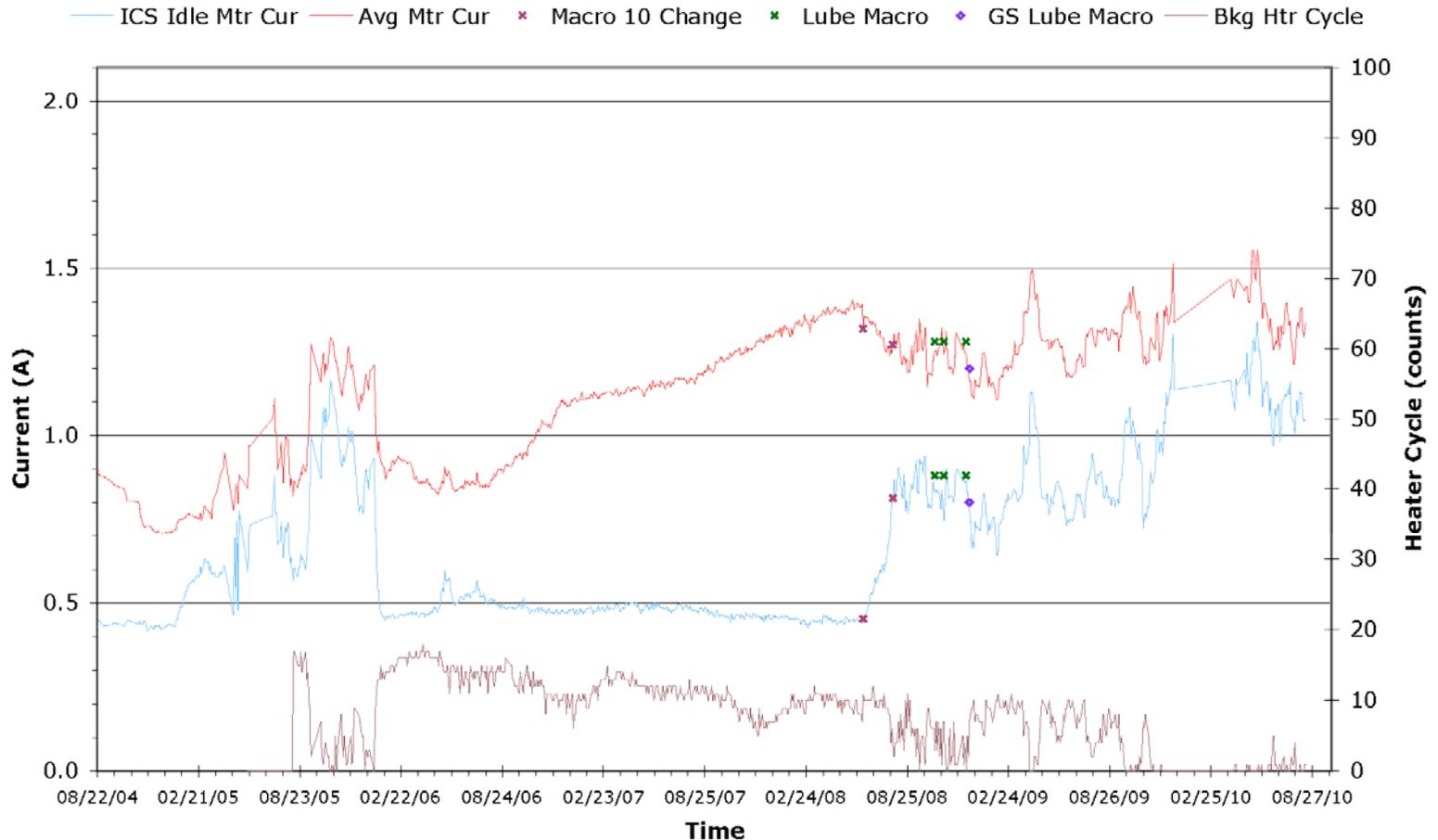
- **Unscheduled instrument downtime**
 - PCS (Pointing Control Subsystem) anomaly
 - Indications of PCS track motor over-currents, motion disturbances, telemetry drop-outs started in August '09
 - Symptoms greatly increased in severity late in December '09; decision was made to suspend global survey collections during investigations – December 21, '09
 - Tiger team identified degradation of the PCS cross-track flex cable as the root cause of the anomaly
 - Global survey operations were re-initiated in April 7, '10, data collection for 52 global surveys cancelled since December
 - Fault event: TES entered Safe April 15th due to PCS motor under-temperature event due to loss of signal
 - Operations restarted April 26th, additional 5 global surveys cancelled

TES ICS Status

- TES ICS (Interferometer Control Subsystem) contains a linear translator that moves a pair of back-to-back cube corners, along with motor, encoder & electronics. The linear motion of the translator modifies the optical path difference in the interferometer.
- Current increases in ICS & loss of velocity control attributed to lack of lubrication & increased friction in ICS motor encoder bearing
- Risk - eventually available current will not be sufficient to overcome encoder bearing friction; velocity instability
- TES Global Survey modified 7/08, 4/10 to reduce global coverage & reduce ICS travel - now 50N..30S
- ICS velocity control is adequate; no science impact at this time
- Contingency macros in place to raise coarse motor voltage when required
- Fault protection is enabled

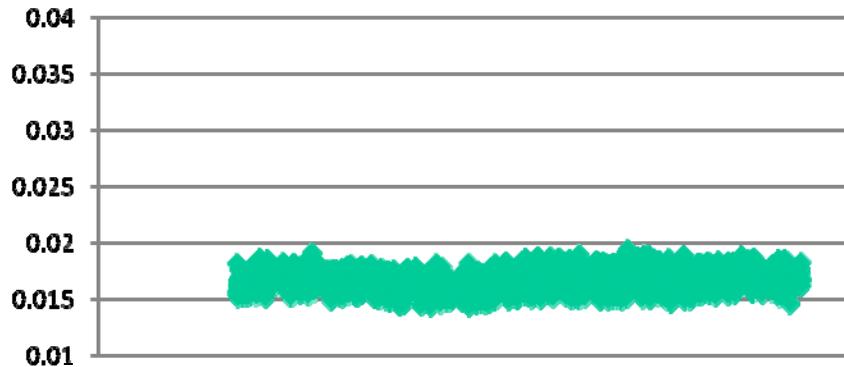
Average TES ICS Motor Current

Global Survey Average ICS Motor Current Idle vs. Scan with Translator Background Heater Cycle Counts

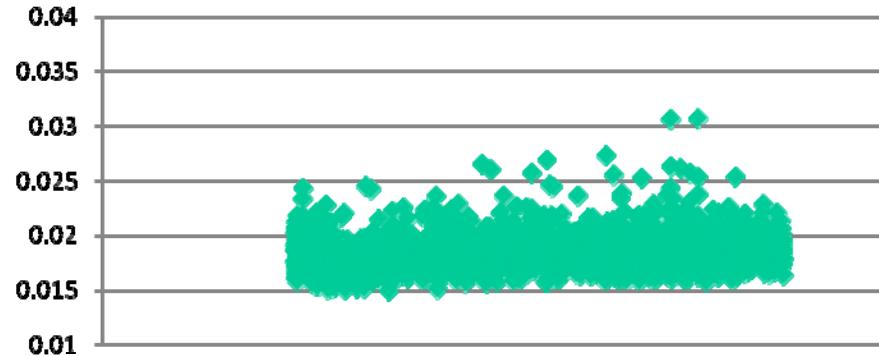


ICS Velocity – Typical GS

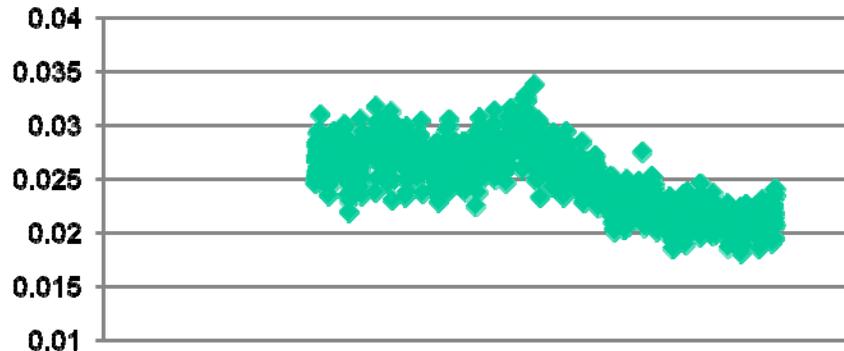
Standard Deviation Velocity 7/8/2008



Standard Deviation Velocity 9/22/09



Standard Deviation Velocity 6/8/2010



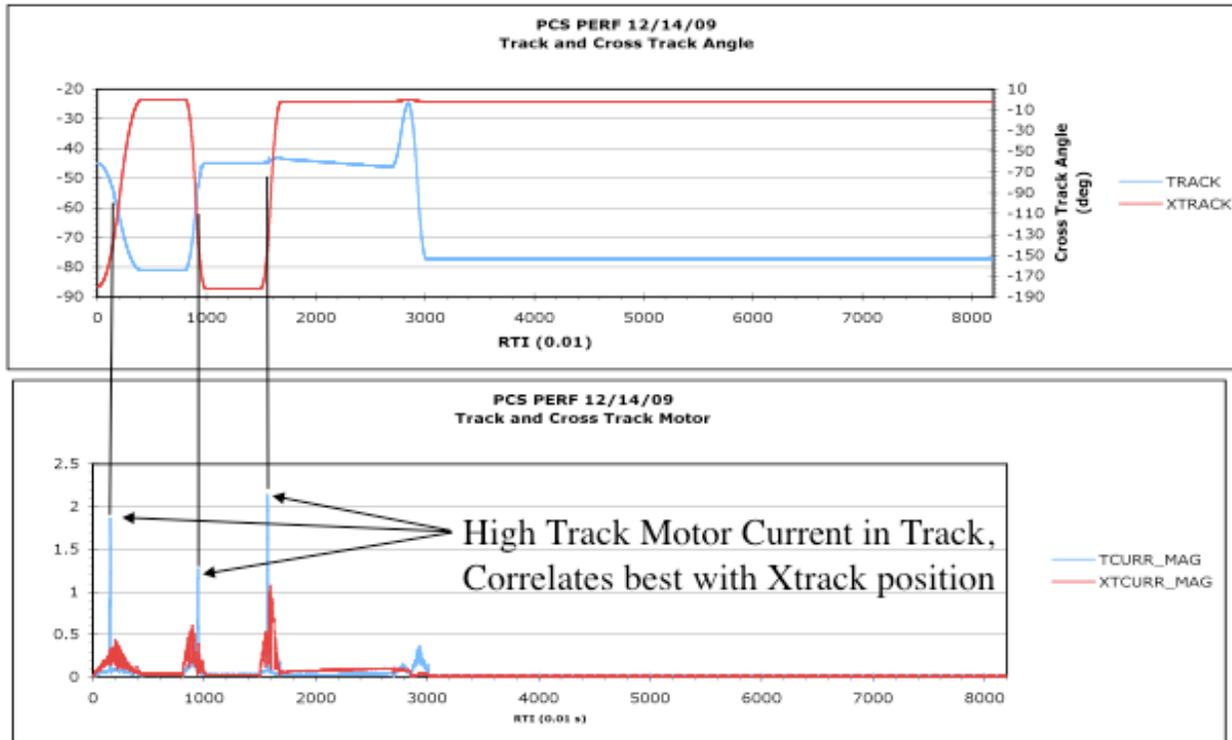
Instrument velocity data is reviewed each week, occasional over-current/velocity events detected by instrument ops team. Over-velocity fault protection is enabled on the instrument. Velocity control has degraded but science impact is minimal.

TES PCS Issue - Summary

- TES Pointing Control Subsystem (PCS) is comprised of a two axis gimballed pointing mechanism & motors, mirror, a closed loop gimbal controller algorithm and PCS electronics – it controls the instrument field of view, provides motion compensation during the time of scan & rotates 180 degrees to view internal blackbody for calibration.
- August – December '09: sporadic current spikes and motion disturbances on track axis, usually under fault protection limits, no impact to science data. Cross-track performance nominal.
- Motion disturbances on track axis became increasing worse mid - December '09, science data impacted due to slew rate errors during nadir scan setup, causing loss of first nadir scan
- TES suspended the global survey December 20th, '09 for investigation & analysis.
- On orbit tests and simulations were performed to characterize issue.
- Following identification of root cause & major revisions to the global survey sequence, TES resumed operations April 7th, 2010.

TES PCS Investigation

- While motion disturbances & current spikes occur on track axis, event occurrence is most closely associated with cross-track movements to / from internal black body calibration source



TES PCS Investigation Results

- Most likely failure mechanism: momentary grounding to cable shielding in **cross-track flex cable** as PCS moves to/from blackbody calibration position, causing loss of velocity sense signal from **track** motor. **Track** V-sense signal is re-established as cross-track continues motion.
- Simulations of PCS model demonstrated similar behavior with grounding of v-sense signal.
- Risk: total loss of track motor v-sense signal will place PCS at soft stops; loss of commanding.
- Additional symptom of flex cable deterioration – momentary loss of **track motor temperature** signal at certain PCS angles; also carried on cross-track flex cable & is adjacent to v-sense conductor.
- Appears to FSW as a track motor under-temperature.
- Occurs at different PCS pointing angles than v-sense signal loss; during off-nadir target tracking of special observations.

PCS Mitigation Investigation

- Identification of root cause 1st priority; resulting recommendation of the tiger team was to limit the number of PCS cross-track axis transitions across the critical angles to maximize remaining lifetime.
 - Critical angles on cross-track correspond to movements to / from blackbody calibration position
 - TES global survey sequence contained a blackbody calibration scan every 'sequence', which results in a 180 degree movement of the PCS, 740 times in each global survey. This global survey sequence in place prior to launch.
- Several alternative calibration alternatives were proposed & investigated with various trade-offs
 - Impact on operations
 - Impact on quality of calibrations
 - Impact on ground / flight software

TES PCS Mitigation & Implementation

- Operations impact - TES Global Survey modified to obtain blackbody calibration scans once before & once after each global survey
 - Reducing transitions across cross-track critical angles to 2 / GS from 740
 - Obtain 40 blackbody scans pre/post global survey
 - Move PCS cross-track axis to earth-viewing angle & leave it there for GS
- Flight SW impact – none
- Ground SW impact – substantial L1B calibration code modifications required to implement modified calibration strategy, including validation
- Quality impact on data – appears to be minimal, within noise of previous product. Science data quality statement is required for L1B and L2.
- TES returned back to Global Survey Operations April 7, 2010
- Ground software updated June, 2010
- SIPS re-initiated Global Survey processing & delivery August 25th following science team evaluation

Instrument Faults

- TES entered SAFE configuration following resumption of Global Survey: April 15, 2010
- Exceeded fault persistence (28 seconds) on PCS Track Motor Under-Temperature fault monitor, triggered fault response
- Cause: Temporary, sporadic loss of signal on this telemetry point; same failure mechanism as PCS track issue (transient flex cable failure – short to ground). Connectivity is re-established as cross-track continues to move
- PCS Track Motor Temperature not determined to be critical to operations
- TES defeated the associated fault response while continuing to monitor events
- CAMs and tag ups with Goddard FOT enabled a quick return to operations April 26th

Instrument Status – summary

- TES has operational issues and constraints; however we are in daily operations and are producing exceptional science data.
- PCS flex cable issue is being mitigated. Mitigation involves minimizing the number of transitions to the black body calibration source. Mitigation introduced very little impact to science quality.
- ICS encoder bearing wear continues to be a concern, mitigated through operational modifications & reduction in global survey coverage.
- Every effort is being made to maximize instrument life-time while providing high science return.
- Extended science team has stated that sustaining the regular base of temporal sampling is vital, spatial modifications to the Global Survey are acceptable.