Aura Science Team Meeting 2016
Mission Operations Working Group

Tropospheric Emission Spectrometer

Project Manager

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Overview

- Instrument status (FOT & IOT inputs)
  - Laser-B degradation
  - ICS Translator Performance
  - Power-On-Reset
- Science data collection changes
  - SimClk data collection and processing
- Documentation
  - POR Recovery SOP
  - ICS Translator Stall Recovery SOP
- Upcoming Activities

Background – TES Laser Overview

- The laser on TES provides a position reference via Optical Path Difference (OPD) for sampling of the interferograms
- Laser is a narrow linewidth (≤ 2.5kHz) diode laser-pumped Nd:YAG Non-Planar Ring Oscillator (NPRO)
  - 1064nm, ≥ 25mW output from optical fiber pigtail
  - Ruggedized version of commercial model 125 laser from Lightwave Electronics Corp.
- Two lasers were flown for redundancy (Laser A and Laser B)
  - Each laser was designed to operate continuously for at least 2.5 years in order to meet the required 5-year mission life
  - Laser A operated nearly perfectly for nearly 10 years from initial turn-on to loss of output due to apparent pump laser diode failure on 7/9/14
  - Laser B activated 7/23/14 after 10 years of “storage” in the instrument

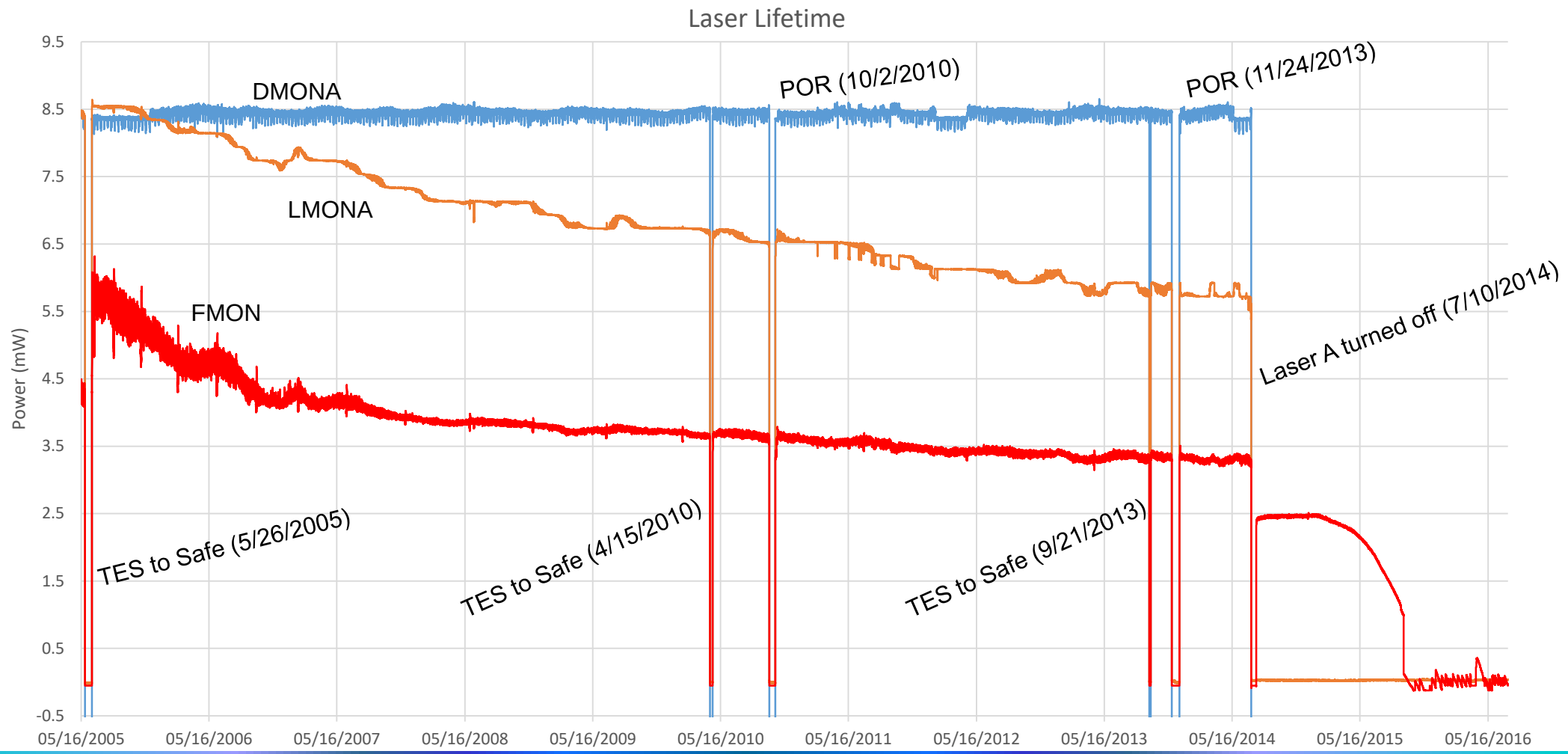
TES Instrument Status

- TES Laser Performance – Both Metrology lasers have failed
  - The FINAL diode current increase occurred on July 28th as expected laser performance resulted in the necessary power for continued science observation and the corresponding LMON, FMON and DMON signals.
    - CURRB_SET maximum command value is x('FF') which provides a laser diode drive current set point of 636 mA.
  - Laser Fringes were maintained continuously until Aug 5th 19:30
  - TES Metrology lasers (both A and B side) have failed
- Cold Detector Test executed on Aug 3rd
  - Resulted showed fiber detector provides better sensitivity to laser metrology signal than cold detector
- Transition to continual SIMCLK Observations was performed on Aug 8th

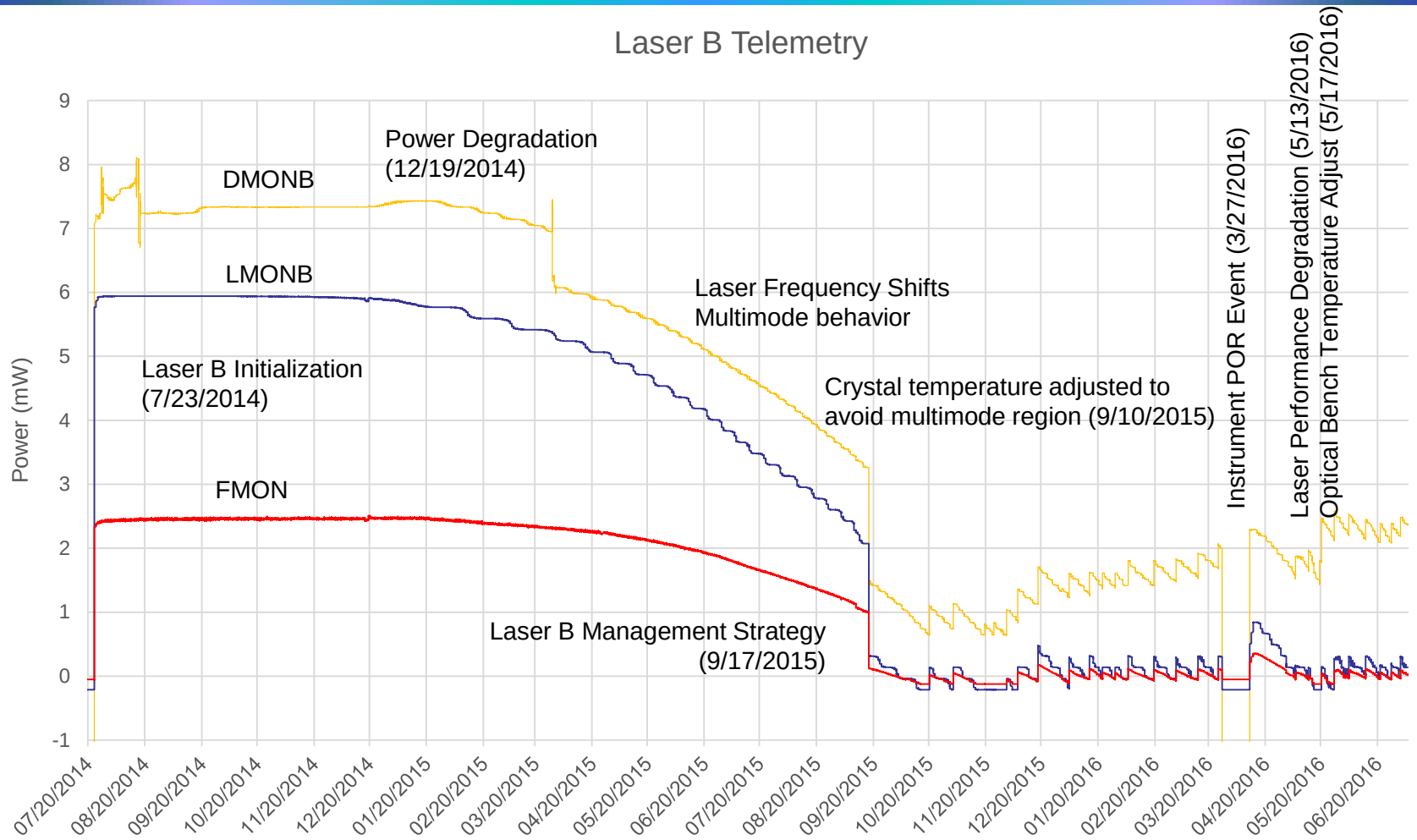
Laser Power Management Plan

- Goal is to maximize science return & laser lifetime
  - Maintain low diode drive current to minimize time rate of change of laser power & extend lifetime
    - Low diode drive current minimizes diode failure risk
    - Use ICS Performance fringe data to determine need to increase diode drive current
    - Increase the diode drive current in small increments (~6mA) as DMONB output drops to maintain constant Nd:YAG laser performance
    - Diode drive current DMONB now at 622 mA, max available current 638mA
  - Adjust laser crystal temperature to avoid multi-mode regions
  - Laser detection gain set to ‘High’ to help maintain robust detection at lower power levels.
  - TES FSW was patched on 1/27/16 to raise the limit on the commanding laser diode power; a likewise increase in the fault protection was necessary to prevent a fault response due to the increase command range. Ground limits and FOT database were also updated.

Brief History of Laser A (PF2)

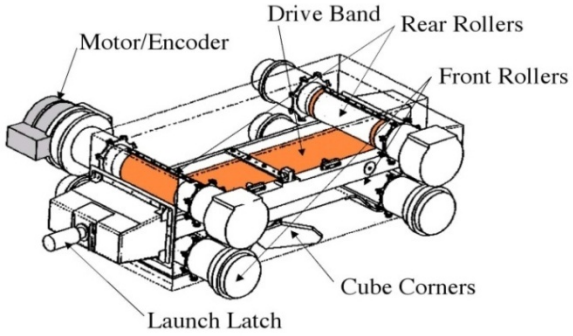


Brief History of Laser B (PF8)

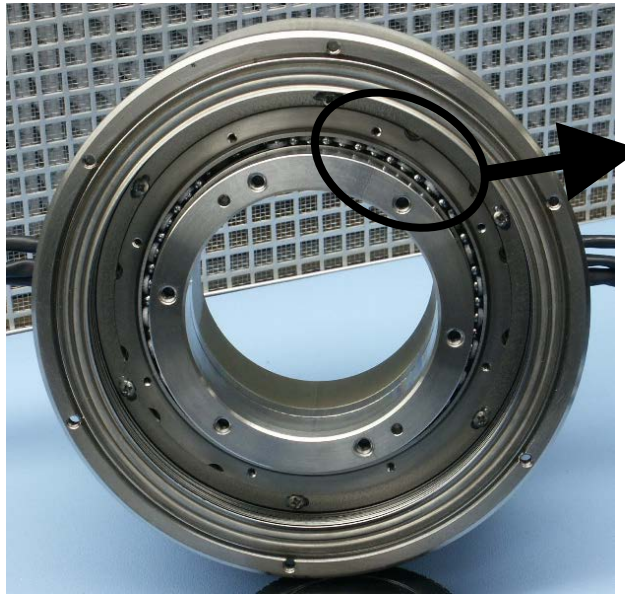


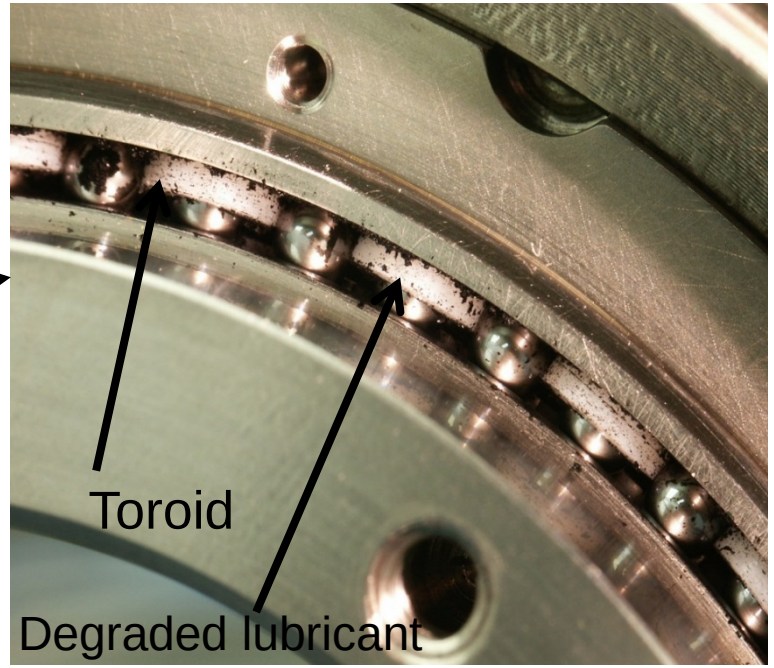
TES ICS Background

- 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, wear & increased friction in ICS motor encoder bearing
- Risk - eventually available current will not be sufficient to overcome encoder bearing friction; velocity instability will become prevalent
- TES Global Survey modified 7/08, 4/10 as mitigation to reduce ICS travel
- ICS velocity control is adequate; no science impact at this time
- Contingency macros in place to raise ICS coarse motor voltage when required
- Fault protection is enabled



TES Life Test Unit (LTU) encoder bearing





TES LTU encoder bearing

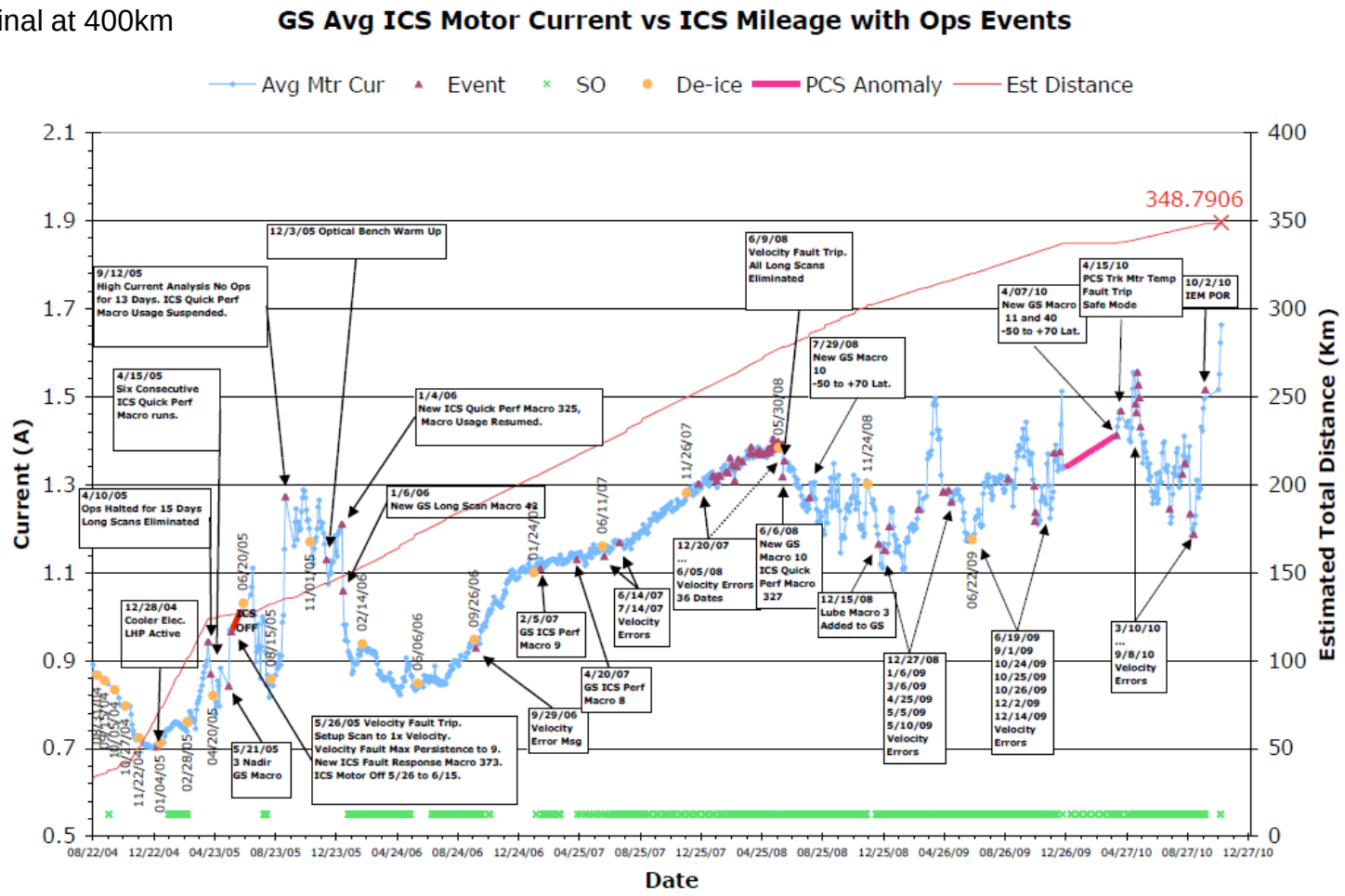
TES ICS identified as a limited lifetime component due to early failure of the LTU encoder bearing.
NASA Glenn analysis of failed TES LTU encoder bearing:
-Lubricant was severally degraded
-Toroids divioted 180 degrees apart
-Metallic particles embedded in toroids
-Toroids contributed to bearing failure; locking of toroid

ATMS bearing of like design showing toroid wear

Encoder bearing wear is most likely cause of degraded velocity control, increased motor current.

ICS Average Motor Current Launch to 2010

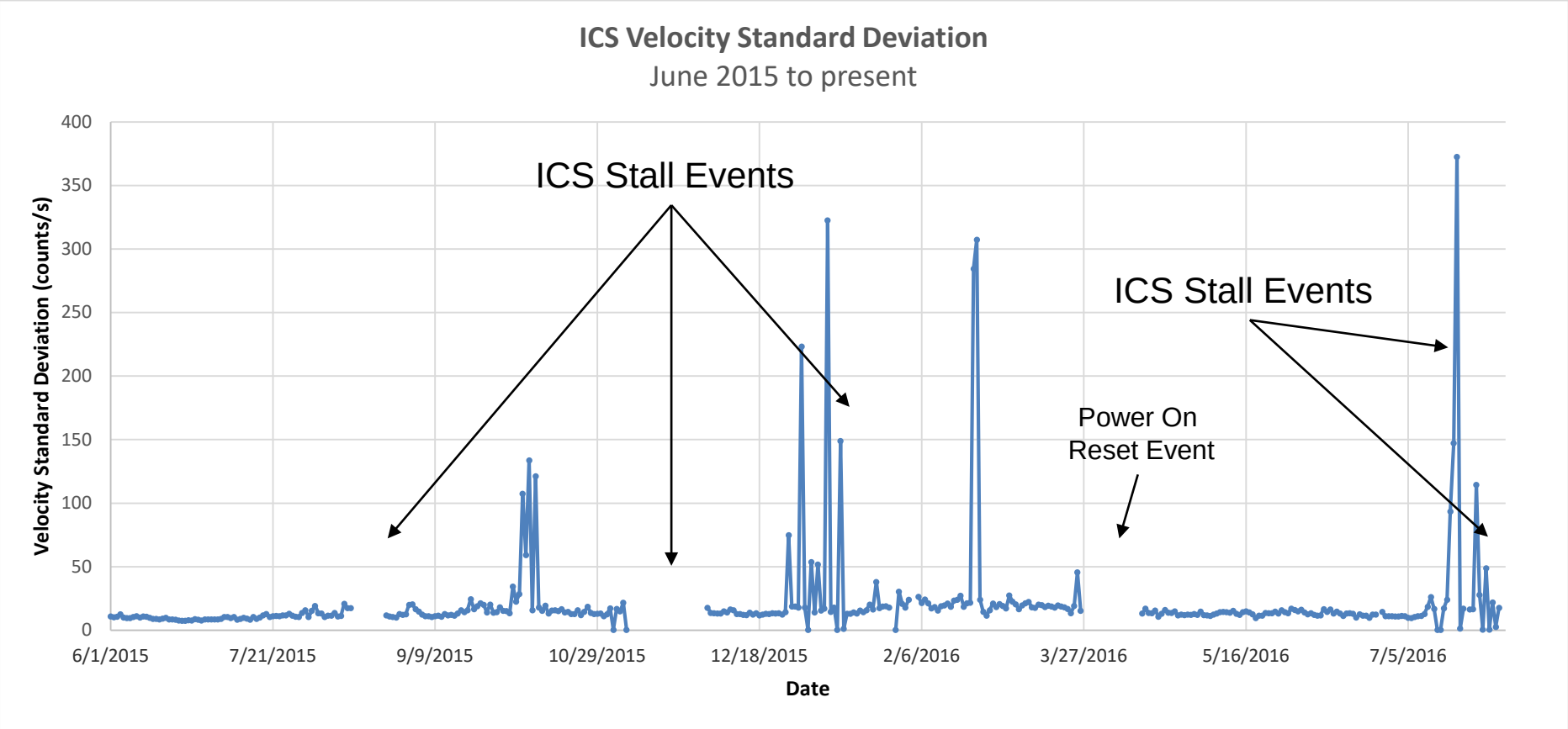
Life-test unit initial stall at 200km, final at 400km



TES Instrument Status

- TES ICS Translator encountered multiple “stalls” where travel along translator becomes restricted
  - Multiple Stalls have occurred since late July
    - The established TES ICS recovery procedure has been able to restore full travel in each of these recent cases within 36 hours
  - Prior Stall in 2016 was in January
    - Again the TES ICS recovery procedure restored full travel was restored within 24 hours
  - Stalls occurring 2015 were in August (2) and November (1)
    - In each case the standard TES ICS stall recovery process was successful

ICS Performance



ICS bearing wear introduces translator velocity variations during operations. These velocity variations significantly impact the science data quality of recent TES data.

TES Self-Test POR
March 27, 2016

- TES experienced a Power on Reset as a result of an anomalous memory checksum self test.
  - Periodic memory checksum tests are executed to remove potential bit errors from dynamic random access memory.
  - Single bit errors are correctable, double bit errors are detectable
  - When a fault is detected the FSW executive task halts and a watchdog timer will trip and execute a power on reset
  - Instrument Recovery was nominal
    - Performance was unchanged for Laser B, ICS, and Coolers