



SNPP ATMS

Alternate Scan Profile For Risk Mitigation To Extend On-Orbit Life

25 August 2015

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Agenda



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 - S-NPP ATMS Scan Drive Bearings
 - Test Unit Toroid Wear
 - Scan Reversal Benefits
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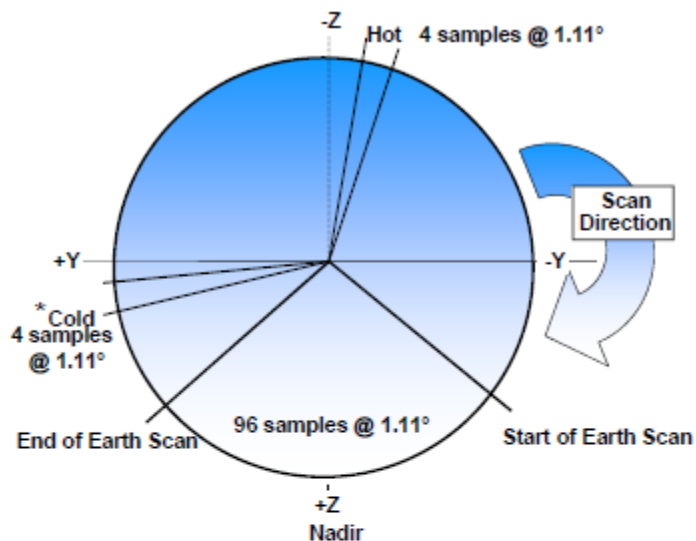
Introduction



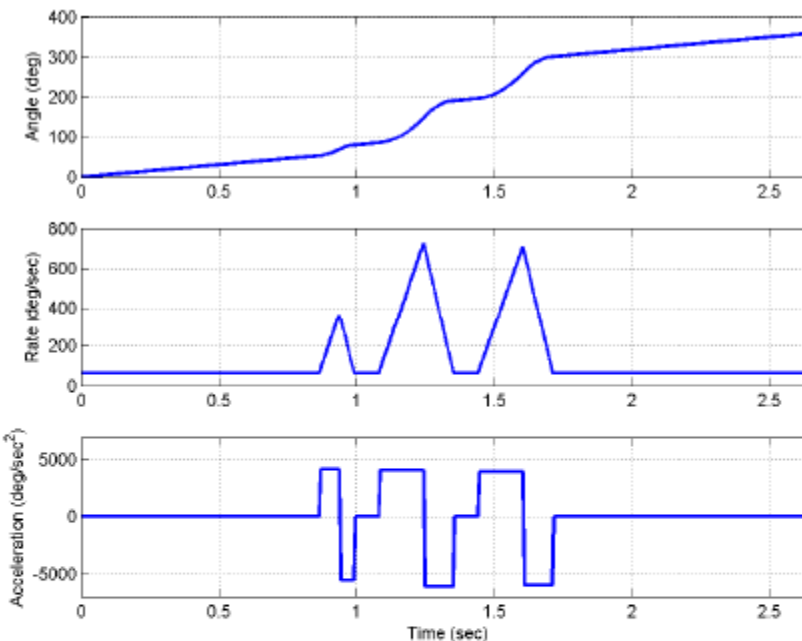
- **Suomi-NPP mission life was 5-years (Oct. 2016 = 5ys on-orbit)**
 - ATMS instrument design life is 7-years
- **NOAA is concerned about a potential gap in polar orbit data**
 - Inspector General, Government Accounting Office, and Independent Review Team reports have substantiated NOAA's concerns regarding the gap.
 - If the follow on satellite launch date is delayed there could be a gap
- **SNPP ATMS performance on-orbit is excellent**
 - ATMS has been anomaly free since launch on October 28, 2011
 - All performance parameters have been and continue to be within specification
 - SNPP ATMS is expected to meet or exceed the 5-year mission life
- **Data suggest scan bearing degradation could limit instrument life**
 - 3 of 3 bearing life test unit results met fail criteria in less than 2 times life
 - On-orbit scan current excursions with increasing frequency and magnitude may indicate bearing wear
- **Periodic on-orbit scan reversals are being implemented to re-distribute lubricant.**



Scan Drive Subsystem Operational Modes



*Primary cold cal sector at 6.66°, alternate sectors at 8.33°, 10.00° and 13.33°



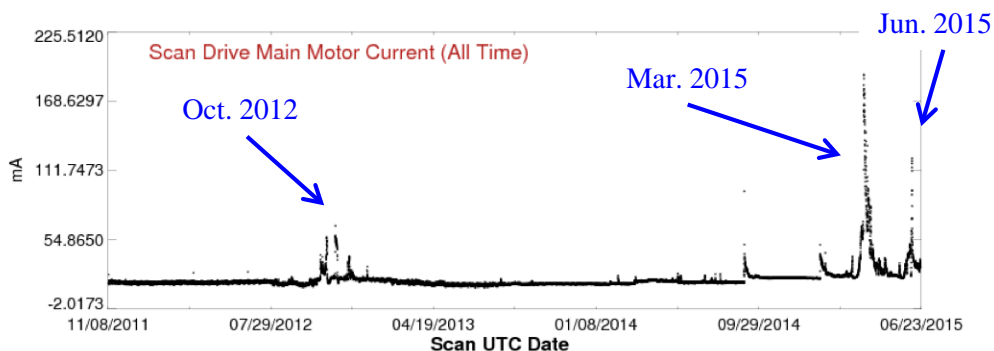
- **Scan Mode**
 - Constant speed during data collection
 - Earth Scan
 - Cold & Hot calibration sectors
 - Accel / Decel profile between sectors
- **Stare Mode**
 - Go to defined position and stop



S-NPP ATMS Scan Drive Investigation



- **S-NPP ATMS is experiencing some Scan Drive Mechanism (SDM) Main Motor Current excursions from the nominal on orbit value**
 - These excursions were first observed in October 2012 and to date, **none** have violated specifications



- In response to the first observation, the Flight Project Scan Drive Working Group (SDWG) was formed to:
 - “Monitor and trend S-NPP ATMS Scan Drive System (SDS) performance; monitor and trend ATMS Bearing Life Test (BLT) performance; and investigate and test mitigations to maximize on-orbit performance of the S-NPP ATMS scan drive system”
 - Membership: JPSS Flight Project, S-NPP Mission Operations, Science (NASA & NOAA), NGES and LM



Life Extension Considerations



- **Scan Drive Subsystem Bearings are the components most likely to limit life expectancy of the instrument**
 - Accelerating and decelerating rotation of the scan drive profile has a minor contribution to bearing wear
 - Unidirectional scan profile results in premature wear of the bearing cage elements (toroids).
- **SDWG has considered several options to mitigate bearing wear**
 - Two scan profile changes were seriously considered
 - Using an alternate scan profile to lessen the stress on the mechanism bearings – not selected as impact to software and science is significant
 - Periodic scan reversals to mitigate bearing wear suggested by LM (Stu Loewenthal)



Scan Reversal Being Implemented

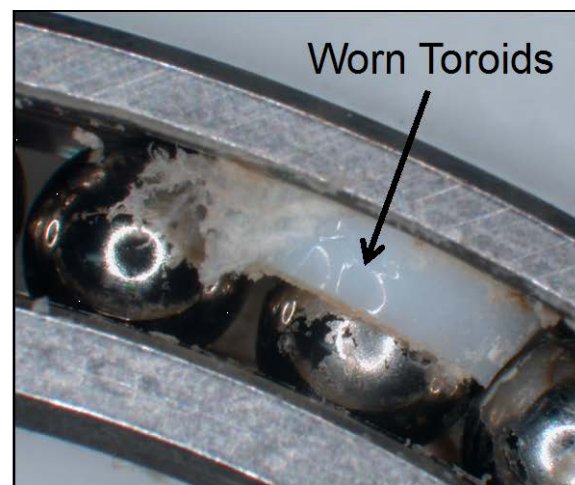
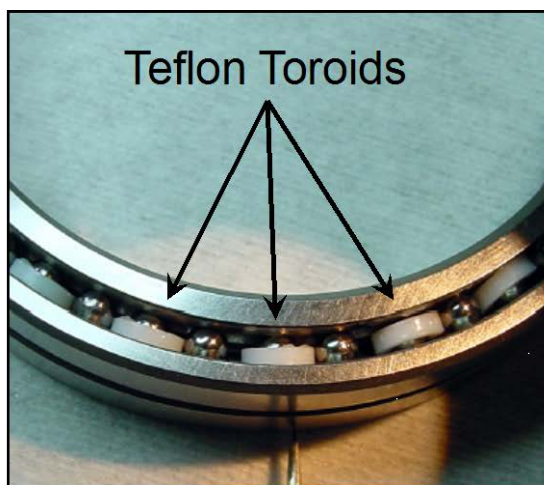


- **Periodic scan reversals are being implemented to mitigate wear according to the plan below:**
 - Scan reversal methodology developed and tested by NGES
 - Scan reversal verified on ATMS Engineering Development Unit
 - Scan reversal tested by Operations on the Flight Vehicle Simulator
 - Scan reversal approved by NASA/NOAA on 6/25/15
 - 6/25/15 periodic scan reversals were recommended at the S-NPP Mission Annual Joint Steering Group (JSG)
 - Permission granted
 - Scan reversal table load and initial reversal on 7/14/15 – continue to monitor
 - One scan reversal via Daily Activity Schedule (DAS) on 8/17/15
 - Daily reversals via DAS start on 8/24/15

- Complete
- To be completed

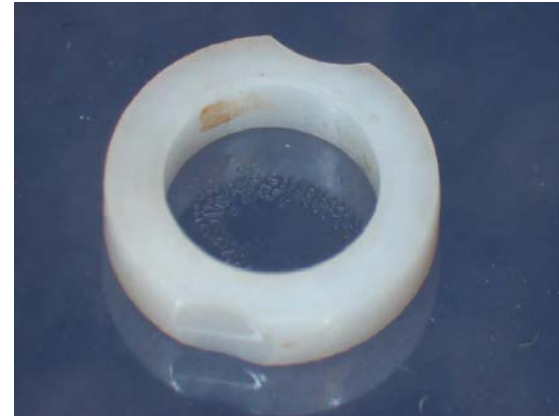
S-NPP ATMS Scan Drive Bearings

- The S-NPP SDM utilizes two sets of Main Motor Bearings that are 2.25" diameter using thirty eight 1/8" balls with Teflon Toroid Spacers on every other ball
- A BLT was started by the S-NPP Project and continues
 - 3 of 3 BLT stations met fail criteria before reaching 2x life
 - 2 of the failed stations successfully restarted after motor reversal



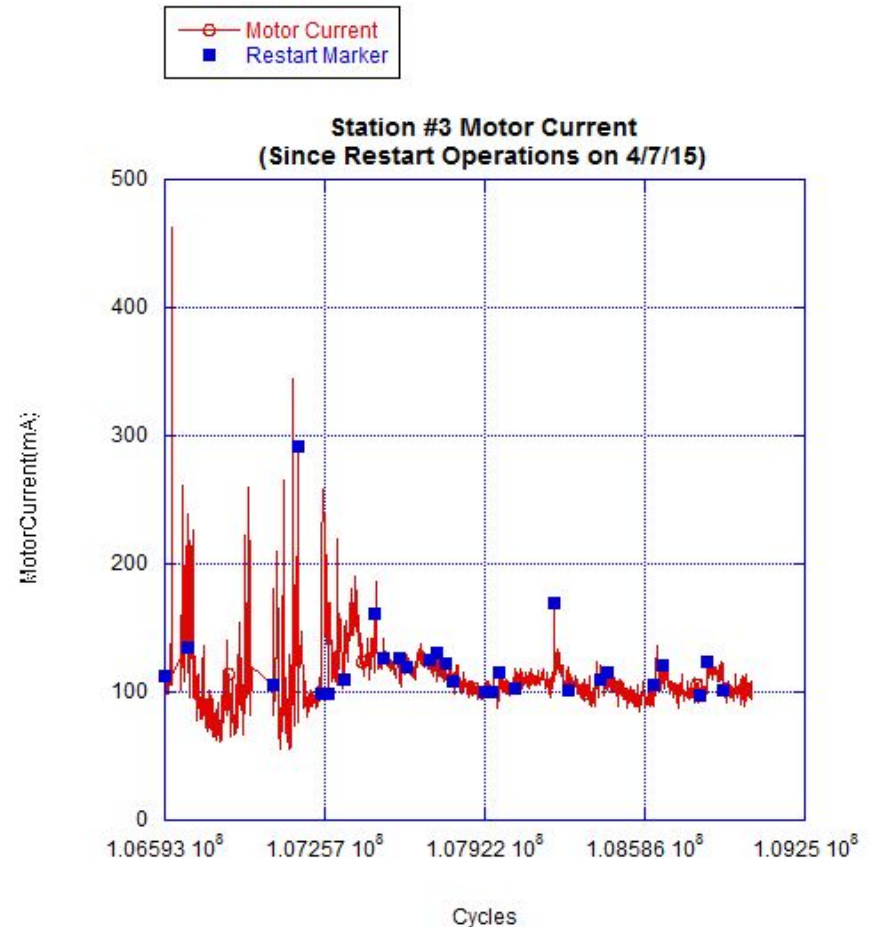
Life Test Unit Toroid Wear

- These two photos show two types of wear characteristics found in the life test bearing.
- The top photo shows the effect of outside balls pinching the toroid and wearing pockets that prevent the toroid from free floating
- The bottom photo shows the effect of the toroid being cocked(forward to back) and wearing due to a 'snowplow' effect on the inner race.



Scan Reversal Benefits

- **Scan Reversals will redistribute the bearing lubricant and Teflon Toroid Spacers to mitigate the “snow plowing” effect of continuous one direction operation**
- **Scan Reversals will slow “wear and degradation” of the Teflon Toroid Spacers**
- **Long-term, Scan Reversals will reduce both the frequency and magnitude of the “high torque events”**



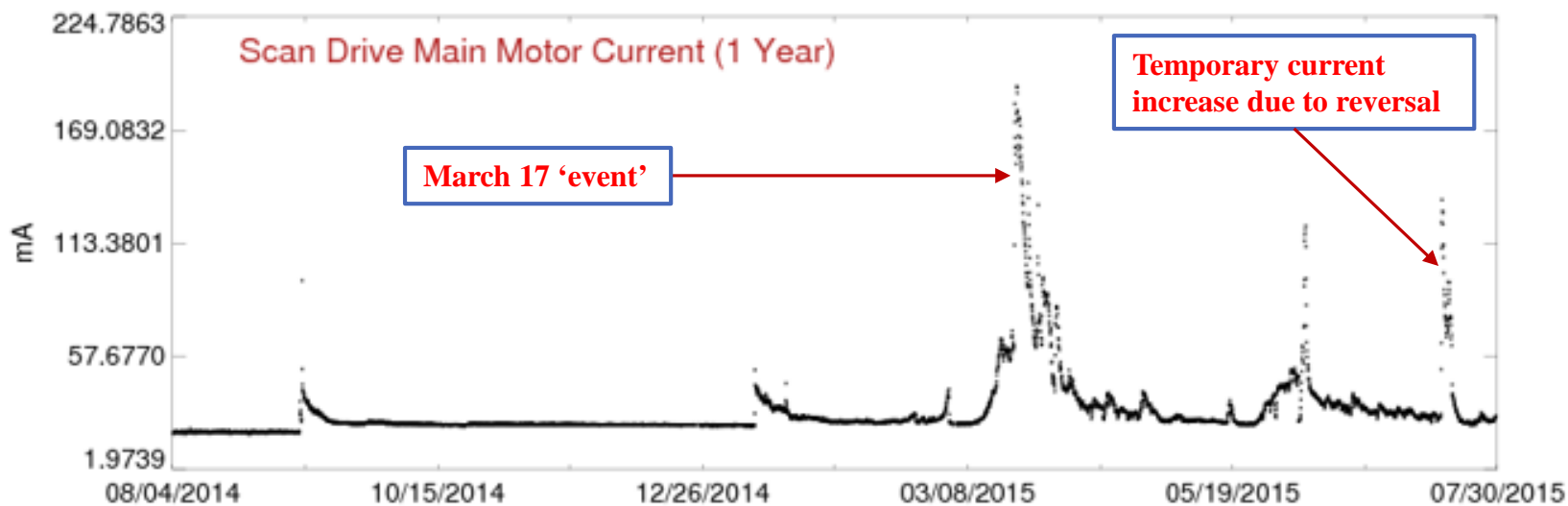
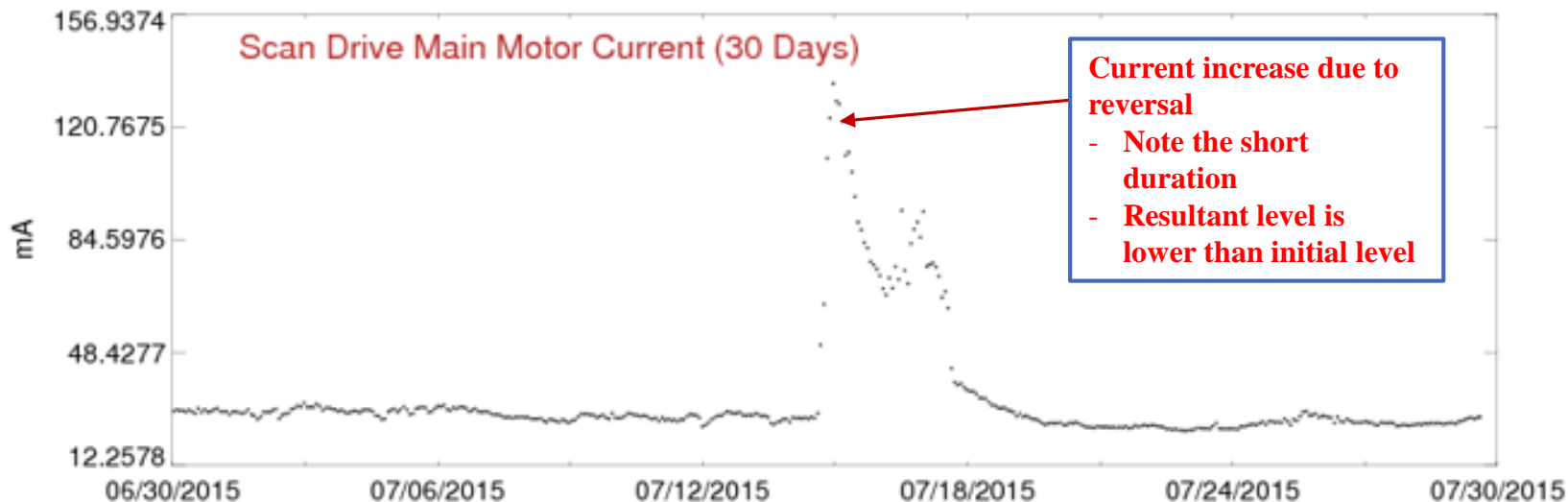
Bench Life Test Station #3 Restart
with Scan Reversals (6/23/15)



Motor Current Since 7/14/15 Reversal



Suomi NPP ATMS Scan Drive Main Motor Current (Jul 29, 2015)





Summary



- **SNPP ATMS performance on-orbit to date has been very good and has been providing reliable data for weather prediction since its launch on October 28, 2011**
 - All performance parameters have been and continue to be well within specification
 - SNPP ATMS is expected to meet or exceed its 5-year mission life
- **Extending operational life significantly beyond the 5-year design life will fill the potential time gap should there be a delay in the follow-on satellite**
- **The reverse scan profile has been developed and demonstrated on the Engineering Development Unit**
- **The reverse scan profile has been loaded on the SNPP ATMS instrument and demonstrated on 7/14/15.**
- **Path forward is to test and implement automated daily scan reversals using the DAS**
 - Planned start of daily reversals 24 August, 2015