

Landsat Science Team

TIRS Scene Select Mechanism (SSM) Encoder Status

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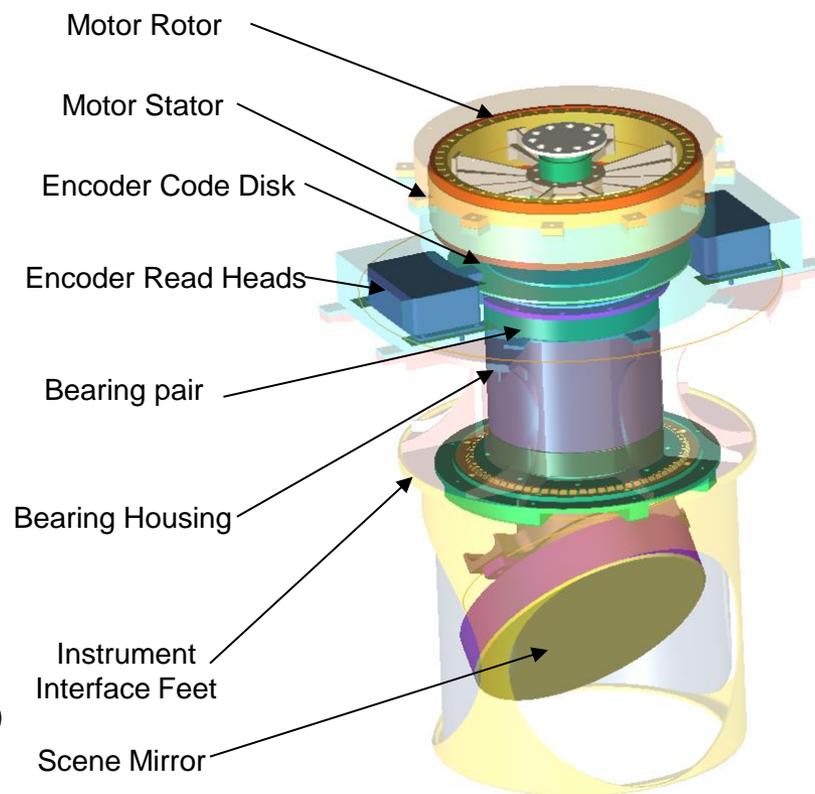
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Topics

- **TIRS scene select mechanism encoder anomaly**
 - Initial primary electronics (side-A) anomaly
 - Redundant electronics (side-B) status
 - TIRS operations and ground processing status
- **TIRS SSM alternative concept of operations**
 - TIRS on-orbit operations - calibration cycle
 - Product generation operations - product latency

TIRS SSM Anomaly Background

- The TIRS scene select mechanism (SSM) is a rotating mirror that directs the TIRS field of view toward the Earth, deep space, or the on-board black body.
- **SSM position is measured by an encoder.**
 - Encoder readings are used to both control and provide knowledge of SSM pointing.
 - SSM also has an “open loop” mode that does not use encoder data feedback.
- **Encoder current draw became anomalous mid-2014.**
 - Current increased and began to threaten yellow limit 4Q2014.



SSM Anomaly Onset on Side-A

- **Unfavorable encoder current trend prompted a test of the open loop “mode 0” control method.**
 - **SSM was operated in mode 0 with the encoder operating but not controlling SSM pointing.**
 - **This made it possible to monitor SSM behavior in mode 0.**
- **Continued degradation prompted intensive testing during 1Q2015.**
 - **Developed techniques to mitigate the initial large SSM motion following a closed loop/open loop mode switch.**
 - ♦ **Designed a “pendulum” maneuver that unloads residual magnetic torque in the motor making the SSM reaction to a mode 0 switch smaller and more repeatable.**
- **TIRS was switched to its redundant (side-B) electronics at the end of the testing period.**



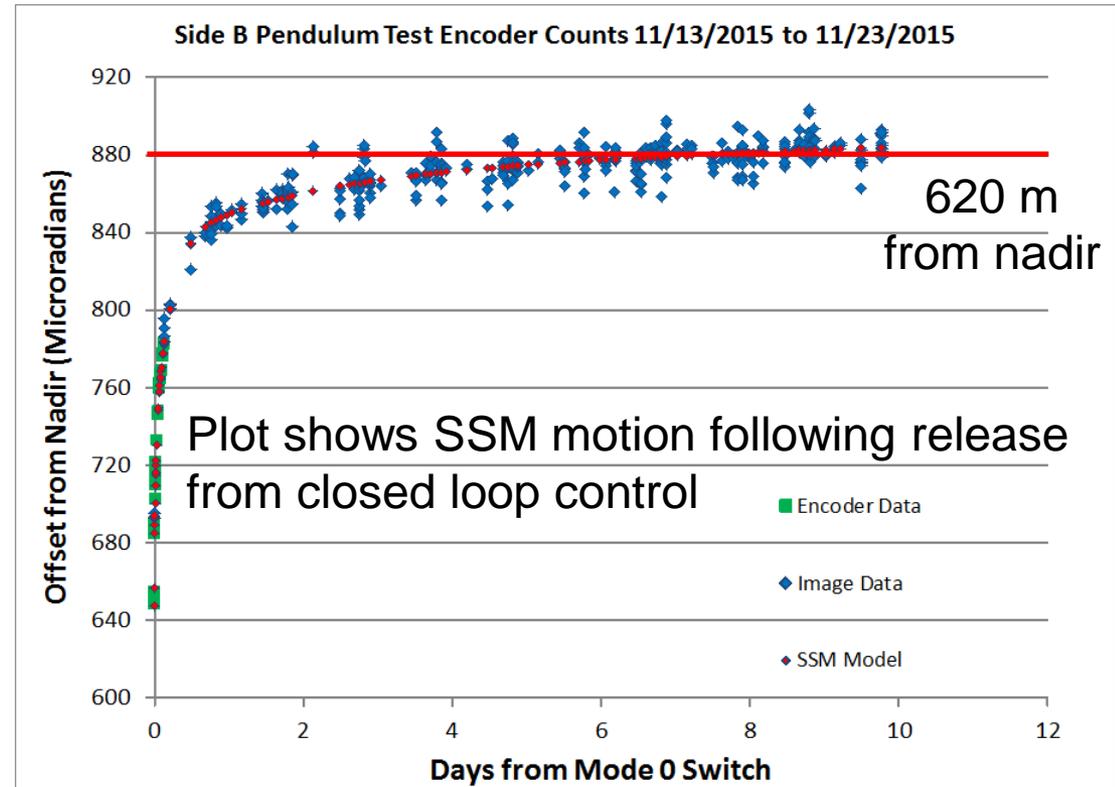
TIRS SSM Side-B Status

- **The TIRS SSM performed nominally after being switched to the side B electronics in March 2015.**
 - **In September 2015 the side B SSM encoder began to exhibit erratic current draw behavior.**
 - **Continued degradation would force TIRS to operate in mode 0 open loop control with the encoder powered off and thus not providing SSM position measurements.**
- **A test of mode 0 on side B (with the encoder powered) commenced on 29 October 2015.**
 - **Goal was to characterize SSM motion in mode 0 following a “pendulum” parking maneuver.**
 - **The encoder was turned off on 02 November 2015 after the encoder telemetry began to exhibit problems (stuck bits).**
 - ♦ **Next LPGS release will enable processing “stuck bit” data.**



TIRS SSM Side-B Testing

- **Additional tests were conducted as encoder current continued to increase.**
 - **These tests mimic the mode 0 operational contingency plan and served as a rehearsal for mode 0 operations.**
- **In late December the decision was made to commence mode 0 operation as the nominal configuration to preserve the remaining encoder life for periodic cal acquisitions.**



Mode 0 Operation and Data Processing

- **Once TIRS begins operating with limited encoder availability, closed loop control will be reserved for periodic (every 2 weeks) radiometric calibration.**
- **Most Earth-view data collection will use mode 0.**
- **Mode 0 scenes require an external source of SSM pointing knowledge.**
 - **The current LPGS release is able to read the required information from an external estimated SSM position file.**
 - **Estimated SSM position files must be generated (by hand, for now) to operate in mode 0.**
 - ◊ **A basic capability to do this exists but requires more automation.**
 - **Final SSM position estimates lag data collection by days to weeks.**
 - ◊ **Final estimates are not generated until the next mode switch, when all calibration scene data are available.**

TIRS SSM Calibration

- **SSM position history following a mode 0 switch is reconstructed using telemetry and image data.**
 - Encoder telemetry is collected for the first few minutes after a switch to initialize the pointing model.
 - Subsequent estimates are derived using TIRS/OLI image measurements at calibration sites.
 - Individual image measurements are not sufficiently accurate so data are fitted to a model of SSM motion.
 - Functional form was derived from mode 0 encoder-on intervals.
 - SSM position estimates are generated using the model.
- **New IAS software is required for SSM calibration.**
 - Cal site processing was delivered in December.
 - Model fit and position generation is in development.

Impact on Radiometric Calibration Cycle

- **Executing the TIRS deep space and blackbody cal collects requires SSM encoder position data.**
 - Without these data, normal TIRS calibration operations are suspended while in mode 0.
 - TIRS stability makes this tolerable for short periods.
- **To make routine mode 0 operations feasible a new operations concept is required for TIRS cal data.**
 - **Periodic switch to closed loop mode 4 control for a calibration sequence.**
 - ◊ This would nominally be done every 2 weeks, coordinated with monthly lunar calibrations (which disrupt SSM pointing).
 - **Return to mode 0 for Earth imaging operations.**
 - ◊ The rapid SSM motion following a switch to mode 0 will degrade geometric accuracy until it can be characterized using calibration scenes.



Impact on Product Generation

- **Until an operational SSM calibration procedure can be deployed in the L8 IAS (2Q2016) TIRS data are being suppressed via CPF gain settings.**
 - Will be reprocessed quarterly once final SSM position estimates are available.
- **Once next IAS/LPGS release is installed, TIRS data will once again be processed as acquired.**
 - TIRS bands will be generated based upon preliminary estimates of SSM position until all calibration scenes have been analyzed and final estimates are available (following the next mode switch).
 - At that point the data will be reprocessed and the provisional near real-time products will be replaced.
 - Implies a time lag between acquisition and final product of up to two weeks.



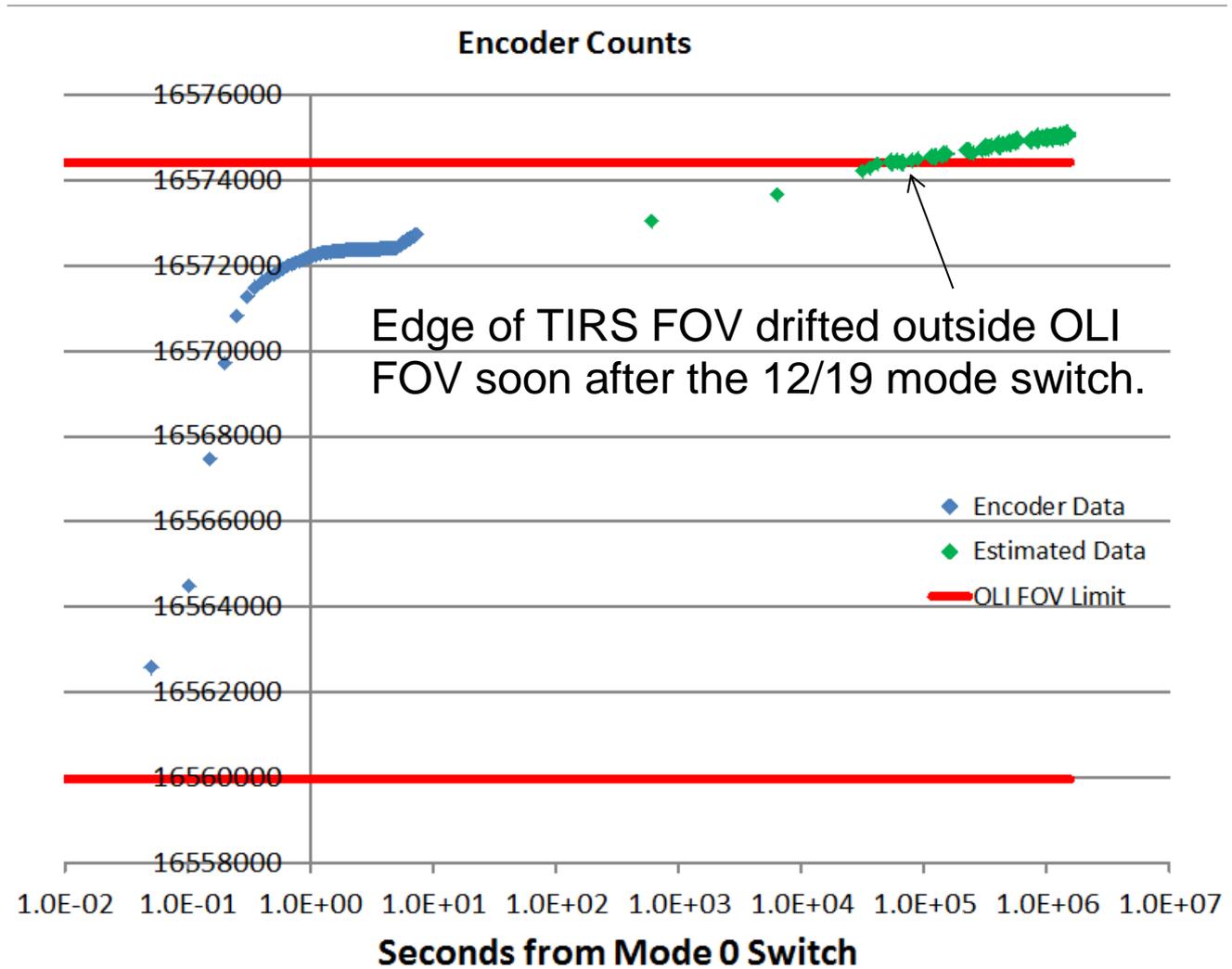
Summary

- **Due to degradation of redundant SSM encoder electronics TIRS has been transitioned to mode 0.**
 - **Implies reduced frequency of radiometric calibration.**
 - **SSM pointing determined by image analysis.**
 - **This imposes delay in availability of final products.**
- **Required new calibration algorithms have been designed but some are still in prototype state.**
 - **Operational deployment expected 2Q2016.**
- **Final products are expected to meet all accuracy requirements, but availability will be delayed.**
 - **Without operational calibration capability**
 - **Quarterly reprocessing of TIRS data and product availability**
 - **With operational calibration capability**
 - **Near real-time availability of provisional products with biweekly reprocessing following SSM calibration events**

Backup Charts

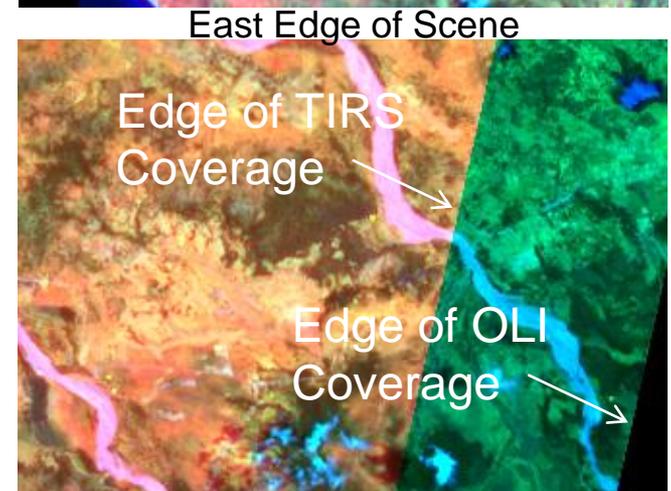
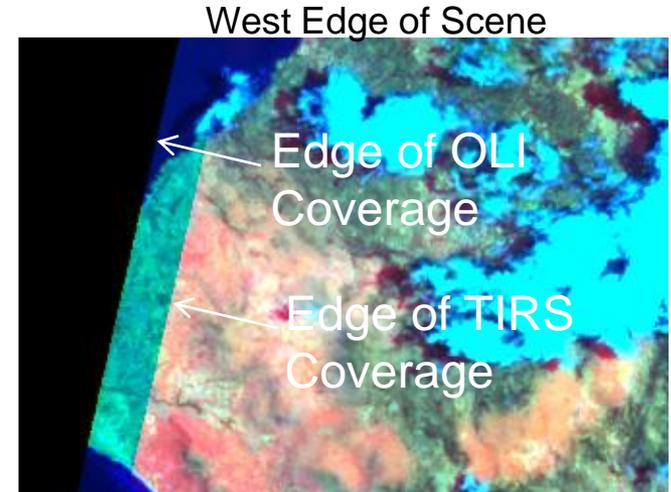
SSM Behavior Following 12/19/14 Switch

- Log time scale used to show initial rapid change
- Blue diamonds are actual SSM encoder data
- Green diamonds are image-derived estimates
- Red lines show OLI field of view limits on the east (top) and west (bottom) sides of the swath



110/066 14OCT2015 (Mode 4)

- Red = Band 10 (TIRS) : Green = Band 7 (OLI) : Blue = Band 2 (OLI)

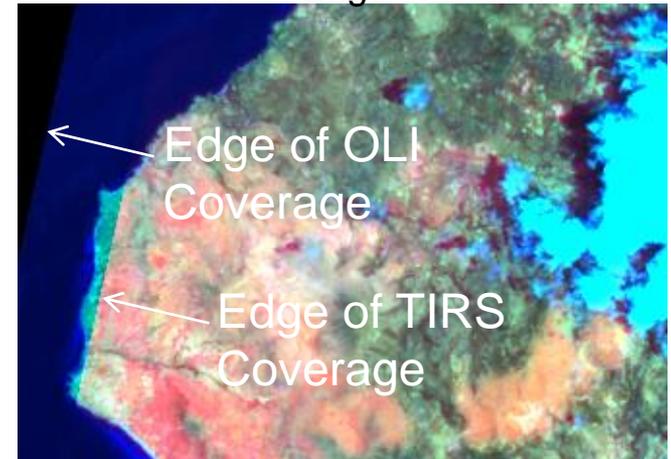


110/066 30OCT2015 (Mode 0)

- Red = Band 10 (TIRS) : Green = Band 7 (OLI) : Blue = Band 2 (OLI)



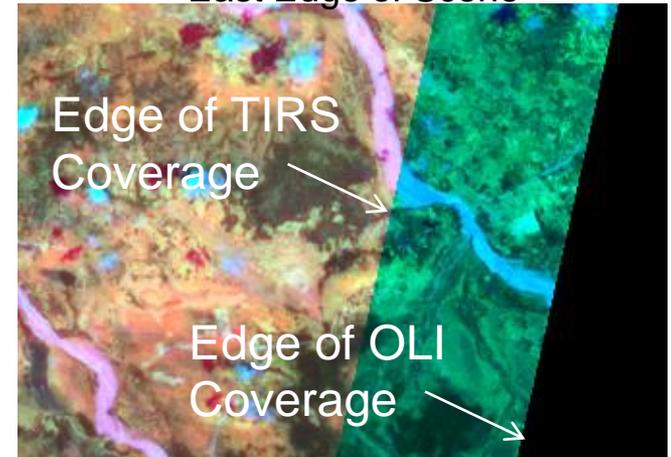
West Edge of Scene



Edge of OLI Coverage

Edge of TIRS Coverage

East Edge of Scene



Edge of TIRS Coverage

Edge of OLI Coverage