P1.28

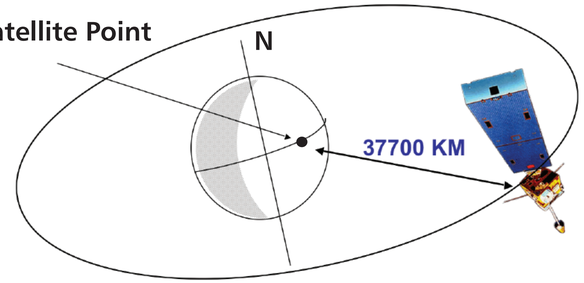
5th GOES Users' Conference: GOES Advanced Baseline Imager – Star Selection and Star Sensing

K. Gounder, K. Ellis, P. Griffith, E. Hoffman, D. Igli, J. Ogle, and V. Virgilio, ITT Corporation

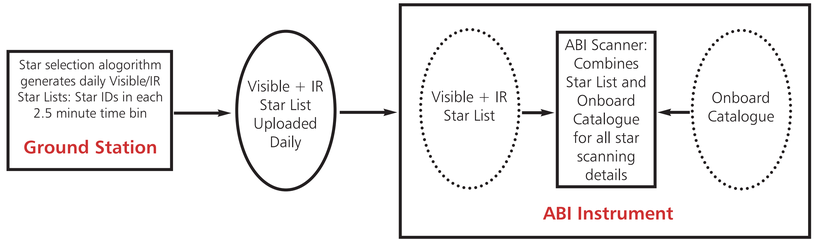
ABI Determines Absolute Instrument Line-of-Sight by Tracking Stars

INR Requirements

Specification	Value
Navigation	21 μrad
Coregistration	~6.3 μrad

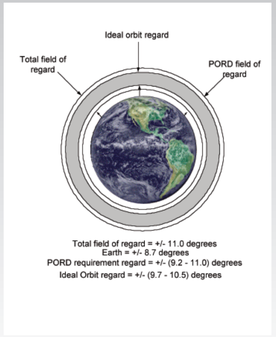


Concept of Operations



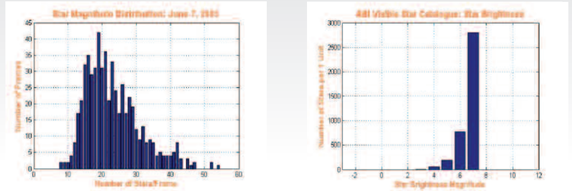
Tailored ABI Star Catalogues for Image Navigation and Registration

- ABI INR Requirement: 3 visible stars and 1 IR star in every five minutes
- Comprehensive star catalogue containing detectable visible and IR stars
- Source Catalogue: SKYMAP SKY2000 Master Catalogue
- Preliminary Selection: No multiple stars, clusters or cephids (variable magnitude)
- Star Selection criteria based on: ABI Field of View (below); Star Brightness; Star Isolation
- Use ABI instrument magnitude (number of photo electrons > 144 (Visible)/1022 (IR) to provide a uniform metric for all spectral classes
- Star Isolation: No star with $\Delta m_V < 2.0$ within 450 μrad or $m_V = 9$ or better within 44 μrad of the target star
- Star Catalogues: Ground Station Visible Star Catalogue (3838 stars); Ground Station IR Star Catalogue (1666 stars); Onboard Star Catalogue (4450 stars)



Daily Star Selection Algorithm Provides Operational Flexibility

- Divide each day into 576 time bin frames of 2.5 minute duration
- During each time bin frame, transform the available catalogue stars from J2K to spacecraft body frame – include Earth's rotation, nutation, precession, proper motion of stars and orbit deviation modeling
- Eliminate stars obscured by the Sun, the Moon and the planets
- Among the stars available during the entire time frame in the ABI FOV, select the best three star combination based on a cost function designed for optimal navigation using a Kalman filter algorithm
- In the case of IR stars, the brightest available star in the time frame is selected
- Star availability: All time bin frames are populated with at least 3 or more visible stars during all 576 frames of a given day. At least 99% frames have one IR star.

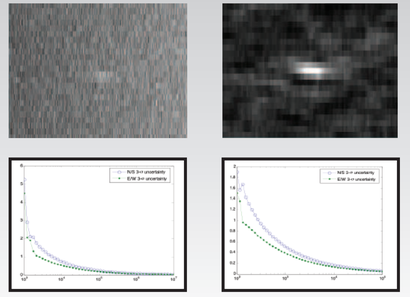


Number of stars available per time frame during daily star selection for June 7, 2005 (left).
ABI Ground station Visible Star Catalogue star visual magnitude distribution (right).

Robust and Highly Efficient Star Sensing Algorithm

- Star sensing in visible (0.64 μm) and IR channel (3.9 μm)
- Collection using sidereal drift with star window of 450 μrad
- Signal Integration time: 4X that of Earth Imagery
- Robust algorithm vs. signal geometry, background noise, clutter, jitter and EOL degradation
- Star sensing in three steps:
  1. Detection; 2. Location; 3. Verification
- Detection using various filters: median, moving average, summation and threshold techniques
- Location using maximum likelihood centroiding technique
- Verification by comparison of star brightness and location

Simulated ABI star data for dimmest detectable star (ClassB0, mV=8.91) before (left) and after filtering (right)



Expected star sense uncertainty for IR channel (left) and visible channel (right) as a function of star instrument magnitude.

Dr. Krish Gounder, ITT Space Systems Division
1919 W. Cook Road MS 613 PO Box 3700, Fort Wayne, IN 46814-3700 Krishnaswamy.Gounder@itt.com

The Advanced Baseline Imager (ABI) is a NOAA funded, NASA administered meteorological instrument program.
This poster does not reflect the views or policy of the GOES-R Program Office.