Attitude and Pointing Concepts for ISS Payload Operations

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Topics

- What Can Pointing Do for Payloads
- Typical Questions for Payload Customers
- Variables that Affect Target Viewing
  - Time
  - Blockage
- Examples of Pointing Support for Payloads
  - SCaN
  - OPALS
  - SOLAR

Attitude and Pointing Office

- The Pointing Officer is responsible for flight control support of communications predictions, unique target lines-of-sight (LOS) computations, and optimization of ISS attitude to support payload, onboard systems, or user pointing requirements, as requested
- Pointing can integrate multiple planning products into a single output
  - TOPO's trajectory predictions
  - ADCO's attitude timeline
  - PRO's solar array plan
  - SPARTAN's radiator plan
  - ROBO's robotic plan

What Can Pointing Do For Payloads?

- Line-of-Sight Capabilities
  - Determine instrument (e.g., sensor, aperture, etc.) operation times based on orbital constraints
    - Compute acquisition times for targets
    - Integrate operational constraints (like sun avoidance) into analysis
  - Compute ISS (and any other orbiting object) overflight information for given ground sites
  - Incorporate any sensor Field of View (FOV) limits/constraints
  - Compute look angles to target, within any reference frame (ISS, payload, etc.)
  - Filter target computations based on S and Ku comm. availability (if required)

What Can Pointing Do For Payloads?

- Attitude Capabilities
  - Compute ISS / Robotics / payload attitude combinations to satisfy requirements for payload release, to acquire science, and to accomplish payload objectives
  - Verify operational constraints are not violated during robotic motion for installation
- Blockage Capabilities
  - Create blockage diagrams for antennas/instrument FOVs, from a specific point on ISS or payload structure
  - Model movement of ISS appendages (SSRMS, radiators, etc.)
- Integration Capabilities
  - Incorporate payload-specific information into analysis
  - Provide information to payload in their language

Typical Questions for Payload Customers

- Does your payload have certain sensor requirements?
  - Can the Sun/Moon get in its field-of-view?
  - Do constraints matter if the sensor is on or off?
  - Time limit for how long it can look at the Sun?
  - Is there an additional buffer that needs to be protected?
- Does your payload need concurrent ISS communication with the ground?
  - S-band for telemetry?
  - Ku-band for video?
- Can ISS elements block your sensor field-of-view?
  - Solar arrays?
  - Thermal radiators?
  - Robotic elements?

Variables that Affect Target Viewing

- Trajectory
  - Weekly trajectory updates realize an average of 10 – 30 seconds of acquisition error
- Attitude
  - The ISS attitude fluctuates during the course of an orbit
- Time
- Structural Blockage

Variables that Affect Target Viewing: Time

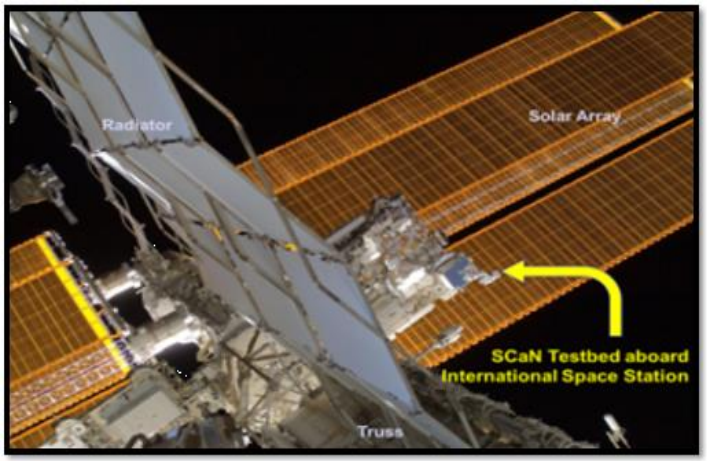
- The ISS is moving at ~7 kilometers per second
- A significant factor in line-of-sight predictions for high resolution instruments is knowledge of exact time
- Depending on sensor resolution, being off by half a second may mean completely missing a small target
- GPS time is official time source for ISS
  - Currently GMT and GPS differ by 17 seconds

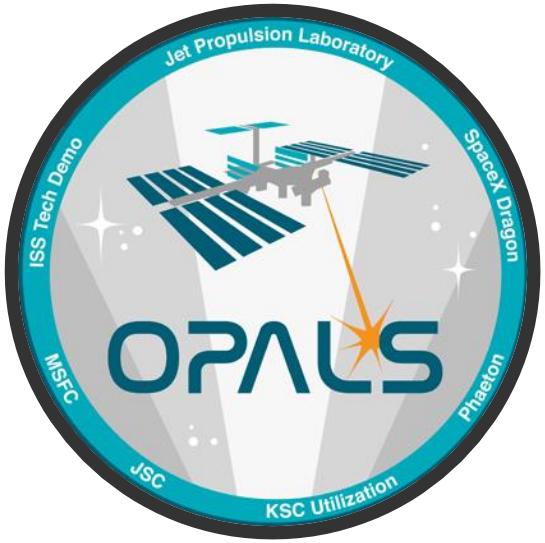
Variables that Affect Target Viewing: Structural Blockage

- ISS structure is big and frequently in the way
- Solar arrays
  - When in autotrack, arrays are moving at 4 deg/min
  - Predictive data received from Power Resource Officer (PRO)
- Radiators
  - Can cause significant amount of blockage
  - Positioning is typically static, but usually repositioned for high beta periods and visiting vehicles
  - Positioning plan for the future received from SPARTAN console
- Robotics
  - Robotic elements – MBS, SSRMS and SPDM – can cause significant blockage
  - Positioning plan for future received from Robotics Officer (ROBO)

Examples of Pointing Support for Payloads

- SCaN Testbed
- OPALS
- SOLAR

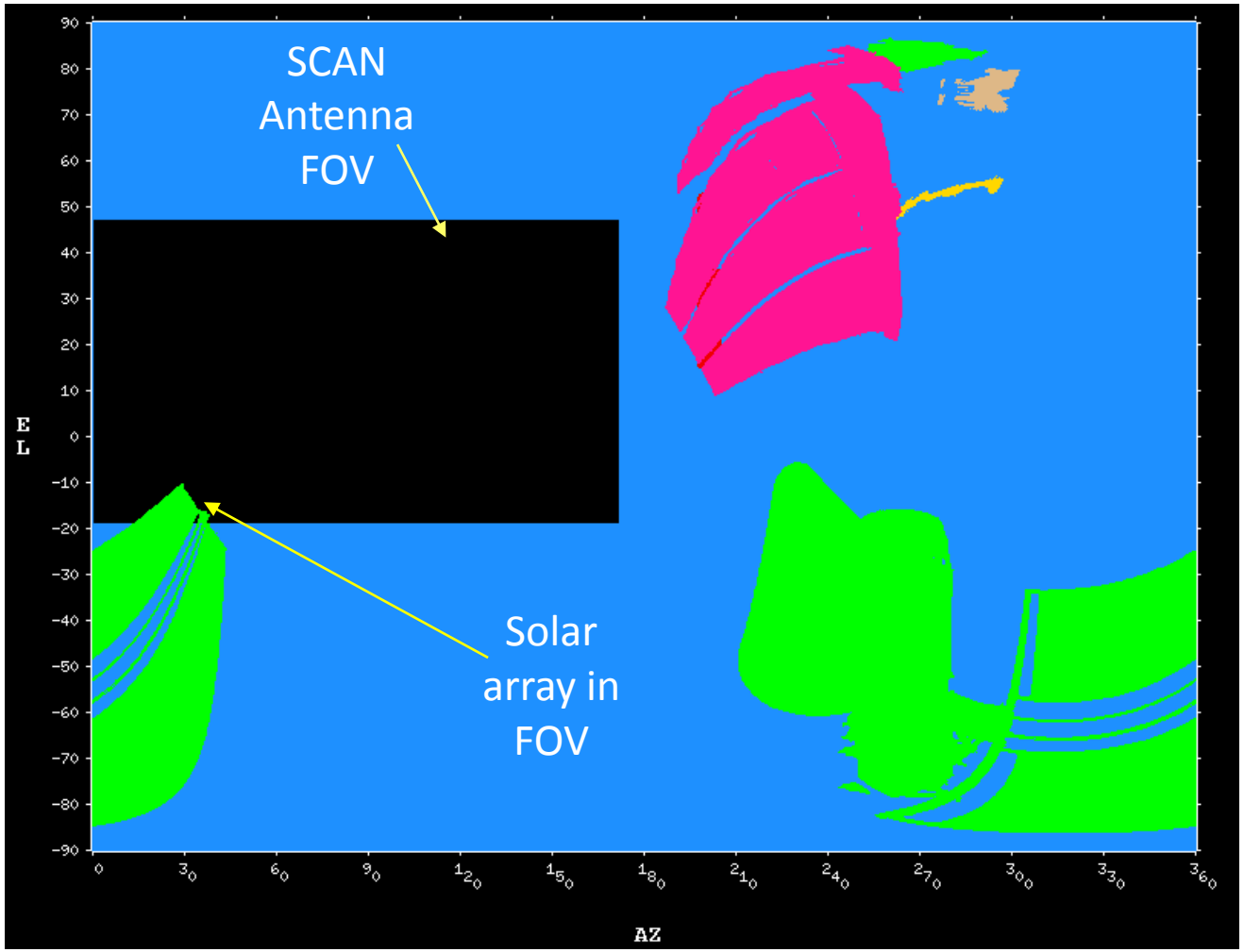




SCaN Testbed

- LOS Operations
  - Line of sight calculations to TDRS
  - Requires scheduled events during times ISS has S-band and Ku-band services available
  - It is also common for SCaN to request LOS analysis of non-TDRS targets such as the Sun and ground sites
- Analysis Provided by ISS Pointing
  - SCaN provides a TDRS Communication Request weekly to Pointing
  - Pointing determines available times SCaN will have events with TDRS satellites three weeks ahead
  - The week prior to SCaN activities, Pointing updates line-of-sight calculations with latest inputs and relays significant changes to scheduled passes

SCaN Testbed FOV



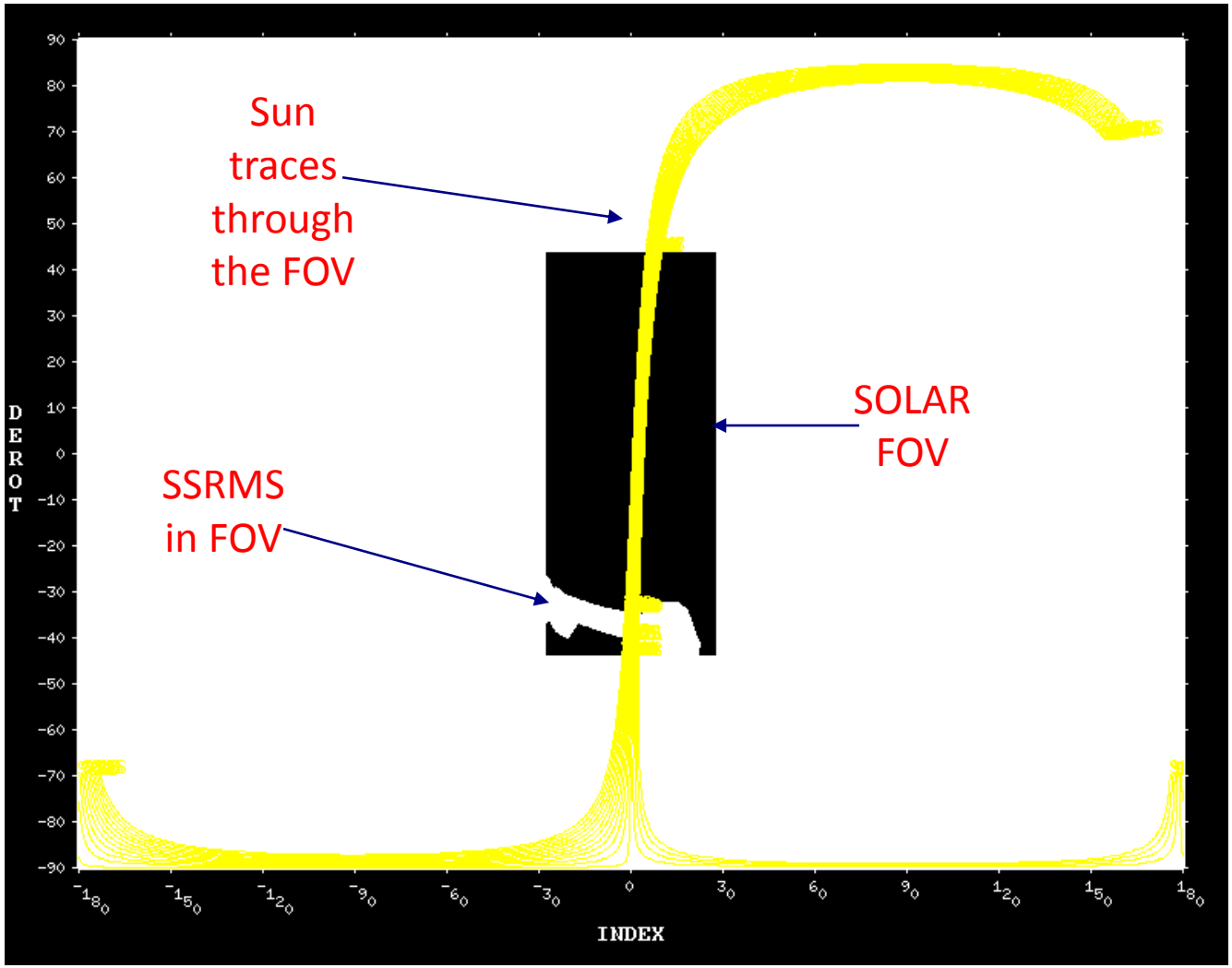
OPALS

- LOS Operations
  - Communication with ground sites via a laser
  - Need considerable accuracy
  - Acquire ground beacon
  - Closed loop
- Analysis Provided by ISS Pointing
  - Provide ISS flyover times of ground sites for next three weeks
  - Determine viable passes when ground site and Sun are not concurrently within OPALS FOV

SOLAR

- LOS Operations
  - Observing Sun
  - Pointed out ISS -Z axis
- Analysis Provided by ISS Pointing
  - ROBO notifies Pointing and SOLAR if planned robotic operations will cause any robotic elements to enter SOLAR FOV
  - Pointing analyzes if Sun's track will pass behind robotic elements and notifies SOLAR of any violations
  - SOLAR uses this information to note potential interruptions to their data

SOLAR FOV


Sun traces through the FOV
SOLAR FOV
SSRMS in FOV
DEROT
INDEX

Questions?

Further Information

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