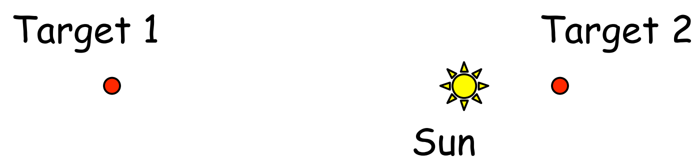
# Spacecraft attitude control

- **Guidance Navigation and Control FSW now largely complete and tested.**
- **A couple of issues were uncovered, both related to pointed mode observations:**
  - **For targets that are close to the Sun there are situations during the slews between targets, or at the Earth avoidance maneuver where the observatory would need to spin very rapidly to satisfy Sun constraints.**
  - **Slewing to targets which are emerging from occultation - observatory will not start to slew until the target has exited one Earth Avoidance Angle (EAA) from the Earth (currently 30 deg).**

# Recap on GLAST observing modes

- The default observing mode is a sky survey mode. The current baseline is to rock the instrument axis 35 deg off zenith perpendicular to the orbit plane (north for one orbit, south for the next), to give fairly uniform exposure of the sky after two orbits.
- Two types of pointed observations: planned (either scheduled or as a ToO) and autonomous (as a response to a GRB).
- Unless commanded otherwise, as the target source becomes occulted by the Earth, the LAT will be repointed to trace the Earths limb (so that we don’t waste time staring at the Earth). The minimum angle between the Earths limb and the center of the FoV is currently set to 30 degrees (known as the Earth Avoidance Angle).
- We plan to use limb following only for autonomous repoints and for Targets of Opportunity (i.e. when we have time to plan we will slew to a second target, or section of sky survey, to keep the Earth completely out of the FoV when the target is occulted).

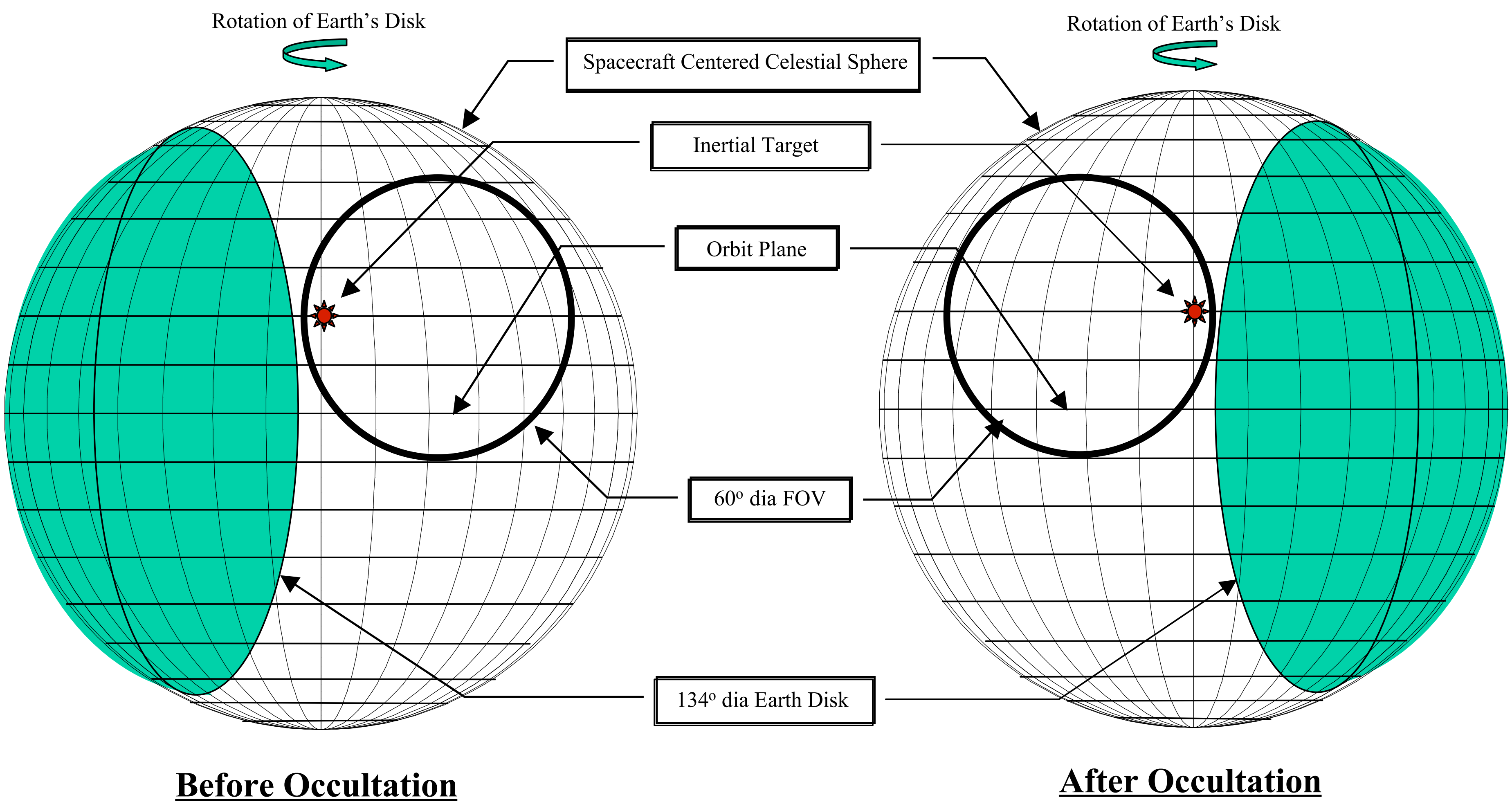
# Sun Constraints




- **We need to keep the sun off the +-Y, and -X faces.**
- **If the Sun lies on the direct path between the two targets we will need to rapidly (~instantaneously) spin the observatory to keep the sun on the +X face. Leading to high rate slew commands. A similar situation arises when a target close to the sun or anti-sun approaches occultation.**
- **When S/C can't keep up with commanded attitude, an attitude control safehold trigger trips (this is not good)**
- **This has been addressed by limiting the yaw rate in slew command and modifying the path traveled by the SC between targets.**
  - **Increases the time to slew between targets. The requirement to slew the +Z axis 75 deg within 10 minutes will not be met in all cases. However, the target will be within 15 deg of the boresight within 10 mins.**
  - **Increases the amount of Sun on the LAT radiators.**
- **Bottom line: Very small impact on science observations**

# Timing of Slews to Emerging Targets

- If a target is occulted by Earth at the time it is commanded, the S/C does not immediately slew to acquire it.
  - This is good. No point looking at an occulted target.
- FSW testing indicates that the slew to target does not begin until the target is one EAA (30 deg) from the Earth limb.
- This may get changed prior to launch, so that the SC begins to slew when the target emerges from occultation. However, there are risks to updating the SC FSW at this stage due to limited testing time, so the change may not get implemented.
- If it is not changed there are some implications:
  - Delayed slew to targets that are emerging from occultation. This may affect 1-2 GRB repoints/year. It will also delay the acquisition of ToO targets (by ~<10 mins).
  - Introduces significant inefficiencies in the current plan for pointed mode observations (this can be addressed by adjustments to observation planning process)
  - Will create regions of the sky that if commanded as the target of a pointed observation the SC will never slew (this does NOT mean that those regions of the sky are unobservable).
- The FSW can be updated after launch

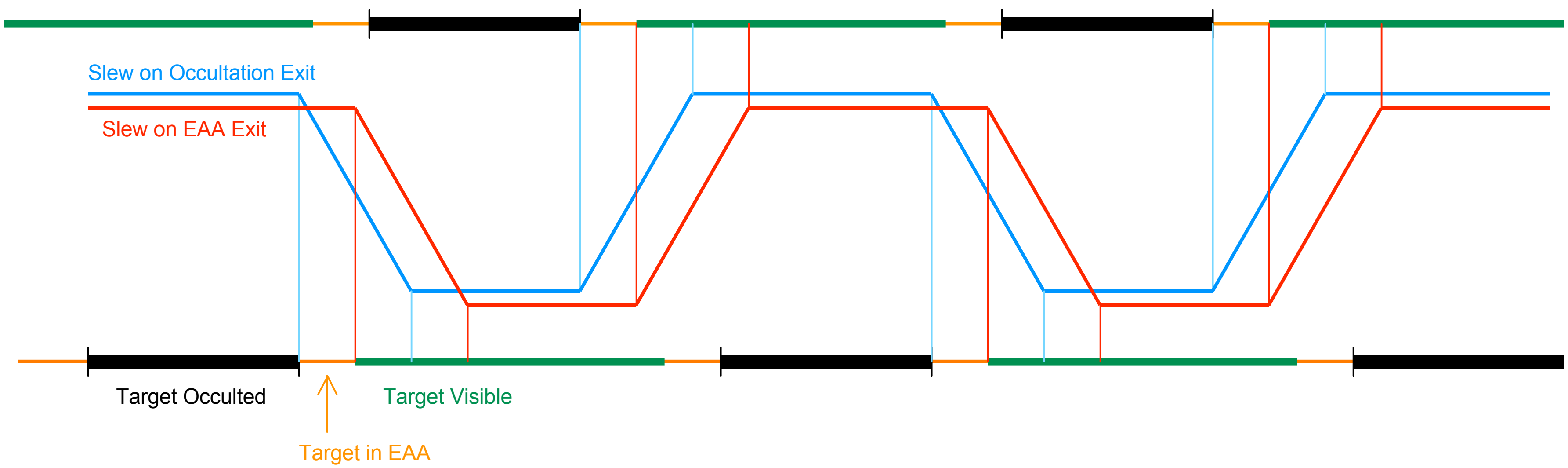



- **For a 30 deg EAA, and a 67 deg radius to the Earth limb avoidance zone includes the orbit poles.**

# How much of the sky is affected?

- **Solid angle subtended by the EAA.**
  - **$2\pi(\cos(67)-\cos(97)) = 3.2$ sr.**
  - **A ARR triggered by GBM detected GRB which falls within this zone will have delayed initial acquisition. However, ~half of this region is about to become occulted anyway.**
- **Regions within 7 deg of the orbit poles will always lie within the EAA. Thus targets which lie close to the orbit pole can experience very significant delays before the SC starts to slew (until the orbit has precessed sufficiently to move the target away from the orbit pole).**
  - **$2\pi(1-\cos(7)) * 2= 0.01$ sr**
  - **Pointed observations (ToO or scheduled) of targets in this region should be offset by ~10 to avoid this issue. This will have a negligible impact on the quality of the observation (target will still be continuously visible).**
- **Bottom line: Some loss in observing efficiency: negligible impact on ToO and planned pointed observations, significant delay on ~<4 GBM triggered ARR/year (all of which start outside the LAT FoV)**

# Scheduled pointed observations




- Inertial Pointing Timeline, alternating between two targets
- Blue profile begins slew as target exits occultation
- Red profile begins slew as target attains Earth Avoidance Angle from Earth limb
- Both profiles have same time-on-target, but phasing of red profile encroaches into EAA
- FSW implementation follows red profile
- Blue profile allows more flexibility, maximization of time-on-target for primary target
- Could achieve the same effect by picking additional targets to cause the SC to slew close to the primary target at the correct time.