



Superior Solar Conjunction Planning

June 13, 2014

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Agenda

- **Schedule Update**
- **MOps Solar Conjunction Preparation Status**
- **HGA Side Lobe Limitations**
- **Instrument Data Return**

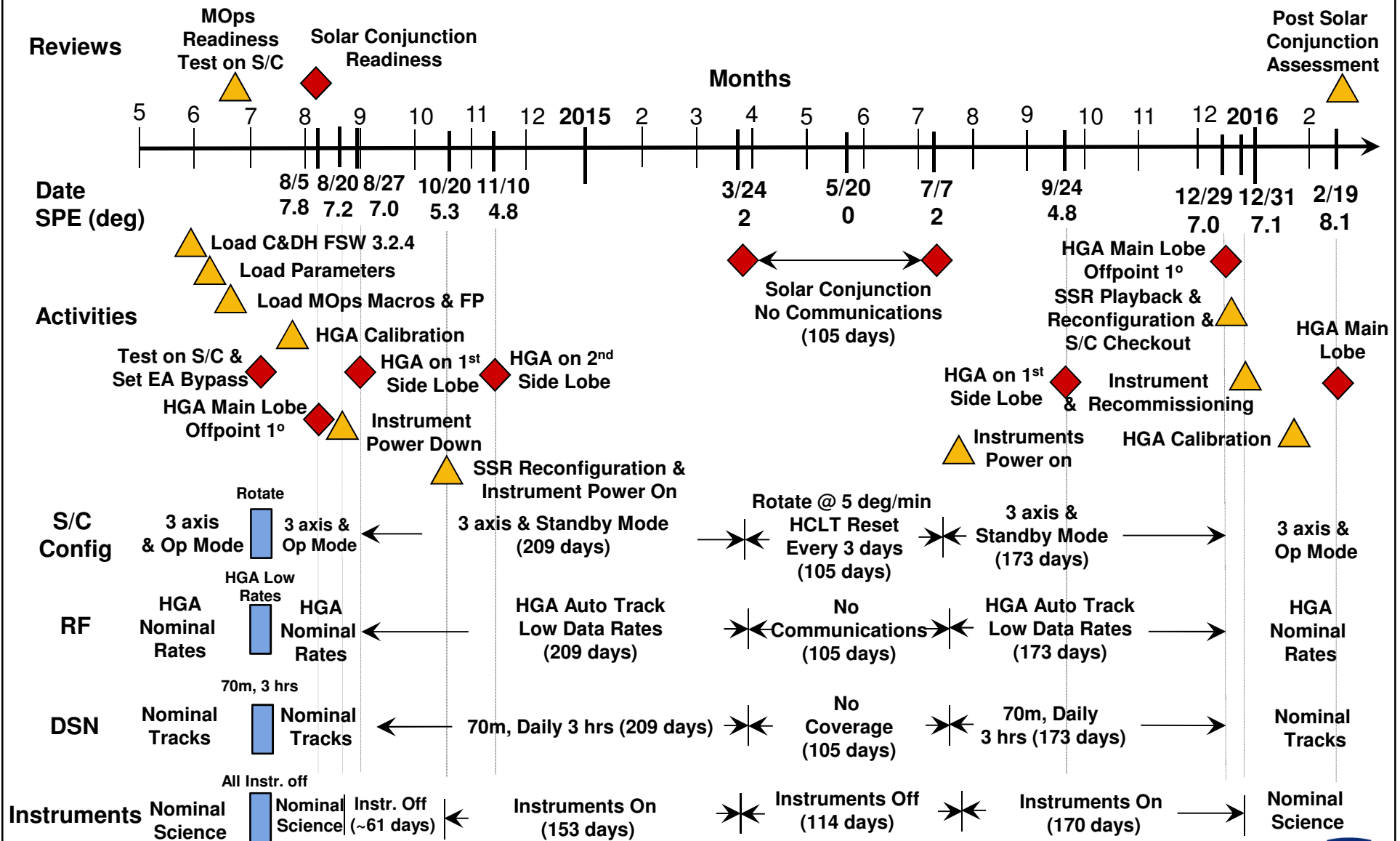
Key Dates (1 of 2)

Event	AHEAD	BEHIND
HGA side lobe test	5/10/14	5/17/14
Load DHS & Power parameters to EEPROM	5/28/14	TBD
Load G&C parameters to EEPROM	6/5/14	TBD
LGA calibration test	6/7/14	TBD
Load C&DH 3.2.4 FSW to EEPROM Copy 2	6/10/14	TBD
Operational HGA Side Lobe Test	6/13/14	TBD
Load MOps macros & FP releases to EEPROM & Select EA bypass	6/23/14	TBD
MOps Readiness for S/C Testing Review	6/26/14	9/18/14
S/C Testing – Instruments off/on	7/6 thru 7/15/14	9/29 thru 10/6/14
Load DHS (S/C APID Rates) parameters to EEPROM	7/6/14	9/29/14
Instrument SSR Partitioning and Real-time Telemetry Rates Due	7/11/14	7/11/14
HGA Calibration – Pre-conjunction	7/23/14	7/23/14
Load C&DH 3.2.4 FSW to EEPROM Copy 1	7/28/14	TBD
Load long duration ephemeris to G&C EEPROM	8/5/14	11/5/14
HGA on Main Lobe, Offpoint 1° (AHEAD only)	8/5/14	NA
Solar Conjunction Readiness Review	8/14/14	10/23/14
Instrument Power Down (AHEAD only)	8/20/14	NA
HGA on 1st Side Lobe	8/23/14	12/1/14
Load DHS & MOps Macros for Instrument Use & SSR Reconfiguration	10/20/14	11/28/14
Instrument Power on (AHEAD only)	10/20/14	NA
HGA on 2nd Side Lobe	11/10/14	1/6/15
Instrument Power Down	3/22/15	1/20/15

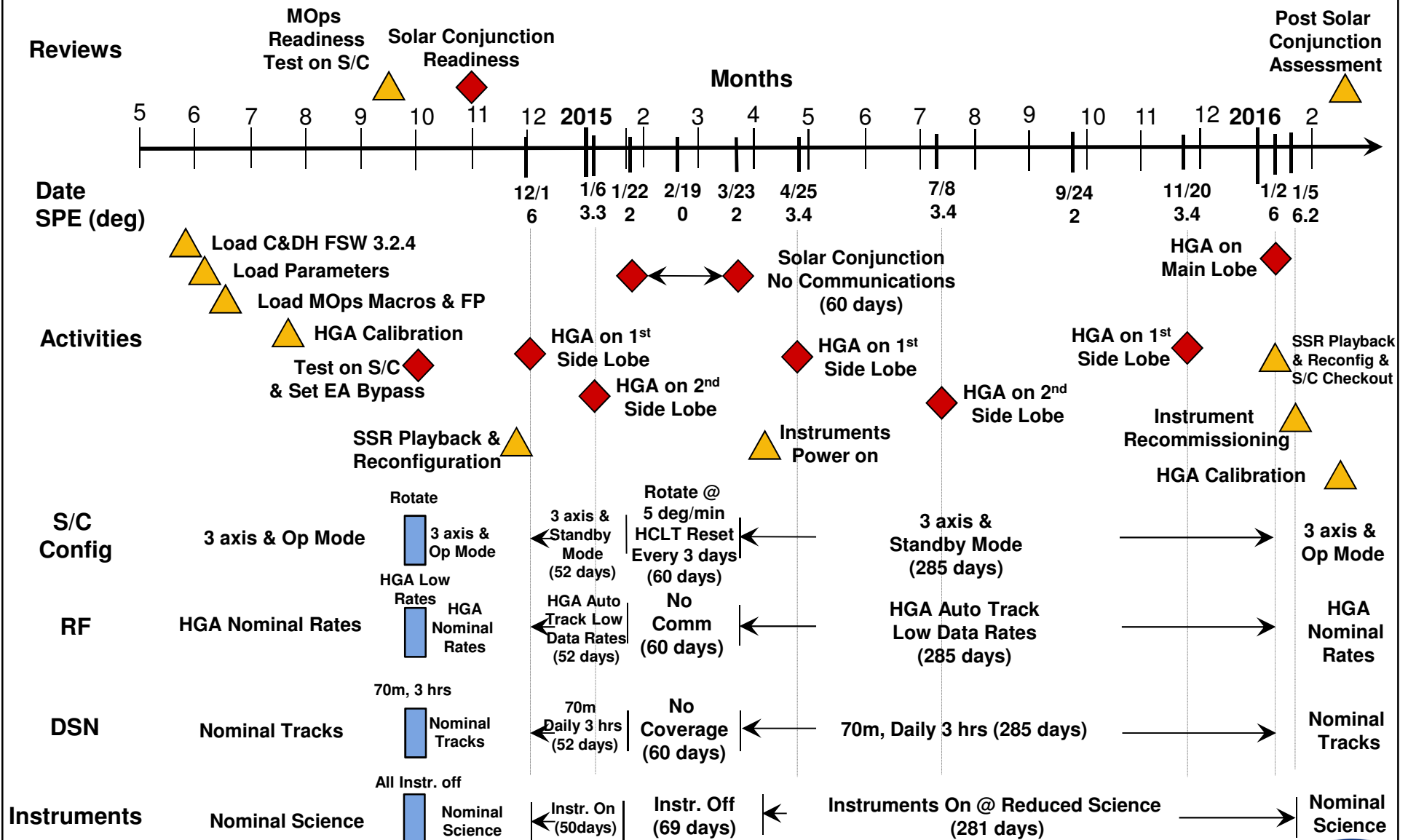
Key Dates (2 of 2)

Event	AHEAD	BEHIND
Superior Solar Conjunction	3/24 thru 7/7/15	1/22 thru 3/23/15
Instrument Power on	7/14/15	3/30/16
HGA on 1 st Side Lobe	9/24/15	4/25/15
HGA on 2 nd Side Lobe (BEHIND only)	NA	7/8/15
HGA on 1 st Side Lobe (BEHIND only)	NA	11/20/15
HGA on Main Lobe, Offpoint 1° (AHEAD only)	12/29/15	NA
SSR Playback & Reconfiguration & S/C Checkout	12/29/15	1/2/16
Instrument Recommissioning	12/31/15	1/5/16
HGA Calibration – Post-conjunction	1/27/16	1/27/16
HGA on Main Lobe	2/19/16	1/2/16
Post Solar Conjunction Assessment Review	3/16	3/16

STEREO AHEAD Timeline Schedule



STEREO BEHIND Timeline Schedule



MOps Solar Conjunction Preparation Status

- **Ensure S/C safety throughout solar conjunction mission phase**
 - **Laws of Solar Conjunction (backup slide)**
 - **S/C solar conjunction configuration is untested on orbit**
 - **Bypassing EA mode**
- **Preparing for **AHEAD** S/C solar conjunction testing starting July 6th**
- **Memory object re-configuration for solar conjunction**
 - **C&DH FSW, fault protection rules, macros (ATS), parameters, and tables**
- **Unit and scenario testing ongoing on the flatsat**
- **Concurrently, ensure daily S/C operations continue smoothly.**
- **Additional STEREO qualified operations staff assisting with preparations.**
 - **1.2 FTE increase**

HGA Side Lobe Limitations

- **HGA side lobes – sweet spot of uplink/downlink**
 - **Current use = main lobe + and – 0.7 degree**
 - **Side lobes + and – 0.1 degree**
- **Available antenna assets**
 - **Extended science mission phase**
 - **15 = 12 DSN + 3 ESA**
 - **Solar conjunction mission phase**
 - **3 = 70 meter stations only due to HGA side lobe use**
 - **Track time = 3 hours/day**
 - **Will have days without a track, especially in the winter as STEREO shares the same view with most missions.**
 - **Significant risk of HCLT reset before the actual superior solar conjunction.**

HGA Side Lobe Data Rates

- **HGA Side lobe data rates**
 - Current nominal rates: 120 kbps downlink, 2000 bps uplink
 - 10 kbps downlink, 500 bps uplink
 - 3 kbps downlink, 125 bps uplink
 - **BEHIND** has 1 dB telemetry margin below 20 degree elevation
- **Reduced S/C housekeeping rate from 2.7 kbps to 0.1 kbps**
 - As the G&C blackbox data is too voluminous to downlink daily at these rates, may not have sufficient data to understand/explain G&C anomalies.
- **Historically to implement new data rates, many iterations with 4 separate instrument teams to determine SSR and real-time telemetry allocations, then implement and test on flatsat.**
 - In 2009, two additional downlink rates were added for the extended mission phase, 240 kbps and 120 kbps, which took over 4 months to implement.
- **As the MOC was not designed for instrument operations using 10 kbps and 3kbps downlink rates, operational impact includes S/C, ground software, configuration, and procedural changes:**
 - DSN schedules – SOE codes (3)
 - S/C – memory objects
 - DHS parameters and tables (9)
 - MOps macros (ATS) (7)
 - MOC planning system
 - Real-time command and control operations
 - Assessment processing
 - Science data products

Instrument Data Return

- **HGA side lobe use will be degraded compared to main lobe**
 - Downlink rate reduced by 91 to 97%
 - Uplink rate reduced by 75 to 93%
 - HGA pointing allowance reduced by 85%
 - Ground stations availability reduced by 80%
 - Track duration reduced by 62%
 - Downlink margin 1 dB at low elevations
- **Instrument SSR allocation = 4.294 Gbits (50% of SSR capacity)**
 - No instrument SSR playback on HGA side lobe use
- **Available real-time telemetry downlink bandwidth for instruments:**
 - 1st HGA side lobe = 7.4 kbps of 10 kbps data rate
 - 2nd HGA side lobe = 1.7 kbps of 3 kbps data rate
- **MOC needs to know by COB, Friday, July 11th:**
 - Instruments powered during pre- and post- conjunction periods
 - Instruments powered during superior solar conjunction period
 - Instruments division of SSR allocation
 - Solar conjunction - one SSR configuration for the duration
 - Post solar conjunction, as EA mode partitions are no longer needed, how to allocate 108.752 Mbits (49,978 packets or 1.2 % SSR capacity).
 - Number of packets/partition
 - Instrument real-time telemetry division on each HGA side lobe
 - If continuous science is desired upon solar conjunction exit in 2016, best interest to minimize daily SSR volume and maximize the SSR partition size for 520 days as operational resources (DSN stations and track time, pointing error, and data rates) are highly constrained.

Summary

- The MOC needs instrument SSR and real-time telemetry configurations while on HGA side lobes by July 11th.
- Recommend instruments update EEPROM with current FSW configuration before July 6th on **AHEAD** & Sept 29th on **BEHIND**
- While MOps will make a good faith effort to implement instrument telemetry and SSR configuration as resources allow by October 20th, currently all instruments will be powered down on:

AHEAD

- July 6th through July 12th = S/C testing
- August 20th through October 20th = HGA 1st side lobe without instrument SSR configuration
- March 24, 2015 through July 7, 2015 = superior solar conjunction

BEHIND

- September 29th through October 6th = S/C testing
- January 22, 2015 through March 23, 2015 = superior solar conjunction



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Three Laws of STEREO Solar Conjunction

1. Take all reasonable precautions to keep the observatory safe.

Of course, “reasonable” is subject to interpretation and judgment. We will be guided by the usual risk assessment methodology of weighing both probability and impact, which is, after all, the implicit thinking behind “engineering judgment.”

2. Return to normal science operations as soon as reasonably possible. In cases where this law conflicts with the First Law, the First Law takes precedence.

There’s that word “reasonably” again. We do not have infinite time and manpower to prepare for conjunction. So, some management judgment is required.

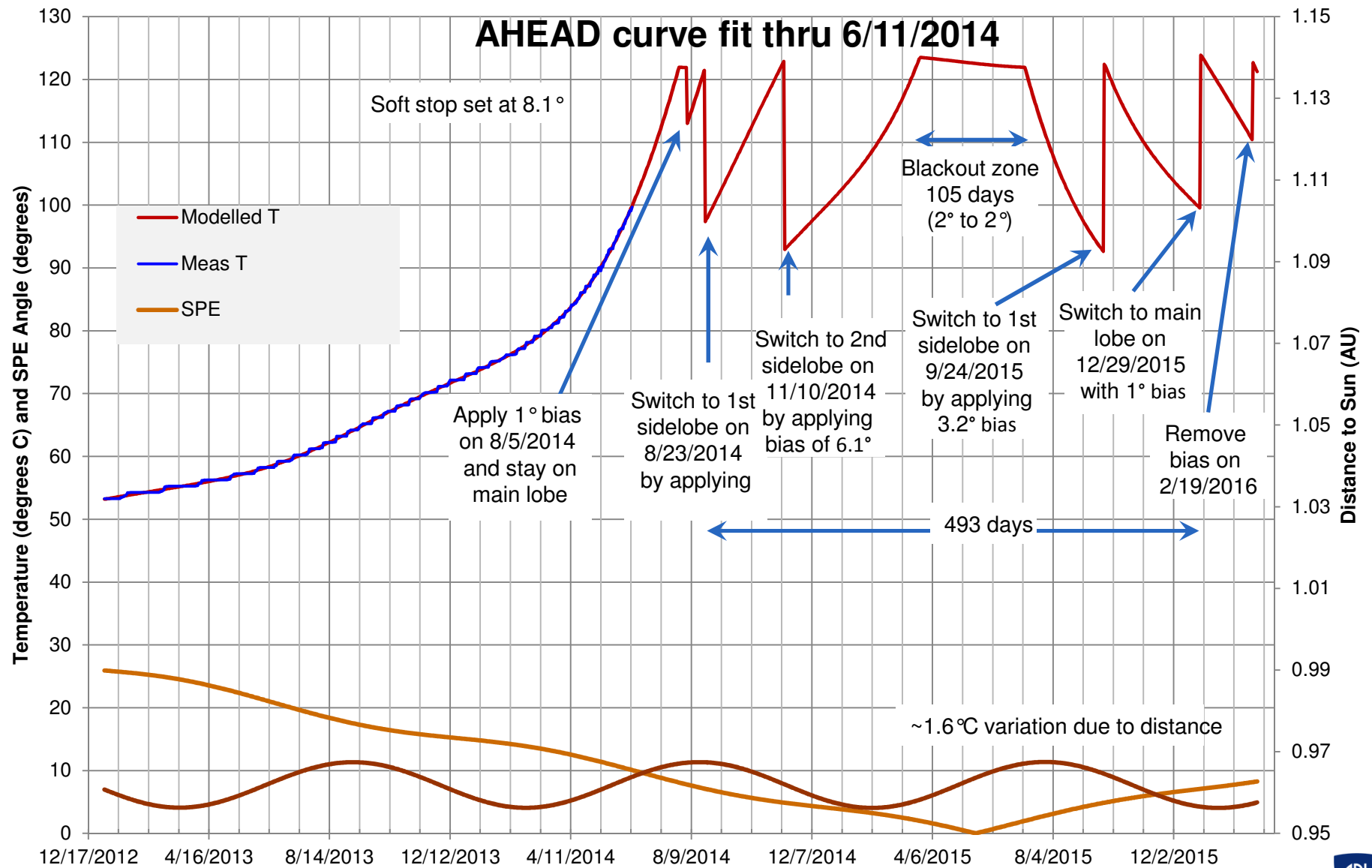
3. Conduct science operations during conjunction, if reasonably feasible. In cases where this law conflicts with the first two, the first two laws take precedence.

We do not have infinite time and manpower.

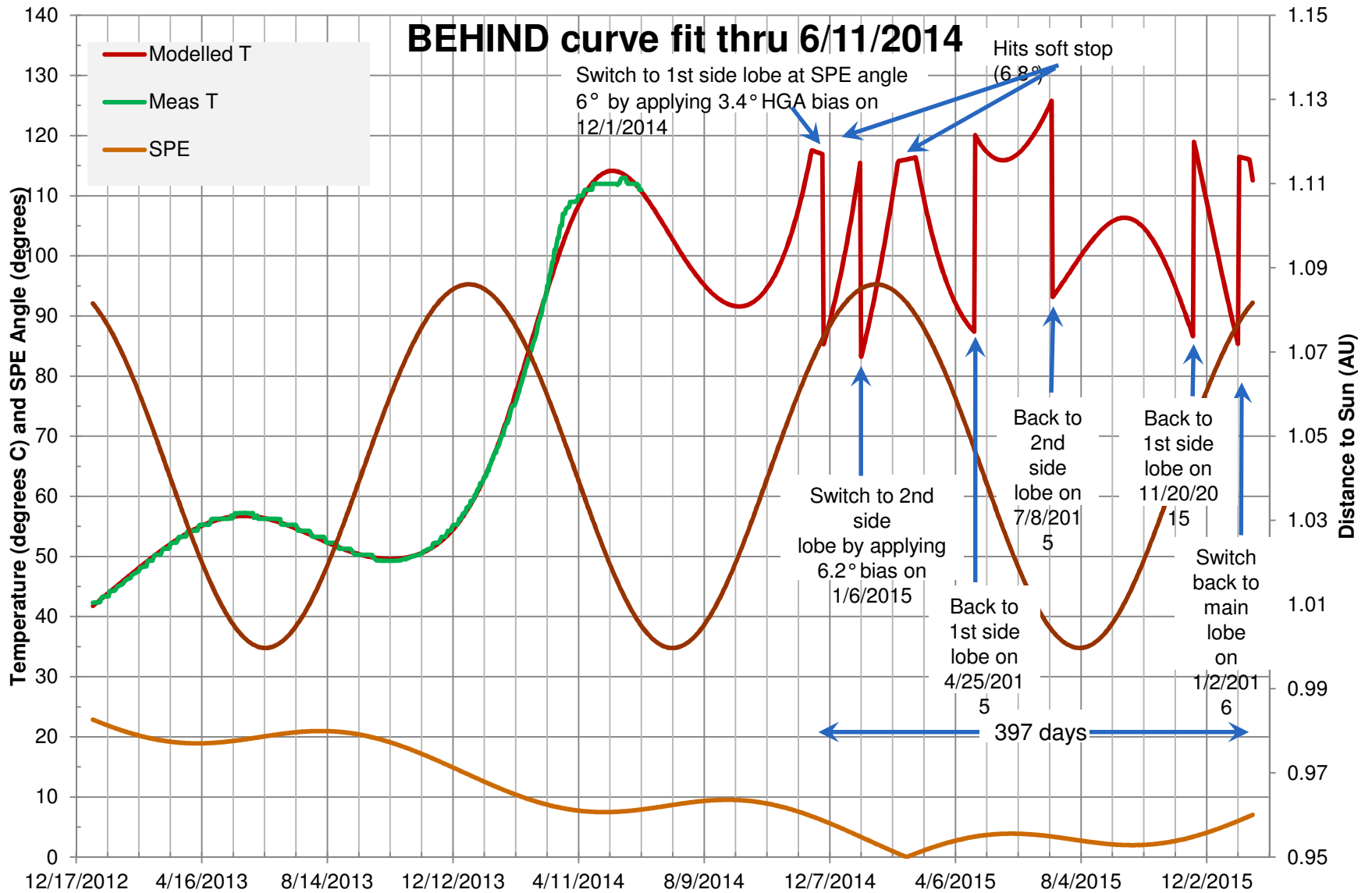
HGA Feed Temperature Constraint

- **HGA feed will increase in temperature beyond acceptable limits with SPE angle below 6.5 degrees.**
 - If SPE angle exceeded, damage to the feed assembly will render the HGA unusable.
 - Thermal modeling and analysis in progress
 - Results due by the end of May
 - Not done before launch as the mission was only two years.
- **Off point HGA to prevent excessive heating**
 - Keep feed temperature below 125 deg C
 - Temperature sensor limit = 136 deg C
 - Damage starts @ 150 deg C (adhesives)
 - **AHEAD** – August 2014 through December 2015
 - **BEHIND** – November 2014 through January 2016
 - At this time, anticipating instruments will off for these durations due to low data rates

Predicted HGA Feed Temperature - **AHEAD**



Predicted HGA Feed Temperature - *BEHIND*



HGA Feed Assembly

