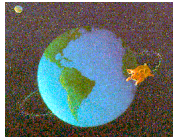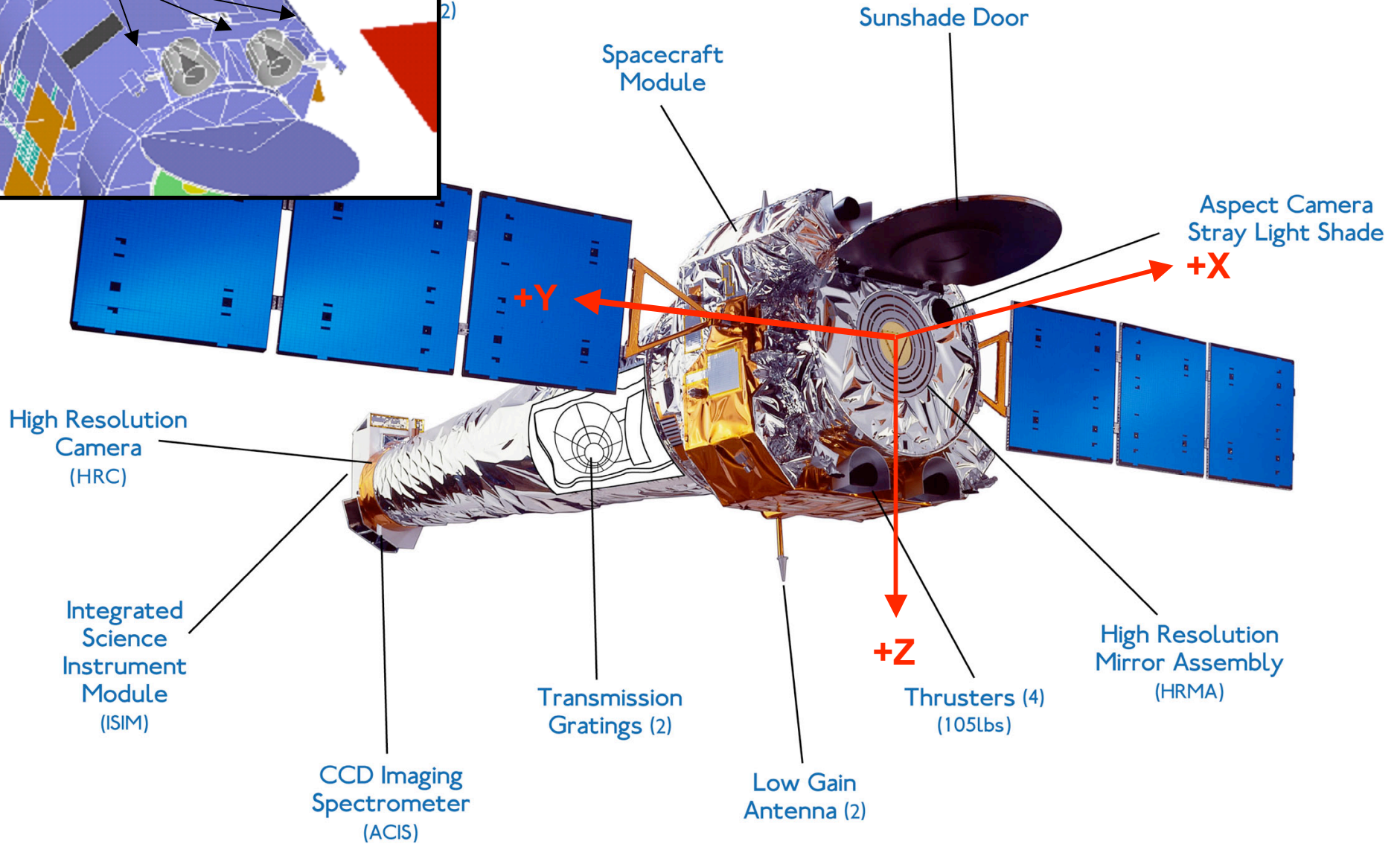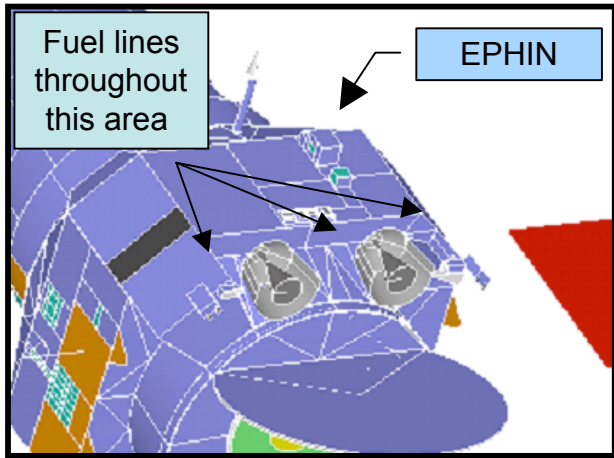# Constraint Classifications and the Chandra Long-Term Schedule

Chandra Spacecraft

Fuel lines throughout this area

EPHIN

Spacecraft Module

Sunshade Door

Aspect Camera Stray Light Shade

+X

+Y

+Z

High Resolution Camera (HRC)

Integrated Science Instrument Module (ISIM)

CCD Imaging Spectrometer (ACIS)

Transmission Gratings (2)

Low Gain Antenna (2)

Thrusters (4) (105lbs)

High Resolution Mirror Assembly (HRMA)

Chandra Observing Constraints
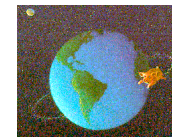
Angle range	Restriction	Reason
0-46	No observations	HRMA Sun aviodance
46-56	Observations with 6 ACIS chips may be limited to ~ 35 ks	ACIS PSMC temperature
56-60	unrestricted	
60-135	Observations limited to ~ 10 ks to substantial fraction of full orbit, depending on pitch of current observation and pitch history	EPHIN temperature limitations
135-152	Unrestricted	
152-170	~ 7 to 25 ks duration, depending on length of previous observations at low pitch angle	Propulsion line temperature limitations
170-180	No observations	Propulsion line temperature limitations
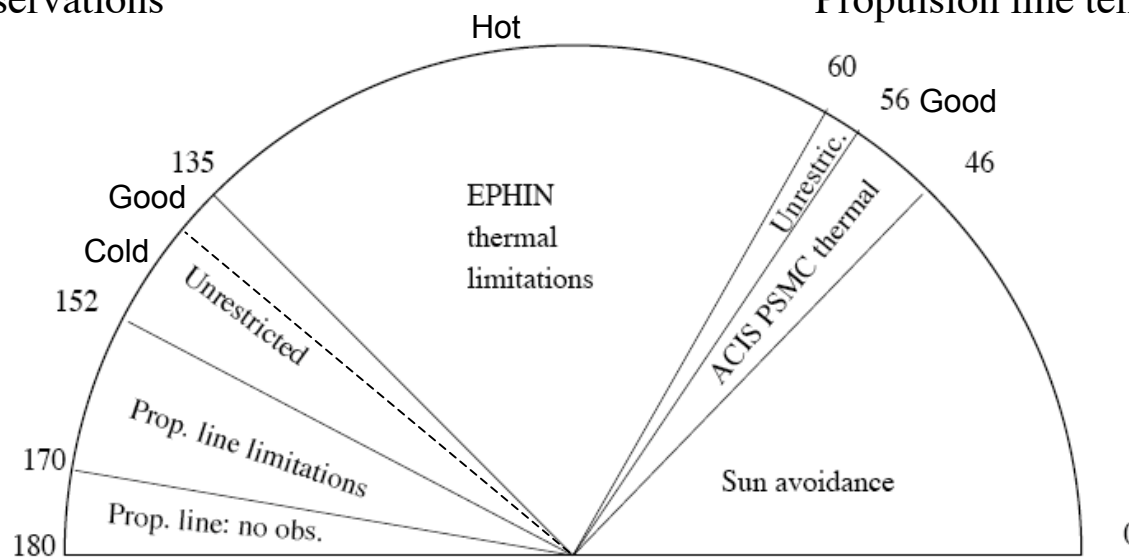
Limits on Constrained Observations
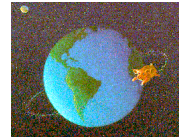
**Table 5.1.   Grading Scheme for Constrained Observations**

Constrain	Parameter	Easy	Average	Difficult
Uninterrupted (ksec)	Duration	<30	30-40	>40
Coordinated (days)	Window	-	>3	<3
Roll (days) (1)	Window	>21	3-21	<3
Time Window (days)	Window	>21	3-21	<3
Phase Interval (days)	Period	<20	20-60	>60
Monitor Interval	(2)	>5	2-5	<2
Group	(3)	>10	4-10	<4
	Annual Quota (4)	**45**	**35**	**20**

- New limitations on observer-constraints were derived in order to differentiate between easy and difficult constraints

- The overall metric is related to the amount of available time to meet a constraint

(2) Metric for monitoring is (initial interval)*(fractional tolerance)/(total duration of single observations)
(3) Metric for groups is (time interval for group)/(total observing time in group)

Breakdown of Approved Constraints
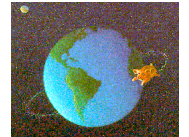
Quantity	Total	CAL
Observations	**885**	**100**
Constrained Observations	186*	100
Roll Constraints	41	0
Window Constraints	63	44
Uninterrupt Constraints	113	100
Monitor Constraints	112	58
Phase Constraints	8	0
Group Constraints	9(85)	4(58)
Coordinated Observations	38	1

*+20 from joint proposals with HST/Spitzer/XMM

• A total of about 11% of non-CAL observations have constraints
  - this is similar to limits in earlier (but post-EPHIN-heating) years

• All constrained observations were placed successfully in LTS
  - a couple had to be modified because the constraints were impossible as specified

• Most preferences also placed successfully in LTS
  - those that required significant time at bad pitch, but could otherwise be done at cold attitudes, were not met
  - note that some preferences may not be met if LTS updates are required (e.g. for TOO/DDT observations or thermal issues with constrained observations)

Difficult Constrained Observations
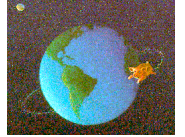
6 pointings, 29 ks each:

Window Constraint:
:window-constr-start-1 2008:122:00:00:00 :window-constr-stop-1 2008:141:00:00:00
:window-constr-start-2 2008:143:00:00:00 :window-constr-stop-2 2008:168:00:00:00
:window-constr-start-3 2008:171:00:00:00 :window-constr-stop-3 2008:195:00:00:00
:window-constr-start-4 2008:198:00:00:00 :window-constr-stop-4 2008:214:00:00:00

Phase Constraint:
:phase-epoch 2008:122:03:50:24 :phase-period 000:23:56:04.128
:phase-start 0.000000 :phase-start-margin 0.020000
:phase-end 0.334000 :phase-end-margin 0.020000

Uninterrupt Constraint: :seg-max-nbr 1

Monitor Constraint: :pre-min-lead 000:00:00:00.000 :pre-max-lead 009:00:00:00.000
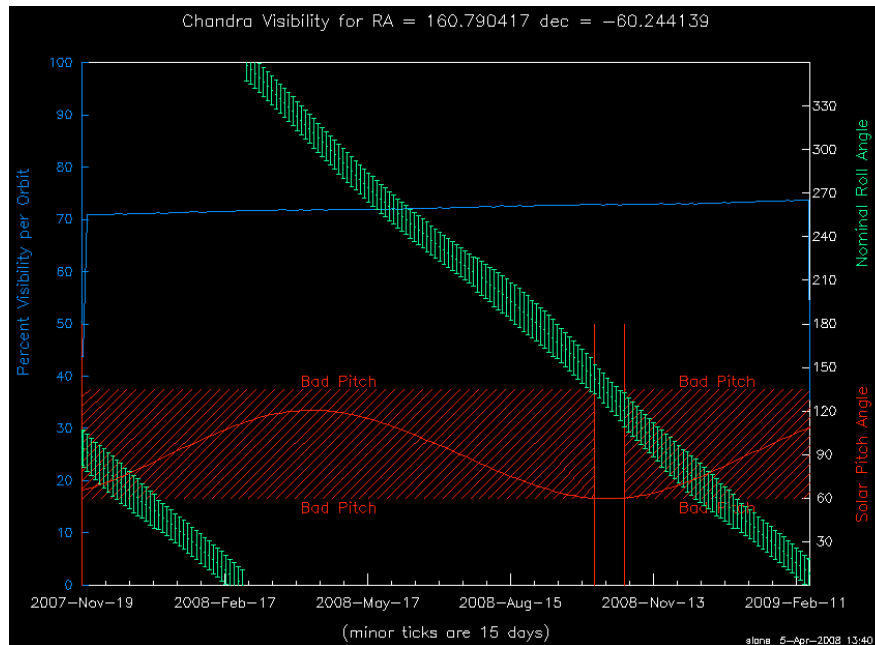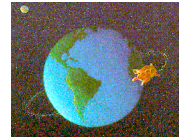
Issues:
• Phase constraint designed to provide coordinated observations w/ ground-based telescope
• Phase constraint + Monitor constraint impossible due to radiation zones
• Window 1 is in PLine; Window 2 is in PLine/PropLine

Solution:
• PI relaxed constraints until this was feasible

Difficult Unconstrained Observations


Carina Region
- Almost always at bad EPHIN pitch
- 1.2 Ms approved over three different Carina regions
- We get ~20-30 ks of "free" hot time per orbit by cooling in radiation zones
  - beyond this, we need cold targets to balance EPHIN temperatures
  - Carina observations use up ~29-44% of this "free" hot time
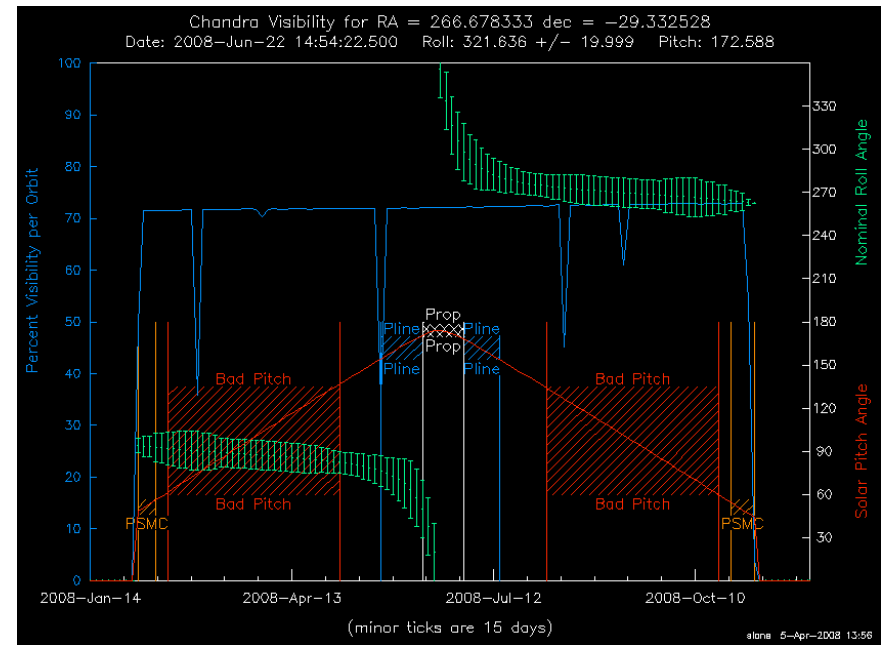
Galactic Center Region
- At good pitch for about 35 days
  - this corresponds to about 1.8-2 Ms once radiation zones are subtracted
- 1.6 Ms approved over four different Galactic Center regions
  - Combined with other targets at good pitch in same time window, some observations forced to be carried out at bad pitch even without observer constraints

Overall Assessment
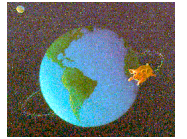
The impact of the modified constraint rules is hard to evaluate at this point

- Difficulty of LTS generation was similar to past several years

- A review with the Flight Operations Team was required to evaluate ~6 weeks
  that appear on the edge of being feasible as planned
  - at least one week that appeared feasible ended up needing modification (because
    thermal conditions were worse than we estimated)
  - we may encounter more such problems as the year progresses

- TOO planning has been very tight in some time periods, with very little flexibility
   in balancing thermal issues, approved constraints, and TOO/DDT requests
   - for some DDT requests, initial constraints (e.g. monitoring intervals) have
     required modification in order to allow schedule to satisfy other constraints (but
     all such modifications were deemed to have negligible science impact before
     they were approved)

- A full assessment of the impact of the new rules will not be possible until we have
  completed the bulk of the Cycle 9 observations
  - Note: any such assessment is, like the preliminary assessment presented here,
    largely subjective since the impact on <u>efficiency</u> is very difficult to assess