XRT Instrument Capabilities

Ed DeLuca, Leon Golub &
Jay Bookbinder
SAO

Level 1 Science Requirements

Topic	Definition/Questions	General Instrument Impact (System drivers are boldfaced)
Coronal Mass Ejections	1. How are they triggered?	High time resolution
	2. What is their relation to the magnetic structures?	High spatial resolution
	3. What is the relation between large scale instabilities	**Large FOV**
	and the dynamics of small structures?	Broad temperature coverage
Coronal Heating	1.How do coronal structures brighten?	High time resolution
	2.What are the wave contributions?	**High spatial resolution**
	3. Do loop-loop interactions cause heating?	Large FOV
		Broad temperature coverage
Reconnection and Jets	1. Where and how does reconnection occur?	High time resolution
	2. What are the relations to the local magnetic field?	High spatial resolution
		Broad temperature coverage
		Co-ordinated observing EIS/SOT
Flare Energetics	1. Where and how do flares occur?	**High time resolution**
	2. What are the relations to the local magnetic field?	High spatial resolution
		Large FOV
		Broad temperature coverage
		High temperature response
		Large dynamic range
Photospheric-Coronal	1. Can a direct connection between coronal	High time resolution
Coupling	and photospheric events be established?	High spatial resolution
	2. How is energy transferred to the corona	Large FOV
	3. Does the photosphere determine coronal	Broad temperature coverage
	fine structure?	**Co-ordinated observing with**
		SOT/EIS

Other Level 1 Requirements		
Item	**Description**	**Value**
Instrument Lifetime	Perform throughout the nominal Solar-B mission	3 years
Instrument Weight		30 kg (TBR)
Instrument Power		20 W (TBR)
Support SOT/EIS	Coordinated Observing capability	S/W timing and coordination

XRT Requirements Flowdown					
Requirement	**Definition**	**Value**	**Primary Hardware**	**Determining Factor**	**Responsibility**
Exposure time	shutter open time (min)	4ms	Shutter	Flare brightness	SAO
	(max)	10sec		Quiescent corona	
Cadence	time between exposures	2 sec	Shutter/MDP	Flare variability	SAO/ISAS
		(reduced FOV)			
T-range	limits of temperature coverage	6.1 < log T < 7.5	Coatings	coronal DEM	SAO
T-resolution	Temperature discrimination	log T = 0.2	F.P. Filters	transverse gradients	SAO
X-ray image resolution	50% encircled energy	2 arcsec	G.I. Mirror	moss size scales	SAO
Field of View	angular coverage of telescope	> 30 arcmin	G.I. Mirror	global variations	SAO
White Light Rejection	reduction of solar visible light	>10**11	Filters	Lx/Lopt ratio	SAO
	at focal plane				
Data Rate	Maximum bit rate out of XRT	2.4 MB/sec	MDP	Flare mode observations	ISAS
Data Volume	Maximum daily data volume	60 MB/orbit	MDP	CME mode observations	ISAS
Spatial Co-alignment	Align Xray to white light images	1 XRT pixel	Mirrror Assy		SAO
(X-ray to WL)					
Spatial Co-alignment	Align Xray to white light images	1 XRT pixel	Structures		ISAS/SAO
(X-ray to SOT or EIS)					
Coordinated	Image start time coordination	0.1 second	MDP		ISAS/SAO
Observing					

Coordinated Observing Programs
XRT

Ed DeLuca, Kathy Reeves &
Harry Warren
SAO

Emerging Flux Program

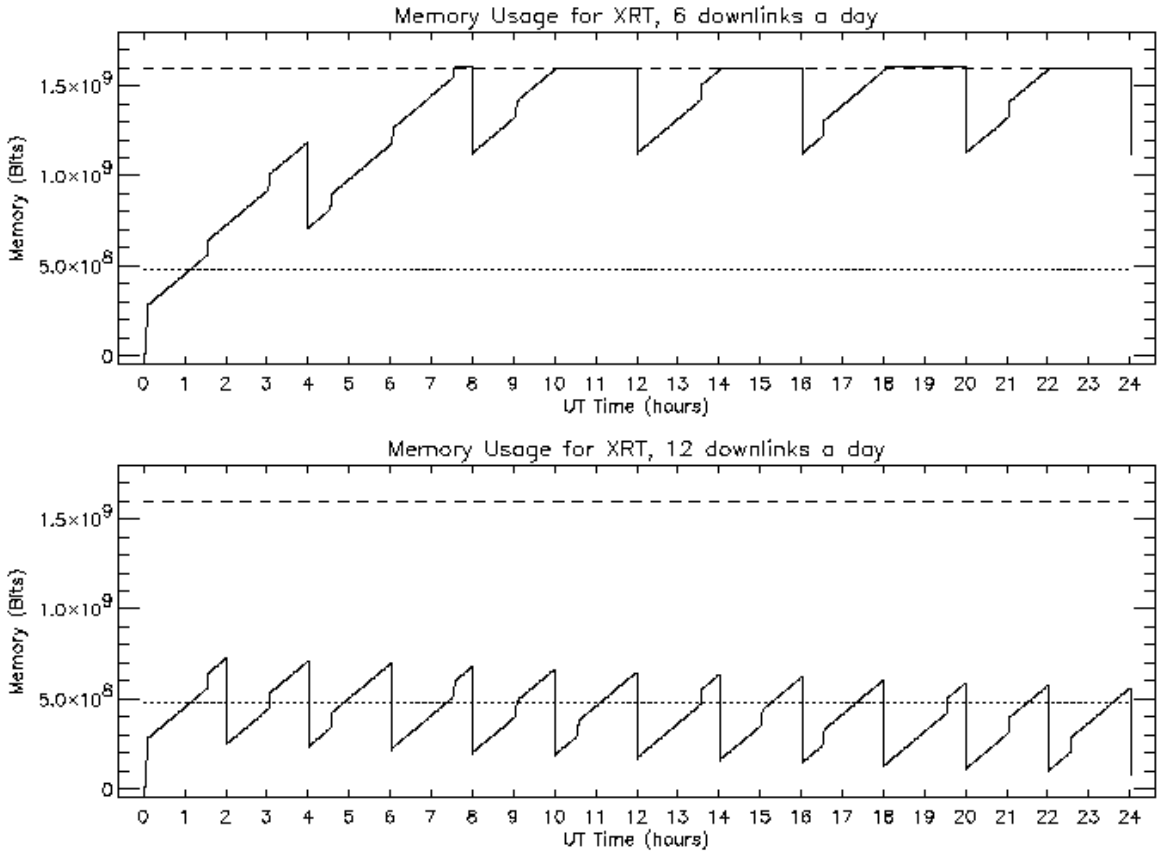
- Primary Instrument: XRT
- Science Goal: Understand the interaction of emerging magnetic flux with the existing coronal magnetic field. For example: Can we demonstrate that a jet is formed when a dipole of a certain size emerges near an existing arcade?

- Implementation:
  - Follow an active region as it crosses disk center (~1 week).
  - Use 768x768 FOV (13'x13') to cover an AR and surrounding area.
  - Use 3 filters to span the XRT temperature response.
  - Run at a fast enough cadence to follow coronal structures (100s based on TRACE experience).
  - Take white light images every 45 min (TBR) for context and alignment.

- Assumptions:
  - X-ray data compress to 3 bits/pixel.
  - White light data compress to 5 bits/pixel.
  - Filter move and settle time 1.2 s per step.
  - Shutter prep time 0.2 s
  - Parallel shift @ 10krows/s
  - Read time 512kpixels/s => 3.075 s to read 768x768 FOV.
  - Exposure times: 1s for filters 1 & 2; 3s for filter 3
- Question: Do we need more than a long and short exposure to cover the dynamic range?

- Data Rate:
  - 53 kBits/s Compressed data
- Duration:
  - 7 days per AR. Longer if FPP can provide useful data near the limb.

EFP On Board Storage



EFR as run timeline
6 downlinks

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0	9	EFR
1	30	Pointing:(0,0)
1	32	SYNOPTIC
1	33	Pointing:(800,200)
1	35	EFR
3	0	Pointing:(0,0)
3	2	SYNOPTIC
3	4	Pointing:(800,200)
3	6	EFR
4	0	Download
4	0	EFR
4	30	Pointing:(0,0)
4	32	SYNOPTIC
4	34	Pointing:(800,200)
4	36	EFR
6	0	Pointing:(0,0)
6	2	SYNOPTIC
6	4	Pointing:(800,200)
6	6	EFR
7	31	Pointing:(0,0)
7	33	SYNOPTIC
7	34	Pointing:(800,200)
7	36	EFR
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8	0	EFR
9	1	Pointing:(0,0)
9	3	SYNOPTIC
9	5	Pointing:(800,200)
9	7	EFR
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10	33	SYNOPTIC
10	35	Pointing:(800,200)
10	37	EFR

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HR	MIN	
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16	1	EFR
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16	33	Pointing:(800,200)
16	35	EFR
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18	2	SYNOPTIC
18	4	Pointing:(800,200)
18	6	EFR
19	30	Pointing:(0,0)
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20	1	EFR
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21	2	SYNOPTIC
21	4	Pointing:(800,200)
21	6	EFR
22	31	Pointing:(0,0)
22	33	SYNOPTIC
22	34	Pointing:(800,200)
22	36	EFR
24	1	Download

EFR as run timeline
12 downlinks

UT		Action
HR	MIN	
0	0	Pointing:(0,0)
0	2	CAL
0	7	Pointing:(800,200)
0	9	EFR
1	30	Pointing:(0,0)
1	32	SYNOPTIC
1	33	Pointing:(800,200)
1	35	EFR
2	1	Download
2	1	EFR
3	0	Pointing:(0,0)
3	2	SYNOPTIC
3	4	Pointing:(800,200)
3	6	EFR
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UT		Action
HR	MIN	
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16	1	EFR
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21	4	Pointing:(800,200)
21	6	EFR
22	0	Download
22	0	EFR
22	31	Pointing:(0,0)
22	33	SYNOPTIC
22	34	Pointing:(800,200)
22	36	EFR
24	1	Download

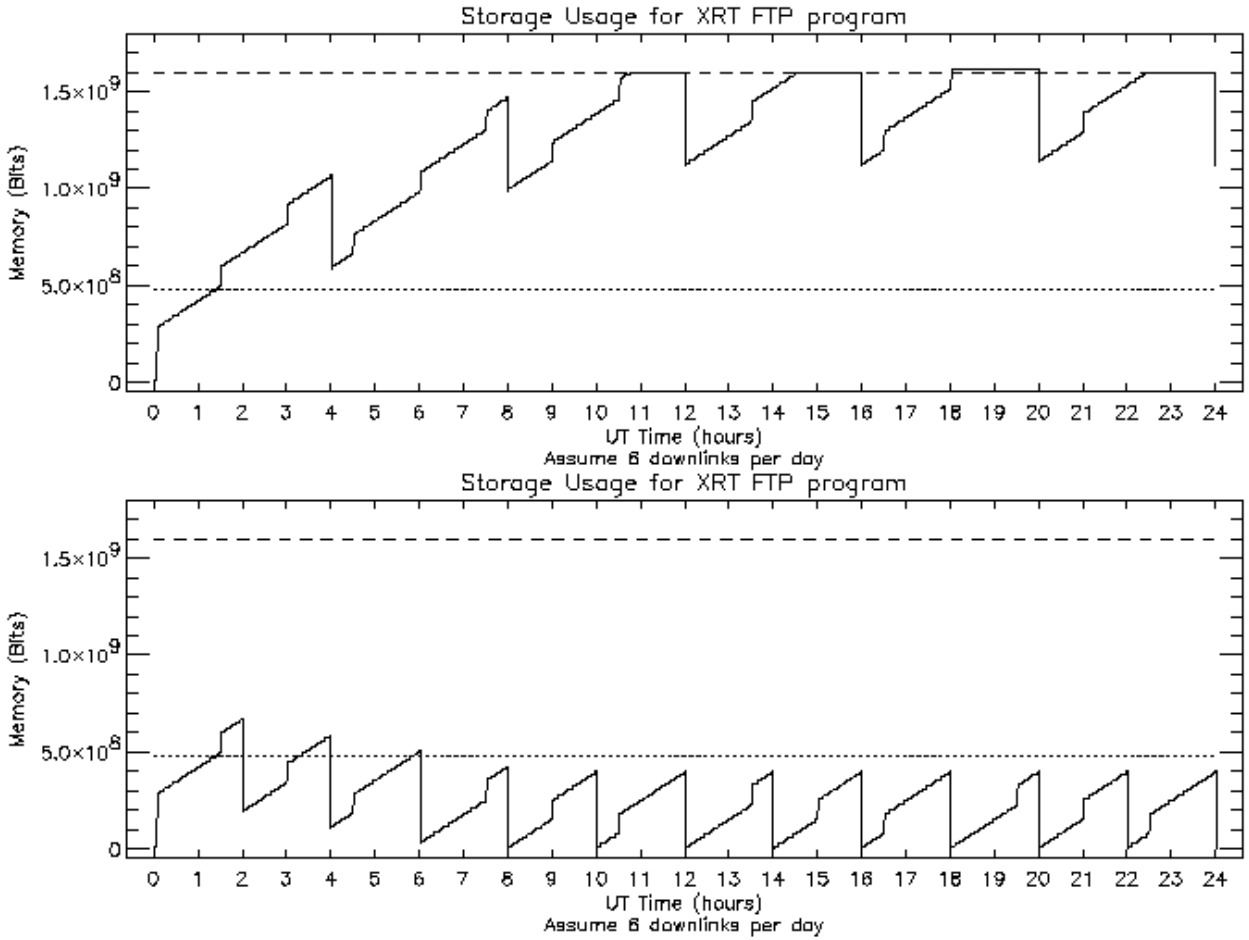
Flux Tube Physics

- Primary Instrument: FPP
- Science Goal: Study the coronal response to network and plage flux tube dynamics.
- Implementation:
  - Select FOV centered on FPP FOV
  - Use 3 filters to span the XRT temperature response
  - Use 256x256 FOV (4.3'x4.3') 33s cadence/set.
  - Use 1024x1024 FOV context every 5 min
  - Take white light images every 10 min.

Flux Tube Physics

- Data Rate: 41 kBits/s Compressed data
- Duration: TBD

FTP On Board Storage



FTP As Run Timeline

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4	0	FTP
4	30	SYNOPTIC
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UT		Action
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21	0	SYNOPTIC
21	1	FTP
22	0	Download
22	0	FTP
22	30	SYNOPTIC
22	31	FTP
24	1	Download

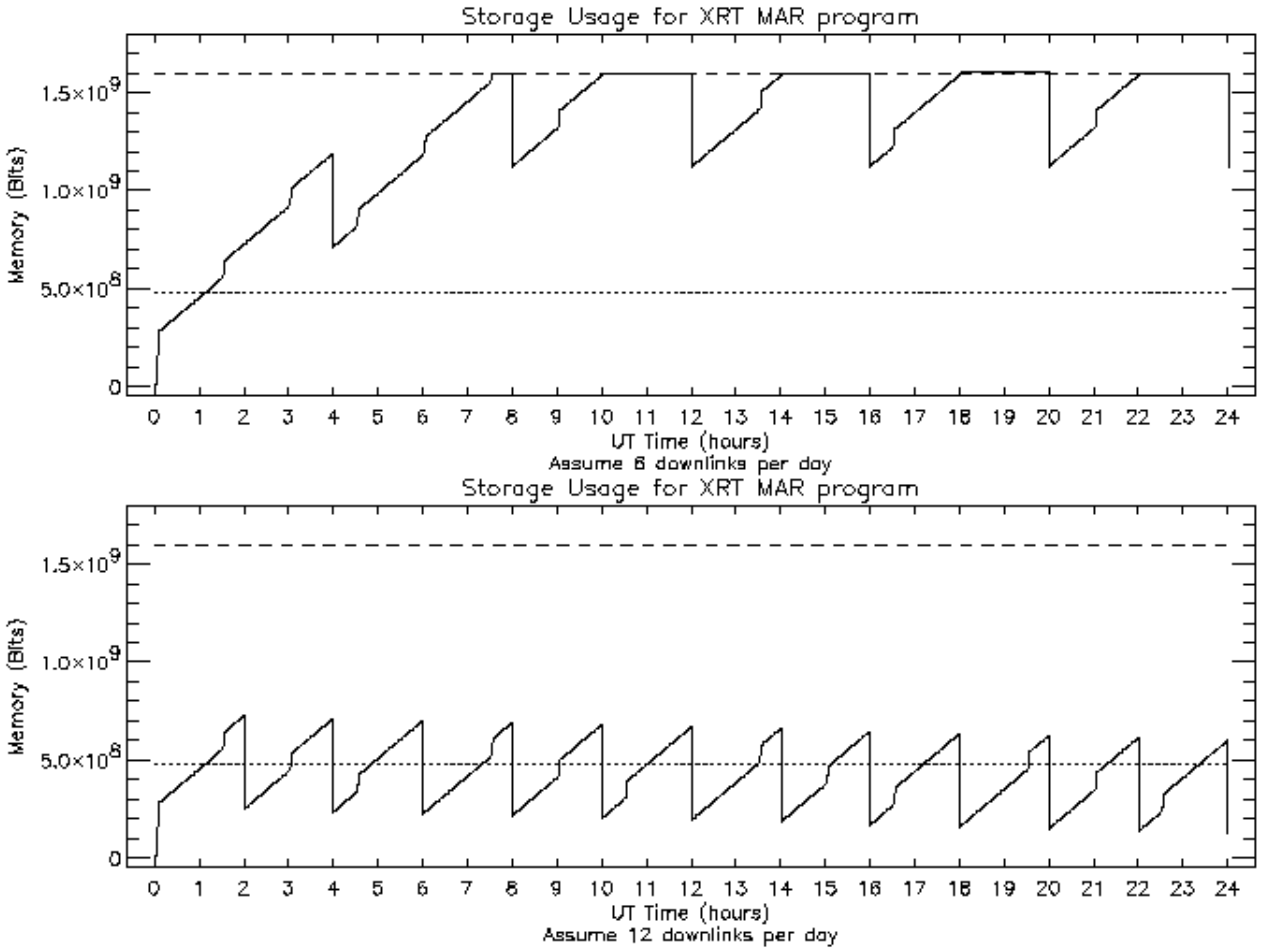
Medium Active Region Program

- Primary Instrument: EIS
- Science Goal: Flows, temperature and density diagnostics in an AR.
- Implementation:
  - Select FOV centered on EIS FOV
  - Use 3 filters to span the XRT temperature response
  - Use 512x512 FOV (8.5'x8.5') 60s cadence/set.
  - Use 768x768 FOV context every 5 min
  - Take white light images every 10 min

Medium Active Region Program

- Data Rate: 53 kBits/s Compressed data
- Duration: TBD

MAR On Board Storage



MAR as run timeline
12 downlinks

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1	33	Pointing:(800,200)
1	35	MAR
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3	2	SYNOPTIC
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3	6	MAR
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10	35	MAR

UT		Action
HR	MIN	
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22	0	Download
22	0	MAR
22	30	Pointing:(0,0)
22	32	SYNOPTIC
22	34	Pointing:(800,200)
22	36	MAR
24	0	Download

XRT Synoptic Program

- Primary Instrument: XRT
- Science Goal: Produce a mission-long data base of the global evolution of the solar corona. Follow the large scale topological changes of the multi-thermal, fine scale coronal fields. Show the evolution of coronal holes, polar plumes and AR streamers over many rotations.

- Implementation:
  - Every 90 minutes, take long and short exposures at sun center in each of three filters that span the XRT temperature response.
  - Take a white light context image.
- Elapsed time: 90s of observing
- Data Rate:
  - Burst: 1082 kBits/s Compressed
  - Daily Avg: 13 kBits/s Compressed
- Duration: Mission Lifetime

XRT Calibration Program

- Primary Instrument: XRT
- Goal:
  - Establish a baseline of standard observations to detect changes in the sensitivity and performance of the telescope.

- Implementation:
  - Once per day (TBR)
  - Disk center
  - Long & Short exposures in each filter
  - Take white light image
  - Dark frames (not yet included in simulations)
  - Flat fields with WL (TBR)
- Elapsed Time: 6 minutes of observing w/o dark frames

- Data Rate
  - Burst: 940kBits/s Compressed
  - Daily Avg: 3 kBits/s Compressed
- Duration: Mission Lifetime