

Observing from Space Orbits, constraints, planning, coordination

Integral



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XMM-Newton



On behalf of the Integral and XMM-Newton Science Operations Centres

Slide 1

Observing from Space - Orbits





http://sci.esa.int/integral/59688-integral-fifteen-years-in-orbit/

Slide 2

Observing from Space - Orbits Highly elliptical Earth orbit: XMM-Newton, Integral, Chandra





Slide 3



Observing from Space - Orbits

Low-Earth orbit: ~1.5 hour, examples: Hubble Space Telescope Swift **NuSTAR** Fermi

Earth blocking, especially low declination objects

 \Rightarrow Only short snapshots of a few 100s possible \Rightarrow No long uninterrupted observations \Rightarrow Only partial overlap with Integral/XMM possible



Observing from Space - Orbits Orbit around Lagrange point L2

past:



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Observing from Space – Constraints



Motivations for constraints:

- Safety of space-craft and instruments
- Contamination by bright optical/X-ray sources or straylight from them
- Functionality of star Tracker
- Power supply (solar panels)
- Thermal stability (avoid heat from the sun)
- Ground contact for remote commanding and downlink of data

Space-specific constraints in bold orange

Observing from Space – Constraints



Examples for constraints:

- No observations while passing through radiation belts
- Orientation of space craft to sun
- Large avoidance angles around Sun and anti-Sun, Moon, Earth, Bright planets
- No slewing over Moon and Earth (planets ok)
- Availability of ground stations
- No commanding during ground-station handovers
- Down times during maintenance

Some constraints only known a short time in advance => Flexibility with long-term planning

Space-specific constraints in bold orange

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Observing from Space – **Observing** Constraints XMM-Newton



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Observing from Space – **Observing** Constraints XMM-Newton++ Nights



esa

366

275

183

92

Hours

12 11

10 9

24

+

Observing from Space – Long-term Planning



Announcement of Opportunity (AO) calls etc => pool of observations per pre-defined time interval (1 year)

All to be observed before end of observing cycle

- Make sure to observe before end of respective visible windows
- Satisfy scientific constraints
- Allow flexibility to accommodate Targets of Opportunity observations

Celestial constraints can be predicted But: some information not available yet e.g., times of ground station contacts

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Observing from Space – Long-Term Planning





5AU	072818 0101	PG1126_041	18000	0	NS.
-					
	072010 0102	FG1120-041	10000		110
	072818-0103	PG1126-041	18000	0	NS
	072810-0101	NCC247 HTV	2 80 0 0		11 C
	072019 0101	NGC24/ 01A	3 80 0 0	<u>v</u>	110
	0/2956 0101	XSS J12270-4856	38000	0	NS.
	072926-0101	TGP 12124745050	12000	õ	110
	072030 0101	100 02124715050	13000		110
	072838 0201	40 0614+091	13000	0	IN S
	074006-0101	NGC1068	54000	0	NS
	074000-0101	1001000	21000		112
	0/4006 0102	NGC1068	54000	0	112
	074006-0103	NGC1068	54000	0	11S
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	074006 0104	NGC1068	54000	0	14 2
	074014 0101	BD+37 1977	50000	30000	NS
	074018-0101	CDD 28 2561	12000		110
	0/4010 0101	CPD -20 2001	13000	0	112
	074018-0102	CPD -28 2561	13000	0	ns
	074019-0102	CDD 28 2561	12000	õ	110
	074018 0103	CPD -20 2501	13000		112
	074018 0104	CPD -28 2561	13000	0	NS
	074018-0105	CDD 28 2561	12000	õ	110
	0/4010 0103	CFD =20 2501	13000		110
	074029 0101	HD 109026	13000	13000	NS
	074020-0301	UD 92664	19000	19000	110
	074025 0501	0000	10000	10000	
	0/4030 0101	CVC OB2 #5	13000	13000	NS.
	074053 0101	HD 17156	2 80 0 0	0	ns
	074083-0103	17180	20000		
	074055 0102	HD 1/100	20000	0	112
	074061 0101	NO Gem	53000	53000	NS
	074061-0201	V1261 Ori	52000	52000	110
	074001 0201	VIZOI OLI	53000	22000	na
	074088 0101	IGR J11014-6103	37000	0	IN S
	074090 0101	Abell 2244	28000	28000	INS.
		100 1500		20000	
	074092 0101	NGC 4593	22000	0	NE
	074092 0 02	NGC 4593	22000	0	ns
	074002-0452	100 450 2	22000	ō	110
	074092 0103	HGC 4595	22000	0	110
	074092 0104	NGC 4593	22000	0	NS
	074092-0105	NGC 4593	22000	ō.	NE
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	074096 0101	GSN 069	83000	83000	NS.
	074114-0101	PSR B1133+16	23000	0	NS
		101 01100-10	20000		
	074114 0102	PSR BIIJJTI0	23000	0	112
	074114-0103	PSR B1133+16	23000	0	NS
	074114-0104	DCD D1122+16	23000	0	110
	074114 0104	POR BIISSIIO	23000		110
	074114 0105	PSR B1133+16	23000	0	NS.
	074116 0101	Virgo X1	50000	50000	NS
	074110 0101	tingo at	50000	20000	
	074116 0201	virgo X2	50000	50000	14.2
	074116-0301	Virgo X3	50000	50000	NS
	074120-0101	DVC11744 6 1150	10000	10000	110
	074120 0101	RAC01244.0-1105	10000	10000	110
	074120 0501	RXCJ1145.3-3425	10000	10000	NS.
	074120-0601	RXCJ1952.2-5503	10000	10000	NS.
	074120-0101	NGG ECOO	45000	15000	110
	074130 0101	NGC 3908	45000	45000	14 2
	074130-0201	NGC 669	112000	112000	ns
	074120-0201	FC0142_C019	80000	80000	110
	074130 0301	EB0142-0019	80000	80000	112
	074130 0401	UGCA 145	107000	0	NS
	074130 0501	NGC 550 1	73000	73000	115
	074130 0501	NGC SSO-1	10000	12000	
	0/4130 0601	NGC 550-2	/3000	/3000	112
	074133 0101	Fairall 9	132000	0	NS
	074120-0101	DY T0420 6 5211	27000	27000	17.0
	074133 0101	KA 00433.0-3311	27000	27000	na
	074139 0201	RX J1355.2+5612	50000	0	ns
	074139 0301	PBS 2041	37000	37000	NS
	074144-0101		120000	37000	116
	0/4144 0101	HCG IS	132000	0	112
	074147-0101	IGR J18214-1318	28000	0	NS
	074140-0201	DCD T1046+1905	24000	ő	110
	074149 0301	F3K 31940+1003	24000		na
	074168 0101	HD 140283	18000	18000	NS.
	074168-0201	HD 19445	23000	23000	NS
	0.7 4 1 7 0 1 0 1 0 1	100 01000	0.0000	20000	10.0
	074170 0101	HP 01003	20000	0	P.L
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	074170-0301	alpha Cen	19000	0	110
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11	074180 0201	[HP991 483	33000	33000	NS
11	074192-0101	Augmun Loop D7	102000	102000	ne
11	0,4102 0101	Clauna roob 1.	103000	102000	115
11	074189 0101	NPS 1	27000	27000	ns.
11	074189-0201	NPS 2	27000	27000	ns
11	074190-0201	NDC 3	54888	22000	116
11	0/4189 0301	HFD 3	27000	27000	112
11	074189-0401	NPS 4	27000	27000	NS
11	074100-0501	NDC 5	22000	22000	inc
11	074109 0501	873 3	27000	51000	14.2
11	074189 0601	NPS 6	24000	24000	NS
11	074189-0701	NPS 7	21000	21000	NS
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11	0/4109 0801	NPB 0	21000	21000	115
11	074189-0901	NPS 9	21000	21000	NS
-11	074189-1001	NDC 10	21000	21000	HC.
-11	0/1109 1001	HF0 10	21000	21000	
11	0/4189 1101	BP5 11	21000	21000	112
	074189-1201	NPS 12	24000	24000	NS
-11	074100-1201	NDC 13	27000	2 20 00	W.C
-11	074109 1301	BP5 13	27000	27000	112
-11	$074189^{-1}401$	NPS 14	24000	24000	NS
11	074180-1501	NDS 15	21000	21000	11 S
11	0/4109 1001	AFO 10	21000	21000	10
-11	074189-1601	NPS 16	21000	Z1000	IS I
-11	074189-1701	NPS 17	21000	21000	NS
11	074190-1001	NDC 10	21000	21000	110
111	0/4103 1001	MED 10	21000	21000	110
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	$074193 0 101 \\ 074195 0 101$	Abel1 5753 HESS_J1626-490	3 40 0 0	34000	NS
	074193 ⁻⁰ 101 074195 ⁻⁰ 101 074196 ⁻⁰ 101	Abel1 5753 HESS-J1626-490 NGC 5204 X-1	34000 23000	34000 23000	NS
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Observing from Space – Long-Term Planning Strategies:

- Always plan as soon as possible as observations may fail and need time for repetition
- Document margins of tolerance
- Leave enough flexibility (accommodate ToOs)
- Plan coordinated observations after most time-critical observations

To some degree can be automated (e.g. APSI)

Observing from Space – Scheduling





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Observing from Space – Coordination Evolution for XMM-Newton



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Observing from Space



- Coordination with other observatories
- Types of coordinated observations
- Joint Programmes (not necessarily all joint observations are coord.)
- Initiatives by Principal Investigators
- Anticipated triggered observations (e.g., X-ray binaries with known outburst cycles)
- Unanticipated Targets of Opportunity (e.g., GRB, GW, SN)

Strategies:

- Coordinated observations, after time-critical observations planned
- Determine available observing slots of own facility
- Present available slots to other facility/-ies and determine overlap
- Some agreements may contain the more flexible observatories to follow the scheduling of the less flexible ones

Observing from Space



- Coordination with other observatories

Strategies:

- Before planning coordinated observations, need to have all time-critical observations planned
- Determine available observing slots of own facility
- Present available slots to other facility/-ies and determine overlap
- Some agreements may contain the more flexible observatories to follow the scheduling of the less flexible ones

All done manually

- Works well with small number of observations and facilities
- Not always optimal slots found
- => Couldn't coordination of any number of observations and facilities within a given time interval be automated?

Observing from Space – Long-Term Planning



- Specific required times (e.g. planet transients)
- Fixed spacing (e.g., multiple observations of same phase)
- Maintenance activities
- Targets with limited visibility
- Coordinated observations
- Needs to be updated in case of high-impact modifications in response to triggered observations

Main differences

XMM-Newton:

Only internal planning and only containing time-critical observations

~30% of mandatory exposure time (A+B targets)

Integral:

Public Long-Term plan containing all mandatory observations

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