Galileo Avionica
Esplorazione della Luna
Tema 7: In-Situ Sensing

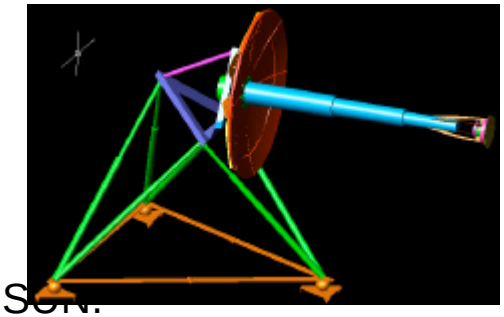
Riunione Plenaria 1 - ASI, 18 Gennaio 2007

ATEC Robotics: V.F.Garelli - INAF/OAC: D. Mancini

GALILEO AVIONICA
A Finmeccanica Company

Payload Description (ATEC Robotics / INAF-OAC)

Solar Gregorian Telescope



Scope: See scientific themes of SUN Observation (WP1310)
Optimized design of a robotic telescope architecture that includes the telescope and the spectroscope seen as unique device.
The telescope will be installed at the pole to continuously observe the SUN.

Architecture: The proposed telescope will be based on a Gregorian Optical design. It is characterized by a 1.5 primary mirror, 25m Focal Length and a scale of 5.5 arcsec/mm that satisfy the requirements. The telescope structure is hexapod derived. The Primary mirror will be segmented and the optics control will allow aligning and phasing the segments. Imagers and spectrometers are not envisaged as critical subsystems from the expertise of GA and ATEC and will be submitted to further studies in order to introduce intelligent pixel detectors and to allow switching from imaging up to spectro-polarimetry through spectroscopy. The FoV requirements will be satisfied by means of a single 1kx1k or slightly larger detector with 15micron pixel size. A rough estimate of telescope optics and mechanics masses is below 300 kg. The imager / spectrometer mass, including electronics, is estimated of the order of 20 kg. Telescope volume when deployed is around 300x300x500 cm, while the volume is about 150x150x150 cm when packed tentatively down to 100x100x100 cm; camera size is around 30 x 30 x 25 cm. Average data volume can be estimated as: 1024 * 1024 * 16 bit / 1 sec integration * 1 day (2800 images) < 50Gbit per day maximum. Power consumption is estimated in 100W for the camera plus the robotic telescope consumption that is estimated in 359W when in operation. Thermal control for the camera and for the telescope is demanded to the telescope control system. Active thermal screen will be investigate to reduce the T° range <=100°K.

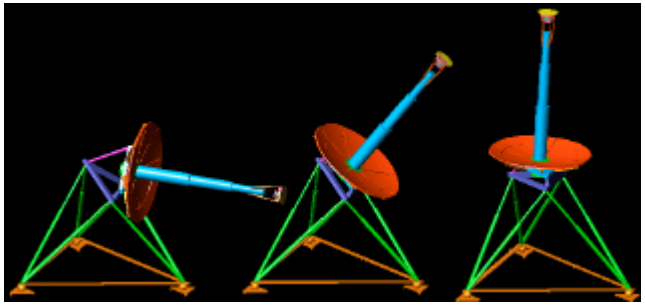
Remark - The telescope structure has been studied to satisfy contemporarily the requirements of various WPs

Payload I/O Table

Element	TYPE	Parameter description	Input Value	Output Value	Units
Solar Gregorian Telescope WP-1310	**GEN**				
Solar Gregorian Telescope	SCI OBJ	Scientific objectives 1	Magn Feat and temp evolution		
Solar Gregorian Telescope	SCI OBJ	Scientific objectives 2	WP1310		
Solar Gregorian Telescope	SCI OBJ	Scientific objectives 3			
Solar Gregorian Telescope	DES REQ	Embarked on Infrastructure 1	Rover		
Solar Gregorian Telescope	DES REQ	Earth Environment	see ref document		
Solar Gregorian Telescope	DES REQ	1. Observation spectral band	[0.4, 1.6]		µm
Solar Gregorian Telescope	DES REQ	2. Sensitivity	500		pm
Solar Gregorian Telescope	DES REQ	3. Spatial/angular resolution	0.1		arcsec
Solar Gregorian Telescope	DES REQ	4. Focal lenght	25		m
Solar Gregorian Telescope	DES REQ	5. Epectral Energy Resolution	30..50		nm
Solar Gregorian Telescope	DES REQ	6. Time Resolution	30..50		sec
Solar Gregorian Telescope	DES REQ	7. Field of View	100x100		arcsec sq
Solar Gregorian Telescope	DES REQ	8. Data rate	NA		Mbit/sec
Solar Gregorian Telescope	DES REQ	9. Overall Mass budget	NA		Kg
Solar Gregorian Telescope	DES REQ	10. Overall Volume budget	NA		m^3
Solar Gregorian Telescope	DES REQ	11. Overall Power budget	NA		W
Solar Gregorian Telescope	DES REQ	12. Operative temperature	NA		°K
Solar Gregorian Telescope	DES REQ	13. Lifetime (by ATC)	>10		years
Solar Gregorian Telescope	DES SPEC	Observation spectral band		[0.4, 1.6]	µm
Solar Gregorian Telescope	DES SPEC	Aperture		m	µ
Solar Gregorian Telescope	DES SPEC	Scale		5.5	arcsec/mm
Solar Gregorian Telescope	DES SPEC	Sensitivity		500	pm
Solar Gregorian Telescope	DES SPEC	Time Resolution		30	sec
Solar Gregorian Telescope	DES SPEC	Mass Budget		220	Kg
Solar Gregorian Telescope	DES SPEC	Max power in operative conditions		500	W
Solar Gregorian Telescope	DES SPEC	Max power in stand by conditions		50	W
Solar Gregorian Telescope	DES SPEC	Data Rate		0.5	Mbit/sec
Solar Gregorian Telescope	DES SPEC	Data Volume		50	Gbit
Solar Gregorian Telescope	DES SPEC	Size stowed		1.5x1.5x1.5 -> 1x1x1	m
Solar Gregorian Telescope	DES SPEC	Size deployed			m
Solar Gregorian Telescope	DES SPEC	*Optical Unit (if any)*		0.3x0.3x0.25	m
Solar Gregorian Telescope	DES SPEC	*Mechanical Unit (if any)*		3x3x5	m
Solar Gregorian Telescope	DES SPEC	*Electronic Unit (if any)*		inluded in mechanics	
Solar Gregorian Telescope	DES SPEC	Operative temperature range		150 to 400	K
Solar Gregorian Telescope	DES SPEC	Stand by temperature range		200 to 400	K
Solar Gregorian Telescope	DES SPEC	Pointing			
Solar Gregorian Telescope	DES SPEC	*accuracy*		1	arcsec
Solar Gregorian Telescope	DES SPEC	*range*		30AZ30ALT	deg
Solar Gregorian Telescope	DES SPEC	Tracking			
Solar Gregorian Telescope	DES SPEC	*accuracy*		0.01-0.02	arcsec RMS

Payload Description (ATEC Robotics / INAF-OAC)

Solar System Lunar Telescope



Scope: See scientific themes of Solar System Study (WP1320) Optimized design of a robotic telescope architecture that includes the telescope and the imager seen as unique device.

Architecture: The proposed telescope will be based on a Ritchey Cretien optical configuration characterized by a 2-m class primary mirror, 15-m Focal Length and a scale of 6.8-7-arcsec/mm. The field of view up to 1x1° as per requirements, requires the presence of a segmented collimator to optimize the field characteristics on an imager matrix. In principle the insertion of a segmented collimator allows to increase the columns and rows of the array matrix in order to increase the field up to 1x1°. The usage of 8x8 4kx4k 15micron pixel size imagers could cover a field of about 1° with a resolution of 0.1 arcsec. The study will investigate the possibility to dispose of large size imagers with a different pixel size. The telescope structure is hexapod derived. Primary mirror will be segmented and the optics control will allow segments aligning and phasing. A rough estimate of telescope optics and mechanics masses is about 450 kg. The imager camera mass, including electronics, is estimated of the order of 35 kg. Telescope size is around 400x400x600 cm while camera size is around 30 x 30 x 25 cm. Average data volume can be estimated as: 4096 *4096 * 64 * 16 bit * 1 day (about 300 images) < 5Tbit per day maximum. This number could be reduced by considering the possible partialization of the imagers. Power consumption is estimated in 100 W for the camera plus the robotic telescope consumption estimated in 350W in operation. Thermal control for the camera and for the telescope is demanded to the telescope control system.

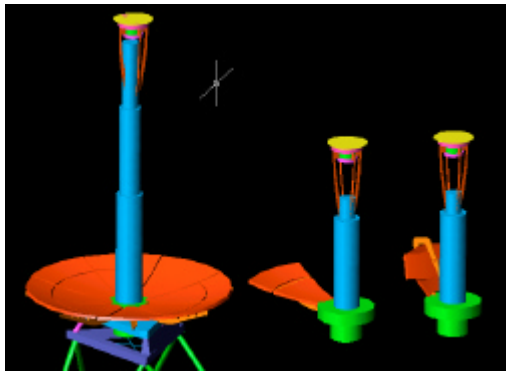
Remark - The telescope structure has been studied to satisfy contemporarily the requirements of various WPs

Payload I/O Table

Element	TYPE	Parameter description	Input Value	Output Value	Units
Solar System Telescope WP-1320	**GEN**				
Solar System Telescope	SCI OBJ	Scientific objectives 1	Comets and minor planets		
Solar System Telescope	SCI OBJ	Scientific objectives 2	WP1320		
Solar System Telescope	SCI OBJ	Scientific objectives 3			
Solar System Telescope	DES REQ	Embarked on Infrastructure 1	Rover		
Solar System Telescope	DES REQ	Earth Environment	see ref document		
Solar System Telescope	DES REQ	1. Observation spectral band	[0.3, 2.1]		µm
Solar System Telescope	DES REQ	2. Sensitivity	23		AB mag
Solar System Telescope	DES REQ	3. Spatial/angular resolution	0.1		arcsec
Solar System Telescope	DES REQ	4. Focal lenght	20		m
Solar System Telescope	DES REQ	5. Spectral Energy Resolution	DL/L 50		
Solar System Telescope	DES REQ	6. Time Resolution	1		sec
Solar System Telescope	DES REQ	7. Field of View	1x1		deg
Solar System Telescope	DES REQ	8. Data rate	NA		Mbit/sec
Solar System Telescope	DES REQ	9. Overall Mass budget	NA		Kg
Solar System Telescope	DES REQ	10. Overall Volume budget	NA		m^3
Solar System Telescope	DES REQ	11. Overall Power budget	NA		W
Solar System Telescope	DES REQ	12. Operative temperature	NA		°K
Solar System Telescope	DES REQ	13. Lifetime (by ATC)	>10		years
Solar System Telescope	DES SPEC	Observation spectral band		[0.3, 2.1]	µm
Solar System Telescope	DES SPEC	Aperture		2	m
Solar System Telescope	DES SPEC	Scale		6.8	arcsec/mm
Solar System Telescope	DES SPEC	Sensitivity		23	AB mag
Solar System Telescope	DES SPEC	Time Resolution		300	sec
Solar System Telescope	DES SPEC	Mass Budget		450	Kg
Solar System Telescope	DES SPEC	Max power in operative conditions		450	W
Solar System Telescope	DES SPEC	Max power in stand by conditions		50	W
Solar System Telescope	DES SPEC	Data Rate		50	Gbit/sec
Solar System Telescope	DES SPEC	Data Volume		5	Tbit
Solar System Telescope	DES SPEC	Size stowed		1.5x1.5x1.5 -> 1x1x1	m
Solar System Telescope	DES SPEC	Size deployed			
Solar System Telescope	DES SPEC	*Optical Unit (if any)*		0.3x0.3x0.25	m
Solar System Telescope	DES SPEC	*Mechanical Unit (if any)*		4x4x6	m
Solar System Telescope	DES SPEC	*Electronic Unit (if any)*		inluded in mechanics	
Solar System Telescope	DES SPEC	Operative temperature range		150 to 400	K
Solar System Telescope	DES SPEC	Stand by temperature range		200 to 400	K
Solar System Telescope	DES SPEC	Pointing			
Solar System Telescope	DES SPEC	*accuracy*		1	arcsec
Solar System Telescope	DES SPEC	*range*		120AZ90ALT	deg
Solar System Telescope	DES SPEC	Tracking			
Solar System Telescope	DES SPEC	*accuracy*		0.01-0.02	arcsec RMS

Payload Description (ATEC Robotics / INAF-OAC)

Wide Field Lunar Telescope



Scope: See scientific themes of Wide Field DL Survey (WP1330) Optimized design of a robotic telescope architecture that includes the telescope and the imager seen as unique device.

Architecture: The tentative telescope could be based on a Ritchey Cretien optical configuration characterized by a 4-m class primary mirror, 6-m Focal Length and a scale of 8.6 arcsec/mm. The field of view from 2x2° possibly up to 5x5°, requires the presence of a segmented collimator to optimize the field characteristics on an imagers matrix. This combination requires an extremely large number of detectors and the right and more appropriate value will be investigated. Referring to a 2.5x2.5° FoV and a resolution of 0.04 arcsec/pixel obtained with a 5 micron pixel size, it is necessary to organize an equivalent square surface of 1.8Mpix per side. This require new investigation of new technologies and on the methodology to be adopted for the organization and management and on the focal plane. The telescope structure is hexapod derived. Primary mirror will be segmented and the optics control will allow segments aligning and phasing. A rough estimate of telescope optics and mechanics masses is below 1100 kg. The imager camera mass, including electronics, is estimated of the order of 60 kg. Telescope size is around 700x700x700 cm while camera size is around 100 x 100 x 40 cm. Average data volume can be estimated as: 1.8E6 * 1.8E6 * 16 bit * 1 day (about 100 images) = 5000TBit per day maximum. Power consumption is estimated in 150 W for the camera plus the robotic telescope consumption estimated in 550W in operation. Thermal control for the camera and for the telescope is demanded to the telescope control system.

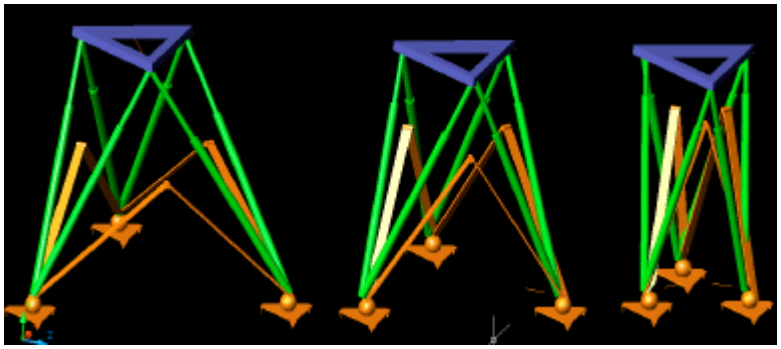
Remark - The telescope structure has been studied to satisfy contemporarily the requirements of various WPs

Payload I/O Table

TYPE	Parameter description	Input Value	Output Value	Units	Remarks
GEN					
SCI OBJ	Scientific objectives 1	Diffraction Lim Survey			
SCI OBJ	Scientific objectives 2	WP1330			
SCI OBJ	Scientific objectives 3				
DES REQ	Embarked on Infrastructure 1	Rover			
DES REQ	Earth Environment	see ref document			ATC-LUNA-ENG-TN-001-A
DES REQ	1. Observation spectral band	[0.3, 2.2]		µm	
DES REQ	2. Sensitivity	28		AB mag	
DES REQ	3. Spatial/angular resolution	0.02-0.05		arcsec	
DES REQ	4. Focal lenght	6		m	
DES REQ	5. Spectral Energy Resolution	DL/L 0.1…0.05			
DES REQ	6. Time Resolution	1		sec	
DES REQ	7. Field of View	2x2 up to 5x5		deg	
DES REQ	8. Data rate	NA		Mbit/sec	
DES REQ	9. Overall Mass budget	NA		Kg	
DES REQ	10. Overall Volume budget	NA		m^3	
DES REQ	11. Overall Power budget	NA		W	
DES REQ	12. Operative temperature	NA		°K	
DES REQ	13. Lifetime (by ATC)	>10		years	
DES SPEC	Observation spectral band		[0.3, 2.2]	µm	
DES SPEC	Aperture		4	m	
DES SPEC	Scale		6.8	arcsec/mm	
DES SPEC	Sensitivity		28	AB mag	
DES SPEC	Time Resolution		850	sec	
DES SPEC	Mass Budget		1100	Kg	Imager 60 Kg; robotic supp. & telesc. 1000 Kg
DES SPEC	Max power in operative conditions		700	W	100W camera; 350W telescope
DES SPEC	Max power in stand by conditions		150	W	
DES SPEC	Data Rate		60	Gbit/sec	
DES SPEC	Data Volume		5000	Tbit	
DES SPEC	Size stowed		1.8x1.8x1.8	m	
DES SPEC	Size deployed				
DES SPEC	*Optical Unit (if any)*		1x1x0.4	m	Imager
DES SPEC	*Mechanical Unit (if any)*		7x7x7	m	Telescope
DES SPEC	*Electronic Unit (if any)*		inluded in mechanics		
DES SPEC	Operative temperature range		250 to 300	K	
DES SPEC	Stand by temperature range		200 to 400	K	
DES SPEC	Pointing				
DES SPEC	*accuracy*		1	arcsec	Relevant to the robotic telescope
DES SPEC	*range*		120AZ90ALT	deg	Relevant to the robotic telescope
DES SPEC	Tracking				
DES SPEC	*accuracy*		0.01-0.02	arcsec RMS	Relevant to the robotic telescope

Payload Description (ATEC Robotics / INAF-OAC)

Lunar Telescope for Earth-Sun observations



Scope: See scientific themes of WP 1100-1500
Optimized design of robotic telescopes structure able to support various payloads described in the WPs.

Architecture: The tentative telescope structure is the same considered in the previous WPs. The telescope structure is Hexapod derived and will be provided of a specialized interface to support the different payloads from ARTSI (40x40x30cm) up to VISIO (100x100x150 cm). The telescope structure is light and transportable as shown in the figure. The telescope model allows the telescope to adapt itself to the ground. The high precision of the movements allow the structure to participate to the deployment phase, demanding to the telescope structure the most precise operations to be done.A rough estimate of telescope structure and electronics is below 50kg. Power consumption is estimated in 200 W for the robotic telescope in operation. The power consumption could increase in the case of SUN observation up to 400W. Thermal control for the camera and for the telescope is a is demanded to the telescope control system.

Remark - The telescope structure has been studied to satisfy contemporarily the requirements of various WPs

Payload I/O Table

ALL DATA TBV					
Element	**TYPE**	**Parameter description**	**Input Value**	**Output Value**	**Units**
Earth-Sun Lunar Telescope WP-1100/1500	**GEN**				
Earth-Sun Lunar Telescope	SCI OBJ	Scientific objectives 1	WP1100/1500		
Earth-Sun Lunar Telescope	SCI OBJ	Scientific objectives 2			
Earth-Sun Lunar Telescope	SCI OBJ	Scientific objectives 3			
Earth-Sun Lunar Telescope	DES REQ	Embarked on Infrastructure 1	Rover		
Earth-Sun Lunar Telescope	DES REQ	Earth Environment	see ref document		
Earth-Sun Lunar Telescope	DES REQ	1. Observation spectral band	WP1100/1500		µm
Earth-Sun Lunar Telescope	DES REQ	2. Sensitivity	WP1100/1500		AB mag
Earth-Sun Lunar Telescope	DES REQ	3. Spatial/angular resolution	WP1100/1500		arcsec
Earth-Sun Lunar Telescope	DES REQ	4. Focal lenght	WP1100/1500		m
Earth-Sun Lunar Telescope	DES REQ	5. Spectral Energy Resolution	WP1100/1500		
Earth-Sun Lunar Telescope	DES REQ	6. Time Resolution	WP1100/1500		sec
Earth-Sun Lunar Telescope	DES REQ	7. Field of View	WP1100/1500		deg
Earth-Sun Lunar Telescope	DES REQ	8. Data rate	NA		Mbit/sec
Earth-Sun Lunar Telescope	DES REQ	9. Overall Mass budget	NA		Kg
Earth-Sun Lunar Telescope	DES REQ	10. Overall Volume budget	NA		m^3
Earth-Sun Lunar Telescope	DES REQ	11. Overall Power budget	NA		W
Earth-Sun Lunar Telescope	DES REQ	12. Operative temperature	NA		°K
Earth-Sun Lunar Telescope	DES REQ	13. Lifetime (by ATC)	>10		years
Earth-Sun Lunar Telescope	DES SPEC	Observation spectral band		WP1100/1500	µm
Earth-Sun Lunar Telescope	DES SPEC	Aperture		WP1100/1500	m
Earth-Sun Lunar Telescope	DES SPEC	Scale		WP1100/1500	arcsec/mm
Earth-Sun Lunar Telescope	DES SPEC	Sensitivity		WP1100/1500	AB mag
Earth-Sun Lunar Telescope	DES SPEC	Time Resolution		WP1100/1500	sec
Earth-Sun Lunar Telescope	DES SPEC	Mass Budget		200	Kg
Earth-Sun Lunar Telescope	DES SPEC	Max power in operative conditions		200	W
Earth-Sun Lunar Telescope	DES SPEC	Max power in stand by conditions		25	W
Earth-Sun Lunar Telescope	DES SPEC	Data Rate		WP1100/1500	Gbit/sec
Earth-Sun Lunar Telescope	DES SPEC	Data Volume		WP1100/1500	Tbit
Earth-Sun Lunar Telescope	DES SPEC	Size stowed		1x1x1.2	m
Earth-Sun Lunar Telescope	DES SPEC	Size deployed			
Earth-Sun Lunar Telescope	DES SPEC	*Optical Unit (if any)*		1x1x1.5	m
Earth-Sun Lunar Telescope	DES SPEC	*Mechanical Unit (if any)*		2.5x2.5x2.5	m
Earth-Sun Lunar Telescope	DES SPEC	*Electronic Unit (if any)*		inluded in mechanics	
Earth-Sun Lunar Telescope	DES SPEC	Operative temperature range		150 to 400	K
Earth-Sun Lunar Telescope	DES SPEC	Stand by temperature range		200 to 300	K
Earth-Sun Lunar Telescope	DES SPEC	Pointing			
Earth-Sun Lunar Telescope	DES SPEC	*accuracy*		1	arcsec
Earth-Sun Lunar Telescope	DES SPEC	*range*		120AZ90ALT	deg
Earth-Sun Lunar Telescope	DES SPEC	Tracking			
Earth-Sun Lunar Telescope	DES SPEC	*accuracy*		10	arcsec RMS