TMT-APS L3 Requirements

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TMT

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Table of Contents

TMT-APS L3 Requirements

1 Introduction

This document will show the APS L3 requirements for each of the sub-assemblies of APS. It will also contain the requirements flow up to L2. All of this is done in SysML and exported through a web interface.

L2 APS, which is maintained in DOORS by TMT is syncronized with our SysML model through RedIF files. Those are documented in the TMT-APS Requirements Flowdown document.
The earlier sections of the document will eventually have explanation of how these requirements came about and may also contain some of the breakdown of for example Mass, Power, and throughput requirements.
The actual sets of L3 requirements will be in tables in later chapters. For now, we only have the L3 APT ones. The first table shows the requirement ID, Name, Text, Description, and Refines (which are the parents at L2). The second table lists the ID, Name, SE Notes, and APS Notes.

2 L3 APT Requirements

This chapter will eventually contain views of particularly important requirements, and also the breakdown of some of the requirements.

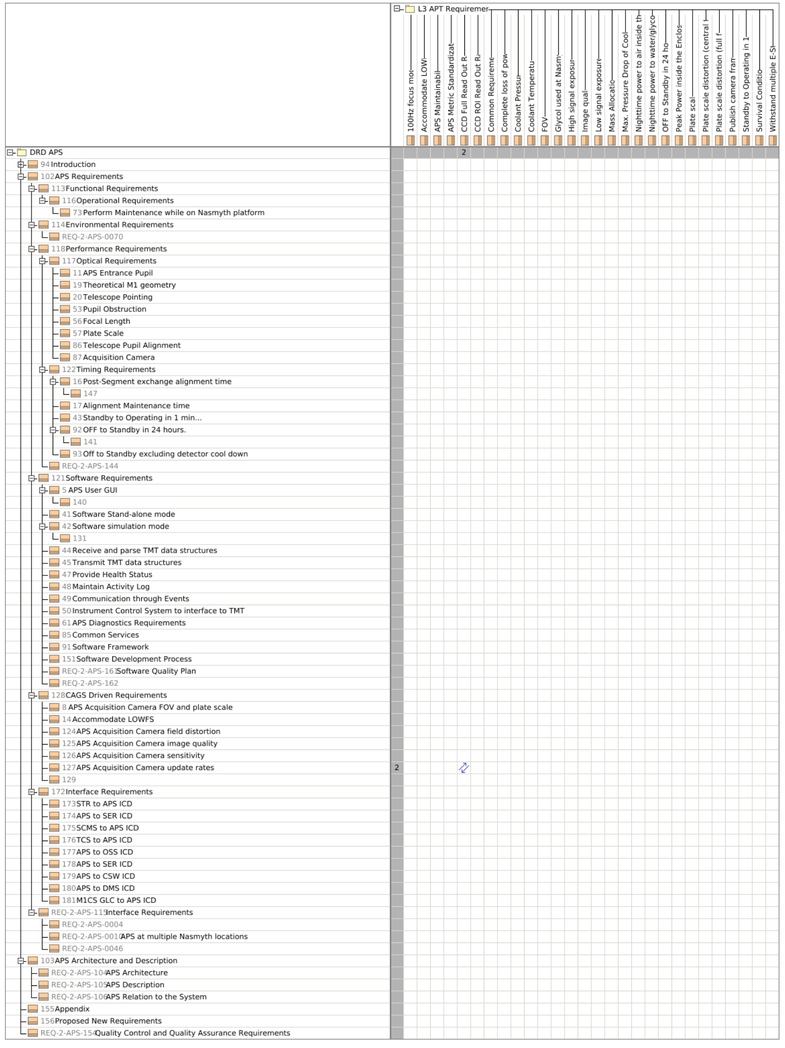
APS Parents and Comments

#	

L1 TMT to L2 APS Requirements Mapping

	01a Parent Requirements (OLD: to be removed once they no longer	Dependency[->] TMT::02 JPL::System Model::APS::01 APS Operationa	Dependency[->] TMT::02 JPL::System Model::APS::01 APS Operationa	Dependency[->] TMT::02 JPL::System Model::APS::01 APS Operationa	REQ-1-ORD-1376 Component Functional Conditions TMT::02 JPL::System M
03 APS Requirements individual views					
APS Architecture Requirements					
APS can't phase isolated segment groups					
APS commands					
APS Starlight					
Incomplete Mirror					
APS Environmental Requirements					
Ambient Operating Temperature					
Complete loss of power					
Coolant Pressure					
Coolant Temperatures					
Daylight Calibration					
Glycol used at Nasmyth					
Max Pressure Drop of Coolant					
Minimize Vibrations					
Observing Conditions					
APS Interface Requirements					
APS at multiple Nasmyth locations					
Backup Generator Power inside the Enclosure					
Backup Generator Power inside the Summit Facilities Building					
Communication through Events					
Daytime power to air inside the Summit Facilities Building					
Daytime power to Glycol inside the Enclosure					
Expected Annualized average power inside the Enclosure					
Expected Annualized average power inside the Summit Facilities Building					
Instrument Control System to interface to TMT					
Maintain Activity Log					
Mass Allocation: Electronics and Misc					
Mass Allocation: Instrument					
N^2					
Nighttime power to air inside the Summit Facilities Building					
Peak Power inside the Enclosure					
Peak Power inside the Summit Facilities Building					
Power Distribution					
UPC Power inside the Enclosure					
UPC Power inside the Summit Facilities Building					
Volume Allocation: Bench					
APS Operational Requirements					
APS Diagnostics Requirements					
APS Optical Requirements					
Acquisition Camera					
APS Entrance Pupil					
APS Hazard Analysis and Safety Practices					
Focal Length					
Perform Maintenance while on Nasmyth platform					
Plate Scale					
Pupil Obscuration					
Telescope Pointing					
Telescope Pupil Alignment					
Theoretical M1 geometry					
APS Performance Requirements					
APS Maintenance Alignment Capture Range					
APS Post-Segment Exchange Capture Range					
Off-Axis measurements					
Segment Measurement Error					
Segment out-of-plane residual error					
Segment tip/tilt/piston measurement error post AO					
APS Product Assurance Requirements					
APS Life Time					
APS max. Down Time					
Diagnostics Telemetry					
Electromagnetic Radiation					
Emergency Stop Switches shall interface wit OSS					
Environmental Regulations and Standards					
Fault Detection Notifications					
Minimize Hazardous Conditions					
Provide Emergency Stop Switches					
Safety Priorities					
Self monitor operations					
Self Monitoring					
Send hazardous faults to OSS					
Take action to mitigate hazards					
Withstand multiple E-Stops					
APS Programmatic Requirements					
APS Maintainability and Standardization					
APS Manuals, as build drawings, and parts lists					
APS Responsibility					
APS Spares					
APS User GUI					
Comply with standards					
TMT Location					
APS Software Requirements					
Common Services					
Receive and parse TMT data structures					
Software can be in stand-alone					
Software Framework					
Software has a simulation mode					
Startup within 1 min.					
Transmit TMT data structures					
APS Timing Requirements					
Alignment Maintenance time					
Off to Standby excluding detector cool down					
OFF to Standby in 24 hours.					
Post-Segment exchange alignment time					
Provide Health Status					
CAGS Driven Requirements					
Accommodate LOWFS					
APS Acquisition Camera FOV					
ICD Requirements					

L3 APT to L2 APS Requirement Mapping



Reworked Table of L2 APS Requirements: Key

Name	Key	#
APS Acquisition Camera FOV and plate scale	Key	1
Telescope Pointing	Key	2

Table of L1 Parent Requirements

#	Id	Name	Text
1	REQ-1-ORD-1375	Component Functional Conditions	[REQ-1-ORD-1375] All mechanical and electrical components of the system shall be designed to function over the range of the Component Functional conditions listed in Table 3.

Table of L2 APS Requirements: All

#	Id	Name	Text
1	REQ-2-APS-0004		APS shall comply with the interface documents specified in the [AD15] TMT Interface N^2 Diagram.
2	5	APS User GUI	**[REQ-2-APS-0005]** APS shall provide an expert user GUI, which includes: • low-level technical software parameter settings that are modifiable during operations. • low-level engineering functions that can be executed by an expert user. • the ability to operate in standalone mode.
3	8	APS Acquisition Camera FOV and plate scale	**[REQ-2-APS-0008]** APS shall have an acquisition camera with a one arcminute diameter field of view and a plate scale finer than 0.025 arcsec/pixel, which can be used by APS for star acquisition as well as CAGS for telescope pointing, acquisition, and tracking tests.
4	REQ-2-APS-0010	APS at multiple Nasmyth locations	APS shall be able to operate at on and off axis Nasmyth mounting positions.
5	11	APS Entrance Pupil	**[REQ-2-APS-0011]** APS shall use the primary mirror as its pupil.
6	14	Accommodate LOWFS	**[REQ-2-APS-0014]** APS shall provide a location for mounting a Low Order Wavefront Sensor (LOWFS), similar in functionality to the one used in the seeing limited instruments.
7	16	Post- Segment exchange alignment time	**[REQ-2-APS-0016]** APS shall be able to perform on-axis alignment in less than 120 minutes (at a single elevation angle) when all optics are within the post-segment exchange specifications.
8	17	Alignment Maintenance time	**[REQ-2-APS-0017]** APS shall be able to perform on-axis alignment in less than 30 minutes (at a single elevation angle) when all optics are within the alignment maintenance specifications.
9	REQ-2-APS-0016	Segment Measurement Error after AO	The APS measurement error of the M1 segments shall be less than 10 nm after AO-compensation processing
10	19	Theoretical M1 geometry	**[REQ-2-APS-0019]** APS shall be designed to the TMT M1 theoretical perfect geometry as documented in the TMT M1 Segmentation Database (AD2).

#	Id	Name	Text
11	20	Telescope Pointing	**[REQ-2-APS-0020]** APS shall be designed to acquire objects given a telescope pointing accuracy of 3 (TBC) arcseconds RMS.
12	41	Software Stand-alone mode	**[REQ-2-APS-0041]** APS software shall be capable of operating in a stand-alone mode, needing only the TMT Common Services, as defined in (RD6).
13	42	Software simulation mode	**[REQ-2-APS-0042]** APS software shall support a simulation mode, which will simulate the APS Instrument Control System (ICS) functionality.
14	43	Standby to Operating in 1 min...	**[REQ-2-APS-0043]** APS shall be able to transition from Standby Mode to Operational Mode in less than 1 minute (TBC), including initialize itself with a default configuratio n and without further human intervention.
15	44	Receive and parse TMT data structures	**[REQ-2-APS-0044]** The APS ICS software shall receive and parse TMT defined data structures containing command, control, and configuration instructions.
16	45	Transmit TMT data structures	**[REQ-2-APS-0045]** APS software shall transmit TMT-defined data structures containing health, status, and history (log) information as well as any science or technical dat a to be captured and stored by the local observatory database.
17	REQ-2-APS-0048	APS contribution to Sys. Demand Load inside the Summit Facilities Building	APS shall have a Contribution to the System Demand Load the Summit Facilities Building of less than 0.6 kW
18	47	Provide Health Status	**[REQ-2-APS-0047]** The APS ICS shall provide health information (e.g. active, idle, error, etc.) through a subscription at up to 1 Hz.
19	48	Maintain Activity Log	**[REQ-2-APS-0048]** APS shall transmit a time-stamped activity log to the local observatory database using common services.
20	49	Communication through Events	**[REQ-2-APS-0049]** APS shall be able to transmit and receive software events using the event service provided by common services.
21	50	Instrument Control System to interface to TMT	**[REQ-2-APS-0050]** APS shall have an Instrument Control System (ICS) that encompasses all the necessary software subsystems (e.g. HCD, component controller, detect or controller, etc.) needed to command and control the instrument as well as interface it to the rest of the TMT software system.
22	53	Pupil Obstruction	**[REQ-2-APS-0053]** APS shall accommodate the pupil obscuration pattern of the telescope as shown in Figure 3-1 (AD14).
23	56	Focal Length	**[REQ-2-APS-0056]** APS shall accommodate a telescope final focal length of 450 m +/- TBD m.
24	57	Plate Scale	**[REQ-2-APS-0057]** APS shall accommodate a telescope focal plane image scale of 0.458366 +/- TBD arcsec/mm.
25	61	APS Diagnostics Requirements	**[REQ-2-APS-0061]** APS ICS shall produce status and diagnostic telemetry for the purposes of performance monitoring and failure analysis.
26	REQ-2-APS-0067	APS GUI with engineering data	APS shall publish performance-related engineering parameters, such as residual errors, internal temperatures of instruments, etc. along with their normal ranges, and notifi cations if these normal ranges are exceeded.
27	REQ-2-APS-0072	Component Functional Conditions	The APS mechanical and electrical components shall function over the range of Component Functional Conditions, which are: • Ambient air temperature range of-13 C to +25 C • Ambient air pressure range of 600 hPa to 1015 hPa (TBC) • Ambient air relative humidity of 0% to 100%, condensing conditions for components external to the enclosure, non-condensing internal to the enclosure
28	73	Perform Maintenance while on Nasmyth platform	**[REQ-2-APS-0073]** The APS service and maintenance operations shall be possible while located on the Nasmyth Platform, from access positions defined in the STR-APS ICD (AD4).
29	85	Common Services	**[REQ-2-APS-0085]** APS shall communicate and integrate with the other OESA systems using the TMT common software services as defined in [REQ-1-OAD-9200].
30	86	Telescope Pupil Alignment	**[REQ-2-APS-0086]** APS shall measure the position the telescope pupil to an accuracy of 0.03% the diameter of the pupil.
31	92	OFF to Standby in 24 hours.	**[REQ-2-APS-0092]** APS shall be able to transition from OFF to Standby Mode in less than 24 hours (TBR).
32	93	Off to Standby excluding detector cool down	**[REQ-2-APS-0093]** APS shall be able to transition from OFF to Standby Mode in less than 10 minutes (TBR) excluding any time needed for detector cool down.
33	87	Acquisition Camera	**[REQ-2-APS-0087]** APS shall have an acquisition camera with a 1 arcmin diameter FOV (on the sky).
34	91	Software Framework	**[REQ-2-APS-0091]** APS shall be built using the standard TMT software framework as provided by TMT Common Software and described in TMT Software Design Docum ent Volumes 1 (RD7) and 2 (RD8).

Table of L2 APS Requirements: Driving

#	Id	Name	Text	Driving	Driving
1	8	APS Acquisition Camera FOV and plate scale	**[REQ-2-APS-0008]** APS shall have an acquisition camera with a one arcminute diameter field of view and a plate scale finer than 0.025 arcsec/pixel, which can be used by APS for star acquisition as well as CAGS for telescope pointing, acquisition, and tracking tests.	Driver - Technical	Driver - Technical
2	86	Telescope Pupil Alignment	**[REQ-2-APS-0086]** APS shall measure the position the telescope pupil to an accuracy of 0.03 % the diameter of the pupil.	Driver - Technical	Driver - Technical

Table of L2 APS Requirements: Key

#	Id	Name	Text	Key	Key
1	8	APS Acquisition Camera FOV and plate scale	**[REQ-2-APS-0008]** APS shall have an acquisition camera with a one arcminute diameter field of view and a plate scale finer than 0.025 arcsec/pixel, which can be used by APS for star acquisition as well as CAGS for telescope pointing, acquisition, and tracking tests.	Key	Key
2	20	Telescope Pointing	**[REQ-2-APS-0020]** APS shall be designed to acquire objects given a telescope pointing accuracy of 3 (TBC) arcseconds RMS.	Key	Key

Table of L2 APS Requirements: SE View

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1	REQ-2-APS-0004		APS shall comply with the interface documents specified in the [AD15] TMT Interface N^2 Diagram.
2	5	APS User GUI	**[REQ-2-APS-0005]** APS shall provide an expert user GUI, which includes: • low-level technical software parameter settings that are modifiable during operations. • low-level engineering functions that can be executed by an expert user. • the ability to operate in standalone mode.
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#	Id	Name	Text
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32	91	Software Framework	**[REQ-2-APS-0091]** APS shall be built using the standard TMT software framework as provided by TMT Common Software and described in TMT Software Design Document Volumes 1 (RD7) and 2 (RD8).

Table of L3 APT Requirements

#	TMT ID	Id	Name	Text	Satisfies	Key	Driving	SE Notes
1	REQ-3-APT-0001		FOV					

#	TMT ID	Id	Name	Text	Satisfies	Key	Driving	SE Notes
2	REQ-3-AP T-0002		Plate scale					
3	REQ-3-AP T-0003		Plate scale distortion (full field)					
4	REQ-3-AP T-0004		Plate scale distortion (central field)					
5	REQ-3-AP T-0005		Image quality					
6	REQ-3-AP T-0006		CCD Full Read Out Rate					
7	REQ-3-AP T-0007		CCD ROI Read Out Rate					
8	REQ-3-AP T-0008		Publish camera frames					
9	REQ-3-AP T-0009		Low signal exposures					
10	REQ-3-AP T-0010		High signal exposures					
11	REQ-3-AP T-0011		100Hz focus mode					
12	REQ-3-AP T-0012		Accommodate LOWFS					
13	REQ-3-AP T-0013		Coolant Temperatures					
14	REQ-3-AP T-0014		Coolant Pressure					
15	REQ-3-AP T-0015		Max. Pressure Drop of Coolant					
16	REQ-3-AP T-0016		Glycol used at Nasmyth					
17	REQ-3-AP T-0017		Peak Power inside the Enclosure					
18	REQ-3-AP T-0018		Nighttime power to water/glycol inside the Enclosure					
19	REQ-3-AP T-0019		Nighttime power to air inside the Enclosure					
20	REQ-3-AP T-0020		Mass Allocation					
21	REQ-3-AP T-0021		Complete loss of power					
22	REQ-3-AP T-0022		Survival Conditions					
23	REQ-3-AP T-0023		Withstand multiple E-Stops					
24	REQ-3-AP T-0024		APS Maintainability					
25	REQ-3-AP T-0025		APS Metric Standardization					
26	REQ-3-AP T-0026		Standby to Operating in 1 min					
27	REQ-3-AP T-0027		OFF to Standby in 24 hours					
28	REQ-3-AP T-0028		Common Requirements					

Verification Activities

#	

3 L3 APT Requirements Table

#	ID	Name	Requirement Text	Description	Refines
1		Plate scale distortion (full field)			
2		Complete loss of power			
3		APS Metric Standardization			
4		Coolant Pressure			
5		CCD Full Read Out Rate			
6		Coolant Temperatures			
7		FOV			
8		Nighttime power to air inside the Enclosure			
9		100Hz focus mode			
10		Glycol used at Nasmyth			
11		Publish camera frames			
12		Survival Conditions			
13		CCD ROI Read Out Rate			
14		Accommodate LOWFS			
15		Peak Power inside the Enclosure			
16		Standby to Operating in 1 min			
17		APS Maintainability			
18		Common Requirements			

#	ID	Name	Requirement Text	Description	Refines
19		High signal exposures			
20		Max. Pressure Drop of Coolant			
21		Withstand multiple E-Stops			
22		Plate scale			
23		Image quality			
24		OFF to Standby in 24 hours			
25		Mass Allocation			
26		Low signal exposures			
27		Plate scale distortion (central field)			
28		Nighttime power to water/glycol inside the Enclosure			

4 L3 APT Requirements SE Notes

#	ID	Name	SE Notes	APS Notes
1		Plate scale distortion (full field)		empty
7		FOV		empty

5 L3 Empty Requirements