Development of National Space Capabilities

National Space Conference 2023

Tebogo Mokgalagadi

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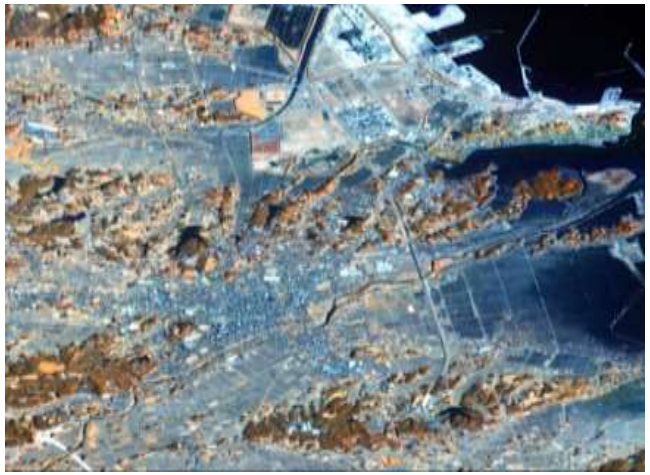
Development of National Space Capabilities
Presentation Content

- Mandate
- EO-SAT1 Satellite Development Programme
- Optical Test Frame (OTF) Development Project
- Concurrent Design Engineering Facility
- Houwteq Assembly Integration and Test (AIT) Facility Upgrade
- Paardefontein Radiometric Calibration Site
- Technology Development Projects
- Future Missions

Space Engineering Programme

- The co-ordinated development and operation of satellite systems, sensors and sub-systems
- State of the art satellite assembly, integration and test services
- An environment conducive to enhancing the competitiveness of the industry
- The development of human capital in Space Engineering



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Space Engineering Strategic Framework

Space Missions

Earth Observation
Science
Experimental
Communication
HCD

Industry Development

Technology Development
Management
Development of Centre of Competence
Innovation Platform
Local and International Partnerships

Facility development

AIT
CAL/Val

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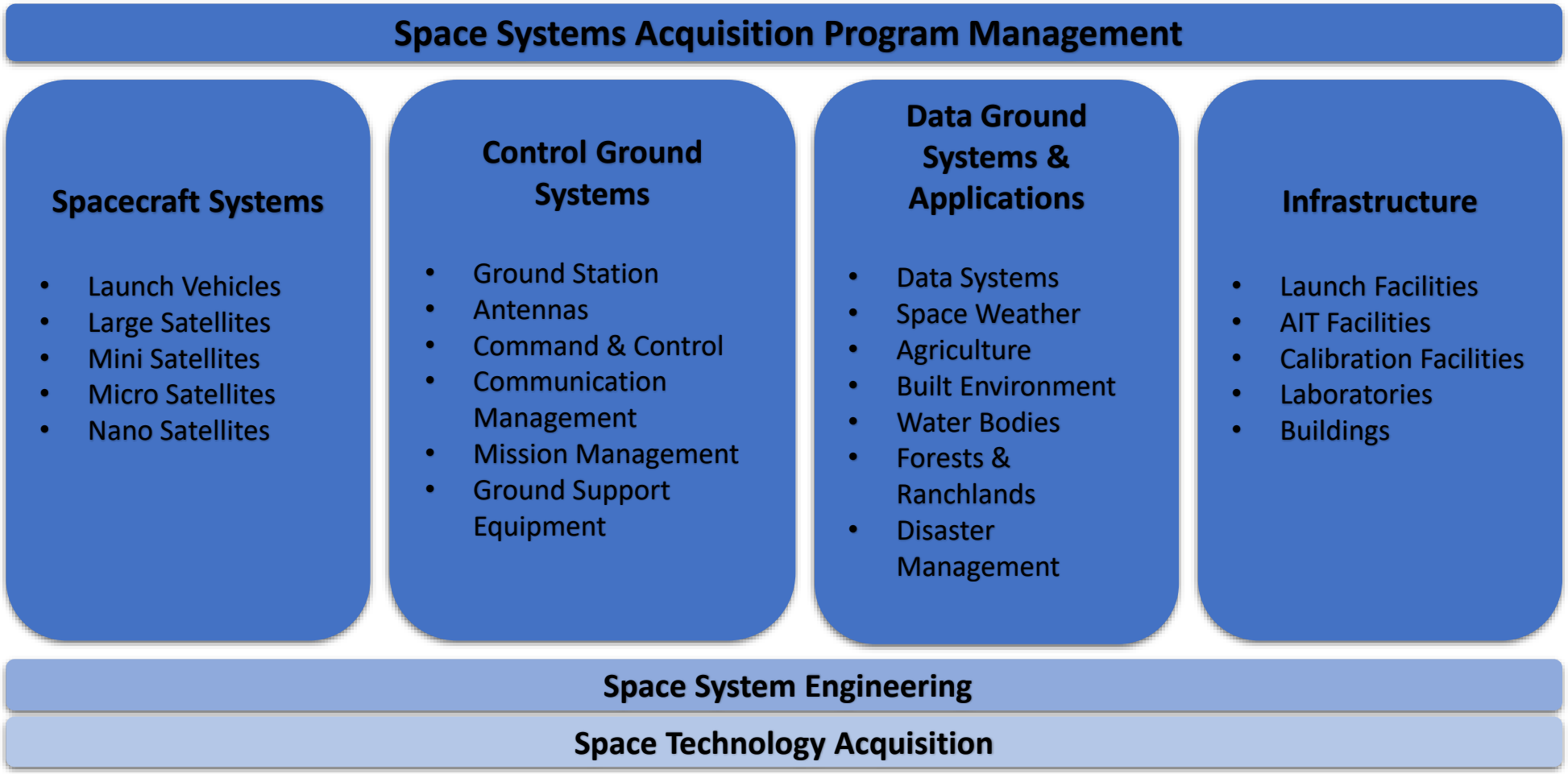
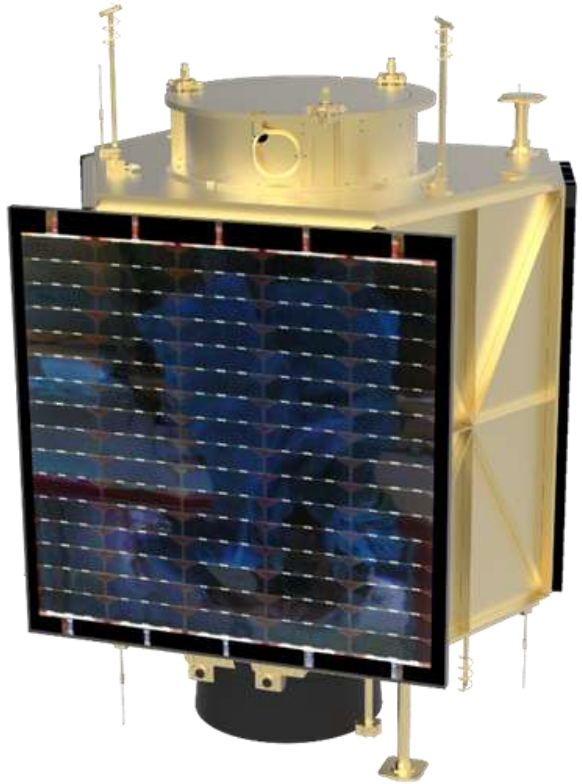
South African Space User Requirements

Key Priority Areas	Specific Needs	Earth Observation										Navigation & Positioning	Communication	Space Exploration
		Spatial Resolution Required								Temporal Frequency	Geographic Area			
		< 50cm	50cm - 1m	1m - 2.5m	2.5m - 5m	5m - 10m	10m - 20m	20m - 30m	>30m					
Environmental Resource Management	Environmental and geospatial monitoring				•	•	•	•	•	Annual	National	•	•	•
	Ocean, coastal and marine management		•	•	•	•	•	•	•	Annual	SADC	•	•	•
	Land management				•				•	Seasonal	National	•	•	•
	Rural development and urban planning		•	•	•					Annual	National	•	•	•
	Topographic mapping						•	•		Annual	National	•	•	•
	Hydrological monitoring					•	•			Twice per annum	National	•	•	•
	Climate change mitigation and adaptation					•	•			Daily	SADC	•	•	•
	Meteorological monitoring		•	•	•	•	•	•	•	Daily	SADC	•	•	•
Health, Safety & Security	Disaster monitoring and relief	•	•	•	•	•	•		•	Daily when required	SADC	•	•	•
	Hazard forecasting and early warning					•	•	•	•	Twice per annum	SADC	•	•	•
	Cross-border risks	•	•	•		•			•	2-4 times per annum	SADC	•	•	•
	Disease surveillance and health risk					•	•			Twice per annum	National	•	•	•
	Asset monitoring									Continuous	SADC	•	•	•
	Regulatory enforcement	•	•	•		•			•	2-4 times per annum	National	•	•	•
	Defence, peacekeeping and treaty monitoring	•	•	•		•			•	High turn around time	Africa	•	•	•
Innovation & Economic Growth	Tourism and recreation				•	•	•	•	•	Annual	National	•	•	•
	Communication									Continuous	SADC	•	•	•
	Space science and exploration										National	•	•	•
	Space technology transfer and spin-offs			•	•	•					National	•	•	•
	Development of the space industry			•	•	•					National	•	•	•

Space Systems Acquisition



EO-Sat1 Satellite Development Programme



EO-Sat1 Satellite Specification

	Specification	EO-Sat1
Payload	Narrow angle Hi-res	*2.5 m-GSD (red-edge, yellow)* *10 m-GSD (8 bands)*
	Hi-res swath	*30 km*
	Wide angle Med-res	*15 m-GSD (red-edge, yellow)* *60 m-GSD (8 bands)*
	Med-res swath	*180 km*
	Spectral bands	*10*
	Video capable (narrow angle)	*Yes*
Bus	Development flight heritage	*SunSat, Client-1 &* *SumbandilaSat*
	Comms	*UHF, VHF, S and X bands*
	ADCS and bus electronics	*Fully dual redundant*
	Propulsion	*30 m/s*
	De-orbit capability (25 yr)	*Yes*
Mission & Orbit parameters	Total launch mass	*500 kg*
	Orbit (km)	*Sun-synchronous, 700 km*
	Mission life	*5 yrs nominal (7 yrs design)*

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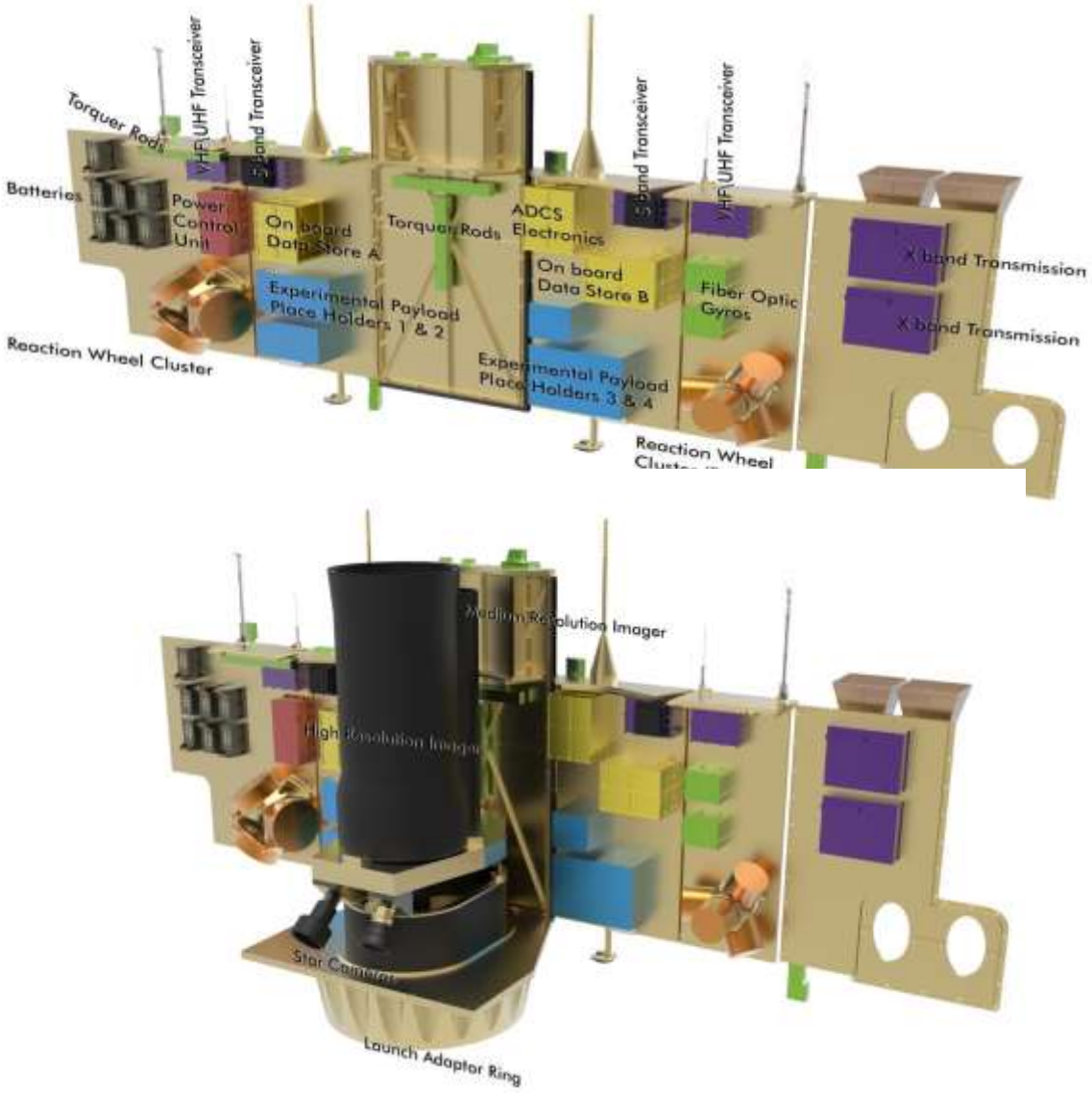
Figure: EO-Sat1 Satellite Blow Up View



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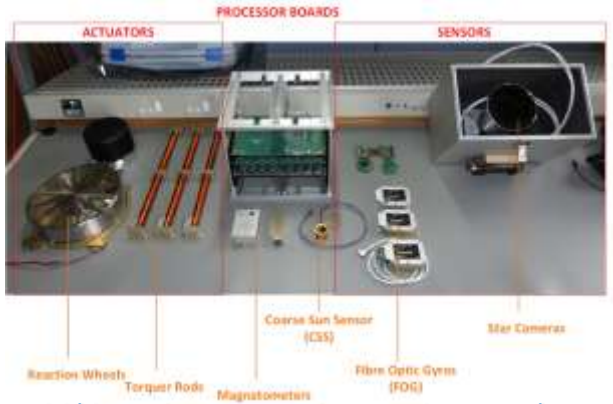
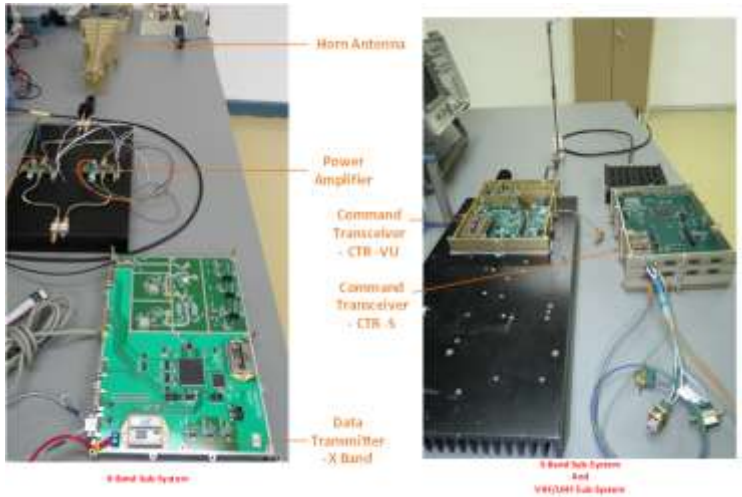
EO-Sat1 Satellite Developmental Models Hardware



Attitude and Determination



Power Distribution Unit

Communications Subsystem

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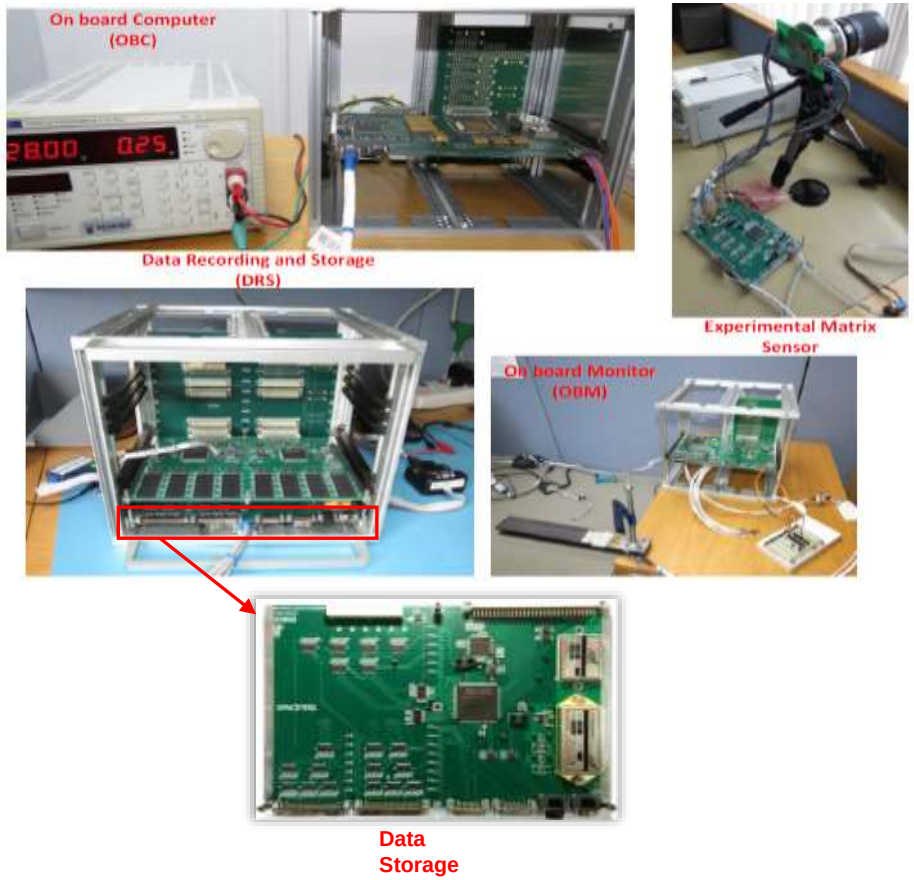
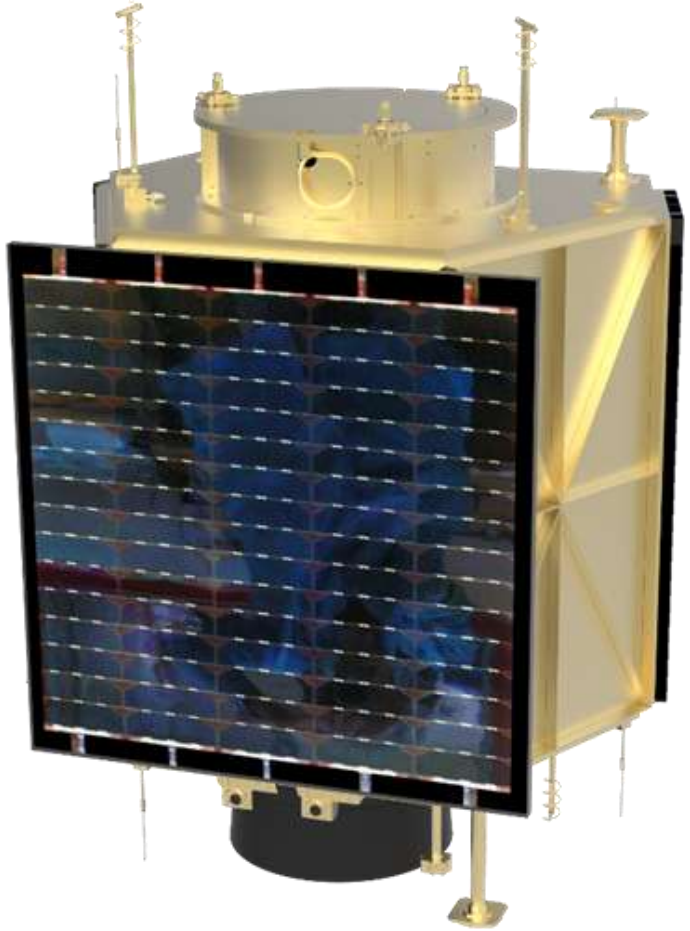
EO-Sat1Satellite Developmental Models Hardware (Cont.)



Data Handling Subsystem

EO-Sat1 Satellite Completion!!!



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Optical Test Frame (OTF) Assembly

SPECIFICATIONS	
Structural mass	10ton
Dimensions	3m x 3m
Height	9m

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OPTICAL TEST FRAME	
Seismic Base (SB)	200 ton decoupled, fully grounded anti-static 5m x 7m working floor area.
Seismic Facility Super Structure (SFSS)	Modular structure which houses all optical AIT instruments & equipment.
Interferometric Test Bench (ITB)	Interferometric performance measurement & alignment of individual optics or assembled optical systems.
Assembly Test Bench (ATB)	Assembly and alignment of optics within space application telescope structures. Optical axis vertical / rotation applied, alignment and measurement methodology.
Collimator Test Bench (CTB)	Vertical collimator used to characterize optical systems.
Liquid Mirror Test Bench (LMTB)	A base mounted, flat optical surface, used for auto collimation.
OTF Controller	Provides the capability to automate complex functions and remotely access and execute sensitive procedures.

Optical Test Frame (OTF) Completion!!!

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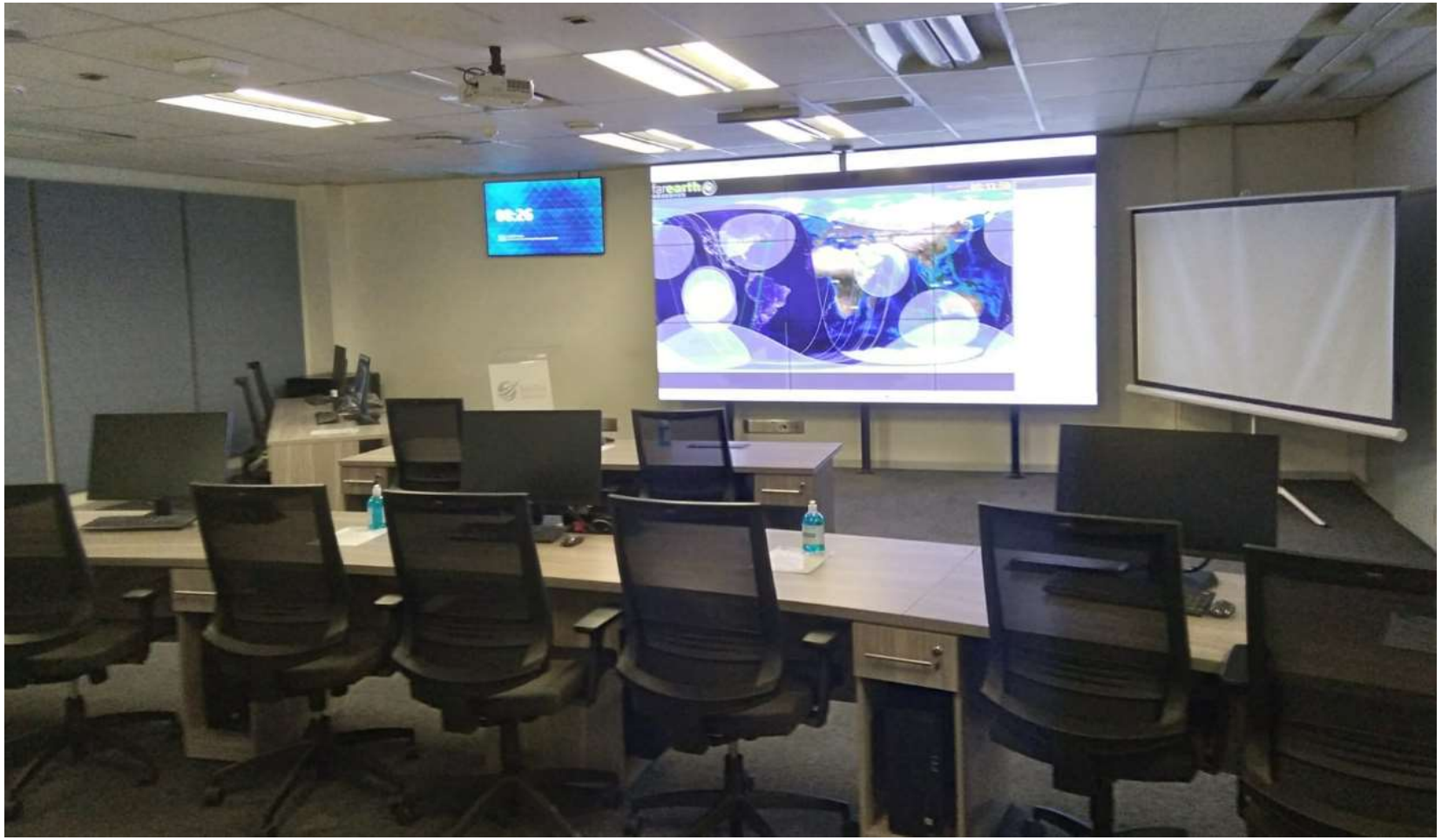
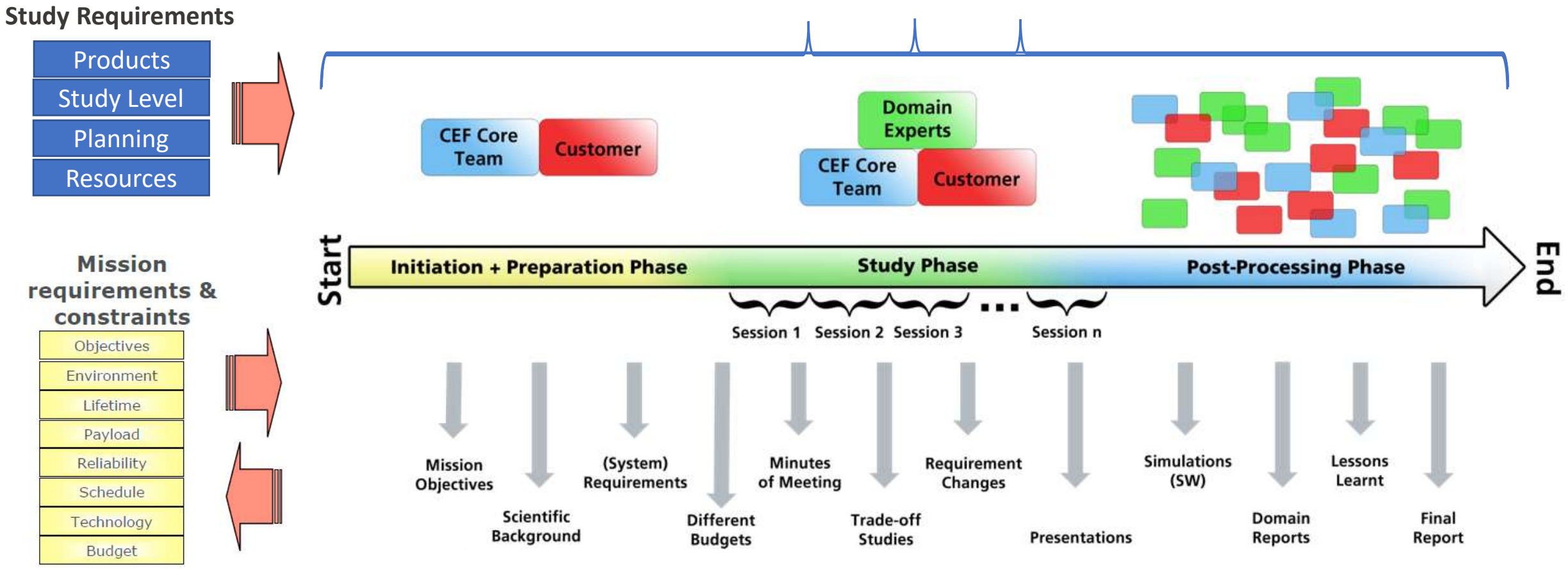
Concurrent Design Engineering Facility (Pilot)



Performance Measure	Benefit
Development Time	30-50% less
Engineering changes	60-95% less
Scrap and rework	75% reduction
Defects	30-85% fewer
Time to market	20-90% less
Field failure rate	60% less
Service life	100% increase
Overall quality	100-600% higher
White collar productivity	20-110% higher
Return on assests	20-120% higher

Source: Lawson and Karandikar 1994

Concurrent Engineering Process



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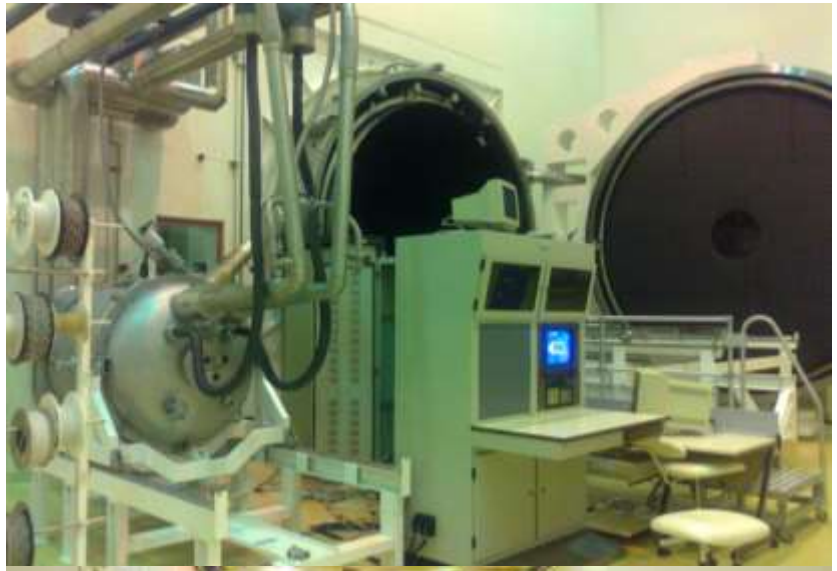
Assembly, Integration Facility (AIT) Upgrade!!!

Equipment

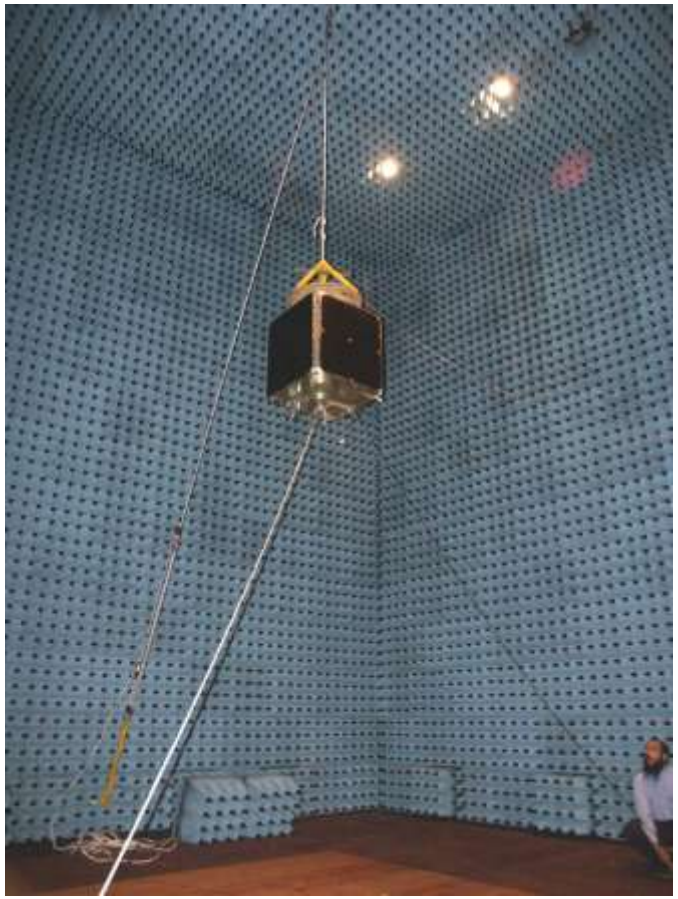
- Satellite Assembly, Integration and Testing (AIT) Facility
- Thermal Vacuum Chamber (Large and Medium Chambers) Test Facility
- Electromagnetic Compatibility Testing (EMC) Facility
- Vibration Shaker Testing Facility
- Acoustic Chamber Testing Facility
- Optical Development and Testing Equipment
- 3-Dimensional Measurement Facility
- Space Material Properties Measurement Facility



Vibration Facility

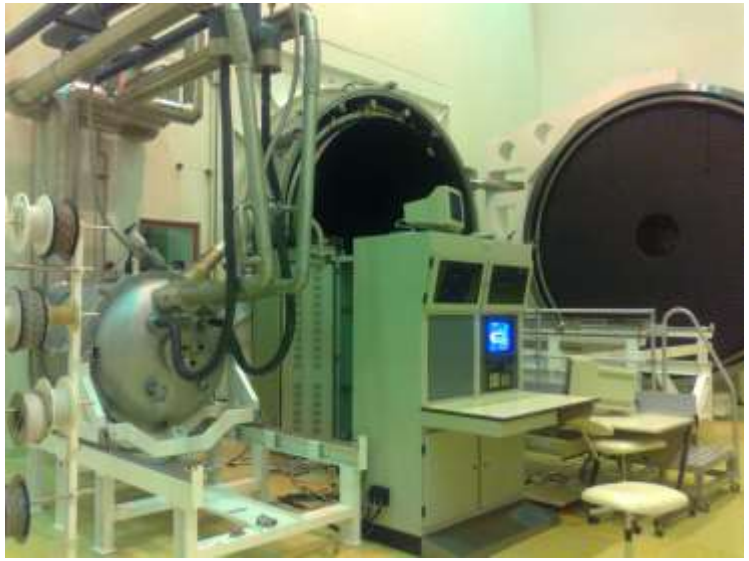
SPECIFICATIONS	
Static Load	1363 kg
Force	160kN
Frequency	5 Hz to 2Hz
Dimensions	1.5m x 1.5m
	Dimensions 1.5m
Crane	10 ton
	10m

Anechoic Chamber



SPECIFICATIONS	
Dimensions	8m x 7m x 8m
	10m
Tests	Electrostatic discharge
	Radiates susceptibility
	Fast transient bursts
	Surges
	Magnetic Immunity

Thermal Vacuum Chamber



SPECIFICATIONS	TVC LARGE
Temperatures	-150 °C
	120 °C
Vacuum	1×10^{-6}
Dimensions	3.4m
	3.8m

SPECIFICATIONS	TVC MEDIUM
Temperatures	-150 °C
	120 °C
Vacuum	1×10^{-6}
Dimensions	0.7m
	0.9m

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Collimator: Electro-optical Testing System

Radiometric Calibration Site

PAARDEFONTEIN RADIOMETRIC CALIBRATION SITE
Dimensions: 100m x 100m
Located away from the ocean
Located in a High Flat Area

ZA-Cube1 (Tshepiso Sat)

- Launched 21 Nov 2013
- First nanosatellite developed on the African continent.
- Top 25% club of successful university nano-satellite missions

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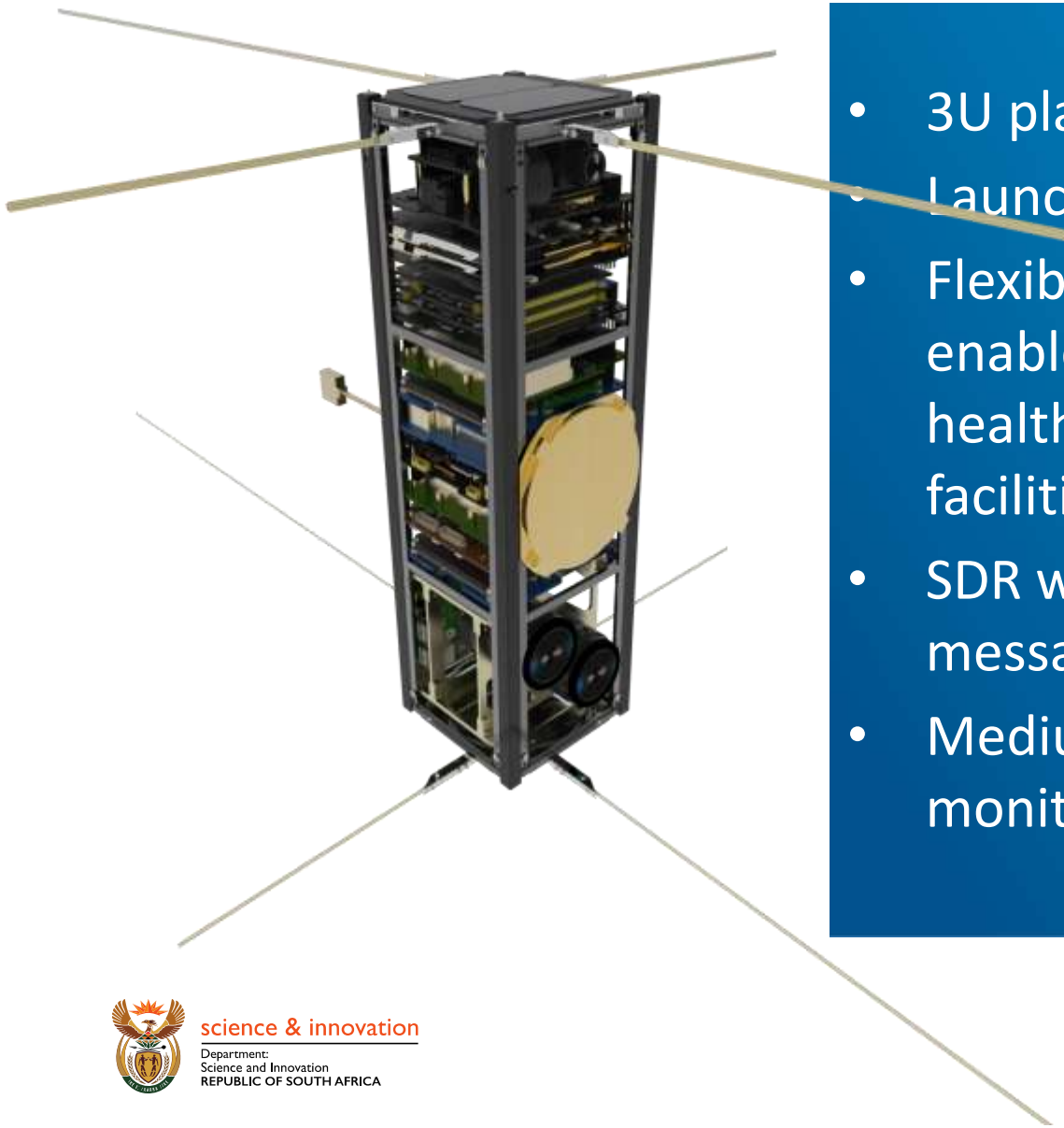
ZA-Cube 2



- 3U platform
- Launch 25 December 2018
- Flexible Software Defined Radio to enable rural connectivity to remote health clinics and educational facilities
- SDR will allow reception of AIS message and will be VDES capable
- Medium resolution imager to monitor veld fires.

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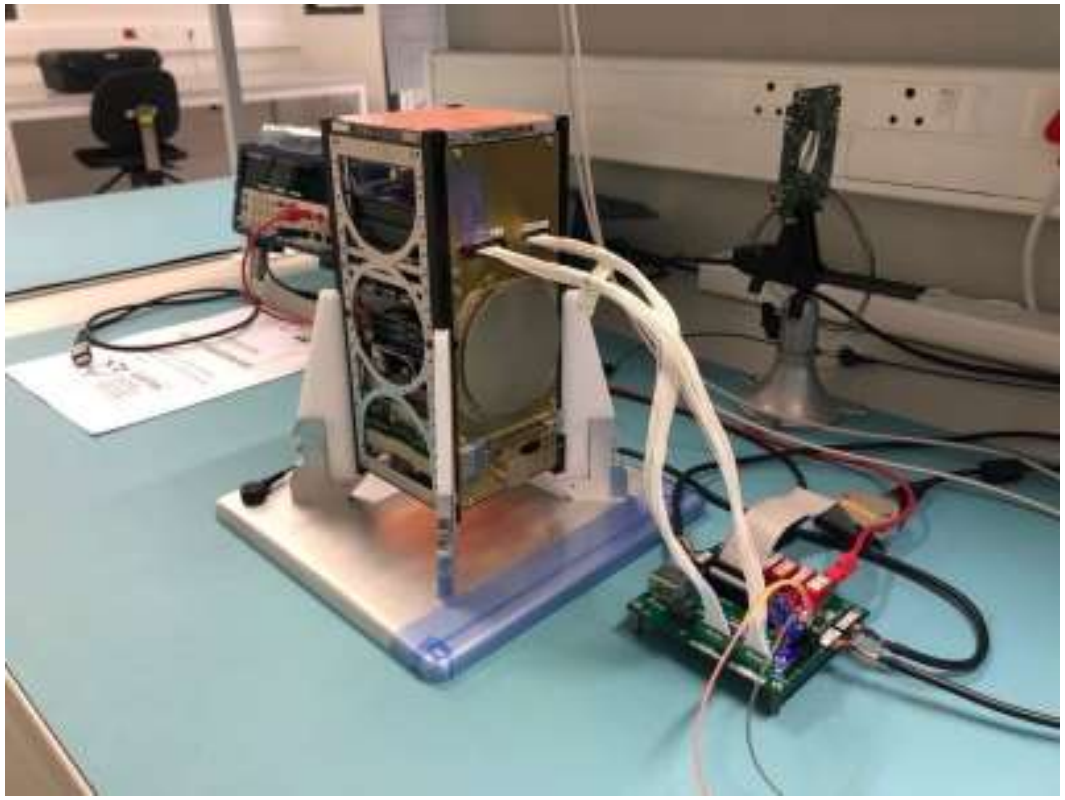
MDASat-1



- 3U Platform
- Launched 13 January 2022
- Demonstrate AIS capabilities in a constellation

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M2MSat

- Launch was planned for Q4 2022/ Q1 2023
- M2MSat mission will demonstrate the very high frequency (VHF) Data Exchange System (VDES) capabilities of a new SDR payload for satellite-to-ship and ship-to-satellite communication.
- Hosts an improved payload compared to ZACube-2 and MDASat-1.

Phoenix 1D Rocket Hybrid Launch

Space Engineering Programme
Projects to be transferred to SANSA

1. K-Line Sensor Development
2. Synthetic Aperture Radar (SAR) Development
3. Launch Capability Establishment
4. Cube Sats Programme
    - MDASat Mission Constellation
    - M2Msat Mission

Future Space Engineering Programs

1. Space Infrastructure Hub (SIH)
   - Earth Observation Mission
   - Space Science Mission (Space Weather Satellite)
2. SAR Satellite Mission
3. Electro-Optic Sensors Center of Competence (COC)
4. Constellations!!!

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