UniMAP ACS

Attitude Control System for InnoSAT

A Research Collaboration of

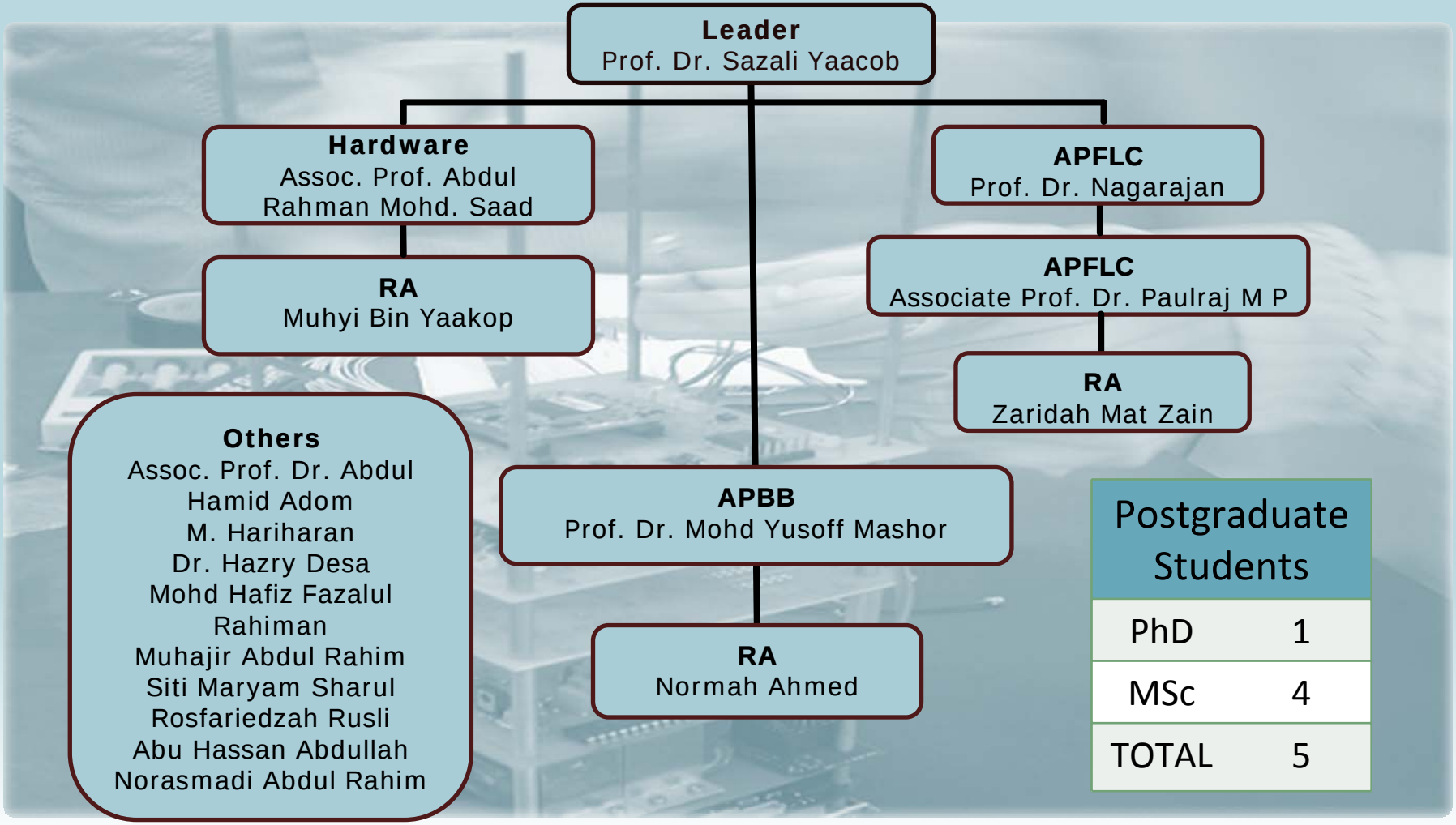
ANGKASA MALAYSIA
Ministry of Science, Technology & Innovation

ATSB

MOSTI

UniMAP
Universiti Malaysia Perlis

Research Members



Postgraduate Students	
PhD	1
MSc	4
TOTAL	5

Table of Contents

Mission & Objectives

Mission Statement

To design, develop and implement indigenous UniMAP ACS

Primary Objectives

To test advanced control algorithms for the InnoSAT attitude control

To utilize the available attitude knowledge of InnoSAT to provide the attitude control using different control algorithms

Secondary Objective

To evaluate control algorithm performance with unpredictable conditions

Project Development

- Scope of Work (SOW)
- System Design Review (SDR)
- Preliminary Design Review (PDR)
- Critical Design Review (CDR)
- Flight Readiness Review (FDR)
- Operation Readiness Review (ORR)

Cont..

Stage	Date	Status
SOW	3/10/2006	Completed
SDR	11/8/2006	Completed
PDR	3/10/2006	Completed
CDR	30/7/2007	Completed
FRR	24/4/2008	Completed
ORR	10/3/2009	Completed

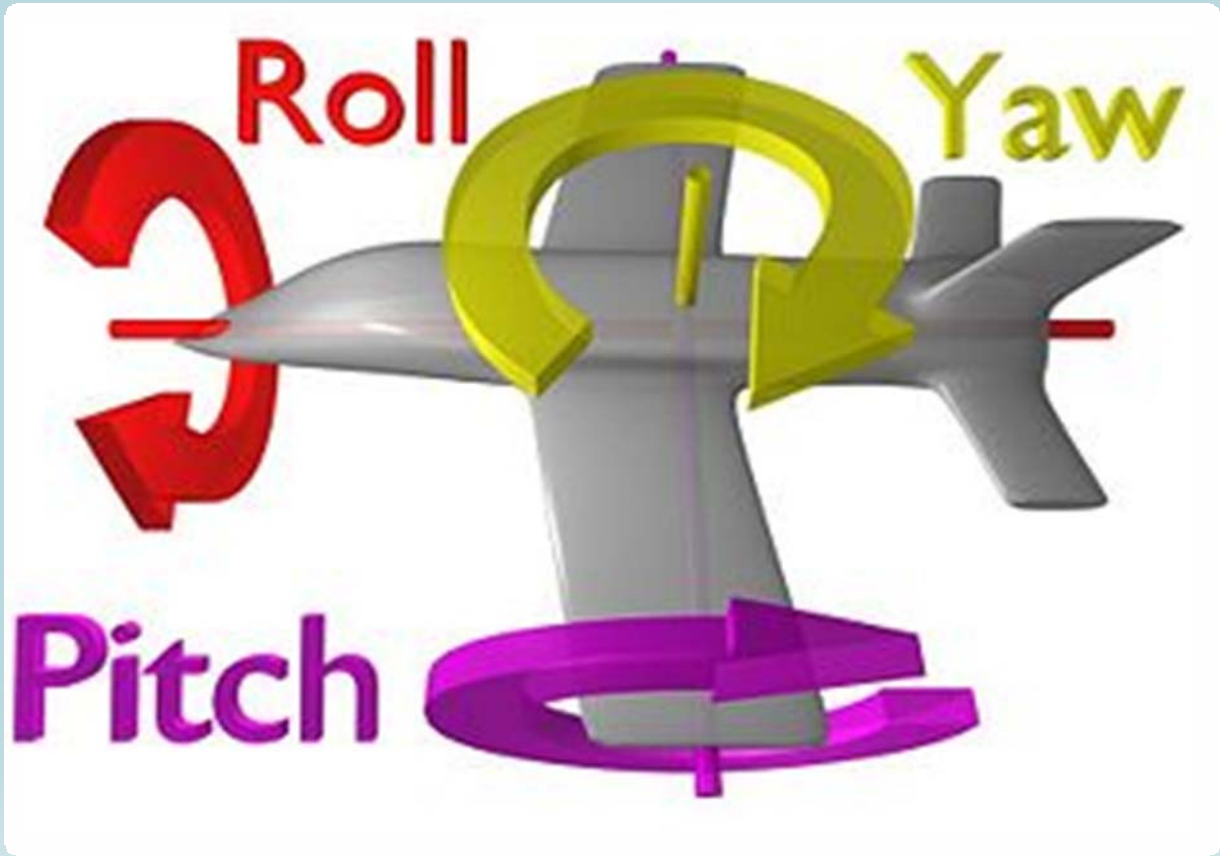
Introduction to UniMAP ACS

- **Innovative Satellite (InnoSAT) is a Pico-class satellite developed by Astronautic Technology (M) Sdn. Bhd. and three local universities.**

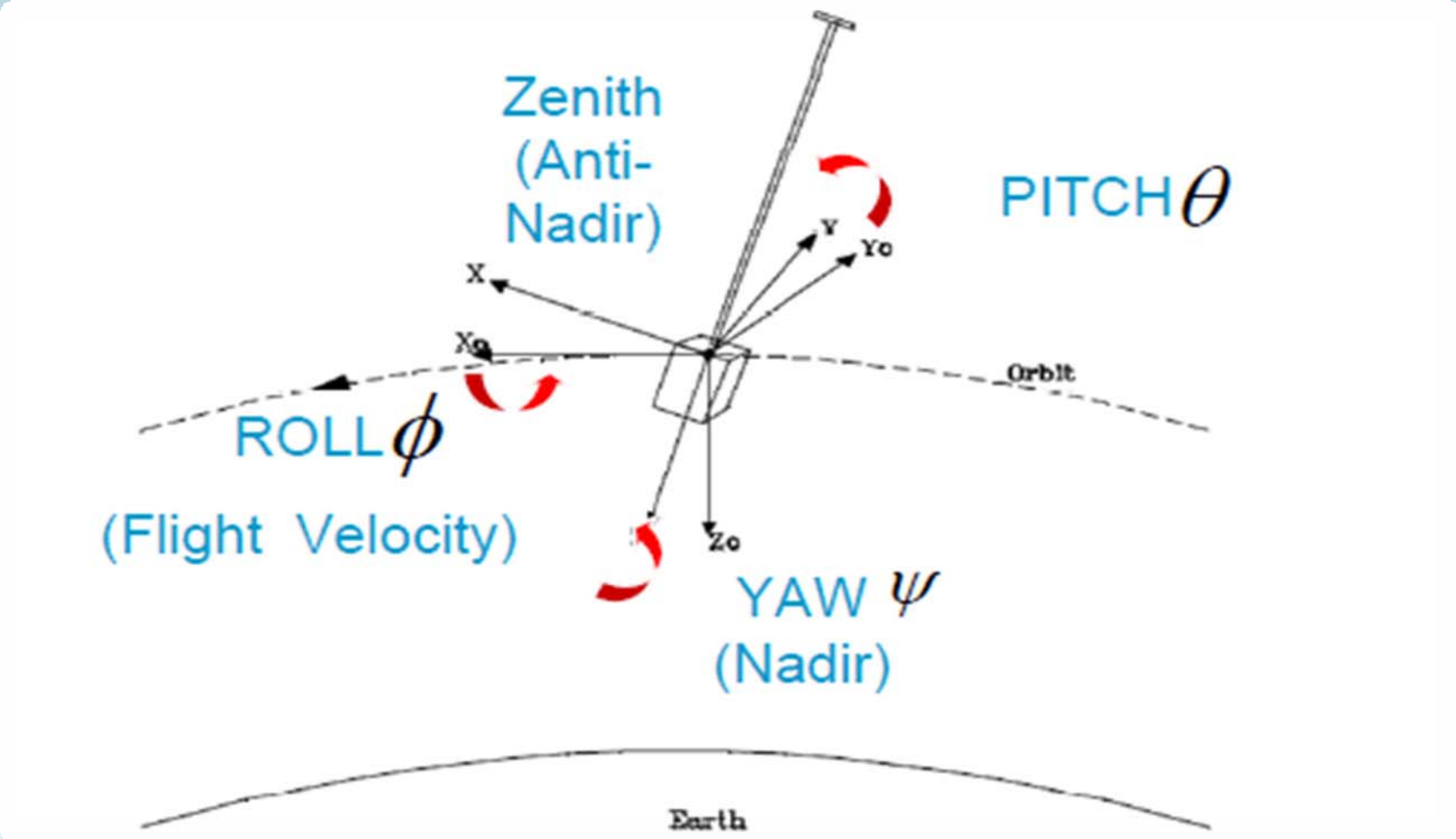
- **InnoSAT will be sent into orbit by launch vehicle Falcon 1 from the Kwajalein launch site in the Republic of Marshall Islands to a Near Equatorial Orbit (NEqO) at an altitude of 685 km and 9° inclination.**

It is difficult to say what is impossible...
for the dream of yesterday is the hope of today...
and reality of tomorrow...
- Robert Goddard

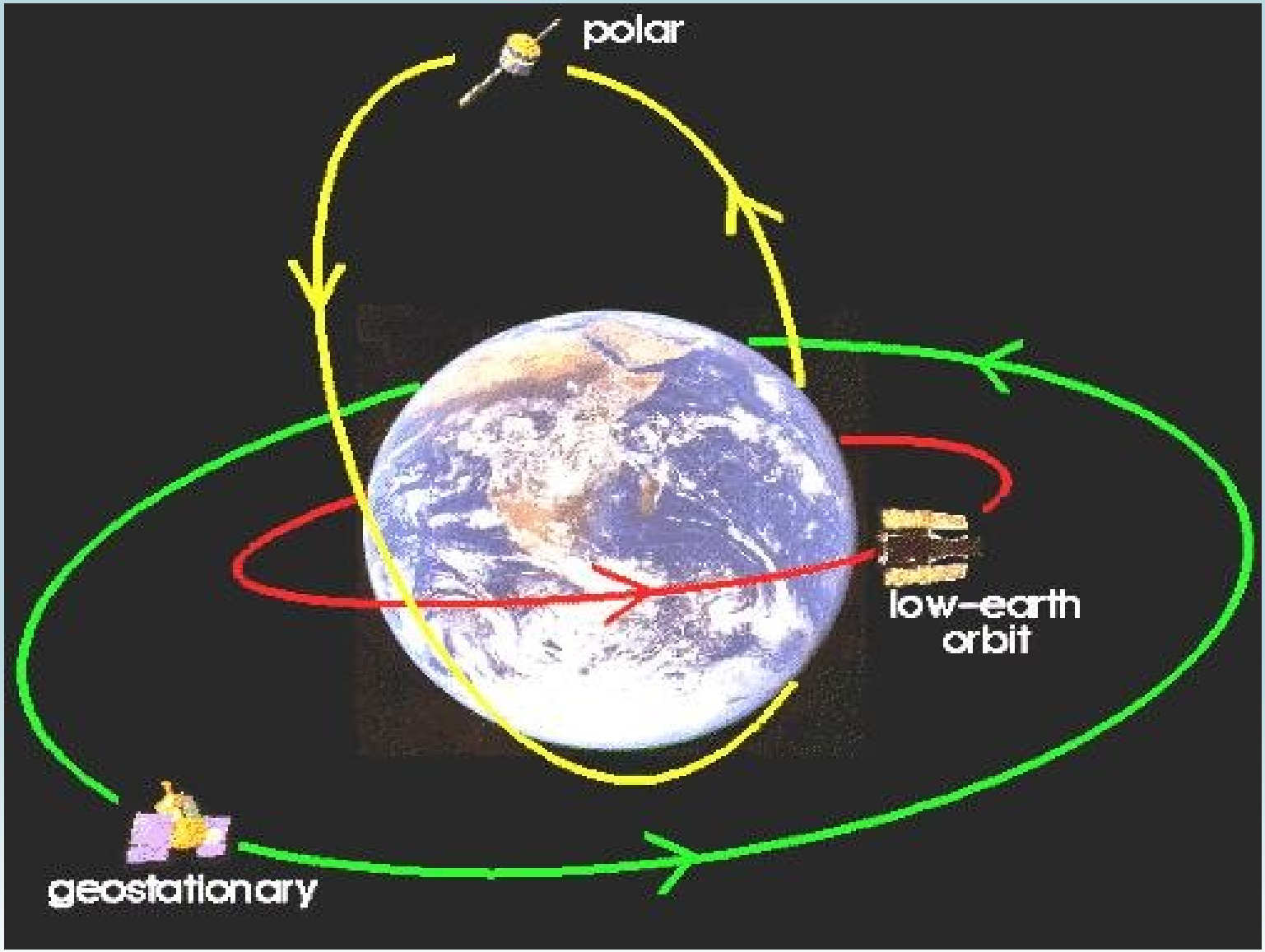
Falcon Launcher

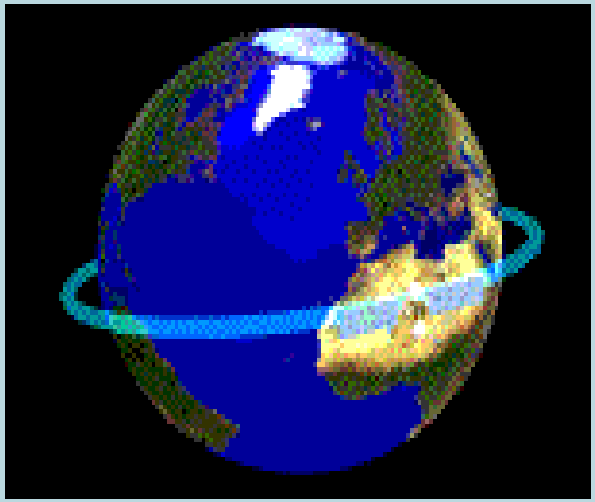


In flight dynamics, the orientation is often described using three angles called roll, pitch and yaw

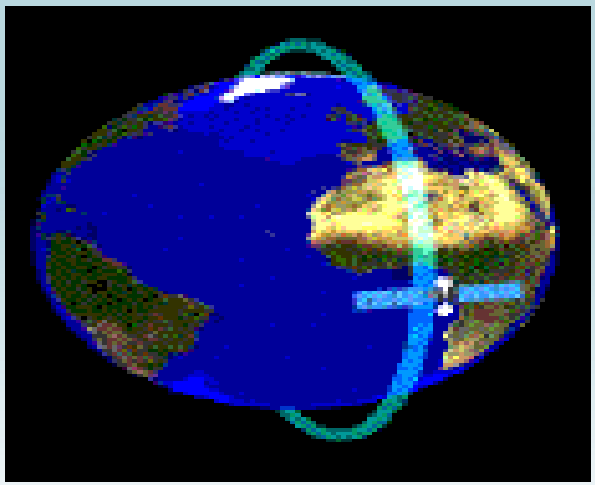


Body Frame with Respect to Orbit Frame

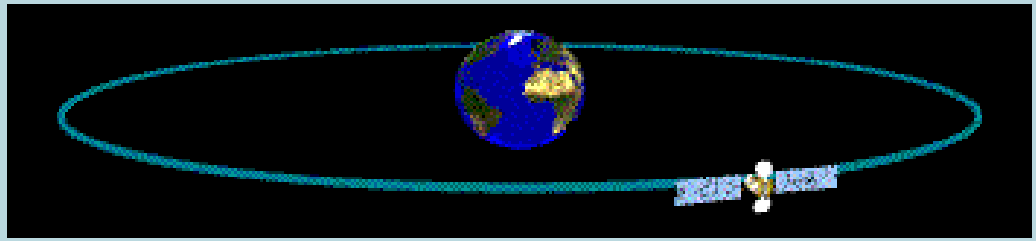

polar
low-earth
orbit
geostationary



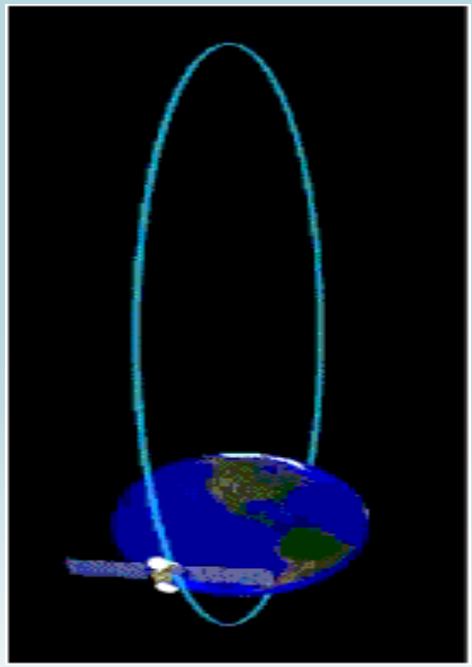
Low Earth Orbit



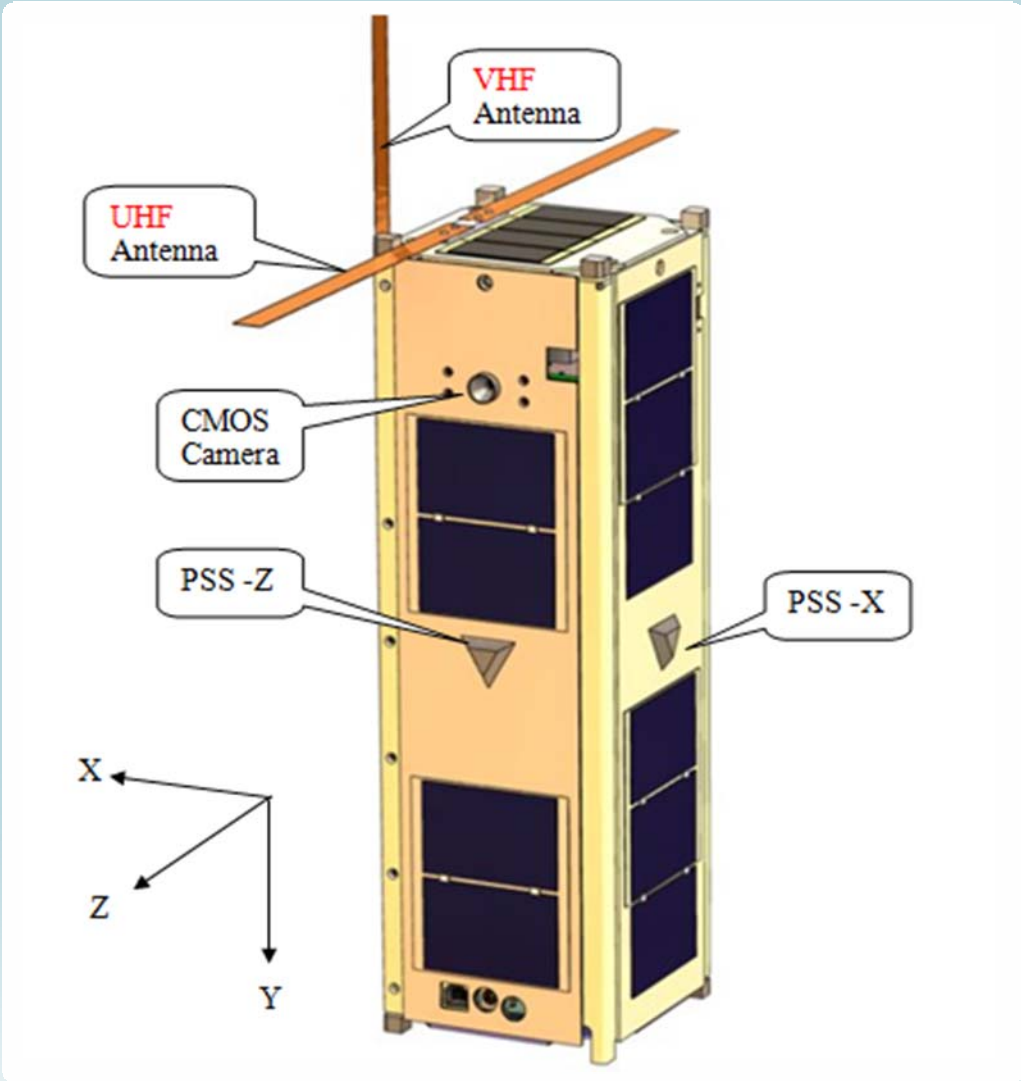
Polar Orbit



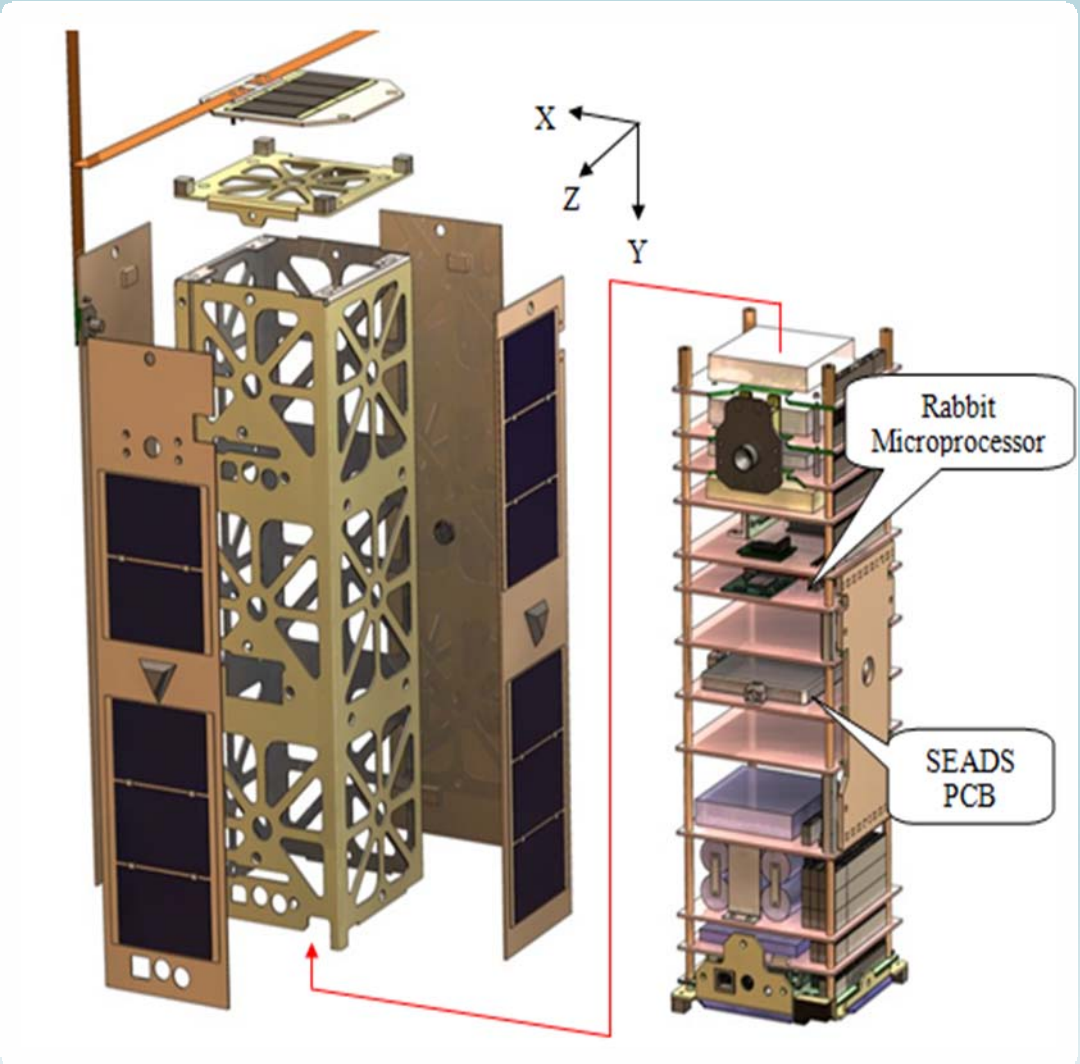
Geosynchronous Equatorial Orbit



Elliptical Orbit

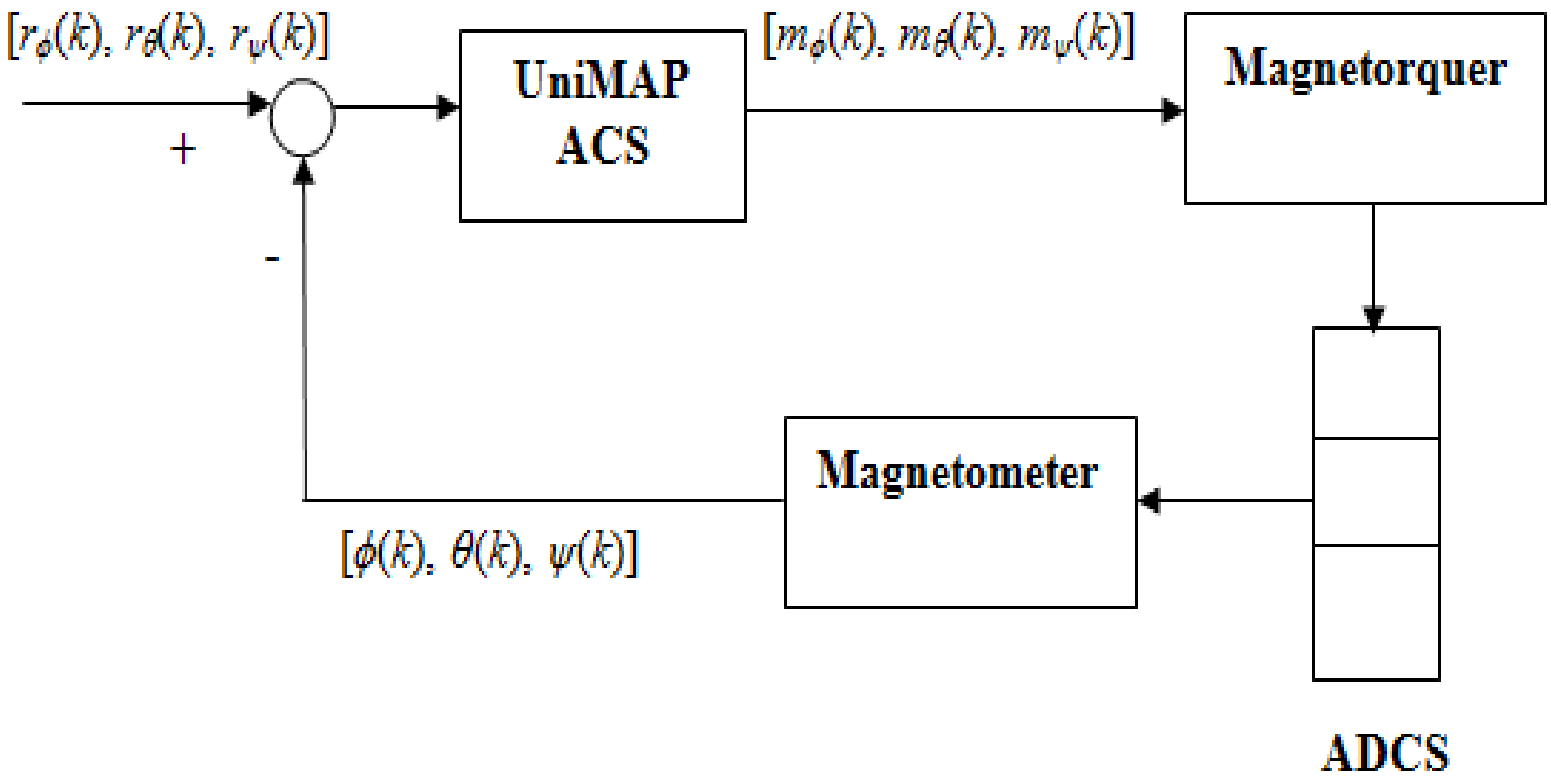


External View Of InnoSAT Showing Main External Components With Coordinate System

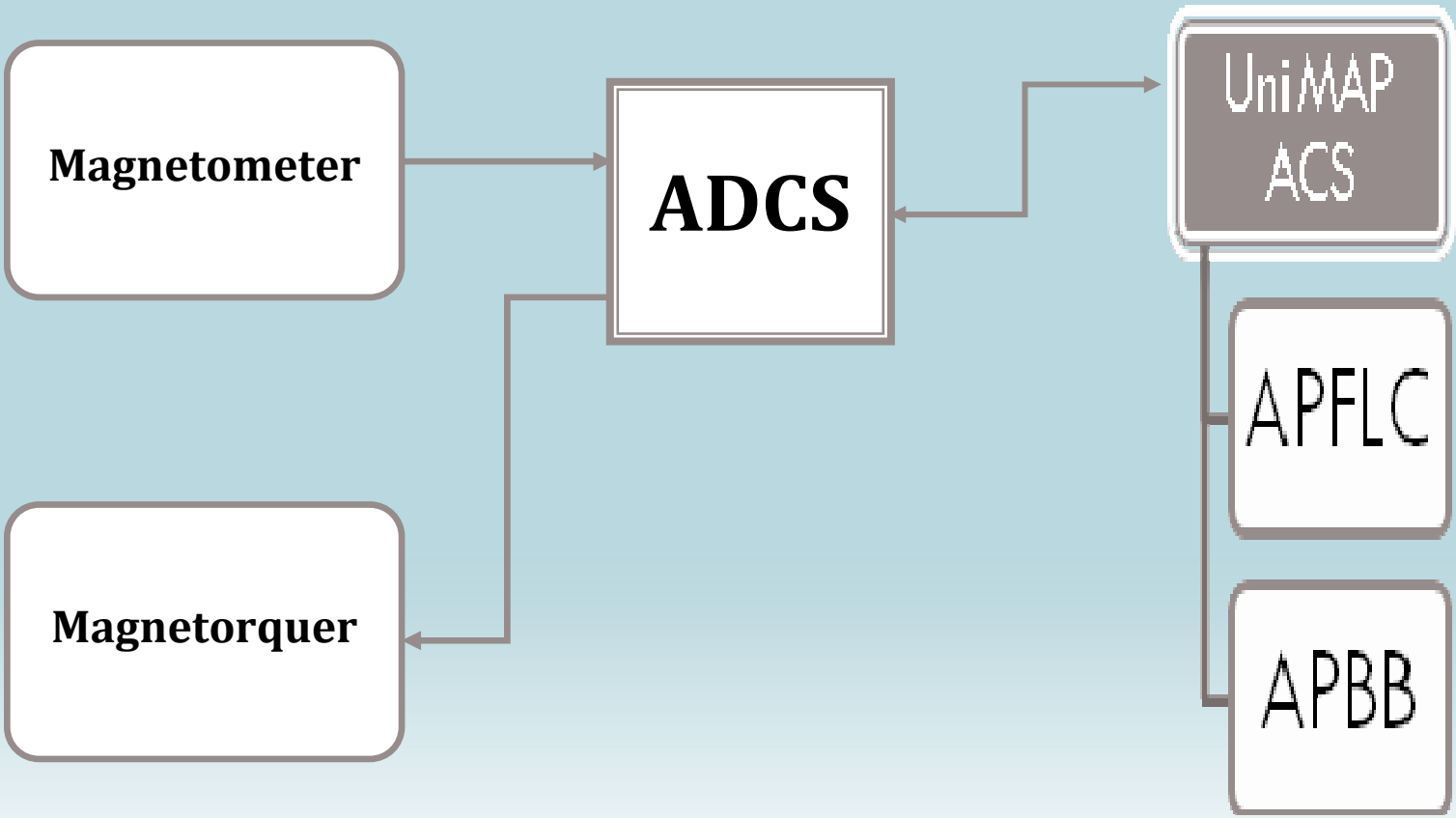


Exploded View Of InnoSAT Showing Locations Of Main University Payloads

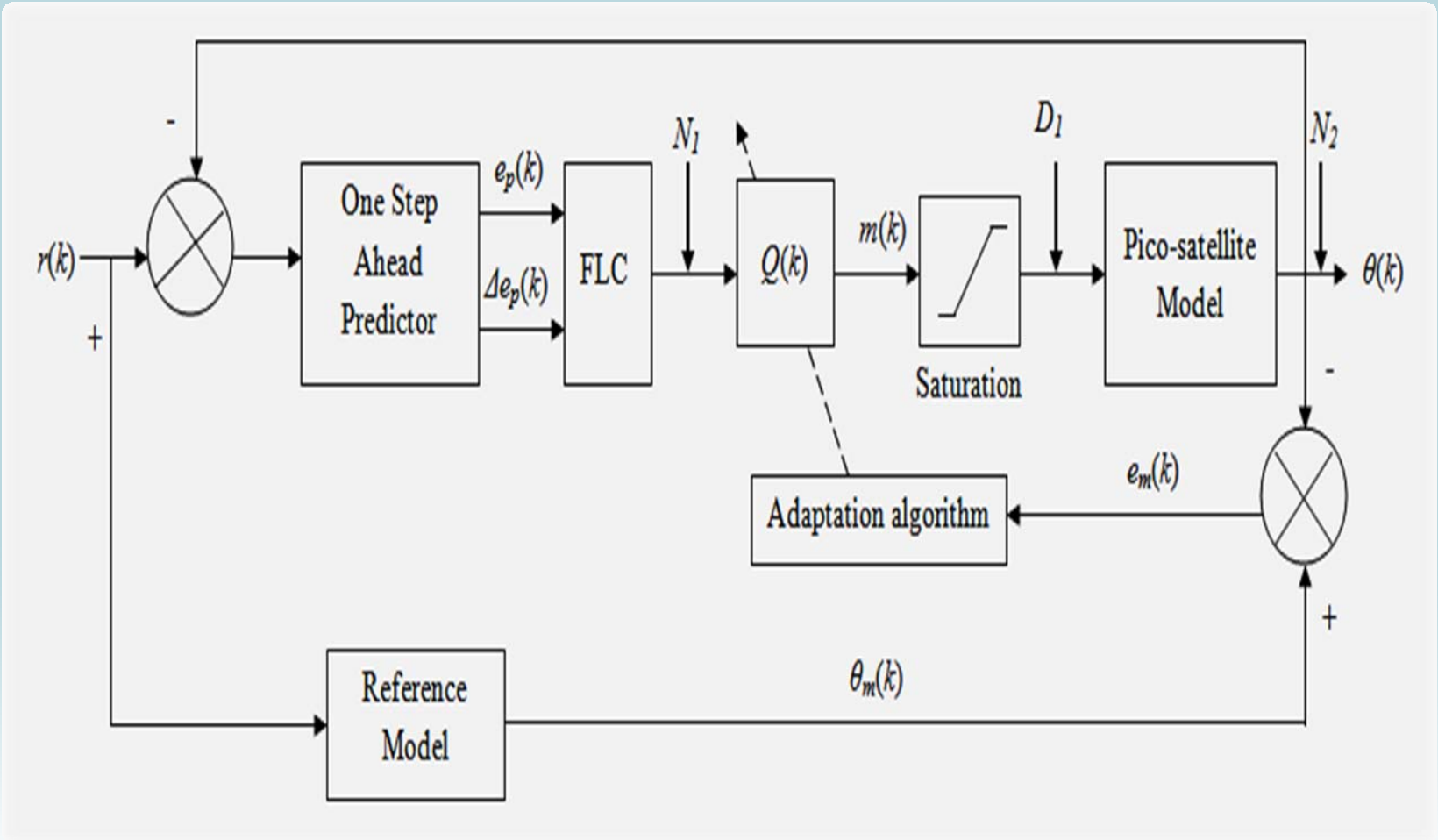
UniMAP ACS


$[r_\phi(k), r_\theta(k), r_\psi(k)]$
+
-
UniMAP ACS
$[m_\phi(k), m_\theta(k), m_\psi(k)]$
Magnetorquer
Magnetometer
$[\phi(k), \theta(k), \psi(k)]$
ADCS

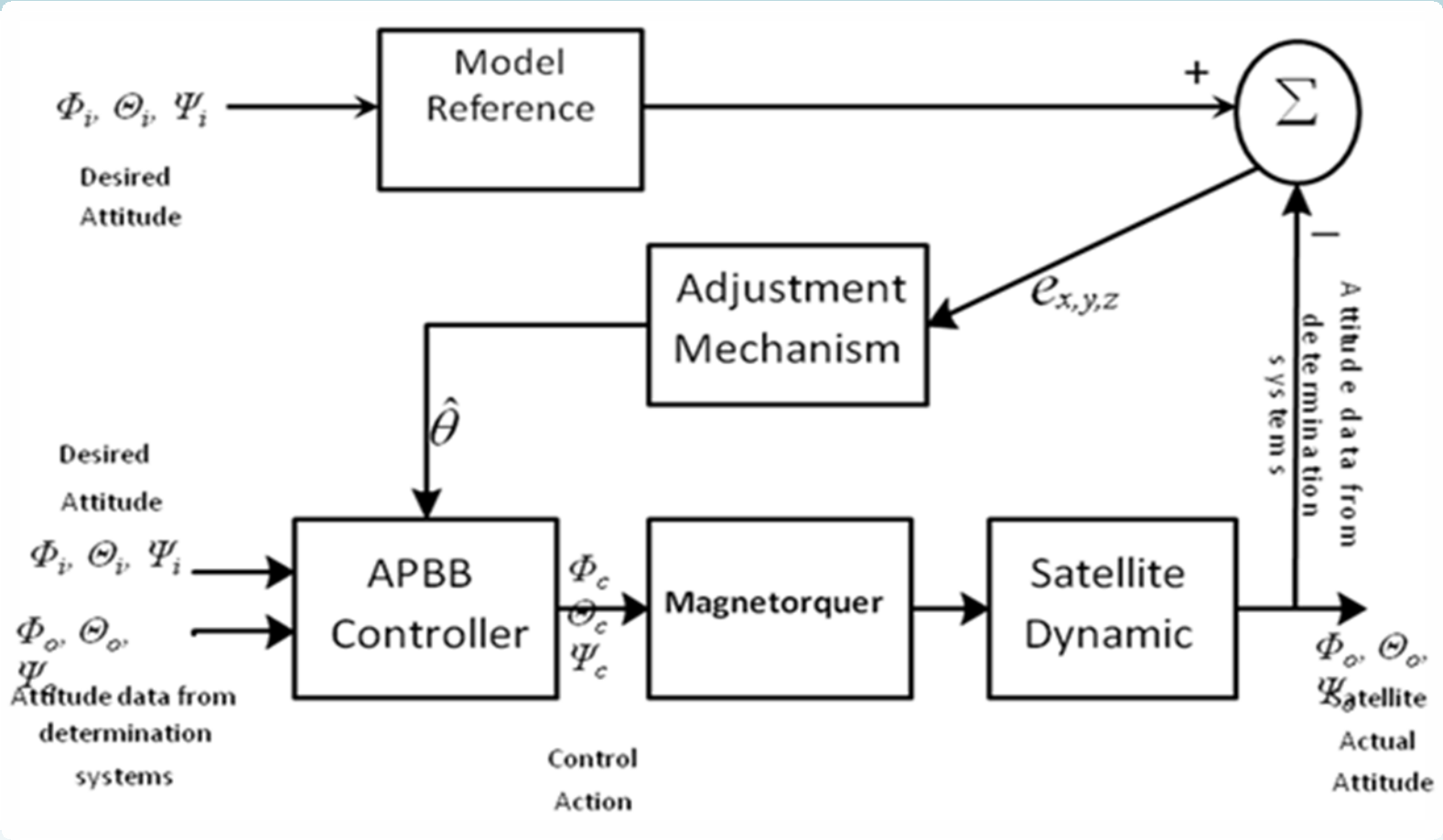
Cont..



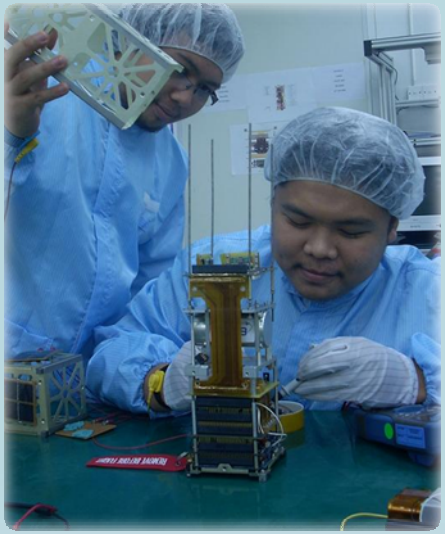
Adaptive Predictive Fuzzy Logic Controller



Adaptive Parametric Black Box



Hardware Development

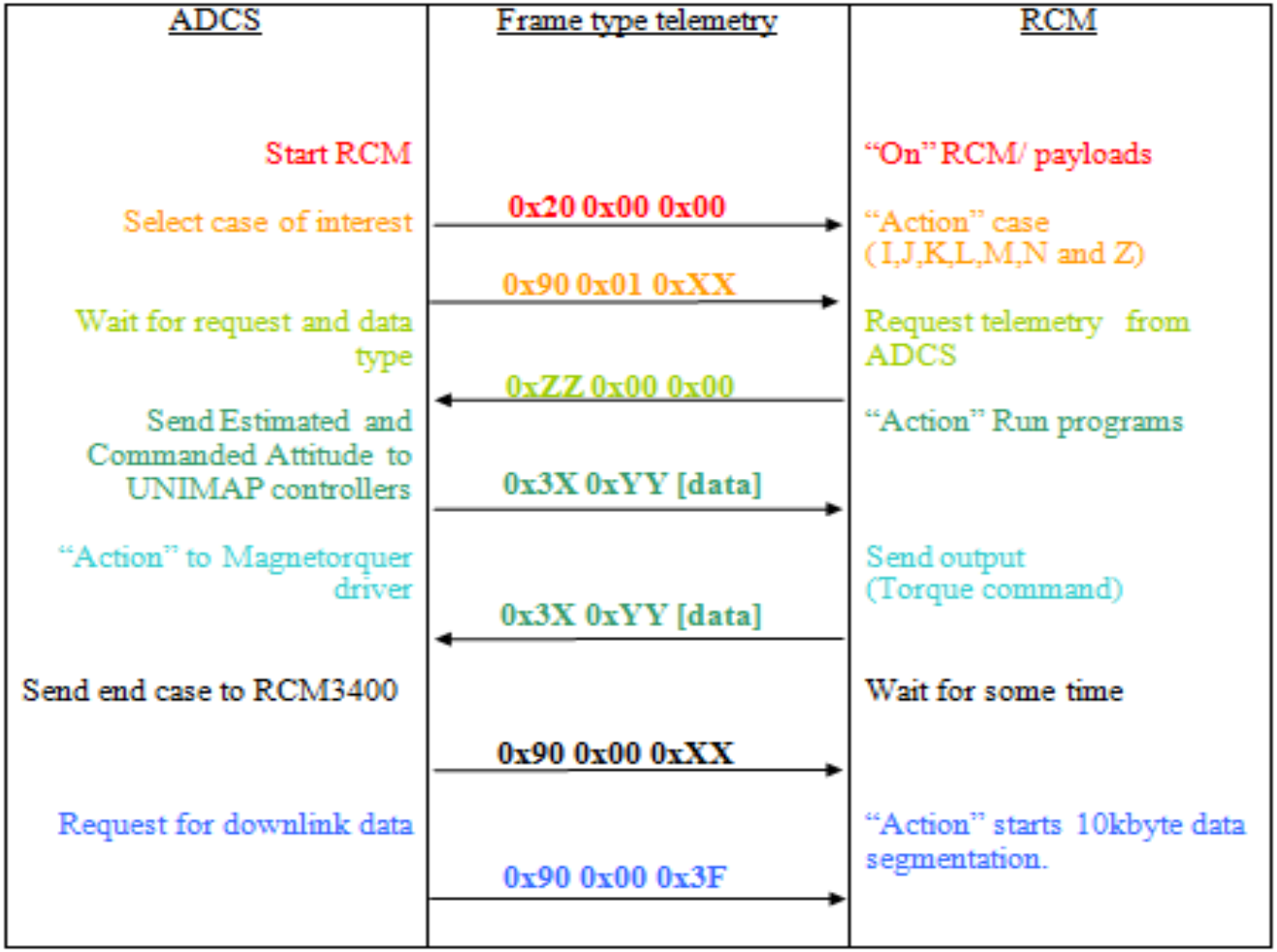


CubeSat

RCM 3400

Dynamic C

Frame Communication Manual



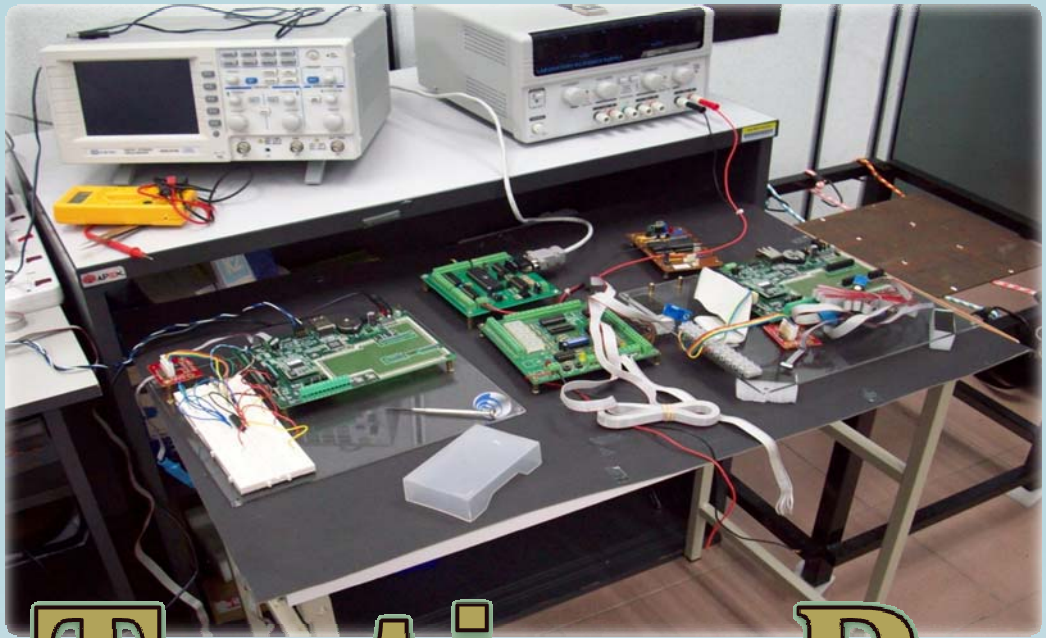
Real Time Operation

- InnoSAT operate in approximately 97 minutes for one full orbit.

- Universities start testing on the 3rd day after the satellite launched to the orbit.

- Testing Availability: 14 links per day, 6 links per day required for InnoSAT, 8 links per day available for other CubeSAT.

- Time in view: approximate 14.35mins per pass. Payload testing during sunlight presence only.



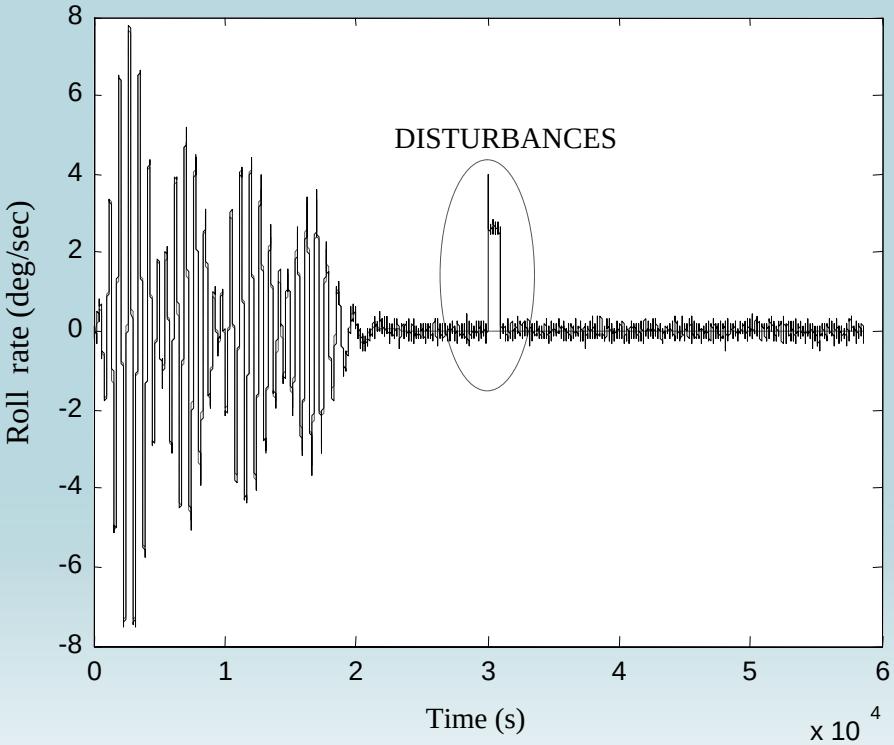
Testing Results

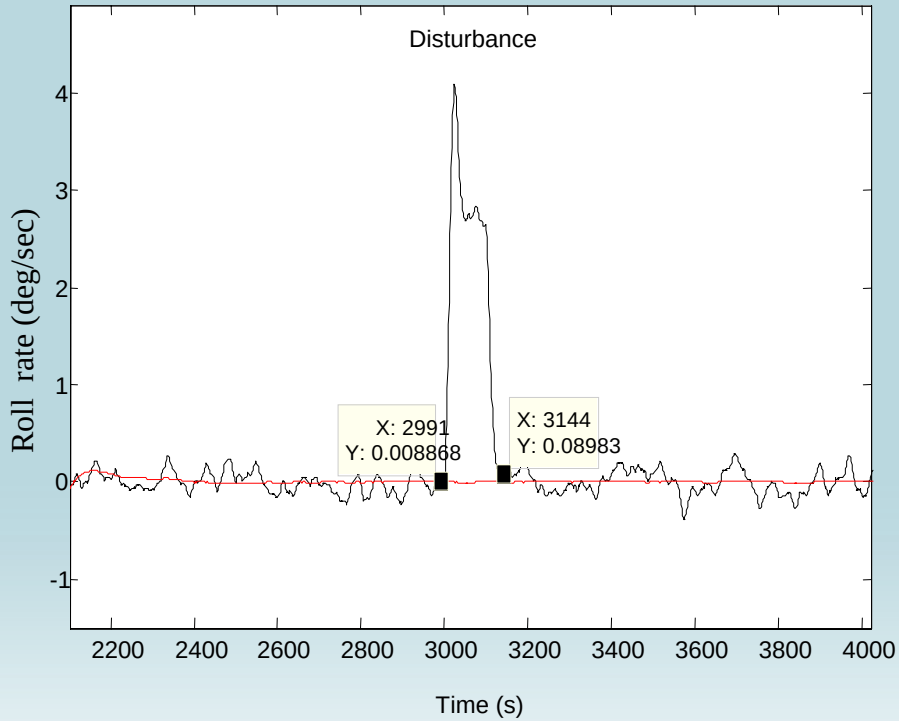
Attitude Control

Axis
1 axis
2 axis
3 axis

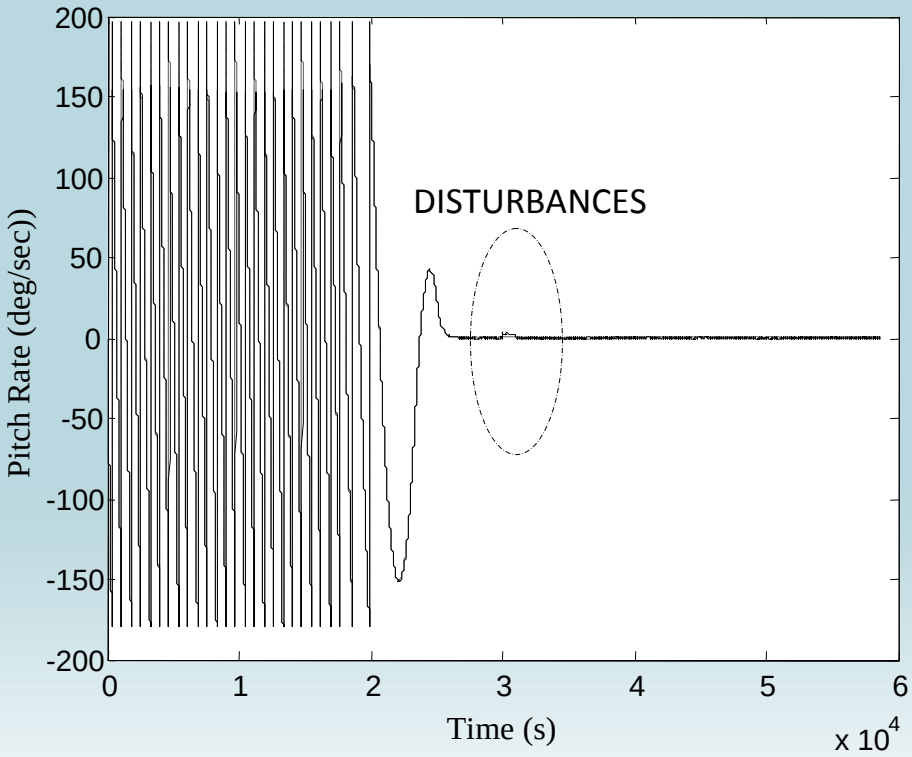
Reference Data Tested
Step Input
Square Wave
Sine Wave
Y-Thompson Spin
Attitude Angle

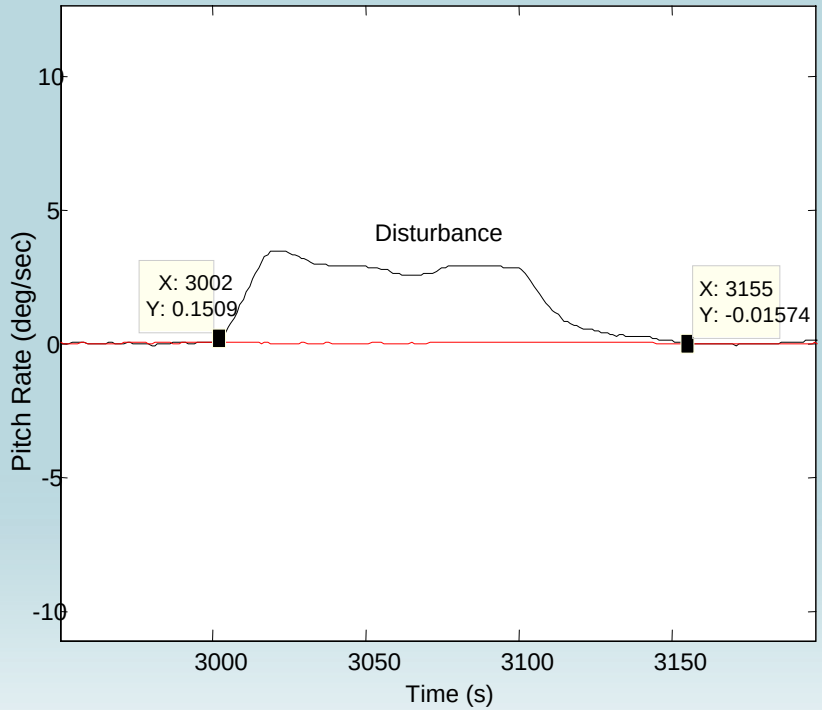
Roll Axis


DISTURBANCES
Roll rate (deg/sec)
Time (s)
x 10^4

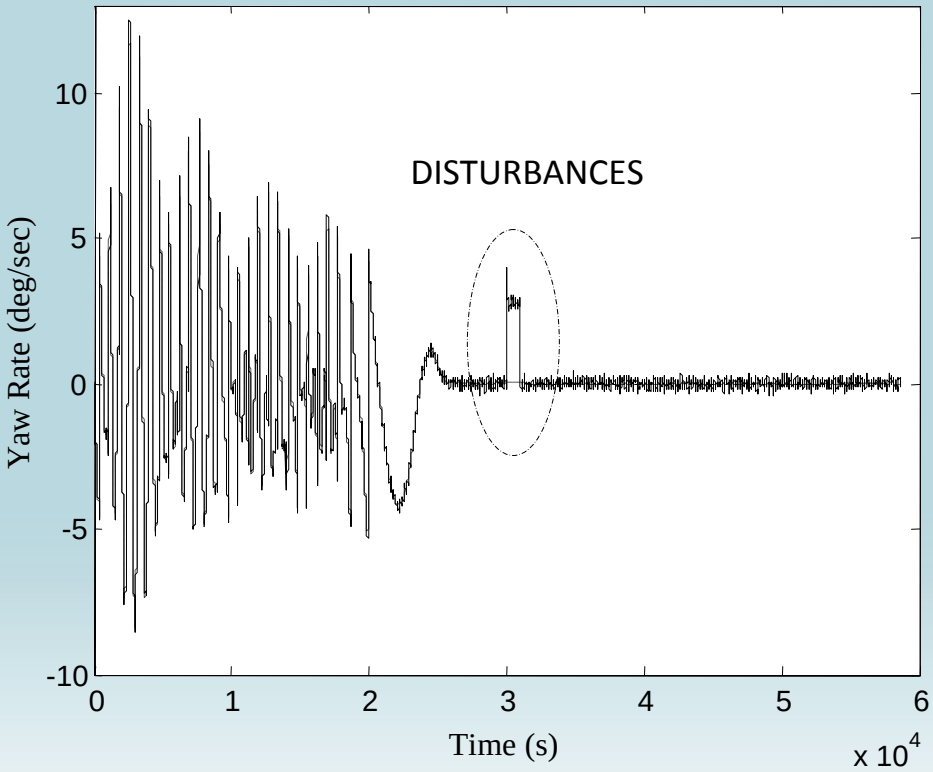

Disturbance
Roll rate (deg/sec)
X: 2991
Y: 0.008868
X: 3144
Y: 0.08983
Time (s)

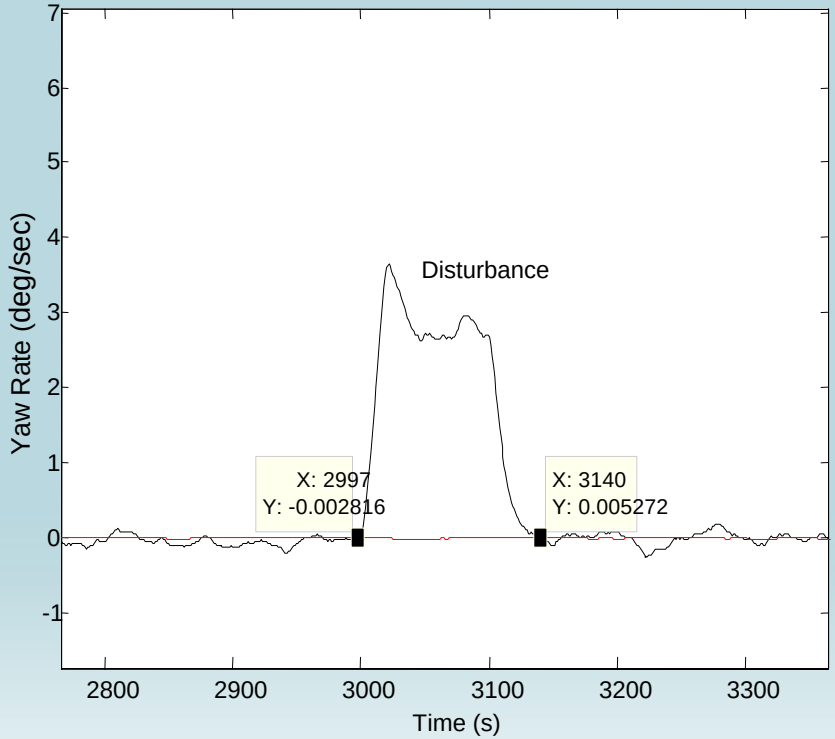
Pitch Axis


DISTURBANCES
Pitch Rate (deg/sec))
Time (s)
x 10^4
200
150
100
50
0
-50
-100
-150
-200
0
1
2
3
4
5
6


Disturbance
X: 3002
Y: 0.1509
X: 3155
Y: -0.01574
Pitch Rate (deg/sec)
Time (s)
10
5
0
-5
-10
3000
3050
3100
3150

Yaw Axis


DISTURBANCES
Yaw Rate (deg/sec)
Time (s)
x 10^4
10
5
0
-5
-10
0
1
2
3
4
5
6

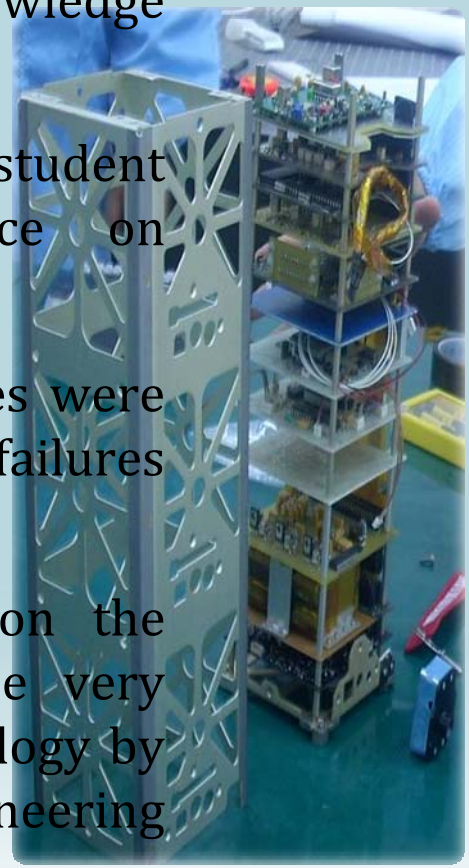

Disturbance
Yaw Rate (deg/sec)
Time (s)
X: 2997
Y: -0.002816
X: 3140
Y: 0.005272
7
6
5
4
3
2
1
0
-1
2800
2900
3000
3100
3200
3300

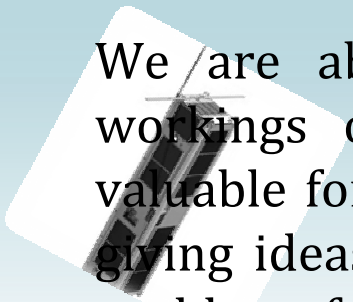
Conclusion

This project is a government effort to gain knowledge and experience in area of space technology.

This research work provides opportunity for student with hands on training and experience on interdisciplinary work and managing projects.

Project planning skills and research techniques were improved further through the successes and failures throughout this research.





We are able to gather useful knowledge on the workings of satellite systems. This can be very valuable for future researches in space technology by giving ideas on how to approach system engineering problems from a system engineer point of view.

Special Thanks to:

Astronautic Technology (M) Sdn Bhd (ATSB)

National Space Agency (ANGKASA)

Ministry of Science, Technology and Innovation Malaysia (MOSTI)

Universiti Malaysia Perlis (UniMAP)

Universiti Sains Malaysia (USM)

Universiti Teknologi Malaysia (UTM)









Coming together is a beginning..Keeping together is progress..Working together is success..