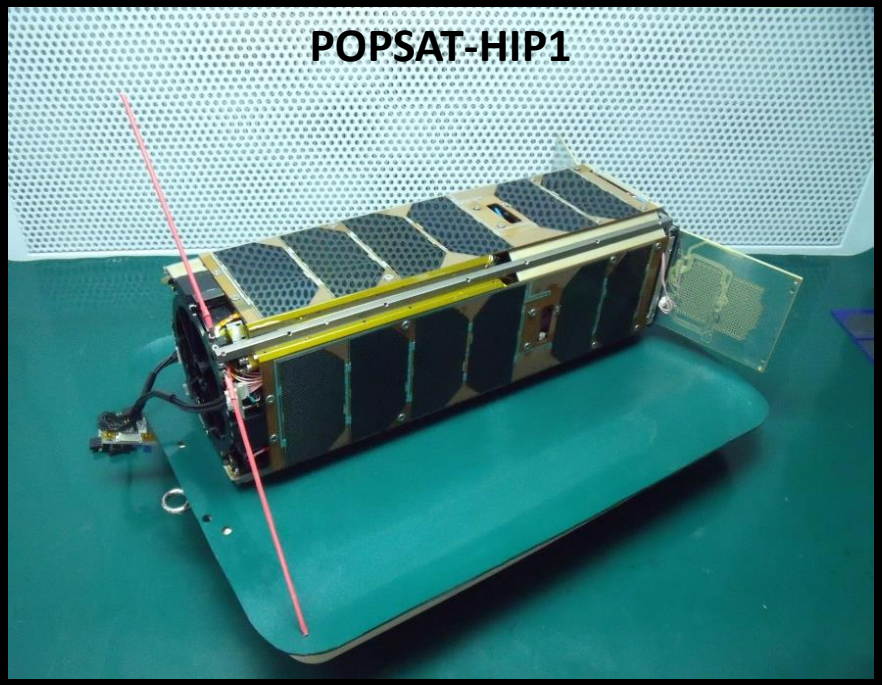
Cubesat Micropropulsion Characterization in Low Earth Orbit



1. Micropropulsion Technology R&D
2. The satellite POPSAT-HIP1
3. In Orbit Experiments
4. Conclusions

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Microspace Rapid Pte Ltd
196 Pandan Loop #06-19, Singapore
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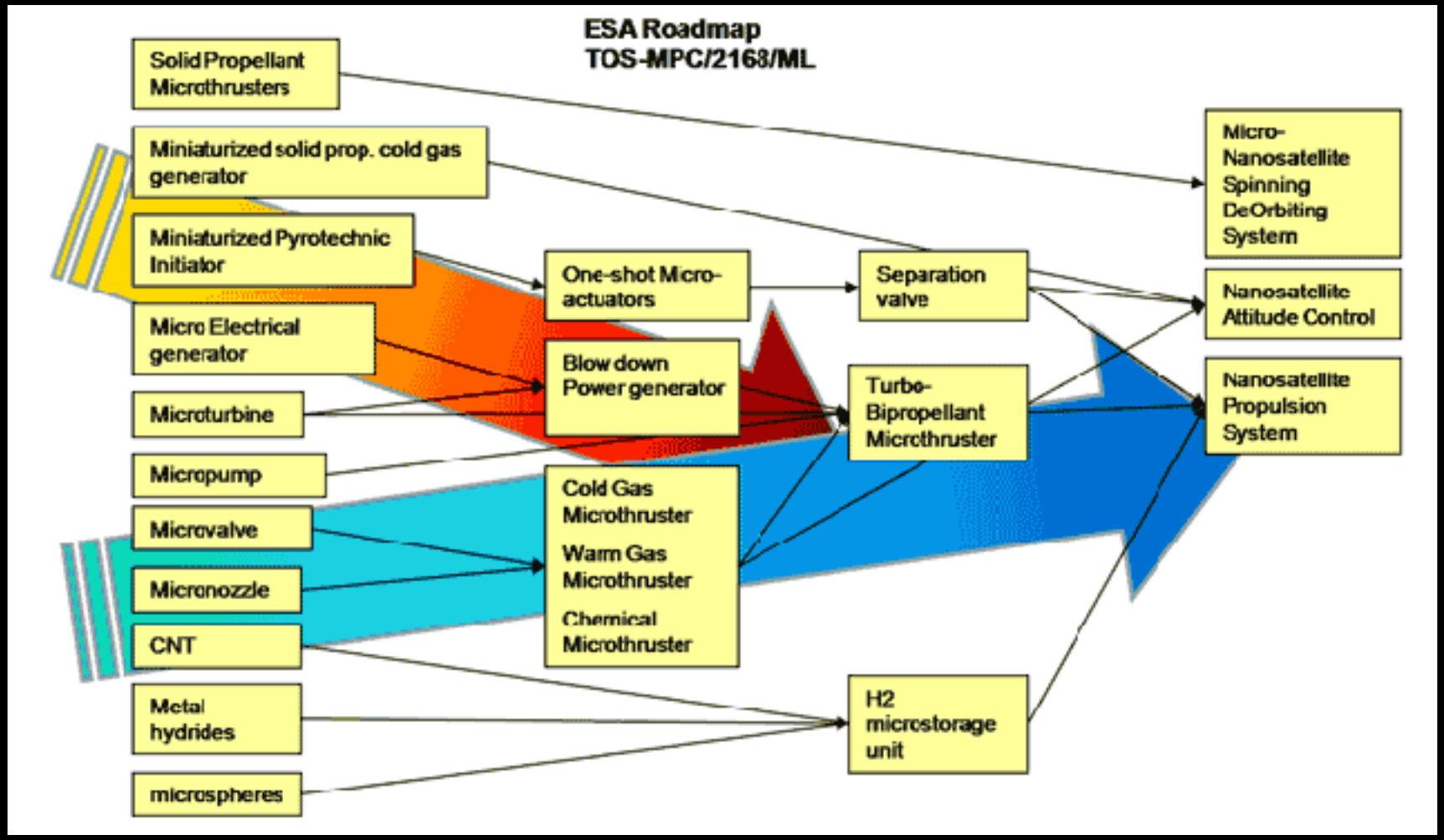
ROADMAPPING

Est. 2002 (Italy), 2007 (Singapore)



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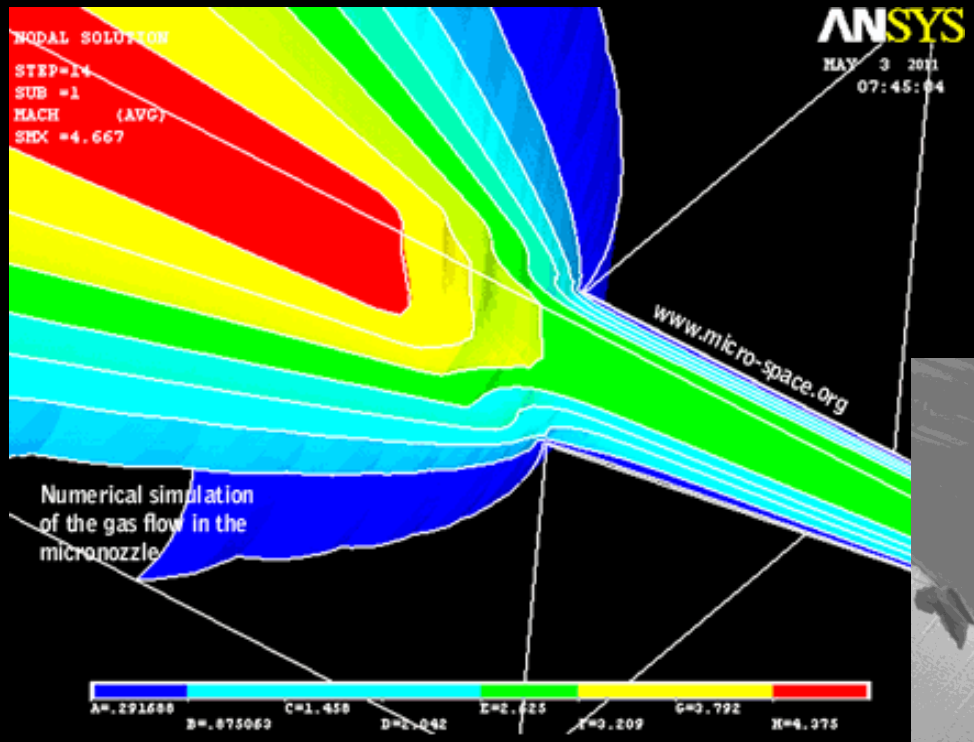
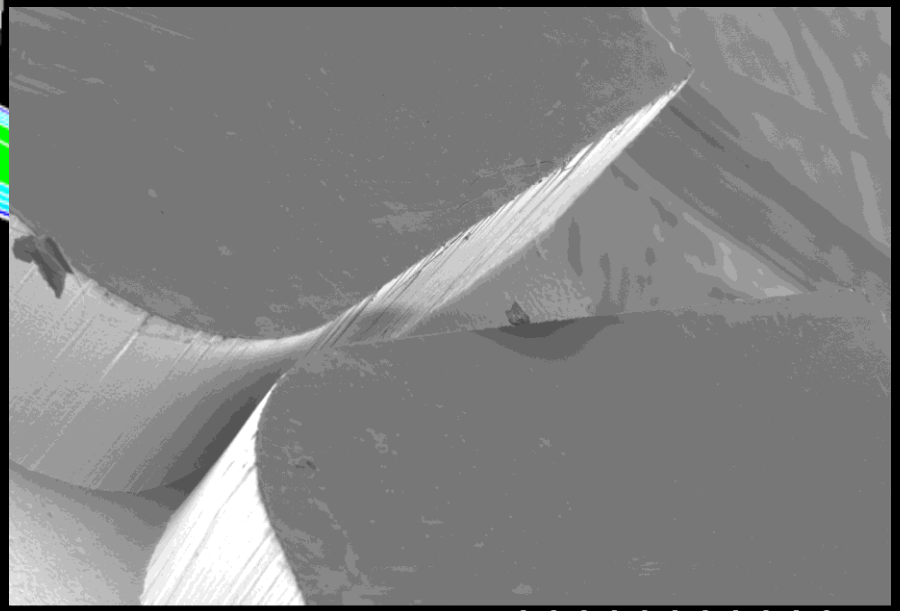
MICRONOZZLES R&D





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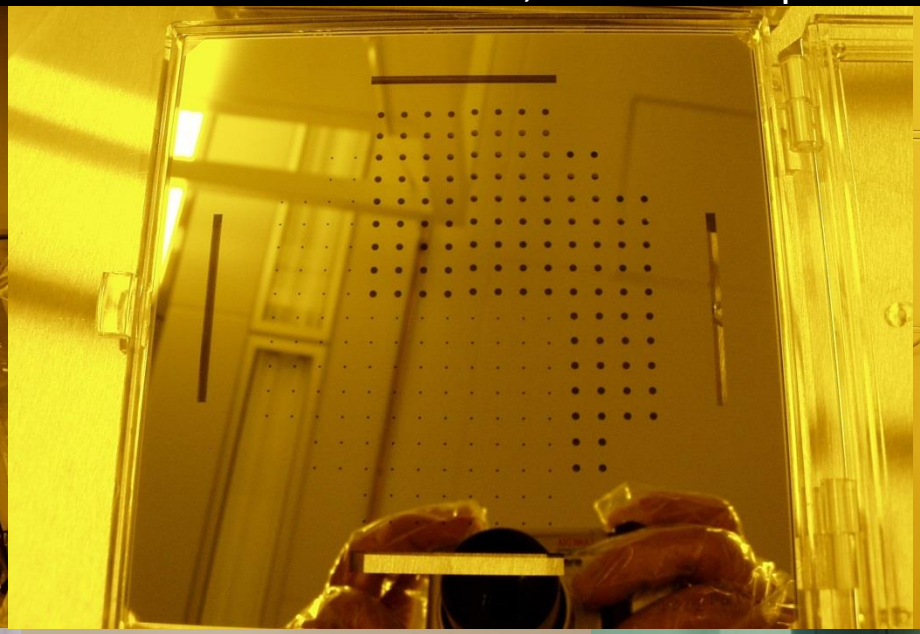
TECHNOLOGY R&D

Collaboration with AIST, Tsukuba - Japan



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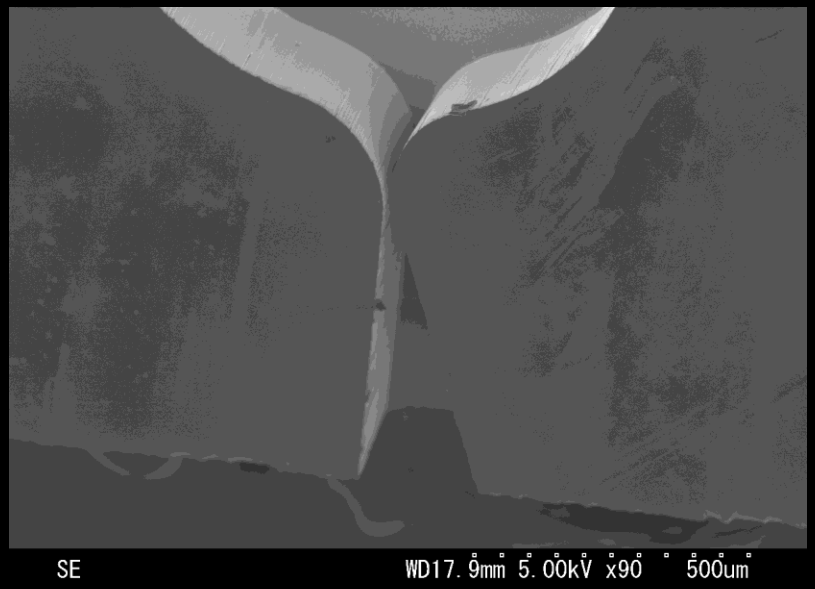
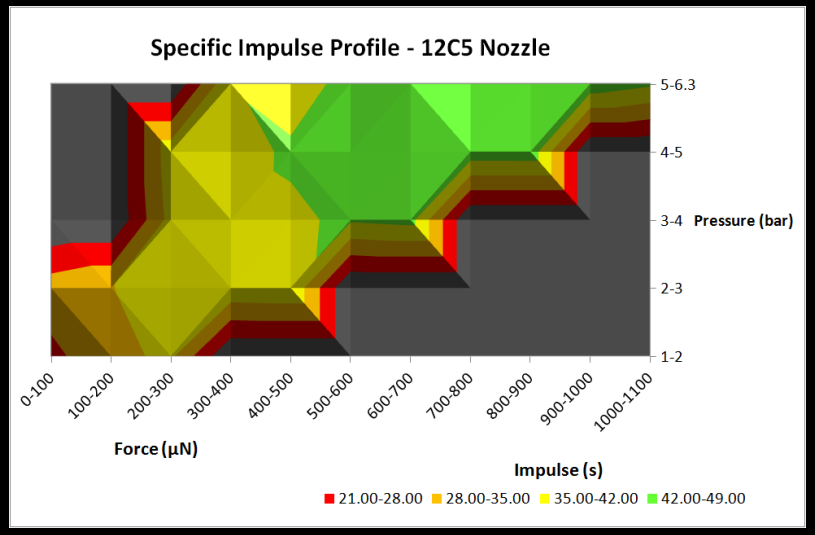
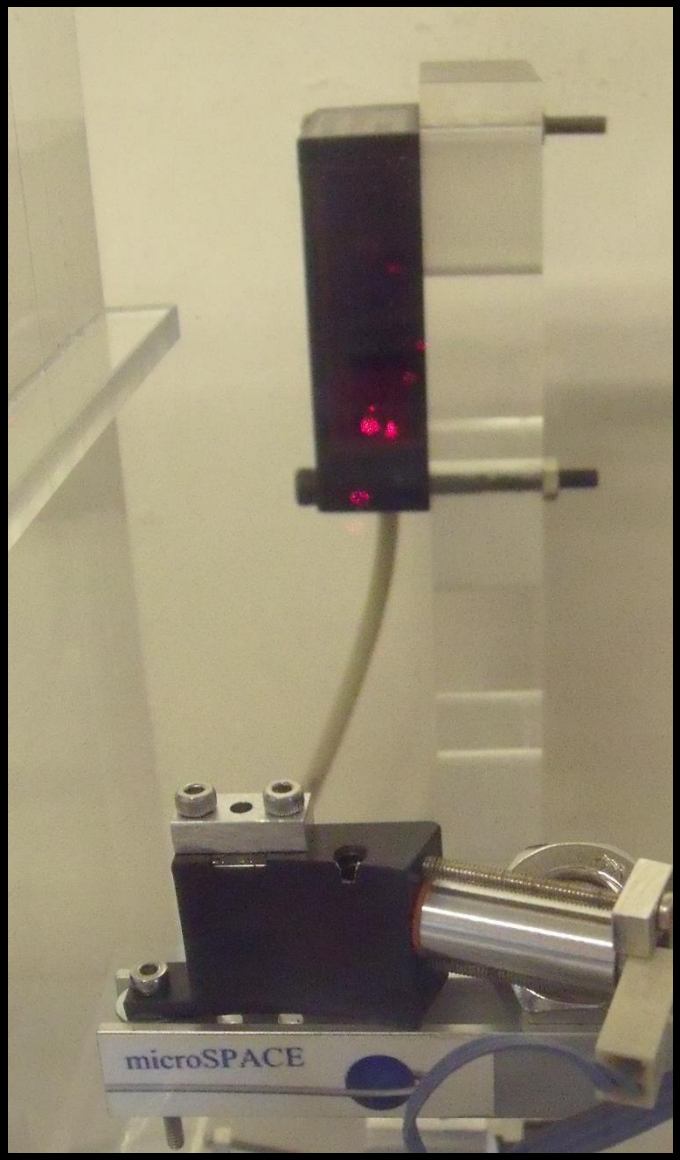
MICRONOZZLES R&D







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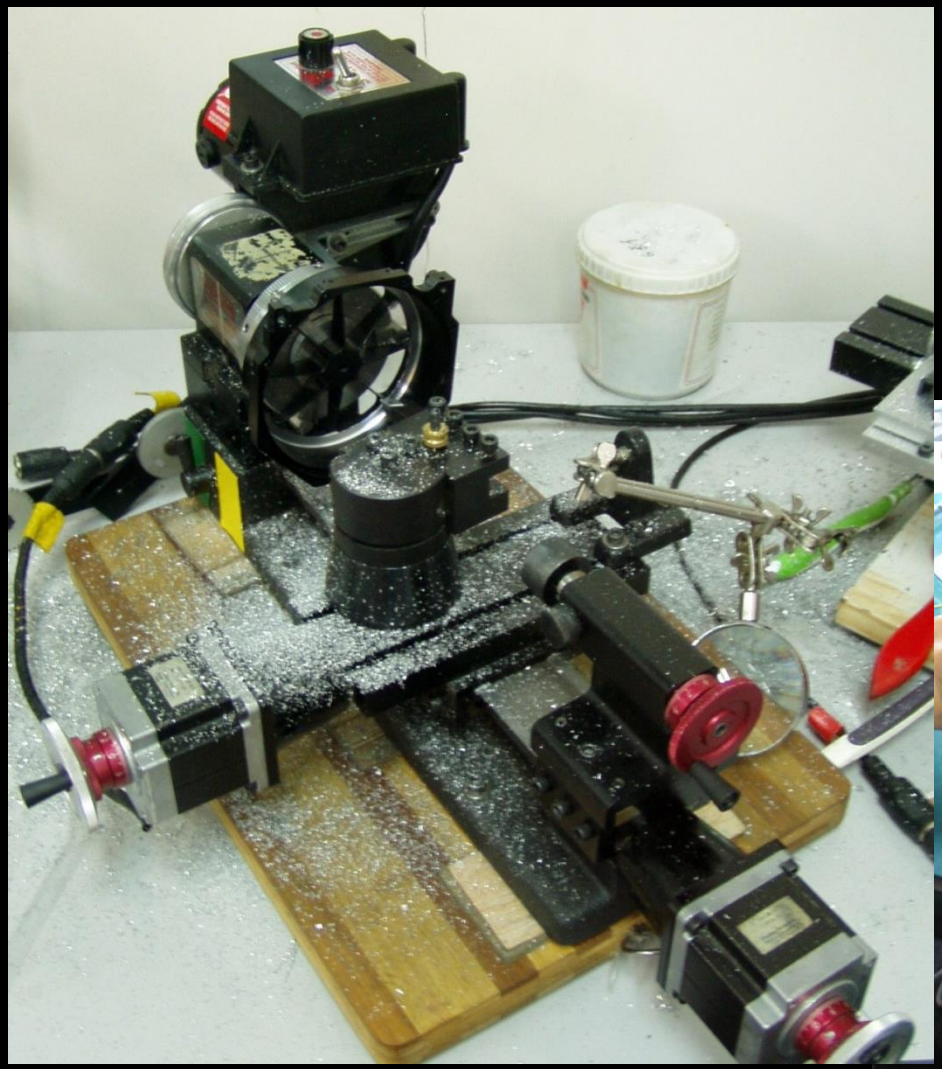
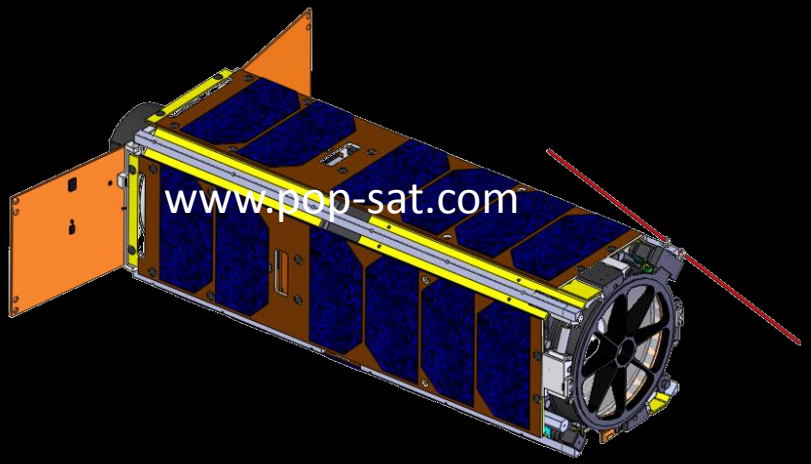
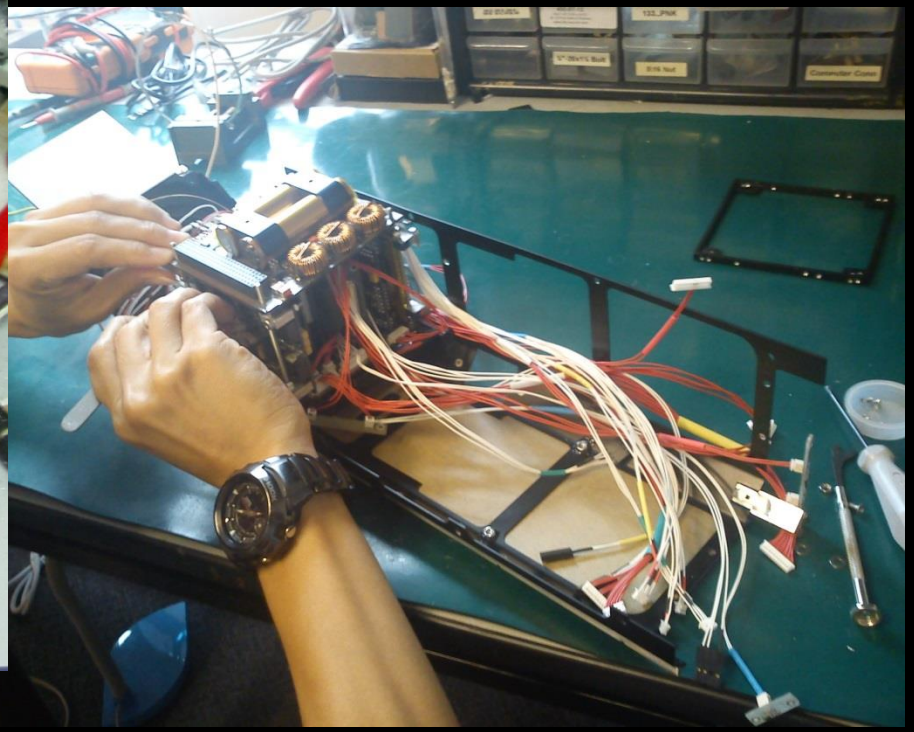
POPSAT Making







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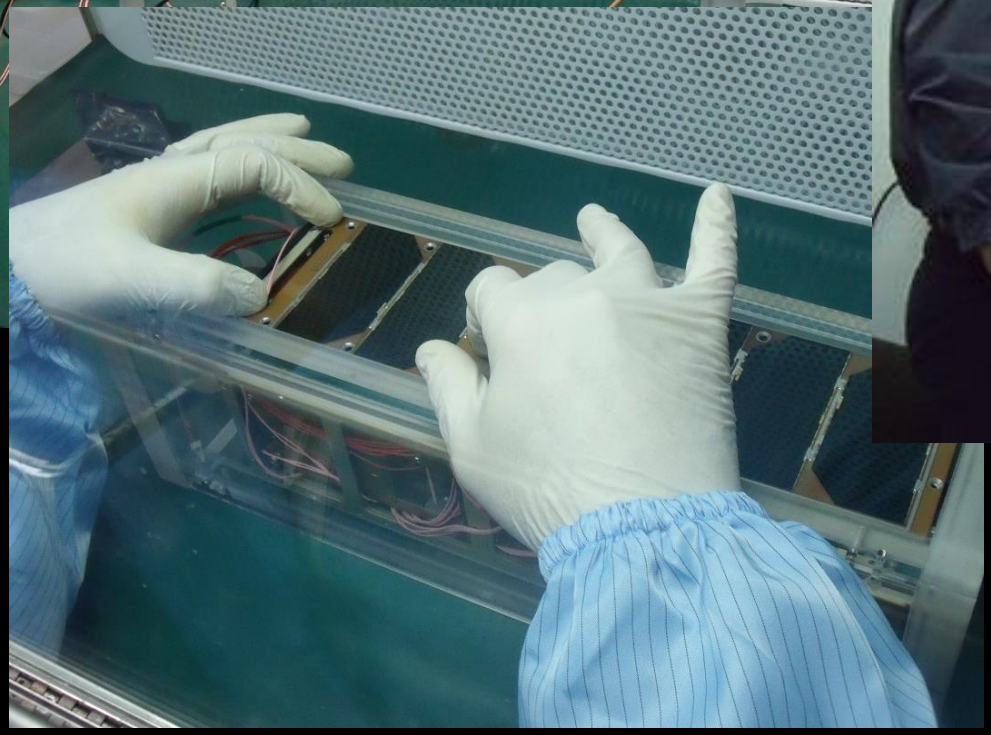
POPSAT Qualification



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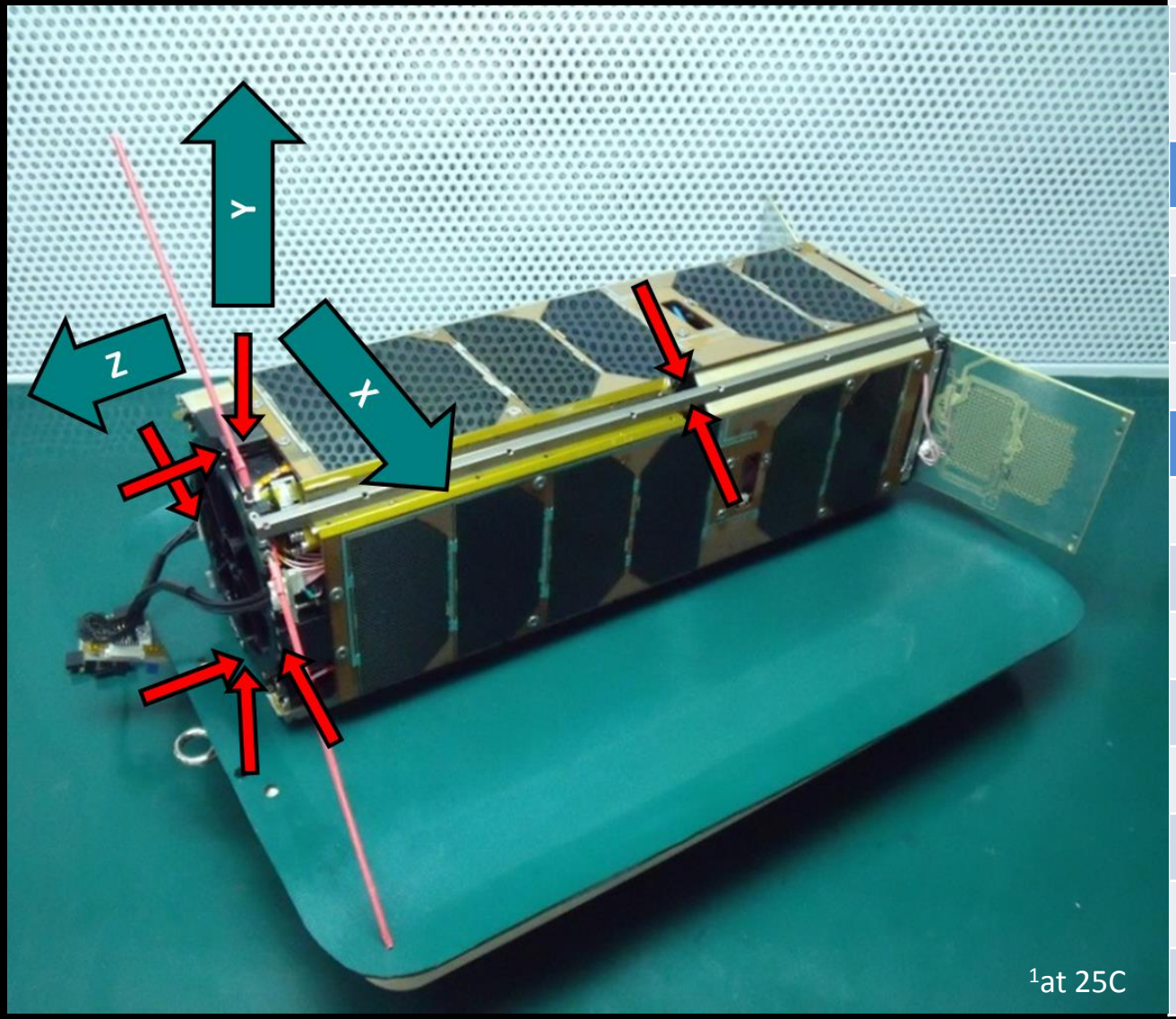
POPSAT- Hip 1



Inertia	Unit	Value
Mass	Kg	3.3
Px	kgm^2	0.043
Py	kgm^2	0.045
Pz	kgm^2	0.009
Torquers	**Axis**	**Max.Mom[1]**
A	X	0.145 Am^2
B	Y	0.145 Am^2
C	Z	0.110 Am^2
Thrusters	**Axis**	**Arm CoM**
S4	+X	0.167m
12B5	(+X)	0.052m
7C5	+Y	0.180m
V4	+Z	0.061m
7E5	-X	0.167m
V5	(-X)	0.052m
12C5	-Y	0.180m
V1	-Z	0.061m

[1]at 25C

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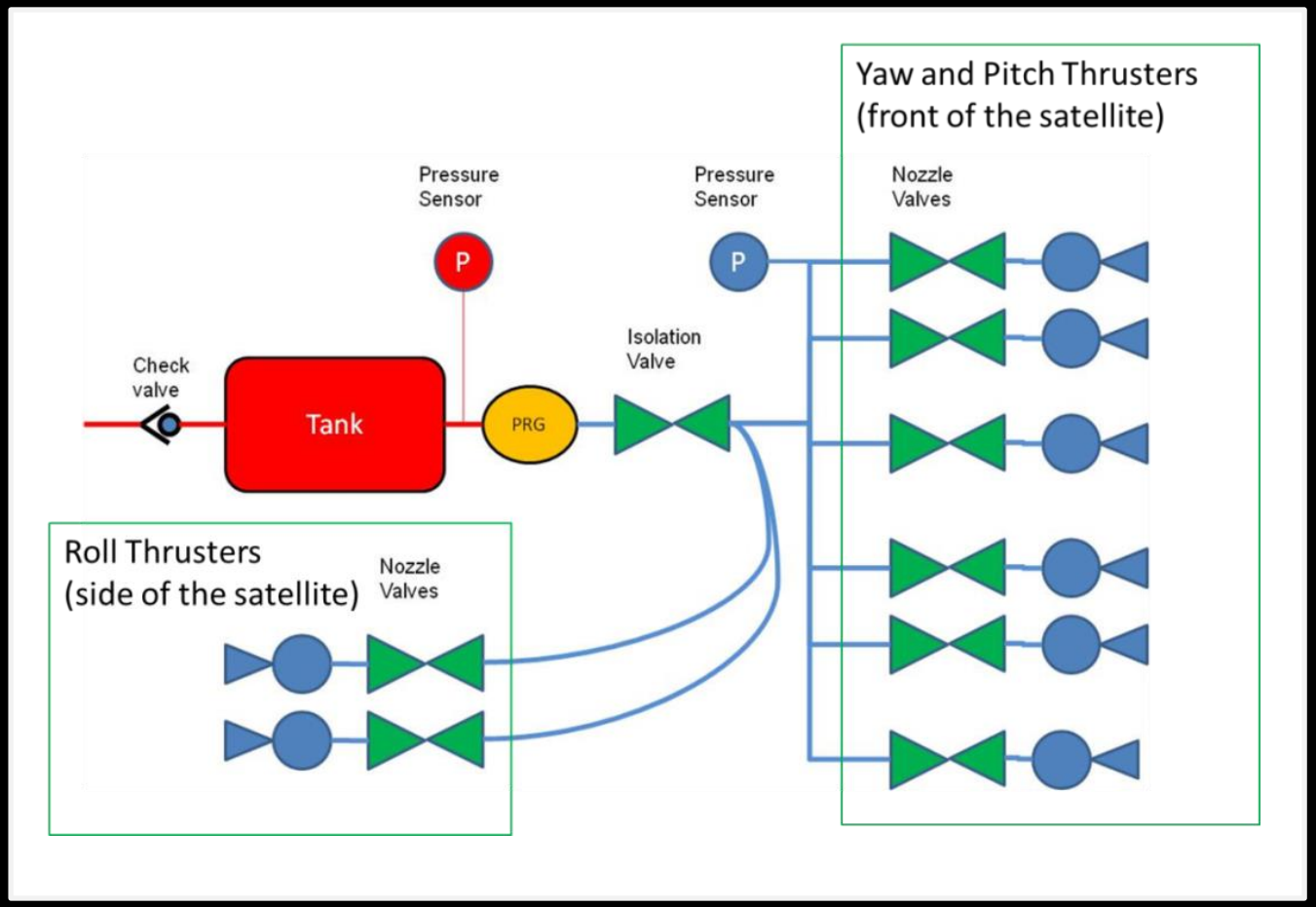
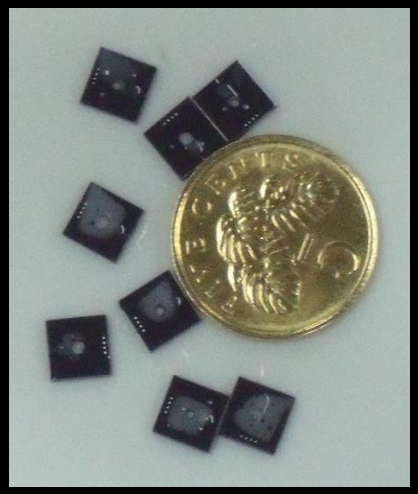
Micropropulsion





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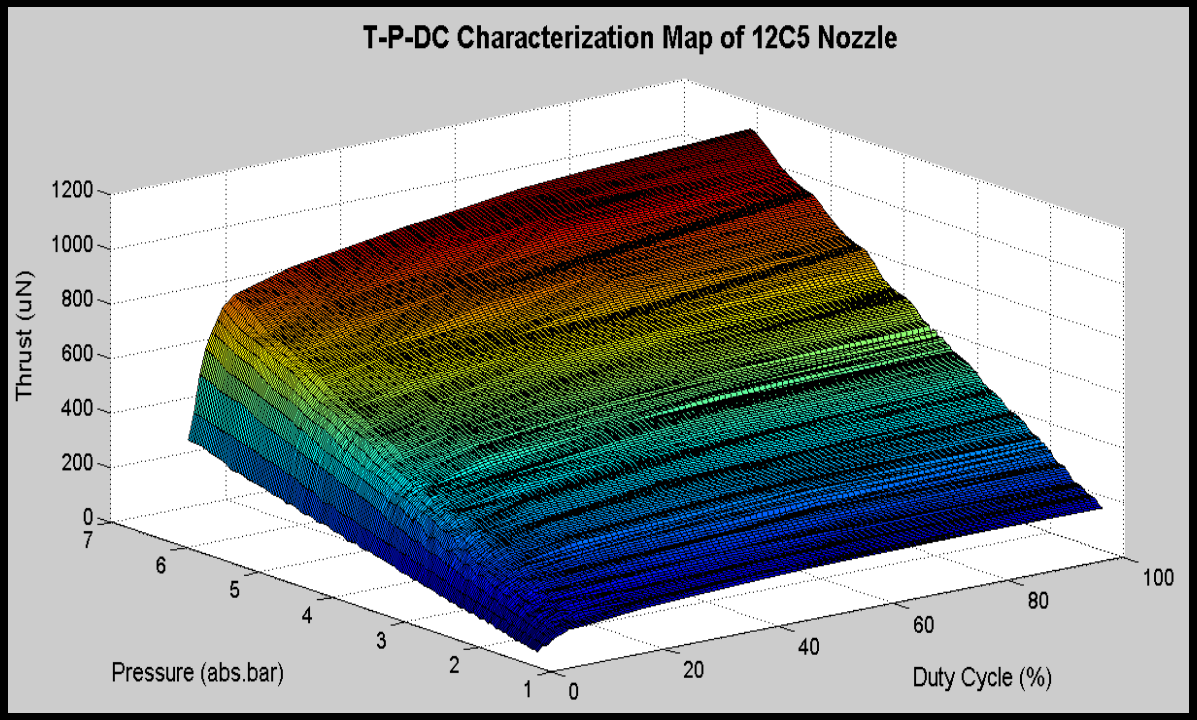
Micronozzle Characterization (before launch)



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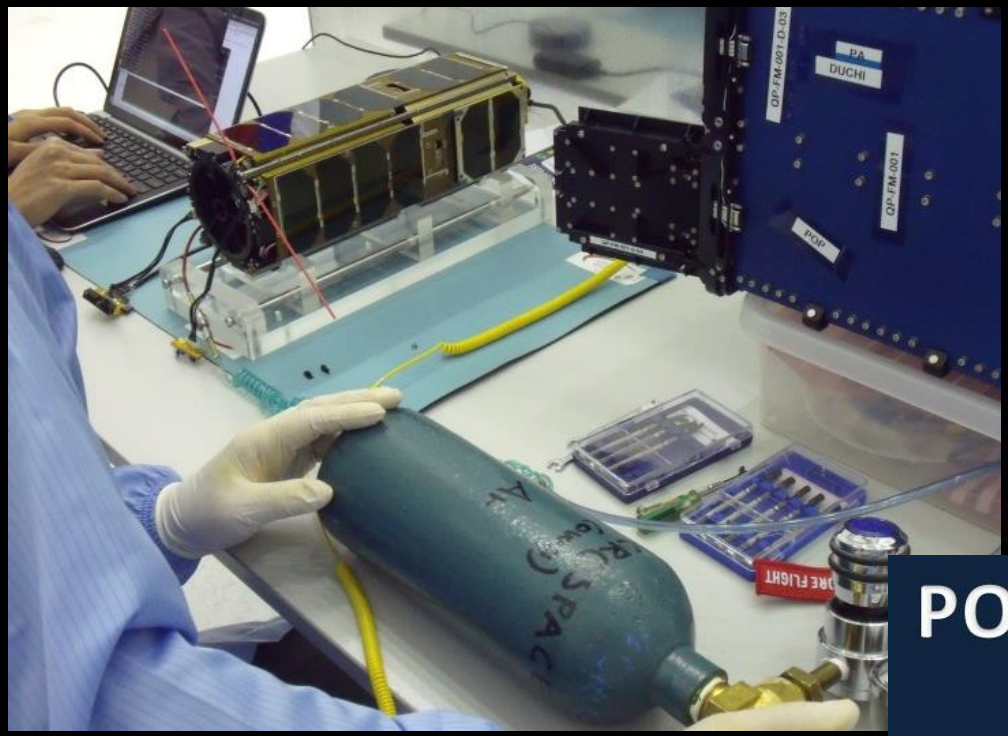
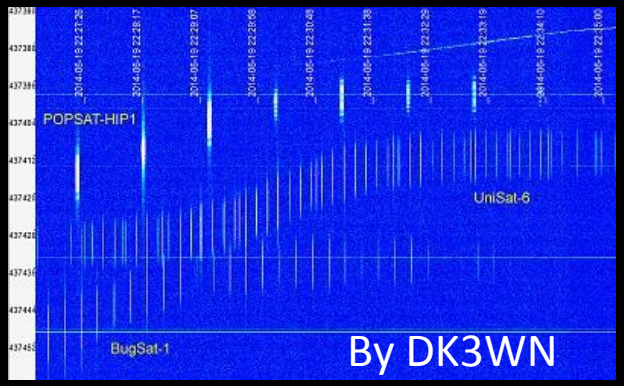
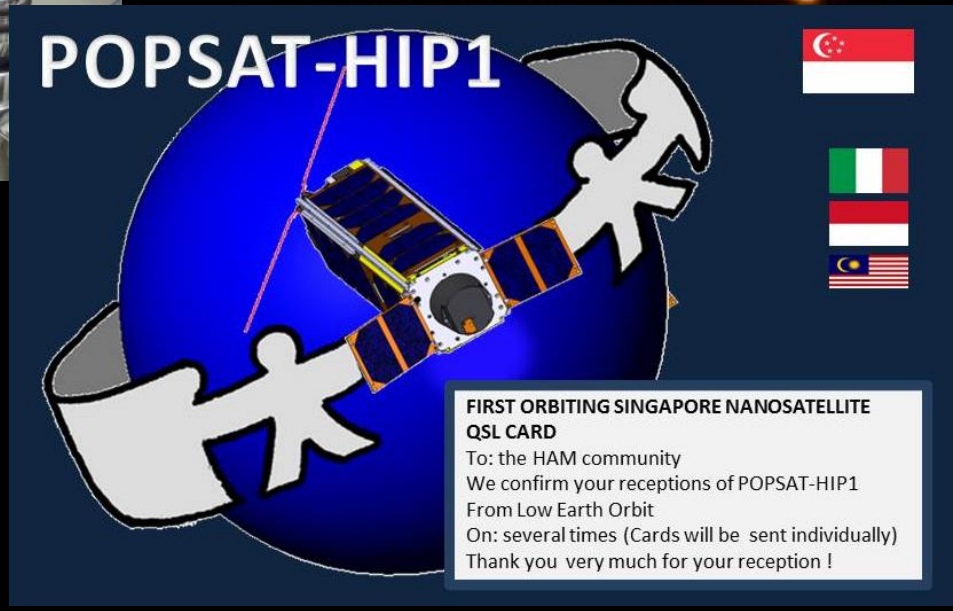
POPSAT Launch



19 June 2014



By DK3WN



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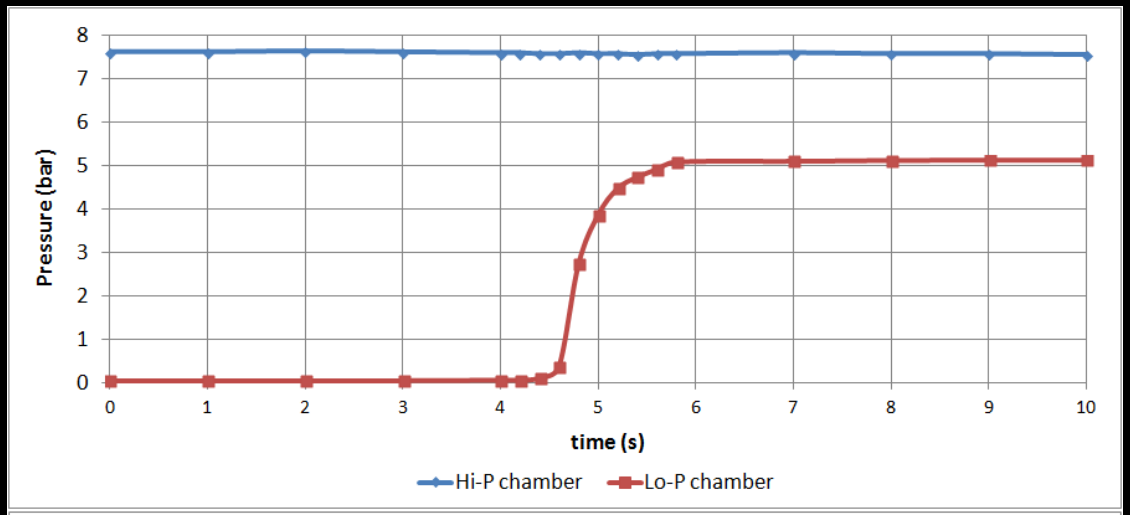
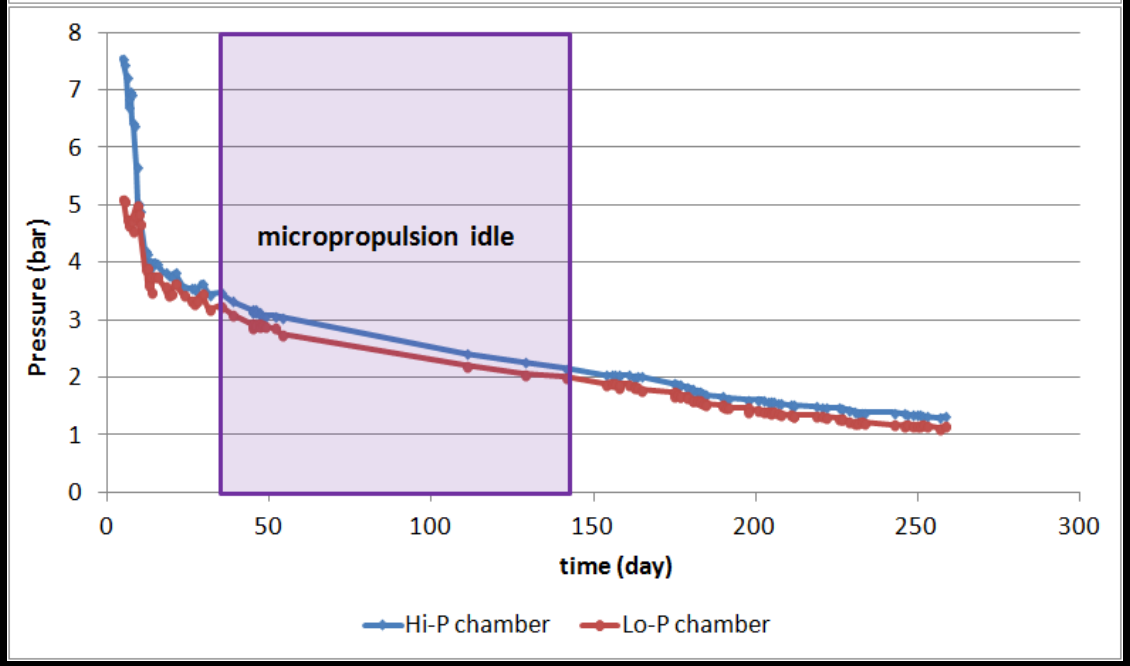
Orbit experiments:
Isolation Valve & Gas Pressure Profile





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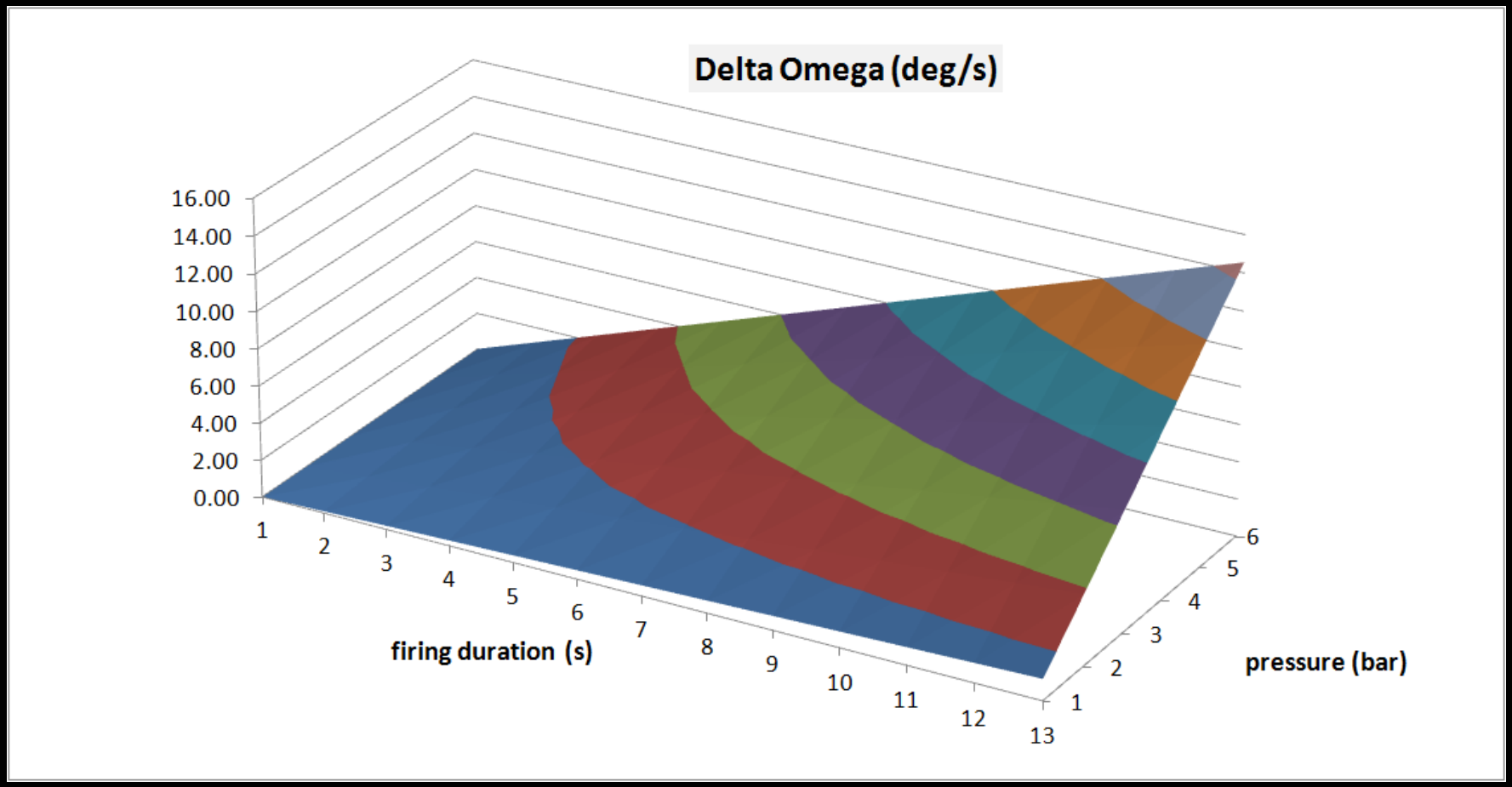
Orbit experiments: Nominal performances



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Experiment Operation

2min

- POPSAT contact (AOS)
- Check Battery, etc…
- Check Stabilization
- Angular rate OK ?

1min

- Decide Axis Maneuver
- Switch ON propulsion
- Log Tank Pressure
- Switch OFF propulsion

3 to 4 min

- Decide Thrust Level
- **Fire – Fire – Fire !!!**
- Log Angular Rate
- Log Tank Pressure

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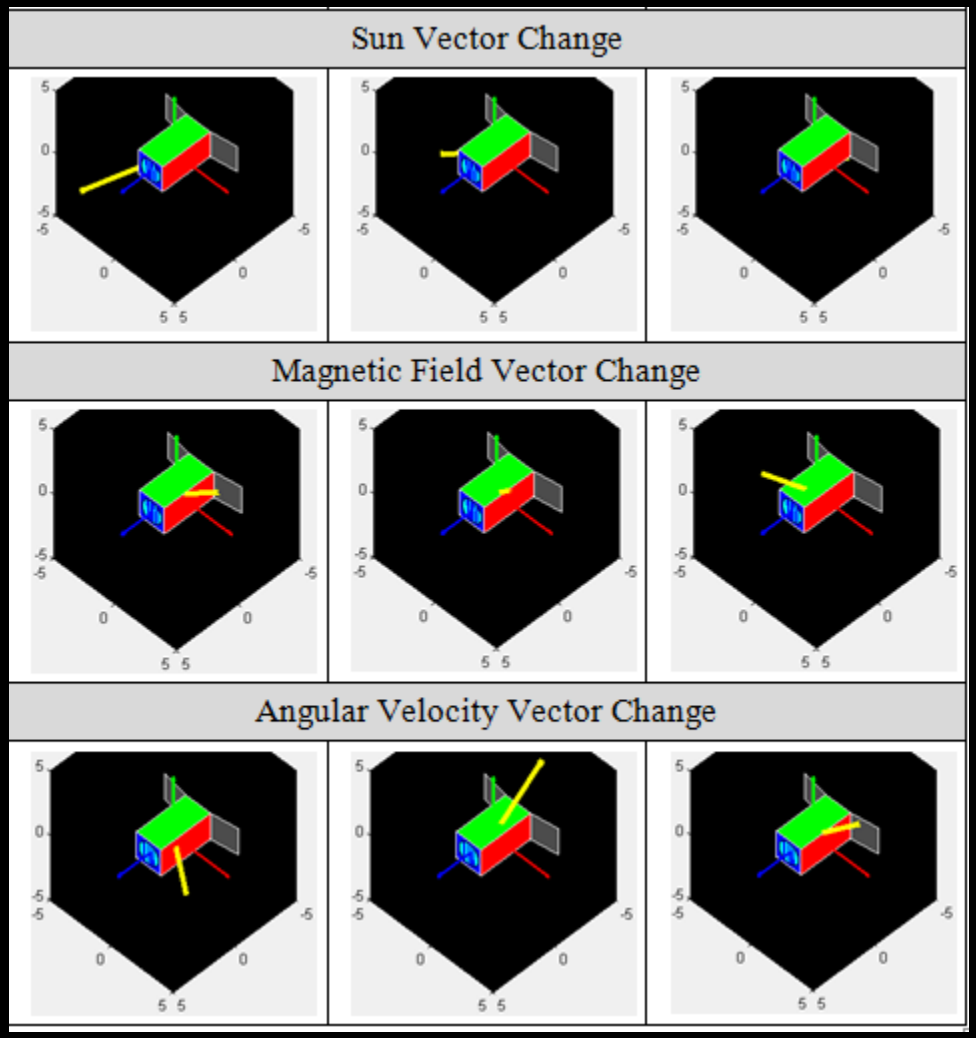
Orbit experiments: Attitude Control

[14/12/2014 11:30:55 SGT] csp-term # fsm now
Current State: NOM
[14/12/2014 11:30:57 SGT] csp-term # fsm goto prm
[14/12/2014 11:31:03 SGT] csp-term # fsm now
Current State: PRM
[14/12/2014 11:31:22 SGT] csp-term # hk getadcs 1 1 0 1
2014-12-14 11:31:20 SGT
w = 0.07 **-0.09** -0.64 [dps]
[14/12/2014 11:31:26 SGT] csp-term # fp commandrunspawn 26
[14/12/2014 11:31:29 SGT] csp-term # log get info 1 0 1
2014-12-14 03:31:28 : LOG_INFO VACO_GPR_REQ A:194 | B:46
[14/12/2014 11:31:31 SGT] csp-term # **fp commandrunspawn 23 100 3 90 2 5 0 2 50**
[14/12/2014 11:31:57 SGT] csp-term # fp commandrunspawn 27
[14/12/2014 11:32:08 SGT] csp-term # hk getadcs 1 1 0 1
2014-12-14 11:32:05 SGT
w = 0.06 **-0.42** -0.56 [dps]
[14/12/2014 11:32:11 SGT] csp-term # **fp commandrunspawn 23 100 3 90 2 5 0 2 50**
[14/12/2014 11:32:14 SGT] csp-term # fp commandrunspawn 27
[14/12/2014 11:32:25 SGT] csp-term # hk getadcs 1 1 0 1
2014-12-14 11:32:25 SGT
w = 0.06 **-1.04** -0.55 [dps]
……..



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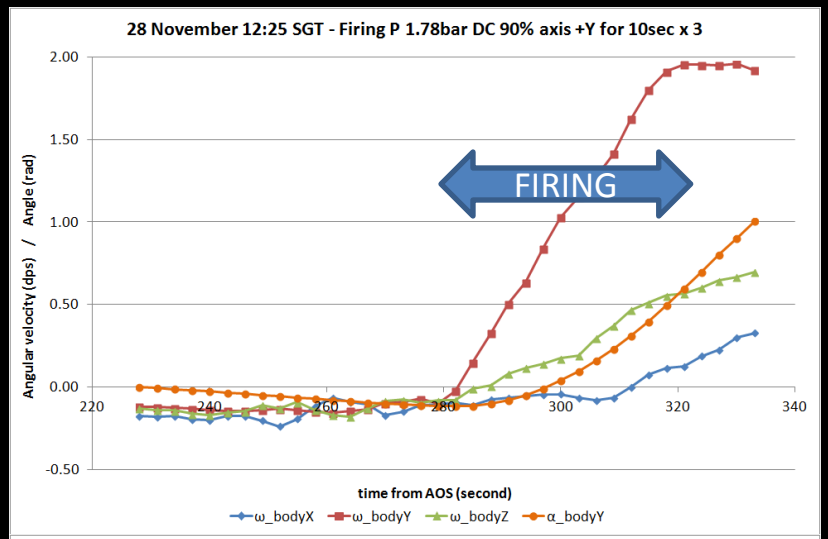
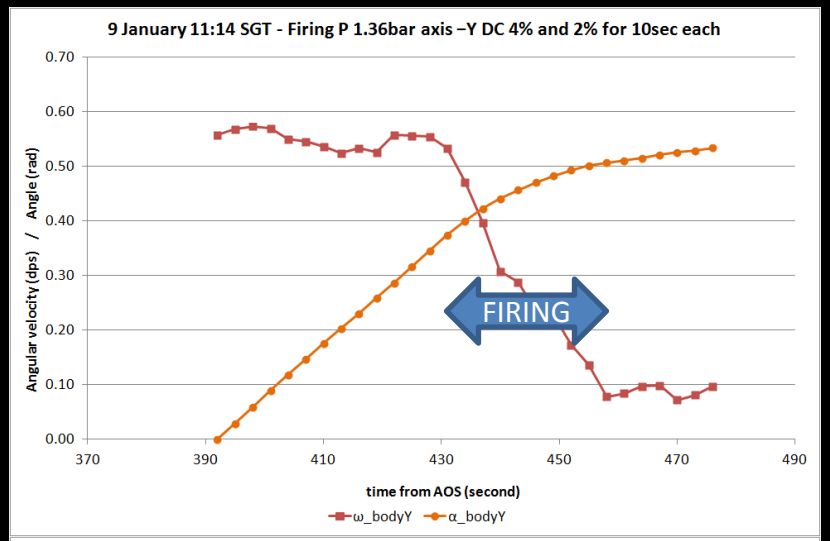
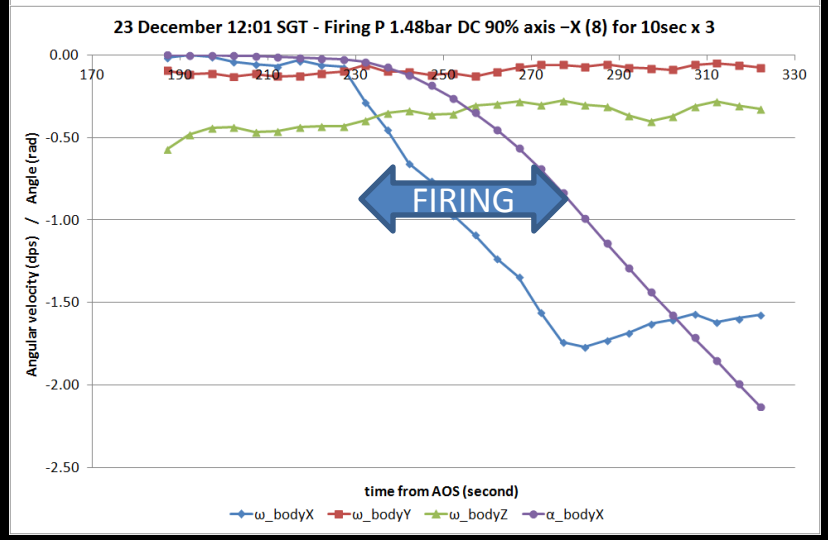
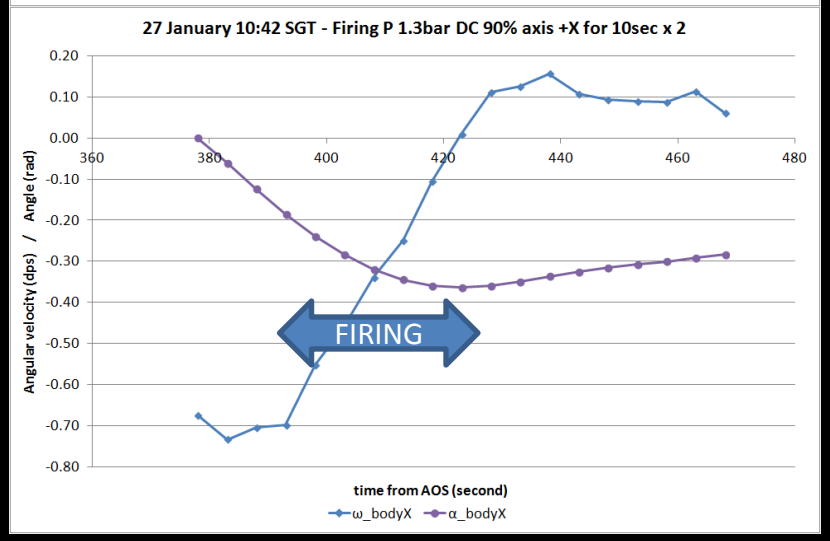
Orbit experiments: Angular velocity change









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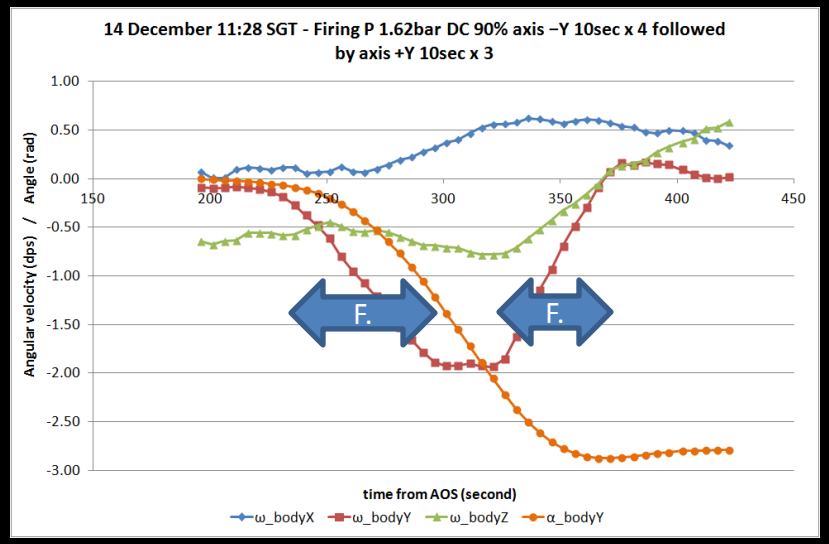
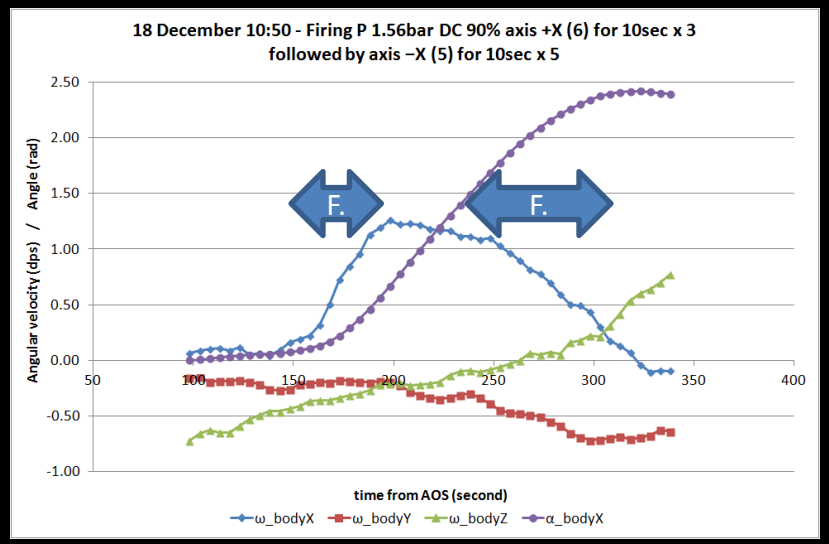
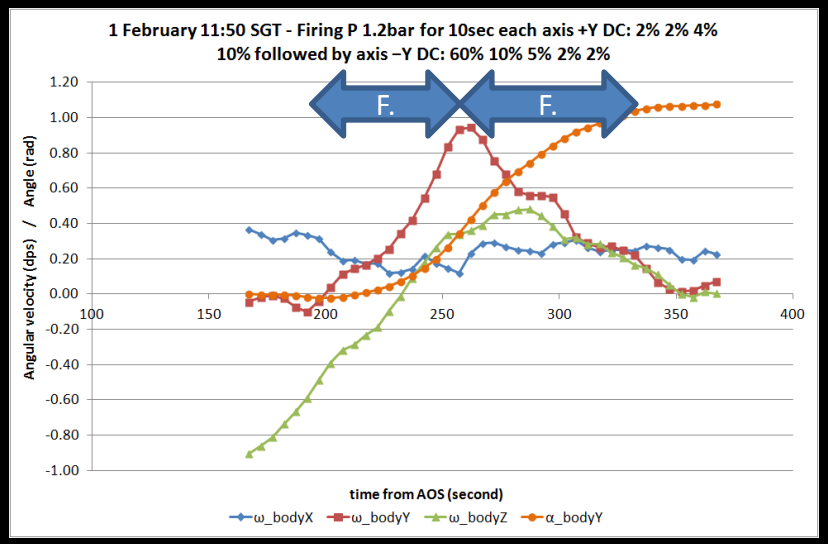
Orbit experiments:

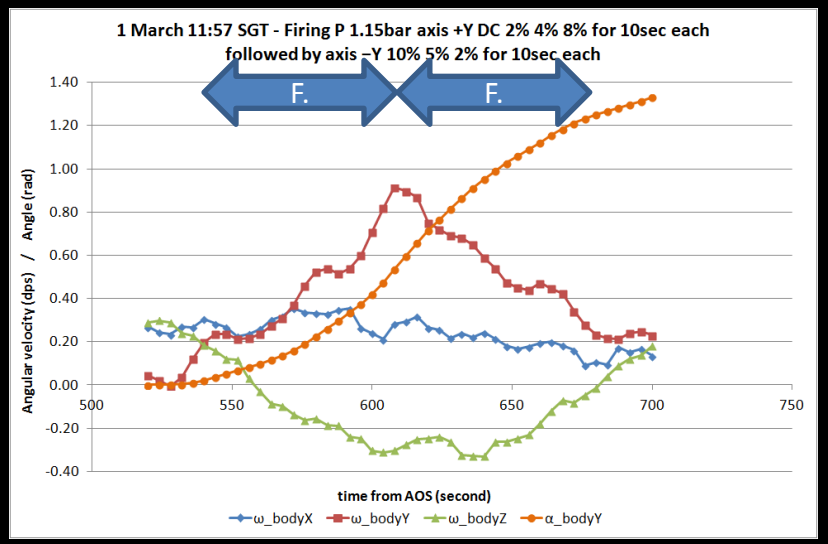
Bang-Bang





Target Pointing





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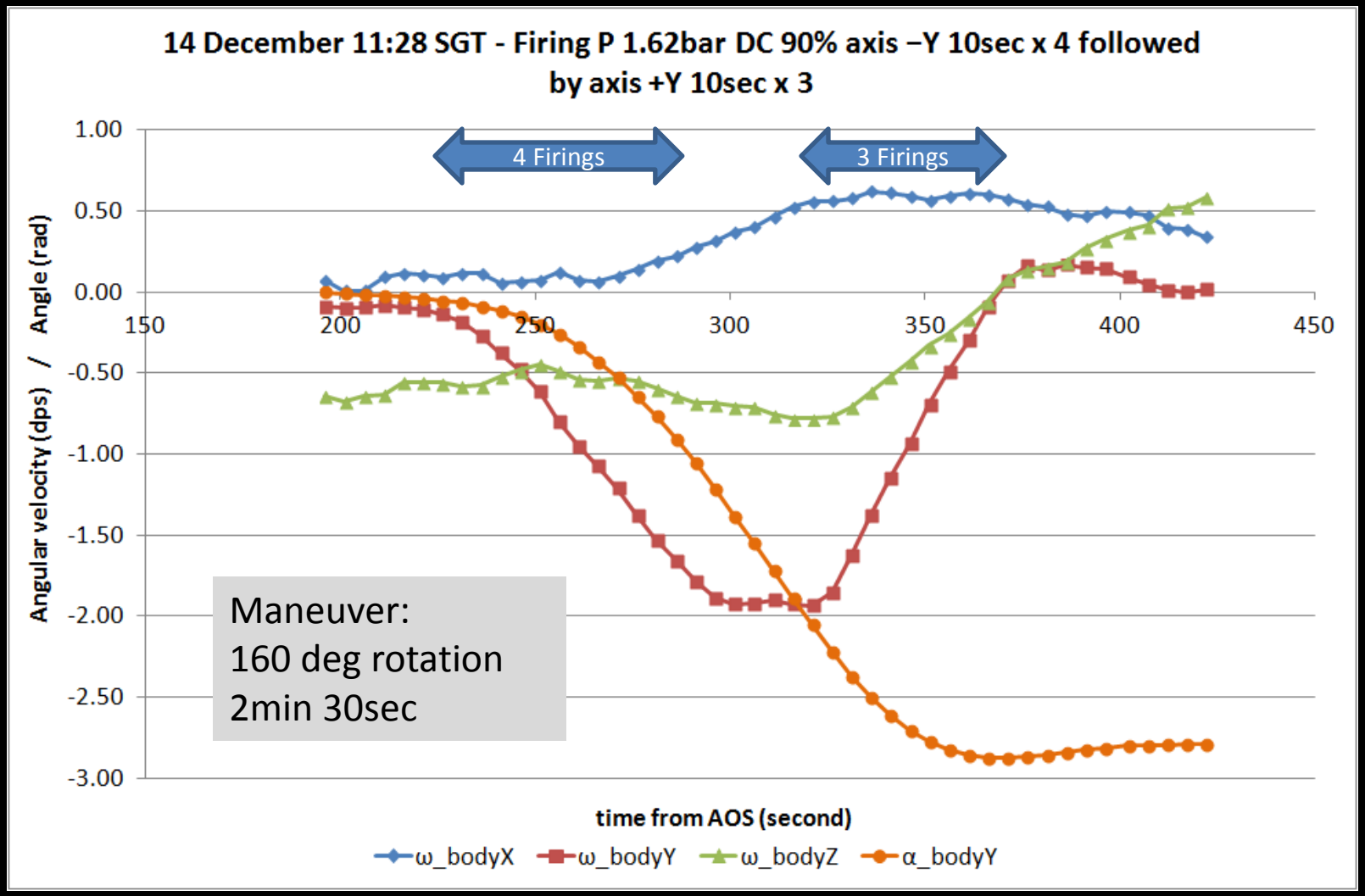
Orbit experiments: Bang-Bang



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Orbit experiments: Conclusions: Cubesat Attitude Control Micropropulsion TRL9 !

Average specific impulse on EOL experiments	I_s	31.8	sec
Average specific impulse on mission	I_s	43.0	sec
Initial pressure	P_0	7.8	bar
Total mass	m_0	24	g
Total ΔV on 9 months mission	Δv	3.05	m/sec
Total ΔV for 1 month mission	Δv	5	m/sec

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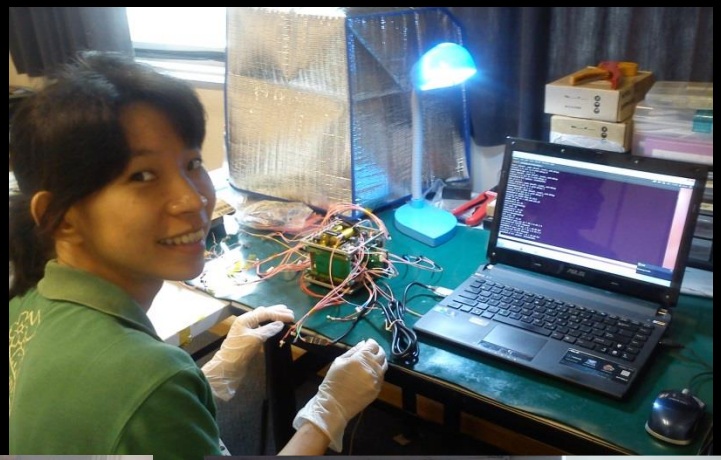
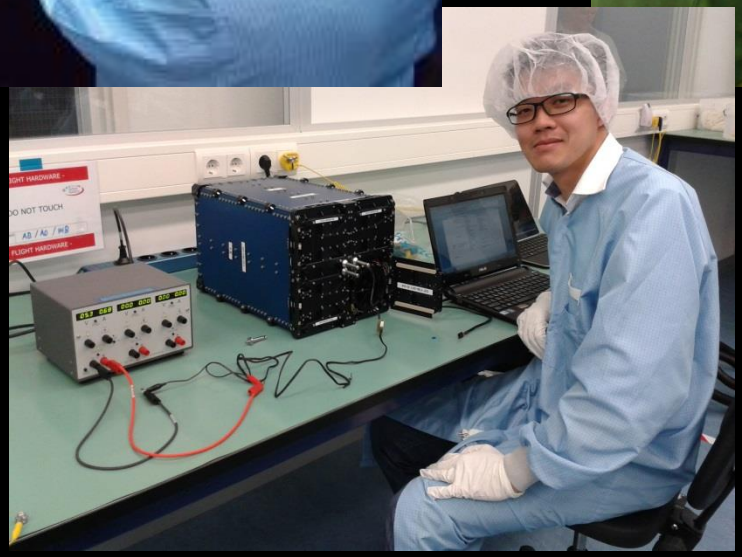
Thanks !

the Team (ready for the next one…)





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