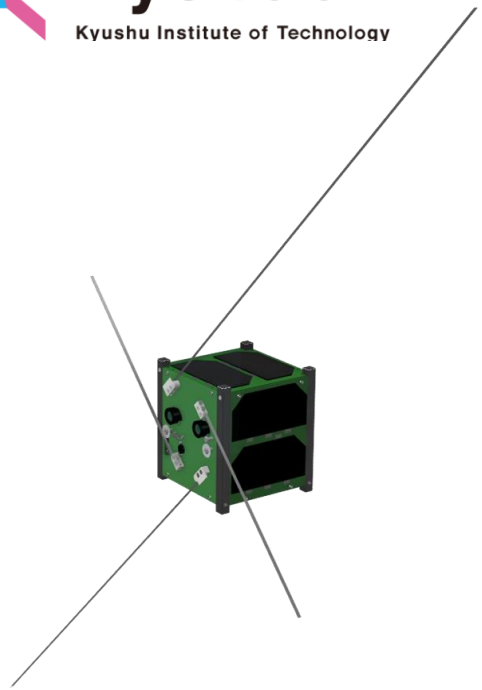
Kyutech
Kyushu Institute of Technology

BIRDS BUS OPEN SOURCE WEBNIAR 14

La SEINE



Sponsors and Collaborators

JAXA
JAXA
Kyutech
Kyushu Institute of Technology
The Republic of Uganda
MINISTRY OF SCIENCE, TECHNOLOGY AND INNOVATION
ZIMBABWE NATIONAL GEOSPATIAL AND SPACE AGENCY
ZINGSA

BIRDS-5 CubeSats
Kyushu Institute of Technology

Lessons Learnt and Findings from BIRDS5-FTA

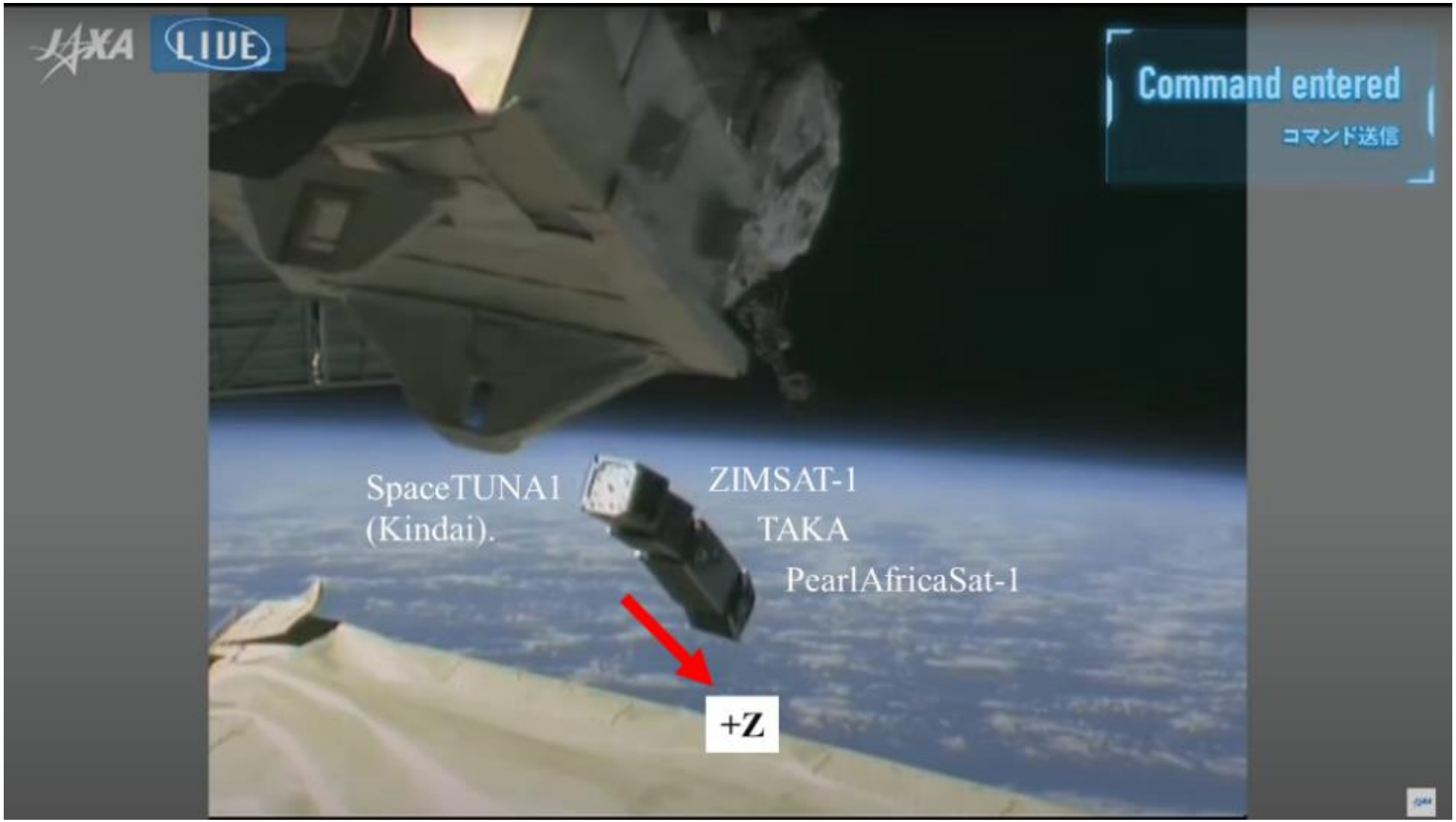
08/03/2023

Outline

- Status of BIRDS5 satellites
- Satellites operation report
- Possible causes of failure
- FTA tests conducted and the obtained results
  - Analysis of the results
- Conclusion of FTA
- Lessons learnt and recommendation for design improvement

BIRDS 5 Status

- BIRDS 5 satellites were deployed on the 2nd of December 2022



https://www.youtube.com/watch?v=oWabTGG4plc

BIRDS 5 In Orbit Status

Look4Sat APP

Name	ID	Satellite	Altitude (km)
1998-067UL	54534	Taka	368
1998-067UM	54535	PearlAfricaSat-1	358
1998-067UN	54536	ZIMSAT1	373
ISS (ZARYA)	25544	ISS	415

- No signal received from all the three satellites

Satellite Operation Report

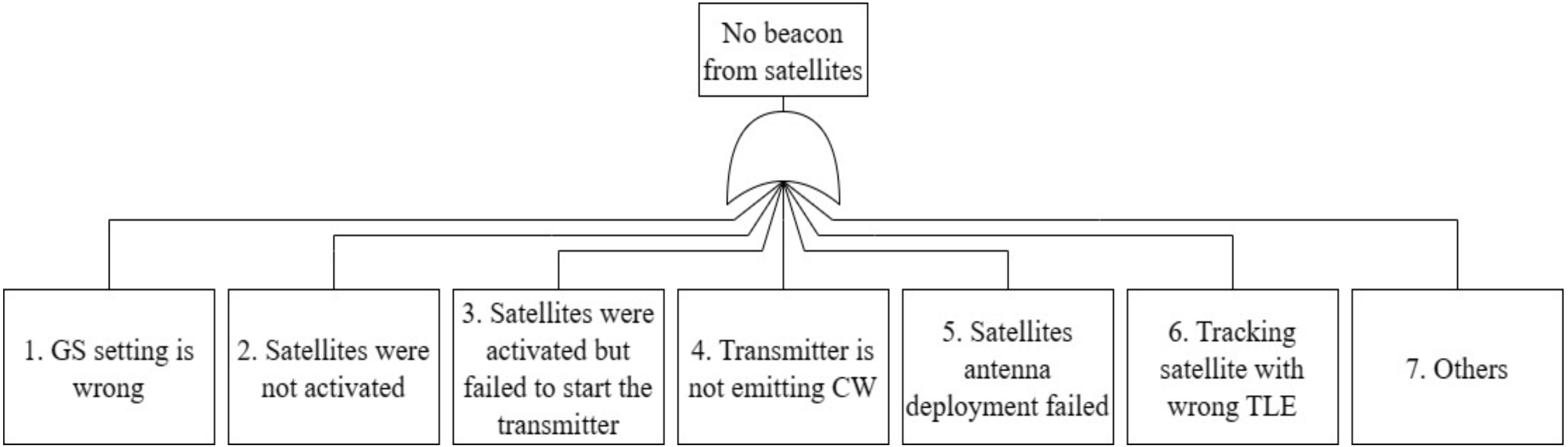
- Satellites tracking
  - Kyutech GS (main)
  - BIRDS GS network
  - SATNOGS
  - Wakayama GS (12 m, 30 dBi Antenna Gain)

Satellite	CW Beacon	UHF Uplink	UHF Downlink	Remark
PearlAfricaSat-1	X	X	X	❑ No CW ❑ No uplink success ❑ No downlink success
TAKA	X	X	X	
ZIMSAT-1	X	X	X	

- Uplink Commands send:
  - Force CW
  - Erase flash memories

● Successful
X Not Successful

Possible Causes of Failure

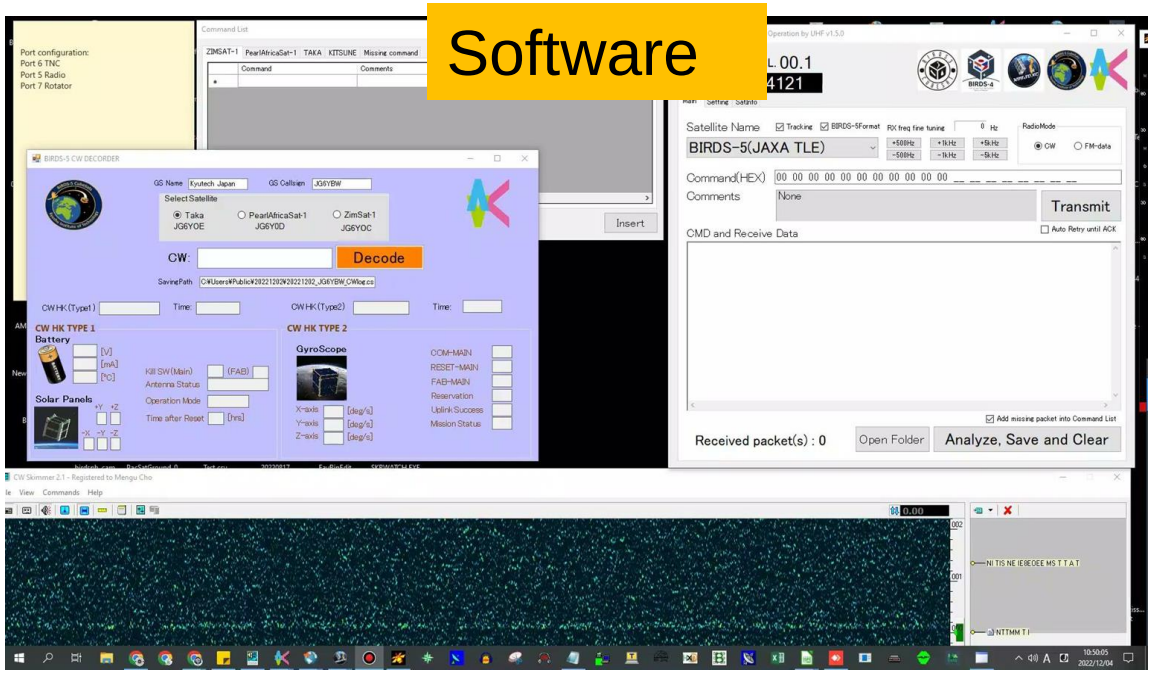


- Others:
  - Design issues? Individual hardware issues? Software issues? Workmanship issues? Fault parts?

1. Wrong GS Settings

A. BIRDS5 Operation Software

- EM satellite is functional
- KITSUNE with the same frequency can be detected.
- BIRDS-5S working properly



B. Wakayama University and BIRDS Network Ground Stations Hardware

- Kitsune CW can be heard
- No signal from BIRDS satellites

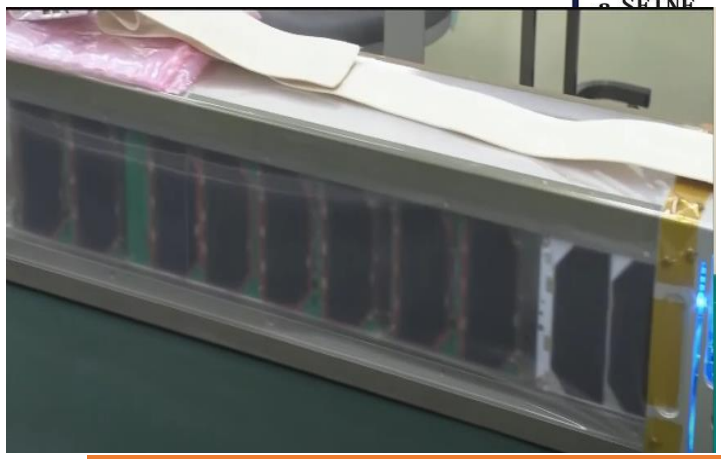
❖Wrong settings: Denied

2. Satellites were not Activated

A. RBF pins were not removed

- ❑ **Denied:** RBF pins removed by JAXA

RBF pins returned to Kyutech

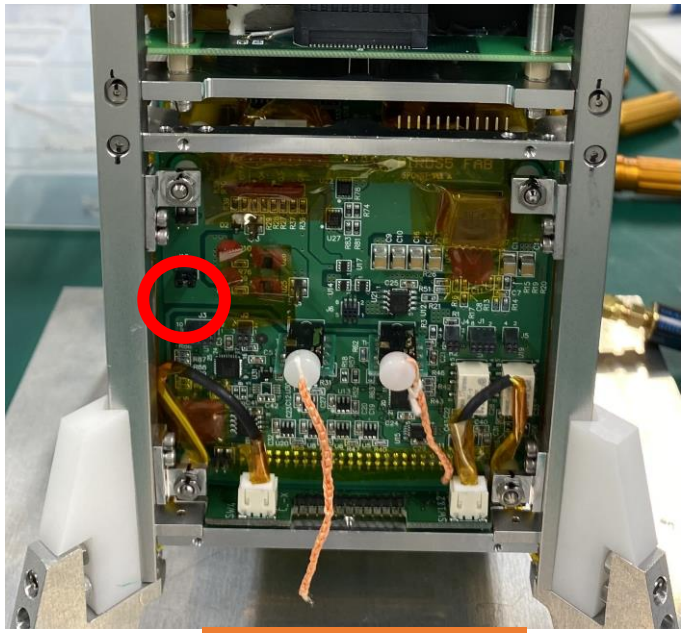


No RBF pins seen in JAXA's video

B. Jumper pins (J15) on the FAB dropped during vibration

- ❑ **Denied:**
  - ❑ Glued during assembly
  - ❑ After vibration the satellites functioned

Small Satellites Deployment J-SSOD#23 from "Kibo" (BIRDS-5, and SpaceTuna1)「きぼう」から超小型衛星の放出 - YouTube



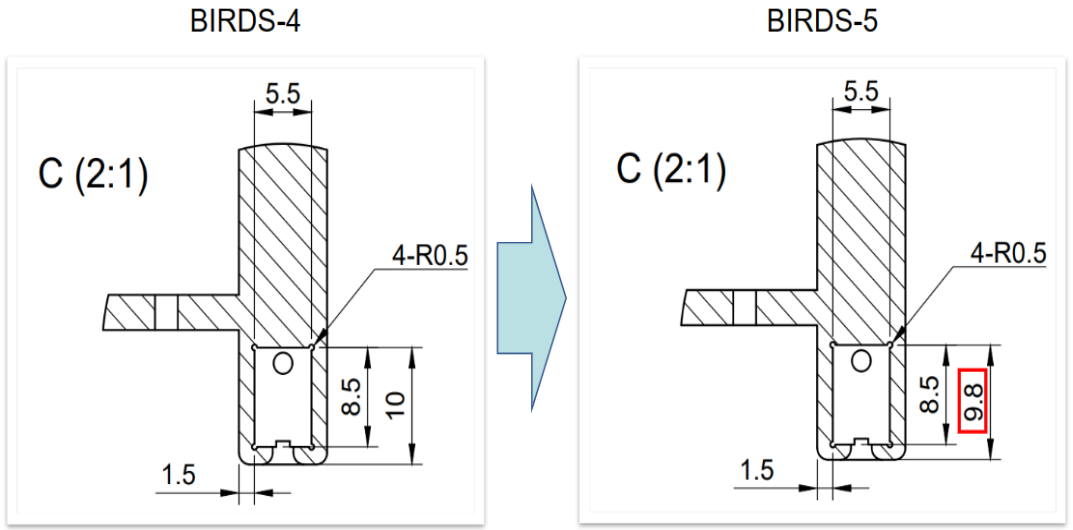
J15 highlighted

2. Satellites were not Activated Continue..

C. Deployment switches failed due to:

I. Design changes

- Position changed from Birds4



	BIRDS-4	BIRDS-5	Futaba
Depression length of the switch when the satellite is stored in the J-SSOD	1.5mm	1.3mm	1.2mm
Period of being stored from handover to release	5.5 months (2020/10/01 - 2021/3/14)	6 months(10%↑) 2022/6/7 - 2022/12/2	5.5 months 2022/02/24- 2022/08/12

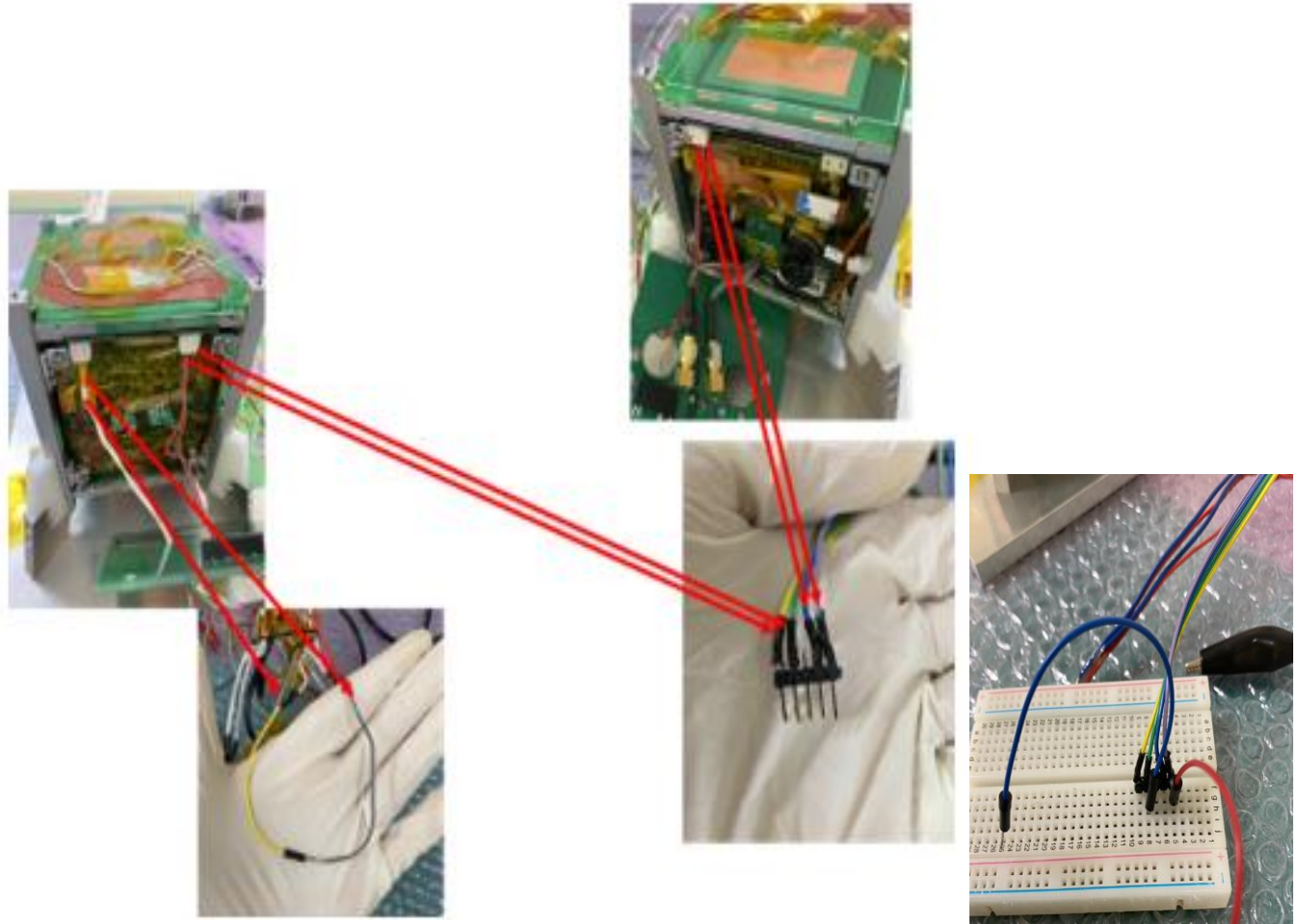
- **Unlikely**

=>Futaba design was in more severe condition

2. Satellites were not Activated Continue..

II. Electrical Chattering

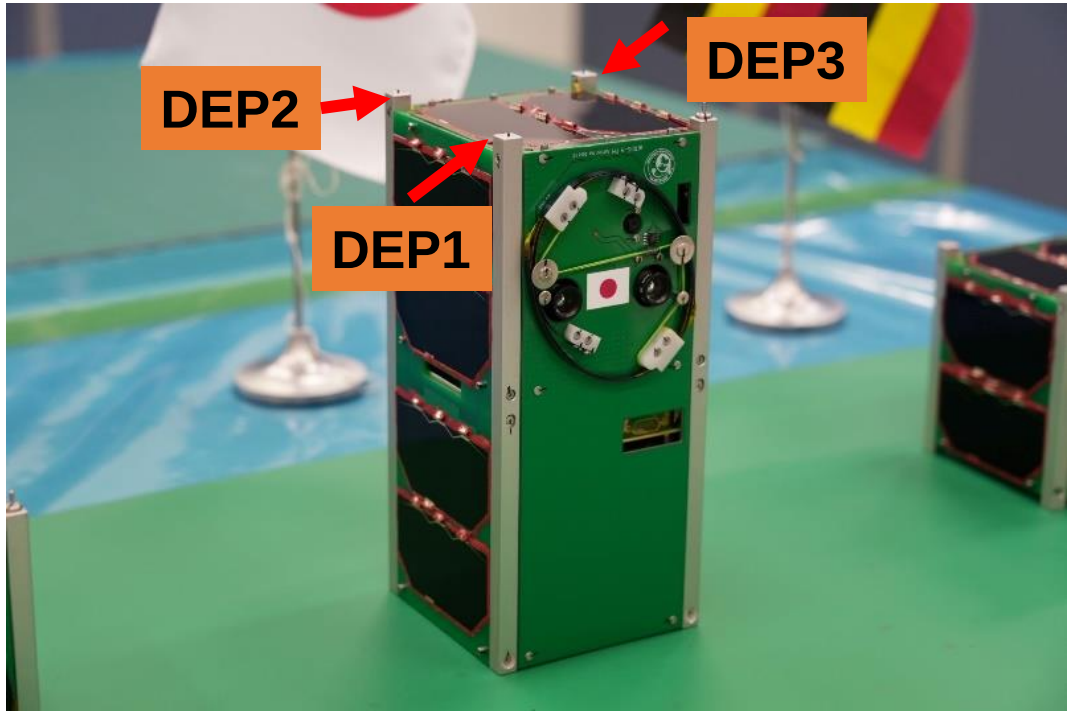
- Likely occur **during launch** and **deployment**
- Dangers
  - Can affect Reset-PIC
  - Can affect powerlines
- Effects tested under atmosphere and vacuum (TVT) conditions



Deployment switch control cables

Illustration of Electrical Chattering: Manual

- Structural Design of BIRDS5 Satellite
  - 3 Deployment switches



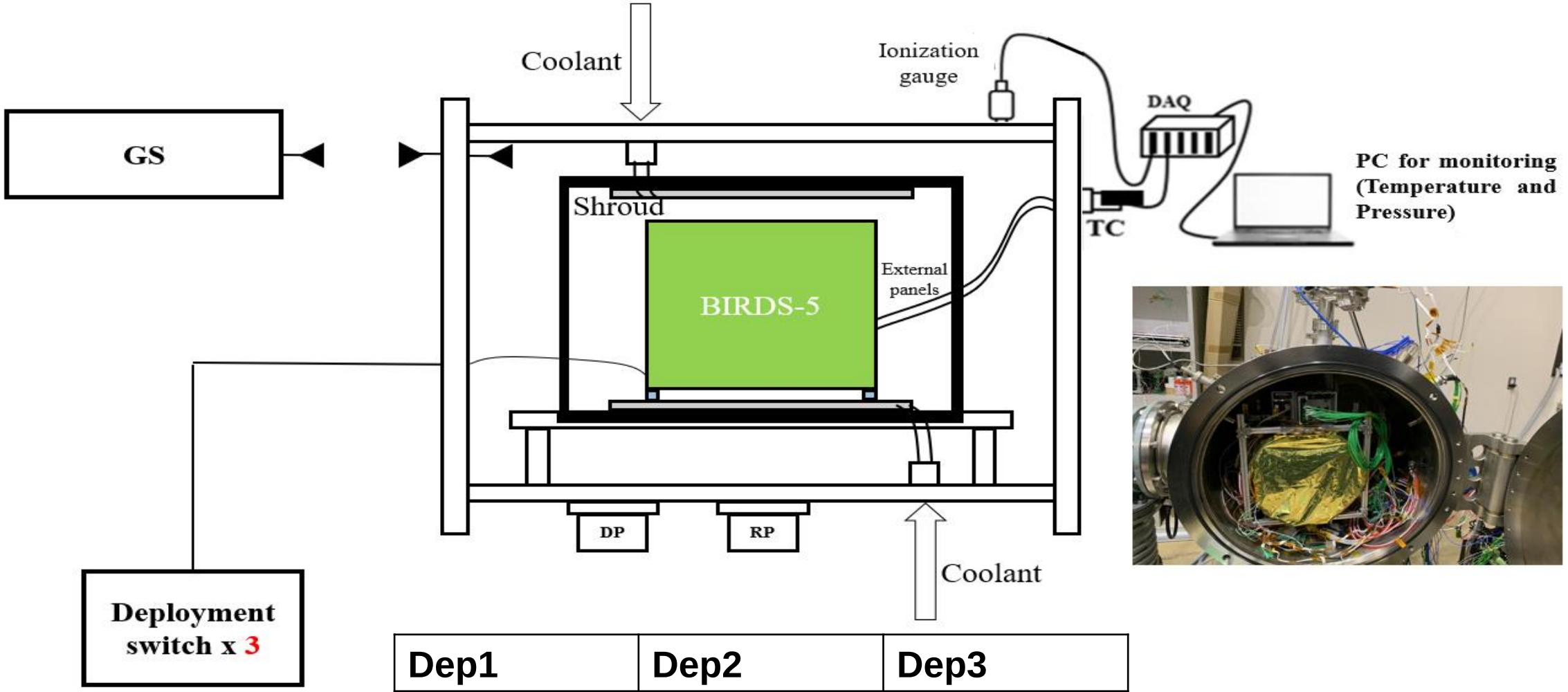
Dep1	Dep2	Dep3
ON	ON	Chattering
ON	Chattering	ON
Chattering	ON	ON

Chattering Test: Atmospheric Conditions

- Simulate rapid turning on/off of satellite:
  1. Program BIRDS-5S Satellite with TAKA FM Code
  2. Fully Erase Satellite
  3. Rapidly turn on/off satellite using deployment switch toggling
  4. Observe data collection and verify normal
  5. Repeat 3–4

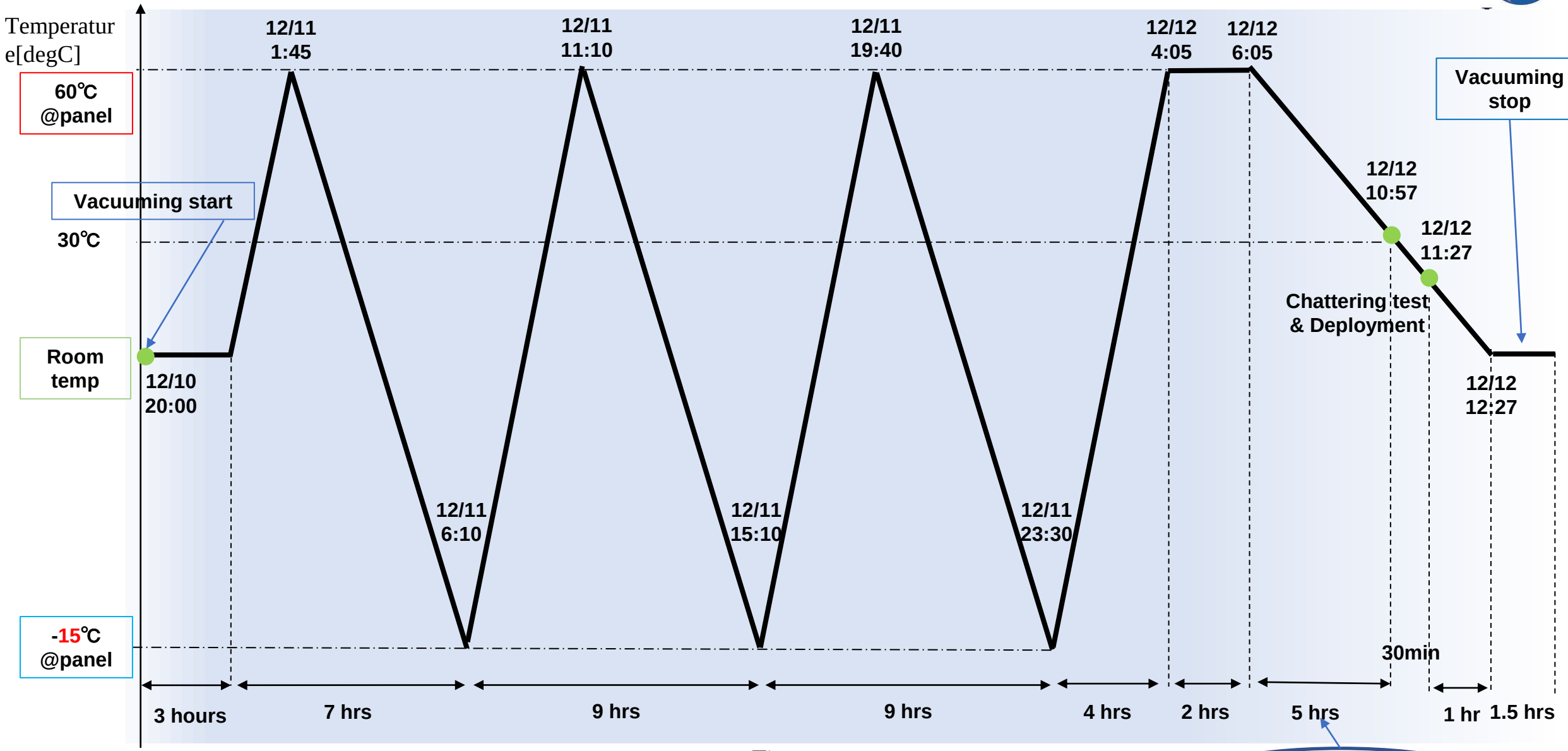
Parameters	Test 1	Test 2	Test 3
FAB data	Normal	Normal	Normal
RESET data	Normal	Normal	Normal
Flags and addresses	Normal	Normal	Normal
CW	Normal	Normal	Normal

Chattering Test: During TVT



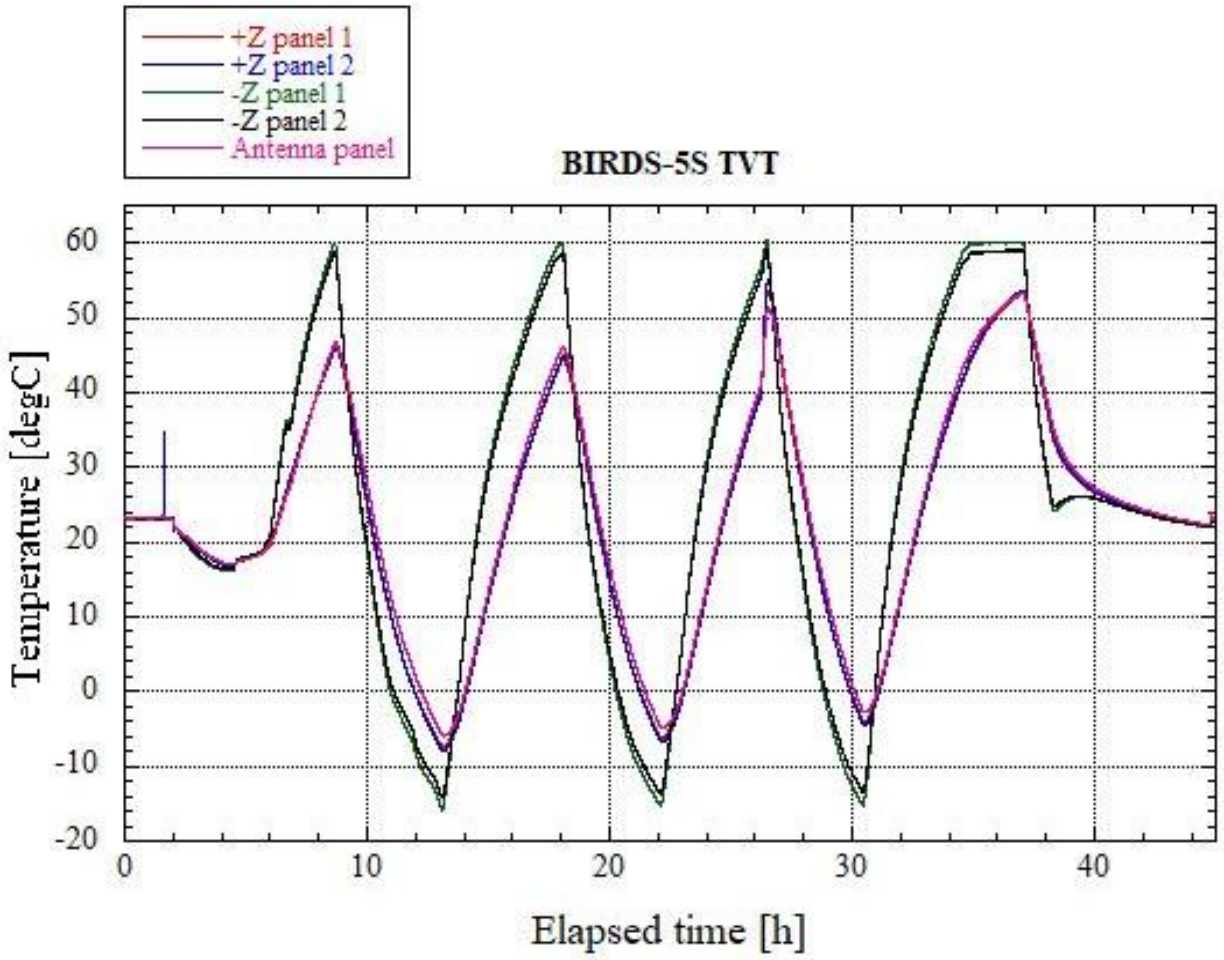
Dep1	Dep2	Dep3
ON	ON	Chattering
ON	Chattering	ON
Chattering	ON	ON

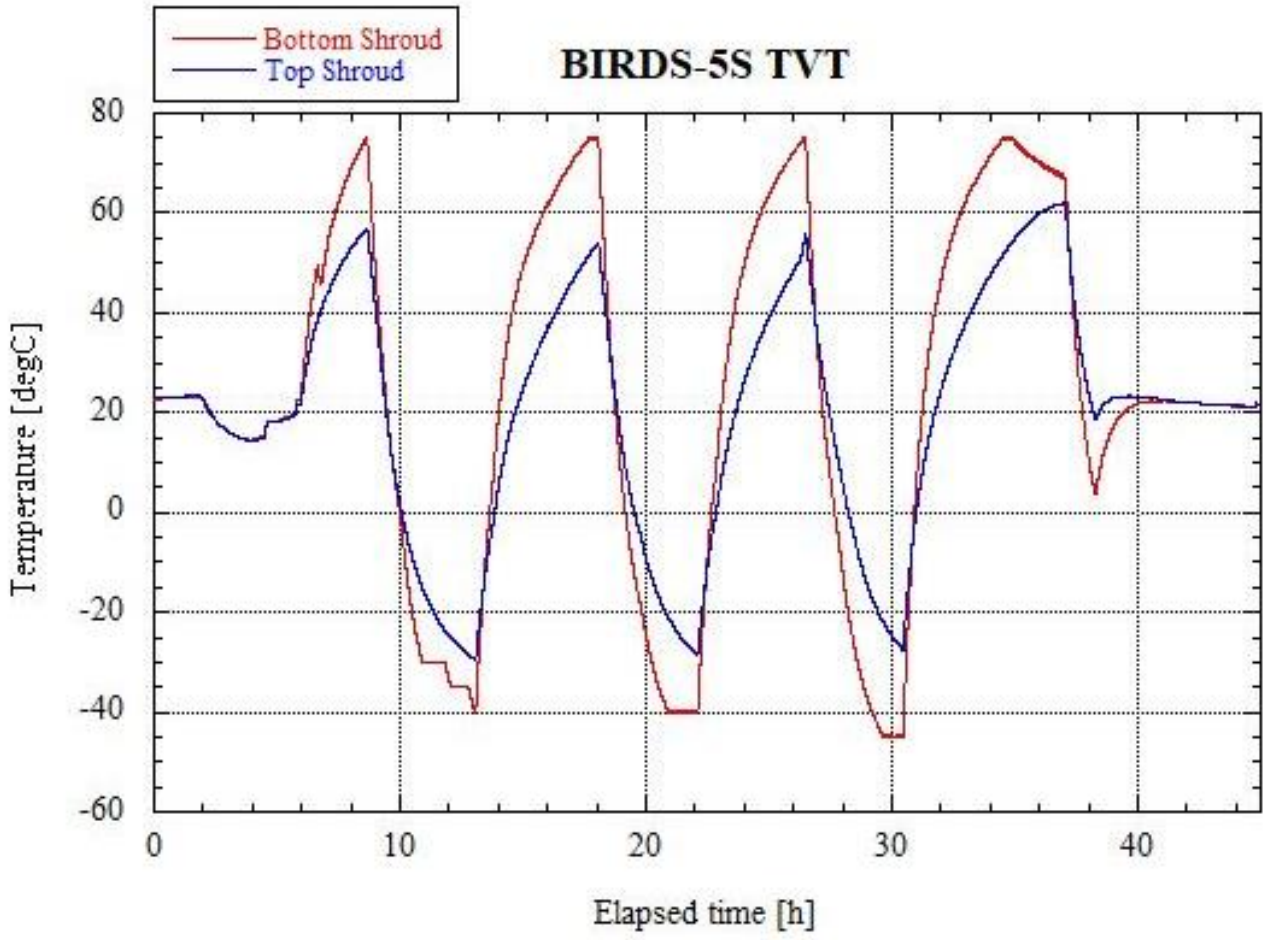
TVT(1&2)Thermal Cycles



TVT: Temperature Profiles (TVT1 &2)

- 3 cycles and 2hr hot soak



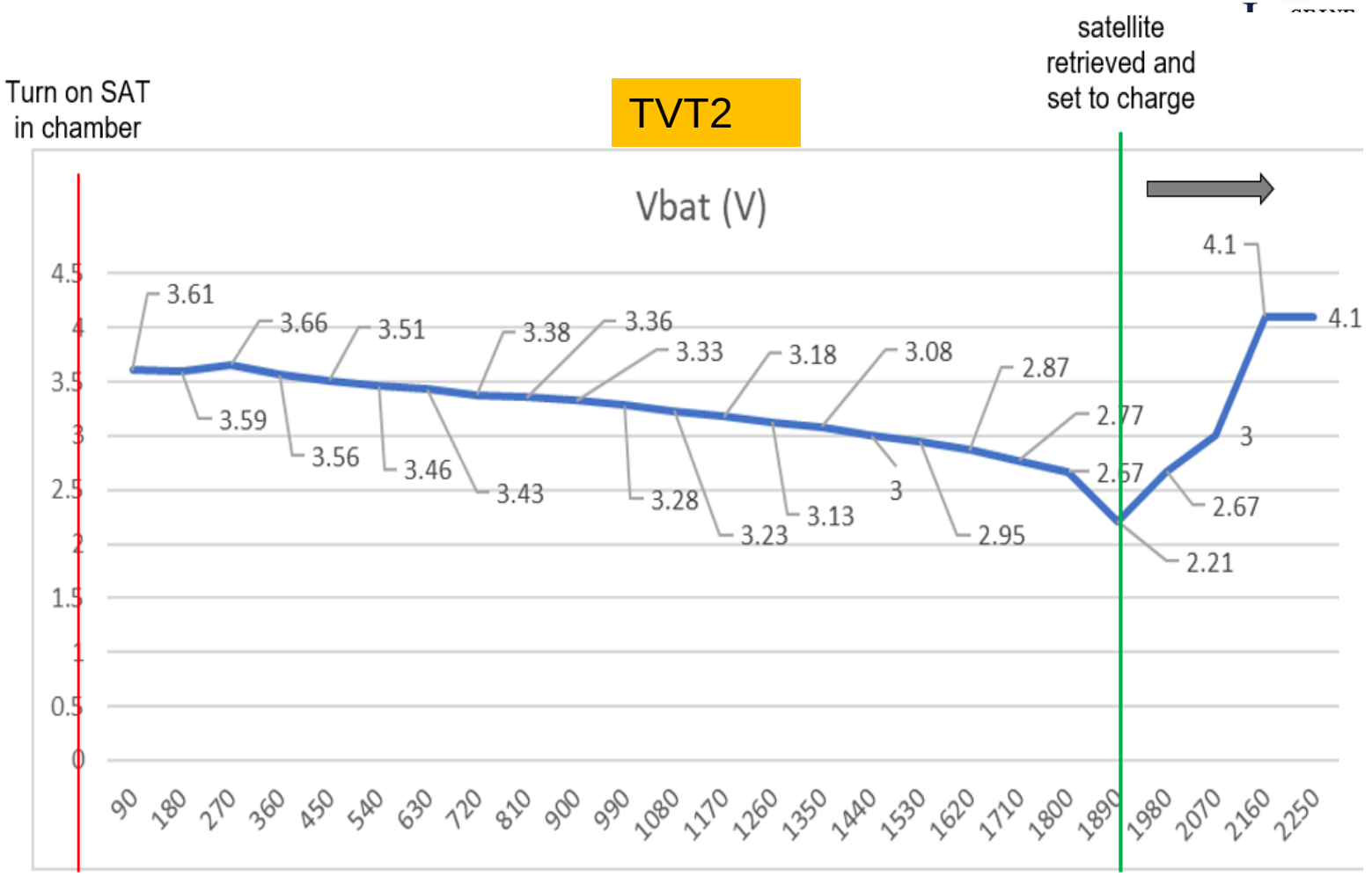


TVT(2) HK Collected Data

TVT2

		sec	min	hour	day	
1	33330300	3	0	0	0	1st turn on
2	33330300	3	0	0	0	2nd turn on
3	33330300	3	0	0	0	3rd turn on
4	33332001	32	1	0	0	
5	33330203	2	3	0	0	
6	33332004	32	4	0	0	
7	33330206	2	6	0	0	
8	33332007	32	7	0	0	
9	33330209	2	9	0	0	
10	3333200a	32	10	0	0	
11	3333020c	2	12	0	0	
12	33331f0d	31	13	0	0	
13	3333010f	1	15	0	0	
14	33331f10	31	16	0	0	
15	33330112	1	18	0	0	
16	33331f13	31	19	0	0	
17	33330115	1	21	0	0	
18	33331f16	31	22	0	0	
19	33330118	1	24	0	0	
20	33331f19	31	25	0	0	
21	3333011b	1	27	0	0	Longest ON time: 27 mins
22	33330200	2	0	0	0	4th turn on
23	33330200	2	0	0	0	5th turn on
24	33330200	2	0	0	0	6th turn on
25	33332001	32	1	0	0	

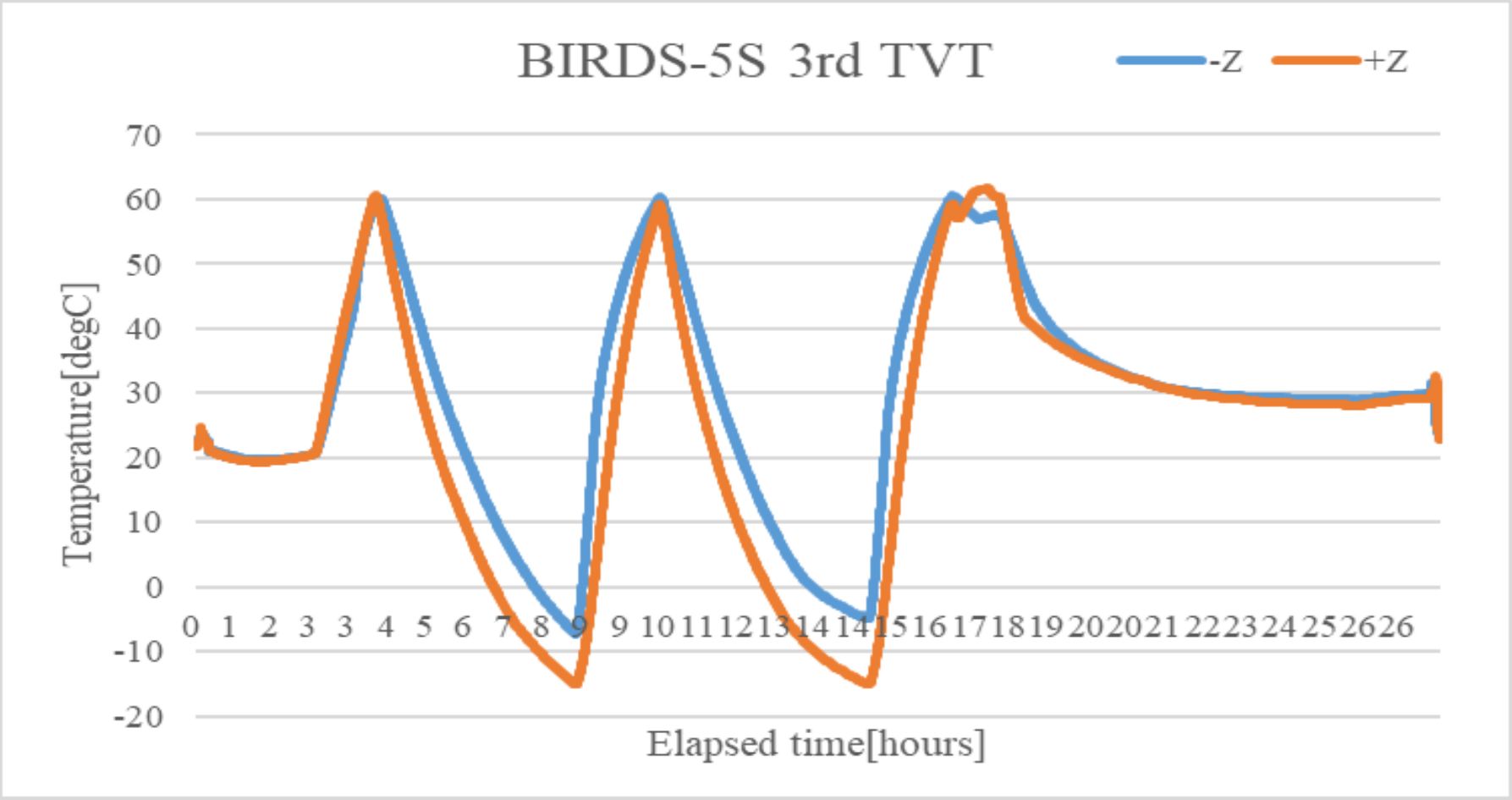
Chattering



- TVT1 Results : **Chattering not successful**, No CW, No FM, Sat OFF
- TVT2 Results: **Chattering was successful**, No CW, No FM, Battery damaged, Sat ON

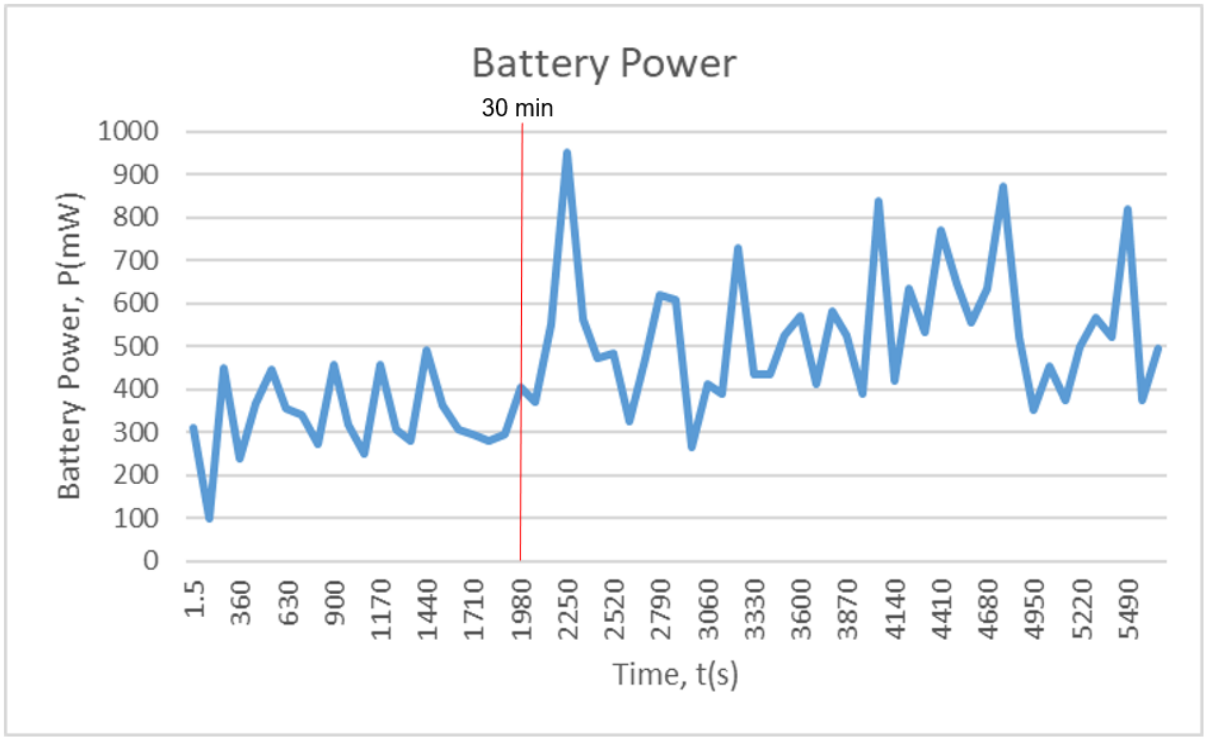
TVT: Temperature Profile (TVT3)

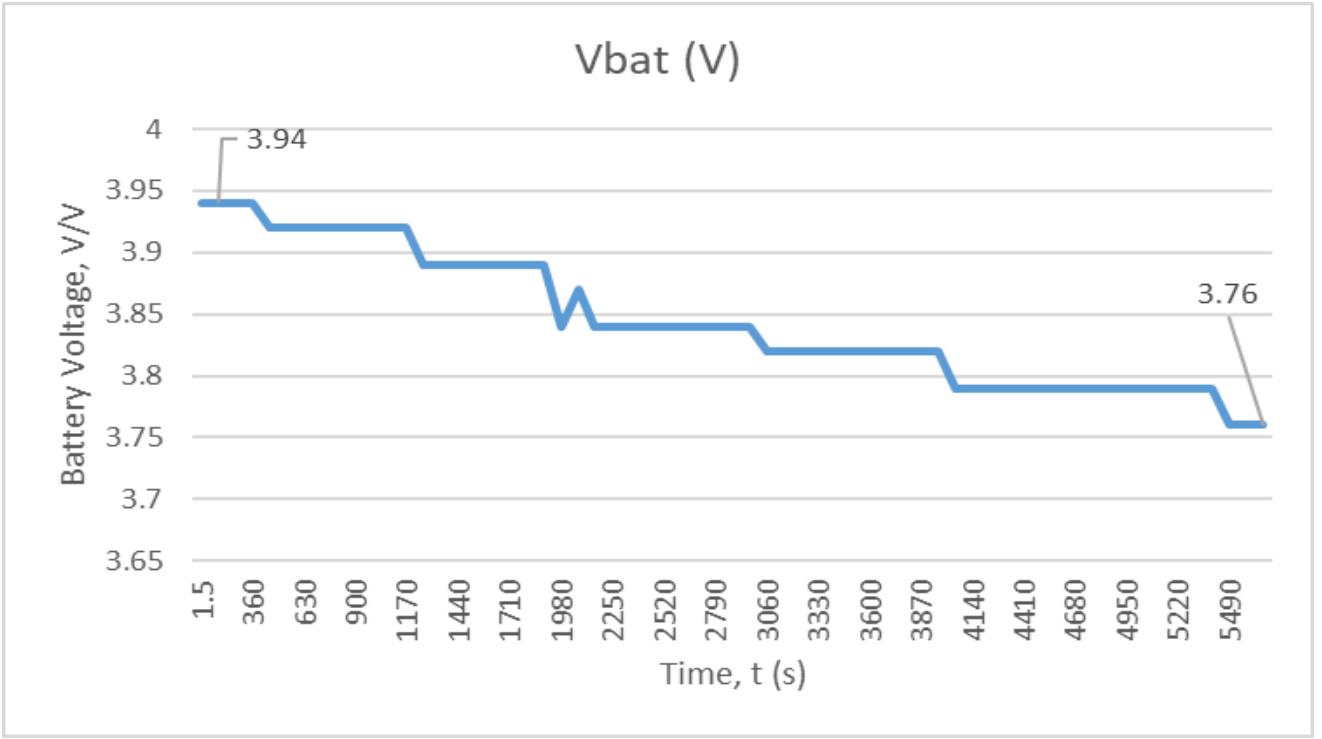
- 2 cycles and 1hr hot soak



TVT(3) HK Data Collected

- CW received, FM command also confirmed, chattering was successful





Summary of Electrical Chattering in Vacuum

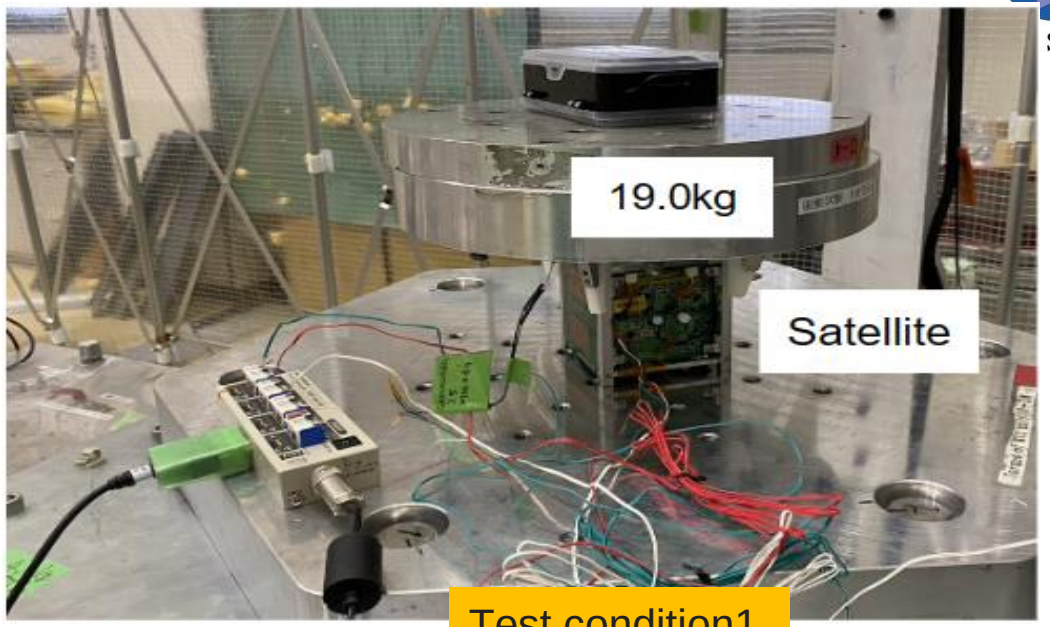
Parameters	TVT1	TVT2	Test 3
FAB data	Not Confirmed	Normal	Normal
RESET data	Not Confirmed	Normal	Normal
Flags and addresses	Not Confirmed	Normal	Normal
CW	Not Confirmed	Not Confirmed	Normal

- **Unlikely** that failure was due to electrical chattering

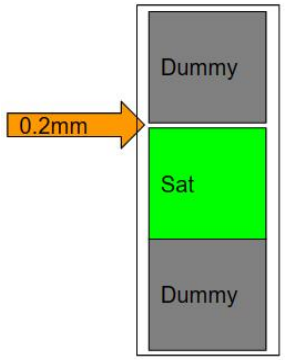
2. Satellites were not Activated Continue..

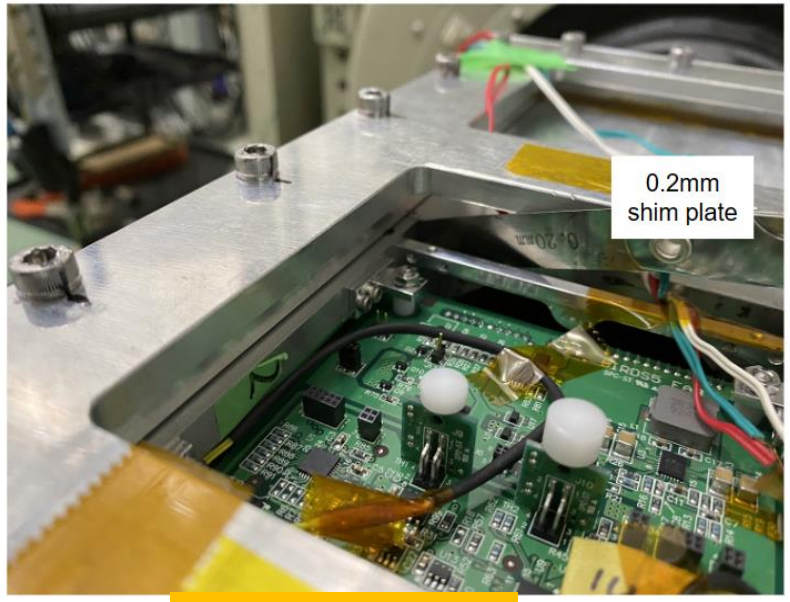
III. Mechanical Chattering

- **Due to vibration**
  - **Dangers**
    - ✓ **Physical damage of deployment switches**
  - **Test condition1 with 46.6N:**
    - ✓ Random and sine burst vibration
    - ✓ Total force to the four rails: 19Kg(186.6N)
    - ✓ Functionality was okay hence **unlikely**
  - **Test condition2 with 0.2mm room:**
    - ✓ Random and sine burst vibration
    - ✓ Functionality was okay hence **unlikely**



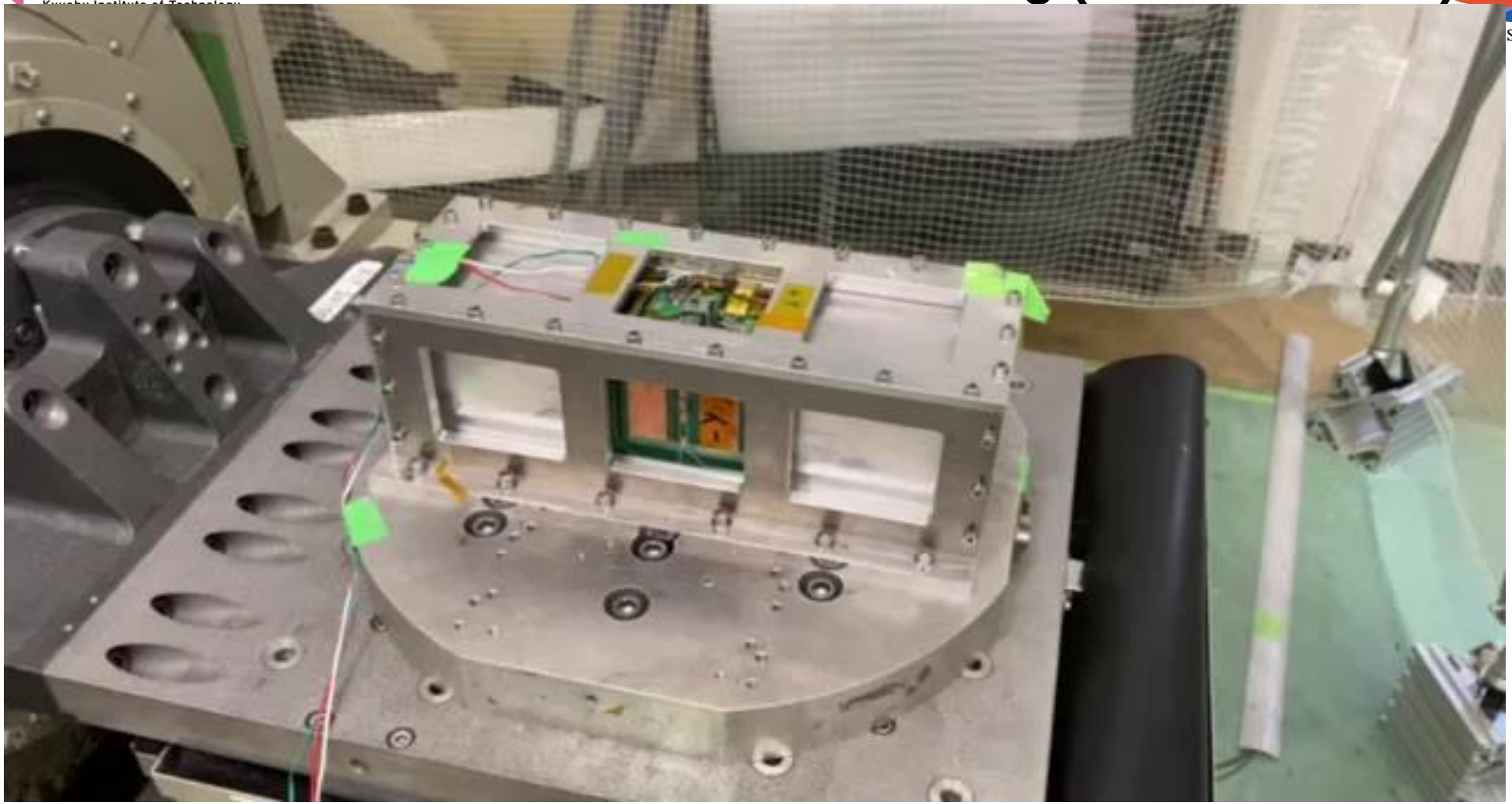
Test condition1





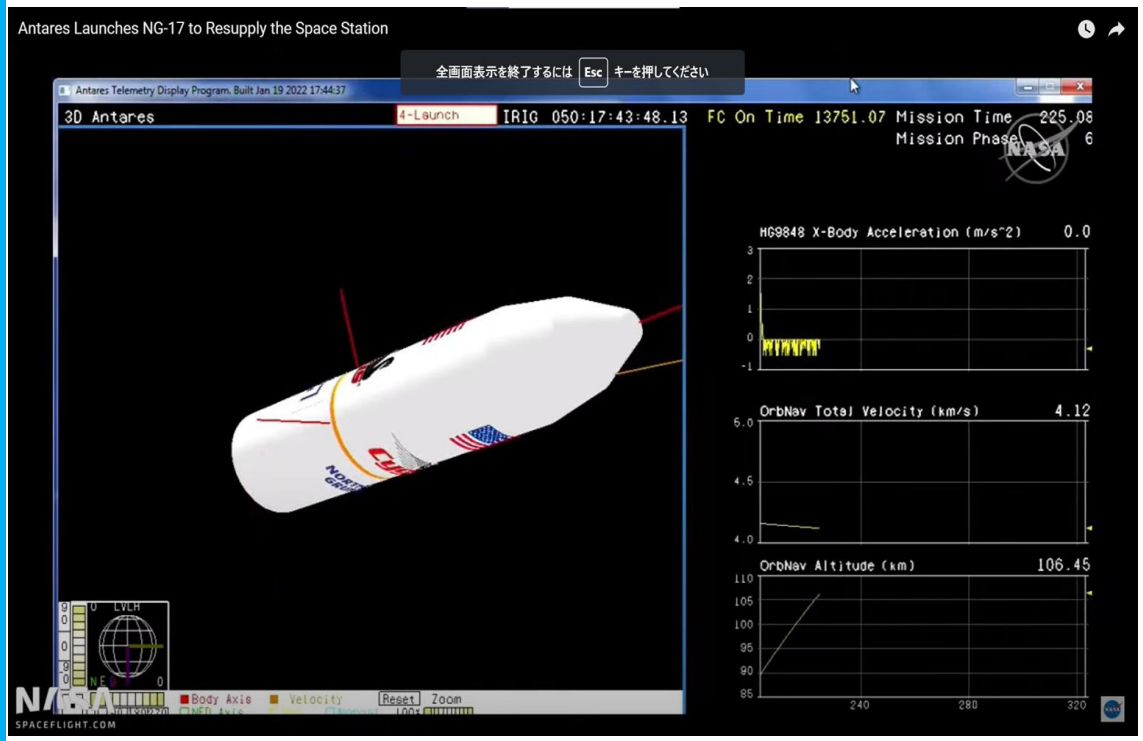
Test condition2

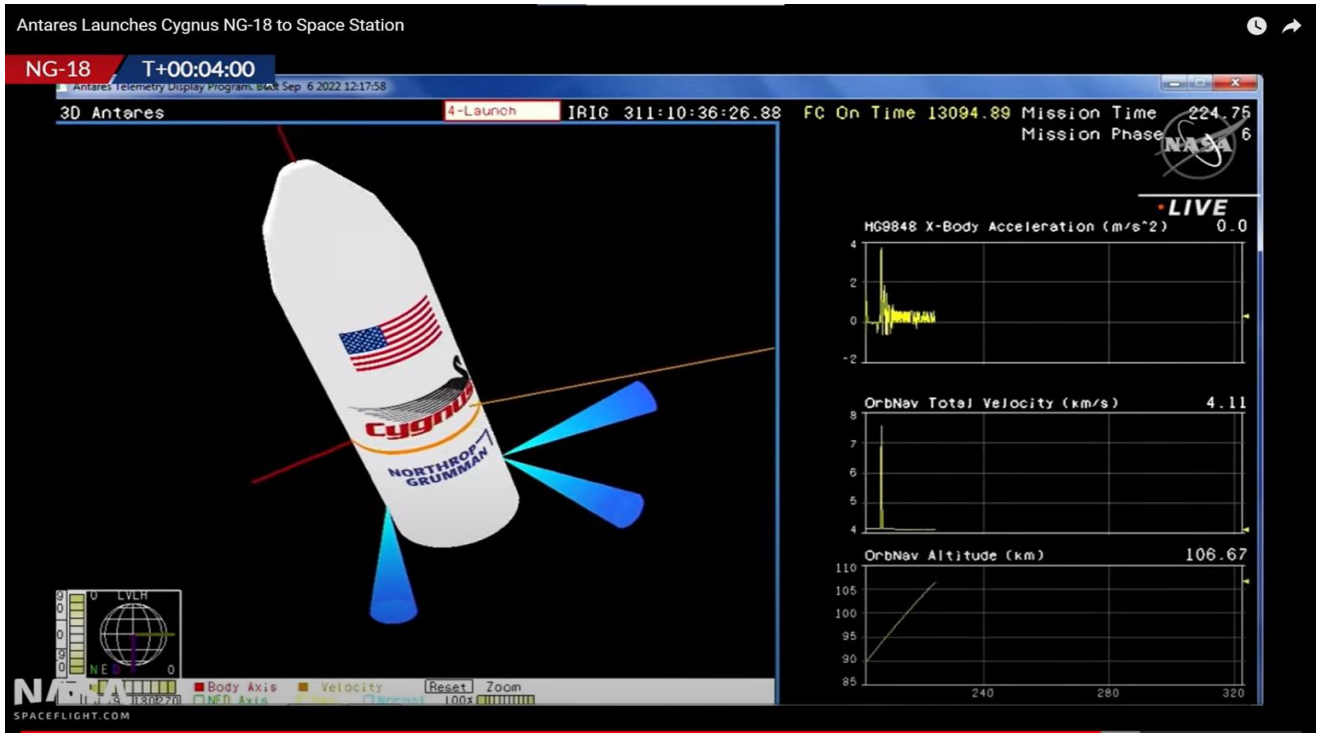
Video of Mechanical Chattering (0.2mm Room)



2. Satellites were not Activated Continue…

D. **Satellites damaged by rocket vibration**





NG-17 (KITSUNE)
→Looks good

NG-18 (BIRDS-5)

- ❑ Direction was wrong after booster separation
- ❑ It has a spike at the time of separation
- ❑ Cygnus Cargo ship failed to deploy one of the solar array

NG-17 and NG-18 Launch Comparison

Only one solar panel deployed

In a statement late Nov. 9, Northrop Grumman blamed the failed deployment of the array on debris from the launch. "During a rocket stage separation event, debris from an Antares acoustic blanket became lodged in one of the Cygnus solar array mechanisms, preventing it from opening," said Cyrus Dhalla, vice president and general manager of tactical space systems at Northrop Grumman. The company did not explain how the debris got into the mechanism, something the company has not reported happening on previous Cygnus launches.

2. Satellites were not Activated Continue… Damaged with Rocket Vibration

- The satellite pod was covered by cushion.
- Vibration level in the rocket is much smaller than the vibration test we conduct
- Satellites were damaged by launch vibration?

=> **Unlikely**

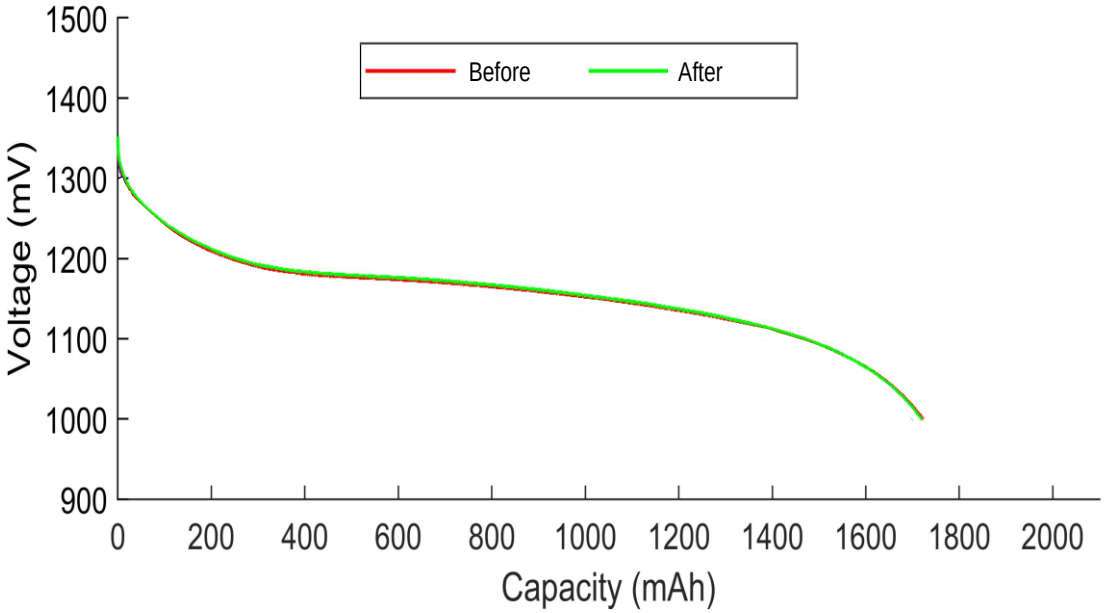
2. Satellites were not Activated Continue…

E. Battery Failure

	2022/5/2	2022/5/20
ZIMSAT-1	4.21V	3.99V
TAKA	4.21V	4.02V
PearlAfricaSat-1	4.2V	3.99V

- In 18 days battery voltage decreased by 0.2V
- Estimated capacity decrease of 3.5% is expected
  - Estimated from battery thermal test.
- Assuming 3.5% in 18 days => 35% decrease in 6 months
- Worst Case 50% capacity decrease => 3.6V
  - Can the satellite turn ON at 3.6V?

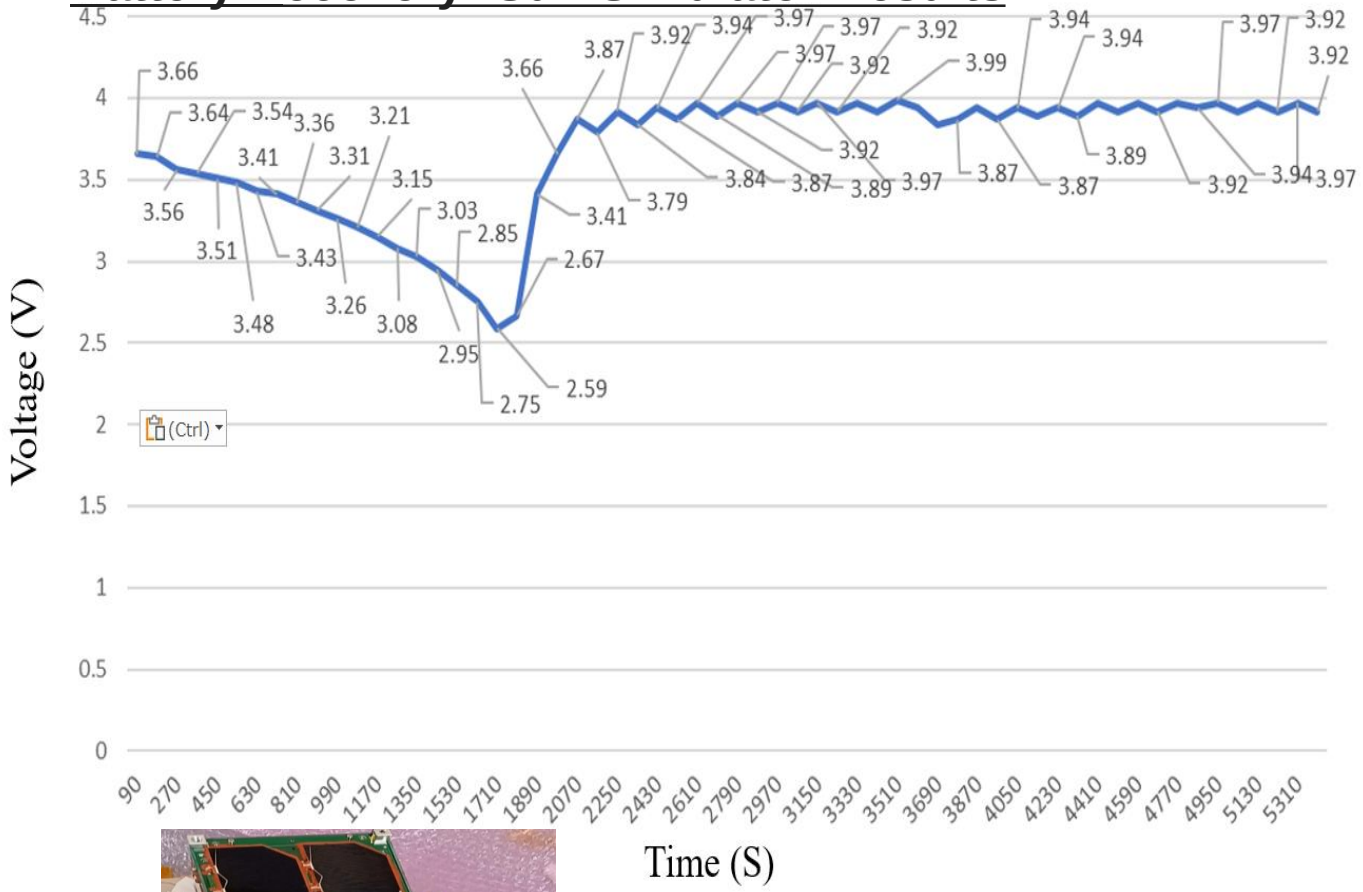
Battery Thermal Test: 1 Cell Discharge Rate

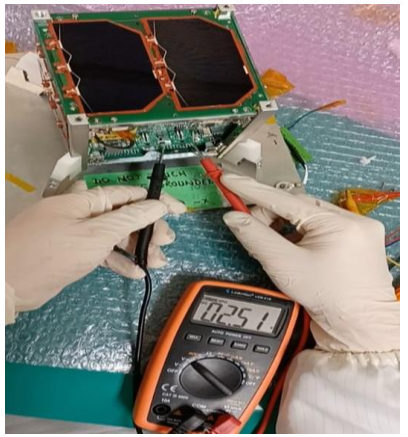


Battery Test

- At 50% battery capacity, satellite was tested for
  - Activation and
  - Antenna deployment
- Condition
  - Vacuum: TVT
  - Atmosphere temperature: Clean roo
- Results
  - No CW
  - Antenna did not deploy
  - Battery was damaged by TVT
- Solution
  - Charge satellite battery with sun simulator
  - After 38 mins, antenna deployed and CW heard

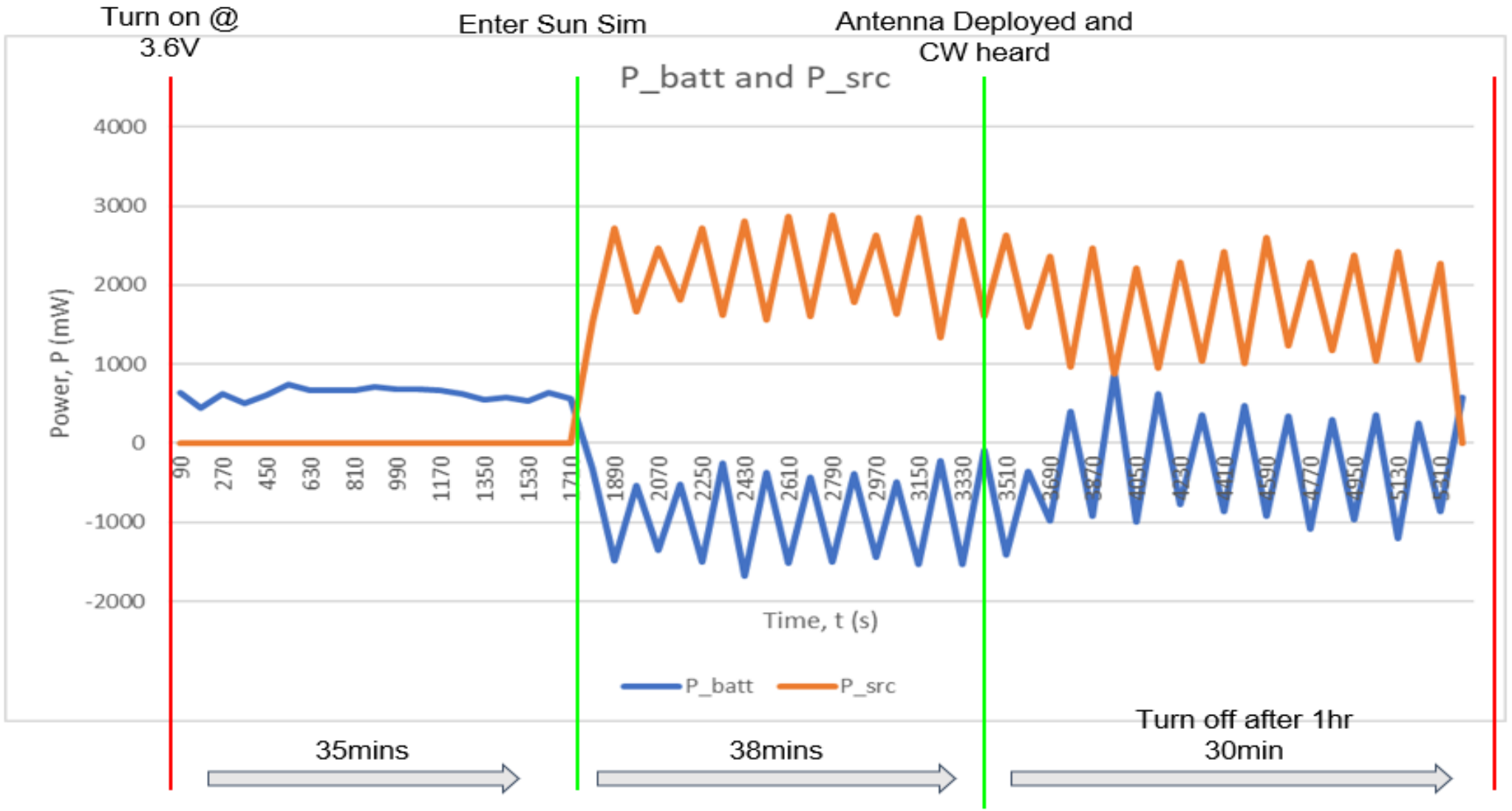
Battery Recovery: Sun Simulator Results





2.51V Battery Voltage

Battery Recovery test

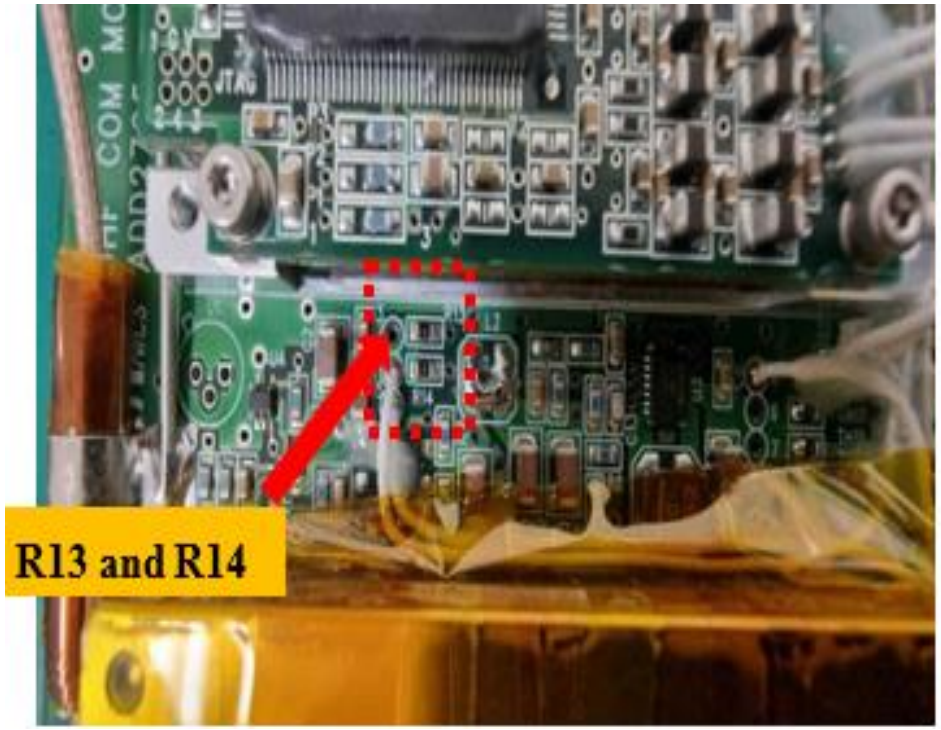


- Failure due to battery is therefore **denied**

3. Satellites were activated but failed to start the Transmitter

A. Malfunctioning

- Transceiver malfunctioning experienced at FM
- Reason: Transceiver design change
- Solution: R13 and R14 removed
- **Unlikely**
  - Long duration test were good
  - Transceiver purchased on different batches
  - Cannot occur on all the three satellites



Summary Transceiver Malfunctioning

Transceiver Mounted on	Problem	Solution	Status of the Flight Model
PealAfricaSat-1	❑ High Power Draw ❑ No Reset Data	❑ Removed R13 and 14	❑ Normal power draw ❑ Reset data obtained ❑ Downlink and uplink were OK
ZIMSAT-1	❑ High Power Draw ❑ No Reset Data	❑ Removed R13 and 14	❑ Normal power draw ❑ Reset data obtained ❑ Downlink and uplink were OK
TAKA	❑ No problem	❑ N/A	❑ Normal power draw ❑ Reset data obtained ❑ Downlink and uplink were OK
BIRDS-5S	❑ High Power Draw ❑ No Reset Data ❑ No CW beacons	❑ Removed R13 and 14 ❑ Send for repair with Kojima San	❑ Normal power draw ❑ Reset data obtained ❑ Downlink and uplink were OK

3. Satellites were activated but failed to start the Transmitter

B. Low battery power

- **Denied** : CW can be emitted when the satellite recovers

C. Main-PIC and COMPIC errors unlikely

D. Reset PIC fails turn on COMPIC and/or Tx after 30 mins

- **Unlikely** -no malfunctioning was found after chattering test and low battery test

3. Satellites were activated but failed to start the Transmitter

E. Main PIC fails to turn on due to low OCP threshold setting (150mA)

- **Unlikely**- not seen on the ground test

F. Reset PIC malfunctioning

- Observed in BIRDS-5 due to transceiver
  - Satellites could not receive reset data
  - Satellite could not reset
- The problem was solved and never encountered again nor reproduced
- **Unlikely but open**

Reset PIC Anomaly Trend

- Comparison of BIRDS3, 4, and KITSUNE
  - BIRDS-3 Reset PICs worked for the entire period of their operations
  - BIRDS-4 Reset PIC malfunctioned after the first CW and lost the time-counting capability and the UART communication with Main PIC.
  - KITSUNE reset PIC worked for almost 1 year in orbit
    - ✓ During SPATIUM-2 development on the ground, It was observed that Reset PIC had a malfunction of time counter .

Different Components LOTS

Difference Lots of BIRDS4, KITSUNE and BIRDS5 components

- DC/DC convertor
- **PICS (RESET, COMPIC, FABPIC)**
- OCP
- MOSFET switch (UNREG1, UNREG2)
- Crystal
- Clock Oscillator

Production Lot of the Reset-PIC (PIC16F1789)

Parts Number	Usage	BIRDS3	BIRDS4	KITSUNE	BIRDS5	MO-1	ChibaTech
PIC16F1789-I/MV	Reset-PIC, COM-PIC, FAB-PIC	2018.5	5 from 2018.5				
			4 from 2019.9				
				2020.4_25intake			
					3 from 2020.4_9intake		
					15 from 2021.8	2021.8	2021.8 or 2022.4

- **Unlikely but open** because failure could not be reproduced
  - => Chattering of deployment switch was expected to generate some noise
  - => No effects observed on the reset PIC

4. Transmitter not Emitting CW

A. Programming errors

B. COMPIC errors

❑ **Unlikely**

- ➢ Long duration test results were okay
- ➢ Errors never detected during operations

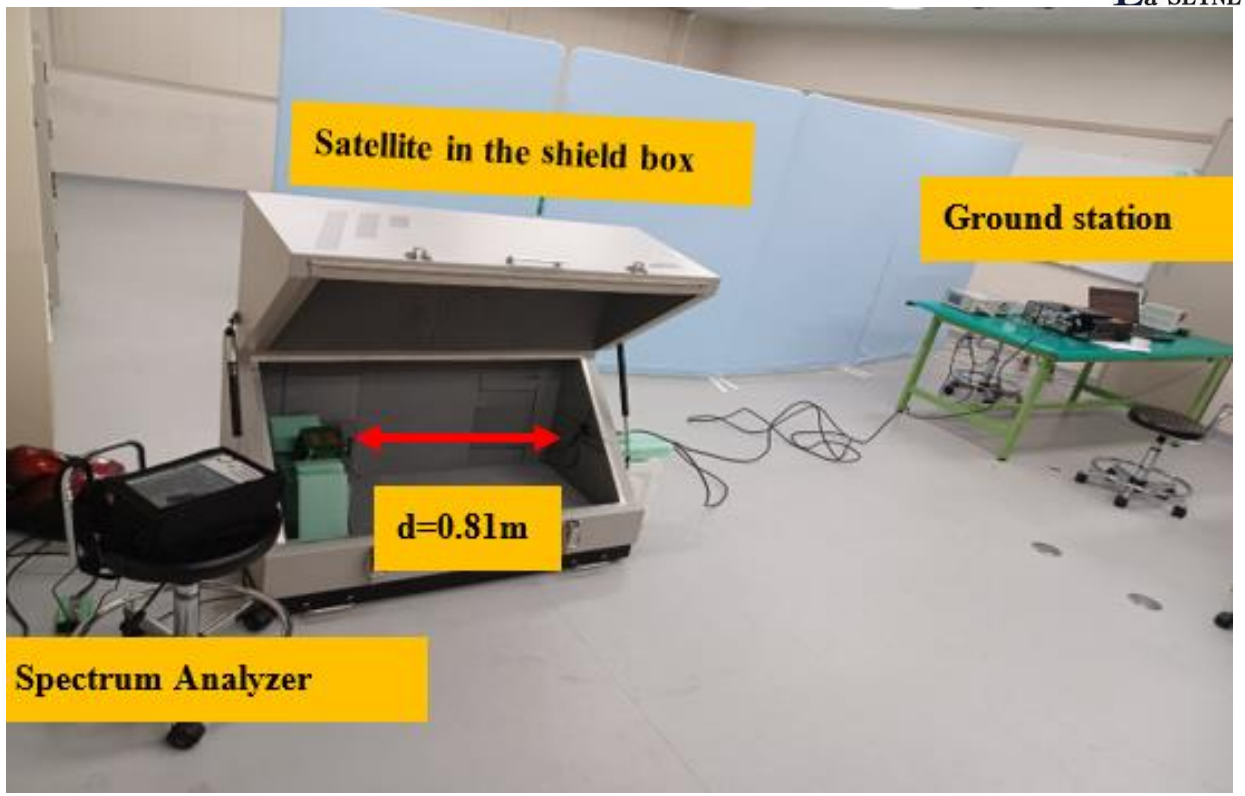
Long Duration Test Report

Transceiver Mounted on	Uplink	Downlink		
	GMSK	GMSK	CW Morse	Downlink Successful on the Following Missions
❑ PEARLAFRICASAT-1 ❑ TAKA ❑ ZIMSAT-1	OK	OK	OK	• Multispectral Camera • Store and Forward Mission • APRS (Automatic Packet Reporting System) Mission • Image Classification • ADCS (Attitude Determination and Control System) and Attitude Visualization: High Sampling and Housekeeping Data

4. Transmitter not Emitting CW

C. Transceiver Sensitivity

- No enough link margin?
  - **Denied**
- Sensitivity was reverified using RF shield box
  - Sensitivity was -99dBm (BIRDS5-S)
  - Similar to anechoic and short range test results
- Link Budget (Uplink) was calculated
  - **There is enough link margin**

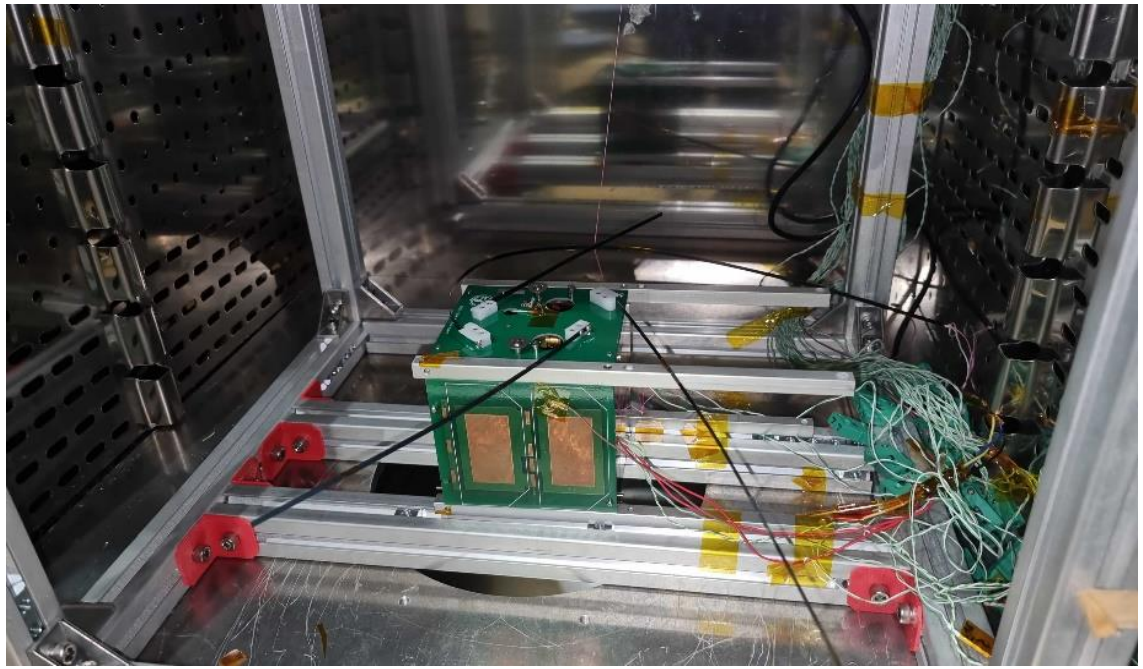


Satellite	Link Margin					
	10^0 Elevation	20^0 Elevation	50^0 Elevation	70^0 Elevation	80^0 Elevation	90^0 Elevation
BIRDS-5FM	5.3 dB	8.6 dB	14. 3 dB	15.9 dB	16.3 dB	16.43 dB
BIRDS-5S FM	4.3 dB	7.6 dB	13.3 dB	14.9 dB	15.3 dB	15.4 dB

5. Antenna Deployment Failed

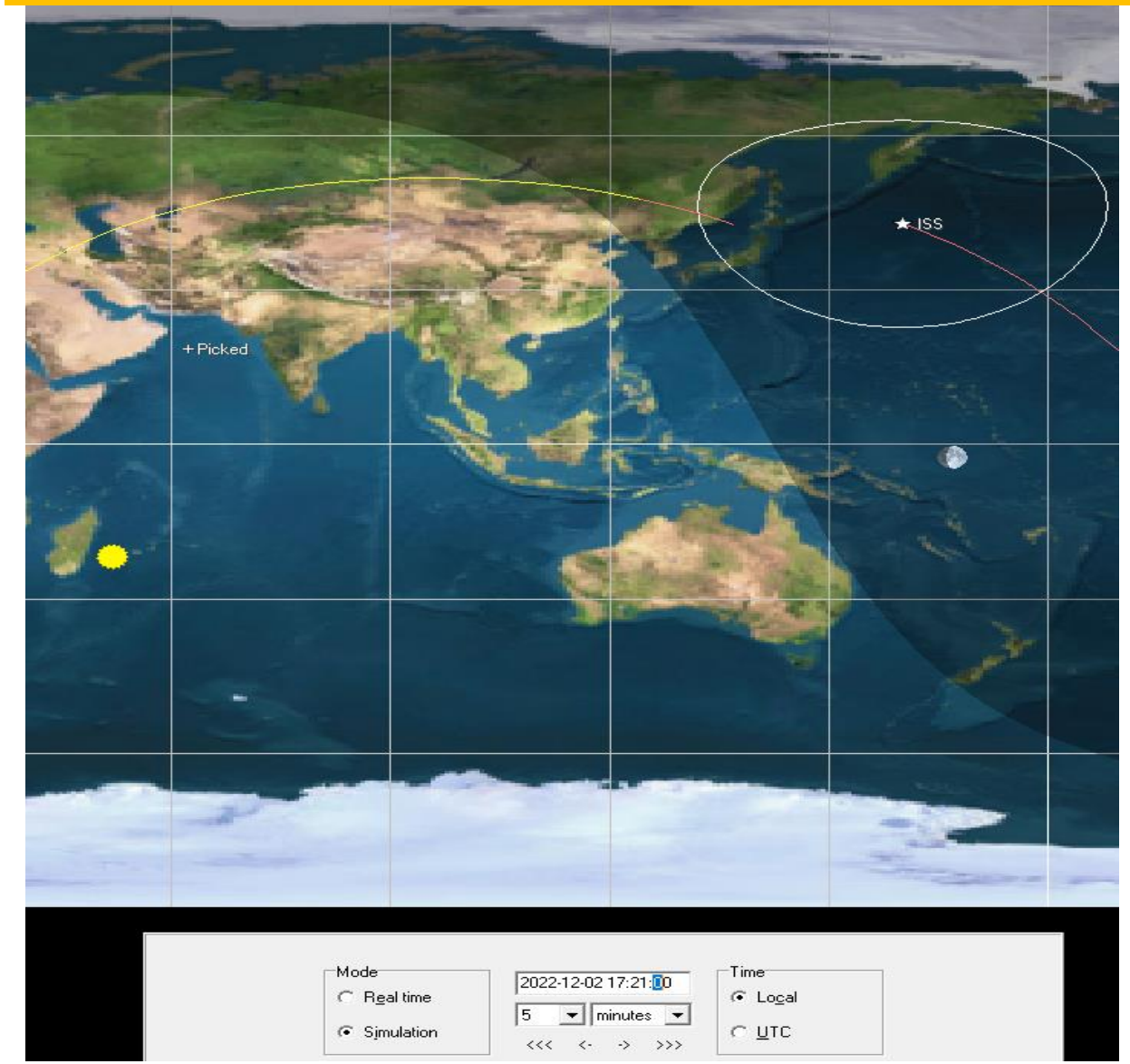
A. Antenna Deployment: Dispatch Chamber

- Successful @ -30 degrees



- In orbit Antenna deployment was set to occur @17:20 JST satellites were not in eclipse
- Low temperature deployment failure **denied**

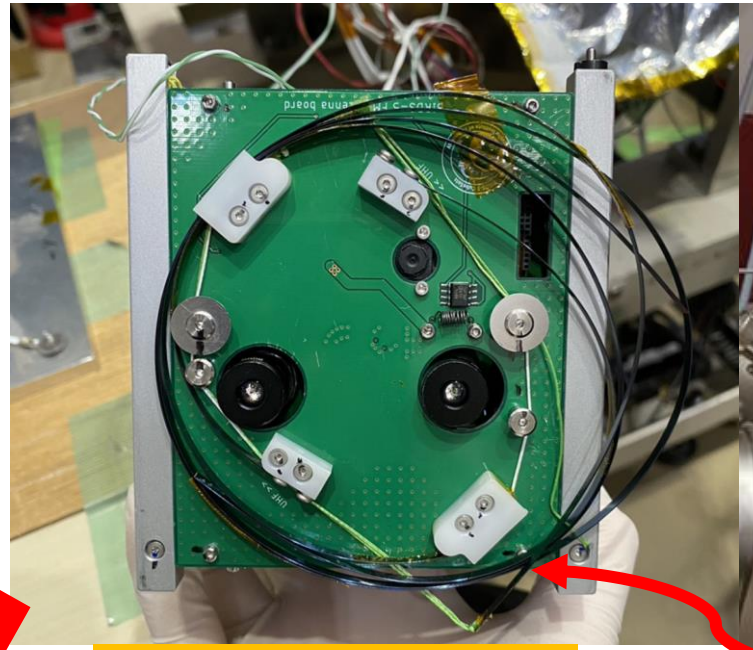
Position of the satellites (ISS TLE) when the antenna was supposed to be deployed



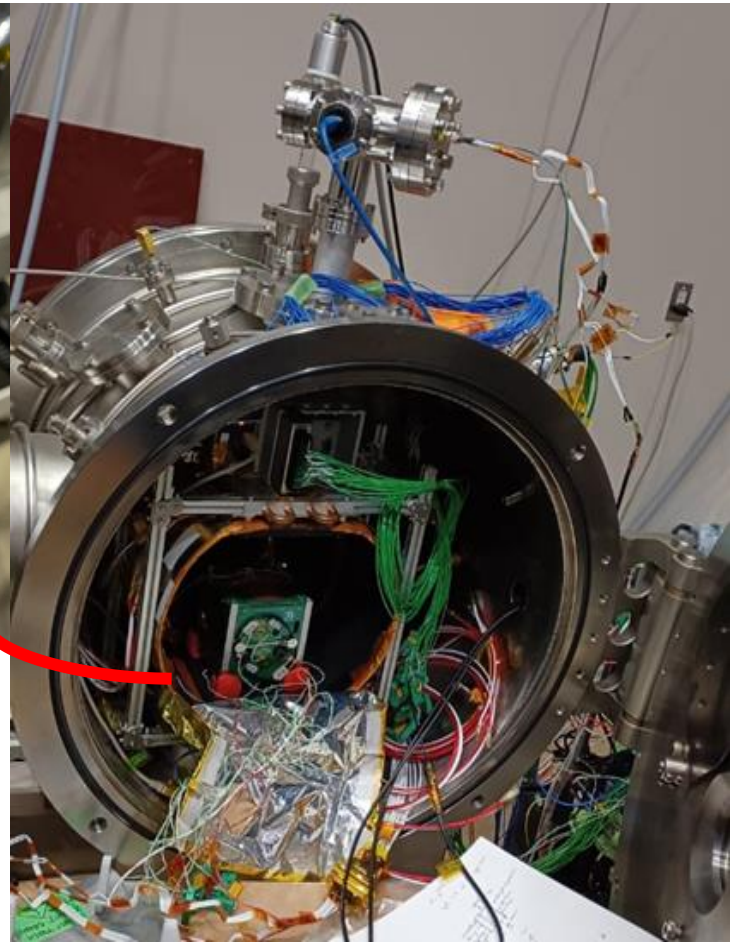
5. Antenna Deployment Failed

B. Antenna Deployment: PETT Chamber

- TVT 1: unsuccessful
  - Wrong FM code
  - Connectivity problem
- TVT2: unsuccessful
  - Battery Damaged
- **TVT3: Partial deployment**
  - EM battery used



Partial deployment

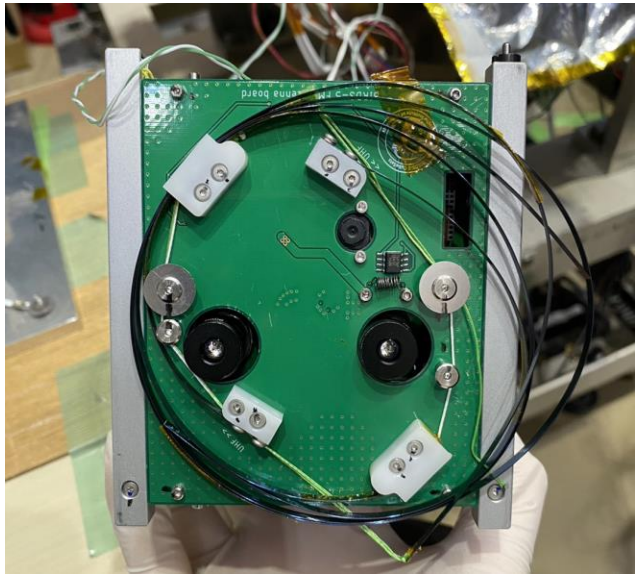


Pett Chamber Test

C. Antenna Deployment: Clean Room

- Done between TVT2 and TVT3
- Partial and full success

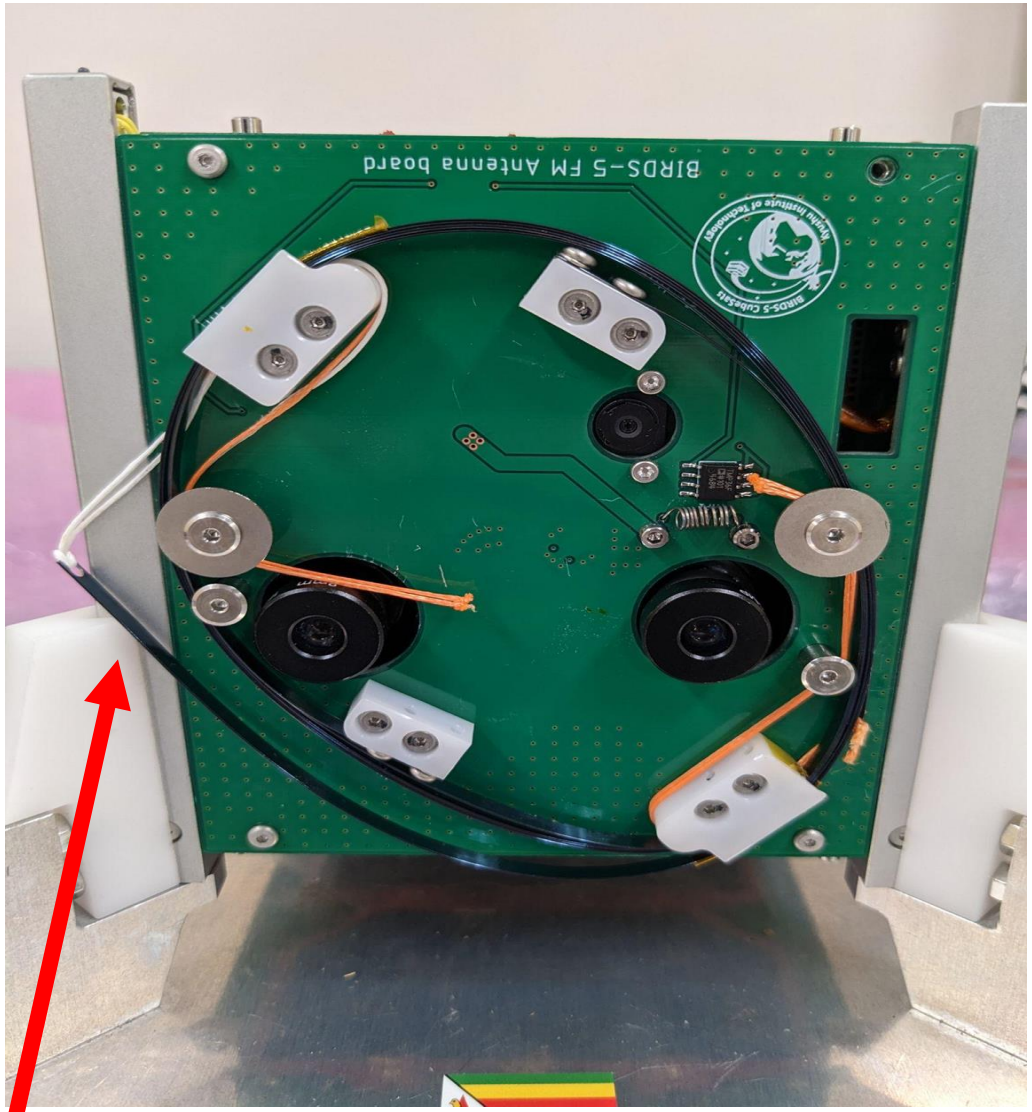
5. Antenna Deployment Failure: Video



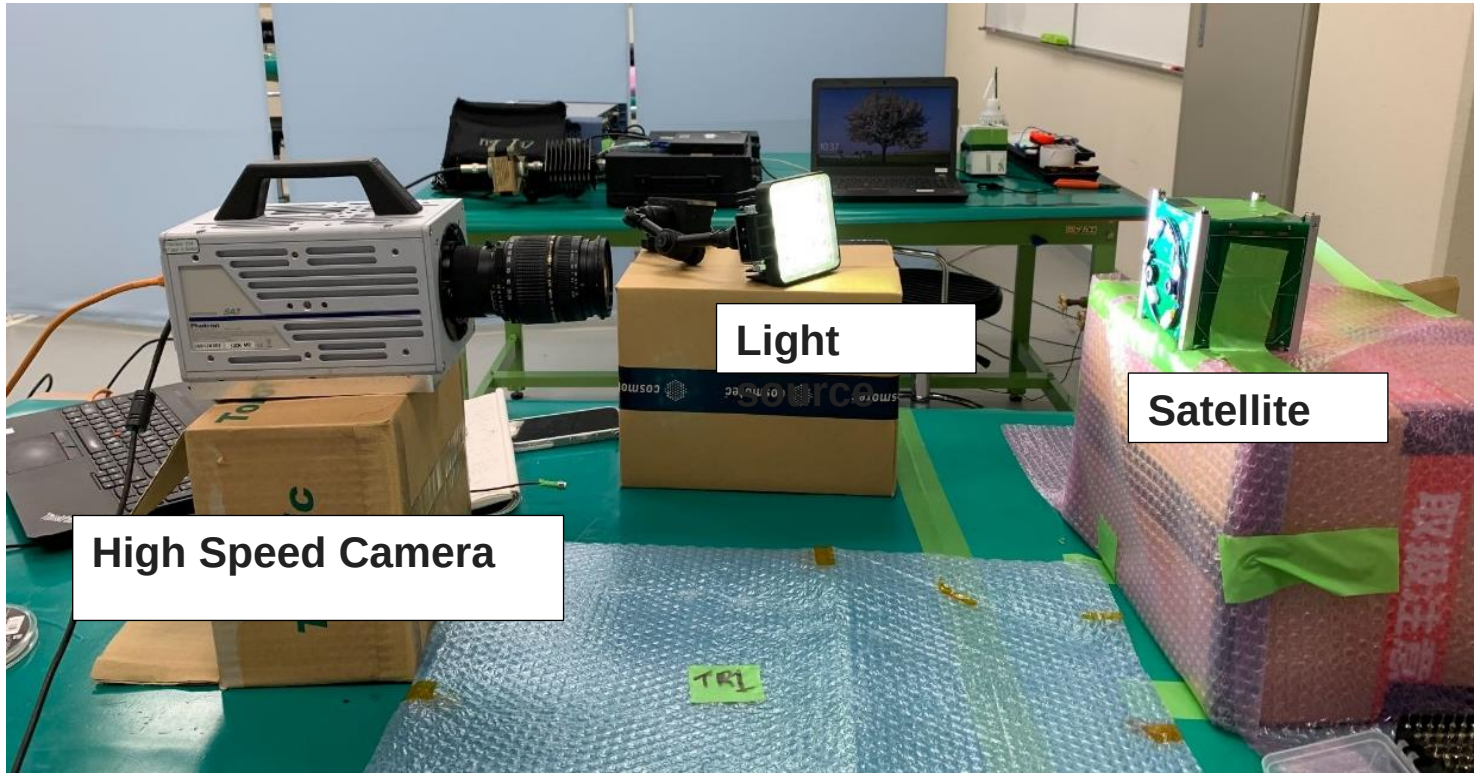
- TVT3 partial deployment (blocked by PETT Chamber)
  - A thermal ball was formed

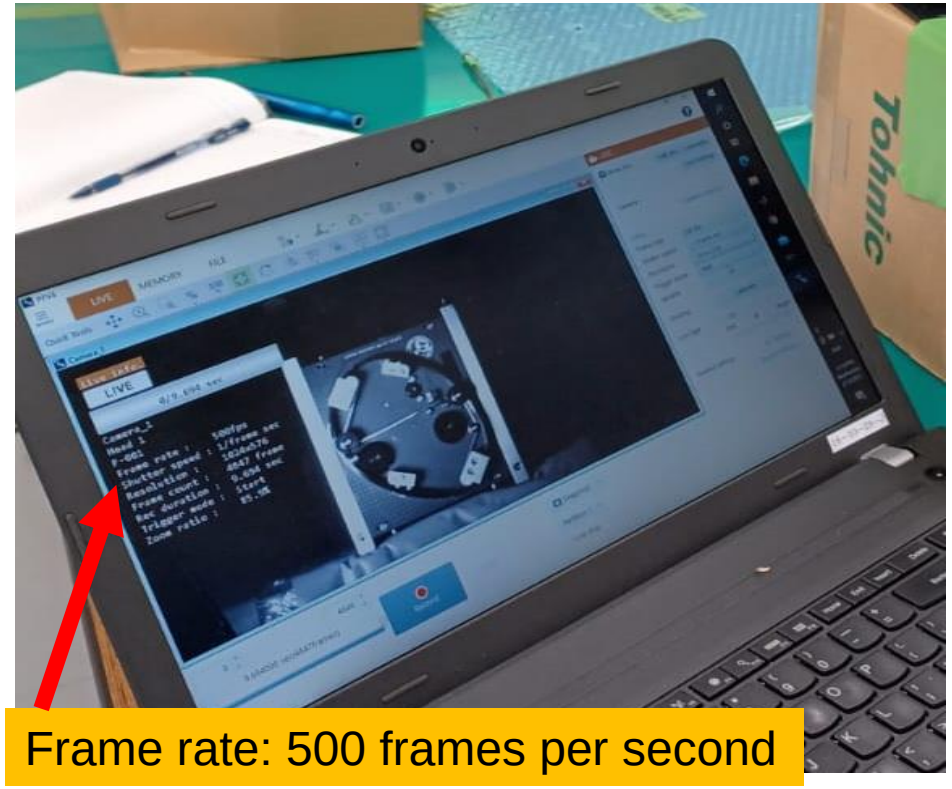
Antenna Deployment: Cleanroom

- FM code, CW verified, normal operation
- Clear memory.
- SAT voltage measured at 3.61V
- SAT chattering testing then turn on
- No deployment, no CW after 35 mins
- Place into sun simulator at 36 mins
- Antenna deployed and CW at 1hr 07min, however thread cut but antenna remained furled
- Deployment was blocked by satellite stand



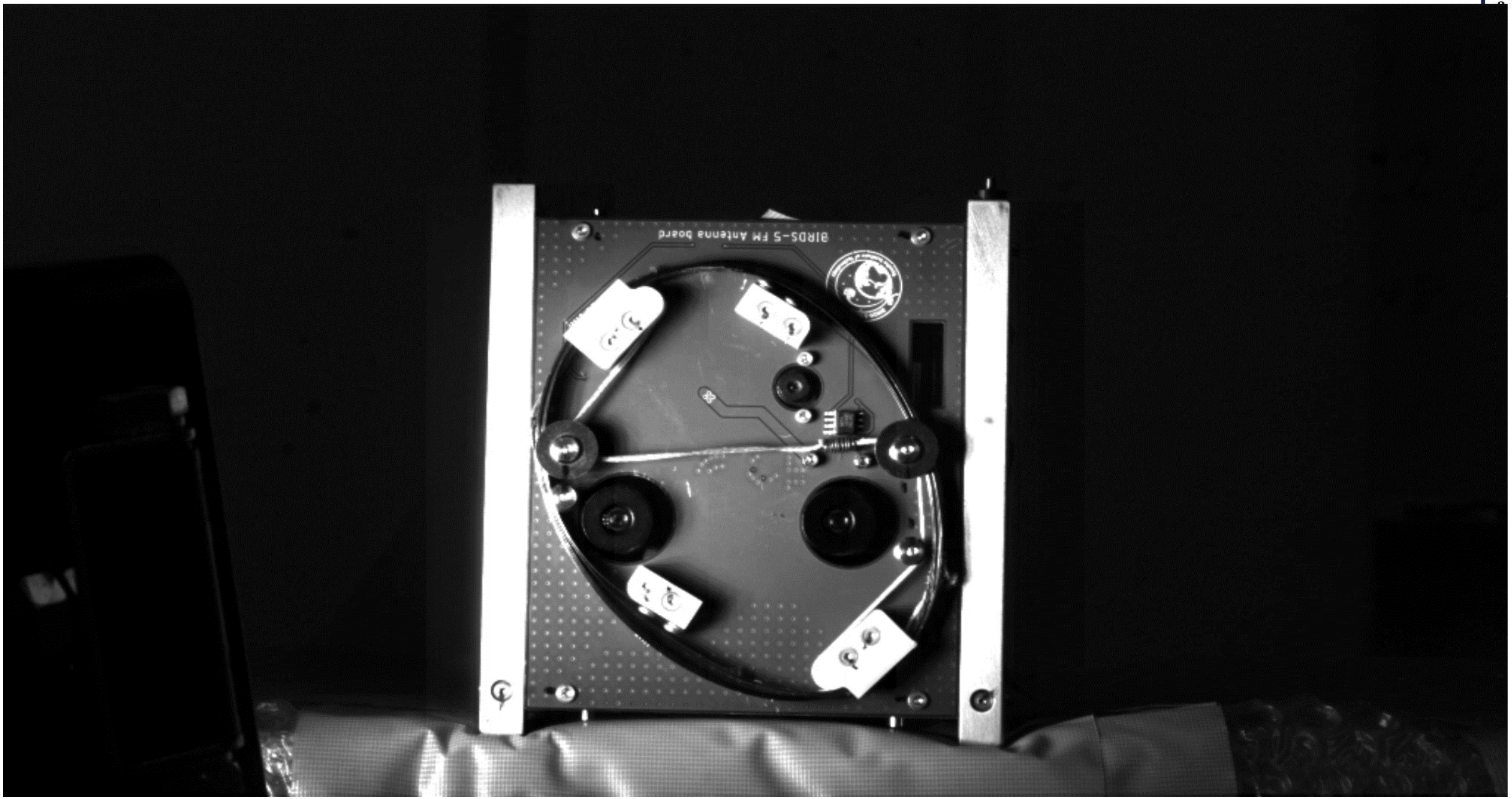
Antenna Deployment: Taken with High Speed Camera



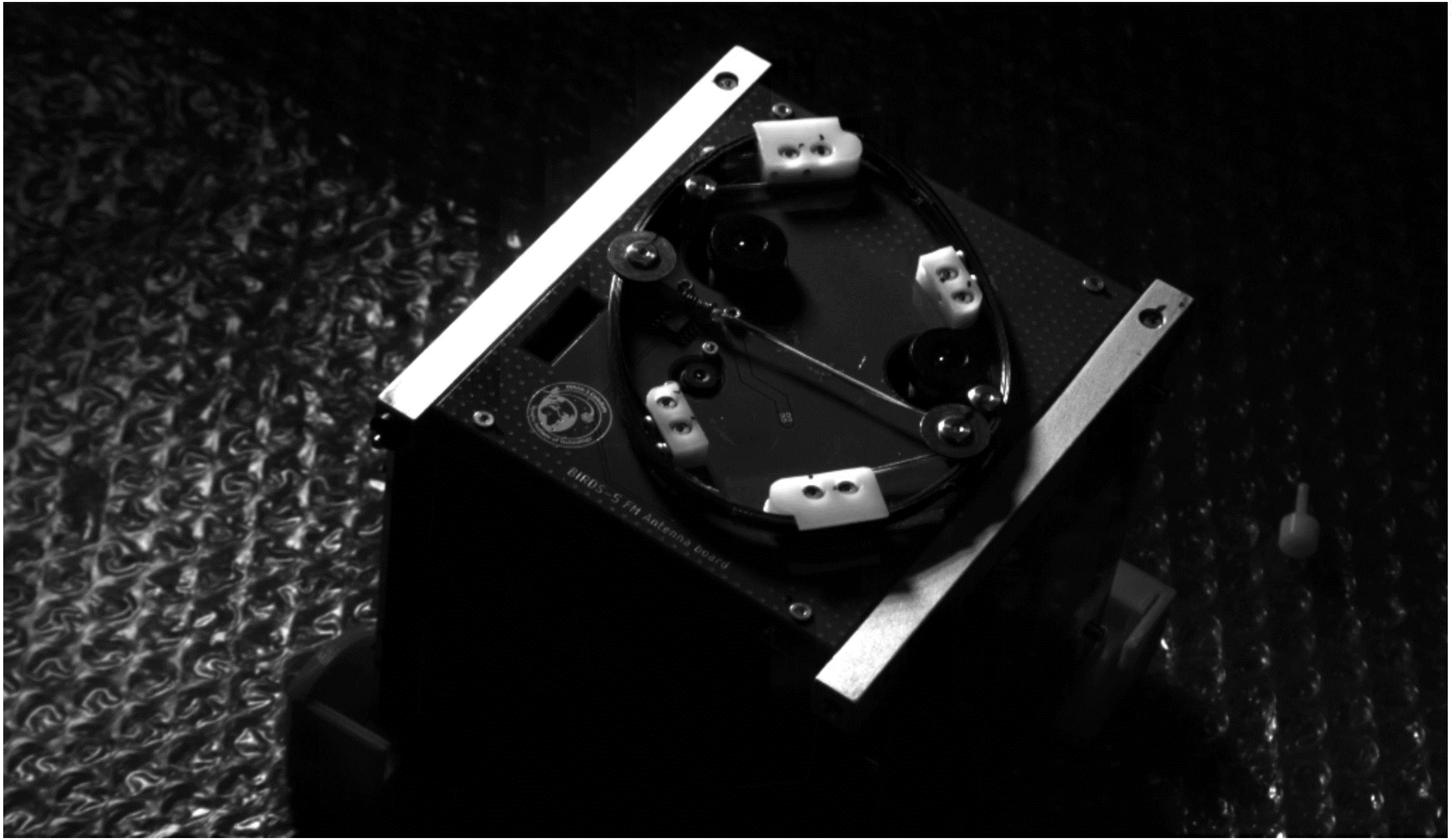


Trial #	Orientation	Deployment Result	Remark
Trial 1	Vertical	success	
Trial 2	Vertical	success	
Trial 3	Horizontal	Success	
Trial 4	Horizontal	success	
Trial 5	Horizontal	Failed	**Antenna was tightly tied**

Video1: Antenna Deployment: Successful (Trial 3)

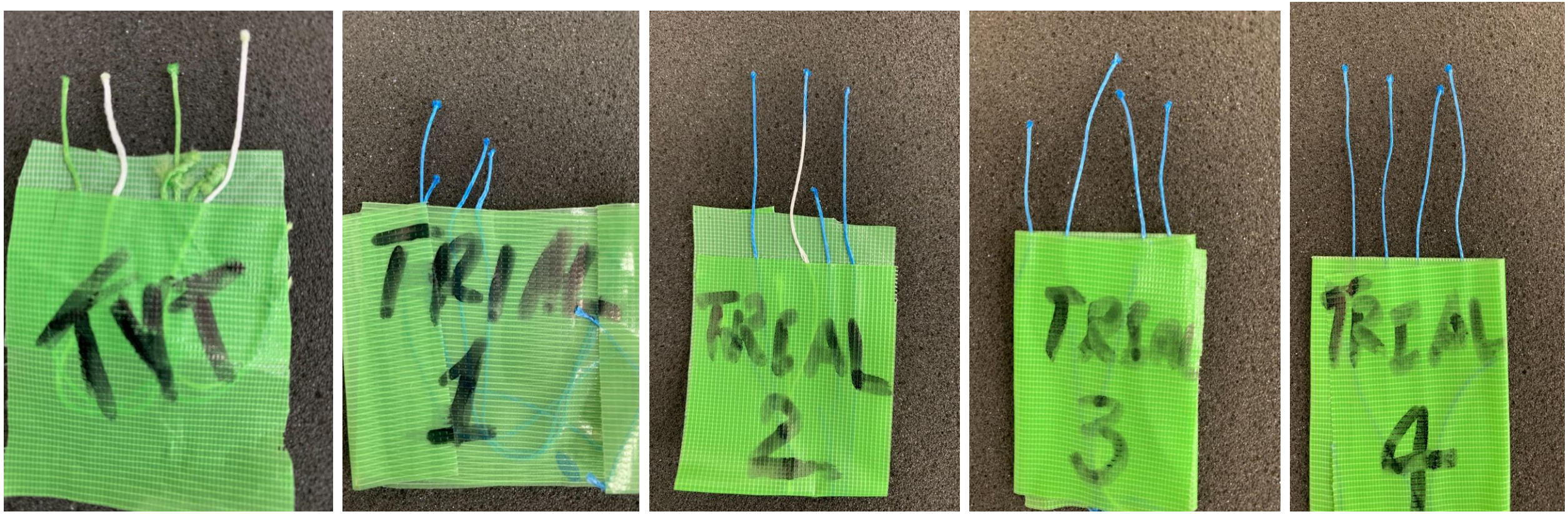


Video2: Antenna Deployment: Trial 5 (Failed)



Fishing wire (Ball) Comparison

- Vacuum vs atmosphere temperature conditions

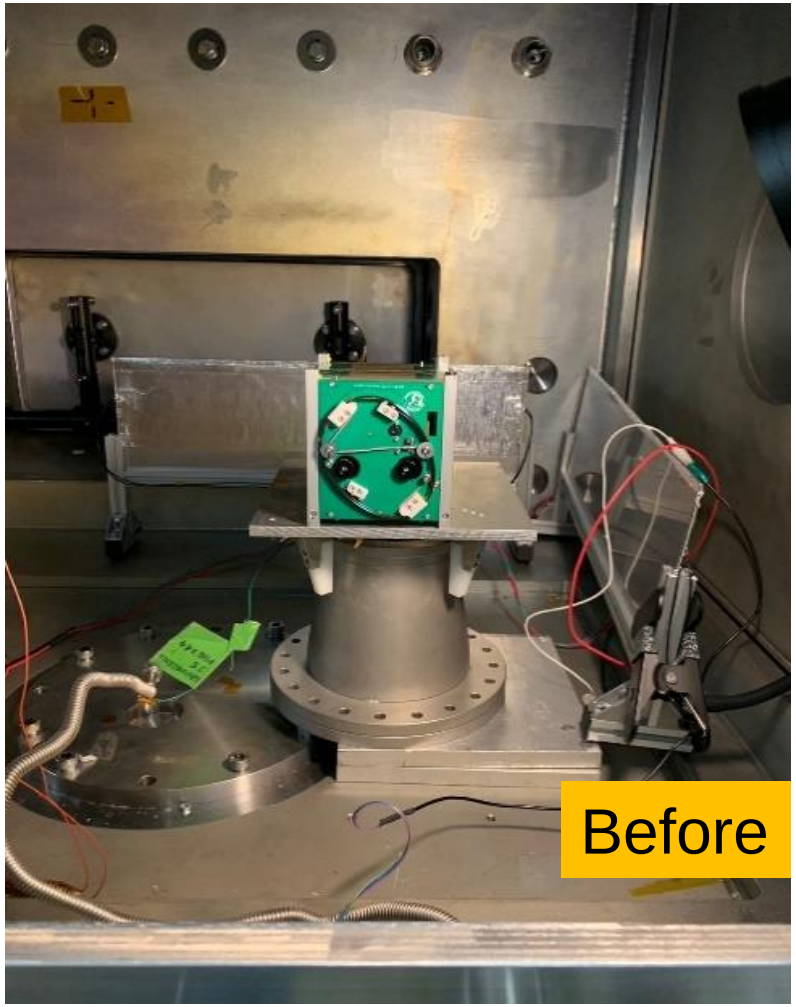


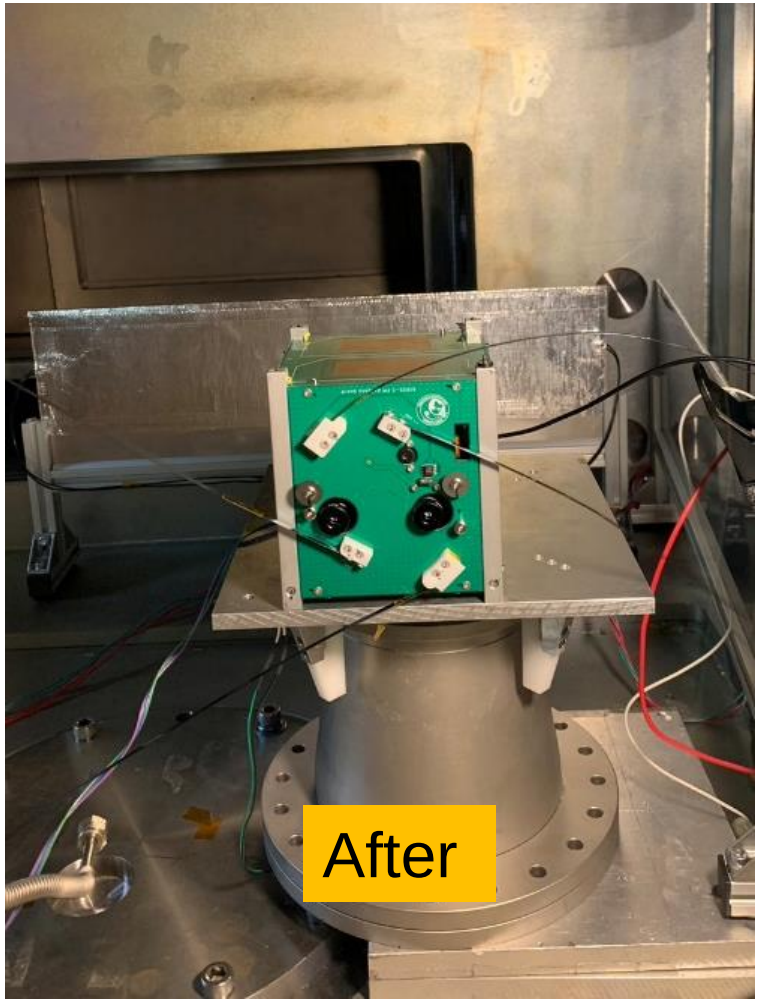
- The fishing wire ball from TVT is slightly bigger by a very small margin hence **denied**

5. Antenna Deployment Failed

D. TVT4 (Square chamber): Full deployment

- ❑ Vacuum Only
- ❑ Failure was therefore **denied**



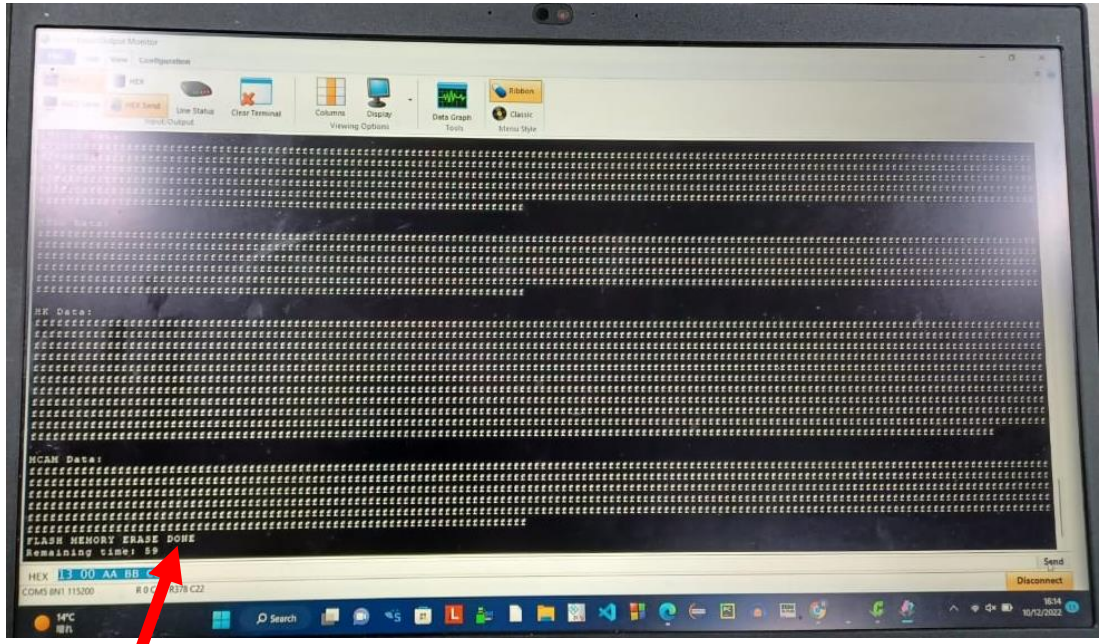


Successful

5. Antenna Deployment Failed

E. Antenna deployment counter was set to a wrong value

- ❑ Deployed occurred as planned
- ❑ Deployment could not occur at voltages below 3V
- ❑ Even if no deployment, deployment counter increment
- ❑ Satellite did not wait for 24hrs to retry deployment and increment counter
- ❑ **Unlikely**: Satellites were reset and memories flashed



Flash Memory Erase Confirmed

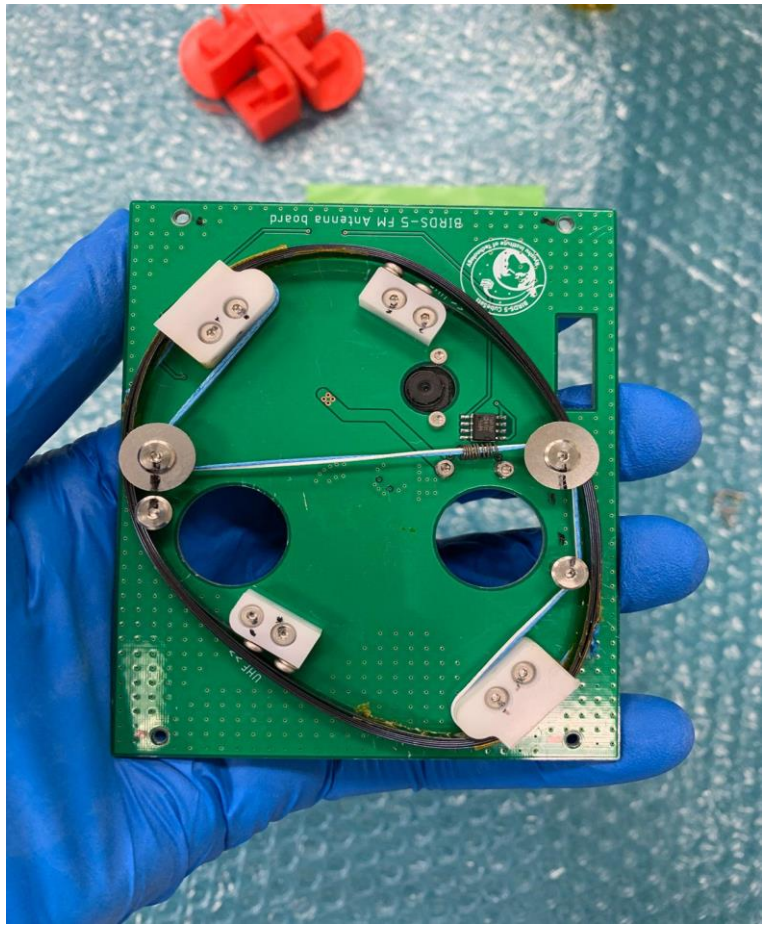
F. Reset PIC failed to activate the satellite

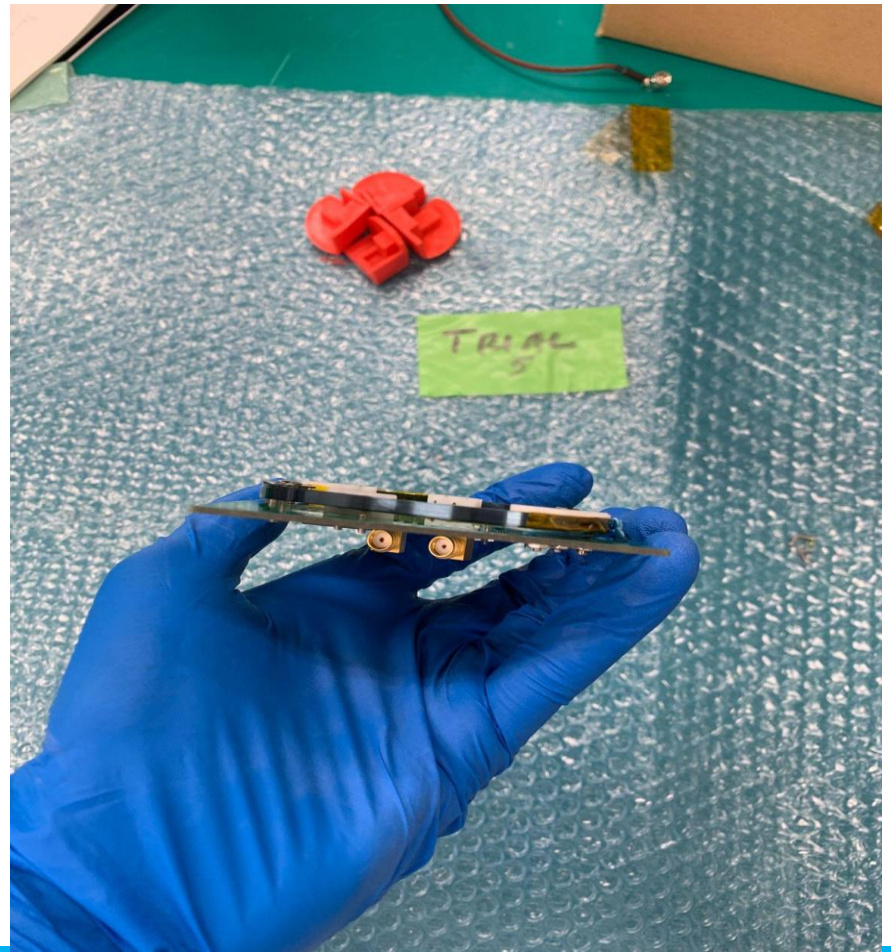
- ❑ Never observed on the ground therefore **unlikely**

5. Antenna Deployment Failed

G. Antenna deployment failed due to too much Kapton Tape.

- ❑ **Denied**- Antenna deployed



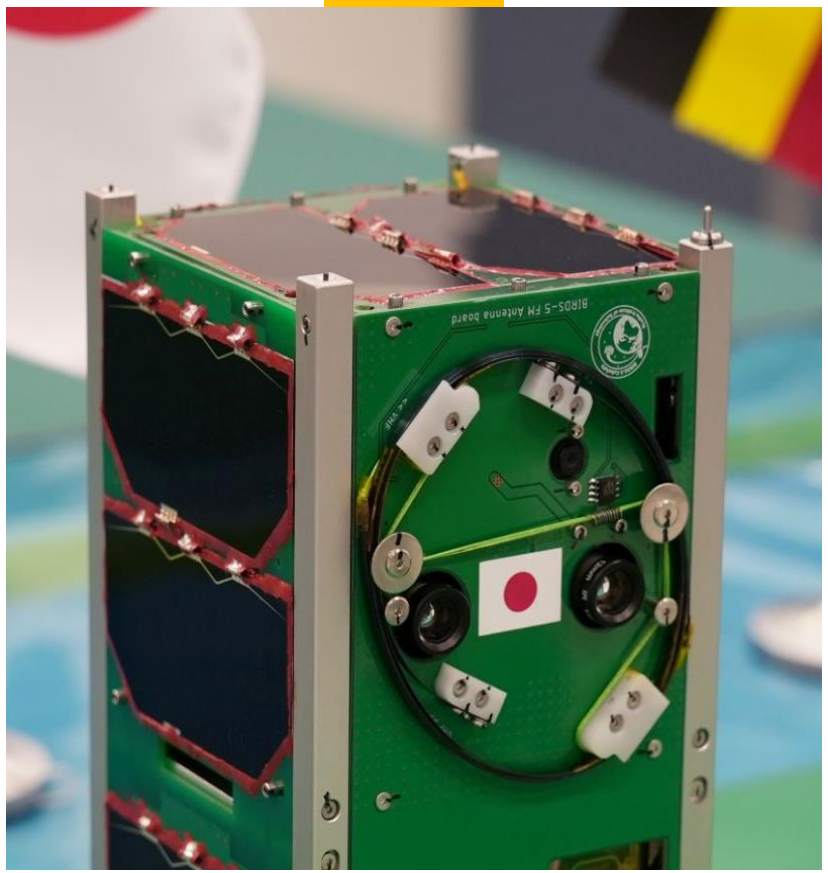


5. Antenna Deployment Failed

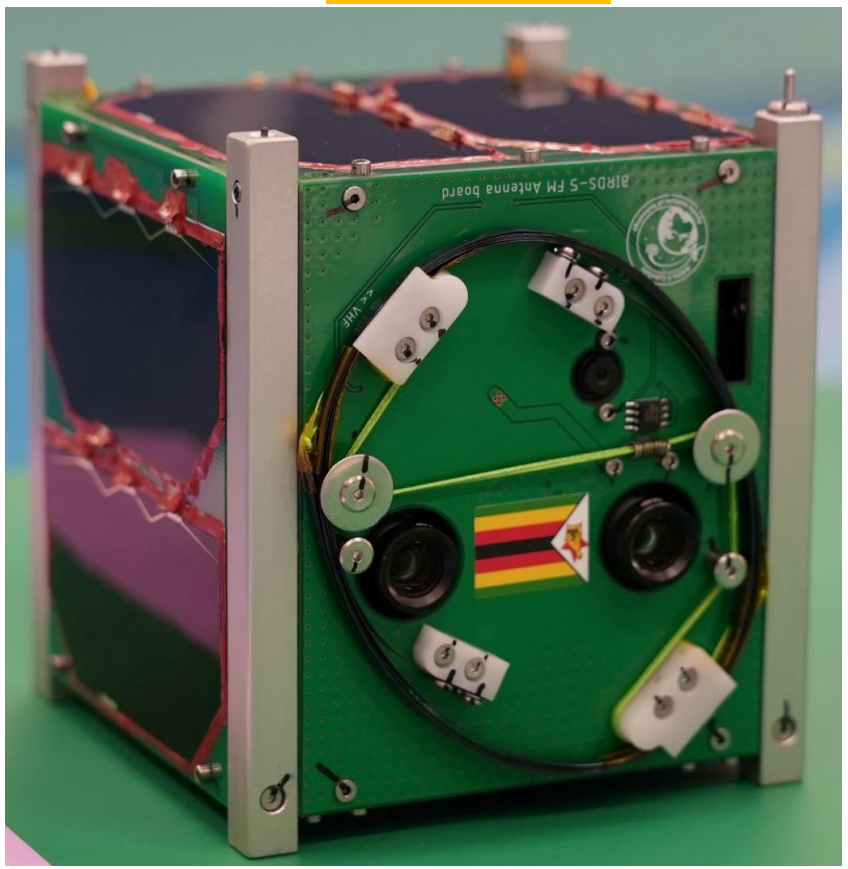
E. Antenna deployment was physically broken

- **Unlikely**- judged from delivery to JAXA

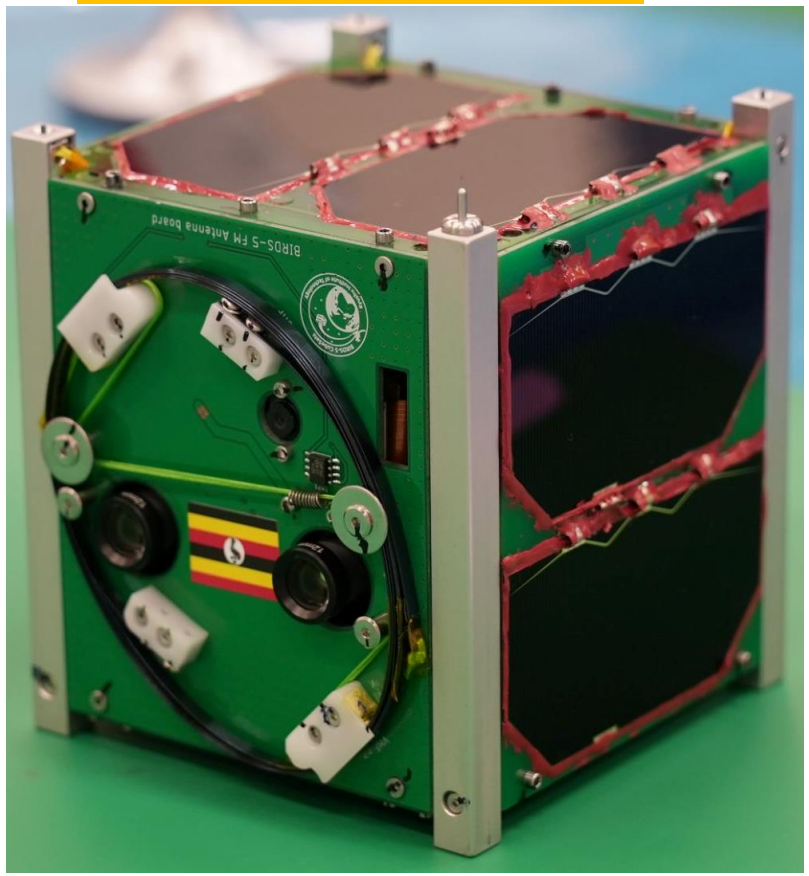
TAKA



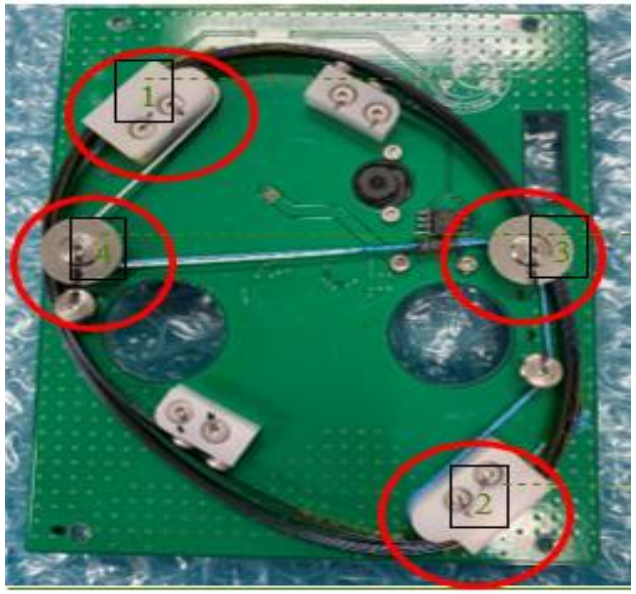
ZIMSAT-1

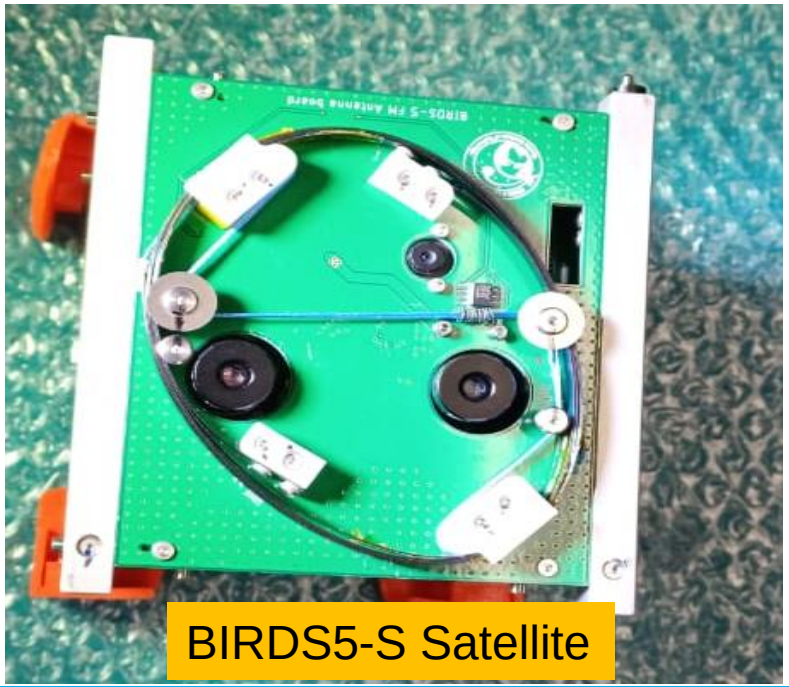


PEARLAFRICASAT-1



5. Antenna Deployment Failed





BIRDS5-S Satellite

H. Fishing wire was stuck

- On points 1 and 2 it can get stuck under the antenna where the fishing wire crosses the antenna elements
- On points 3 and 4 the fishing wire can get pressed under the antenna guides when the antenna is stowed too tightly.
- This was known and was avoided at EM and FM
- **Denied:** Antenna deployed with proper tying method

Note: This was noticed when deployment was blocked by PETT chamber and satellite stand.

Kyutech
Kyushu Institute of Technology

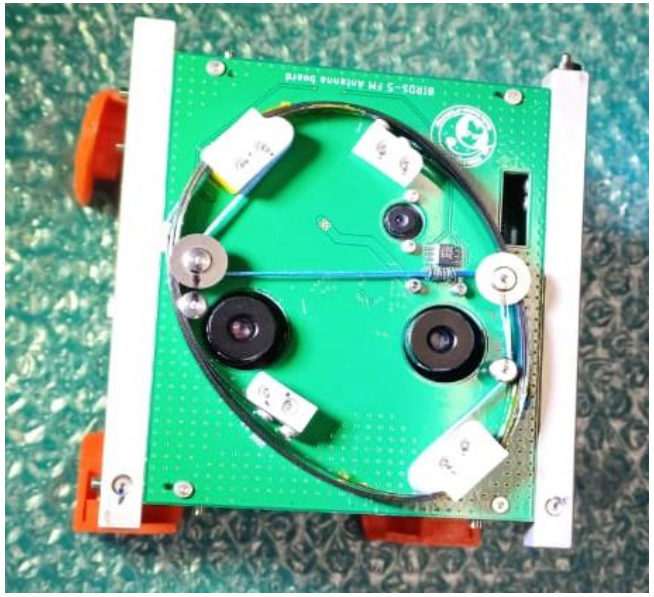
Summary of Antenna Deployment Tests

Test Conducted	Conditions	Chattering Confirmed	Sat Activated	Antenna Deployment	Note
FM Stage	❑ Low temperature (-30 deg) and atmosphere temperature	No	Yes	Yes	❑ 100 % success using dispatch chamber and in atmosphere temperature
Test in Clean room1	❑ Atmosphere temperature	Yes	Yes	Yes	❑ 98+ % successful
TVT1	❑ 3cycles ❑ 2hr vacuum + high temperature	No	No	No	❑ Problem with connection cables ❑ Wrong code
TVT2	❑ 3cycles ❑ 2hr vacuum + high temperature	Yes	Yes	No	❑ Battery damaged ❑ Low battery power
Test in Clean room1	❑ Atmosphere temperature	Yes	Yes	Partial	❑ Sun Simulator used Antenna blocked by satellite stand
TVT3	❑ 2 cycles ❑ 1hr vacuum + high temperature	Yes	Yes	Partial	❑ PeTT chamber size blocked deployment
TVT4	❑ Vacuum only	No	Yes	Yes	❑ 100% successful
Test in Clean room1 (High speed camera)	❑ Atmosphere temperature	No	Yes	Yes	❑ 98% Successful

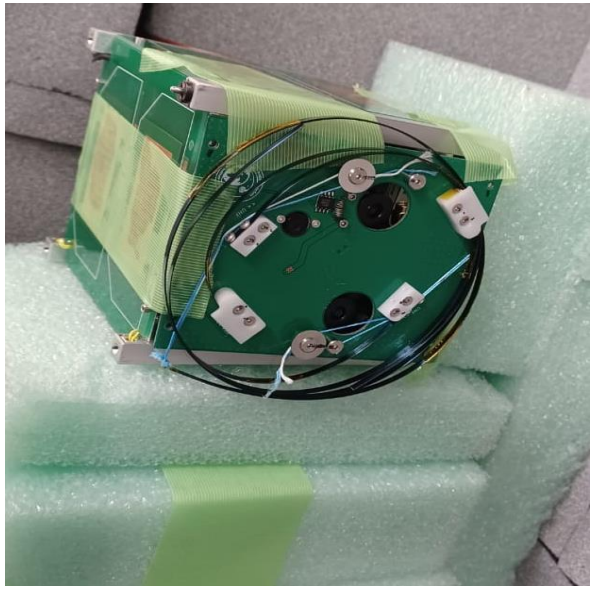
Impact of Antenna Deployment Failure

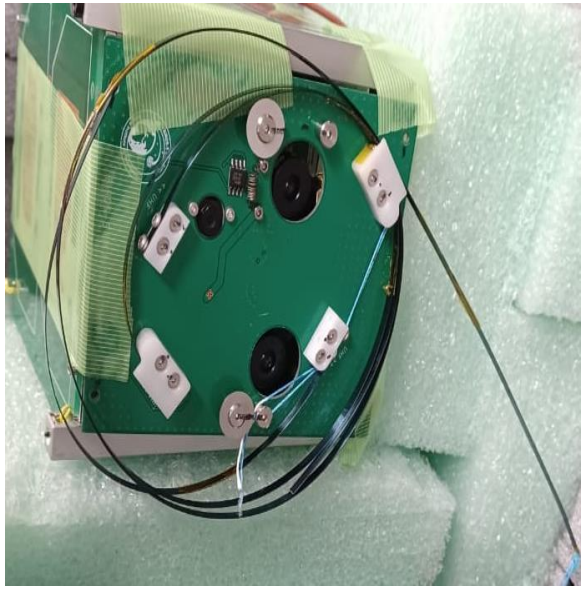
- Use shield box
- Compare the gains of :

Folded antenna

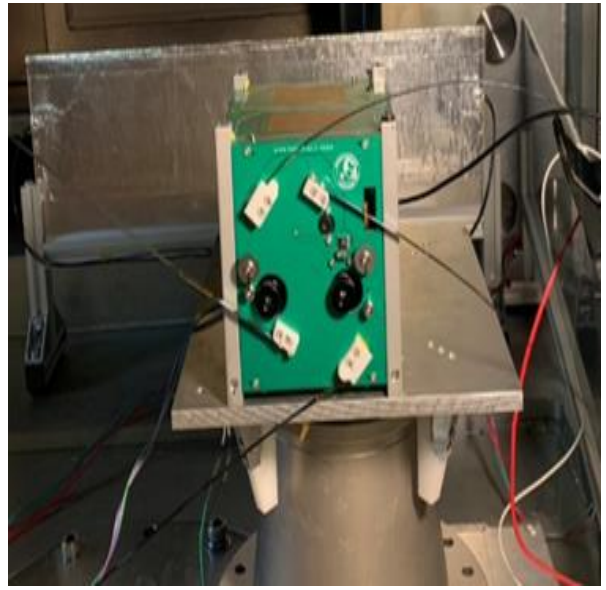


Partially deployment antenna (2 cases)





Full deployed antenna



Measuring Antenna Gain

Signal Power (dBm)	CASE1: Gain (dBi) (Small Partial Deployment)			CASE1: Gain (dBi) (High Partial Deployment)			CASE2: Gain dBi (Full Deployment)		Case 3: Gain (dBi) Folded	
	E-Plane	H-Plane		E-Plane	H-Plane		E-plane	H-Plane	E-plane	H-Plane
PTXlow &Att:39dB)	-36.10	-32.49		-28.09	-24.08		1.41	2.13		
PTXhigh (&Att:39dB)	-36.85	-32.25		-28.65	**-23.65**		1.44	2.25		
CW (19dBm)									**-42.8**	**-45.38**

Link Budget Summary (CW)

- CW downlink link budget
- Considerations

Kyutech GS

- Partial deployment
- Satellite antenna gain, -23dBi
- Kyutech GS Antenna Gain, 22dB
- High Elevations +**70^0**

Satellite	LINK MARGIN		
	70^0 Elevation	**80^0 Elevation**	**90^0 Elevation**
BIRDS-5S FM	-3.99 dB	-3.62 dB	-3.49 dB

Wakayama University GS

- Partial deployment
- Satellite antenna gain, -23dBi
- GS Antenna Gain, 30dB
- High Elevations +**40^0**

Satellite	LINK MARGIN		
	40^0 Elevation	**80^0 Elevation**	**90^0 Elevation**
BIRDS-5S FM	1.02 dB	4.38 dB	4.51 dB

Expected Outcome from Antenna Deployment

- **Antenna in folded state,**
  - ***Communication with the satellites***
    - ✓ Impossible with both BIRDS GS network and Wakayama University GS

- **Antenna in partial deployment**
  - ***Communication with the satellites***
    - ✓ unlikely with BIRDS GS network
    - ✓ Likely with Wakayama GS
  - Depends on the degree of partial deployment

- **Fully deployed antenna**
  - ***Communication with the satellites***
    - ✓ Possible with all BIRDS GS network

6. Tracking Satellite with Wrong TLE

A. TLE provided by JAXA (Almost same as ISS

- No signal received

B. SATNOGS TLEs

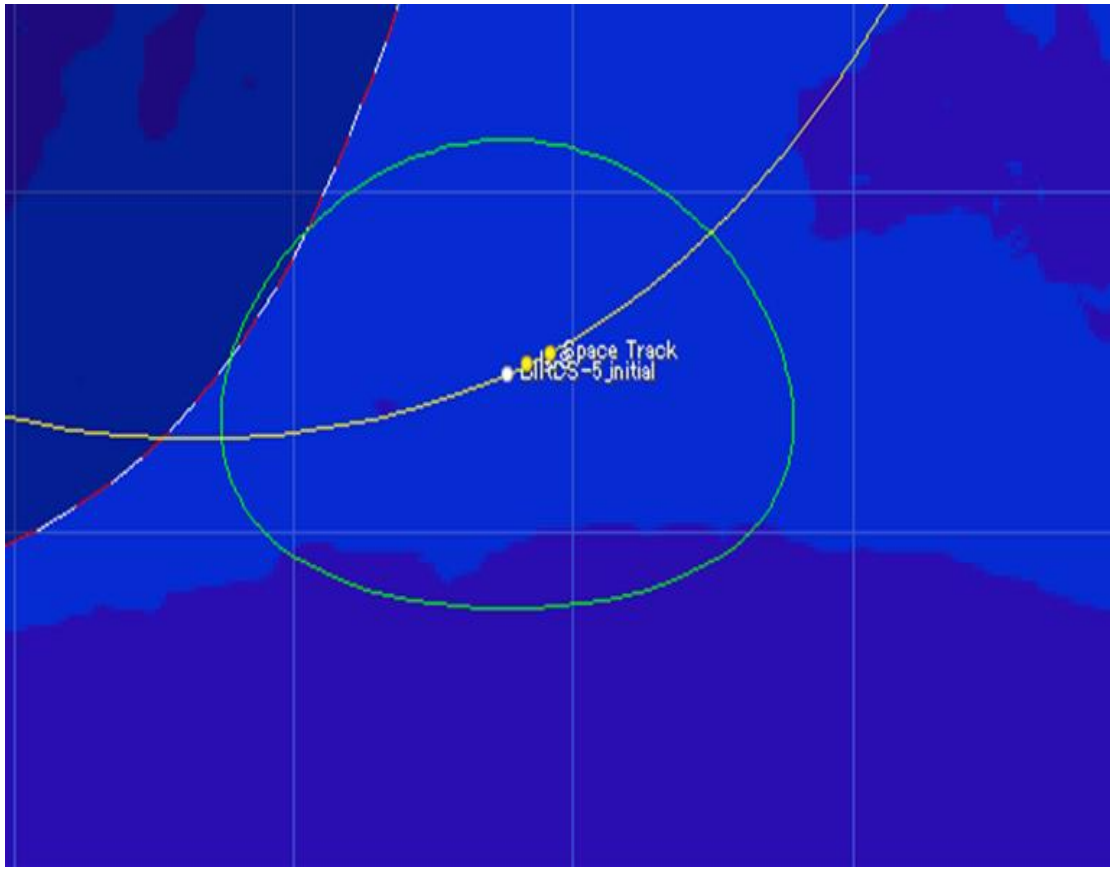
- No signal received

C. TLE provided by NORAD

- No signal received

TLE differences

- Initially NORAD vs ISS vs JAXA TLEs
  - Very small difference
- Hence **unlikely**



Satellite position in orbit after deployment.

7. Others

A. Design Changes :

- The difference among BIRDS-3/BIRDS-4/KITSUNE/BIRDS-5
  - Changes in the EPS1 board of KITSUNE and FAB of BIRDS-5 from FAB of BIRDS-3
- **Unlikely but open**- the changes were for improvements

B. **Open Cases**

- **Kill Main flag observed in 1st TVT**
  - **The flag went high**
- **Antenna counter increment before 24hours reset**

FTA Conclusion

- Three months Intensive investigations were conducted

- BIRDS5-S satellite was used for testing
  - Similar design to BIRDS 5 satellites in orbit

- Two major issues observed during TVT were
  - Battery failure
    - ✓ Unlikely because BIRDS5-S demonstrate satellite could operate under sunlight
  - Antenna deployment failure was observed due to
    - ✓ Tight tying of the antenna and it was already a known case that was taken care of
    - ✓ Creation of a thermal ball on fishing string, but no noticeable difference on the balls were observed in vacuum and room temperature
    - ✓ PETT chamber was small for full antenna deployment
    - ✓ However
      - ❖ Square chamber demonstrated that the antenna can deploy

FTA Conclusion

- Flight software failure denied because LDT results were OK
- Human errors (Workmanship) denied as observed from the records
- Reset PIC is suspected as it occurred also in BIRDS4, however, BIRDS 5S could not reproduce the failure
- Suspicion remains about difference of production lots
  - Still inconclusive because we cannot reproduce the failure in orbit

OVERALL CONCLUSION

- **No clear cause was identified to explain the failure of all the three satellites**

Lessons Learnt/ Areas for Design Improvements

1. Software change

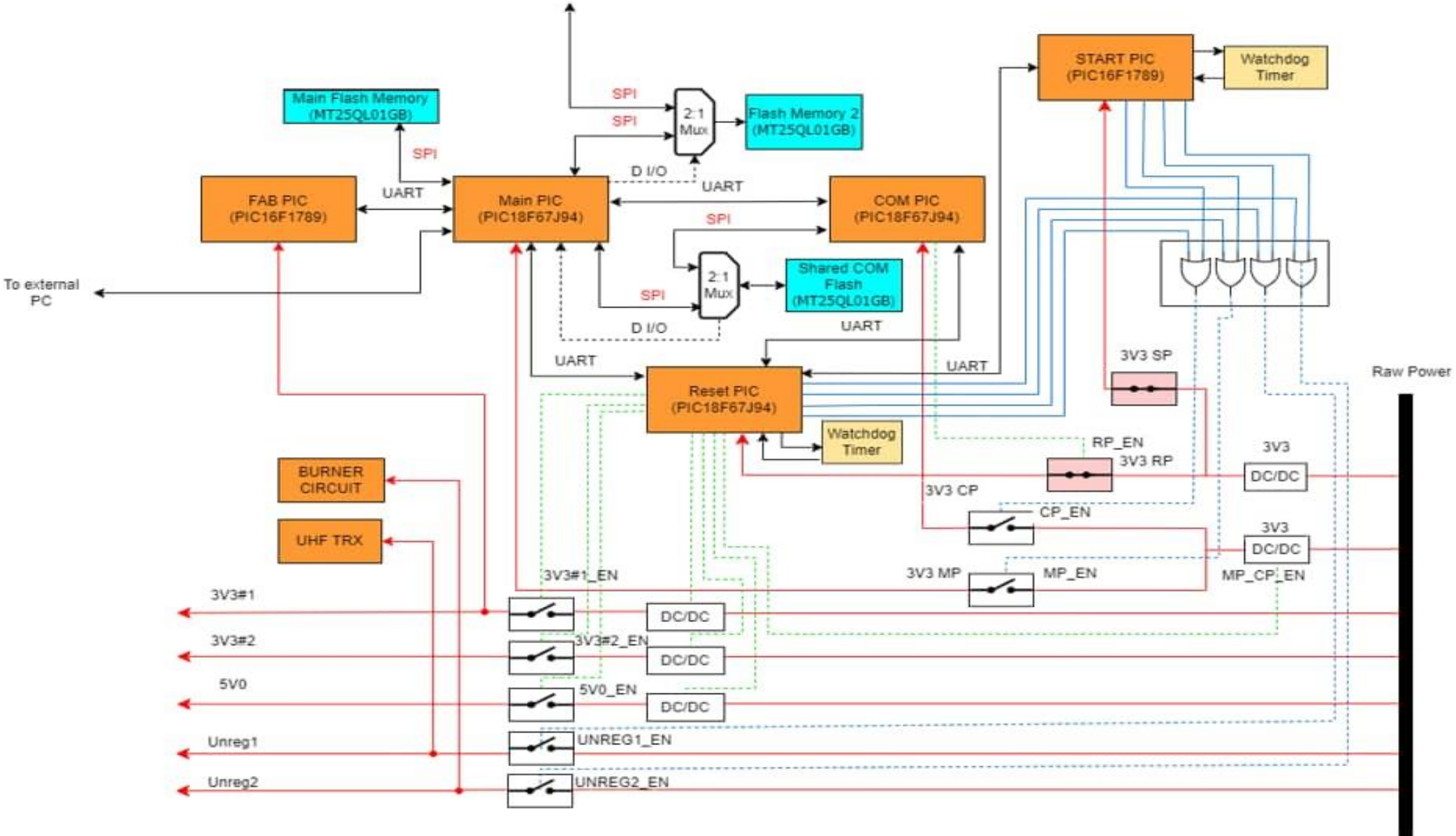
- Add capability to COM Code to change CW duty cycle
- Change RESET PIC Code so watchdog timer clear is in the main code loop
- Add code to MAIN PIC for various mission executions (IMG-CLS, MULT-SPEC, PINO)
- Add code to MAIN PIC to automatically turn off missions after 15 minutes
- Changed command structure for all MAIN PIC and MISSION commands
- Add code for MISSION BOSS
- Change FAB code to increase resolution of ADCs

Lessons Learnt/ Areas for Design Improvements

2. OBC/EPS board

- Reset PIC design change options:
  - Change PIC16F to PIC18F
  - Have two PICS from PIC16F to 2 x PICs (16F + 18F) or 2x PICs(16F)
  - Change PIC16F1789 to FUTABA PIC 16F877A (low power)
  - Have two PICS and assign the PICs, one for monitoring and the other for power control

New Block Diagram of OBC/EPS: New Design Change



Lessons Learnt/ Areas for Design Improvements

3. EPS change

- Consider using Li-Ion batteries, so far have good flight heritage
- Add small solar cells on antenna panel if space is available to aid satellite power

4. Structural design change

- Solder Jumper pin (J15) on FAB
- Use rail switch

5. Antenna Deployment Mechanism

- To increase the height of the antenna guides so that the fishing string will have more margin of passing under the antenna elements
- Do antenna deployment under vacuum conditions using thermal vacuum chamber


thank
you