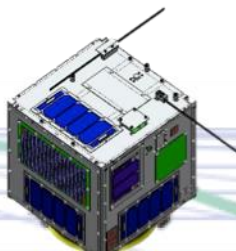
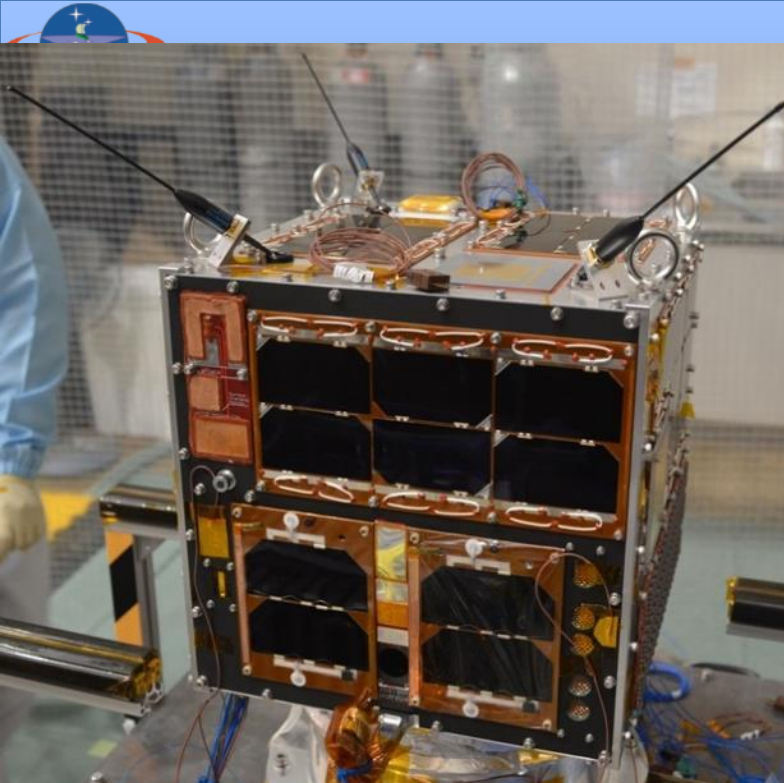


Initial Results from In-orbit High Voltage Experiment on HORYU-4

T. Shimizu, H. Fukuda, K. Toyoda, M. Cho
and HORYU-4 Project Team

Laboratory of Spacecraft Environment Interaction Engineering
Kyushu Institute of Technology





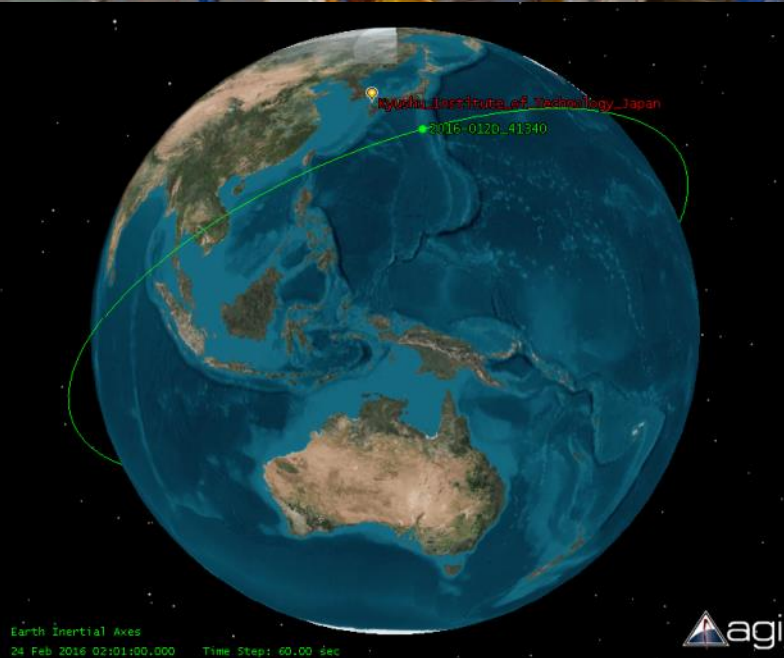
HORYU-4 Satellite

(specifications) Kyutech

Kyushu Institute of Technology

Size	33x33x33cm, 10kg
Power	TJ 34 cells in total, Ni-MH Battery
Telecommand	VHF 1.2kbps, L-band DTMF
Telemetry	UHF 1.2kbps, S-band 100kbps
Launch	H-IIA Rocket, 17 th Feb 2016
Orbit	575km, 31deg

Mission 1	Capture ESD Current
Mission 2	Capture ESD Flash Light
Mission 3	High Voltage Technology Demonstration
Mission 4	Secret Ink
Mission 5	Vacuum Arc Thruster
Mission 6	Langmuir Probe
Mission 7	Photoelectron Measurement
Mission 8	Earth Imaging
Mission 9	DigiSinger (Vocaloid)



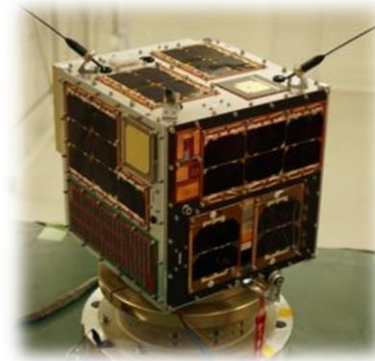
It is still difficult to fully simulate complex space environments...



Vacuum Pressure
Plasma Conditions
Satellite Motion
Chamber Wall



Verify Ground Testing Method
Qualify New (High Risk) Technologies



So, bring a laboratory into orbit
Repeat same tests performed on ground

results comparison
Evaluate testing method
Find conditions

Idea of New
Technology

Simulations
Ground Testing

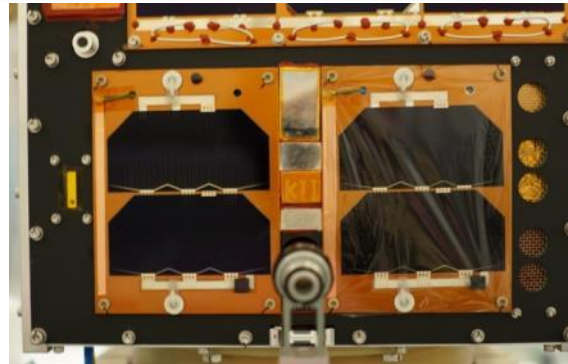
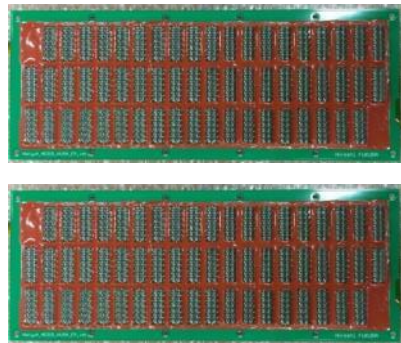
**In-Orbit
Demonstration**

Practical
Application

In House Developed Instruments

Kyutech

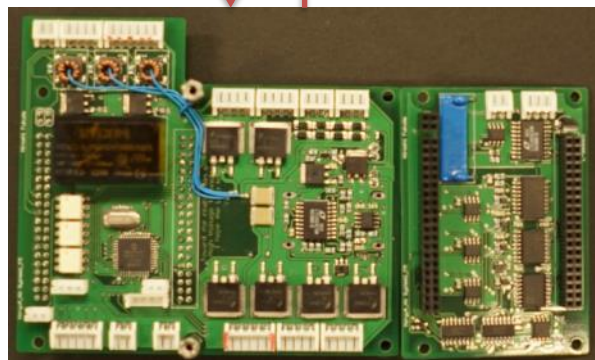
Kyushu Institute of Technology



350V 2mA

High Voltage Bias Distribution

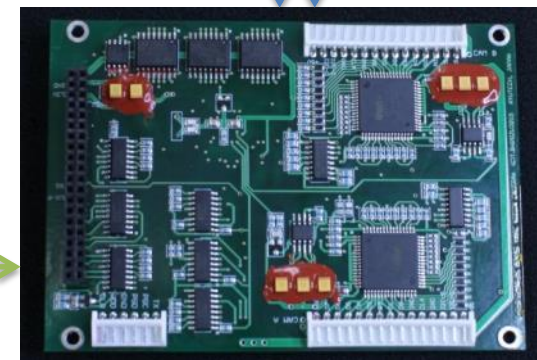
Video Signal



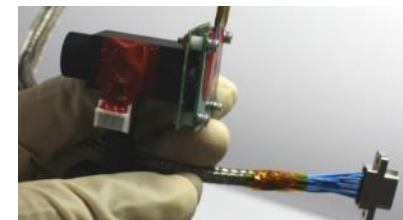
Sensor Signal



Trigger Signal



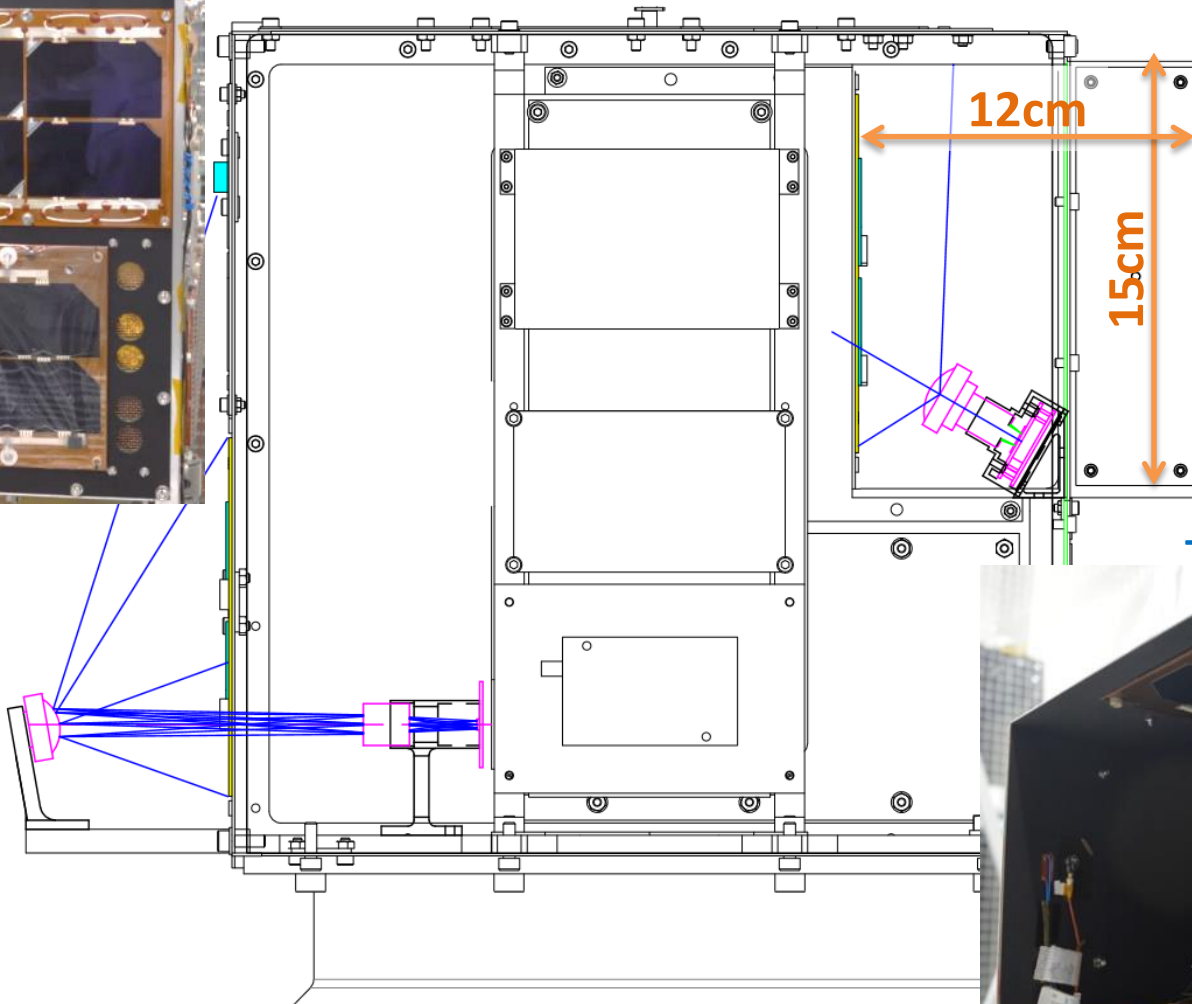
OBC Bus



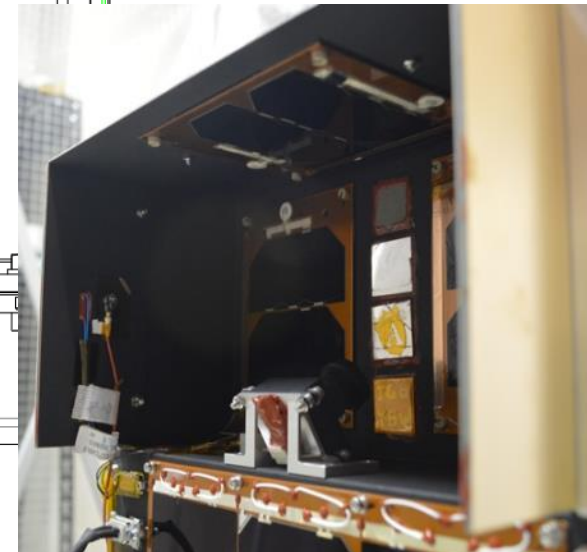
Experimental Solar Array



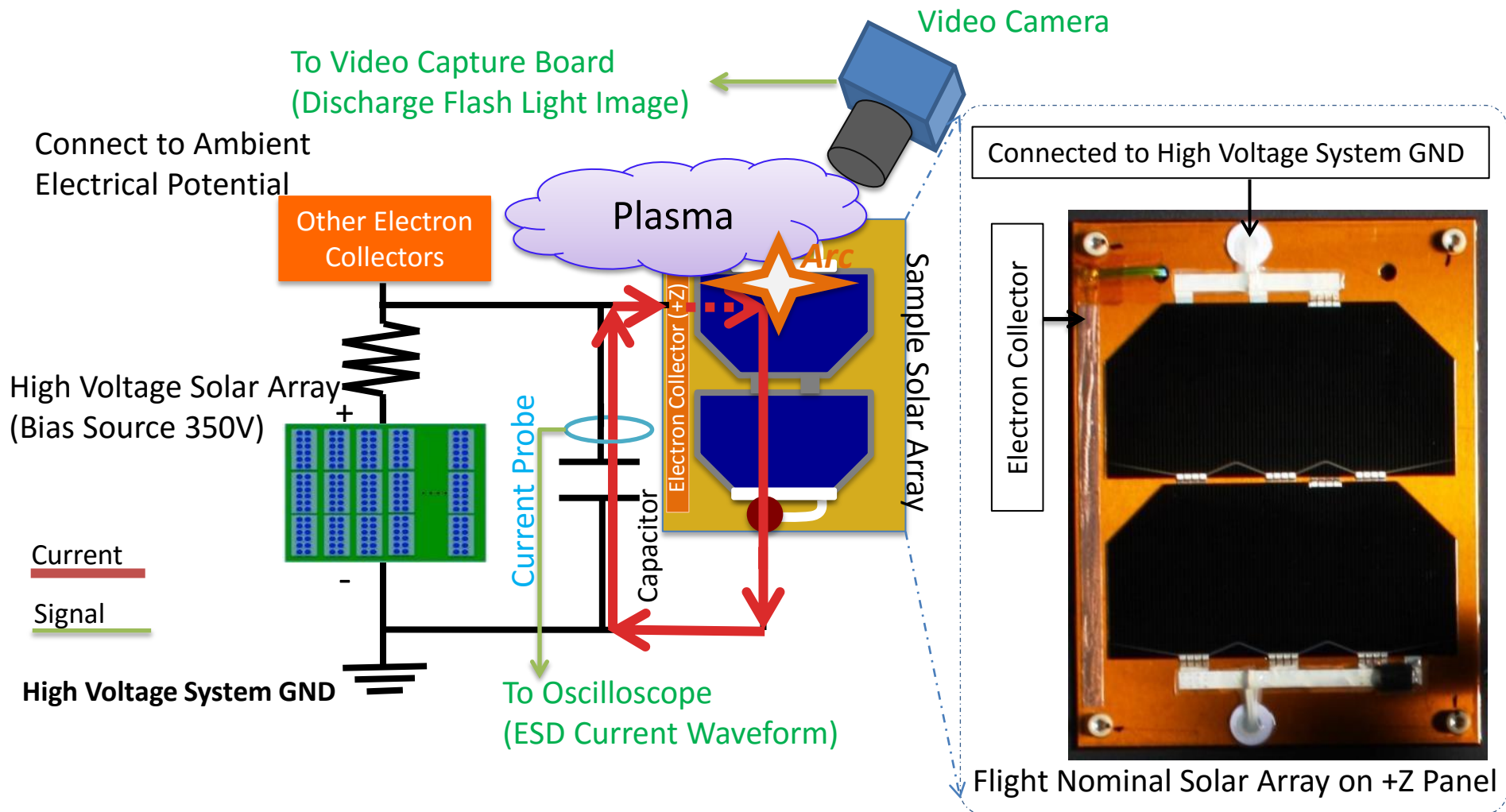
-Z Panel



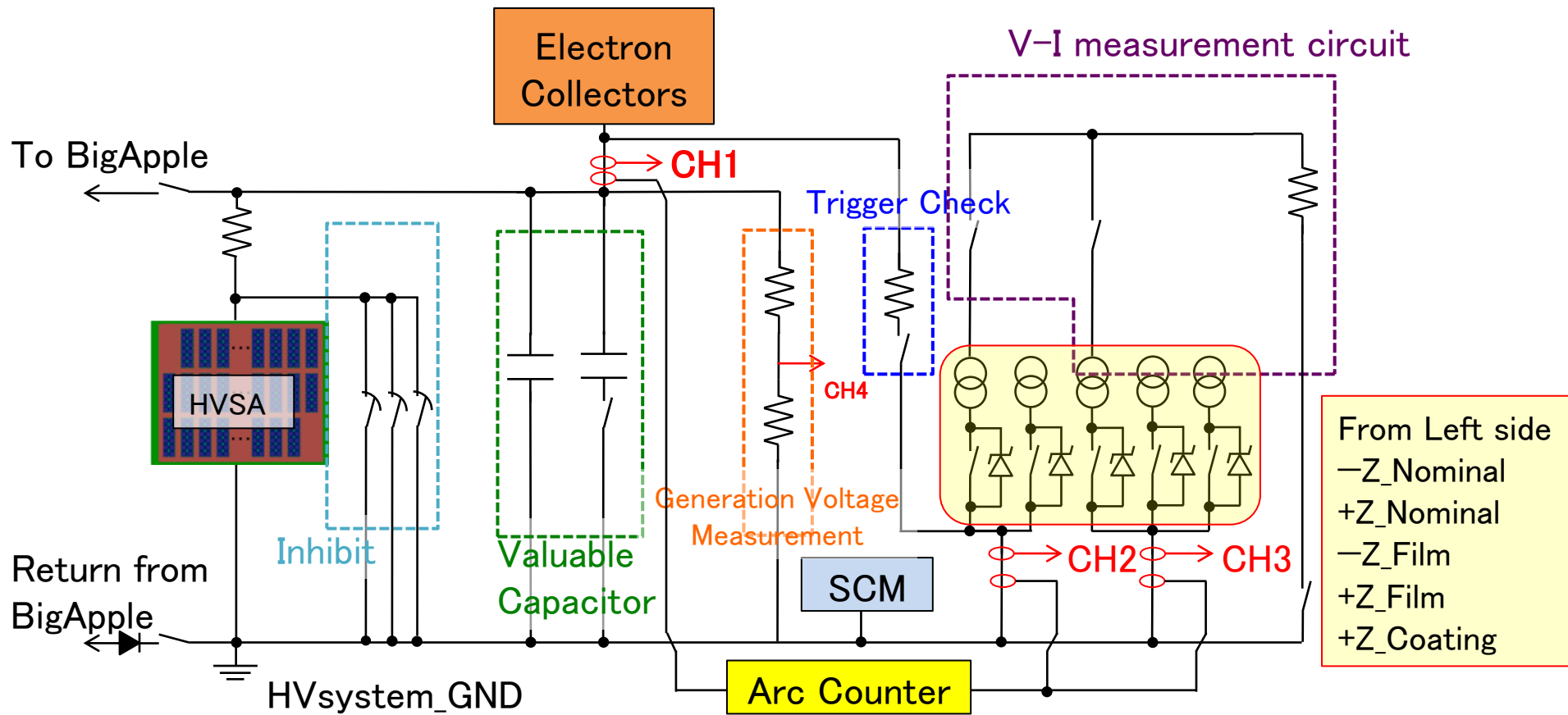
+Z Panel



Overview of Experimental Setup

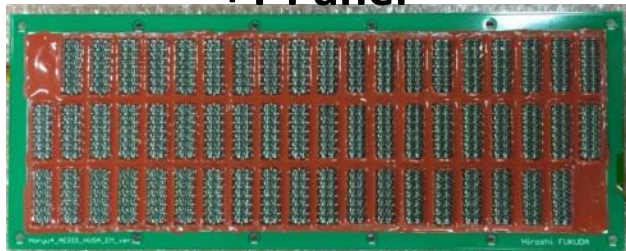


Schematic of Experimental Setup

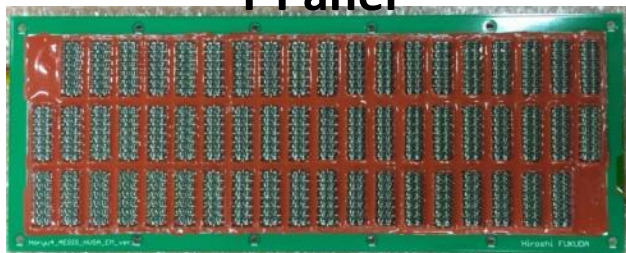


High Voltage Solar Array

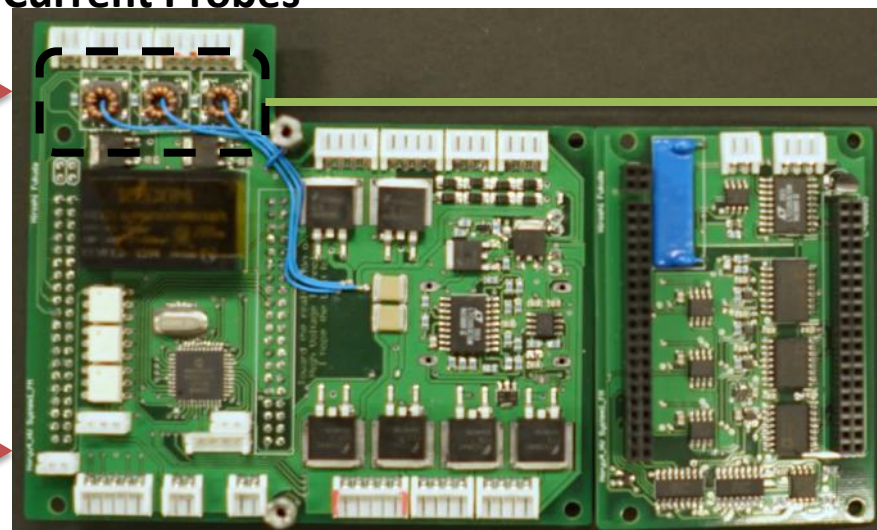
+Y Panel



-Y Panel

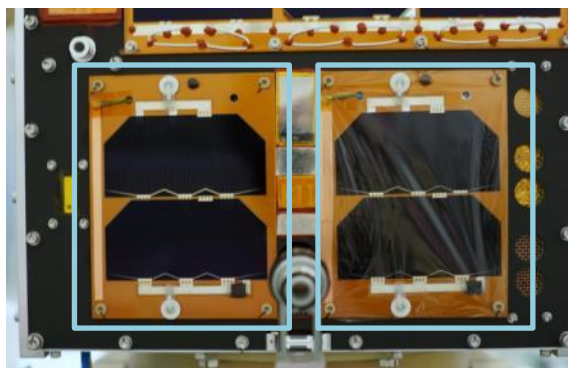


Current Probes

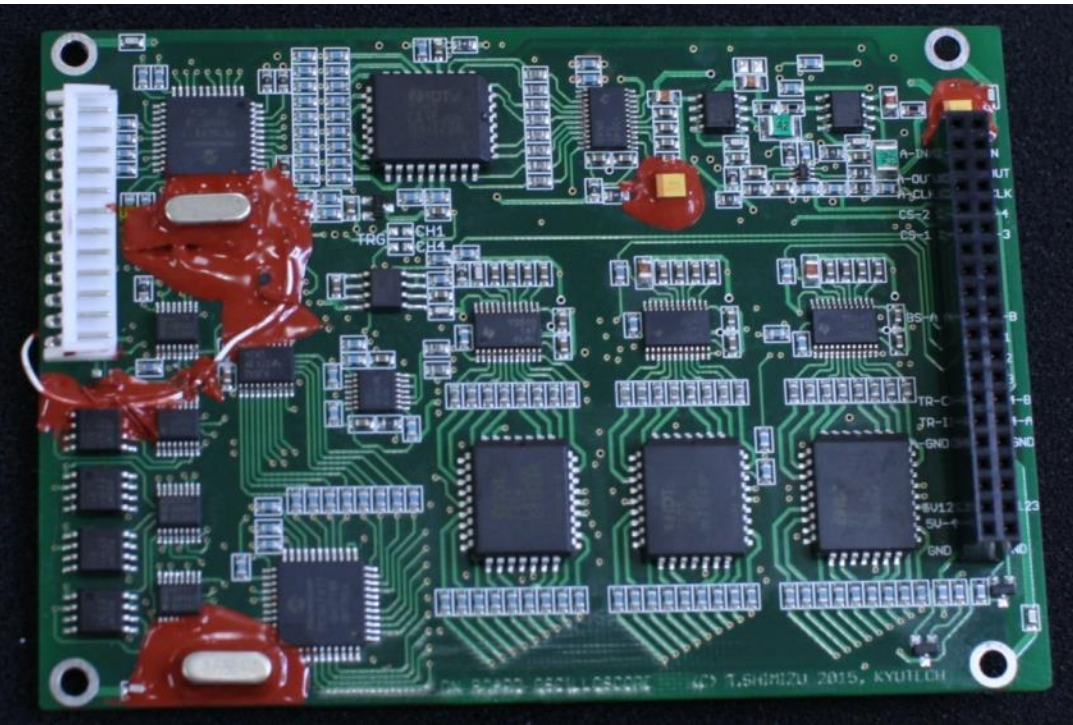


OBO Analog Input

High Voltage Distribution



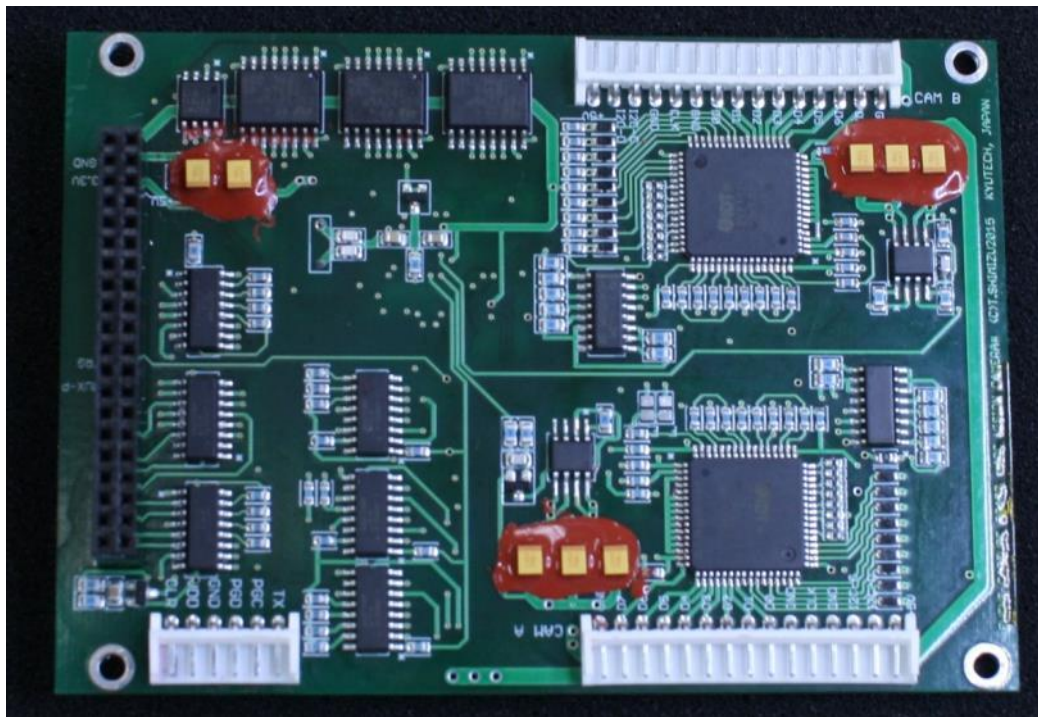
On Board Oscilloscope



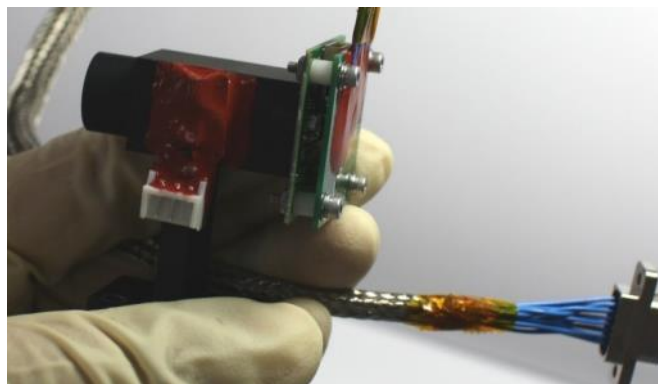
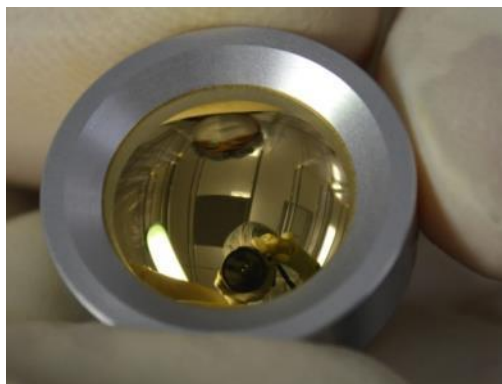
- ← Analog Signal (4CH)
- ← Discharge Currents & Capacitor Voltage
- ← Trg Out to AVC Shutter

Channel	CH1	CH2 and CH3	CH4
Input Range	-10 to 70 A, -0.1 to 0.7 kA	0 to 40 A	0 to 400V
Vertical Resolution	8bit	8bit	8bit
Sampling Rate	6MHz	40MHz	1MHz
Record Length	170μs	205μs	1024μs

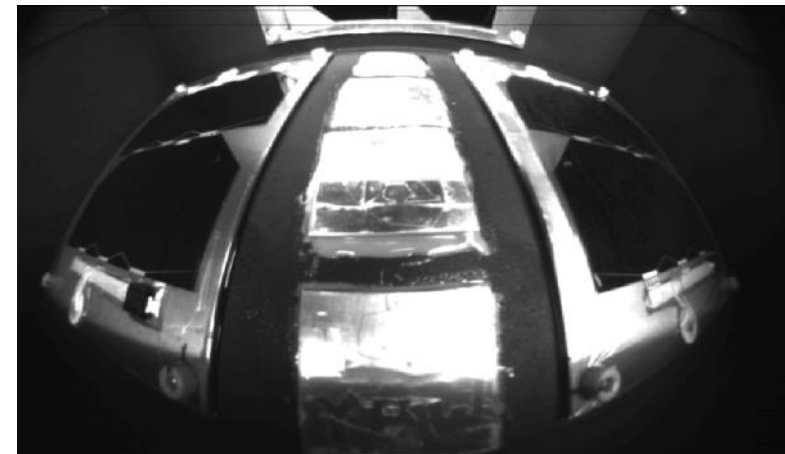
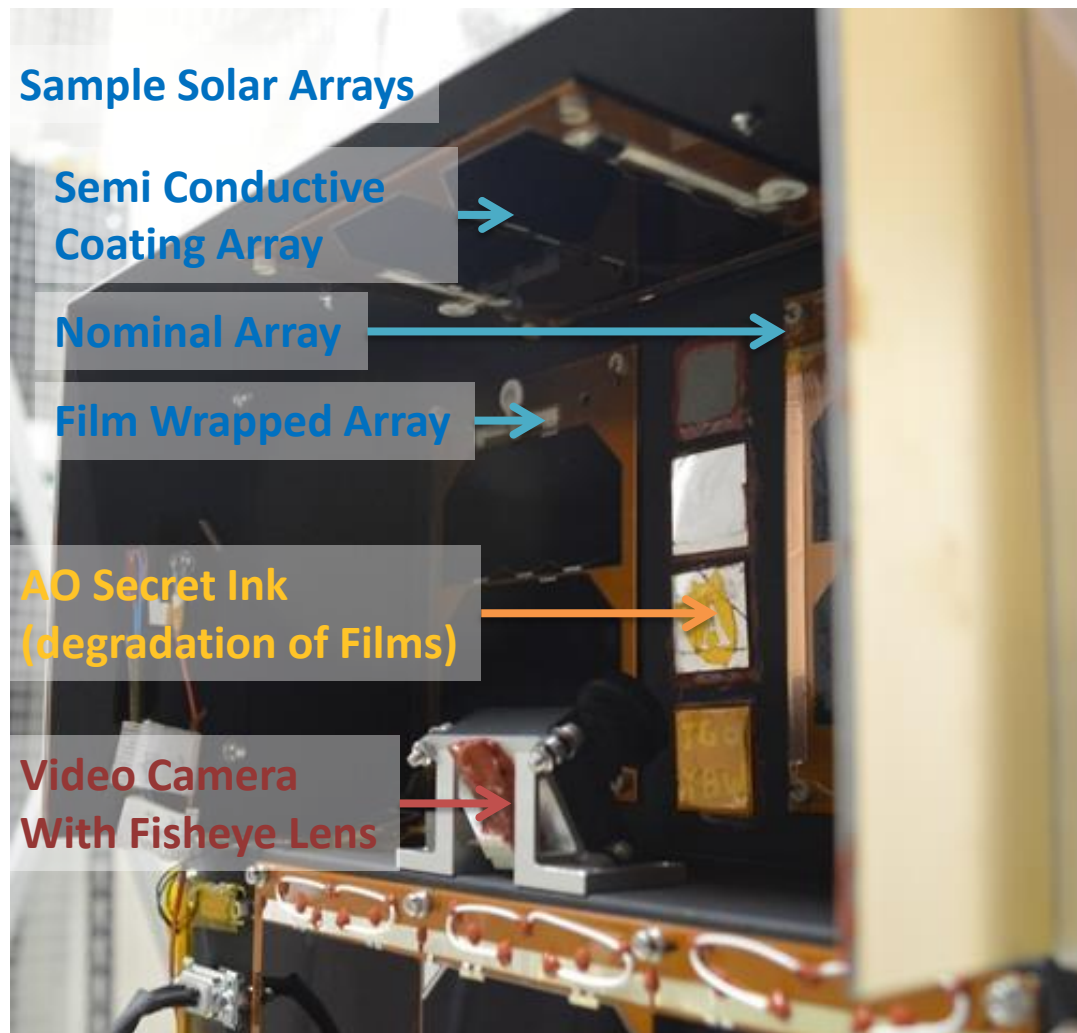
Arc Vision Camera



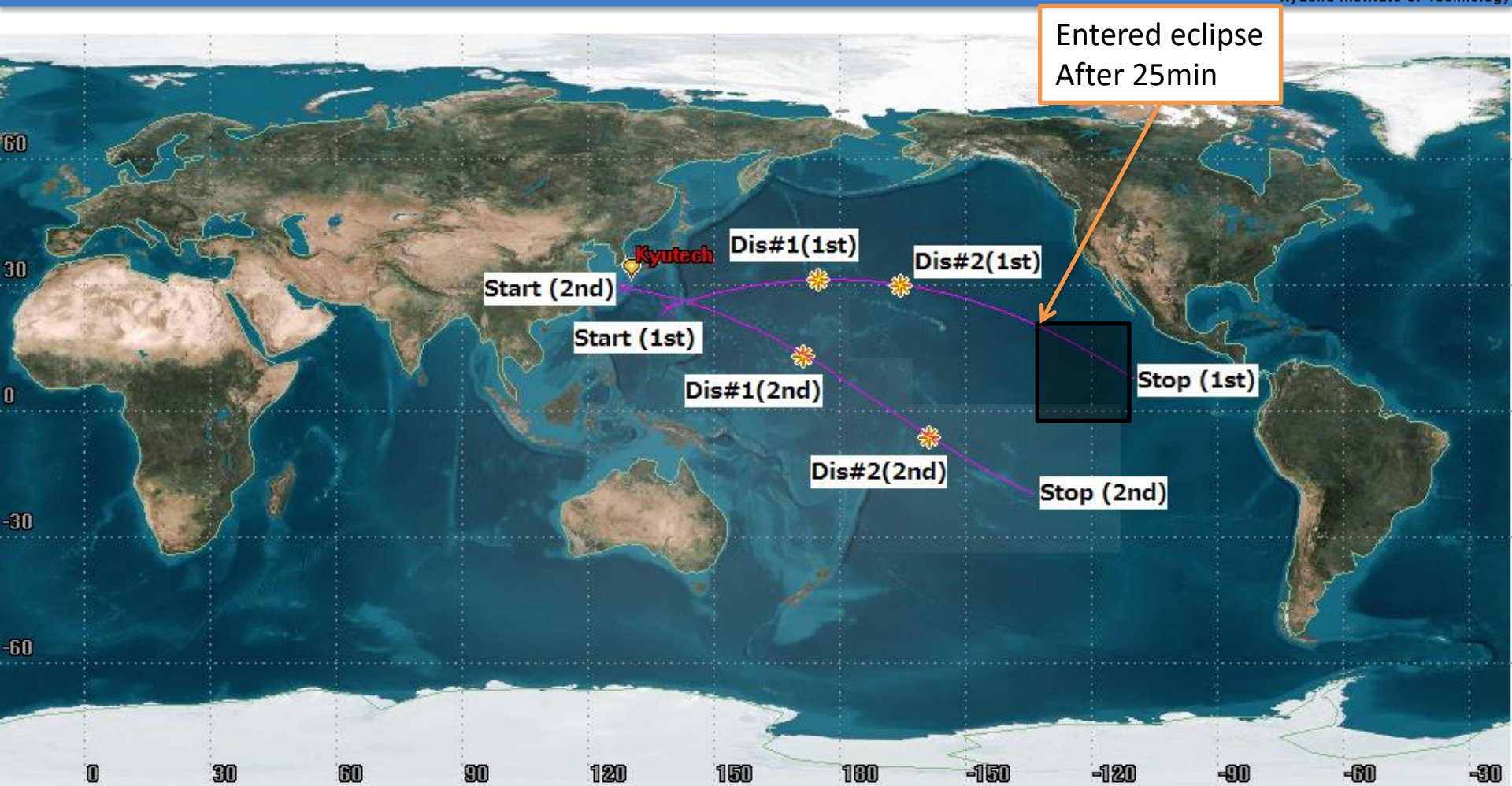
Resolution	752x480 (interlace)
Frame Rate	60fps (120fps max)
Record Length	2.8 frames
Gradation Depth	8bit
Storage	24 events
Power	0.5W in total



+Z Panel, Experimental Space



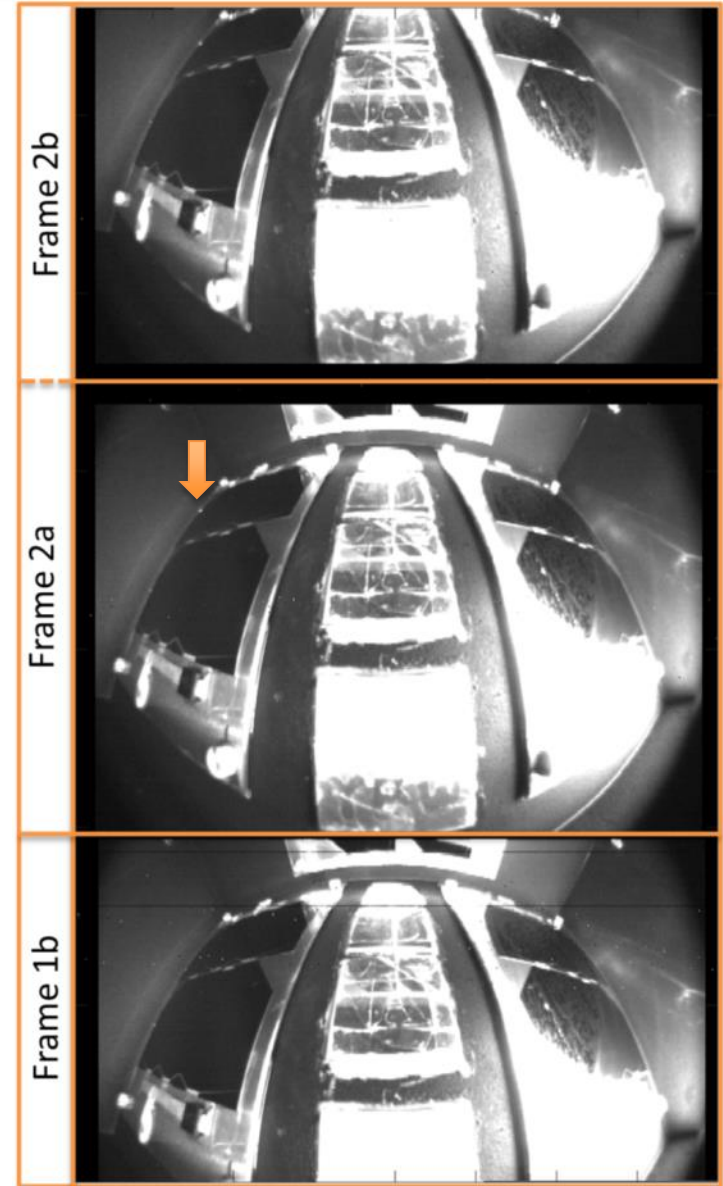
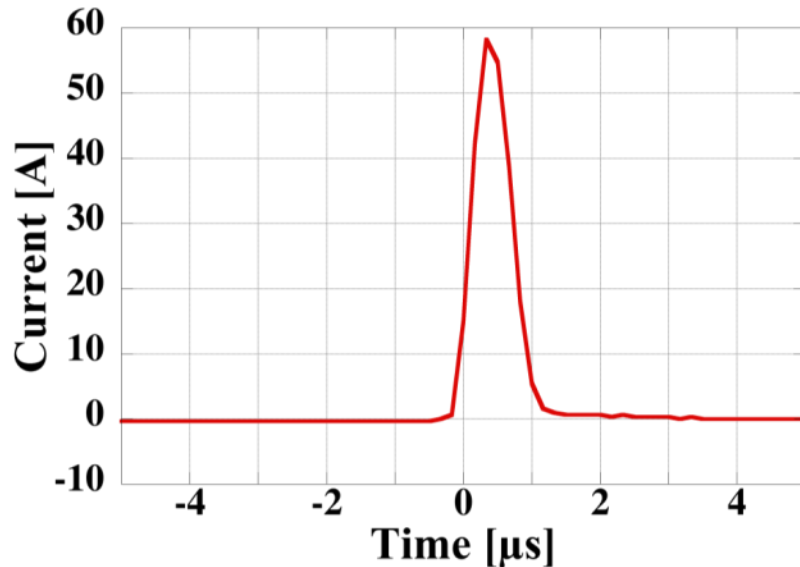
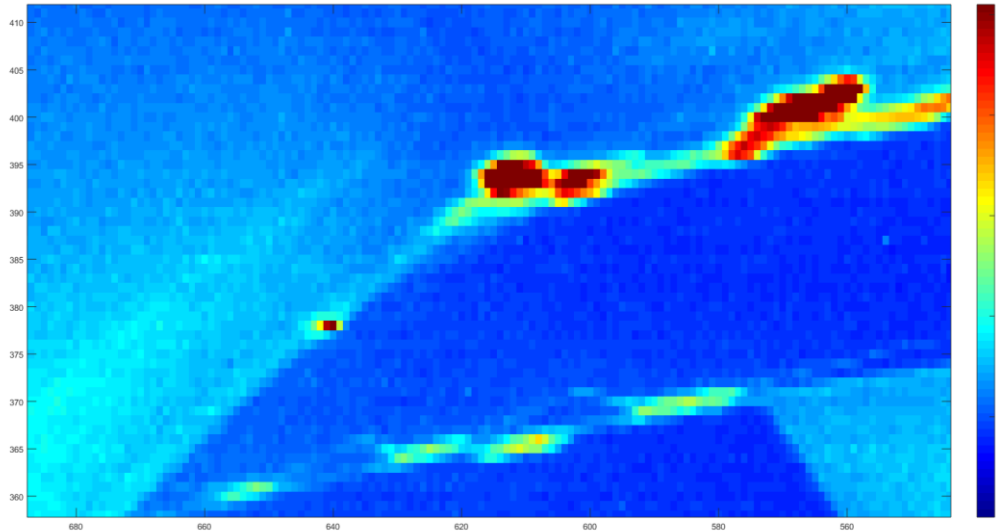
Discharge Location



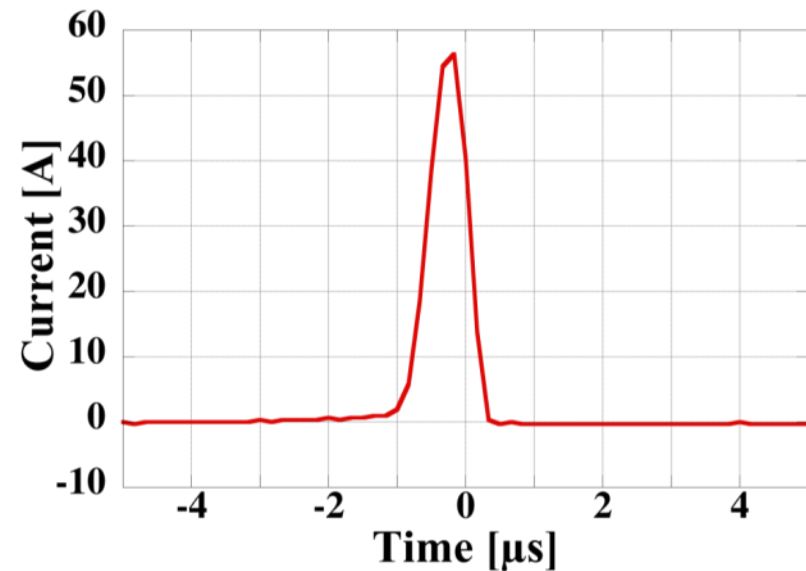
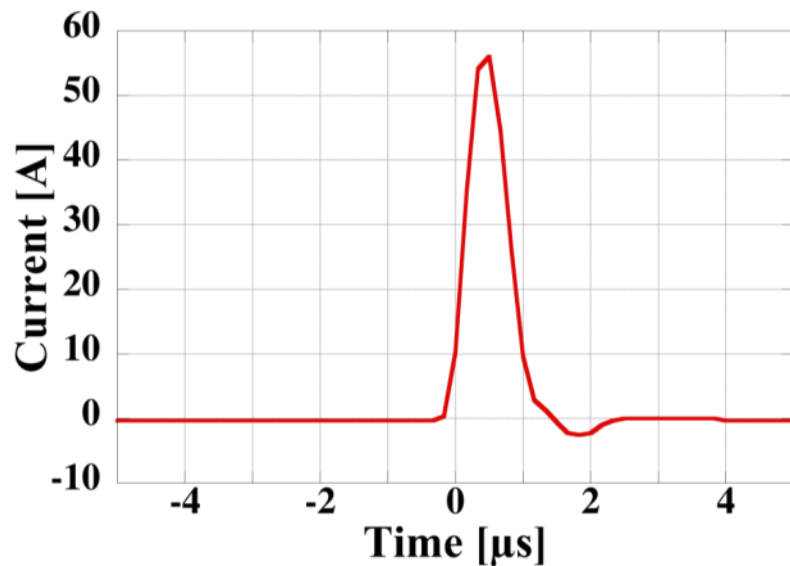
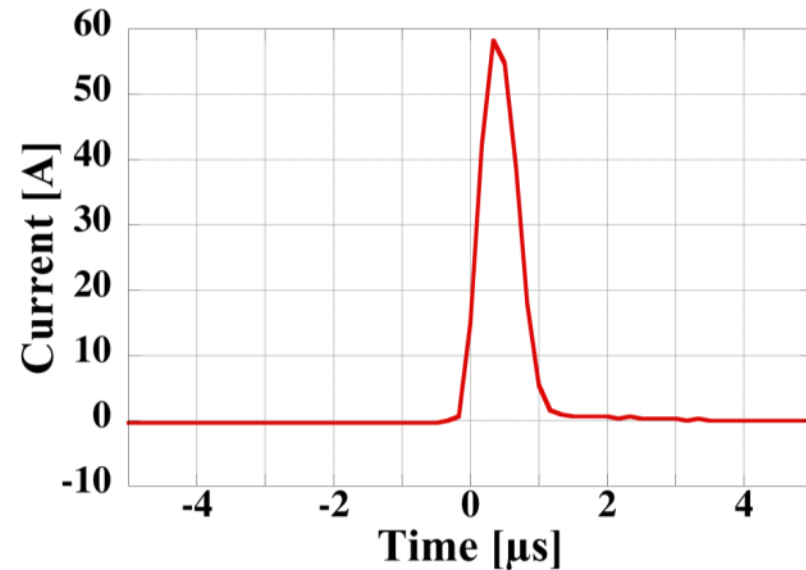
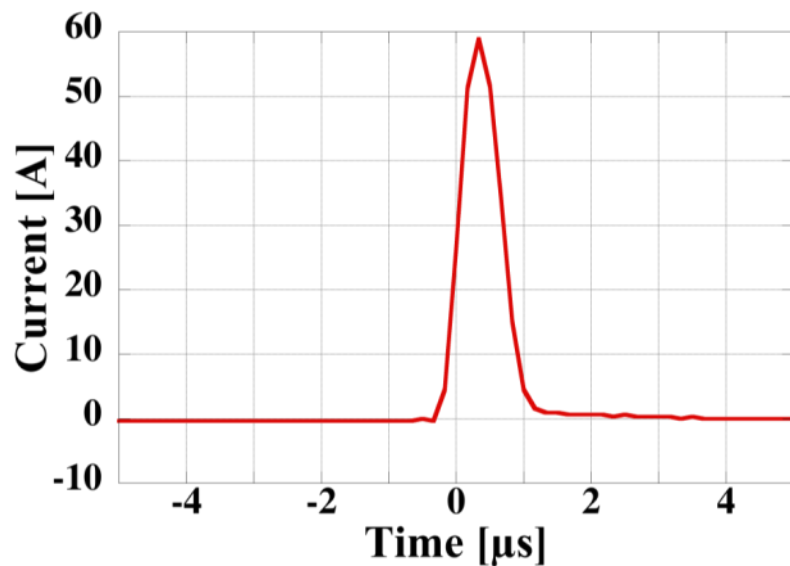
1st: 24th February 2016

2nd: 9th March 2016

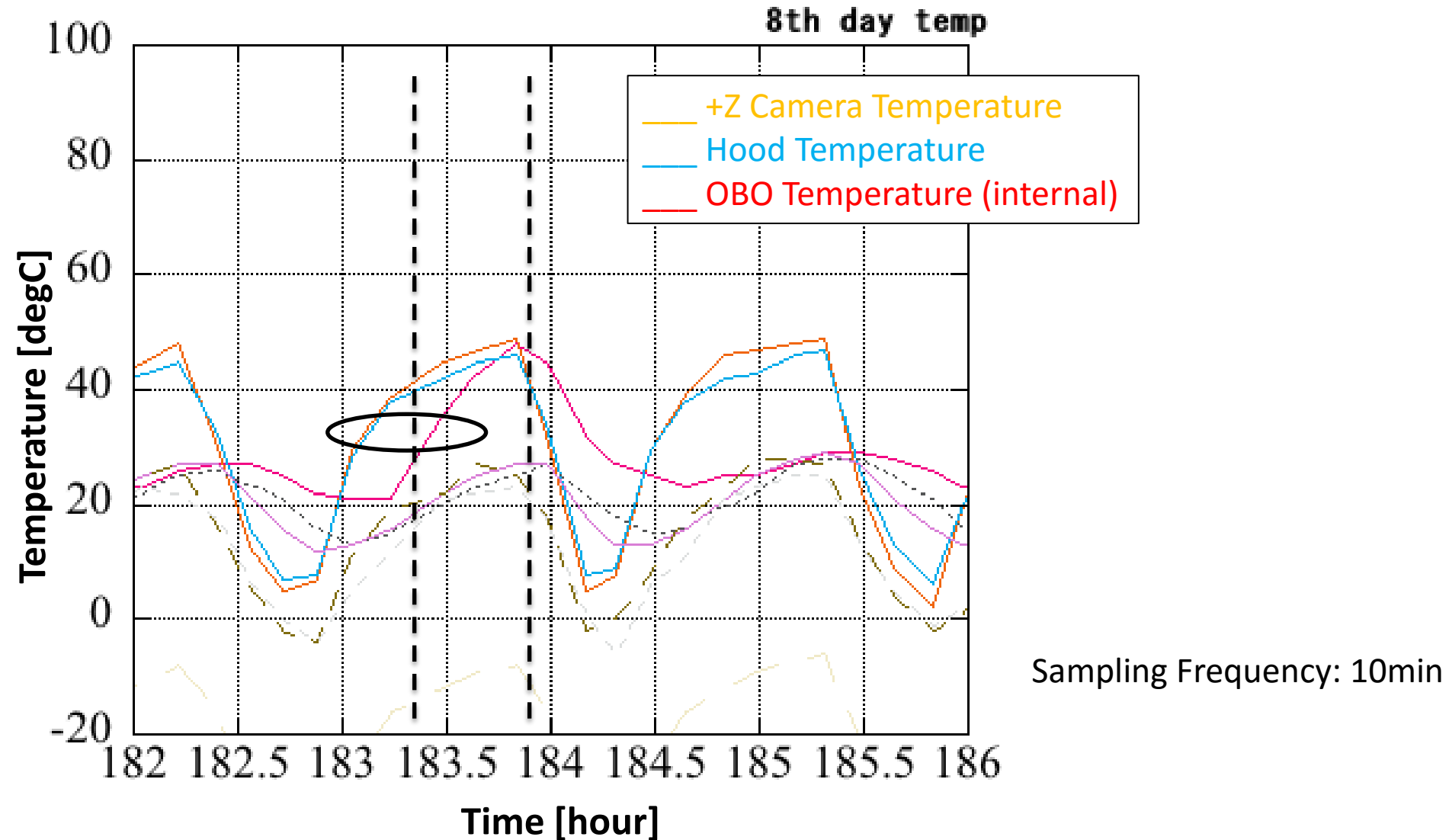
Captured Waveform and Image



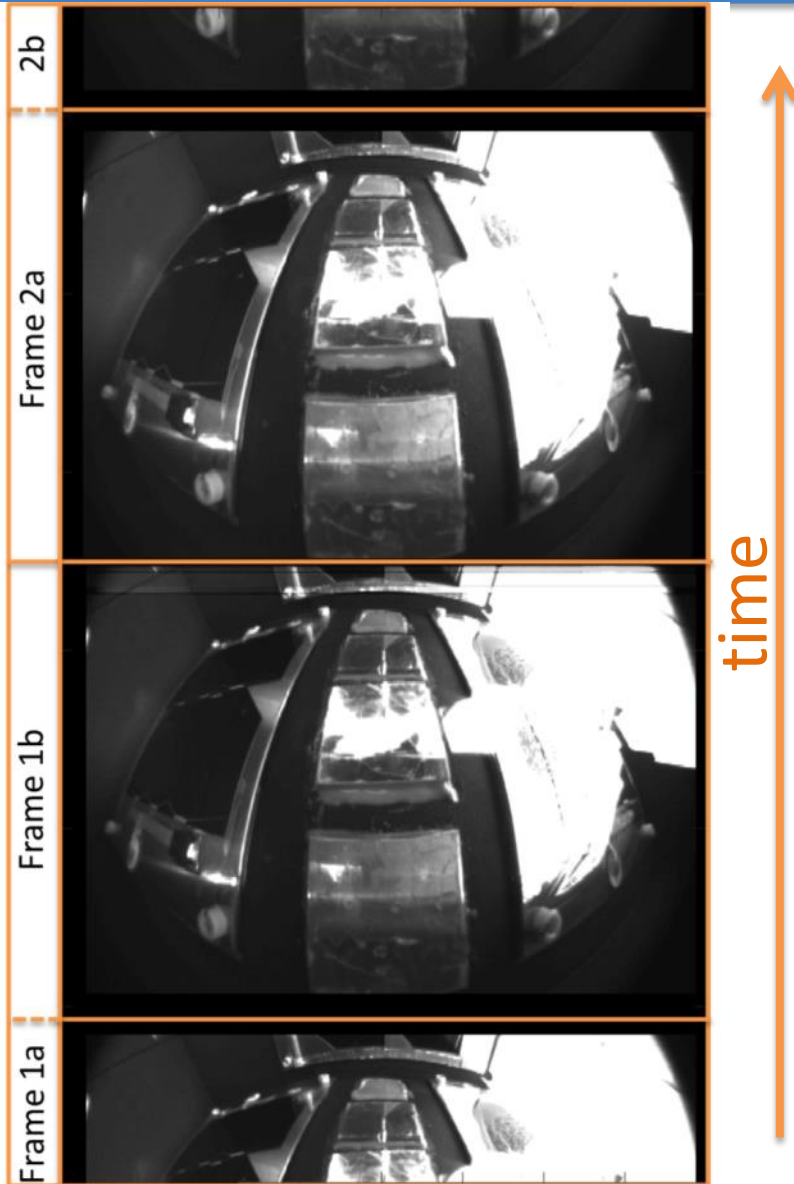
Observed Waveforms



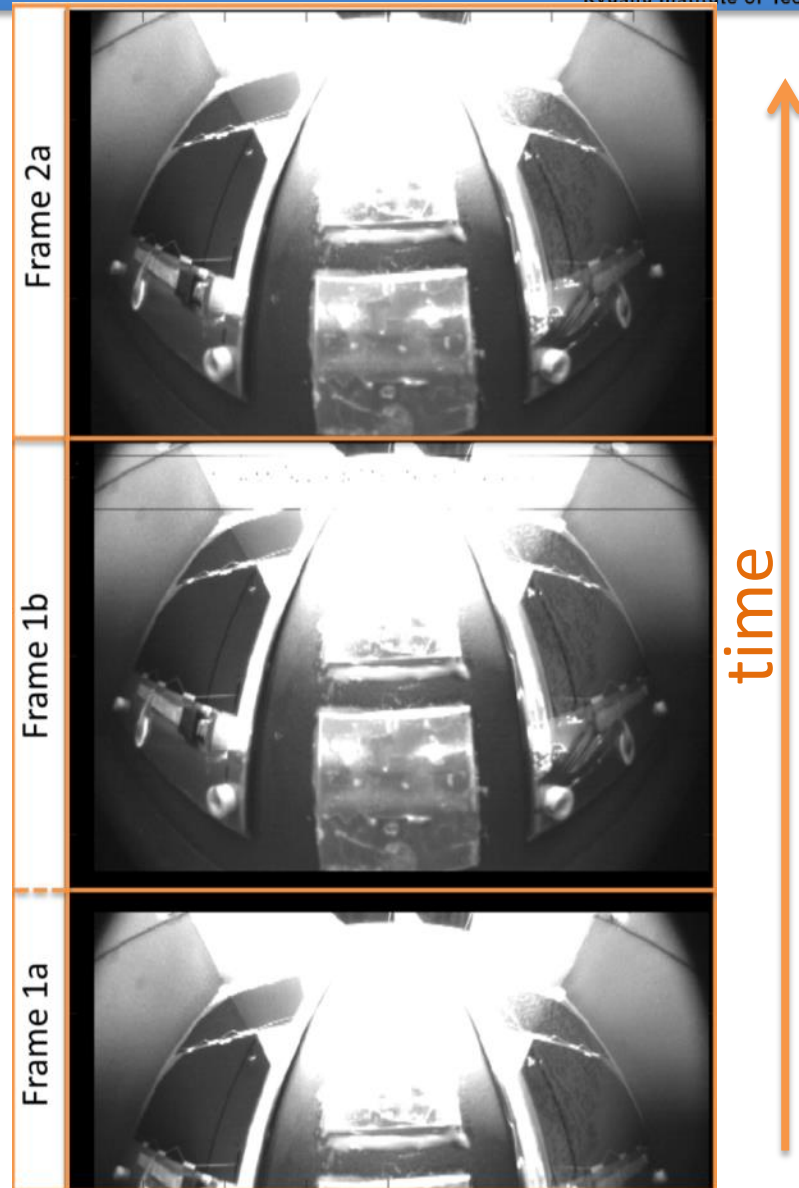
Temperature during the 1st Experiment



Captured Image



T.Shimizu



Conclusion and Future Works

HORYU-4 has successfully operated and conducted the high voltage experiment.

We acquired the world's first results from in-orbit experiment.

The acquired waveforms were different from our expectations...
Our expectation was that low peak currents and long discharge durations.

This observation will be clarified through further experiments both in-orbit and on the ground.

The obtained data will be used to evaluate and improve present ground testing methods (e.g. ISO-1221).



