



# ARRISSat-1 Overview

Feb 12 2011

Lou McFadin W5DID

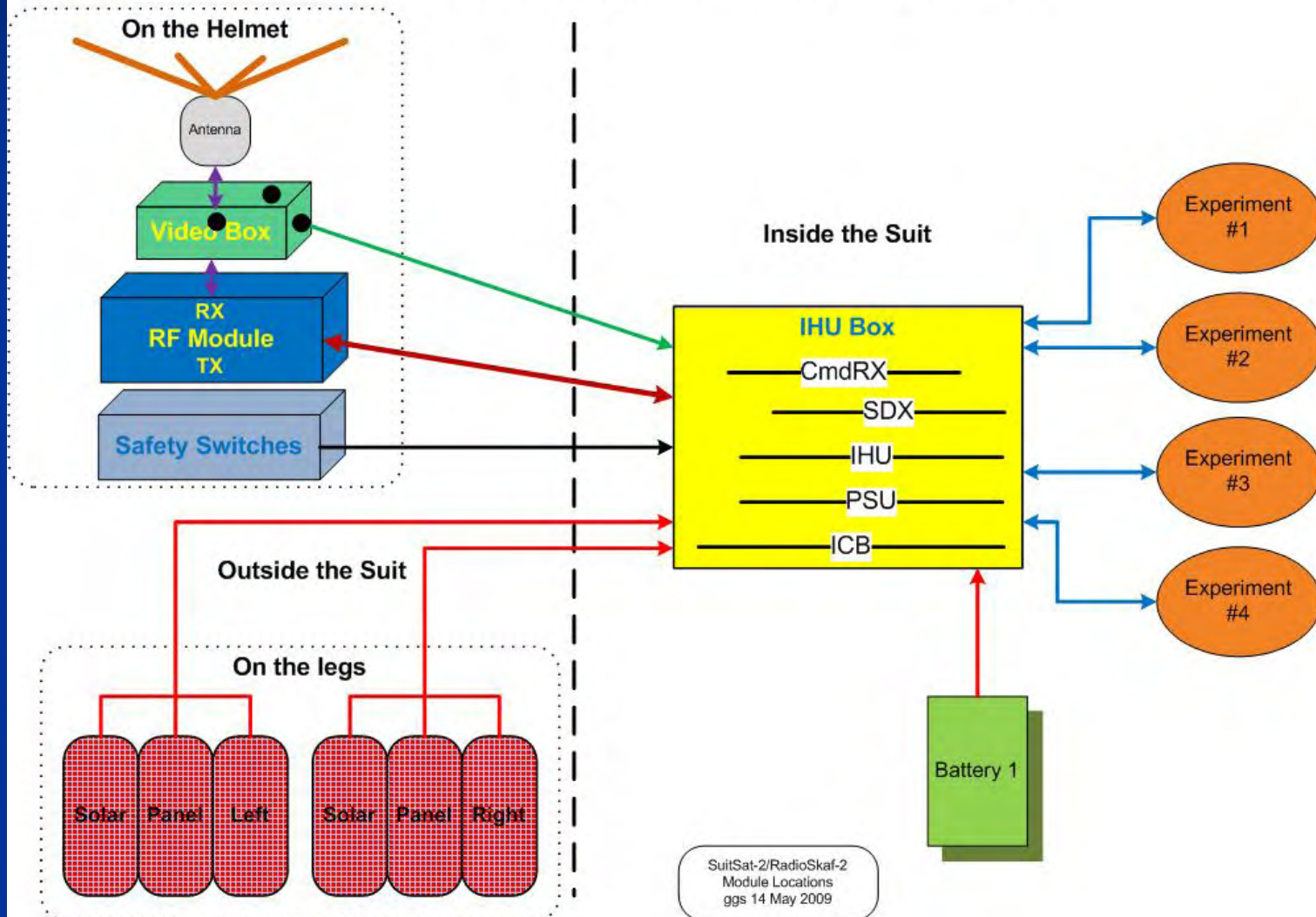
ARRISS U.S. Hardware manager

# SuitSat-2 Mission

- Suitsat II was an enhanced follow-up to the 2006 SuitSat project
- It was a joint project between AMSAT, ARISS, NASA and Energia
- Major mission is to promote STEM education
- AMSAT to build the modules, Energia to launch, NASA to interface, ARISS to publicize

# SuitSat-2 System

## SuitSat-2/RadioSkaf-2 Modules



# SuitSat-2 System 05/09



# SuitSat became 'SuitlessSat'

- Due to safety issues and space constraints, Orlan suit #27 was placed into Progress vessel 33 and released from the ISS to deorbit on 13 July 2009
- We still had the upmass for a Jan '10 launch and EVA time in the Spring of 2010

# ARISSat-1 Hardware Changes

- New structure
- New antennas
- Cameras on separate sides of the structure with mirrors
- Module changes – MPPT & IHU
- New cables
- Battery attachment
- Control Panel attachment
- Experiment attachment

# ARISSat-1 Innovations and Experiments

- New structure
- microSD card to store voice data
- Cameras with mirrors
- MPPT
- SDX Technology
- Shallow Charge/Discharge of AgZn Battery
- Velcro Solar Panel attachment
- New Vacuum Data Experiment
- More microcontrollers than a satellite 5 times its size
- Colder satellite than most other AMSAT sats
- Multiple communication protocols

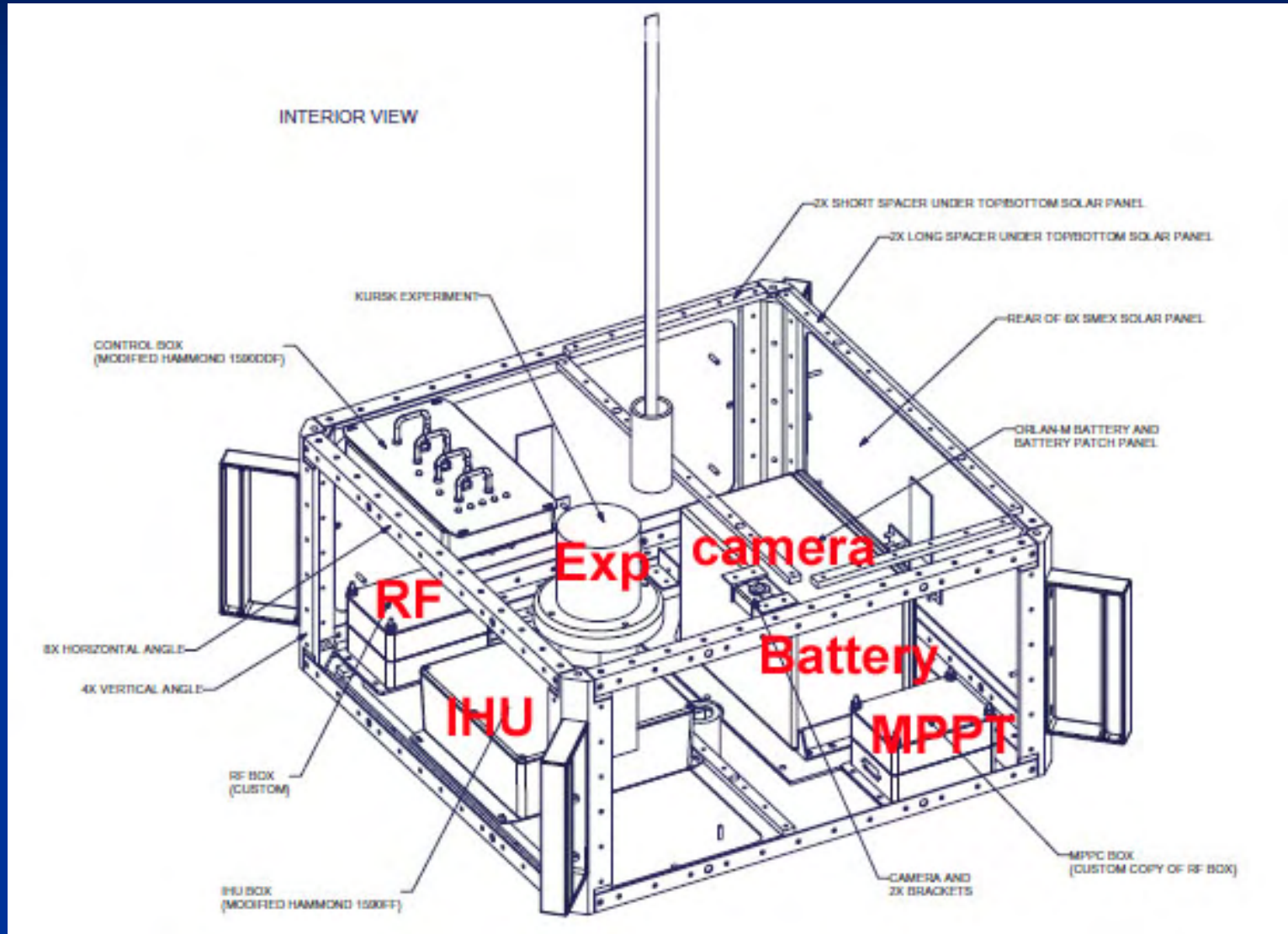
# ARISSat-1 Hardware Changes

\*5

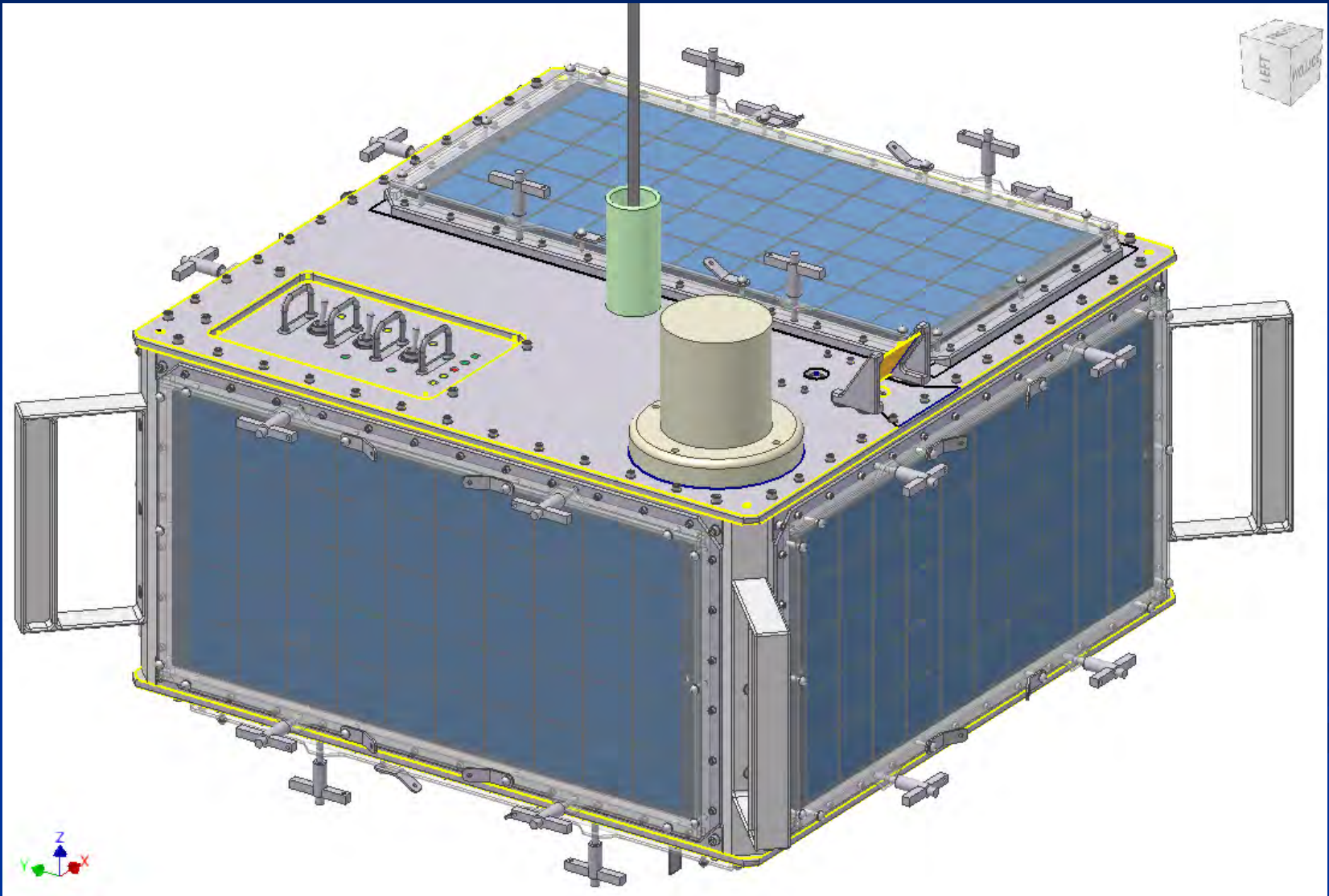
+ development



# ARISSat-1 Module Locations



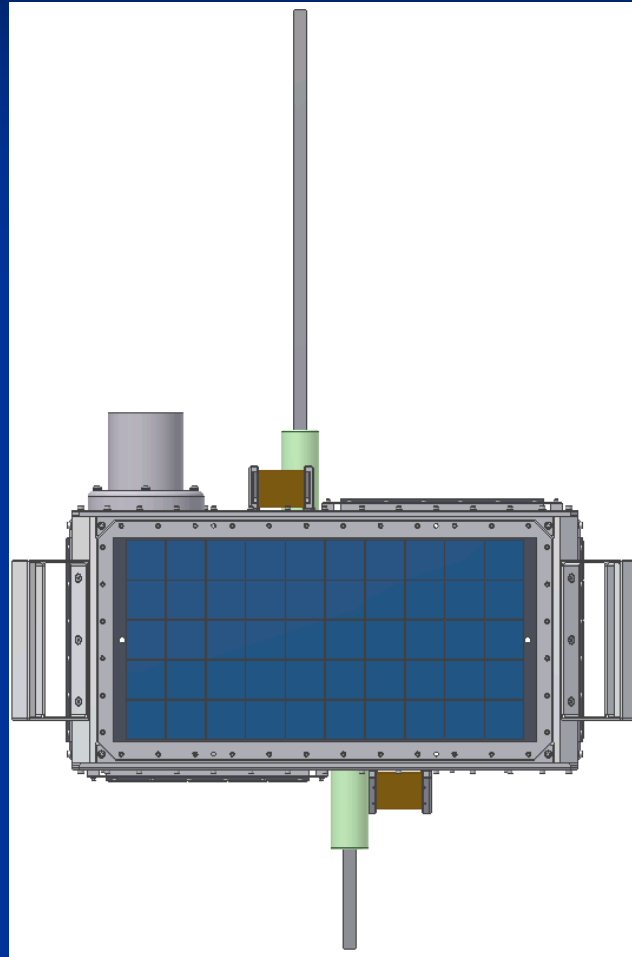
# ARISSat-1 Structure



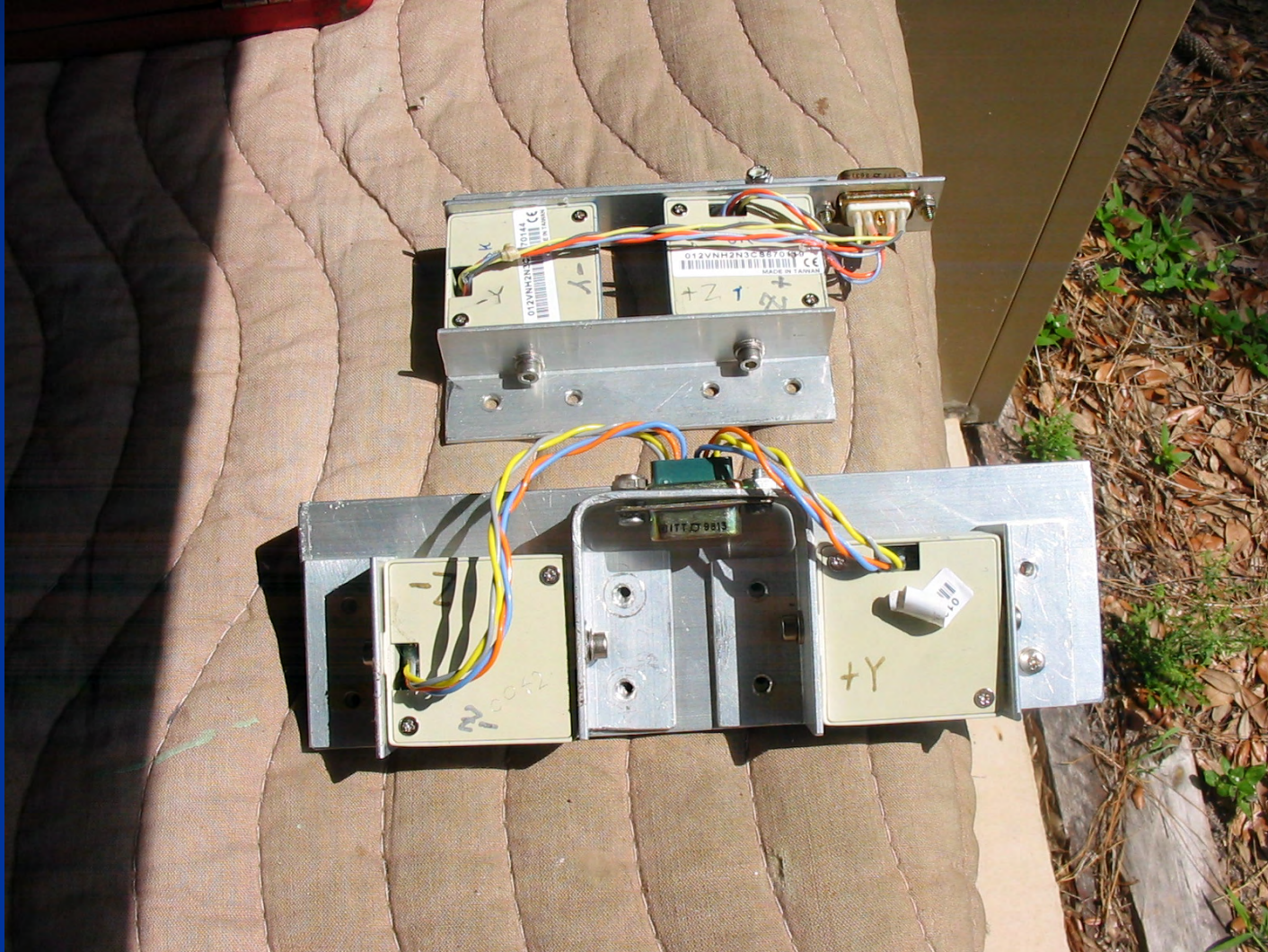
# Thermal



# Antennas

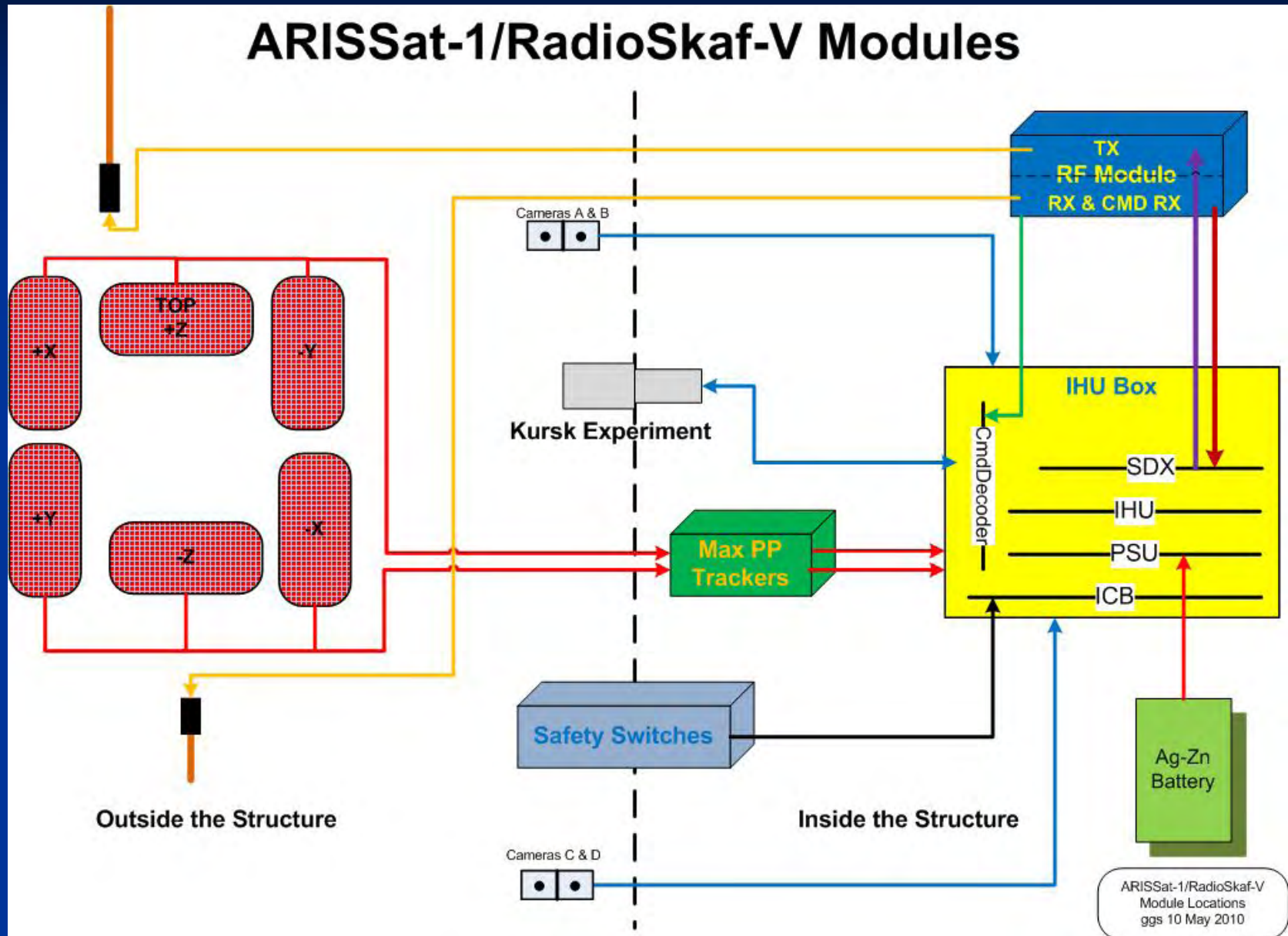


# Cameras

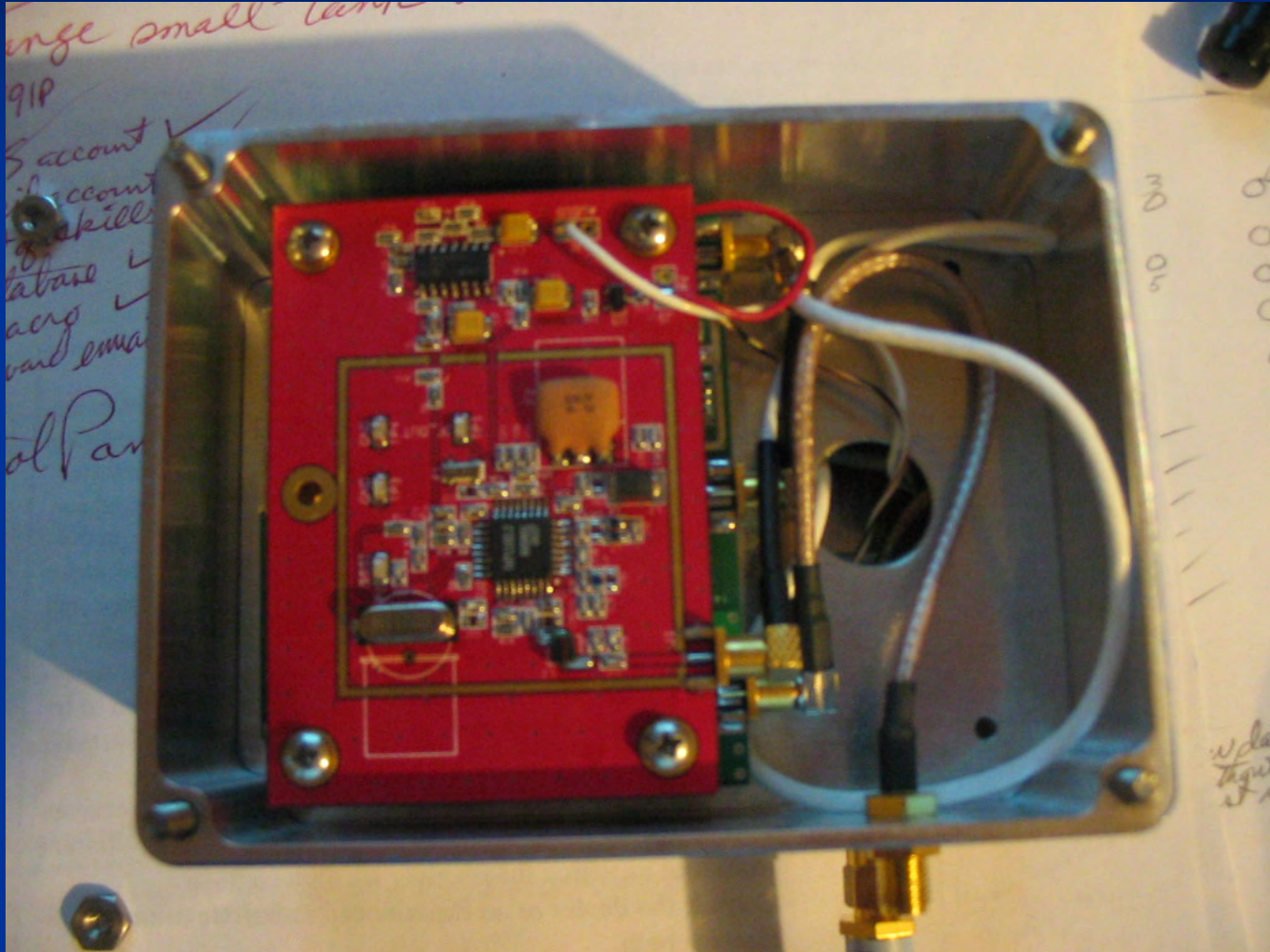


# ARISSat-1 System

## ARISSat-1/RadioSkaf-V Modules



# RF Module

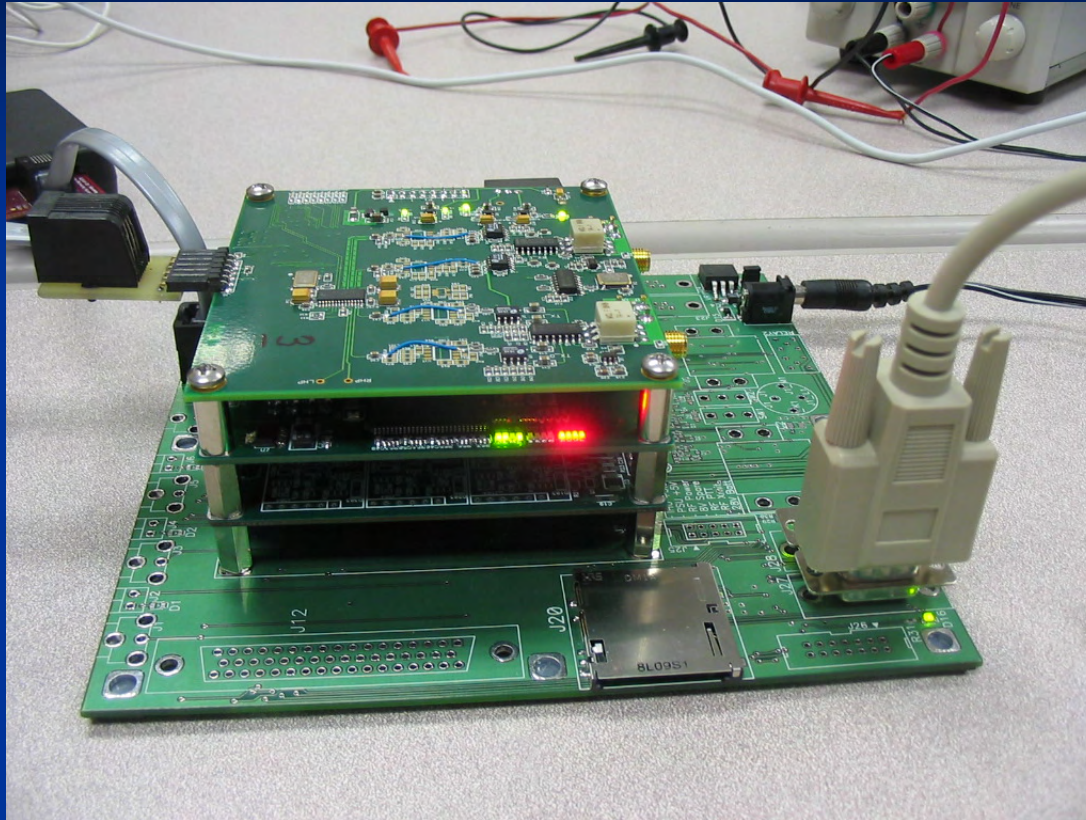


# New MPPT module





# IHU Modular Design



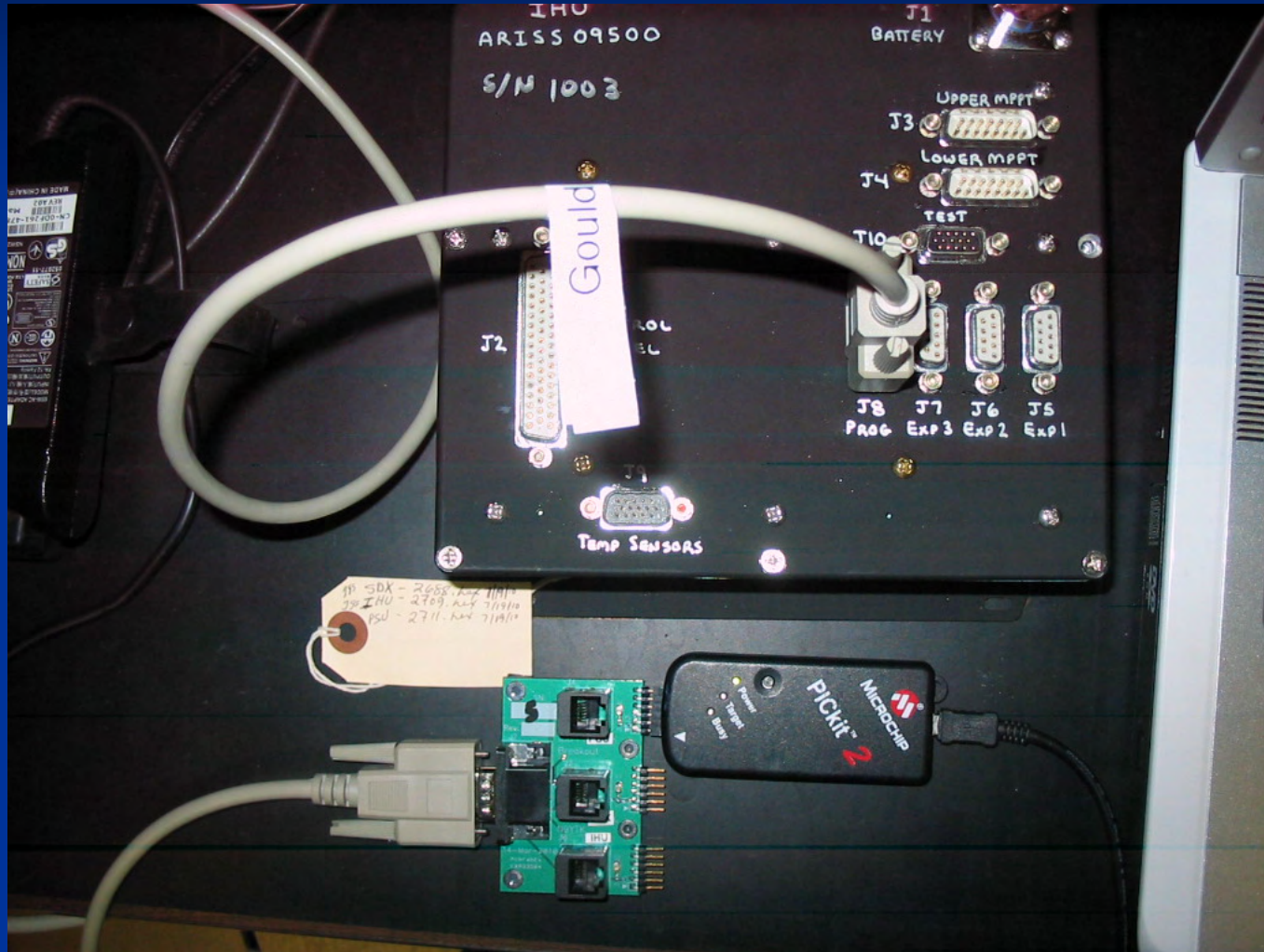
- **SDX** Software Defined Transponder
- **IHU** Integrated Housekeeping Unit
- **PCB** Power Converter Board
- **ICB** Interconnect Board (bottom)

# IHU / SDX / PSU / ICB enclosure



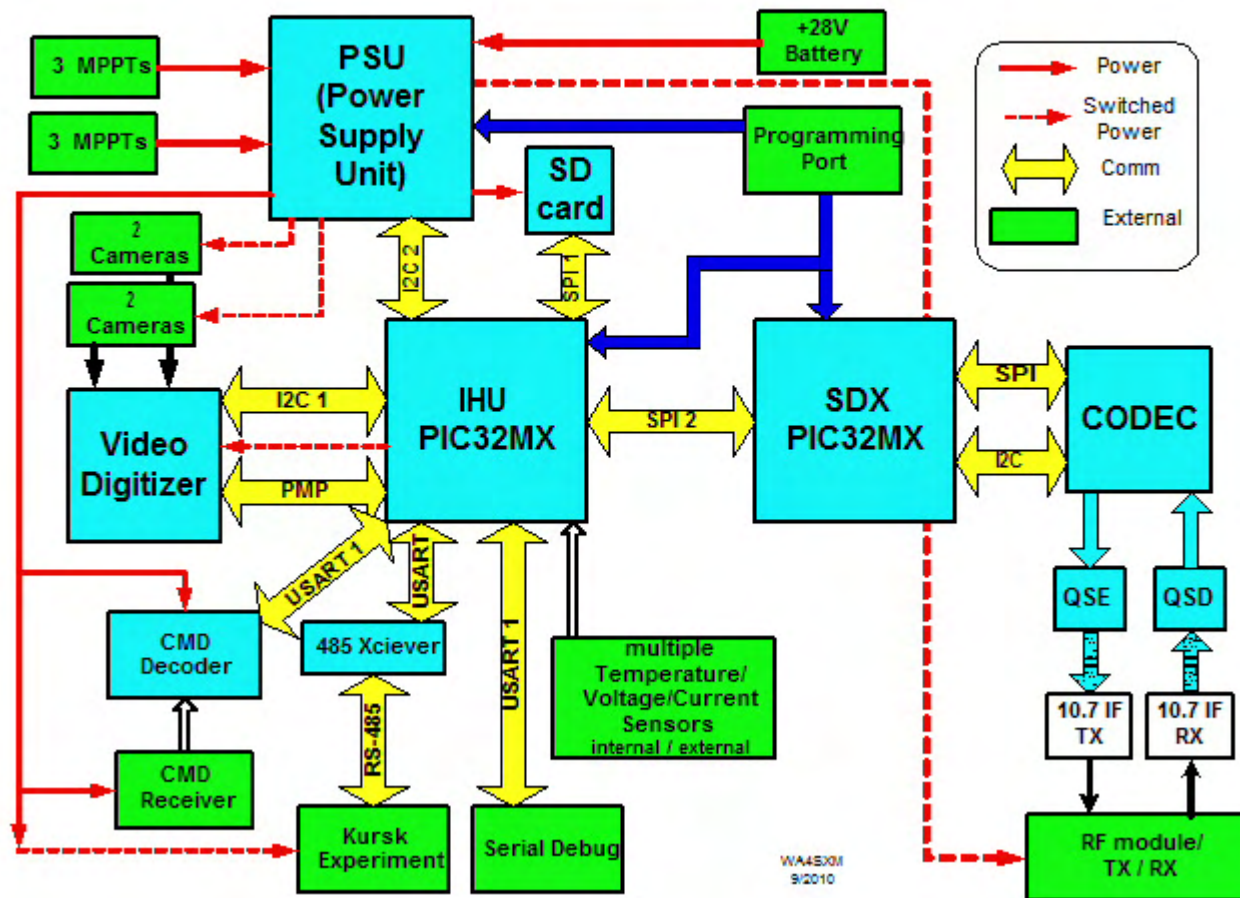
Power cable, 50 pin control/signal cable, 2 solar panel cables, 4 experiment connectors

# ARISSat-1 IHU module



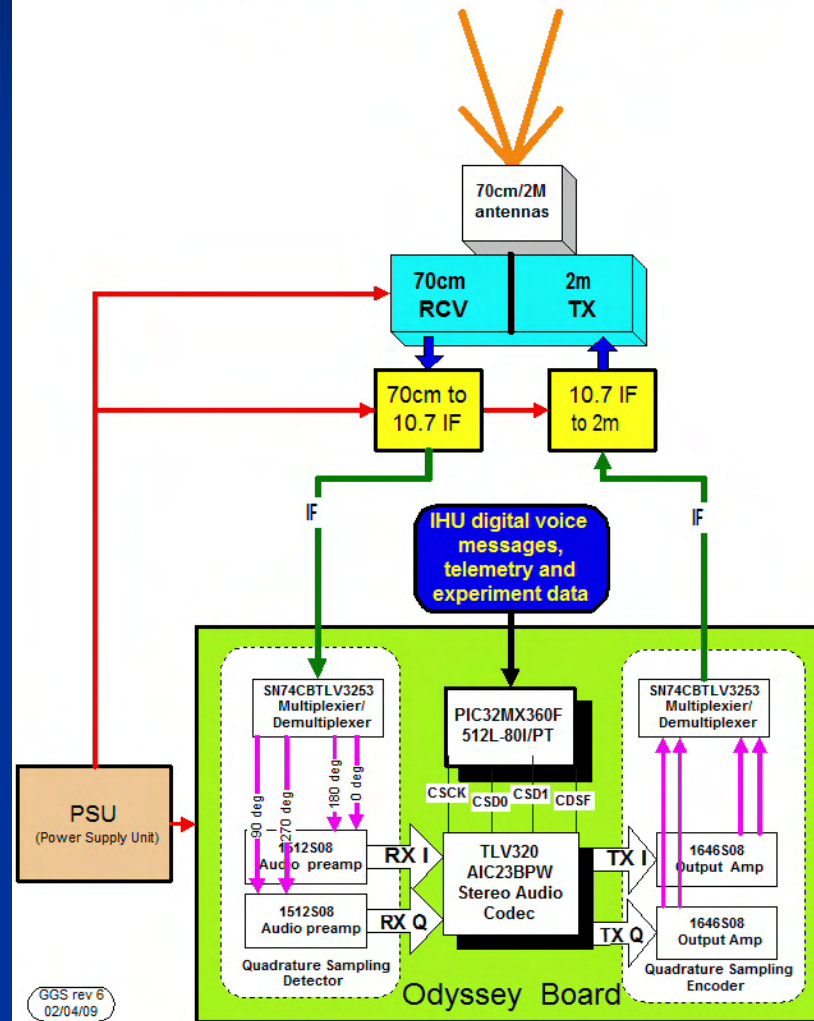
# IHU

## ARISSat-1 IHU Module Diagram



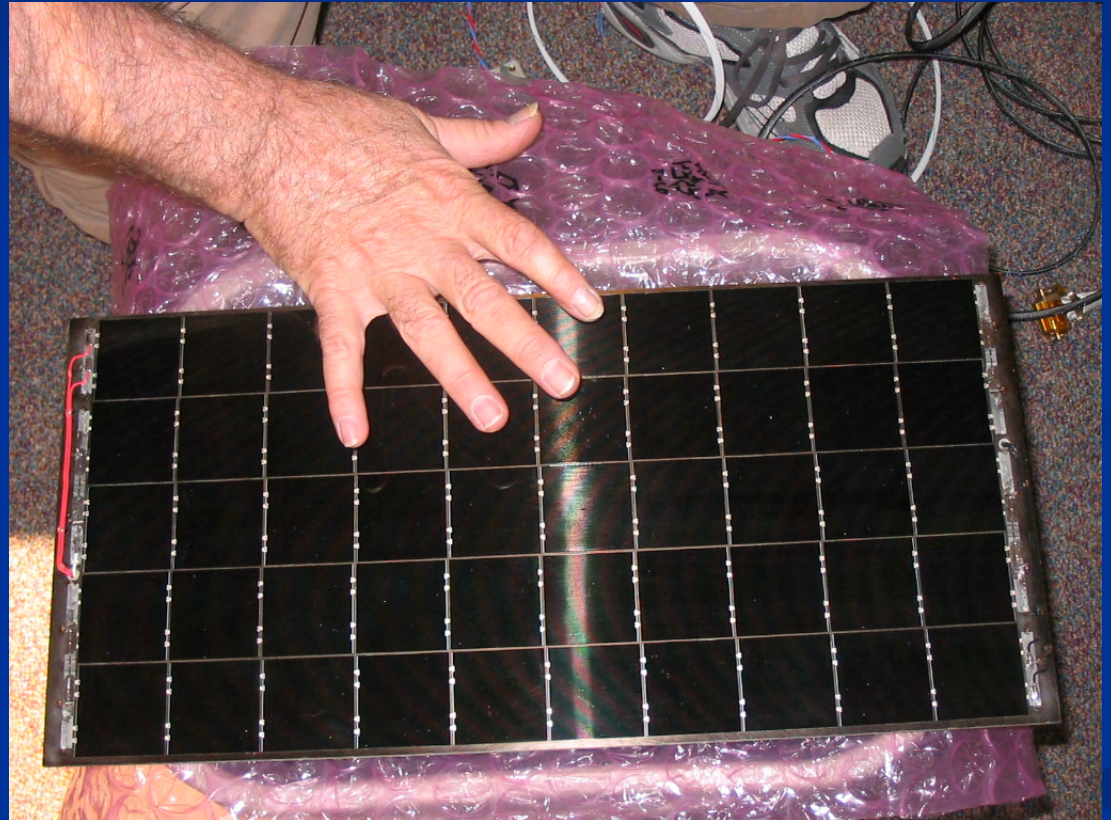
# SDX

## SuitSat-2 SDX System

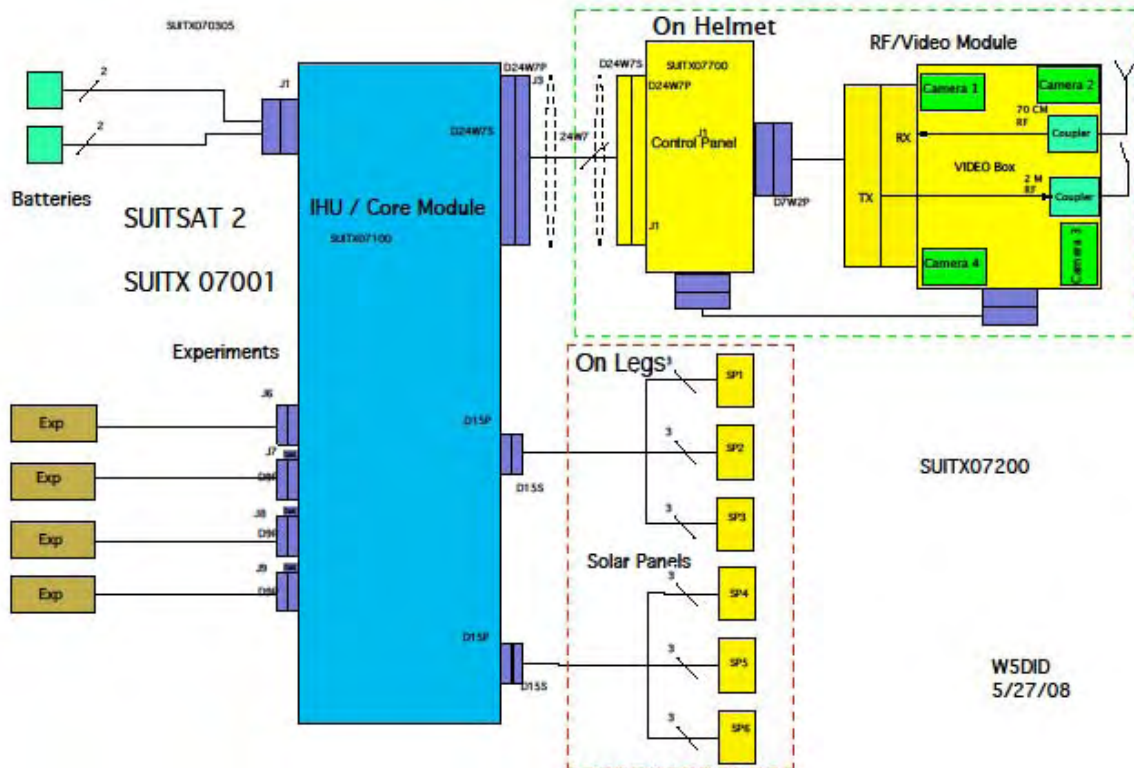


# Solar Panels

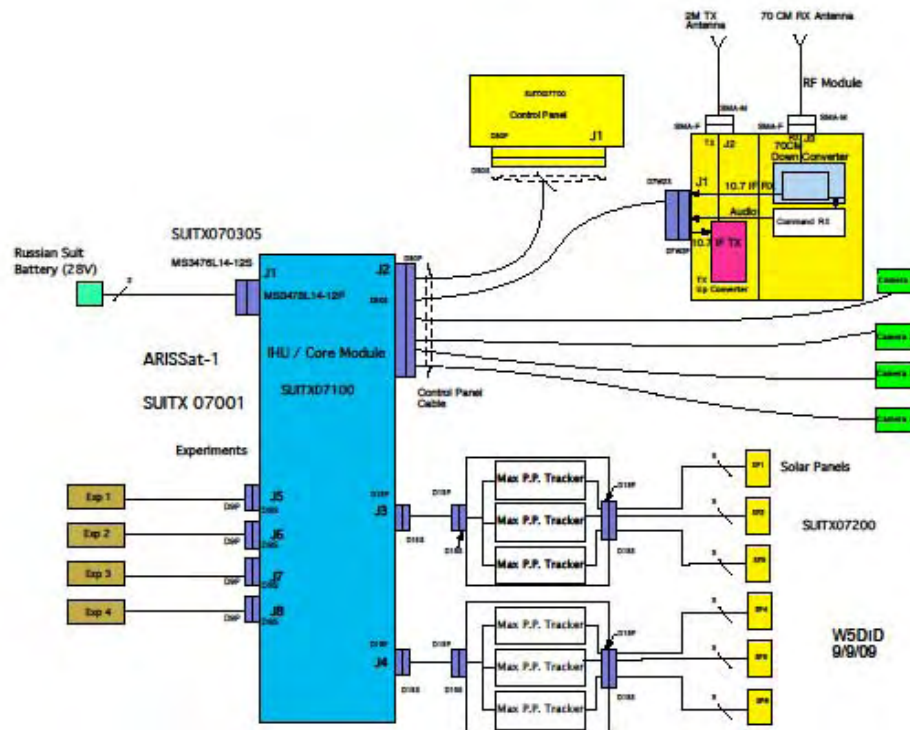
- 6 High efficiency panels
- Panels donated by NASA from SMEX project
- 19" x 10.5"



# SuitSat-2 Cabling

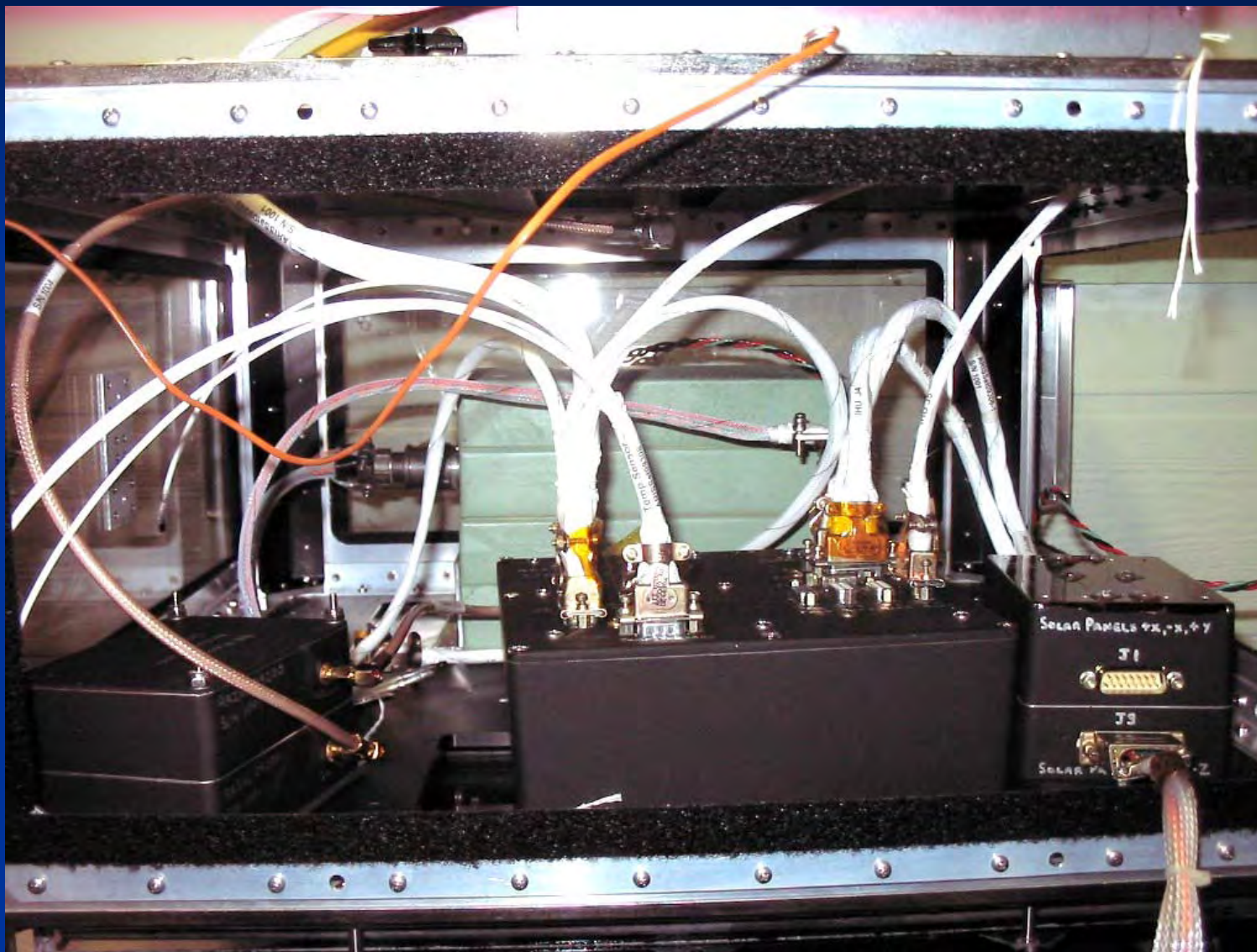


# ARISSat-1 Cabling





# ARISSat-1 Cabling



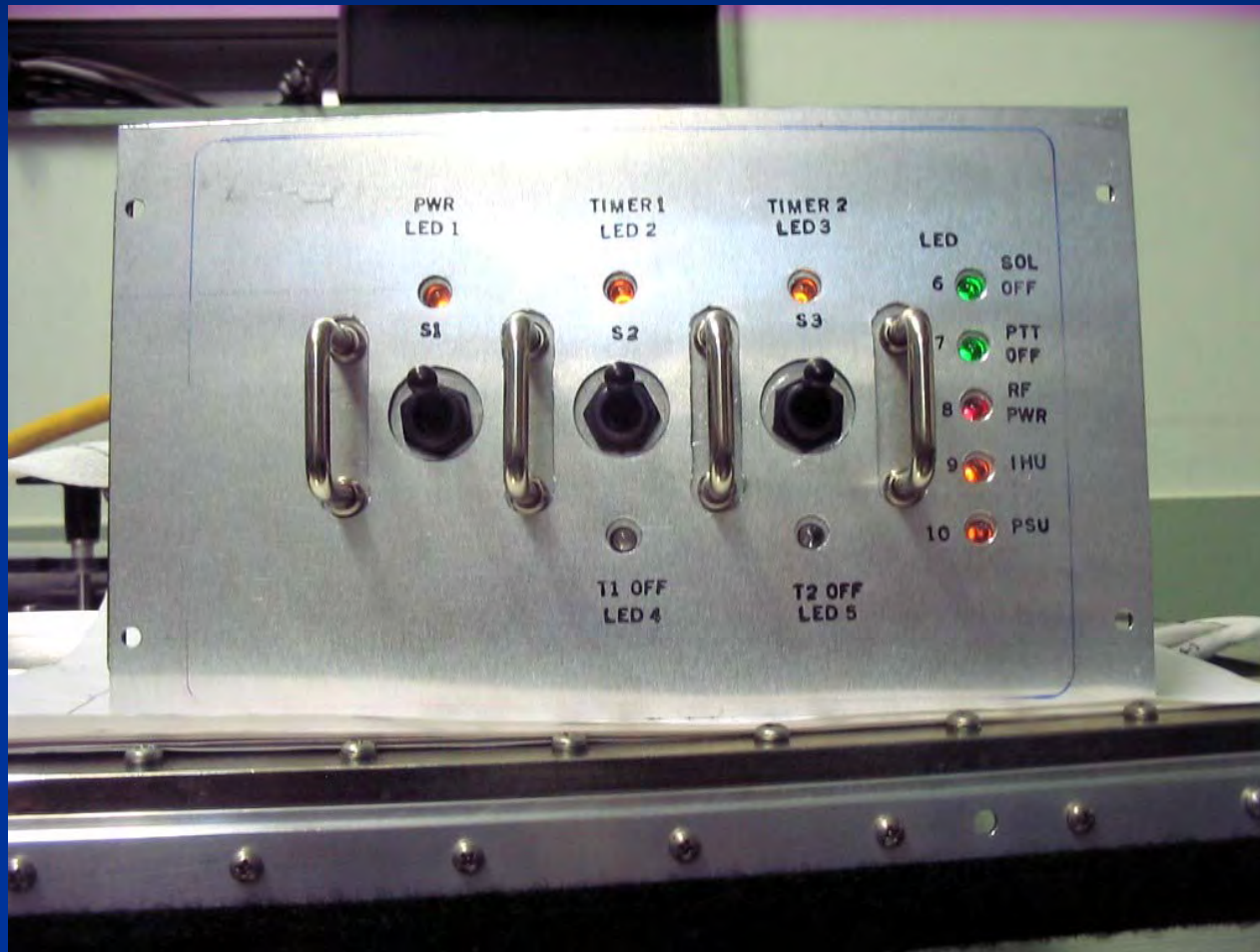
# ARISSat-1 Battery

- 825M3 Orlan Suit Battery
- 18 AgZn cells
- 28 volts
- Designed for 5 recharges



01/2010 16:33

# ARISSat-1 Control Panel



# ARISSat-1 Experiment

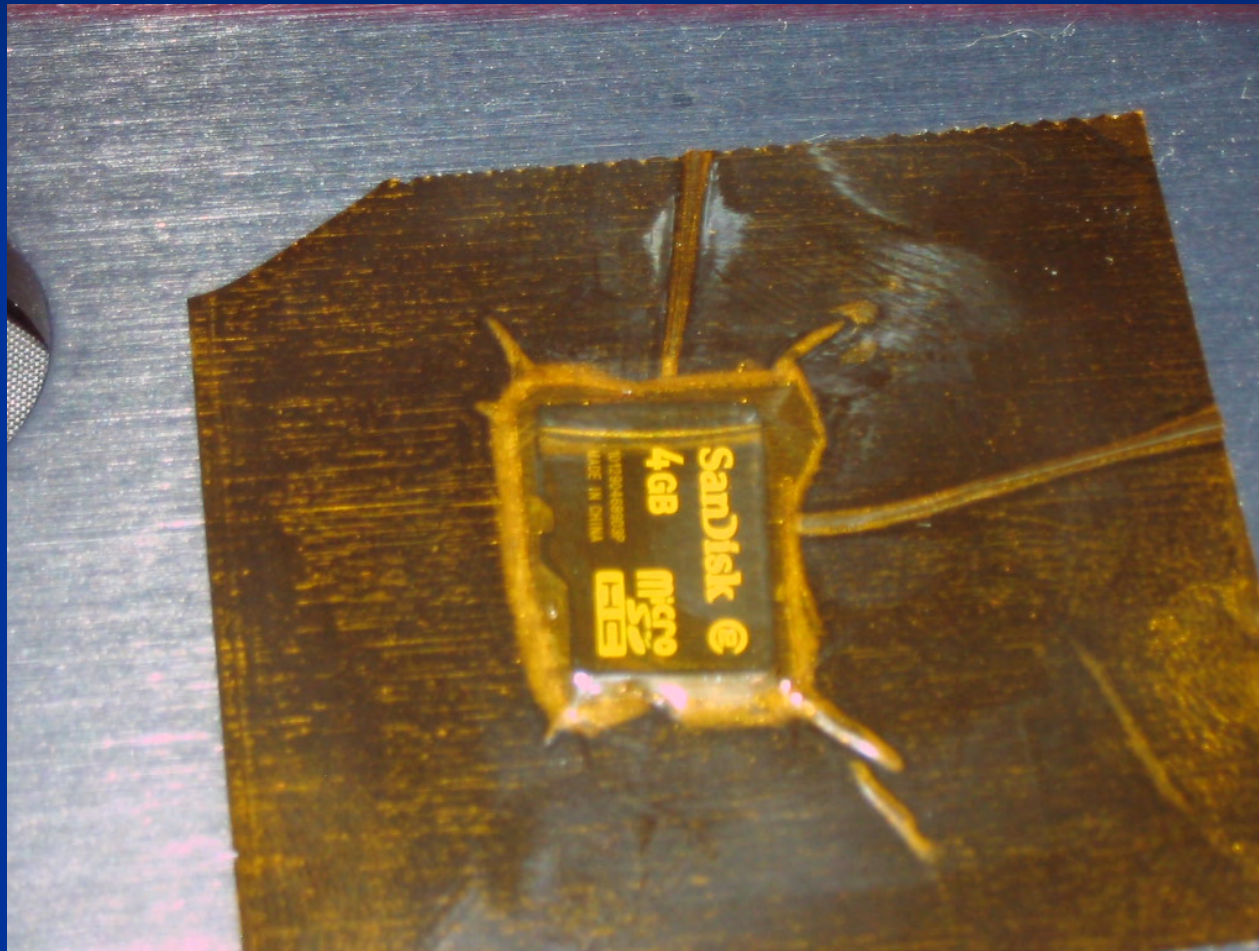
- Experiment sampled once per orbit
- Experiment must run on  $+5V \leq 100ma$
- Experiment powered for 100 min/orbit
- Collect up to 2k of data
- Then 2k of data downloaded to IHU for 2 seconds, then Exp powered down
- Data transmitted in BPSK data stream with Telemetry

# Kursk Experiment

- Kursk State Technical University
- Measures the vacuum at different altitudes



# Submitted Drawings and Docs from around the world

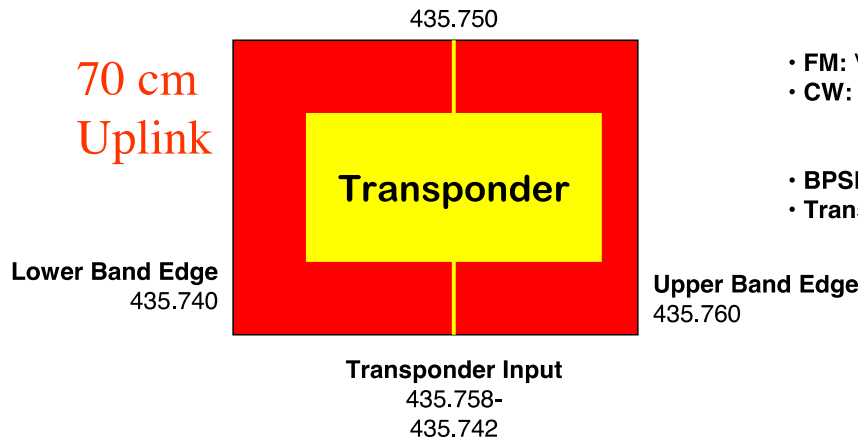
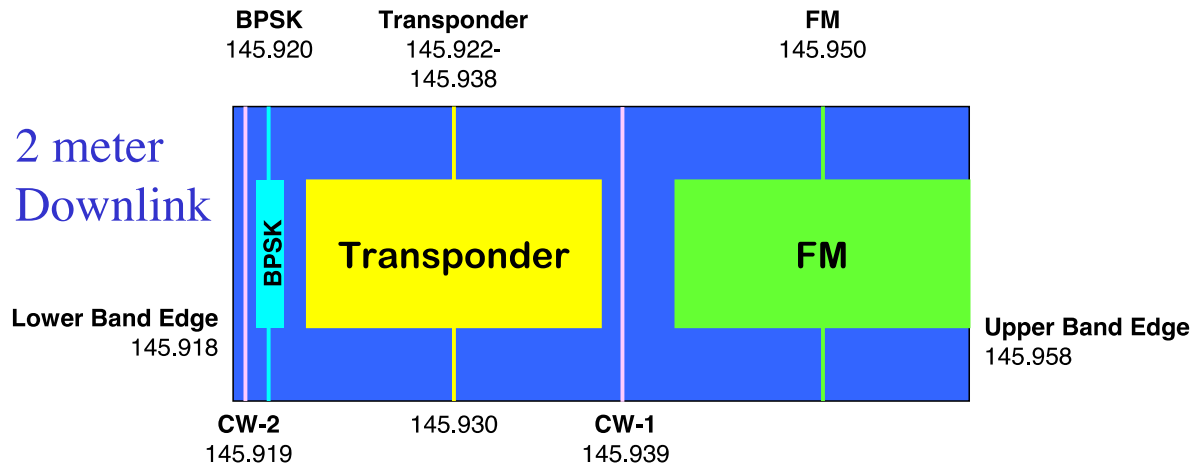


# ARISSat-1 Operation



# ARISSat-1 Band Plan

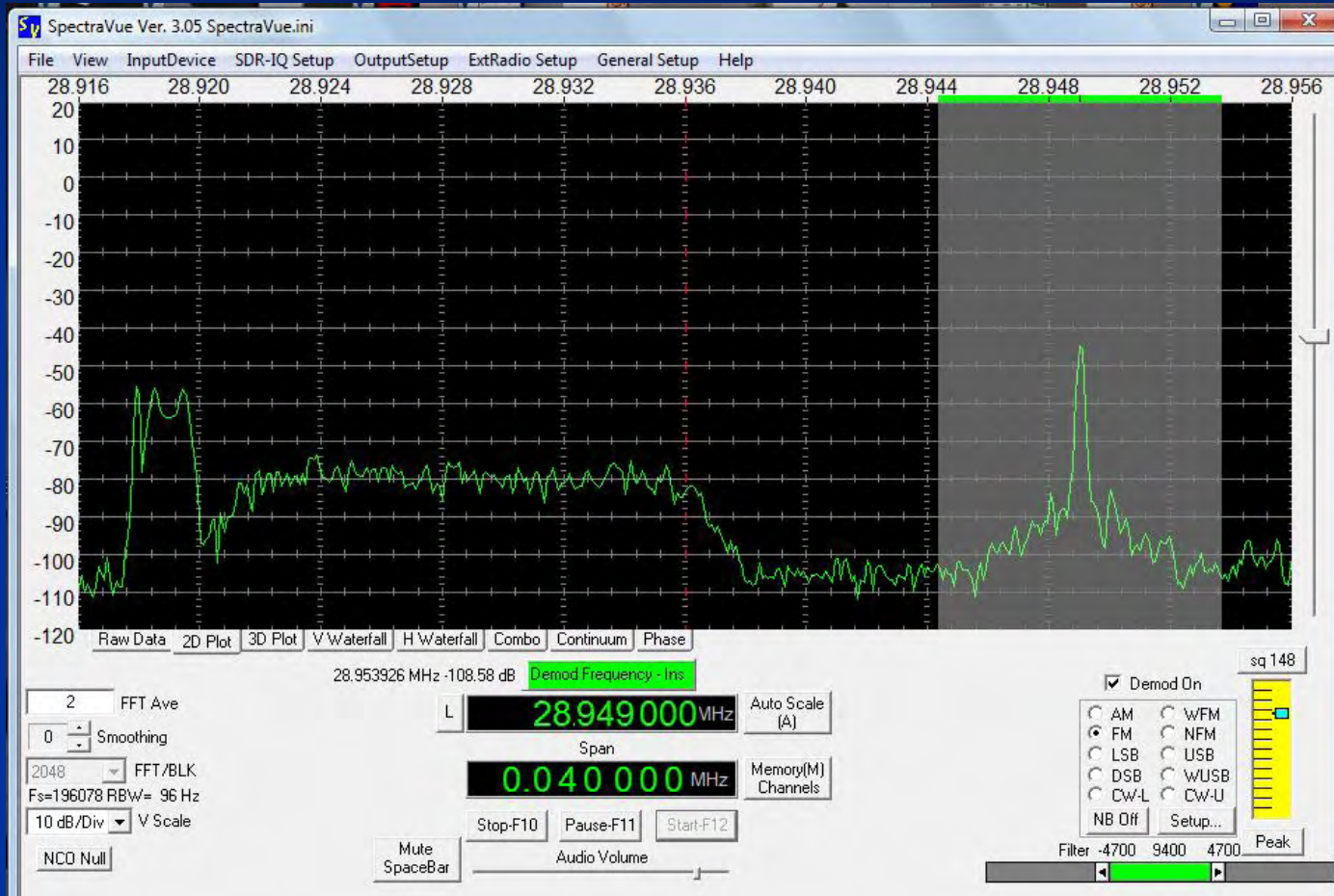
## ARISSat-1 Band Plan



- **FM**: Voice announcements, SSTV, Telemetry.
- **CW**: Morse code beacon
  - CW1 active with BPSK-400
  - CW2 active with BPSK-1000
- **BPSK**: Telemetry, Experiment data
- **Transponder**: linear, inverting
  - $f_{out} = 581.68 \text{ MHz} - f_{in}$



# Live ARISat-1 Signals



CW, BPSK, Transponder, FM (Voice/SSTV)

# ARISSat-1 Signals

- FM on 2m
- CW ID, Telemetry and Callsigns
- BPSK Experiment and Telemetry Data
  - New Phil Karn, KA9Q BPSK-1000 encoding scheme, plus old Phase 3 400 bps BPSK
- 70cm/2m U/V Transponder

# Voice Greetings



- 24 different greetings
- Mainly from children, some adults, and Gagarin

- Secret word 

- 15 different languages

English      Spanish      Russian      French

Italian      Dutch      Swedish      Japanese

Chinese      Catalan      Bengali      Portuguese

Hebrew      Nepalese      German

# ARISSat-1 Telemetry

**ARISSatTLM Version 0.30-DQ**

```

File
ARISSatTLM Ready.
Select File/Open to decode a WAVE
Select File/Start to start the so
The expected size of the regular
DLL test passed.
Starting interprocess communicati
Inbound pipe created. Waiting for
Starting soundcard.

Packet received at 01:24:32. Leng
000: 54 0d 0f 00 00 48 69 2c 20 5
010: 20 41 52 49 53 53 61 74 2d 3
020: 00 00 00 ff 03 ff 03 ff 03 f
030: 03 ff 03 ff 03 c2 01 a1 01 f
040: ff 00 00 00 00 00 00 50 ea a
050: 02 00 00 27 00 b0 ee 7c 3f 1
060: a6 0f 00 00 6c 30 fd 6b be 2
070: e3 39 00 00 f0 31 c3 4a 4b 2
080: 0c 00 00 00 00 00 b0 00 00 0
090: 00 00 00 00 00 00 00 00 00 0
0a0: ff 00 00 00 00 00 00 00 00 0
0b0: 00 00 ff 00 00 00 00 00 00 0
0c0: 00 00 00 00 ff 00 00 00 00 0
0d0: 00 00 00 00 00 00 ff 00 00 0
0e0: 00 00 00 00 00 00 00 00 ff 0
0f0: 00 00 00 00 00 00 00 00 00 0
100: 6d 0c 90 90 c0 f9 4c 4f
  
```

**ARISSatTLM Telemetry As Text**

MET		Battery		Power Consumption		
Mission Elapsed Time (sec)	42574	Batt Voltage	17.764	Instant	Total Flight	
		Batt Current	-0.373	Camera	0.038	33845858
		PSU Vdd	5.034	Experiment	0.100	289373422
		2.5 V Ref	1FC	IHU	0.106	262597688
		Charging Coulombs	0	SDX	0.274	582904829
		Discharging Coulombs	178842192	5 volt	0.488	971239277
		Net Coulombs	-17884219	RF (8v)	0.319	743131843
		Battery is	Discharging			

Status				Temp					
IHU	ON	Camera1	OFF	Experiment	ON	IHU	-112	Top Camera	-112
PSU	---	Camera2	OFF	5 volt	ON	PSU	-112	Bottom Camera	-112
SDX	ON	Camera3	OFF	8 volt	ON	RF	-112	Control Panel	-112
		Camera4	OFF			Batt	-112	Experiment	-112

+X PPT 1		-X PPT 2		+Z PPT 3	
Panel Energy	0	Panel Energy	0	Panel Energy	0
Panel Voltage	0.000	Panel Voltage	0.000	Panel Voltage	0.000
Panel Current	0.000	Panel Current	0.000	Panel Current	0.000
Panel Temp	127.000	Panel Temp	127.000	Panel Temp	127.000
Inductor Temp	127.000	Inductor Temp	127.000	Inductor Temp	127.000
FET Temp	127.000	FET Temp	127.000	FET Temp	127.000
Setpoint	0.000	Setpoint	0.000	Setpoint	0.000
Age	255	Age	255	Age	255
Corrupt Count	0	Corrupt Count	0	Corrupt Count	0

-Y PPT 4		+Y PPT 5		-Z PPT 6	
Panel Energy	0	Panel Energy	0	Panel Energy	0
Panel Voltage	0.000	Panel Voltage	0.000	Panel Voltage	0.000
Panel Current	0.000	Panel Current	0.000	Panel Current	0.000
Panel Temp	127.000	Panel Temp	127.000	Panel Temp	127.000
Inductor Temp	127.000	Inductor Temp	127.000	Inductor Temp	127.000
FET Temp	127.000	FET Temp	127.000	FET Temp	127.000
Setpoint	0.000	Setpoint	0.000	Setpoint	0.000
Age	255	Age	255	Age	255
Corrupt Count	0	Corrupt Count	0	Corrupt Count	0

Show RAW Telemetry Values

# Experiment Data

SuitSat-2 Experiment Data Receive and Decoding

Receive Stop Set Time Save As Open

Transmitted Data Decoded KSTU Experiment Data

HW State

Reserved3  Reserved2  Reserved1  HiVoltage  CVC  ADC  EEPROM  RTC

Signature: KURSĚ

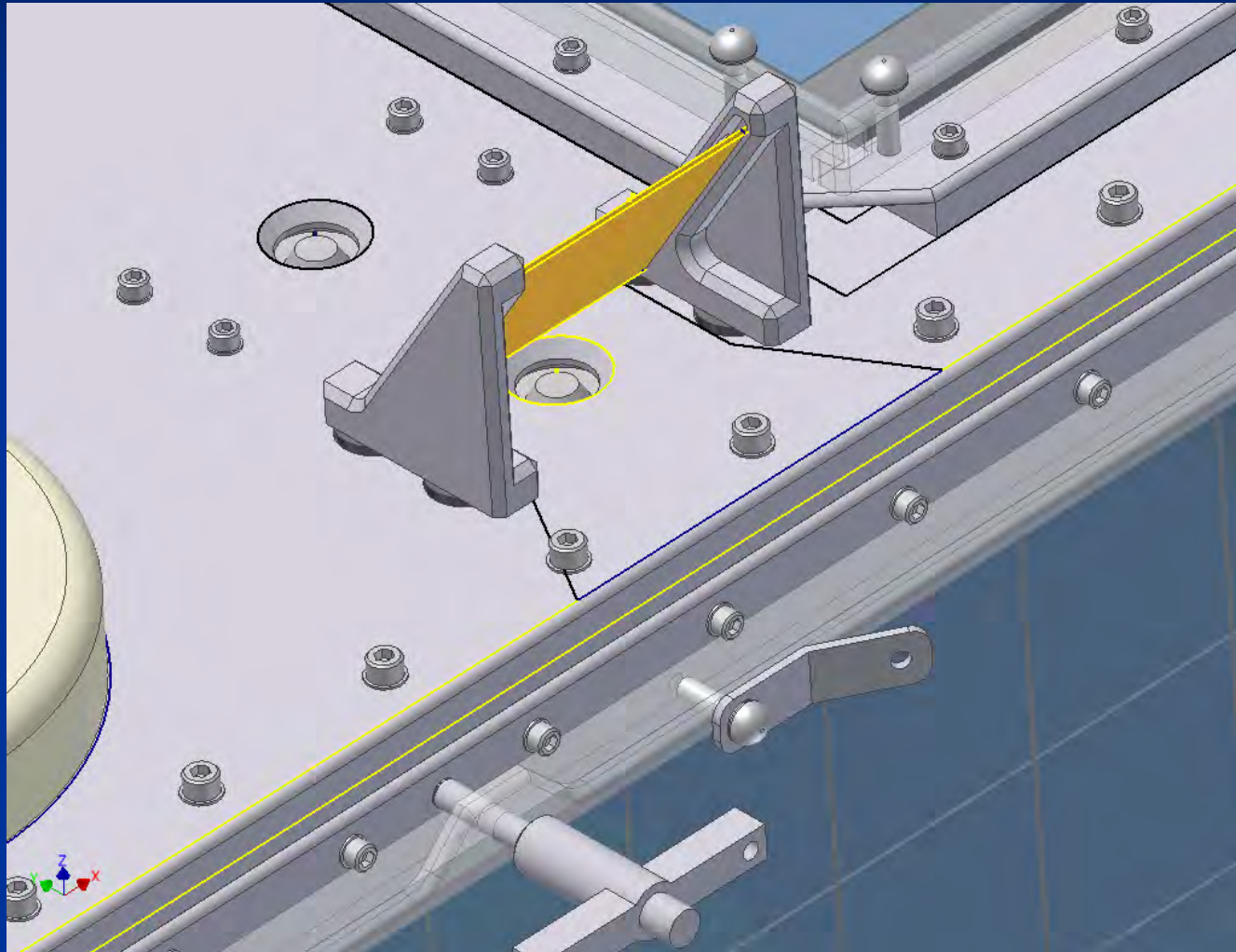
Frame creating Date and Time: 20.03 11:03:46

Check Summa: 6A Okt

	Time	Temperature	CVC coeff.	ADC gain	ADC value	Current, mA	Pressure, Pa
1	09:18:07	21	2	5	41325	4.93E-4	3,25E-5
2	09:18:27	21	2	5	41326	4.93E-4	3,25E-5
3	09:18:47	21	2	5	41368	4.93E-4	3,26E-5
4	09:19:07	21	2	5	41335	4.93E-4	3,25E-5
5	09:19:27	21	2	5	41338	4.93E-4	3,25E-5
6	09:19:47	21	2	5	41358	4.93E-4	3,26E-5
7	09:20:07	21	2	5	41340	4.93E-4	3,25E-5
8	09:20:27	21	2	5	41333	4.93E-4	3,25E-5
9	09:20:47	21	2	5	41343	4.93E-4	3,25E-5
10	09:21:07	21	2	5	41346	4.93E-4	3,25E-5
11	09:21:27	21	2	5	41329	4.93E-4	3,25E-5
12	09:21:47	21	2	5	41348	4.93E-4	3,26E-5

Loaded 2048 byte(s)

# ARISSat-1 Mirrors

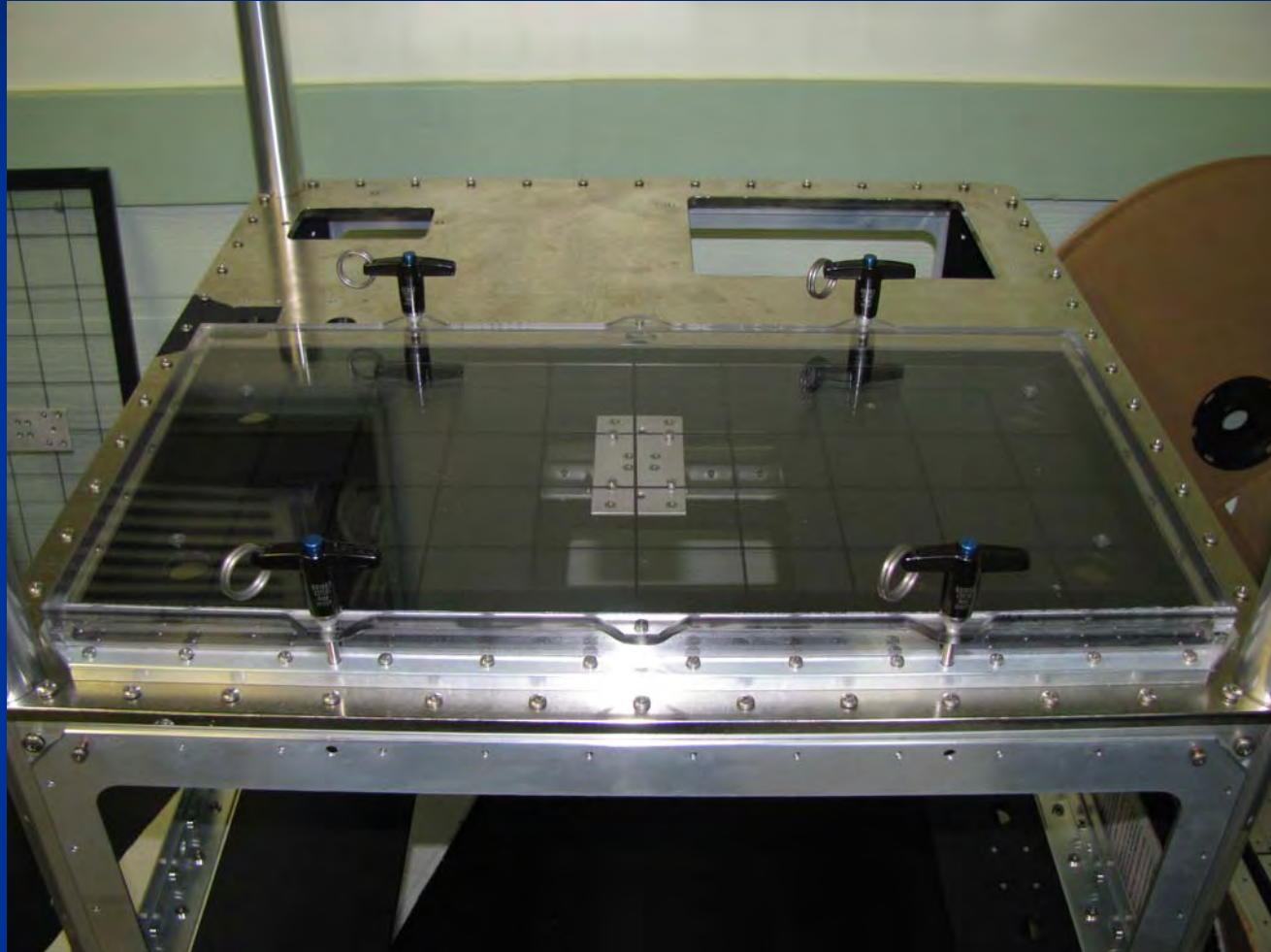


# ARISSat-1 Video Image



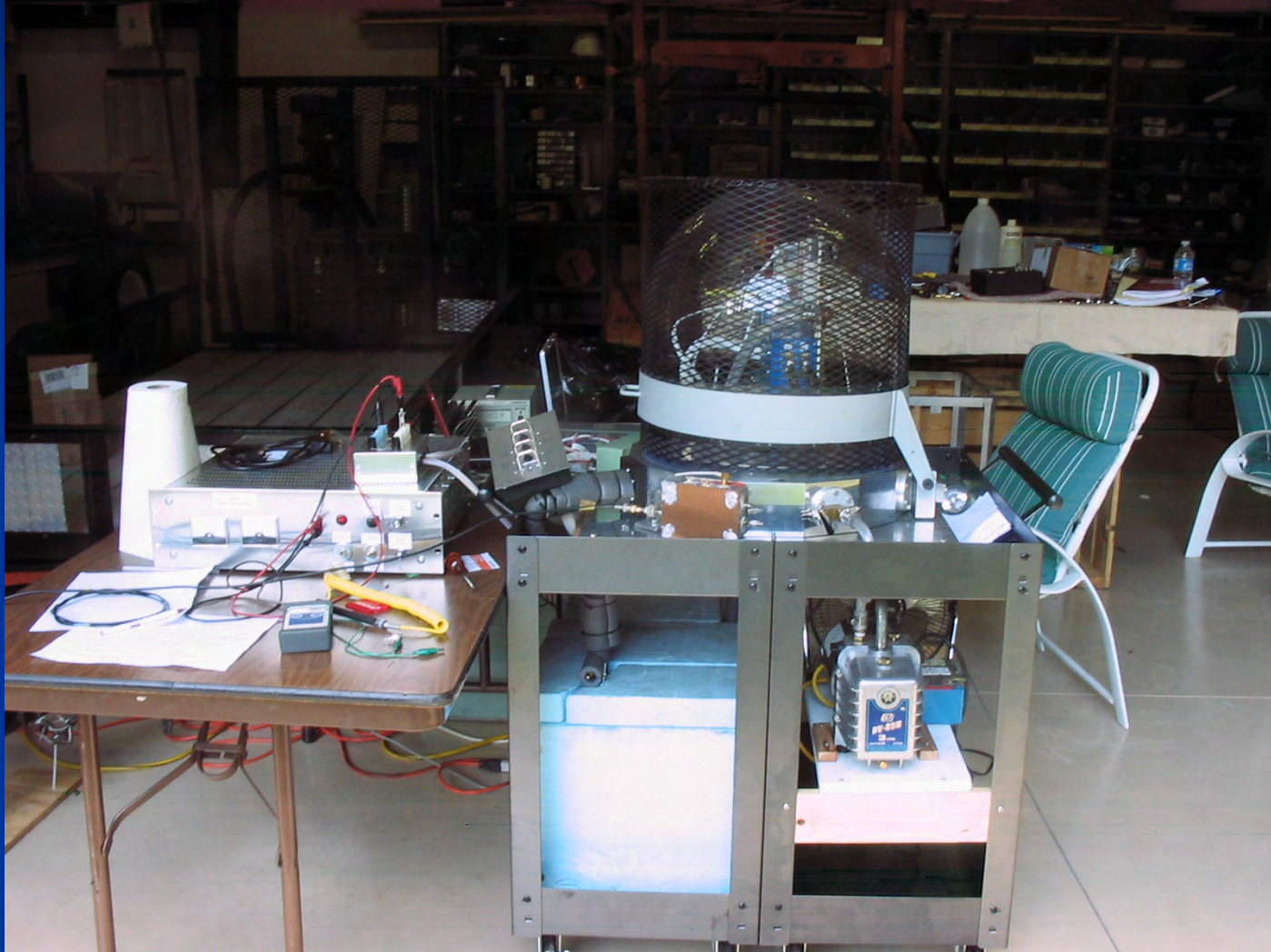
Actual Robot-36 SSTV image transmitted from the ARISSat-1 using the +Y mirror

# ARISSat-1 Solar Panel Covers





# ARISSat-1 Thermal/Vacuum



# ARISSat-1 NASA Safety Review

ARISSat-1 FSDP Rev. -

PHASE III  
SAFETY DATA PACKAGE  
FOR THE  
INTERNATIONAL SPACE STATION (ISS) HAM RADIO  
ARISSat-1

Prepared by:

Orbital / Technical Services Division  
Greenbelt, Maryland

Contract NNG07CA21C

PREPARED FOR:

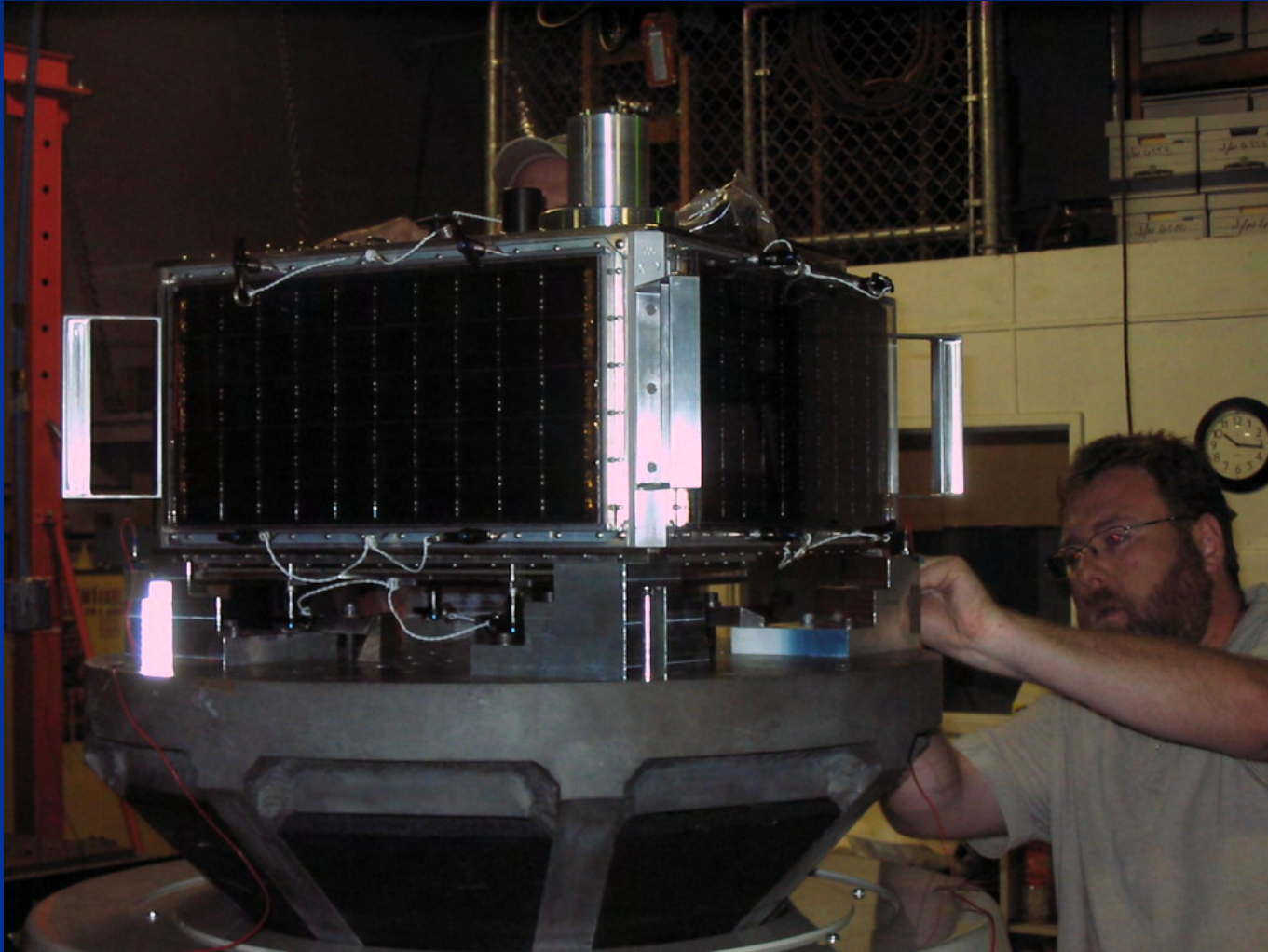
THE MISSION ENGINEERING AND SYSTEMS ANALYSIS DIVISION (CODE 590)  
APPLIED ENGINEERING AND TECHNOLOGY DIRECTORATE

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION  
GODDARD SPACE FLIGHT CENTER

GREENBELT, MARYLAND

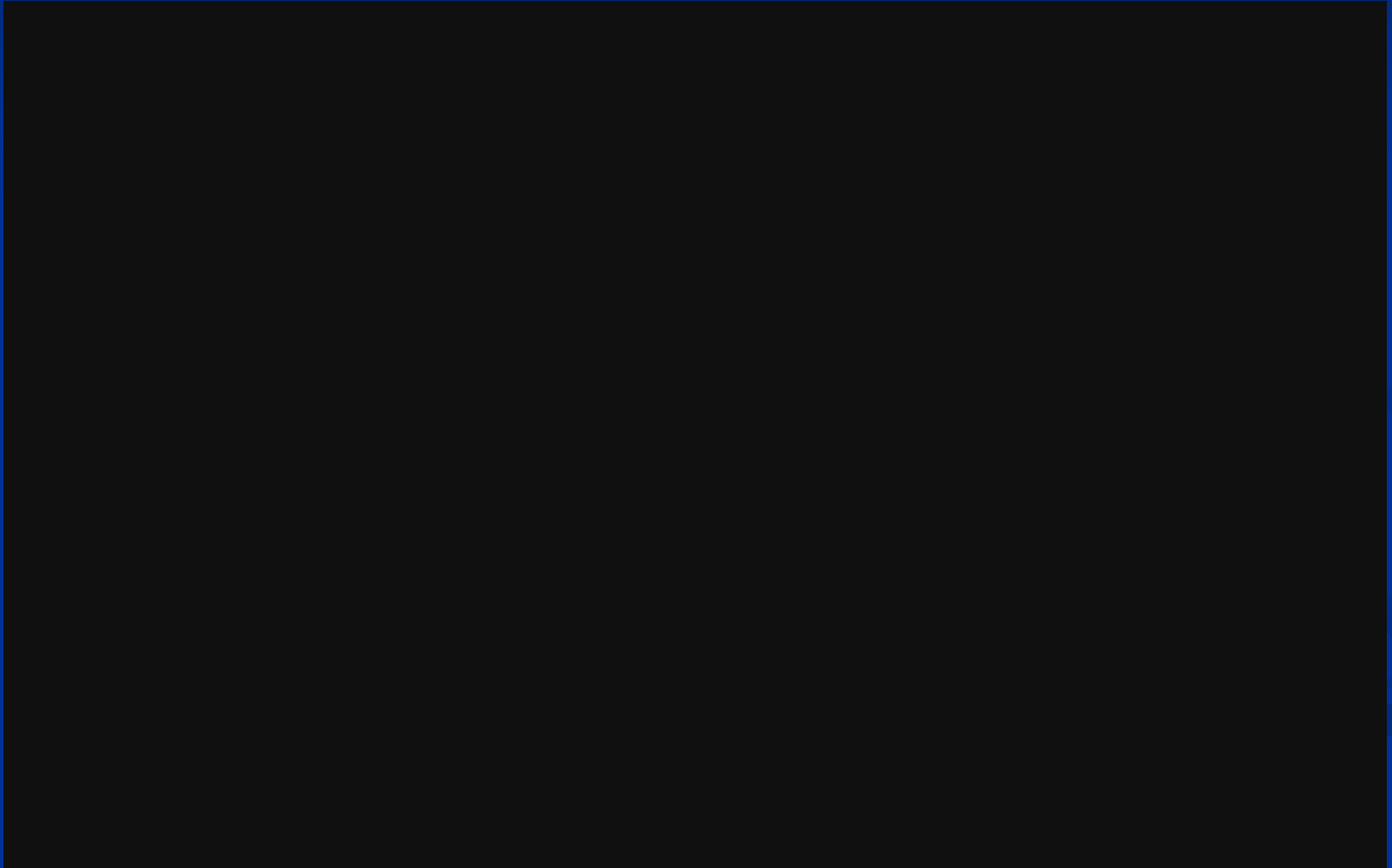
May 2010

# ARISSat-1/RadioSkaf V vibration testing



# ARISSat-1/RadioSkaf V

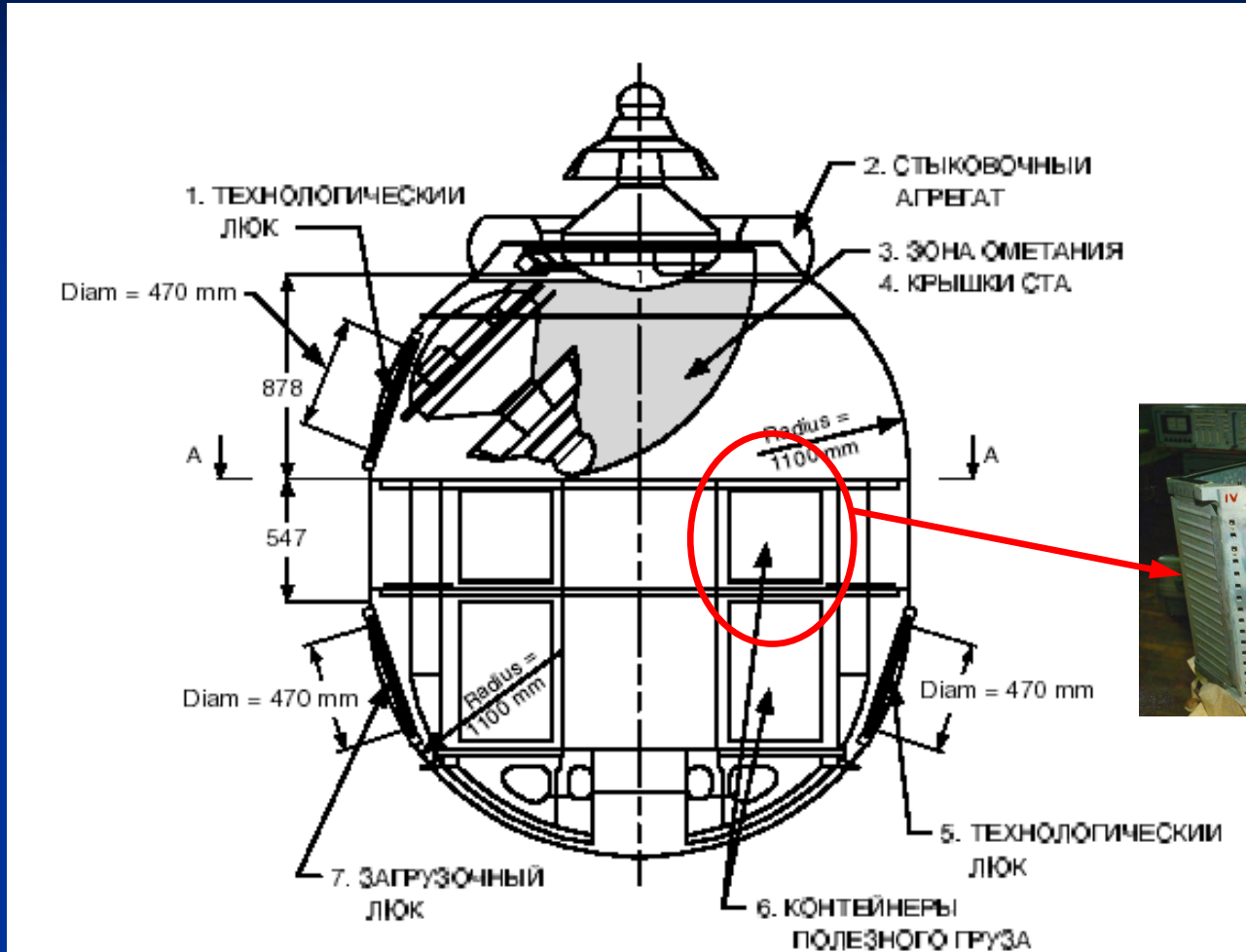
## Underwater testing



# Preparation for the ride to ISS



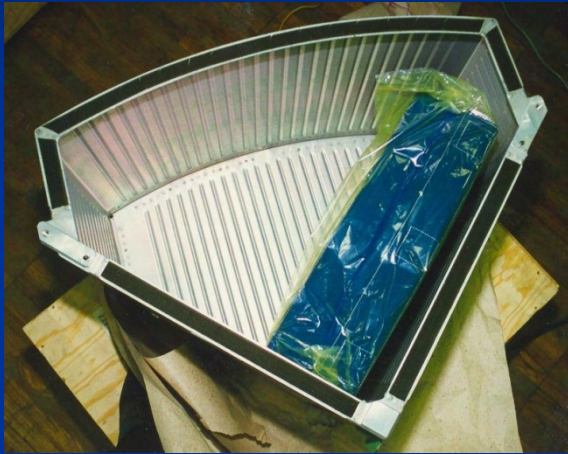
# ■Progress Vehicles for ISS Cargo



## ■Progress Cargo Module (Side View)

# ■ Progress Vehicles for ISS Cargo

## ■ Progress Stowage Planning



# ■ Progress Vehicles for ISS Cargo

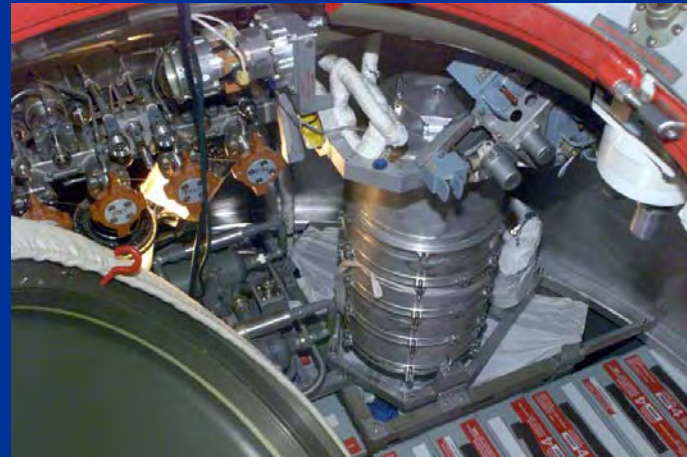
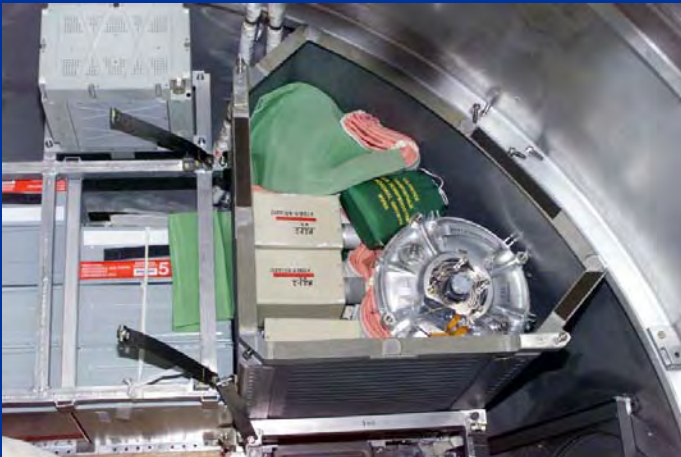
## ■ Progress Stowage for Flight





# ■ Progress Vehicles for ISS Cargo

## ■ Progress Stowage for Flight



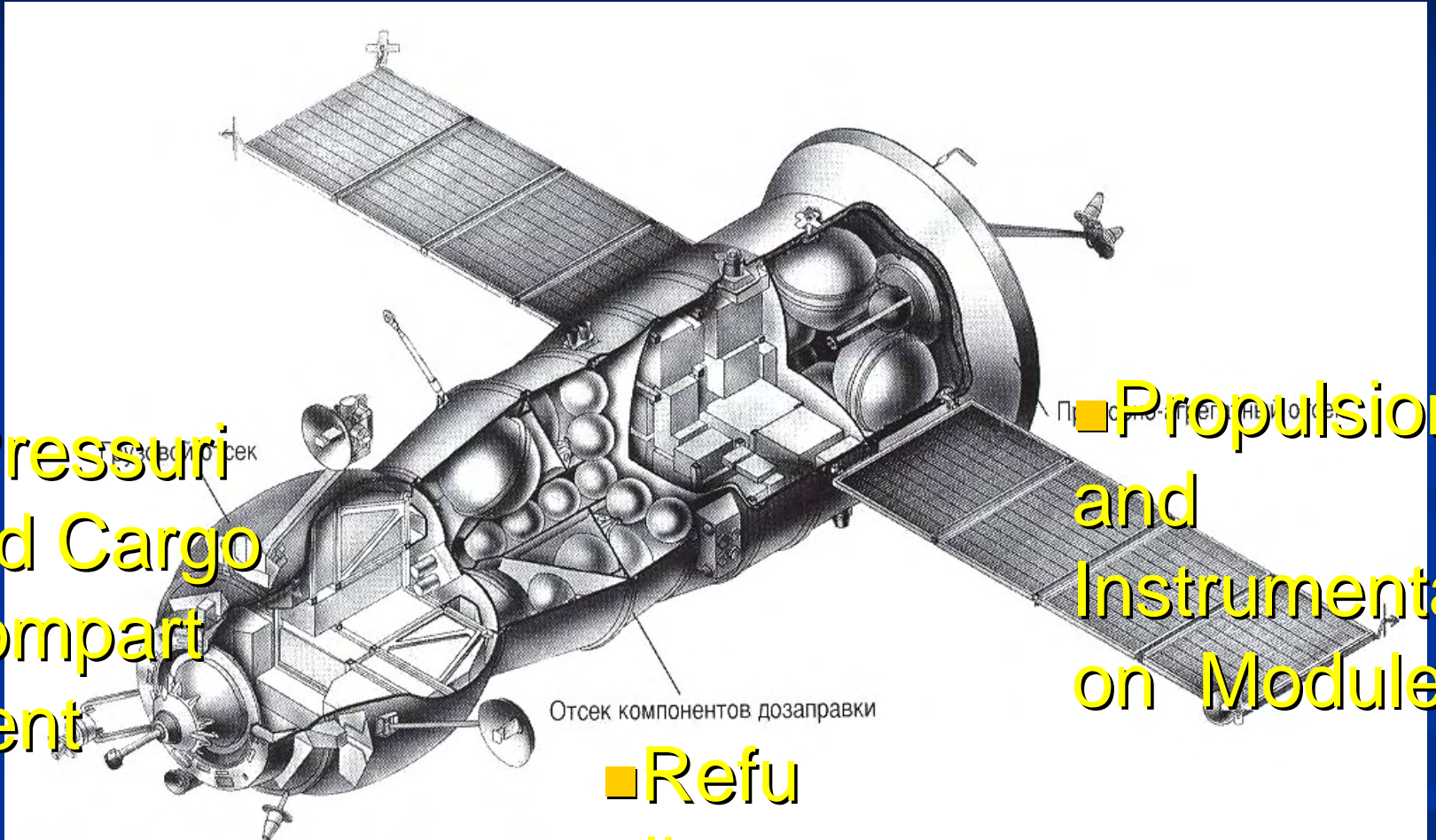
# ■ Progress Vehicles for ISS Cargo

■ Pressurized Cargo Compartment

■ Propulsion and Instrumentation Module

■ Refueling

■ Progress M / M1 Module



# Installation into Progress Vehicle



**ARISSat-1/RadioSkaf V  
traveled to the ISS on Russian Progress  
vessel 41P on 28 January 2011**



# ARISSat-1 Onboard ISS



# **ARISSat-1/RadioSkaf V**

## **“Amateur Radio Experiment”**

**Deployed 3 August 2011**

**Russian Battery failed within a week**  
**Currently operating in Backup mode**  
**without the battery.**

# **ARISSat-1/RadioSkaf V**

## **“Amateur Radio Experiment”**

# **Questions?**