ARISS 10 Years as a Team and 6 Years in Space!

AMSAT Symposium
October 8, *2006*

Frank H. Bauer, ka3hdo@amsat.org

Amateur Radio on the International Space Station (ARISS)

What is ARISS?

- International program that inspires students, worldwide, to pursue careers in science, engineering and mathematics through communication with the ISS on-orbit crew via amateur radio
- Local community drawn into this once-in-a-lifetime human spaceflight pursuit
- Provides an experiment platform for new telecommunications techniques
- Promotes interest in the amateur radio (ham radio) hobby as a link to better engage students in science and math

ARISS development, operations and student mentoring is performed almost exclusively by a world-wide network of amateur radio volunteers who are passionately committed to the above objectives

ARISS Beginnings
Houston Meeting, November 1996

Ten Years Later—Our Accomplishments

- 1st human spaceflight freq plan for 2 m & 70 cm
- Installed Ericsson 2 m radio system for voice & packet in the FGB less than two weeks after first crew arrival
  - Making ARISS the first payload on ISS
- Developed and mounted 4 multi-functional antenna systems by 3 EVAs on the periphery of the Russian service module; supports 2 m, 70 cm, L band, S Band, HF and GPS reception
- Installed UHF/VHF Kenwood D-700E in Service Module, near the dinner table and window
- Successful completion of over 255 international schools—kudos to the operations team and volunteer mentors on a job well done!
- 14 consecutive ISS expedition crews used our radio system to conduct thousands of QSOs with hams on the ground
- Over 15,000 students touched each year
- Millions, worldwide have heard an ARISS connection
- Witnessing students, worldwide, become scientists and engineers as a direct result of the ARISS connection
- The first Spacesuit satellite—SuitSat-1/Radioskaf deployed from ISS.

On-Orbit Capabilities

VHF 2-way Voice in the FGB (Zarya) Module

Slow Scan TV (Picture uplink and downlink)

VHF and UHF Voice in Service Module (Zvezda)

Capabilities (Continued)

Computer-to-Computer Radio Links (IM-Type Radio Links)

Amateur Radio E-mail from Mike Foale after Progress collision with Mir Spektr Module

To : ALL
From : R0MIR
Subject: Mir Status

We have now got the base block, the module Kvant 2 back on line, leaving 2 more modules. Working very hard, lights in our mouths, in the dark, moving batteries about, to enable better charging, with solar arrays. O2 electrolysis soon, in old Kvant. Much interest from control center to do internal eva to reconnect power to lost Spkektr module, to receive its substantial electrical power from its large arrays.

Thanks for all your good wishes. Mike.

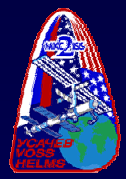
Student experimentation through deployed satellites and on-board equipment

PCSAT-2
Built by Naval Academy Students

ARISS--13 ISS Expeditions Completed

Nearly 6 Years continuous ARISS operations

Nov 2000 – Mar 2001



Mar 2001 – Aug 2001

Aug 2001 – Dec 2001

Dec 2001 – June 2002

June 2002 – Nov 2002

Nov 2002 – Mar 2003

Apr 2003 – Oct 2003

Oct 2003 – Apr 2004

Apr 2004 – Oct 2004

Oct 2004 – Apr 2005

Apr 2005 – Oct 2005

Oct 2005 – Apr 2006

Apr 2006 – Oct 2006

Oct 2006 – Present

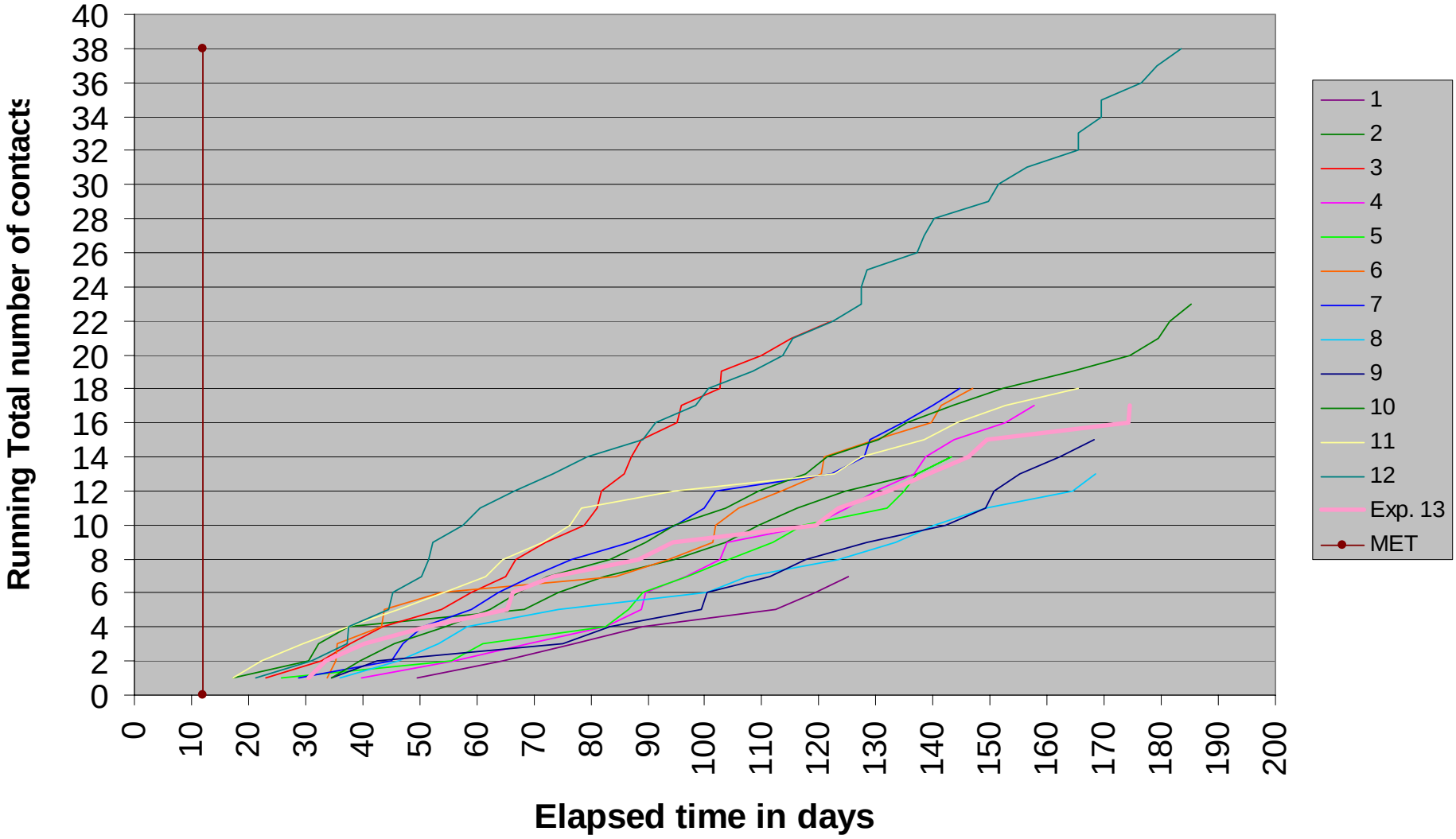
ARISS School Contact Summary

ISS Expedition	School Contacts
1	7
2	14
3	22
4	17
5	14
6	18
7	18
8	13
9	15
10	23
11	18
12	38
13	17
Total Contacts	**234**

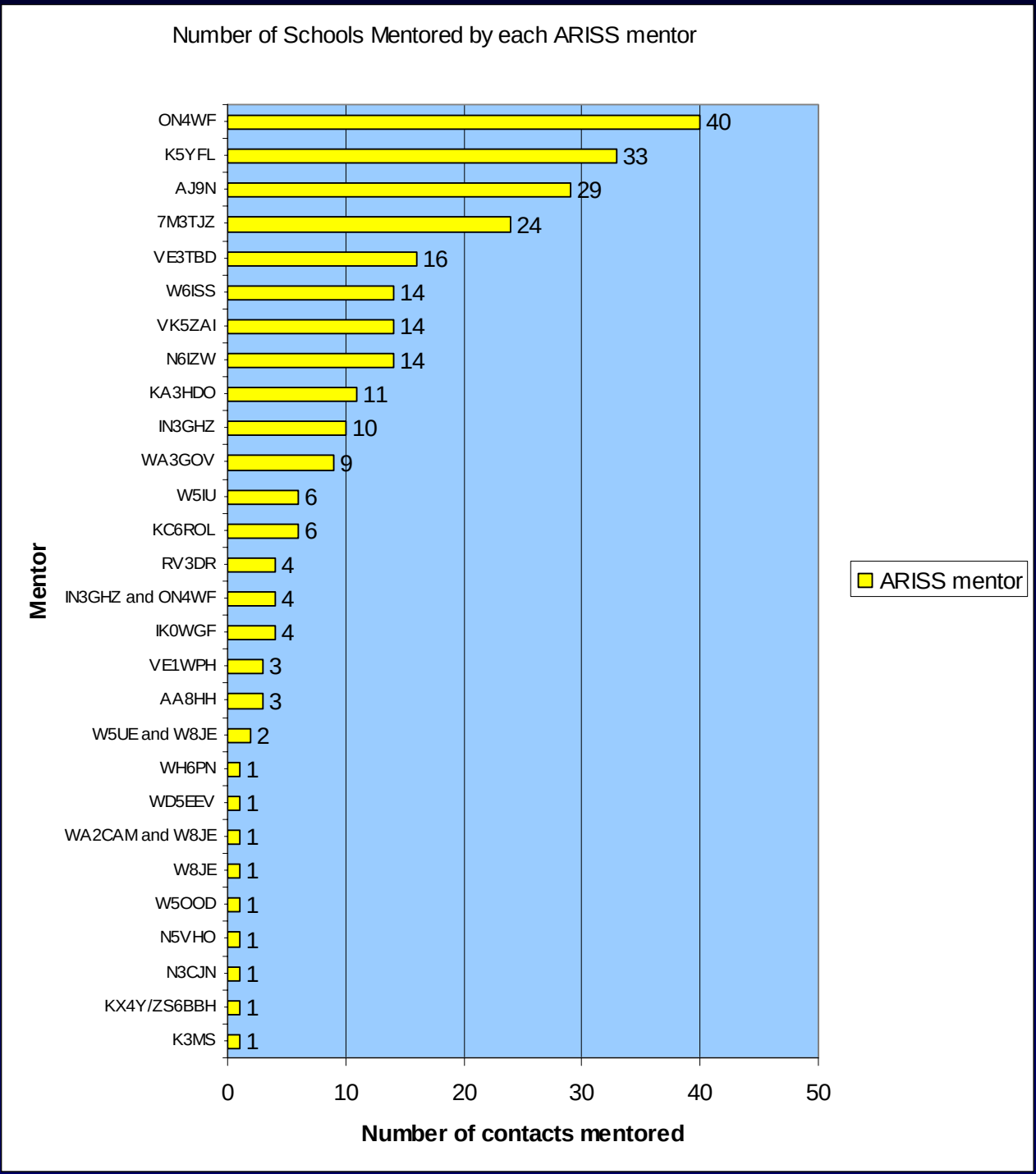
Additional Contacts Supported	Schools
Shuttleworth	4
De Winne	2
TMA3/TMA2 Duque	2
Barbara Morgan #121	1
Soyuz TMA4/TMA3 Kuipers	2
Soyuz TMA 5/4 Shargin	2
Soyuz TMA 6/5 Vittori	3
Soyuz TMA 7/6 Olsen	3
Soyuz TMA 8/7 Pontes	1
Ansari	1
Total Contacts	**21**

255 International Schools!!
Over 15,000 participate per year
Millions witness events each year
ARISS in Space Station 3D IMAX

Running contact total versus mission elapsed time (MET) per expedition

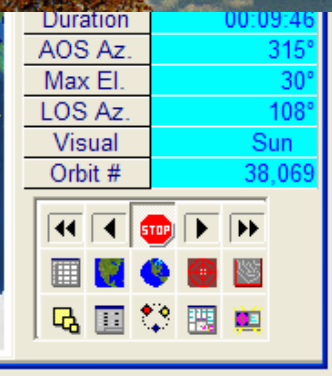


Courtesy: Charlie Sufana, AJ9N

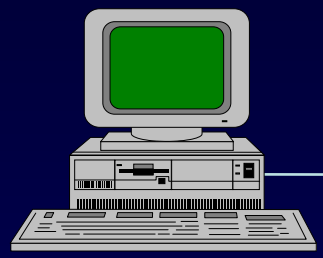


Courtesy: Charlie Sufana, AJ9N

School Radio Station



DIRECT CONTACT INSTALLATION



PC WITH ORBIT PREDICTION PROGRAM AND TRACKING INTERFACE

ROTOR CONTROL UNIT

CIR. POL. YAGI

AZ/EL ROTOR

AC POWER

12 V POWER SUPPLY

2 METER TRANSCEIVER

2 METER AMPLIFIER 80-170 W

ANTENNA PREAMP

PRIME STATION

UPS

12 V POWER SUPPLY

2 METER TRANSCEIVER

2 METER AMPLIFIER 80-170 W

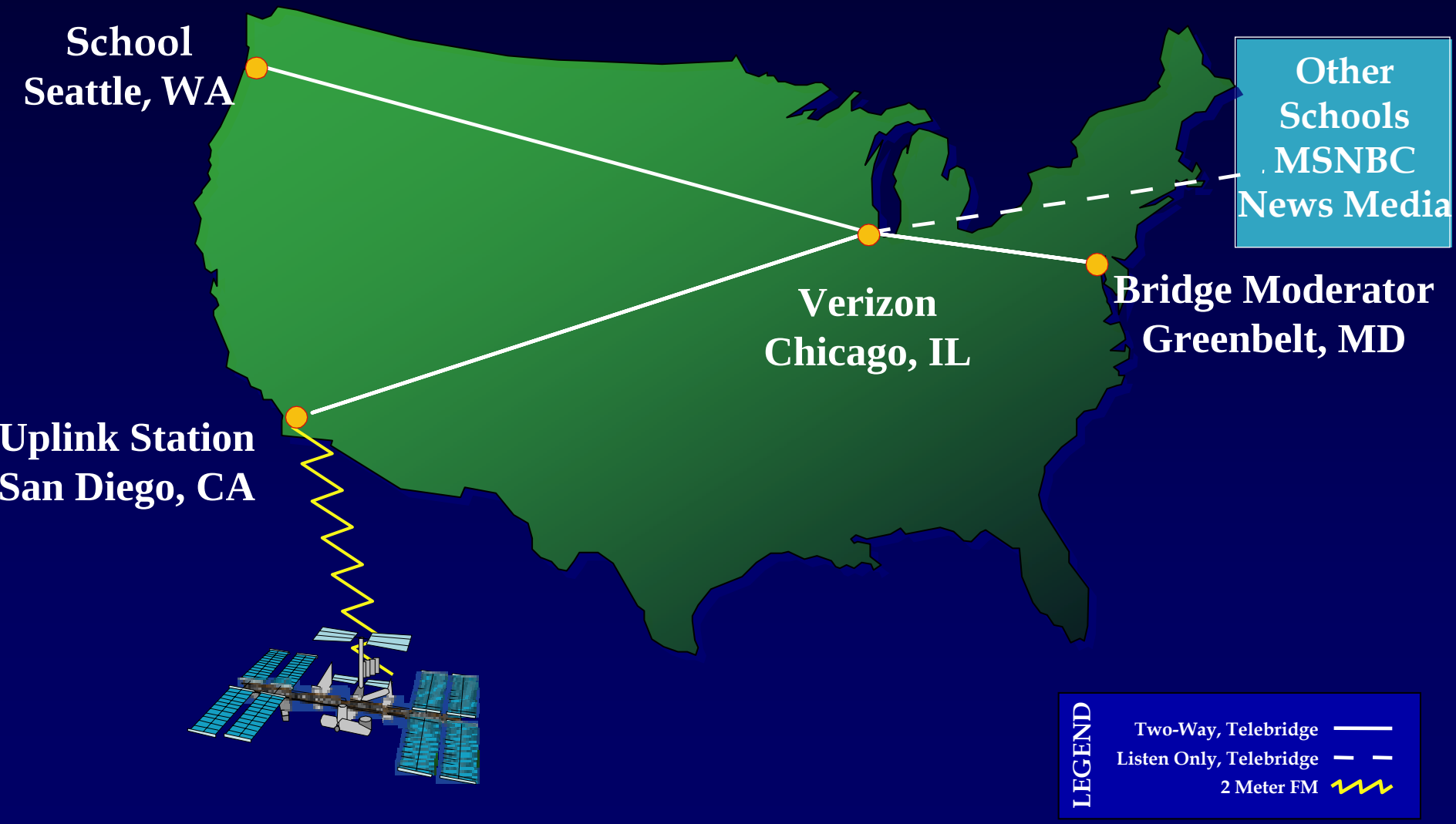
COAX

2 METER VERTICAL

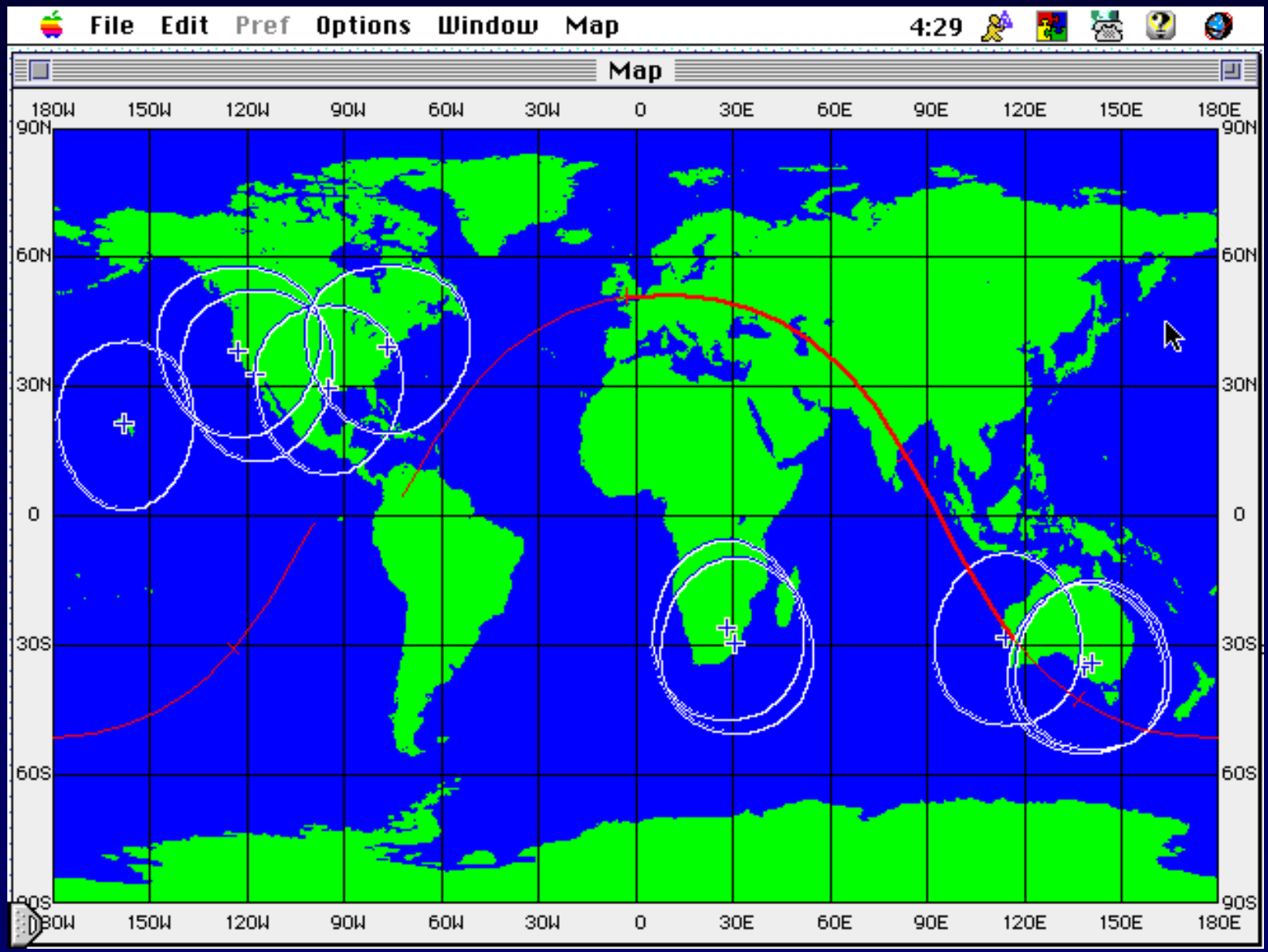
BACKUP STATION

ROOF TOP

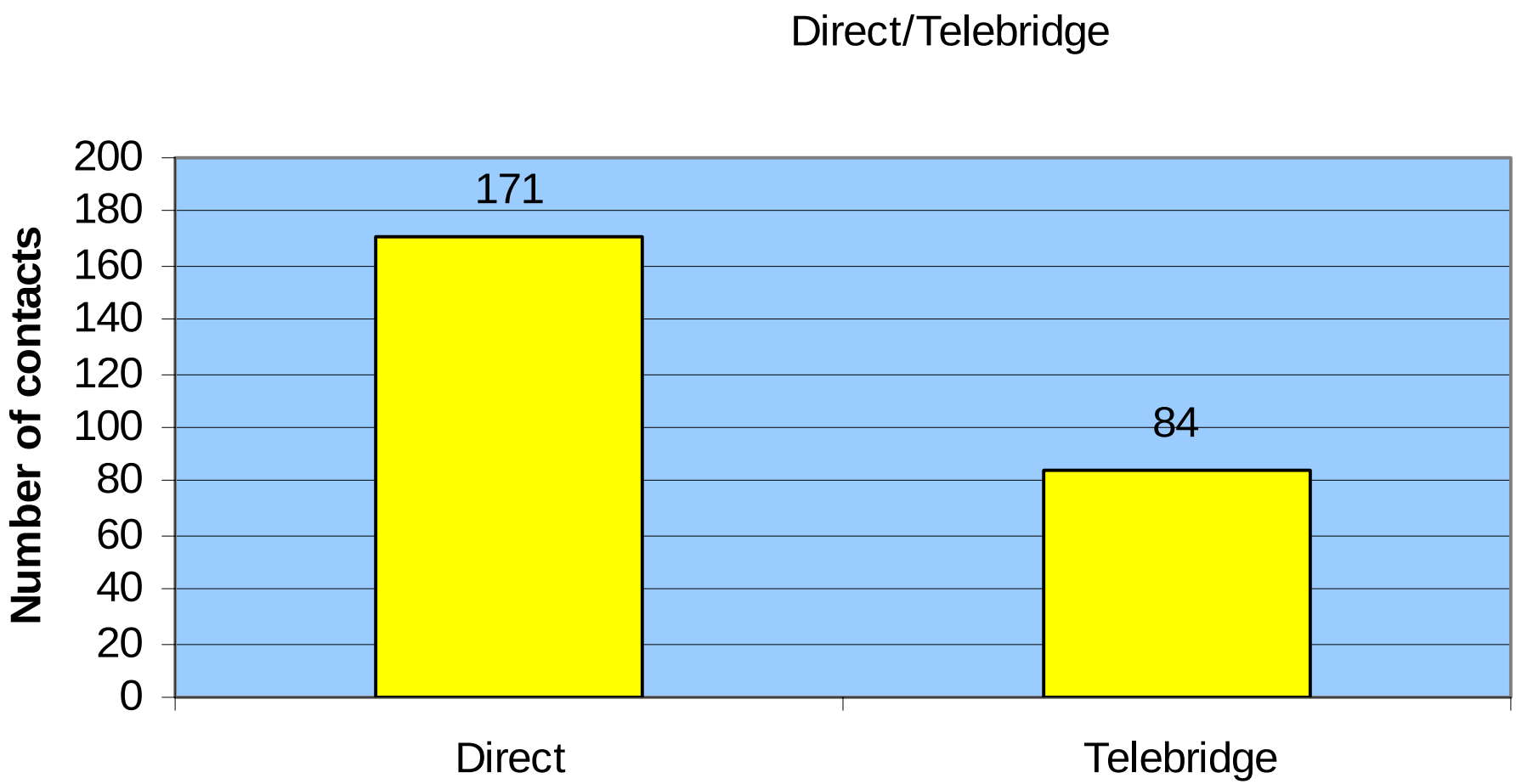
Telebridge Communications Links



Telebridge Network



ARISS Preparation Pyramid

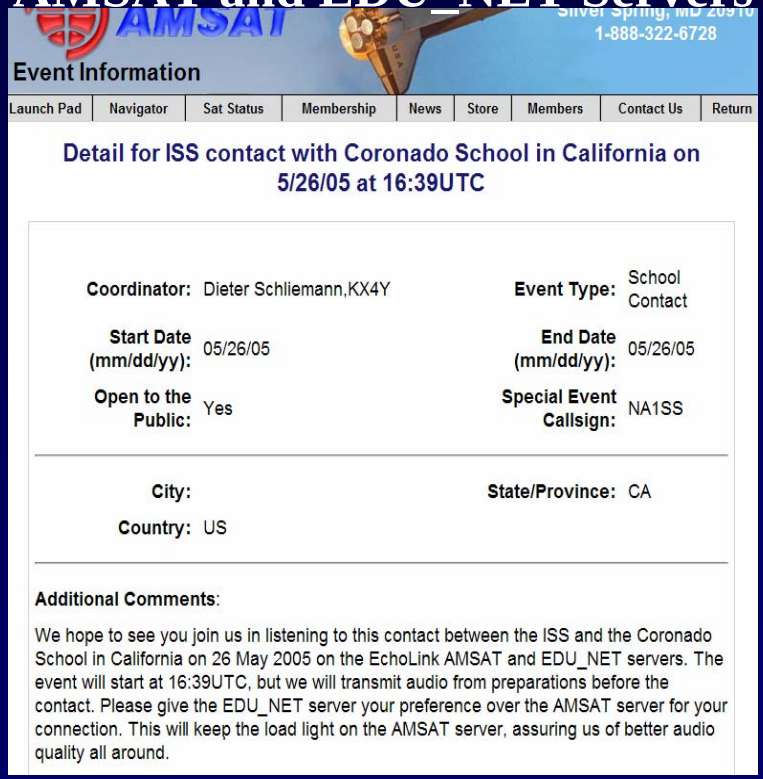


Courtesy: Charlie Sufana, AJ9N

Voice Over Internet Protocol (VOIP)

IRLP, Echolink and Internet Streaming Provides a Wider Reach to Schools and Ham Radio Operators

Echolink
AMSAT and EDU_NET Servers



www.amsat.org
Calendar of Events

IRLP
9010 "Discovery" Reflector

www.discoveryreflector.ca

Expedition 12 Highlights

The Best Increment Ever for Ham Radio

- Inspired students at 37 schools
- Over 1800 general QSOs made
- 130 DXCC entities contacted (approximately 94 U.N. recognized countries). ARRL has confirmed 52.
- Earned ISS Honorary Awards
  - Worked All States
  - Worked All Continents on UHF
  - Worked All Continents on VHF
  - DXCC
- SuitSat-1
  - Assembled and deployed SuitSat-1.

Bill McArthur, KC5ACR

Most active ham aboard ISS

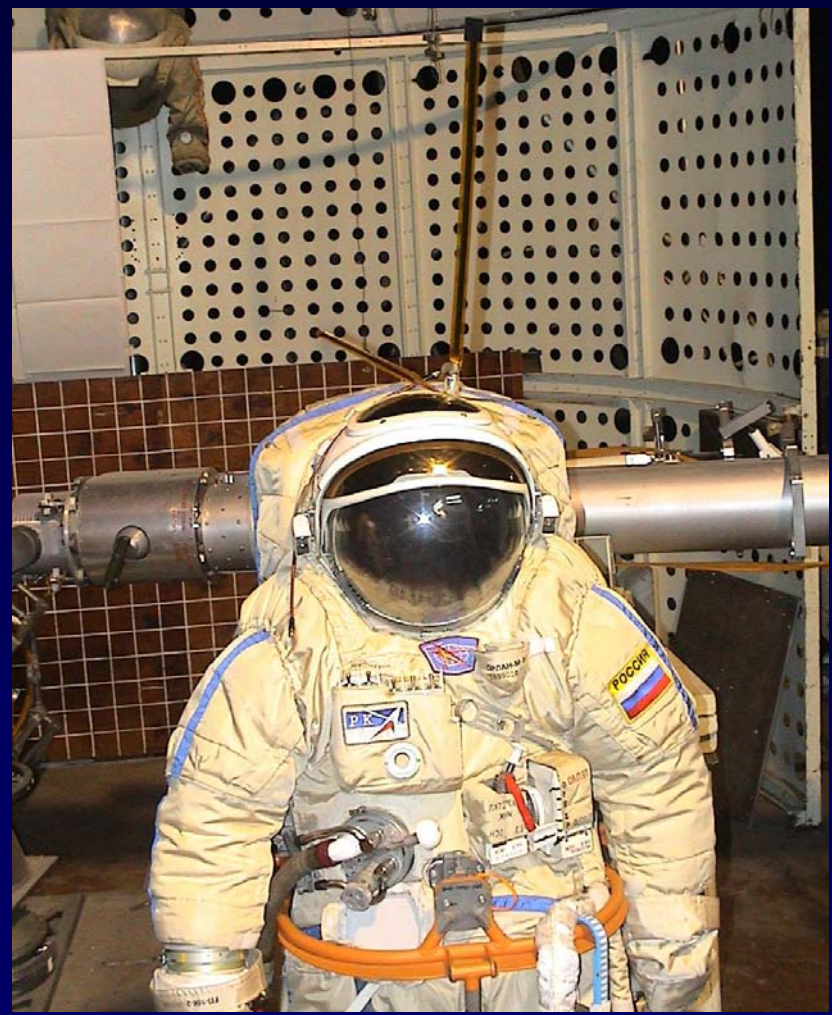
Anousheh Ansari

QSL Card

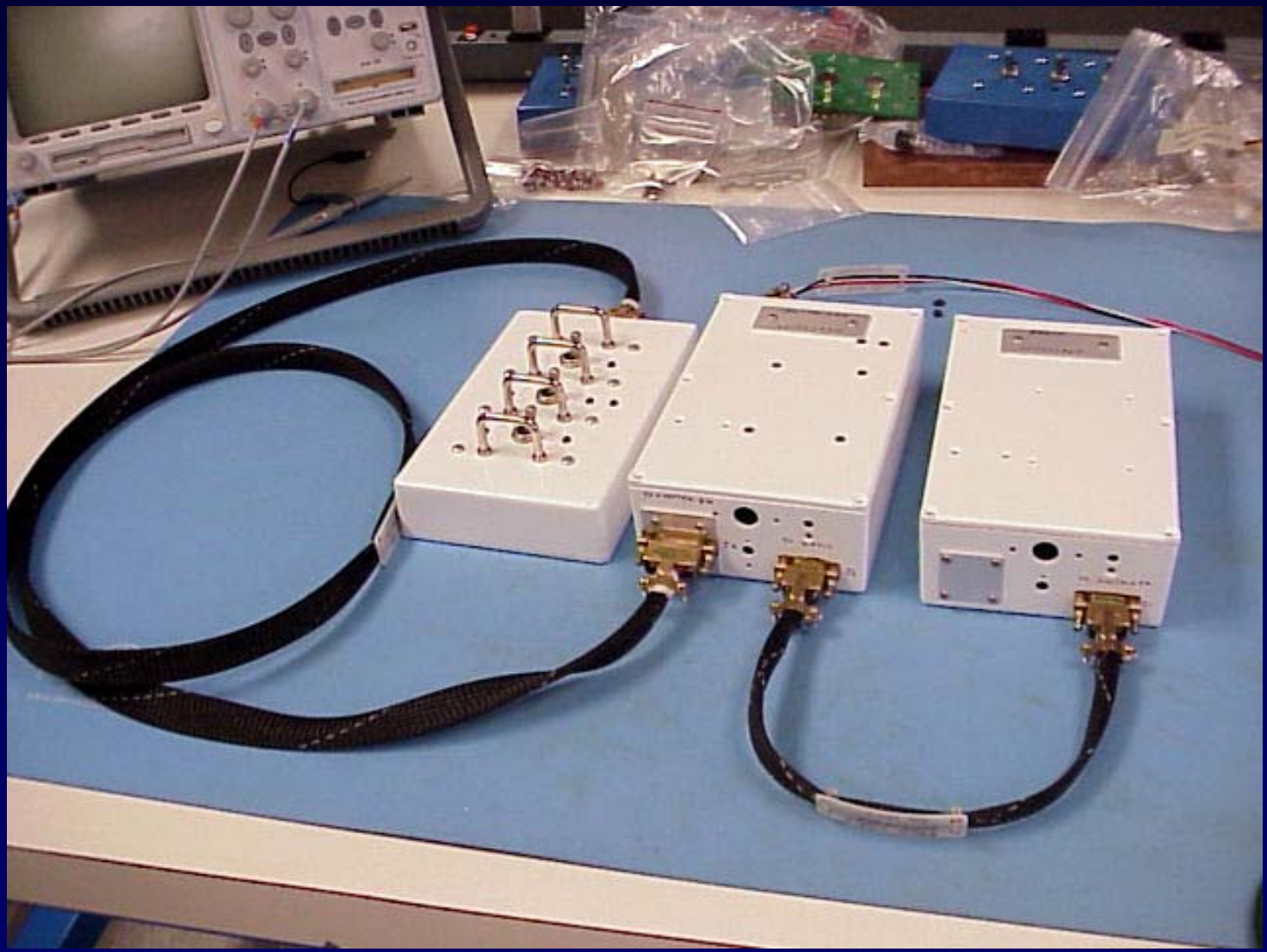

AMATEUR RADIO ON INTERNATIONAL SPACE STATION
AR
ISS
NA1SS
RSØISS

SuitSat-1--Amateur Radio Extra Vehicular Activity (EVA) In a Space Suit

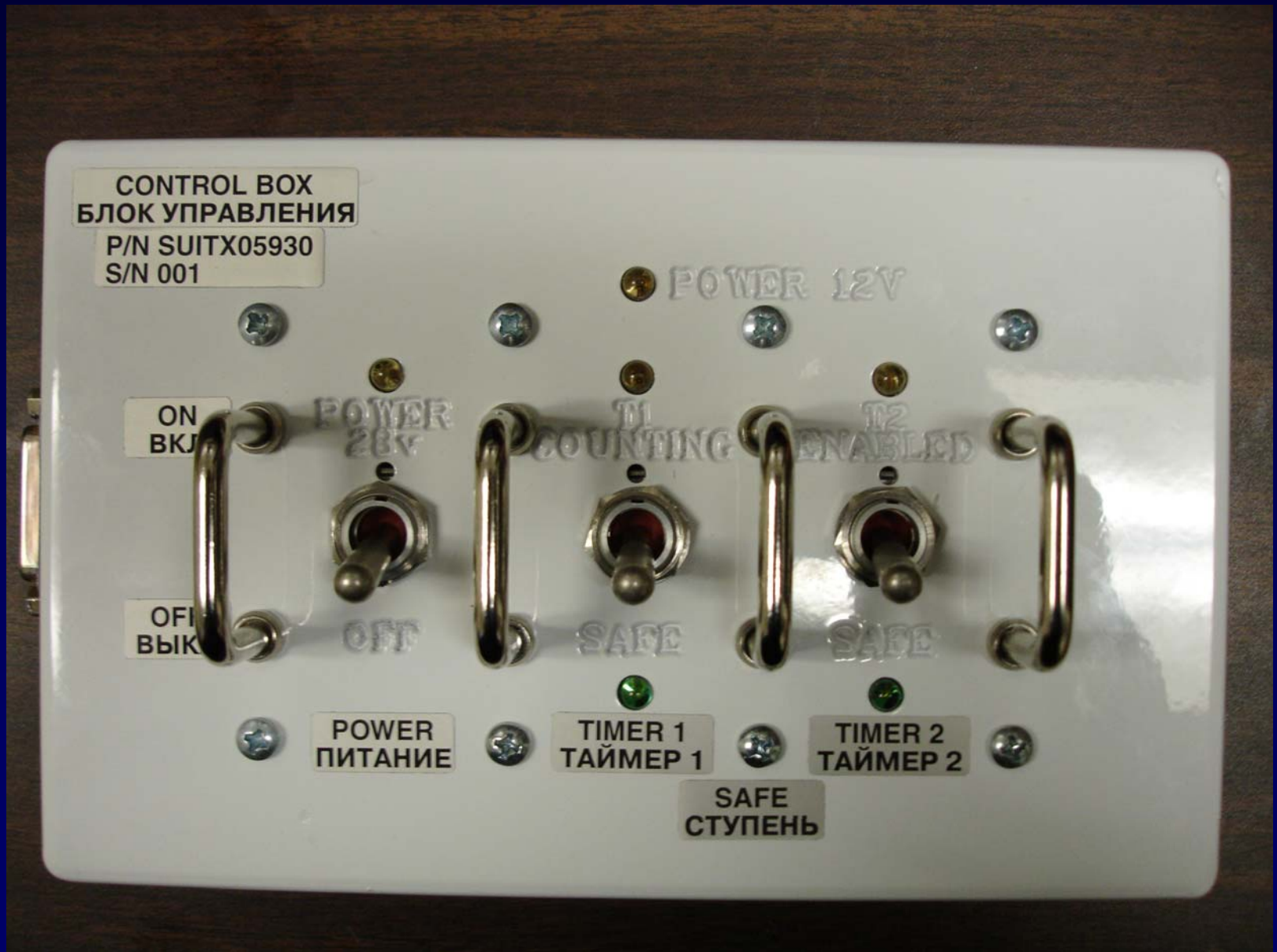
- 2-week battery-operated satellite station
- Capabilities:
  - International Student Message Downlink
  - SSTV Picture
  - Telemetry
  - School Spacewalk—DVD with school name, artwork and student names included
- Deployment: Feb 3, 2006
- Re-entry: Sept 7, 2006



Suitsat Flight Hardware System



Suitsat Control Box

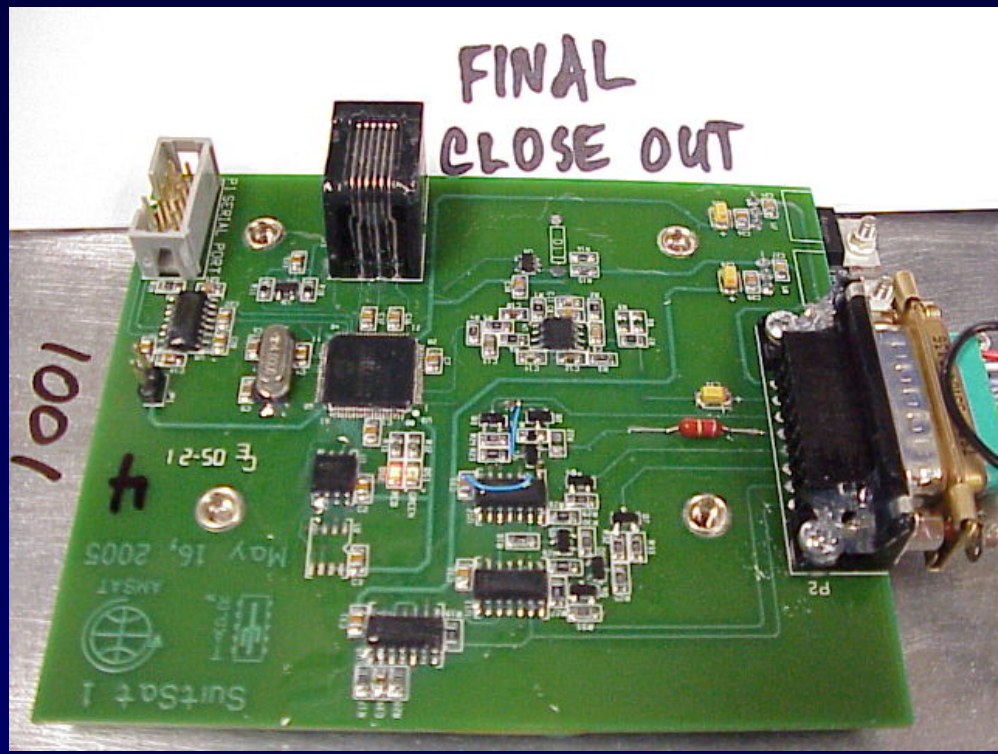


Radio Box


RADIO BOX
БЛОК РАДИОСТАНЦИИ
P/N SUITX05920
S/N 1002


KENWOOD
TH-K2 FM TRANSCEIVER
REV
MENU
VFO
MR
CALL
ENT

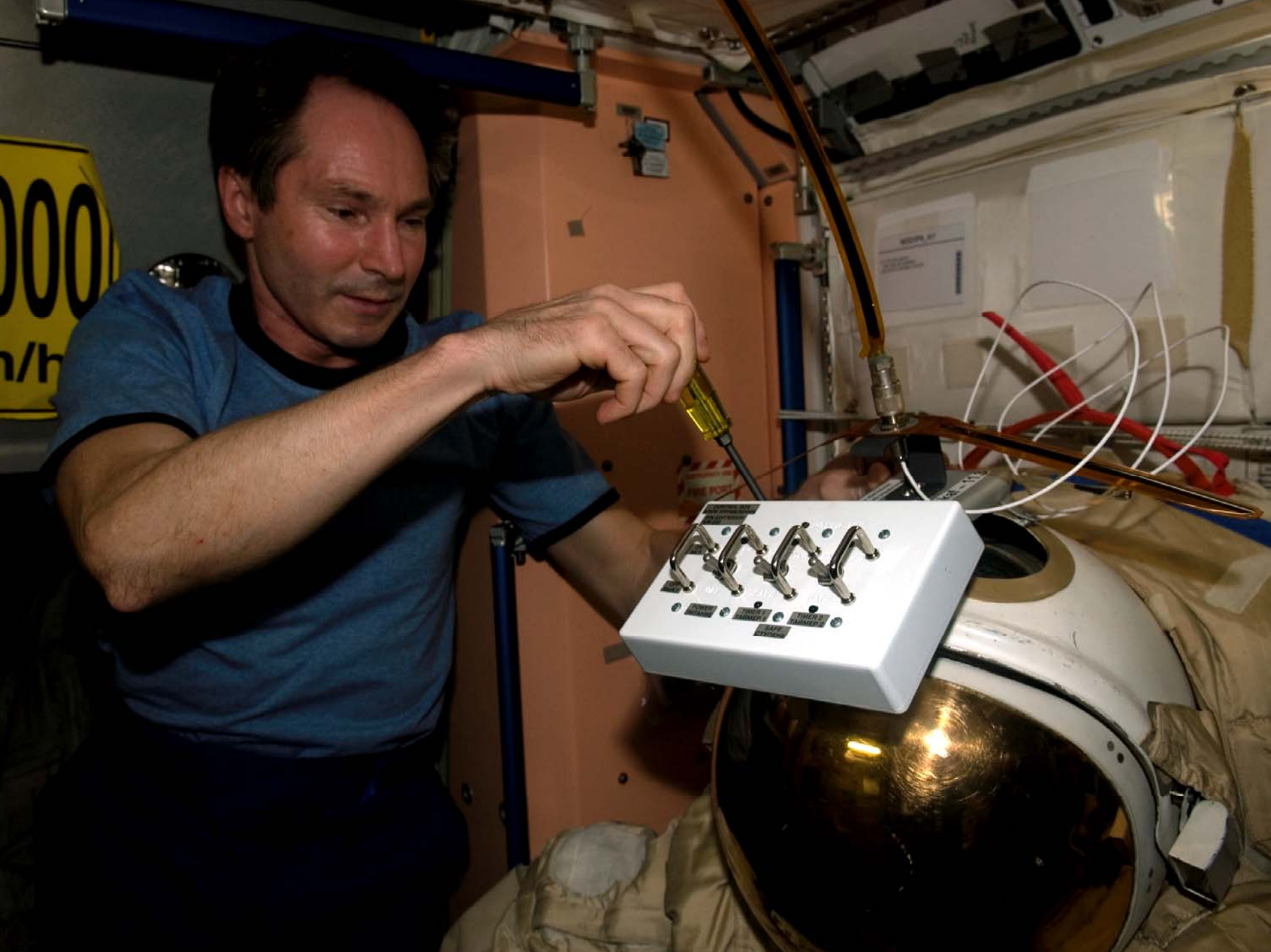
Digitalker Box



Suitsat Crew Training

On-Orbit Installation


17500




SPEED
LIMIT
17500
2800
km/h
CLOSING HATCH

17500

km/h

SM-RadioSkaf-11.2

ISS

БЕРМОС

SM-RadioSkaf-11.2

ANTENNA
АНТЕННА


ARISS
БЕРМОС
SM-RadioSkaf-11.2
SM-RadioSkaf-11.2


РОССИЯ
МГТУ
МАИ
SM-RadioSkaf-11.1
ТЕПЛО
ХОЛОД


МГТУ
175
МАИ
75
35
ОТДЕЛЯЮЩАЯ ПСС
SM-RadioSKaf-11.1
ОРЛАН-М
128001

РОССИЯ

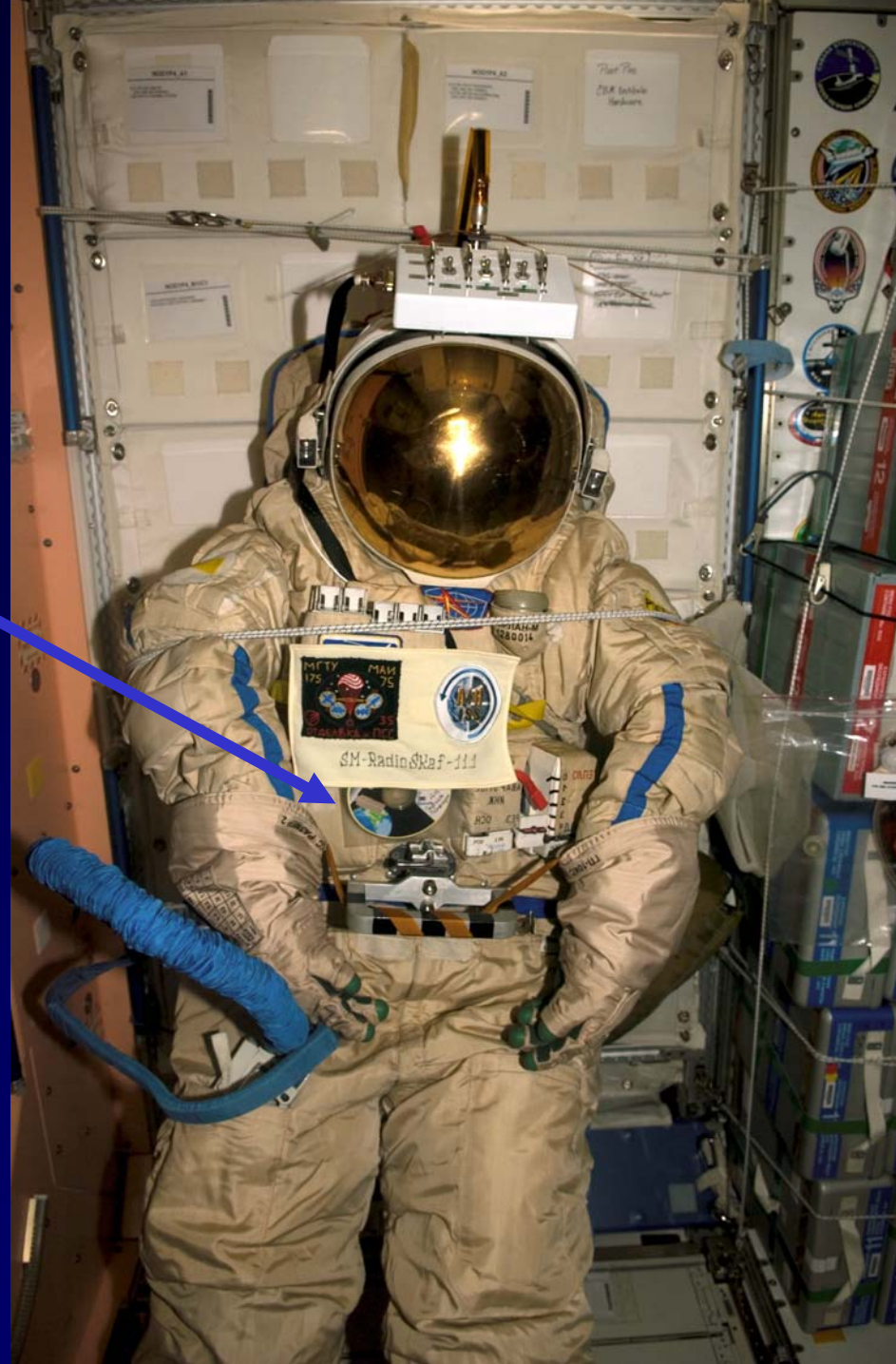
Deployment

Operations

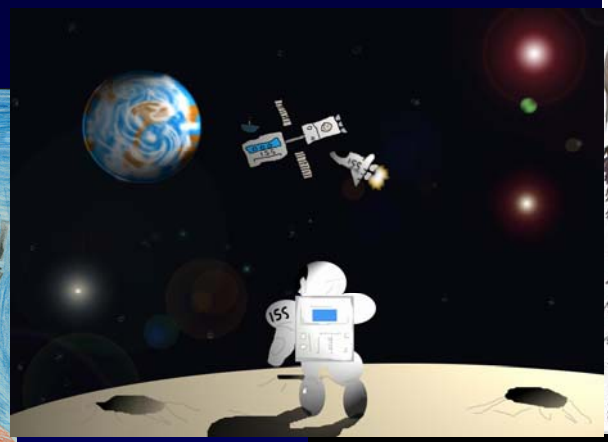
SuitSat-1
School Spacewalk
Compact Disk

Station ID

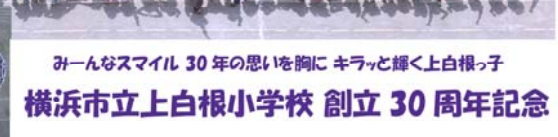
On-Orbit Signal



SuitSat School Spacewalk Pictures, Artwork and Signatures from Students around the world



Kamishirane Elementary School, Yokohama Japan



The Issue

- SuitSat Signal Strength much lower than expected
- Significant fades due to SuitSat spin exacerbated this issue
- Signal strength equivalent to 1-10 mW out of a 0 dBi antenna
- Potential causes: Antenna, feedline, connectors, power amplifier of the radio, or some combination
- Anomaly investigation will be conducted to best understand how to proceed in the future

Downlink Summary

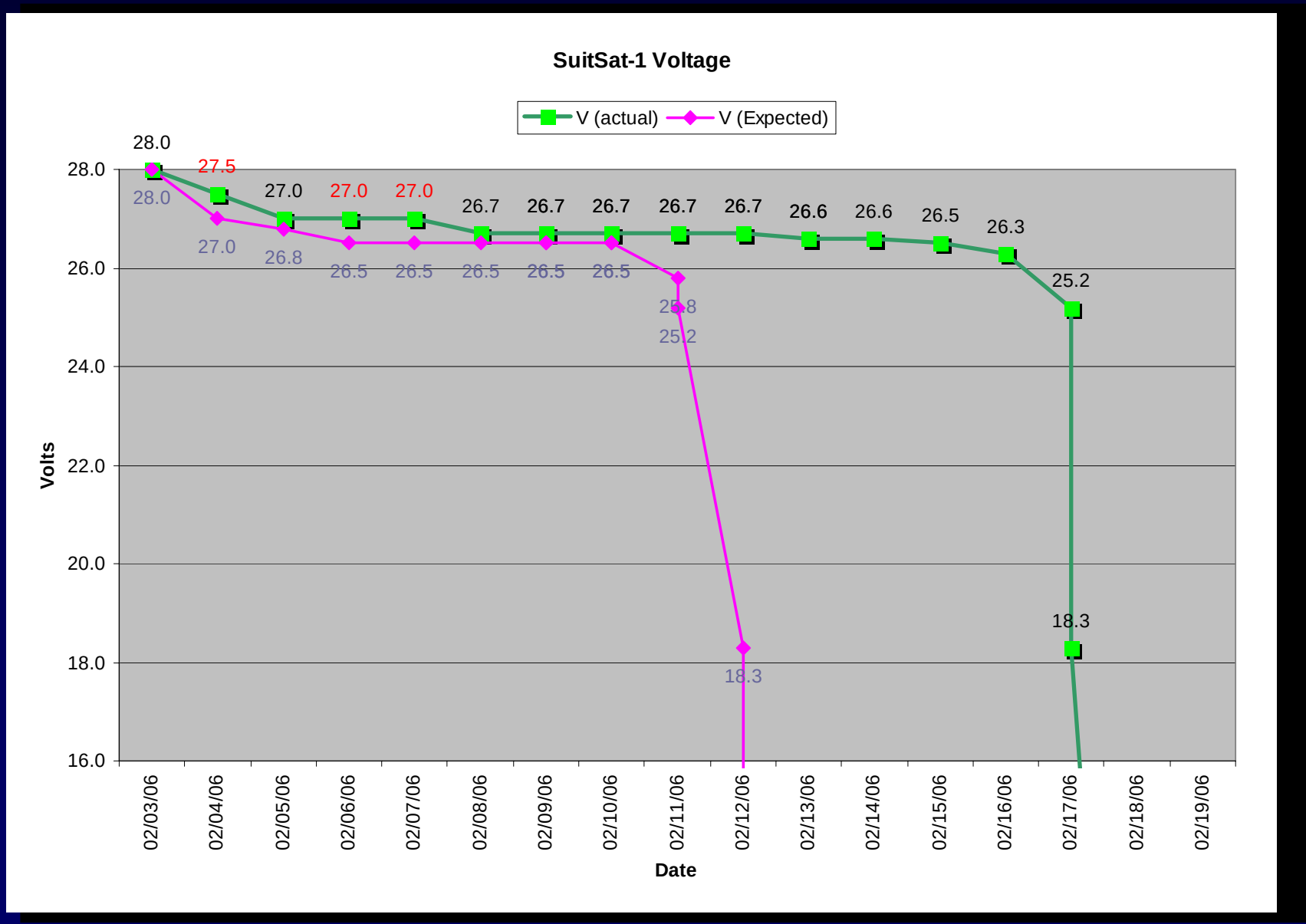
General Description

- Voice ID, SuitSat Information, 30 second pause
- 8 minutes, 46 seconds total running time
- Student messages include special word

SuitSat Information Specifics

- Telemetry (Elapsed Time, Battery Voltage, Suit Temperature)
- Russian Message
- European Student Messages (Spanish and German)
- Bauman Institute Congratulations (Russian)
- Canada Student Message (French)
- Mr. Alexandrov Message (Russian speaking English)
- Japan Student Message (Japanese)
- USA Student Message (English)
- SSTV
- Repeat

Battery Voltage Telemetry



SSTV Picture

Before

After

Press Visbility
Small Sampling

Major Web Sites
- CNN
- National Geographic News
- Aljazeera
- Discovery Web Site
- MSNBC
- Spaceflight Now
- Yahoo

Television
- Fox 5 News (DC)
- ABC News (National)
- CBS News

Radio
- NPR—All Things Considered
- CBC
- Discovery Channel Canada
- WTOP (DC)

Newspapers/Periodicals
- New York Times
- Washington Post
- Florida Today
- Houston Chronicle
- Washington Times
- Boy's Life
- Reader's Digest
- Popular Science
- Aviation Week & Space Technology
- Design Electronics
- QST
- CQ-Japan

Reader's Digest

Popular Science

Popular SuitSat Myths Debunked

- Frozen battery
  - NEVER occurred; telemetry demonstrated that temperatures within the Suit were 12-16C during the entire mission
- Early demise and resurrection of the SuitSat
  - It was alive and operated flawlessly (except for the signal strength issue) from crew turn-on until battery drain
- Radio output was 1-10 mW
  - SIGNAL STRENGTH is much lower than expected
  - It is entirely possible that the radio output could have been at 500 mW and the feedline, connector or the antenna caused the problem

SuitSat Accomplishments

Outreach

- Captured the imagination of people and students worldwide
- Unprecedented outreach and visibility for a ham radio event
- Over 9.5 million hits to www.SuitSat.org website in February!

Student Educational Outreach

- Student's creative artwork, signatures and voices have been carried in space and are on-board the spacesuit---the students are space travelers in the Suit as it circles the Earth
- Collaboration with the NASA Explorer Schools
- Exciting post-flight lesson plans will be developed

SuitSat Accomplishments (Continued)

Science and Engineering

- The ARISS international team was able to fabricate, test and deliver a safe ham radio system to the ISS team 3 weeks after space agencies agreed to allow SuitSat to happen

This was a tremendous feat in of itself

- Demonstrated important safety interlock system to space agencies
- Telemetry information confirmed that internal suit thermal environment is benign for future experiments

Special Certificate/Diploma

- If you heard SuitSat, don't forget to request the special SuitSat certificate/diploma
- Information on obtaining this certificate/diploma can be found on the AMSAT web site: www.amsat.org
- Certificate will be distributed in the next two months

Chicken Little Contest

"Oh my goodness!" said Chicken Little. "The sky is falling! I must go and tell the king!"

- Predict SuitSat's re-entry
- K-8, grades 9-12 and adult categories
- Special awards

www.amsat.org/amsat-new/ariss/suitsatContest.php

SuitSat-1 Chicken Little Contest Winners
Re-entry: September 7, 2006 at 16:00 GMT

K-8 Student	High School Student	Adult
Aaron Russo - 10 August	Kaleb - 17 August	Brian W4OGU - 07 September
Kai Thomas - 12 August	Jconnop - 17 August	N3RCU - 07 September
Matt - 17 August	Joanna K W. - 17 August	SW6JIV - 07 September
Ralf Klebermass - 17 August	leila - 24 August	Beth Ransom - 07 September
Alexander Akers - 06 September	alex - 31 August	Kazumasa Ibata - 07 September
Joshauah - 11 September	Stanislav Babenko - 05 Sept	Reidar Larsen - 08 September
andy bond - 11 September	weathernut27 - 07 September	Chad Briggs - 08 September
Abriana - 15 September	mike - 08 September	kb3nds - 08 September
lucy bullfrog - 24 September	Addison Call - 10 September	nalro - 08 September
cameron... - 04 October	Richard - 03 October	kg6hsq - 09 September

SuitSat Future

- Serious discussions on SuitSat-2
- Expected deployment: October 2007—in conjunction with the 50th anniversary of Sputnik-1
- Initial Design thoughts:
  - Correcting the signal strength issue
  - Longer-term power generation device, like solar arrays
  - Additional sensors
  - SSTV
  - Student experiments

SuitSat Summary

- SuitSat-1/Radioskaf/AO-54 represented a space pioneering effort
- While not a total success, we captured the imagination of students and the general public worldwide
- A lot was learned from this activity
- Will help us and others grow from this experience

On behalf of the AMSAT, ARISS and SuitSat teams, thanks for your help, encouragement and advice

Thanks!

Pre-flight & Flight Support

- Alexander Alexandrov, Alexander Poleshuk, Sergey Samburov, RV3DR, Lou McFadin, W5DID, Kenneth Ransom, N5VHO, Frank Bauer, KA3HDO, Mark Steiner, K3MS, Steve Bible, N7HPR, Joe Julicher, N9WXU, Rawin Rojvanit, Farrell Winder, W8ZCF, Jeffery Winder, KB8VCO, Hiroto Watarikawa, JJ1LYU, Stan Wood, WA4NFY, Herb Sullivan, K6QXB, Dave Taylor, W8AAS, Deanna Lutz, K7DID, Claire Fredlund, Carol Jackson, KB3LKI, ARISS International Delegates, Kenwood and Microchip Technology Inc.

Web/Blog Pages

www.amsat.org sponsored by Emily Clarke, N1DID

www.suitsat.org sponsored by Steve Dimse, K4HG,

http://www.aj3u.com/blog/ sponsored by A.J. Farmer, AJ3U

http://pd0rkc.ontwikkel.nl/ sponsored by Cor, PD0RKC

Bulletins

- Emily Clarke, N1DID, JoAnne Maenpaa, WB9JEJ, Rick Lindquist, N1RL, and Miles Mann, WF1F

Operations Support

- Thousands!!!
- Special recognition to: Bob King, VE6BLD and Richard Crow, N2SPI,

The Future

- On January 14, 2004, US President Bush proclaimed a new exploration initiative for NASA---go to the Moon by 2020, Mars next and beyond Mars later
- ARISS team developing Exploration Initiative strategy
- ARISS's solid performance and outstanding international teamwork is recognized and respected by the Space Agencies
- The challenges will be high due to the long path lengths

ARISS Information

http://www.rac.ca/ariss