

Amateur Radio On The International Space Station (ARISS)

The First Operational Payload on the ISS



*53rd International
Astronautical Congress
World Space Congress
October 15, 2002*

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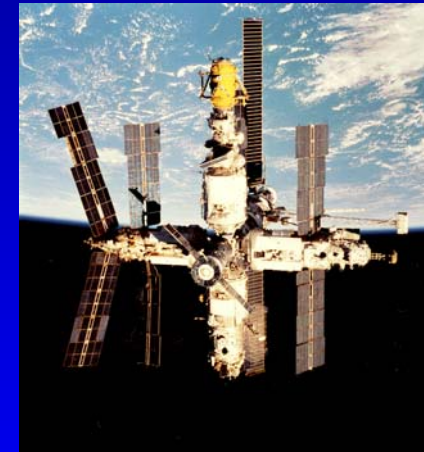
Amateur Radio on Human Spaceflight Missions

Since 1983, organizations in the U.S. (SAREX), Germany (SAFEX) and Russia (MIREX), have worked with the space agencies to fly amateur radio and to support Educational Outreach on:



Space Shuttle

ISS



Mir

ARISS Objectives



Spark Student's Interest
In Science & Technology



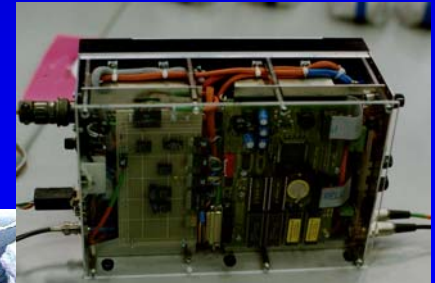
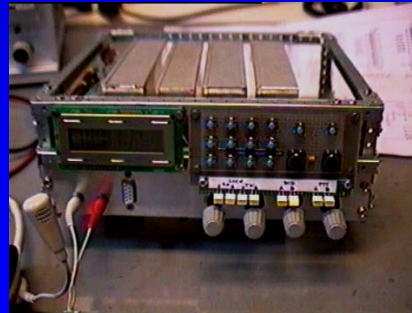
Crew Family Contacts
(Crew Psychological Ops)



Promote Interest
In Amateur Radio



Human Spaceflight
Awareness



Mir SSTV
Dec 12 99 17:29 UTC Rec W8ZCF

Experimentation

Development & Operations on the International Space Station (ISS)

Working with our international partners to develop & operate Amateur Radio on the International Space Station (ARISS)

ARISS Organization

- Nine international partners thus far—Belgium, Canada, France, Germany, Italy, Netherlands, Japan, Russia and United States
- MOU—Formed ARISS to represent the amateur radio community to the ISS Program
- All volunteer organization



USA Sponsors



**National Aeronautics and
Space Administration
(NASA)**



**American Radio Relay
League (ARRL)**



**Radio Amateur Satellite Corporation
(AMSAT-NA)**

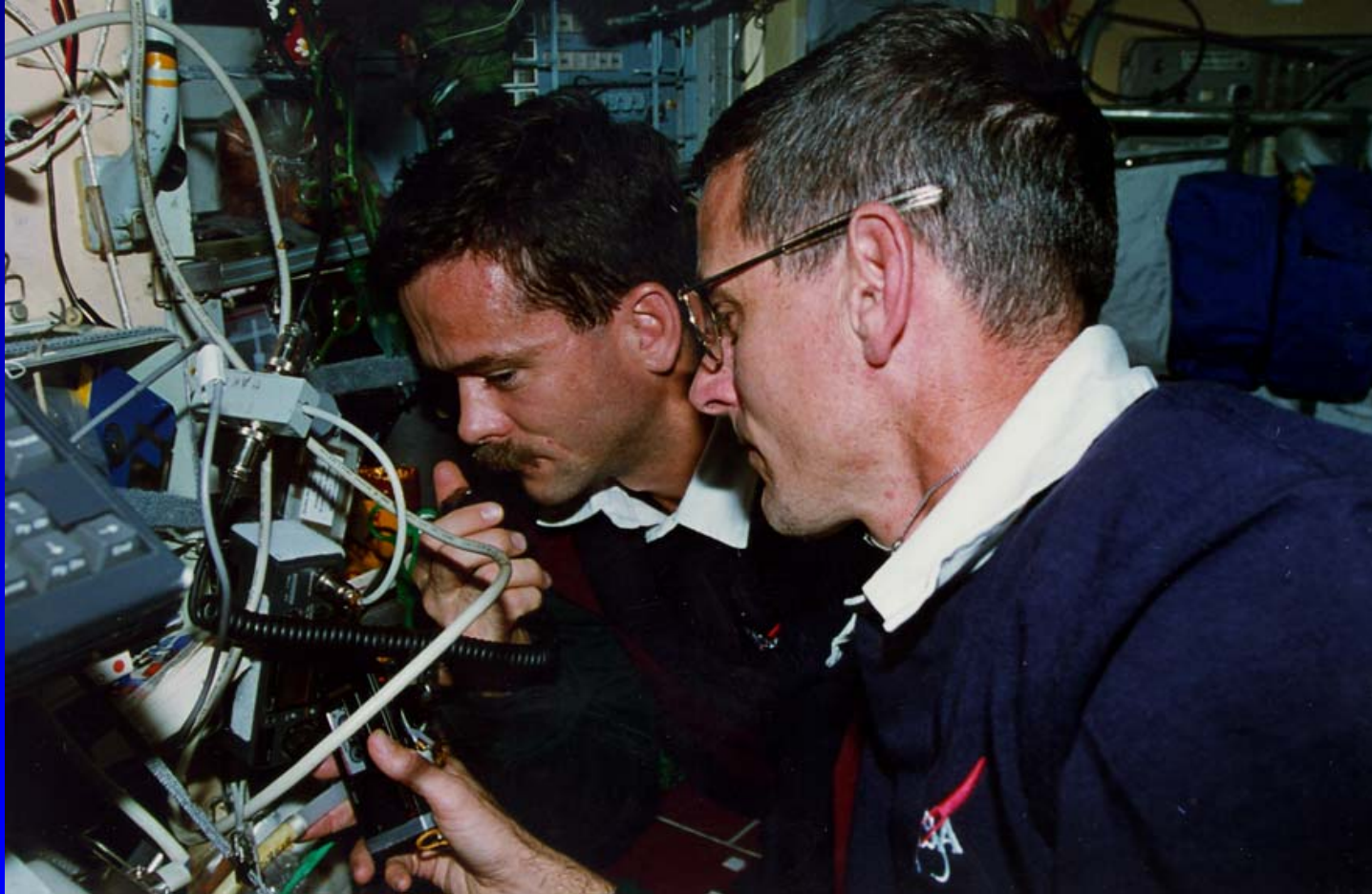
HARDWARE DEVELOPMENT PLANS

Development to be conducted in four phases

- **Initial Amateur Station (Part 1 of Phase 1 is on-orbit)**
- **Transportable Amateur Station—Phase 2 (Developing)**
- **Permanent Amateur Station (Future)**
- **Express Pallet/External Experiments (Future)**

Capabilities of Initial Station

ISS Ham Phase 1



2-way voice operations on VHF & UHF

Capabilities of Initial Station ISS Ham Phase 1 (Continued)

Posted : 06/28/97 17:58

To : ALL

From : R0MIR

Subject: Mir Status

Computer-to- Computer Radio Links

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 Sppektr module, to receive its substantial electrical power from its large arrays.

Thanks for all your good wishes. Mike.

CMD(B/H/J/K/KM/L/M/R/S/SR/V/?)>

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

Planned Capabilities for Initial Station

ISS Ham Phase 1



DigiTalker
(Voice Repeater)



Slow Scan TV
(Photos/JPEG Images)

Planned Capabilities for Phase 2 Station



- Phase 1 VHF & UHF Systems
- Higher power (35-50 W) VHF & UHF FM Radio System
- HF (shortwave) radio system for ionospheric experimentation
- Packet Radio
- SSTV

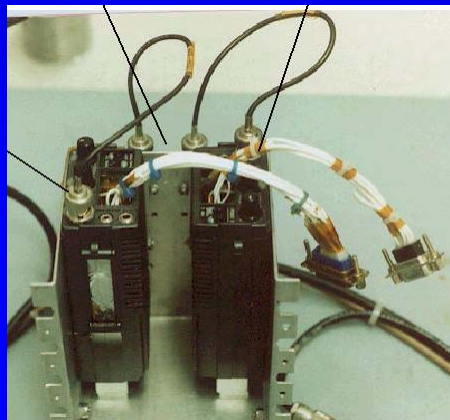
*Supports Multi-Band, Multi Operator
Autonomous and Crew-tended Modes*

Future Capabilities

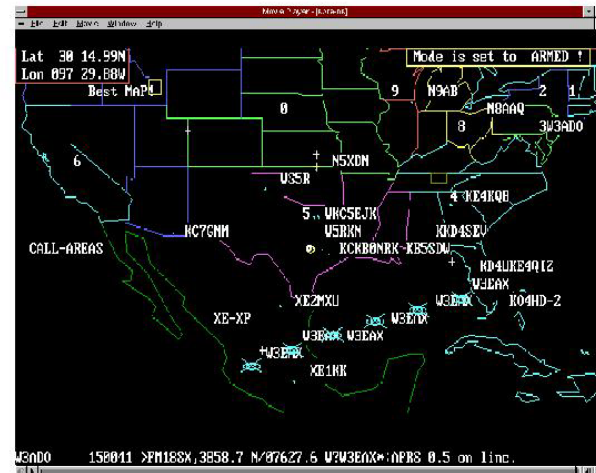


Amateur TV

(Standard, Spread spectrum, & MPEG)



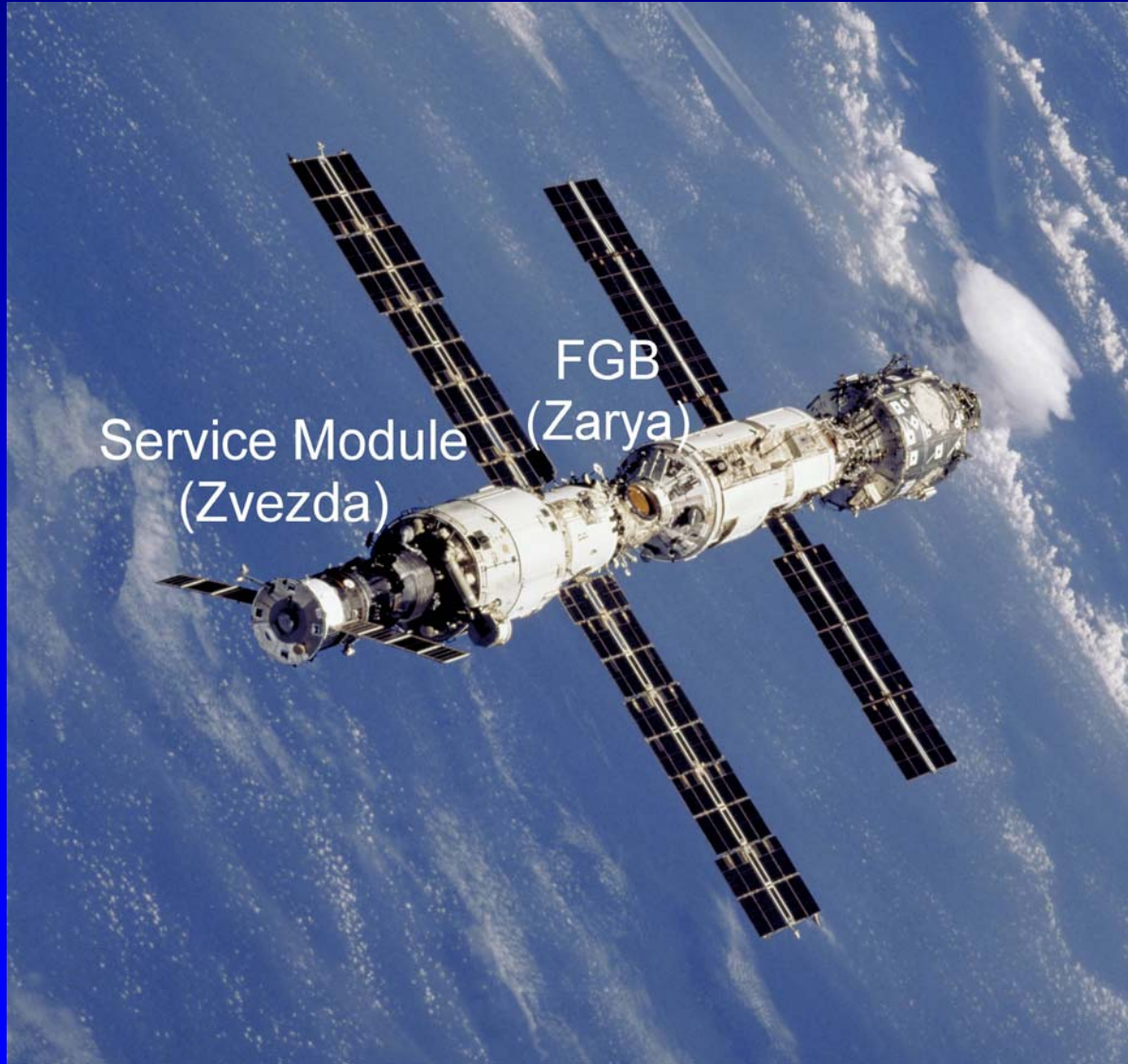
SPRE Pass Over U.S.



R/T Internet TLM
using amateur radio

Express Pallet---
External payloads w/
antennas & student
experiments

Ham Station Location: Service Module and FGB



- **Initial ops in FGB**
 - Using Phase 1 VHF radio system
- **Primary ops in Service Module**
 - Multi-mode, multi-operator capability after installation of 4 antenna systems

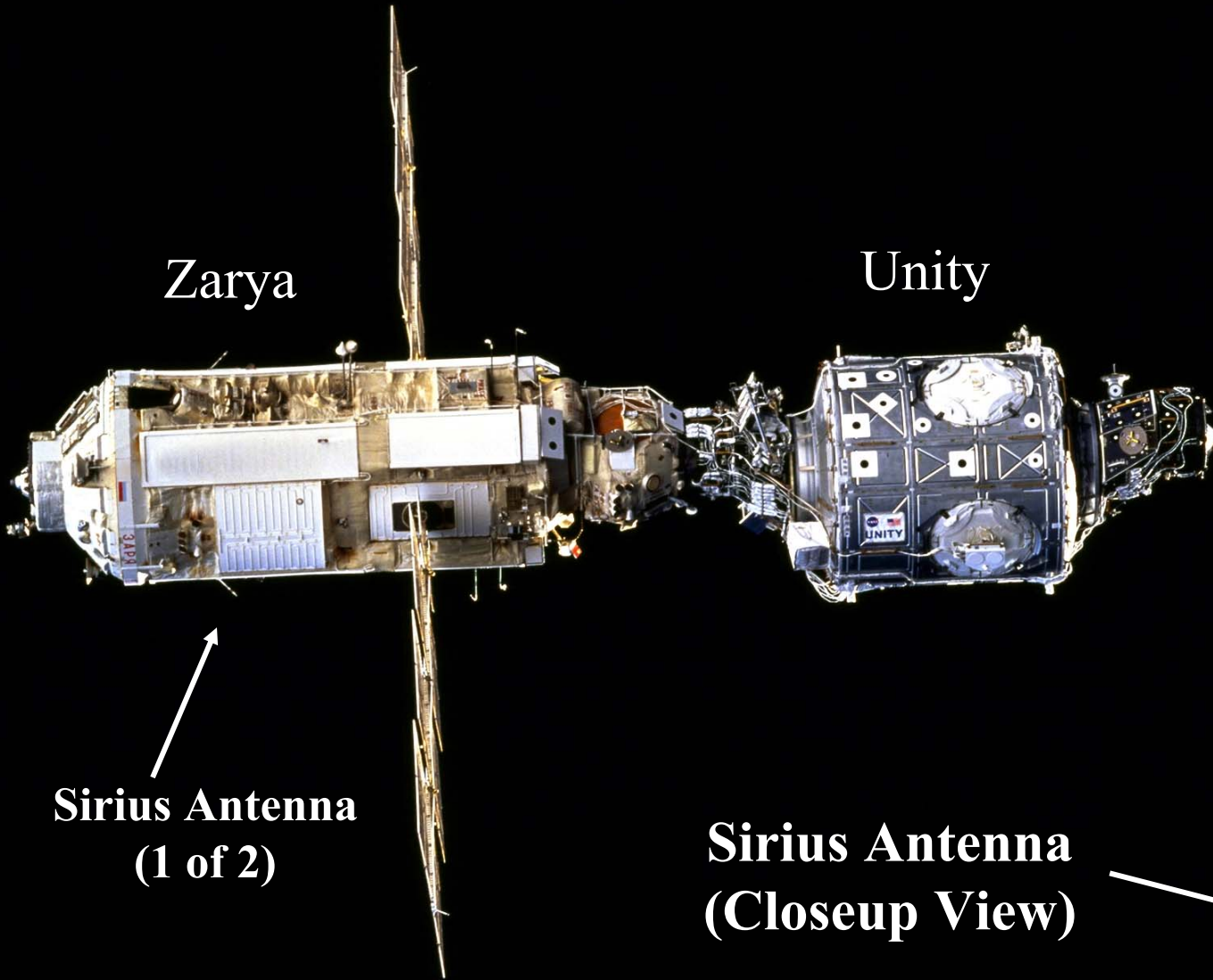
SIRIUS ANTENNA LOCATION ON ZARYA

Zarya

Unity

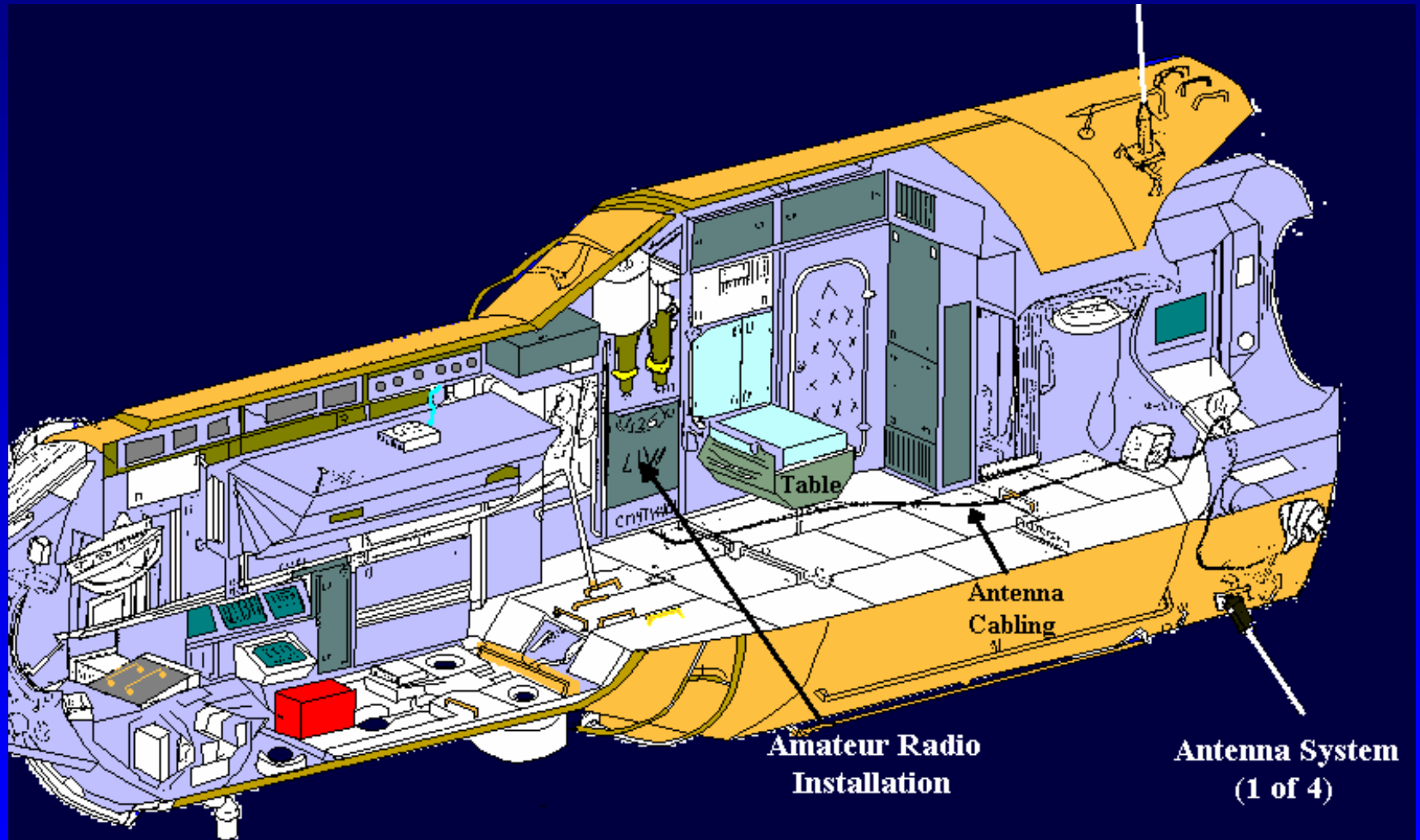
Sirius Antenna
(1 of 2)

Sirius Antenna
(Closeup View)



ARISS / ISS HAM

Location in and on the Service Module



ARISS Hardware Location in Service Module



ARISS Team Members Sergej Samburov (Russia), Frank Bauer (US) & Alberto Zagni (Italy) (L to R) in front of ARISS Hardware Installation Area

Initial Amateur Station Part 1



Initial Amateur Radio Station Undergoing EMI Tests at GSFC



ВЫХОД ПИТ
POWER OUT

GPS

ENABLE
BK5

ОТКЛ
DISABLE

COEL
COCT
STA
PTT
DCD
PIIT
PWR

 **AMSAT NA**

ПАКЕТНЫЙ МОДУЛЬ
PACKET MODULE

РАДИО СТ.
RADIO

ВКЛ ПИТ
POWER ON

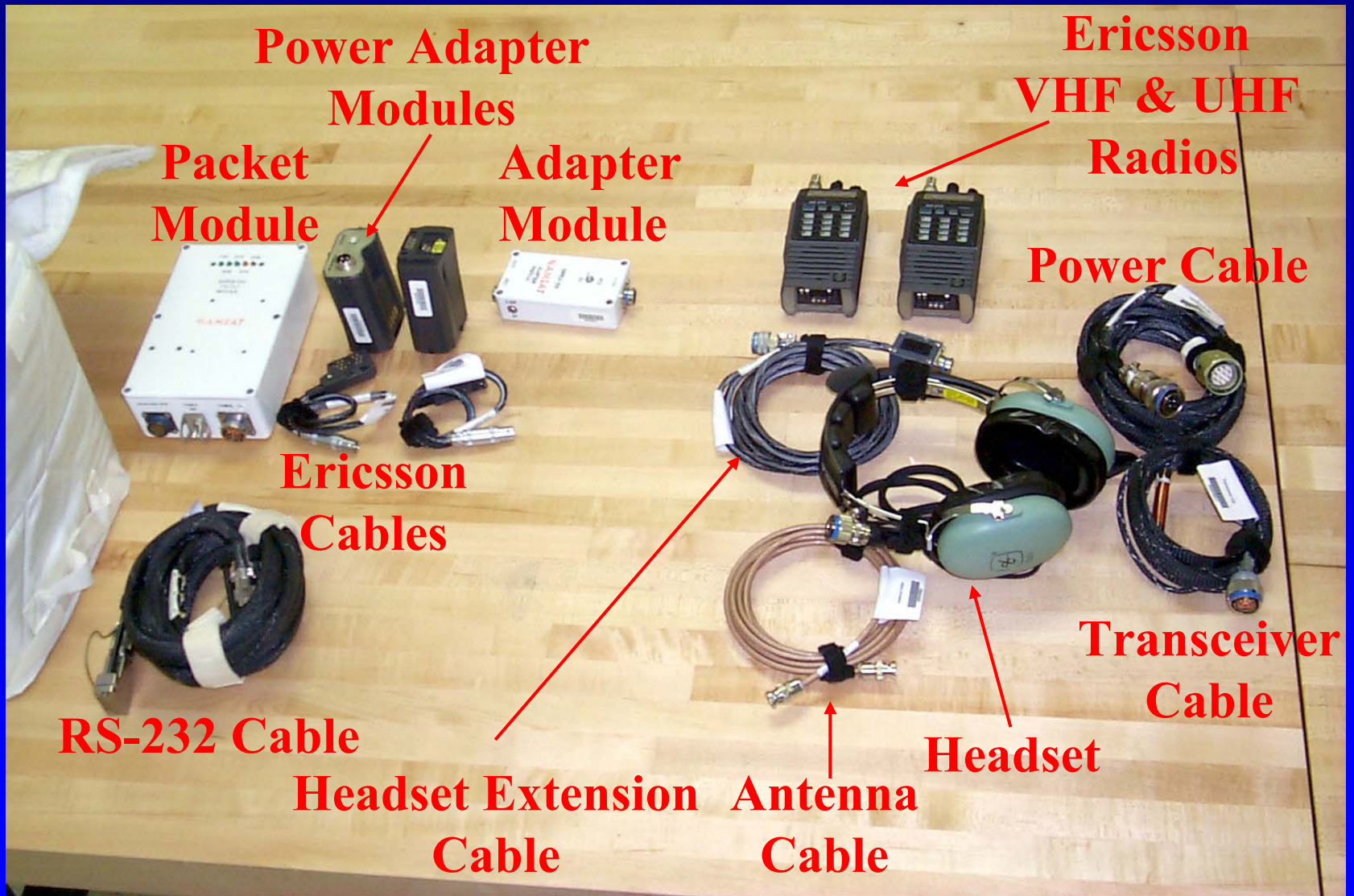
ВХОД ПИТ
POWER IN

РАДИО СТ.
RADIO

ВКЛ ПИТ
POWER ON

ВХОД ПИТ
POWER IN

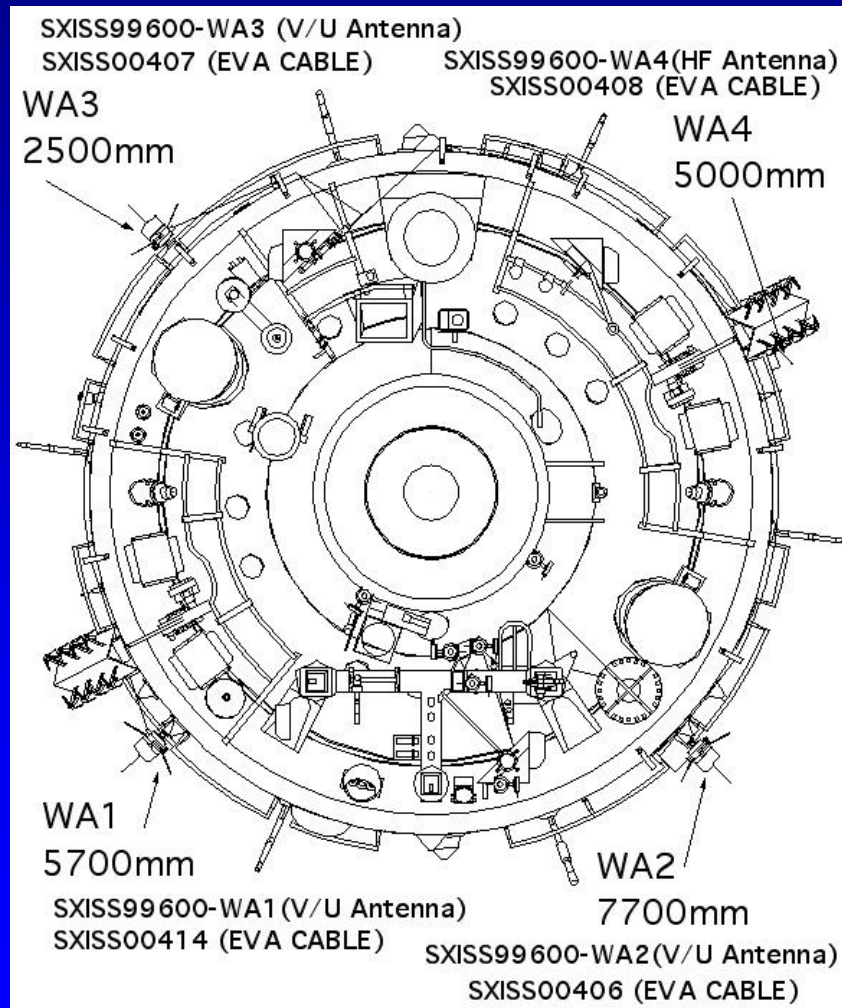
ARISS Provided Hardware to ISS HAM at SPACEHAB for Launch on STS-106 (2A.2b)



Antenna System Locations: Soyuz-end of Service Module



Antenna System Installation on Service Module



Antenna System w/ VHF/UHF Antenna Installed

(1 of 4)

Internationally Developed

Italian Contribution:

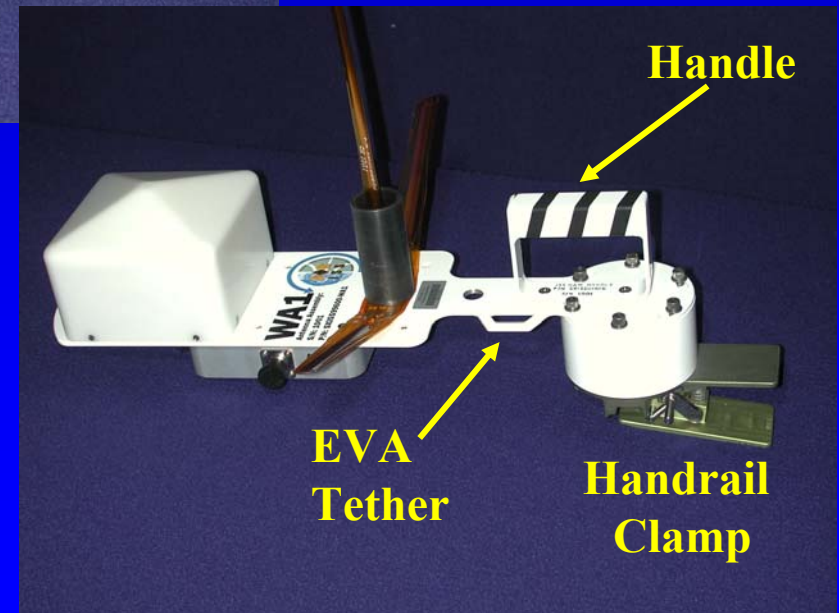
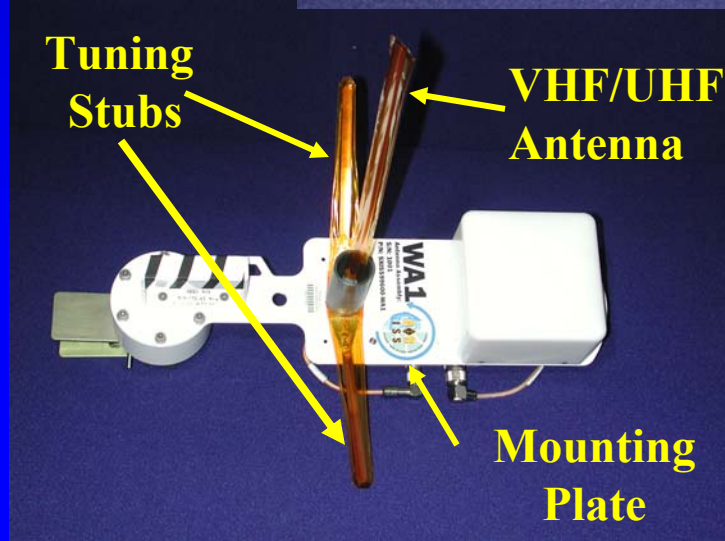
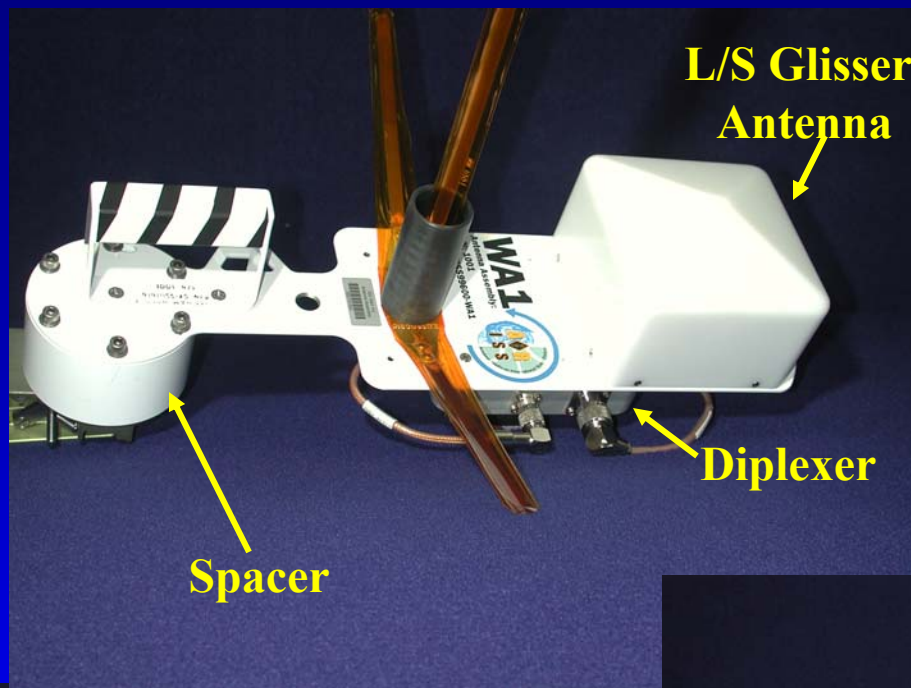
Microwave Antennas
Diplexer

US Contribution:

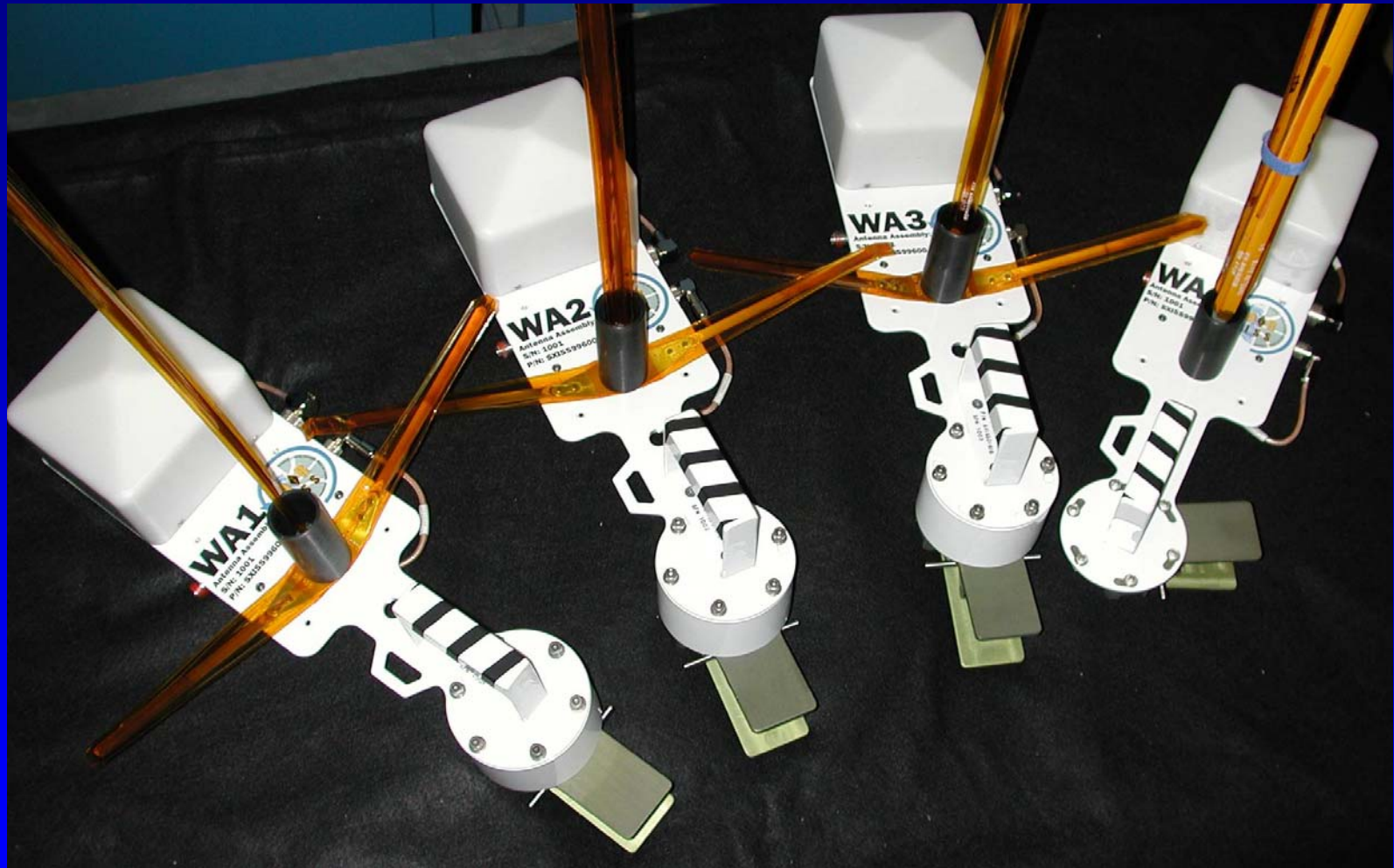
Mounting Plate
Handle & Spacer
VHF/UHF & HF Antennas

Russian Contribution:

Handrail Clamp
Interconnecting Cables



Antenna Systems WA1-WA4



Russian Sub-components

Handrail Clamp



**Power Connector
(Internal)**

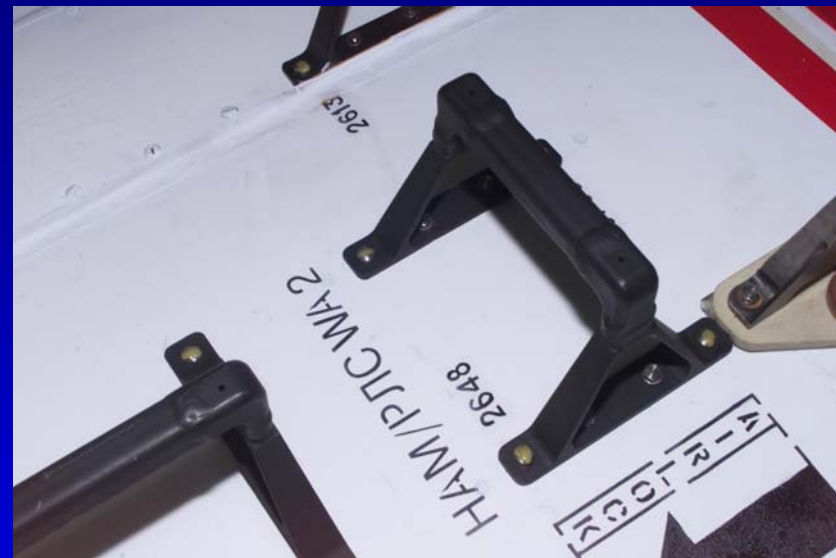
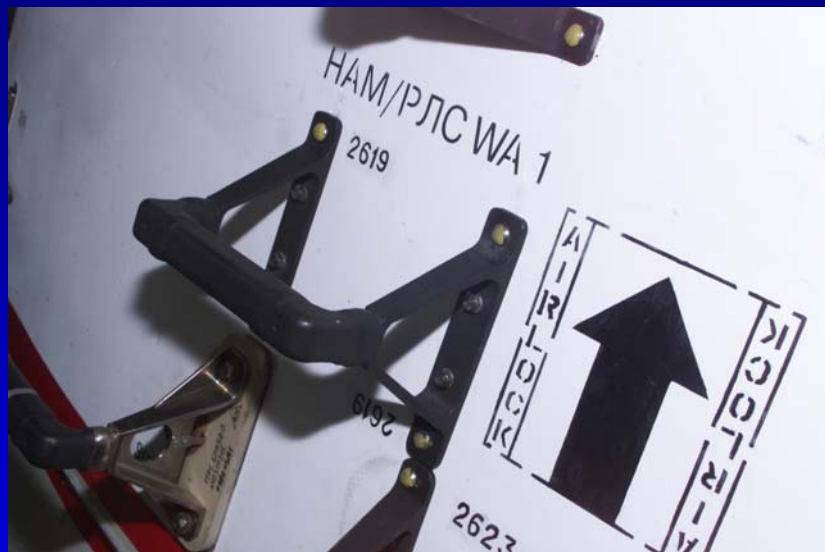
**ISS Ham EVA Cable
(w/ EVA RF Interface
Connector Attached)**



EVA Connector



Antenna Handrail Closeout Photos



Installation Status

- STS-106 (2A.2B), September 2000
 - delivered Phase 1 VHF & UHF Ericsson radios to ISS
 - VHF FM (144 MHz) radio system installed in Zarya (FGB) & attached to Sirius antenna system
 - Supports voice & packet ops
- Soyuz Flight 2R
 - Increment 1 crew activates VHF equipment on November 13, 2000 (14 days after crew arrives)
- STS-105 (7.a.1) August 2001
 - Delivered new packet module to support simultaneous 2 radio ops in FGB & Service Module
- Progress 6P flight, November 2001
 - Delivered EVA cable clips

Installation Status (continued)

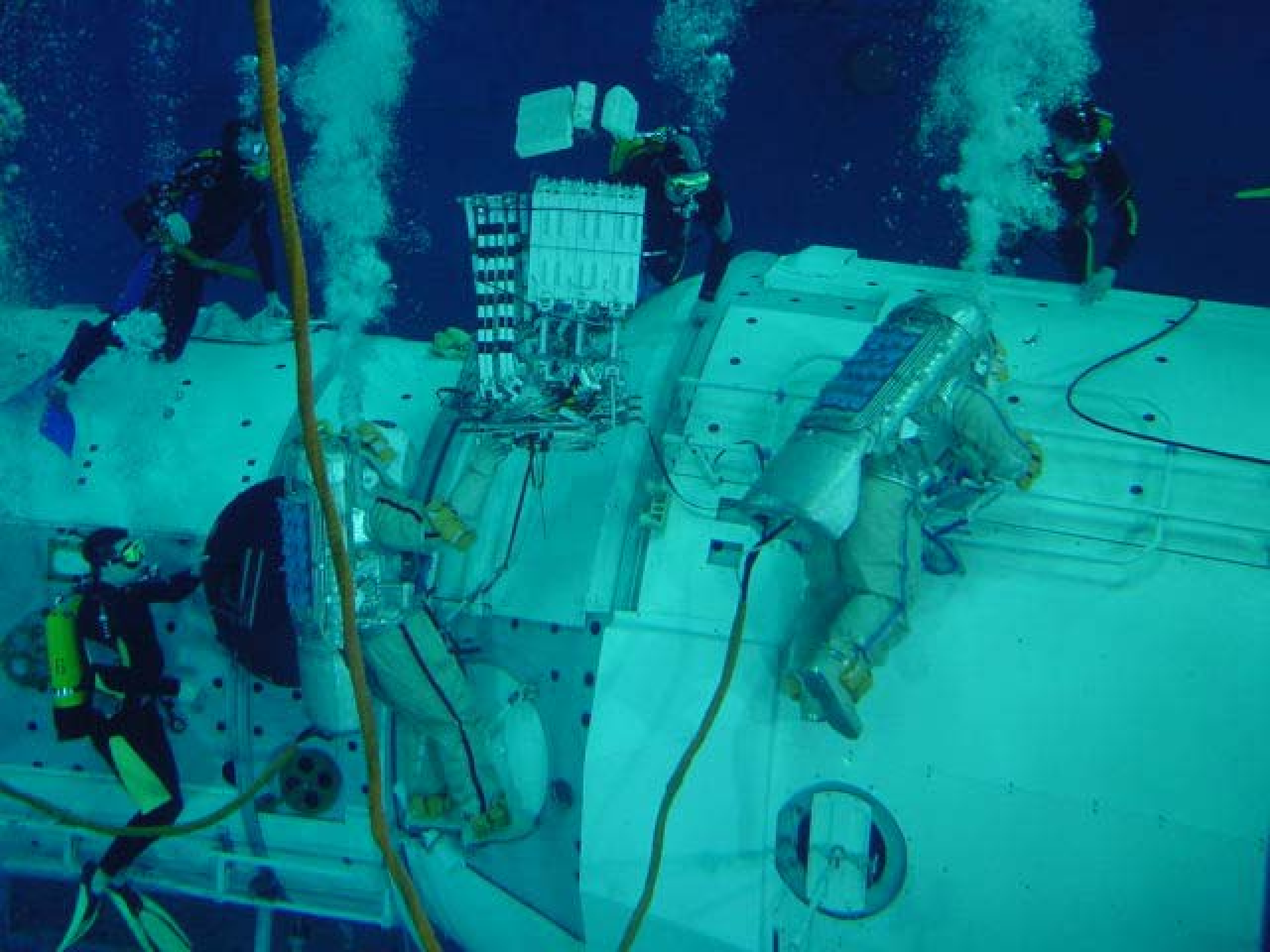
- STS-108 (UF-1) December 2001
 - Delivered 4 antenna systems to ISS
 - Delivered additional Phase 1 hardware to support 2 radio (VHF/UHF) ops
- Soyuz Flight 4S April 2002
 - Laptop computer left behind by Mark Shuttleworth for ARISS use
- Expedition 4 & 5 crews install 4 antennas during Extra Vehicular Activities (EVAs)
 - WA3 on January 14, 2002
 - WA4 on January 25, 2002
 - WA1 & WA2 on August 26, 2002

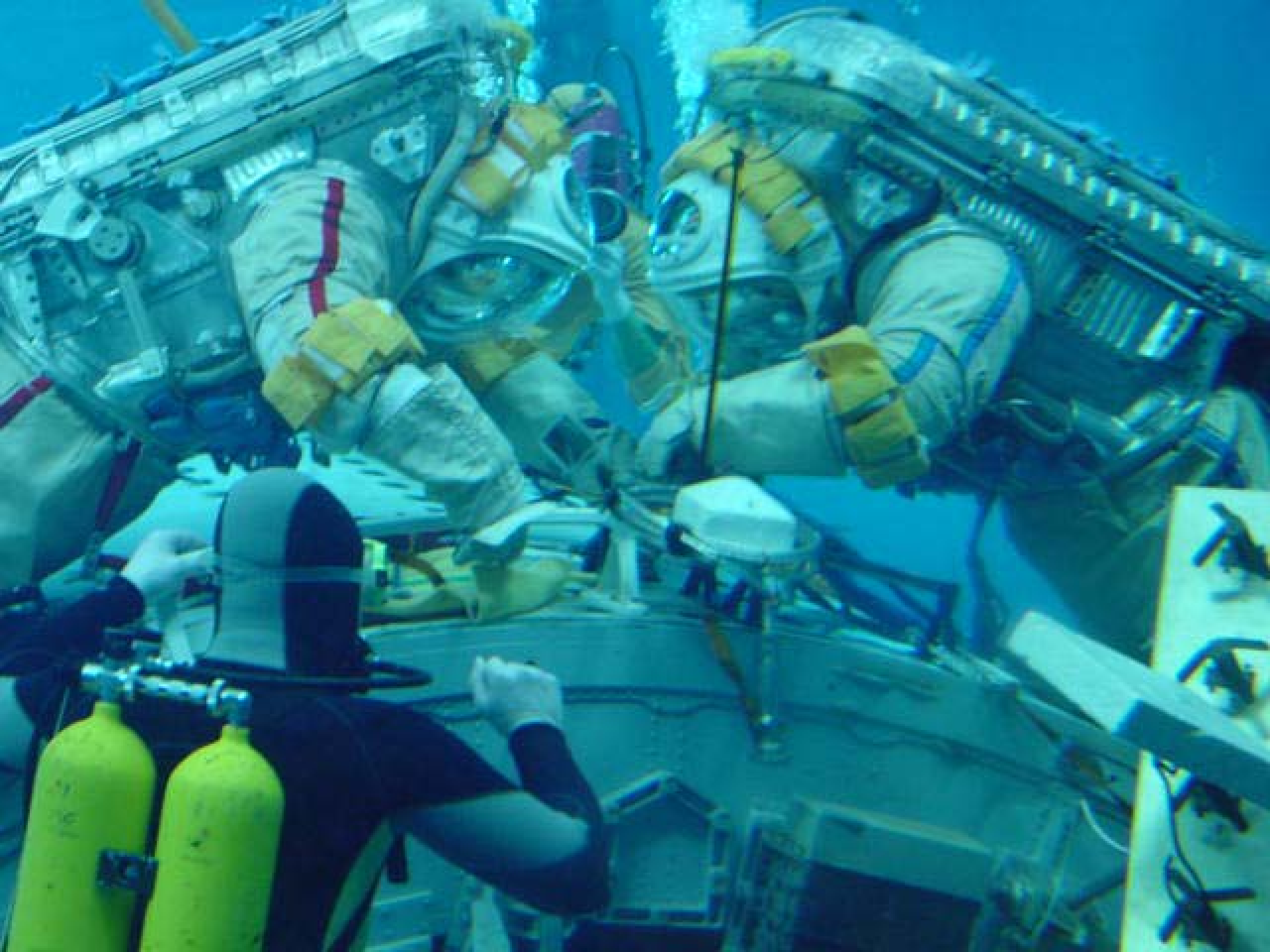
Sergei Krikalev in the FGB ham shack



Valery Korzun with ISS Ham Computer







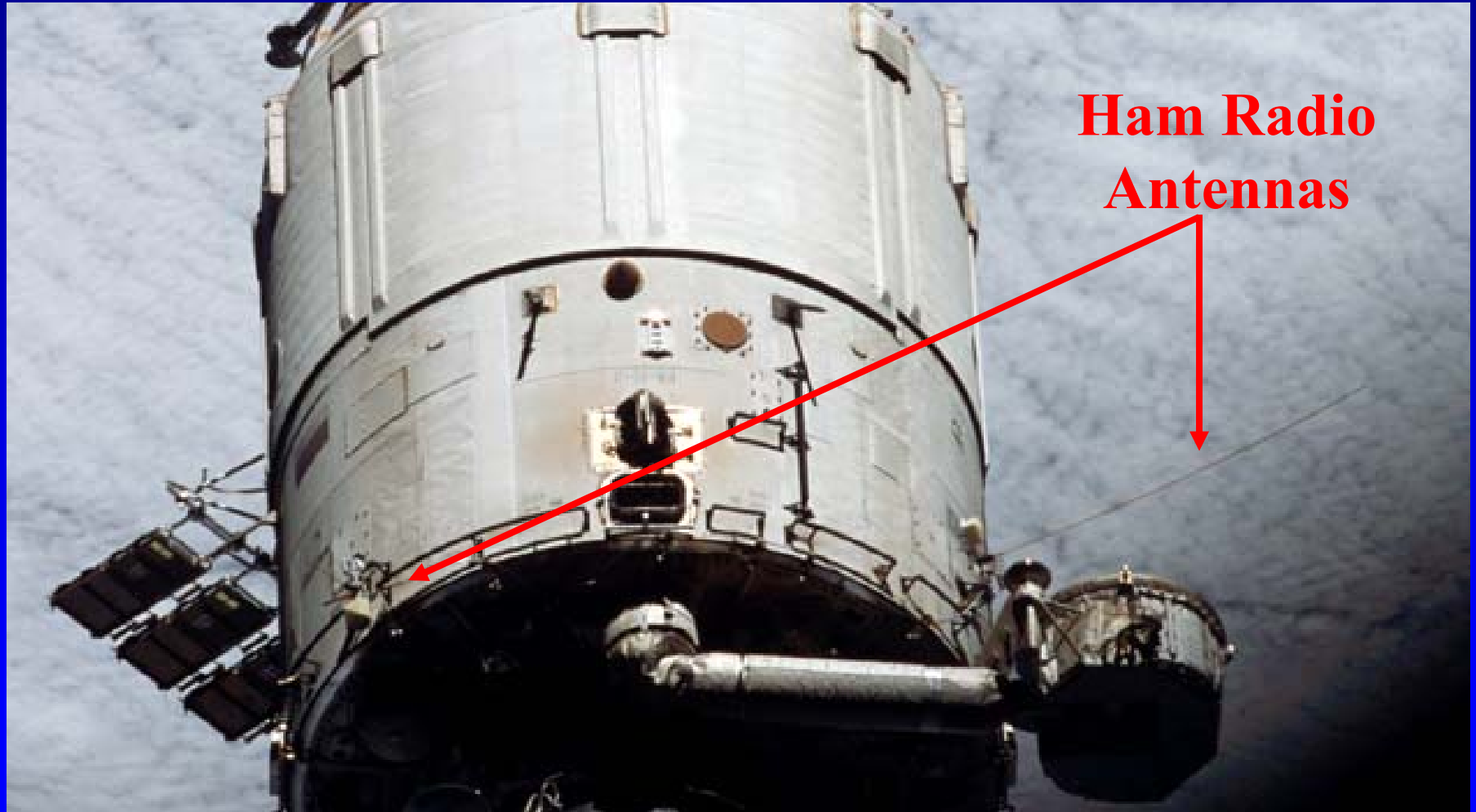
WA4 Antenna Ready for EVA



Antenna Installation EVA



WA3 and WA4 Antennas on Service Module



Ham Radio
Antennas

Future Hardware Deployments

- SSTV—Mid-2003
- Phase 2 hardware—Mid-2003
- External payload--TBD



Phase 2 System

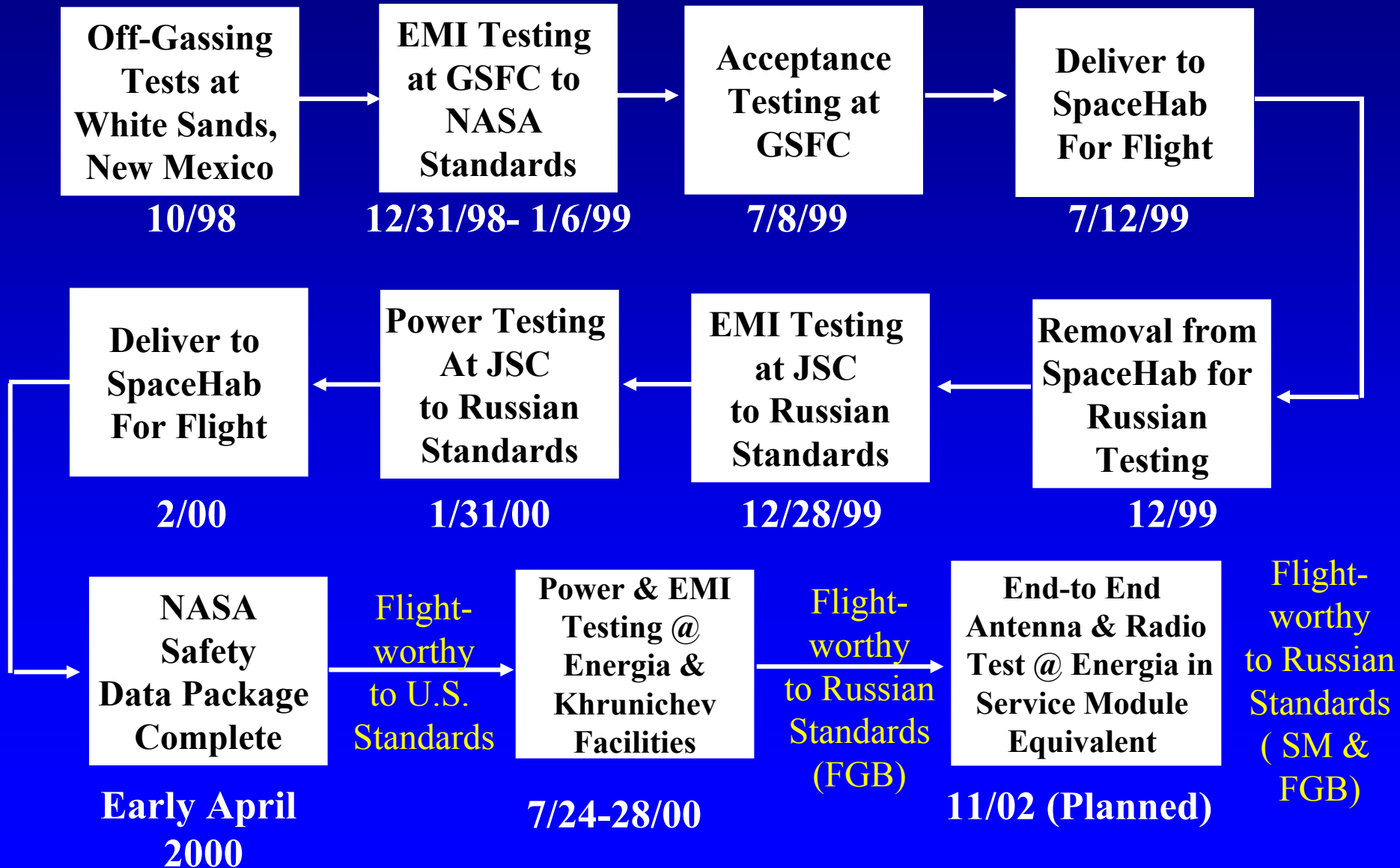


SSTV Software

Challenges

- First payload to fly on ISS
 - Space agencies focused on ISS system, not payloads
 - Unclear requirements for flight certification resulted in repeating tests up to four times to meet U.S. and Russian certification requirements
 - Shuttle
 - U.S. Segment ISS
 - Russian segment ISS (FGB)
 - Russian segment ISS (Service Module)
 - Certification/Qualification testing performed in U.S. (NASA GSFC, NASA JSC, & White Sands) and Russia (Khrunichev and Energia)

Initial Station Radio System Test Flow



Challenges (continued)

- Cultural differences of international volunteer team
- Communication Challenges
 - Language and cultural barriers
 - Reliable E-mail delivery, especially into space agencies
 - Mitigation: USA/Russian Technical teleconference 2/month, ARISS-I Teleconference 1/month, ARISS-I face-to-face 2/year
- International Space Agency Issues
 - Example: Dennis Tito's request to use ISS Ham radio to talk to family during his flight
 - Mitigation: Close, working relationship with space agency and Energia managers

Conclusions

- ARISS-International team of volunteers developed first payload to be certified to fly and operate on ISS
- Paved the way for future payloads on ISS
- Success is a testament of team's tenacity, international teamwork and drive
- Equipment is highly utilized by ISS crew
- Payload provides an outstanding Educational Outreach foundation for ISS



Frank Culbertson During Scout Jamboree on the Air

ARISS Information

<http://ariss.gsfc.nasa.gov>

