HAMTV

AMSAT Italia Proposal for a television down link from ESA Columbus module

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AMSAT Italia ®

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- **Down-link Frequency Band Identification**
- **2.4 GHz Band limits**

- **Television Standard Selection**
- **Link Budget definition**
- **First experiments and preliminary results**

PROPOSAL OUTCOME

- **De Paolis and Nespoli trip to Naples**
- **Exchange of some preliminary ideas through Skype**
- **Identification of study structure**
- **Disclosure of the study to ARCOL WG**
- **Ideas for an “unsolicited proposal” to ESA**
- **ESA, Astrium, Kayser Italia and Amsat Italia Technical Interchange Meeting on 11 Nov 2010**
- **Contract signed between ESA and Kayser Italia on August 2011**
- **Contract deadline February 1, 2013**

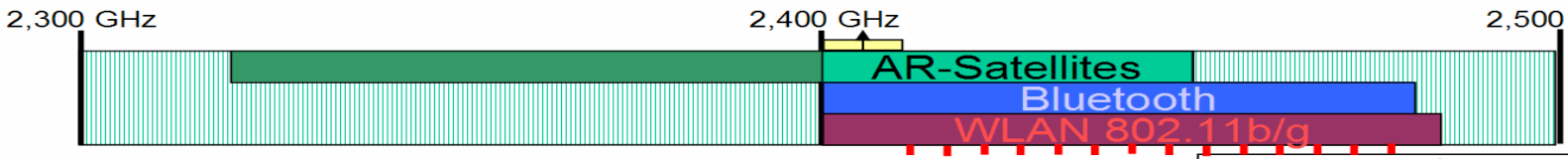
FREQUENCY BAND IDENTIFICATION

- **ITU Table of frequency allocations to services– Footnote 5.282**

- ***5.282 In the bands 435-438 MHz, 1 260-1 270 MHz, 2 400-2 450 MHz, 3 400-3 410 MHz (in Regions 2 and 3 only) and 5 650-5 670 MHz, the amateur-satellite service may operate subject to not causing harmful interference to other services operating in accordance with the Table (see No. 5.43). Administrations authorizing such use shall ensure that any harmful interference caused by emissions from a station in the amateur-satellite service is immediately eliminated in accordance with the provisions of No. 25.11. The use of the bands 1 260-1 270 MHz and 5 650-5 670 MHz by the amateur-satellite service is limited to the Earth-to-space direction.***

- **The frequency band 2400-2450 MHz is the only one usable in down link with enough bandwidth to accomodate a television transmission and for which a suitable antenna is installed on board ISS.**

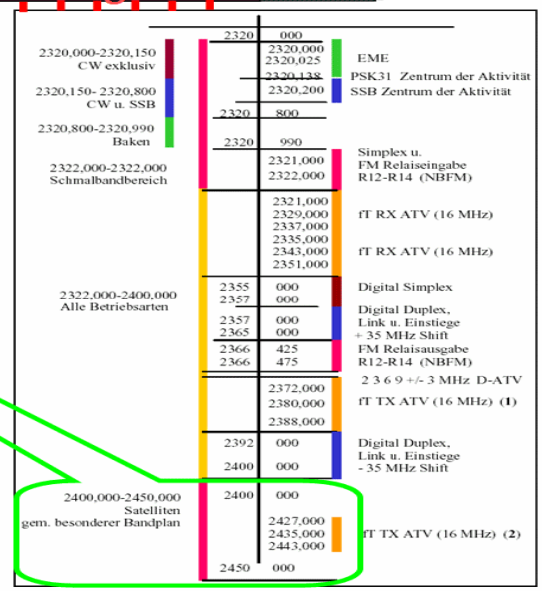
S-BAND SPECTRUM ALLOCATION



Amateur Radio 13cm Band:
- 2,320 GHz to 2,450 GHz
- 2,400 GHz to 2,450 GHz allocated to satellites

Bluetooth:
- 2,402 GHz to 2,480 GHz
- 79 seperate frequencies, 1MHz spacing
- Frequency Hopping, up to 1600hps

WLAN (IEEE 802.11b/g):
- 2,400 GHz to 2,4835 GHz
- US: 11 channels, EU: 13 channels
- 5 MHz spacing
- 802.11b: max 11Mbps, 802.11g: max 54Mbps



Ch 01: 2.412 GHz
Ch 02: 2.417 GHz
Ch 03: 2.422 GHz
Ch 04: 2.427 GHz
Ch 05: 2.432 GHz
Ch 06: 2.437 GHz
Ch 07: 2.442 GHz
Ch 08: 2.447 GHz
Ch 09: 2.452 GHz
Ch 10: 2.457 GHz
Ch 11: 2.462 GHz
Ch 12: 2.467 GHz
Ch 13: 2.472 GHz
Ch 14: 2.484 GHz

2.4 GHz FREQUENCY BAND LIMITS
I Part

- **Secondary allocation to the amateur satellite service (or even less)**
- **ISM Band (Wi-Fi, Bluetooth, Microwave ovens, medical equipments, WLAN, etc.)**
- **Wi-Fi applications on ISS**
- **On-ground reception interfered-with by pervasive applications (Wi-Fi, Bluetooth, microwave ovens, etc.)**

2.4 GHz FREQUENCY BAND LIMITS
II Part

- **Fall-back proposal for an alternative channel (i.e. 2395 MHz) in the higher part of the band 2300-2400 MHz on non-interfering basis (RR. 4.4) in addition to the nominal channel at 2422 MHz (channel 3 of Wi-Fi raster)**

- **Consciousness of no primary allocation to the amateur satellite service in the UHF band (300 – 3000 MHz) with a suitable bandwidth**

TELEVISION STANDARD SELECTION

Comparison between:

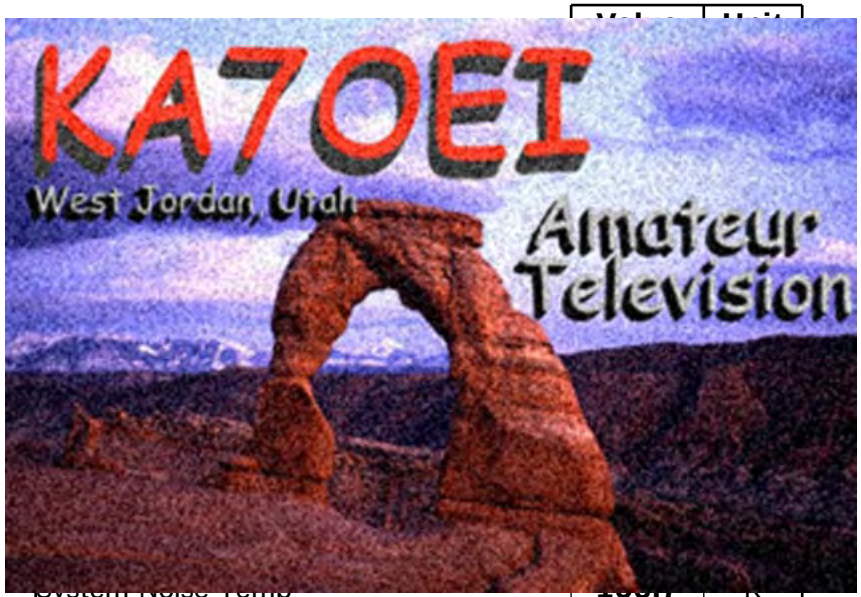
- ***Analogue standard (FM)***

ΔFpp=16 MHz, BW=28 MHz

- ***Digital standard (DVB)***

DVB-S (QPSK)

FM TV from Columbus



System Noise Figure	**1.9**	dB
G/T	**2.3**	dB/K

CARRIER CHARACTERISTICS		
Peak to Peak frequency deviation ΔFpp	**16**	MHz
TV signal bandwidth Bv	**6**	MHz
Modulation	**FM**	
Carrier's occupied bandwidth	**28**	MHz
pw [Unified] CCIRR Rep. 637 pre/de-emphasis	**13.2**	dB

TX & Downlink		
TX power	10.0	dBW
cable & connector losses	7.0	dB
TX Antenna gain (boresight)	8.0	dBi
pointing losses	10.5	dB
Downlink e.i.r.p. toward earth receive station	0.5	dBW
Downlink path loss (free space)	**160.3**	dB
Atmospheric losses	0.0	dB
Rain attenuation losses	0.0	dB

C/N (Available)	**-3.4**	dB
C/N (required due to demod. threshold)	**7.0**	dB
Margin on C/N	**-10.4**	dB
S/N (Required for P3 video quality)	**25.0**	dB
C/N0 (Required for P3 quality)	**69.3**	dBHz
C/N0 (available)	**71.1**	dBHz
Margin on C/N0	**1.8**	dB
Link Margin	**-10.4**	**dB**

$$\frac{S}{N} = \frac{3}{2}\frac{\Delta F_{pp}^{\ 2}}{B_v^{\ 3}}\frac{C}{N_0}pw$$

Antenna noise temperature DO NOT include noise contributions from interfering systems close to the receiving station (e.g. WiFi access point, microwave ovens, video senders, etc.). A preliminary measurement of G/T is strongly recommended. Sun-noise measurement at sunrise or sunset should be a convenient method to test RX station figure-of-merit at low elevations.

DVB-S TV from Columbus

	Value	Unit
Downlink frequency	2.450	GHz
ISS to E/S range	**1000**	Km

EARTH STATION CHARACTERISTICS		
Antenna diameter	0.90	meters
Efficiency	50%	
Rx Antenna gain	**24.3**	dBi

Antenna Noise Temperature	100	K
LNB gain	35	dB
LNB noise figure	0.8	dB
LNB equiv noise temp	**58.7**	K

FIGURE of MERIT G/T		
System Noise Temp	**158.7**	K
System Noise Figure	**1.9**	dB
G/T	**2.3**	dB/K

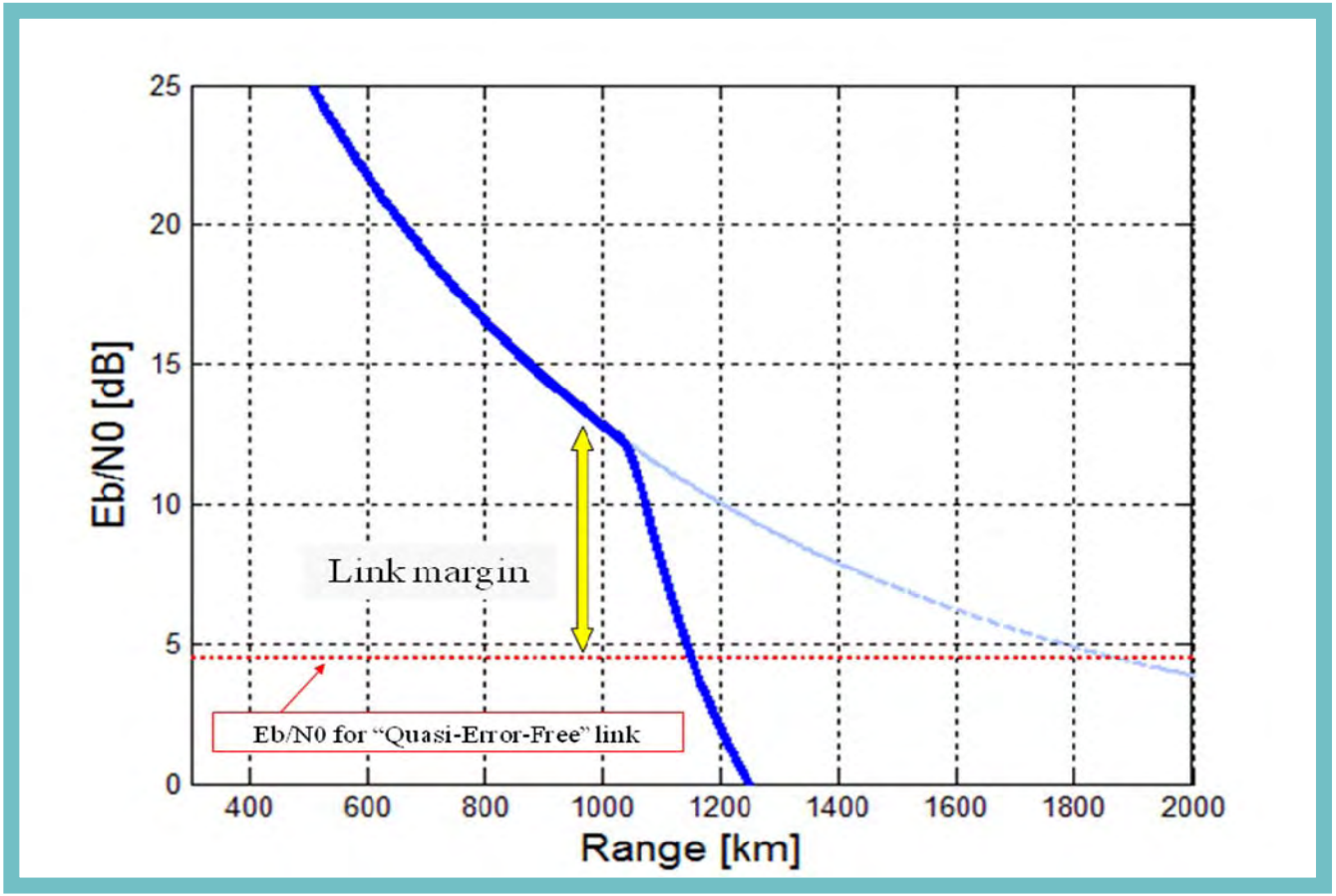
CARRIER CHARACTERISTICS		
Data Rate	**922**	kbps
Reed Solomon	188/204	
Modulation	QPSK	
FEC	1/2	
Symbol Rate	**1000**	kbaud
Carrier's occupied bandwidth	**1.35**	MHz

TX & Downlink		
TX power	10.0	dBW
cable & connector losses	7.0	dB
TX Antenna gain (boresight)	8.0	dBi
pointing losses	10.5	dB
Downlink e.i.r.p. toward earth receive station	0.5	dBW
Downlink path loss (free space)	**160.3**	dB
Atmospheric losses	0.0	dB
Rain attenuation losses	0.0	dB

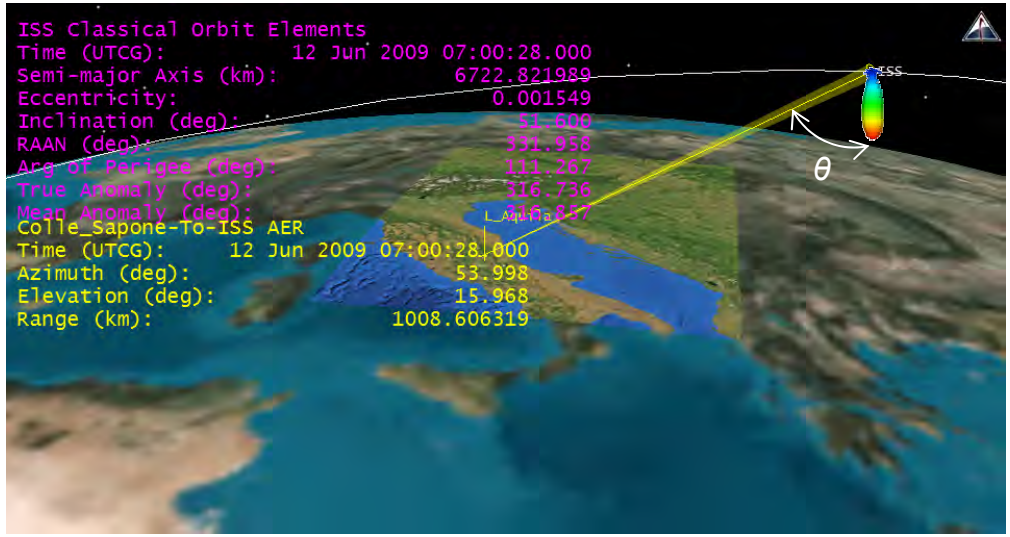
C/No	**71.1**	dBHz
C/N	**9.8**	dB
Eb/No (Available)	**11.4**	dB
Eb/No (Required)	**4.5**	dB
Link Margin	**6.9**	**dB**

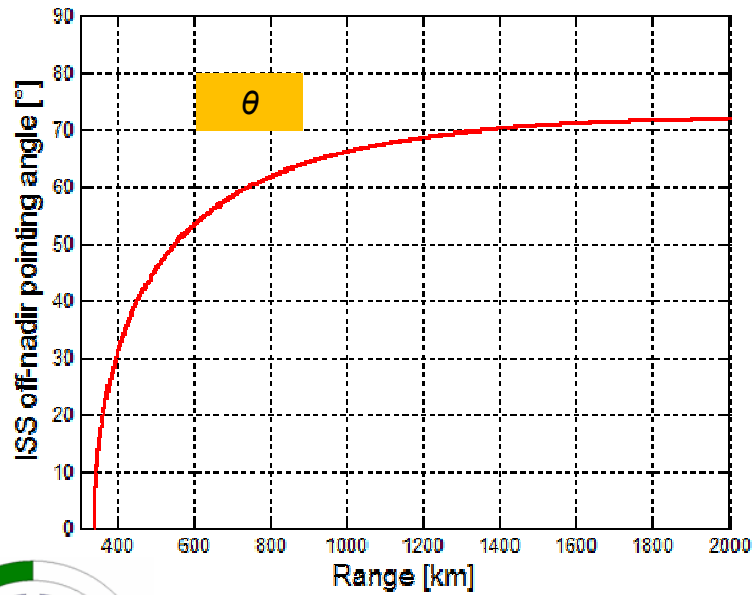
Preliminary transmission parameters based on DVB-S Television Standard

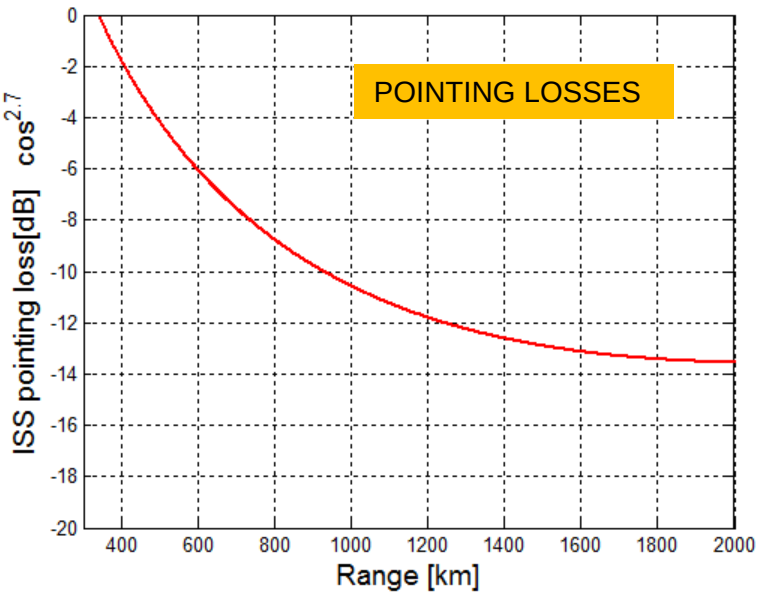
Link Margin


25
20
15
10
5
0
Eb/N0 [dB]
Link margin
Eb/N0 for "Quasi-Error-Free" link
400
600
800
1000
1200
1400
1600
1800
2000
Range [km]

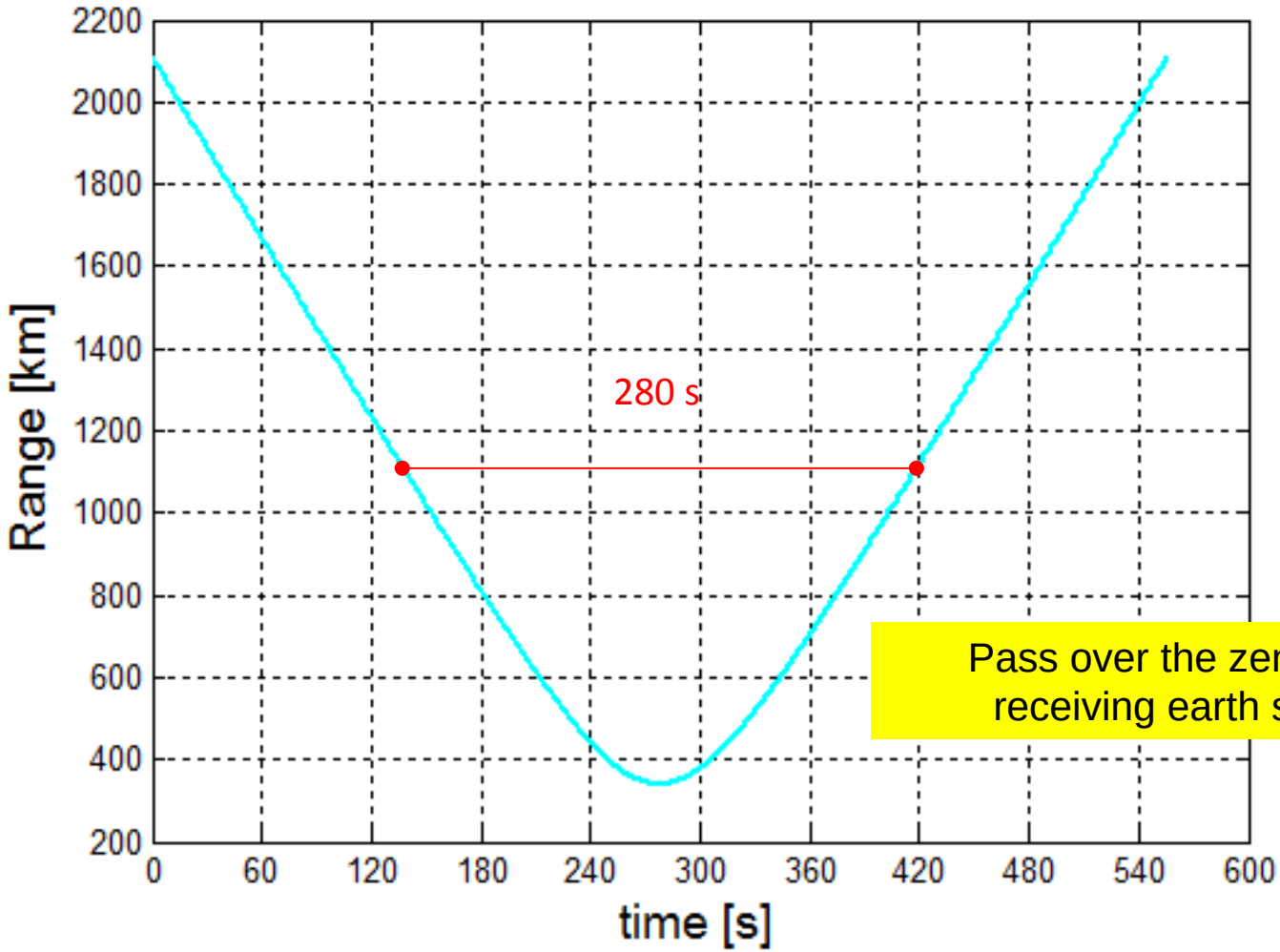
Pointing losses





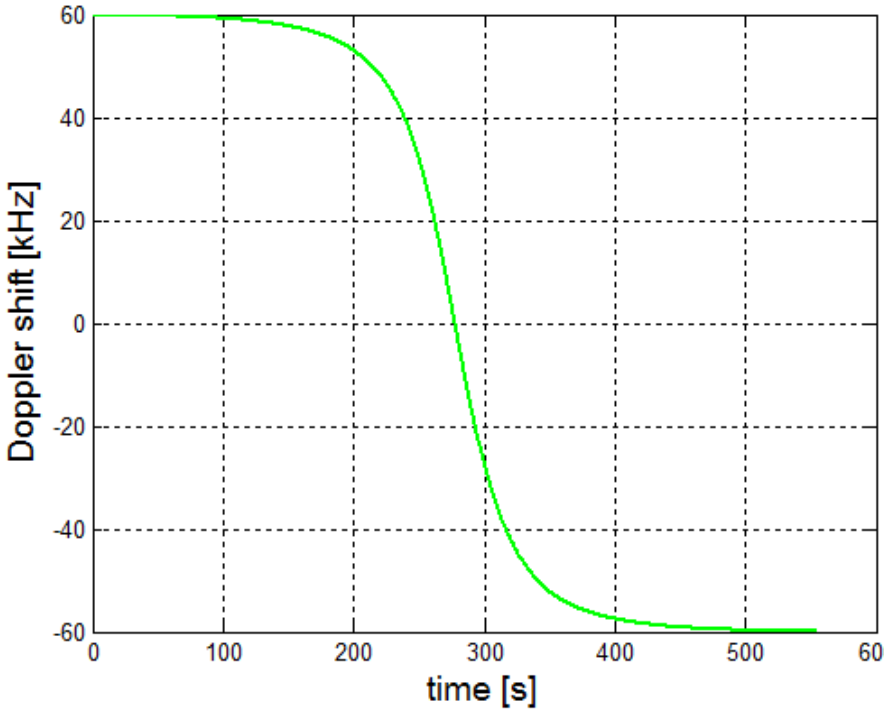


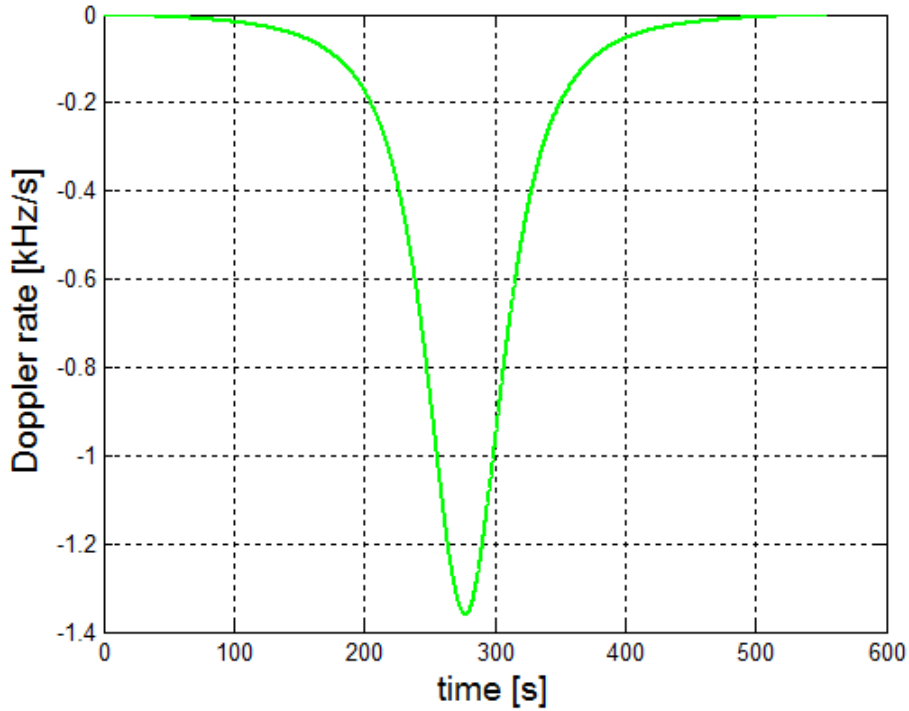
Video link duration



Pass over the zenith of a receiving earth station

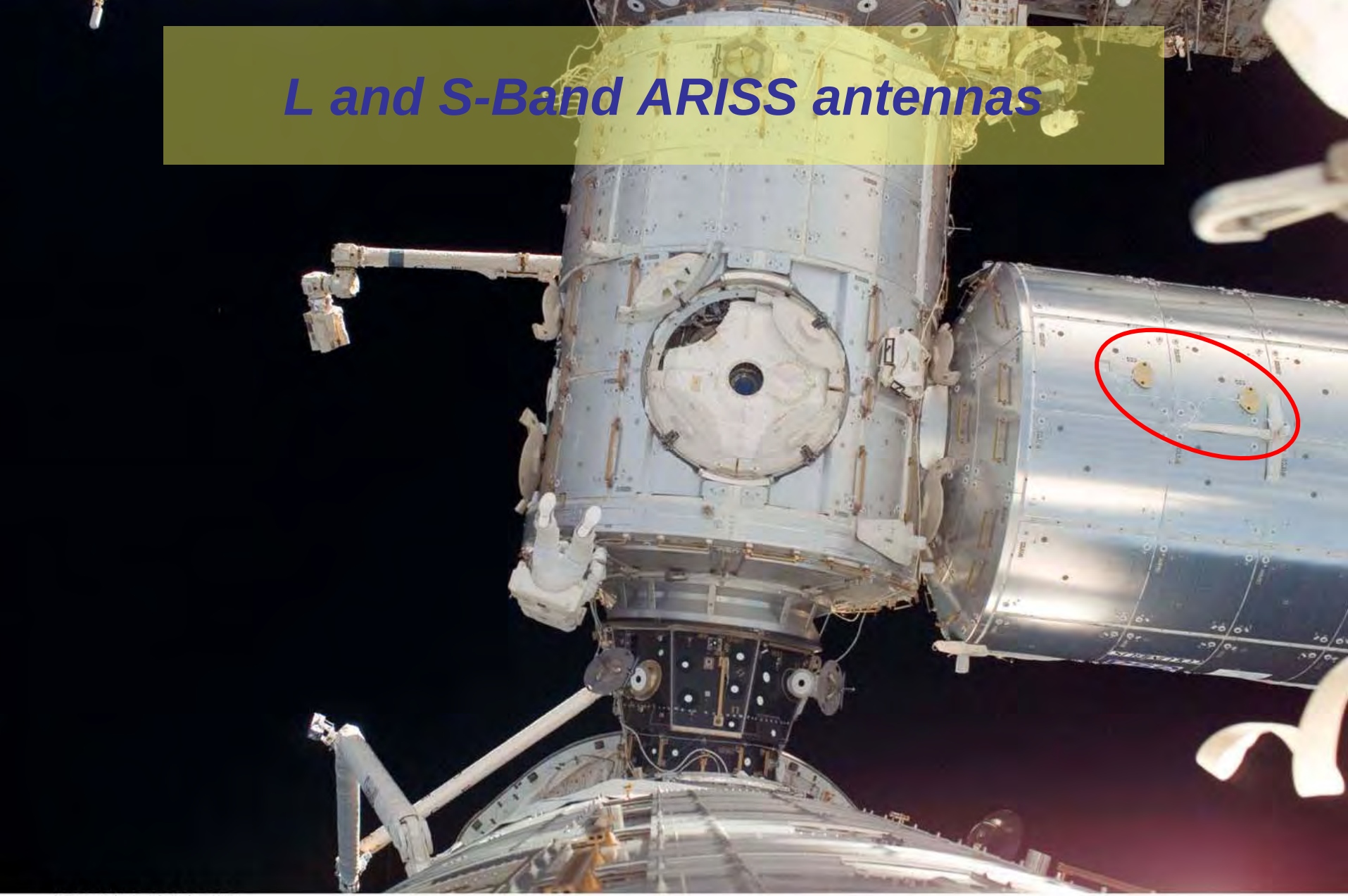
DOPPLER Effect





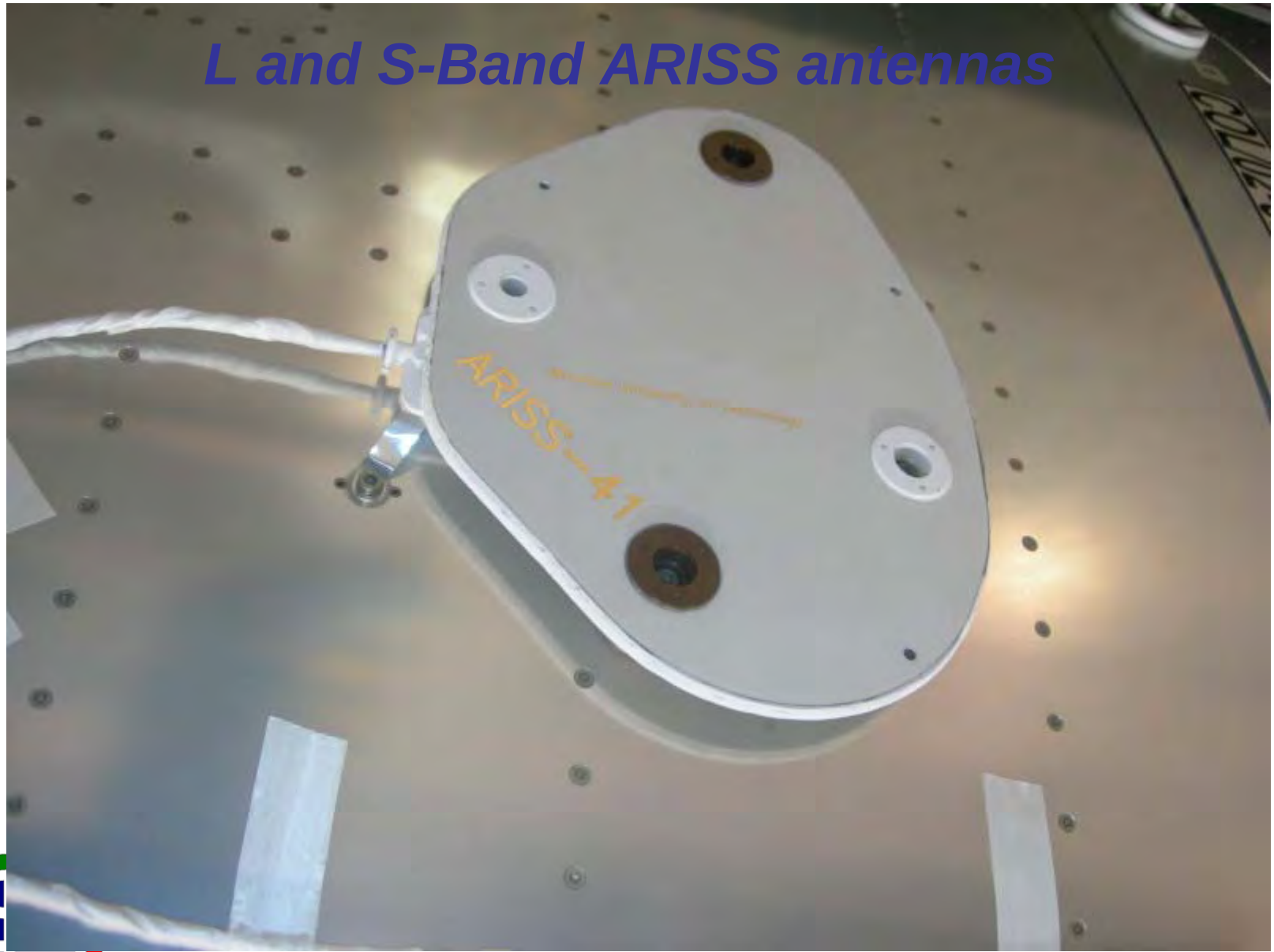
Computer simulations by Centro Ricerche RAI, Torino, show no negative impact due to Doppler-rate

L and S-Band ARISS antennas

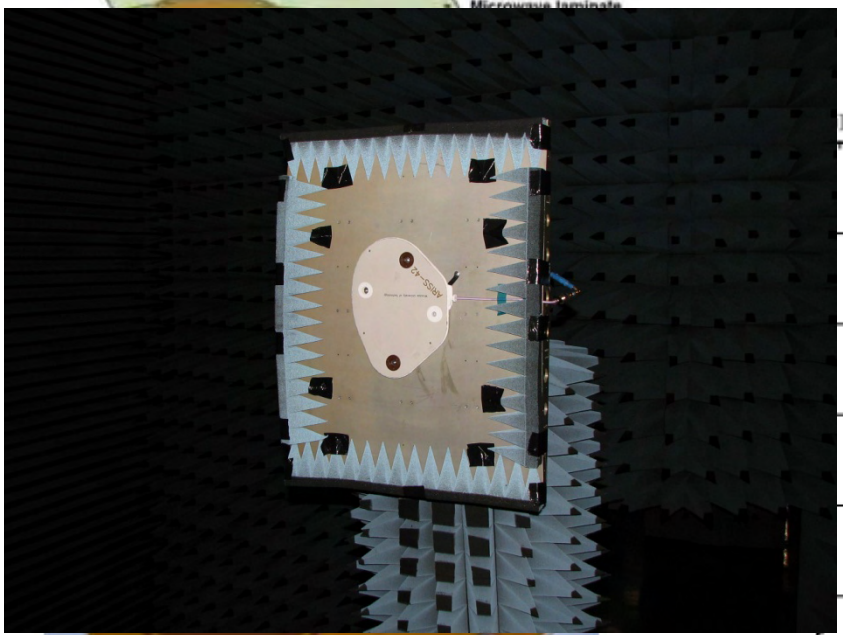


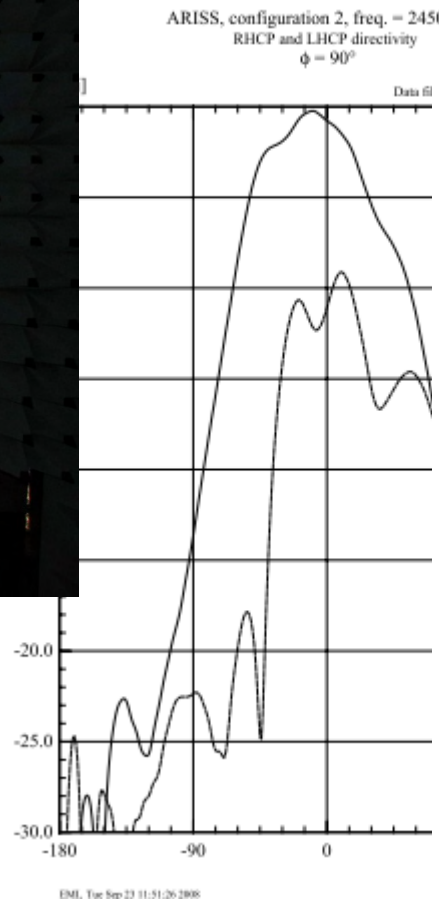
ISS017E008746

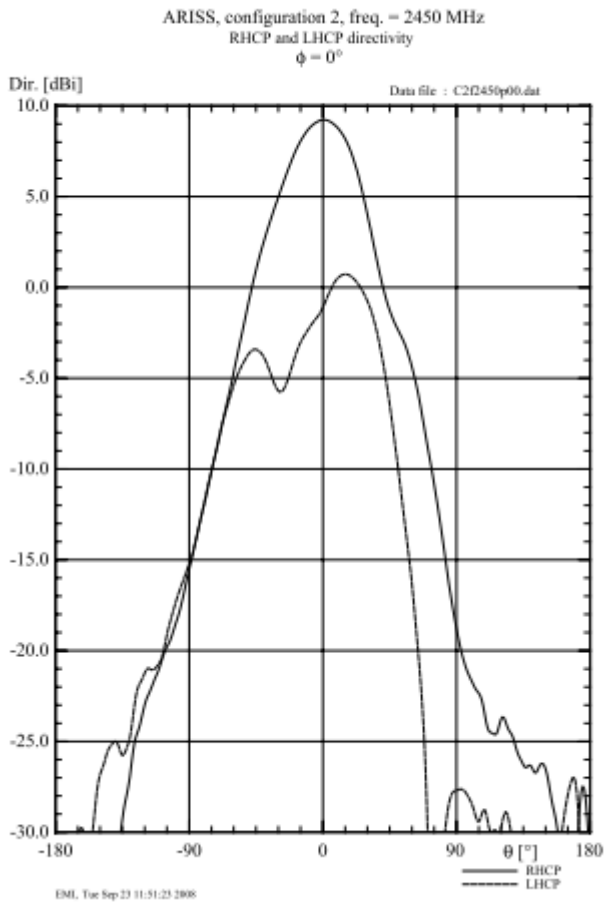
L and S-Band ARISS antennas



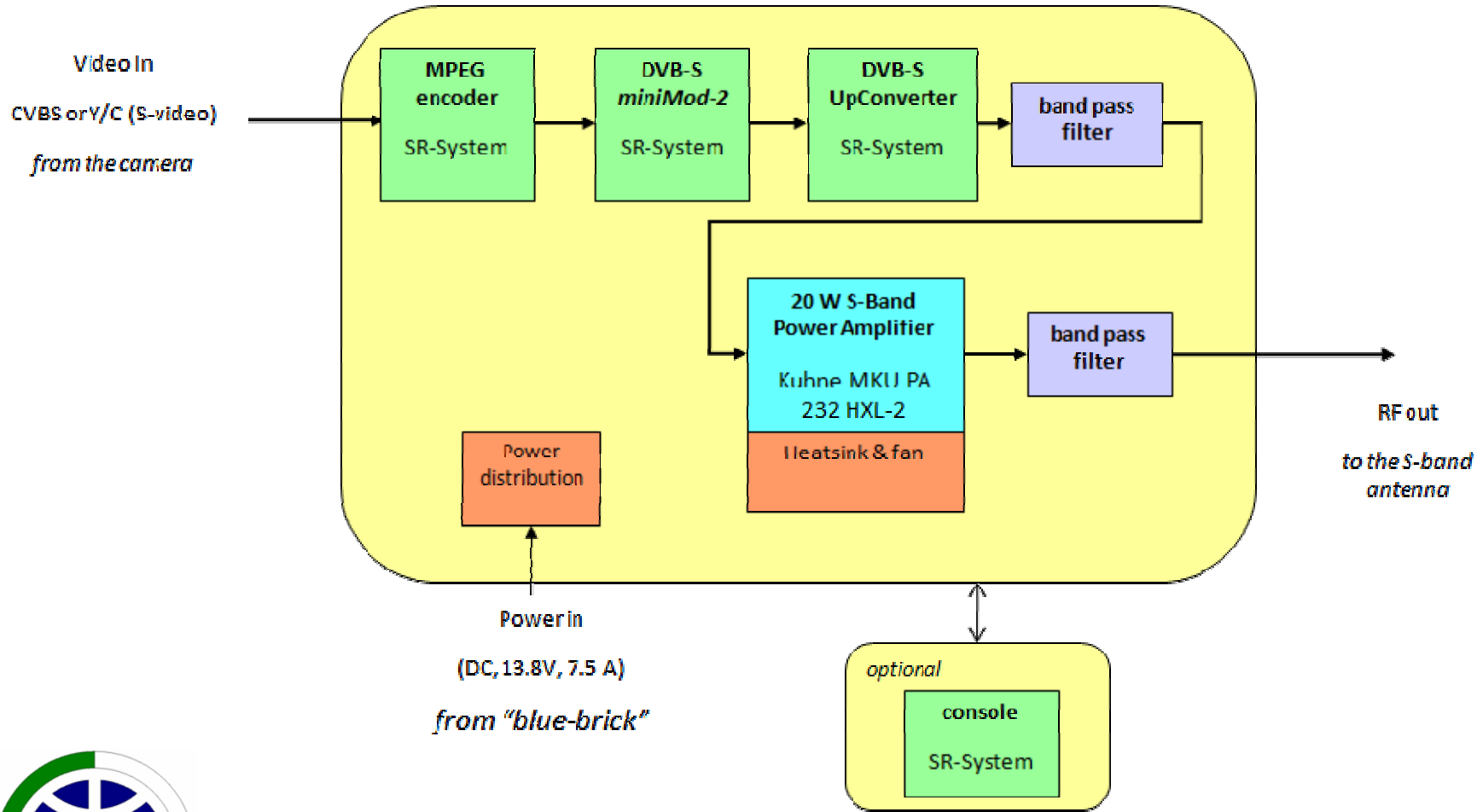
L and S-Band ARISS antennas





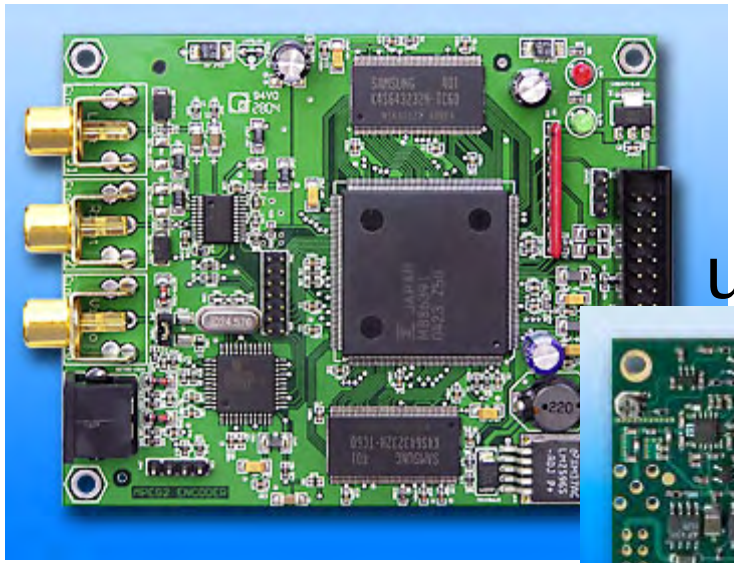


HAMTV transmitter

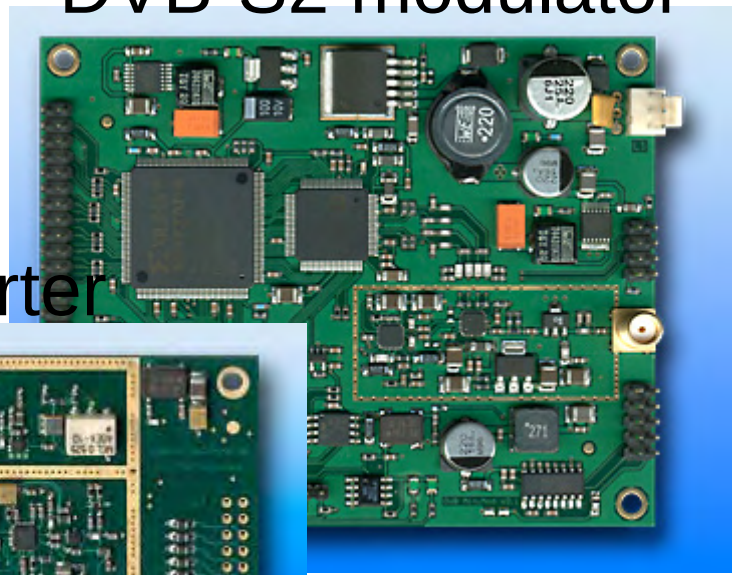


Main modules

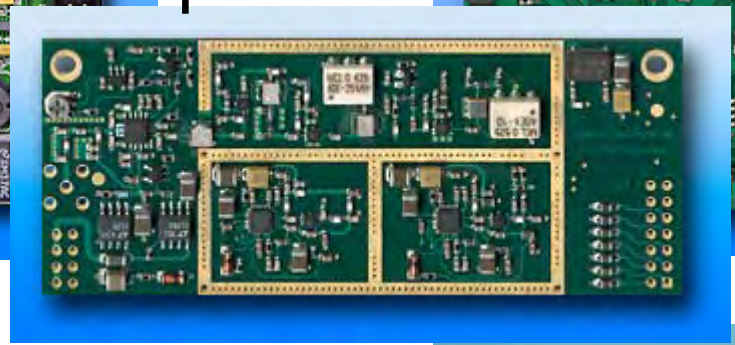
MPEG encoder



DVB-S2 modulator



upconverter

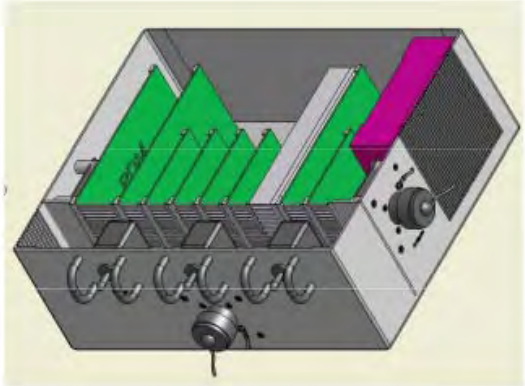


P.A.

console

HAMVIDEO box

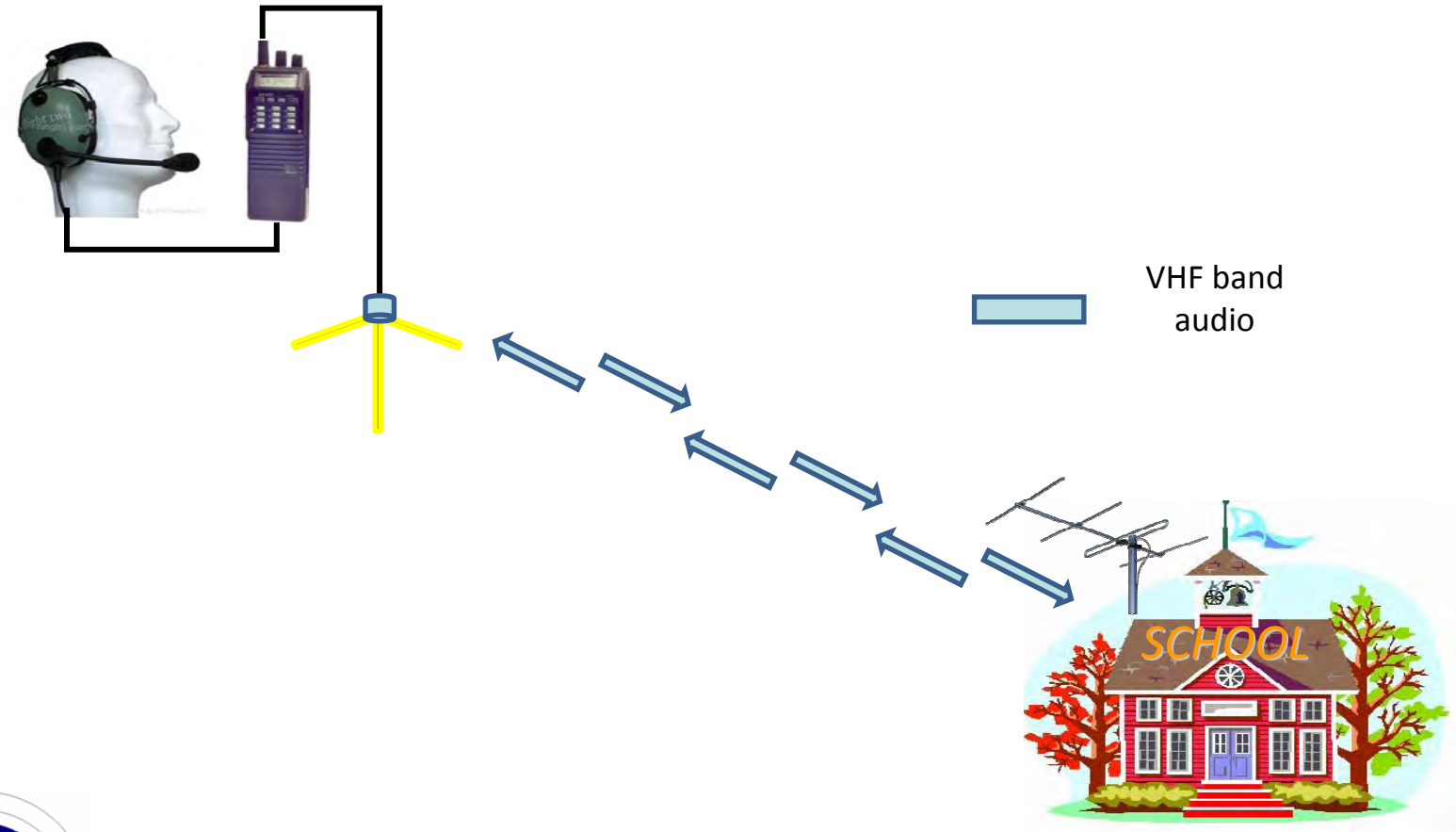
The HAMVIDEO payload will be accommodated inside a suitable container, developed and qualified by KI, based on the heritage of the BIOKON container.



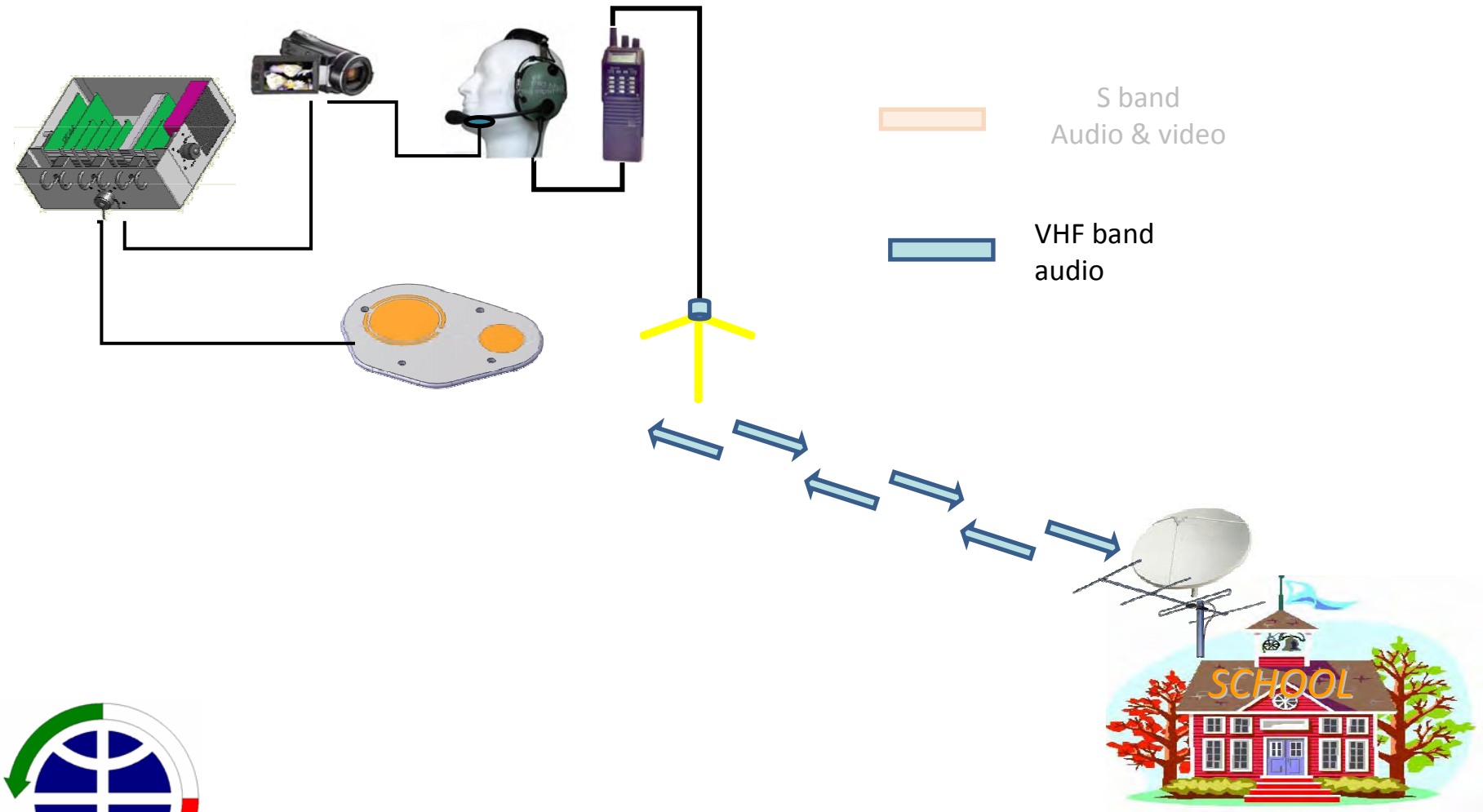
HAMVIDEO units accommodation

Front Panel

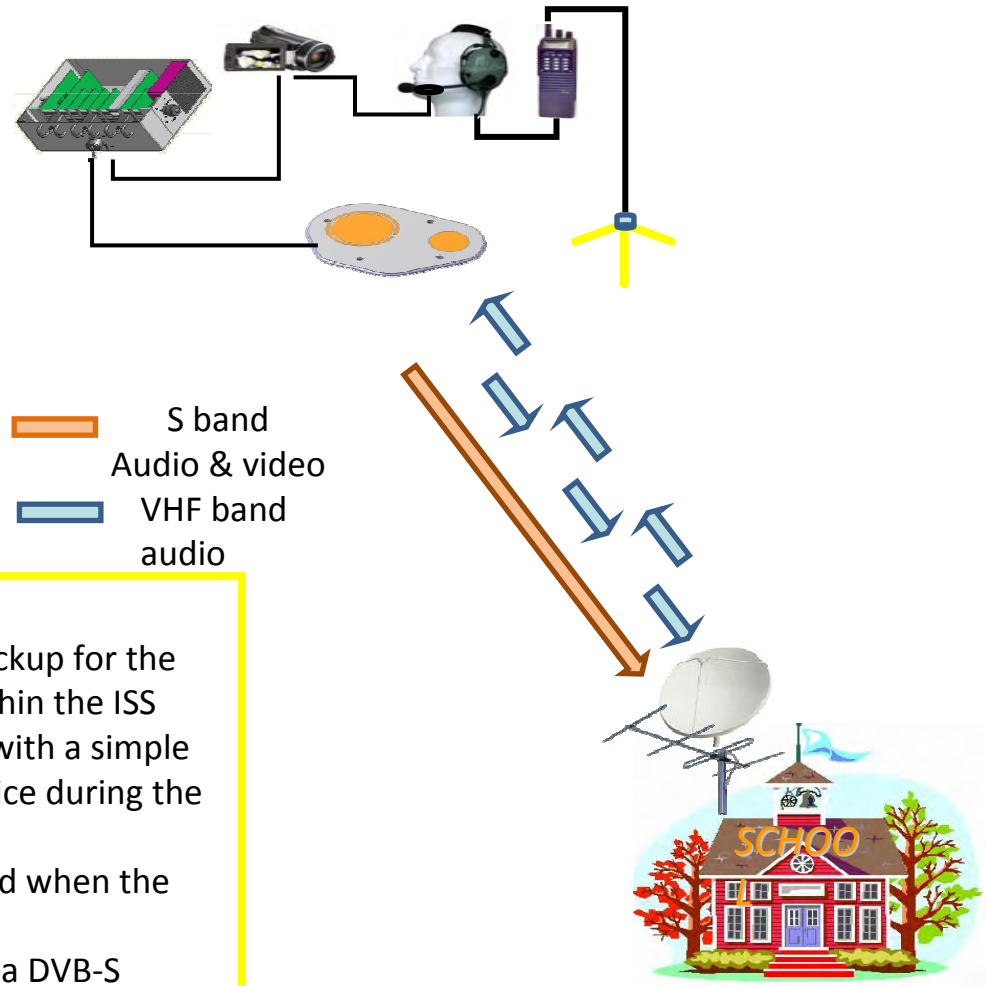
Traditional, voice-only, bidirectional, half-duplex school contact



First portion of the HAMTV school contact (approx. first 3 minutes)

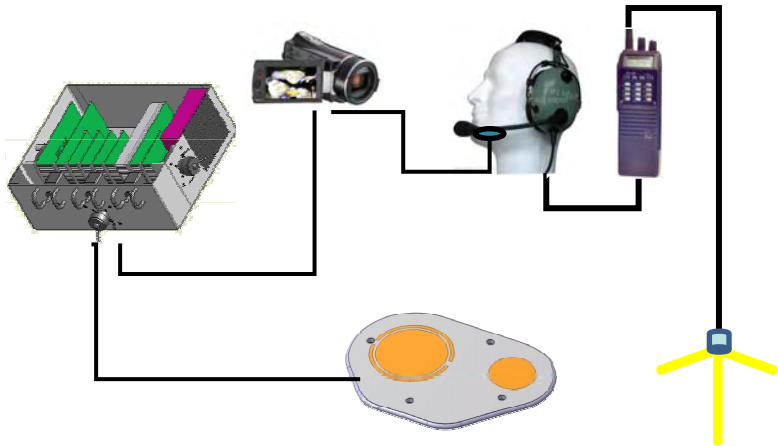


Central part of the HAMTV school contact: live video from ISS (duration up to 5 minutes)



NOTE:
1) VHF audio downlink acts as a backup for the school and allows ham stations within the ISS visibility circle to receive ISS voice with a simple hardware. Hams will receive ISS voice during the whole pass.
2) Lip synchronizazion is guaranteed when the school listen to the “S band voice”
3) Any ham station, equipped with a DVB-S receiver similar to the one used in the school and within the ISS visibility circle, can catch the video downlink.

Last part (greetings) in voice-only mode



S band
Audio & video

VHF band
audio

On ground receiving station

Low-Noise-Amplifier
& Downconverter
e.g. SPECTRA SPDC2400

Free-To-Air DVB-S
Set-Top-Box

TV set or videoprojector

outdoor unit

indoor unit

Ground station receiving antenna

2.4 GHz Circular polarized patch feed for prime focus dishes

2G4PF1L

for every prime focus dish

2.4 GHz circular polarized helix feed for TVRO offset dishes

2G4HF1L

for every "sat-tv" offset dish

- LHCP for dish mounting
- Professional milled aluminium
- Specially designed for satellite use
- Fits to every offset TV dish
- PE low loss radome
- Male and Female N conn. available
- Very easy dish mounting

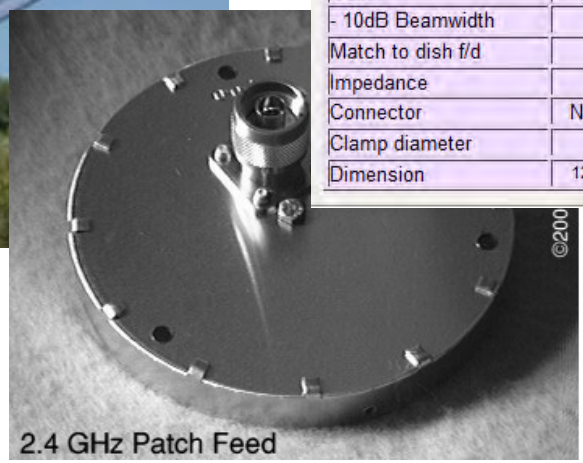
Polarization	LHCP
Center frequency	2400 MHz
Bandwidth	100 MHz
Gain	9.5 dB iso circ.
- 10dB Beamwidth	105°
Match to dish f/d	0.48 - 0.65
Impedance	50 ohm
Connector	N male or female
Clamp diameter	35 mm
Dimension	120 x 120 x 240 mm

Male N connector order code is: 2G4HF1L/M
Female N connector order code is: 2G4HF1L/F

download datasheet

mounting
milled aluminium
igned for satellite use
prime focus dish
unting
nale N conn. available

r code is: 2G4PF1L/M
der code is: 2G4PF1L/F



2.4 GHz Patch Feed

Ground station pointing system

Example of a mobile receiving antenna by PRO.SIS.TEL (Bari)

80-cm dish

0.2° accuracy

complete track 6 s

COTS LNBs

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S-Band Downconverter

Summary

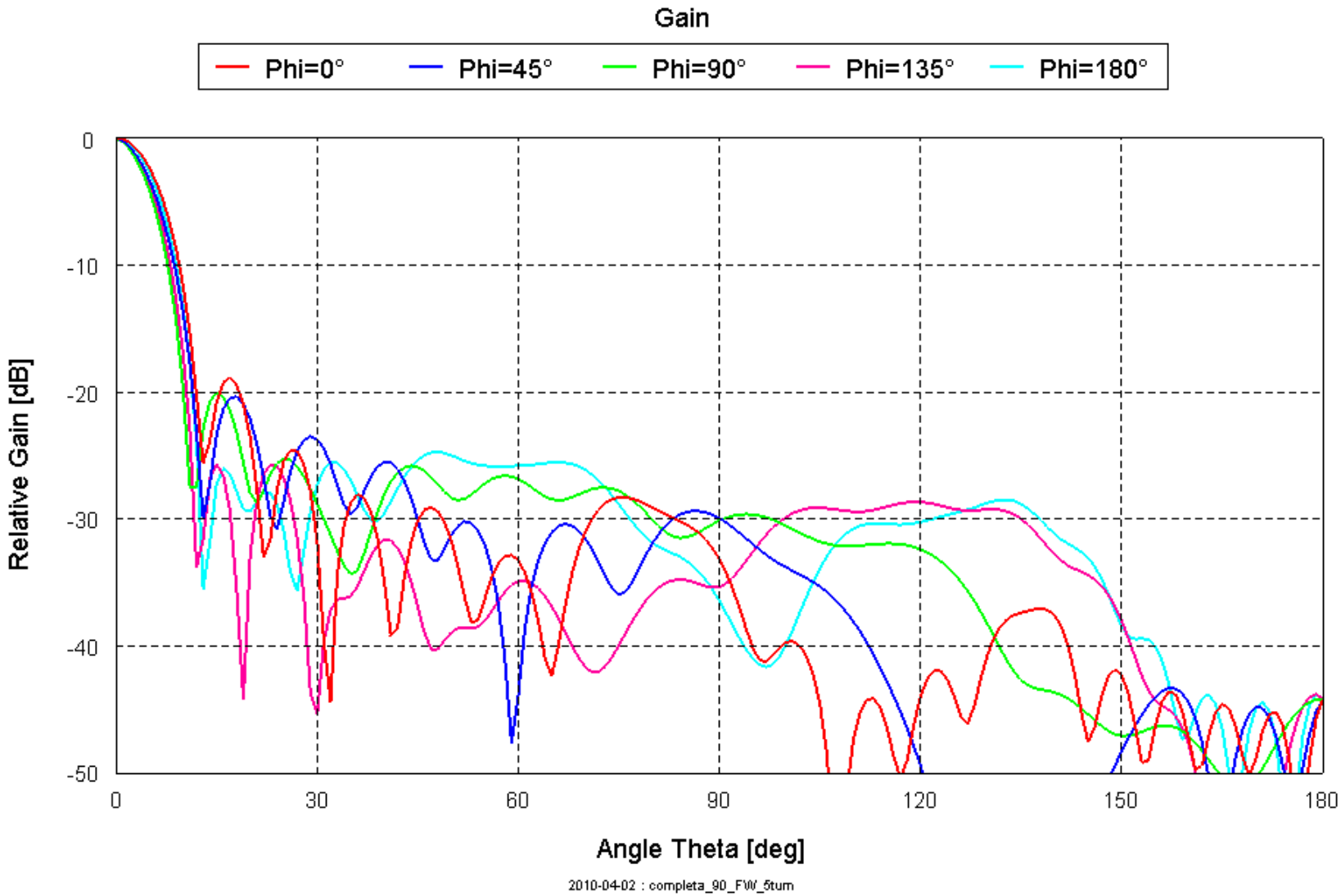
Low Cost Drop-in solution
Plug and play ready for standard settop boxes.

Low phase noise
Due to a very stable and low noise internal synthesized source an ideal solution for phase noise susceptable applications.

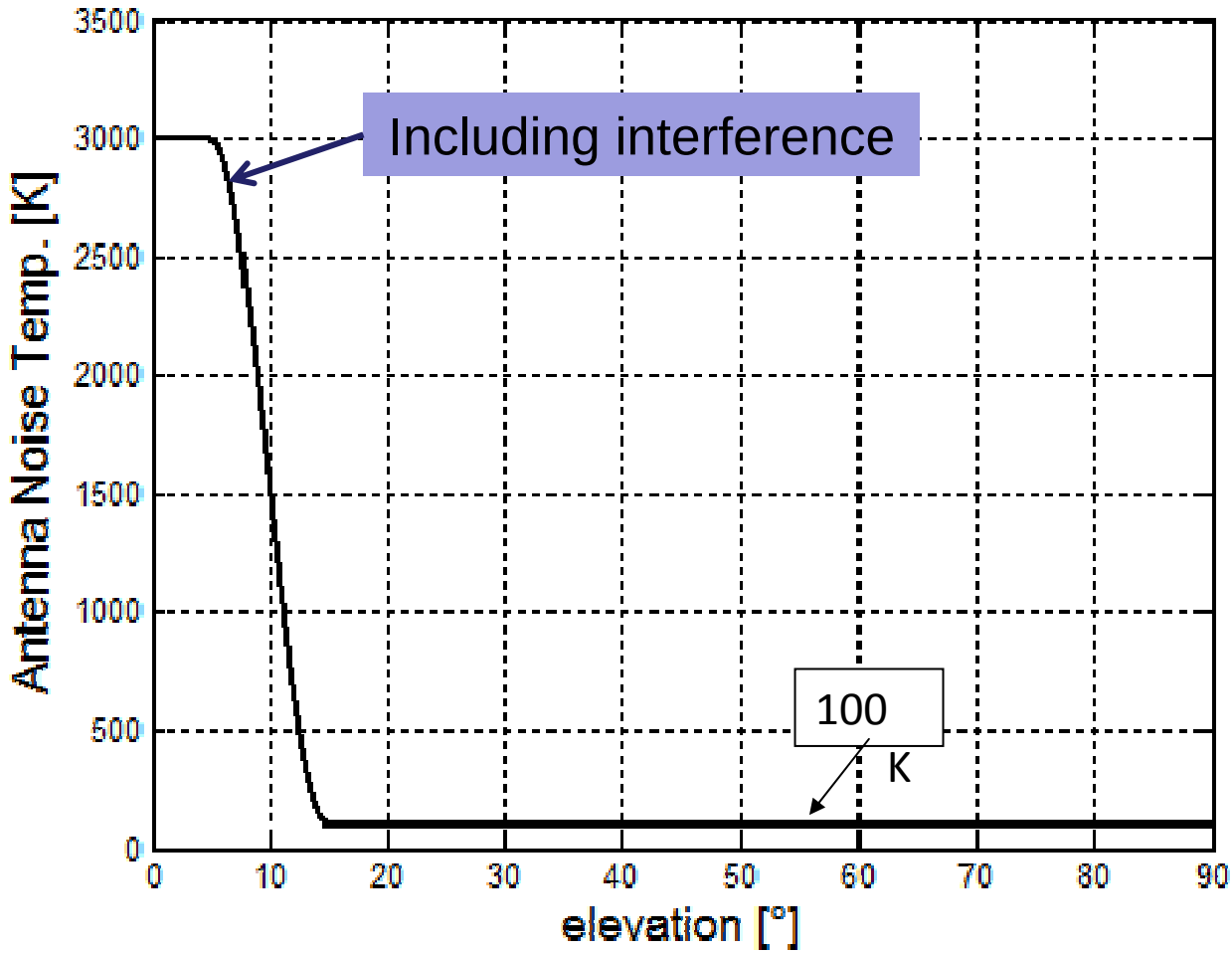
Unconditional stable design
No parasitic oscillations. Unconditional stable for a wide range of input terminations.

Excellent overall Noise Figure
With an overall noise figure of better than

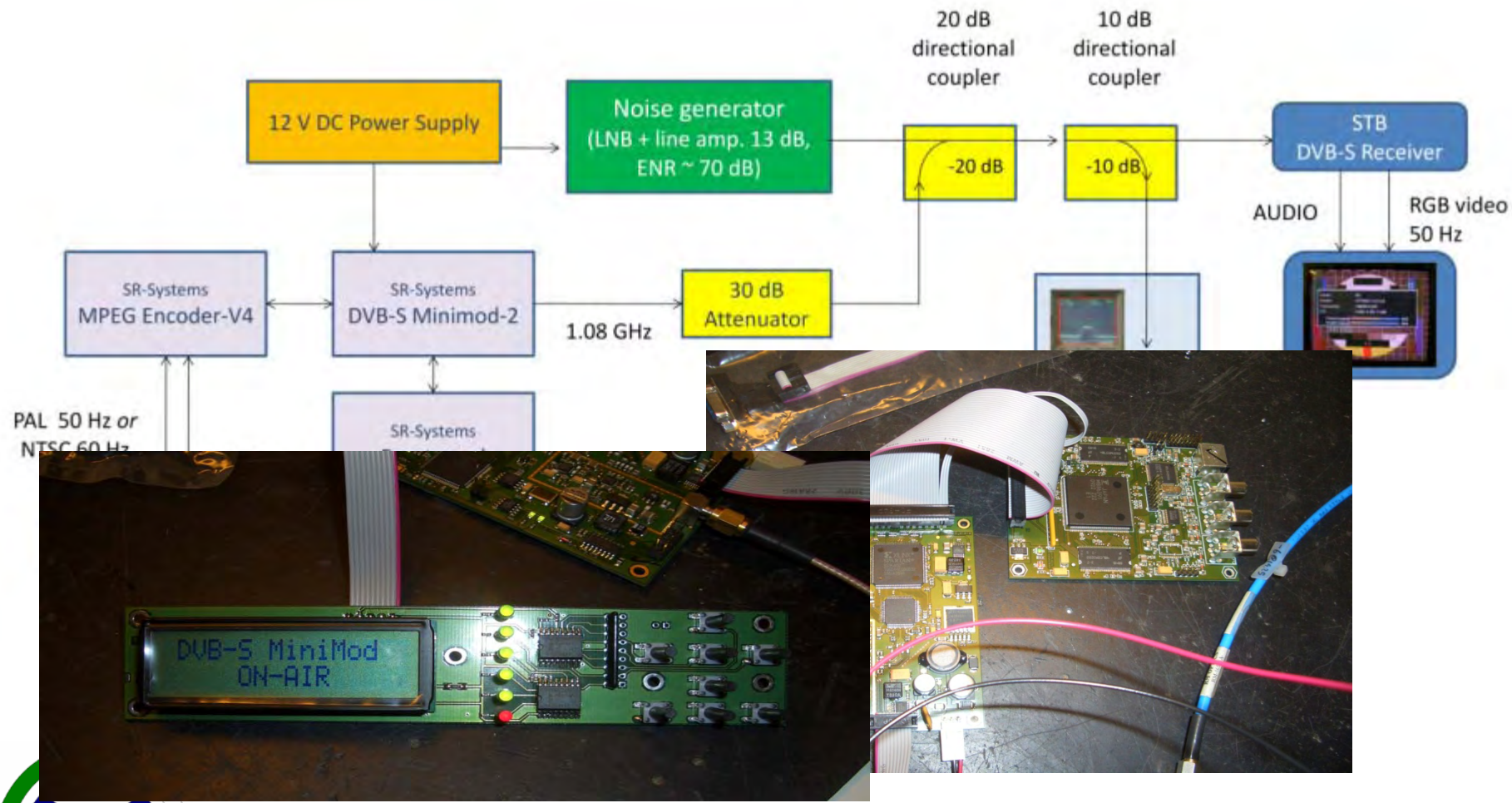
A computer model Antenna pattern



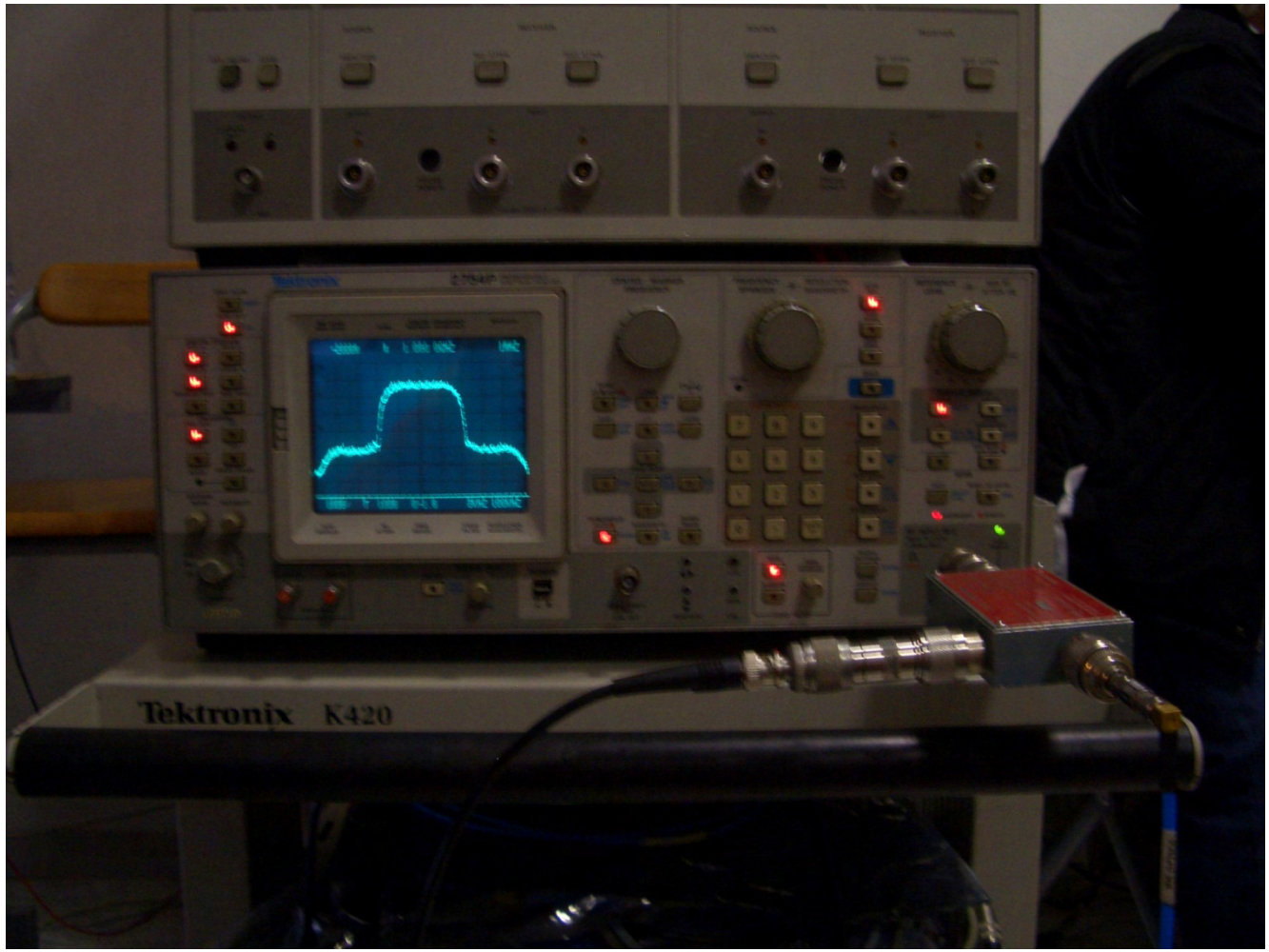
Earth Station Antenna Noise Temperature



TEST-BED at LTG Elettronica

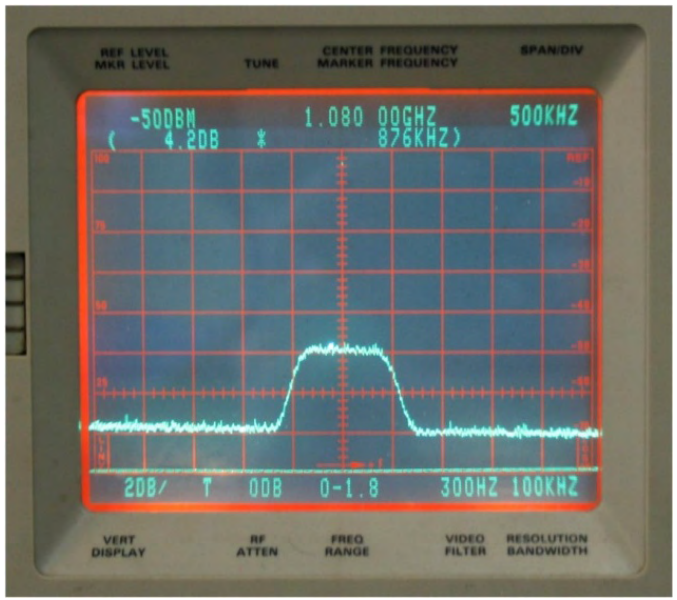


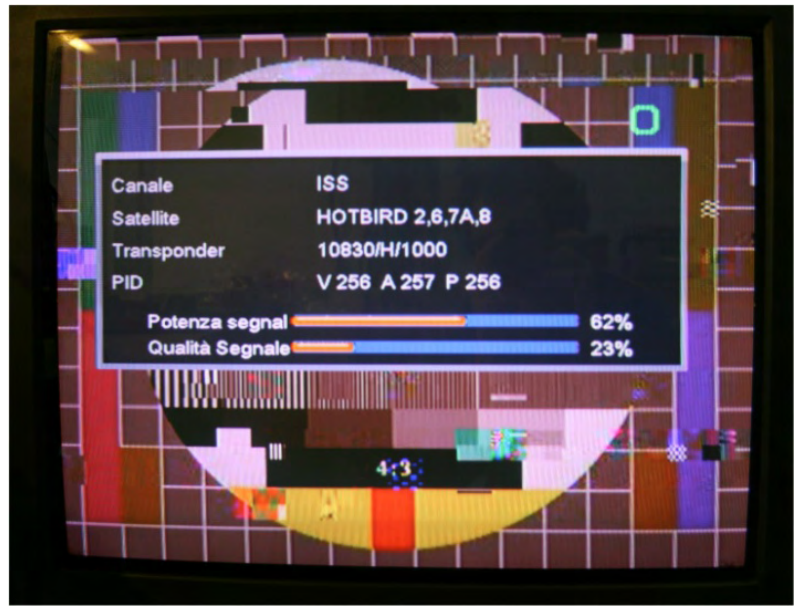
First results in IF-LOOP



First results in IF-LOOP

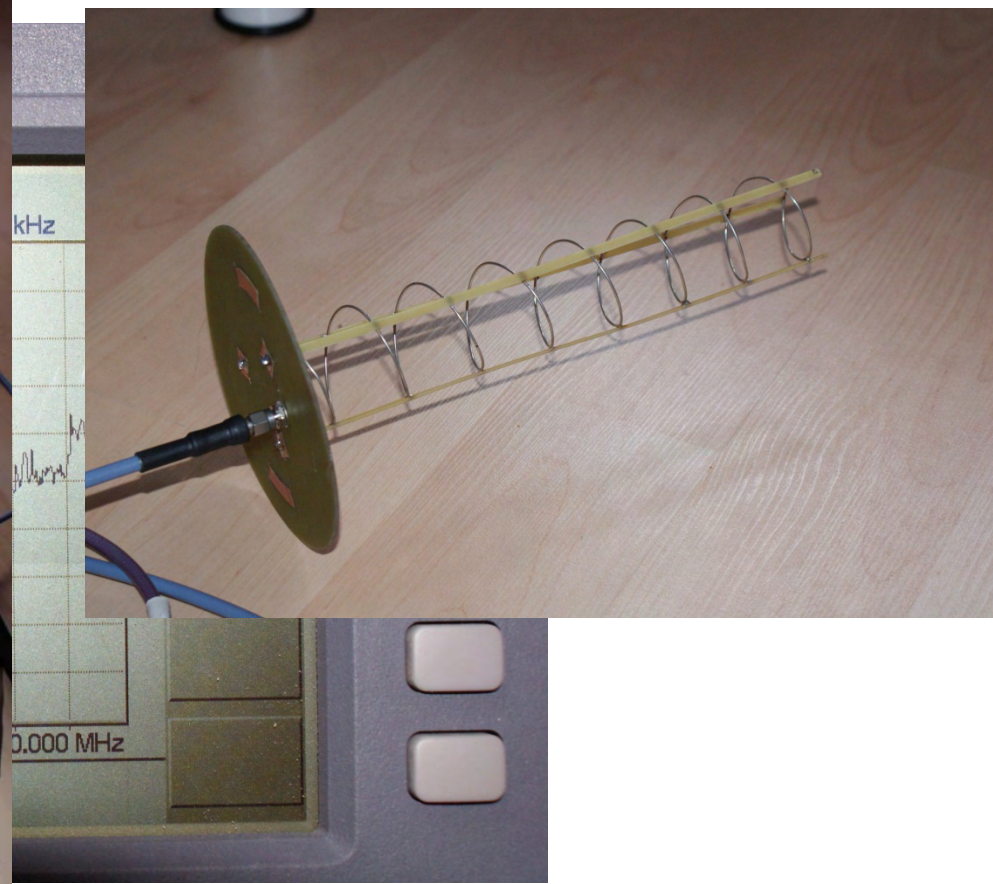
First results in IF-LOOP



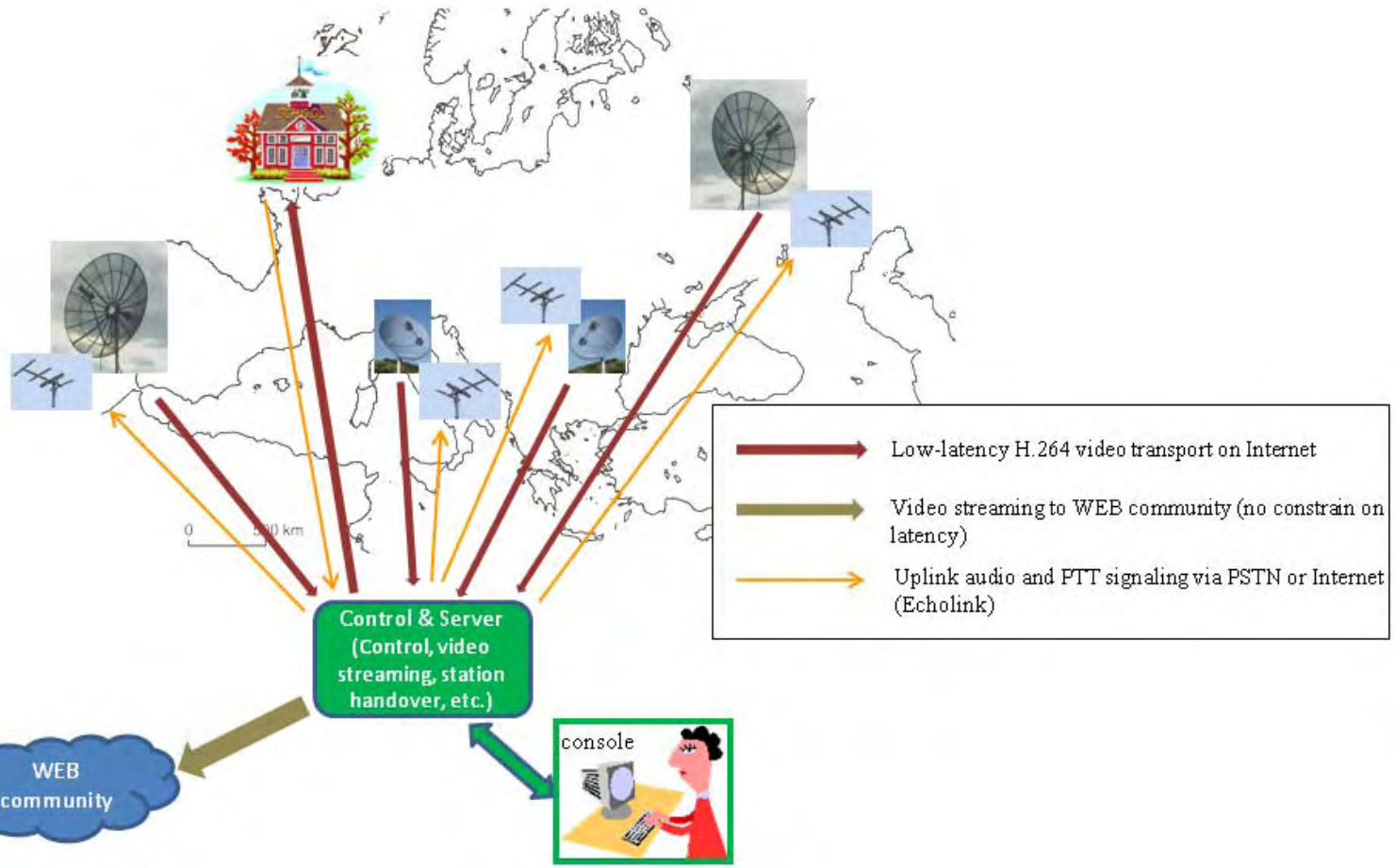


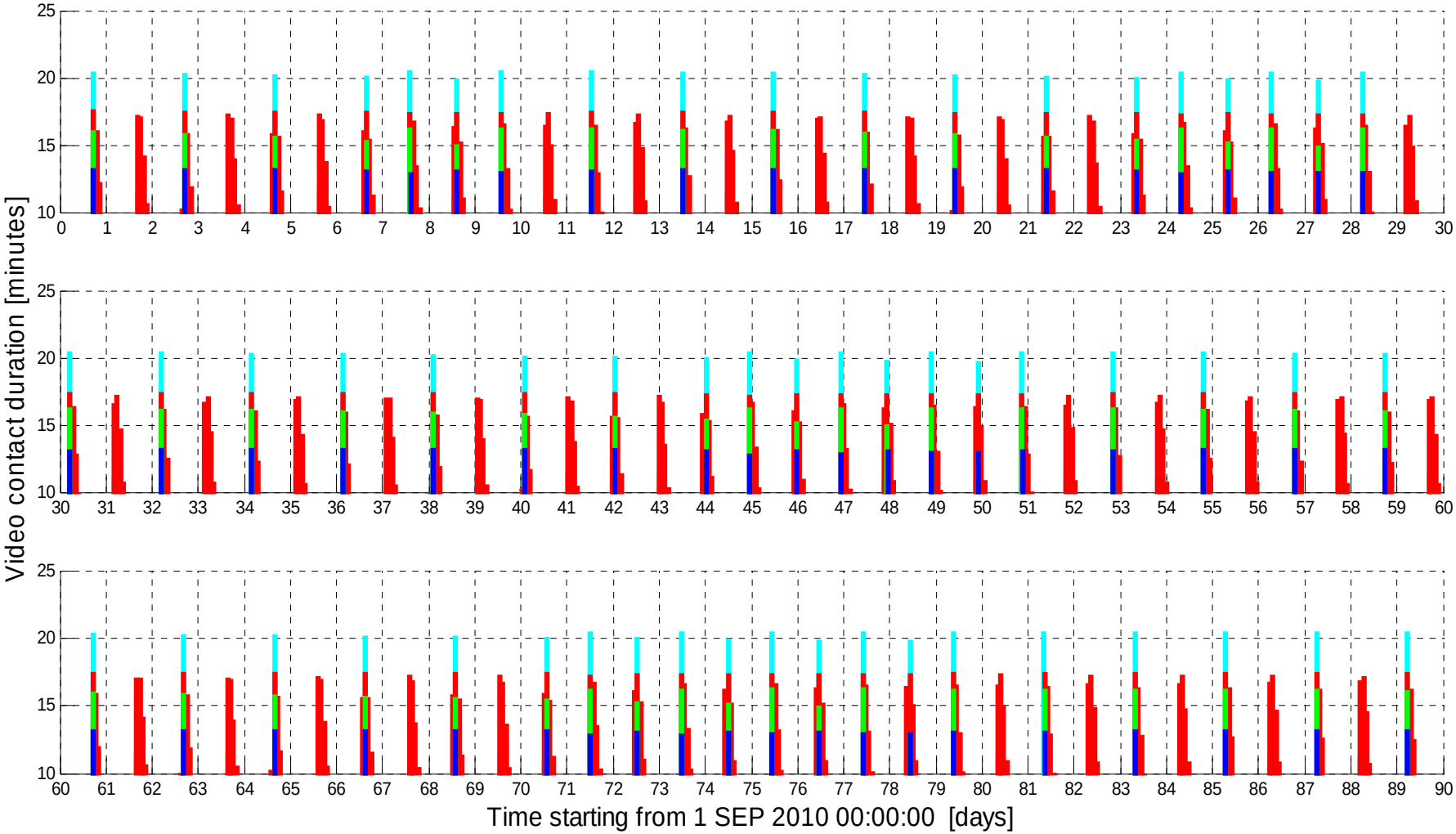
An example of noise level setting, corresponding to $(C_0+N_0)/N_0$ = 4.2 dB and its effect on video quality, as shown in the image on the right. FEC = 3/2. This situation was considered to be below the receiver threshold. The threshold was at about $(C_0+N_0)/N_0$ = 4.5 dB.

First environment measurements



Chained Ground Segment





Video contact duration for a 90 days period starting September 1st, 2010

Chained stations (and antenna diameters):

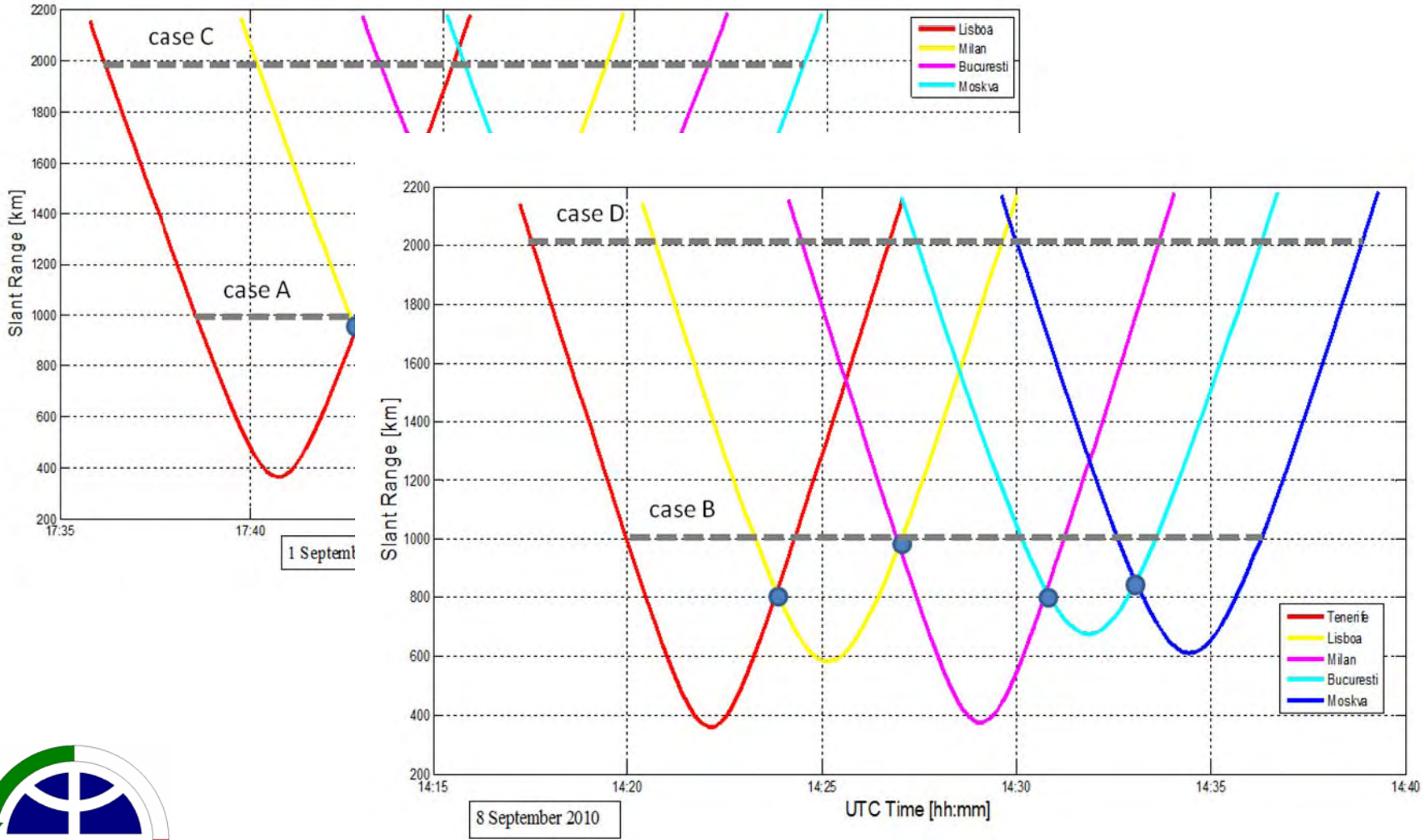
Blue: (case A) Lisboa (1 m), Milano (1 m), Bucaresti (1 m), Moskva (1 m)

Green: (case B) Tenerife (1m), Lisboa (1m), Milano (1m), Bucaresti (1m), Moskva (1m)

Red: (case C) Lisboa (2.5m), Milano (1m), Bucaresti (1m), Moskva (2.5m)

Cyan: (case D) Tenerife (2.5m), Lisboa (1m), Milano (1m), Bucaresti (1m), Moskva (2.5m)

Hand-over among earth stations



THANKS to

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Francesco De Paolis IKØWGF,

Tonino Giagnacovo

Fabio Azzarello IW8QKU,

Paolo Pitacco IW3QBN,

Pierluigi Poggi IW4BLG

Gaston Bertels ON4WF

Oliver Amend DG6BCE

and the international ARISS/ARCOL WGs