ARISS HAMTV:
Ground Stations and TS Merger

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HAMTV Transmitter

- 2395MHz, 2 watts feed power.
- 2Msps DVB-S (QPSK), FEC ½
- Inputs:
  - NTSC Analogue Video
  - Analogue Audio
- Encoding
  - MPEG-2 Video (1500kb/s)
  - MP2 Audio (64kb/s)

HAMTV Transmitter - History

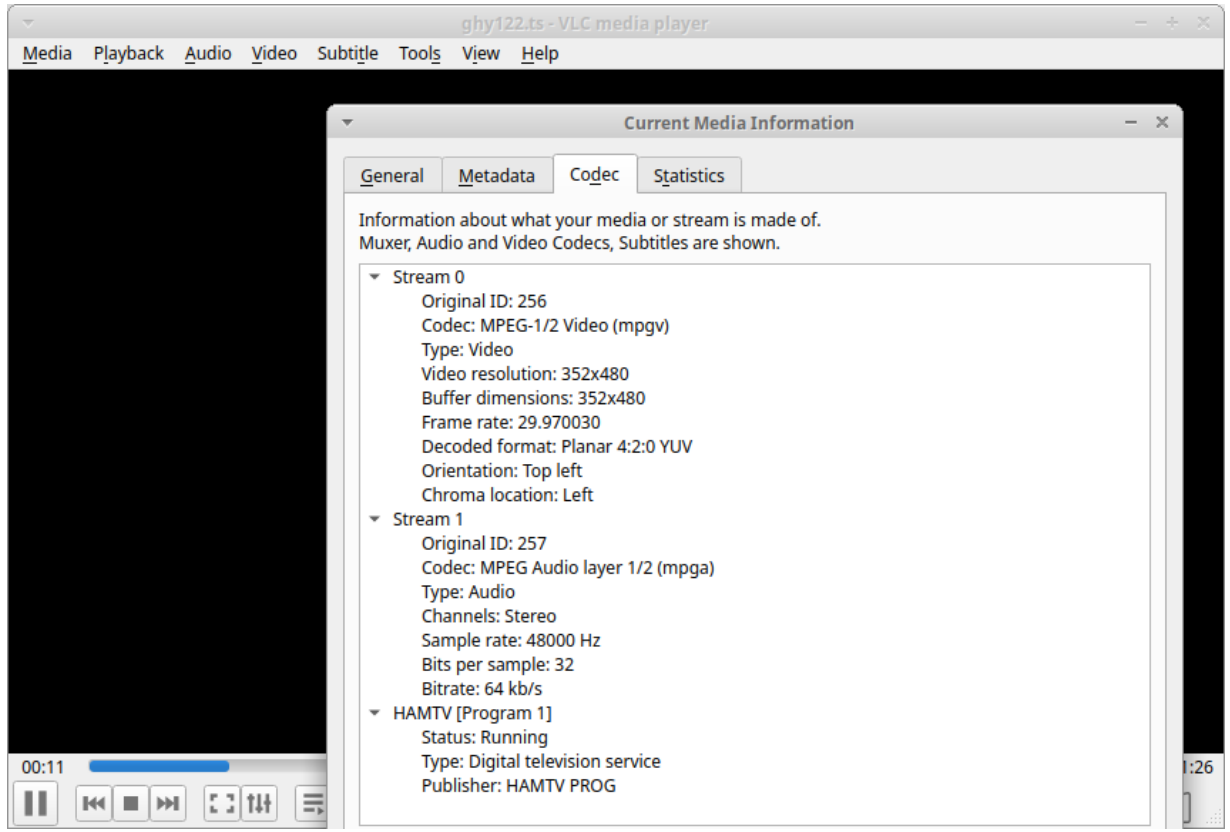
- 2008 - ESA's Columbus module launched with S- & L-band antennas
- HAMTV Transmitter built & certified for ARISS by Kayser Italia
- 2013 - Transmitter launched to Columbus Module
- March 2014 - First commissioned on ISS
- February 2016 - First used in a HAMTV Contact
  - Used in Tim Peake contacts, then others.
- April 2018 – Transmitter Failed
- January 2019 – Transmitter returned to earth
- March 2024 – Re-launched to ISS
- July 2025 – Installed and powered on!

Credit: Sian Cleaver

HAMTV Use

- ARISS Contacts use VHF/UHF FM Voice
  - Although HAMTV has audio, we do not use it in contacts
- HAMTV provides additional facet of live video via Amateur Radio.
- Students can ask for a wave!
- Astronaut can float upside down!
- Technical aspect, can talk about dishes alongside the yagis.

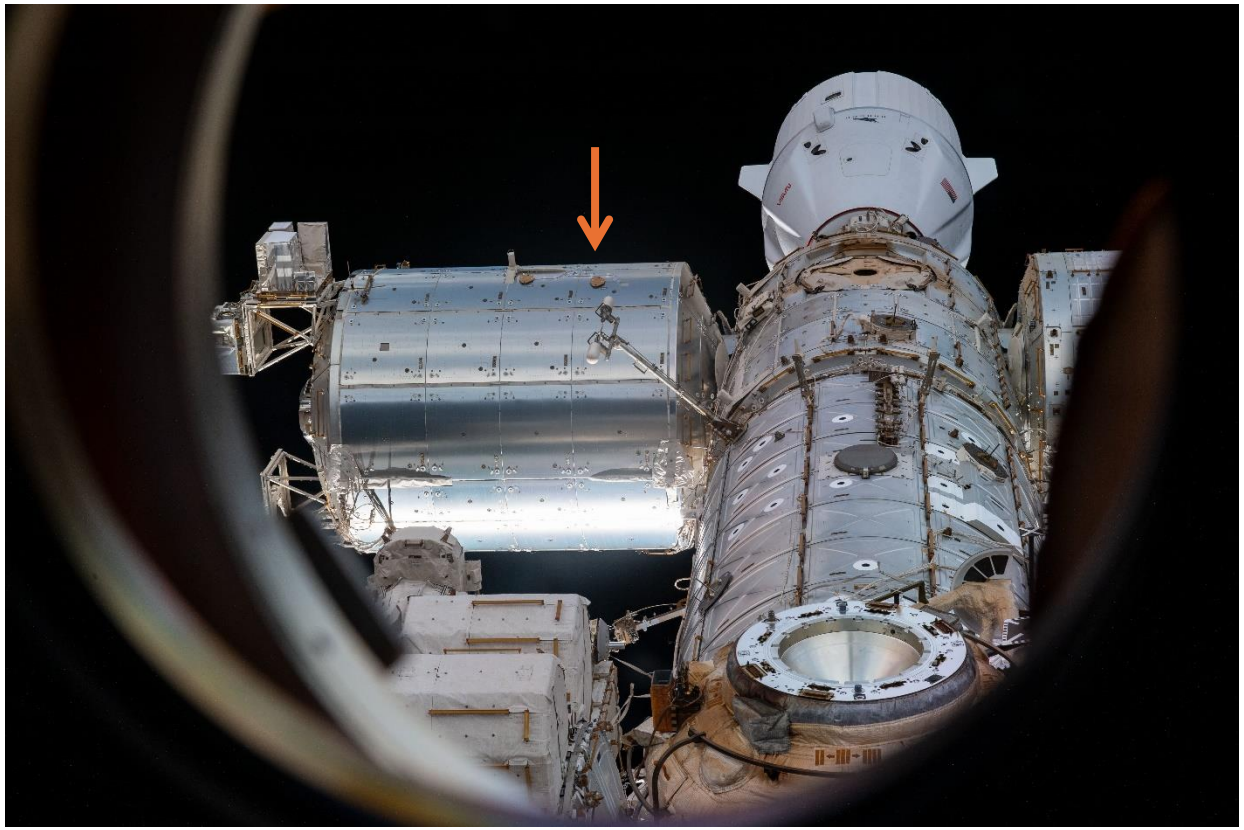
HAMTV Current Transmission

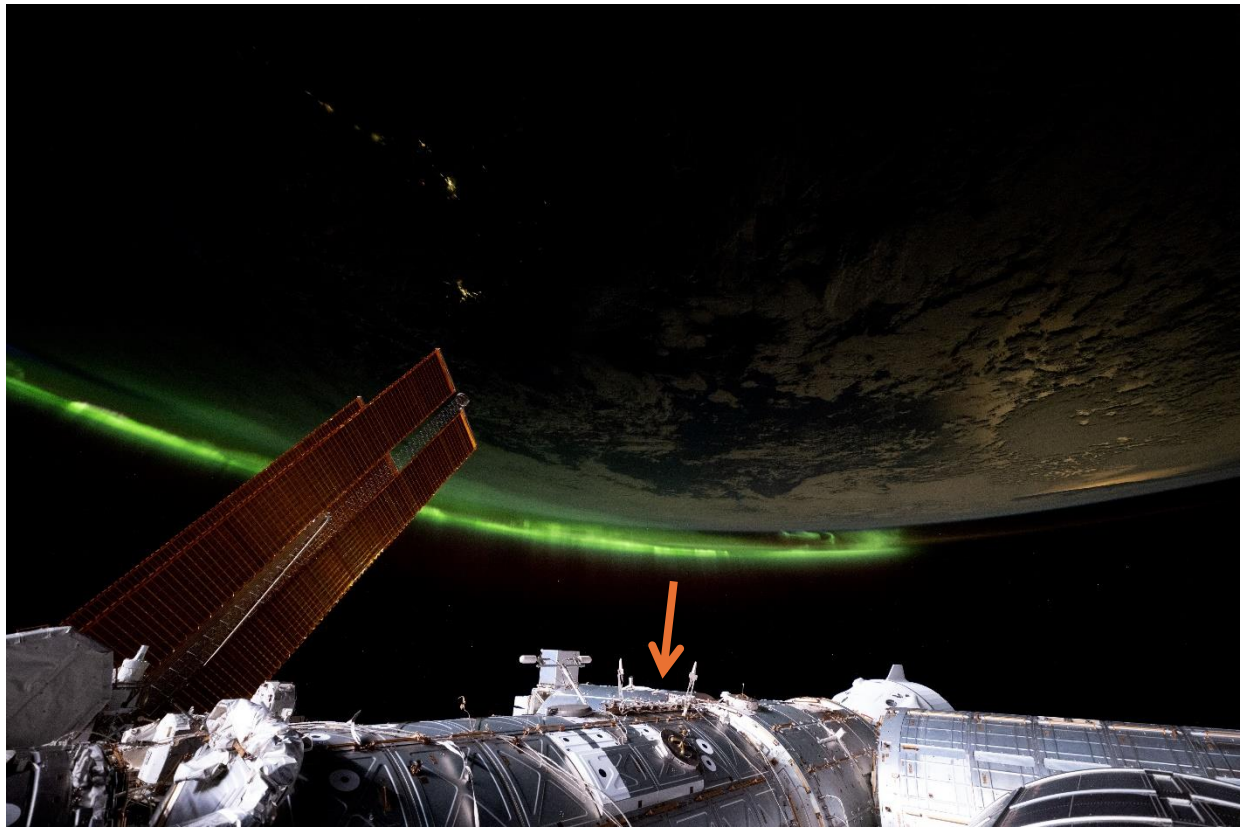


- Transmitter is on!
- Video ‘Sync Detection’ has been added during repairs.
- Video is ‘blanked’, audio is muted.
  - No blue line
  - No audio hiss
- Resolution is 352x480 (??!!)
  - Aspect Ratio still 16:9

- We expect camera video to be unchanged from 2017.
  - 854x480

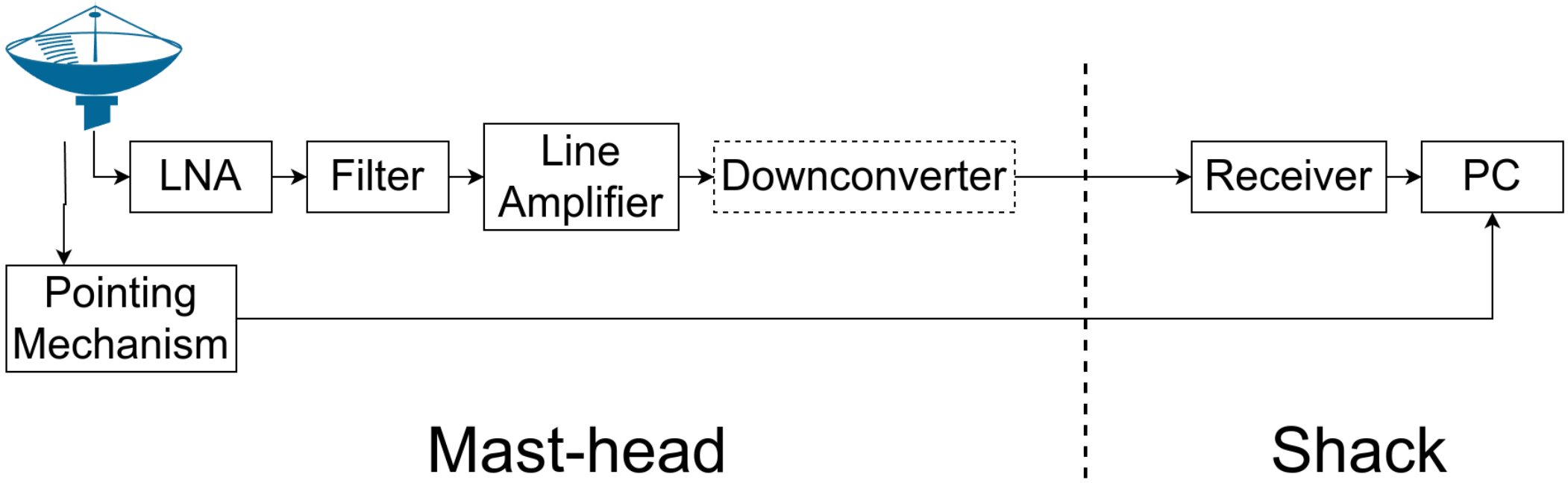
HAMTV Antenna





Photos courtesy of NASA

Ground Station - Overview



Ground Station – Dish size requirements

- Maximising link budget – drives push for large dishes

- In experience: 0.9m @ 90 del El: MER of 12dB+ (1.7dB required)

- 45° Elevation: 550km, -3dB (+7dB margin)
- 30° Elevation: 740km, -5dB (+5dB margin)
- 20° Elevation: 1000km, -8dB (+2dB margin)
- 10° Elevation: 1440km, -11dB (Negative margin)

Ground Station – Pointing

- 3dB BW:
  - 0.6m: +/- 7°
  - 0.9m: +/- 4.5°
  - 1.2m: +/- 3.5°

- G-5500: “+/- 4%”: ***+/- 14.4°***
  - Usable with careful calibration

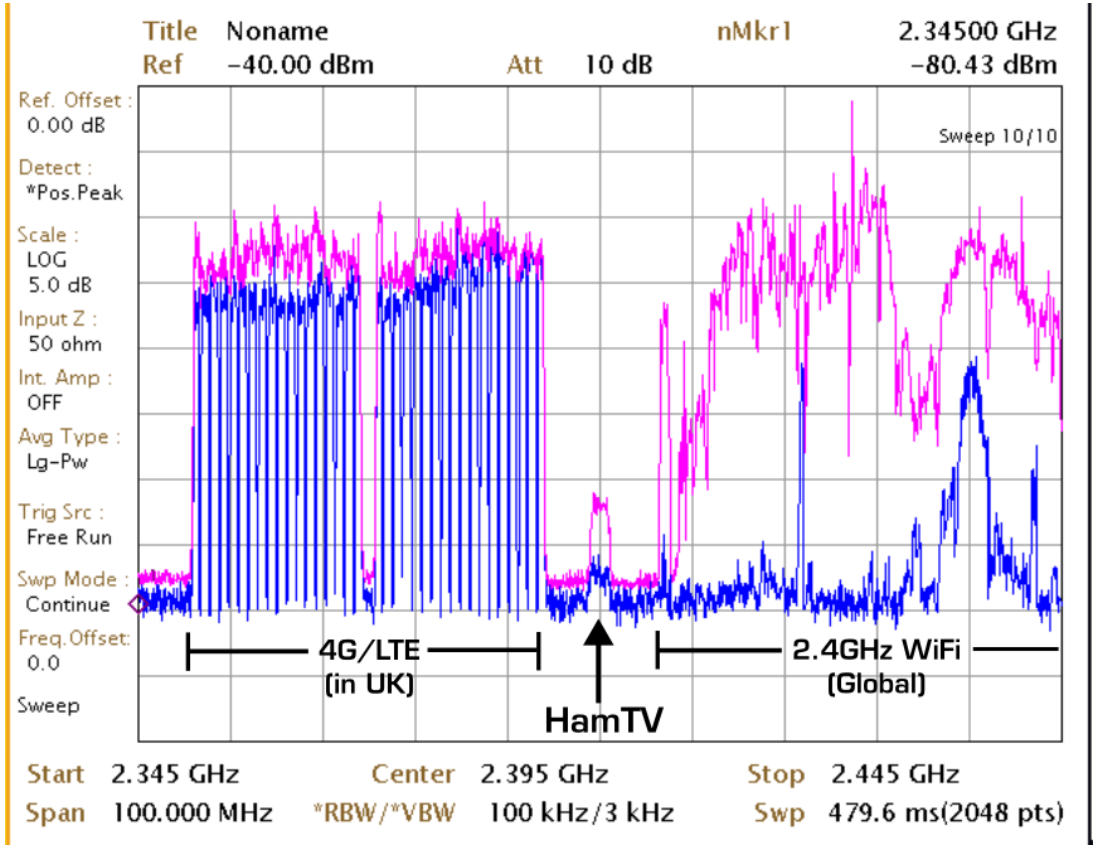
Ground Station - System Noise Figure

LaNA: 2dB Noise Figure, 12dB Gain
Ham It Down: 12dB Noise Figure, 0dB Gain
(Cabling): 2dB Loss
RTL-SDR: 6dB Noise Figure

System Noise Figure: **5.2dB** !

Intermediate gain stage required.
e.g. Cheap 5dB NF, 20dB gain "LNA" before Ham It Down = 2.4dB System NF

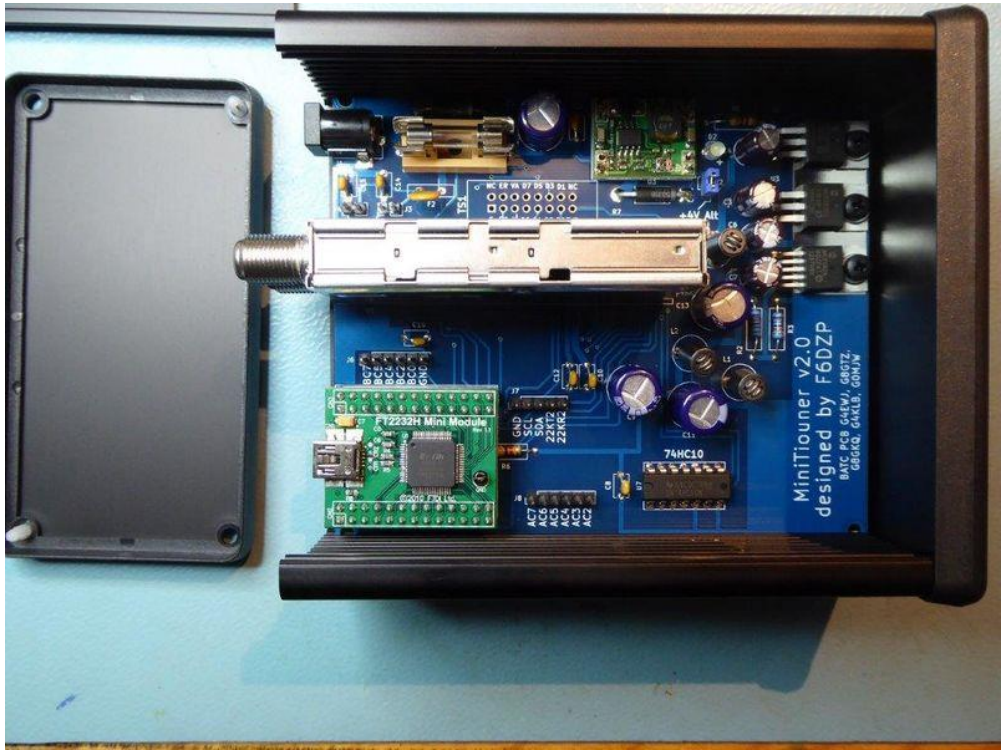
Ground Station – RFI

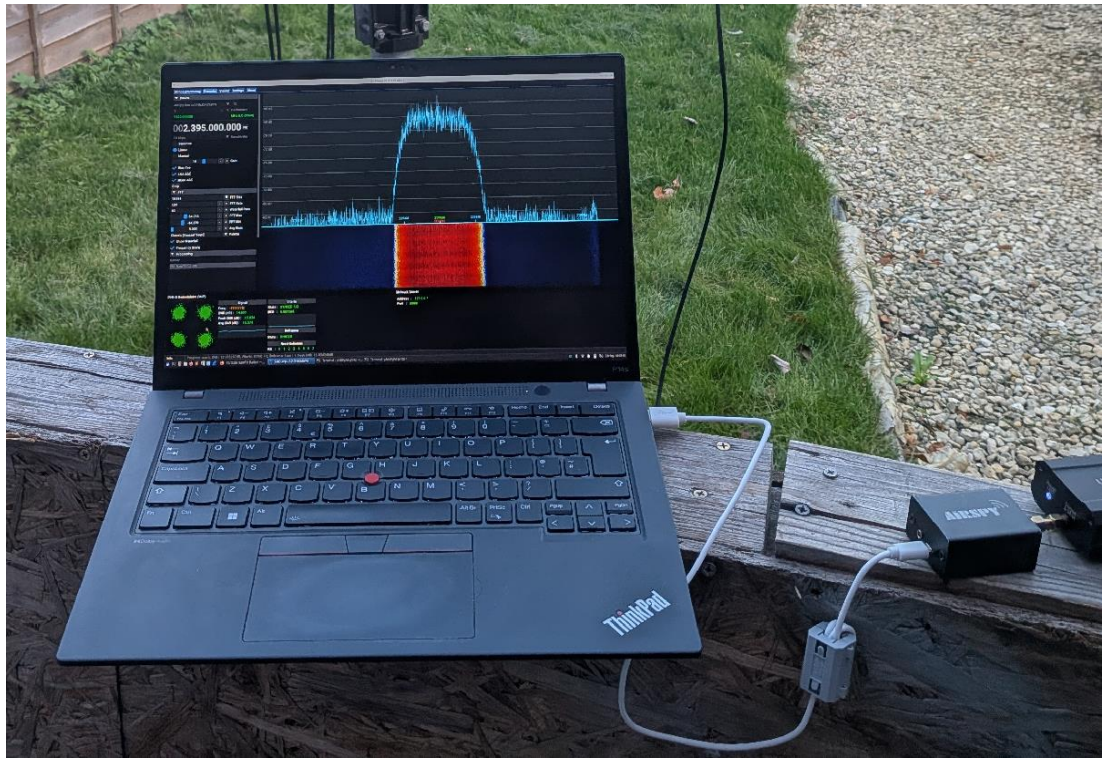


RX Spectrum of Graham G8FXB

- WiFi Channel 1
  - 2401-2423 MHz
  - Intermittent power peaks
- UK 4G Band 40 - Telefónica
  - 2350-2390 MHz
  - High power density
- Very high system dynamic range required.

Ground Station - Receivers





Ground Station - Examples

M0DNY
0.9m

IK1SLD
1.2m

G8GKQ (2015)
0.6m

Goonhilly
5m

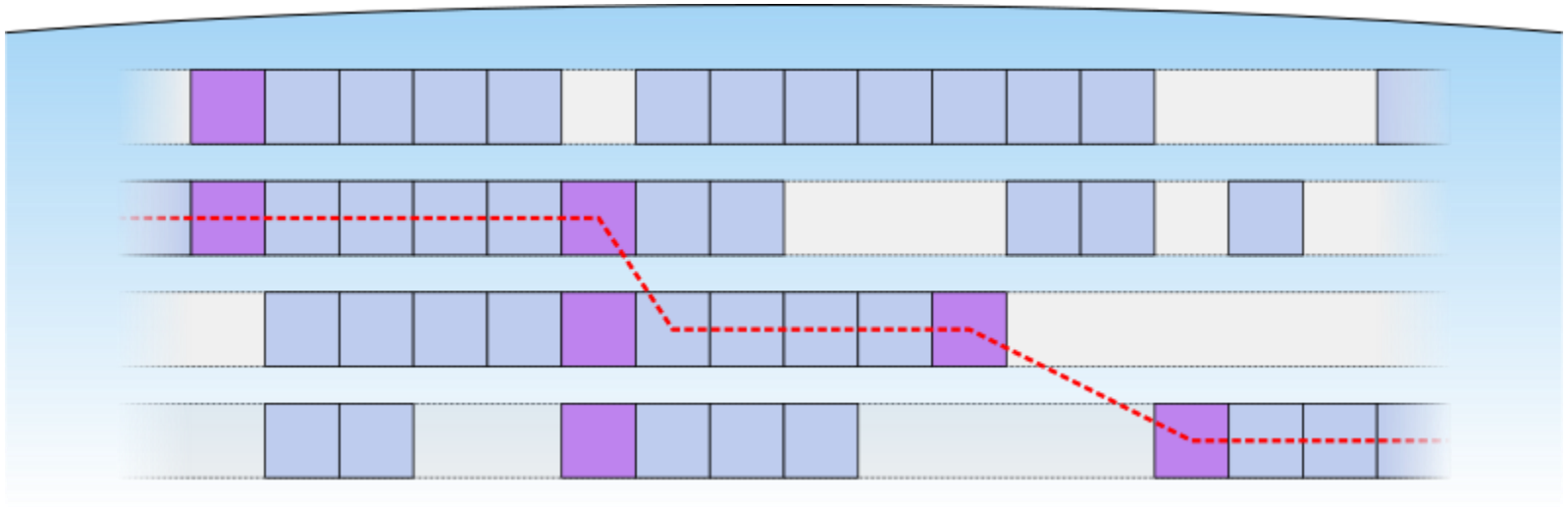
HAMTV Operational Use – Educational Contacts

- Venue station set up in 24 hrs
  - Pointing Calibration
  - RFI – WiFi, etc.
  - .. and standard portable station challenges (cables, connectors, rain, etc.)
- Need to ensure that participants get the HAMTV experience during the contact.

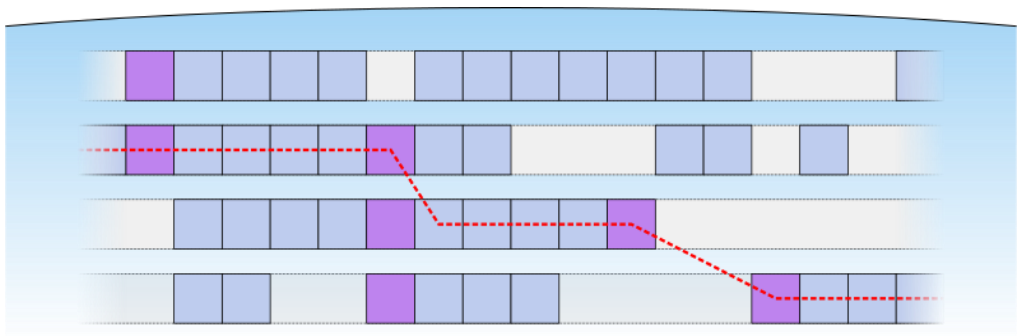
HAMTV Operational Use – Manual Switching

- Assembled by Noel G8GTZ
- RTMP stream per ground station
- Manual switching (close one, open another)
- 6 partial streams = partial stream at best

MPEG-TS Real-time Merging

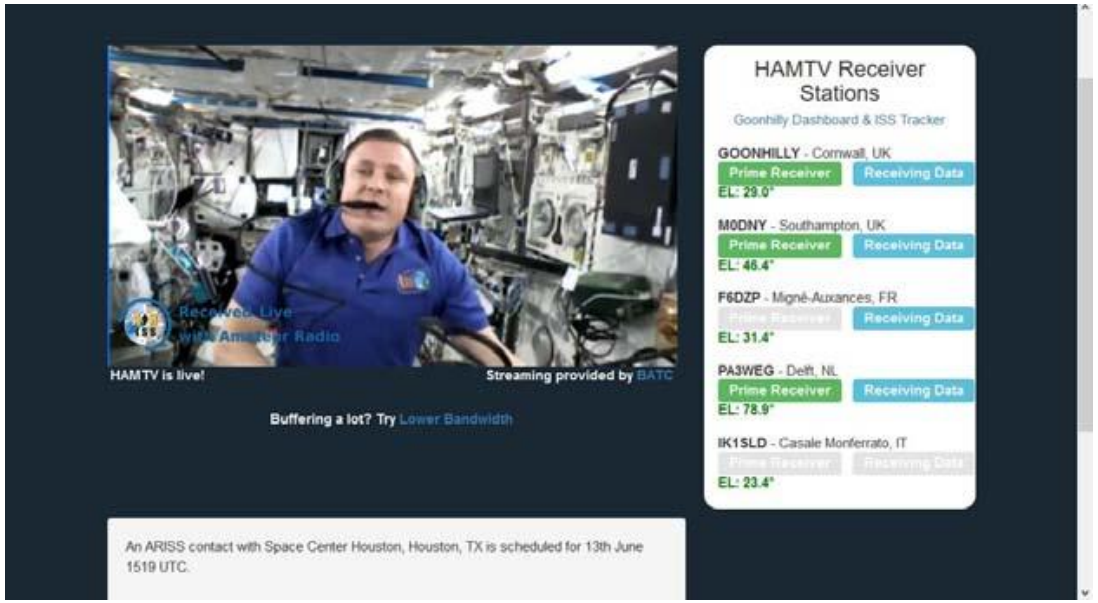


MPEG-TS Real-time Merging



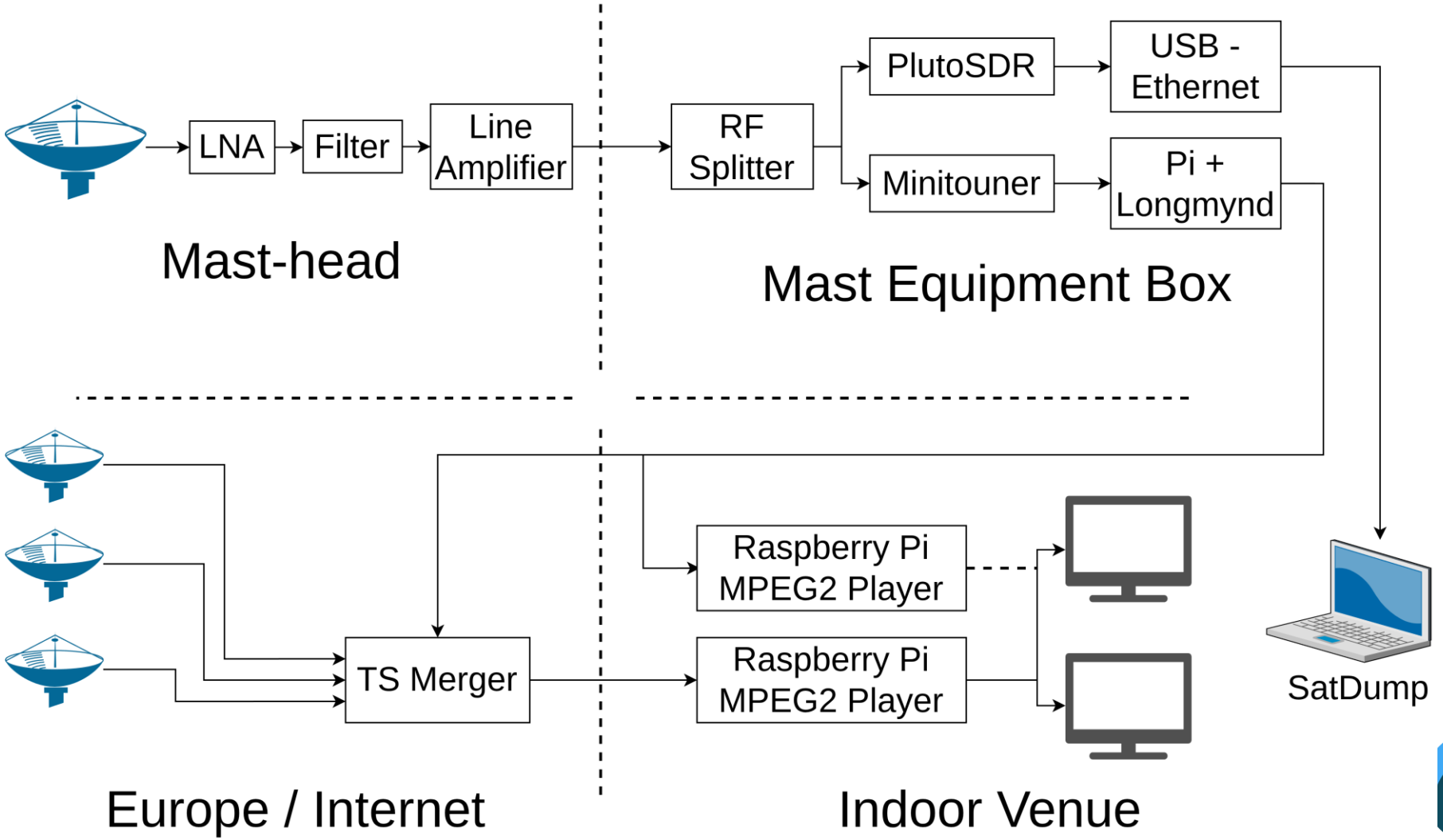
- MPEG-TS is packetised
  - 188 Byte Packets
- Some packets have PCR timestamp (~1/50)
- PCR is used to synchronise ground station feeds
- 100ms delay to aggregate data from stations with variable ISP delay
- The earliest PCR segment is copied to output, and displayed

HAMTV TS Merger in Use

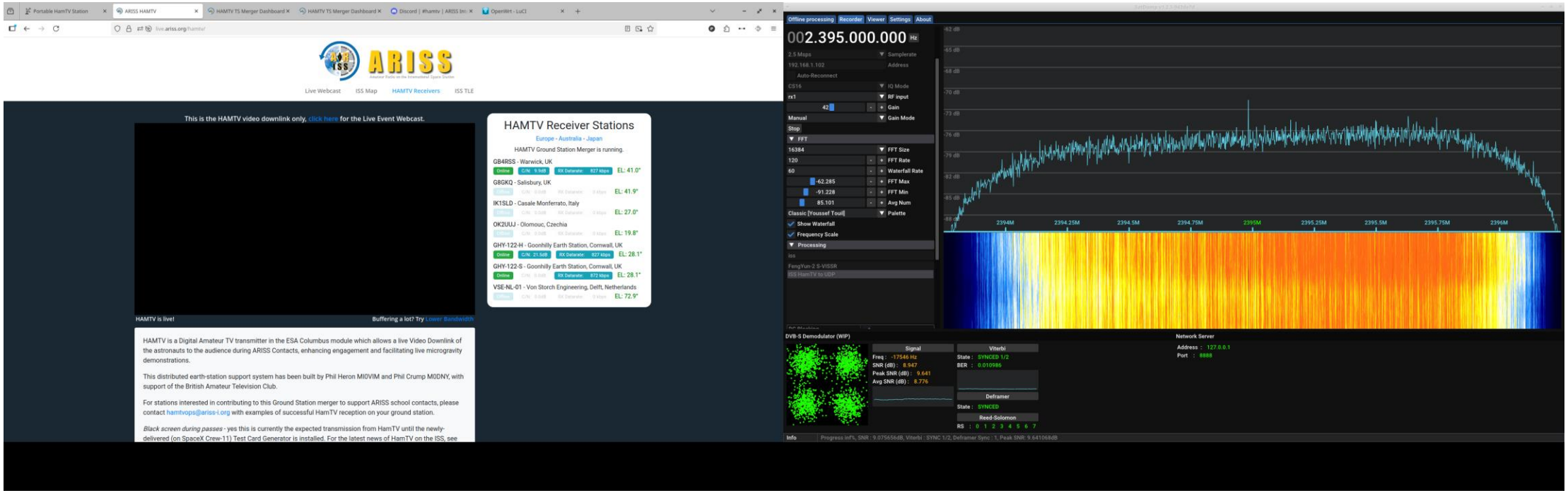


HAMTV – Antenna at Warwick Contact

HAMTV – System at Warwick Venue

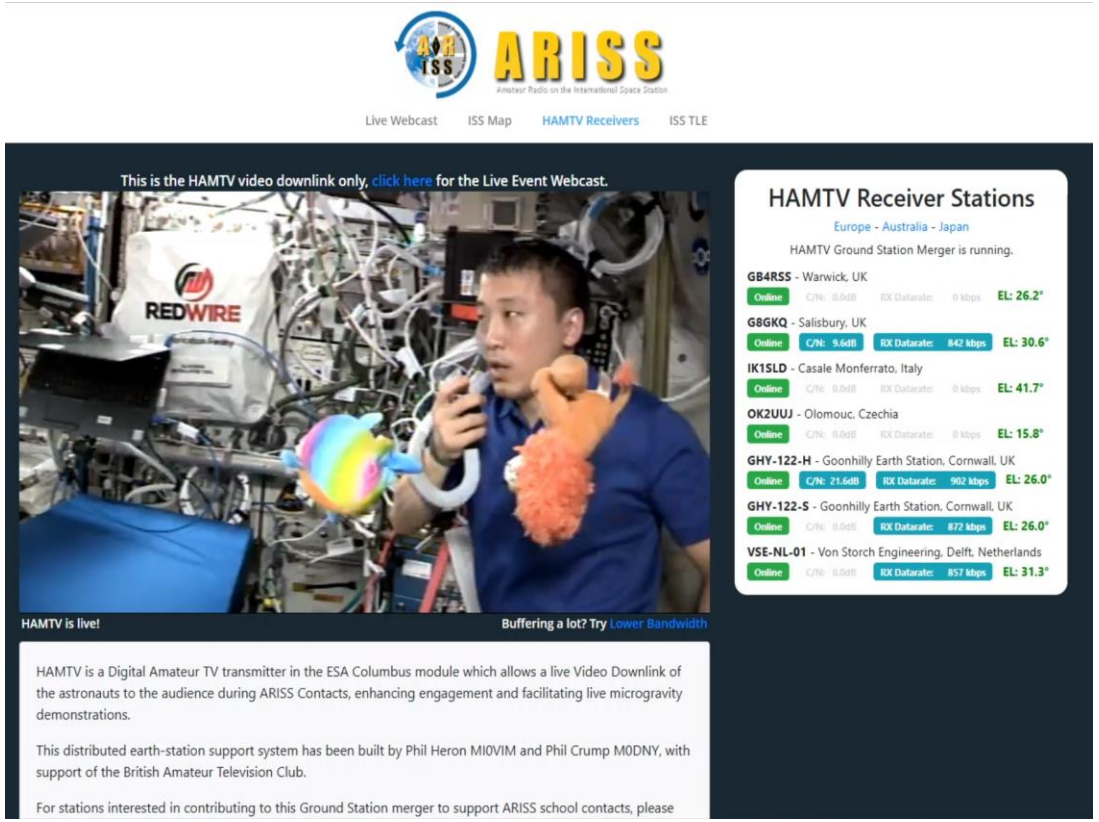


HAMTV – Reception at Warwick Venue



HAMTV – Display at Warwick Contact

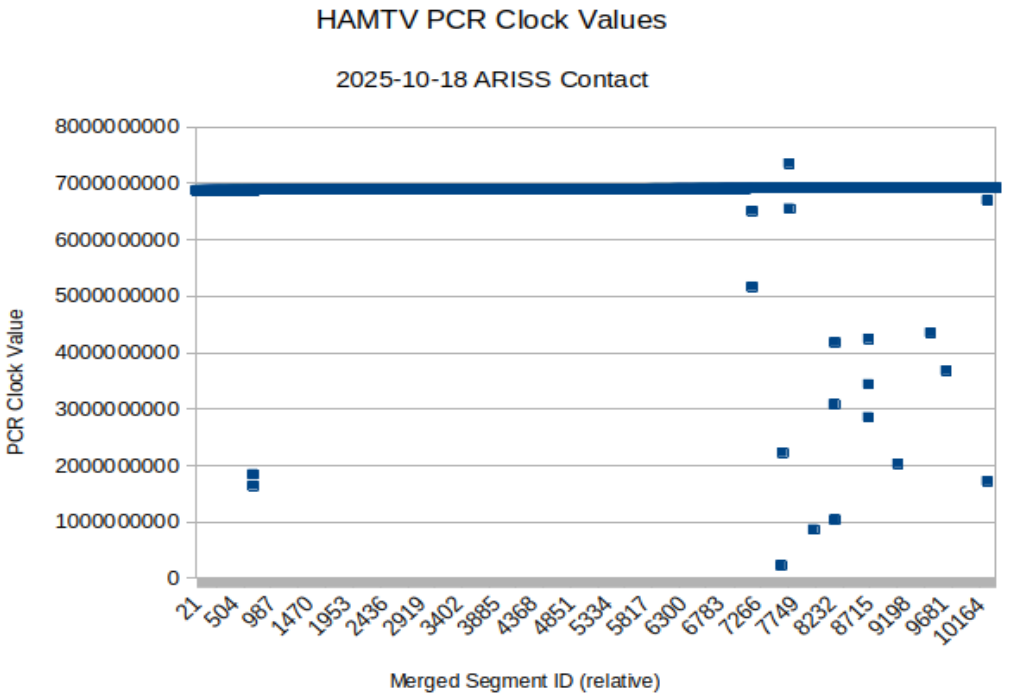
HAMTV – Contributors to Warwick Contact



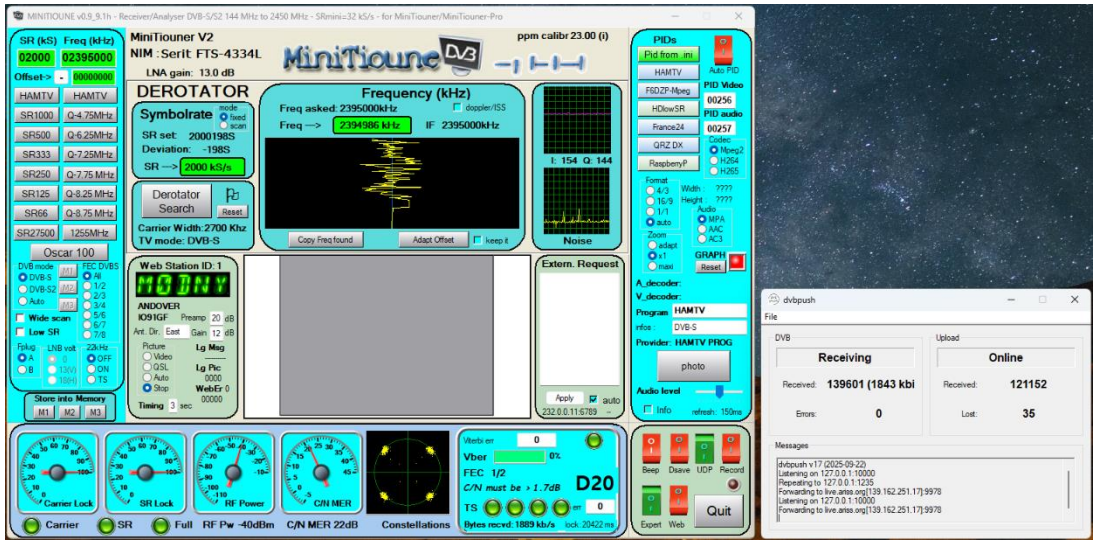
- G8GKQ
  - Salisbury, UK
- IK1SLD
  - Casale Monferrato, Italy
- OK2UUJ
  - Olomouc, Czechia
- Goonhilly Earth Station
  - Cornwall, UK
- Von Storch Engineering
  - Delft, NL

SatDump Issues – Errored DVB Frames

- More discontinuities in merged TS stream than expected.
  - Caused stalling of players.
- MPEG-TS PCR values in the merged stream are not regular.
  - During a pass the clock should be predictable.
- Irregular PCR values only seen from SatDump SDR receivers.
- SatDump does not filter frames where Reed-Solomon reports uncorrected errors.
  - Modified version is in local testing.



HAMTV Operational Use – Volunteers?



- Suitable Receiver
  - Minitioune + dvbpush
  - Portsdown (/Longmynd)
  - SatDump + dvbpush
- Reliable internet
  - 5Mbps upload required
- Onboarding process
  - Internet connection assessment
  - Upload error-rate tests

Questions?

- ARISS School Contacts Live Streams: https://live.ariss.org/
- HAMTV TS Merger Output: https://live.ariss.org/hamtv/
- Documentation: https://wiki.batc.org.uk/HAMTV_from_the_ISS
  - Linked pages on Ground Station construction, Contributing to the Merger.
- Join us on the ARISS Discord: https://discord.gg/EBSctaKN
  - Dedicated #hamtv channels