ARISS HAMTV: Ground Stations small, large, and combined.

Phil Crump M0DNY

Phil Crump M0DNY - Background

- Originally involved with ARISS-UK through the BATC Streaming of Principia contacts in 2016
- Assisted with HAMTV infrastructure using GHY-99 ground station at Goonhilly Earth Station
- Developed HAMTV TS Merger with Phil Heron MI0VIM
- Deployed the HAMTV TS Merger in 2017 – used for contacts worldwide
- Eagerly waiting since then for HAMTV's return!

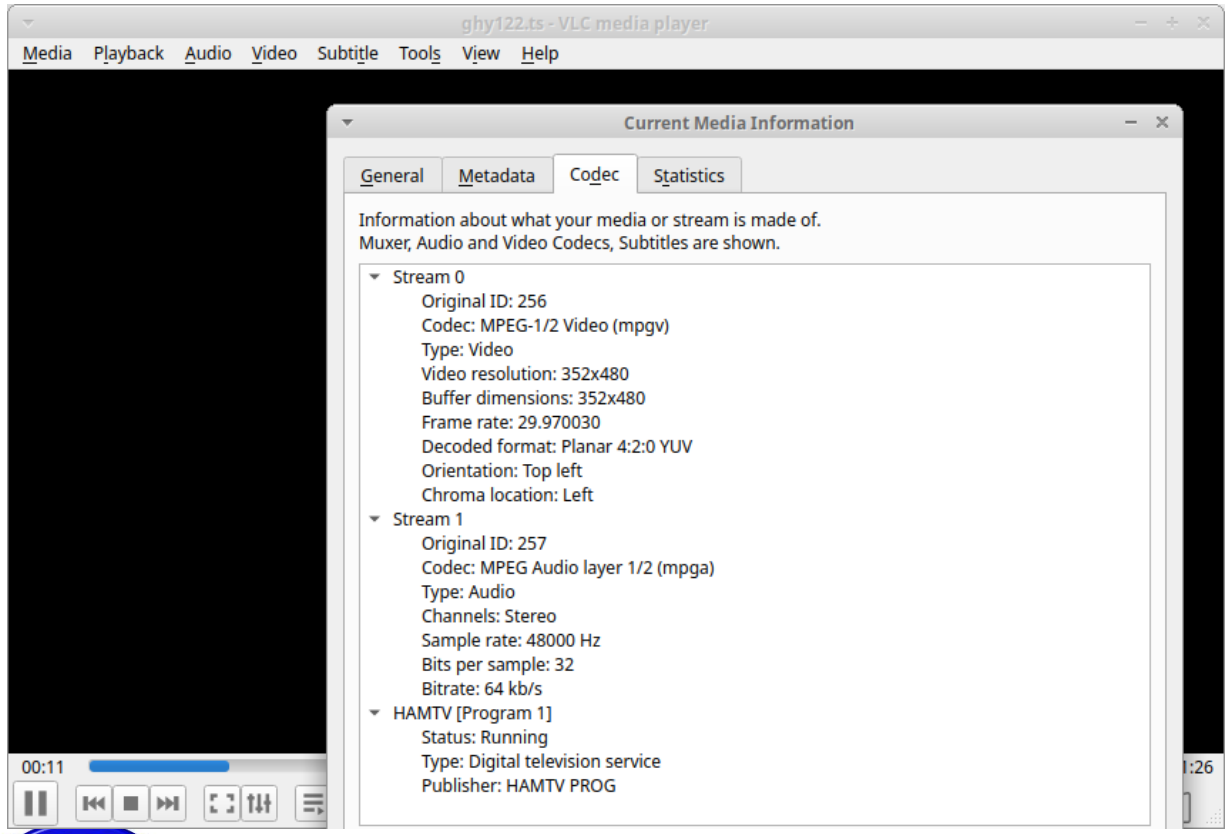
HAMTV Transmitter

- 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 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.

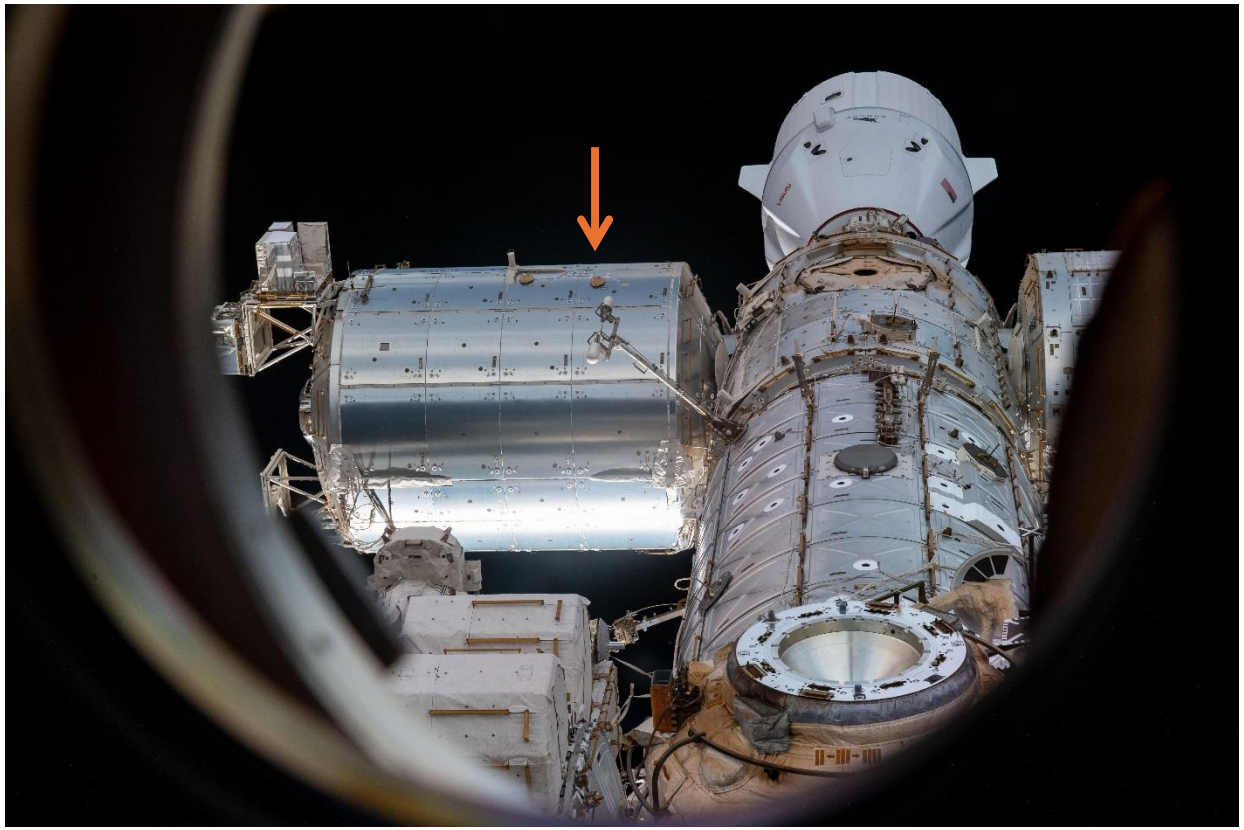
HAMTV Current Transmission

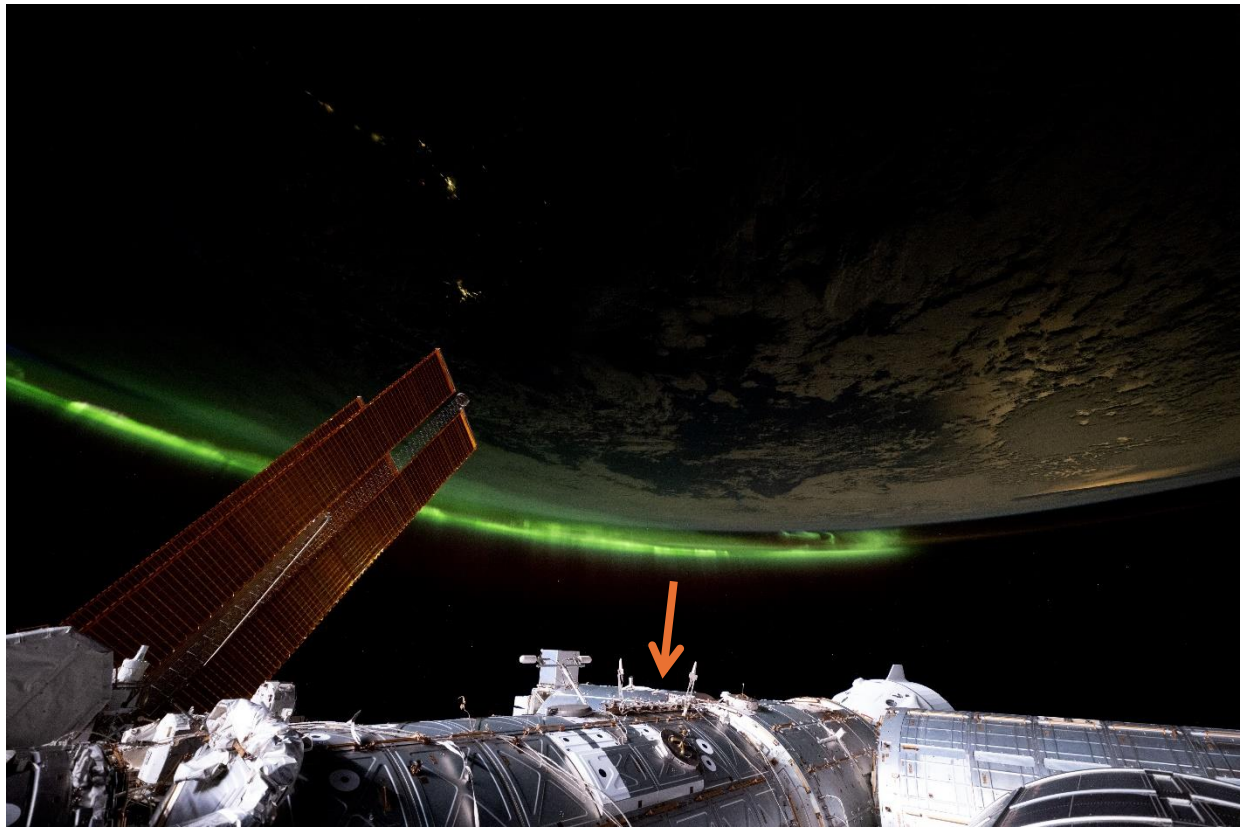


- Transmitter is on!
- Video ‘Sync Detection’ has been added during repairs.
- Video is ‘blanked’, audio is muted.
  - No blue line
  - No audio hiss
- Resolution is 352x480 (??!!)
  - Aspect Ratio still 16:9

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

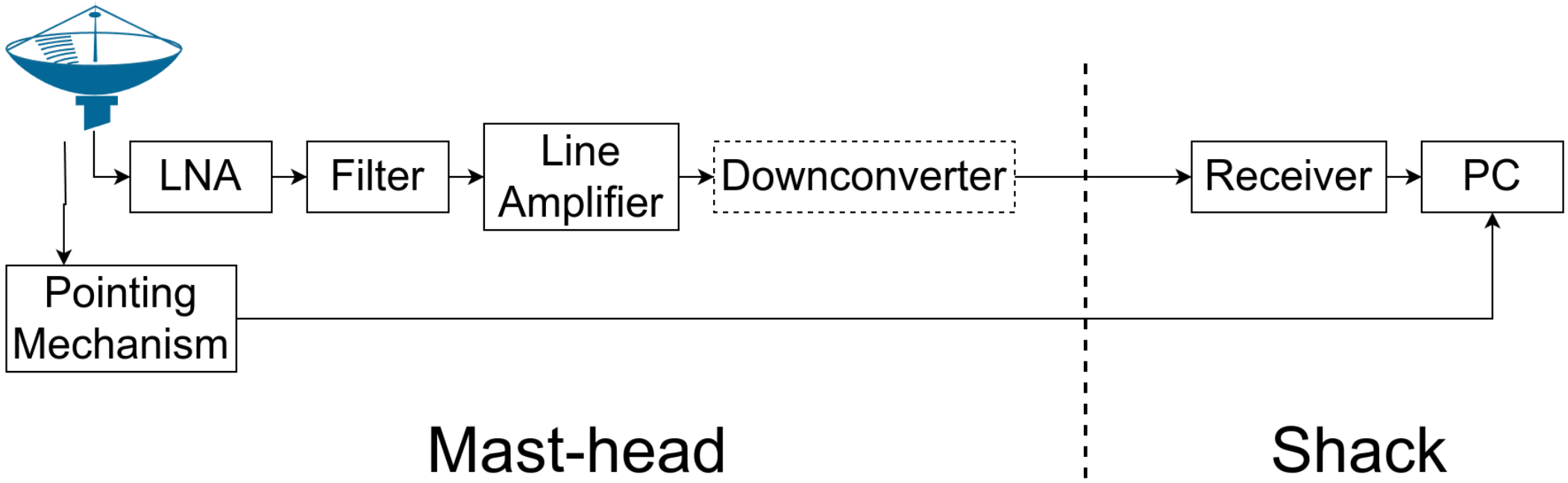
HAMTV Antenna





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)

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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

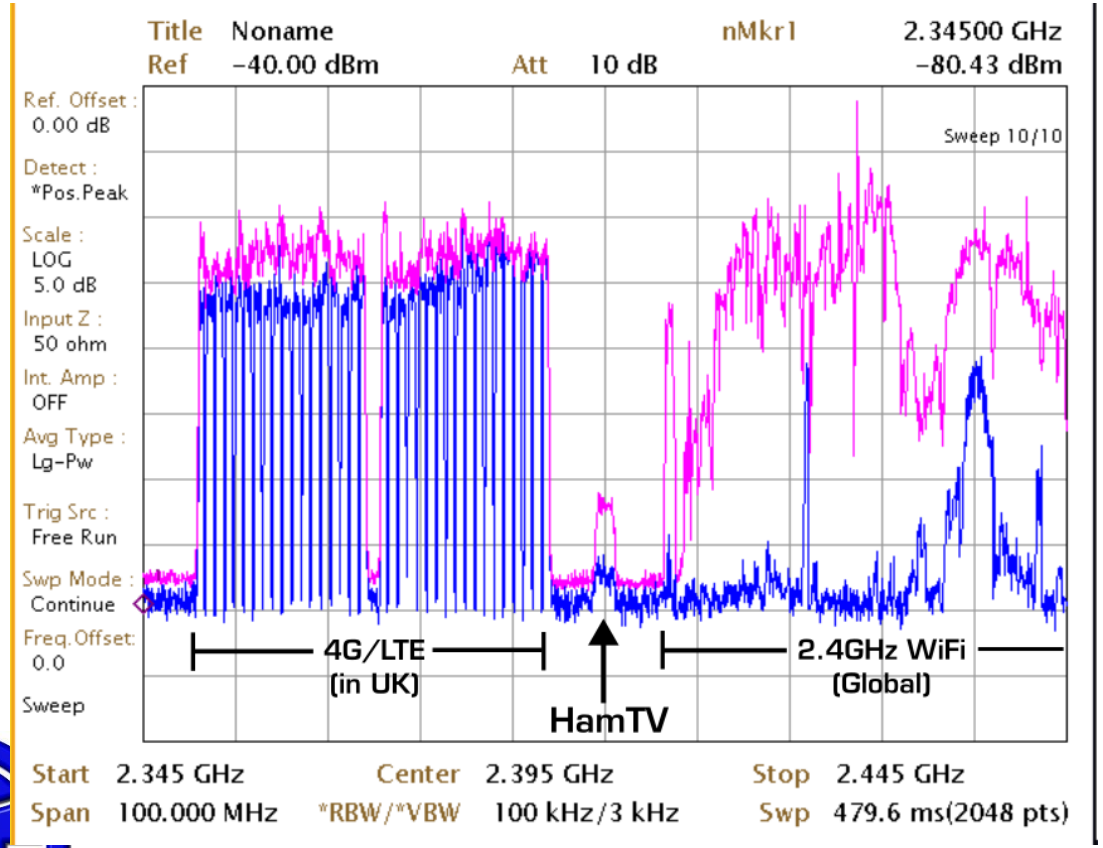
Ground Station - System Noise Figure

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

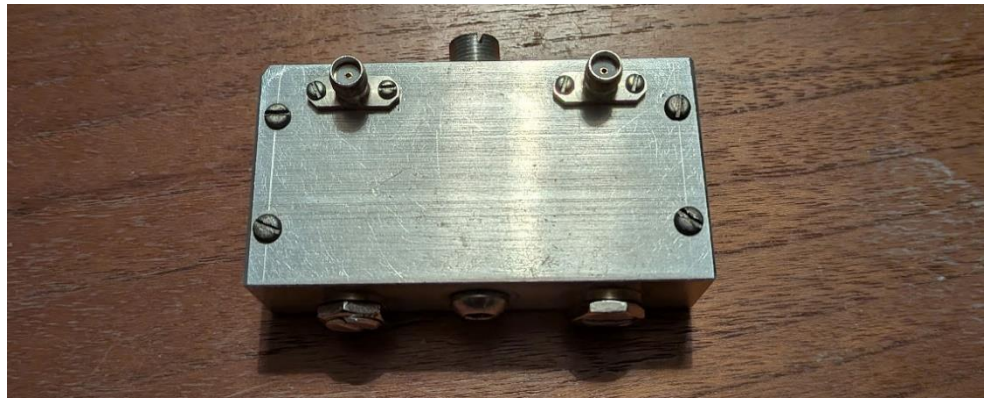
Ground Station – RFI

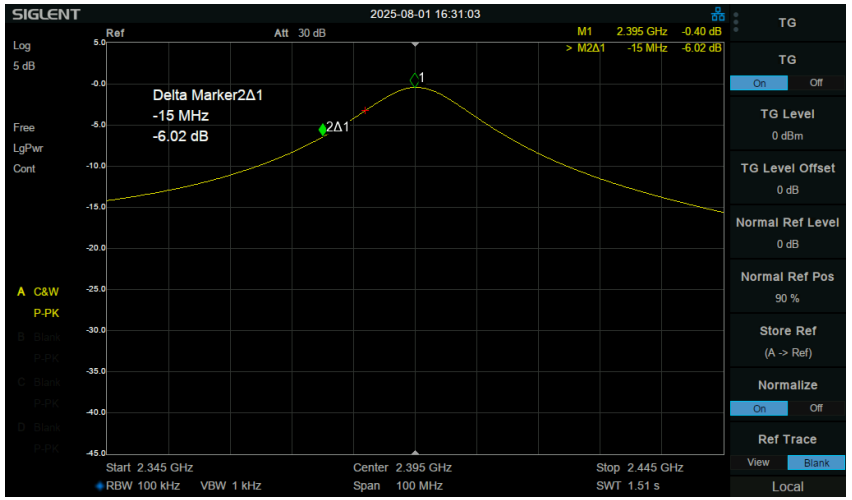


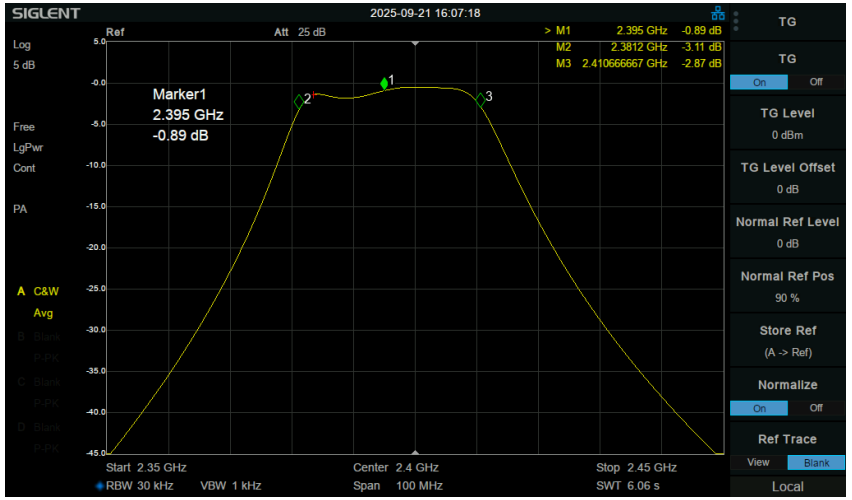
RX Spectrum of Graham G8FXB

- 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.

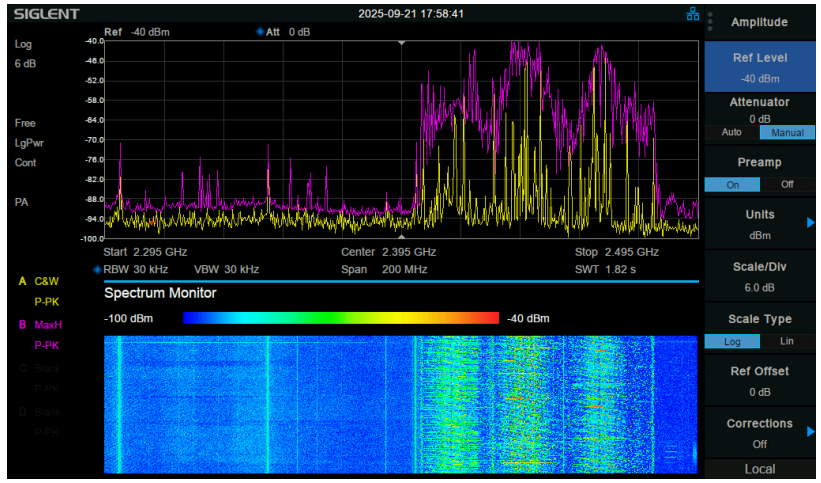
Ground Station - Filters

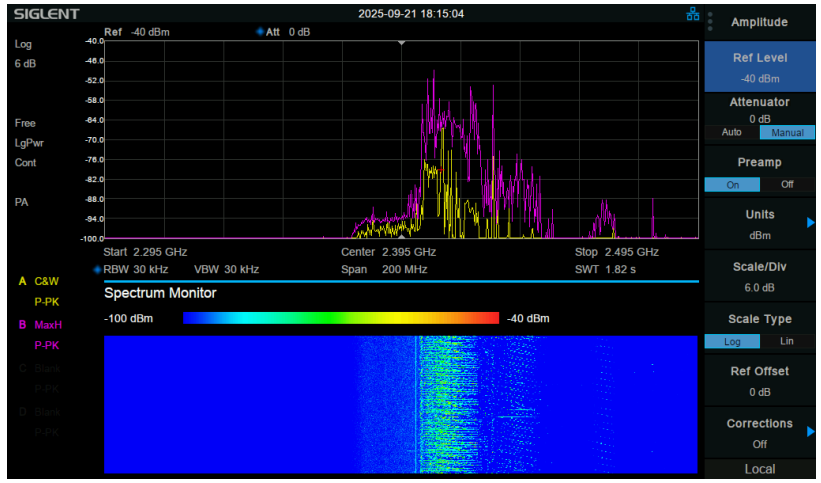






Ground Station – Filter Results





- No filter: -30dBm
- With filter: -48dBm
- Result: +18dB dynamic range margin!
  - With only WiFi RFI
  - 4G/LTE presence would increase this advantage.

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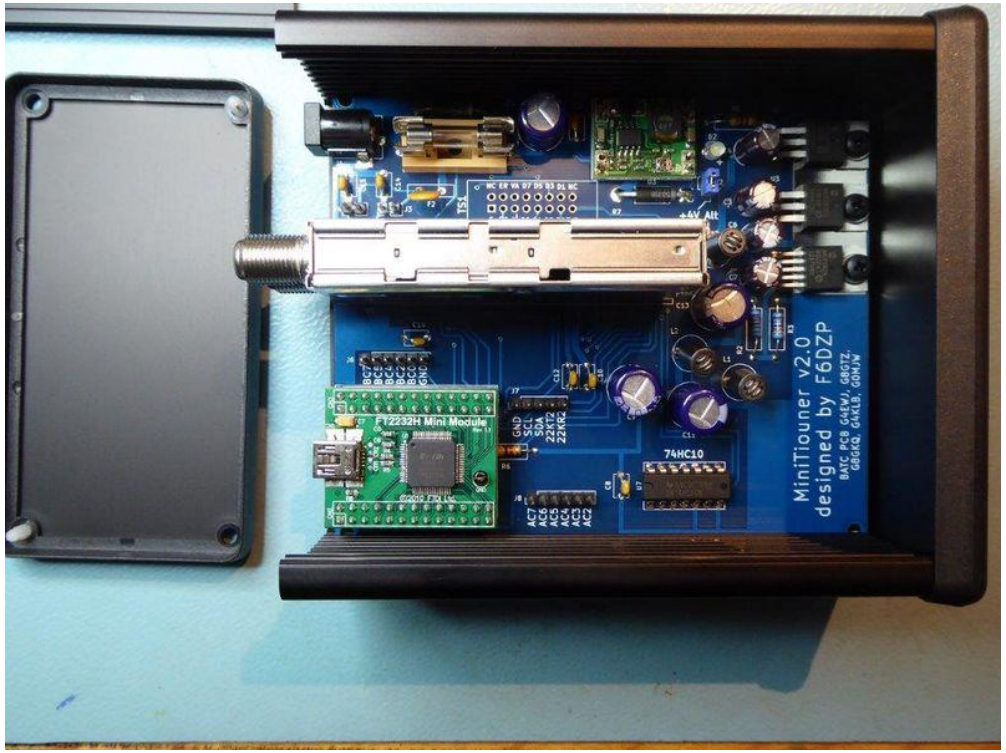
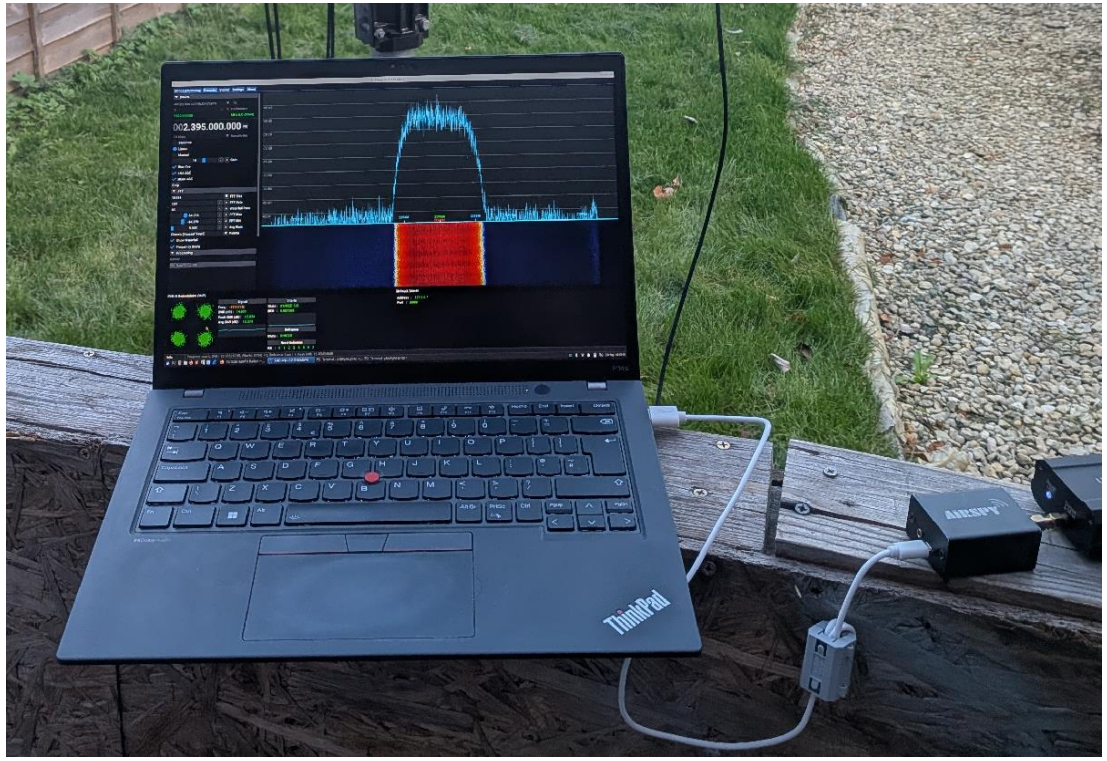
Ground Station - Receivers





Ground Station - Examples

M0DNY
0.9m

IK1SLD
1.2m

G8GKQ (2015)
0.6m

Goonhilly
5m

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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

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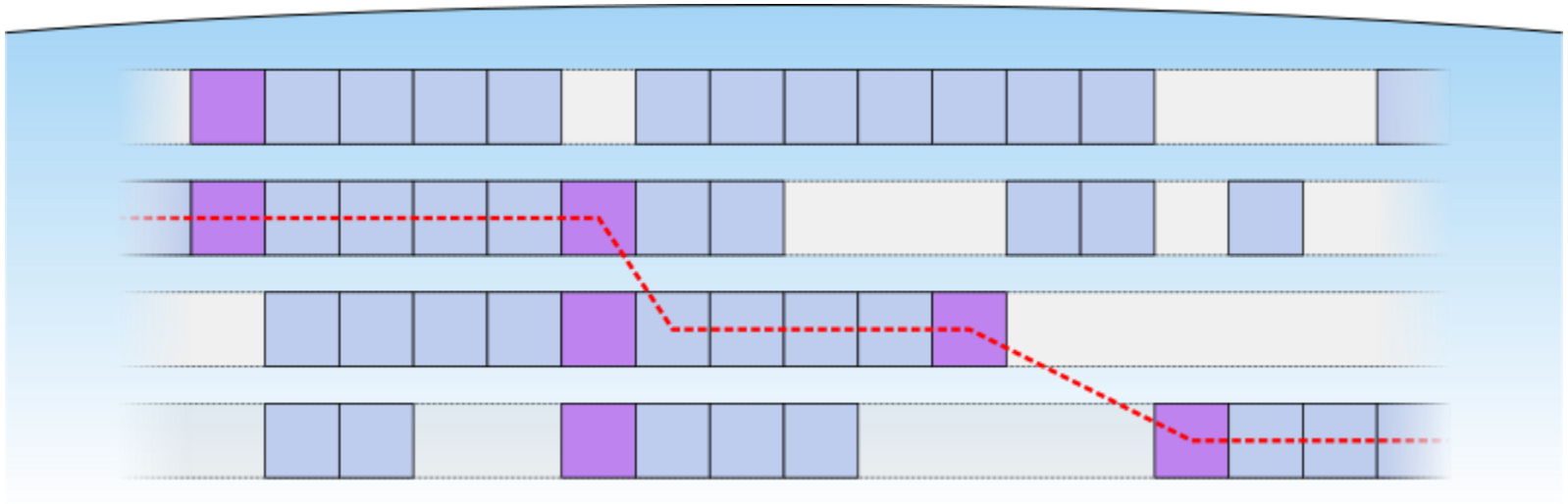
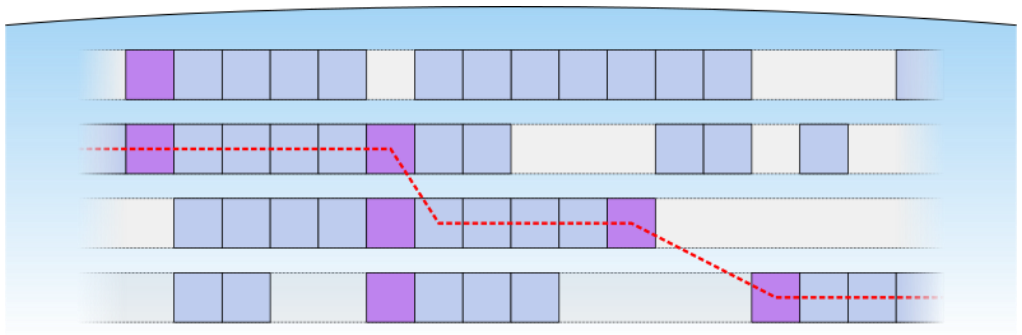
MPEG-TS Real-time Merging

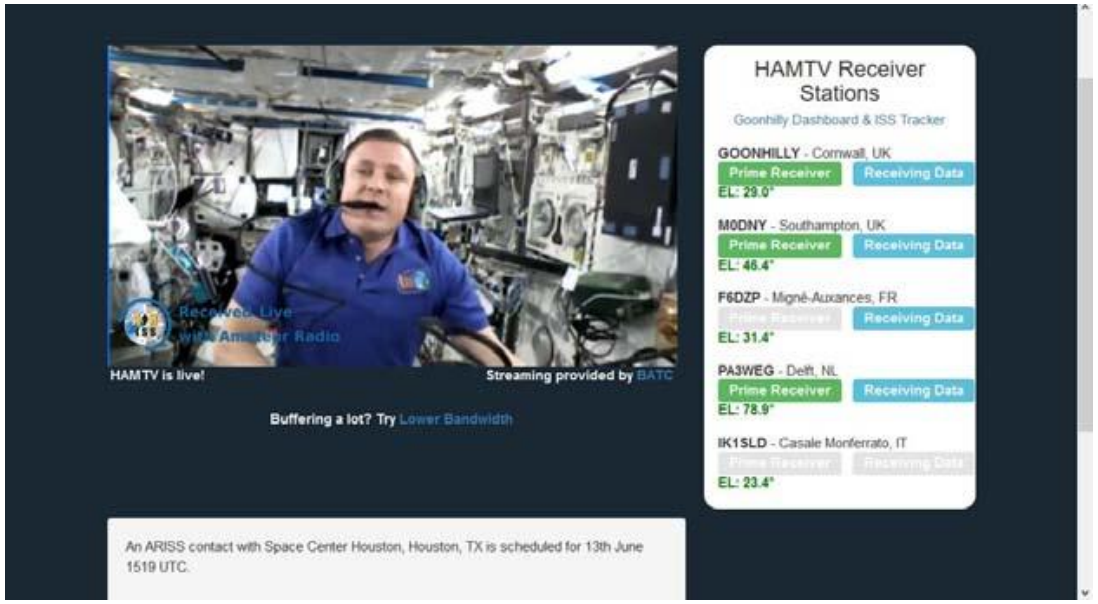


MPEG-TS Real-time Merging

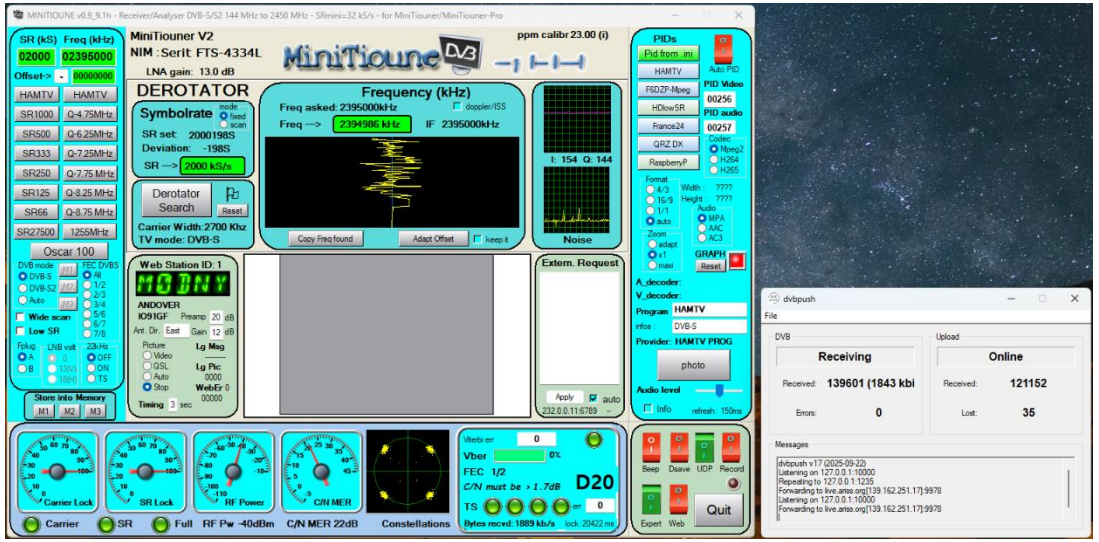


- MPEG-TS is packetised
  - 188 Byte Packets
- Some packets have PCR timestamp (~1/50)
- PCR is used to synchronise ground station feeds
- 100ms delay to aggregate data from stations with variable ISP delay
- The earliest PCR segment is copied to output, and displayed

HAMTV TS Merger in Use



HAMTV 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

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