ARISS and the Principia mission

principia

BRITISH ESA ASTRONAUT TIM PEAKE'S MISSION

UK SPACE AGENCY

esa

European Space Agency

ARISS and Principia

- ARISS goal is to inspire students to pursue interests in careers in Science, Technology, Engineering and Maths
- Co-ordinate all formal amateur Radio operation from the ISS
- Principia project set up in 2015 by UK Space Agency and ARISS UK
  - Up to 10 live contacts between Tim Peake and UK schools
  - First ever live TV from the ISS
- Key highlight of the Principia STEM outreach programme
  - Only opportunity for direct contact with Tim!
  - UKSA published a “tender” inviting responses from schools to say why they should host a contact
- 10 schools chosen across the country
  - Team of 8 amateurs “toured the country”!

ARISS Principia schedule

- Dates have to be maximum duration day time ISS passes during the school week and term time!

- 8th Jan 2016 – Sandringham School, St Albans (8:40am)

- 11th Feb 2016 –Rickmansworth (18:10pm)
- 19th Feb 2016 – Bristol (14:30pm)
- 26th Feb 2016 - Norwich (14:15pm)
- 5th Mar 2016 – Powys (10:35am)

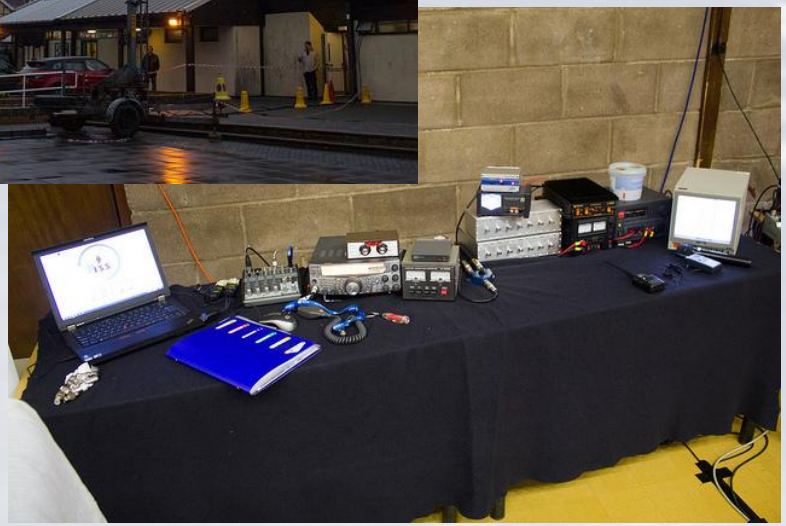
- April18th - Bexhill on Sea (4:30pm)
- Saturday 23rd April 2016 – Broadstairs (12:30)
- Monday 25th April – Bury
- 2nd May – Otley Leeds
- 9th May – Ottery St Mary.

Onboard the ISS

- Equipment for ARISS contacts is in Columbus module
- VHF comms via a 20 year old Ericsson handheld!
- Dual band whip antenna with groundplane and matching box.
  - Designed and built by Lou McFadin W5DID
- Switched to packet operation on 145.825 when not in use for ARISS contact
- The HamTV transmitter is also in Columbus
  - Not always switched on due to power requirements
- There is equipment in the Russian module but managed by the Russian ARISS program
  - Kenwood D710
- Equipment is always turned off for EVA
- Normally turned off for docking

VHF comms – the easy bit!

- Ground station performance for maximum duration contact is crucial
- Wimo VHF and UHF 10 XY with phasing and mast head pre-amps mounted on 60 ft trailer tower
- Main station is a TS2000 and external PA
  - Interdigital filters on Tx and Rx
  - EcoFlex 15 feeder on Tx and Rx
- Running half duplex receiving on 145.800 MHz
- Az / El Yaesu rotator tracked using pstrotator s/w
  - Vital to keep the KEPs up to date
  - especially after reboosts!



Live video!

- HamTV Tx was used for first time
  - Impact was awesome!
- SR systems Tx and 20 watt PA
  - Dual band patch antennas
- S band receive equipment is located in vehicle at school
  - 1.2 mtr dish in to DB6NT downconverter
  - Tutioune rx system
- Back up receive system at Goonhilly
  - 3.8 mt dish
  - Back hauled over private VPN
- See TxFactor edition 10 and 11

Receiving the ISS

- You can hear the contacts on a handheld!
- HamTV can be received on a 60cms dish
  - Lying on its back!
- 4 minutes is easy – it's the other 6 minutes that makes all the difference!
- And there were other challenges!

HamTV – the challenges

- Actual link budget not proven
  - HamTV signal only received once before!
  - Goal was at least 7 minutes video and 10 minutes if possible
- 2395 MHz DATV signal but not DVB compliant!
  - Only Tutioune will receive and decode it!
- HamTV transmitter shares PSU with 2 other experiments
  - Not guaranteed to be on!
  - Camera is never turned before the contact!
- Need to track with a 1.2 mt dish mounted on a vehicle!
  - Parked in a different place everytime!
- How to get the video in to the school...
- Seemed like a fun challenge ☺

Rx system

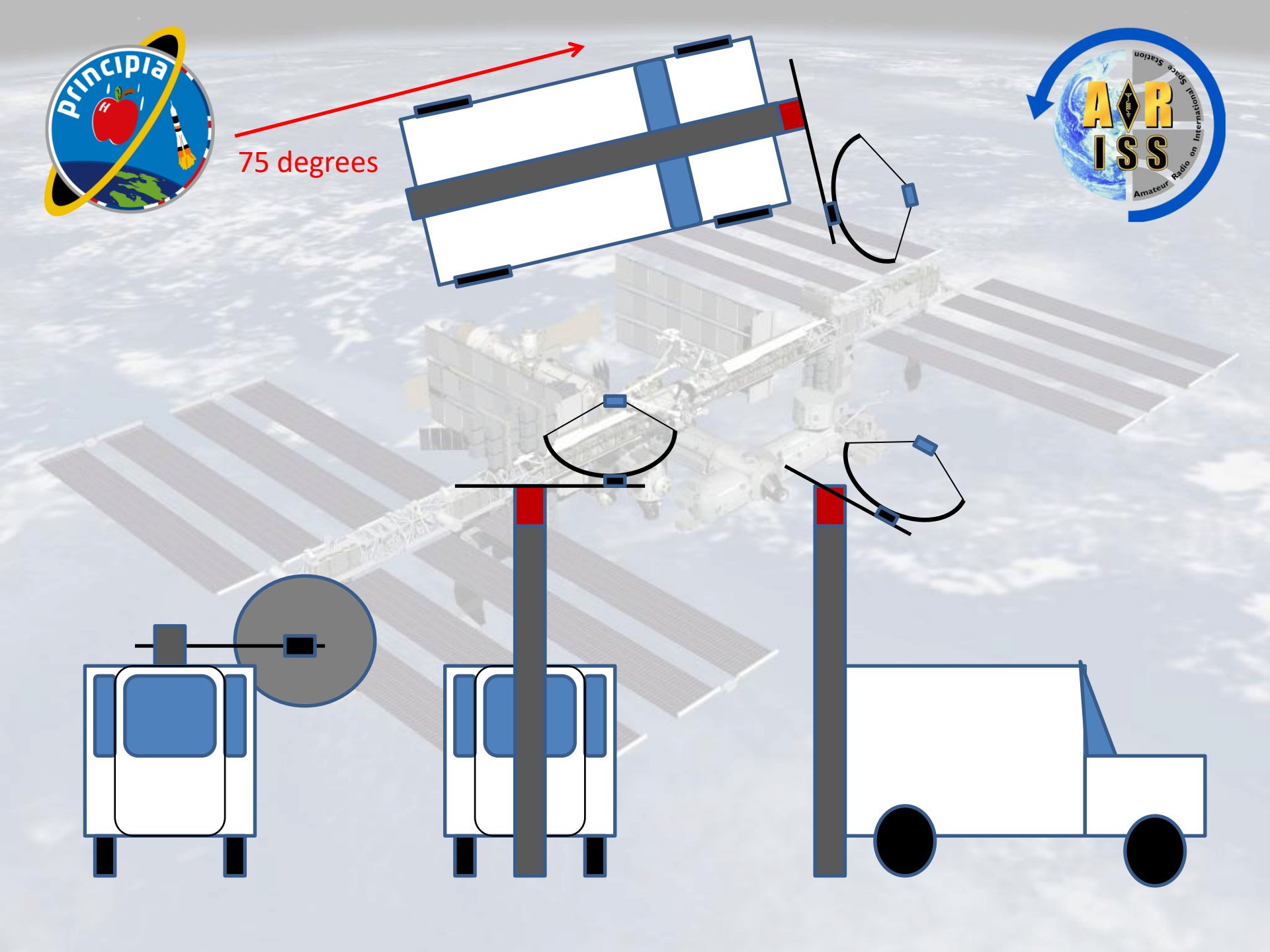
- Similar rx system at school and GH
  - DB6NT down converter to L band
  - Tutioune rx software
- Landrover used a 1.2 mt dish
  - RF Hams feed
  - L band Interdigital filter to protect against WiFi
- Mechanical alignment critical to avoid squint or under illumination
  - Beam width of approx 6 degrees
- The sun proved very useful!
  - Adjusted the prime focus feed for focal point on a sunny day
  - Laser alignment used at venues
  - Not always sunny!

Tracking on a mobile platform

- Most amateurs spend a long time tweaking their dish mounts to track orbital satellites
  - A 1.2 mt has a beam width of approx 6 degrees
  - The ISS moves at 17,000 mph
  - The dish needs to track it very accurately in all planes
- We had just 12 hours at every school with only 2 or 3 practice passes maximum!
  - Azimuth heading needed to be calibrated to the car park space!
  - Could not guarantee a flat platform for elevation tracking
  - Horizon may be obstructed
- The dish and rotator had to be mounted on the horizontal pole!
  - And then raised vertically

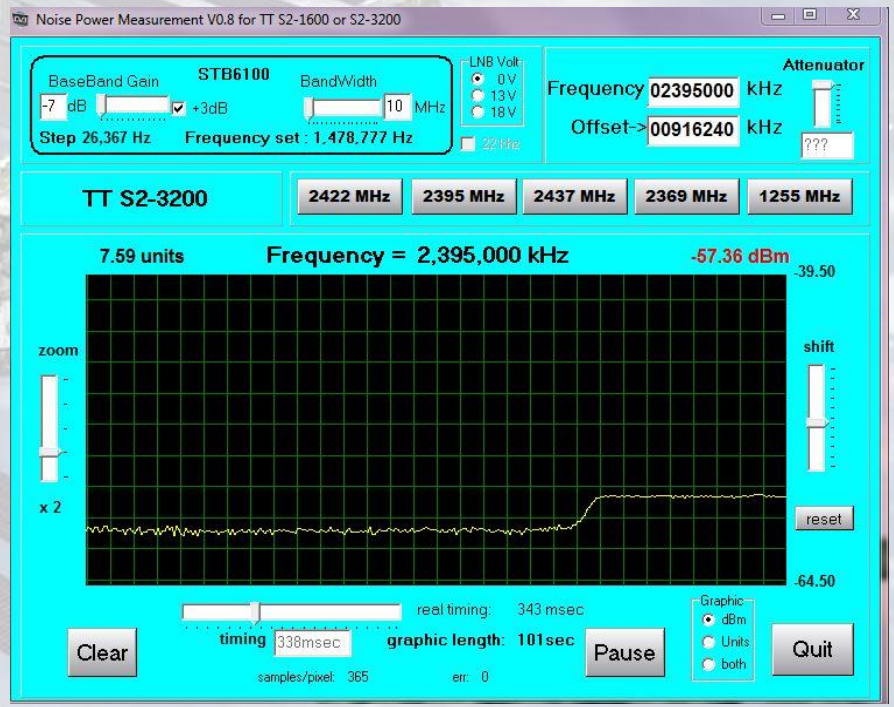
The process

- Spent a long time refining the mechanics and process!
  - The dish mount arrangement had to be sturdy and reproducible
- Park the vehicle on the level
- Assemble dish feed using laser alignment
- Calculate the exact angle the vehicle was parked at
- Set the rotator to that angle
  - Not the inverse!
- Mount the dish on the cross pole
  - Pointing to horizon
  - Set the Azimuth to 90 degrees!
- Check all the angles again
- Raise the mast
  - the dish should be pointing vertically
  - Pointing along the vehicle


75 degrees

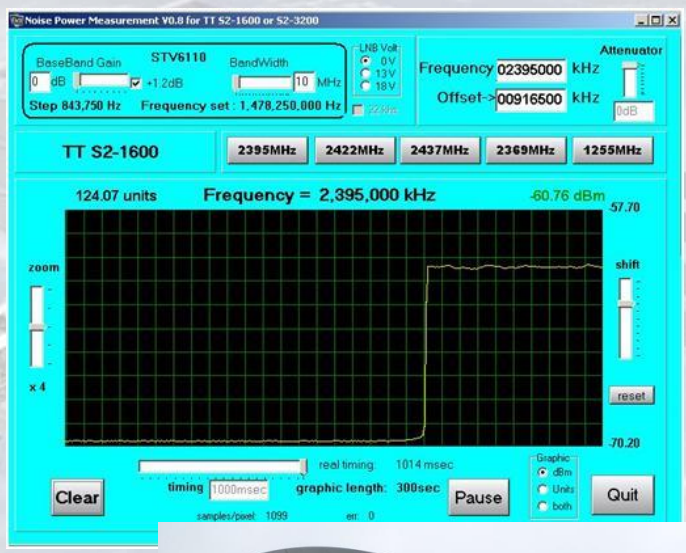
But was it accurate?

- Managed to get it better than 10 degrees every time
- But still not good enough
  - Would not receive the ISS
- The answer was F6DZP and the sun again!
- We used the Tutioune NMP program to make final offset adjustments in Pstrotator at every venue
- And it worked!
  - We received 5 – 7 minutes of video at every school
  - Proved the standard Yaesu Az / El rotator can track fast enough



Sun noise measurement

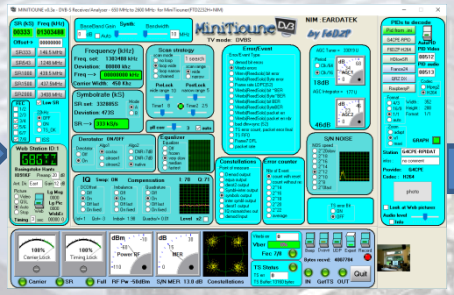
- Also made sun noise tests on the 3.8mt dish at Goonhilly
- Consistently 10 dB greater than the 1.2 mt dish
  - 25dB vs 36 dB gain
- Proved both systems were optimised
- Very useful tool now available for minituner
  - 10 GHz dish feed alignment
  - Yes, it works when it's cloudy!
  - CQ-TV 253



Video

- The 2nd challenge was how to deliver video in to the school hall
  - From Land Rover and Goonhilly
- We needed a clean HDMI feed
  - We couldn't use the Tutioune screen
  - Did not want yet more PCs
- The answer was F6DZP (again) and M0DNY
- The UDP output from Tutiuione was fed across a VPN to a headless Raspberry Pi running OMX player
  - HDMI output in to presentation mixer
  - Just worked when it received a valid TS stream
- Major network issues with school firewalls and IS departments!
- Private BATC VPN set up to ensure connectivity
  - Worked at 90% of venues

ARISS video CDN network

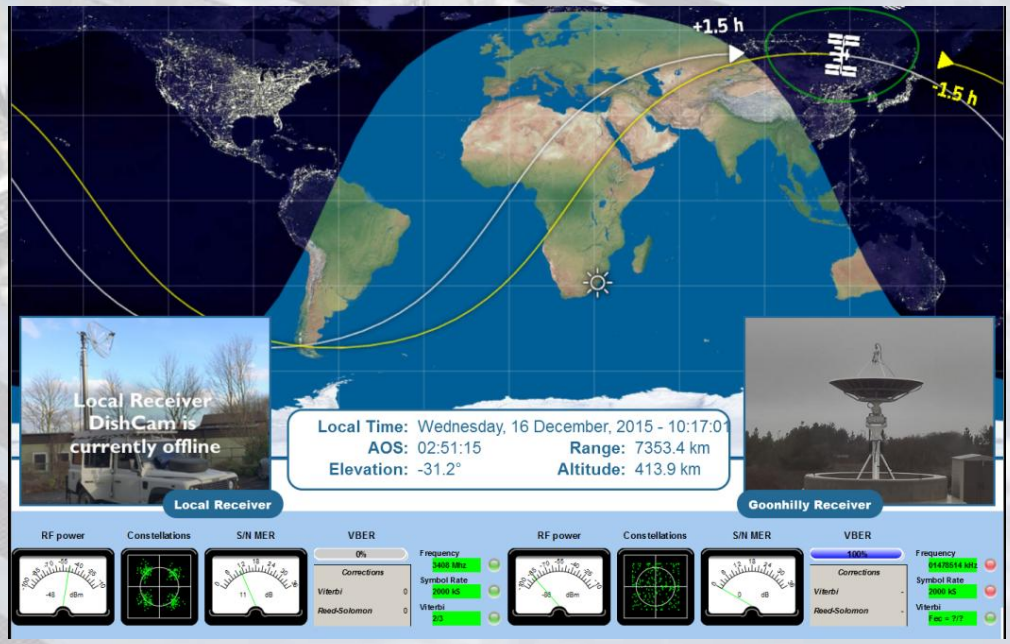


BATC CDN

Rpi - HDMI

Presentation at the school

- We believe it is important that we present a professional “show” at the school
- We present the ISS dashboard showing position of the ISS plus countdown to AOS
  - Plus dishcams of HamTV receivers
- Large screen for presentations and live video from the ISS



Contact at CNS Norwich and...

The webcast

- Aim of the ARISS principia project is to engage as many people as possible in STEM and amateur radio.
- HD production using 2 cameras, dashboard and other graphics plus live contact video
- Streamed live on to BATC server
  - 1,600 viewers
  - On campus distribution server
- Recordings available on ARISS UK youtube page
- And more gear than the VHF station!
- HD and audio feeds for broadcasters

Summary

- We believe it is essential to promote STEM in a professional and engaging way
- Despite being “amateur radio” we are be providing a professional event
- Every event has been covered by national or local TV and Radio
  - When did Amateur Radio get that much publicity!

“We are called Amateurs – just look what we have achieved here today and imagine what you could achieve as tomorrow’s professionals”

Just imagine!