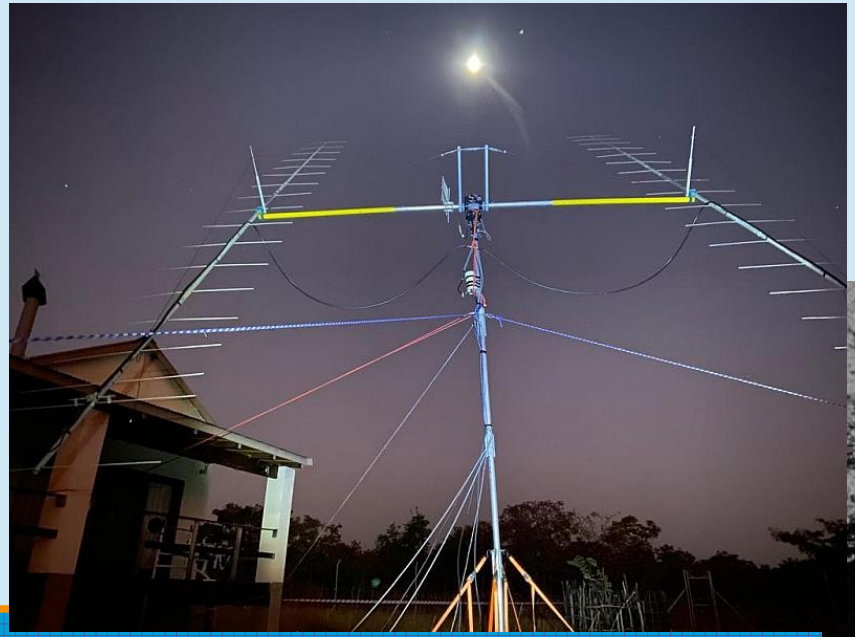
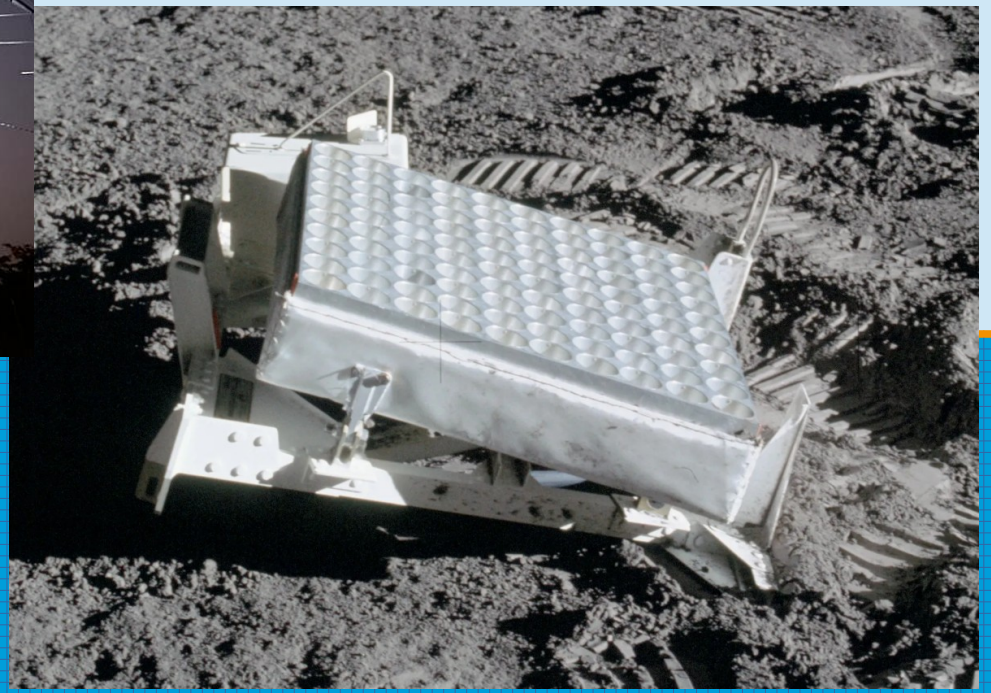
# Moon Bounce / Space Comms





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# E-M-E – What the hell is that?

- E-M-E or Earth Moon Earth
- Normally used on 2m (144.025-144.100 MHz)
- 70cms (432.000 – 432.070 Mhz)
- 23cms (1296.00–1296.025 Mhz)
- Not a QRP mode. Needs a little power
- Results can be had on 2m with 100 watts and 13Ele Yagi-Uda

# Receive Equipment

- You might well need a masthead pre amp.
- You definitely require good or great sensitivity.
- A good antenna plays a huge part.


VE1KG
NOVA SCOTIA
CANADA
FN84

# Receiving.....

- Path loss: Approximately 250 dB (massive signal loss due to ~770,000 km round trip)
- A good quality mast head pre amp will help
- 2.5 Seconds travel time. Its possible to catch your tail.
- Digital modes: WSJT-X (JT65, Q65) for weak signal work

# Transmitting…

- A mixed mode setup is preferable.
- You could work Digital Modes one day and work CW/SSB the next.
- SSB takes power – You might need an Amplifier
- Why not start with just one Antenna?

# Antenna Considerations

- 2m Antennas can be quite large.
- 70cms Beams can pack an impressive Gain Figure.
- Forward Gain figures normally start at :
- 2m 12dBi
- 70cms – 18dBi
- 23cms – 21 dBi Upwards
- That is until you stack and bay the antennas….

# Stack and Bay

- Stack and Bay refers to how many antennas you wish to use and its configuration.
- A stack is how many antennas are in the vertical plane.
- Bayed is how many exist in the horizontal plane

# Budget?

- You CAN have some results with a large Yagi on 2m
- Ideally you would have a 4x4 (2Stack 2Bay) arrangement
- You can use cheaper Beams if you want to go mad (8x8)
- Cheaper, higher gain beams on 70cms.

# Considerations

- Libration fading, Faraday rotation, atmospheric noise
- Moon positioning and elevation requirements
- Equipment costs and complexity

# Libration Fading – WTF?

- Libration refers to the Moon's slight "wobbling" motion as seen from Earth. The Moon doesn't rotate uniformly relative to us - it rocks back and forth slightly in multiple axes.
- Different parts of the Moon's surface reflect your signal at slightly different distances.
- This creates interference patterns - signals add constructively or destructively.

# Faraday Rotation

- Faraday rotation is the rotation of a radio wave's polarization plane as it passes through the ionosphere (Earth's ionized upper atmosphere).
- Your signal passes through the ionosphere twice (up and down)
- The polarization can rotate unpredictably - sometimes 180° or more
- If you transmit horizontal polarization but it rotates to vertical, and your receive antenna is horizontal, you'll experience severe signal loss (cross-polarization loss can be 20-30 dB)

# Polarisation

- The rotation amount varies with frequency, time of day, solar activity, and signal path
- Solution: Many EME operators use circular polarization or dual-polarization systems that can receive both H and V simultaneously

# H and V (Crossed Yagi's)

- Mount Yagi antennas in both horizontal and vertical orientations
- Example: 4 Yagis total - 2 horizontal + 2 vertical
- Feed each polarization separately with its own feedline
- Use a relay or hybrid combiner to switch between or combine polarizations
- Advantages: Relatively straightforward, uses standard Yagi's

# VHF EME

- By far the easiest band to get started on is the 2m band. Antennas with excellent forward gain are often smaller than 6m counterparts.
- Two Yagi antennas (each with 4-6 elements) mounted at 90° to each other (one horizontal, one vertical)
- Mount them on a rotator to track the Moon
- Use separate feedlines for each polarization
- Connect to two receivers or a dual-input receiver with low noise amplifiers (LNAs) for each polarization
- Software like WSJT-X can be used to combine signals or switch between polarizations

# The Magic Band

- This is a less common EME band, but still used by some operators
- The same crossed Yagi array approach can be used, but 6m Yagis are larger and more complex to build
- You may need more space for the antenna system
- 50.310-50.320MHz - See the Bandplan!

# Getting Started...

- If you're planning to operate on 144 MHz, I'd suggest starting with a crossed Yagi array for H and V polarization. It's effective, relatively easy to build, and widely used in the amateur radio community for EME.

# ISS

- The International Space Station uses a Kenwood D710E and a Kenwood D710GA.
- Four externally mounted antennas for redundancy.
- One 10m whip for which they have no hardware (Yaesu FT-100)

# NASA

- NASA placed 5 reflective panels on the Lunar surface.
- Two were delivered by Apollo 11 and 14 crews in 1969 and 1971, respectively.
- One larger unit was placed by Apollo 15 in 1971
- Soviet robotic rovers called Lunokhod 1 and 2, landed in 1970 and 1973.

# Moon Facts

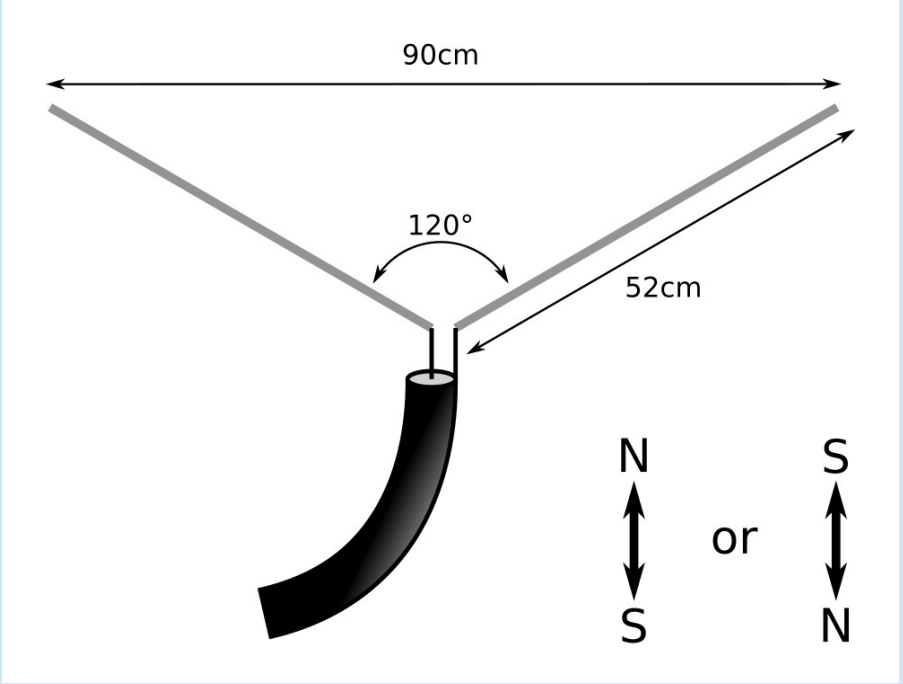
- 240,000 miles (385,000 K) away from Earth.
- Pulling away from orbit at 1.5” per annum
- What begins as a light beam that’s about 10 feet, or a few meters, wide on the ground can spread out to more than 1 mile, or 2Km, by the time it reaches the Moon’s surface, and much wider when it bounces back. That translates to a one-in-25-million chance that a photon launched from Earth will reach the Apollo 11 reflector. For the few photons that manage to reach the Moon, there’s an even lower chance, one in 250 million, that they will make it back.

# Odd's on!

- If those odds seem daunting, reaching LRO's reflector is even more challenging. For one, it is a 10th the size of the smaller Apollo 11 and 14 panels, with only 12 corner cube mirrors. It's also attached to a fast-moving target the size of a compact car that's 70 times farther away from us than Miami is from Seattle. Weather at the laser station impacts the light signal, too, as does the alignment of the Sun, Moon and Earth.

# Signals from above

- You can easily receive signals from NOAA Satellites
- APT (Automated Picture Transmission)



# APT Frequencies

- NOAA 15: 137.62 MHz
- NOAA 18: 137.9125 MHz
- NOAA 19: 137.1 MHz

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- NO LONGER IN USE – August 2025

# So what else can we receive?

| Organization | Satellite Name | Orbit | Service | Frequency | Data rate | Status |
|---|---|---|---|---|---|---|
| NOAA | NOAA-15 | Polar | HRPT | 1702.5 MHz | 0.665Mbps[12] | Offline |
| NOAA | NOAA-18 | Polar | HRPT | 1707.0 MHz | 0.665Mbps[12] | Offline |
| NOAA | NOAA-19 | Polar | HRPT | 1698.0 MHz[13] | 0.665Mbps[12] | Offline |
| EUMETSAT | Metop-A[14] | Polar | AHRPT | 1701.3 MHz | 4.66Mbps[15] | Offline |
| EUMETSAT | Metop-B | Polar | AHRPT | 1701.3 MHz | 4.66Mbps[15] | Transmitting |
| EUMETSAT | Metop-C | Polar | AHRPT | 1701.3 MHz | 4.66Mbps[15] | Transmitting |
| CMA | Fengyun 3A[16] | Sun-synchronous | AHRPT | 1704.5 MHz | 4.2Mbps[17] | Offline |
| CMA | Fengyun 3B[18] | Sun-synchronous | AHRPT | 1704.5 MHz | 4.2Mbps[17] | Offline |
| CMA | Fengyun 3C[19] | Sun-synchronous | AHRPT | 1701.3 MHz | 4.2Mbps[17] | Offline |
| RosHydroMet | Meteor-M N2 | Sun-synchronous | HRPT | 1700.0 MHz[20] | 0.6654Mbps[21] | Offline |
| RosHydroMet | Meteor-M N2-2 | Sun-synchronous | HRPT | 1700.0 MHz[22] | 0.6654Mbps[21] | Offline |
| RosHydroMet | Meteor-M N2-3 | Sun-synchronous | HRPT | 1700.0 MHz[23] | 0.6654Mbps[21] | Transmitting |
| RosHydroMet | Meteor-M N2-4 | Sun-synchronous | HRPT | 1700.0 MHz[24] | 0.6654Mbps[21] | Transmitting |