How Not To Do EME

The Long Road To Moon Bounce

Talking Notes

This presentation will give you a glimpse of my decades long fascination with Moon Bounce or EME (Earth Moon Earth as the big guys call it).

Hold on to your seat this is going to be a wild ride.

How not to do EME

- 1975-76
  - In college my friend decides to build a EME station for his Senior Project

Talking Notes

My first brush with Moon Bounce was in college. In your senior year engineering students need to complete a senior project to graduate.

My friend decided his senior project was to do moon bounce. He was a ham and figured it would be easy.

You still had to take a full class load of 18 or more units (and I was working two jobs).

How not to do EME

- He was not able to get an EME station on the air and make a EME contact
- He did graduate

Talking Notes

In 1976 it takes a lot of effort and money to put an EME station on the air. Even if you have license and a rig.

Part of your senior project was learning how to deal professionally with failure.

How not to do EME

- Lessons learned
  - It takes time
  - It takes money

How not to do EME

- Jump ahead
- Central States 1989
  - Tim Pettis KL7WE shows off his, home built, portable 432 MHz EME setup
  - He flies to different locations with the equipment disguised as fishing paraphernalia and takes the amplifier /power supply as carry on

Talking notes

He buys some parts of the array at or near the operating site to save weight while flying. All parts for the array are common hardware store items.

He rents a generator at the site or if operating out of a hotel he gets a room near the laundry and gets them to let him use the 220 volt clothes drier plug.

The power supply for the amp is heavy so he carries it on board hoping his arm does not fall off before he can stow it under the seat in front of him. It might break the overhead bin. It’s heavy, if he checked the amp and supply as baggage the airlines would charge extra, a lot extra. You

Talking Notes

This is his array outside the Central States conference hotel in Lincoln, Nebraska 1989.

It’s a 432 MHz station.

You get a idea of the size of the array from the people standing around it.

He used a clothes drier outlet from the hotel to power the amplifier.

The antennas array is hand positioned. The array is held in position by a rope. You can see the rope tied to the vertical support, just below the bottom row of antennas.

There are plastic protractors on the base and elevation part of the array.

How not to do EME

- His antenna consists of an array of 12; 11 element yagi antennas
- the array can be rotated to change antenna polarization
- The antennas, the mount and stand come apart and can be bundled as a small package

Talking Notes

Antennas were home built and based on a DL6WU design. The array and mount use standard electrical conduit. Only two wrenches are needed to put the array together. Most pieces are common hardware store items.

There are two six way power combiners, each connected to six antennas. The output of the power combiners go to a two way power combiner. From there the coax goes to an antenna switch.

One side of the switch had two low noise preamps connected in series. The output of the preamps go to a RG-58 coax. One preamp was to make up for the loss of the RG-58.

RG-58 and RG-8 are much lighter and easier to work with than hardline. Hardline has lower loss and would need only one preamp. LMR-400 didn’t exist back then.

How not to do EME

- Work gets in the way
  - Heavy work load
  - Heavy travel schedule

Talking Notes

Heavy work load. On the road one week a month, fly out on Saturday and fly back on Sunday. When I got back it was rush to debrief and then get ready for the next trip. On top of that there were family duties.

How Not To Do EME

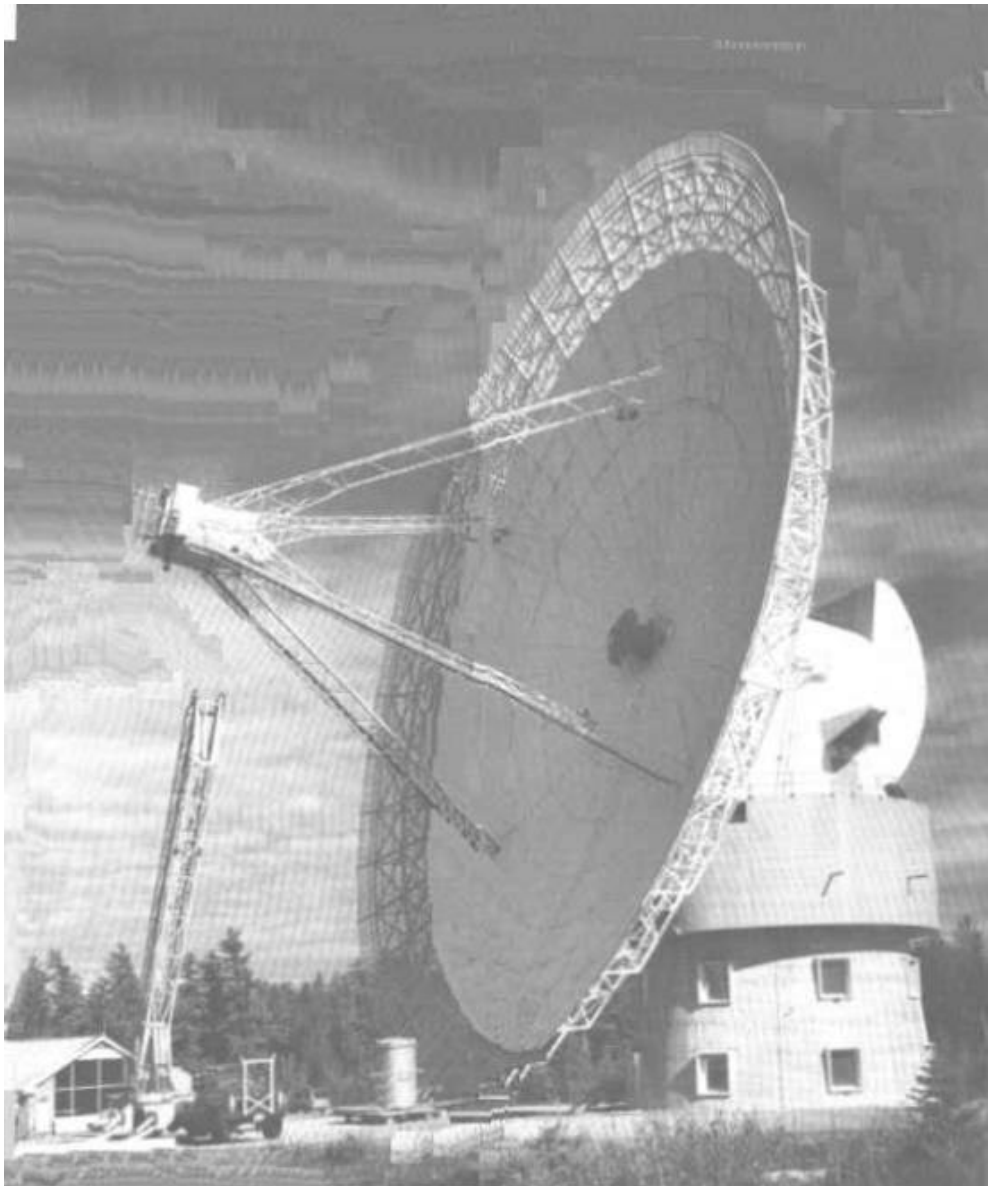
- Skip ahead to 1992
- Algonquin is going on the air

Talking Notes

They advertise that Algonquin can hear a station on 432 running only a hundred watts.

I have a hundred watt amp.

All I need is the antenna array.



Talking Notes

This is the dish at Algonquin. It's a 46 meter dish. That's 150 feet in English, half the size of an American football field. Located in north central Ontario, Canada. 150 km northwest of Ottawa.

That's a truck in front of the ladder. The truck has a mount on the front bumper to hold the ladder when they lower the ladder to stow it.

How not to do EME

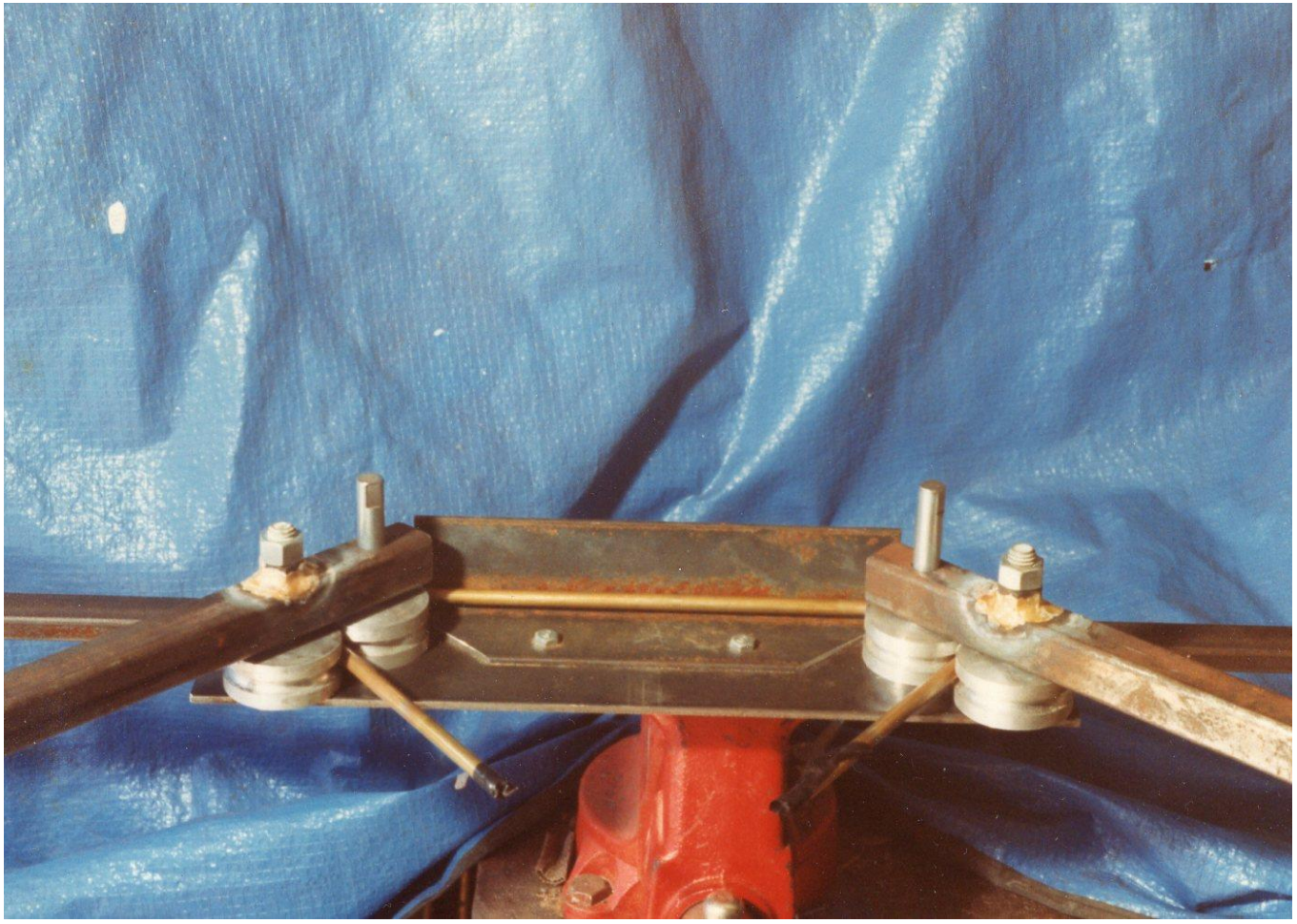
- First I had to build the antennas
- Then the array

Talking Notes

DL6WU is a Germany ham, so I had to buy some metric measuring tools.

432 MHz antennas take careful measuring.

How not to do EME



Talking Notes

This is the jig I used to bend the driven elements. A good friend of mine machined the aluminum wheels in the bender.

The driven elements are brass. It took a lot of misshapen and wrinkled brass to figure that out how to bend the driven elements. I made 12 driven elements plus a couple of spares.

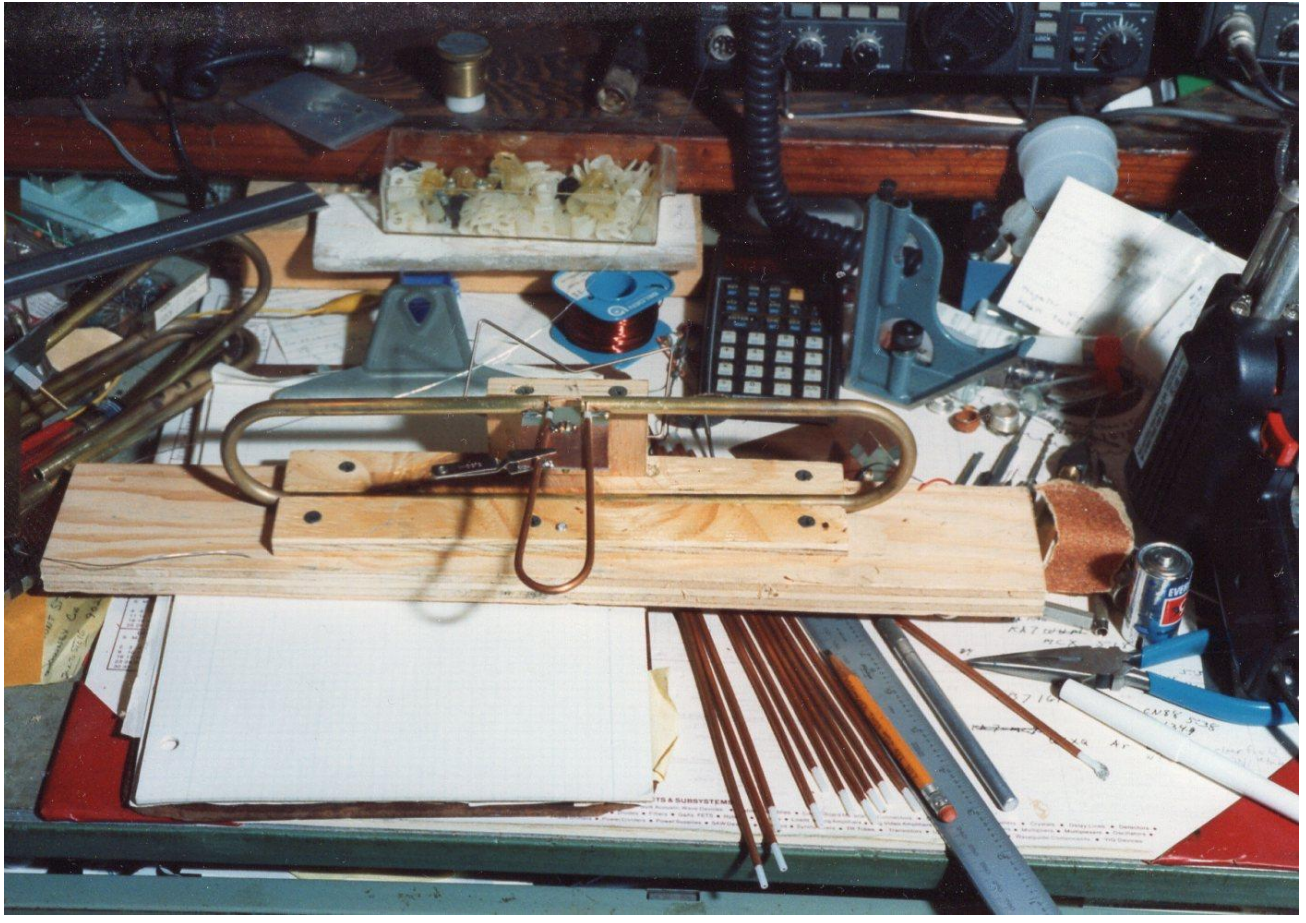
How not to do EME

Talking Notes

Notice the blue discoloring, of the brass near the rim of the bucket. This is where the brass was heated to soften it.

Then I filled the brass tube with sand to keep the brass from wrinkling when I bent it.

How not to do EME



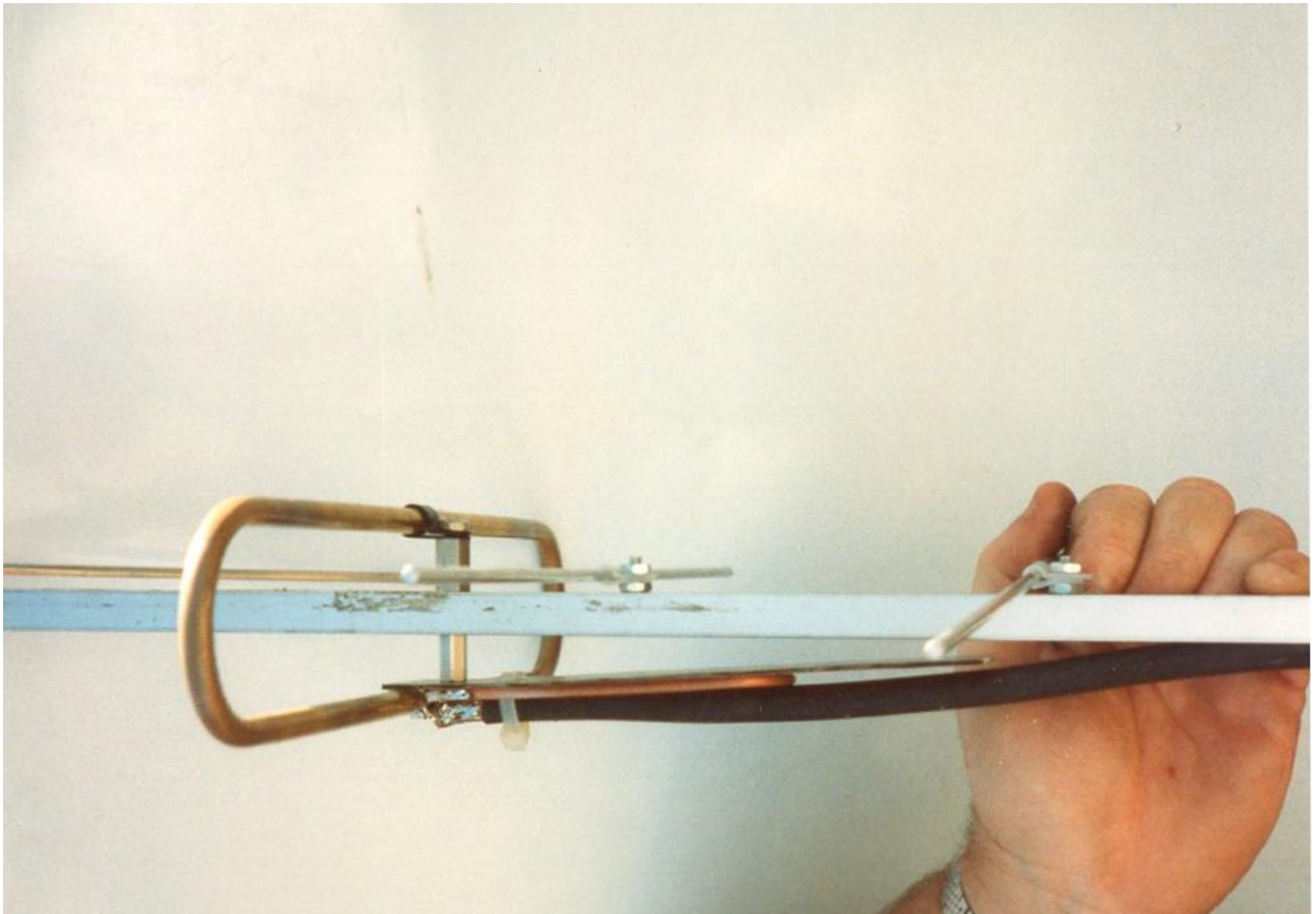
Talking Notes

This is the jig for holding the brass driven element while soldering the matching section and the coax pig tail on.

The matching section is a half wave length of RG-141 semi-ridged coax (the smaller tube).

There is a square piece of PC board under the RG-141 and the brass driven element to make it easier to solder everything together.

I made fourteen driven elements (two spares).



Talking Notes

This is a picture of the prototype antenna. Looks slick when put together. Some of my better work.

The prototype has a bigger piece of PC material soldered to the driven element. I made the PC board smaller for the rest of the antennas.

That 12 antennas with 11 elements each. Total of 12 driven elements and 120 elements cut to exact length. Plus one prototype antenna and one spare antenna.

How not to do EME

Talking Notes

The array, folded up and, loaded on top of my car to be hauled down to DM22.

The rest of the station is in the back seat and trunk of the car. You can see that the car is down on its springs, in the rear, from the weight of all the equipment I have crammed in the car.

How not to do EME

Talking Notes

First thing we did when I got to DM22 is test antennas. A framer's field makes for a good test range.

In my old home town, in DM22, is flat for fifty to a hundred miles around. We used a trailer to haul the generator and test equipment. In the 1990s the test equipment was line powered and heavy.

Yes, that's a car jack holding up the end of the trailer so we could walk on it.

How not to do EME

Talking Notes

My array, set up in my friend’s front yard.

That’s a lot of elements. All of them were ground to less than a millimeter of their required in length.

We later moved the array to the back yard. The yard light next to the drive way was attracting too many bugs.

How not to do EME

Talking Notes

The operating bench set up in the back yard.

We used an Icom IC4 luggy talkie and a KLM amp to work the moon.

There’s plenty of backup equipment on the table.

There is only one coax connected to the rig. The second line is a shadow caused by the flash. This is from the days before photoshop.

How not to do EME

- Partial success
  - I hear Algonquin, the signal is loud
  - I hear other stations but they are weak
  - Algonquin does not get a solid copy of my signal
  - No confirmed contact

Talking Notes

There is a small cassette tape recorder on the operating table. I have a recording of the signals from Algonquin.

Talking Notes

Lesson learned from Algonquin

- I need more power

How not to do EME

- To get more output power
  - I buy a used K2RIW amp
  - The amp did not come with a power supply
  - I start to build the power supply build a power supply
  - I blow up the power supply twice

How not to do EME

- This is a 2200 volts at 2 amps power supply.
- The second time there was a primary jumper in the wrong place.
- I flashed the jumper wire, light show, scorch marks, smoke.
- I did not blow the fuse on the power pole, but I should have.
- This shook me up, luckily I was at the fuse box

Talking Notes

Shorting the 220 volt mains through a small wire makes for a light show you don’t soon forget.

How not to do EME

- Life gets in the way
- Computer modeling of antennas is born and matures
- Old antennas ideas are proven wrong
- Better antennas are designed

Talking Notes

Today EMEers talk about antennas in terms of the length of the boom wave lengths.

For a reasonable number of elements it’s the length of the boom that determines the gain of the antenna.

How not to do EME

- It’s now the 2000s
- New transistors are developed that can deliver 1000 watts at two meters
- Continual improvement in low noise transistor bring lower noise pre-amps to hams

Talking Notes

The first transistors, for high power RF, run on 12 volts, then 24, then 50, now run at 65 volts.

They were made for 12 volts to be used in mobile radios. It took many 12 volts transistors to get a KW out.

Using 12 volt transistors, takes lots of current (160 amps do to inefficiencies) to get a 1000 watts RF output.

The low noise transistors were developed for the TVRO industry and repurposed for EME.

How not to do EME

- 2016
- The EME bug bites again
- This time it’s two meter EME
- Lesson learned from 12 antenna array
  - building 12 phasing lines is a pain and expensive
  - Go with fewer longer antennas
  - Phasing lines have loss

Talking Notes

WSJT 65 is big at the Central States convention.

You can get a LDMOS power amp and power supply for a reasonable price (but it’s still a lot of money).

Talking Notes

The DL6WU antenna design is a good design, even compared to computer modeled designs of today.

Tim used short antennas so he could pack them up and get them on a plane.

Still working within a fraction of a millimeter is a pain whether building a 2 meter or a 432 MHz antenna.

How not to do EME

- Meet with KK6FAH Jimmy Blanchette
- After meeting with him I decide to build a 32 foot long, two meter, antenna
  - with two 32 foot long antennas you can work almost anyone
  - they only require two phasing lines

Talking Notes

Steve Noll WA6EJO recommended I talk to Jimmy.

Jimmy had his antennas on the top of his house, but he moved them to the back yard. The antenna is not high off the ground. It works and being low to the ground saves a lot of effort when working on the array.

With the antenna in the back yard and lower to the ground he picks up less noise from other houses and the city.

I have built long antennas before, but not 32 foot long. It only has 14 elements and they will only need two phasing lines.

How not to do EME

- Life gets in the way
- It’s now 2017
- One antenna completed

Talking Notes

There was an total eclipse of the sun, visible in Oregon. That took a lot of work to get ready for and a couple of weeks to travel to.

Family problems.

BigTex

Talking Notes

The first 32 foot antenna mounted on the first a elevation set up.
That's an eight foot step ladder next to the antenna. The trailer is 12 feet long.
This is a big antenna and I made it too heavy.

This version used a TV rotor (where the mast goes through the middle of rotor) to elevate the antenna .

The rotor was not strong enough for one antenna and I was planning on two antennas.

15LT

Talking Notes

I used a tripod that I had used for contesting on mountain tops in the 1980s.

Bolted it to the wood floor of a small trailer.

The tripod was very shaky. I added angle iron and square steel tubing to brace it. Then I added more bracing and then more bracing.

Talking Notes

This is a close up of the new elevation plate.

Two pillow blocks and a short length of one inch steel bar between the two pillow blocks (bearings). Pieces of one and a quarter inch electrical tubing slip over the ends of the one steel shaft.

The arm that sticks out near the middle of the assembly will connect to a jack screw to lift the arm and rotate the boom.

City of
Port Hueneme
b

Talking Notes

A photograph of a jack screw off a TVRO dish attached to the lifting arm to elevate the antenna.

It works well to elevate the antenna.

Talking Notes

Picture of the array assembled. (getting down with the antenna.

The ends of the boom are fiberglass, so it does not interfere with the antenna elements. This saves adding a short piece of mast at the ends of the boom to lift the antennas away from a metallic cross boom.

Added a T shaped brace to the antenna to take the bow out of it and keep it from swinging side to side in the breeze. There is always an on shore sea breeze when you don’t want one.

How not to do EME

- The antenna still bobbed up and down in the breeze, like a toy drinking bird

Talking Notes

The bobbing was caused by the boom twisting. The boom is one and a quarter inch EMT conduit. In fit over the one inch solid steel shaft tightly and the the fiberglass end pieces slipped over the EMT nicely.

The EMT and fiberglass are not strong enough.

If I do it again I will use at least two inch conduit or a section of a light tower. I like using the end pieces made of fiberglass, but would also go with two inch, and thicker wall, fiberglass poles.

How not to do EME

- Solution, add a second boom

Talking Notes

I’ve got too much time and money invested in what I have done.

I’m so close.

Talking Notes

Looks good.

How not to do EME

- The second boom did not help as much as I wanted
- Purchase two used 11 element Cushcraft antennas at the Yuma hamfest

Talking Notes

Got the antennas cheap.

Shorter antennas will place a lot less torque on the two booms.

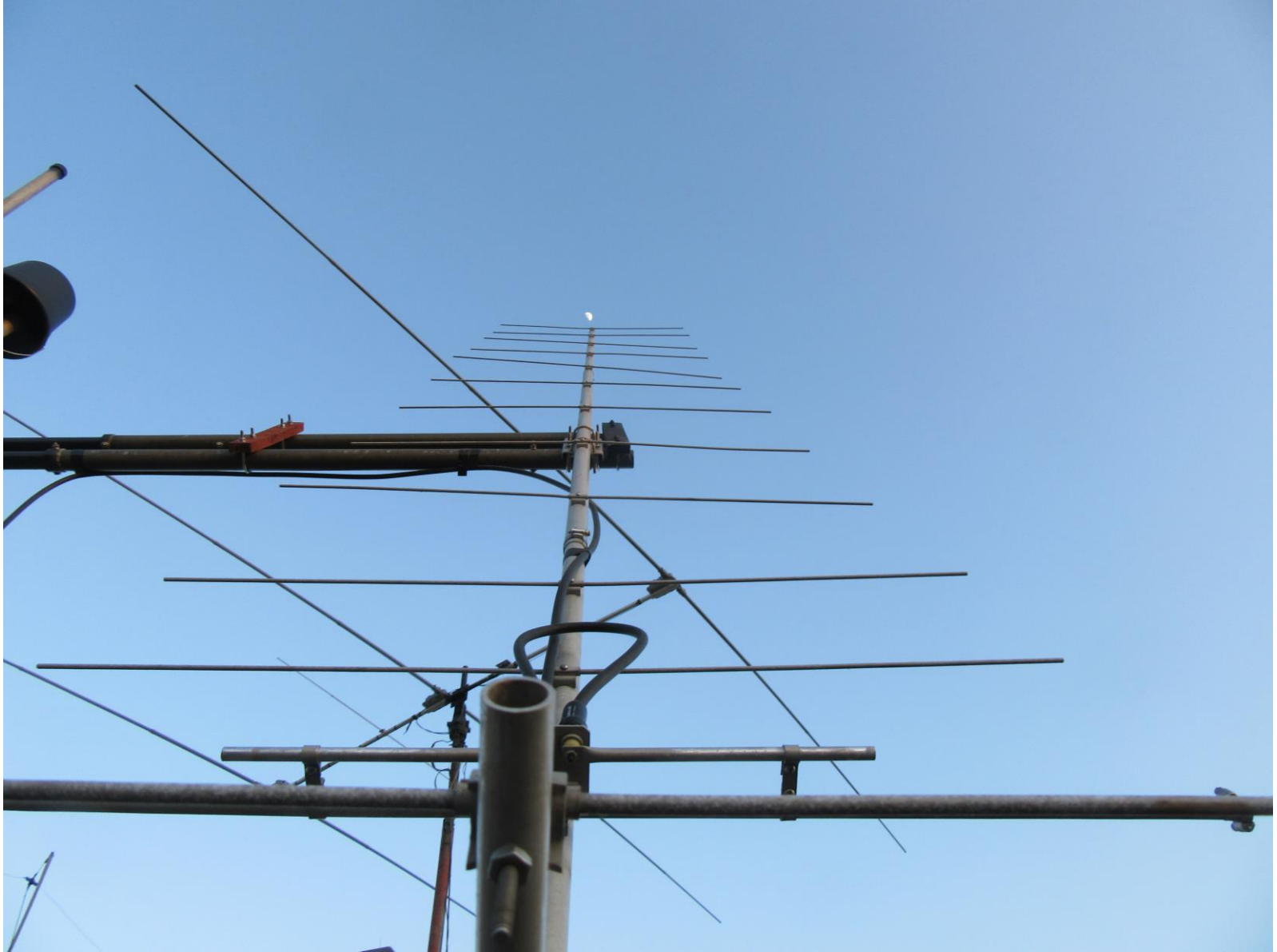
Talking Notes

Two booms and two antennas.

My back yard is getting crowded.

The elevation jack screw will not point the antennas up vertical enough.

The antennas do not have enough gain. They are an older design.



Talking Notes

The system does tracks the moon, if the moon is not too high in the sky.

It is almost impossible to get all the elements straight on an old antenna.

How not to do EME

- Life happens, work on the EME project stopped
- Within a year and a half the Cushcraft antennas had corroded to pieces
- Needed bigger (longer) antennas and a azimuth rotor that indicates better and can move one or two degrees at a time
- Elevation assembly would not elevate to 90 degrees

How not to do EME

- Antennas are not stable enough
  - Add another boom
  - Buy a better azimuth rotor at Yuma
  - Rework the elevation pivot point

Talking Notes

The Yuma hamfests are getting expensive.

Purchase another pair of antennas, these are 13 elements antennas. These are not from Yuma and are a newer design. Clean, sand, then paint the new antennas. I live close to the ocean, I don’t want these antennas to corrode away.

Rework of the pivot point for the elevation jack screw. Had to get out the welder and the grinder. After several tries I got it to where it will point almost straight up.

1513

Talking Notes

A picture of the three boom elevation assembly. The ends of all three booms are fiberglass.

Talking Notes

A close up of the lowered/offset pivot point. You can see from the holes that it took a couple of tries.

Talking Notes

Got the elevation assembly in the air.

Saving up money to buy bigger antennas.

Working on the many little things needed to get the station on the air.