



My Itinerary to L-Band Moonbouncing...

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THIS PRESENTATION

- WHY L-BAND MOONBOUNCE?
- A LONG TERM PROJECT...From Fall 2008 until Now:
 - The dish,
 - The feed,
 - The mount,
 - The feedlines,
 - The remote controller,
 - The steering,
 - The PC software.
- THE OUTCOME!
- THE MATHS
- WEB REFERENCES



WHY L-BAND MOONBOUNCE?

- **MY DREAM-COME-TRUE**
 - Owning a big dish had always been my objective!
- **1296 MHZ EME MORE CROWDED THAN 432MHZ**
 - Had walked the park on 432 MHz EME. QSO repeats.
- **MORE GAIN! LESS IMPAIREMENTS**
 - Still using a manageable size antenna.
 - Circular Polarization, no Faraday Rotation issue.
- **LOTS OF NEW CONCEPTS TO LEARN**
 - Dish theory,
 - Feed construction,
 - Motorization of dish mount,
 - Orbit tracking automation,
 - Tube-based Power Amplifier construction,

A LONG TERM PROJECT...

- **Fall 2008**

- A 3.2m (10.5') Al. mesh dish becomes available via VE2ASL, picked up for 40\$ + gas. No mount, no feed arms, no actuator.
- Convince my wife...
 - Only after the above-ground swimming pool is removed.
 - To be installed out of sight in the backyard.
 - Still...



- **Summer 2009**

- Pick up two more dishes from VA3KS via donation to WCARC. 2.7m and 3.0m + mounts, actuators, cables, feeds, a dozen receivers, etc. The mounts and actuators are what is needed.



NOW A SHORT TERM PROJECT!...

- **September 2009**

- Emergency! Houses to be built behind my backyard.
- Must put up a placeholder dish to “mark my territory”,
- Wife understands issue and accepts to move forward dish installation.
- Get a pipe, 2 3/8” diam. A bit small but all I could quickly find.
- Dig a hole 44” deep, 14” diam., pour 8 cu.ft. of concrete.
- Install the 3.0m dish. I notice a bit of a bend on the pipe...

- **Fall 2009**

- Replace 500 rusted-out screws for mesh on 3.2m dish. A 5-hour job! Ten 30-minute sessions.
- Choose polar tracking over Az-El.



THE FEED TAKING SHAPE

- **Fall 2009 (cont.)**
 - Start to work on VE4MA feed.
 - Made from Tx-Rx Systems 2m Duplexer cavity.
 - Initial results show good resonance, but too high in frequency (1334 MHz)
- **Winter 2010**
 - Build a PHEMT (ATF54143) LNA (preamp). 17.5dB Gain, 0.4dB NF. OZ2OE design. Available on the web.



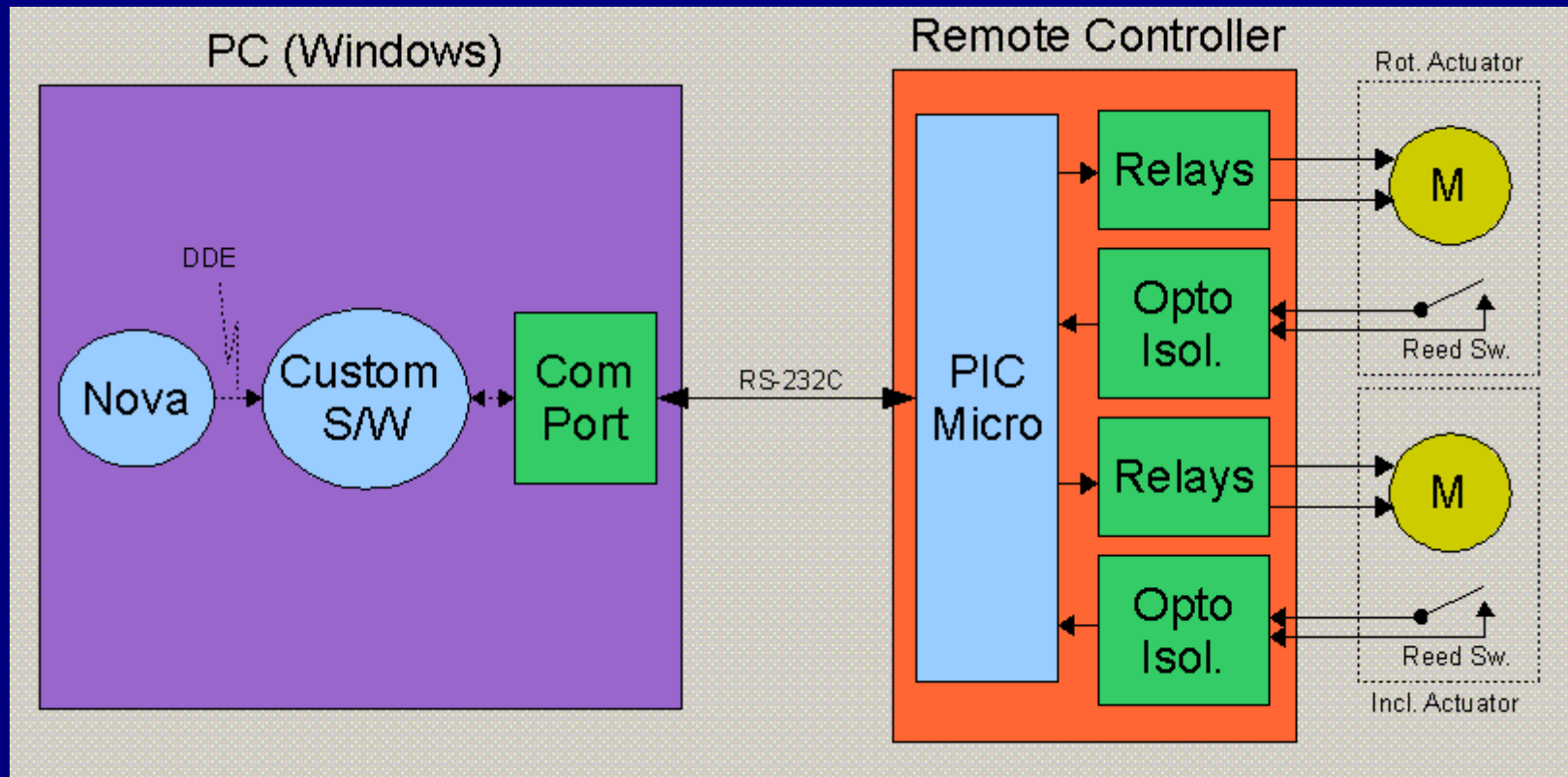
DISH STEERING DECISIONS

- Summer 2010
 - 6 houses build behind my backyard...
 - Decide on Azimuth-Over-Elevation tracking scheme.
 - Have a mount that can tilt 0-85 degrees.
 - Az-El to Azimuth-over-Elevation conversion formulas readily available on Internet.
 - Will mimic polar tracking as moon progresses in a pass.
 - Will give about 90 degrees of azimuth (rotation) and 85 degrees of Inclination.
 - More on this later...



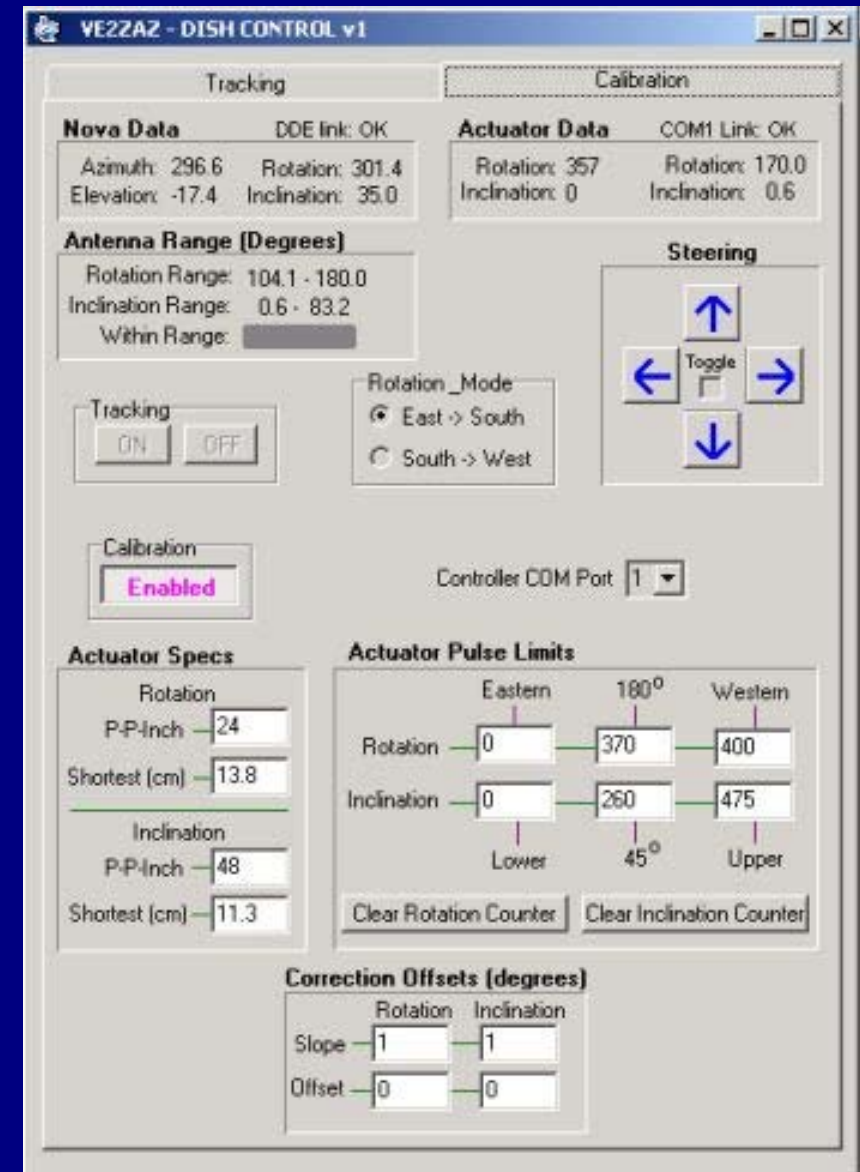
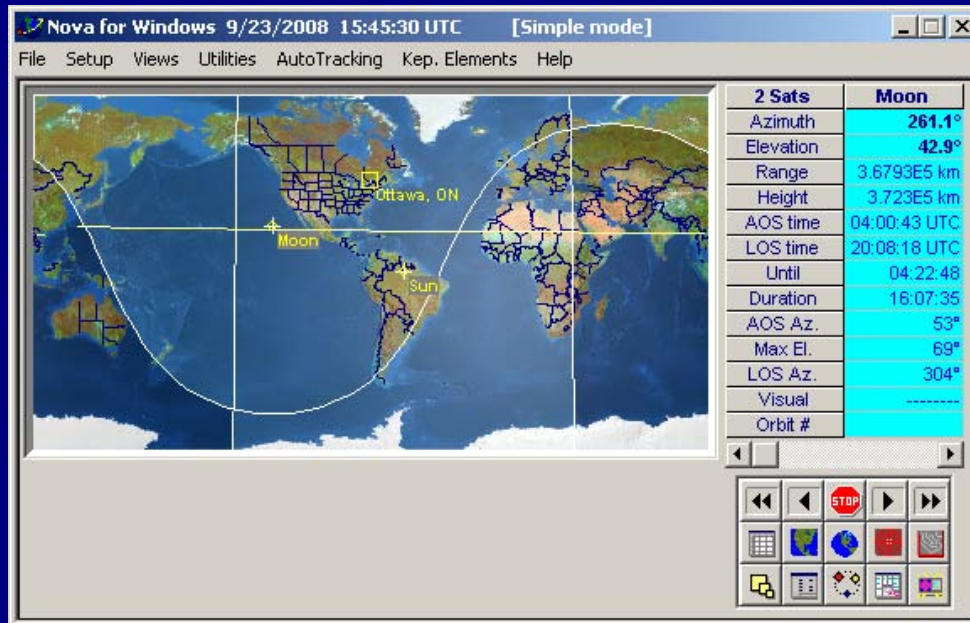
THE CONTROL SYSTEM

- Summer 2010 (Cont.)
 - Control System architecture decided.



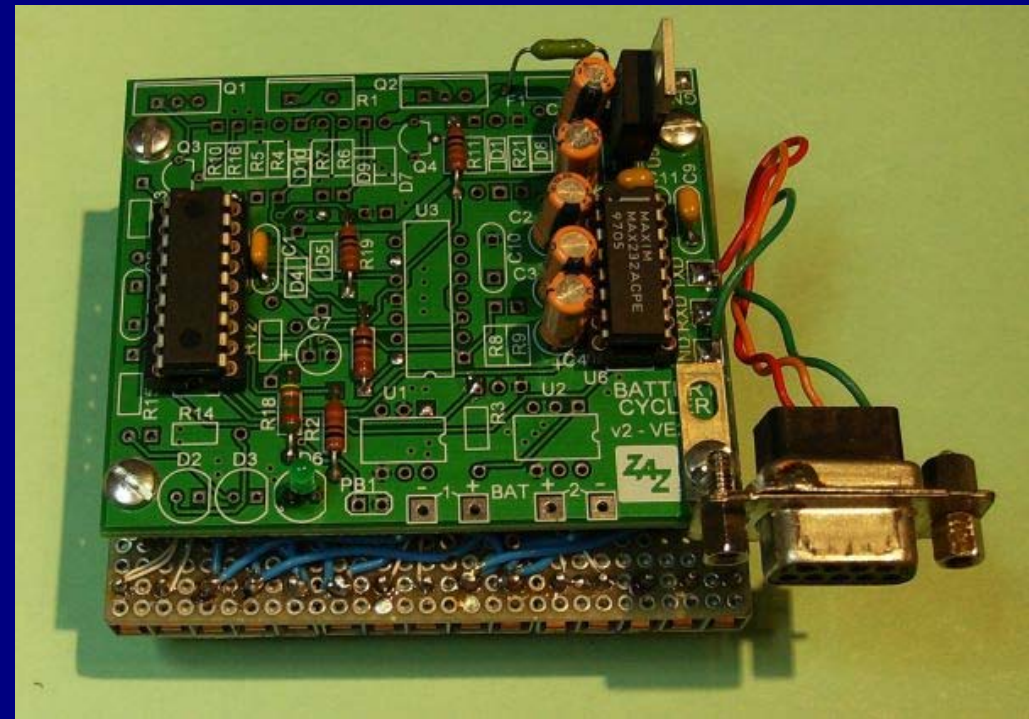
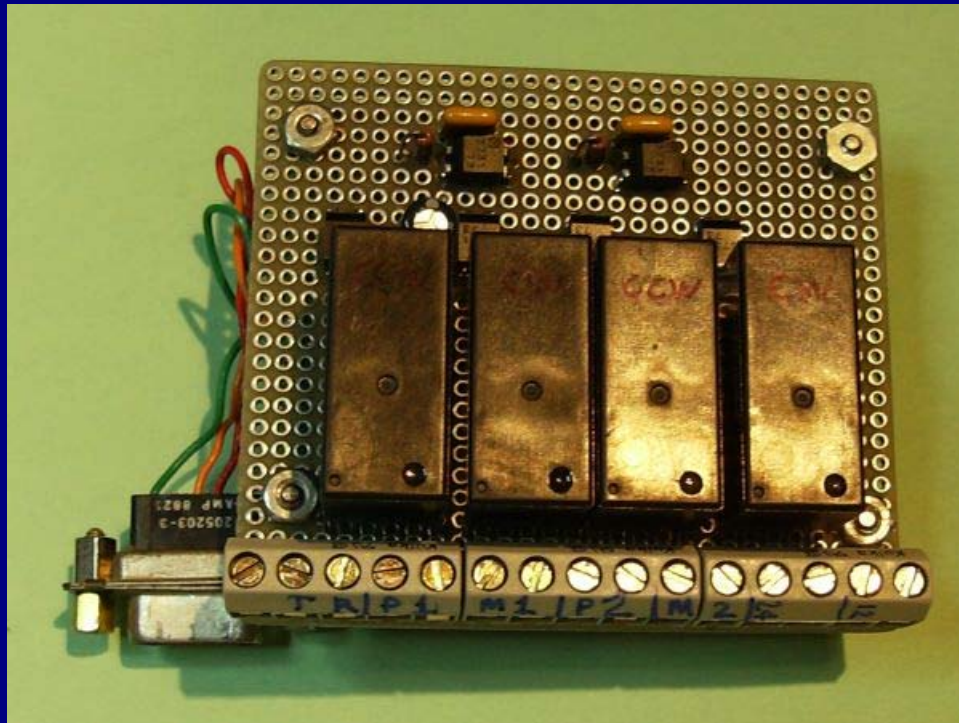
THE WINDOWS SOFTWARE

- Summer 2010 (Cont.)
 - Will use Nova-for-Windows tracking Software and DDE capability.
 - Write a Windows conversion and tracking software.



THE REMOTE CONTROLLER

- Summer 2010 (Cont.)
 - Design an outdoors PIC controller to control actuators and read actuator pulses. RS-232 to/from PC. Located right by the dish.



THEN THE NOISE PROBLEM...

- September 2010
 - Bugged by actuator motor EMI/RFI noise problems.
 - Motor brushes cause EMI/RFI to flow all over the controller board.
 - Cause mis-counting of the actuator rotation pulses.
 - Spend weeks trying to solve
 - Solution is Common-Mode Choke. Used PULSE P0502, ~5\$ at Digikey.
 - Math formulas to derive the rotation and inclination angles from the pulse counts do work!
 - built and installed the super-scalar ring on the feed.



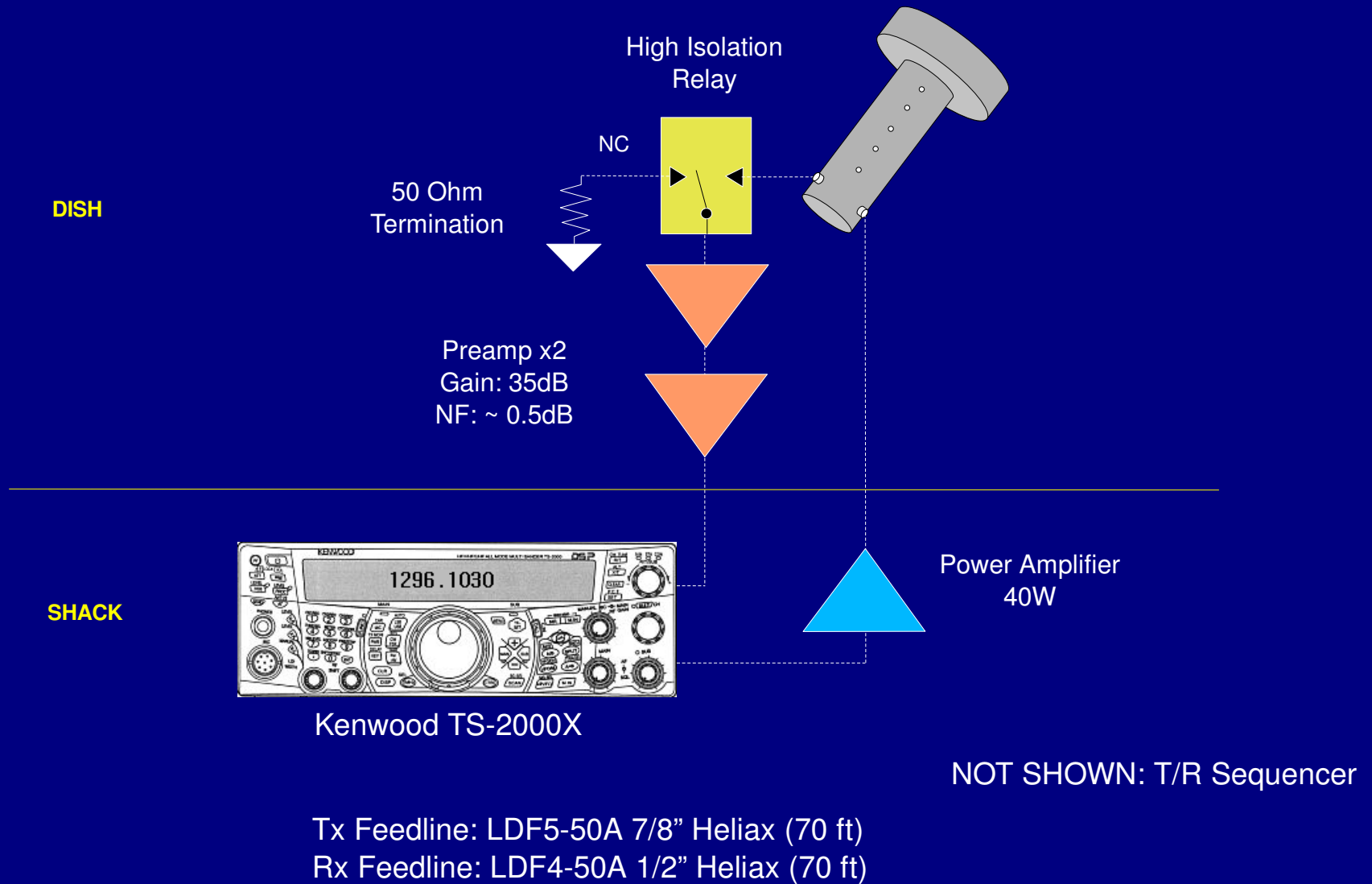
TWEAKING AND TESTING...

- October 2010 (Cont.)

- Built Super Scalar Ring, the big plate. Painful Jigsaw work!
- Adjusted Feed for best:
 - S11 (VSWR): 23dB (1.2:1) on both Tx and Rx ports.
 - Axial Ratio (Circularity): ~ 1dB.
- First Sun noise measurements!
 - 8.3dB of Sun-to-Cold_Sky,
 - 2-3dB lower than predicted.
 - VK3UM EME Calculator highlights lack of gain at feed.
 - Need >30dB of amplification.
- Built of 2nd PHEMT preamp.
 - Identical as 1st one,
 - Combined, 35 dB of gain.
 - 0.5dB of NF



VE2ZAZ – OCTOBER 2010



WE HAVE LIFTOFF!

- **October 2010 (Cont.)**
 - Found out why reading lower Sun noise
 - TS-2000X audio is not linear with RF noise amplitude, despite AGC turned off! Likely the IF DSP saturation.
 - Used 1296-144 K7RR Transverter, two 144MHz preamps and a low pass filter, sent into HP Spectrum analyzer (averaging used)
 - Got 11.3dB of Sun-to-Cold_Sky noise! Yes!
 - 2nd preamp also helped somewhat.
 - ARRL EME Contest (Oct. 30th-31st)
 - Total 3.5 hours of listening.
 - Copied 23 station calls and many more partials, despite heavy thick snow on dish.
 - What an improvement from my 432MHz EME performance!



THE HELIAX STORY

- October 2010 (Cont.)
 - Picked up 250 feet of used LDF5-50A Heliax 7/8" Cable in Deerfield for 80\$, including connectors. Cheap! Painted orange and white.
 - Catch #1: N connector at one end, UHF (SO-239) connector at other end... No good at 1296!
 - Catch #2: Old type Heliax with spiraled corrugated copper shield. Need old type connector (45AW, 45AN).
 - Found an N-type connector (giveaway from VE7 ham)
 - Had moisture inside connectors during installation
 - When sub-zero temperature, everything OK, when thawed, high SWR!



AND THE LOOGBOOK FILLS UP...

- November 2010
 - First EME contact on 1296!
 - CW QSO with K1RQG (10m dish)
 - Easy contact despite my 22W at the feed!
 - Second EME QSO
 - JT-65C contact with PY2BS (4.6m dish and 500W)
 - I heard him -9dB WOW! (speaker copy)
 - He heard me -24dB (weak but OK)
- Many more QSOs since then.



SOME MATHS...

- AZIMUTH-OVER-ELEVATION vs. AZIMUTH & ELEVATION
 - The equations:

Summary. The tilted azimuth and elevation \overline{AZ} and \overline{EL} are determined by the equations

$$\tan \overline{EL} = \frac{\tan EL}{\cos(180 - AZ)}$$

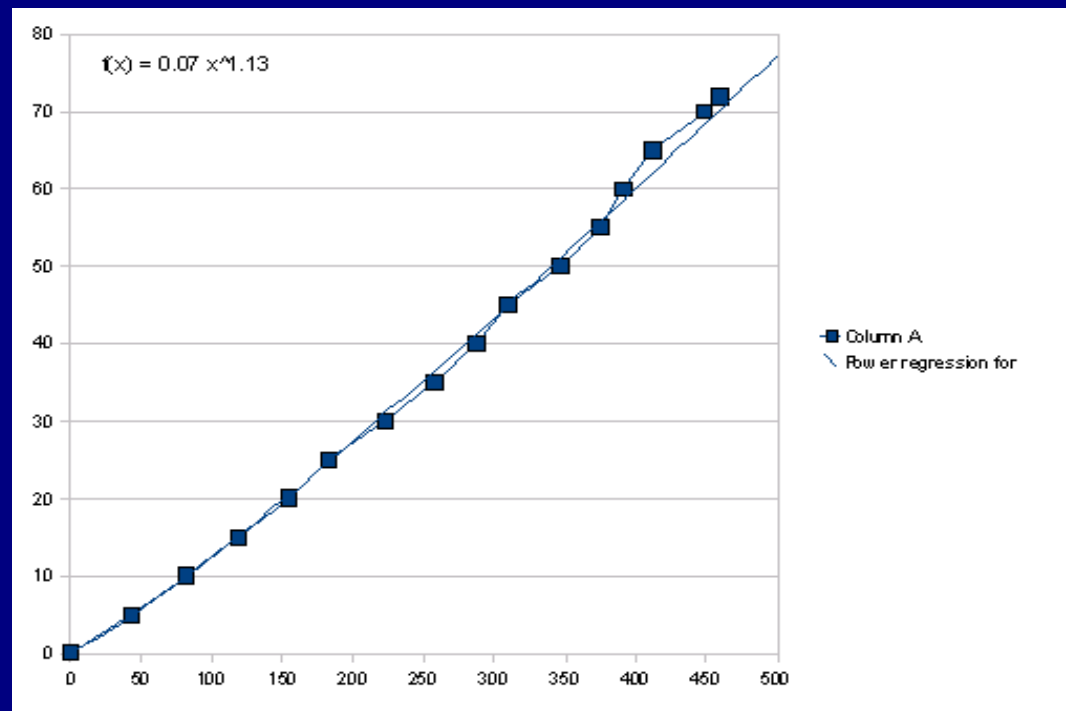
and

$$\cos \theta = \cos EL \cos(180 - AZ) \cos \overline{EL} + \sin EL \sin \overline{EL}.$$

$$\overline{AZ} = 180 \pm \theta :$$

MORE MATHS...

- **INCLINATION vs. ACTUATOR ARM LENGTH (PULSE COUNT)**
 - Used mechanical Inclinator,
 - Took pulse counts at every 5 degrees,
 - Did some curve fitting in a spreadsheet program,
 - Derived an equation of Angle vs. Pulse Count,
 - Plucked the equation into Windows conversion & tracking software.



EVEN MORE MATHS...

- **ROTATION vs. ACTUATOR ARM LENGTH (PULSE COUNT)**
 - Kitchen table drawings of exact mount dimensions to derive the formula,
 - Lots of ArcCos and ArcSin trigonometry.
 - I'll spare you the details...
 - Will likely try to measure Rotation angle vs. Actuator arm length instead.

Some References

- VE2ZAZ Website
 - http://ve2zaz.net/3.2m_Dish/3.2m_Dish.htm
- Azimuth-over-Elevation conversion equations
 - <http://www.math.msu.edu/~maccluer/AzEl/azel.html>
- Pulse P0502 EMI Filter
 - http://productfinder.pulseeng.com/products/datasheets/SPM2007_63.pdf