SAN BERNARDINO MICROWAVE SOCIETY, Incorporated

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A NON-PROFIT AMATEUR TECHNICAL ORGANIZATION DEDICATED TO THE ADVANCEMENT OF COMMUNICATIONS ABOVE 1000 MC.

W6IFE Newsletter

November 2009 Edition

At the **5 November 2009** SBMS meeting the "Tech Talk" will be Rein, W6SZ on using WSPR digital mode on microwaves . The SBMS meets at the American Legion Hall 1024 Main Street (south of the 91 freeway) in Corona, CA at 1900 hours local time on the first Thursday of each month. Check out the SBMS web site at http://www.ham-radio.com/sbms/.

REMINDER- NO PARKING IN THE CHURCH LOT

Last meeting.. President, John Oppen, KJ6HZ, called the October 1, 2009 SBMS meeting to order at 7:04 pm. There were 26 people present. The Pledge of Allegiance was recited. Larry, K6HLH, read the secretary’s report. Dick, K6HIJ, read the treasurer’s report. Pat, N6RMJ gave a report on the 2010 MUD progress. Things are moving ahead nicely. We need to give the hotel another installment payment. Pat asked for a report back from those that go to MUD in Dallas on what we could do to improve our conference. We also need a speaker for the banquet and suggestions for tours. Dick, K6HIJ will do registration and badges, and Jerry, N7EME, will do the proceedings Dick made lots of badges for people and they need to be picked up. Dick also helped a college student get his magnetron oscillator working for a school project. We then went around the room for activity reports. Dick showed some 47 GHz W/G switches that he had built and will take to MUD. Paul, KH6HME, reported that there were very few openings to Hawaii last year. Walt gave a demonstration of how to make a waveguide to type “N” adapter and how to tune it up. We took ATV check-ns. Dick gave a Tech Talk on Mismatch and Noise measurements. The meeting was adjourned at 9:04 PM.
Recording Secretary, Larry Johnston, K6HLH

Scheduling.
3 December- 1296 MHz rig designs
7 January- Agilent on New equipment
4 February- Open- Suggestions?
MUD 2010 Wednesday October 20 ----- Sunday October 24 Los Angeles area. SBMS is sponsoring it.

As requested at the last SBMS meeting, Here is the links to the JPL DESCANSO web site. This JPL site has a lot of information that is useful to the amateur microwave community. The home page is:
http://descanso.jpl.nasa.gov/index.cfm
The Descanso Books that are available for downloading are at:
http://descanso.jpl.nasa.gov/Monograph/mono.cfm?force_external=0
Several of these books are directly applicable to amateur radio work, particularly Volume 4 and Volume 10.
The periodic reports on work done by JPL in space communications can be found at:
http://ipnpr.jpl.nasa.gov/ipn_progress_report/issues.cfm?force_external=0
Happy Hunting...Dick K6HIJ

Wants and Gots for sale.
For Sale- Gonset 20mtr 5 elm beam $20; 220MHz heavy duty 7 el beam $15 ; 6 ft spin aluminum dish (no back mounting support) $50; Hallicrafter HT32A transmitter with manual $100, Scott Navy WW2 18 KHz-20 MHz receiver Bill WA6QYR 760-375-8566 bburns@ridgenet.net.

Threads .
W1GHZ es The MW Group de K2RIW 9/16/09
Dear Paul, GOOD WORK -- Your 9/15/09 PDF submittal entitled "Parabolic Dish Focus, Zoom and Tilt" contains some fine work. <http://www.w1ghz.org/new/Parabolic_Dish_Focus_Zoom_and_Tilt.pdf>
I really like the 3D colored antenna patterns. I would like to know which program created those simulations, and I wish I could afford it -- Hi.

THE CRITICAL FOCAL DISTANCE -- Your article clearly indicates the importance of using the correct Parabolic Dish Feed Focal Distance -- with a required accuracy of a fraction of a wavelength -- when using a small F/D Reflector.

MY PURPOSE -- I want to supply some information to increase the understanding of a Zoom Control.
A ZOOM CONTROL -- For 5 years I used a 3 step Zoom Control on my 16 Yagi array of RIW-19 Yagis on 432 MHz. That Zoom Control made it about 5 times easier to find people that were at an Unknown Azimuth during a VHF Contest, and it helped me make the top score in the W2 (NY and NJ) area on three occasions while using nothing but 432 MHz. It was the "Most Fun" antenna I have ever owned.
That experience convinced me that the Zoom Control concept needs more favorable acknowledgement, and more deployment -- all good cameras have a Zoom Lens. A person can view a picture of my antenna, and the three 3D Zoom Patterns, in the March 2008 issue of "CQ Amateur Radio", page 36.

THE OFFSET FED PARABOLA ELEVATION PROBLEM -- On almost all of the available Offset Fed Parabolas, the apex of the "Parent Parabola" is located at the "bottom edge" of the Asymmetric Reflector. Once that fact is known, an amateur can easily determine the Elevation Setting of his Dish by sighting from behind that lower edge, and looking through the Phase Center of the Feed Horn. This assumes the Feed Horn is properly located at the Focus.

"AXIAL" DISPLACEMENT -- If you want to displace the Feed Horn in an Axial Manner on a Prime Fed Parabolic Dish you would merely move the Horn closer or further from the center of the Reflector, because that is the Axis of the antenna.

BUT, WHERE IS THE OFFSET AXIS? -- However, on an Offset Fed Parabola, the correct way to do an Axial Feed Displacement is to move the Feed Horn toward a spot that is very close to the Geometric Center of the Asymmetric Reflector, because that is the True Axis of that complete antenna system. If you stood off at a long distance and measured the "Apparent Phase Center" of the Radiation from that antenna, it would be on a line that goes through the Geometric Center of the Asymmetric Reflector

SQUINT -- I know this seem opposite from common sense. The further evidence is that the total antenna will develop "Squint" (a change in Elevation, or an Elevation Error) if you move the Horn in any other way. Figure 12 in the W1GHZ article is displaying the 5.75 degree Squint Error that occurred -- that's a 1.4 Beam width Error for a one wavelength Displacement.

PATTERN DEGRADATION -- When you displace the Feed Horn toward the Apex of the "Parent" of the Parabolic Reflector (toward the lower edge of the remaining Reflector) you will be creating both an Azial Displacement, and a Transverse Displacement. That will cause the Pattern to break up more rapidly, and the Gain will decrease more rapidly.

THE ZOOM POSSIBILITY -- However, even with the disadvantage of the simultaneous Displacement Error, I believe Figure 14 of your article is displaying the potential advantage of a Zoom Control. Here are the details.

1. A properly fed 18 inch Offset Fed Parabola on 10 GHz will have a -3 dB Beam width of about 4 degrees, and a -10 dB beam width of about 7 degrees.

2. Figure 14 (with 1 wavelength of Displacement in both an Axial and Transverse manner) shows a beam width of 14 degrees, at -12 dB from the Non-displaced Peak Gain. If the Feed had been Displaced only axially, the 14 degree Beam width would probably be at -10 dB (instead of -12 dB), and the Pattern would be very nearly the same in Azimuth and Elevation.

3. That's a doubling of the Azimuth and Elevation Beam widths at the -10 dB level, a 4:1 increase in the "Area" at -10 dB. That increase you chances by almost a 4:1 ratio of finding that signal, just as long as the signal is 10 dB above your Ultimate Threshold when your Gain is peaked (no Feed Displacement, no Zoom).

THE ZOOM DISADVANTAGE -- Make no mistake, any operation of a Zoom Control must be accompanied by a Decrease in Gain; it's a trade off. If you're spreading your signal over a greater Angular Area, it has got to get weaker -- that's the Physics of "The Conservation of Energy". Therefore, if the signal of interest is only 1 dB above your Ultimate Threshold (and it has no QSB), then a Zoom Control will give you no benefit. But, in the Real World a weak signal almost always has QSB, and you're really not sure of the Azimuth, the Elevation, the Frequency, and the Time he is transmitting (your doing a 4 Dimensional Search). That signal is periodically going through brief QSB peaks. If you're not on the right Azimuth, Elevation, and Frequency at the Time he has the key down, you will miss that QSB Peak, and you will not know he is there. The Zoom Control (in this example) can give you a 4:1 increase in the Probability of Intercept.

TOTAL ACCURACY? -- I'll admit that a Zoom Control is not for everybody. You have to have "the faith" that it's going to give you some advantage a certain percentage of the time. If you and the guy you're contacting are using a Rubidium Reference, and you know your frequency (and his) to the nearest 1 Hz; if your Dish is perfectly leveled, and has 0.5 degree of Azimuth Accuracy; you've calculated his exact Azimuth; and if you know the propagation so well that you're sure the signal is not arriving 2.5 degrees above the horizon -- than under those conditions you probably do not need a Zoom Control. I think very few of us have that much accuracy and confidence in all of those areas at the same time.

SIDELOBES -- We should be careful of the way we view the Side lobes of a Dish Pattern. The Decibel Display can greatly expand the apparent level of those zillions of Side lobes. If the display was in Volts, they would look much smaller. If they were being displayed in Power (which is the way the antenna really works), you wouldn't see them at all. Until the Side lobes get up to a level of about -13 dB (or stronger), or cover a zillion square degrees, their Total Integrated Power is usually quite small. Therefore, Dish Efficiency and Gain is mostly due to what is happening in the Main Lobe -- as long as there are no Lossy Resistive Components within the antenna system.
73 es Good Dish DX, Dick, K2RIW

Well Tim, you certain have an interesting way of looking at Log Periodics and I may need to tweak the data sheets. You can think of a Log Periodic as a closed spaced 3 element Yagi. And as you change frequency, the three elements used, move up and back along the boom. (Yes, it gets a bit more complex when current is split between two elements, but I'm trying to keep it simple here.) If you are using the 2.1-11 GHz Log Periodic on 2304 MHz, you are using the last 3 elements, or the longer elements of the antennas. If you are using the 900-2600 MHz on 2304 MHz, then it's pretty much the first 3 elements you are using. So on one antenna it's the front of the antenna you want at the focus of the dish, on the other antenna is the rear end you want at the focus of the dish.

But in each case it is the active elements you want at the focus. From a practical point, if the LP and dish are focused at the highest frequency you plan to use, the lower frequency bands will have little phase error.As Paul will note, this varies quite a bit with the f/D of the dish, but unless it's an f/D of .2-.25 or so, you should be fine.
Power:
The active area changes quite a lot with frequency. At 900 MHz the RF currents are spread over an area of about 6 square inches. At 10 GHz the currents are in an area less than 1/3 square inch. So there is less surface area to dissipate heat as you
Go up in frequency. At 10 GHz they will handle about 10 watts on SSB and CW, but a Long Key down or using FM will toast one. I as recall the Packrats ran one for an entire contest at 40 watts SSB/CW on 3.4 GHz. But after the contest they decided to run FM for the heck of it. And 40 watts FM on 3.4 GHz will again toast one.
Now to find our how much the Phase center moves on a 1-10 GHz Vivaldi.
Anyone have info on phase centers of Vivaldi's?
Kent WA5VJB

Being an old fart I sometimes don't listen to my Elmer. I am often faced with "reality" .vs. "perfection" when deciding if something is good enough or needs more perfection. Most often I take the easy way out. If it works, leave it alone. Some of you may think this is basic and obvious but I missed it. Dish feeds MUST be mounted at the focal point! Period. At 5 GHz it MUST be pretty accurate! Something I have not been careful about. I changed from the WA3RMX feed to the WA5VJB feed years ago and did not adjust for the size or position. I just knew that the 900-2600 MHz WA5VJB feed was fantastically better on 2 GHz than the WA3RMX feed! Easily reproducible. The problem is that the different bands have different focal points on the feed. ALSO the VJB 2, 3, 5 feed is totally different than the VJB 900, 1.2, 2gig feed. One problem was that I did not compensate for the different type of feed. Second problem was that the Log periodic feed does not have an obvious focal point. W1GHZ had a nice explanation of these feeds and feed points with hard data on what can happen. Check this: http://www.w1ghz.org/antbook/conf/WA5VJB_LPA_feed.pdf. I did not take any action since the 2 GHz had improved in a major way over the WA3RMX feed so I ignored the idea that the 2, 3, 5 VJB feed could do better. Even with my mounting error the WA5VJB LPA had just about the same performance as the WA3RMX feed. I did not know that I could do better! (I was too lazy to listen)
http://www.w1ghz.org/antbook/conf/WA5VJB_LPA_feed.pdf>
How I discovered this was by accident, I tried a home made half wave Dipole on 5 GHz to see if it was better than the WA5VJB feed and it was. I had intended to see if the feed was working or maybe broken when compared to the WA3RMX. In the June contest I just tried the half wave Dipole at a distance site (over 250 miles). I was surprised when the Half wave dipole was better than the WA5VJB 2, 3, 5 feed so I
investigated further. Finally I listened. This contest (Sept) using my Most often contacted and consistent station (W2SZ) I tried moving the WA5VJB feed in closer to the dish while they were in TX and just about
Doubled or more my receive ability on 5 GHz! My peek point appears to be about 3 inches closer to the dish than I had the feed located before. I repeated this test at 4 different sites and found the improvement fairly consistent. 3 INCHES for double the receive! 3 inches ain't much but at 5 GHz it seems to be ALOT! As you now know I am lazy so my 900-2600 VJB feed was also 3 inches closer to the dish which proved to be a problem near the end of the contest as I probably lost some of my gain. I WILL fix this next year. In summary LPA feeds work GREAT but you have to adjust for the strange focal point on the PC Board feeds. In my case I discovered that I now need two different ways to mount my two different feeds (900, 1.2,2 and2, 3, 5 WA5VJB feeds). I even bet that I can get an improvement in performance by having each band on a given feed mount at a different distance from the dish to optimize the focal point of that band on the feed. I will probably take the easy way out and mount one spot per feed. A side note I discovered that the WA5VJB feeds seem to be able to handle more power than the WA3RMX before burning up the boards. 900 MHz at 100watts on VJB! So these WA5VJB feeds are GREAT! I will let you know this winter if they can handle 100watts of 2403! I found this so enlightening I had to spread the word! I wanted to let everyone know how lazy I can be. Read the bible for uwave hams by W1GHZ
<http://www.w1ghz.org/antbook/conf/WA5VJB_LPA_feed.pdf>and try it your self in the field. It worked for me!
Tim Ertl (KE3HT)

This is fascinating to me. I have been using the WA3RMX feed on a 24 inch dish with an f/D of 0.333 for a while and I've been pleased with the performance. The most desirable aspect is not having to change feeds when I switch from 2304 to 3456 to 5760 MHz. I have no way of measuring the losses but I've read that it is less optimum at 5760 MHz. However, I have made many QSO's with it and that is what counts.

Kent now has feeds available that cover 2 to 11 GHz. I haven't tried one as a dish feed yet. I use a separate single-band feed for 10 GHz on my dish.
For those who are ARRL members, this is the feed I use. Mine is mounted on a length of UT-141:
http://p1k.arrl.org/cgi-bin/topdf.cgi?id=76423&pub=qst
But I wonder if the performance of the newer WA5VJB LP antennas is good enough that it could be used from 2304 through 10 GHz without changing the feed location? 73, Zack W9SZ

Hi Tim, I couldn't have asked for a better endorsement if I paid for it! Thanks. I've written a paper for Microwave Update on the same subject with a bit of new info
<http://www.w1ghz.org/new/Parabolic_Dish_Focus_Zoom_and_Tilt.pdf>
http://www.w1ghz.org/new/Parabolic_Dish_Focus_Zoom_and_Tilt.pdf
73 Paul Wade W1GHZ <q.w1ghz@comcast.net>

There is a NASA solution. The NASA solution uses the LP feed, and positions the dish for the lowest frequency focus. Then for the higher bands dielectric dishes with resonant elements for each band are mounted at their focal positions. The resonant elements can be dipoles or crosses (for circular or any axis polarization) and there needs to be many of them. There can be more than one dielectric dish. It's also possible to make the dielectric resonant element reflectors flat getting the phase shift for the parabolic focus by adjusting the resonant frequency and thus the phase angle of the reflections. It's just possible that the NASA solution looses more in the resonant reflectors than the miss focus of the LP feed on a plain dish. It's probably more effective to use really broad bow tie radiators with reactance compensation of the feed impedance, but it's really hard to get 5:1 frequency coverage that way. 2:1 is really hard; 1.5:1 is fairly easy. Has been since WW2. 73, Jerry, K0CQ

Now to find our how much the Phase center moves on a 1-10 GHz Vivaldi... Anyone have info on phase centers of Vivaldi's? Wouldn't the Vivaldi phase center movement begin to match that of the
Wide band double ridged horn where the ridges have about the same shape as the Vivaldi? Surely with an antenna range and a collection of parabolic reflectors the effect on gain of the Vivaldi position could be found experimentally. I'd guess the phase center to be closer to the open end of the Vivaldi the lower the frequency. .Kent WA5VJB

A quick google search on Vivaldi antenna "phase center" shows it's considered by the UWB gang to be a great antenna. That the phase center is not significantly affected by frequency which is a property needed to allow UWB pulses to be radiated without destruction. The better report from KU at http://www.cresis.ku.edu/about/tech_reports/TechRpt135.pdf reports that Gibson developed the Vivaldi primarily for a broad band dish feed. That's reported in the 2007 book "Ultra-wide band antennas and Propagation" from John Wiley and Sons publisher. KU thinks their half size (1/4 wave length and mouth) is better than Gibson's where he sets the LF at 1/2 wave length and mouth. The full title seems to be "Ultra-wide band antennas and propagation for communications, radar, and imaging." World cat says there is a copy at UT Arlington. 73, Jerry, K0CQ

All RIW is saying is that most offset dishes are cut from the full circularly symmetrical parabolic reflector to include right to the center of the full reflector. That center is where the feed horn shoots energy that bounces right back to the feed horn causing a serious change in the feed horn match which is one of the disadvantages of the conventional prime focus dish. Among several disadvantages like scattering from that feed to raise G/T and shadowing from the feed and its mounts to cause scattering and lowered gain. Anyway, just that the center of the prime focus dish is exactly perpendicular to the path from the feed, so is the edge of most offset dishes perpendicular to the path from the feed. Try it. Take the blade from your 12" machinist's adjustable combination square. Its end is square. Hold the end of the blade against the face of the dish at the edge where the feed mount is.
With the blade up and down (dish aimed at the horizon, feed on the bottom or top) the blade will most likely pass right by the center of the feed horn adjusted for maximum gain. Since I've converted the Direct TV LNB to feed horn, it's positioned correctly. Alternate feeds that aren't so well placed may not be there precisely and will cause the beam angle to be off, and the gain to be down. My gain may be down from the feed being designed for 12 GHz instead of 10. 73, Jerry, K0CQ

For another ham radio reference on an LPA to feed dish, check out:" A Broadband Dish Feed for Amateur Radio SHF" in Microwave Update 1994 Tom WA1MBA

Hi, Thanks to everyone for the replies (many direct replies as well as list ones)! I will definitely check out the references given in the replies. I hope to have the antennas up there one way or another before winter sets in.
One antenna is a 21 element 15' 432 that was a gift which needed plenty of TLC; but it's just about set to go. The 222, also a gift is an old Cushcraft with the triple "planar" reflector, in nice shape. All my front ends are in the transverters not at the antennas, since the roof has a 45 deg pitch and hazards of going up there make it preferable to have a situation where visits up there happen as seldom as possible. Thanks again for your help.--Lenny W2BVH

Hi Lenny and group. Here is one genuine "half data point" -
I used to have a 6 M (37' boom) with a pair of F9FT Yagis stacked 2.5 ft above and below it. They all seemed to have good clean patterns. Since the stacking distance was 5 ft. total, the capture areas of the two 432 antennae ended at the height of the 6 Meter beam.
PS: Above the top 432 a few feet was a 220 trigonal, and the at the top was a 2M A32-19 as far away from the 432 as possible.
73, good dxing, John K1AE

Ben wrote:
After deciding that an LPA would make a great multi-band fed for a dish, I decided to design one to cover at least the two bands I wanted to use; 1296 MHz and 2304 MHz. As WA5VJB pointed out, this antenna is essentially a beam with only three active elements at a given frequency. Using design data I acquired from Dr. Bob Carroll, one of the original log periodic design team members 3 or 4 decades ago at the Univ. of Illinois, I was able to achieve a respectable return loss for my antenna at 902, 1296, and 2304 MHz. Also, the azimuth and elevation beam widths were relatively constant at all design frequencies as to be expected since the gain is relatively constant at all frequencies. I constructed my feed design from brass tubing and rod obtained from Hobby Lobby because of my aversion to any material with dielectric loss. While the AZ and EL beam widths were constant, they aren't the same, so right away I decided this feed was not very well suited to a circular parabolic reflector. However, several years ago, I obtained from WA5VJB a 2 ft. x 3 ft. BBQ grill reflector with a rectangular parabolic surface. By placing the feed at the focal point and designing for -10 dB pattern roll-off at the edges, I obtained a very close match for the angles of the LPA pattern at the edges of the reflector with angles from the focal point to the reflector edges. Even though the feed AZ and EL beam widths matched with the reflector, the LPA pattern is probably elliptical whereas the reflector is rectangular, so there is still spill over/under illumination of the feed pattern at the corners and sides of the reflector. What I couldn't do is have an automatic adjustment of the phase center of the LPA feed to match it to the dish focal point depending on the operating frequency. So, I let the 1296 and 2304 MHz phase centers straddle the focal point of the parabolic reflector and accepted whatever degradation I got. By doing this, even though the return loss of the feed at 903 MHz was o.k., this phase center was on the far side of the 1296 MHz phase center from the focal point, so I knew it was suffer gain loss because of this. I entered the antenna in the home brew gain contest at the S.E. VHF Conference 2006.Calculating the gain for this 2 ft. x 3 ft. reflector, while assuming a 55% aperture efficiency for a parabolic reflector, I should have obtain the following gains; 903 MHz - 15.4 dB, 1296 MHz - 18.6 dB, & 2304 MHz - 23.6 dB. In order to compare apples to apples, I added 2.1 dB gain to adjust my measured gains from the conference which were referenced to a dipole to get isotropic gains. My antenna measured as follows; 903 MHz - 8.9 dB, 1296 MHz- 18.0 dB, and 2304 MHz - 22.8 dB. It appears that I sacrificed 6.5 dB at903 MHz, 0.5 dB at 1296 MHz, and 0.8 dB at 2304 MHz. Since I don't have equipment for 903 MHz, for my two bands of interest, I covered them with one antenna for less than 1 dB of gain loss. This one antenna won the award for top gain for homebrew antennas for all three bands, although one commercial antenna did have 1.7 dB more gain at 1296. It wasn't eligible for the award since it was commercial. I wanted a completely independent measurement of the antenna, so this conference gave me the opportunity for that. I don't validate or substantiate the gain measurements, but I was happy with my reported results. Years ago at one military test site, I questioned the results of the measured antenna gains, and it became such an issue that we contacted a Dr. Alex Newell from NIST in Boulder who flew down to assist us. One of his tasks at NIST was to validate outdoor antenna ranges and anechoic chambers. It was a delight to get to work with and learn from him for a week, but I did realize that range validation was a science unto itself. I later asked the range facility manager how long they had been measuring antenna performance. He told me they'd been at it for 15 years, but no one had ever questioned their measurements before. Want to know why some systems work so poorly? I enjoyed the simulations of W1GHZ on this subject and the comments by K2RIW and WA5VJB. K4QF

[Mw] Antenna separation Hi Ben:
I wouldn't put much stock in those numbers. This has been an ongoing point of discussion.

I knew you had to make sure the test area has a uniform field over an area at least as big as the capture area of the antenna. Dick K2RIW ran the numbers and their test method has 9 dB of uncertainty in just the test method. For all you knew, there was a big ground bounce null right in the center of your dish. You cannot use the same range geometry on all frequencies. The nulls mover around. You must measure your test area for a fairly uniform field strength. Kent WA5VJB

To: W2BVH, W4OTN, W9SZ, KL7UW, WA2SAY, K0CQ, VE3FHM,
VE3SMA, N0UU, NU8I, WA1MBA, K1AE & The MW Group, 9/22/09.
Dear Lenny, Eric, Zack, Edward, Doug, Gerald, Graham, Steve,
Lawrence, Alf, Tom, & John,

HERE IS A YAGI STACKING PHILOSOPHY by K2RIW 9/23/09

INTRODUCTION -- The following antenna stacking philosophy has been used within certain circles of amateurs for four decades, with most of the users being happy with results. To my knowledge it has not been published, or properly explained in an open forum, such as this one.
By using the philosophy, these amateurs have saved a large amount of area within a single EME Phased Array that is being used on two bands (for instance). When vertically stacking antennas, they have saved a lot of Mast Length -- which has considerably increased the Wind Survivability.
I know that some amateurs who have used the more popular stacking techniques may believe that the philosophy outlined within this memo is radical, and wrong. Please read it, study the details, and then let's discuss it.
A significant number of amateurs have used these suggested stacking distances, and they have made careful measurements that confirmed that the Gain and Pattern were not degraded by the much closer stacking distances of Yagis that were on different frequencies.
If there are readers who have found a detriment when using these techniques, I would like to here the details. There usually is an explanation, such as the Phase of some of the antennas being reversed.

THE CONTROVERSY -- The proper stacking of Yagi antennas has long been a controversial subject with many possible answers. Many of the answers may sound logical -- but, only if you don't dig too deeply into the details.
I find that the popular answers that have been used usually cause us to be too conservative, and they space our antennas at too great a distance to be practical. This can cause a mast failure on a windy day.
THE CONCEPTS -- In my opinion, if you want to arrive at a more correct answer, there are some basic concepts that should be considered:

(1) All antennas have an "Effective Aperture" that is directly related to:
(A) The "True" Gain -- but only at the Frequency of Interest.
(B) The Wave Length.
For instance, if you double the True Gain (a 3.01 dB increase), than the Effective Aperture must double.
Effective Aperture = (Gain x Lambda Squared) / (4 x Pi), where:
Gain = an anti-logged "dBi" number (not dBs).
Aperture = the units of Lambda, such as Sq. Feet, or Sq. meters.

(2) The desirable Stacking Distance will allow only a small amount of overlap of the Effective Apertures of each of the antennas, if you want to avoid a degradation in Gain, or a change in Pattern. However, the problem has been to properly calculate the Apertures of the Adjacent Antennas -- on the Appropriate Frequency. This often is NOT the Design Frequency of those Adjacent Antennas.

(3) All Good Yagis display a significant Gain (and thus a significant Aperture), but ONLY on the Design Frequency, and it almost doesn't matter if the Test Frequency is Harmonically Related to the Design Frequency -- this is explained below in Concept (3C).

(3A) For instance, a 2 meter Yagi will have Almost No Significant Gain on 432 MHz, even though there is a 3:1 Frequency Relationship. The 432 Gain will not be much more than that of a 432 MHz Dipole (with a pretty high VSWR); the Peak Gain will be in a slightly crazy direction, and the Pattern will be quite "lumpy".

(3B) Here is an APERTURE EXAMPLE: A 2 meter Yagi with a True Gain of 16 dBi MUST HAVE an Effective Aperture (EA) of 148 square feet (or 13.75 square meters). A 432 MHz Dipole (with a Gain of +2.14 dBi) will have an EA of 0.68 square feet (0.063 square meters). That's an Aperture ratio of 219:1. In other words, the Effective Aperture of a 2 meter Yagi with 16 dBi of Gain will Decreases by about 200 times, when you use it on 432 MHz -- because of the change in EA, and the change in wavelength. That's a 15:1 Decrease in the Diameter of the EA.

(3C) TO EXPLAIN: A Long Yagi derives its Gain by acting like a Synthesized Slow Wave Structure. The wave that is traveling near the Boom travels more slowly than it would in Free Space. That effect, with the help of Huygens Principle [see the diagrams at] <http://en.wikipedia.org/wiki/Huygens%E2%80%93Fresnel_principle> causes the Directors to act like a Magnifying Glass that Focuses a Big Area of the incoming wave onto the Driven Element. To Maximize the Gain, that Slow Wave Structure must display a Particular Velocity Profile at various positions along the Boom. To make all this happen, EACH Director must present a Particular Reactance (at the Design Frequency), and it must be located at a Particular Position along the Boom. When you use a 2 meter Yagi on 432 MHz, essentially all the Directors are not presenting the Correct Reactance, almost all of them are not located in the Correct Position, and there are too few of them for that length of Boom -- thus the whole Yagi Principle breaks down, and you are left with a Driven Element (a high VSWR Dipole) that has almost the same Gain as a 3/2 Lambda 432 MHz Dipole in Free Space.

(3D) The situation is even worse when you feed 2 meter energy into a 432 MHz Yagi. The Driven Element will have a VSWR of about 20:1, and each of the Directors are so mistuned that they are essentially "transparent" to the incoming wave. The antenna will display an "Apparent Gain" of about -10 dBi, with a pattern that looks like a Shortened Dipole. The "Apparent Gain" you will experience is also being decreased by the huge VSWR. I'm using the word "Apparent" because the IEEE Antennas and Propagation Society defines [True] "Antenna Gain" as that property you will measure after you have corrected the VSWR -- they do not include the VSWR effects in the Gain Measurement. For all these reasons, the Effective Aperture of a 432 MHz Yagi on 2 meters will be smaller that that of a normal 432 MHz Dipole (which was 0.68 square feet).

(4) Therefore, when you are stacking a 2 meter yagi with a 432 MHz Yagi (for instance), you DO NOT have to stack them at a distance that is any where near the sum of the Radiuses of the Effective Apertures of each antenna. When you are on 432 MHz, the adjacent 2 meter yagi has a Radius of its Effective Aperture that is about 15 times smaller that it has on 2 meters. When you are on 2 meters, the adjacent 432 MHz Yagi has an Effective Aperture that is smaller that that of a 432 MHz Dipole.

(5) So how do you determine the proper stacking distance?
(A) You CAN recognize that the stacking distance can be calculated by considering a slight overlap of the Effective Apertures, but ONLY if the stacked antennas are on the Same Frequency.
(B) When the stacked Yagi antennas are on different frequencies, then a whole new set of rules are appropriate. Here is my interpretation of those rules:

-- ONE KIND OF STACKING RULES for YAGI ANTENNAS on DIFFERENT BANDS --
Here is an example of stacking 2 meter Yagis, and 432 MHz Yagis (for instance).

(1) When considering the Lower Frequency Yagi (2 m), the Higher Frequency Yagi
(432) nearby is essentially transparent, and can almost be ignored when using Vertically Stacking. In fact, it is possible to place the 432 MHz Yagi Elements on the same Boom with the 2 m Elements, with no detriment on 2 m -- but, the 432 Elements will need Length Corrections due to the Capacitance that is being added to their Tips, caused by the nearby 2 m Elements; there have been commercial Dual Band Yagi Designs that used this concept.

(2) When considering the Higher Frequency Yagi (432), the nearby Lower Frequency Yagi (2 m, or lower) only creates a Gain Detriment by adding Capacitance to the Tips of the 432 MHz Elements (which tunes them to a lower frequency), similar to what would happen with any other piece of Nearby Metal. With a Vertical Stacking Distance of 1 to 1.5 feet, that effect will essentially disappear on 432, and it doesn't depend on the Boom length of either antenna. If you were stacking a 2 m Yagi with a 6 m Yagi, a stacking distance of about 2 to 3 feet will protect the 2 m Yagi. The 6 m Yagi will not even "see" the 2 m Yagi.

(3) When stacking Antennas that are on the Same Band, the proper Stacking Distance should be selected by considering a chosen amount of overlap of the Effective Apertures. As always, the amount of Overlap is a compromise between Maximum Gain, and Cleanliness of Pattern. Using a wider Stacking Distance than required

will increase the level of the Side lobes in the Stacking Direction -- example: the Vertical Side lobes will grow stronger (and closer to the Main Lobe) with an Excessive Vertical Stacking Distance.

(4) Rules (1), (2) and (3) can be used in combinations. For instance, it is possible to stack a pair of 2 m Yagis at their normal distance [Rule (3)] by considering the 2 m overlapping Apertures, and then stack Higher Frequency Yagis in between them. Use Rule (2) when considering the spacing between the higher frequency Yagis to the 2 m Yagis. Use Rule (3) when considering the Higher Frequency Yagis stacking distance between themselves, if they are on the Same Frequency.

CONCLUSION -- By using these principles, it is possible to build a Vertical Stack that has a 2 m Yagi at the top and the bottom, a pair of 432 Yagis in between them, and a pair of 1296 Yagis in between the 432 Yagis -- for instance. It would even be possible to stack additional 1296 Yagis in between the 432 MHz Yagis and the 2 m Yagis. A naive amateur might think that the Overlapping Apertures of these antennas would cause a detriment in performance. In reality, each of those Apertures almost disappear when considering the Non-design Frequencies. Once these Rules are understood (and believed), there are many more stacking combinations (both Horizontal and Vertical) that are possible.

LET ME KNOW -- Please inform me of your objections and exceptions, particularly if you have made Real Measurements of Pattern and Gain, before and after using certain stacking distances and combinations. For instance, a well calibrated Sun Noise Measurement System is particularly good a revealing Gain and Pattern characteristics that are "Traceable to the Bureau".
73 es Good VHF/UHF Yagi Stacking DX, Dick, K2RIW

Good points, Dick. I certainly agree that the higher frequency Yagi should be transparent at the lower frequency (assuming no extra low frequency resonances involving element halves and portions of the boom). I am not entirely convinced that the effect of the lower frequency Yagi at the higher frequency is as minimal as you suggest. My gut feel tells me the cumulative scattering from all those dipoles may not be negligible, particularly with regard to the front-to-back ratio.
But.....I have no data to refute your suggestions and your practical experience may prove you right. Some computer modeling would be a great, and easy, check. Surely someone has done this by now. Maybe in the HF contesting community, if not amongst VHF/Microwavers.
That said....I do use 2 ft spacing between 144/222/432 antennas for my rover, but that is more because I have little choice than due to good theoretical design !
73, Steve VE3SMA

Check with Lionel (ve7BQH) I would be surprised if he has not already done this Folks.
Regards & Thanks, Darrell

Larry, K6HLH showing off a new transverters. The San Bernardino Microwave Society is a technical amateur radio club affiliated with the ARRL having a membership of over 90 amateurs from Hawaii and Alaska to the east coast and beyond. Dues are $15 per year, which includes a badge and monthly newsletter. Your mail label indicates your call followed by when your dues are due. Dues can be sent to the treasurer as listed under the banner on the front page. If you have material you would like in the newsletter please send it to Bill WA6QYR at 247 Rebel Road Ridgecrest, CA 93555, bburns@ridgecrest.ca.us, or phone 760-375-8566. The newsletter is generated about the 15th of the month and put into the mail at least the week prior to the meeting. This is your newsletter. SBMS Newsletter material can be copied as long as SBMS is identified as source.

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