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To: EDGES group
From: Alan E.E. Rogers
Subject: Software for EDGES-3 and information for deployment on Devon Island

The software for running EDGES-3 uses the ASU fastspec written by Judd Bowman compiled with functions to control the “mezio” on the nuvo PC to the executable fastspec_mezio. The acquisition of vna s11 data and processing software is written in c-code and along with fastspec is run from c-shell scripts.

key c-shell scripts in /home/edges/edges3/vnackh/ are:

dospec_all - obtains the spectra needed for calibration using 400 3-position switch cycles
dospec_ant - obtains the spectrum from the antenna only with 3200 cycles which runs for 21 hours
dospec_all and dospec_ant run fastspec which keeps the Nuvo very busy
nohup ./dospec_all or _ant > temp & with occasional checks on temp for status
dovna(all) - runs vna on amb hot open short S O L for the s11 files needed along with spectral files needed for the calibration which is written into a single file named specal.txt
dovna(antSOL) - runs vna on ant SOL to obtain the antenna s11 which along with antenna spectrum and specal.txt to obtain a calibrated sky spectrum
dovna is a “sample” script which has sections which can be included or skipped over and are easily modified for the particular task at hand. (all and antSOL) are edited samples. All raw data and s11 files are saved with names that indicate the time the data was taken. Some sections of dovna only process raw data and these sections need to be edited to specify which data to use using times and wildcard “*”).

```
dospec_all
#!/bin/csh
foreach s (ant amb hot open short)
set d = ` /home/edges/edges3/readtime ` # gets yyyy_ddd_hh for file name
/home/edges/edges3/genini $s -site hay -dr vnackh -cyc 400 >! $s.ini # 400 3-position cycles
sleep 1 # each 400 cycles takes about 2.5 hours
/home/edges/edges3_fastspec/fastspec/fastspec_mezio -i $s.ini
/home/edges/edges3/pr59 -reg 100 |tail -n 1 >>! $d\_ $s.tmp # record thermal box temperature
/home/edges/edges3/pr59 -reg 101 |tail -n 1 >>! $d\_ $s.tmp # ambient load
/home/edges/edges3/pr59 -reg 102 |tail -n 1 >>! $d\_ $s.tmp # hot load
/home/edges/edges3/pr59 -reg 152 |tail -n 1 >>! $d\_ $s.tmp # thermal current
end
```

pr59 -mode 4 having been sent manually to turn on the thermal control – see memo 300

dospec_ant - obtains spectra from antenna with 3200 3-position switch cycles for 21 hours data same as dospec_all with foreach s (ant) and -cyc 3200

Portion of script dovna(all) to acquire vna data

```

#!/bin/csh -f
set e = 1
if($e == 1) then
/home/edges/edges3/mezior s11 amb # turns on vna
sleep 200 # needed for vna startup to talk vna
foreach s (1 2 3 4 5 6 7 8 9 10 11 12)
/home/edges/edges3/vna -mode temp -num 400 -nodisp # add dummy runs vna warm_up of 1 hour
end # each 400 vna scan takes about 5 minutes
set d = ` /home/edges/edges3/readtime `
/home/edges/edges3/pr59 -reg 101 |tail -n 1 >>! $d.tmp
/home/edges/edges3/pr59 -reg 102 |tail -n 1 >>! $d.tmp
foreach s (ant amb hot open short S O L)
/home/edges/edges3/mezior s11 $s
/home/edges/edges3/vna -mode $d\_ $s -num 400 -nodisp
end
/home/edges/edges3/vna -mode temp -lna -30 -num 400 -nodisp # add short run before connecting to
lna
/home/edges/edges3/mezior lna
/home/edges/edges3/vna -mode $d\_ lna -lna -30 -num 400 -nodisp
foreach s (S O L)
/home/edges/edges3/mezior s11 $s
/home/edges/edges3/vna -mode $d\_ lna\_ $s -lna -30 -num 400 -nodisp
end
#/home/edges/edges3/mezior ant # turn off vna
endif

# portion of dovna to calibrate all S11 and correct lna S11

set e = 0
if($e == 1) then
set d = 2021_214_17 # select vna data to be used
set ps = 33 # calibration SOL offsets in picoseconds
set rs = 49.962 # cal load resistance 49.962 30C 49.994 25C
foreach s (ant amb hot open short)
/home/edges/edges3/reads1p1 -res $rs -Tfopen $d\_ O.s1p -Tfshort $d\_ S.s1p -Tfload $d\_ L.s1p -Tfant
$d\_ $s.s1p -loadps $ps -openps $ps -shortps $ps
cp s11.csv s11$s.csv
end
/home/edges/edges3/reads1p1 -res $rs -Tfopen $d\_ lna\_ O.s1p -Tfshort $d\_ lna\_ S.s1p -Tfload
$d\_ lna\_ L.s1p -Tfant $d\_ lna.s1p -loadps $ps -openps $ps -shortps $ps
/home/edges/edges3/corrcsv s11.csv -cablen 4.26 -cabdiel -1.24 -cabloss -91.5 # cablen 4.26 diel -1.24
loss -91.5 from memo 367
cp c_s11.csv s11lna.csv
endif

portions to process calibration spectra to obtain the calibration file specal.txt
set e = 0
if($e == 1) then
foreach s (ant amb hot open short)

```

#foreach s (ant) # edit for only antenna data and add rfi parameters

rm temp.acq

cat /home/edges/edges3/vnack/hay/\$s/2021/2021_209_*.acq >>! temp.acq # edit to select data

/home/edges/edges3/acqplot7amoon temp.acq -fstart 48 -fstop 198 -pfit 27 -smooth 8 -rfi 0

cp spe.txt sp\$s.txt

end

endif

set e = 0 # to process and search for absorption feature

if(\$e == 1) then

Lh -1 for 4" hot load cable lmode -1 for no loss

/home/edges/edges3/edges3 -fstart 50 -fstop 190 -spant spopen.txt -spcold spamb.txt -sphot sphot.txt -

spopen spopen.txt -spsshort spshort.txt -s11ant s11open.csv -s11hot s11hot.csv -s11cold s11amb.csv -

s11lna s11lna.csv -s11open s11open.csv -s11short s11short.csv -Lh -1 -mfit -1 -smooth -8 -wfstart 50 -

wfstop 190 -eorcen 0 -eorwid 0 -tcold 303 -thot 391.9 -wtmode 1 -lmode -1 -tant 303 -tcab 303 -wfit 7

-nfit3 10 -ldb 0.0 -adb 0.0 -delaylna 0 -nfit4 37 |grep Sum # grep is used to limit text sent to screen

#!/home/edges/edges3/longav spe0.txt -lim 10 -nfit 5 -dmax 5 -fstart 55 -fstop 120 -schk 0 -tchk 200 -

rfi 0 -ti GHA= -sig 0 -tau 7 -md 1 -seor -1 -pmode 0 -ti GHA= -feor 78 -wid 19 -fsmin 77 -fsmax 79

|grep rmsin

#cp specal.txt specal_169.txt # save calibration with name to preserve a particular calibration

endif

summary of key edges-3 c-code in /home/edges/edges3/ (see also memos 96, 113, 244 and 387)

fastspec_mezio c++ spectral data acquisition code for px14400 ADC and mezio switch control

args: -i inifilename -p (for realtime Gnuplot of spectrum)

outputs: raw spectral data in yyyy_ddd_hh_mm_ss_ant.acq for antenna spectra for example

genini.c generates fastspec ini file

args: ant amb hot open short -site sitename -dr directoryname -cyc number_of_cycles

outputs: text which can be piped (via >!) to a file

acqplot7amoon.c processes fastspec .acq output files

args: acqfile # -fstart 48 -fstop 198 -pfit 0 -smooth 8 -rfi 0 -scaledb 60 # example for plot in dB

-fstart 48 -fstop 198 -pfit 27 -smooth 8 -rfi 0 # example for calibration data

-gha 12 -dgha 6 -rfi 2.5 -tcal 1000 -pfit 37 -fstart 50 -fstop 120 -smooth 8 -pkpwr 40

-peakpwr 10 -minpwr 0.7 -nrifi 4 -dloadmax 1000 -adcov 0.4 -maxrmsf 200 -maxfm 200

example for data with rfi and GHA 12 +/- 6 hours Haughton crater coords are default

peakpwr and minpwr are max and min pwr accepted power in percent accepted

pkpwr max power in dB of frequencies over 80 MHz plus orbcom 127 MHz accepted

maxrmsf max rms power in deg K 60 to 80 MHz accepted

maxfm max FM power in deg K 88 to 120 MHz accepted

outputs: spe.txt spe.pos water.pos waterfall plots if -water 1 used

pr59.c runs pr59 thermal controller with temperature probes run without arguments to get cmds

args: -mode 0(set ref. to 25C) 10(set ref. to 30C) 4(run thermal) 5(clear thermal) 103(set ref. 3C)

-reg 100(lna box temp) 101(amb load temp) 102(hot temp) 103(computer box temp) 150(voltage) 152(thermal current) note: text in () describes the function if pr59 is recompiled perms are -rwsrwxr-x 1 root edges Thermal control can cool from 30 to 25C at +1.8a and heat from 30 to 35C at 0.5a. In general it is easier and more efficient to set control temperature above computer box temperature.

outputs: text piped to a file

meziar.c switch control for mechanical switches and vna DC power

args: -spec(for spectra) -s11 -ant -amb -hot -S -O -L -short(cable) -open(cable) -vnaon -lna(vna path to lna) -cal(turn on 3-pos cal) Note: comments in ()

readtime.c reads UTC time outputs yyyy_ddd_hh to add to filename of s11 and temperature data

args: -yrday outputs yyyy_ddd

vna.c controls vna

args: -mode filename -lna -30(sets power to -30 dbm for lna s11) -num number_of_scans -nodisp(no display)

reads1p1.c does vna calibration on s1p vna files and converts to csv files

args: -res loadresistance -Tfopen -Tfshort -Tfload -Tfant each followed by s1pfile -loadps -openps -shortps each followed by offset in picosecs

corrcsv.c corrects lna s11 file for the different vna path to lna

args: s11.csv -cablen -cabdiel -cabloss

outputs c_s11.csv

edges3.c solves for calibration, does optional beam correction – see memos 113

args: -fstart -fstop -spant -spcold -sphot -spopen -spshort -s11ant -s11hot -s11cold -s11lna -s11open -s11short -Lh -mfit -smooth -wfstart -wfstop -eorcen -eorwid -tcold -thot -wtmode -lmode -tant -tcab -cfit -wfit -nfit3 -adb -delaylna -nfit4

-Lh -1 for hot load loss -mfit 5 -lmode -1 -cfit 7(cal fit terms) -wfit 7(noise wave terms) -nfit3 10(lna s11 fitting) -nfit4 37(s11 fitting) Note: comments in () otherwise values or file names must follow args

longav.c weighted LSQ grid search for absorption and plots residuals

args: filename -lim rms_limit_to_accept -nfit number_of_terms_to_fit -dmax plot_scale -fstart -fstop -rfi sigma_to_accept(0 = all) -ti label -tau 7 (flattening of 7) -md 1(plot signature)

-sig 0(nfit phy terms) 10(nfit poly terms) -seor 0(no search) -1(search) -pmode 0(normal plot)

-ti title -fsmin -fsmax [optional search center frequency limits]

Note: optional parms in [] and comments in () otherwise values must follow arguments

sim4.c simulates spectra and s11 data test script /home/edges/edges3/simdata/dosimcen4

simvna2.c adds vna cable to s11 measurements for simulations

Haslam map map and beams are in /home/edges/edges3/simbeam

408-all-noh Haslam map which is needed for beam correction – needs to be in same directory

Beam files – need to be copied to azelq.txt in same directory

azelq_bladebox_50x25m_mspac4_gravel_3.5_1e-6_18a_permap_2cm.txt # dry sand

azelq_bladebox_50x25m_mspac4_gravel_3.5_2e-2_18a_20cm.txt # moist sand

Calibration file needed to be written by edges3 to specal.txt or copied to specal.txt

Added notes:

noisechk.c EDGES-3 noise calculation – see memo 174 about 35 mK for 1 day Tsky = 2000 K
also calculates fastspec efficiency ~ 90%

Battery and disk space:

Approx total disk space for 1-day's data ~ 1 gigabyte 100 Ah battery runs for about 14 hr with fastspec running. Battery swap should be made without dropping DC power

Wire and filter resistance from batteries 2x25m 6awg 2m 18 awg 4251-004 10VR1 = 0.08 + 0.05 + 0.001 + 0.01 = 0.141 ohms = 0.85v drop at 6 amps. Need 9v min at Nuvo. RELiON RB LiFePo4 14.4 to 13.6v 100% charged to 12.0v at 9% charged. Batteries are rapidly charged at 45amps using PD9145ALV charger

A test with fastspec running on a fully charged battery measured 13.19v at the battery and 12.5v at the input to the inner box with the 100 ft of 6awg cable to the battery in the pelican case.

Ground plane orientation: (not very critical 5 deg is best) antenna should be on flat ground out to 100m and away from objects or ridges in the terrain as per memo 383.

Optimum azimuth of antenna 5+/-5 deg expect av rms 5-terms 55-95 MHz 100mK dry 80mK moist sand expected from simulation scripts at /home/edges/edges3/simbeam/dosim. The sky noise maximum is at about 08 UT (03 CDT) on 10 August 2022 when Cas A is at transit at about 75 deg elevation and the largest amount of the Galactic plane is up the Sun is close to the horizon the GHA is about 6 hours and the beam chromaticity is a maximum owing to the combination of Cas A and the Galactic plane. Accurate Az and El of Sun, Cas A can be calculated by jpl horizons.

Sky 75MHz	rms	rms2	center	amp	width	rms3	rms4
t75 2121.908	rms 0.017	rms2 0.063	GHA=00	78	0.65	19.4	0.0105 0.0114
t75 2229.827	rms 0.052	rms2 0.097	GHA=03	78	0.76	17.7	0.0249 0.0209
t75 2342.532	rms 0.027	rms2 0.073	GHA=06	78	0.67	18.6	0.0154 0.0123
t75 2227.965	rms 0.018	rms2 0.066	GHA=09	78	0.64	19.0	0.0116 0.0105
t75 1987.224	rms 0.021	rms2 0.066	GHA=12	78	0.60	18.6	0.0147 0.0099
t75 1863.390	rms 0.020	rms2 0.066	GHA=15	78	0.60	18.6	0.0127 0.0092
t75 1862.124	rms 0.022	rms2 0.067	GHA=18	78	0.60	18.4	0.0127 0.0095
t75 2000.759	rms 0.017	rms2 0.065	GHA=21	78	0.60	18.6	0.0095 0.0076

Simulation for 3-hour blocks with 1e-6 S/m soil with permafrost 0.5 below using 5-terms 55 – 95 MHz
rms (degK) = without added Nature feature
rms2 (degK) = with added Nature feature
rms3 (degK) = rms residual with 5-terms for sky plus grid search with tau =7
rms4 (degK) = same as rms3 using 1e-2 S/m soil – shows relatively small effect of soil conductivity owing to the relatively large ground plane.

The rms noise expected for 30 hours integration a 3-hour block at Devon island 10 days is about 20 mK based on the rms of 40 mK in Figure 1 of memo 382 which is 75 hours on the antenna simulator which puts out about 5000 K at 75 MHz. The soil conductivity has a relatively small effect based on simulations but soil measurements would be useful for the beam correction of the data but we need to be sure that the conductivity/dielectric meter transmitter gets turned off during observations.

Cable to battery:

Wire to battery is about 100ft long. It should come down vertically from the middle of the antenna and be run perpendicular to the ground plane wires to about 12m beyond the pegs on the edges of the ground plane to the pelican case with the battery. It should be pegged down under the antenna to keep the wire down from the antenna vertical. Simulations show that the scatter from the pelican case 25m east or west of the antenna is under 5mK. The fiber from the antenna can take the same route but since

it is an insulator it's route is not critical. There is no significant preference for the pelican case being on the east or west. The most critical is having the antenna aligned with the ground wires within 1 degree and having the battery cable perpendicular to the wires within about 2 degrees all the way to the pelican case. There should be a Laird 28A digikey 240-2245-ND cable ferrite on the cable as close as possible to the metal box at the bottom of the pipes on the antenna.

Thermal control - estimates of the temperatures we might expect at Devon Island:

convection cooling 1684.780800 1 m/s wind watts/20K
radiation cooling 495.401224 watts/20K
convection cooling 780.406000 no-wind watts/20K
convection cooling 2395.194957 with 10m/s wind watts/20K
convection cooling 117.606299 with _cover watts/20K
solar heat 193.234500 watts
solar heat with Goldstone paint 64.411500 watts
LNA box convection loss 35.135414 watts/20K
LNA box cover 18.981416 watts/20K

Based on the above it is hard to know what temperature will be inside the antenna box. With 1m/s wind the convection cooling estimate is 1684 watts for temperature difference of 20 degC so that unless we use a cover (as in memo 324) the convection cooling is likely to be dominant since there is only 72 watts of heating when fastspec is running. In this case the temperature in the antenna box might be close to the outside air temperature. This would be fine as there is enough heat (of about 5W in the front-end box plus about 24W from the thermal control) to get the frontend box up to about 20C for 0C outside air. It is more efficient and best to set the pr59 controlled temperature higher than the temperature in the antenna box.

I have run some tests with insulation on the front-end box which was not used in Oregon and it doesn't help enough to get a 30 degree rise to get to 30C if the outside air is only 0C so that adding a cover might be the only way. We need to be sure that we don't get moisture condensation on the connection between boxes.

Looking at the max Teflon knee at 20C simulations in memo 332 we might expect only very small effect of the +/- 0.3% change in the Teflon cables. I ran test of +/- 1% change using recent EDGES-3 data using antenna simulator and found virtually no change in the rms for a 5-term search for the added Nature feature so I don't think we need to be concerned about the selection of a thermal control temperature close to 20 C.

Optimum box separation:

The nominal box separation is 1.5" in memo 316 but when S11 was measured in Oregon in figure 10 of memo 310 the S11 is above -12 dB at 75 MHz. This result is close to a simulation of the S11 which peaks above at 75 MHz at about -11 dB with 1.5" separation. The S11 at 75 MHz can be lowered to a little below -12 dB with a separation of 1.3" so I recommend the nominal 1.5" separation be reduced to 1.3" to improve the S11.

Antenna assembly:

Memo 306 describes that assembly for the prototype. The main difference is that the battery power now comes on a cable. I have simulated the effects of the 6 awg cable and find the perpendicularity to the ground wires should be within 2 degrees. The large ferrite filter on the wire from the inner box to the front-end was removed for shipping and needs to be reinstalled. Simulations of separation of 6 awg which lies on top of the 18 awg made no appreciable difference since both are insulated no electrical contact is made.

Potential sources of RFI:

CBL Resolute 86W 105.1 MHz about 200 km away - estimate about 185 mK in 6 kHz

CBC Grise Fiord 107.1 no info on pwr – also about 200 km

Local soil-probe 70 MHz CB radio 26-27 MHz Marine 157-174 MHz 2 Orbcomm satellites 137-138 MHz have polar orbit. Truck/hunters radios VHF-MURS 157-160 MHz (ATVs use UHF 900 MHz or FRS/GMRS 462-467 MHz which should not be a problem). Nearby VHF (30 – 200 MHz) closer than 5 km might cause EDGES ADC saturation in some circumstances. Eureka 80N SkimET radar at 31 MHz should not be a problem as it is 500 km away.

Typical solar panel inverters, LED/CFL lights within a few meters generate noise power at a level as high as +45dB above one microvolt into 50 ohm scale at 70 MHz which if radiated isotropically corresponds to ~ 45 K at 200m and ~ 4mK at 2km from the EDGES-3 antenna assuming a line of sight path. 45 dB μ V into 50 ohms equals -61 dBm. Juswardy, Budi, Franz Schlagenhauer, Shantanu Padhi, and Peter Hall. "Radiated EMI emission study on photovoltaic module for radio astronomy receiver front-end." In *2011 Electromagnetic Compatibility Symposium-Perth*, pp. 1-4. IEEE, 2011.

Ham radio reports on noise from Champion 3400 watt inverter generator about -60 dBm level radiated. Wireless microphones should be UHF 653-657 MHz.

The drones will use 2.400-2.4835 and 5.7275-5.85 GHz which should not be a problem. Closer than 20m the microwave RF might saturate the amplifiers which have 41 dB gain up to the 200 MHz low pass filter.

The YANMAR 7.5 kW is A.C. without inverter so it is probably radio quiet except when charging batteries the charging electronics will most likely generate RFI but the level received by the EDGES-3 antenna 2km away should be negligible. If the EDGES antenna is located approximately North and is pointed at 5 degrees azimuth the HMP camp will be below -38 dBi gain in the beam.

Potential scattering concerns:

While the best location for the ground plane should be made at the site there some general considerations noted in memo 383 which when applied to Devon Island I suggest

- a. maximum height of object within 50m of antenna 1m
- b. maximum height of object within 100m of antenna 5m
- c. maximum height of object within 200m of antenna 10m
- d. Flattened area of at least 60x30m to within +/- 5 cm peak deviation from flatness and clear of bushes, mounds of gravel or any objects higher than 10 cm out to 25m from the center.
- e. maximum overall slope of 1 degree which is 87 cm over 50m

As one potential region for a site I have used Google street view to look at 75.44604 -89.86678 which is about 1.47 km North of the HMP camp site. I note that it is about 100m east of a 2x4x2m rock which is probably O.K. and about 250m east of another rock and about 1km east of the Battle Herc 15-30m

high ridge. FEKO simulations show that a 15m high ridge at 200m and a rock at 100m result in an average chromaticity of 13 and 14 mK respectively so at 1km the high ridge should have negligible effect.

File sizes:

- 1] acq data typical 1.5 GB/day or 400 kB per 3-pos switch cycle
- 2] pos file 500 kB converted to pdf file 50 kB i.e. conversion reduces size by a factor of 10
- 3] specal.txt calibration file 410 kB

Site coordinates for geometry calculations in c-code:

acqplot7amoon has Houghton crater coordinates as default which is used if -gha -dgha are used to limit processing range

edges3 requires -site 4 for Houghton crater coordinates when beam correction is used

Sample script with sections that process existing uncalibrated s11 and acq spectra

```
#!/bin/csh -f
# /home/aeer/data/nuvo3/edges3 # location of c-code
# /home/aeer/data/nuvo3/edges3/vnachk # location s11 and spectral data
if(0) then # change to if(1) to run
set d = /home/aeer/data/nuvo3/edges3/vnachk/2022_161_17
set ps = 33
set rs = 49.962 # 49.962 30C 49.994 25C
foreach s (ant amb hot open short)
/home/aeer/data/nuvo3/edges3/reads1p1 -res $rs -Tfopen $d\_O.s1p -Tfshort $d\_S.s1p -Tfload
$d\_L.s1p -Tfant $d\_$.s1p -loadps $ps -openps $ps -shortps $ps
cp s11.csv s11$s.csv
end
/home/aeer/data/nuvo3/edges3/reads1p1 -res $rs -Tfopen $d\_lna\_O.s1p -Tfshort $d\_lna\_S.s1p -
Tfload $d\_lna\_L.s1p -Tfant $d\_lna.s1p -loadps $ps -openps $ps -shortps $ps
/home/aeer/data/nuvo3/edges3/corresv s11.csv -cablen 4.26 -cabdiel -1.24 -cabloss -91.5 # cablen 4.26
diel -1.24 loss -91.5
cp c_s11.csv s11lna.csv
endif
```

if(0) then

foreach s (amb hot open short)

rm temp.acq

cat /home/aeer/data/nuvo3/edges3/vnachk/hay/\$s/2022/2022_16*_* .acq >>! temp.acq # 16

acqplot7amoon temp.acq -fstart 48 -fstop 200 -pfit 0 -smooth 0 -rfi 0 # -scaledb 60

/home/aeer/data/nuvo3/edges3/acqplot7amoon temp.acq -fstart 48 -fstop 198 -pfit 27 -smooth 8 -rfi 0 -

peakpwr 10 -minpwr 1 -pkpwr 40 -maxrmsf 400 -maxfm 200

cp spe.txt sp\$s.txt

end

endif

if(0) then

foreach s (ant)


```

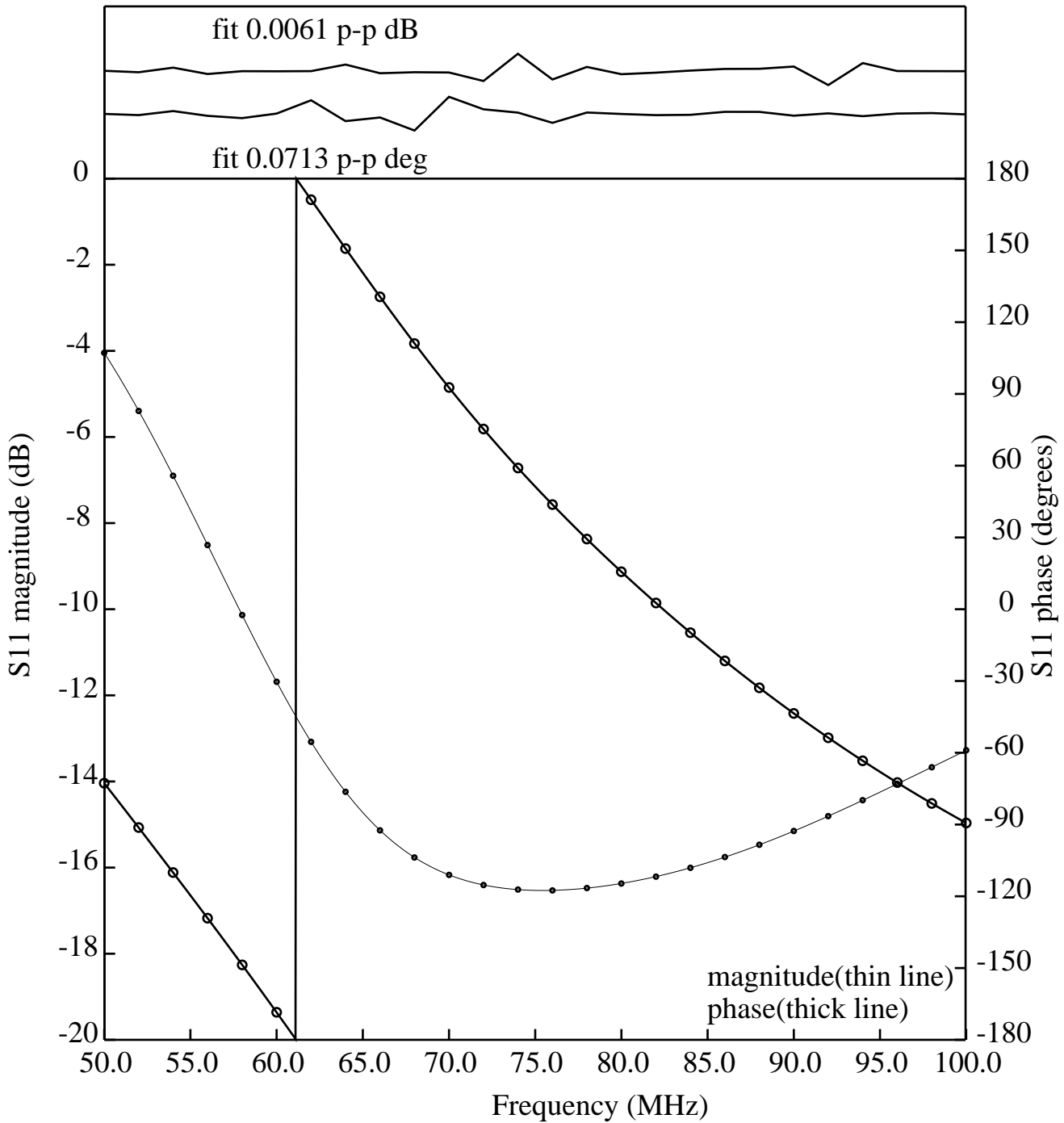
rm temp.acq
cat /home/aeer/data/nuvo3/edges3/vnachk/hay/ant/2022/2022_16*ant.acq >>! temp.acq # sim2 30C
# acqplot7amoon temp.acq -fstart 48 -fstop 200 -pfit 0 -smooth 0 -rfi 0 -scaledb 60 for plot in spe.pos
no terms removed use -rfi
/home/aeer/data/nuvo3/edges3/acqplot7amoon temp.acq -fstart 48 -fstop 198 -pfit 27 -smooth 8 -rfi 5 -
nrfi 4 -adcov 0.4 -peakpwr 10 -minpwr 1 -pkpwr 40 -maxrmsf 400 -maxfm 200 # -scaledb 60 # -
water 1
cp spe.txt sp$s.txt
end
endif

if(0) then
# Lh -1 for 4" hot load cable lmode -1 for no loss to spant
/home/aeer/data/nuvo3/edges3/edges3 -fstart 50 -fstop 190 -spant spopen.txt -spcold spamb.txt -spshot
spshot.txt -spopen spopen.txt -spshort spshort.txt -s11ant s11open.csv -s11hot s11hot.csv -s11cold
s11amb.csv -s11lna s11lna.csv -s11open s11open.csv -s11short s11short.csv -Lh -1 -mfit -1 -smooth -8
-wfstart 50 -wfstop 190 -eorcen 0 -eorwid 0 -tcold 303 -thot 391.9 -wtmode 1 -lmode -1 -tant 303 -tcab
303 -cfit 7 -wfit 7 -nfit3 10 -ldb 0.0 -adb 0.0 -delaylna 0 -nfit4 37 # |grep Sum
endif

if(0) then
cp azelq_box_pec.txt azelq.txt
#cp azelq_bladebox_50x25m_mspac4_gravel_3.5_1e-6_18a_permap_2cm_batt.txt azelq.txt # for beam
correction
/home/aeer/data/nuvo3/edges3/edges3 -fstart 50 -fstop 120 -spant spant.txt -s11ant s11ant.csv -Lh -1 -
mfit 5 -smooth -8 -wfstart 52 -wfstop 190 -tcold 303 -wtmode 1 -lmode 1 -tant 303 -tcab 303 -nfit3 10 -
ldb 0.0 -adb 0.0 -delaylna 0 -nfit4 10 -skymode 384 -antaz 5 -sim 0 -test 8 -eorwid 19 -eoramp 0.5 -
eorcen 78 -tau 7 -site 4 # -eor 0.5 adds feature -384 for no beam correction -sim 9 to simulate data

/home/aeer/data/nuvo3/edges3/longav spe0.txt -lim 10 -nfit 5 -dmax 5 -fstart 55 -fstop 120 -schk 0 -
tchk 200 -rfi 0 -ti GHA= -sig 10 -tau 7 -md 1 -seor -1 -pmode 0 -ti GHA= |grep rmsin
gs -sDEVICE=ps2write -dNOPAUSE -dPATCH -dSAFER -sOutputFile=spe.ps spe0.pos spe1.pos
spe2.pos spe3.pos spe99.pos spevna0.pos spevna1.pos spevna2.pos spevna3.pos spevna4.pos
spevna5.pos spewav.pos
psnup -s0.31 -12 -m50 spe.ps comb.ps
ps2pdf comb.ps comb.pdf
endif

```



11 term Fit to antenna S11 rms diff 0.001 dB 0.013 deg
 file: azelq2.csv

Figure 1. FEKO simulation of EDGES-3 antenna S11 on 50x25m wire grid ground plane with 1.3" box separation.

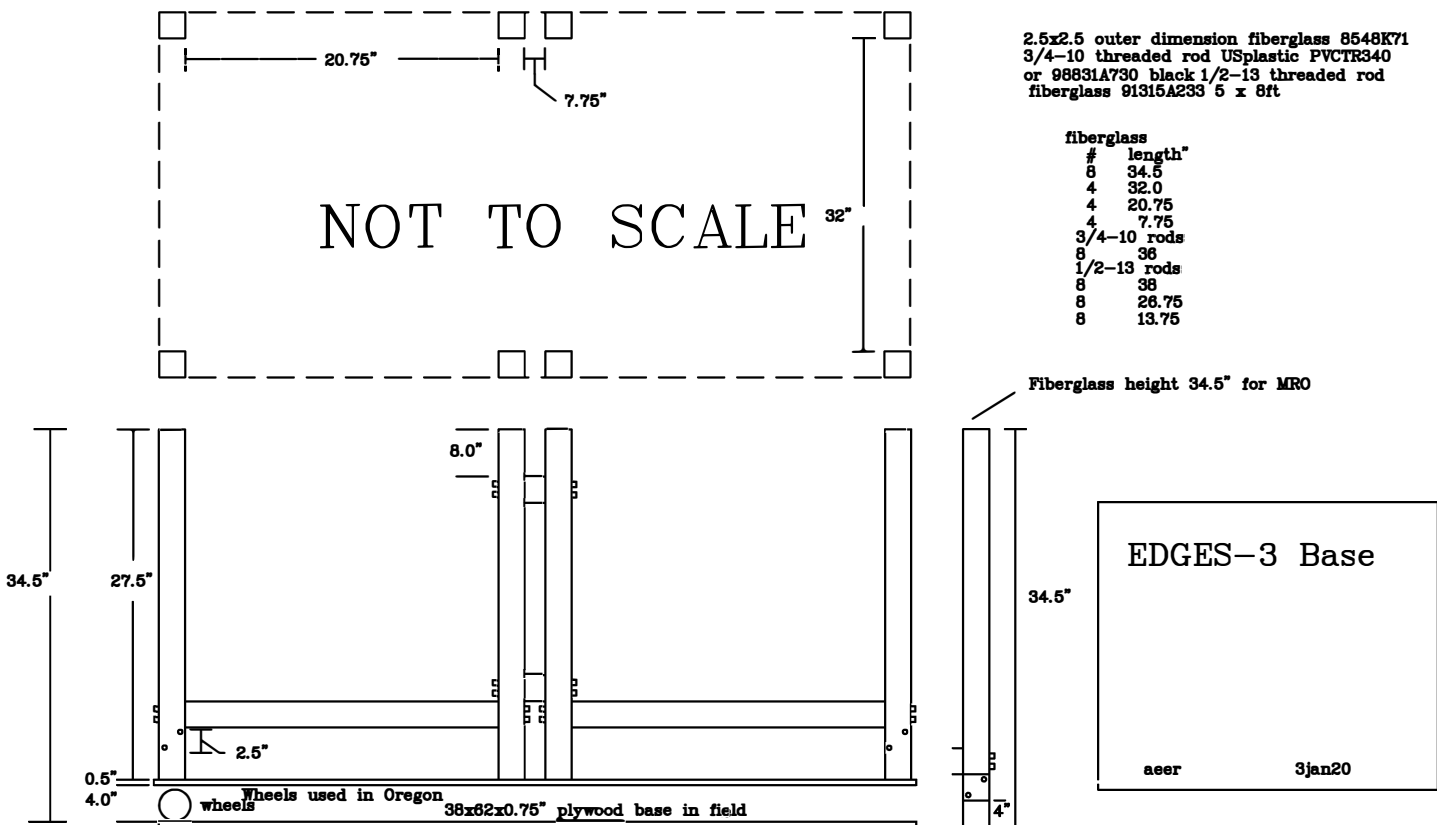


Figure 2. EDGES-3 base deployed in Devon Island with fiberglass height of 34.5".