

SUG Eclipse Observation and Analysis Campaign

During the last year, with considerable financial assistance from the HEC grant, all of the SUG stations have received significant hardware upgrades.

The August 21 solar eclipse is our first opportunity to make coordinated spectrograph observations in an attempt to better understand the ionospheric and to study the effects of the eclipse on radio propagation.

The HEC grant is also supporting single frequency radio Jove observations and has formed a network of Jove observers across the country who will be submitting SkyPipe data to the Jove Archive. SUG stations are part of this network and will also be contributing data to the Archive.

We have put together the attached Standard Operating Procedure (SOP) for spectrograph observations. Dave Typinski has written Mathematica code to read and analyze the spectrograph data generated during this observing campaign. It is our plan that data from all the SUG stations will be sent to Dave for processing and analysis. We hope to publish results in concert with the HEC presentation of the Jove single frequency data.

We anticipate seeing changes in terrestrial signal propagation in the spectrograph images and also variations in ionospheric attenuation which we plan to measure at several frequencies. The multi-frequency spectrograph attenuation measurements (every 2 MHz between 15 and 30 MHz) will complement the 20.1 MHz Jove data. This quantitative absorption data will require calibration as well as operating all spectrograph receivers and antennas in a standard configuration.

Please read over the attached draft SOP and be prepared to discuss it in detail during Tuesdays SUG telecon.

Richard Flagg & Dave Typinski
July 2017

SUG Standard Operating Procedure for the Solar Eclipse of 21 Aug 2017

1. Spectrograph configuration

- a. 15 to 30 MHz
- b. 300 channels
- c. Switching mode: both RCP and LCP

2. Steer TFD array to zenith August 1 or ASAP.

- a. To do this you must remove the two delay cables currently used to steer TFD beam south for Jupiter. See delay lines circled in pink in the TFD diagram following this Procedure.
- b. Mark the cables as necessary so they can be re-connected properly after the eclipse observing campaign.

3. Steer Jove array to zenith August 1 or ASAP.

- a. To do this you must remove the phasing cable currently used to steer Jove array beam south for Jupiter.

4. Calibration

- a. If possible, run daily spectro step calibrations from 8/1/17 through 10/1/17.**
 - i. The preferred calibration method for the spectrograph is to use the HEC-funded calibrator. Set the range for Jupiter (800 kK max) and Slow cal (10 seconds per step). The calibration will occur automatically every day at 0 hours UTC and 12 hours UTC.
 - ii. If you do not have a HEC calibrator then we suggest a stair-step calibration every few weeks using an HP461 noise source and a Kay step attenuator. Knowing the temperature of your noise source, you can use the attenuation values necessary to calibrate in 3 dB steps from about 6 kK to 800 kK. As you manually go thru the calibration steps dwell at each

step for about 10 sec. Try to run a calibration at the same time UTC each day; while this is not strictly required, it sure would be nice.

b. If possible, run daily strip chart calibrations from 8/1/17 through 10/1/17.

- i. Note the temperature shown in SkyPipe in the log; this will allow early detection of system problems. In addition to keeping the data calibrated, running a calibration every day will also allow us to determine system response drift.
- ii. If using the RF-2080, record 15 to 20 seconds of its output.
- iii. If using an HP-461 and a step attenuator, record 15 to 20 seconds at about 25 kK output and document the temperature used.
- iv. Try to run a calibration at the same time UTC each day; while this is not strictly required, it sure would be nice.

c. On the day of the eclipse, August 21, ensure that a calibration is *not* performed between 1700 UTC and 1930 UTC to avoid contaminating your eclipse observation data; however, ensure that a calibration *is* performed before or after that time period.

d. Do not stop the charts to perform the calibrations as the calibration levels are needed within the Jove receiver (SPD) and spectrograph (SPS) data files.

5. Record SPS and SPD files continuously from August 1 through October 1.

- a. Use the most current versions of Radio Sky software:
 - i. RSP version 2.7.28 <http://radiosky.com/skypipe/RSP11 Update 2 7 28.exe>
 - ii. RSS version 2.8.42 <http://radiosky.com/spec/Spectrograph Update 2 8 42.exe>
- b. Add beam steering notes to the RSS and RSP metadata.
- c. Add beam steering notes to the white boxes above the waterfalls in RSS and to the x-axis label in RSP.
- d. Record SPS and SPD data 24/7 on your internal or external hard drive as you normally do.
- e. Either 12 or 24 hour runs are acceptable.
- f. Note that Jove/HEC may request more strip chart data than this 2-month time span.

6. **Keep an accurate engineering log** indicating any technical issues as well as times the equipment is off-line due to local lightning or other conditions. Please provide an accurate drawing of the equipment configuration used for the eclipse. Document exactly how you perform the calibration by showing the calibrator location (cal plane) in your system drawing. This can be hand drawn or simply a markup of your standard station drawing.

7. **Return to normal beam steering after October 1.**
 - a. Reinstall the TFD array delay cables removed in step 2.
 - b. Reinstall the Jove array phasing cable (unless continued zenith steering is requested by Jove/HEC).

8. **Snail-mail your SPS and SPD data files from August 1 through October 1 to Dave for processing.**
 - a. When the eclipse campaign is over, the data should be copied to the portable 2 TB hard drives provided for this experiment by HEC.
 - b. Send your drive to: Dave Typinski, PO Box 2423, High Springs, FL 32655.
 - c. Drives will be copied and returned immediately, so include a return address.

Total Solar Eclipse of 2017 Aug 21

Ecliptic Conjunction = 18:31:19.6 TD (= 18:30:11.2 UT)

Greatest Eclipse = 18:26:40.3 TD (= 18:25:31.8 UT)

Eclipse Magnitude = 1.0306 Gamma = 0.4367

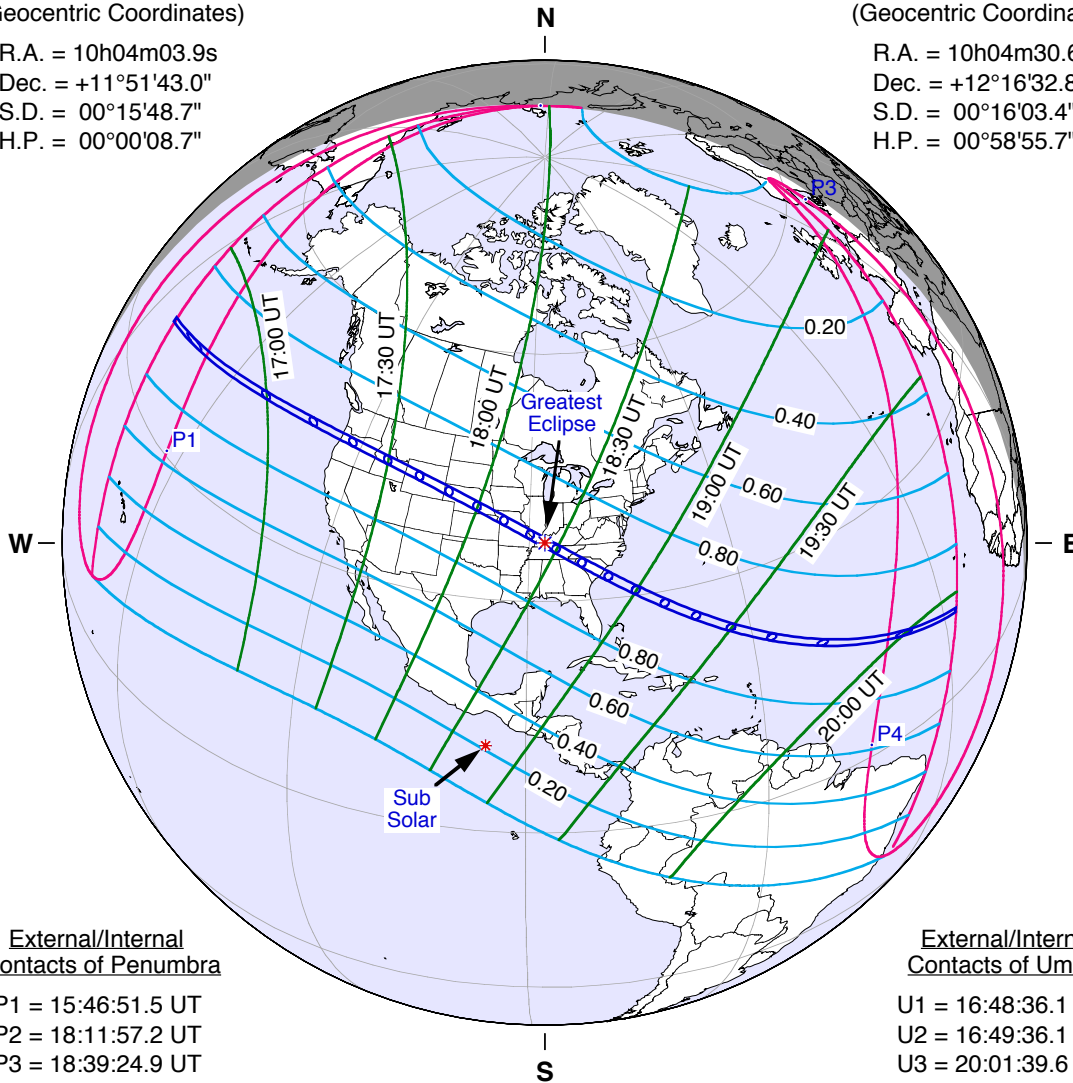
Saros Series = 145 Member = 22 of 77

Sun at Greatest Eclipse (Geocentric Coordinates)

R.A. = 10h04m03.9s
Dec. = +11°51'43.0"
S.D. = 00°15'48.7"
H.P. = 00°00'08.7"

Moon at Greatest Eclipse (Geocentric Coordinates)

R.A. = 10h04m30.6s
Dec. = +12°16'32.8"
S.D. = 00°16'03.4"
H.P. = 00°58'55.7"



External/Internal Contacts of Penumbra

P1 = 15:46:51.5 UT
P2 = 18:11:57.2 UT
P3 = 18:39:24.9 UT
P4 = 21:04:23.5 UT

Constants & Ephemeris

$\Delta T = 68.4$ s
k1 = 0.2725076
k2 = 0.2722810
 $\Delta b = 0.0''$ $\Delta l = 0.0''$
Eph. = JPL DE405

External/Internal Contacts of Umbra

U1 = 16:48:36.1 UT
U2 = 16:49:36.1 UT
U3 = 20:01:39.6 UT
U4 = 20:02:34.4 UT

Geocentric Libration (Optical + Physical)

l = 4.64°
b = -0.57°
c = 21.90°

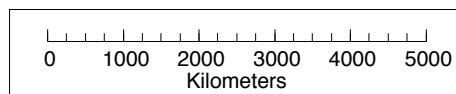
Brown Lun. No. = 1171

Circumstances at Greatest Eclipse: 18:25:31.8 UT

Lat. = 36°58.0'N Sun Alt. = 63.9°
Long. = 087°40.3'W Sun Azm. = 197.9°
Path Width = 114.7 km Duration = 02m40.1s

Circumstances at Greatest Duration: 18:21:49.2 UT

Lat. = 37°35'N Sun Alt. = 63.8°
Long. = 089°07'W Duration = 02m40.2s

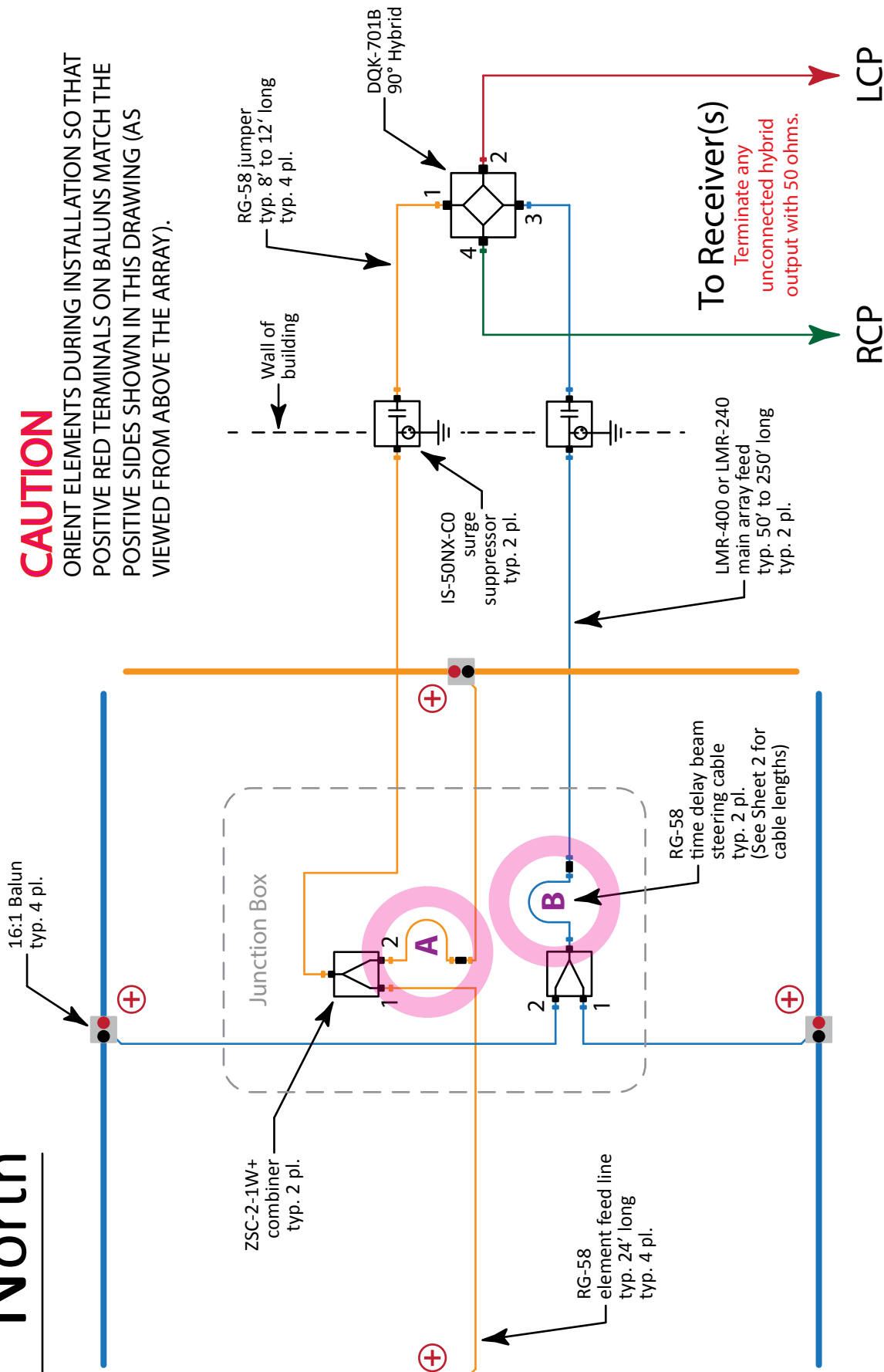


F. Espenak, NASA's GSFC
eclipse.gsfc.nasa.gov
2014 Feb 22

North

CAUTION

ORIENT ELEMENTS DURING INSTALLATION SO THAT POSITIVE RED TERMINALS ON BALUNS MATCH THE POSITIVE SIDES SHOWN IN THIS DRAWING (AS VIEWED FROM ABOVE THE ARRAY).



NOTES:

- 1) Coax is 50 Ω Belden 8259 RG-58 or Times Microwave LMR-240 or LMR-400 cable.
- 2) All coax terminated with AMP or Times crimp-type BNC or N connectors.
- 3) Main feeds cut to customer specified length.
- 4) Feed system supplied with two BNC-F to BNC-F adapters for use with time delay cables.
- 5) Cables individually trimmed to proper electrical length using a VNA.
- 6) Cable test reports include measured 20 MHz phase error and loss from 10 to 40 MHz.



AN-TFD-24 Square Array / Elec.

SIZE	DATE	DRAWN BY	REV
A	16-NOV-2016	DAVE TYPINSKI	1
SCALE	NONE	SHEET	1 OF 2