

Experiment Pre-Checks for Mark IV and VLBA Systems

See also: “Basic Checklists” section of Mark IV Field System manual
Sample checklist in Operations workshop notes

Please note that all references to Mark IV apply to Mark III as well unless specific separate instructions are given for Mark III. The same applies to VLBA and VLBA4.

Experiment SNAP and procedure files

- Run DRUDG on the session (.skd or .drg) file to create the SNAP and procedure file. Print hardcopies of the schedule and session notes.
- Edit the session procedure file to insert station-specific parameters such as IF distributor attenuator settings.
- Be sure to create a new procedure file for each session from the .skd or .drg file. Do *not* rely on default set-up procedures in the station procedure file, as the frequency sequence may have been changed, for instance.

Computer control

- Check that the FS is controlling the VLBI terminal and antenna.
 - On a Mark IV terminal, check that the remote/local switches on all the modules are set to remote, and that the remote button on the tape drive is depressed.
- Set up the VLBI terminal with the session set-up procedure (e.g., ‘setupa=1’).

Station timing

- Check that the formatter time agrees with GPS time at the one-second level. If it does not, use ‘fmset’ to adjust the formatter time. For Mark III you must set the time manually.
- Check that the FS clock is correct to <1 second. If it is not, enter the command ‘sy=run setcl offset &’. This command should also be issued whenever the formatter time is reset. If ‘fmset’ is used to set the formatter time, the FS time will automatically be reset when ‘fmset’ exits.
- If a computer other than the FS computer controls the antenna pointing, check that its timing agrees with GPS to <1 second.

- Using a counter with time interval measurement accuracy <100 ns, measure the time interval between the 1pps signals from
 - formatter clock and GPS receiver
 - maser and GPS receiver.

The formatter should be within a few microseconds of GPS, but in any event should be no more than ± 30 milliseconds away.

- Check that the formatter/GPS/maser 1pps offsets are consistent with other recent measurements.

Feed polarization

- Ensure that the feed polarization is correct.
- For geodetic S/X observations, the correct polarization is RCP.

Receiver

- Check that the physical temperatures of the 20 K and 70 K stations in the dewar are within their normal ranges and are not rising.
- Check that other receiver parameters that can be monitored, such as FET currents, LO and phase cal temperatures, power levels, power supply voltages, etc., are within their normal ranges.
- Check that the receiver LO is set to the correct frequency.
- If there is any uncertainty about the LO frequency, measure it.
 - If the LO is accessible, measure its frequency directly with a counter.
 - Alternatively, radiate a coherent test tone at a frequency in the RF passband toward the antenna and measure its frequency in the IF or at baseband. Suitable test tones can be generated up to a few GHz by using an amplifier and frequency multiplier on the LO monitor output of a BBC or VC.

IF distributor/IF3 module/IF upconverter or downconverter

- Check that the inputs to these modules are connected to the correct IF signals.
- In a Mark IV DAT, check that the VC inputs are connected to the correct IF signals (IF1/IF2 low/high or IF3). The IF switch box controlled through the IF3 module can be used to switch the VC03 and VC10 inputs automatically between low and high bands.

Video or baseband converters

- Measure the frequency of each VC/BBC LO with a frequency counter and compare against the correct value.
- Check that the baseband bandwidth in each VC/BBC is correct.
- In a VLBA DAR, check that the IF input to each BBC is correct.
- Check that the baseband power levels are in the proper range.
 - In a Mark IV DAT, adjust the IFD/IF3 attenuation to give USB and LSB power readings of 0.1–2.0 on the front-panel meter of each VC, with the 10-dB attenuators in. Use the largest amount of IFD/IF3 attenuation that keeps all channels being recorded above 0.1 volt.
 - If readings of 0.1–2.0 cannot be achieved in all VCs, as a temporary measure the lower limit can be relaxed to 0.05, or small (1–3 dB) SMA attenuators can be added to the inputs to the stronger VCs.
 - Do not use large (≥ 10 dB) attenuators on the VC inputs, as those VCs without attenuators are liable to saturate.
 - In a VLBA DAR, check that the baseband power readings are all approximately 16000 counts. The AGC gain in each BBC should be between –10 dB and +10 dB.
 - The proper long-term solution to strongly frequency-dependent VC power readings or BBC gains is to flatten the IF passband with appropriate filtering. Please find this describe in more detail in the Ops Impact on Analysis chapter.
- For a Mark IV system, the command ‘ifadjust’ may be used to set the attenuators automatically, provided the VC TPI readings are working and RFI is not severe. The DAT must first be configured with the set-up procedure from the experiment procedure library. The antenna should be pointed near zenith (or toward any direction that gives nearly the minimum system temperatures), and the weather should be clear. If ‘ifadjust’ converges, the results should be the optimum attenuation for that mode. (No changes should be necessary during the experiment as the source elevation or the weather changes.) The resulting values should be edited into the IFD set-up procedure for the mode. If there is more than one mode in an experiment, this procedure should be repeated for each mode.

Antenna focus

- For geodetic and astrometric observations, lock the focus at the position that gives peak response at mid-elevations.
- For astronomy-only (i.e., source mapping) observations, the focus may be adjusted with elevation angle to give maximum gain.

Antenna pointing

- Check antenna pointing on two or more widely-separated sources.
- Pointing errors in both axes should be smaller than beamwidth/10 at the highest observation frequency.
- The FS command ‘fivept’ may be used to automate the measurement.

System Equivalent Flux Density (SEFD)

- Measure the SEFD in each frequency band and compare against the nominal value.
 - Using a strong radio source of known flux density, measure T_{source}/T_{sys}
 - Convert to SEFD by dividing T_{source}/T_{sys} into the source flux density (corrected for size effect if the source angular extent is comparable to, or larger than, the antenna beamwidth).
 - The FS command ‘onoff’ may be used to automate the measurement.

System temperatures

- With the antenna pointed near zenith, measure the system temperatures in all VC/BBC and broadband IF channels, and compare against nominal values.

Phase calibration signal

- Use an oscilloscope and 10–kHz viewing filter to examine the baseband phase cal signal in each USB channel. (This section assumes that phase cal is present at 10 kHz in each baseband USB channel, as will be the case with a 1 MHz phase cal pulse rate and a total LO frequency of nnn.99 MHz.) Trigger the oscilloscope with a timing signal derived from the maser (e.g., the frame sync signal from a Mark IV formatter).
 - Phase cal should be present with the proper amplitude.
 - Phase cal should be stable in phase relative to the maser timing signal.
- Use the same equipment to examine each LSB channel.
 - The LSB phase cal level should be >20 dB weaker than in USB.
- A good end-to-end system test is to check for phase cal in the bit stream from each USB data track.
 - For a Mark IV system, connect one of the decoder DATA outputs to the 10–kHz viewing filter input. Enter the commands ‘enable=s1’ and ‘st=for,0,on’. Select USB tracks with the ‘repro=byp,<trackA>,<trackB>,,<rate>’ command and check for phase cal on the oscilloscope.
 - For a VLBA system, use the ‘repro’ and ‘dqa’ commands to measure the phase cal amplitude in each USB channel.

Cable calibration

- The cable counter should be operating in single-sample mode, not averaging.
- The cable counter reading should be in the normal range.
- Single-sample readings should be stable to ± 1 μ sec.
- Check that the cable calibration system measures cable length changes correctly.
 - Log the cable reading.
 - Insert a short cable length in the cable from the ground unit to the antenna unit, and log the cable reading again.
 - Remove the short cable and log the cable reading again.
 - Compare the change in readings with the nominal value.

Mark 5A

Please note that Mark-5A operational procedures are in the TOW07 notebook.

- 8-Pack Installation –
 1. Remove the 8-pack from the shipping box and their shipping covers.
 2. Inspect for damage.
 3. Pull front lever down so that it is horizontal.
 4. Slide 8-pack easily into Mark5A machine until it stops.
 5. Lift front lever which will insert the 8-pack into the connector.
 6. Turn the key switch to the right until it stops.
 7. Repeat with second 8-pack.

- Conditioning the 8-Pack –

If there is time each 8-pack that is received at a station should be conditioned before it is used to verify there has been no shipping damage. This can be done in any appropriate length gap in recording (4 hours or more) or left running overnight or over a weekend. Please see <ftp://web.haystack.mit.edu/pub/mark5/Conditioning.txt> for more information. A copy of this document follows in this section. Please note that the SSERase program is run outside the Mark 5A. If the 8-pack is write protected, you will be prompted to remove the write protection, and you should do so. When the conditioning is complete, please check the results to confirm that the 8-pack is okay before using it.

- Mark5A Start-Up –
 1. From the Mark5A terminal, login as oper.
 2. Enter the password.
 3. From the prompt, start a script running by entering ‘script -f anyname’.
 4. To start the Mark5A running, enter ‘Mark5A -m0 -f0 &’.
 5. To stop the Mark5A, enter ‘EndM5’.

- Field System Checks –
 1. Test the communications with the Mark5A by entering ‘disk_serial’ at the Field System prompt. Sample output:


```
2003.245.16:42:48.40/disc_serial/VNVF11G6G9BS9L,VNVF11G6G9BW6L,VNV
F11G6G99V7L,VNVF11G6G9BVDL,VNVF11G6G9BUVL,VNVF11G6G9A2HL,
VNVF11G6G99XZL,VNVF11G6G9A2XL,
```
 2. Enter ‘disk_pos’. This will give the position of the disk pointers. Sample output:


```
2003.245.16:42:53.42/disc_pos/81952,0,
```
 3. Enter ‘mk5=VSN?’. This will check if a VSN is assigned to the 8-pack.
 4. Erase the disk with ‘mk5=reset=erase’. Be very careful that the disk installed should be erased before entering this command.
 5. Enter ‘disk_pos’. This will respond with the disk pointers at 81952,0 (or it may be 0,0, depending on the version of erase).
 6. Set up the procedure file that will be used for the session, e.g., ‘proc=r1087wf’.
 7. Issue the set-up command from the session, e.g., ‘setup4f’.
 8. Enter ‘disk_record=on’.
 9. Enter ‘disk_pos’. Repeat this command many times to confirm recording.
 10. Enter ‘disk_record=off’. This stops the recording.
 11. Enter ‘scan_check’. Sample output:


```
2005.115.17:41:54.26/scan_check/2,r1172_0552+398_115-
1741,mark4,32,2005y115d17h41m1.080s,49.1s,8.000000,0
```
 12. Erase the disk with ‘mk5=reset=erase’.

Meteorological sensors

- Check that the values of barometric pressure, temperature, and relative humidity reported by the ‘wx’ command are reasonable and repeatable.

‘Ready’ message

- Approximately an hour before the session is to start, or as soon thereafter as possible, send a “ready” email message containing the following information:
 - comments on any unusual conditions
 - pointing offsets and source az/el
 - SEFDs and source az/el
 - system temperature for each IF
 - formatter offset from GPS
 - source and epoch of first scheduled observation
 - tape drive relative humidity
 - weather and sky conditions

See the Operations workshop notes for more information.

More extensive testing

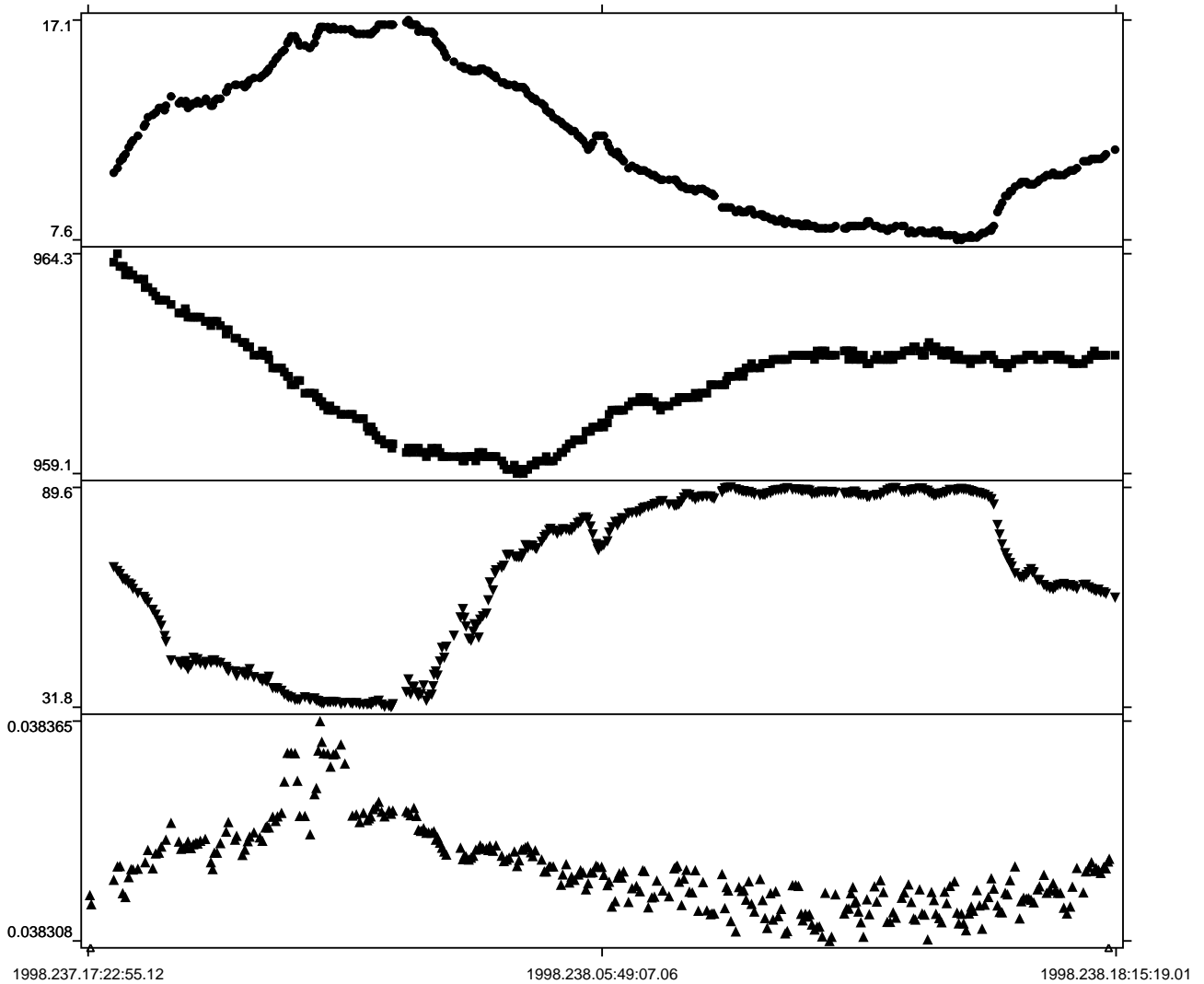
- After any equipment changes or if a long period of time has elapsed since the last VLBI session, more extensive testing of the VLBI systems should be carried out. More rigorous testing should also be conducted on a periodic basis (monthly to annually). Such tests include:
 - Measure pointing offsets over the full sky.
 - Check for RFI and for jumps in the phase cal phase and cable cal as the antenna is slewed across the sky.
 - Calibrate the meteorological sensors, especially the barometer.
 - Measure the DC level and AC ripple in the DAT/DAR power supplies.
 - Measure the strength of the phase cal signal by observing how much the IF or baseband power level changes when phase cal is turned off.
 - Measure the levels of spurious phase cal signals:
 - with phase cal turned off via the ground unit switch
 - with phase cal turned on and the receiver LO unlocked
 - with the cable driving the antenna unit disconnected from the ground unit.
 - For each VC/BBC:
 - Check that the LO will lock over the full design frequency range (100–500 MHz for a VC, 500–1000 MHz for a BBC).
 - Measure the LO phase noise at 2-3 frequencies spanning the design range.

- Measure the USB/LSB image rejection at the upper and lower ends and middle of the baseband frequency range.
 - Check each sideband signal on a spectrum analyzer for anomalous shape.
- Monthly execution of the ‘overnite’ procedure is recommended to check the stability of the VLBI systems. The procedure should be run for at least 12 hours, and preferably 24 hours, with the antenna stationary. At a minimum, the values of the following quantities should be logged at least every 15 minutes:
 - wx
 - cable
 - formatter-GPS time interval
 - system temperatures in all channels
 - phase cal amplitude and phase in at least 1 channel per frequency band
 - receiver parameters: dewar temperatures, phase cal temp, etc.
 - other station-specific parameters

● 1: Temperature
▼ 3: Humidity

Station: GILCREEK
Filename: /usr2/log/ca043gc.log

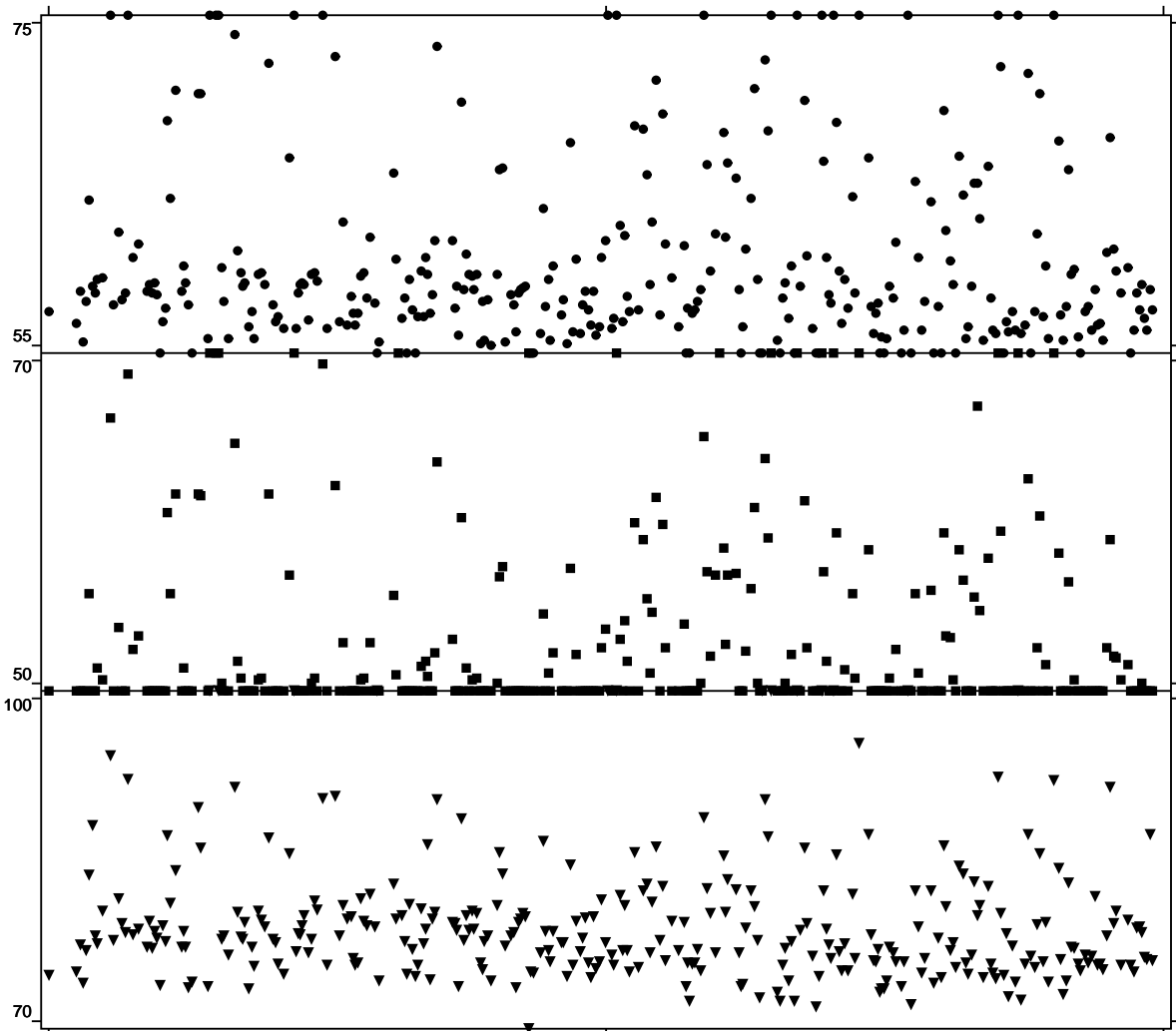
■ 2: Pressure
▲ 4: Cable-length



● 1: Cmd=tsys1/ Parm=9
▼ 3: Cmd=tsys2/ Parm=7

Station: GILCREEK
Filename: /usr2/log/ca043gc.log

2: Cmd=tsys1/ Parm=10 ■



1998.237.17:22:55.12

1998.238.05:49:07.06

1998.238.18:15:19.01

