

# Manual for observations in beam-former mode

22 April 2021  
Bhaswati Bhattacharyya

## Step-1 Plan observations based on the available modes doc

Plan the observations with feasible modes (for remote observations, please communicate with Friend of Astronomer just after approval of time; within 2 weeks of approval for regular proposal or within a day after getting approval for DDT/TOO).

Refer to **Section -1** for the details regarding the available modes of observations.

## Step-2 Plan for data back up

Estimate the data volume (maximum possible data rate **170 GB per hour**) and arrange for backup devices. **For remote observations** (not having CO-I from NCRA) please discuss the data backup plan and make necessary arrangement beforehand, e.g. buy a disk and get it delivered directly to NCRA address before the observations (please refer to **Section-4**).

## Step -3 Preparation for observations

### a) Command file creation :

i) Consult the template command files (**Section -3**) for different modes kept in public area

ii) Send the **command file** to control room ([ctrlgmrt@gmail.com](mailto:ctrlgmrt@gmail.com)) 1 week before observations

(exception, for last minute approval of DDT/TOO, send the command file within a day of approval)

**c) Settings for observations :** Prepare and send for observations to control room (**Section -2**)

**d) Disk space requirement :** Calculate the disk-space required knowing the total duration of proposed observations and the data rate for the observing mode from **Section -1**, and send to control room  
(Note : Maximum allowed data rate 48 MB/s)

Make sure that control room received your instructions, add gtac code and date in the subject line  
(**for remote observations** keep [bhaswati@ncra.tifr.res.in](mailto:bhaswati@ncra.tifr.res.in) in cc for time being)

## Step-4 Stay online and available during your observations

Google Chat with [ctrlgmrt@gmail.com](mailto:ctrlgmrt@gmail.com)

## Abbreviations

**IA :** Incoherent array of GMRT suitable for searches and study of the newly discovered objects for which accurate position is not well known

**PA :** Coherent/phased array of GMRT, more sensitive and suitable for study of the objects with well known position

**CDP :** Coherent-dedispersion pipeline, suitable for the low-frequency high time resolution study

## **Section -1: Time/frequency resolution for available observing modes**

Presently the maximum allowable data rate for beam data recording to disk at the GMRT for various combination of time and frequency resolutions is ~ 48 MB/s.

Observing bands      Band2 : 125-250 MHz  
                               Band3 : 260-500 MHz  
                               Band4 : 550-850 MHz  
                               Band5 : 980-1500 MHz

- Simultaneous 3 intensity beams (any combination of IA and PA) at maximum time resolution

Table 1 : Allowed observing modes for recording with maximum allowable data rate ~48 MB/s

Observing mode	Observing band-width	Time resolution	Frequency channels
16 bit – Total intensity	400/200 MHz	81 microsec	2048 channels
16 bit – Total intensity	400/200 MHz	163 microsec	4096 channels
16 bit – Total intensity	400/200 MHz	327 microsec	8192 channels
16 bit – Total intensity	400/200 MHz	655 microsec	16384 channels
8 bit – Total intensity	400/200 MHz	81 microsec	4096 channels
8 bit – Total intensity	400/200 MHz	40 microsec	2048 channels
8 bit – Total intensity	400/200 MHz	163 microsec	8192 channels
8 bit – Total intensity	400/200 MHz	327 microsec	16384 channels
16 bit – Polar	400/200 MHz	655 microsec	4096 channels
16 bit – Polar	400/200 MHz	327 microsec	2048 channels

Note:

- i) For 8bit data recording mode, factor of two higher time/frequency resolution is possible as seen in Table 1
- ii) For the polar mode, factor of four lower time/frequency resolution is possible

Table 2 : Allowed observing modes for coherently de-dispersed data (16-bit recording) considering maximum allowable data rate as ~48 MB/s

Band width	Time Resolution (max)	Frequency Resolution
200/100 MHz	20 microsec	512 channels

- 2 simultaneous CDP beams at max time resolution for 100 MHz
- 2 simultaneous CDP beam recording for 200 MHz is currently not possible
- 1 CDP beam at 200 MHz and 2 intensity beams (IA or PA) at maximum time resolution is possible
- 400 MHz CDP recording is currently not available

## **Section -2 : Settings and steps of observations**

**a) Example of typical RF / LO setting in Band5:**

1460 MHz LO, 400 MHz BW, LSB

**b) Example of typical RF / LO setting in Band4:**

550 MHz LO, 200 MHz BW, USB

**c) Example of typical RF / LO setting in Band3:**

500 MHz LO, 200 MHz BW, LSB

**d) Example of typical RF / LO setting in Band2:**

300 MHz LO, 200 MHz BW, LSB

Note: Usable band can be checked in ETC calculator <http://www.ncra.tifr.res.in/etc>

---

**Please fill in the following with the settings required and send to control room**

---

**Project Code :**

**Frequency Band :** \_\_\_\_\_ (e.g. Band2/ Band3/ simultaneous Band2 and Band3)

**Chosen of RF-LO combination:**

**Chosen RF:** \_\_\_\_\_, **Chosen LO:** \_\_\_\_\_, **Chosen Bandwidth:** \_\_\_\_\_

**Sideband:** \_\_\_\_\_ (LSB if RF>LO, USB if RF<LO)

**Beam Details :** \_\_\_\_\_ (e.g. IA/ IA+IA/ IA+PA/ PA+CDP/ IA+PA+CDP)

**Antenna Selection :** \_\_\_\_\_

**Backend :** \_\_\_\_\_ (e.g. GWB)

**Frequency resolution:** \_\_\_\_\_ (e.g. 2048 frequency channels over 200 MHz, Ref. Table 1)

**Time resolution:** \_\_\_\_\_ (e.g. 81 micro sec, Ref. Table 1)

**Backend:** \_\_\_\_\_ (e.g. GWB)

**Data space required per beam :** \_\_\_\_\_ (e.g. 500 GB)

**Recording Machine and data area:** \_\_\_\_\_ (e.g. gwbh10/data4)

---

Note:

i) For simultaneous multi frequency observations provide details of settings for each frequency band

ii) For simultaneous multi-frequency observations divide the antennas in sub-arrays corresponding to each frequency band, keep closely spaced near to central square antennas for lower frequencies.

iii) For the allowed modes of observations check Section-1

iv) If recording in GSB then provide settings for GSB as well

v) **For remote observations** "Recording machine and data area" needs to be decided in consultation with the operators

## Example set up files

### Example1: Setting to be sent to control room for single frequency band3 observations

**Project code :** 38\_062

**Frequency Band :** Band3

**Chosen RF/LO combination:**

**Chosen RF:** 500 MHz, **Chosen LO:** 200 MHz, **Chosen Bandwidth:** 200 MHz

**Sideband:** LSB

**Beam Details :** IA+PA

**Antenna Selection :** All central square antennas and first two arm antennas

**Backend :** GWB

**Frequency resolution:** 2048

**Time resolution:** 81 micro sec

**Recording Machine and data area:** gwbh10/data4

### Example2: Setting to be sent to control room for single frequency band2 observations

**Project code :** 39\_002

**Chosen RF/LO combination:** Band2

**Chosen RF:** 300 MHz, **Chosen LO:** 200 MHz, **Chosen Bandwidth:** 200 MHz

**Sideband:** LSB

**Beam Details :** CDP

**Antenna Selection :** C00, C01, C02, C03, C06, C08,C10,C11,C13,S01,E02,S04

**Backend :** GWB

**Frequency resolution:** 512

**Time resolution:** 20 micro sec

**Recording Machine and data area:** gwbh10/data4

### Example3: Setting to be sent to control room for simultaneous dual frequency observations

**Band3(PA) + Band2(CDP)**

**Project code :** 39\_007

**Frequency Band :** Band3 + Band2

**Chosen RF/LO combination:** Band3

**Chosen RF:** 500 MHz, **Chosen LO:** 200 MHz, **Chosen Bandwidth:** 200 MHz

**Sideband:** LSB

**Beam Details :** PA

**Antenna Selection :** C04,C05,C09,C12,C14,W01,W02,E03,S02,S03,W03

**Backend :** GWB

**Frequency resolution:** 2048

**Time resolution:** 81 micro sec

**Recording Machine and data area:** gwbh10/data4

## Steps for observations

- Step-1 (for IA,PA and CDP mode) : Power equalise @150 count on nearby calibrator source
- Step-2 (for PA and CDP mode, not required for IA mode): Phasing the array
- Step-3 (Antenna selection in GAC): All working antennas can be used to form the array for IA mode observations  
All central square and the first few arm (up to 2<sup>nd</sup> or 3<sup>rd</sup> arm antennas) antennas advisable for PA/CDP mode observations  
(note: phase degradation happen more rapidly for the far away arm antennas)
- Step-4 : start scan on the source (via cmd file is preferable)

Note: For PA/CDP mode observations phasing on a calibrator is suggested every 30 mins in Band 2, 35 mins for Band 3, 35 mins for Band 4 observations and 40 mins for Band 5 observations.

### Phase calibrator sources

Strong point sources that are not resolved at the frequency of observations act as good phase calibrator sources. Some of the phase calibrator sources that are used for phasing the GMRT array are listed in the following,

3C48, 3C286, 3C147, 815+365, 0837-198, 1154-350, 1427-421, 1459+716, 1526-138, 1623-116, 1822-096, 1830-360, 2052+365, 2225-049

Calibrator list above is does not cover the full GMRT sky so users are requested to consult VLA calibrator manual (<http://www.vla.nrao.edu/astro/calib/manual/csource.html>) for additional sources. We request users to provide feed back on new calibrator sources that they use for phasing to <mailto:bhaswati@ncra.tifr.res.in>.

## Section -3 : Preparation of command file

**Command files needs to be prepared by the observers and supplied to the control room**

### **Recording commands in different modes**

---

PA/IA mode data recording (16 bit recording)

gwbpsr.start dataarea pulsarname centralfrequency1 centralfrequency2

1<sup>st</sup> entry : data area (e.g. data4)

2<sup>nd</sup> entry : pulsar name (e.g. J0332+5434)

3<sup>rd</sup> entry : centre frequency (e.g. 400 for band3 using 300-500MHz)

4<sup>th</sup> entry : centre frequency (e.g. 650 for band4 using 550-750MHz)

omit the 4<sup>th</sup> entry for single frequency observations

Example : gwbpsr.start data4 J0332+5434 400

PA/IA mode data recording (8 bit recording)

run\_record.gwb2 dataarea pulsarname recording\_bit scaled\_duration post\_integ scaling centralfrequency1  
centralfrequency2

1st entry : data area (e.g. data4)

2nd entry : pulsar name (e.g. J0332+5434)

3rd entry : 8 bit recording (e.g. 8)

4th entry : scaled duration/0.671 (scaled duration; )

5th entry : post integ (1 in general)

6th entry : scaling to convert from 16bit to 8bit (e.g. 16)

Example : run\_record.gwb2 data4 J0332+5434 8 5365 1 16 400

CDP mode recording (16 bit recording)

Step 1: do coherent dedisp

runsubband-cd-bm1.pl bandwidth lowest\_freq output\_subbands DM input\_subbands band\_flag

1st entry : band width in MHz (e.g. 200 )

2nd entry : lowest frequency of band (e.g 300 for 500-300)

3rd entry : output number of subbands (e.g. 1024 frequency channels)

4th entry : DM of the pulsar in pc/cc (e.g. 26.76)

5th entry : input number of subbands (e.g. 2048 frequency channels)

6th entry : band\_flag (e.g. for LO>RF, -1 for inverted band)

Above configuration will generate 1024 output frequency channels

Example : runsubband-cd-bm1.pl 200.0 300.0 1024 26.76 2048 -1

Step 2 : write the CD output (16 bit recording)

write-cd-bm1.pl output\_subbands time\_integ duration dataarea filename

1st entry : output number of subbands (e.g. 1024 frequency channels)

2nd entry : time integration factor (e.g. 4,8,16..)

3rd entry : observation duration in sec (e.g 3600 s)

4th entry : data area (e.g. data4)

5th entry : filename (keep short)

This will write 1024 channels at 40.96 micro sec time resolution

Example : write-cd-bm1.pl 1024 4 3600 data4 J0332+5434\_CDP\_400\_200\_1024\_4.raw0

### **Sample command files**

- i) single frequency IA (for 8 bit)
- ii) single frequency IA (for 16 bit)
- iii) single frequency PA (for 8 bit)
- iv) single frequency PA (for 16 bit)
- v) single frequency CDP (for 16 bit)
- vi) dual-frequency PA+PA (for 16bit)
- vii) dual-frequency CDP+CDP (for 16 bit)
- viii) dual-frequency CDP+PA (for 16 bit)

are kept in [http://www.gmrt.ncra.tifr.res.in/gmrt\\_users/help/help.html](http://www.gmrt.ncra.tifr.res.in/gmrt_users/help/help.html)

## **Section -4 : Data backup**

### **Modes for data backup**

1) GTAC data transfer using USB disk provided by the user

**Users are requested to send USB hard disk online (e.g. amazon) and send it directly to NCRA (i.e. while buying ask to deliver the disk in NCRA)**

**In this way we can avoid the Customs duty in India. Send this to the following postal address,**

Postal address :  
Reena Shrikumar,  
NCRA-TIFR, Pune University Campus,  
Pune- 411007, Phone no. +91 20 2571 9000.

In case users receive OTPs then the OTP should be emailed immediately to  
[reena@ncra.tifr.res.in](mailto:reena@ncra.tifr.res.in), [hemant@ncra.tifr.res.in](mailto:hemant@ncra.tifr.res.in) and [haswati@ncra.tifr.res.in](mailto:haswati@ncra.tifr.res.in)

2) For relatively short duration observations (< 1TB) data can be transferred via internet from  
<ftp://wm.gmrt.ncra.tifr.res.in/gtacuser/>  
(contact Kamble Jayprakash [jprakash@gmrt.ncra.tifr.res.in](mailto:jprakash@gmrt.ncra.tifr.res.in))

---

User Feedback : Thanks for using this manual.

Please email your inputs for further improvement of the manual to [haswati@ncra.tifr.res.in](mailto:haswati@ncra.tifr.res.in)

Acknowledgement : Inputs from the NCRA faculties, students and others in different stage of preparation of this manual is appreciated.