Version 4.1 *Date : 13th October 2023.*

OPERATING PROCEDURE
FOR
RUNNING GWB - release

Authors :

Nilesh Raskar
Harshavardhan Reddy
Sanjay Kudale
Jayanta Roy

Table of Contents

Illustration Index

Updates from previous version (version 4)

1. Enabled Narrowband mode for 200 MHz Bandwidth for Decimation 2 i.e final bandwidth of 100 MHz.

Note : For 200 MHz Bandwidth, narrowband mode for decimation factor greater than 2 is not released.

Available modes in GWB

Input Bandwidth = 100/200/400MHz

No. of spectral channels = 2048/4096/8192/16384

Interferometry modes = Total Intensity/Full Polar

Output time resolution = 0.671 / 1.34 / 2.68 / 5.36 / 10.73 / 21.4 seconds

Beamformer modes = IA/PA/Voltage/PC

No. of beams = 4, IA/PA beam bits = 16/8, Voltage beam bits = 8/4

IA/PA/PC beam recording bits = 16/8 (Even when IA/PA/PC beam bits are selected 16, recording can be done for 8 bits)

Narrowband mode possible BW = 100/50/25/12.5/6.25/3.125/1.5625 MHz
For 200 MHz bandwidth only decimation factor 2 is possible i.e final bandwidth of 100 MHz

Narrowband mode possible spectral channels = 2048/4096/8192/16384

Possible modes with PFB : For 200 MHz BW, maximum 16 taps and all modes possible

For 400 MHz BW, maximum 4 taps and no beams possible above 8192 spectral channels
For narrowband modes below 6.25 MHz BW PFB is not possible

For narrowband modes 100 MHz, 50 MHz and 25 MHz, maximum 16 taps and all modes possible

For narrowband mode 12.5 MHz, maximum 8 taps and all modes possible

For narrowband mode 6.25 MHz, maximum 4 taps and all modes possible

Walsh Demodulation and RFI filtering.

Note : 1. Voltage beam mode is possible only in Total Intensity mode of Interferormeter.
2. PA beam full polar mode is available only in Full Polar mode of Interferometer.

Note :Packet loss information is saved at the end of every observation at /home/gpuuser/GWB/log/loss_log.txt in gwbh6 machine along with timestamp. Ex : loss_log_2018_03_26_12_10_AM.txt

Chapter 1: GWB Parameters

1.1 Available GWB config parameter selections and resultant values

GWB Parameter	GUI Selection	Resultants in hdr file	
MODE	REALTIME	0	
LTA (for 200MHz/8-bit and 400MHz/4-bit modes)	32	0.671088 * 32 = 21.474816 sec	
	16	0.671088 * 16 = 10.737408 sec	
	8	0.671088 * 8 = 5.368704 sec	
	4	0.671088 * 4 = 2.684352 sec	
	2	0.671088 * 2 = 1.342176 sec	
	1	0.671088 sec	
LTA(for 100MHz BW and Narrowband modes)	32	1.342176 * 32 = 42.949632	
	16	1.342176 * 16 = 21.474816 sec	
	8	1.342176 * 8 = 10.737408 sec	
	4	1.342176 * 4 = 5.368704 sec	
	2	1.342176 * 2 = 2.684352 sec	
	1	1.342176 sec	
ACQ BW	400 MHz	400.0000	
	200 MHz	200.0000	
	100 MHz	100.0000	
DDC (see Appendix 5)	0	Narrowbandmode OFF	
	1	Narrowbandmode ON	
Final BW (Decimation Factor)		**100 MHz ACQ BW**	**200 MHz ACQ BW**
	1	100MHz	200 MHz
	2	50 MHz	100 MHz
	4	25 MHz	50 MHz
	8	12.5 MHz	25 MHz
	16	6.25 MHz	12.5 MHz
	32	3.125 MHz	6.25 MHz
	64	1.5625 MHz	3.125 MHz
Channels	2048	2048	
	4096	4096	
	8192	8192	
	16384	16384	
STOKES	2 STOKES	2 (Total Intensity mode)	
	4 STOKES	4 (Full polar mode)	
CONTROL	ONLINE	1	

TPA SELECTION	Online (tpa)	1
	Manual (GWB)	0
SIDEBAND FLAG	Flipped (LSB)	1
	Normal (USB)	-1
GAB LO FREQUENCY	LO 130 & LO 175	LO SET at GAB taken as RF for GWB.
GAIN	ON/OFF	1/0 respectively.
FSTOP	ON/OFF	1/0 respectively.
Beam – 1 / Beam – 2 / Beam – 3 / Beam - 4	OFF/IA/PA/Voltage/PC	0/1/2/3/4 respectively
Beam Stokes	1 Stokes/ 4 Stokes.	1/4 respectively
Beam Bits	Beam output bits for IA/PA beam	16/8
Voltage Beam Bits	Beam output bits for voltage beam	8/4
Beam Integration	A range of values	**Appendix 1 and Appendix 2**
BITS	8	8 (for ACQ BW <= 200 MHz)
	4	4 (for ACQ BW > 200 MHz)
Beam Steering	OFF/ON	Edit file beam_str_src.list in gwbh6:/home/gpuuser/GWB/release/header for pointing beam2,beam3 and beam4 away from reference beam1
PFB (See Appendix 6)	OFF/ON	2/4/8/16 taps
Walsh	OFF/ON	GPU_WLASH flag is set to 1

Chapter 2: Configuring and Running GWB

2.1 Configuring GWB

Configuration is done through TGC GUI.

```
LTA               :    Visibility data output time resolution

ACQ BW(MHz)       :    Acquisition BW 400/200/100 MHz

CHANNELS          :    No. of spectral channels

STOKES            :    Mode of interferometer. Total Intensity (2 Stokes)
                      or Full Polar (4 stokes)

TPA selection     :    1. Online (TPA) : This will take TPA parameters
                       from  online machine, and disables the Sideband Flag
                       and GAB LO entries at GUI, for each relevant sub-
                       array
                       2. Manual (GWB) : This enables user to choose
                       sideband, and  GAB LO Entries.
DDC               :    Narrowband mode ON/OFF

Final BW          :    Decimation factor for Narrowband mode.

Decimation value:      BW selection in Narrowband mode



RFI Filtering     :    RFI Filtering selection.
                       OFF – No RFI Filtering,
                       ON(MAD) – Median of Absolute Deviation based RFI
                       Filtering
                       ON(MoM) – Median of MAD based RFI Filtering
BEAM 1/STOKES
BEAM 2/STOKES
BEAM 3/STOKES
BEAM 4/STOKES     :    Beam type selection and Beam Stokes selections
BEAM STEERING     :    Beam Steering OFF/ON
Beam Integration:      Sampling period of beam. See Appendix 1 and 2.
                       Beam Integration is same for all beams.
BEAM BITS         :    No. of IA/PA beam output bits 16/8
VLT BEAM BITS     :    No. of voltage beam output bits 8/4
PFB               :    PFB mode OFF/ON
PFB TAPS          :    No. of PFB taps 2/4/8/16
WALSH             :    WALSH demodulation OFF/ON
```

2.2 Starting acquisition and recording

Log on to **observer@astro8** and enter commands as:

cd ~/bin/gwb-release/

./gwbcorr

This will open a qt interface for gwb release (gwb-dasconsole).

1. Go to the gwb-dasconsole
2. On Menubar go to "**Start -> GWB - Windows -> Getcmd** "

   This will popup the client workspaces for each command with following order:
   - "192.168.4.75**::gwb_corr_released.sh**":
     It can also be termed as acquisition client. This starts and broadcasts the acquisition processes to the compute nodes and host machines. .
   - "192.168.4.75**::collect.sh**":
     This dumps the Astronomical data into the buffer and keeps it there for a while and removes it as per the FIFO logic.
   - "192.168.4.75**::record**":
     one can write the acquired data into specified lta format file as per requirement.

3. Now, click the **start button** (blue icon button) of first client window named "gwb_corr_released.sh" and wait till it shows the following message:

   gmrt_correlator : Waiting For Initialization Cmd ..

4. Now click the **start button** (blue icon button) of "collect.sh" wondow
5. Give *init* command command from TGC online.

   After this command wait(nearly 15 to 20 seconds) for following messages in the first window.

   Full Polar mode :
   "collecting data for full polar mode
   collecting data for full polar mode"
   Total Intensity mode :
   "collecting data for indian polar mode
   collecting data for indian polar mode"

   If beamformer is selected, timestamps information will be printed in between the above given messages.

6. Initialize the project and start the scan from TGC online.

7. Start and stop scan as per requirement and one can start record for the same.
   To record the data in record window type in the format as :
   GWBTST /gwbifrdata2/31mar/gwbtst_31mar2017.lta
   GWBTST /gwbifrdata2/31mar/gwbtst_31mar2017.lta 4

8. Starting **DASMON** :
   login to gwbh6 : **ssh -X gpuuser@gwbh6**
   enter commands as : **/home/gpuuser/GWB/release/bin/dasmon.pl**

   Also, DasMon Can be Started from the main DasConsole GUI from "**MenuBar->Tools->Interferometry->GWB DasMon" or *CTRL* + *M*** as an accelerator.

9. Starting Power Equalisation Program :
   GWB Power Equalise GUI Can be Started from the main DasConsole GUI from "**MenuBar->Tools->Interferometry->GWB_PowerEq" or CTRL + E** as an accelerator. This can also be done as explained in later section(2.3) 'GAB - GWB Power Equalise'.

2.3 GAB Power Equalise

Power Equalise program is released for GWB, which uses the output self visibility data from GWB and equalizes the power levels at GAB (GMRT Analog Backend) system.

Steps to follow (with GUI)

GWB Power Equalise GUI Can be Started from the main DasConsole GUI from "**MenuBar->Tools->GWB_PowerEq"**

1. Select the antennas to be equalized.
2. Set the Optimum level, Begining channel, End channel, Upper level, Lower level and Integrations as per requirement.
3. Click on the button save to generate text files as per selected gui options.
4. Click the button 'EQUALISE' to start first iteration.
5. Run the process 'run gwblev' from TGC online.
6. Repeat steps 5 and 6 till optimum level is attained.

2.4 Running Phasing on GWB data :

This can be invoked from GWB-CORRELATOR Main Window from " **Tools -> Pulsar Tools -> GWB Phasing**", or pressing **Alt+P** as an accelerator.

This utility temporarily provided with small tool which calls the phase_gwb.pl from online machine. Phasing Widget allows to choose the following :

- **Reference Antenna** Name for selected sub-array.
- **Sub-array** Number for which to carry phasing iteration.
- **Data recording Time** on which Phasing will work for the solutions.
- **Project Code** to be entered for related subarray which is used.

Note : Antenna selection Button is provided, but code for Antsel is not yet ready.

2.5 GAC selection:

GAC (GMRT Array Combiner) is the tool to configure the set of antennas into possible Beam configurations. This allows user to select and deselect the antennas for particular beam configuration.

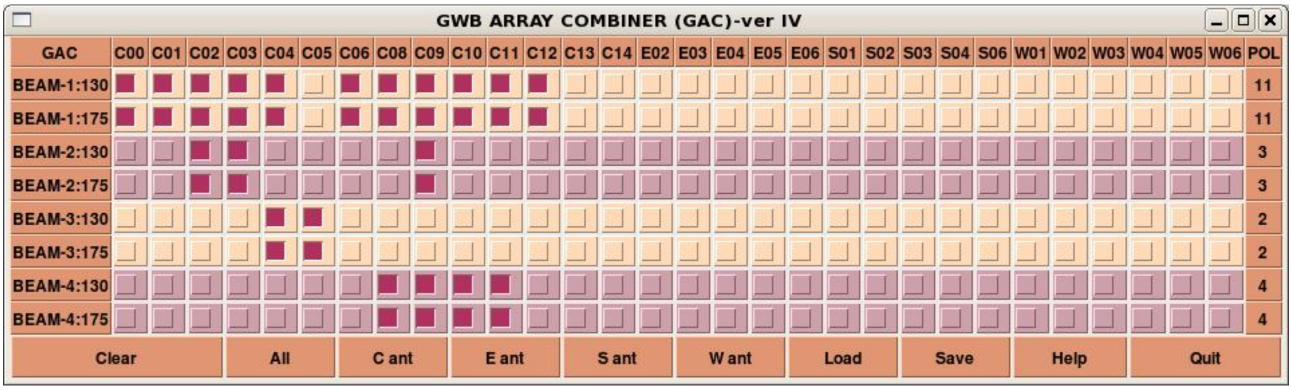


Illustration 1: GAC showing antennas selected (marked in Red) for Beam data acquisition.

2.6 Starting Pulsar Acquisition GUI :

1. This can be invoked from GWB-CORRELATOR Main Window from " **Tools -> Pulsar Tools -> Pulsar DasConsole**", or pressing **Alt+B** as an accelerator.
2. On Menubar go to "**Start -> All Windows"** or "**Ctrl+N"** or go to "**Start -> BEAM1 - Windows -> All "** to open all client processes to run gwb pulsar mode processes on gwbh7.

   This will popup the client processing windows for Beam 1 host machine (set from the Preferences of the Main DasConsole GUI), in the following order :
   1. **"gwbh7::bm1_process_psr"**:
      It can also be termed as incoherent array pulsar data acquisition and processing client.
   2. **"gwbh7::collect_psr"**:
      This dumps the incoherent array pulsar data into the Shared memory.
   3. **"gwbh7::bm1_record_psr"**:
      one can write the acquired incoherent pulsar data into specified .raw format file as per requirement.

3. Start the clients processes, **bm1_process_psr** and **collect_psr** by pressing Blue (start) button on the Client windows.
4. On the ToolBar There are Four Different Buttons viz., InitBm1, StartBm1, StopBm1, FinishBm1, etc.
5. On Menubar go to "**Start -> All Windows"** or "**Ctrl+N"** or go to "**Start -> BEAM2 - Windows -> All "** to open all client processes to run gwb coherent array pulsar mode processes on gwbh8(gwbh8).

   In similar way, each beam client processes can be started.
6. In addition to this, there are Buttons to control data for pulsar beams which are named by InitAll, StartAll, StopAll, FinishAll. These four buttons will control the process simultaneously, If user is working with the all Beams data.

   1. InitBm1/InitBm2/InitBm3/InitBm4/InitBoth :

Initializes the beam Process Pulsar Beam Acquistion.

2. StartBm1/StartBm2/StartBm3/StartBm4/StartBoth :

   Starts the pulsar DATA acquisition for beam collect pulsar.

3. StopBm1/StopBm2/StopBm3/StopBm4/StopBoth :

   Stops the pulsar DATA acquisition for beam collect pulsar.

4. FinishBm1/FinishBm2/FinishBm3/FinishBm4/FinishBoth :

   Halts the beam Processes Pulsar Beam acquisition.

Illustration 2: Pulsar Data acquisition Interface (Pulsar DAS).

2.7 8-bit beam recording mode :

GWB supports 16-bit beam (IA or PA) data recording through process_psr, collect_psr and record_psr pipeline.

This new recoding mode is to write 8-bit beam data directly to disk after reading from process_psr shared memory and carrying out 16-bit to 8-bit conversion. Considering 16-bit beam data mean is at 10-bit level, if one does power equalization to 150 counts, the 8-bit mean is set to at 5-bit (as default) by applying a scaling of 32.

Usage details,

Executable in ~/GWB/release/bin/beams for gwbh[7-10]
read_process_beam

read_process_beam -M 1 1 -w -p <data-dir> -f <file_name> -b <bit> -i <post-integration> -n <#time-blocks> -s <scaling>

E.g. ~/GWB/release/bin/beams/ read_process_beam -M 1 1 -w -p /data3/gpuuser/TEST/ -f B0329+54.raw -b 8 -i 1 -n 100 -s 32

The outputs on disks consist of a 8-bit binary beam data file (same format as 16-bit standard ourput) and an ascii timestamp file in the following format
[<BUFFER_time> <BUFFER_time> <Absobute_Buffer_count> <Shared_memory_bufffer_count>]

The source code is in
/home/gpuuser/GWB/ver5/code/psrdada/gmrt_gwb4_ver5/src/ACQPSR/READ_PROCESS_PSR/

Command file usage,

The above code can be used from command file in the following way,

“run_record.gwb2 <data-disk> <PSR name> <output bit> <# of time-block> <post-integration> <scaling> <Frequency edge>”

E.g.

“run_record.gwb2 data2 B0329+54 8 100 1 32 500”

The corresponding command for killing the recording is “kill_psr_record.gwb”

Chapter 3: Troubleshooting

Some Quick Checks

If acquisition program fails to run then check for the following :

1. Machines required to run gpu cluster are ON.
2. Check for the programming of ROACH boards is getting executed sucessfully at the start of observation. It can be observed from the acquisition window “gwb_corr_released.sh”. If not then **GWB ROACH-BOARDS may not be communicating / hanged / not in sync** with each other.
3. Check for the processes , shared memory segment which are not closed properly. According clear those processes and shared memory segments,using following commands on gwbh6
   a. */home/gpuuser/GWB/release/bin/clear_beam_shm.sh* // for shm
   b. */home/gpuuser/GWB/release/bin/kill_all_nodes.csh* // for orte-clean
4. Check for background mpi processes and clear the same.

Antenna connections to GWB Roach boards

Antenna (Pol)	GWB Node No.	
C00(pol1)	gwbcorr1	ROACH 1
C01(pol1)	gwbcorr1	
C02(pol1)	gwbcorr1	
C03(pol1)	gwbcorr1	
C04(pol1)	gwbcorr2	ROACH 2
C05(pol1)	gwbcorr2	
C06(pol1)	gwbcorr2	
C08(pol1)	gwbcorr2	
C09(pol1)	gwbcorr3	ROACH 3
C10(pol1)	gwbcorr3	
C11(pol1)	gwbcorr3	
C12(pol1)	gwbcorr3	
C13(pol1)	gwbcorr4	ROACH 4
C14(pol1)	gwbcorr4	
E02(pol1)	gwbcorr4	
E03(pol1)	gwbcorr4	
E04(pol1)	gwbcorr9	ROACH 5
E05(pol1)	gwbcorr9	
E06(pol1)	gwbcorr9	
S01(pol1)	gwbcorr9	
S02(pol1)	gwbcorr10	ROACH 6
S03(pol1)	gwbcorr10	
S04(pol1)	gwbcorr10	
S06(pol1)	gwbcorr10	
W01(pol1)	gwbcorr11	ROACH 7
W02(pol1)	gwbcorr11	
W03(pol1)	gwbcorr11	
W04(pol1)	gwbcorr11	
W05(pol1)	gwbcorr12	ROACH 8
W06(pol1)	gwbcorr12	
C07(pol1)	gwbcorr12	

S05(pol1)	gwbcorr12	
C00(pol2)	gwbcorr5	ROACH 9
C01(pol2)	gwbcorr5	
C02(pol2)	gwbcorr5	
C03(pol2)	gwbcorr5	
C04(pol2)	gwbcorr6	ROACH 10
C05(pol2)	gwbcorr6	
C06(pol2)	gwbcorr6	
C08(pol2)	gwbcorr6	
C09(pol2)	gwbcorr7	ROACH 11
C10(pol2)	gwbcorr7	
C11(pol2)	gwbcorr7	
C12(pol2)	gwbcorr7	
C13(pol2)	gwbcorr8	ROACH 12
C14(pol2)	gwbcorr8	
E02(pol2)	gwbcorr8	
E03(pol2)	gwbcorr8	
E04(pol2)	gwbcorr13	ROACH 13
E05(pol2)	gwbcorr13	
E06(pol2)	gwbcorr13	
S01(pol2)	gwbcorr13	
S02(pol2)	gwbcorr14	ROACH 14
S03(pol2)	gwbcorr14	
S04(pol2)	gwbcorr14	
S06(pol2)	gwbcorr14	
W01(pol2)	gwbcorr15	ROACH 15
W02(pol2)	gwbcorr15	
W03(pol2)	gwbcorr15	
W04(pol2)	gwbcorr15	
W05(pol2)	gwbcorr16	ROACH 16
W06(pol2)	gwbcorr16	
C07(pol2)	gwbcorr16	
S05(pol2)	gwbcorr16	

Settings on signal generator :

800MHz frequency, +20 dbm power level, RF ON

Appendix - 1 BEAM INTEGRATION TABLE – for 200MHz 8-bit mode

This appendix gives the possible values for beam integration. The values are different for different no. of spectral channels. Below given are the values for both four stokes and single stokes. The corresponding sampling periods in milliseconds are also given

Note : All the values may not support pulsar das recording(writing beam data to disk)

Accurate Sampling period calculation :

Time(ms) = (No. of channels x 2 x No. of FFTs) / (400 x 10^3)

Interferometer : Full Polar mode				Interferometer : Total Intensity mode		
Channels	Stokes	No. of FFTs	Time(ms)	Channels	No. of FFTs	Time(ms)
16384	4	32(max)	2.6	16384	32(max)	2.6
		16(min)	1.3		16	1.3
	1	32(max)	2.6		8	0.65
		16	1.3		4	0.32
		8	0.65		2(min)	0.16
		4(min)	0.32	8192	64(max)	2.6
8192	4	64(max)	2.6		32	1.3
		32	1.3		16	0.65
		16(min)	0.65		8	0.32
	1	64(max)	2.6		4	0.16
		32	1.3		2(min)	0.08
		16	0.65	4096	256(max)	5.2
		8	0.32		128	2.6
		4(min)	0.16		64	1.3
4096	4	256(max)	5.2		32	0.65
		128	2.6		16	0.32
		64	1.3		8	0.16
		32	0.65		4	0.08
		16(min)	0.32		2(min)	0.04
	1	256(max)	5.2	2048	256(max)	2.6
		128	2.6		128	1.3
		64	1.3		64	0.65
		32	0.65		32	0.32

		16	0.32		16	0.16
		8	0.16		8	0.08
		4(min)	0.08		4	0.04
2048	4	256(max)	2.6		2(min)	0.02
		128	1.3	1024	256(max)	1.3
		64	0.65		128	0.65
		32	0.32		64	0.32
		16(min)	0.16		32	0.16
	1	256(max)	2.6		16	0.08
		128	1.3		8	0.04
		64	0.65		4	0.02
		32	0.32		2(min)	0.01
		16	0.16			
		8	0.08			
		4(min)	0.04			
1024	4	256(max)	1.3			
		128	0.65			
		64	0.32			
		32	0.16			
		16(min)	0.08			
	1	256(max)	1.3			
		128	0.65			
		64	0.32			
		32	0.16			
		16	0.08			
		8	0.04			
		4(min)	0.02			

Appendix - 2 BEAM INTEGRATION TABLE – for 400MHz 4-bit mode

This appendix gives the possible values for beam integration for 400MHz 4-bit mode. The values are different for different no. of spectral channels. Below given are the values for both four stokes and single stokes. The corresponding sampling periods in milliseconds are also given

Note : All the values may not support pulsar das recording(writing beam data to disk)

Accurate Sampling period calculation :

Time(ms) = (No. of channels x 2 x No. of FFTs) / (800 x 10^3)

Interferometer : Full Polar mode				Interferometer : Total intensity mode		
Channels	Stokes	No. of FFTs	Time(ms)	Channels	No. of FFTs	Time(ms)
16384	4	32(min)	1.3	16384	32(max)	1.3
	1	32(max)	1.3		16	0.65
		16	0.65		8	0.32
		8(min)	0.32		4(min)	0.16
8192	4	64(max)	1.3	8192	64(max)	1.3
		32(min)	0.65		32	0.65
	1	64(max)	1.3		16	0.32
		32	0.65		8	0.16
		16	0.32		4(min)	0.08
		8(min)	0.16	4096	256(max)	2.6
4096	4	256(max)	2.6		128	1.3
		128	1.3		64	0.65
		64	0.65		32	0.32
		32(min)	0.32		16	0.16
	1	256(max)	2.6		8	0.08
		128	1.3		4(min)	0.04
		64	0.65	2048	256(max)	1.3
		32	0.32		128	0.65
		16	0.16		64	0.32
		8(min)	0.08		32	0.16
2048	4	256(max)	1.3		16	0.08
		128	0.65		8	0.04
		64	0.32		4(min)	0.02

<table>
<tr><td rowspan="7"></td><td></td><td>32(min)</td><td>0.16</td><td rowspan="7">1024</td><td>256(max)</td><td>0.65</td></tr>
<tr><td rowspan="6">1</td><td>256(max)</td><td>1.3</td><td>128</td><td>0.32</td></tr>
<tr><td>128</td><td>0.65</td><td>64</td><td>0.16</td></tr>
<tr><td>64</td><td>0.32</td><td>32</td><td>0.08</td></tr>
<tr><td>32</td><td>0.16</td><td>16</td><td>0.04</td></tr>
<tr><td>16</td><td>0.08</td><td>8</td><td>0.02</td></tr>
<tr><td>8(min)</td><td>0.04</td><td>4(min)</td><td>0.01</td></tr>
<tr><td rowspan="10">1024</td><td rowspan="4">4</td><td>256(max)</td><td>0.65</td><td rowspan="10" colspan="3"></td></tr>
<tr><td>128</td><td>0.32</td></tr>
<tr><td>64</td><td>0.16</td></tr>
<tr><td>32(min)</td><td>0.08</td></tr>
<tr><td rowspan="6">1</td><td>256(max)</td><td>0.65</td></tr>
<tr><td>128</td><td>0.32</td></tr>
<tr><td>64</td><td>0.16</td></tr>
<tr><td>32</td><td>0.08</td></tr>
<tr><td>16</td><td>0.04</td></tr>
<tr><td>8(min)</td><td>0.02</td></tr>
</table>

Appendix - 3 BEAM INTEGRATION TABLE – for 100MHz 8-bit mode

This appendix gives the possible values for beam integration. The values are different for different no. of spectral channels. Below given are the values for both four stokes and single stokes. The corresponding sampling periods in milliseconds are also given

Note : All the values may not support pulsar das recording(writing beam data to disk)

Accurate Sampling period calculation :

Time(ms) = (No. of channels x 2 x No. of FFTs) / (200 x 10^3)

Interferometer : Full Polar mode				Interferometer : Total Intensity mode		
Channels	Stokes	No. of FFTs	Time(ms)	Channels	No. of FFTs	Time(ms)
16384	4	32(max)	5.3	16384	32(max)	5.3
		16(min)	2.6		16	2.6
	1	32(max)	5.3		8	1.3
		16	2.6		4	0.65
		8	1.3		2(min)	0.32
		4(min)	0.65	8192	64(max)	5.3
8192	4	64(max)	5.3		32	2.6
		32	2.6		16	1.3
		16(min)	1.3		8	0.65
	1	64(max)	5.3		4	0.32
		32	2.6		2(min)	0.16
		16	1.3	4096	256(max)	10.6
		8	0.65		128	5.3
		4(min)	0.32		64	2.6
4096	4	256(max)	10.6		32	1.3
		128	5.3		16	0.65
		64	2.6		8	0.32
		32	1.3		4	0.16
		16(min)	0.65		2(min)	0.08
	1	256(max)	10.6	2048	256(max)	5.3
		128	5.3		128	2.6
		64	2.6		64	1.3
		32	1.3		32	0.65

		16	0.65		16	0.32
		8	0.32		8	0.16
		4(min)	0.16		4	0.08
2048	4	256(max)	2.6		2(min)	0.04
		128	2.6	1024	256(max)	2.6
		64	1.3		128	1.3
		32	0.65		64	0.65
		16(min)	0.32		32	0.32
	1	256(max)	5.3		16	0.16
		128	2.6		8	0.08
		64	1.3		4	0.04
		32	0.65		2(min)	0.02
		16	0.32			
		8	0.16			
		4(min)	0.08			
1024	4	256(max)	2.6			
		128	1.3			
		64	0.65			
		32	0.32			
		16(min)	0.16			
	1	256(max)	2.6			
		128	1.3			
		64	0.65			
		32	0.32			
		16	0.16			
		8	0.08			
		4(min)	0.04			

Appendix – 4 IO budget, cost of Visibility IO and beam IO

Total IO budget = 64

Cost of visibility IO (W_{visi}) :

For Stokes = 2,

W_{visi} = (16 x channels x no. of stokes^2) / (LTA * 2048 * 4) + 0.1

For Stokes = 4,

W_{visi} = (32 x channels x no. of stokes^2) / (LTA * 2048 * 4)

Cost of Beam IO (W_{beam}) :

For Interferometry in Total Intensity mode,

W_{beam} = ((128 * BW * BeamStokes) / (BeamIntegration * 200 * (16 / BeamBits)) + 0.1)

For Interferometry in Full Polar mode,

W_{beam} = ((0.5 * 128 * BW * BeamStokes) / (BeamIntegration * 200 * (16 / BeamBits)))

Note : BeamIntegration in No. of FFTS

Cost of Voltage Beam IO = (32 * BW / (200 * (8 / VoltageBeamBits)))

Appendix – 5 Narrowband mode

For 100 MHz ACQ BW

Decimation	No. of taps	Actual BW(MHz)	Usable BW (% of actual BW around centre)	Spectral Channels	Resolution (kHz)
1	64	100	100	2048, 4096, 8192, 16384	48.8, 24.4, 12.2, 6.1
2	64	50	98	2048, 4096, 8192, 16384	24.4, 12.2, 6.1, 3.05
4	64	25	97	2048, 4096, 8192, 16384	12.2, 6.1, 3.05, 1.52
8	128	12.5	97	2048, 4096, 8192, 16384	6.1, 3.05, 1.52, 0.76
16	128	6.25	96	2048, 4096, 8192, 16384	3.05, 1.52, 0.76, 0.38
32	128	3.125	75	2048, 4096, 8192, 16384	1.52, 0.76, 0.38, 0.19
64	256	1.5625	80	2048, 4096, 8192, 16384	0.76, 0.38, 0.19, 0.095

For 200 MHz ACQ BW

Decimation	No. of taps	Actual BW(MHz)	Usable BW (% of actual BW around centre)	Spectral Channels	Resolution (kHz)
1	64	200	100	2048, 4096, 8192, 16384	97.6, 48.8, 24.4, 12.2
2	64	100	98	2048, 4096, 8192, 16384	48.8, 24.4, 12.2, 6.1
Higher decimation modes not possible for 200 MHz ACQ BW					

Appendix – 6 PFB mode

Possible modes in GWB with PFB mode ON

<table>
<tr><th>Bandwidth</th><th>Interferometry</th><th>Beamformer</th></tr>
<tr><td>200 MHz/ 100 MHz</td><td>Maximum taps = 16</td><td>All modes possible</td></tr>
<tr><td rowspan="2">400 MHz</td><td rowspan="2">Maximum taps = 4</td><td>Above 8192 channels no beams possible</td></tr>
<tr><td>Up to 8192 channels all modes possible</td></tr>
<tr><td rowspan="4">Narrowband mode</td><td>Decimation <= 4
Maximum taps = 16</td><td rowspan="4">All modes modes</td></tr>
<tr><td>Decimation = 8
Maximum taps = 8</td></tr>
<tr><td>Decimation = 16
Full Stokes mode, Maximum taps = 8
Total Intensity, Maximum taps = 4</td></tr>
<tr><td>Decimation > 16,
PFB mode not possible</td></tr>
</table>

Appendix – 7 Output data rates

Visibility data rate

No. of baselines = 930 (Total Intensity mode) and 1860 (Full Polar mode)

Total Intensity mode =

((No. of baselines x Channels / 2) + (No. of baselines x Channels x 8)) / (LTA x 0.671) bytes per second

Full Polar mode = ((No. of baselines x Channels / 2) + (No. of baselines x Channels x 8)) / (LTA x 0.671) bytes per second

Total Intensity mode :

Channels	LTA	Visibility data rate (MB/s)
2048	1	23
	2	11.5
	4	5.75
	8	2.87
	16	1.43
	32	0.72
4096	1	46
	2	23
	4	11.5
	8	5.75
	16	2.87
	32	1.43
8192	1	92
	2	46
	4	23
	8	11.5
	16	5.75
	32	2.87
16384	1	184
	2	92
	4	46
	8	23
	16	11.5
	32	5.75

Full Polar mode :

Channels	LTA	Visibility data rate (MB/s)
2048	1	46
	2	23
	4	11.5
	8	5.75
	16	2.87
	32	1.43
4096	1	92
	2	46
	4	23
	8	11.5
	16	5.75
	32	2.87
8192	1	184
	2	92
	4	46
	8	23
	16	11.5
	32	5.75
16384	1	368
	2	184
	4	92
	8	46
	16	23
	32	11.5

Beam data rate =
(2 x Bandwidth x No. of Stokes x BeamBits) / (Beam Integration in FFTs x 16) bytes per second
Note : Below calculations are for beambits = 16. For beambits = 8, the data rates are half the data rates given in the table

200MHz Total Intensity mode(Interferometer) IA/PA and Full Polar mode(Interferometer) IA/PA (PA Total Intensity mode)

Channels	Integration in no. of FFTS	Integration in time (ms)	Beam data rate (MB/s)
2048	128	0.65536	3.125
	64	0.32768	6.25
	32	0.16384	12.5
	16	0.08192	25
	8	0.04096	50
4096	128	1.31072	3.125
	64	0.65536	6.25
	32	0.32768	12.5
	16	0.16384	25
	8	0.08192	50
8192	64	1.31072	6.25
	32	0.65536	12.5
	16	0.32768	25
	8	0.16384	50
16384	32	1.31072	12.5
	16	0.65536	25
	8	0.32768	50

400MHz Total Intensity mode(Interferometer) IA/PA and Full Polar mode(Interferometer) IA/PA (PA Total Intensity mode)

Channels	Integration in no. of FFTS	Integration in time (ms)	Beam data rate (MB/s)
	128	0.65536	6.25
	64	0.32768	12.5
	32	0.16384	25

2048	16	0.08192	50
	8	0.04096	100
4096	128	1.31072	6.25
	64	0.65536	12.5
	32	0.32768	25
	16	0.16384	50
	8	0.08192	100
8192	64	1.31072	12.5
	32	0.65536	25
	16	0.32768	50
	8	0.16384	100
16384	32	1.31072	25
	16	0.65536	50
	8	0.32768	100

200MHz Full Polar mode(Interferometer) PA (PA Full Polar mode)

Channels	Integration in no. of FFTS	Integration in time (ms)	Beam data rate (MB/s)
2048	128	1.31072	12.5
	64	0.65536	25
	32	0.32768	50
	16	0.16384	100
4096	128	2.62144	12.5
	64	1.31072	25
	32	0.65536	50
	16	0.32768	100
8192	64	2.62144	25
	32	1.31072	50
	16	0.65536	100
16384	32	2.62144	50
	16	1.31072	100

400MHz Full Polar mode(Interferometer) PA (PA Full Polar mode)

Channels	Integration in no. of FFTS	Integration in time (ms)	Beam data rate (MB/s)
2048	128	0.65536	25
	64	0.32768	50
	32	0.16384	100
	16	0.08192	200
	8	0.04096	400
4096	128	1.31072	25
	64	0.65536	50
	32	0.32768	100
	16	0.16384	200
	8	0.08192	400
8192	64	1.31072	50
	32	0.65536	100
	16	0.32768	200
	8	0.16384	400
16384	32	1.31072	100
	16	0.65536	200
	8	0.32768	400
	4	0.16384	800

Appendix - 8   POWER ON/OFF PROCEDURE

1. Switch OFF procedure

a. Switch off the PPS unit first and then ROACH UNITS in the racks by holding down the Black switch on the front panel for ~5 sec.

b. Switch off the Clock generator. This feeds clock signal of 800 MHz, +20dBm to the ROACH boards.

c. No need to switch off the infiniband switch. This will get switched off directly from mains.

d. Halt the compute nodes, host nodes and roach programming machine by executing the script shutdown.sh in gwbh6:/home/gpuuser/project/harsha folder.

NOTE : a. ssh -X gpuuser@gwbh6   b. ./shutdown.sh

2. Switch ON procedure

a. Switch ON the control PC (192.168.4.68) in rack 3. It is 1 U pc.

b. Make sure the infiniband switch is ON.

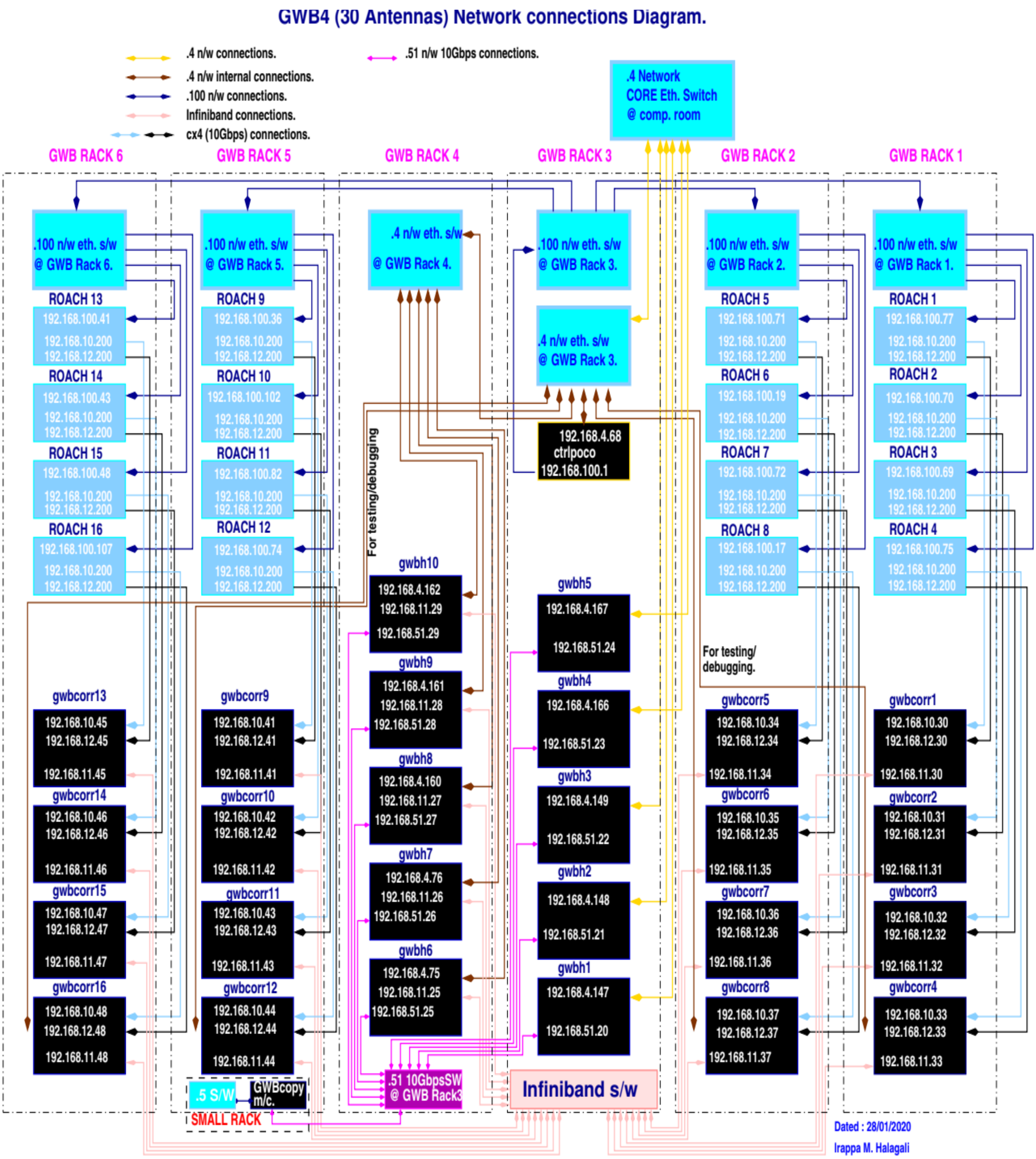
c. Switch ON the Clock Generator. Set the frequency to 800 MHz, amplitude to +20dBm, RF ON.

d. Switch ON the ROACH UNITS in all racks 1,2,5,6 by holding down the Black switch on the front panel for ~2 sec.

e. Switch ON the PPS unit.

f. Swich ON the compute nodes and host machines in all racks.

Appendix – 9 GWB NETWORK DIAGRAM



Appendix – 10 Coherent de-dispersion – highest DM supported

- Number of output sub-bands less than or equal to number of input channels

* Final Resolution (micro-sec) with integration = 2 provided to write data.
# DM in pc/cc

Band 4 :

Output sub-bands	DM# 550-750 MHz	Resolution* 550-750 MHz	DM# 550-650 MHz	Resolution* 550-650MHz
32	547	0.64	2171	1.28
64	1085	1.28	4324	2.56
128	2162	2.56	8630	5.12
256	4315	5.12	17241	10.24
512	8620	10.24	34465	20.48
1024	17232	20.48	68912	40.96
2048	34456	40.96	137807	81.96
4096	68903	81.92	275596	163.84
8192	137798	163.84	551174	327.84
16384	275587	327.68	1102330	655.36

Band 3:

Output sub-bands	DM# 500-300 MHz	Resolution* 500-300 MHz	DM# 500-400 MHz	Resolution* 500-400 MHz
32	90	0.64	354	1.28
64	177	1.28	704	2.56
128	352	2.56	1403	5.12
256	701	5.12	2800	10.24
512	1400	10.24	5595	20.48
1024	2797	20.48	11185	40.96
2048	5592	40.96	22366	81.92
4096	11183	81.92	44727	163.84
8192	22363	163.84	89449	327.68
16384	44724	327.68	178893	655.36

Band 2:

Output sub-bands	DM# 300-100 MHz	Resolution* 300-100 MHz	DM# 100-200 MHz	Resolution* 100-200 MHz
32	3	0.64	13	1.28
64	6	1.28	26	2.56
128	13	2.56	52	5.12
256	26	5.12	104	10.24
512	52	10.24	207	20.48
1024	103	20.48	414	40.96
2048	207	40.96	828	81.92
4096	414	81.92	1656	163.84
8192	828	163.84	3313	327.68
16384	1656	327.68	6626	655.36