Version 3 ***Date : 10th September 2020.***

OPERATING PROCEDURE
FOR
RUNNING GWB - release

Authors :

Nilesh Raskar

Harshavardhan Reddy

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Updates from previous version (ver 2)

1. PFB mode added. See Appendix 6 for possible modes with PFB mode ON.

2. Re-calculated the visibility and beam IO weights. See Appendix 4.

3. Updated GWB network connections diagram. See Appendix 9.

<u>Available modes in GWB</u>

Input Bandwidth = 200/400MHz

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

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

No. of beams = 4

Interferometry modes = Total Intensity/Full Polar

Beamformer modes = IA/PA/Voltage

Narrowband mode possible BW = 100/50/25/12.5/6.25/3.125/1.5625 MHz

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 8 taps and all modes possible in Total Intensity mode and maximum 4 taps and all modes possible in Full Stokes mode

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.
Example : 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 Narrowband mode)	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 chapter 2.1.4)	0	Narrowbandmode OFF
	1	Narrowbandmode ON
Final BW (Decimation Factor)	1	100MHz Final BW
	2	50 MHz
	4	25 MHz
	8	12.5 MHz
	16	6.25 MHz
	32	3.125 MHz
	64	1.5625 MHz
CHANNELS	512	512
	1024	1024
	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	0/1/2/3 respectively
Beam Stokes	1 Stokes/ 4 Stokes.	1/4 respectively
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

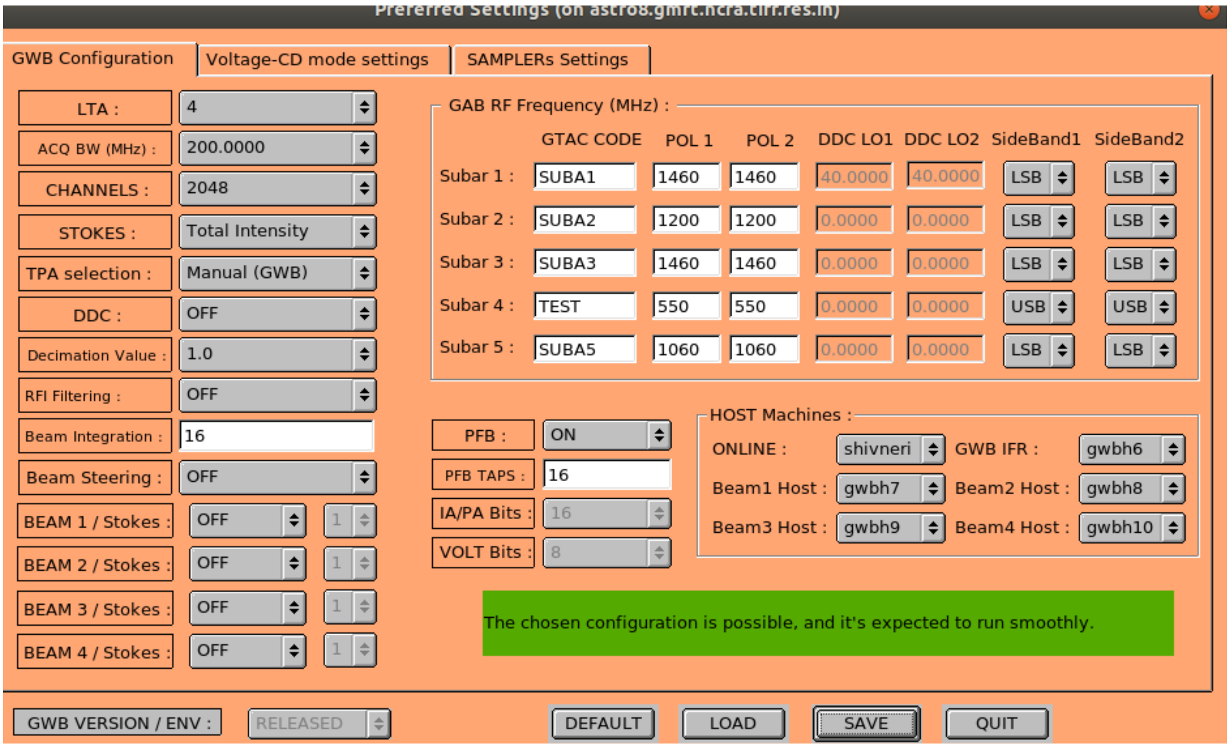

Illustration 1: GWB configuration parameters to save gpu.hdr file. An example.

Chapter 2: Configuring and Running GWB

2.1 Configuring GWB

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).

Go to Edit→Preferences (Ctrl + P) to pop up the settings window (see Illustration 1). The first tab in the window is GWB configuration window. The options in the window are described below :

```
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
Decimation value:      BW selection in Narrowband mode
                       1 – 100MHz, 2 – 50MHz, 4 – 25MHz, 8 – 12.5MHz,
                       16 – 6.25MHz, 32 – 3.125MHz, 64 – 1.5625MHz
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.
PFB               :    PFB mode OFF/ON
PFB TAPS          :    No. of PFB taps 2/4/8/16
```

In the same window, enter the GTAC code and RF settings for each sub-array. Sideband flags for each pol depends on the GAB LO and RF band of observation. LSB if RF < GAB LO and USB if RF > GAB LO.

After entering the configuration, press SAVE button at the bottom. On pressing SAVE, a message(highlighted in GREEN color) appears (see Illustration 1) whether the given configuration runs in real-time or not. If not, a warning message(highlighted in RED color) appears, that the given configuration does not run in real-time. Whether the configuration runs in real-time or not, depends on the total amount of IO required for the given configuration and IO budget. For details regarding IO budget and cost of IO for each setting (Interferometer and Beamformer), see **Appendix 3**.

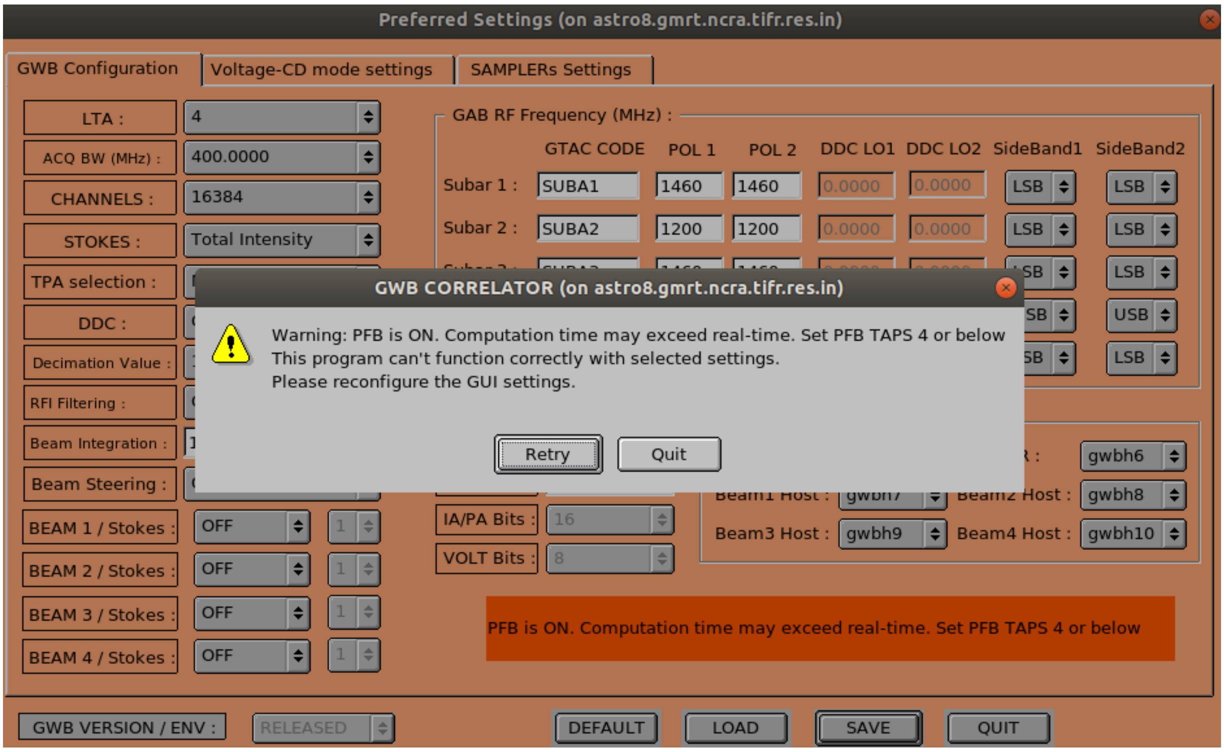

Illustration 2: GWB configuration window with warning message showing the entered configuration does not run in real-time

In case of **narrowband mode**, set DDC parameter ON and enter the decimation value depending on the BW required. Enter the values of DDC LO1 (pol 1) and DDC LO2 (pol 2). DDC LO value is the starting frequency of the narrowband. For example, if decimation is 4 and DDC LO is 50MHz, then the signal that can be seen is from 50MHz and 75MHz of the actual 100MHz BW baseband signal.

Note : 1. Decimation is same for all the subarrays. There is no option for subarray specific decimation value.
2. DDC LO can be different for subarrays. Also, DDC LO can be different for each polarization.

The possible decimation values, no. of taps used for filtering, actual BW and usable BW along with spectral channels and spectral resolution values given in **Appendix 5**.

2.2 Starting acquisition and recording

1. Go to the gwb-dasconsole
2. On Menubar go to "**Start -> Open All Windows"** or "**Ctrl+O"** or go to "**Start -> GWB - Windows -> Sockcmd "** to open all client processes to run gwb with sockcmd and online dassrv processes, or "**Start -> GWB - Windows -> Getcmd "** to run gwb without sockcmd and dassrv processes.

   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**::sockcmd.sh**": (can be started only when GWB running with sockcmd mode)
     This sets up the communication between online and correlator and gives acknowledgments to the commands from the correlator to the online and vice versa.
   - "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. Start sockcmd.sh, collect.sh, and dass-srv (from online machine) for gwb.

   ssh -X observer@shivneri
   cd /odisk/online1/gsbe/dassrv-gpu/
   ./dassrv_released

   This is also aliased as **`gwbdassrv`** on online machine (shivneri). In Case, if you are running GWB, in **"getcmd"** mode, then there is no need to start both sockcmd.sh and dassrv-gpu processes, user just have to start the process "collect" only.
5. Now click the **start button** (blue icon button) of "collect.sh" wondow
6. Enter initndas command from online user0.

   ```
   allant;cmode 1;tpa(11)=15;initndas'/temp2/data/gsb.hdr' **(GWB ONLY).
   allant;cmode 9;tpa(11)=15;initndas'/temp2/data/gsb.hdr' **(GSB + GWB).
   ```

   For getcmd mode :

   On the online machine terminal, enter command

   `gwbcmd-gwb4 initndas`

   `gwbcmd-gwb4` is the modified getcmd program, specially designed for acquiring data for multi-sub-array observations.

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.

7. Enter the command for initializing the Project for given subarray.
allant;subar 4; prjtit '' ; prjobs ''; initprj(15,'TEST'); **(GWB ONLY).
allant;subar 4; prjtit '' ; prjobs ''; initprj(15,'TEST'); **(GSB + GWB).

For getcmd mode :
On the online machine terminal, enter command
gwbcmd-gwb4 initprj x (where x is subar # = 2,3,4,5 etc.
or

gwbcmd-gwb4 initprj ** This takes default subarray as subar 4

8. 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
For GWB with Sockcmd mode default commands strtndas and stpndas from online user / subar controller (command file) can be used.

Recording (start and stop scans) using getcmd :
gwbcmd-gwb4 strtndas *;for subar 4.*
gwbcmd-gwb4 stpndas
gwbcmd-gwb4 strtndas <subar number> *;for multi-sub-array observation.*
gwbcmd-gwb4 stpndas <subar number>

9. 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.

10. 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'.

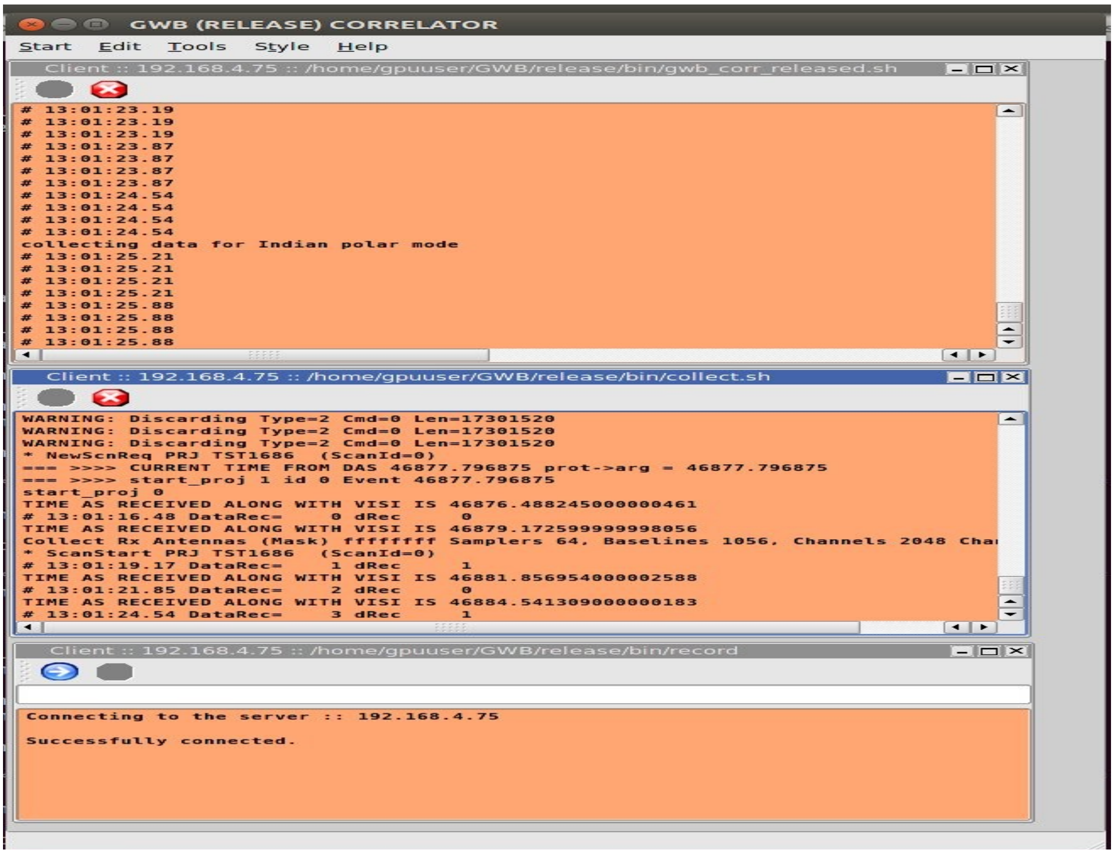

Illustration 3: GWB data acquisition window

2.3 GAB Power Equalise

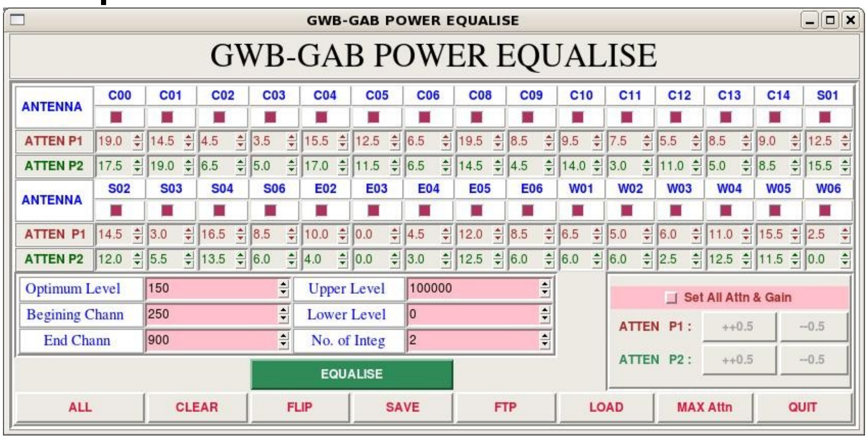

Illustration 4: GWB-GAB power Equalise Window

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" or CTRL + E** as an accelerator (as explained earlier in GWB-CORRELATOR).

Also, The same can be started manually as follows:

1. Select the antennas connected to the GAB and GWB.
2. Initially make all GAB attenuation's same for both the polarization's, as set in the cdsetX file, or change Attenuation's to MAXIMUM, by clicking on button 'MAX Attn', apply it to GAB accordingly.
3. Set the Optimum level, Begining channel, End channel, Upper level, Lower level and Integrations as per requirement.
4. Click on the button save to generate text files as per selected gui options.
5. Click the button 'EQUALISE' to start first iteration.
6. Run the process 'run gwblev' from userX window from online(2-3 times).
7. 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.

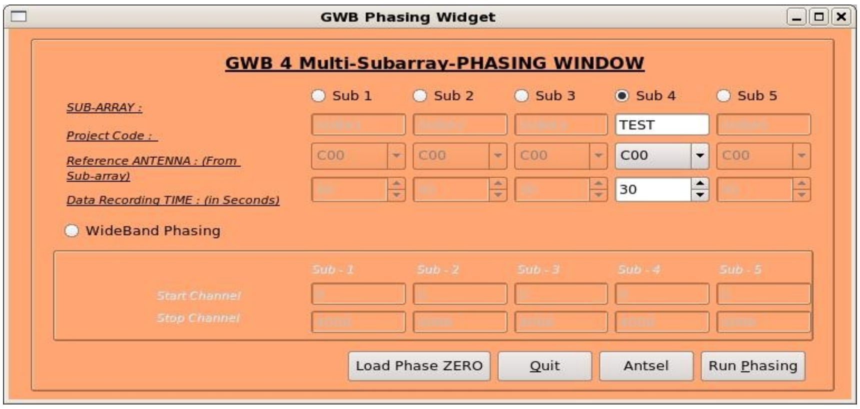

Illustration 5: Phasing widget to run and apply phasing iteration on GWB.

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. In some way, this can be done as per the requirement of the user. This allows user to select and deselect the antennas for particular beam configuration.

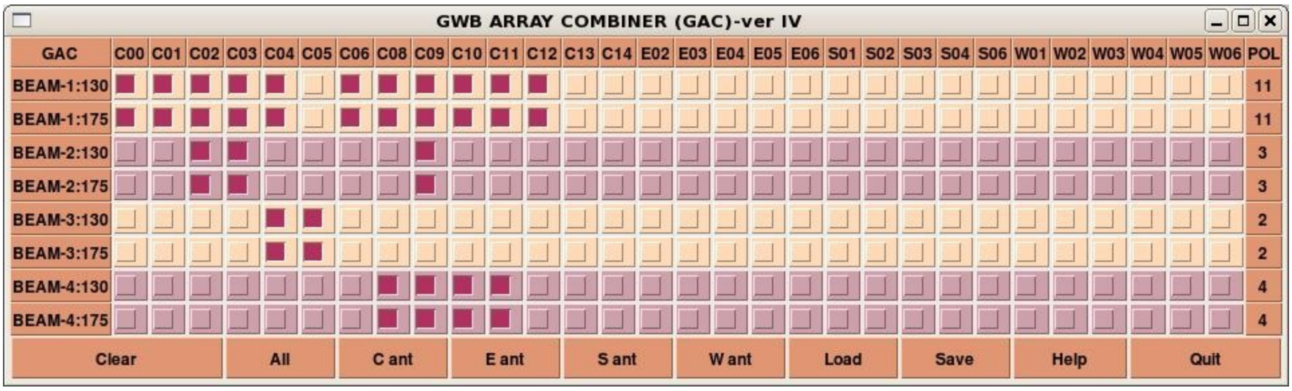

Illustration 6: GAC showing antennas selected (marked in Red) for Beam data acquisition.

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 7: Pulsar Data acquisition Interface (Pulsar DAS).

2.7 Multi-sub-array observations:

For this user has to split up the working antennas into two or more sub-arrays as per their requirement, and start the individual PROJECT from the ONLINE, for each of the sub-array. This works with both ONLINE and MANUAL TPA selection explained in section 3.6.

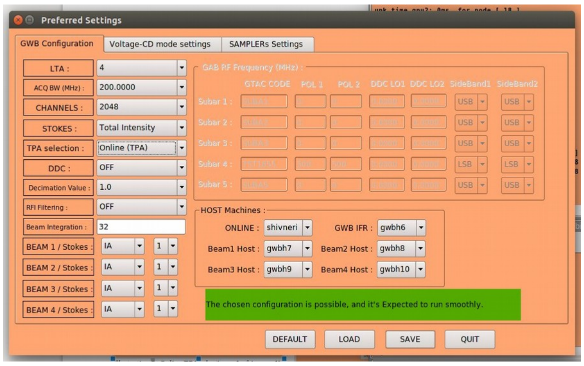

Illustration 8: Online TPA selection – In this case No need to enter the values at GUI. ACQ straightaway reads the TPA parameters given at ONLINE for relevant sub-array. Irresepctive of the values of GAB RF/LO, GTAC CODE, SideBand FLAG etc. Here, user needs to confirm that TPA parameters and Frequency settings done at GAB, GWB are matching. If not then it may result in bad data.

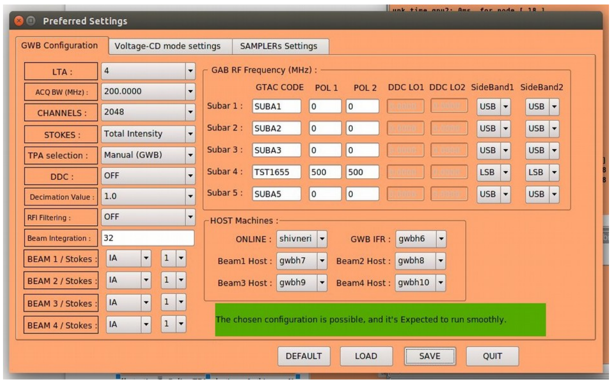

Illustration 9: Manual TPA selection – for this user has to provide the PRJCODE entered at online for given particular sub-array, so that the GAB RF/LO Frequency entered at GUI for relevant sub-array will be taken calculation of TPA, along with selected SideBand FLAG. Otherwise, ACQ will consider the TPA values given at the ONLINE, which may be wrong considering the values set at GAB.

2.8 TPA selection:

There are two ways in which TPA can be set for GWB, i.e. Online and Manual. As explained in Illustrations 8 and 9 above. For **Online TPA** user has to enter values as:

tpa (GABLO)$_{p1}$ (GABLO)$_{p2}$ (GABLO+70)$_{p1}$ (GABLO+70)$_{p2}$ 70 70 ==> FOR LSB
tpa (GABLO)$_{p1}$ (GABLO)$_{p2}$ (GABLO-70)$_{p1}$ (GABLO-70)$_{p2}$ 70 70 ==> FOR USB

In case of **Manual TPA** the tpa values will be calculated by GWB ACQ using GAB RF/LO values entered at relevant sub-arrays.

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 Processes DualAdcConfig and SetCluster are getting executed sucessfully, If not then **GWB ROACH-BOARDS may not be communicating / hanged / not in sync** with each other. Sometimes extension of this can be observed in acquisition program **"gwb_corr_released.sh"**
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.

IMPORTANT Notes

i. GWB (GPU) can be run in parallel with GSB.
   1. Using above mentioned procedure. i.e. Using sockcmd.sh and dassrv-gpu processes.
   2. Using getcmd mode, while GSB is already running. No need to start sockcmd.sh and dassrv-gpu processes.
   3. Options to start client windows with sockcmd.sh and without sockcmd.sh are available in "Start->Gwb -Windows" options. And use gpucmd commands from online machine with arguments as initndas, initprj, strtndas, stpndas, etc.
   4. If no subar number is provided for gpucmd command then it will be executed for subar 4**.**

ii. Dasmon is released, and can be started with following command :
ssh -X gpuuser@gwbh6 -f dasmon

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)

<table>
<tr><th colspan="4">Interferometer : Full Polar mode</th><th colspan="3">Interferometer : Total intensity mode</th></tr>
<tr><th>Channels</th><th>Stokes</th><th>No. of FFTs</th><th>Time(ms)</th><th>Channels</th><th>No. of FFTs</th><th>Time(ms)</th></tr>
<tr><td rowspan="4">16384</td><td>4</td><td>32(min)</td><td>1.3</td><td rowspan="4">16384</td><td>32(max)</td><td>1.3</td></tr>
<tr><td rowspan="3">1</td><td>32(max)</td><td>1.3</td><td>16</td><td>0.65</td></tr>
<tr><td>16</td><td>0.65</td><td>8</td><td>0.32</td></tr>
<tr><td>8(min)</td><td>0.32</td><td>4(min)</td><td>0.16</td></tr>
<tr><td rowspan="6">8192</td><td rowspan="2">4</td><td>64(max)</td><td>1.3</td><td rowspan="5">8192</td><td>64(max)</td><td>1.3</td></tr>
<tr><td>32(min)</td><td>0.65</td><td>32</td><td>0.65</td></tr>
<tr><td rowspan="4">1</td><td>64(max)</td><td>1.3</td><td>16</td><td>0.32</td></tr>
<tr><td>32</td><td>0.65</td><td>8</td><td>0.16</td></tr>
<tr><td>16</td><td>0.32</td><td>4(min)</td><td>0.08</td></tr>
<tr><td>8(min)</td><td>0.16</td><td rowspan="7">4096</td><td>256(max)</td><td>2.6</td></tr>
<tr><td rowspan="10">4096</td><td rowspan="4">4</td><td>256(max)</td><td>2.6</td><td>128</td><td>1.3</td></tr>
<tr><td>128</td><td>1.3</td><td>64</td><td>0.65</td></tr>
<tr><td>64</td><td>0.65</td><td>32</td><td>0.32</td></tr>
<tr><td>32(min)</td><td>0.32</td><td>16</td><td>0.16</td></tr>
<tr><td rowspan="6">1</td><td>256(max)</td><td>2.6</td><td>8</td><td>0.08</td></tr>
<tr><td>128</td><td>1.3</td><td>4(min)</td><td>0.04</td></tr>
<tr><td>64</td><td>0.65</td><td rowspan="7">2048</td><td>256(max)</td><td>1.3</td></tr>
<tr><td>32</td><td>0.32</td><td>128</td><td>0.65</td></tr>
<tr><td>16</td><td>0.16</td><td>64</td><td>0.32</td></tr>
<tr><td>8(min)</td><td>0.08</td><td>32</td><td>0.16</td></tr>
<tr><td rowspan="4">2048</td><td rowspan="4">4</td><td>256(max)</td><td>1.3</td><td>16</td><td>0.08</td></tr>
<tr><td>128</td><td>0.65</td><td>8</td><td>0.04</td></tr>
<tr><td>64</td><td>0.32</td><td>4(min)</td><td>0.02</td></tr>
<tr><td>32(min)</td><td>0.16</td><td>1024</td><td>256(max)</td><td>0.65</td></tr>
</table>

<table>
<tr><td rowspan="6"></td><td rowspan="6">1</td><td>256(max)</td><td>1.3</td><td rowspan="6"></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

<table>
<tr><td rowspan="4"></td><td rowspan="4"></td><td>32</td><td>1.3</td><td rowspan="5"></td><td>32</td><td>0.65</td></tr>
<tr><td>16</td><td>0.65</td><td>16</td><td>0.32</td></tr>
<tr><td>8</td><td>0.32</td><td>8</td><td>0.16</td></tr>
<tr><td>4(min)</td><td>0.16</td><td>4</td><td>0.08</td></tr>
<tr><td rowspan="12">2048</td><td rowspan="5">4</td><td>256(max)</td><td>2.6</td><td>2(min)</td><td>0.04</td></tr>
<tr><td>128</td><td>2.6</td><td rowspan="8">1024</td><td>256(max)</td><td>2.6</td></tr>
<tr><td>64</td><td>1.3</td><td>128</td><td>1.3</td></tr>
<tr><td>32</td><td>0.65</td><td>64</td><td>0.65</td></tr>
<tr><td>16(min)</td><td>0.32</td><td>32</td><td>0.32</td></tr>
<tr><td rowspan="7">1</td><td>256(max)</td><td>5.3</td><td>16</td><td>0.16</td></tr>
<tr><td>128</td><td>2.6</td><td>8</td><td>0.08</td></tr>
<tr><td>64</td><td>1.3</td><td>4</td><td>0.04</td></tr>
<tr><td>32</td><td>0.65</td><td>2(min)</td><td>0.02</td></tr>
<tr><td>16</td><td>0.32</td><td rowspan="15" colspan="3"></td></tr>
<tr><td>8</td><td>0.16</td></tr>
<tr><td>4(min)</td><td>0.08</td></tr>
<tr><td rowspan="12">1024</td><td rowspan="5">4</td><td>256(max)</td><td>2.6</td></tr>
<tr><td>128</td><td>1.3</td></tr>
<tr><td>64</td><td>0.65</td></tr>
<tr><td>32</td><td>0.32</td></tr>
<tr><td>16(min)</td><td>0.16</td></tr>
<tr><td rowspan="7">1</td><td>256(max)</td><td>2.6</td></tr>
<tr><td>128</td><td>1.3</td></tr>
<tr><td>64</td><td>0.65</td></tr>
<tr><td>32</td><td>0.32</td></tr>
<tr><td>16</td><td>0.16</td></tr>
<tr><td>8</td><td>0.08</td></tr>
<tr><td>4(min)</td><td>0.04</td></tr>
</table>

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)

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) + 0.1)

For Interferometry in Full Polar mode,

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

Note : BeamIntegration in No. of FFTS

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

Appendix – 5 Narrowband mode

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

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 = 4
Total Intensity, Maximum taps = 8</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 =

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

Full Polar mode = ((348 + (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) / (Beam Integration in FFTs) bytes per second
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)
2048	128	0.65536	6.25
	64	0.32768	12.5
	32	0.16384	25
	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
	64	1.31072	50

8192	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 control PC (192.168.4.68).
NOTE : a. ssh -X root@192.168.4.68 (gmrttifr) b. sudo halt -p

e. Halt the compute nodes and host nodes 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.
Instructions on How to set clock settings :

1. Power ON the clock geneator by clicking the POWER button at botton left hand corner.
2. Set the clock to 800MHz. By clicking on the FUNCTION knob the cusrsor can be moved and value can be changed by rotating the knob.
3. Set the amplitude to +20dBm using the FUNCTION knob.
4. Click on the RF STANDBY button to turn 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

GWB4 (30 Antennas) Network connections Diagram.