NATIONAL CENTRE FOR RADIO ASTROPHYSICS

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Internal Technical Report

Finalization of GWB Racks and Placement in the Correlator Room

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Objective : To propose a suitable rack with efficient cooling arrangements for the new Backend system GMRT Wideband Backend (GWB) for the uGMRT (Upgraded GMRT) receiver. So that the GWB system can co-exist with the GMRT Software Backend (GSB) receiver in the correlator room of Central electronics building (CEB).

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1. Introduction :

A GMRT Wideband Backend (GWB) is being developed for the uGMRT, based on FPGA/GPU hybrid technology. The system being developed utilises Casper designed FPGA/ADC boards to digitise the baseband signals, packetize the data and pass it on to server class machines with GPU cards. These machines works as compute nodes. The processed data is collected in host nodes through a high speed switch.

As per the current design, 16 nos. of Dell make server class T620 machines with nVIDIA GPU K20 cards – 2nos., Myricom Single Port 10GbE cards – 2 nos. & Mellanox Infini NIC card – 1 no., will be used as the compute nodes. And three nos. of T620 with one Mellanox Infini NIC card will be used as host. If required, T620 will be replaced by T630 machines. Power requirement of both the PCs is same ie 1100 watts.

The 30 antennae GWB system will have 5 racks. Racks 1 to 4 will have compute node machines alongwith ROACH & PPS/Clock units. Each of these racks will consume about 4,900 Watts of maximum power & typical power consumption is 2,800 Watts. The fifth rack will have host machines, Mellanox Infiniband 38 ports Switch, Control PC and Instruments. This rack will consume about 3,400 watts of maximum power & typical power consumption is 2,000 watts. Total maximum power consumption by 30 antennae GWB system will be about 23,000 watts and typically about 13,200 watts. This includes one hot spare of T620 with all cards, which can be used as either host or node machine whenever required.

The aim of this report is to propose a rack suitable to accommodate the units for 30 antennae GWB system. And placement of these units between the racks, keeping in mind the power consumption is almost equal and cables movement within and inter racks is best possible one. Also deciding the placement of racks in the correlator room by considering various factors like cool air inlets, hot air exhausts, cables movement mainly external & inter racks and space for man movements.

Also to propose our requirements to constomize these racks, to achieve the following things :

1. Use the infrastructure available with us to it's best, in such a way that, we will be able to meet our specific goals & expectations.
2. By doing simple modifications / additions to racks, bring down the cost of racks to be acquired.
3. Reduce the running cost of AC plant by utilizing the cool air efficiently. And
4. Reduce the failure of components by providing sufficient & regular cooling at all points in a rack and all the time.

2 Summary of efficient cooling test :

An experiments and study on the efficient cooling arrangement in the correlator room to accommodate the GWB system has been done. The final report on this “A Proposal for Efficient Cooling Arrangement for uGMRT Digital Backend” has been released. Summary of this report is as follows :

A 22 page final report has many diagrams to explain the things in a better way and for future reference. The diagrams are AC distribution layout, Correlator Room Floor & rooftop diagram & setup diagrams. The report includes 1. The GWB system's unit wise & rack wise power consumption details, 2. measuring of air flow using air flow meter, 3. Theoretical & practical calculations of heat generated & heat absorption capacity of the cool air and 4. final conclusions. This report also includes appendices like 1. auto calculator, 2. experiment setup details, 3. summary of daily readings, 4. average of daily readings and 5. using of air flow meter.

The theoretical and practical calculations were re-evaluated using the air flow meter.

Finally all the calculations and measured values are matching. Theoretically the cool air output from each outlet in the correlator room is 1000 cfm over a duct.

We have created about 11 setups. Practically the best setup is 3a. Setup 3a has these modifications in the rack. An aluminium cage has been created inside the 42U rack. Aluminum cage has an opening for cool air to enter at the front bottom about 2 feet height. And another opening in the back top for hot air to exit after passing through the heat load of 1 to 4 KWs. Kept the rack 5 feet away from the cool air outlet, without any aluminum enclosure underneath the false floor to bring the cool air from outlet to the rack. And 2 fans of 600cfm each in the rack's front bottom to suck the cool air into the cool air channel ie space between the rack's front door and aluminum cage. This cool air enters the aluminum cage through an opening. And no obstacles in the cool air flow in the rack's aluminum cage, where heat load is kept. And hot air exits through the opening at backside top. Monitored the temperature at both the openings to findout the temperature difference ie temperature of hot air minus temperature of cool air. The cool air flow is 812cfm (5 feet away from the duct). This is calculated using the heat load and temperature difference.

By using air flow meter, the volume of air flow is about 1200 to 1600cfm over the duct (measured at half a foot height ie false floor level).

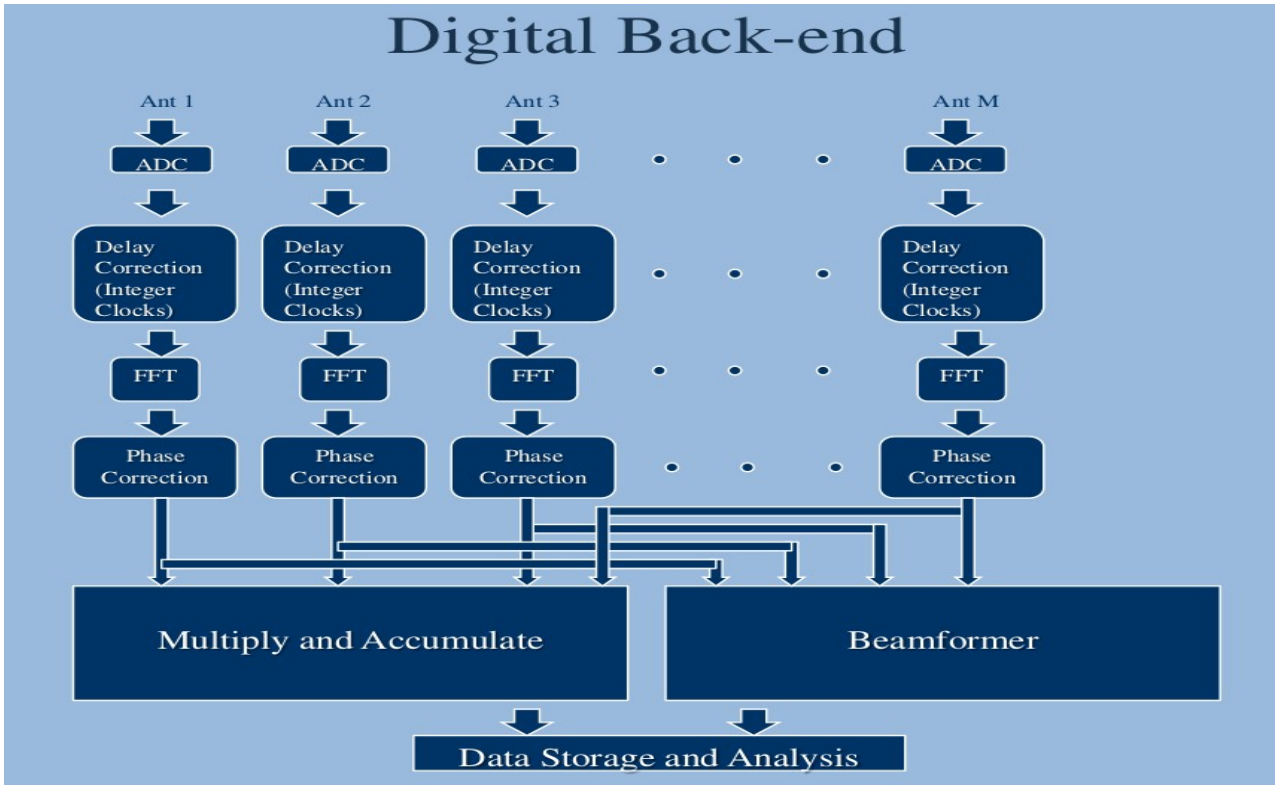
So all the three readings are close to each other. This confirms the volume of cool air is around 1000cfm from each outlet in the correlator room and heat absorption by the cool air is maximum in the setup 3a.

Auto calculator : please use the file auto_calc_temp.ods to change the input parameters to get output values. Sample file attached with this report in apendix A.

3 30 antennae GWB system :

Introduction :

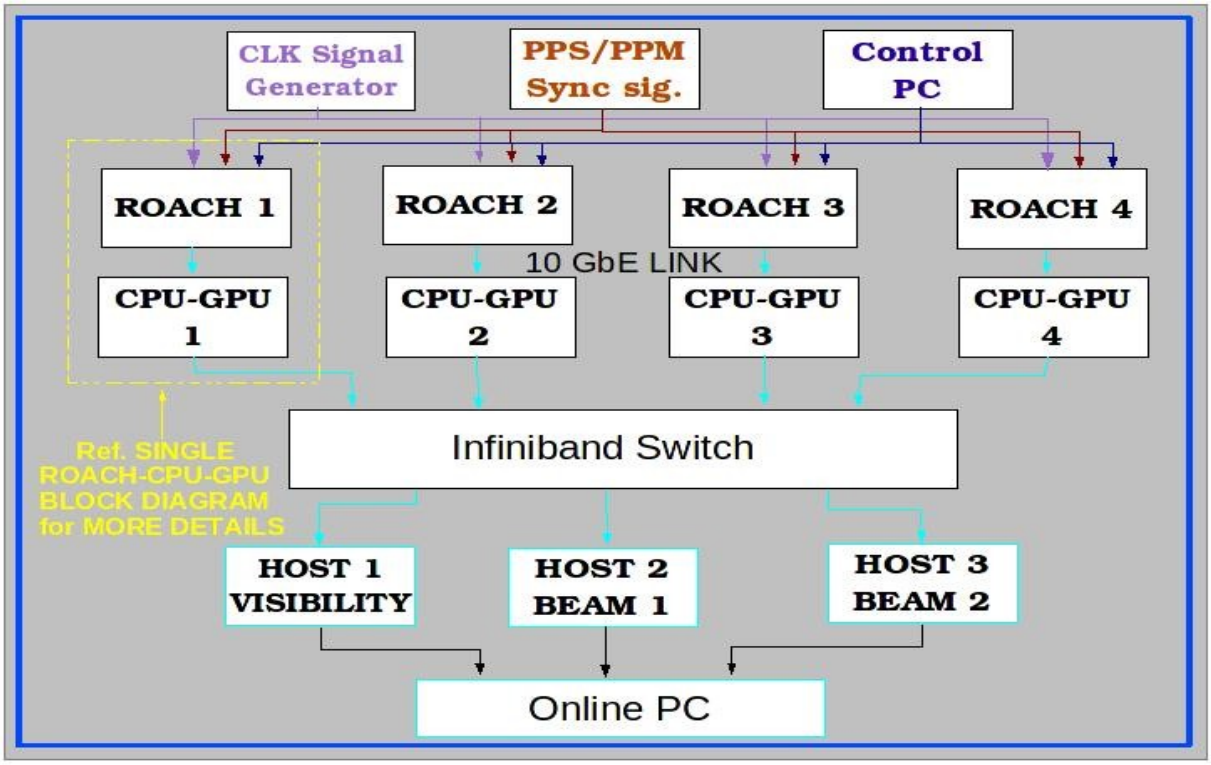
The GMRT consists of an array of 30 antennas, each of 45 m diameter, spread over a region of 25 km diameter, and operating at 5 different wave bands from 150 MHz to 1450 MHz. The maximum instantaneous operating bandwidth at any frequency band is 32 MHz. Each antenna provides signals in two orthogonal polarizations, which are processed through a heterodyne receiver chain and brought to the central receiver building, where they are converted to baseband signals and fed to the digital back-end consisting of correlator and pulsar receiver. The existing GMRT Software back-end (GSB) is built on software based approach designed from off-the-shelf components, PCI based ADC cards and a Linux cluster of 48 nodes with gigabit inter-node connectivity for real-time data transfer requirements.

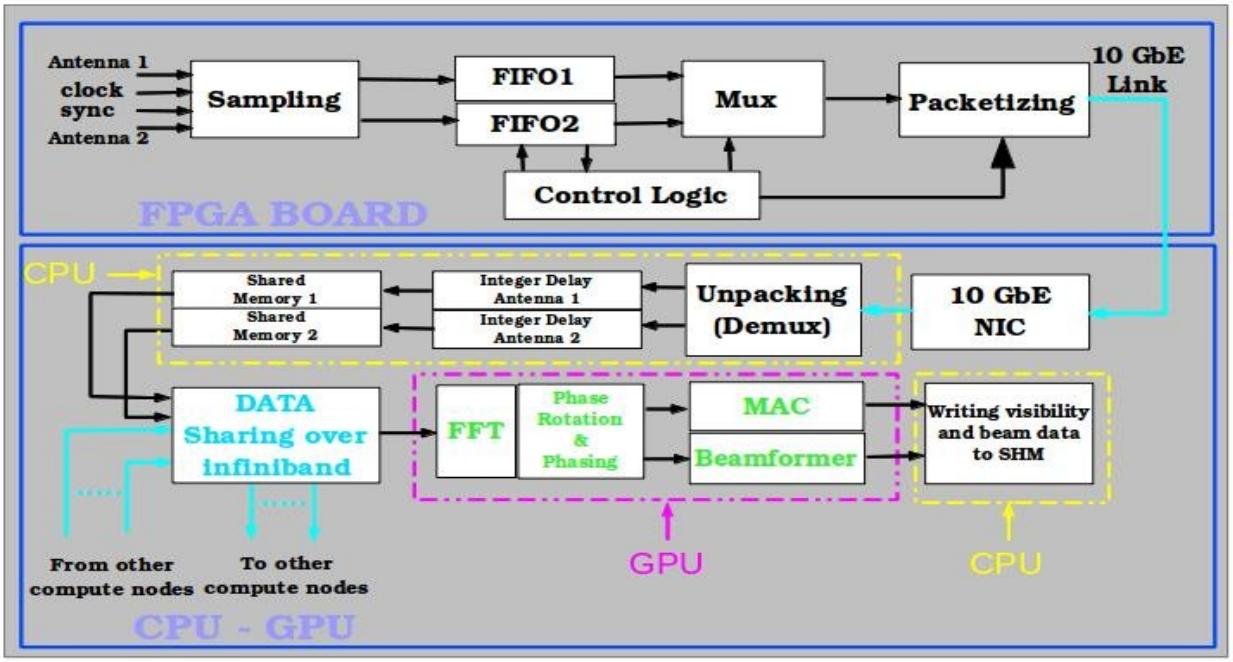


GMRT is upgrading to uGMRT and the back-end systems are undergoing major changes to achieve the upgrade system specifications like increased bandwidth of 400MHz, direct processing of RF signals, increased dynamic range, improved channel resolution. The digital backend part of this upgrade was named GWB(GMRT WIDEBAND BACKEND). As part of this upgrade, a version of GWB(GWB-II) has been built and released for users. This is a 4-antenna dual polarization or 8-antenna single polarization correlator developed on CPU-GPUs and FPGA boards.

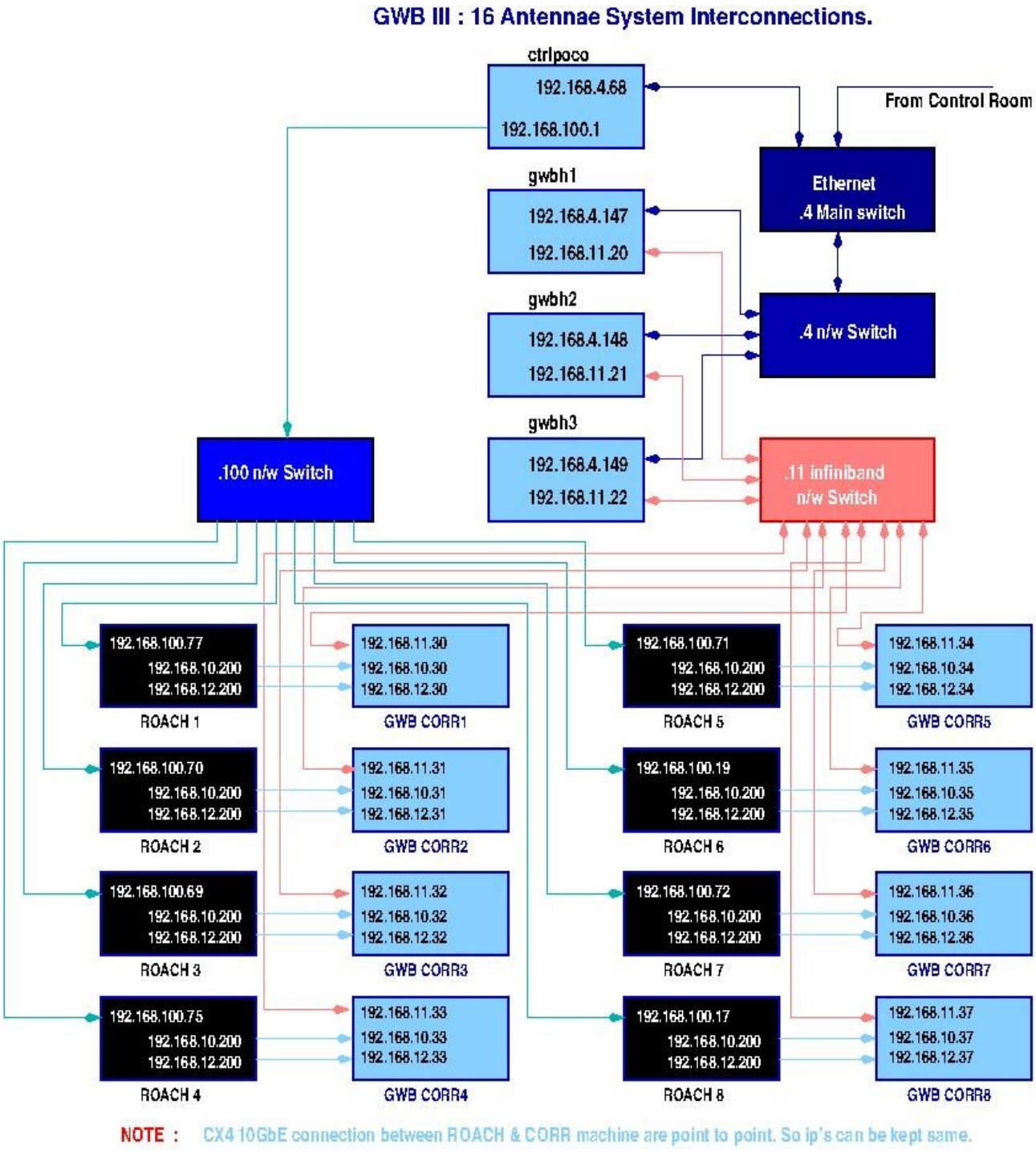
The design is a hybrid one using FPGAs and CPU-GPUs for various processes in the digital back-end chain. FPGAs connected with ADCs perform the digitisation and packetising the data while CPU-GPUs acquire the data, perform correlation and record the visibilities onto a disk for post-processing and analysis.

Block Diagrams :

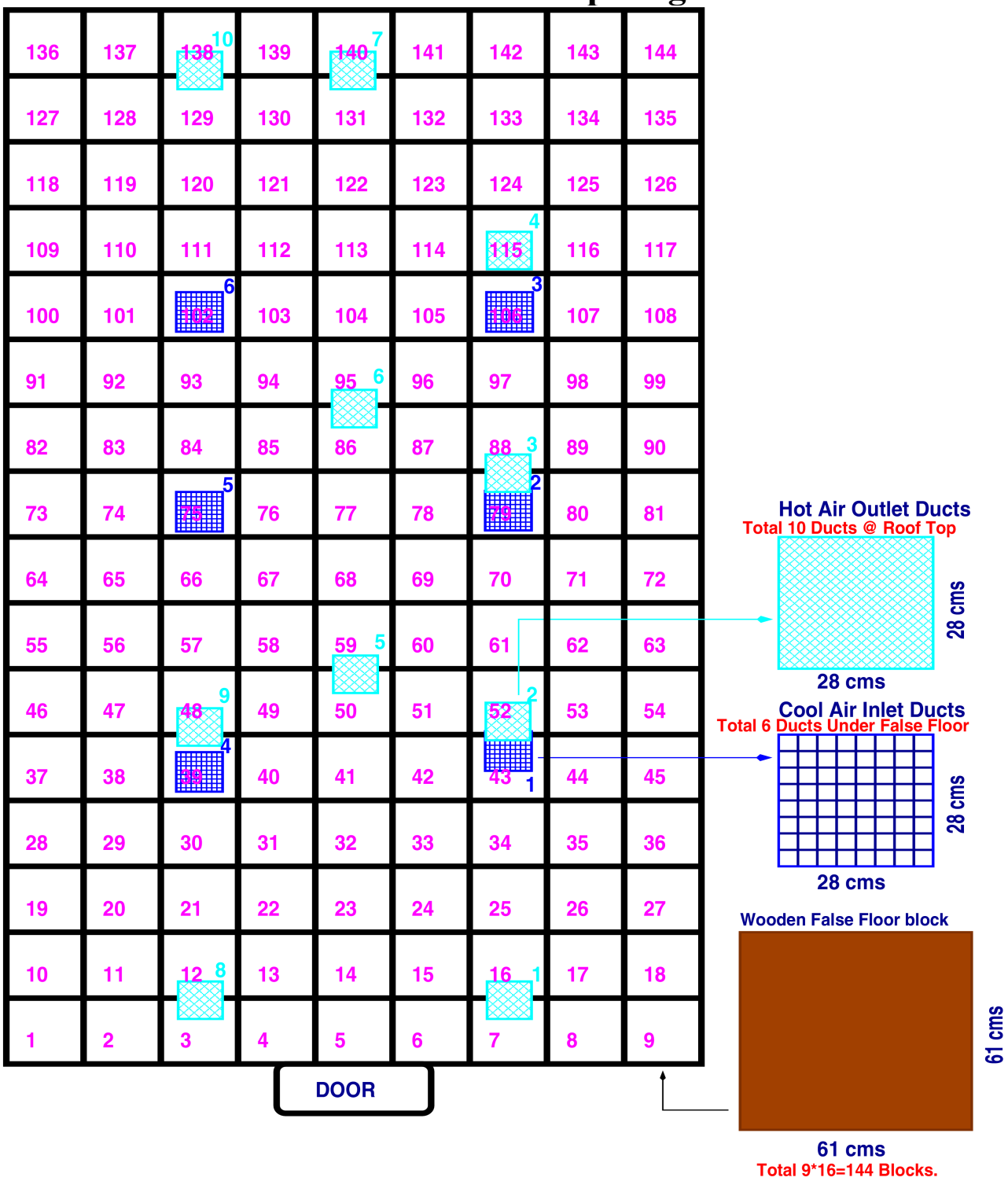




Inter Connections in GWB System :

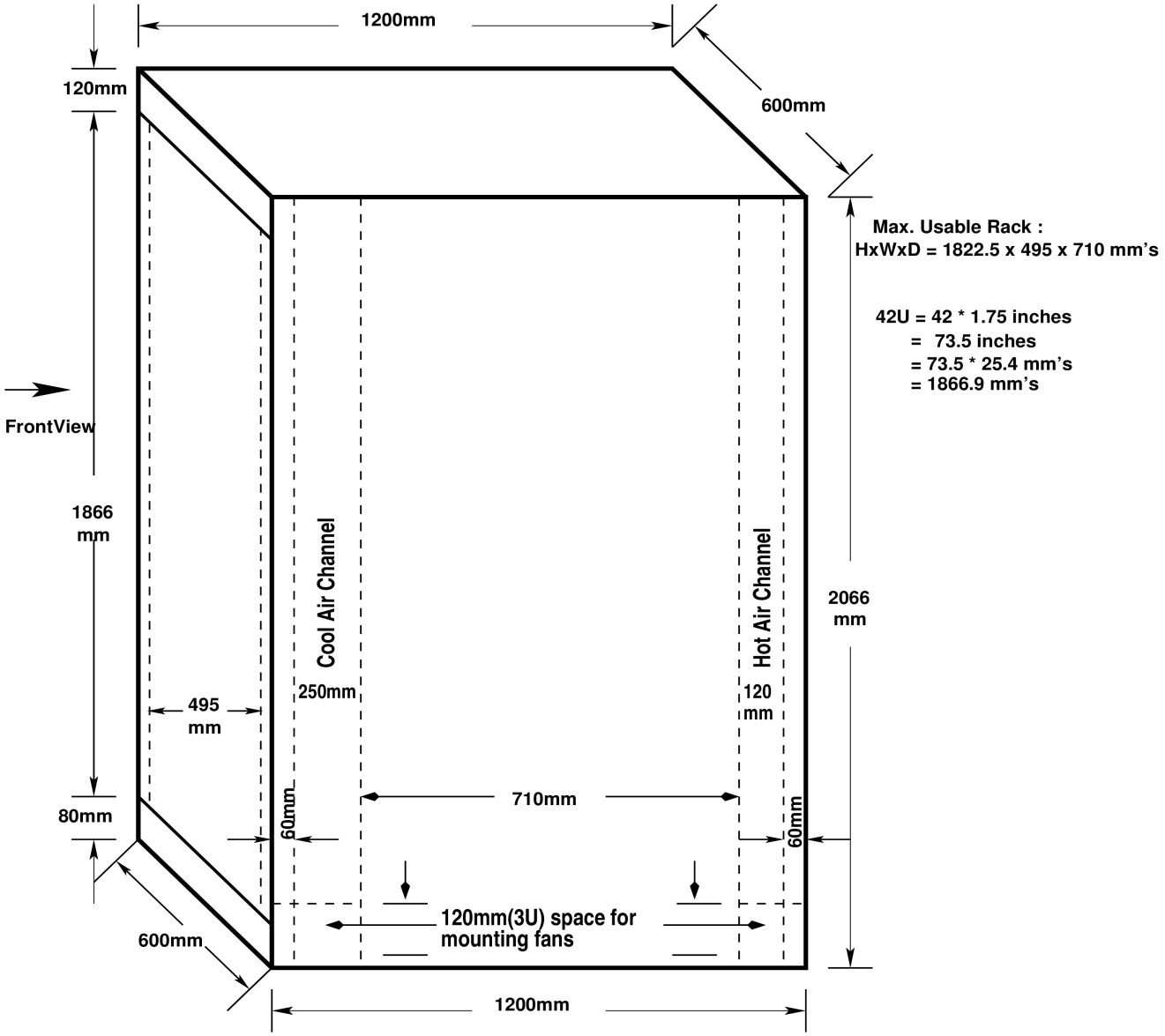


4 Correlator Room Floor & roof top diagram



5 Diagrams of proposed rack and units :

Proposed Rack :

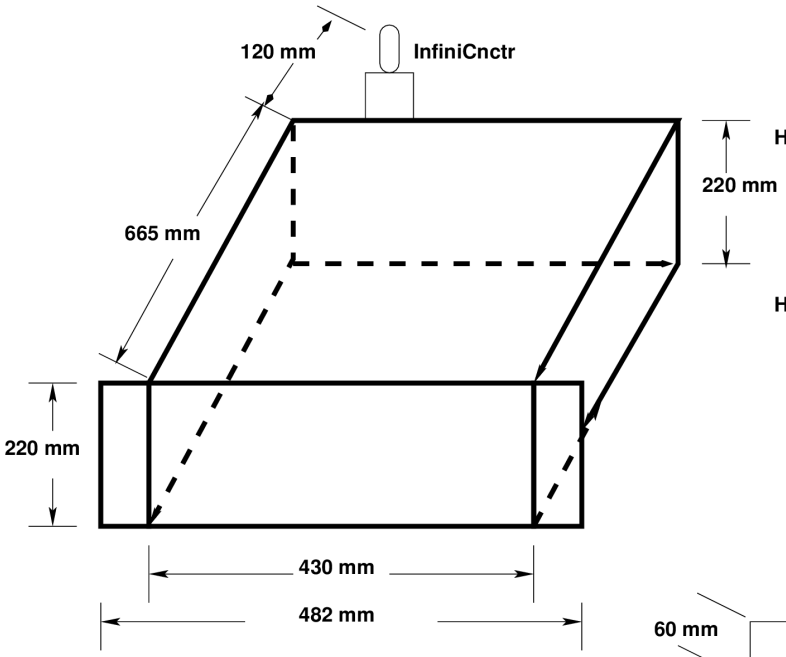


http://www.computerhope.com/jargon/num/1u.htm

Unit	Dimension (W x H x D)				
1U	19" x 1.75" x 17.7"		19" x 1.75" x 19.7"		19" x 1.75" x 21.5"
2U	19" x 3.5" x 17.7"		19" x 3.5" x 20.9"		19" x 3.5" x 24"
3U	17.1" x 5.1" x 25.5"	**4U :**	19" x 7" x 17.8"		19" x 7" x 26.4"
5U	19" x 8.34" x 19.67"		19.1" x 8.75" x 26.4"	**6U :**	19" x 10.5" x 19.5"
7U	17" x 12.2" x 19.8"				

1U = 44.45mm = 1.75 inch **1 inch = 25.4mm.**

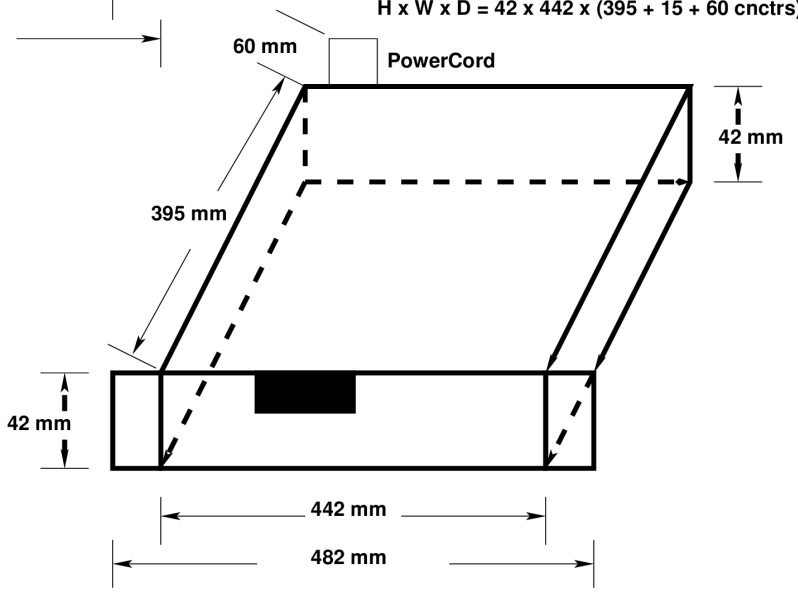
Nodes , Host and Control Machines :



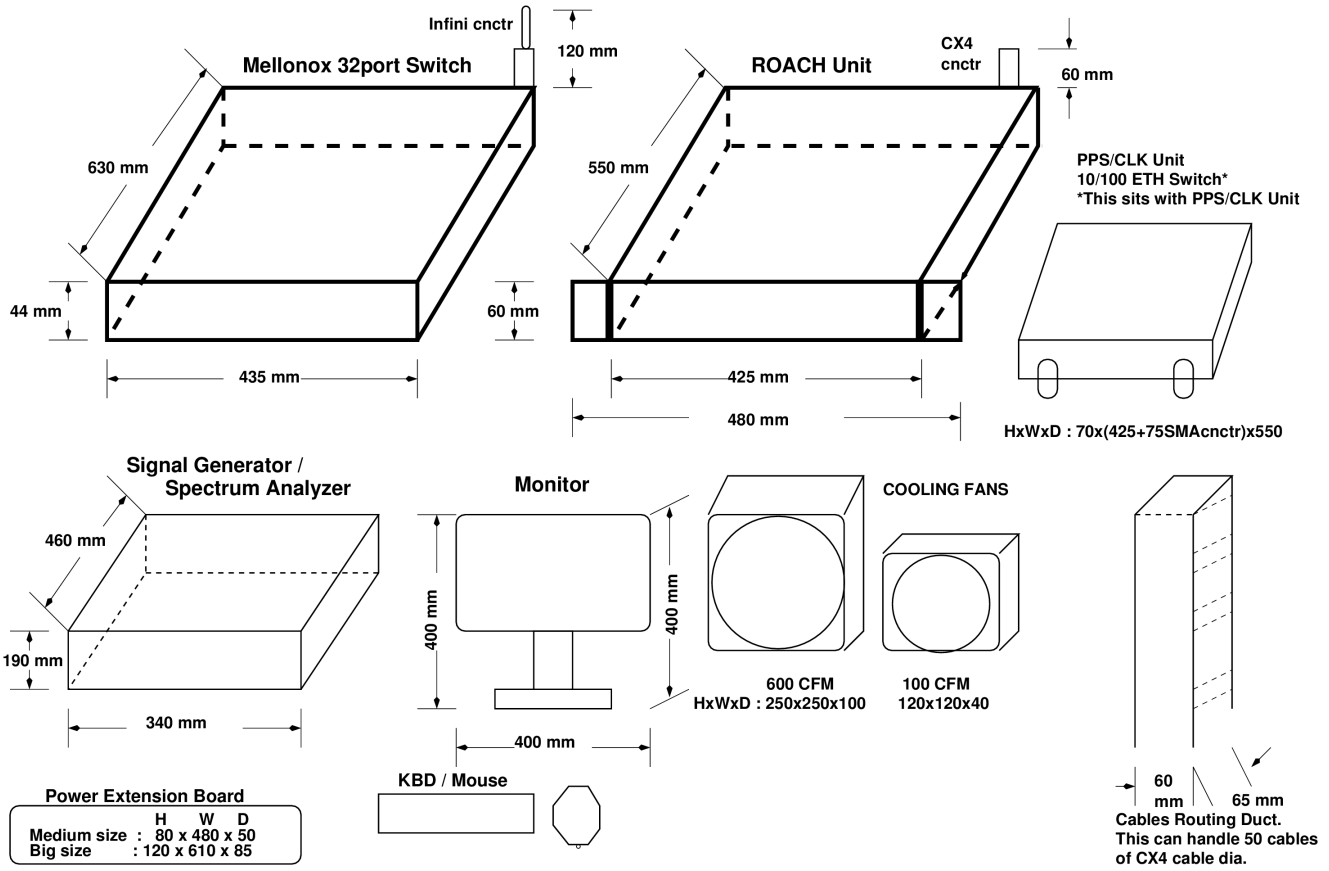
Dell T620 Host/Node m/c.
Max. space required :
H x W x D = 220 x 482 x (630 + 110 cnctrs) mm's

Dell T630 Host/Node m/c.
Max. space required :
H x W x D = 220 x 482 x (750 + 110 cnctrs) mm's

Dell R210 1U PC for control works
Max. space required :
H x W x D = 42 x 442 x (395 + 15 + 60 cnctrs) mm's



Switch, ROACH unit, PPS/CLK unit, eth switch, Signal Generator, Monitor+KBD+Mouse, Fans, Power Extension & Distribution Boards, Cable Guide Ducts.



6 Units and size :

Sl.No.	Units/Machines/Instruments	Actual Size in mm			Remarks
		Height (Units)	Width+ (Handle)	Depth+ (Connector)	
1	Control PC Dell R210	40(1)	445(40)	395(60^)	^ Power Cord
2	Dell T620 Host/Node PC	220(5)	430(52)	665(110^)	^ Infiniband connector.
3	Dell T630 Host/Node PC	220(5)	430(52)	750(110^)	Depth accommodatable??
4	ROACH Unit	60(1.5)	425(55)	550(60^)	^ CX4 cnctr
5	Melonox 32p Switch	44(1)	435	630(110^)	

6	PPS/CLK/1Gbps ETHsw	70(2)	500	550(100^)	^ SMA & RJ45
7	Monitor/KBD/Mouse	400(9)	400	400	
8	SignalGenerator/SpectrumAnalyzer/Noise Source	190 (4.5)	340	460(60^)	
9	Power Ext'n Board (can be mounted at backside of units).	120$ (3)	610#	85(60^)*	$ Make sure mountable at backside. # Available in many standards. * shouldn't obstacle the doors.
10	Fans (2 fans of ~350cfm) & 3 fans of 100cfm	100(2.5)	500#	250+120	# 50 mm space between & ends # Can be Extended in LR margins
11	Left margin Space from Mounting Pole	--	60	--	
12	Right margin Space from Mounting Pole	--	60	--	
13	Front Door Margin	--	--	60	
14	Back Door Margin	--	--	60	

Notes :

I Width.....

a. Margins on left side from the mounting pole = 60mm
b. Max. width of the unit (fans) = 550mm. But can be Extended in LR margins
Look for ~350 cfm fans with lesser width say 220mm.... to accommodate in 600mm rack.
c. Margings on right side from the mounting pole = 60mm
So Total Width required = 60 + 550 + 60 = 670mm

II Depth.....

a. Front door closing clearance - 60mm
b. Front cool air channel (~350cfm fan) / Cable Duct + margin space - 250+20= 270mm
c. Max. Unit depth (T620 PC) - 665mm (T630 PC - 750mm) ??
In the rack with 1200mm depth, Dell T630 will sit with 40mm extend in hot air channel and 110mm infini cnctrs in 80mm in hot air channel + 30mm in the door closing margin.
d. Connector / Cable Duct / Hot air Channel (100cfm fan) + margin space – 100+20 =140mm
e. Back door closing clearance – 60mm
So Total Depth required – 60 + 270 + 665 + 140 + 60 = 1195mm
Total Depth required for T630 wil be – 60 + 270 + 750 + 140 + 60 = 1280mm

7 Power consumption Unitwise & Rackwise :

Power consumption Unitwise in Watts :

Sl.No.	**Units/Instruments**	Power Consumption/Unit		Total Units Required	Total Power Consumption	
		Typical	Maximum		Typical	Maximum
1	Control PC Dell R210	200	250	01	200	250
2	Dell T620 Node PC	369	628	16	5,904	10,048
3	Dell T620 Host PC	369	628	03	1,107	1,884
4	Dell T630 Node/Host PC#		PS-1100#			PS-1100#
5	K20 GPU Cards	105	225	32	3,360	7,200
6	Myricom 10GbE Single Port card	5	5	32	160	160
7	Mellanox infiniband NIC Card	2	2	19	38	38
8	ROACH Board	50	60	32	1,600	1,920
9	ADC in ROACH Board	1.5	1.5	64	96	96
10	Mellanox infiniband 32p Switch	3	3	01	3	3
11	PPS/CLK/1Gbps ETHsw	10	20	04	40	80
12	Monitor/KBD/Mouse	40	80	01	40	80
13	SignalGenerator/Instruments	65	65	01	65	65
Grand Total of Power Consumption					12,613	21,824

 # May replace the Dell T620 in future. T630 power supply is 1100watts, which is same as Dell T620.

Power consumption Rackwise in Watts :

For Racks : 1 to 4

Sl.No.	**Units/Instruments**	Power Consumption/Unit		Total Units Required	Total Power Consumption	
		Typical	Maximum		Typical	Maximum
1	Dell T620 Node PC	369	628	4 * 4 = 16	5,904	10,048
2	K20 GPU Cards	105	225	8 * 4 = 32	3,360	7,200
3	Myricom 10GbE Single Port	5	5	8 * 4 = 32	160	160
4	Mellanox infiniband NIC Card	2	2	4 * 4 = 16	32	32

5	ROACH Board	50	60	8 * 4 = 32	1,600	1,920
6	ADC in ROACH Board	1.5	1.5	16* 4 = 64	96	96
7	PPS/CLK/1Gbps ETHsw	10	20	1 * 4 = 04	40	80
	Total Power Consumption per Rack				2,798	4,884
Sub Total 1					11,192	19,536

For Rack Number : 5

Sl.No.	**Units/Instruments**	Power Consumption/Unit		Total Units Required	Total Power Consumption	
		Typical	Maximum		Typical	Maximum
1	Dell T620 Host PC	369	628	03	1,107	1,884
2	Control PC Dell R210	200	250	01	200	250
3	Mellanox infiniband NIC Card	2	2	03	6	6
4	Mellanox infiniband 32p Switch	3	3	01	3	3
5	SignalGenerator/Instrument	65	65	01	65	65
6	Monitor/KBD/Mouse	40	80	01	40	80
7	Hot Spare – Dell T620Host/Node	591	1090	01	591	1090
8	Eth 1Gbps Switch	2	2	01	2	2
Sub Total 2					2,014	3,380
Grand Total of Power Consumption (Sub Total 1+2)					13,206	22,916

Note : Grand Total of power consumption at unitwise and rackwise differs due to hot spares required included in the racks.

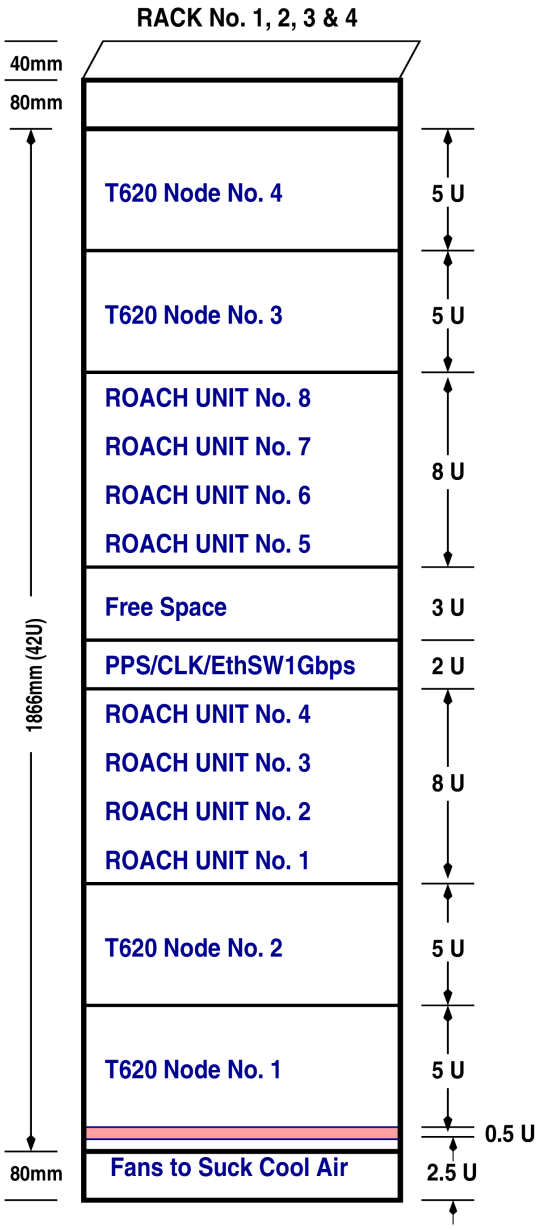
8 Rack requirements and configuration :

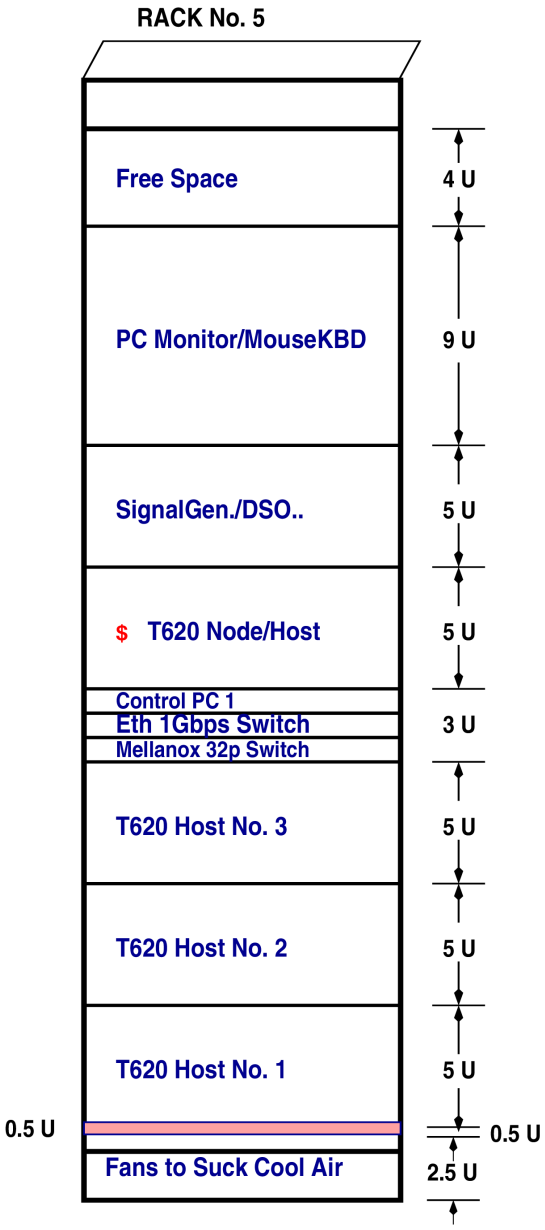
1. **Height x Width x Depth – 2065mm (42+4.45 U) x 670mm x 1195mm**

Height – Take care of room height from false floor and also it should pass through the door.
Width – Tow fans of ~350cfm can be mounted at the front / 3 fans of 100cfm at the backside + margings between fans and at the end of rack (sliding/mounting arrangement bars)
Depth – Front Door closing clearance + ~350cfm fans mounting / cool air channel + max. Depth req. for units + Connectors / 100cfm fan mounting to suck some cool air and push the hot air up to aviod mixing / stayback of air + Back Door closing clearance.

2. Make sure the rack passes through the main door.
3. Vertical mounting arrangement for units should be in step of half a Unit ie 22.22mm. Also mounting bars should be moveable horizontaly, so that we can decide the cooling and hot air channels.
4. Mounting arrangement for Machines using sliding bars and ROACH/Switch using aluminum angles or readymade better options available.
5. Cable Routing inside the Rack (take care of cables length)
6. Cable In/Out from the Rack at Top & Bottom and Front & Back
7. Fans Mouning : ~350cfm at the Rack's front bottom to suck the cool air into the cool air channel, 100cfm at back bottom(if req.) and 100cfm at the back top to suck out the hot air from the rack's hot air channel.
8. Power Distribution Board's mounting arrangement at Rack's Backside.
9. Temperature Monitors in and around Rack.
10. Make sure Doors can be closed to maintain cool air inside and no leakages of cool air at front (if req. close the gaps between units at the bottom and top of the rack to force the cool air through the units
11. Rubber cushion at the rack's bottom to plug the cool air leakout between false floor and rack's bottom.
12. Hot air exhaust opening at the rack's top backside center.
13. Arrangement for conneting hot air exhaust to the exhaust ducts in the roof top.

9 Units placement in the Racks :





Space Used : 39 U

Power Consumption in Watts

Maximum : (1090*4) + (63*8) + 20 = 4884

Typical : (591*4) + (53*8) + 10 = 2798

Space Used : 38 U

Power Consumption in Watts

Maximum : (630*3)+3+250+65+1090+80+2=3380

Typical : (371*3)+3+200+65+591+40+2=2014

Total Power Consumption : Typically – 13,206 Watts and Maximum – 22,916 Watts

Note : ROACH with 2 ADCs & T620 with cards, K20–2nos, 10Gbe–2nos & NIC–1no.

\# – Hot spares

Units	Size in mm	Units	Size in mm
0.5	22.22	2.5	111.125
1	44.45	4.5	200.10
1.5	66.70	5	222.25
2	88.90	9	400.20

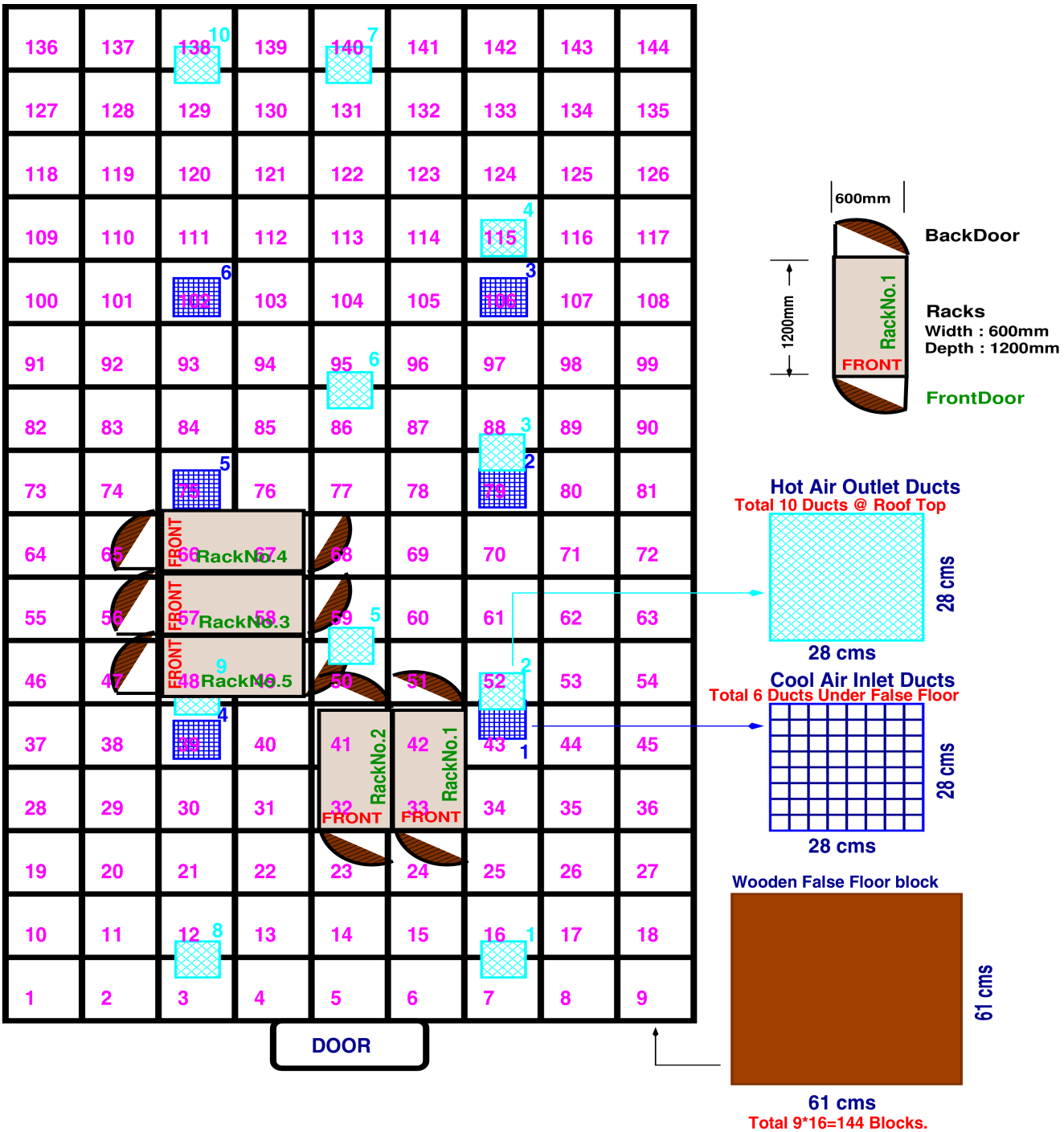
Note : Maximum Power Consumption for Racks 1 to 4 is about 4,900 Watts and for 5th rack about 3,400 Watts. So Maximum Power Consumption for 30 antennae GWB system will be 23,000 Watts.

The Units placement in the Racks is done by keeping in mind :

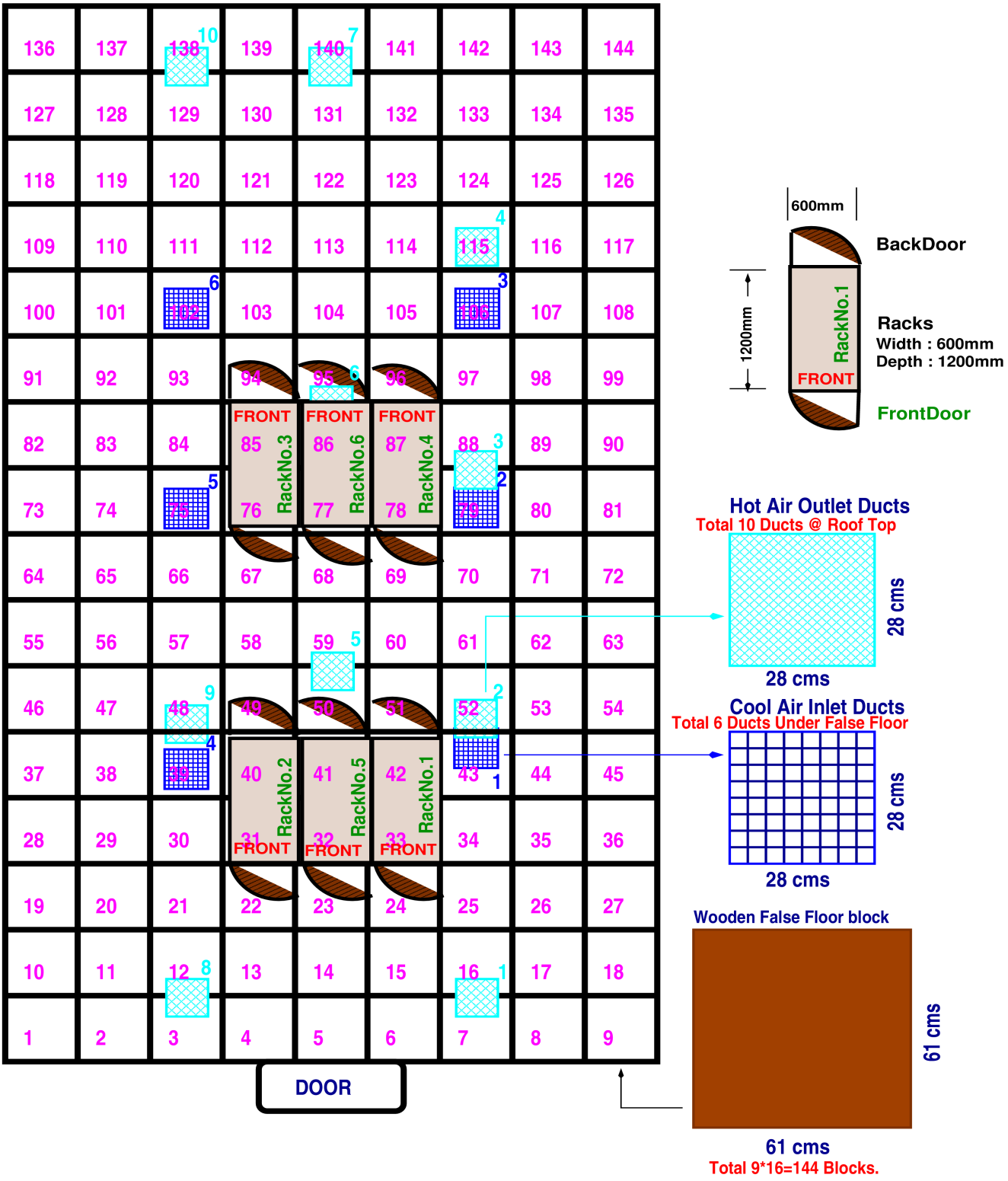
1. Minimum inter rack cables movement.
2. Cables (infiniband and ethernet) from 5th rack will go to T620/T630 's in the racks 1 to 4. So it is placed in between the racks.
3. By using PPS/CLK units in each racks minimizes the inter rack PPS/CLK cables.
4. Using ROACH units and Nodes required for 8 antennae in the same rack, will avoid inter rack CX4 cables movement. This is also necessary due to maximum 5 meter length of CX4 cables.
5. Best utilization of space with almost equal power consumption from all racks.

10 Racks placement in the correlator room :

Proposal 1 :



Proposal 2 :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64 65 66 67 68 69 70 71 72
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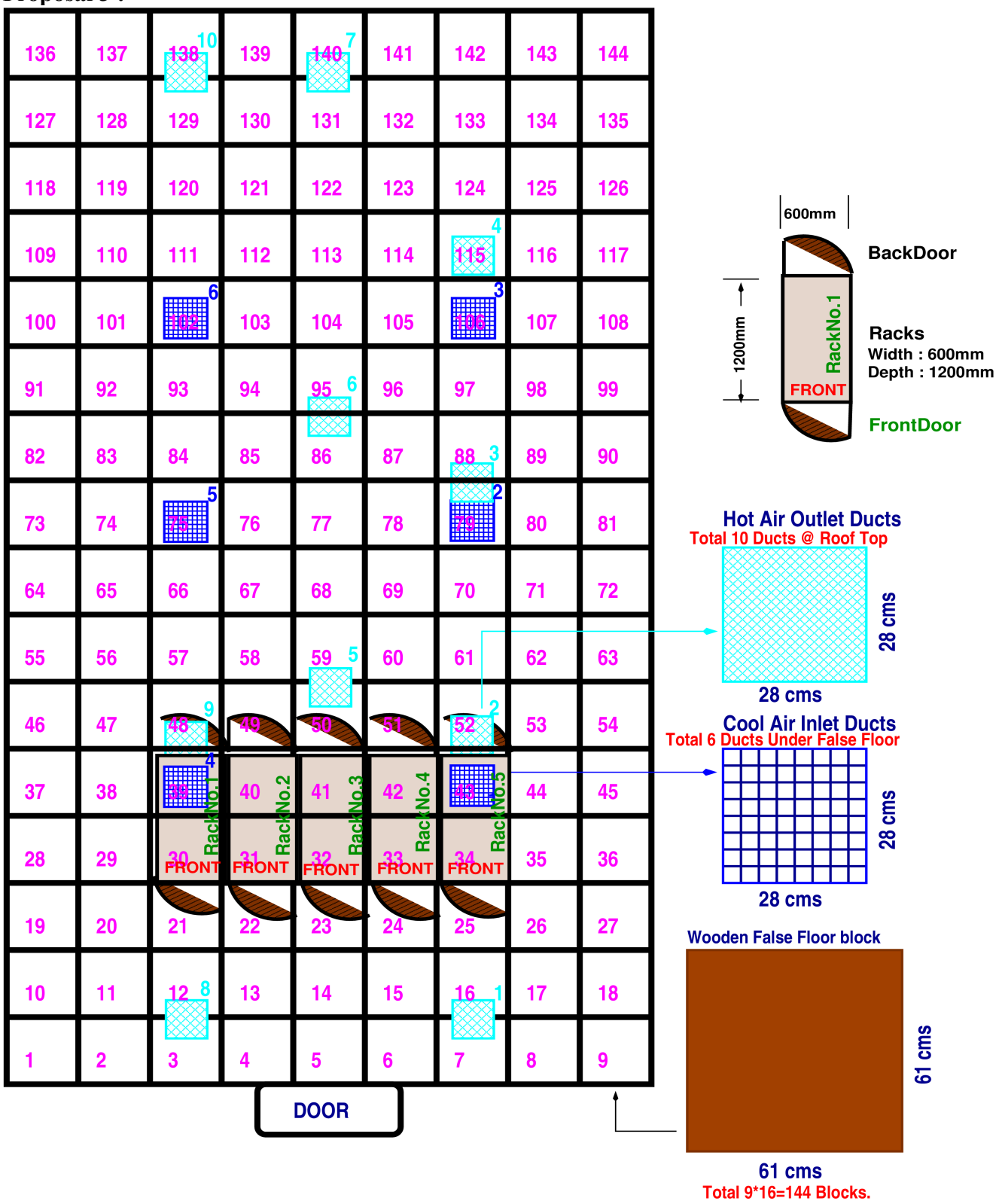
46 47 48 49 50 51 52 53 54
37 38 39 40 41 42 43 44 45
28 29 30 31 32 33 34 35 36
19 20 21 22 23 24 25 26 27
10 11 12 13 14 15 16 17 18
1 2 3 4 5 6 7 8 9
FRONT
RackNo.3
RackNo.6
RackNo.4
RackNo.2
RackNo.5
RackNo.1
DOOR
600mm
1200mm
BackDoor
RackNo.1
FRONT
Racks
Width : 600mm
Depth : 1200mm
FrontDoor
Hot Air Outlet Ducts
Total 10 Ducts @ Roof Top
28 cms
28 cms
Cool Air Inlet Ducts
Total 6 Ducts Under False Floor
28 cms
28 cms
Wooden False Floor block
61 cms
61 cms
Total 9*16=144 Blocks.

Proposal 3 :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37 38 39 40 41 42 43 44 45
28 29 30 31 32 33 34 35 36
19 20 21 22 23 24 25 26 27
10 11 12 13 14 15 16 17 18
1 2 3 4 5 6 7 8 9
10
7
6
4
3
6
3
2
5
9
2
4
8
1
RackNo.1
RackNo.2
RackNo.3
RackNo.4
RackNo.5
FRONT
DOOR
600mm
1200mm
BackDoor
RackNo.1
FRONT
FrontDoor
Racks
Width : 600mm
Depth : 1200mm
Hot Air Outlet Ducts
Total 10 Ducts @ Roof Top
28 cms
28 cms
Cool Air Inlet Ducts
Total 6 Ducts Under False Floor
28 cms
28 cms
Wooden False Floor block
61 cms
61 cms
Total 9*16=144 Blocks.

The Racks placement in the Correlator Room is done by keeping in mind :

1. Cool Air inlets and Exhaust ducts are near by.
2. We can use cool air inlets 1, 4 & 5 fully and 2nd partially if required.
3. We can use exhausts 2,5 & 9.
4. Doors opening/closing and man movements space requirements.
5. Cables movement between racks. Cables (infiniband and ethernet) from 5th rack will go to T620/T630 's in the racks 1 to 4. So it is placed in between the racks.
6. Cables in/out will be only from top. This avoids cool air leakage at the bottom.
7. Main Clock and PPS's will be split into 4 copies for 4 racks, then again multiple copies will ge generated in the unit placed in the racks. This avoid inter rack cables movement.
8. This placement avoids shifting of packetised correlator.

11 Bill of material :

Note : Spare quantity taken as 20% , except costly items like Rack, Dell T620 PC's & 32pSwitch.

Sl.No.	Items	Qty Required	Qty (20%) Spare	Total Required	Remarks
1	Racks -	05	00	05	GWB Racks
2	Dell R210 poweredge 1U PC	01	01*	02	Control PC
3	Dell T620 Node machines	16	01#	17	
4	Dell T620 Host machines	03	01#	04	
5	Dell T630 Node machines				May be used to replace T620 PC
6	K20 GPU Cards	32	06	38	
7	K40 GPU Cards				May be used to replace K20 card
8	Myricom 10Gbe Single Port	32	06	38	
9	Mellanox Infiniband NIC Card	19	04	23	
10	Mellanox 32p Switch	01	01*	02	
11	ROACH Units	32	06	38	
12	ADC Cards	64	13	77	
13	PPS/CLK Unit	04	01#	05	
14	Signal Generator	01	01*	02	
15	DSO	01*	00	01	
16	SpectrumAnalyzer	01*	00	01	

17	1Gbps ETH switch	??	01*	??	
18	Power Extension Board(6sockets)	15	03*	18	
19	Cooling Fans ~350 CFM	10	05	15	
20	Cooling Fans 100 CFM	10	05	15	
21	Monitor	01	01*	02	
22	Key Board	01	01*	02	
23	Mouse	01	01*	02	
24	Cables Routing Duct ??x60x65	20^	01^	21^	Hadles 50cables of CX4dia
25	TNC to SMA Cables – 5 mtrs	60	12	72	Input to ADC's.
26	CX4, 5 mtr Cables	64	13	77	ROACH to Nodes.
27	Infiniband Cables	19	04	23	Nodes to Switch
28	Ethernet Cables (5 mtr)	62	12	74	Switch to Nodes/ROACH
29	Ethernet Cables (>20mtr)	08	01	09	Network to Switches
30	Power Cords	83	17	100	Power to all units
31	Aluminum angles				For ROACH units & SW
32	Aluminum angles				For PPS-CLK unit/ SignalGenerator/ Noise Source/ Monitor /

Hot spare should be in the working Rack
* Spare may be shared with other activities.
^ This provision may be done while purchasing the Racks

12 Final Conclusions :

Collecting the details of racks manufacturer in & around Pune. Personal enquiry about the racks and constomization will be started to short list them. Then purchasing procedure will be initiated.

Appendices will follow .....

Appendices :

I Auto calculator :

please use the file auto_calc_temp.ods to change the input parameters to get output values.
Sample file attached here for standard input parameters...

User Parameters :	**INPUTS**	**Output Parameters**	**OUTPUTS**
PowerConsumption in Watts -->	21500	**Total Heat Energy** in calories/minute -->	**3,08,185**
Difference in Temperature -->	15.5	**Heat Absorption of Cool Air cal/min -->**	**96,551**
Volume of Cool Air in ft^3 -->	812	**Number of cool air inlets required..**	**3.19**
Heat absorption in watts -->	4,000		
Difference in temperature deg. Cel. -->	9.21	**Volume of Cool Air in ft^3 :**	**812**

Constant Parameters :	**Constant Values**	**Intermittent Calculation Parameters :**	**int'nt. results**
1 Joule equal to --> Calories	0.2389029576	Volume of Cool Air in mtr^3 -->	22.99584
1 Cubic feet equal to --> Cubic mtr	0.02832	Mass of cool air in kg/minute -->	25.954638088
Air Density kg/mtr^3 @ 25dC & 1 Pascal	1.128666667		
Specific Heat of Air cal/kgdC @ 20dC & 1 Pascal	240		

Tables :

Total Heat Energy in Cal./min.	
For 1000 watts of Power Consumption -->	14,334
For 1500 watts of Power Consumption -->	21,501
For 2000 watts of Power Consumption -->	28,668
For 2500 watts of Power Consumption -->	35,835
For 3000 watts of Power Consumption -->	43,003
For 3500 watts of Power Consumption -->	50,170
For 4000 watts of Power Consumption -->	57,337
For 4500 watts of Power Consumption -->	64,504
For 5000 watts of Power Consumption -->	71,671

Volume of Cool Air in ft^3 @1KW heat if :	
Temperature difference of 3 deg. Cel.	2,491
Temperature difference of 3.5 deg. Cel.	2,135
Temperature difference of 4 deg. Cel.	1,869
Temperature difference of 4.5 deg. Cel.	1,661
Temperature difference of 5 deg. Cel.	1,495

Heat Absorption of Cool Air in cal./min.	**For 1000ft^3/ min. Cool air**
For Temperature difference of 1 deg.Cel.	6,229
For Temperature difference of 1.5 deg.Cel.	9,344
For Temperature difference of 2 deg.Cel.	12,458
For Temperature difference of 2.5 deg.Cel.	15,573
For Temperature difference of 3 deg.Cel.	18,687
For Temperature difference of 3.5 deg.Cel.	21,802
For Temperature difference of 4 deg.Cel.	24,916
For Temperature difference of 4.5 deg.Cel.	28,031
For Temperature difference of 5 deg.Cel.	31,146
For Temperature difference of 5.5 deg.Cel.	34,260
For Temperature difference of 6 deg.Cel.	37,375
For Temperature difference of 6.5 deg.Cel.	40,489
For Temperature difference of 7 deg.Cel.	43,604
For Temperature difference of 7.5 deg.Cel.	46,718
For Temperature difference of 8 deg.Cel.	49,833
For Temperature difference of 8.5 deg.Cel.	52,947
For Temperature difference of 9 deg.Cel.	56,062
For Temperature difference of 9.5 deg.Cel.	59,177
For Temperature difference of 10 deg.Cel.	62,291

The following information is not part of the report.....

Finalization of Rack :

Height x Width x Depth – 2065mm (42U+4.45 U) x 670mm x 1195mm

the persent one used for cooling efficiency testing is : 2065 x 600 x 1000

Enquiries may be start with the following vendors :

http://dir.indiamart.com/pune/networking-rack.html

1. President : *www.apw**president**.com/* *Phone: 020 2711 2219*

Address: *1st Floor, Parvati, Near Mitra Mandal Chowk, Parvati, Pune, Maharashtra 411009*

2. Jyoti Tech Industries : www.jyotitech.com +91 22 27696631

R-607, T.T.C. industrial Area,Thane-Belapur Road,Rabale Navi Mumbai – 400 701

3. NetRack Enclosures Private Ltd. http://www.netrackindia.com/contact.php

Manufacuture @ : Sy No 130, Machohalli Cross. Magadi Main Road. Pin Code - 560 091, Karnataka 080 - 67846618 403, ION7, Behind Keys Hotel, Opp.Sterling Honda, Off Mumbai, Pune Road, Pin Code - 411018,MH

Mob – 09657702477 Email- lalit@netrackindia.com

4. Excel Enclosures www.excelenclosures.co.in Phone : **08447504189**

Gat No. 1567, Shelar Vasti, Dehu - Alandi Road, Chikhali, Near Indtech ,Pune - 412114, Maharashtra

5. Rahi Systems Pvt. Ltd. www.indiamart.com/rahi-systems Phone : **08376807021**

Office 201-202, Corporate Plaza Premises Near Chaturshringi Temple, Senapati Bapat Road, Shivajinagar,Pune - 411016, Maharashtra

6. Farz Engineers www.indiamart.com/farz-engineers Phone : **08046049246**

Flat No 8B, SR No. 51, Vishwakarma Apartment, Kondhwa Khurd,Pune - 411048, Maharashtra

7. P Systems www.indiamart.com/psystems Phone : **09922910800**

Survey No. 22, Ganesh Nagar, Sinhgad Road, Dhayari ,Pune - 400041, Maharashtra

8. Best It World (India) Private Limited www.indiamart.com/bestitworld **08045137484**

87, Mistry Industrial Complex, Midc Cross Road A. Andheri East,Mumbai - 400093,MH

9. Hilink Networks www.indiamart.com/hilinknetworks **08048401978**

No. 203, Navkar Commercial , Opposite Andheri Station, Andheri East ,Mumbai - 400069, MH

10. Prestige Metal Systems (India) Private Limited www.indiamart.com/prestigemetal-systems

09702862030 Plot A - 511, T. T. C.,M.I.D.C.Mahape,Off Thane- Belapur Road,Navi Mumbai – 400701

http://www.apwpresident.com/products/thermal-management/coolrack

President's CoolRack is an innovative enclosure that can address heat loads upto 5 KW. Using the concept of Focused Cooling, the CoolRack allows cool air to enter the rack directly from below through the raised datacenter flooring. A high-pressure cool air wall is created between the front faces of the servers and the front glass door of the rack. All the sides in the front are sealed to prevent any air leakages, thereby forcing the cool air through the server. The exhaust hot air is then taken out of the rack through a rear perforated door into the Hot Aisle. Additional fan enhancers can be installed to address any specific hot pockets that may arise at the exhaust points of the servers.

http://www.apwpresident.com/products/thermal-management/chillrack

ChillRack is a self-contained server cabinet that works on a closed loop cooling system. With the rack mount AC unit built into the rack, precise delivery of inlet air and immediate capture of return air keeps the electronic equipment at optimal temperature. Closed-loop cooling addresses the heat load independent of the outside room air temperature.

ChillRack, facilitates the installation and fault-free maintenance of sensitive electronic equipment even in harsh environments where dust, dirt and varying heat levels are common – as in factories, retail outlets, remote offices, warehouses and workspaces in arid locations.

Features and Benefits:

- Closed loop cooling system – ensures precision cooling
- Lesser foot print
- Synchronized air distribution
- High sensible cooling – custom-designed for server applications
- Evaporative condensation – for superior AC unit performance
- High static 'backward curved' fan – for long-lasting performance
- Microprocessor controller with variable digital display
- Potential free contact alarm

http://www.apwpresident.com/products/thermal-management/cold-aisle-containment

As the majority of servers sold today require air as the cooling medium, it is essential for any datacenter design to ensure that each and every server location be provided with the correct volume, temperature and humidity of air.

Using the Hot/Cold Aisle principle, server racks in modern data centers are arranged perpendicular to the CRAC (Computer Room Air-Conditioning) units. All under-floor obstructions (such as cable trays), should be removed.

According to the Green Grid, cooling solutions consume approximately 63 percent of the power in a datacenter. As the power consumption increases, there is more heat generation, with an increase in carbon emission. Since power is a big expense, any power savings will only mean reduced costs.

By simply preventing the common and increasingly critical problem of short-circuited hot airflow returning directly back into the cold aisle, significant cooling and energy efficiencies are achieved. This is the concept used in President's Cool Way solution for Cold Aisle Containment.

http://www.apwpresident.com/wp-content/uploads/2008/11/CoolWay.pdf

Goodone to look for cool air way and hot air way outs in the room.....

http://www.apwpresident.com/products/thermal-management/coolrack-hd

President's Cool Rack-HD is an innovative enclosure that can address heat loads upto 10 KW. This solution is based on simple principle of isolating the incoming cold air from the hot return air being exhausted from the rear of the cabinet. The innovative Fan Exhaust duct combination helps in this isolation of the cold and hot air streams in line with ASHRAE guidelines. This results in tremendous energy savings while maintaining the high heat density servers at comfortable temperatures.

Cold air emitted out from the raised datacenter flooring enters the rack through the front perforated door. The rear door is a plain door with high suction exhaust fans mounted on the top cover at the rear side which creates negative pressure. All the side openings of the rack in the front are sealed to prevent any air leakages, thereby forcing the cold air to pass through the servers. The exhaust hot air is then taken out of the rack through an exhaust duct which connects the cabinet with the false Ceiling, thus preventing the cold air mixing with the hot air.