Installation Planning for BPM-HRM Booster DAQ Extension

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Revision 4

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I. Introduction

Currently the Beam Position Monitors (BPM's) in the Booster are digitized using Omnibyte 2 MHz "Comet" VME modules. The data from these modules is processed to provide turn by turn beam position plots for operations. It is desired to also be able to plot the BPM data in "Snap Shot" plots and "Fast Time" plots alongside other data such as beam losses, corrector magnet currents, etc..

We intend to accomplish this by teeing the BPM signals at the VME crates and additionally digitizing them using the HRM electronics. A proposal for this new cabling arrangement is shown in Figure 1. We are planning to mock-up the new cabling arrangement and test to see if there is any negative impact on the position signal or its digitized values.

The 64 channel HRM digitizer data is transmitted over a high speed serial link to a VME PMC carrier module with associated PMC Hotlink data link module and a VME power PC processor module. Both the HRM chassis and VME crates/power supplies will need to be installed.

We are also considering putting in new electronics for the Beam Loss Monitors (BLM's). In a few of the locations, we are going to be adding full size VME crates to accommodate this in addition to the BPM-HRM readouts.

The following pages provide information on the physical location and installation of the current BPM position demodulation and position data acquisition electronics.

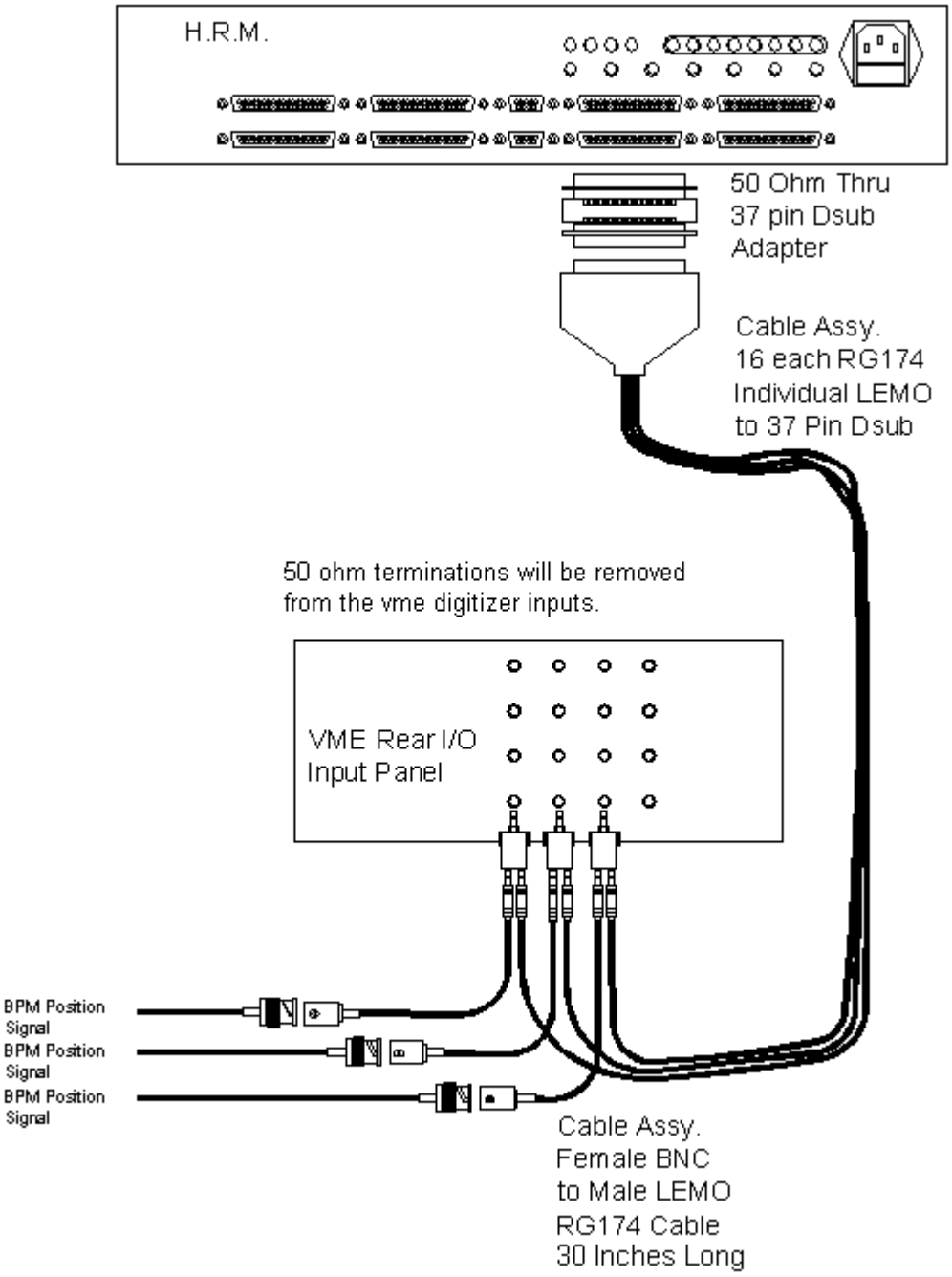


Figure I.1 Cabling modification for the BPM Position signals.

Adapter Cable Assembly Specification

Cable ==========
RG-174
Length = 30" +/- 0.5"

Connector 1 ==========
LEMO - FFA.00.250.CTAC29Z - RF/Coaxial Connector or equivalent.
Manufacturer: LEMO
Newark Part Number: 70C8241
Manufacturer Part No: FFA.00.250.CTAC29Z

Connector 2 ==========
AMPHENOL CONNEX - 112160 - RF/Coaxial Connector or equivalent.
Manufacturer: AMPHENOL CONNEX
Newark Part Number: 99H4294
Manufacturer Part No: 112160

Length Table for Individual Lemo to 37 Pin DSub Cable Assembly

Location	**Length**	**Comment**
G01-RR6-2	6 feet	This applies whether the HRM is in G01-RR6-2 or G01-RR6-1.
G21-RR5-2	6 feet	HRM in G21-RR5-2.
Period 18	6 feet	
G17-RR2	20 feet	Cable runs from VME crate in G17-RR2 to HRM in the bottom of G17-RR1-3.
G14-RR1	6 feet	
G11-RR6-1	8 feet	Cable runs from VME crate in G11-RR6-1 to HRM in G11-RR6-2.

II. Period 1 Racks

Status: Space Available

A 21-slot VME crate is installed in rack G01-RR6-3 that can be used for housing the VME processor for reading back the HRM data and for housing future Beam Loss Monitor Integrators. There appears to be plenty of space in rack G01-RR6-1 for mounting an HRM chassis.

Rack Numbers: G01-RR6-1, G01-RR6-2, G01-RR6-3.

BPM's Serviced Here:

Name	Period	Demod Rack #	VME alias	HRM alias	VME Crate	MODULE	CHAN
HL1	1	G01-RR6-1	HP01L	HK01L	BBPM24	1	0
HL2	2	G01-RR6-1	HP02L	HK02L	BBPM24	2	0
HL24	24	G01-RR6-1	HP24L	HK24L	BBPM24	0	0
HS1	1	G01-RR6-1	HP01S	HK01S	BBPM24	1	2
HS2	2	G01-RR6-1	HP02S	HK02S	BBPM24	2	2
HS24	24	G01-RR6-1	HP24S	HK24S	BBPM24	0	2
VL1	1	G01-RR6-1	VP01L	VK01L	BBPM24	1	1
VL2	2	G01-RR6-1	VP02L	VK02L	BBPM24	2	1
VL24	24	G01-RR6-1	VP24L	VK24L	BBPM24	0	1
VS1	1	G01-RR6-1	VP01S	VK01S	BBPM24	1	3
VS2	2	G01-RR6-1	VP02S	VK02S	BBPM24	2	3
VS24	24	G01-RR6-1	VP24S	VK24S	BBPM24	0	3
HL4	4	G01-RR6-2	HP04L	HK04L	BBPM24	4	0
HL5	5	G01-RR6-2	HP05L	HK05L	BBPM24	5	0
HS3	3	G01-RR6-2	HP03S	HK03S	BBPM24	3	2
HS4	4	G01-RR6-2	HP04S	HK04S	BBPM24	4	2
HS5	5	G01-RR6-2	HP05S	HK05S	BBPM24	5	2
HL3	3	G01-RR6-2	HP03L	HK03L	BBPM24	3	0
VL3	3	G01-RR6-2	VP03L	VK03L	BBPM24	3	1
VL4	4	G01-RR6-2	VP04L	VK04L	BBPM24	4	1
VL5	5	G01-RR6-2	VP05L	VK05L	BBPM24	5	1
VS3	3	G01-RR6-2	VP03S	VK03S	BBPM24	3	3
VS4	4	G01-RR6-2	VP04S	VK04S	BBPM24	4	3
VS5	5	G01-RR6-2	VP05S	VK05S	BBPM24	5	3
HP03LU	3	G01-RR6-3	HP03LU	HK03LU	BBPM24	7	2
VP03LU	3	G01-RR6-3	VP03LU	VK03LU	BBPM24	7	3

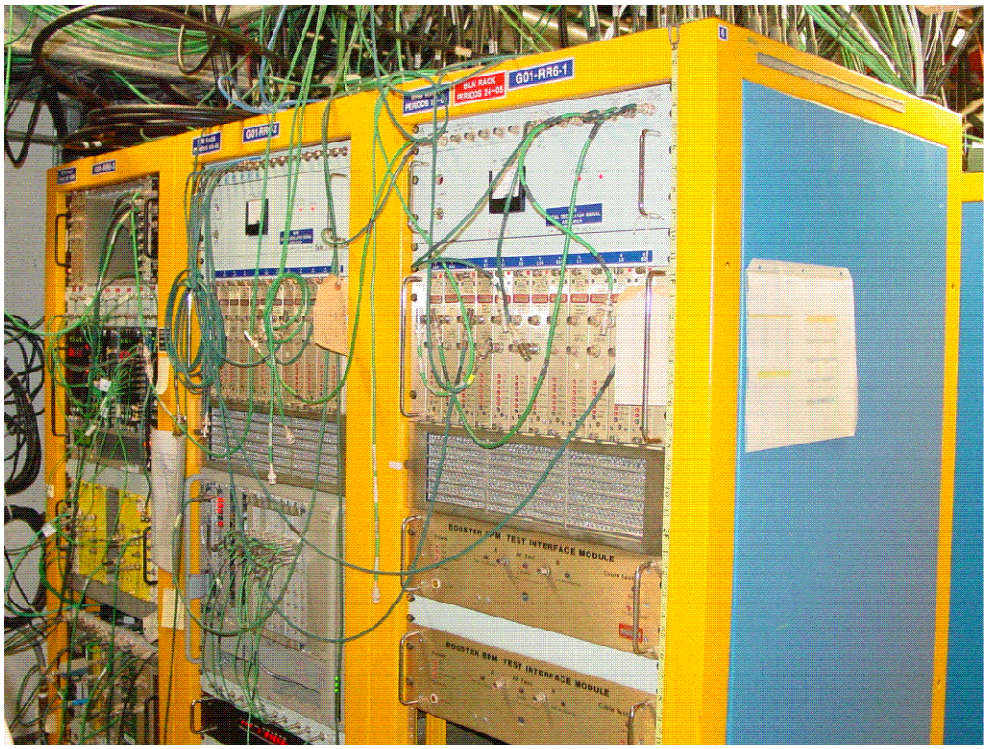


Figure II.1 G01-RR5 racks (front, top).

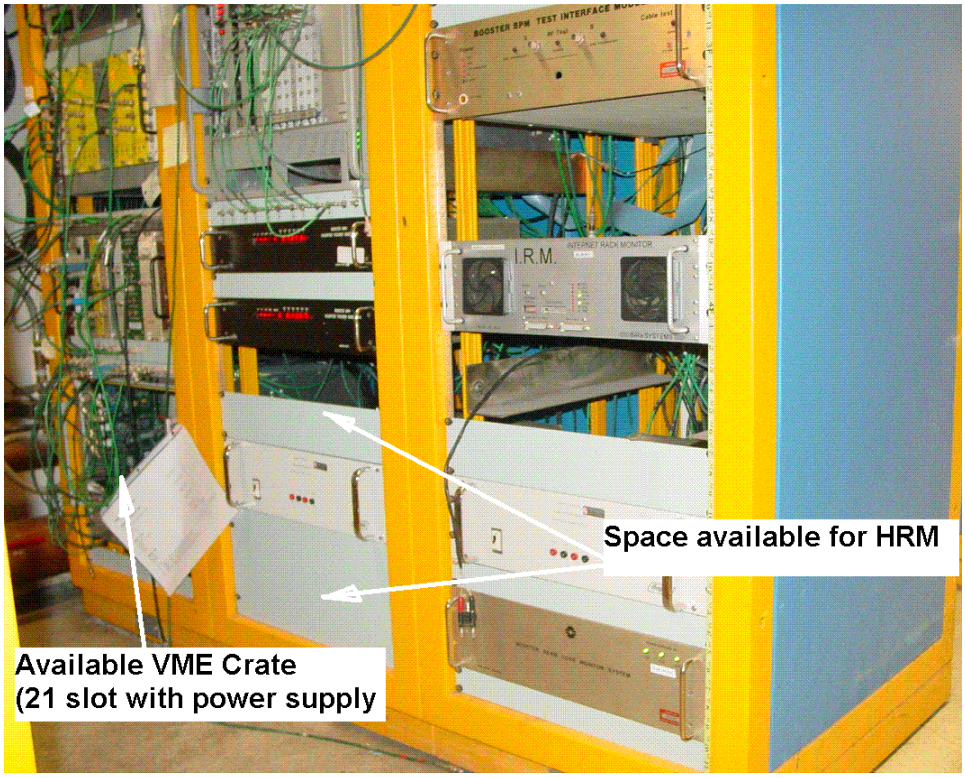


Figure II.2 G01-RR5 racks (front, bottom).

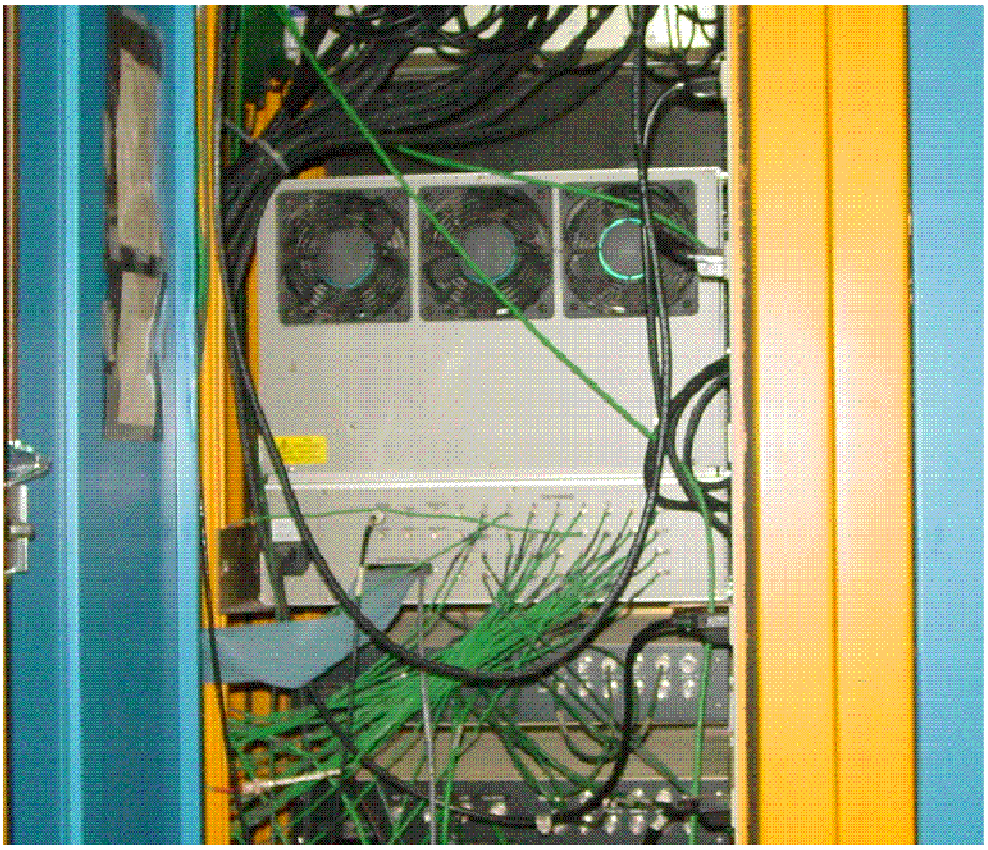


Figure II.3 G01-RR5 Digitizer VME crate (rear).

Period 1 -- TODO

1. Procure components for the Lemo to 37 pin Dsub cable assembly. *See length chart for cable length requirements*.
2. Build Lemo to 37 pin Dsub cable assembly.
3. Install HRM into rack G01-RR6-2.
4. Make BPM position signal cable modifications.
    a. Label existing BPM position signal cables at the VME IO panel if necessary.
    b. Attach to each signal cable a new Lemo Tee and reconnect to the VME IO panel in the correct port.
    c. Run the multi-RG174 Lemo to 37 pin Dsub cable assembly in the rack.
    d. Connect the cable for the assigned HRM channel to the appropriate position signal Lemo Tee.
    e. Connect the 37 pin Dsub end of the assembly to the 50 Ohm connector adapter.
    f. Connect the cable assembly with adapter to the HRM.
5. Monitor the Turn-By-Turn and HRM data to ensure proper connections

III. Period 21 Racks

Status: Consider removing old corrector power supplies.

Once the old sextupole magnet power supplies are removed from Rack G21-RR5-1 there will be more than enough room for a VME crate at the location. A 5 slot VME crate and an HRM could be fit into G21-RR5-2 regardless of whether the old corrector power supplies are removed, however. The VME processor here could receive data from an HRM located here at period 21 and an HRM down the hall in the North-West corner of the Booster Gallery.

Rack Numbers: G21-RR5-1, G21-RR5-2, G21-RR5-3.

BPM's Serviced Here:

Name	Period	Demod Rack #	VME alias	HRM alias	VME Crate	MODULE	CHAN
HL21	21	G21-RR5-2	HP21L	HK21L	BBPM21	0	0
VL21	21	G21-RR5-2	VP21L	VK21L	BBPM21	0	1
HS21	21	G21-RR5-2	HP21S	HK21S	BBPM21	0	2
VS21	21	G21-RR5-2	VP21S	VK21S	BBPM21	0	3
HL22	21	G21-RR5-2	HP22L	HK22L	BBPM21	1	0
VL22	21	G21-RR5-2	VP22L	VK22L	BBPM21	1	1
HS22	21	G21-RR5-2	HP22S	HK22S	BBPM21	1	2
VS22	21	G21-RR5-2	VP22S	VK22S	BBPM21	1	3
HL23	21	G21-RR5-2	HP23L	HK23L	BBPM21	2	0
VL23	21	G21-RR5-2	VP23L	VK23L	BBPM21	2	1
HS23	21	G21-RR5-2	HP23S	HK23S	BBPM21	2	2
VS23	21	G21-RR5-2	VP23S	VK23S	BBPM21	2	3

Figure III.1 G21-RR5 racks (front).

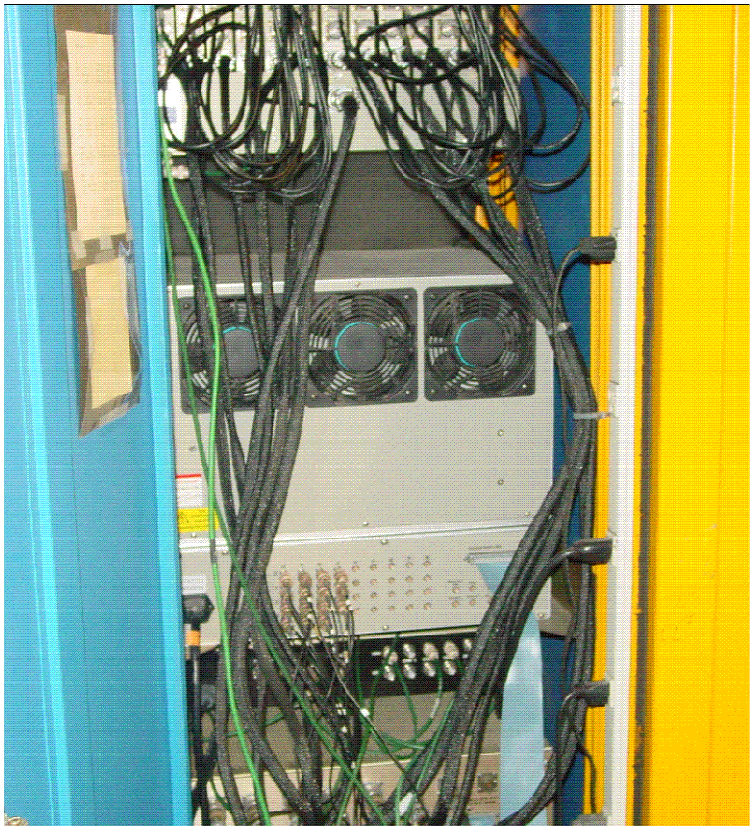


Figure III.2 G21-RR5-2 Digitizer VME crate (rear).

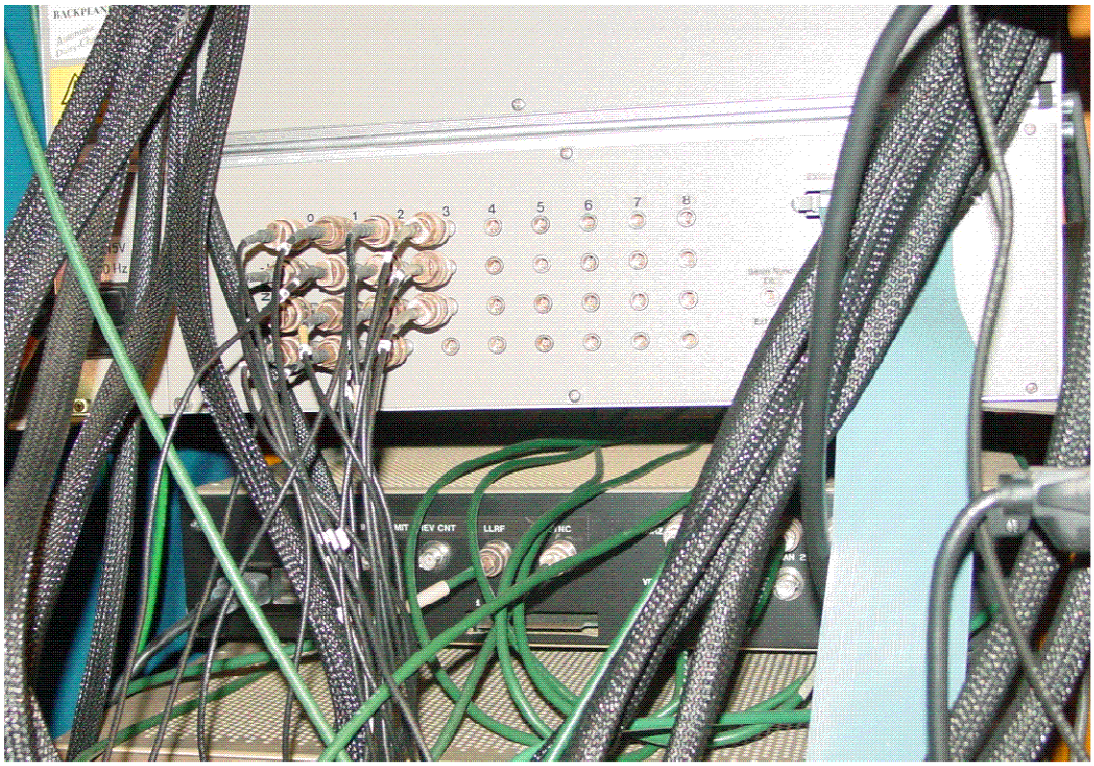


Figure III.3 G21-RR5-2 Digitizer VME crate close-up.

Period 21 -- TODO

1. Procure components for the Lemo to 37 pin Dsub cable assembly. *See length chart for cable length requirements*.
2. Build Lemo to 37 pin Dsub cable assembly.
3. Install HRM and 5 Slot VME Crate into rack G21-RR5-2. The BPM RF Module Power Supply will need to be move upward or downward in the rack to make room.
4. Run Hotlink cable from G21-RR5-2 down to the HRM in the Period 18 rack.
5. Make BPM position signal cable modifications.
    a. Label existing BPM position signal cables at the VME IO panel if necessary.
    b. Remove existing BNC to Lemo adapter.
    c. Attach to each signal cable the new BNC to Lemo cable and Lemo Tee and reconnect to the VME IO panel in the correct port.
    d. Run the multi-RG174 Lemo to 37 pin Dsub cable assembly in the rack.
    e. Connect the cable for the assigned HRM channel to the appropriate position signal Lemo Tee.
    f. Connect the 37 pin Dsub end of the assembly to the 50 Ohm connector adapter.
    g. Connect the cable assembly with adapter to the HRM.
6. Monitor the Turn-By-Turn and HRM data to ensure proper connections

IV. Period 18 Rack (BGW-North Corner)

Status: Difficult, limited space. Run Hotlink to VME at period 21.

This is a difficult location. We would need to squeeze in the HRM chassis and run the Hotlink data link down the hall to period 21 where the processor there would handle the data from both this HRM at period 18 and the HRM at period 21. The cable length for the Hotlink would be just under the 30 meter limit. The figures below indicate how we would squeeze in the HRM.

Rack Numbers: Period 18 - 20 .

BPM's Serviced Here:

Name	Period	Demod Rack #	VME alias	HRM alias	VME Crate	MODULE	CHAN
HL18	18	P. 18-20 (BGW-North)	HP18L	HK18L	BBPM18	0	0
HS18	18	P. 18-20 (BGW-North)	HP18S	HK18S	BBPM18	0	2
HL19	18	P. 18-20 (BGW-North)	HP19L	HK19L	BBPM18	1	0
HS19	18	P. 18-20 (BGW-North)	HP19S	HK19S	BBPM18	1	2
HL20	18	P. 18-20 (BGW-North)	HP20L	HK20L	BBPM18	2	0
HS20	18	P. 18-20 (BGW-North)	HP20S	HK20S	BBPM18	2	2
VL18	18	P. 18-20 (BGW-North)	VP18L	VK18L	BBPM18	0	1
VS18	18	P. 18-20 (BGW-North)	VP18S	VK18S	BBPM18	0	3
VL19	18	P. 18-20 (BGW-North)	VP19L	VK19L	BBPM18	1	1
VS19	18	P. 18-20 (BGW-North)	VP19S	VK19S	BBPM18	1	3
VL20	18	P. 18-20 (BGW-North)	VP20L	VK20L	BBPM18	2	1
VS20	18	P. 18-20 (BGW-North)	VP20S	VK20S	BBPM18	2	3

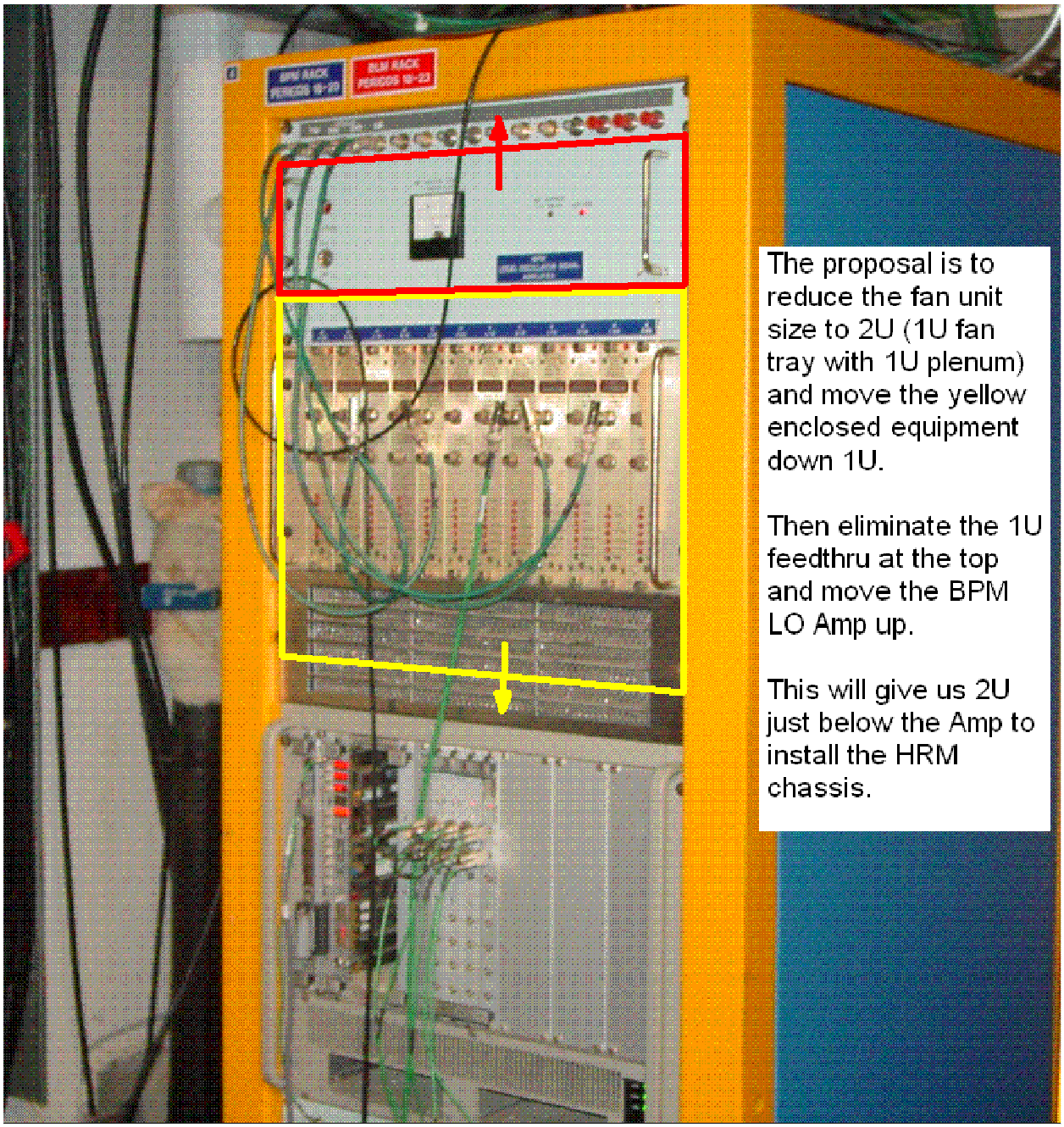


Figure IV.1. Period 18 rack (front) with modification proposal.

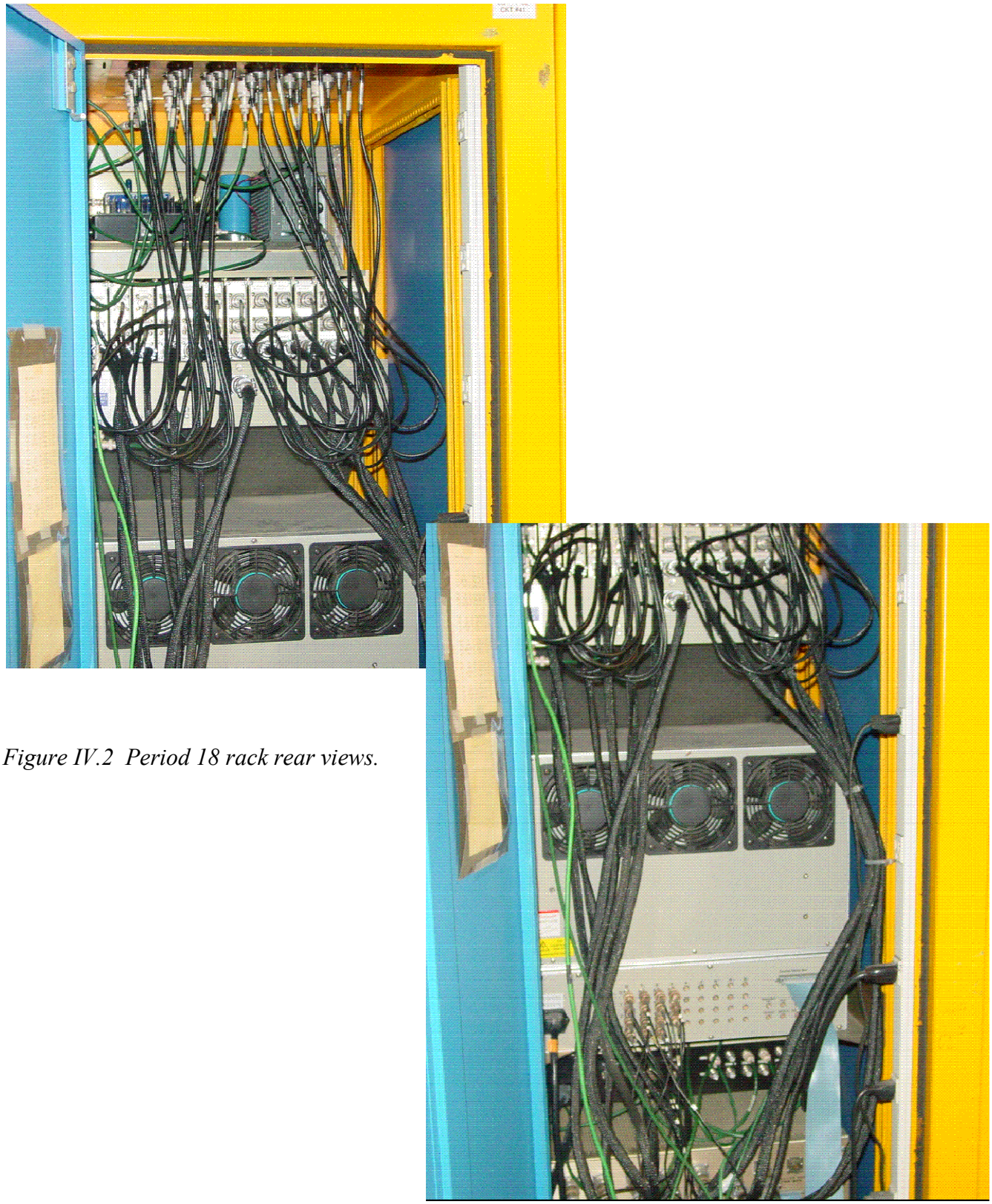


Figure IV.2 Period 18 rack rear views.

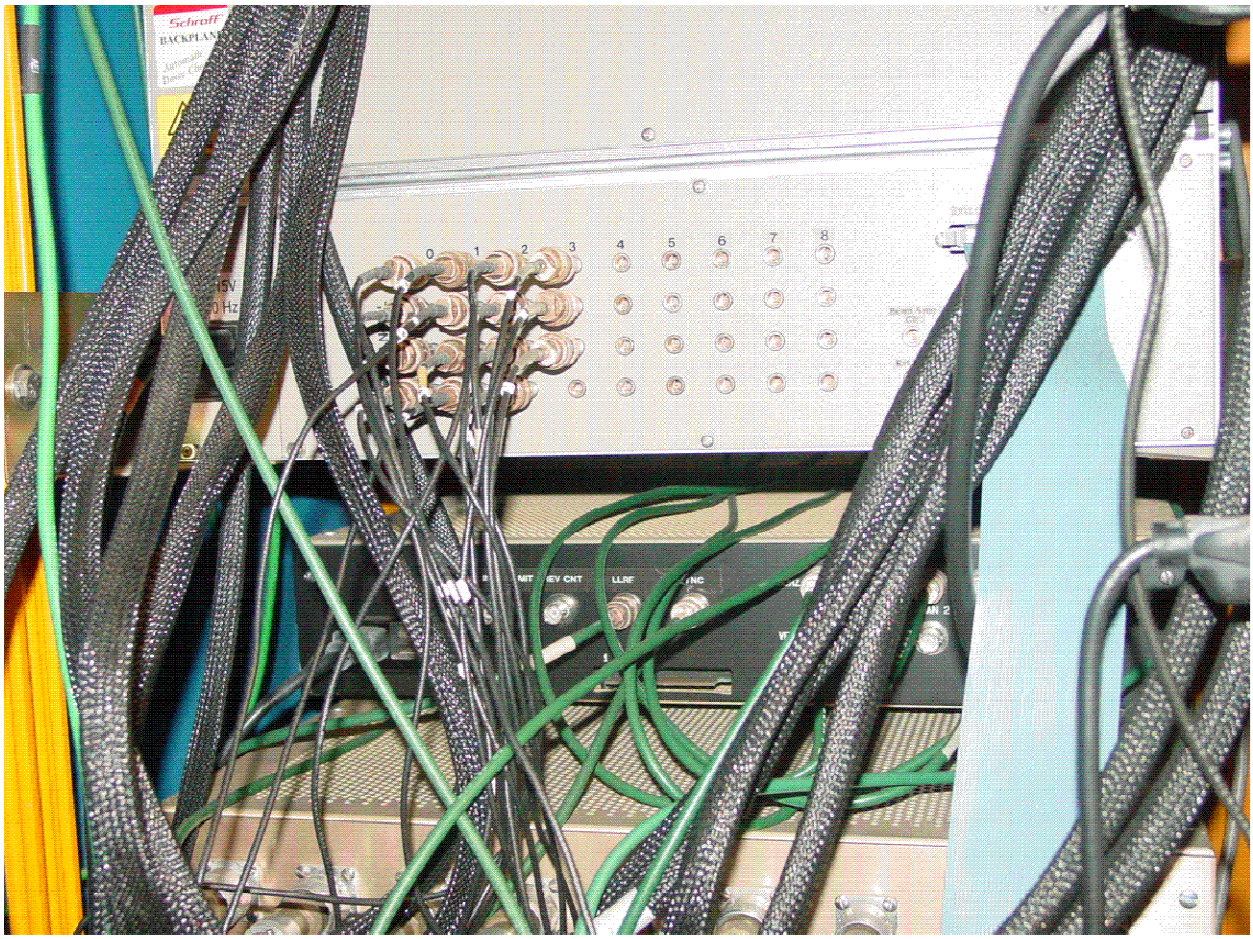


Figure IV.3 Period 18 Digitizer VME crate close-up.

Period 18 -- TODO

7. Procure components for the new 2U fan unit.
    a. Panel Chasis, 1.75” High x 8” Deep x 17” Wide, Newark # 52F6474.
    b. Slotted Ventilation Panel, 1U High, Newark # 94B8070.
    c. AC Fan Tray, three fans, 1.75” High x 7.5” Deep x 17” Wide, Newark# 93B7361.
8. Assemble fan unit components.
9. Procure components for the Lemo to 37 pin Dsub cable assembly. *See length chart for cable length requirements*.
10. Build Lemo to 37 pin Dsub cable assembly.
11. Submit shutdown work request for powering down the rack and moving the chassis.
12. Make rack modifications.
    a. Remove existing fan, filter and plenum.
    b. Install 90 degree shelf brackets for supporting the crate in the new position.
    c. Lower the NIM crate into the new position.
    d. Install new fan unit below the NIM crate.
    e. Install new signal feedthru above the IRM chassis.
    f. Move IRM signals from the top feedthru panel to the new panel.
    g. Remove the top feedthru panel.
    h. Move the BPM LO Amplifier up 1U.
13. Install HRM into the new 2U opening.
    **** Power can be returned to rack at this point and shutdown can end.
14. Make BPM position signal cable modifications.
    a. Label existing BPM position signal cables at the VME IO panel if necessary.
    b. Remove existing BNC to Lemo adapter.
    c. Attach to each signal cable the new BNC to Lemo cable and Lemo Tee and reconnect to the VME IO panel in the correct port.
    d. Run the multi-RG174 Lemo to 37 pin Dsub cable assembly in the rack.
    e. Connect the cable for the assigned HRM channel to the appropriate position signal Lemo Tee.
    f. Connect the 37 pin Dsub end of the assembly to the 50 Ohm connector adapter.
    g. Connect the cable assembly with adapter to the HRM.
15. Monitor the Turn-By-Turn and HRM data to ensure proper connections

V. Period 17 Racks

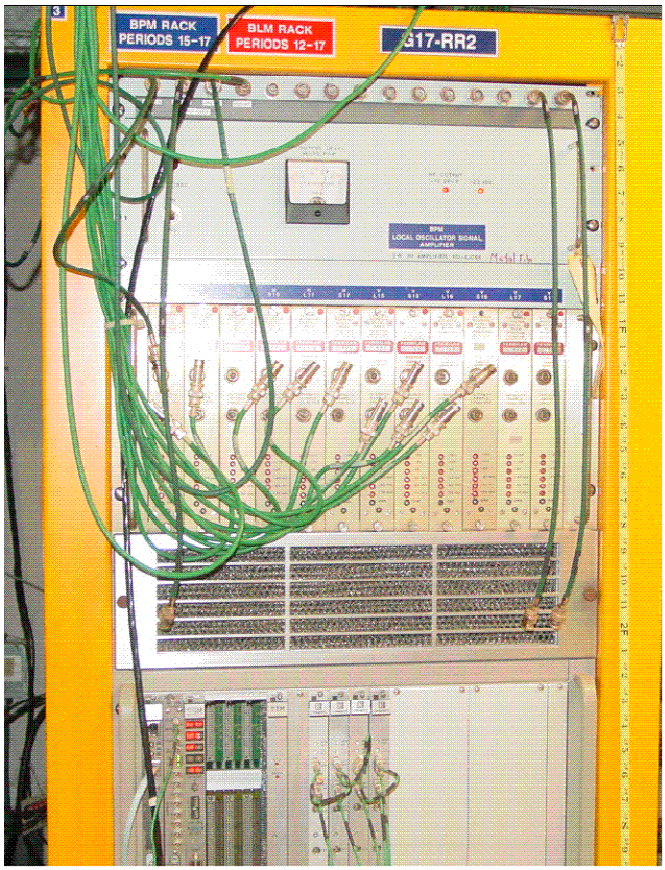
Status: Consider removing old corrector power supplies in rack G17-RR1-1.

The nearby rack G17-RR1-3 can be used to house both the VME crate, VME processor and the HRM chassis. With the HRM chassis in G17-RR1-3 a longer cable assembly with the analog BPM signals would have to be run over from G17-RR2.

Rack Numbers: G17-RR2, G17-RR1-3.

BPM's Serviced Here:

Name	Period	Demod Rack #	VME alias	HRM alias	VME Crate	MODULE	CHAN
HL15	17	G17-RR2	HP15L	HK15L	BBPM15	0	0
HS15	17	G17-RR2	HP15S	HK15S	BBPM15	0	2
HL16	17	G17-RR2	HP16L	HK16L	BBPM15	1	0
HS16	17	G17-RR2	HP16S	HK16S	BBPM15	1	2
HL17	17	G17-RR2	HP17L	HK17L	BBPM15	2	0
HS17	17	G17-RR2	HP17S	HK17S	BBPM15	2	2
VL15	17	G17-RR2	VP15L	VK15L	BBPM15	0	1
VS15	17	G17-RR2	VP15S	VK15S	BBPM15	0	3
VL16	17	G17-RR2	VP16L	VK16L	BBPM15	1	1
VS16	17	G17-RR2	VP16S	VK16S	BBPM15	1	3
VL17	17	G17-RR2	VP17L	VK17L	BBPM15	2	1
VS17	17	G17-RR2	VP17S	VK17S	BBPM15	2	3



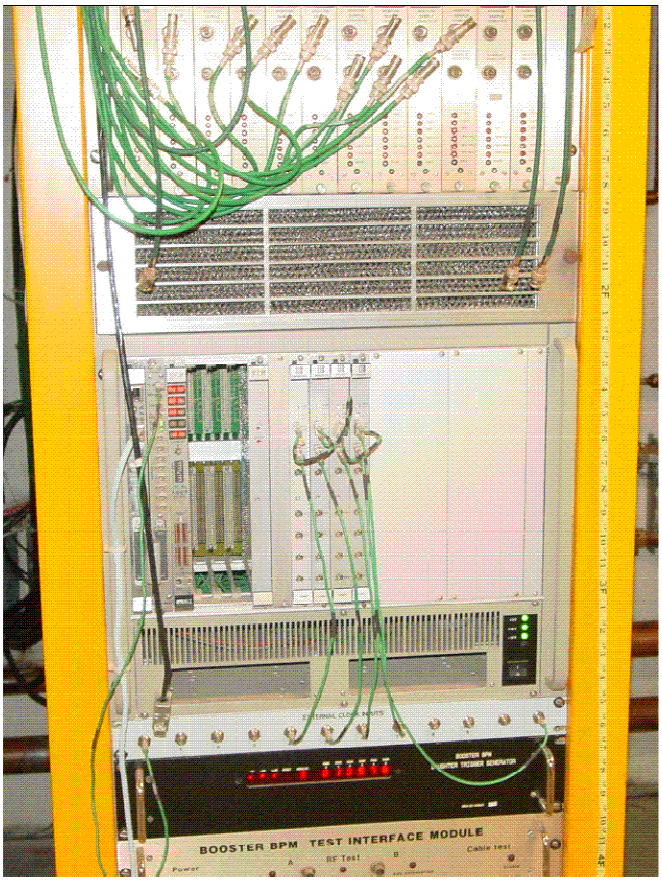
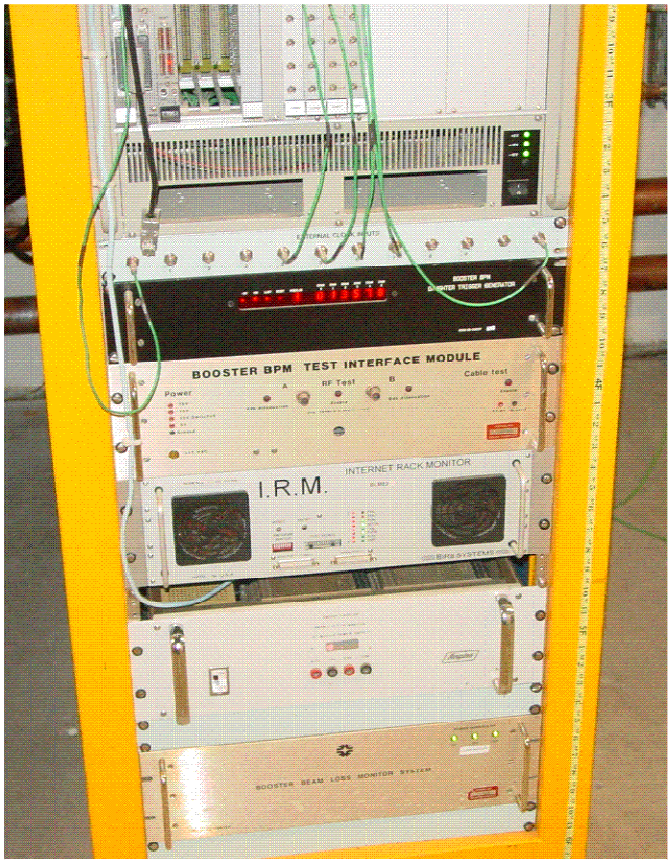


Figure V.1 G17-RR2 rack front views.



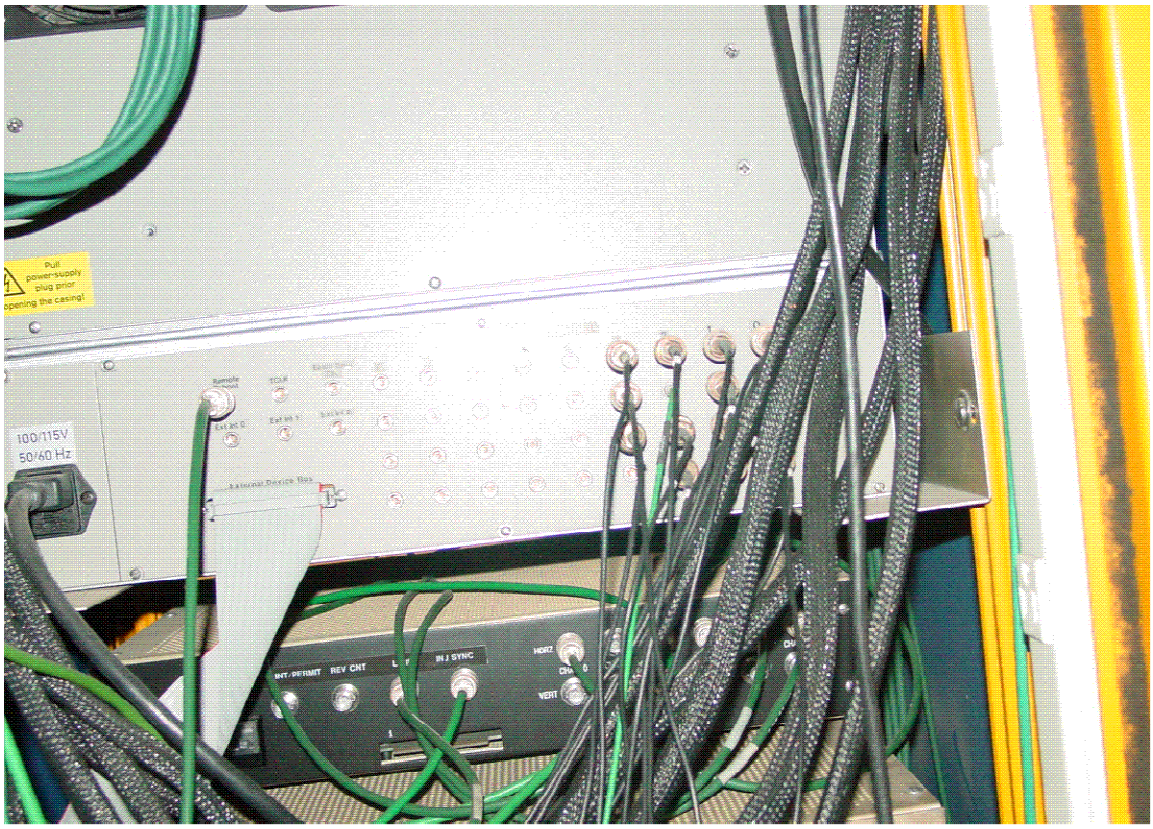


Figure V.2 G17-RR2 Digitizer VME crate close-up.

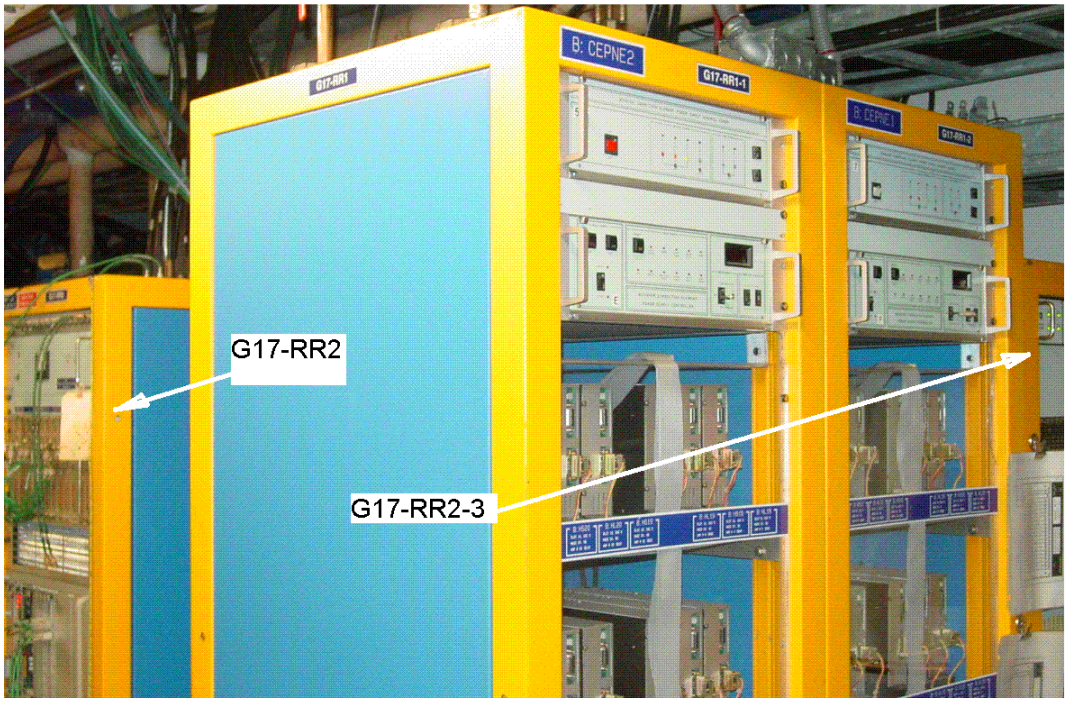


Figure V.3 G17-RR1-1 rack. Possible location of the HRM and VME Crate

Figure V.4 G17-RR1-3 rack front views.

Period 17 -- TODO

1. Procure components for the Lemo to 37 pin Dsub cable assembly. *See length chart for cable length requirements*.
2. Build Lemo to 37 pin Dsub cable assembly.
3. Install HRM and 5 Slot VME Crate into rack G17-RR1-3. The BPM RF Module Power Supply will need to be move upward or downward in the rack to make room.
4. Make BPM position signal cable modifications.
    a. Label existing BPM position signal cables at the VME IO panel if necessary.
    b. Remove existing BNC to Lemo adapter.
    c. Attach to each signal cable the new BNC to Lemo cable and Lemo Tee and reconnect to the VME IO panel in the correct port.
    d. Run the multi-RG174 Lemo to 37 pin Dsub cable assembly from rack G15-RR2 to G17-RR1-3.
    e. Connect the cable for the assigned HRM channel to the appropriate position signal Lemo Tee.
    f. Connect the 37 pin Dsub end of the assembly to the 50 Ohm connector adapter.
    g. Connect the cable assembly with adapter to the HRM.
5. Monitor the Turn-By-Turn and HRM data to ensure proper connections

VI. Period 14 Racks

Status: Space available.

HRM and VME Equipment can go in the bottom portion of G14-RR1.

Rack Numbers: G14-RR1.

BPM's Serviced Here:

Name	Period	Demod Rack #	VME alias	HRM alias	VME Crate	MODULE	CHAN
HL12	14	G14-RR1	HP12L	HK12L	BBPM12	0	0
HS12	14	G14-RR1	HP12S	HK12S	BBPM12	0	2
HL13	14	G14-RR1	HP13L	HK13L	BBPM12	1	0
HS13	14	G14-RR1	HP13S	HK13S	BBPM12	1	2
HL14	14	G14-RR1	HP14L	HK14L	BBPM12	2	0
HS14	14	G14-RR1	HP14S	HK14S	BBPM12	2	2
VL12	14	G14-RR1	VP12L	VK12L	BBPM12	0	1
VS12	14	G14-RR1	VP12S	VK12S	BBPM12	0	3
VL13	14	G14-RR1	VP13L	VK13L	BBPM12	1	1
VS13	14	G14-RR1	VP13S	VK13S	BBPM12	1	3
VL14	14	G14-RR1	VP14L	VK14L	BBPM12	2	1
VS14	14	G14-RR1	VP14S	VK14S	BBPM12	2	3

Figure VI.1 G14-RR2 rack (front).

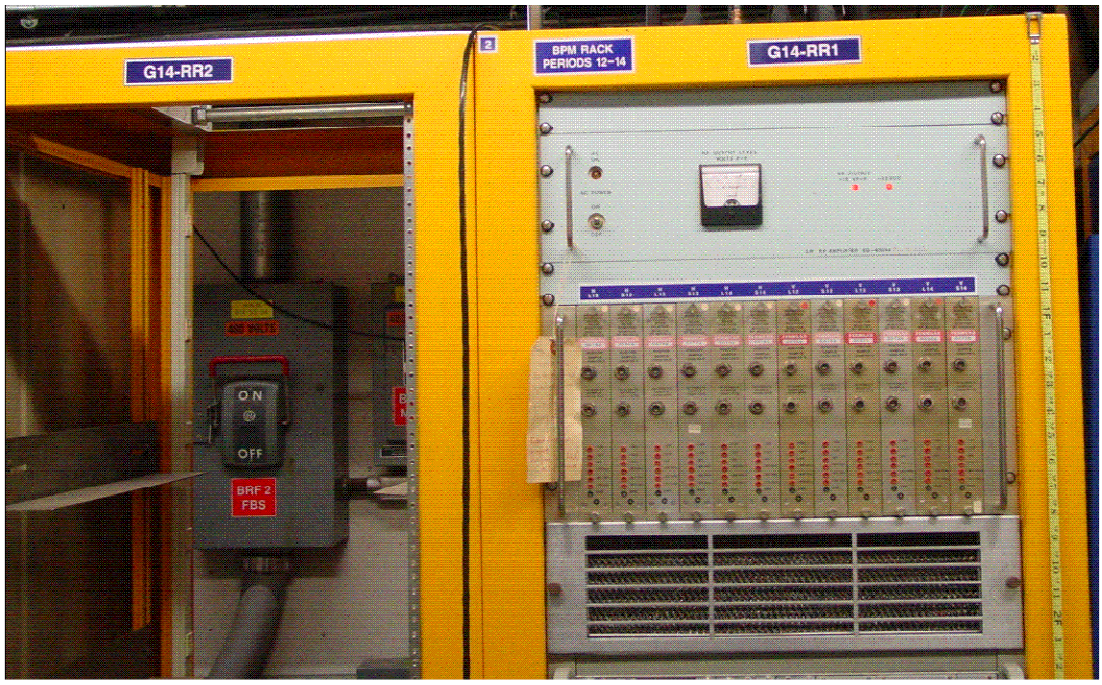


Figure VI.2 G14-RR1 rack (top, front).

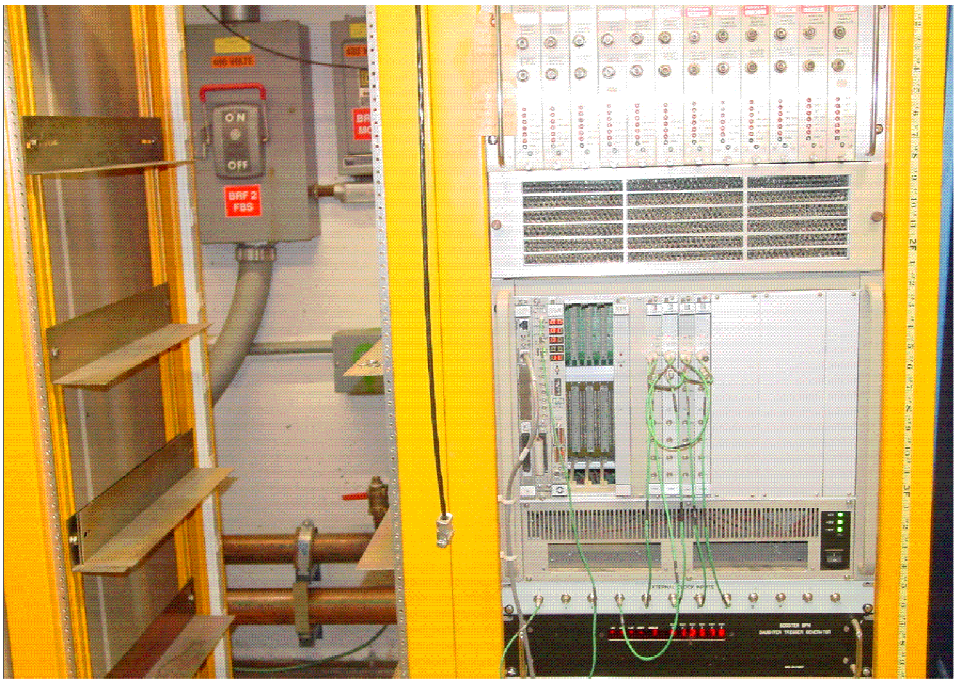


Figure VI.3 G14-RR1 rack (mid, front).

Figure VI.4 G14-RR1 rack (bottom, front).

Period 14 -- TODO

1. Procure components for the Lemo to 37 pin Dsub cable assembly. *See length chart for cable length requirements*.
2. Build Lemo to 37 pin Dsub cable assembly.
3. Install HRM and 5 Slot VME Crate into bottom portion of rack G14-RR1. The BPM RF Module Power Supply will need to be move upward or downward in the rack to make room.
4. Make BPM position signal cable modifications.
    a. Label existing BPM position signal cables at the VME IO panel if necessary.
    b. Remove existing BNC to Lemo adapter.
    c. Attach to each signal cable the new BNC to Lemo cable and Lemo Tee and reconnect to the VME IO panel in the correct port.
    d. Run the multi-RG174 Lemo to 37 pin Dsub cable assembly in the rack.
    e. Connect the cable for the assigned HRM channel to the appropriate position signal Lemo Tee.
    f. Connect the 37 pin Dsub end of the assembly to the 50 Ohm connector adapter.
    g. Connect the cable assembly with adapter to the HRM.
5. Monitor the Turn-By-Turn and HRM data to ensure proper connections

VII. Period 11 Racks

Status: Space available for HRM, VME crate already installed.

The BPM racks at Period 11 have plenty of space for an HRM and the VME crate is already installed.

Rack Numbers: G11-RR6-1, G11-RR6-2, G11-RR6-3.

BPM's Serviced Here:

Name	Period	Demod Rack #	VME alias	HRM alias	VME Crate	MODULE	CHAN
HL9	11	G11-RR6-1	HP09L	HK09L	BBPM06	3	0
HS9	11	G11-RR6-1	HP09S	HK09S	BBPM06	3	2
HL10	11	G11-RR6-1	HP10L	HK10L	BBPM06	4	0
HS10	11	G11-RR6-1	HP10S	HK10S	BBPM06	4	2
HL11	11	G11-RR6-1	HP11L	HK11L	BBPM06	5	0
HS11	11	G11-RR6-1	HP11S	HK11S	BBPM06	5	2
VL9	11	G11-RR6-1	VP09L	VK09L	BBPM06	3	1
VS9	11	G11-RR6-1	VP09S	VK09S	BBPM06	3	3
VL10	11	G11-RR6-1	VP10L	VK10L	BBPM06	4	1
VS10	11	G11-RR6-1	VP10S	VK10S	BBPM06	4	3
VL11	11	G11-RR6-1	VP11L	VK11L	BBPM06	5	1
VS11	11	G11-RR6-1	VP11S	VK11S	BBPM06	5	3
HL6	11	G11-RR6-2	HP06L	HK06L	BBPM06	0	0
HS6	11	G11-RR6-2	HP06S	HK06S	BBPM06	0	2
HL7	11	G11-RR6-2	HP07L	HK07L	BBPM06	1	0
HS7	11	G11-RR6-2	HP07S	HK07S	BBPM06	1	2
HL8	11	G11-RR6-2	HP08L	HK08L	BBPM06	2	0
HS8	11	G11-RR6-2	HP08S	HK08S	BBPM06	2	2
VL6	11	G11-RR6-2	VP06L	VK06L	BBPM06	0	1
VS6	11	G11-RR6-2	VP06S	VK06S	BBPM06	0	3
VL7	11	G11-RR6-2	VP07L	VK07L	BBPM06	1	1
VS7	11	G11-RR6-2	VP07S	VK07S	BBPM06	1	3
VL8	11	G11-RR6-2	VP08L	VK08L	BBPM06	2	1
VS8	11	G11-RR6-2	VP08S	VK08S	BBPM06	2	3
VUL6	11	G11-RR6-3	VP06LU	VK06LU	BBPM06	7	1
HUL6	11	G11-RR6-3	HP06LU	HK06LU	BBPM06	7	0
VUL7	11	G11-RR6-3	VP07LU	VK07LU	BBPM06	7	3
HUL7	11	G11-RR6-3	HP07LU	HK07LU	BBPM06	7	2

Figure VII.1 G11-RR5 racks (top, front).

Figure VII.1 G11-RR5 racks (bottom, front).

Period 11 -- TODO

1. Procure components for the Lemo to 37 pin Dsub cable assembly. *See length chart for cable length requirements*.
2. Build Lemo to 37 pin Dsub cable assembly.
3. Install HRM and 5 Slot VME Crate into bottom portion of rack G11-RR5-2. The BPM RF Module Power Supply will need to be move upward or downward in the rack to make room.
4. Make BPM position signal cable modifications.
    a. Label existing BPM position signal cables at the VME IO panel if necessary.
    b. Remove existing BNC to Lemo adapter.
    c. Attach to each signal cable the new BNC to Lemo cable and Lemo Tee and reconnect to the VME IO panel in the correct port.
    d. Run the multi-RG174 Lemo to 37 pin Dsub cable assembly in the rack.
    e. Connect the cable for the assigned HRM channel to the appropriate position signal Lemo Tee.
    f. Connect the 37 pin Dsub end of the assembly to the 50 Ohm connector adapter.
    g. Connect the cable assembly with adapter to the HRM.
5. Monitor the Turn-By-Turn and HRM data to ensure proper connections

VIII. BPM Listing

Name	Period	Demod Rack #	VME alias	HRM alias	VME Crate	MODULE	CHAN
HL1	1	G01-RR6-1	HP01L	HK01L	BBPM24	1	0
HL2	2	G01-RR6-1	HP02L	HK02L	BBPM24	2	0
HL24	24	G01-RR6-1	HP24L	HK24L	BBPM24	0	0
HS1	1	G01-RR6-1	HP01S	HK01S	BBPM24	1	2
HS2	2	G01-RR6-1	HP02S	HK02S	BBPM24	2	2
HS24	24	G01-RR6-1	HP24S	HK24S	BBPM24	0	2
VL1	1	G01-RR6-1	VP01L	VK01L	BBPM24	1	1
VL2	2	G01-RR6-1	VP02L	VK02L	BBPM24	2	1
VL24	24	G01-RR6-1	VP24L	VK24L	BBPM24	0	1
VS1	1	G01-RR6-1	VP01S	VK01S	BBPM24	1	3
VS2	2	G01-RR6-1	VP02S	VK02S	BBPM24	2	3
VS24	24	G01-RR6-1	VP24S	VK24S	BBPM24	0	3
HL4	4	G01-RR6-2	HP04L	HK04L	BBPM24	4	0
HL5	5	G01-RR6-2	HP05L	HK05L	BBPM24	5	0
HS3	3	G01-RR6-2	HP03S	HK03S	BBPM24	3	2
HS4	4	G01-RR6-2	HP04S	HK04S	BBPM24	4	2
HS5	5	G01-RR6-2	HP05S	HK05S	BBPM24	5	2
HL3	3	G01-RR6-2	HP03L	HK03L	BBPM24	3	0
VL3	3	G01-RR6-2	VP03L	VK03L	BBPM24	3	1
VL4	4	G01-RR6-2	VP04L	VK04L	BBPM24	4	1
VL5	5	G01-RR6-2	VP05L	VK05L	BBPM24	5	1
VS3	3	G01-RR6-2	VP03S	VK03S	BBPM24	3	3
VS4	4	G01-RR6-2	VP04S	VK04S	BBPM24	4	3
VS5	5	G01-RR6-2	VP05S	VK05S	BBPM24	5	3
HP03LU	3	G01-RR6-3	HP03LU	HK03LU	BBPM24	7	2
VP03LU	3	G01-RR6-3	VP03LU	VK03LU	BBPM24	7	3
HL21	21	G21-RR5-2	HP21L	HK21L	BBPM21	0	0
VL21	21	G21-RR5-2	VP21L	VK21L	BBPM21	0	1
HS21	21	G21-RR5-2	HP21S	HK21S	BBPM21	0	2
VS21	21	G21-RR5-2	VP21S	VK21S	BBPM21	0	3
HL22	21	G21-RR5-2	HP22L	HK22L	BBPM21	1	0
VL22	21	G21-RR5-2	VP22L	VK22L	BBPM21	1	1
HS22	21	G21-RR5-2	HP22S	HK22S	BBPM21	1	2
VS22	21	G21-RR5-2	VP22S	VK22S	BBPM21	1	3
HL23	21	G21-RR5-2	HP23L	HK23L	BBPM21	2	0
VL23	21	G21-RR5-2	VP23L	VK23L	BBPM21	2	1
HS23	21	G21-RR5-2	HP23S	HK23S	BBPM21	2	2
VS23	21	G21-RR5-2	VP23S	VK23S	BBPM21	2	3
HL18	18	P. 18-20 (BGW-	HP18L	HK18L	BBPM18	0	0

		North)					
HS18	18	P. 18-20 (BGW-North)	HP18S	HK18S	BBPM18	0	2
HL19	18	P. 18-20 (BGW-North)	HP19L	HK19L	BBPM18	1	0
HS19	18	P. 18-20 (BGW-North)	HP19S	HK19S	BBPM18	1	2
HL20	18	P. 18-20 (BGW-North)	HP20L	HK20L	BBPM18	2	0
HS20	18	P. 18-20 (BGW-North)	HP20S	HK20S	BBPM18	2	2
VL18	18	P. 18-20 (BGW-North)	VP18L	VK18L	BBPM18	0	1
VS18	18	P. 18-20 (BGW-North)	VP18S	VK18S	BBPM18	0	3
VL19	18	P. 18-20 (BGW-North)	VP19L	VK19L	BBPM18	1	1
VS19	18	P. 18-20 (BGW-North)	VP19S	VK19S	BBPM18	1	3
VL20	18	P. 18-20 (BGW-North)	VP20L	VK20L	BBPM18	2	1
VS20	18	P. 18-20 (BGW-North)	VP20S	VK20S	BBPM18	2	3
HL15	17	G17-RR2	HP15L	HK15L	BBPM15	0	0
HS15	17	G17-RR2	HP15S	HK15S	BBPM15	0	2
HL16	17	G17-RR2	HP16L	HK16L	BBPM15	1	0
HS16	17	G17-RR2	HP16S	HK16S	BBPM15	1	2
HL17	17	G17-RR2	HP17L	HK17L	BBPM15	2	0
HS17	17	G17-RR2	HP17S	HK17S	BBPM15	2	2
VL15	17	G17-RR2	VP15L	VK15L	BBPM15	0	1
VS15	17	G17-RR2	VP15S	VK15S	BBPM15	0	3
VL16	17	G17-RR2	VP16L	VK16L	BBPM15	1	1
VS16	17	G17-RR2	VP16S	VK16S	BBPM15	1	3
VL17	17	G17-RR2	VP17L	VK17L	BBPM15	2	1
VS17	17	G17-RR2	VP17S	VK17S	BBPM15	2	3
HL12	14	G14-RR1	HP12L	HK12L	BBPM12	0	0
HS12	14	G14-RR1	HP12S	HK12S	BBPM12	0	2
HL13	14	G14-RR1	HP13L	HK13L	BBPM12	1	0
HS13	14	G14-RR1	HP13S	HK13S	BBPM12	1	2
HL14	14	G14-RR1	HP14L	HK14L	BBPM12	2	0
HS14	14	G14-RR1	HP14S	HK14S	BBPM12	2	2
VL12	14	G14-RR1	VP12L	VK12L	BBPM12	0	1
VS12	14	G14-RR1	VP12S	VK12S	BBPM12	0	3
VL13	14	G14-RR1	VP13L	VK13L	BBPM12	1	1
VS13	14	G14-RR1	VP13S	VK13S	BBPM12	1	3

VL14	14	G14-RR1	VP14L	VK14L	BBPM12	2	1
VS14	14	G14-RR1	VP14S	VK14S	BBPM12	2	3
HL9	11	G11-RR6-1	HP09L	HK09L	BBPM06	3	0
HS9	11	G11-RR6-1	HP09S	HK09S	BBPM06	3	2
HL10	11	G11-RR6-1	HP10L	HK10L	BBPM06	4	0
HS10	11	G11-RR6-1	HP10S	HK10S	BBPM06	4	2
HL11	11	G11-RR6-1	HP11L	HK11L	BBPM06	5	0
HS11	11	G11-RR6-1	HP11S	HK11S	BBPM06	5	2
VL9	11	G11-RR6-1	VP09L	VK09L	BBPM06	3	1
VS9	11	G11-RR6-1	VP09S	VK09S	BBPM06	3	3
VL10	11	G11-RR6-1	VP10L	VK10L	BBPM06	4	1
VS10	11	G11-RR6-1	VP10S	VK10S	BBPM06	4	3
VL11	11	G11-RR6-1	VP11L	VK11L	BBPM06	5	1
VS11	11	G11-RR6-1	VP11S	VK11S	BBPM06	5	3
HL6	11	G11-RR6-2	HP06L	HK06L	BBPM06	0	0
HS6	11	G11-RR6-2	HP06S	HK06S	BBPM06	0	2
HL7	11	G11-RR6-2	HP07L	HK07L	BBPM06	1	0
HS7	11	G11-RR6-2	HP07S	HK07S	BBPM06	1	2
HL8	11	G11-RR6-2	HP08L	HK08L	BBPM06	2	0
HS8	11	G11-RR6-2	HP08S	HK08S	BBPM06	2	2
VL6	11	G11-RR6-2	VP06L	VK06L	BBPM06	0	1
VS6	11	G11-RR6-2	VP06S	VK06S	BBPM06	0	3
VL7	11	G11-RR6-2	VP07L	VK07L	BBPM06	1	1
VS7	11	G11-RR6-2	VP07S	VK07S	BBPM06	1	3
VL8	11	G11-RR6-2	VP08L	VK08L	BBPM06	2	1
VS8	11	G11-RR6-2	VP08S	VK08S	BBPM06	2	3
VUL6	11	G11-RR6-3	VP06LU	VK06LU	BBPM06	7	1
HUL6	11	G11-RR6-3	HP06LU	HK06LU	BBPM06	7	0
VUL7	11	G11-RR6-3	VP07LU	VK07LU	BBPM06	7	3
HUL7	11	G11-RR6-3	HP07LU	HK07LU	BBPM06	7	2