Liquid Argon HEC Wheel Assembly Database

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Chris Oram (oram@triumf.ca)
Mike Losty (losty@triumf.ca)
Leonid Kurchaninov (Leonid.Kurchaninov@cern.ch)

TRIUMF, Canada

Mikhail Kazarinov (Mihail.Kazarinov@cern.ch)
JINR, Dubna, Russia

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This document describes the details of the contents of the LAr Hadronic EndCap Wheel Assembly Database. This database contains the important data from the wheel assembly: mechanical alignment, electrical properties, cabling, and a summary of the readout gap failures. This document describes the final database that is intended mainly for archival purposes. This database should be viewed in conjunction with the HEC module production database that describes the modules that form the wheel and the Feedthrough database that describes the signal feedthroughs. This wheel database lists for instance the location of the modules, the amplifiers to which they are connected, and the details of the alignment measurements. It also details all non-conformances. It is important that for all non-conformances, whether they occurred during wheel assembly or in the B180 cold tests, that a single table be produced of all the non-conformances listing the non-conformance in a format suitable for making offline corrections to the data. This non-conformance table will be derived from a set of queries of this database.

This database covers the description of the HEC from the liquid argon gaps to the pins in the front end crate (FEC). As some non-conformances are described in terms of FEC module number and FEC module channel number some extension is included to this basic definition.

The database is initially being developed as a MS Access Database, initially maintained by the TRIUMF group. Now the data in this database is complete (as the work in B180 is completed), the data will be transferred to the CERN Oracle Database, maintained by the CERN IT group. This wheel assembly data will be maintained for the lifetime of ATLAS, and are useful for the experts who produced the HEC, and the end-users (technicians, physicists) to aid access to any or all pertinent details regarding a particular HEC module or component. In addition, it is required by the ATLAS Technical Coordination (TC) that any parts of the detector that will be moved to the ATLAS Cavern should have detailed data in the database at the time of installation.

IMPLEMENTATION:

The LAr Hadronic EndCap Wheel Assembly data is currently residing in the MS Access database 'HEC_Wheel_Assembly_Database'. This effort is now completed. The database will soon be permanently handed over to the LAr database group. This database will be migrated to the official CERN production database infrastructure upon final review.

Structure of the database:

The database covers four major areas:

- Mechanical information of the wheel such as alignment measurements.
- Electrical information such as the measurements of the pre-amplifiers on the wheel.
- Cabling information that details how individual towers are readout and transmitted to the front-end board.
- A non-conformance tables that detail such failures as channels that cannot hold full high voltage.

The critical aspect of this database is the HV, LV, calibration and signal cable wiring and the use of this information with the non-conformance tables. During the design of the database, it was decided to keep the input electrical and non-conformance data in tables natural to the recording of this data. So the input forms are just those provided by those who did the work with an extra first column that provides a unique identifier for each entry in the table, and some lines added for ease of cross reference within the database. For the cabling data, one summary table with a line for each readout tower was formed. From this summary table (Signal Line Summary) it is trivial to find which tower is connected to each pin of the front-end crate, and which towers are affected when for instance a HV line fails. While the database contains the details of the wiring, and some details must be described here, it is not our intent to describe in this document the complete wiring of the HEC. This is definitively described in full in "Cabling of the ATLAS liquid argon calorimeters **ATL-A-EN-0001** v.**2**".

The mechanical aspects described in this database are for archival purposes. The alignment measurements are not detailed enough to describe exactly the location of each plate in the calorimeter, so it is not anticipated that these measurements will be used to describe alignment information for the "Conditions Database" of the calorimeter. The wheels are constructed to tolerances in the millimetre region. It would seem likely that variations within these tolerances will not affect the calorimeter operation. Alignment information used in data manipulation will likely be limited to design values and 6 numbers for each wheel (such as 3 positions and 3 rotations). These six numbers can only be measured when the wheels are in ATLAS. They are not part of this database.

The database architecture does not lend itself to be shown on a single page. So we will first show the overall structure then detail the various aspects in separate architecture charts. In the overall structure we will show how this database could be connected to the HEC Module Production Database and the Signal Feedthrough Production Database.

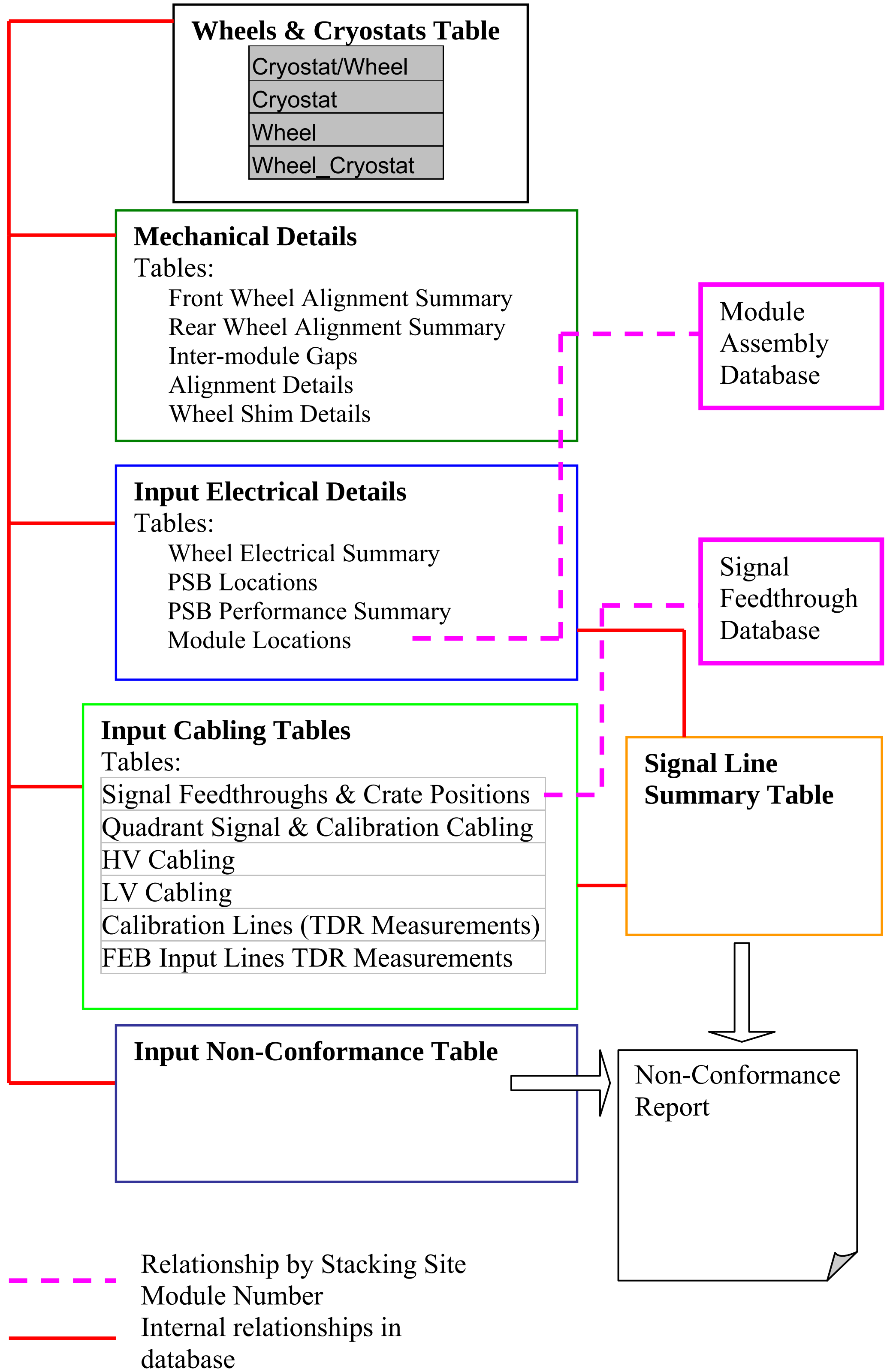


Figure 1 : Architecture for LAr HEC Wheel Assembly Database. The *module serial number*, allows this database to be connected to the HEC module production database, by making a relationship on this entry between to two databases. The *Feedthrough Database* connects through the feedthrough location identifier. Shown also is the highest level table the *Wheels & Cryostats Table* that lists the four wheels and two cryostats described in the database.

Mechanical Details

Tables:

Front Wheel Alignment Summary
Rear Wheel Alignment Summary
Inter-module Gaps
Alignment Details
Wheel Shim Details

Front Wheel Alignment Summary

Cryostat/Wheel/WheelLocation
Cryostat
Wheel
Wheel_Cryostat
Wheel Location
Date
Name
Comment
Outer Faces of the Two Sliding Rails
Maximum Inner Radius (Plates 1-8)
Minimum Inner Radius (Plates 1-8)
Maximum Inner Radius (Plates 9-24)
Minimum Inner Radius (Plates 9-24)

Rear Wheel Alignment Summary

Cryostat/Wheel/WheelLocation
Cryostat
Wheel
Wheel_Cryostat
Wheel Location
Date
Name
Comment
Outer Faces of the Two Sliding Rails
Maximum Inner Radius (Plates 25-40)
Minimum Inner Radius (Plates 25-40)

Alignment Details

Cryostat/Wheel/Wheel Location/AlignmentLocNumber
Cryostat
Wheel
Wheel_Cryostat
Wheel Location
Alignment Location Number
X
Y
Z

Wheel Shim Details

Cryostat/Wheel/Wedge1_2/PlateNumber
Cryostat
Wheel
Wheel_Cryostat
Wedge 1
Wedge 2
Plate Number
Shim Thickness Required
Installed Shim Thickness

Inter-module Gaps

Cryostat/Wheel/Wheel Location/ModuleLoc1_2
Cryostat
Wheel
Wheel_Cryostat
Wheel Location
Module Location 1
Module Location 2
Gap Top Inner
Gap Top Outer
Gap Bottom Inner
Gap Bottom Outer

Figure 2 : Architecture for LAr Mechanical Aspects of the HEC Wheel Assembly Database. The *Wheel-Cryostat* identifier allows these tables to be connected, internally within the mechanical aspects and externally to the other tables of the HEC Wheel Assembly Database.

Electrical Details

Tables:

- Wheel Electrical Summary
- PSB Locations
- PSB Performance Summary
- Module Locations

Module Locations

Cryostat/Wheel/Wedge
Cryostat
Wheel
Wheel_Cryostat
Wedge
Module Serial Number

Wheel Electrical Summary

Cryostat/Wheel/Wedge
Cryostat
Wheel
Wedge
Cryostat/Wedge
Wheel_Cryostat
Module Serial Number
HV test Passed ?
Did HV problems have to be addressed
Comment on HV fixes
Other Comments
Date of Final Check

PSB Performance Summary

PSB Serial/Tower
PSB Serial
Tower
Amplifiers in Tower
% Non-Linearity
Average Transfer Coefficient kOhm
% Uniformity of Preamplifier Gains
RMS Noise (mV) at Nominal Vee
RMS Noise (mV) at High Vee

PSB Locations

Cryostat/Wedge
PSB A Serial
PSB B Serial
PSB C Serial
PSB D Serial
PSB E Serial

PSB Locations by PSB Letter

Cryostat/Wedge/PSB_Letter
Cryostat
Wedge
PSB Letter
PSB Serial

Figure 3 : Architecture for LAr Electrical Aspects of the HEC Wheel Assembly Database. The *Wheel-Cryostat, Cryostat/Wheel/Wedge* and *PSB Serial/Tower* identifiers allow these tables to be connected, internally within the electrical aspects and externally to the other tables of the HEC Wheel Assembly Database.

Signal Feedthrough and Crate Positions

Quadrant
F/T and Crate Position
Cryostat

Figure 4A : Tables of signal feedthroughs and crate positions.

Cabling Details

Tables: Quadrant Signal Cabling
HV Cabling
LV Cabling

LV Cabling

Cryo/Wedge/PSB_letter/Voltage
Cryo/Wedge/PSB_letter
Cryostat
Quadrant
Wedge
PSB Letter
Function
Q number
Q line
Q LV Channel
Q PB Connector
Q PB Connector Pin
FEC slot
FEC In Connector
FEC Back Plane Connector
FEC Back Plane Connector Pin
Warm FT Cable pin
Signal Feedthrough
ATI Pin
Quadrant LV patch panel
Quadrant LV patch panel input connector
Quadrant LV patch panel in-connector pins
Quadrant LV patch panel out-connector pins
PSB
PSB Letter repeated
PSB Pin
Q Wedge

HV Cabling

Cryostat/Wedge/Z/SubGap
Cryostat/Wedge/Z
Cryostat/FT conn #/Pin #
Cryostat
ISEG Module
Channel Number
Cable
Pin Number
FeedThrough
HV Patch Panel (Plug)
HV Patch Panel (Socket)
Wedge
Z
SubGap
Module Serial Number
Patch Panel Connector In
Patch Panel Pin In
Patch Panel Connector Out
Patch Panel Pin Out
Section of Module

Quadrant Signal & Calibration Cabling

Cryostat/Qwedge/PSB_letter/Pad/SubZ
Cryostat/Qwedge/PSB_letter/Tower
Cryostat
Qwedge
PSB Letter
Tower
Pad
Gap
Gap_new
ETA
PHI
PHI_letter
Z
SubZ
PSB
INCON
INPIN
OUTCON
OUTPIN
Signal Patch Panel Input Connector
Signal PP Input Connector Pin
Signal Patch Panel Output Connector
Signal PP Output Connector Pin
Signal Patch Panel
Cold flange pigtail Connector Pin
Feedthrough Connector Number
Front End Board Number
Front End Crate SLOT
Front End Board Connector
FEB input connector pin
FEB Shaper Channel Number
FEB ADC Number
FEB ADC Channel
FEB Output connector pin
Trigger Driver Board Number
Trigger Driver Channel
Trigger Driver input connector
Trigger Driver input connector pin
Trigger Driver output connector
Trigger Driver output connector pin
Calibration Generator Channel
Calibration Feedthrough connector #
Calibration lines of Wedges
Calibration Patch Panel Number
Calibration PP Input Connector #
Calibration PP Input Conn Pin #
Calibration PP Output Connector #
Calibration PP Output Conn Pin #
Calibration distribution board on wheel
Distribution board Input Connector
Distribution board Input Connector Pin
Distribution Board Output Connector
Distribution Board Output Connector Pin
Strip-line Type

Figure 4B : Tables of the Signal, LV and HV wiring. The identifiers shown in bold allow these tables to be connected, internally within the cabling aspects and externally to the other tables of the HEC Wheel Assembly Database.

Calibration Lines (TDR Measurements) Table

Quadrant1to4/cryostat/channel
Quadrant1to4
Cryostat
Channel
Warm Cable Impedance (Ohm)
Vacuum Cable Impedance (Ohm)
Pigtail Impedance (Ohm)
Pigtail resistance (Ohm/ns)
Quadrant Cable Impedance (Ohms)
Quadrant Cable Resistance (Ohms/ns)
Stripline Impedance (Ohms)
Stripline Resistance (Ohms/ns)
Stripline Termination Impedance (Ohms)

FEB Input Lines TDR Measurements Table

Quadrant1to4/cryostat/FEB/channel
Quadrant1to4
Cryostat
FEB
Channel
Warm cable Impedance (Ohms)
Vacuum Cabe Impedance (Ohms)
Pigtail Impedance (Ohms)
Pigtail Resistance (Ohms/ns)
Quadrant Cable Impedance (Ohms)
Quadrant Cable Resistance (Ohms/ns)
Calibration Cable PSB Termination Impedance (Ohms)

Quadrant Definition Table

Quadrant
Cryostat
Quadrant(1 to 4)

Quadrant-Wedge Definition Table

Cryostat/Wedge
Quadrant
Cryostat
Wedge
Qwedge

FEB Definitions Table

FEB Shaper Channel
FEB Channel Number

Figure 4C : Tables of the FEB Input Lines TDR measurements and the Calibration Lines (TDR Measurements) tables. These TDR measurements were made in B180 with the cryostat cold.
Also shown to the right are the related Quadrant, Quadrant-Wedge and FEB definition Tables, that help connect these tables to the other cabling tables.

Cryostat/Wedge/Z/Tower
Cryostat/Qwedge/PSB_letter/Tower
Cryostat/Wedge/Z
Cryostat/Wedge/PSB_letter
PSB_Serial/Tower
Wheel_Cryostat
Cryostat/Wheel/Wedge
Cryostat
Wedge
QWedge
Z
Wheel
Tower
ETA
PHI
PSB Letter
Module Serial
PSB Serial
Calibration Generator 1
Calibration Generator 2
Calibration Generator 3
Calibration Generator 4
Ntiles
HV Est1
HV Est2
HV Pad1
HV Pad2
LV1 Q Number -1,5v
LV1 Q Number GND
LV2 Q Number +3V
LV2 Q Number GND
LV3 Q Number +7V
LV3 Q Number GND
Feedthrough Location
FT Connector
FEC Slot
FEB Connector
FEC Pin

Figure 5: The signal line summary table. This table describes for each readout volume in the HEC its corresponding pin in the Front End Crate. In addition it lists the serial numbers of all items that might fail, or be affected by a failure, that are associated with this readout volume. This table provides simple interconnection between the tables of the database. To the left of the table is shown the Signal & Calibration table (truncated), along with the LV and HV cabling tables (truncated). To the right are the connections to the mechanical and electrical tables. The connecting lines show the database relationships.

Non-Conformance Table

Problem #
Issue FEB=1, CAL=2, HV_Pin=3,HV_Line=4
Cryostat
Quadrant(1 to 4)
Front End Board Number
Front End Board Channel
Calibration Board Channel
Comment
Wedge
Module
Gap with HV pin cut
Gap Cut
Z
Severity of Problem
Comment on Severity of Problem

Figure 6: Table of non-conformance. The concept here is to have one table to list all known non-conformances of the system on leaving B180 (so hopefully as on arrival at the ATLAS pit).

Tables required to interpret the Non-Conformance Table

FEC Pin to FEB Channel Definitions

FEB Channel
FEC Pin
FEB Connector

FEB Slot_Module Definitions

FEC Slot
FEB Module Number

Figure 7: The database describes all aspects of the HEC cabling from the liquid argon cell to the pins on the front end crate. However some information beyond this is required to understand the non-conformances as described by those making measurements in the front end crate.

SUMMARY OF DATA ENTRIES:

A definition of each of the data entries in this database is given along with a short statistical summary to allow anyone interested to decide if the data is likely to contain pertinent information

Data Definitions:

Wheels & Cryostats

This is the entry point into the database. All the tables describing the mechanical details, are directly related to this table through the *Wheel_Cryostat* entry.

Cryostat/Wheel	A/HEC1	A/HEC2	C/HEC1	C/HEC2
Cryostat	A	A	C	C
Wheel	HEC1	HEC2	HEC1	HEC2
Wheel_Cryostat	HEC1A	HEC2A	HEC1C	HEC2C

Complete listing of the Wheels & Cryostats table

Cryostat/Wheel

Unique identifier for this table. 2 cryostats and 2 wheels: 4 entries in total.

Cryostat

This is the cryostat location in ATLAS: A end or C end. The A end is installed nearest the airport, the C end nearest to St Genis.

Wheel

The HEC1 refers to the wheel being a front wheel. Only 1 (Front) and 2 (Rear) wheels were produced.

Wheel_Cryostat

This is the identifier that is used to make the relationships between all the tables except the amplifier PSB board performance summary. It is also the unique identifier for this table. It has the typical format HEC1A, where:

The HEC1A refers to the wheel being a wheel manufactured for the A cryostat. HEC1 refers to this being a front wheel. Only 1 (Front) and 2 (Rear) wheels were produced.

1. MECHANICAL TABLES

Front Wheel Alignment Summary
Rear Wheel Alignment Summary
Alignment Details
Inter-module Gaps
Wheel Shim Details

Front Wheel Alignment Summary

The table below gives the contents of this table in March 2004. The comment field has been truncated to allow easy reproduction of this table in this document. As row 1 is not completed at time of writing, row 2 will be used as table as our *specimen value*.

Cryostat/Wheel/WheelLocation	Cryostat	Wheel	Wheel_Cryostat	Wheel Location	Date	Name	Comment	Outer Faces of the Two Sliding Rails	Maximum Inner Diameter (Plates 1-8)	Minimum Inner Diameter (Plates 1-8)	Maximum Inner Diameter (Plates 9-24)	Minimum Inner Diameter (Plates 9-24)
A/HEC1/T6	A	HEC1	HEC1A	T6			Measurement not made as of Feb04					
A/HEC1/Table	A	HEC1	HEC1A	Table	29-Oct-03	Mark Lenckowski	For survey details refer to edms doc# 408291/2…	4255	746	745	952	951
C/HEC1/T6	C	HEC1	HEC1C	T6	27-Sep-02	ROY LANGSTAFF	ALL GAP MEASUREMENTS …	4255	746	744	952	950.5
C/HEC1/Table	C	HEC1	HEC1C	Table	15-Aug-02	ROY LANGSTAFF	ALL …	4255	746	743.5	951	949

Cryostat/Wheel/WheelLocation

Unique identifier for this table in the database: two cryostat, two wheel and two wheel locations: eight entries in this table.
Specimen value: A/HEC1/Table, where:
A : The A cryostat.

HEC1 : The front(1) wheel.
Table : The wheel was first constructed in the horizontal on a wheel assembly *table*. Then the wheel was rotated and placed on the cradle *T6* in front of the cryostat. At these two locations *Table* and *T6* alignment measurements were made. In this specimen line the measurement was made on the wheel assembly Table.

Cryostat

Specimen value: A, where:
A : The A cryostat.

Wheel

Specimen value: HEC1, where:
HEC1 : The front(1) HEC wheel.

Wheel_Cryostat

Specimen value: HEC1A, where:
HEC1A : The front(1) wheel in the A cryostat.

Wheel Location

Specimen value: Table, where:
Table : The wheel was first constructed in the horizontal on a wheel assembly *table*. Then the wheel was rotated and placed on the cradle *T6* in front of the cryostat. At these two locations *Table* and *T6* alignment measurements were made. In this specimen line the measurement was made on the wheel assembly Table.

Date

Date of the measurements.

Name

Name of person recording measurements.

Comment

Free format comment to encourage transfer of useful information.

Outer Faces of the Two Sliding Rails

Specimen value: 4255 mm, this being the distance between the two outer faces of the two sliding rails (the rails at 3 and 9 o'clock on the wheel, on which the wheel is supported). This number is recorded because it partly defines the outer envelope of the HEC.

Maximum Inner Diameter (Plates 1-8)

Specimen value: 746 mm, this being the maximum inner diameter of the hole in the middle of the HEC (for plates 1-8). This number is recorded because it partly defines the inner envelope of the HEC.

Minimum Inner Diameter (Plates 1-8)

Specimen value: 745 mm, this being the minimum inner diameter of the hole in the middle of the HEC (for plates 1-8). This number is recorded because it partly defines the inner envelope of the HEC.

Maximum Inner Diameter (Plates 9-24)

Specimen value: 952 mm, this being the maximum inner diameter of the hole in the middle of the HEC (for plates 9-24), in which the Forward Calorimeter sits. This number is recorded because it partly defines the inner envelope of the HEC.

Minimum Inner Diameter (Plates 9-24)

Specimen value: 951 mm, this being the minimum inner diameter of the hole in the middle of the HEC (for plates 9-24), in which the Forward Calorimeter sits. This number is recorded because it partly defines the inner envelope of the HEC.

Rear Wheel Alignment Summary

The table below gives the contents of this table in March 2004. The comment field has been truncated to allow easy reproduction of this table in this document. As row 1 is not completed at time of writing, row 2 will be used as table as our *specimen value*.

Cryostat/Wheel/Wlocation	Cryostat	Wheel	Wheel_Cryostat	Wheel Location	Date	Name	Comment	Outer Faces of the Two Sliding Rails	Maximum Inner Diameter (Plates 25-40)	Minimum Inner Diameter (Plates 25-40)
A/HEC2/T6	A	HEC2	HEC2A	T6			Measurement not made as of Feb04			
A/HEC2/Table	A	HEC2	HEC2A	Table	04-Feb-04	ROY LANGSTAFF	FOR SURVEY DETAILS REFER TO EDMS DOCUMENT ATL-AE-UR-0029.	4257	952	950
C/HEC2/T6	C	HEC2	HEC2C	T6	15-Apr-03	ROY LANGSTAFF	TOP' MEASUREMENTS WERE …	4257	951	950
C/HEC2/Table	C	HEC2	HEC2C	Table	06-Nov-02	ROY LANGSTAFF	ALL GAP MEASUREMENTS ….	4256	951	950

This identical to the front wheel alignment summary except:

- Maximum Inner Diameter (Plates 1-8)
- Minimum Inner Diameter (Plates 1-8)
- Maximum Inner Diameter (Plates 9-24)
- Minimum Inner Diameter (Plates 9-24)

are not present. Instead the following two items are present:

Maximum Inner Diameter (Plates 25-40)

Specimen value: 952 mm, this being the maximum inner diameter of the hole in the middle of the HEC2 (for plates 25-40), in which the Forward Calorimeter sits. This number is recorded because it partly defines the inner envelope of the HEC.

Minimum Inner Diameter (Plates 25-40)

Specimen value: 950 mm, this being the minimum inner diameter of the hole in the middle of the HEC2 (for plates 25-40), in which the Forward Calorimeter sits. This number is recorded because it partly defines the inner envelope of the HEC.

Alignment Details

Cryostat/Wheel/Wheel Location/AlignmentLocNumber	Cryostat	Wheel	Wheel_Cryostat	Wheel Location	Alignment Location Number	X	Y	Z
A/HEC1/Table/10	A	HEC1	HEC1A	Table	10	-783.1	-1891.6	1000.9
A/HEC1/Table/11	A	HEC1	HEC1A	Table	11	-1137.5	-1702.4	999.6
A/HEC1/Table/12	A	HEC1	HEC1A	Table	12	-1448.2	-1447.5	1000
A/HEC1/Table/13	A	HEC1	HEC1A	Table	13	-1702.6	-1137	1000.4
A/HEC1/Table/14	A	HEC1	HEC1A	Table	14	-1892	783.4	1001
A/HEC1/Table/15	A	HEC1	HEC1A	Table	15	-2008.4	-399.6	1000.8
A/HEC1/Table/16	A	HEC1	HEC1A	Table	16	-2069.8	-0.2	1006.9
A/HEC1/Table/17	A	HEC1	HEC1A	Table	17	-2008.6	399.8	1000.9

Cryostat/Wheel/Wheel Location/AlignmentLocNumber

Unique identifier for this table in the database: two cryostat, two wheel, two locations, 32 alignment locations: 256 entries in this table.

Specimen value: A/HEC1/Table/10, where:

A : The A cryostat.

HEC1 : The front(1) wheel.

Table : The wheel was first constructed in the horizontal on a wheel assembly *table*. Then the wheel was rotated and placed on the cradle *T6* in front of the cryostat. At these two locations *Table* and *T6* alignment measurements were made. In this specimen line the measurement was made on the wheel assembly Table.

10 : The position number on the wheel of this alignment measurement.

Cryostat

Specimen value: A, where:

A : The A cryostat.

Wheel

Specimen value: HEC1, where:

HEC1 : The front(1) wheel.

Wheel_cryostat

Specimen value: HEC1A, where:

HEC1A : The front(1) wheel in the A cryostat.

Wheel Location

Specimen value: Table, where:

Table : The wheel was first constructed in the horizontal on a wheel assembly *table*. Then the wheel was rotated and placed on the cradle *T6* in front of the cryostat. At these two locations *Table* and *T6* alignment measurements were made. In this specimen line the measurement was made on the wheel assembly Table.

Alignment Location Number

Specimen value: 10, where:
10 : The position number on the wheel of this alignment measurement.

X

Specimen value: -783.1, where:
-783.1 mm : The x position of the alignment location.

Y

Specimen value: -783.1, where:
-1891.6 mm : The y position of the alignment location.

Z

Specimen value: 1000.9, where:
-1891.6 mm : The z position of the alignment location.

To give the reader a feel for the typical variation in x and y, we determine the average and RMS radius:

	Radius (excluding 16 & 32)	Radius of points 16 & 32
Radius (mm)	2279.27	2302.04
RMS (mm)	0.49	0.85

and for the z variation, the corresponding values:

	Z (excluding 16 & 32)	Z of points 16 & 32
Z (mm)	1000.00	1007.31
RMS (mm)	0.57	1.49

For details on the alignment please refer to:

HEC1C	Wheel on Assembly Table	ATL-AE-UR-0005
HEC1C	Wheel vertical	ATL-AE-UR-0006
HEC2C	Wheel on Assembly Table	ATL-AE-UR-0007
HEC2C	Wheel vertical	ATL-AE-UR-0011
HEC1A	Wheel on Assembly Table	ATL-AE-UR-0025
HEC1A	Wheel vertical	ATL-AE-UR-0028
HEC2A	Wheel on Assembly Table	ATL-AE-UR-0029
HEC2A	Wheel vertical	(NOT YET DONE)

Inter-module Gaps

These are the gaps between the 32 modules that form the wheel. The nominal inter-module gap is 2 mm. A sample section of this table is given below. We will use the first column as our specimen entry.

Cryostat/Wheel/Wheel Location/Wedge1_2	A/HEC1/Table/31_32	A/HEC1/Table/32_1	C/HEC1/T6/1_2	C/HEC1/T6/2_3
Cryostat	A	A	C	C
Wheel	HEC1	HEC1	HEC1	HEC1
Wheel_Cryostat	HEC1A	HEC1A	HEC1C	HEC1C
Wheel Location	Table	Table	T6	T6
Wedge 1	31	32	1	2
Wedge 2	32	1	2	3
Gap Top Inner	1.45	1.27	2.68	2.15
Gap Top Outer	2.77	1.78	2.01	2.01
Gap Bottom Inner	2.16	1.81	1.81	2.46
Gap Bottom Outer	2.36		2.25	2.53

Cryostat/Wheel/Wheel Location/Wedge1_2

Unique identifier for this table in the database, four wheel_cryostats, two locations, 32 gaps: 256 entries in this table.
Specimen value: A/HEC1/Table/31_32, where:
A : The A cryostat.
HEC1 : The front(1) HEC wheel.
Table : The measurements were made when the wheel was horizontal on the HEC wheel assembly table.
31_32 : The gap between the modules in the wheel at wedge locations 31 and 32. The nominal ϕ location of the centre of module in location *n* is given by :

$$\phi = 2\pi(n - 0.5)/32$$

Cryostat

A or C cryostat. The A end is nearest Geneva airport. Specimen value: A, where:
A : The A cryostat.

Wheel

HEC1 is the front wheel, HEC2 is the rear wheel.

Wheel_Cryostat

Specimen value: HEC1A, where:
HEC1A : The front(1) HEC wheel destined for the A cryostat.

Wheel Location

Specimen value: Table, where:
Table : The measurements were made when the wheel was horizontal on the HEC wheel assembly table.

Wedge 1

Specimen value: 31, where:

31 : The module on the first side of the gap is part of wedge 31.

Wedge 2

Specimen value: 32, where:

32 : The module on the second side of the gap is part of wedge 32.

Gap Top Inner

Specimen value: 1.45, where:

1.45 mm : The gap measured in mm at the inner radius of the wheel, between plates 1 (for a front wheel) or 26 (for a rear wheel) of the two adjacent modules.

Gap Top Outer

Specimen value: 2.77, where:

2.77 mm : The gap measured in mm at the outer radius (~ 2.03 m) of the wheel, between plates 1 (for a front wheel) or 26 (for a rear wheel) of the two adjacent modules.

Gap Bottom Inner

Specimen value: 2.16, where:

2.16 mm : The gap measured in mm at the inner radius (~ 475 mm) of the wheel, between plates 25 (for a front wheel) or 42 (for a rear wheel) of the two adjacent modules.

Gap Bottom Outer

Specimen value: 2.36, where:

2.36 mm : The gap measured in mm at the outer radius (~ 2.03 m) of the module, between plates 25 (for a front module) or 42 (for a rear module) of the two adjacent modules.

To give the reader a feeling for the variance in this value we have calculated the mean and RMS values. After ignoring null entries (where the position was not accessible), the mean and RMS for the entries is given in the table below.

	Gap Top Inner	Gap Top Outer	Gap Bottom Inner	Gap Bottom Outer
Average (mm)	1.72	1.78	1.77	1.62
RMS (mm)	1.09	0.92	0.96	0.90

Wheel Shim Details

The connecting bar that connects the adjacent modules together at the outer radius is a large flat bar. To marry this flat connecting bar to the many copper plates of the module which do not present a perfectly flat face, it was anticipated that shims would be used. One shim for each plate was anticipated. However it was found that these shims were not mechanically necessary, and as they were a potential source of metal material that can cause HV shorts, it was decided NOT to use them. We leave in the database the record of the measurements made to check that these shims were not required at any location. All these measurements were made on the wheel assembly table, prior to rotation.

Cryostat/Wheel/Wedge1_2/PlateNumber	A/HEC1/4_5/10	A/HEC1/4_5/11
Cryostat	A	A
Wheel	HEC1	HEC1
Wheel_Cryostat	HEC1A	HEC1A
Wedge 1	4	4
Wedge 2	5	5
Plate Number	10	11
Shim Thickness Required	0.718	0.656
Installed Shim Thickness	0	0

Cryostat/Wheel/Wedge1_2/PlateNumber

Unique identifier for this table in the database. Two cryostats, two wheels, 32 wedges, and 41 plates/wheel pair (no shim on plate 1): 2624 entries in this table.

Specimen value: A/HEC1/4_5/10, where:

A : The A cryostat

HEC1 : The front(1) HEC wheel.

4_5 : The measurements were made when the wheel was horizontal on the HEC wheel assembly table between modules locations 4 and 5.

20 : This is the shim measurement for plate # 10 (plate #'s go from 1 to 42)

Cryostat

Specimen value: A where:

A : Wheel destined for the A cryostat.

Wheel

Specimen value: HEC1 where:

HEC1 : Front HEC wheel.

Wheel_Cryostat

Specimen value: HEC1A where:

HEC1A : Front HEC wheel destined for the A cryostat.

Wedge 1

Specimen value: 4 where:

4 :Wedge location. Connecting bar goes between the module in wedge location 4 and that specified in *wedge 2*.

Wedge 2

Specimen value: 5 where:

5 : Wedge location. Connecting bar goes between the module in wedge location 5 and that specified in *wedge 1*.

Plate Number

Specimen value: 10 where:

10 : Plate number for which spacer thickness required is being measured.

Shim Thickness Required

Specimen value: 0.718 where:

0.718mm : Required spacer thickness in mm

Note that positive (negative) spacer thickness implies a spacer is required under the connecting bar on the n+1 (n) module side.

Installed Shim Thickness

Specimen value: 0 where:

0.0 mm : Spacer thickness used in mm. The spacer thickness installed is always zero, because no spacers were installed.

The mean spacer thickness required was –0.036 mm, the average spacer thickness was 0.50 mm.

2. ELECTRICAL TABLES

Wheel Electrical Summary

This table provides a précis of HV problems encountered. Amplifier PSB boards were installed on modules during the final steps prior to wheel assembly, so these are the first tests with the final amplifiers present.

Cryostat/Wheel/Wedge	A/HEC1/1	A/HEC1/2
Cryostat	A	A
Wheel	HEC1	HEC1
Wedge	1	2
Cryostat/Wedge	A/1	A/2
Wheel_Cryostat	HEC1A	HEC1A
Module Serial Number	AF21	AF14
HV test Passed ?	TRUE	TRUE
Did HV problems have to be addressed?	TRUE	TRUE
Comment on HV fixes	ET:EST1, gap 11 – HV off	3 trips at 900 V
Other Comments		
Date of Final Check	18-Feb-03	20-Feb-03

Cryostat/Wheel/Wedge

Unique identifier for this table, four wheel_cryostat and 32 wedges: 128 entries in this table.

Cryostat

A or C cryostat initially intended, for installation in the A or C end of ATLAS. The A end is nearest Geneva airport.

Wheel

HEC1 is the front wheel, HEC2 is the rear wheel.

Wedge

This refers to the wedge location *n* of the module in the wheel. The nominal ϕ location of the centre of module in location *n* is given by :

$$\phi = 2\pi(n - 0.5)/32$$

Cryostat/Wedge

Identifier to connect to the PSB location table.

Wheel_Cryostat

Identifier to connect to the Module Location table.

Module Serial Number

This has the typical format CF04, where:

- The C refers to the wheel (C or A) that the module was nominally built for. Two initially special, but actually standard series modules, SF01 and SF02 were also built.
- The F refers to the module being a Front module. Only F (Front) and R (Rear) modules were produced. Front modules have plate numbers 1 to 25 and rear 26 to 42. Front modules have gaps (layers) 1 to 24 and rear 25 to 40.
- 04 refers to the number of that series module 01 to 33

This number is written on the module, on the rear copper plate at the outer radius.

HV test Passed ?

By definition .TRUE. otherwise the module was rejected!

Did HV problems have to be addressed?

TRUE if problems were encountered. Then the next field should describe the actions taken to overcome the problem(s).

Comment on HV fixes

In free format here are described any problems that have to be overcome to obtain *HV test passed* status.

Other Comments

Free format field to encourage useful information to be entered.

Date of Final Check

This would point you to the logbook entry for this action.

PSB Locations

Cryostat/Wedge	A/1	A/10	A/11
PSB A Serial	A51	A11	A69
PSB B Serial	B48	B60	B70
PSB C Serial	C57	C44	C68
PSB D Serial	D49	D06	D73
PSB E Serial	E45	E65	E64

Cryostat/Wedge

Unique identifier for this table, with two cryostats and 32 wedges this table has 64 entries.

PSB A Serial Number

The serial number of the printed circuit board (PSB) containing the pre-amplifiers and summing circuit, installed at the outer radius of the HEC 1 (~2 m radius) in the front position of the 3 PSB boards at this location. This board serves gaps 1-8.The A PSB boards are closest to the EMEC. (24 Channels on this board). See Fig.7 and Appendix I.

PSB B Serial Number

The serial number of the printed circuit board (PSB) containing the pre-amplifiers and summing circuit, installed at the outer radius of the HEC 1 (~2m radius) in the middle position of the 3 PSB boards at this location. This board serves gaps 9-24 outer radius ($\eta < 1.9$) readout locations. (8 Channels on this board). See Appendix I.

PSB C Serial Number

The serial number of the printed circuit board (PSB) containing the pre-amplifiers and summing circuit, installed at the outer radius of the HEC 1 (~2m radius) in the rear position of the 3 PSB boards at this location. This board serves gaps 9-24 inner radius ($\eta > 1.9$) readout locations. (15 Channels on this board) . See Appendix I.

PSB D Serial Number

The serial number of the printed circuit board (PSB) containing the pre-amplifiers and summing circuit, installed at the outer radius of the HEC 2 (~2m radius) in the front position of the 2 PSB boards at this location. This board serves gaps 25-32 readout locations. (23 Channels on this board). See Appendix I

PSB E Serial Number

The serial number of the printed circuit board (PSB) containing the pre-amplifiers and summing circuit, installed at the outer radius of the HEC 2 (~2m radius) in the rear position of the 2 PSB boards at this location. This board serves gaps 33-40 readout locations. (24 Channels on this board) . See Appendix I.

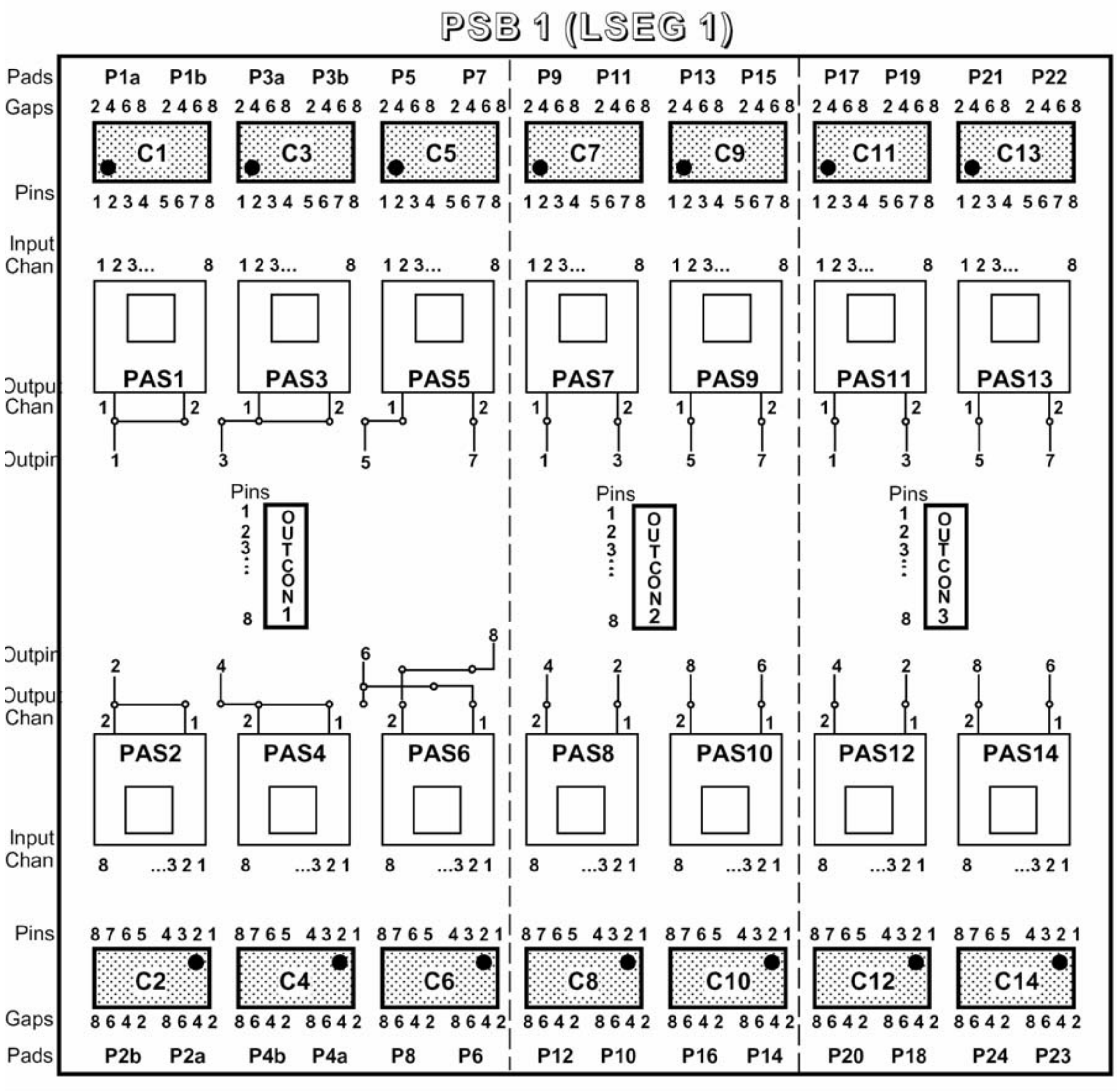
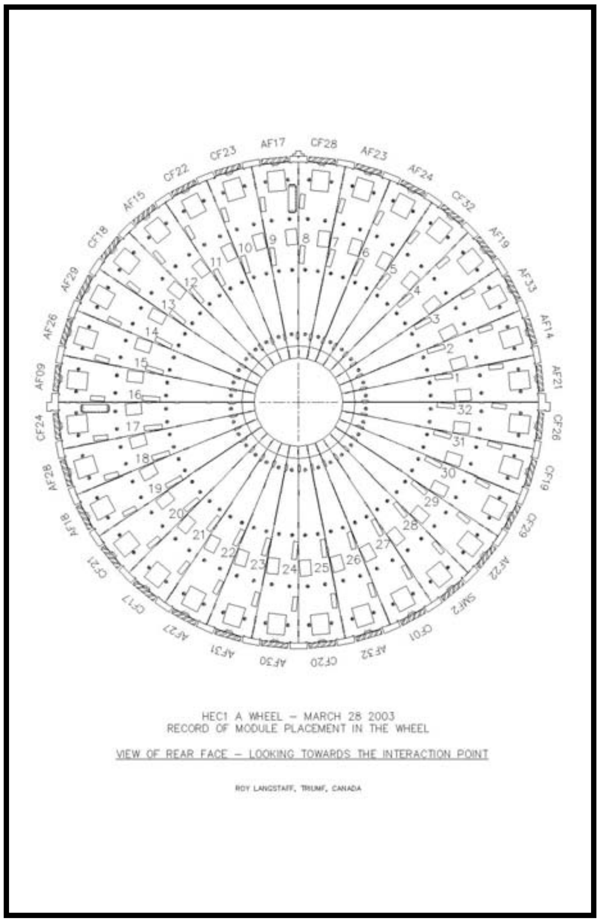


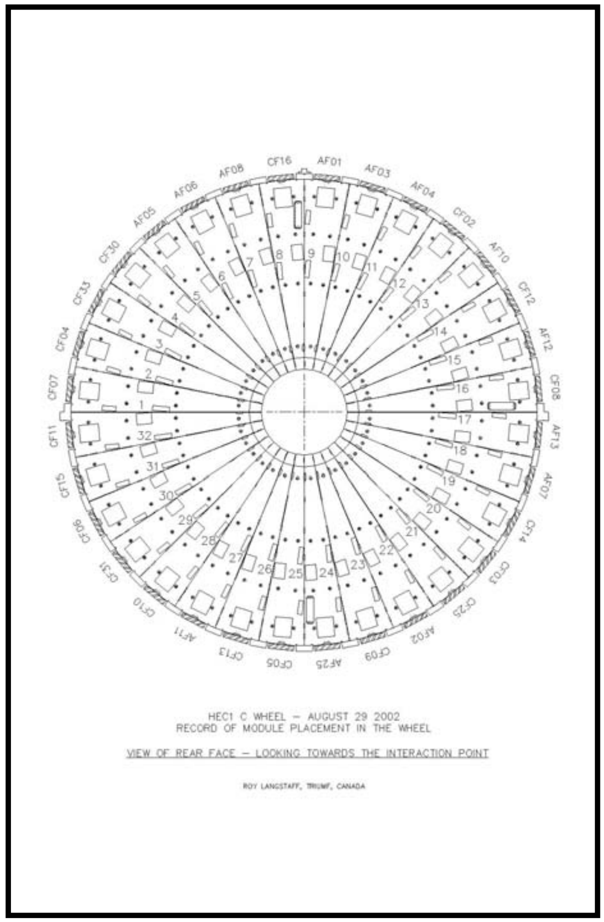
Figure 8:
Diagram of the PSB type A. Shown are many of the terms used in the Signal Quadrant Wiring Table. Further PSB diagrams are in ApendixII

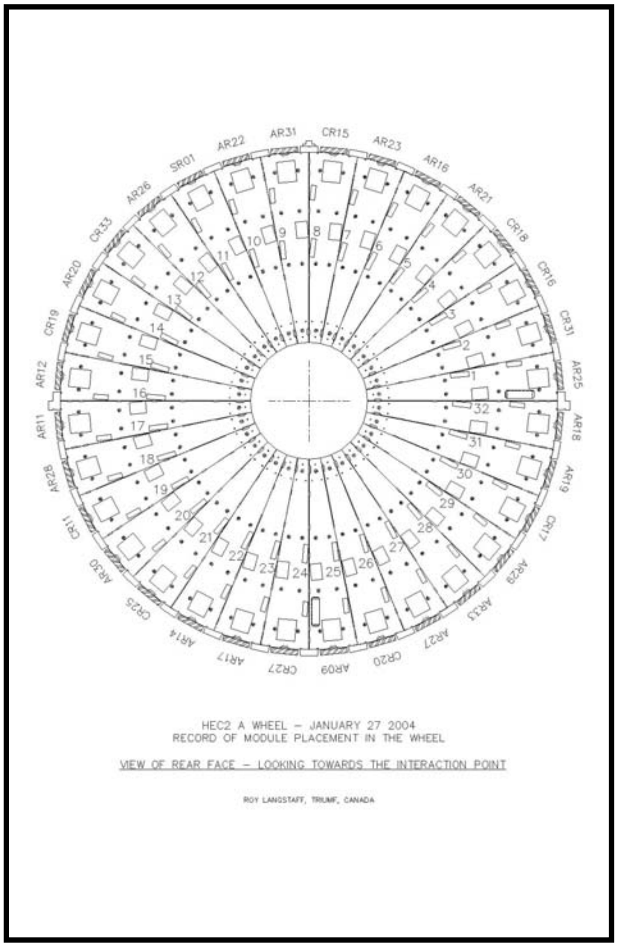
Module Locations

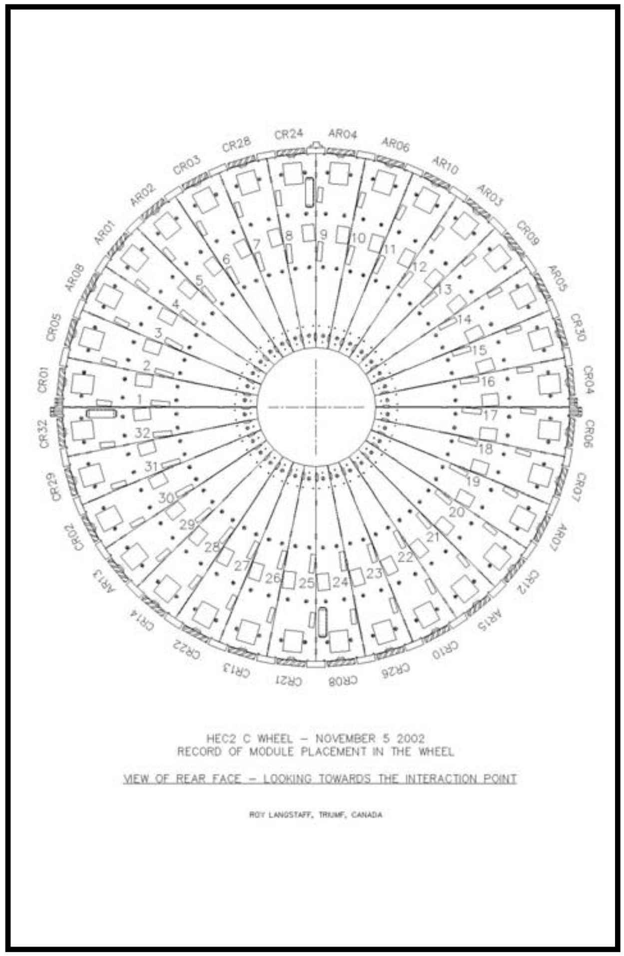
Cryostat/Wheel/Wedge	A/HEC1/1	A/HEC1/10	A/HEC1/11	A/HEC1/12
Cryostat	A	A	A	A
Wheel	HEC1	HEC1	HEC1	HEC1
Wheel_Cryostat	HEC1A	HEC1A	HEC1A	HEC1A
Wedge	1	10	11	12
Module Serial Number	AF21	CF23	CF22	AF15

This table connects this wheel assembly database with the database that describes the 128 modules that make up the four wheels. This is done through the serial number of the modules. The items in this table have already been described in the description of the mechanical detail tables. For completeness we give below the reference drawings of the locations of the modules in the four wheels.






HEC2 A WHEEL – JANUARY 27 2004
RECORD OF MODULE PLACEMENT IN THE WHEEL
VIEW OF REAR FACE – LOOKING TOWARDS THE INTERACTION POINT
ROY LANGSTAFF, TRIUMF, CANADA


HEC2 C WHEEL – NOVEMBER 5 2002
RECORD OF MODULE PLACEMENT IN THE WHEEL
VIEW OF REAR FACE – LOOKING TOWARDS THE INTERACTION POINT
ROY LANGSTAFF, TRIUMF, CANADA

PSB Performance Summary

Overview:
One HEC wedge is equipped with 5 PSBs:

Amplifier Table PSB type	A	B	C	D	E
HEC Segment	Gaps1-8	Gaps 9-24, pads 1-8	Gaps 9-24, pads 9-23	Gaps 25-32	Gaps 33-40
Quadrant Cabling Table PSB type	1	2-1	2-2	3	4

Table 1: PSB labeling conventions.

The production volume was 75 PSBs of each type. All PSBs are named like "*A23*", where "*A*" is the PSB type, "*23*" is the serial number.

The PSB's A00, A01, A02, B01, B02, C00, C02, D00, D01, E00, E01 are "reference" PSBs, they were not used for HEC modules, so they are not included into data base.

During the QC tests, the main parameters of all preamplifiers were measured. A PSB passed the QC tests if all parameters were within the specified window. A summary of these parameters is given in the database. A review of the tests undertaken is given in:
http://atlas.web.cern.ch/Atlas/GROUPS/LIQARGSTORE/HEC_Calo/QC/Series.Production/PRR/QCDocuments/MPI/elqc2000.pdf

Two pads are connected to every amplifier. So for instance 4 amplifiers are used to produce the signal for gaps 1-8, with gaps 1 - 2, gaps 3 - 4, gaps 5 – 6, and gaps 7 – 8 connected to them.

Given below are some typical values from this table. In what follows we will use the first row of this table as our *specimen value*.

PSB Serial/Tower	PSB Serial	Tower	# Amplifiers in Tower	% Non-Linearity	Average Transfer Coefficient kΩ	% Uniformity of Preamplifier Gains	RMS Noise (mV) at Nominal V_{ee}	RMS Noise (mV) at High V_{ee}
A06/1	A06	1	8	0.76	0.74	1.62	0.52	0.58
A06/2	A06	2	8	0.82	0.70	0.96	0.55	0.53
A06/3	A06	3	8	0.85	0.72	1.53	0.47	0.59
A06/4	A06	4	8	0.87	0.73	1.56	0.48	0.43
A06/5	A06	5	4	0.68	0.77	0.69	0.53	0.55
A06/6	A06	6	4	0.61	0.73	0.99	0.65	0.59
A06/7	A06	7	4	0.89	0.78	1.45	0.56	0.73

PSB Serial/Tower

Unique identifier for this table in the database. This table includes some spare amplifiers. There are typically about 67 amplifiers of each type (64 are required) and about 19 towers on average per amplifier (A:24, B:8, C:15, D:23, E:24), total entries should be about 6000 entries in total. There are 6097 entries.

Specimen value: A06/1, where:

A06 : PSB board serial number as described above

1 : Tower number from 1 to 24 (at most)

PSB Serial

Specimen value: A06, where:

A06 : PSB board serial number as described above

Tower

Specimen value: 1, where:

1 : Tower number from 1 to 24 (at most)

See Figure 8 for the definition of these tower numbers.

 # Amplifiers in Tower

Specimen value: 8, where:

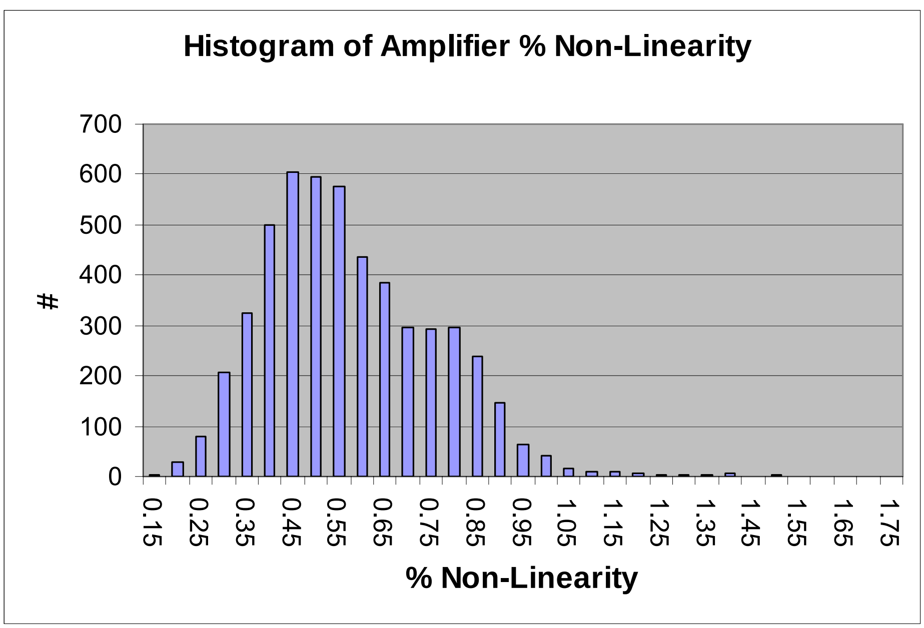
8 : Number of amplifiers in tower (between 2 and 16)

% Non-Linearity

Specimen value: 0.76, where:

0.76 : Non-linearity in %, measured when varying the input current from 0 to 1 mA

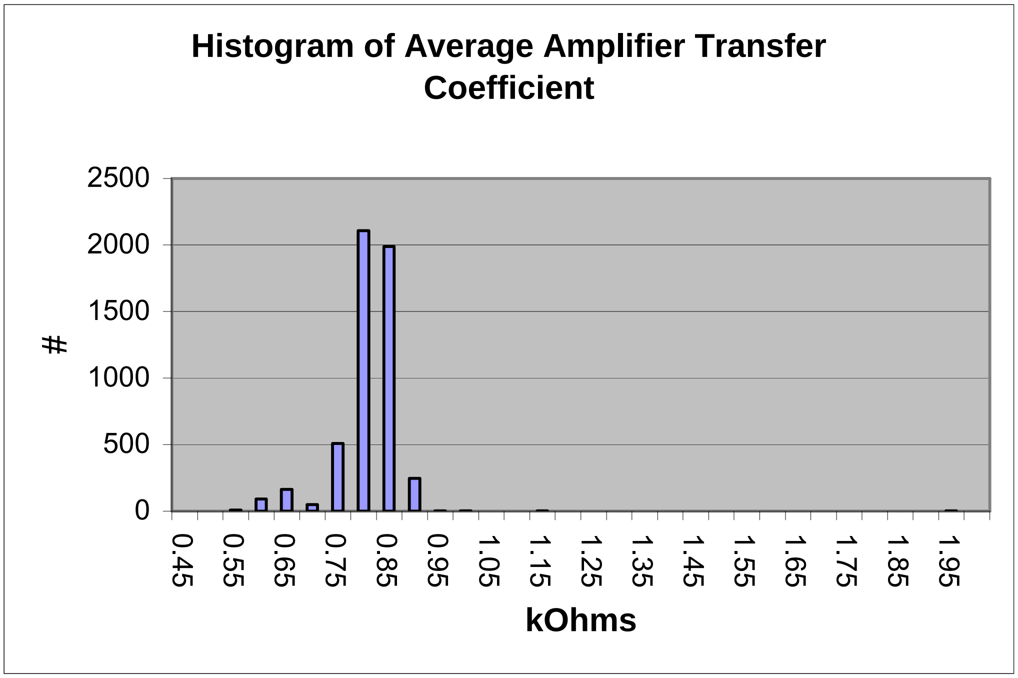
The definition of the linearity was that the input current was varied from 0 to 1 mA (15 points), then the 15 points fit with linear (y = ax) function. Then the non-linearity is just the percentage deviation of the point furthest from the fitted line.



Average Transfer Coefficient kOhm

Specimen value: 0.74 kΩ, where:

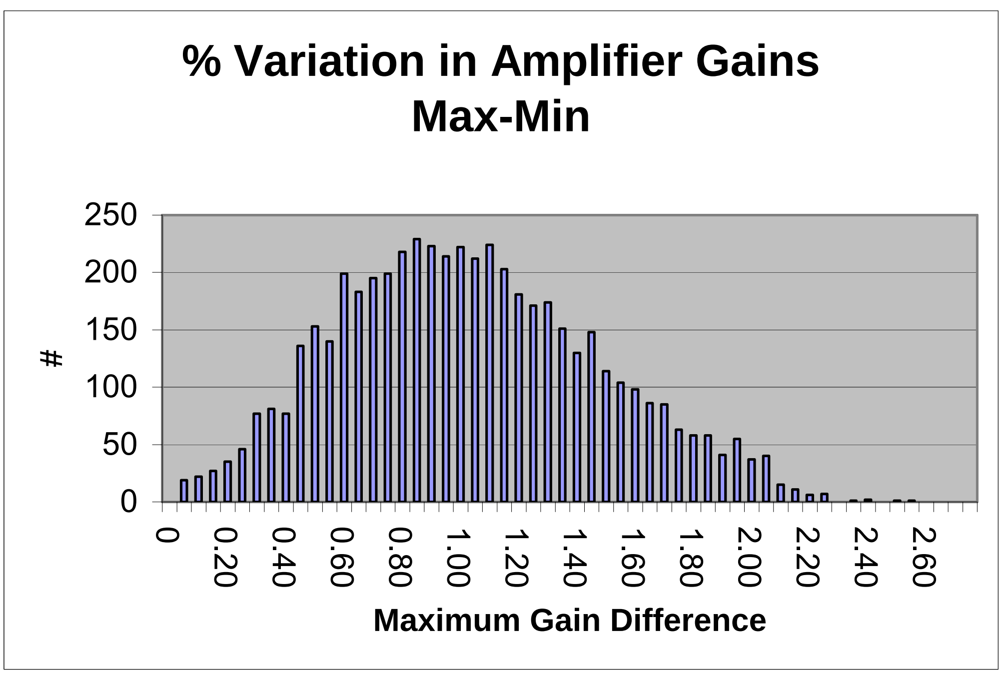
0.74 kΩ: The average transfer coefficient of this set of *n* amplifiers (*n* = # Amplifiers in Readout Channel).



% Uniformity of Preamplifier Gains

Specimen value: 1.62, where:

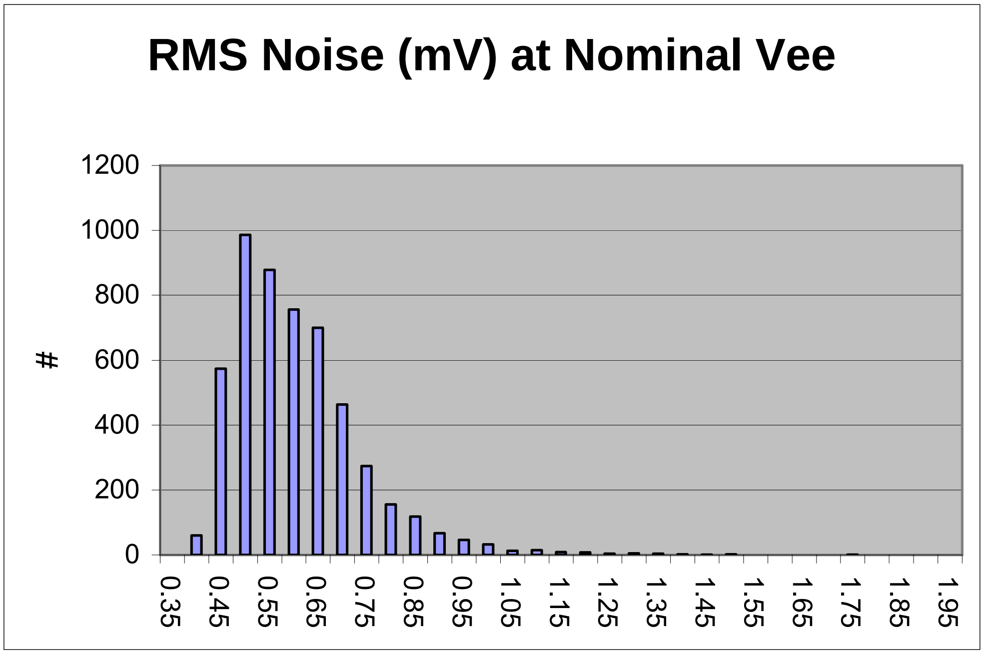
1.62 : The difference between the maximum and minimum % amplifier gain of this set of *n* amplifiers (*n* = # Amplifiers in Readout Channel).



RMS Noise (mV) at Nominal V_{ee}

Specimen value: 0.52, where:

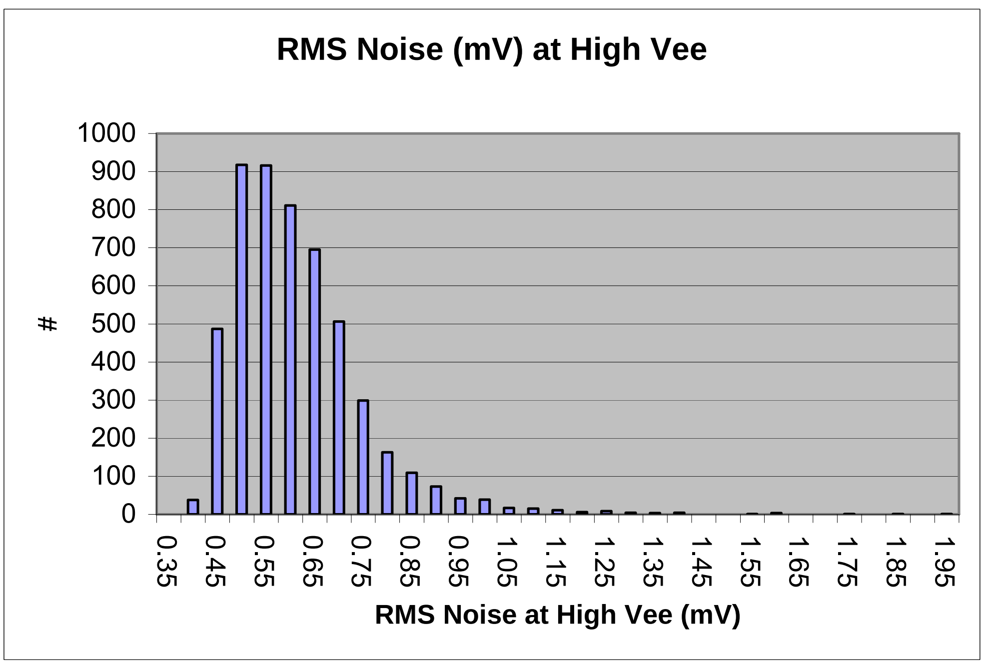
0.52 : The RMS noise (mV) when using the standard V_{ee} = -1.5 V



RMS Noise (mV) at High V_{ee}

Specimen value: 0.58, where:

0.58 : Is the RMS noise (mV) when using the high V_{ee} = -1.8 V



3. CABLING TABLES

Quadrant Signal and Calibration Cabling

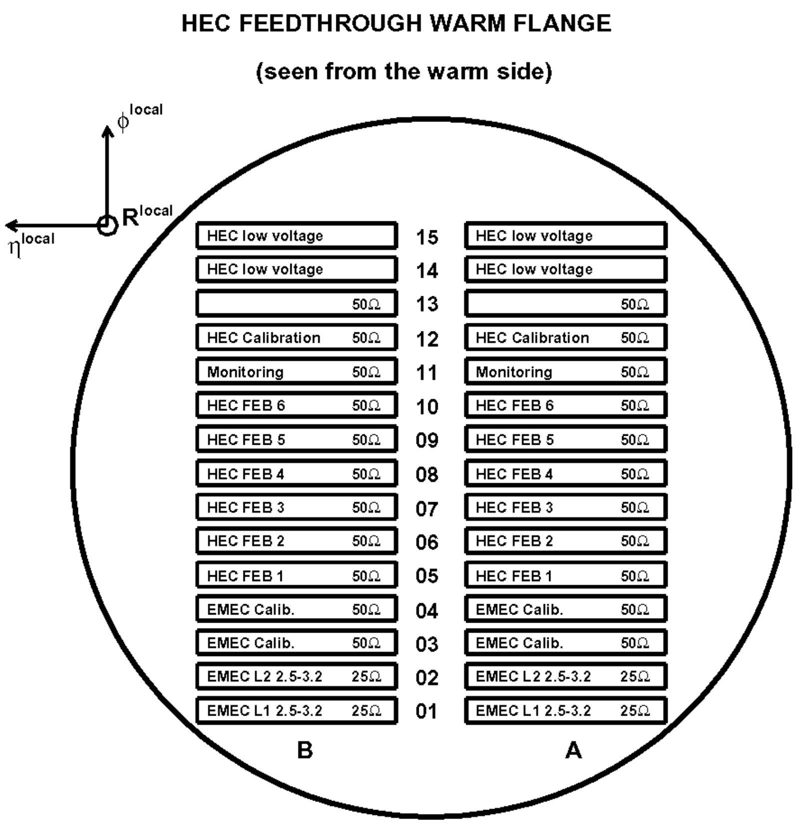
Cryostat/Qwedge/PSB_letter/Pad/SubZ	A/1/C/P19/2
Cryostat/Qwedge/PSB_letter/Tower	A/1/C/19
Cryostat	A
Qwedge	1
PSB Letter	C
Tower	19
Pad	P19
Gap	10-16
Gap_new	17 to 24
ETA	11
PHI	1
PHI_letter	A
Z	2
SubZ	2
PSB	2-2
INCON	11
INPIN	5-8
OUTCON	3
OUTPIN	3
Signal Patch Panel Input Connector	2
Signal PP Input Connector Pin	6
Signal Patch Panel Output Connector	6
Signal PP Output Connector Pin	3
Signal Patch Panel	9
Cold flange pigtail Connector Pin	18
Feedthrough Connector Number	9A
Front End Board Number	5
Front End Crate SLOT	30
Front End Board Connector	J1
FEB input connector pin	A24
FEB Shaper Channel Number	17
FEB ADC Number	3
FEB ADC Channel	2
FEB Output connector pin	A9
Trigger Driver Board Number	2
Trigger Driver Channel	48
Trigger Driver input connector	2
Trigger Driver input connector pin	9
Trigger Driver output connector	7
Trigger Driver output connector pin	1
Calibration Generator Channel	11
Calibration Feedthrough connector #	12A
Calibration lines of Wedges	11
Calibration Patch Panel Number	1
Calibration PP Input Connector #	2
Calibration PP Input Connector Pin #	3
Calibration PP Output Connector #	2
Calibration PP Output Connector Pin #	1
Calibration distribution board on wheel	FRONT
Distribution board Input Connector	6
Distribution board Input Connector Pin	1
Distribution Board Output Connector	3
Distribution Board Output Connector Pin	4
Strip-line Type	16/B

Each HEC calorimeter wedge has 5 PSB boards , three on the front wheel (1, 2-1, 2-2) and two on the rear wheel (3, 4) (see table 1, page 25). They correspond to the 4 longitudinal readout depths (Z=1 to 4). The PSB boards have 3 output connectors. Signals from the outer psuedo-rapidity η region are collected at PSB OUTCON 1 (ETA=2-5), those from the middle psuedo-rapidity η region at PSB OUTCON 2 (ETA=6-9), and those from the inner region (ETA=10-15) at PSB OUTCON 3. Signals from 2 neighbouring wedges are transfered to patch panels with Harness A cables. There are 12 patch panels in a quadrant, four for each psuedo-rapidity η region:

- P1, P2, P3, P4 - ETA=2-5 (OUTCON=1);
- P5, P6, P7, P8 - ETA=6-9 (OUTCON=2);
- P9, P10, P11, P12 - ETA=10-15 (OUTCON=3).

Harness B (Pigtail) cables serve to connect the patch panels with the feedthroughs. At the patch panel end they have 8 (8 signal pin) MPI connectors J1 to J8, at the cold feedthrough end an ATI connector (64 signal pin) . Diagrams of patch panel connectors are shown in Appendix I. Connectors positoning at the HEC feedthrough warm flange and their mapping to FEC slots are shown in the figure below and Fig.?? .

Feedthrough connectors (FT) column A are connected with FEB input connector J1 (FEB channel 1 – 64), those of column B - with FEB input connector J3 (FEB channel 65 – 128).



For FT column A the FEB channel number is equal to the ATI_Pin number and for FT column B the FEB channel number is equal to ATI_Pin number plus 64 . The shaper channel number is equal to the FEB channel number minus 1.

There are 16 ADC's in the FEB. Each serves 8 channels. ADC 1 – 8 belongs to FEB channels 1 – 64, while ADC 9 – 16 belongs to FEB channels 65 – 128.

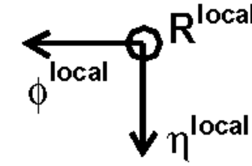
FEB connector J2 serves to transfer trigger sums from shaper mixer outputs to the baseplane.

Two trigger driver boards (TDr= 1 and TDr=2) are used to transfer trigger sums to reciever.

Cleland notations for TDr pins and channels are used (W.E.Cleland. Layer Sum Boards for the ATLAS Liquid Argon Calorimeters. EDMS Document ATL-AL-EN-0019)

EMEC + HEC FRONT END CRATE

(seen from the warm side)



			FT (A)	connector (B)
38	HEC LV supply	[LV SUPPLIES]	15	15
37	HEC LV supply	[LV SUPPLIES]	14	14
36				
35	HEC Calibration	[CALIBRATION]	12	12
34	Controller	[MONITORING]		
33	Monitoring	[MONITORING]	11	11
32	HEC FEB 6	[FEB 6]	10	10
31	HEC Tower Driver	[TDB 2]		
30	HEC FEB 5	[FEB 5]	09	09
29	HEC FEB 4	[FEB 4]	08	08
28	HEC FEB 3	[FEB 3]	07	07
27	HEC Tower Driver	[TDB 1]		
26	HEC FEB 2	[FEB 2]	06	06
25	HEC FEB 1	[FEB 1]	05	05
24	Controller			
23	EMEC Calibration	[CAL 1]	04	04
22	EMEC Calibration	[CAL 0]	03	03
21	L2 FEB 2.5-3.2	[L2]	02	02
20	Tower Builder	[TB 2]		
19	L1 FEB 2.5-3.2	[L1]	01	01
18	Middle FEB 2.4-2.5	[MID 5]	15	15
17	Middle FEB 2.4-2.5	[MID 4]	14	14
16	Tower Builder	[TB 1]		
15	Back FEB 2.4-2.5	[BACK 1]	13	13
14	Front FEB 2.4-2.5	[FRONT 5]	12	12
13	Middle FEB 1.5-1.6	[MID 3]	11	11
12	Middle FEB 1.5-1.6	[MID 2]	10	10
11	Back FEB 1.5-1.6	[BACK 0]	09	09
10	Controller	[CONTROL]		
09	Tower Build 1.5-1.6er	[TB 0]		
08	Front FEB 1.5-1.4	[FRONT 4]	08	08
07	Front FEB 1.5-1.2	[FRONT 3]	07	07
06	Front FEB 1.5-1.6	[FRONT 2]	06	06
05	Front FEB 1.5-1.6	[FRONT 1]	05	05
04	Middle FEB 1.4-1.5	[MID 1]	04	04
03	Middle FEB 1.4-1.5	[MID 0]	03	03
02	Front FEB 1.4-1.5	[FRONT 0]	02	02
01	PS FEB 1.5-1.6	[PS]	01	

There is one calibration board (128 channels) in a quadrant. 16 generators are used for calibration of one wedge using 6 for the rear and 10 for a front module:

- Cal_Gen = (1 – 6) + (QWedge –1) x 16 for rear module
- Cal_Gen = (7 –16) + (QWedge-1) x 16 for front module

Initially there were two tables in the data base: EC_A_upd and EC_C_upd for the quadrant of end cap A and C respectively. They differed in 2 columns: Wedge and PHI. Both items are reversed for EC_C_upd compared to EC_A_upd. For simplicity these two tables have been combined in this database. The column Cryostat has been added to allow these tables to be appended to each other.

The calibration lines are arranged in such a way as to be able to calibrate the calorimeter with the minimum number of lines. To avoid signal saturation at the summing stage of amplifiers different calibration generators for different parts of readout channels formed with more than the normal 8 pads (such as tower 5 in the gaps 9-24 depth, which is composed of 16 5a pads and 16 5b pads) . Hence regions where tiles are split (into a and b) and/or the depth is 16 liquid argon gaps not the more normal 8, are calibrated by two or four independent calibration lines.

Quadrant Signal and Calibration Cabling Table Entries:

Cryostat/QWedge/Z/Sub_Z/Pad:

This is the unique identifier for this table. Cryostat is either A or C. QWedge (described below) goes from 1 to 8. Z (described below) goes from 1 to 4, and combines with Sub_Z (1 or 2) to give the possibility of two entries for each Z = 2 entry. Pad (described below) is the descriptor for each type of pad in a HEC wedge. Table 3 lists all entries per wedge. At the bottom of table 3 the entries are summed. There are 28 Z = 1 SubZ = 1 entries, 27 Z = 2 SubZ = 1 entries, 25 Z = 2 SubZ = 1 entries, 25 Z = 3 SubZ = 1 entries, 22 Z = 4 SubZ = 1 entries, giving at total of 127 entries in total per wedge. In addition there are 9 redundant entries (cables present but not attached to towers, denoted by SubZ = 0) in this table per wedge. So in total there are 136 entries per wedge, giving with 8 wedges per quadrant and two cryostats: 2176 entries in this quadrant table.

Cryostat/Qwedge/PSB_letter/Tower:

This is the entry to connect to the table with one entry per signal line. There can be up to four lines in this table for a line in the signal summary table.

Cryostat:

A or C cryostats.

QWedge:

A wedge is the combination of a front and rear HEC module. It has a φ width of 2π/32 radians. Eight wedges make a quadrant. Thus the value of quadrant wedge QWedge goes between 1 – 8 in a quadrant. QWedge number increases with increasing φ.

PSB Letter:

A letter between A and E, denoting the type of PSB board.

Pad:

All the pads are labeled according to the notation on page 287, ATLAS Liquid Argon TDR (reproduced below in Figure 7). A typical value is P1A, where P stands for PAD and 1a is the label on the drawing. 1 is the lowest psuedo-rapidity pad, and 24 is the highest psuedo-rapidity pad (having psuedo-rapidity = 3.2 as its nominal high psuedo-rapidity boundary).

Gap:
Within each Z region the tiles are readout in pairs. The first pair in a Z region is called channel 2, the second pair channel 4 etc.. The notation used by the gap identifier is the first pair channel dash last pair channel. Allowed values are: 2-4 , 2-8, and 10-16. So for instance:

- Z=1 , Gap = 2-8 corresponds to gap_new 1 to 8.
- Z=2 , Gap = 2-8 corresponds to gap_new 9 to 16.
- Z=2 , Gap = 10-16 corresponds to gap_new 17 to 24.
- Z=3 , Gap = 2-4 corresponds to gap_new 25 to 28. (see for instance pad P3 in table 2)

Gap_new:
The liquid argon filled gaps between the copper plates in the HEC are numbered from front to rear: 1 to 40. Gaps 1 to 24 are in the front wheel, and 25 to 40 in the rear wheel. In this database numbers of gaps summed to make towers or sub-towers are given. Allowed values are: 1 to 8, 9 to 16, 17 to 24, 25 to 28, 25 to 32, 33 to 36, and 33 to 40.

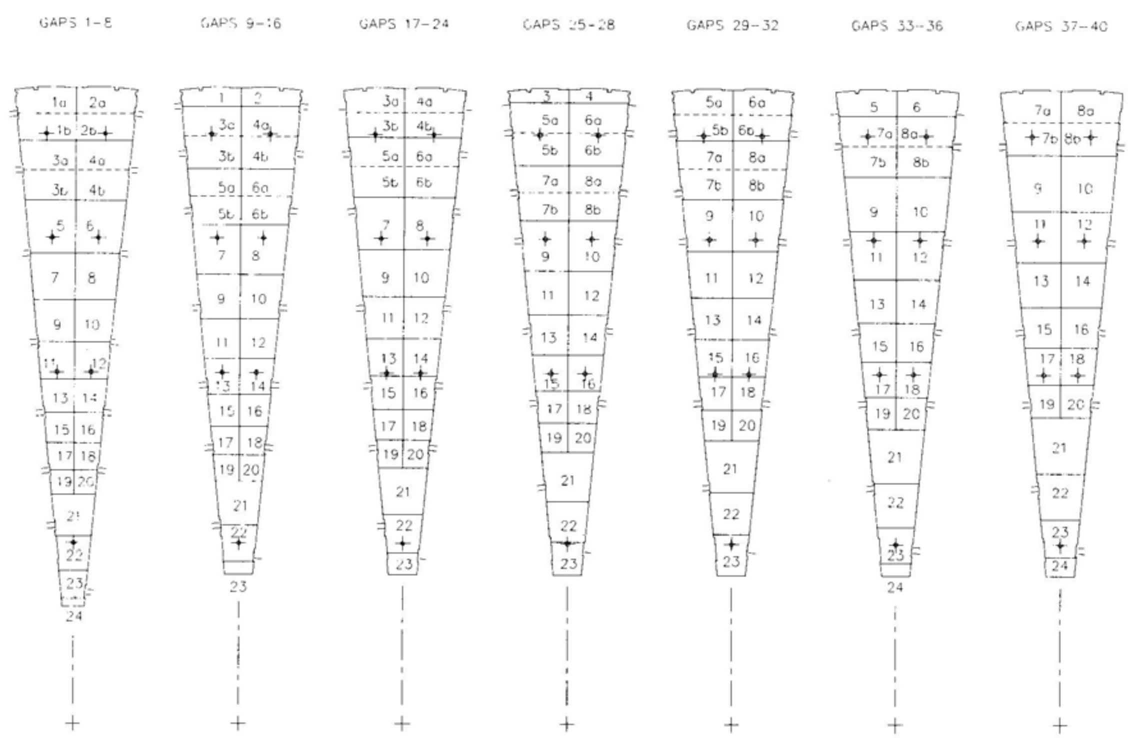


Figure 9: Definition of the pads of the readout electrodes, as given in the ATLAS Liquid Argon TDR, Figure 8-5.

ETA:
ETA is a number between 2 and 15. Below is a lookup table (table 1) between this ETA number and the nominal range of psuedo-rapidity the entry lies within. This number indicates which output connector is used from the PSB board for this entry.

PHI:
For the inner tiles where there is only one tile across the whole module (pads 21 to 24) this number is equal to wedge. Where the module is two tiles wide (pads 1 to 20) it is twice wedge if the tile is on the high φ side of the module, and it is twice wedge minus one if it is on the low φ side of the module

ETA	Nominal Pseudo-Rapidity	
	Low Edge	High Edge
2	1.50	1.60
3	1.60	1.70
4	1.70	1.80
5	1.80	1.90
6	1.90	2.00
7	2.00	2.10
8	2.10	2.20
9	2.20	2.30
10	2.30	2.40
11	2.40	2.50
12	2.50	2.70
13	2.70	2.90
14	2.90	3.10
15	3.10	3.20

Table 2: Look-up between the Offline Identifier ETA, and the nominal psuedo-rapidity range of tiles with that ETA.

			Nominal warm position			
			Relative to front face HEC Module		Relative to ATLAS interaction Point	
Z	Gap	Gap_new	First Gap	Last Gap	First Gap	Last Gap
			(mm)	(mm)	(mm)	(mm)
1	2-8	1 to 8	16.75	251.25	4293.75	4528.25
2	2-8	9 to 16	284.75	519.25	4561.75	4796.25
2	10-16	17 to 24	552.75	787.25	4829.75	5064.25
3	2-4	25 to 28	29.25	204.75	5163.25	5338.75
3	2-8	25 to 32	29.25	438.75	5163.25	5572.75
4	2-4	33 to 36	497.25	672.75	5631.25	5806.75
4	2-8	33 to 40	497.25	906.75	5631.25	6040.75

Table 3: Nominal warm z position of the centre of the first and last readout gap in each Z/Gap volume. Note these are nominal positions that do **not** allow for the several centimetre setback of the end caps from their nominal design positions, nor for the thermal shrinkage during cool down.

Pad	ETA	Psuedo-Rapidity		PHI	Z				Gaps						
		Low	High	(A End)	1	2	3	4	1 to 8 SubZ=1	9 to 16 SubZ=1	17 to 24 SubZ=2	25 to 28 SubZ=1	29 to 32 SubZ=1	33 to 36 SubZ=1	37 to 40 SubZ=1
P1A	2	1.5	1.6	2 wedge-1	x				1						
P1B	2	1.5	1.6	2 wedge-1	x				1						
P1	2	1.5	1.6	2 wedge-1		x				1					
P2A	2	1.5	1.6	2 wedge	x				1						
P2B	2	1.5	1.6	2 wedge	x				1						
P2	2	1.5	1.6	2 wedge		x				1					
P3A	3	1.6	1.7	2 wedge-1	x	x			1	1	1				
P3B	3	1.6	1.7	2 wedge-1	x	x			1	1	1				
P3	3	1.6	1.7	2 wedge-1			x					1			
P4A	3	1.6	1.7	2 wedge	x	x			1	1	1				
P4B	3	1.6	1.7	2 wedge	x	x			1	1	1				
P4	3	1.6	1.7	2 wedge			x					1			
P5A	4	1.7	1.8	2 wedge-1		x	x			1	1	1	1		
P5B	4	1.7	1.8	2 wedge-1		x	x			1	1	1	1		
P5	4	1.7	1.8	2 wedge-1	x			x	1					1	
P6A	4	1.7	1.8	2 wedge		x	x			1	1	1	1		
P6B	4	1.7	1.8	2 wedge		x	x			1	1	1	1		
P6	4	1.7	1.8	2 wedge				x	1					1	
P7A	5	1.8	1.9	2 wedge-1			x	x				1	1	1	1
P7B	5	1.8	1.9	2 wedge-1			x	x				1	1	1	1
P7	5	1.8	1.9	2 wedge-1	x	x			1	1	1				
P8A	5	1.8	1.9	2 wedge			x	x				1	1	1	1
P8B	5	1.8	1.9	2 wedge			x	x				1	1	1	1
P8	5	1.8	1.9	2 wedge	x	x			1	1	1				
P9	6	1.9	2	2 wedge-1	x	x	x	x	1	1	1	1	1	1	1
P10	6	1.9	2	2 wedge	x	x	x	x	1	1	1	1	1	1	1
P11	7	2	2.1	2 wedge-1	x	x	x	x	1	1	1	1	1	1	1
P12	7	2	2.1	2 wedge	x	x	x	x	1	1	1	1	1	1	1
P13	8	2.1	2.2	2 wedge-1	x	x	x	x	1	1	1	1	1	1	1
P14	8	2.1	2.2	2 wedge	x	x	x	x	1	1	1	1	1	1	1
P15	9	2.2	2.3	2 wedge-1	x	x	x	x	1	1	1	1	1	1	1
P16	9	2.2	2.3	2 wedge	x	x	x	x	1	1	1	1	1	1	1
P17	10	2.3	2.4	2 wedge-1	x	x	x	x	1	1	1	1	1	1	1
P18	10	2.3	2.4	2 wedge	x	x	x	x	1	1	1	1	1	1	1
P19	11	2.4	2.5	2 wedge-1	x	x	x	x	1	1	1	1	1	1	1
P20	11	2.4	2.5	2 wedge	x	x	x	x	1	1	1	1	1	1	1
P21	12	2.5	2.7	Wedge	x	x	x	x	1	1	1	1	1	1	1
P22	13	2.7	2.9	Wedge	x	x	x	x	1	1	1	1	1	1	1
P23	14	2.9	3.1	Wedge	x	x	x	x	1	1	1	1	1	1	1
P24	15	3.1	3.2	Wedge	x			x	1					1	1
							SUM		28	27	25	25		22	

Table 4: Description of all entries for a wedge in the Signal and Calibration Table.

PHI_letter:

This is the same as PHI except the notation instead of being from 1 to 16 is from A to P. PHI = 1 is equivalent to PHI_letter=A. This letter along with ETA defines the Trigger Towers in "Colas-Clelend notation". (W.E.Cleland. Layer Sum Boards for the ATLAS Liquid Argon Calorimeters.
EDMS Document ATL-AL-EN-0019)

Z:

This is the readout depth. Z=1 is the readout depth gaps 1-8, Z=2 is the readout depth gaps 9-24, Z=3 is the readout depth gaps 25-32, Z=4 is the readout depth gaps 33-40. See table 2 for conversion from Z to nominal position in ATLAS in mm.

SubZ :

This is 1 for all entries except:

- For entries with Z = 2 where it is 1 for the gaps 9-16 and 2 for gaps 17-24.
- For entries where the cable is not connected to a tower it is set to 0.

PSB:

Pre-amplifier and summing board (PSB) type used. Allowed values are : 1, 2-1, 2-2, 3, 4. Where 1, 2-1, 2-2 are on the front wheel and 3 and 4 are on the rear wheel. PSB n contains the amplifiers for readout depth n. PSB boards 2-1 and 2-2 are used for readout depth 2 (inner and outer regions). (See Appendix I)

INCON:

PSB input connector (value 1 to 15).

INPIN:

PSB input connector pin this has a notation of the type: 1-2, 1-4, 5-6 and 5-8. Each of these represents a set of pins: 5-8 means pins 5, 6, 7, and 8 are used. Connected to each pin are a pair of readout pads. Each pin has an amplifier attached to it. Inside the PSB the various signals from the various pad pairs that make up a readout tower are summed and the anologue signal is sent out on a single output pin. As an example of this pin assignment notation in table 4 below we take tower 7 in the third readout depth where we sum pads 7a and 7b for gaps 25 to 32.

OUTCON:

PSB output connector (value 1 to 3).

OUTPIN:

PSB output connector pin (1 to 8)

Tower:

This is the tower as defined on page 287 Figure 8-5 of the TDR (or the number in the **Pad** entry defined above). Note at this point in the readout chain divided pads such as 2a and 2b have been summed to provide a single tower (number 2 in the case of 2a and 2b). The tower can be derived from OUTCON and OUTPIN by:

Tower = 8(OUTCON-1) + OUTPIN

Except in the case of PSB readout channels, 22 and 23 where the output pin is switched, so:

Tower 22 is connected to OUTCON 3 and OUTPIN 7
Tower 23 is connected to OUTCON 3 and OUTPIN 6

This switching of the OUTPIN for these two pads was required due to engineering constraints in the layout of the PSB board and the mechanical design of the HEC modules (that did not allow all even numbered pads to be on the wiring harness on one side of the module and all odd numbered on the other side).

Pad	Gap	Input Pin Number	INCON	INPIN	OUTCON	OUTPIN	Tower
7a	25	1	1	1-4	1	7	7
7a	26						
7a	27	2					
7a	28						
7a	29	3					
7a	30						
7a	31	4					
7a	32						
7b	25	5		5-8			
7b	26						
7b	27	6					
7b	28						
7b	29	7					
7b	30						
7b	31	8					
7b	32						

Table 5: Example of how a readout tower is summed in the PSB board. Here we give the information for pad 7 that, for amplifier noise reasons, is split into two pads (7a and 7b) on the pad board.

Signal Patch Panel input connector (1-4) (LS)

Signal Patch Panel input connector pin (1-8) (LS_Pin)

Signal Patch Panel output connector (1-8) (JF)

Signal Patch Panel output connector pin (1-8) (JF_Pin)

Signal Patch Panel (1-12) (PP) See Appendix I

Cold flange (Pig tail) connector pin (1-64) (ATI_Pin)

Feedthrough connector number (A5-B10) (FT)

Front-End Board number (1 – 6) (FEB)

FEB input connector (J1 or J3) (FEB_Con)

FEB input connector pin (J_Pin)

FEB Shaper channel number (0 – 127) (Shaper)

FEB ADC number (1 – 16) (ADC)

FEB ADC channel number (1 – 8) (ADC_Ch)

FEB Output connector pin For trigger sums signals (A1-C32) (J2_Pin)

Trigger driver board number (1 – 2) (TDr)

Trigger driver channel (0 – 95) (TDr_Ch)

Trigger driver input connector (1 – 3) (TINC)

Trigger driver input connector pin (1 – 96) (TINP)

Trigger driver output connector (4 – 9) (TOUC)

Trigger driver output connector pin (1 – 16) (TOUP)

Calibration generator channel (1 – 128) (Cal_Gen)

Calibration feedthrough connector number (12A or 12B) (Cal_FT)

Calibration lines of wedge (1 –16) (Cal_line)

Calibration patch panel number (1 – 2) (Cal_PP)

Calibration patch panel input connector number (1 – 8) (Cal_In)

Calibration patch panel input connector pin number (1 – 8) (Cal_In_Pin)

Calibration patch panel output connector number (1 – 12) (Cal_Out)

Calibration patch panel output connector pin number (1 – 8) (Cal_Out_Pin)

Calibration distribution board on module (FRONT or REAR) (Cal_DB)

Distribution board input connector (5 or 6) (DB_In)

Distribution board input connector pin (1 - 8) (DB_In_Pin)

Distribution board output connector (1 - 4) (DB_Out_Pin)

Strip line type (1/A to 32/D) (Str_Line)

HV Cabling Table

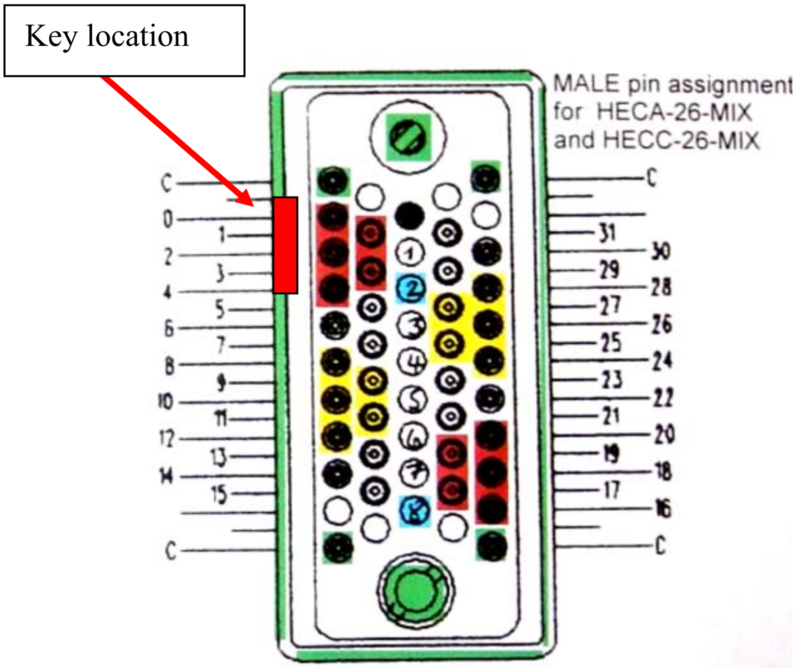
Cryostat/Wedge/Z/SubGap	A/1/1/EST1	A/1/1/EST2	A/1/1/PAD1	A/1/1/PAD2
Cryostat/Wedge/Z	A/1/1	A/1/1	A/1/1	A/1/1
Cryostat/FT conn #/Pin #	A/0/2	A/0/1	A/0/3	A/0/0
Cryostat	A	A	A	A
ISEG Module	64	64	64	64
Channel Number	2	1	3	0
Cable	ALL-POS-40	ALL-POS-40	ALL-POS-40	ALL-POS-40
Pin Number	2	1	3	0
FeedThrough	0	0	0	0
HV Patch Panel (Plug)	Q1-P1-J1	Q1-P1-J1	Q1-P1-J1	Q1-P1-J1
HV Patch Panel (Socket)	Q1_HV_P1	Q1_HV_P1	Q1_HV_P1	Q1_HV_P1
Wedge	1	1	1	1
Z	1	1	1	1
SubGap	EST1	EST2	PAD1	PAD2
Module Serial Number	AF21	AF21	AF21	AF21
Patch Panel Connector In	1-1-1	1-1-1	1-1-1	1-1-1
Patch Panel Pin In	3	2	4	1
Patch Panel Connector Out	J8 A	J8 A	J8 A	J8 A
Patch Panel Pin Out	C	B	D	A
Section of Module	Est1-Cell 1-8	Est2-Cell 1-8	Pad1-Cell 1-8	Pad2-Cell 1-8

Description

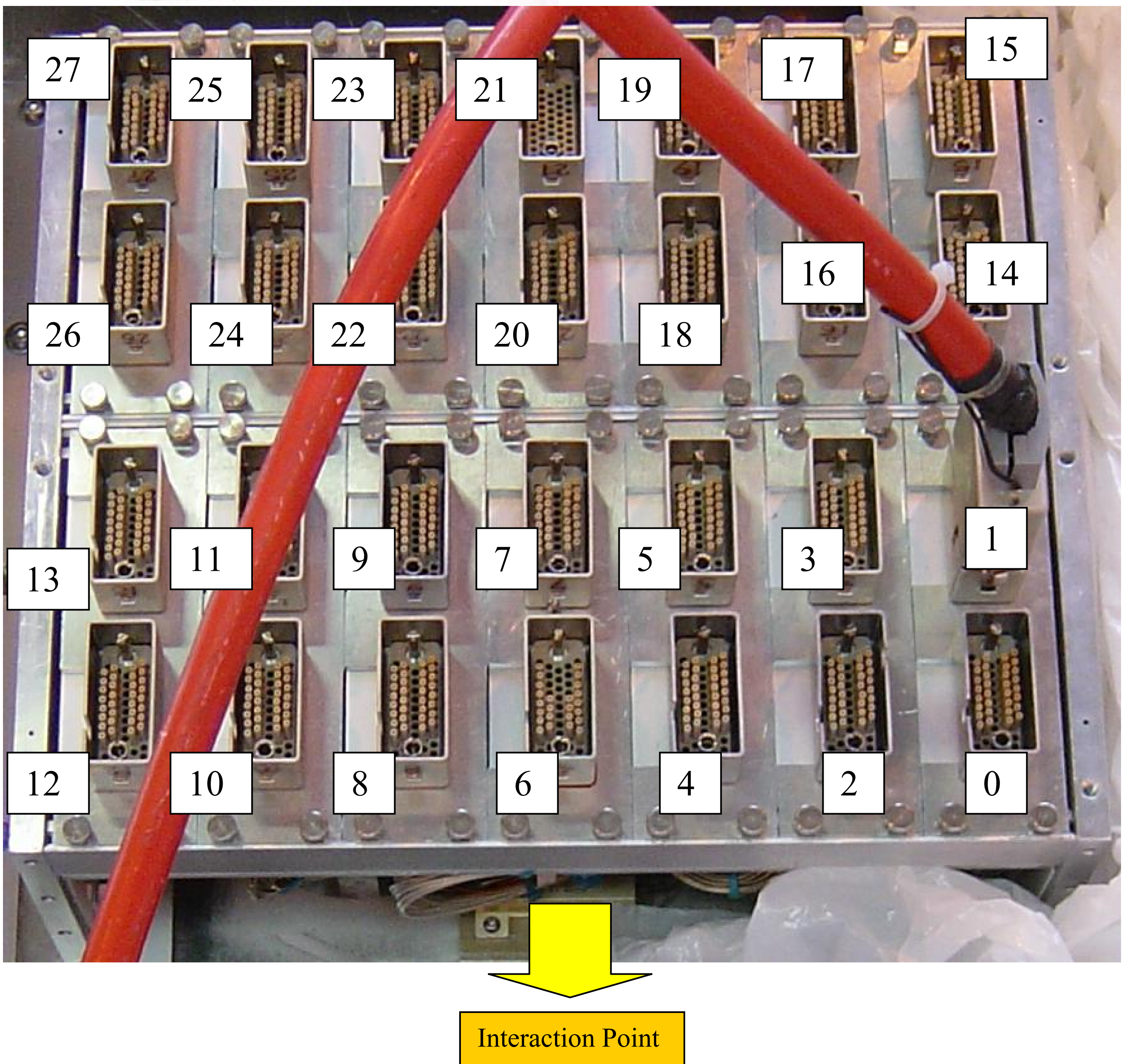
Two unique identifiers exist for each entry. The first defines the calorimeter volume served, the second the location of the pin on the cryostat serving this HV volume.

- The first unique identifier for this table is Cryostat/Wedge/Z/subgap, with 2 cryostats, 32 wedges, 4 Z depths and 4 subgaps, there are 1024 entries in this table. The table gives the wiring details for these lines.
- The second unique identifier for this table is Cryostat/HVfeedthrough/Pin, with 2 cryostats, 16 feedthroughs and 32 pins, there are 1024 entries in this table. The figures below define the locations of the pins and HV feedthroughs.

The entries for ISEG module and channel number are included for completeness but this is not the definitive definition of these. If for technical reasons these assignments are changed this database will not be changed. The database seeks only to define the items that will not change, in this case: feedthrough and pin number.



Figures Defining the HV feedthrough connectors and pins. The picture below defines the feedthroughs, note the direction to the interaction point. Also in the picture the notches can be seen on some of the connectors. The diagram to the left shows the pin definitions. Note the key location that goes into the notch.



<u>List of entries:</u>

1. **Cryostat/Wedge/Z/subgap**
   Unique Identifier (A or C / 1 to 32 / 1 to 4 / EST1, PAD1, PAD2, or EST2)
2. **Cryostat/Wedge/Z**
   As previous entry
3. **Cryostat/FeedThrough Connector#/Pin #**
   A unique identifier for the table, useful for describing or locating non-conformances observed after the cryostat is closed.
4. **Cryostat**
   A or C
5. **ISEG Module**
   The module number assigned to this line in the initial HV setup.
6. **Channel Number**
   The channel number within the ISEG module assigned to this line in the initial HV setup.
7. **Cable**
   ALL-POS- followed by a 2 digit number
8. **Pin Number**
   Number of pin in cable or Feedthrough (see diagram above)
9. **Feedthrough**
   HV Feedthroughs are numbered 0-27 see photograph above.
10. **HV Patch Panel (Plug)**
    What is written on the plug
11. **HV Patch Panel (Socket)**
    What is written on the patch panel next to the socket
12. **Wedge**
    EC wedge number (1 – 32)
13. **Z**
    Z section of module (1-4)
14. **Subgap**
    (4 possible values: EST1, PAD1, PAD2, or EST2)
15. **Module Serial Number**
    Serial Number of calorimeter module as defined at production site. Only included for information. (128 possible values: AF(R)1 – AF(R)32, CF(R)1 – CF(R)32)
16. **HV patch panel number**
    (1 – 4) per quadrant (HV PP)
17. **HV patch panel connector in**
    Three number designator such as: 2-3-16
18. **HV patch panel input connector pin**
    Number between 1 and 4
19. **HV patch panel output connector**
    16 possible connectors: J1A – J8A, J1H – J8H
20. **HV patch panel output connector pin**
    8 possible pins: A-H
21. **Section of module**
    (16 possible values, such as Est1-Cell 1-8)

Low Voltage Cabling Tables

Cryostat/Wedge/PSB_letter/Voltage	A/1/A/Minus1.5V_GND	A/1/A/Minus1.5Volts
Cryostat/Wedge/PSB_letter	A/1/A	A/1/A
Cryostat	A	A
Quadrant	1	1
Wedge	1	1
PSB Letter	A	A
Function	Minus1.5V_GND	Minus1.5Volts
Q number	60	59
Q line	1	1
Q LV Channel	1	1
Q PB Connector	1	1
Q PB Connector Pin	4	23
FEC slot	37	37
FEC Input Connector	1	1
FEC Back Plane Connector	J1	J1
FEC Back Plane Connector Pin	C-30	A-30
Warm FT Cable pin	C-3	A-3
Signal Feedthrough	14A	14A
ATI Pin	3	4
Quadrant LV patch panel	LV_PP1	LV_PP1
Quadrant LV patch panel input connector	A1	A1
Quadrant LV patch panel in-connector pins	15-16	1-2
Quadrant LV patch panel out-connector pins	9-10	7-8
PSB	1	1
PSB Letter repeated	A	A
PSB Pin	9-10	7-8
Q Wedge	1	1

The unique identifier for this table is: Cryostat/Wedge/PSB/Voltage. There are 2 cryostats, 32 wedges, 5 PSB per wedge, and 6 voltage lines per PSB. In addition there are two shield lines per wedge: 2048 entries in this table (2x32x(5x6+2) entries).
This table describes the wiring of the low voltages that power the PSB boards which are mounted on the modules in the liquid argon. These low voltages are supplied from a power supply box, feed into the front end crate (in slots 37 and 38), and then through the signal feedthroughs to the PSB's of the HEC.

Description.

One Power Box is used to supply low voltage to each HEC quadrant. Each Power Box has 40 Low Voltage Channels (a channel being a set of 3 voltages suitable for supplying one PSB), produced on 8 output connectors each with 5 channels. The Power Box output cables 1 to 4 are connected to four inputs of LV FEB1 (slot 37), cables 5 to 8 to those of LV FEB2 (slot 38). Outputs of FEB1 are connected with signal feedthrough (FT) 14A (J1) and FT 14B (J3), and those of FEB2 with FT15A (J1) and FT15B (J3). In the cold the LV pigtail has an ATI connector at the feedthrough end and 10 MPI connectors A1-E1, A2-E2 at the patch panel end. Each HEC quadrant is equipped with 4 Low Voltage patch panels (LV PP) each of these serves two neighbouring wedges (Wedge = n, n+1) For both End-Caps the connectors (A1-E1) belong to a wedge n, and (A2-E2) to wedge n+1. Connectors sets 1 and 2 are swapped at End Cap C patch panels. Two MS Excel tables were produced describing this situation for each end-cap: HEC_LV_A and

HEC_LV_C. These have only one difference: in the table HEC_LV_A LV PP is ordered by wedge number, while in the table HEC_LV_C LV PP is in the inverse order. During feedthrough cabling installation it was found that some swapped voltage and ground lines had been produced. Two new tables HEC_LV_A_new and HEC_LV_C_new with swapped voltage and ground lines were produced and are used in this database. In the list of items below the label used in these files for each entry is given in brackets.

List of items:

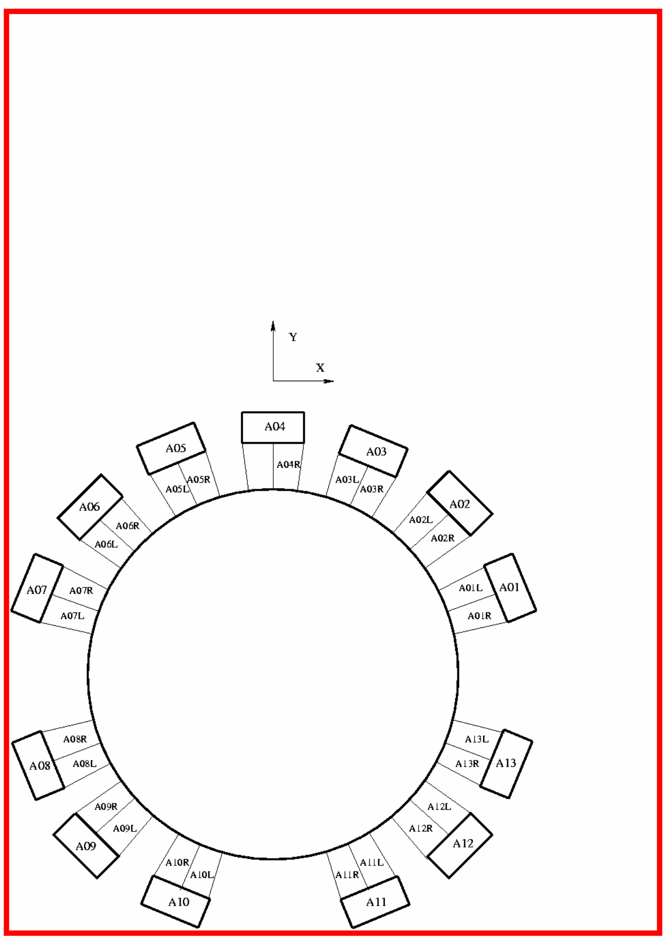
1. **Cryostat/Wedge/PSB_letter/Voltage**
   Unique identifier for this table
2. **Cryostat/Wedge/PSB_letter**
   Identifier for location signal lines affected if this line is off.
3. **Cryostat**
   A or C.
4. **Quadrant**
   1 to 8
5. **Wedge**
   1 to 32
6. **PSB Letter**
   A to E
7. **Function**
   Description of type of LV line this is, such as: Minus1.5V_GND
8. **Q Number**
   Unique identifier within a quadrant (1- 256 ordered by FEB_InC and ATI_Pin) (Num)
9. **Q Line**
   Quadrant low voltage line number (1-128) (Line)
10. **Q LV Channel**
    Quadrant LV channel number (1-40) (LV_Chan)
11. **Q PB Connector**
    Power Box Output Connector number (1-8) (PB_Con)
12. **Q PB Output Connector Pin**
    Quadrant Power Box Connector pin number (A1 to C32) (PB_Con_Pin)
13. **FEC Slot**
    LV Front End Board position in Front End Crate (37 or 38) (FEC Slot)
14. **FEB Input Connector**
    (1-4) (FEB_InC)
15. **FEC Back Plane Connector**
    (FEB Output Connector J1 or J3) (BP_Con)
16. **FEC Back Plane Connector pin**
    (A1-A32, C1-C32) (BP_Con_Pin)
17. **Warm FT connector pin**
    (A1-A32, C1-C32) (Warm-Cable_Pin)
18. **Signal Feedthrough**
    (14A, 14B, 15A, 15B) (FT)
19. **ATI Pin**
    LV Pig Tail connector pin, Also signal feedthrough pin (1-64) (ATI_ Pin)
20. **Quadrant LV Patch Panel**
    (LV_PP1 – LV_PP4) (LV PP)
21. **Quadrant LV Patch Panel input connector**
    (A1-E1, A2-E2) (PP_InC)

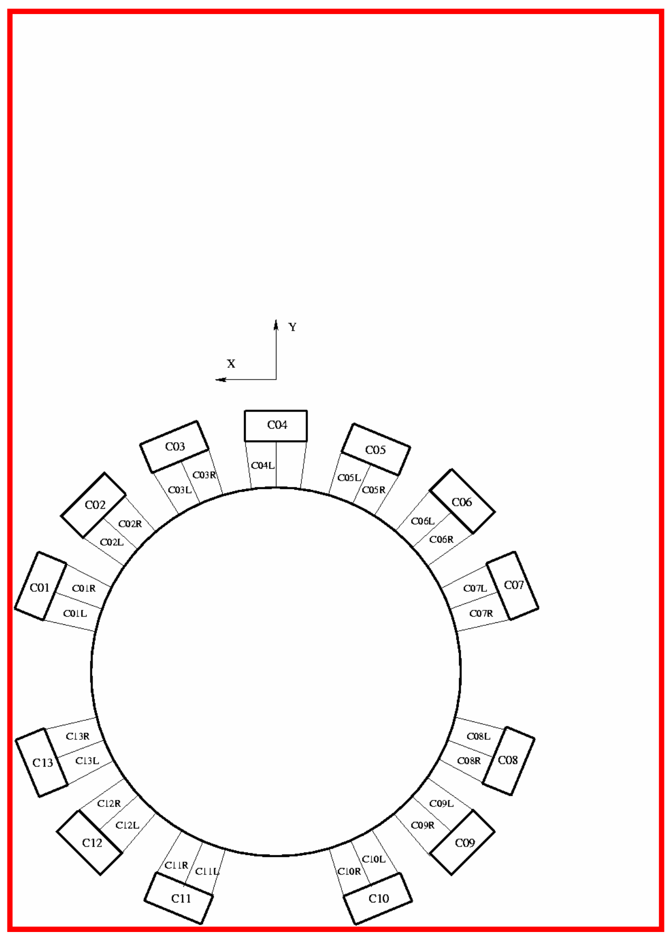
22. **Quadrant LV Patch Panel input connector pin**
    (1-16) PP_InC_Pin
23. **Quadrant LV Patch Panel output connector pin**
    (1-16) PP_OutC_Pin
24. **PSB**
    Preamplifier-Summing Board number (1, 2-1, 2-2, 3, 4)
25. **PSB letter repeated**
    Preamplifier Summing Board letter. Same as PSB except in letter notation (A, B, C, D, E)
26. **PSB Pin**
    PSB LV connector pin (1-16) (PSB_Pin)
27. **Qwedge**
    Wedge number in quadrant (1-8), QWedge=PB_Con (Wedge)

Signal Feedthrough and Crate Positions

Quadrant	F/T and Crate Position	Cryostat
1	AF-A-02L	A
2	AF-A-06L	A
3	AF-A-09L	A
4	AF-A-12L	A
5	AF-C-02L	C
6	AF-C-06L	C
7	AF-C-09L	C
8	AF-C-12L	C

This table lists the positions of the feedthroughs and their associated crate positions. The above table is a complete listing of all 8 HEC feedthroughs. For more information please refer to the Feedthrough database.





Calibration Lines (TDR Measurements) Table

Quadrant1to4/cryostat/Calibration Generator Channel	1/A/1	1/A/10	1/A/100
Quadrant1to4	1	1	1
Cryostat	A	A	A
Calibration Generator Channel	1	10	100
Warm Cable Impedance (Ohm)	37.00	37.03	36.58
Vacuum Cable Impedance (Ohm)	36.85	37.03	37.11
Pigtail Impedance (Ohm)	51.15	50.84	52.22
Pigtail resistance (Ohm/ns)	0.04	0.07	0.06
Quadrant Cable Impedance (Ohms)	53.67	46.97	51.78
Quadrant Cable Resistance (Ohms/ns)	0.03	0.03	0.05
Calibration Impedance (Ohms)	53.68	51.1	52.66
Calibration Resistance (Ohms/ns)	-0.02	0.04	-0.02
Stripline Impedance (Ohms)	56.47	55.85	56.36
Stripline Resistance (Ohms/ns)	-0.11	-0.09	-0.11
Stripline Termination Impedance (Ohms)	54.82	54.44	54.95

FEB Input Lines TDR Measurements Table

Quadrant1to4/cryostat/FEB/Channel	1/C/1/1	1/C/1/10	1/C/1/100
Quadrant1to4	1	1	1
Cryostat	C	C	C
FEB	1	1	1
Channel	1	10	100
Warm cable Impedance (Ohms)	35.09	35.19	36.39
Vacuum Cabe Impedance (Ohms)	34.54	36.07	37.33
Pigtail Impedance (Ohms)	50.14	50.15	51.62
Pigtail Resistance (Ohms/ns)	0.06	0.05	0.08
Quadrant Cable Impedance (Ohms)	44.56	45.05	45.79
Quadrant Cable Resistance (Ohms/ns)	0.05	0.06	0.05
Calibration Cable PSB Termination Impedance (Ohms)	355.27	375.27	438.42
Propagation Time (ns)	109.95	110.2	105.3

These two tables of TDR measurements have self explanatory labels. For more details see Appendix I that describes these measurements.

Quadrant Definitions Table

Quadrant	1	2	3	4	5	6	7	8
Cryostat	A	A	A	A	C	C	C	C
Quadrant(1 to 4)	1	2	3	4	1	2	3	4

This table simply defines the somewhat un-orthodox quadrant. Unlike the normal definition of quadrant that goes from 1 to 4, this Quadrant goes from 1 to 4 in the A cryostat and 5 to 8 in the C cryostat. For clarity when the more orthodox quadrant is called Quadrant(1 to 4) in this database.

Quadrant-Wedge Definition Tables

Cryostat/Wedge	A/1	A/10	A/11
Quadrant	1	2	2
Cryostat	A	A	A
Wedge	1	10	11
Qwedge	1	2	3

This table simple makes a definition for Qwedge. Qwedge is 1 for the first wedge in a quadrant and goes up to 8 for the final wedge in the quadrant.

Hence:

Qwedge = Wedge – 0 for Quadrant(1 to 4) = 1
Qwedge = Wedge – 8 for Quadrant(1 to 4) = 2
Qwedge = Wedge – 16 for Quadrant(1 to 4) = 3
Qwedge = Wedge – 24 for Quadrant(1 to 4) = 4

FEB Definitions Table

FEB Shaper Channel	0	1	2
FEB Channel Number	1	2	3

This table simply makes the definition:

FEB Shaper Channel = FEB Channel Number - 1

Signal Line Summary Table

Cryostat/Wedge/Z/Tower	A/1/1/1	A/1/1/10	A/1/1/11
Cryostat/Qwedge/PSB_letter/Tower	A/1/A/1	A/1/A/10	A/1/A/11
Cryostat/Wedge/Z	A/1/1	A/1/1	A/1/1
Cryostat/Wedge/PSB_letter	A/25/A	A/25/A	A/25/A
PSB_Serial/Tower	A51/1	A51/10	A51/11
Wheel_Cryostat	HEC1A	HEC1A	HEC1A
Cryostat/Wheel/Wedge	A/HEC1/25	A/HEC1/25	A/HEC1/25
Cryostat	A	A	A
Wedge	1	1	1
QWedge	1	1	1
Z	1	1	1
Wheel	HEC1	HEC1	HEC1
Tower	1	10	11
ETA	2	6	7
PHI	1	2	1
PSB Letter	A	A	A
Module Serial	CF20	CF20	CF20
PSB Serial	A51	A51	A51
Calibration Generator 1	11	15	9
Calibration Generator 2	10		
Calibration Generator 3			
Calibration Generator 4			
Ntiles	16	8	8
HV Est1	3	3	3
HV Est2	2	2	2
HV Pad1	4	4	4
HV Pad2	1	1	1
LV1 Q Number -1,5v	59	59	59
LV1 Q Number GND	60	60	60
LV2 Q Number +3V	61	61	61
LV2 Q Number GND	62	62	62
LV3 Q Number +7V	63	63	63
LV3 Q Number GND	64	64	64
Feedthrough Location	AF-A-02L	AF-A-02L	AF-A-02L
FT Connector	5A	7A	7A
FEC Slot	25	28	28
FEB Connector	J1	J1	J1
FEC Pin	C32	C30	C24

The following table lists the items already described in this document:

Cryostat/Wedge/Z/Tower
Cryostat/Qwedge/PSB_letter/Tower
Cryostat/Wedge/Z
Cryostat/Wedge/PSB_letter

PSB_Serial/Tower
Wheel_Cryostat
Cryostat/Wheel/Wedge
Cryostat
Wedge
QWedge
Z
Wheel
Tower
ETA
PHI
PSB Letter
Module Serial
PSB Serial
Feedthrough Location
FT Connector
FEC Slot
FEB Connector
FEC Pin

The ***Calibration Generator 1 to 4*** lists the calibration generator lines (see table Quadrant Signal & Calibration Cabling) attached to this signal line.

Ntiles lists the number of gaps on this readout line.

When *Ntiles* is 4 or 8 there is only one calibration line attached. When *Ntiles* is 16 there are two calibration lines attached. When *Ntiles* is 64 there is four calibration line attached. *Calibration Generator 1* pulses the first 8 gaps on a readout line. *Calibration Generator 2* pulses the gaps 9 to 16 on a readout line. When a tile is split into two tiles as is the case with tile 5, gaps 9-24 (see figure 9, page 36) *Ntiles* can be 4, with one generator attached to the first 8 gaps of tile 5a, one to the second 8 gaps of tile 5a.

HV EST1(2) is the high voltage channel that provides HV to the first(second) EST board in each gap.

HV Pad1(2) is the high voltage channel that provides HV to the front(back) face of the PAD board in each gap.

LV1 Q Number -1,5v is the low voltage line number that supplies the negative 1.5V to the PSB board that contains the amplifiers and summation circuit for this signal line.

LV1 Q Number GND is the low voltage line number that supplies the ground return of the 1.5V line to the PSB board that contains the amplifiers and summation circuit for this signal line.

LV2 Q Number +3V is the low voltage line number that supplies the 3V to the PSB board that contains the amplifiers and summation circuit for this signal line.

LV2 Q Number GND is the low voltage line number that supplies the ground return of the 3V line to the PSB board that contains the amplifiers and summation circuit for this signal line.

LV3 Q Number 7V is the low voltage line number that supplies the 7V to the PSB board that contains the amplifiers and summation circuit for this signal line.

LV3 Q Number GND is the low voltage line number that supplies the ground return of the 7V line to the PSB board that contains the amplifiers and summation circuit for this signal line.

Non-Conformance Table

Problem #	1	4	38	64
Issue FEB=1, CAL=2, HV_Pin=3,HV_Line=4	1	2	3	4
Cryostat	C	C	A	A
Quadrant(1 to 4)	1	1		
Front End Board Module Number	2			
Front End Board Channel	24			
Calibration Generator Channel		13		
Comment	No termination at PSB. Channel not used	C cable high impedance	HV Pin … disconnected at Module one sub gap OFF	EC_A CT Fall 2005 Short
Wedge			1	2
Module			AF21	AF14
Gap with HV pin cut			11	
Gap Cut			EST1	EST1
Z			2	2
Severity of Problem				0
Comment on Severity of Problem				Short

Problem # :
There are 91 problems numbered from 1 to 91

Issue :

1 for a Front End Board (FEB) problem. In the example given there is no termination at the cold PSB board.

2 For a calibration line problem. In the example given the calibration cable has a high impedance.

3 For the case where a HV pin was cut due to a short in that sub gap. If this gap belongs to a tower of 8 tiles then 1/(8x4) of the signal on average will be missing from this tower. The signal from this channel should on average be multiplied by 32/31

4 For this case one sub-gap has not got voltage. ¼ of the signal will be lost. The signal from this channel should be multiplied by 4/3.

Cryostat: Already described in this document.

Quadrant(1 to 4): Already described in this document.

Front End Board Module Number: See *FEB module number* in table *FEB Slot_Module Definitions.*

Front End Board Channel: See *FEB Channel* in table *FEB Slot_Module Definitions.*

Calibration Generator Channel: See *Quadrant and Signal and Calibration Cable Table.*

Comment: Short helpful comment.

Wedge: Already described in this document.

Module: Already described in this document.

Gap with HV pin cut: This is the gap number within the module where the HV pin was cut.

Gap Cut: This was the type of sub-gap cut: EST1, PAD1, PAD2, or EST2

Z: This is the depth of the readout where the problem is present *Z* = 1, 2, 3, or 4.

Severity of problem: This describes the nature of the short as observed in B180 prior to transport of cryostat to the ATLAS pit:

0	Short, appears permanent.
1	Disappeared after warming cryostat in B180.
2	Present in warm in B180 prior to cool down of cryostat. Disappeared when cryostat was cooled down in B180.

Comment on Severity of Problem: Short helpful comment.

FEC Pin to FEB Channel Definitions

FEB Channel	1	2	3
FEC Pin	C32	A32	C31
FEB Connector	J1	J1	J1

This table give the FEB channel number (1-128) correspondence to the FEC connector (J1 or J3) and pin number.
(This table is not part of the core of the database as it describes items in the FEC where the database strictly only extends to the FEC connector and pin number.)

FEB Slot_Module Definitions

FEC Slot	25	26	28	29	30	32
FEB Module Number	1	2	3	4	5	6

This table lists the FEC slots that the FEB modules sit in. This information can be seen on page 34 where the FEC crate is drawn. So for instance FEB5 is in the slot marked as 30 in the FEC. (This table is not part of the core of the database as it describes items in the FEC where the database strictly only extends to the FEC connector and pin number.)

Non-Conformance Reports (Queries)

Calibration Line Failure: List of towers affected by the 7 calibration line failures.

Problem #	Cryostat	Quadrant(1 to 4)	Calibration Board Channel	ETA	PHI	Z
37	A	4	42	6	5	2
37	A	4	42	11	5	1
37	A	4	42	2	5	1
37	A	4	42	6	5	1
37	A	4	42	3	5	2
37	A	4	42	7	5	2
37	A	4	42	10	5	2
37	A	4	42	11	5	2
36	A	4	36	15	3	4
36	A	4	36	14	3	4
36	A	4	36	8	6	4
36	A	4	36	7	6	4
36	A	4	36	4	6	3
36	A	4	36	8	6	3
36	A	4	36	4	6	4
36	A	4	36	6	6	3
36	A	4	36	6	6	4
36	A	4	36	7	6	3
36	A	4	36	14	3	3
28	A	3	48	5	6	1
28	A	3	48	3	6	2
28	A	3	48	4	6	2
28	A	3	48	5	6	2
28	A	3	48	2	6	1
28	A	3	48	10	6	1
28	A	3	48	11	6	2
28	A	3	48	2	6	2
28	A	3	48	10	6	2
27	A	3	15	6	2	1
27	A	3	15	11	2	2
27	A	3	15	10	2	2

Problem #	Cryostat	Quadrant(1 to 4)	Calibration Board Channel	ETA	PHI	Z
27	A	3	15	7	2	2
27	A	3	15	6	2	2
27	A	3	15	3	2	2
27	A	3	15	2	2	1
27	A	3	15	11	2	1
27	A	3	15	8	2	2
12	C	4	80	11	7	2
12	C	4	80	10	7	2
12	C	4	80	4	7	2
12	C	4	80	5	7	2
12	C	4	80	10	7	1
12	C	4	80	2	7	1
12	C	4	80	5	7	1
12	C	4	80	2	7	2
12	C	4	80	3	7	2
6	C	2	24	13	7	2
6	C	2	24	12	7	2
6	C	2	24	9	14	2
6	C	2	24	8	14	2
6	C	2	24	4	14	2
6	C	2	24	3	14	2
6	C	2	24	3	14	1
6	C	2	24	13	7	1
6	C	2	24	8	14	1
4	C	1	13	3	15	2
4	C	1	13	3	15	1
4	C	1	13	4	15	2
4	C	1	13	9	15	2
4	C	1	13	14	8	2
4	C	1	13	15	8	1

HV Failure:

Each HV failure causes the loss of ¼ of the signal on the entire readout depth of a module. Below are the effected towers due to 8 HV line failures.

Problem #	Issue FEB=1, CAL=2, HV_Pin=3,HV_Line=4	Cryostat	Wedge	Module	Z	Comment on Severity of Problem	Severity of Problem	ETA	PHI	Ntiles
64	4	A	2	AF14	2	Short	0	5	4	16
64	4	A	2	AF14	2	Short	0	6	3	16
64	4	A	2	AF14	2	Short	0	5	3	16
64	4	A	2	AF14	2	Short	0	4	4	32
64	4	A	2	AF14	2	Short	0	4	3	32
64	4	A	2	AF14	2	Short	0	3	4	32
64	4	A	2	AF14	2	Short	0	3	3	32
64	4	A	2	AF14	2	Short	0	14	2	16
64	4	A	2	AF14	2	Short	0	13	2	16
64	4	A	2	AF14	2	Short	0	12	2	16
64	4	A	2	AF14	2	Short	0	11	4	16
64	4	A	2	AF14	2	Short	0	8	3	16
64	4	A	2	AF14	2	Short	0	2	3	8
64	4	A	2	AF14	2	Short	0	2	4	8
64	4	A	2	AF14	2	Short	0	7	4	16
64	4	A	2	AF14	2	Short	0	6	4	16
64	4	A	2	AF14	2	Short	0	8	4	16
64	4	A	2	AF14	2	Short	0	9	3	16
64	4	A	2	AF14	2	Short	0	9	4	16
64	4	A	2	AF14	2	Short	0	10	3	16
64	4	A	2	AF14	2	Short	0	10	4	16
64	4	A	2	AF14	2	Short	0	11	3	16
64	4	A	2	AF14	2	Short	0	7	3	16

Problem #	Issue FEB=1, CAL=2, HV_Pin=3,HV_Line=4	Cryostat	Wedge	Module	Z	Comment on Severity of Problem	Severity of Problem	ETA	PHI	Ntiles
69	4	A	27	CF01	1	Short	0	11	6	8
69	4	A	27	CF01	1	Short	0	2	6	16
69	4	A	27	CF01	1	Short	0	11	5	8
69	4	A	27	CF01	1	Short	0	10	6	8
69	4	A	27	CF01	1	Short	0	10	5	8
69	4	A	27	CF01	1	Short	0	9	6	8
69	4	A	27	CF01	1	Short	0	9	5	8
69	4	A	27	CF01	1	Short	0	12	3	8
69	4	A	27	CF01	1	Short	0	8	5	8
69	4	A	27	CF01	1	Short	0	4	6	8
69	4	A	27	CF01	1	Short	0	8	6	8
69	4	A	27	CF01	1	Short	0	13	3	8
69	4	A	27	CF01	1	Short	0	14	3	8
69	4	A	27	CF01	1	Short	0	15	3	8
69	4	A	27	CF01	1	Short	0	3	5	16
69	4	A	27	CF01	1	Short	0	4	5	8
69	4	A	27	CF01	1	Short	0	5	5	8
69	4	A	27	CF01	1	Short	0	5	6	8
69	4	A	27	CF01	1	Short	0	6	5	8
69	4	A	27	CF01	1	Short	0	7	6	8
69	4	A	27	CF01	1	Short	0	2	5	16
69	4	A	27	CF01	1	Short	0	3	6	16
69	4	A	27	CF01	1	Short	0	6	6	8
69	4	A	27	CF01	1	Short	0	7	5	8

Problem #	Issue FEB=1, CAL=2, HV_Pin=3,HV_Line=4	Cryostat	Wedge	Module	Z	Comment on Severity of Problem	Severity of Problem	ETA	PHI	Ntiles
72	4	A	23	AR17	4	Short	0	10	13	8
72	4	A	23	AR17	4	Short	0	7	14	8
72	4	A	23	AR17	4	Short	0	8	13	8
72	4	A	23	AR17	4	Short	0	8	14	8
72	4	A	23	AR17	4	Short	0	9	14	8
72	4	A	23	AR17	4	Short	0	7	13	8
72	4	A	23	AR17	4	Short	0	10	14	8
72	4	A	23	AR17	4	Short	0	11	13	8
72	4	A	23	AR17	4	Short	0	11	14	8
72	4	A	23	AR17	4	Short	0	6	13	8
72	4	A	23	AR17	4	Short	0	13	7	8
72	4	A	23	AR17	4	Short	0	14	7	8
72	4	A	23	AR17	4	Short	0	15	7	8
72	4	A	23	AR17	4	Short	0	4	13	4
72	4	A	23	AR17	4	Short	0	4	14	4
72	4	A	23	AR17	4	Short	0	5	13	16
72	4	A	23	AR17	4	Short	0	5	14	16
72	4	A	23	AR17	4	Short	0	12	7	8
72	4	A	23	AR17	4	Short	0	9	13	8
72	4	A	23	AR17	4	Short	0	6	14	8

Problem #	Issue FEB=1, CAL=2, HV_Pin=3,HV_Line=4	Cryostat	Wedge	Module	Z	Comment on Severity of Problem	Severity of Problem	ETA	PHI	Ntiles
76	4	A	28	AR33	3	Short	0	12	4	8
76	4	A	28	AR33	3	Short	0	13	4	8
76	4	A	28	AR33	3	Short	0	14	4	8
76	4	A	28	AR33	3	Short	0	3	7	4
76	4	A	28	AR33	3	Short	0	3	8	4
76	4	A	28	AR33	3	Short	0	4	7	16
76	4	A	28	AR33	3	Short	0	4	8	16
76	4	A	28	AR33	3	Short	0	5	8	16
76	4	A	28	AR33	3	Short	0	11	8	8
76	4	A	28	AR33	3	Short	0	5	7	16
76	4	A	28	AR33	3	Short	0	11	7	8
76	4	A	28	AR33	3	Short	0	10	8	8
76	4	A	28	AR33	3	Short	0	10	7	8
76	4	A	28	AR33	3	Short	0	9	8	8
76	4	A	28	AR33	3	Short	0	9	7	8
76	4	A	28	AR33	3	Short	0	8	8	8
76	4	A	28	AR33	3	Short	0	8	7	8
76	4	A	28	AR33	3	Short	0	7	8	8
76	4	A	28	AR33	3	Short	0	6	8	8
76	4	A	28	AR33	3	Short	0	6	7	8
76	4	A	28	AR33	3	Short	0	7	7	8

Problem #	Issue FEB=1, CAL=2, HV_Pin=3,HV_Line=4	Cryostat	Wedge	Module	Z	Comment on Severity of Problem	Severity of Problem	ETA	PHI	Ntiles
80	4	C	11	AF04	2	Short	0	6	5	16
80	4	C	11	AF04	2	Short	0	3	6	32
80	4	C	11	AF04	2	Short	0	2	6	8
80	4	C	11	AF04	2	Short	0	6	6	16
80	4	C	11	AF04	2	Short	0	5	5	16
80	4	C	11	AF04	2	Short	0	5	6	16
80	4	C	11	AF04	2	Short	0	4	5	32
80	4	C	11	AF04	2	Short	0	3	5	32
80	4	C	11	AF04	2	Short	0	14	3	16
80	4	C	11	AF04	2	Short	0	13	3	16
80	4	C	11	AF04	2	Short	0	12	3	16
80	4	C	11	AF04	2	Short	0	11	5	16
80	4	C	11	AF04	2	Short	0	7	5	16
80	4	C	11	AF04	2	Short	0	4	6	32
80	4	C	11	AF04	2	Short	0	7	6	16
80	4	C	11	AF04	2	Short	0	2	5	8
80	4	C	11	AF04	2	Short	0	8	6	16
80	4	C	11	AF04	2	Short	0	8	5	16
80	4	C	11	AF04	2	Short	0	9	6	16
80	4	C	11	AF04	2	Short	0	9	5	16
80	4	C	11	AF04	2	Short	0	10	6	16
80	4	C	11	AF04	2	Short	0	10	5	16
80	4	C	11	AF04	2	Short	0	11	6	16

Problem #	Issue FEB=1, CAL=2, HV_Pin=3,HV_Line=4	Cryostat	Wedge	Module	Z	Comment on Severity of Problem	Severity of Problem	ETA	PHI	Ntiles
82	4	C	24	AF25	2	Short	0	11	15	16
82	4	C	24	AF25	2	Short	0	5	15	16
82	4	C	24	AF25	2	Short	0	5	16	16
82	4	C	24	AF25	2	Short	0	4	15	32
82	4	C	24	AF25	2	Short	0	4	16	32
82	4	C	24	AF25	2	Short	0	3	15	32
82	4	C	24	AF25	2	Short	0	3	16	32
82	4	C	24	AF25	2	Short	0	14	8	16
82	4	C	24	AF25	2	Short	0	13	8	16
82	4	C	24	AF25	2	Short	0	12	8	16
82	4	C	24	AF25	2	Short	0	6	16	16
82	4	C	24	AF25	2	Short	0	6	15	16
82	4	C	24	AF25	2	Short	0	2	15	8
82	4	C	24	AF25	2	Short	0	2	16	8
82	4	C	24	AF25	2	Short	0	7	16	16
82	4	C	24	AF25	2	Short	0	7	15	16
82	4	C	24	AF25	2	Short	0	8	16	16
82	4	C	24	AF25	2	Short	0	9	16	16
82	4	C	24	AF25	2	Short	0	9	15	16
82	4	C	24	AF25	2	Short	0	10	16	16
82	4	C	24	AF25	2	Short	0	10	15	16
82	4	C	24	AF25	2	Short	0	8	15	16
82	4	C	24	AF25	2	Short	0	11	16	16

Problem #	Issue FEB=1, CAL=2, HV_Pin=3,HV_Line=4	Cryostat	Wedge	Module	Z	Comment on Severity of Problem	Severity of Problem	ETA	PHI	Ntiles
83	4	C	29	CF31	2	Short	0	5	9	16
83	4	C	29	CF31	2	Short	0	12	5	16
83	4	C	29	CF31	2	Short	0	13	5	16
83	4	C	29	CF31	2	Short	0	3	10	32
83	4	C	29	CF31	2	Short	0	2	10	8
83	4	C	29	CF31	2	Short	0	4	10	32
83	4	C	29	CF31	2	Short	0	6	10	16
83	4	C	29	CF31	2	Short	0	5	10	16
83	4	C	29	CF31	2	Short	0	11	9	16
83	4	C	29	CF31	2	Short	0	14	5	16
83	4	C	29	CF31	2	Short	0	4	9	32
83	4	C	29	CF31	2	Short	0	8	10	16
83	4	C	29	CF31	2	Short	0	3	9	32
83	4	C	29	CF31	2	Short	0	2	9	8
83	4	C	29	CF31	2	Short	0	7	9	16
83	4	C	29	CF31	2	Short	0	6	9	16
83	4	C	29	CF31	2	Short	0	8	9	16
83	4	C	29	CF31	2	Short	0	9	10	16
83	4	C	29	CF31	2	Short	0	9	9	16
83	4	C	29	CF31	2	Short	0	10	10	16
83	4	C	29	CF31	2	Short	0	10	9	16
83	4	C	29	CF31	2	Short	0	11	10	16
83	4	C	29	CF31	2	Short	0	7	10	16

Problem #	Issue FEB=1, CAL=2, HV_Pin=3,HV_Line=4	Cryostat	Wedge	Module	Z	Comment on Severity of Problem	Severity of Problem	ETA	PHI	Ntiles
91	4	C	32	CR32	3	Short	0	13	8	8
91	4	C	32	CR32	3	Short	0	14	8	8
91	4	C	32	CR32	3	Short	0	3	16	4
91	4	C	32	CR32	3	Short	0	3	15	4
91	4	C	32	CR32	3	Short	0	4	16	16
91	4	C	32	CR32	3	Short	0	4	15	16
91	4	C	32	CR32	3	Short	0	12	8	8
91	4	C	32	CR32	3	Short	0	5	15	16
91	4	C	32	CR32	3	Short	0	8	16	8
91	4	C	32	CR32	3	Short	0	5	16	16
91	4	C	32	CR32	3	Short	0	11	15	8
91	4	C	32	CR32	3	Short	0	11	16	8
91	4	C	32	CR32	3	Short	0	10	15	8
91	4	C	32	CR32	3	Short	0	10	16	8
91	4	C	32	CR32	3	Short	0	9	15	8
91	4	C	32	CR32	3	Short	0	8	15	8
91	4	C	32	CR32	3	Short	0	7	15	8
91	4	C	32	CR32	3	Short	0	7	16	8
91	4	C	32	CR32	3	Short	0	6	15	8
91	4	C	32	CR32	3	Short	0	6	16	8
91	4	C	32	CR32	3	Short	0	9	16	8

HV Pins disconnected:
26 pins were disconnected causing the average loss of *1/(4 x Ntiles)* in signal. The following table give the list of all affected towers and the value of *Ntiles*.

Problem #	Issue FEB=1, CAL=2, HV_Pin=3,HV_Line=4	Cryostat	Wedge	Gap with HV pin cut	Gap Cut	Z	ETA	PHI	Ntiles	Wheel
38	3	A	1	11	EST1	2	2	2	8	HEC1
38	3	A	1	11	EST1	2	2	1	8	HEC1
38	3	A	1	11	EST1	2	3	1	32	HEC1
38	3	A	1	11	EST1	2	3	2	32	HEC1
38	3	A	1	11	EST1	2	4	2	32	HEC1
38	3	A	1	11	EST1	2	4	1	32	HEC1
38	3	A	1	11	EST1	2	5	1	16	HEC1
38	3	A	1	11	EST1	2	5	2	16	HEC1
38	3	A	1	11	EST1	2	6	2	16	HEC1
38	3	A	1	11	EST1	2	6	1	16	HEC1
38	3	A	1	11	EST1	2	7	1	16	HEC1
38	3	A	1	11	EST1	2	7	2	16	HEC1
38	3	A	1	11	EST1	2	8	1	16	HEC1
38	3	A	1	11	EST1	2	8	2	16	HEC1
38	3	A	1	11	EST1	2	9	1	16	HEC1
38	3	A	1	11	EST1	2	9	2	16	HEC1
38	3	A	1	11	EST1	2	10	1	16	HEC1
38	3	A	1	11	EST1	2	10	2	16	HEC1
38	3	A	1	11	EST1	2	11	2	16	HEC1
38	3	A	1	11	EST1	2	11	1	16	HEC1
38	3	A	1	11	EST1	2	12	1	16	HEC1
38	3	A	1	11	EST1	2	13	1	16	HEC1
38	3	A	1	11	EST1	2	14	1	16	HEC1

Problem #	Issue FEB=1, CAL=2, HV_Pin=3,HV_Line=4	Cryostat	Wedge	Gap with HV pin cut	Gap Cut	Z	ETA	PHI	Ntiles	Wheel
39	3	A	5	22	PAD2	2	2	10	8	HEC1
39	3	A	5	22	PAD2	2	2	9	8	HEC1
39	3	A	5	22	PAD2	2	3	9	32	HEC1
39	3	A	5	22	PAD2	2	3	10	32	HEC1
39	3	A	5	22	PAD2	2	4	10	32	HEC1
39	3	A	5	22	PAD2	2	4	9	32	HEC1
39	3	A	5	22	PAD2	2	5	10	16	HEC1
39	3	A	5	22	PAD2	2	5	9	16	HEC1
39	3	A	5	22	PAD2	2	6	10	16	HEC1
39	3	A	5	22	PAD2	2	6	9	16	HEC1
39	3	A	5	22	PAD2	2	7	10	16	HEC1
39	3	A	5	22	PAD2	2	7	9	16	HEC1
39	3	A	5	22	PAD2	2	8	10	16	HEC1
39	3	A	5	22	PAD2	2	8	9	16	HEC1
39	3	A	5	22	PAD2	2	9	10	16	HEC1
39	3	A	5	22	PAD2	2	9	9	16	HEC1
39	3	A	5	22	PAD2	2	10	9	16	HEC1
39	3	A	5	22	PAD2	2	10	10	16	HEC1
39	3	A	5	22	PAD2	2	11	9	16	HEC1
39	3	A	5	22	PAD2	2	11	10	16	HEC1
39	3	A	5	22	PAD2	2	12	5	16	HEC1
39	3	A	5	22	PAD2	2	13	5	16	HEC1
39	3	A	5	22	PAD2	2	14	5	16	HEC1

Problem #	Issue FEB=1, CAL=2, HV_Pin=3,HV_Line=4	Cryostat	Wedge	Gap with HV pin cut	Gap Cut	Z	ETA	PHI	Ntiles	Wheel
40	3	A	6	21	EST2	2	2	11	8	HEC1
40	3	A	6	21	EST2	2	2	12	8	HEC1
40	3	A	6	21	EST2	2	3	12	32	HEC1
40	3	A	6	21	EST2	2	3	11	32	HEC1
40	3	A	6	21	EST2	2	4	11	32	HEC1
40	3	A	6	21	EST2	2	4	12	32	HEC1
40	3	A	6	21	EST2	2	5	12	16	HEC1
40	3	A	6	21	EST2	2	5	11	16	HEC1
40	3	A	6	21	EST2	2	6	12	16	HEC1
40	3	A	6	21	EST2	2	6	11	16	HEC1
40	3	A	6	21	EST2	2	7	11	16	HEC1
40	3	A	6	21	EST2	2	7	12	16	HEC1
40	3	A	6	21	EST2	2	8	11	16	HEC1
40	3	A	6	21	EST2	2	8	12	16	HEC1
40	3	A	6	21	EST2	2	9	11	16	HEC1
40	3	A	6	21	EST2	2	9	12	16	HEC1
40	3	A	6	21	EST2	2	10	11	16	HEC1
40	3	A	6	21	EST2	2	10	12	16	HEC1
40	3	A	6	21	EST2	2	11	11	16	HEC1
40	3	A	6	21	EST2	2	11	12	16	HEC1
40	3	A	6	21	EST2	2	12	6	16	HEC1
40	3	A	6	21	EST2	2	13	6	16	HEC1
40	3	A	6	21	EST2	2	14	6	16	HEC1

Problem #	Issue FEB=1, CAL=2, HV_Pin=3,HV_Line=4	Cryostat	Wedge	Gap with HV pin cut	Gap Cut	Z	ETA	PHI	Ntiles	Wheel
41	3	A	12	5	EST2	1	2	8	16	HEC1
41	3	A	12	5	EST2	1	2	7	16	HEC1
41	3	A	12	5	EST2	1	3	8	16	HEC1
41	3	A	12	5	EST2	1	3	7	16	HEC1
41	3	A	12	5	EST2	1	4	8	8	HEC1
41	3	A	12	5	EST2	1	4	7	8	HEC1
41	3	A	12	5	EST2	1	5	8	8	HEC1
41	3	A	12	5	EST2	1	5	7	8	HEC1
41	3	A	12	5	EST2	1	6	8	8	HEC1
41	3	A	12	5	EST2	1	6	7	8	HEC1
41	3	A	12	5	EST2	1	7	8	8	HEC1
41	3	A	12	5	EST2	1	7	7	8	HEC1
41	3	A	12	5	EST2	1	8	7	8	HEC1
41	3	A	12	5	EST2	1	8	8	8	HEC1
41	3	A	12	5	EST2	1	9	7	8	HEC1
41	3	A	12	5	EST2	1	9	8	8	HEC1
41	3	A	12	5	EST2	1	10	8	8	HEC1
41	3	A	12	5	EST2	1	10	7	8	HEC1
41	3	A	12	5	EST2	1	11	8	8	HEC1
41	3	A	12	5	EST2	1	11	7	8	HEC1
41	3	A	12	5	EST2	1	12	4	8	HEC1
41	3	A	12	5	EST2	1	13	4	8	HEC1
41	3	A	12	5	EST2	1	14	4	8	HEC1
41	3	A	12	5	EST2	1	15	4	8	HEC1

Problem #	Issue FEB=1, CAL=2, HV_Pin=3,HV_Line=4	Cryostat	Wedge	Gap with HV pin cut	Gap Cut	Z	ETA	PHI	Ntiles	Wheel
42	3	A	15	22	EST2	2	2	14	8	HEC1
42	3	A	15	22	EST2	2	2	13	8	HEC1
42	3	A	15	22	EST2	2	3	13	32	HEC1
42	3	A	15	22	EST2	2	3	14	32	HEC1
42	3	A	15	22	EST2	2	4	13	32	HEC1
42	3	A	15	22	EST2	2	4	14	32	HEC1
42	3	A	15	22	EST2	2	5	13	16	HEC1
42	3	A	15	22	EST2	2	5	14	16	HEC1
42	3	A	15	22	EST2	2	6	14	16	HEC1
42	3	A	15	22	EST2	2	6	13	16	HEC1
42	3	A	15	22	EST2	2	7	14	16	HEC1
42	3	A	15	22	EST2	2	7	13	16	HEC1
42	3	A	15	22	EST2	2	8	13	16	HEC1
42	3	A	15	22	EST2	2	8	14	16	HEC1
42	3	A	15	22	EST2	2	9	13	16	HEC1
42	3	A	15	22	EST2	2	9	14	16	HEC1
42	3	A	15	22	EST2	2	10	14	16	HEC1
42	3	A	15	22	EST2	2	10	13	16	HEC1
42	3	A	15	22	EST2	2	11	13	16	HEC1
42	3	A	15	22	EST2	2	11	14	16	HEC1
42	3	A	15	22	EST2	2	12	7	16	HEC1
42	3	A	15	22	EST2	2	13	7	16	HEC1
42	3	A	15	22	EST2	2	14	7	16	HEC1

Problem #	Issue FEB=1, CAL=2, HV_Pin=3,HV_Line=4	Cryostat	Wedge	Gap with HV pin cut	Gap Cut	Z	ETA	PHI	Ntiles	Wheel
43	3	A	17	14	EST2	2	2	1	8	HEC1
43	3	A	17	14	EST2	2	2	2	8	HEC1
43	3	A	17	14	EST2	2	3	2	32	HEC1
43	3	A	17	14	EST2	2	3	1	32	HEC1
43	3	A	17	14	EST2	2	4	2	32	HEC1
43	3	A	17	14	EST2	2	4	1	32	HEC1
43	3	A	17	14	EST2	2	5	1	16	HEC1
43	3	A	17	14	EST2	2	5	2	16	HEC1
43	3	A	17	14	EST2	2	6	1	16	HEC1
43	3	A	17	14	EST2	2	6	2	16	HEC1
43	3	A	17	14	EST2	2	7	1	16	HEC1
43	3	A	17	14	EST2	2	7	2	16	HEC1
43	3	A	17	14	EST2	2	8	1	16	HEC1
43	3	A	17	14	EST2	2	8	2	16	HEC1
43	3	A	17	14	EST2	2	9	2	16	HEC1
43	3	A	17	14	EST2	2	9	1	16	HEC1
43	3	A	17	14	EST2	2	10	2	16	HEC1
43	3	A	17	14	EST2	2	10	1	16	HEC1
43	3	A	17	14	EST2	2	11	1	16	HEC1
43	3	A	17	14	EST2	2	11	2	16	HEC1
43	3	A	17	14	EST2	2	12	1	16	HEC1
43	3	A	17	14	EST2	2	13	1	16	HEC1
43	3	A	17	14	EST2	2	14	1	16	HEC1

Problem #	Issue FEB=1, CAL=2, HV_Pin=3,HV_Line=4	Cryostat	Wedge	Gap with HV pin cut	Gap Cut	Z	ETA	PHI	Ntiles	Wheel
44	3	A	20	22	EST1	2	2	7	8	HEC1
44	3	A	20	22	EST1	2	2	8	8	HEC1
44	3	A	20	22	EST1	2	3	7	32	HEC1
44	3	A	20	22	EST1	2	3	8	32	HEC1
44	3	A	20	22	EST1	2	4	7	32	HEC1
44	3	A	20	22	EST1	2	4	8	32	HEC1
44	3	A	20	22	EST1	2	5	8	16	HEC1
44	3	A	20	22	EST1	2	5	7	16	HEC1
44	3	A	20	22	EST1	2	6	8	16	HEC1
44	3	A	20	22	EST1	2	6	7	16	HEC1
44	3	A	20	22	EST1	2	7	7	16	HEC1
44	3	A	20	22	EST1	2	7	8	16	HEC1
44	3	A	20	22	EST1	2	8	7	16	HEC1
44	3	A	20	22	EST1	2	8	8	16	HEC1
44	3	A	20	22	EST1	2	9	7	16	HEC1
44	3	A	20	22	EST1	2	9	8	16	HEC1
44	3	A	20	22	EST1	2	10	7	16	HEC1
44	3	A	20	22	EST1	2	10	8	16	HEC1
44	3	A	20	22	EST1	2	11	8	16	HEC1
44	3	A	20	22	EST1	2	11	7	16	HEC1
44	3	A	20	22	EST1	2	12	4	16	HEC1
44	3	A	20	22	EST1	2	13	4	16	HEC1
44	3	A	20	22	EST1	2	14	4	16	HEC1

Problem #	Issue FEB=1, CAL=2, HV_Pin=3,HV_Line=4	Cryostat	Wedge	Gap with HV pin cut	Gap Cut	Z	ETA	PHI	Ntiles	Wheel
45	3	A	3	8	EST1	3	3	6	4	HEC2
45	3	A	3	8	EST1	3	3	5	4	HEC2
45	3	A	3	8	EST1	3	4	5	16	HEC2
45	3	A	3	8	EST1	3	4	6	16	HEC2
45	3	A	3	8	EST1	3	5	5	16	HEC2
45	3	A	3	8	EST1	3	5	6	16	HEC2
45	3	A	3	8	EST1	3	6	6	8	HEC2
45	3	A	3	8	EST1	3	6	5	8	HEC2
45	3	A	3	8	EST1	3	7	5	8	HEC2
45	3	A	3	8	EST1	3	7	6	8	HEC2
45	3	A	3	8	EST1	3	8	5	8	HEC2
45	3	A	3	8	EST1	3	8	6	8	HEC2
45	3	A	3	8	EST1	3	9	6	8	HEC2
45	3	A	3	8	EST1	3	9	5	8	HEC2
45	3	A	3	8	EST1	3	10	6	8	HEC2
45	3	A	3	8	EST1	3	10	5	8	HEC2
45	3	A	3	8	EST1	3	11	6	8	HEC2
45	3	A	3	8	EST1	3	11	5	8	HEC2
45	3	A	3	8	EST1	3	12	3	8	HEC2
45	3	A	3	8	EST1	3	13	3	8	HEC2
45	3	A	3	8	EST1	3	14	3	8	HEC2

Problem #	Issue FEB=1, CAL=2, HV_Pin=3,HV_Line=4	Cryostat	Wedge	Gap with HV pin cut	Gap Cut	Z	ETA	PHI	Ntiles	Wheel
46	3	A	22	14	EST1	4	4	12	4	HEC2
46	3	A	22	14	EST1	4	4	11	4	HEC2
46	3	A	22	14	EST1	4	5	11	16	HEC2
46	3	A	22	14	EST1	4	5	12	16	HEC2
46	3	A	22	14	EST1	4	6	11	8	HEC2
46	3	A	22	14	EST1	4	6	12	8	HEC2
46	3	A	22	14	EST1	4	7	11	8	HEC2
46	3	A	22	14	EST1	4	7	12	8	HEC2
46	3	A	22	14	EST1	4	8	11	8	HEC2
46	3	A	22	14	EST1	4	8	12	8	HEC2
46	3	A	22	14	EST1	4	9	12	8	HEC2
46	3	A	22	14	EST1	4	9	11	8	HEC2
46	3	A	22	14	EST1	4	10	11	8	HEC2
46	3	A	22	14	EST1	4	10	12	8	HEC2
46	3	A	22	14	EST1	4	11	12	8	HEC2
46	3	A	22	14	EST1	4	11	11	8	HEC2
46	3	A	22	14	EST1	4	12	6	8	HEC2
46	3	A	22	14	EST1	4	13	6	8	HEC2
46	3	A	22	14	EST1	4	14	6	8	HEC2
46	3	A	22	14	EST1	4	15	6	8	HEC2

Problem #	Issue FEB=1, CAL=2, HV_Pin=3,HV_Line=4	Cryostat	Wedge	Gap with HV pin cut	Gap Cut	Z	ETA	PHI	Ntiles	Wheel
47	3	A	27	11	EST2	4	4	5	4	HEC2
47	3	A	27	11	EST2	4	4	6	4	HEC2
47	3	A	27	11	EST2	4	5	6	16	HEC2
47	3	A	27	11	EST2	4	5	5	16	HEC2
47	3	A	27	11	EST2	4	6	5	8	HEC2
47	3	A	27	11	EST2	4	6	6	8	HEC2
47	3	A	27	11	EST2	4	7	6	8	HEC2
47	3	A	27	11	EST2	4	7	5	8	HEC2
47	3	A	27	11	EST2	4	8	5	8	HEC2
47	3	A	27	11	EST2	4	8	6	8	HEC2
47	3	A	27	11	EST2	4	9	6	8	HEC2
47	3	A	27	11	EST2	4	9	5	8	HEC2
47	3	A	27	11	EST2	4	10	6	8	HEC2
47	3	A	27	11	EST2	4	10	5	8	HEC2
47	3	A	27	11	EST2	4	11	6	8	HEC2
47	3	A	27	11	EST2	4	11	5	8	HEC2
47	3	A	27	11	EST2	4	12	3	8	HEC2
47	3	A	27	11	EST2	4	13	3	8	HEC2
47	3	A	27	11	EST2	4	14	3	8	HEC2
47	3	A	27	11	EST2	4	15	3	8	HEC2

Problem #	Issue FEB=1, CAL=2, HV_Pin=3,HV_Line=4	Cryostat	Wedge	Gap with HV pin cut	Gap Cut	Z	ETA	PHI	Ntiles	Wheel
48	3	C	8	8	PAD2	1	2	15	16	HEC1
48	3	C	8	8	PAD2	1	2	16	16	HEC1
48	3	C	8	8	PAD2	1	3	15	16	HEC1
48	3	C	8	8	PAD2	1	3	16	16	HEC1
48	3	C	8	8	PAD2	1	4	15	8	HEC1
48	3	C	8	8	PAD2	1	4	16	8	HEC1
48	3	C	8	8	PAD2	1	5	16	8	HEC1
48	3	C	8	8	PAD2	1	5	15	8	HEC1
48	3	C	8	8	PAD2	1	6	16	8	HEC1
48	3	C	8	8	PAD2	1	6	15	8	HEC1
48	3	C	8	8	PAD2	1	7	16	8	HEC1
48	3	C	8	8	PAD2	1	7	15	8	HEC1
48	3	C	8	8	PAD2	1	8	16	8	HEC1
48	3	C	8	8	PAD2	1	8	15	8	HEC1
48	3	C	8	8	PAD2	1	9	16	8	HEC1
48	3	C	8	8	PAD2	1	9	15	8	HEC1
48	3	C	8	8	PAD2	1	10	16	8	HEC1
48	3	C	8	8	PAD2	1	10	15	8	HEC1
48	3	C	8	8	PAD2	1	11	15	8	HEC1
48	3	C	8	8	PAD2	1	11	16	8	HEC1
48	3	C	8	8	PAD2	1	12	8	8	HEC1
48	3	C	8	8	PAD2	1	13	8	8	HEC1
48	3	C	8	8	PAD2	1	14	8	8	HEC1
48	3	C	8	8	PAD2	1	15	8	8	HEC1

Problem #	Issue FEB=1, CAL=2, HV_Pin=3,HV_Line=4	Cryostat	Wedge	Gap with HV pin cut	Gap Cut	Z	ETA	PHI	Ntiles	Wheel
49	3	C	9	10	EST2	2	2	1	8	HEC1
49	3	C	9	10	EST2	2	2	2	8	HEC1
49	3	C	9	10	EST2	2	3	1	32	HEC1
49	3	C	9	10	EST2	2	3	2	32	HEC1
49	3	C	9	10	EST2	2	4	2	32	HEC1
49	3	C	9	10	EST2	2	4	1	32	HEC1
49	3	C	9	10	EST2	2	5	2	16	HEC1
49	3	C	9	10	EST2	2	5	1	16	HEC1
49	3	C	9	10	EST2	2	6	1	16	HEC1
49	3	C	9	10	EST2	2	6	2	16	HEC1
49	3	C	9	10	EST2	2	7	2	16	HEC1
49	3	C	9	10	EST2	2	7	1	16	HEC1
49	3	C	9	10	EST2	2	8	2	16	HEC1
49	3	C	9	10	EST2	2	8	1	16	HEC1
49	3	C	9	10	EST2	2	9	1	16	HEC1
49	3	C	9	10	EST2	2	9	2	16	HEC1
49	3	C	9	10	EST2	2	10	1	16	HEC1
49	3	C	9	10	EST2	2	10	2	16	HEC1
49	3	C	9	10	EST2	2	11	2	16	HEC1
49	3	C	9	10	EST2	2	11	1	16	HEC1
49	3	C	9	10	EST2	2	12	1	16	HEC1
49	3	C	9	10	EST2	2	13	1	16	HEC1
49	3	C	9	10	EST2	2	14	1	16	HEC1

Problem #	Issue FEB=1, CAL=2, HV_Pin=3,HV_Line=4	Cryostat	Wedge	Gap with HV pin cut	Gap Cut	Z	ETA	PHI	Ntiles	Wheel
50	3	C	28	6	EST1	1	2	8	16	HEC1
50	3	C	28	6	EST1	1	2	7	16	HEC1
50	3	C	28	6	EST1	1	3	7	16	HEC1
50	3	C	28	6	EST1	1	3	8	16	HEC1
50	3	C	28	6	EST1	1	4	7	8	HEC1
50	3	C	28	6	EST1	1	4	8	8	HEC1
50	3	C	28	6	EST1	1	5	7	8	HEC1
50	3	C	28	6	EST1	1	5	8	8	HEC1
50	3	C	28	6	EST1	1	6	7	8	HEC1
50	3	C	28	6	EST1	1	6	8	8	HEC1
50	3	C	28	6	EST1	1	7	8	8	HEC1
50	3	C	28	6	EST1	1	7	7	8	HEC1
50	3	C	28	6	EST1	1	8	8	8	HEC1
50	3	C	28	6	EST1	1	8	7	8	HEC1
50	3	C	28	6	EST1	1	9	8	8	HEC1
50	3	C	28	6	EST1	1	9	7	8	HEC1
50	3	C	28	6	EST1	1	10	8	8	HEC1
50	3	C	28	6	EST1	1	10	7	8	HEC1
50	3	C	28	6	EST1	1	11	8	8	HEC1
50	3	C	28	6	EST1	1	11	7	8	HEC1
50	3	C	28	6	EST1	1	12	4	8	HEC1
50	3	C	28	6	EST1	1	13	4	8	HEC1
50	3	C	28	6	EST1	1	14	4	8	HEC1
50	3	C	28	6	EST1	1	15	4	8	HEC1

Problem #	Issue FEB=1, CAL=2, HV_Pin=3,HV_Line=4	Cryostat	Wedge	Gap with HV pin cut	Gap Cut	Z	ETA	PHI	Ntiles	Wheel
51	3	C	31	12	PAD1	2	2	13	8	HEC1
51	3	C	31	12	PAD1	2	2	14	8	HEC1
51	3	C	31	12	PAD1	2	3	13	32	HEC1
51	3	C	31	12	PAD1	2	3	14	32	HEC1
51	3	C	31	12	PAD1	2	4	14	32	HEC1
51	3	C	31	12	PAD1	2	4	13	32	HEC1
51	3	C	31	12	PAD1	2	5	14	16	HEC1
51	3	C	31	12	PAD1	2	5	13	16	HEC1
51	3	C	31	12	PAD1	2	6	13	16	HEC1
51	3	C	31	12	PAD1	2	6	14	16	HEC1
51	3	C	31	12	PAD1	2	7	14	16	HEC1
51	3	C	31	12	PAD1	2	7	13	16	HEC1
51	3	C	31	12	PAD1	2	8	13	16	HEC1
51	3	C	31	12	PAD1	2	8	14	16	HEC1
51	3	C	31	12	PAD1	2	9	13	16	HEC1
51	3	C	31	12	PAD1	2	9	14	16	HEC1
51	3	C	31	12	PAD1	2	10	14	16	HEC1
51	3	C	31	12	PAD1	2	10	13	16	HEC1
51	3	C	31	12	PAD1	2	11	13	16	HEC1
51	3	C	31	12	PAD1	2	11	14	16	HEC1
51	3	C	31	12	PAD1	2	12	7	16	HEC1
51	3	C	31	12	PAD1	2	13	7	16	HEC1
51	3	C	31	12	PAD1	2	14	7	16	HEC1

Problem #	Issue FEB=1, CAL=2, HV_Pin=3,HV_Line=4	Cryostat	Wedge	Gap with HV pin cut	Gap Cut	Z	ETA	PHI	Ntiles	Wheel
52	3	C	32	22	PAD1	2	2	15	8	HEC1
52	3	C	32	22	PAD1	2	2	16	8	HEC1
52	3	C	32	22	PAD1	2	3	16	32	HEC1
52	3	C	32	22	PAD1	2	3	15	32	HEC1
52	3	C	32	22	PAD1	2	4	16	32	HEC1
52	3	C	32	22	PAD1	2	4	15	32	HEC1
52	3	C	32	22	PAD1	2	5	15	16	HEC1
52	3	C	32	22	PAD1	2	5	16	16	HEC1
52	3	C	32	22	PAD1	2	6	16	16	HEC1
52	3	C	32	22	PAD1	2	6	15	16	HEC1
52	3	C	32	22	PAD1	2	7	16	16	HEC1
52	3	C	32	22	PAD1	2	7	15	16	HEC1
52	3	C	32	22	PAD1	2	8	16	16	HEC1
52	3	C	32	22	PAD1	2	8	15	16	HEC1
52	3	C	32	22	PAD1	2	9	15	16	HEC1
52	3	C	32	22	PAD1	2	9	16	16	HEC1
52	3	C	32	22	PAD1	2	10	15	16	HEC1
52	3	C	32	22	PAD1	2	10	16	16	HEC1
52	3	C	32	22	PAD1	2	11	16	16	HEC1
52	3	C	32	22	PAD1	2	11	15	16	HEC1
52	3	C	32	22	PAD1	2	12	8	16	HEC1
52	3	C	32	22	PAD1	2	13	8	16	HEC1
52	3	C	32	22	PAD1	2	14	8	16	HEC1

Problem #	Issue FEB=1, CAL=2, HV_Pin=3,HV_Line=4	Cryostat	Wedge	Gap with HV pin cut	Gap Cut	Z	ETA	PHI	Ntiles	Wheel
53	3	C	3	14	EST2	4	4	6	4	HEC2
53	3	C	3	14	EST2	4	4	5	4	HEC2
53	3	C	3	14	EST2	4	5	5	16	HEC2
53	3	C	3	14	EST2	4	5	6	16	HEC2
53	3	C	3	14	EST2	4	6	5	8	HEC2
53	3	C	3	14	EST2	4	6	6	8	HEC2
53	3	C	3	14	EST2	4	7	5	8	HEC2
53	3	C	3	14	EST2	4	7	6	8	HEC2
53	3	C	3	14	EST2	4	8	5	8	HEC2
53	3	C	3	14	EST2	4	8	6	8	HEC2
53	3	C	3	14	EST2	4	9	5	8	HEC2
53	3	C	3	14	EST2	4	9	6	8	HEC2
53	3	C	3	14	EST2	4	10	5	8	HEC2
53	3	C	3	14	EST2	4	10	6	8	HEC2
53	3	C	3	14	EST2	4	11	6	8	HEC2
53	3	C	3	14	EST2	4	11	5	8	HEC2
53	3	C	3	14	EST2	4	12	3	8	HEC2
53	3	C	3	14	EST2	4	13	3	8	HEC2
53	3	C	3	14	EST2	4	14	3	8	HEC2
53	3	C	3	14	EST2	4	15	3	8	HEC2

Problem #	Issue FEB=1, CAL=2, HV_Pin=3,HV_Line=4	Cryostat	Wedge	Gap with HV pin cut	Gap Cut	Z	ETA	PHI	Ntiles	Wheel
54	3	C	7	16	EST2	4	4	14	4	HEC2
54	3	C	7	16	EST2	4	4	13	4	HEC2
54	3	C	7	16	EST2	4	5	14	16	HEC2
54	3	C	7	16	EST2	4	5	13	16	HEC2
54	3	C	7	16	EST2	4	6	13	8	HEC2
54	3	C	7	16	EST2	4	6	14	8	HEC2
54	3	C	7	16	EST2	4	7	14	8	HEC2
54	3	C	7	16	EST2	4	7	13	8	HEC2
54	3	C	7	16	EST2	4	8	14	8	HEC2
54	3	C	7	16	EST2	4	8	13	8	HEC2
54	3	C	7	16	EST2	4	9	14	8	HEC2
54	3	C	7	16	EST2	4	9	13	8	HEC2
54	3	C	7	16	EST2	4	10	14	8	HEC2
54	3	C	7	16	EST2	4	10	13	8	HEC2
54	3	C	7	16	EST2	4	11	13	8	HEC2
54	3	C	7	16	EST2	4	11	14	8	HEC2
54	3	C	7	16	EST2	4	12	7	8	HEC2
54	3	C	7	16	EST2	4	13	7	8	HEC2
54	3	C	7	16	EST2	4	14	7	8	HEC2
54	3	C	7	16	EST2	4	15	7	8	HEC2

Problem #	Issue FEB=1, CAL=2, HV_Pin=3,HV_Line=4	Cryostat	Wedge	Gap with HV pin cut	Gap Cut	Z	ETA	PHI	Ntiles	Wheel
55	3	C	10	15	EST1	4	4	4	4	HEC2
55	3	C	10	15	EST1	4	4	3	4	HEC2
55	3	C	10	15	EST1	4	5	3	16	HEC2
55	3	C	10	15	EST1	4	5	4	16	HEC2
55	3	C	10	15	EST1	4	6	3	8	HEC2
55	3	C	10	15	EST1	4	6	4	8	HEC2
55	3	C	10	15	EST1	4	7	4	8	HEC2
55	3	C	10	15	EST1	4	7	3	8	HEC2
55	3	C	10	15	EST1	4	8	4	8	HEC2
55	3	C	10	15	EST1	4	8	3	8	HEC2
55	3	C	10	15	EST1	4	9	4	8	HEC2
55	3	C	10	15	EST1	4	9	3	8	HEC2
55	3	C	10	15	EST1	4	10	4	8	HEC2
55	3	C	10	15	EST1	4	10	3	8	HEC2
55	3	C	10	15	EST1	4	11	4	8	HEC2
55	3	C	10	15	EST1	4	11	3	8	HEC2
55	3	C	10	15	EST1	4	12	2	8	HEC2
55	3	C	10	15	EST1	4	13	2	8	HEC2
55	3	C	10	15	EST1	4	14	2	8	HEC2
55	3	C	10	15	EST1	4	15	2	8	HEC2

Problem #	Issue FEB=1, CAL=2, HV_Pin=3,HV_Line=4	Cryostat	Wedge	Gap with HV pin cut	Gap Cut	Z	ETA	PHI	Ntiles	Wheel
56	3	C	12	7	EST2	3	3	7	4	HEC2
56	3	C	12	7	EST2	3	3	8	4	HEC2
56	3	C	12	7	EST2	3	4	8	16	HEC2
56	3	C	12	7	EST2	3	4	7	16	HEC2
56	3	C	12	7	EST2	3	5	8	16	HEC2
56	3	C	12	7	EST2	3	5	7	16	HEC2
56	3	C	12	7	EST2	3	6	7	8	HEC2
56	3	C	12	7	EST2	3	6	8	8	HEC2
56	3	C	12	7	EST2	3	7	8	8	HEC2
56	3	C	12	7	EST2	3	7	7	8	HEC2
56	3	C	12	7	EST2	3	8	7	8	HEC2
56	3	C	12	7	EST2	3	8	8	8	HEC2
56	3	C	12	7	EST2	3	9	8	8	HEC2
56	3	C	12	7	EST2	3	9	7	8	HEC2
56	3	C	12	7	EST2	3	10	8	8	HEC2
56	3	C	12	7	EST2	3	10	7	8	HEC2
56	3	C	12	7	EST2	3	11	7	8	HEC2
56	3	C	12	7	EST2	3	11	8	8	HEC2
56	3	C	12	7	EST2	3	12	4	8	HEC2
56	3	C	12	7	EST2	3	13	4	8	HEC2
56	3	C	12	7	EST2	3	14	4	8	HEC2

Problem #	Issue FEB=1, CAL=2, HV_Pin=3,HV_Line=4	Cryostat	Wedge	Gap with HV pin cut	Gap Cut	Z	ETA	PHI	Ntiles	Wheel
57	3	C	13	1	PAD1	3	3	9	4	HEC2
57	3	C	13	1	PAD1	3	3	10	4	HEC2
57	3	C	13	1	PAD1	3	4	9	16	HEC2
57	3	C	13	1	PAD1	3	4	10	16	HEC2
57	3	C	13	1	PAD1	3	5	10	16	HEC2
57	3	C	13	1	PAD1	3	5	9	16	HEC2
57	3	C	13	1	PAD1	3	6	9	8	HEC2
57	3	C	13	1	PAD1	3	6	10	8	HEC2
57	3	C	13	1	PAD1	3	7	10	8	HEC2
57	3	C	13	1	PAD1	3	7	9	8	HEC2
57	3	C	13	1	PAD1	3	8	10	8	HEC2
57	3	C	13	1	PAD1	3	8	9	8	HEC2
57	3	C	13	1	PAD1	3	9	10	8	HEC2
57	3	C	13	1	PAD1	3	9	9	8	HEC2
57	3	C	13	1	PAD1	3	10	10	8	HEC2
57	3	C	13	1	PAD1	3	10	9	8	HEC2
57	3	C	13	1	PAD1	3	11	9	8	HEC2
57	3	C	13	1	PAD1	3	11	10	8	HEC2
57	3	C	13	1	PAD1	3	12	5	8	HEC2
57	3	C	13	1	PAD1	3	13	5	8	HEC2
57	3	C	13	1	PAD1	3	14	5	8	HEC2

Problem #	Issue FEB=1, CAL=2, HV_Pin=3,HV_Line=4	Cryostat	Wedge	Gap with HV pin cut	Gap Cut	Z	ETA	PHI	Ntiles	Wheel
58	3	C	16	16	EST2	4	4	15	4	HEC2
58	3	C	16	16	EST2	4	4	16	4	HEC2
58	3	C	16	16	EST2	4	5	16	16	HEC2
58	3	C	16	16	EST2	4	5	15	16	HEC2
58	3	C	16	16	EST2	4	6	15	8	HEC2
58	3	C	16	16	EST2	4	6	16	8	HEC2
58	3	C	16	16	EST2	4	7	16	8	HEC2
58	3	C	16	16	EST2	4	7	15	8	HEC2
58	3	C	16	16	EST2	4	8	15	8	HEC2
58	3	C	16	16	EST2	4	8	16	8	HEC2
58	3	C	16	16	EST2	4	9	15	8	HEC2
58	3	C	16	16	EST2	4	9	16	8	HEC2
58	3	C	16	16	EST2	4	10	16	8	HEC2
58	3	C	16	16	EST2	4	10	15	8	HEC2
58	3	C	16	16	EST2	4	11	16	8	HEC2
58	3	C	16	16	EST2	4	11	15	8	HEC2
58	3	C	16	16	EST2	4	12	8	8	HEC2
58	3	C	16	16	EST2	4	13	8	8	HEC2
58	3	C	16	16	EST2	4	14	8	8	HEC2
58	3	C	16	16	EST2	4	15	8	8	HEC2

Problem #	Issue FEB=1, CAL=2, HV_Pin=3,HV_Line=4	Cryostat	Wedge	Gap with HV pin cut	Gap Cut	Z	ETA	PHI	Ntiles	Wheel
59	3	C	17	15	EST2	4	4	2	4	HEC2
59	3	C	17	15	EST2	4	4	1	4	HEC2
59	3	C	17	15	EST2	4	5	2	16	HEC2
59	3	C	17	15	EST2	4	5	1	16	HEC2
59	3	C	17	15	EST2	4	6	1	8	HEC2
59	3	C	17	15	EST2	4	6	2	8	HEC2
59	3	C	17	15	EST2	4	7	2	8	HEC2
59	3	C	17	15	EST2	4	7	1	8	HEC2
59	3	C	17	15	EST2	4	8	2	8	HEC2
59	3	C	17	15	EST2	4	8	1	8	HEC2
59	3	C	17	15	EST2	4	9	2	8	HEC2
59	3	C	17	15	EST2	4	9	1	8	HEC2
59	3	C	17	15	EST2	4	10	2	8	HEC2
59	3	C	17	15	EST2	4	10	1	8	HEC2
59	3	C	17	15	EST2	4	11	1	8	HEC2
59	3	C	17	15	EST2	4	11	2	8	HEC2
59	3	C	17	15	EST2	4	12	1	8	HEC2
59	3	C	17	15	EST2	4	13	1	8	HEC2
59	3	C	17	15	EST2	4	14	1	8	HEC2
59	3	C	17	15	EST2	4	15	1	8	HEC2

Problem #	Issue FEB=1, CAL=2, HV_Pin=3,HV_Line=4	Cryostat	Wedge	Gap with HV pin cut	Gap Cut	Z	ETA	PHI	Ntiles	Wheel
60	3	C	19	1	EST2	3	3	6	4	HEC2
60	3	C	19	1	EST2	3	3	5	4	HEC2
60	3	C	19	1	EST2	3	4	5	16	HEC2
60	3	C	19	1	EST2	3	4	6	16	HEC2
60	3	C	19	1	EST2	3	5	6	16	HEC2
60	3	C	19	1	EST2	3	5	5	16	HEC2
60	3	C	19	1	EST2	3	6	6	8	HEC2
60	3	C	19	1	EST2	3	6	5	8	HEC2
60	3	C	19	1	EST2	3	7	6	8	HEC2
60	3	C	19	1	EST2	3	7	5	8	HEC2
60	3	C	19	1	EST2	3	8	6	8	HEC2
60	3	C	19	1	EST2	3	8	5	8	HEC2
60	3	C	19	1	EST2	3	9	6	8	HEC2
60	3	C	19	1	EST2	3	9	5	8	HEC2
60	3	C	19	1	EST2	3	10	5	8	HEC2
60	3	C	19	1	EST2	3	10	6	8	HEC2
60	3	C	19	1	EST2	3	11	5	8	HEC2
60	3	C	19	1	EST2	3	11	6	8	HEC2
60	3	C	19	1	EST2	3	12	3	8	HEC2
60	3	C	19	1	EST2	3	13	3	8	HEC2
60	3	C	19	1	EST2	3	14	3	8	HEC2

Problem #	Issue FEB=1, CAL=2, HV_Pin=3,HV_Line=4	Cryostat	Wedge	Gap with HV pin cut	Gap Cut	Z	ETA	PHI	Ntiles	Wheel
61	3	C	24	12	EST2	4	4	16	4	HEC2
61	3	C	24	12	EST2	4	4	15	4	HEC2
61	3	C	24	12	EST2	4	5	16	16	HEC2
61	3	C	24	12	EST2	4	5	15	16	HEC2
61	3	C	24	12	EST2	4	6	16	8	HEC2
61	3	C	24	12	EST2	4	6	15	8	HEC2
61	3	C	24	12	EST2	4	7	16	8	HEC2
61	3	C	24	12	EST2	4	7	15	8	HEC2
61	3	C	24	12	EST2	4	8	15	8	HEC2
61	3	C	24	12	EST2	4	8	16	8	HEC2
61	3	C	24	12	EST2	4	9	16	8	HEC2
61	3	C	24	12	EST2	4	9	15	8	HEC2
61	3	C	24	12	EST2	4	10	15	8	HEC2
61	3	C	24	12	EST2	4	10	16	8	HEC2
61	3	C	24	12	EST2	4	11	15	8	HEC2
61	3	C	24	12	EST2	4	11	16	8	HEC2
61	3	C	24	12	EST2	4	12	8	8	HEC2
61	3	C	24	12	EST2	4	13	8	8	HEC2
61	3	C	24	12	EST2	4	14	8	8	HEC2
61	3	C	24	12	EST2	4	15	8	8	HEC2

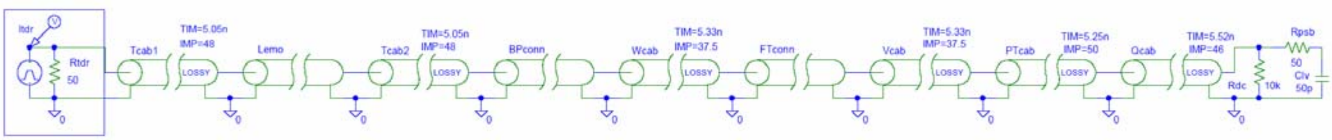
Problem #	Issue FEB=1, CAL=2, HV_Pin=3,HV_Line=4	Cryostat	Wedge	Gap with HV pin cut	Gap Cut	Z	ETA	PHI	Ntiles	Wheel
62	3	C	30	6	EST1	3	3	12	4	HEC2
62	3	C	30	6	EST1	3	3	11	4	HEC2
62	3	C	30	6	EST1	3	4	12	16	HEC2
62	3	C	30	6	EST1	3	4	11	16	HEC2
62	3	C	30	6	EST1	3	5	11	16	HEC2
62	3	C	30	6	EST1	3	5	12	16	HEC2
62	3	C	30	6	EST1	3	6	11	8	HEC2
62	3	C	30	6	EST1	3	6	12	8	HEC2
62	3	C	30	6	EST1	3	7	12	8	HEC2
62	3	C	30	6	EST1	3	7	11	8	HEC2
62	3	C	30	6	EST1	3	8	12	8	HEC2
62	3	C	30	6	EST1	3	8	11	8	HEC2
62	3	C	30	6	EST1	3	9	11	8	HEC2
62	3	C	30	6	EST1	3	9	12	8	HEC2
62	3	C	30	6	EST1	3	10	11	8	HEC2
62	3	C	30	6	EST1	3	10	12	8	HEC2
62	3	C	30	6	EST1	3	11	12	8	HEC2
62	3	C	30	6	EST1	3	11	11	8	HEC2
62	3	C	30	6	EST1	3	12	6	8	HEC2
62	3	C	30	6	EST1	3	13	6	8	HEC2
62	3	C	30	6	EST1	3	14	6	8	HEC2

Problem #	Issue FEB=1, CAL=2, HV_Pin=3,HV_Line=4	Cryostat	Wedge	Gap with HV pin cut	Gap Cut	Z	ETA	PHI	Ntiles	Wheel
63	3	C	32	6	EST1	3	3	15	4	HEC2
63	3	C	32	6	EST1	3	3	16	4	HEC2
63	3	C	32	6	EST1	3	4	15	16	HEC2
63	3	C	32	6	EST1	3	4	16	16	HEC2
63	3	C	32	6	EST1	3	5	15	16	HEC2
63	3	C	32	6	EST1	3	5	16	16	HEC2
63	3	C	32	6	EST1	3	6	16	8	HEC2
63	3	C	32	6	EST1	3	6	15	8	HEC2
63	3	C	32	6	EST1	3	7	16	8	HEC2
63	3	C	32	6	EST1	3	7	15	8	HEC2
63	3	C	32	6	EST1	3	8	16	8	HEC2
63	3	C	32	6	EST1	3	8	15	8	HEC2
63	3	C	32	6	EST1	3	9	16	8	HEC2
63	3	C	32	6	EST1	3	9	15	8	HEC2
63	3	C	32	6	EST1	3	10	15	8	HEC2
63	3	C	32	6	EST1	3	10	16	8	HEC2
63	3	C	32	6	EST1	3	11	15	8	HEC2
63	3	C	32	6	EST1	3	11	16	8	HEC2
63	3	C	32	6	EST1	3	12	8	8	HEC2
63	3	C	32	6	EST1	3	13	8	8	HEC2
63	3	C	32	6	EST1	3	14	8	8	HEC2

APPENDIX I

TDR Measurements and Reconstruction of HEC Cable Parameters in the EC-C cold test (reproduced here from ATL-AE-QR-0001 v.1)

The TDR waveform displays structure that indicates the wave impedances in the line and its termination conditions. The HEC signal line (PSB to Baseplane) is a set of cables:



The measurements were done with TDS 8000 oscilloscope running in TDR mode. The instrument settings are shown in the table below. One channel (CH1) was used for all tests. The measurements were not automated, as all re-plugging operations were done manually.

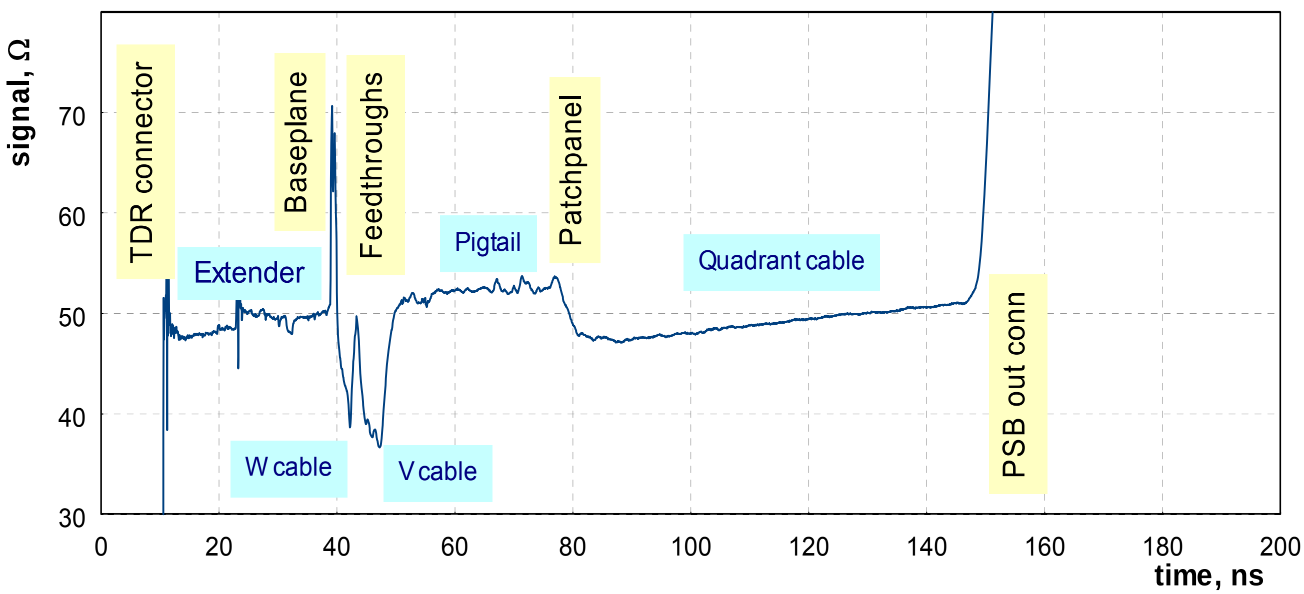
VERT	Scale	100 mV/div
	Offset	250 mV
HOR	Scale	20 ns/div (50 for calibration channels)
	Offset	21.4 ns
	Length	4000 samples
ACQ	Type	Average
	N of samples	50
	Stop	Condition
	N of acquisitions	50
TRIG	Source	Internal
	Frequency	25 KHz
	Mode	Auto
TDR	Channel	C1
	Scale	V

Each waveform is saved in an ASCII file with csv format. The file name reflects the board number and channel number e.g.: s1a33.txt means FEB (signal) line of FEB #1, connector "a" (first half of FEB, "b" corresponds to the second half of FEB), channel 33. Other files are: "p" – re-measurement of signal channel, "c" – calibration line, "d" – calibration line with 50 ns/div (200 ns is not enough to see all the line). There is no quadrant number in the file name because the files are grouped in four folders, one per quadrant.

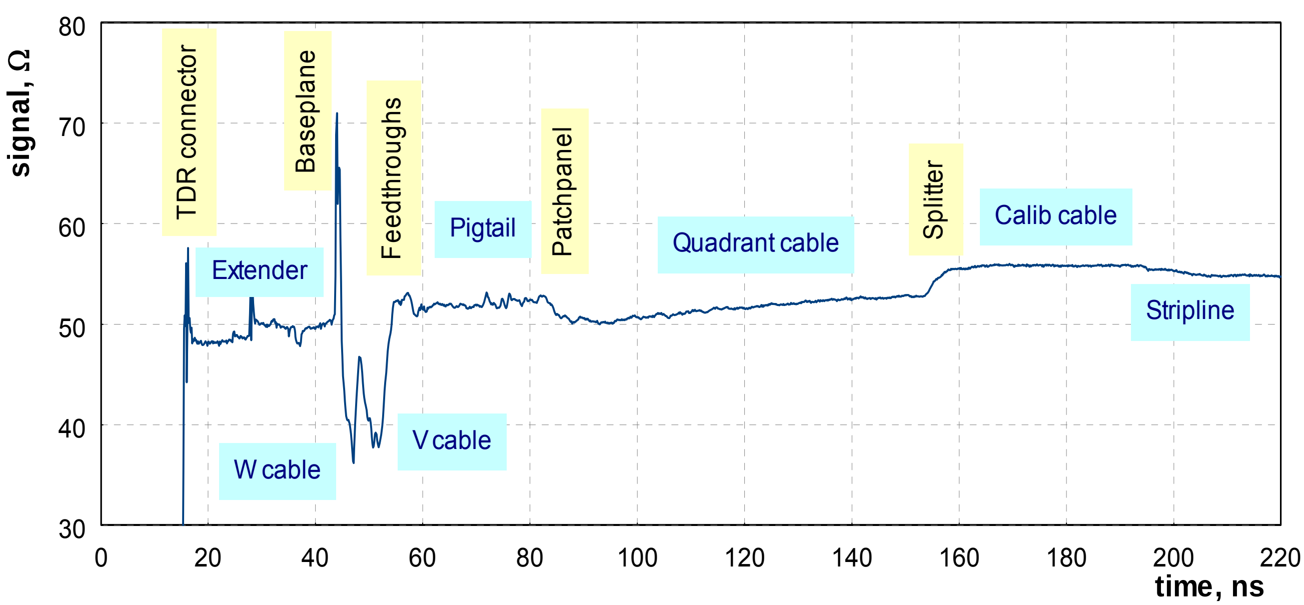
There is a mismatch between in-board channels numbering and TDR file numbers. File number 01 corresponds to pin A32 of the baseplane connector while the FE boards starts with C32. Channel number (counted from 1, not 0) can be obtained from file number by applying simple odd-even transform.

There are 128 calibration lines and 768 signal lines per quadrant, so in total 3584 measurements are done. In the case that the measurement quality was in doubt, the test was repeated.

A typical oscillogram for signal line is shown below. Each part of the line can be recognized in the waveform:



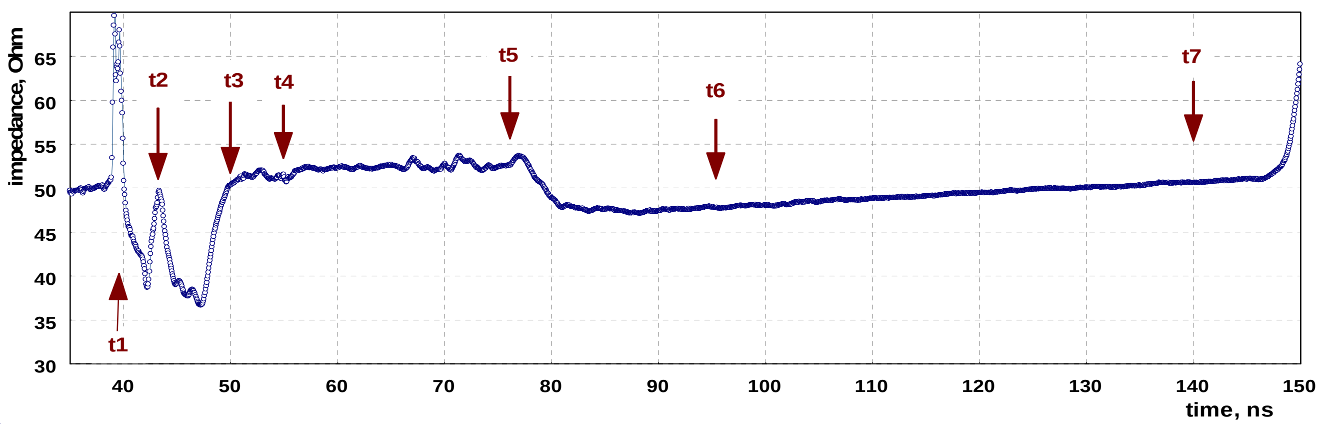
Similar waveform for calibration line (from baseplane to the end of strip line):

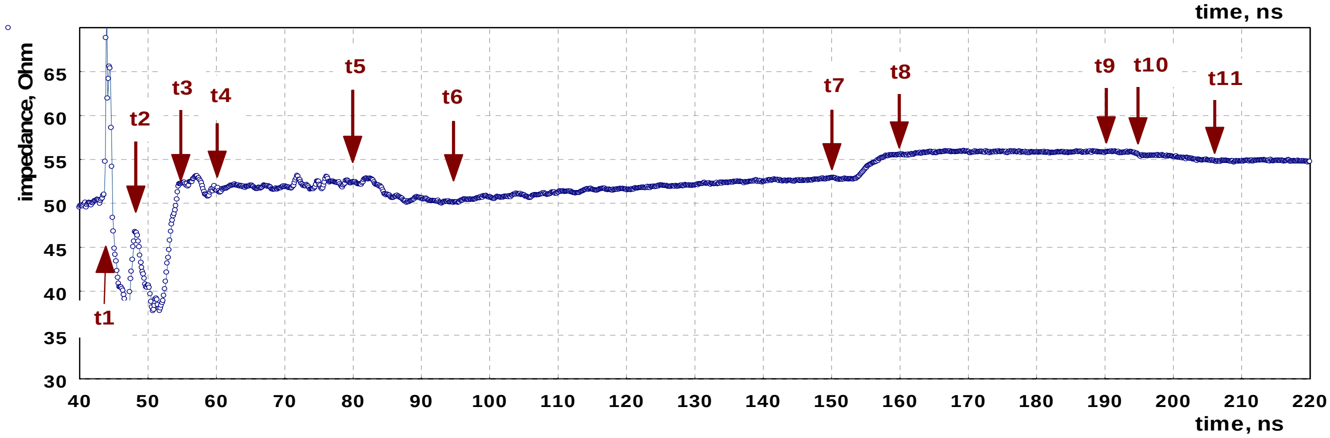


The vertical scale, originally measured in mV, is recalculated to equivalent impedance:

$$Z = 50\Omega \cdot \frac{V}{500mV - V}$$

For each cable a time window is defined as shown at the next two plots. The cable parameters are determined by analyzing data from corresponding window. The impedance of W and V cables are determined from the minimum value found in slots [t1, t2] and [t2, t3] respectively. For long cables: pigtail (P), quadrant (Q), calibration (C) and stripline (S) both wave impedance and serial resistivity can be reconstructed. It is done by a linear fit of the corresponding subset of points: [t4, t5] for P-cable, [t6, t7] for Q-cable, etc.





Then, the resistivity is determined from the slope of the fit line. It is measured in Ω/ns. The wave impedance is obtained from the value of fit function in the area of the cable start point: t3 for pigtail, t5 for quadrant cable, t8 for calibration cable and t10 for strip line. To obtain a better estimation of the wave impedance, the integral resistivity of all cables up to this point has been subtracted. Such subtraction is done only for Q-cables and not done for others. Therefore the reconstructed value is not exactly the cable wave impedance. It is shifted with respect to the real value by few Ω. Another source of shift is the inexact definition of the cable starting point.

The length of each cable can not be accurately determined because all the lines have nearly equal impedance of 50 Ω. Also there is no well defined boundary between two consecutive cables because of signal slow down due to skin effect in the cables. But the total length of signal line can be easily estimated. It is done only for FEB lines where the PSB is connected. For disconnected channels it makes no sense and thus this parameter is fixed to 0. The beginning of the chain is defined as t1 and the end of the chain is determined in the region of 150 ns (upper plot of the last figure) when the waveform starts to rise rapidly. The end point is calculated as a point where waveform crosses the level of Q-cable impedance plus 5 Ω. Then the propagation time is the distance between end point and t1.

Other reconstructed parameters are PSB output impedance (impedance at the end of the FEB oscillogram) and strip line termination (impedance at the end of the CAL oscillogram). These values are calculated as an average over last 10-20 samplings.

The distributions of the cable parameters both for the signal and calibration lines can be found in a separate EDMS documents:

ATL-AE-QR-0003

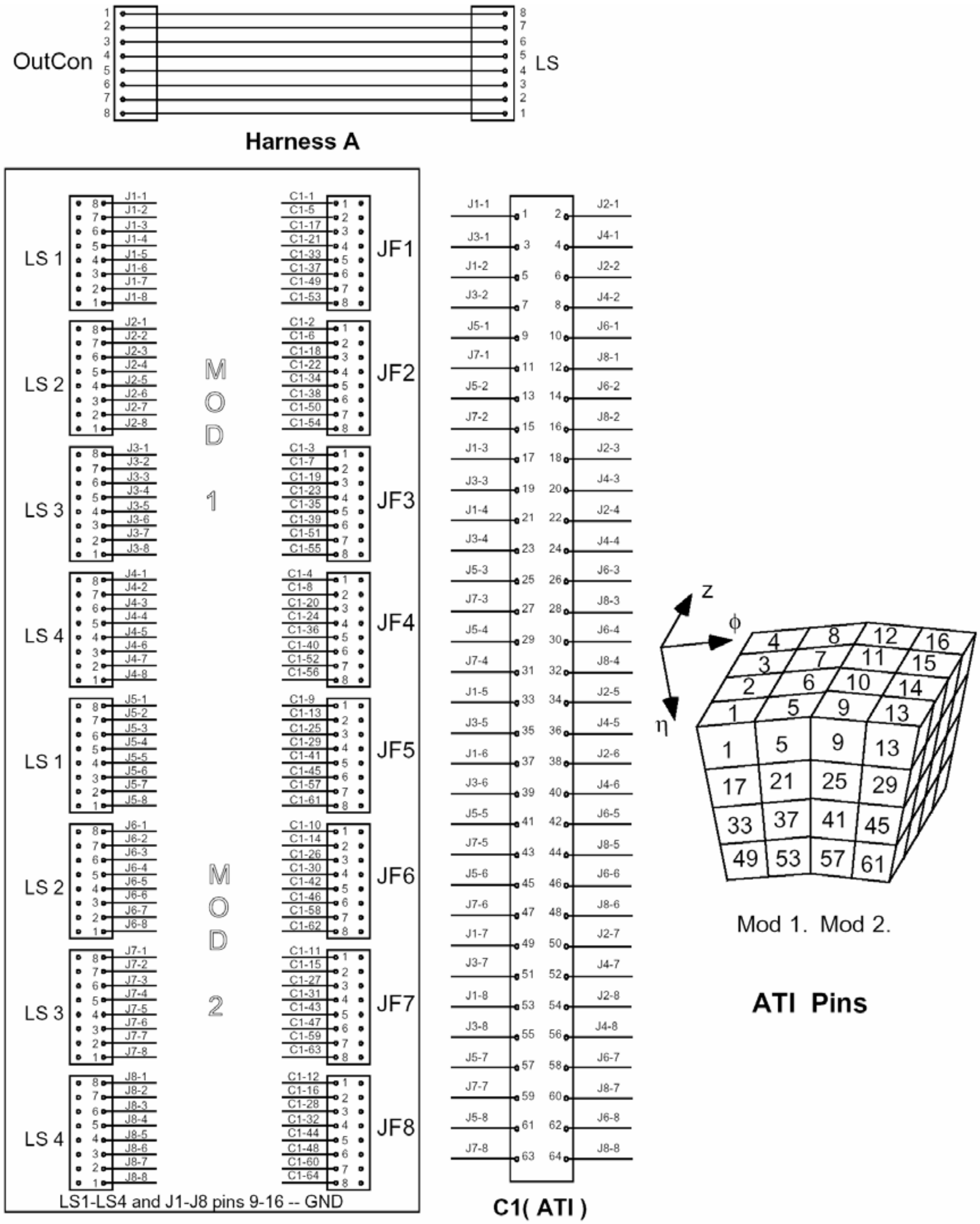
HEC cables parameters measured with TDR in EC-C cold test

https://edms.cern.ch/file/563843/1/febhist.doc

https://edms.cern.ch/file/563843/1/calhist.doc

https://edms.cern.ch/file/563843/1/cabhist.doc

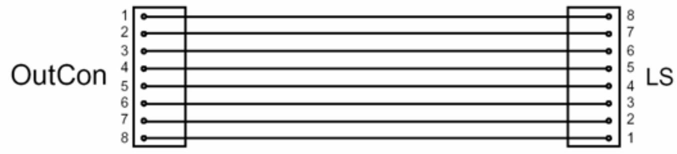
Appendix II:
Diagrams of Connection Patch Panel to ATI, and PSB boards



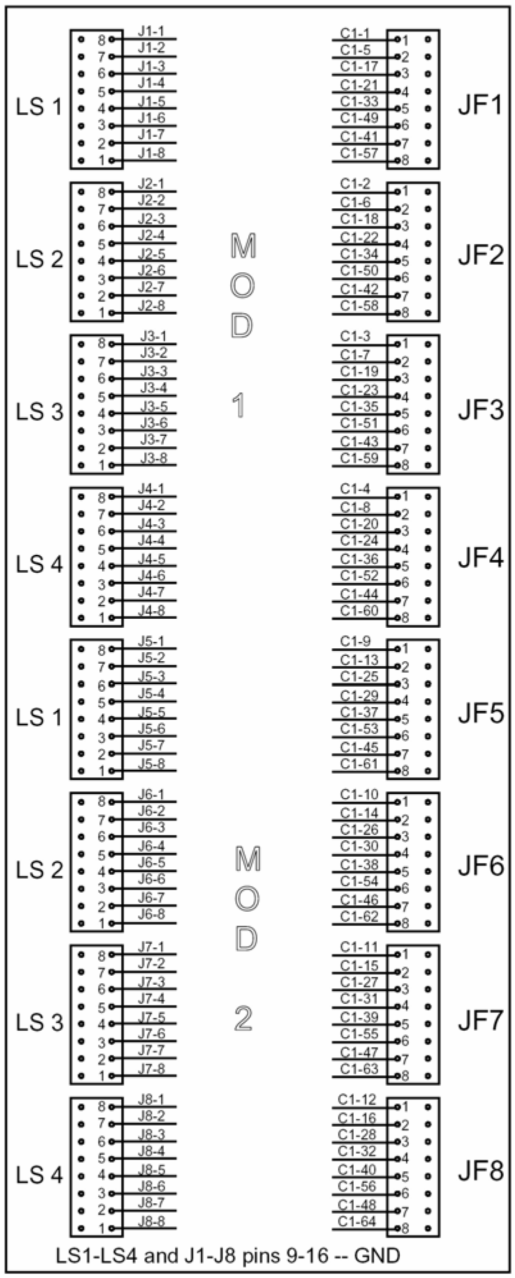
Connection Patch Panel to ATI
(type 1)

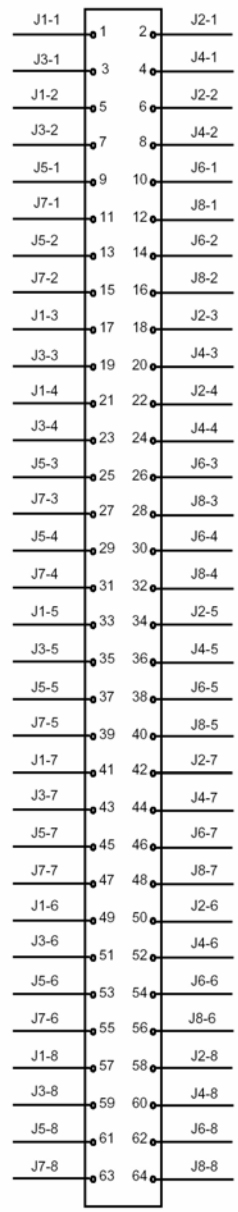
$\eta = 1.5 - 1.9$

$\eta = 1.9 - 2.3$

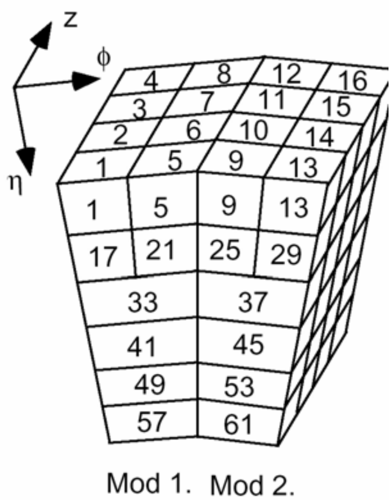


Harness A





C1(ATI)



ATI Pins

Connection Patch Panel to ATI
(type 2)

$\eta = 2.3 - 3.2$

PSB 1 (LSEG 1)

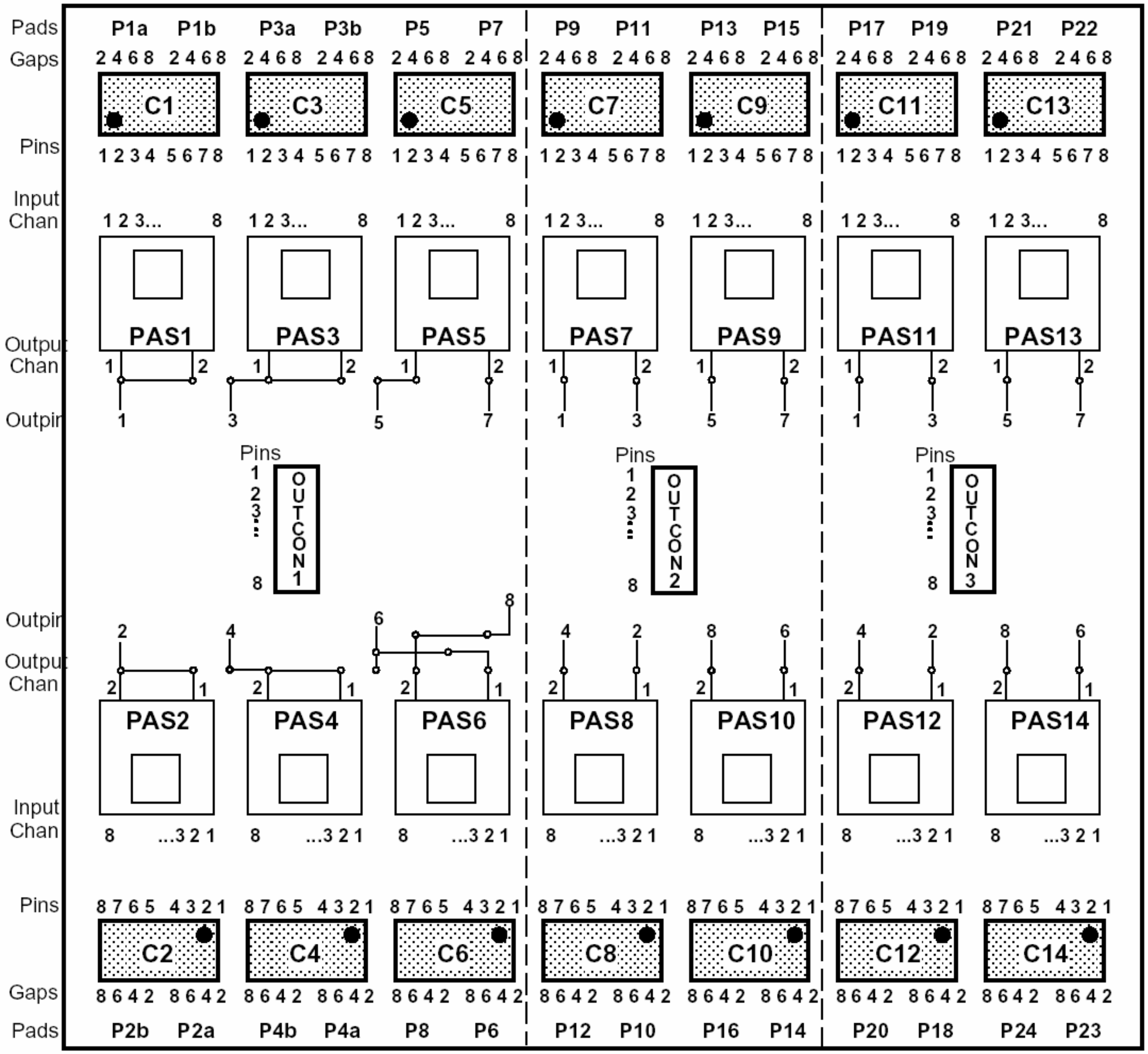


Table 1 (LSEG 1)

Eta	PAS# Incon	Inpin	Pad	Outcon/	Outpin
1.55	1	1-8	1a+1b	1	1
1.65	3	1-8	3a+3b	1	3
1.75	5	1-4	5	1	5
1.85	5	5-8	7	1	7
1.95	7	1-4	9	2	1
2.05	7	5-8	11	2	3
2.15	9	1-4	13	2	5
2.25	9	5-8	15	2	7
2.35	11	1-4	17	3	1
2.45	11	5-8	19	3	3
2.6	13	1-4	21	3	5
2.8	13	5-8	22	3	7
1.55	2	1-8	2a+2b	1	2
1.65	4	1-8	4a+4b	1	4
1.75	6	1-4	6	1	6
1.85	6	5-8	8	1	8
1.95	8	1-4	10	2	2
2.05	8	5-8	12	2	4
2.15	10	1-4	14	2	6
2.25	10	5-8	16	2	8
2.35	12	1-4	18	3	2
2.45	12	5-8	20	3	4
3.0	14	1-4	23	3	6
3.2	14	5-8	24	3	8

PSB 2_1 (LSEG 2)

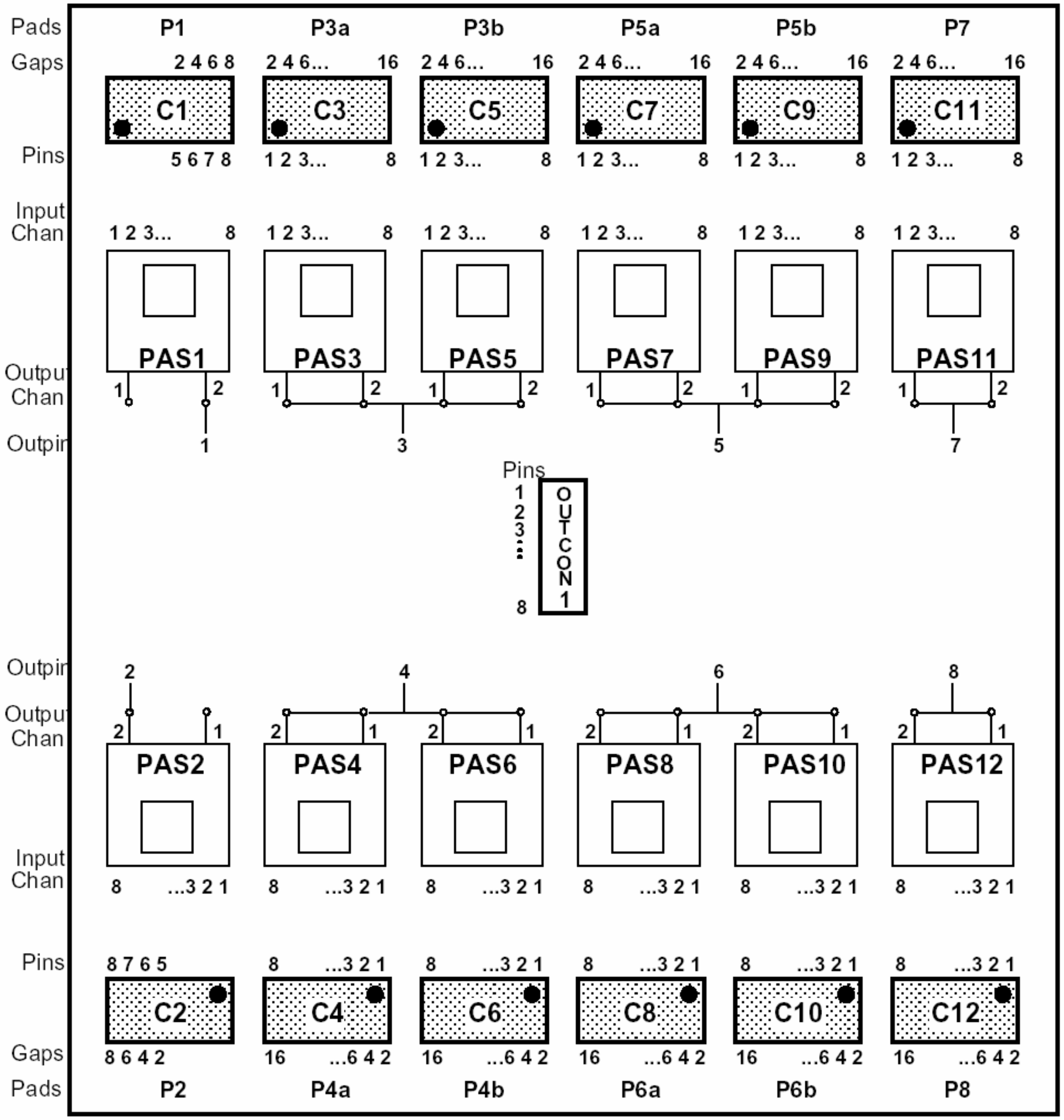
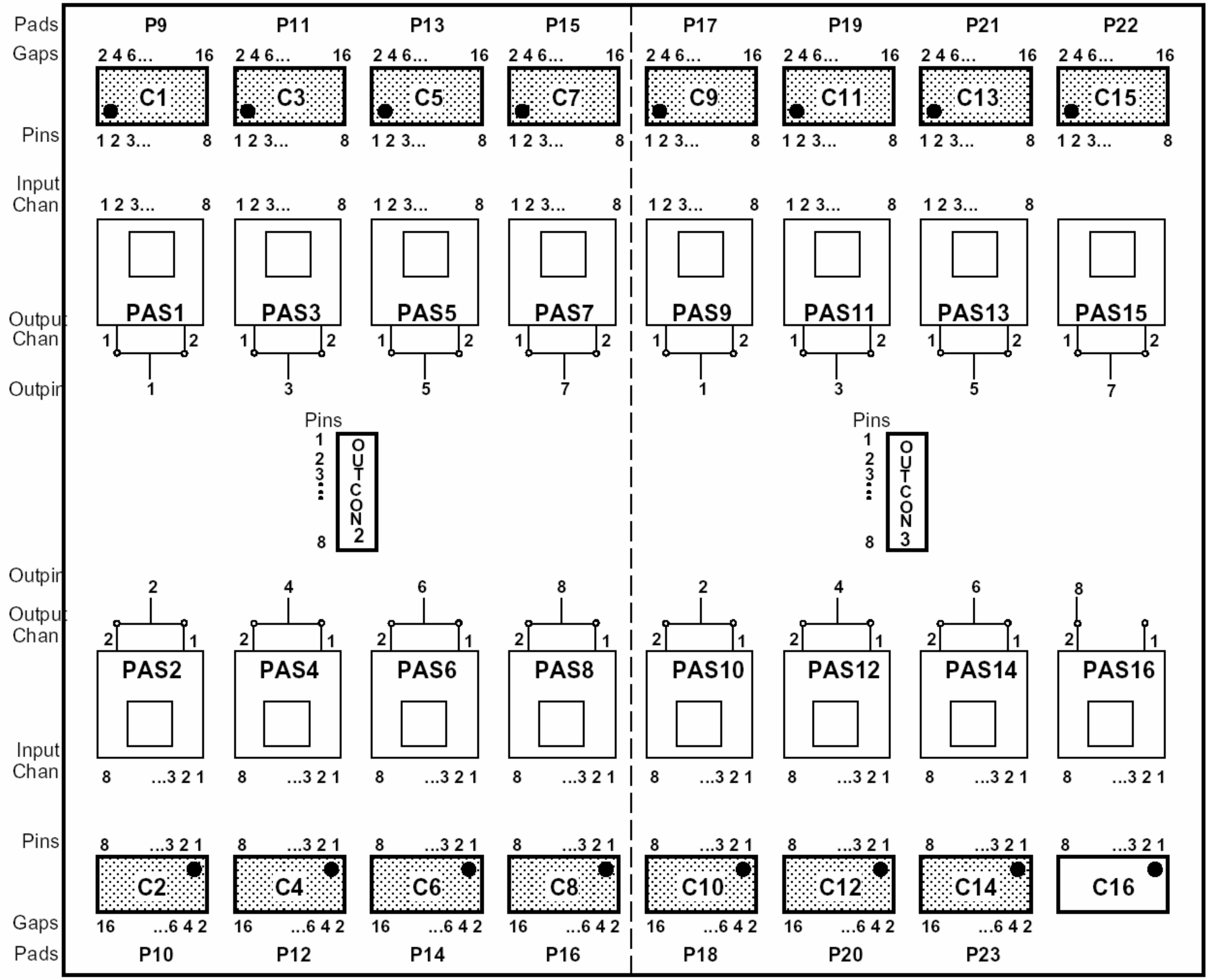


Table 2 (LSEG 2)

Eta	PAS# Incon	Inpin	Pad	Outcon/ Outpin	
1.55	1	5-8	1	1	1
1.65	3	1-8	3a	1	3
1.65	5	1-8	3b	1	3
1.75	7	1-8	5a	1	5
1.75	9	1-8	5b	1	5
1.85	11	1-8	7	1	7
1.95	1	1-8	9	2	1
2.05	3	1-8	11	2	3
2.15	5	1-8	13	2	5
2.25	7	1-8	15	2	7
2.35	9	1-8	17	3	1
2.45	11	1-8	19	3	3
2.6	13	1-8	21	3	5
2.8	15	1-8	22	3	7
1.55	2	5-8	2	1	2
1.65	4	1-8	4a	1	4
1.65	6	1-8	4b	1	4
1.75	8	1-8	6a	1	6
1.75	10	1-8	6b	1	6
1.85	12	1-8	8	1	8
1.95	2	1-8	10	2	2
2.05	4	1-8	12	2	4
2.15	6	1-8	14	2	6
2.25	8	1-8	16	2	8
2.35	10	1-8	18	3	2
2.45	12	1-8	20	3	4
3.0	14	1-8	23	3	6
3.2	16	---	---	3	8

PSB 2_2 (LSEG 2)



Pads
Gaps
Pins
Input Chan
Output Chan
Outpin
P9
P11
P13
P15
P17
P19
P21
P22
2 4 6... 16
C1
C3
C5
C7
C9
C11
C13
C15
1 2 3... 8
PAS1
PAS3
PAS5
PAS7
PAS9
PAS11
PAS13
PAS15
1 2
1 3 5 7 1 3 5 7
Pins
1 2 3 ... 8
OUTCON2
OUTCON3
2 4 6 8 2 4 6 8
PAS2
PAS4
PAS6
PAS8
PAS10
PAS12
PAS14
PAS16
8 ...3 2 1
C2
C4
C6
C8
C10
C12
C14
C16
16 ...6 4 2
P10
P12
P14
P16
P18
P20
P23

PSB 3 (LSEG 3)

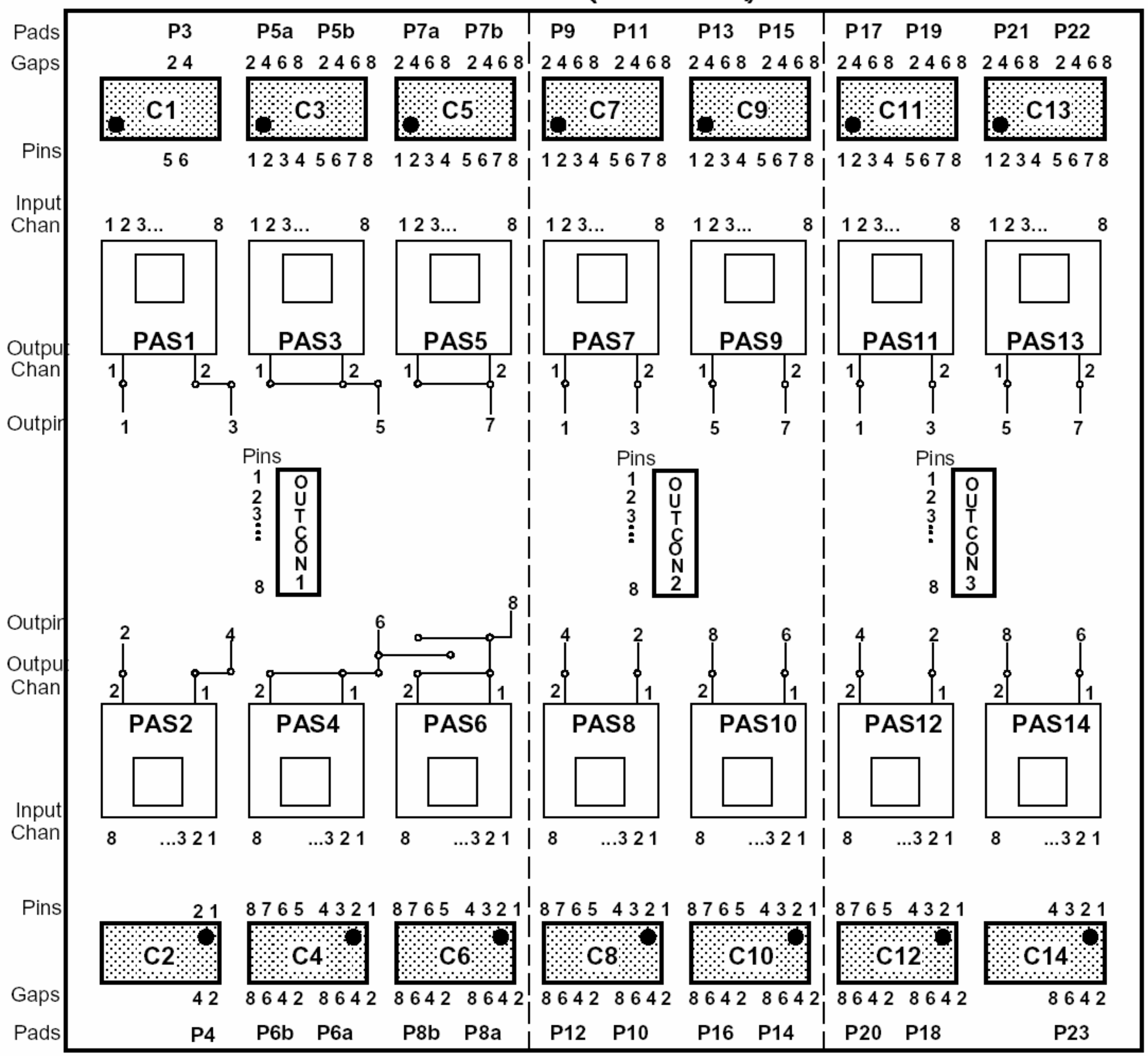


Table 3 (LSEG 3)

Eta	PAS# Incon	Inpin	Pad	Outcon/ Outpin	
1.55	---	---	---	1	---
1.65	1	5-6	3	1	3
1.75	3	1-4	5a	1	5
1.75	3	5-8	5b	1	5
1.85	5	1-4	7a	1	7
1.85	5	5-8	7b	1	7
1.95	7	1-4	9	2	1
2.05	7	5-8	11	2	3
2.15	9	1-4	13	2	5
2.25	9	5-8	15	2	7
2.35	11	1-4	17	3	1
2.45	11	5-8	19	3	3
2.6	13	1-4	21	3	5
2.8	13	5-8	22	3	7
1.55	---	---	---	1	---
1.65	2	1-2	4	1	4
1.75	4	1-4	6a	1	6
1.75	4	5-8	6b	1	6
1.85	6	1-4	8a	1	8
1.85	6	5-8	8b	1	8
1.95	8	1-4	10	2	2
2.05	8	5-8	12	2	4
2.15	10	1-4	14	2	6
2.25	10	5-8	16	2	8
2.35	12	1-4	18	3	2
2.45	12	5-8	20	3	4
3.0	14	1-4	23	3	6
3.2	14	---	---	3	---

PSB 4 (LSEG 4)

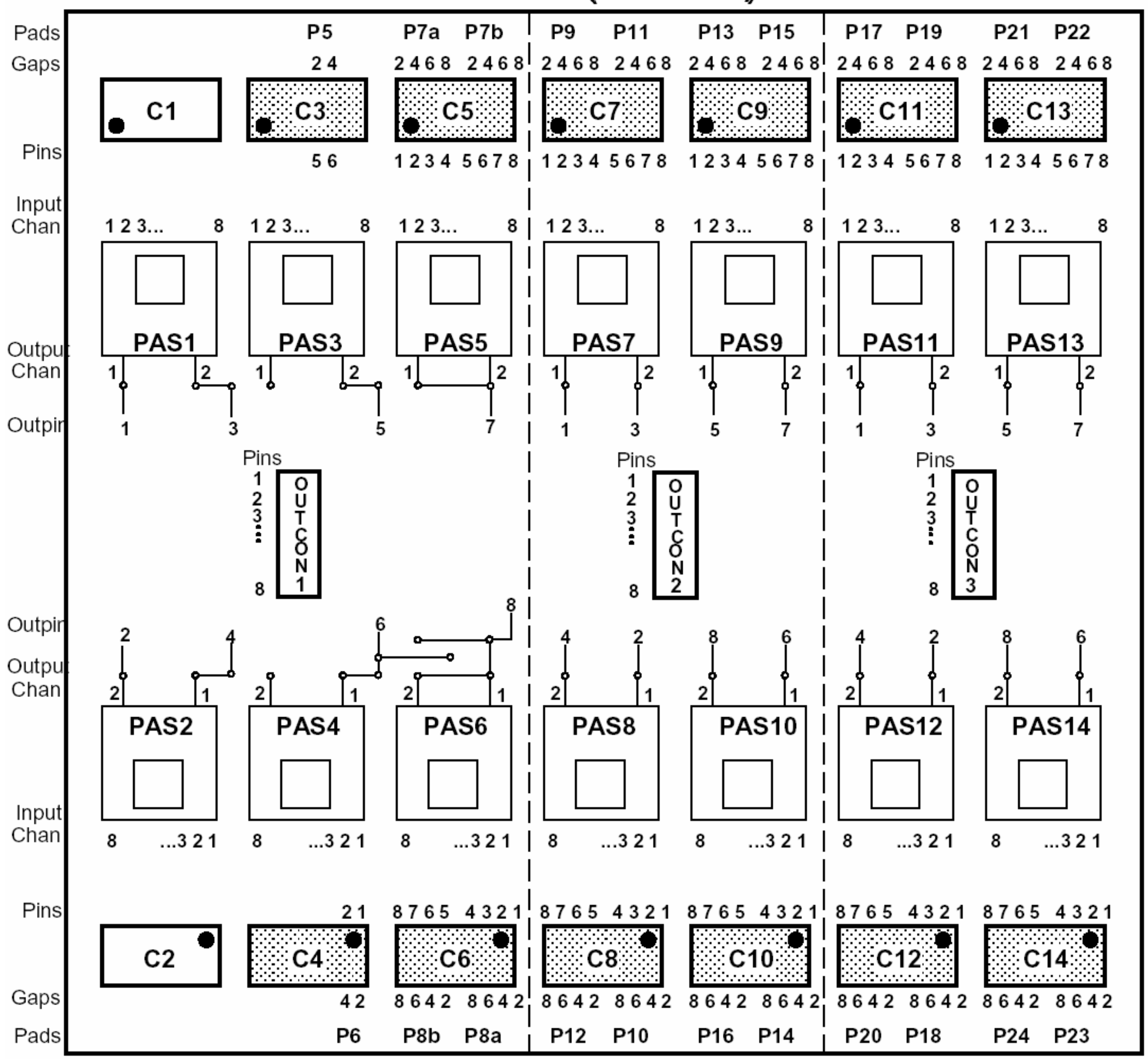


Table 4 (LSEG 4)

Eta	PAS# Incon	Inpin	Pad	Outcon/ Outpin	
1.55	---	---	---	1	---
1.65	---	---	---	1	---
1.75	---	---	---	1	---
1.75	5	5-6	5	1	5
1.85	5	1-4	7a	1	7
1.85	5	5-8	7b	1	7
1.95	7	1-4	9	2	1
2.05	7	5-8	11	2	3
2.15	9	1-4	13	2	5
2.25	9	5-8	15	2	7
2.35	11	1-4	17	3	1
2.45	11	5-8	19	3	3
2.6	13	1-4	21	3	5
2.8	13	5-8	22	3	7
1.55	---	---	---	1	---
1.65	---	---	---	1	---
1.75	---	---	---	1	---
1.75	4	1-2	6	1	6
1.85	6	1-4	8a	1	8
1.85	6	5-8	8b	1	8
1.95	8	1-4	10	2	2
2.05	8	5-8	12	2	4
2.15	10	1-4	14	2	6
2.25	10	5-8	16	2	8
2.35	12	1-4	18	3	2
2.45	12	5-8	20	3	4
3.0	14	1-4	23	3	6
3.2	14	5-8	24	3	8