ING Technical Note 120
The EEV #13 CCD Camera

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CONTENTS

1. General Description.

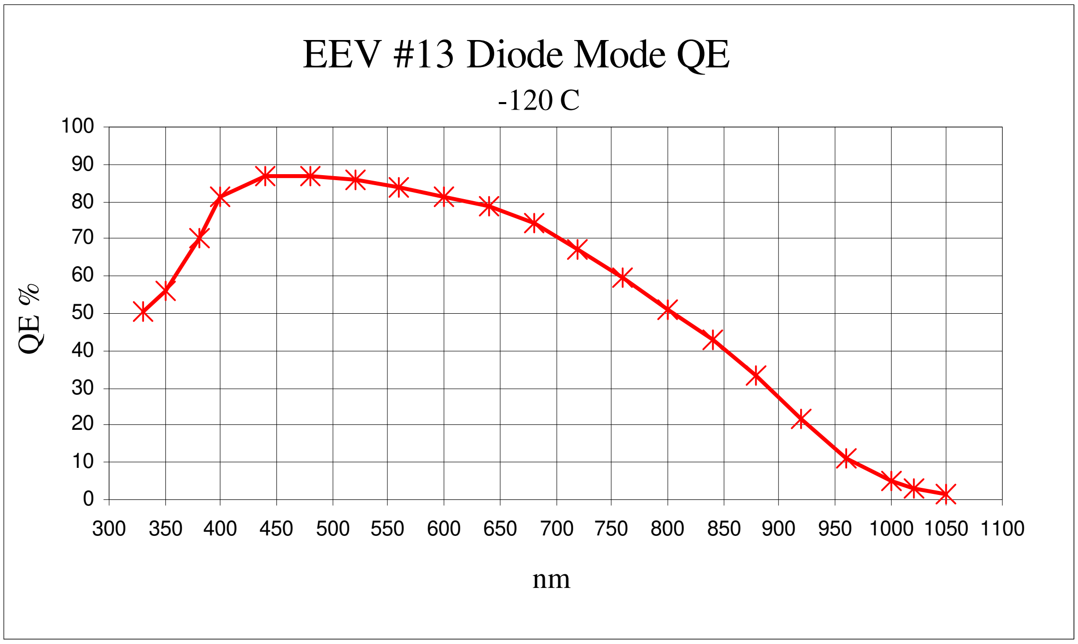
The camera contains a single EEV-42-80 thinned and AR coated. 13.5µm pixels. 2148 x 4128 pixels total including 50 x-underscan and 50 x-overscan. The active area of the device measures 55.8 x 55.3mm.

CCD Device number : 7061-8-3
Grade 2 device with nine dark columns arranged in three clusters and no bright columns. Bright defects :179 total, 48 in central zone. No measurable dark current at –120C. Full well 240,000 electrons. The device was tested using the same operating waveforms as for EEV #12, the bias voltages however were slightly different.

All test data was recorded at -120C.

2. Quantum Efficiency.

This was measured using a new DC technique and a monochromator to give greater spectral resolution.

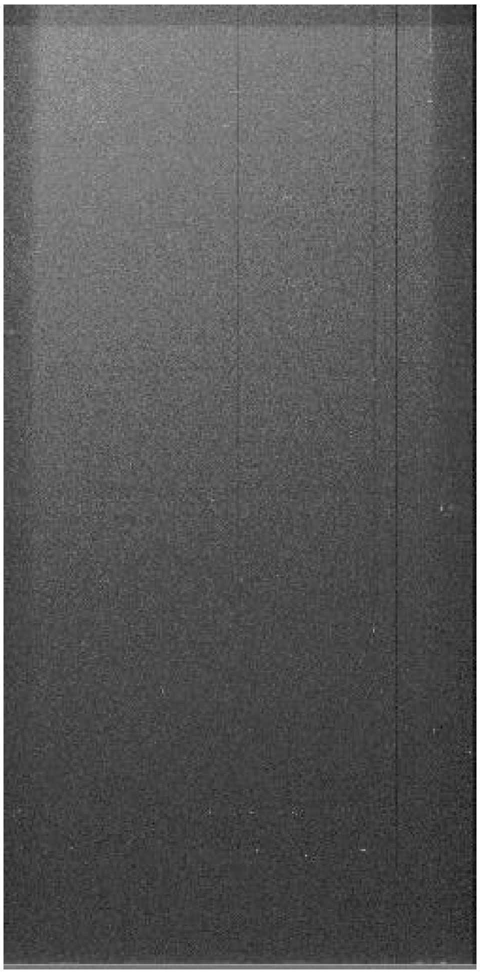


3. Image Quality

3.1. Image Defects.

The following dark frame is a stack of five 900s dark frames that are combined to reject cosmic rays. The flat field shows the clustering of the nine dark columns.

Dark Frame

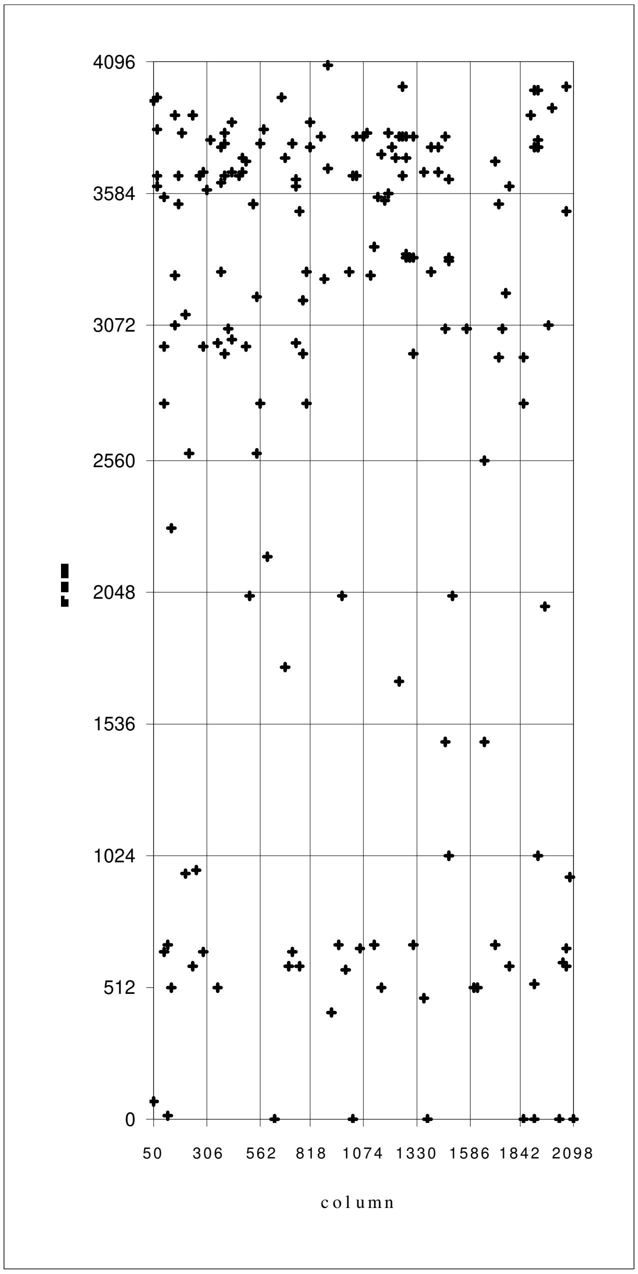


Flat Field

Both Images taken with right hand amplifier

Bright Columns locations	Dark Columns locations	Number of Hot Spots
none	1076,1077 1671,1672,1673 1761,1762,1763,1764	179

Hot Pixel Map (right hand amplifier) :-

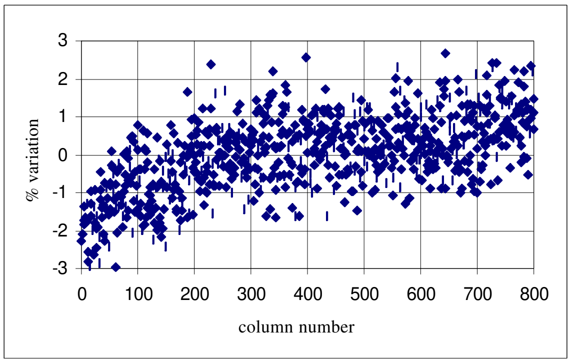


Cosmic ray count is 2000 events per hour.

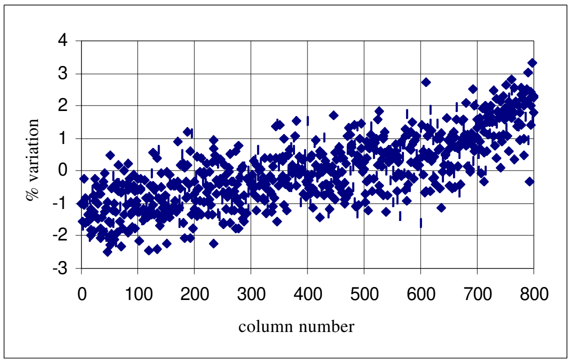
3.2. Pixel Response Non-Uniformity.

This was measured using deeply exposed flat-fields and taking a cut across each image. There was some uneveness in the illumination but the pixel to pixel sensitivity variations are clearly visible. The cross-hatch pattern in the blue flat-field was much less pronounced than with previous 42-80 CCDs. If the chip was illuminated at 950nm with a collimated source, fringes with an amplitude of 14 % were also visible. This fringing does not show in the flat field exposures because the illumination was non-collimated.

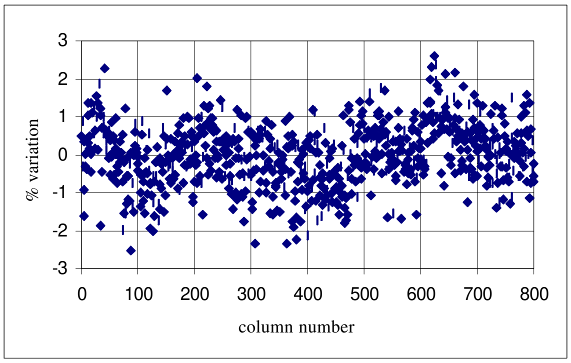
950nm



565nm



390nm



4. Read Out Noise.

The readout noise was characterised for both outputs in both hi-gain and lo-gain mode. These modes were selected by switching the voltage on OG2 so as to vary the output node capacitance.

The output sensitivities of the CCDs are shown below in μV/electron.

	Hi-gain Sensitivity	Lo-gain Sensitivity
Left Output	3.93	1.3
Right Output	3.96	1.32

The RMS noise is tabulated below for a variety of CDS integration times. In all cases the CDS RC constant was 4.3μs.

Hi-Gain	8+8μs CDS time	6+6μs CDS time	4+4μs CDS time
Left Output	3.3e	3.7e	4.6e
Right Output	3.3e	3.7e	5.6e

Lo-Gain	8+8μs CDS time	6+6μs CDS time	4+4μs CDS time
Left Output	10.8e		
Right Output	11e		

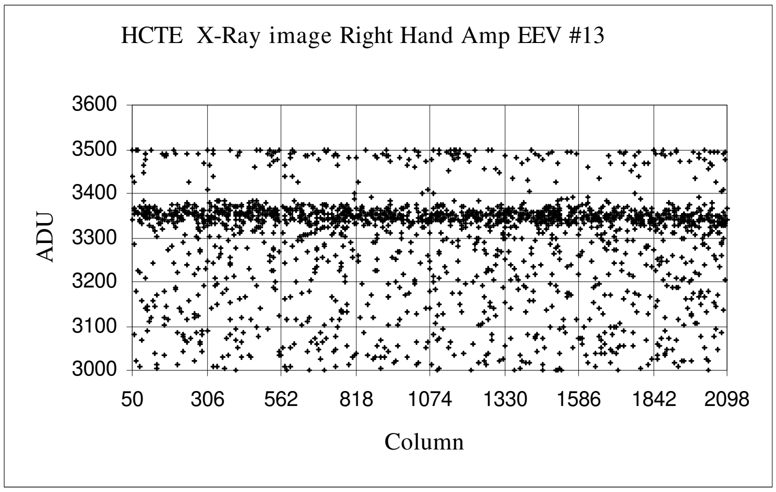
Noise and gain are critically dependent on the operational voltages. In particular the output FET drain and image area clock- low should be set to within 100mV of the voltages recommended in Appendix A.

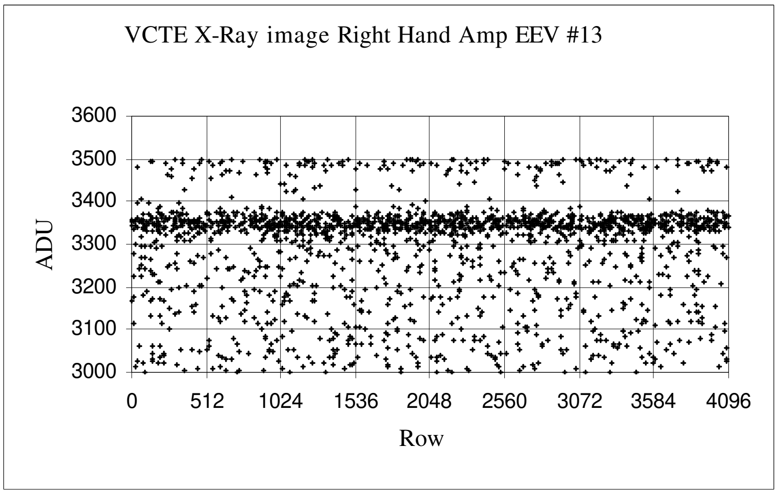
5. Charge Transfer Efficiency

Measured using extended pixel edge response with an exposure of approximately 10,000 electrons. X-ray images were also taken using both outputs when measuring the gain and noise. The X-ray plots derived from these images showed very good low level CTE also, although this was not quantified.

	VCTE	HCTE
Left Output	0.999994	0.9999974

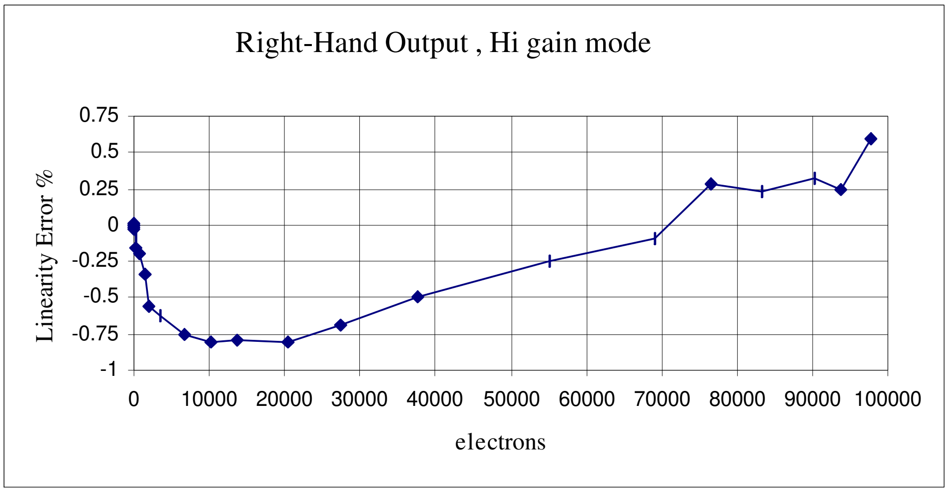
The Fe55 x-ray plots from the left hand amplifier of each chip are shown below.

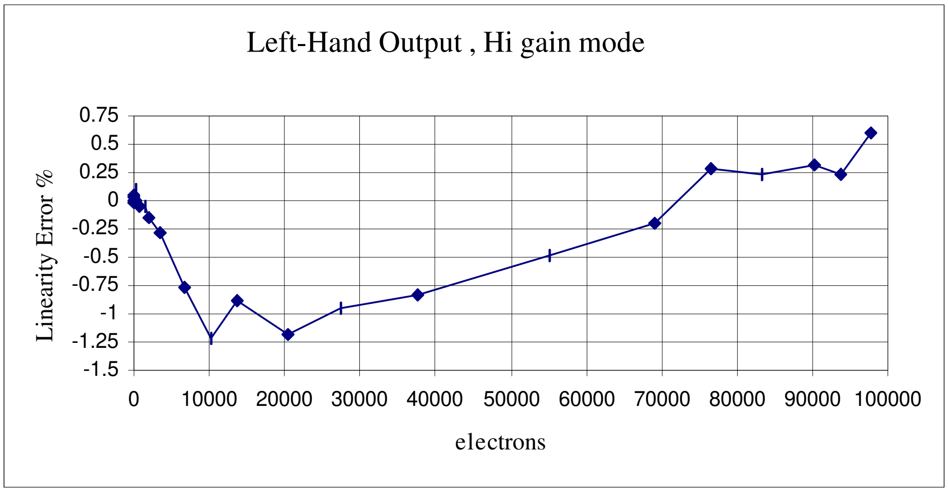


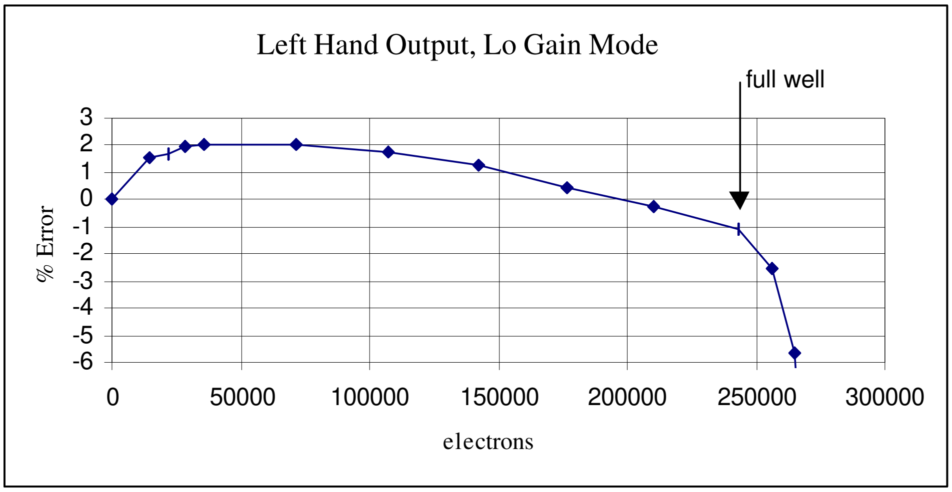


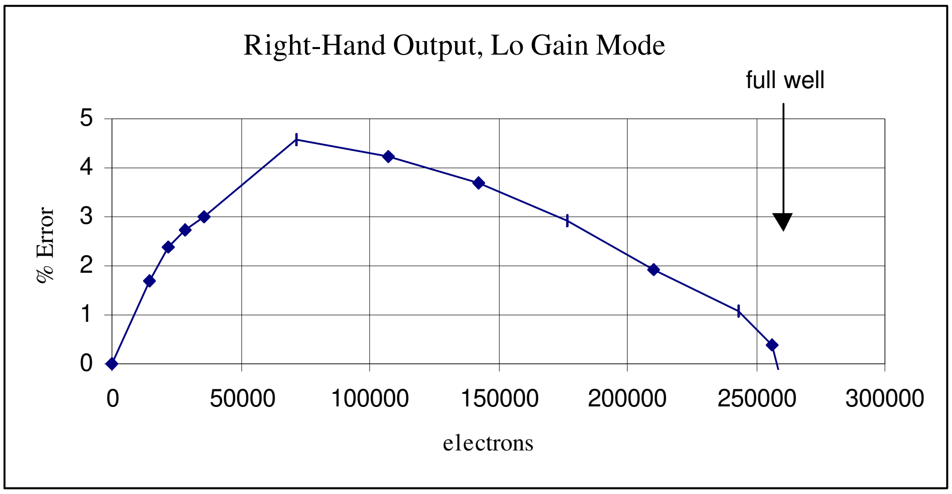
6. Full Well and Linearity

Full well was measured in Lo-gain mode using a pulsed LED source. The point at which the signal became non-linear was coincident with the onset of vertical blooming in the image. The non-linearity associated with the onset of full well had a very 'soft' edge in comparison with other chips. Linearity was excellent from both outputs.



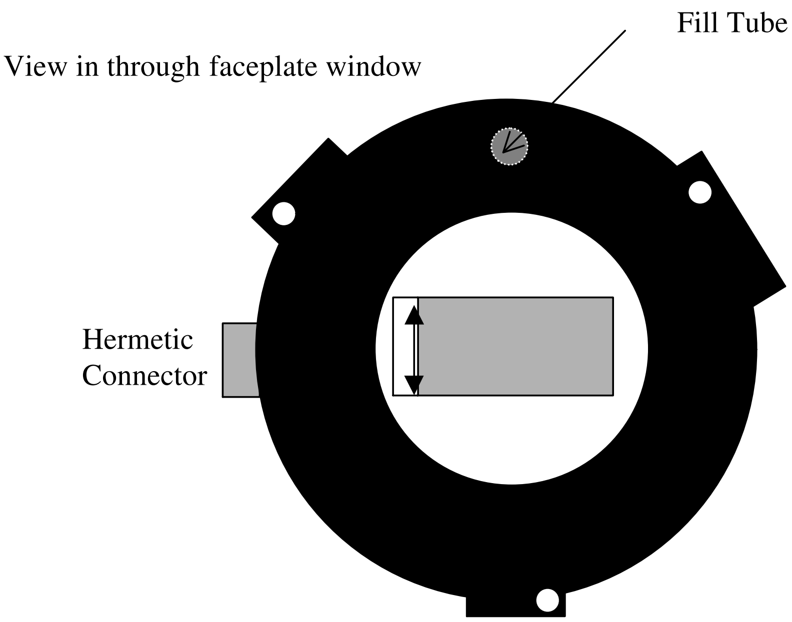



Left Hand Output, Lo Gain Mode
full well
3
2
1
0
-1
-2
-3
-4
-5
-6
% Error
0
50000
100000
150000
200000
250000
300000
electrons

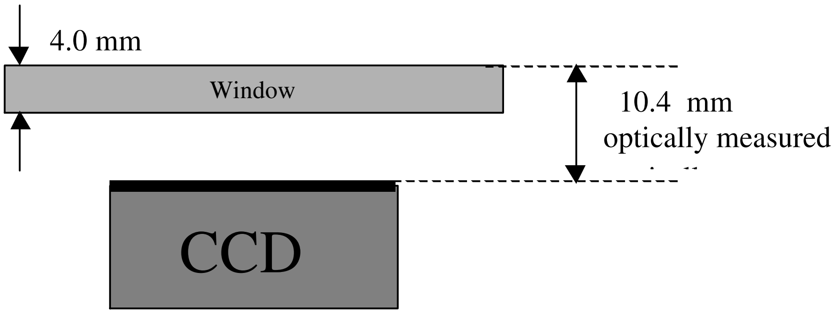

Right-Hand Output, Lo Gain Mode
full well
5
4
3
2
1
0
% Error
0
50000
100000
150000
200000
250000
300000
electrons

7. Mechanical Parameters.

The Camera used a 2.5 l Oxford Instruments blue cryostat. The LN_2 hold time when servoing at -120^{o}C with the cryostat vertical , was19.5 hours. The heater servo power required to maintain this temperature was 600mW.



The cryostat window had a thickness of 4mm. The distance from the front face of the window to the surface of the CCD was measured using a travelling microscope.



Appendix A. Operating Voltages

The operating voltages were measured at the pre-amp using a DVM, they are those recomended by EEV .

Image Area clocks :	Lo	-15.4V
	Hi	-3.4V
Serial Register clocks:	Lo	- 14 V
	Hi	- 4.4V
Substrate:		-6.4V
OG2 Lo-gain		+3V
OG2 Hi-gain		-11.4V
OG1		-12.4V
RD		+2.6V
OD		13.6V
RPhi :	Lo	-12.5V
	Hi	-3.4V
Dump Drain		+7V

The output FET Drain current was set to 2mA.

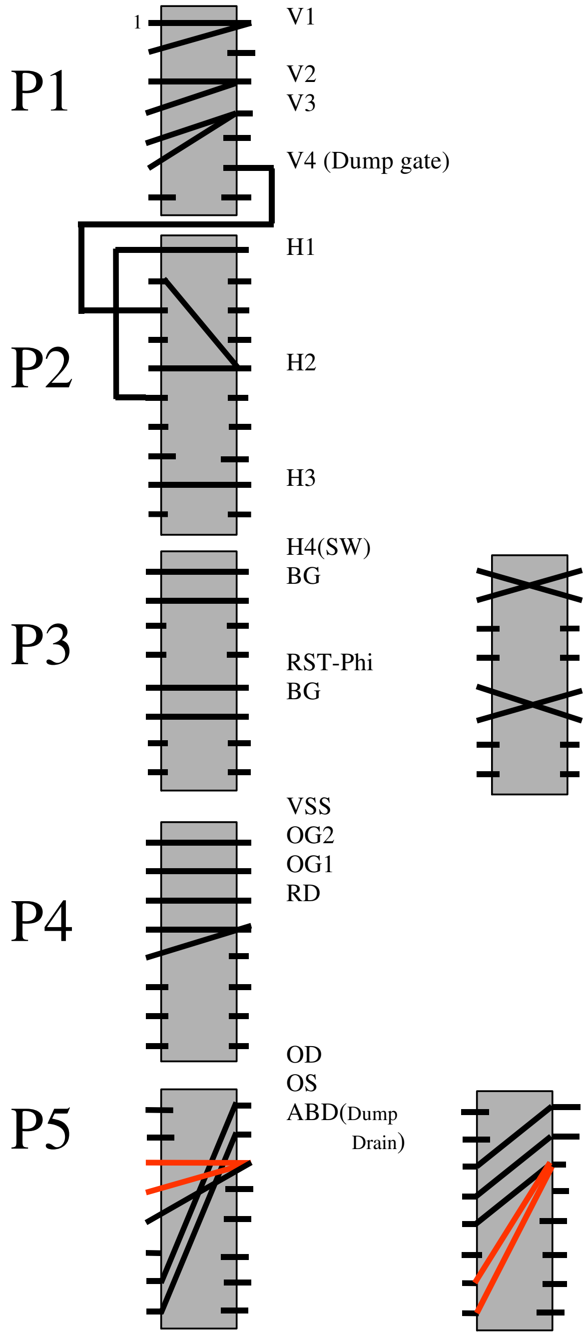
Appendix B. Cryostat Wiring

21 way micro-D	flanged 20-41
1	F
2	j
3	E
4	J
5	G
6	L
7	R
8	N
9	T
10	j
11	S
12	m
13	Y
14	K
15	g
16	M
17	n/c
18	n/c
19	n/c
20	Y
21	m

15 way micro-D	flanged 20-41
1	q
2	C
3	D
4	n/c
5	n/c
6	D
7	V
8	q
9	c
10	a
11	Y
12	Y
13	Y
14	W
15	U

EEV4280 Pre-amp Links

Selected output | Left | Right (where different)



red links denote 100K resistors

Cryostat Temperature Connector

Amphenol 12-10 connector

A Heater +
B Heater -
C LED +
D LED -
E Temp Sense ground
F Temp sense
G Temp sense ref.
H Temp sense +10V

The heater is a 100 Ohm power resistor. The temperature sensor is built into a bridge arrangement inside the cryostat. Its resistance can be measured directly between pins E and F. It is a Pt100 sensor with a coefficient of -0.4046 Ohms per degree C. The internal LEDS have no current limiting resistors, a current of 5mA for about 1s will give a deep exposure.