Testing the readout channels – Is the problem in the controller or the CCD head?

When a problem has been determined to be in one or more quadrants of the detector, and software problems have been ruled out, it is then necessary to determine of the problem is due to malfunctioning hardware in the detector controller or in the detector head. It is possible to do this by taking a few test images in combination with swapping cables between the detector head and controller.

First, set up conditions that show the problem in an image. Some problems may require only that you read out the detector with a short or 0 length exposure, while some problems may require X-ray background or even strong X-ray reflections on the detector in order to demonstrate the problem. I'll refer to this as a demonstration image.

- Take a demonstration image.
- Determine which quadrant has the problem (the quadrants are called A,B,C and D).
- Swap two analog cables at the detector head. The analog cables are the 4 blue cables labeled A,B,C,and D which plug into the ports on the back of the detector head labeled A,B,C, and D. One of the cables to be swapped should be from the bad channel and one from a good channel. **Warning – these are NOT standard single conductor BNC connectors - these are dual conductor, differential cables. Do not rotate the cable nor the inner part of the connector when inserting it or you may break one of the pins!**

  exit ~~turn off~~ software/ turn off controller bel swapping cab
- Take new demonstration image and note the position of the problem quadrant.
  - If the problem has NOT MOVED, then the problem is in the CONTROLLER or in the CABLE.
  - If the problem has MOVED to the other quadrant (with which you swapped the cable), then the problem is in the DETECTOR HEAD.
- If the problem has been found to be in the controller or cable, then it is necessary to determine which is the problem. To do this it will be necessary to repeat the above tests swapping the cable at the controller.
- Reconnect the cables as they were originally
- Take new demonstration image and confirm that the problem quadrant is back where you expect it to be.
- Swap two cables (preferably the same two cables as earlier) at the controller end.
- Take a new demonstration image.
  - If the problem has NOT MOVED (Same as before), then the problem is in the CONTROLLER.
  - If the problem has MOVED, then the problem is in the DETECTOR HEAD or CABLE. Given the result of the first test, which has lead you to do this test, then this means that the problem is in the cable. If the problem is a dead channel, then this may be a reasonable result. Please then inspect the cable for obvious damage. If the problem is noise or a distorted image, then this would be a very unusual result and it would probably be wise to

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repeat the first test, to be sure that the problem is not really in the detector head.

Temporary solution for a malfunctioning readout channel

In the event that 1 or more readout channels is not working properly, it is possible to setup the detector to read from 1 or 2 of the remaining working channels. First determine which readout channel(s) is(are) not working. Then follow the procedure for reconfiguring the detector to read out from a reduced number of channels.

Configuring the marCCD detector for a reduced number of readout channels.

Normally all the 133mm and 165mm marCCD detectors are read out from 4 channels. Sometimes, either for special data acquisition techniques, or for temporarily working around a malfunctioning channel, it is necessary to reconfigure the detector to read out through 1 or 2 channels. This is accomplished through software and cabling changes.

The 4 corners of the detector are referred to as the A, B, C, and D quadrants. As normally displayed in the marccd software, viewing the detector from the source, the A quadrant is the upper left or the image, B is the upper right, C is the lower left, and D is the lower right.

Also, you can go to "Options/ Mode --> Administrator. Password is marccd; Then the "Readout Pattern" will appear.

In the Configure/Detector dialog, there is a field called "Readout Pattern". This controls which channel(s) are read from the detector. This field cannot normally be changed, but can be changed by running the special marccd.dev program.

The quadrants are each assigned a bit in a 4-bit binary field. Bit 0 = A, bit 1 = B, bit 2 = C, bit 3 = D. Expressing this in hexadecimal notation is convenient, giving A=0x1, B=0x2, C=0x4, D=0x8 (where 0x indicates that the number following is a hexadecimal number). To indicate a certain channel or group of channels, these numbers are simply added together. For example, in the normal readout configuration, the detector is read from all 4 channels. The readout pattern to indicate this is A+B+C+D = 0x1 + 0x2 + 0x4 + 0x8 = 0xf (decimal 15 expressed in hexadecimal).

Each of the quadrants is cabled separately between the detector head and the electronics chassis. Some readout configurations may require rearranging the cabling as described below. In each case it is only necessary to assure that the cables for the readout channels in use be connected. The cables for the other channels may remain connected, or not – it does not matter.

Configuring for 1 readout channel.

Configuring for 1 readout channel is easy. To configure for:

- A channel only - simply change the readout pattern to 0x1 and check that the cabling is in the normal configuration, cable port A on the detector head to port A on the electronics chassis.
- B channel only – change readout pattern to 0x2. Cable port B on the detector head to port A on the electronics chassis.
- C channel only – change readout pattern to 0x4. Cable port C on the detector head to port A on the electronics chassis.
- D channel only – change readout pattern to 0x8. Cable port D on the detector head to port A on the electronics chassis.

Configuring for 2 readout channels.

Configuring for 2 readout channels is a little more complicated. The software part is as described above – simply add the numbers corresponding to the two readout channels. For example, to readout from A and B, set the readout pattern to 0x3. The cabling can be a little more complicated. The two channels to be used must be plugged into the first two readout ports on the electronics chassis – in order, lowest channel (alphabetically) to first port. The possibilities are:

- A and B channels– change readout pattern to 0x3. Cable port A (head) to port A (chassis) and port B (head) to port B (chassis).
- A and C channels– change readout pattern to 0x5. Cable port A (head) to port A (chassis) and port C (head) to port B (chassis).
- B and D channels– change readout pattern to 0xa. Cable port B (head) to port A (chassis) and port D (head) to port B (chassis).
- C and D channels– change readout pattern to 0xc. Cable port C (head) to port A (chassis) and port D (head) to port B (chassis).

Note, that for a normal detector, it is not possible to readout from two corners that are opposite from each other (A and D or B and C), although this is possible in some specially configured detectors.

Reconfiguring when the A or B input port is malfunctioning.

You will notice that reading from one port always uses the A input port on the electronics chassis and reading from two ports always requires the A and B input ports. The above procedures will only work if the detector is being reconfigured and the required input ports on the electronic chassis are working properly. In particular, the A (and B) ports must be working. If either the A or B input ports are not working, it is still possible to reconfigure the detector, but it becomes more complicated and requires opening the electronics chassis. The directions for doing this follow, but it is strongly suggested that you contact Mar USA for assistance before attempting this procedure. In particular, opening the controller chassis without permission of Mar USA, may invalidate the warranty or service contract.

When reading from one or two channels, the controller actually reads out, not from the first two physically located cards (labeled A and B externally), but from the cards which have an address jumper set to indicate that they are the first two cards. Therefore, in the case of a malfunctioning #1 or #2card, it is possible to rejumper the cards to configure two working cards to be #1 and #2. To do this, it is necessary to open the controller chassis.

- Switch off the main power switch in the controller cabinet.
- Using the supplied key, remove both side doors of the controller cabinet.
- Using a 5mm Allen key, remove the two M6 screws in the front panel of the controller. (The controller is the upper chassis in the cabinet. It is black with a beige front panel, but older version are all black).
- Slide the chassis as far forward as possible. You may need to cut a cable tie or two on cables in the rear of the cabinet in order to free them enough to allow the chassis to slide forward fully.
- Remove the Phillips head screws from the top of the chassis and remove the top cover. **Be careful – do not drop screws or other hardware into the chassis.**
- You will see a shelf containing 5 printed circuit boards (PCBs). The large PCB is the "controller card" and the 4 identical smaller ones are the "analog cards". Facing the controller from the front (with the cables coming from the side opposite where you are standing), the controller card will be on the right and the analog cards on the left. The right-most analog card (closest to the controller) is normally the #1 card and the left-most card (farthest from the controller card) is normally the #4 card. In the normal configuration, #1 is the A channel, #2 is the B channel, #3 is the C channel and #4 is the D channel and this is the way that the input ports are labeled on the outside of the chassis.
- Determine which card is the bad card. It is probably a good idea to mark it with a piece of tape on the large A/D module on the card. The bad card will be the one corresponding to the bad quadrant determined by your demonstration images.
- Please not the Part Number (printed) and Revision level (hand written) on the bad analog card so that a proper replacement card can be ordered.
- Locate the jumper jacks J1, J2, J3, J4 on the analog cards. This group of pins will be at the end of the card nearest the power connector. You should find that the first card is jumpered at J1, the second at J2, etc.
- If you are following this procedure, then the bad analog card is either #1 or #2. Choose one of the other cards (#3 or #4) to operate in its place and move the jumper on that card to correspond to the jumper on the bad card (#1 or #2). Now move the jumper on the bad card to correspond to the old position of the jumper on the modified good card. It is important that no two cards share the same jumper position. If this happens no signal will come from either card.
- When the rejumpering is finished, you will need to move the positions of the analog signal cables on the back of the controller chassis. You will need to keep two things in mind as you do this – the 1 or 2 good quadrants that you will be using in the CCD (A, B, C, D) and the position and order of the 1 or 2 good analog cards that you will be using. Plug the cable from the FIRST good quadrant (A < B < C < D) into the input corresponding to the #1 analog card (the card now

jumpered at JP1). Plug the cable from the SECOND good quadrant in the input connector on the #2 card (the card now jumpered at JP2). The connections of the remaining analog cables are not important and may be left connected or disconnected as is convenient. Here are two typical examples: Note that in the case if a malfunctioning analog card, usually all the CCD channels are working, so it is easiest to use A and B outputs.

  - Malfunctioning 1st card, working quadrants A,B. Jumpers: 1,2,3,4 → 3,2,1,4; Cables A,B,C,D → C,B,A,D
  - Malfunctioning 2nd card, working quadrants A,B, Jumpers: 1,2,3,4 → 1,3,2,4; Cables A,B,C,D → A,C,B,D

- It is probably wise to test this configuration before closing everything up. Replace the cover on the controller chassis to guard against anything falling into the open chassis. Check that all the cables are connected and power up the controller cabinet. Check that the software has been reconfigured to correspond the to the jumper/cable configuration. Reboot the controller and acquire a new image. Check that this image has the correct geometry (all quadrants present, left is left, up is up)
- When you are confident that the jumpering has been performed correctly, replace the screws in the top of the controller chassis, slide the chassis back into place and replace the two M6 screws in the front of the chassis.

Permanent reconfiguration.

The software reconfiguration will only remain valid until the detector is rebooted. To make the change more permanent so that the detector will reboot into the proper new configuration, it is necessary to edit the `~marccd/configuration/marccd_xxxx` file (where xxxx is the detector serial number). This is a plain text file. Change the following line appropriately to match the changes described above:

```
ccd_readout_configuration          0xf
```

Do NOT change the line

```
ccd_hardware_readout_configuration      0xf
```

Example Configuration Tables for Reconfiguration of marCCD.

Table 1 - Single failed analog card but all CCD quadrants OK

Apparent Failed Quadrant	Failed Analog Card	CCD Quadrants to Be Used	Readout Pattern	Analog Card Jumper Settings	Cabling
A	1	A,B	0x3	Card / Jumper 1 / JP3 or X 2 / JP1 3 / JP2 4 / JP4 or X	Head / Controller A / B B / C C / A or X D / D or X
B	2	A,B	0x3	Card / Jumper 1 / JP1 2 / JP3 or X 3 / JP2 4 / JP4 or X	Head / Controller A / A B / C C / B or X D / D or X
C	3	A,B	0x3	Normal	Normal
D	4	A,B	0x3	Normal	Normal

Table2 – Single failed quadrant in detector head, but all analog cards are OK

Apparent Failed Quadrant	Failed CCD Quadrant	CCD Quadrants to Be Used	Readout Pattern	Analog Card Jumper Settings	Cabling
A	A	C,D	0xc	Normal	Head / Controller A / C or X B / D or X C / A D / B
B	B	C,D	0xc	Normal	Head / Controller A / C or X B / D or X C / A D / B
C	C	A,B	0x3	Normal	Normal
D	D	A,B	0x3	Normal	Normal

X indicates not connected.

Normal Jumper Settings:

Card	Jumper
1	JP1
2	JP2
3	JP3
4	JP4

Normal Cabling:

Head	Controller
A	A
B	B
C	C
D	D