IRSF: Faultfinding SIRIUS Instrument detectors

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1. Introduction: The Sirius instrument on IRSF produces three simultaneous images of a starfield in the K-, H- and J-band respectively. It happens, from time to time, that one of these bands produces garbled images (circled, Fig. 1). This document gives some background and procedures for faultfinding such problems, based on a fault which occurred in November 2015.

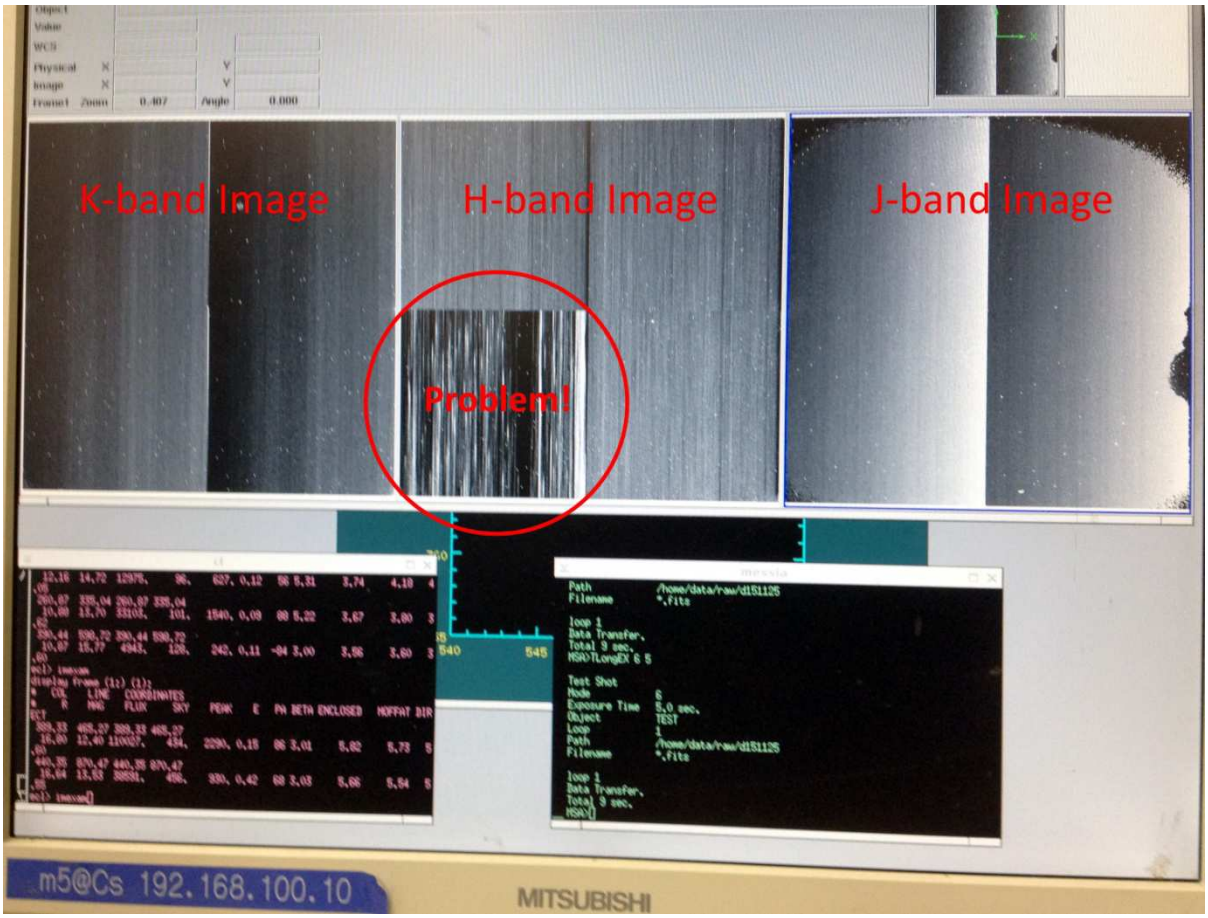

Fig. 1 Screenshot of m5, identifying the respective bands and showing an example of a fault

2. Background Information

Since each band reads out through four amplifiers, a problem with one amplifier shows up as in Fig. 1 above.

In the block diagram below (Fig. 2) it can be seen that the three channels (bands) are all identical. The output of each detector connects to its own ADC-module and each channel is clocked by its own Clock Driver board. This means that faults can be traced by swopping cables between channels and by noticing how this affects the resultant image, deductions can be made whether the fault is inside the cryostat, in the wiring or with any of the modules.

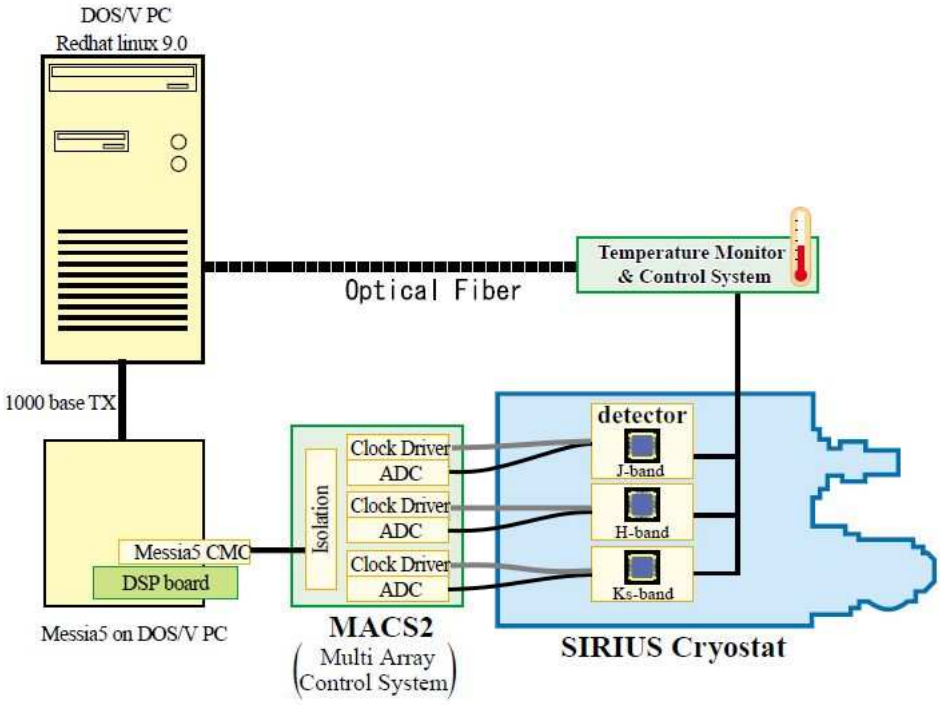

Fig. 2 Block diagram of the SIRIUS instrument

3. Caution - Very Important

1. Always switch off detector power at the two Kenwood PSUs before disconnecting or reconnecting any cables.
2. Static can destroy a detector, so use ESD protection throughout, i.e. always use a conductive wriststrap (Fig. 4) connected to the instrument earth and discharge yourself to the instument potential by touching it with both hands before connecting or disconnecting any cables.
3. When unplugging the connectors on the instrument itself (mil-spec connectors, plugging into the vacuum-wall plugs), terminate the vacuum plugs as soon as possible, using special shorting plugs (Fig. 4).

4. Locating Test Gear

Locate the SIRIUS Toolbox (Fig. 3), kept under the camping table in the control room and identify the relevant items shown in Fig. 4 below.

Fig. 5 identifies the different connectors and boards for the three channels in the SIRIUS instrument itself. Please familiarise yourself with these before doing tests.

Fig. 3 The SIRIUS Toolbox

Fig. 4 The relevant items (from the SIRIUS Toolbox) required for these tests

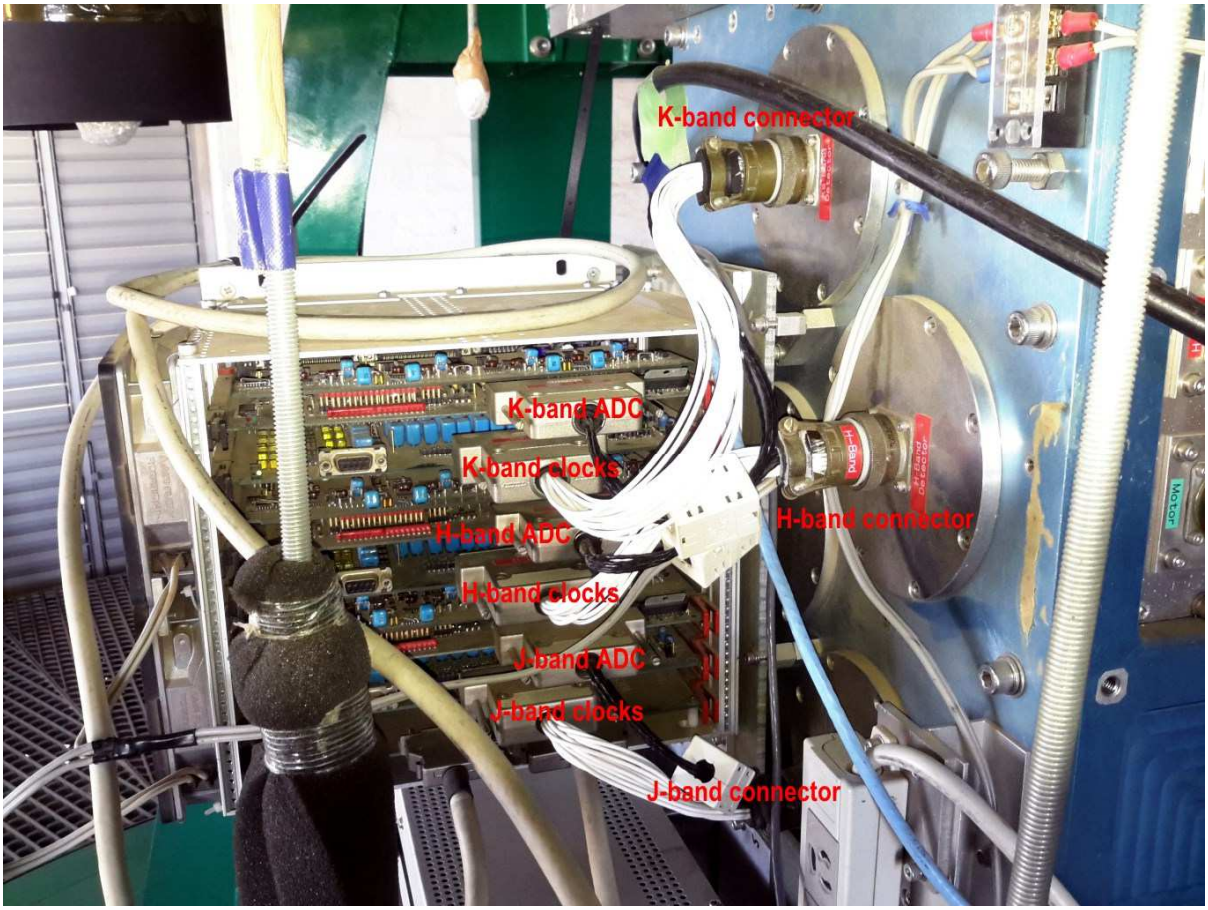

Fig. 5 Identifying the relevant connectors and channels on the SIRIUS instrument

5. Test 1: Try and pinpoint where the fault is located

In November 2015 the He Compressor tripped, causing the instrument to start warming up. This was detected early enough to simply restart the cooling while pumping the vacuum. However, one of the quadrants on the K-band was noisy. Taka suggested the following faultfinding procedure to try and pinpoint where the fault was located:

1. Switch off the detector system [Kenwood] PSUs

2. Swap the H-band cable and Ks-band cables.
   The cables between the detectors and clock driver/ADC cards are compatible. Only the length is different. I suppose the cable length of H-band and Ks-band cables are not so big difference. So, we can swap them.
   If the faulty detector images are also swapped, the cable is problem.

3. Return the cable to the original configuration.

4. Swap the D-Sub connectors for the ADC cards (black wires) between the H-band and Ks-band.

After swapping, the Ks-band detector is now driven by the Ks-band clock driver card but the detector output is amplified and digitized by the H-band detectors, and vice versa for the H-band detector.

If the faulty detector image is also swapped, the Ks-band clock driver has a problem. If the faulty detector image is not swapped, the ADC for the Ks-band has a problem.

I am not sure that the cables are long enough or not for the swapping only the ADC connectors but try to swap.

All work should be done with ESD protection. Please use the wrist strap for ESD (Fig. 4).

The white wires are the clock driver card to the Ks-detector and the black wires are the Ks-detector to the ADC card (Fig. 5).

Do not swap the connectors for the clock driver cards because the voltage setting is slightly different between the H- and Ks-bands. The difference is not so much, and it will be most likely not damage the detectors but I think we should not do it at this stage.

In my view, the suspect order list is
1. Ks-ADC
2. The cable between the detector and ADC
3. Ks-clock driver card

If the cable between clock driver/ ADC cards and the m5 computers, or the circuit in the m5 have a problem, all the detector images should be affected because the data is transferred and processed sequentially for all the JHKs-bands by the same cable and board.

Willie and Carlson did these tests as follows:

Carlson (the resident technician) and I did the cable swop tests you suggested and we found the following.

1) **Test 1: Swopping H- and K-band cable looms:** We found that the cable looms are too short to swop in the instrument, so we swopped both the black and white looms at the D-type connectors. The attached image (see Fig. 1) shows that the fault shifted to the H-band panel, suggesting a faulty cable as you said.

2) **Test 2: Swop only the black cable looms (ADCs swopped):** To do this, after Test 1, we simply swopped the white looms back. The fault remained with the H-band panel (Fig. 1), suggesting the white loom of the K-band could be the fault.

Taka's reply to this was as follows:

Test 1: Yes, this is a clear result. I agree that there is a problem in the Ks-band cable.

Test 2: Although you mention that the problem could be in the white looms, we cannot rule out the possibility that the problem is in the black looms of Ks-band cable because the images displayed in the H-band panel is operated by the Ks-band white and black looms even if we connected the white looms back to the K-band clock driver card.

6. Test 2: Localising the fault position

We must localize the fault position as a next step:

Is it inside or outside the instrument?
If outside, the repair will be easy. However, if inside, it is serious problem and it will be difficult.

To do it, the easiest is that we operate the Ks-band detector using the H-band detector or operate the H-band detector using the Ks-band detector. Since the H-band cable is too short for fully swapping cables, we can do the former as follows:

1. Short Plug (see Fig. 4):
   This is a plug for the ESD protection of detector during the cable is unplugged. Just the instrument side connector with conducting foam. This plug should be attached when the detector cables are unplugged from the instrument.

2. Test cable:
   One side is D-sub 50-pin connector, while another side is D-sub 37-pin connector (see Fig. 4). I suppose only two wires are connected to the 50-pin connector. They are both separated into 4 wires and connected to the 37-pin connector. This cable should be used when we operate the detector readout system without the connection to the detector in order to avoid the open input of ADC card. Please connect this cable to the ADC and clock driver if you operate the readout system without the connection of detector. Then the 5V is connected to the ADC input (see Fig. 6).

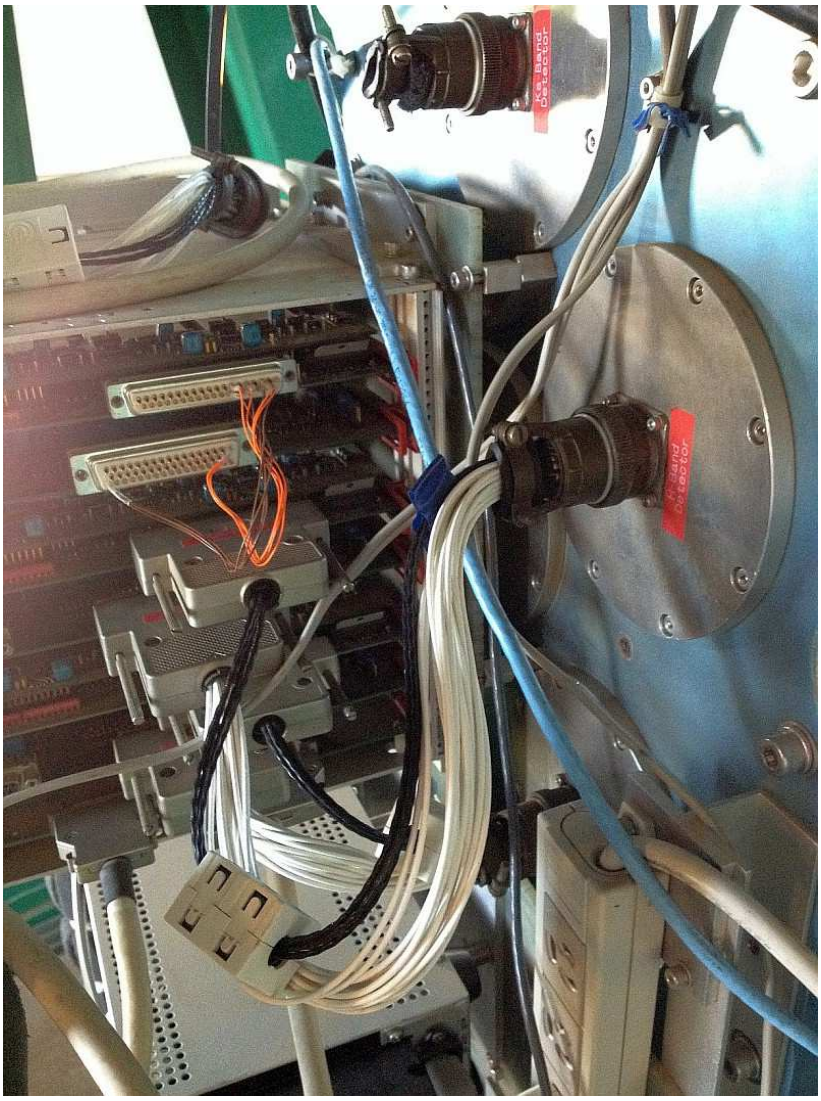

Fig. 6 The connections for doing Taka's 2nd test described above.

After this test, Willie replied as follows:

As can be seen from Fig. 6, the following was done:

1) On the K-band (the faulty channel with the longest cable loom):
   a) Unplugged the vacuum-wall plug and installed ESD-shorting plug.
   b) Removed the loom (the longer one).
   c) Installed the patch/test cable which supplies 5V DC to its ADC.

2) On the H-band:
   a) Removed its loom completely.
   b) Plugged in the longer (suspect) loom.

7. Conclusion

The resulting bias-exposure is shown in Fig. 7. Since the middle (H-band) (now fed by the suspect long loom) is fine, it suggests the long loom is fine and that the fault is inside the dewar.

The fault eventually disappeared after the instrument went through its full warm-up, re-pump and cool-down cycle, proving it actually was “inside”.

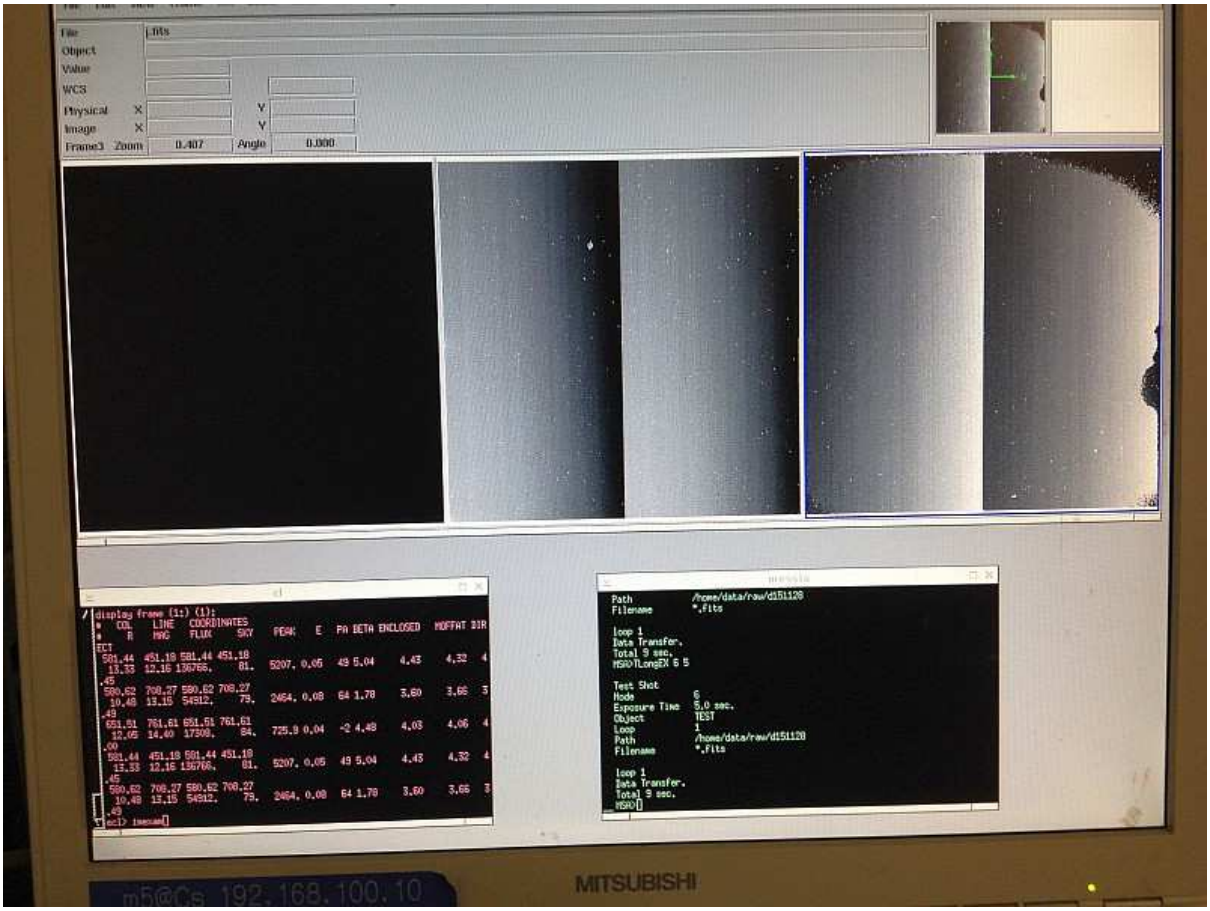

Fig. 7 Resultant image from the 2nd test described above