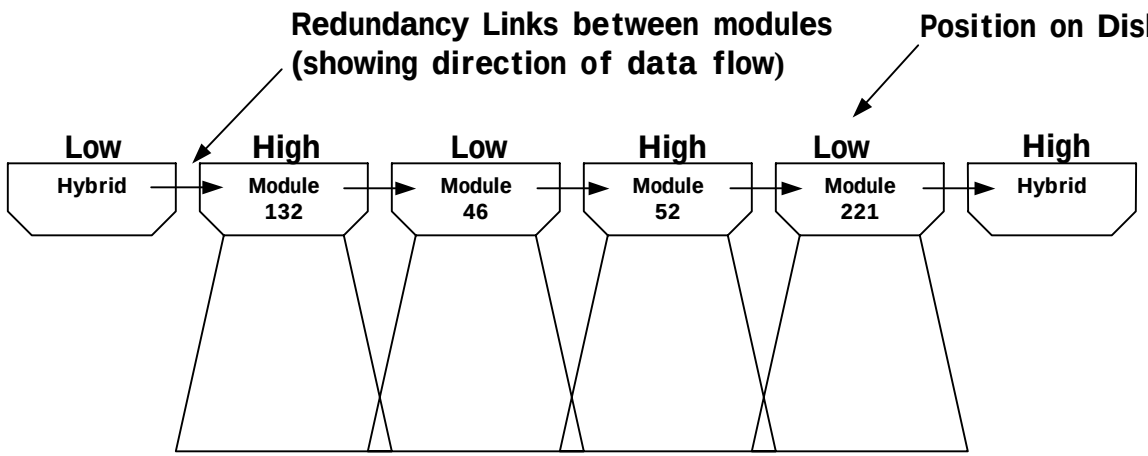
Modules on Disk 9

- All tests have been made using baseline power supplies (LV0 etc. No common-mode filters are used). Readout is either RODDAQ or SCTDAQ and OPTIF.
- All modules have, initially, 5K1 Dgnd return path link on their Redundancy input connector



Module orientation on the Disk

- As a reference the redundancy link between modules was left out. The 4 modules are then characterised. The Input Noise (ENC) from the Noise Occ. per module is then obtained. This is then repeated but this time with the links in.

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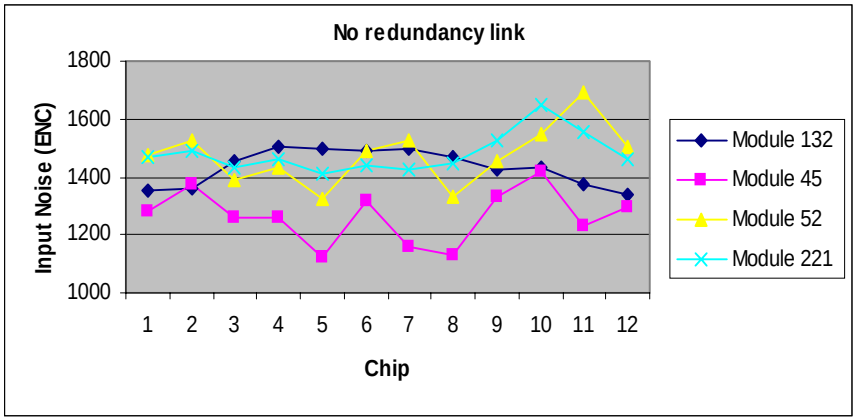
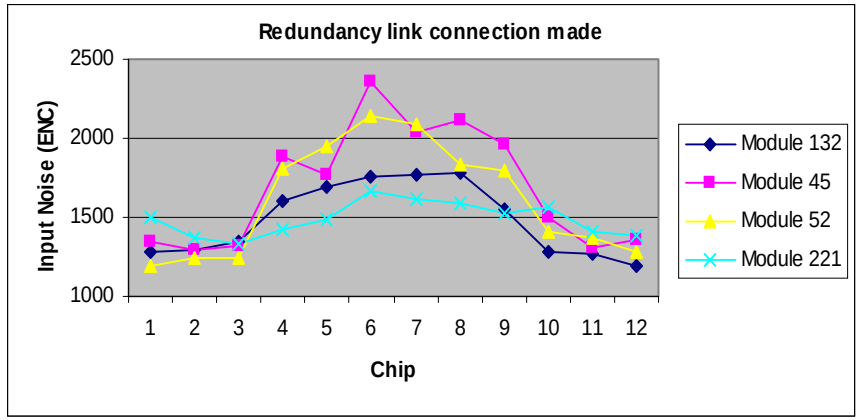
Modules on Disk 9

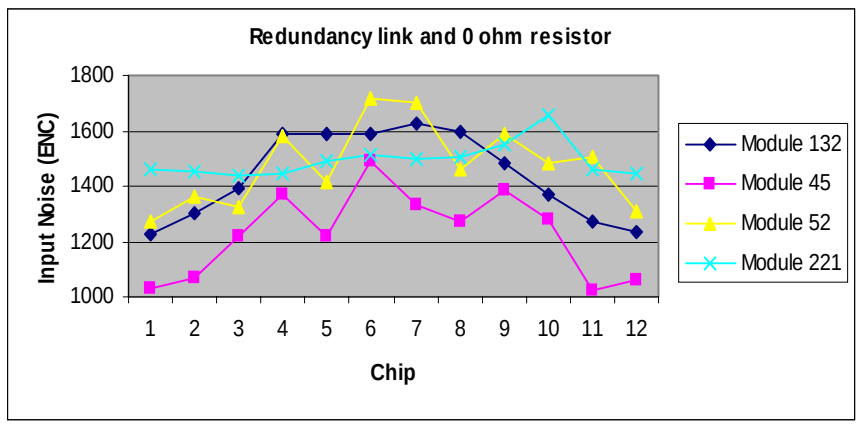


Disk Input Noise with no Redundancy Links



Disk Input Noise with Redundancy Links and 5K1 resistor

- **Extra noise problem could be due to common-mode noise current coupling into the modules via the redundancy link. Reducing the value of the 5K1 resistor to 0 ohms, in the Redundancy Dgnd return path, should force this current to flow back to its source along a shorter route. Thereby reducing the loop inductance and hence minimise any noise injection between the modules**



Disk Input Noise with Redundancy Links and 0 ohm resistor

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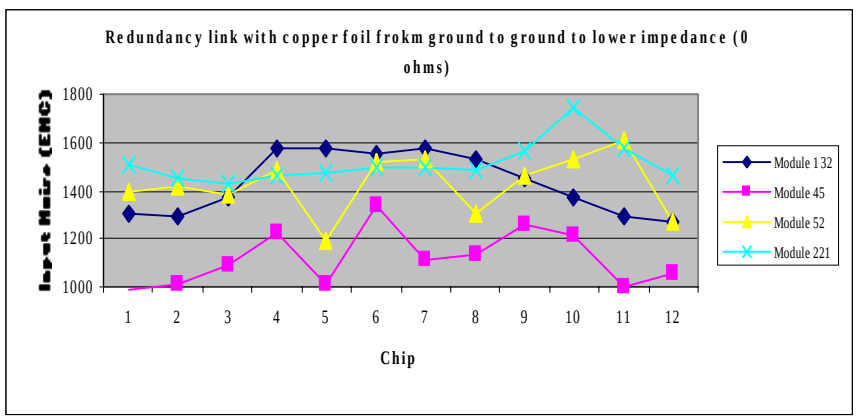
Modules on Disk 9

Thus:

- **Modules on the Disk without the Redundancy Links in show flat(ish) noise profile.**
- **Once the Redundancy Links are present, but not used, extra noise is seen on Chips 4,5,6 and 7,8,9 i.e. those chips adjacent to the Redundancy input connector.**
- **Reducing the 5K1 resistor to 0 ohms dramatically reduces the extra noise seen.**

But, even with changing the 5K1 to 0 ohms the modules never fully recover back to their original state when the links where not in place. It could be that there is still a residual impedance in the return path which is causing common-mode noise injection into the modules. The Redundancy link was further enhanced by wrapping a Cu foil around it. This should present the shortest route possible for any common-mode switching currents to return and means that the loop area is further minimised.



Disk Input Noise with Redundancy Links (0 ohm resistor and 'shield' added to link)

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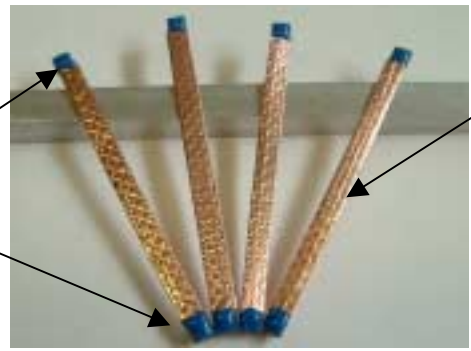
Modules on Disk 9

The following strategy is then adopted:

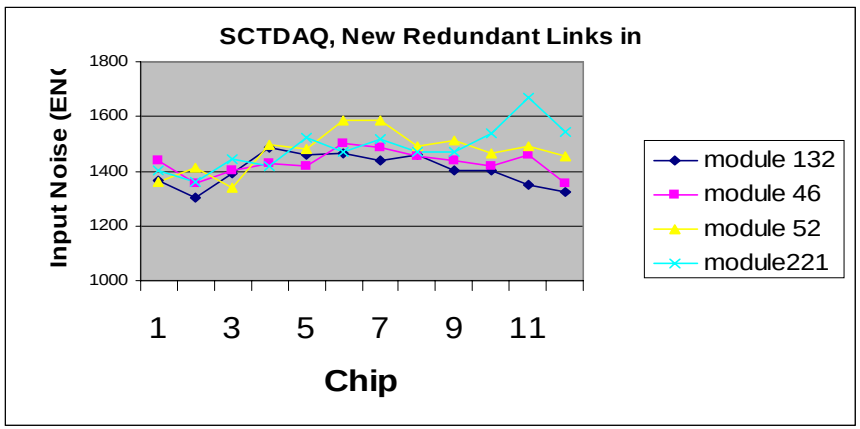
- **The 5K1 resistors on modules are replaced with a 0 ohm link.**
- **Existing Redundancy Links to be modified such that they have a shield added:**

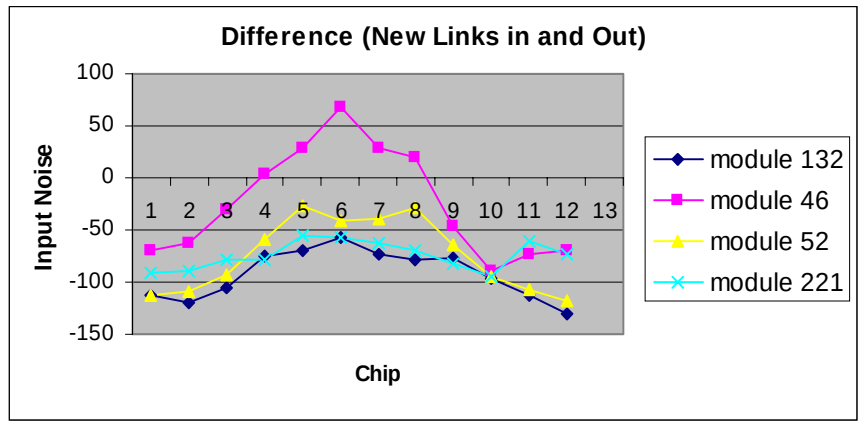
Samtec connectors



Cu shield wrapped around link

(connected to Dgnd at each connector end)





The above plots still show increasing noise in those chips adjacent to the redundancy connectors when the links between modules are in, (at the level of approx. +/-100e ENC).

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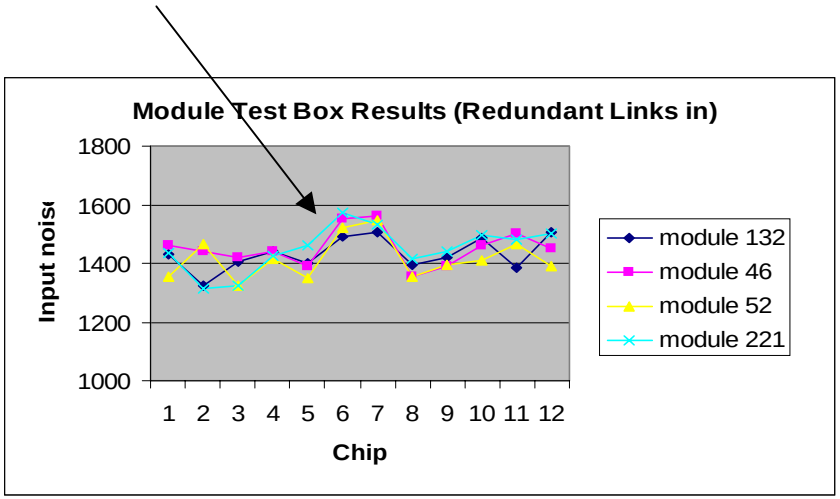
Modules on Disk 9

- As a reference, comparing the results with those from test boxes:

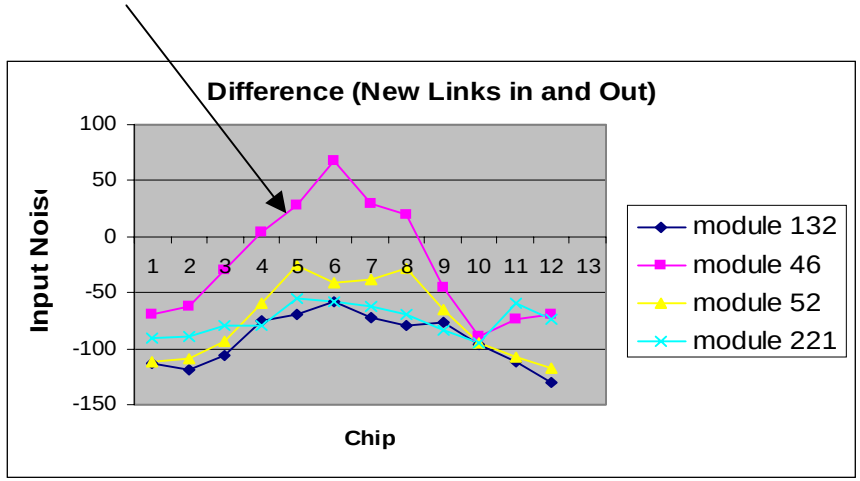
Excess noise is seen only on chips 6 & 7



Test-box Input Noise with Redundancy Links

(5K1 resistor is present on these modules)

Noise increases across chips 4,5,6,7,8 & 9(?)



Disk Input Noise (difference)

- Results for test boxes only exist for Redundancy Links in, but the plot above shows the Input Noise increasing (only?) on chips 6 & 7.

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Recent Results from Disk 9

Comparing the Noise Occupancy values for modules on the Disk (with and without their Redundancy Links in)

Module	Noise Occ. (Links-out)	Noise Occ. (Link-in)
M_O_132	2.87E-05/2.07E-05	1.10E-05/7.90E-05
M_O_046	1.09E-05/1.74E-05	1.10E-05/1.25E-05
M_O_052	3.50E-05/4.69E-05	2.17E-05/2.57E-05
M_O_221	2.40E-05/7.52E-05	1.15E-05/4.16E-05
M_O_046		2.26E-05/2.39E-05

Modules in RED are overlapped both sides, whilst that in Blue is for single operation (retaining the links), results shown are for both Link0 and Link1

With the 'new' shielded links in place the module(s) performance show:

- Improved Noise Occupancy (except for 1 Link).
- Input noise 'nearly' recovers BUT is still asymmetric with increasing noise towards one side of the module.

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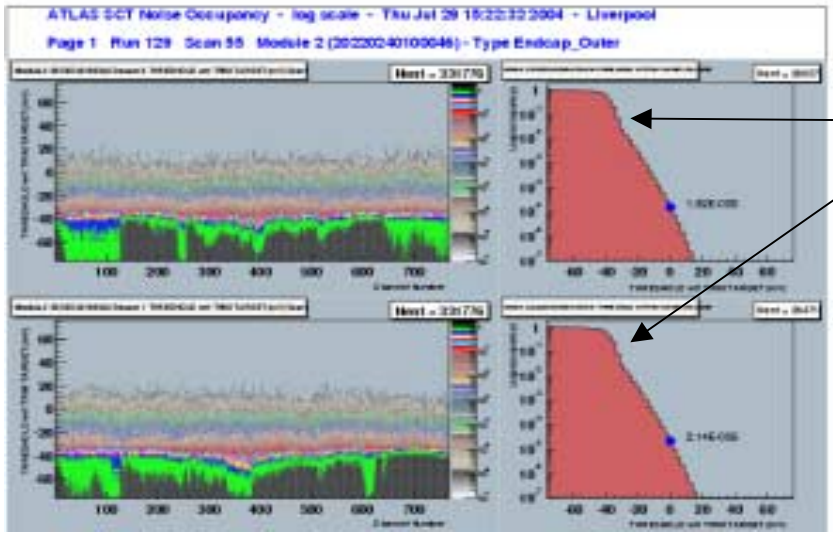
Modules on Disk 9

• So we are nearly able to recover the modules operation with the links in, except that we are also seeing the following:

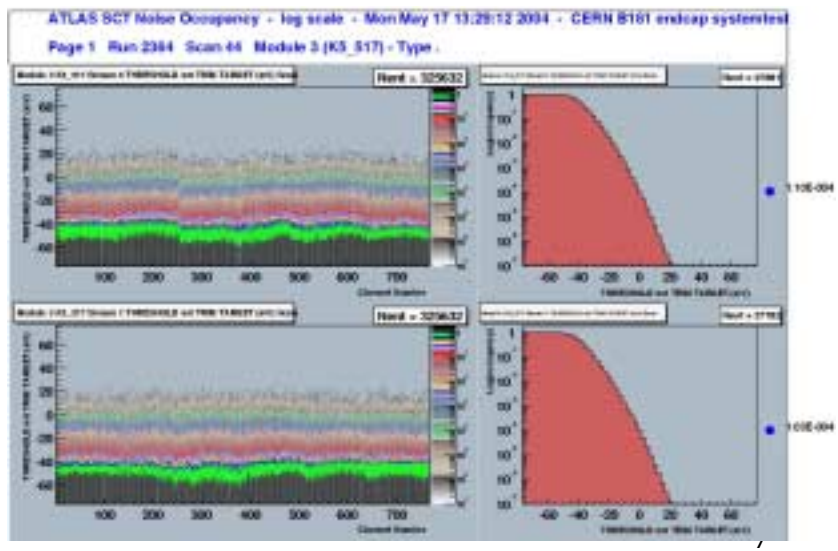


Noise Occ. Scan with no Redundancy Links

• Discontinuities are seen on modules on the Disk.

• It is occurring at ~0.24fC

• It is <u>independent</u> of trigger rate, optical power or whether the Redundancy Links are in or not.



• Compared with the SystemTest results where there is little evidence of any discontinuity.

• Threshold scan is also more uniform.

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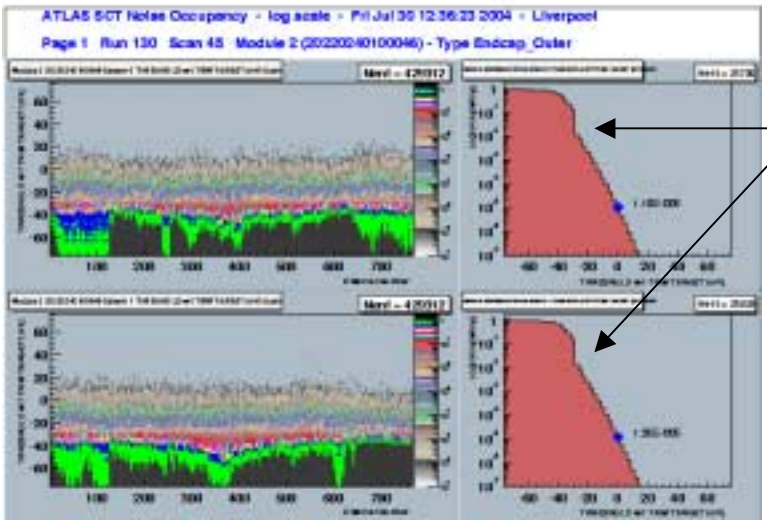
Modules on Disk 9

- Furthermore, to complicate matters, using the 'new' shielded Redundancy Links increases the magnitude of the discontinuity:



Discontinuities occur at same threshold but now appear to have increased in magnitude

- The discontinuity has little impact upon the absolute value of Noise Occupancy.
- It is independent of module position on the Disk.
- Maybe we can afford to ignore these discontinuities as they occur at such low threshold?

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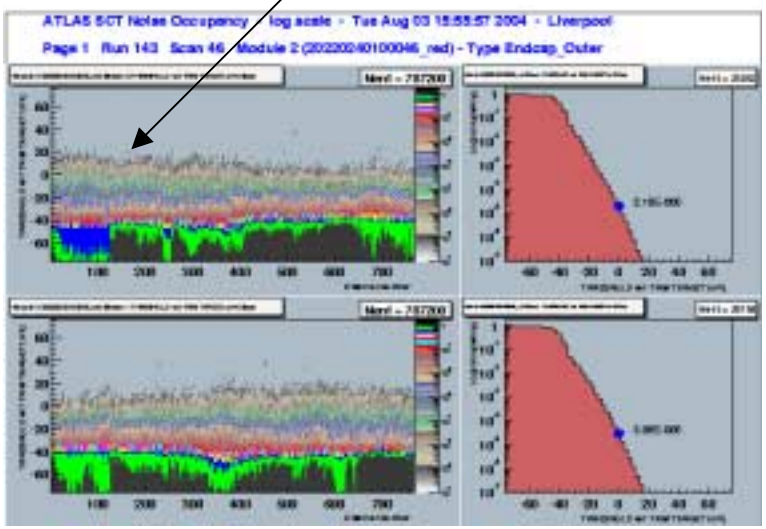
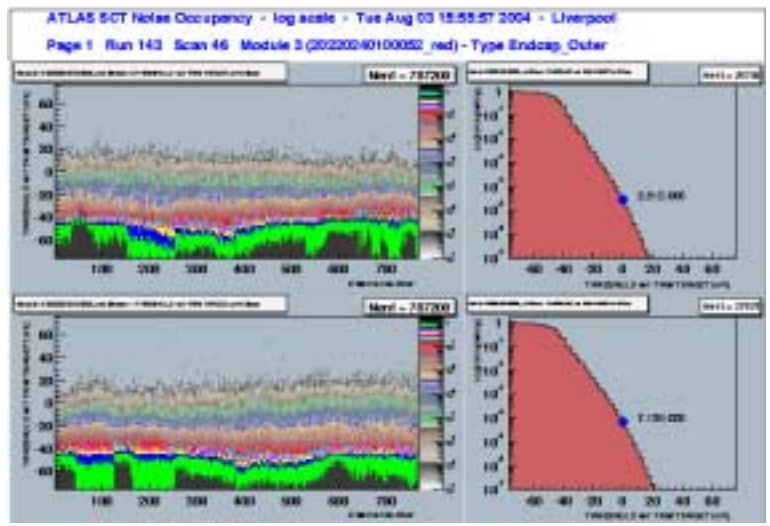
Modules on Disk 9

- As a final test we then check if the Redundancy Links between modules actually work.
- The link between modules 46 and 52 is tested i.e. Select is set to 1 on module 52, this means that module 46 is required to source CLK1/COM1.

Increasing occupancy





Module 46 (Sources CLK1/COM1) → Module 52 (Receives CLK1/COM1)

- Module 46 appears to show increased occupancy in those chips adjacent to its Redundancy Output connector. Otherwise the modules do appear to operate correctly when their Redundant Links are used.

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Modules on Disk 9

To summarise

- **If the Redundancy Links are to be retained then it is necessary for:**
  - **All modules have a 0 Ohms link at their redundancy input.**
  - **Use Cu shielded links between modules.**

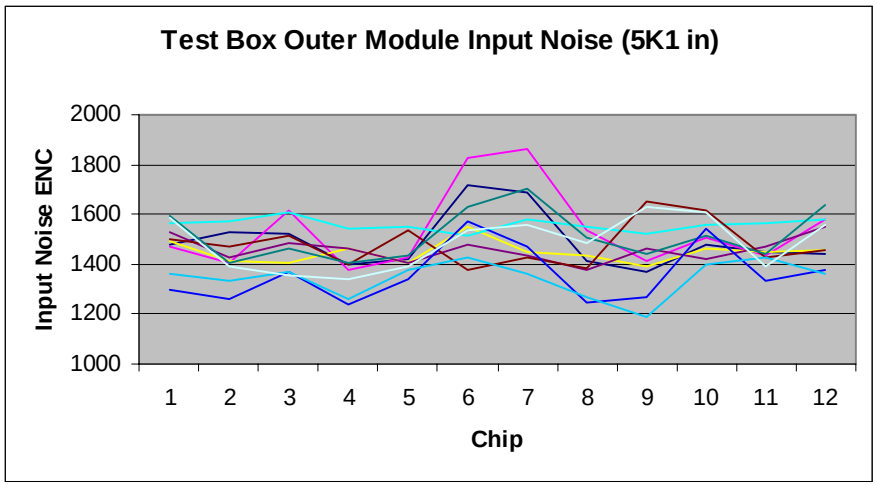
- **The calculated ENC from the Noise Occ. Scans still show increasing noise in those chips adjacent to the redundancy connectors when the links between modules are in.**
- **With the links in there is approx. +/-100e ENC extra noise.**
- **The absolute value of Noise Occ. Does not change dramatically whether the links are in or not.**
- **The Links also appear to work with little impact upon the modules performance.**

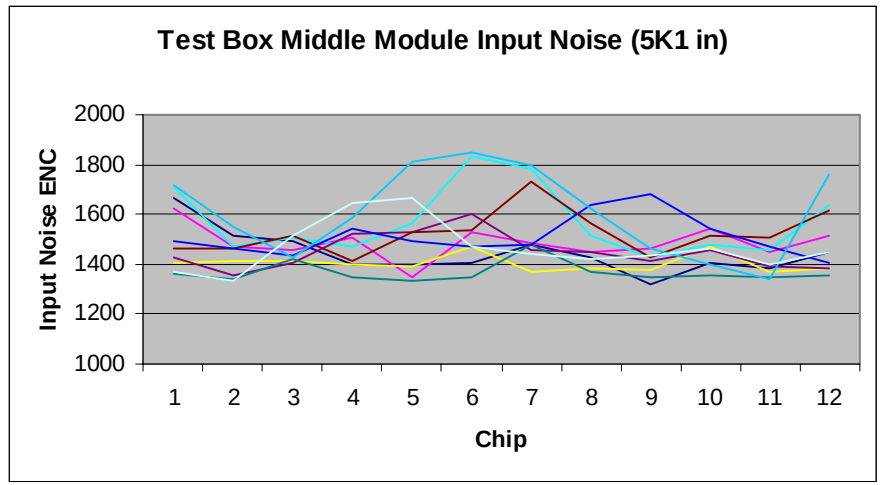
Furthermore

- **A discontinuity can clearly be seen, at low threshold, on the Noise Occ. Scan with or without the Redundancy Links in.**
- **It is independent of the trigger rate or the optical power used for Tx and Rx of data.**

New Results (05.08.04)

Module Test Box Results





- **The results above are for 10 modules of types Outer and Middle.**
- **The modules are tested such that their Redundancy Links are always connected.**
- **Some, but not all, Outer modules show a trend of having extra noise adjacent to their Redundancy Input connector. Not so obvious for the Middles.**

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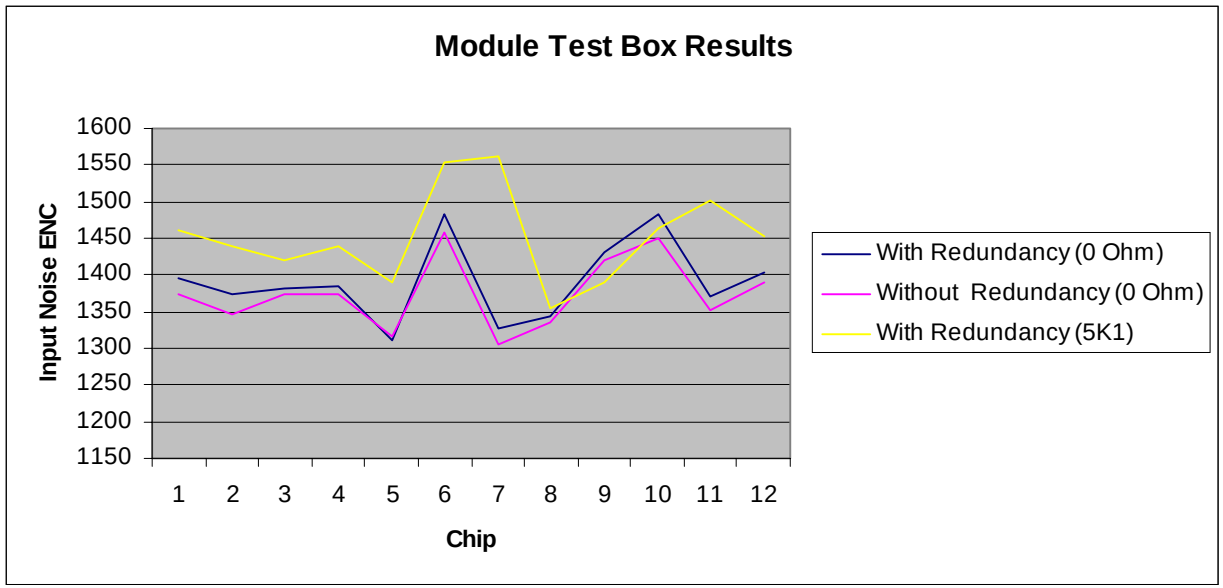
New Results (05.08.04)

Module Test Box Results (cont'd)

- Comparing test box results for a module with 5K1 resistor and then 0 Ohms:



- With the Redundancy connection made, the 5K1 results show higher input noise.
- Whereas with the 0 Ohms link, there is a small increase in the input noise (~30e) when the Redundancy connections are made.
- Changing to 0 Ohms clearly makes the module more electrically robust and reduces the input noise.

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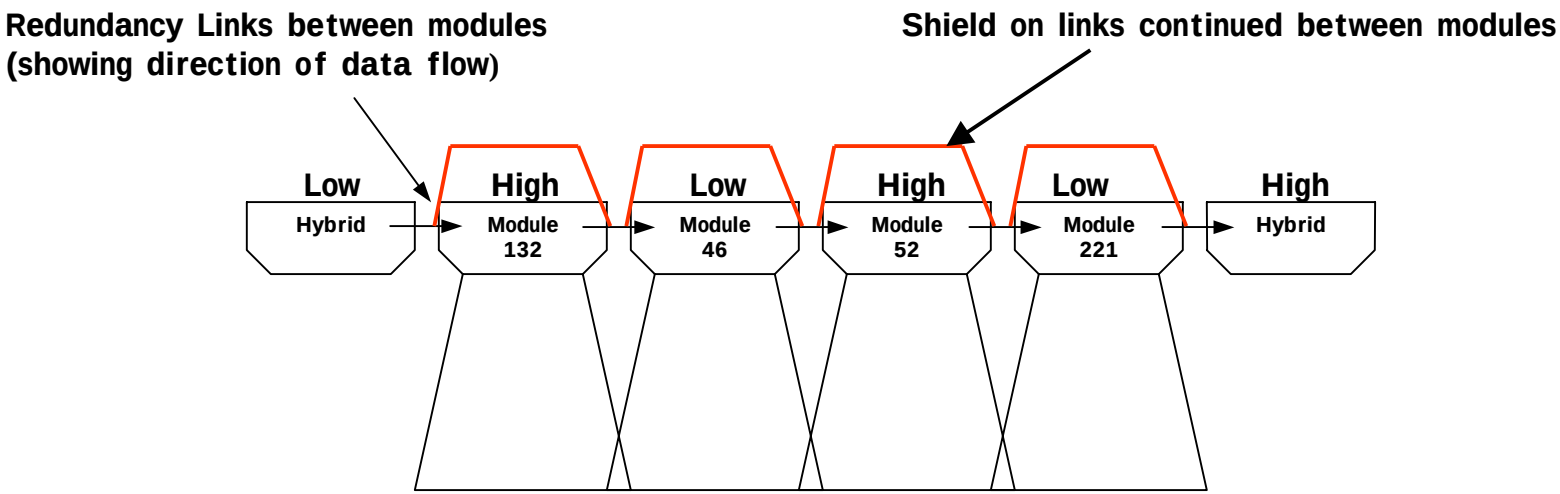
Modules on Disk 9

New Disk Results

- Using the 'new' shielded links, we now continue the shield from link-to-link, see below:



- By continuing the shield between the modules one is effectively improving the inter-module ground connection.
- The modules are readout such that Module 52 has Select set to 1, all other modules have Select set to 0.

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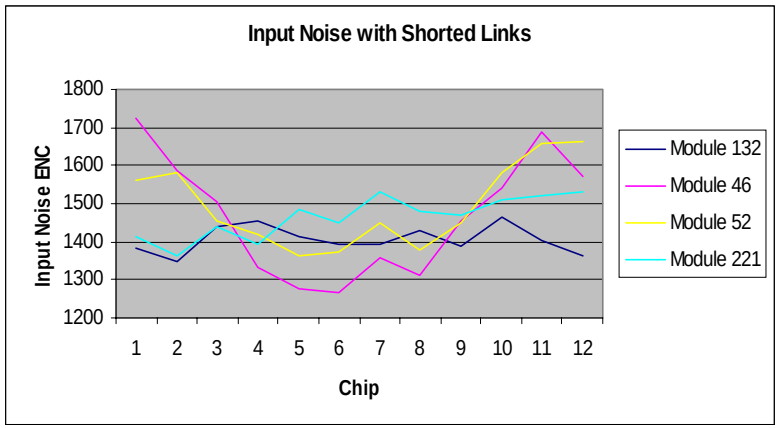
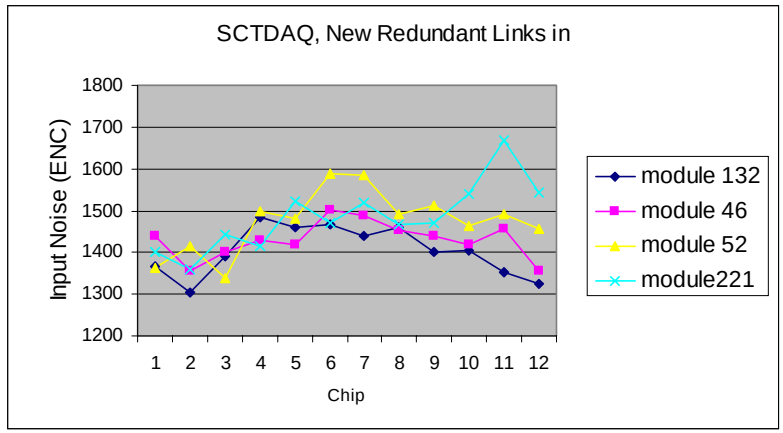
New Results (05.08.04)

New Disk Results (cont'd)

We now observe the following:



Whereas with just the shielded links in:



- **The noise profile appears to have inverted!**
- **Module 46, which sources CLK1/COM1, shows increased noise adjacent to its output connector – as one might expect(?).**
- **But Module 52 also shows similar increased noise profile – not obvious why.**
- **Module 132 shows uniform noise distribution BUT Module 221 shows increasing noise on the underside.**

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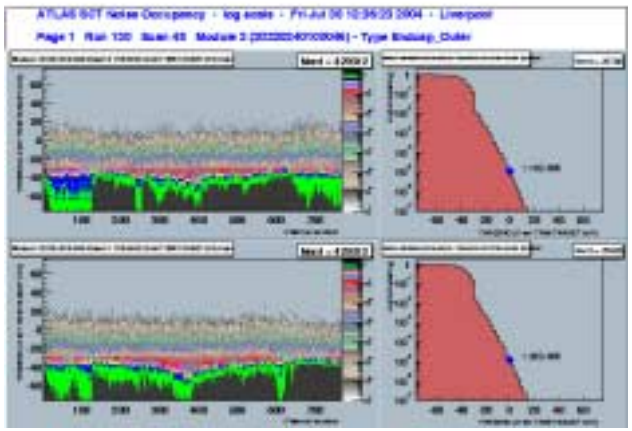
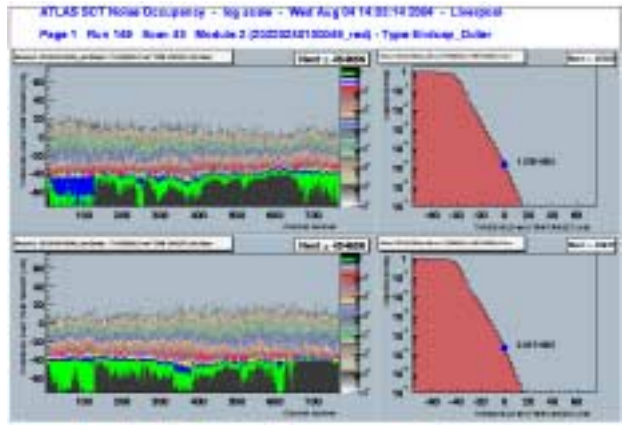
New Results (05.08.04)

New Disk Results (cont'd)

- We also see reduced discontinuity on the noise occ. plots



With shielded links in



With shielded links in, but now the shields continue between modules

Module	Noise Occ. (Links-in)	Noise Occ. (Shields shorted)
M_O_132	1.10E-05/7.90E-05	9.66E-06/8.44E-06
M_O_046	1.10E-05/1.25E-05	1.53E-05/2.21E-05
M_O_052	2.17E-05/2.57E-05	1.55E-05/4.88E-05
M_O_221	1.15E-05/4.16E-05	1.09E-05/5.28E-05

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Modules on Disk 9

To conclude

- **The test box results clearly show that it is beneficial to change the 5K1 resistor to 0 Ohms, if one wishes to retain the redundant links.**
- **Test box results also indicate that Outer modules might be more sensitive to the use of the redundant links.**

- **Continuing the Redundant Link shield between modules appears to improve the module stability BUT has little impact upon the absolute value of Noise Occupancy.**
- **Extending the shield also appears to have changed the Noise profile – not obvious why.**