Modules Operating at Cold Temperature

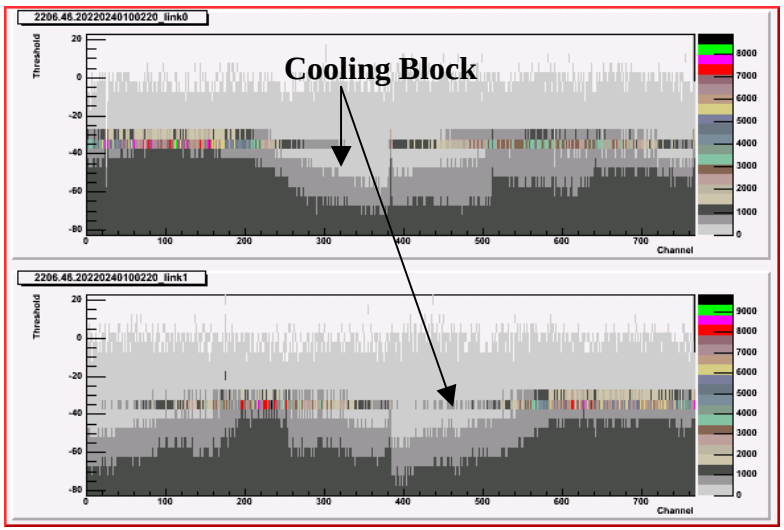
Disk 9 now fully populated with 52 Outers:

- **Confirmation Tests indicate nothing untoward**

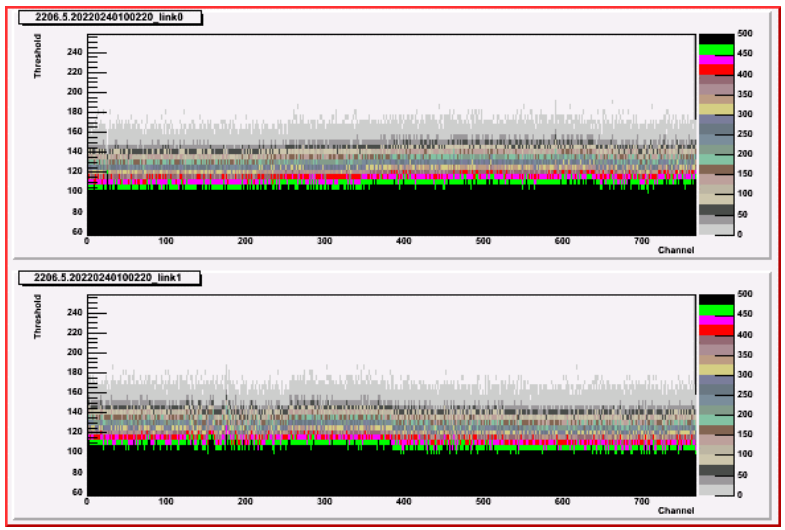
BUT

- **After Characterisation, the Noise Occupancy plots are still not ideal, see diagram below.**
- **Initially thought that the noise structure, especially around the cooling block, was due to the disk and its associated grounding.**
- **Although threshold scan at 1fC appears ok.**

Typical Noise Occupancy



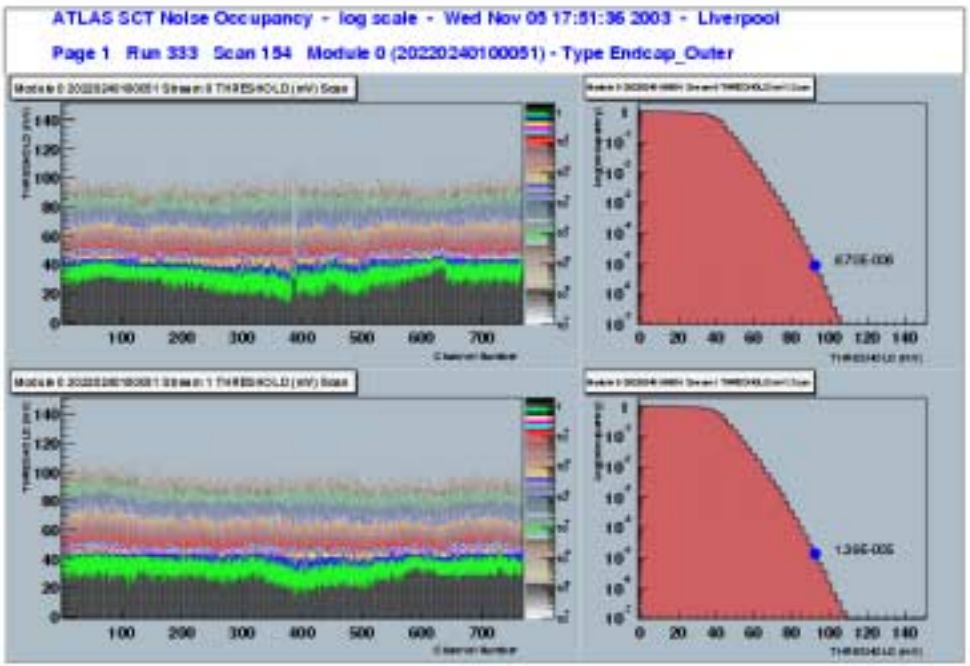
Threshold Scan (1fC Qinj)



Modules Operating at Cold Temperature

- **Comparing with results from a test box. Hybrid thermistor temperature is +10C. The modules on disk 9 are typically operating with a thermistor temperature of –3C.**

- **Scurves fall off more uniformly – though there is still evidence of structure within those chips adjacent to the cooling block.**

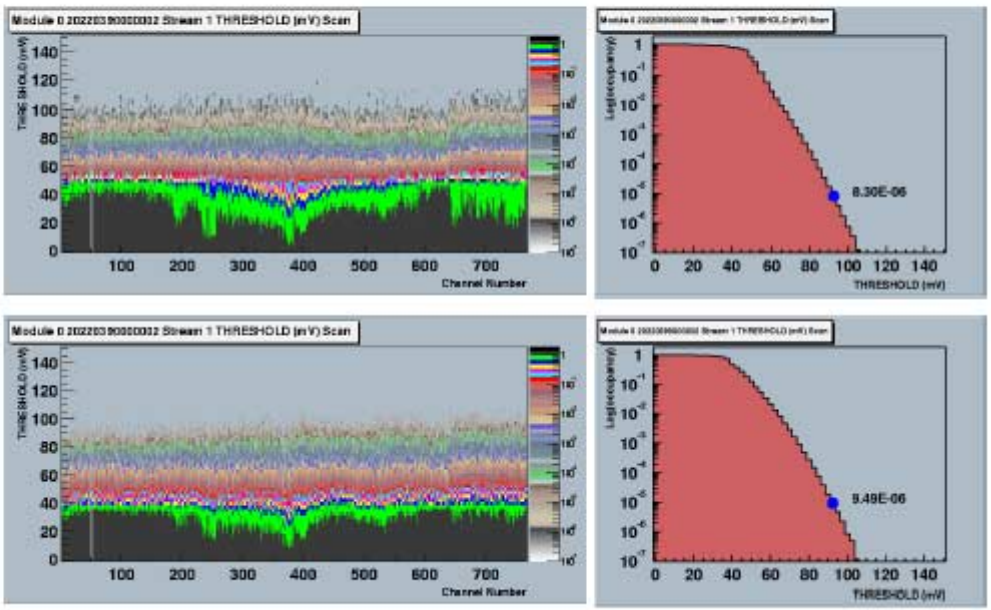


Modules Operating at Cold Temperature

- **Structure around the cooling block has been seen before – See presentation given by Carlos Lacasta (S-curve Discussion, SCT Week Septmber 2003).**
- **Indicated that there appeared to be a temperature dependency, see below:**

Temperature…

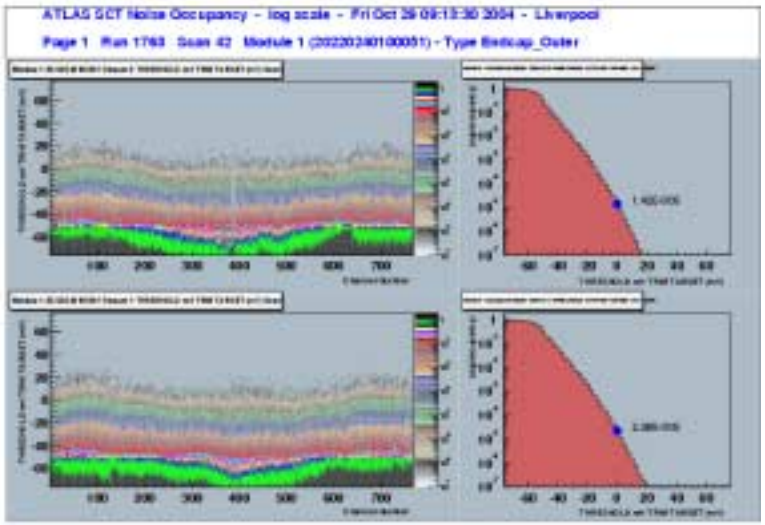
- Structure around cooling block
  - Same module, different temperatures
    - Top: 10°C
    - Bottom: 30°C
  - Distortion still there but at a smaller threshold. CB structure less pronounced
  - No change in noise occupancy @1fC



Modules Operating at Cold Temperature

- **As a crosscheck a module was then tested, within a test box, at a temperature similar to that on the disk**

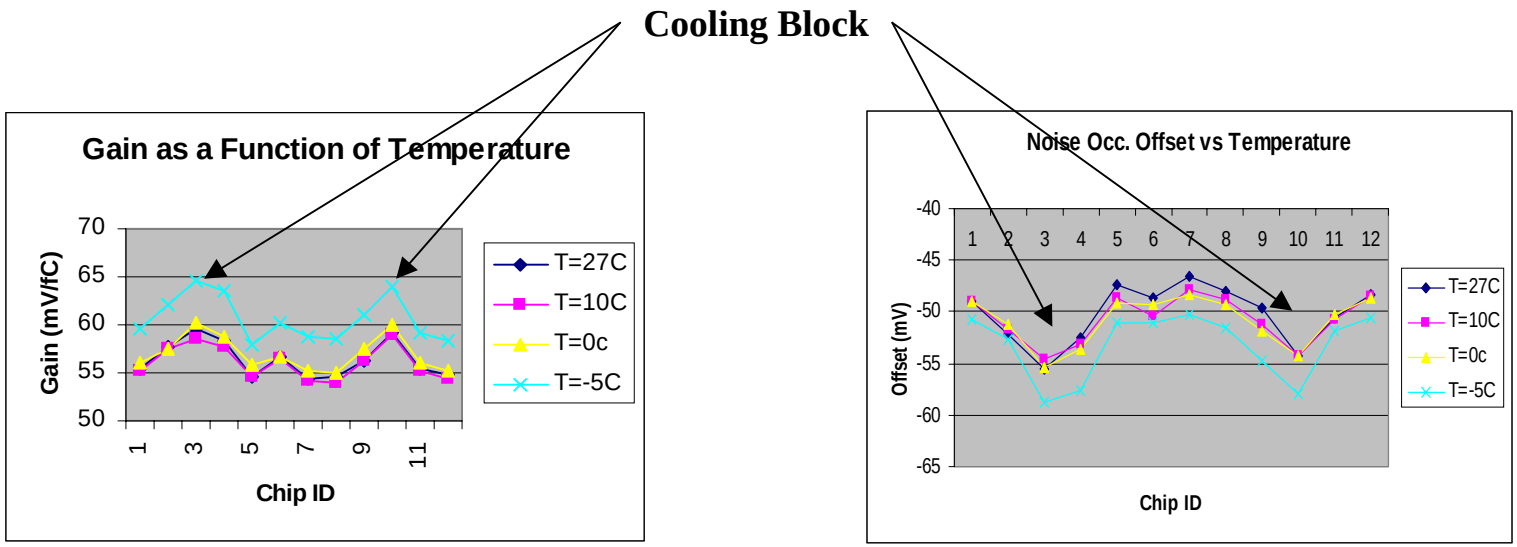
Thermistor Temperature –5C



- **Noise Occupancy scan at low temperature clearly shows an increased negative offset – which appears more pronounced around the cooling block area.**
- **Clearly the trend is similar to that which is seen for modules mounted on the disk operating at low temperature.**
- **Points to evidence that the problem is not a grounding issue BUT is related to temperature.**

Modules Operating at Cold Temperature

- **Looking in detail to what is happening, for a module operating at different thermistor temperatures (within a test box):**

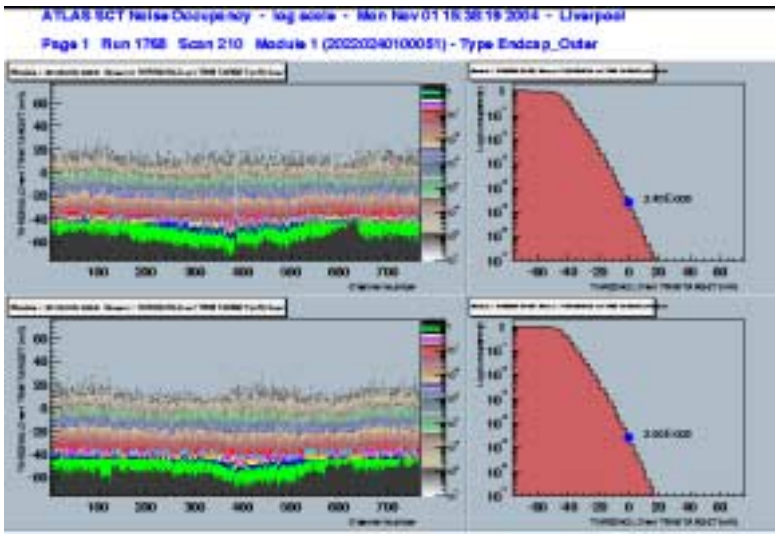


- **The Gain remains constant until 0C.**
- **Below 0C, the Gain increases non-linear. For those chips that are coldest i.e. adjacent to the cooling block, the change in Gain becomes more dramatic.**
- **Even though the module is trimmed, there is an increase in the offset for those chips operating at lower temperature. This becomes more pronounced below 0C – it is this affect which is being seen on the Noise Occupancy Scans.**

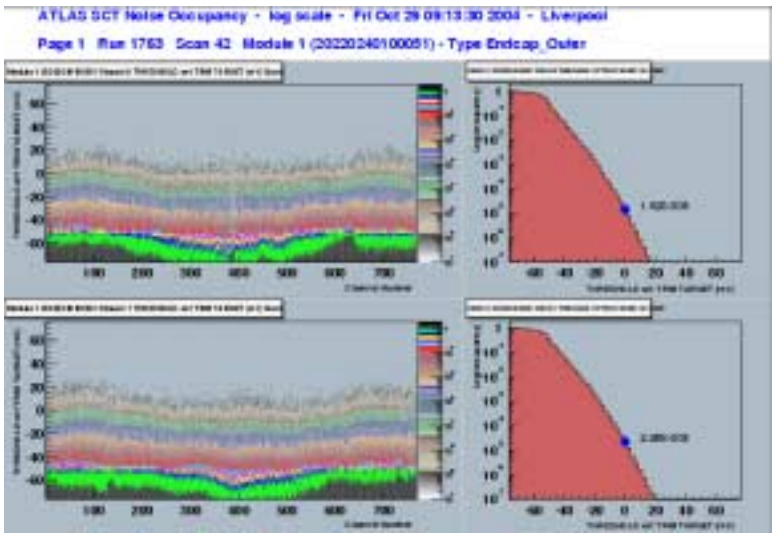
Modules Operating at Cold Temperature

- **Indicates that ABCD operation below 0C is becoming non-linear.**
- **Could be due to the ABCD Front-end settings being incorrect for low temperature. These are presently set to their nominal values of 30uA and 220uA for the Shaper and Pre-bias respectively.**
- **<u>It should be noted that the ABCD3T Specification Version 1.2 indicates that the nominal Shaper current should be 20uA.</u>**
- **So, quickly changing to 20uA shaper current, results in the following Noise Occupancy plot:**

<u>Thermistor Temperature -5C, 20uA Shaper</u>

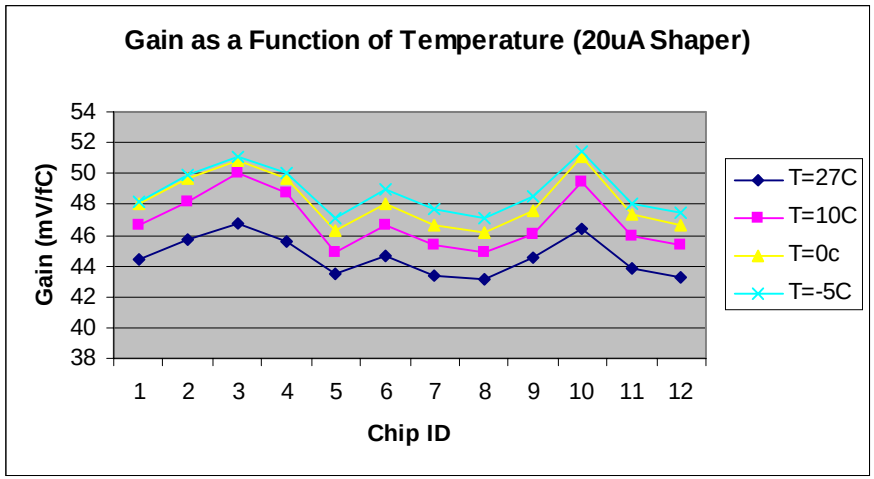


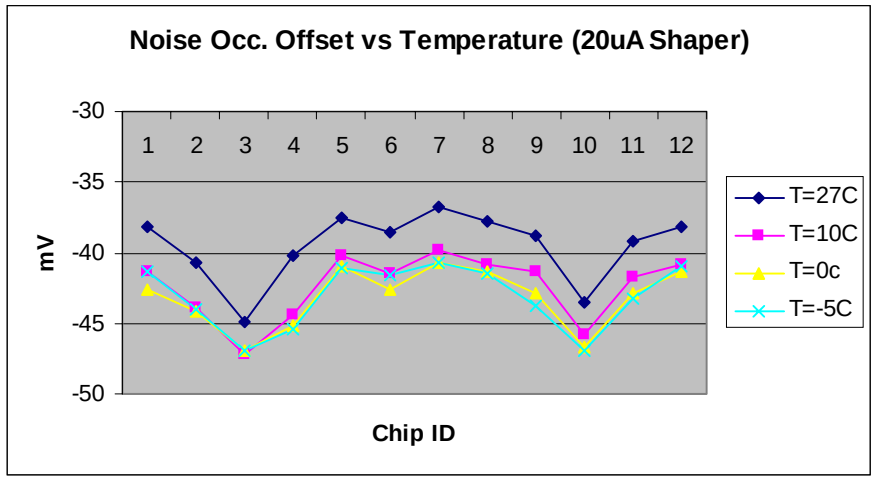
<u>Thermistor Temperature -5C, 30uA Shaper</u>

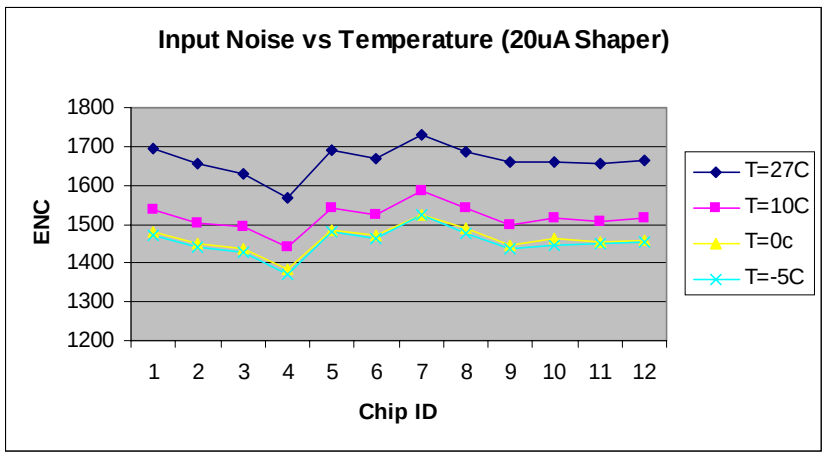


Modules Operating at Cold Temperature

- **Again, looking in a bit more detail:**







Operating with 20uA Shaper current results in:

- **Reducing spread on the Gain and Offset as temperature reduces.**
- **Input Noise, using calibration circuit, is still within spec i.e. <1500e ENC. at Disk operating temperature of ~0C.**
- **But the Gain is lower.**

Modules Operating at Cold Temperature

Conclusions

- **Results indicate that there is a strong correlation between module performance and temperature.**
- **With nominal front-end settings, at low temperature, the modules' Gain becomes non-linear.**
- **The 'noise structure' seen within the Noise Occupancy scan is clearly an artefact of this non-linearity. The colder the operating temperature the worse it becomes.**
- **Performance can be recovered by changing the Shaper Current from 30uA to 20uA (the suggested nominal value according the ABCD specification). But there is still room for improvement, maybe necessary to modify the Strobe Delay setting as well?**
- **This could also explain why the SystemTest results are always better than what is seen here in Liverpool with modules on the Disk. The hybrid temperatures are typically >30C, we operate at typically –3C.**