# Possible module-ROD mapping

## (Second Draft)

*John Hill, 22 October 1999*

## 1. Introduction

This is a first attempt at defining the mapping from the silicon modules to the RODs. It is intended as a basis of discussion, and everything in this document is open to modification. However, I have attempted to take into account the latest ideas on cabling, as well as the preference for an ROI rather than layer mapping.

## 2. Basic assumptions

- There will be a single exit per quadrant [1].
- ROI mapping will be used.
- A basic MUR (Minimum Unit of Readout) is 6 modules. The scheme in [2] is used for the purposes of this note. However, this clearly needs tuning, especially in the case of the SCT endcaps, where MURs of 7 modules are used in the outermost wheel.
- In the barrel, it is assumed that the "adjacent-pair" restriction applies.

## 3. Barrel ROD mapping

The adjacent-pair tower mapping from Figure 3 of [2] is reproduced below.

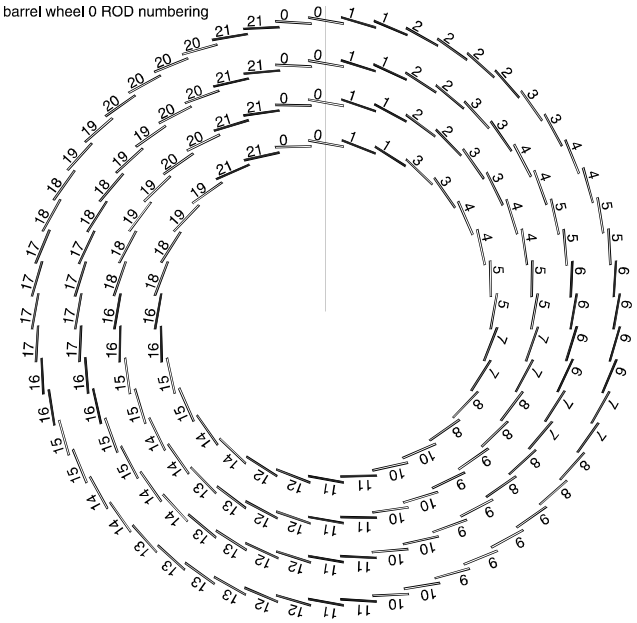


**Figure 1: SCT Barrel Tower ROD mapping**

The breaks into 4 quadrants are (arbitrarily) taken at 0°, 90°, 180° and 270°. This suggests the best places for the cable bundles to exit the barrel are at 45°, 135°, 225° and 315°. Since the orientation is arbitrary, I don't see this as a major issue, but it would be helpful if the cable exit locations were known. The octant arrangement in [3] is consistent with the arrangement presented here if a rotation of 45° is done. However, it is not possible with any quadrant arrangement, assuming the the adjacent-pair constraint, to have all the modules associated with a ROD within the same quadrant.The following table summarises how the 4 quadrants map onto RODs. There are of course another four identical quadrants from the other half of the SCT barrel.

| Quadrant | ROD Numbers | Number of modules | Number of 12-way fibre bundles |
|---|---|---|---|
| A | 1 – 5,6a | 264 | 66 |
| B | 6b – 11 | 264 | 66 |
| C | 12 – 16,17a | 264 | 66 |
| D | 17b – 21,0 | 264 | 66 |

Hence for RODs 6 and 17, half the modules are cabled in one quadrant, and half in the other. Since adjacent pairs ARE in the same quadrant, and quadrants A&B and C&D each go to the same ROD crate, this should not be an issue.

## *4. Endcap ROD mapping*

The tower mapping from Figure 7 of [2] is reproduced below. Though the exact detail of the layout may change, the suggested mapping shown is probably reasonably close to the best we can achieve to get a sensible ROI mapping.

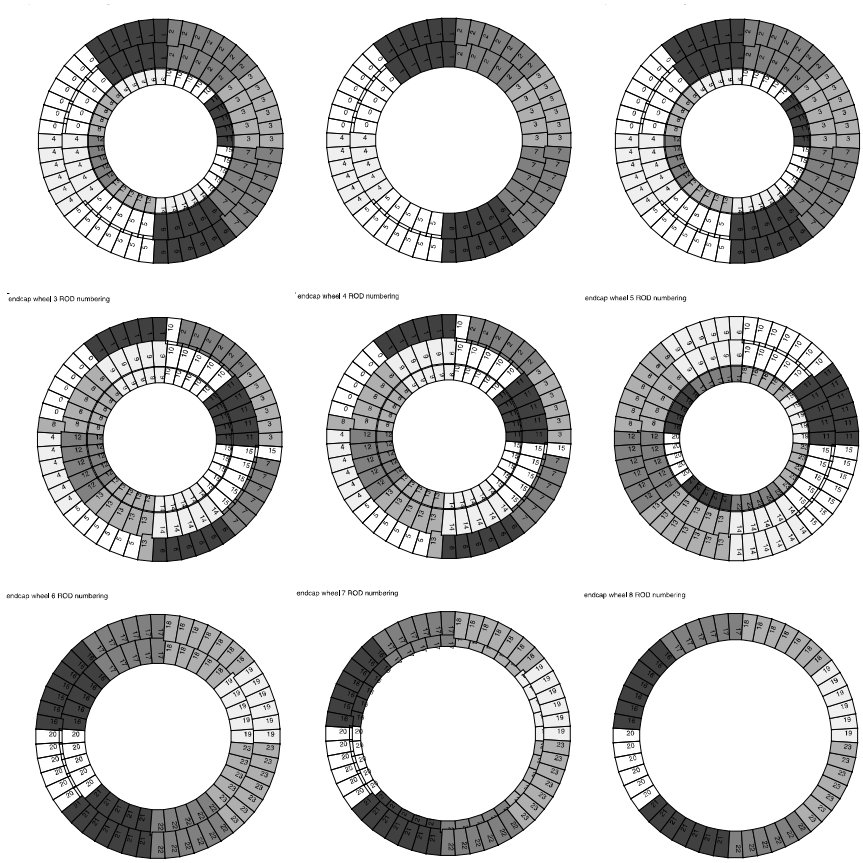


**Figure 2: SCT Endcap Tower ROD mapping**

As with the barrel, the quadrants are split at 0°, 90°, 180° and 270°. The table below shows how these four quadrants map onto RODs. Again the information is duplicated for the second endcap.

| Quadrant | ROD numbers | Number of modules | Number of 12-way fibre bundles |
|---|---|---|---|
| A | 2,3,10,11,18,19 | 247 | 68 |
| B | 6,7,14,15,22,23 | 247 | 68 |
| C | 4,5,12,13,20,21 | 247 | 68 |
| D | 0,1,8,9,16,17 | 247 | 68 |

As can be seen, the endcaps split naturally into quadrants, unlike in the barrel. On the downside, the utilisation of fibre is not 100% efficient. (None of this is exactly earth-shattering, as it is shown explicitly in [1]).

## 5. Mapping to ROD crates

With the cabling exiting from the SCT in a quadrant arrangement, with the barrel and endcap bundles physically adjacent, it makes efficient use of the 96-way cables which will be used between PP2 and the ROD crate to combine the two sets of 12-way cables. Each quadrant has 66 off 12-way cables from the barrel and 68 off 12-way cables from the endcap. This gives 134 off 12-way cables per quadrant in total, and hence 17 off 96-way bundles. Exactly how the 12-way cables will be bundled into the 96-way cables is not yet defined.

The RODs are expected to be housed in 8 crates – 4 crates each for barrel and endcap. It seems very unlikely that either the barrel or endcap community would wish to share a crate (though this should not be excluded if it becomes necessary), as then it becomes impossible to separate barrel and endcap into different partitions. Planning for the TTC system already assume the barrel and endcap are in different partitions (though I don't believe there is any fundamental reason why this couldn't be changed). For the purposes of this note, I assume we will have separate barrel and endcap crates. This implies that the 96-way cable will have to be broken out into smaller bundles near the base of the racks.

The SCT has 6 racks allocated in USA15 for "ROD + Trigger" ([4]). In principle we can house 4 off 9U crates in each of the 57U racks proposed. However, given the uncertainty in design of the ROD crates (a draft proposal exists at [5], but may not be suitable to house our BOC cards), and to give flexibility, it makes sense to house 2 ROD crates/rack. This would imply there is one barrel and one endcap ROD crate per rack, each serving two quadrants from one end of the detector. This arrangement also recombines the cables for RODs 6 and 17 in a convenient way.

Using the MUR numbering scheme from [2] (figures reproduced below), the MUR to ROD mapping would be as in the following tables. It is beneficial to have the MURs in the innermost regions connected to low-numbered ROD channels – the MUR order in the tables is in ascending ROD channel number order.

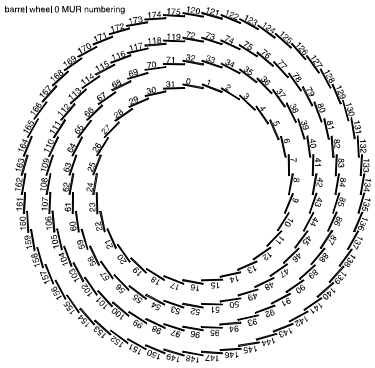


**Figure 3: SCT barrel MUR numbering**

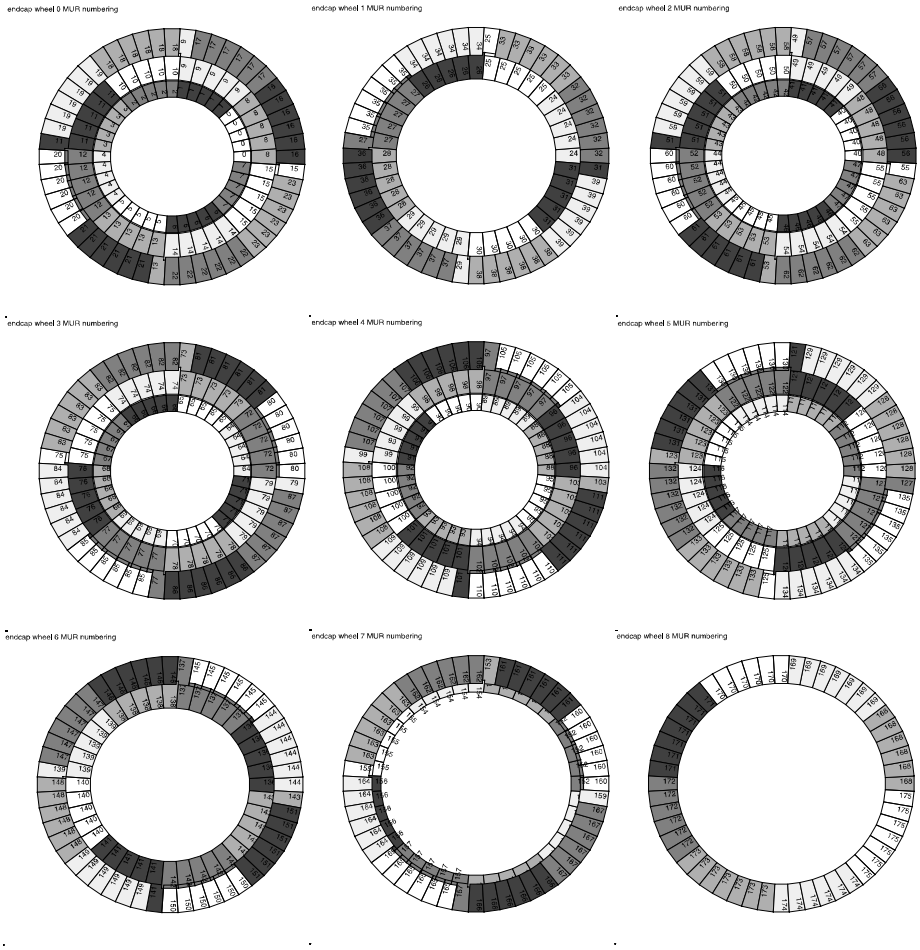


**Figure 4: SCT endcap MUR numbering**

In the following tables, “ROD number” refers to the designation from Figures 1 and 2, “MUR number” from Figures 3 and 4.

**Barrel Crate – Quadrants A and B**

| ROD number | MUR numbers | Number of modules |
|---|---|---|
| 1 | 1,2,33,34,73,74,121,122 | 48 |
| 2 | 35,36,75,76,123,124,125, 126 | 48 |
| 3 | 3,4,37,38,77,78,127,128 | 48 |
| 4 | 5,6,39,40,79,80,129,130 | 48 |
| 5 | 7,8,41,42,81,82,131,132 | 48 |
| 6 | 83,84,85,86,133,134,135, 136 | 48 |
| 7 | 9,10,43,44,87,88,137,138 | 48 |
| 8 | 11,12,45,46,89,90,139,140 | 48 |
| 9 | 47,48,91,92,141,142,143, 144 | 48 |
| 10 | 13,14,49,50,93,94,145,146 | 48 |
| 11 | 15,16,51,52,95,96,147,148 | 48 |

The other barrel crates are populated similarly, hence there are 11 RODs in barrel crates, with a total of 528 modules connected.

**Endcap crate – Quadrants A and B**

| ROD number | MUR numbers | ROD channels not connected | Number of modules |
|---|---|---|---|
| 10 | 1,41,65,73,89,97,121,129 | 5,11,17,29 | 44 |
| 2 | 9,17,25,33,49,57,81,105 | - | 48 |
| 11 | 0,40,64,72,88,96,120,128 | 5,11,17,23,29 35,41 | 41 |
| 3 | 8,16,24,32,48,56,80,104 | 5,17,29 | 45 |
| 18 | 113,137,145,153,161,169 | 5,37-47 | 36 |
| 19 | 112,136,144,152,160,168 | 5,11,23,36-47 | 33 |
| 15 | 7,47,71,79,95,103,127,135 | 5,11,17,29 | 44 |
| 7 | 15,23,31,39,55,63,87,111 | - | 48 |
| 14 | 6,46,70,78,94,102,126,134 | 5,11,17,23,29 35,41 | 41 |
| 6 | 14,22,30,38,54,62,86,110 | 5,17,29 | 45 |
| 23 | 119,143,151,159,167,175 | 5,37-47 | 36 |
| 22 | 118,142,150,158,166,174 | 5,11,23,36-47 | 33 |

Hence there would be 12 RODs in an endcap crate, with a total of 494 modules connected. The “not connected” channels assume an MUR starts on a channel number modulo 6.

## 6. Outstanding issues

The mapping suggested above is based on a number of assumptions that may erroneous in part or in whole. In this section I try to highlight areas where further iterations are probably needed, and to remind readers of assumptions made where it would be helpful to know what the true position is.

- The single exit per quadrant seems to be the favoured solution at present. This is very compatible with the plan for 8 ROD crates. (As an aside, the minimum number of ROD crates possible is 6, but 8 seems more natural, and is also consistent with the 4 TTC partitions envisaged for SCT, and allows for possible upgrading by the addition of more RODs.) Knowing the orientation of the exit points would be helpful (though not critical). The diagrams in [3] don't specify the angle between the octant boundaries and the optoribbon routes, but it would seem natural to identify 45° there as 0° in the diagrams in this note.

- The tentative arrangement of 2 ROD crates per rack is again compatible with this plan, but might potentially cause problems if the 4 racks are not in appropriate locations. Having only 2 crates per rack also gives us more flexibility to position the crates to minimise the fibre lengths.

- Having barrel and endcap crates separately in a rack implies that the 96-way cables have to be split at the base of the rack, rather than at the back of the crate. This may cause concern over "fibre spaghetti" in the services area of the rack. Guidance on how much of a problem this would be is needed. Mixing barrel and endcap RODs in a crate is possible, but we then lose the partitioning already assumed for TTC, and might cause logistical problems.

- ROI mapping solves a number of problems in the data throughput of the RODs, [6] and the Off Detector group view this as the baseline solution. If we can't use ROI mapping, then we may have to consider providing extra RODs to service the inner layers (which might break the Off Detector budget).

- The ROI mapping in the endcap is more complex than in the barrel. There seems to be a consensus developing ([2],[7]), but are there any problems with the proposed mapping?

## 7. References

[1] J.Troska, “Fibre Routing for SCT Optical Links”, in preparation
[2] S.Wheeler, “Optimisation of ROB mapping for SCT and Pixel detectors”, ATL-DAQ-99-006
[3] See diagrams regarding the optoribbon route at http://www.hep.ucl.ac.uk/~tjf/atlasmod.html
[4] P. LeDu, “ATLAS Rack Space Survey”, http://www.cern.ch/Atlas/GROUPS/FRONTEND/WWW/rack1.pdf
[5] P. Farthouat, “9U VME crates for the ATLAS Read-out Drivers”, http://www.cern.ch/Atlas/GROUPS/FRONTEND/crate.pdf
[6] Several documents at http://www-wisconsin.cern.ch/~atlas/off-detector/ROD/ROD.html
[7] P. Clarke et al, “Detector and Read-Out Specification, and Buffer-RoI Relations, for Level-2 studies, ATL-COM-DAQ-99-017