

# **SCT Endcap OTE Manufacturing Review**

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It is clear that the manufacture of the OTE is a difficult job. The Valencia group has produced several prototypes from small to a full size half meter OTE cylinder with rear flange. The most significant concern is associated with the dimensions of the OTE cylinder. Other concerns are the bonding of the Al-Kapton and Cu-Kapton foils onto the Airex foam, and the delivery schedule.

The mandrel and collapsibility of it was tested at RAL on a small prototype (30 cm diameter and 30 cm length) with positive results. It is clear that the prototype mandrel (120 cm diameter and 100 cm length) did not perform as was expected from the small prototype. Valencia had to make several adjustments for the first prototype, but did not succeed in getting a good enough cylindrical shape. The origin of the defects was discussed and decided to leave the imperfections in the mandrel for the first prototype. From the RAL measurements it was seen that the diameter of the OTE cylinder is too large and is conical. The prototype was send back to Valencia and more careful metrology indicates that the problem may only be at the end opposite to the rear Flange. That metrology shows a constant diameter with in 0,3mm and 2mm larger than nominal from 0 to 45 cm to the rear flange. At 50cm the diameter rises 2mm from the mean (see attached plot at the end of the document)

For the full size prototype Valencia adopted a different bonding method than was suggested by RAL. The Cu-Kapton sheet is bonded to the Airex foam on a flat bench with weights. After curing the Airex + Cu-Kapton is then bonded to the Al-Kapton sheet on the mandrel using straps to load the surface. The concerns from the prototype are creases and not bonded or delaminated areas.

RAL would have liked to see the foam compressed onto the mandrel with a vacuum-bag technique (the compression of the foam gives strength to the OTE), with the Cu-Kapton wrapped around separately and under tension. Nevertheless, it was agreed that the current approach did provide some compression of the foam at the position of the neutral axis and was probably satisfactory (and probably much easier to achieve).

The method of wrap the Cu-Kapton around the foam also showed problems with creases at RAL, not further test were done at RAL due to time schedule and some suggestions were recommended to Valencia that involved new tooling. Therefore an alternative procedure was followed by the Valencia team after try to wrap the Cu-Kapton on the mandrel.

The final integration for EC-C will take place in February 2006. In that frame work the first OTE needs to be ready for mounting at CERN February 1<sup>st</sup> 2006. The second OTE needs to be available one month later. As a prelude, the OTEs need Heater Pads bonded and they should be tried in the Integration Tooling. The aim is to get the first OTE to CERN by mid-December.

## Comments and recommendations

- Valencia did actually have the released drawings. The last release was done on the 8th of October.
- Make a second full size half meter prototype with the correct dimensions and as complete as reasonably possible; i.e. to be confident that the prototype works.
- The size of the Airex foam and Cu-Kapton foil is not big enough to cover the full length of the cylinder. Valencia will test connection and procedure of the edges with the next prototype.
- The tolerances on the diameter ( $1213.3 +1 -0$  mm) were not met with the full size prototype. It is important for integration issues that maximum OD (1214.3 mm) is not exceeded. If the tolerances cannot be met it is probably the only solution is to reduce the ID such that the end cap stays within its envelope. This needs obviously a discussion with Jason, and will be difficult to achieve; so every effort must be made to achieve the tolerances.

The measurement results from the first full size prototype done at RAL and the measurements of the Valencia mandrel deviated approximately 2 mm from each other. It is recommended to sort out what the cause is of this difference and what the actual circumference is. The careful measurements of the prototype done at Valencia are in agreement with the RAL measurements (see attached plot). The deviations shown between the adjusted cylinder and the prototype final measurements will be corrected in the new cylinder.

- With the knowledge of the defects of the first prototype Valencia is now constructing a new mandrel. The mandrel can be measured using a laser tracker. This method will give a 3D image of the mandrel.  
([http://www.leica-geosystems.com/corporate/en/products/laser\\_tracker/lgs\\_814.htm](http://www.leica-geosystems.com/corporate/en/products/laser_tracker/lgs_814.htm))
- The OTE cylinder is very flexible and can easily be deformed and brought out of cylindrical shape, and therefore difficult to measure. It was found most important that the circumferential length of the OTE cylinder is used as qualification.

- The production method followed by Valencia seems to be the best way to proceed; the Cu-Kapton will be bonded to the Airex foam flat. To improve bonding all bonding will be done through vacuum bagging to apply a uniform load on the surfaces. The unique experience from Peter is needed to make this method a success.
- The rear flange grounding tabs will be removed and separate tabs will be used to electrically connect the OTE cylinder and rear flange. The maximum space allowed between the grounding tabs is 1 cm. The size of the tabs is not important and can be made to what is convenient.
- The request from Valencia is to sort out if Cu-tape with conductive adhesive can be used as is used for the TRT.
- The OTE is a deliverable of Valencia following the RAL design and main assemble guidelines, and in that sense makes Valencia responsible for the acceptance and delivery of the OTE.
- RAL should send drawings of the rail positions to Valencia, such that Valencia can decide if possible imperfections can cause problems with the integration.
- If Valencia is happy with the next Prototype, they should send a thin bad (10 cm in z) to Liverpool to test on the actual Cylinder.

#### List of Actions:

**Action 1:** Patrick to discuss with Jason and Marco the possibility to reduce the ID of the OTE and hence relax the tolerances.

**Action 2:** Peter to supply Valencia with a list of materials for vacuum bagging

**Action 3:** Patrick to sort out if conductive tape can be used

Martin Gibson has considered this. We have proposed a modified solution. Valencia will investigate the modified solution.

**Action 4:** RAL to send drawings of the rail positions to Valencia

Dates when things will be achieved:

New Prototype	05.11.05
OTE Endcad C	05.12.05
OTE Endcap C Send to CERN	12.12.05

## Prototype Metrology

