Module S1-global design at 20th January 2008

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Summary

This document resumes the design modification agreed by INFN and KEK concerning the S1-Global module design. This document incorporates several requests for information after a preliminary discussion with the vendor, needed to prepare fabrication drawings and to resolve issues related to material availability.

1. GRP design

KEK requires an overlength of all pipes of 500 mm at each vessel end, including the GRP.
Usually, in the Type 3 cryomodule fabrication the GRP has been fabricated using stock size steel sheets and forming machines with a maximum length of 6 m. Thus we suggest to limit the total length of the 312 mm pipe below 6000 mm and to extend it to the nominal overlength out of the vessel after the reduction to the 76.3 mm pipe connection, using the smaller size piping. Thus Zanon will provide the 312-76.3 mm welded transition, as shown schematically in figure 1. The total length of the gas return pipe with the reducer will be 6800 mm, with 500 mm overlength from the vacuum vessel end flange as before.

Figure 1: Vacuum vessel, shields and GRP lengths and relative positioning (dwg file available)

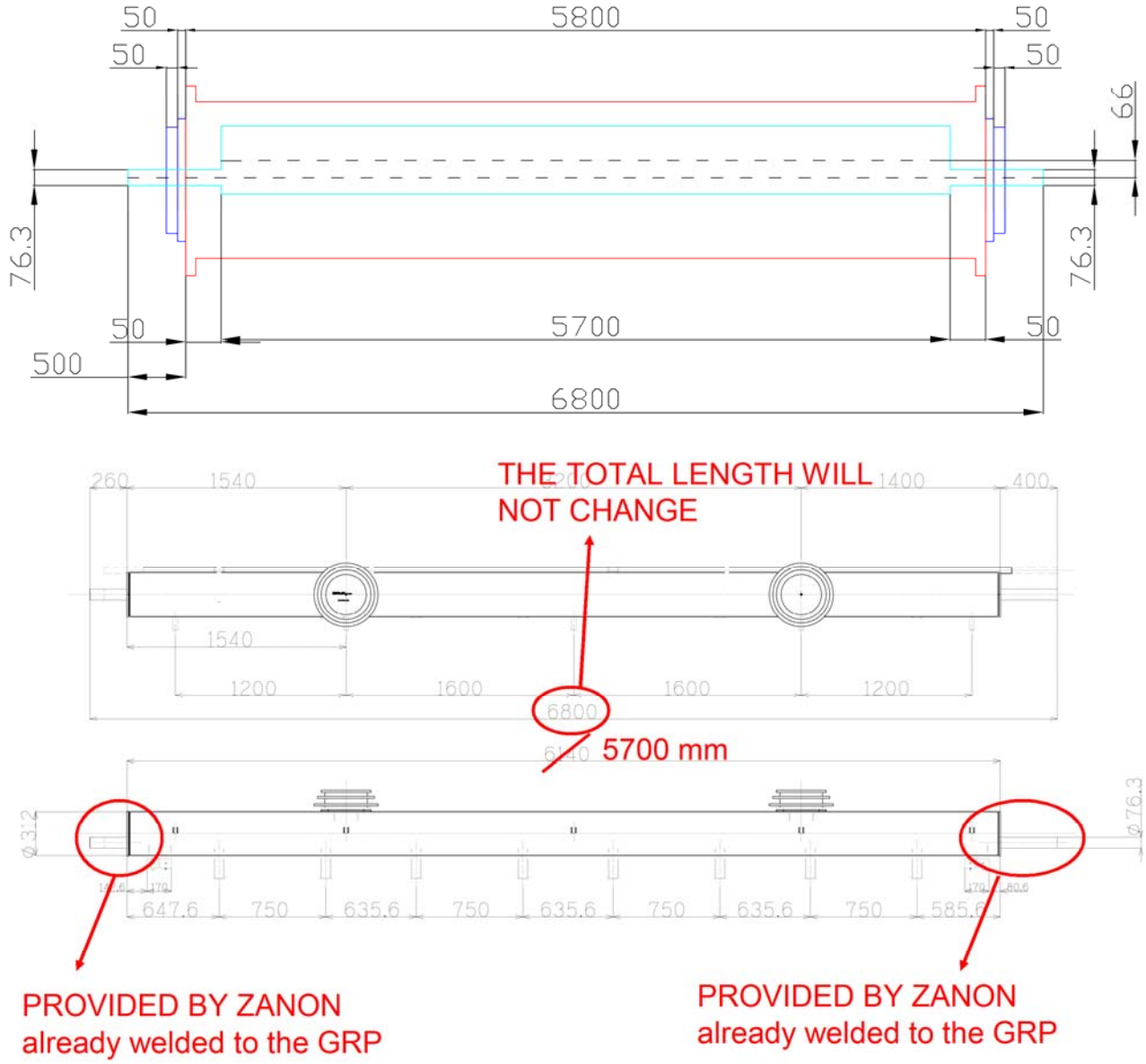


Figure 2 shows the position of the reducer with respect to all other pipes. KEK specified the pipe external diameter (76.3 mm), we miss specifications for the internal diameter (or wall thickness).

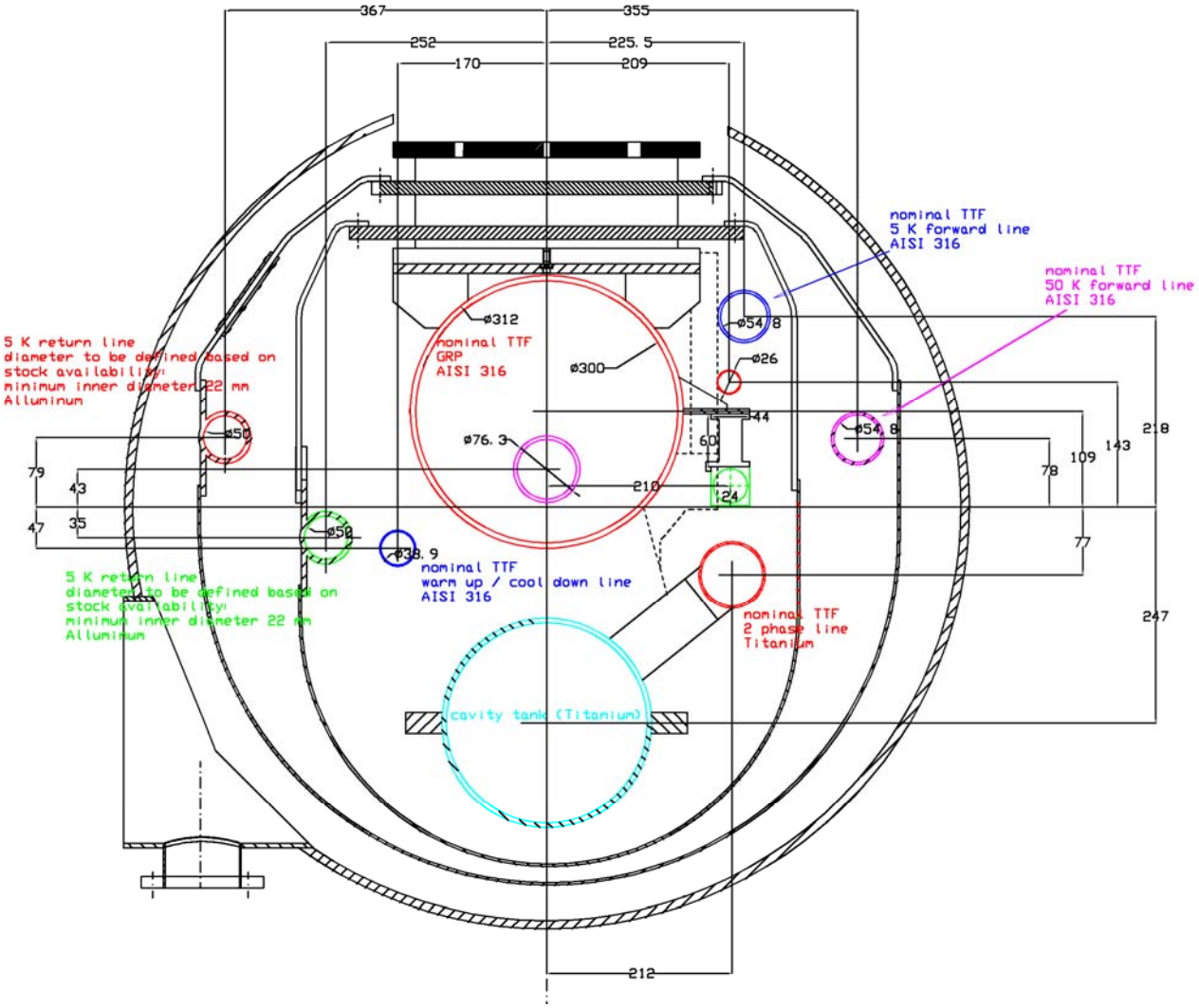
2. Thermal shields overlength

As shown in figure 1, we need to fix the overlength of the shields, to allow mounting of the shield extensions between modules and to the end/feed boxes. Also in this case, to decide the fabrication procedure, one has to take into account that currently the shield parts are assembled and formed starting from Al sheets with a length of 3000 mm, so to minimize material usage the total shield length should be restricted to 6000 mm (2 sheets). The top shield parts will be connected by means of welded reinforcements as in the standard Type 3 production.

We suggest:
Distance between shield 4.5 K and vacuum vessel: 100 mm
Distance between shield 70 K and vacuum vessel: 50 mm

As a comparison, in the Type 3 module the 70 K shield protrudes by about 80 mm from the vessel flange and the 4.5 K shield about 180 mm.

Figure 2: cryomodule cross section (dwg file available)



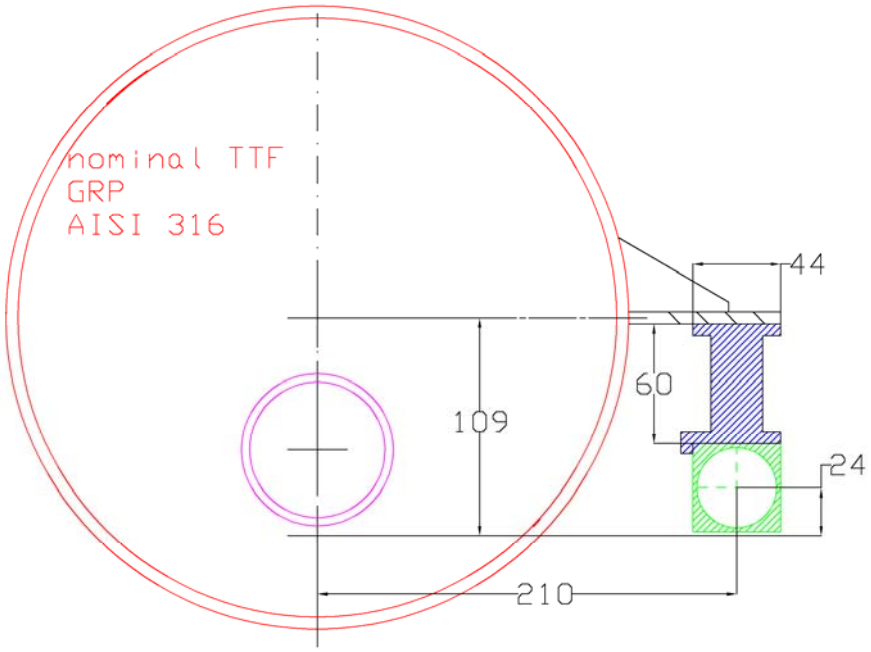
3. Piping and module cross section

We suggest the pipe position and dimension as shown in figure 2. It is the same cross section as TTF cryomodule type 3+ with the following modifications:

- WPM position
- 5 K forward line and cable pipe position
- 5 K and 70 K return line (extruded pipes) diameter can be reduced (up to a minimum of 22 mm), depending on stock availability.
- 5 K and 70 K return line (extruded pipes) profile can change (slightly different fin design), depending on stock availability (available in Zanon: 2 pipes about 6 m long in total and another pipe with smaller fin).
- 2.2 K forward line has been removed.

All distances in the drawing are referred to the vacuum vessel center, chosen as the reference position.

Figure 3: WPM position (dwg available)

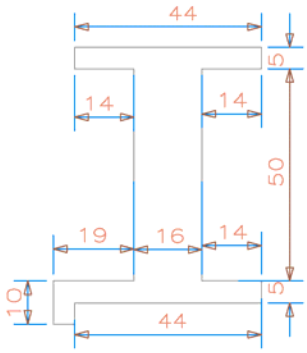


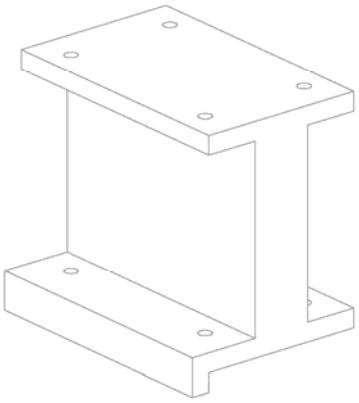
4. WPM position and support design

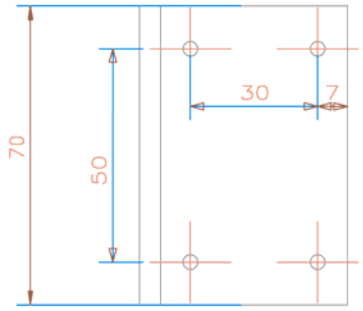
In figure 3 and 4 we suggest the positioning of the WPM and his supports, as required for the KEK configuration of the stretched wire position in the transverse cross section. Looking at the WPM design of KEK WPMs and INFN support to the GRP, to simplify machining and assembly, we need however to rotate the WPM support as shown in figure 3, and KEK should confirm if the suggested fixture is possible. We also need to decide who will provide the WPM support structure (the blue piece in the drawing. Possibly KEK will provide the blue support, defining its interface (position, dimension of holes and required tolerances) with the support plane welded on the GRP. The lower part of the welded brackets to the GRP will be precision milled to define a plane with respect to the planes defined by the two post connections and the lower part of the shapes, where the connection to the spring loaded roller bearing clamps are fixed.

Please note that all tolerances and surface properties have to be defined and that the WPM sensors and supports will have to be delivered from KEK to Zanon before the final preassembly of the module. Usually the installation of the WPM supports, sensors and cabling takes place before the final preassembly of the inner cold mass package (GRP + top shield parts and posts, including inner superinsulation blankets on the GRP and 4.5 K shield).

Figure 4: WPM support (3D model available)



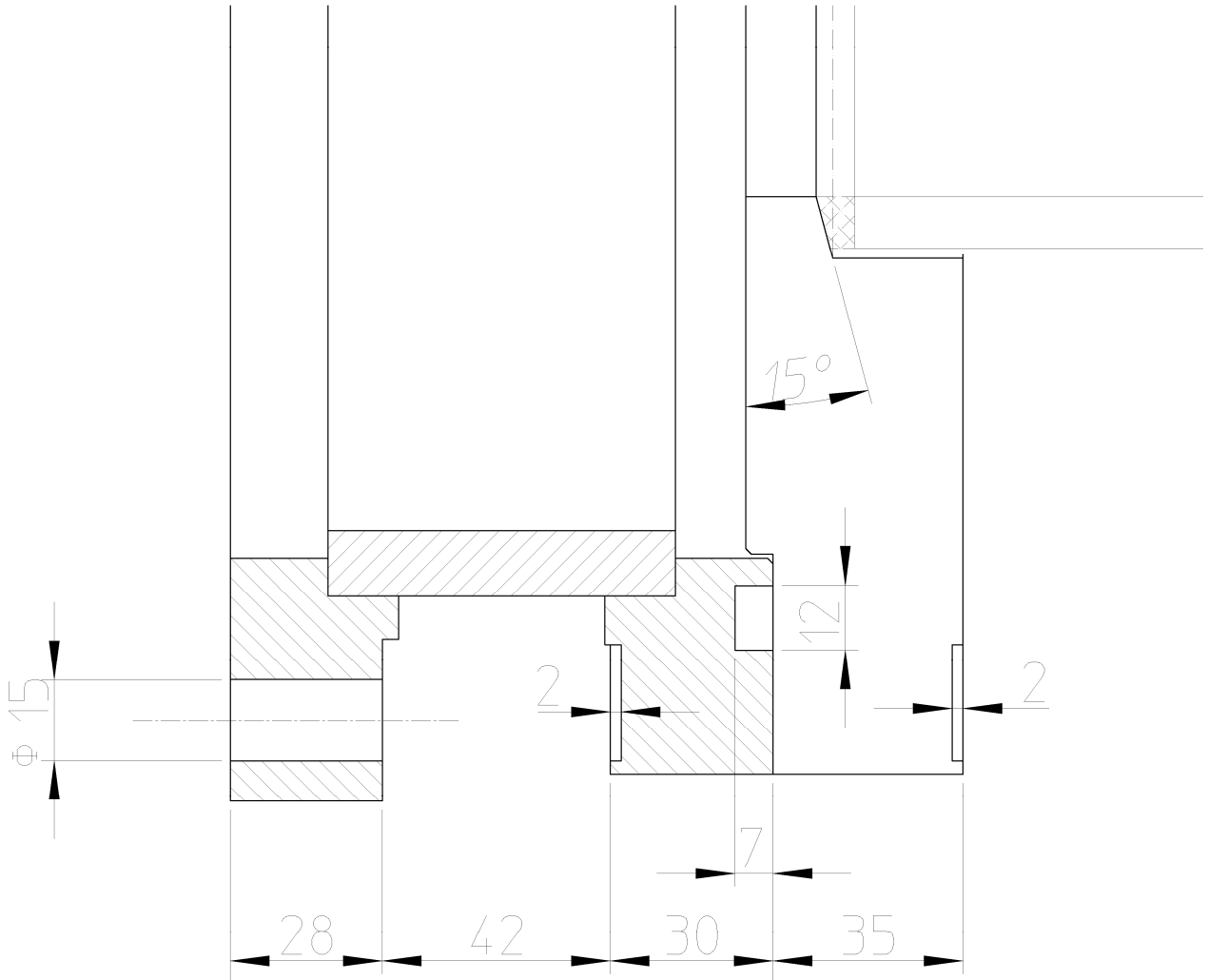




5. Vacuum vessel end flange and adaptor

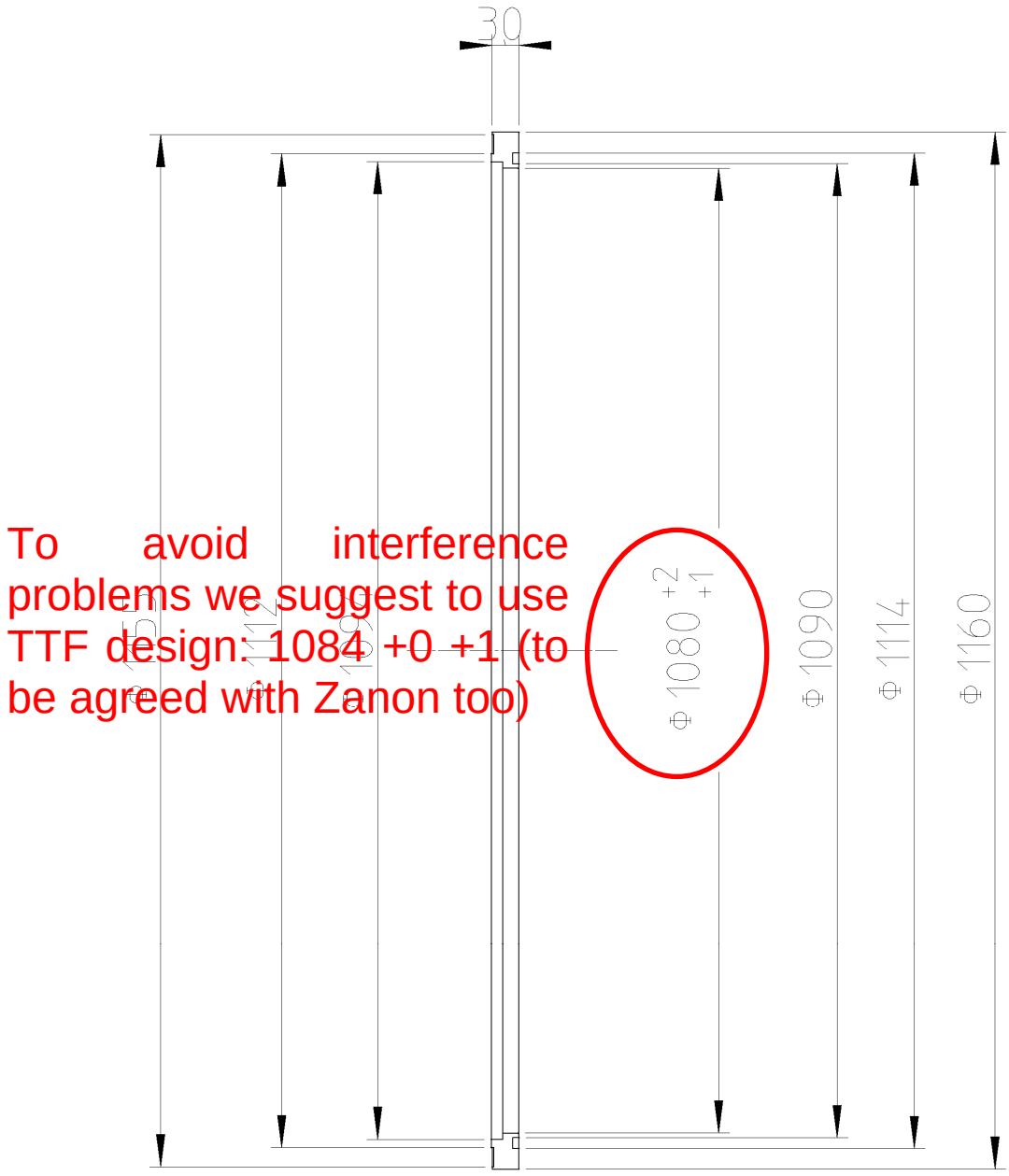
We verified the design of the adaptor connecting TTF end flange with KEK flange, we have 2 remarks shown in pictures 5 and 6.
The final design will have to be agreed with Zanon too.

Picture 5: end flange adaptor spacing
(from drawing S1-Assembly_1 Vac_Vessel_Flane_L100 08/12/08 Rev.10)



Too short for clearance of clamps and bolts

Picture 6: end flange adaptor inner diameter
(from drawing S1-Assembly_1 Vac_Vessel_glane_L100 08/12/08 Rev.10)



6. Longitudinal positions of coupler ports on the vessel

KEK needs to analyze and fix the longitudinal position of one coupler port opening on the vessel. After this decision, using the nominal cavity distances (coupler port to pad and between pads) the longitudinal positions of the cavity supports can be decided, taking into account the warm-cold contraction of the invar rod. This information is also needed in order to determine the segmentation of the bottom shield panel.

We resume here some consideration about the cold and warm behavior of coupler, cavity and shape spacing.

Distance between consecutive couplers at 2 K = 1383.6 mm.
This distance is the one to be used as distance between two consecutive coupler openings on the vacuum vessel.

Once the positioning of the coupler openings on the vacuum vessel with respect to the fixed post is defined, all other distances can be calculated.

Invar thermal contraction coefficient: 0.0004 m/m.
Distance between two consecutive couplers on the invar rod at 300 K = 1383.6 * (1+0.0004) = 1384.15 mm.
This is the distance between two consecutive cavity coupler centers at warm after clamping to the invar rod (distance between cavities for string alignment).

The cavities are suspended to the gas return pipe through the pads (the distance at 2K between pads on consecutive cavities is the same as the distance between cavity coupler centers: 1383.6 mm). The shapes have to hold the pads both at 300 K and 2 K. For this reason to calculate the distance between two consecutive set of shapes on the gas return pipe I use a mean value of the thermal contraction coefficient of invar and stainless steel (stainless steel thermal contraction coefficient: 0.003 m/m). The obtained distance between two consecutive set of shapes on the gas return pipe is then 1385.6 mm.

Invar rod fixture

In TTF cryomodule type 3+ a special shape has been design to fix the longitudinal position of the invar rod just below the fixed post. We suggest to use the same scheme.

7. Further actions

We propose to iterate this document between INFN and KEK, adding a table and schematic drawing of the main longitudinal positions (ports, shapes, …) and to submit it to Zanon in order to proceed with the finalization of the vendor drawings, to be reviewed jointly before the approval for construction.