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UBC
SCUBA-2 Project

AG, CS
2003-09-30
SC2_MEC_S580_801
Version 1.1

Cryostat Mounting Test Results

Introduction:

The following document is a report on experiments performed to verify the design used to mate the MDM 100-pin connectors. Results of these tests should demonstrate that the success of the prototype is repeatable. Results will also be used in order to specify manufacturing tolerances for the positioning of the connector, which lies in the Subrack Bus Backplane.

Part 1:

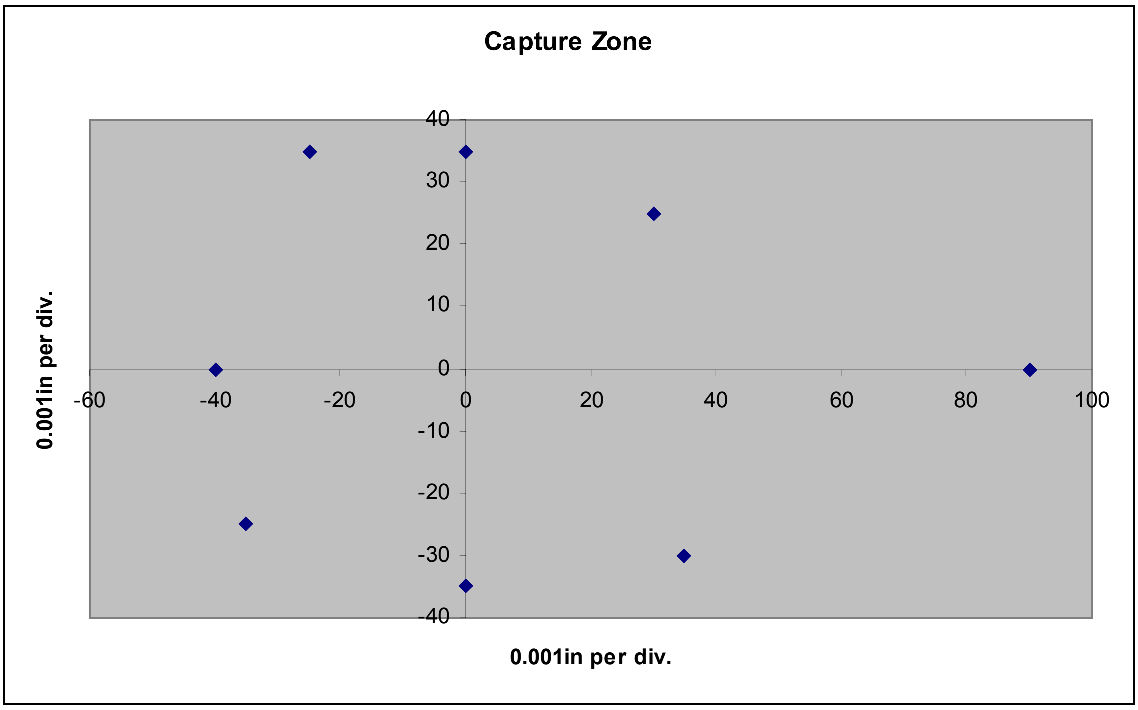
Purpose:
The first test was performed to determine the offset at which the MDM 100 pin connectors (that will be used for connecting the cryostat SQUIDS to the electronics) can be misaligned and still capture when both connectors were held in a test apparatus. In this case, neither connector is mobile, but the apparatus is flexible enough to permit motion

Equipment:
The test was performed by mounting the subrack side connector – female – to a two dimensional stage that can translate in the x and y direction (ie in the plane of the dewar surface) and be adjusted to a 0.0005” precision. The cryostat connector – male – was mounted directly above the female on a stage that could translate in the z direction at 90^0 to the female. The mounting brackets were machined aluminium.

Procedure:
The two connectors were aligned visually and the male was moved down onto the female and mated. This point was taken as the zero. The female side was then moved incrementally in the x direction and the mating was attempted again. This continued until the two connectors would no longer mate. The test was then repeated in the opposite direction. The same procedure was then followed in the y direction. However, the amount to which the connectors may be misaligned along one axis and still mate is a function of the misalignment along the other axis. The test is therefore repeated a number of times to establish a zone centred on the nominal position inside which mating will be successful.

In order to avoid confusion, the maximum allowable tolerance should be the same in both the x and y directions. Thus, determining the maximum allowable tolerance is a matter of fitting the largest possible square inside the experimentally determined zone of successful mating.

Results:
Limits of capture range shown below:



The points on the plot above indicate the points at which the connectors failed to mate. The first important explanation is the cause of the asymmetry about the vertical axis. The stages used each only move along one axis; however, along that axis, the stages are only rigidly confined in one direction and rely on a spring to maintain position in the other. Since the stage is mobile in one direction and not in the other, the points at (-40,0) and (90,0) illustrate the difference in capture range depending on whether the connector is rigidly fixed or not, along the long dimension of the connector. This inference relies on the assumption that the connectors are symmetric, which is quite reasonable. **Therefore, for determining the maximum capture range of the connector, one can use symmetry based on whether one desires the condition of a rigid or mobile base.**

Measurements along the vertical axis indicate that the mating is independent of the mobility of the stage and also that the capture range is noticeably less along the axis corresponding to the short dimension of the connector.

Determining the maximum allowable tolerance requires one to choose a tolerance from the nominal position such that deviation in either the X or Y direction to that tolerance still allows for successful mating. Graphically, determining the tolerance corresponds to fitting the largest possible square inside the capture zone shown above.

Conclusion:
When the test was run, it was found that a tolerance of +/- 0.025" in the x and y directions could be accepted until the connectors would no longer mate.

Direction	Tolerance (in)
X	+/- 0.025
Y	+/- 0.025

Table 1: Maximum Tolerances for test 1

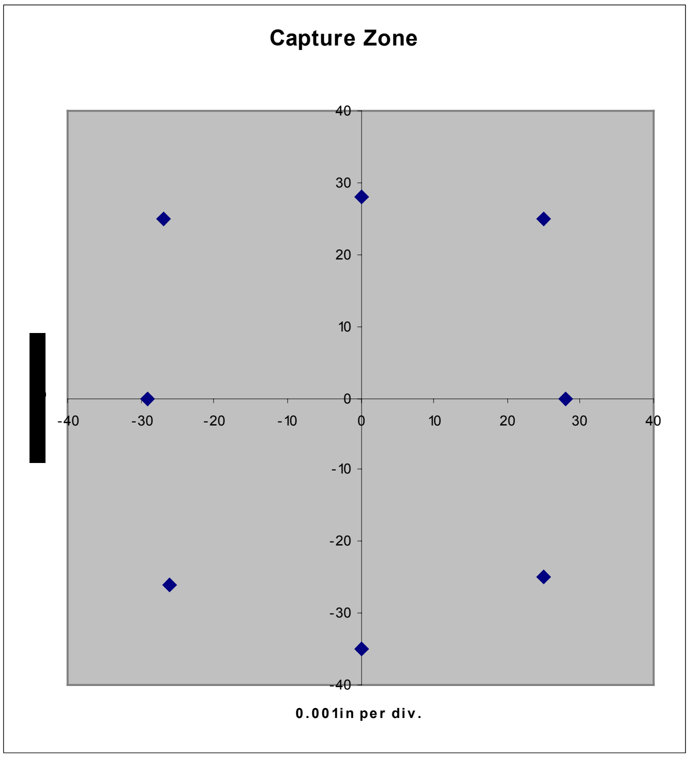
Part 2:

Purpose:
The second test was performed to determine the level at which the 100 pin connectors could be misaligned and still capture using the mounting/aligning device designed at UBC.

Equipment:
Similar to the equipment used in the first test, except that a prototype of the filter assembly rail was connected to the z direction stage and the Filter Box Shaft was rotated to lower the female side onto the male side.

Procedure:
The method is identical to that of Part 1 except that whereas moving the stage on the z-axis was used to mate the connectors beforehand, for this test the connectors were mated by rotating the Filter Box Shaft to move the cage containing the female connector. Furthermore, the stages were fixed such that they were unable to move; i.e. they were not free to translate in one direction as in the previous experiment. Thus, all motion came from the Cage/Rail Assembly.

Results:
Limits of capture range shown below:



Analysis of the results from this test follows the procedure of the first part. One can assume that the shape of the capture range follows the model of the first test, given that the mounting structure is less rigid and therefore permits greater flexibility.

The testing was limited by a problem in the apparatus, which arose during testing. The clearance between the Filter Box Shaft and the Filter Rail Assembly was insufficient and the Shaft seized. The design has since been revised and the prototype adjusted by widening the holes on the Filter Box Shaft.

Conclusion:
It was found the tolerance in the x and y directions were very similar to those obtained in the first test: the filter assembly rail had little effect on the ability of the connectors to mate.

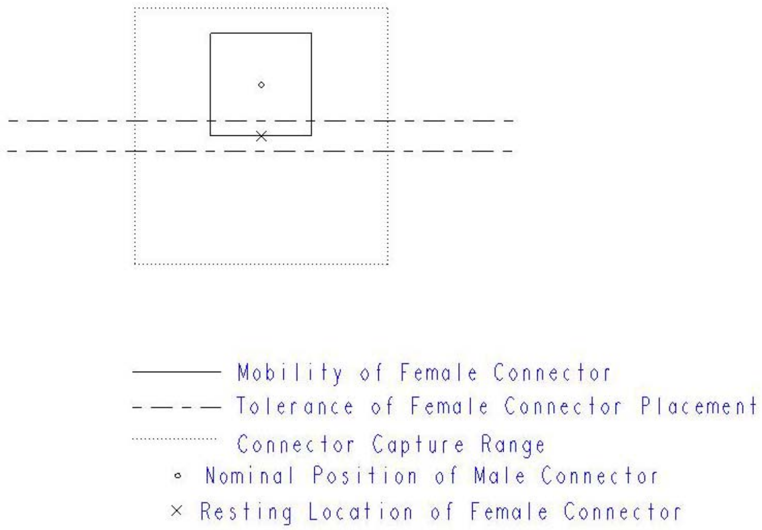
Direction	Tolerance (in)
X	+/- 0.025
Y	+/- 0.025

Table 2: Maximum Tolerances for test 2

Recommendations:
The female end of the connector is mounted in the Filter Assembly Cage. The Cage is connected to the Filter Assembly Rail by means of a keyway which is intentionally too large such that the Cage has a mobility of +/- 0.010" from its nominal position. In other words, the Cage, and therefore the female end of the connector as well, is free to move by 0.020in. As the locator pins are the means by which the subracks are located on the subrack bus Backplane, the locator pins are the logical choices as references for the positioning on either side of the connectors. The manufacturing of the filter rail and filter cage bounds the error in the nominal position of

the centre of the female end of the connector at +/- 0.003” with respect to the centre of the locator pins. This is a function of machining accuracy and the number of relocations of the work piece that will take place.

One can assume that, because of gravity, the resting position of the Cage is at one of the extremes of its range of motion. Given that the range of motion of the Cage can deviate by as much as 0.003in, the worst-case scenario is one in which the key is too wide by this amount. In this case, the female connector is misaligned by 0.013in in its starting position. Since capture is successful up to 0.025in, the male end of the connector can deviate by 0.012in with respect to the locator pins. A diagram showing the relative positions of the two ends to the connector and the limiting tolerances is shown below:



The above diagram shows the end of the female connector defined as the centre of the capture range. The solid lined box indicates mobility resulting from the +/- 0.010in clearance of the Filter Assembly Cage mounting keyways. The tolerance of the female connector shows the possible deviation of the initial position of the female connector from the state shown above. The limiting case occurs when the resting location of the female connector is at the bottom of this range, meaning that the minimum distance from the nominal position of the male connector to the edge of the capture range is 0.012in. This situation guarantees successful mating, but does rely on the flexibility of the components. The preferred case guarantees that all of the motion required comes from the mobility of the Cage and not from the elasticity of the components. In the ideal case, the male and female connectors will be aligned perfectly, with the Cage “floating” in the keyway, with 0.010” on each side. However, from the above discussion it was shown that the deviation in this distance could be as much as to 0.003”. Thus, to ensure that the connectors will mate in a stress free environment, we would require that the male end be located within 0.007”.

Summary:
The male ends of the connectors in the Subrack Bus Backplane must be located to +/- 0.007” to ensure successful stress free mating. Functionality of the design is conditional on being able to have the Subrack Bus Backplane manufactured to the above tolerance.