LHCb 2000-078 RICH

Proposal for the Installation of LHCb RICH-1 and the Beampipe.

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Introduction

This note is an outline proposal for the installation and alignment of RICH1 and the beampipe/vertex window into the experimental area. It is intended as a first attempt to firm up and expand on the previously proposed scheme into a fully detailed plan. As such it will not go into full 'nuts and bolts' detail but will concentrate on the procedure using techniques that have been successful in other experiments and adapting them where necessary. At this stage it is likely that some details or problems may have been overlooked (or maybe unknown at this stage) therefore suggestions and constructive criticism will be welcome. We will try to highlight any problems that may arise from installing these large items of delicate equipment into an area with both limited space and access and hopefully offer solutions.

The Experimental Area.

The area into which RICH 1 and the beampipe assembly have to be installed at point 8 is not in the experimental cavern but in the transition from machine tunnel to cavern. This is the area that was used by the LEP experiments to house the super conducting quadrupoles and the mobile shielding. The mobile shielding will be removed from this region giving a larger area, see Fig. 1.

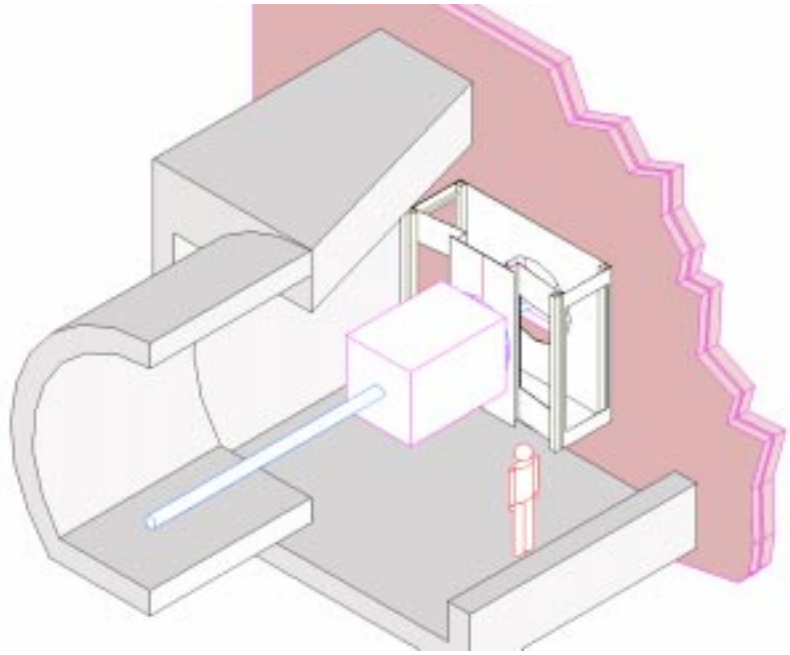

Fig. 1 Existing cavern with RICH 1 assembly on beamline.

The problem with this area as it exists is that there is very little access other than for personnel when the experiment is assembled. Behind RICH 1 there is a magnet mirror

plate which will completely block access from the downstream side, upstream the machine tunnel will be blocked by shielding. It is therefore necessary to modify the existing concrete on both sides of the beamline by cutting access openings and allowing access to the region not only for RICH 1 and the beampipe but also for the Vertex detector and the tracking stations see, Fig.2.

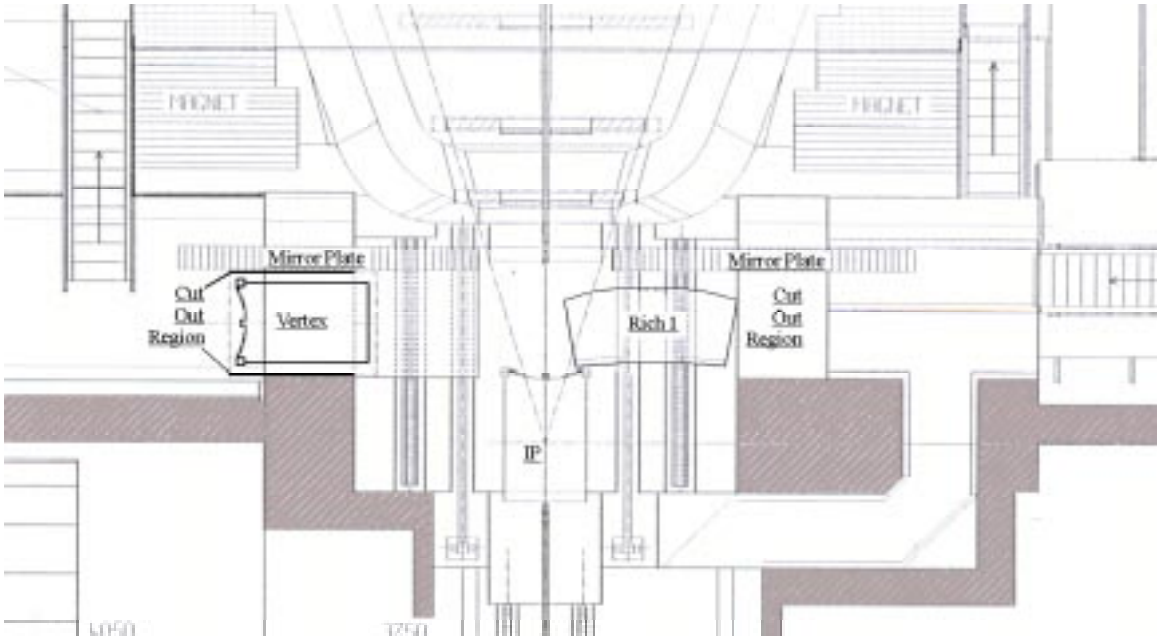

Fig.2 Plan View showing the cut out regions in the existing concrete

The additional infrastructure should also include a support structure and rail system for the RICH 1 assembly which will allow it to move in the directions shown in Fig.3.

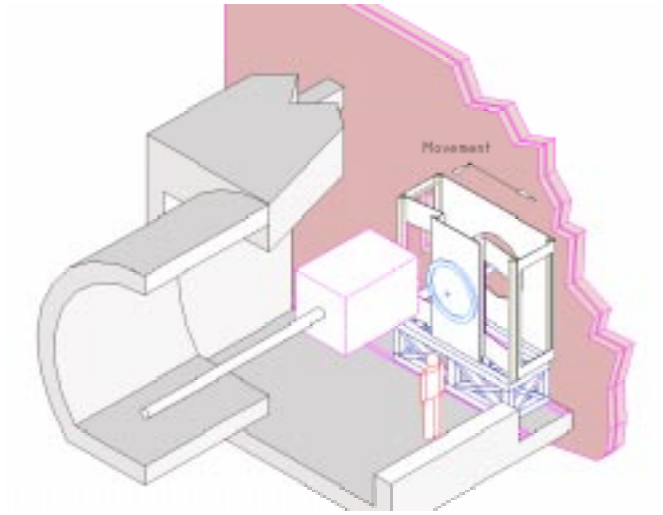

Fig. 3 Modified cavern with RICH 1 assembly displaced from beamline.

RICH 1

A detailed description of the Rich 1 mechanics can be found in LHCb 2000-077 RICH but a brief outline follows.
RICH 1 consists of three main elements:-

1) The optical system
2) The support structure
3) The gas envelope

The optical system comprises the mirrors, the photo detector array and possible calibration and monitoring systems. These will all be supported by a structure which is designed to keep the optical system positioned within tolerance, see Fig.4.

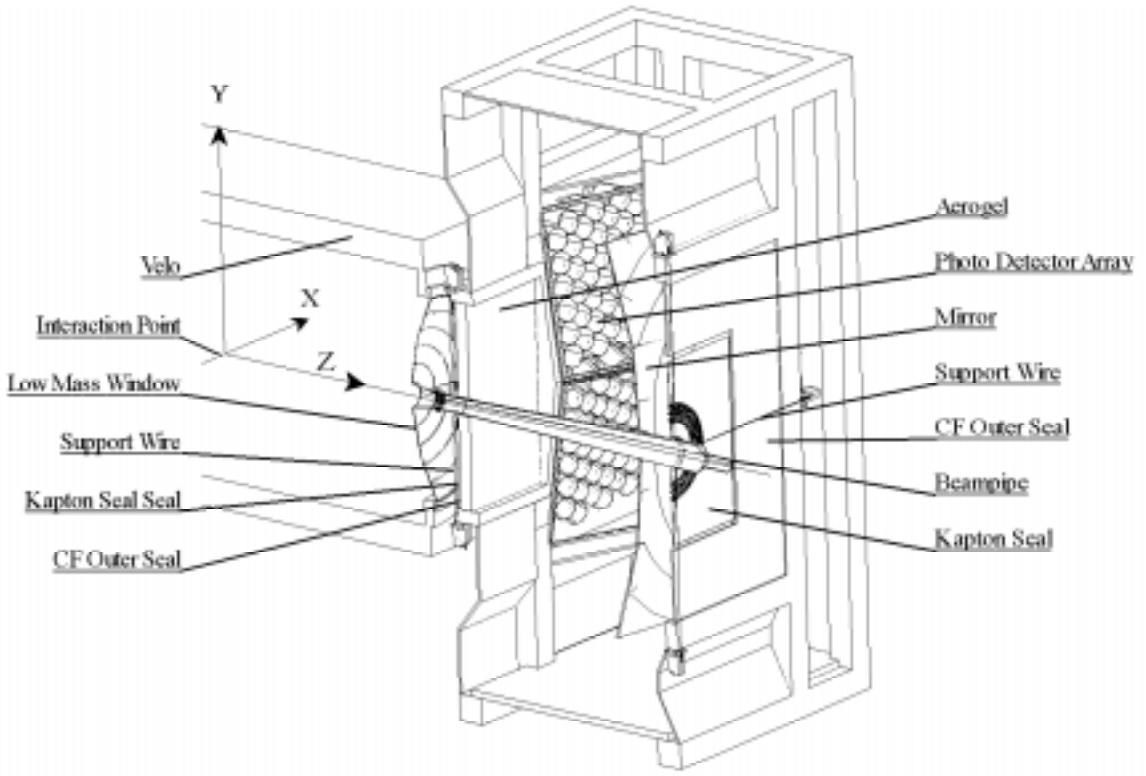

Fig.4 A section through RICH 1 with components fitted.

A gas envelope will be built into the support structure and will use the beampipe as the inner gas seal. This is achieved by fitting kapton sealing discs at the front and the rear of RICH 1 between the entrance and exit windows of the gas envelope and the beampipe, see Fig.5. The floor of the chamber will act as a support and location for: the beam-pipe protection, used whenever work is carried out inside RICH 1, and the kapton seal assembly equipment which enables the seals to be assembled in situ.

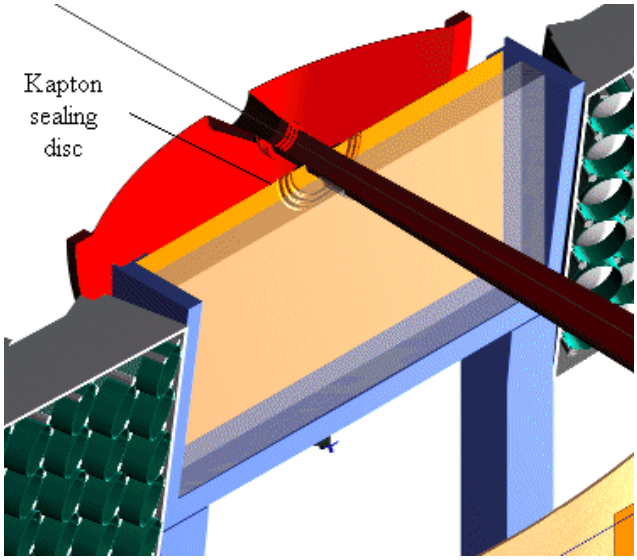

Fig.5 The front kapton sealing disc, sealing between frame and beampipe

The kapton seals arrive in three pieces to fit around the beampipe see Fig.6, and have to be assembled under pressure. This equipment is heavy and will need to be held stable during use, dependent on the glue chosen it may also be necessary to include heating elements.

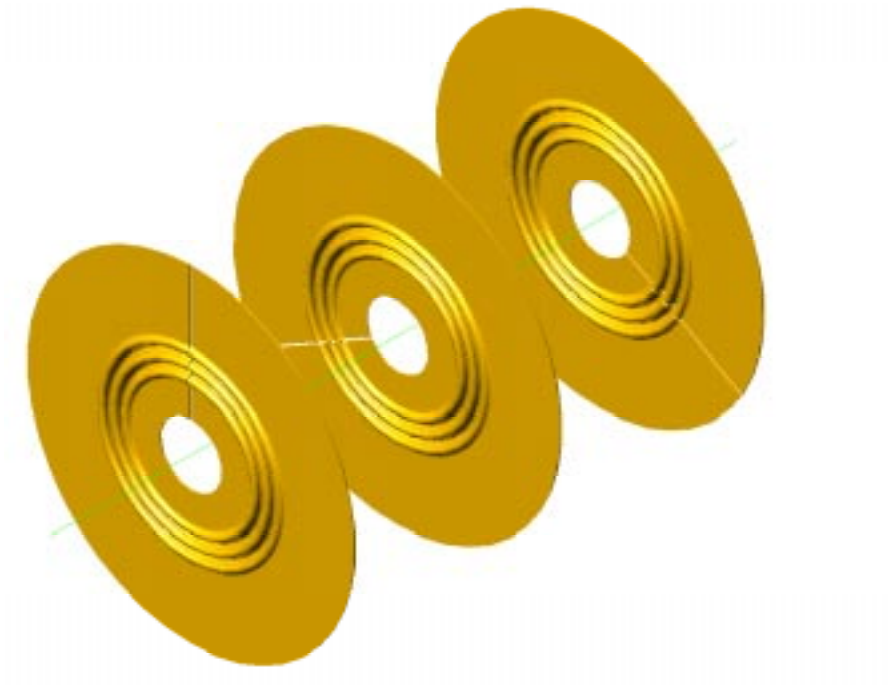

Fig.6 The three kapton discs that make up the kapton seal.

Installation

Stage 1 - RICH 1 mobile support structure.

Prior to any installation in the experimental area the detector will be assembled on the surface. This will ensure that all components go together and enable us to solve any problems. It is probable that the experimental area will not be available to us all of the time because work on the machine and the infrastructure may be continuing. Another advantage of assembling the detector elsewhere is that there will be more room to carry out any survey work that is required, in the experimental area space is very limited and a geometric and optical survey may prove difficult. Therefore before installation proceeds it is assumed that all items have been assembled and that a preliminary survey has been carried out and all survey points fixed and mapped. We don't believe that this work will be carried out with the real beampipe as it will be too risky but with a replica that is to the same dimensions.

The first thing that will need to be installed into the area is the rail system, this allows the RICH 1 vessel to be moved into and out of the beamline (along the 'X' axis) it could also be used to take the vessel into the area, see Fig. 3. Onto this rail will be built the vessel support structure which will raise the vessel to the correct height ('Y' axis) by incorporating adjustment. The support structure also allows movement in 'Z', (approximately 150mm) to allow the low mass window of the beampipe assembly to pass the vertex tank.

Stage 2 - RICH 1 vessel .

With the rail and support structure in place the vessel can be moved into position. With the support structure moved to the extreme of the rail system (it will be necessary to extend the rails out of the area) the support structure will come under the crane from the main cavern although a cantilever mechanism may have to be used see Fig. 7.

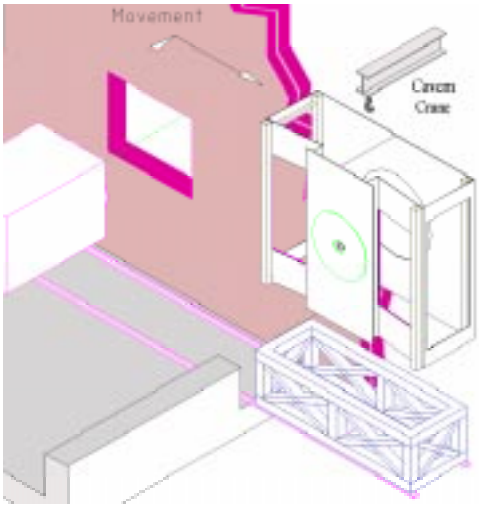

Fig.7 RICH 1 lifted onto the extended rails.

With the vessel secured on to its support the whole assembly can be moved into the area. There are now a number of scenarios and the one followed will depend on the time-scales

of the groups involved, RICH 1, Beampipe, Machine and Velo. The options at present are:-

1) We are ready for a full installation of all components, or-
2) We carry out tests to install the beampipe using a dummy or spare beampipe, again to ensure no unforeseen problems, or-
3) We move the detector onto the beamline (no beampipe) and assemble all the sub-systems to ensure that there are no unexpected problems, this will allow the commissioning of the detector, this is unlikely as the machine will hopefully be trying to run.

Which ever of the above, or even a different scenario is to be used, the final installation of Rich 1 and the beampipe assembly into its final position will be the same.

Stage 3 - Arrival of the beampipe into the area.

The openings that will be cut into the existing concrete will also allow access for the beampipe into the area. Because of the design of the beampipe, see Fig.8, which incorporates a large low mass window surrounded by a heavy sealing flange, the unit will

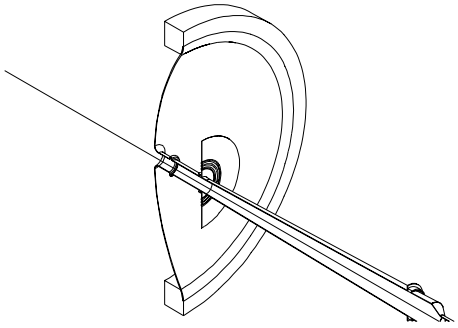

Fig.8 A section through the low mass window, flange and beampipe assembly.

need to be in a stiffening frame, see Fig. 9 until in its final position supported by both the vertex tank flange and the support wires at the front and rear of RICH 1. The stiffening frame shown is only an illustration and the final version may be different in detail because it is also needed for the manufacture of the beampipe assembly.

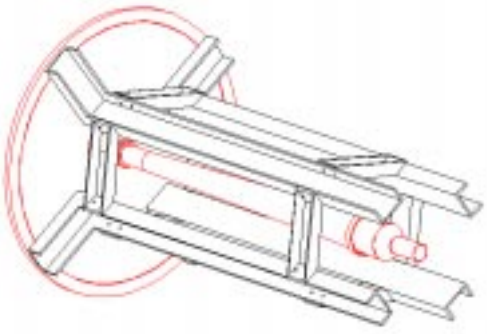

Fig.9 The beampipe held in its stiffening frame.

To allow the beampipe assembly into the area the RICH 1 structure will need to be put on the beamline, the beampipe assembly is then moved through the opening in the concrete

and moved upstream (beside the beamline). RICH 1 is then moved back out of the beamline and the beampipe assembly is lifted in and supported on the two specially designed brackets that are temporarily attached to RICH 1, see Fig. 10. These brackets can be adjusted in both 'X' & 'Y' directions independent of each other. When the beampipe assembly is aligned to RICH 1 with the help of the survey group it is locked in position and still with the stiffening frame in place the RICH 1/beampipe assembly is moved back onto the beamline. The RICH 1/beampipe assembly is aligned with the Vertex tank flange and the machine using adjustments which are bolted into the RICH 1 support structure. When the alignment is achieved the support structure and RICH 1 are locked in position and should not move again as the support of the beampipe assembly will ultimately be shared between RICH 1 and the vertex tank so any relative movement between the two will result in stresses being applied to the beampipe assembly and this may lead to failure.

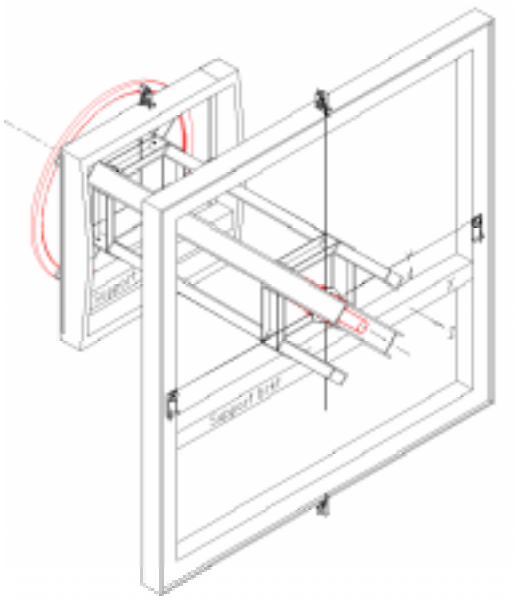

Fig. 10 - RICH 1, the beampipe support brackets, viewed from the downstream side.

Stage 4 - Transfer of the support of the beampipe from stiffening frame.

It is now necessary to transfer the support of the beampipe assembly from the stiffening frame to the final support system of RICH 1 and the vertex tank flange. This is the most critical stage of the installation procedure and must be executed with the utmost care. The flange is simply a face to face bolted joint but the support for the pipe section in RICH 1 is achieved using stainless steel wires, 4 wires at 2 positions see Fig. 11. During the transfer of load from the stiffening frame to the Vertex/Rich 1 system every step has to be monitored using dial gauges and load cells to ensure that no unforeseen stresses are passed to the beampipe assembly. The transfer is carried out by gradually adding tension to the final support system wires whilst releasing tension on the wires between the stiffening frame and the beampipe assembly until the assembly is no longer dependent on the stiffening frame.

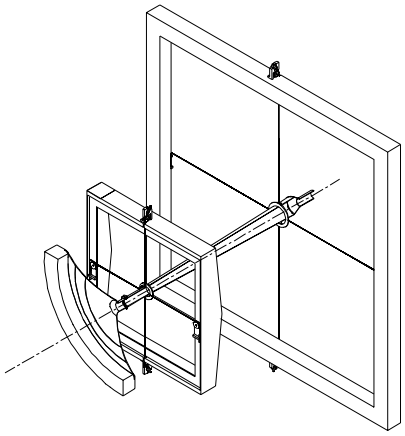

Fig. 11 - RICH 1, the beampipe support wires, viewed from upstream side.

When the transfer is complete the stiffening frame will be removed and the frame support brackets can also be removed from the RICH 1 support frame. After this is completed the beampipe will need to be baked out and the assembly checked for leaks, it should be noted at this stage that none of the RICH 1 components are fitted so there is free access inside the detector to allow the machine people to work although clean room clothing will be required to stop any unwanted dust particles from entering the detector. When the beampipe has been checked out, a protective structure is built around it which is supported from the floor of Rich 1, this protective structure can also be used to support the equipment that is used to assemble the kapton seals described above. It is at this stage that the kapton seals are fitted, and because they are attached to the beampipe great care will be required and the beampipe should again be monitored to ensure no stresses are imparted. At this stage the fused silica windows can be fitted and it would be prudent to carry out gas tightness tests to ensure the integrity of all the seals.

IMPORTANT. At no time should any leak tests be carried out on either the RICH 1 envelope or the beampipe using Helium with the photo-detector array in the vicinity because the helium would destroy the vacuum inside the photo tubes and render them inoperable.

Stage 5 - Installation of the optical system into RICH 1.

As previously stated there are none of the RICH 1 active components in situ during the installation of the beampipe. The components are designed to be installed on guided rail systems, this is for two reasons. Firstly to enable the optics to return to the same position after removal and secondly because they need to move to close proximity of the beampipe and therefore the movement will have to be very tightly controlled. They will be heavy units and so it is envisaged that the final positioning around the beampipe would be done using a mechanical motion and not a manual motion (pushing).

Conclusions

The system outlined is a rather complicated procedure but is necessary because of the nature of the components. It should be stated that this procedure is likely to be carried out any time there is a problem with or upgrade of the beampipe assembly. There will also be a requirement to bake out the beampipe on an annual basis and to achieve this the kapton seals will need to be disconnected from the beampipe at the very least and possibly replaced altogether.
There will need to be a scenario devised to install tracker 1 between the large flange of the beampipe assembly and the front beampipe support wires.
At present prototype kapton seals are being produced and we will carry out tests on these to determine what forces we can expect to exert on the beampipe for a range of pressure differences and also the C_4F_{10} compatibility with the kapton and the glue used.
For the installation of large pieces of equipment we have already stated that major modifications will need to be made to the cavern walls, it will also be necessary to ensure that there is ample access to these openings at the correct level and that the floor is capable of taking the load.