

Short Working Distance and High Numerical Aperture Applications	App-003
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Question: I want to set up for high magnification with a high NA lens. How do we setup the Cryostation for short working distance?

Answer: There are many ways the sample may be placed for evaluation in the housing. The standard Cryostation sample chamber has five windows for optical access. Each of these windows has an outer (warm) and inner (cold) window for thermal efficiency. The inner windows are mounted on a removable radiation shield assembly. The standard sample holder has an adjustable post that allows motion horizontally or vertically about the center. Most configurations allow the user to set up the position and the rest of the optics or equipment, and then later seal the chamber for the experiment.

Short working distance applications can be done using a side window or the top window. There are three main ways to obtain low working distance:

- 1) The windows on one axis can be brought close together, but not touching, and the sample positioned close to the inner window, so the distance from the sample to the user lens is minimized. This distance can be made quite small, with the use of specialized thin windows. The two windows should be separated by the vacuum, which is the key to insulating the heat flow. The large glass windows on one axis could be replaced with smaller thinner windows mounted very close. Realistically, in order to support the vacuum, the outer window may need to be smaller in diameter if made thin. For example, windows can be made of special materials as thin as 150 microns and still support a vacuum. The inner window is fully within the vacuum, so it's diameter is not as important. The amount of spacing between the windows is not very critical. If the sample has a full radiation shield in place, and the sample is not touching the inner window, then low temperatures should be achievable.
- 2) If even shorter distances are required, then the inner "cold" window can be removed. Without the inner cold window present, room temperature radiation may heat the sample, depending on its absorption characteristics. This will compromise the low temperature performance limit of the system, but it may be acceptable in some applications.
- 3) By doing some optical design engineering, the inner cold window could be replaced by a focusing optic. If that optic is separated from the warm window, and the sample can be positioned into the proper focus plane, then this can achieve any short working distance. Optical design should be done confirm focus, etc. Some of the off the shelf optics are fairly long in the optical direction. If one of those optics was chosen, the window assembly could be modified to enclose the optic. In addition, it may be necessary to have a way to perform fine

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focus on the sample. It is possible to use piezo positioning stages for this purpose.

Figure 1 below shows a possible setup for side viewing. The sample has been moved to just inside the inner window. Both the outer window and the inner windows can be screwed in or out relative to the window housing to minimize their separation. This does not require any special windows or mounts.

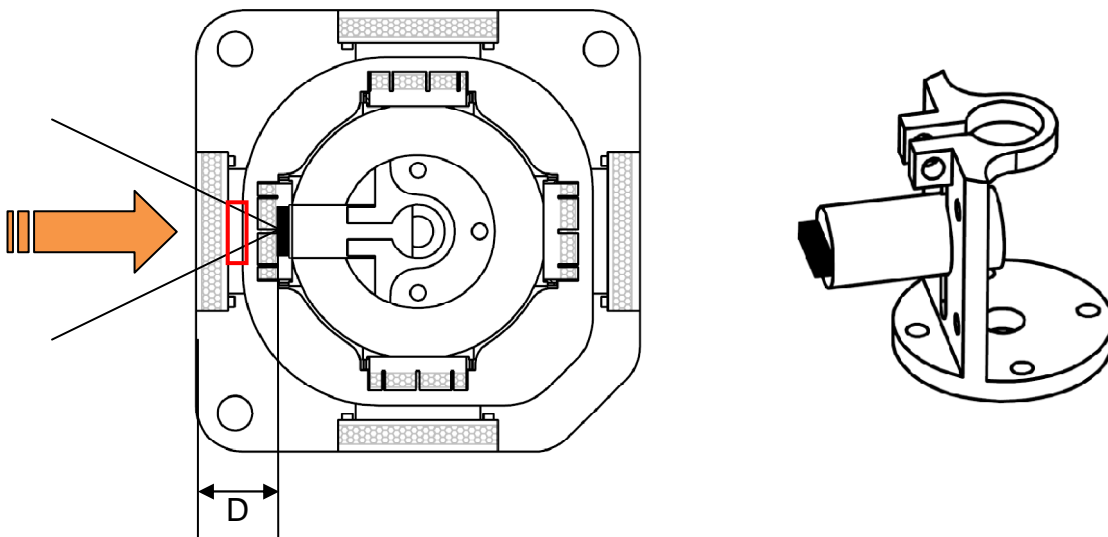


Figure 1. High NA, close working distance (radiation shield present).
Sample is positioned near cold window.
Alternate sample position shown in red.

Figure 2 shows a configuration for top viewing. The diagram shows the inner window removed, but this works just as well with the inner window present.

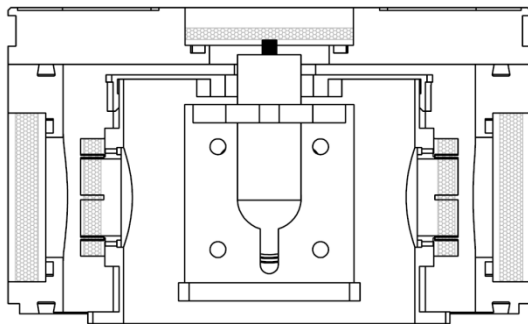
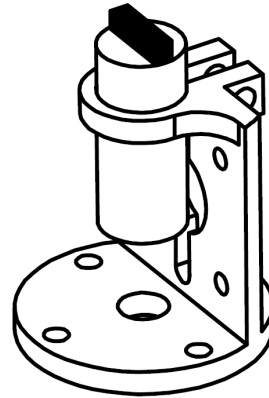
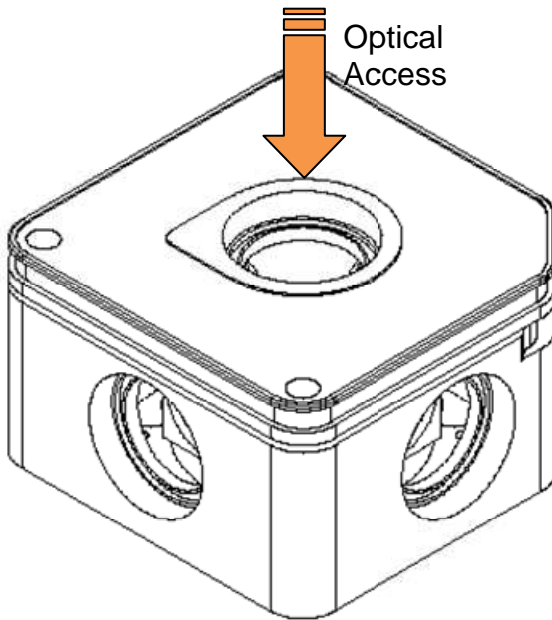


Figure 2. Vertical viewing, high NA (microscope type application)
Sample is mounted on top and positioned just inside warm window.

Figure 3 shows a cutaway view of a top view application. The top window has a reduced diameter and is very thin to allow a high NA lens to be used.

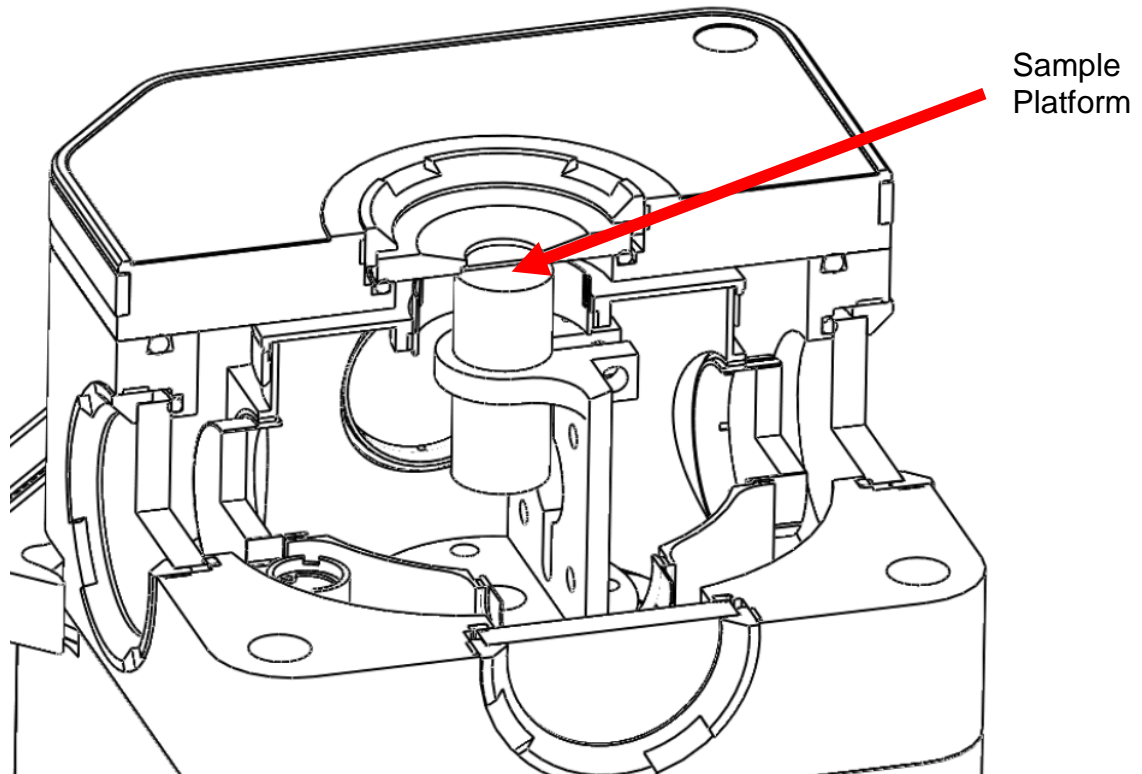


Figure 3. Cutaway view of thin window concept.

Due to the simplicity of the sample housing, it is possible to create a custom housing that allows unique optical or magnetic access to the sample. For example, it is possible to replace the window assembly level with a design which is thinner and allows either windows or room temperature magnets to be located within a few mm of the sample on each side. This would have a very high numerical aperture on both windows simultaneously with the sample located at the center. Similarly, interfaces to AFM or SNOM are possible that preserve the vacuum and temperature performance of the housing.

If you have special access or interface needs, please contact our application engineers. We are interested in supporting these projects.