**Specifications Sheet: Insulator Ring**

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**Functional specifications:**

The insulator ring is designed to separate the HV and ground electrodes by 12 cm. The ring will contain the UCN volume, therefore, the surface needs to be able to store them with minimal loss. Hence a UCN reflecting layer must be applied to its inside surface.

Windows on the x-y axis of the experiment need to be placed on the insulator for transmission of the Hg UV laser light.

**Insulator dimensions:**

The inside insulator diameter of 800 mm is defined by the aimed UCN storage volume of the baseline design. The height of the insulator is limited by the available raw material of ~ 154 mm, resulting a fixed maximum groove depth in the electrodes of 15 mm. The ring will require a window to be placed on the x-y axis of the experiment in order to transmit UV light for the Hg laser. The thickness of the material is limited by the mechanical requirements: to avoid large deflection of the walls due to potential changes form pumping pressures as well as the weight being supported (~ 150 kg on bottom insulator just considering top electrode, top insulator, and central electrode). There is concern that the thicker the insulator the larger the surface area in the groove, hence, a possible increased risk for breakdown to occur due to the cathode triple junction. Ideally, keeping the insulator as thin as mechanically possible would mitigate this problem. Hence, an outer diameter of the insulator ring of 840 mm, i.e. a wall thickness of 20 mm, seems reasonable from HV and mechanical point of view.

The insulator has to support the electrodes, therefore, maintain parallelism of the electrode surfaces with respect to each other to $θ<10 mrad$. This is determined from the electric field asymmetry due to quadratic frequency shift in $d\_{n}<1×10^{-27}e⋅cm$, hence the difference of the electric fields between two chambers should be $\left|\frac{ΔE}{E}\right|<10^{-2}$. The insulator compression also needs to be considered: the top insulator will not hold as much weight as the bottom, therefore, it will be compressed slightly less, resulting in a different electric field in the top compared to the bottom. Therefore, the accuracy of the two insulator heights has to be better than 1 mm with respect to the other (under mechanical compression).

**Mercury window:**

The insulator requires two windows to transmit UV light for the readout of the Hg co-magnetometer. The windows have to have a good enough vacuum seal to avoid Hg gas from escaping into the vacuum chamber.

The window geometry needs to be designed in such a way as to avoid electric field enhancements at its edges: caused by a changing dielectric constant as the insulator and window are different materials. Electric fields in the region of the grooves are also enhanced due to the window. Discharges were observed in nEDM from this region to the edge of the window, demonstrating a weak point.