Description of ICRR's Nodal Support for Disk Loss Measurements

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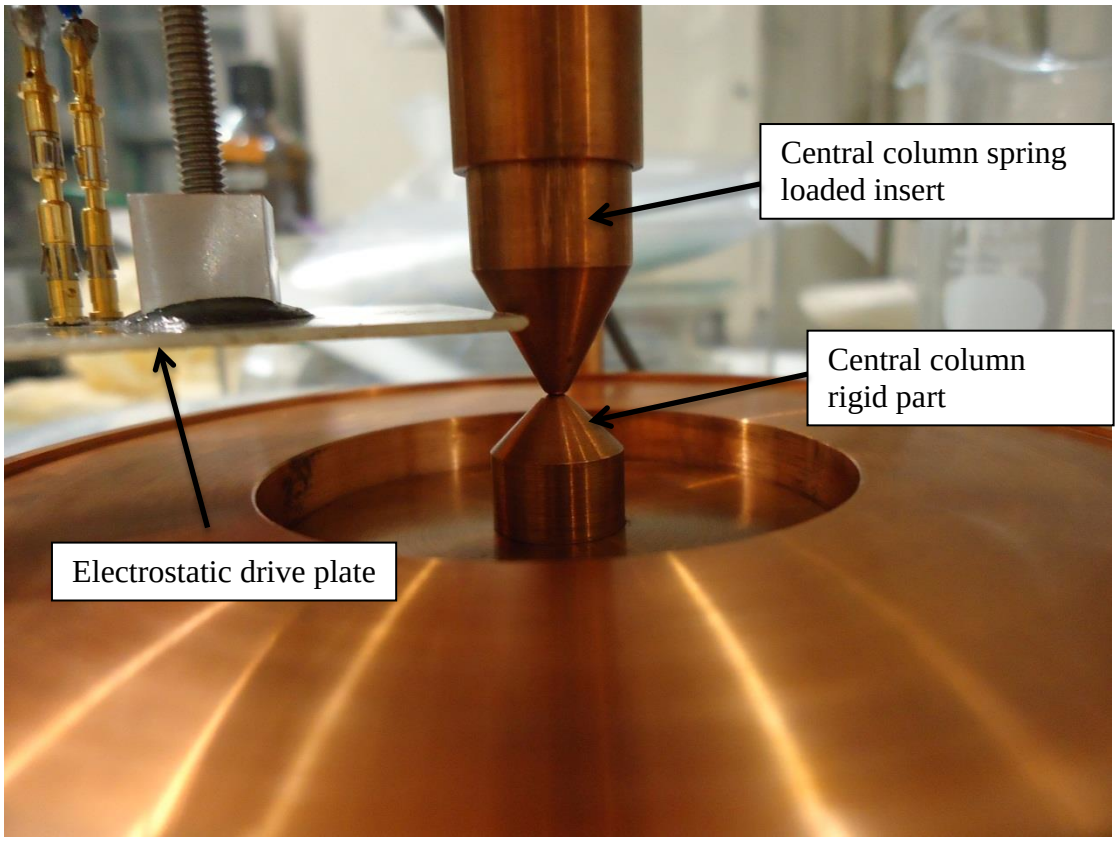
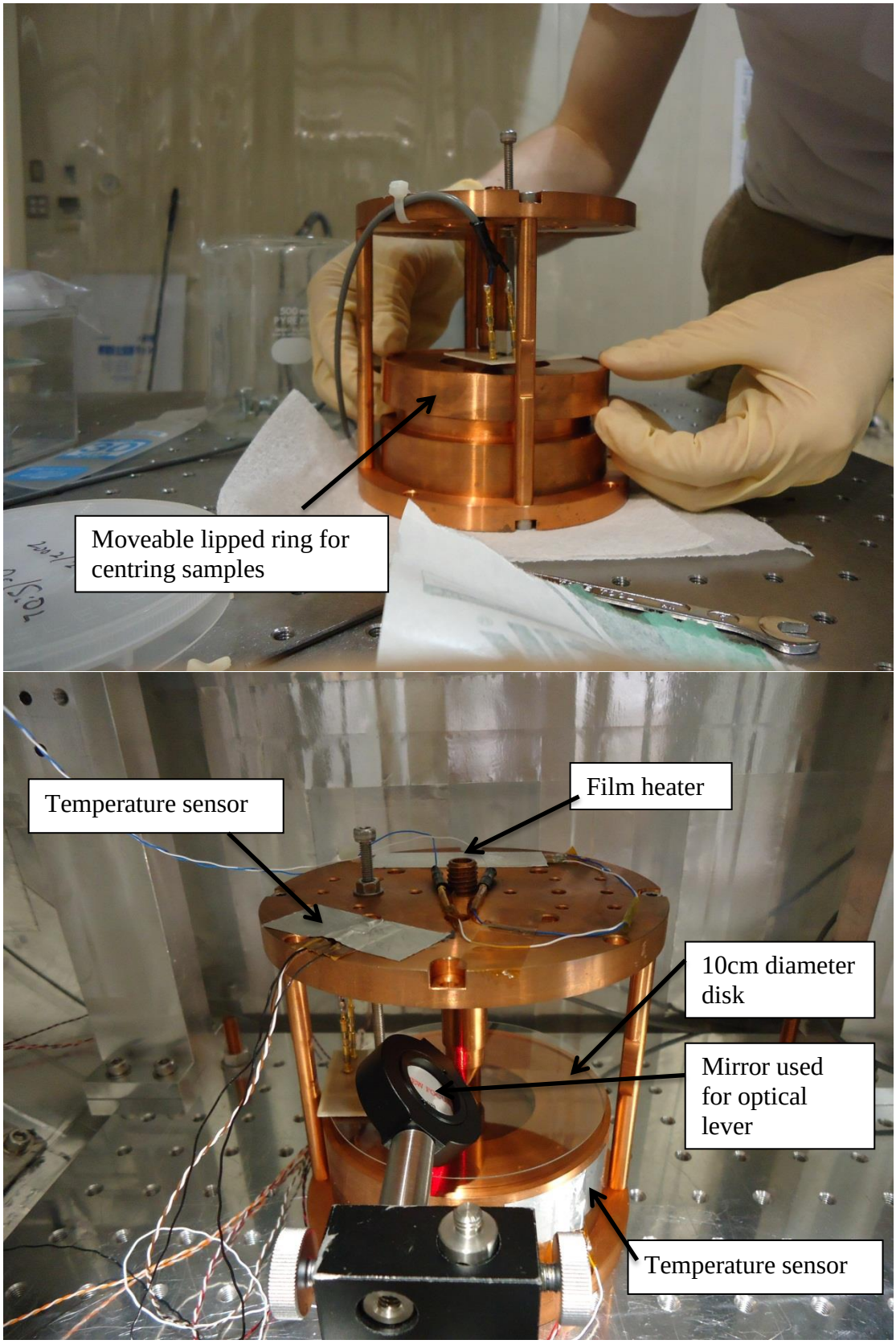
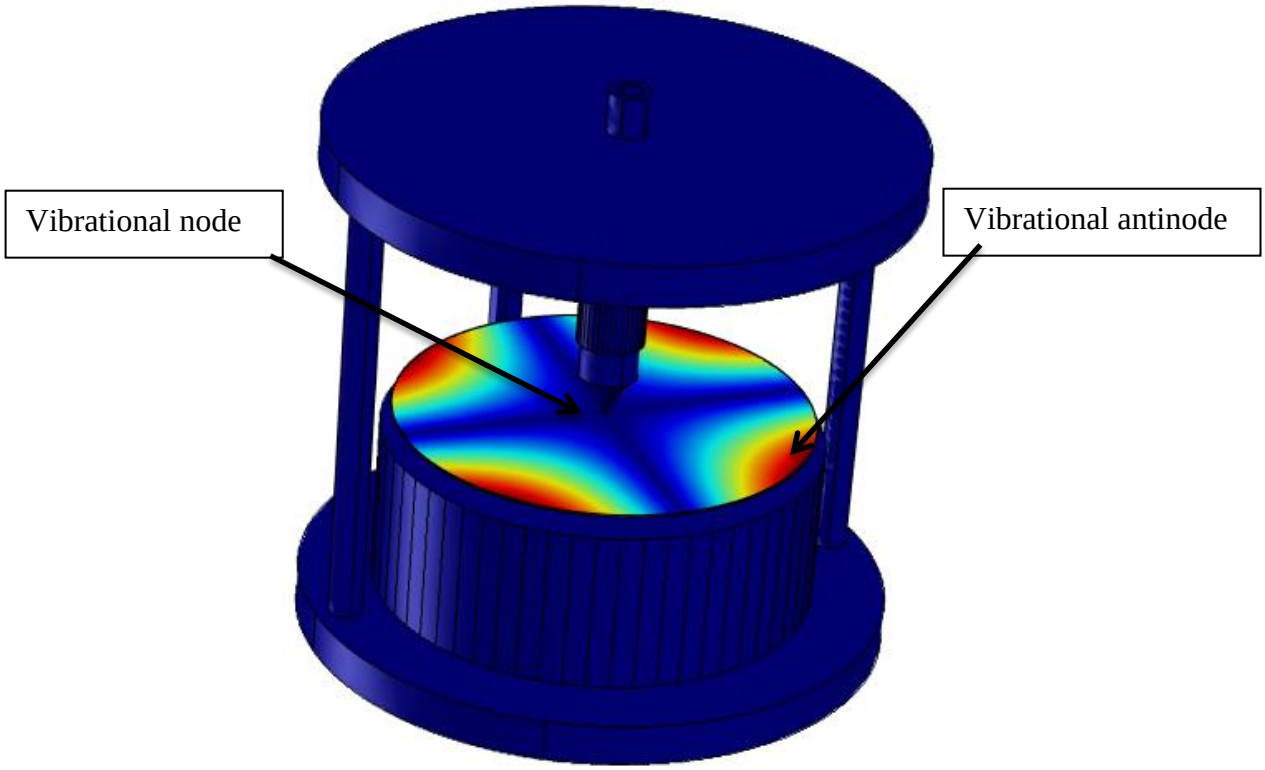
ICRR Nodal Support

The nodal support system used at the ICRR for measuring the mechanical loss of disks is a cylindrical copper frame with a central column which supports a 10cm diameter disk by its centre. The material is copper for its high thermal conductivity, since the system is used at cryogenic temperatures. The central column is rigid underneath the disk and spring loaded from above. This allows samples to be changed quickly and easily. The contact points between the column and the disk are rounded cones, to minimise the area of contact. The disk is centred during placement using a lipped ring which slides up and down to keep the disk in position relative to the contact points. Pictures of the clamp are shown below for more detail. The disk is excited using an electrostatic drive plate, positioned close to the disk. The read out is an optical lever, with the return laser spot being tracked by a split photodiode connected to an oscilloscope, a spectrum analyser and a laptop for data acquisition. The disk suspension system is placed within a cryostat which is pumped out to high vacuum to remove any gas damping, and cooled using a GM cryocooler. All cooling is done by conduction, with appropriate radiation shields in place to limit heat leaks. The minimum temperature achievable is around 12K. Temperature sensors on the top of the structure, on the barrel of the bottom section and on the baseplate read out temperatures which are fed into COMSOL to model the temperature of the disk. This system can be used to measure modes with a central node as shown in the last picture.

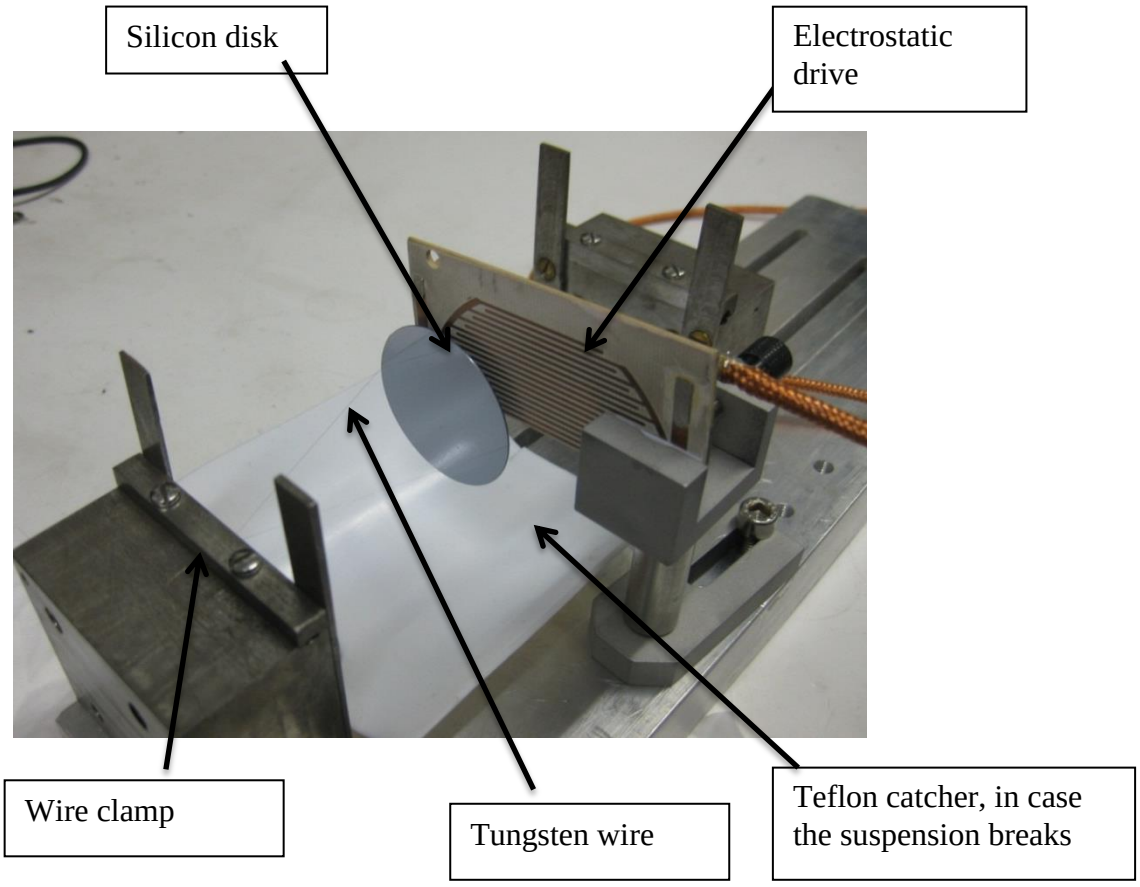



Moveable lipped ring for centring samples
Temperature sensor
Film heater
10cm diameter disk
Mirror used for optical lever
Temperature sensor


Vibrational node
Vibrational antinode

Disk Nodal Support by Suspension – Glasgow

At Glasgow, the mechanical loss of disks may be measured at both room and cryogenic temperatures by suspension using thin wires. This suspension technique involves holding the disk between two taut wires, placed such that they are at the vibrational nodes at the edge of the disk to mitigate energy loss into them. A picture of this suspension technique is shown below. The disks are excited using an electrostatic drive and the vibrational amplitude is measured with an interferometer.



Glasgow Cantilever Systems

At Glasgow there are several cryostats for measuring the mechanical loss of cantilevers at both room temperature and cryogenic temperature. The cantilevers are both coated and uncoated to allow the mechanical loss of various coatings to be deduced. The cantilevers are made from silica (for room temperature measurements) and silicon (for cryogenic measurements). The cantilevers are of dimension 35mm x 5mm x 70µm for silicon and 42mm x 5mm x 150 µm for silica. Each cantilever has a thick block at one end which is placed into the clamp structure to be able to reliably clamp the cantilevers without either breaking them or changing the length significantly between re-clamps while also preventing loss of energy into the clamp. A schematic of an oscillating clamped cantilever is shown below. The clamp is made from stainless steel and is placed within a vacuum chamber which is evacuated to prevent gas damping. The displacement amplitude can be measured with a split photodiode using either an optical lever or shadow readout. Mechanical loss measurements can be made at temperatures between 10K and room temperature.