Beryllium windows for wiggler light

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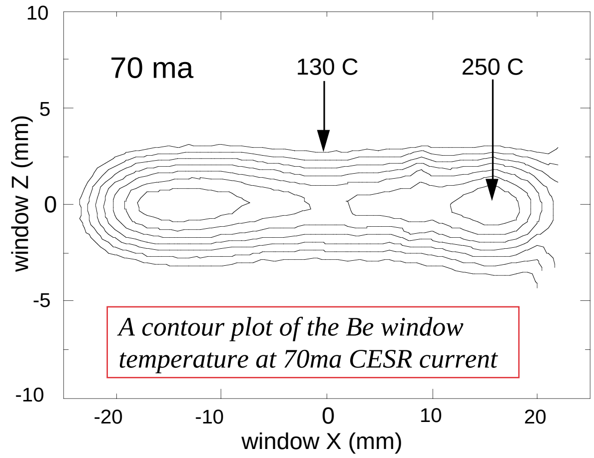
CHESS has an on-going effort to design new and better vacuum chamber x-ray-transmitting windows, an absolute necessity in light of the aggressive plans to increase the CESR current fivefold. At the present 100mA operating conditions, upwards of 7000 Watts of power are produced by the F-line (and new A-line) wiggler, and ~500 Watts are absorbed by the first of three Beryllium windows (typically 0.015 inch thick). Three vacuum-tight Be windows are mounted on water-cooled copper "gaskets" (see photographs) that separate two tee-shaped UHV chambers (see drawing). At only 100mA of current, past windows have shown discoloration, distortions, and in one case, considerable disintegration.

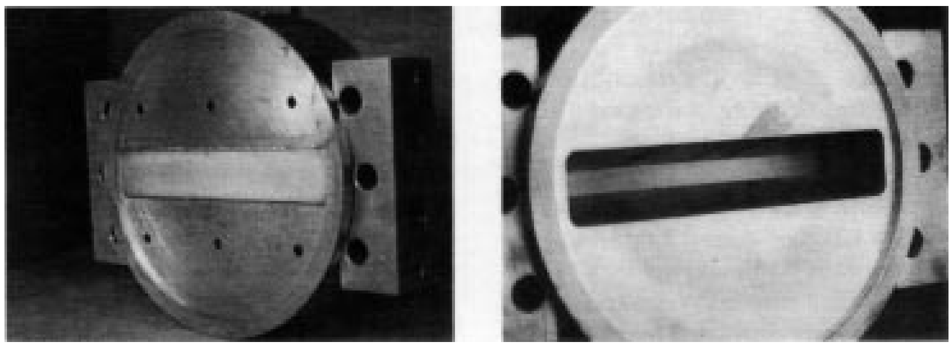
As part of this development project, a 2D scanning Infra-Red camera is being used to monitor the temperature of the Be windows *in-situ*. The IR detector is a thermoelectrically cooled PbSe photodiode, using a CaF_2 optical arrangement to realize a $1mm.^2$ active area. Two computer controlled mirrors are used to scan the entire illuminated area of the downstream side of the first (or second) Be window. An equal-temperature contour plot (above) shows the thermal footprint during stable HEP running. The non-uniformity of the peak temperature is due to optical edge distortions caused by the vacuum chamber.

One and two-dimensional temperature profiles agree very well with ANSYS calculations. Surprisingly, the peak temperatures do not occur during normal beam conditions, but rather, the temperature increases by ~100 ˚C during CESR injection and tuning. At those times, the incident x-ray beam comes into contact with the edge of the Be-Cu junction at the window edge. The absorption of large amounts of heat in the Cu and the good thermal contact to Be results in rapid overheating of the window.

In order to increase window longevity, current designs include a modification to the Cu mask so that the Be-Cu junction cannot be directly illuminated with x-rays, and a thin Carbon filter to reduce the thermal load on the first Be window from 500 to 75 Watts.



A contour plot of the Be window temperature at 70ma CESR current



(Above) Upstream (left) and downstream (right) views of the Beryllium window gasket assembly, as discussed in text. (Below) An upstream view of the mechanical design of the IR viewports on the two UHV chambers between the three Be window assemblies.