# §57. Laser Calibration of the Infrared Imaging Video Bolometer

Parchamy, H., Peterson, B.J. (NIFS),
Konoshima, S. (JAEA)

The energy loss from a magnetically confined plasma due to radiation (such as impurity line radiation) is an important measurement for describing a plasma. The infrared imaging video bolometer (IRVB) with a single large metal foil is a foil bolometer that absorbs the broad band radiation from nearly all spectral regions from the plasma.

The calibration technique of the IRVB gives confidence in the measured values of the plasma radiation that is necessary for tomographic analyses.[1] The foil calibration could be carried out in order to obtain local foil properties such as the thermal diffusivity, $\kappa$, and the product of the thermal conductivity, $k$ and the foil thickness, $t_f$, of the foil.[2] These quantities are necessary for solving the two-dimensional heat diffusion equation of the foil which is used in the experiments. A schematic of the camera calibration and foil calibration setup is shown in Fig.1. For camera calibration (the IR camera calibration is made to determine the foil temperature from the IR camera signal) a heat lamp can be mounted behind a plate which is blackened with graphite in the same manner as the foil. Calibration of the foil was made in-situ using a HeNe laser (~ 27 mW) as a known radiation source to heat the foil from the IR camera side using a beam steerer and IR mirror. The calibration parameters are determined by comparing the measured temperature profiles and their decays from the experimental results (from laser profile on the foil) with the corresponding solution to the heat diffusion equation.

The IR thermal data from the foil during a steady state condition for the experiment can be taken by the IR camera to get the steady state data. The temperature profile is fitted to a 2-D Gaussian, to find the coefficient parameters. This is shown in Fig.2. The heat diffusion equations in two dimensions have been solved analytically by using the FEM. Then a 2nd order polynomial is fitted to the relationship between $1/k \bullet t_f$ and the temperature rise ($\Delta T$), so that the appropriate value of the $k.t_f$ could be determined from the experimental value of data.

The resulting temperature decay data is fit to the exponential equation to find $\tau$ then a 2nd order polynomial is fitted to the relationship between the inverse of the thermal diffusivity and the decay time and used to find the appropriate value of the thermal diffusivity ($\kappa$) of the foil from the experimental value of the decay time. These results are shown in Fig. 3.

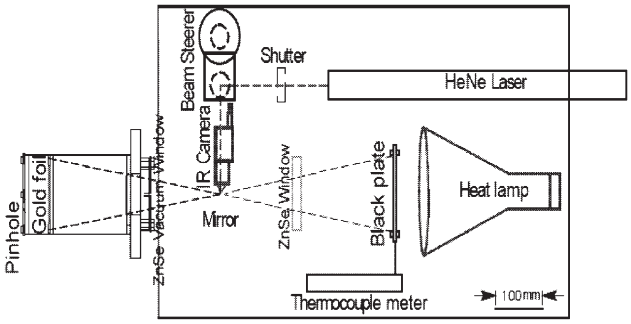

**FIG. 1.** Drawing of Calibration setup for the IRVB calibration.

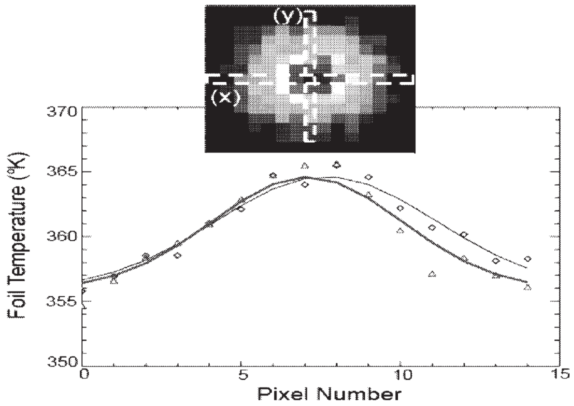

**FIG. 2.** The temperature profile is fitted to a 2-D Gaussian,thin line and diamonds symbol are from y direction of IR thermal data and Thick line and triangle horizontal symbol are from x direction.

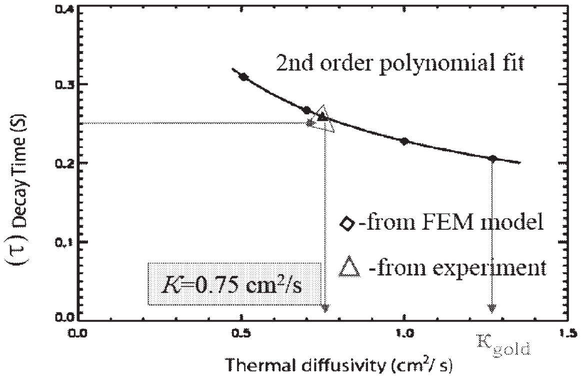

**FIG. 3.** A 2nd order polynomial is fitted (line to the $\kappa$ and $\tau$ data from the FEM to find the appropriate value of the thermal diffusivity of the foil (nominal value of $\kappa_{Gold}$ = 1.27 cm$^2$/s) from the experimental value of the decay time.

**Reference**

[1]B. J. Peterson, *et al.*, Rev. Sci. Instrum. **74**, 2040 (2003).

[2]H. Parchamy, *et al.*, Sub. to Rev. Sci. Instrum. (2006).