§24. Improvements of Imaging Bolometers at LHD

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Imaging bolometers are a reactor-relevant alternative to resistive bolometers for the measurement of total radiated power from a fusion plasma [1]. They rely on a single thin metal foil which absorbs the incident radiation from the plasma as collimated by an aperture. The resulting temperature change of the foil is then measured by an infrared camera located outside the vacuum vessel.

A possible means to increase the sensitivity of the imaging bolometer is to raise the operating temperature since from Planck's Law it is known that the black body radiation intensity increases and the emitting wavelength decreases as the temperature is raised. For an InSb detector which is sensitive to radiation in the wavelength range of 3 – 5 μm the optimum temperature range is approximately 750 – 1400 °C. This temperature range also corresponds to the operating temperature of the first wall of ITER of about 800 °C which is where the imaging bolometer foil will be located.

To prove the above mentioned statements there were two experiments planned. The first one was aimed at the quantitative characterization of the sensitivity depending on the temperature. The second one considered the qualitative and quantitative characteristics of the local temperature distribution within a laser exposed area on the foil.

The results of the first experiment showed that for temperatures from 22 C up to 330 C the sensitivity dependency on temperature is close to linear. The fitting polynomial coefficients are following: 892-18x + 0.21 x ^2 For sensitivity we assume the following expression,

$$\Delta S=(S_{l.on}-S_{l.off})/t_i, \qquad (1)$$

where $S_{l.on}$ - is the camera signal with the laser on, $S_{l.off}$ - is the camera signal with the laser off, t_i - is the camera integration time. Figure 2 shows how ΔS depends on a frame temperature; also we've included a heaters voltage waveform. It is obvious that the sensitivity increases with temperature growth and the dependence is close to linear.

Figure 3 shows three temperature line profiles for the laser

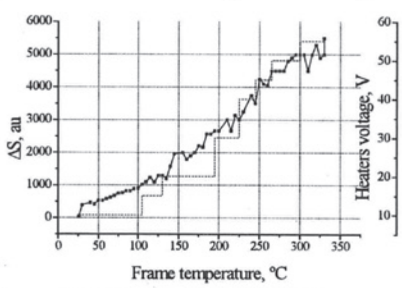

Fig.1 sensitivity over frame

exposed area of the foil with different frame temperatures.

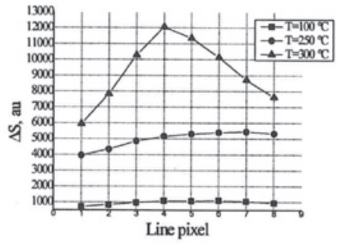

Fig.2 Line intensity of a laser spot

Also, current calibration procedure was found to be inadequate. The calibration procedure explained in [3] in details. Figure 3 shows the results. The picture doesn't show any reasonable pattern. We have found out the reason and it was because of laser power change due to the window which the laser beam goes though transmission un-uniformity. After mapping the window un-uniformity, we have corrected that. Figure 4 shows the foil temperature weighted on the laser power after correction. The calibration procedure became too complicated and needs to be revised.

We are now developing the new calibration layout taking into

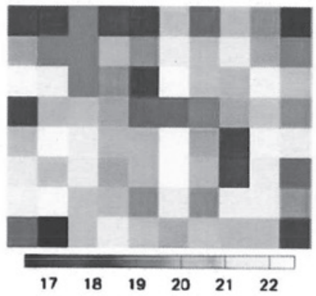

Fig. 3 foil temperature peak change

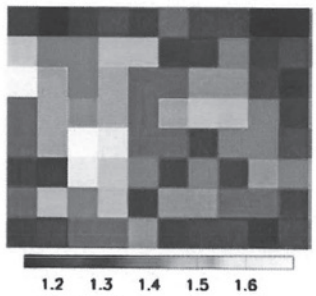

Fig. 4 foil temperature peak change weighted

account those results.

1. B.J. Peterson et al., Plasma Fusion Res. **2** S1018 (2007).
2. B.J. Peterson et al., Rev. Sci. Instrum. **74**, 2040 (2003).
3. H. Parchamy et al., Plasma Fusion Res. **2** S1116 (2007).