MEASUREMENT OF PLASMA EMISSION PROFILES IN THE RANGE FROM 800 - 1000 nm FOR Z_{EFF}-ANALYSIS IN ASDEX

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We report the attempt to use the 16-point ND-YAG Thomson scattering device on ASDEX (Fig. 1) for measurements of plasma radiation profiles as well. The system offers the possibility to measure three spectral ranges simultaneously: 780 - 880 nm, 900 - 970 nm and 985 - 1020 nm.

The plasma light can be analysed in two different ways:

As the Thomson scattering system is only transparent to high-frequency signals because of the AC coupling of the avalanche diodes, direct measurement of the plasma light calls for a fast chopping technique. This is achieved by a special chopper wheel (Fig. 2) in front of the large observation lens which interrupts the plasma radiation fast enough (chopper frequency 3 kHz).

On the other hand, without the installation of the wheel, it is possible to determine the plasma radiation by analysing the radiation shot noise signal (Fig. 3) which is necessarily detected during each Thomson measurement.

Both of the two possibilities have been applied. The first has the advantage of delivering the time evaluation of radiation profiles. The installation of the chopper wheel in the present form, however, doesn't allow simultaneous measurements of the Thomson scattering, and the lack of n_e, T_e profiles prevents direct comparison of the measured radiation with bremsstrahlung in the same discharge.

The second method yields averaged results during selectable time intervals of the order of a few 100 msec or more. The calibration of the noise signals is done by illuminating the avalanche diodes by LED's with different intensities. Owing to the simultaneously measured Thomson scattering profiles this method allows comparison with actual bremsstrahlungs profiles.

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The two methods show rough agreement of the brightness profiles, which are nearly the same in the 3 spectral channels. In both cases the signals show relatively large statistical errors. The reason is the relatively weak plasma radiation in the infrared and the poor transmission of the electronics even at a chopper frequency of 3 kHz, on the one hand, and the small amplitude of the noise signals, on the other hand.

The absolute calibration of the measured plasma radiation can be done by comparing the signals with Thomson scattered signals in combination with the corresponding electron density and temperature. As the same observation system is used for Thomson scattering and plasma light measurements, only laser power in the observation volume and the length of the scattering volume must be known additionally.

Another method of Z_{eff} calibration is comparison with values gained by using the measured electron temperature profiles in conjunction with classical resistivity for well-defined ohmic plasmas.

As an example, we show the brightness and Z_{eff} profiles before and after pellet injection in ASDEX. Figure 4 shows the time behaviour of the central electron density measured simultaneously by Thomson scattering. About 12 pellets are injected into the discharge between 1.4 and 1.8 sec. After pellet injection the density keeps the high value for about 0.3 sec without any gas puffing. Figure 5a shows the Abel-inverted radiation profile averaged over the 3 spectral channels in the ohmic phase (averaged from 0.5 - 1.3 sec), and Fig. 5b the profile in the high-density phase from 1.7 - 2.0 sec. The radiation increases by a factor of more than 20 and scales as $n^2/\sqrt{T}$ (bremsstrahlung). The scaling already indicates that there is no essential change of Z_{eff} due to pellet injection. The corresponding Z_{eff} profiles are shown in Fig. 6a,b.

The results show that combined measurement of Thomson scattering and plasma radiation profiles is possible and reasonable. In a new system, e.g. for ASDEX Upgrade, we include this method by adding a second exit with dc-coupling for measuring plasma radiation directly without the complications of high-frequency coupling.

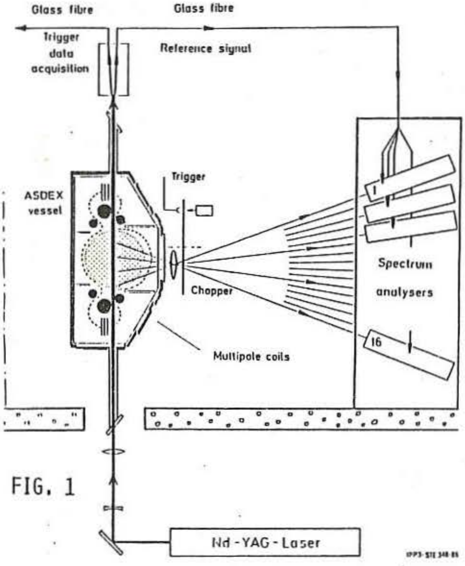


FIG. 1

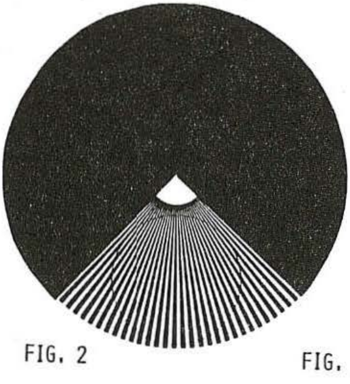
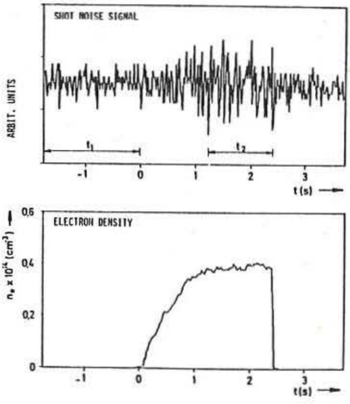


FIG. 2

FIG. 3



PELLET INJECTION

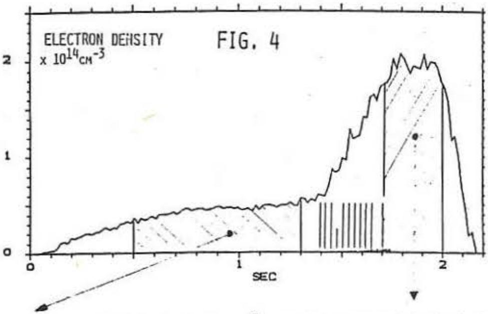


FIG. 4

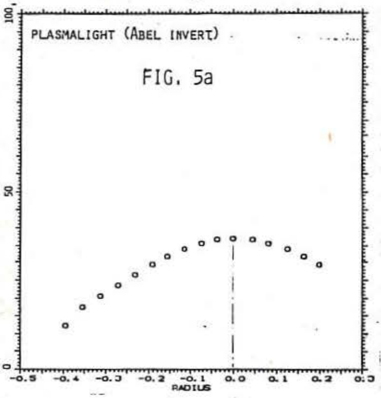


FIG. 5a

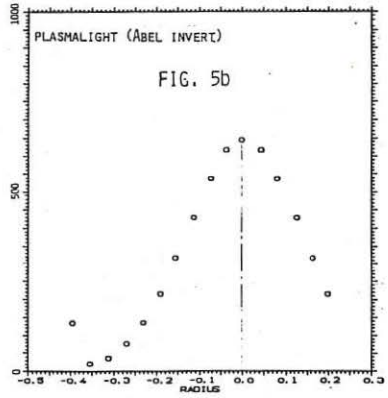


FIG. 5b

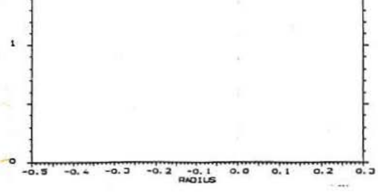


FIG. 6a

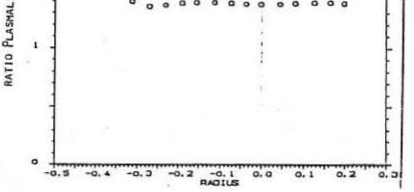


FIG. 6b