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Design of a NIR Spectrometer for Aditya-U Tokamak and Initial Results.

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The hydrogen line series is a sensitive diagnostic of detached divertor. Divertor plasma is characterized by low temperature (1-10 eV) and high density (1019~1020 m-3). The three body recombination dominates the divertor region and is highly sensitive to the divertor plasma Te and ne. Based on earlier experiments, NIR (800 nm-2300 nm) spectroscopy system is designed for Aditya-U tokamak since it can be used for machine protection, plasma control and performance evaluation. Three experiments are proposed here. First is the spectral survey for Paschen H line series and low-Z impurity monitoring. The second one is to provide a validated background emission for divertor Thomson scattering experiments wherein blackbody radiation, bremsstrahlung, recombination and impurity lines contribute largely to the background noise. The third is the measurement of Br9/Paα intensity ratio as it is a possible Te sensitive diagnostic.
The signal estimation for the Paα line for present plasma parameters has been carried out in the edge region of Aditya-U tokamak. Since the dark current levels of the commercially available detectors in the NIR range is significantly high (10 Ke-/p/s), signal estimation becomes important. Theoretical estimation of the line and bremsstrahlung emission for the Paα line using the atomic data from the ADAS database has been done [2]. These are found to be ~3*108 and 1.5*108 photons cm-2 s-1 for ne= 1*1012 cm-3, Te=15 eV and nn=7*109 cm-3 respectively. The intensity estimates are well above the dark current levels of the detector. In order to observe clearly resolved spectra, the design and selection of the spectroscopic system comprising of the spectrometer, grating, detector and the collection optics plays an important role. This is also discussed in this work. With this system and with proper line of sight collection optics and optimization for maximum throughput, we can provide information on the plasma control, divertor recycling and machine protection. Initial results namely the survey spectrum and the plasma electron density and temperature estimates will be presented for various Aditya-U plasma shots and a comparison with other existing diagnostics will be presented.

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