Design and Operation of a Frequency Doubled Nd:YAG Thomson Scattering System with Transmission Grating ICCD Spectrometer

N.L. SCHOENBECK, A.S. DOWD, R.J. FONCK, D.J. SCHLOSSBERG, G.R. WINZ, University of Wisconsin-Madison — A novel Thomson scattering system has been deployed on the Pegasus Toroidal Experiment. It provides a relatively low-cost, simplified design. Scattering is achieved using a 7 ns, 2 J frequency doubled Nd:YAG laser operating at 532 nm. The laser focuses to \(~3\) mm diameter within the plasma via a 7 m beam-line. The beam-line contains cameras as beam finders and remotely adjustable mirrors for shot-to-shot alignment. A custom multi-element lens collects scattered photons from \(15\text{ cm} < R_{maj} < 85\text{ cm}\) with \(1.2\) cm radial resolution. Eight fiber optic bundles provide 8 spatial points for sampling the laser or background light. Each set of 8 channels is measured in a single spectrometer that utilizes a high efficiency (\(~80\%)\) volume phase holographic grating and a high quantum efficiency (\(> 40\%\)) image intensified CCD (ICCD) camera. Three spectrometers provide a total of 24 channels. Two interchangeable gratings exist to cover low (\(T_e = 10\text{–}100\text{ eV}\)) and high (\(T_e = 0.10\text{–}1\text{ keV}\)) electron temperature regimes on Pegasus. The spectrometer is optimized for \(n_e\) from \(\text{mid-10}^{18}\) to \(\text{mid-10}^{19}\text{ m}^{-3}\). The signal-to-noise expected is \(~0.5\) of an equivalent system using Nd:YAG at 1064 nm and avalanche photodiode detectors.

\(^1\)Work supported by US DOE Grant DE-FG02-96ER54375 and the American Recovery and Reinvestment Act.

M.W. Bongard
University of Wisconsin-Madison