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ALPHA PARTICLE KINETICS IN IGNITED
FUSION PLASMAS:
DESIGN APPLICATIONS FOR A CO₂
LASER THOMSON SCATTERING EXPERIMENT

Final Report

August 1989 - Dec 1993

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- i) Technical achievements during the initial budget phase of this study consists of work accomplished under the following categories:

a) Hot Cell Notch Filter

A variable temperature absorption cell was designed and fabricated, which was capable of containing pressures of CO₂ from zero to one atmospheres at temperatures as high as 1000 degrees Kelvin. The 1.5 m cell exhibited an optical thickness of nearly four at temperatures above 800 degrees Kelvin (See Figure). Using this information, we designed and fabricated a triple-pass cell with one-inch clear aperture, which would provide an attenuation of about 67,000 for non-doppler shifted CO₂ laser radiation, while attenuating radiation shifted more than 6GHz less than about a factor of two. This was more than sufficient to shield our detectors from observed stray radiation levels.

b) System Integration

The hot cell was integrated into the signal beam line and was found to introduce an acceptably small decrease in post detection signal to noise ratio. By June 1990, the entire system was aligned so that the receiver antenna beam passed through ATF and onto a remote

calibration blackbody source; the pulsed CO₂ laser was also aligned through ATF and into a beam dumped situated to achieve a 0.86 degree scattering angle. Background receiver measurements during ATF shots revealed no perturbations due to reactor movement and magnetic field fluctuations. With the entire system in a data-ready condition, we fired our first full power test pulse through ATF; unfortunately, the coated ZnSe windows on ATF failed under this radiation load, and we were forced to redesign using uncoated brewster angle ZnSe windows for the reactor. These modifications were costly, mostly in time, since large pieces of ZnSe had to be special ordered and extensive design and fabrication efforts were required to integrate these innovations. Nonetheless, in about three weeks, we were again ready to proceed with realignment of the system. As we approached a new data-ready condition, an ORNL administrative priority concerning laboratory-wide laser safety terminated our experiment beyond an October 1 shutdown of ATF. We were, however, able to determine that the new brewster windows design was adequate to withstand the pulsed laser beam and that the hot cell notch filter provided more than adequate protection from observed stray radiation levels.

- ii) In the two week period just prior to the 1993 shutdown of ATF, we were able to make the planned scattering

measurement. The experiment was a complete success, and the feasibility of our approach was unambiguously demonstrated. These measurements have been reported in the following article:

R.K. Richards, D.P. Hutchinson, C.A. Bennett, H.T. Hunter, and C.H. Ma,
"Measurement of CO₂ Laser Small Angle Thomson Scattering on a Magnetically
Confined Plasma", Appl. Phys. Lett **62**(1), 28(1993).

OPTICAL THICKNESS VERSUS TEMPERATURE

10P20 LINE

DATE

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