22P117-P

Development of two color laser interferometer/polarimeter
２波長レーザー干渉・偏光計測の開発

Kazuo Kawahata[1], Tsuyoshi Akiyama[1], Kazuya Nakayama[2], Shigeki Okajima[2]
川端一男[1], 秋山毅志[1]，中山和也[2]，岡島茂樹[2]

[1]*National Institute for Fusion Science*
322-6 Oroshi-cho, Toki-shi, Gifu 509-5292, Japan
核融合科学研究所　〒509-5292　岐阜県土岐市下石町322-6

[2]*Chubu University*
Matsumoto-cho, Kasugai-shi, Aichi 487-8501, Japan
中部大学　〒487-8501　愛知県春日井市松本町

Two color laser diagnostics using THz laser sources are under development for a high performance operation of the Large Helical Device and for future fusion devices such as ITER. So far, we have achieved high power laser oscillation lines simultaneously oscillating at 57.2 μm and 47.7 μm by using a twin optically-pumped CH3OD laser, and confirmed the original function, compensation of mechanical vibration, of the two color laser interferometer. In this article, recent progress of the two color laser polari-interferometer will be presented.

1. Introduction

Measurement of the plasma current density profile is indispensable for the so-called advanced modes of tokamak operation. In ITER, a poloidal polarimeter based on the Faraday effect of a far-infrared laser beam passing though the plasma has been designed[1] to measure the profile. A 118.8-μm CH_3OH laser line is proposed as a probing light source for the polarimeter, since the CH_3OH laser line is the shortest and high power far infrared laser oscillation line among many oscillation lines applied on fusion devices so far. The Faraday rotation angles expected in ITER are large enough to be measured accurately. However, the Cotton-Mouton effect is also large, and then should be taken into account for evaluation of the rotation angle. Therefore, we have been developing shorter wavelength laser oscillation lines[2] around 50 μm, since the Faraday rotation angle is still large enough and the Cotton-Mouton effect is small enough. Another advantage of adapting 50 μm is to reduce the beam bending effect to a quarter of that at 118.8 μm. Here, development of a two color laser interferometer/polarimeter is described.

2. Two Color Laser Interferometer/Polarimeter

Figure 1 shows a schematic drawing of the two color laser interferometer[3,4] combined with a polarimeter. The system consists of a twin terahertz laser which simultaneously oscillates at 57.2 μm and 47.6 μm, beam splitters (BS), beam combiners (BC), and phase/rotation detection systems. In the phase detection part, Ge:Ga photoconductors (D1 and D2) detect two color beat signals having different beat frequencies. Figure 2 shows the frequency spectrum of two color beat signals at 1.2 MHz for 57.2 μm and 0.55 MHz for 47.6 μm. It can be seen in this figure that the signal-to-noise ratio is excellent to be about 40 dB. The interference signals detected are separated electronically, and then introduced into phase comparators for phase measurement. In the Faraday rotation detection part, one wavelength is selected by using a Fabry-Perot interferometer (Filter), and its polarization rotation is detected with a dual photo-elastic modulators (PEMs)[5] made of highly resistive silicon.

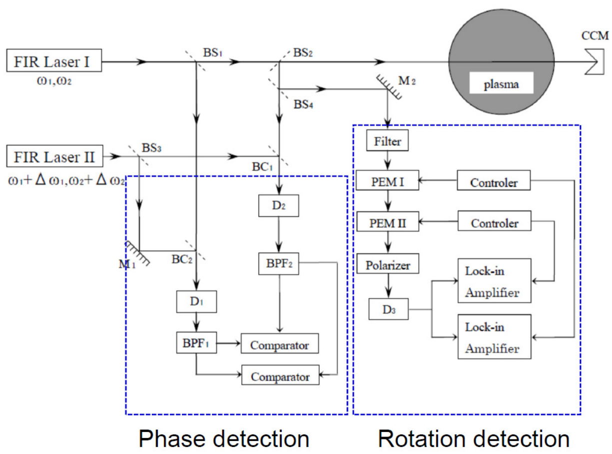
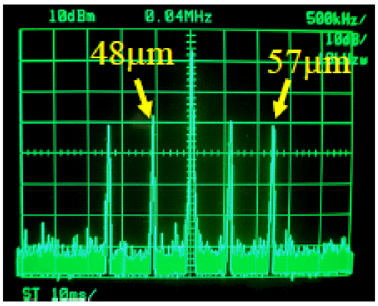


Fig.1. Schematic drawing of a combined system of the two color laser interferometer/polarimeter.



500 kHz/div.

Fig. 2 Two color beat signals detected by the Ge:Ga photoconductor. The spectrum analyser trace shows two color beat signals corresponding to a 57.2 μm beat of 1.2 MHz and a 47.6 μm beat of 0.55 MHz.

3. Simultaneous Measurements of A Phase Shift and A Rotation Angle

In order to simulate a phase shift caused by plasma, we have applied a gas cell as is shown in Fig. 3. The gas cell of 24 cm in length can be pumped down, and filled with air or other gasses with known indices of refraction. Figure 4 shows time behaviors of pressure of a gas cell (a), phase shifts of two color laser interferometers (b), and polarization angle (c). (d) and (e) are the expanded scale plots of the polarization angle and the phase shift. The magnitude of the phase shift is close to the value estimated by using the refractive index of air (n = 1.0002726 in the condition of the atmospheric pressure and 18 degrees). Large amplitude signals are seen in the traces (d) and (e), which are considered to be due to a nonlinear effect of the silicon windows of the gas cell caused by the pressure difference.

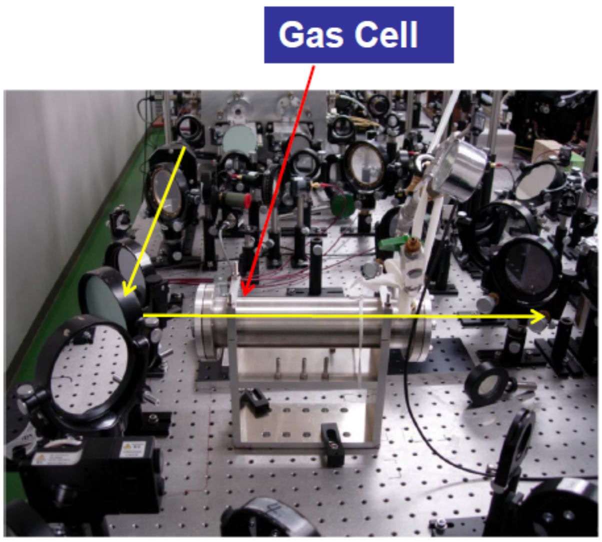


Fig. 3. A photograph of the bench testing of the two color laser interferometer/polarimeter.

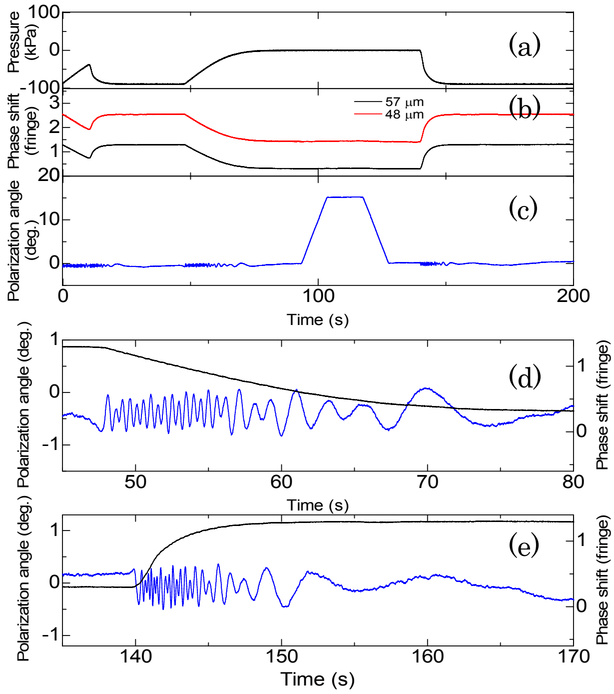


Fig. 4. Time behaviors of (a) pressure of a gas cell, (b) phase shifts of two color laser interferometers, and (c) polarization angle. (d) and (e) are expanded scale plots of the polarization angle and the phase shift.

Acknowledgments

This work was supported in part by a Grant-in-Aid for Science Research from the Japanese Ministry of Education, Culture, Sports, Science and Technology (Grant No. 22360393) and also by the NIFS budget code of NIFS10ULHH004.

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