§55 Development of Diamond Radiation Detectors for ToF Measurement in Inertial Confinement Fusion

Shimaoka, T., Kaneko, J.H., Tsubota, M., Miyazaki, D. (Hokkaido Univ.),
Arikawa, Y., Azechi, H., Nakai, M. (Osaka Univ.),
Isobe, M.,
Mokuno, Y., Chayahara, M., Umezawa, H. (AIST)

1. Introduction

To achieve effective fast ignition, studies on stability of implosion, behavior of core plasma, heating dynamics by high-energy electrons and dynamics of neutron production are important. However, huge amount of adjoining X-rays caused by high-energy electrons at fast ignition is obstacle against neutron measurement above mentioned. As results, neutron bang time or burn history measurements have not been succeeded under fast ignition at FIREX, because neutron peaks buried in an afterglow of a large pulse caused by the adjoining X-rays on conventional fast plastic scintillator or liquid scintillator.

To realize neutron bang time and/or burn history monitor in future, we tried to adopt a single crystal CVD diamond radiation detector that had fast time response and low sensitivity for X-rays as a time of flight detector to detect neutrons from implosion plasma. We tried to detect neutrons at shots with 10^8 neutrons/shot.

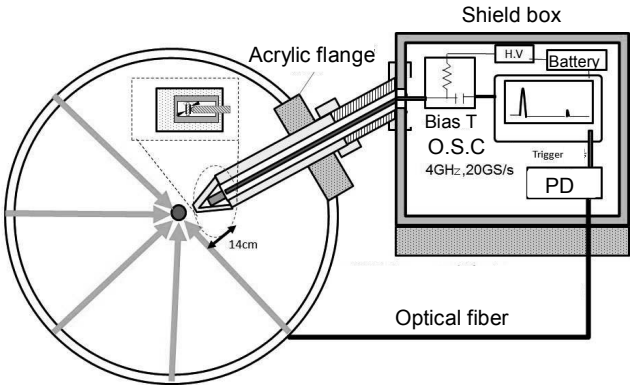

Fig. 1 Schematic drawing of DD neutron ToF measurement system based on a diamond radiation detector.

2. DD neutron ToF measurement with Gekkiko XII laser shots

Figure 1 shows schematic drawing of DD neutron ToF measurement system based on a diamond radiation detector. All measurement system was encapsulated in a metallic shield box and a metallic probe shell. The diamond single crystal was grown in Hokkaido University by a chemical vapor deposition method. A distance between the diamond radiation detector and a target was 14 cm.

3. Experimental results and discussion

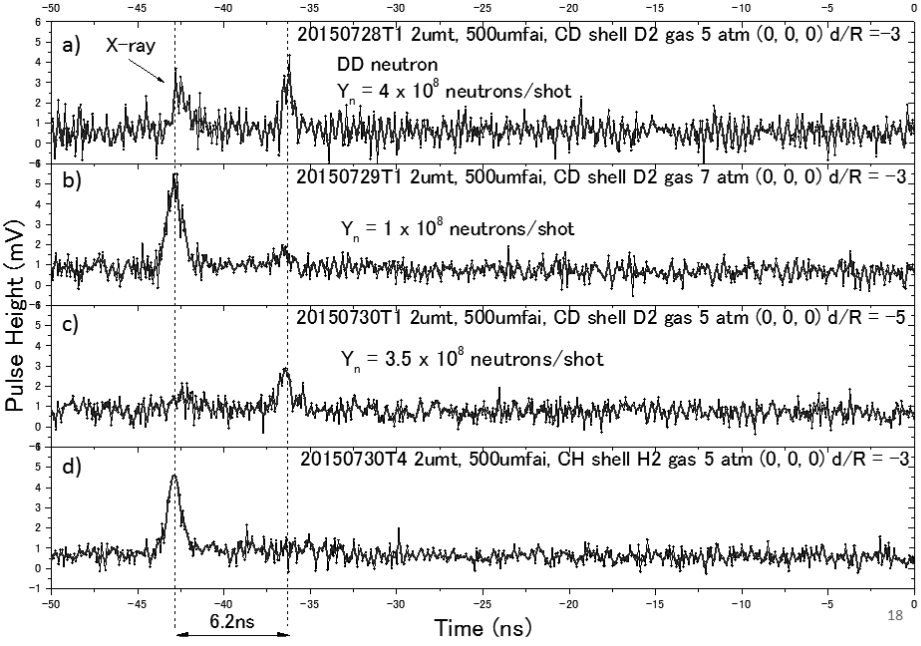

Figure 2 Examples of time responses of the diamond radiation detector for implosion of a), b), c), CD(C_8D_8) shells, and d) CH (C_8H_8) shell.

Figure 2 show examples of time responses of the diamond radiation detector for several implosions; figure 2 a), b) and c) were obtained with CD (C_8D_8) shells, and d) was obtained with CH (C_8H_8) shell for comparison. In figure 2 a), b) and c), peaks caused by adjoining X-rays were observed at t = - 43 ns, and peaks caused by neutrons were observed at t = -37 ns. The time difference of 6.2 ns corresponded to flight length of 14.5 cm between the target shell and the detector. Pulse heights of neutrons were almost proportional to neutron yield of each shot measured by other method. In contrast, no peak appeared at t = -37 on the time response obtained with the CH shell shown in figure 2 d).