# §4. Construction of Electron Spectrometer for FIREX I

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At the diagnostic group of the laser section in Coordination Research Center, we have constructed an electron spectrometer (ESM) collaborating with Institute of the Laser Engineering (ILE), Osaka University. The high-energy electron is generated by a strong electric field based on the interaction between the laser and plasma. In FIREX, the electron generated from the gold-cone irradiated by the heating laser, is utilized to heat the imploded core region. Therefore the high energetic electron measurement is one of the most important issues to realize the ignition. It is also important for the rough energy spectra with angular distribution. We have a plan to prepare some analyzers where are set on different angular positions. Therefore we have been developing ESM with compactness rather than energy resolution.

The magnet and the detector are designed by ILE group. The chamber and other equipments are prepared in NIFS. Figure 1 shows the photograph of the ESM. In order to obtain the wide energy range, the electron beam enters obliquely into the analyzer. The imaging plates (IP, Durr Dental Co.) are used as the beam detector. This has merits about no electrical noise and the wide dynamic range for the intensity. Two IP folders are installed for measurements in high and low energy regions in order to extend observable energy ranges. In Table I, those holder parameters are shown. The analyzer is separated by the small gate valve so as to remove the holders without the vacuum break of the GXII target chamber. The IP is shielded from the lights by the shutter in the holder. The shutter is open just before the installation. The holders with the light shield are brought to IP reader (Vista Scan, Durr Dental Co., 12.5 micron/step, 40 LP/mm). The alignment is performed from the viewing port behind the beam line and the two-dimensional adjusting mechanism.

A neodymium alloy is used as the permanent magnet. The magnet circuit is determined as to minimize the leakage of the magnetic field. The triangle shape of the magnet is chosen due to the compactness and the wide energy range. Therefore small leakage of the magnetic field still remains near the top of the triangle. The two-dimensional magnetic field has been measured every 5 mm. The beam orbit calculation has been done by using the observed magnetic field.

The equation of motion of the relativistic electron beam is given by

$$\frac{d^2x,y}{dt^2} = \mu \frac{eB_z\sqrt{1-(v/c)^2}}{m_0}\frac{dx,y}{dt}, \qquad (1)$$

Here, $m_0$, $c$, $v$, $B_z$, $e$ and $\mu$ are the electron rest mass, the light speed in vacuum, the electron velocity, the magnetic field, the electron charge and the sign (minus for $x$ and plus for $y$), respectively. The equation (1) is solved by using the Ruge-Kutta-Vemer method. The magnetic field at the electron position is estimated from the average of the magnetic fields on nearest mesh points. The electron beam orbits are shown in Figure 2.

We are preparing the calibration using L-band Linac in the Institute of Scientific and Industrial Research Osaka University. The purposes are (a) comparison of the beam orbit with the simulation, (b) the beam intensity calibration. Main energy and current for the calibration are 27 MeV and 0.4 A (1 nC), respectively.

Table I IP holders

| | | |
|---|---|---|
| Cassette I | 25 cm | 1 – 40 MeV |
| Cassette II | 10 cm | 60 –150 MeV |

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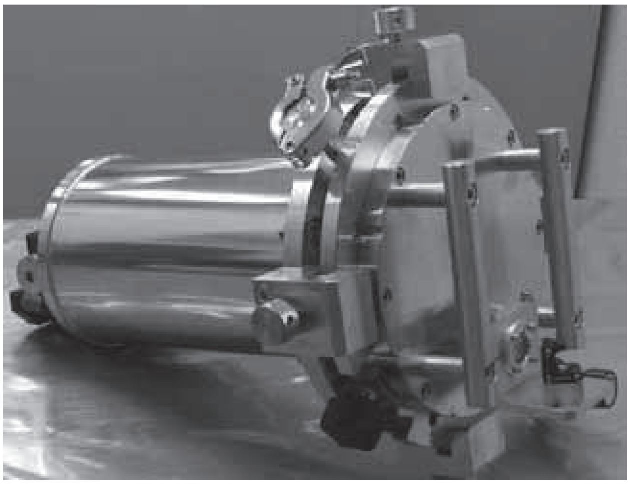

Fig.1 The photograph of the ESM.

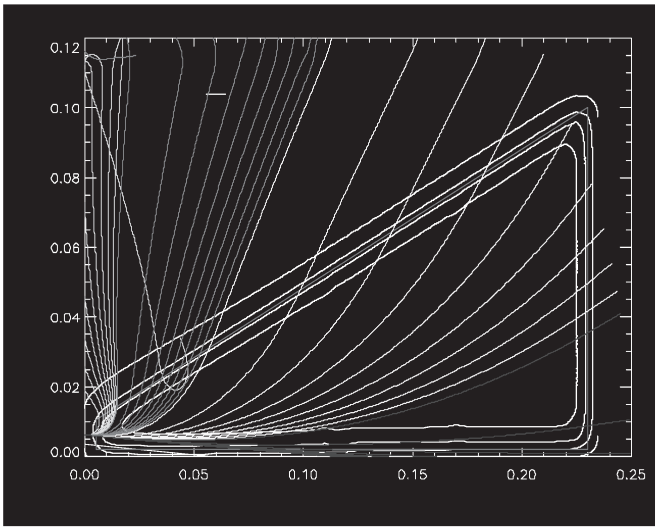


Fig.2 The beam orbits
Red Magnet
White Magnetic field contour
Light blue Beam orbits in 0.1 –0.9 MeV
Violet Beam orbits in 1 –9 MeV.
Yellow Beam orbits in 10 – 90 MeV.