4. Basic, Applied and Innovative Research

NIFS is an inter-university research institute. The most important role is to activate collaborations with researchers in universities as well as to conduct world-wide top level researches. Its relationship with universities is very unique in the world in that the emphasis is put on the collaborations rather than competing with universities and other research institutes.

The largest project in NIFS is the LHD experiment where many researchers from universities join in the experimental programs as collaborations. Although the experimental programs of LHD are discussed and planned in the collaborations with university researchers, a strong leadership of NIFS in the research plans is necessary. There are two other projects in NIFS, namely, numerical simulation reactor project and fusion engineering research project. These projects are also lead by NIFS with clear research purposes.

The programs in basic, applied and innovative research are different from those projects in the sense that the research motivations and purposes in this programs are given from the collaboration researchers in universities. Fusion research is now in the phase of producing D-T reacting plasmas in ITER and strongly concentrated works for big projects is necessary. A large part of research funding is given for big projects and many research programs are prepared for them. However it is also important to establish the academic research base for various scientific field related to the fusion science and to maintain powerful scientific community to support it. In order to realize them, programmatic and financial support to researchers in universities who works for small sciences are important. As an inter-university research institute in fusion science, NIFS has such an important role and the programs in basic, applied and innovative research are prepared for this purpose.

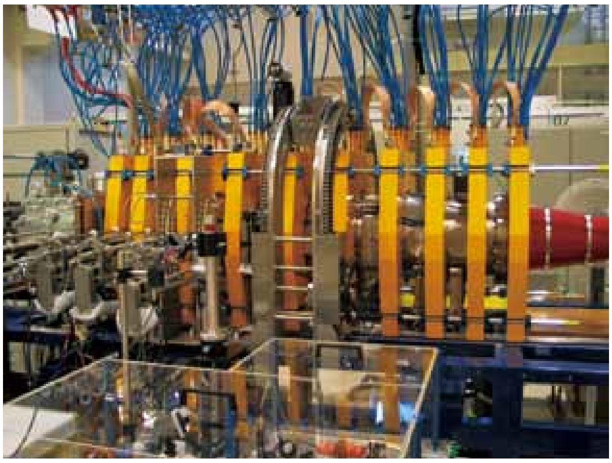

Fig. 1 Side-view of HYPER-I (High Density Plasma Experiment) device.

For the basic plasma science, NIFS operates several experimental devices and offers opportunities to utilize them in the collaboration program for university researchers. A middle-size plasma experimental device HYPER-I (Fig. 1) is prepared for basic plasma researches. Plasmas are produced with 80 kW CW micro-wave of 2.45 GHz and high density plasmas ($n_e > 10^{19}m^{-3}$) are obtained with the special heating scheme for overcoming the cut-off density of microwave. Several kinds of gas species are used with precise mass flow controllers. The neutral density is also carefully controlled as well as the plasma density to give well-defined experimental conditions. Reliable infrastructures for the device operation and full set of diagnostics provide useful environment for collaboration researches. Proposals of basic plasma physics are reviewed in the general collaboration research category and supported with fundamental research costs and trip expenses for making collaborations. Recent research topics of HYPER-I device are 1) fine measurements of neutral particles with laser induced fluorescence method, 2) new method of neutral density measurement with acoustic sound, 3) development of novel laser diagnostics based on the optical vortex.

Although the atomic data of tungsten ions are strongly required for good operation of ITER, the next generation nuclear fusion plasma device, especially atomic data of highly charged tungsten ions are not available in present. In order to generate ions of such a highly charged-state it is necessary to operate the electron beam ion trap (EBIT).

For the spectroscopic study of highly charge-state ions, we have developed a new compact EBIT (CoBIT) at NIFS (Fig. 2). The electron energy range of CoBIT is from 100 to 2500 eV and the electron current is 30 mA, which is suitable for this purpose. CoBIT has six ports that are currently used for the extreme ultraviolet (EUV), the vacuum ultraviolet (VUV), the visible spectrometer, and the gas injector. The measurement wavelength range is from 1 nm to 2000 nm using three types of spectroscopes. As a vapor of tungsten carbonyl ($W(CO)_6$), tungsten

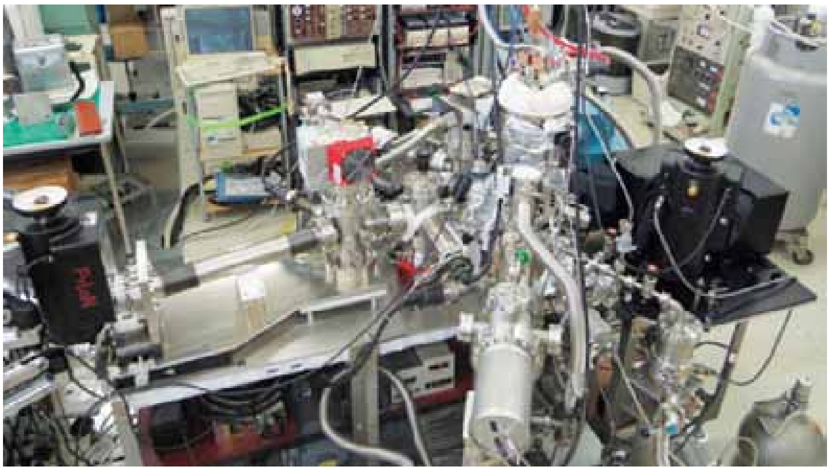

Fig. 2 Experimental apparatus of compact electron beam ion trap (CoBIT).

is injected from a gas injector. By adjusting the electron beam energy to the ionization energy of tungsten ions, the charge state of tungsten spectral lines can be identified.

It is possible to observe EUV, VUV, and visible spectra of highly charged tungsten ions, which are unreported lines, by using this CoBIT. These lines are possible to identify by comparing theoretical calculations with the wavelengths.

In addition to the collaboration support with experimental facilities in NIFS, various small experiments conducted in universities for the basic plasma science are supported by NIFS for its operational cost and most importantly giving the community network relationship for the research information exchanges and personal exchanges. Large part of scientific topics for these university collaborations are the development of various plasma diagnostics, physics of ion spectroscopy and studies of ion and electron impact phenomena on various material. On the other hand, supports to plasma experimental devices in university are given to the MPD (magneto-plasma-dynamic) device in Tohoku university for the fast flow dynamics, the FRC experiment for high beta plasma confinement in Nihon university and the merging spheromak experiment UTST in Tokyo university.

For the applied plasma science, the effects of the application of strong microwave power on various materials were studies in the NIFS collaboration program. Imaging science of the microwave irradiation for the medical use is also supported in the hardware development and software production. A progress in the Microwave Computed Tomography (MWCT) was made with a scope of the application to the breast cancer diagnostics without pain nor X-ray radiation exposure to human body. A special microwave receiver DiLDAS (Dielectric Laminated Dipole Antenna with Shield) was developed and a preliminary test was completed.

For the innovative programs which are very important part of the research institute with the academic base, two research programs for developing new concepts of stellarator experiment are supported. One is for the basic discussions for the new heliotron concept based on LHD experiment and another is to develop an advanced stellarator concept prepared for the first stellarator experiment CFQS in China (Fig. 3). The latter program is based on the magnetic configuration design program of CHS-qa, which was conducted at NIFS for the quasi-axisymmetric stellarator concept. These two programs should be strongly linked with the discussions of next generation program of NIFS.

(S. Okamura)

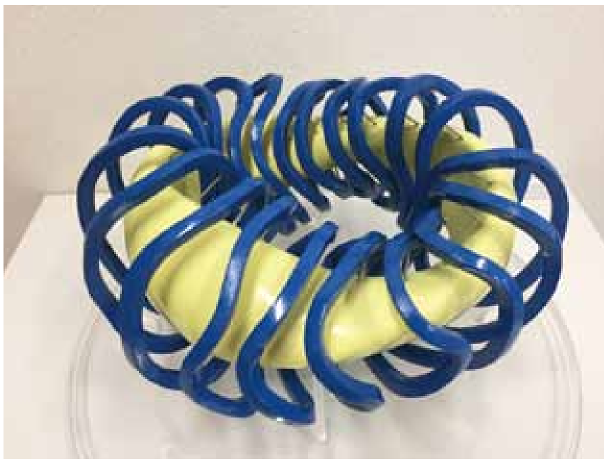

Fig. 3 Model picture of CHS-qa quasi-axisymmetric stellarator.