

## Operation of TIARA Dedicated to R&D on Materials and Biotechnology

*Tuesday 16 September 2014 09:20 (20 minutes)*

The Takasaki Ion Accelerators for Advanced Radiation Application (TIARA) is an ion beam accelerator complex consisting of a K110 cyclotron and three electrostatic accelerators, which is dedicated to R & D on materials and biotechnology. It provides, for example, microbeams/single-ion hits for irradiation/analysis with high-spatial resolution and scanned/defocused beams for uniform and simultaneous irradiation over a wide area.

Beam times used for these experiments at the cyclotron take several minutes to some hours, very shorter than those used for physical study or medical treatment. This specificity characterizes the operation of the TIARA, typically the cyclotron as follows. Beam energy and/or ion species are changed over 200 times every year. More than 30% of about 3200-hours annual operation time is spent for tuning of the ion source and the cyclotron and beam transportation. While the total beam time required by users exceeds twice of the provided one.

The following measures are therefore taken to minimize beam time loss due to troubles at the cyclotron.

- \* Careful and systematic maintenance scheduled over years to avoid significant troubles.

- \* Quick recovery from small troubles by well-trained in-house staffs and operators.

- \* Recording of troubles, their source and recovering measures into a searchable database.

These measures lead to a high ratio of the actual beam time to the scheduled beam time, 99% or higher for recent several years.

A number of technologies on the cyclotron and beam irradiation were developed to meet requirements of users, e.g. shortening of tuning time. The topical technologies are as follows;

- \* High stabilization of the cyclotron magnetic field resulted in stable beam intensity.

- \* Quick change of beam energy and/or ion species by cocktail beam acceleration.

- \* Microbeam formation with 1 pm spatial accuracy for biological irradiation experiments

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**Session Classification:** Fulfilling User Requirements at Various Types of Facilities