Superconducting transition edge sensor for heavy ion detection

Main author:

OHNO Masashi

Co-authors:

Irimatsugawa Tomoya, The University of Tokyo
Matsuzaki Hiroyuki, The University of Tokyo
Miyake Yasuto, The University of Tokyo
Ohno Masashi, The University of Tokyo
Ohno Masashi, The university of tokyo
Takahashi Hiroyuki, The University of Tokyo

Heavy ion cancer therapy allows the tumors to destroy while sparing surrounding, healthy tissues. Heavy ions penetrate into the body to a specific depth, and the dose is concentrated in the very small volume in which the ions come to a stop. By controlling the incident energy of heavy ions, the penetration depth can be adjusted precisely to the tumor area. Precision measurement of the absorbed dose in heavy ion beam is required to realize the effective therapy. The ionizing chambers are usually used for determination of absorbed dose in the heavy ion irradiation fields, however, uncertainty in measurement of these detectors is expected to remain by more than 5 percent, and this has a negative influence on the therapeutic effect. Therefore the demand for minimizing of the uncertainty in dose rate measurement, led us to the directly detection of the absorbed energy in heavy ion beam utilizing the high sensitive calorimeter which is operated at the low temperature.

Now we began to develop the precision heavy ion beam detector applying the superconducting transition edge sensor (TES). As a first step, using the Ir/Au-TES coupled to a tin absorber, we have detected the carbon ions which were injected from the tandem accelerator in the University of Tokyo. At the beam injection port, each energy of the 14C 4+ ion and the 14C 5+ ion are 24 MeV, and 29 MeV respectively. However these ions transmit through the radiation shields which consist of 4 aluminum mylar in the dilution refrigerator before they reach the TES detector on the 100mK cold stage. The energy of the 14C 4+ ion and the 14C 5+ ion at the detection point of TES detector are estimated to 4 MeV and 11 MeV respectively from the numerical calculation of the energy loss due to transmission through the radiation shields. Because the thickness of the tin absorber is 0.3mm, injected 14C ion is fully stopped inside the tin absorber, namely the TES detects the total energy of the incident heavy ion. The signal pulses of the 14C incident events were observed as shown in the figure. Although pulses are fully saturated because the temperature change is beyond the transition region, the signal length is reflected the incident energy of the injected heavy ions. These results indicate the possibility of the precision heavy ion energy detection applying the TES detector.