Cu Ion Beam from MEVVA Ion Source for Simulations of High-Temperature Superconductors Radiation Resistance

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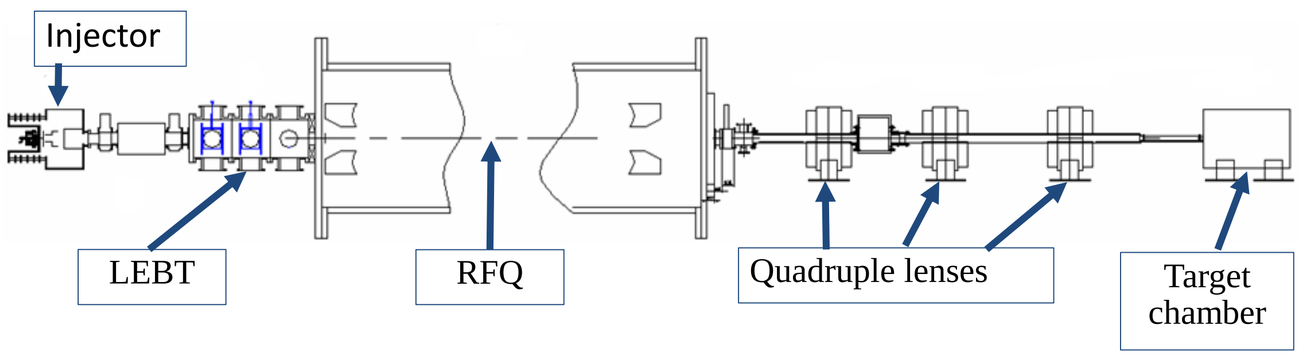
Introduction

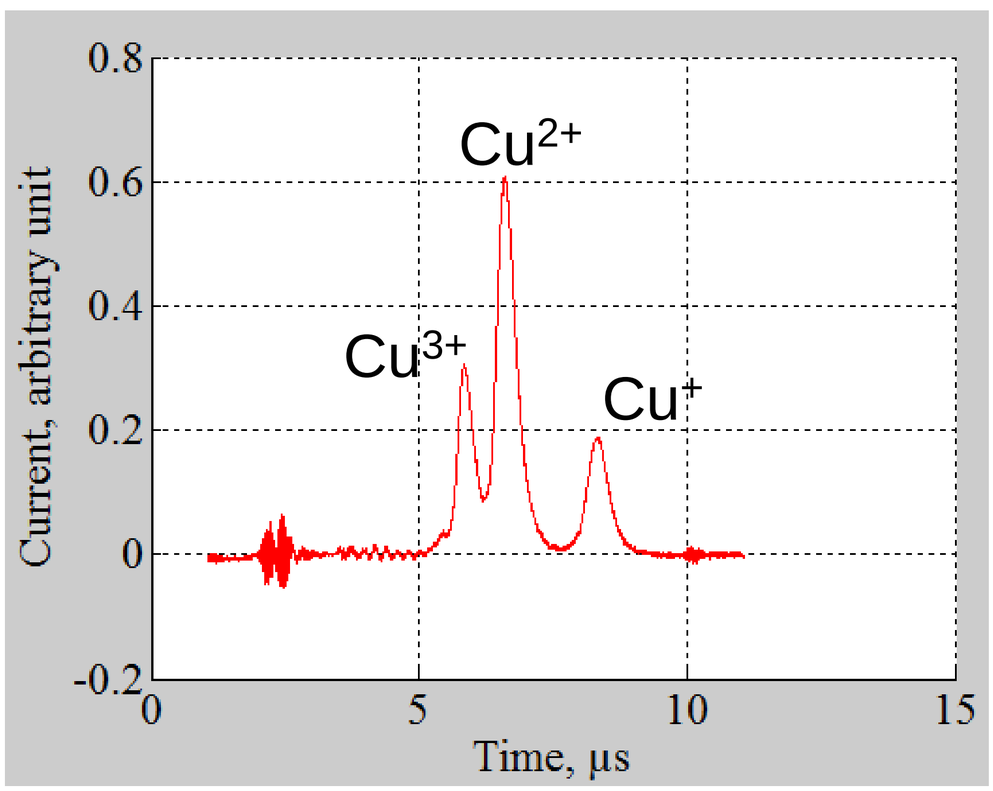
Experiments on irradiation of high-temperature superconducting (HTSC) materials simulating the results of radiation exposure are carried out at ITEP at the HIPr accelerator. Samples of HTSC are irradiated by a copper ion beam generated by metal vapor vacuum-arc (MEVVA) ion source and accelerated to an energy of 6.4 MeV. The results of experiments give unique information on the radiation resistance of composite HTSC materials, which is important in connection with the use of HTSC materials in various systems operating under radiation exposure.

The RFQ linac HIPr



The HIPr operates in a pulsed mode with a pulse duration of 450 μs and a pulse frequency of 0.5 Hz. The Cu ion beam is generated in the metal vapor vacuum arc ion source (MEVVA). The time-of-flight method was used to measure the ion composition of the copper beam from the source: Cu^{+} – 27%; Cu^{2+} – 60%; Cu^{3+} – 13%.

In the Radio Frequency Quadruple (RFQ) structure the beam is accelerated to energy of 100 keV per nucleon (6.4 MeV for Cu). Mainly Cu^{2+} fraction is accelerated in RFQ (94%), other fraction is Cu^{3+} (6%). The beam output channel includes three magnetic quadruple lenses, forming the required transverse beam sizes on the target. In the target chamber an assembling with samples is set.



Waveform with separation of ions generated by MEVVA ion source

HTSC irradiation

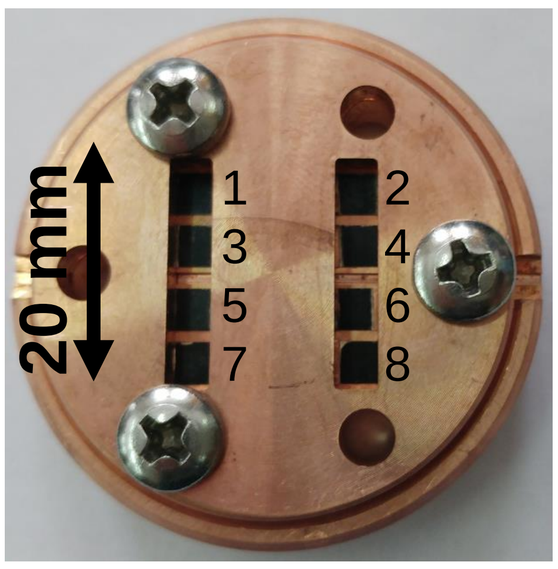
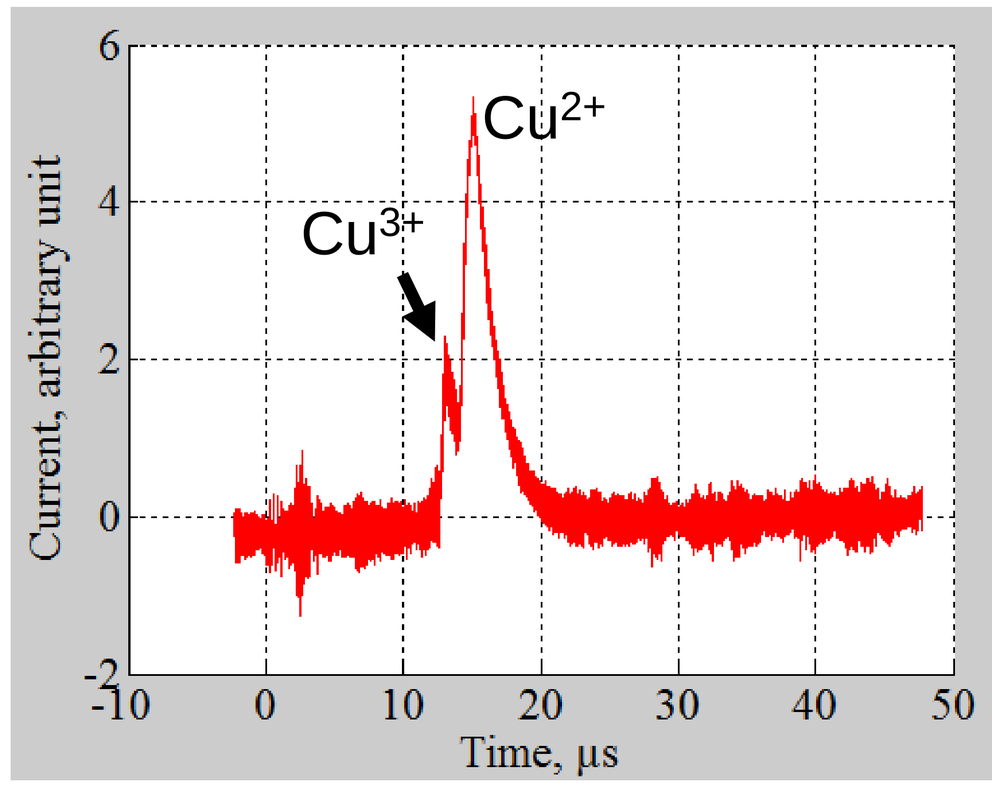
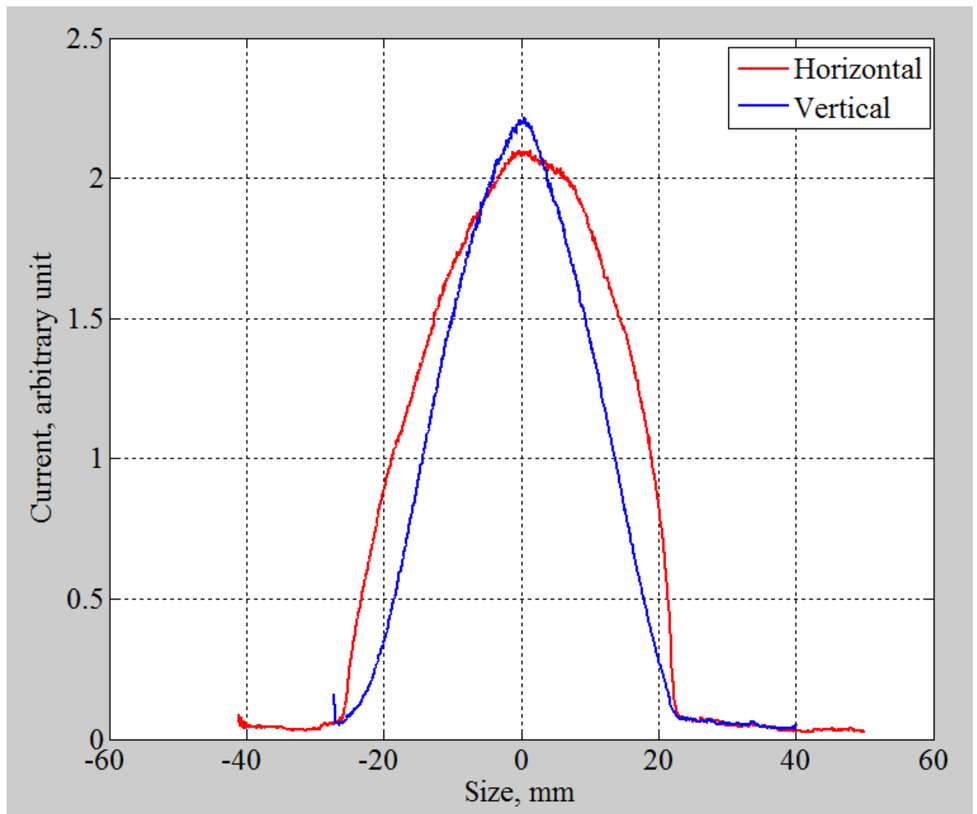


Photo of an assembly with 4 HTSC tapes, each has two areas for irradiation.

For irradiation the quadrupole lenses are adjusted so that the Cu^{3+} component is defocused and the irradiation is performed with Cu^{2+} ions. The assembly with 4 HTSC tapes is installed in the target chamber. In the assembly each HTSC tape has two areas for irradiation. The beam delivered to the target was measured with a scintillator, beam profile monitor and faraday cup. Irradiations were made at room temperature to fluences from $5 \cdot 10^{12}$ to $1.5 \cdot 10^{14}$ cm^{-2}. Taking into account the Cu beam profile, the fluences on areas № 3,4,5,6 are 10% higher than the average fluence and on areas № 1,2,7,8 are less than the average by 10%.



Waveform with separation of ions after RFQ accelerator



Waveform with separation of ions after RFQ accelerator