# Portal imaging with mixed beams: Status and future potential

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**Abstract**

Ions of similar mass/charge ratio, such as helium and carbon ions, can be accelerated in a synchrotron simultaneously to the same velocity. This can be exploited for portal imaging: in carbon ion therapy, a small fraction helium ions could be added to the primary beam. Compared to carbon ions helium ions have triple the range in water at equal velocity and exit the patient. This enables range probing and real-time image guidance. Recently, the first demonstration of controlled multi-isotope beam acceleration was achieved at GSI.
An ECR source, operated with methane and helium as support gas, produced 4He+ and 12C3+, which were simultaneously accelerated to 225 MeV/u in the SIS18 synchrotron at GSI. The beam was delivered to the medical research cave and monitored with a setup of three ionization chambers in between which two range shifters were postioned, as well as a dE-E telescope, and gafchromic films. Tuning the chromaticity enabled to separate as well as overlap the beams at extraction. Beam ratios at isocenter were controlled by adapting the helium contamination at the source. A _˜24% and _˜7.2% helium cotamination was investigated, which both resulted in clear helium signal. Gafchromic film measurements revealed a difference of 2mm between the helium and carbon ion spot centers at 10cm lateral scan position. Due to technical limitations, an oxygen contamination was present that will be further investigated. Scanning the beam over a PMMA edge showed the mixed beams' capability to monitor range changes.

This is the first experimental demonstration of a mixed C/He beam. This technique will be tested as range monitor and portal imaging in heavy ion therapy. In the future, we plan to investigate this technology in conjunction with upright patient positioning for lung cancer treatments.
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