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## Recent breakthroughs in delivering mixed helium and carbon ion beams for online treatment monitoring research at MedAustron

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Simultaneous irradiation with mixed helium and carbon ions is being proposed for online range verification in carbon ion beam therapy. In 2024, a mixed  ${}^4\text{He}^{2+}$  and  ${}^{12}\text{C}^{6+}$  beam was extracted successfully for the first time at the MedAustron center for ion beam therapy and research, which was facilitated by a mixed beam generation during two sequential multi-turn injections into the synchrotron.

This double injection scheme comes with challenges concerning the capture, acceleration and slow extraction, as apart from the small offset in charge-to-mass ratio between  ${}^4\text{He}^{2+}$  and  ${}^{12}\text{C}^{6+}$ , also significant injection energy offsets and differences in horizontal phase distributions have to be considered.

This proceeding reports on the first successful delivery of a mixed ion beam in a clinical facility, outlines recent developments in overcoming the various challenges imposed by the mixed beam produced via sequential injection and discusses further steps required for providing mixed helium and carbon beams for imaging research at the MedAustron facility in the near future.

### Footnotes

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