LINAC INJECTOR 352 MHz DESIGN

for $^{12}C^{4+}$ ions, $^{4}He^{2+}$ ions and protons

HITRI plus
Heavy Ion Therapy Research Integration

www.hitriplus.eu

DECADES OF EXPERIENCE IN ACCELERATOR DESIGN, CONSTRUCTION AND OPERATION. EXPERTISE AND KNOW-HOW OF LINAC DESIGN AND OPERATION.

DESCRIPTION

Operating at a frequency of 352 MHz, which aligns with recent proton linac designs like Linac4 at CERN or the European Spallation Source in Sweden, this medical linac design offers higher power efficiency.

It could potentially utilize standard radiofrequency power sources, enhancing accessibility and cost-effectiveness.

The versatile design accommodates three different alternating sources: $^{12}C^{4+}$ ions, $^{4}He^{2+}$ ions and protons, providing flexibility for various treatment needs.

With an input energy of 0.7 MeV/u and an output energy of 5 MeV/u for carbon injection deeper into the synchrotron, this linac design ensures efficient and precise treatment delivery.

SCHEME OF THE 352 MHz LINAC BASELINE

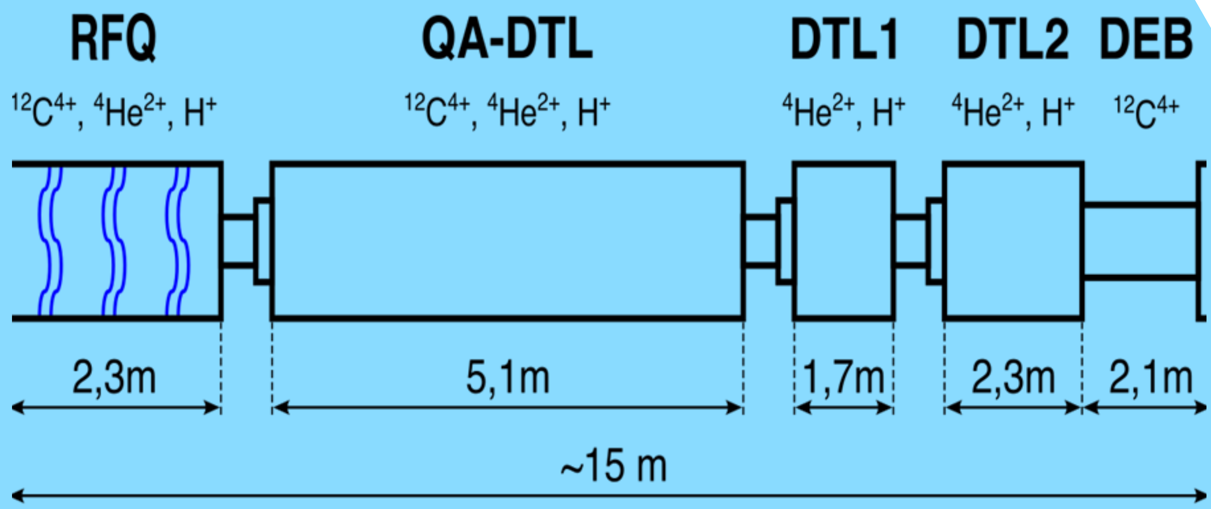
SECTION 1

comprises an RFQ and a Quasi-Alvarez DTL (Drift Tube Linac), meticulously engineered to accelerate ions to the optimized injection energy for carbon ions into the synchrotron

A DEBUNCHING CAVITY HAS ALSO BEEN POSITIONED AFTER THE ACCELERATING STRUCTURES TO MINIMIZE THE ENERGY SPREAD OF THE BEAM BEFORE SYNCHROTRON INJECTION

SECTIONS 2 AND 3

are optional and designed to capitalize on the pre-accelerated beam for the production of radioisotopes, which can be utilized for imaging and therapy purposes. Section 2 is tailored with a defined energy for the optimum production of As-211 , a highly promising alpha-emitter for cancer therapy.



CHALLENGE

The current operational designs are characterized by high costs and significant space requirements. There is a clear demand for a new linac injector design capable of operating at higher frequencies and accelerator gradients.
Planned development facilities for cancer treatment would greatly benefit from the option of producing isotopes concurrently with main operations. This opens up new possibilities, such as treating diffused tumours with targeted radioisotope therapy and solid tumours with ion irradiation, all within the same facility. Such innovations promise to revolutionize cancer treatment and offer new avenues for improved patient care.

SOLUTION

HITRI*plus*' linac design offers superior beam characteristics at minimal cost and size, ensuring higher precision in treatment. It sustains higher energy current, and fields, providing cleaner beams with improved control.
With doubled beam acceptance and increased beam transmission, it overcomes ion source limitations, enabling higher synchrotron intensities - vital for the next-gen synchrotrons used in FLASH therapy.
Its parallel radioisotope production feature allows for optional production of various isotopes for treatment and imaging, with a duty factor increase of up to 10% and minimal beam losses. This innovation advances cancer therapies and imaging, enhancing patient outcomes.

VALUE

The HITRI*plus* system enables parallel production of radioisotopes (e.g., At-211) for both imaging and treatment purposes.
Ion injections include mass-to-charge ratios of three and two for synchrotron acceleration (e.g., $^{12}C^{4+}$ ions, $^{4}He^{2+}$).
Compared to conventional Alvarez DTL, the QA-DTL offers considerably higher efficiency due to its increased effective shunt impedance. With focusing magnets in every n-th drift tube, the QA-DTL benefits significantly from F0D0-based beam focusing.
Designed to operate at high frequency, the QA-DTL offers the additional possibility of using klystrons instead of solid-state amplifiers as RF sources, resulting in roughly two times lower usage.
The accelerator structures are specifically designed for a duty factor of 10% to facilitate additional radioisotope production, ensuring versatility and efficiency in operation.