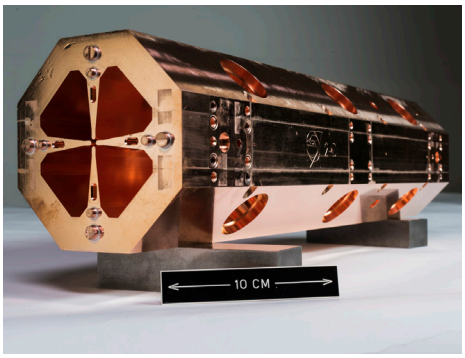
COMPACT PARTICLE ACCELERATOR



A very compact, radio-frequency quadrupole (RFQ) linear particle accelerator, for use in medical applications and material analysis.

In the frame of its programme for medical applications, and building on its experience with the LINAC4 injector (the first stage in the Large Hadron Collider accelerator chain), the High Frequency Radio Frequency Quadrupole (HF-RFQ) was constructed with the goal of providing a compact, low current injector for a proton therapy linear accelerator.
The HF RFQ can act as a stand-alone accelerator or as an injector for a larger, higher energy accelerator, and is adaptable to the power availability and portability needs of other applications, such as medical isotope production and ion beam analysis (a material analysis technique).
The HF RFQ can accelerate any charged particle with a mass to charge ratio up to 2, for example protons, deuterons, alpha particles, fully stripped carbon ions.

AREA OF EXPERTISE

- Accelerators

IP STATUS

- Patented
- Know-how based

SEEKING

- Licensing
- Development partner
- Commercial partner
- University spin out
- Seeking investment

CONTACT

kt@cern.ch

Find out more at:
kt.cern

APPLICATIONS

- Linear accelerator (linac) based hadron / proton therapy facilities.
- Medical isotope production e.g. for use in PET (Positron Emission Tomography) and SPECT (Single Photon Emission Computed Tomography).
- Material analysis (ion beam analysis).
- Other applications requiring a low or medium output current beam.

TECHNOLOGY OVERVIEW

Operating at a frequency of 750 MHz and having adapted beam optics, this HF RFQ (Figure 1, Figure 2, Figure 3) has accelerated protons to an energy of 5 MeV over a distance of only 2 metres. RFQs are traditionally designed to capture as many particles as possible from the ion source before accelerating them. CERN's HF-RFQ is different because its particle beam acceptance is intentionally kept narrow. By accepting only a small portion of the particle beam at the source, the particles can be accelerated over a much shorter length than possible using other RFQs. It has also been designed to limit the loss of particles to almost zero once they reach an energy above a few hundred keV – thus significantly reducing the risk of radiation exposure for those operating the machine.

ADVANTAGES

- Compact - can be placed close to where it is needed.
- Low beam-loss - no need for external shielding.
- Modular - two or more HF-RFQs may be joined together in order to increase the energy output of the system (energies up to 10-15 MeV).
- Particle compatibility - the particles provided by the source can be any charged particle with a mass to charge ratio up to 2. For example protons, deuterons, alpha particles, fully stripped carbon ions.
- Multi user - as the HF RFQ is capable of pulsed operation, redirecting the beam to multiple, individual targets is possible by triggering the re-direction in-between pulses.
- Low maintenance - one-piece device with a minimum number of parameters to adjust.

PATENTS

- PCT filed August 2014 (PCT/EP2014/067512)
- US patent granted in 2018 (US10051721)
- Europe patent granted in 2021 (EP20140757869)
- China patent granted in 2019 (CN107079577)
- India application pending (201747008606)
- Israel application pending (250621)

OPPORTUNITY

This technology is patented and available for licensing. CERN also has detailed technical drawings of the HF RFQ that can be made available as part of a licence agreement.
CERN will consider participating in joint R&D projects in cases where there are novel fields of application identified. We do not seek to engage in R&D projects where the main objective is to redesign the HF-RFQ for the needs of only one customer. In these cases, a commercial licence for the HF-RFQ must be agreed, which may include a limited amount of consultancy on RFQ design and manufacturing.

STAGE OF DEVELOPMENT

- 2 metre HF RFQ design for use in proton therapy has been successfully manufactured and tested. This HF RFQ forms the injector of a larger, linear proton accelerator. Project in collaboration with Advanced Oncotherapy (AVO), UK & Switzerland. Further information here: https://kt.cern/startups/adam
- 1 metre HF RFQ for use in Proton Induced X ray Emission (PIXE) analysis has been manufactured at CERN. PIXE is a form of ion beam analysis – a material analysis technique. In order to make the complete accelerator system transportable, the electrical power requirement has been reduced to less than 6 kVA. Project in collaboration with National Institute for Nuclear Physics (INFN), Italy. Further information here: https://kt.cern/article/new-small-scale-accelerator-help-study-heritage-artworks.

For both of the above designs, CERN is seeking licensing and collaborative R&D opportunities. The HF RFQ can also be re designed for other applications.

MANUFACTURING

- In order to facilitate transfer of the technology, CERN has made public the manufacturing methods used for the HF RFQ. Information is availablehere: https://indico.cern.ch/event/686876/timetable/#20180309

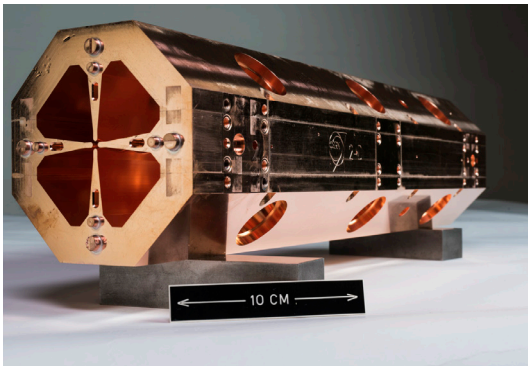


Figure 1

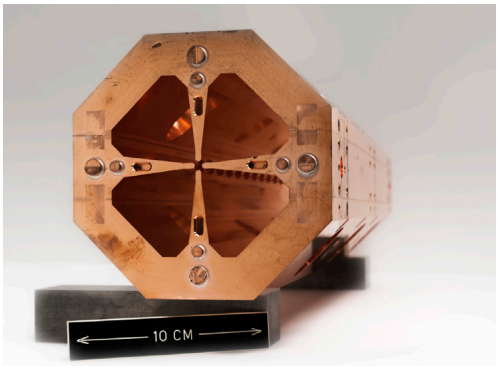


Figure 2

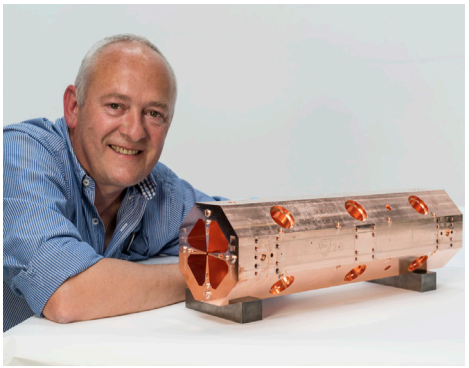


Figure 3

CERN technology

Knowledge Transfer
Accelerating Innovation