DESIGN OF A 750 MHz IH STRUCTURE FOR MEDICAL APPLICATIONS

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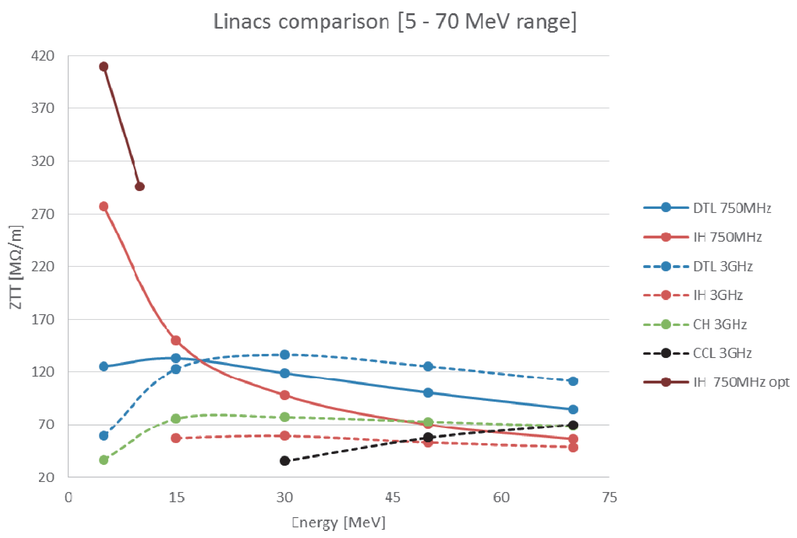
Medical accelerators are characterized by low beam current and high desirable accelerating gradient. This set of parameters is unique amongst low beta accelerators, and thus call for a specific design. A solution based on a 750 MHz H-mode accelerating structure for the 2.5-10 Mev/u range is here presented

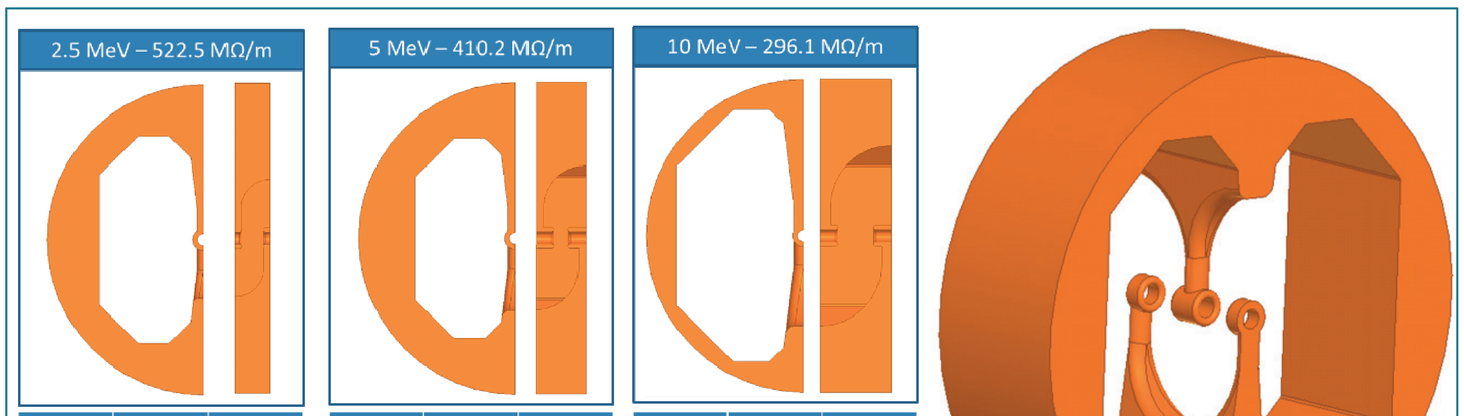
RF Design

RF cavities comparison



RF optimization of regular cells as a function of β performed for different accelerating cavities (TE and TM mode) and two different frequencies of 750 MHz and 3 GHz. Beam aperture radius equal to 2.5 mm in all the studied cases. In dark red the Shunt Impedance (ZTT) of the optimized IH structure

Three regular cells were optimized to maximize the Shunt Impedance (ZTT). The cell geometry is similar to the one of the CERN 750 MHz RFQ [1], to maximize the experience gained at CERN in terms of brazing – assembly, and tuning, of structures that were never built at such high frequency



Q	R/Q	T
10074	52072	0.780
Lcell	**Gap**	**S. Rad**
14.561	9	2.5

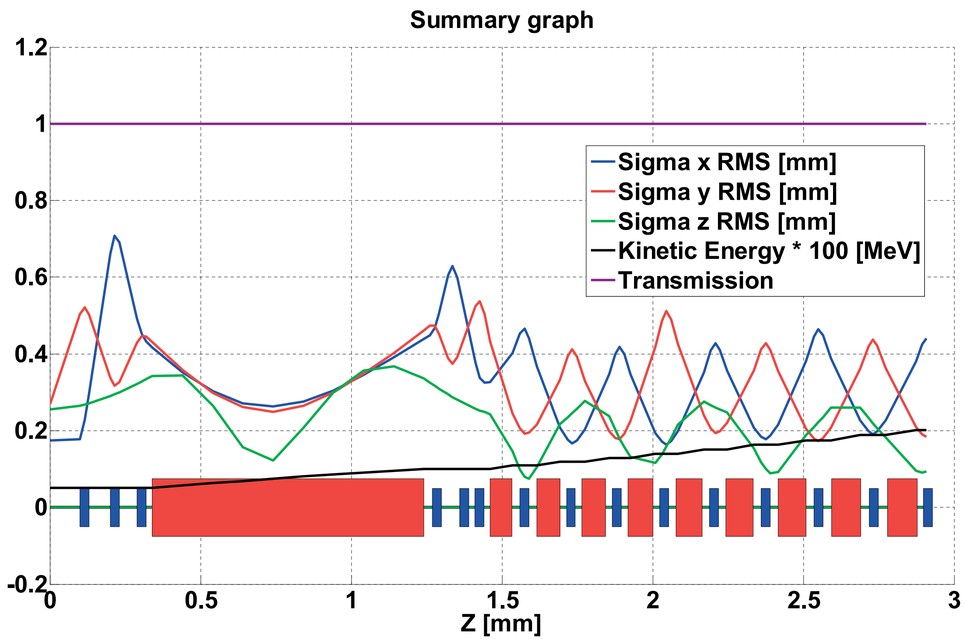
Q	R/Q	T
10732	38224	0.826
Lcell	**Gap**	**S. Rad**
20.586	11	3

Q	R/Q	T
11681	25352	0.842
Lcell	**Gap**	**S. Rad**
28.949	15	4

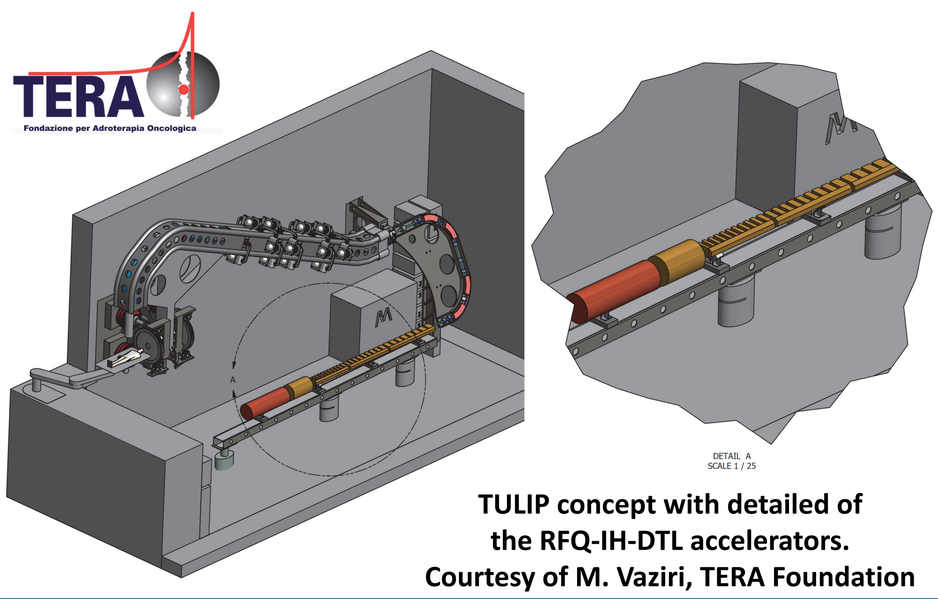
Comparison between geometric and main accelerating parameters at the 3 geometric βs optimized, corresponding to 2.5, 5 and 10 MeV/u. Dimensions are in mm. Assembly view (right)

Beam Dynamics

An accelerating structure approximately 0.9 m long, length tapered, was designed using the code RF-Track [2]. The structure accelerates particle from 5 to 10 MeV, using one 100 kW 750 MHz IOT, and has been matched to the 750 MHz CERN medical RFQ. Particles are further on accelerated in a 3 GHz DTL linac. The IH-DTL solution was compared with a DTL solution proposed in [3] for the 5-20 MeV range, resulting in improved transition from the 750 MHz to the 3 GHz structures

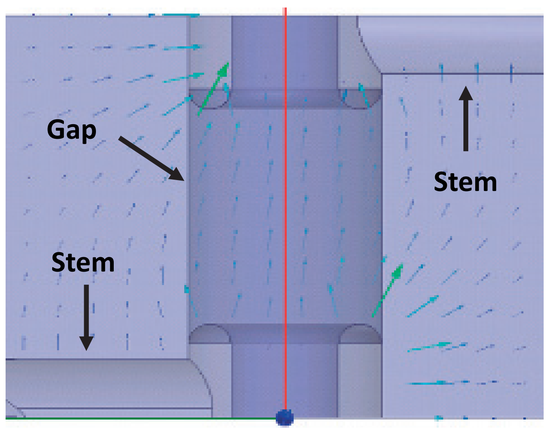


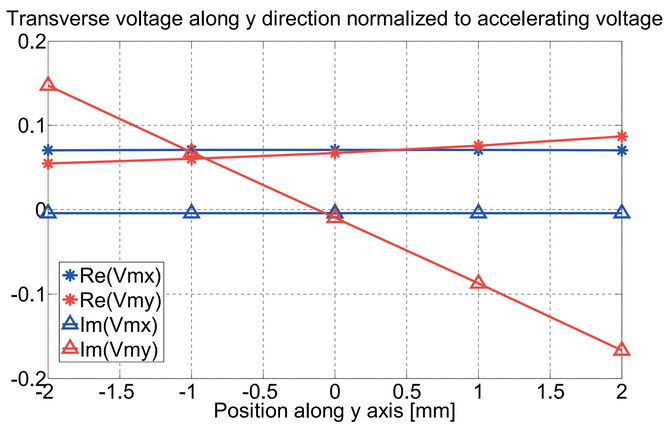
5-10 MeV IH and 10-20 MeV 3 GHz DTL solution studied (top). TULIP concept [5] (bottom)



TULIP concept with detailed of the RFQ-IH-DTL accelerators. Courtesy of M. Vaziri, TERA Foundation

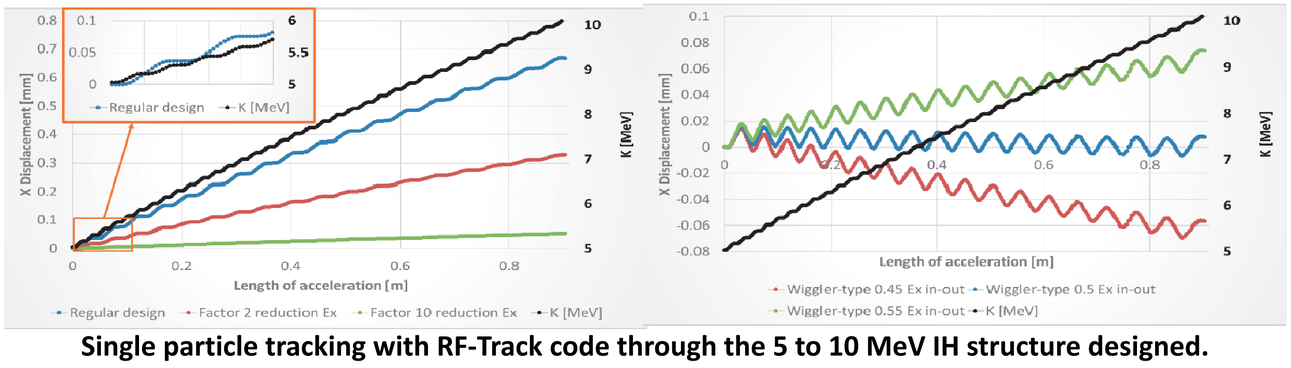
Dipole kicks





Graphic (left) and analytical (right) representation of dipole kicks over one IH cell

Dipole kicks act linearly along the structure thanks to the constant voltage of IH cavities. The beam can be thus successfully controlled by halving the dipole kicks in the first RF cell (bottom right), having a trajectory similar to the one of undulators



Single particle tracking with RF-Track code through the 5 to 10 MeV IH structure designed. Classic dipole kicks compensation [4] (left) and solution adopted in this design (right)

REFERENCES:
[1] M. Vretenar et al, A compact high-frequency RFQ for medical applications, in Proceeding of LINAC (2014)
[2] A. Latina, RF-Track: Beam Tracking in Field Maps Including Space-Charge Effects. Features and Benchmarks, *this conference*
[3] C. Roncisvalle et al, First Acceleration of a proton beam ina sice coupled drift tube linac, EPL,111 (2015) 14002
[4] S. Kurennoy et al, H-mode accelerating structures with PMQ beam focusing, Los Alamos National Laboratory, USA
[5] A. Degiovanni et al, Design of a Fast-Cycling High-Gradient Rotating Linac for Protontherapy, in Proceeding of IPAC (2013)