The RF parameters of heavy ions linac

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Abstract

The new linac for A/Z = 8, output energy 4 MeV/u and few mA current of ions from Na to Bi is under development at NRC “Kurchatov Institute”-ITEP. The linac consists of Radio-Frequency Quadrupole (RFQ) with operating frequency 40 MHz and two sections of Drift Tube Linac (DTL) with operating frequency 80 and 160 MHz, correspondently. Both DTL have a modular structure and consists of separated individually phased resonators with focusing magnetic quadrupoles located between the cavities. The DTL_1 is based on the quarter-wave resonators meanwhile DTL_2 is based on IH 5-gap resonators. The 6D beam matching between RFQ and DTLs is provided by magnetic quadrupole lenses and 2-gaps RF-bunchers.

The paper presents results of the radio-frequency (RF) design of linac accelerating structures.

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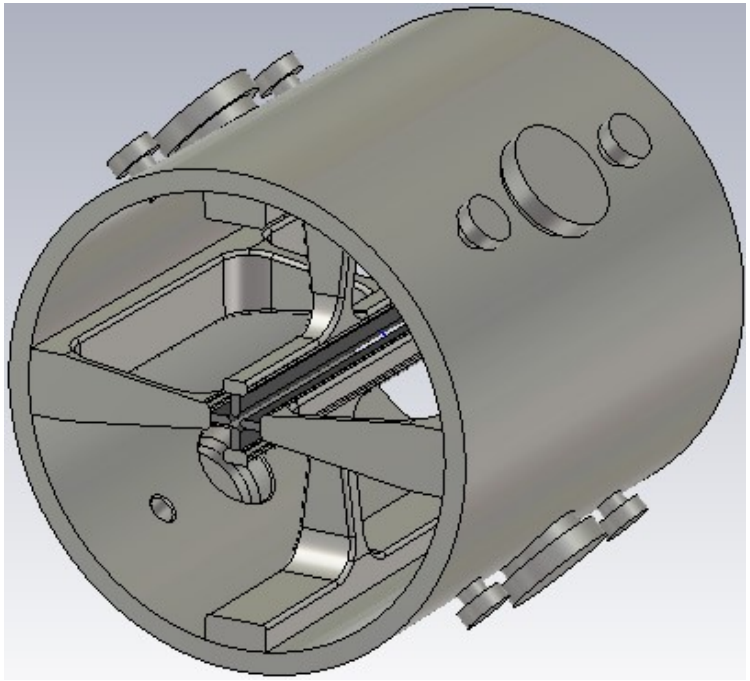
RFQ design



The regular RFQ section

The main dimensions of RFQ

Parameter	Value, mm
Cavity inner diameter	1025
Cavity length	1222
Vane base width	150
Vane base height	65
Vane top width	60
Vane window length	780
Vane window height	352.5
Vane tip height	30

The main RF RFQ parameters.

Parameter	Value
Resonant frequency, MHz	40.625
Resonant frequency of the dipole mode, MHz	46.5
Inter-vane voltage, kV	170
Self quality factor	13000
RF power losses, kW/m	46
Full RF power losses, kW	506

The RFQ cavity consists of 1222 mm long 9 identical sections and input/output flanges. The best RF parameters of RFQ cavity could be achieved by using a 4-vane structure and would require a bigger diameter of the cavity compared to shifted windows structure. The last one structure was chosen. The windows areas were chosen as bigger as possible in order to minimized the cavity`s inner diameter.

Each RFQ section has a 4 CF200 flanges and 8 CF63 flanges. It would be used for RF power feeders, RF signal antennas, motorized and stationary plungers, vacuum pumps and detectors.

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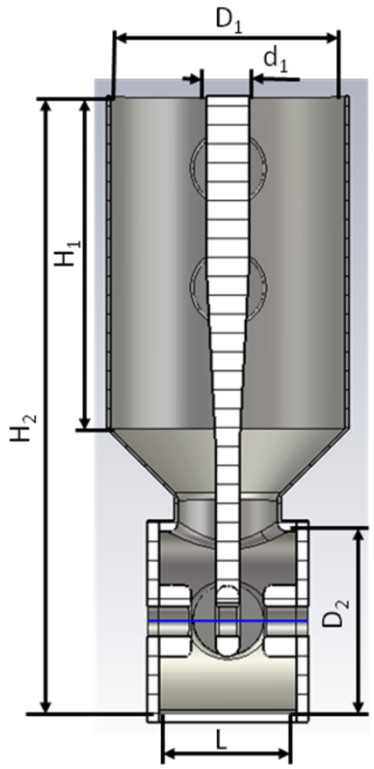
DTL_1 design



The DTL_1 cavity

The main dimensions of DTL_1

Parameter	Value, mm
Full height H_2	865
Base height H_1	470
Length of accelerating section L	194
Accelerating section diameter D_2	250
Base diameter D_1	330
Stem diameter d_1	60
Gap length	34÷48

The main RF DTL_1 parameters

Parameter	Value
Resonant frequency, MHz	81.25
Accelerating field intensity, kV/cm	80
Shunt impedance, MΩ/m	20
Self quality factor	9600
RF power losses, kW/cavity	60÷95

DTL_1 section consists of 12 identical separated individual phased 2-gaps cavities based on quarter-wave resonator (QWR).The accelerating gap increases from cavity to cavity with beam energy growth. In order to simplify DTL_1 construction the cavities length was taken constant while gap variation was achieved by varying the front/end tubes length. Each DTL_1 cavity consists of accelerating section where drift tubes are located and base where central drift tube`s stem is fixed. The aperture radius is equal to 21 mm in each cavity. The base diameter was chosen in order to minimize the distance between cavities which is required by particles dynamics simulation. Each DTL_1 cavity has a 6 CF100 flanges for the same purpose as RFQ. The full RF power loss for DTL_1 section is equal to 0.9 MW

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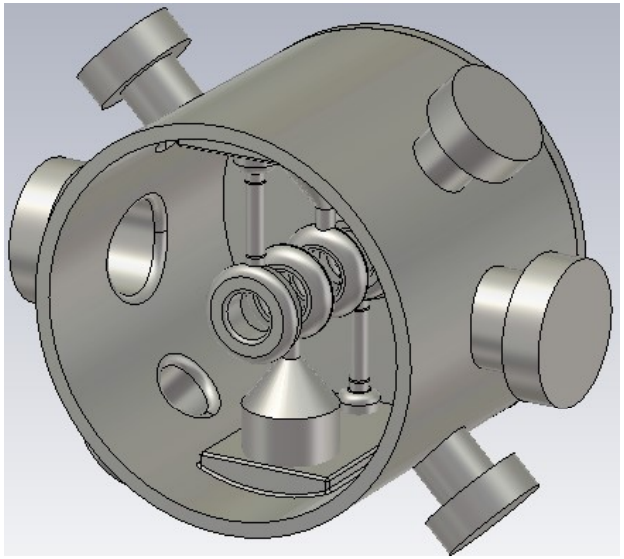
DTL_2 design



The DTL_2 cavity

The main dimensions of DTL_2

Parameter	Value, mm
Cavity inner diameter	420
Cavity length	280÷442
Central stem diameter	97
Side stem diameter	41
Gap length	24÷42

The main RF DTL_2 parameters

Parameter	Value
Resonant frequency, MHz	162.5
Accelerating field intensity, kV/cm	77÷107
Shunt impedance, MΩ/m	12÷27
Self quality factor	7200÷10800
RF power losses, kW/cavity	150÷200

The DTL_2 section consists of 28 separated individual phased IH 5-gaps cavities. The DTL_2 cavities length is increasing from cavity to cavity with beam energy growth. The aperture radius is equal to 25 mm in each cavity. Each DTL_2 cavity has a 2 CF100 flanges and 4 CF63 flanges. The main purpose for flanges is the same as for RFQ and DTL_1. Every DTL_2 cavity has the same inner diameter in order to unify DTL_2 cavity`s construction. It should be mentioned that various accelerating gaps lead to different RF parameters of the cavities while cavities inner diameter is constant. The resonant frequency was tuned by varying the drift tubes diameters not taking into account the cavities shunt impedance. The full RF power loss for DTL_2 section is equal to 4.3 MW.