LINAC 16
28TH LINEAR ACCELERATOR CONFERENCE

RF DESIGN OF A DEUTERON BEAM RFQ

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1.Introduction

CMIF-China Material Irradiation Facility

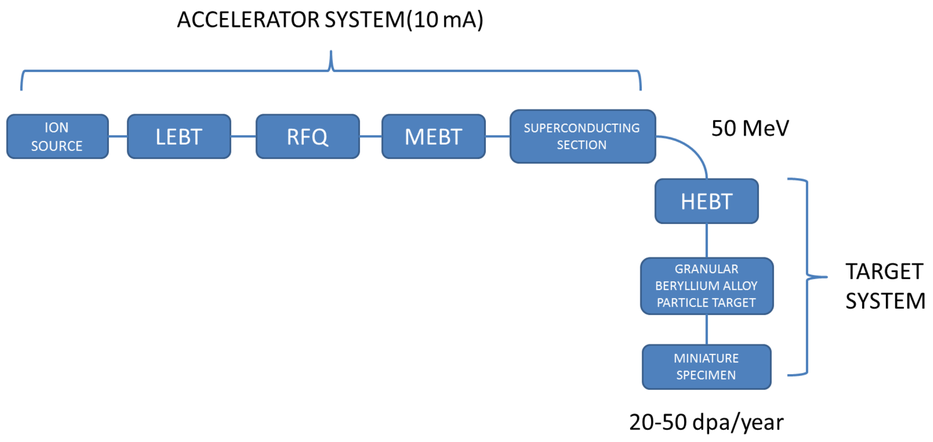
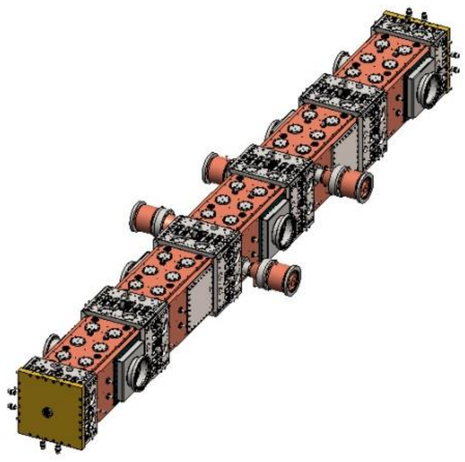


Figure 1: Layout of CMIF.

2.Main Parameters of CMIF RFQ



- Five modules
- Four couplers
- 100 tuners
- 20 pairs of PISLs

Figure 7: Assembly drawings of CMIF RFQ.

Table 1: The main parameters of CMIF RFQ.

Particle	D+ (q/A=1/2)
Operation	CW/pulsed
Vane type	Four vane
Frequency (MHz)	162.50
Kp	1.4
Inter-vane voltage (kV)	65
Vane length (mm)	5250.00
Mean aperture (mm)	4.807

6.RF simulation of whole length model

Table 5: RF results of whole model simulation.

Parameter	Value(with modulation)
H (mm)	169.3
Quadrupole 1 freq.	162.459 MHz
Quadrupole 2 freq.	164.768 MHz
Quadrupole 3 freq.	171.371 MHz
Dipole mode 1 freq.	180.119 MHz
Dipole mode 2 freq.	184.154 MHz
Dipole mode 3 freq.	190.195 MHz
Q factor	14148
Tuning coefficient for one tuner (kHz/mm)	0.933
Tuning range (MHz)	1.865/-1.557 （160.901~164.323）

Table 6: Power loss of each part of the cavity.

Part	Power loss (kW)	%
Walls	42.5	39
Vanes, 4 units	47.1	43.2
Input cutbacks, 4 units	1.5	1.4
Output cutbacks, 4 units	1.3	1.2
Pi-mode rods, 40 units	8.7	8
Tuners, 100 units	7.9	7.2
Total	109	100

3.2D Cross Section Design

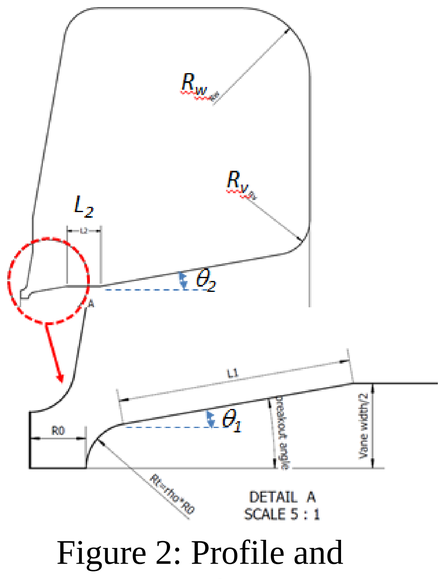


Figure 2: Profile and the parameters of cross section.

Table 2: Parameters to generate 2D cross section profile.

Variables	Value	Unit
R0	4.807	mm
ρ	0.8	
L1	27.82	mm
L2	11.89	mm
θ_1	7.1	Deg.
θ_2	10	Deg.
R_V	20	mm
R_W	40	mm
H	169.3	mm
$r_T = \rho r_0$	3.85	mm

4.Simulation of PISL Period Structure

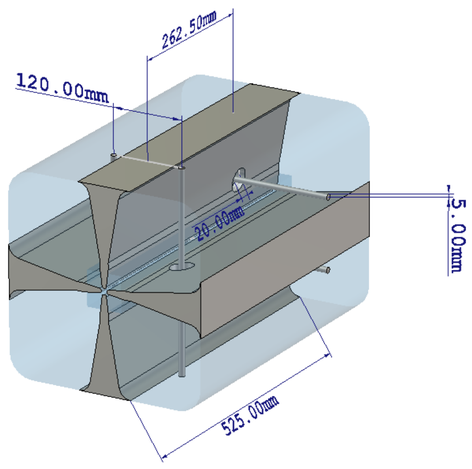


Figure 3: The period structure of PISLs.

Table 3: RF parameters of PISLs period.

parameter	Value
H(mm)	168
Frequency (MHz)	162.498
Frequency shift due PISLs(MHz)	-5.464
Q factor	15159
Power loss per PISL(W)	199
Dipole mode frequency (MHz)	180.5
Dipole mode shift (MHz)	17.539

5. Simulation of tuner Period Structure

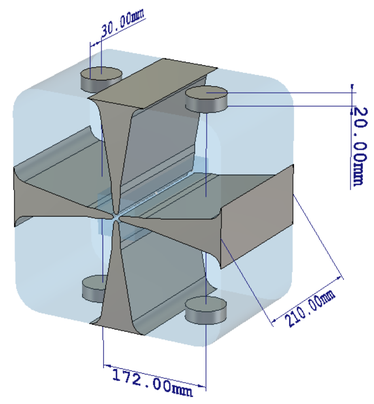


Figure 4: Period of tuner.

Table 4 RF parameters of tuners period.

Parameter	Value
H (mm)	174.33
Frequency (MHz)	162.497
Frequency shift due tuners	1.571
Q factor	15856
Power loss per tuner (W)	68
Tuning sensitivity for one tuner (kHz/mm)	22

7. Multiphysics analysis

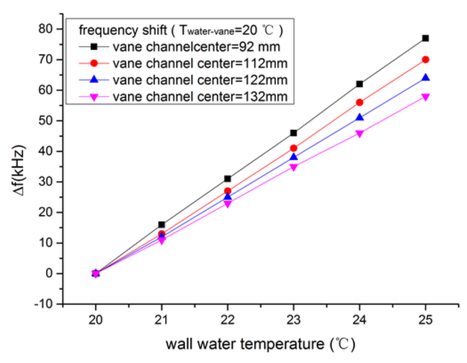


Figure 5: Frequency shift caused by changes of wall cooling water with different vane channel position(Vane cooling water keeps 20° C).

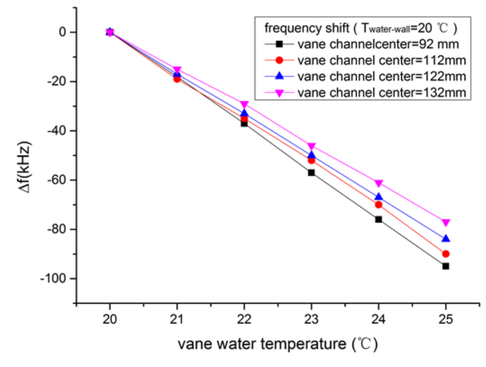


Figure 6: Frequency shift caused by changes of vane cooling water with different vane channel position(wall cooling water keeps 20° C).

Table 7: Frequency shift coefficient of different vane cooling channel position.

Vane cooling channel position(mm)	Δf for ΔTwall	Δf for ΔTvane	Δf for ΔTwall & ΔTvane
92	15.4	-19.1	-3.7
112	14.1	-17.7	-3.6
122	12.9	-16.8	-3.9
132	11.6	-15.4	-3.8