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MAX MYRRHA ACCELERATOR EXPERIMENT RESEARCH & DEVELOPMENT PROGRAMME

GOETHE UNIVERSITÄT FRANKFURT AM MAIN

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General Layout of the 17 MeV Injector for MYRRHA*

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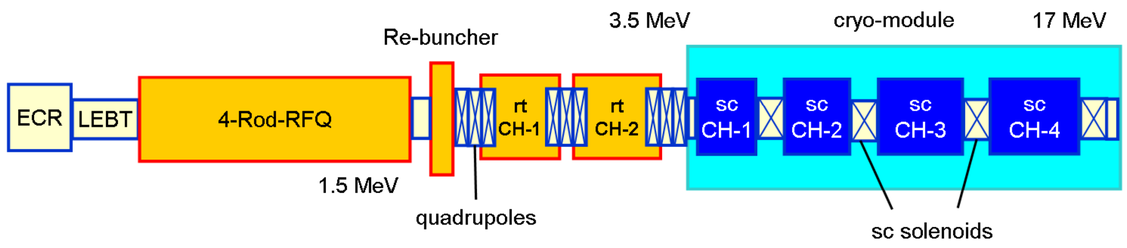
Abstract:
The MYRRHA Project (Multi Purpose Hybrid Reactor for High Tech Applications) at Mol/Belgium will be a user facility with emphasis on research with neutron generated by a spallation source. One main aspect is the demonstration of nuclear waste technology using an accelerator driven system. A superconducting linac delivers a 4 mA, 600 MeV proton beam. The first accelerating section is covered by the 17 MeV injector. It consists of a proton source, an RFQ, two room temperature CH cavities and 4 superconducting CH-cavities. The initial design has used an RF frequency of 352 MHz. Recently the frequency of the injector has been set to 176 MHz. The main reason is the possible use of a 4-rod-RFQ with reduced power dissipation and energy, respectively. The status of the overall injector layout including cavity design is presented.

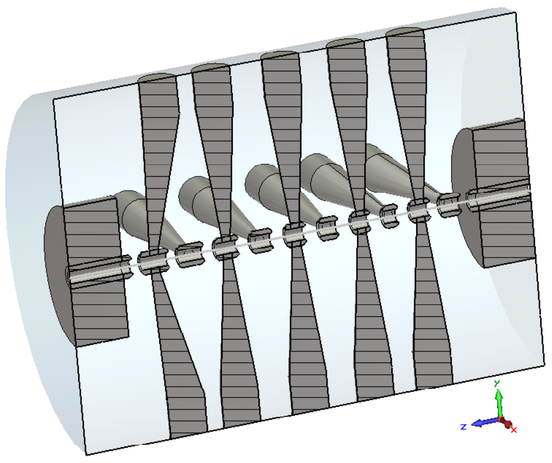
Layout of the 17 MeV Injector for MYRRHA

The Injector will accelerate the beam to an energy of 17 MeV. The frequency has been changed from 352 MHz (EUTROTRANS) to 176 MHz. One main reason is the use of a 4-Rod-RFQ at the lower frequency. After the RFQ two room temperature CH-cavities are used to cover the energy range between 1.5 and 3.5 MeV. The main acceleration is finally provided by 4 superconducting CH-cavities with superconducting solenoids in between.



Parameter	Unit	value
Energy	MeV	17
RF frequency	MHz	176
Particles	---	protons
Beam current	mA	4
Operation mode	---	cw
RF structures	---	4-Rod-RFQ/CH-DTL

1.5-3.5 MeV, 176 MHz Room Temperature CH-Section

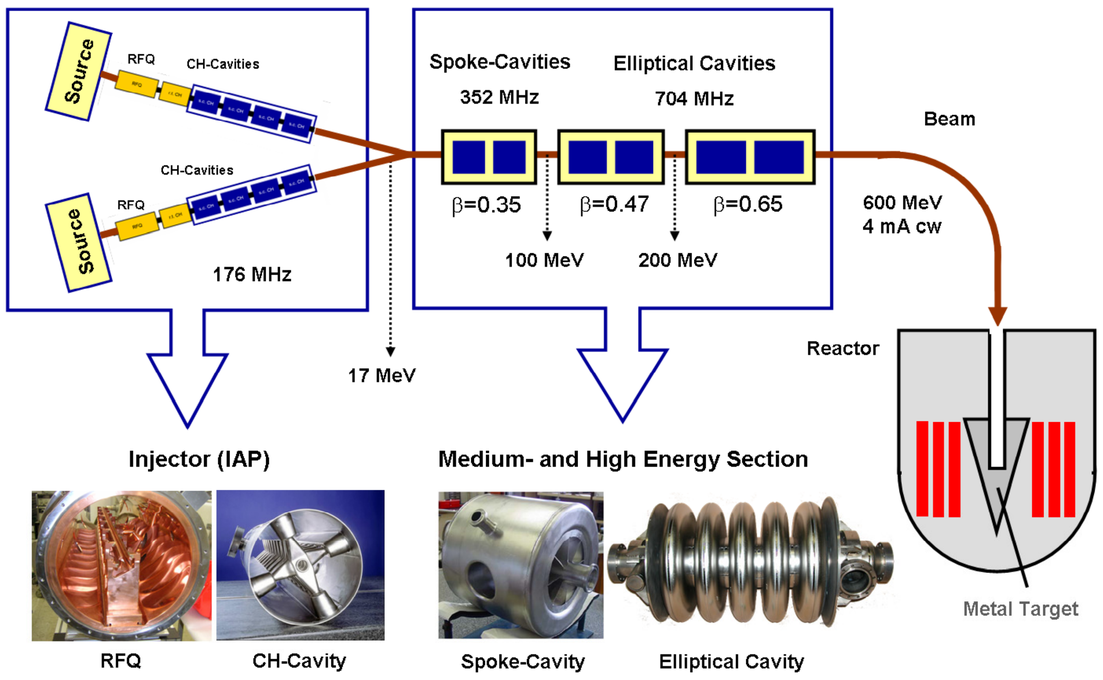


Room temperature 176 MHz CH-cavities are foreseen to accelerate the beam from 1.5 to 3.5 MeV. To avoid an internal focusing element two cavities have been chosen. Each cavity provide about 1 MV of effective voltage. Both cavities have a β-profile for the length of the accelerating cells.

Parameter	Unit	value
RF structure	---	rt CH-DTL
RF frequency	MHz	176
Length (βλ)	cm	54/66
U_{eff}	MV	1.03/1.14
E_a	MV/m	1.91/1.72
Q_0 (85% MWS)	---	15000
$Z_{eff}\cdot\cos^2\varphi$ (85% MWS)	MΩ/m	124/93
P_c	kW	16/21
P/L	kW/m	30/32

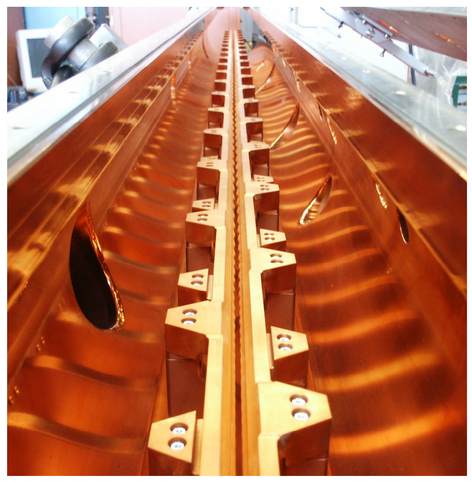
Layout of the MYRRHA-Project

The MYRRHA Linac has to provide up to 4 mA protons with a final energy of 600 MeV. It is planned to build two identical 17 MeV injectors to fulfill the reliability requirements. Because of the cw operation it has been decided to use superconducting cavities. The main linac consists of the intermediate (17-100 MeV, 352 MHz poke cavities) and the high energy (100-600 MeV, 704 MHz elliptical cavities) section.



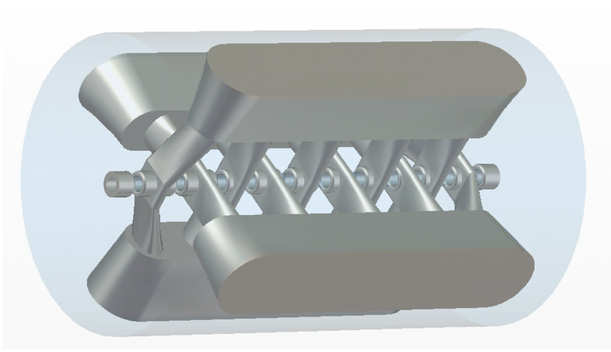
1.5 MeV, 176 MHz 4-Rod RFQ

As RFQ-structure a 4-Rod-RFQ at 176 MHz has been chosen because of the lower technical risk, excellent tuning possibilities and easy access. The electrode voltage has been set to 40 kV to keep the thermal load on the RFQ as low as possible. An estimated impedance of 67 kΩm will result in a thermal load of less than 25 kW per meter which is considered to be a safe value for reliable operation.



Parameter	Unit	Value
RF structure	---	4-Rod RFQ
RF frequency	MHz	176
Length	Cm	400
Electrode voltage	kV	40
Impedance	kΩm	67
Thermal load	kW/m	25
RF power	kW	100
E_{in}	keV	30
E_{out}	keV	1500

3.5-17 MeV, 176 MHz Superconducting CH-Section



The main acceleration of the injector is provided by 4 superconducting CH-cavities operated at 176 MHz. The cavities provide an effective voltage between 3.5 and 4 MV. The gradient has been set to a moderate value of around 4 MV/m to limit the electric peak fields below 25 MV/m for safe operation.

Parameter	Unit	value
RF structure	---	sc CH-DTL
RF frequency	MHz	176
Length (βλ)	cm	87/101/107/1.07
U_{eff}	MV	3.50/3.98/4.18/4.09
E_a	MV/m	4.02/3.94/3.89/3.82
R_a/Q_0	Ω	3000
Q_0 (design @Ea)	---	$3\cdot10^8$
P_c	W	20-30
G	Ω	50-60
Gaps	---	10/9/8/7
Aperture Ø	mm	30/30/40/40