MAX MYRRHA Accelerator eXperiment research & development programme

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R&D of the 17 MeV MYRRHA Injector*

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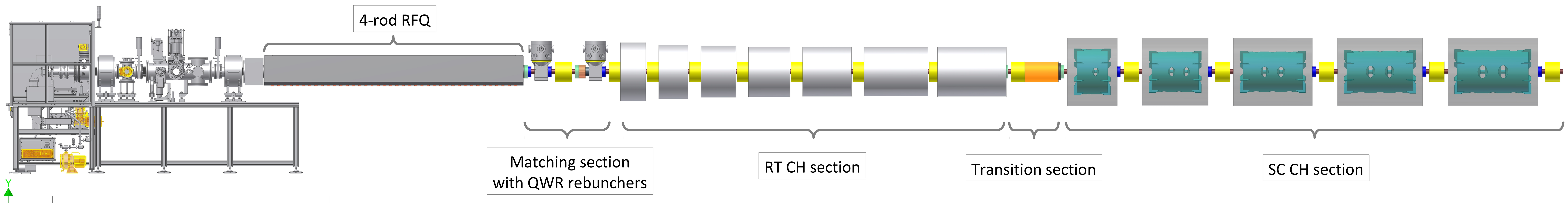


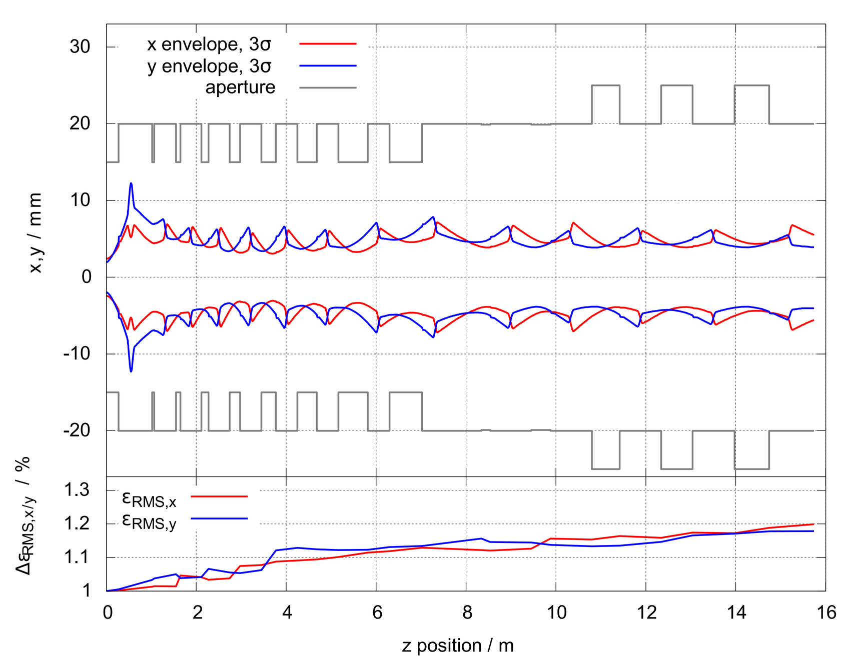
Key

- Quadrupol triplet
- Steerer
- Bellow
- Current transformer
- Beam position monitor
- Diagnostics box
- Collimator
- Phase probe

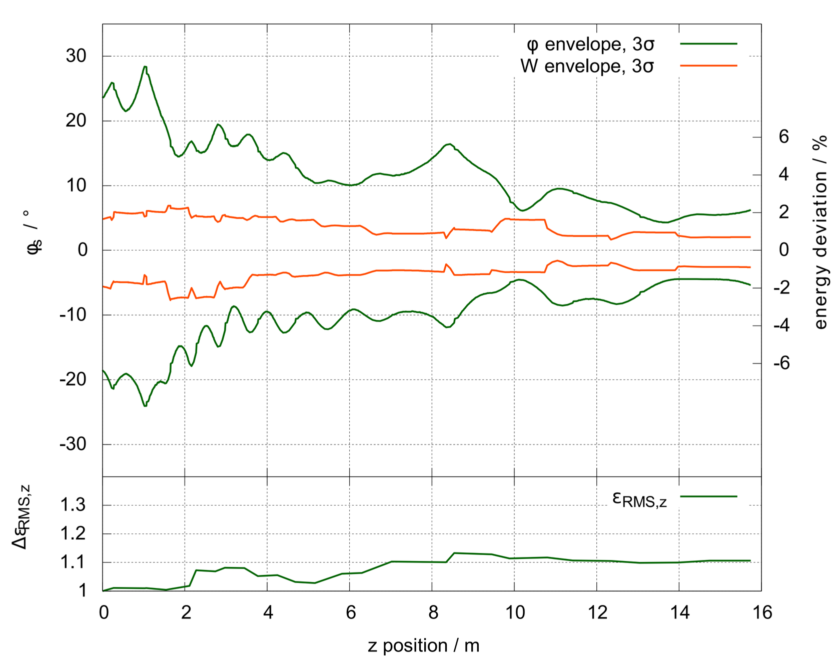
Abstract: MYRRHA is designed as an accelerator driven system (ADS) for transmutation of long-lived radioactive waste. The challenge of the linac development is the very high reliability of the accelerator to limit the thermal stress inside the reactor. With the concept of parallel redundancy the injector will supply a cw proton beam with 4 mA and 17 MeV to the main linac. The new MYRRHA injector layout consists of a very robust beam dynamics design with low emittance growth rates. Sufficient drift space provides plenty room for diagnostic elements and increases the mountability. Behind a 4-Rod-RFQ and a pair of two-gap QWR rebunchers at 1.5 MeV the protons are matched into the CH cavity section. A focussing triplet between the rebunchers ensures an ideal transversal matching into the doublet lattice. Each of the 7 room temperature (RT) CH structures has a constant phase profile and does not exceed thermal losses of 29 kW/m. The transition to the 5 superconducting (SC) CH cavities with constant beta profile is at 5.9 MeV. For a safe operation of the niobium resonators the electric and magnetic peak fields are defined below 25 MV/m and 57 mT respectively.

Beam Dynamics Design

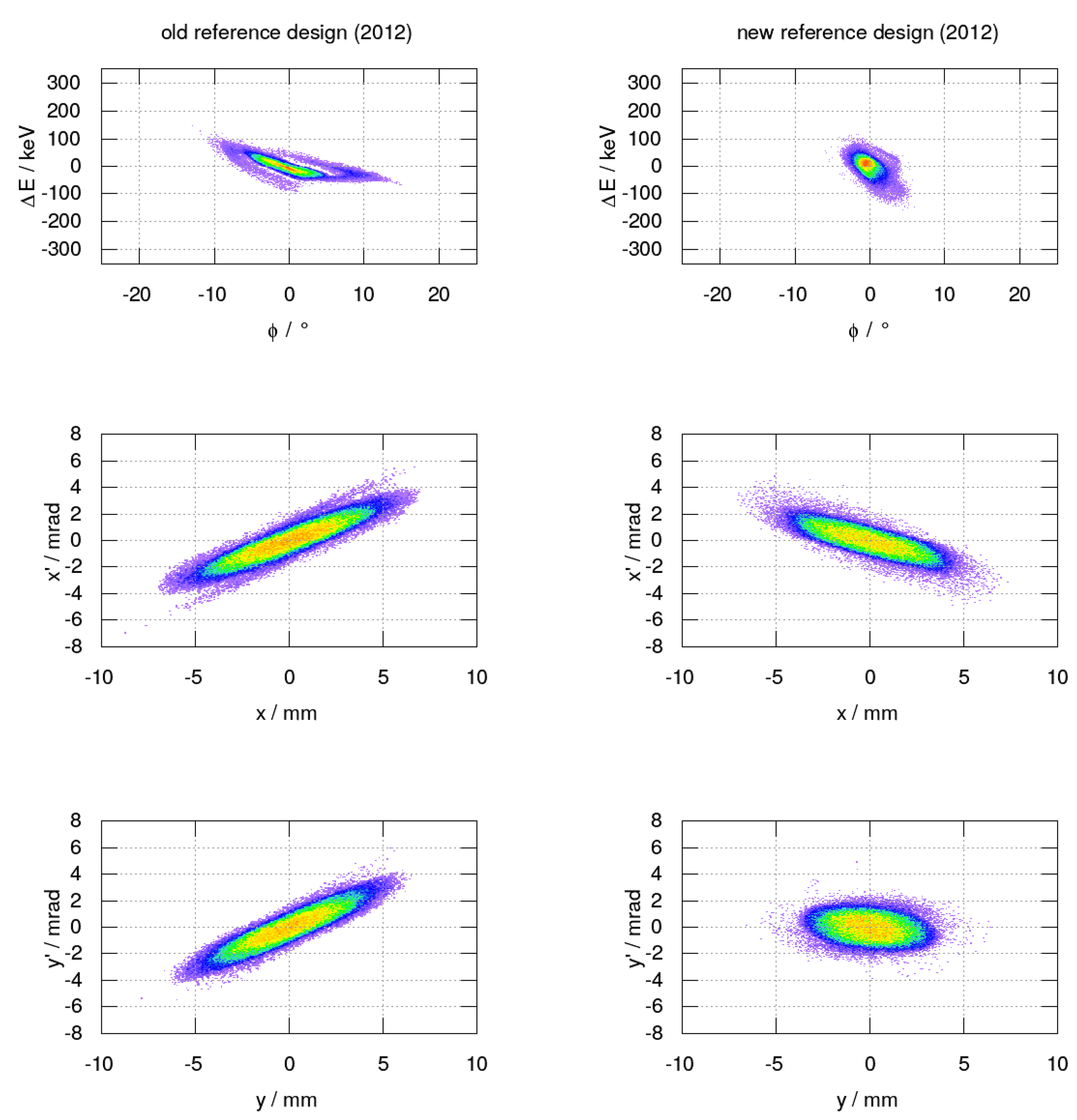
Transversal Beam Envelopes



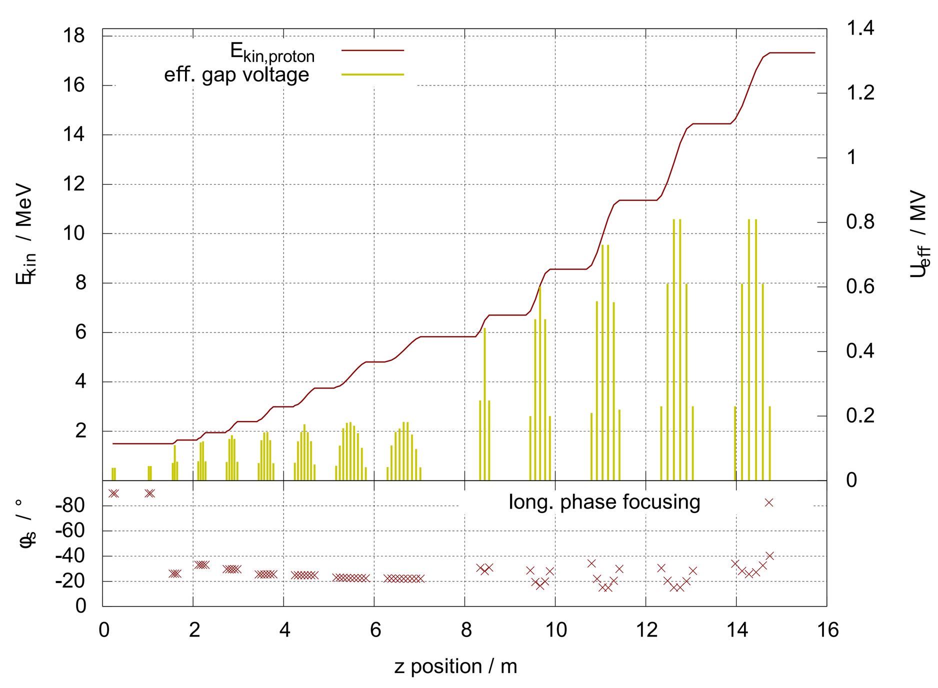
Longitudinal Beam Envelopes



Proton Beam Output Distributions



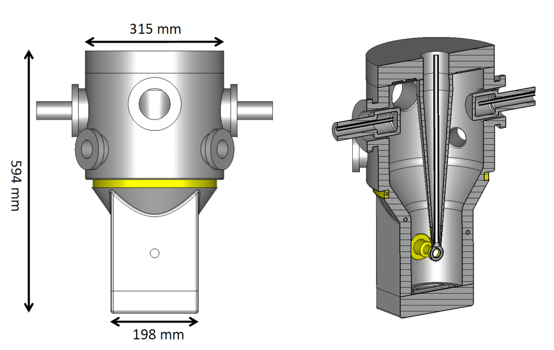
Energy Gain & Voltage Distribution



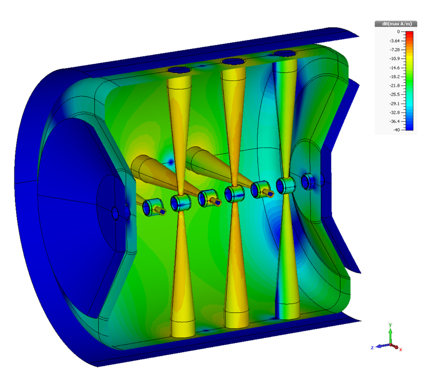
Emittances

	2012 ref. design	2014 ref. design
$\varepsilon_{n,x,rms,in}$	0,220 mm mrad	0,206 mm mrad
$\varepsilon_{n,x,rms,out}$	0,279 mm mrad	0,247 mm mrad
$\varepsilon_{n,y,rms,in}$	0,216 mm mrad	0,210 mm mrad
$\varepsilon_{n,y,rms,out}$	0,272 mm mrad	0,247 mm mrad
$\varepsilon_{n,z,rms,in}$	1,007 ns keV	0,639 ns keV
$\varepsilon_{n,z,rms,out}$	1,390 ns keV	0,707 ns keV

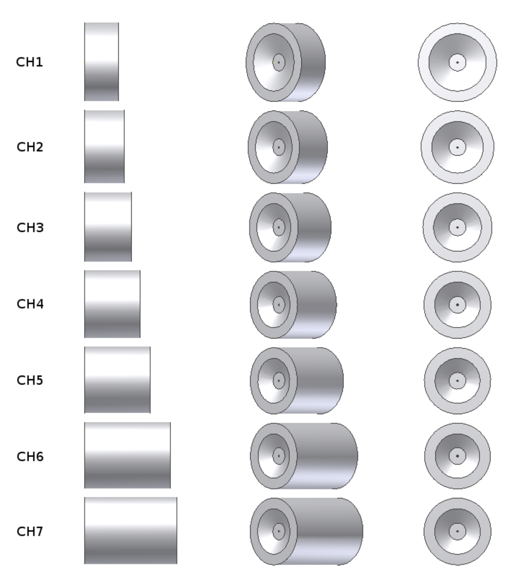
Room Temperature Cavities



QWR Rebuncher cavity



Surface Current Density of CH 5

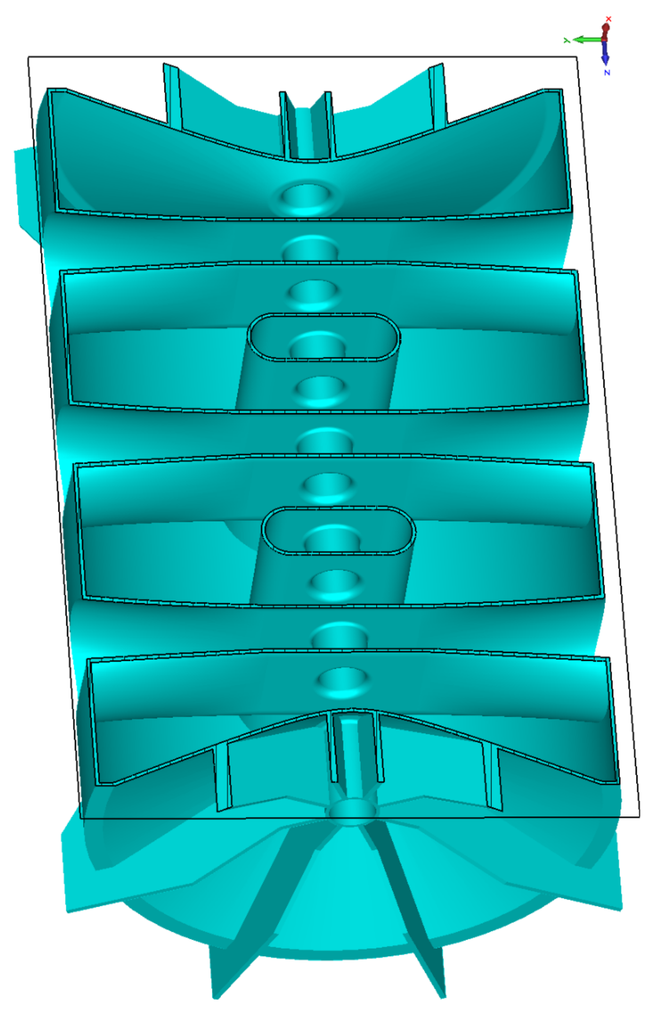


Parameter	CH1	CH2	CH3	CH4	CH5	CH6	CH7
R [mm]	392,22	359,90	340,29	330,08	326,39	323,42	329,82
L_{innen} [mm]	313,8	376,50	452,73	546,66	660,51	881,42	959,32
N_{Spalte}	3	4	5	6	7	9	9
a [mm]	30	30	30	30	30	30	30

Parameter	CH1	CH2	CH3	CH4	CH5	CH6	CH7
ϕ_S	-26	-33	-30	-26	-25	-23	-23
$\beta_{eing.}$	0,0565	0,0601	0,652	0,0721	0,0803	0,0896	0,1012
$\tilde{\beta}$	0,0584	0,0628	0,689	0,0764	0,0852	0,0958	0,1065
$\beta_{ausg.}$	0,0601	0,0652	0,721	0,0803	0,0896	0,1012	0,1113
U_{eff} [MV]	0,224	0,360	0,516	0,660	0,826	1,140	1,109
E_a [MV/m]	0,714	0,956	1,140	1,207	1,251	1,293	1,156
Q_{sim}	12566	14056	15449	16547	17298	18001	18096
P_c [kW]	7,59	10,01	12,79	14,74	17,68	23,86	21,83
p_c [kW/m]	24,18	26,60	28,25	26,96	26,77	27,07	22,76
R_a [MΩ]	6,96	13,62	21,90	31,11	40,62	57,35	59,30
Z_a [MΩ/m]	22,18	36,18	48,38	56,91	61,50	65,06	61,81

CH Prototype Cavity

Superconducting CH Structures



CH10 with Constant β Profile

Parameter	CH8	CH9	CH10	CH11	CH12
$L_{\beta\lambda-def.}$ [mm]	293,87	533,47	738,01	838,69	919,82
L [mm]	444,89	684,32	875,95	968,90	1043,15
β_{design}	0,115	0,127	0,145	0,164	0,180
R [mm]	330,00	293,49	296,09	306,67	315,17
N_{Spalte}	3	5	6	6	6
a [mm]	40	40	50	50	50

Parameter	CH8	CH9	CH10	CH11	CH12
$\beta_{eing.}$	0,1113	0,1190	0,1342	0,1542	0,1734
$\beta_{ausg.}$	0,1190	0,1342	0,1542	0,1734	0,1893
$\phi_{s,mittel}$ [°]	-29,5	-20,4	-19,7	-19,0	-29,4
f [MHz]	176,1	176,1	176,1	176,1	176,1
U_a [MV]	0,97	2,0	3,0	3,3	3,3
E_a [MV/m]	3,301	3,749	4,065	3,935	3,588
E_p/E_a	5,38	5,36	5,94	5,34	5,82
B_p/E_a	7,78	10,14	12,61	14,45	14,99
R_SQ [Ω]	56	58	59	60	61
R_a/Q_0 [Ω]	334	389	570	566	569
R_aR_S [Ω^2]	19219	22524	33464	33836	34583

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