HOM Damping in Multi-Cell Superconducting Cavities for the Future Electron Source BriXSinO

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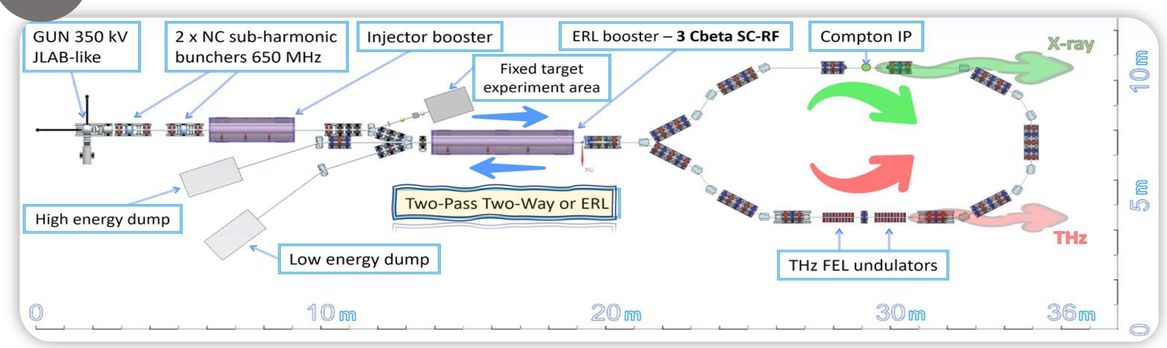
Introduction

We developed a model called HOMEN to study the consequences of high order modes on beam dynamics and the stored energy inside a superconducting cavity, located in the main Linac of BriXSino. Investigations about wakefield calculations and HOM damping were carried out.

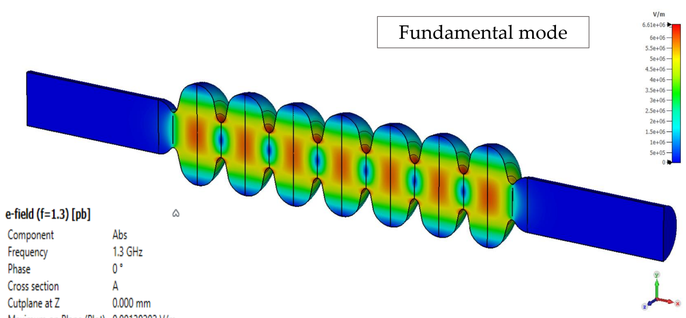
BriXSinO layout



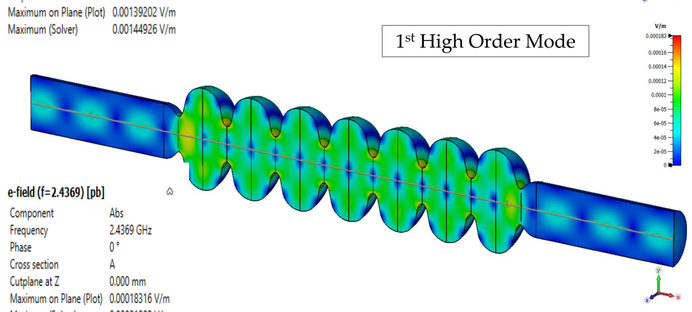
Cavity fields

Schematic of the field in the 7-cell cavity simulated by CST

Fundamental mode



1st High Order Mode



HOMEN

$$\frac{dU_n}{dt} = P_{kly} - P_{dis} - P_{av} + P_{HOM}$$

$$\frac{dA_n}{dt} = \frac{A_n}{2U_n}\frac{dU_n}{dt}$$

$$\frac{d\gamma}{dt} = \frac{e}{m_e c^2 \tau_{cav}} \sum_{n=1}^{N_{RF}} V_{acc_n}$$

HOMEN MODEL

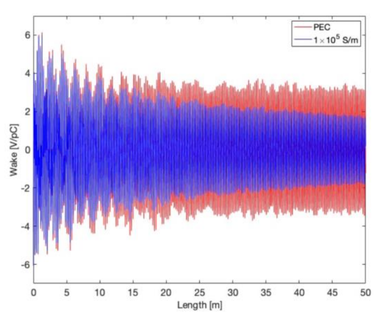
High Order Modes *Evolution based on ENergy budget*

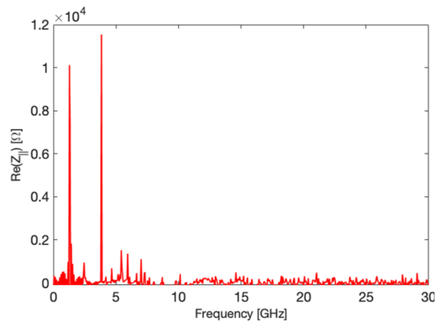
The main parameters of the model are:

- The power lost on the cavity walls: $P_{dis} = \frac{\omega_n U_n}{Q_{L_n}}$
- The Klystron Power : P_{kly}
- The average Power to accelerate the e- bunch $P_{av} = \frac{q_i V_{acc_{i,n}}}{\tau_{cav_i}}$.
- Power lost acording to the wakefield $P_{HOM} = \frac{q_i^2 k_{loss,n}}{\tau_{cav_i}}$

Wakefield Simulations

- Wakefield simulations are done by CST.
- The real part of the Longitudinal Impedance shows important peaks relative to the parasitic HOMs.
- The calculated loss parameter for each HOM are shown in the table below.



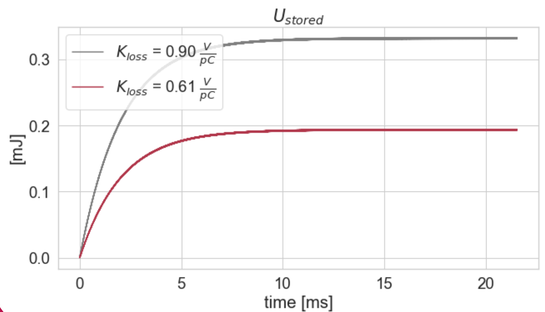


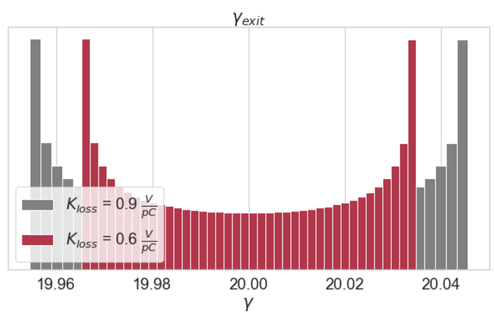
HOMs	Frequency [GHz]	k_{loss} [V/pC]
Mode 1	2.46	0.60
Mode 2	3.84	0.61
Mode 3	5.45	0.33
Mode 4	5.93	0.17
Mode 5	6.70	0.15
Mode 6	7.01	0.47
Mode 7	10.70	0.51

Table 1: Frequencies and k_{loss} values of HOMs

HOM Analysis

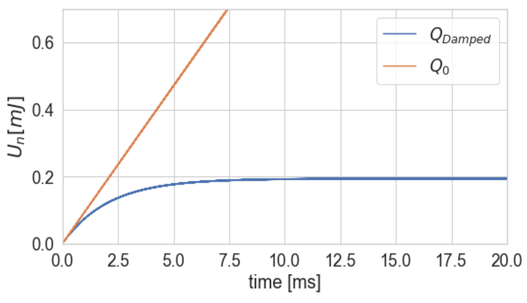
- The calculated loss factor parameter shows a better results for the stored energy variation inside the cavity.
- For a high order mode with (ν_n = 2.43 GHz), $t_{ch,n} = \frac{Q_n}{\omega_n}$ = 12.91 ms, the stored energy reach stabilisation with a higher value in case of high loss factor.
- The variation of the bunch energy gain at the cavity exit shows that the relative energy spread decrease from 2×10^{-3} to 1×10^{-3}.
- Good improvement for the FEL injection which located in the arc of BriXSinO.

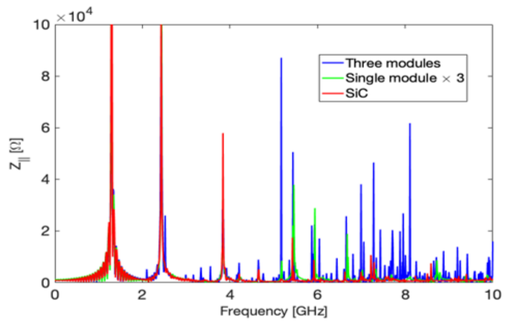




HOM Damping

- HOM damping leads to store less energy in the cavity in a short time.
- The loaded quality factor used in this simulations is in the order of 10^7.
- Without damping, the stored energy will take long time to reach the equilibrium.
- An absorbing material like SiC composie results in damping almost all the parasitic modes.
- The Figure below presents the longitudinal Impedance pointing the importance of the designed absorber.





Summary & Perspectives

- The excited wakefields of the HOMs were evaluated in the 7-cell SW cavity of the main Linac of BriXSinO.
- The results show that the proposed model and the approaches followed in the simulations works for a TPTW ERL scheme.
- The HOMs can be damped with SC-35 from Coorstek, the results showed that the absorbers work as it is designed.
- The obtained results are intended to be used for further beam dynamics simulations including the full cavity system of BriXSinO.

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