Distributed Coupling Linac for Efficient Acceleration of High Charge Electron Bunches

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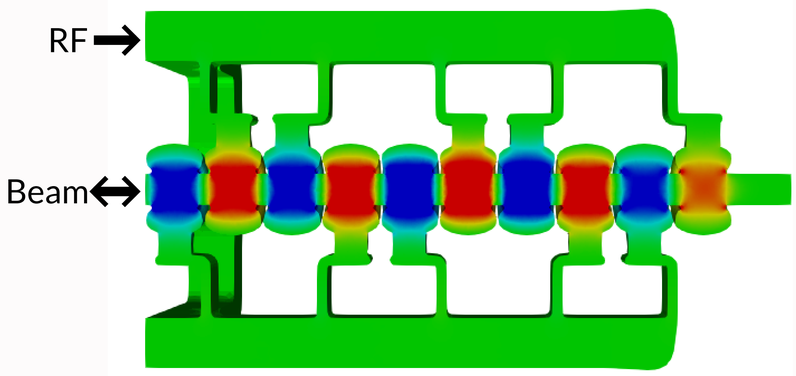
Motivation

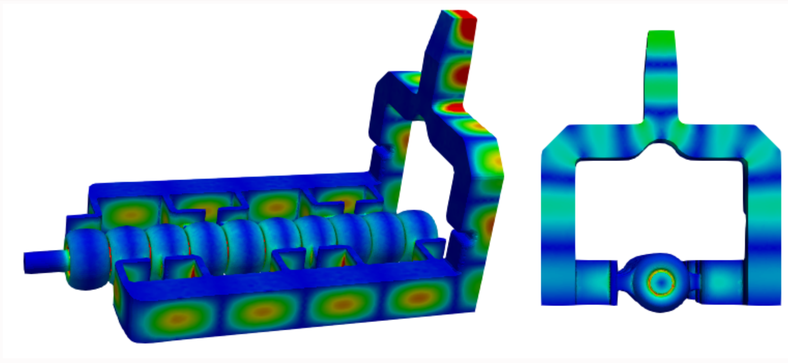
Future colliders will require injector linacs to accelerate large electron bunches over a wide range of energies [1]. We propose the use of distributed coupling designs as an efficient means of achieving high gradient acceleration.

Distributed Coupling



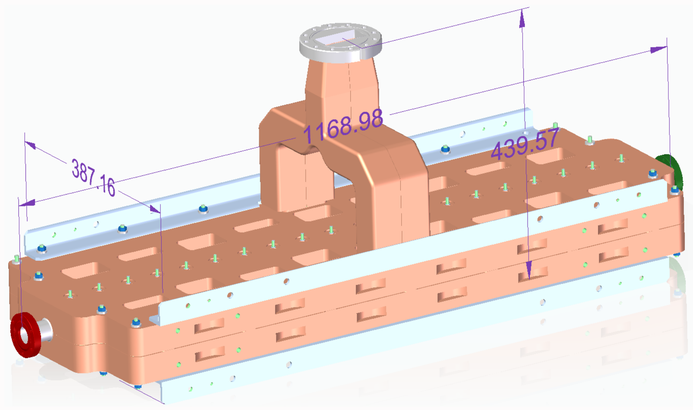
Distributed coupling uses unique waveguide and coupler design to power each cavity individually [2].

Electromagnetic Simulation



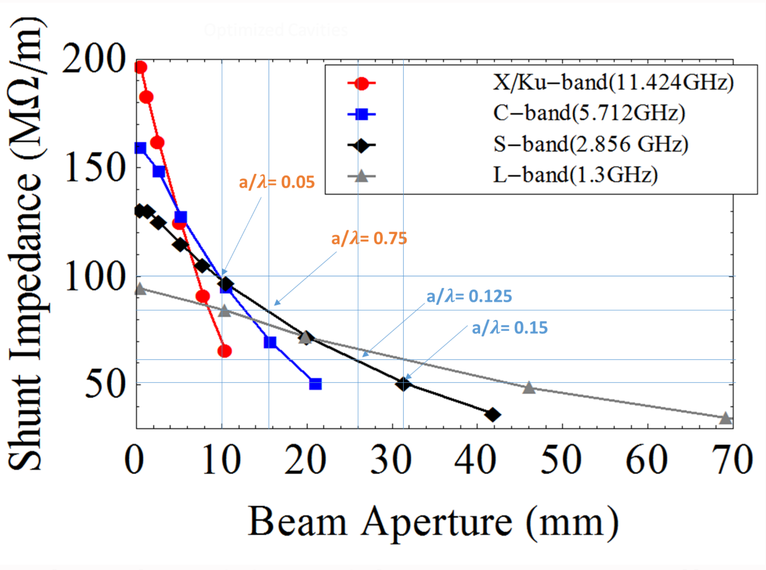
Simulations in HFSS and ACE3P verify the distributed power, with a π phase shift between successive cavities [3].

Mechanical Design

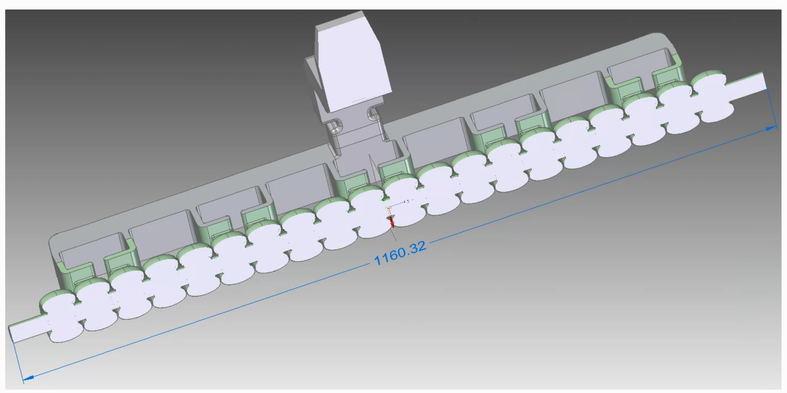


Current design uses two slabs to form the vacuum region in a meter-long structure, with a Y-coupler to distribute power.

Linac Design



S-band cavities with a reentrant cell design feature a good balance of aperture radius and shunt impedance.



Linac Properties at 5 MW

Frequency	2.856 GHz
Aperture	14.12 mm
a/λ	0.135
E_{max}/E_{acc}	2.63
E_{acc}/Z_0H_{max}	0.995

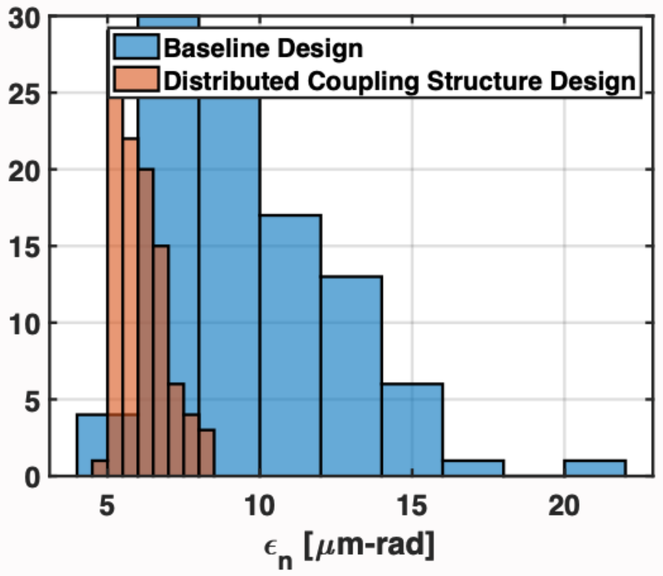
At 300K

R_s	58 MΩ/m
E_{acc}	18 MV/m

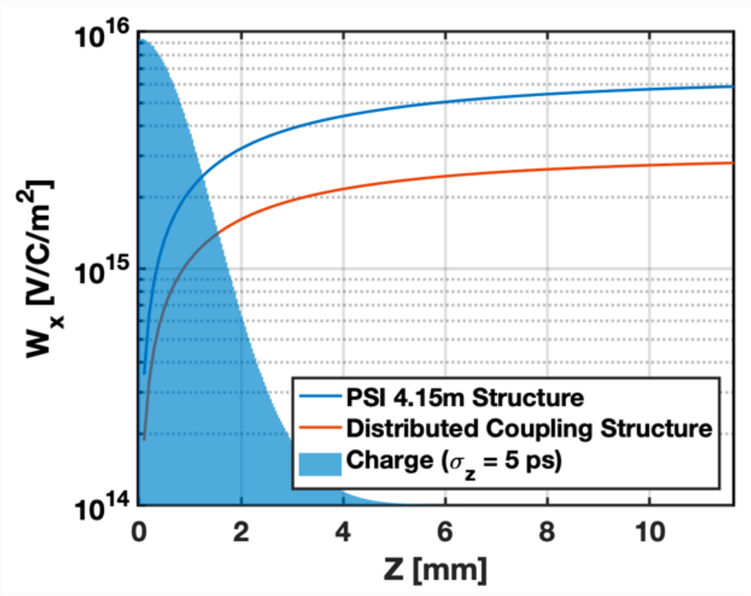
At 80K

R_s	145 MΩ/m
E_{acc}	30 MV/m

Beam Dynamics Simulations

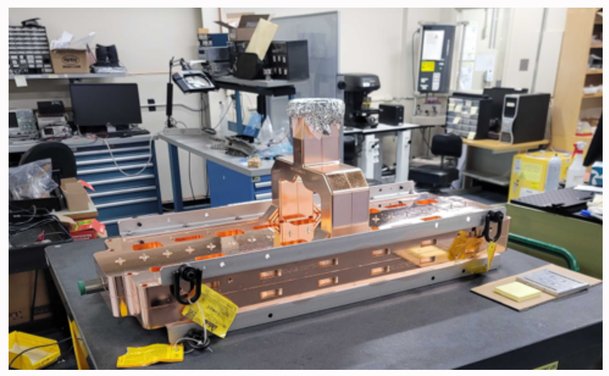


Compared to baseline traveling wave structures, our design maintains better output emittance for 14 nC bunches.

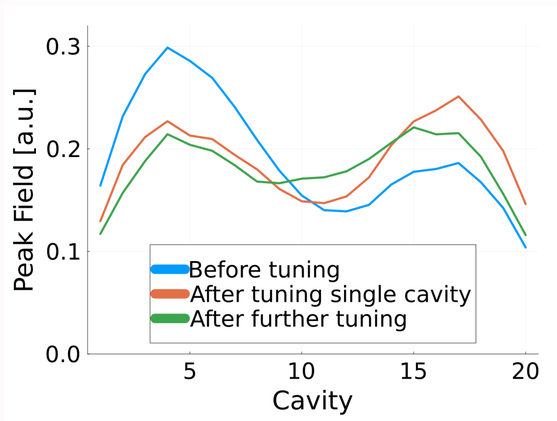


Similar comparisons to a traveling wave structure from PSI show better handling of wakefields too.

Initial Characterization



Assembly of one structure is complete, with tuning of field flatness underway.



First pass of tuning looks promising, with further tuning after final brazes.

Acknowledgements

[1] F. Willeke, "Electron ion collider conceptual design report" 2021,tech. rep., 2021.
[2] S. Tantawi et al., Phys. Rev. Accel. Beams, vol. 23, p. 092001, Sep 2020.
[3] Li, Zenghai et al. AIP Conference Proceedings , Vol. 1507, No. 1 p. 837-842

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