SRF cavity testing fixture and HOM analysis

James Griggs, University of Kentucky

Internship Final Talk

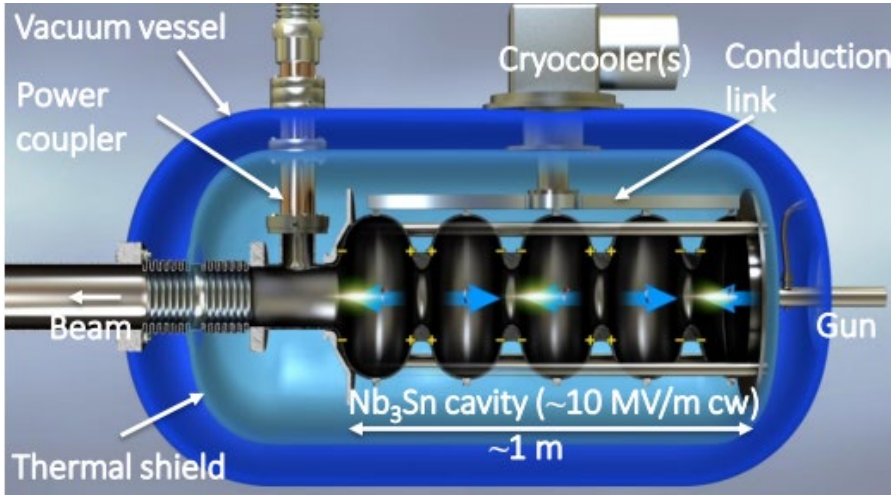
3 August 2020

Introduction

- Junior Electrical Engineering student at the University of Kentucky
- 2nd year returning SIST intern working on a project at IARC(Illinois Accelerator Research Center)
- Supervisors: Michael Geelhoed, Ram Dhuley

IARC accelerator program

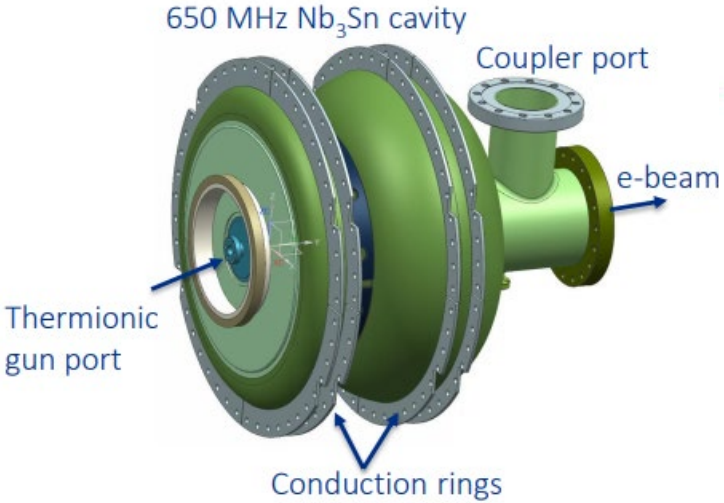
- Two types: normal conducting and superconducting accelerators
- Superconducting accelerators are energy efficient but need Liquid Helium for operation.
- Liquid helium is operationally complex and expensive.
- IARC is developing a cryogen free accelerator for industrial applications.

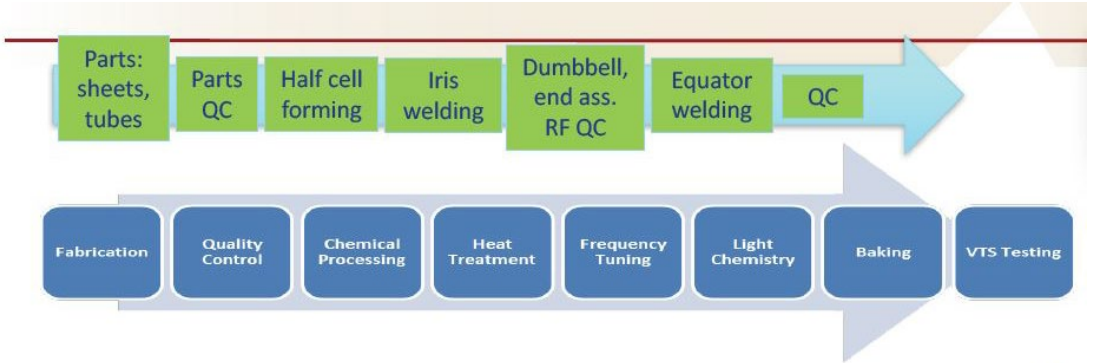


Fermilab

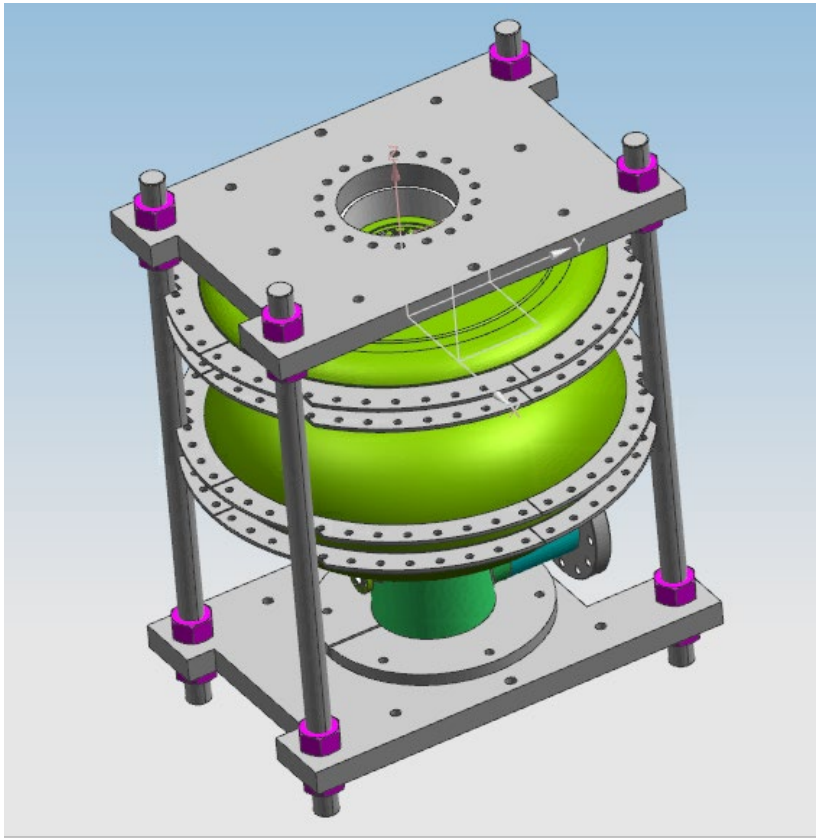
Engine of the accelerator

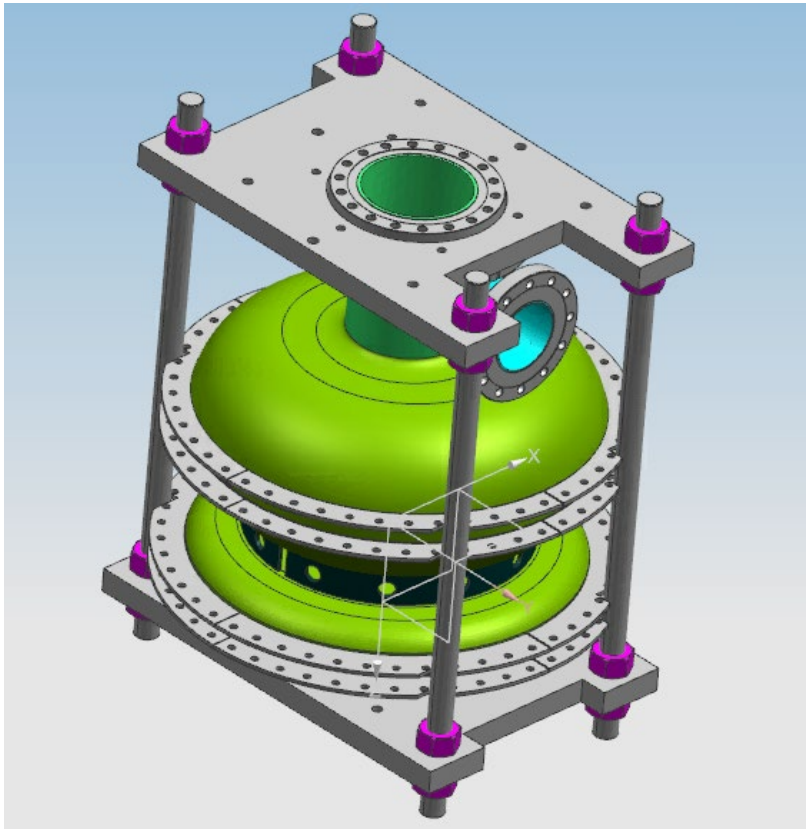
- During fabrication, transportation and testing, the cavity will have varying pressures both internally and externally.





Fixture Design Process

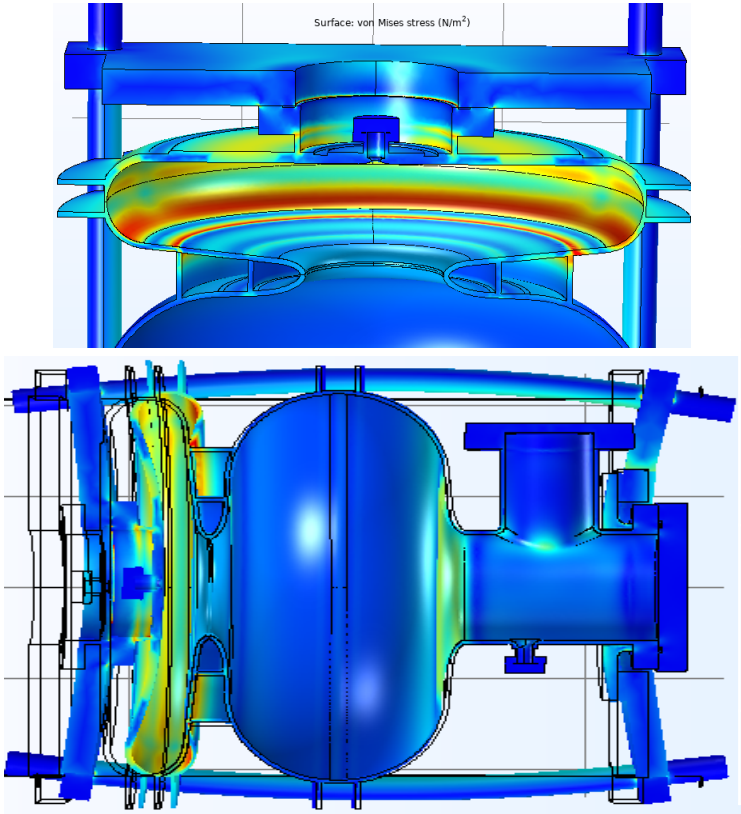




Fermilab

Fixture Design Results

	Membrane Stress Pm (Mpa)		Allowable stress (A) Mpa	Ratio (Pm+Pb)/A
Iris	4.4		15/25	.18
outer stiffening ring	8.3		15/25	0.332
inner stiffening ring	3.4		15/25	0.136
half cell equator	.92		15/25	0.0368

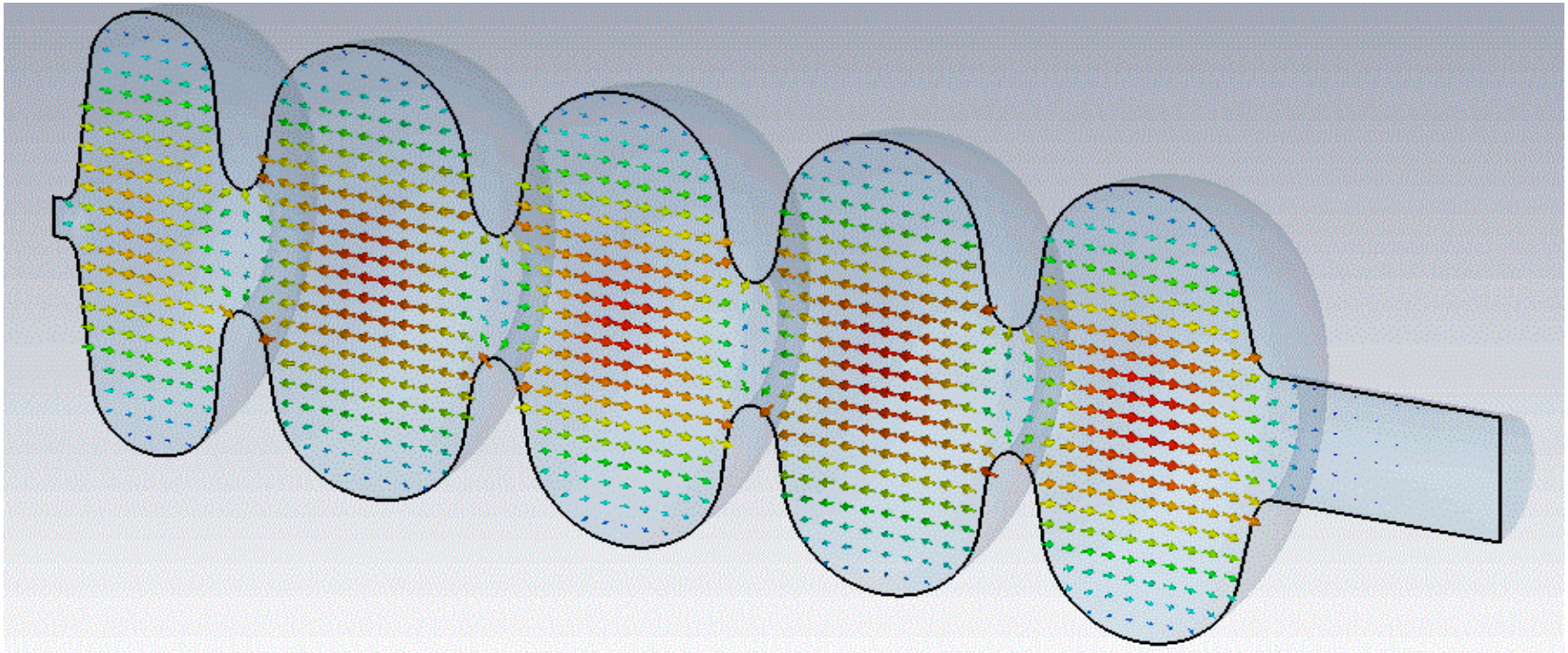


	Membrane Stress + Bending Stress Pm+Pb(MPa)		Allowable stress (A) MPa	Ratio (Pm+Pb)/A
Iris	5.15		22.5/38	0.137
outer stiffening ring	1.07		22.5/38	0.0285
inner stiffening ring	3.61		22.5/38	0.096
half cell equator	1.41		22.5/38	0.0376

Fermilab

HOM Analysis

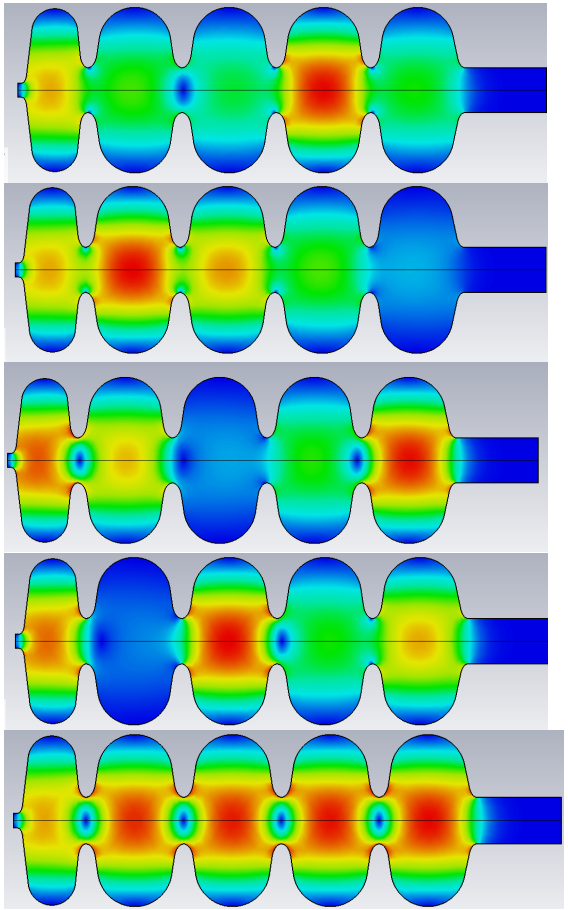
- How does a cavity work?



HOM analysis

Each cell has its own resonate frequency

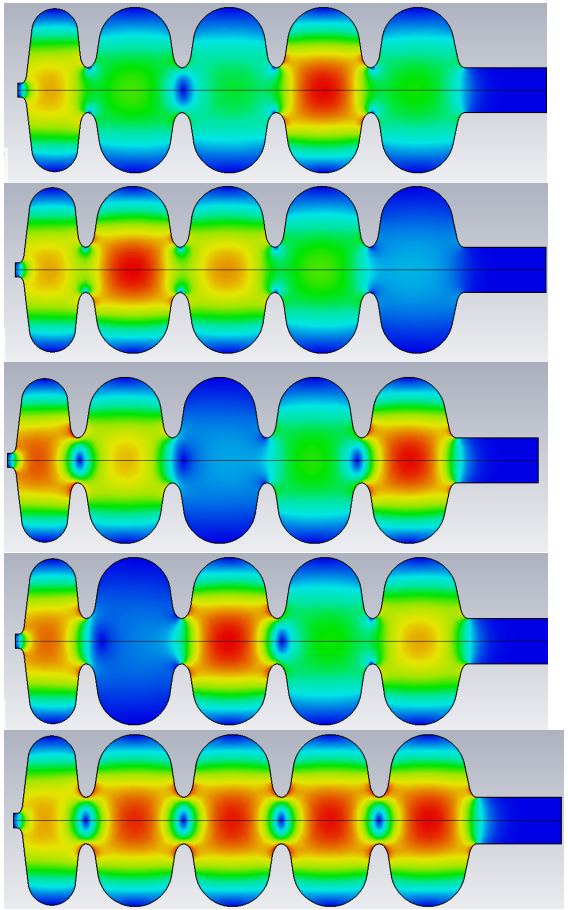
- Operating frequency of 650MHz
- Multiples of the fundamental frequency, such as 1300MHz and 1950MHz



HOM analysis

- What did I have to do?

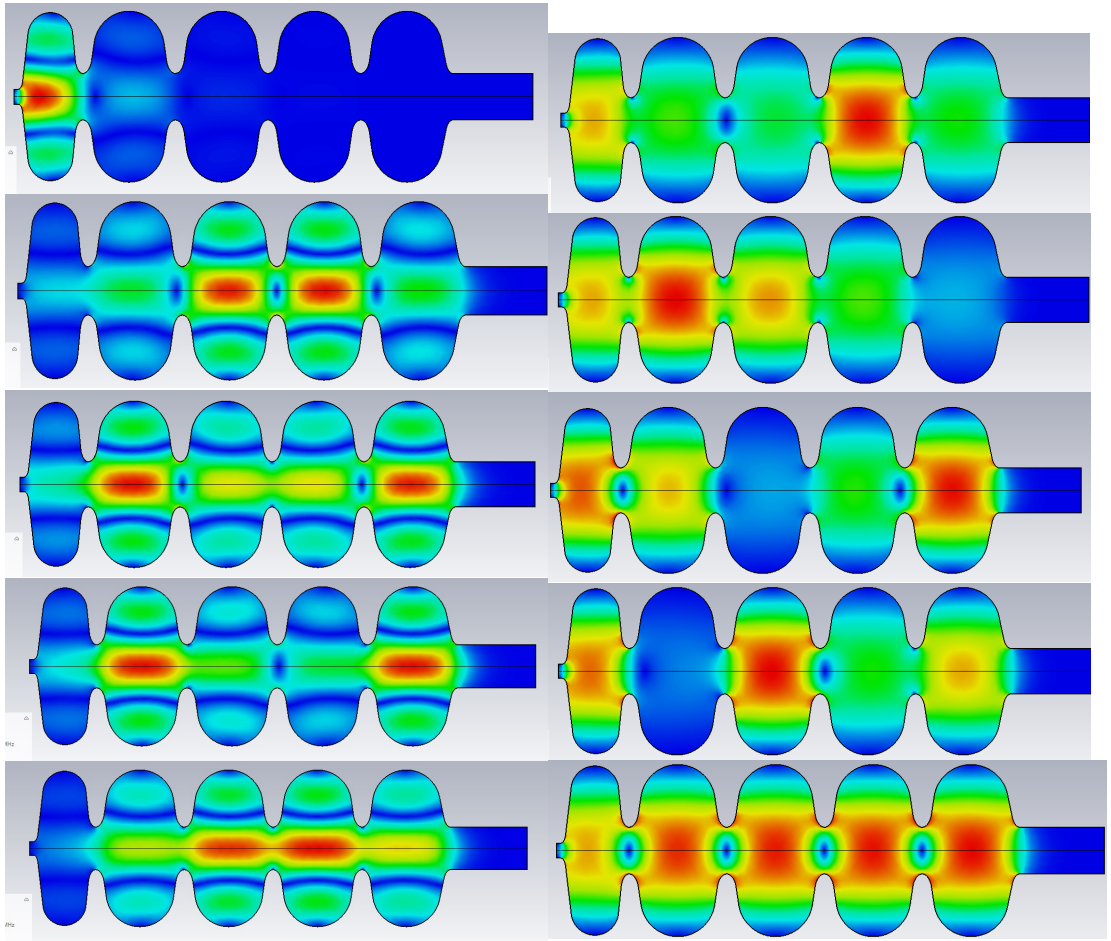
Frequency (MHz)	R/Q (Ω)	error
644.942	8.480229	3.35E-08
646.09	9.386036	3.72E-08
647.862	10.57334	5.37E-08
649.405	10.84468	5.10E-08
650.021	657.3929	6.47E-08



Fermilab

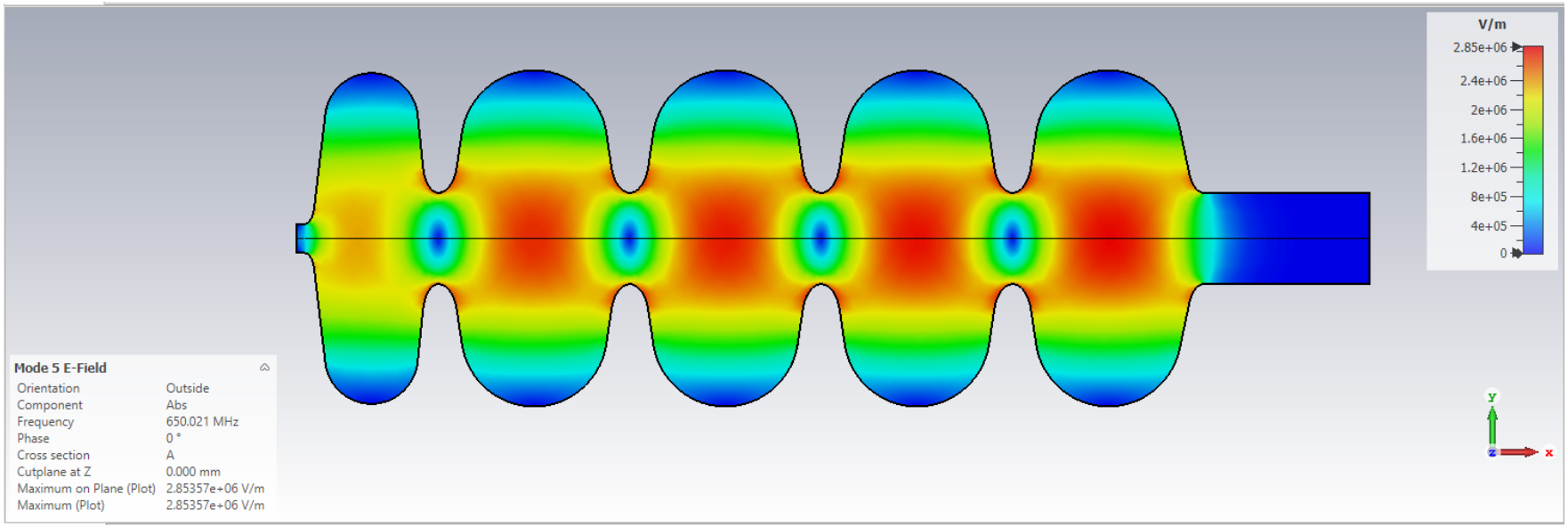
HOM analysis

Frequency(MHz)	R/Q(Ω)	error
644.942	8.480229	3.35E-08
646.09	9.386036	3.72E-08
647.862	10.57334	5.37E-08
649.405	10.84468	5.10E-08
650.021	657.3929	6.47E-08
1185.499	3.126159	7.53E-08
1188.923	2.072631	9.06E-08
1193.714	45.75199	1.04E-07
1198.032	133.8583	1.23E-07
1376.733	0.552395	3.91E-07
1381.654	0.530997	3.75E-07
1389.034	0.677806	5.03E-07
1396.003	0.355496	7.01E-07
1415.581	23.74861	5.61E-08
1532.955	24.75373	1.34E-07
1761.69	4.744791	4.61E-07
1774.985	4.491849	9.38E-07
1795.08	0.122324	2.85E-07
1815.592	0.024954	1.04E-07
1902.883	3.486004	9.74E-08
1905.529	1.406817	1.44E-07
1906.921	30.95568	1.29E-07
2012.885	8.554	5.17E-07
2030.612	3.930114	7.28E-07
2055.034	2.386919	6.66E-07
2083.673	13.40303	7.76E-07
2109.417	16.16926	3.31E-07
2120.488	35.73229	4.25E-07
2285.557	19.81638	1.06E-06
2341.627	0.99798	1.03E-06



Fermilab

HOM analysis



This was the main operating frequency with the highest R/Q

Fermilab

Conclusion

- Huge thank you to Michael Geelhoed, Ram Dhuley, and the SIST program.

- Stay safe!