

Special Topic RF Course – Numerical Analysis of RF Problems

N. Baboi, H. Glock, A. Neumann, R. Singh, S. Udongwo, C.
Vollinger, M. Wendt

Supervisors: Dr. Shahnaz Gorgi Zadeh, Dr. Rama Calaga, Prof. Ursula van Rienen

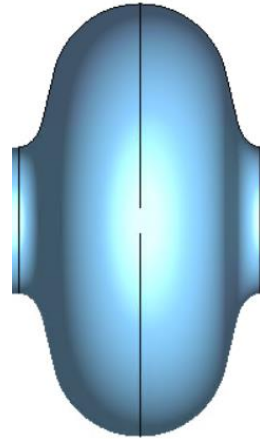
Content



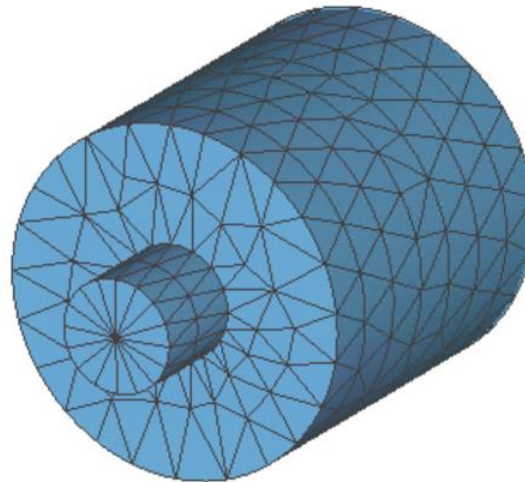
- Parametric modelling
- Eigenmode simulation
- Time domain and Wakefield simulation
- Particle in Cell (PIC) simulation

Parametric Modelling

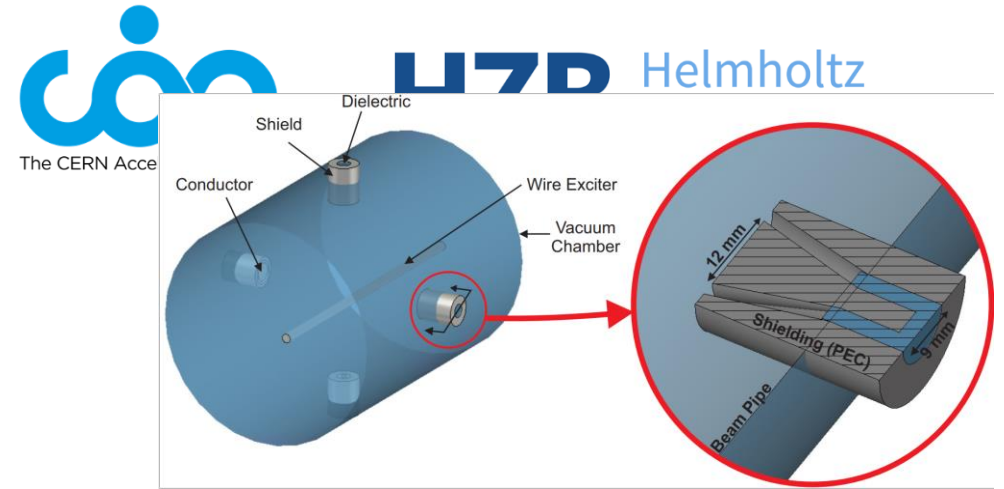
- Parametric modelling is a feature in CAD software that allows designers to create and modify 2D or 3D models flexibly and efficiently.



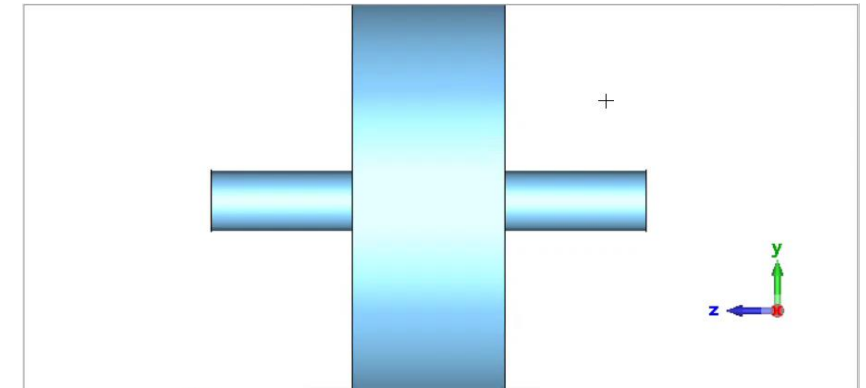
TESLA Cavity mid-cell



Pillbox Cavity



Button Beam Position Monitor (BPM)

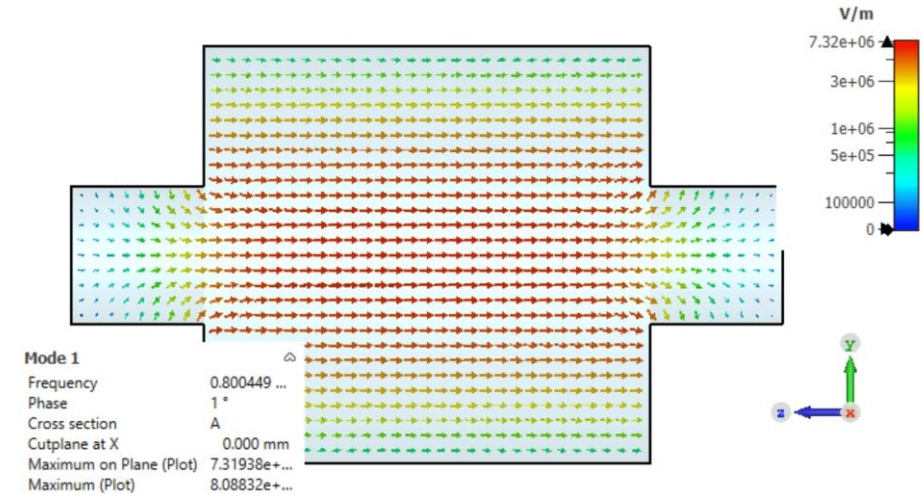


Name	Expression	Value	Description
r_cav	= 144.67602186539	144.67602186539	Cavity radius
l_cav	= 310	310	Cavity length
r_bp	= 48	48	Beampipe radius
l_bp	= 92	92	Beampipe length

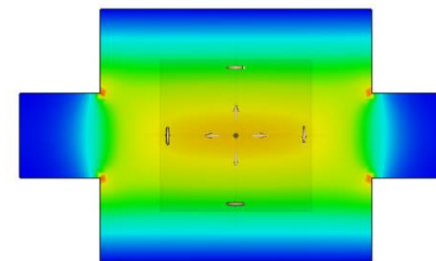
Parametric Modelling

Eigenmode Simulation

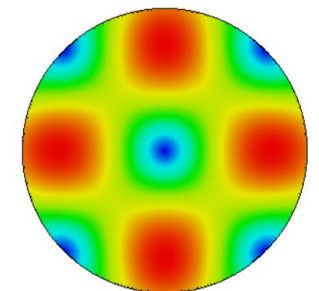
- Eigenmode analysis is a method for analysing the resonant modes of an electromagnetic system.



TM010 mode electric field simulation



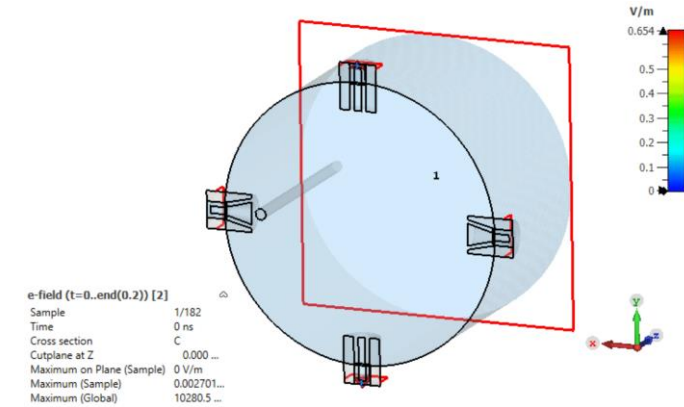
TM010 mode electric field contour



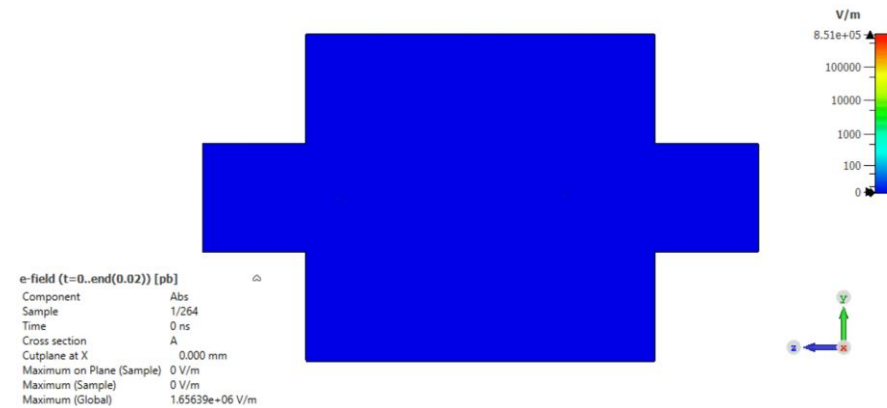
HOM electric field contour

Time Domain and Wakefield Simulations

- Wakefield solver is essentially an extension of a time-domain solver to simulate the interaction of charged particle beams with the environment.



Time domain simulation of a button BPM excited by a wire



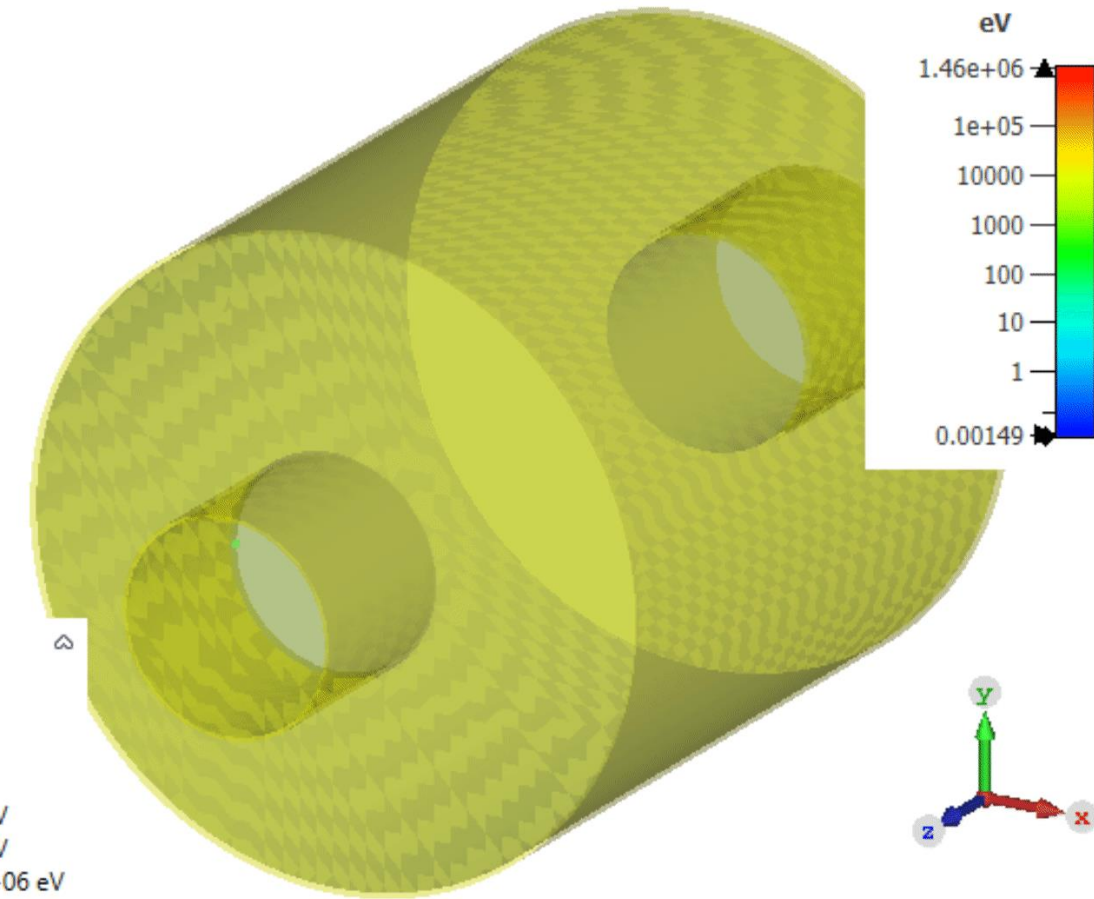
Wakefield Simulation of a pillbox cavity

Particle in Cell (PIC) Simulation

- PIC simulation is a tool for simulating the behaviour of charged particle beams in complex electromagnetic environments
- In the tutorial, multipacting is simulated in a pillbox cavity.

position monitor 1

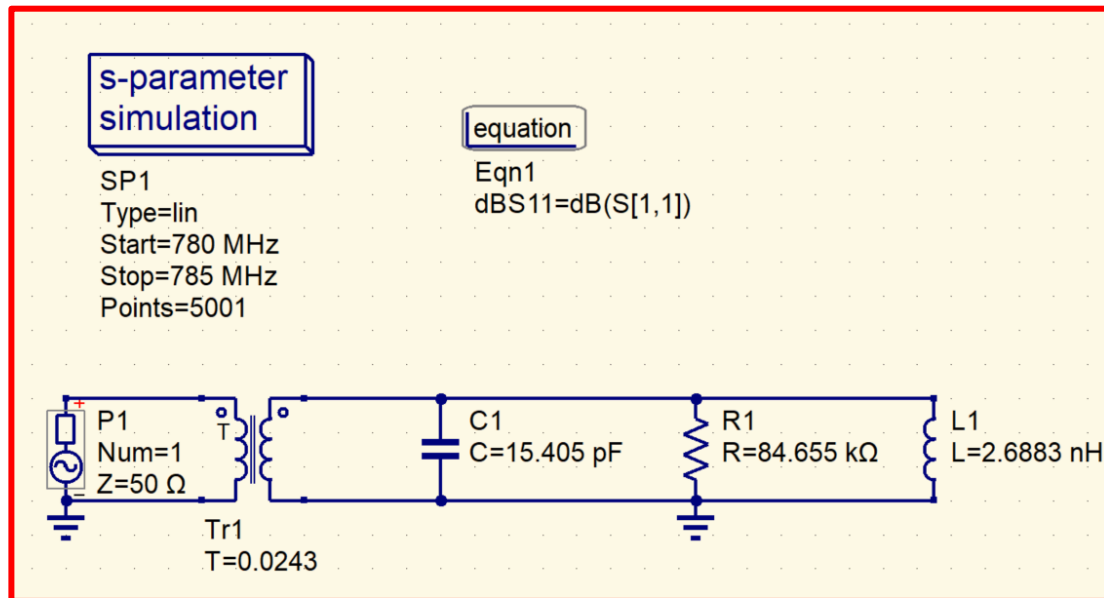
Output	Energy
Sample	1/769
Time	0 ns
Particles	1
Maximum (Sample)	1378.75 eV
Minimum (Sample)	1378.75 eV
Maximum (Global)	3.04616e+06 eV
Minimum (Global)	8.82357e-06 eV



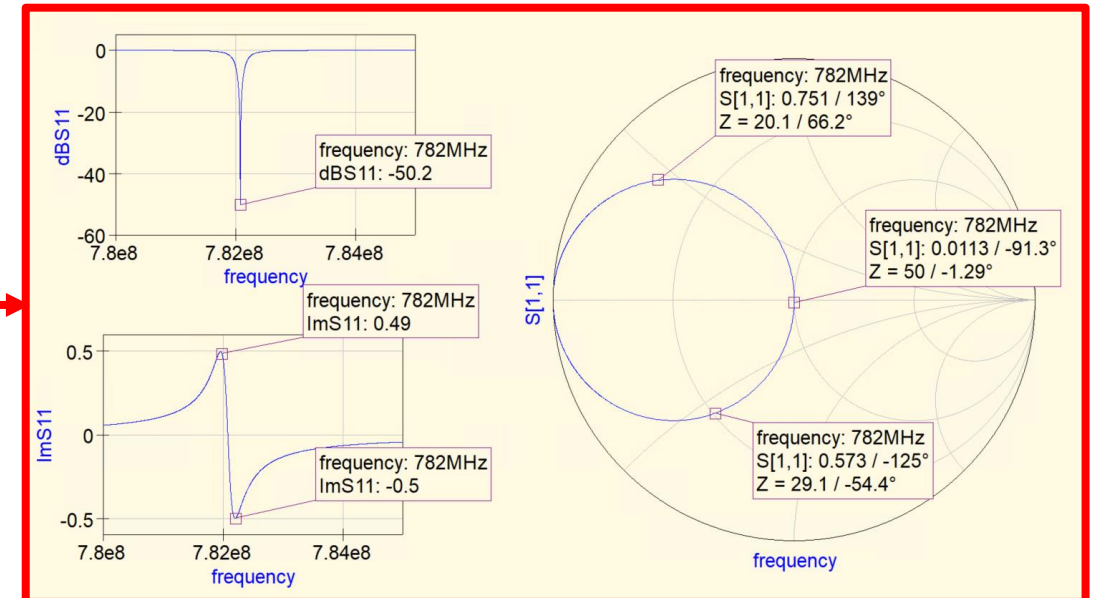
Multipacting in pillbox cavity

Equivalent Circuit Analysis - Qucs Studio

- Equivalent circuit simulations provide a simplified representation of complex systems, enabling efficient analysis and prediction of system behaviour.



RLC equivalent circuit of a resonant mode.



Transmission curves and Smith's chart of the equivalent circuit