Model a cylindrical cavity with the CST Microwave Studio

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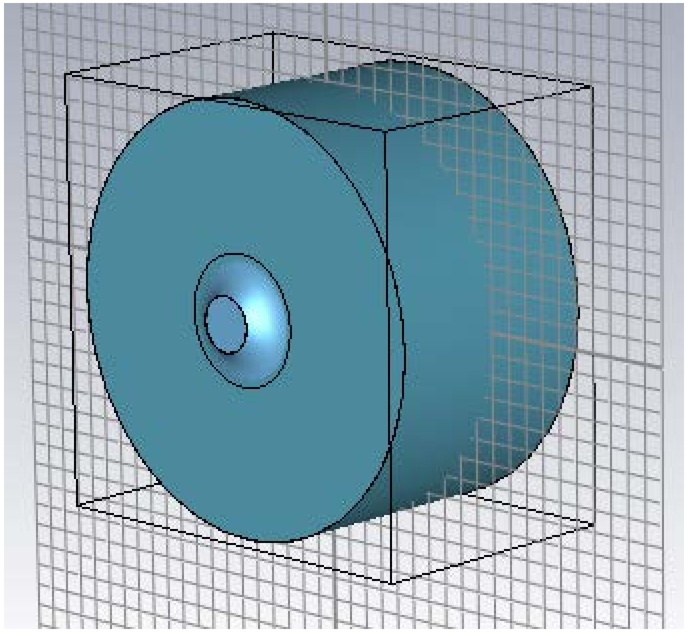
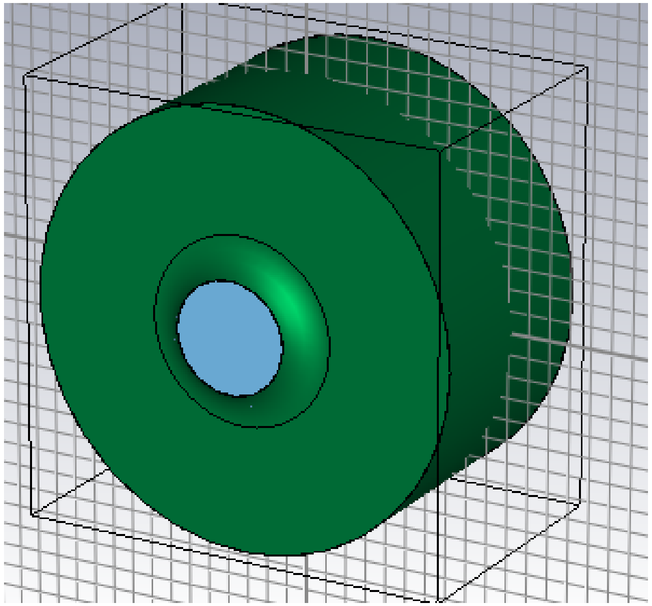
Model set up for the π-mode

- Draw a cylindrical cavity with iris.
  - Length: λ/2 (π-mode)
  - Thickness of the iris: 2 mm
  - Three iris radii: 0.05*λ, 0.1*λ, 0.2*λ
- Tune to 11.424 GHz:
  - Radius: optimize numerically



Model set up for the 2π/3-mode

- Draw a cylindrical cavity with iris.
  - Length: λ/3 (2π/3-mode)
  - Thickness of the iris: 2 mm
  - Iris radius 0.1*λ
- Define periodic boundary conditions.
- Tune to 11.424 GHz:
  - Radius: optimize numerically
- Plot the dispersion curve: frequency vs. phase shift per cell (~ 5 points).

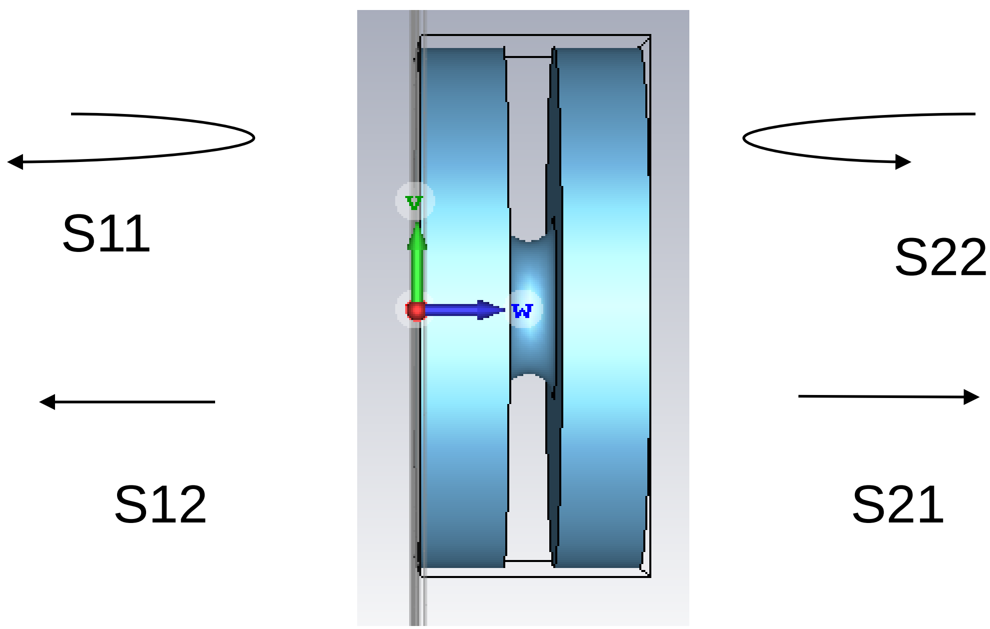


Compute:

- Quality factor Q_0.
- Shunt impedance R_s.
- Accelerating gradient E_a.
- Peak surface electric field E_p.
- Peak surface magnetic field H_p.
- The ratios of E_p / E_a, zH_p / E_a.

Scattering matrix studies

- Calculate the scattering matrix for the half-cell with the iris radius 0.1*λ.



Bonus tasks

- Study the $2\pi/3$-mode cavity with iris radii $0.05*\lambda$ and $0.2*\lambda$. Tune, compute the dispersion curves and the accelerator characteristics.

Results for the π-mode, $a=0.05*\lambda$.

- R0=10.078 mm, L=13.12 mm.
- Quality factor Q_0=8550.
- Shunt impedance $R_s=1.71*10^6$.
- Voltage $V=3.788*10^6$. Accelerating gradient E_a= 288 MV/m.
- Peak surface electric field E_p= 570 MV/m.
- Peak surface magnetic field H_p= 753 kA/m.
- $E_p/E_a=1.97$; $Z*H_p/E_a=0.98$.

Results for the π-mode, a=0.1*λ.

- R0=10.167 mm, L=13.12 mm.
- Quality factor Q_0=8609.
- Shunt impedance $R_s=1.61*10^6$.
- Voltage $V=3.660*10^6$. Accelerating gradient E_a= 279 MV/m.
- Peak surface electric field E_p= 548 MV/m.
- Peak surface magnetic field H_p= 748 kA/m.
- E_p/ E_a=1.96; $Z*H_p/ E_a$=1.01.

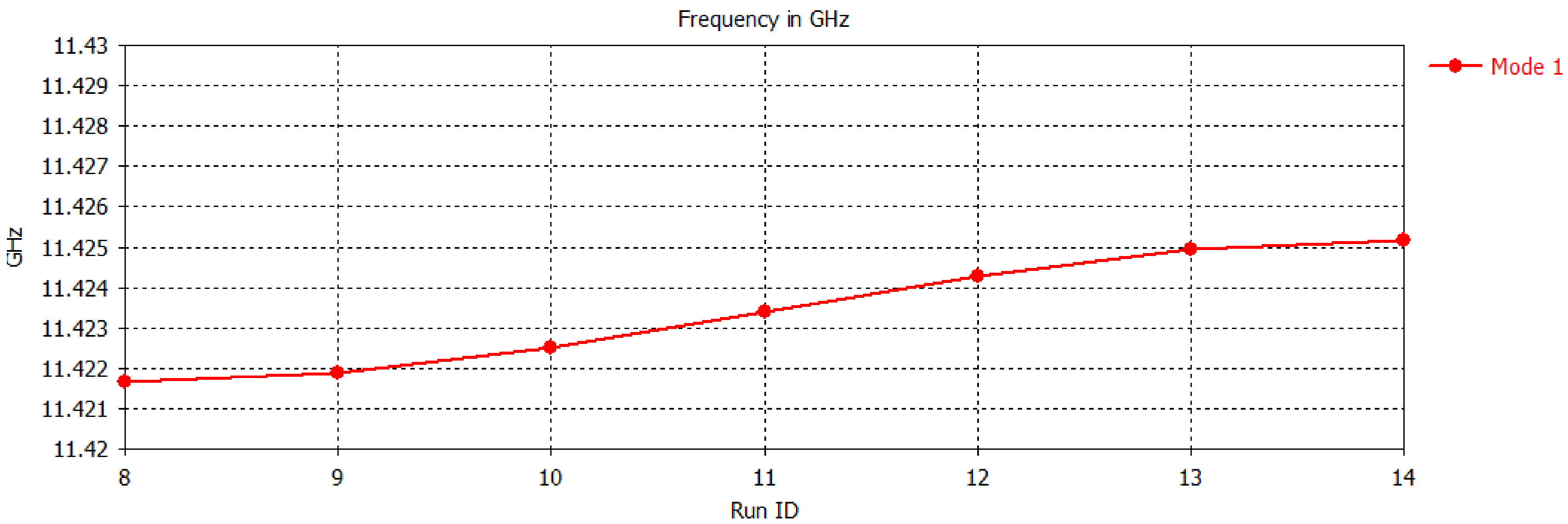
Results for the π-mode, $a=0.2*\lambda$.

- R0=10.394 mm, L=13.12 mm.
- Quality factor Q_0=8919.
- Shunt impedance $R_s=1.64*10^6$.
- Voltage $V=3.630*10^6$. Accelerating gradient E_a= 277 MV/m.
- Peak surface electric field E_p= 410 MV/m.
- Peak surface magnetic field H_p= 720 kA/m.
- $E_p/ E_a=1.48$; $Z*H_p/ E_a=0.98$.

Results for the $2\pi/3$-mode, $a=0.05*\lambda$.

- R0=10.101 mm, L=8.75 mm.
- Quality factor Q_0=6534.
- Shunt impedance $R_s=1.04*10^6$.
- Voltage $V=3.381*10^6$. Accelerating gradient E_a= 387 MV/m.
- Peak surface electric field E_p= 730 MV/m.
- Peak surface magnetic field H_p= 967 kA/m.
- $E_p/E_a=1.89$; $Z*H_p/E_a=0.94$.

Dispersion for the 2π/3-cavity, a=0.05*λ.



Results for the 2π/3-mode, $a=0.1*\lambda$.

- R0=10.299 mm, L=8.75 mm.
- Quality factor Q_0=6563.
- Shunt impedance $R_s=0.657*10^6$.
- Voltage $V=2.681*10^6$. Accelerating gradient E_a= 306 MV/m.
- Peak surface electric field E_p= 718 MV/m.
- Peak surface magnetic field H_p= 958 kA/m.
- $E_p/E_a=2.34$; $Z*H_p/E_a=1.18$.

Dispersion for the 2π/3-cavity, a=0.1*λ.

Results for the 2π/3-mode, $a=0.2*\lambda$.

- R0=11.289 mm, L=8.75 mm.
- Quality factor Q_0=6767.
- Shunt impedance $R_s=2.23*10^5$.
- Voltage $V=1.539*10^6$. Accelerating gradient E_a= 176 MV/m.
- Peak surface electric field E_p= 669 MV/m.
- Peak surface magnetic field H_p= 907 kA/m.
- $E_p/E_a=3.8$; $Z*H_p/E_a=1.94$.

Dispersion for the 2π/3-cavity, a=0.2*λ.