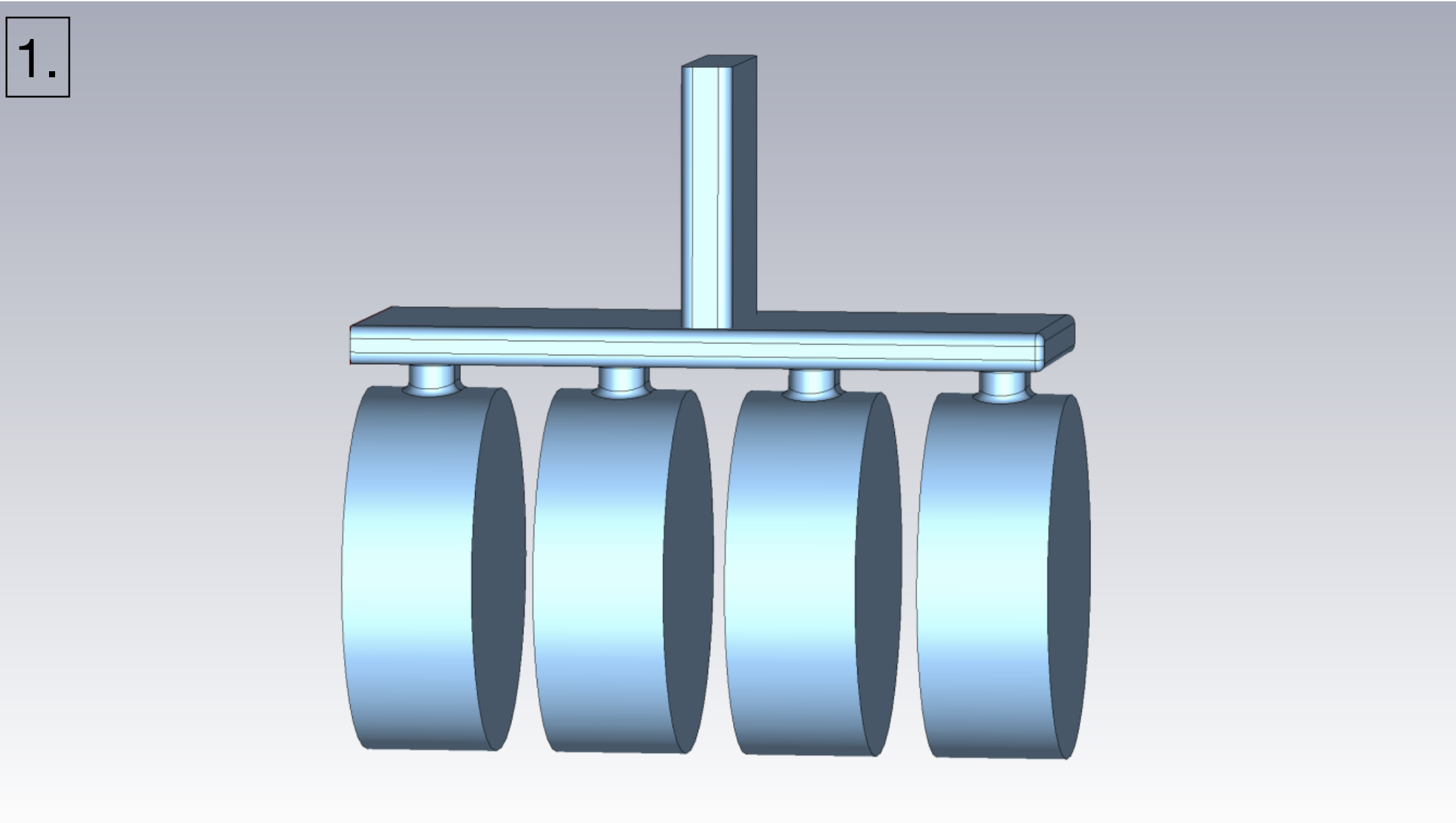


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Exposition



1. Conceptual Design of an 805MHz Cavity with Beryllium Windows and Distributed Coupling
2. RF Basics I & II

1.

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CONCEPTUAL DESIGN OF AN 805 MHz CAVITY WITH BERYLLIUM WINDOWS AND DISTRIBUTED COUPLING

T. Luo*, Lawrence Berkeley National Laboratory, Berkeley 94720, California, USA
D. Merenich, Northern Illinois University, DeKalb, Illinois 60115, USA

Abstract

For the future multi- is a critical step to i for a proton-driven mu tense muon beams reqt normal-conducting RF magnetic fields. The M. has demonstrated the R for cooper surface and : 3T solenoid B field. TI demonstrated several ke of cavity. Based on the conceptual design a ne curved beryllium wind ent (without the transit explore the distributed c multiple cavities within ing solenoids. This cav for the cavities in the m to experimentally evalu

INT

Muon collider (MuC) promising contenders fi in energy frontier, in te ever, there are technici achieve the targeted lu high flux. Presently th source is based on prot ionization cooling. In muon beam loses ener materials and regains o RF cavities which resu Due to the large diverge decay, a strong solenoid conducting (SC) magn beam within the coolin The normal conducti are essential compone tion cooling. These ca in a multi-tesla B-field SC solenoids. Achievin is critical for the ioniza luminosity of the MuC NCRF cavities is overce ing high RF gradient in Other important topics the high power RF cav

* tlao@lbl.gov

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2.

CERN Accelerator School Proceedings — RF for Accelerators — Berlin, Germany, 2023

RF Basics I & II

F. Gerigk
CERN, Geneva, Switzerland

Abstract

This lecture starts with a brief historical introduction and an explanation how to get from Maxwell's Equations to a simple cavity. After simplifying and adapt- ing the equations for their application to Radio Frequency problems, the most important formulae and characteristics for cavities and wave-guides are de- rived. The most common figures of merit are explained and some of the dif- ferent cavity types are introduced. The alternative description of cavities as a lumped circuit model is then introduced, which is often used to characterise the cavity-coupler-generator interplay.

1 Historical introduction

The first RF linear accelerator (linac) was proposed and tested by Rolf Wideröe in 1927/1928. He connected a single drift tube between two grounded electrodes to an RF source, which delivered 25 keV at a frequency of 1 MHz. In his experiment he accelerated potassium ions to an energy of 50 keV and thus demonstrated the principle of RF acceleration. This meant that for the first time the maximum obtainable energy of an accelerator was no longer limited by the electrostatic breakdown voltage of DC machines, which were in operation at the time. With this principle it was now possible to multiply the available voltage of an RF source V_{RF} by the number of gaps N and thus to increase the maximum energy gain ΔE of a particle with charge q to

$$\Delta E = qN_{gap}V_{RF}.$$

energy gain

(1)

The principle was soon extended to 30 drift tubes and a 10 MHz RF source by Sloan and Lawrence in 1931 to accelerate mercury ions to 1.26 MeV.

The basic idea of the Wideröe's linac is shown in Fig. 1. Subsequent drift tubes are connected to opposite polarities of an RF source. This means that at a 'frozen' point in time every second gap has an RF phase suitable for acceleration. The idea is that while the particles move from one gap to the next the polarity of the RF source changes, so that particles always see an accelerating field in the gaps. In order for this to work, the RF oscillations have to be in synchronism with the passage of the accelerated particles. For a fixed RF frequency f this leads to the following condition for the distance l_n between the gaps of a Wideröe's linac:

$$l_n = \frac{v}{2f},$$

synchronism condition

(2)

which means that the distance between the gap centres l_n has to become larger with increasing particle velocity v .

Even though the Wideröe linac revolutionized the acceleration of particles, its maximum energy was still severely limited for two reasons: i) For higher velocities the length of the drift tubes has to increase, which means that there was a natural 'practical' limit for these machines. Especially for light ions or protons the drift tubes would simply become too long (see Fig. 2). One can solve this problem by

Available online at <https://cas.web.cern.ch/previous-schools>

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Study of the pillbox cavity

Frequency	Radius	Length	β	κ	U
805MHz	142.65mm	100mm	0.9	58MS/m	1J

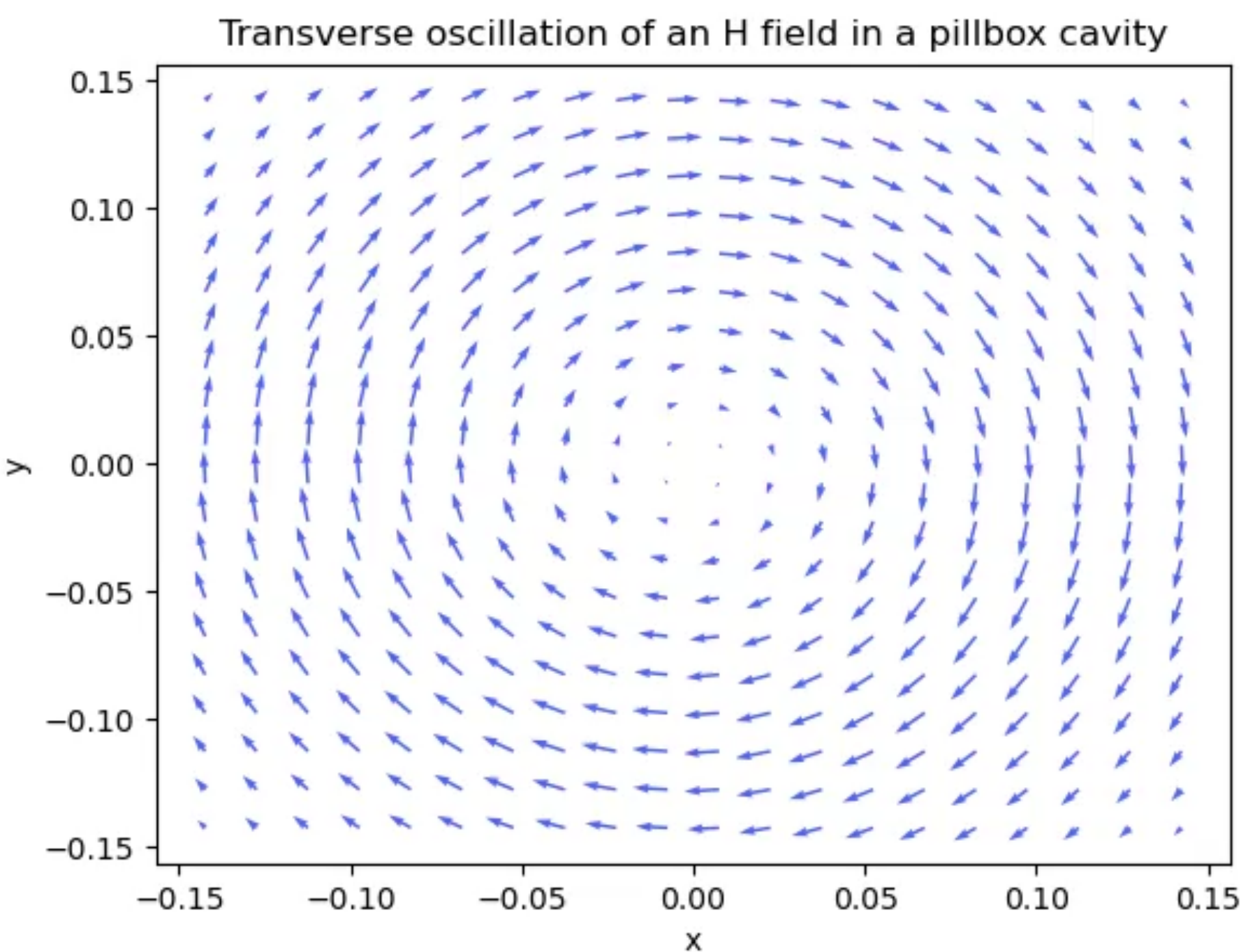
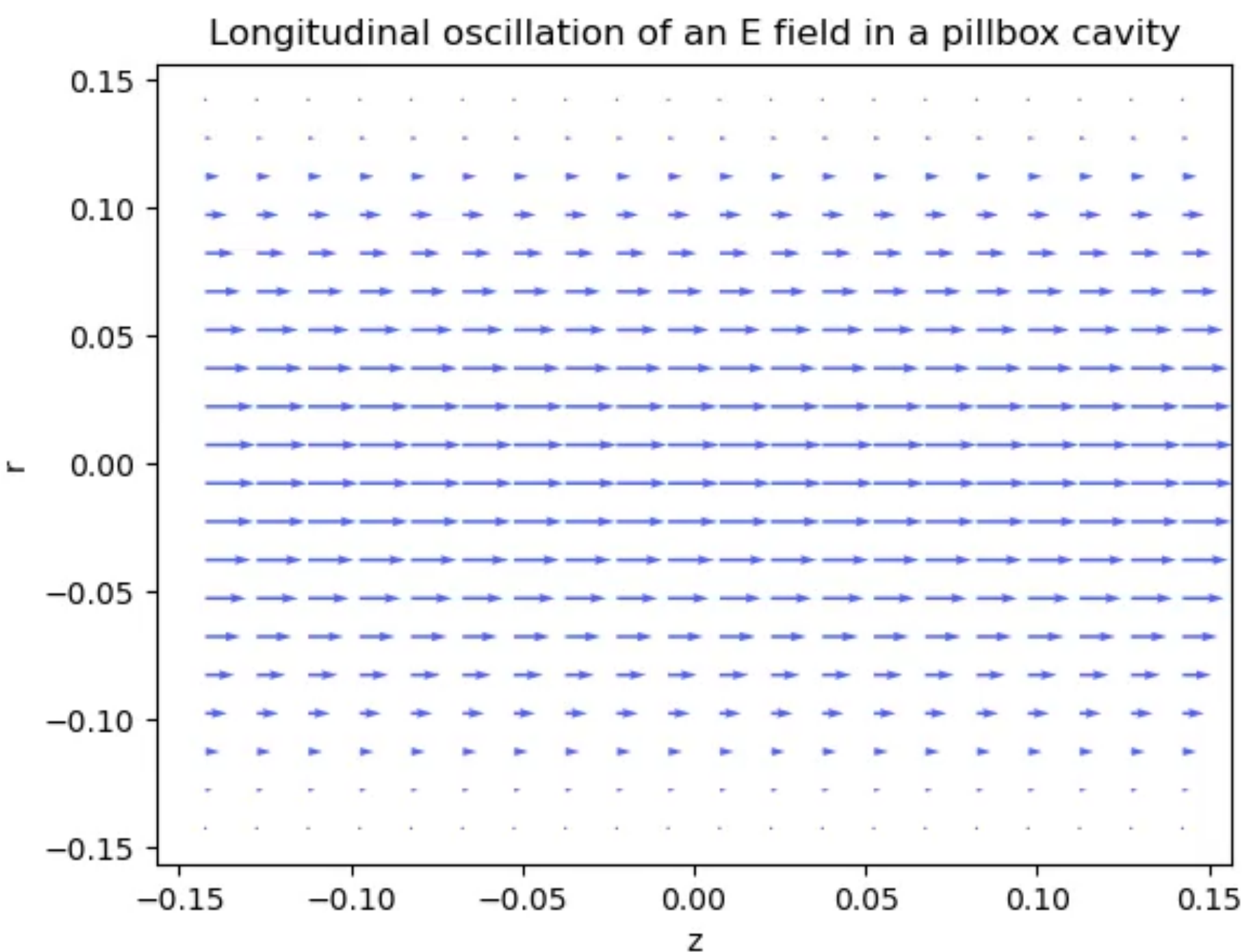
Result type	Transitive time	Q_0	RT^2/L	R/Q	Dissipated power
Analytical	0.861	2.57e4	5.0e4	192.94	1.97e5
CST	0.861	2.51e4	4.85e4	192.90	2e5

Frequency of the TM — 010 mode:

$$f_{010}^{TM} = \frac{j_{01}c}{2\pi a} \approx \frac{2.405c}{2\pi a}$$

Effective shunt impedance per unit length:

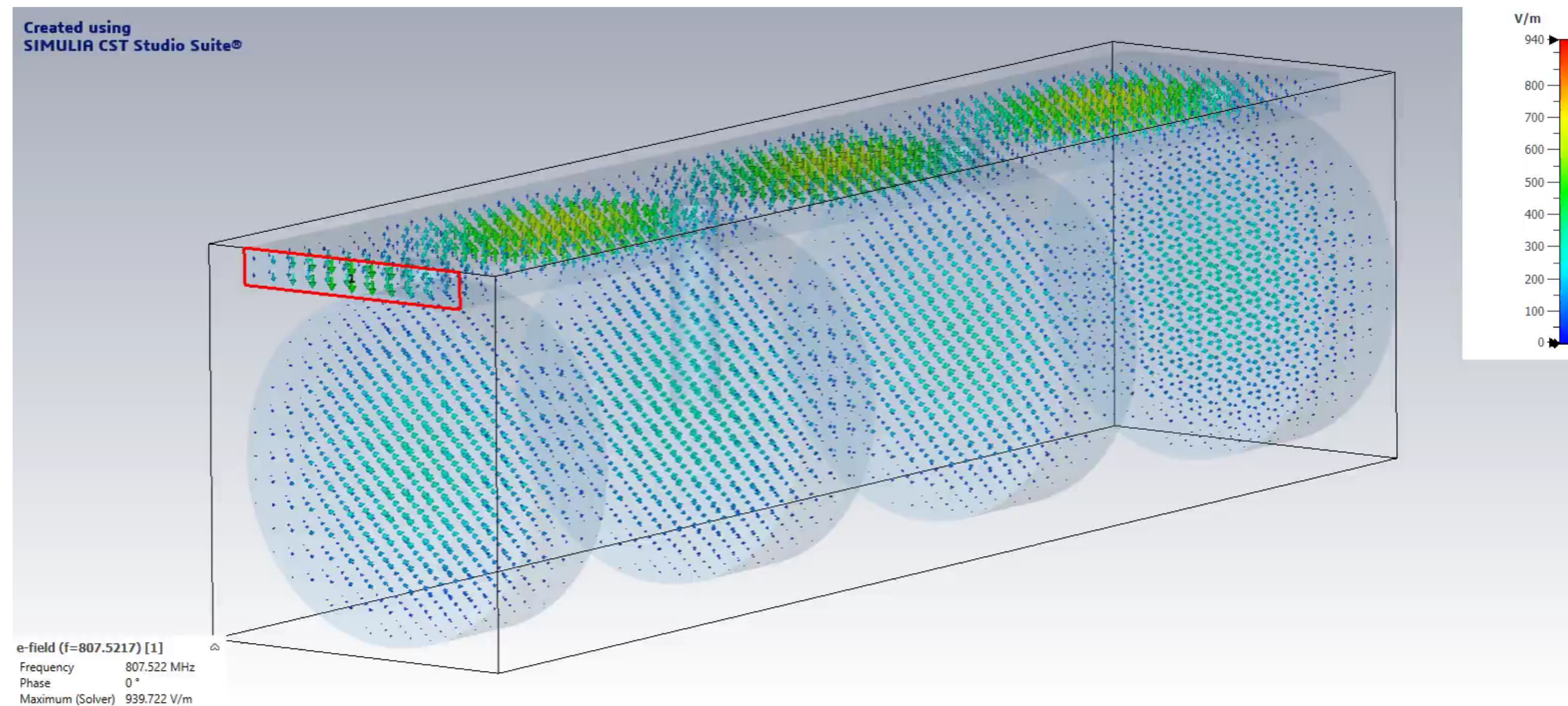
$$R = \frac{(V_0T)^2}{P_dL}$$



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Cutoff frequency	TE_{02} mode frequency	a
700.475MHz	1400.96MHz	142.65mm

Implementing a rectangular waveguide



Phase and spacing of
cavities:

$$\Delta l = \frac{v}{f_0}$$

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Next steps

- Start exploring alternative waveguide geometries!
- Optimize couplers for $\beta = \frac{Q_{ex}}{Q_0} \approx 1$
- Look at more complex cavities