# The Drive Beam accelerating structure

CLIC Project Meeting #37

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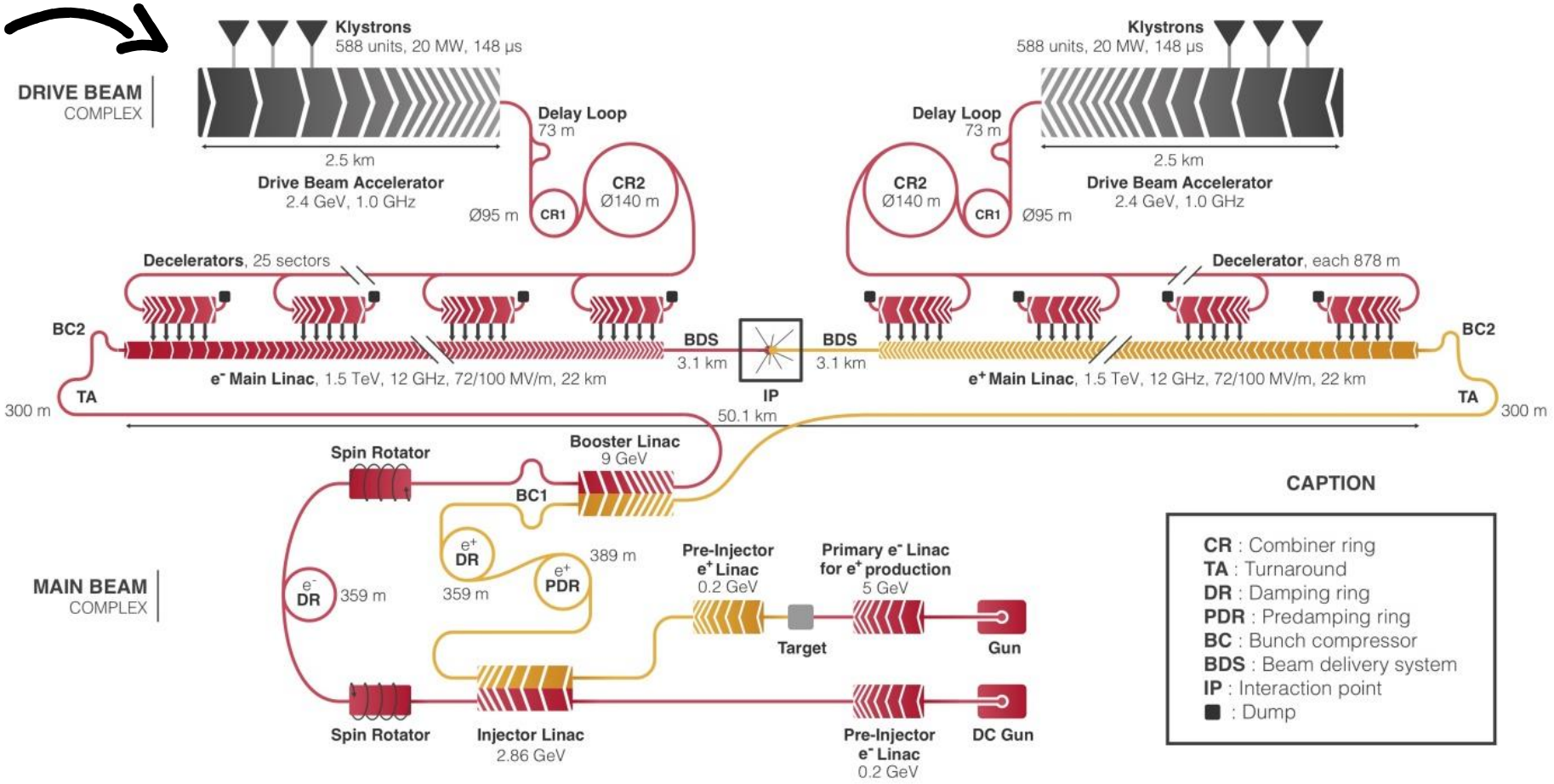
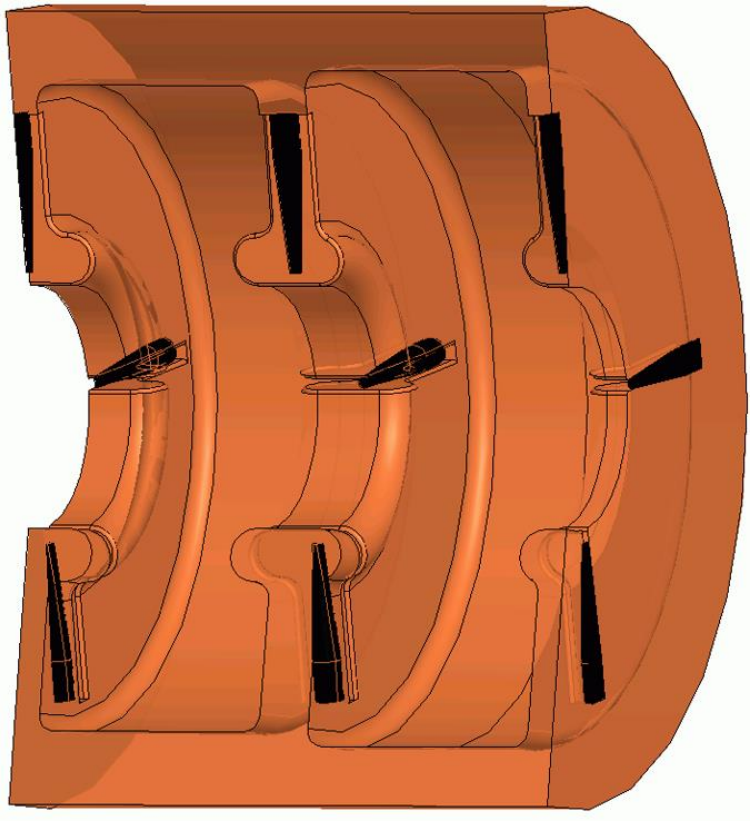
# 1. CLIC Drive Beam Accelerator (DBA)



# 2. Travelling wave structure for CLIC's DBA



- Full beam loading (over 95%)
- SICA (Slotted Iris – Constant Aperture).
- Filtering of frequencies ~ 4.1 MHz (filling time around 245 ns)
- Reduction of wakefields by damping and detuning.
- Previous design made by Rolf Wegner [1] for 15 MW RF input power.

## Objective:

- Adapt the structure to the new input power of 18 MW achieving RF to beam efficiency over 95% and filling time of 245 ns.

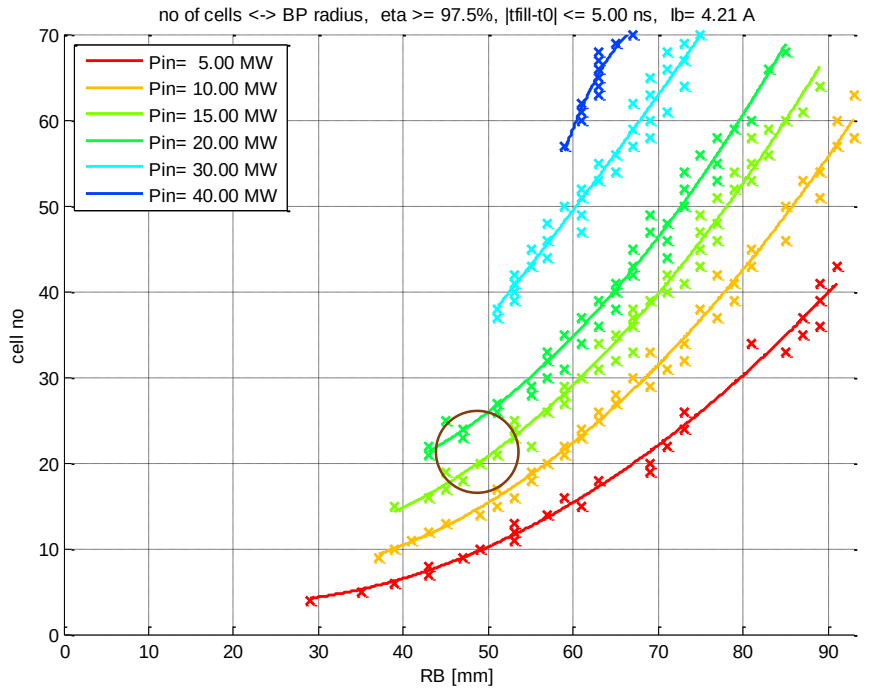
# 3. Structure optimization (I)

- Based on a proportional relation between de input power and the number of cells, the size of the structure was increased from 19 to 21 cells for an input power of 18MW.

$$N_{cell} \sim \sqrt{P_{rf}}$$

Avni Aksoy. *CLIC drive beam LINAC optimization*. CLIC Workshop, 2018.

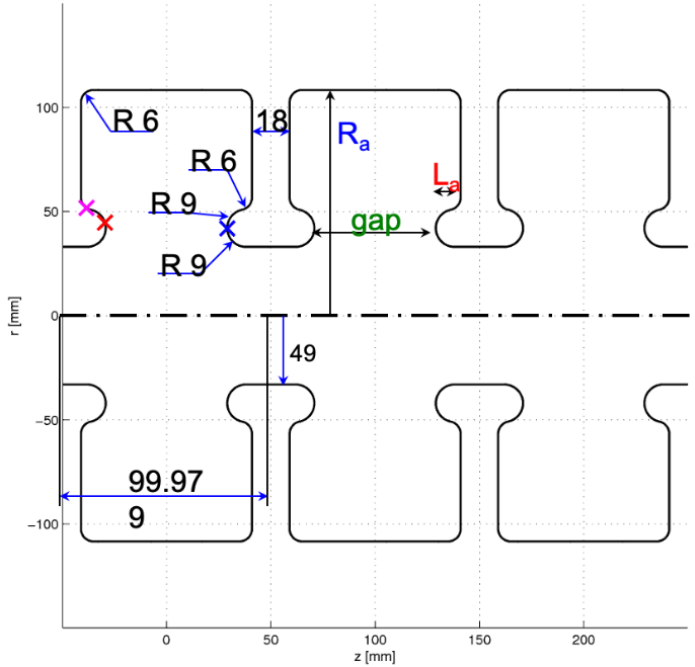
- The result matches with the beam dynamic simulations performed for the structure of 19 cells.

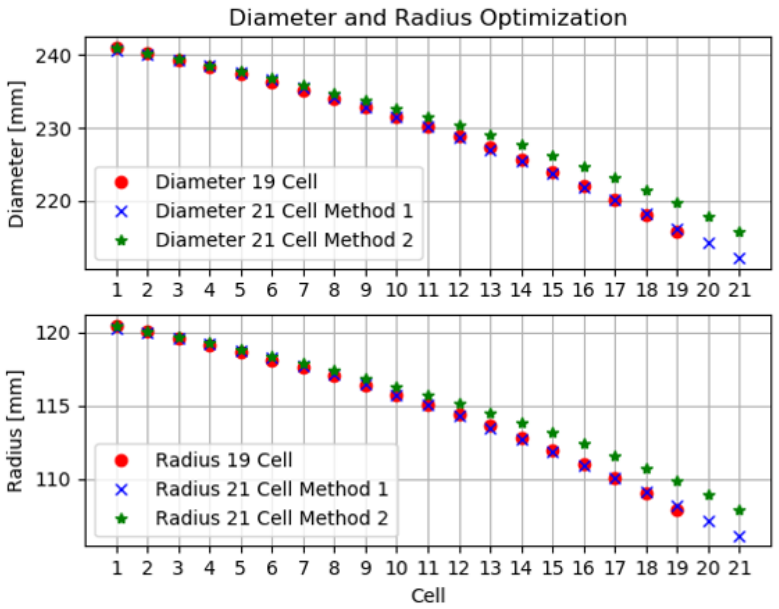


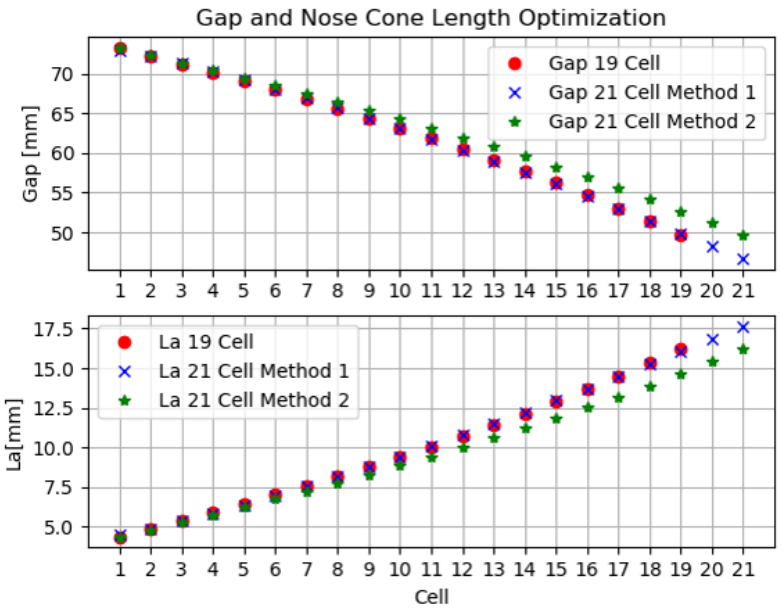

Rolf Wegner and Erk Jensen. *CLIC drive beam accelerating structures*. 2012

# 3. Structure optimization (II)

- After increasing the number of cells, an escalation of the cell radius, gap and nose cone length was performed.
- Bore radius kept to 49 mm and cell length of 99.979 mm (same values as for 15 MW input power).

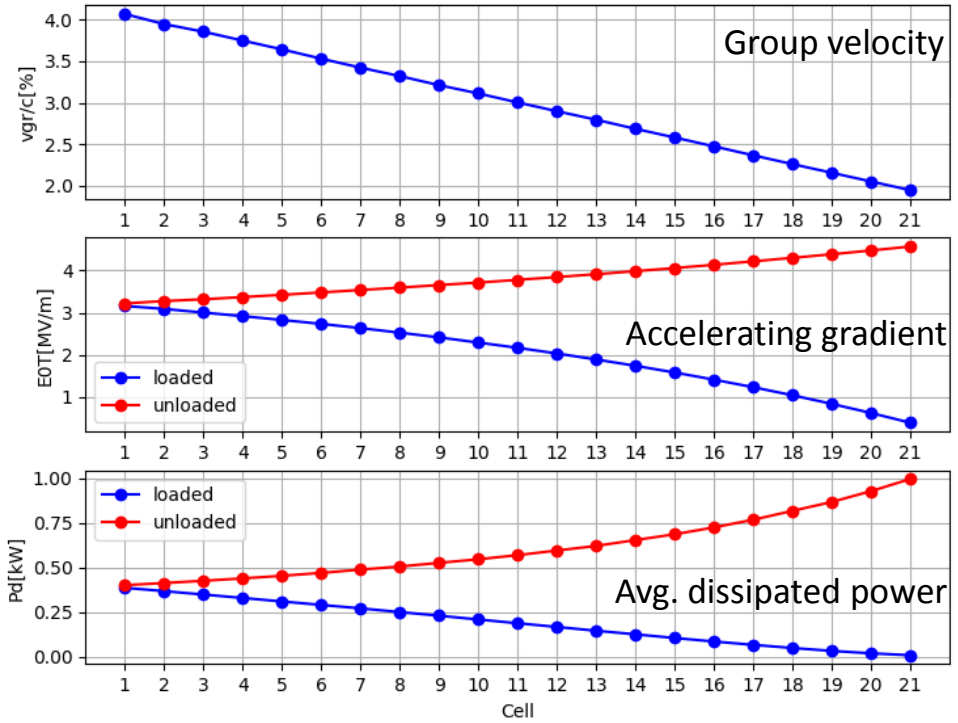


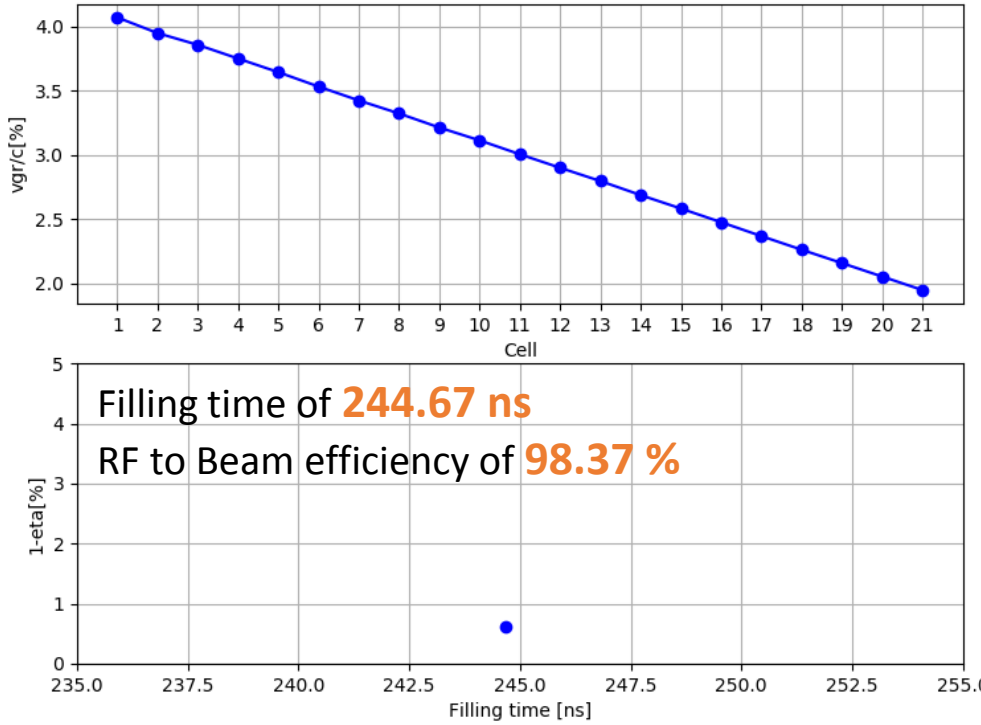



# 3. Structure optimization (III)

- Based in the principle of energy conservation, the multi cell TWS behavior was modeled in Python to optimize the group velocity.

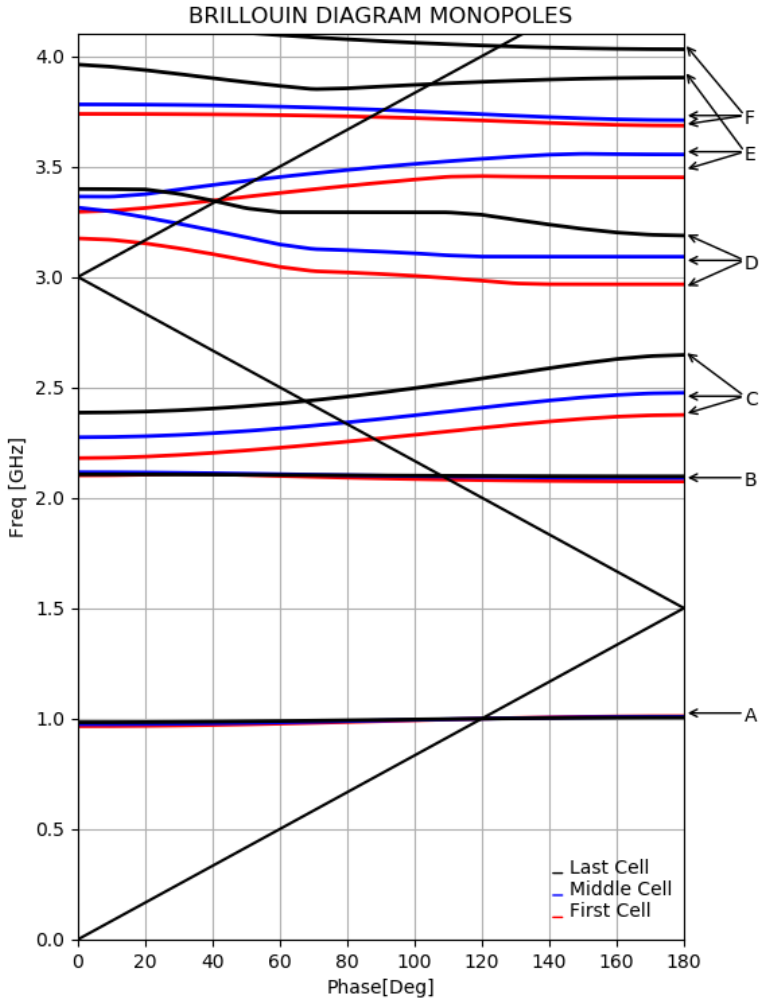


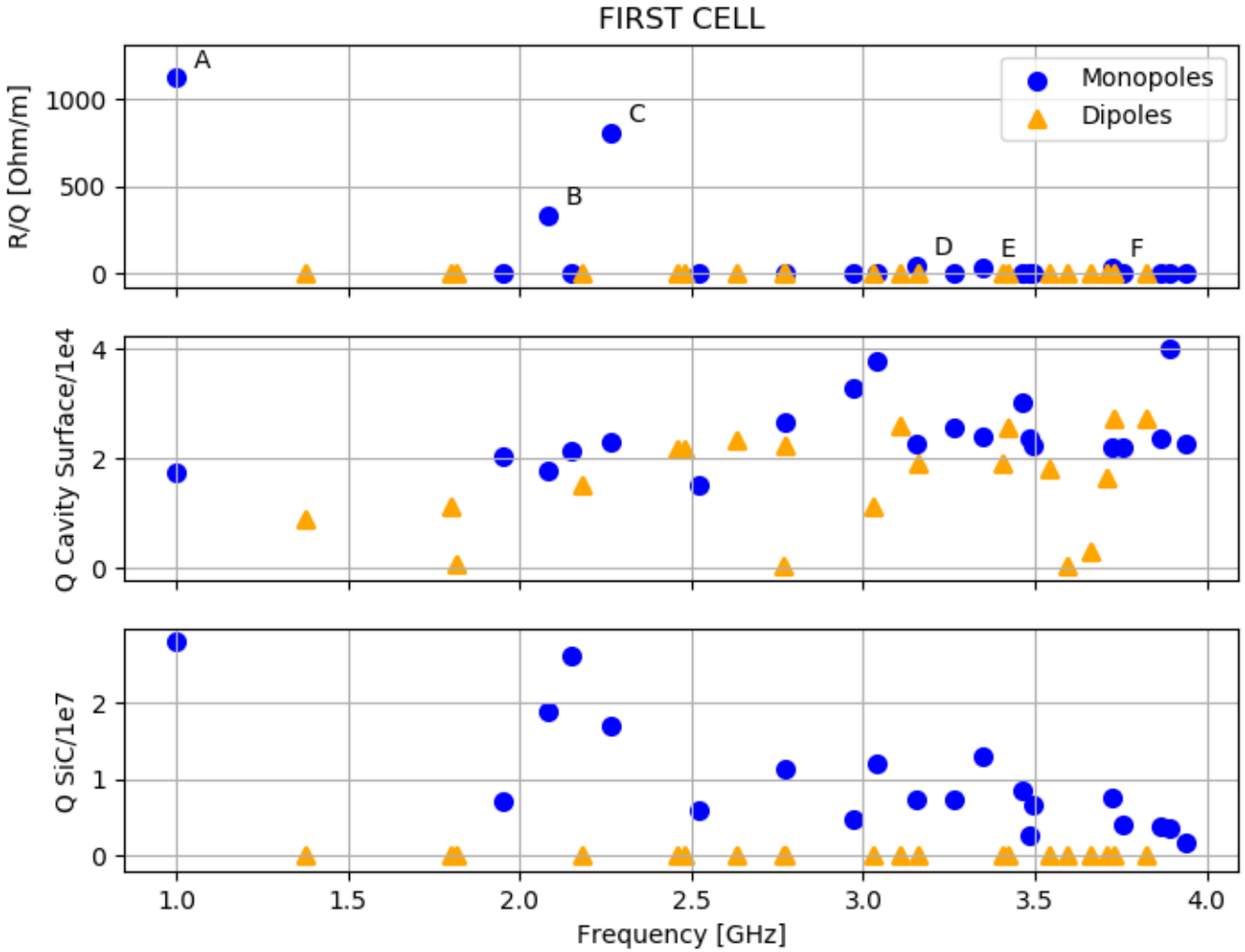




$$\eta = \frac{\sum_n P_{b,n}}{P_{in}} \qquad t_{fill} = \sum_n \frac{L_n}{v_{gr,n}}$$

# 4. HOM Study

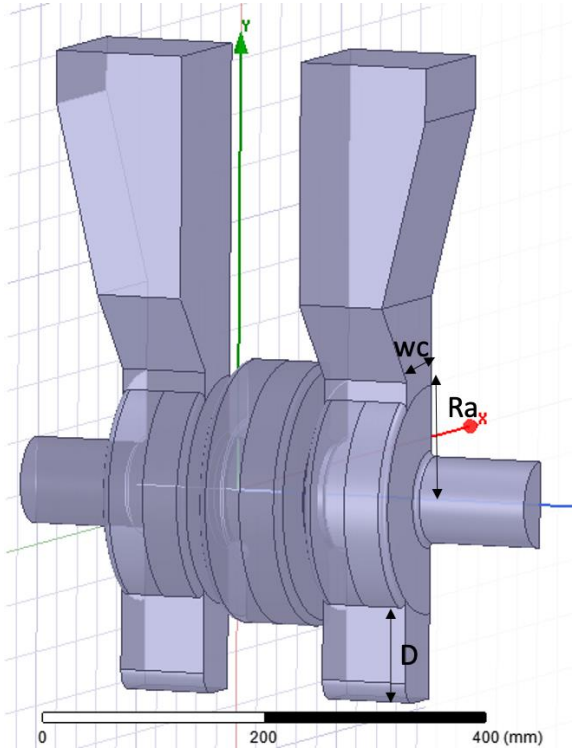
$$R/Q = \frac{|V_{acc}|^2}{wW_e} \qquad Q_{CavitySurface} = \frac{wW_e}{P_{loss}}$$

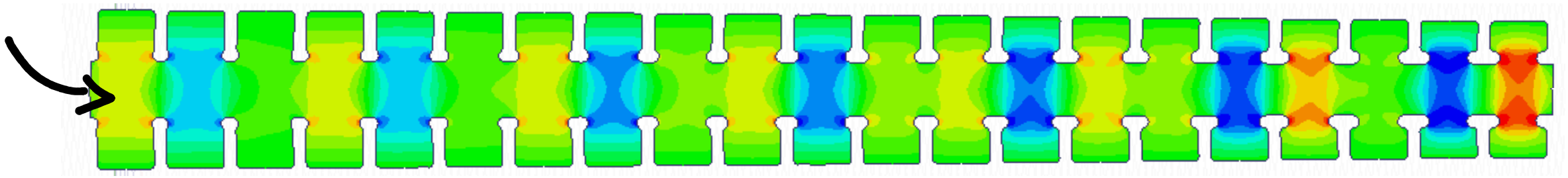


# 5. Coupler design (I)

- S11 lower than -30 dBs at the operating frequency of 999.5 MHz.
- S11 lower than -30 dBs in a bandwidth of 1 MHz.
- Reduction of the dipole kick in the coupler.
- Keep the phase advance per cell of 120 degrees.

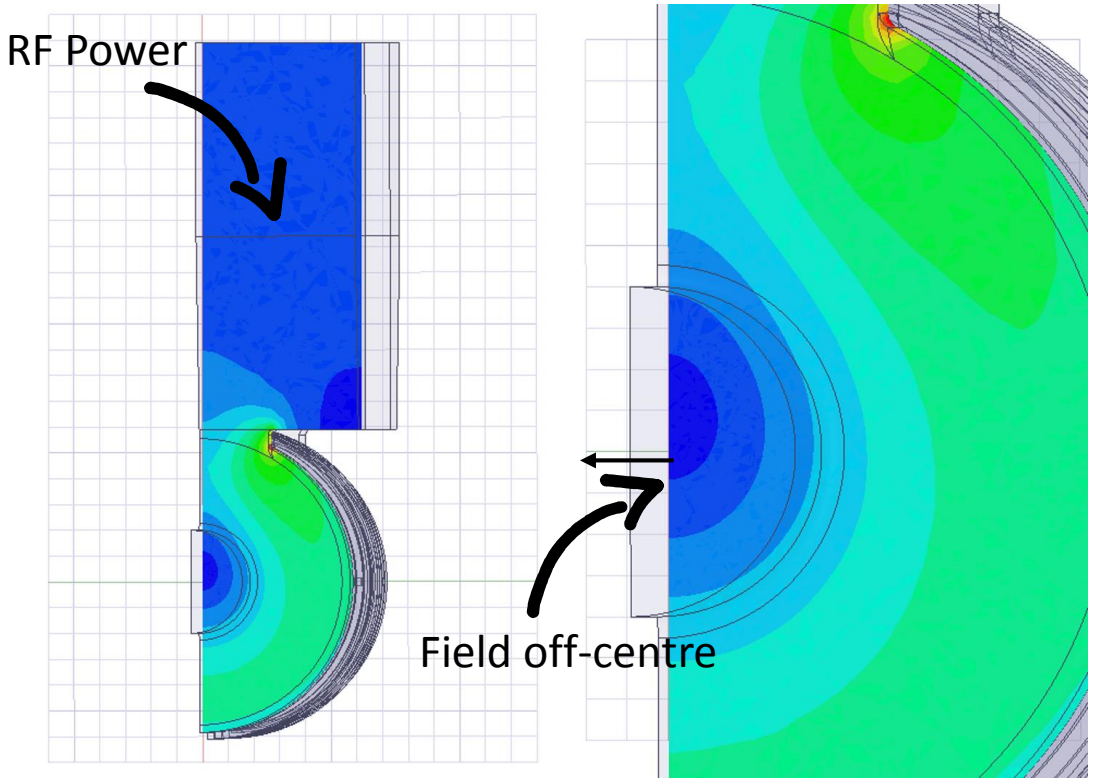


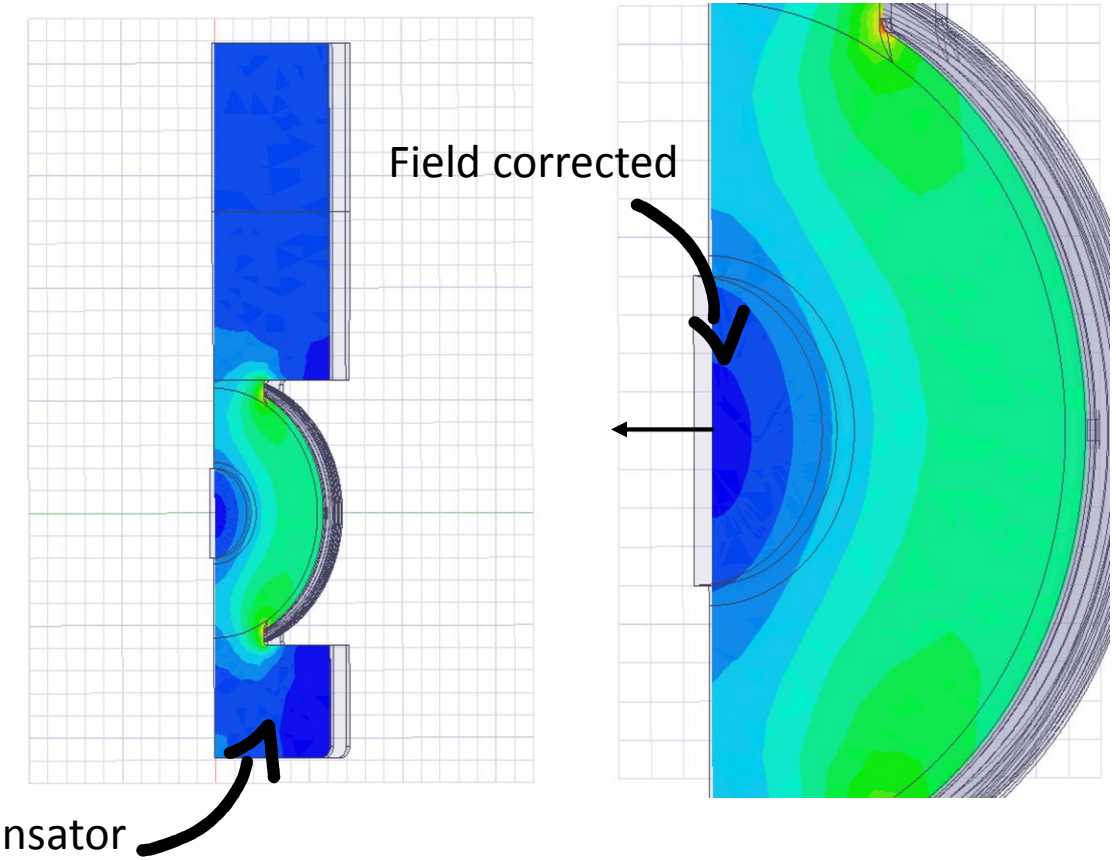
21 cells

# 5. Coupler design (II)

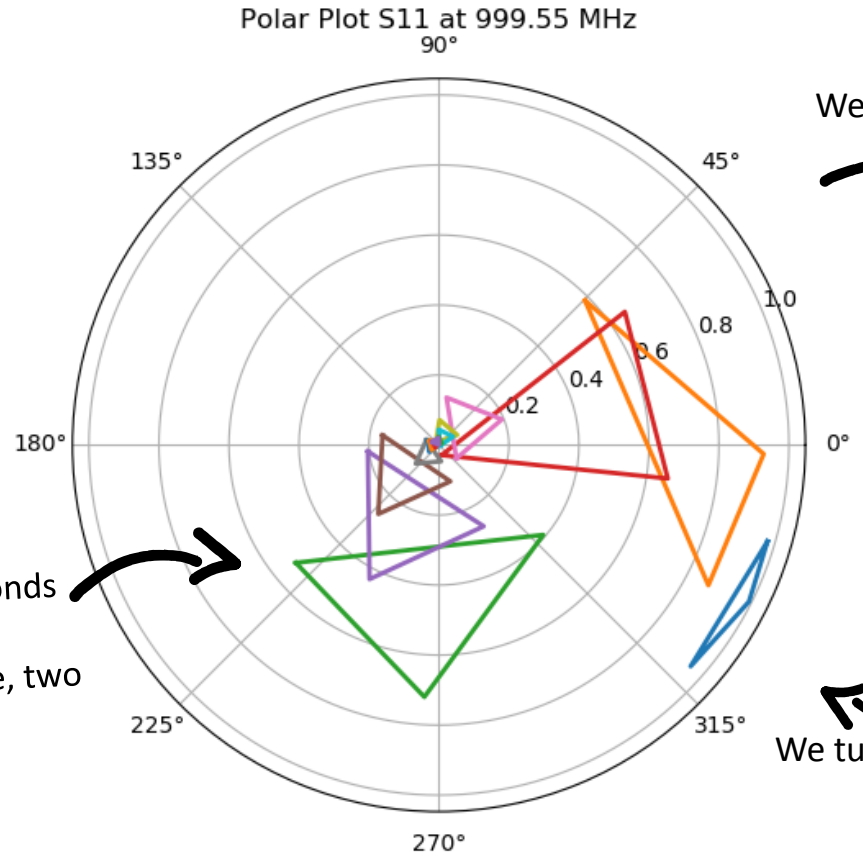
## Coupler's profile without compensator




## Coupler's profile with compensator



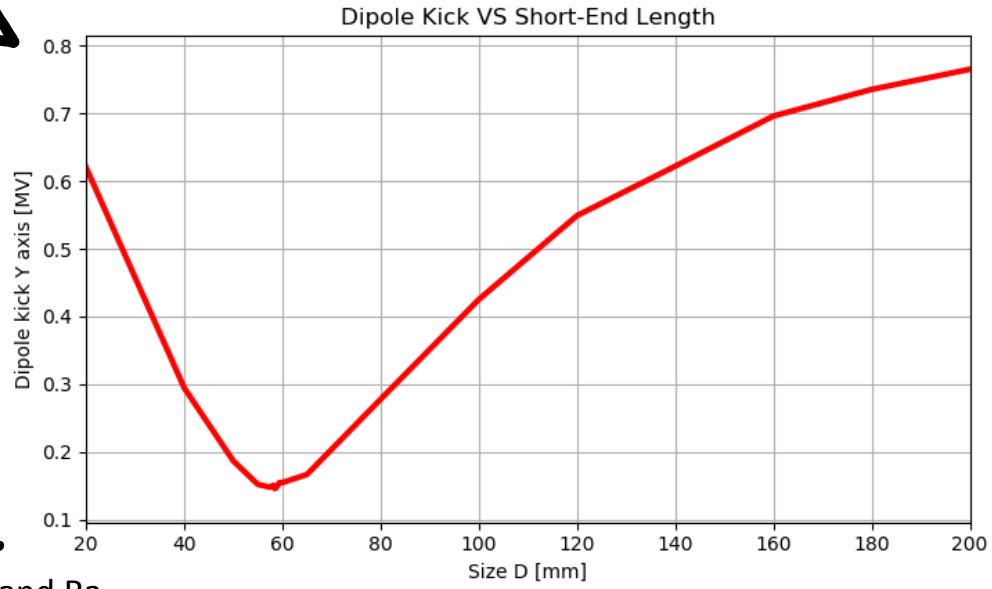
# 5. Coupler design (III)




Every vertex of a triangle corresponds to the S11 of the coupler with one, two or three cells

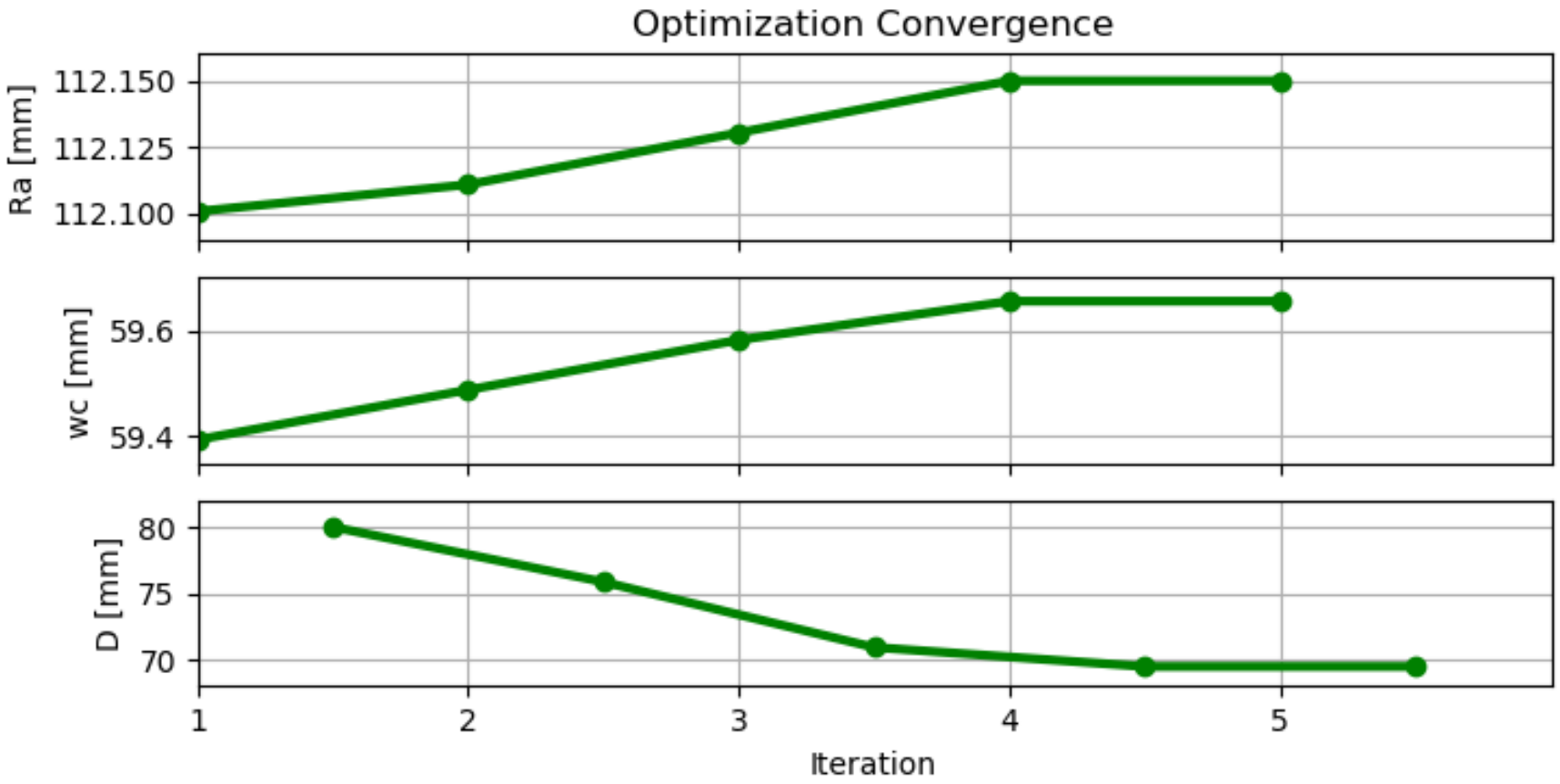
*Idea from A. Grudiev*

We tune D

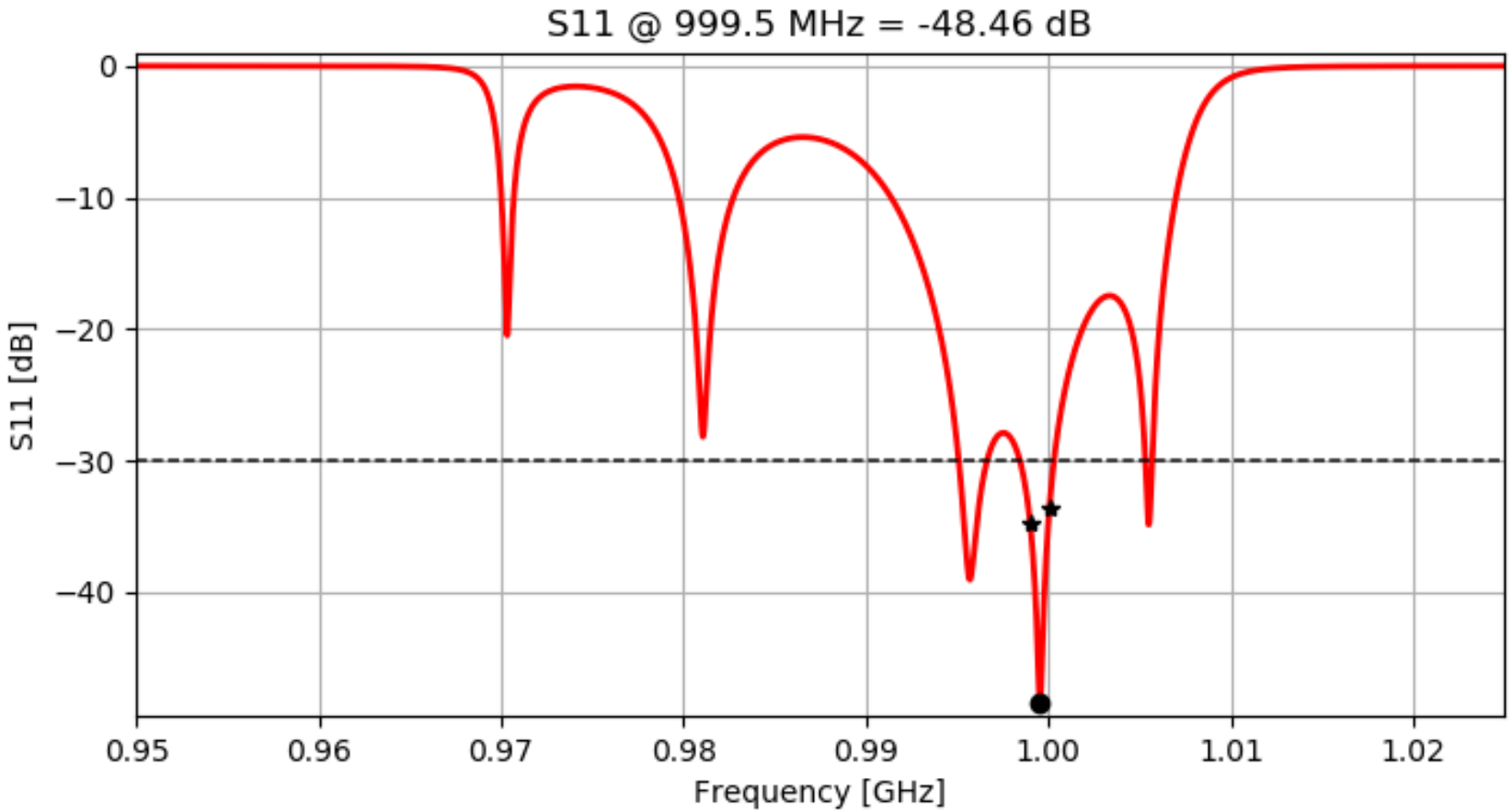



We tune wc and Ra

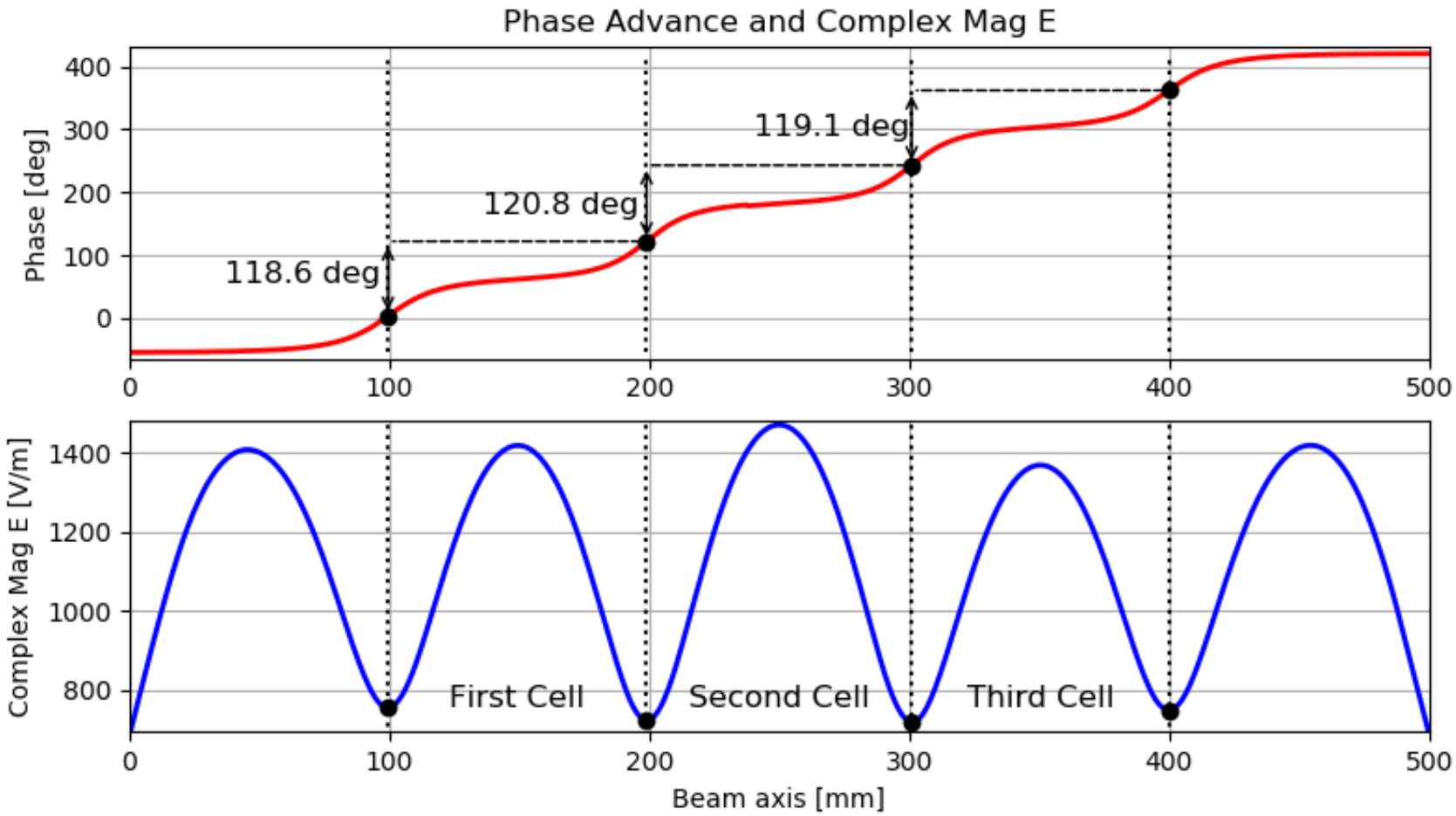
# 6. Input coupler results (I)



# 6. Input coupler results (II)



# 6. Input coupler results (III)



# Thanks! 

# References


[1] Rolf Wegner and Erk Jensen. CLIC drive beam accelerating structures. Technical report, CERN, Geneva, Switzerland, 2012. Available as CLIC-Note-945.

[2] Günther Geschonke and Andrea Ghigo. CTF3 design report. Technical report, CERN, Geneva, Switzerland, 2002. Available as CERN/PS 2002-008 (RF).

[3] Rolf Wegner. CLIC drive beam LINAC. The Workshop of Future Linear Colliders,2012.

[4] Avni Aksoy. CLIC drive beam LINAC optimization. CLIC Workshop, 2018.

[5] E. Jensen. RF Cavity Design. In CERN Accelerator School: Advanced Accelerator Physics Course, pages 405–429, 2014.

[6] David Alesini, Alessandro Gallo, Bruno Spataro, Agostino Marinelli, and Luigi Palumbo. Design of couplers for traveling wave RF structures using 3D electro-magnetic codes in the frequency domain. Nucl. Instrum. Meth. A, 580:1176–1183,2007.

[7] Agostino Marinelli, Luigi Palumbo, and Dott David Alesini. Progetto di unaccoppiatore in guida d'onda per una struttura accelerante ad onda viaggiantein banda x. Tesi di Laurea, University of Rome "La Sapienza", 2004.

[8] Seyd Hamed Shaker, Steffen Döbert, Raphael Leuxe, Shahin Sanaye Hajari, and Luca Dassa. Sub-harmonic Buncher Design for the CLIC Drive Beam Injector.In4th International Particle Accelerator Conference, page TUPME052, 2013.