HOM Detuning and Damping of C-Band Distributed Coupling Structure

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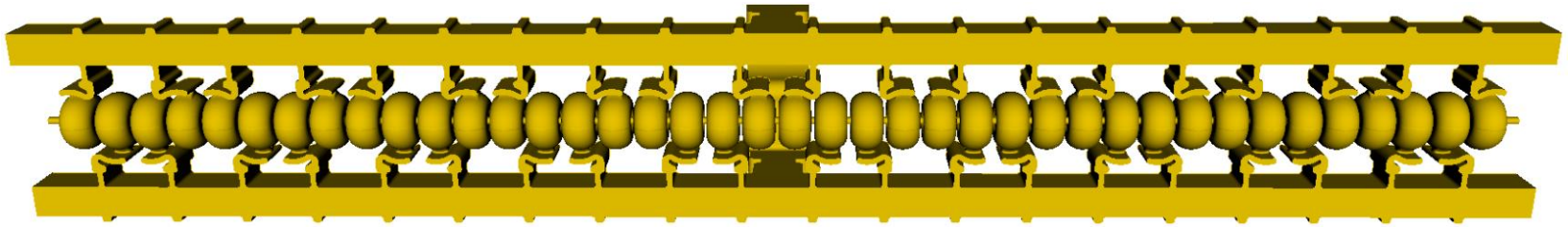
U.S. DEPARTMENT OF ENERGY
Office of Science

SLAC NATIONAL ACCELERATOR LABORATORY

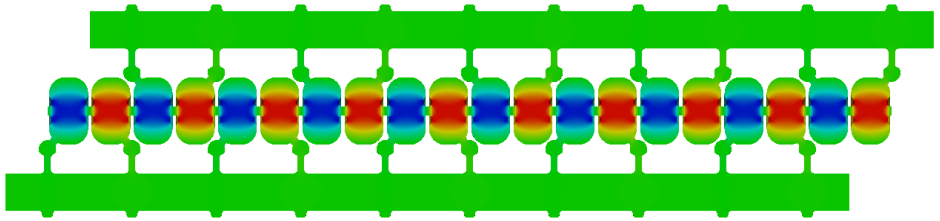
Outline

- Parallel feed scheme for linac structure design
- High efficiency, larger aperture 135 deg/cell parallel feed structure
- HOM detuning
- HOM damping
- Outlook

Parallel Feed Scheme Extends Parameter Space for Linc Structure Design



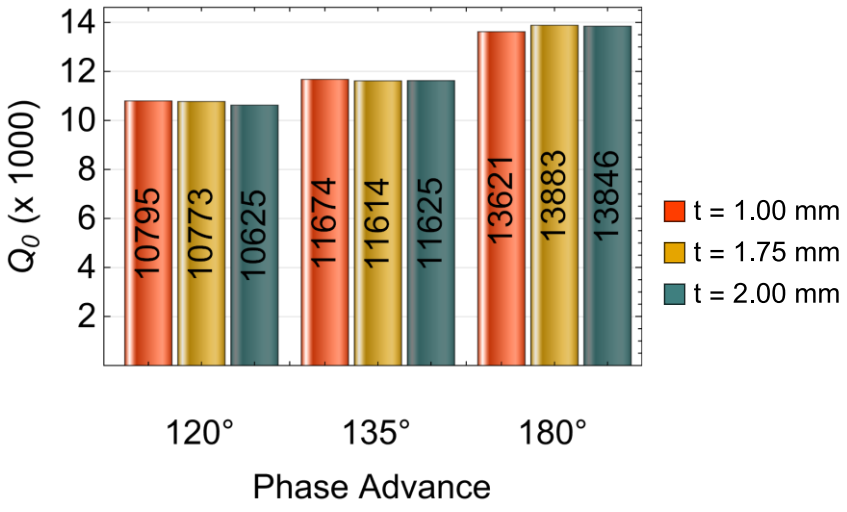
- Parallel Feed Structure
  - Cells fed individually
  - Feed waveguide distribute power equally to each cell (at 180 135, … deg phase difference)

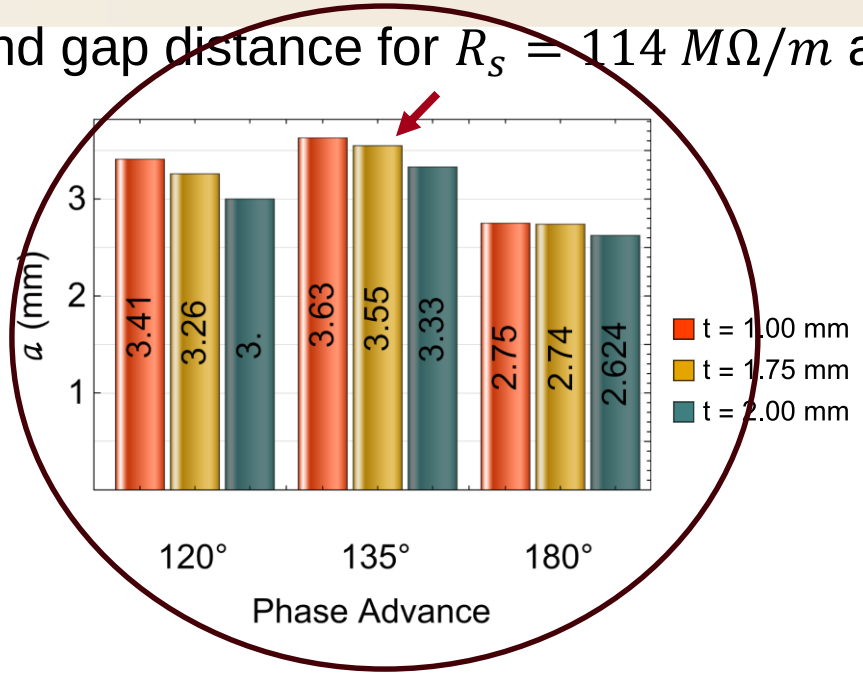


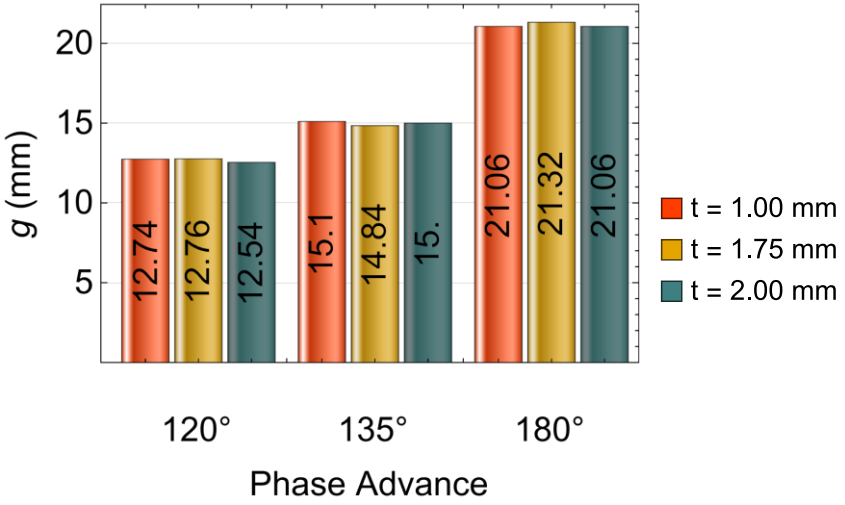
- Advantages
  - Iris radius not dictated by cell-to-cell RF coupling
  - Cell shape can be optimized to achieve higher efficiency
  - Structure can be machine in two halves or quadrants
  - Structure tuning straight forward

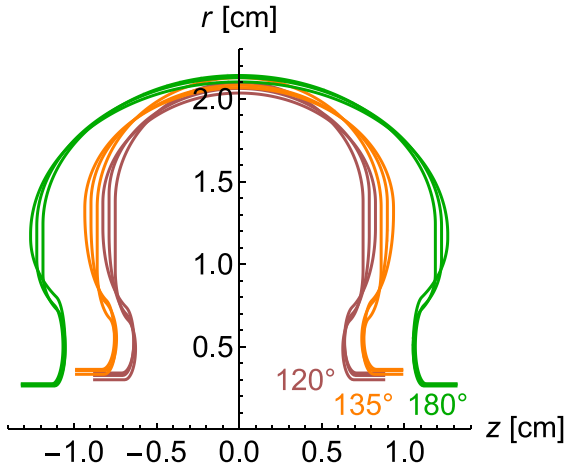
Phase Advance Comparison (Muhammad Shumail)

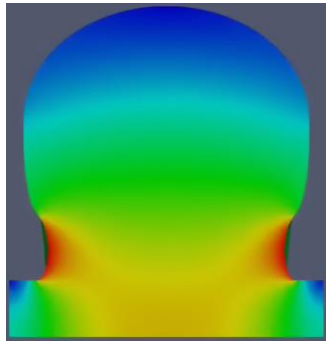
Quality factor, aperture size, and gap distance for $R_s = 114\ M\Omega/m$ and $\frac{E_s}{G} = 2$



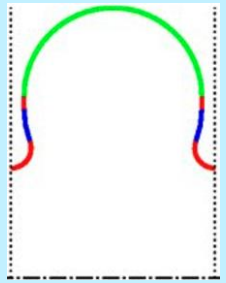








135 deg/cell, field profile



NLC X-Band structures for comparison:

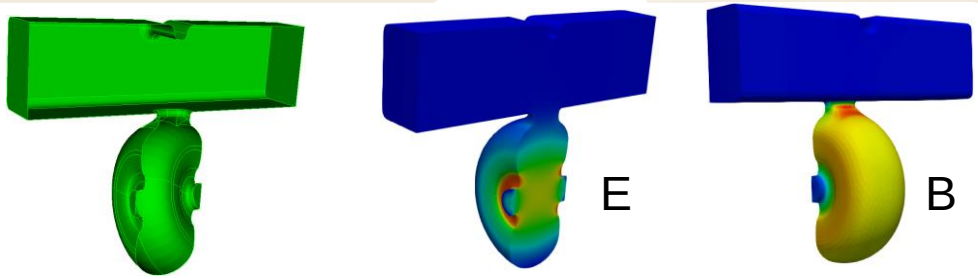
- shunt impedance (300K) : 98 MΩ/m
- iris radius: 4.75 mm

C-Band 135 deg/cell Structure – (power-feed V1)

Power-feed v2
(Muhammad Shumail)

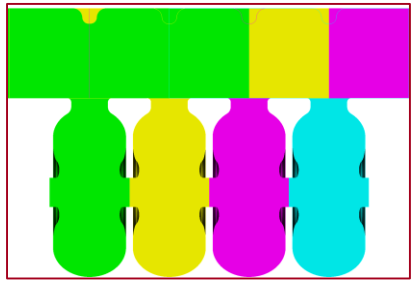
SLAC

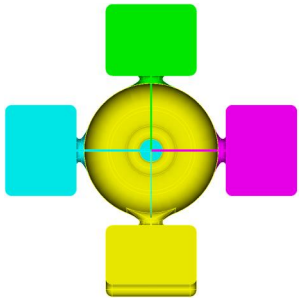
- Cell length: 19.682 mm
- Total number of cells: 104
- Parallel feed waveguides: 4, feed at middle of structure



single cell with parallel feed waveguide

- A period = 4 cells
  - 4 135-deg cells form a 360+180 deg section
  - each cell fed by a respective waveguide



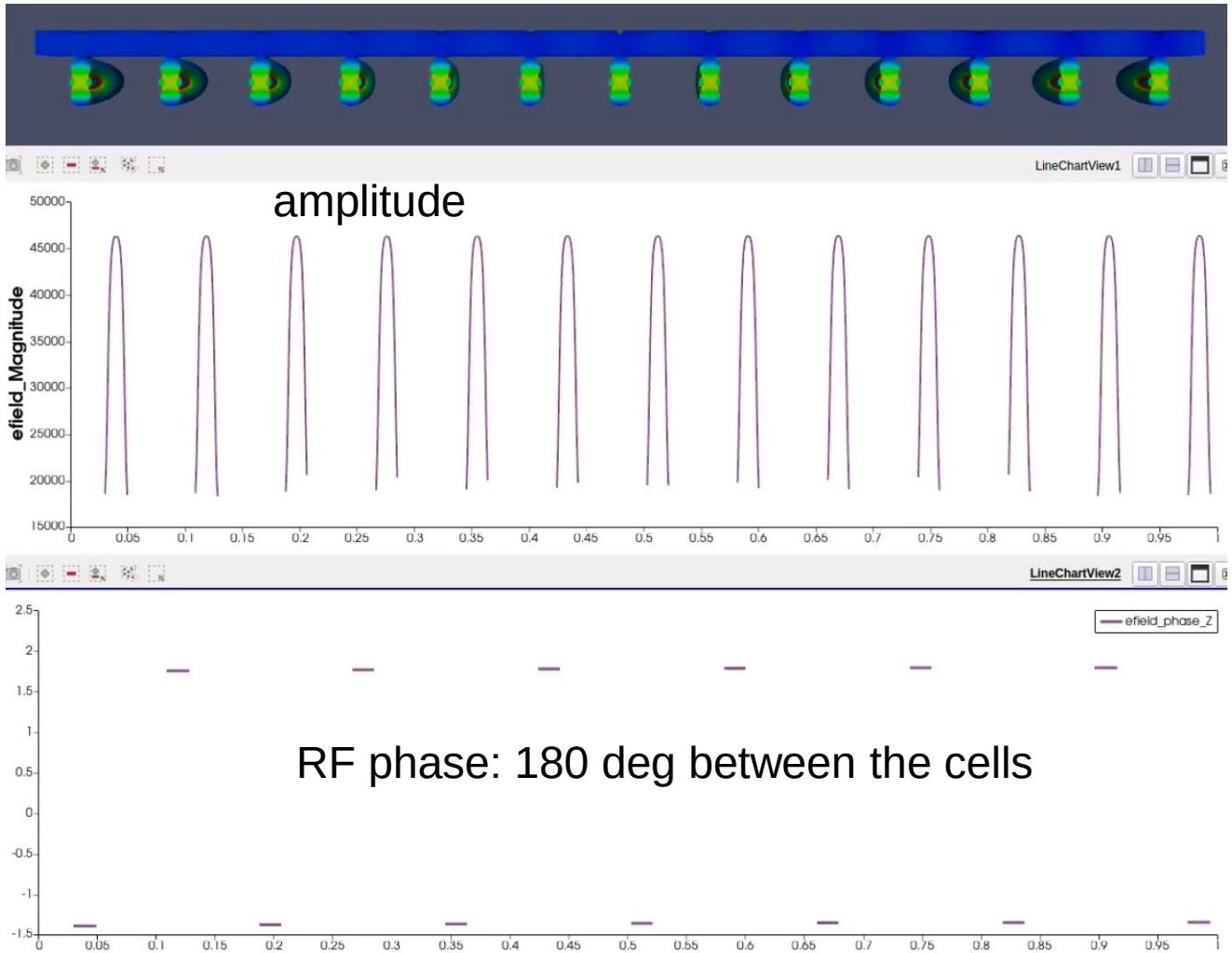


Cross section

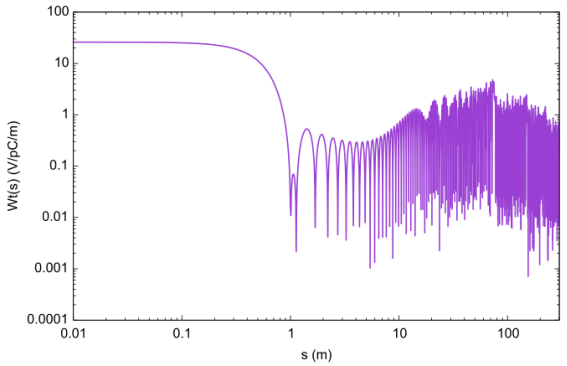
2m 104 cell Structure

135 deg/cell Parallel Feed System Simulation

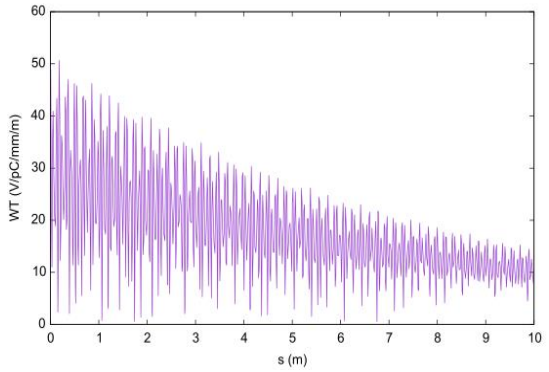
- RF power fed at the middle of the structure
- RF phase between the cells is 180 degrees
- Parallel waveguide feed 13 cells on either side of upstream and down stream



HOM Detuning and Damping



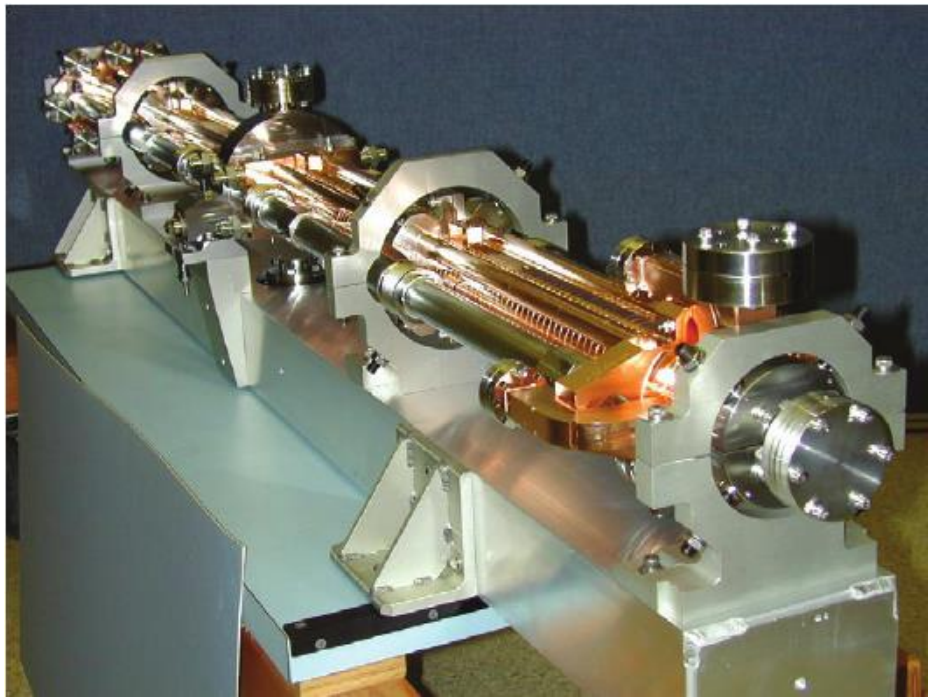
Effect of detuning



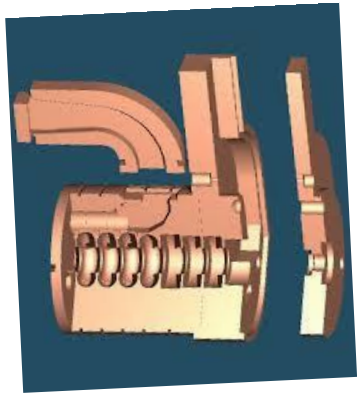
Effect of damping

Past Work on RDDS Structure Wakefield Damping

Round Damped Detuned Structure (RDDS)

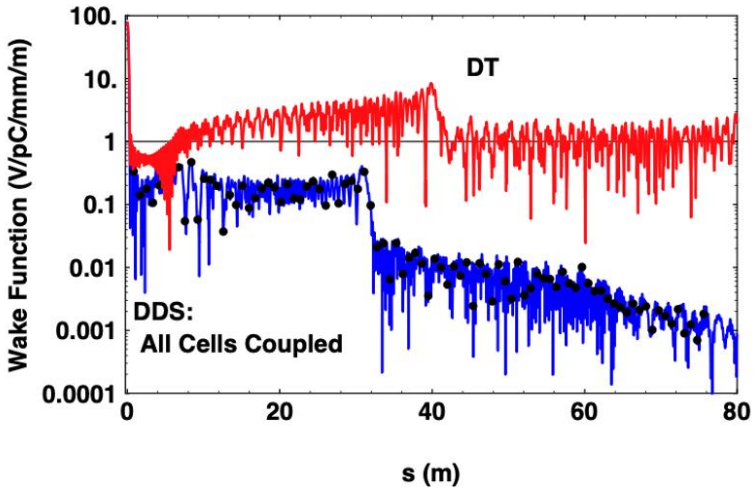


RDDS structure
HOM couples to manifold via slots cut into disk



Manifold matched to external HOM load

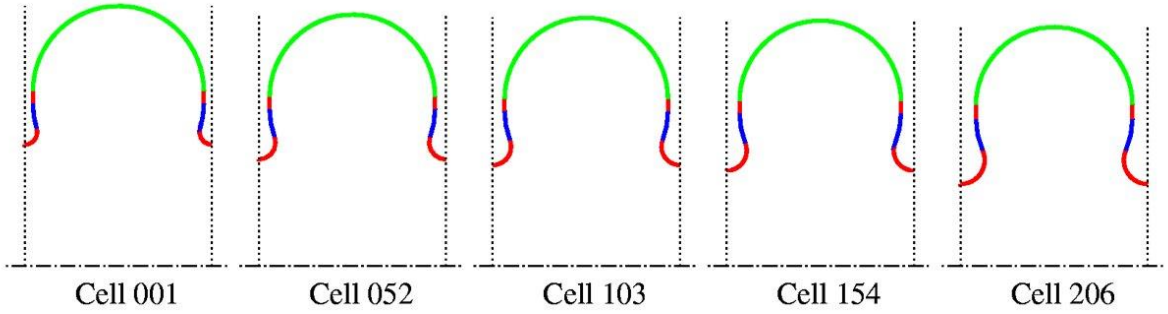
Wakefield profile for Detuned Structure and Damped Detuned Structure

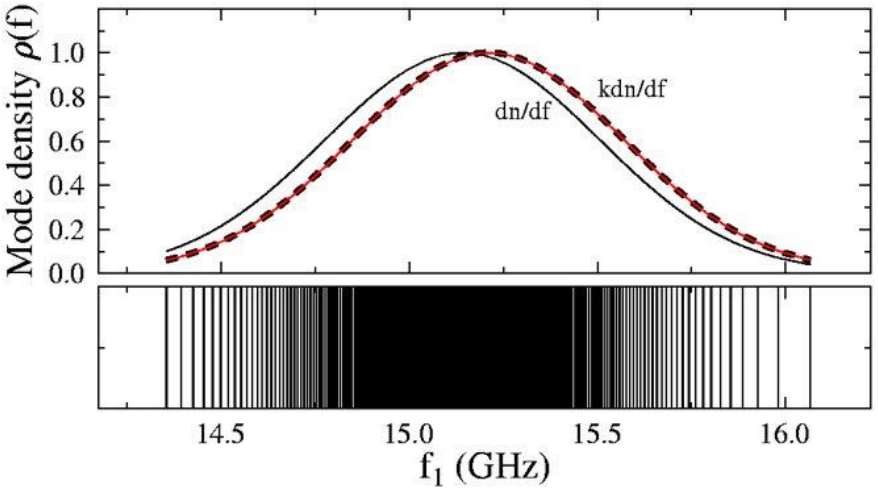


NLC X-Band Traveling Wave Structure Detuning

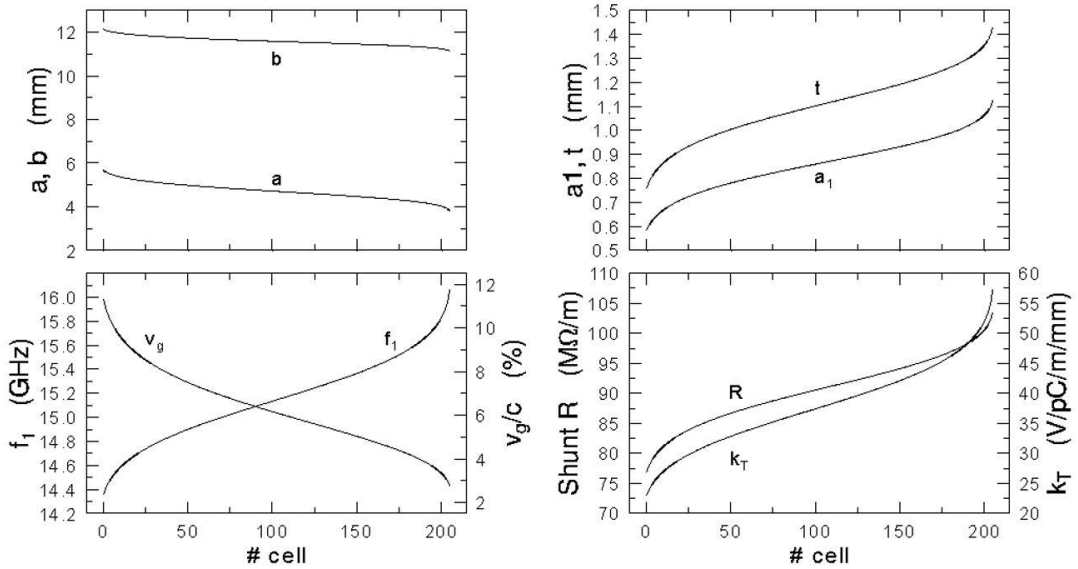
NLC RDDS structure

- 206 cells
- Gaussian detuning vis aperture (1st band) and disk thickness (6th band)





Dipole mode spectrum (1st band)

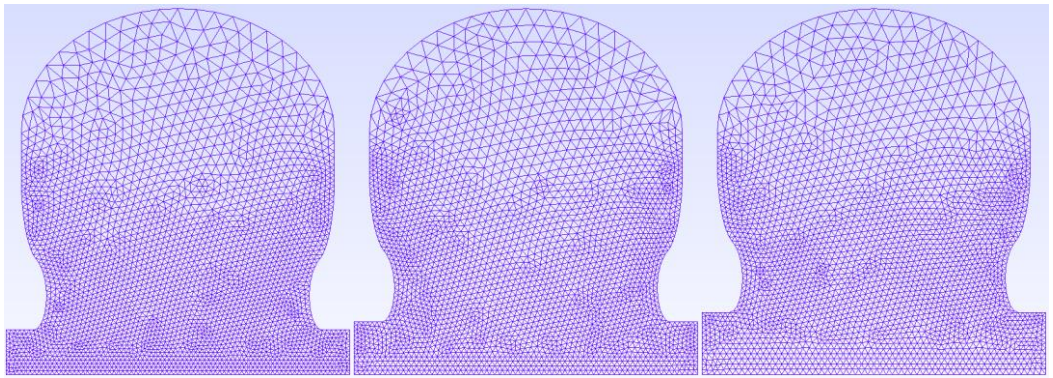


Cell dimension for HOM detuning

C-Band 135/deg Dipole detuning via Iris Radius “a” – No effective

Cell-to-cell phase advance: 135 deg

- Cell length: 19.682 mm
- Detuning using iris “a”

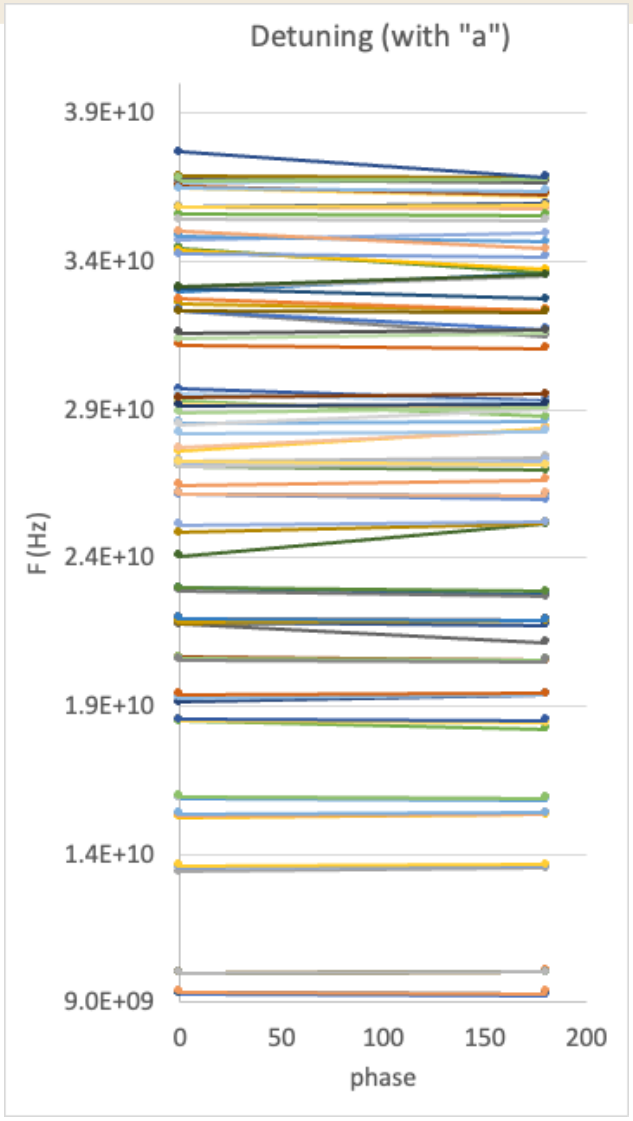


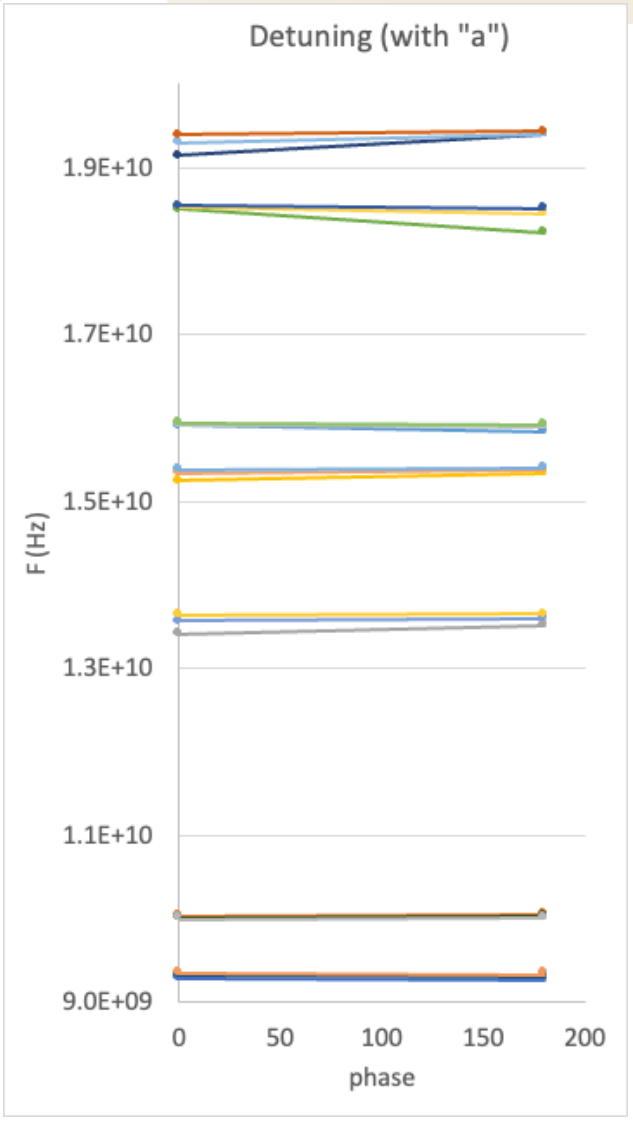
a=2.55mm
R=129 Mohm/m

a=3.00mm
R=122 Mohm/m

a=3.55mm
R=114 Mohm/m

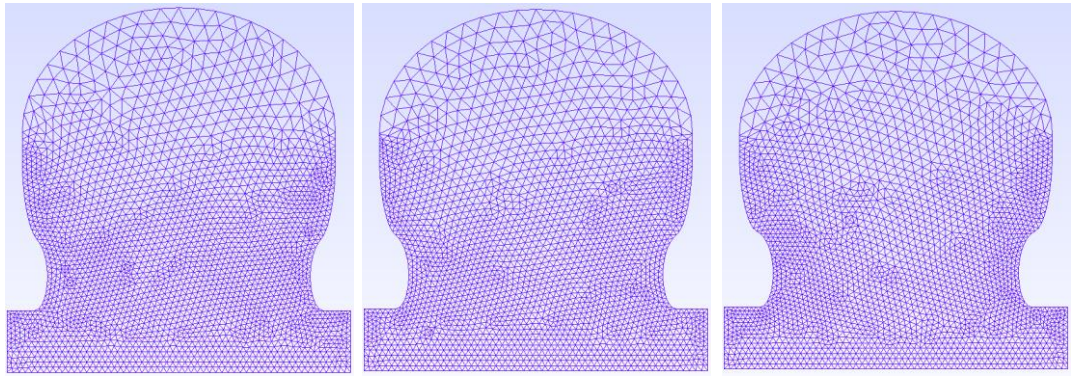
(vg/c=0.056%)





C-Band 135/deg Dipole detuning

- Cell length: 19.682 mm
- Detuning using iris “thickness”

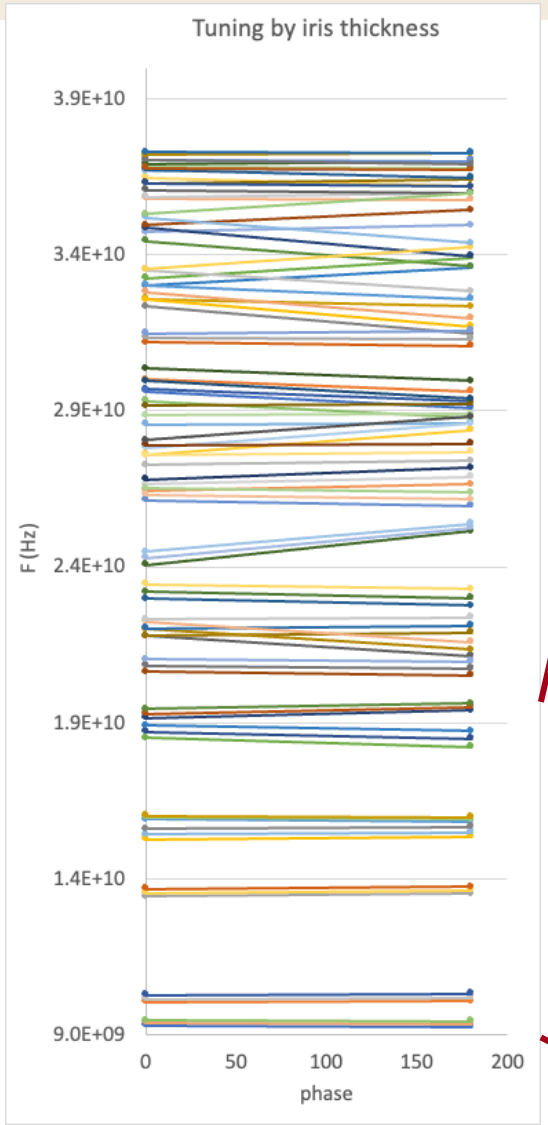


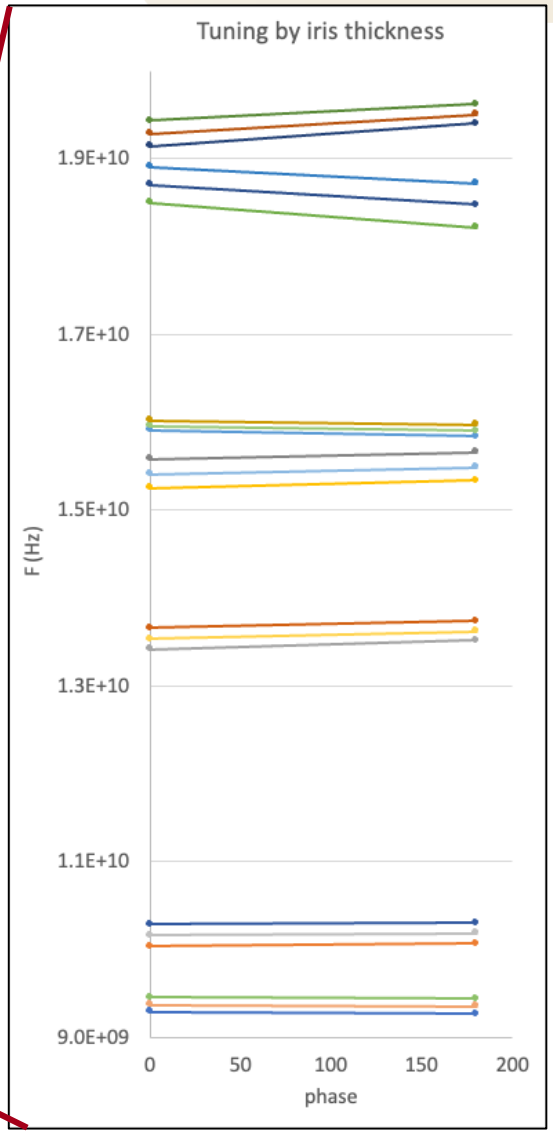
Gap1
R=113.67 Mohm/m

Gap1-0.5mm
R=114.32 Mohm/m

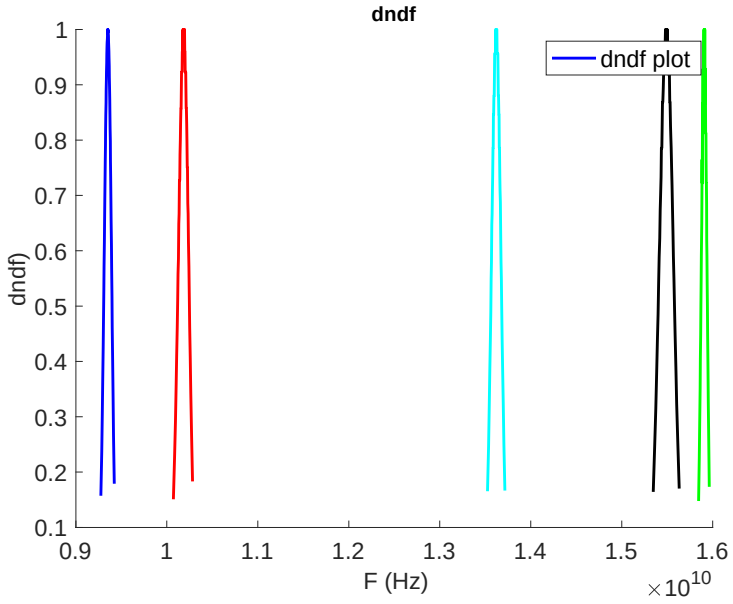
Gap1-1mm
R=114.38 Mohm/m

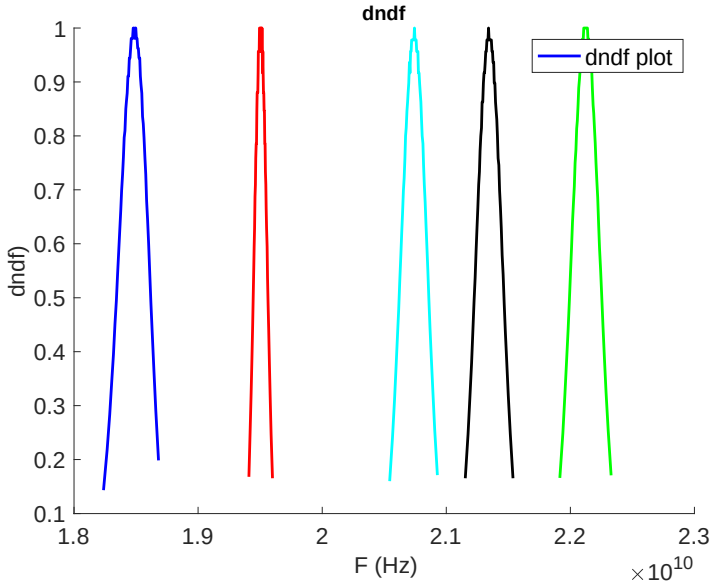
- Detuning effective
- Need to explore effect of profile details on different HOM bands

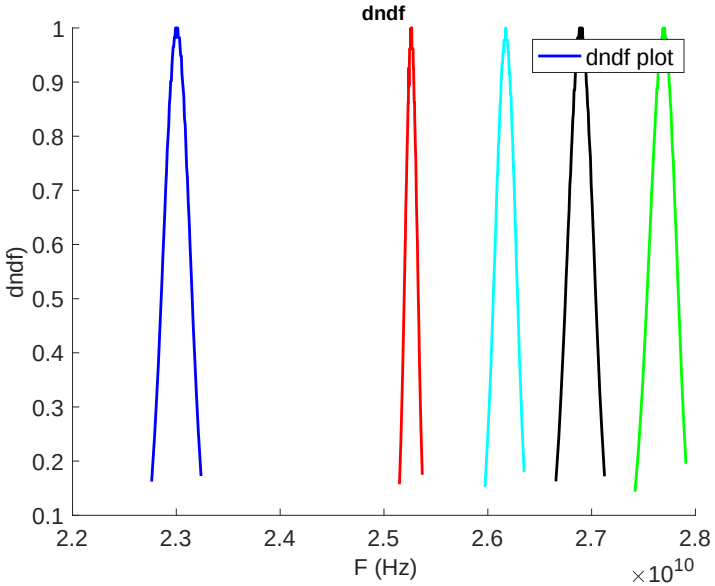




Gaussian Detuned Spectrum





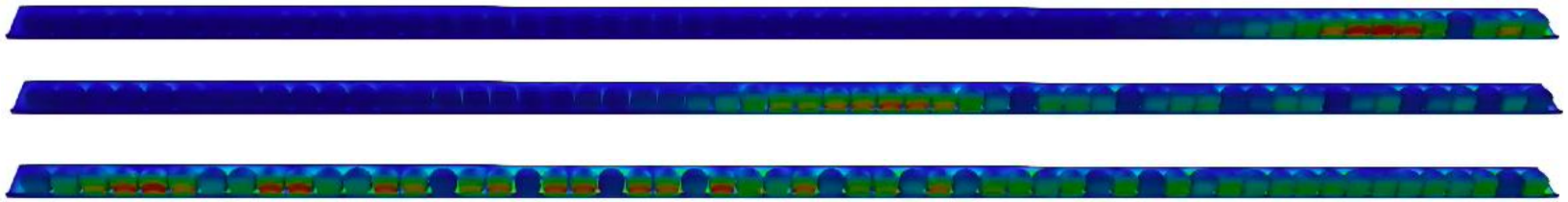


TE11 beam pipe cutoff

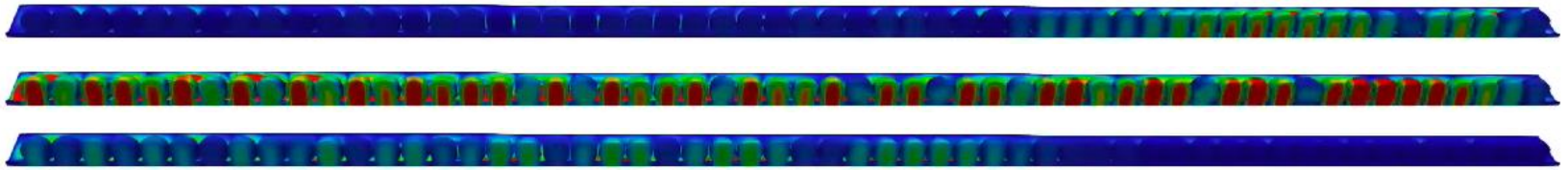
- A=3.55 mm
- Fc=24.74 GHz

56-Cell Structure Tapered HOM Mode

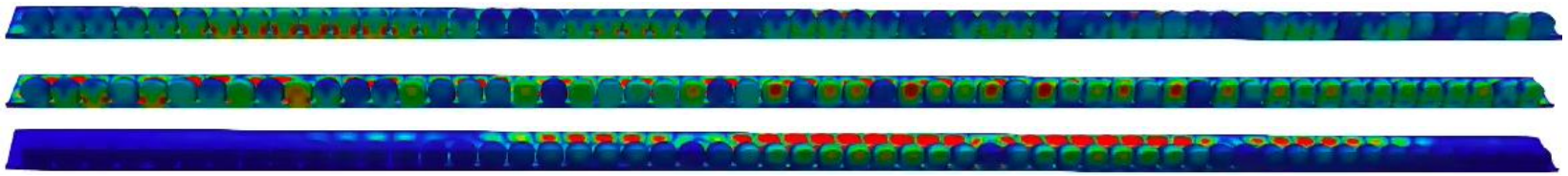
- Band 1 (9.3 GHz)



- Band 2 (10.0 GHz)

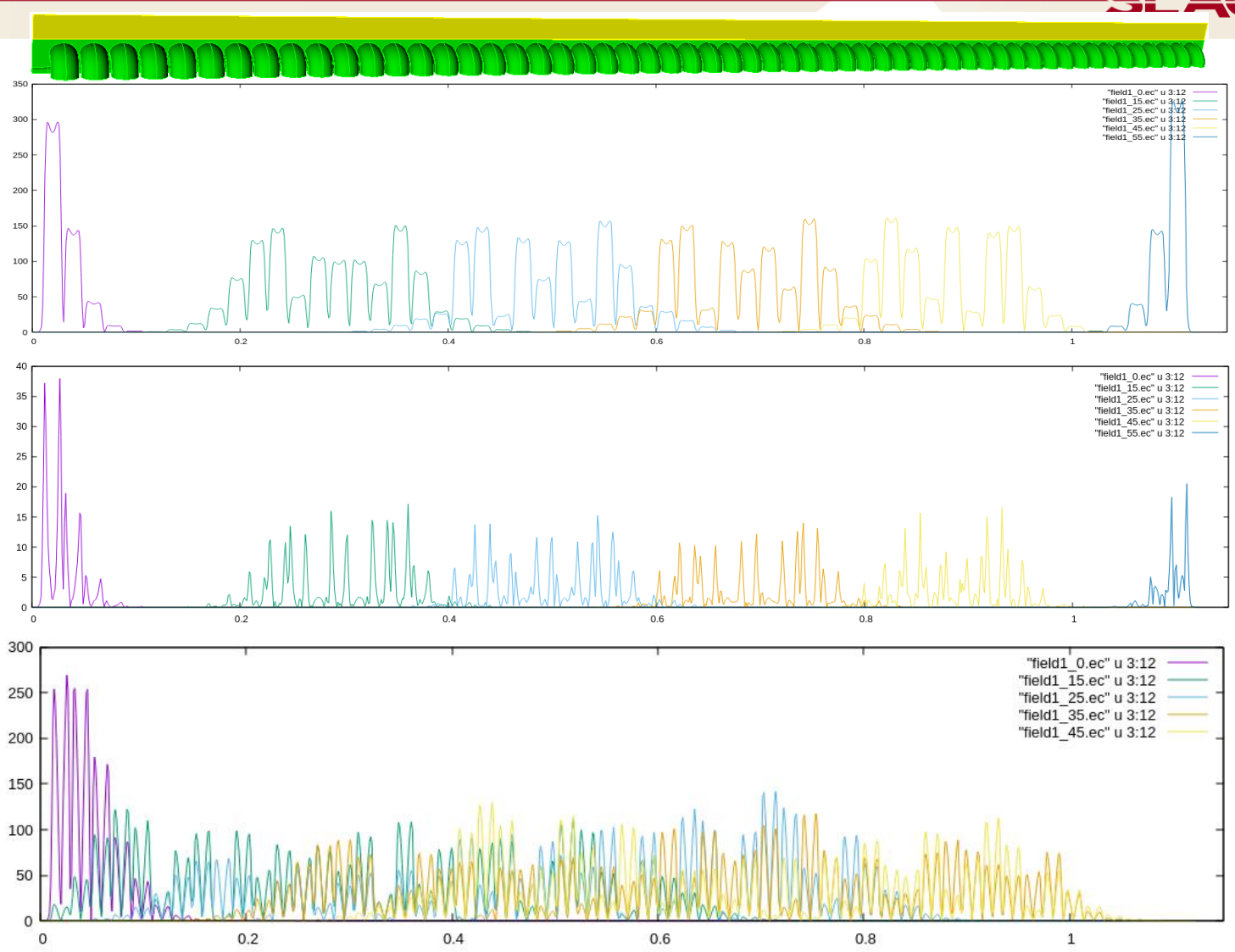


- Band 3 (13.6 GHz)



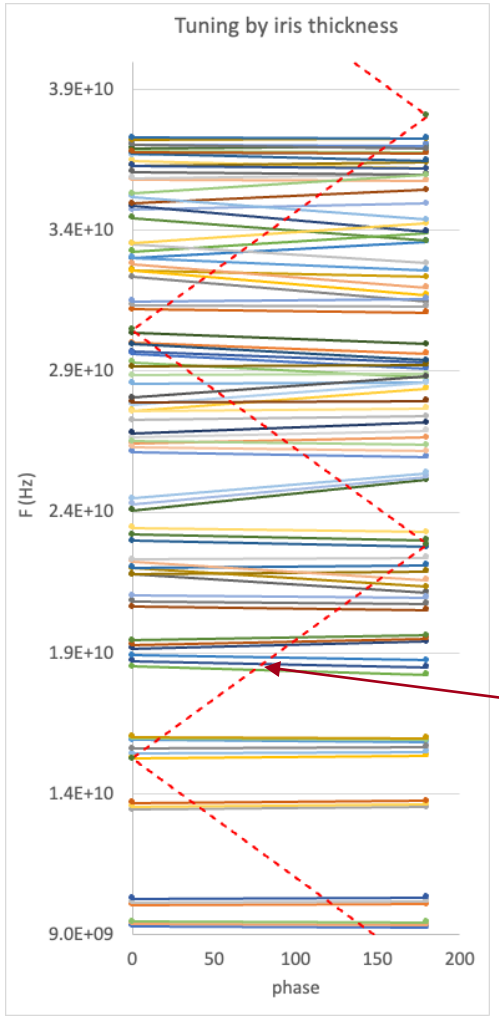
56-Cell Structure Tapered HOM Mode

- Band 1 (9.3 GHz)
- Band 2 (10.0 GHz)
- Band 3 (13.6 GHz)

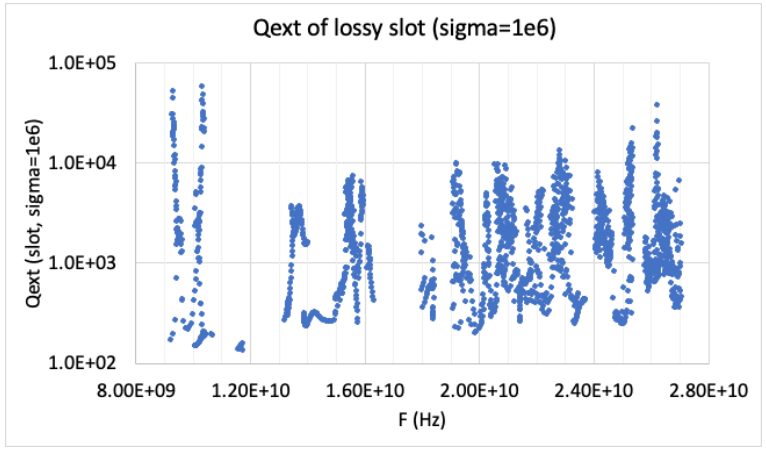


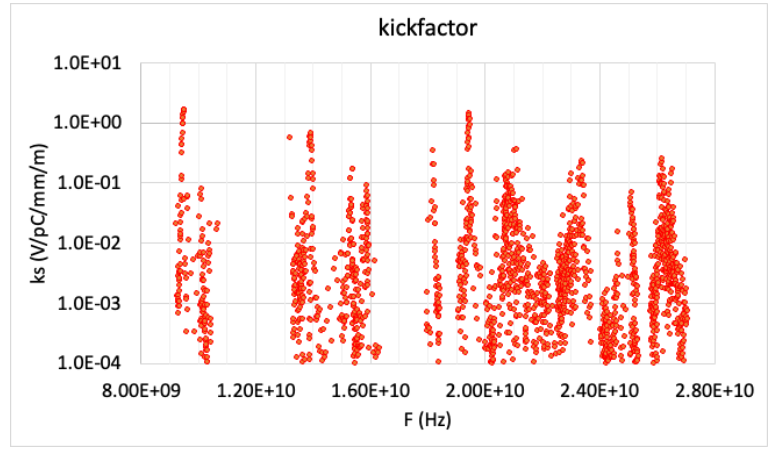
HOM Mode via Lossy Slots

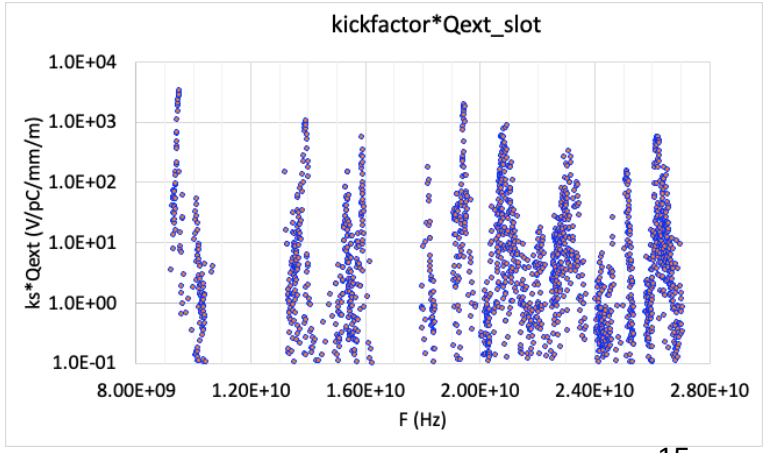
0.5mm slot
Conductivity on slot surface: 1e6



Mod synchronize with beam
interact stronger with beam





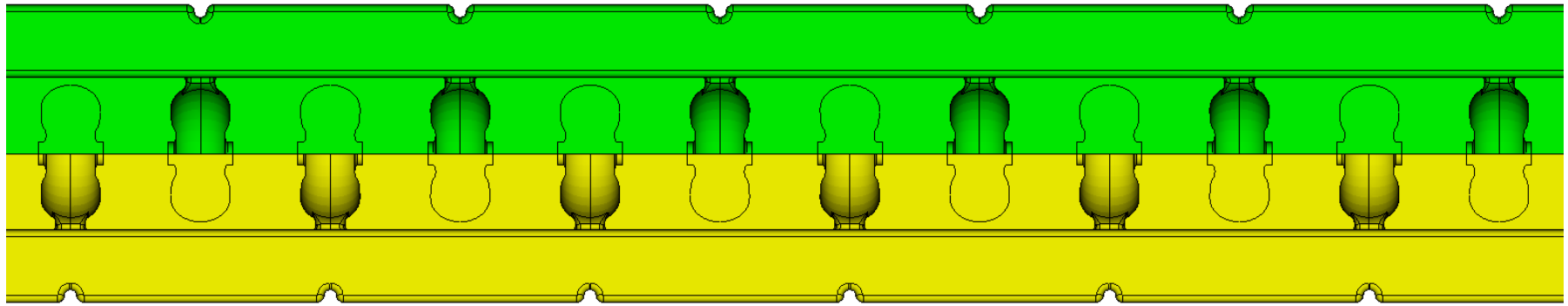


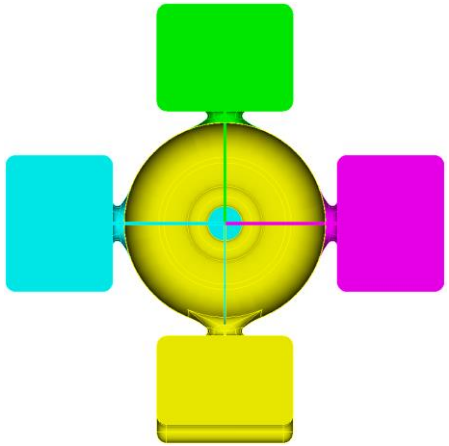
135/cell Structure – Possible Damping Scheme (power feed V1)

- Parallel feed waveguide acting as damping manifold
  - similar to NLC DDS structure

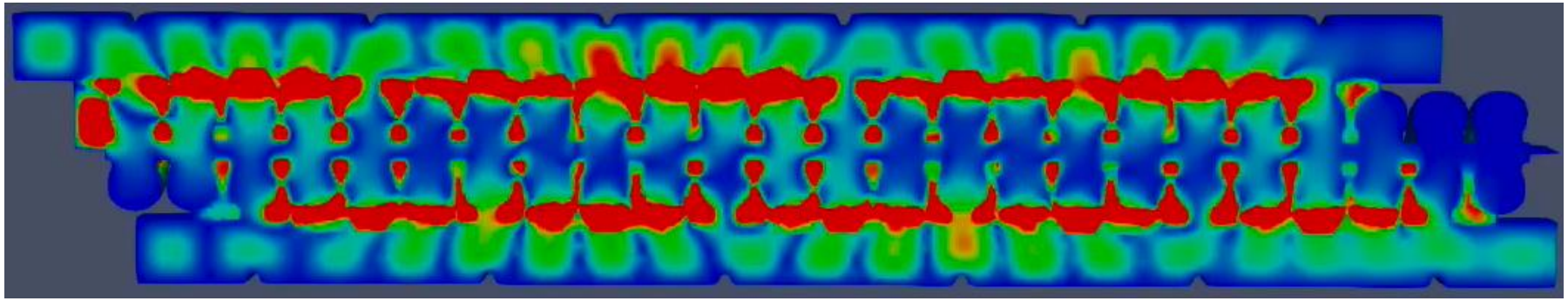
- Narrow slot cutting through the iris couples the cells to waveguide
- HOM calculation in progress

NLC RDDS





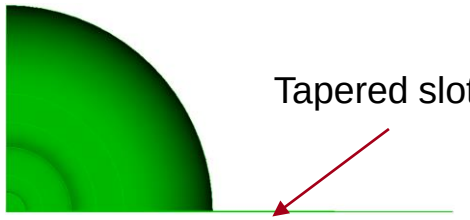
(illustration of damping)



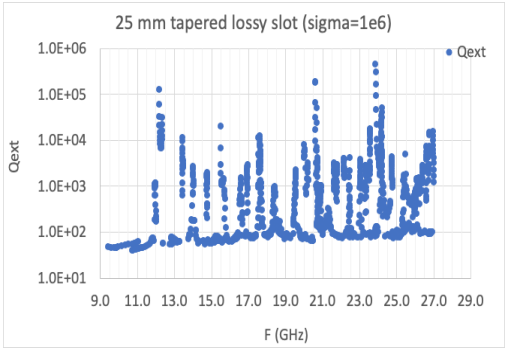
➡ HOM power extraction

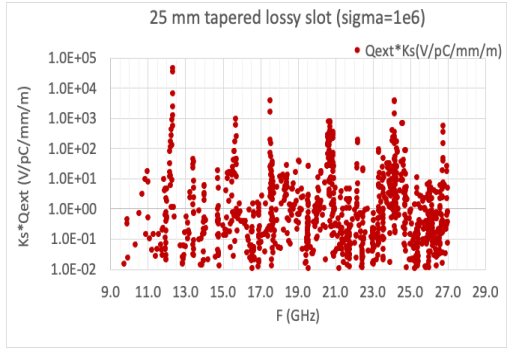
180 deg/cell Structure HOM Damping with Tapered Lossy Slot – Dongsung Kim

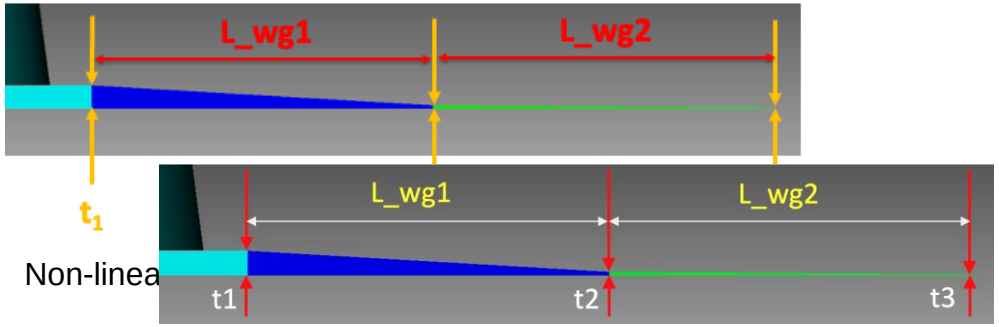
Slot surface conductivity (Ni-Cr) 1.0E+6 S/m



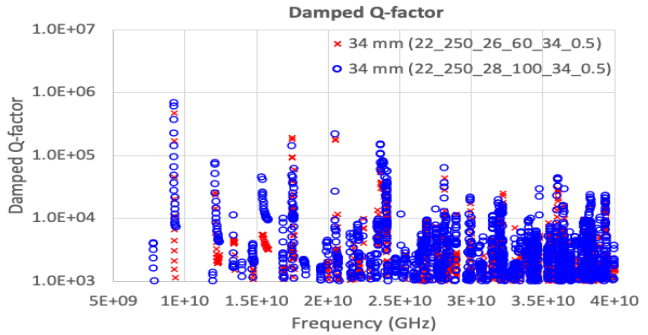
Linear taper: slot height: from 300 micron to 100 micron

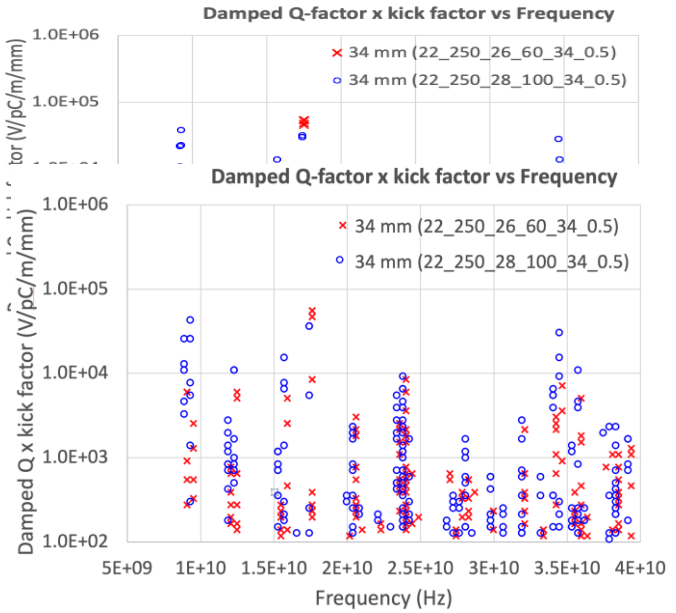






Non-linea





- Optimization in progress
- Need more studies in
  - Lossy materials at cold temperature (77K)
  - Coating or thin layers brazing on to structure

Outlook

- Detuning
  - Optimize detuning spectrum
  - Explore interleaved detuning as needed
  - Iterate with beam dynamics
- Damping
  - Include waveguide system
  - Optimize slot dimension
  - Study tolerance of conductivity of lossy surface