# *Normal Conducting Deflecting cavity development at the Cockcroft Institute*

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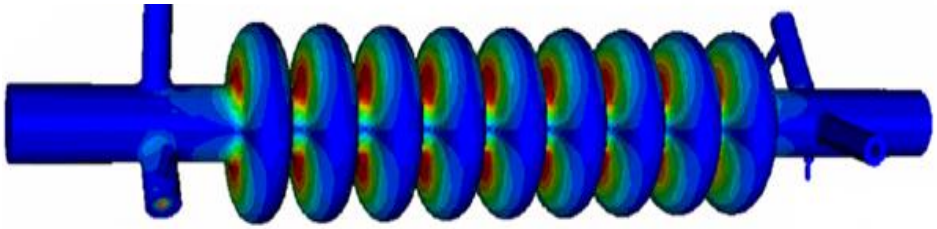
Lancaster University

Cockcroft Institute

Linac 2012

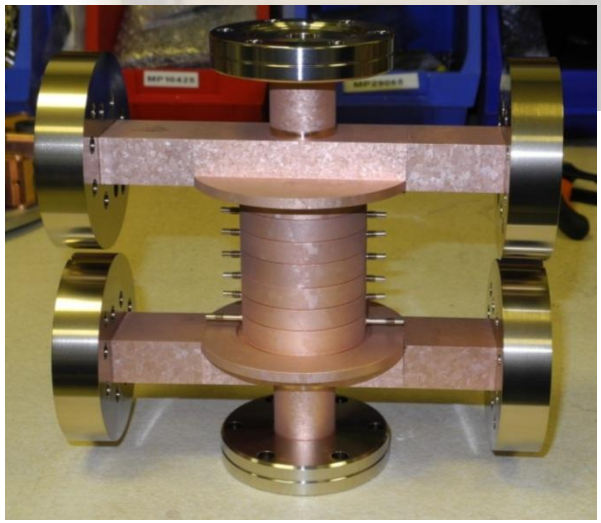
# Deflecting mode cavities Developed at Cockcroft

**International Linear Collider (ILC)**

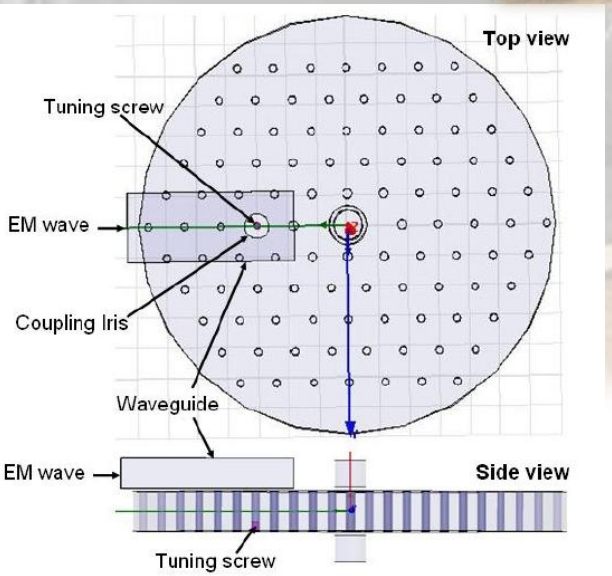


**Large Hadron Collider (LHC)**

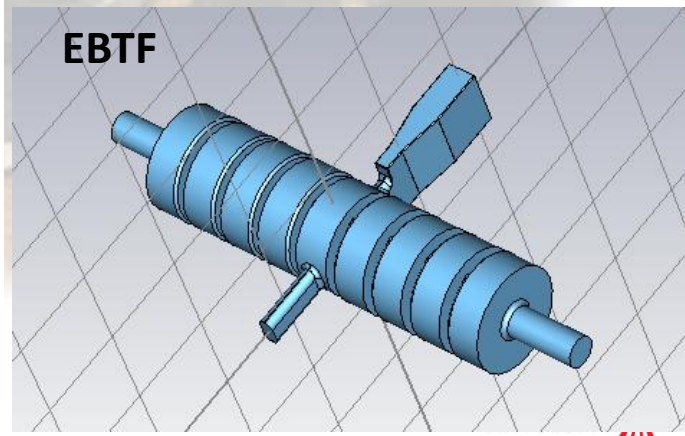
**CLIC**



**PBG crab**

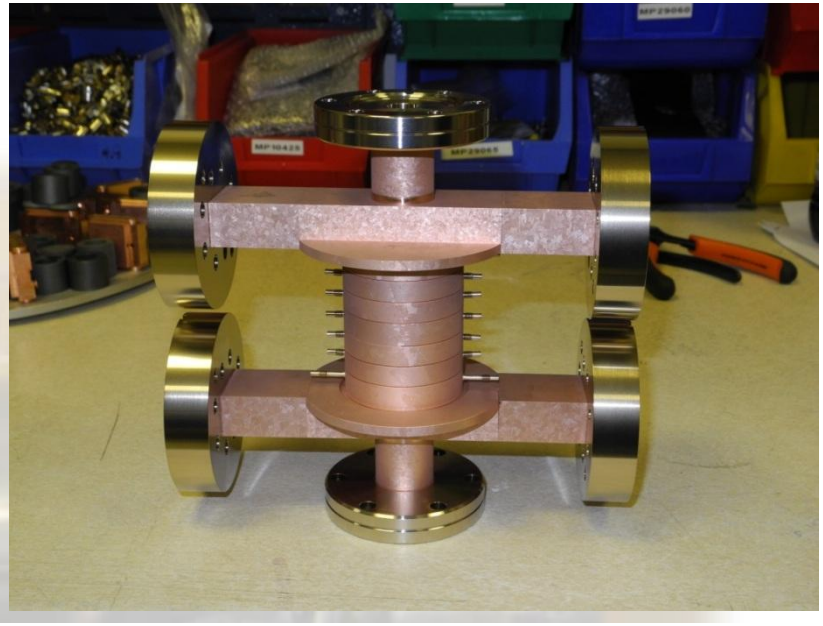


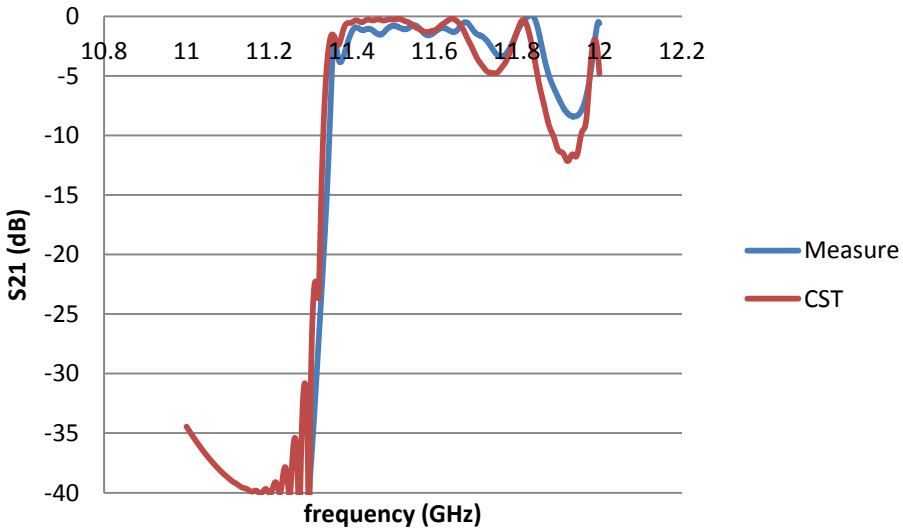

**EBTF**

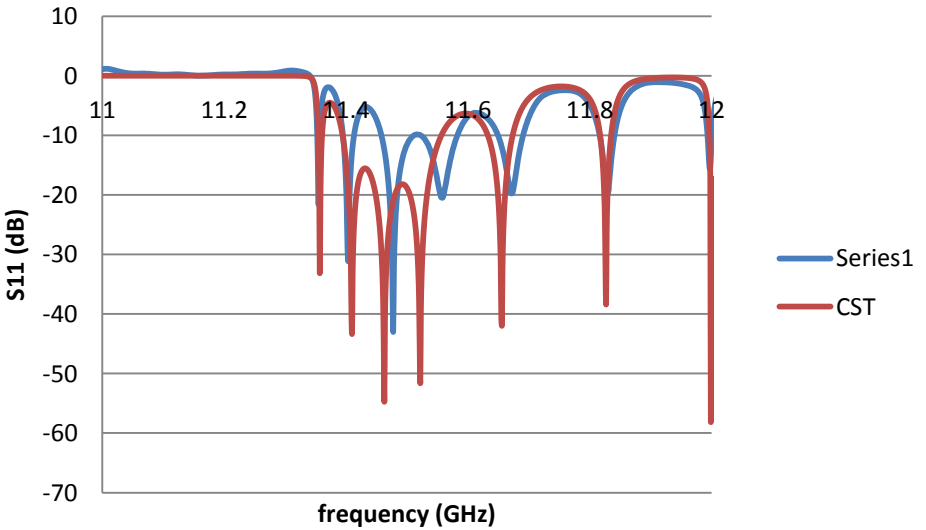


# CLIC Prototype 1 - UK manufactured

The 1st CLIC crab cavity prototype has been manufactured by Shakespeare Engineering in the UK. Tolerance and surface roughness on single parts have been measured and are acceptable.



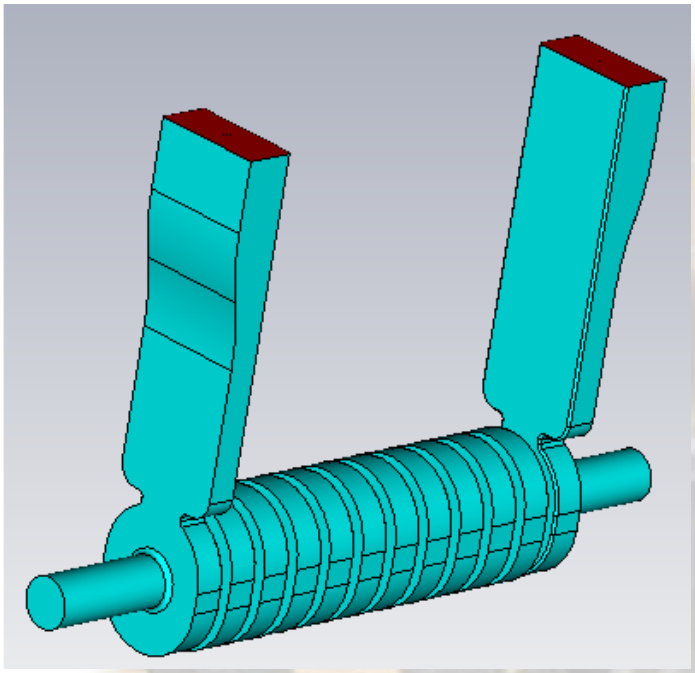



Structure is planned to be tested at SLAC in the near future.

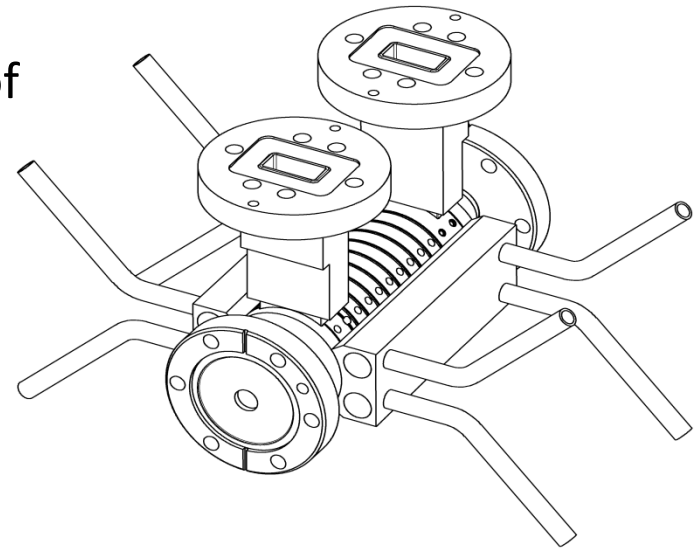
- Test by measuring S-parameters at each port then combining to get the dual port F-parameters.
- Cavities have not been tuned yet.

# Prototype 2 – CERN/VDL Built



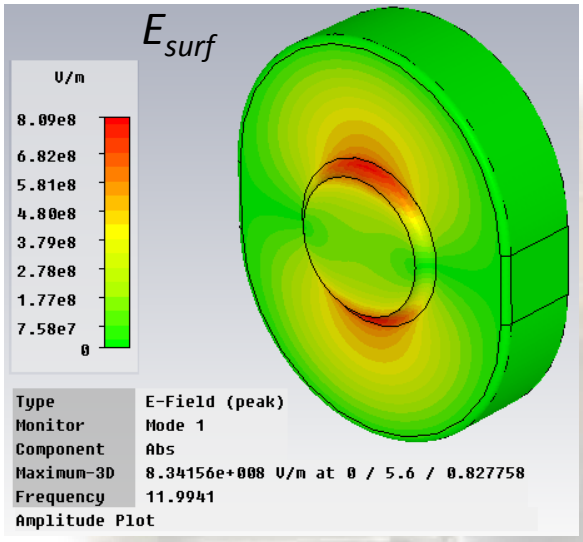
The structure being built for high gradient test at CERN has only a single feed as it will not see beam.

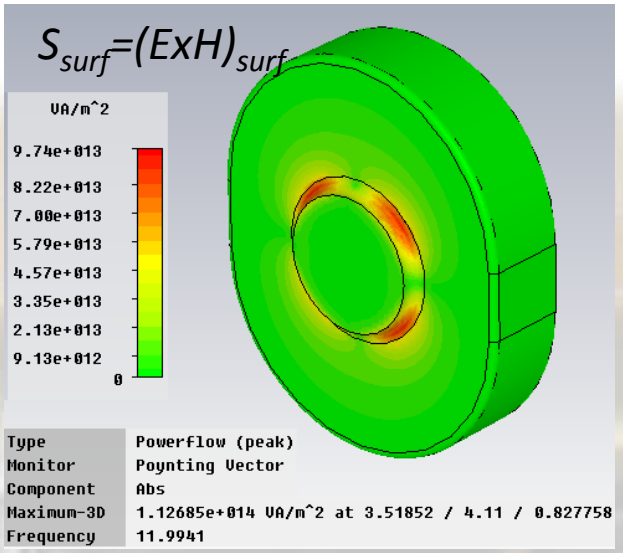
Cavity is being machined at VDL along with main linac structure to allow comparison of gradients.

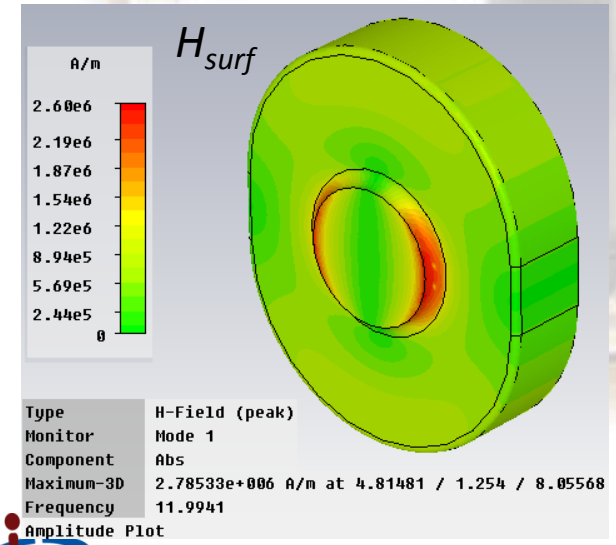


| Size | |
|---|---|
| Number of cells | 12 |
| Total length (mm) | 149.984 |
| Active length (mm) | 99.984 |

# Surface Fields



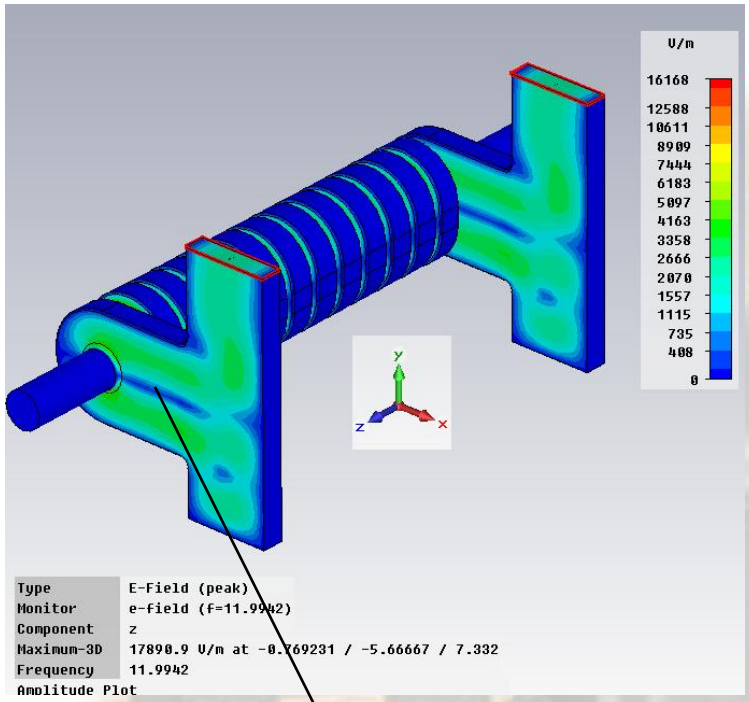



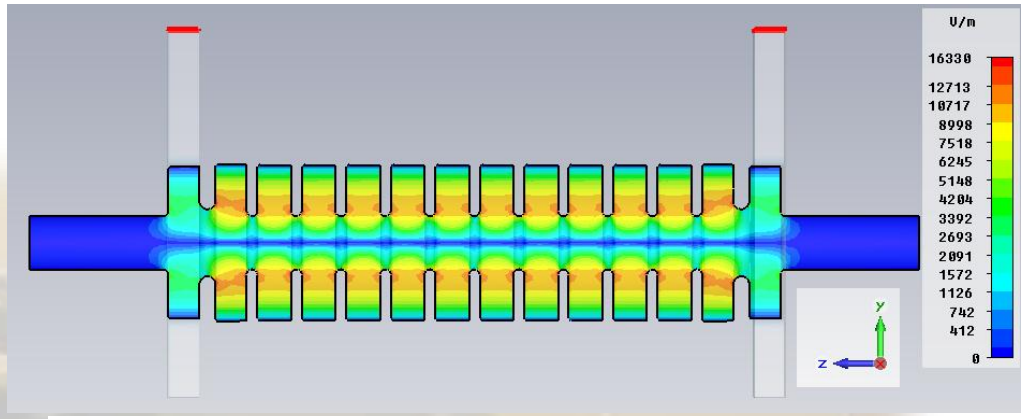



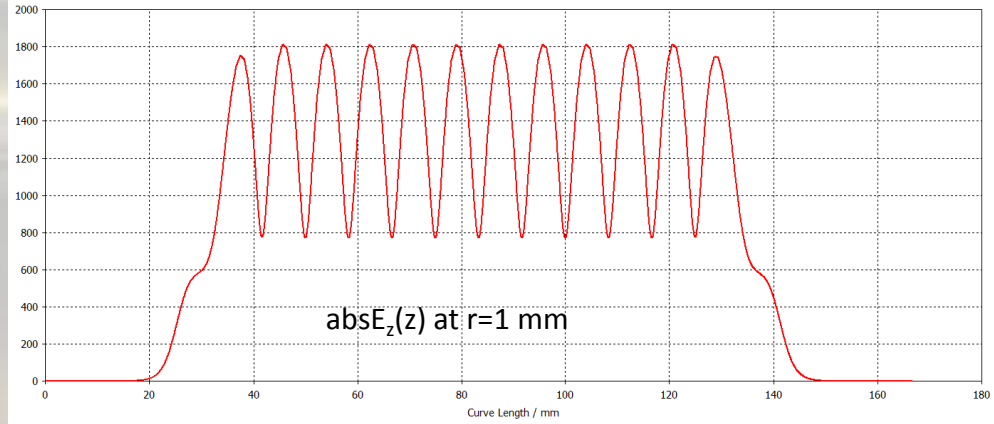

| Property | Value |
|---|---|
| Energy stored, J | 1 |
| $Q_{Cu}$ | 6395 |
| $R_t/Q$, Ohm | 54.65 |
| $v_{gr}$, % | -2.92 |
| $E_{surf}/E_t$ | 3.43 |
| $H_{surf}/E_t$ | 0.0114 |
| Sc (W/μm$^2$) | 3.32 |

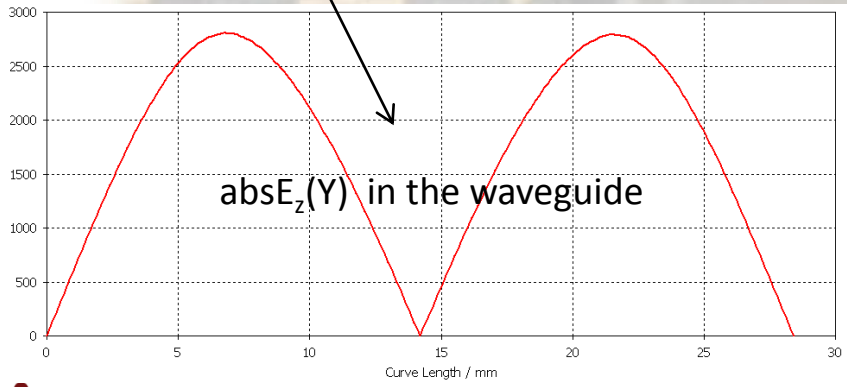
- Peak electric and magnetic fields of the dipole mode are located 90 degrees from each other on the iris
- Surface Poynting flux $S_{surf}$ is however at 45 deg to both E and H
- Location of the breakdown on the iris provides critical information about the role of magnetic field in breakdown.
- The cavity has a large Sc but relatively low E and H fields at the surface so this also provides an independent verification of new theories.

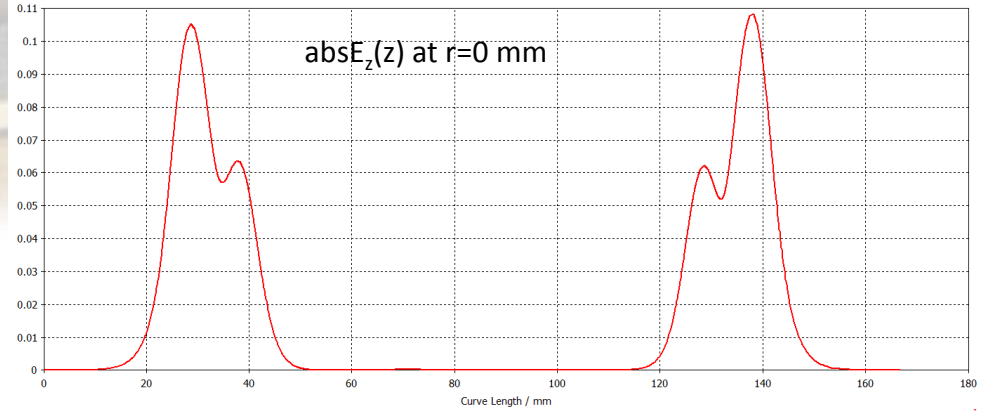
# TE02 mode coupler

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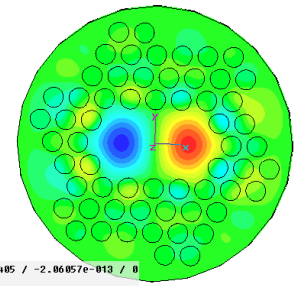
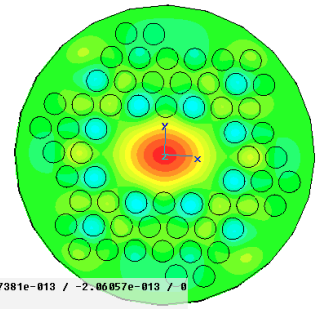
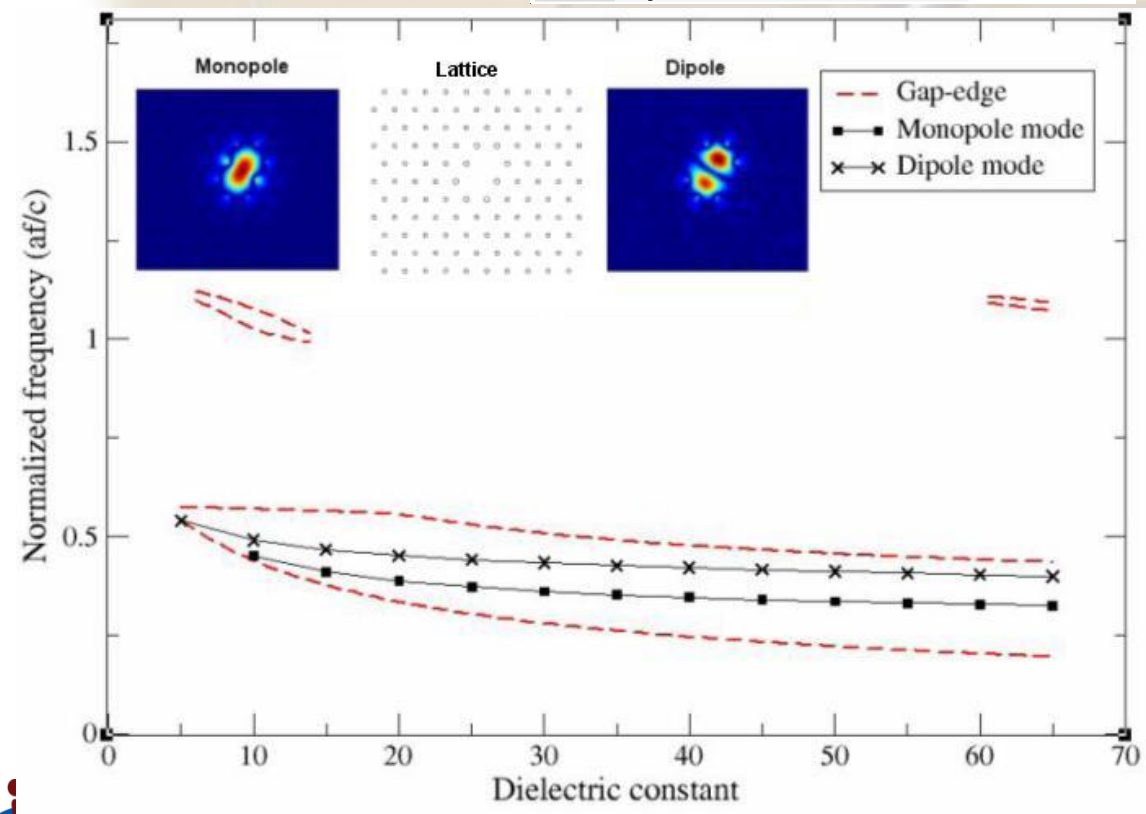
# PBG crab cavities



| | |
|---|---|
| Type | E-Field (peak) |
| Monitor | Mode 15 |
| Component | z |
| Plane at z | 0 |
| Maximum-2d | 5.55352e+008 V/m at 5.81405 / -2.06057e-013 / 0 |
| Frequency | 16.9897 |
| Phase | 0 degrees |



| | |
|---|---|
| Type | E-Field (peak) |
| Monitor | Mode 17 |
| Component | z |
| Plane at z | 0 |
| Maximum-2d | 4.44114e+008 V/m at -3.57381e-013 / -2.06057e-013 / 0 |
| Frequency | 14.6704 |
| Phase | 0 degrees |




A PBG dipole cavity would allow the construction of a crab cavity with no trapped higher order modes.

However, one must be careful not to trap other modes in the band-gap as well.

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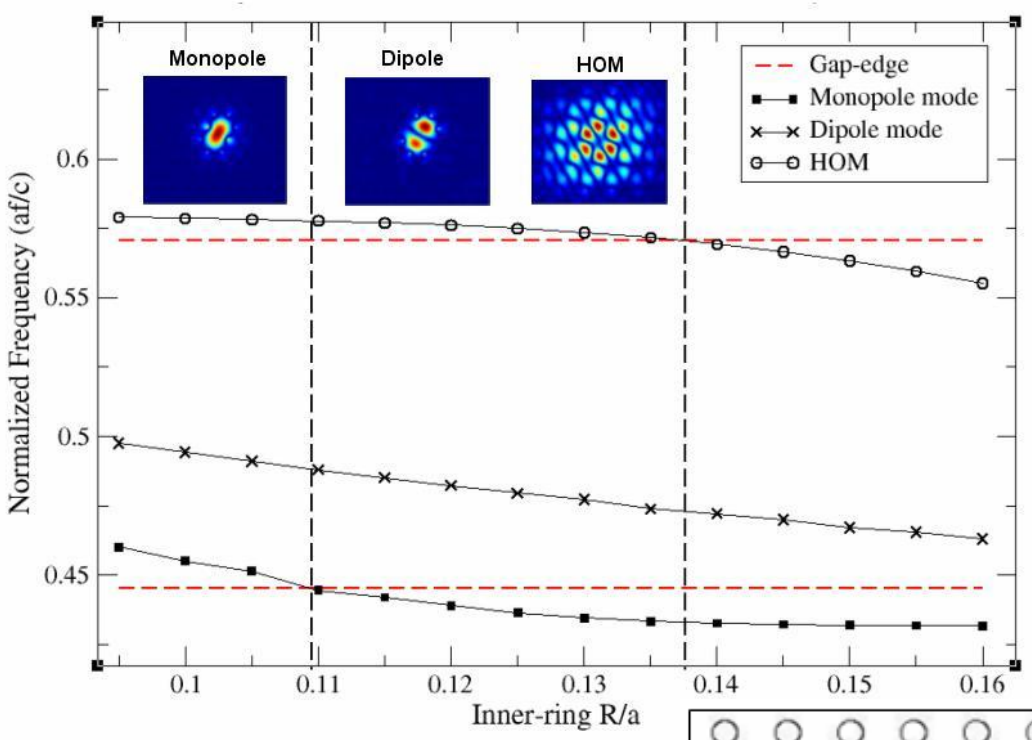
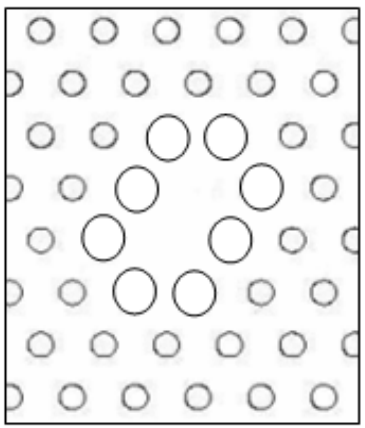
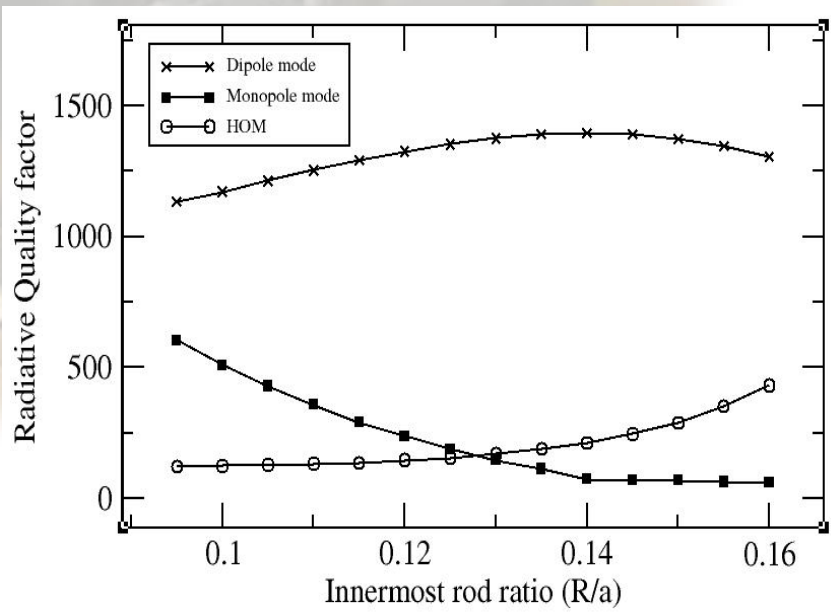
# PBG Crab Cavities




A solution was found, where the rods around the defect (two missing rods) where enlarged.

This pushes the modal frequencies down allowing the monopole to be pushed out of the bandgap.






**See Rebecca Seviour's talk**

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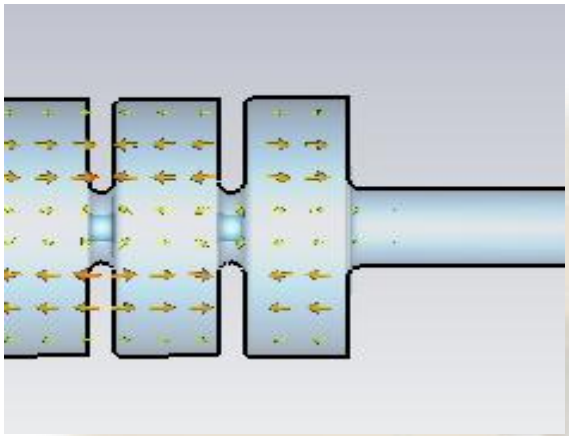
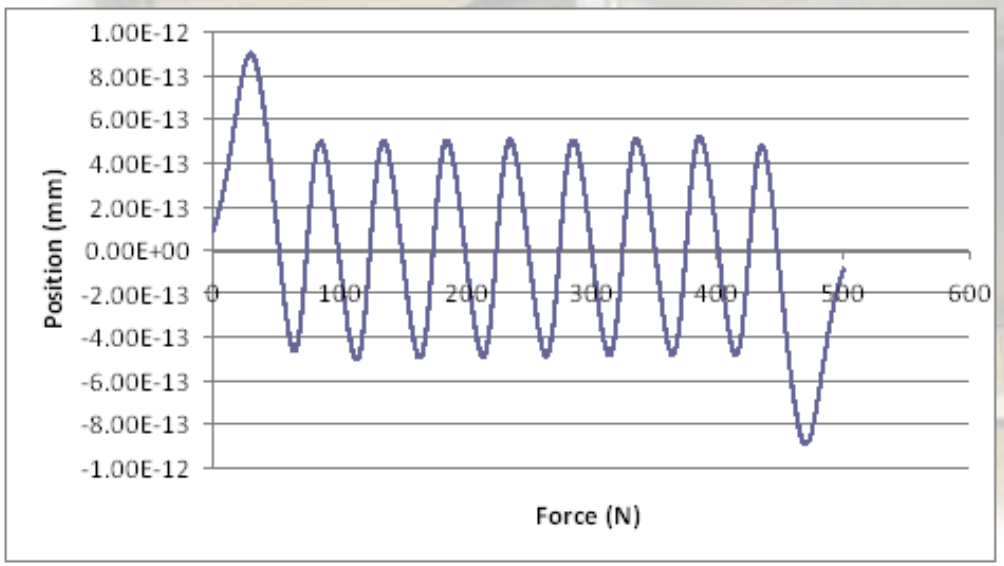
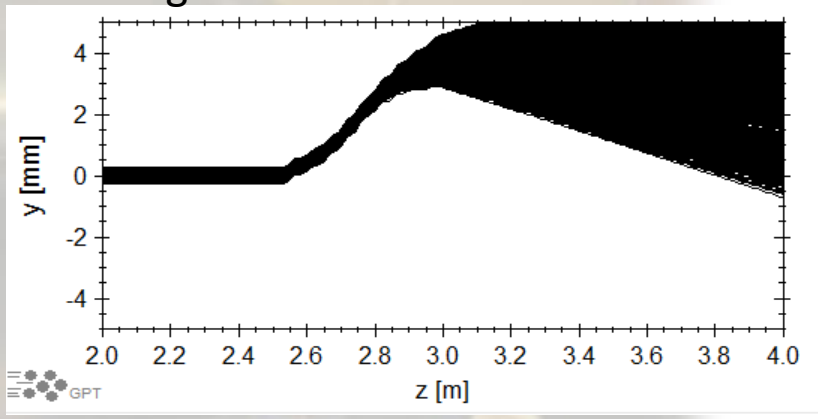
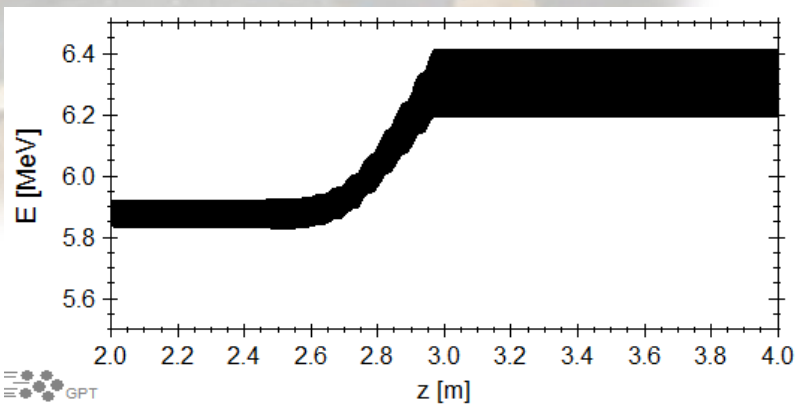
# EBTF Deflector



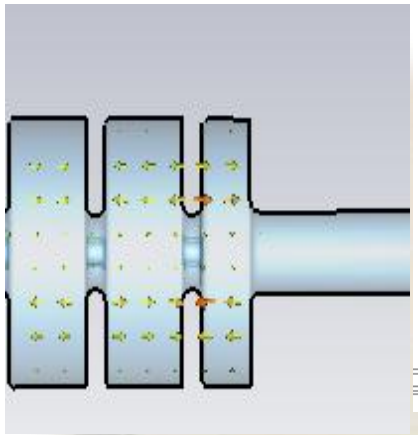
The field in the end cell is not symmetric as the field penetrates into the beampipe. This causes the field in this cell not to cancel. This leads to a large transverse offset in the structure.
The beam hence travels off-axis and see the large longitudinal electric field and gets accelerated.

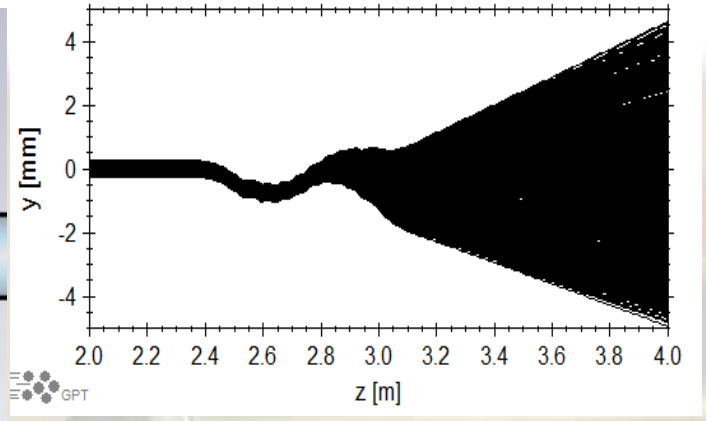


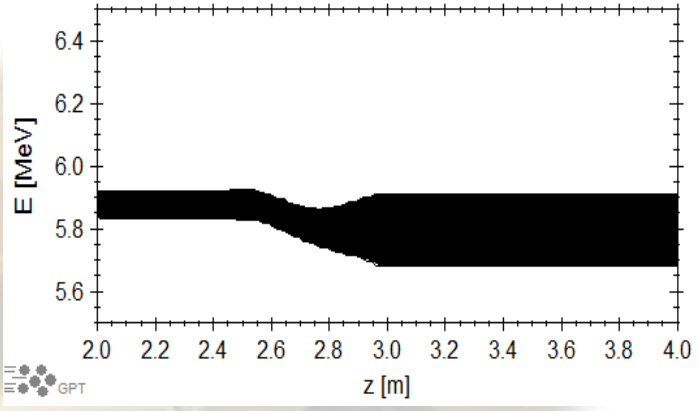



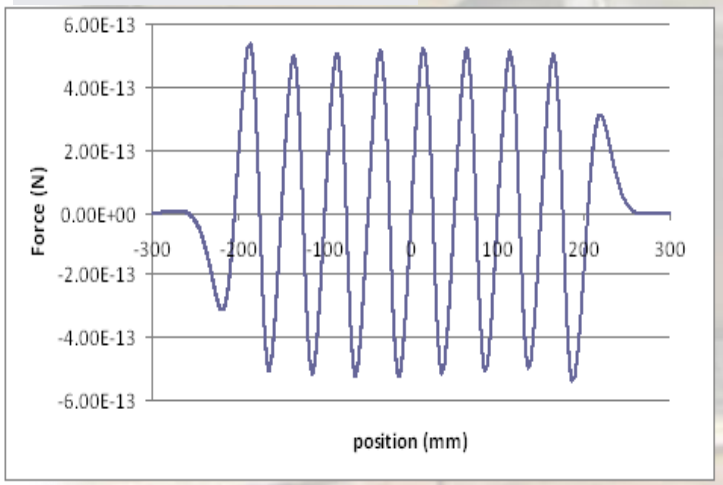



# Modified Deflector

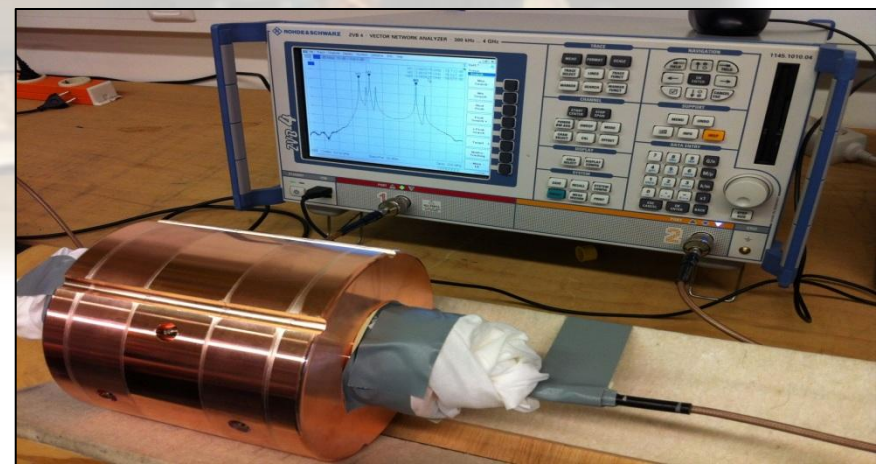





Making the end cell roughly half the length causes the field to cancel removing the offset. Similar work on 2 cell cavities was performed at ANL.



A 3 cell prototype has been manufactured for cold tests and the final 9 cell is now being manufactured.

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