X Band Choke Structures

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CERN

X Band Choke Structures

Acknowledgments

Thanks very much to Sami Tantawi and Valery Dolgashev who have inspired and help me to get involved in the world of high gradient rf structures.

The structures, I will be discussing here, are all inspired by Valery Dolgashev.

X Band Choke Structures

Motivation

3 Structures

- Choke Flange

-Triple Choke

-Full Choke

X Band Choke Structures

Motivation

High gradient RF breakdown studies include structures of various materials, some of which do not braze well or should not be brazed. There is also the desire to view the hotspots on the cell irises by a high speed camera or microscope without perturbing the electromagnetic fields by the viewport pipe. Reducing the gradient at the outer wall of the cell permits us to do these studies.

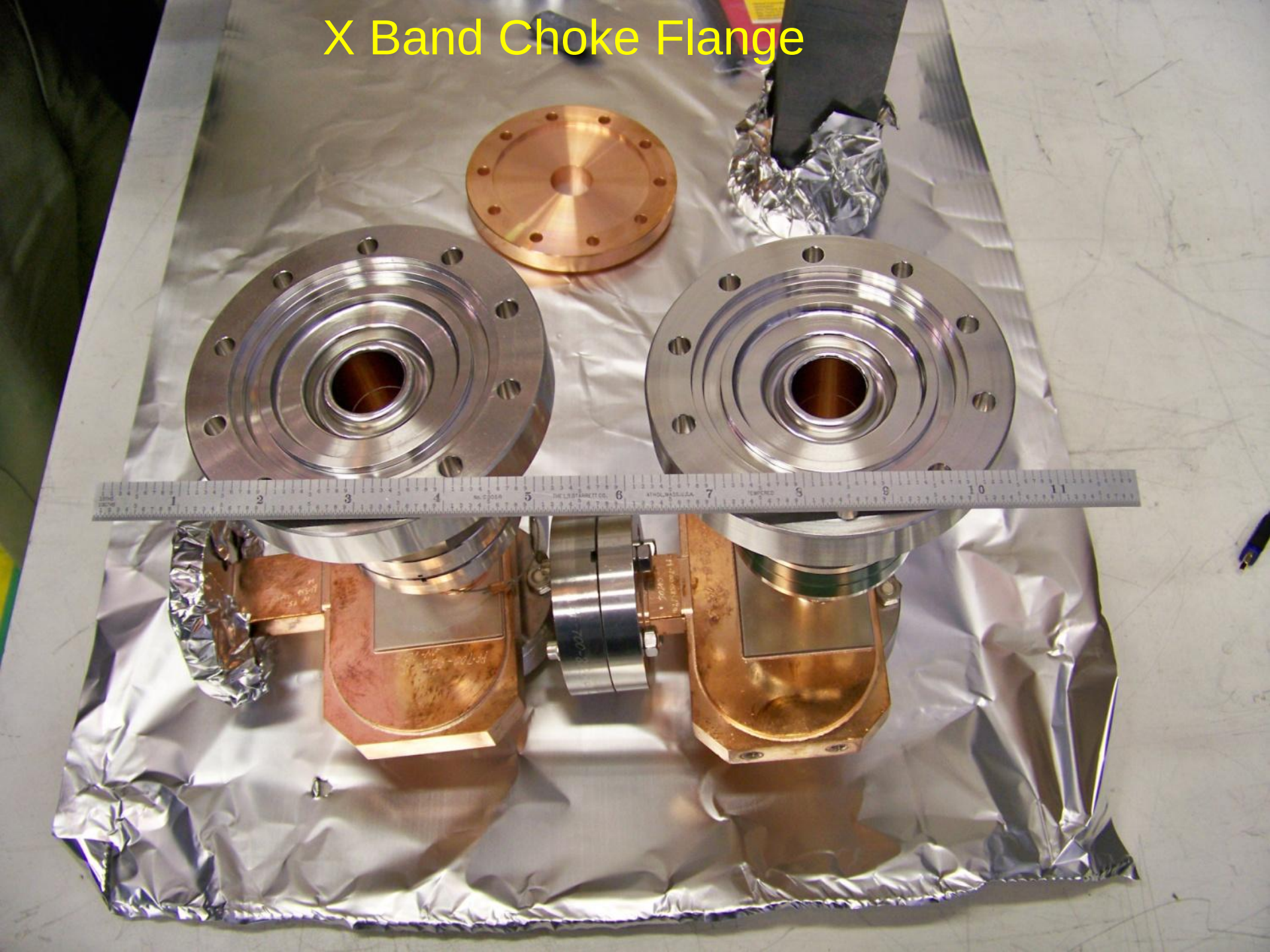
X Band Choke Structures

1. The *choke flange* was designed to replace the flange with an rf joint by an rf-lip. The joint is not always perfect and deteriorates with assembly/disassembly cycles.

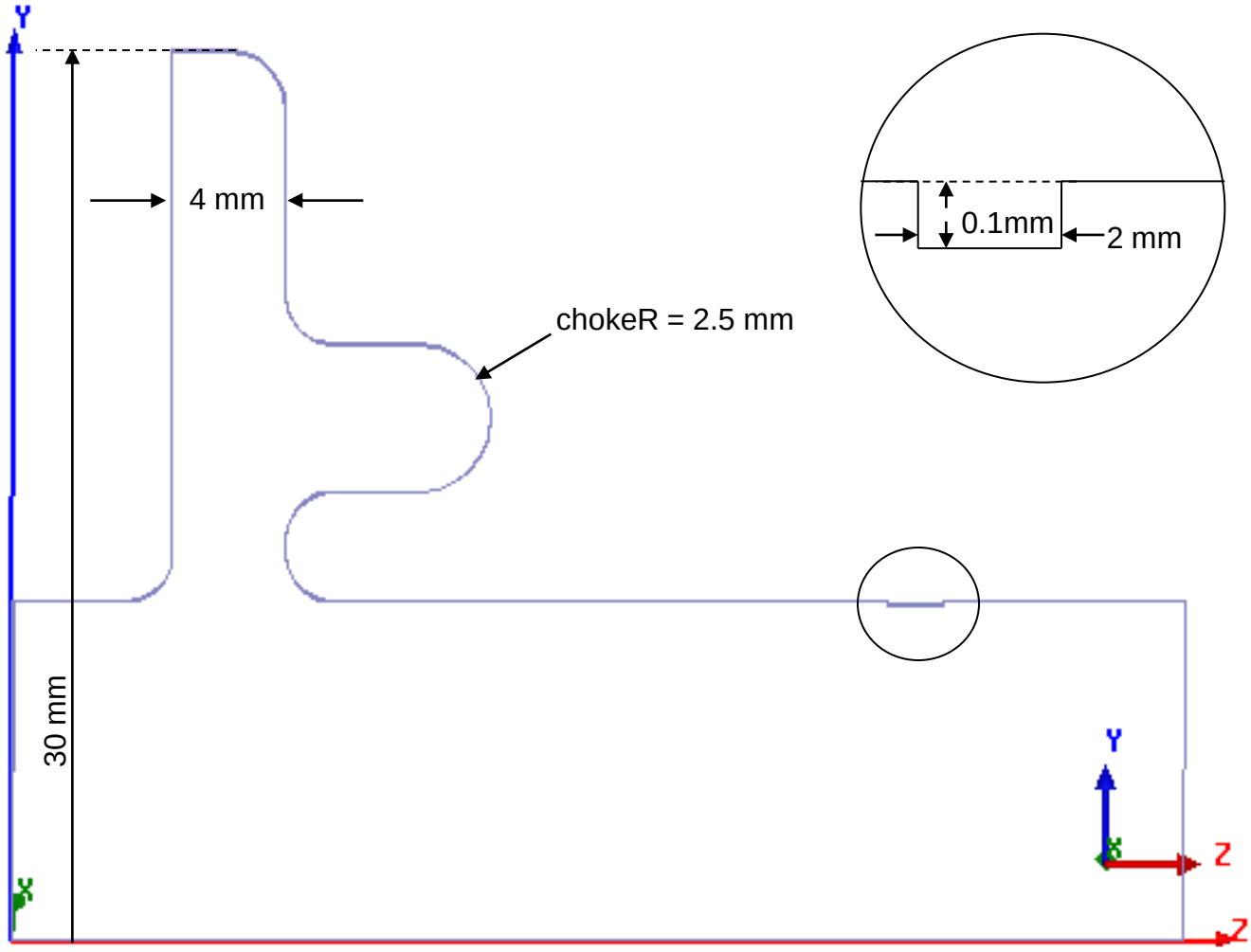
2. The *triple choke structure* was designed in order to significantly reduce the electric and magnetic fields on the rf joint.

3. The *full choke structure* was designed to reduce the electric and magnetic fields at the outer radius of the cell so that we can put a view port without perturbing the fields. With the view port, a microscope or any other device could be used to view both high electric and high magnetic field areas between and during rf pulses.

X Band Choke Flange



11.424 GHz Choke Flange



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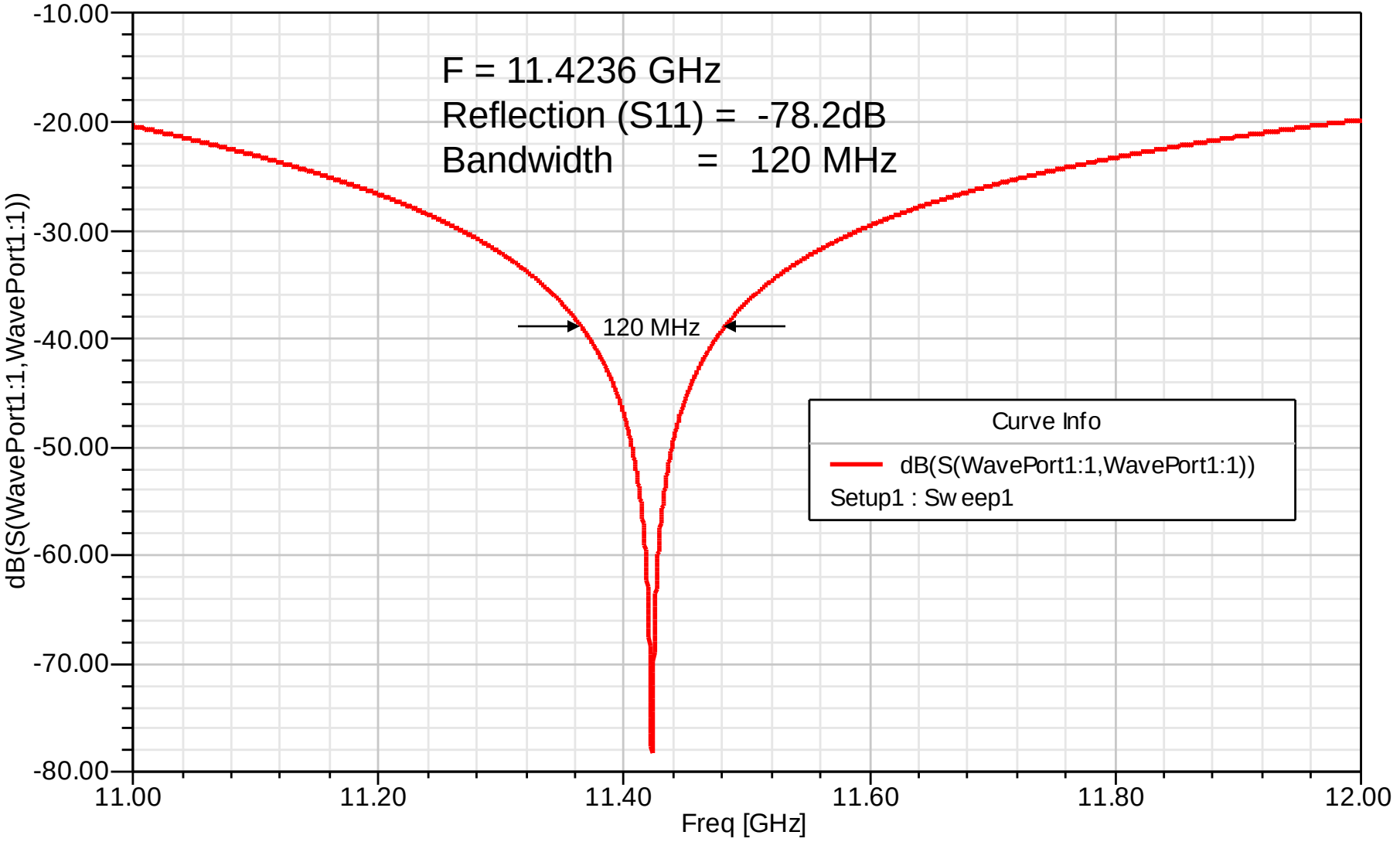
X band Choke Flange Optimized Assuming Ideal Conducting Walls



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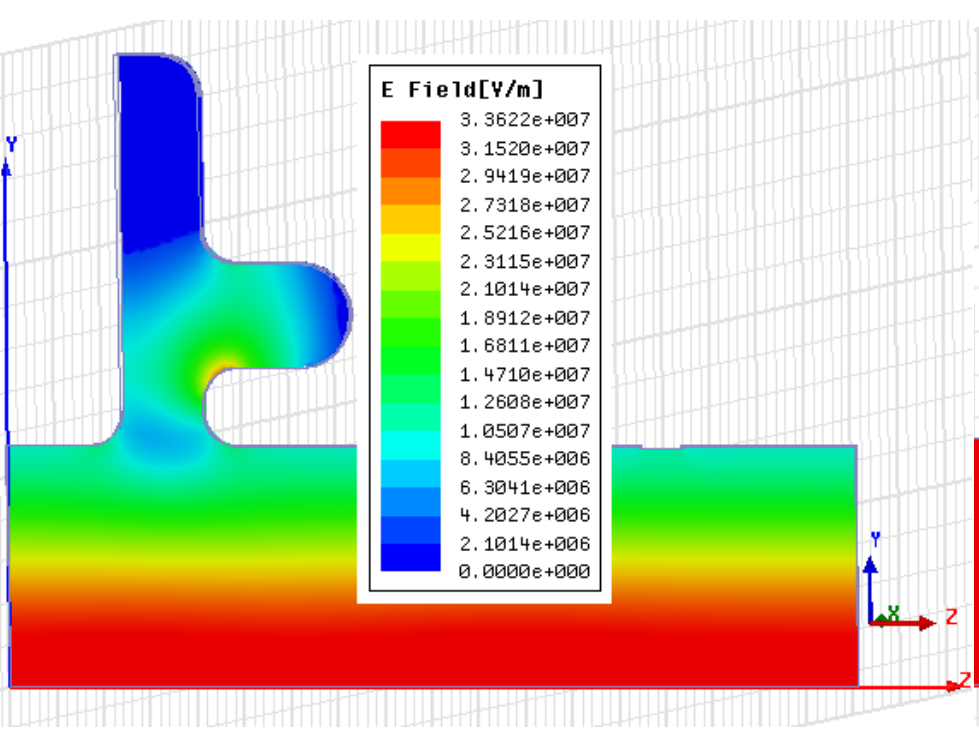
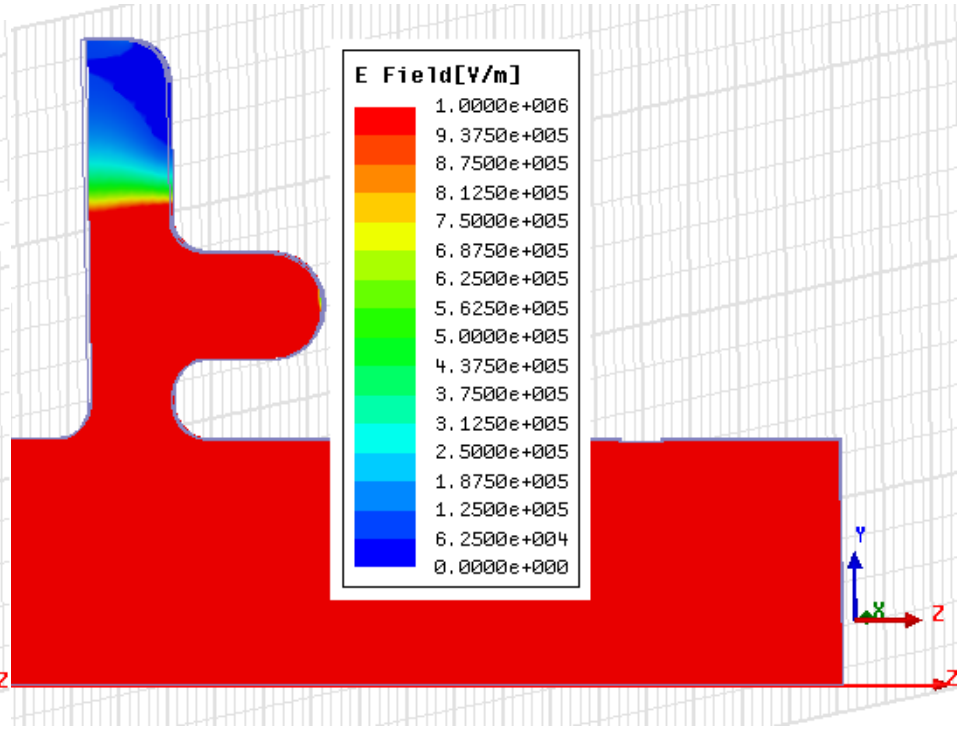
X band Choke Flange Electric Fields

100 MW input,
on-axis E=33.6MV/m,
at the top of the gap E=125kV/m or 1.25kV/cm





a) Autoscaled to demonstrate max field on axis

b) Manually scaled to demonstrate max field at top of choke gap

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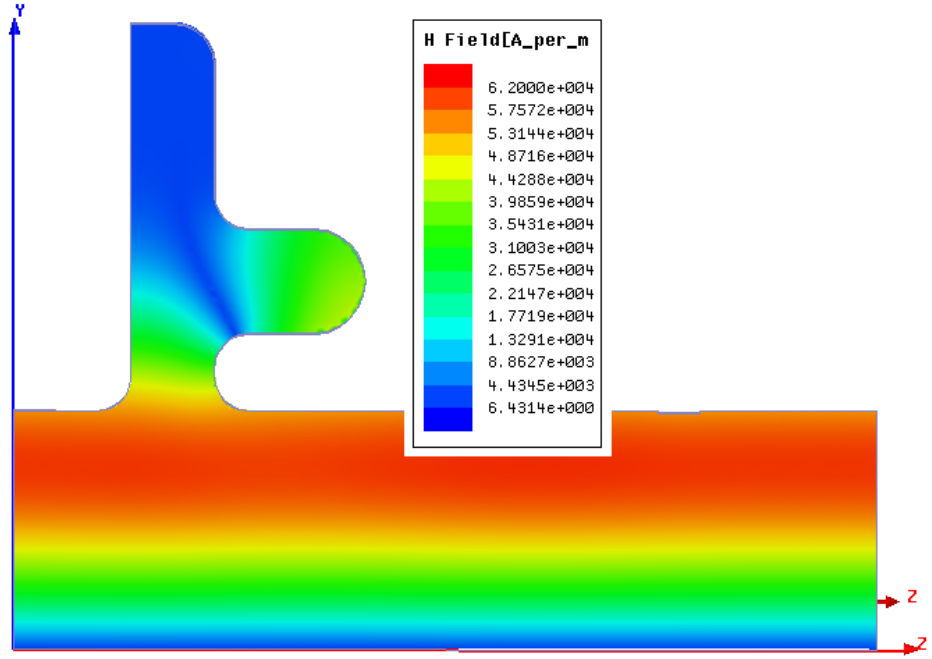
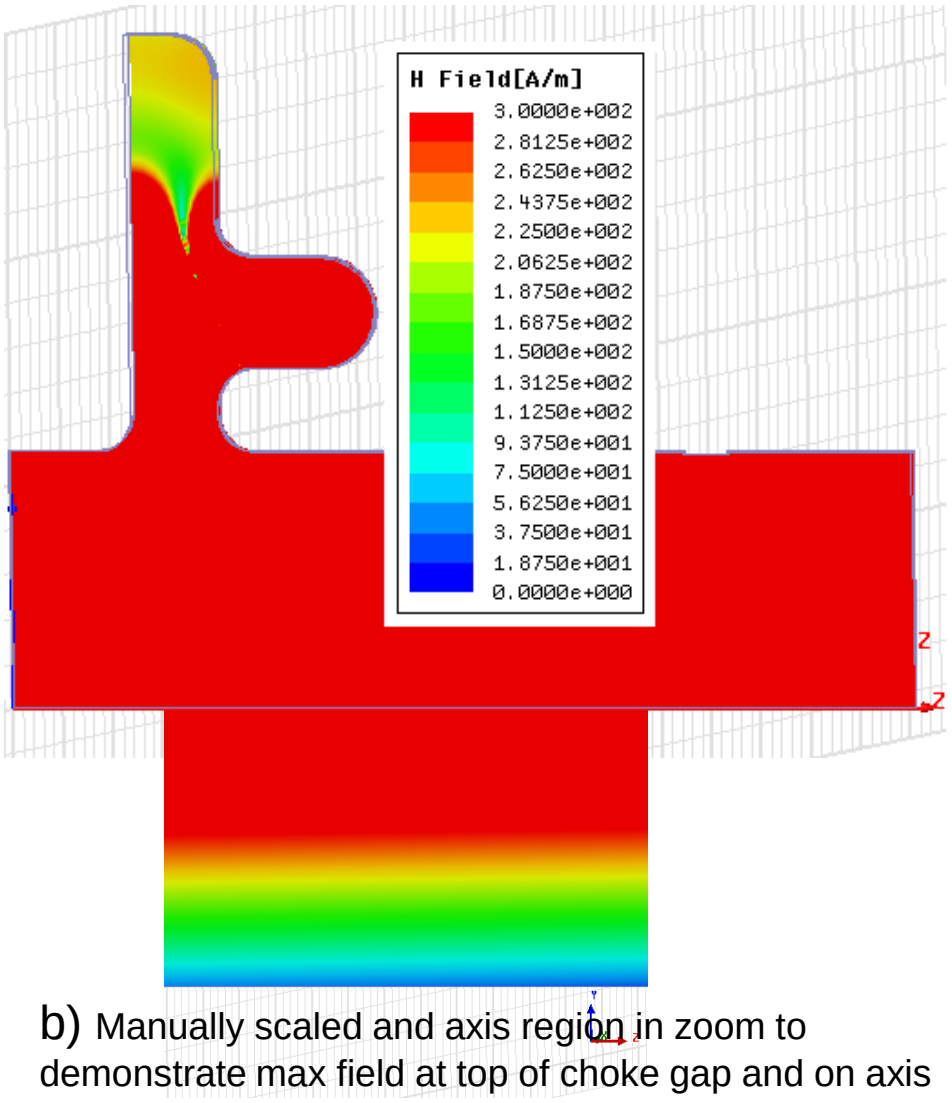
X band Choke Flange Magnetic Fields



a) Auto-scaled to demonstrate max field on axis



b) Manually scaled and axis region in zoom to demonstrate max field at top of choke gap and on axis

100 MW input
On the pipe H=57 kA/m,
at top the of the gap H=225A/m

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X band Choke Flange Trapped Modes
Scanning from 11 GHz
Looking for 3 modes

Dipole

Eigenmode	Frequency (GHz)
Mode 1	13.3268
Mode 2	14.5710
Mode 3	16.1351

Quadrupole

Eigenmode	Frequency (GHz)
Mode 1	13.1796
Mode 2	14.5360
Mode 3	16.0355

Sextupole

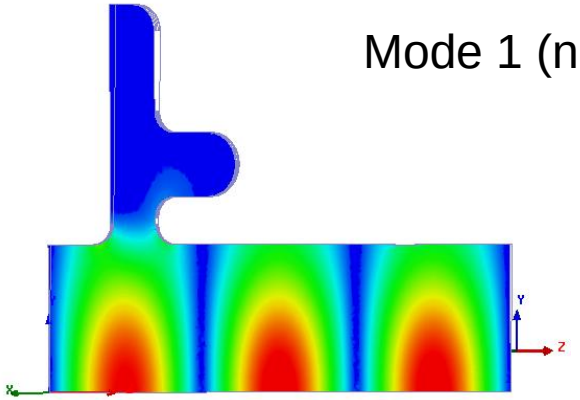
Eigenmode	Frequency (GHz)
Mode 1	12.2536
Mode 2	17.2796
Mode 3	17.8275

X band Choke Flange Trapped Modes
Dipole Mode Electric Fields

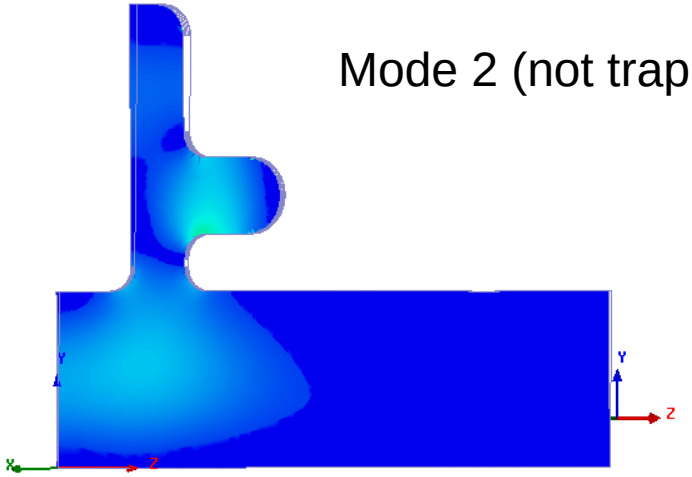
Dipole

Eigenmode	Frequency (GHz)
Mode 1	13.3268
Mode 2	14.5710
Mode 3	16.1351

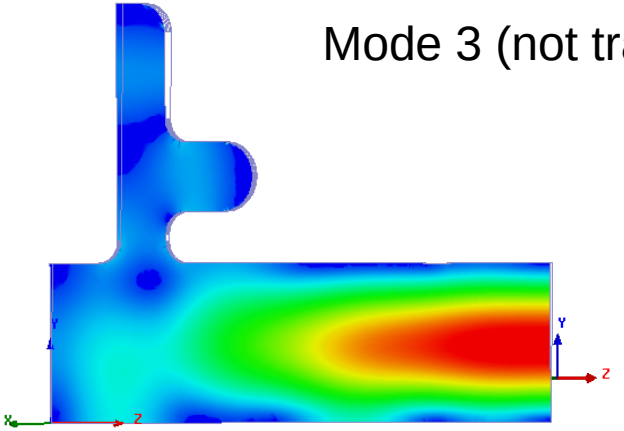
Mode 1 (not trapped)



Mode 2 (not trapped)



Mode 3 (not trapped)



No trapped modes!

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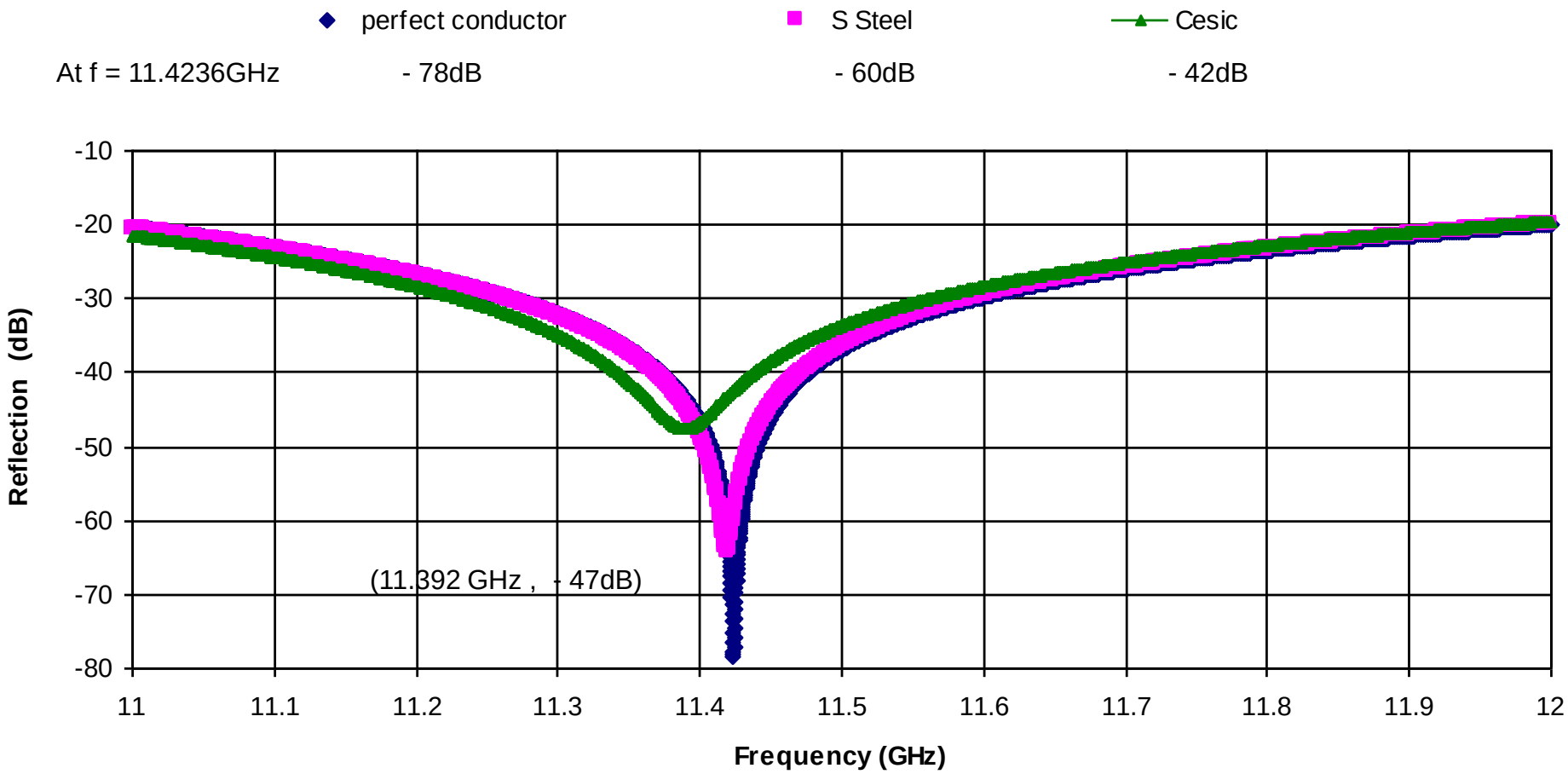
Choke Flange Frequency Scan Overlay



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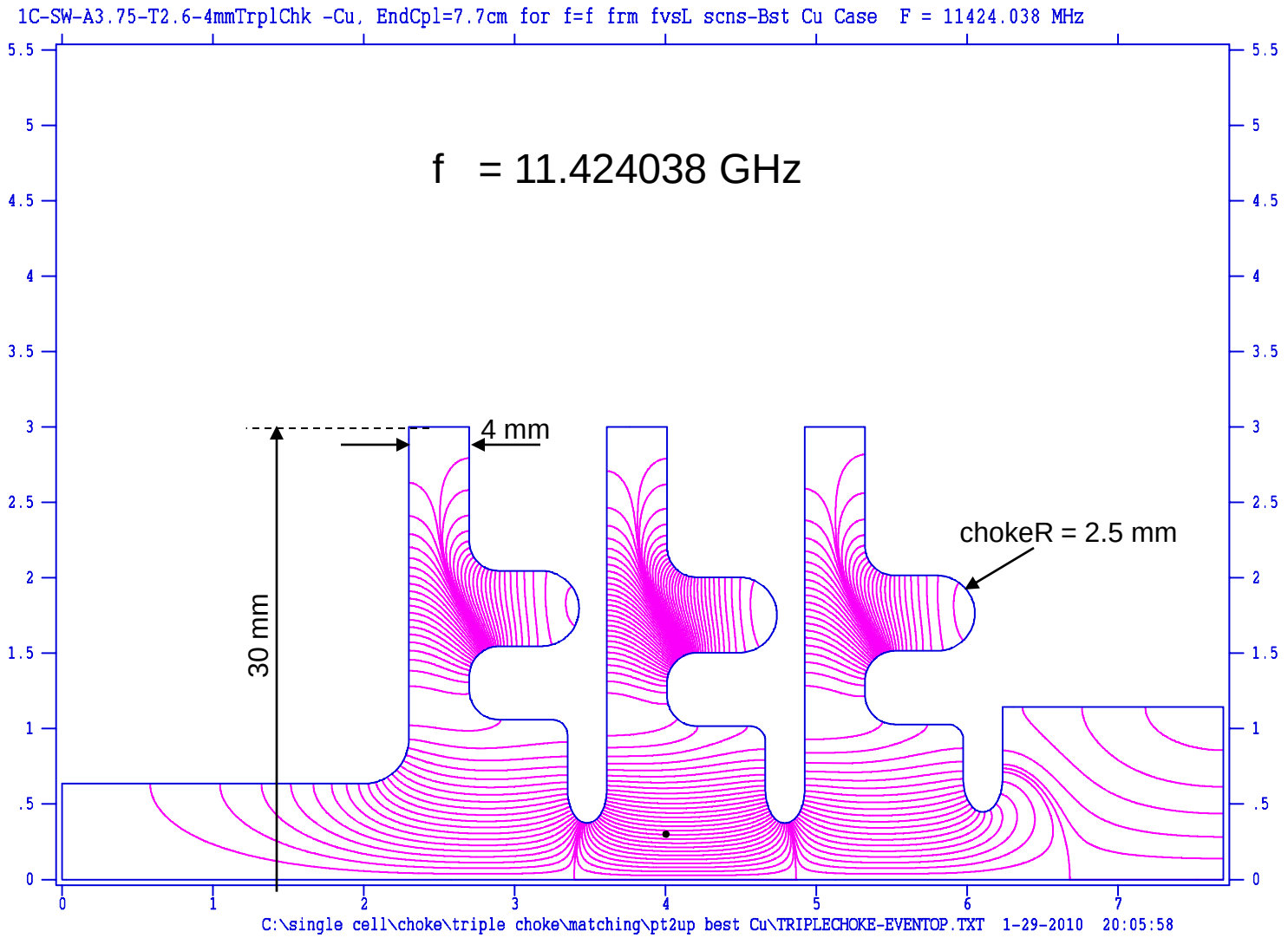
X-band 1C-SW-A3.75-T2.6 Triple Choke Structure



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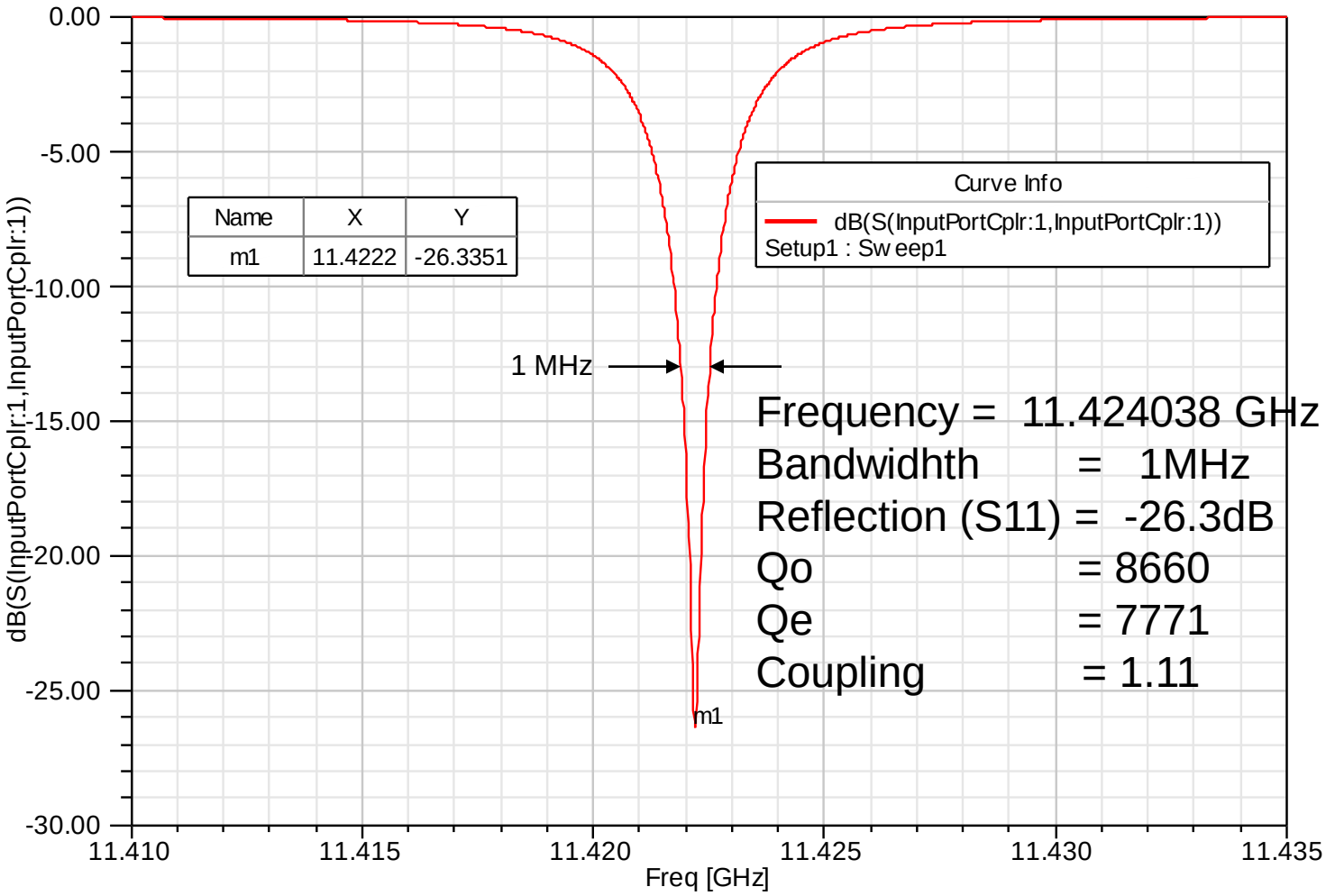
X-band 1C-SW-A3.75-T2.6 Triple Choke-Cu Structure



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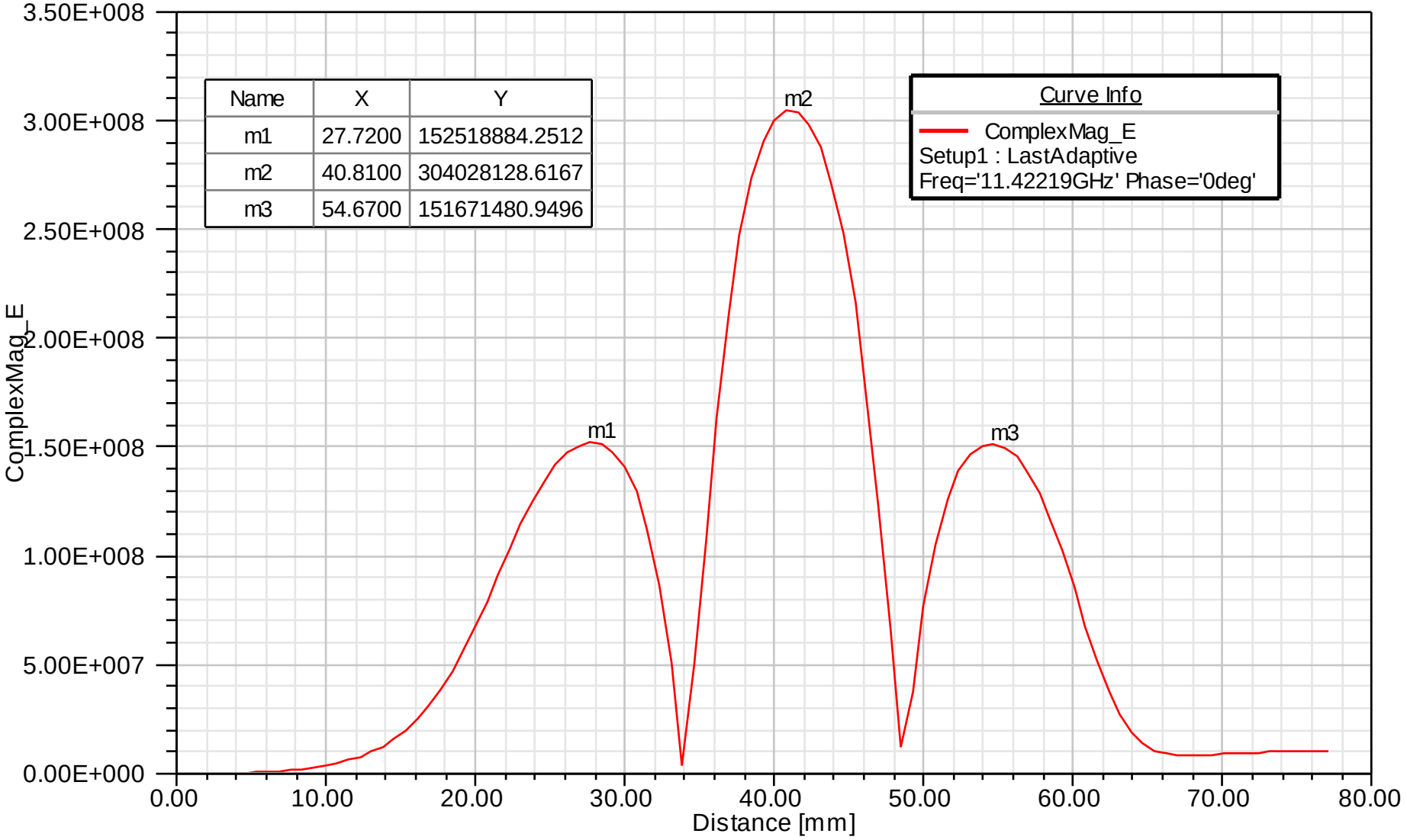
X-band 1C-SW-A3.75-T2.6 Triple Choke Structure-Cu



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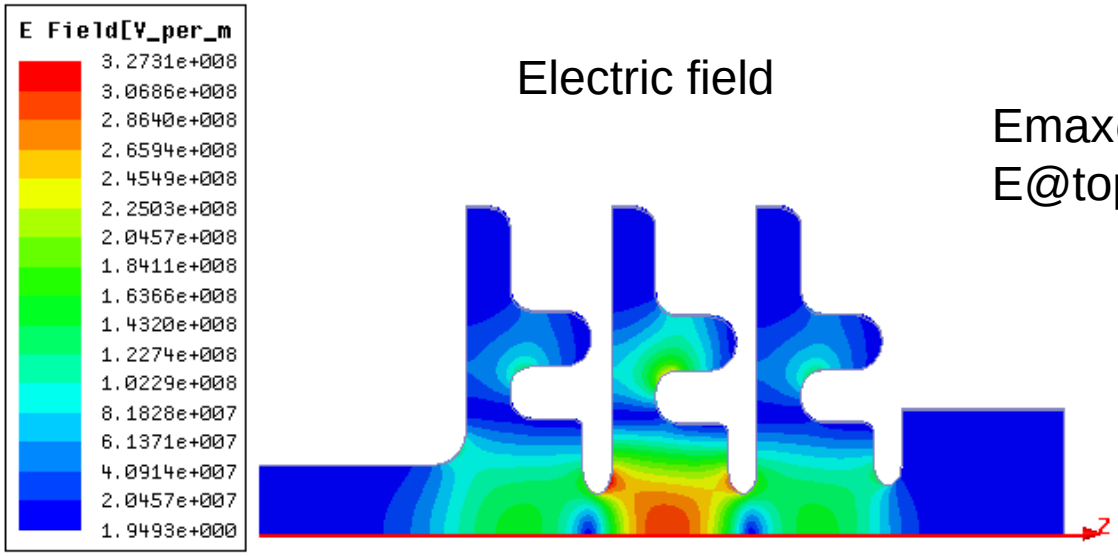
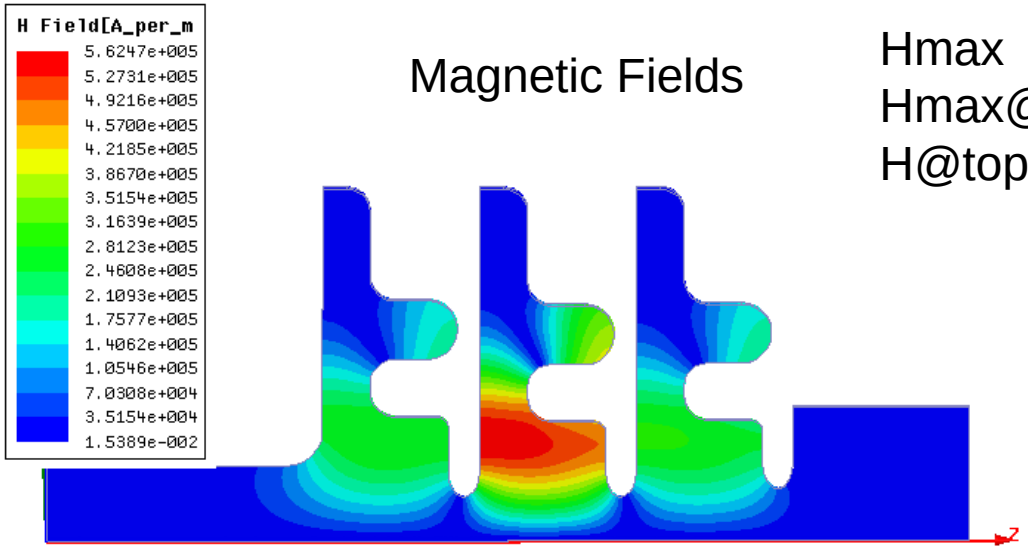
X-band 1C-SW-A3.75-T2.6 Triple Choke Cu, Fields Normalized to 10MW RF Losses



Electric field

Emax@iris = 320 MV/m
E@top = 37 KV/m



Magnetic Fields

Hmax = 560KA/m = 5.6KA/cm
Hmax@b = 510KA/m = 5.1KA/cm
H@top = 40 A/m = 0.4A/cm

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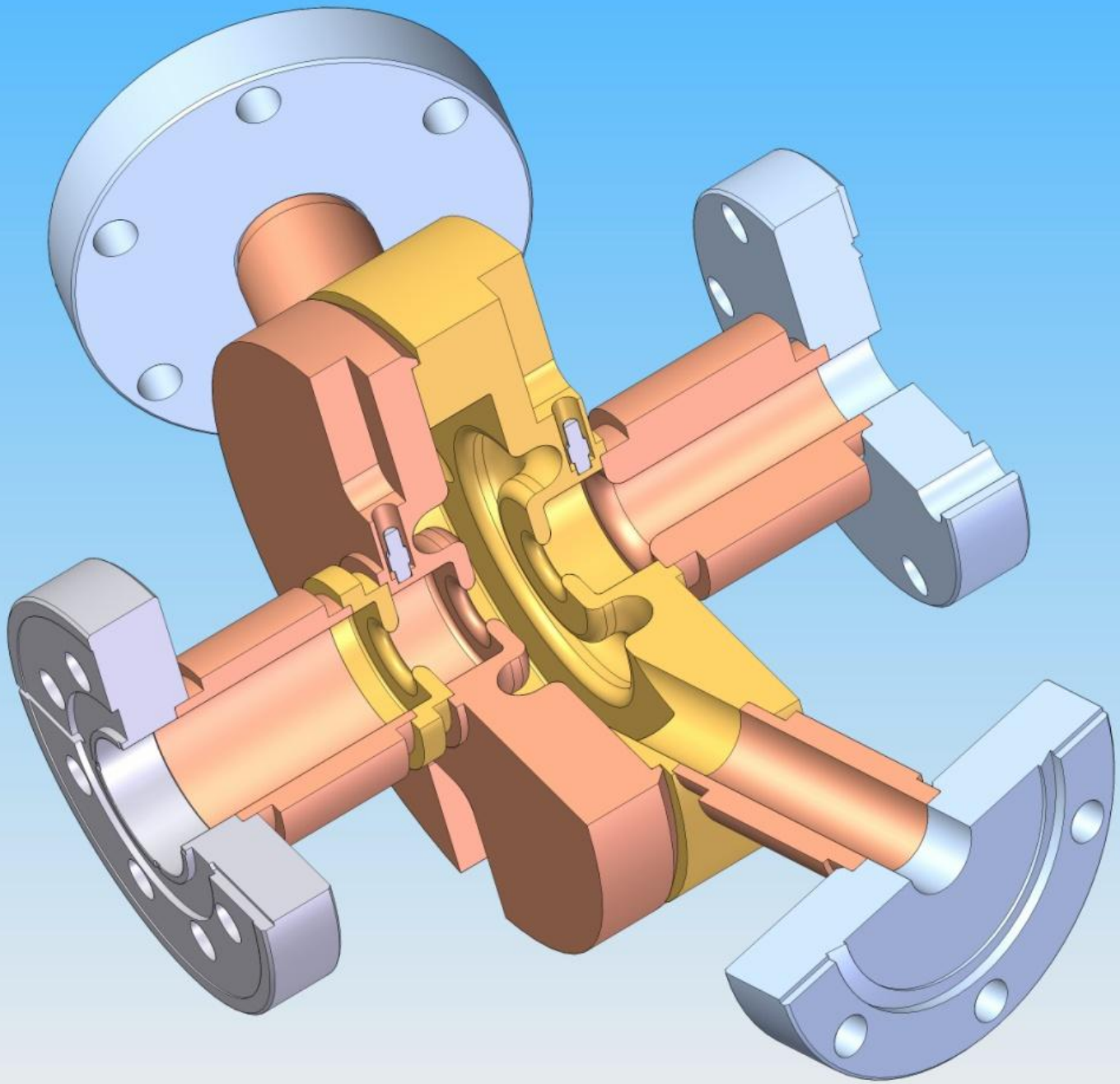
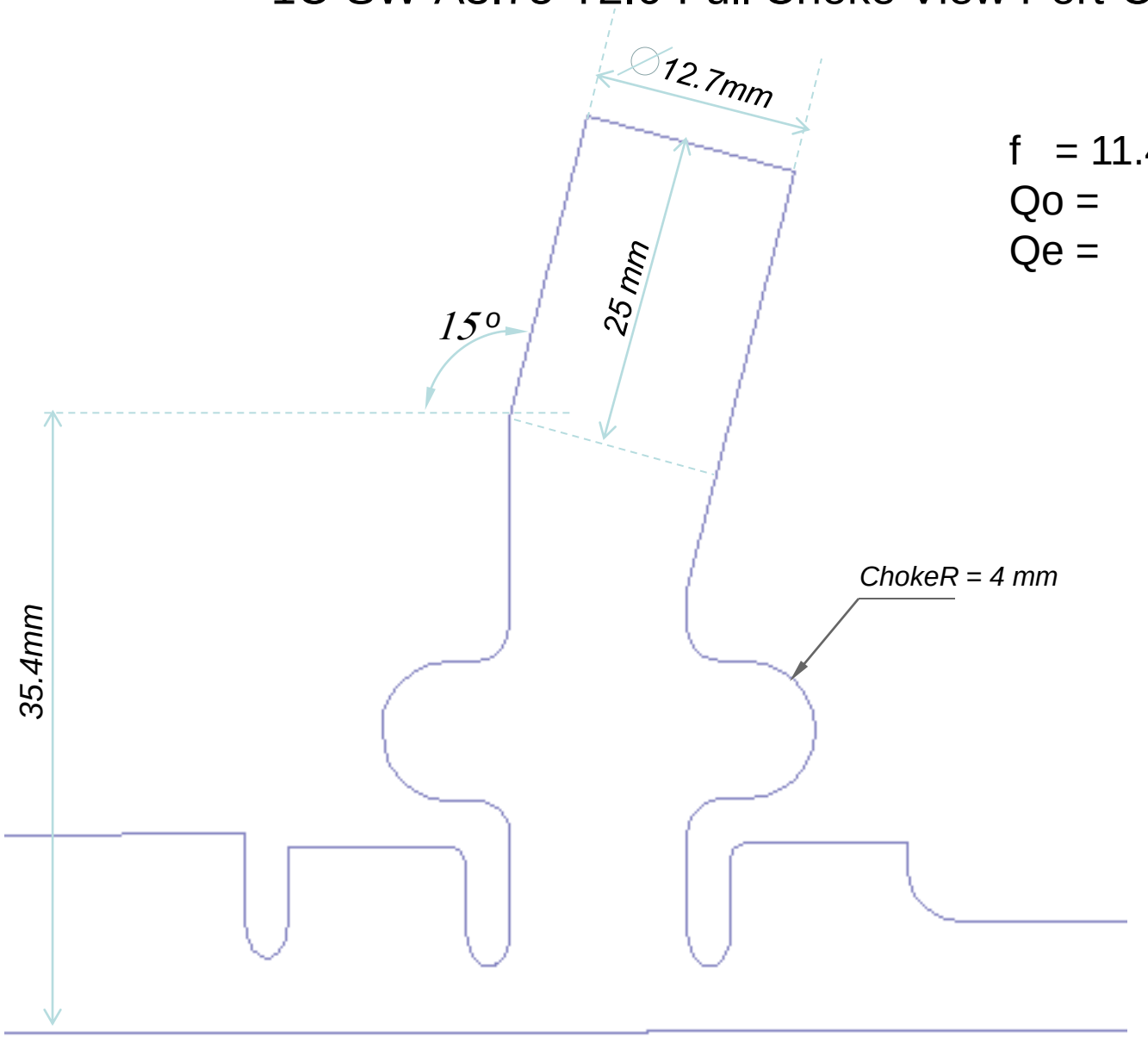
X Band Full Choke Structure 1C-SW-A3.75-T2.6 View Port-Cu



Solid model by David Martin

1C-SW-A3.75-T2.6-Full Choke View Port-Cu



f = 11.4216 GHz
Qo = 12416
Qe = 11938

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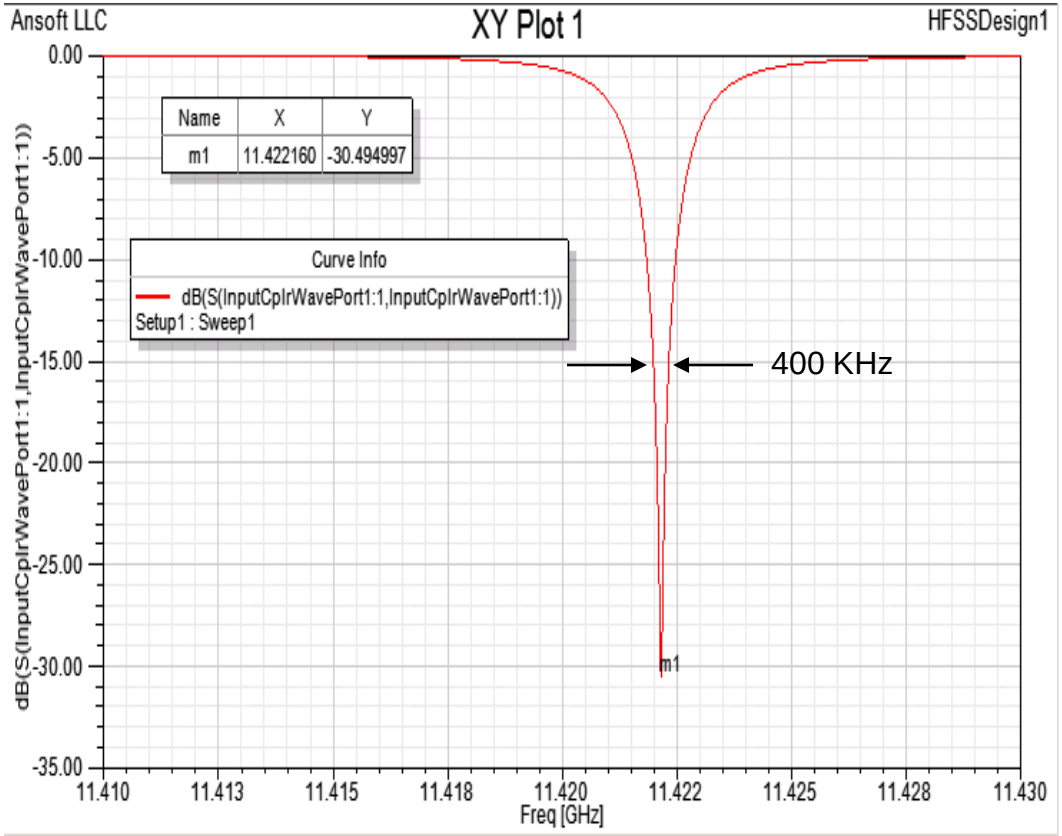
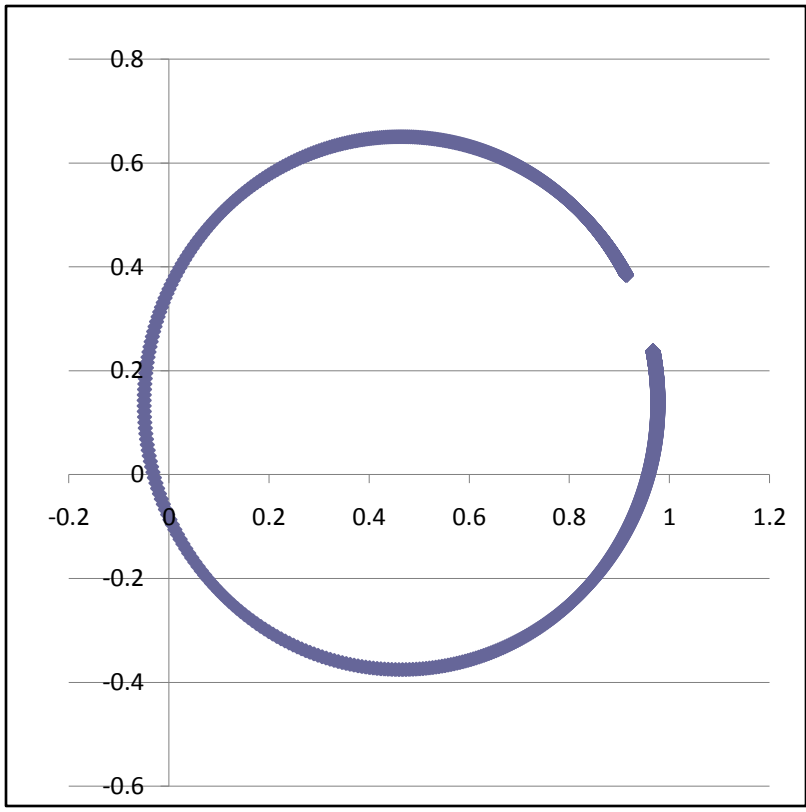
1C-SW-A3.75-T2.6-Choke View Port-Cu

F = 11.42216
Band width = 400KHz
S11= -30.5dB
Qo = 12416
Qe = 11938
Coupling = 1.07





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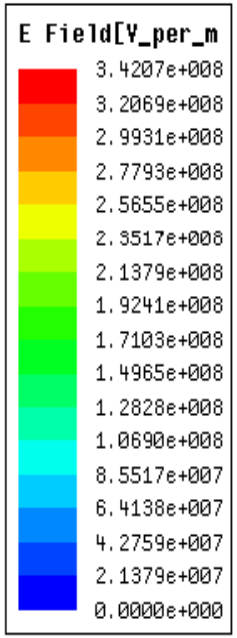
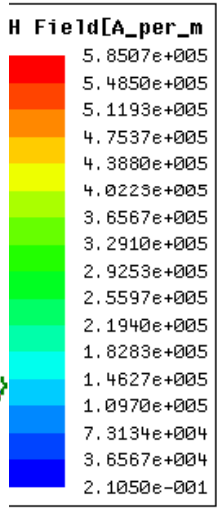
1C-SW-A3.75-T2.6-Full Choke View Port-Cu, Fields Normalized to 10MW RF Losses

Eigenmode	Frequency (GHz)
Mode 1	11.4228
Mode 2	12.4296



Electric Field



Magnetic Field

	f (GHz)	Emax(Iris) (MV/m)	Hmax(Iris) (kA/m)	Emax(ch) (KV/m)	Hmax(ch) (A/m)
At location		**Iris**	**Iris/cell**	**VPbase/@VP**	**VPbase/@VP**
	11.4228	350	200/580	50/28	300/200

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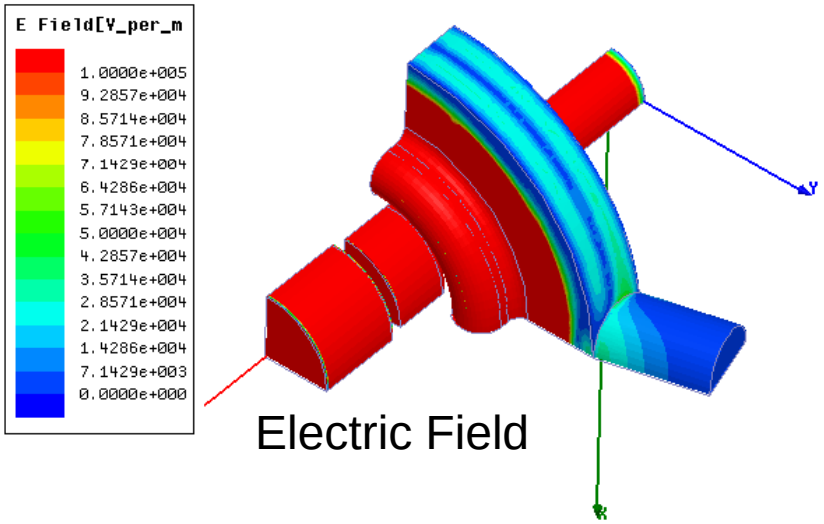
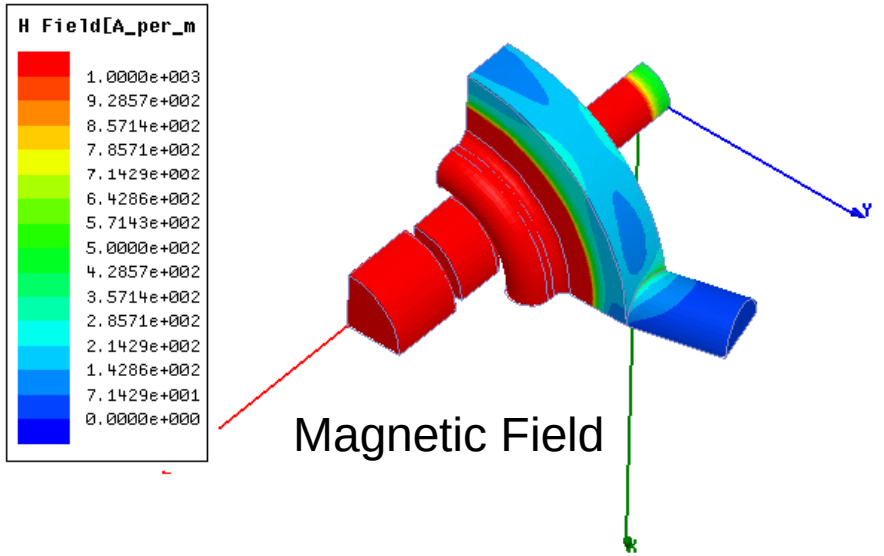
1C-SW-A3.75-T2.6-Full Choke View Port-Cu, Fields Normalized to 10MW RF Losses



Electric Field



Magnetic Field

	f (GHz)	Emax(Iris) (MV/m)	Hmax(Iris) (kA/m)	Emax(ch) (KV/m)	Hmax(ch) (A/m)
At location		**Iris**	**Iris/cell**	**VPbase/@VP**	**VPbase/@VP**
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Eigenmode	Frequency (GHz)
Mode 1	11.4228
Mode 2	12.4296

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X Band Choke Structures

Summary

- SLAC has built the choke flanges to test a Cesic structure.
- KEK and Frascati are building the triple choke structures.
- SLAC are building the full choke structure with a view port.