GTS 300 kV p-gun CST microwave studio simulations

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Summary

- Solidworks
 - Geometry modifications
- CST
 - Details of simulation
 - Electric field and potential plots
- Additional slides

Solidworks geometry modifications:



Solidworks geometry modifications:



Solidworks geometry modifications:





CST materials: PEC

 Steel for all metal components with Perfect electric conductor (PEC). Since this is a preset we don't need to define anything. Also, Thermal, Mechanical and Density properties are not included in the calculation.

roblem type:	Default		Density		~	
ieneral inem	nai Mec	nanics	Density			
-General prop Material nar	perties — ne:					
Steel						
Material fold	ler:					
		\sim				
Type:						
PEC		\sim			Coating	
Epsilon:				Mu:		



CST materials: Insulator

- For **black** alumina I used the same parameters as in COMSOL.
- ε=8.4
- σ=2E-12 [S/m]

Material Parameters: New insulator 2	X Material Parameters: New insulator 2	×
Problem type: Default ~	Problem type: Default V General Conductivity Dispersion Thermal Mechanics Density	
General properties Material name: New insulator 2	Electric conductivity Magnetic conductivity Image: Electric conductivity Image: Electric conductivity Image: Electric conductivity Image: Electriconductivity <t< th=""><th>n</th></t<>	n
Material folder: Type: Normal V Nonlinear Prop	O Tangent delta el.: O Tangent delta mag.: 0.0 0.0 at frequency: 0.0 GHz GHz	2
Epsilon: Mu: 8.4 1	Const. fit tan delta Const. fit tan delta User order: 1 User order: 1	
Color 0% Transparency 100%	Frequency range [GHz] Fmin: 0 Fmax: 1	





Materials Mew insulator 2 Rubber plugg corrected Steel Vacuum



CST materials: Insulator

- For rubber I used the same parameters as in COMSOL.
- ε=2.37
- σ=1E-14 [S/m]

Material Parameters: Rubber plugg corrected	Х	Material Parameters: Rubber plugg corrected X
Problem type: Default \checkmark		Problem type: Default \checkmark
General Conductivity Dispersion Themal Mechanics Density General properties Material name:		General Conductivity Dispersion Themal Mechanics Density Electric conductivity
0% Transparency 100%		Frequency range [GHz] Fmin: 0 Fmax: 1



CST materials: Insulator

- For vacuum cylinder and soroundings.
- ε=1.0
- σ=0 [S/m]

Material Parameters: Vacuum	X Material Parameters: Vacuum
Problem type: Default ~	Problem type: Default ~ General Conductivity Dispersion Thermal Mechanics Density
General Conductivity Dispersion Themal Mechanics Density General properties Material name: Vacuum Material folder: Type: Number of the second	Electric conductivity Magnetic conductivity Image: Black of the stress of th
Normal Normal Epsilon: Mu: 1.0 1.0 Color O% Transparency 100%	Specification: Specification: Const. fit tan delta Const. fit tan delta User order: 1 Frequency range [Hz] Fmax: Fmin: 0



CST mesh:

- The mesh was separated into (maybe too many) pieces. :P
- The important part is, I only set some individual parts that require fine detail and left the rest to be auto-meshed.





CST mesh: Pierce geometry

 The front Pierce geometry has a maximum step width of 0.01m.

Local Mesh Properties - Tetrahedral	×				
Name:	OK				
Assem6_Pierce geometry front:Pierce geometr	Cancel				
Consider for simulation	Cancer				
Consider for bounding box	Apply				
Mesh group:	Update				
meshgroup 10 V	Help				
Maximum mesh step width settings					
Max. step width: 0.01					

Components Components Assem6_cathode Cathode triple geometry back Cathode triple point Cathode triple point Cylinder Cylinder Cylinder Cylinder Cylinder New chamber with anode_anode and beamline New chamber with anode_chamber New chamber with anode_NEGs New insulator 2 Cylinder Cylinder



CST mesh: Cathode triple-point

• The cathode triple-point has a maximum step width of 0.001 [m].

Name:	
	ОК
Cathode triple point:Cathode triple point	
	Cancel
	Apply
Consider for bounding box	Арріу
Mesh group:	Update
meshgroup11 v	Help
Maximum mesh step width settings	
Max. step width: 0.001	





CST mesh: Upper Kovar ring

 The Kovar ring that holds the insulator to the upper flange has a maximum step width of 0.001 [m].

Local Mesh Properties - Tetrahedral	×
Name:	OK
Kovar ring:Kovar ring	Cancel
Consider for simulation	Cancel
Consider for bounding box	Apply
Mesh group:	Update
meshgroup13 ~	Help
Maximum mesh step width settings	
Max. step width: 0.001	









CST simulation: Background

• The background is defined as vacuum.

ackgrou	nd Material	Parameters			
Problem t	type: Defa	ult		\sim	
General	Conductivity	Dispersion	Thermal	Mechanics	Density
-Gener Mater	ral properties rial name:				
[Bac	kground]				
Mater	rial folder:				
		\sim			
Туре	:				
Nom	nal	\sim		Nonlinear Pro	p
Epsilo	on:		Mu:		
1.0			1.0)	

Background Material Parameters

Fmin: 0

 \times

1/Sm

Hz

Fmax: 1e+09



ackground Properties		
Material properties Material type:		OK
Normal	Properties	Close
Multiple layers		Apply
Surrounding space		Help
Apply in all directions		
Distance:	Upper X distance;	
0.0001		
Lower Y distance;	Upper Y distance;	

CST simulation: Boundaries

• The boundaries are set to ground except the top and the back of the beam line

Boundary Conditions	
Boundaries Symmetry Planes Boundary Potentials	
Xmin: electric (Et = 0) V Xmax: electric (Et = 0)	
Ymin: electric (Et = 0) Vmax: open	
Zmin: electric (Et = 0) V Zmax: open	
Open Boundary	
OK Cancel H	felp

CST simulation: Potential



- I defined the potential in three parts:
 - Chamber, upper flange, Kovar ring, anode and beam-pipe at 0
 [V]

Edit Potential		×
Name:		ОК
Potential value:		Cancel
0	V	Help
Phase:		
0	deg	
Type Fixed Floating		



CST simulation: Potential



- I defined the potential in three parts:
 - Also the NEG's at 0 [V]

Edit Potential	×
Name: potential3	OK
Potential value:	Help
Phase:	
Type Fixed O Floating	



CST simulation: Potential



- I defined the potential in three parts:
 - Cathode electrode (including Pierce geometry), shield and high voltage cable at -300 [kV]

Edit Potential		×
Name: potential2		ОК
Potential value:		Cancel
-300000	v	Help
Phase:		
0	deg	
Type Fixed Floating		



CST simulation: Solver

- Used the Low frequency as suggested by Fay.
- Did not use the adaptative mesh refinement this time.



CST results: Potential



CST results: Electric field norm



CST results: Electric field norm

Cathode- anode gap close up.



CST results:

 The results for electric field magnitude and potential plotted as false color. Also produced 2D and 3D field maps for the cathode-anode gap.

)) Export 3D Field Result	×	
Field Result		
E-Field [1]	Browse Results	
	Set Frq / Time Browse All	
	frq = 0	
Export Settings		
③ 3D Export in Volume	🗹 Use Subvolume	
◯ 3D Export on Surfaces	Xmin: Xmax:	
O Export Field on Pointlist		
◯ Export Field on 2D Plane		
Normal:	Zmin: Zmay:	
Position: 0	0.063	
Stepsize: 0.001		
File location of pointlist		
relative to Master-Projectpath	BrowseFile	
File Options		
ASCII	Use Prefix	
O Binary (.bix)	Use Postfix	
OK Cancel	Specials Help	

Photocathode-anode line:

The data for the following plots was taken along a horizontal line from the center of the photocathode to the back of the chamber passing through the anode center as shown in the red line



Photocathode-anode line :

• This image shows the electric field Ey component in MV/m as a function of position on the z axis.



Photocathode-anode line :

• This image shows the electric field Ez component in MV/m as a function of position on the z axis.



Future steps

- Recalculate for the **white insulator** case and obtain field maps.
- Use to investigate the upper flange triple-point.
- Get fields on the insulator surface for insulator studies.

Fin.

CST frame of reference:

y x z

X goes into the page.

