

INDIAN INSTITUTE OF INFORMATION TECHNOLOGY KOTA



**TRANSMISSION LINES AND ANTENNA**

**ASSIGNMENT 7**

**ECP307**

**NEHA SINGH**

**2019KUEC2012**

**DR. CHETNA SHARMA**

**ASSISTANT PROFESSOR**



**Aim:-**Design and compare the operation of the Tee junctions.

**Software:-**CST Studio

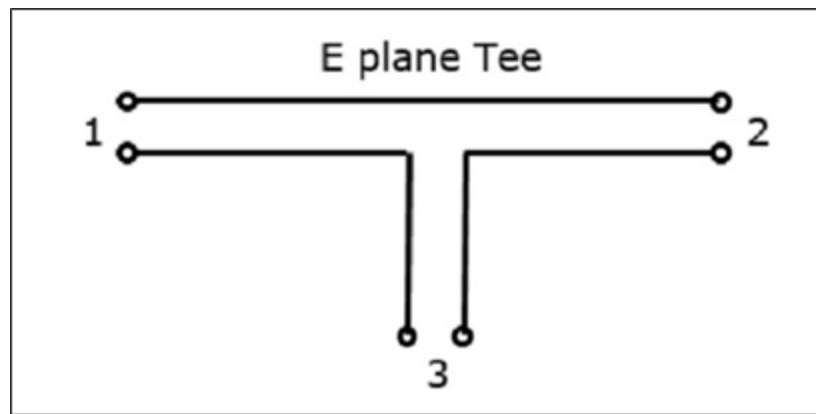
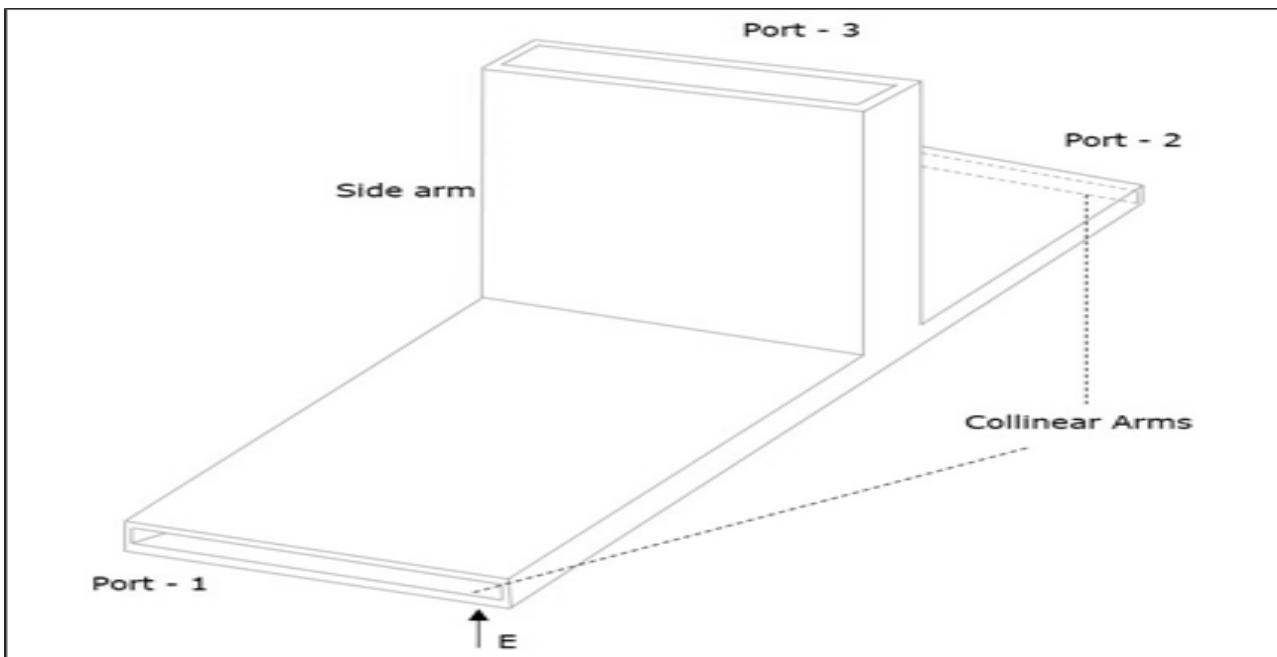
**Theory:-**Tee Junctions:

### 1. E plane Tee

An E-Plane Tee junction is formed by attaching a simple waveguide to the broader dimension of a rectangular waveguide, which already has two ports. The ports 1 and 2 are  $180^\circ$  out of phase with each other.

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As the axis of the side arm is parallel to the electric field, this junction is called the E-Plane Tee junction. This is also called Voltage or Series junction. The ports 1 and 2 are  $180^\circ$  out of phase with each other. The cross-sectional details of the E-plane tee can be understood by the following figure.



## 2. H plane Tee

An H-Plane Tee junction is formed by attaching a simple waveguide to a rectangular waveguide which already has two ports.

## 3. Magic Tee



An E-H Plane Tee junction is formed by attaching two simple waveguides one parallel and the other series, to a rectangular waveguide which already has two ports. This is also called Magic Tee, or Hybrid or 3dB coupler.

### **Design Parameters:**

Waveguide :-WR-90

Material Inside waveguide:- Air

a=22.86mm b=10.16mm dominant mode

Cutoff frequency coming  
dominant mode-6.557GHz

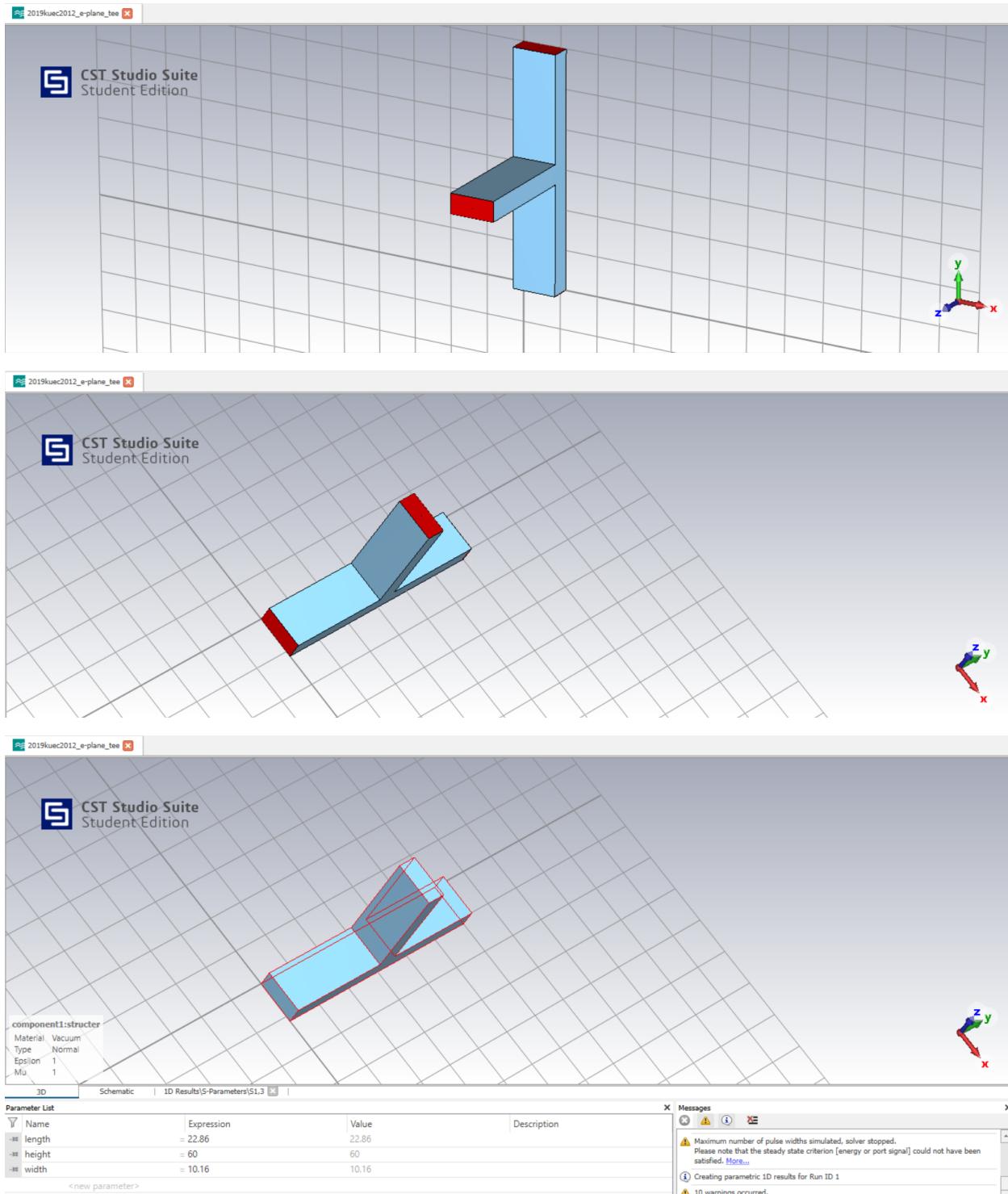
## **WR90 | WG16 | R100 - Rectangular Waveguide Size**

### **Waveguide Size**

EIA Standard:	WR90
RSCS Standard (British Military):	WG16
IEC Standard:	R100

### **WR90 Specifications**

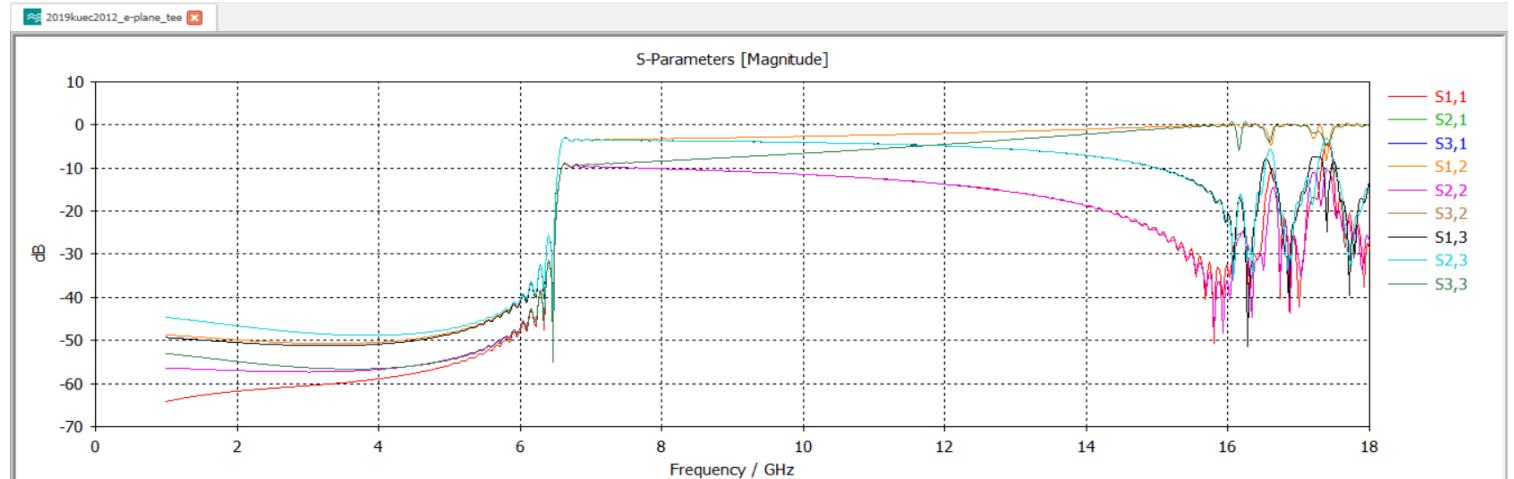
Recommended Frequency Band:	8.20 to 12.40 GHz
Cutoff Frequency of Lowest Order Mode:	6.557 GHz
Cutoff Frequency of Upper Mode:	13.114 GHz
Dimension:	0.9 Inches [22.86 mm] x 0.4 Inches [10.16 mm]



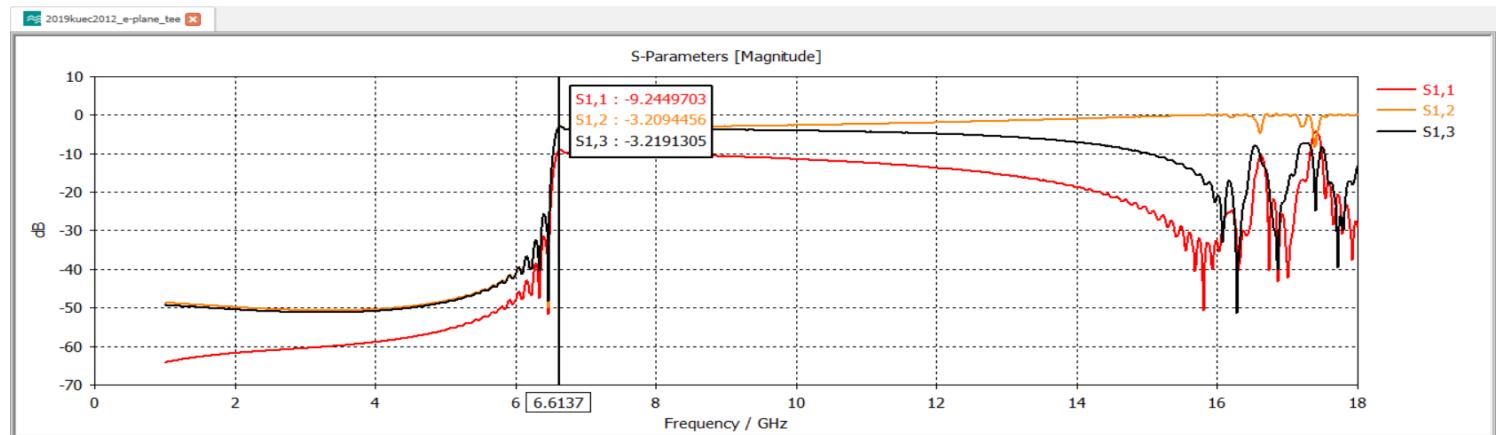


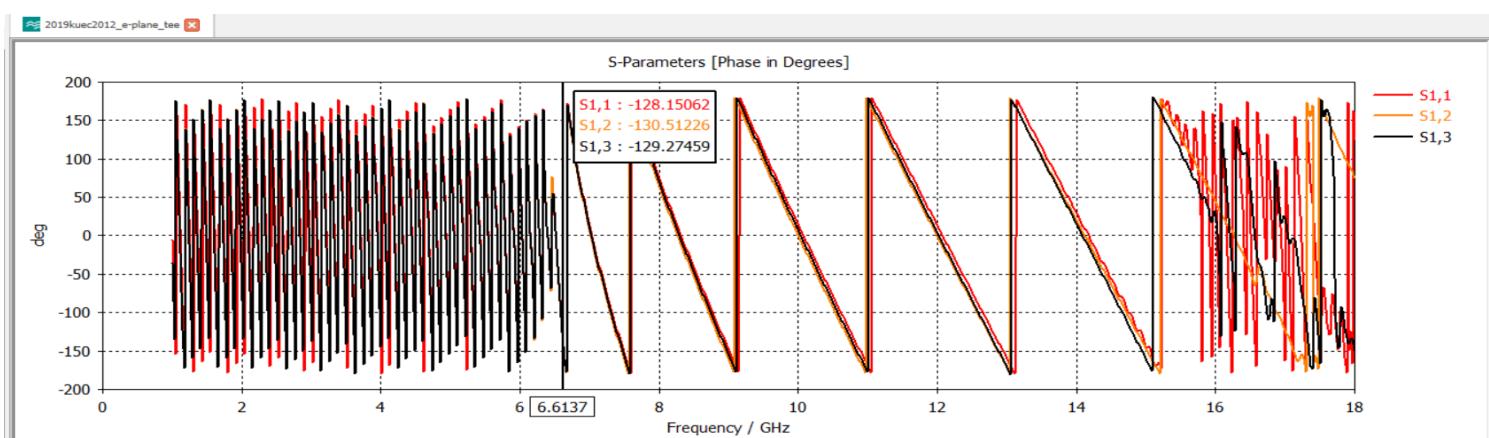
## Result/Observation for E Plane Tee

S Parameter at port 1:-



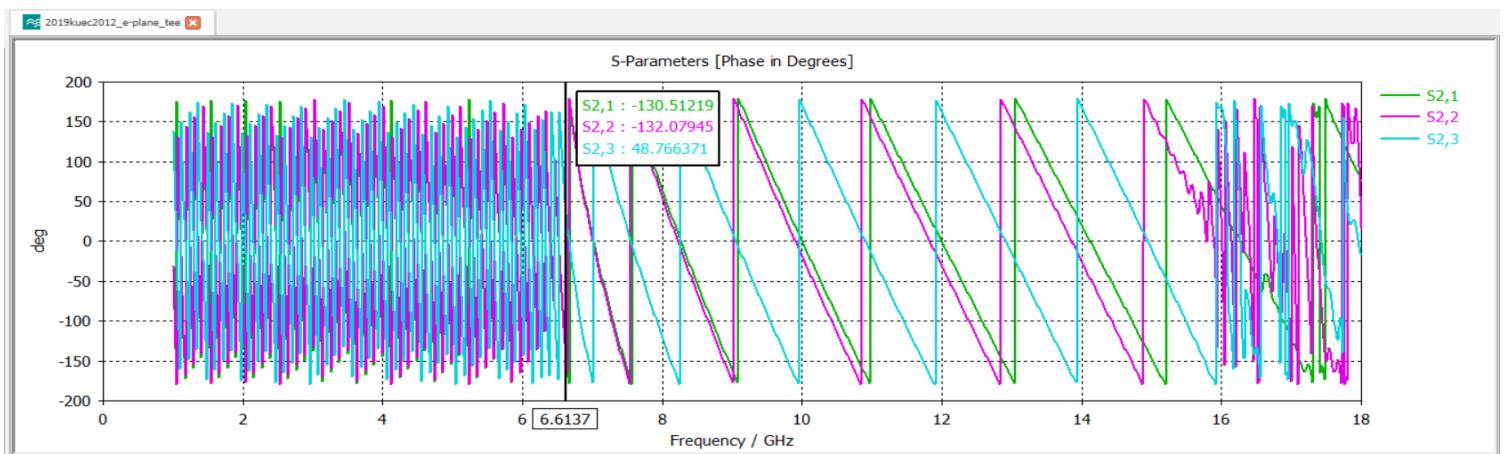
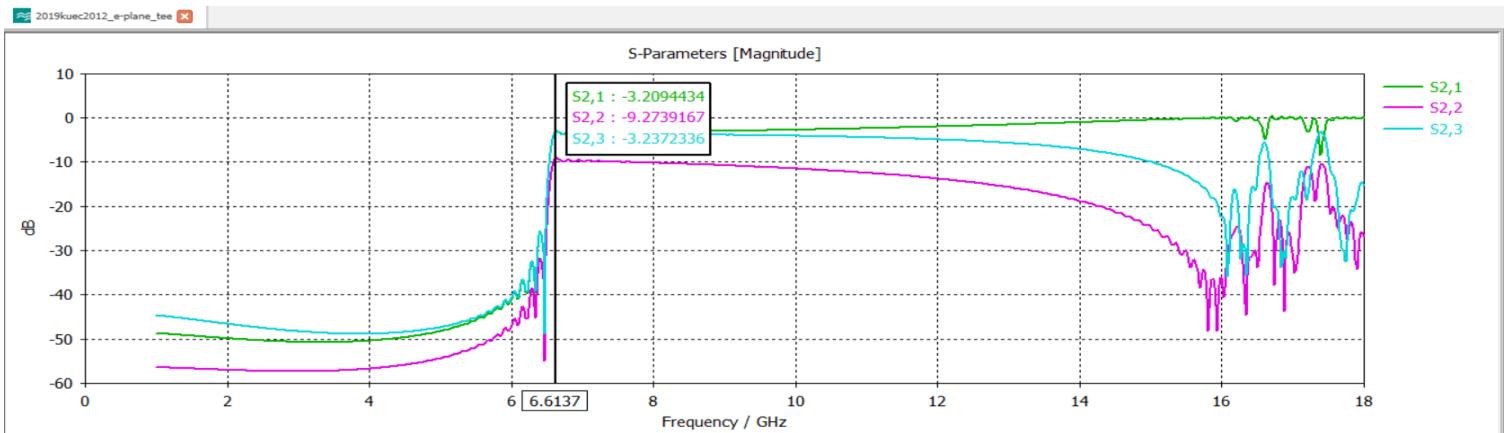
The above plot is too complex





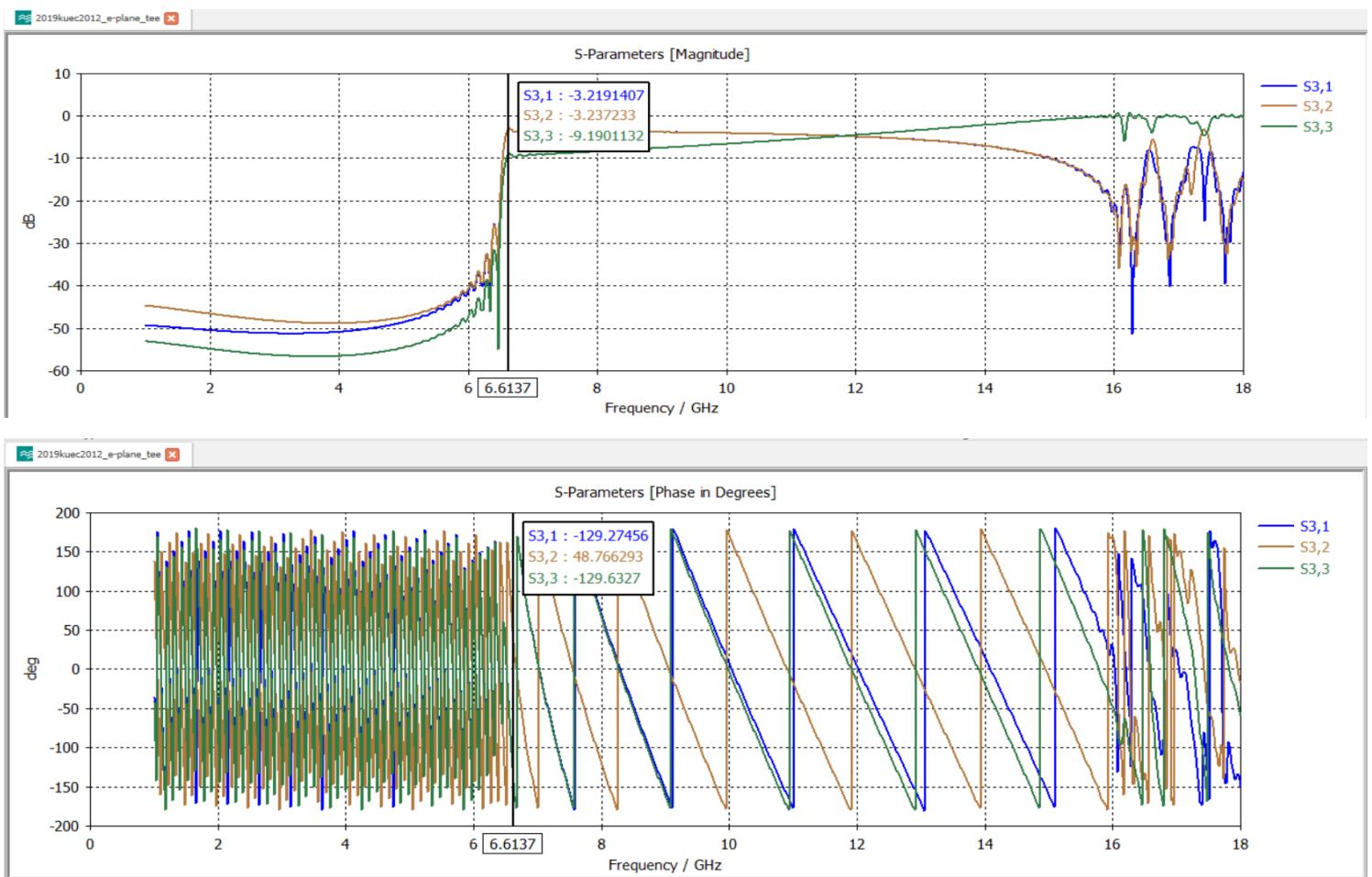
Here we can clearly observe that when power is applied at port 1, equal power is distributed among port 2&3.

## S Parameter at port 2:-



Here we can observe that when we applied energy at port 2, there is unequal flow of energy at port 1&3 as well as they are in approximately the same phase.among port 1&3 and there is phase difference of 180 degree approx.

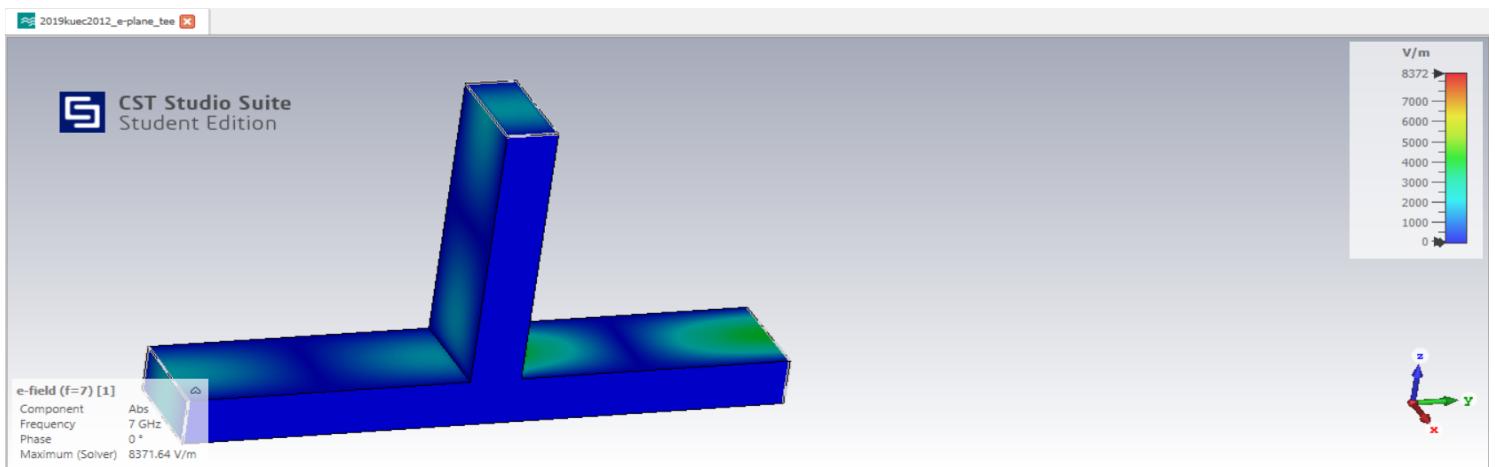
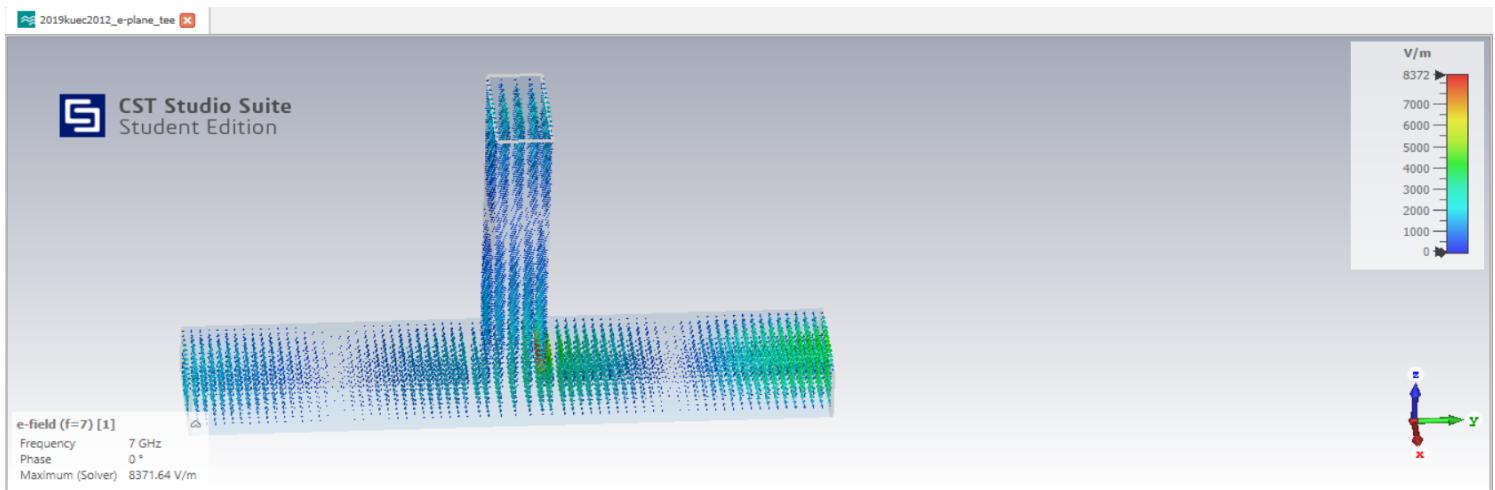
### S Parameter at port 3:-



Here we can clearly observe that when power is applied at port 3, equal power is distributed among port 2&3 and

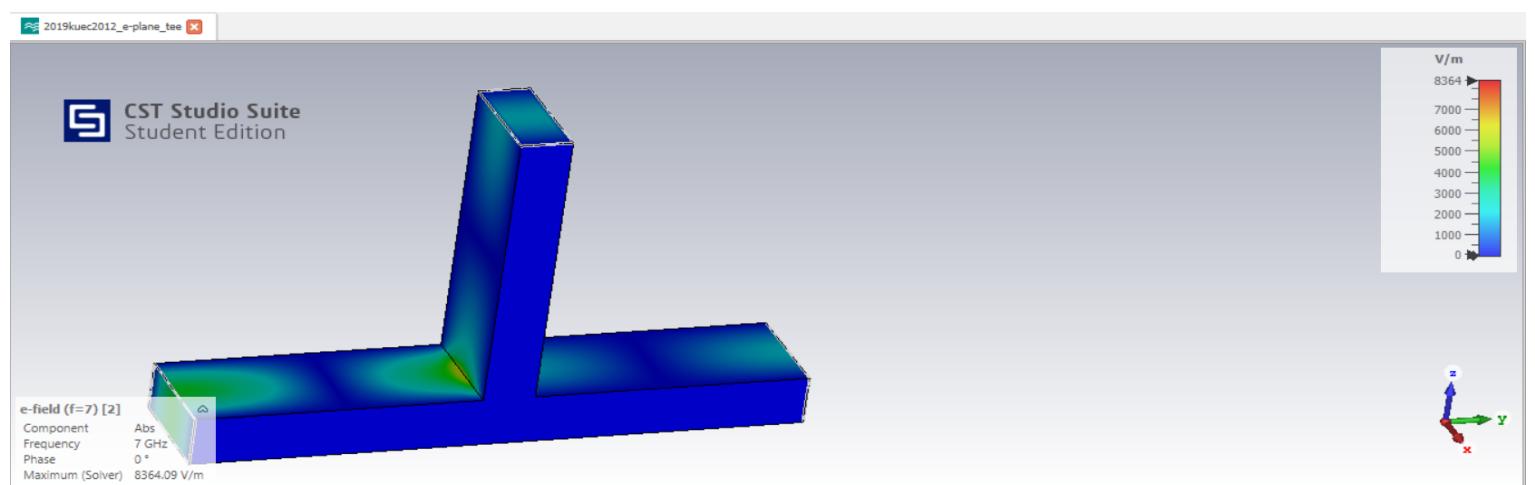
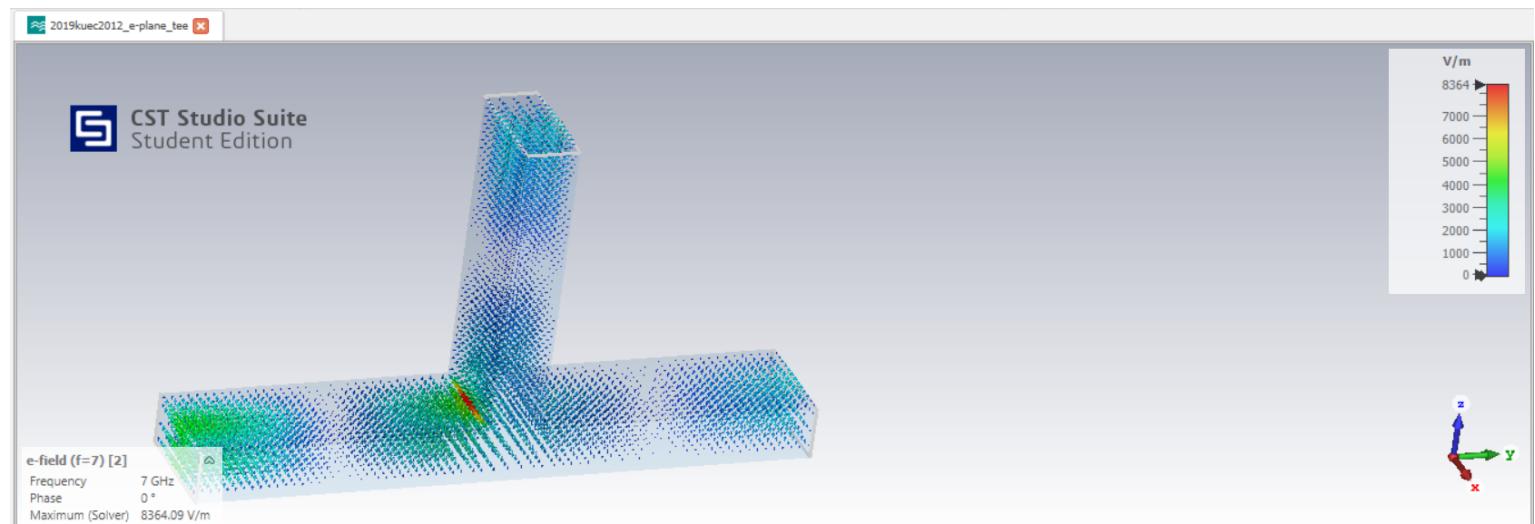
there is a phase difference of 180 degree approx. This is the only case which creates a difference between all other tee's which we'll see in later parts of our report.

## E FIELD of E Tee( when power is applied at port 1)



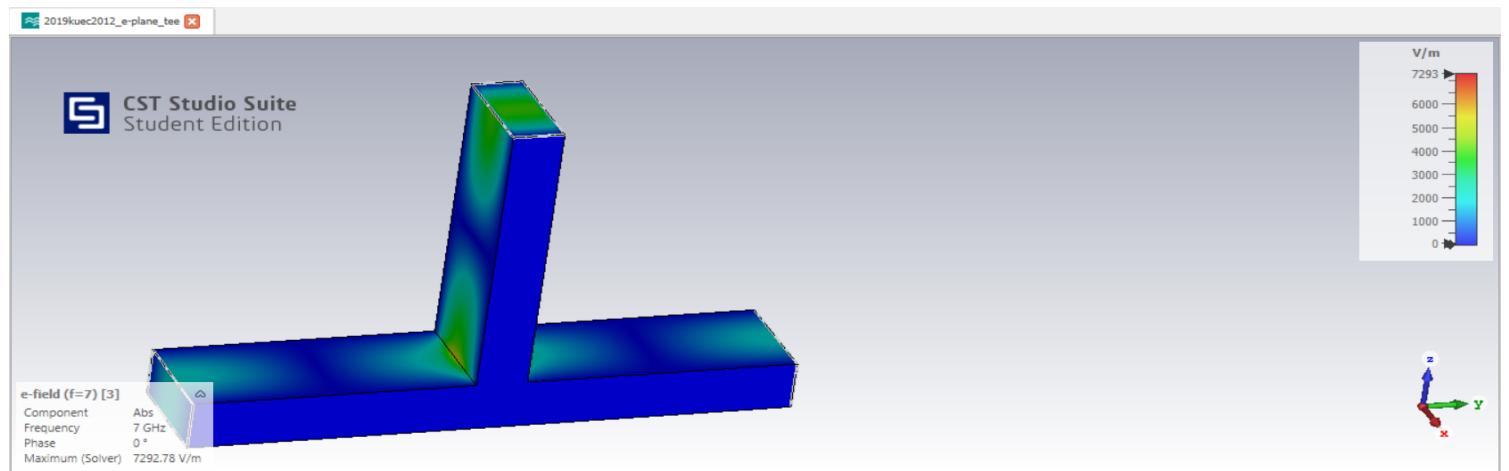
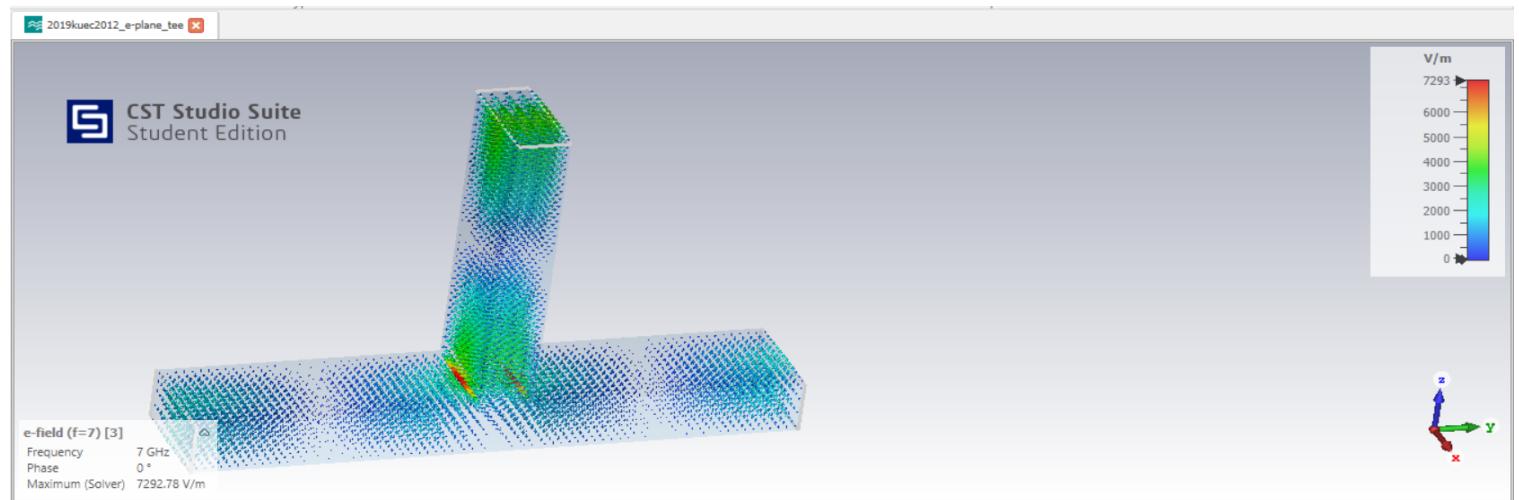
From here we can see when we applied the E-field at port1 , equally field distributed at port2 and port3.

## E FIELD of E Tee( when power is applied at port 2



From here we can see that when we applied E-Field at port two electric field is distributed from port 1&3 respectively.

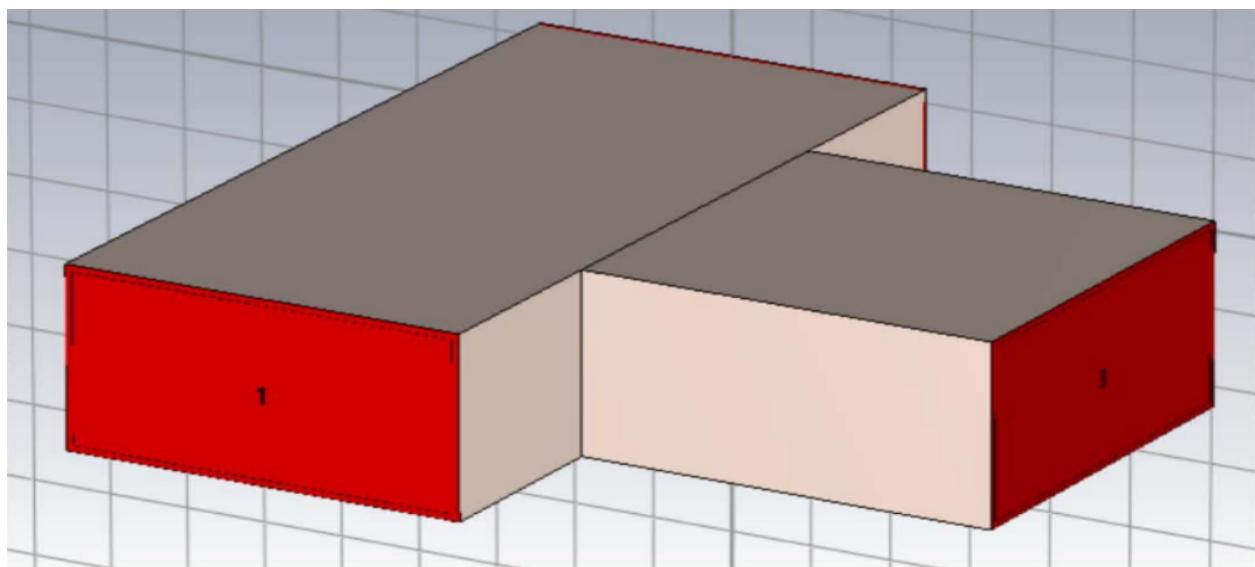
## E FIELD of E Tee( when power is applied at port 3)



From here we can see that when we applied E-Field at port three equal electric field is distributed from port 1&2 with the phase difference of 180 degree respectively.

Now we'll compare our result with the results of our group mates (Kapil & Nipur) & try to find out what is the difference in all three Tee planes.

### H plane Tee



### Design Parameters:

Waveguide :- Rogers RT Duroid 5880

Material Inside waveguide:- Air

a=22.86mm b=10.16mm dominant mode

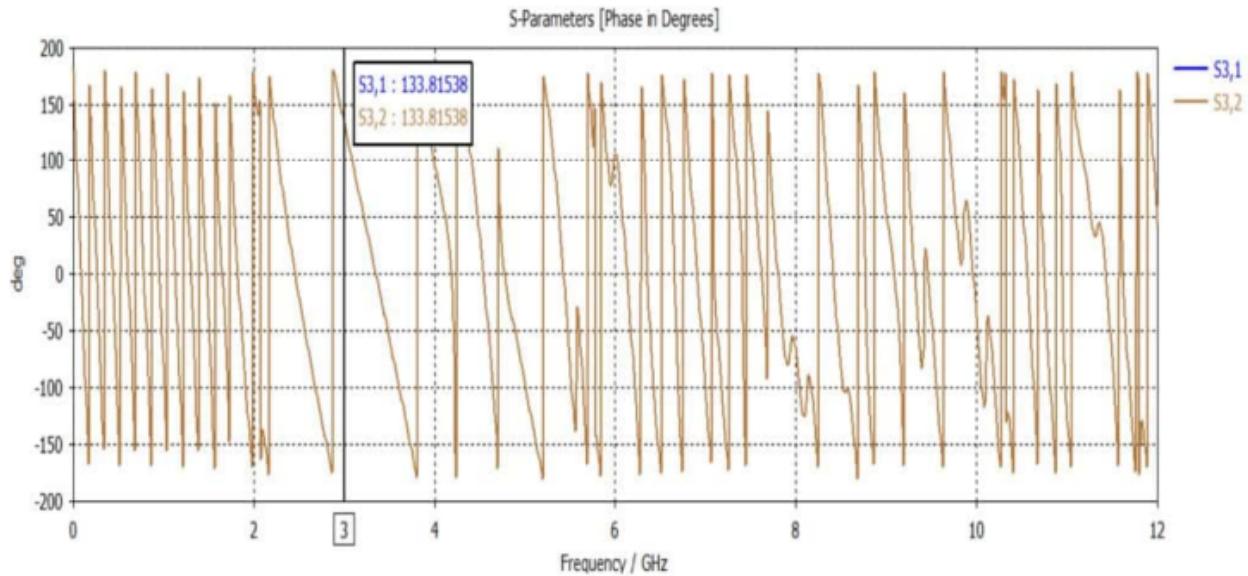
Cutoff frequency coming

dominant mode-6.557GHz

Epsilon:-2.2

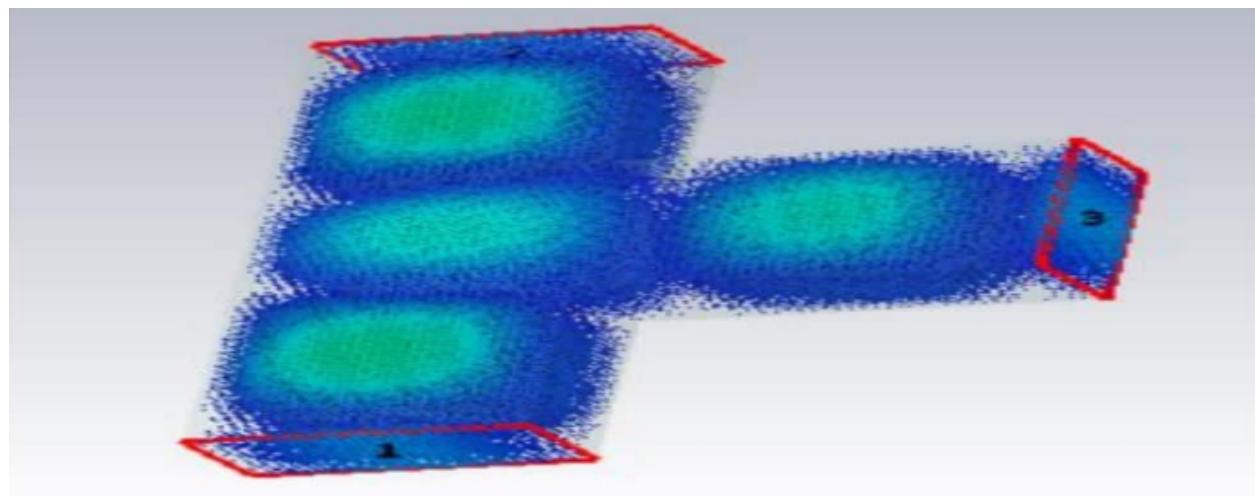


## Phase of S Parameter



Here we can notice when input is applied at the Third port, then power is distributed among the ports equally and the field is in same phase  $S_{31}=S_{32}$ .

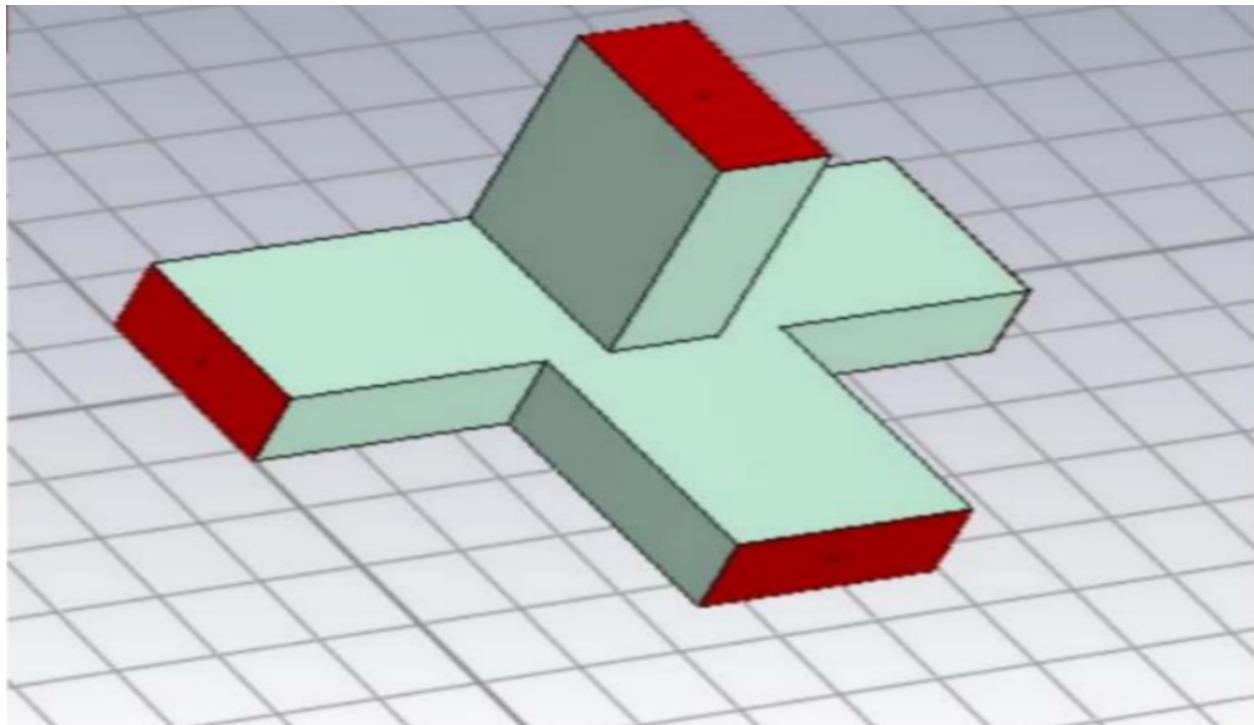
## E field for H plane (applied at port 1)





If a signal is fed at port 3 , then the power is divided between port 1 and 2 and in the same phase.

### **Magic Plane Tee:-**



### **Design Parameters:**

Waveguide :- FR-4

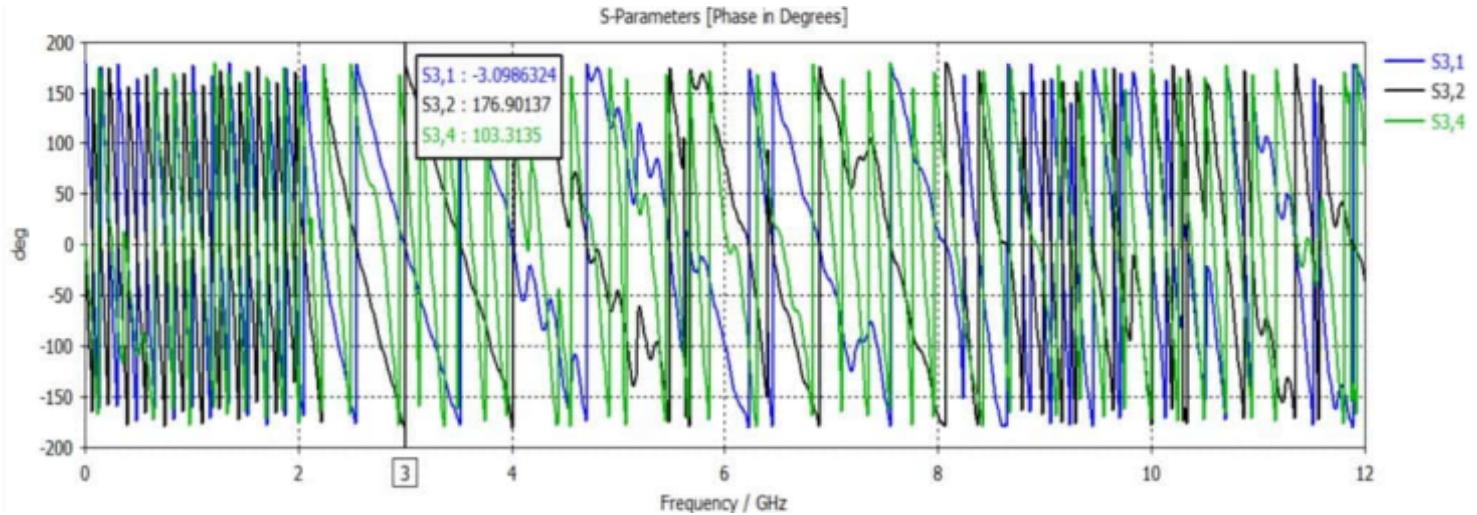
Material Inside waveguide:- Air

a=22.86mm b=10.16mm dominant mode

Cutoff frequency coming  
dominant mode-6.557GHz

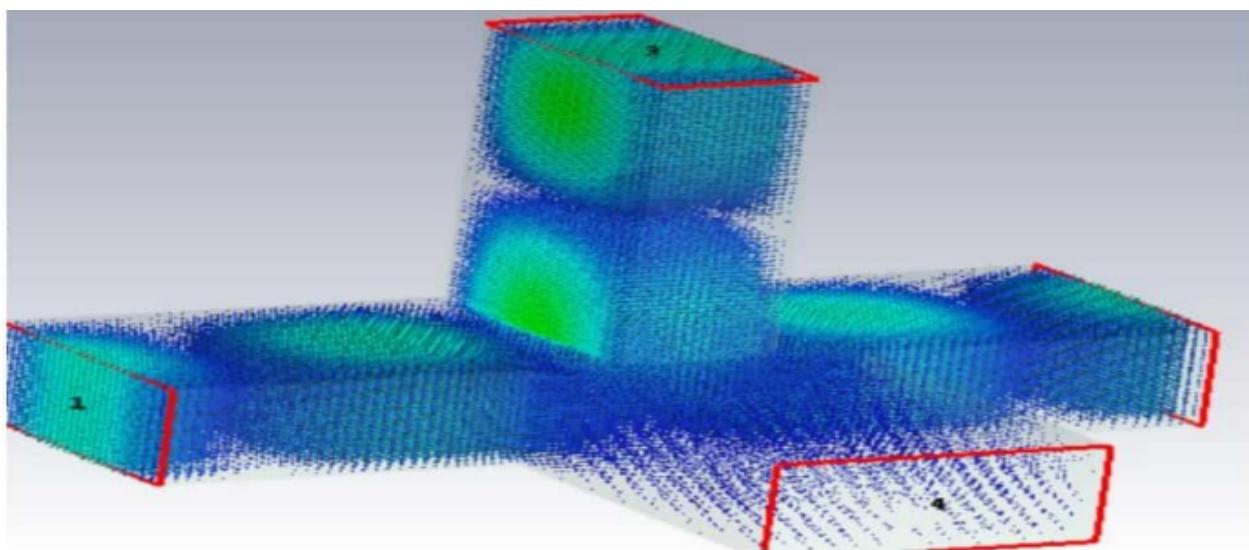
Epsilon:-2.2

## S parameter for magic plane tee



When we applied input at 3 port then we get the same output at port 1 & 2 but no output at port 4 is 0 and also output at port 1 & 2 have 180 degree phase shift.

## E field at port 3



When we apply the signal at port 3, then the power is divided between port 1 & 2 equally there would be no output at port 4 hence it behave like a E plane Tee

## Results

- The E-Plane tee :- we saw when we pass power at the third port equal power is distributed between port 1&2 and the phase difference is 180 degree approx.
- H-Plane tee :-we saw when we pass power at the third port equal power is distributed between port 1&2 but phase difference between them is 0.
- For the Magic-Plane tee we saw when we passed power at the third port the power was divided between port 1&2 equally and there would be no output at port 4, so it started behaving like an E-Plane tee. And, when we pass power at the fourth port the power is divided between port 1&2 equally but in opposite phase while there would be no output at port 3,so it started behaving like a H-Plane tee.
- Also, we have attached the E-field in all three Tee planes above. So, we can conclude that our theoretical and practical outputs on Cst studio are the same.