

# Device Model User Guide

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# Contents

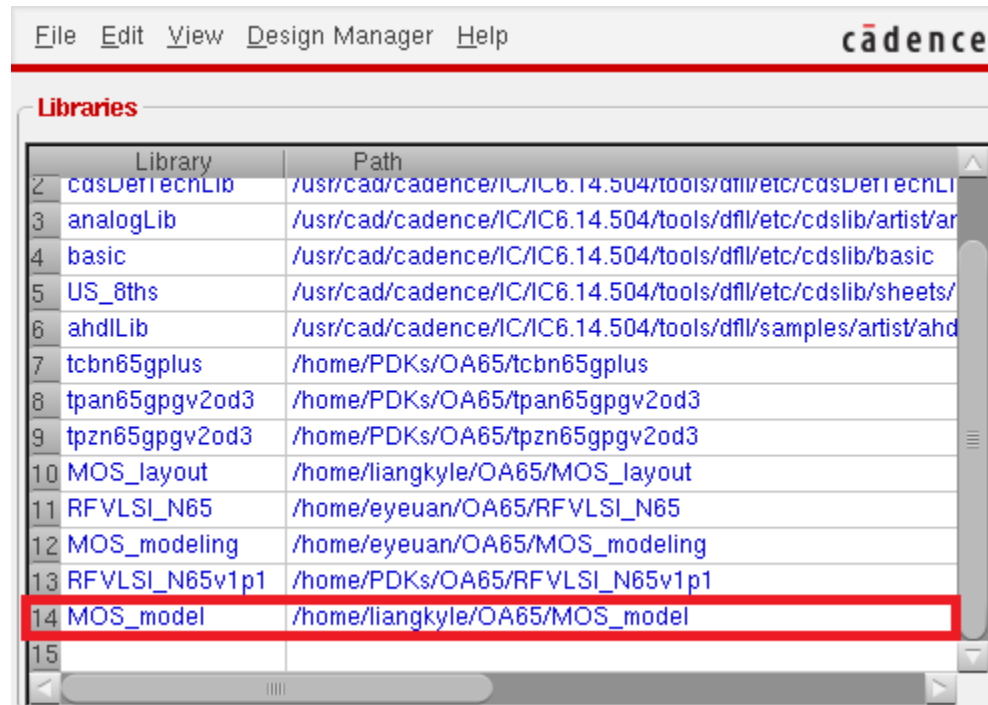
- [Device Types](#)
- Model Setup
  - [Pre-simulation](#)
  - [Post-simulation](#)
- Model Comparison Results
  - [THz\\_NMOS\\_CS](#)
  - [MOS\\_BGDSGB\\_CG](#)
  - [MOS\\_SGDGS\\_CS](#)
  - [MOS\\_BSGGDB\\_Gilbert](#)
  - [PowerM\\_CSAr](#)
  - [PowerM\\_CCAr\\_longL](#)

# Device Types

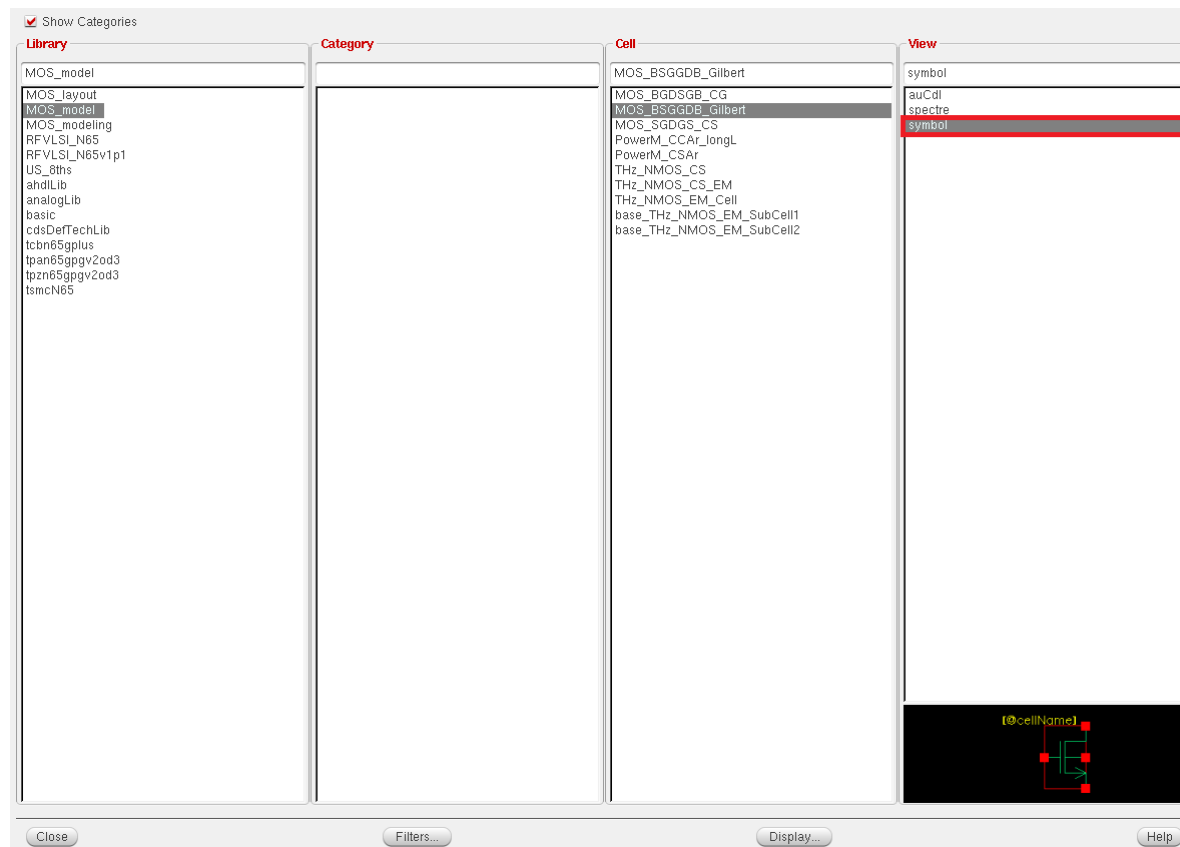
- THz MOS
  - THz\_NMOS\_CS
- Analog MOS
  - MOS\_BGDSGB\_CG
  - MOS\_SGDGS\_CS
  - MOS\_BSGGDB\_Gilbert
- Power MOS
  - PowerM\_CSAr
  - PowerM\_CCAr\_longL

# Pre-simulation

- Add library path:  
**/home/liangkyle/OA65/MOS\_model**



- Use custom symbol for simulation



- Parameter PEX\_Parasitics are used to estimate the effect of increasing or decreasing parasitics in pre-simulation (default is 1), they will all be neglected in post-simulation
- Example: 20% increase in Cgs,  $PEX\_CGS = 1.2$

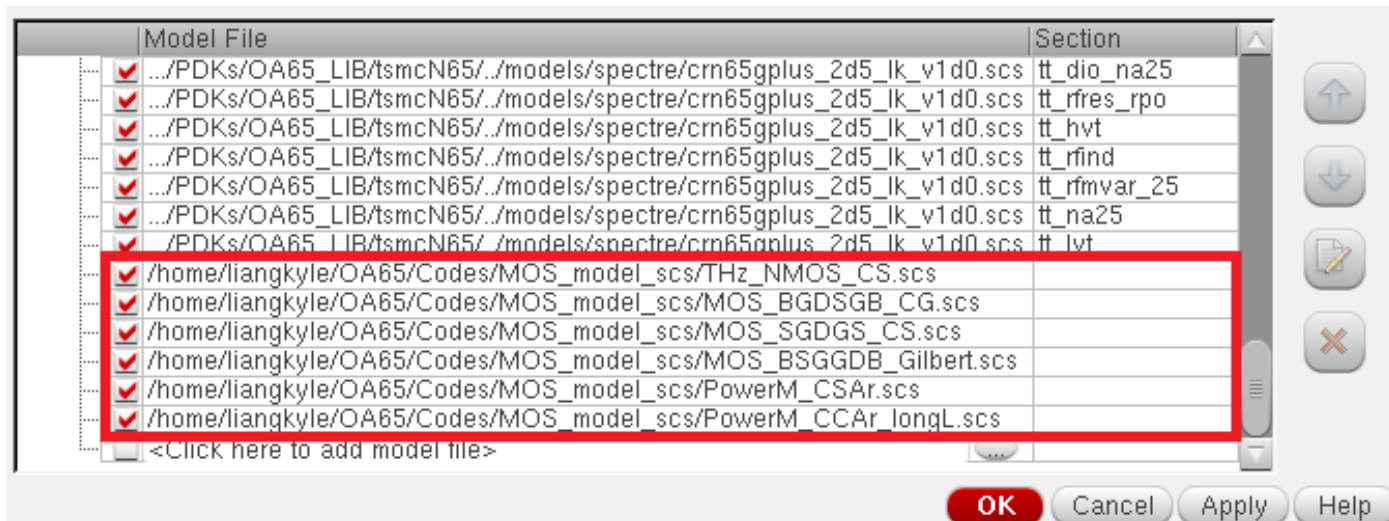
The screenshot shows a software configuration window with the following sections:

- Apply To:** ☒ only current ☒ instance
- Show:** ☐ system ☒ user ☒ CDF
- Buttons:** Browse, Reset Instance Labels Display
- Property Section:**

Property	Value	Display
Library Name	msc_model	off
Cell Name	MOS_BSGDB_Gilbert	value
View Name	symbol	off
Instance Name	134	off
- Buttons:** Add, Delete, Modify
- CDF Parameter Section:**

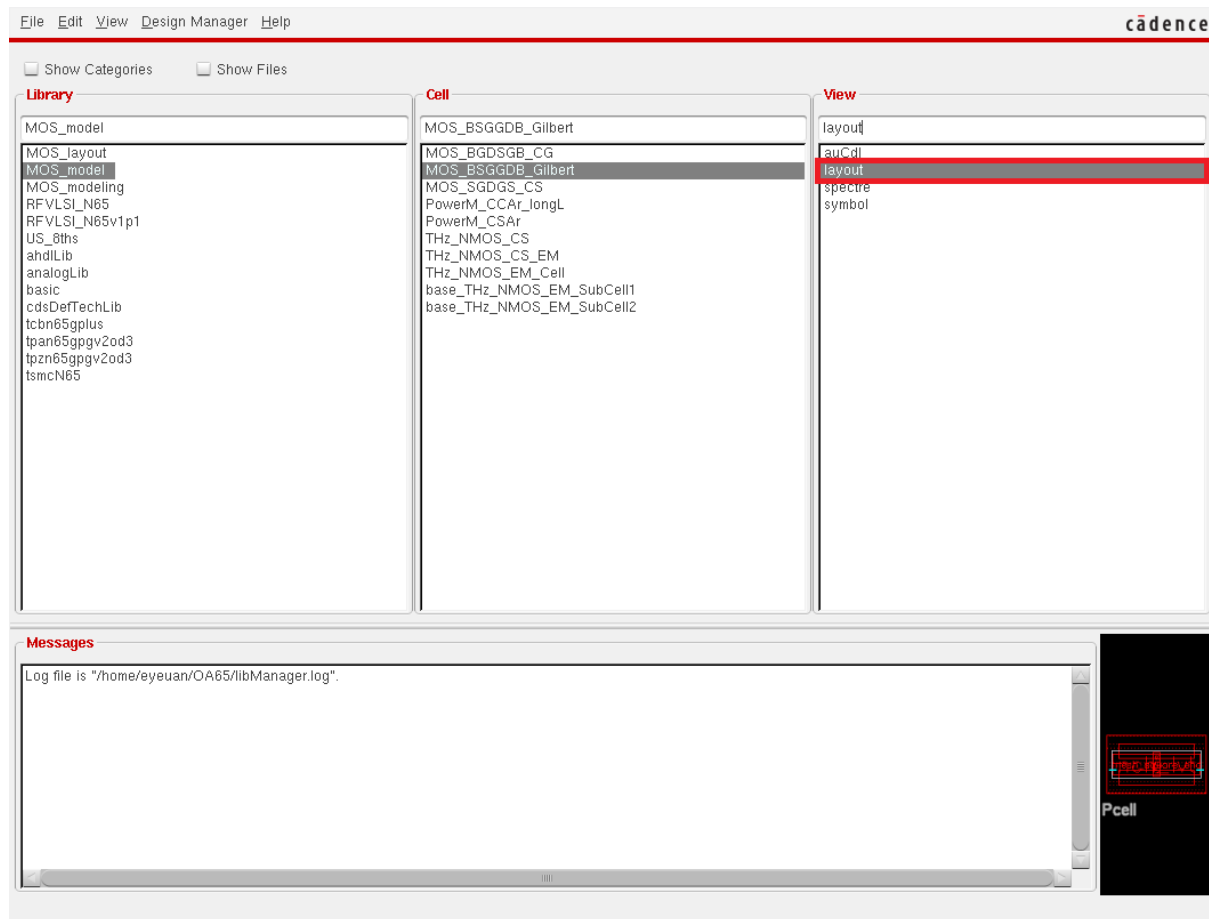
CDF Parameter	Value	Display
transistorCode	3	off
transistor	nch_lvt	off
MOS_L	60n M	off
MOS_w	1.0u M	off
MOS_f	20	off
PEX_RG	1	off
PEX_RS	1	off
PEX_RD	1	off
PEX_CGS	1	off
PEX_CGD	1	off
PEX_CDS	1	off
- Bottom Buttons:** OK, Cancel, Apply, Defaults, Previous, Next, Help

- Add model file in ADE model libraries:  
**/home/liangkyle/OA65/Codes/MOS\_model\_scs/DeviceName.scs**



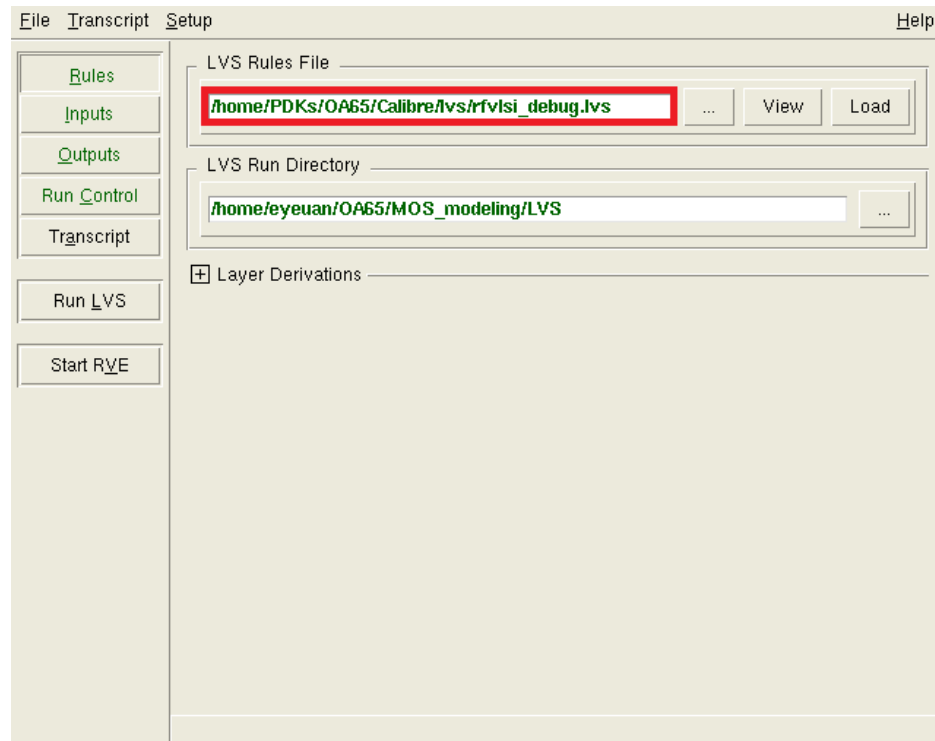
# Post-simulation

- Use custom layout



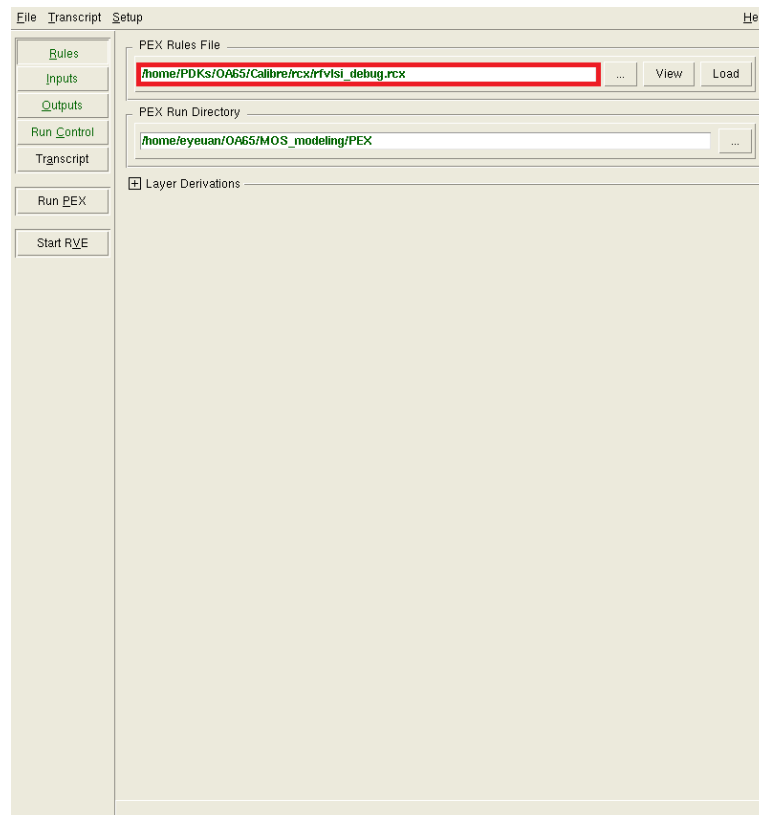


- Use LVS rule file:  
**`/home/PDKs/OA65/Calibre/lvs/rfvlsi_debug.lvs`**

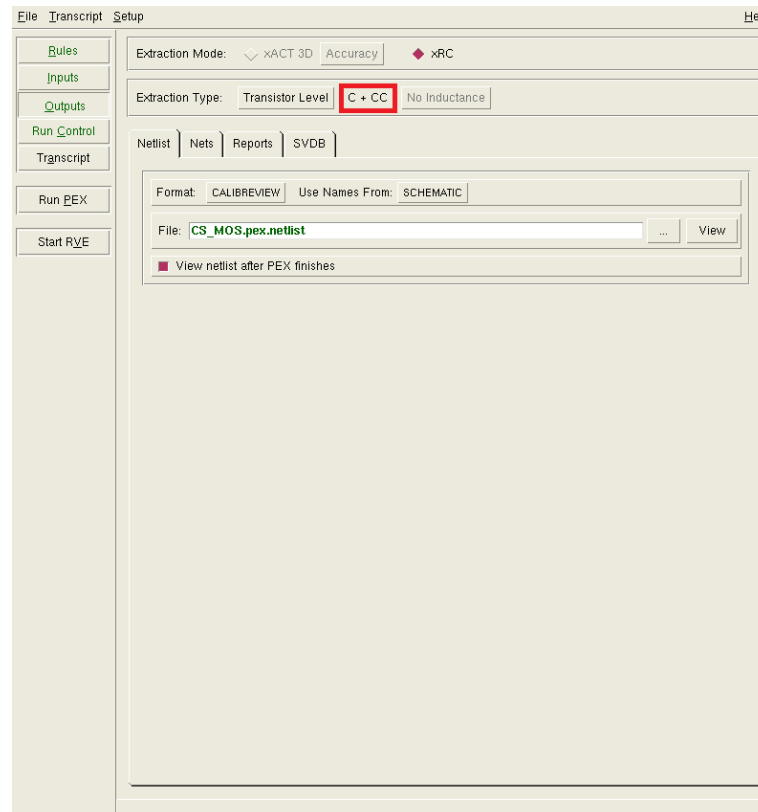


- Use PEX rule file:

**`/home/PDKs/OA65/Calibre/rcx/rfvlsi_debug.rcx`**



- Extract C+CC with modeled parasitic resistances for better simulation performance



- Use Cellmap file:  
**`/home/PDKs/OA65/Calibre/rcx/calview_debug.cellmap`**

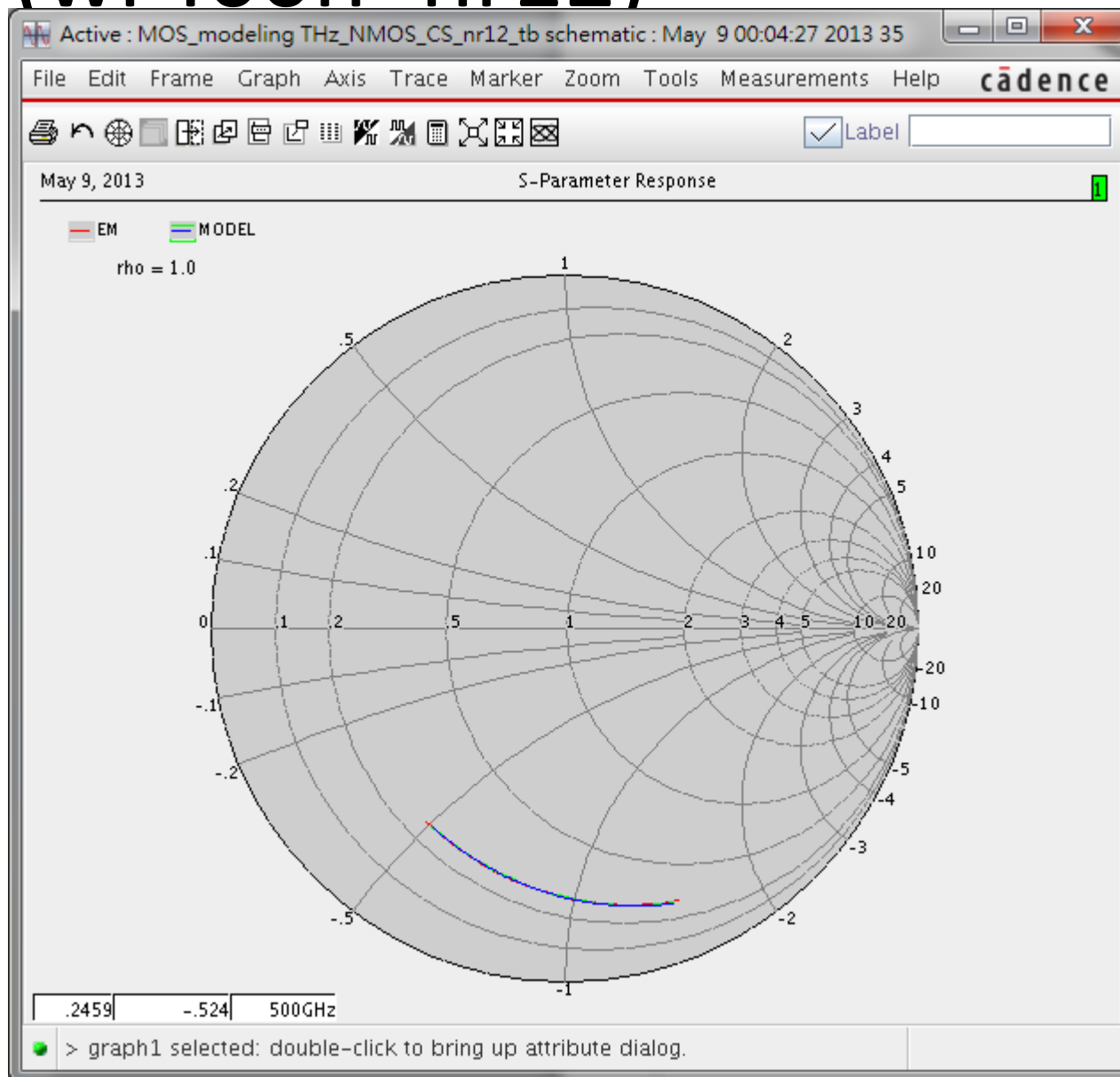
The screenshot shows the Calibre CellView dialog box. The 'Cellmap File' field is highlighted with a red rectangle and contains the path `/home/PDKs/OA65/Calibre/rcx/calview_debug.cellmap`. Below this field are 'View' and 'Edit' buttons. Other fields include 'Output Library' (MOS\_modeling), 'Schematic Library' (MOS\_modeling), 'Log File' (./calview.log), 'Calibre View Name' (calibre), 'Calibre View Type' (maskLayout selected), 'Create Terminals' (if matching terminal exists on symbol selected), 'Preserve Device Case' (unchecked), 'Execute Callbacks' (unchecked), 'Reset Properties' (n=1), 'Magnify Instances By' (1), 'Device Placement' (Layout Location selected), 'Parasitic Placement' (Arrayed selected), 'Show Parasitic Polygons' (unchecked), 'Open Calibre CellView' (Don't Open selected), and 'Always Show Dialog' (checked). At the bottom right are 'OK', 'Cancel', and 'Help' buttons.

Output Library:	MOS_modeling
Schematic Library:	MOS_modeling
Cellmap File:	/home/PDKs/OA65/Calibre/rcx/calview_debug.cellmap
<input type="button" value="View"/> <input type="button" value="Edit"/>	
Log File:	./calview.log
Calibre View Name:	calibre
Calibre View Type:	<input checked="" type="radio"/> maskLayout <input type="radio"/> schematic
Create Terminals:	<input checked="" type="radio"/> if matching terminal exists on symbol <input type="radio"/> Create all terminals
Preserve Device Case	<input type="checkbox"/>
Execute Callbacks	<input type="checkbox"/>
Reset Properties:	n=1
Magnify Instances By:	1
Device Placement:	<input checked="" type="radio"/> Layout Location <input type="radio"/> Arrayed
Parasitic Placement:	<input type="radio"/> Layout Location <input checked="" type="radio"/> Arrayed
Show Parasitic Polygons	<input type="checkbox"/>
Open Calibre CellView:	<input type="radio"/> Read-mode <input type="radio"/> Edit-mode <input checked="" type="radio"/> Don't Open
Always Show Dialog	<input checked="" type="checkbox"/>
<input type="button" value="OK"/> <input type="button" value="Cancel"/> <input type="button" value="Help"/>	

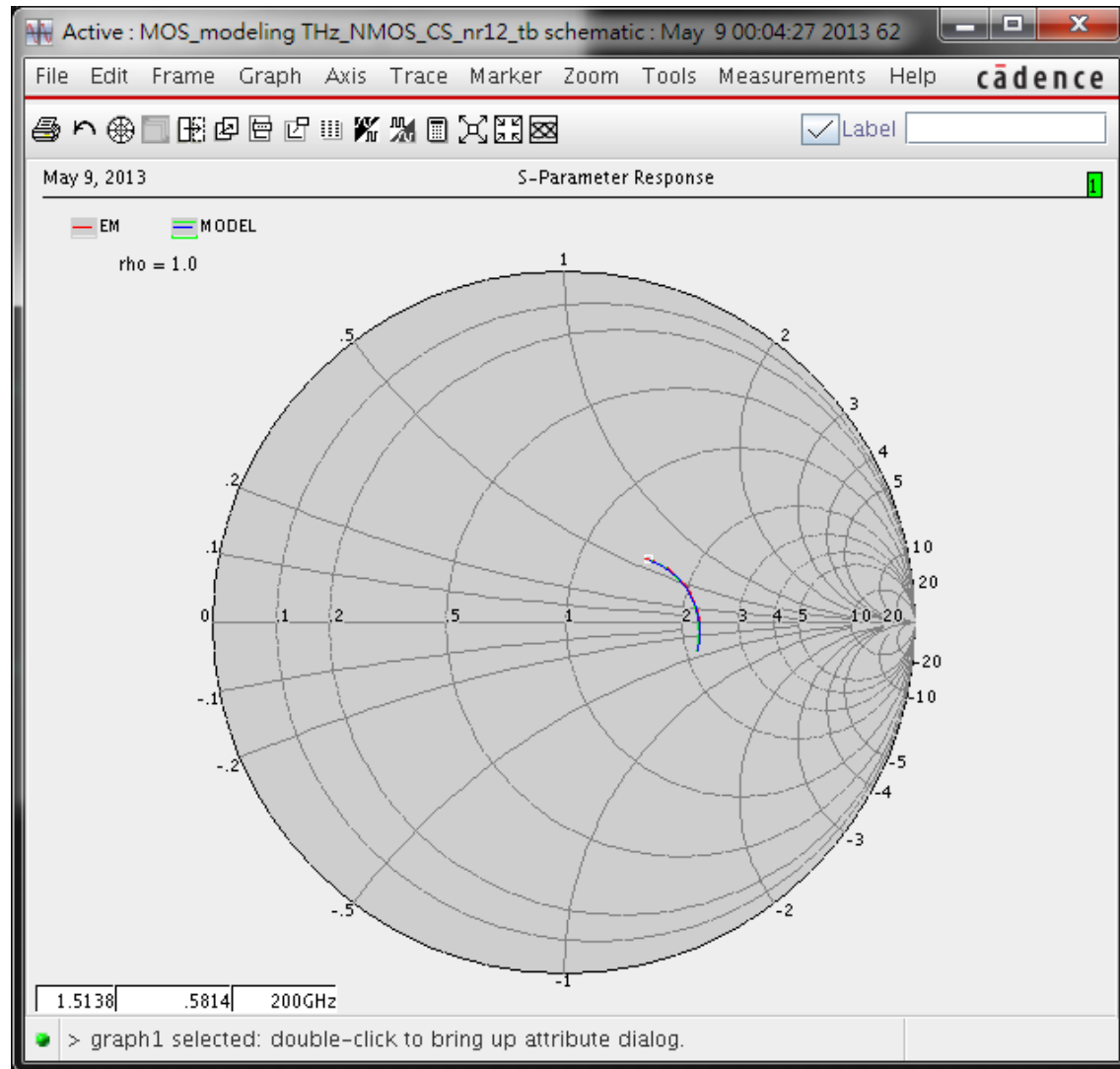
# Model Comparison Result

- THz MOS
  - THz\_NMOS\_CS
- Analog MOS
  - MOS\_BGDSGB\_CG
  - MOS\_SGDGS\_CS
  - MOS\_BSGGDB\_Gilbert
- Power MOS
  - PowerM\_CSAr
  - PowerM\_CCAr\_longL

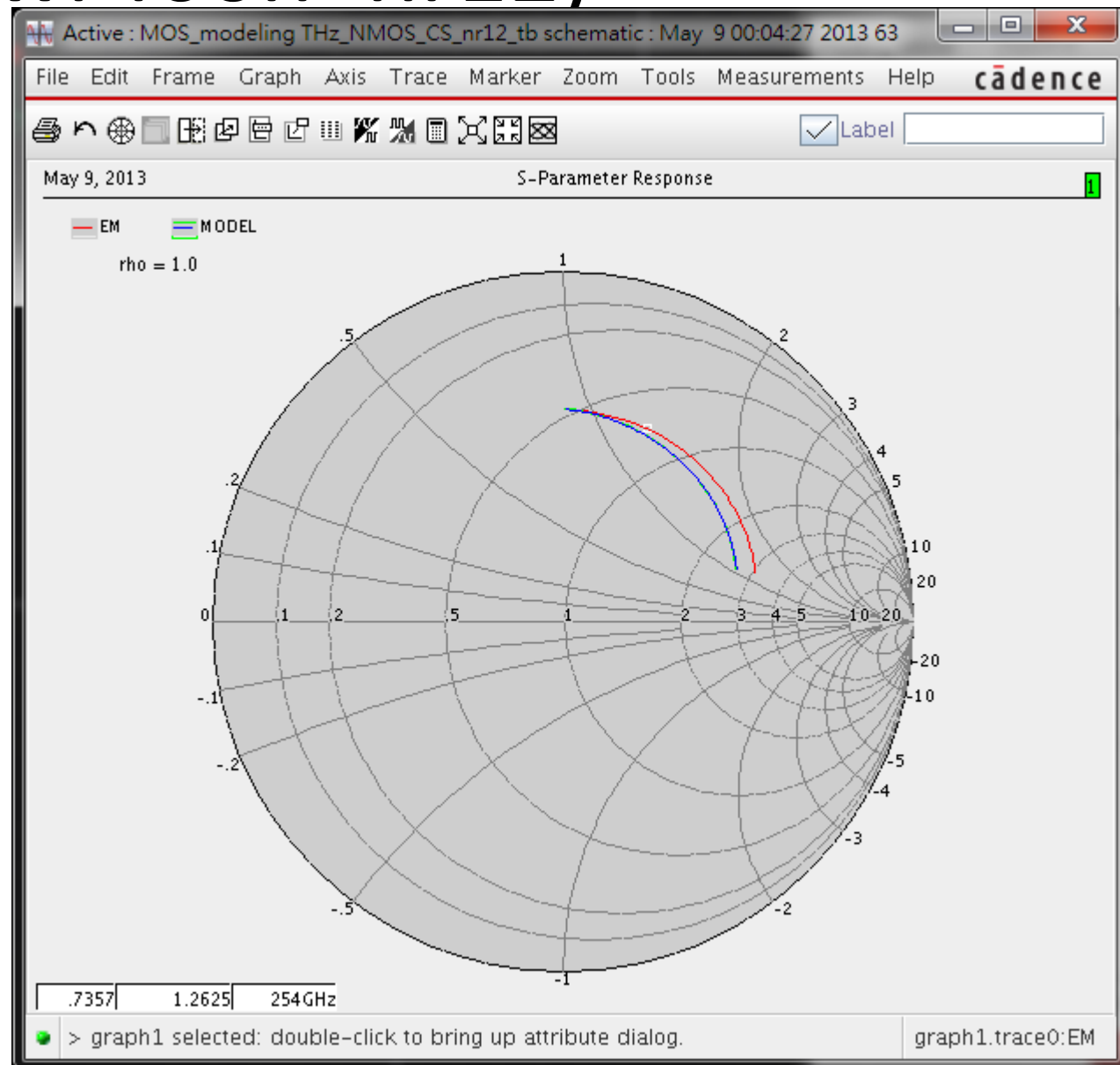
# S11 (wr400n nr12)



# S12 (wr400n\_nr12)

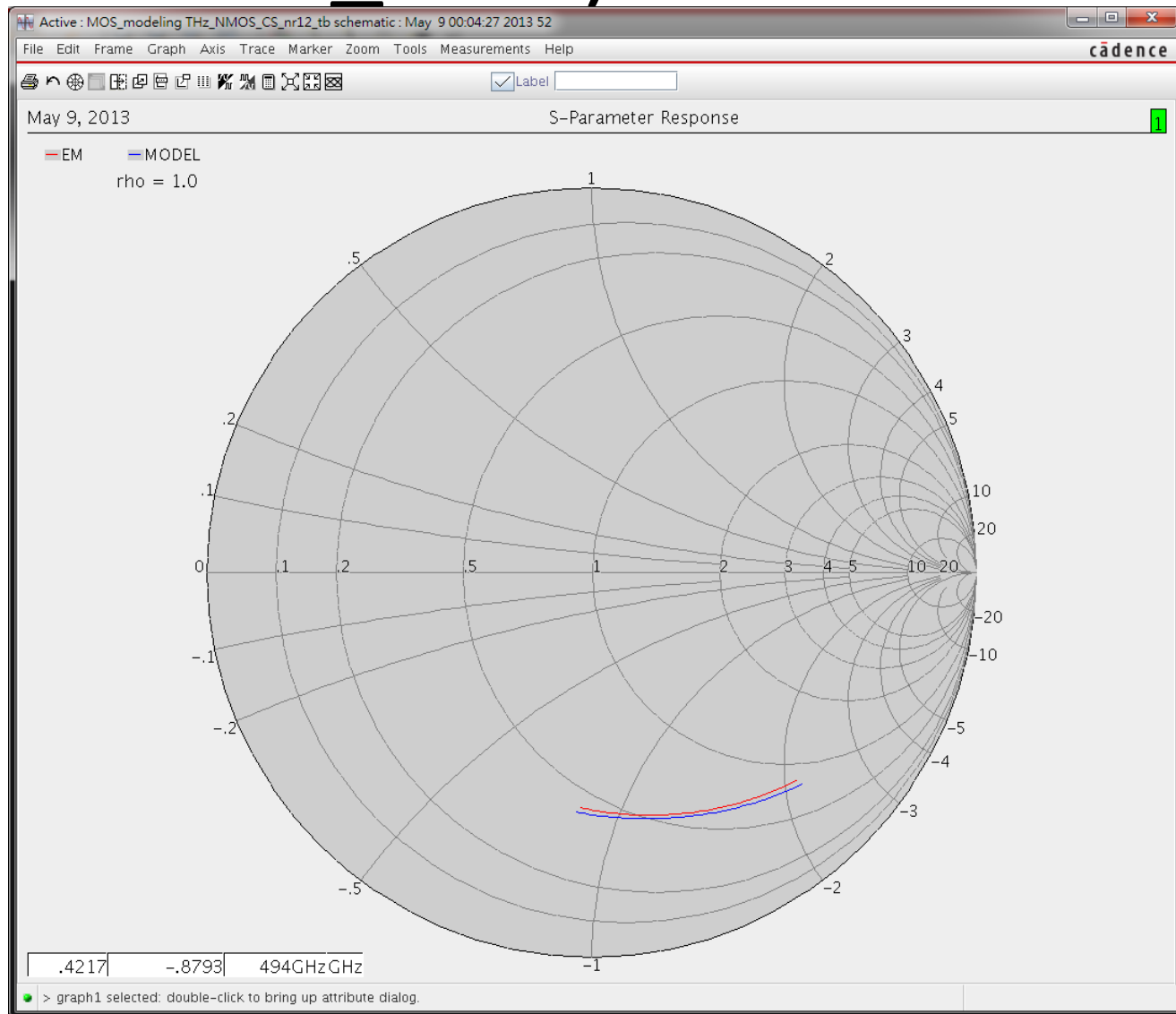


# S21 (wr400n nr12)

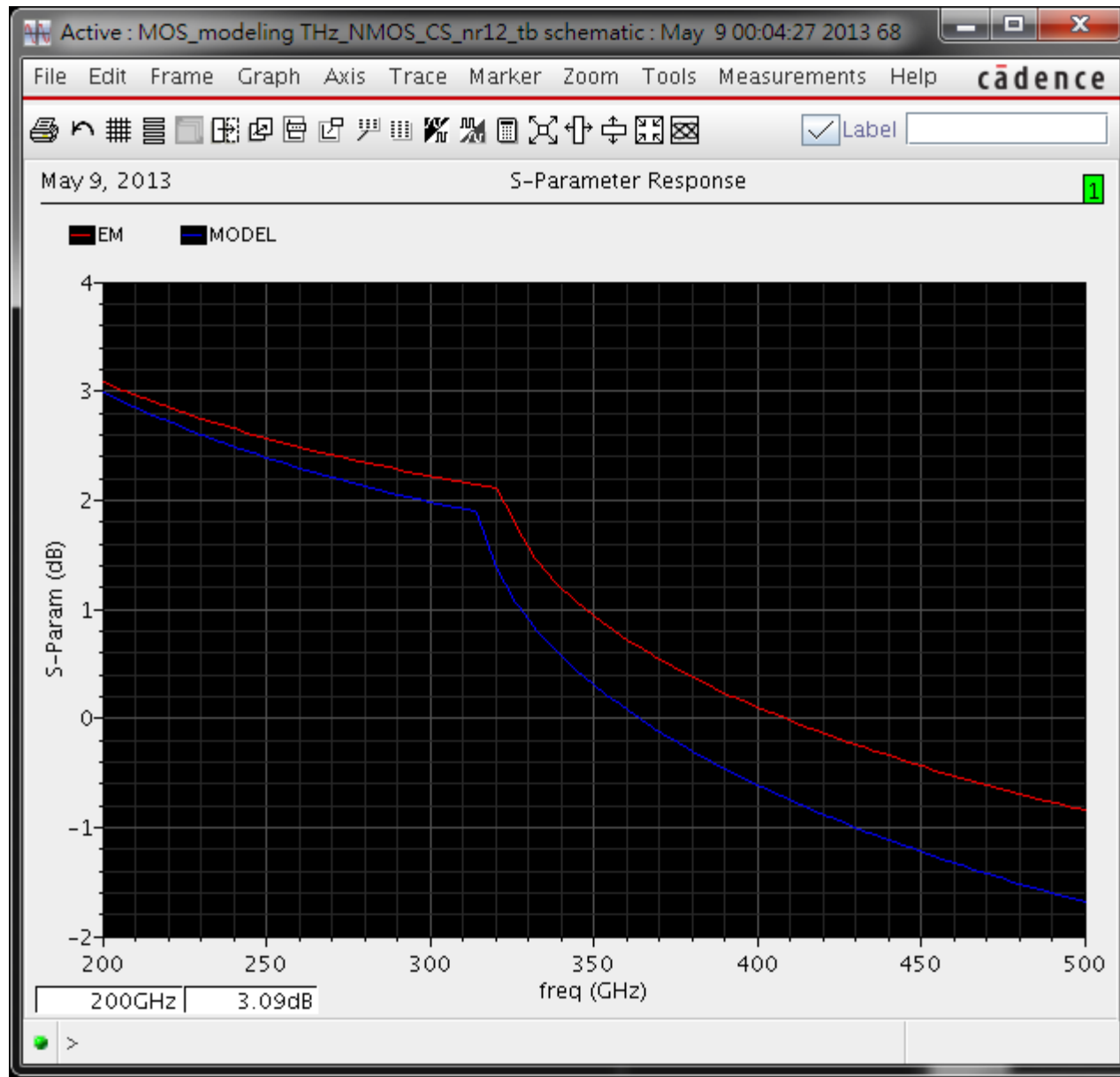




# S22 (wr400n\_nr12)



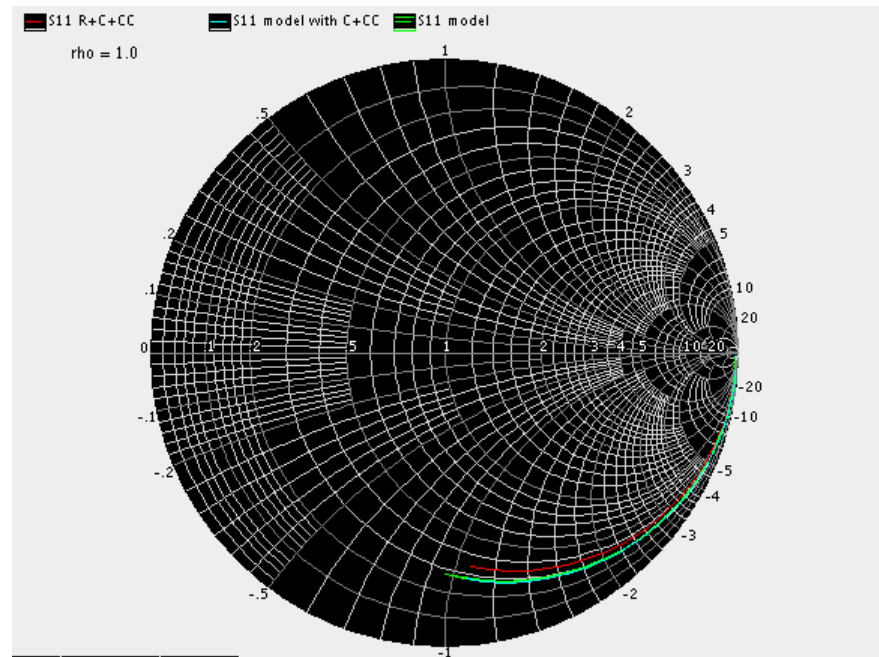
# fmax wr400n nr12



# Model Comparison Result

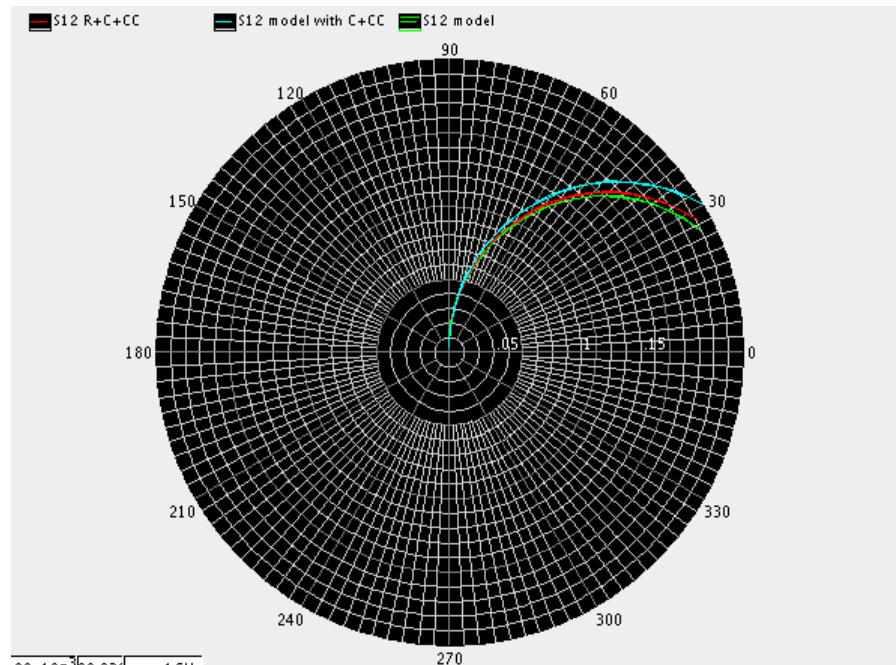
- THz MOS
  - THz\_NMOS\_CS
- Analog MOS
  - MOS\_BGDSGB\_CG
  - MOS\_SGDGS\_CS
  - MOS\_BSGGDB\_Gilbert
- Power MOS
  - PowerM\_CSAr
  - PowerM\_CCAr\_longL

# MOS\_BGDSGB\_CG @ (60n/1u/20)



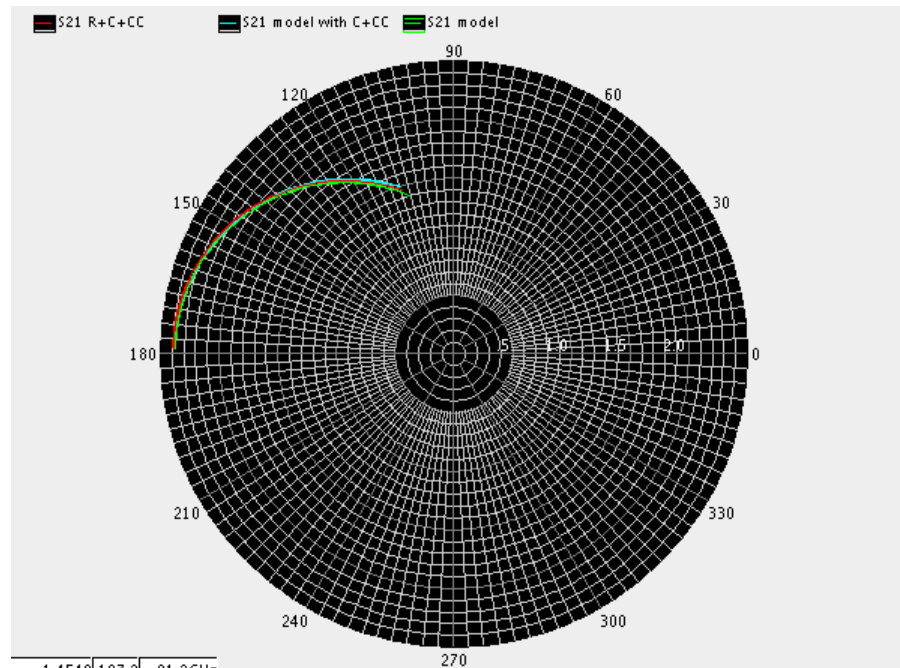
S11

# MOS\_BGDSGB\_CG @ (60n/1u/20)



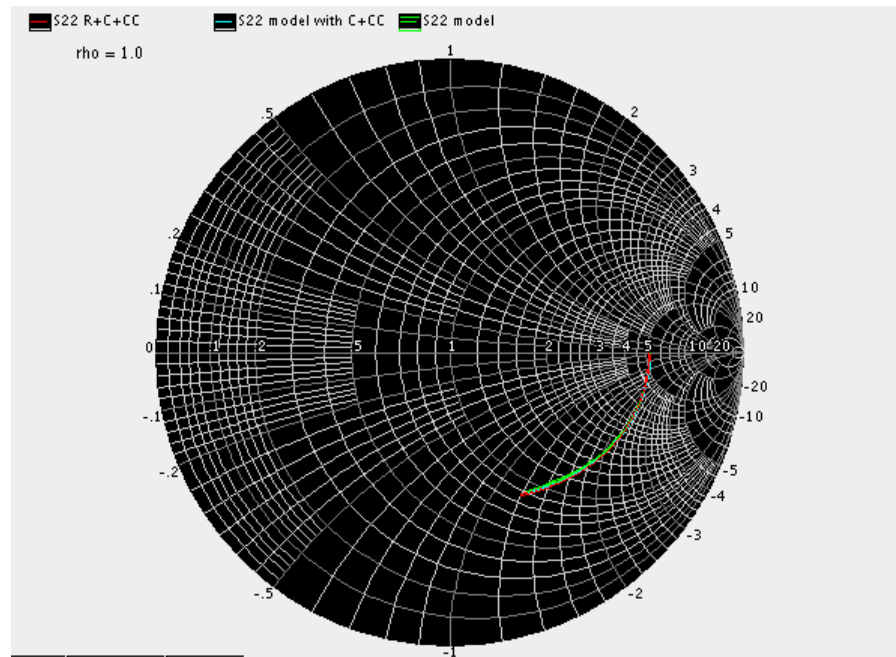
S12

# MOS\_BGDSGB\_CG @ (60n/1u/20)



S21

# MOS\_BGDSGB\_CG @ (60n/1u/20)



S22

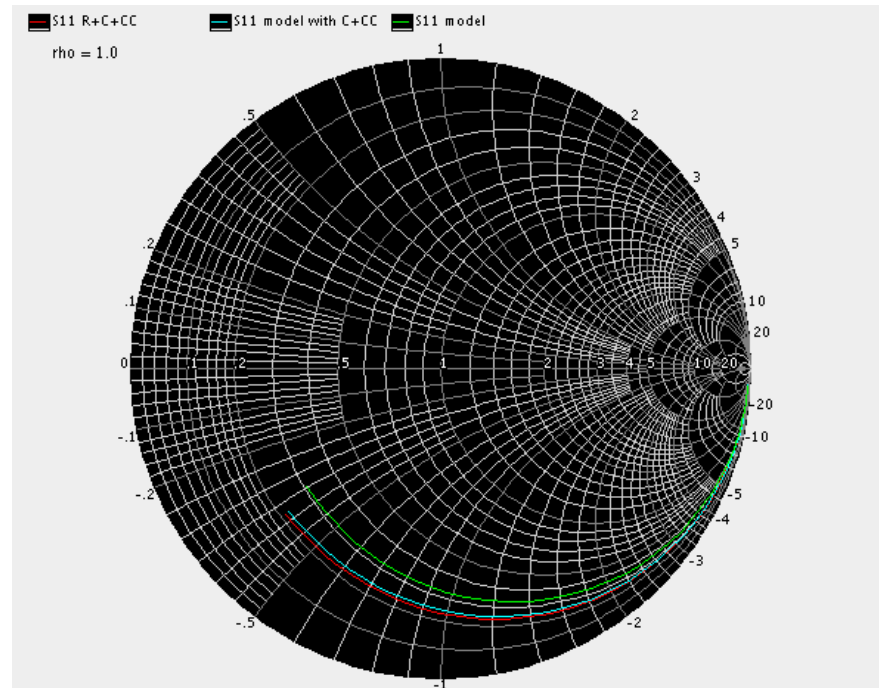
# MOS\_BGDSGB\_CG @ (60n/1u/20)

- R + C + CC :  $I_d = 12.38 \text{ mA}$
- C + CC with model :  $I_d = 12.11 \text{ mA}$
- model :  $I_d = 12.11 \text{ mA}$



# MOS\_BGDSGB\_CG @ (60n/1u/50)

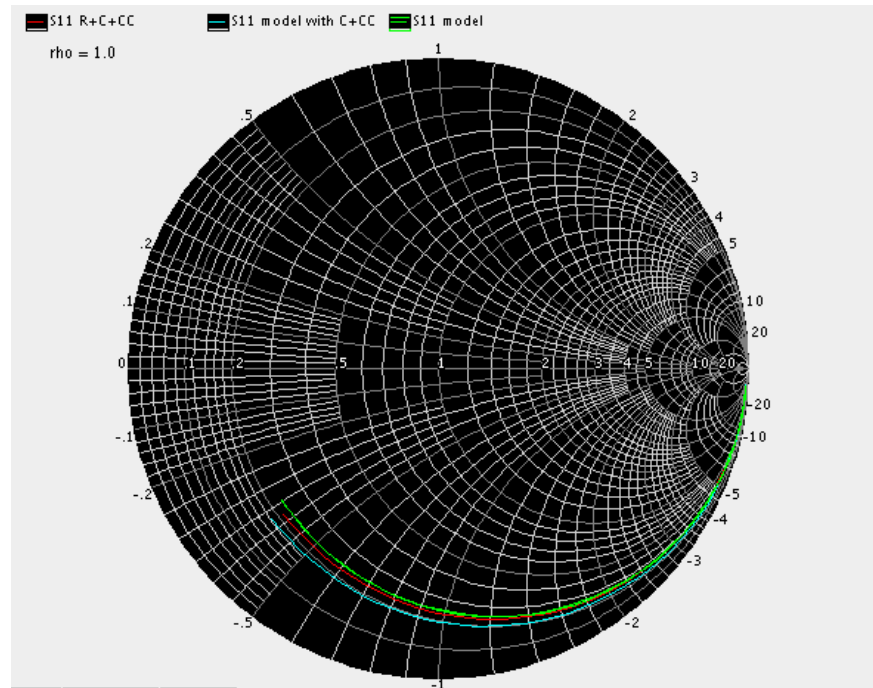
## $2R_g * 3.2$



**S11**

# MOS\_BGDSGB\_CG @ (60n/1u/50)

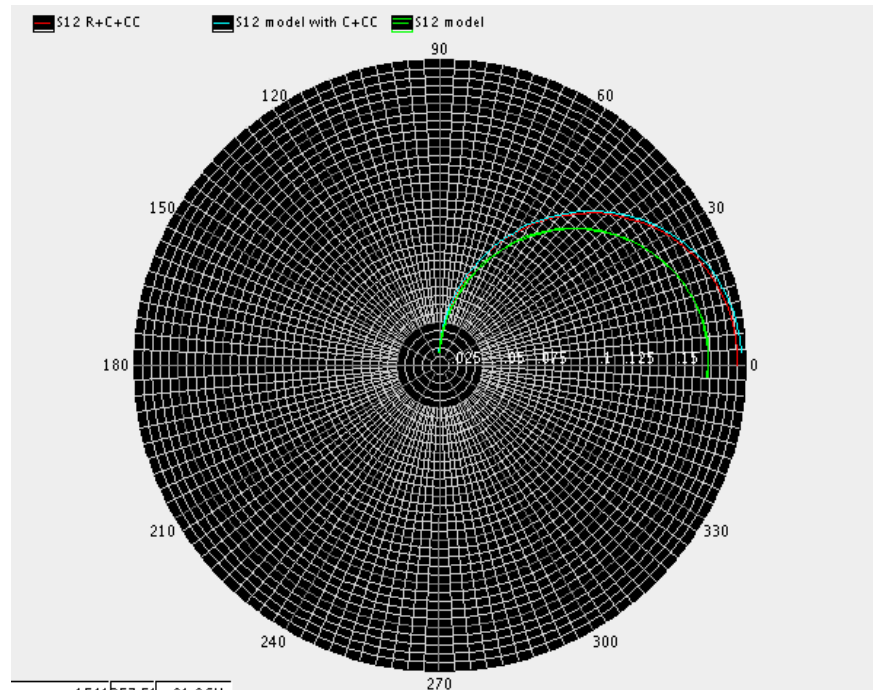
## $2R_g \times 2$



$S_{11}$

# MOS\_BGDSGB\_CG @ (60n/1u/50)

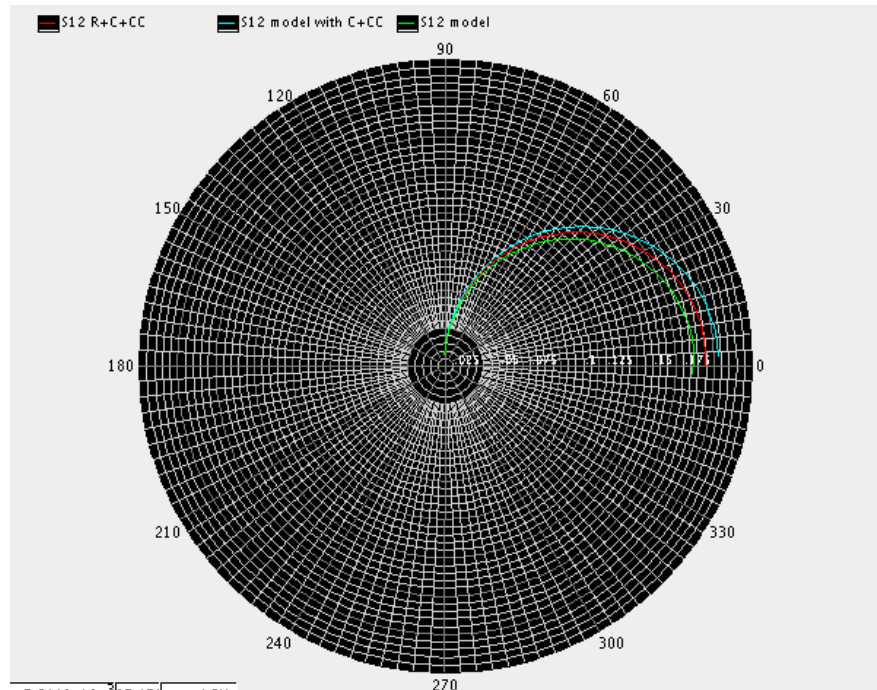
## $2R_g * 3.2$



# S12

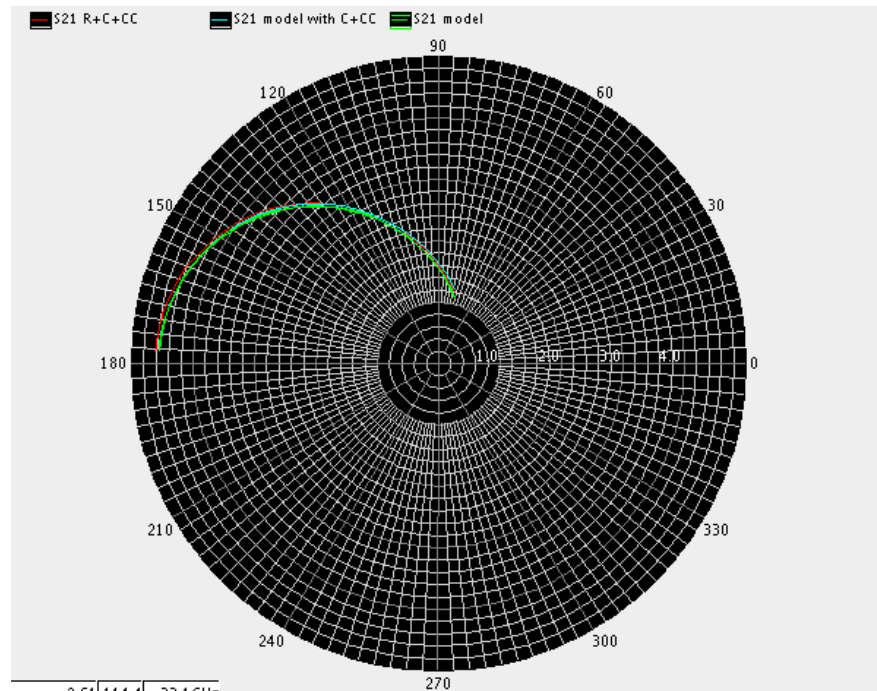
# MOS\_BGDSGB\_CG @ (60n/1u/50)

## $2R_g * 2$



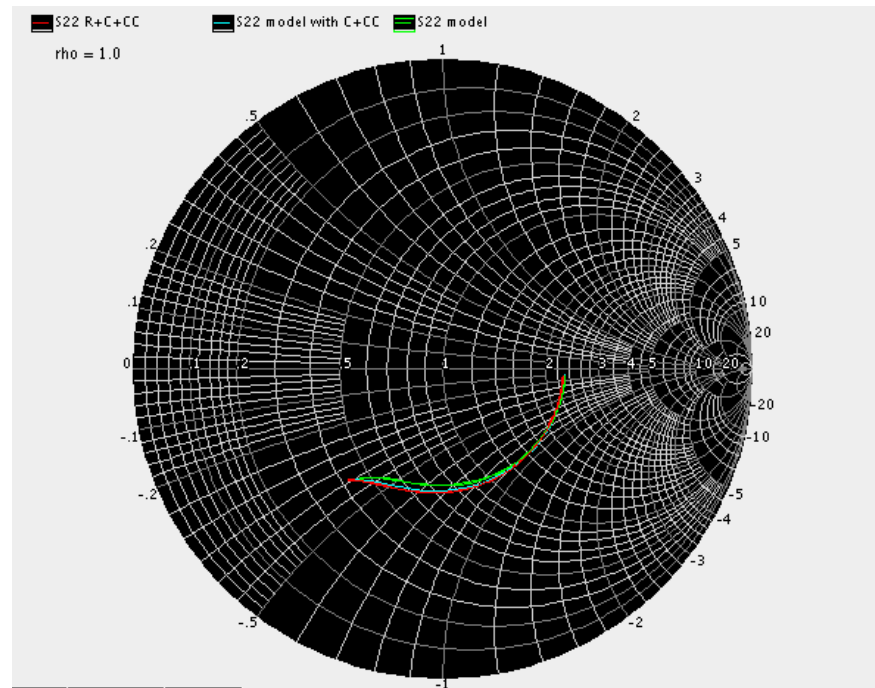
# S12

# MOS\_BGDSGB\_CG @ (60n/1u/50)



S21

# MOS\_BGDSGB\_CG @ (60n/1u/50)



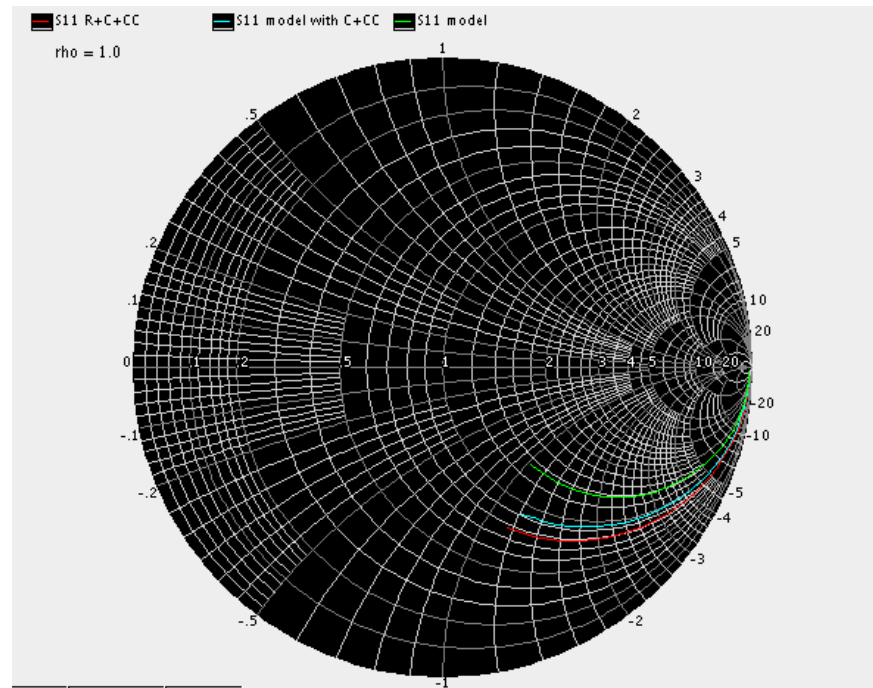
S22

# MOS\_BGDSGB\_CG @ (60n/1u/50)

- R + C + CC :  $I_d = 29.18 \text{ mA}$
- C + CC with model :  $I_d = 28.32 \text{ mA}$
- model :  $I_d = 28.32 \text{ mA}$

# MOS\_BGDSGB\_CG @ (60n/2u/10)

## 2Rg\*3.2

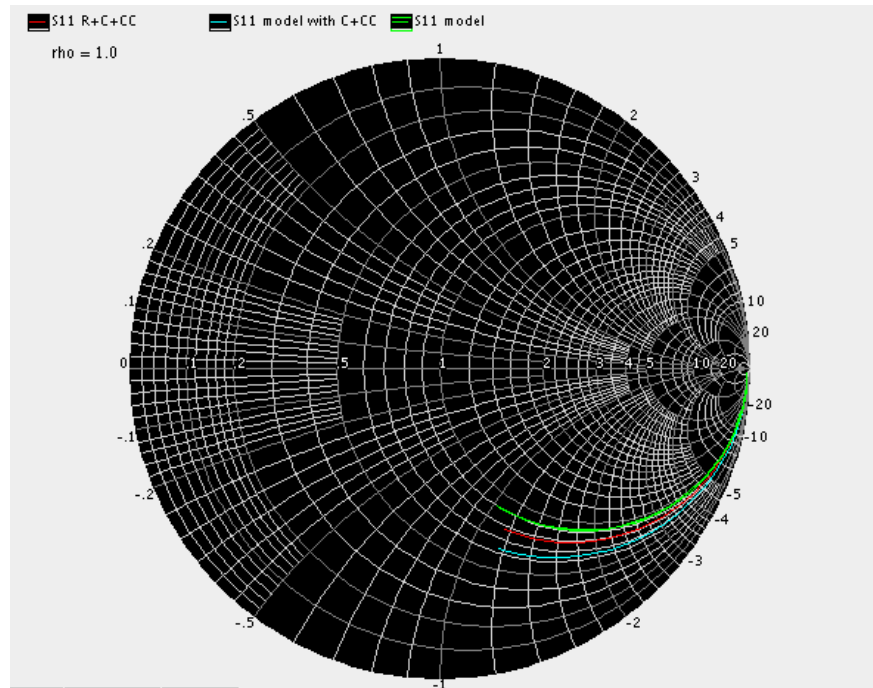


S11



# MOS\_BGDSGB\_CG @ (60n/2u/10)

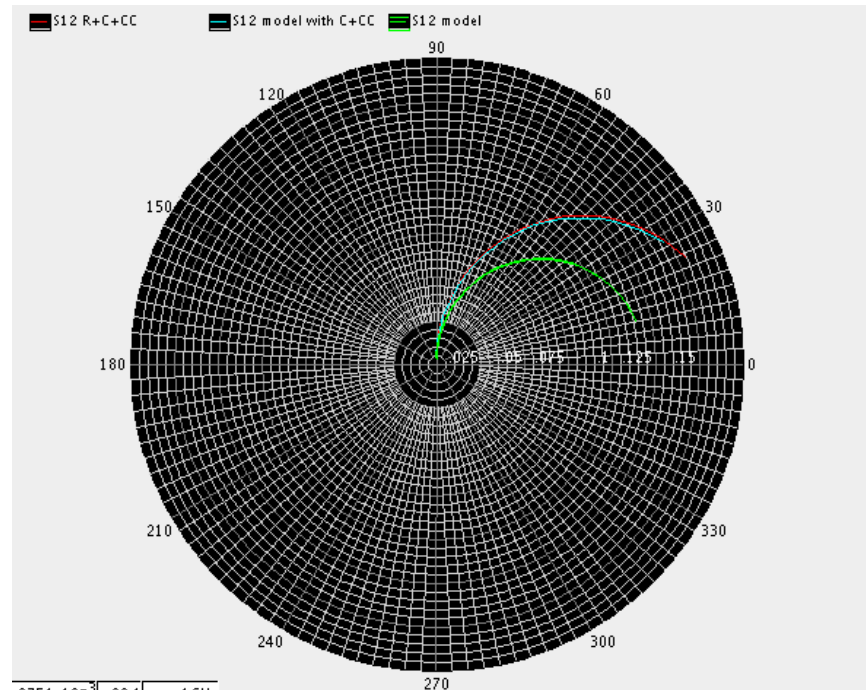
## $2R_g \times 2$



$S_{11}$

# MOS\_BGDSGB\_CG @ (60n/2u/10)

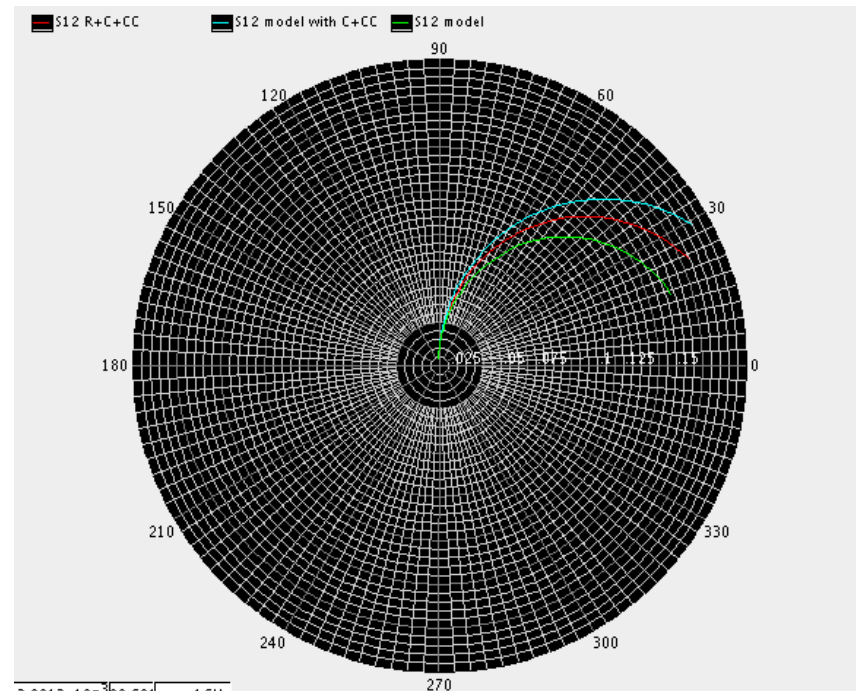
## 2Rg\*3.2



# S12

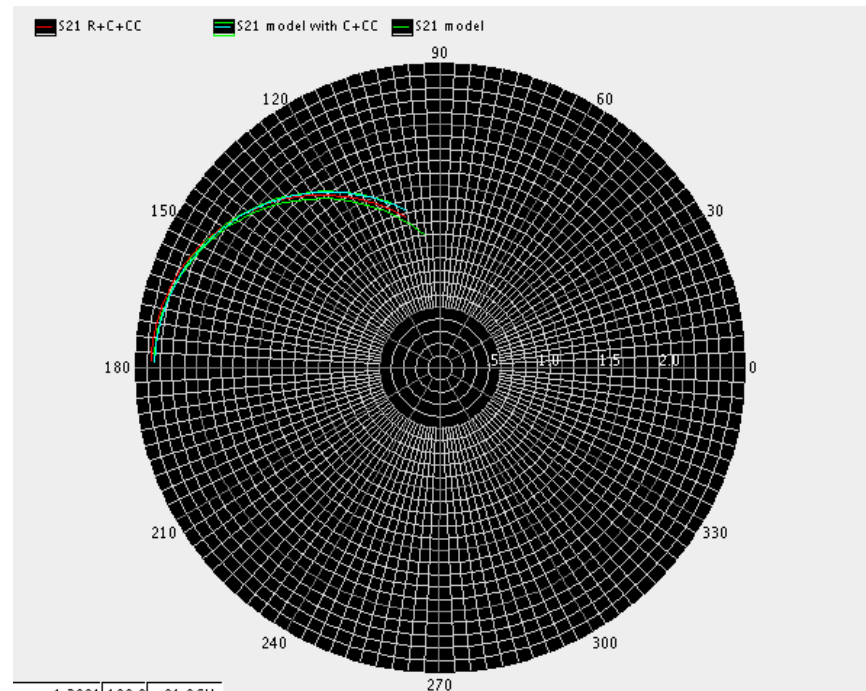
# MOS\_BGDSGB\_CG @ (60n/2u/10)

## $2R_g \cdot 2$



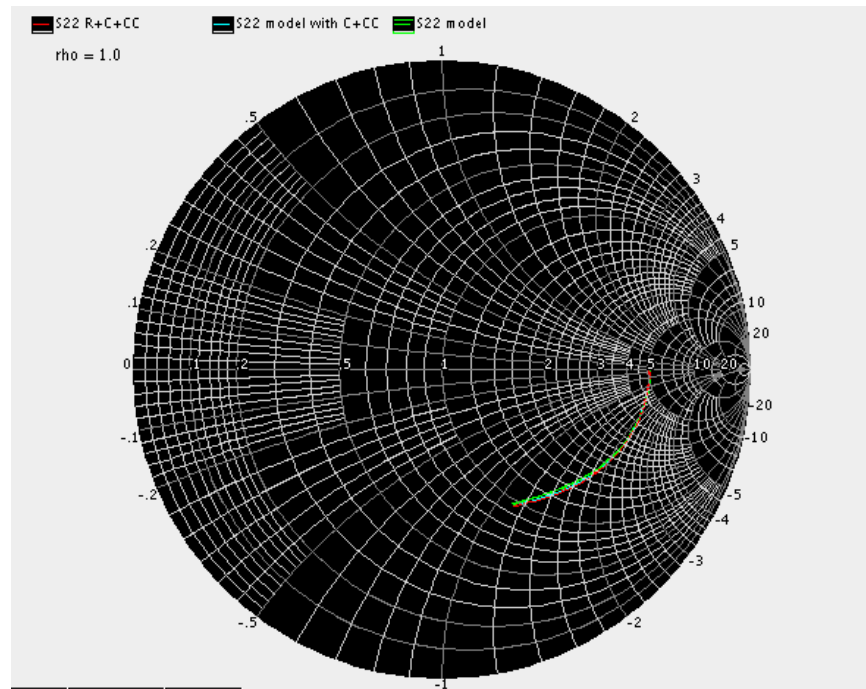
# S12

# MOS\_BGDSGB\_CG @ (60n/2u/10)



S21

# MOS\_BGDSGB\_CG @ (60n/2u/10)



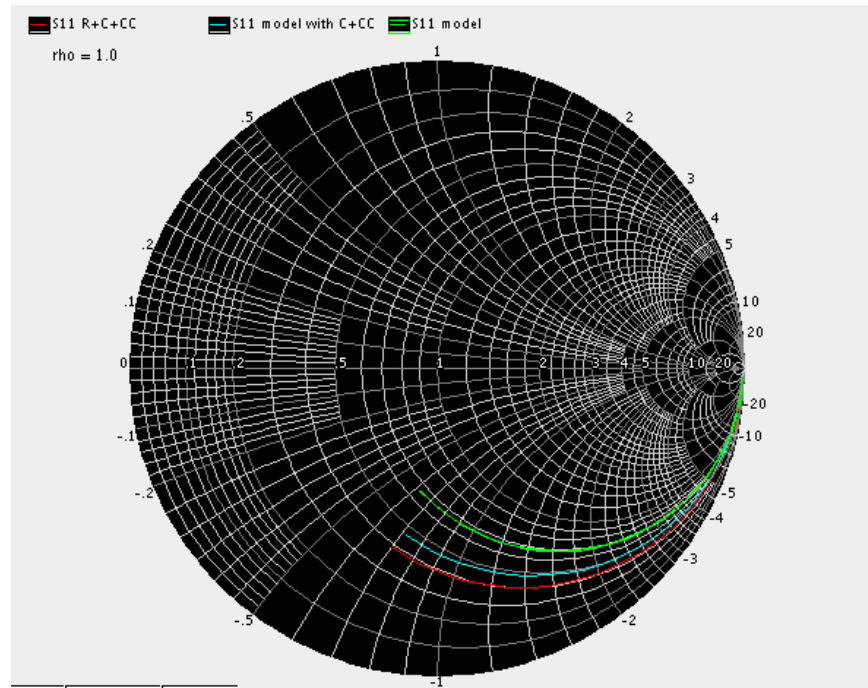
S22

# MOS\_BGDSGB\_CG @ (60n/2u/10)

- R + C + CC :  $I_d = 12.35 \text{ mA}$
- C + CC with model :  $I_d = 12.09 \text{ mA}$
- model :  $I_d = 12.09 \text{ mA}$

# MOS\_BGDSGB\_CG @ (60n/1.5u/20)

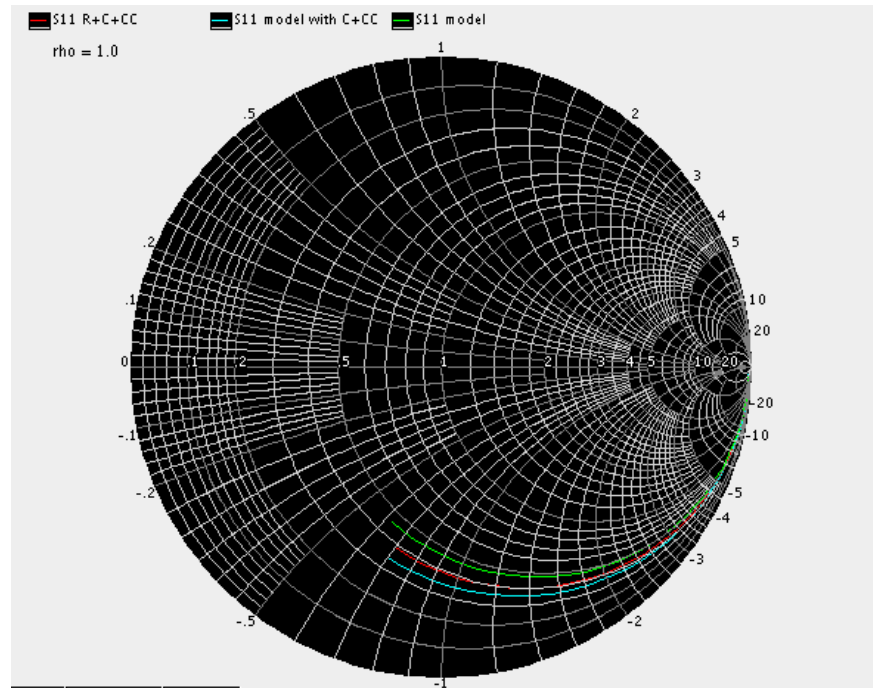
## $2R_g * 3.2$



**S11**

# MOS\_BGDSGB\_CG @ (60n/1.5u/20)

## $2R_g \times 2$

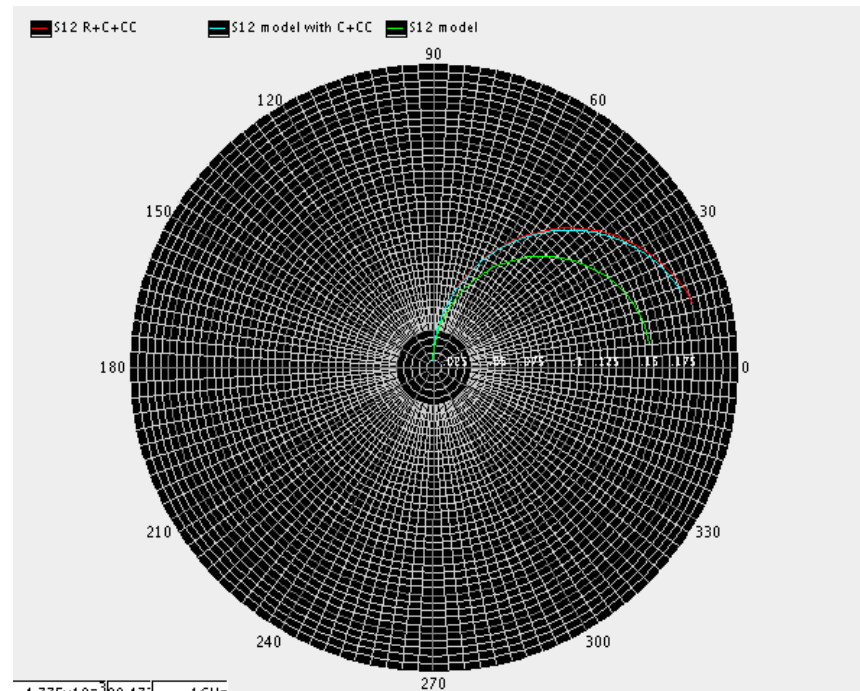


$S_{11}$



# MOS\_BGDSGB\_CG @ (60n/1.5u/20)

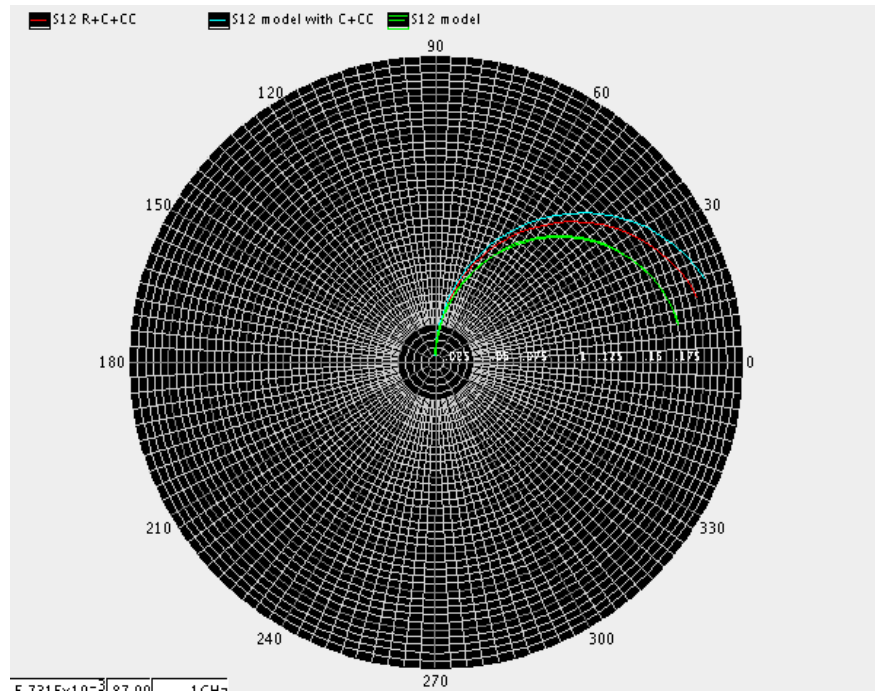
## $2R_g * 3.2$



# S12

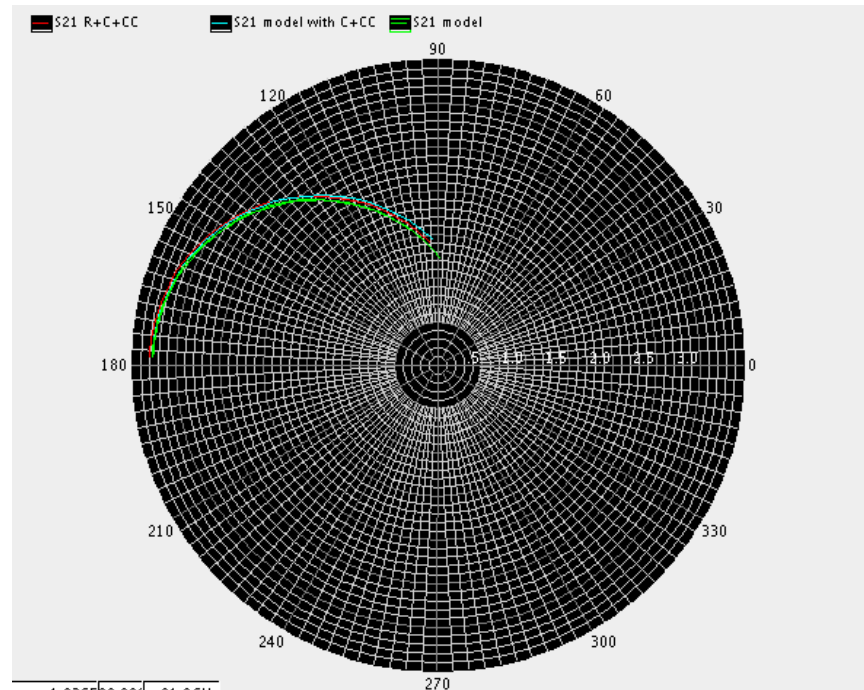
# MOS\_BGDSGB\_CG @ (60n/1.5u/20)

## $2R_g * 2$



# S12

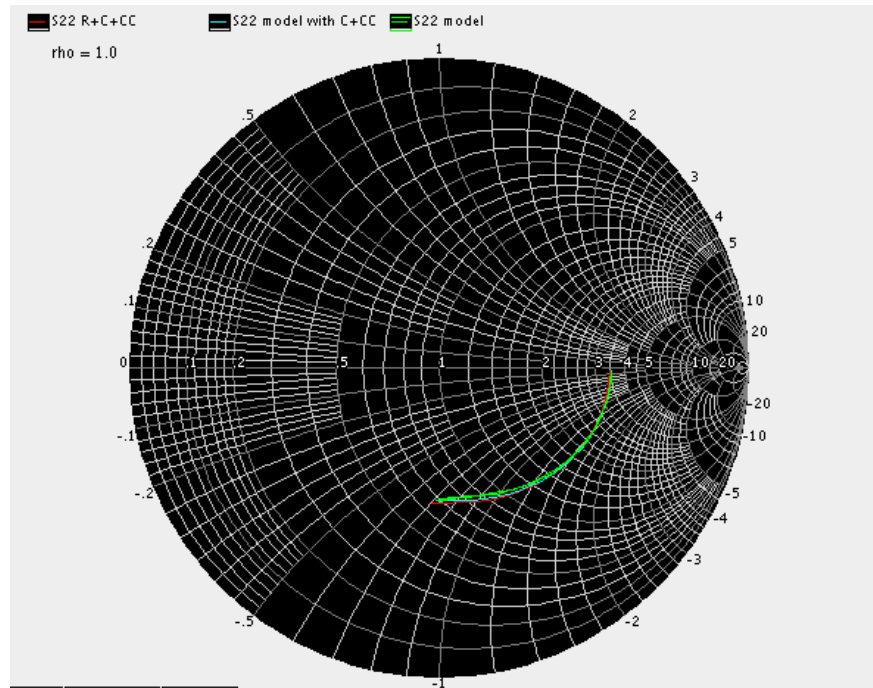
# MOS\_BGDSGB\_CG @ (60n/1.5u/20)



S21

# MOS\_BGDSGB\_CG @ (60n/1.5u/20)

## 2Rg\*3.2



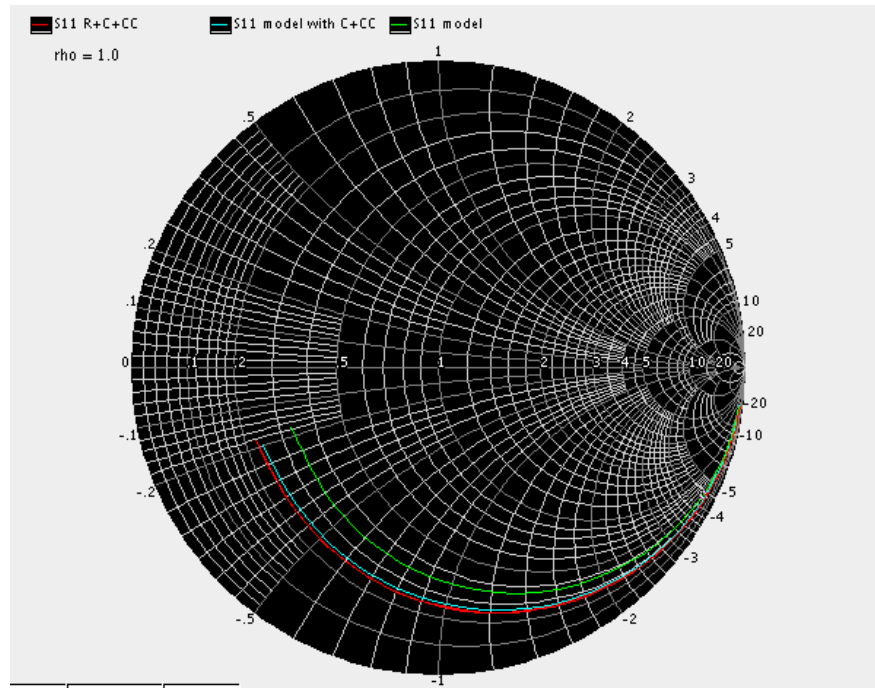
S22

# MOS\_BGDSGB\_CG @ (60n/1.5u/20)

- R + C + CC :  $I_d = 18.58 \text{ mA}$
- C + CC with model :  $I_d = 18.1 \text{ mA}$
- model :  $I_d = 18.1 \text{ mA}$

# MOS\_BGDSGB\_CG @ (60n/2u/50)

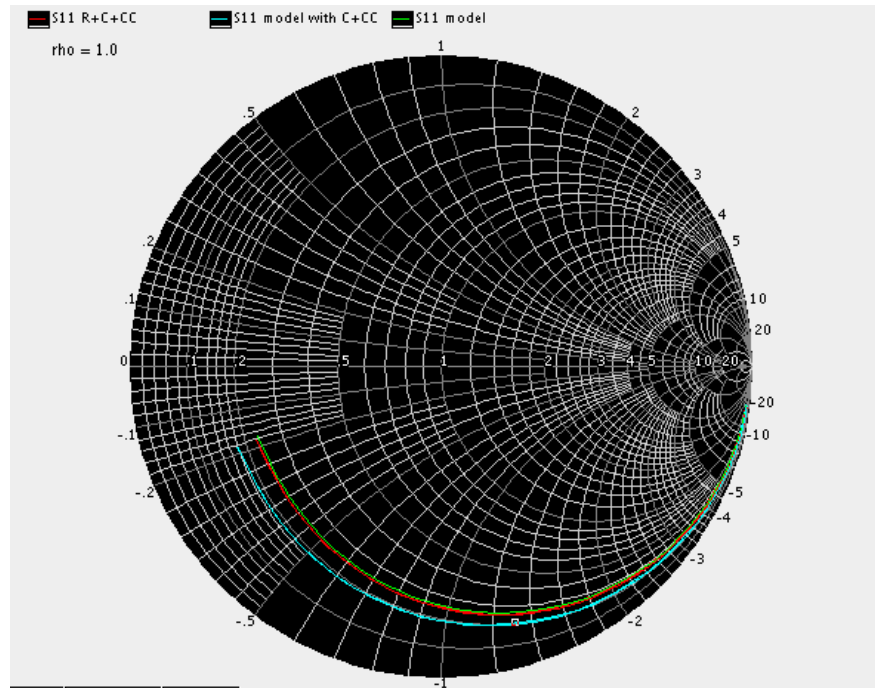
## $2R_g * 3.2$



**S11**

# MOS\_BGDSGB\_CG @ (60n/2u/50)

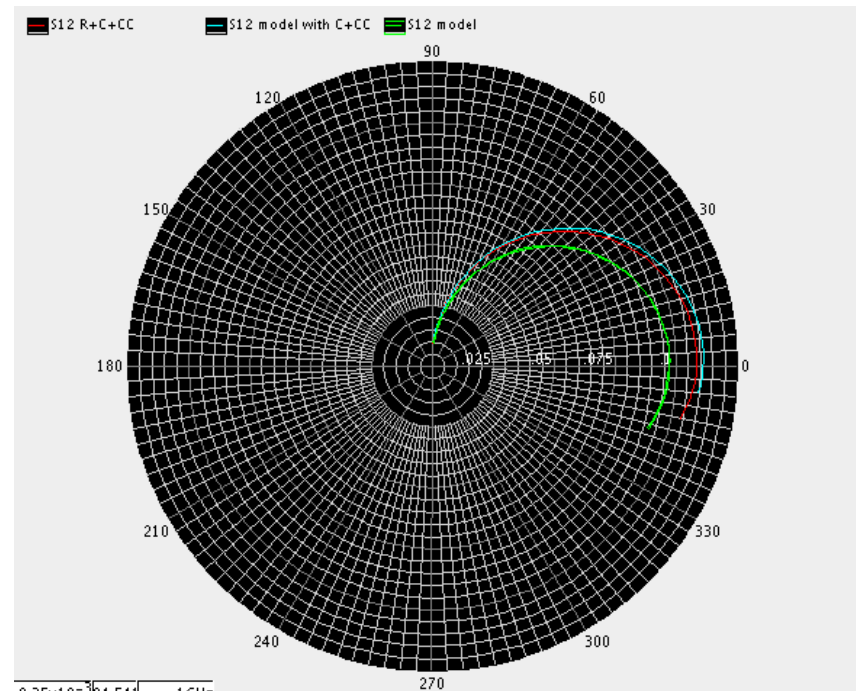
## $2R_g \cdot 2$



$S_{11}$

# MOS\_BGDSGB\_CG @ (60n/2u/50)

## 2Rg\*3.2

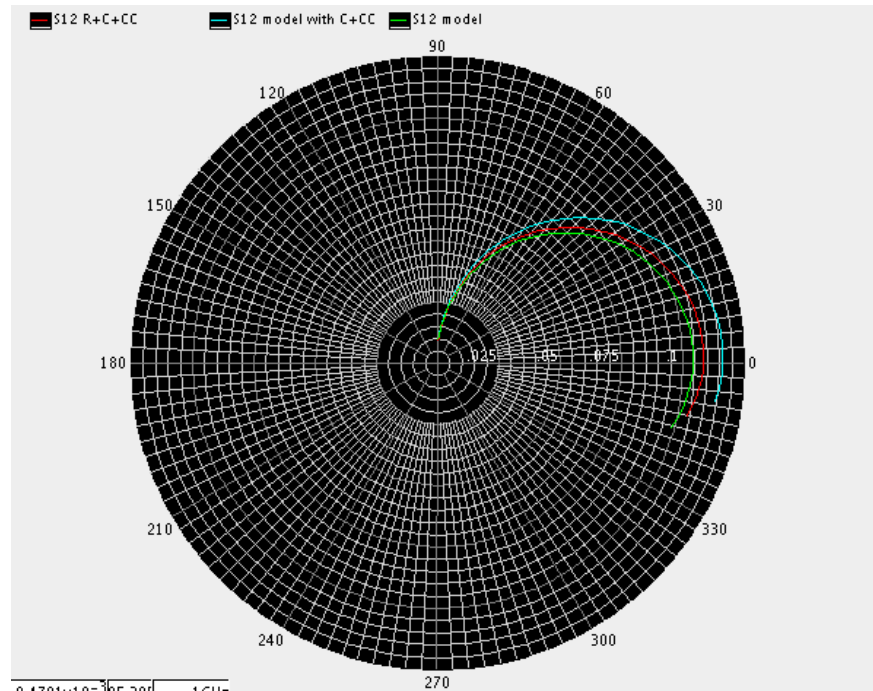


# S12



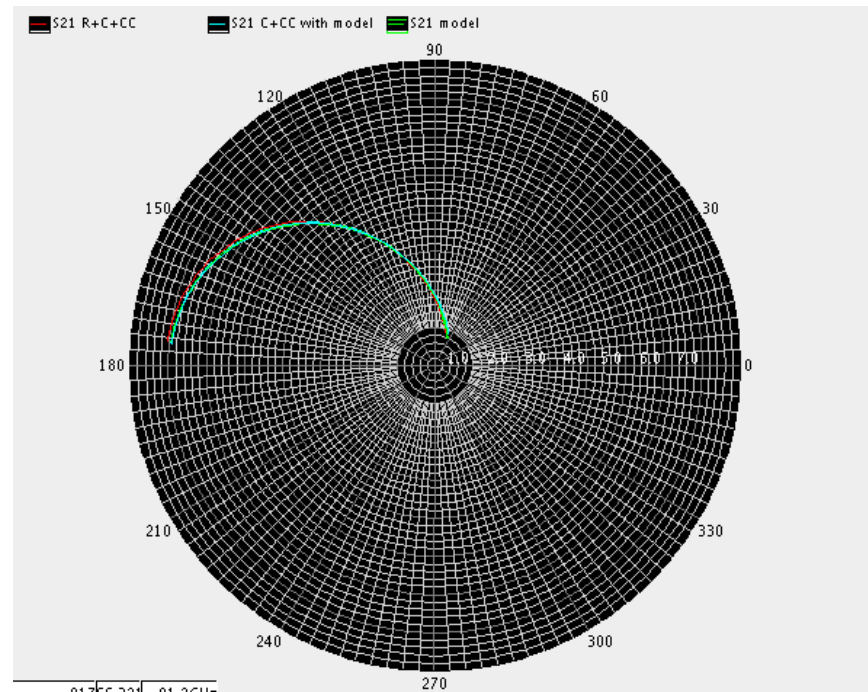
# MOS\_BGDSGB\_CG @ (60n/2u/50)

## $2R_g \cdot 2$



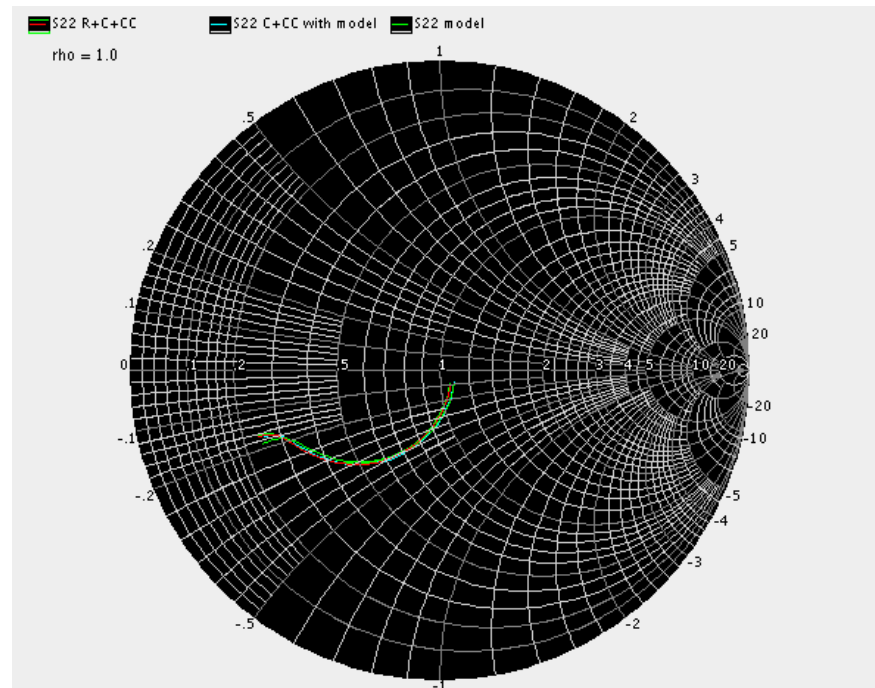
# S12

# MOS\_BGDSGB\_CG @ (60n/2u/50)



S21

# MOS\_BGDSGB\_CG @ (60n/2u/50)



$S_{22}$

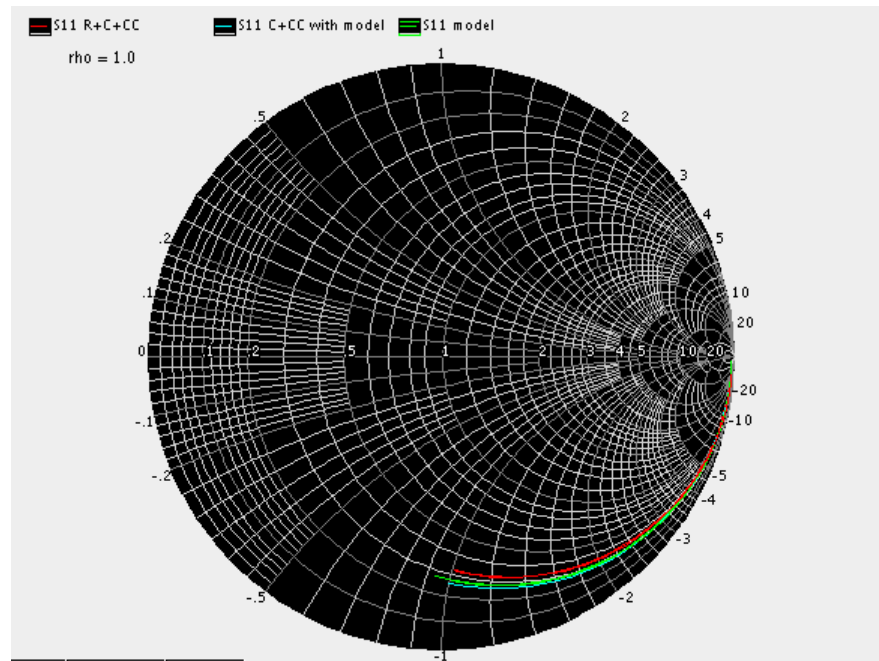
# MOS\_BGDSGB\_CG @ (60n/2u/50)

- R + C + CC :  $I_d = 59.97 \text{ mA}$
- C + CC with model :  $I_d = 57.58 \text{ mA}$
- model :  $I_d = 57.58 \text{ mA}$

# Model Comparison Result

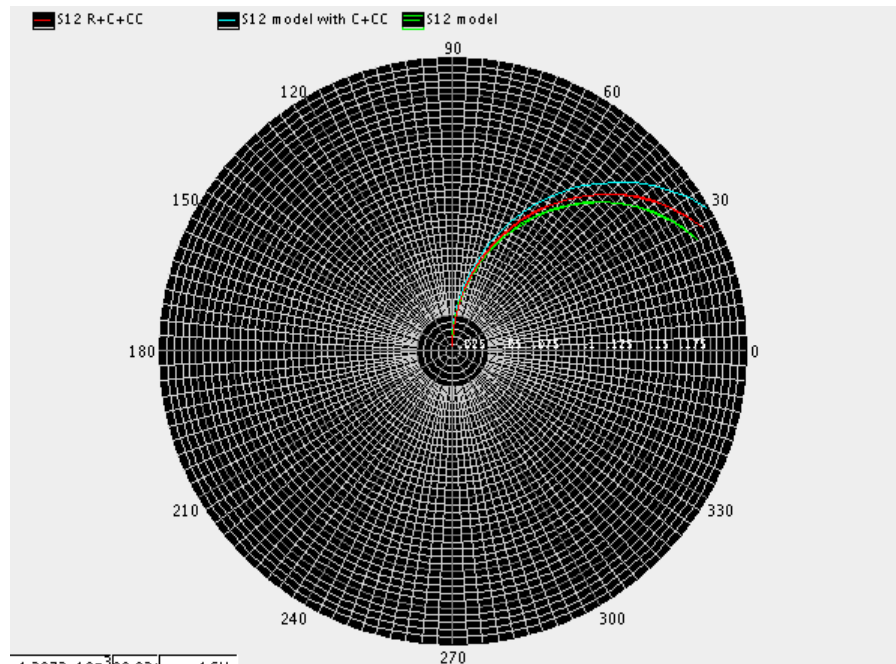
- THz MOS
  - THz\_NMOS\_CS
- Analog MOS
  - MOS\_BGDSGB\_CG
  - MOS\_SGDGS\_CS
  - MOS\_BSGGDB\_Gilbert
- Power MOS
  - PowerM\_CSAr
  - PowerM\_CCAr\_longL

# MOS\_SGDGS\_CS @ (60n/1u/20)



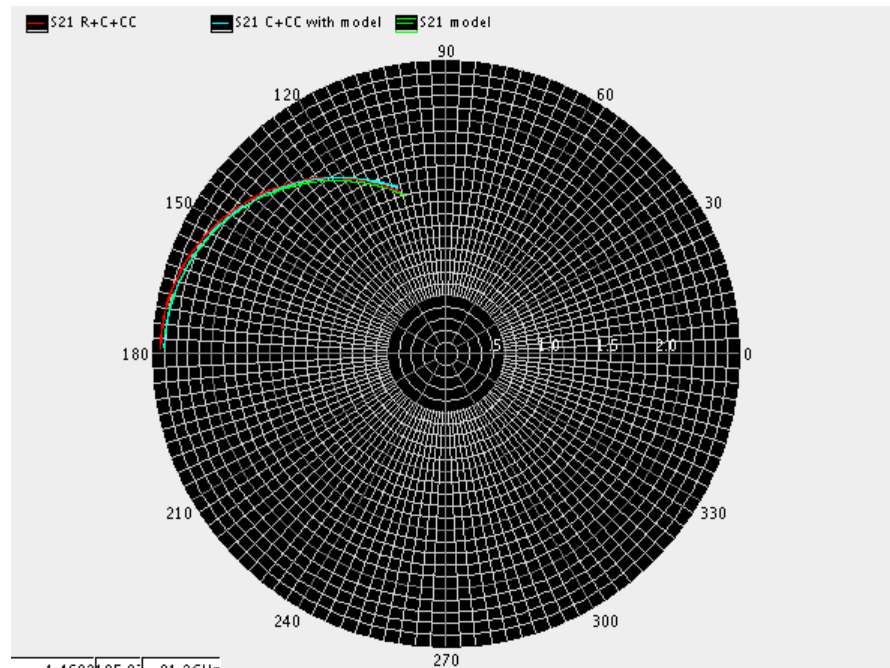
S11

# MOS\_SGDGS\_CS @ (60n/1u/20)



S12

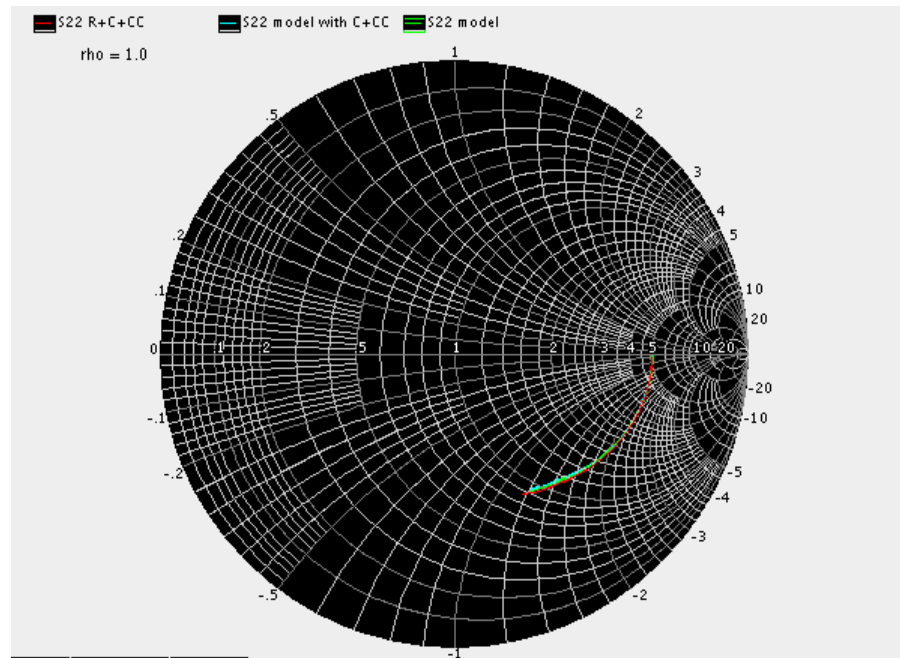
# MOS\_SGDGS\_CS @ (60n/1u/20)



S21



# MOS\_SGDGS\_CS @ (60n/1u/20)



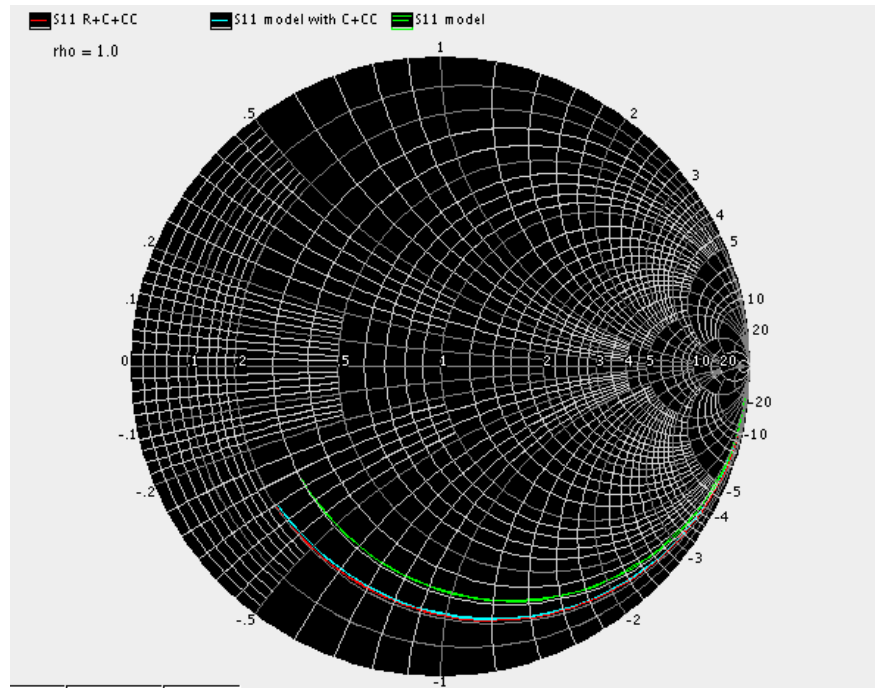
S22

# MOS\_SGDGS\_CS @ (60n/1u/20)

- R + C + CC :  $I_d = 12.63 \text{ mA}$
- C + CC with model :  $I_d = 12.31 \text{ mA}$
- model :  $I_d = 12.31 \text{ mA}$

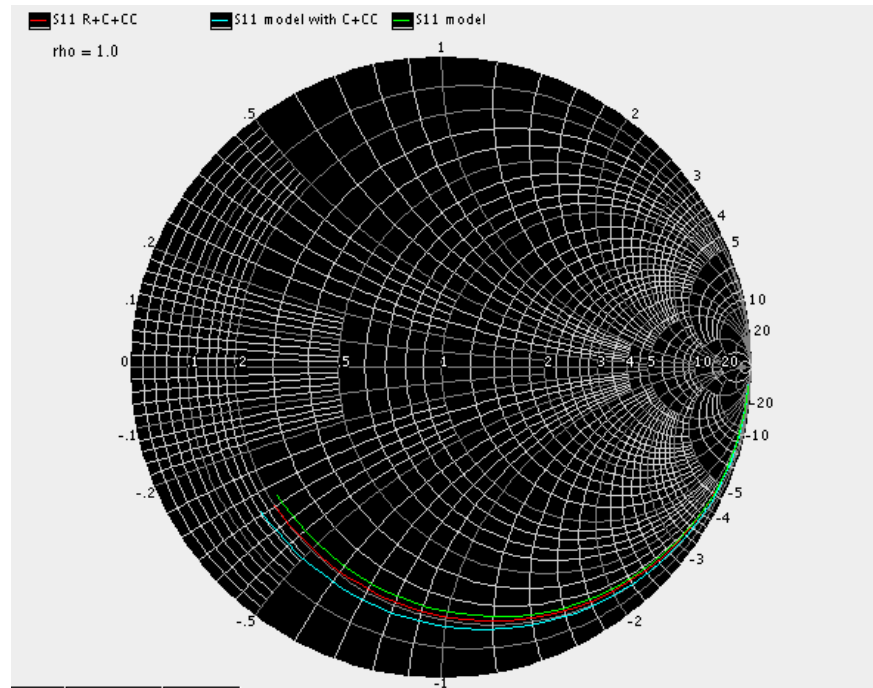
# MOS\_SGDGS\_CS @ (60n/1u/50)

## $2R_g * 3.2$



$S_{11}$

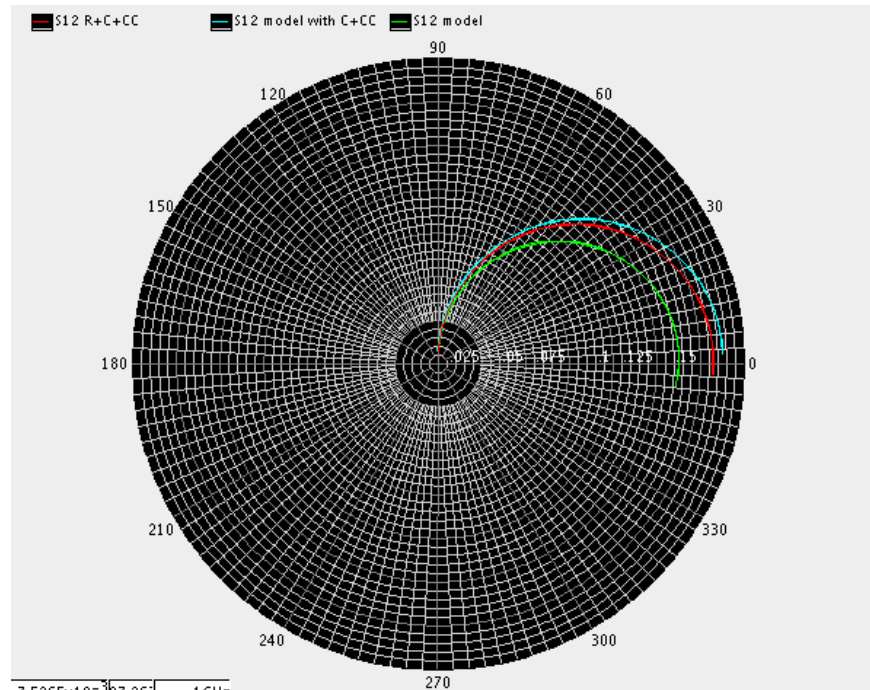
# MOS\_SGDGS\_CS @ (60n/1u/50) 2Rg\*2



S11

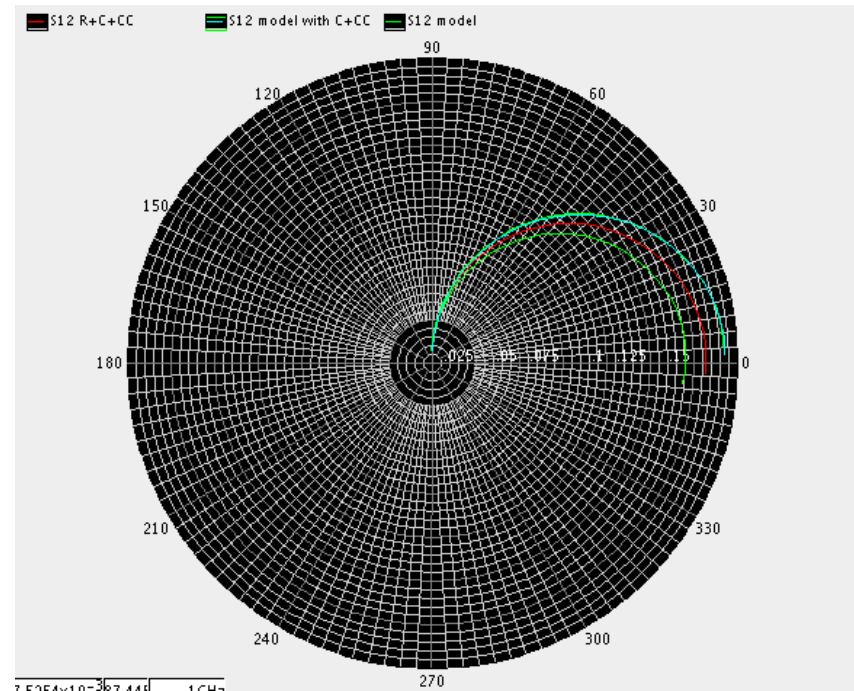
# MOS\_SGDGS\_CS @ (60n/1u/50)

## $2R_g * 3.2$



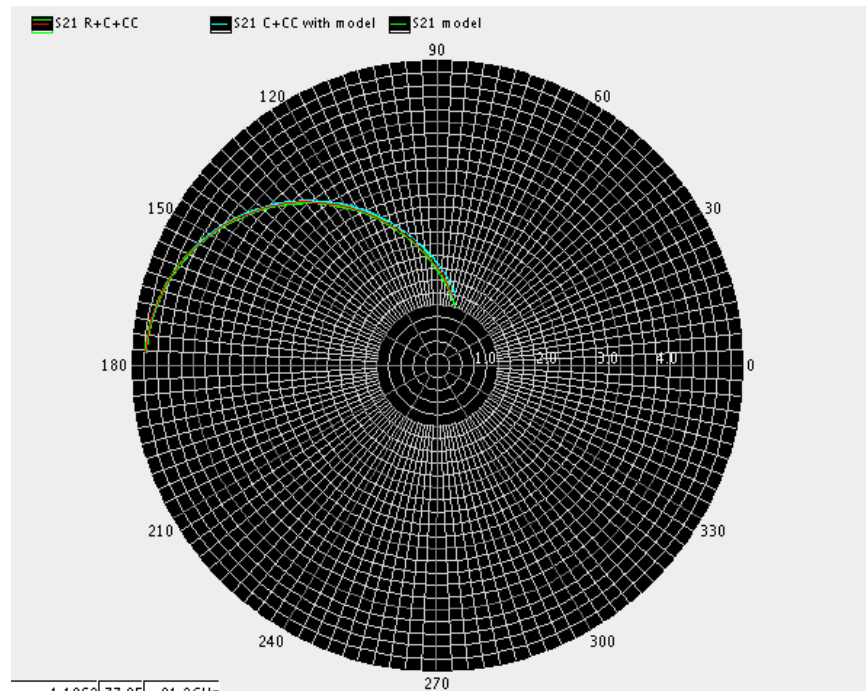
# S12

# MOS\_SGDGS\_CS @ (60n/1u/50) 2Rg\*2



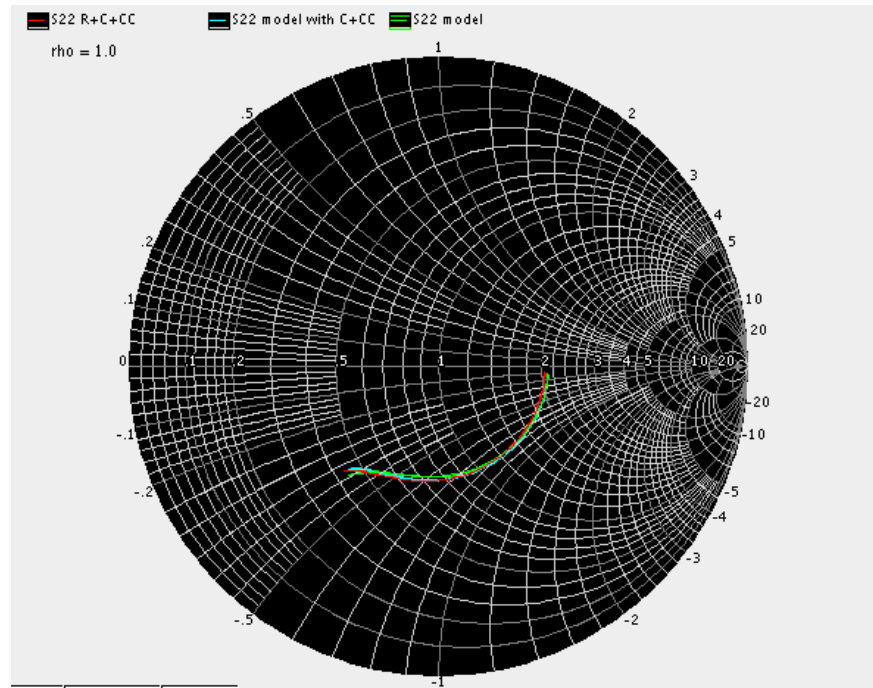
S12

# MOS\_SGDGS\_CS @ (60n/1u/50)



S21

# MOS\_SGDGS\_CS @ (60n/1u/50)



S22

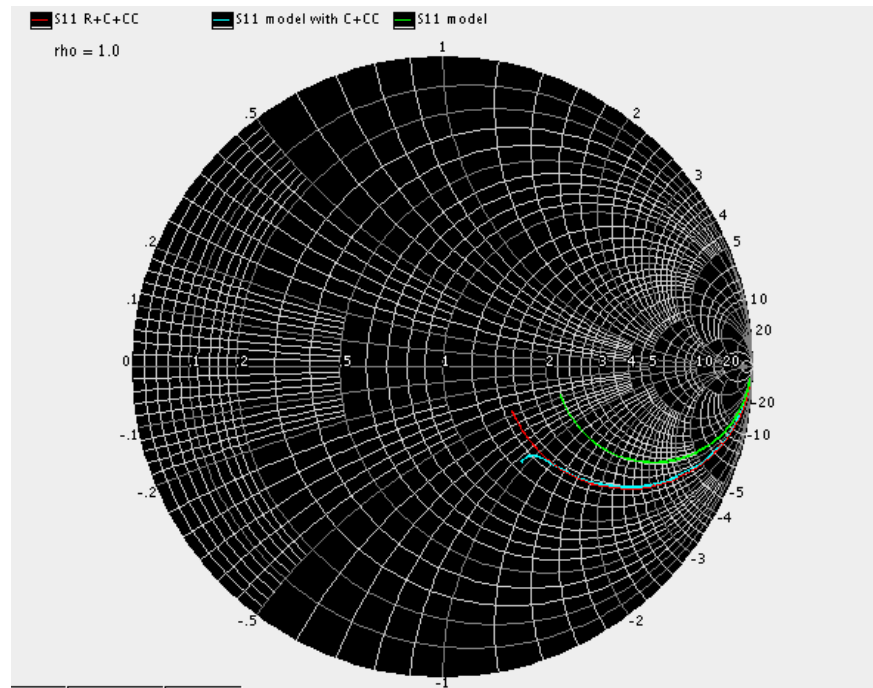


# MOS\_SGDGS\_CS @ (60n/1u/50)

- R + C + CC :  $I_d = 31.24 \text{ mA}$
- C + CC with model :  $I_d = 30.35 \text{ mA}$
- model :  $I_d = 30.35 \text{ mA}$

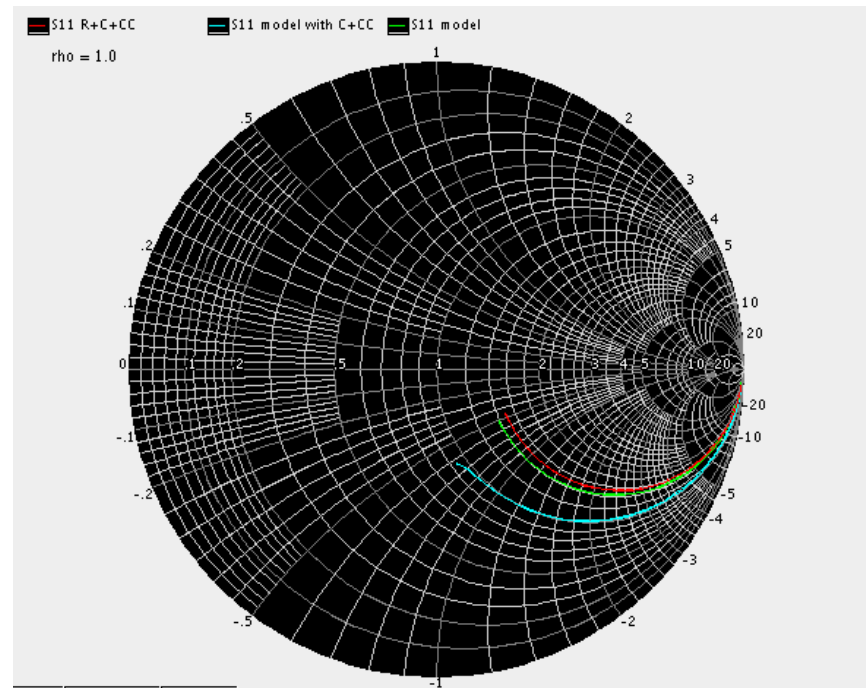
# MOS\_SGDGS\_CS @ (60n/5u/10)

## $2R_g * 3.2$



**S11**

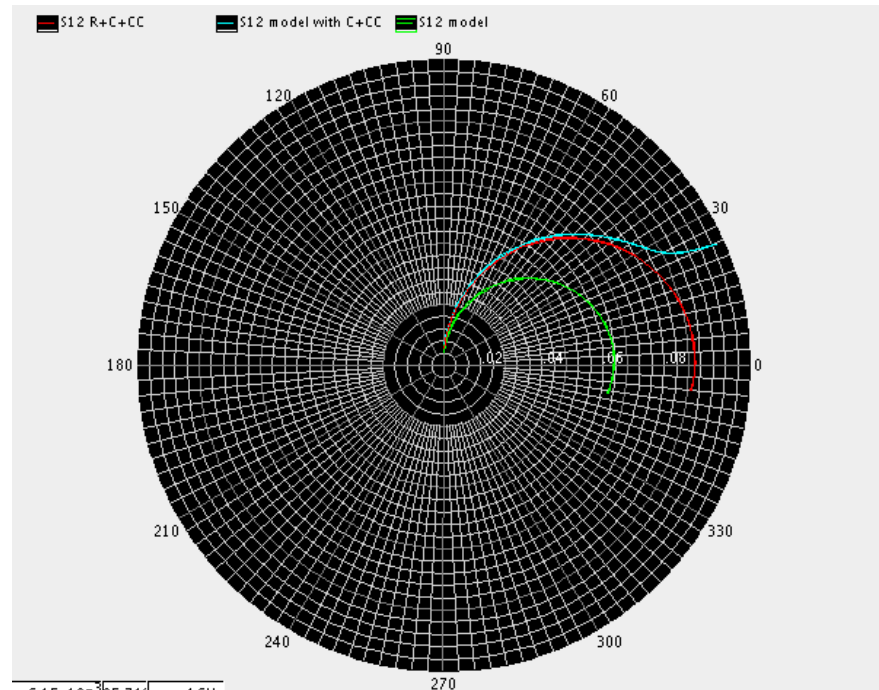
# MOS\_SGDGS\_CS @ (60n/5u/10) 2Rg\*2



S11

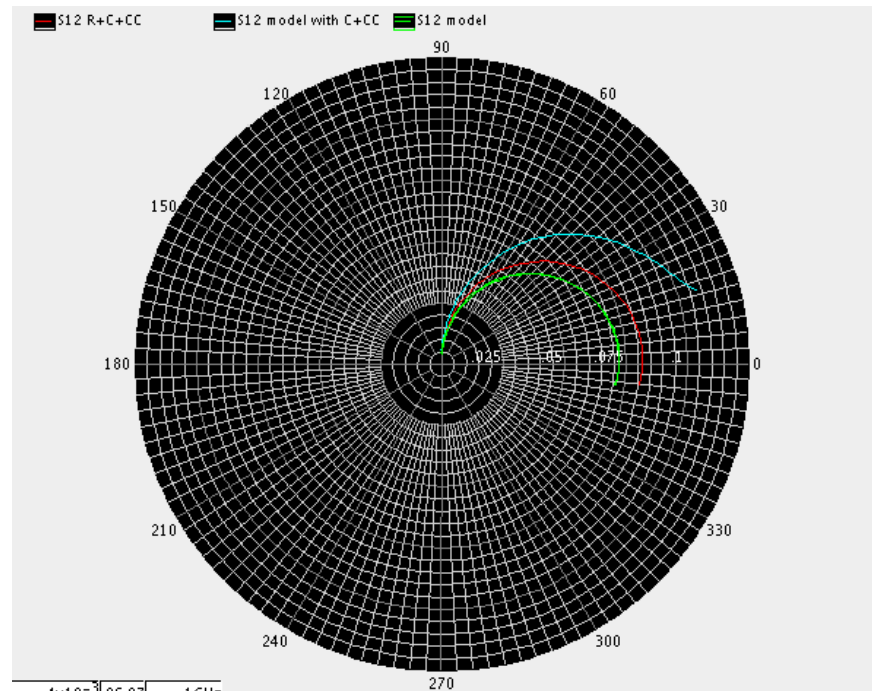
# MOS\_SGDGS\_CS @ (60n/5u/10)

## $2R_g * 3.2$



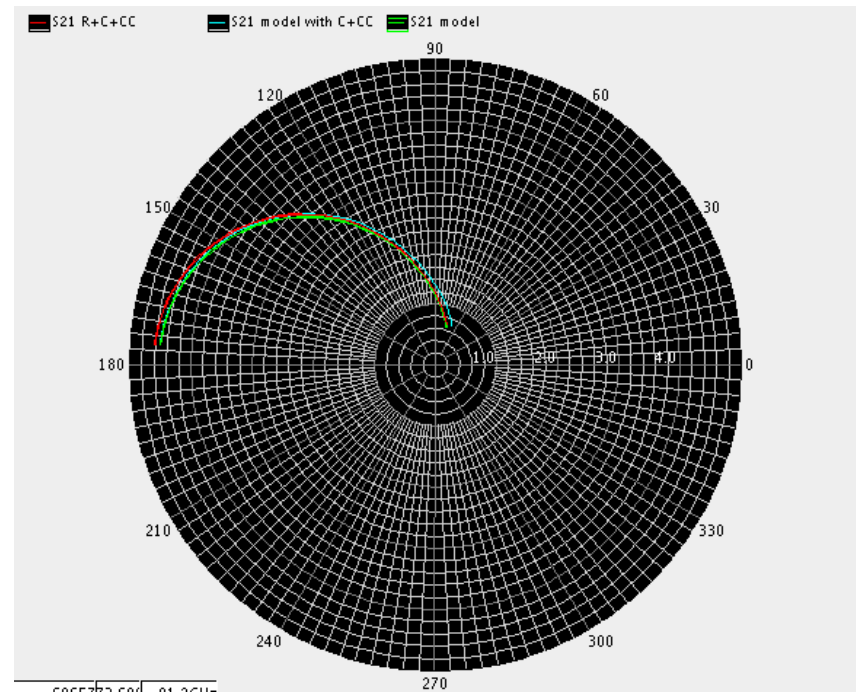
# S12

# MOS\_SGDGS\_CS @ (60n/5u/10) 2Rg\*2



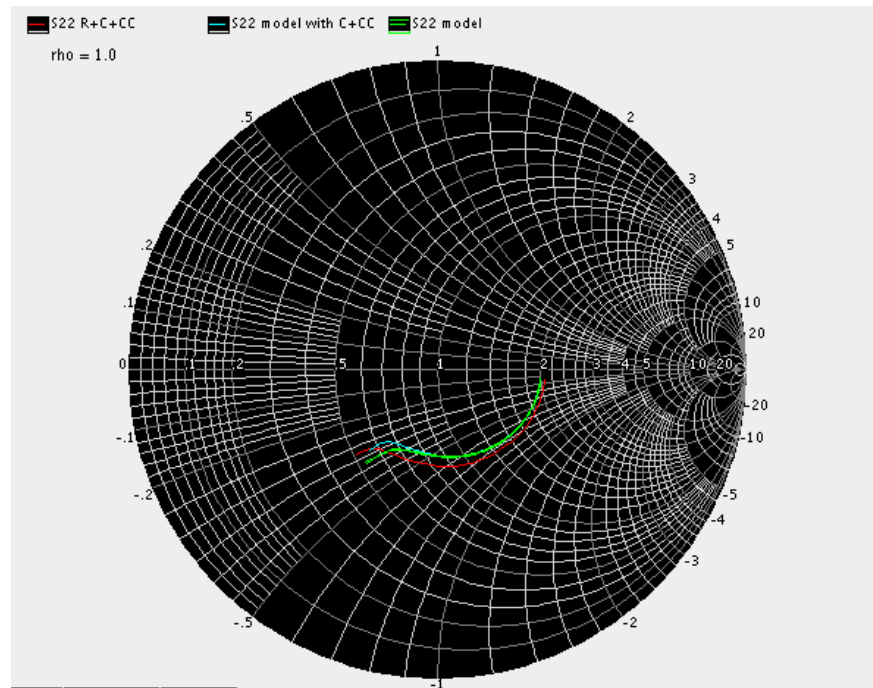
S12

# MOS\_SGDGS\_CS @ (60n/5u/10)



S21

# MOS\_SGDGS\_CS @ (60n/5u/10)



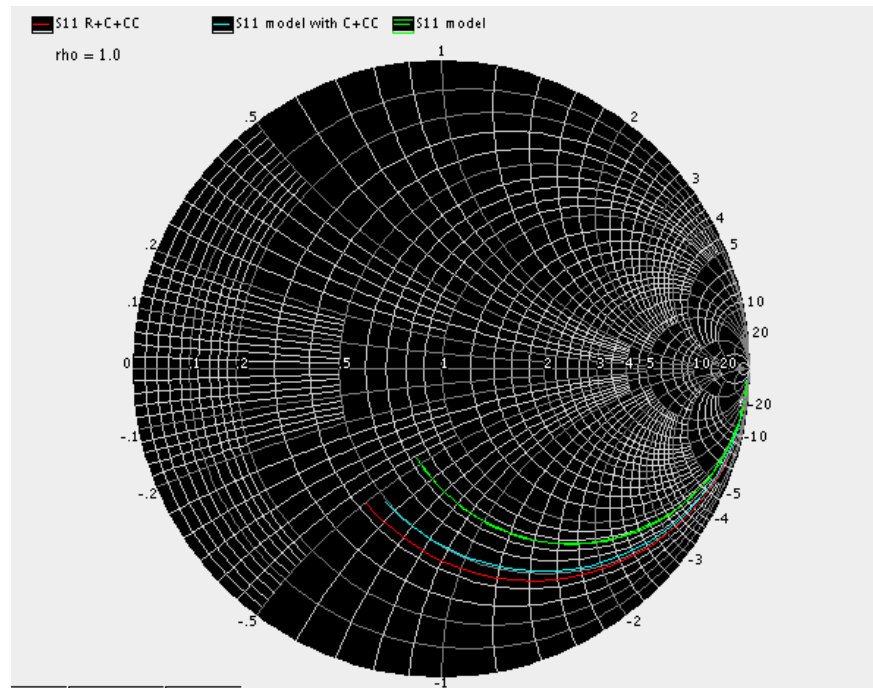
S22

# MOS\_SGDGS\_CS @ (60n/5u/10)

- R + C + CC :  $I_d = 30.07 \text{ mA}$
- C + CC with model :  $I_d = 29.71 \text{ mA}$
- model :  $I_d = 30.07 \text{ mA}$

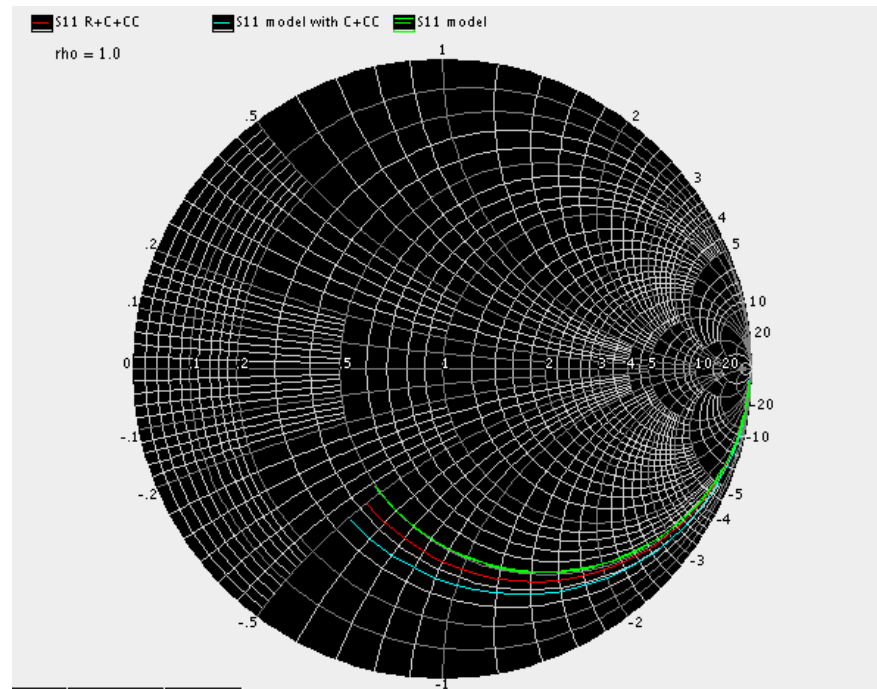


MOS\_SGDGS\_CS @  
(60n/2u/20)2Rg\*3.2



S11

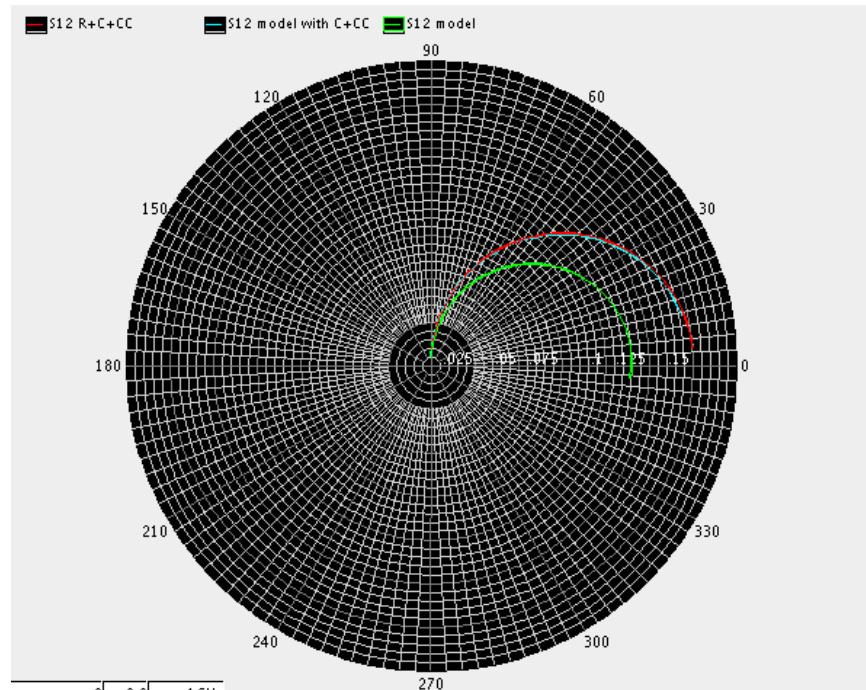
# MOS\_SGDGS\_CS @ (60n/2u/20)2Rg\*2



S11

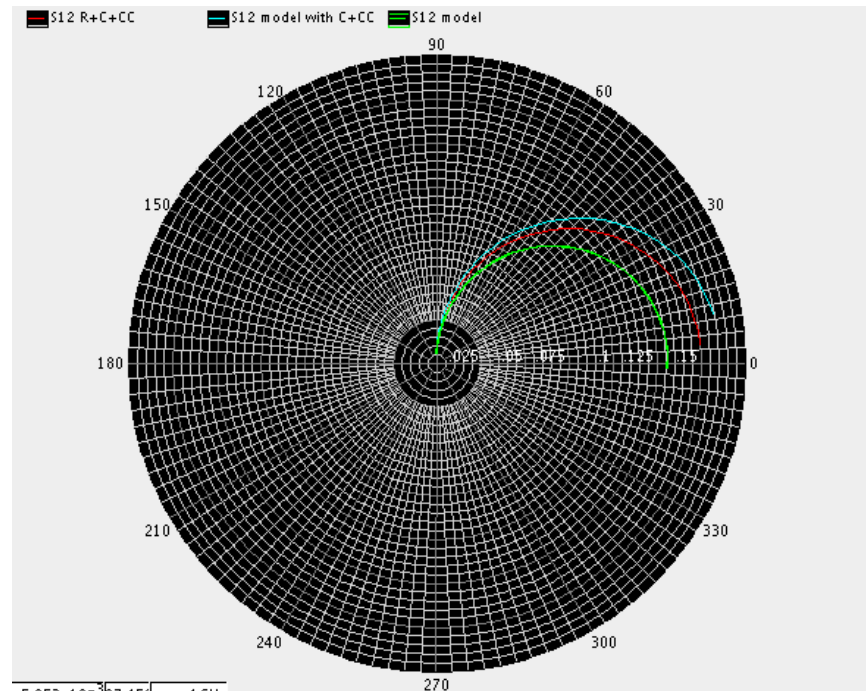
# MOS\_SGDGS\_CS @ (60n/2u/20)

## 2Rg\*3.2



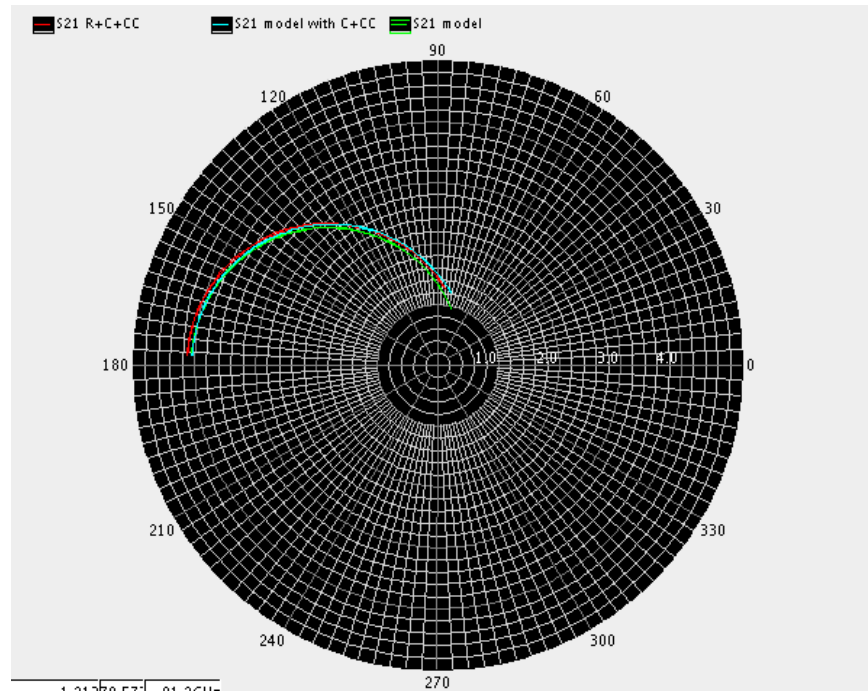
S12

# MOS\_SGDGS\_CS @ (60n/2u/20) 2Rg\*2



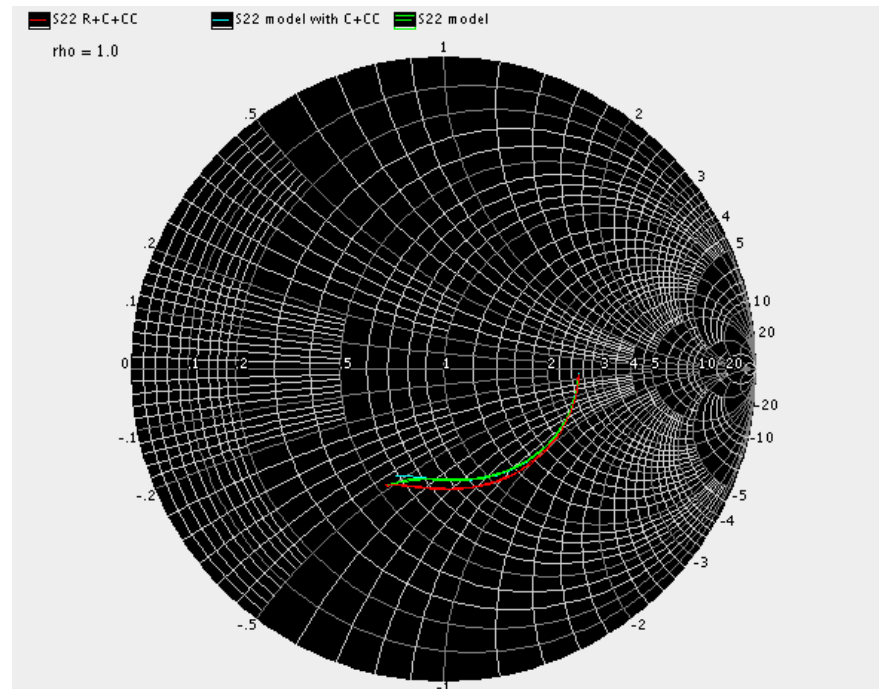
S12

# MOS\_SGDGS\_CS @ (60n/2u/20)



S21

# MOS\_SGDGS\_CS @ (60n/2u/20)



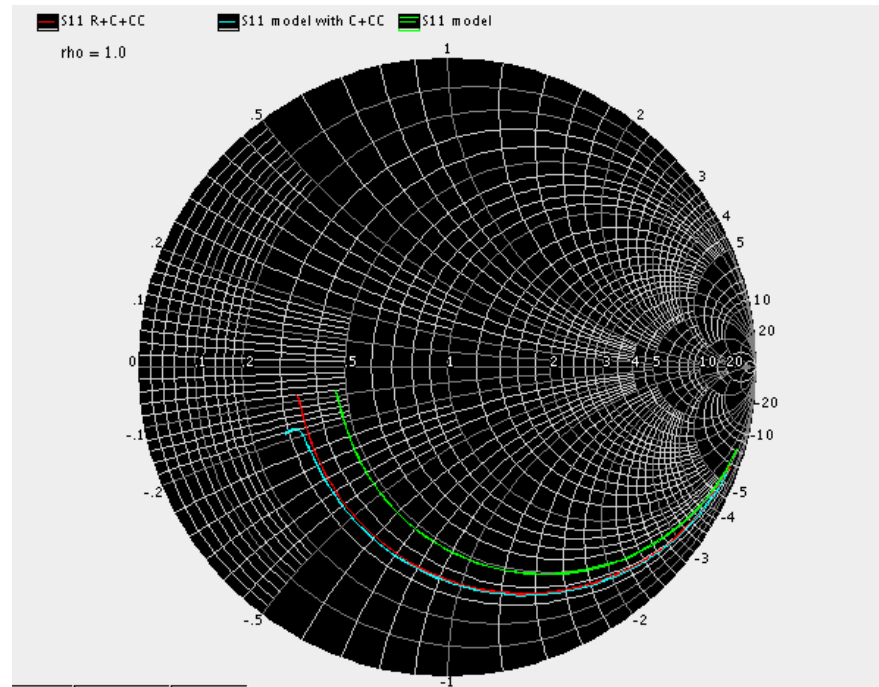
S22

# MOS\_SGDGS\_CS @ (60n/2u/20)

- R + C + CC :  $I_d = 25.15 \text{ mA}$
- C + CC with model :  $I_d = 24.44 \text{ mA}$
- model :  $I_d = 24.44 \text{ mA}$

# MOS\_SGDGS\_CS @ (60n/5u/50)

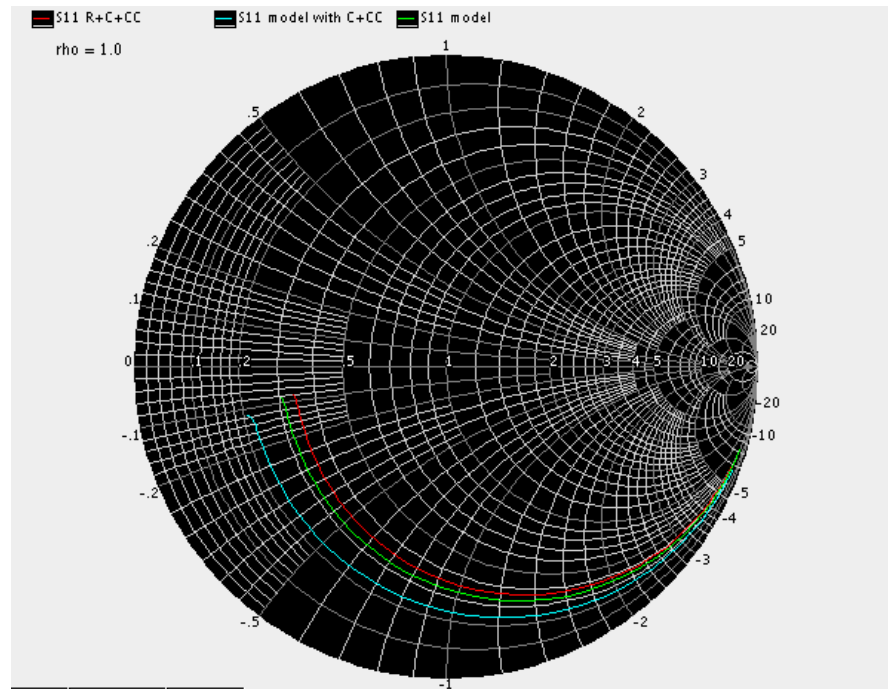
## $2R_g * 3.2$



**S11**



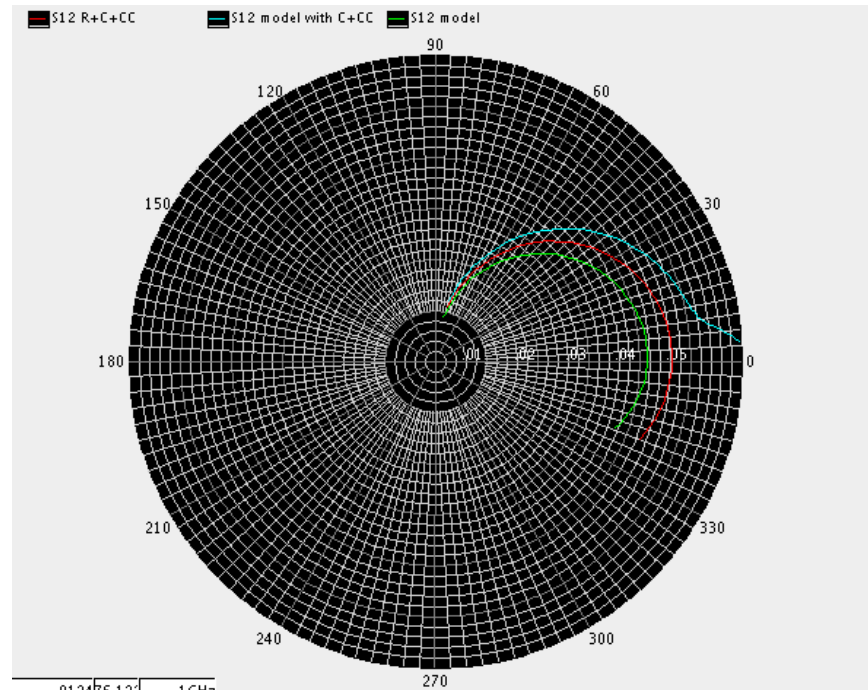
# MOS\_SGDGS\_CS @ (60n/5u/50) 2Rg\*2



S11

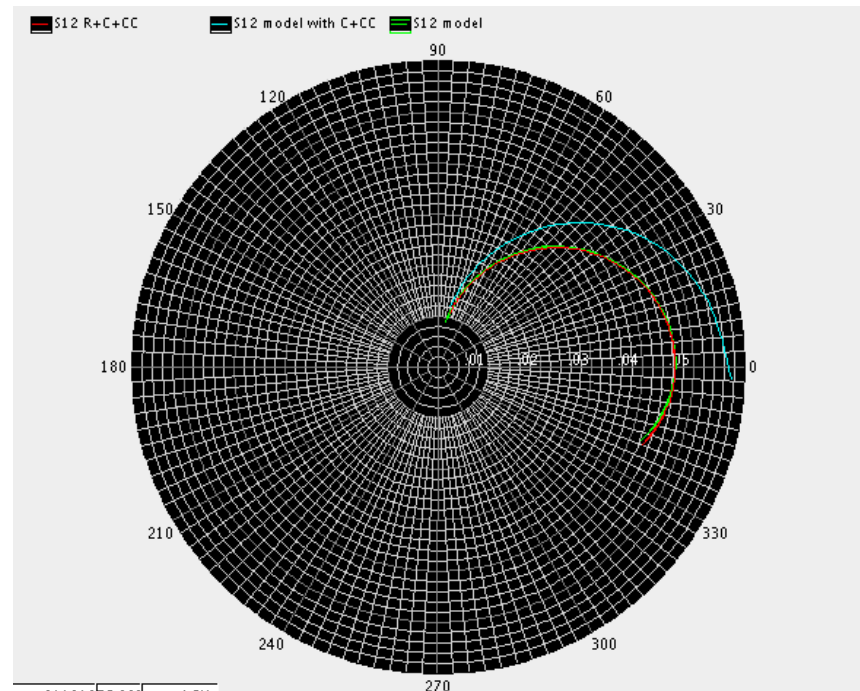
# MOS\_SGDGS\_CS @ (60n/5u/50)

## $2R_g * 3.2$



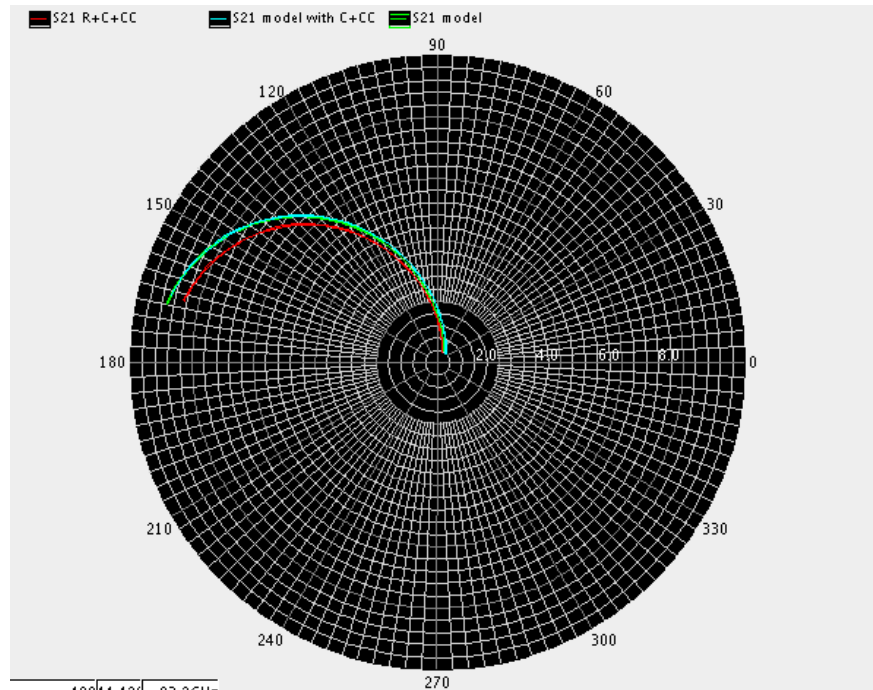
# S12

# MOS\_SGDGS\_CS @ (60n/5u/50) 2Rg\*2



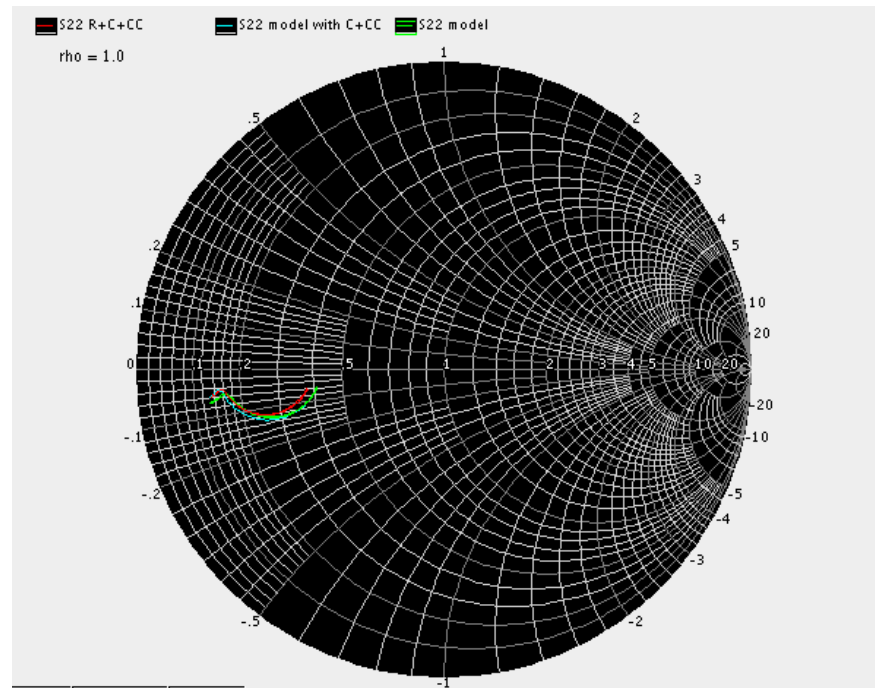
S12

# MOS\_SGDGS\_CS @ (60n/5u/50)



S21

# MOS\_SGDGS\_CS @ (60n/5u/50)



S22

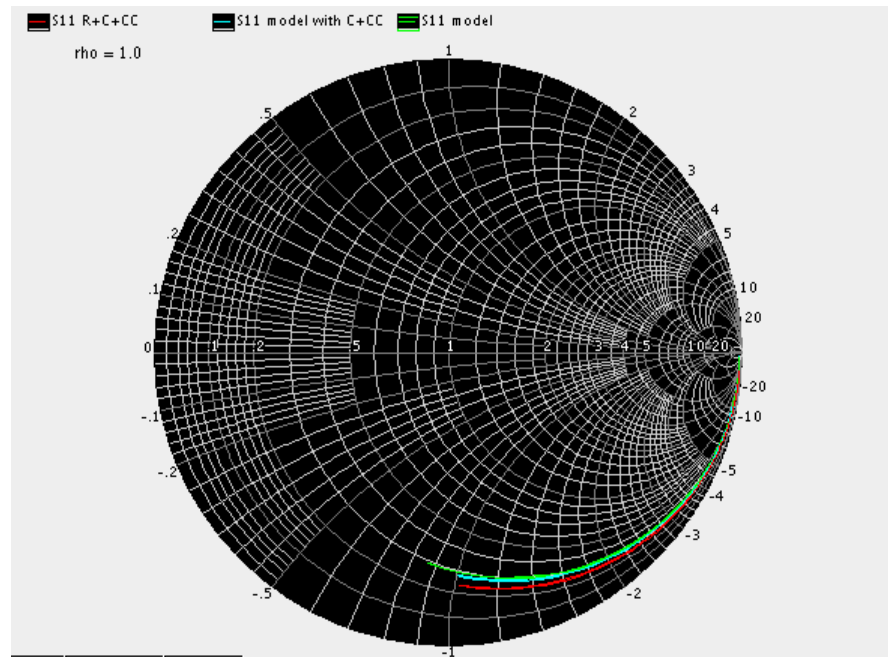
# MOS\_SGDGS\_CS @ (60n/5u/50)

- R + C + CC :  $I_d = 142.2 \text{ mA}$
- C + CC with model :  $I_d = 137.8 \text{ mA}$
- model :  $I_d = 137.8 \text{ mA}$

# Model Comparison Result

- THz MOS
  - THz\_NMOS\_CS
- Analog MOS
  - MOS\_BGDSGB\_CG
  - MOS\_SGDGS\_CS
  - MOS\_BSGGDB\_Gilbert
- Power MOS
  - PowerM\_CSAr
  - PowerM\_CCAr\_longL

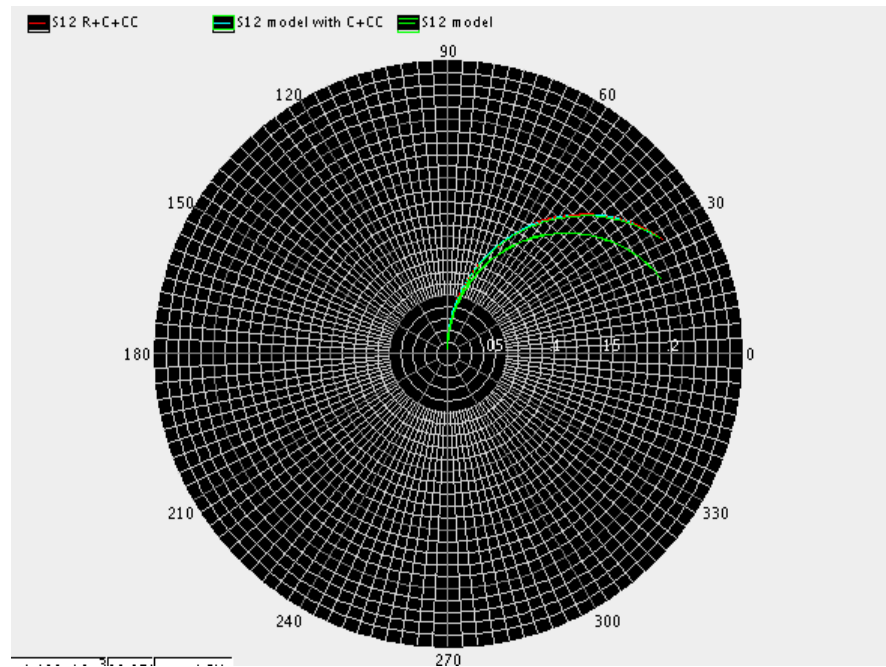
# MOS\_BSGGDB\_Gilbert @ (60n/1u/20)



S11

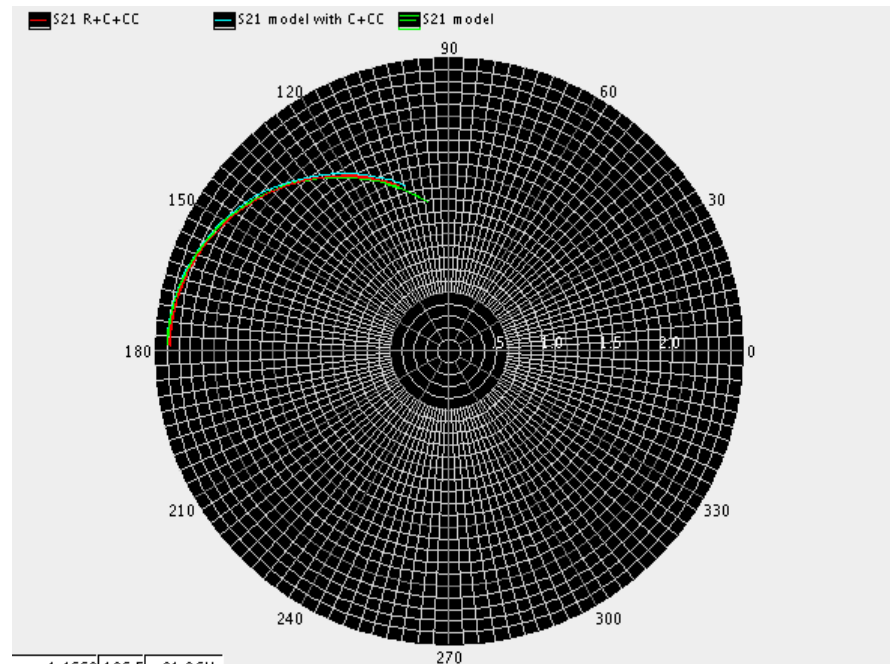


# MOS\_BSGGDB\_Gilbert @ (60n/1u/20)



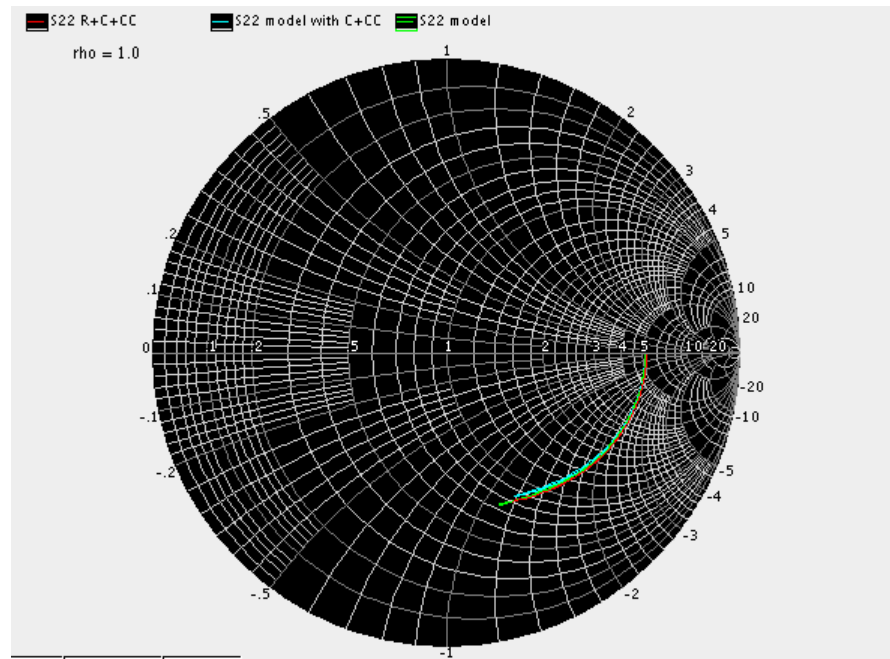
S12

# MOS\_BSGGDB\_Gilbert @ (60n/1u/20)



S21

# MOS\_BSGGDB\_Gilbert @ (60n/1u/20)



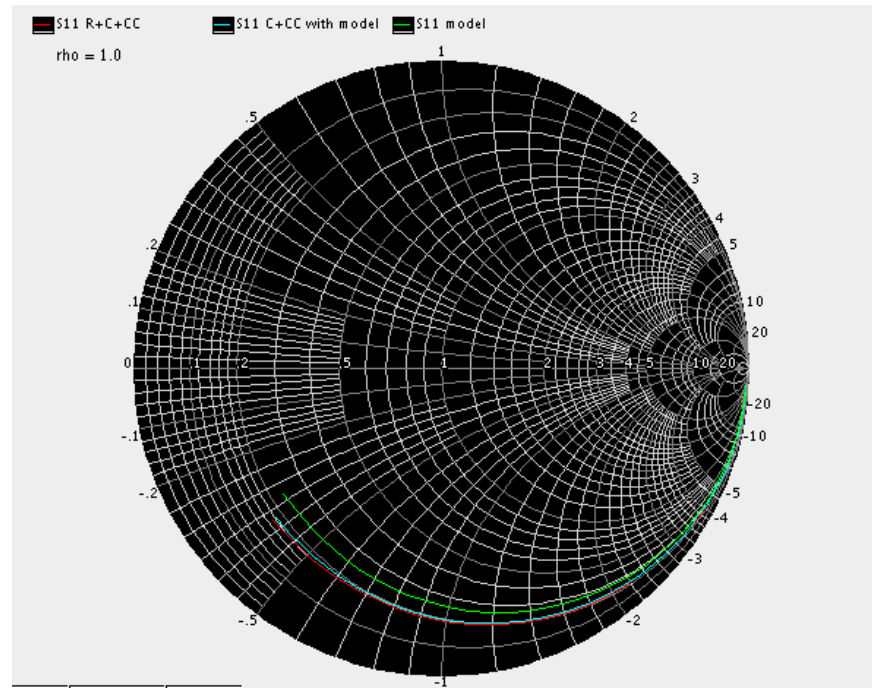
S22

# MOS\_BSGGDB\_Gilbert @ (60n/1u/20)

- R + C + CC :  $I_d = 12.32 \text{ mA}$
- C + CC with model :  $I_d = 12.24 \text{ mA}$
- model :  $I_d = 12.24 \text{ mA}$

# MOS\_BSGGDB\_Gilbert @ (60n/1u/50)

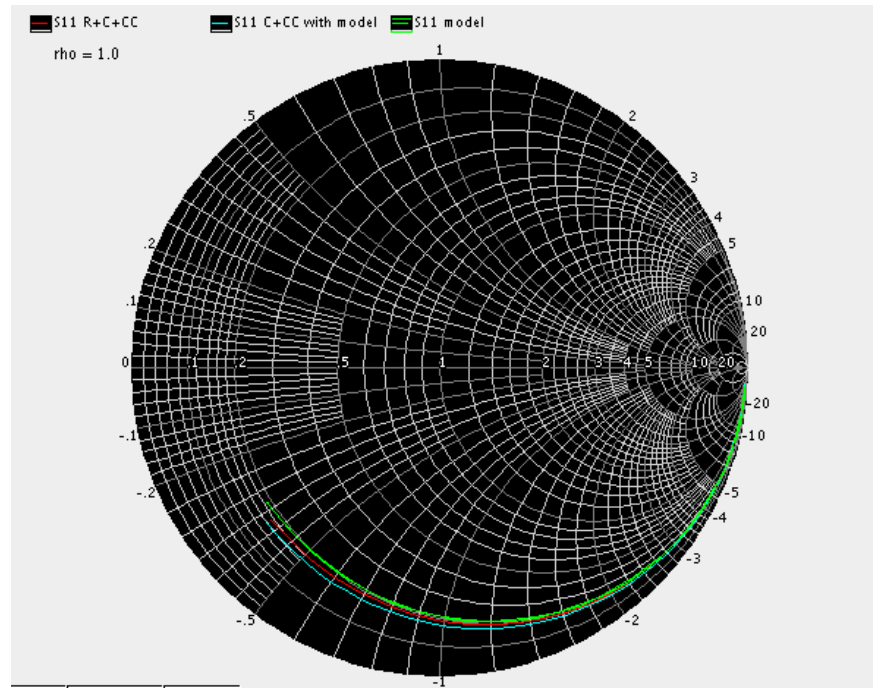
## $R_g * 3.2$



$S_{11}$

# MOS\_BSGGDB\_Gilbert @ (60n/1u/50)

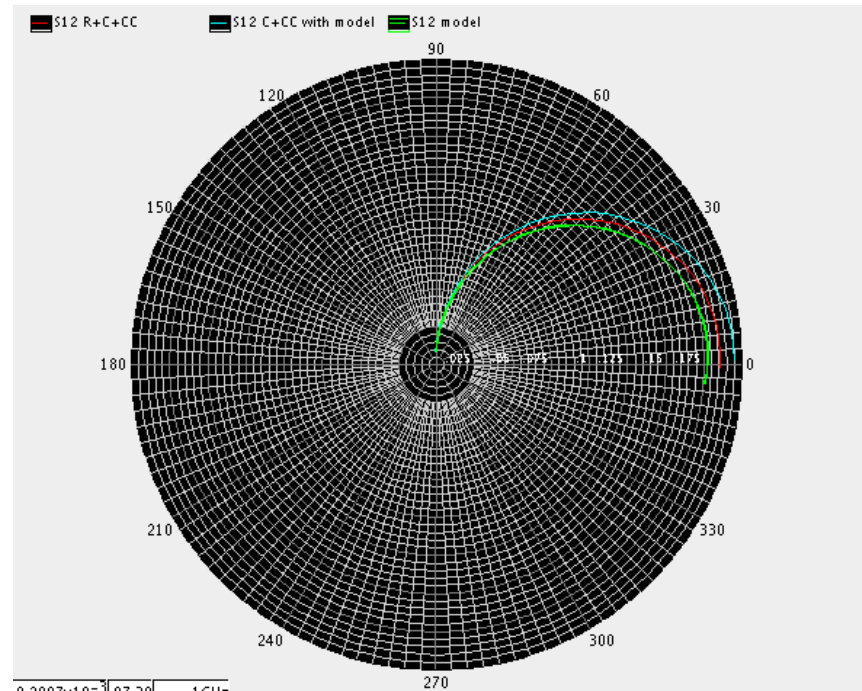
## $R_g * 2$



$S_{11}$

# MOS\_BSGGDB\_Gilbert @ (60n/1u/50)

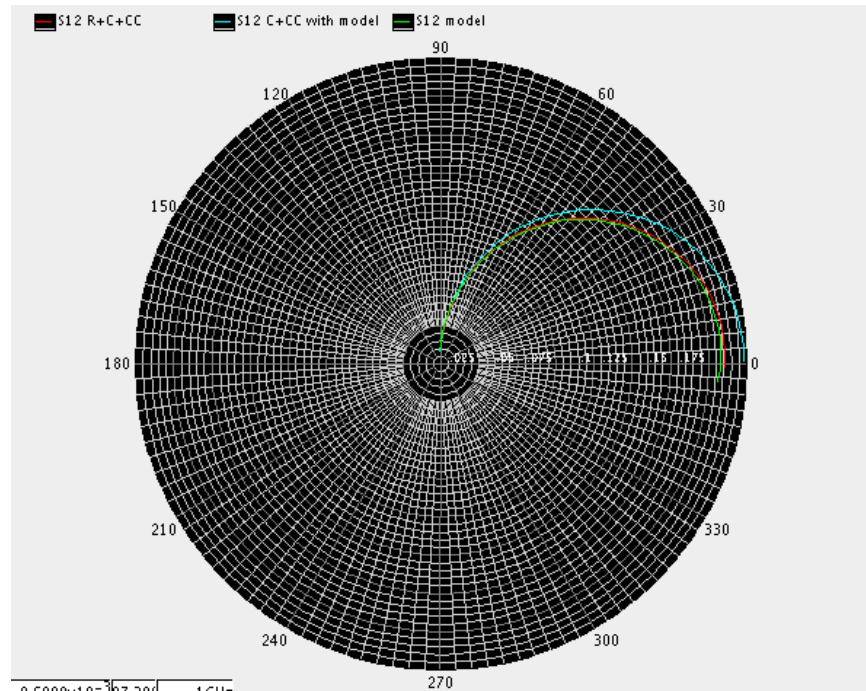
## $R_g * 3.2$



S12

# MOS\_BSGGDB\_Gilbert @ (60n/1u/50)

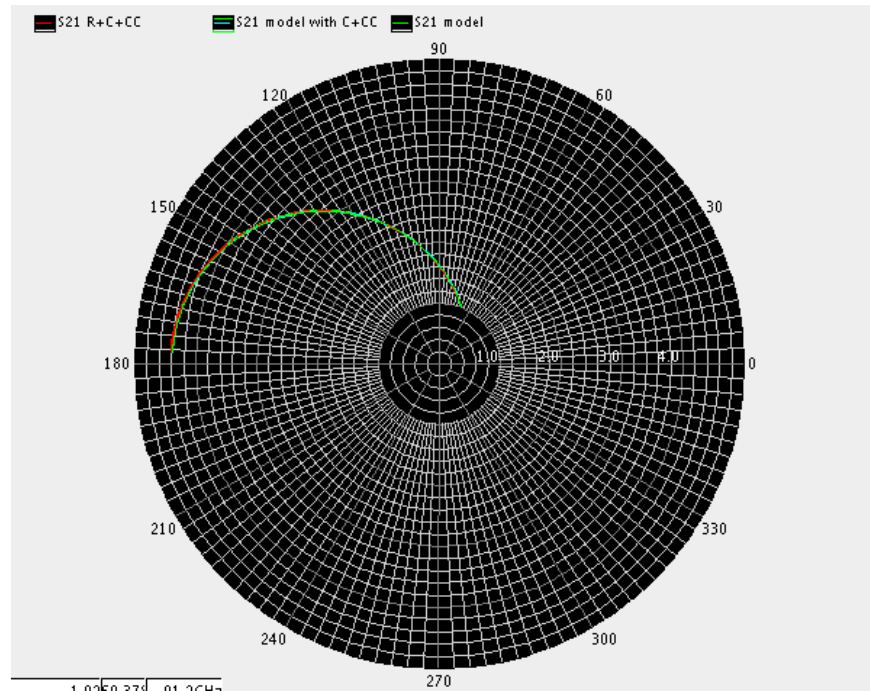
## $R_g \times 2$



# S12

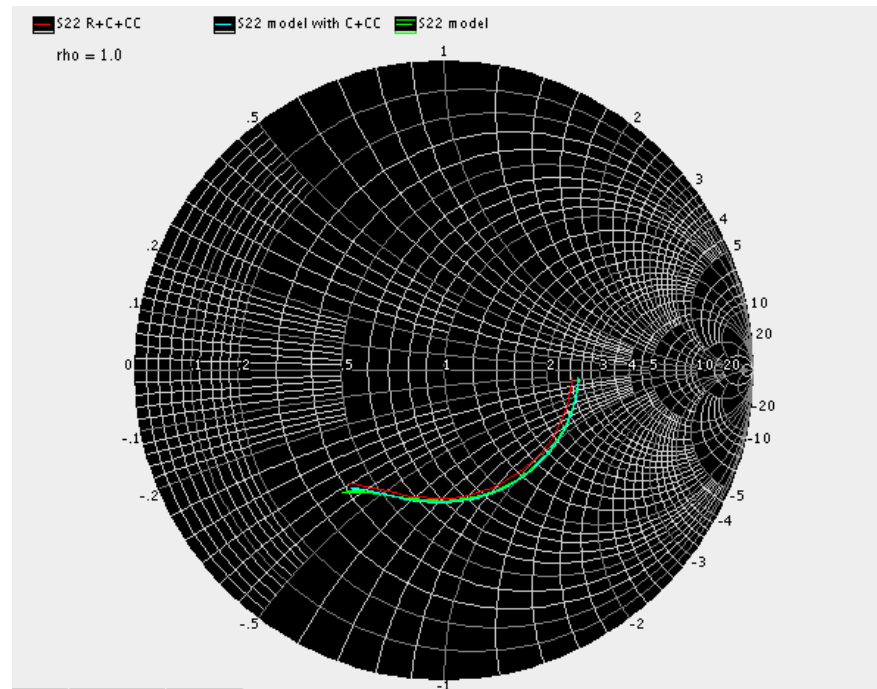


# MOS\_BSGGDB\_Gilbert @ (60n/1u/50)



S21

# MOS\_BSGGDB\_Gilbert @ (60n/1u/50)



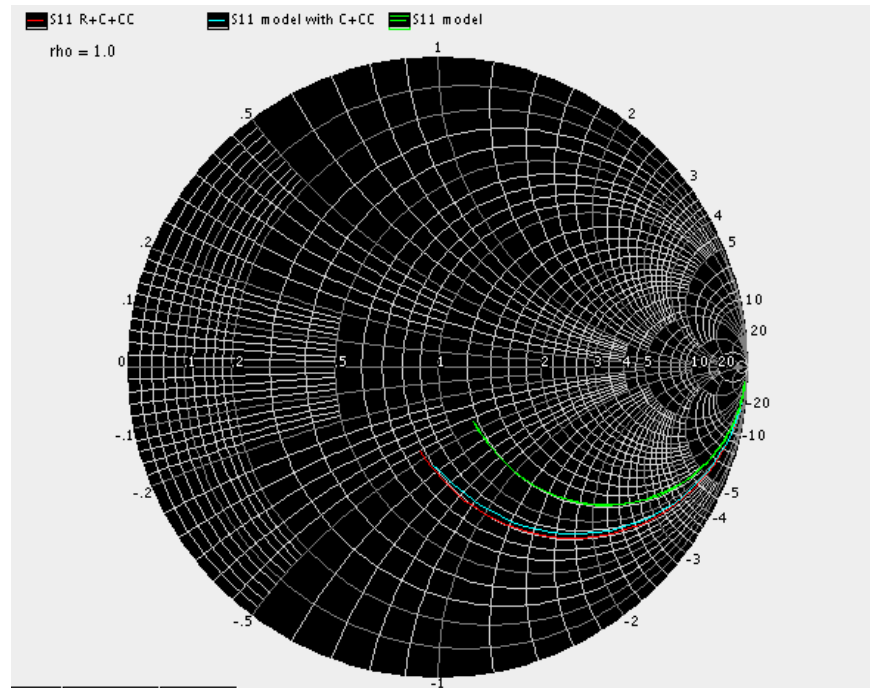
S22

# MOS\_BSGGDB\_Gilbert @ (60n/1u/50)

- R + C + CC :  $I_d = 27.7 \text{ mA}$
- C + CC with model :  $I_d = 26.63 \text{ mA}$
- model :  $I_d = 26.63 \text{ mA}$

# MOS\_BSGGDB\_Gilbert @ (60n/5u/10)

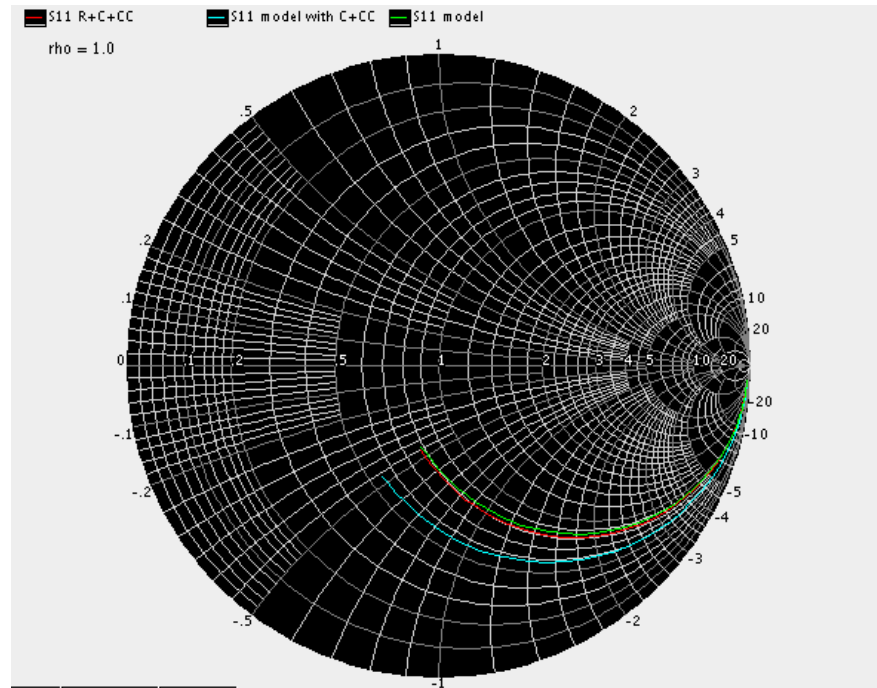
## $R_g * 3.2$



$S_{11}$

# MOS\_BSGGDB\_Gilbert @ (60n/5u/10)

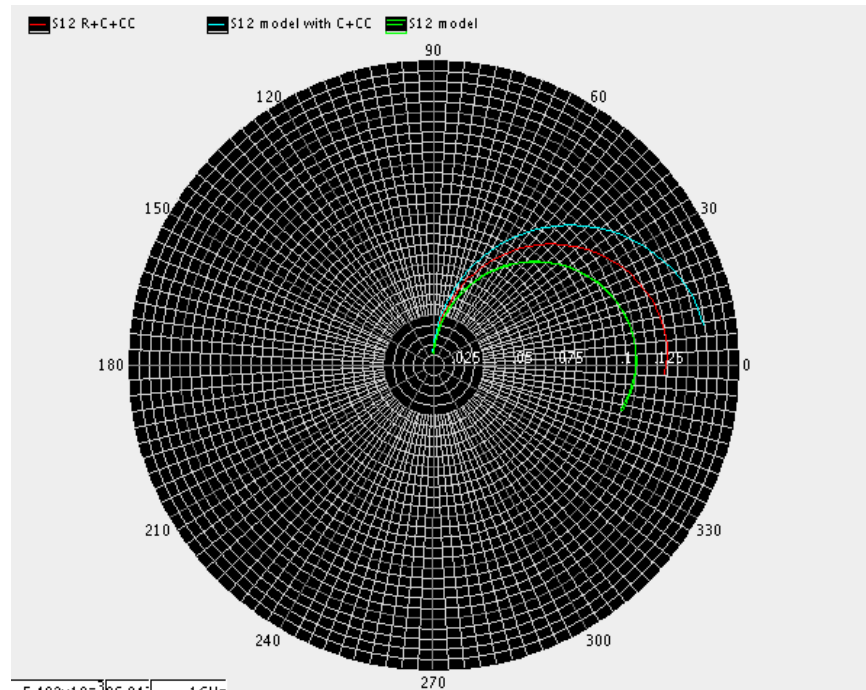
## $R_g \cdot 2$



$S_{11}$

# MOS\_BSGGDB\_Gilbert @ (60n/5u/10)

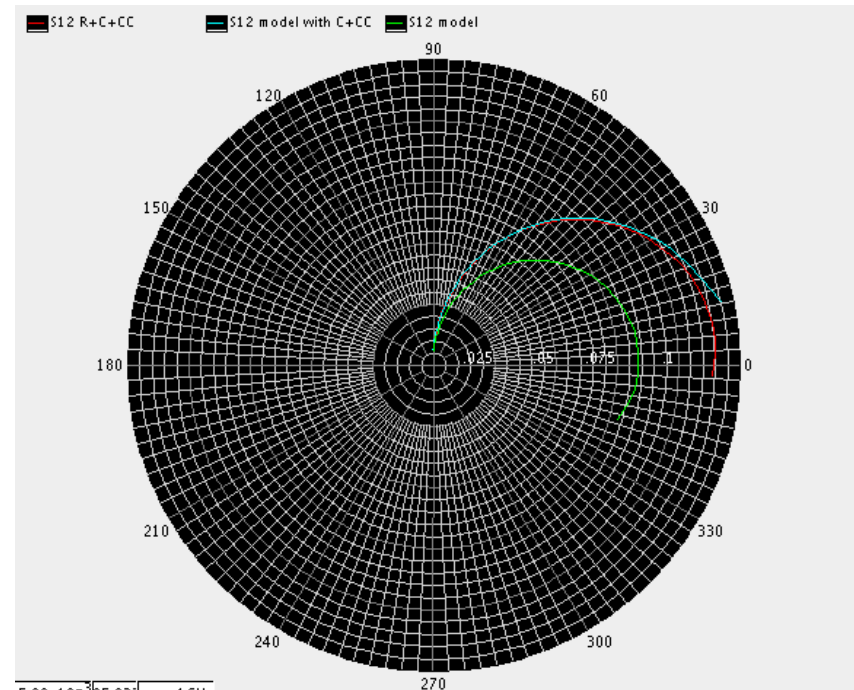
## $R_g * 3.2$



S12

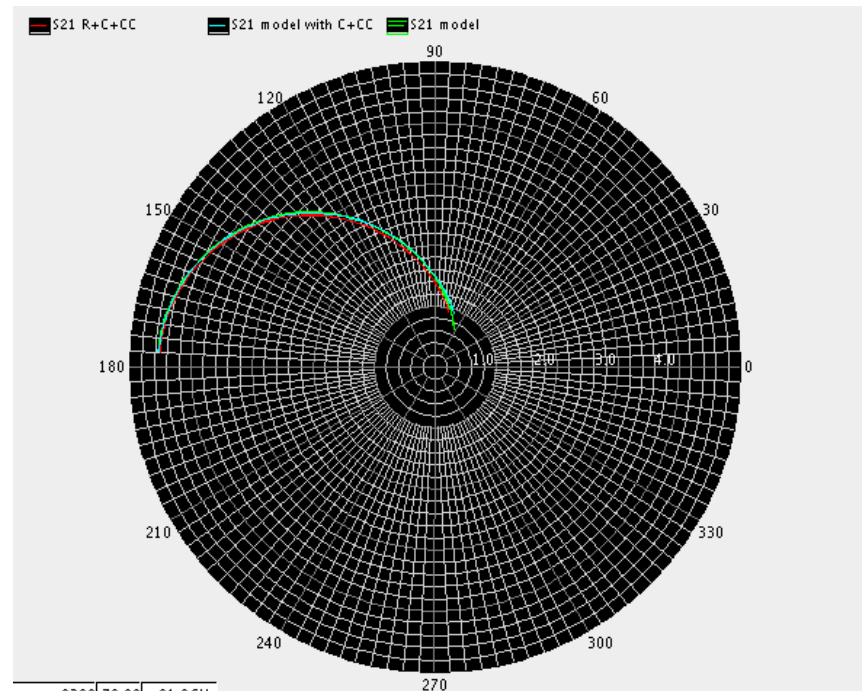
# MOS\_BSGGDB\_Gilbert @ (60n/5u/10)

## $R_g \times 2$



# S12

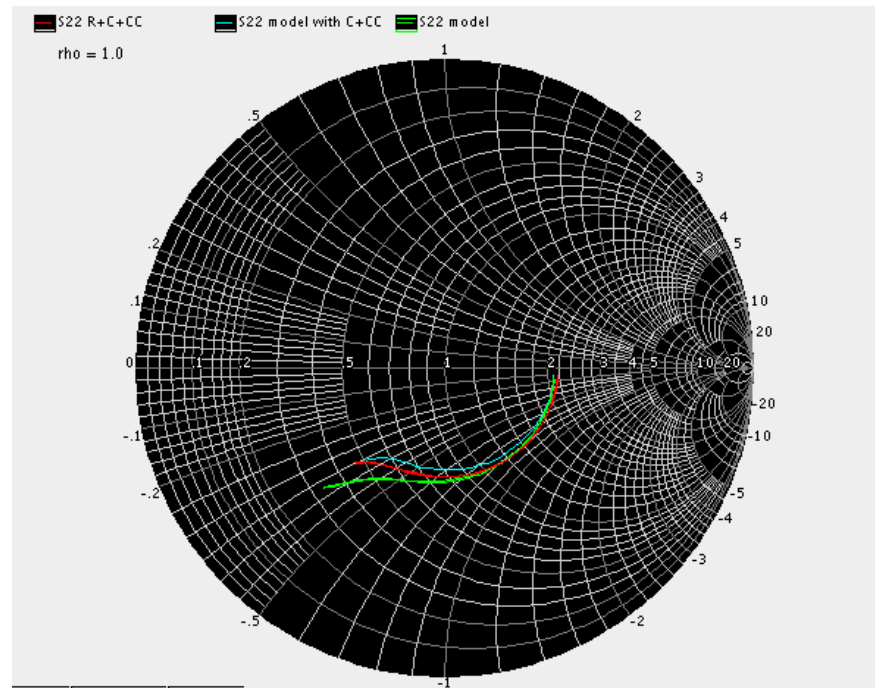
# MOS\_BSGGDB\_Gilbert @ (60n/5u/10)



S21



# MOS\_BSGGDB\_Gilbert @ (60n/5u/10)



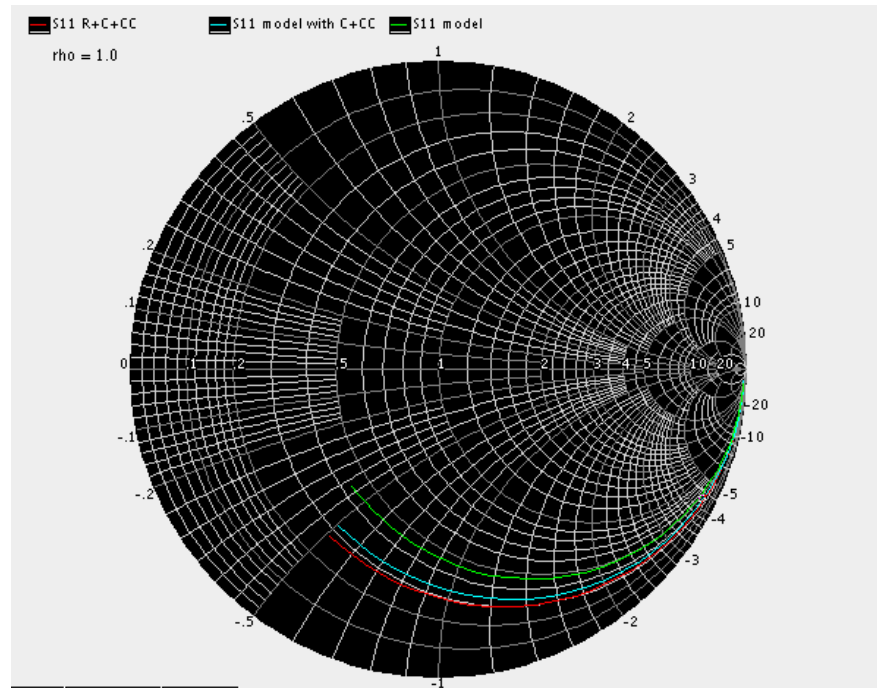
S22

# MOS\_BSGGDB\_Gilbert @ (60n/5u/10)

- R + C + CC :  $I_d = 29.25 \text{ mA}$
- C + CC with model :  $I_d = 29.25 \text{ mA}$
- model :  $I_d = 29.25 \text{ mA}$

# MOS\_BSGGDB\_Gilbert @ (60n/2u/20)

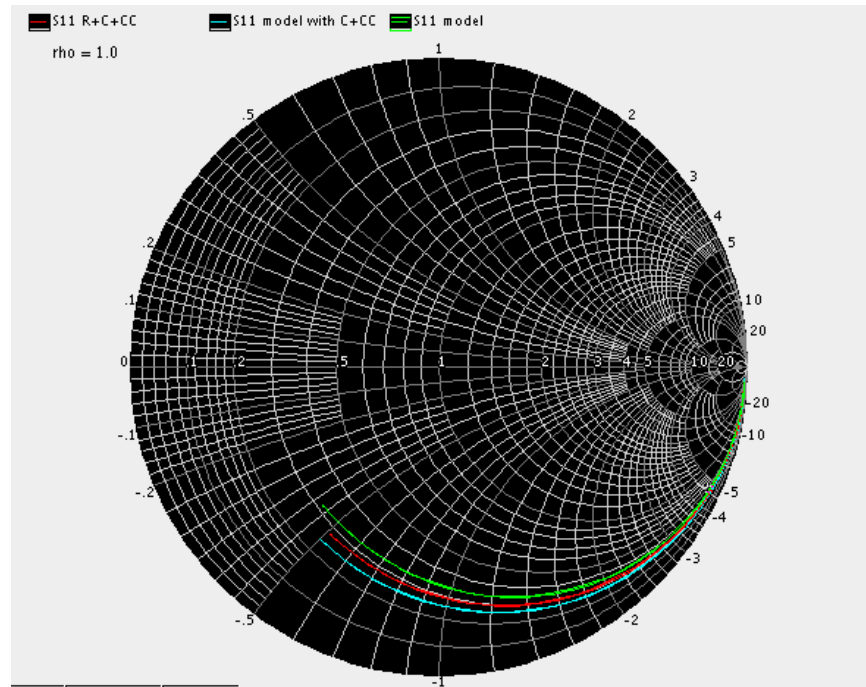
## $R_g * 3.2$



$S_{11}$

# MOS\_BSGGDB\_Gilbert @ (60n/2u/20)

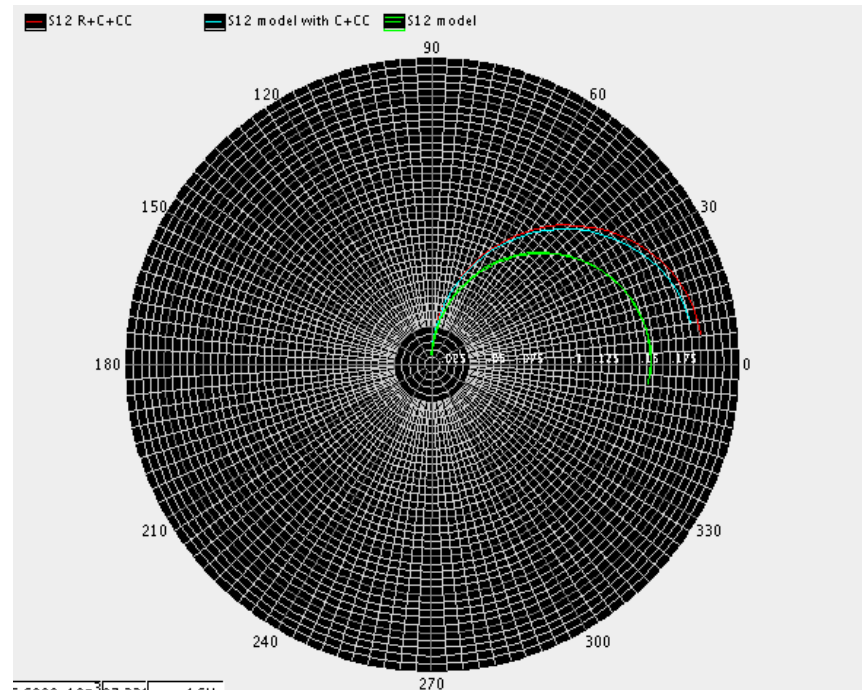
## $R_g \cdot 2$



$S_{11}$

# MOS\_BSGGDB\_Gilbert @ (60n/2u/20)

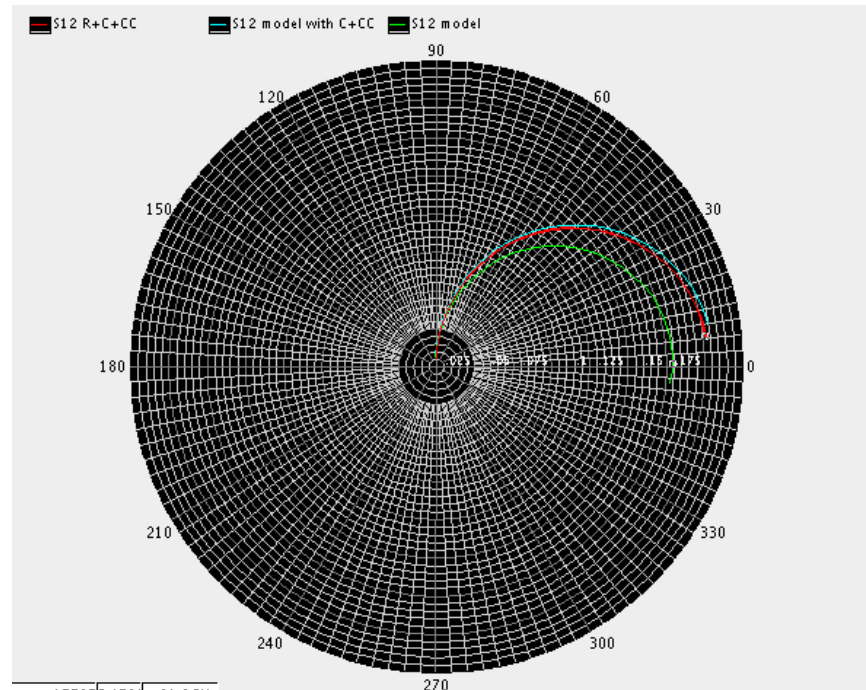
## $R_g * 3.2$



S12

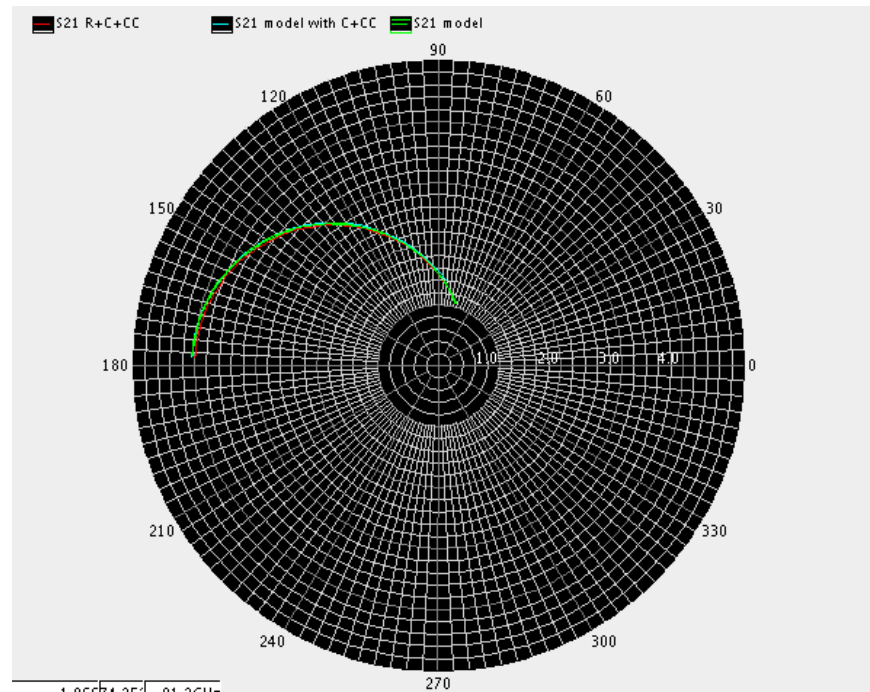
# MOS\_BSGGDB\_Gilbert @ (60n/2u/20)

## $R_g \cdot 2$



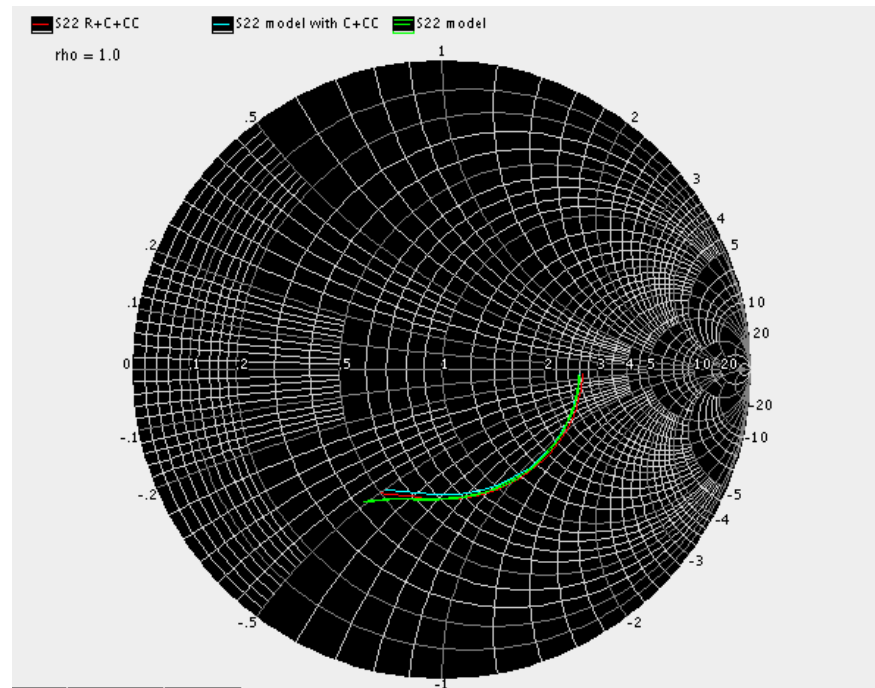
# S12

# MOS\_BSGGDB\_Gilbert @ (60n/2u/20)



S21

# MOS\_BSGGDB\_Gilbert @ (60n/2u/20)



S22

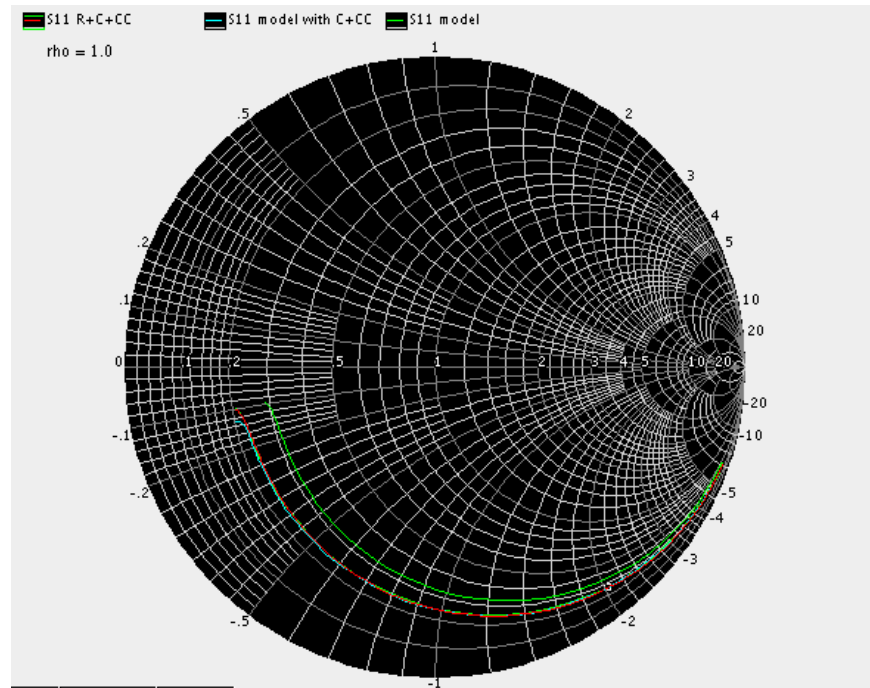


# MOS\_BSGGDB\_Gilbert @ (60n/2u/20)

- R + C + CC :  $I_d = 24.02 \text{ mA}$
- C + CC with model :  $I_d = 24.12 \text{ mA}$
- model :  $I_d = 24.12 \text{ mA}$

# MOS\_BSGGDB\_Gilbert @ (60n/5u/50)

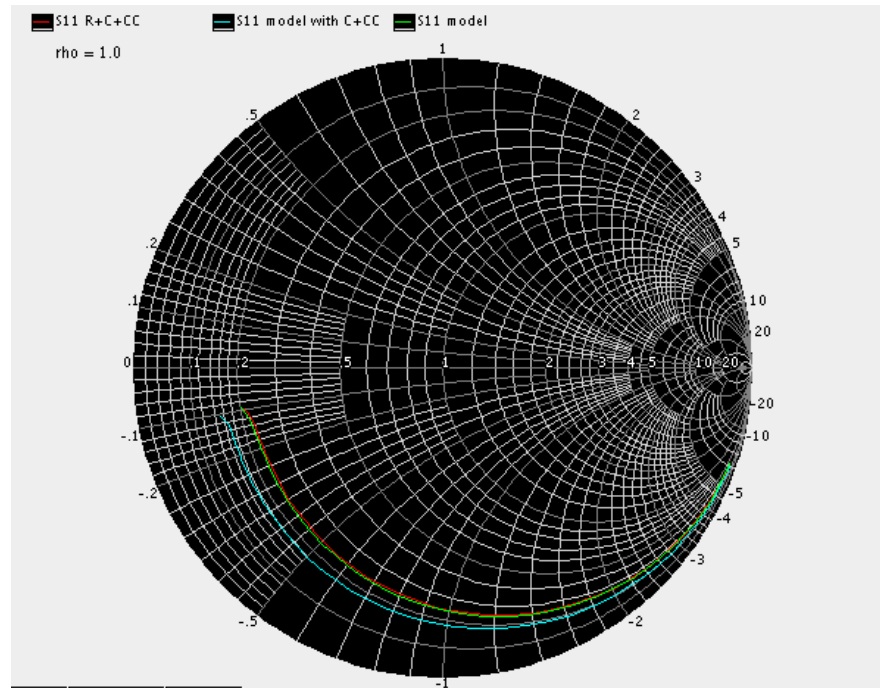
## $R_g * 3.2$



**S11**

# MOS\_BSGGDB\_Gilbert @ (60n/5u/50)

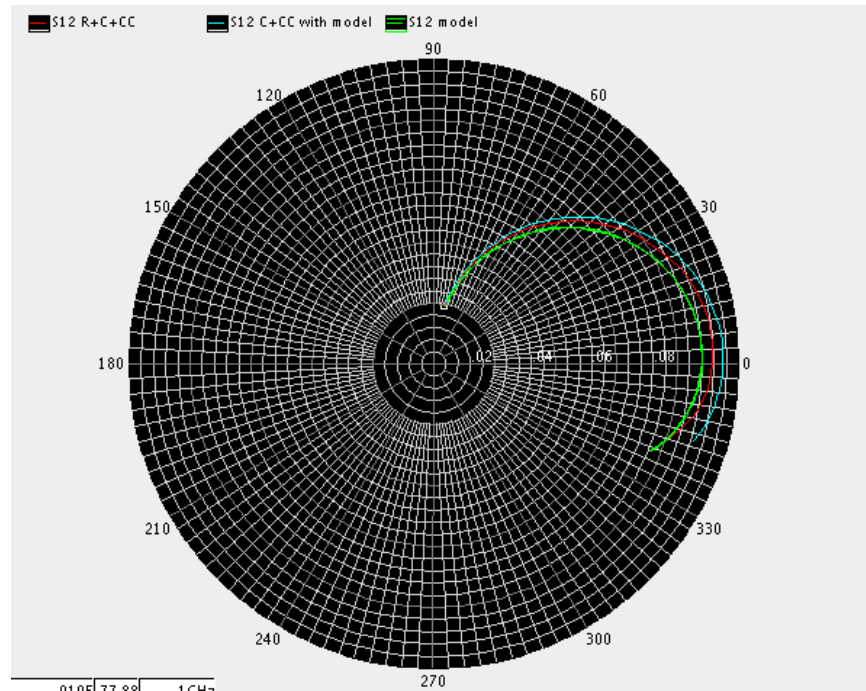
## $R_g \times 2$



$S_{11}$

# MOS\_BSGGDB\_Gilbert @ (60n/5u/50)

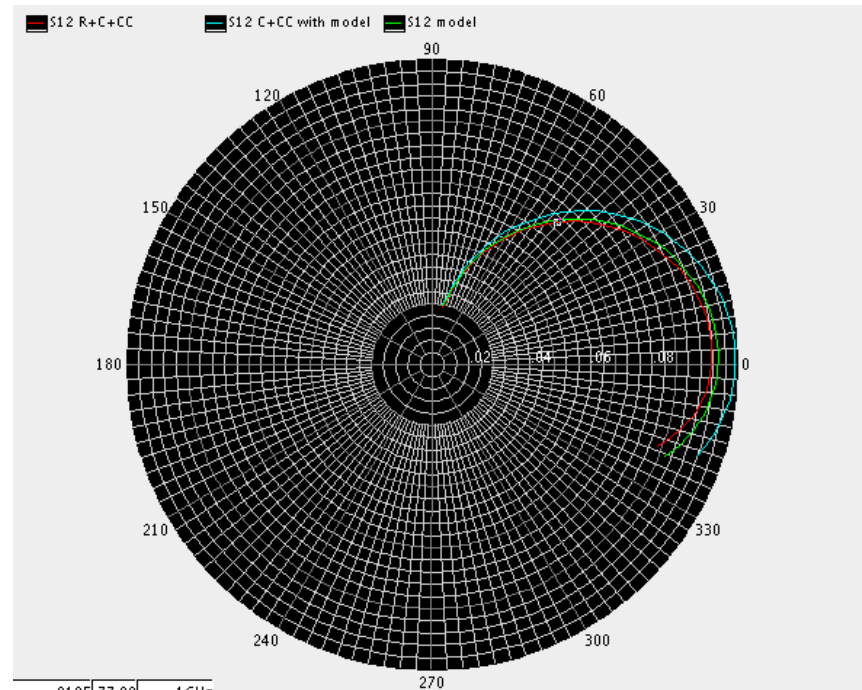
$R_g * 3.2$



## S12

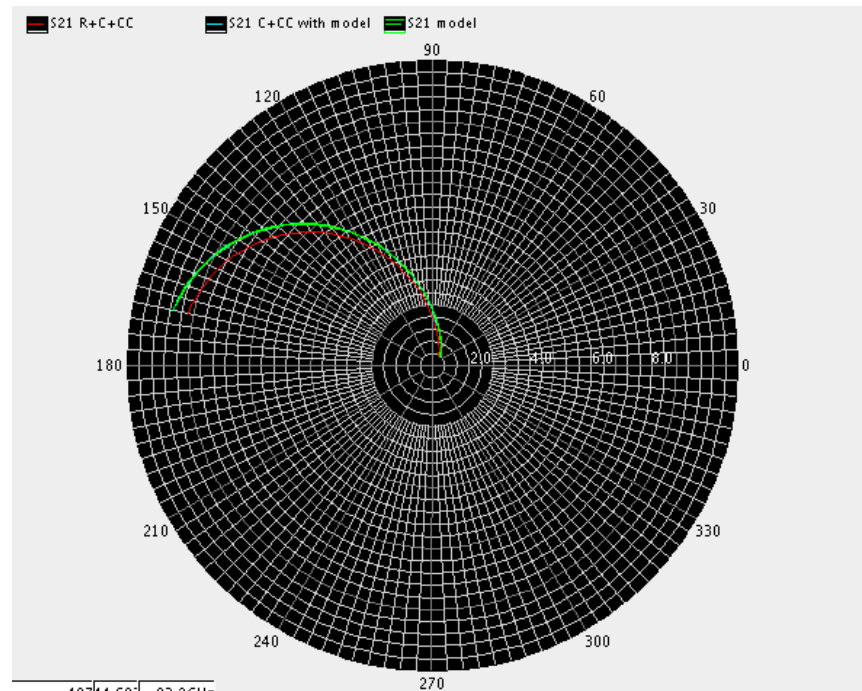
# MOS\_BSGGDB\_Gilbert @ (60n/5u/50)

## $R_g \times 2$



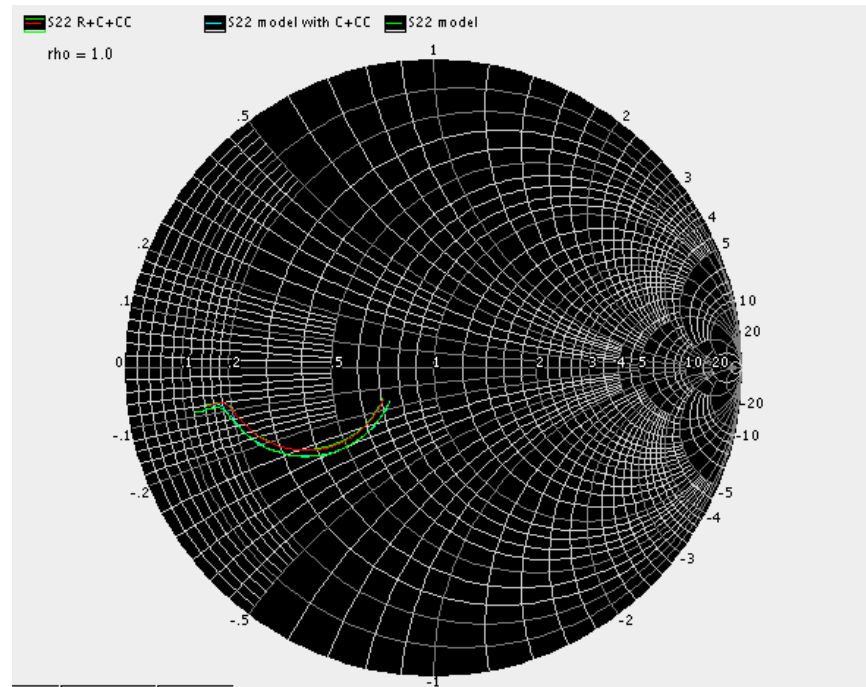
S12

# MOS\_BSGGDB\_Gilbert @ (60n/5u/50)



S21

# MOS\_BSGGDB\_Gilbert @ (60n/5u/50)



S22

# MOS\_BSGGDB\_Gilbert @ (60n/5u/50)

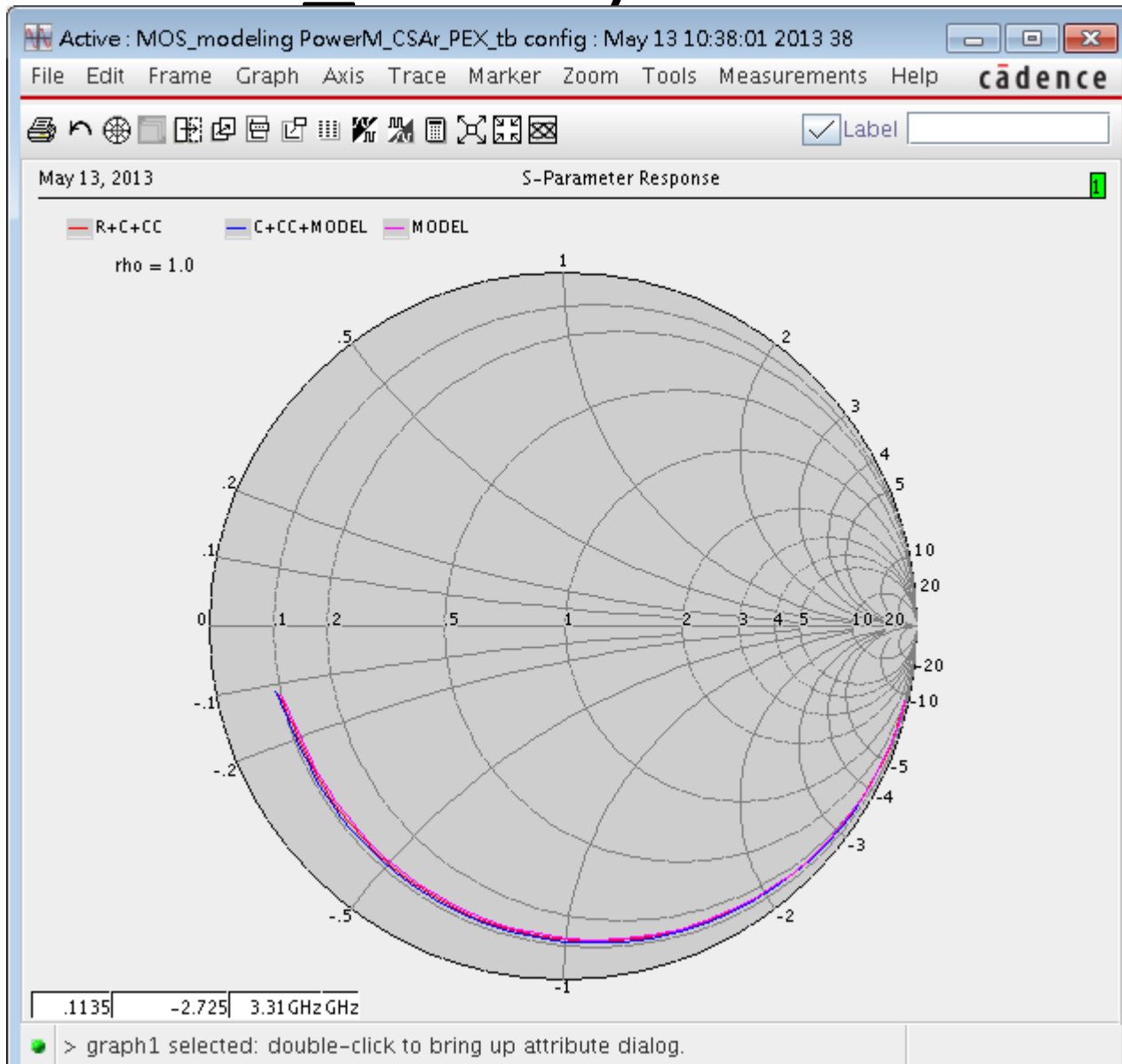
- R + C + CC :  $I_d = 92.08 \text{ mA}$
- C + CC with model :  $I_d = 91.66 \text{ mA}$
- model :  $I_d = 91.66 \text{ mA}$



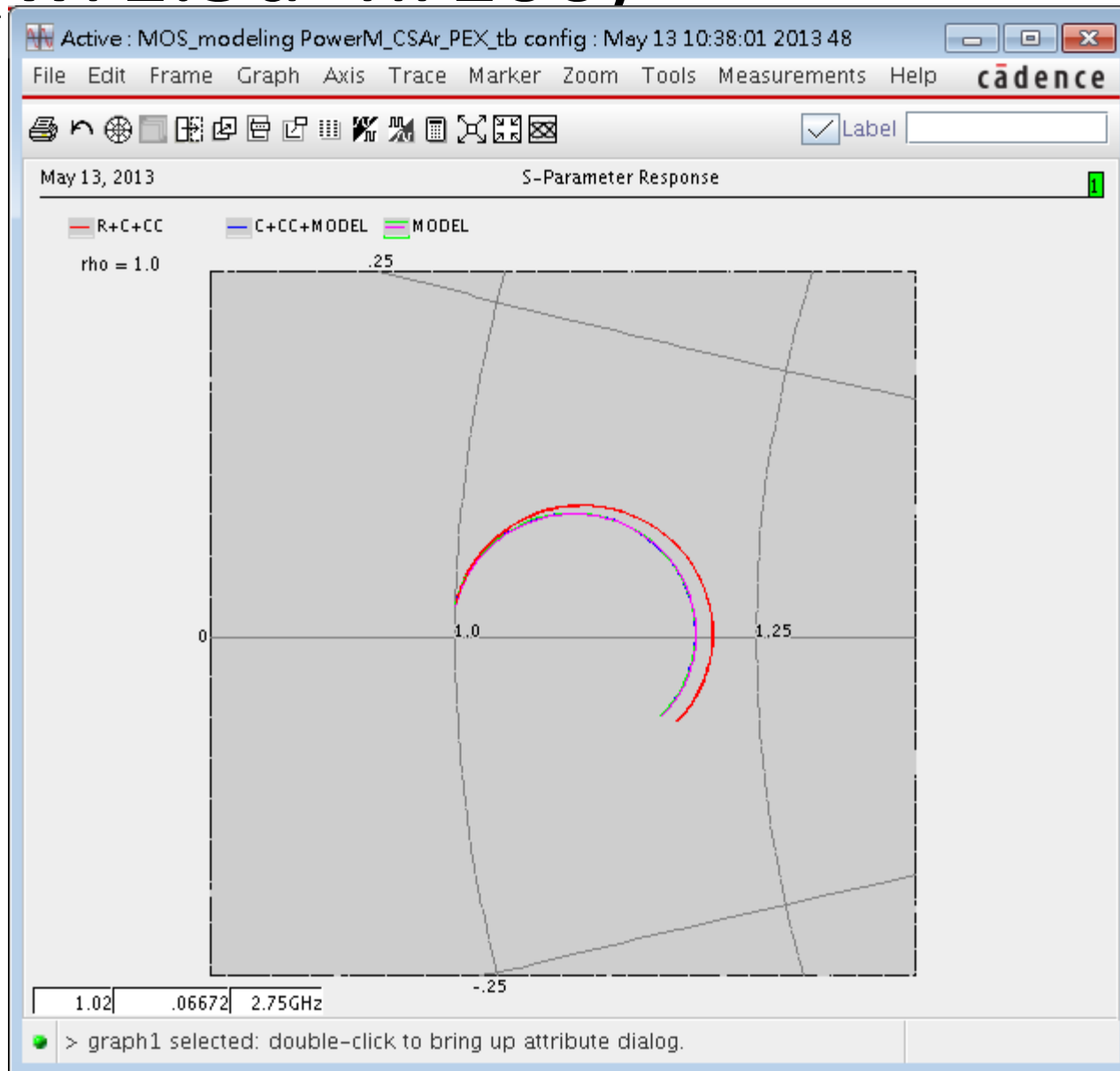
# Model Comparison Result

- THz MOS
  - THz\_NMOS\_CS
- Analog MOS
  - MOS\_BGDSGB\_CG
  - MOS\_SGDGS\_CS
  - MOS\_BSGGDB\_Gilbert
- Power MOS
  - PowerM\_CSAr
  - PowerM\_CCAr\_longL

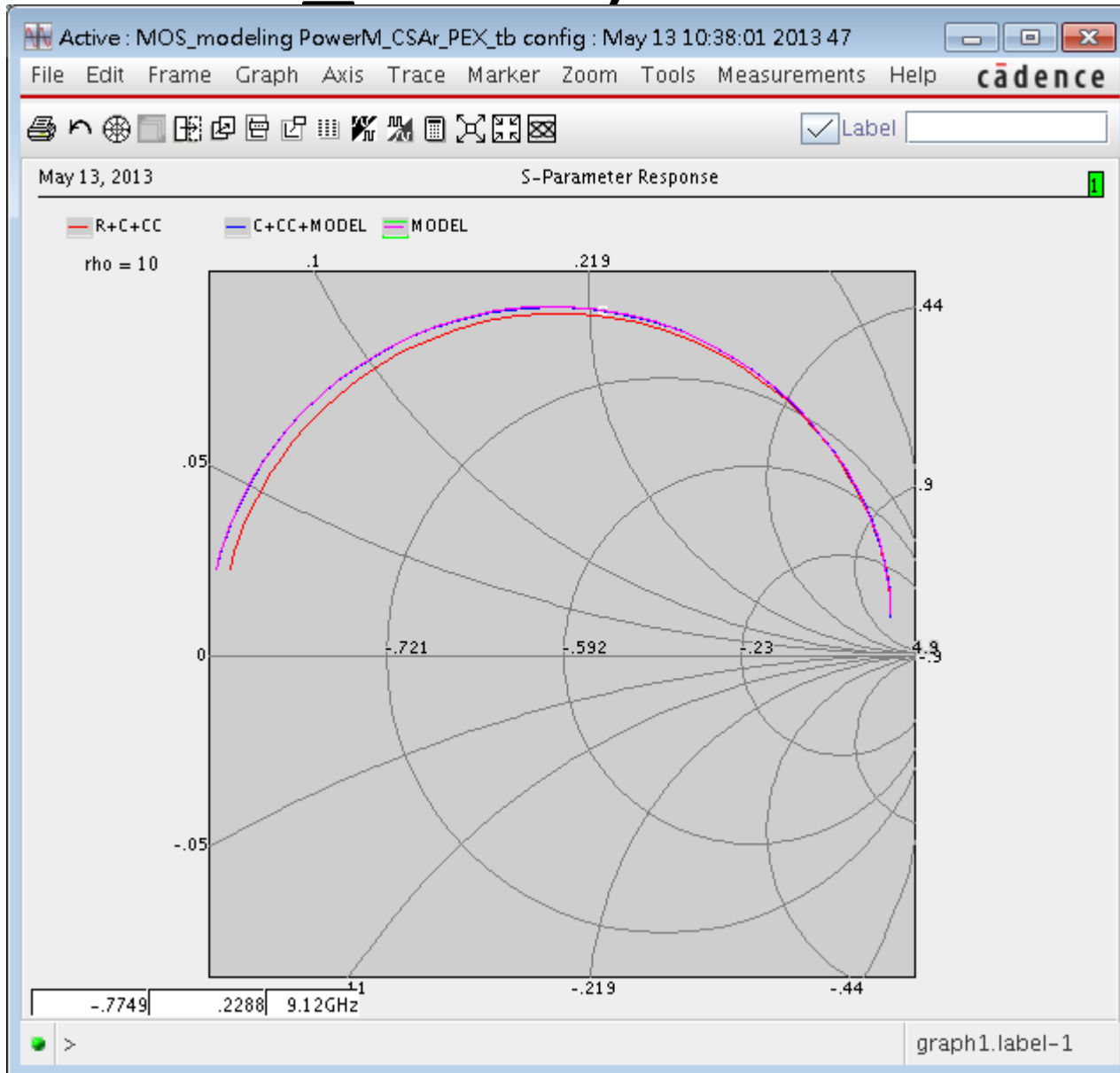
# $S_{11}(\text{wr1.5u\_nr100})$



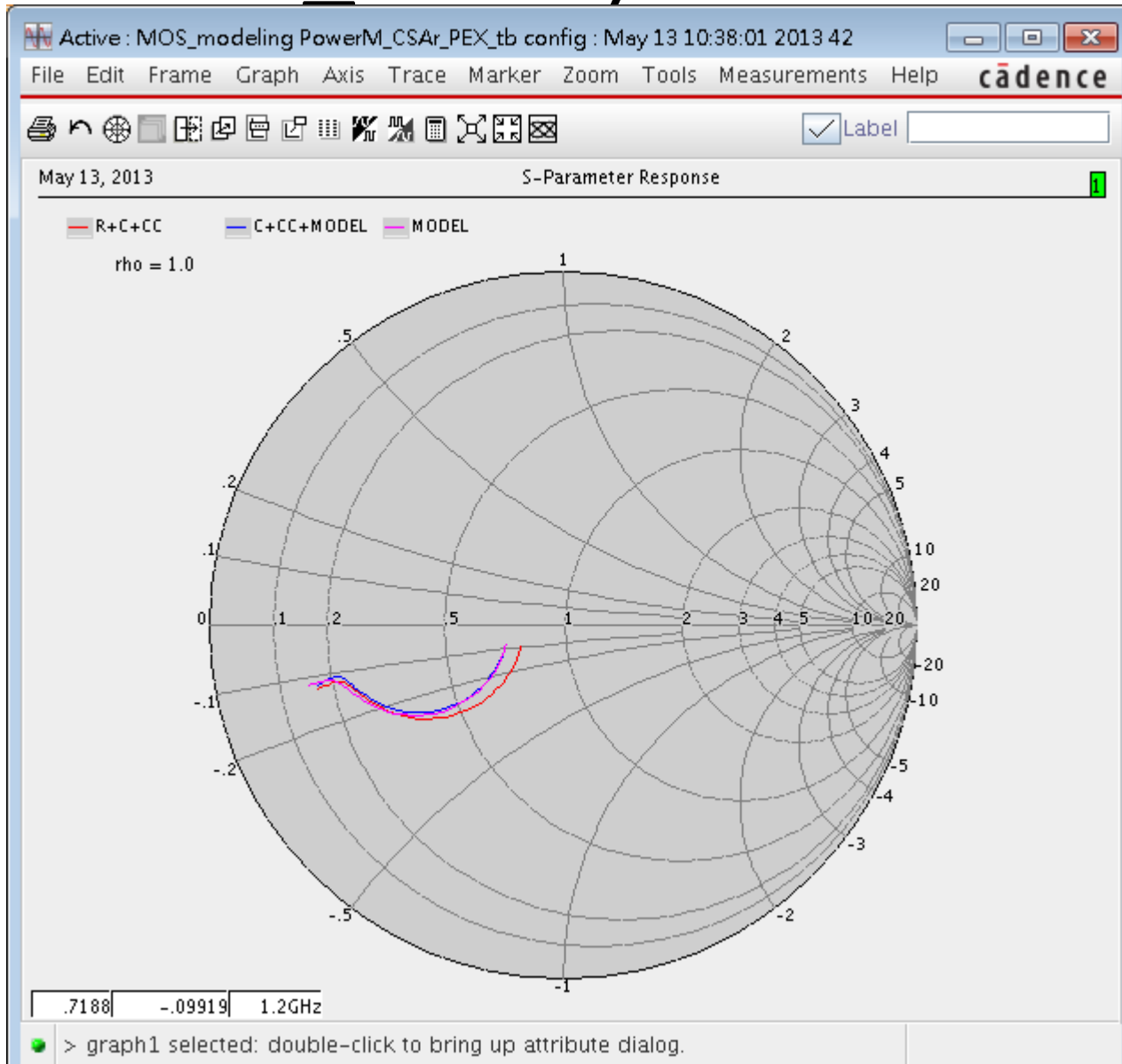
# $S_{12}(wr1.5u \text{ nr}100)$



# $S_{21}(\text{wr1.5u\_nr100})$



# $S_{22}(\text{wr1.5u\_nr100})$



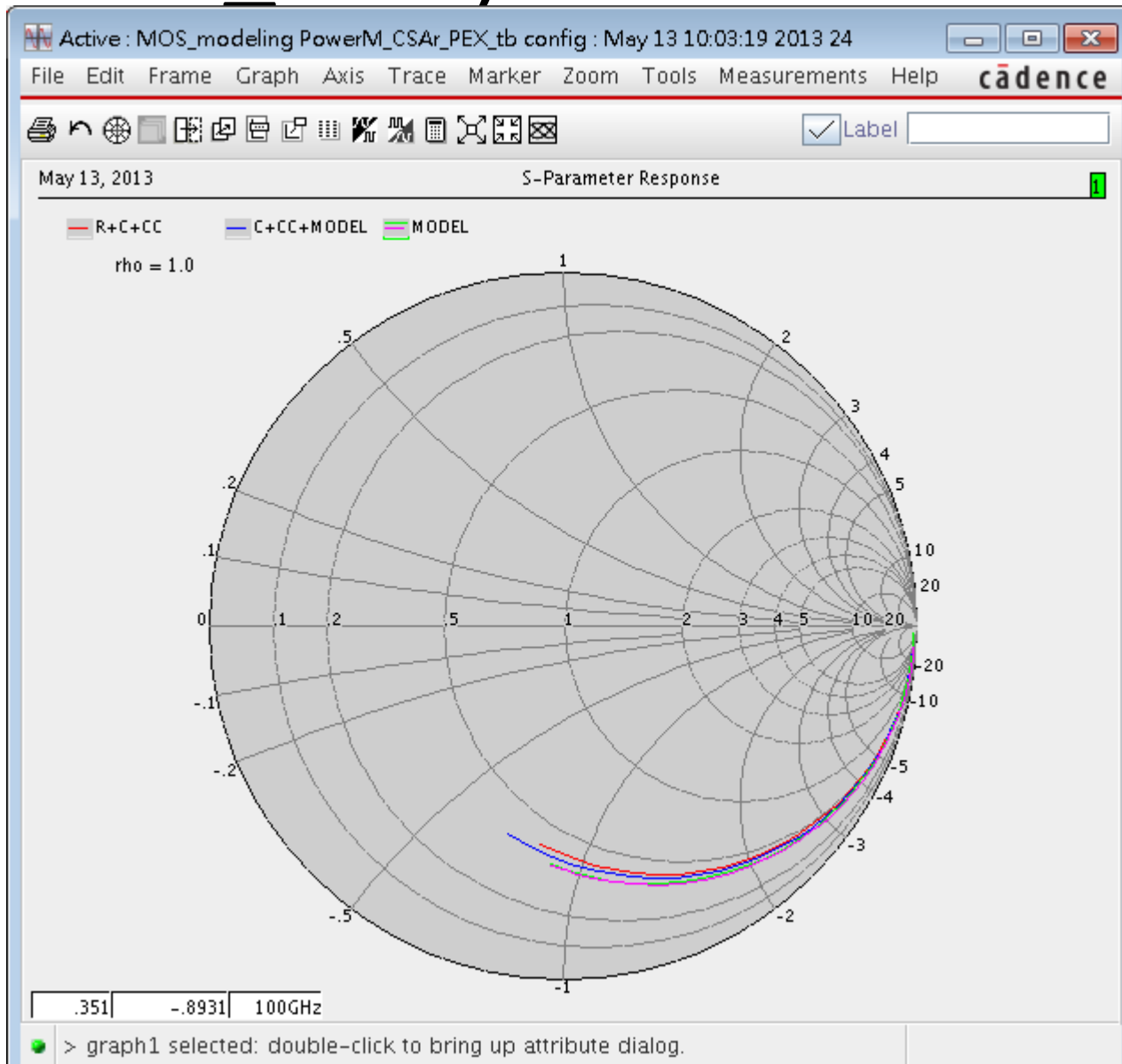
(wr1.5u\_nr100)

R+C+CC : Id = 83.7mA

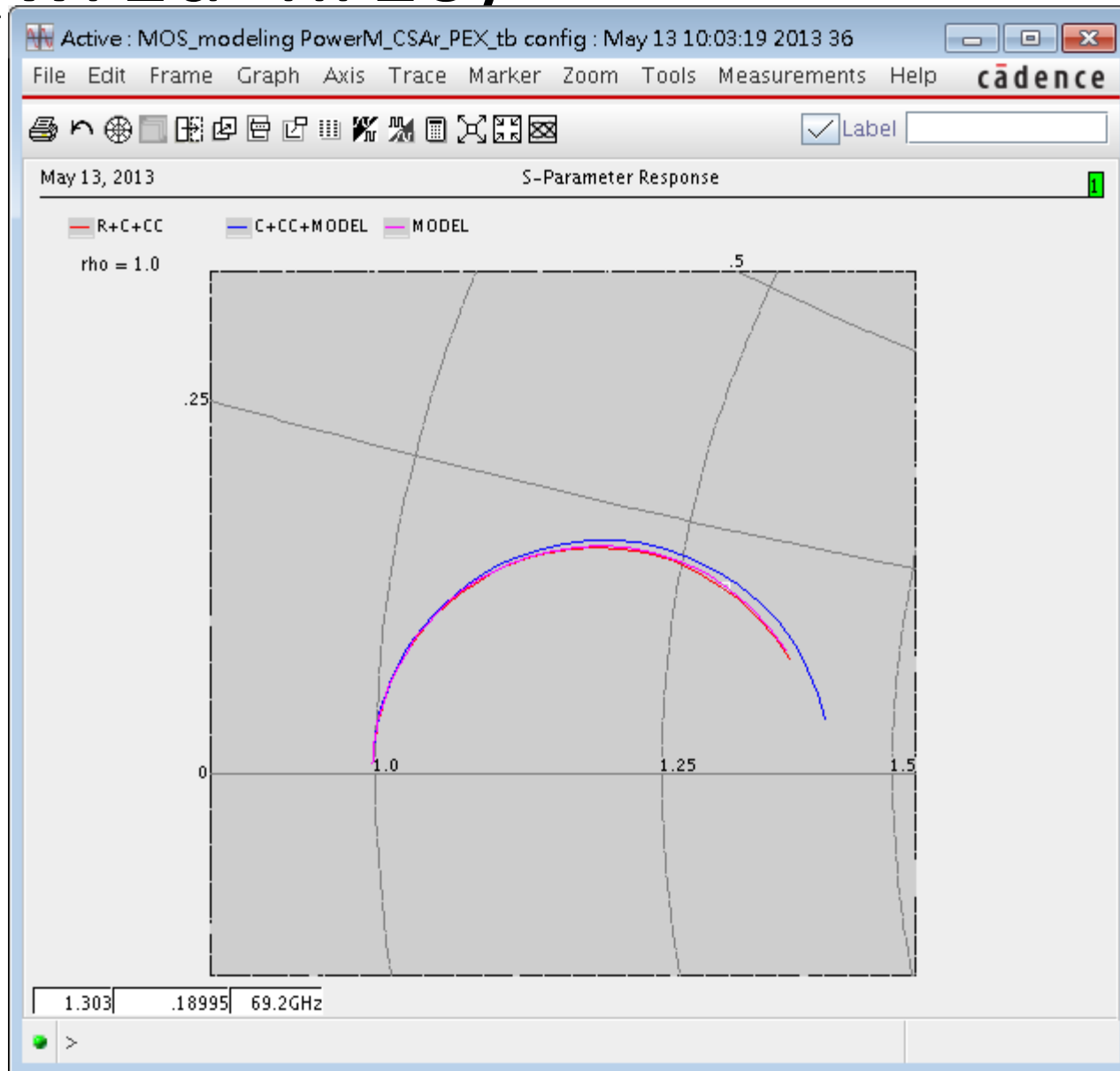
C+CC+MODEL : Id = 87.6mA

MODEL : Id = 87.6mA

# $S_{11}(wr1u\_nr10)$

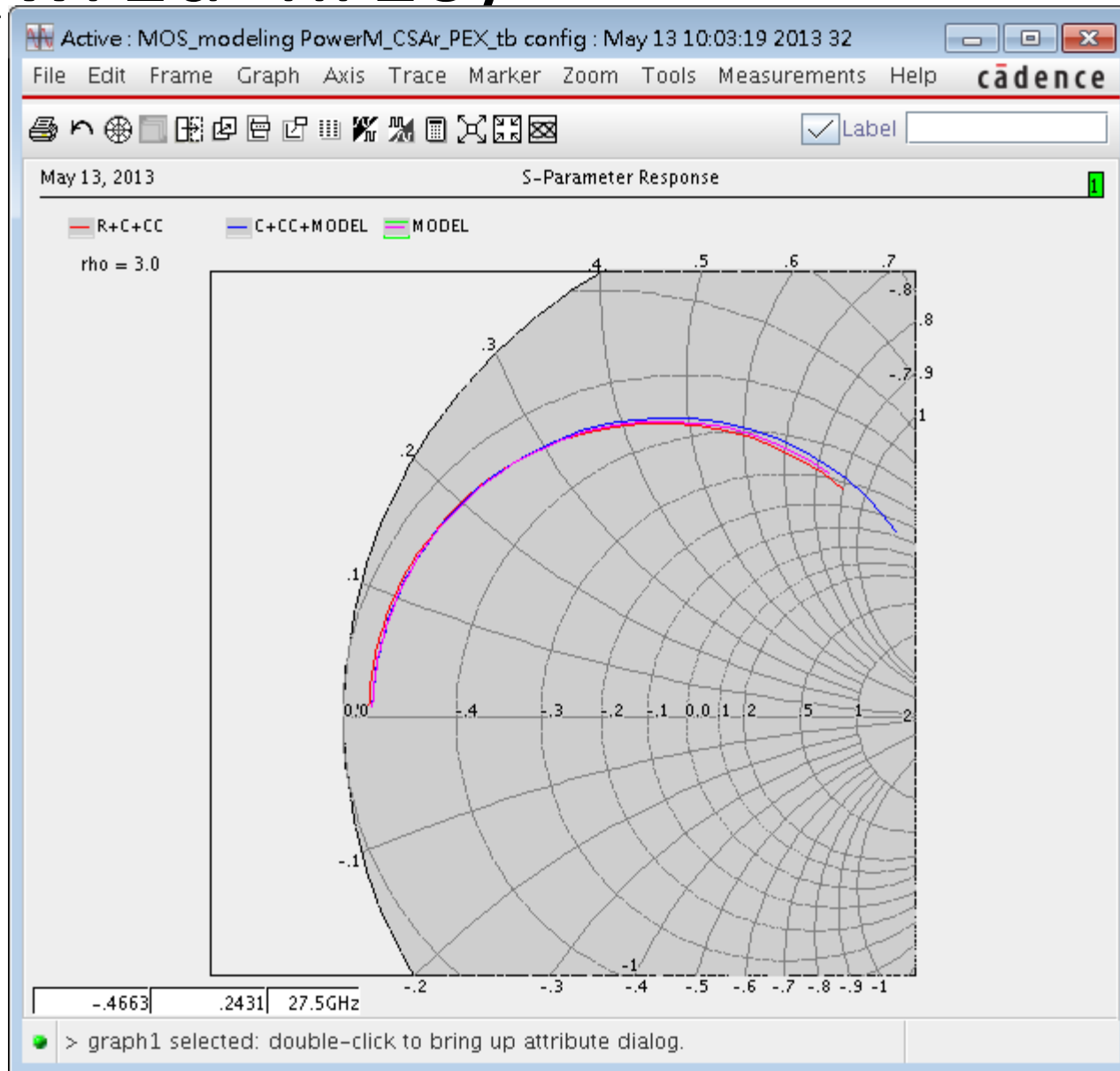


# $S_{12}(w_{r1u} \text{ nr}10)$

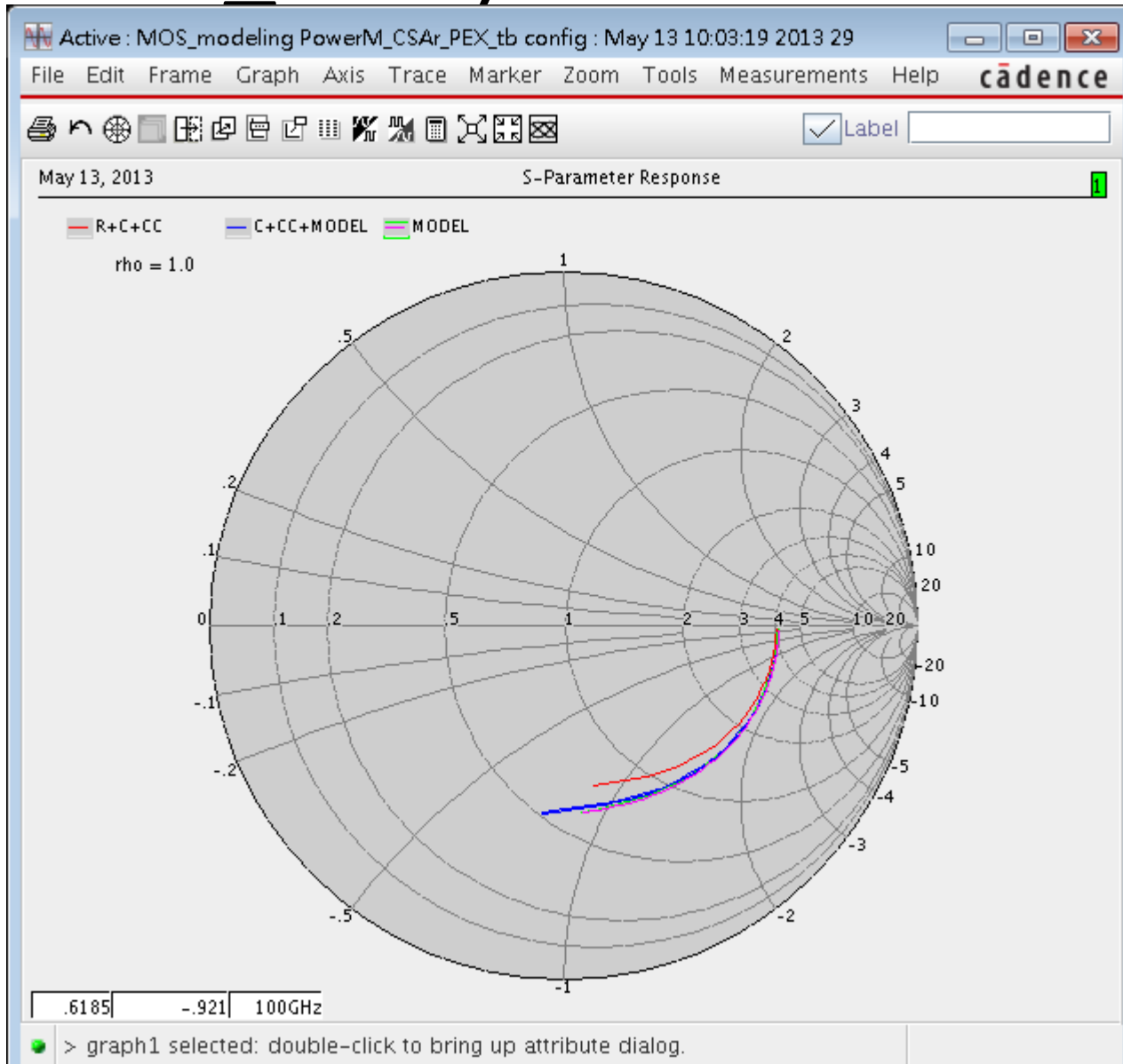




# S21(wr1u nr10)



# $S_{22}(wr1u\_nr10)$



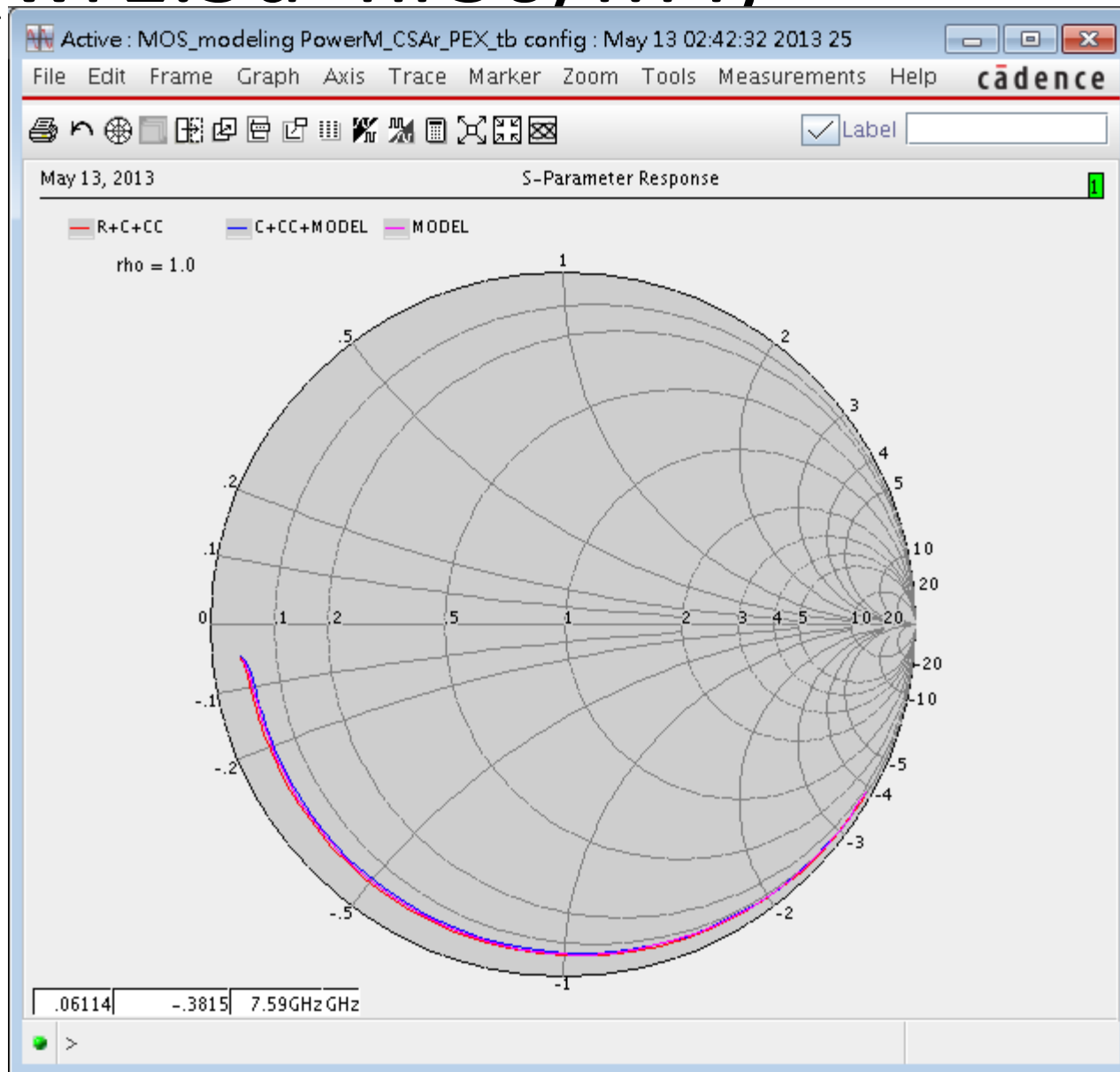
(wr1u\_nr10)

R+C+CC :  $I_d = 15.61\text{mA}$

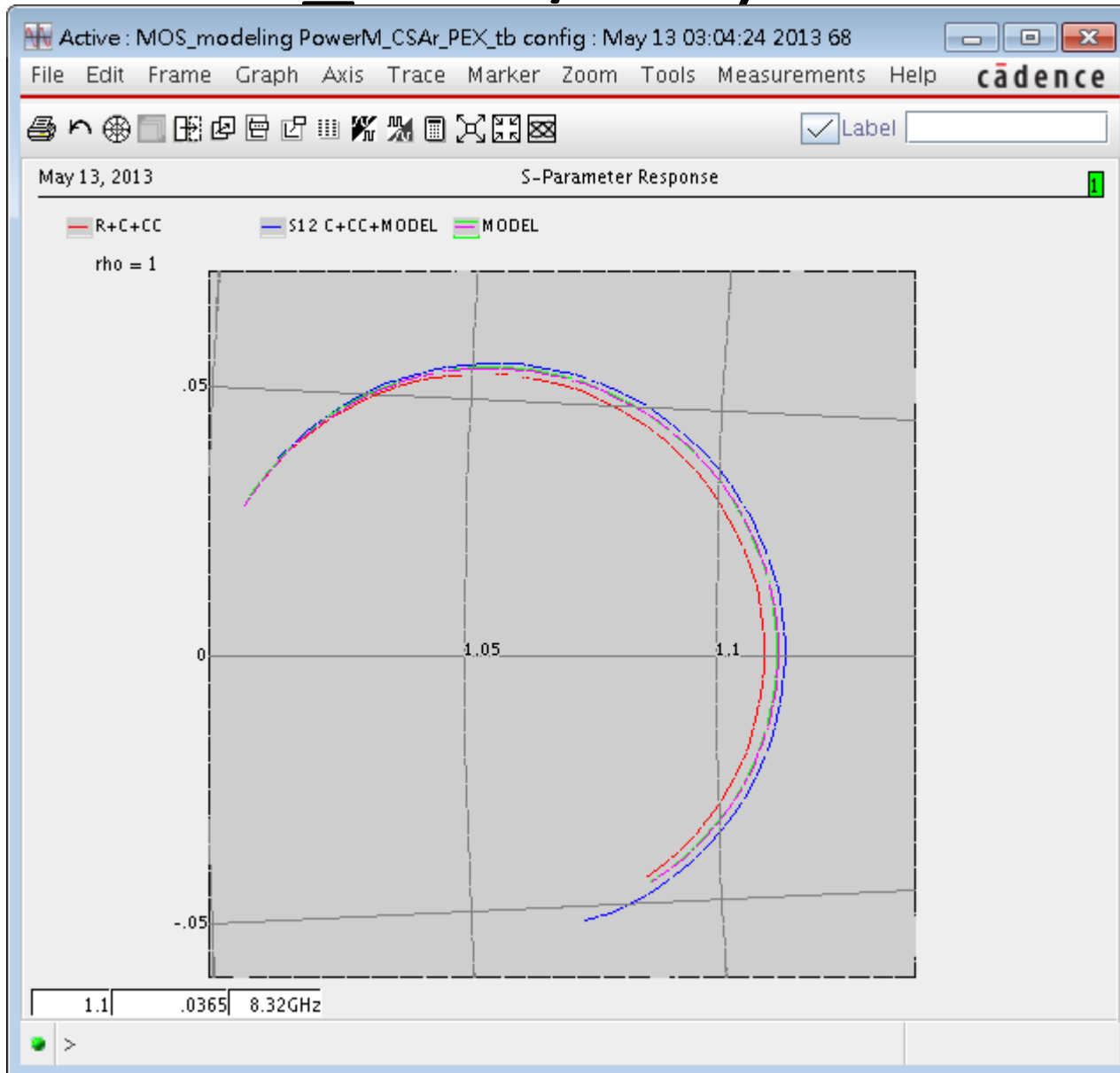
C+CC+MODEL :  $I_d = 15.25\text{mA}$

MODEL :  $I_d = 15.25\text{mA}$

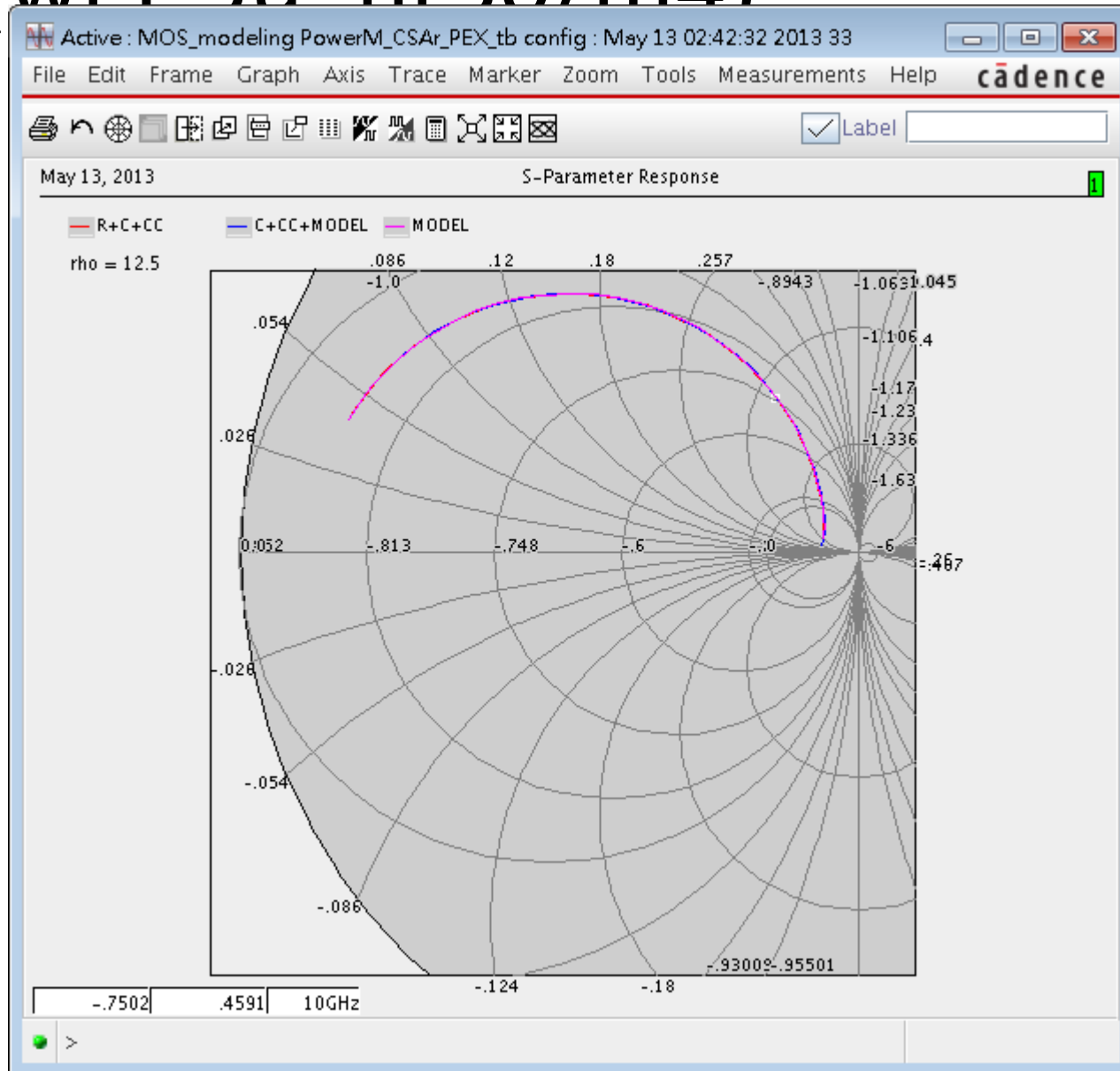
# $S_{11}(\text{wr1.5u nr50/M4})$



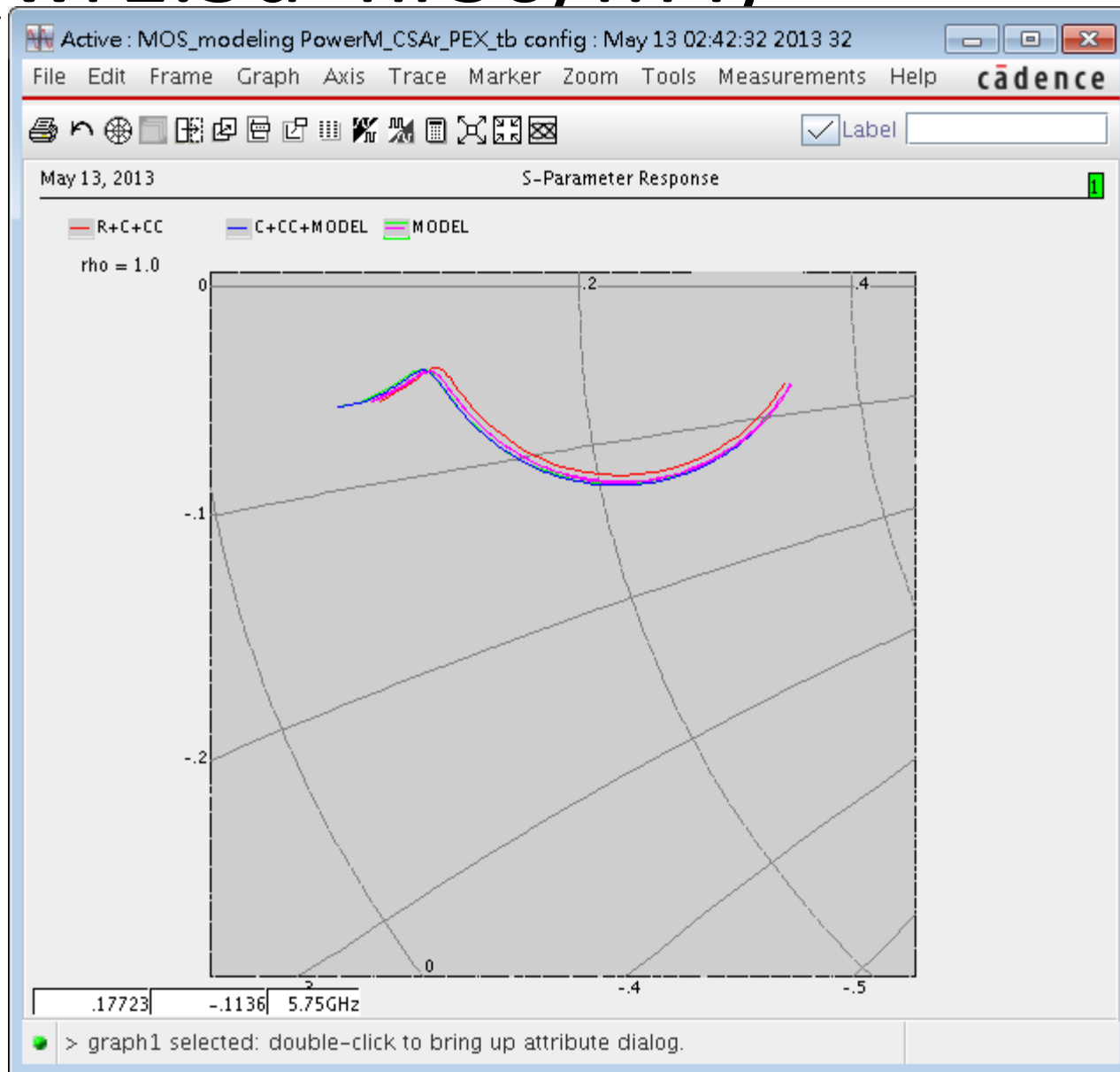
# S12(wr1.5u\_nr50/M4)



# $S_{21}(wr1\ 5u\ nr50/m4)$



# $S_{22}(\text{wr1.5u nr50/M4})$



(wr1.5u\_nr50/M4)

R+C+CC : Id = 180.4mA

C+CC+MODEL : Id = 175.6mA

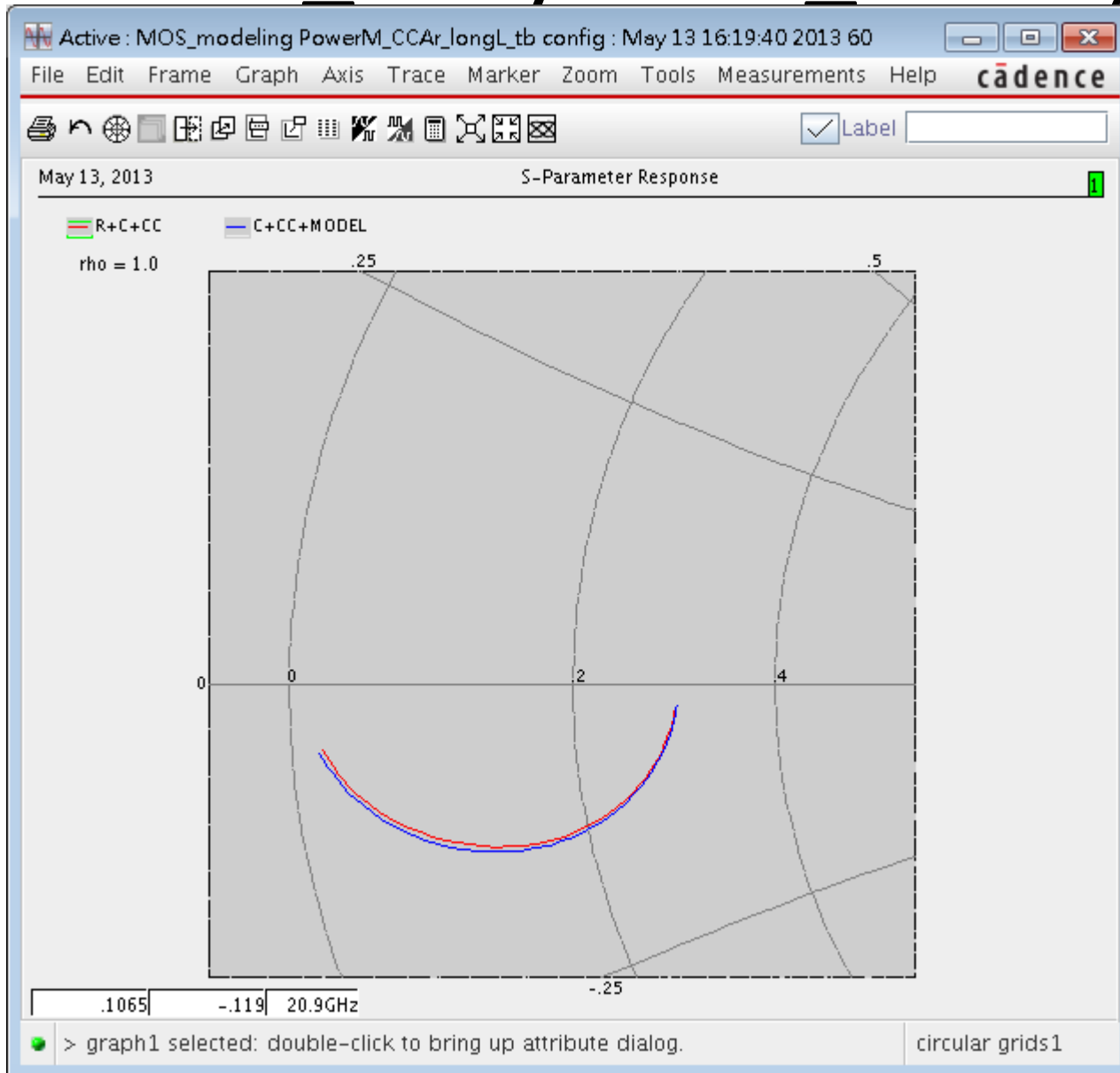
MODEL : Id = 175.6mA



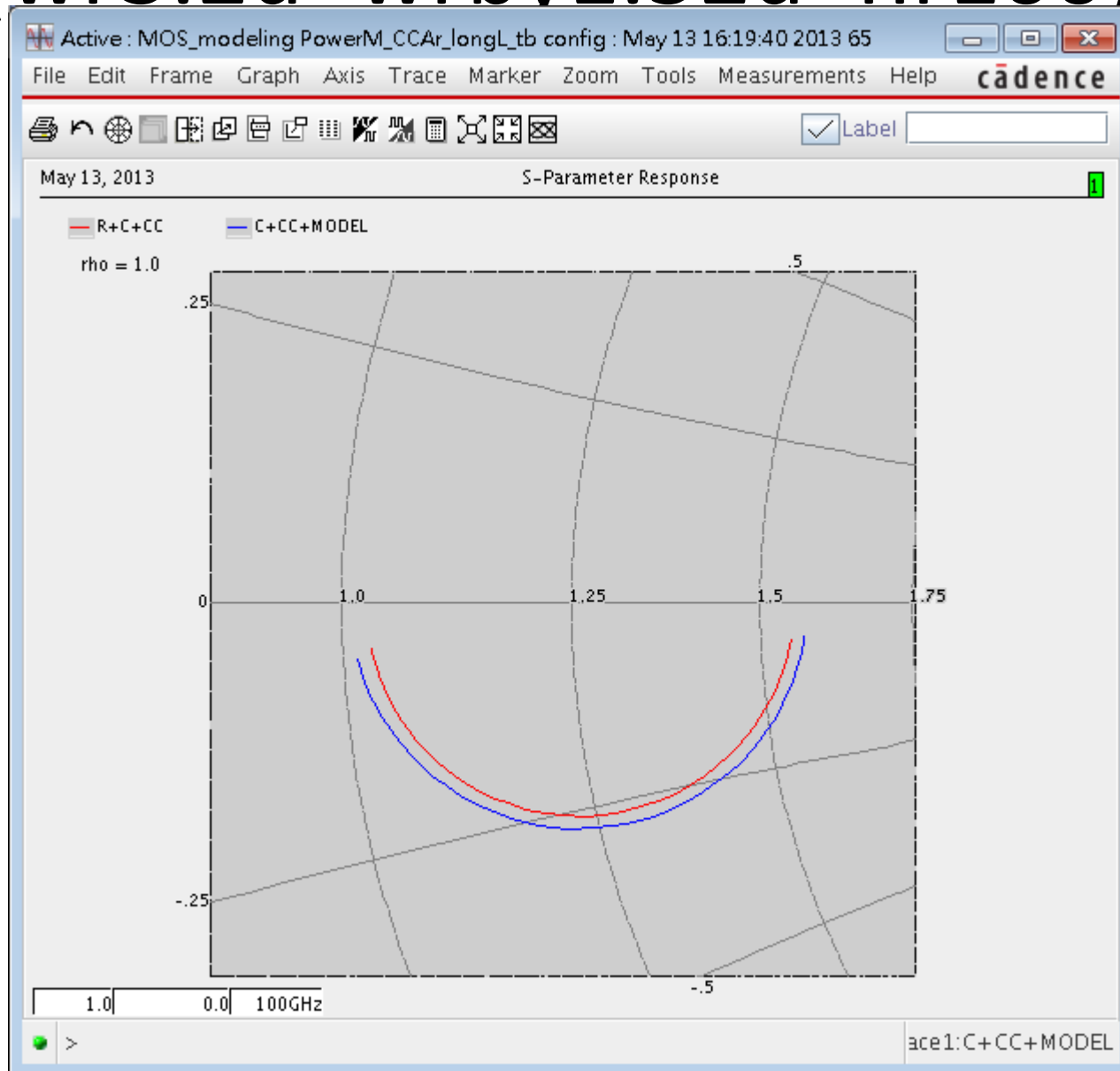
# Model Comparison Result

- THz MOS
  - THz\_NMOS\_CS
- Analog MOS
  - MOS\_BGDSGB\_CG
  - MOS\_SGDGS\_CS
  - MOS\_BSGGDB\_Gilbert
- Power MOS
  - PowerM\_CSAr
  - PowerM\_CCAr\_longL

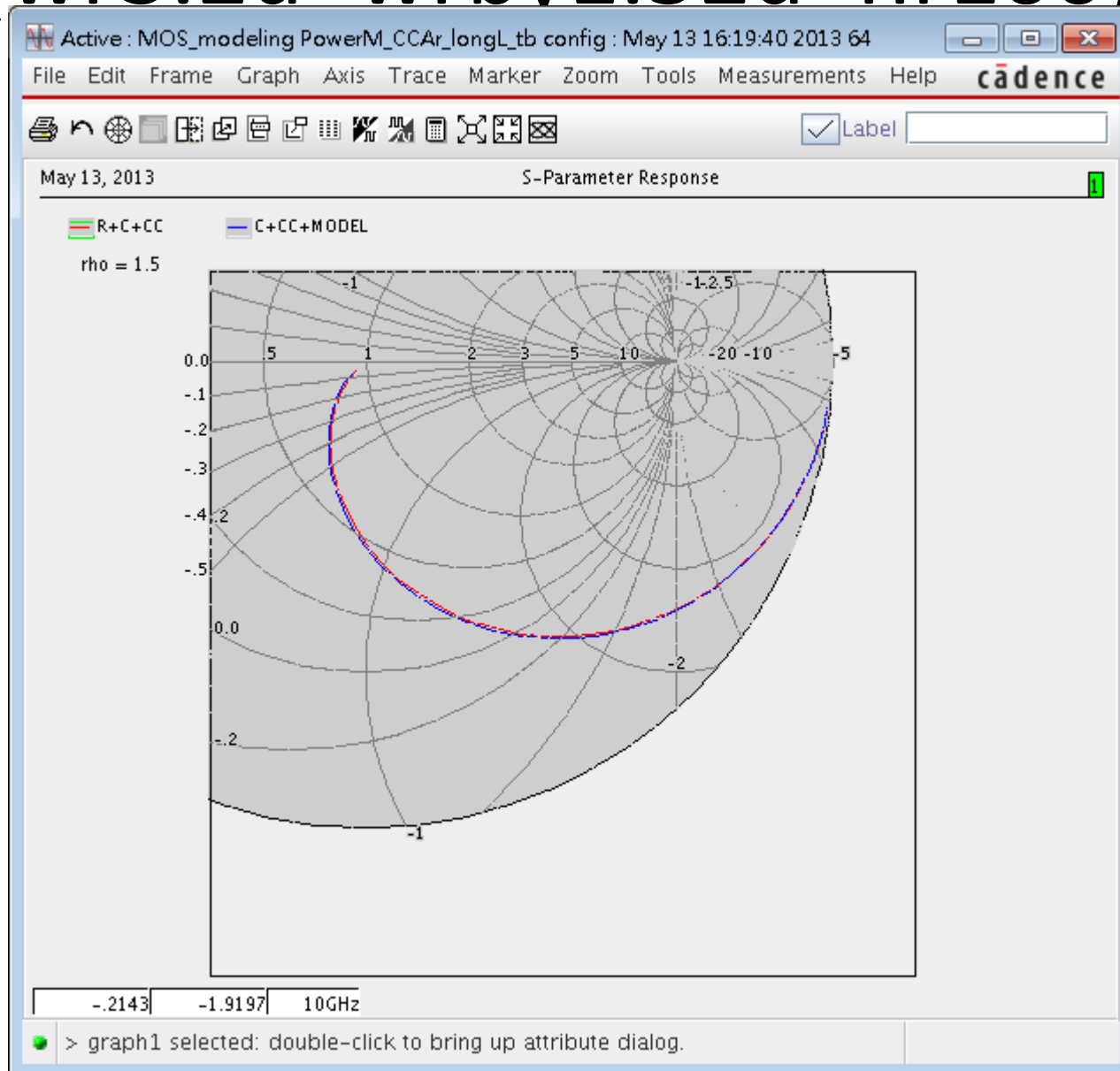
# $S_{11}(\text{wr3.2u\_wrby1.52u\_nr100})$



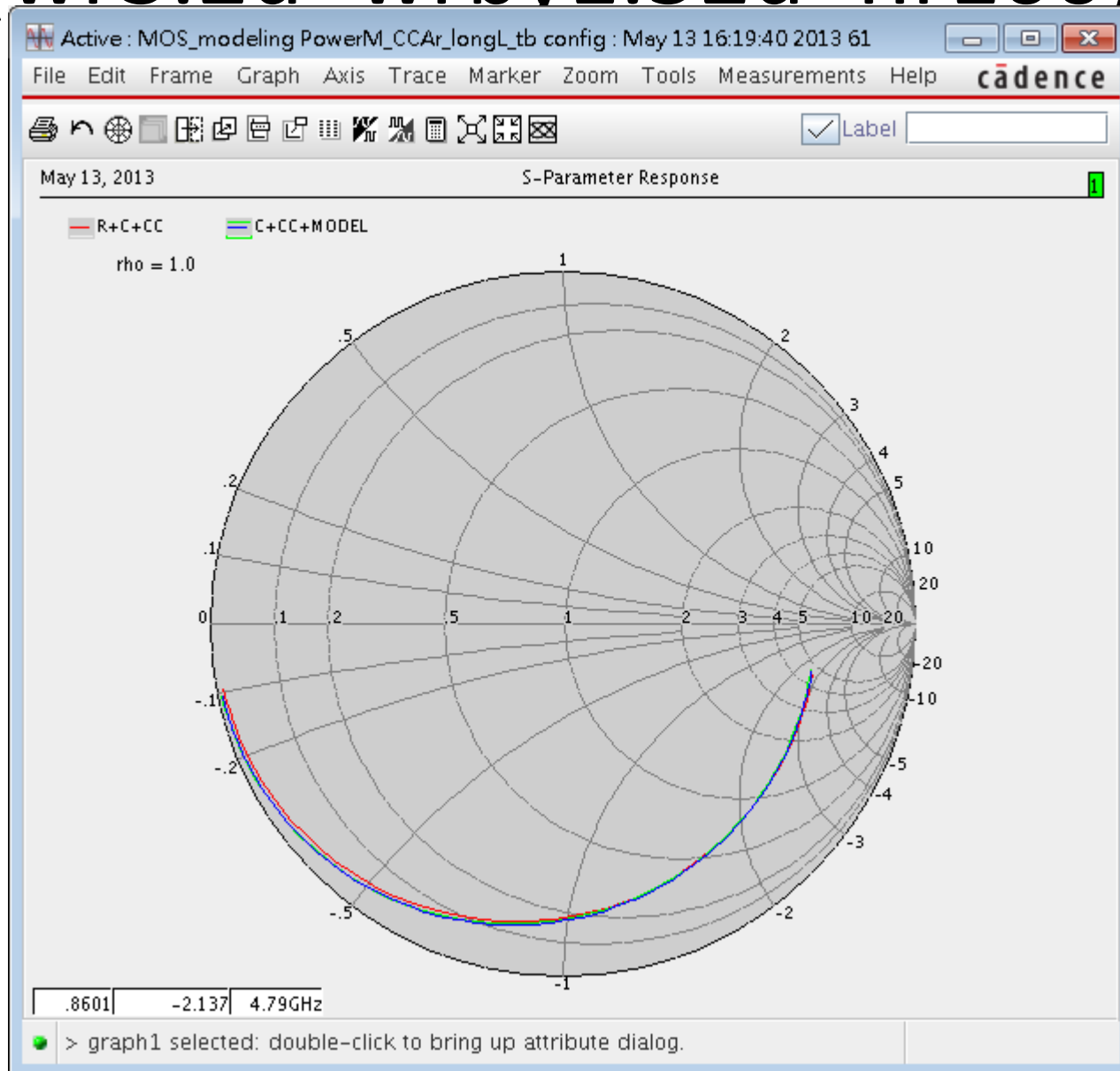
# $S_{12}(\text{wr3.2u} \ \text{wrbv1.52u} \ \text{nr100})$



# $S_{21}(\text{wr3.2u} \ \text{wrbv1.52u} \ \text{nr100})$



# $S_{22}(\text{wr3.2u wrbv1.52u nr100})$

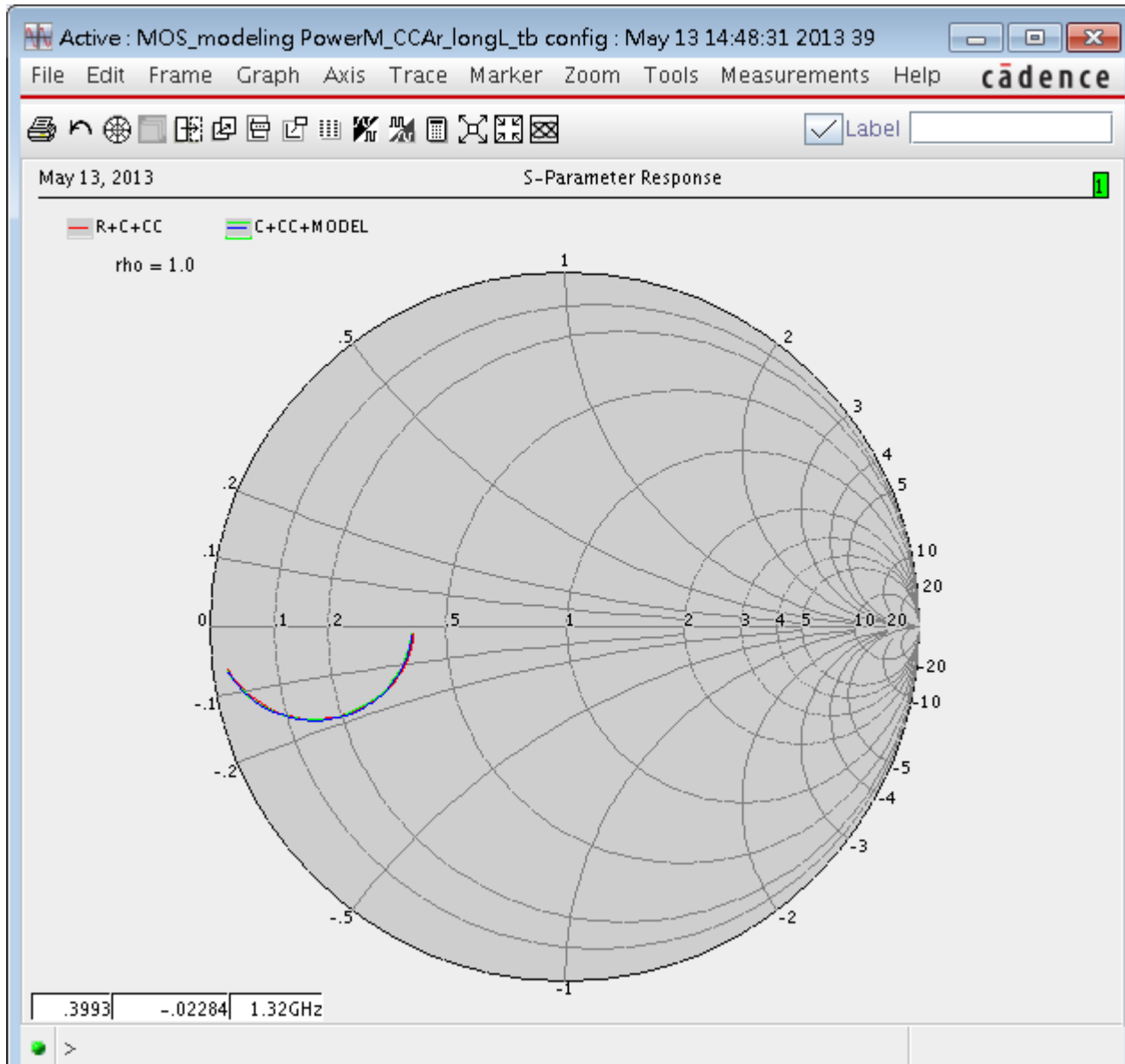


(wr3.2u\_wrby1.52u\_nr100)

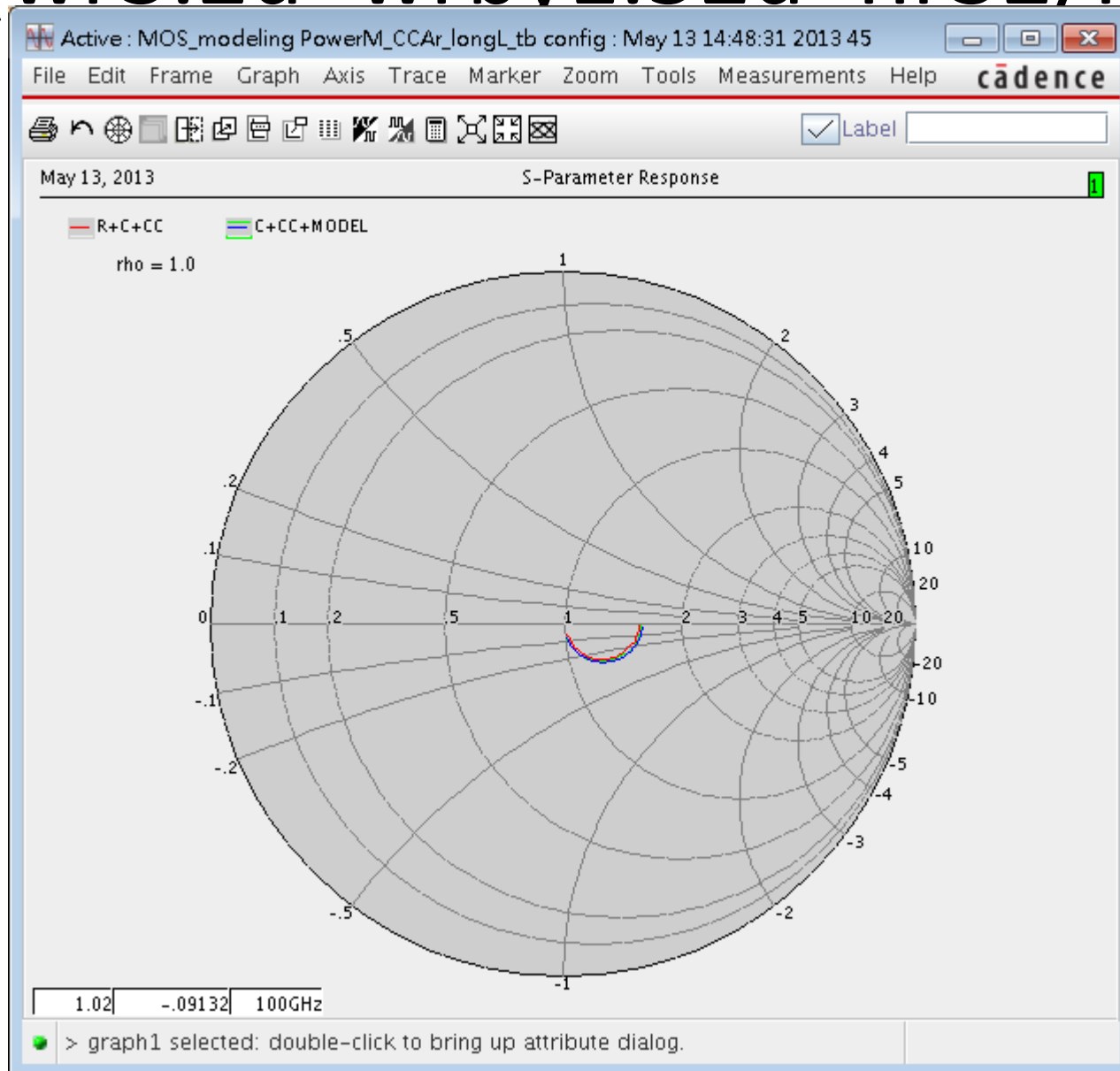
R+C+CC: Id = 50.52mA

C+CC+MODEL: Id = 60.3mA

# $S_{11}(\text{wr3.2u\_wrby1.52u\_nr32/M4})$

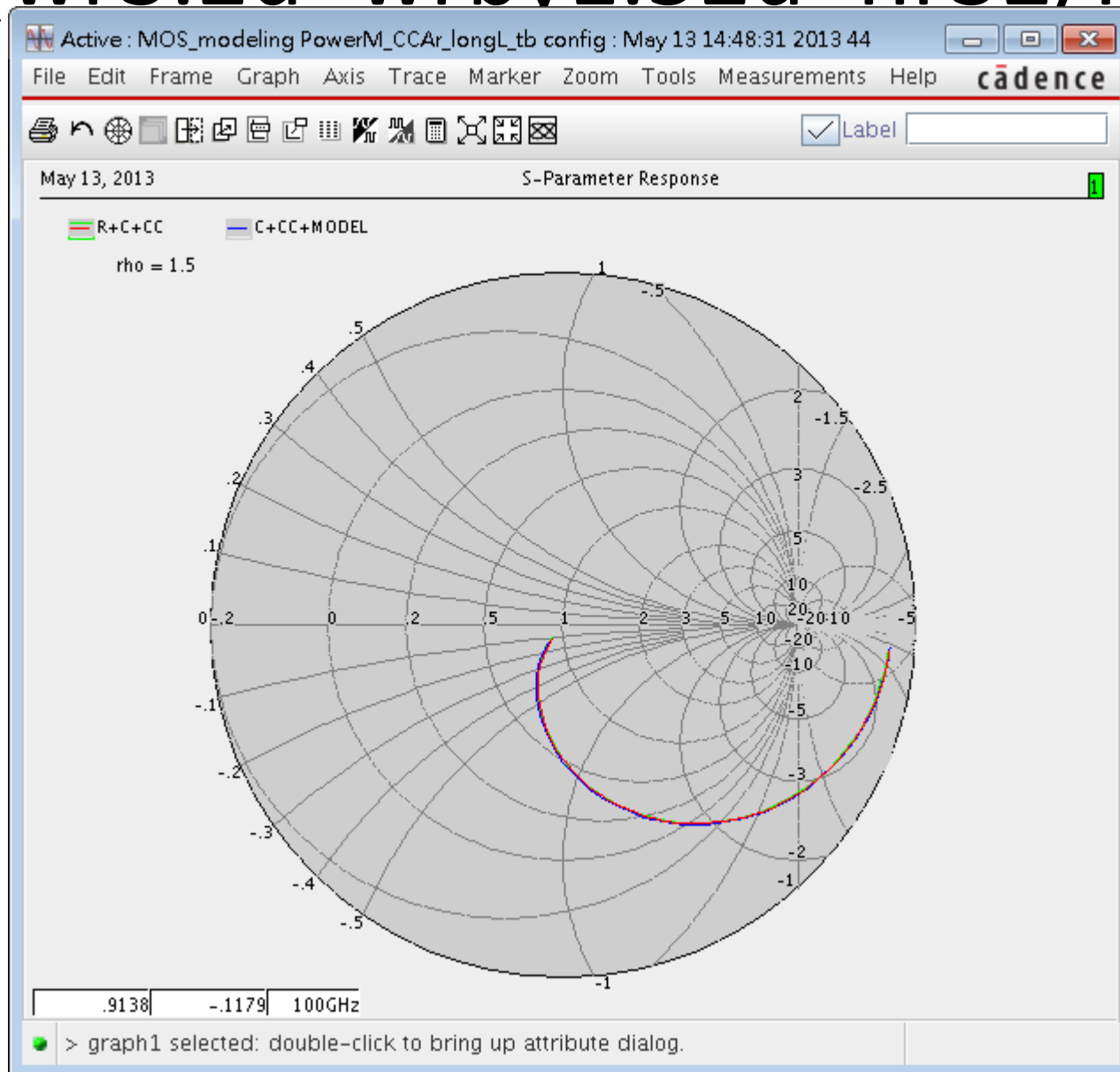


# S12(wr3.2u wrbv1.52u nr32/M4)

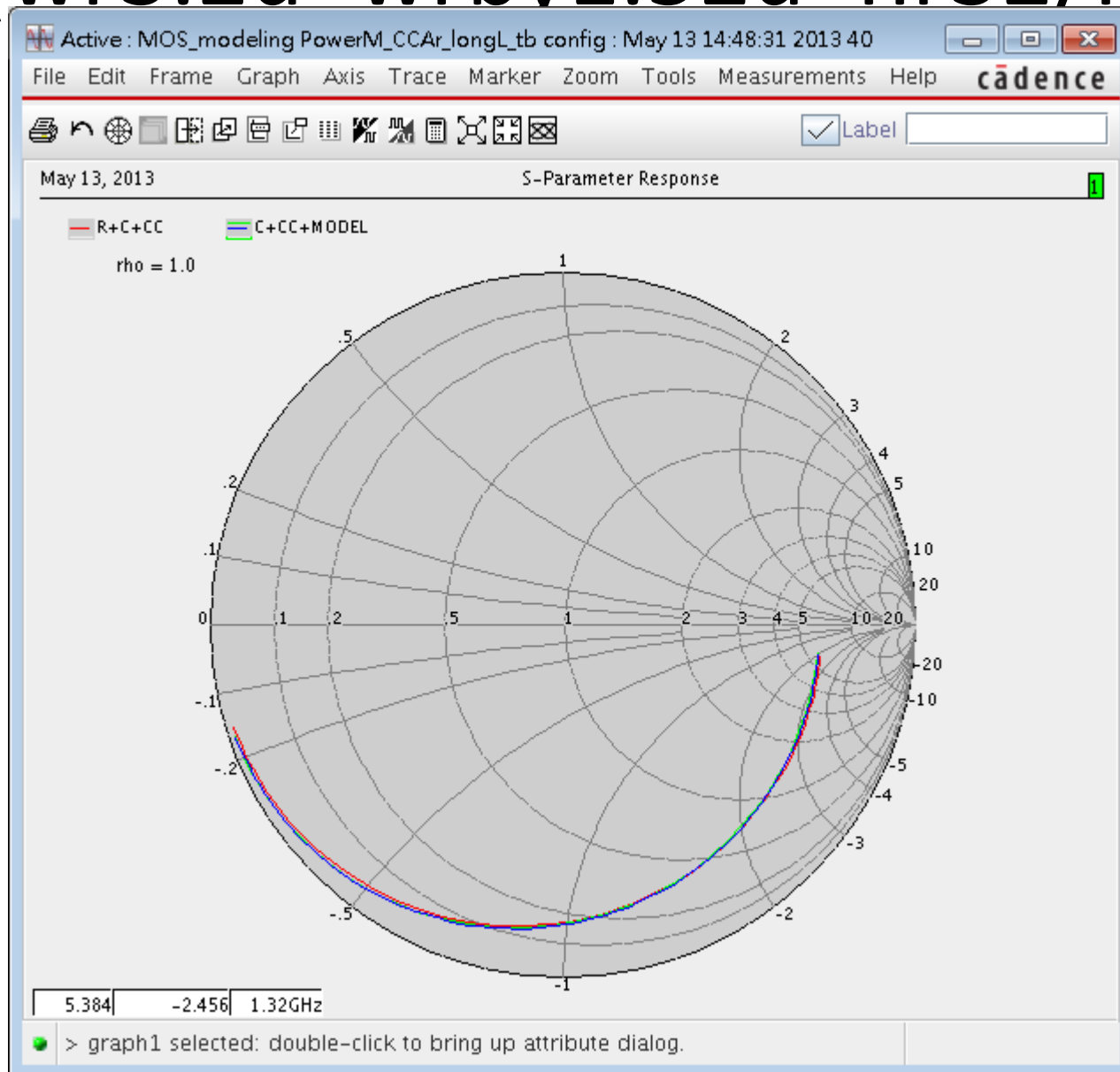




# $S_{21}(\text{wr3.2u} \quad \text{wrbv1.52u} \quad \text{nr32/M4})$



# $S_{22}(\text{wr3.2u wrbv1.52u nr32/M4})$



(wr3.2u\_wrby1.52u\_nr32/M4)

R+C+CC: Id = 32.08mA

C+CC+MODEL: Id = 39.59mA