Python library (scikit-rf) - example: Ring slot, Tee, T line.

->Jay Gautam, Darmstadt, Germany.\ ->*Learning objective:*

1. *Different information about the device.*
2. *Smith Chart*
3. *Scattering parameter- frequency domain, time domain*
4. *Phase diagram*
5. *Cascading of two network and phase difference*

Install the library and import the packagaes.

In [174]:
```
!pip3 install scikit-rf
# pip install scikit-rf
```

In [161]:
```
import skrf as rf # import the rf module
from skrf.data import ring_slot, line, tee # import the data of a particular model(example- 2 port n/w ring slot device).

import matplotlib.pyplot as plt
import numpy as np
```

Device information

In [162]:
```
## information about the ring slot device. It imports the impedance matrix in the frequency range 75-110 GHz
ring_slot
# tee
# line
```

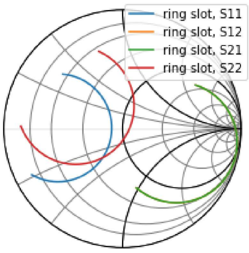
Out[162]:
```
2-Port Network: 'ring slot',  75.0-110.0 GHz, 201 pts, z0=[50.+0.j 50.+0.j]
```

In [163]:
```
## Several attributes: scattering matrix- attribute of this model.
## ways to see the attributes or property: ring_slot.<click tab>, ring_slot.frequency.<click tab>
# ring_slot.s
ring_slot.s.shape # complex matrix of individual 2X2 matrix with 201 elements. no. of frequencies = 201. no. of port=2
# len(ring_slot.s)
# ring_slot.frequency # frequency property
# ring_slot.frequency.f # frequency vector in terms of GHz
# ring_slot.frequency.f_scaled # scaled frequency vector in terms of GHz
```

Out[163]:
```
(201, 2, 2)
```

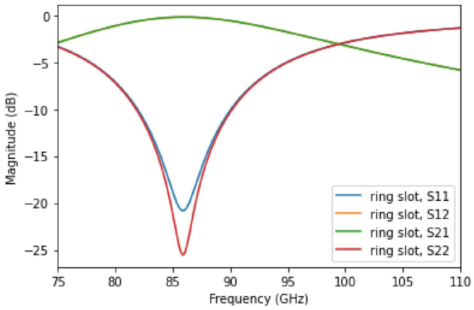
Ring Slot- Smith Chart

In [164]:
```
## Smith chart of the ring slot. Information about scattering parameters
ring_slot.plot_s_smith() # polar plot.
#line.plot_s_smith() # polar plot.
#tee.plot_s_smith() # polar plot.
```

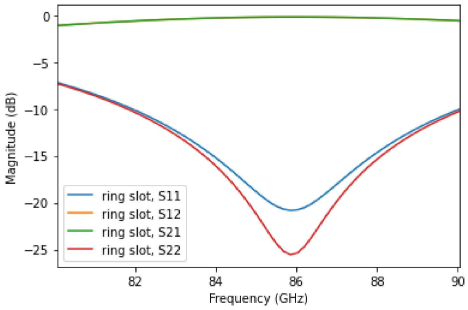


Ring Slot- S-Parameter: Frequency and time domain

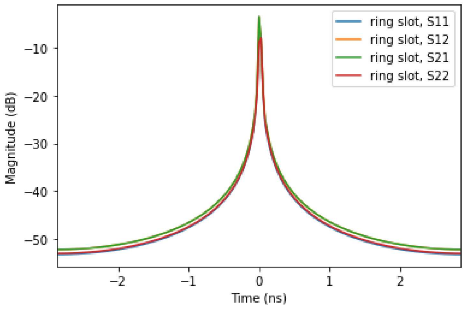
In [165]:
```
ring_slot.plot_s_db() # dB- scale plot of S parameters- frequency domain. Magnitude plot.
```



```
In [166]: #ring_slot[80:90].plot_s_db() # dB- scale plot of S parameters- frequency domain. Magnitude plot.
          ring_slot['80-90ghz'].plot_s_db() # sliced: dB- scale plot of S parameters- frequency domain. Magnitude plot.
          # ring_slot['80-90ghz'].plot_s_db(m =0, n=0) # sliced and s11 with m and n value: dB- scale plot of S parameters- frequency domain. Magni
          tude plot.
```

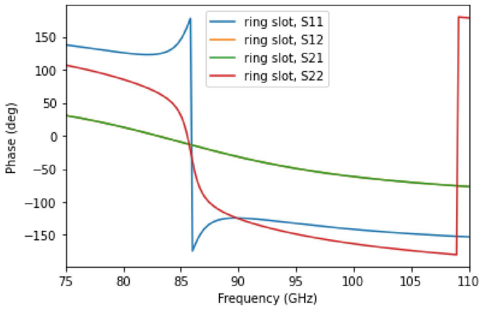



```
In [167]: ring_slot.plot_s_time_db() # dB- scale plot of S parameters- time domain
```



Ring Slot- Phase diagram

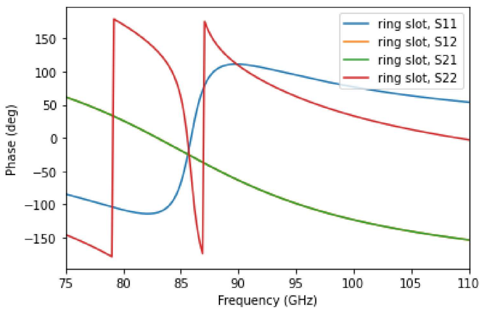
```
In [168]:  # phase (in degree) vs frequency plot of S parameters.
          ring_slot.plot_s_deg()
```



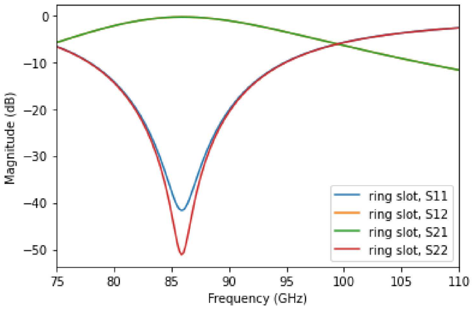
Ring Slot- cascading two port network

```
In [169]: netw11 = ring_slot.copy()
          netw12 = ring_slot.copy()
          ## cascading two 2 port networks- r1 and r2. Currently both are same.
          netw1 = r1*r2
```

```
In [170]: # Phase plot connected network- netw1
          netw1.plot_s_deg()
```



In [171]:
```
# s-para of connected network: netw1
netw1.plot_s_db()
```



In [172]:
```
# Finding phase diference of the devices connected together. Complex division equivalent to substraction.
netw_phase_diff = (r1*r2)/r2
netw_phase_diff.plot_s_deg() # it will give the phase plot of r1.
```