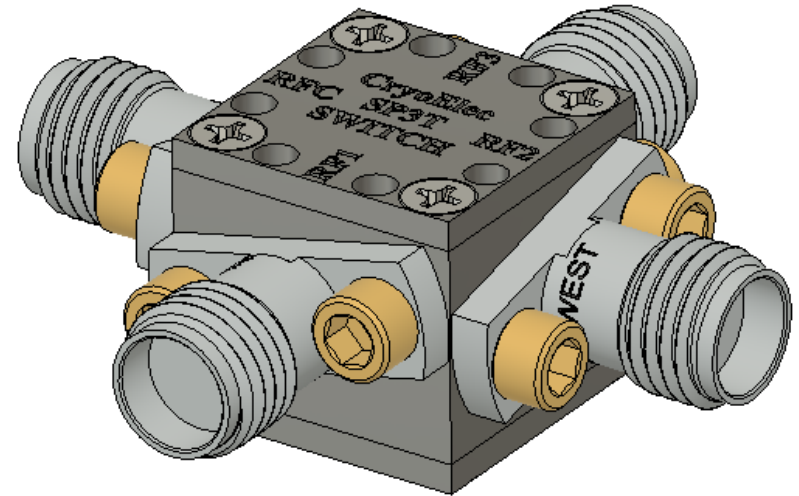
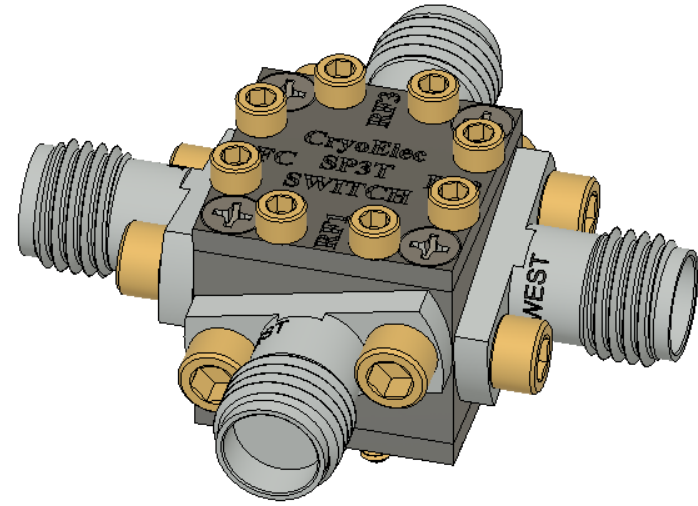
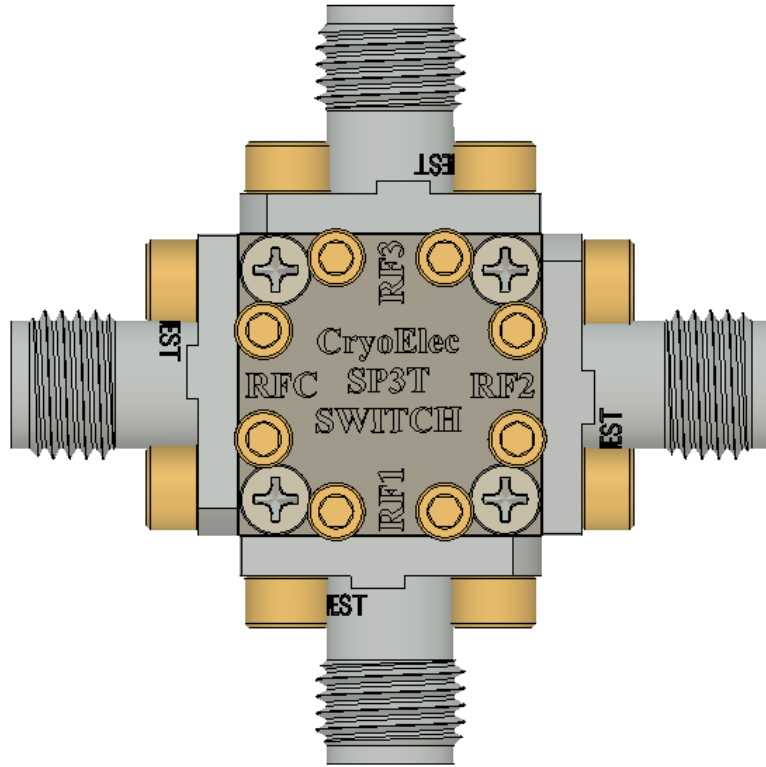




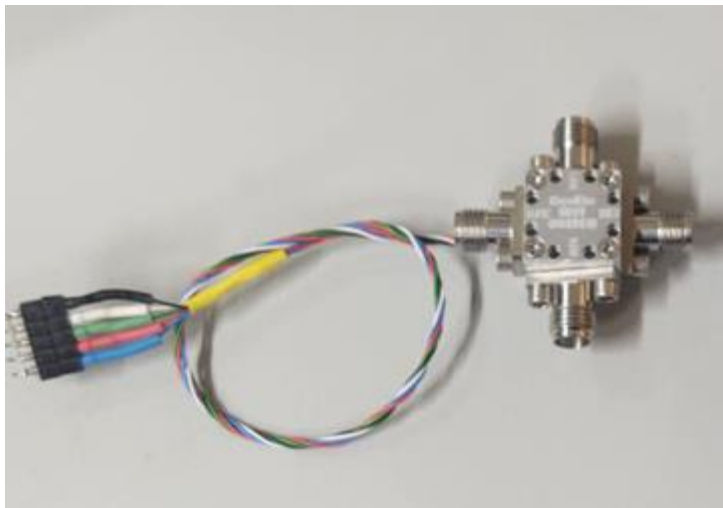
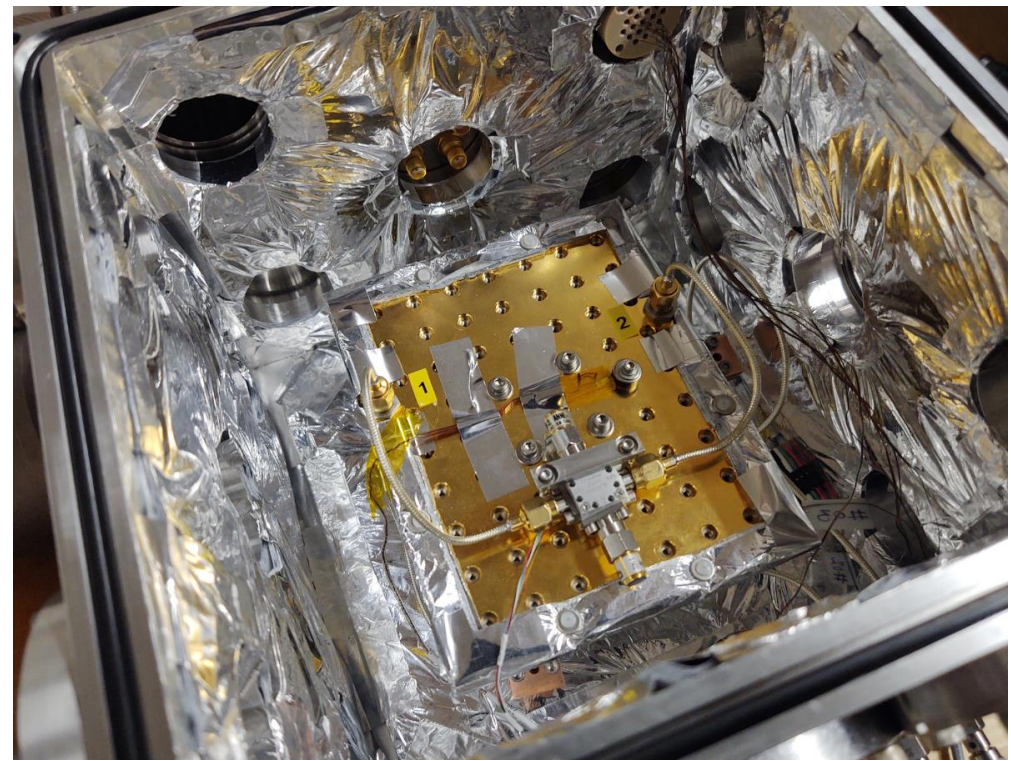
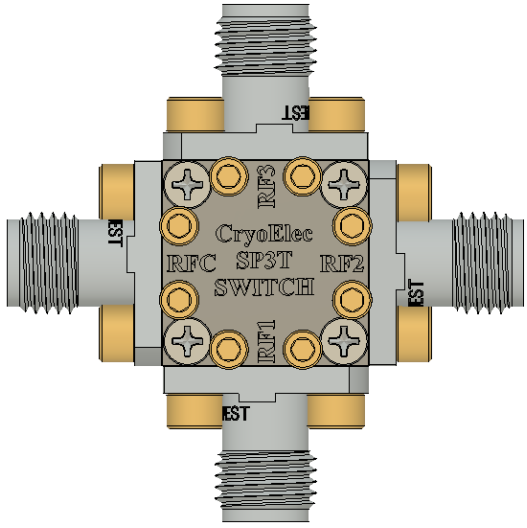
# CryoElec SP3T CryoSwitch

Prototype Data 05/2023

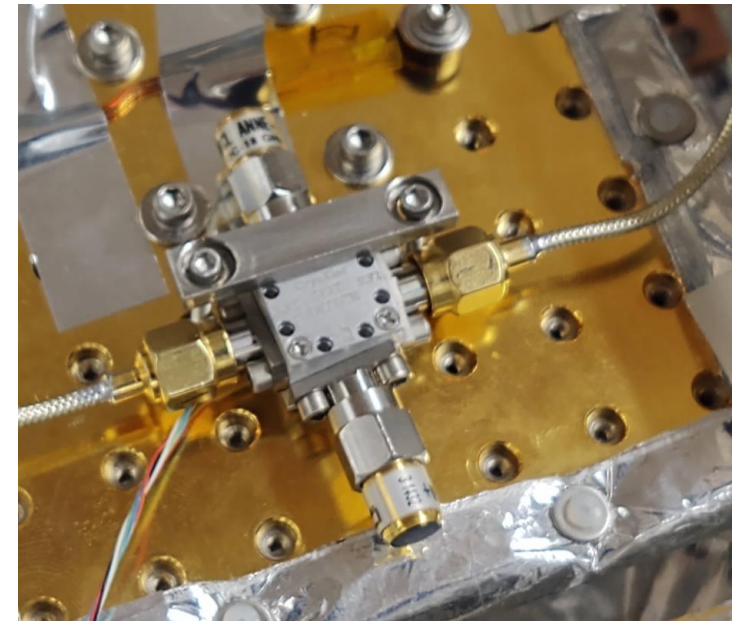
Low Loss SP3T Miniature Switch  
Size: 0.5 x 0.5 x 0.5 in



## Low Loss SP3T Miniature Switch Size: 0.5 x 0.5 x 0.5 in



Switch cooled many times to 13K  
Works reliably  
Loss is very low (hard to measure)  
More measurements are being  
Conducted to accurately measure  
The cryogenic loss of the switch

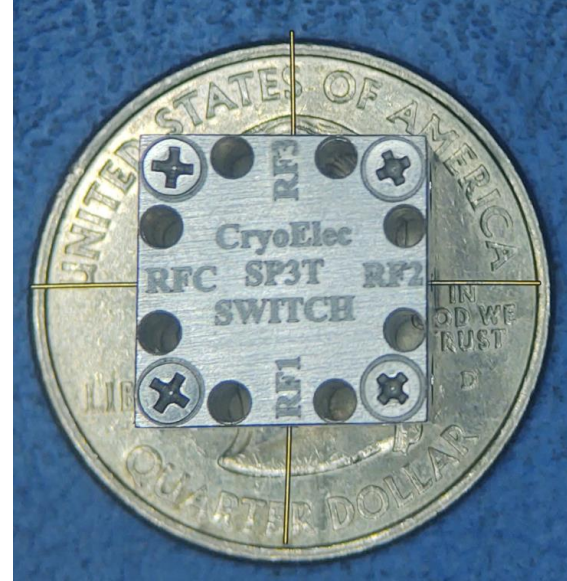


**Low Loss SP3T Miniature Cryogenic Switch**  
**Size: 0.5 x 0.5 x 0.5 in (not including SMAs)**

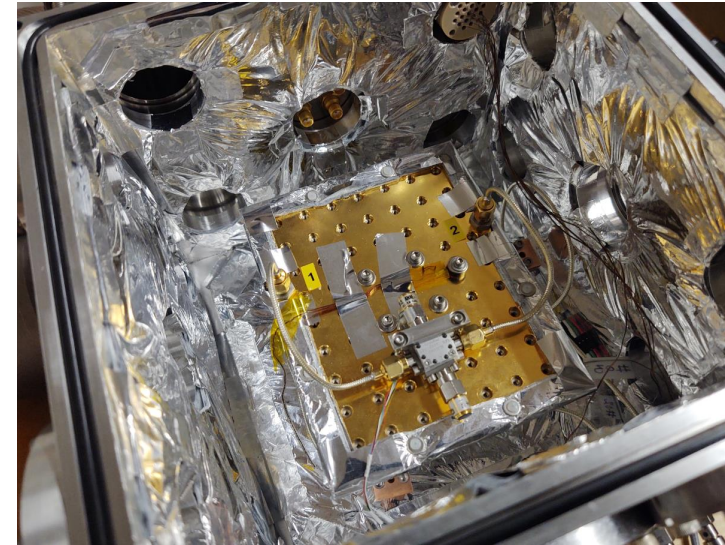
**Prototype**



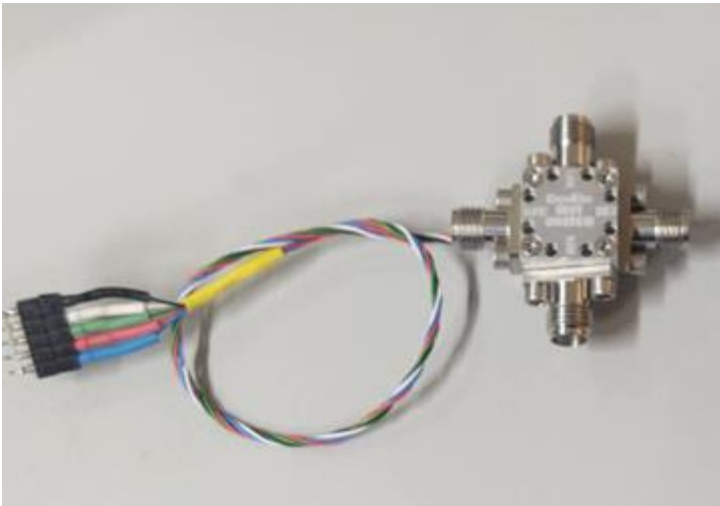
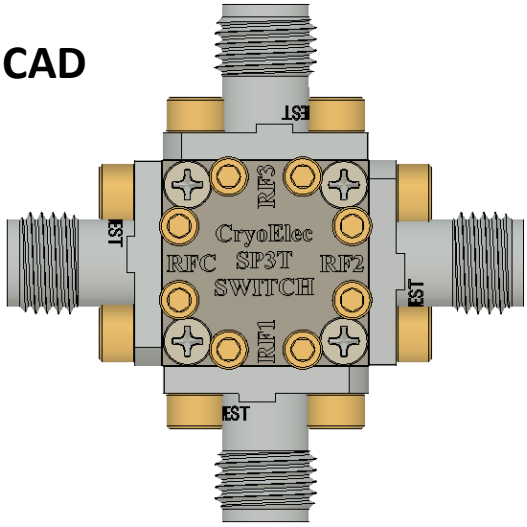
**“Drop-in” Package  
Can be soldered to PCBs**



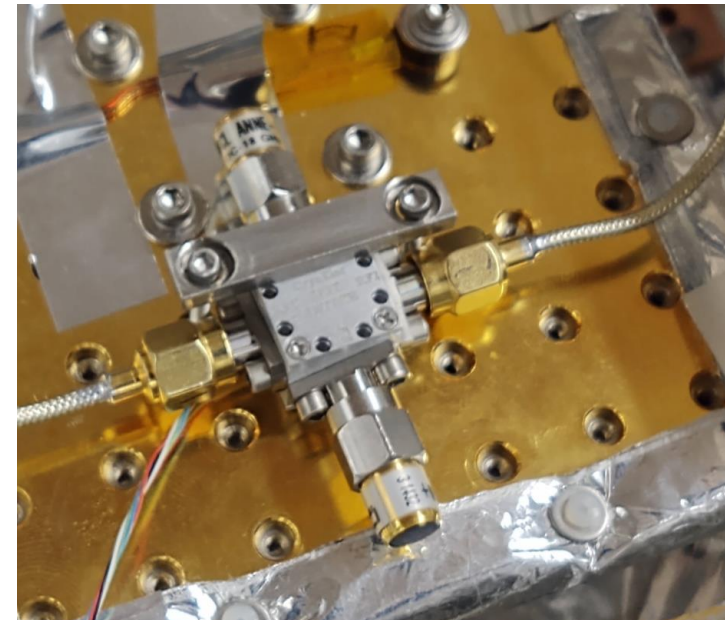
**Inside the 15K Cryogenic system  
At CryoElec Chandler**



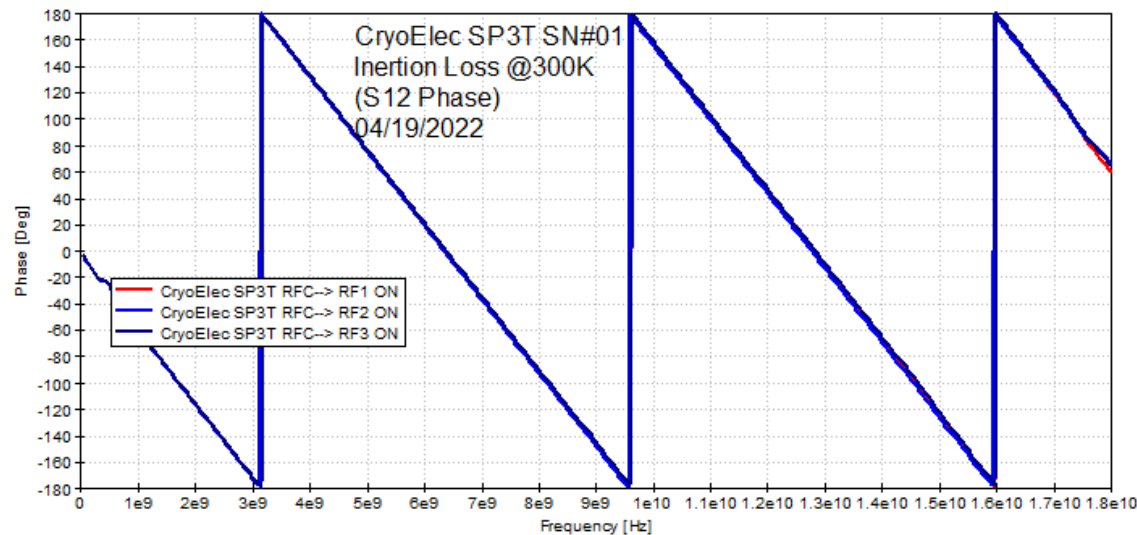
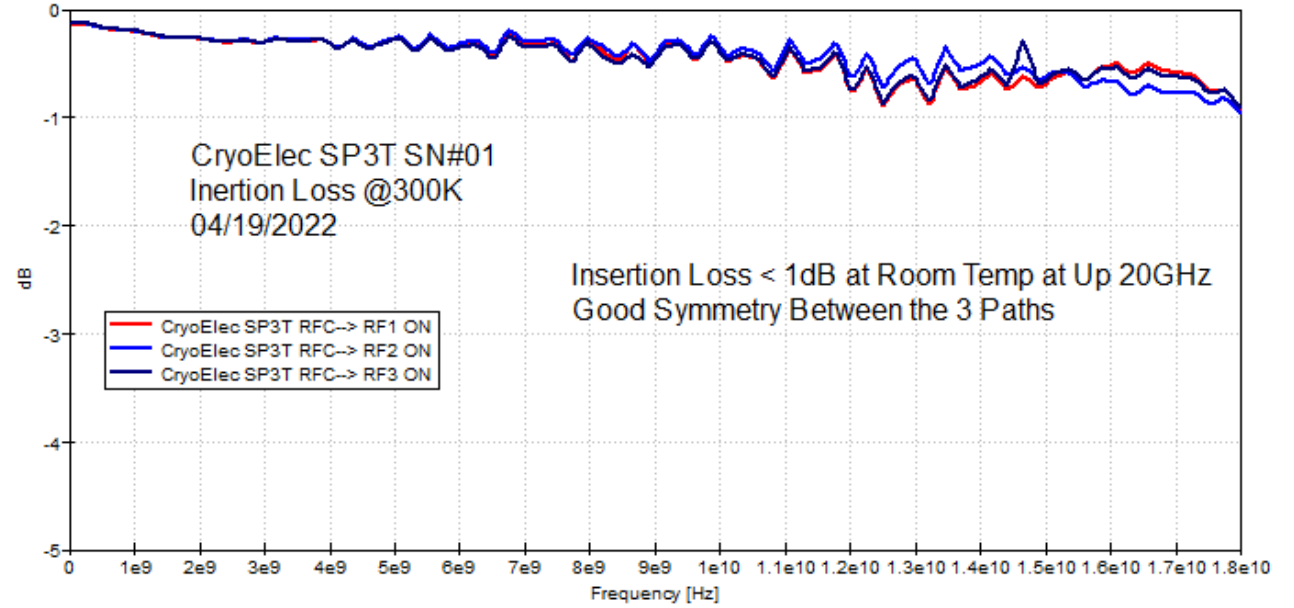
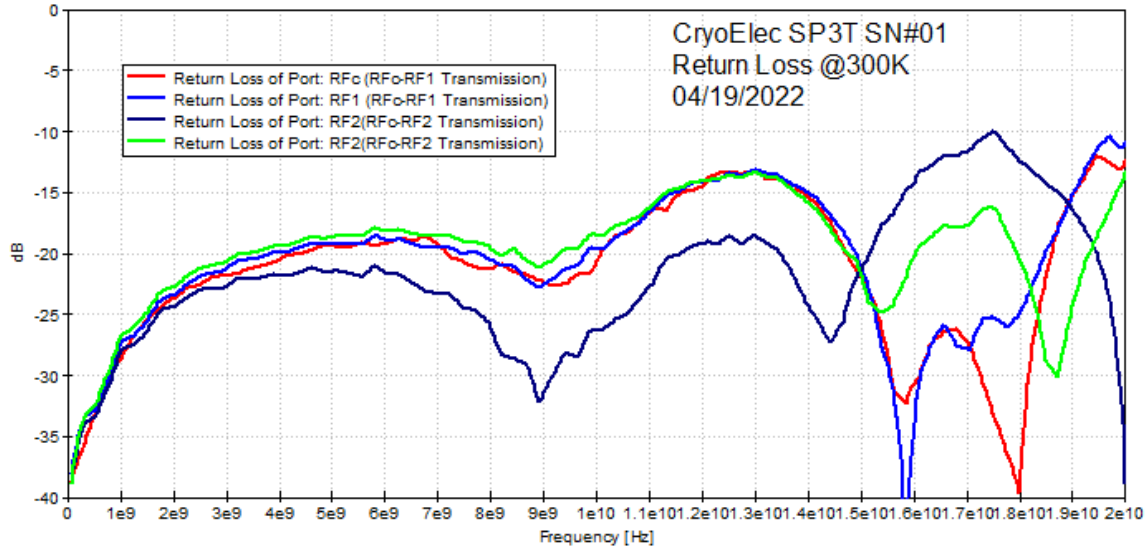
**CAD**



**Switch cooled many times to 13K  
Works reliably  
Loss is very low (hard to measure)  
More measurements are being  
Conducted to accurately measure  
The cryogenic loss of the switch**

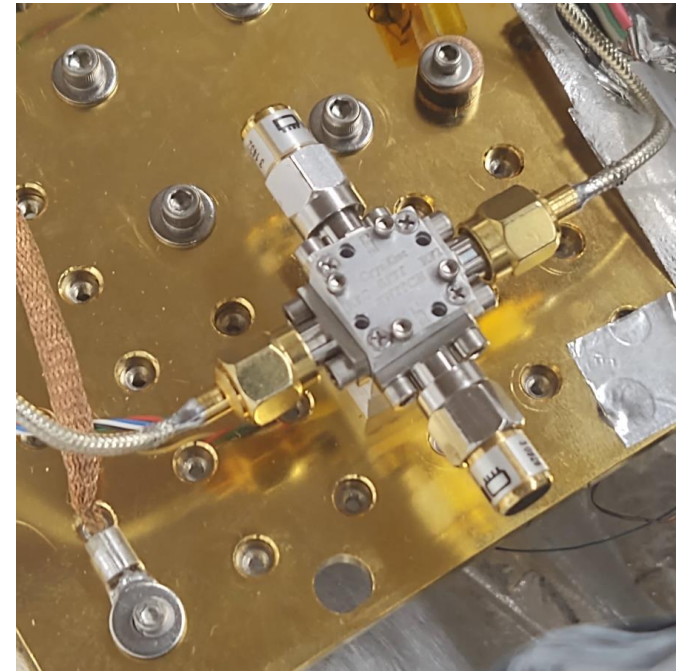
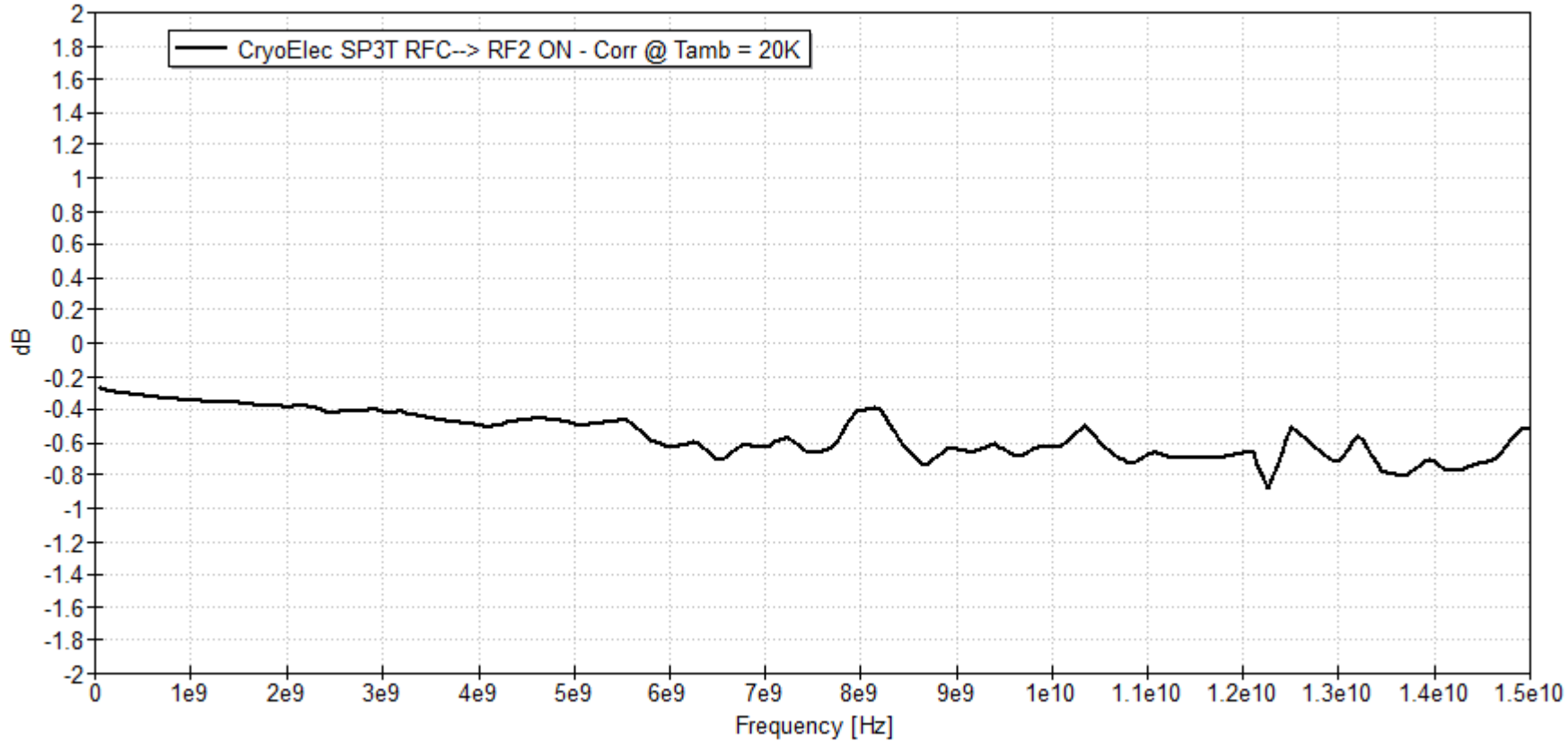


Measured Performance of the CryoElec SP3T  
At 300K : 50MHz – 20 GHz



Measurement of the SP3T at Cryogenic Temperature  
Corrected Loss Data of the Entire Switch package  
At Tamb = 20K

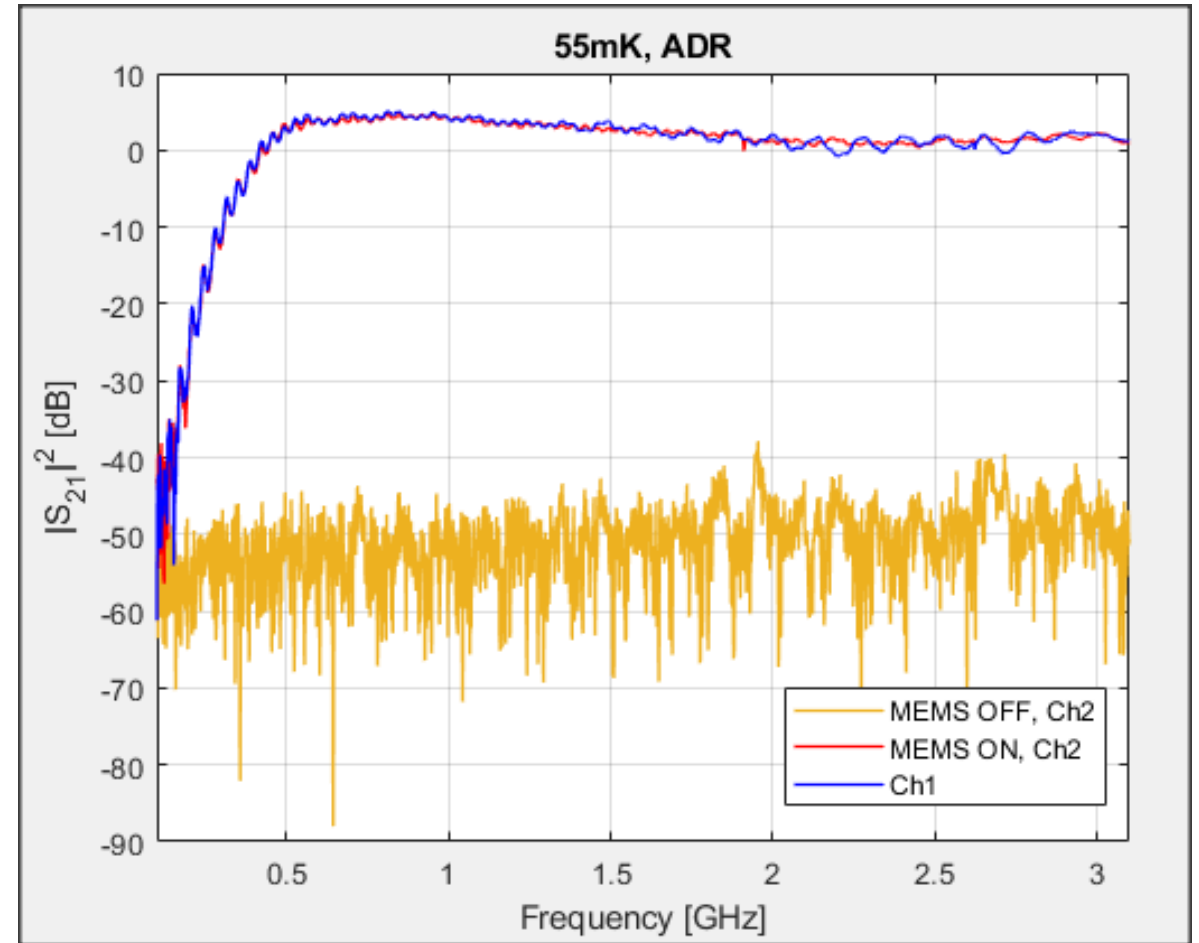
< 1dB Loss at < 15GHz



“Functional Test” (uncalibrated Data) of SP3T SN#01 at 55mK  
Data courtesy of Dr Jiansong Gao of NIST Boulder

This test shows:

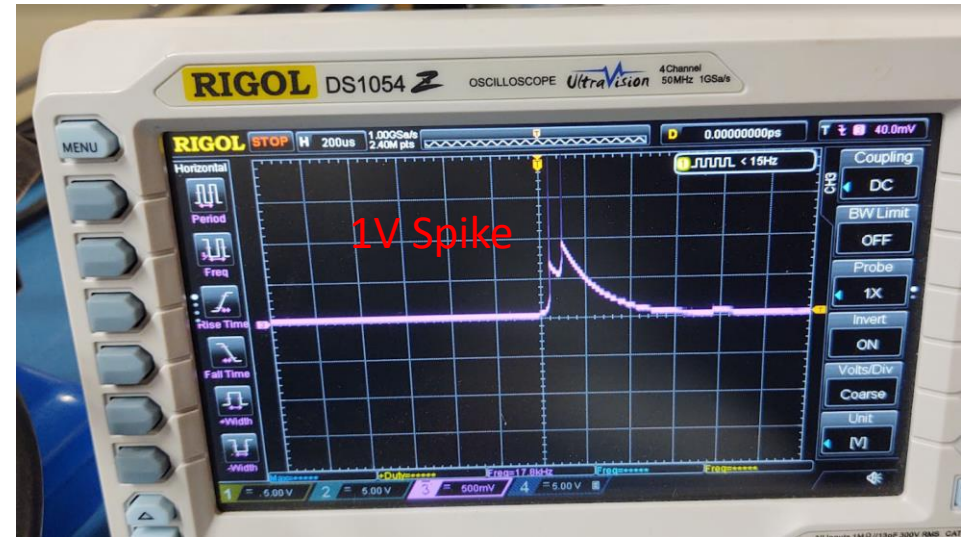
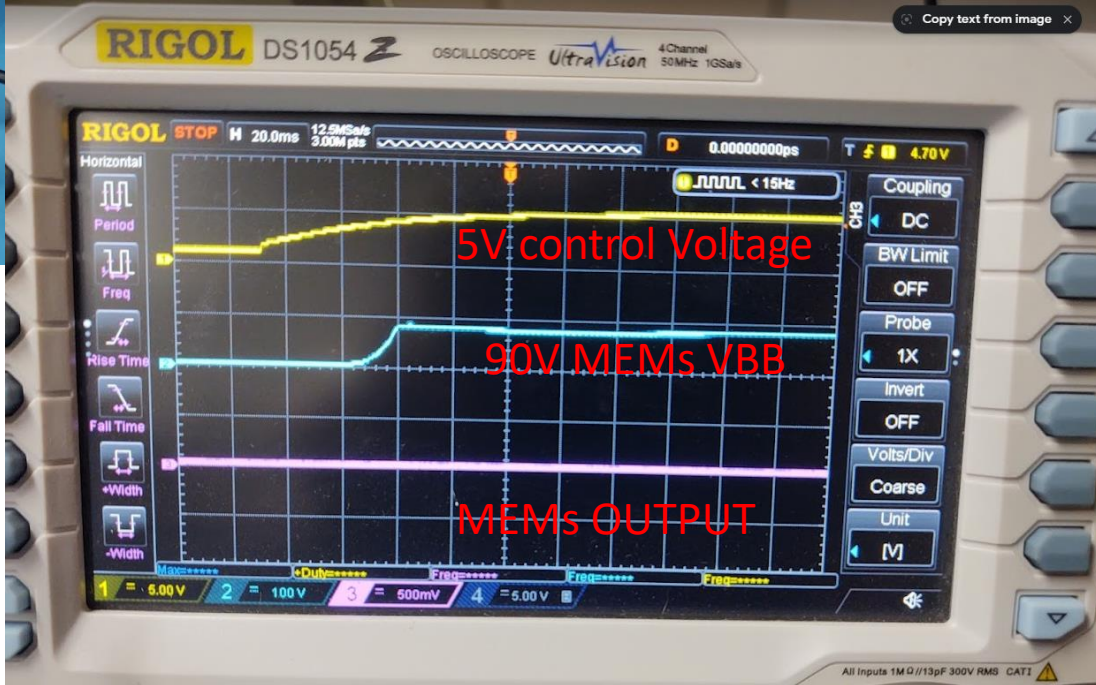
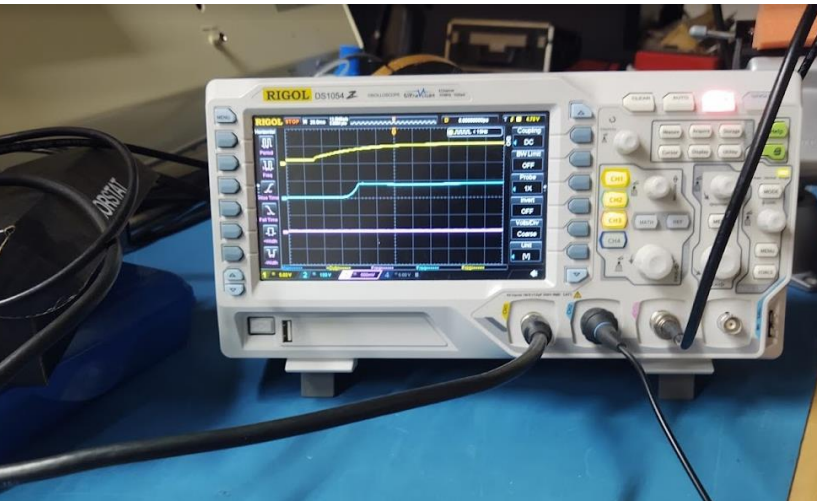
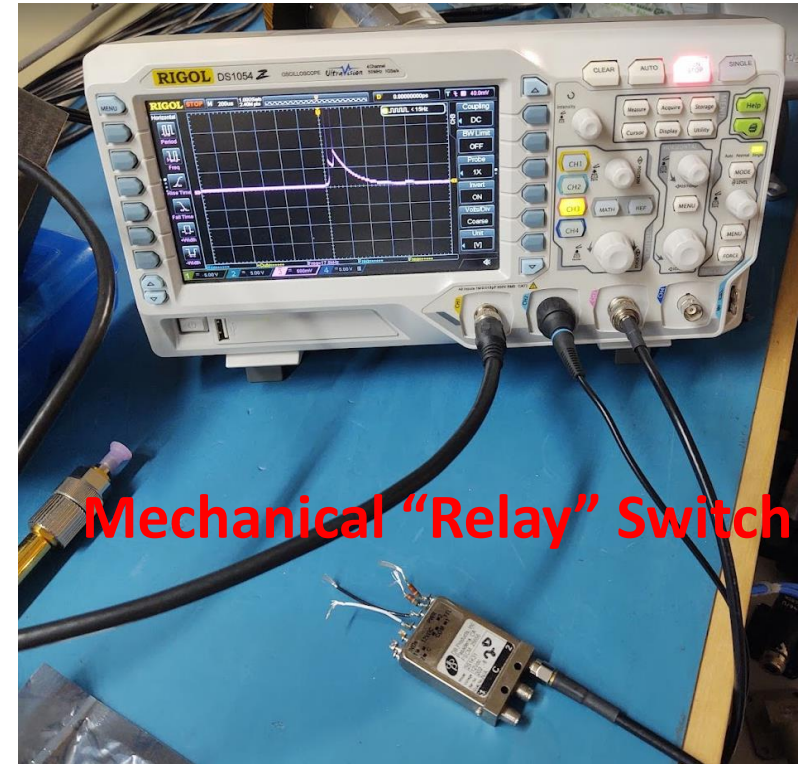
- The switch is working well at 55mK (as seen on the large S21 on/off different)
- There is no heating of the 55mK stage due to Very low (< 1uW) power dissipation of the switch on its ON state
- The switch has very low loss: comparable to the loss Of an SMA adapter thru (blue curve)



SP3T Switches SN#01 and SN#05 are current being tested at 55mK at NIST Boulder , ADR system (55mK Temp)

Transients / Voltage spikes at Switch output

No Voltage spikes observed from CryoSwitches





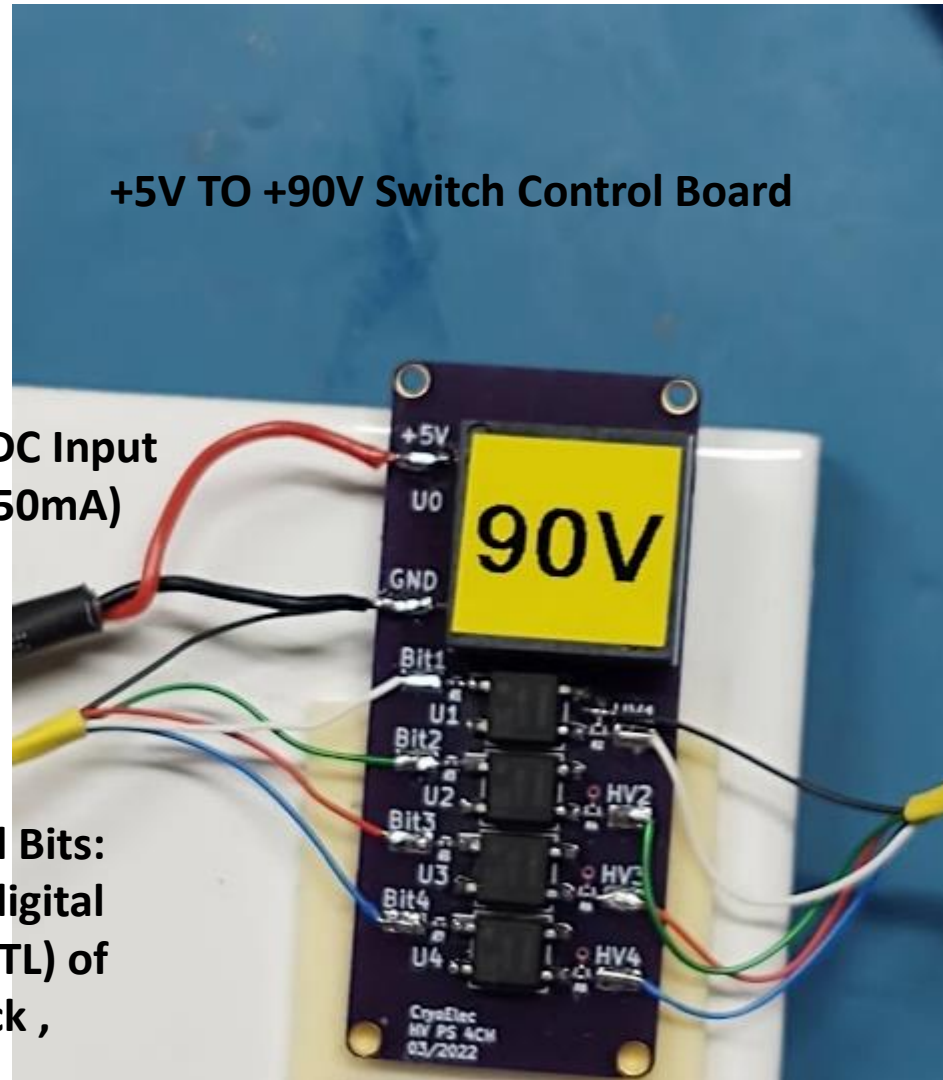
## 90V Control Board

CryoElec SP3T Switch Truth Table

Controller Input Wire		Controller Output Wire		RFc-->RF1	RFc-->RF2	RFc-->RF3	Logic 1	90V Applied Voltage
Wire Color	Function	Wire Color	Function					
White	Cbit1	White	VG1	1	1	1		
Green	Cbit2	Green	VG2	1	0	0		
Red	Cbit3	Red	VG3	0	1	0		
Blue	Cbit4	Blue	VG4	0	0	1		
Black	GND	Black	GND					

### +5V TO +90V Switch Control Board

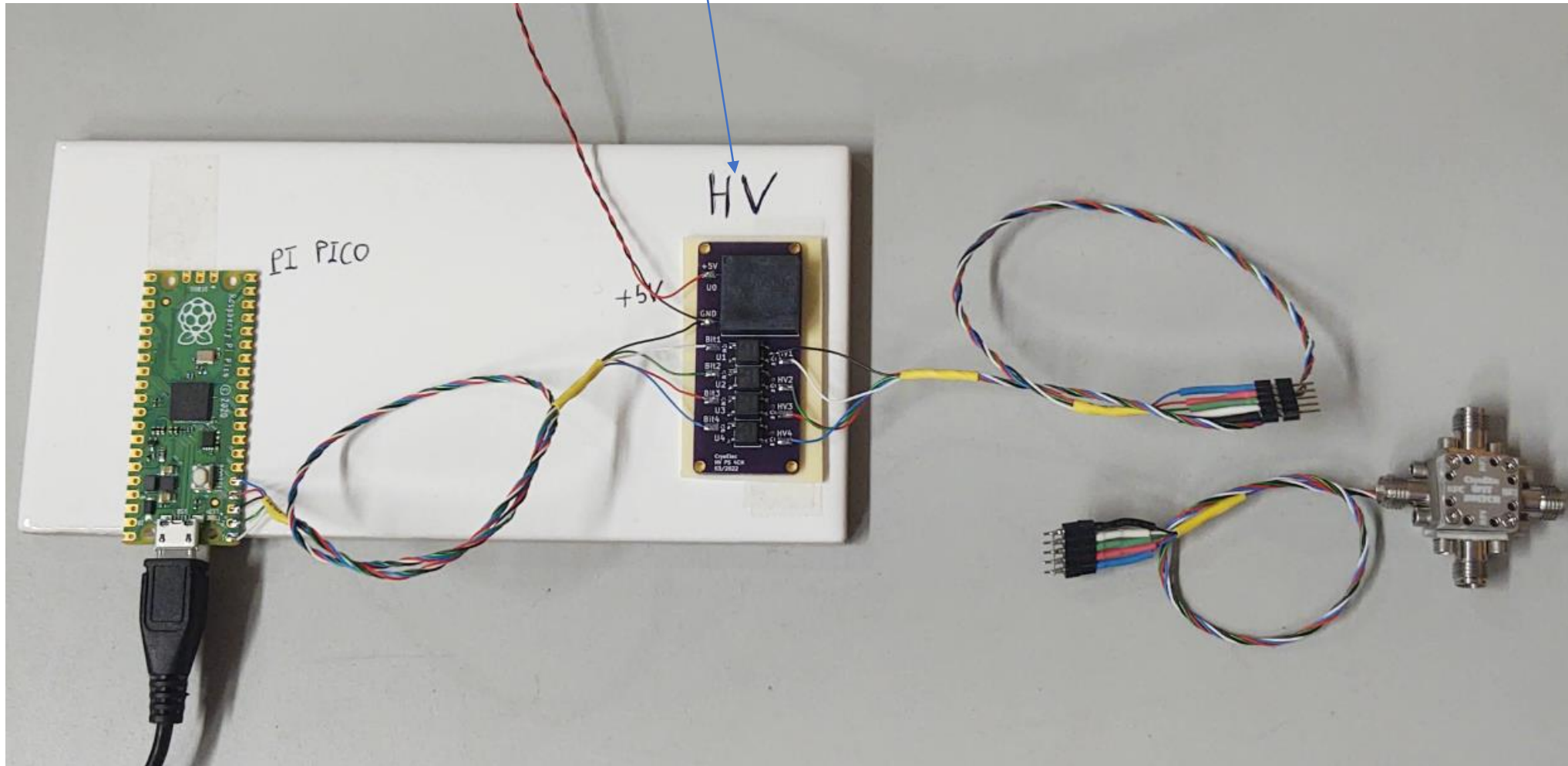
+5V DC Input  
(@ 150mA)



90V output lines:  
Connect to Switch  
GND, VG1 to VG4

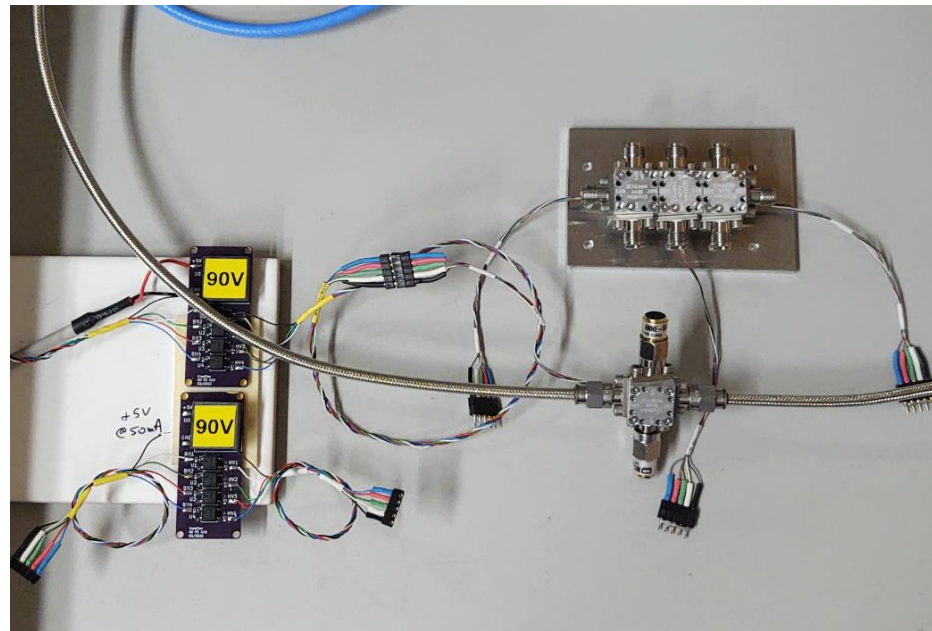
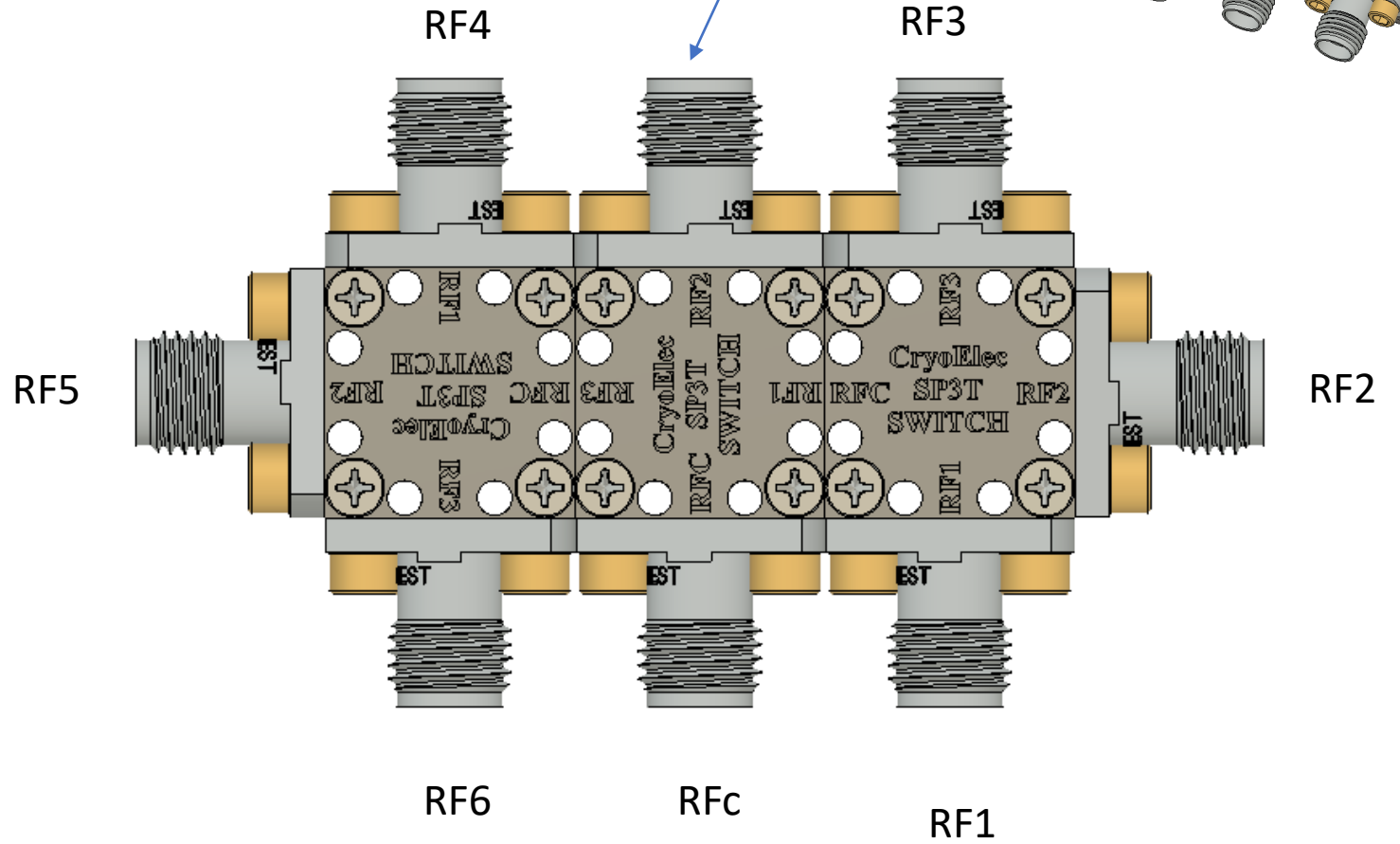
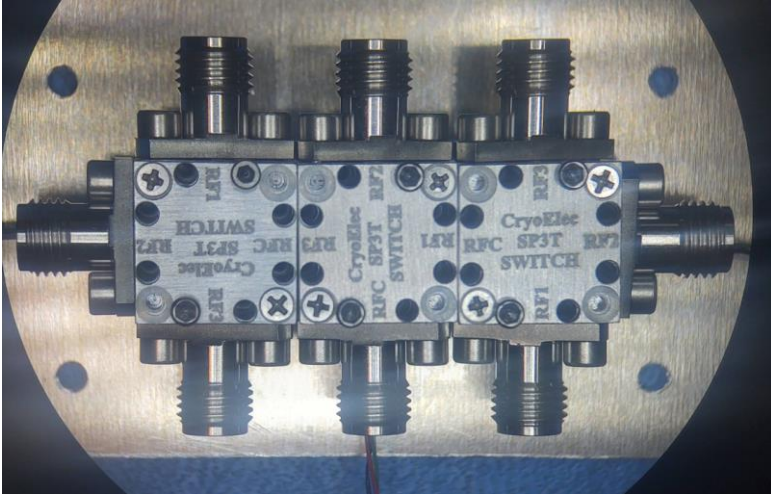
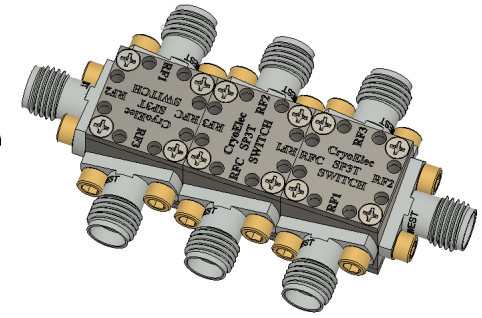
Digital Control Bits:  
CONNECT To digital  
Outputs (5V TTL) of  
A DAQ (Labjack ,  
Arduino...)

Custom HV (90V) PCB with 4CH HV output  
Controlled with a raspberrypi Pico (Python)

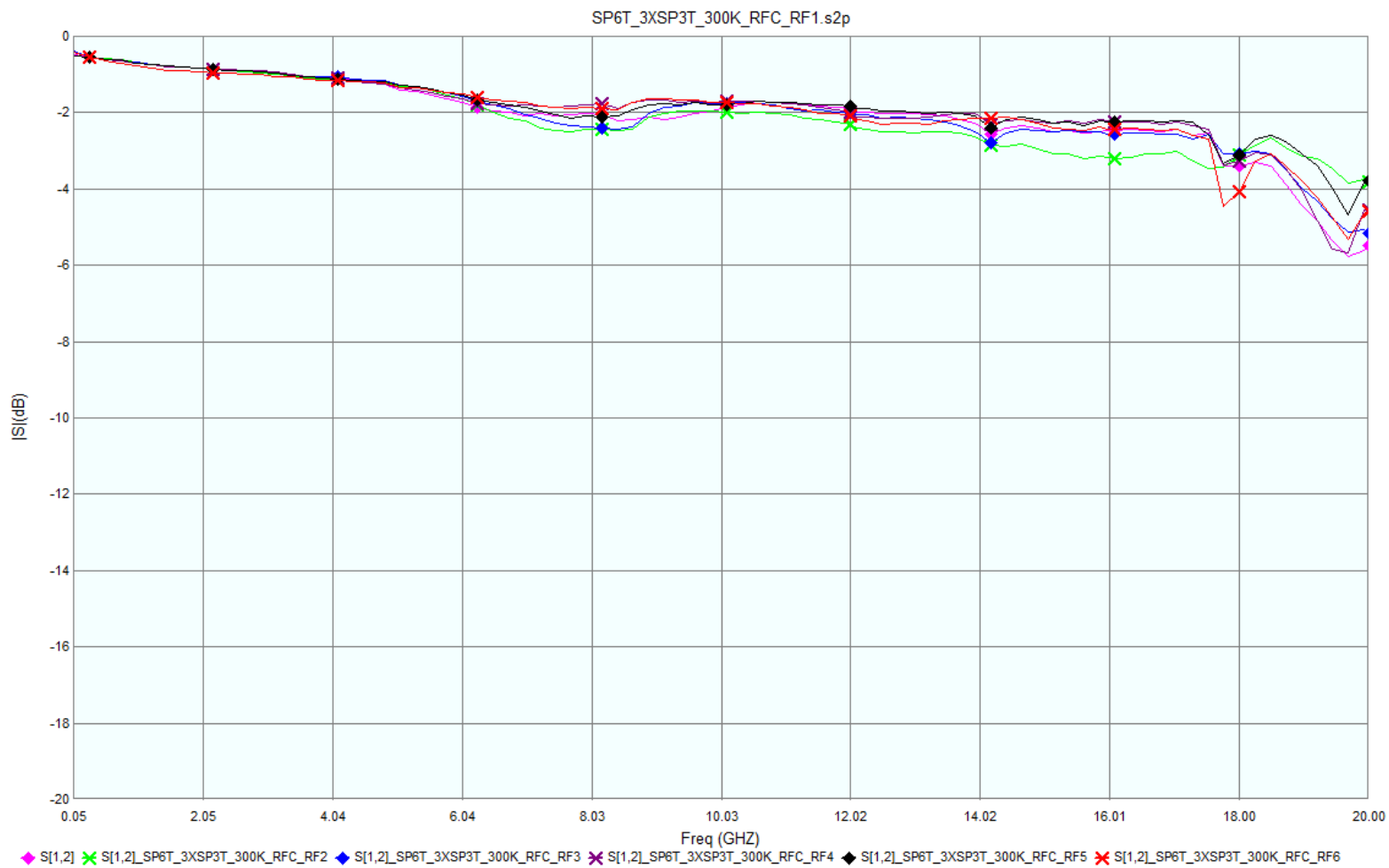
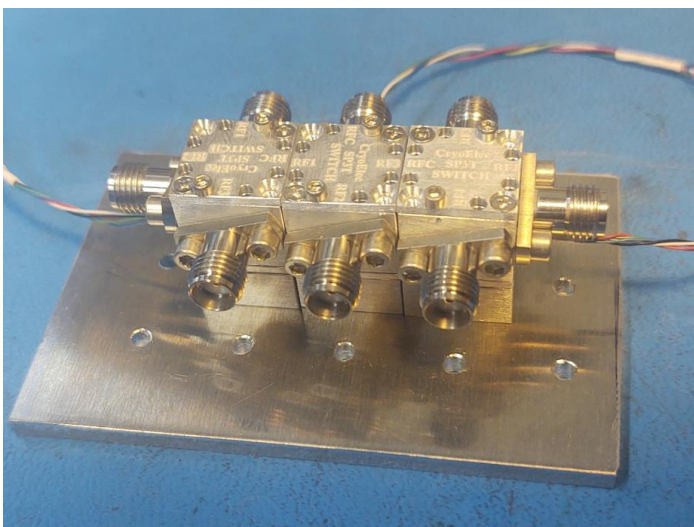
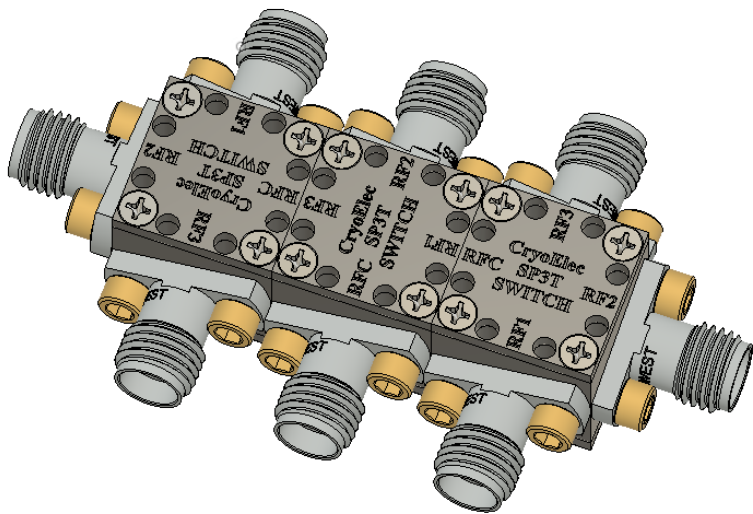


SP6T built using 3 x SP3T  
All 6 paths are equal magnitude/phase

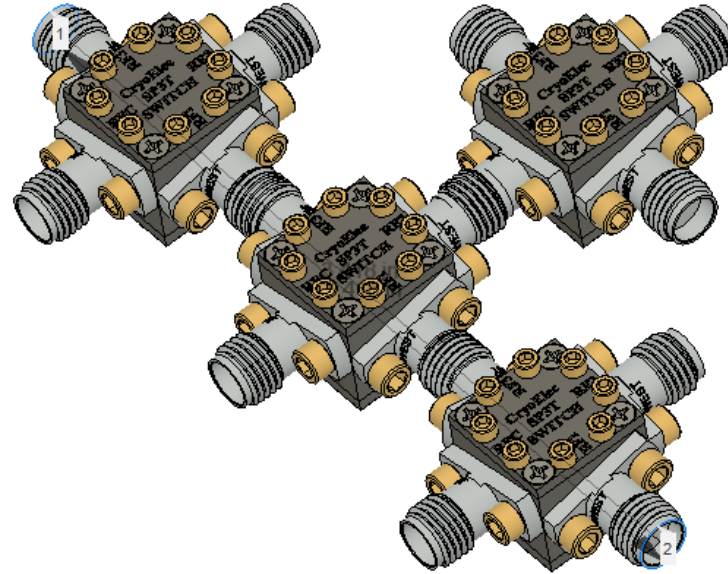
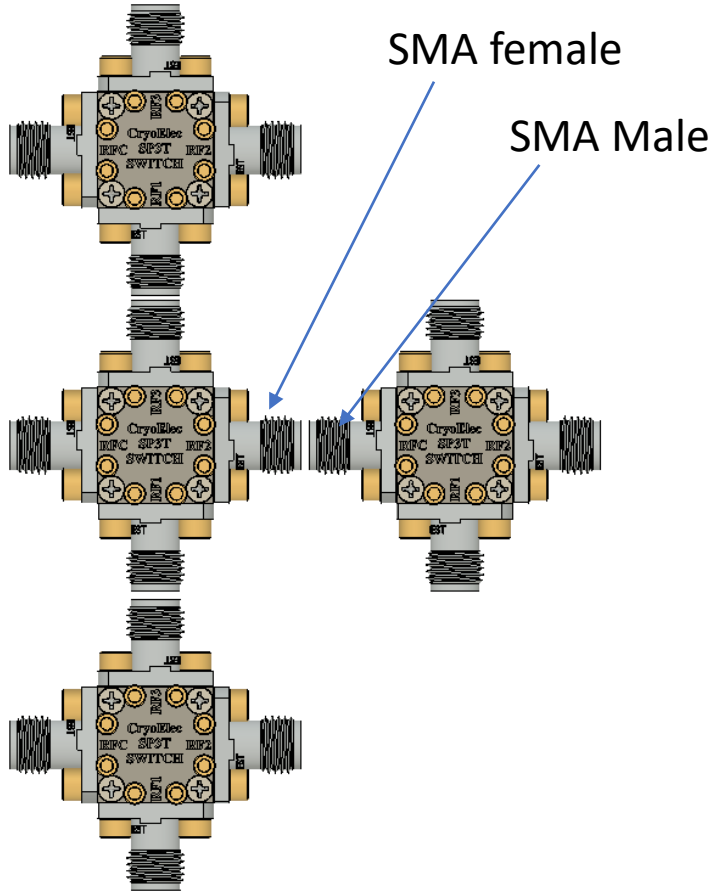
Terminate this port  
 Or  
 Use it as RF7 ( has lower loss,  
 Length than other ports



SP6T built using 3 x SP3T  
 All 6 paths are equal magnitude/phase



SP9T configuration



MEASURE

Selection Filter

Precision 0.123

Secondary Units None

Restart Selection

Show Snap Points

▼ Results

Distance 3.418 in

Minimum Distance 3.418 in

XYZ Delta

▼ Selection 1

Edge selected

Length 0.661 in

Radius 0.105 in

Diameter 0.211 in

Center Position X 0.113 in

Center Position Y -0.005 in

Center Position Z 1.718 in

▼ Selection 2

Edge selected

Length 0.661 in

Radius 0.105 in

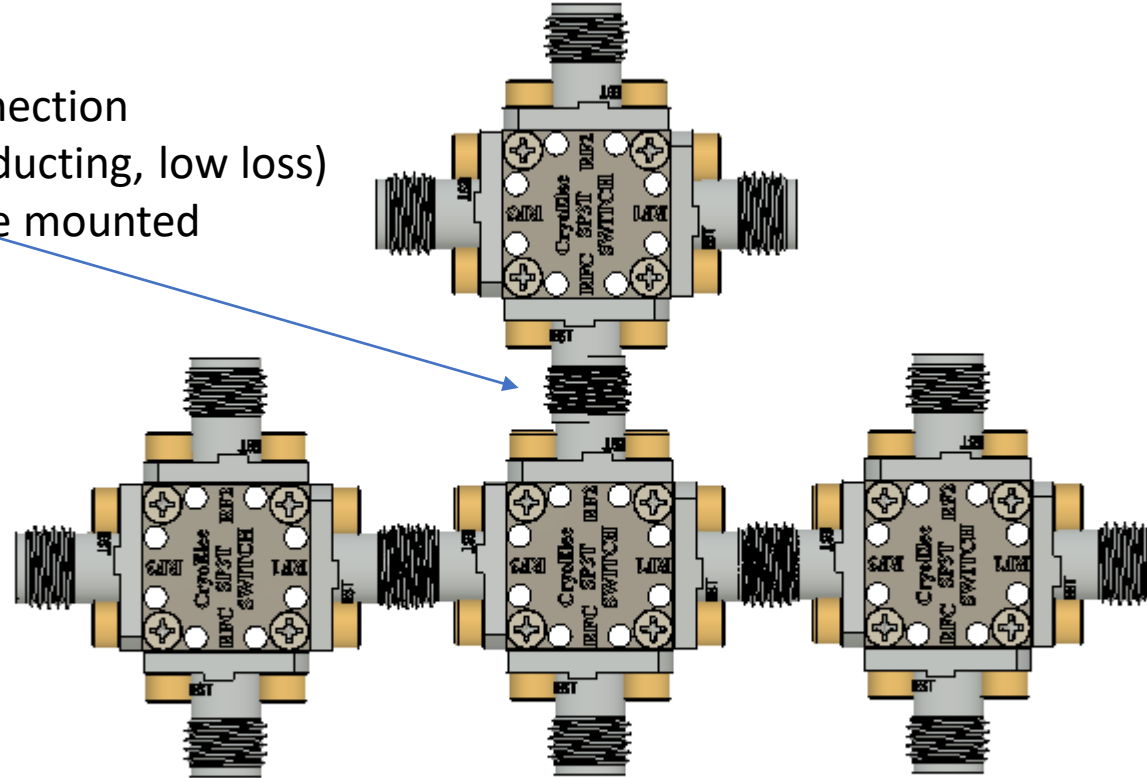
Close

An SP9T can be made by connecting 4 separate SP3Ts

Connection can be made with:

- Male / Female direct SMA connection
- Short Cables (Can be superconducting, low loss)
- Individual SP3T Switches can be mounted

At different cryostat stages



A total of 6 switches built and are being tested at cryogenic temperature  
For reliability / repeatability during cryogenic thermal cyclings

