

# LoCo EDGES Memo #201

Ground Plane Resonance testing at the WA site  
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# Slot selection in the inner-5m:

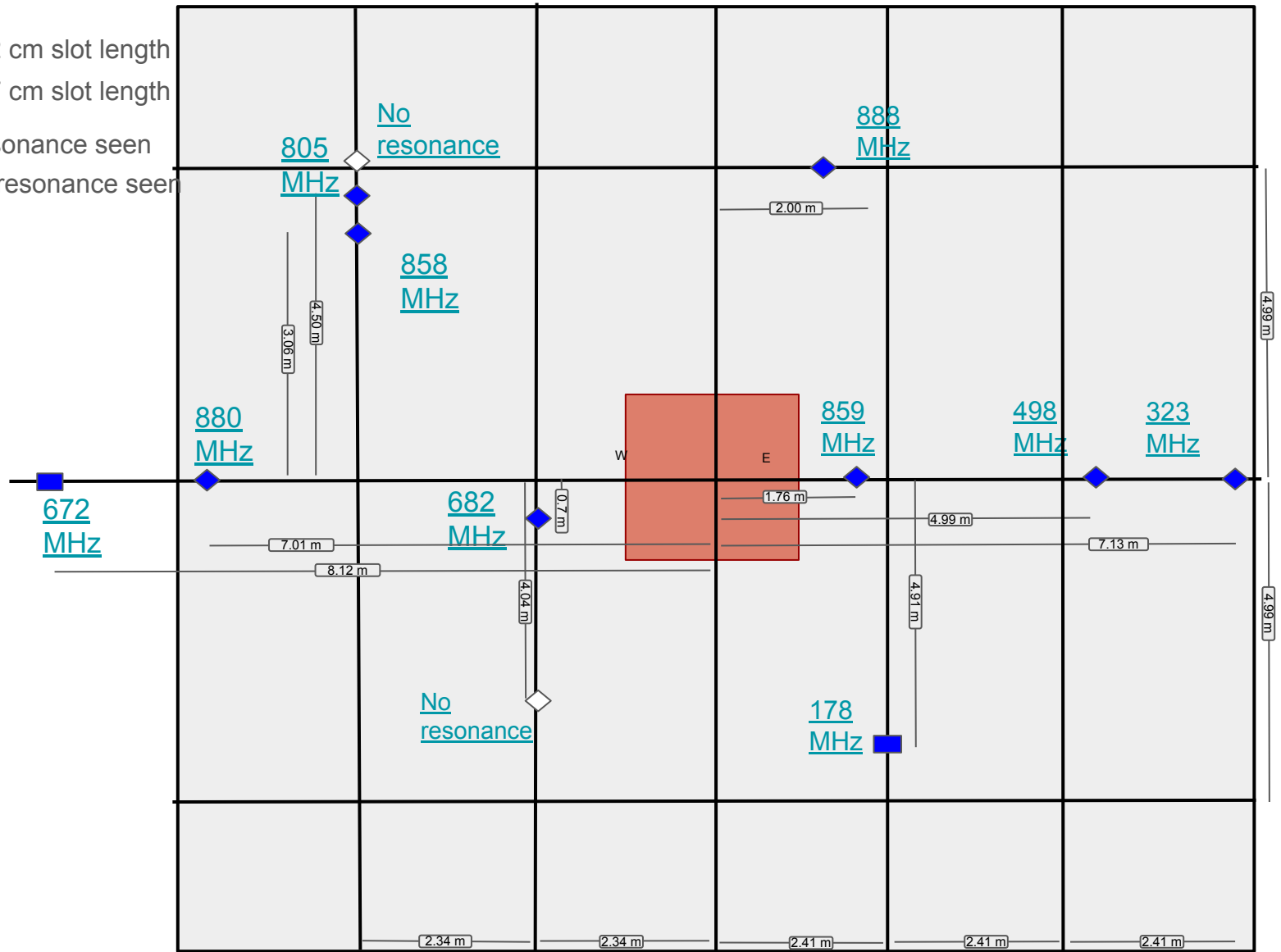
- As a first order testing, we visually picked out 12 slots that could potentially be candidates of producing resonance.
- We had three main criteria: Really close welds ( $<0.25\text{mm}$ ), long slots ( $>20\text{ cm}$ ), overlapping along z axis



Example of using a feeler gauge to measure the separation distance of the slot. This is an example of a slot with a small distance separation  $<0.25\text{mm}$

[left] Slot of a typical length ( $\sim 17\text{cm}$ ) where there are 3 mesh boxes between two weld joints. Most of the slots on the ground plane will be of this size. [right] an atypical slot where there are four mesh boxes between the weld joints making the slot length  $\sim 22\text{cm}$ .

- 22 cm slot length
- ◆ 17 cm slot length
- ◆ Resonance seen
- ◇ No resonance seen



# Slot resonance tracking

S.No.	Distance from N (m)	Distance from E (m)	Distance from S (m)	Distance from W (m)	Slot length (cm)	Slot width (mm)	Freq before clamping (MHz)	Freq after clamping (MHz)	Remarks
1	0	1.760	0	0	17	0.65	859	Not seen	After clamping results in VNA
2	0	4.990	0	0	17	0.55	498	777	Resonance moved to higher freq
3	0	7.130	0	0	17	<0.18	323	623	Resonance moved to higher freq
4	0	2.415	4.910	0	22	>0.9	178	Not seen	“
5	4.990	2.000	0	0			888	Not seen	
6	0	0	4.040	2.340			No resonance	No clamping	Stopped clamping.

# Slot resonance tracking

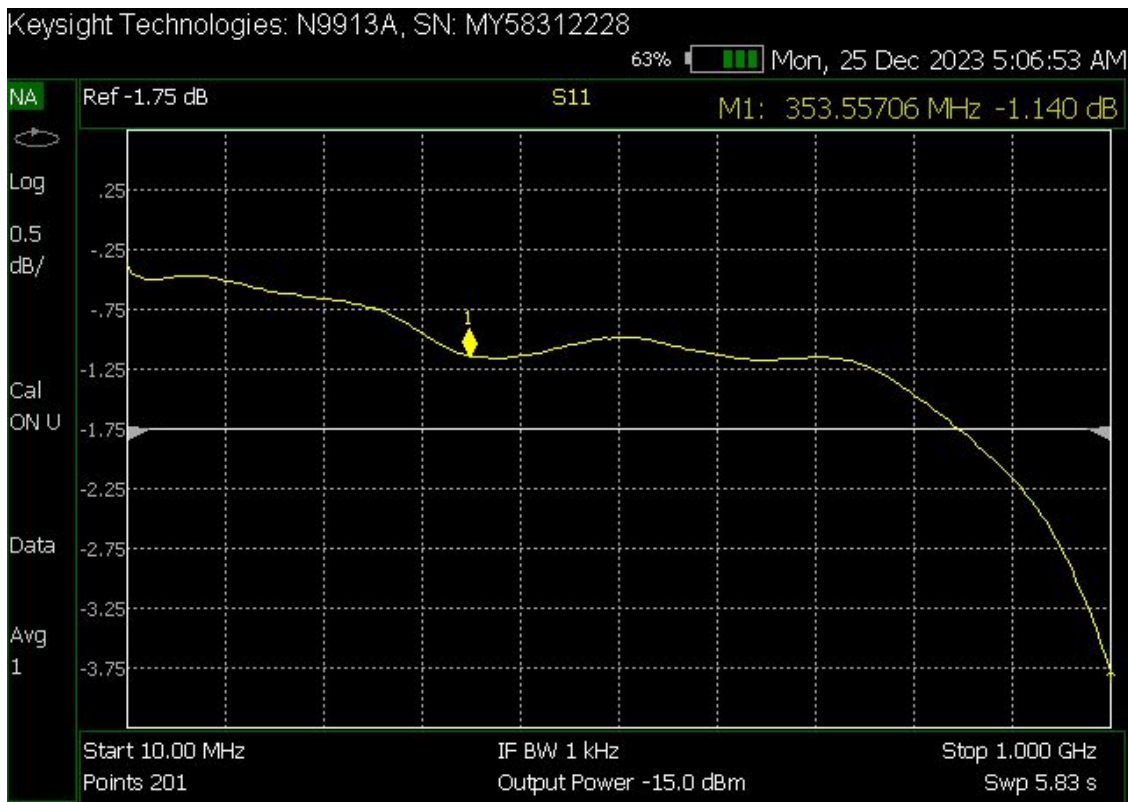
S.No.	Distance from N (m)	Distance from E (m)	Distance from S (m)	Distance from W (m)	Slot length (cm)	Slot width (mm)	Freq before clamping (MHz)	Freq after clamping (MHz)
7	0	0	0.700	2.360	17		682	No clamping, since the resonances are out of band.
8	0	0	0	8.120	22		672	
9	3.060	0	0	4.710	17		858	
10	4.500	0	0	4.710	17		805	
11	0	0	0	7.010	17		880	
12	4.990	0	0	4.710	17		No resonance	

# Spot 1

After clamping. Measurement made by connecting crocodile clips directly to mesh

Before clamping:

Resonance freq just noted. No data saved



# Spot 2

Before clamping:

Resonance freq just noted. No data saved

After clamping. Measurement made by connecting crocodile clips directly to mesh



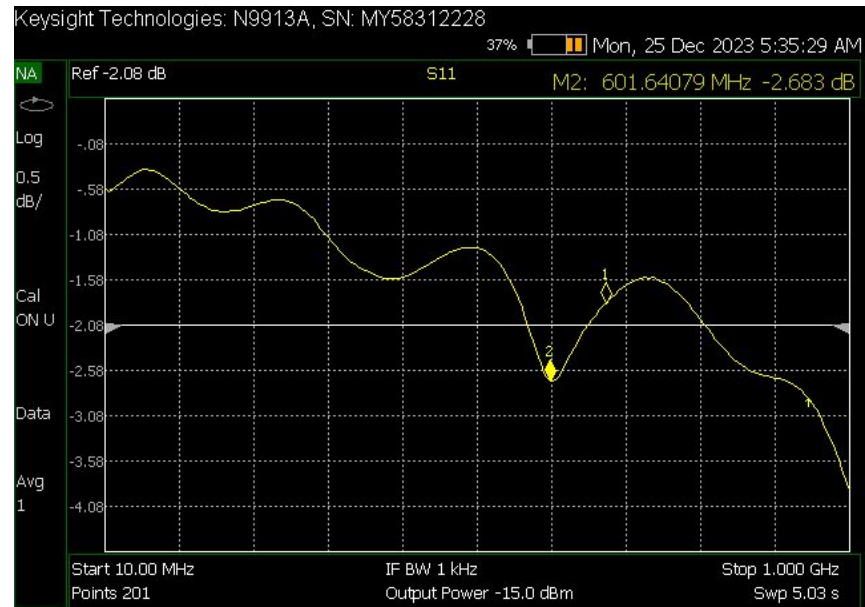
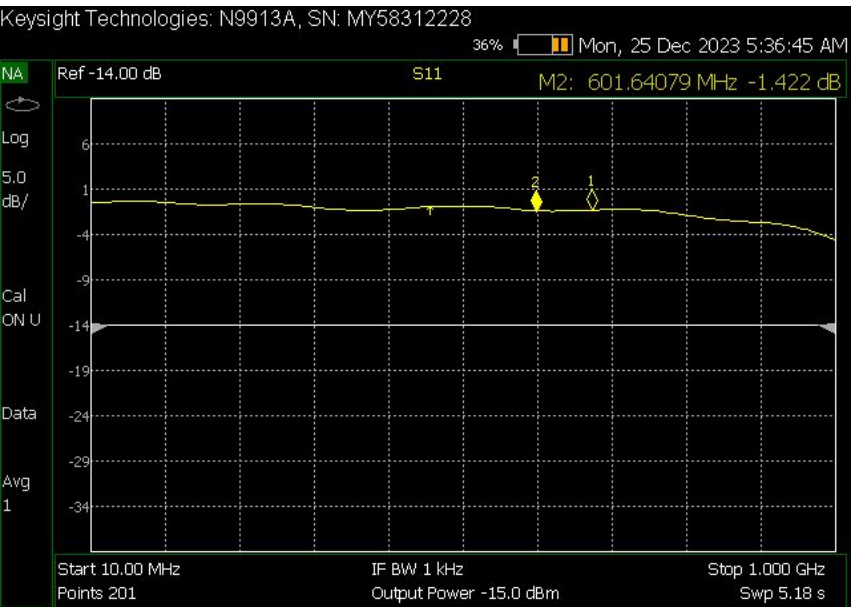
# Spot 3

Before clamping:

Resonance freq just noted. No data saved

After clamping. Measurement made by connecting crocodile clips directly to mesh. Did the calibration get messed up?

After clamping. Measurement made via clamps





# Spot 4

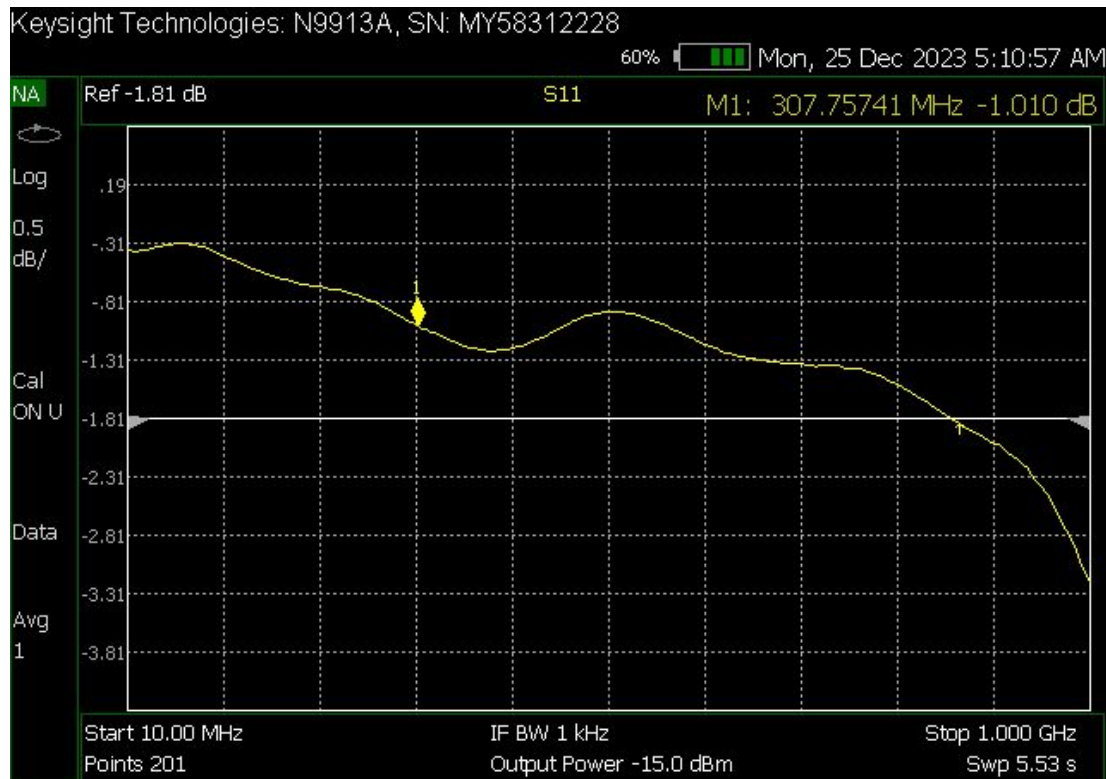
Before clamping:

Data is there as a csv file (no png).

To be plotted

After clamping.

Measurement made by connecting crocodile clips directly to mesh.



# Spot 5

Before clamping.

Measurement made by connecting crocodile clips directly to mesh.



After clamping.

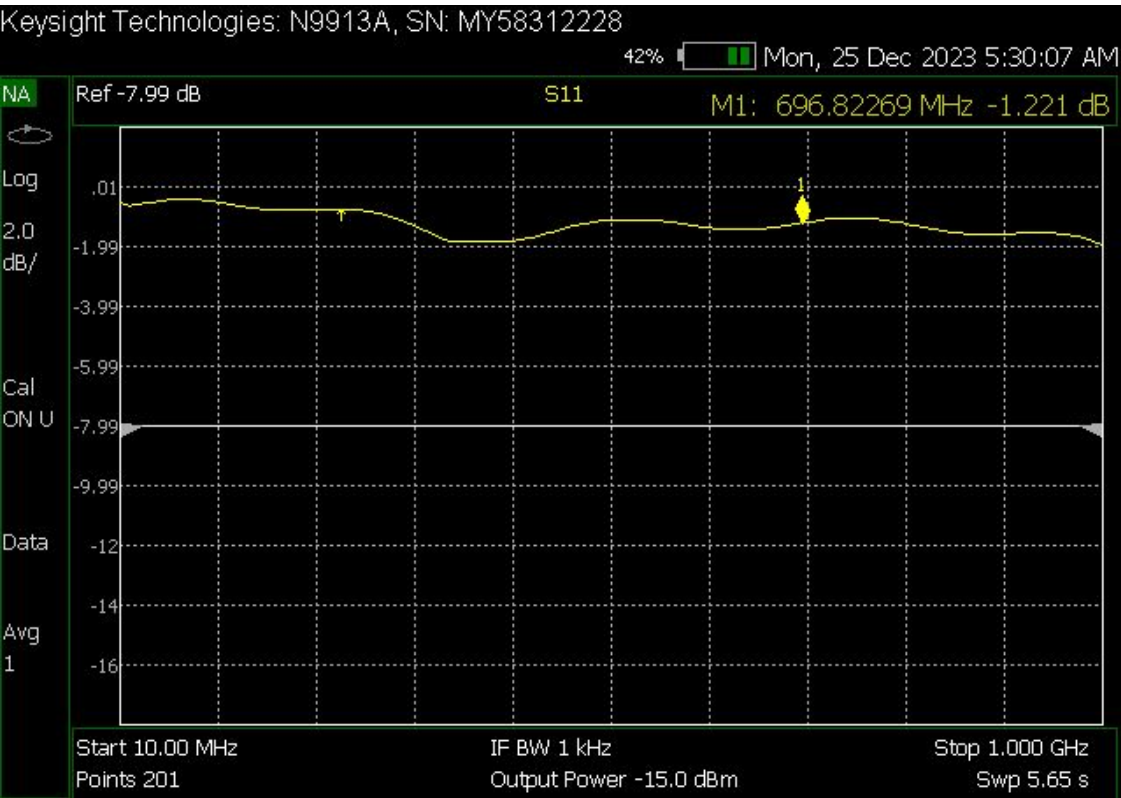
Measurement made by connecting crocodile clips directly to mesh.



# Spot 6

No clamping.

Measurement made by connecting crocodile clips directly to mesh.



# Spot 7

No clamping.

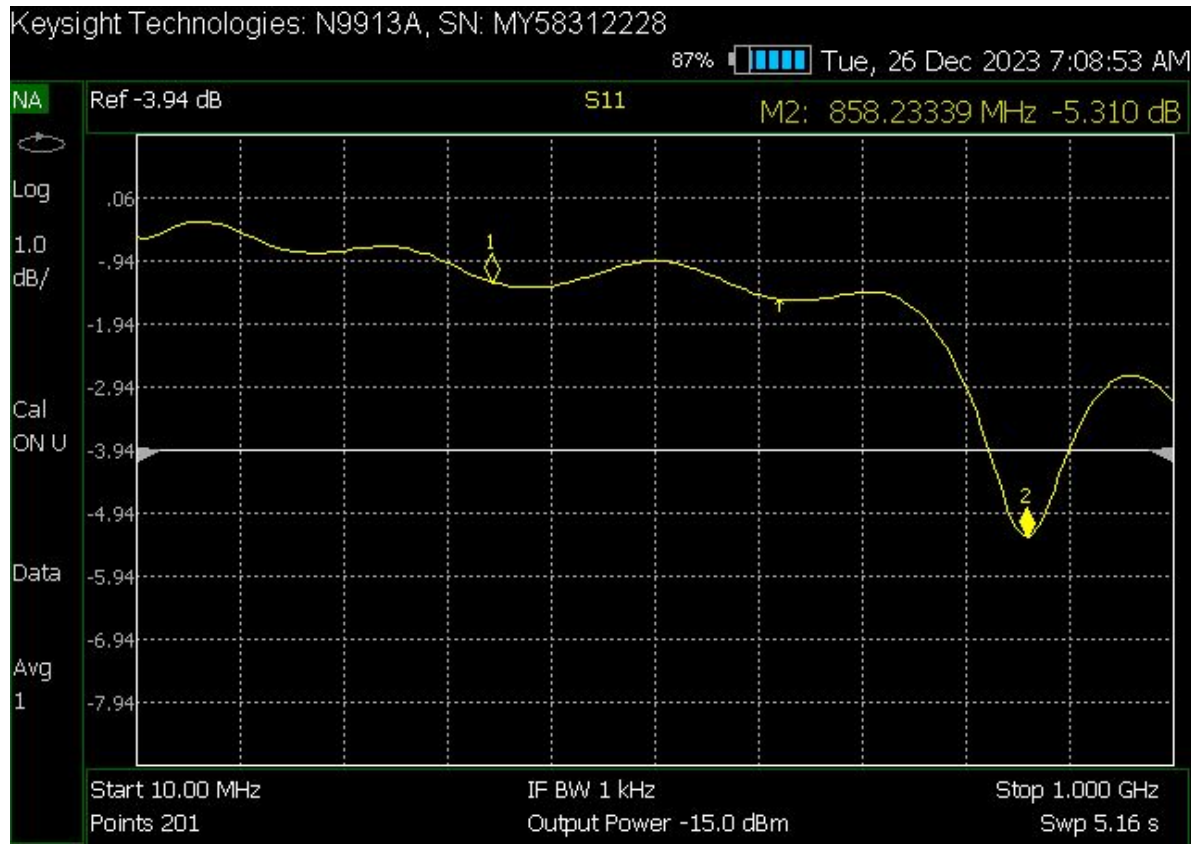
Measurement made by connecting crocodile clips directly to mesh.



# Spot 8



# Spot 9



# Spot 10



# Spot 11





# Spot 12



# Clamps for electrical contact:

- We find no difference in measurements with and without using clamps for establish electrical contact.
- Putting clamps on is also slightly tricky, and needs some sand digging.
- We also tested by scraping the layer of galvanized iron and then connecting the crocodile clips, and see no difference in measurements/
- For the remainder of testing, we don't use clamps, instead use the crocodile clips directly on the wire mesh.



# Clamping the slots

- We clamped a few slots and noticed the resonance frequency disappear (note: all resonant frequencies  $>600$  MHz).
- The clamps seem to be small for the clamping two wires together, when there is gap. The wires are very rigid, and we used pliers to hold them together, dig some sand out and clamped using the bigger clamps that Alan mailed out.



# Resonance grid search

- Since no resonances were found in visually selected slots, we measured S11 for each slot along North weld line at  $E-W = 0$  and the west weld line at  $N-S = 0$ .
- Next slide is the zoomed in version of the Ground plane map shown in slide 3. This is to highlight all the slots that were examined. We have also plotted/drawn 5 of the initial 12 slots examined that fall inside this zoomed in version.

No resonance

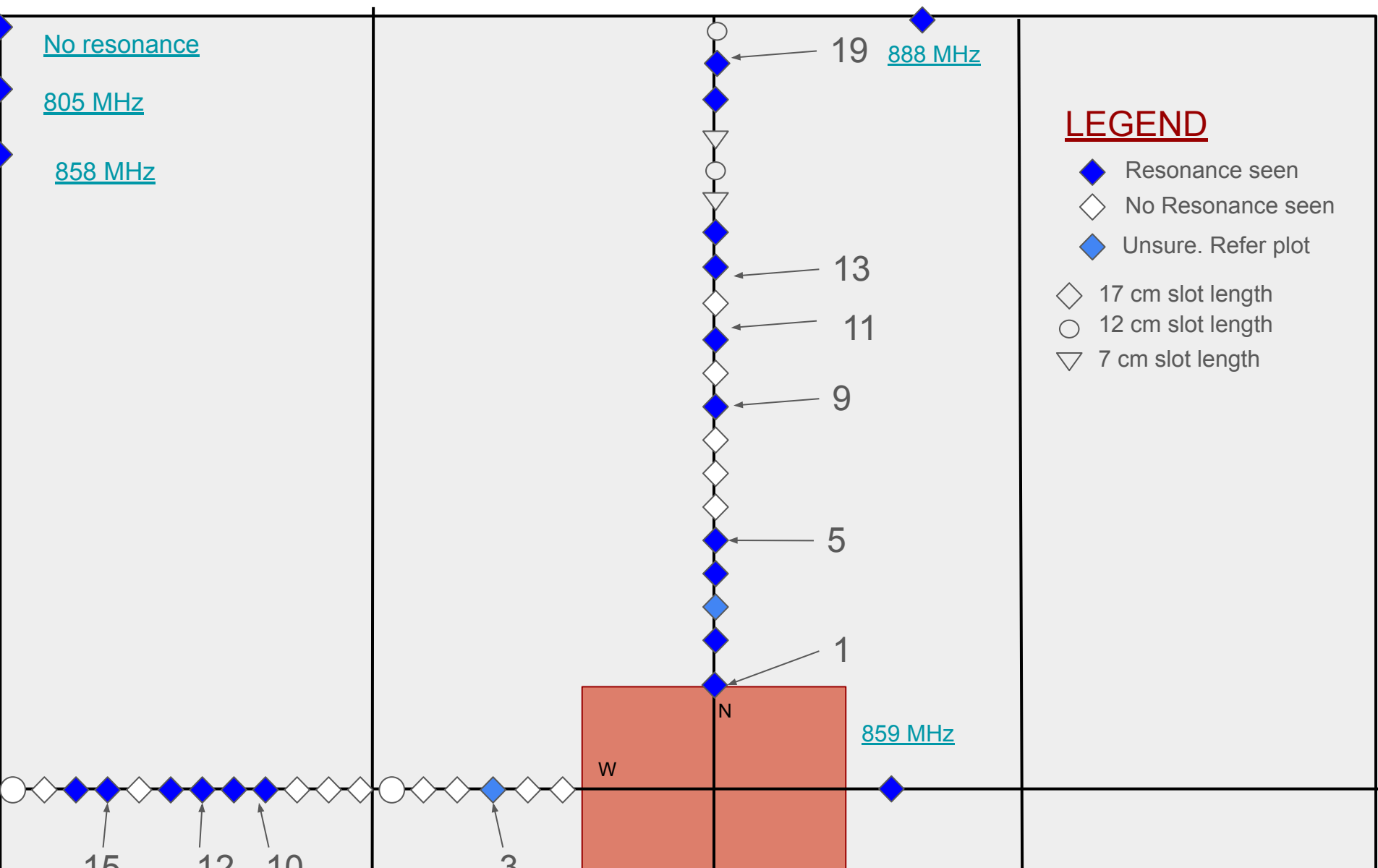
805 MHz

858 MHz

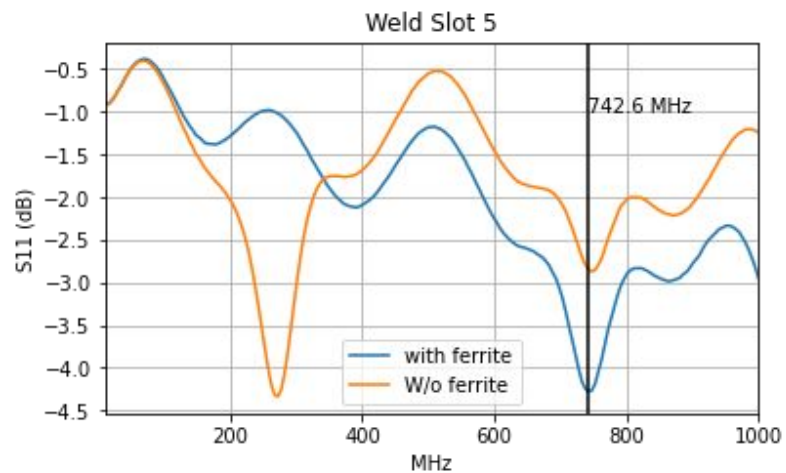
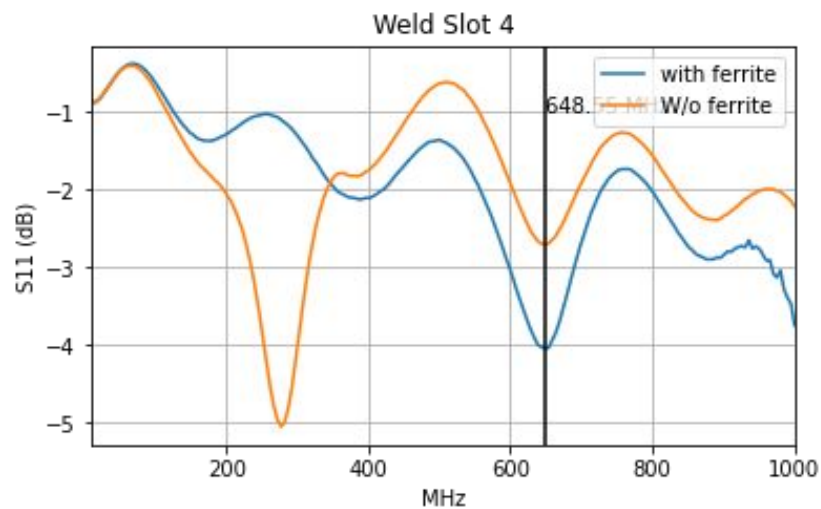
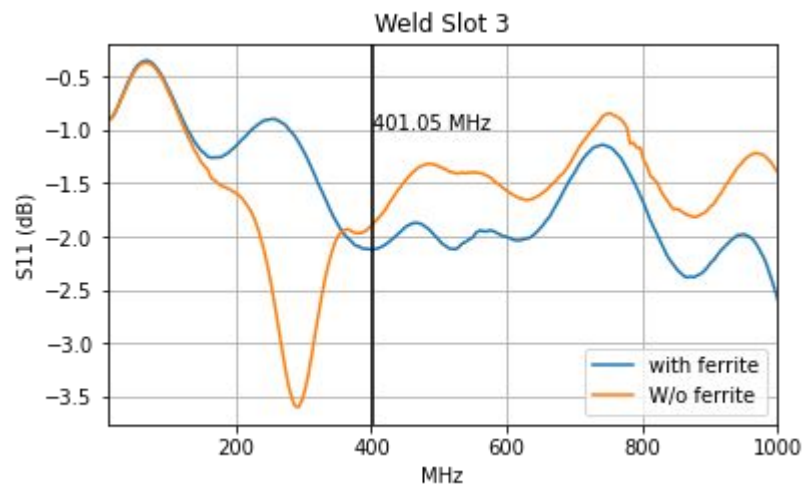
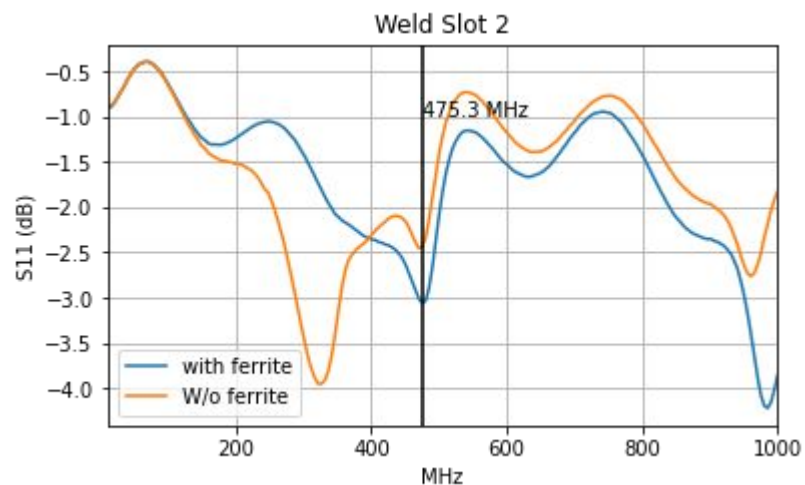
## LEGEND

- ◆ Resonance seen
- ◇ No Resonance seen
- ◆ Unsure. Refer plot

- ◇ 17 cm slot length
- 12 cm slot length
- ▽ 7 cm slot length



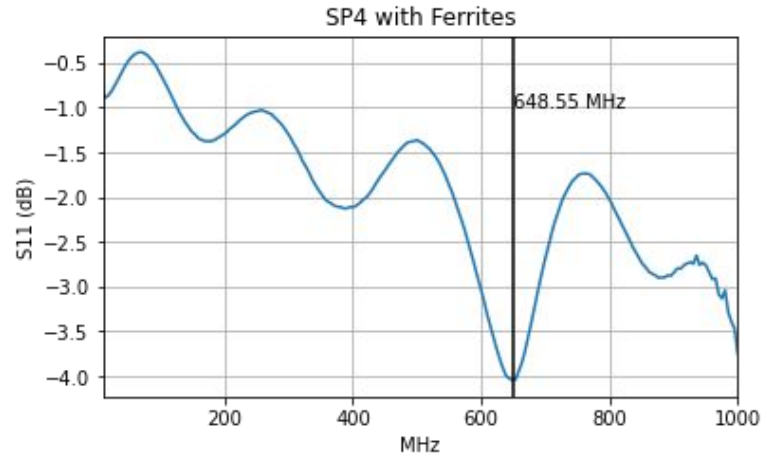
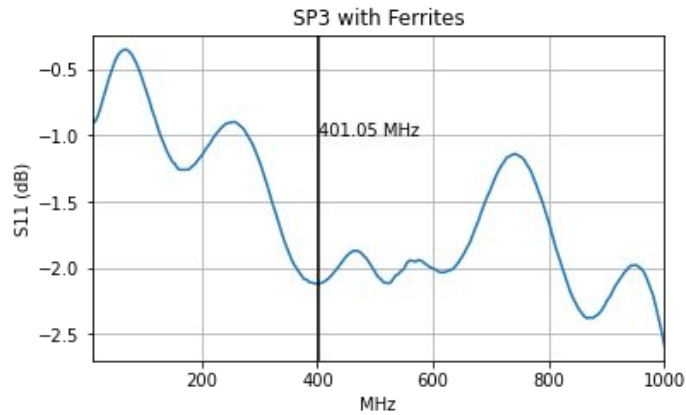
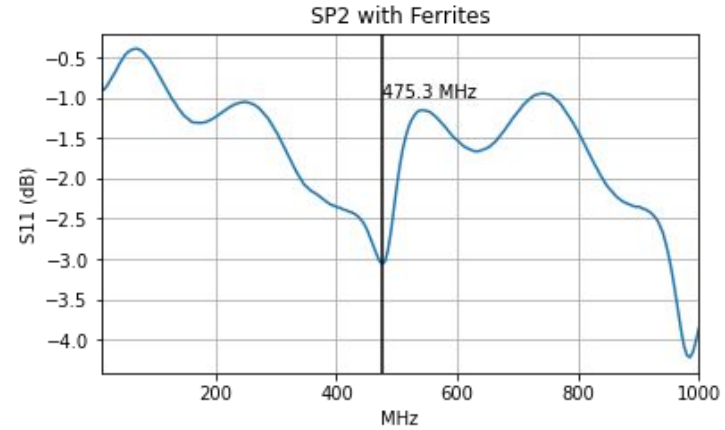
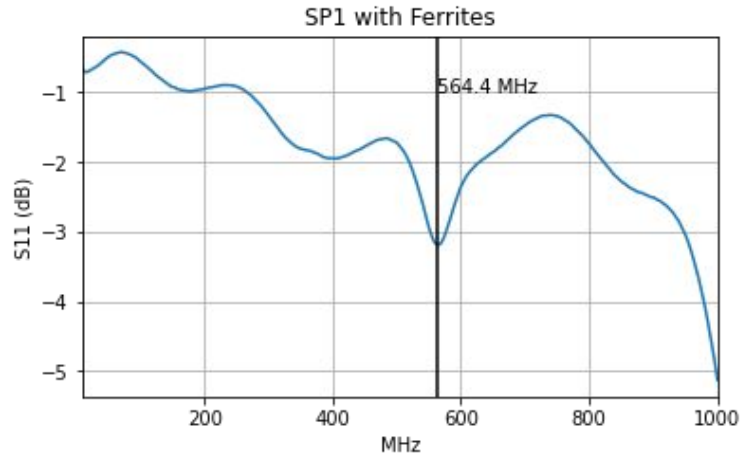
# Effects of not adding ferrites



# Effects of not adding ferrites

- Cable seems to have an internal structure that keeps reappearing between 280-310 MHz in each measurement, but disappeared when the ferrite is moved closer to the crocodile clip.
- For slots showing resonance at  $>600$  MHz, we see two resonances when not using the ferrite, and only one ( $>600$  MHz) when using the ferrite.
- Making sure ferrite sits close to the crocodile clip seems necessary.

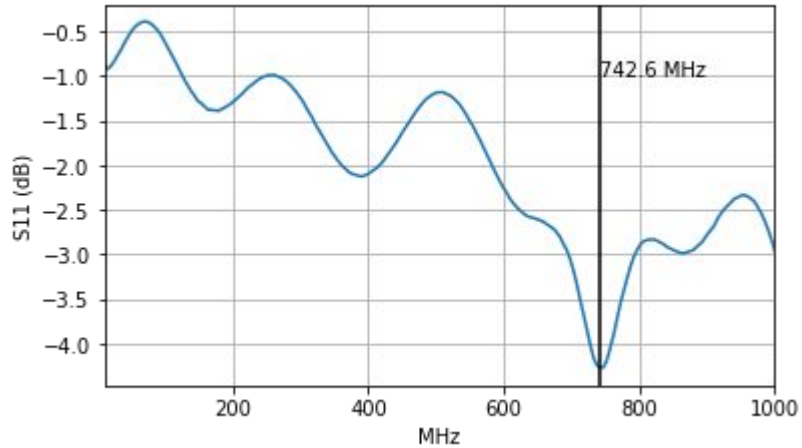
# Spots along the North line at E-W = 0



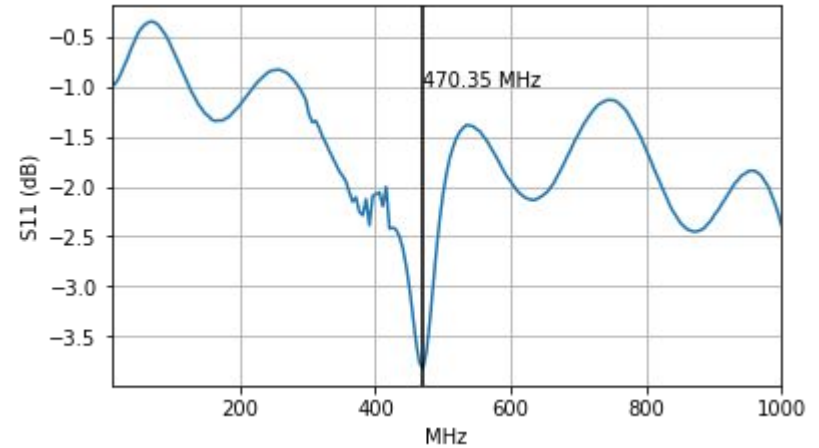


# Spots along the North line at E-W = 0

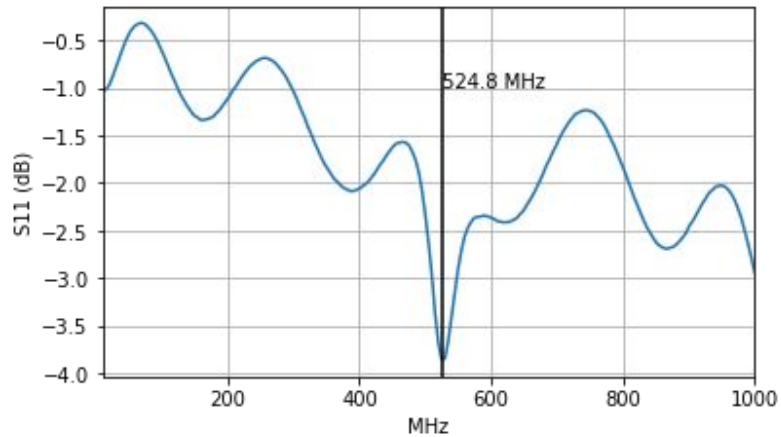
SP5 with Ferrites



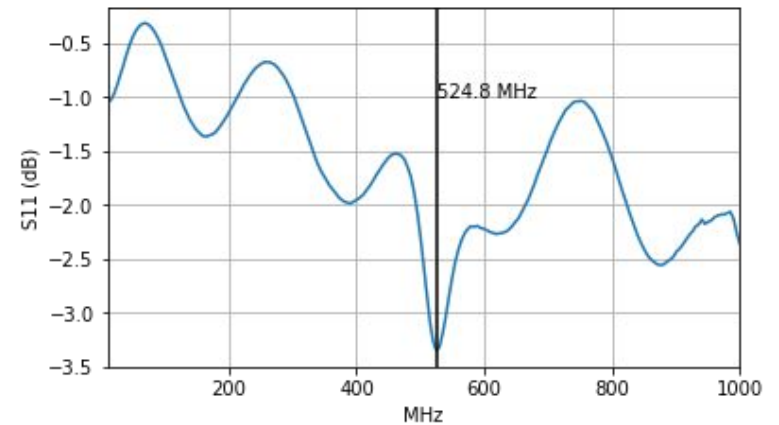
SP9 with Ferrites



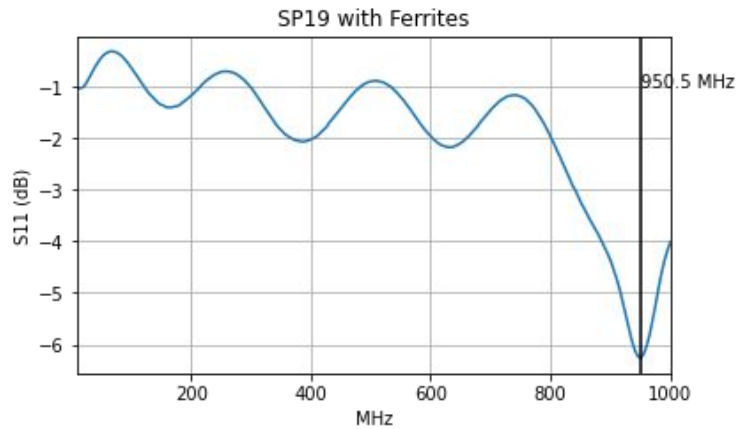
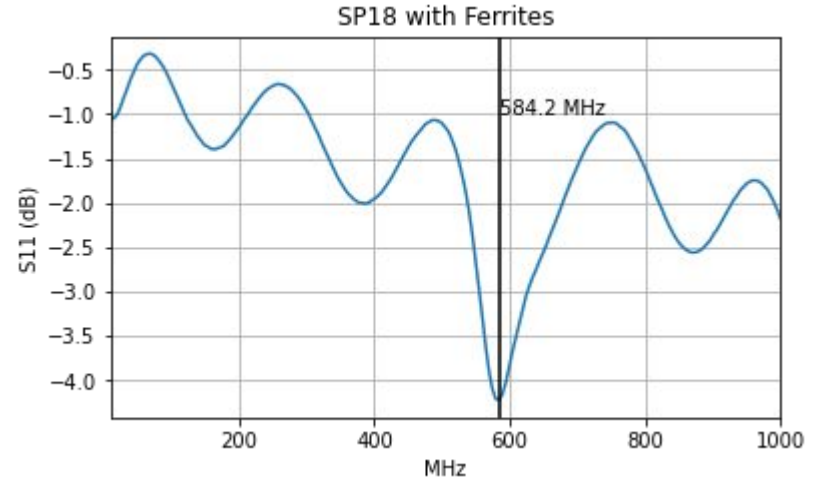
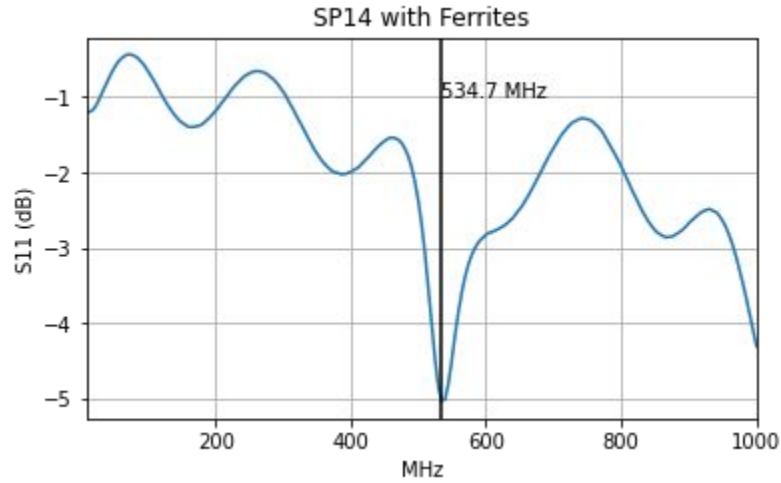
SP11 with Ferrites



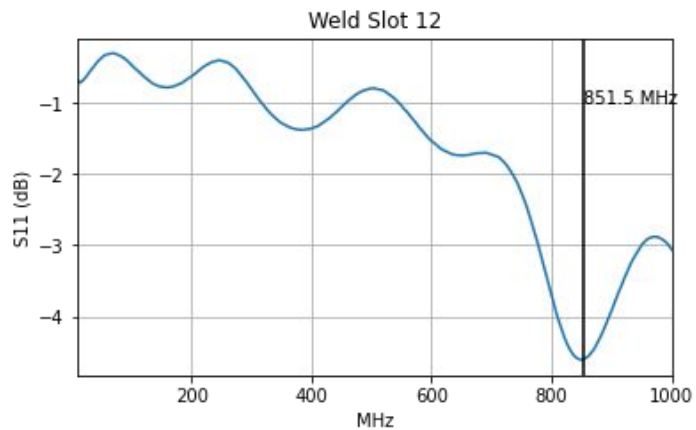
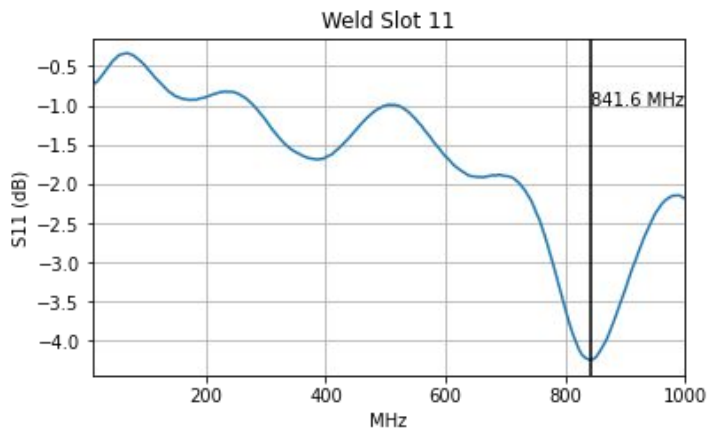
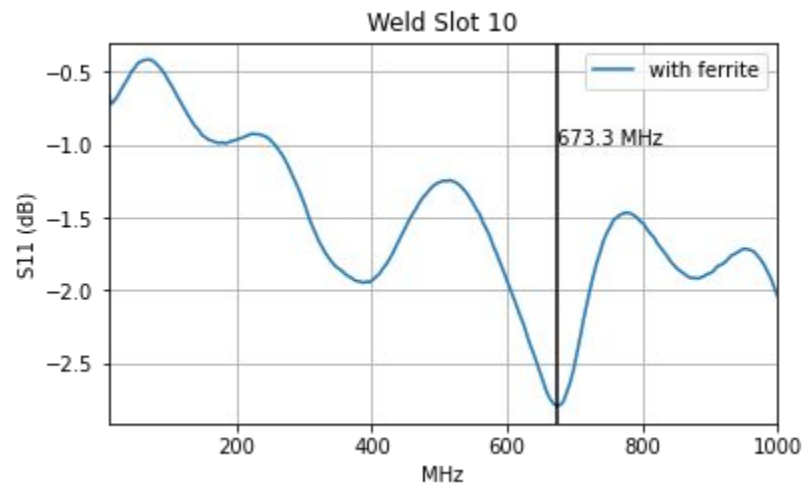
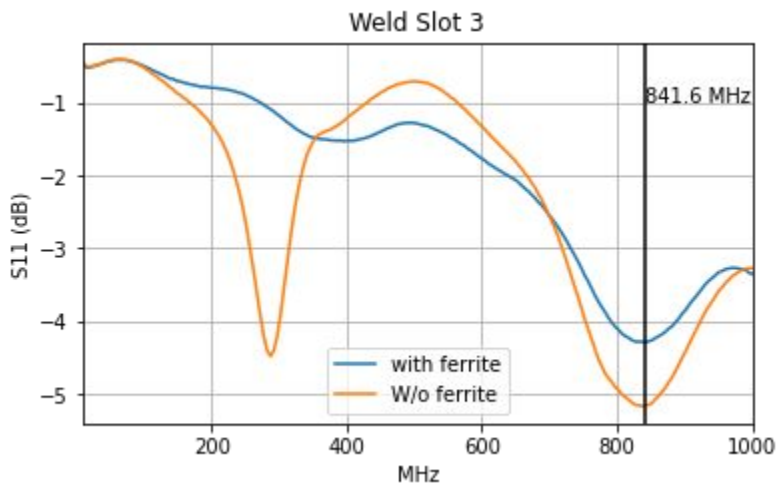
SP13 with Ferrites



# Spots along the North line at E-W = 0

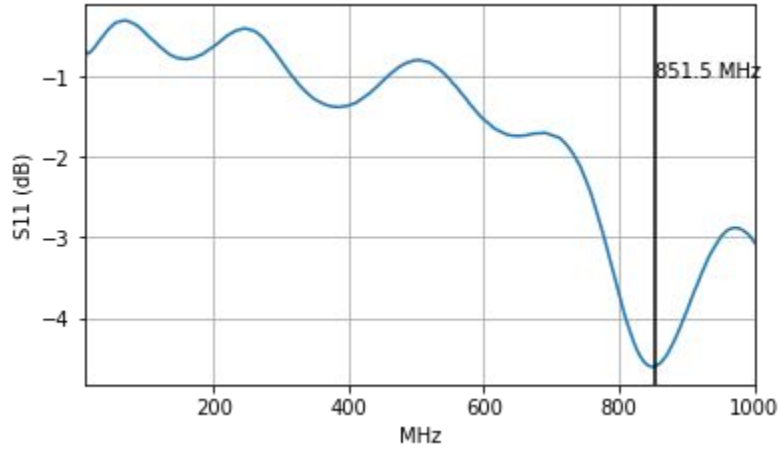


# Spots along the West line at N-S = 0

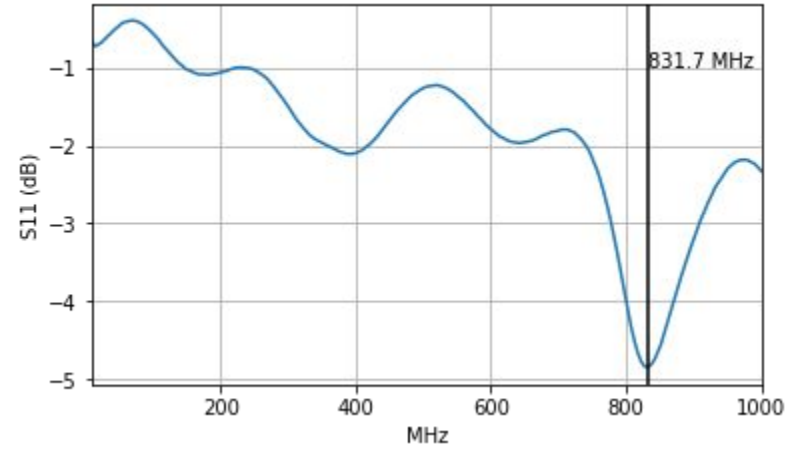


# Spots along the West line at N-S = 0

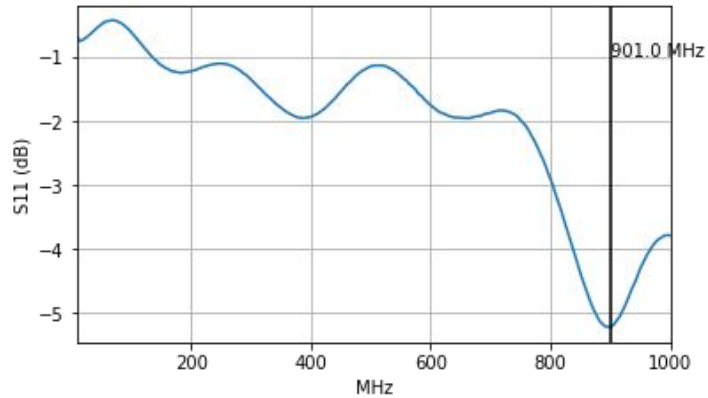
Weld Slot 13



Weld Slot 15



Weld Slot 16



# Conclusion

- We looked for slots in two ways: 1.) first day we spent time visually selecting the suspect slots, 2.) Next we moved on to more rigorous grid search along two weld arms
- No resonances measured below 200 MHz for any of the 50 slots examined so far. The slots have been of varying lengths and separation distances.
- Using ferrites is necessary in all VNA measurements.
- Clamping the first 5 slots we learnt - Clamps are harder to use, wire twisters worked better. We have used wire twisters on four slots (three on the East of Antenna, NS=0 and one at E=2.41 m, S= 4.91 m), and stopped after slot 6 since no resonances were seen in the band of interest.
- In terms of clamping, out of the 5 slots we clamped, 3 of them disappeared. For the other two cases, clamps seemed to have moved it to a higher frequency.
- We examined and measured the S11 at every slot along the west weld line of the GP at N-S =0, and north weld line at E-S=0. We still don't see any resonance <200 MHz.