Transmission with Resonance Identification

resonance 0 at 3.1127 GHz
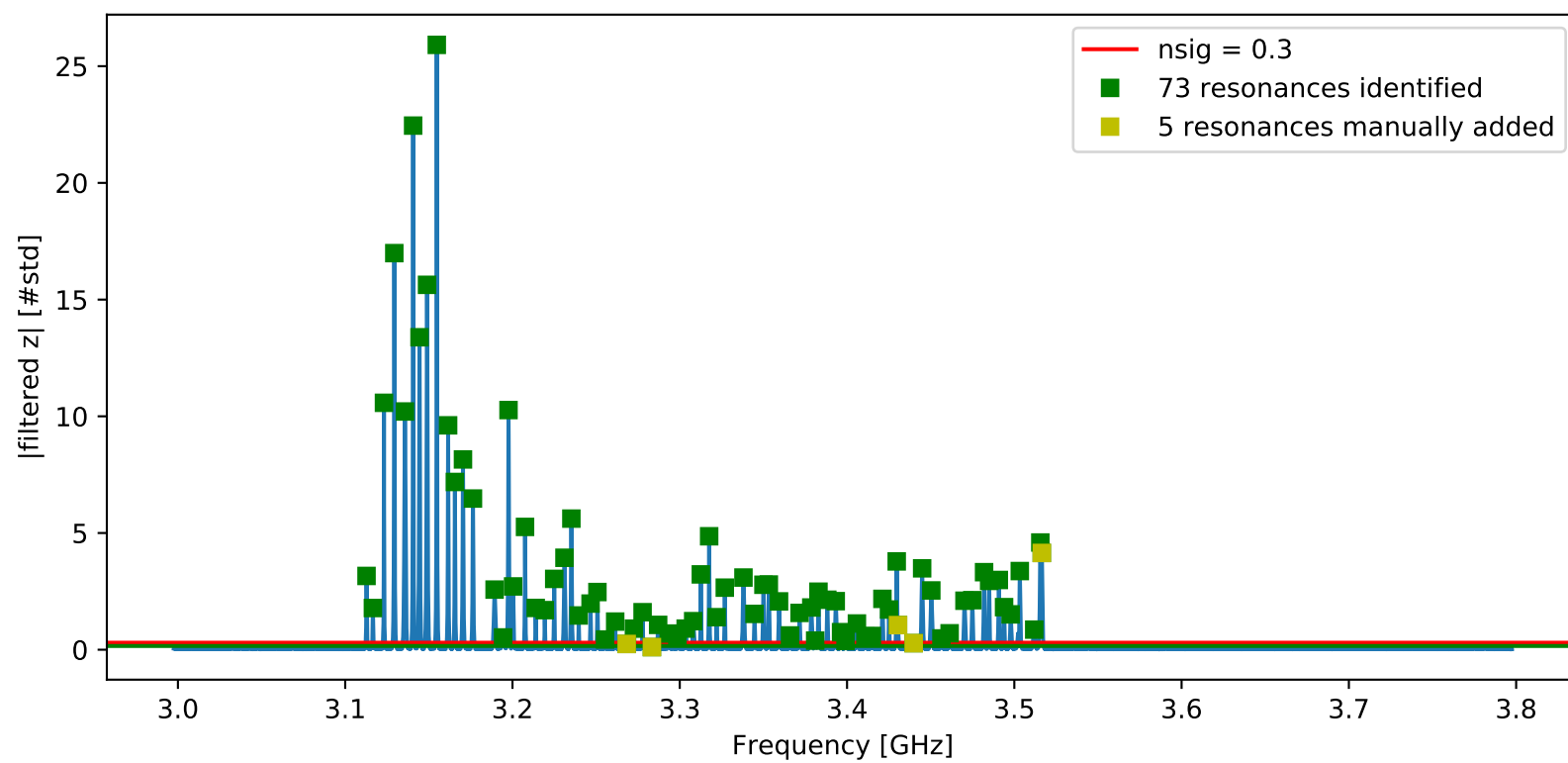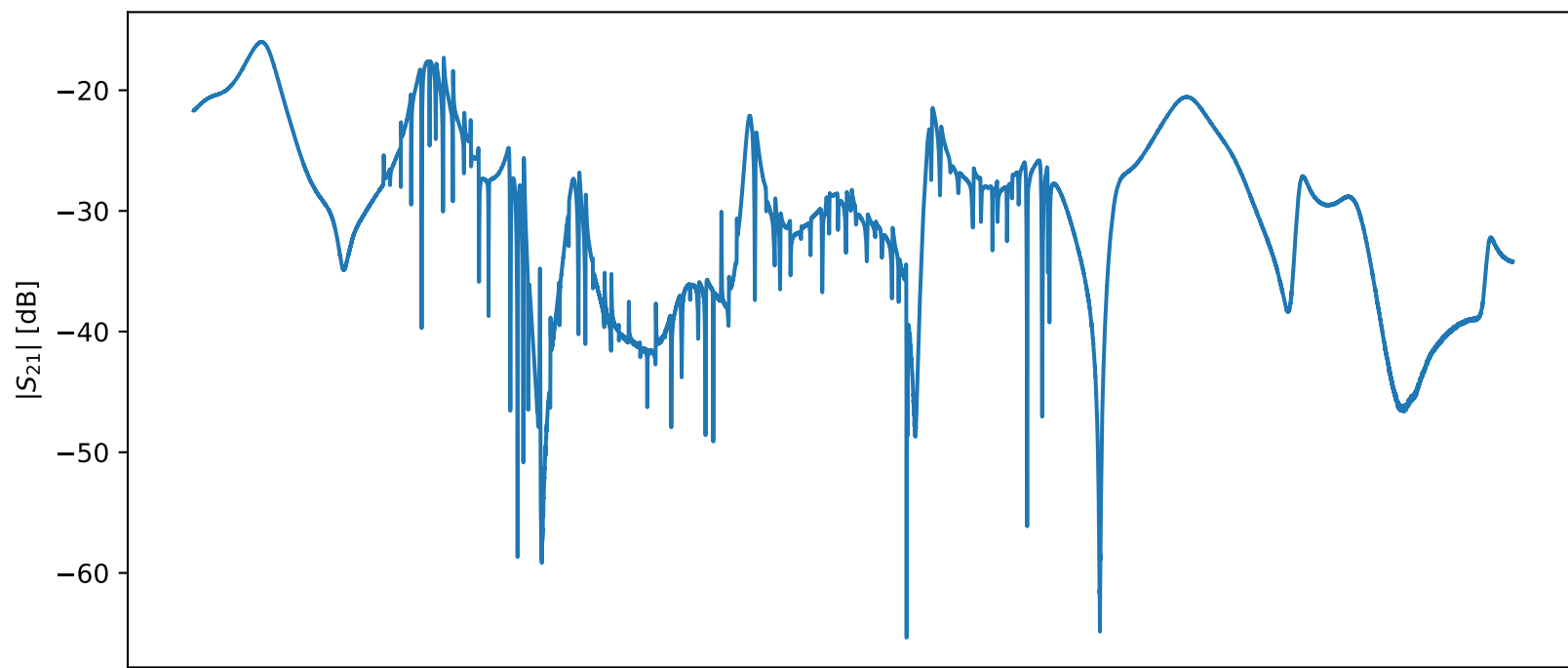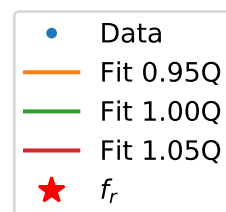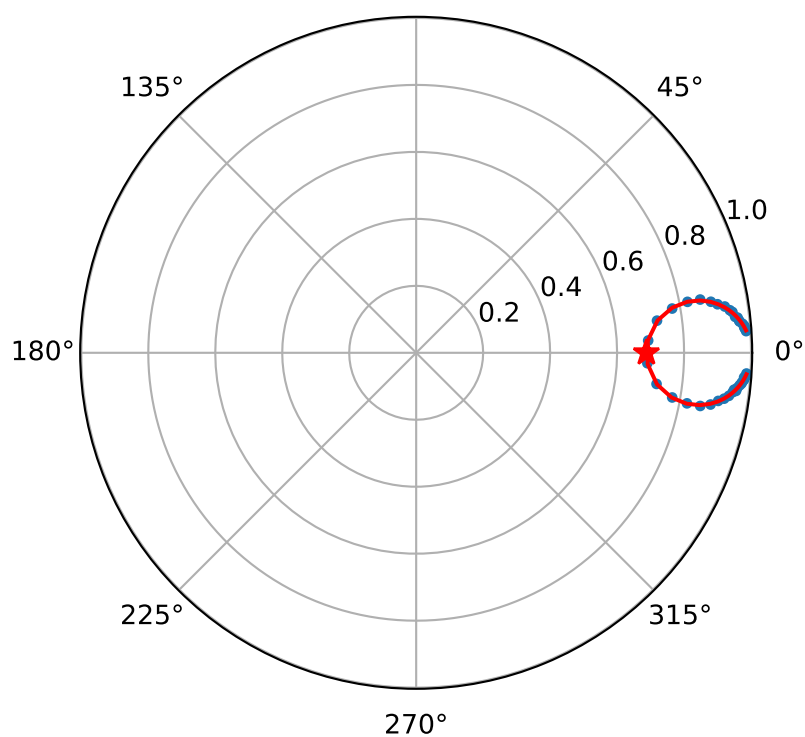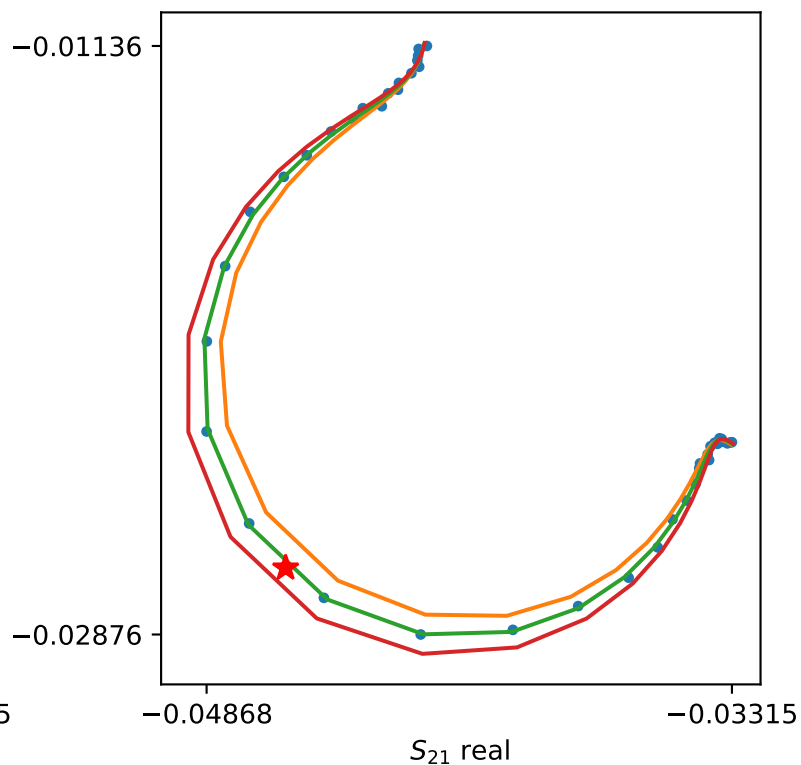
$$S_{21}(f) = ae^{-2\pi jf\tau}\left[1 - \frac{Q_r/Q_c e^{j\phi_0}}{1 + 2jQ_r(\frac{f-f_r}{f_r})}\right]$$

$f_r = 3.1127619793060672$
$Q_r = 14160.451268180468$
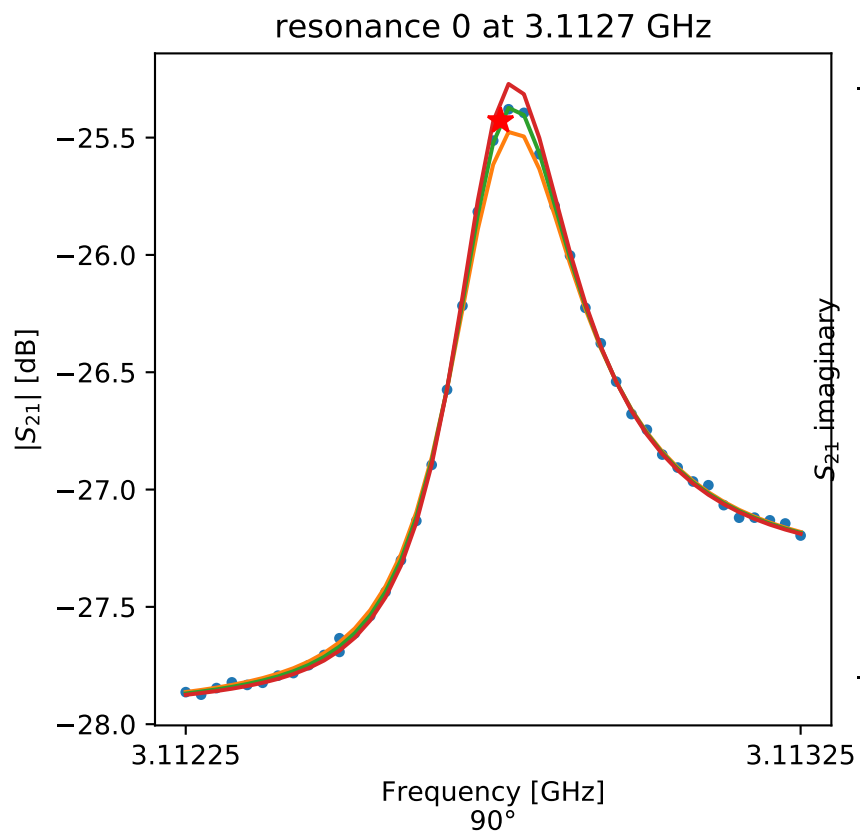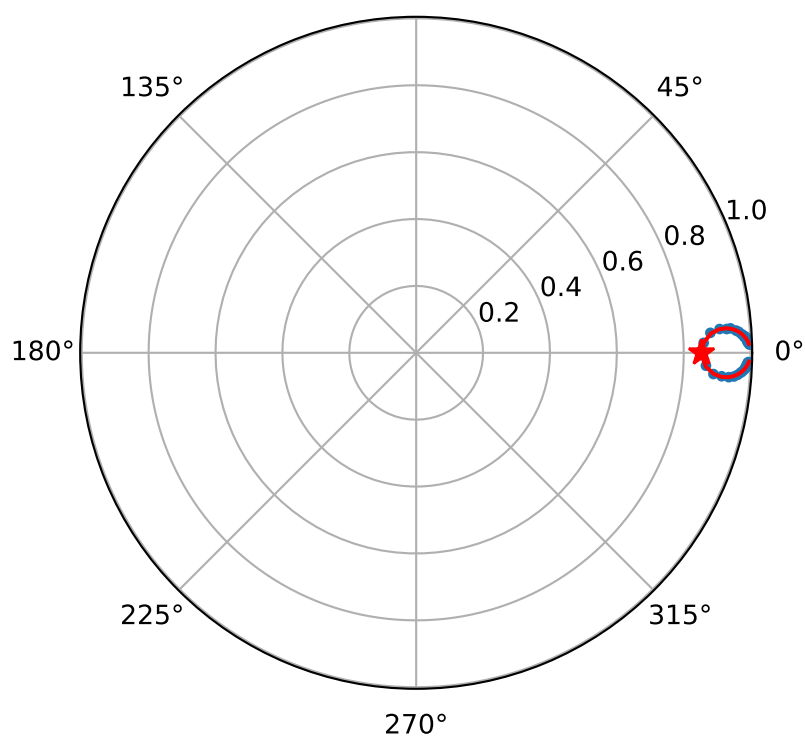$Q_c = 45303.830228774845$
$Q_i = 20599.006968004473$
$a = (-1.0563914254740885e-37-3.6818690609081354e-$
$\phi_0 = -2.7278823986946295$
$\tau = (36.618749778842876+4.187507698704237j)$

resonance 1 at 3.1165 GHz
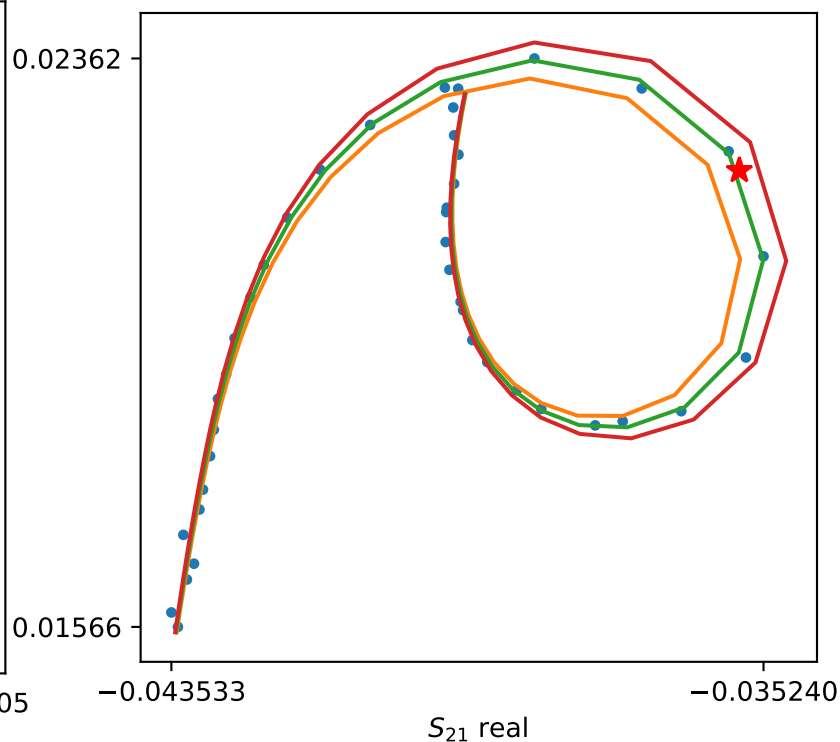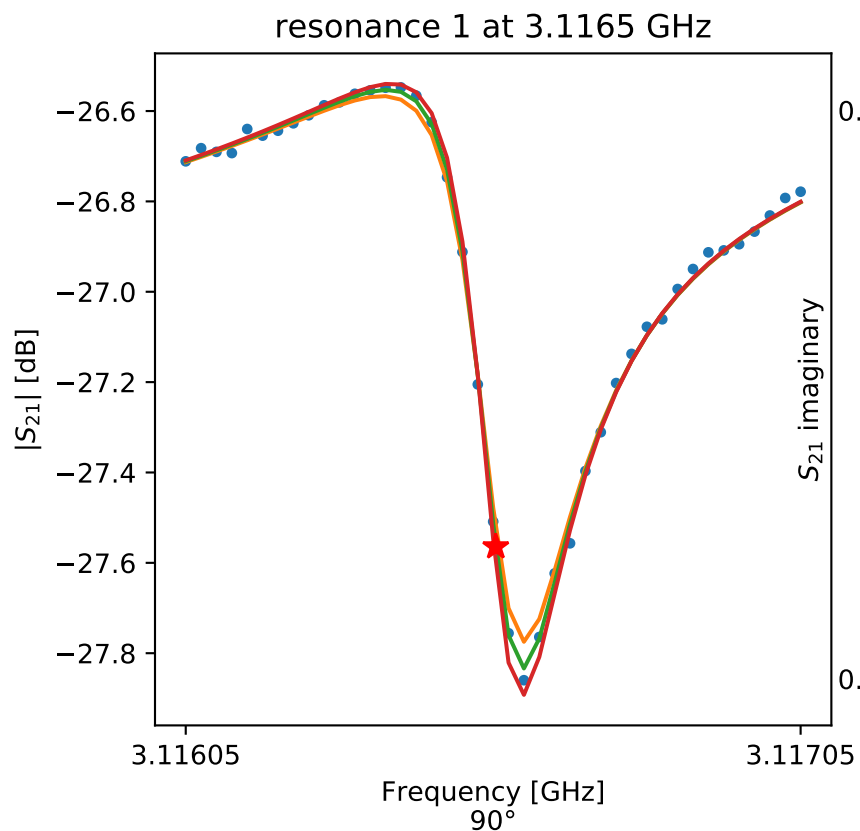
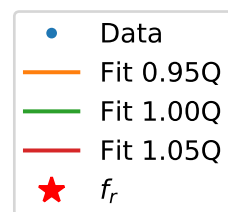$$S_{21}(f) = ae^{-2\pi jf\tau}\left[1 - \frac{Q_r/Q_c e^{j\phi_0}}{1 + 2jQ_r(\frac{f-f_r}{f_r})}\right]$$

f_r = 3.1165542390760974
Q_r = 16465.397332037825
Q_c = 112253.8570191234
Q_i = 19295.68931279957
a = (-1.989598626606777e-42-3.2815680998943996e-4...
ϕ_0 = 0.832413915669385
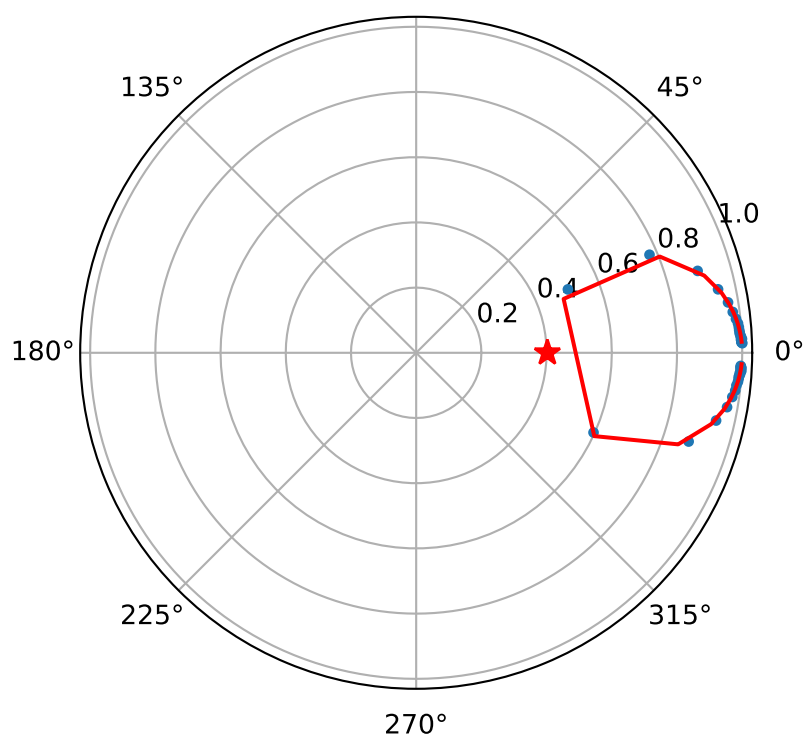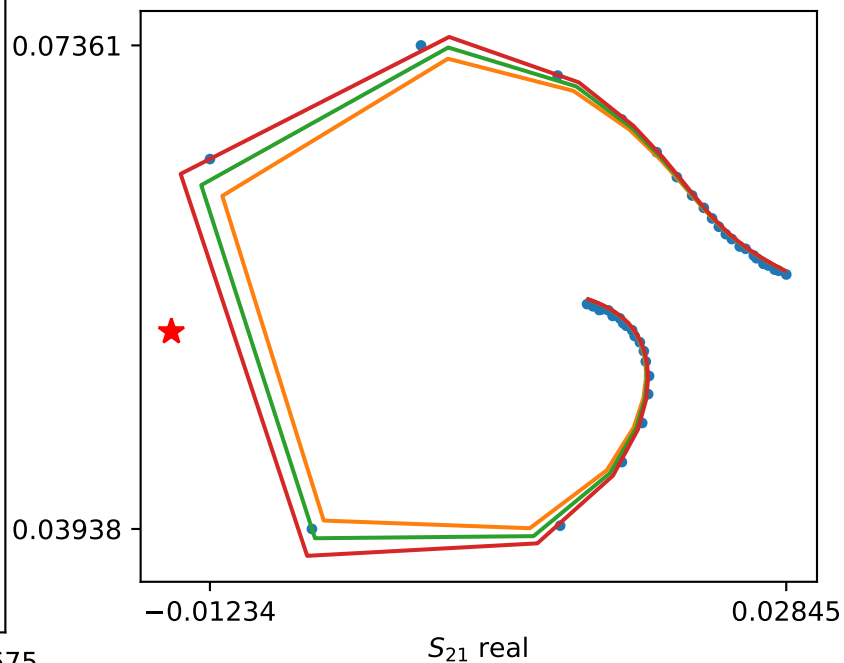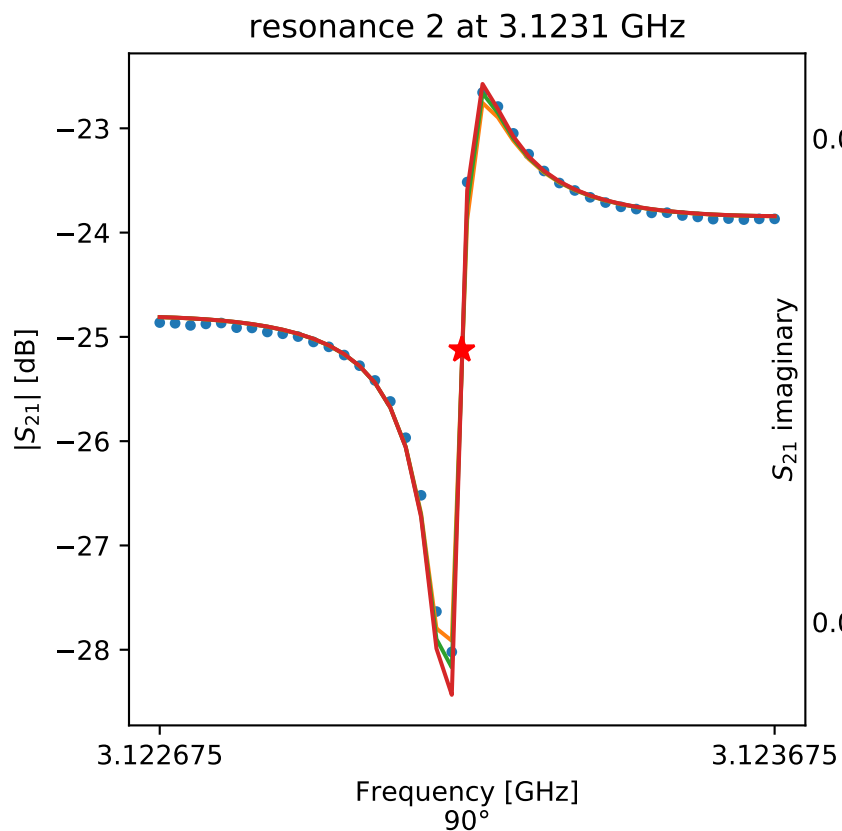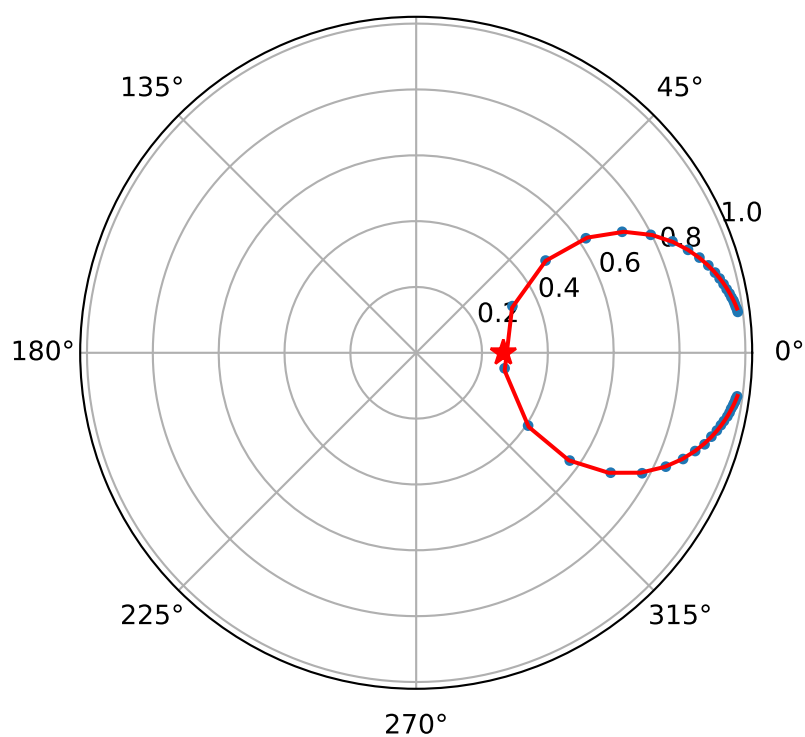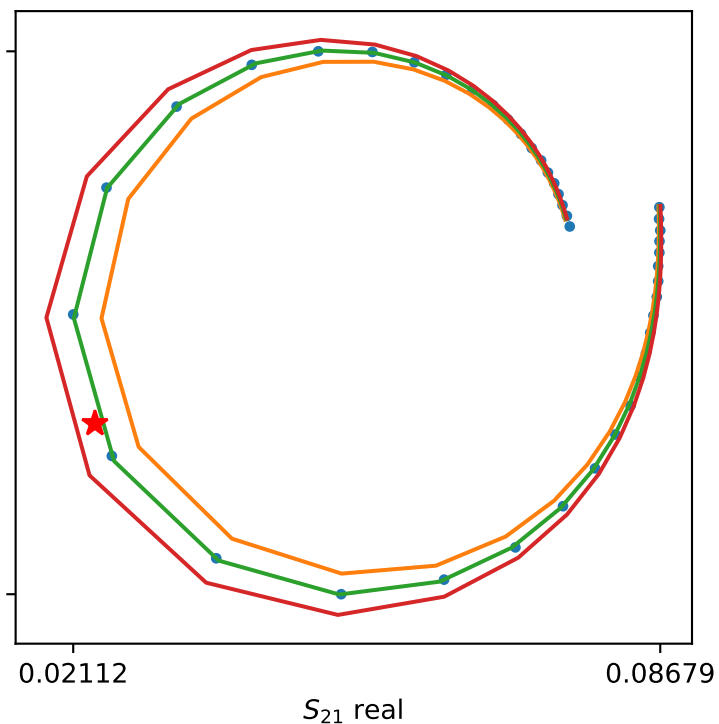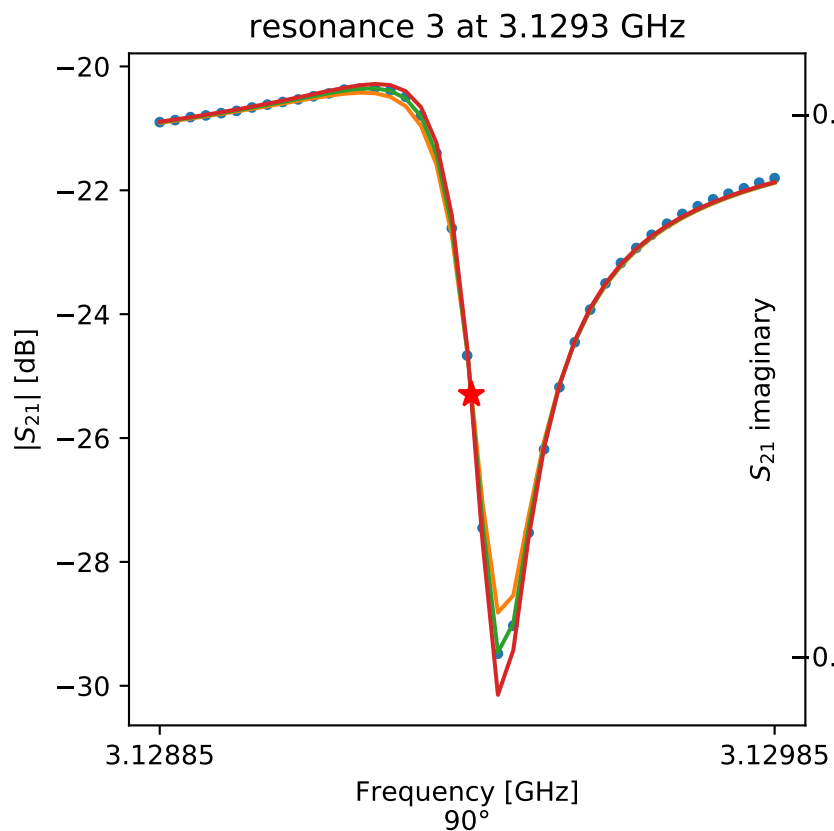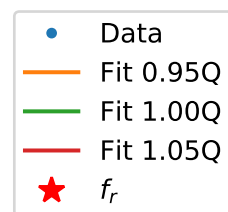τ = (35.36999211420525+4.712876927028428j)

resonance 2 at 3.1231 GHz

$$S_{21}(f) = ae^{-2\pi jf\tau}\left[1 - \frac{Q_r/Q_c e^{j\phi_0}}{1 + 2jQ_r(\frac{f-f_r}{f_r})}\right]$$

f_r = 3.1231662789246135
Q_r = 54032.078531800595
Q_c = 90408.22882596673
Q_i = 134289.76074549212
a = (5.29569840499929e-69-2.0898055038111763e-69j)
ϕ_0 = -1.1139693298090034
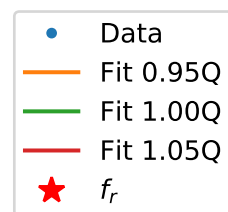τ = (37.06064175634839+7.865075959864977j)

resonance 3 at 3.1293 GHz

$$S_{21}(f) = ae^{-2\pi jf\tau}\left[1 - \frac{Q_r/Q_c e^{j\phi_0}}{1 + 2jQ_r(\frac{f-f_r}{f_r})}\right]$$

f_r = 3.129356940639144
Q_r = 16753.199619252788
Q_c = 22786.964082416845
Q_i = 63269.715004633086
a = (-6.731179226165837e-83+1.201502817734538e-83
ϕ_0 = 0.6734342930294043
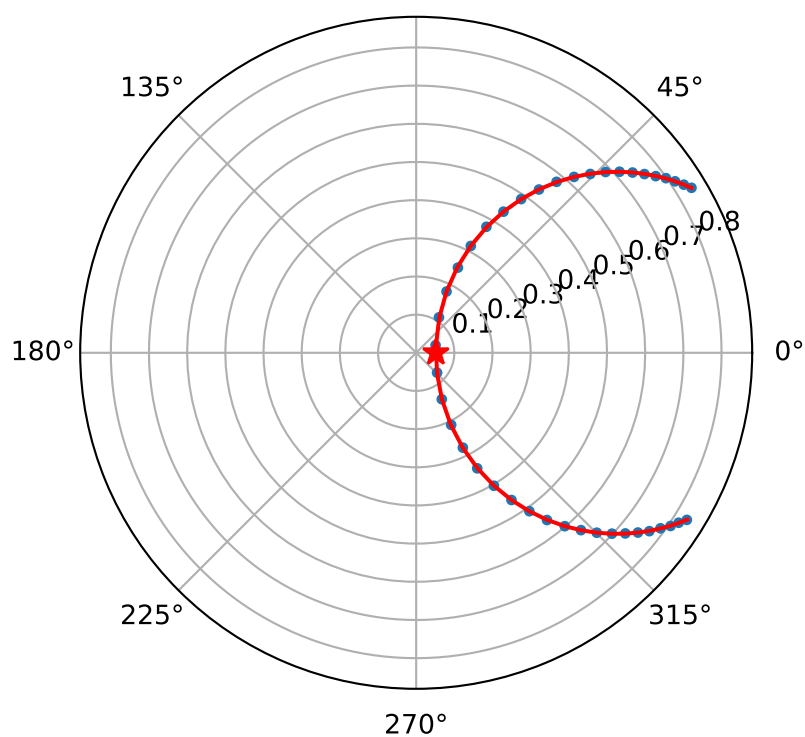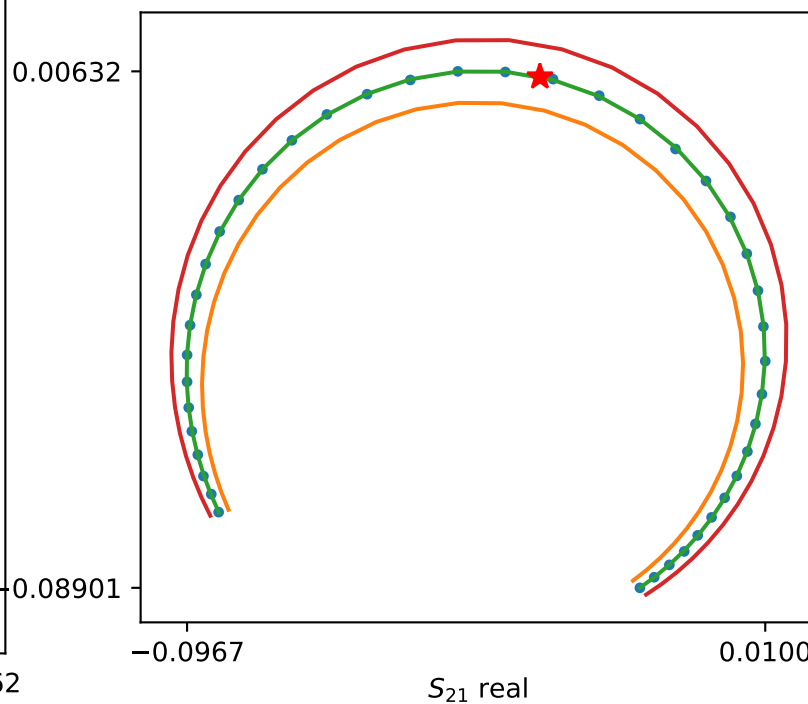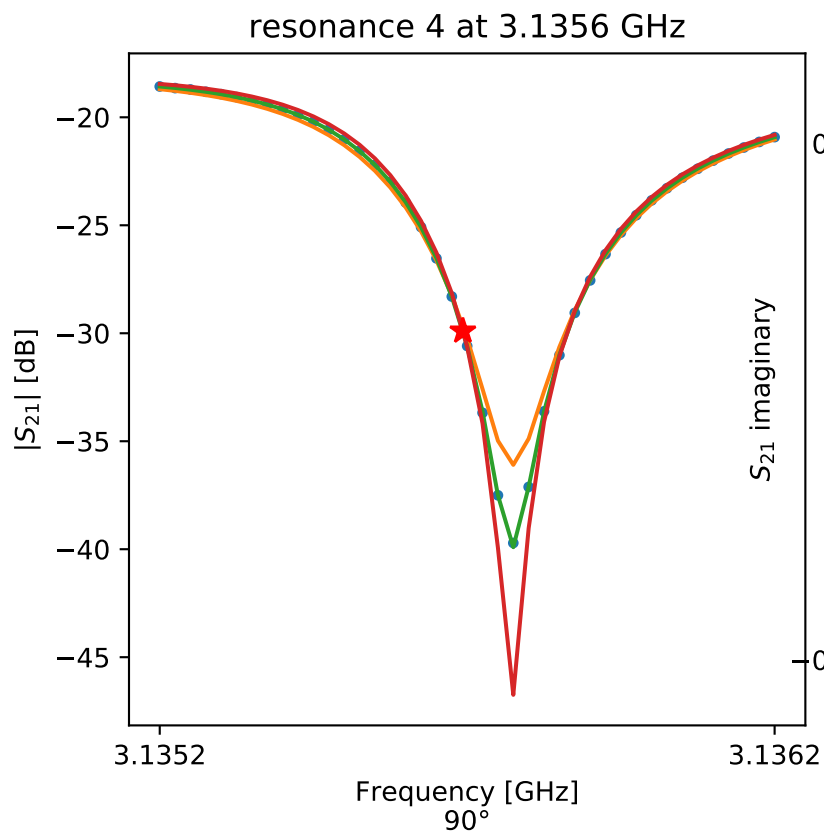τ = (41.708112329896046+9.497806821546211j)

resonance 4 at 3.1356 GHz

$$S_{21}(f) = ae^{-2\pi jf\tau}\left[1 - \frac{Q_r/Q_c e^{j\phi_0}}{1 + 2jQ_r(\frac{f-f_r}{f_r})}\right]$$
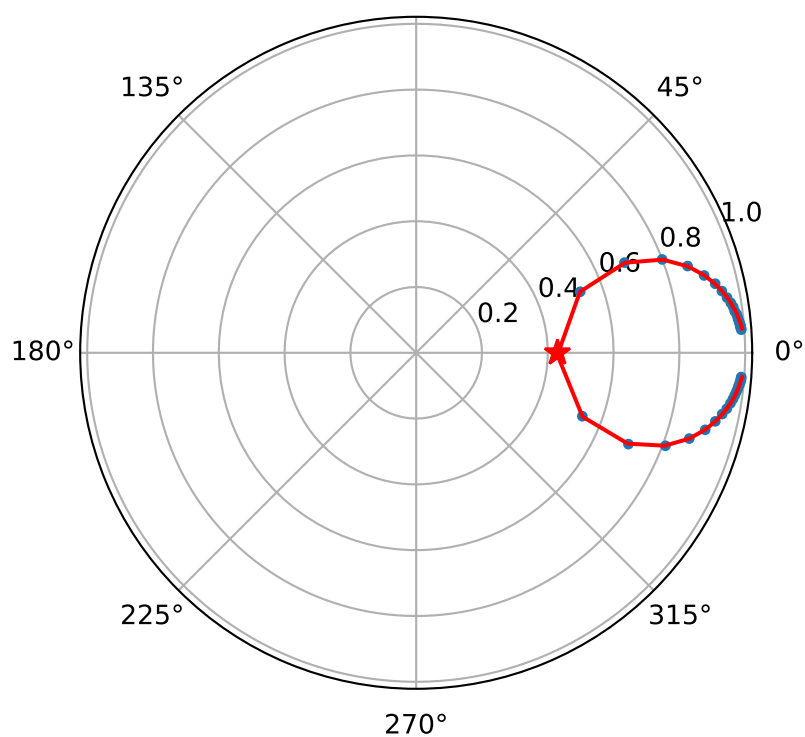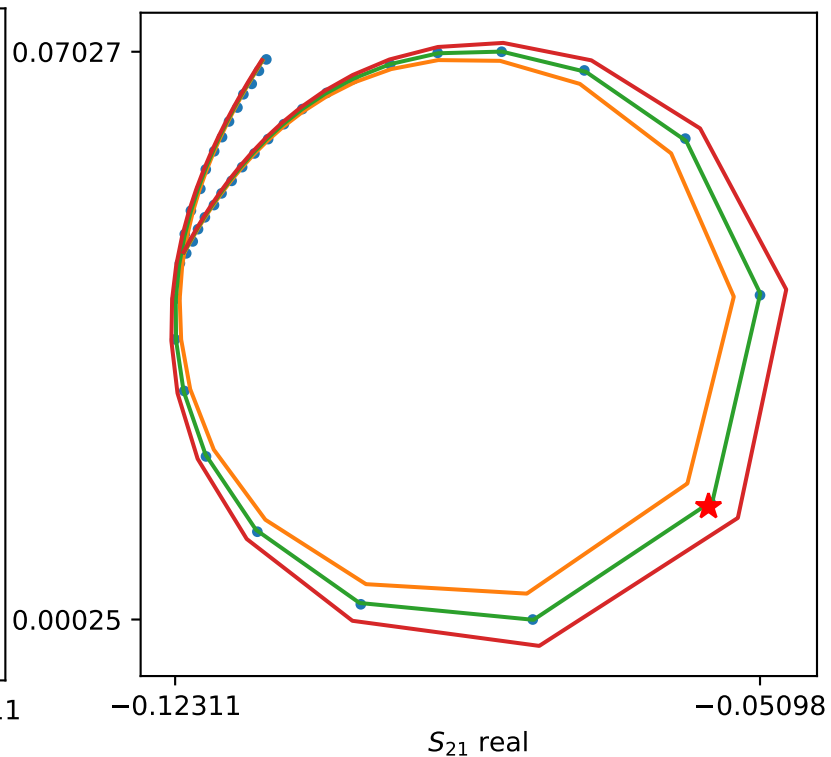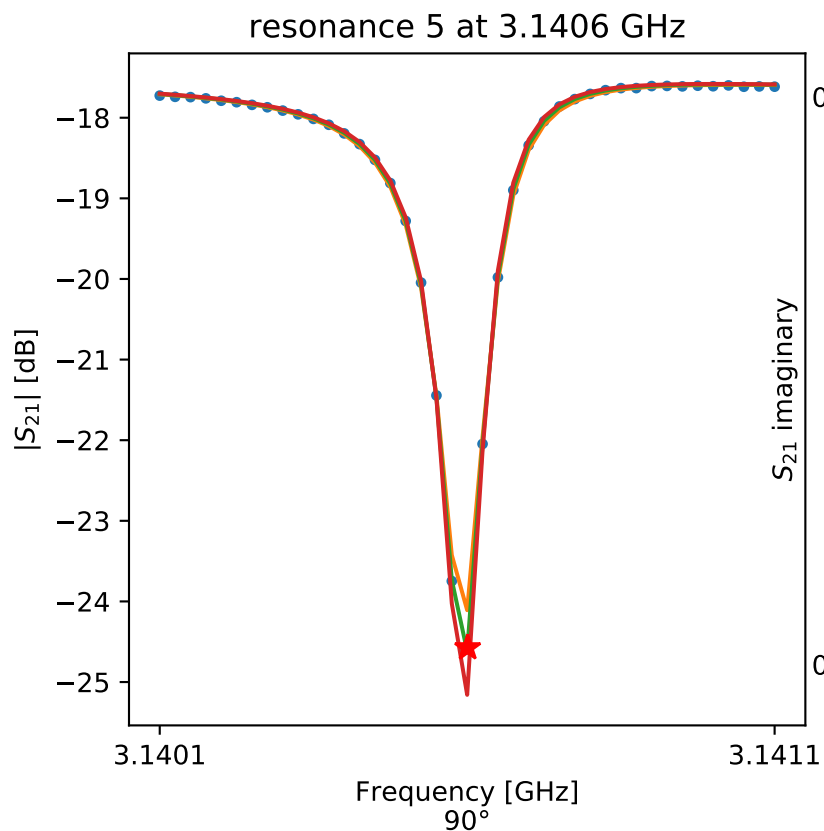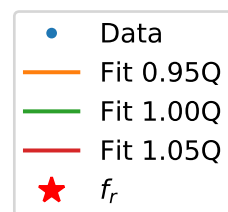
f_r = 3.1356929772927
Q_r = 4790.167484196841
Q_c = 5050.0558139294
Q_i = 93080.79811878211
a = (-4.543899232837668e-59-5.999156607094183e-59j)
ϕ_0 = 0.26017030438449956
τ = (50.060955590711046+6.686985085341134j)

resonance 5 at 3.1406 GHz

$|S_{21}|$ [dB]

Frequency [GHz]

3.1401 3.1411

S_{21} imaginary

0.07027

0.00025

S_{21} real

-0.12311 -0.05098

90°

135° 45°

0.2 0.4 0.6 0.8 1.0

180° 0°

225° 315°

270°

- Data
- Fit 0.95Q
- Fit 1.00Q
- Fit 1.05Q
- ★ f_r

$$S_{21}(f) = ae^{-2\pi jf\tau}\left[1 - \frac{Q_r/Q_c e^{j\phi_0}}{1 + 2jQ_r(\frac{f-f_r}{f_r})}\right]$$

f_r = 3.140600778355665
Q_r = 23929.8186506367
Q_c = 41936.53432083221
Q_i = 55731.07719997784
a = (5592612215157266+256840261515318.12j)
ϕ_0 = -0.16654621360778743
τ = (54.33388029815747-1.8283162526299963j)

resonance 6 at 3.1444 GHz
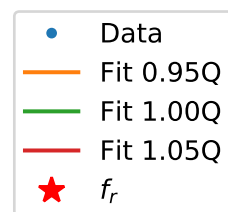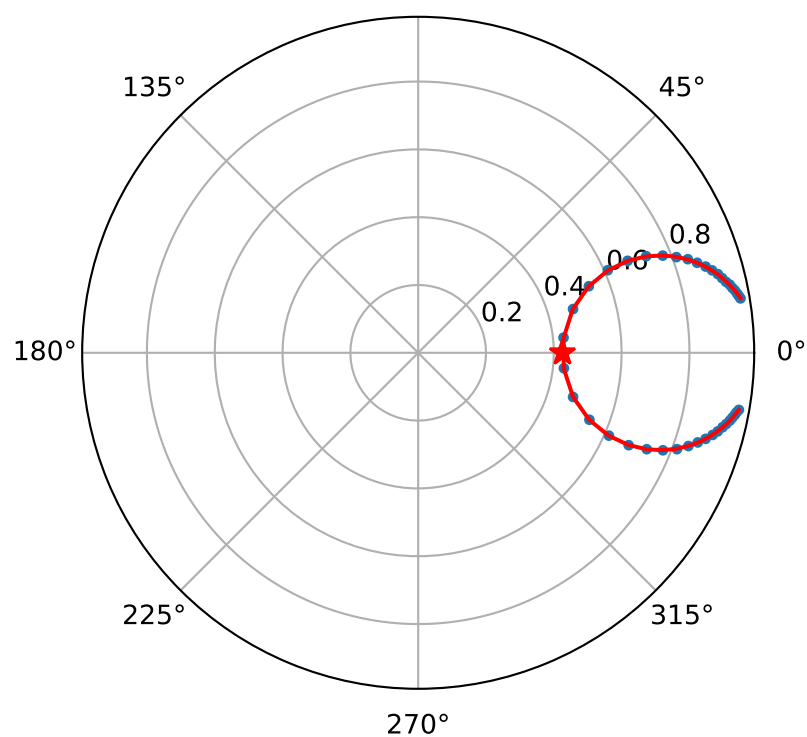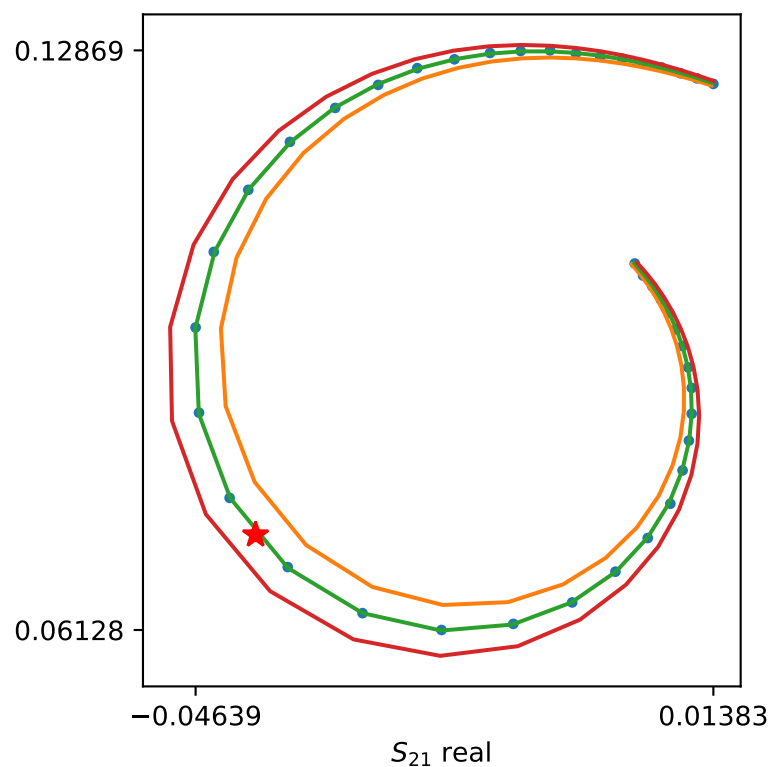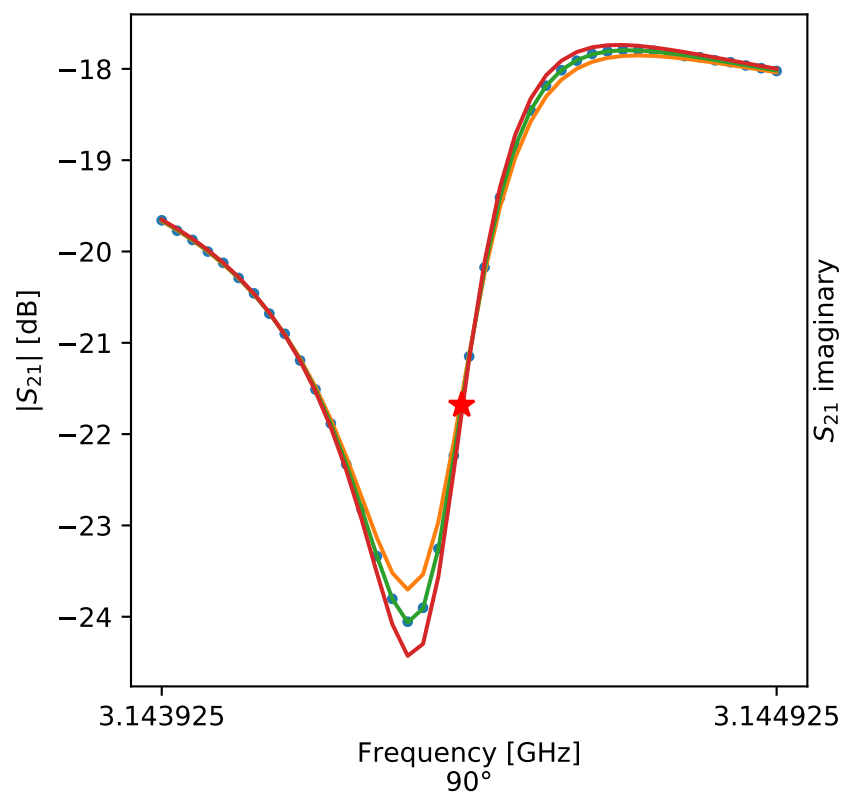
$$S_{21}(f) = ae^{-2\pi jf\tau}\left[1 - \frac{Q_r/Q_c e^{j\phi_0}}{1 + 2jQ_r(\frac{f-f_r}{f_r})}\right]$$

$f_r = 3.1444128369212163$
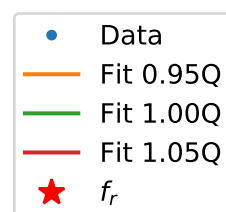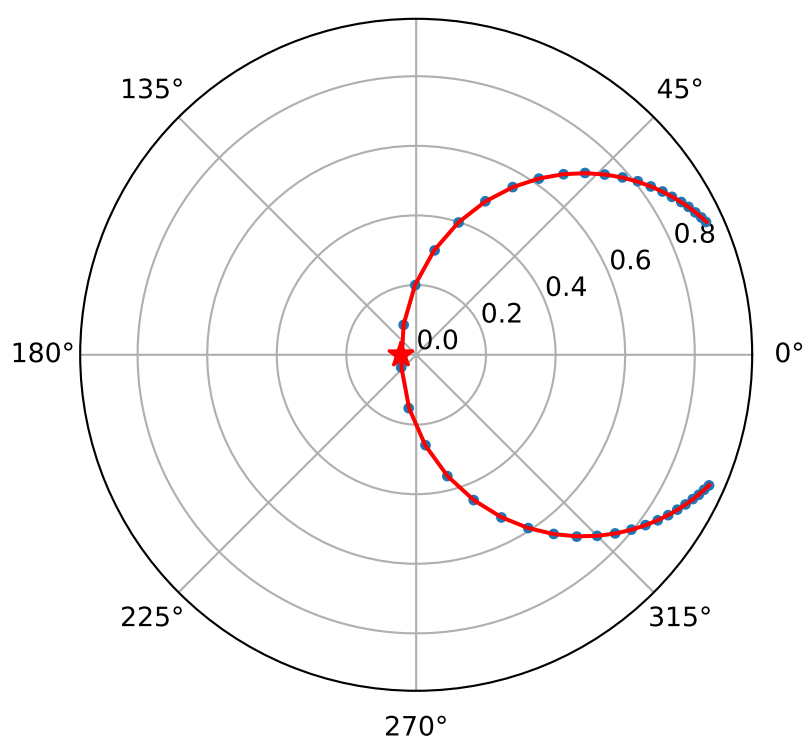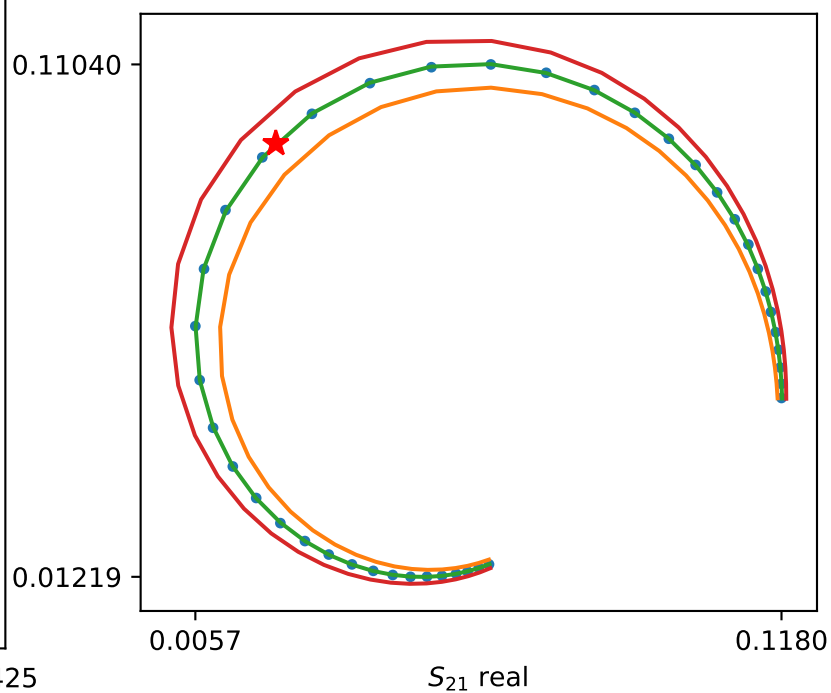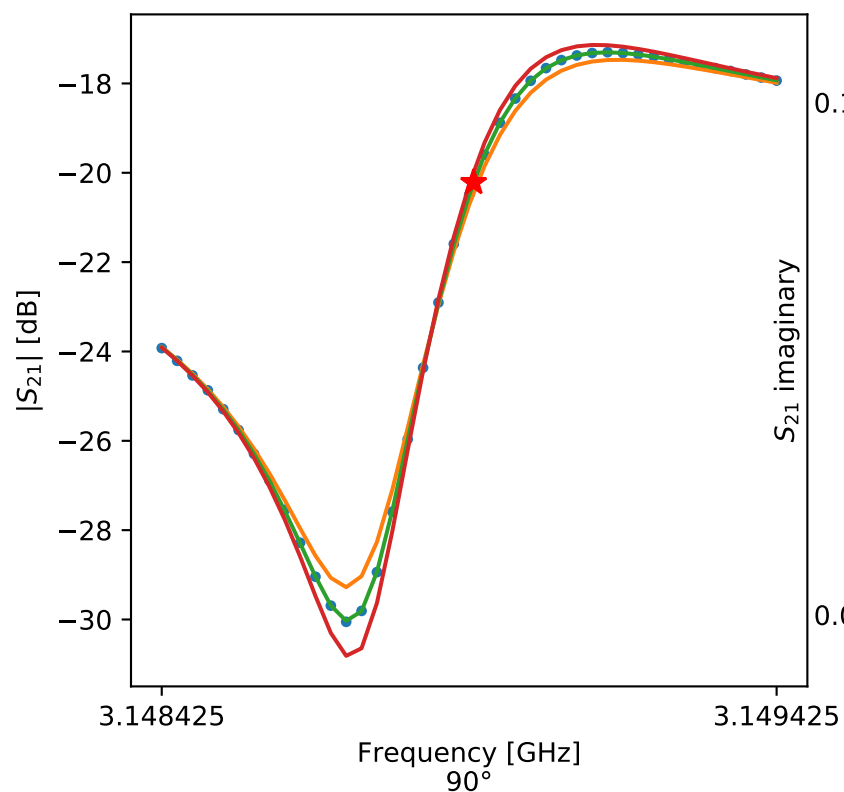$Q_r = 9969.180307403241$
$Q_c = 17353.092245772237$
$Q_i = 23428.78773921523$
$a = (-4.977809778030999e+68-3.361220392729197e+6$
$\phi_0 = -0.7356229522650688$
$\tau = (49.408034173800196-8.123530586859761j)$

resonance 7 at 3.1489 GHz

$|S_{21}|$ [dB]

Frequency [GHz]

S_{21} imaginary

S_{21} real

- Data
- Fit 0.95Q
- Fit 1.00Q
- Fit 1.05Q
- ★ f_r

$$S_{21}(f) = ae^{-2\pi jf\tau}\left[1 - \frac{Q_r/Q_c e^{j\phi_0}}{1 + 2jQ_r(\frac{f-f_r}{f_r})}\right]$$

f_r = 3.148932234089738
Q_r = 7338.3736663263235
Q_c = 7035.478718944543
Q_i = -170451.7431121979
a = (-1.5530595081194413e+67-3.377975791089712e+
ϕ_0 = -0.9698221215285849
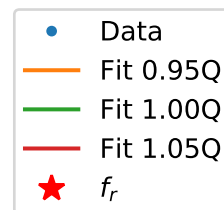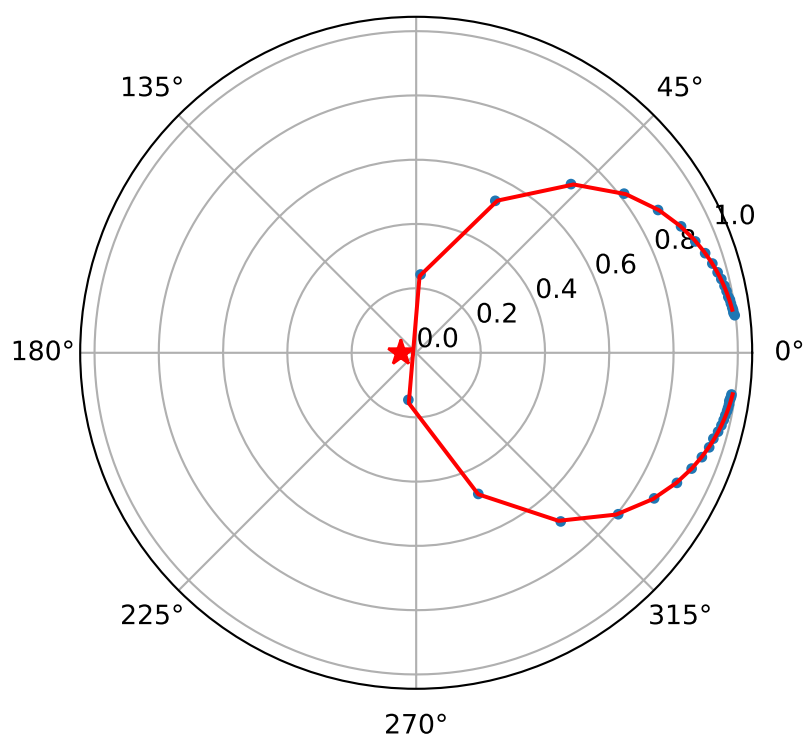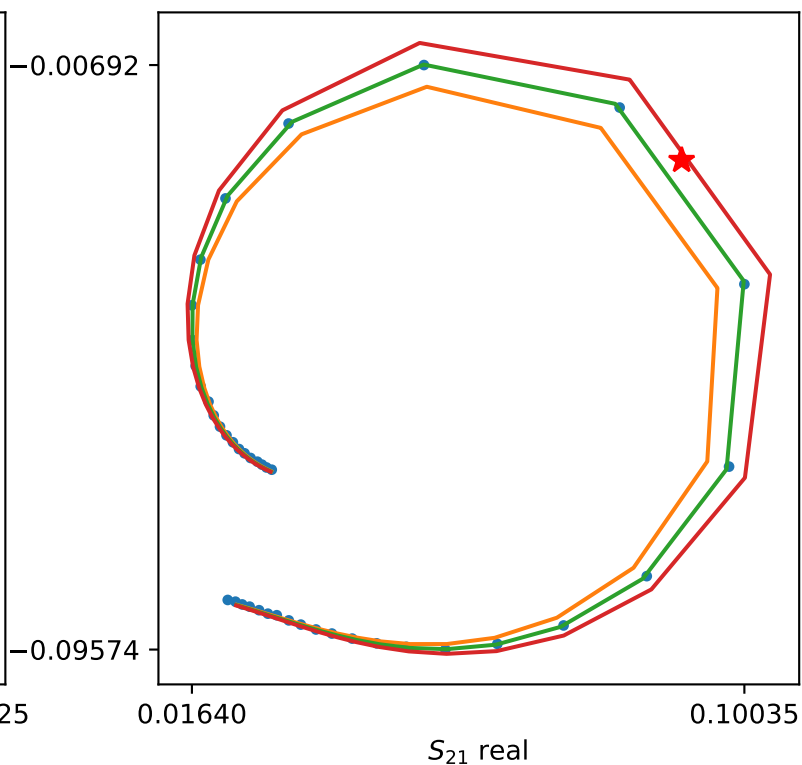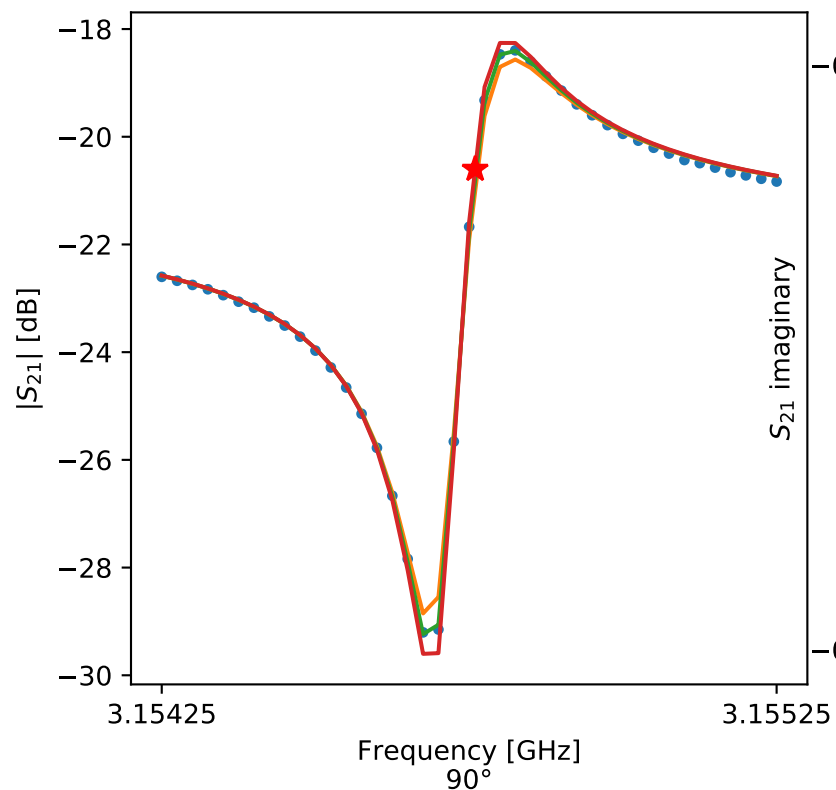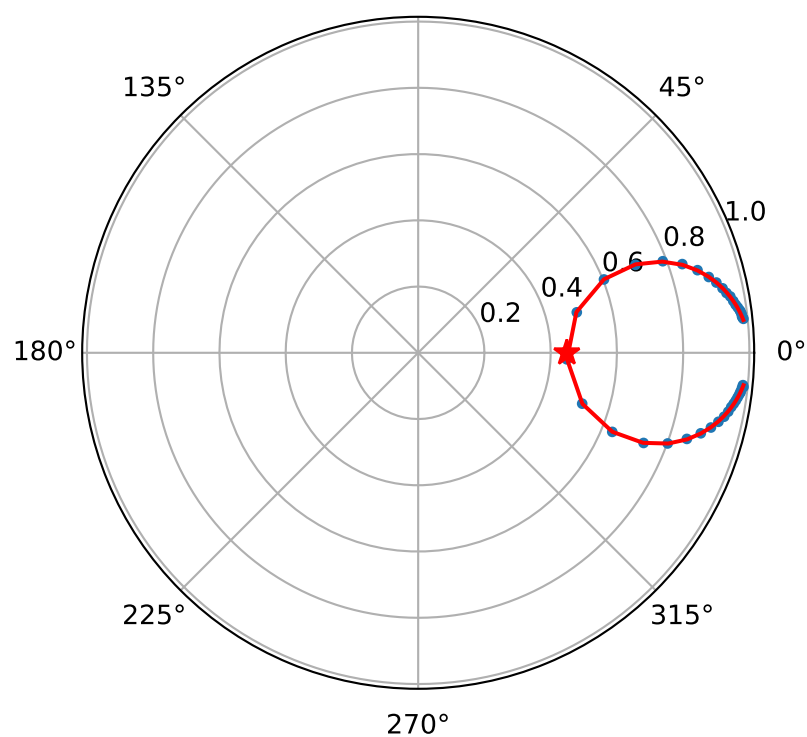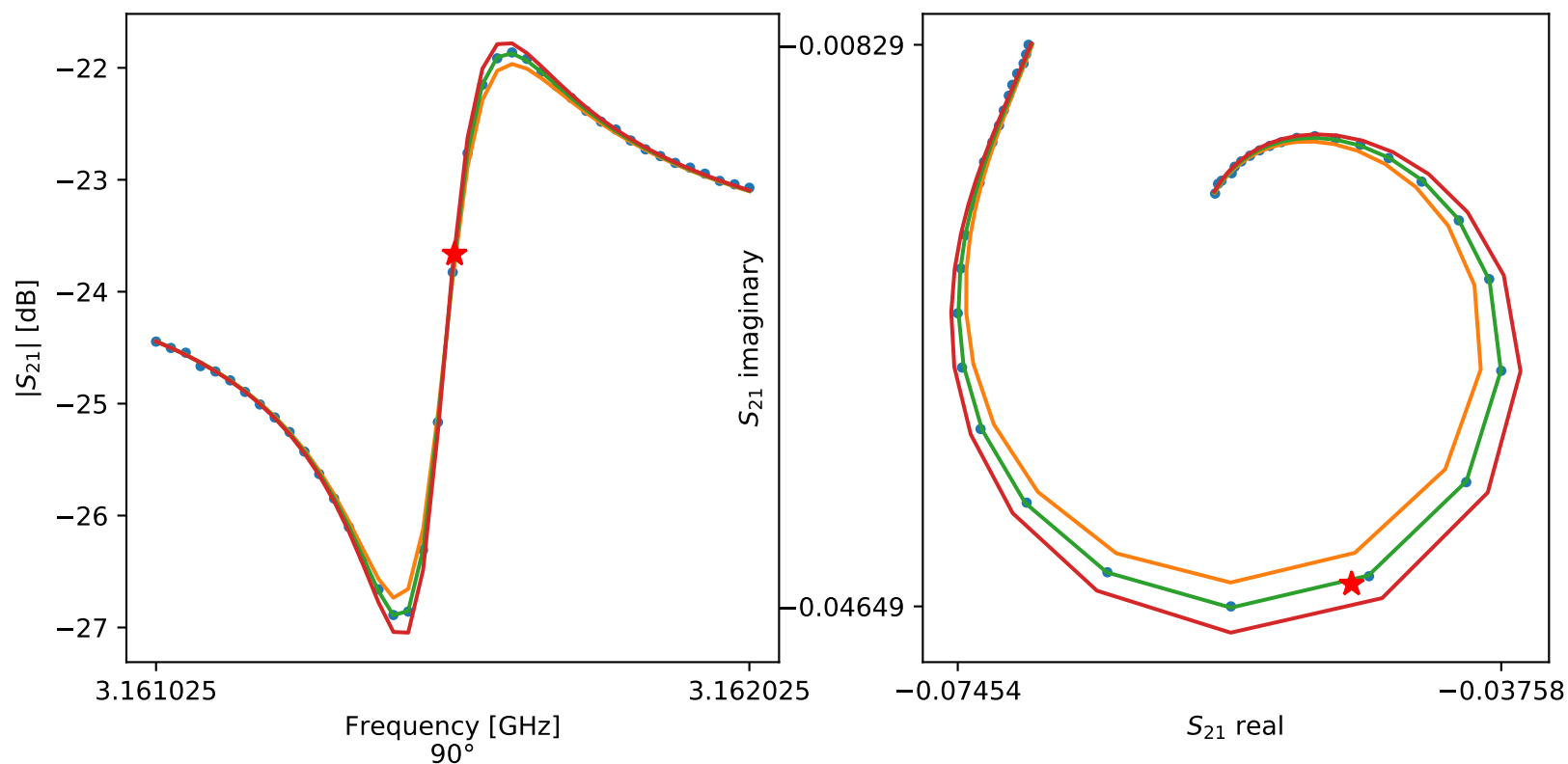τ = (43.39416430788054-7.978927933944356j)

resonance 8 at 3.1547 GHz

$$S_{21}(f) = ae^{-2\pi jf\tau}\left[1 - \frac{Q_r/Q_c e^{j\phi_0}}{1 + 2jQ_r(\frac{f-f_r}{f_r})}\right]$$
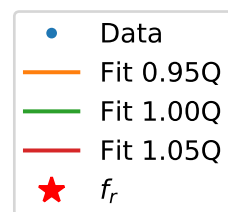
f_r = 3.1547596989242805
Q_r = 24742.31488779612
Q_c = 23642.653836790094
Q_i = -531958.4479943678
a = (-4.588255617063742e+39-9.108080664207566e+3
ϕ_0 = -1.1542477320402866
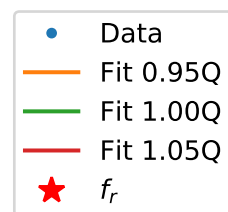τ = (38.632499205519586-4.772786863689572j)

resonance 9 at 3.1615 GHz

$$S_{21}(f) = ae^{-2\pi jf\tau}\left[1 - \frac{Q_r/Q_c e^{j\phi_0}}{1 + 2jQ_r(\frac{f-f_r}{f_r})}\right]$$

f_r = 3.161528270438056
Q_r = 17101.507136672328
Q_c = 31024.321176311983
Q_i = 38107.429180376064
a = (2.2795333690433165e+49-3.6835093868907856e-
ϕ_0 = -1.2994044229446637
τ = (38.685937100350976-5.890975468466407j)

resonance 10 at 3.1655 GHz
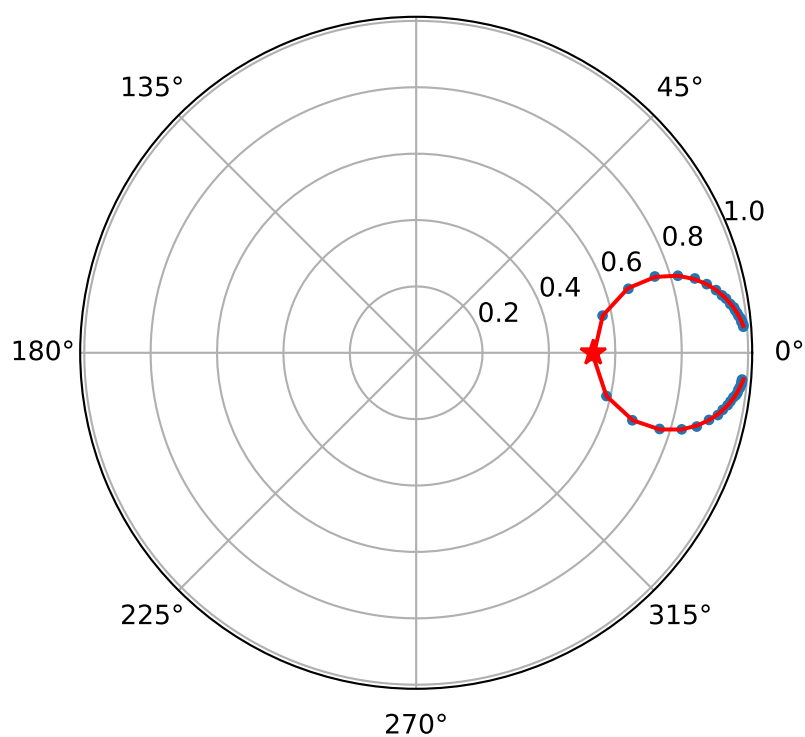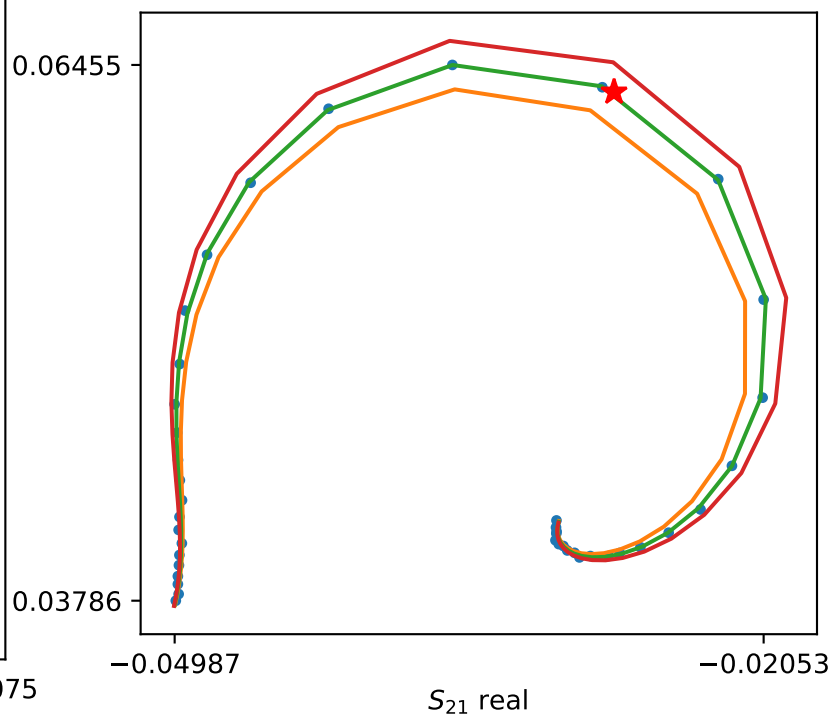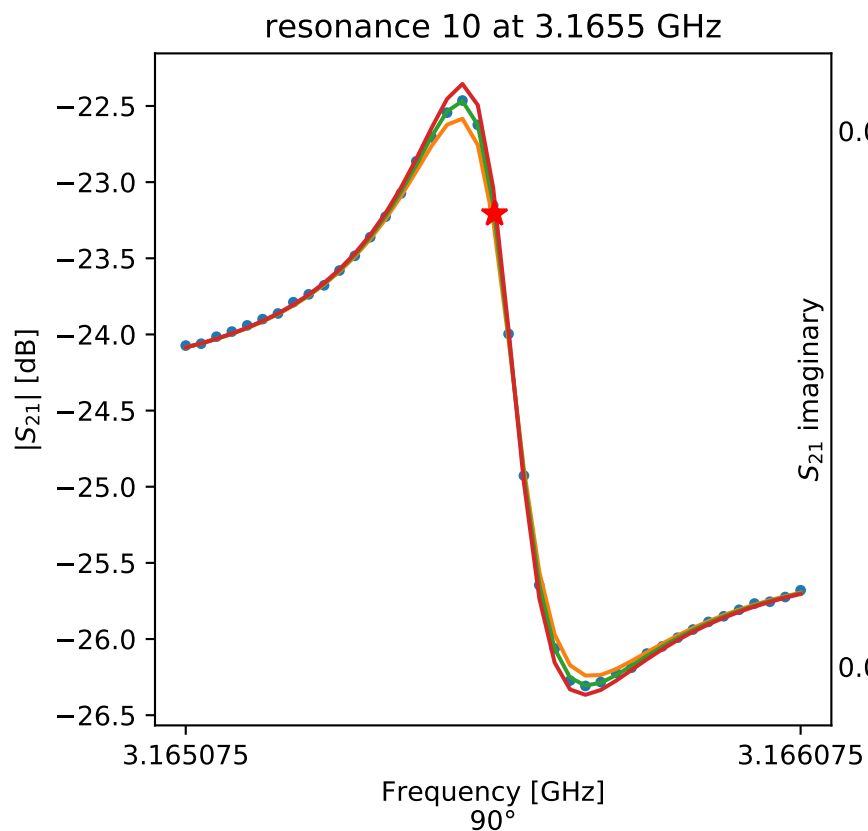
$$S_{21}(f) = ae^{-2\pi jf\tau}\left[1 - \frac{Q_r/Q_c e^{j\phi_0}}{1 + 2jQ_r(\frac{f-f_r}{f_r})}\right]$$

f_r = 3.165577173175095
Q_r = 17765.3420051192
Q_c = 38077.770541410704
Q_i = 33302.99059277912
a = (-6.22251896676094e+41-9.632532093146751e+42
ϕ_0 = 1.8528079373802158
τ = (38.65434234929937-5.120328387362435j)

resonance 11 at 3.1704 GHz
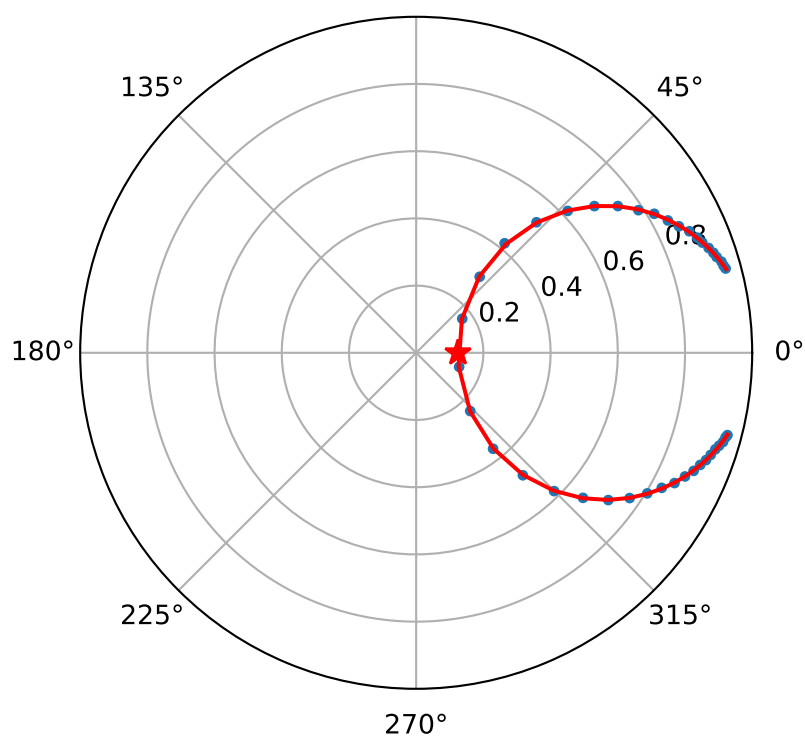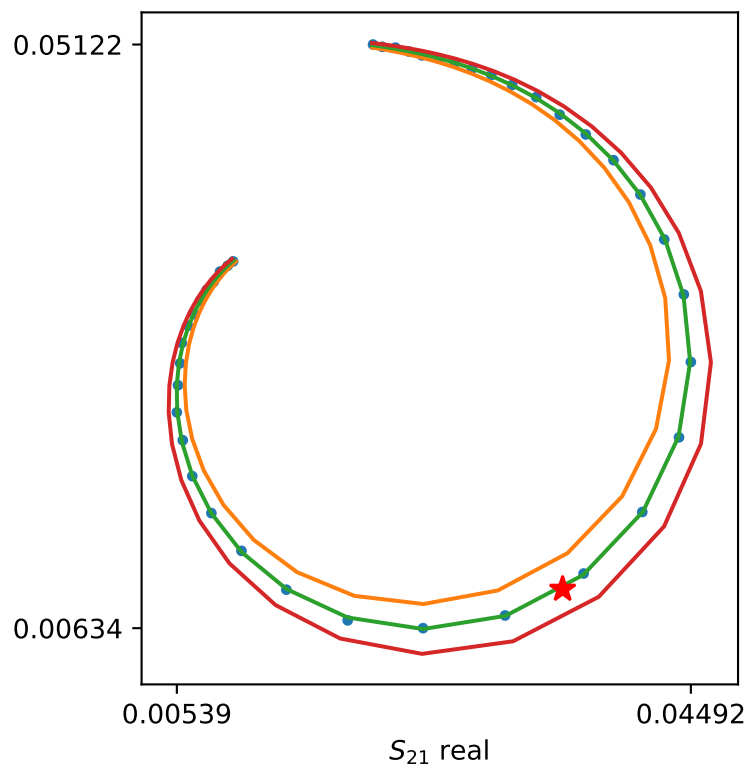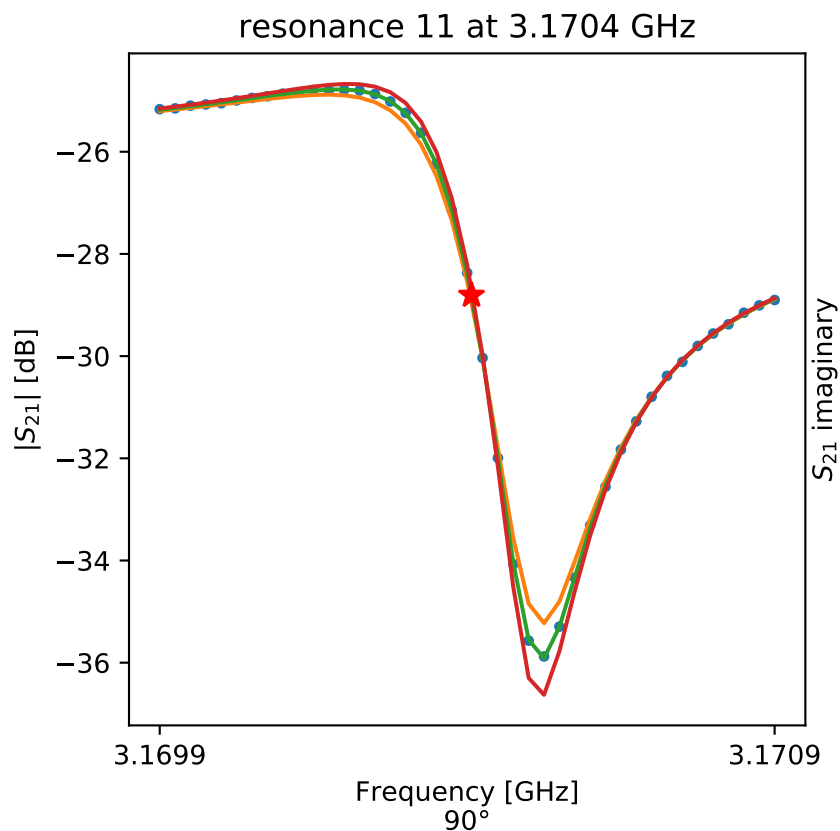
$$S_{21}(f) = ae^{-2\pi jf\tau}\left[1 - \frac{Q_r/Q_c e^{j\phi_0}}{1 + 2jQ_r(\frac{f-f_r}{f_r})}\right]$$
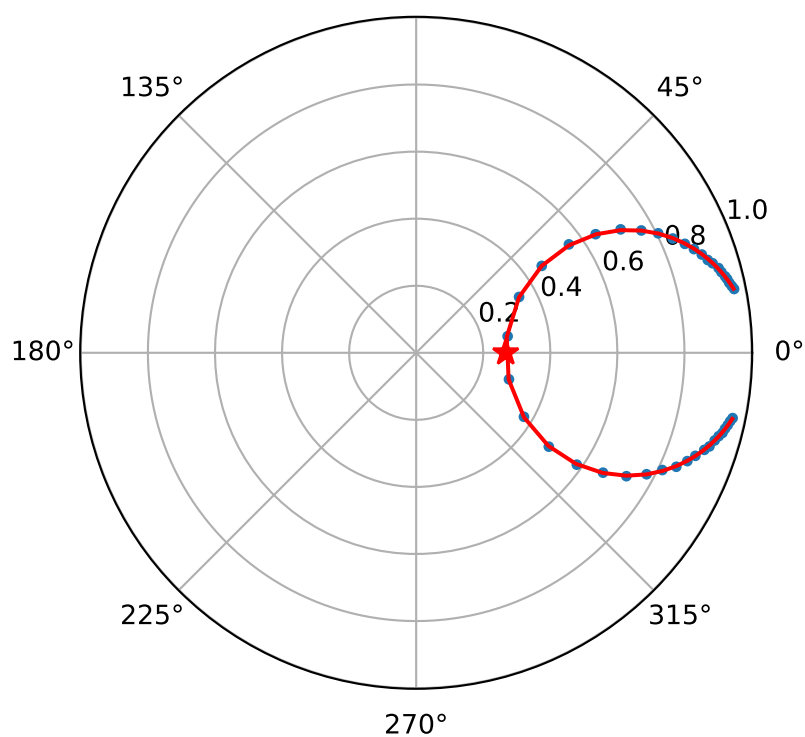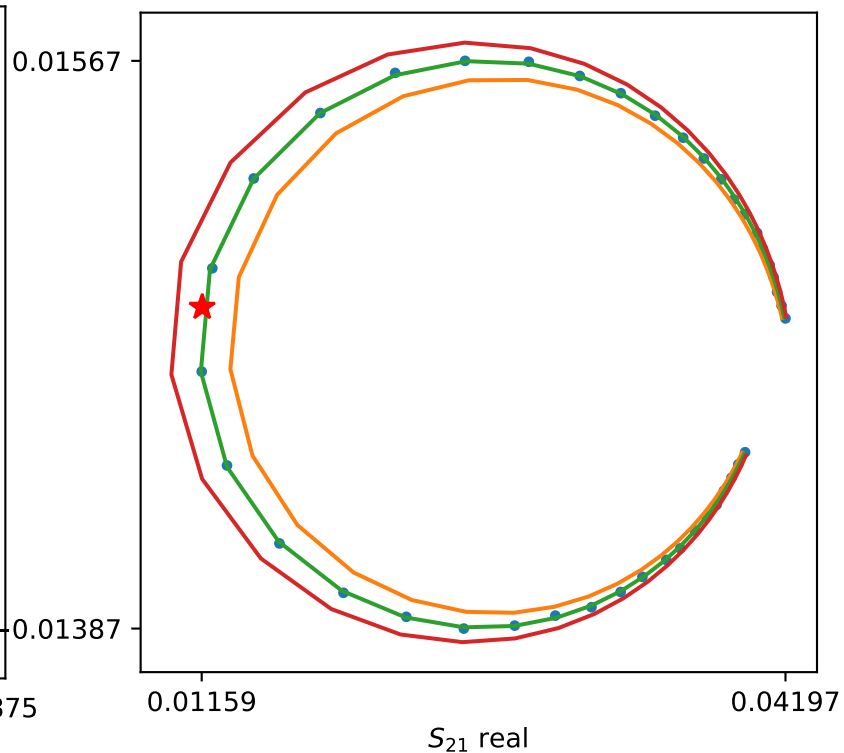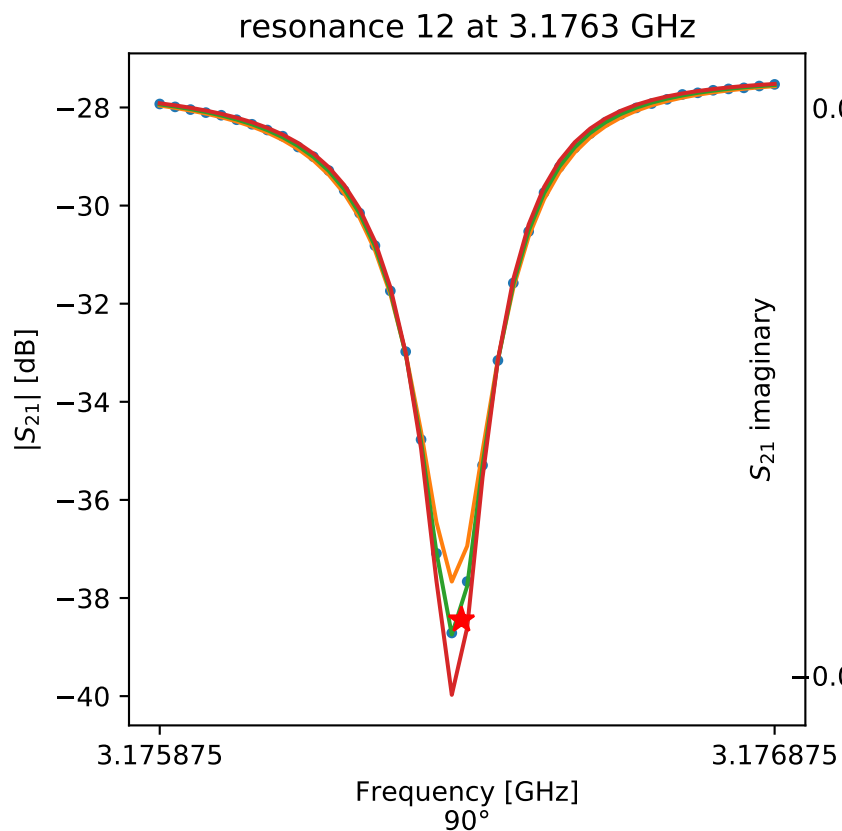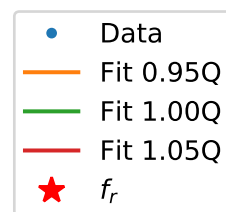
f_r = 3.17040701920343750
Q_r = 10305.29216162619
Q_c = 11768.2849929584
Q_i = 82895.56346170403
a = (-9.47835624331409e+32-1.396519800050733e+33
ϕ_0 = 0.8337129951820126
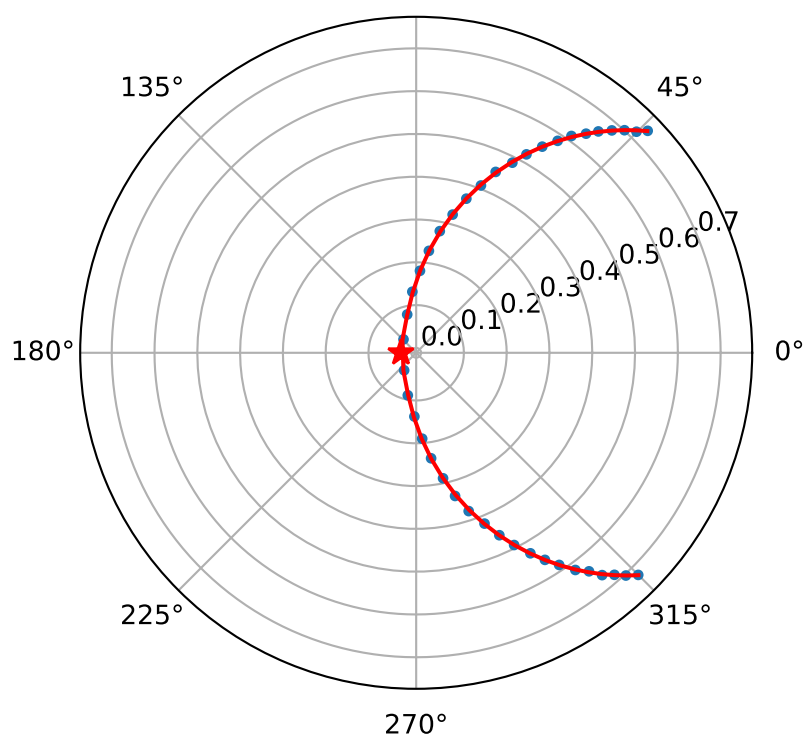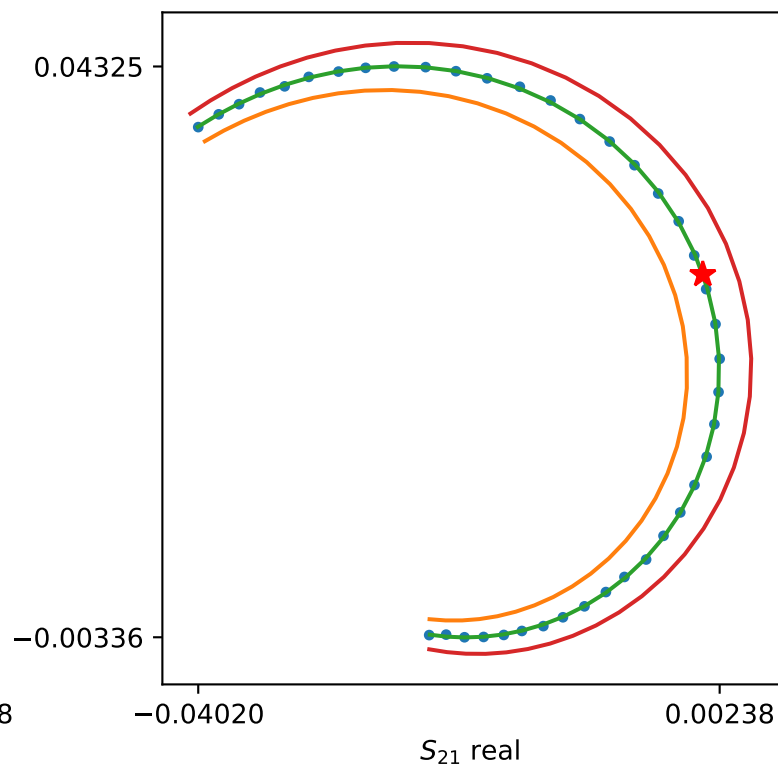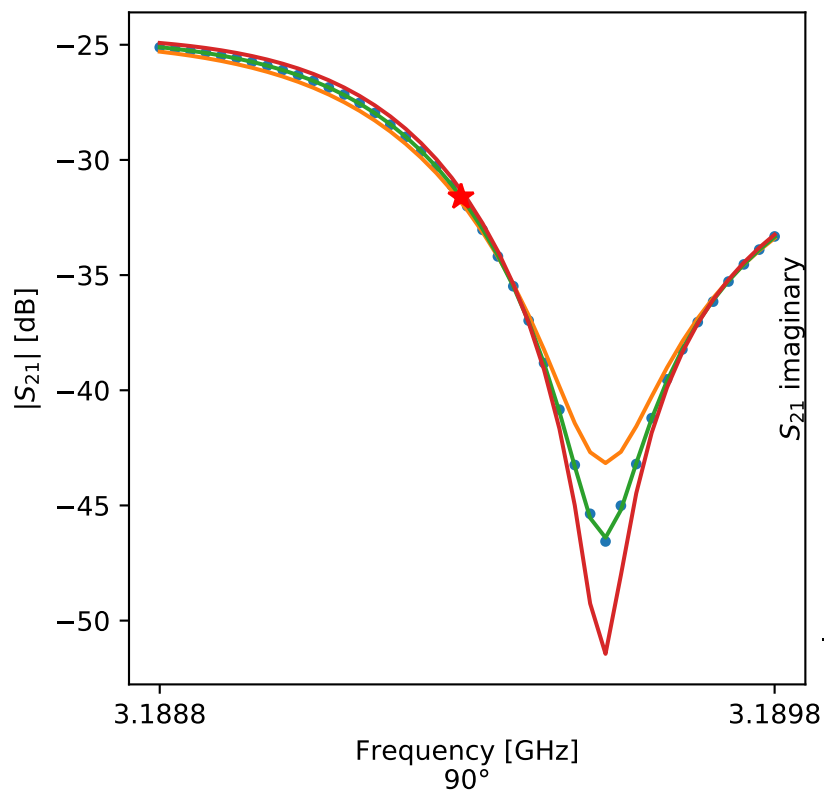τ = (36.416028552174446-3.9939807757784256j)

resonance 12 at 3.1763 GHz

$$S_{21}(f) = ae^{-2\pi jf\tau}\left[1 - \frac{Q_r/Q_c e^{j\phi_0}}{1 + 2jQ_r(\frac{f-f_r}{f_r})}\right]$$

f_r = 3.17636569758622284
Q_r = 11085.353432258287
Q_c = 15122.588766091794
Q_i = 41523.27705000206
a = (0.009722897017517789+0.017903803029139784j)
ϕ_0 = -0.10221575256966241
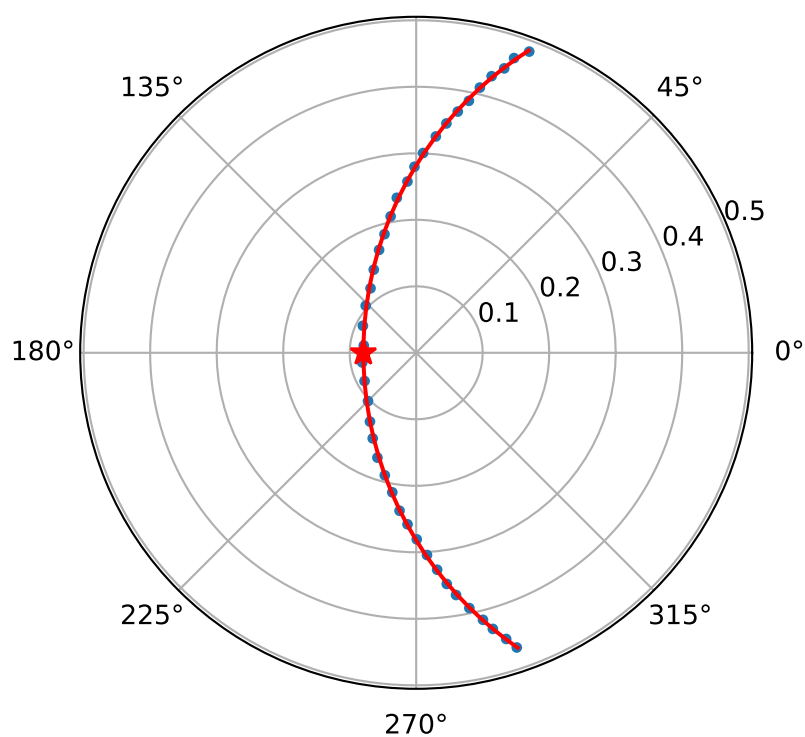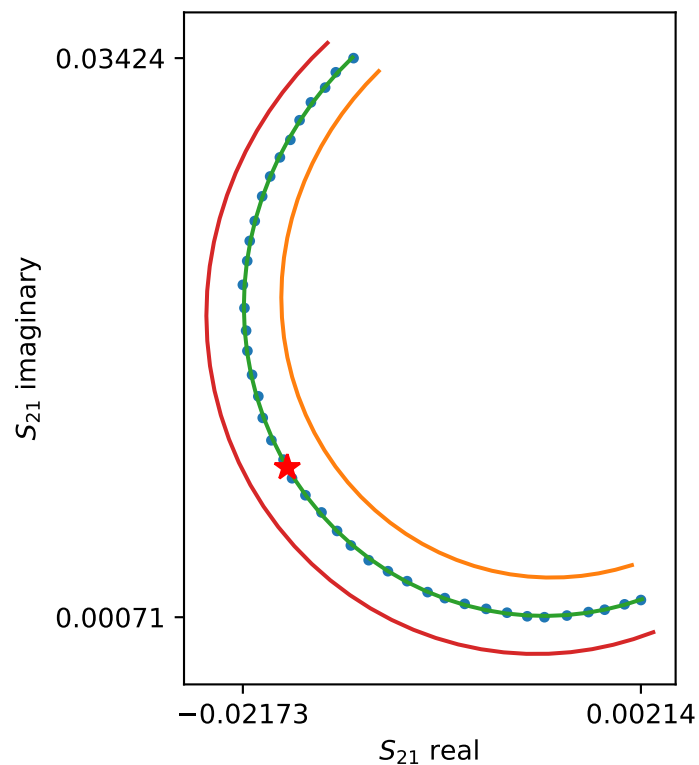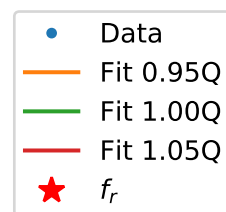τ = (36.260093650210386+0.03692593736939175j)

resonance 13 at 3.1892 GHz
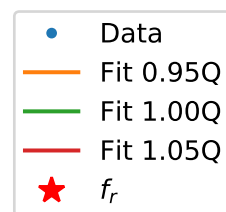
$$S_{21}(f) = ae^{-2\pi jf\tau}\left[1 - \frac{Q_r/Q_c e^{j\phi_0}}{1 + 2jQ_r(\frac{f - f_r}{f_r})}\right]$$

f_r = 3.18928994296355593
Q_r = 3406.743845480375
Q_c = 3326.2543967102197
Q_i = -140784.8714041169
a = (-5.29500093544918e-11-2.762784651770305e-11j)
ϕ_0 = 0.5010213890894069
τ = (57.729173826444644+1.0275525116255415j)

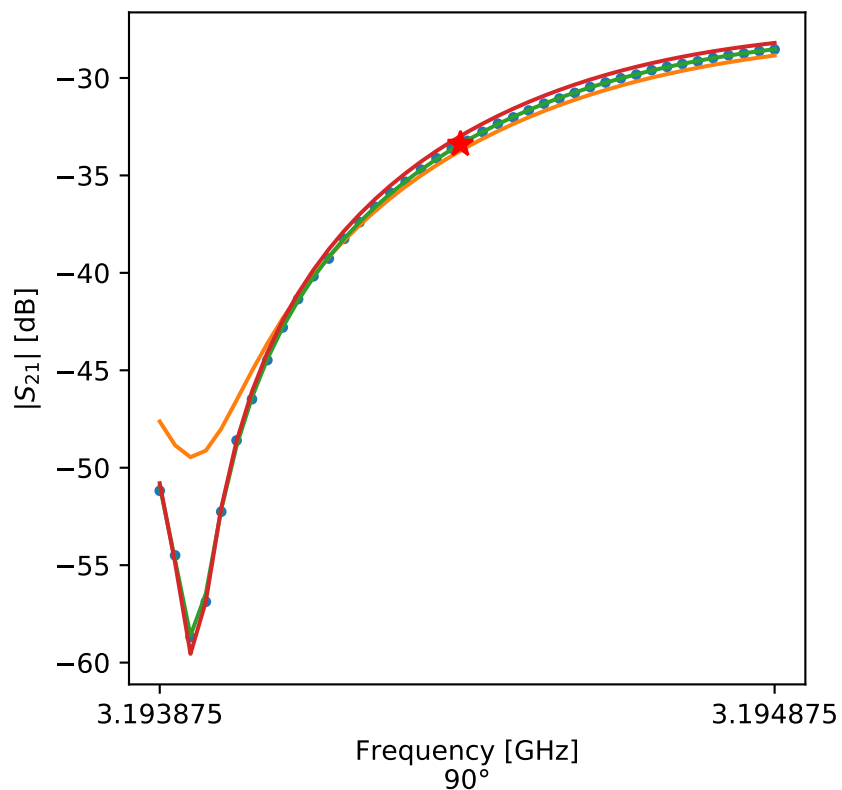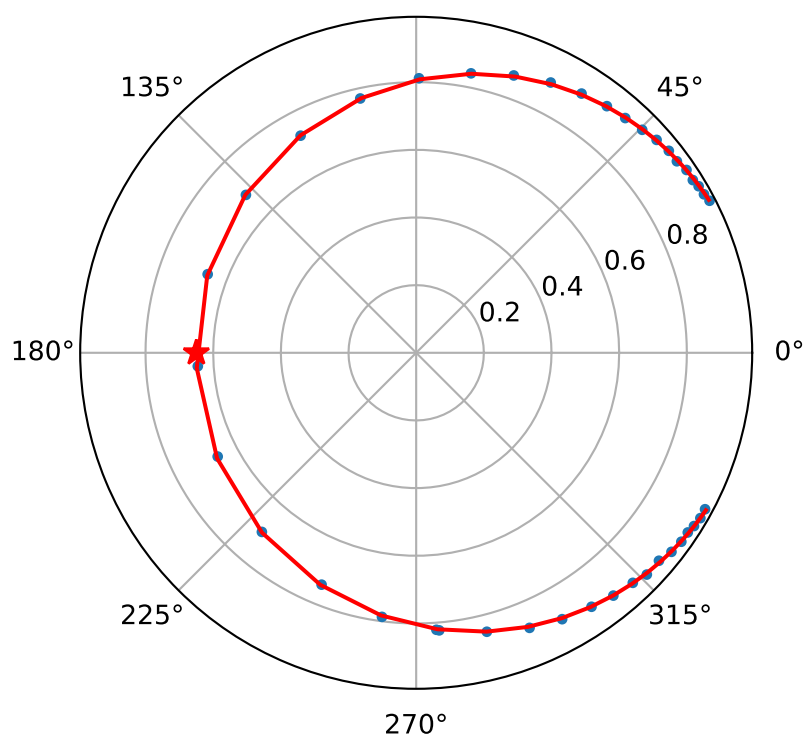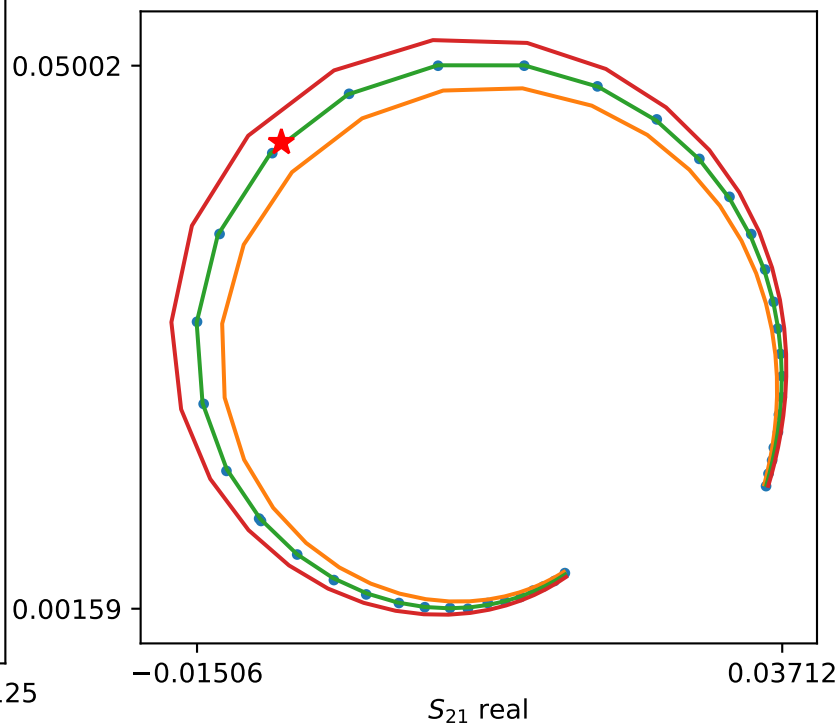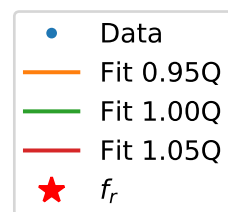## resonance 14 at 3.1943 GHz

$$S_{21}(f) = ae^{-2\pi jf\tau}\left[1 - \frac{Q_r/Q_c e^{j\phi_0}}{1 + 2jQ_r(\frac{f-f_r}{f_r})}\right]$$

f_r = 3.194364061906337
Q_r = 1709.813884486692
Q_c = 1583.9765196351868
Q_i = -21522.264465479682
a = (-4.8784456217818325e+227-2.0510341563312704
ϕ_0 = -0.44494806946505283
τ = (66.54290694946164-26.460879470692387j)

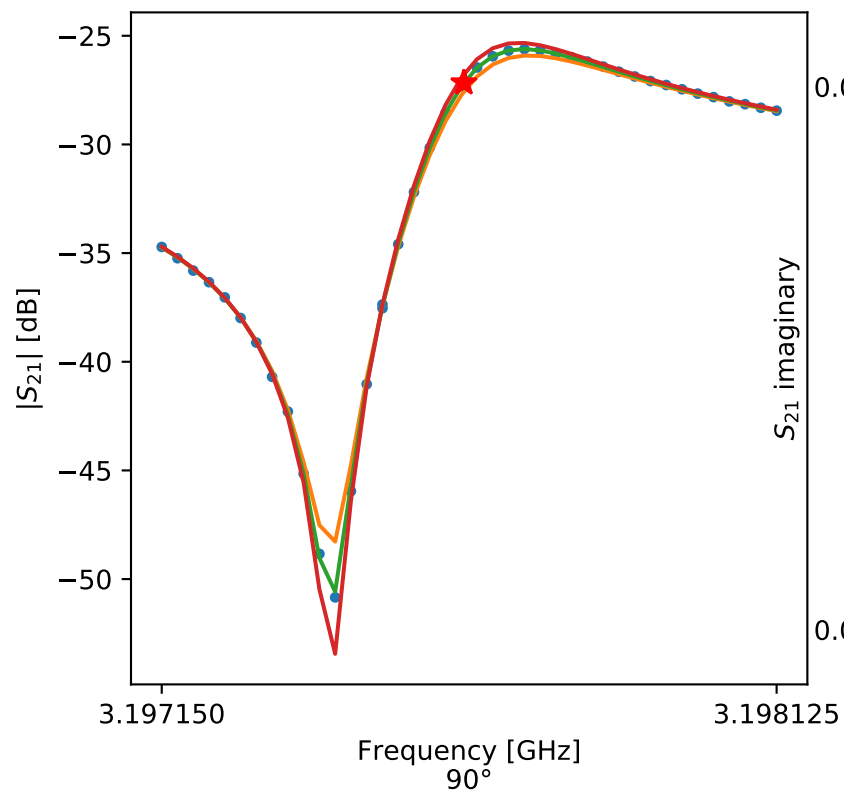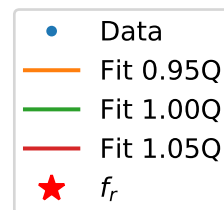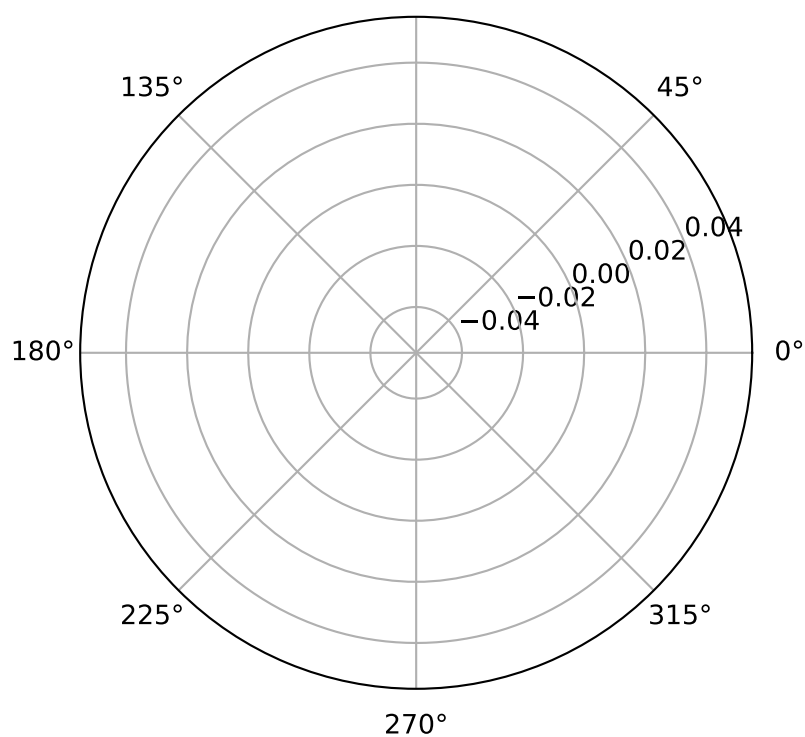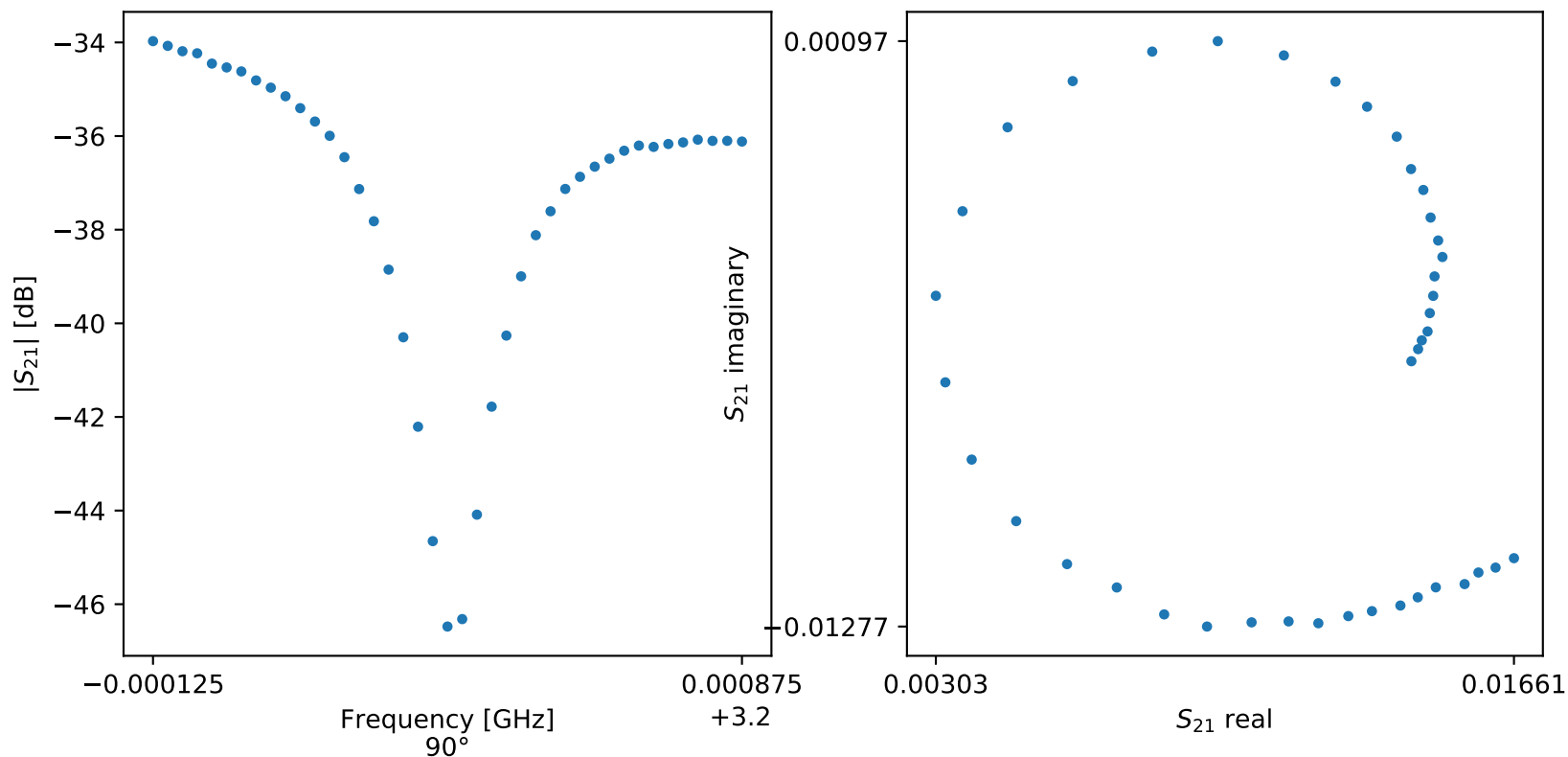resonance 15 at 3.1976 GHz

$$S_{21}(f) = ae^{-2\pi jf\tau}\left[1 - \frac{Q_r/Q_c e^{j\phi_0}}{1 + 2jQ_r(\frac{f-f_r}{f_r})}\right]$$

f_r = 3.197629081348268
Q_r = 10800.747654417963
Q_c = 6546.611285213711
Q_i = -16621.069553627014
a = (1.7419356956438697e+287-2.5110242950435823e
ϕ_0 = -1.0312100792853593
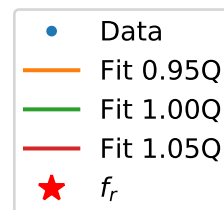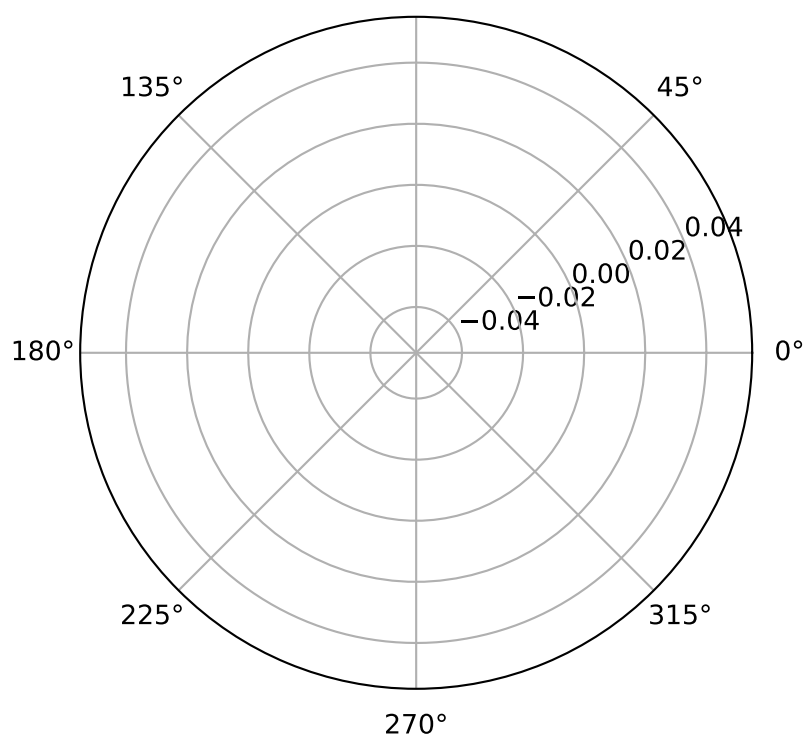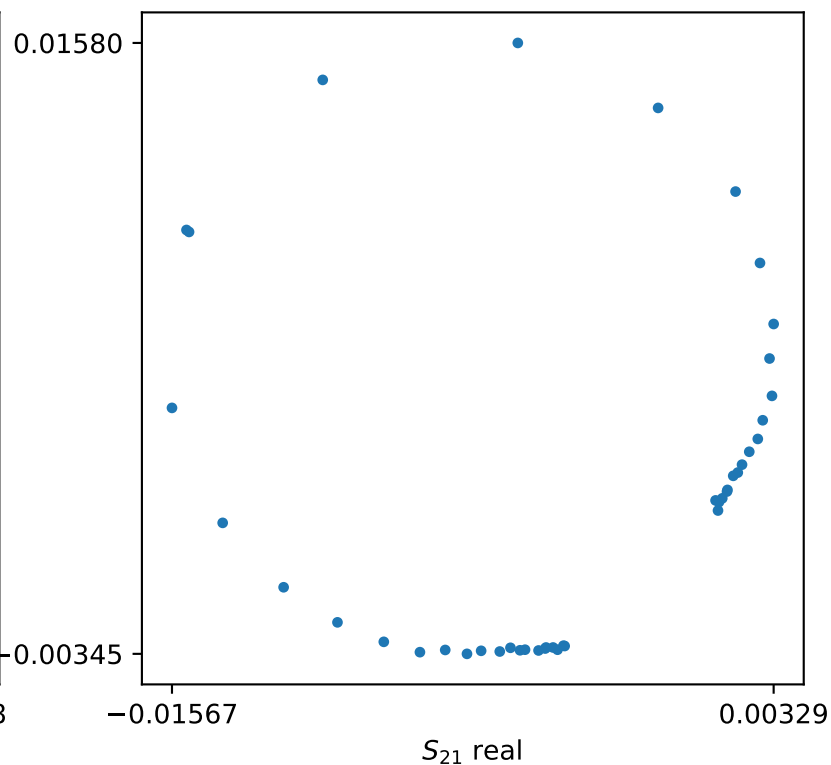τ = (63.735327677816095-33.12078702947409j)

resonance 16 at 3.2003 GHz

$$S_{21}(f) = ae^{-2\pi jf\tau}\left[1 - \frac{Q_r/Q_c e^{j\phi_0}}{1 + 2jQ_r(\frac{f - f_r}{f_r})}\right]$$

f_r = 3.200381519120663
Q_r = 10113.643712480374
Q_c = 13384.615734351053
Q_i = 41384.40618280449
a = (inf+nanj)
ϕ_0 = 0.014053538491544202
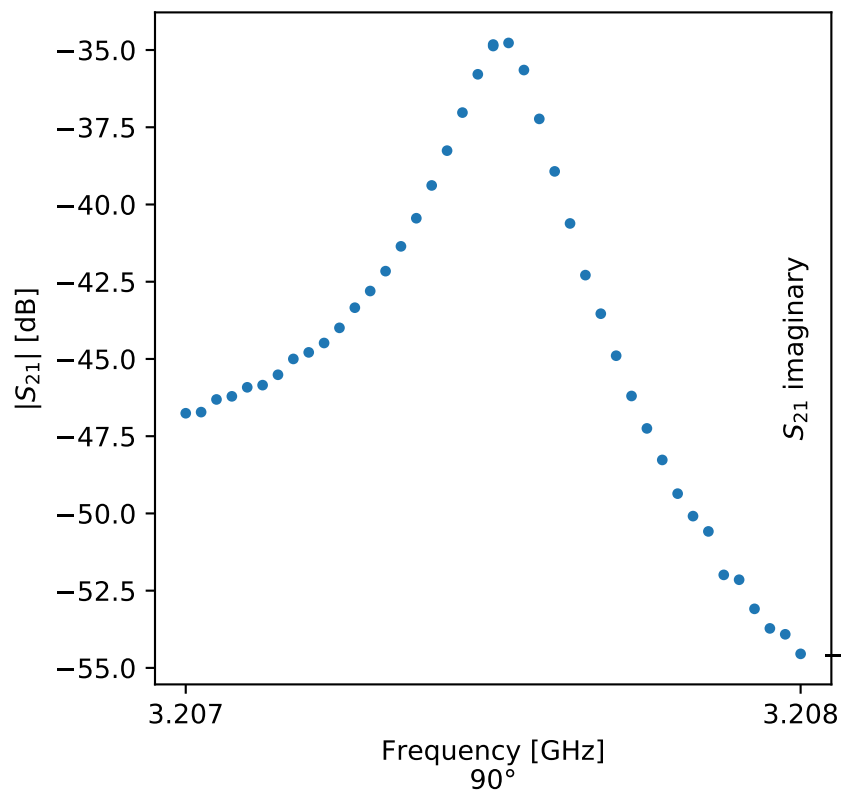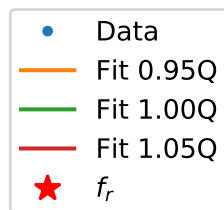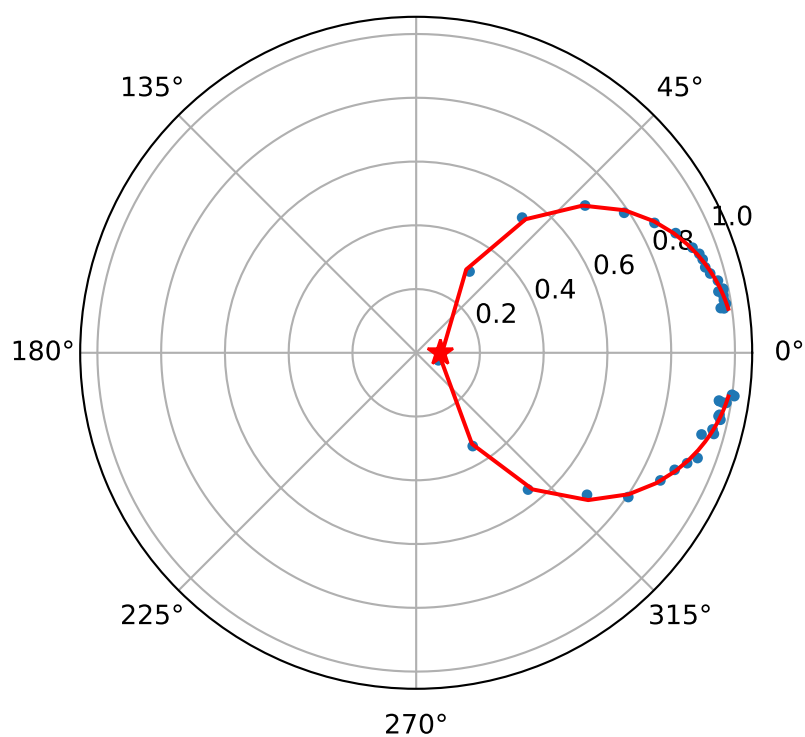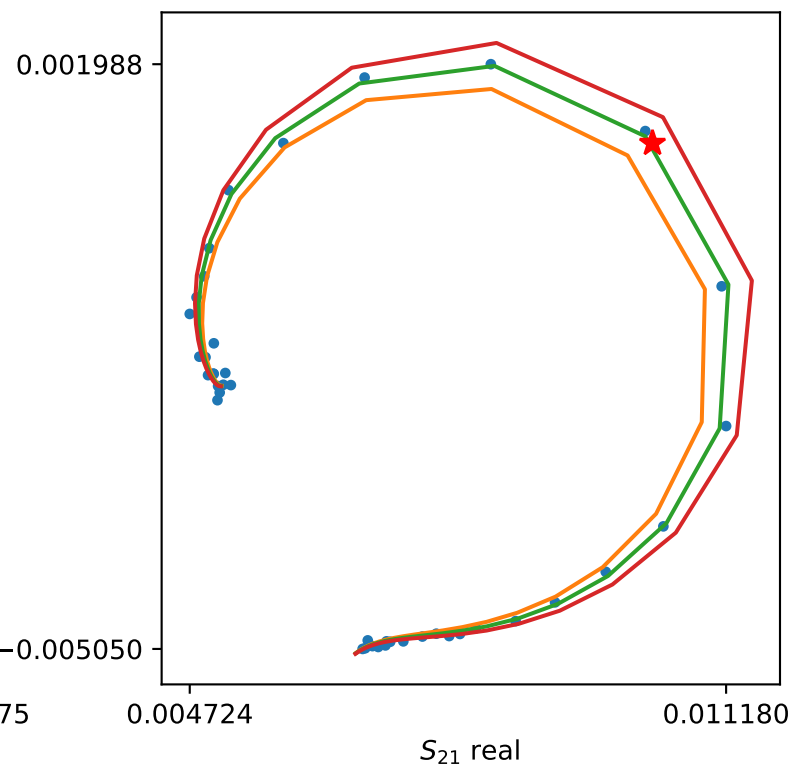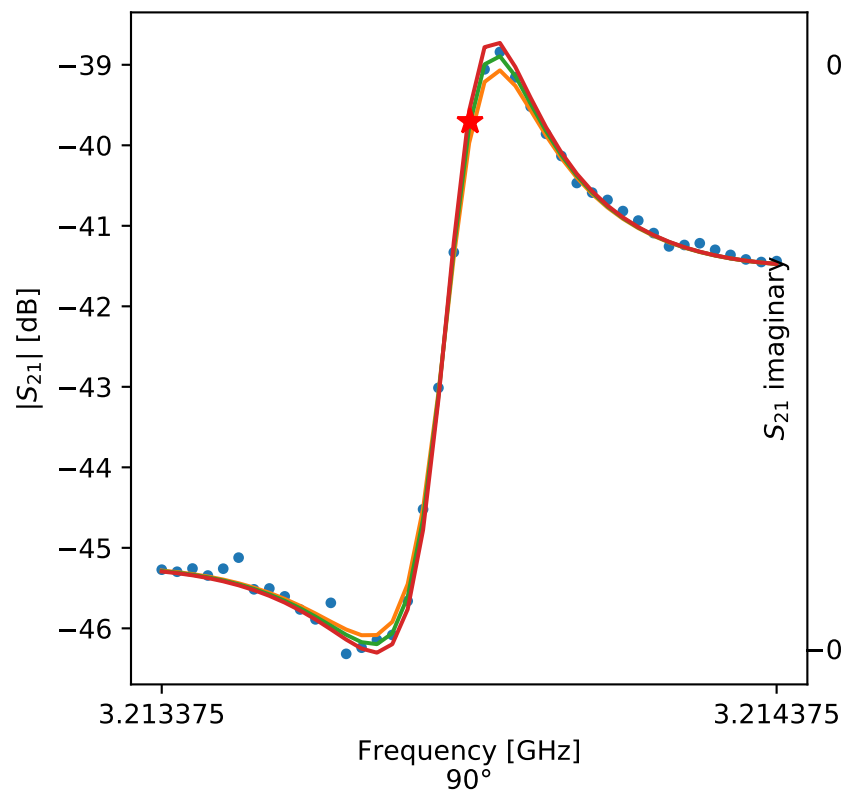τ = (47.53866269571255-37.12019122158312j)

resonance 17 at 3.2075 GHz

$$S_{21}(f) = ae^{-2\pi jf\tau}\left[1 - \frac{Q_r/Q_c e^{j\phi_0}}{1 + 2jQ_r(\frac{f-f_r}{f_r})}\right]$$

f_r = 3.2075205854231683
Q_r = 22490.740095026464
Q_c = 910.3440534889181
Q_i = -948.7458647498198
a = (inf+nanj)
ϕ_0 = 0.4797282701209829
τ = (6.58932732562149e-07-126.28715248545468j)

resonance 18 at 3.2138 GHz

$$S_{21}(f) = ae^{-2\pi jf\tau}\left[1 - \frac{Q_r/Q_c e^{j\phi_0}}{1 + 2jQ_r(\frac{f-f_r}{f_r})}\right]$$
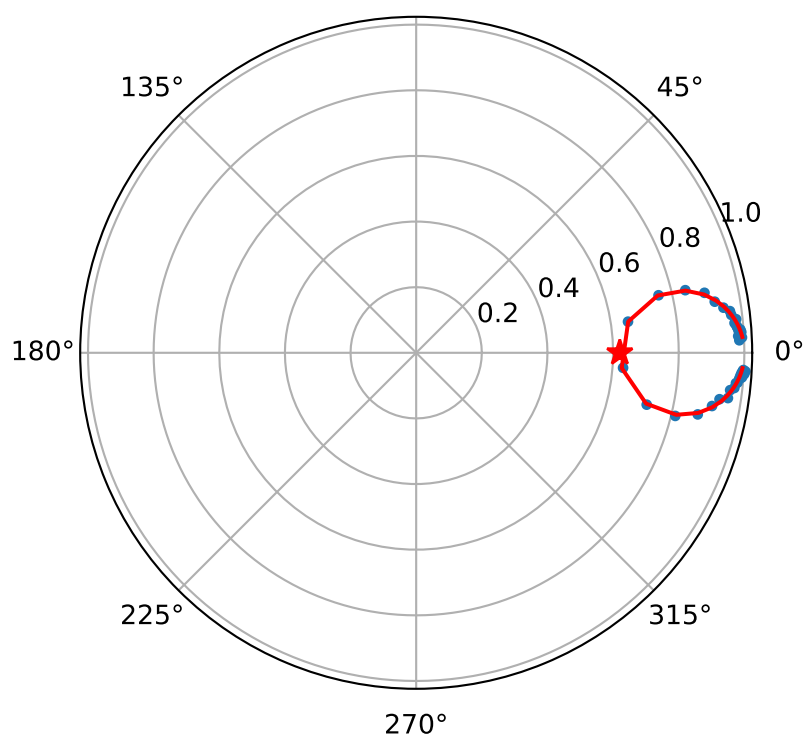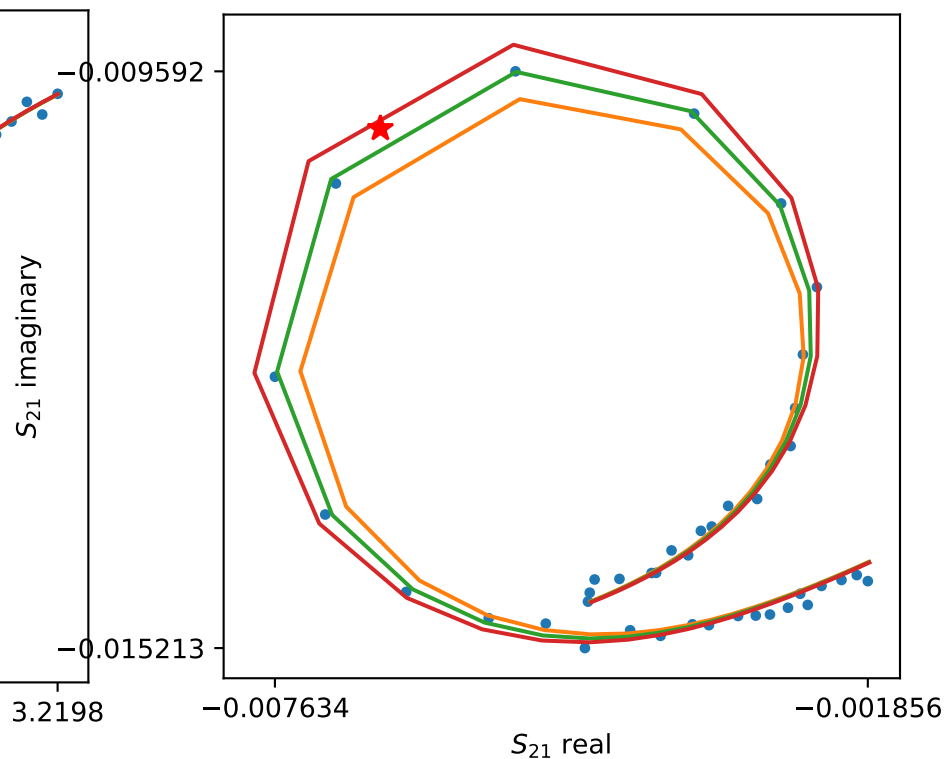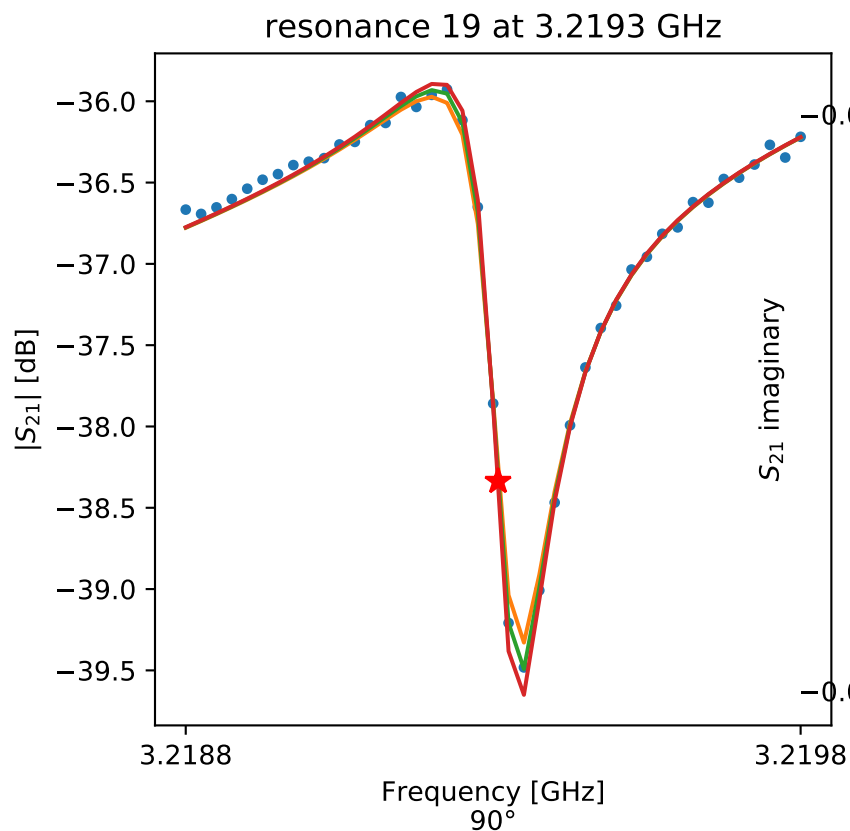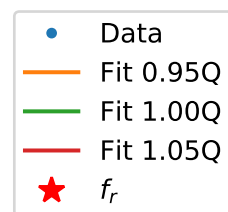
f_r = 3.213876405898489
Q_r = 21100.556698520664
Q_c = 22834.53809309741
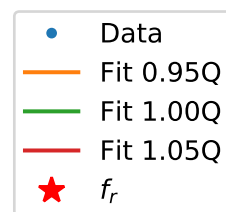Q_i = 277870.032068909
a = (-9.491077733371855e-247+3.037713594800312e-2
ϕ_0 = -1.825892101664138
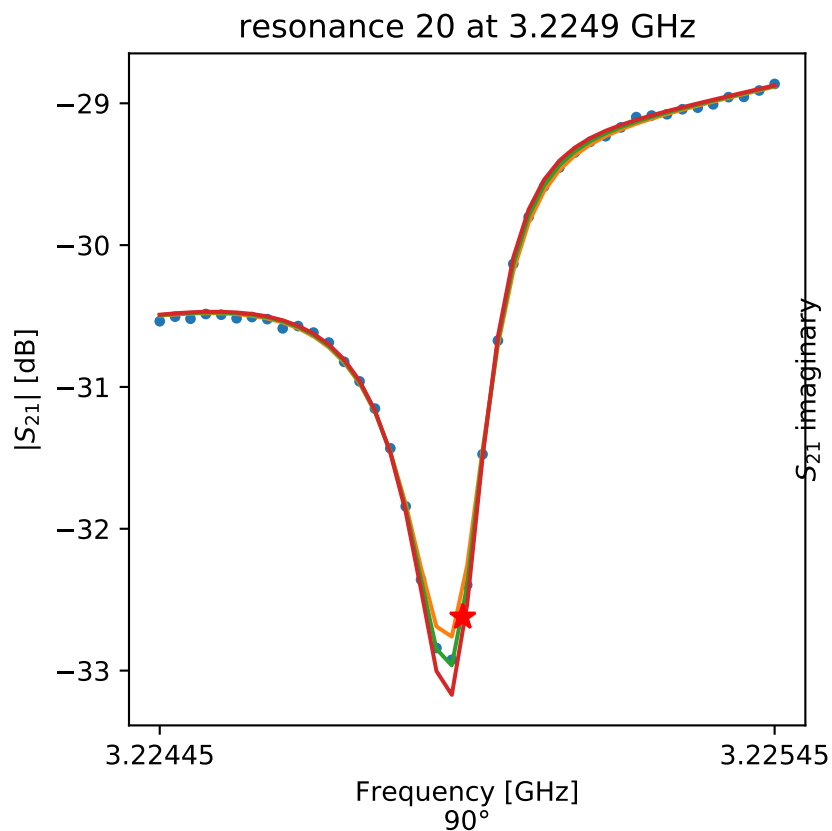τ = (35.0152133278492+27.803536448628936j)

resonance 19 at 3.2193 GHz

$$S_{21}(f) = ae^{-2\pi jf\tau}\left[1 - \frac{Q_r/Q_c e^{j\phi_0}}{1 + 2jQ_r(\frac{f-f_r}{f_r})}\right]$$

$f_r = 3.219307912596391$
$Q_r = 25305.938648191855$
$Q_c = 66677.56303059713$
$Q_i = 40784.91827313495$
$a = $ (-1.7796321014617062e-193+6.478678918741159e
$\phi_0 = 0.8575988553820687$
$\tau = $ (37.1906703092142+21.73099953839892j)

resonance 20 at 3.2249 GHz
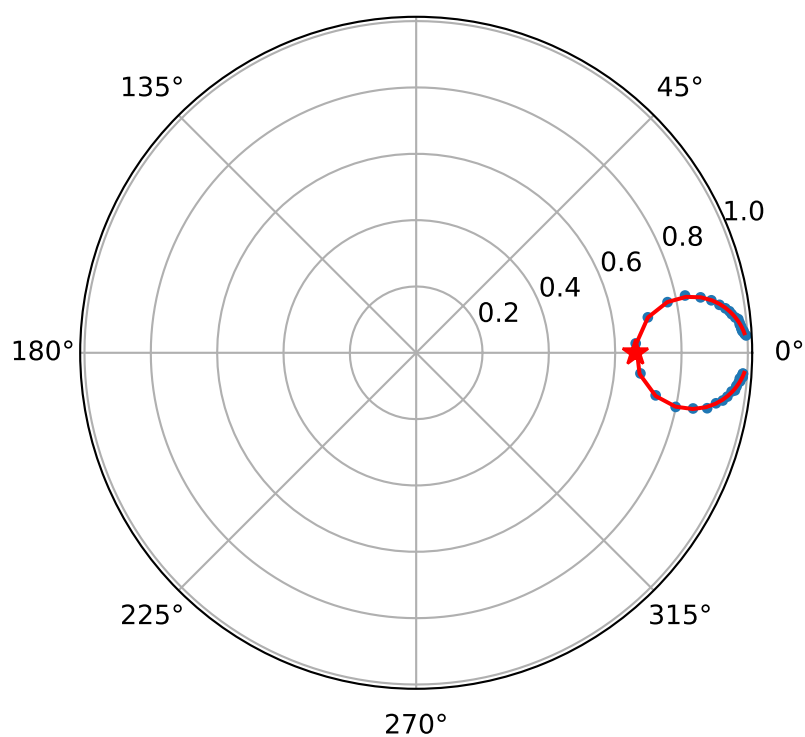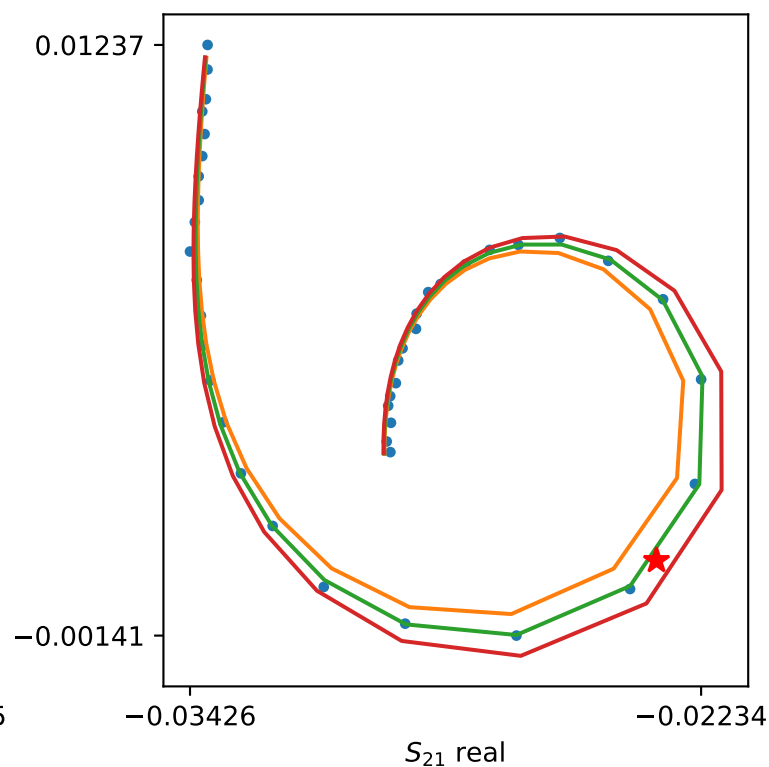
$$S_{21}(f) = ae^{-2\pi jf\tau}\left[1 - \frac{Q_r/Q_c e^{j\phi_0}}{1 + 2jQ_r(\frac{f-f_r}{f_r})}\right]$$
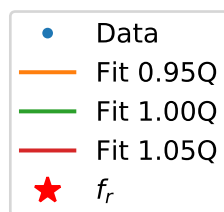
$f_r = 3.2249428137600873$
$Q_r = 17727.62709011778$
$Q_c = 52283.71792958782$
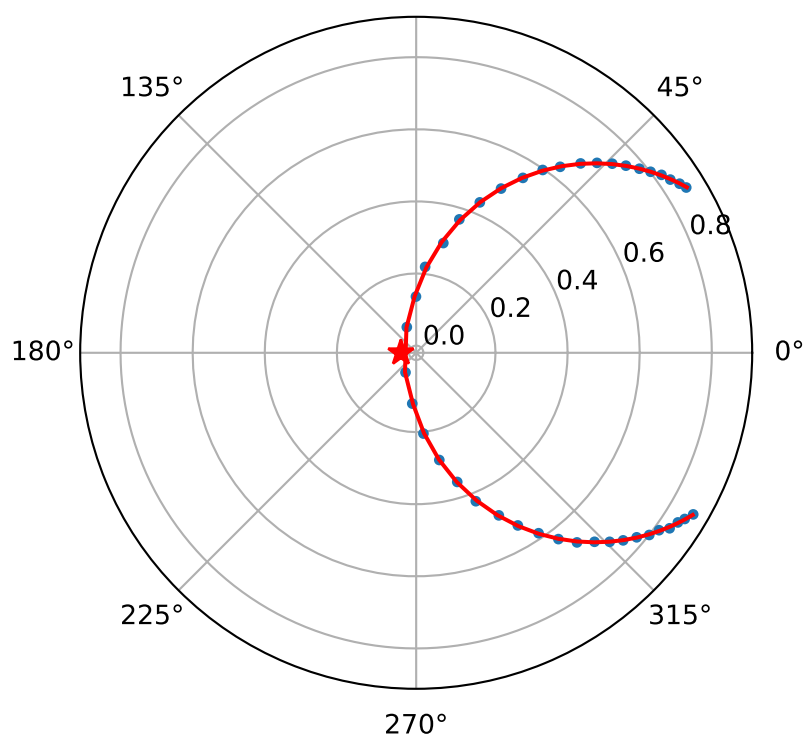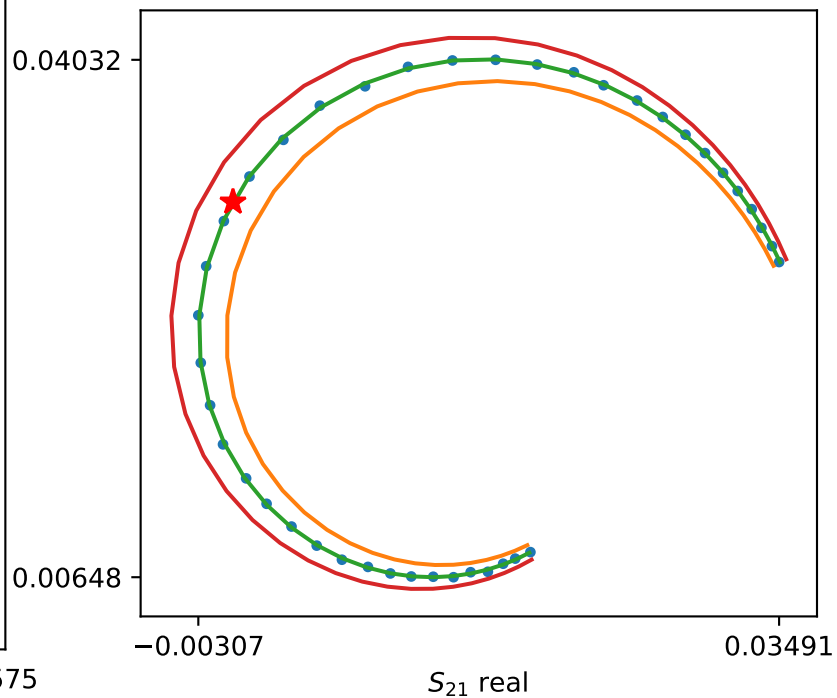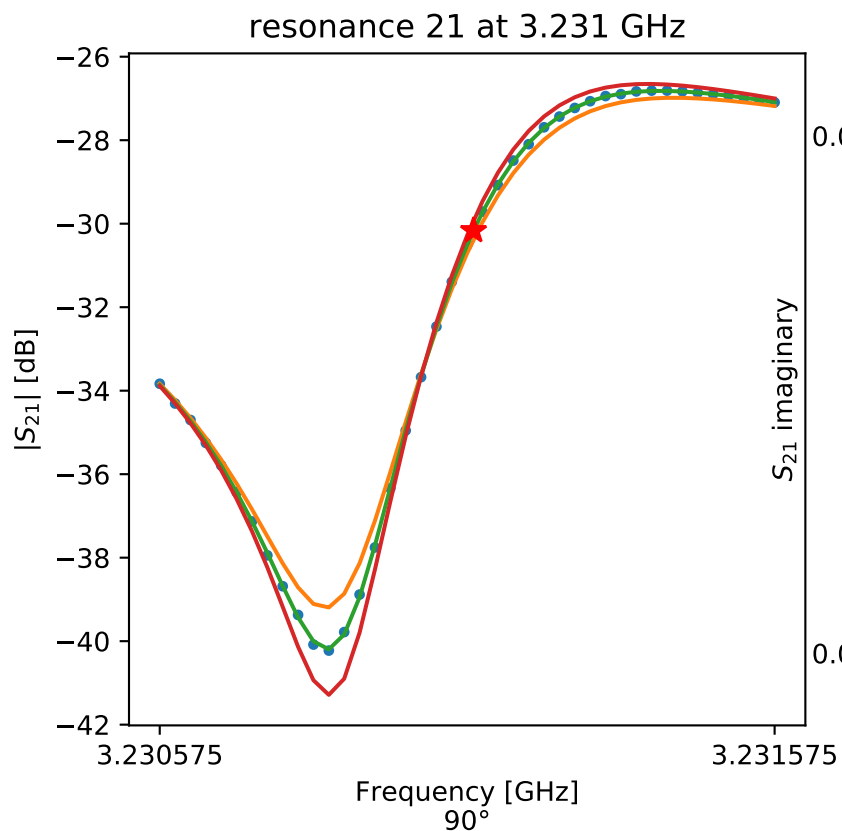$Q_i = 26822.080618041706$
$a = (2.639372059937995e\text{-}190 + 1.6573614951418636e\text{-}$
$\phi_0 = -0.436362115286391$
$\tau = (56.62861196858659 + 21.36636745098004j)$

resonance 21 at 3.231 GHz

$$S_{21}(f) = ae^{-2\pi j f\tau}\left[1 - \frac{Q_r/Q_c e^{j\phi_0}}{1 + 2jQ_r(\frac{f-f_r}{f_r})}\right]$$

f_r = 3.2310853442817686
Q_r = 5560.091963582563
Q_c = 5438.575920159333
Q_i = -248847.65348795708
a = (5.394925248251053e+164-1.1254667272060213e-
ϕ_0 = -0.8529364632218643
τ = (55.94188700115145-18.88740241217861j)

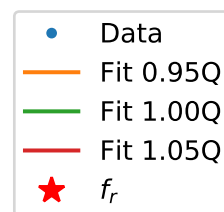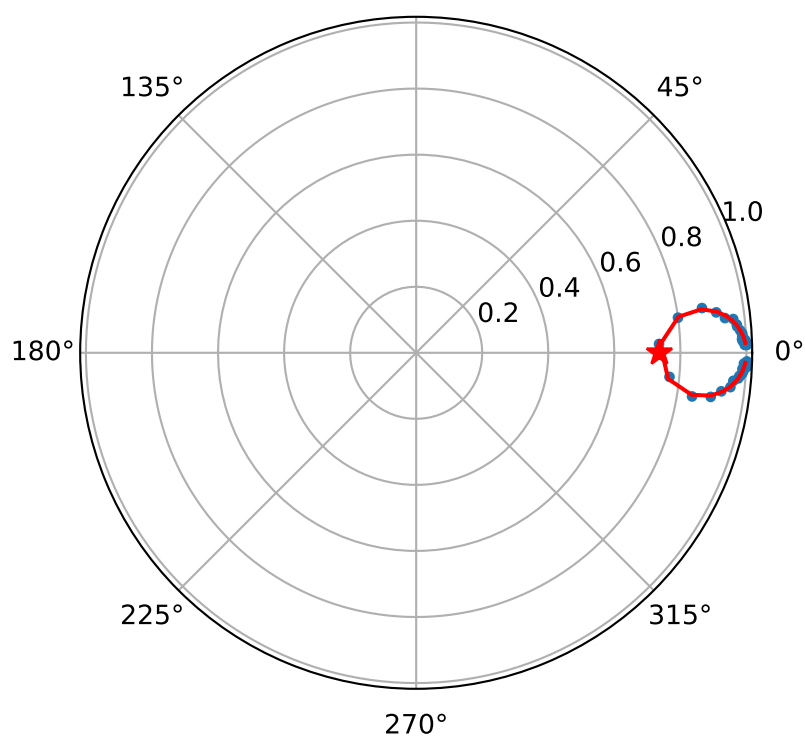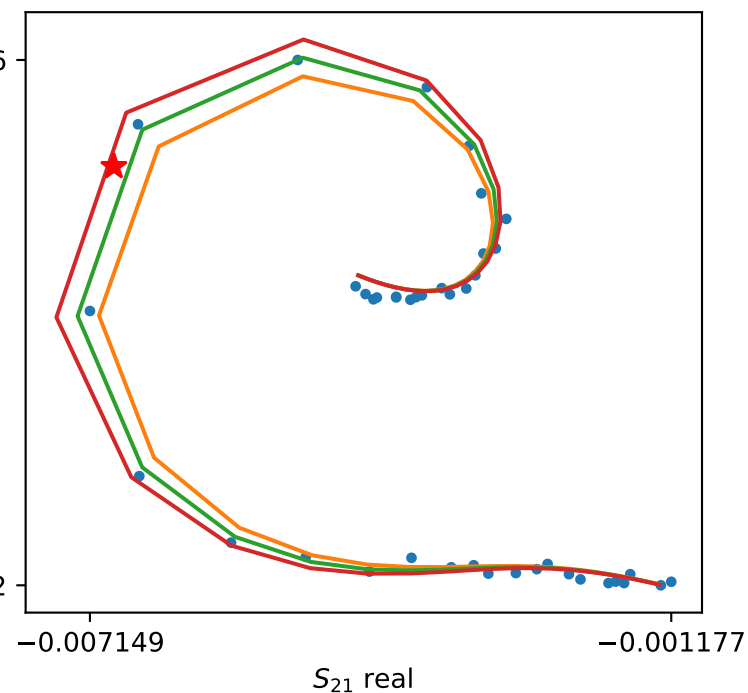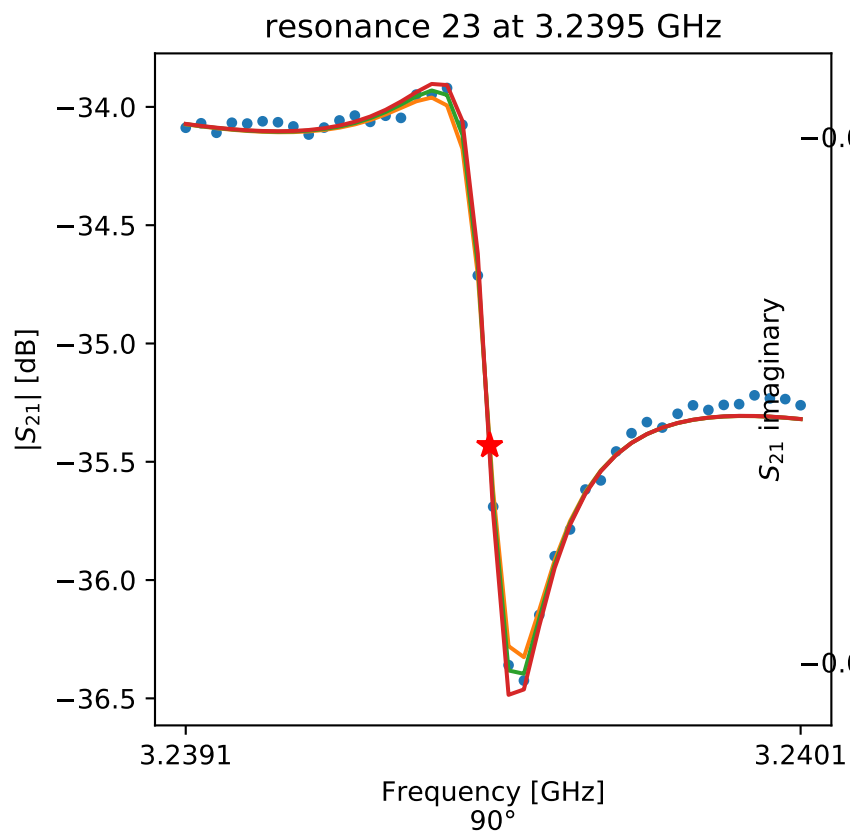## resonance 22 at 3.2351 GHz

Data
Fit 0.95Q
Fit 1.00Q
Fit 1.05Q
f_r
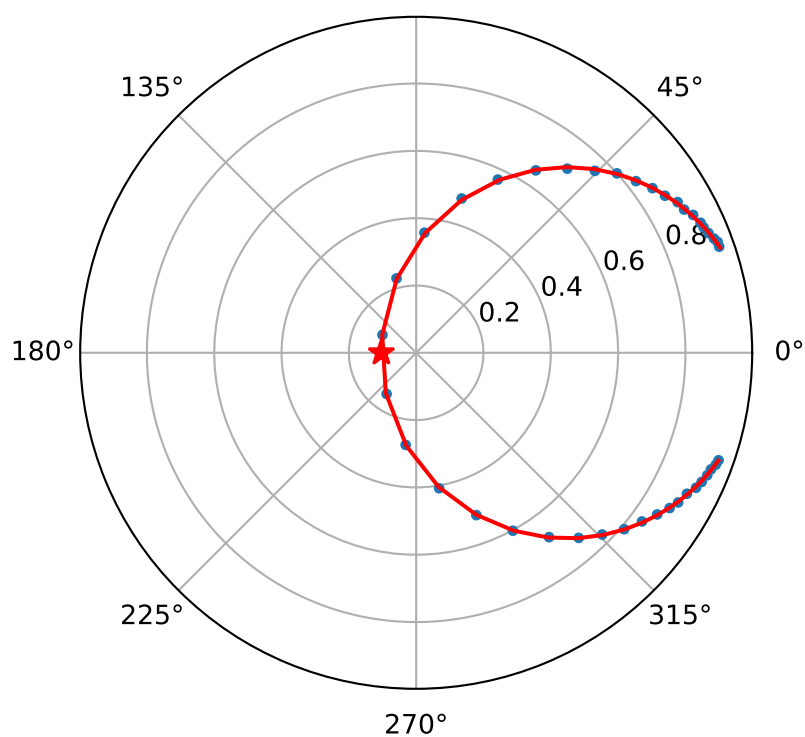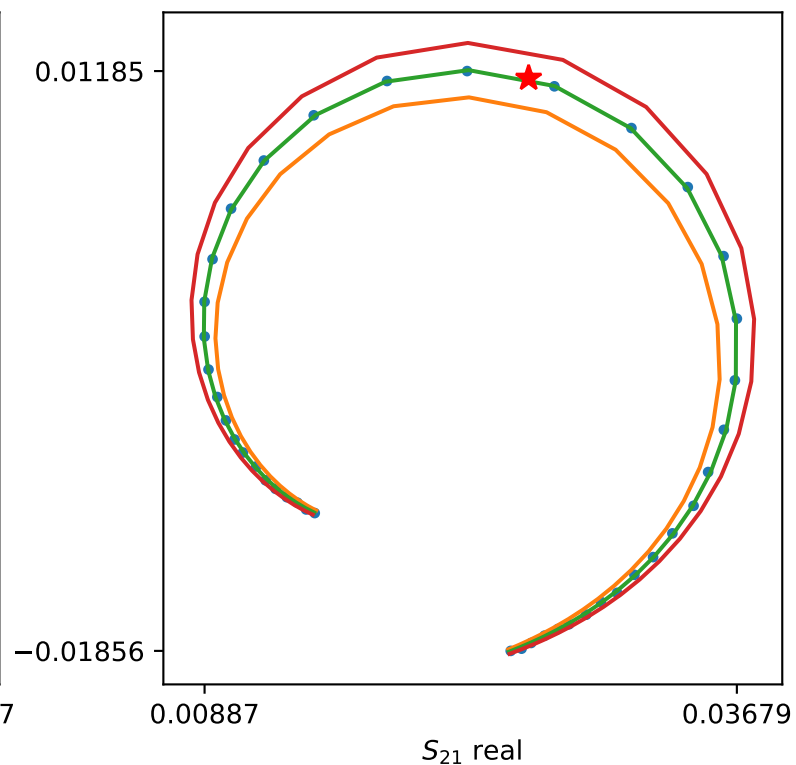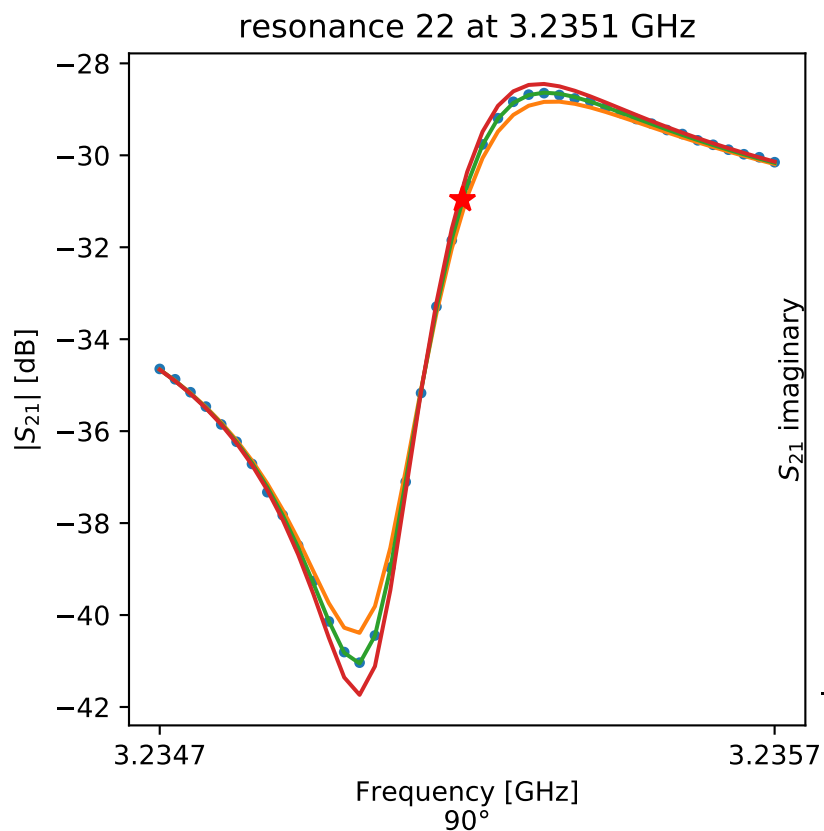
$$S_{21}(f) = ae^{-2\pi jf\tau}\left[1 - \frac{Q_r/Q_c e^{j\phi_0}}{1 + 2jQ_r(\frac{f - f_r}{f_r})}\right]$$

f_r = 3.2351923088307366
Q_r = 10269.817700580874
Q_c = 9306.991229848238
Q_i = -99271.37046690937
a = (-5.850394685783334e+142-2.769486820791898e+
ϕ_0 = -1.0775128236321883
τ = (41.98442716580683-16.428854516204083j)

resonance 23 at 3.2395 GHz

$$S_{21}(f) = ae^{-2\pi jf\tau}\left[1 - \frac{Q_r/Q_c e^{j\phi_0}}{1 + 2jQ_r(\frac{f - f_r}{f_r})}\right]$$
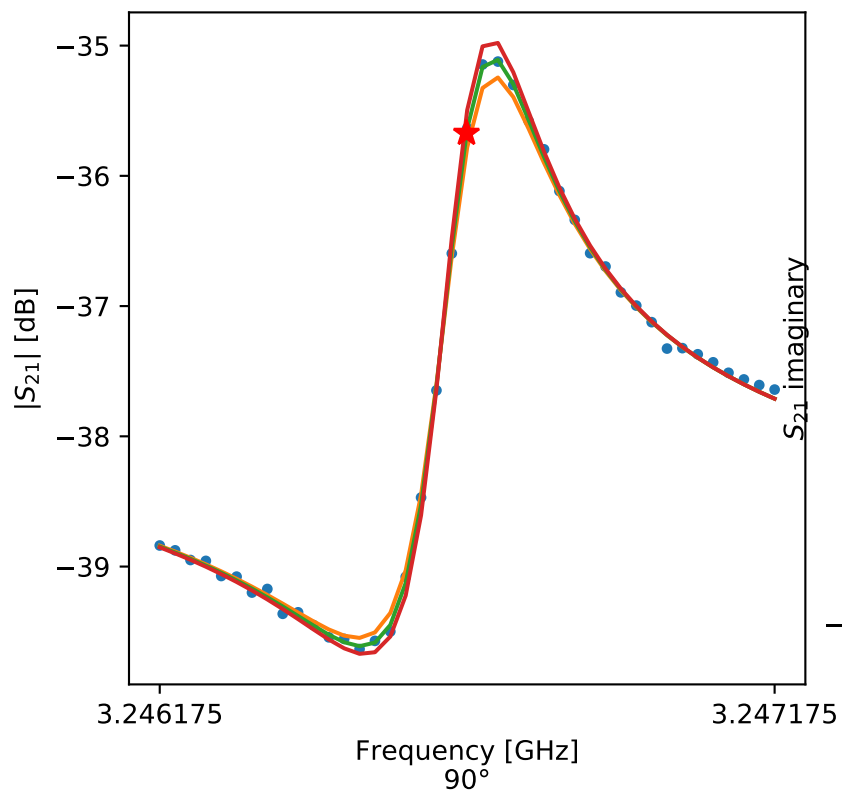
$f_r = 3.2395943107759377$
$Q_r = 27983.15416412617$
$Q_c = 106193.3719051892$
$Q_i = 37995.36151490715$
$a = (4.8529725210824275e+123-3.561160165023038e-$
$\phi_0 = 1.1222751066020116$
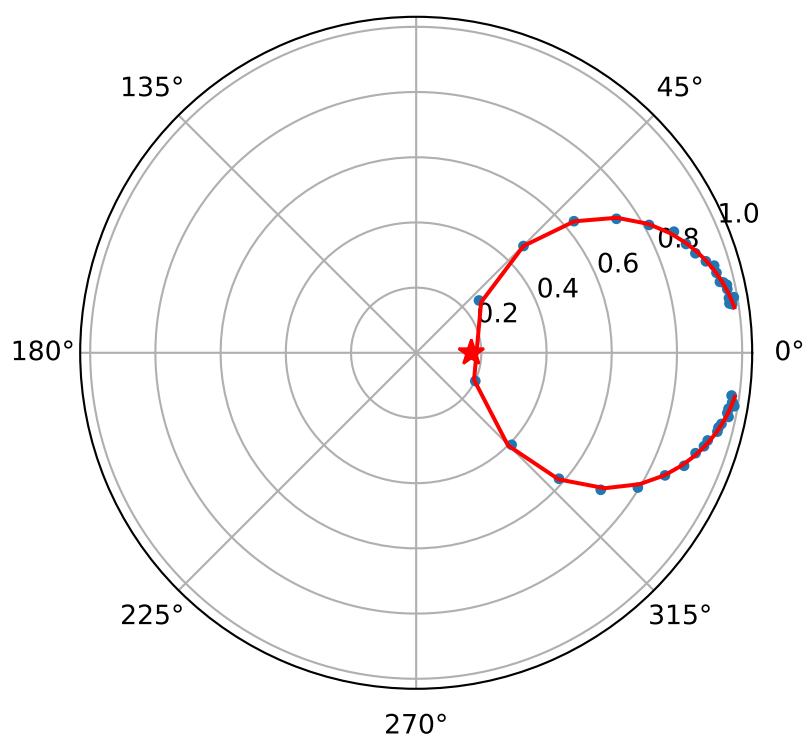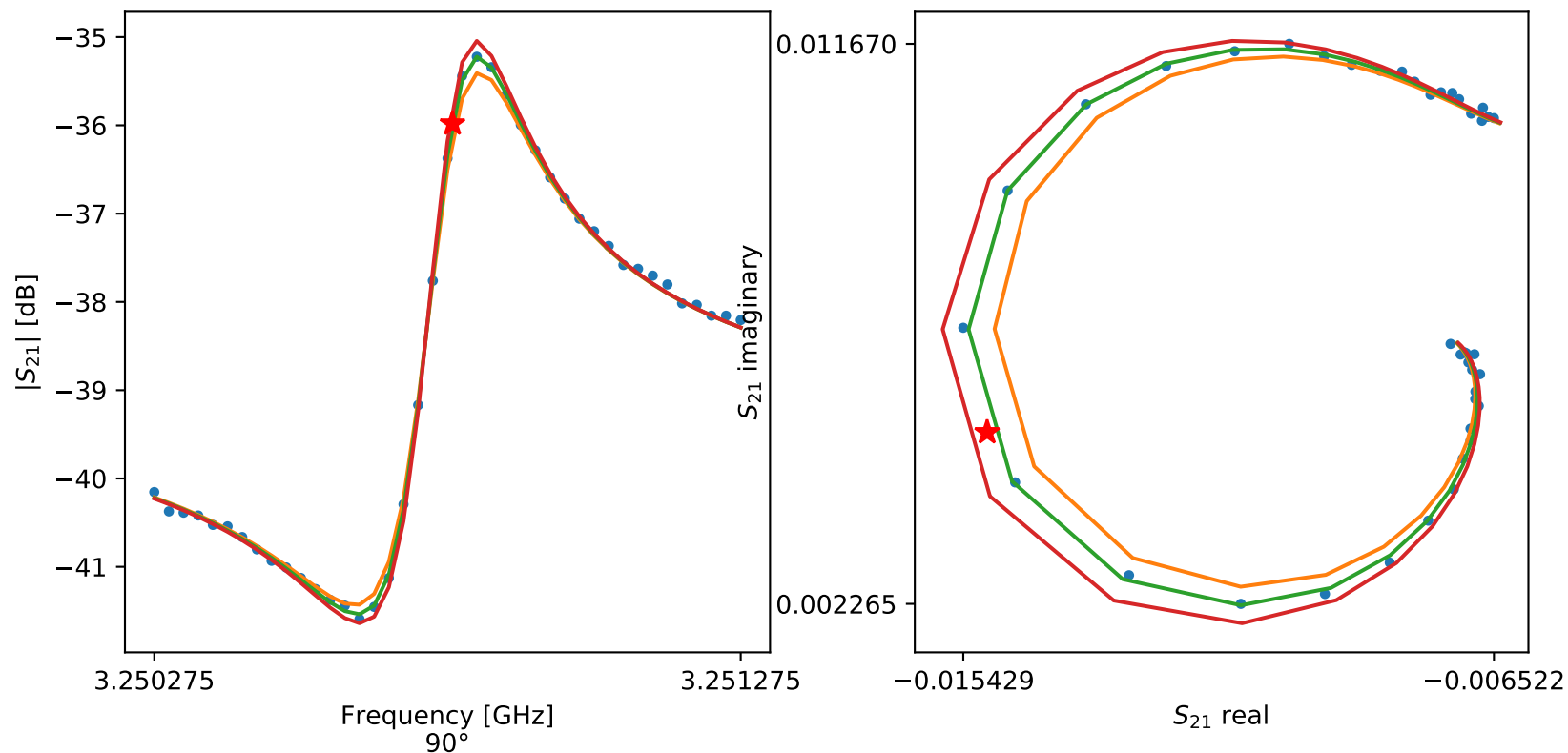$\tau = (34.934754754629225-14.198275529221423j)$

resonance 24 at 3.2466 GHz
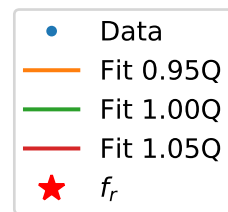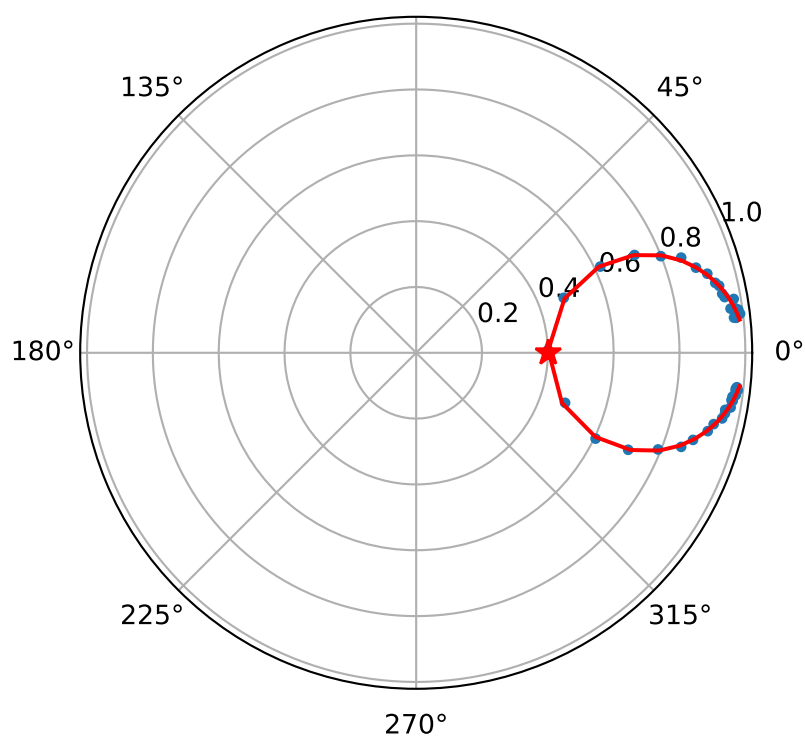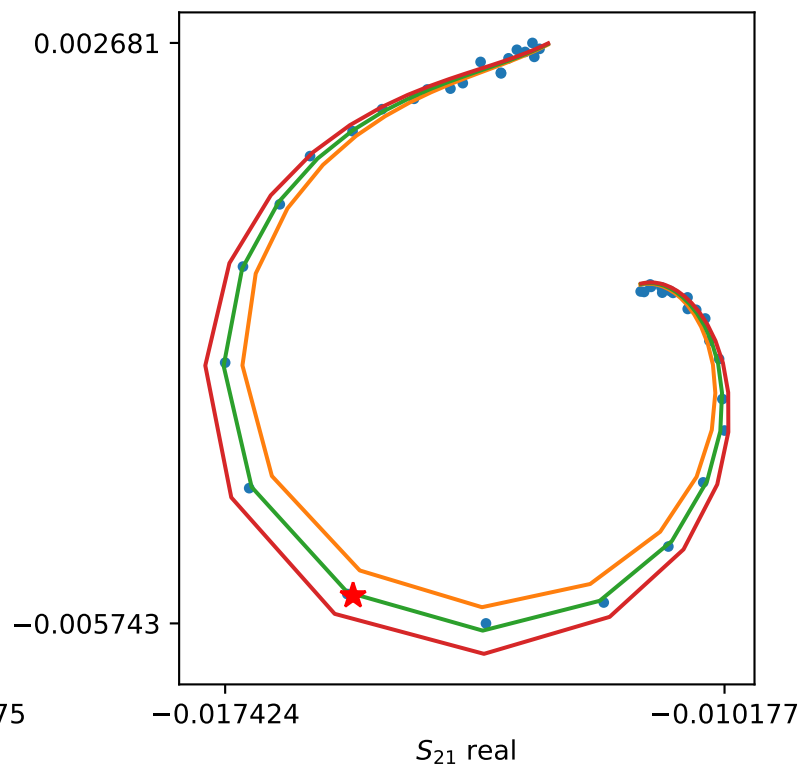
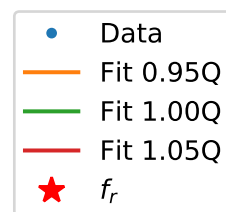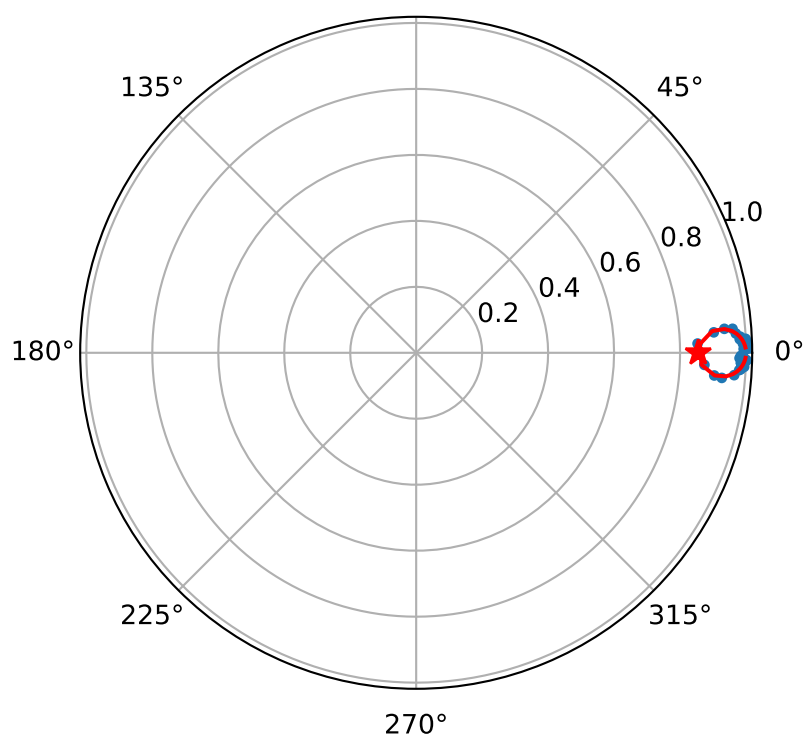$$S_{21}(f) = ae^{-2\pi jf\tau}\left[1 - \frac{Q_r/Q_c e^{j\phi_0}}{1 + 2jQ_r(\frac{f-f_r}{f_r})}\right]$$

f_r = 3.2466738395549175
Q_r = 18647.406430724208
Q_c = 31140.95213365902
Q_i = 46479.83886108956
a = (6.802450651106538e+71-1.0378208697344457e+7
ϕ_0 = -1.9802180486024143
τ = (30.91046266245522-8.35377796583879j)

resonance 25 at 3.2507 GHz

$$S_{21}(f) = ae^{-2\pi jf\tau}\left[1 - \frac{Q_r/Q_c e^{j\phi_0}}{1 + 2jQ_r(\frac{f - f_r}{f_r})}\right]$$
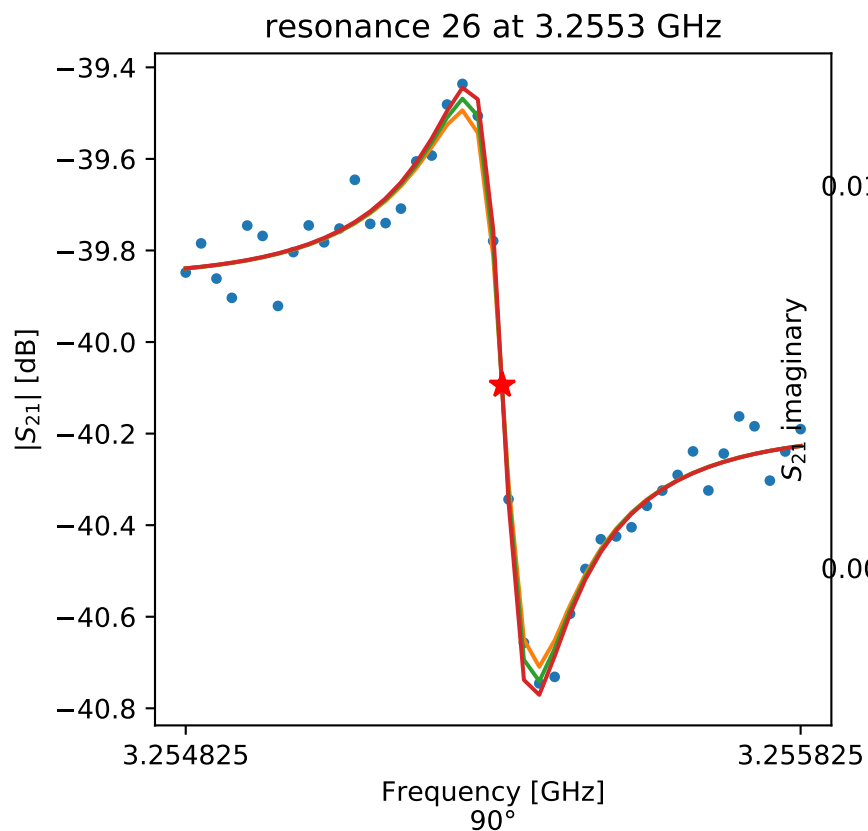
f_r = 3.2507835647832892
Q_r = 19156.94038071775
Q_c = 23057.29631310441
Q_i = 113247.93389827896
a = (-1.3932842844680175e+54+2.78091935961002776...
ϕ_0 = -1.838873812180095
τ = (29.873915869018994-6.326049389537186j)

resonance 26 at 3.2553 GHz
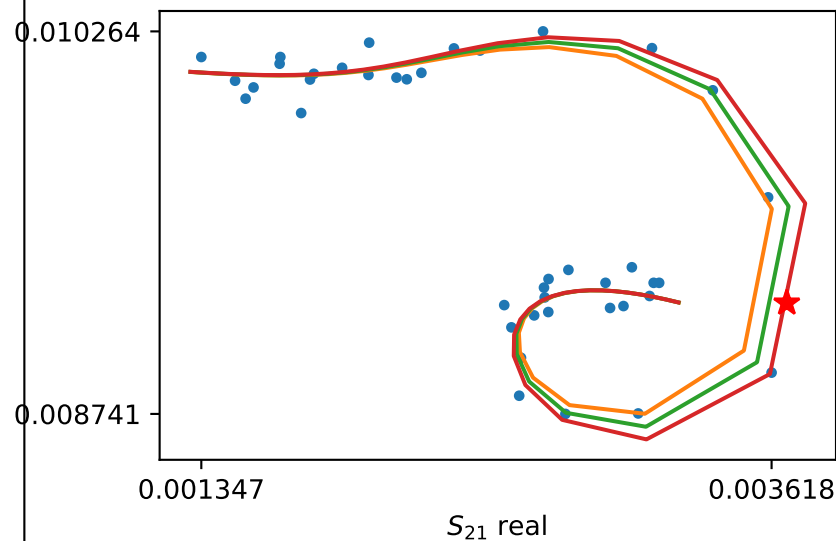
$$S_{21}(f) = ae^{-2\pi jf\tau}\left[1 - \frac{Q_r/Q_c e^{j\phi_0}}{1 + 2jQ_r(\frac{f-f_r}{f_r})}\right]$$

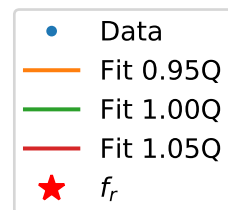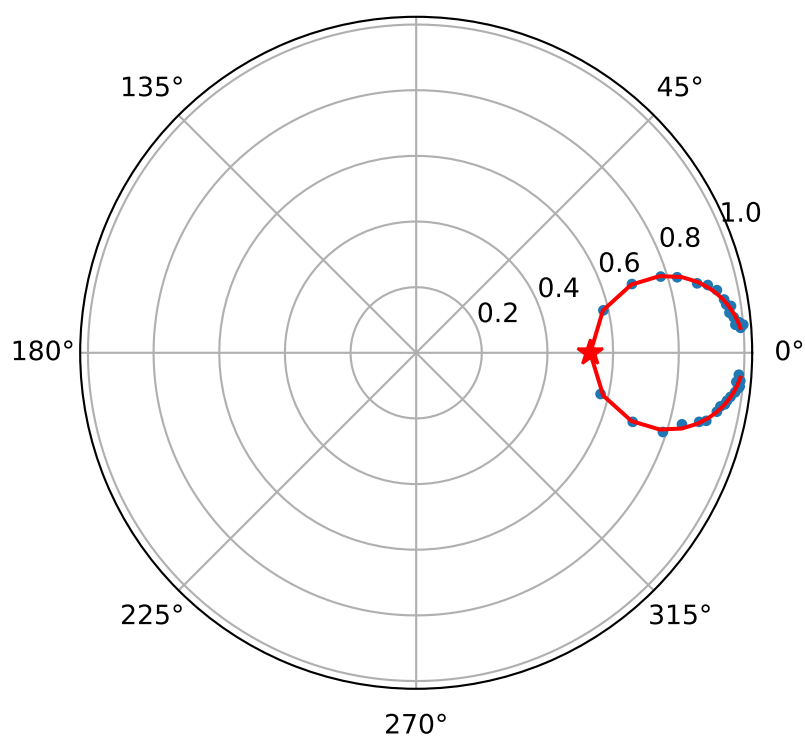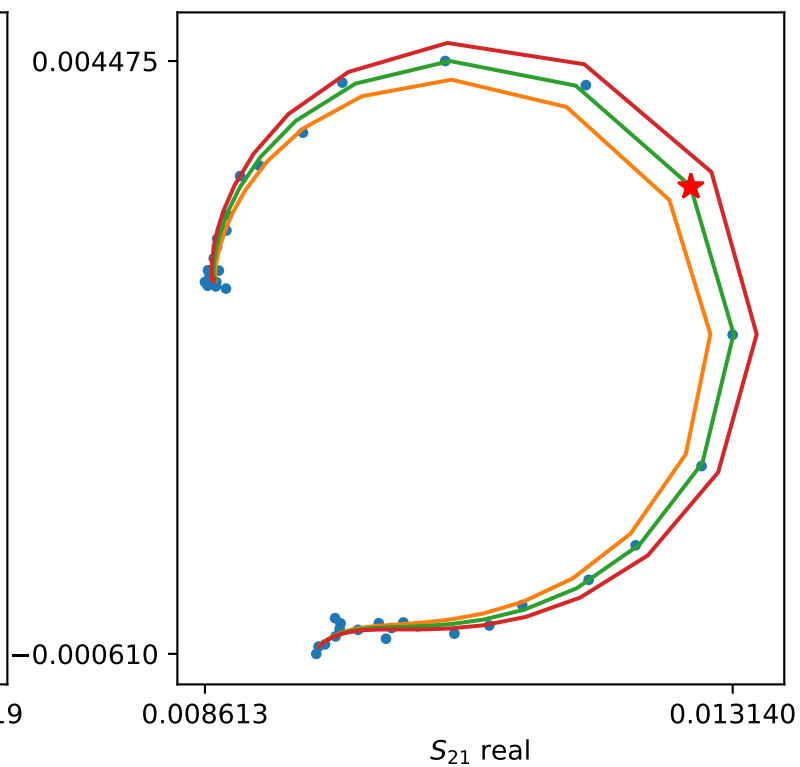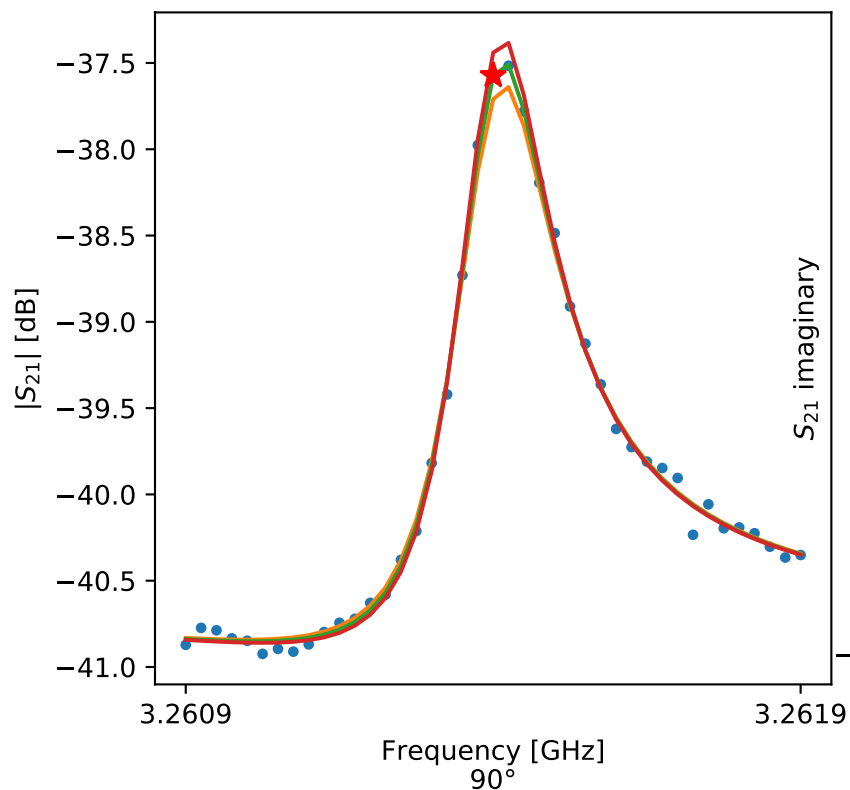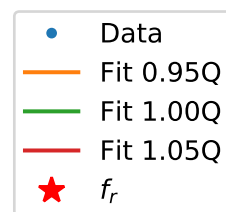$f_r = 3.2553397098453307$
$Q_r = 29589.702740981335$
$Q_c = 204215.72320771677$
$Q_i = 34603.56325248753$
$a = (-2.185158916775139e+16-6.374979742402921e+1$
$\phi_0 = 1.445949863863966$
$\tau = (34.24679215800021-2.1197753551559035j)$

resonance 27 at 3.2614 GHz

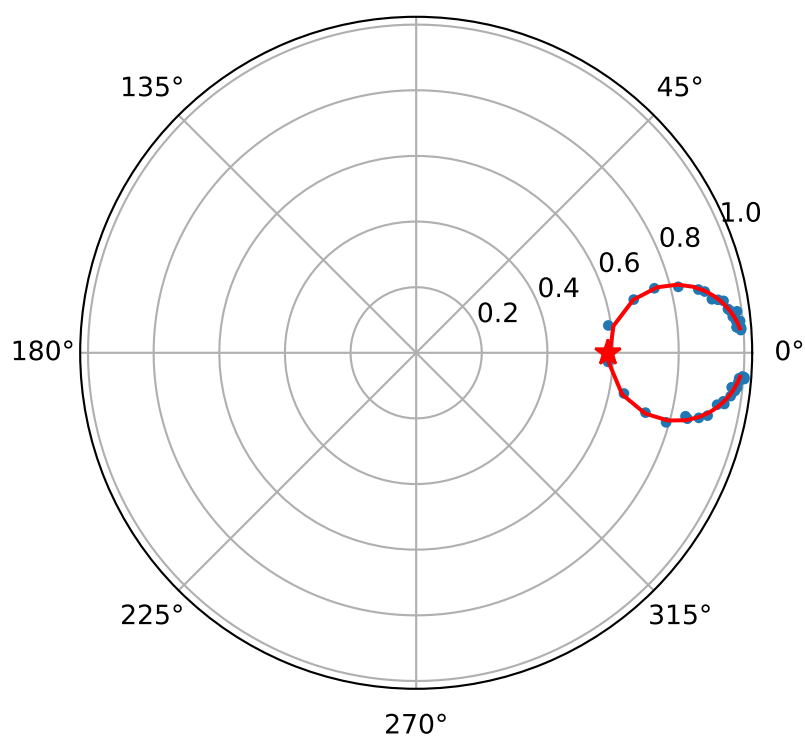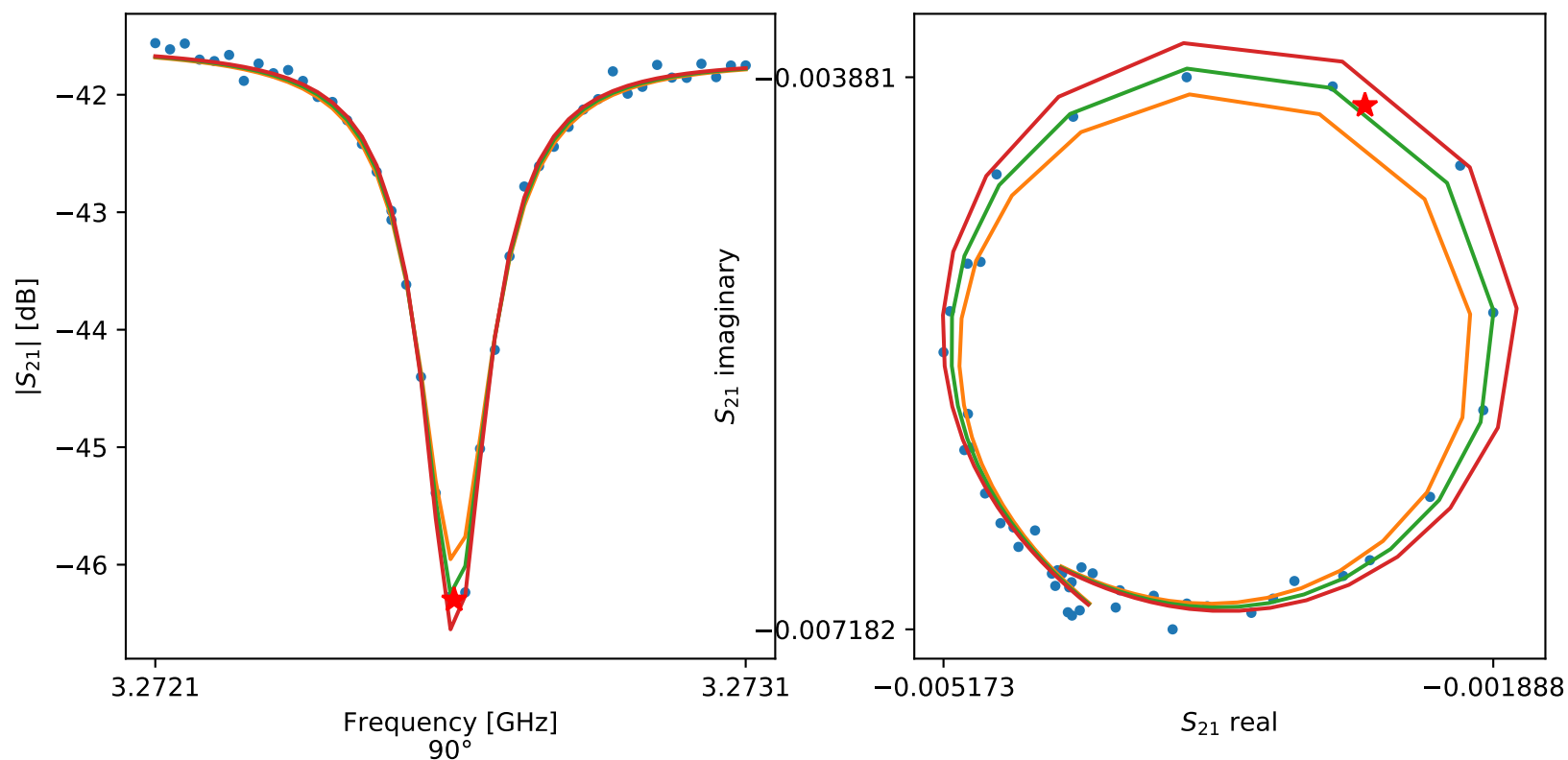$$S_{21}(f) = ae^{-2\pi jf\tau}\left[1 - \frac{Q_r/Q_c e^{j\phi_0}}{1 + 2jQ_r(\frac{f-f_r}{f_r})}\right]$$

f_r = 3.261400137560612
Q_r = 19675.200911597214
Q_c = 41888.037997037616
Q_i = 37102.66996576197
a = (5322484043712.011+26483771308573.566j)
ϕ_0 = -2.667232916636427
τ = (34.096092776980186-1.737923352495113j)

resonance 28 at 3.2682 GHz
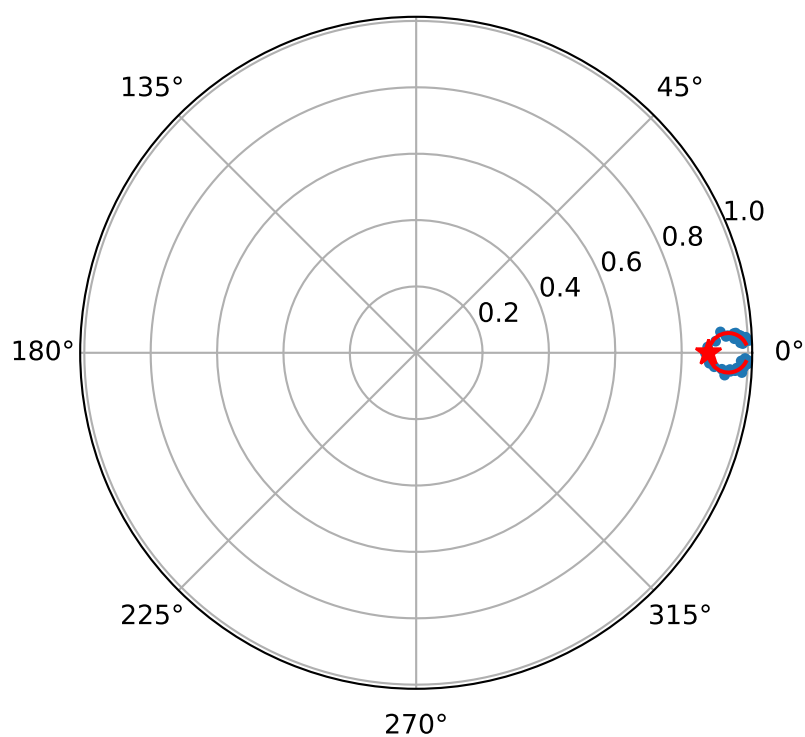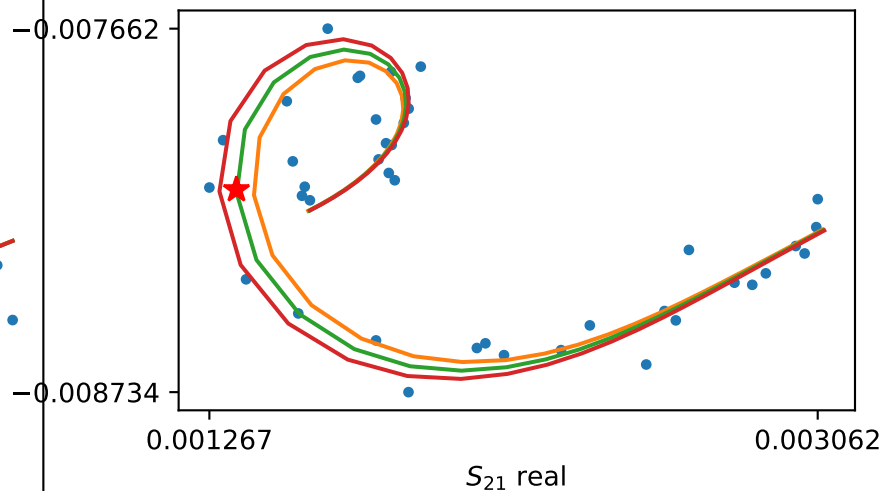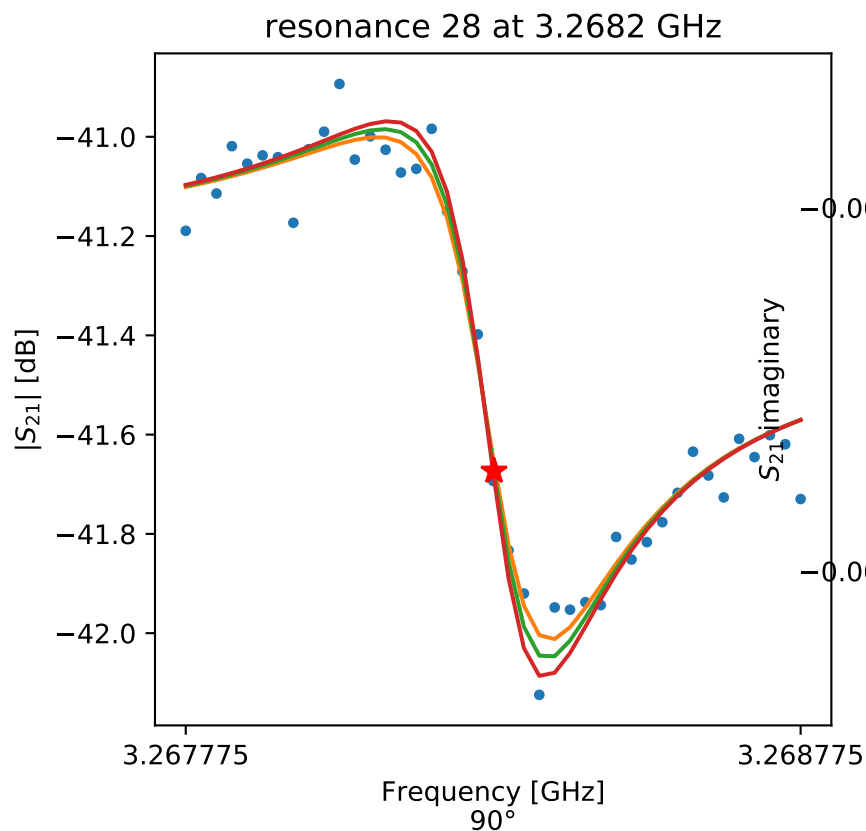
$$S_{21}(f) = ae^{-2\pi jf\tau}\left[1 - \frac{Q_r/Q_c e^{j\phi_0}}{1 + 2jQ_r(\frac{f-f_r}{f_r})}\right]$$

f_r = 3.268276348134199
Q_r = 13266.635034502653
Q_c = 111352.60230195841
Q_i = 15061.016127353332
a = (147.30600011606305-246.7498657989796j)
ϕ_0 = 1.161581979956588
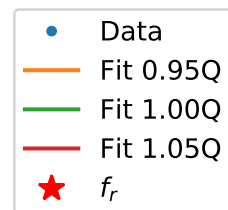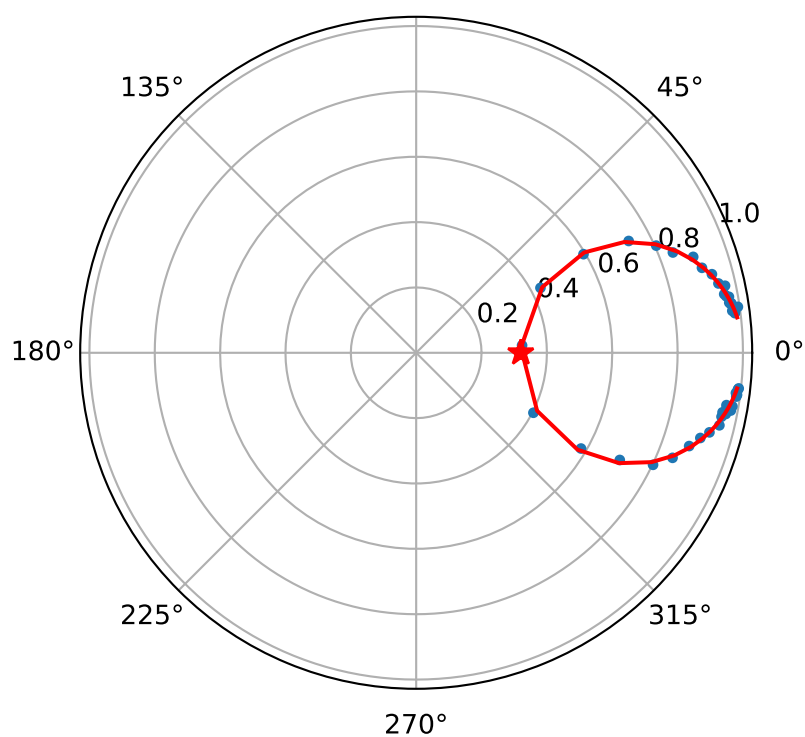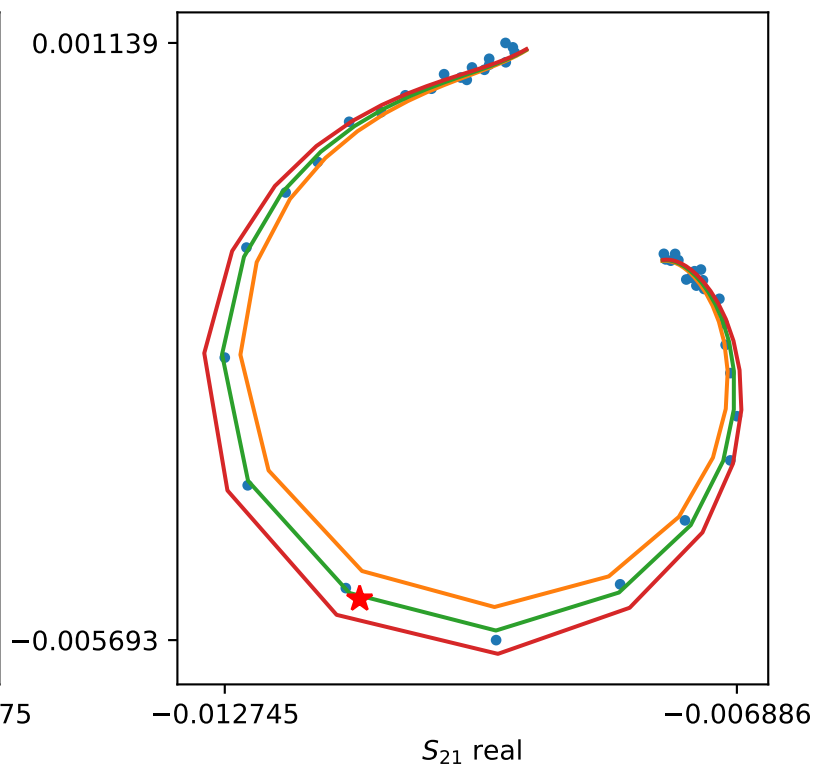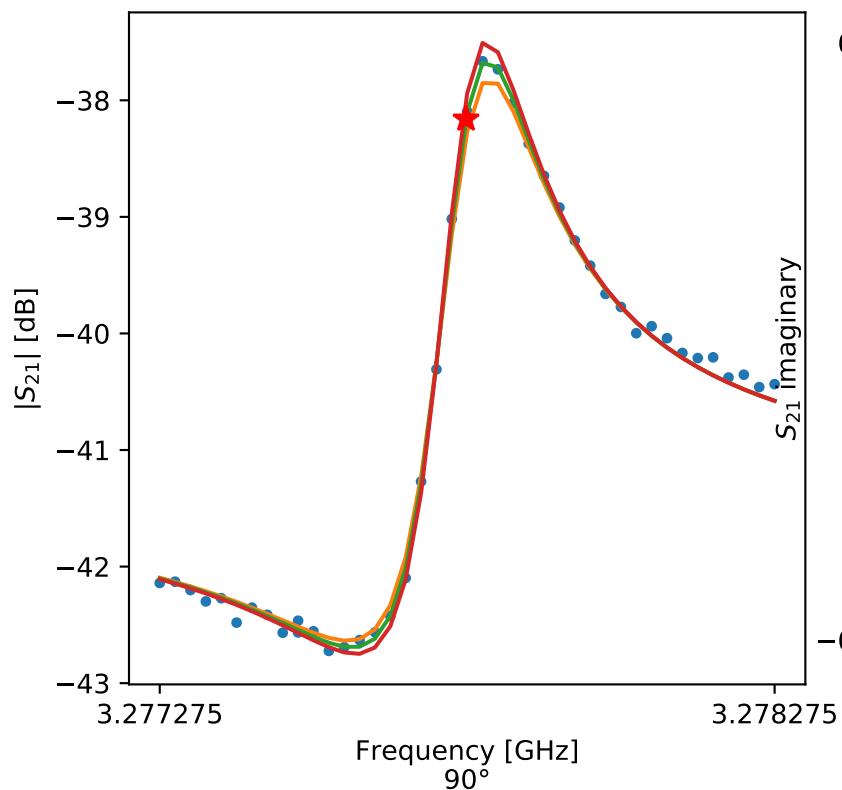τ = (30.303850694041387-0.5072557656598063j)

resonance 29 at 3.2726 GHz

$$S_{21}(f) = ae^{-2\pi jf\tau}\left[1 - \frac{Q_r/Q_c e^{j\phi_0}}{1 + 2jQ_r(\frac{f - f_r}{f_r})}\right]$$

f_r = 3.2726062260860234
Q_r = 17865.6622569532
Q_c = 42981.544753106224
Q_i = 30574.03067396626
a = (-2196039117.2567844-6405097542.084136j)
ϕ_0 = 0.018669029201487424
τ = (28.7347969204801-1.3339533745118237j)

resonance 30 at 3.2777 GHz

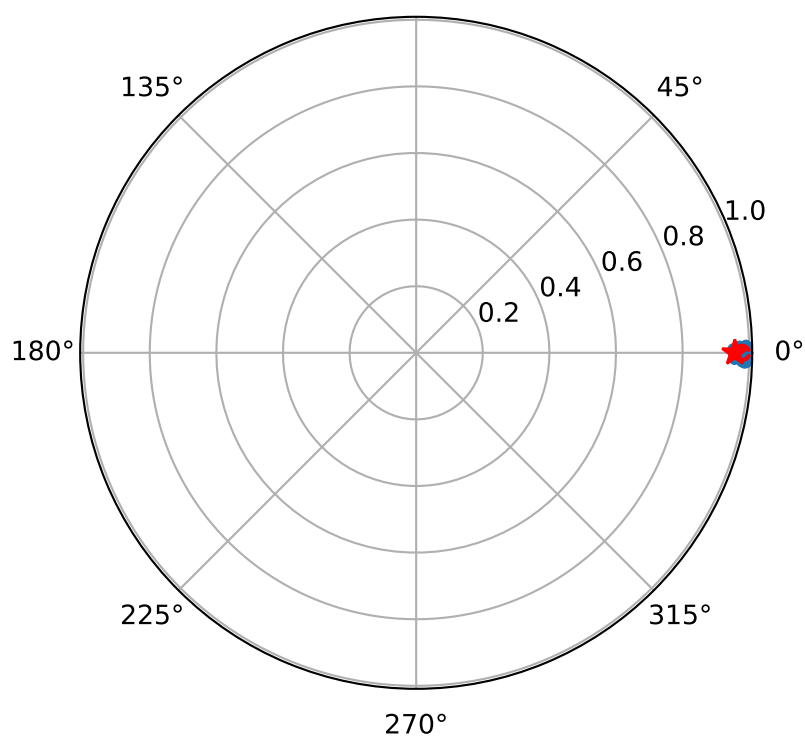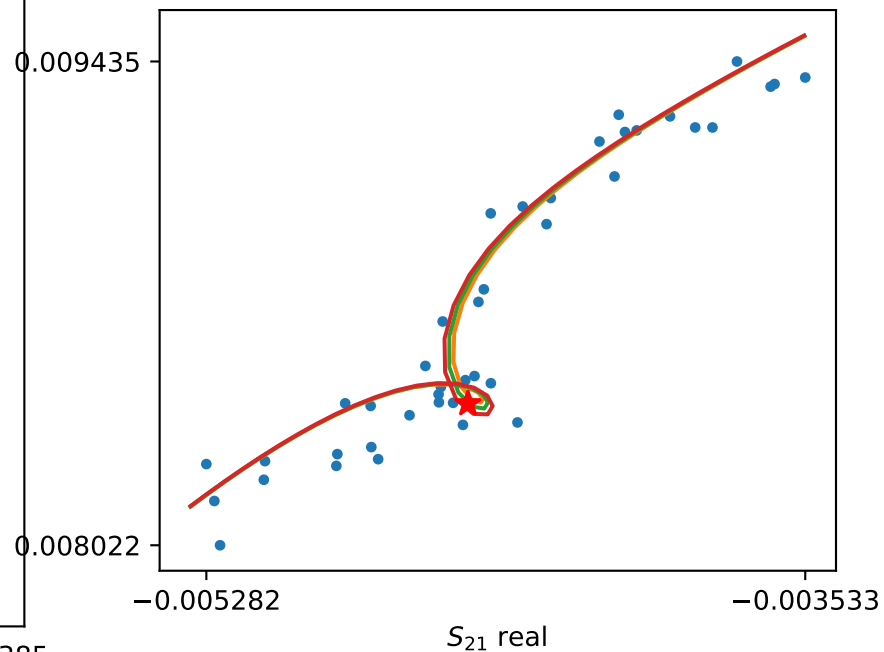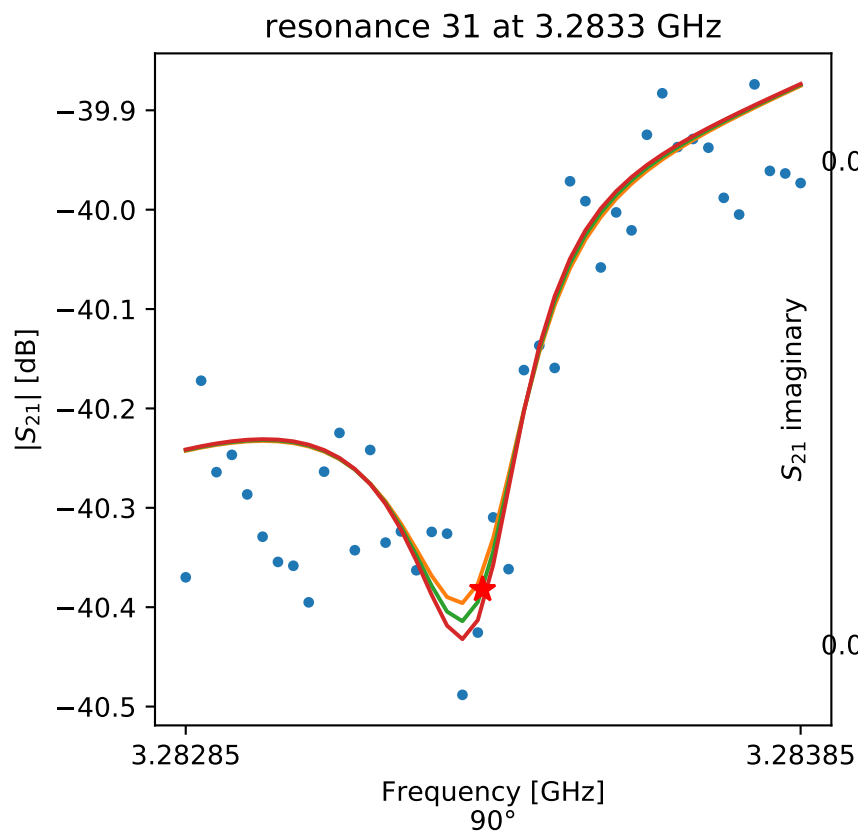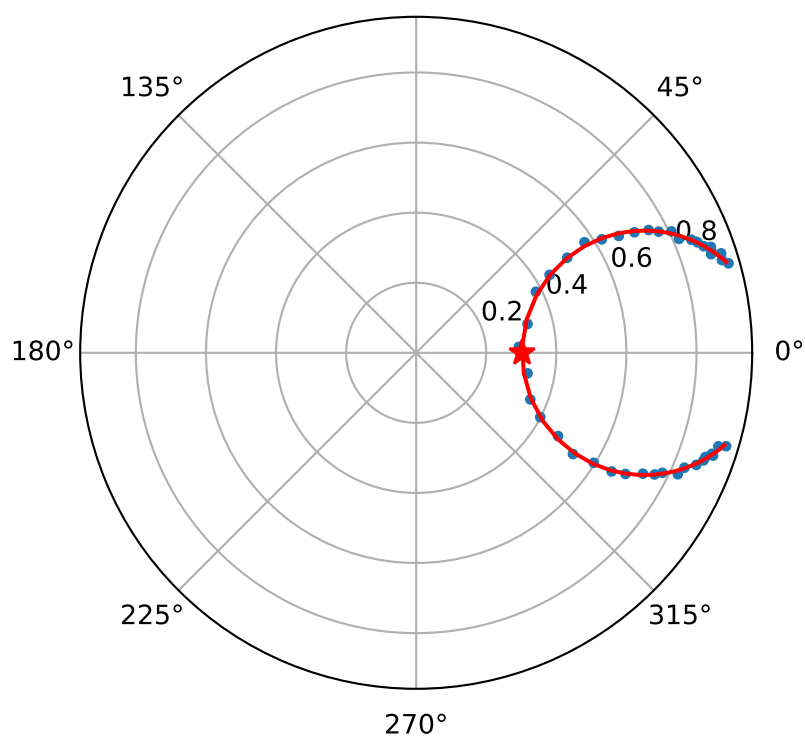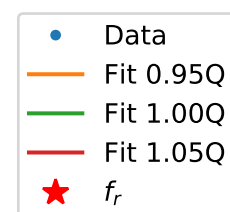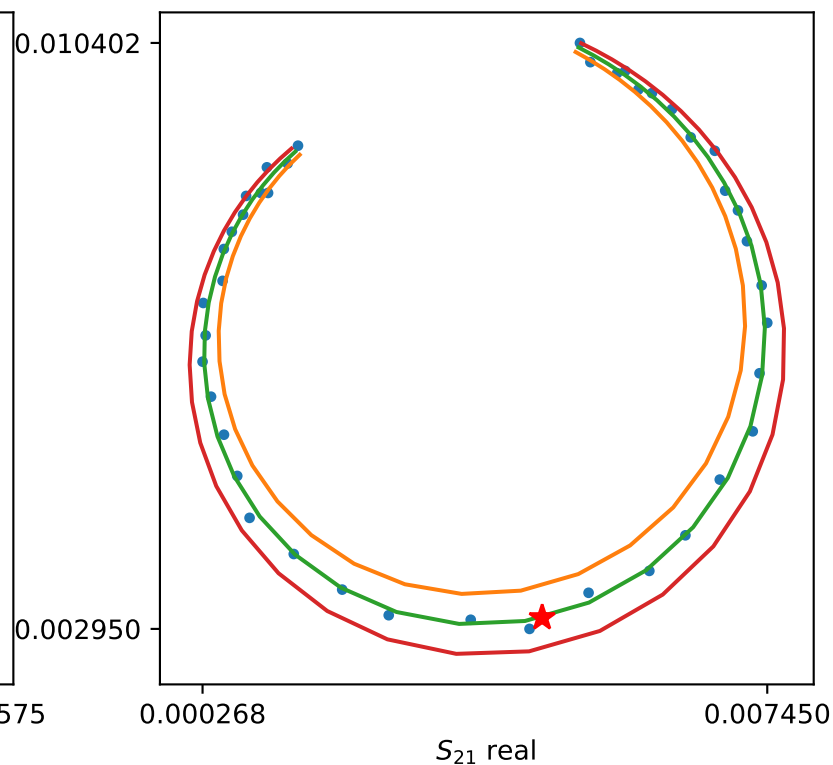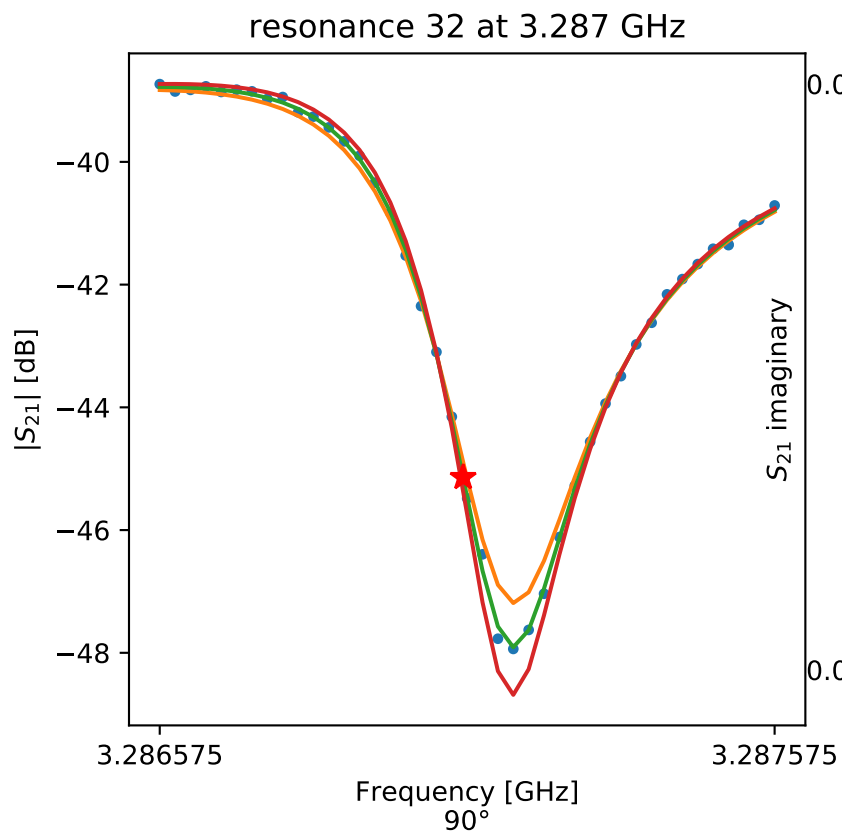$$S_{21}(f) = ae^{-2\pi jf\tau}\left[1 - \frac{Q_r/Q_c e^{j\phi_0}}{1 + 2jQ_r(\frac{f-f_r}{f_r})}\right]$$

f_r = 3.2777731176643212
Q_r = 19962.273741882487
Q_c = 29359.95480133648
Q_i = 62365.5400822496
a = (5.0528387482522904e+16-1.8563329681690164e-
ϕ_0 = -2.0594684440758804
τ = (28.81301041674725-2.1019372481398912j)

resonance 31 at 3.2833 GHz

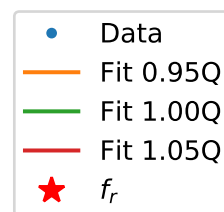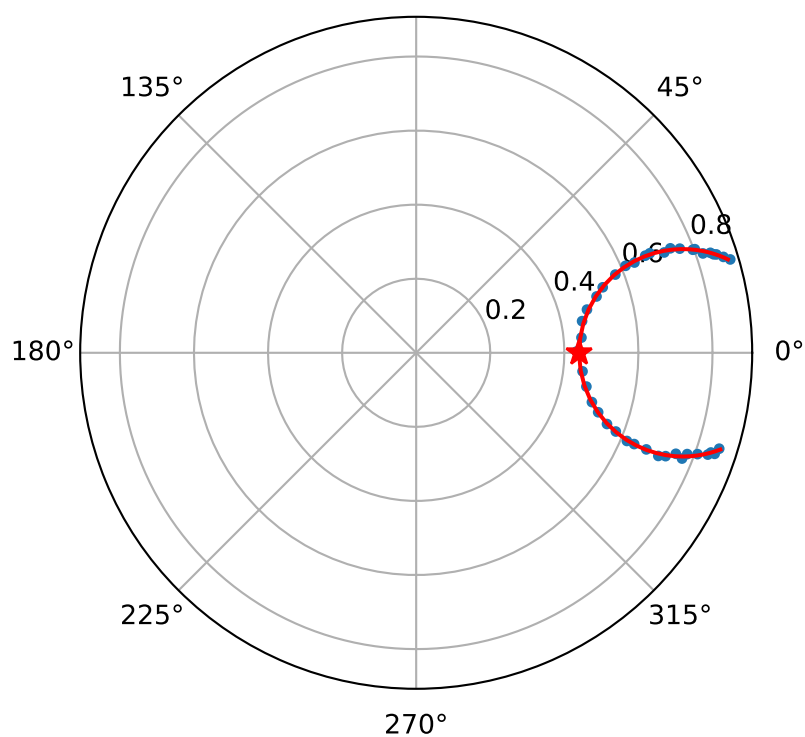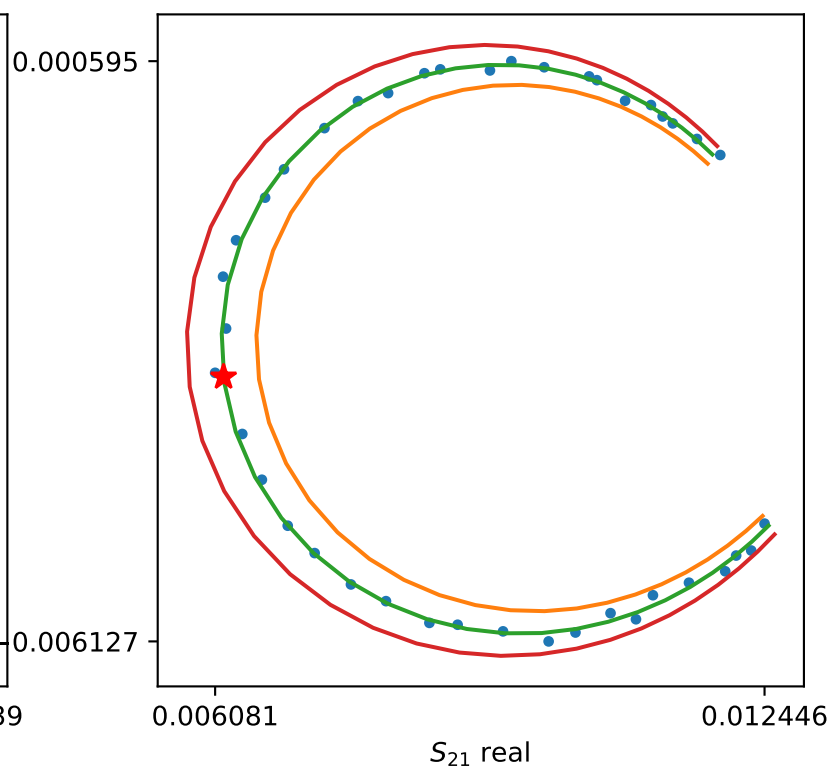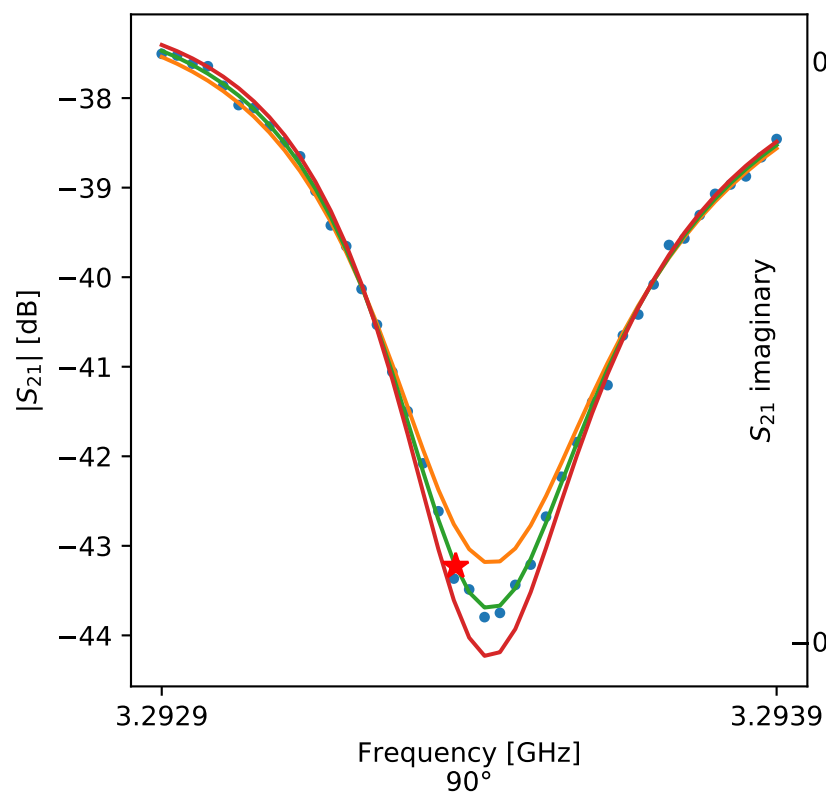$$S_{21}(f) = ae^{-2\pi j f\tau}\left[1 - \frac{Q_r/Q_c e^{j\phi_0}}{1 + 2jQ_r(\frac{f-f_r}{f_r})}\right]$$

f_r = 3.2833327309589944
Q_r = 13729.187208955445
Q_c = 318526.1117498647
Q_i = 14347.600868156416
a = (-1.321069040881734e-50+5.50779885165839e-50j
ϕ_0 = -0.4725689692058834
τ = (38.364206153830374+5.273194114697153j)

resonance 32 at 3.287 GHz

$$S_{21}(f) = ae^{-2\pi jf\tau}\left[1 - \frac{Q_r/Q_c e^{j\phi_0}}{1 + 2jQ_r(\frac{f-f_r}{f_r})}\right]$$

f_r = 3.2870684480306913
Q_r = 7302.355245870658
Q_c = 10464.075132207783
Q_i = 24167.983465286205
a = (-1.0166400453903904e-67-2.7270719843400117e-
ϕ_0 = 0.47434297721119073
τ = (33.004340917245145+7.200328854703765j)

resonance 33 at 3.2933 GHz

$$S_{21}(f) = ae^{-2\pi jf\tau}\left[1 - \frac{Q_r/Q_c e^{j\phi_0}}{1 + 2jQ_r(\frac{f - f_r}{f_r})}\right]$$

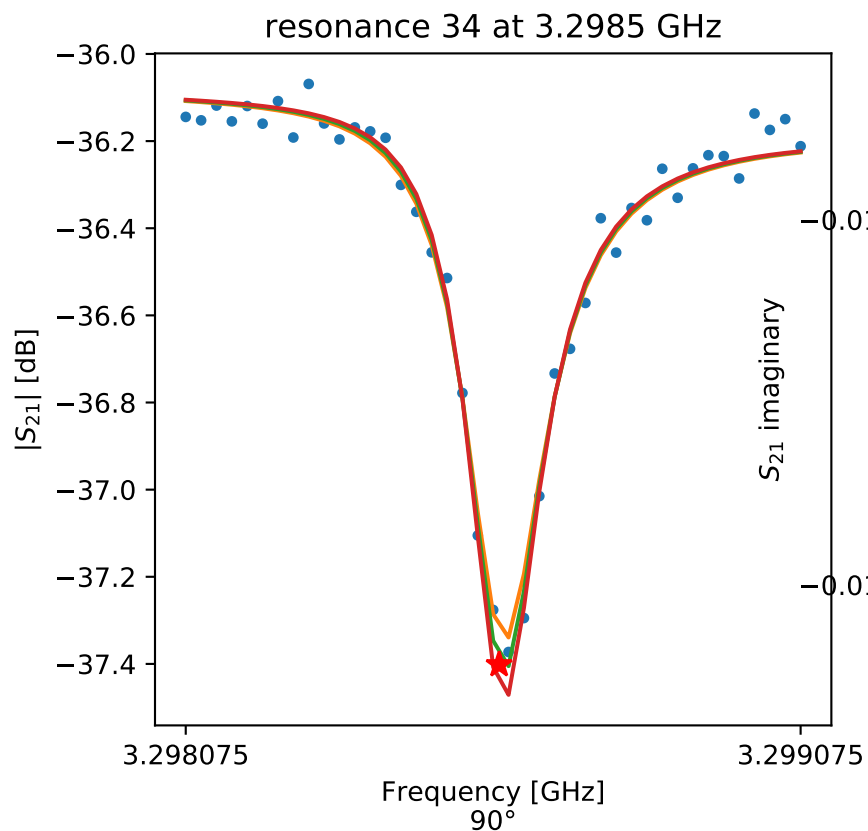f_r = 3.2933780989946673
Q_r = 5026.177639677897
Q_c = 8973.897209593173
Q_i = 11425.431998603965
a = (-1.0793662403081819e-41+9.51945612013579e-43
ϕ_0 = 0.2514336809243906
τ = (40.23595495487497+4.353502874544269j)

resonance 34 at 3.2985 GHz
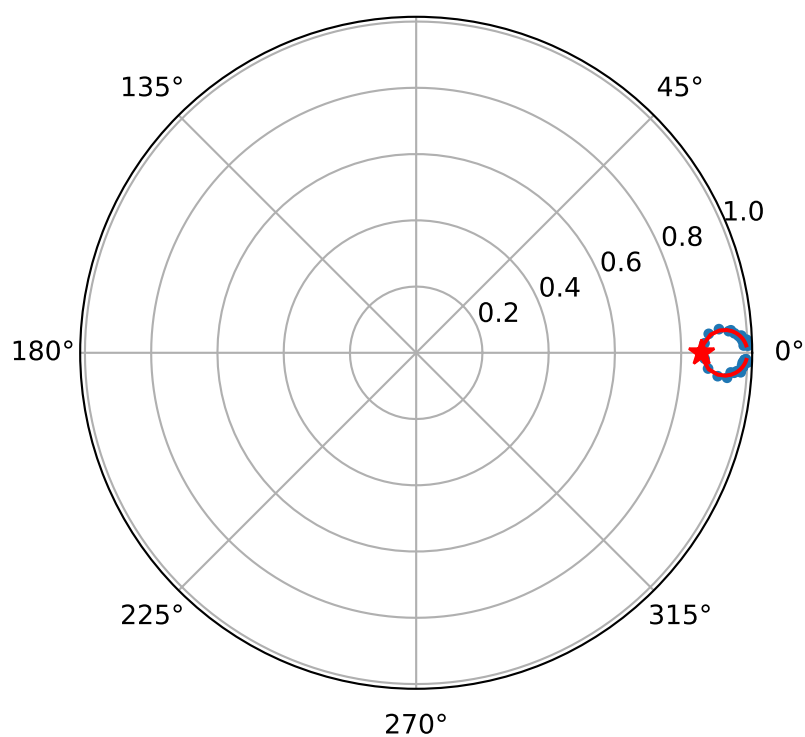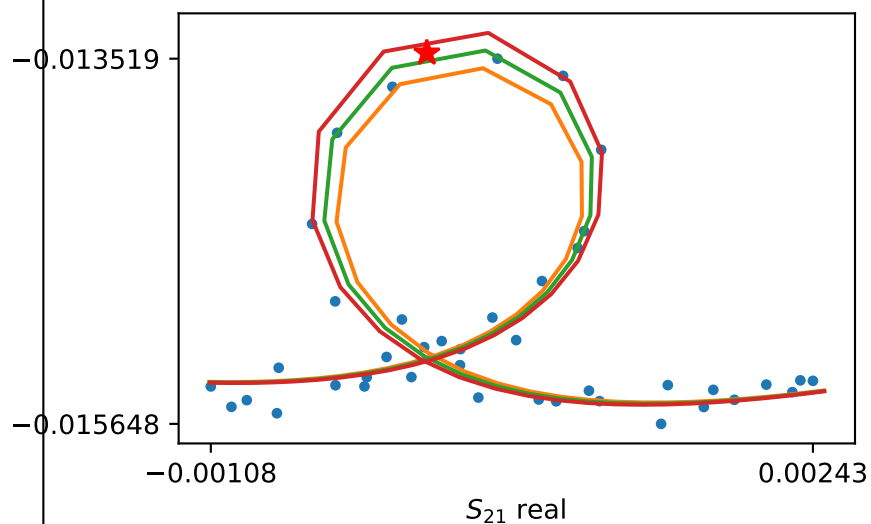
$$S_{21}(f) = ae^{-2\pi jf\tau}\left[1 - \frac{Q_r/Q_c e^{j\phi_0}}{1 + 2jQ_r(\frac{f-f_r}{f_r})}\right]$$

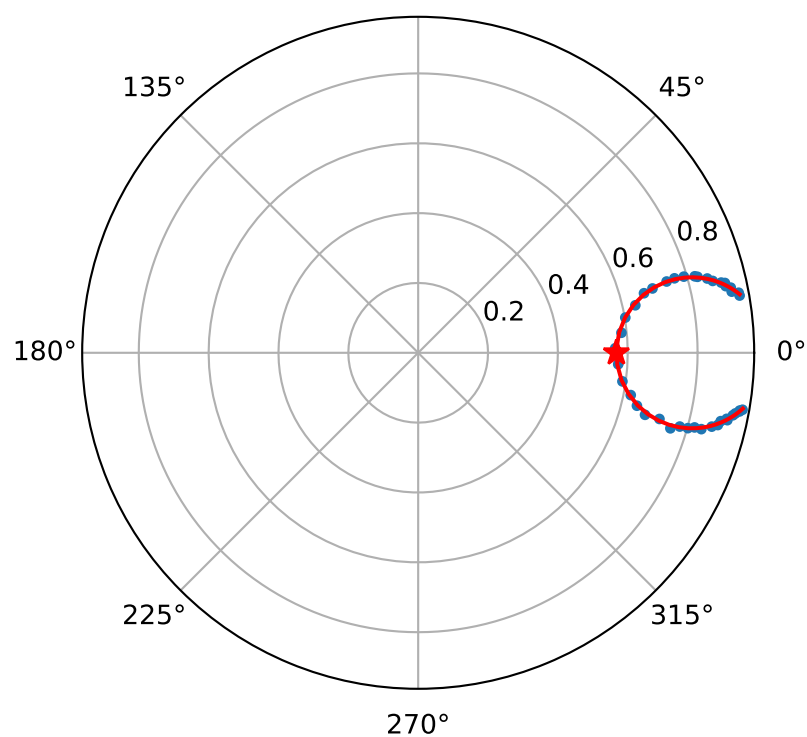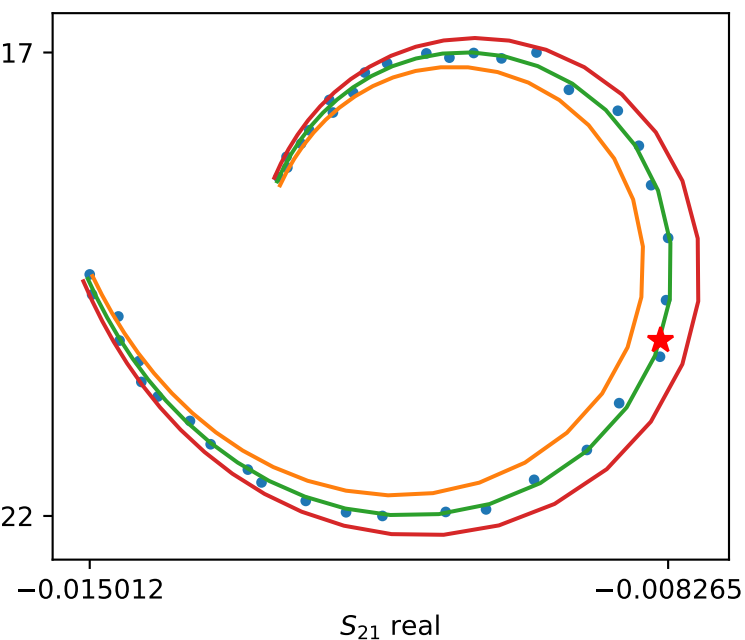f_r = 3.298584687581525
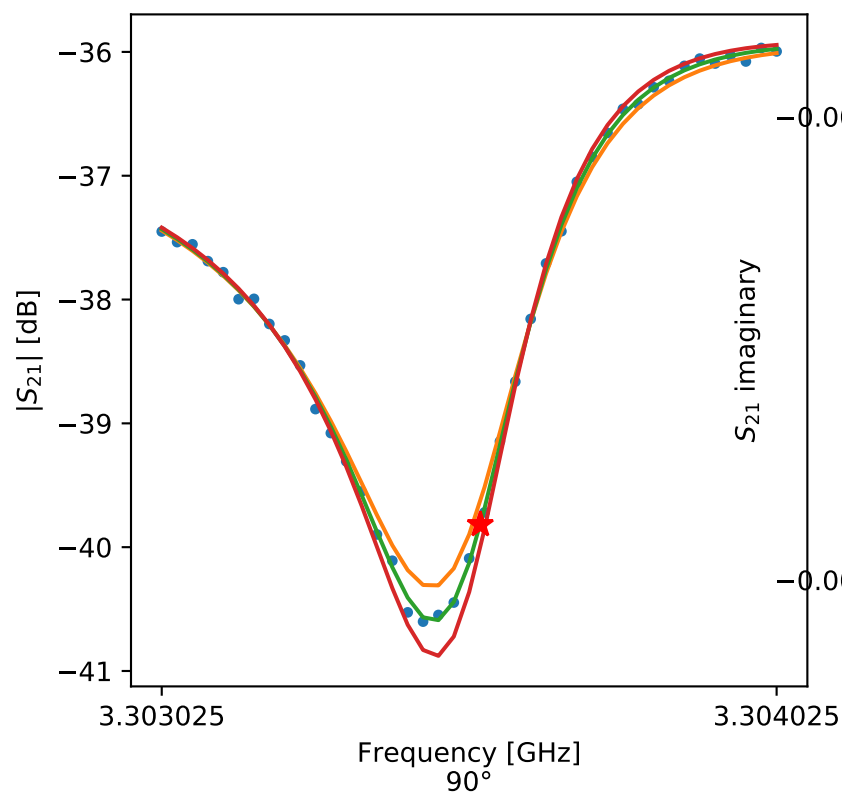Q_r = 20255.53860517128
Q_c = 146602.63525361416
Q_i = 23502.837950143137
a = (-701003.4502688192+153242.0167939717j)
ϕ_0 = 0.1826361399772698
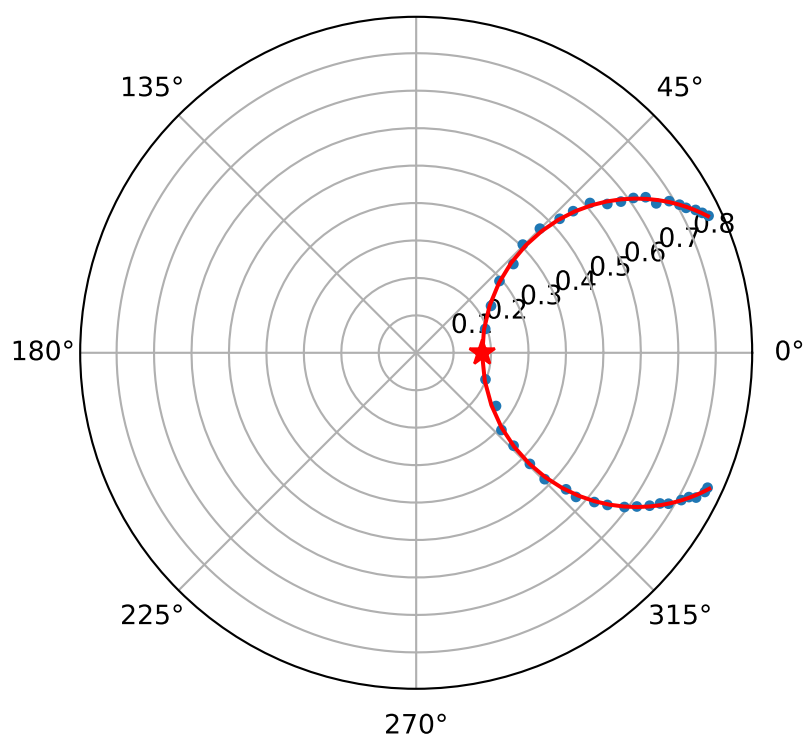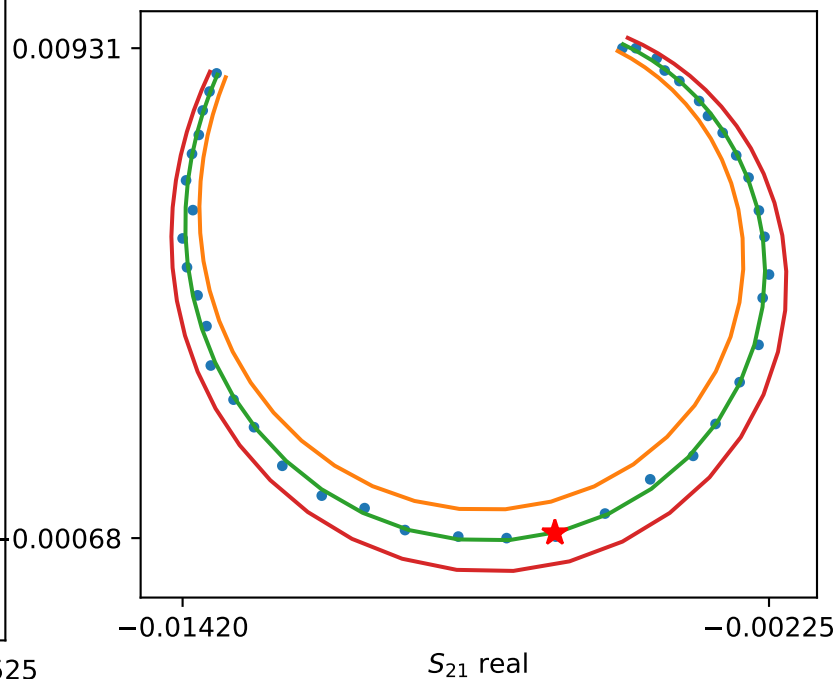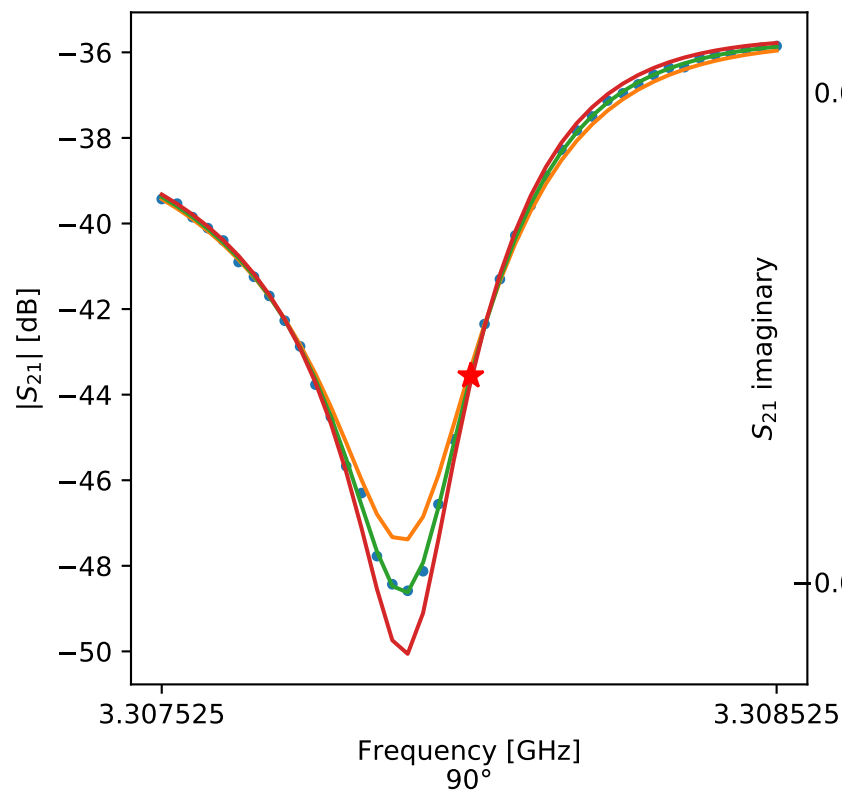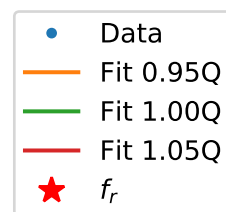τ = (43.5668718219415-0.85131434991395j)

resonance 35 at 3.3035 GHz
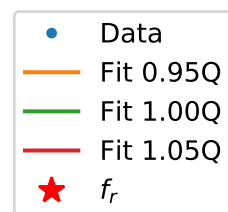
$$S_{21}(f) = ae^{-2\pi jf\tau}\left[1 - \frac{Q_r/Q_c e^{j\phi_0}}{1 + 2jQ_r(\frac{f - f_r}{f_r})}\right]$$

f_r = 3.3035430939552066
Q_r = 7222.531455949386
Q_c = 16698.081446811728
Q_i = 12727.748639382871
a = (-83898962.72800948-20106607.275567558j)
ϕ_0 = -0.5186665844615531
τ = (43.58730803909932-1.081182004299006j)

resonance 36 at 3.308 GHz

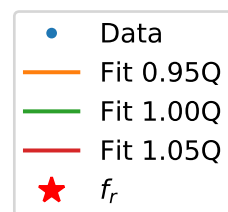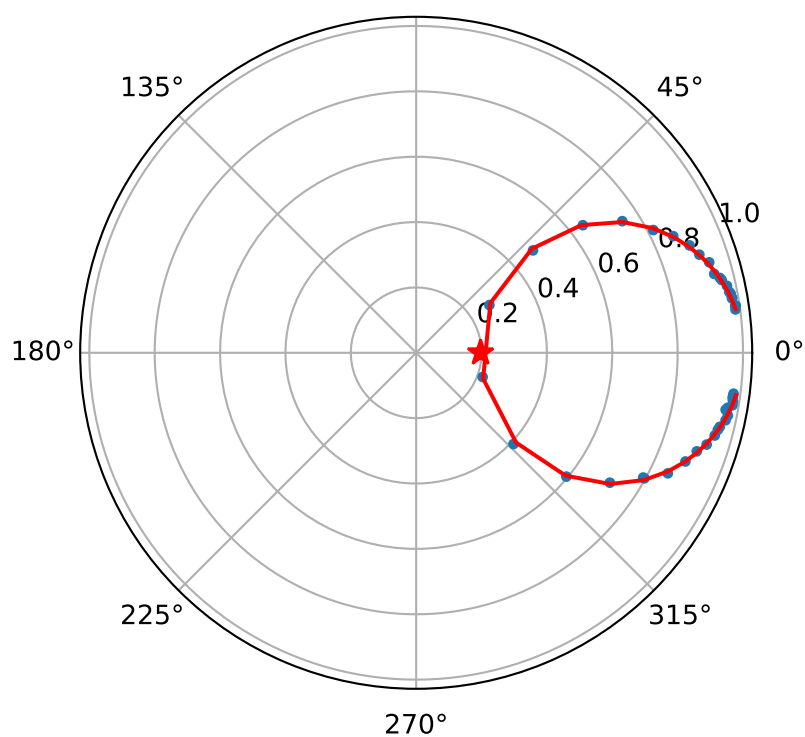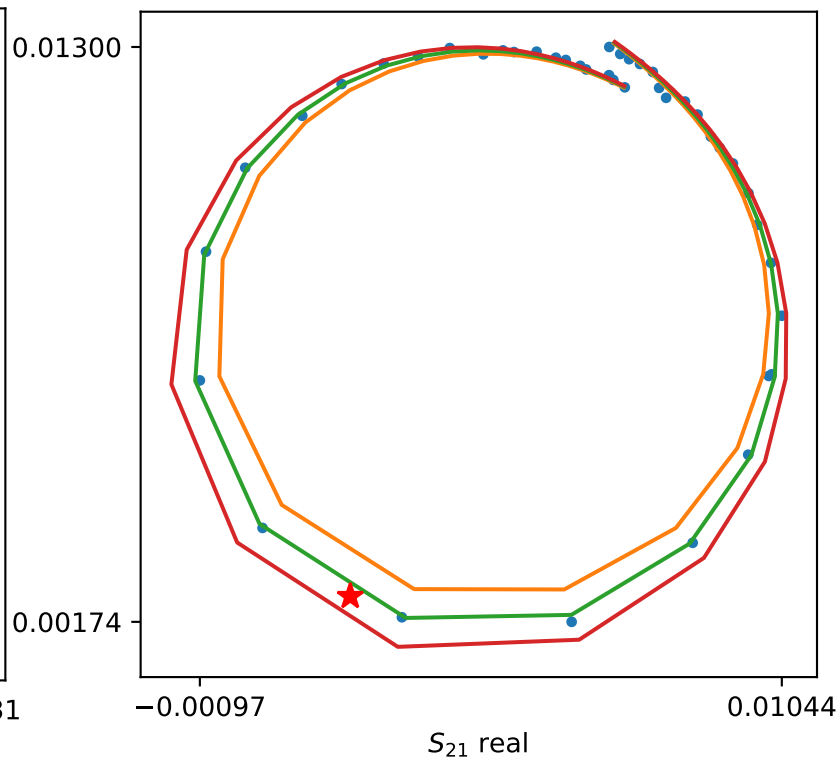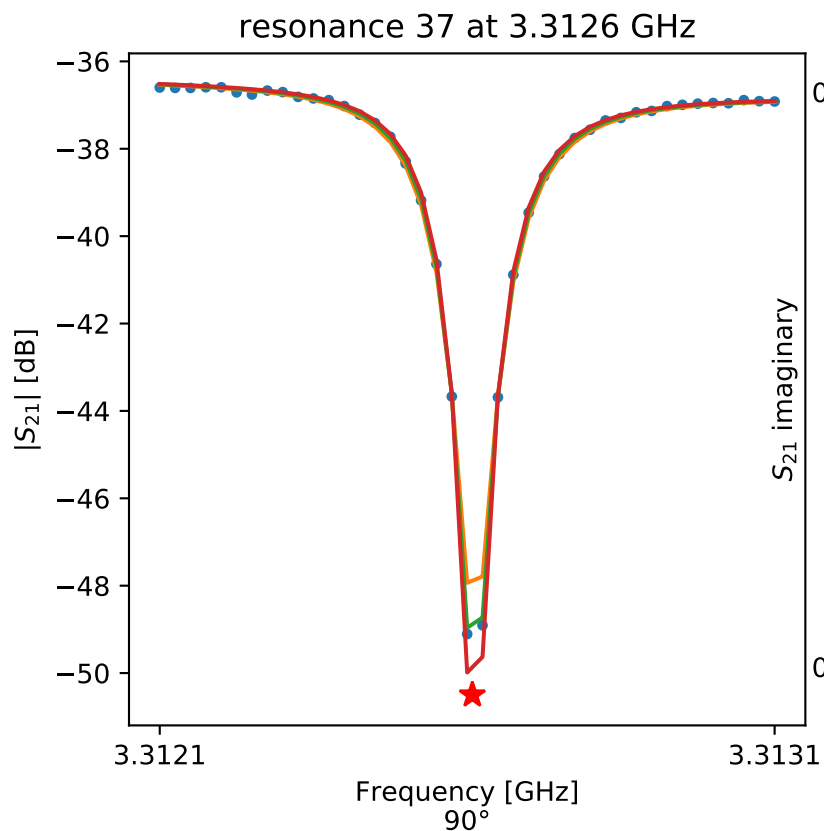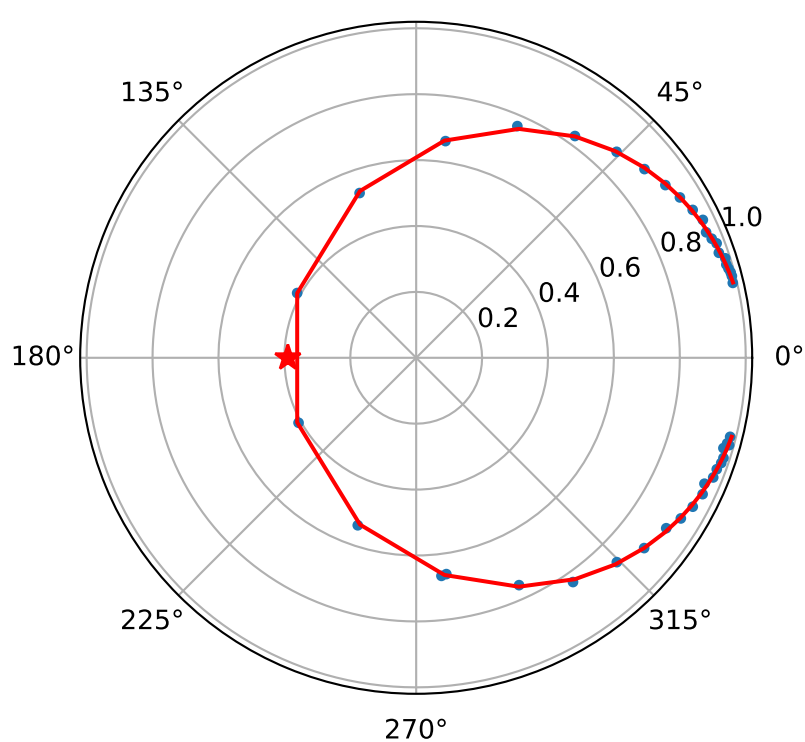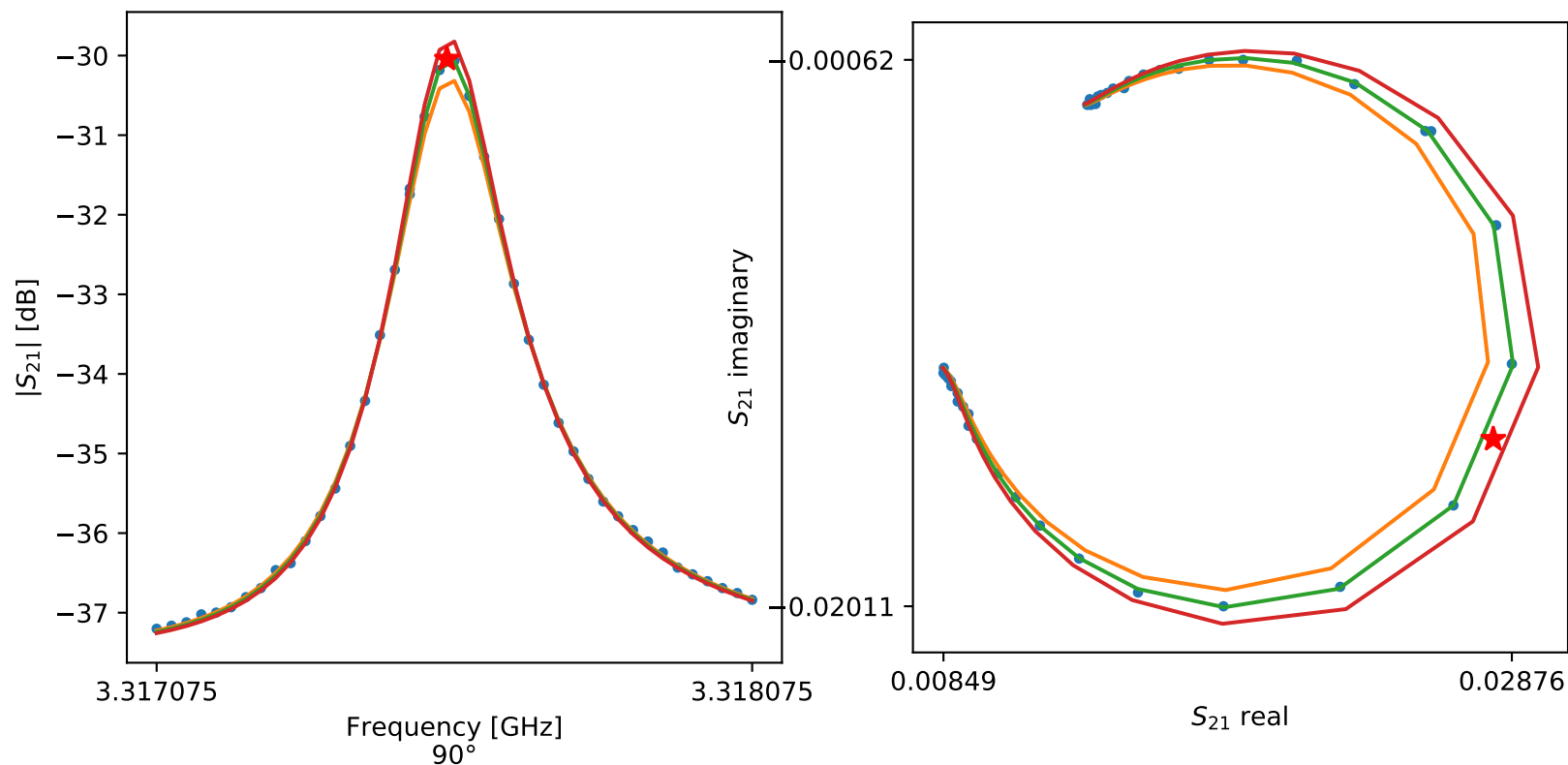$$S_{21}(f) = ae^{-2\pi jf\tau}\left[1 - \frac{Q_r/Q_c e^{j\phi_0}}{1 + 2jQ_r(\frac{f-f_r}{f_r})}\right]$$

f_r = 3.30802767711551516
Q_r = 5493.120629058093
Q_c = 6668.9815068857015
Q_i = 31154.637917676835
a = (-2347632.1297699814+10209501.246181551j)
ϕ_0 = -0.43419738772572386
τ = (45.01834871438703-0.9782580701167781j)

resonance 37 at 3.3126 GHz

$$S_{21}(f) = ae^{-2\pi jf\tau}\left[1 - \frac{Q_r/Q_c e^{j\phi_0}}{1 + 2jQ_r(\frac{f - f_r}{f_r})}\right]$$

f_r = 3.3126084017315893
Q_r = 19622.158386117135
Q_c = 24435.78133970594
Q_i = 99609.54074700768
a = (8.53820521384706e+41-1.587656682265226e+42j)
ϕ_0 = 0.04975130650444902
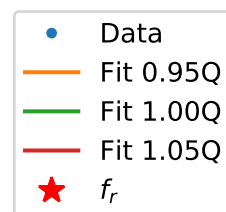τ = (49.10394209959699-4.877168514218633j)

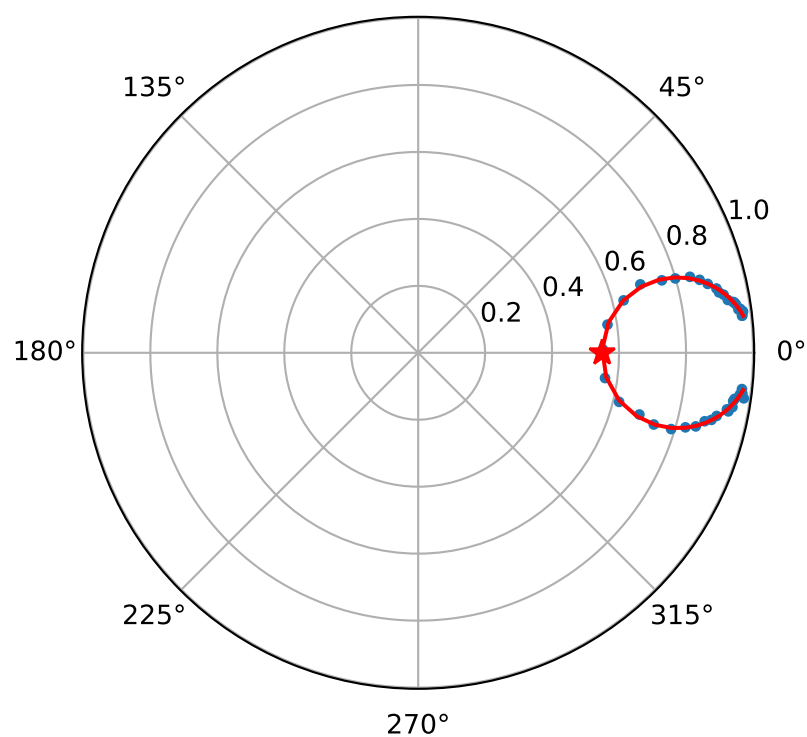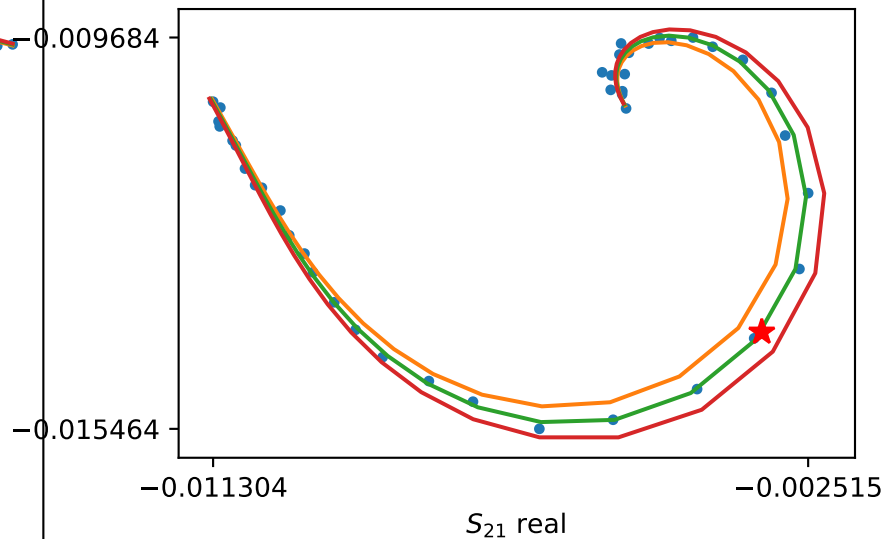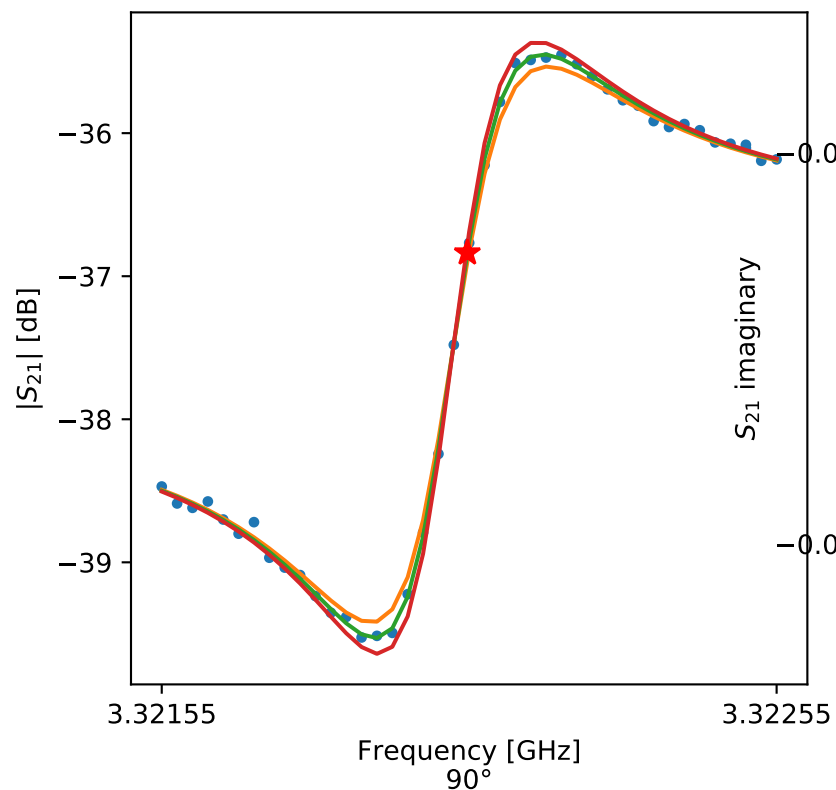# resonance 38 at 3.3175 GHz

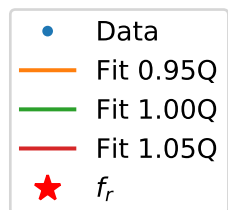$$S_{21}(f) = ae^{-2\pi jf\tau}\left[1 - \frac{Q_r/Q_c e^{j\phi_0}}{1 + 2jQ_r(\frac{f-f_r}{f_r})}\right]$$

f_r = 3.31756250399982
Q_r = 19126.216632935128
Q_c = 13766.534248115275
Q_i = -49126.365595826894
a = (3.985870837502302e+23-4.734901198746032e+2...
ϕ_0 = -2.9711909286156986
τ = (53.940629397569495-2.8356439298894727j)

resonance 39 at 3.322 GHz

$$S_{21}(f) = ae^{-2\pi jf\tau}\left[1 - \frac{Q_r/Q_c e^{j\phi_0}}{1 + 2jQ_r(\frac{f-f_r}{f_r})}\right]$$

f_r = 3.322047024933524
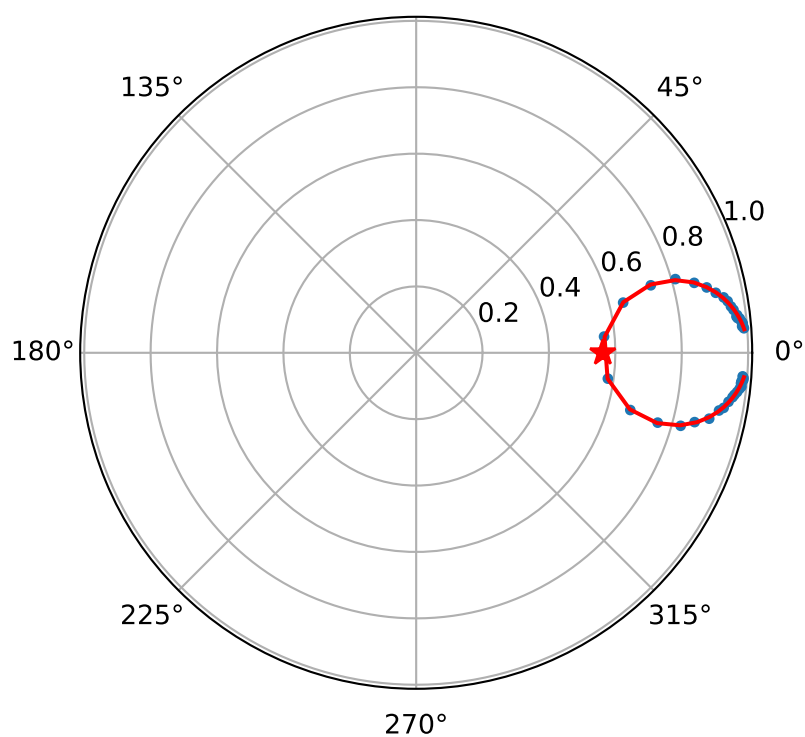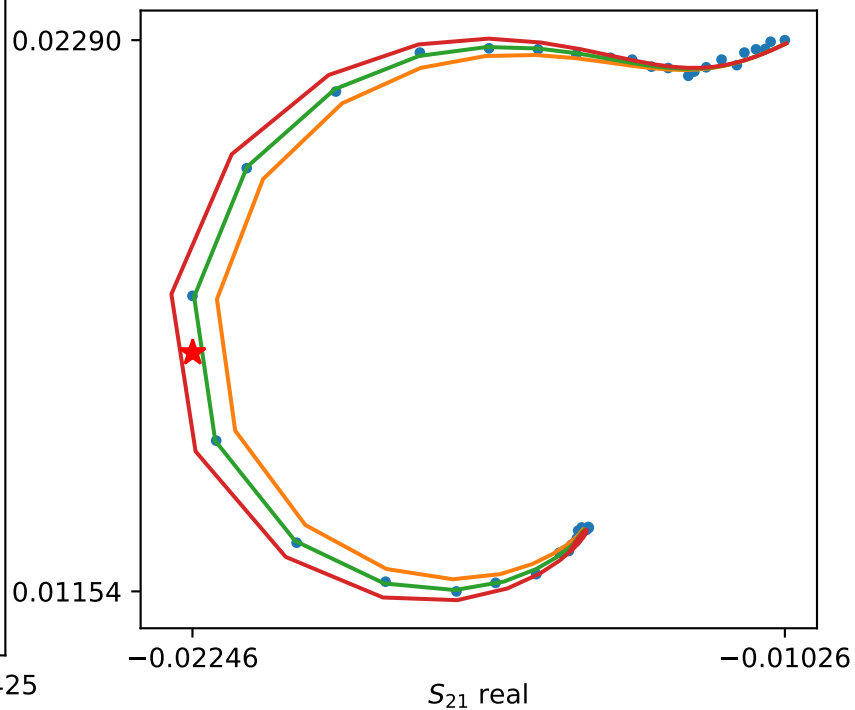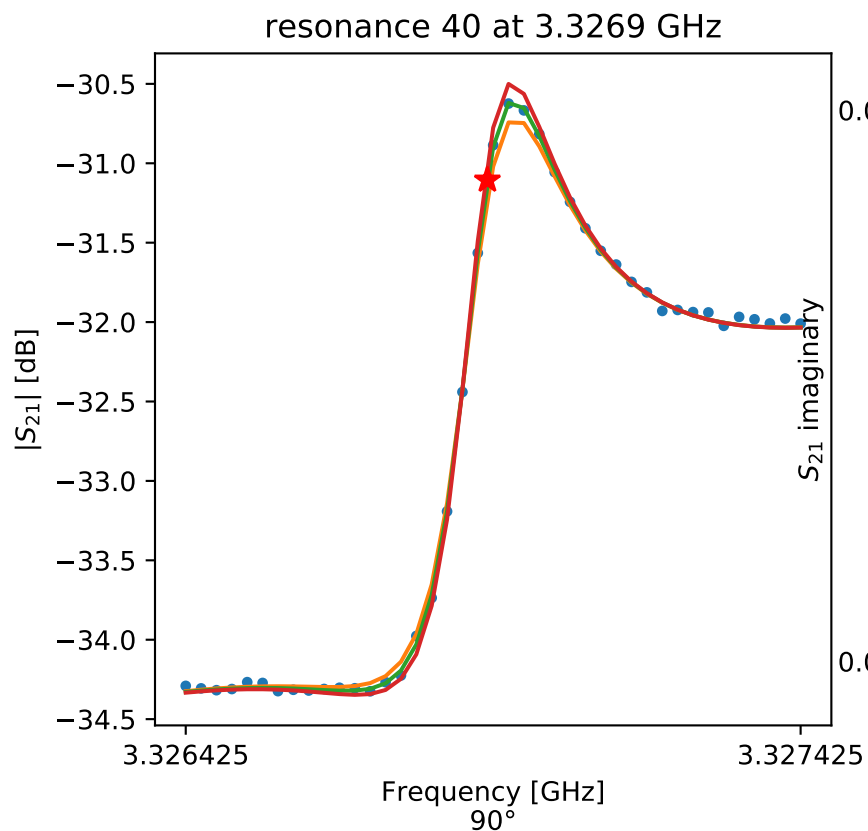Q_r = 12589.75122426902
Q_c = 27943.63529701205
Q_i = 22912.991593809365
a = (-4.037280971279791e-65-4.2526092336650855e-6
ϕ_0 = -1.458861203010944
τ = (60.76750020209538+6.897763289678455j)

resonance 40 at 3.3269 GHz

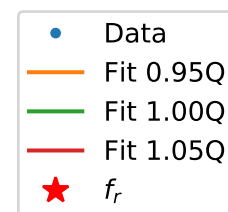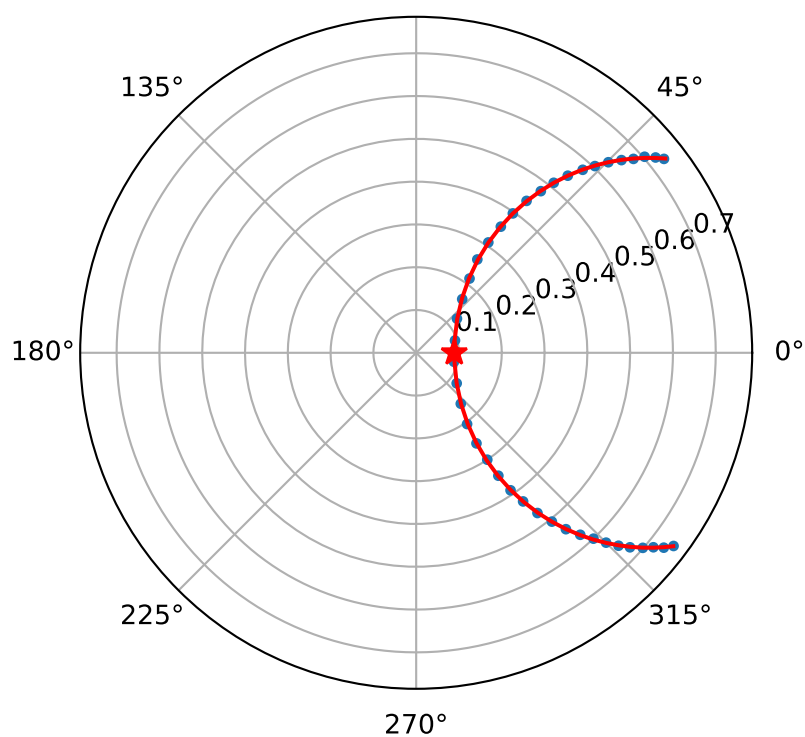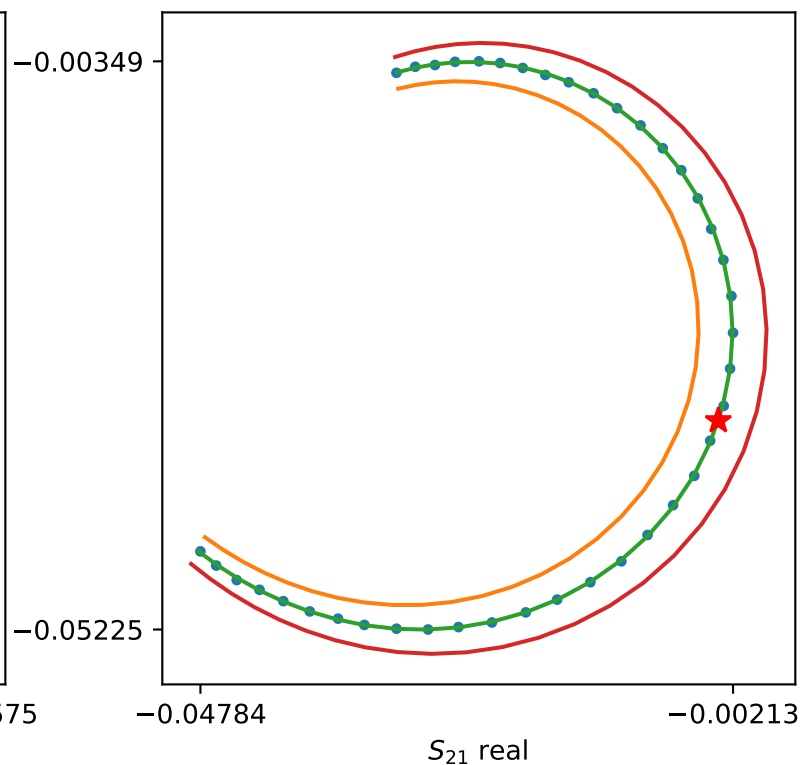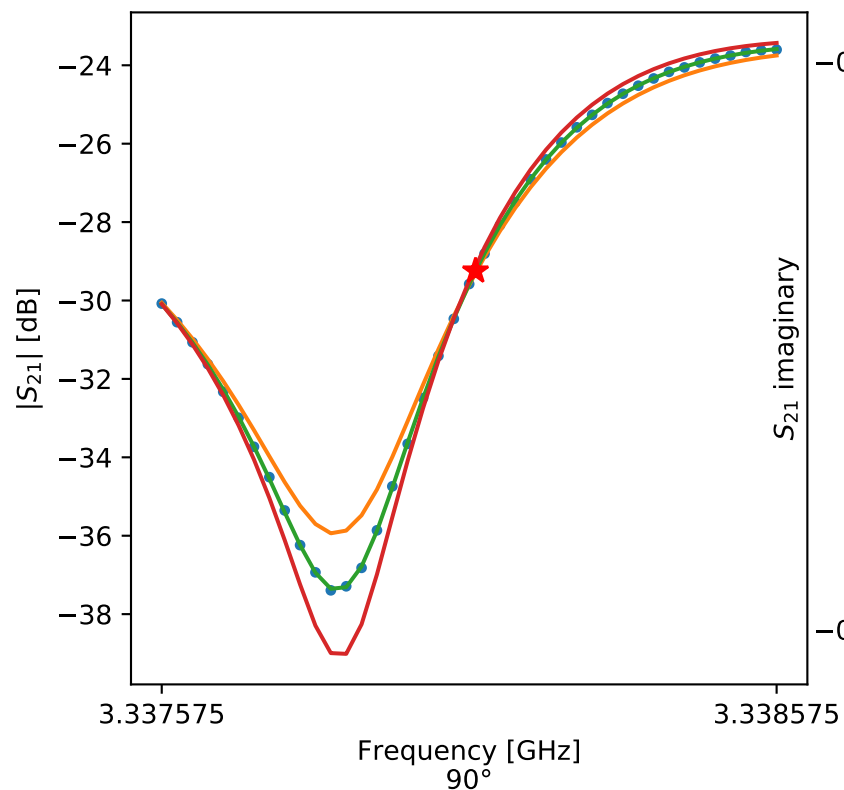$$S_{21}(f) = ae^{-2\pi jf\tau}\left[1 - \frac{Q_r/Q_c e^{j\phi_0}}{1 + 2jQ_r(\frac{f-f_r}{f_r})}\right]$$

f_r = 3.326915620459933
Q_r = 19603.764460092483
Q_c = 44773.58911927894
Q_i = 34872.348417689536
a = (-2.5319363174772874e-206+2.4802548135090715
ϕ_0 = -2.0946367309333627
τ = (59.82276606887838+22.447866229972465j)

resonance 41 at 3.338 GHz

$$S_{21}(f) = ae^{-2\pi jf\tau}\left[1 - \frac{Q_r/Q_c e^{j\phi_0}}{1 + 2jQ_r(\frac{f-f_r}{f_r})}\right]$$

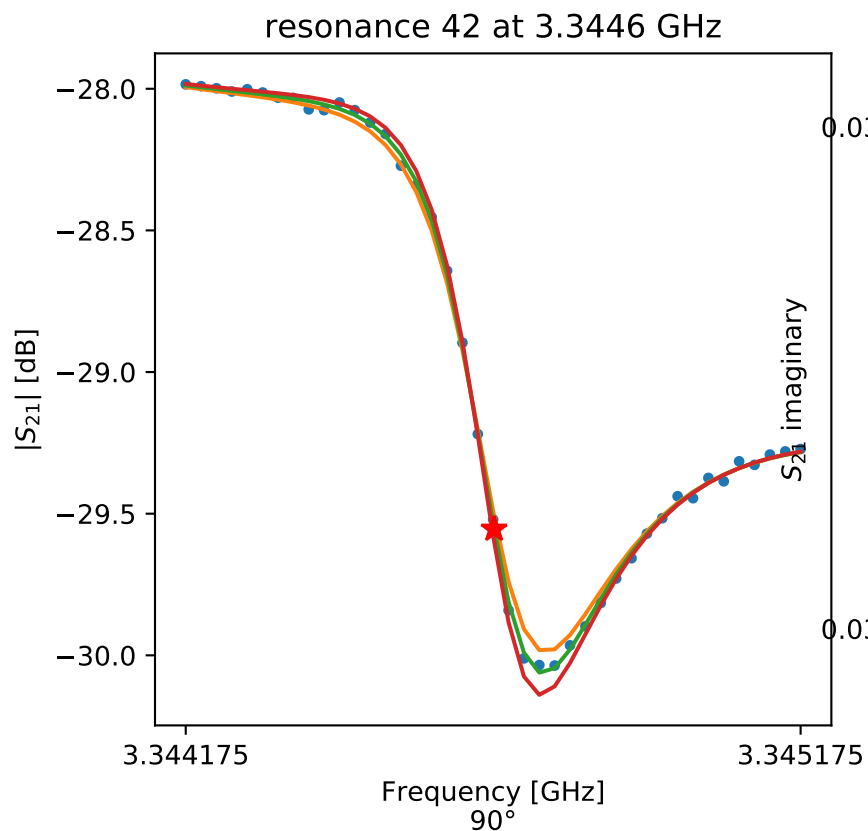f_r = 3.3380853387653695
Q_r = 3702.6196889860653
Q_c = 4064.268532224924
Q_i = 41610.64239545607
a = (-1.1831416362354062e+150+9.0117129029126360...
ϕ_0 = -0.5555962099113873
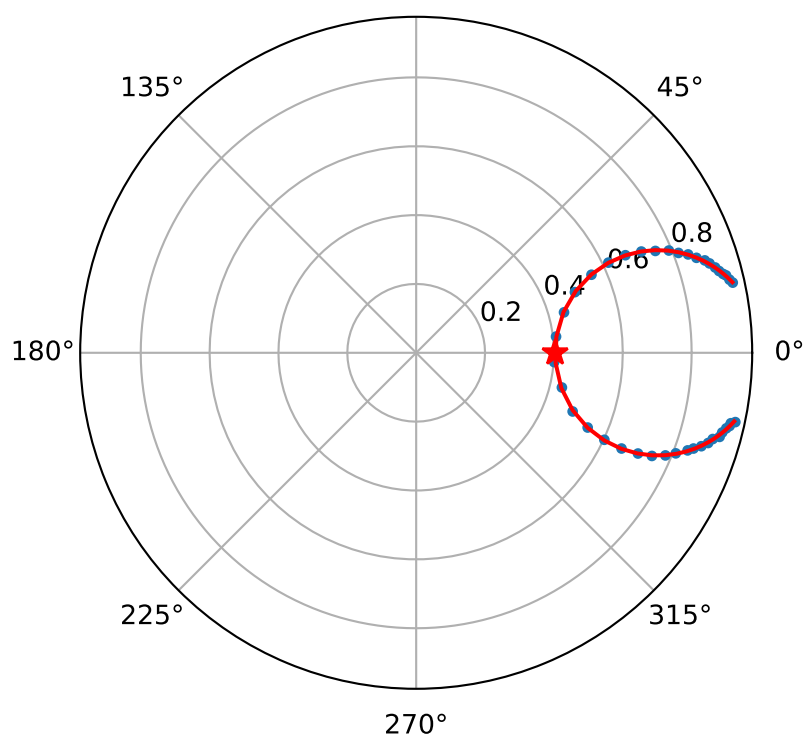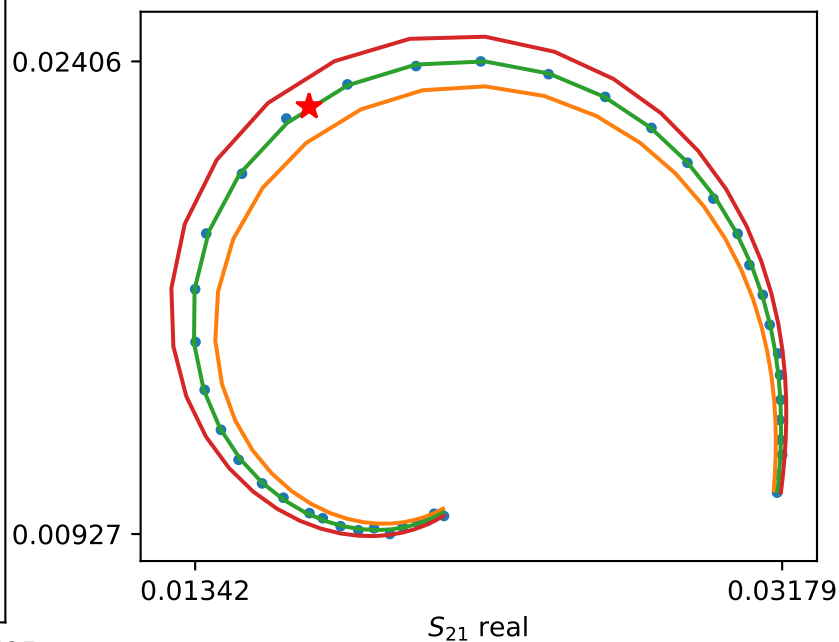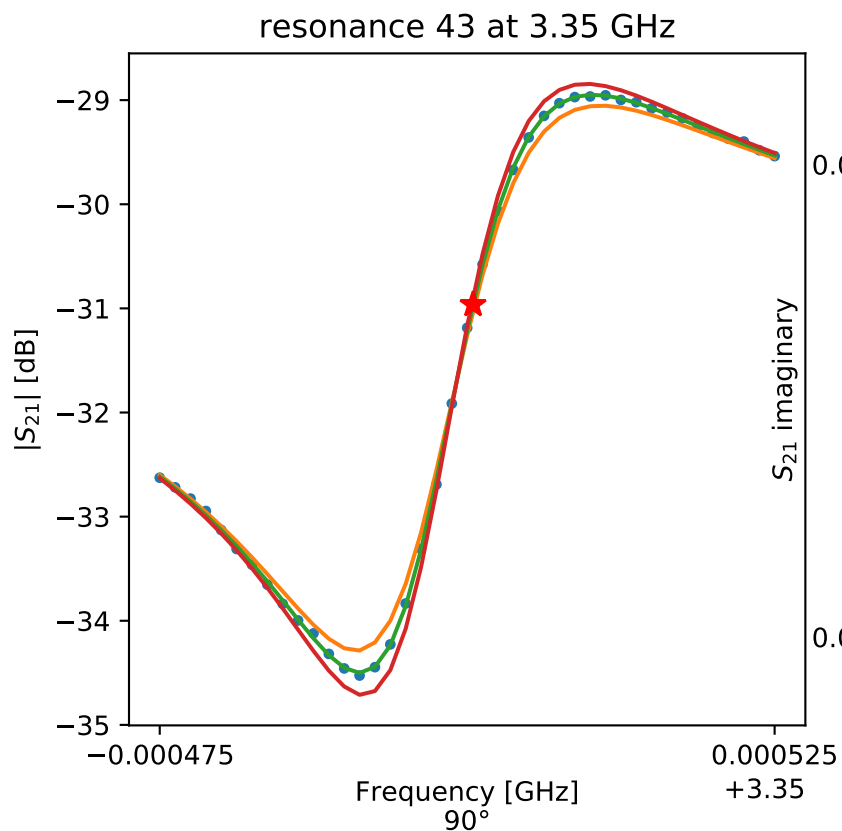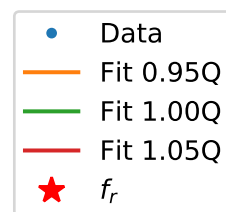τ = (59.56771617704868-16.616852462615856j)

resonance 42 at 3.3446 GHz
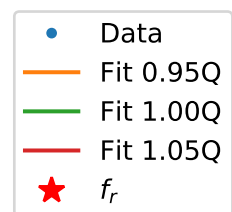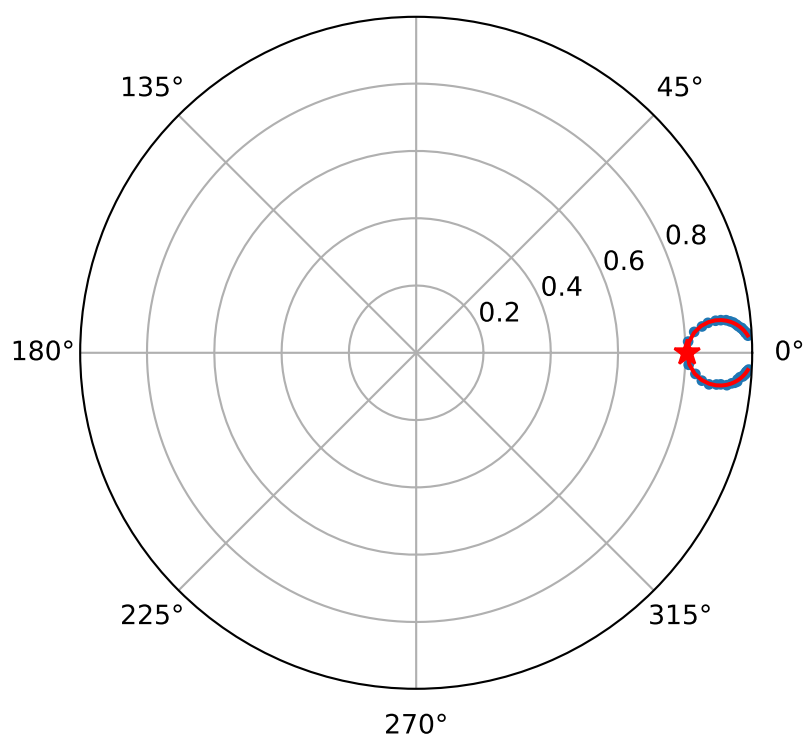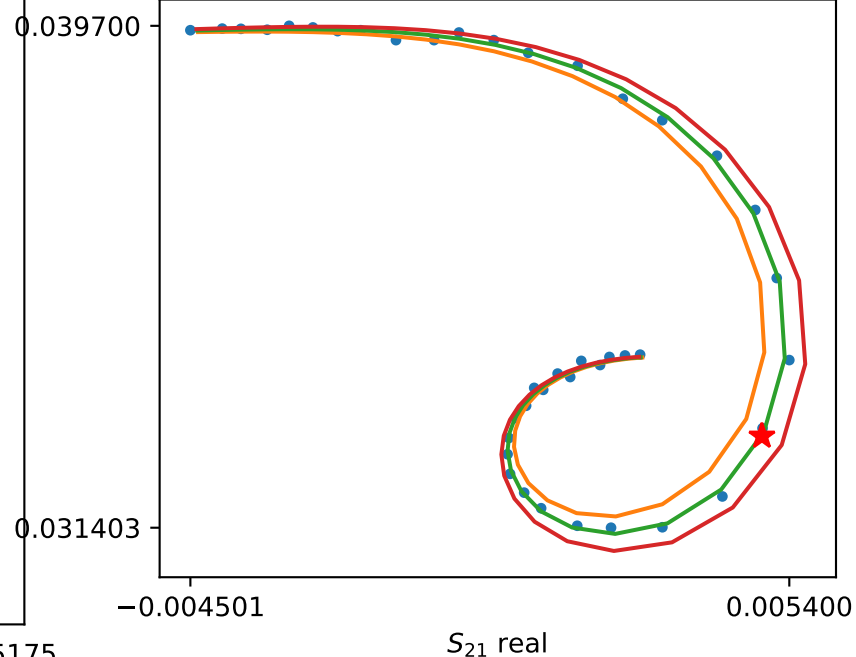
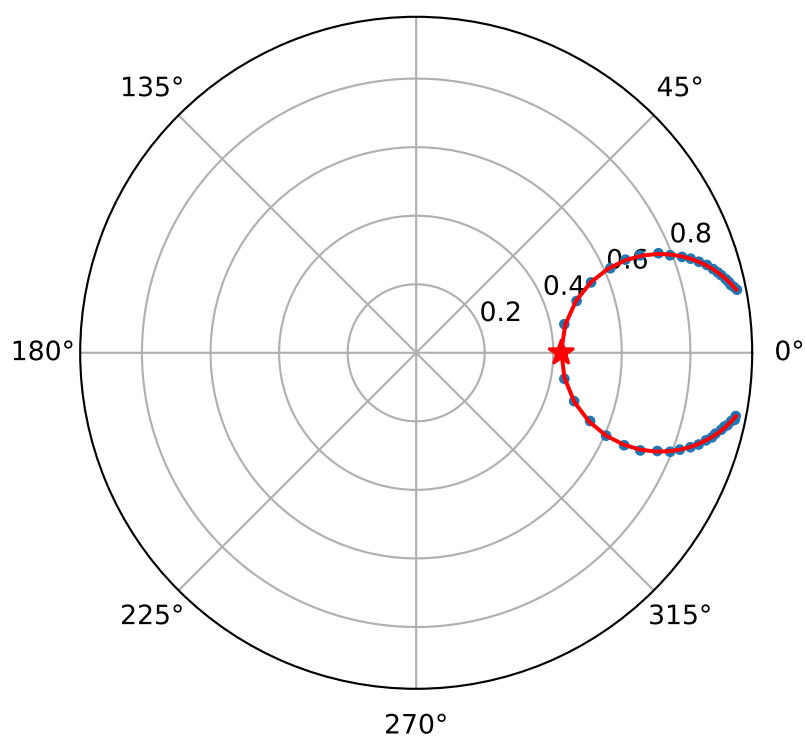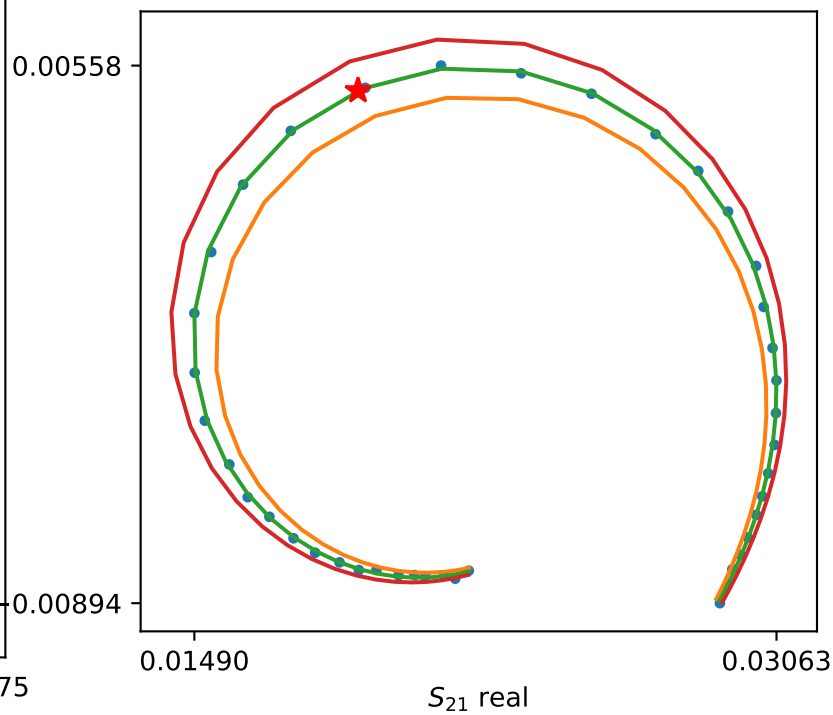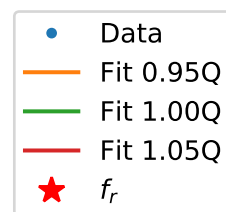$$S_{21}(f) = ae^{-2\pi jf\tau}\left[1 - \frac{Q_r/Q_c e^{j\phi_0}}{1 + 2jQ_r(\frac{f - f_r}{f_r})}\right]$$

f_r = 3.344676506940624
Q_r = 11731.659054387212
Q_c = 60259.918925325976
Q_i = 14567.776082576935
a = (-1.5327377222082723e+96-1.9251677333859862e
ϕ_0 = 0.8941407173381041
τ = (41.37604456337599-10.717751847559104j)

resonance 43 at 3.35 GHz

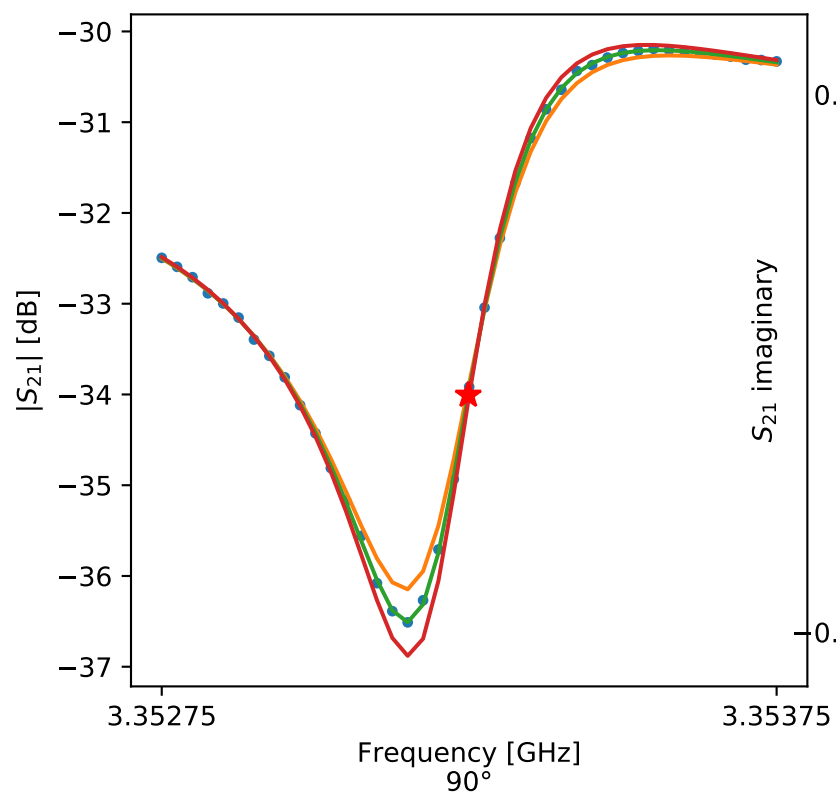$$S_{21}(f) = ae^{-2\pi jf\tau}\left[1 - \frac{Q_r/Q_c e^{j\phi_0}}{1 + 2jQ_r(\frac{f-f_r}{f_r})}\right]$$

f_r = 3.350034617218947
Q_r = 8581.875182517333
Q_c = 14386.179581992965
Q_i = 21270.48980013808
a = (9.120285671866293e+63-3.996235650551866e+6...
ϕ_0 = -1.2222585079542838
τ = (37.577020132210464-7.168995129328192j)

resonance 44 at 3.3532 GHz

$$S_{21}(f) = ae^{-2\pi jf\tau}\left[1 - \frac{Q_r/Q_c e^{j\phi_0}}{1 + 2jQ_r(\frac{f-f_r}{f_r})}\right]$$

f_r = 3.353248501582911
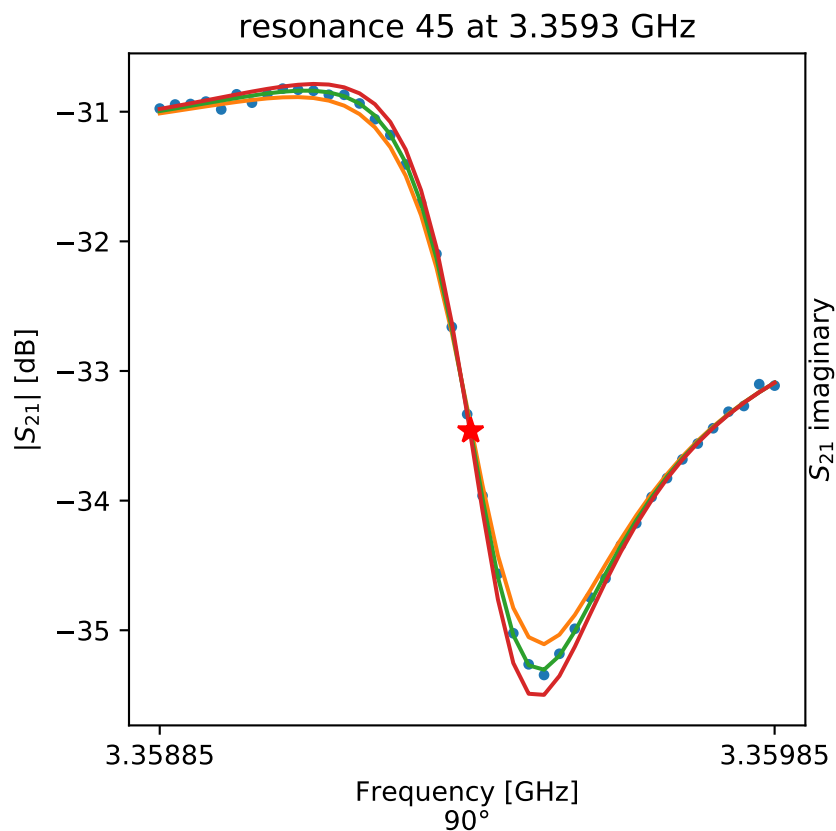Q_r = 9251.077940042316
Q_c = 16036.997889473148
Q_i = 21862.845200856496
a = (-2.6012715596528153e+42-1.1134518078387464e
ϕ_0 = -0.7629277357468186
τ = (34.82275551099672-4.875041288490468j)

resonance 45 at 3.3593 GHz
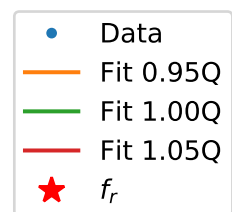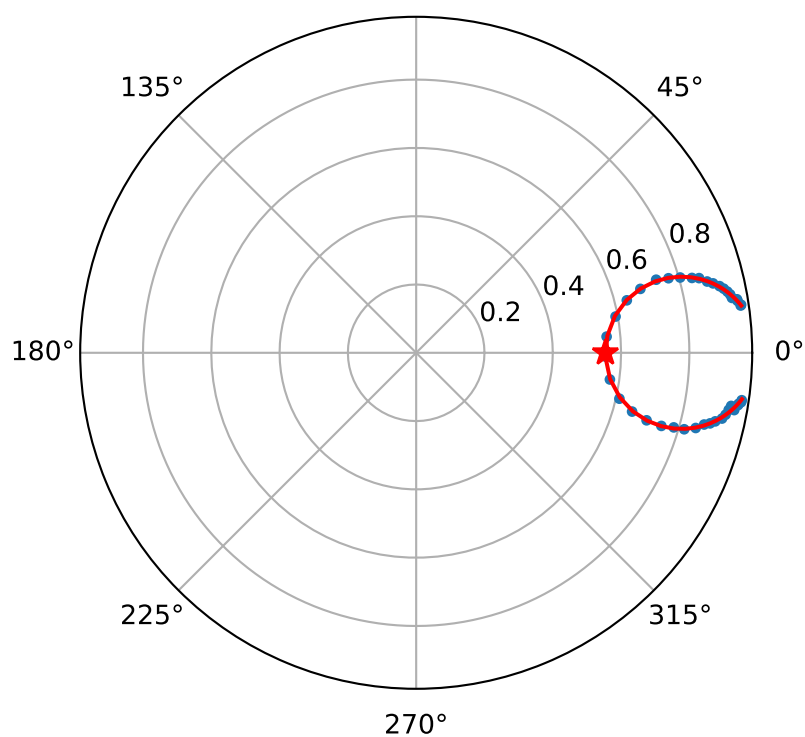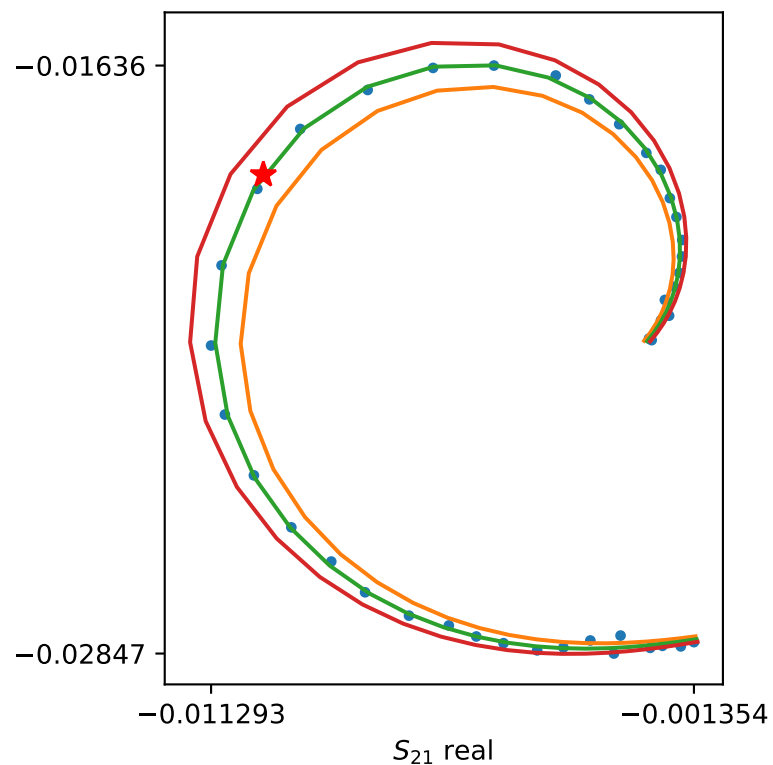
$$S_{21}(f) = ae^{-2\pi jf\tau}\left[1 - \frac{Q_r/Q_c e^{j\phi_0}}{1 + 2jQ_r(\frac{f-f_r}{f_r})}\right]$$

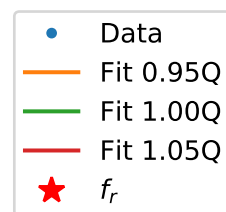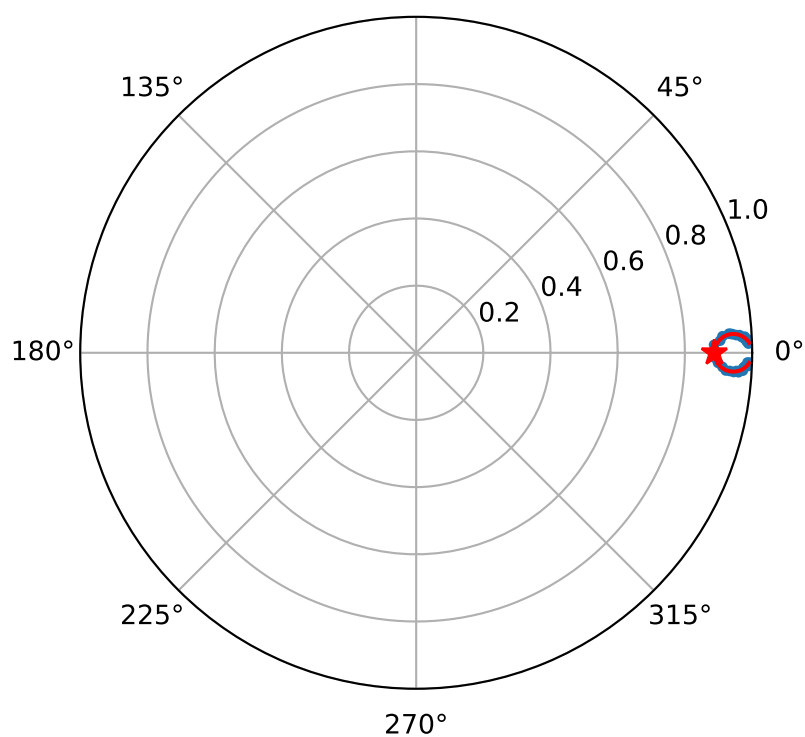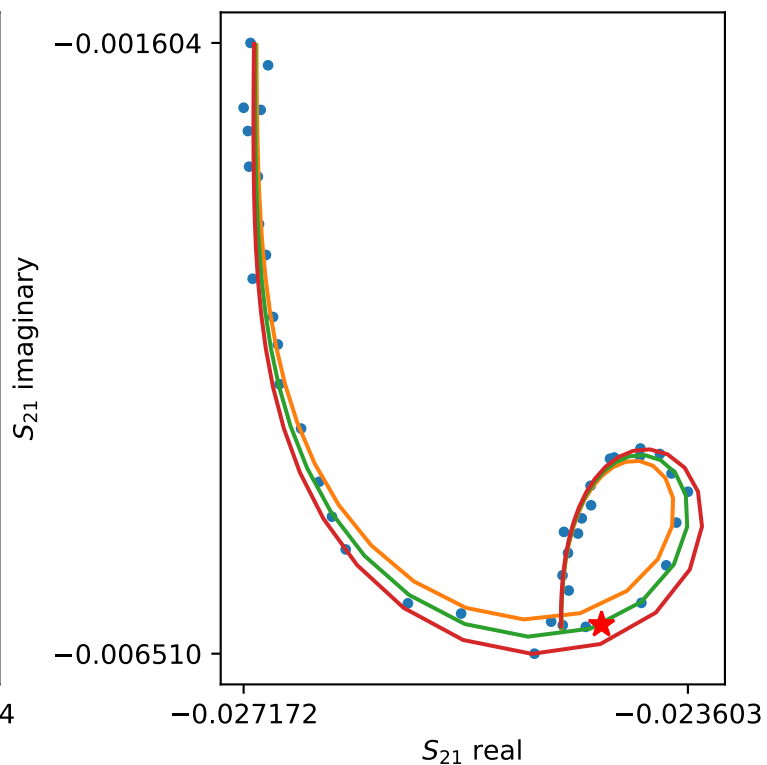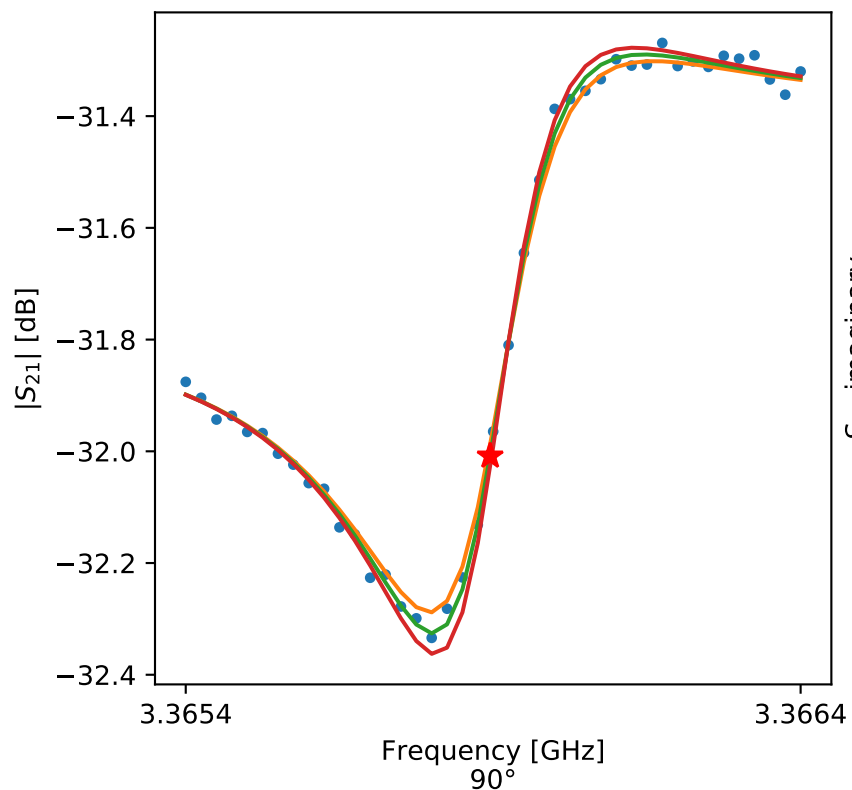$f_r = 3.3593556156565767$
$Q_r = 9777.400441226022$
$Q_c = 21929.649371240244$
$Q_i = 17644.05622968467$
$a = (-5316550.2221405525-7521968.896541869j)$
$\phi_0 = 0.9451101845424962$
$\tau = (34.20584472488595-0.9329833700128828j)$

Legend: Data, Fit 0.95Q, Fit 1.00Q, Fit 1.05Q, f_r

resonance 46 at 3.3658 GHz

$$S_{21}(f) = ae^{-2\pi jf\tau}\left[1 - \frac{Q_r/Q_c e^{j\phi_0}}{1 + 2jQ_r(\frac{f-f_r}{f_r})}\right]$$
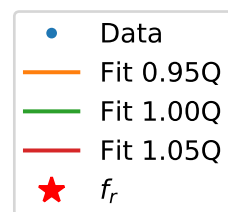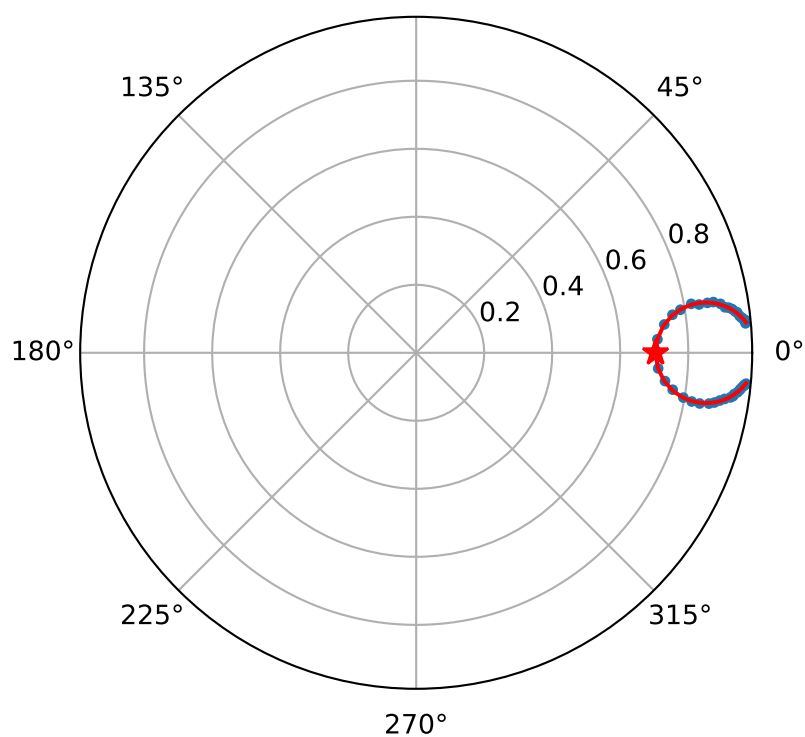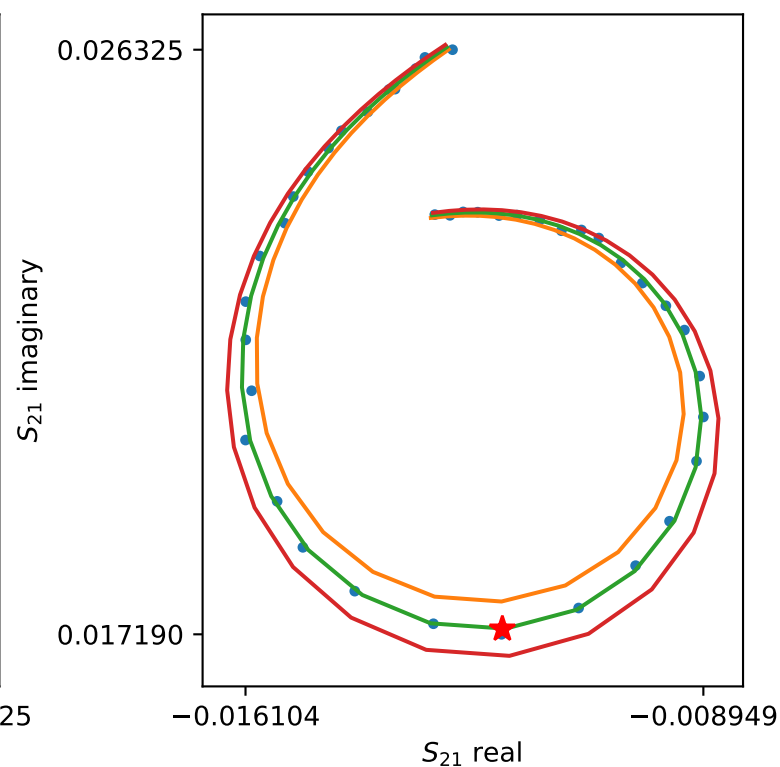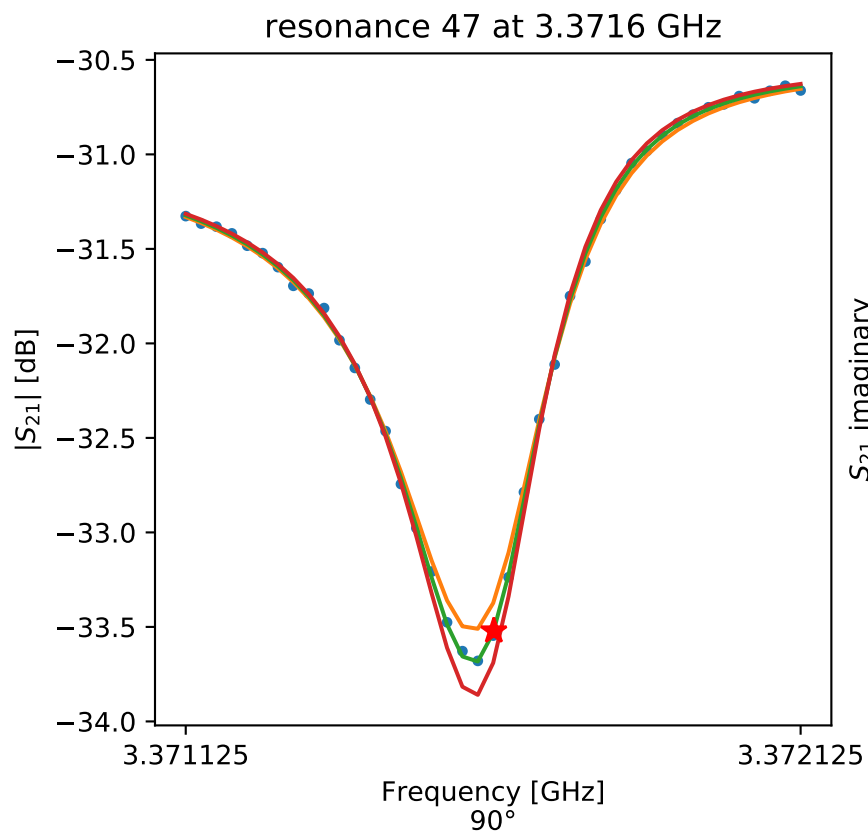
f_r = 3.3658950859698353
Q_r = 11585.523946678115
Q_c = 103142.42015639806
Q_i = 13051.545302530963
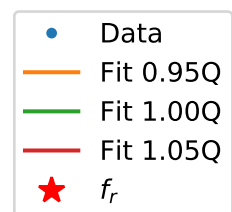a = (1.082757888381046e-19-9.478861979329767e-20j)
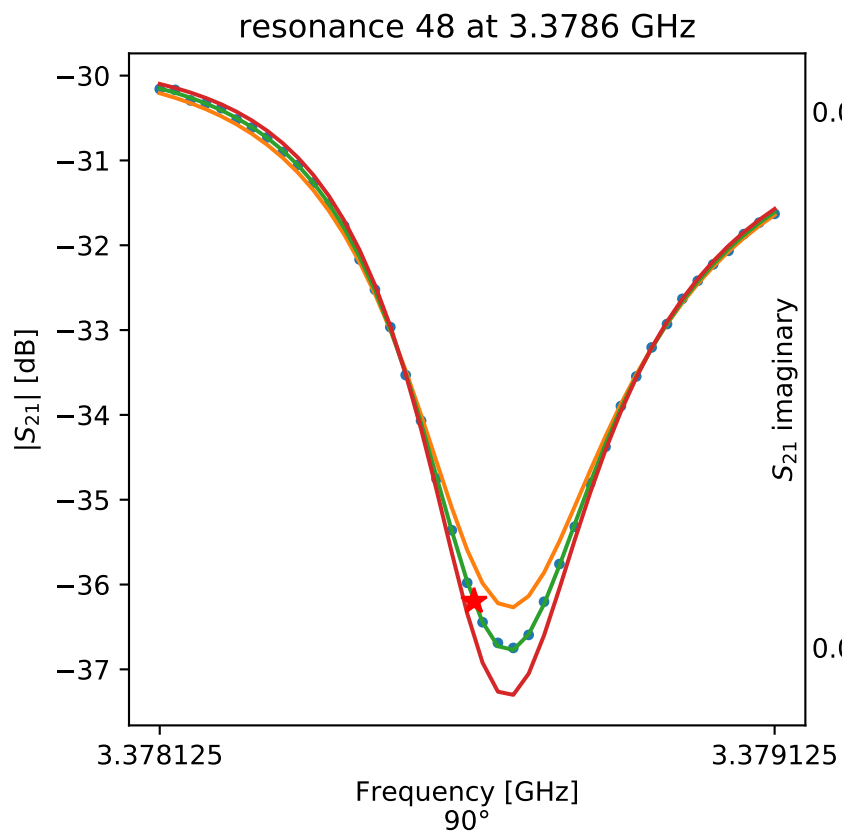ϕ_0 = -1.0718633367157073
τ = (34.86794722530733+1.8795564641926303j)

resonance 47 at 3.3716 GHz

$$S_{21}(f) = ae^{-2\pi jf\tau}\left[1 - \frac{Q_r/Q_c e^{j\phi_0}}{1 + 2jQ_r(\frac{f-f_r}{f_r})}\right]$$

f_r = 3.3716260525732706
Q_r = 10025.305267956717
Q_c = 33849.10955169244
Q_i = 14244.058264695183
a = (2.022338349251284e-25+3.999624948634382e-26
ϕ_0 = -0.34158956324735806
τ = (35.503833243646845+2.5159745076025866j)

resonance 48 at 3.3786 GHz
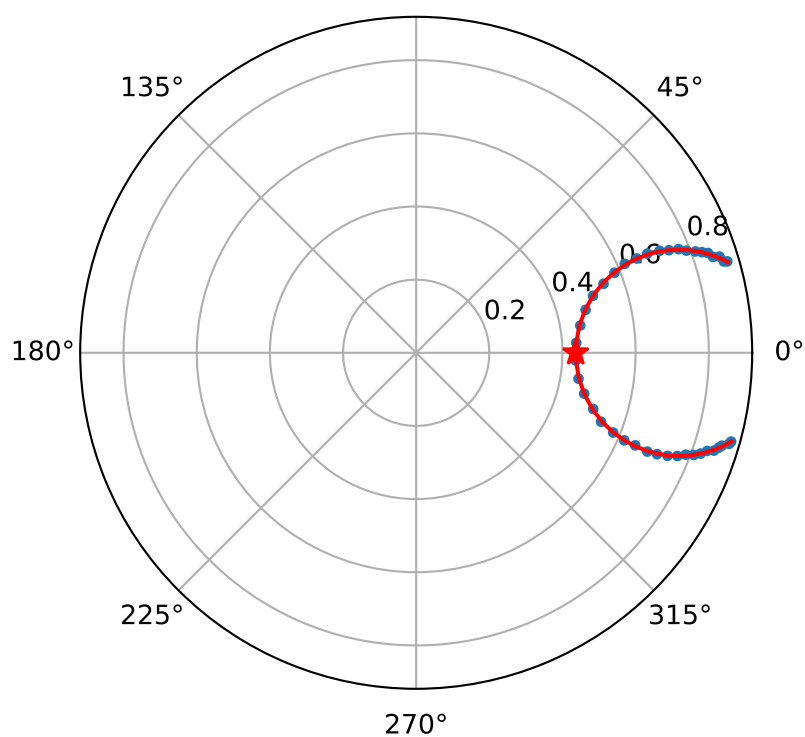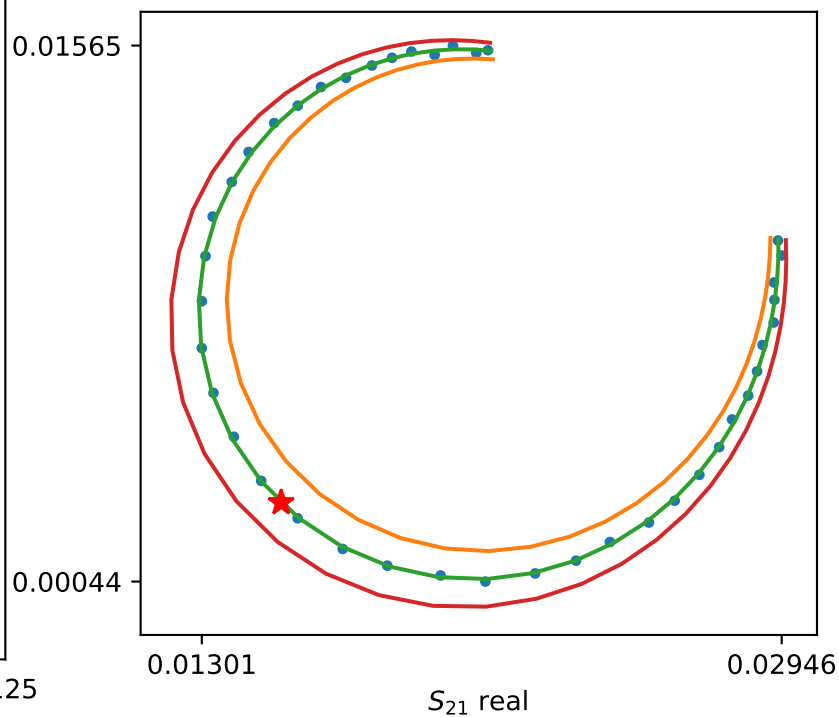
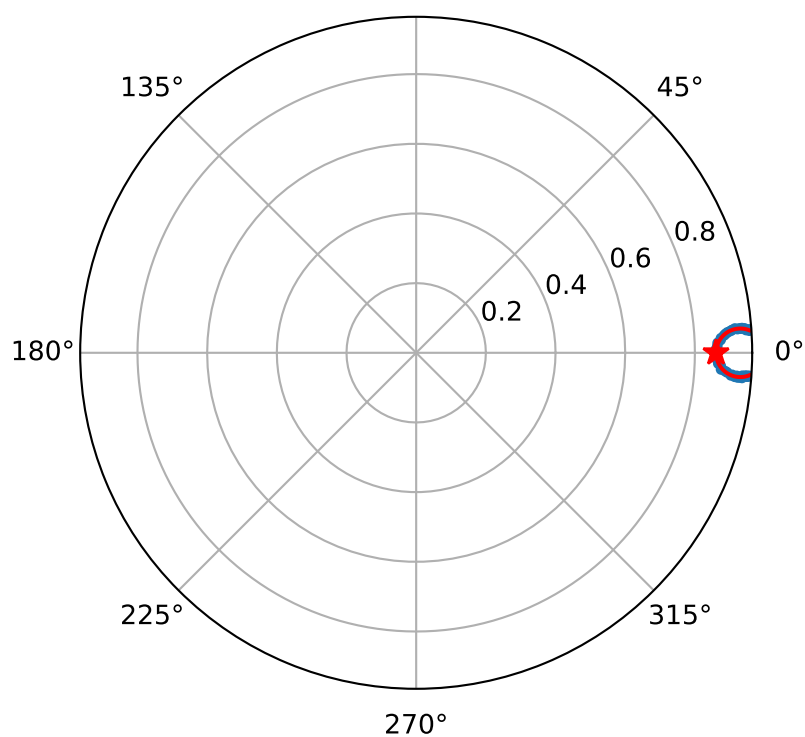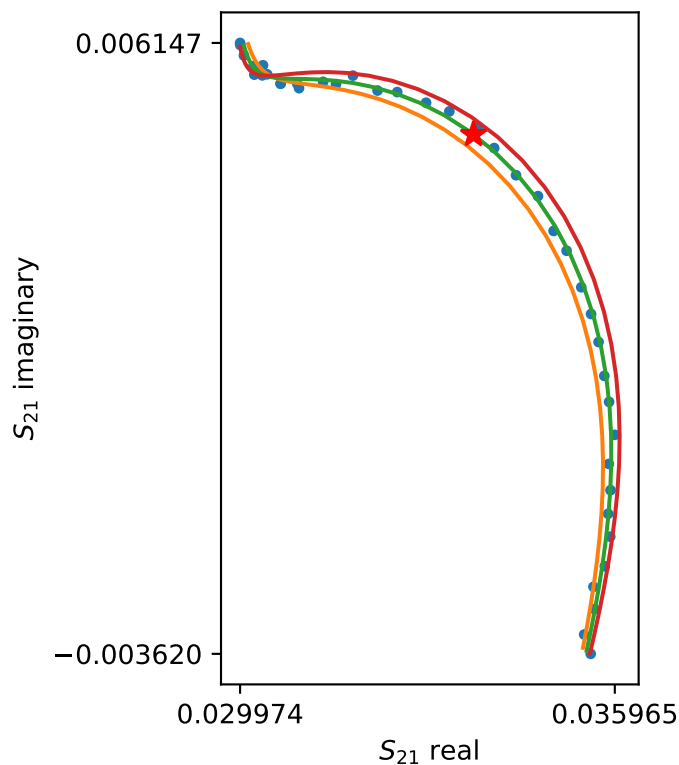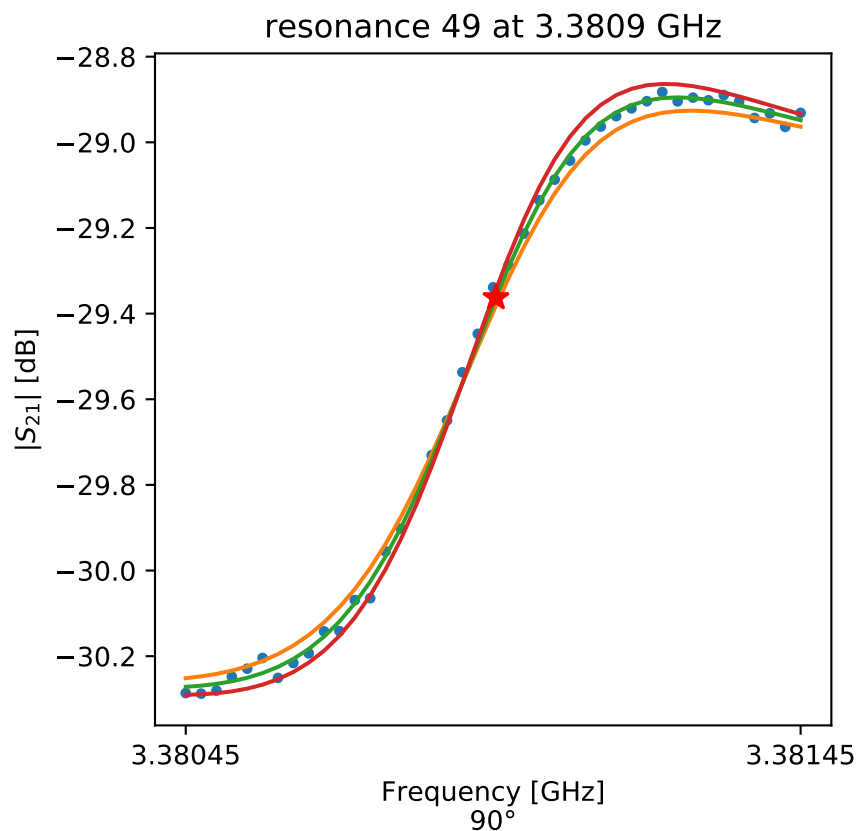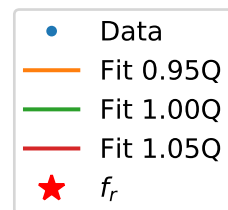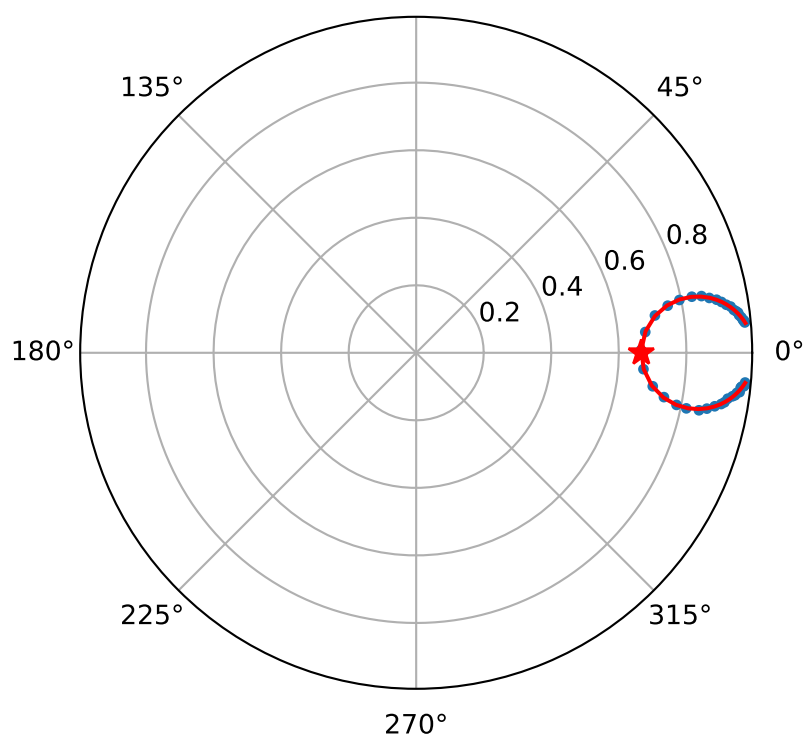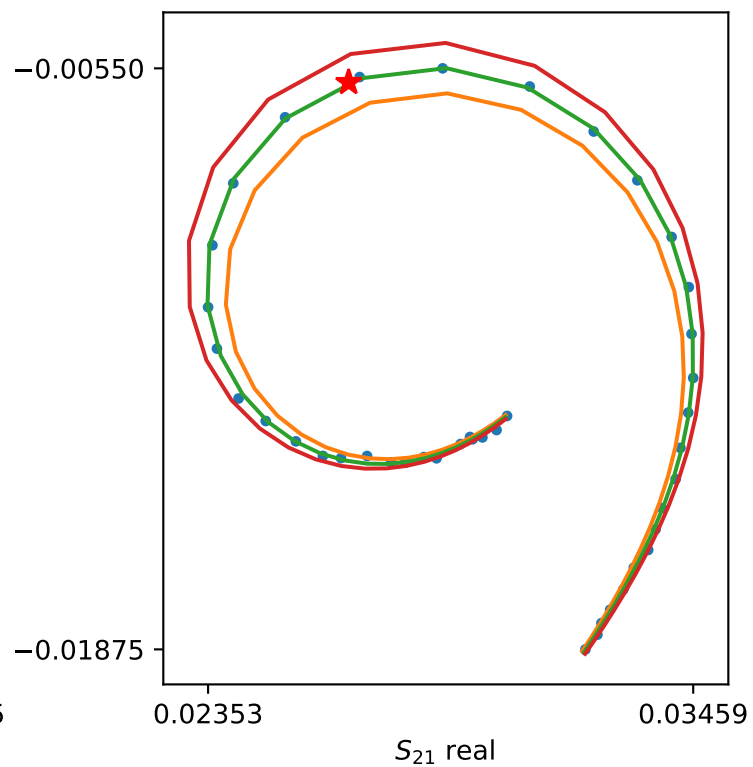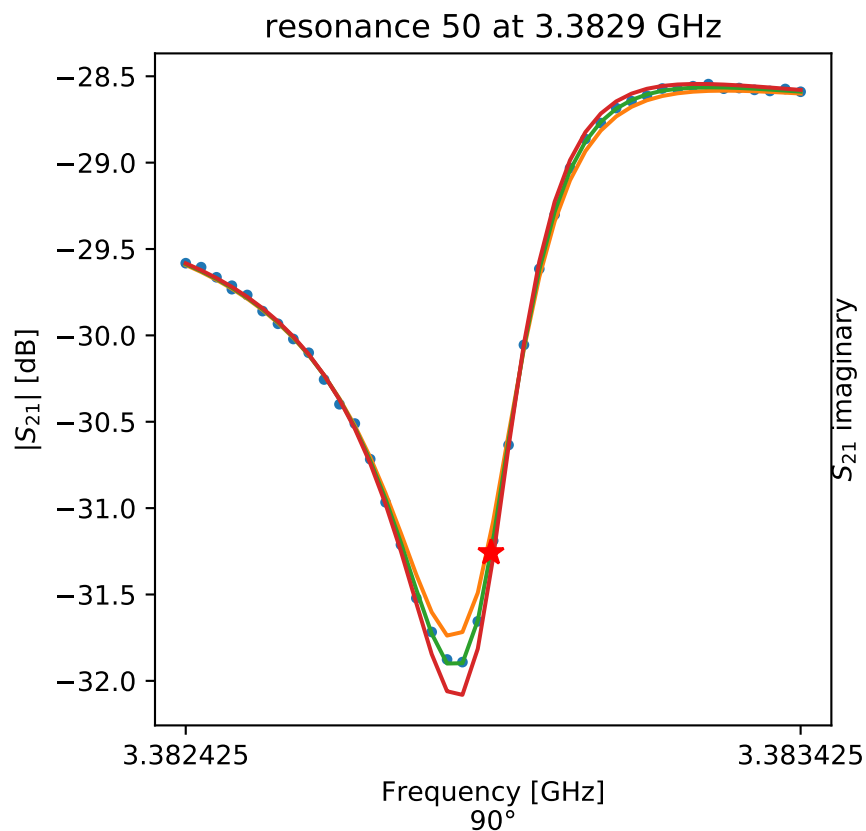$$S_{21}(f) = ae^{-2\pi jf\tau}\left[1 - \frac{Q_r/Q_c e^{j\phi_0}}{1 + 2jQ_r(\frac{f - f_r}{f_r})}\right]$$

f_r = 3.37863613124226845
Q_r = 5809.3292519110955
Q_c = 10302.705514378318
Q_i = 13320.008168120843
a = (-1.5759164752433776e-14-4.701422880806814e-1
ϕ_0 = 0.27577058007536615
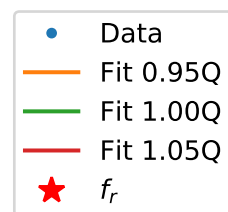τ = (36.58853177452783+1.2811258121133635j)

resonance 49 at 3.3809 GHz

$$S_{21}(f) = ae^{-2\pi jf\tau}\left[1 - \frac{Q_r/Q_c e^{j\phi_0}}{1 + 2jQ_r(\frac{f - f_r}{f_r})}\right]$$

f_r = 3.380954505760047
Q_r = 5035.251313571464
Q_c = 36143.752107233355
Q_i = 5850.2618458690795
a = (7.83208770316711e-44-2.131797116321846e-43j)
ϕ_0 = -1.7722160710942476
τ = (43.12541617478369+4.461395176076265j)

resonance 50 at 3.3829 GHz

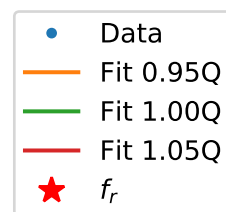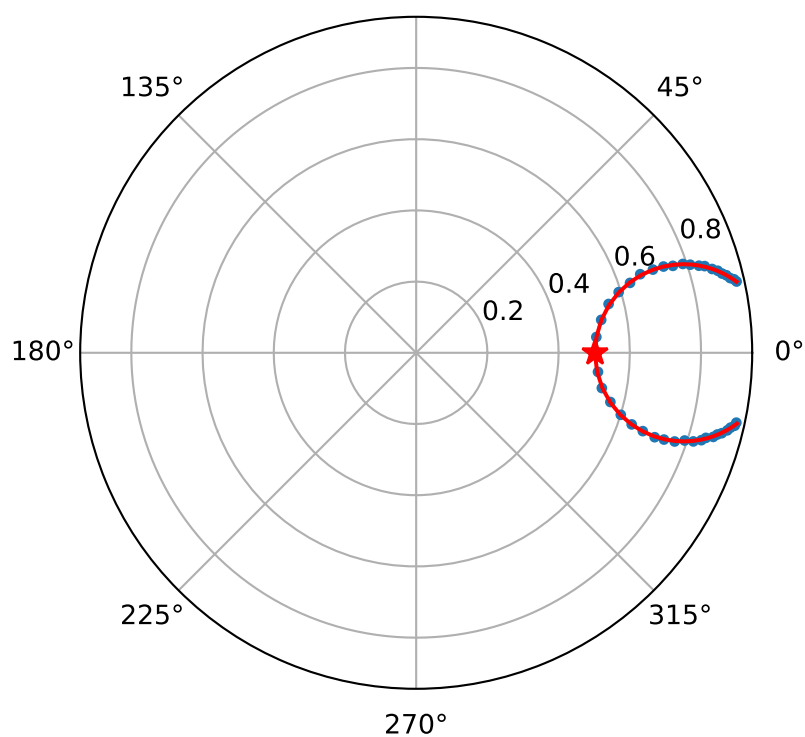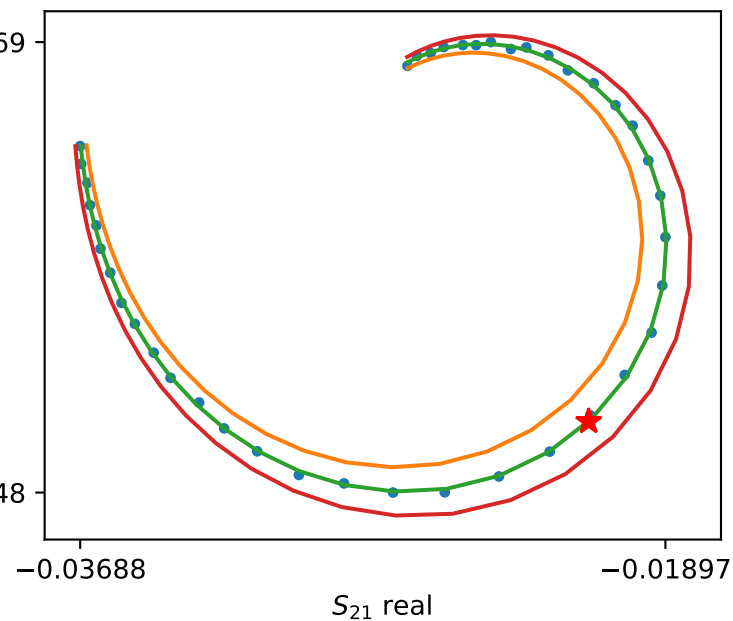$$S_{21}(f) = ae^{-2\pi jf\tau}\left[1 - \frac{Q_r/Q_c e^{j\phi_0}}{1 + 2jQ_r(\frac{f-f_r}{f_r})}\right]$$

f_r = 3.3829214557709455
Q_r = 11744.018119990627
Q_c = 35212.03880038353
Q_i = 17621.035337633504
a = (-1.061588146864661e-05-5.284467912798645e-05j)
ϕ_0 = -0.6576747017884591
τ = (40.437115512955295+0.3057657337034423j)

resonance 51 at 3.3881 GHz
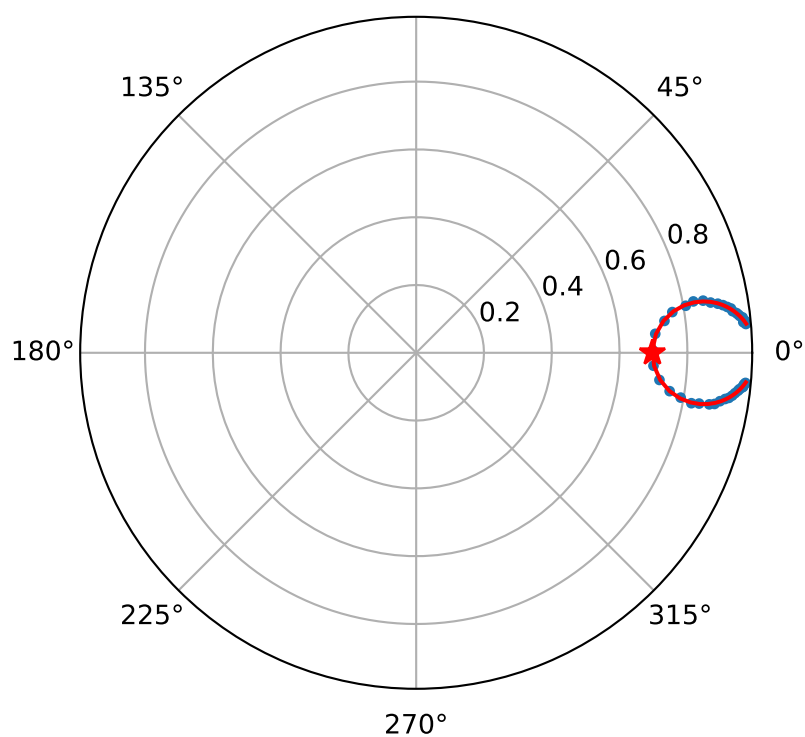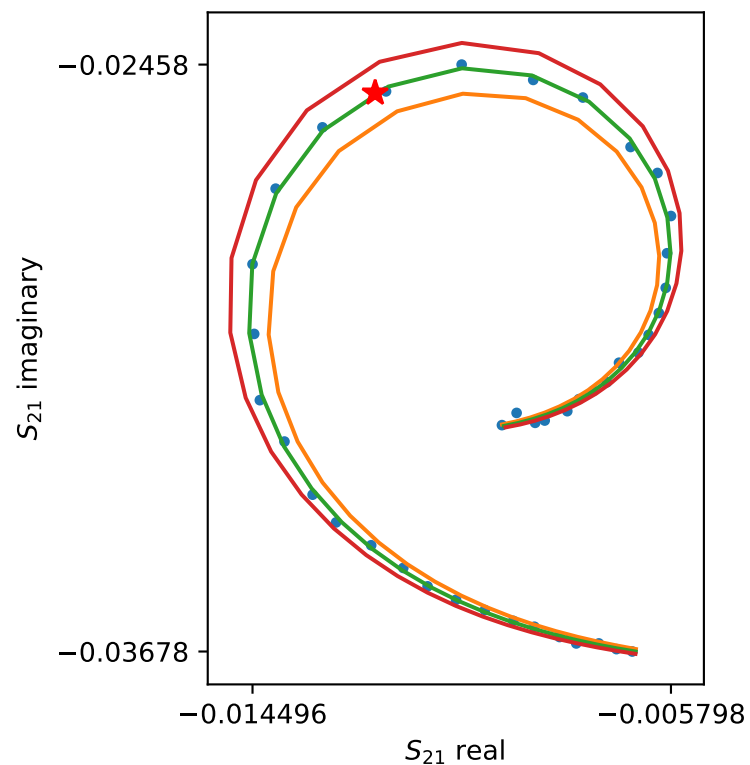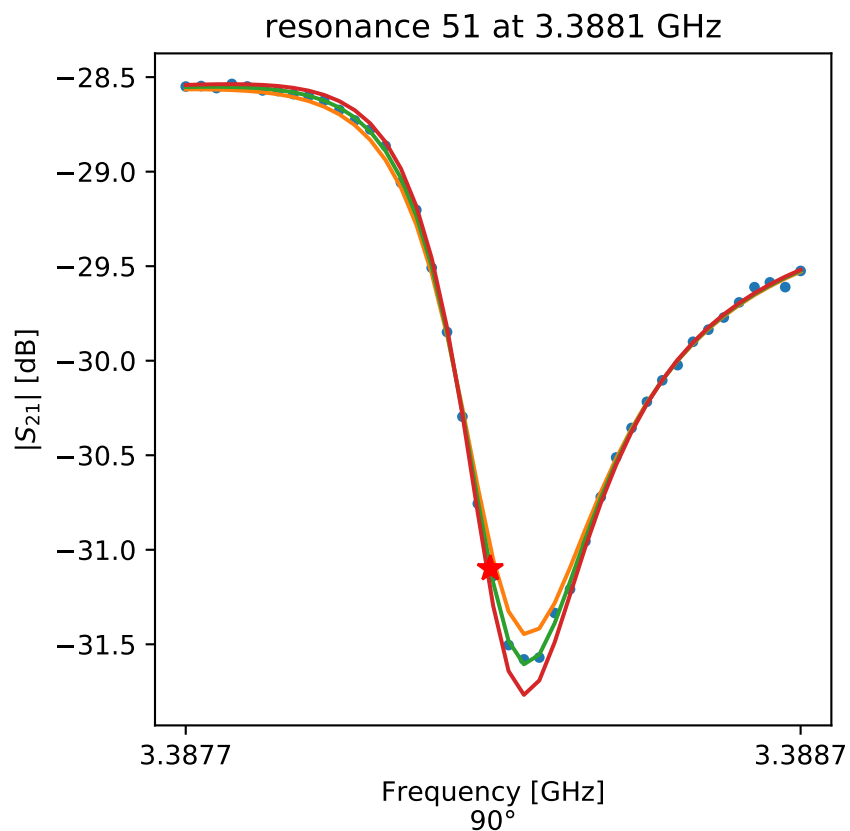
$$S_{21}(f) = ae^{-2\pi jf\tau}\left[1 - \frac{Q_r/Q_c e^{j\phi_0}}{1 + 2jQ_r(\frac{f - f_r}{f_r})}\right]$$
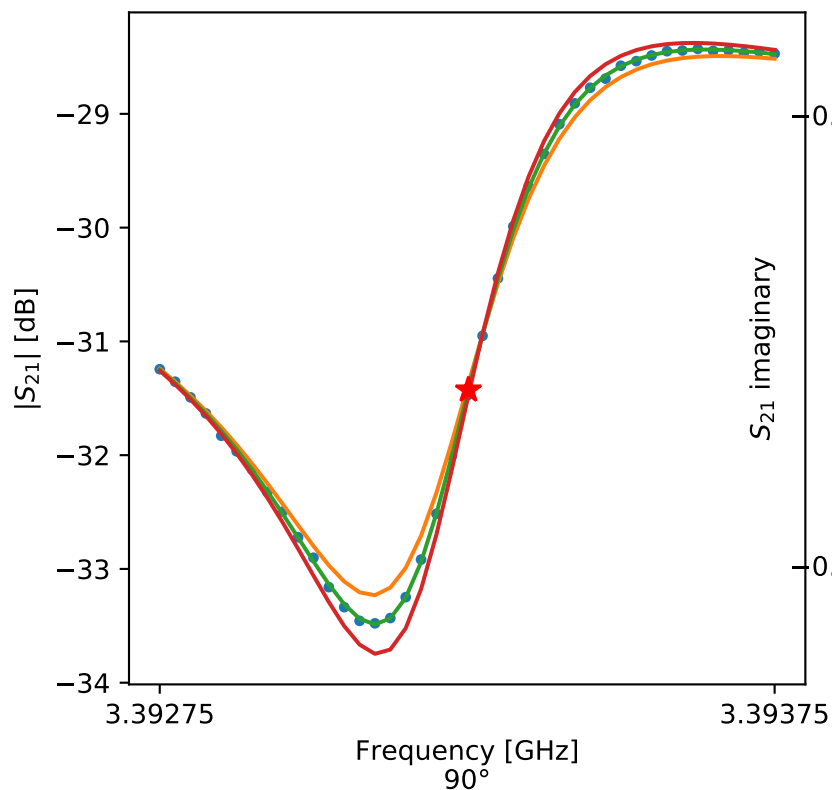
f_r = 3.388195333661932
Q_r = 10811.165576288498
Q_c = 35655.14525223832
Q_i = 15515.778228627456
a = (91254519176.46239-61350859962.75228j)
ϕ_0 = 0.6158043851758538
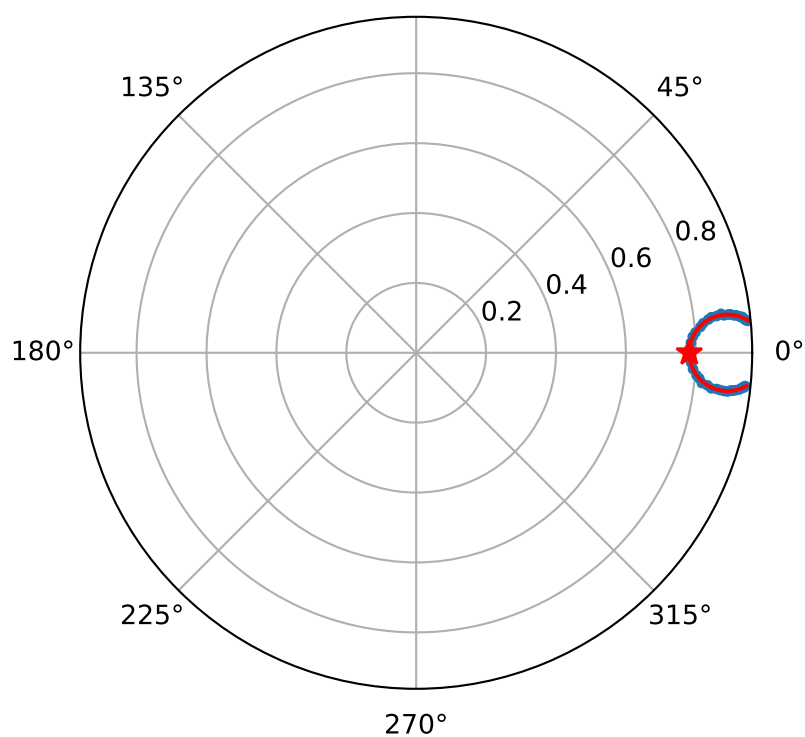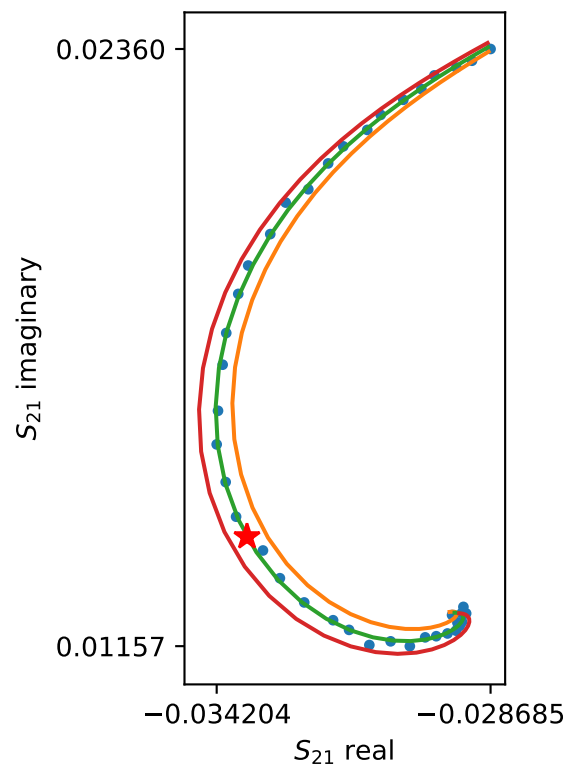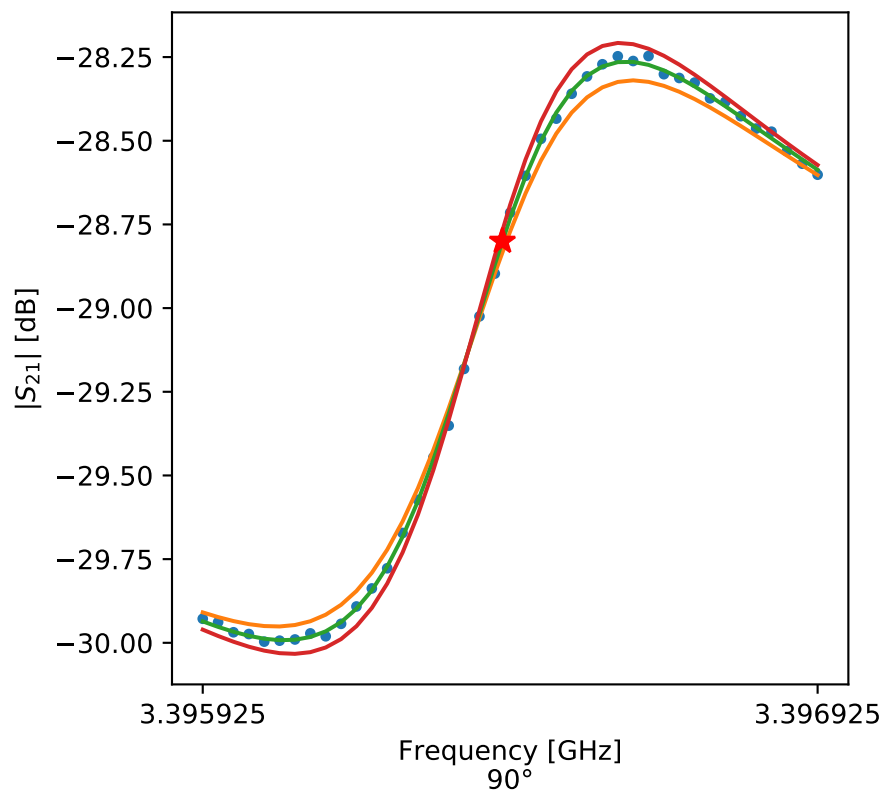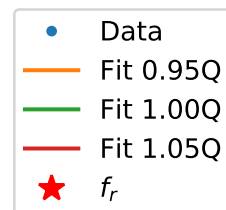τ = (39.60513454388895-1.3502891609764658j)

resonance 52 at 3.3932 GHz

$$S_{21}(f) = ae^{-2\pi jf\tau}\left[1 - \frac{Q_r/Q_c e^{j\phi_0}}{1 + 2jQ_r(\frac{f-f_r}{f_r})}\right]$$

f_r = 3.3932520351678104
Q_r = 6779.627886410725
Q_c = 13622.634567764948
Q_i = 13496.463981783625
a = (9.856013780914802e+32-1.1295246342422646e+3
ϕ_0 = -0.8717969139191737
τ = (37.82259072663285-3.740957010696984j)

resonance 53 at 3.3964 GHz

$$S_{21}(f) = ae^{-2\pi jf\tau}\left[1 - \frac{Q_r/Q_c e^{j\phi_0}}{1 + 2jQ_r(\frac{f-f_r}{f_r})}\right]$$
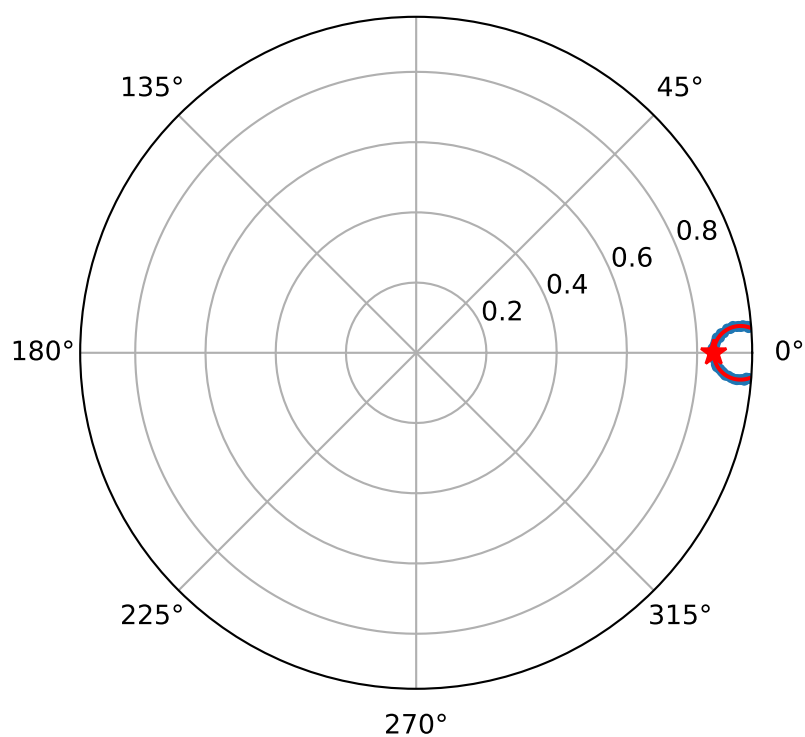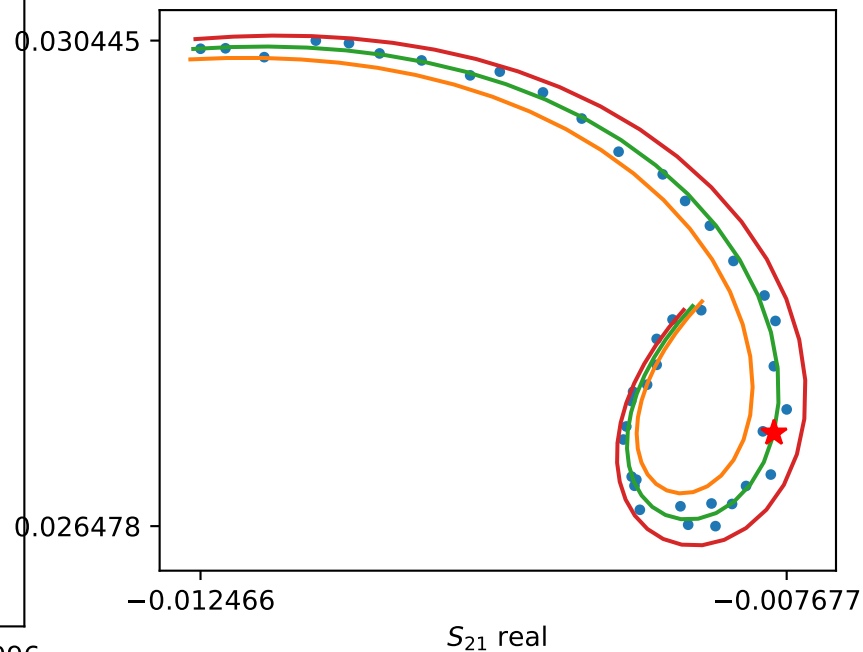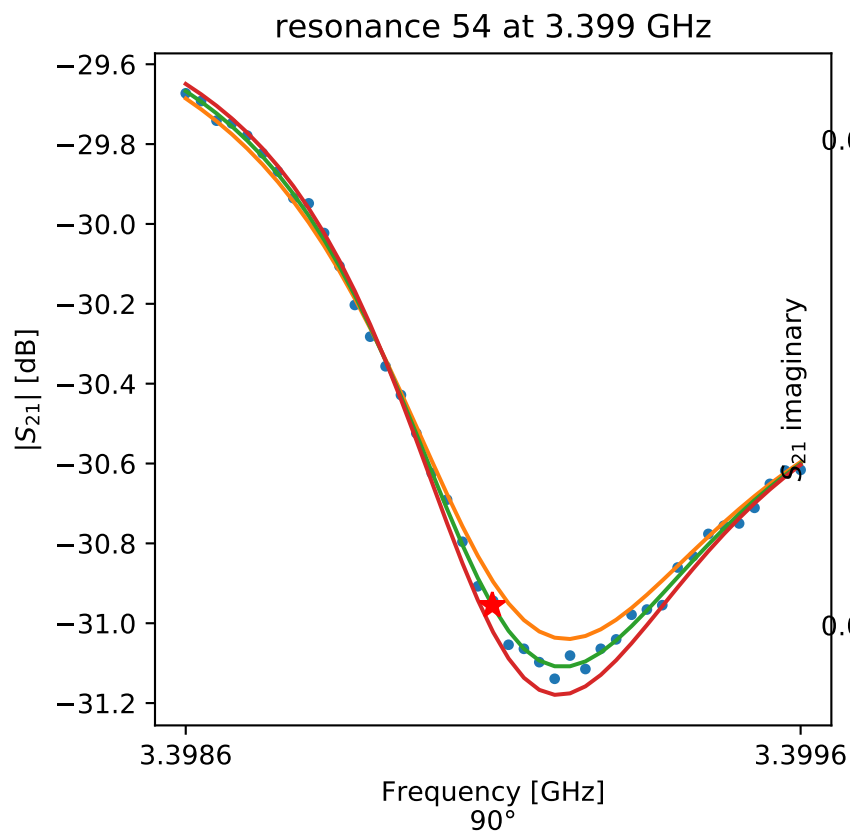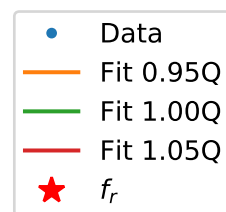
f_r = 3.3964123776254582
Q_r = 5919.54712090902
Q_c = 27080.546857107773
Q_i = 7575.472575920479
a = (1.1241799288342247e+37+1.9461377605980833e
ϕ_0 = -1.7470505737212785
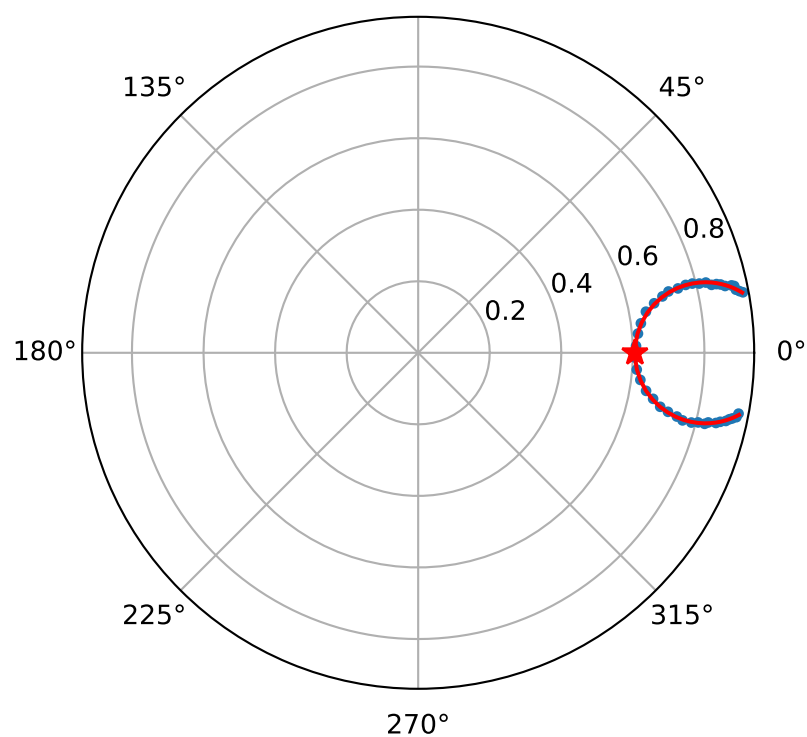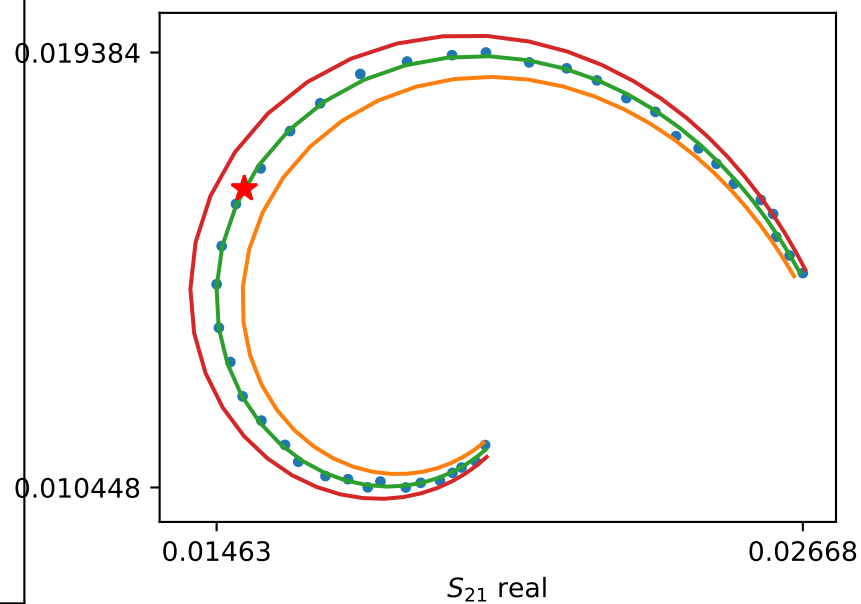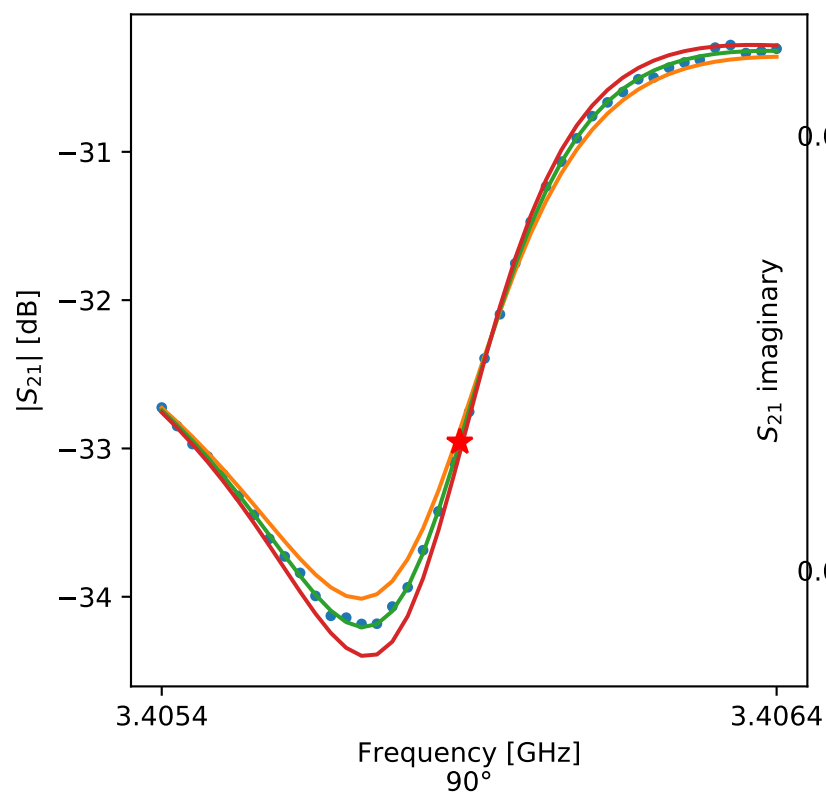τ = (39.342024371221626-4.156542767152092j)

resonance 54 at 3.399 GHz

$$S_{21}(f) = ae^{-2\pi jf\tau}\left[1 - \frac{Q_r/Q_c e^{j\phi_0}}{1 + 2jQ_r(\frac{f-f_r}{f_r})}\right]$$

$f_r = 3.3990985586480016$
$Q_r = 4765.175550549146$
$Q_c = 31171.949718035135$
$Q_i = 5625.06467913153$
$a = (2.5870593181294302e+42-1.259677569704621e+$
$\phi_0 = 0.5176795213138833$
$\tau = (36.68152676134023-4.733091743415286j)$

resonance 55 at 3.4058 GHz
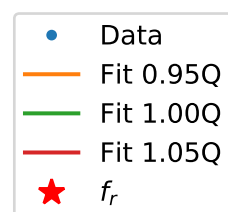
$$S_{21}(f) = ae^{-2\pi jf\tau}\left[1 - \frac{Q_r/Q_c e^{j\phi_0}}{1 + 2jQ_r(\frac{f-f_r}{f_r})}\right]$$

f_r = 3.4058846603129935
Q_r = 5884.282467191386
Q_c = 14922.035701157782
Q_i = 9715.409436178144
a = (1.0270000404414284e+18-1.1674731374285555e-
ϕ_0 = -0.8278787328532907
τ = (35.20673013389198-2.1045267232173934j)

resonance 56 at 3.4109 GHz
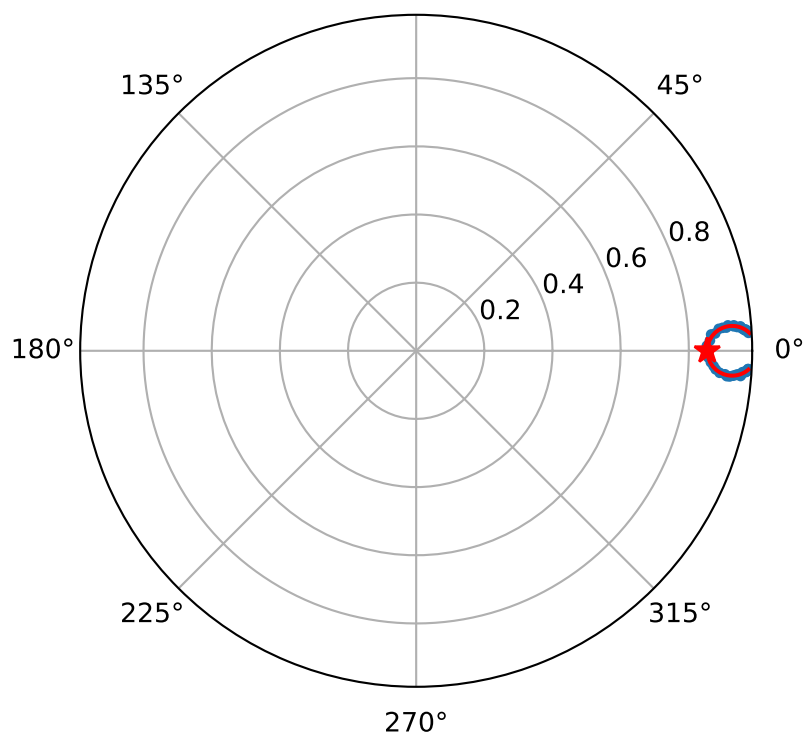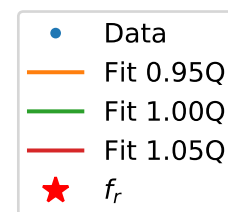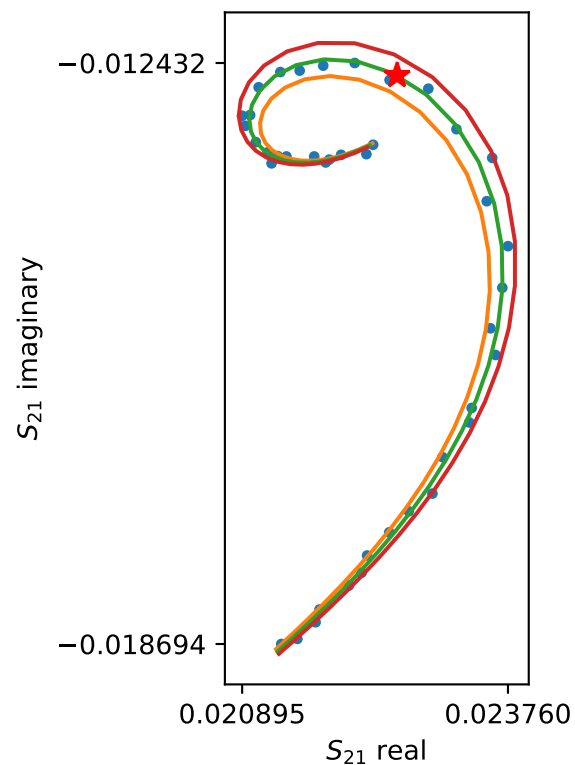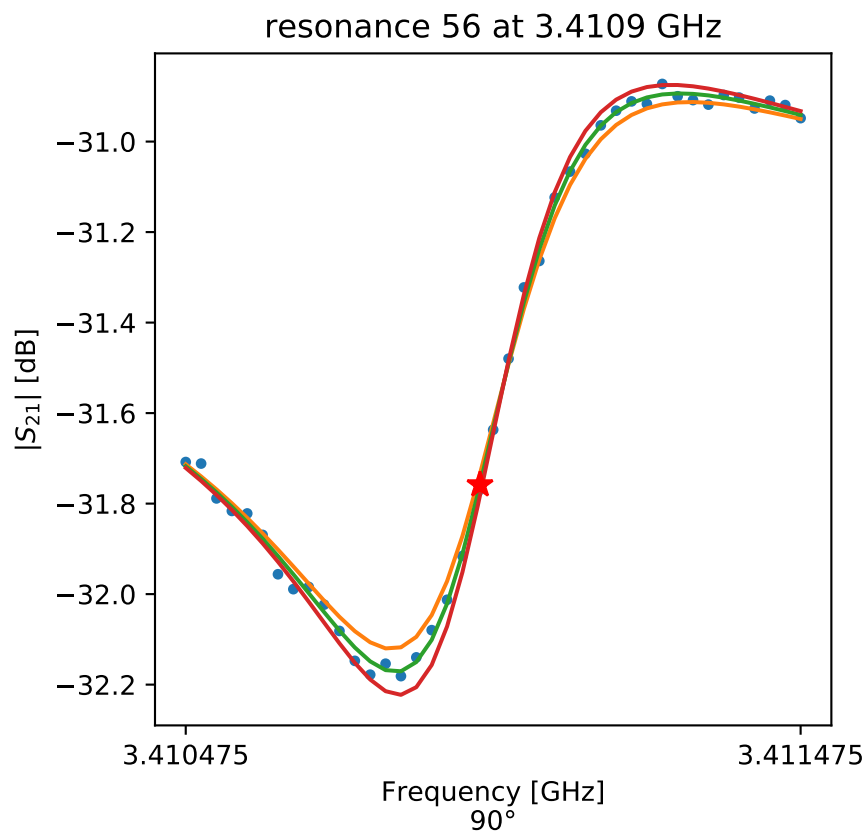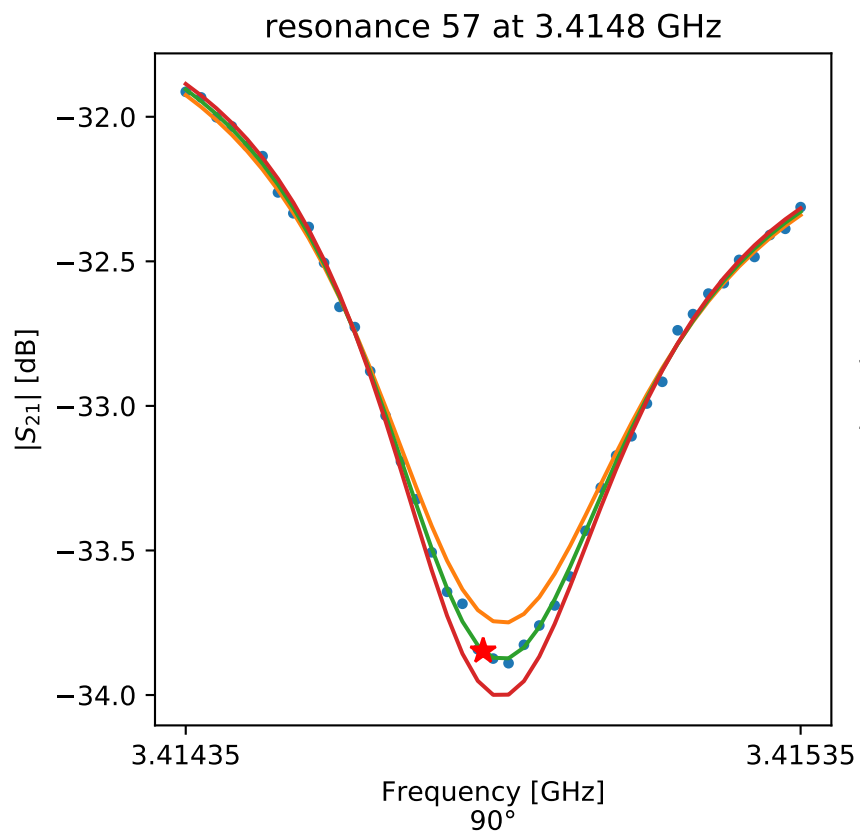

$$S_{21}(f) = ae^{-2\pi j f \tau}\left[1 - \frac{Q_r/Q_c e^{j\phi_0}}{1 + 2jQ_r(\frac{f-f_r}{f_r})}\right]$$

f_r = 3.4109535869065057
Q_r = 7795.878404172561
Q_c = 53390.424882783605
Q_i = 9128.838698473432
a = (-108150652630.26566+134678262960.99808j)
ϕ_0 = -1.0718757038574098
τ = (36.78160656388252-1.3749881719172616j)

resonance 57 at 3.4148 GHz
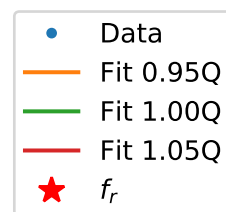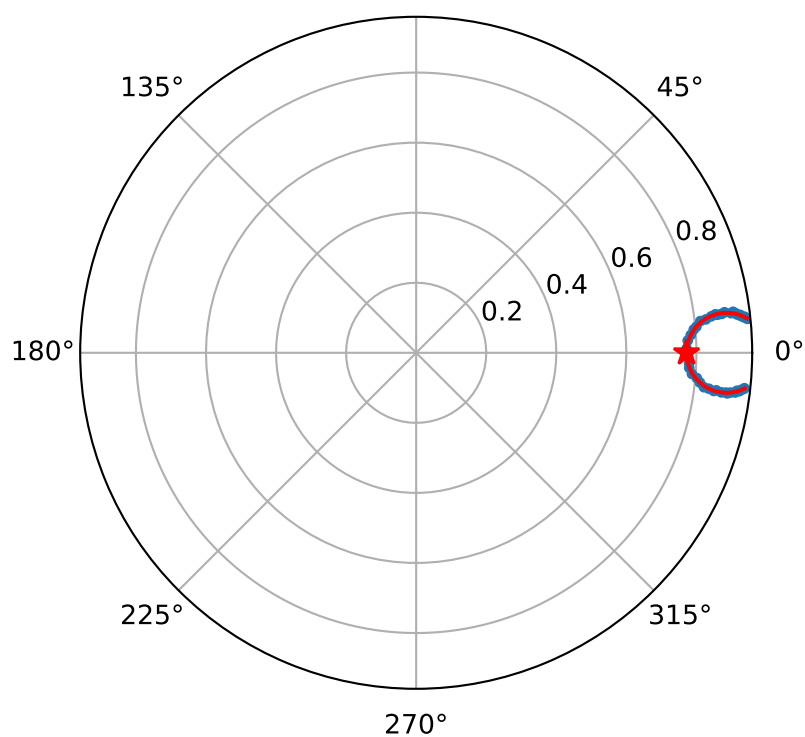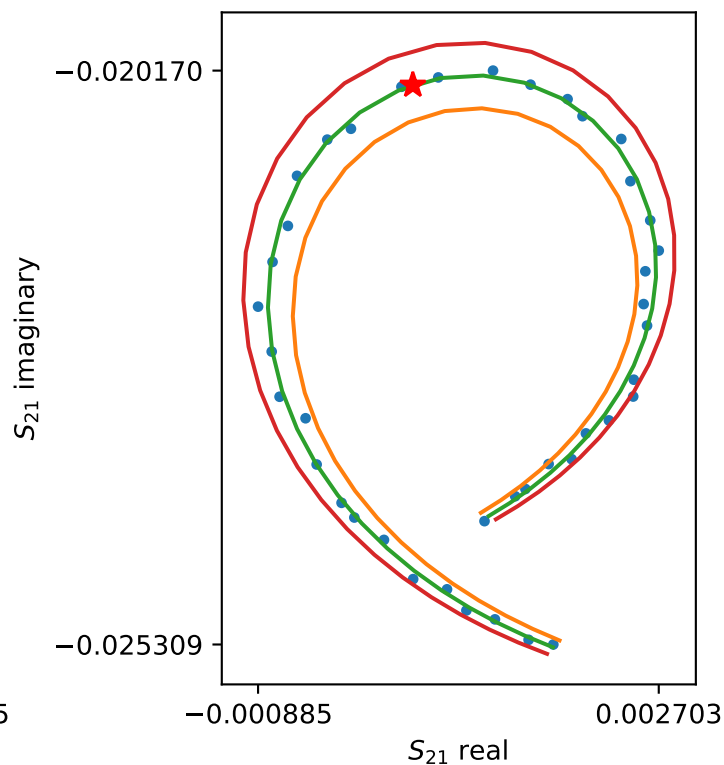
$$S_{21}(f) = ae^{-2\pi jf\tau}\left[1 - \frac{Q_r/Q_c e^{j\phi_0}}{1 + 2jQ_r(\frac{f-f_r}{f_r})}\right]$$

$f_r = 3.414833666375695$
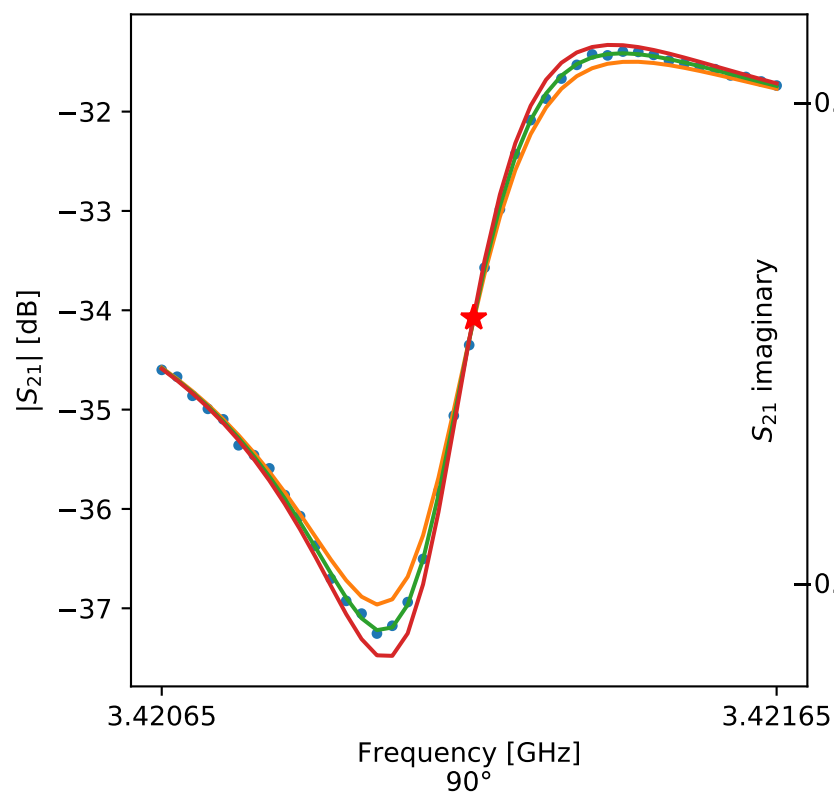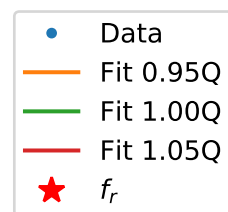$Q_r = 5776.318851978723$
$Q_c = 25297.38535351719$
$Q_i = 7485.542037970901$
$a = (-2.2019679577933577e+24-2.30415336877712514e$
$\phi_0 = 0.16521111637612312$
$\tau = (36.56604866291746-2.799398597633401j)$

resonance 58 at 3.4211 GHz
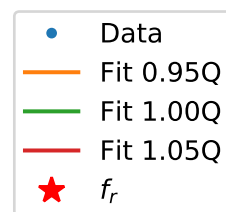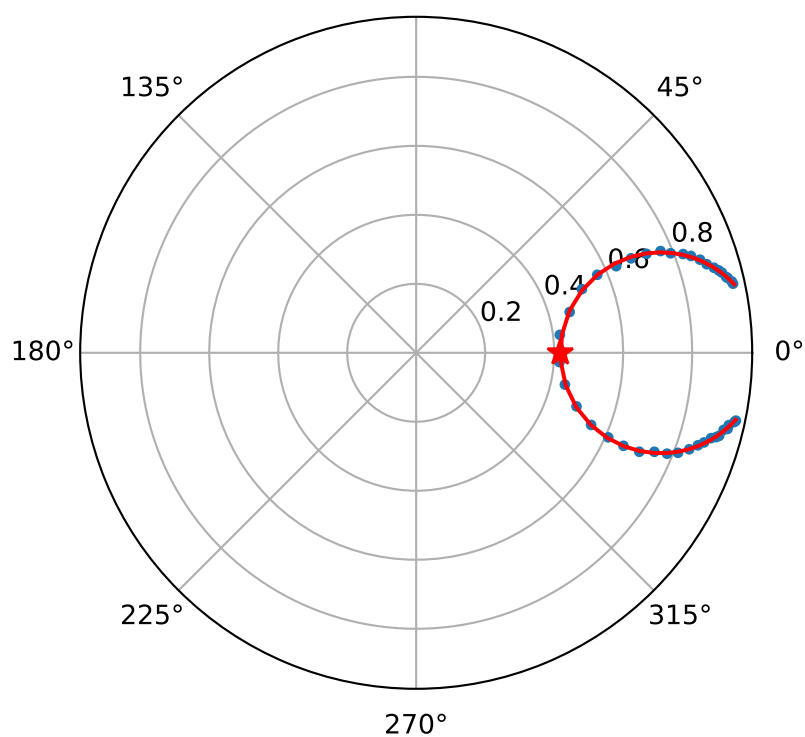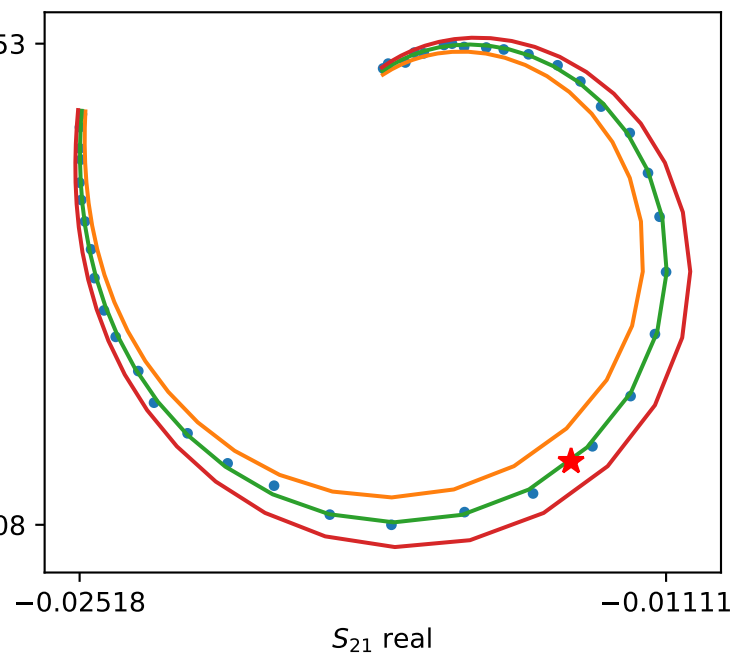
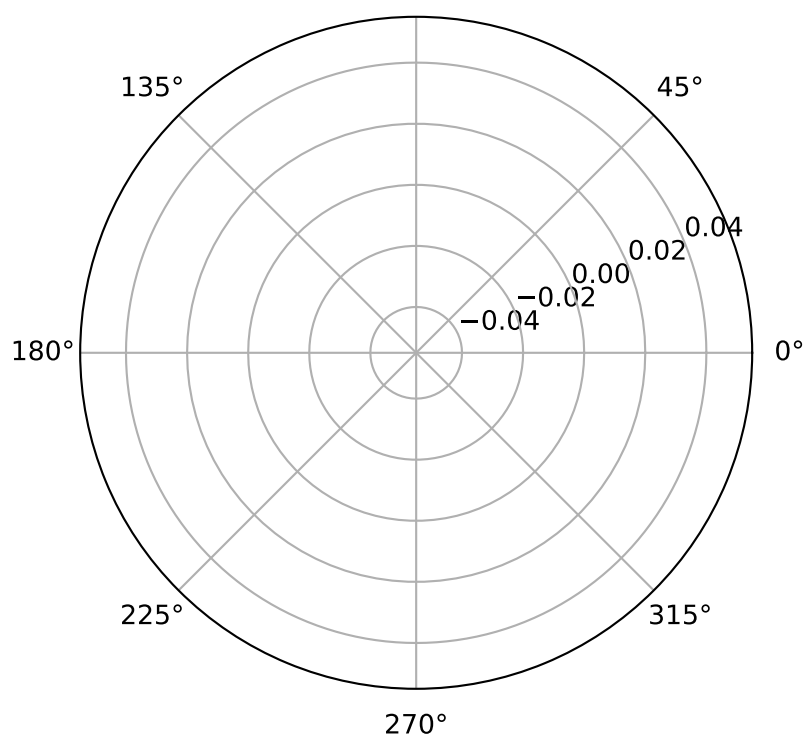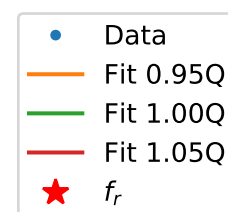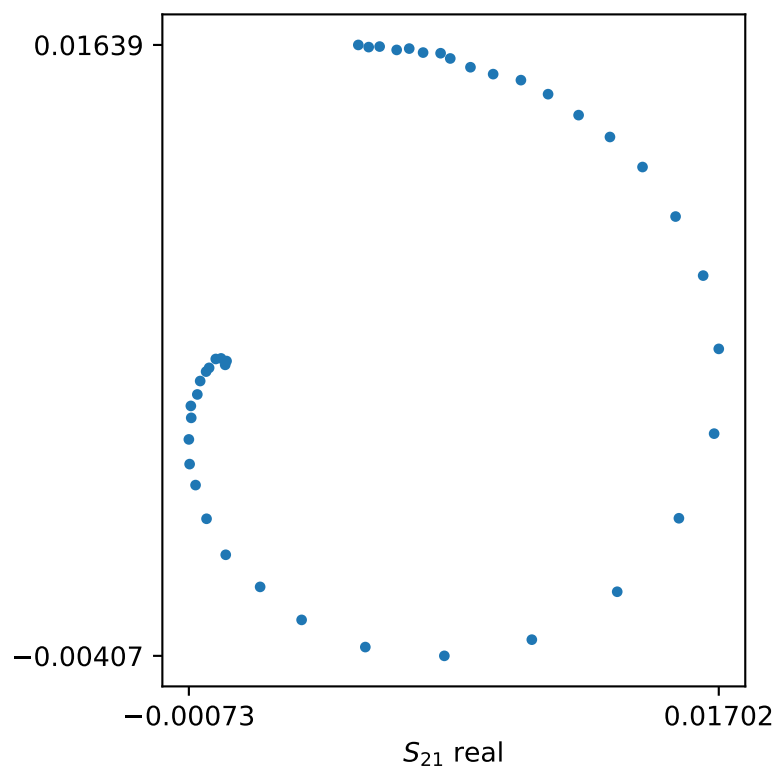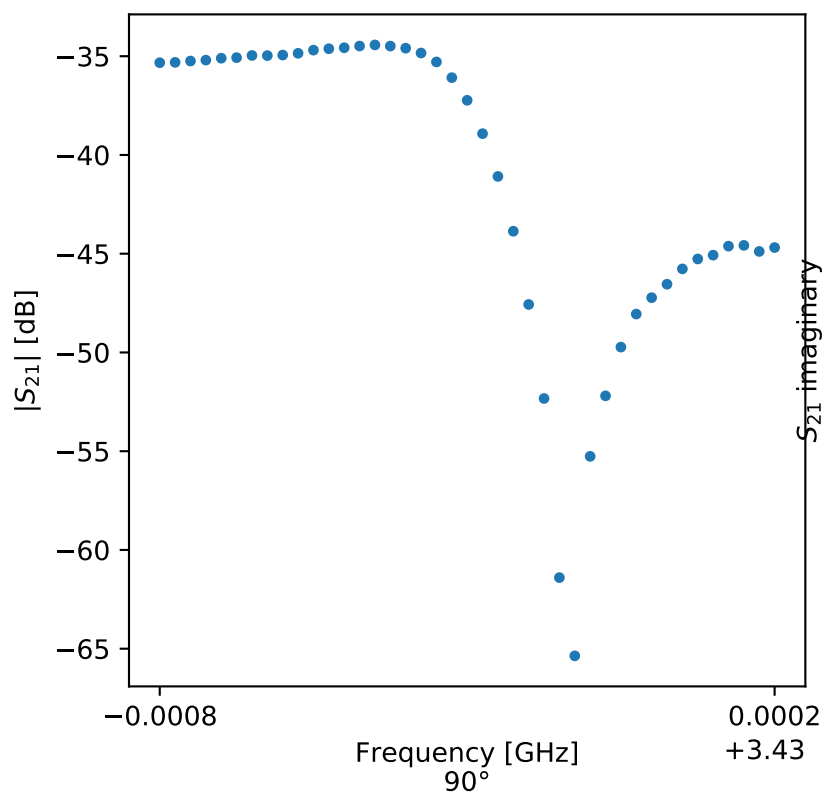$$S_{21}(f) = ae^{-2\pi jf\tau}\left[1 - \frac{Q_r/Q_c e^{j\phi_0}}{1 + 2jQ_r(\frac{f-f_r}{f_r})}\right]$$

f_r = 3.421157420586042
Q_r = 8816.593660894565
Q_c = 15140.499996310353
Q_i = 21108.41451630504
a = (-1.1596945640612593e+48-2.0965551243079993e
ϕ_0 = -1.0278483972254382
τ = (37.74645582654749-5.357737357145384j)

resonance 59 at 3.425 GHz
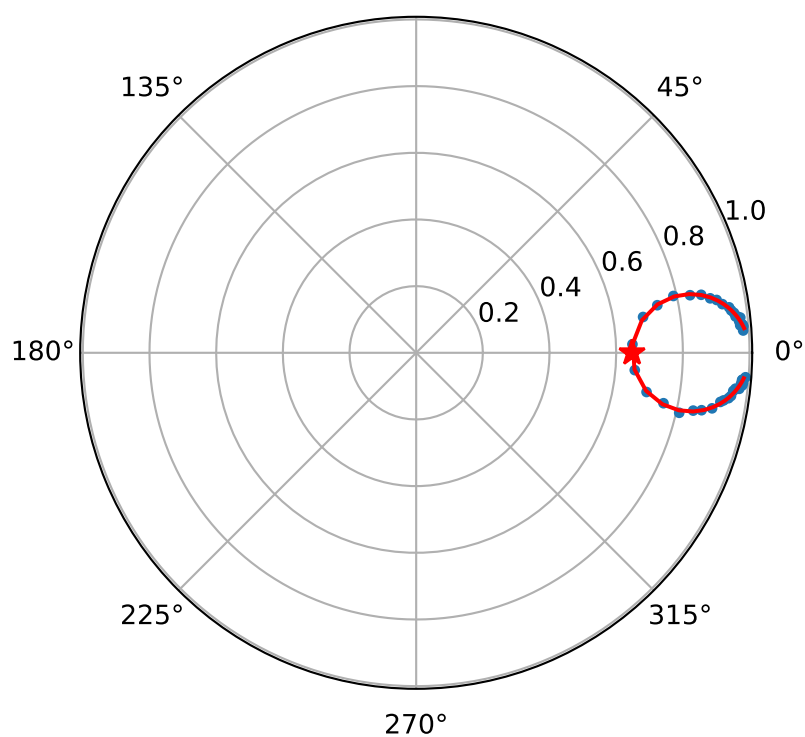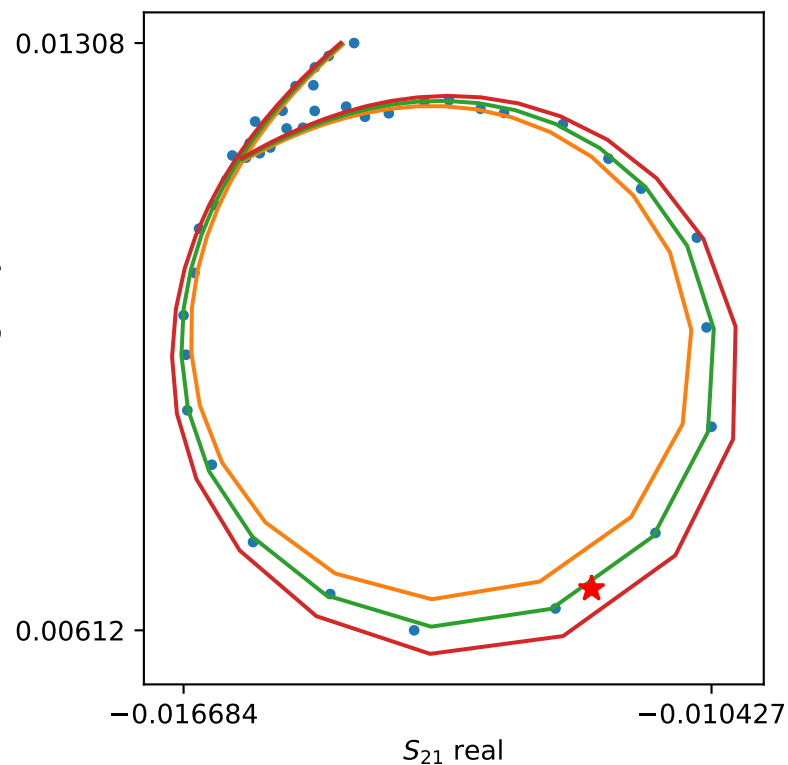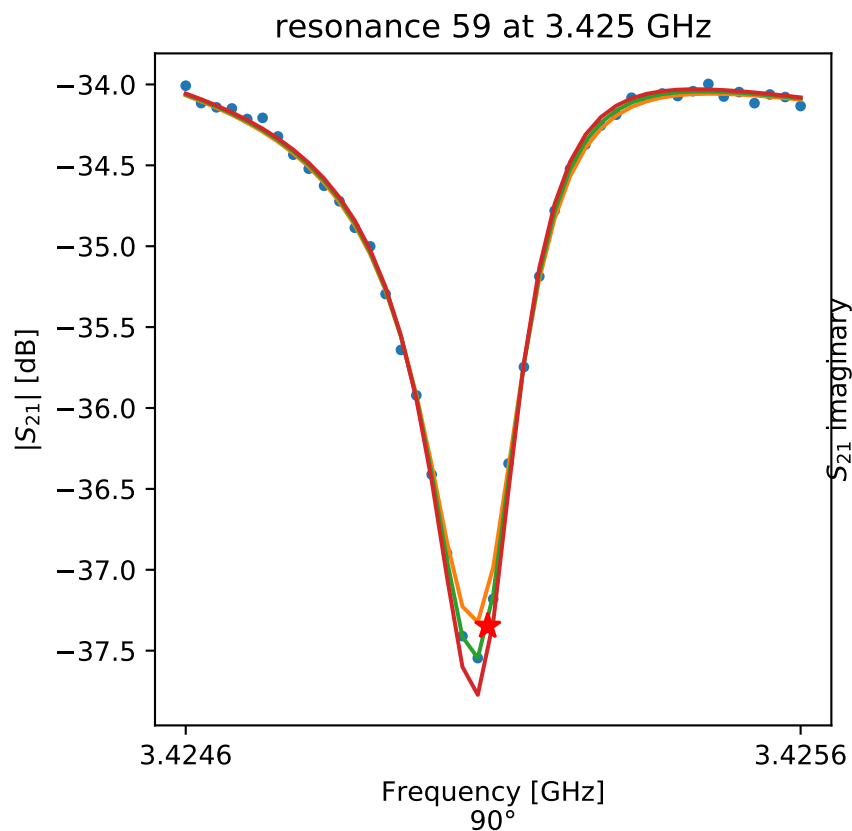
$$S_{21}(f) = ae^{-2\pi jf\tau}\left[1 - \frac{Q_r/Q_c e^{j\phi_0}}{1 + 2jQ_r(\frac{f - f_r}{f_r})}\right]$$

f_r = 3.4250911518092173
Q_r = 15301.94946455516
Q_c = 43422.238769405296
Q_i = 23628.66527026397
a = (-6.200185731734359e+77-8.171626737465737e+7
ϕ_0 = -0.32803333124763256
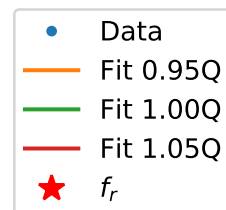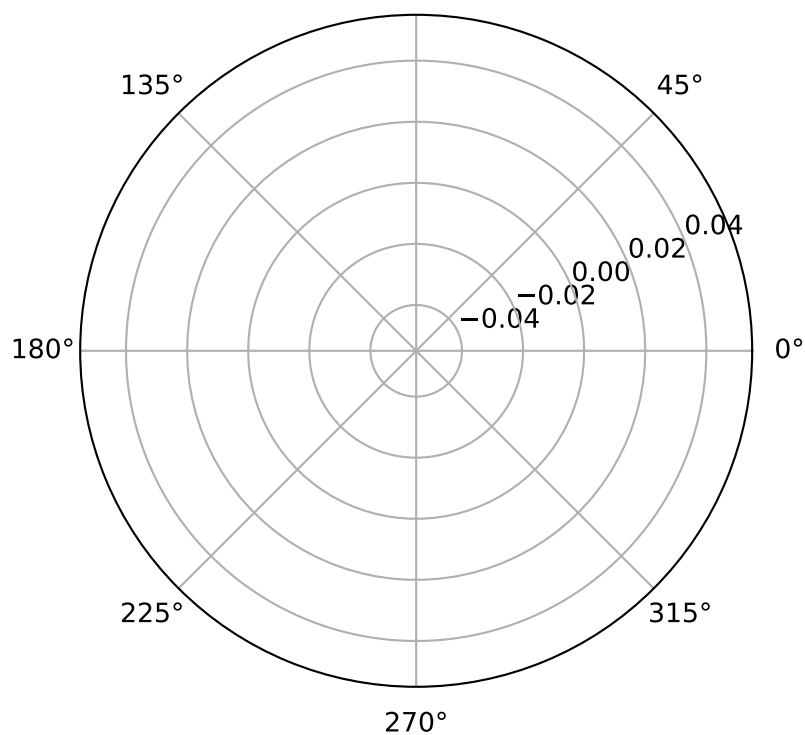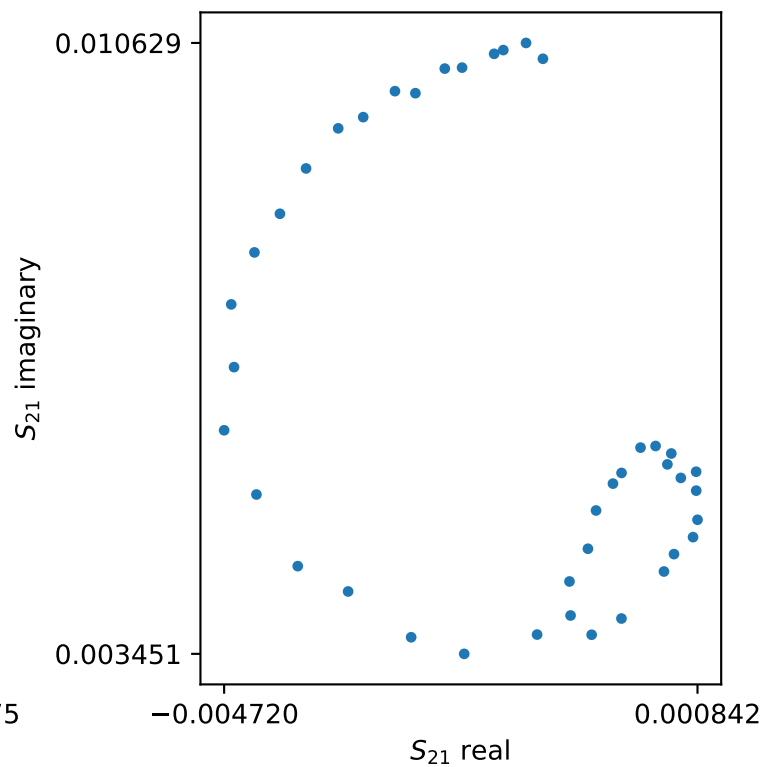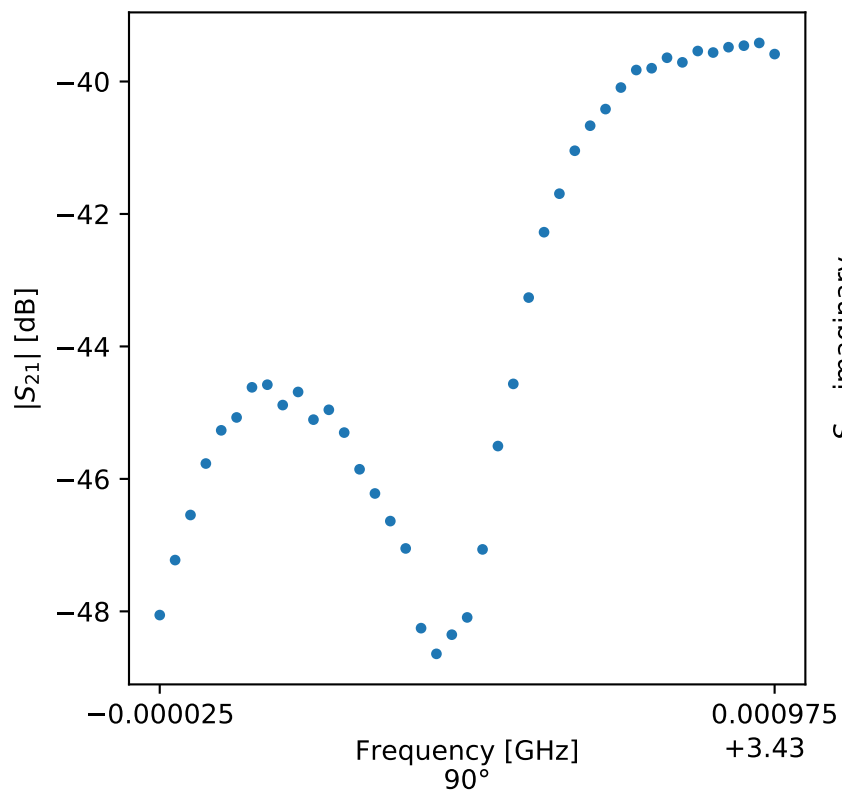τ = (37.44559550979229-8.528404559238952j)

resonance 60 at 3.4296 GHz

$$S_{21}(f) = ae^{-2\pi jf\tau}\left[1 - \frac{Q_r/Q_c e^{j\phi_0}}{1 + 2jQ_r(\frac{f-f_r}{f_r})}\right]$$
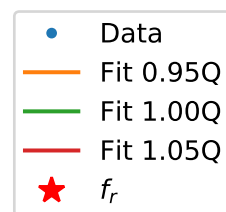
f_r = 3.429697536993881
Q_r = 12356.08180828249
Q_c = 8016.656053291138
Q_i = -22826.62813377844
a = (-inf+nanj)
ϕ_0 = 0.9023974465279627
τ = (46.21356534648687-50.06996736995394j)

resonance 61 at 3.4305 GHz

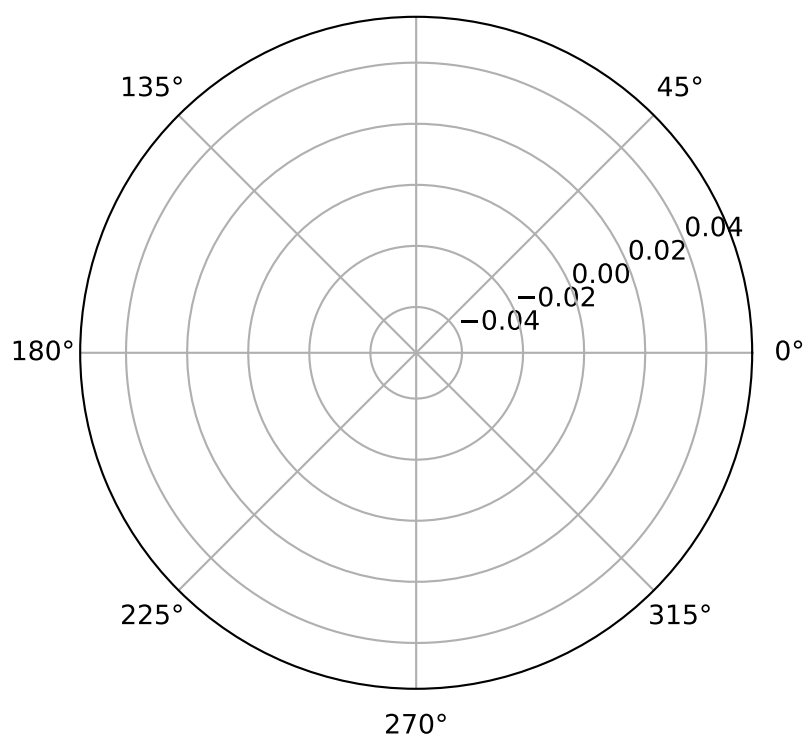$$S_{21}(f) = ae^{-2\pi jf\tau}\left[1 - \frac{Q_r/Q_c e^{j\phi_0}}{1 + 2jQ_r(\frac{f - f_r}{f_r})}\right]$$

f_r = 3.430538630421916
Q_r = 10183.855834063448
Q_c = 15166.873004893829
Q_i = 30996.732068183574
a = -0j
ϕ_0 = -0.6834382857579879
τ = (37.79096601570775+48.304955044292j)

resonance 62 at 3.4398 GHz

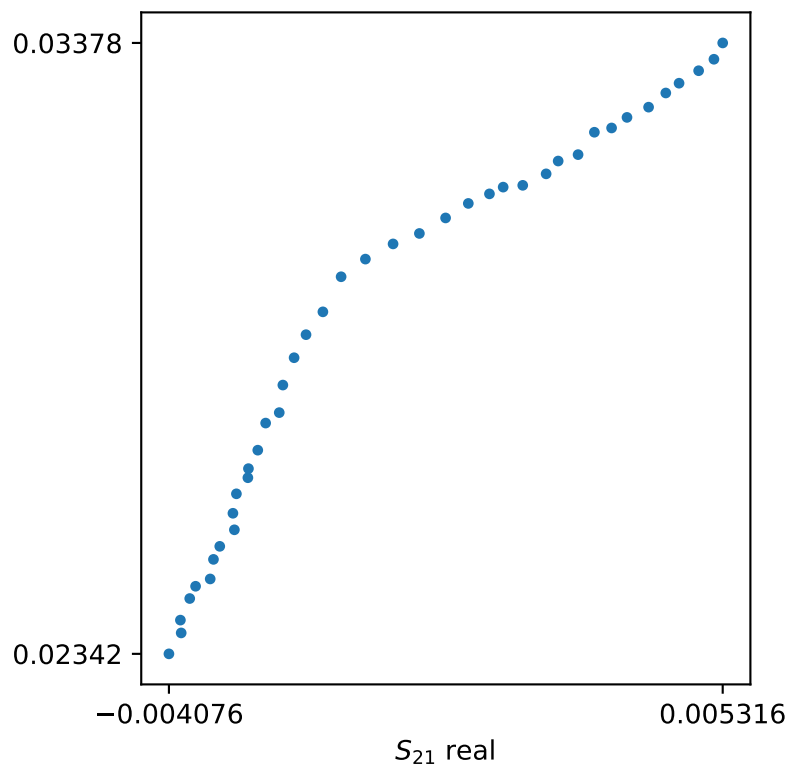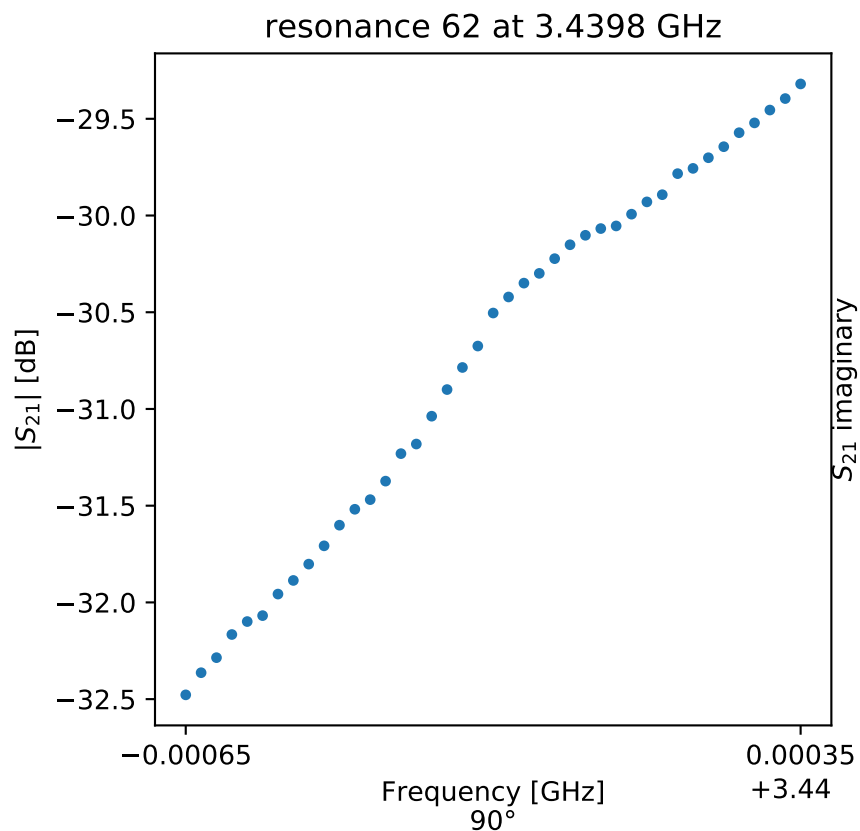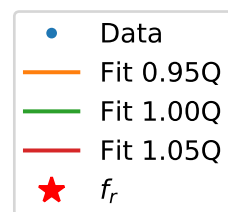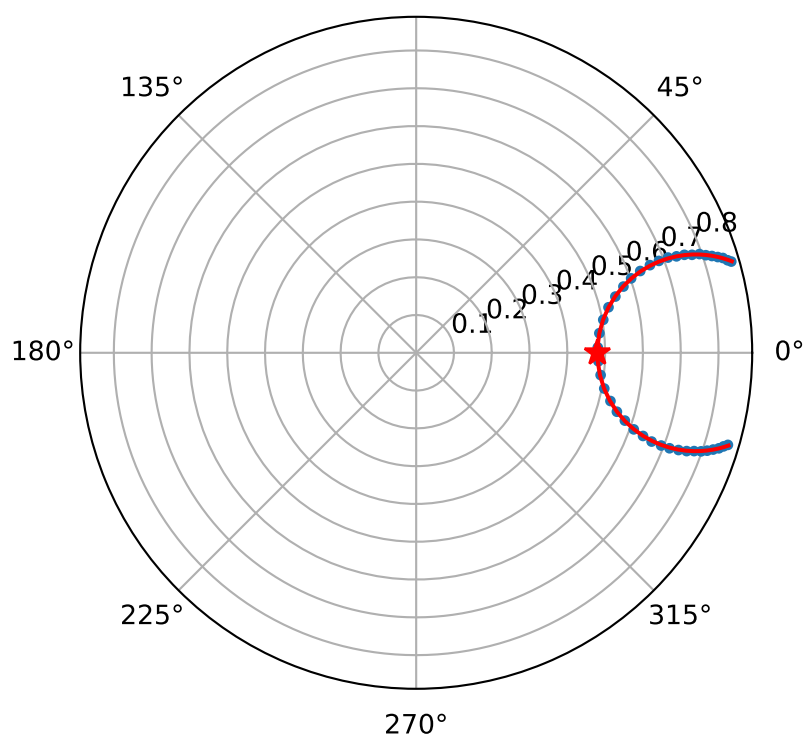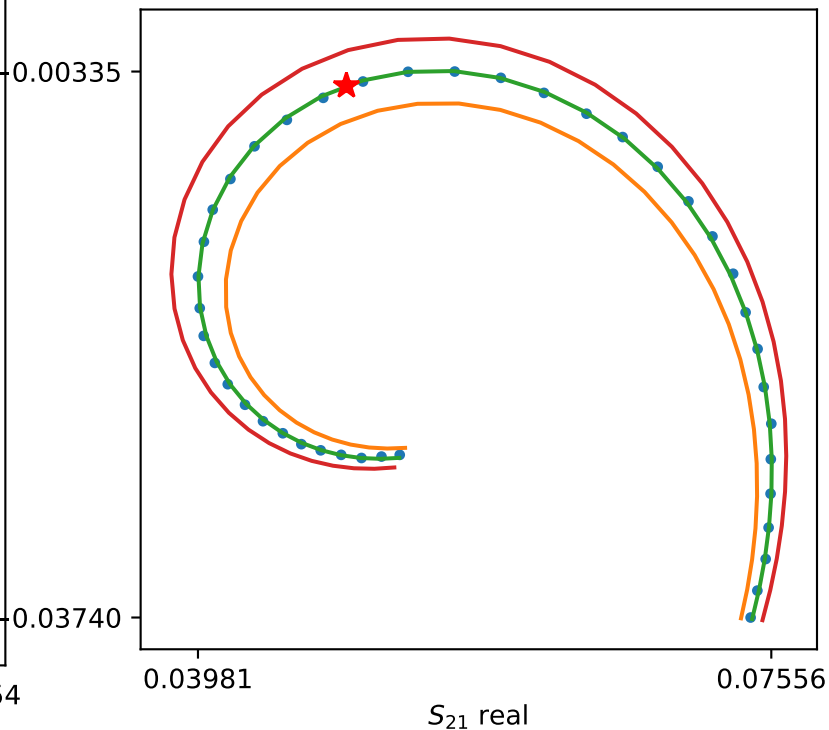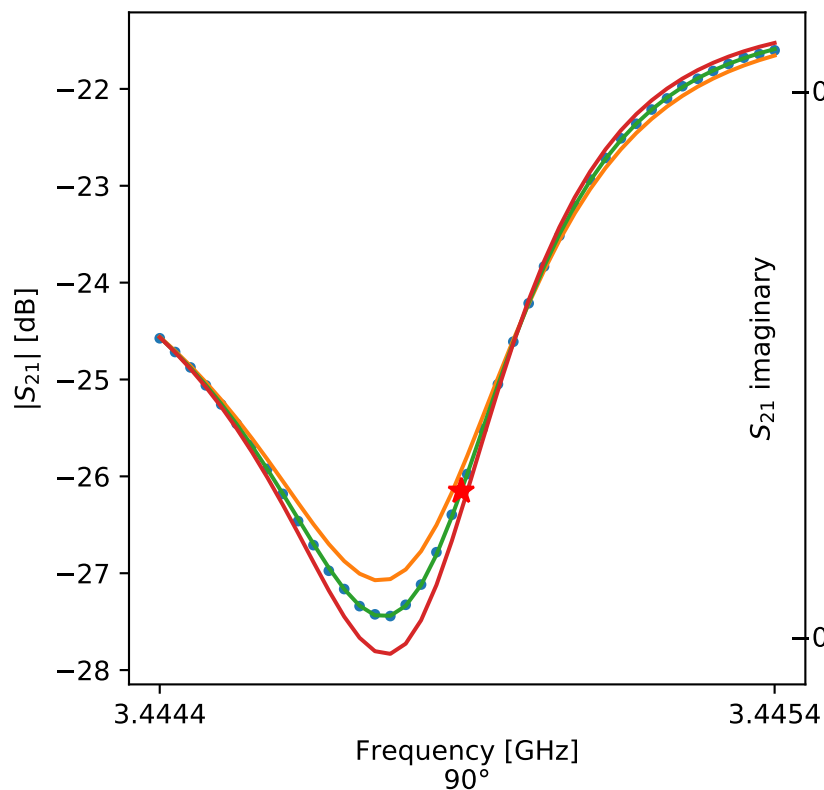$$S_{21}(f) = ae^{-2\pi jf\tau}\left[1 - \frac{Q_r/Q_c e^{j\phi_0}}{1 + 2jQ_r(\frac{f-f_r}{f_r})}\right]$$

f_r = 3.43985316609524094
Q_r = 9393.53961864622
Q_c = 168380.34252941856
Q_i = 9948.545348377122
a = (-0+0j)
ϕ_0 = -2.4687041690870326
τ = (47.992153904375684+52.86678323445063j)

resonance 63 at 3.4448 GHz

$$S_{21}(f) = ae^{-2\pi jf\tau}\left[1 - \frac{Q_r/Q_c e^{j\phi_0}}{1 + 2jQ_r(\frac{f - f_r}{f_r})}\right]$$

f_r = 3.4448903734605985
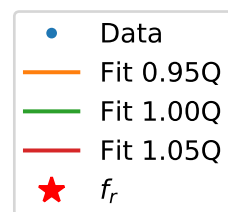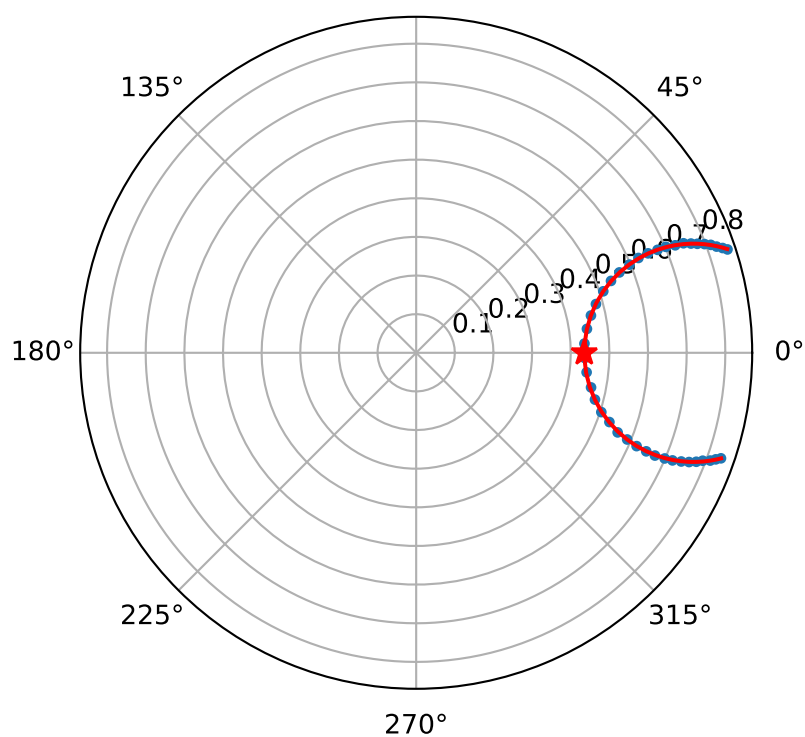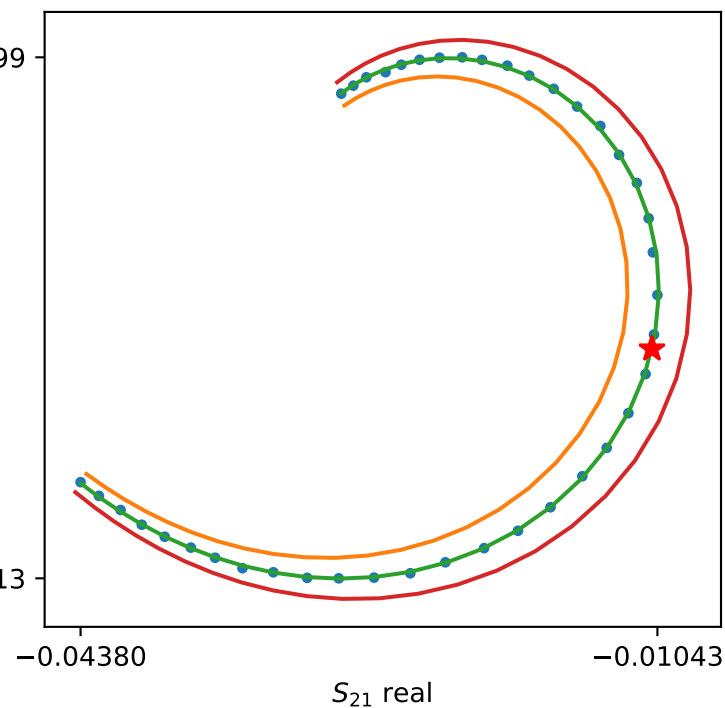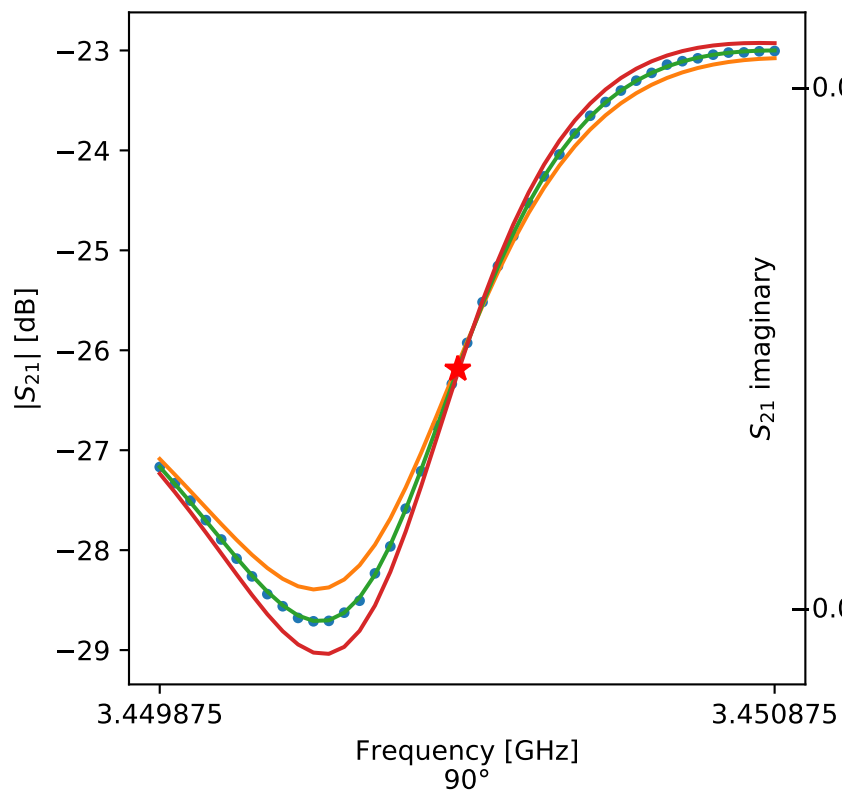Q_r = 4964.512891203023
Q_c = 9536.338105739787
Q_i = 10355.442572537806
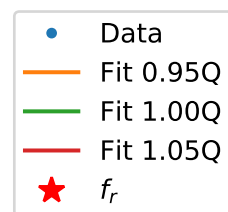a = (-1.8024286181846577e-25-2.378893344774007e-2
ϕ_0 = -0.5271893062718346
τ = (70.71497061167385+2.5156758578993745j)

resonance 64 at 3.4503 GHz

$$S_{21}(f) = ae^{-2\pi jf\tau}\left[1 - \frac{Q_r/Q_c e^{j\phi_0}}{1 + 2jQ_r(\frac{f-f_r}{f_r})}\right]$$

f_r = 3.45035974212954333
Q_r = 4611.650699136678
Q_c = 8162.618955666819
Q_i = 10600.812143128114
a = (-6.378037991443858e+79+1.1830399603326174e+
ϕ_0 = -0.844065795208946
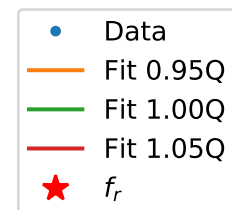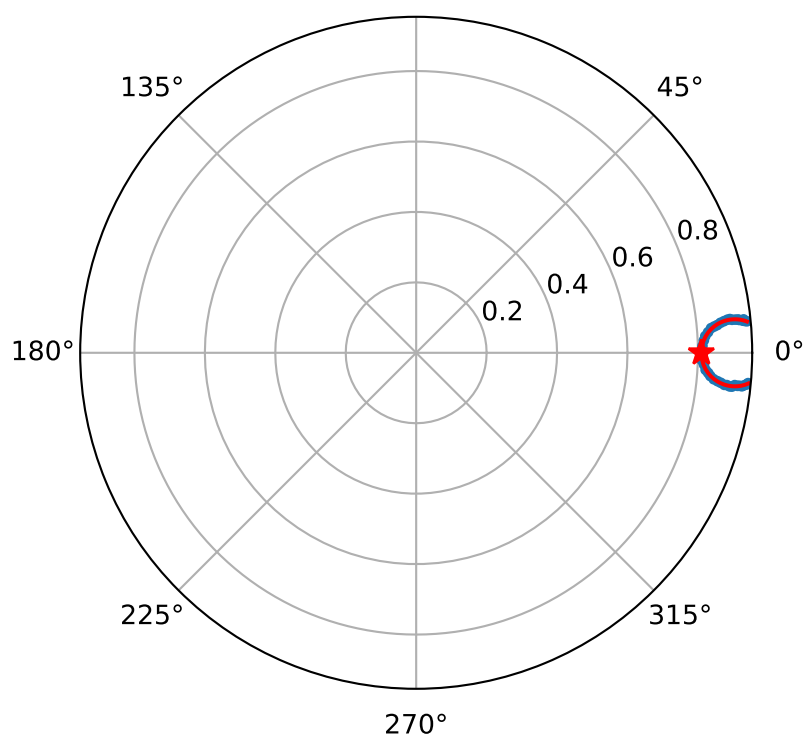τ = (44.838355151390296-8.636600356566799j)

resonance 65 at 3.4563 GHz
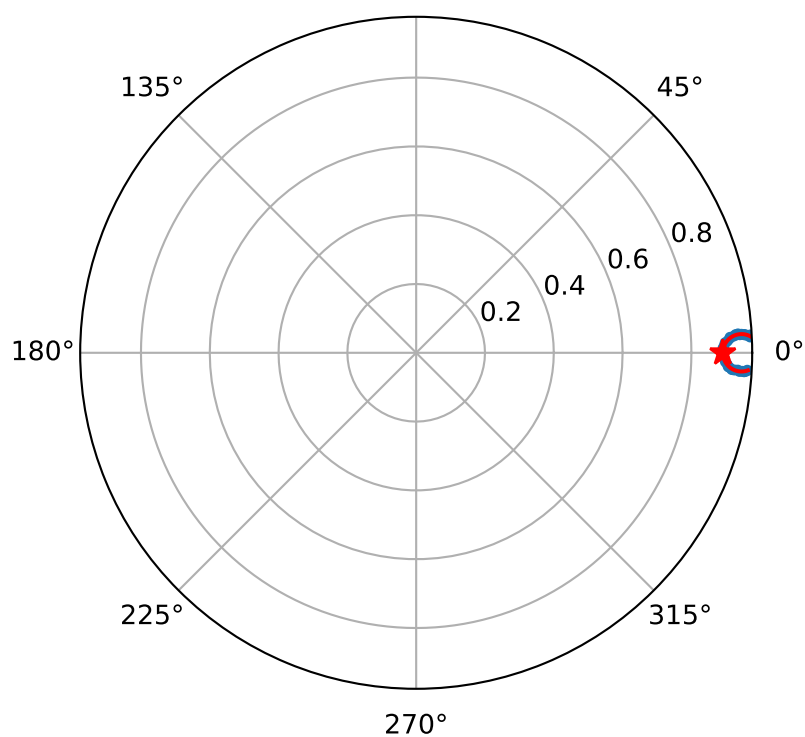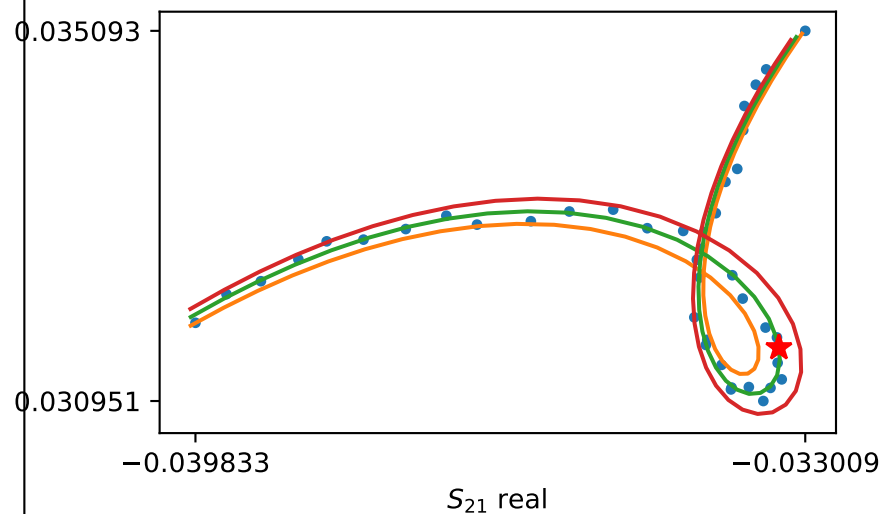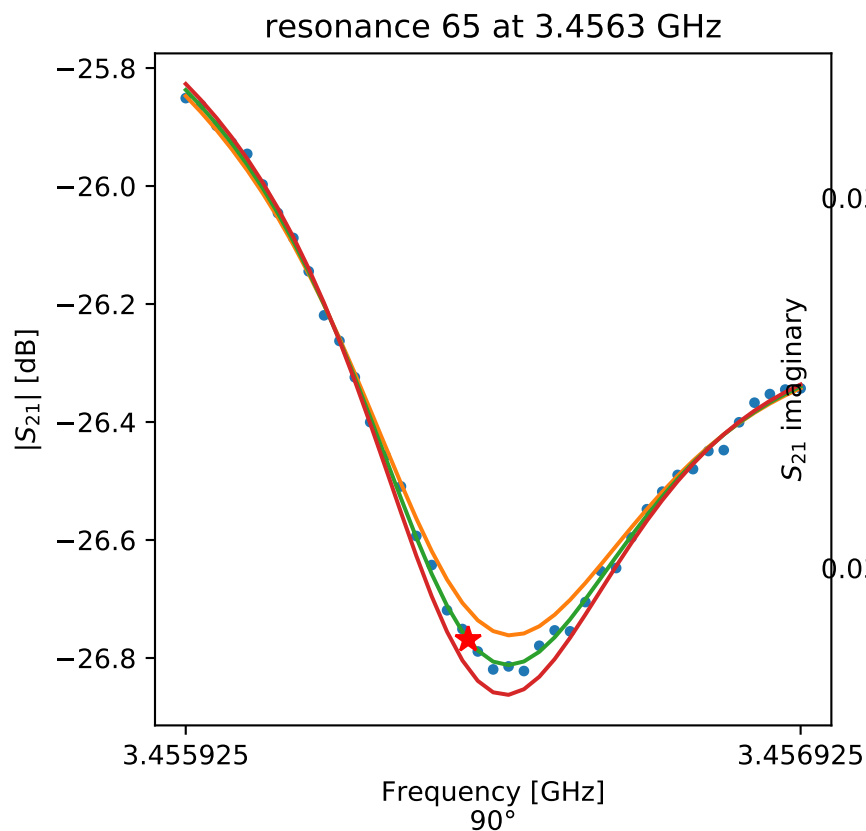
$$S_{21}(f) = ae^{-2\pi jf\tau}\left[1 - \frac{Q_r/Q_c e^{j\phi_0}}{1 + 2jQ_r(\frac{f-f_r}{f_r})}\right]$$

$f_r = 3.4563843032874693$
$Q_r = 5354.935528396306$
$Q_c = 49265.1025400393$
$Q_i = 6007.980972420184$
$a = (-5.493245424189177e+50-1.4868133486394833e+$
$\phi_0 = 0.2894898637997596$
$\tau = (37.99023640253787-5.565424951659664j)$
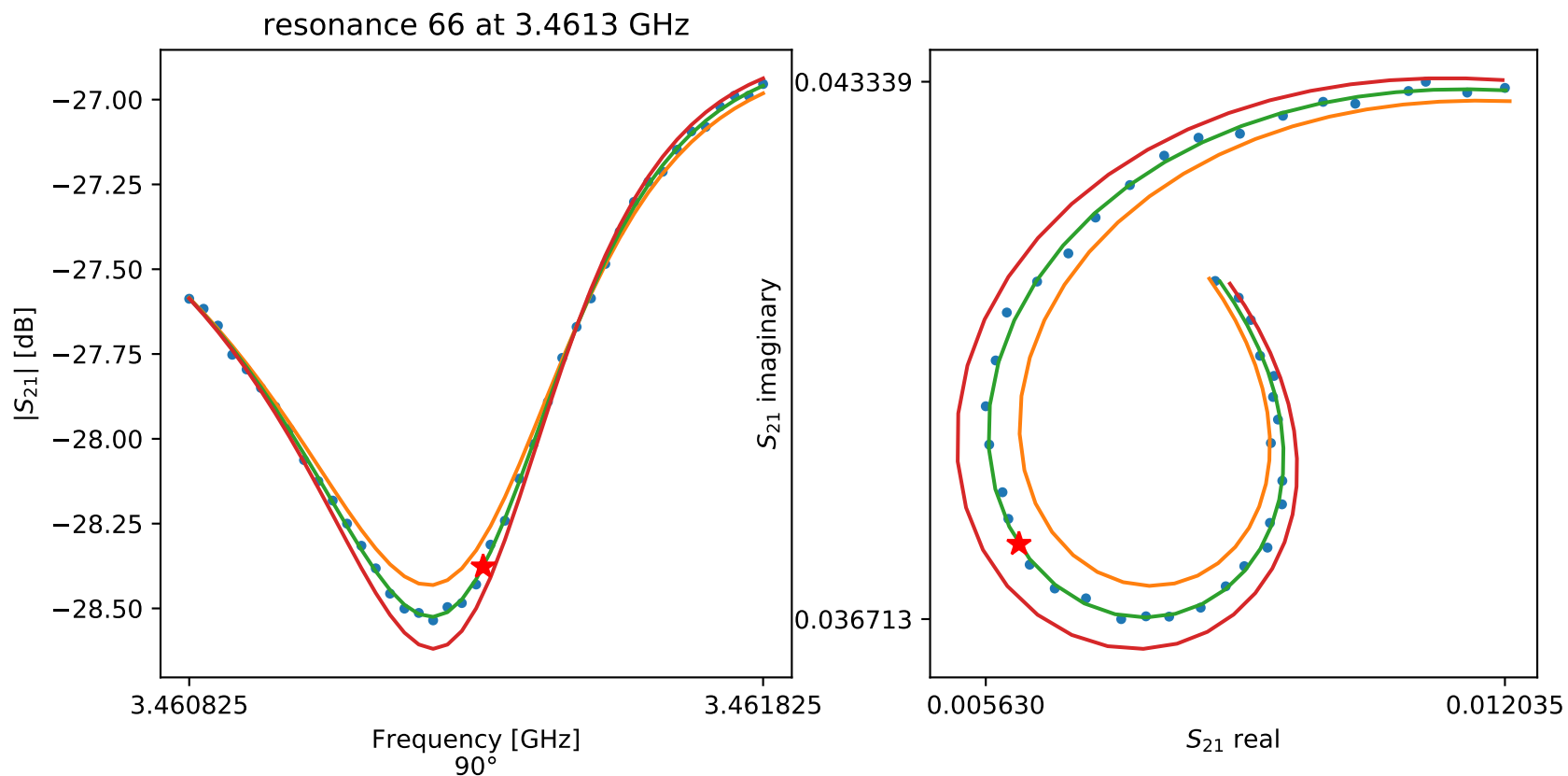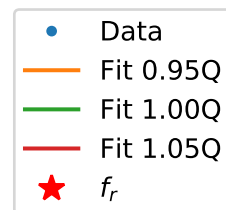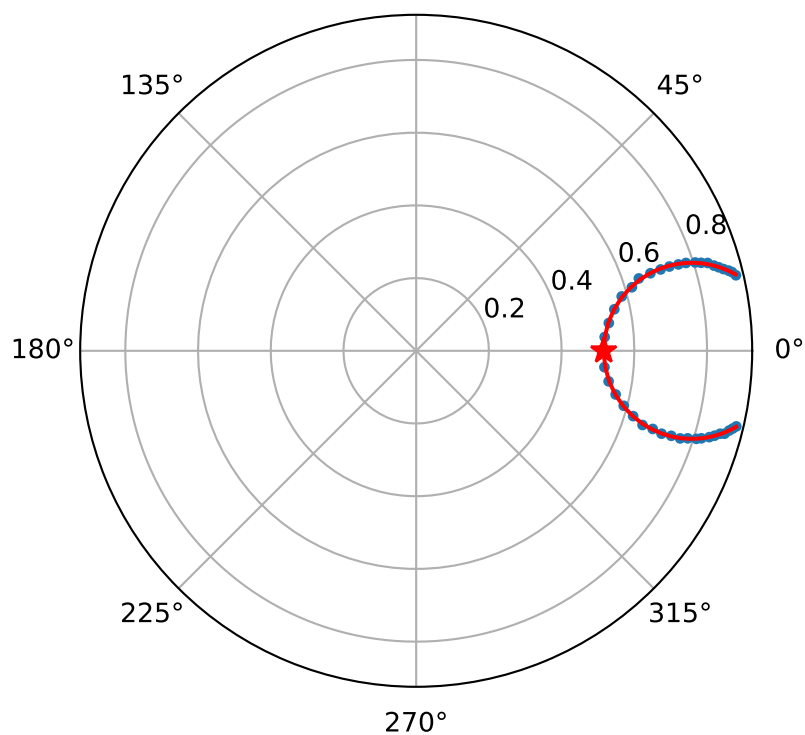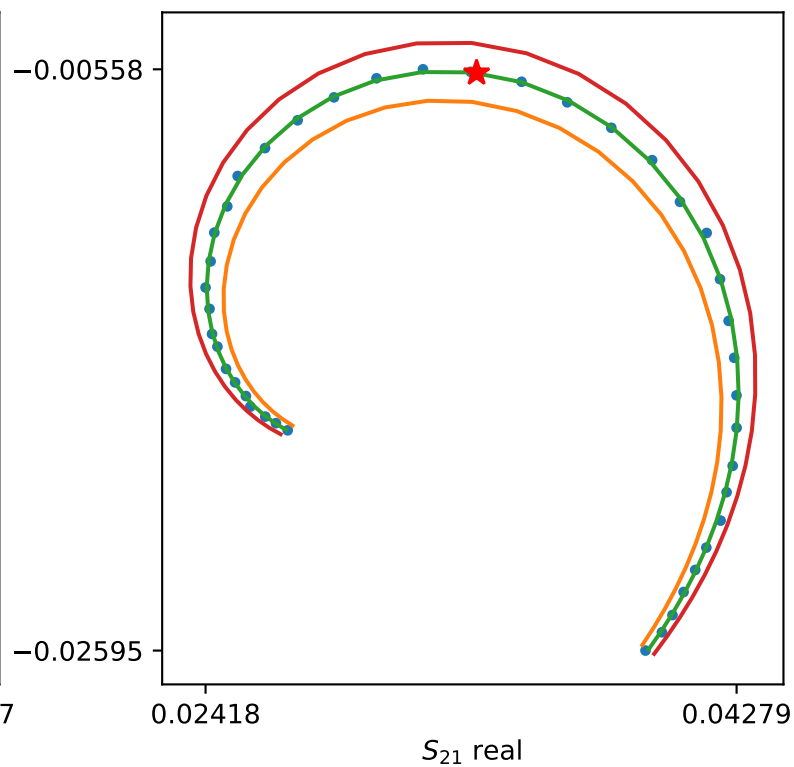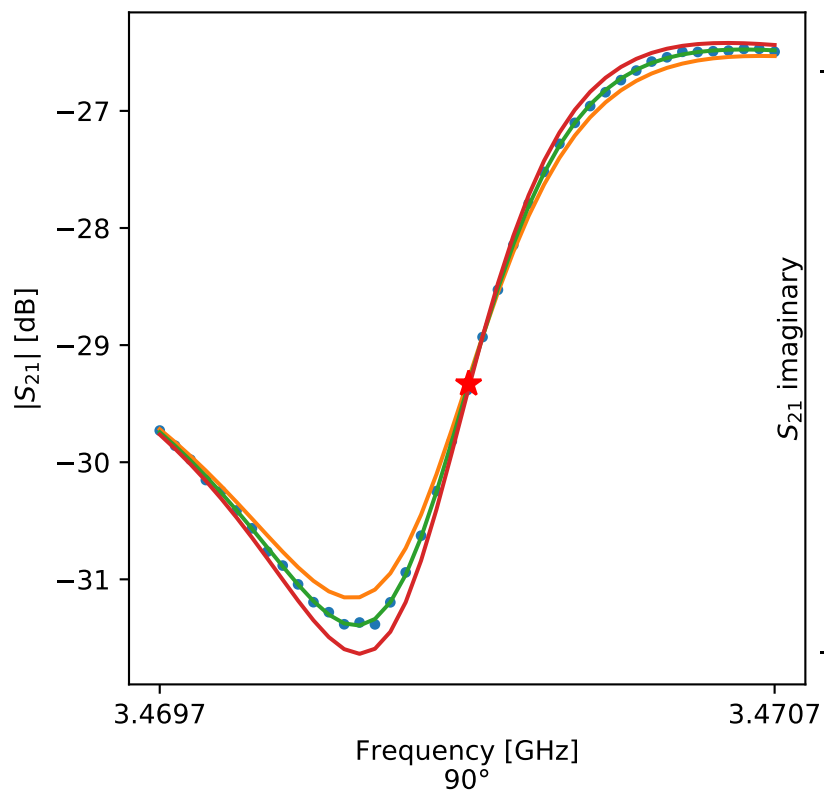
resonance 66 at 3.4613 GHz

Data
Fit 0.95Q
Fit 1.00Q
Fit 1.05Q
f_r

$$S_{21}(f) = ae^{-2\pi jf\tau}\left[1 - \frac{Q_r/Q_c e^{j\phi_0}}{1 + 2jQ_r(\frac{f-f_r}{f_r})}\right]$$

f_r = 3.461337183765735
Q_r = 5173.163118832539
Q_c = 27170.027868656893
Q_i = 6389.7736203024315
a = (8.440458467619014e+24-2.0004107932858875e+2
ϕ_0 = -0.49993466102864714
τ = (36.33152521310251-2.7824131781259793j)

resonance 67 at 3.4702 GHz

$$S_{21}(f) = ae^{-2\pi jf\tau}\left[1 - \frac{Q_r/Q_c e^{j\phi_0}}{1 + 2jQ_r(\frac{f-f_r}{f_r})}\right]$$

f_r = 3.4702023585148156
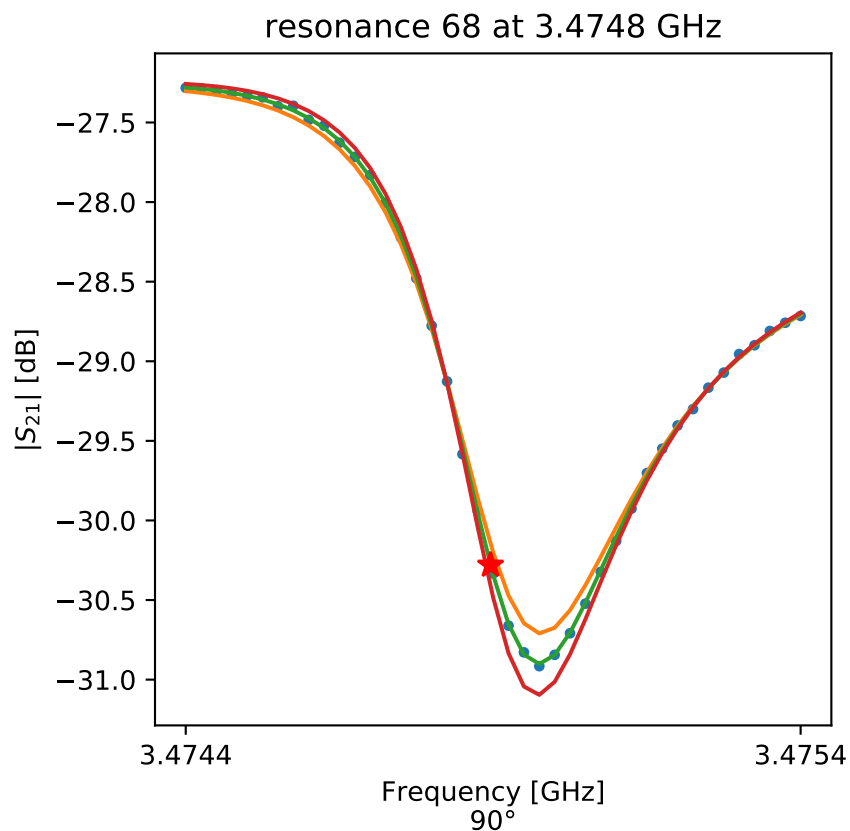Q_r = 6016.138401510018
Q_c = 12422.517364494935
Q_i = 11665.80750089463
a = (-88261.93650447694-1316887.9482424185j)
ϕ_0 = -0.9118442213735107
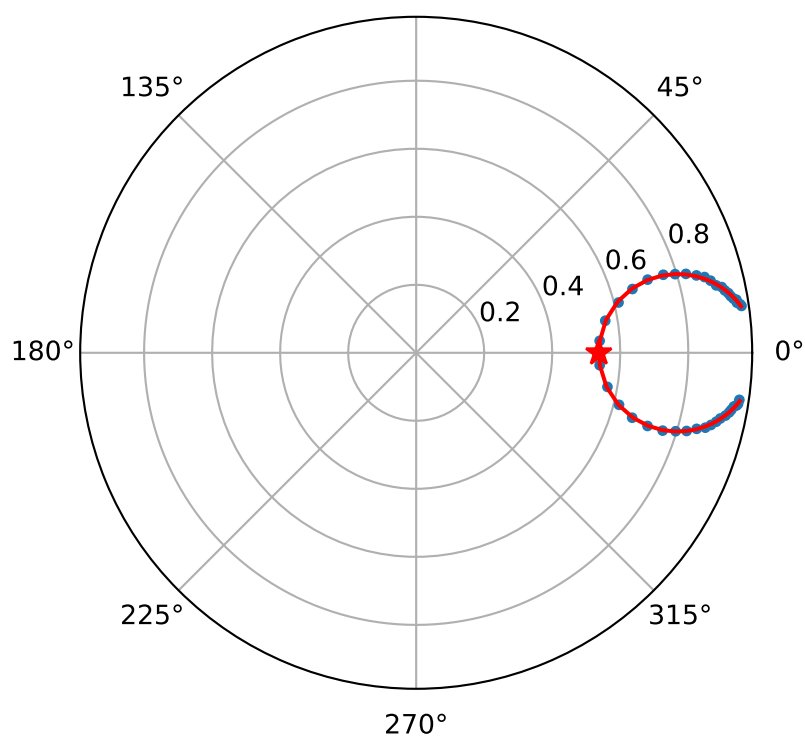τ = (36.84089890325806-0.791044385407275j)

resonance 68 at 3.4748 GHz
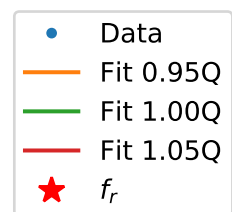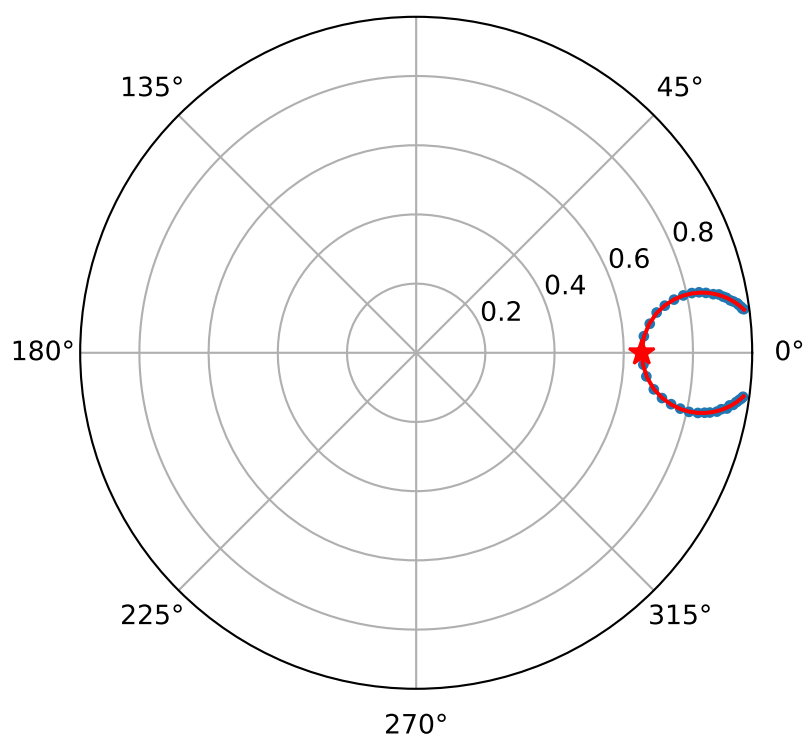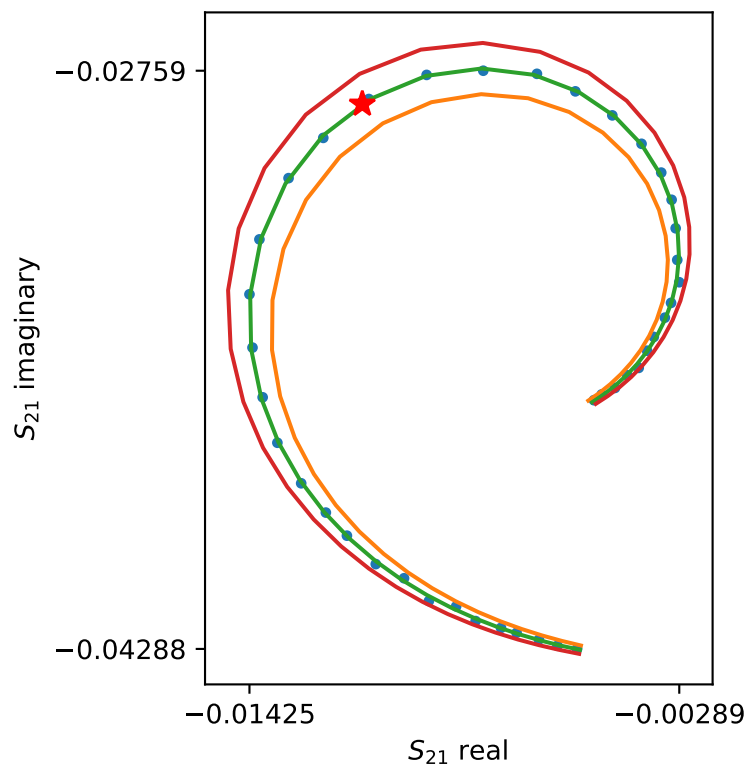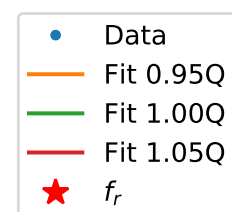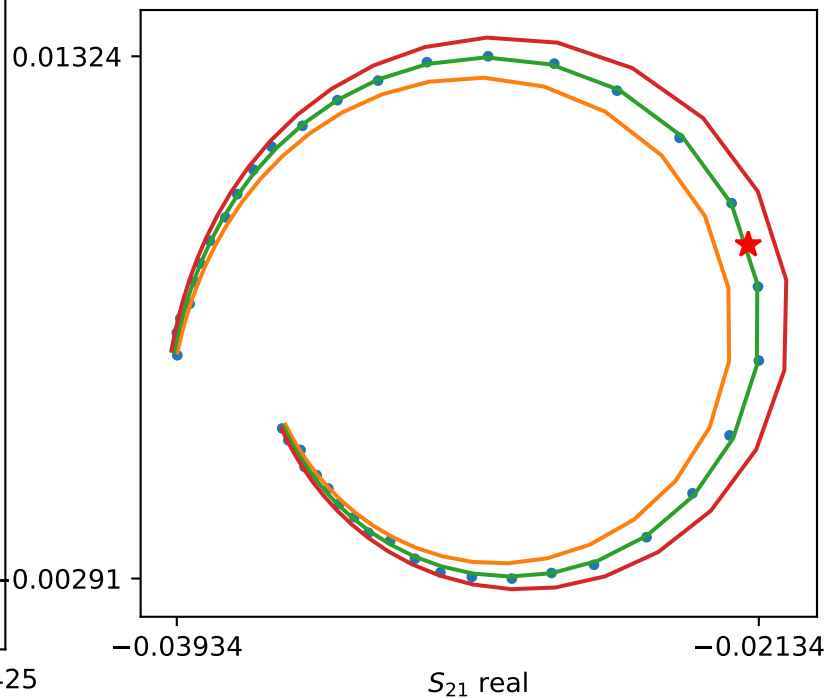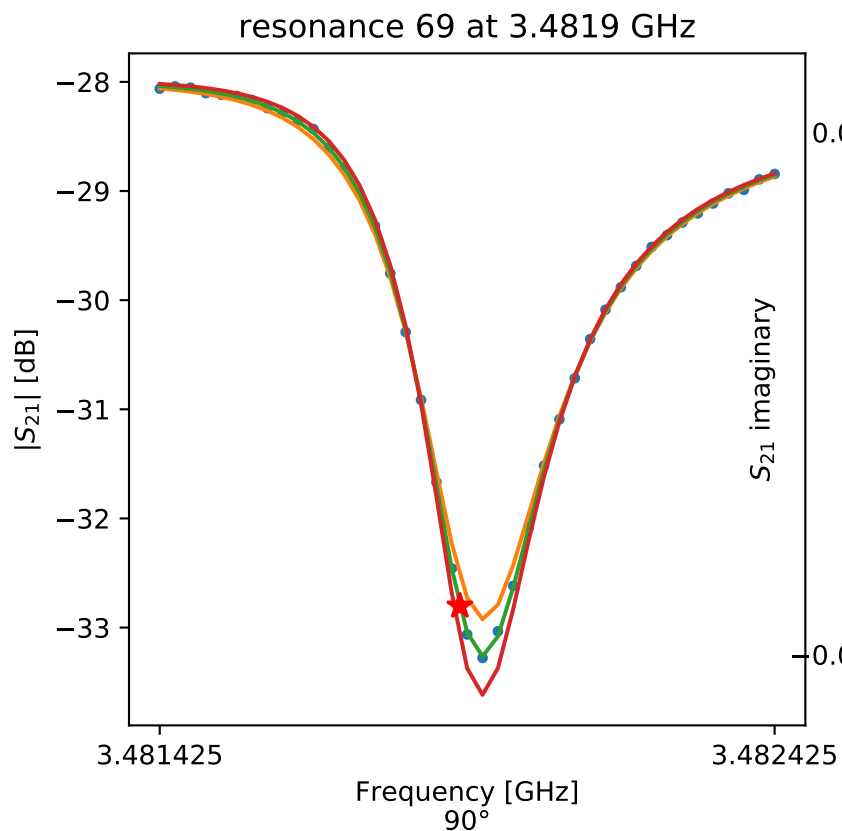

$$S_{21}(f) = a e^{-2\pi j f \tau} \left[1 - \frac{Q_r/Q_c e^{j\phi_0}}{1 + 2jQ_r(\frac{f-f_r}{f_r})} \right]$$

$f_r = 3.4748956920337095$
$Q_r = 8195.819262458444$
$Q_c = 23545.519835352203$
$Q_i = 12571.895073442267$
$a = (-1.9903430959511085e+19-1.210715282238924e+$
$\phi_0 = 0.5919554654942766$
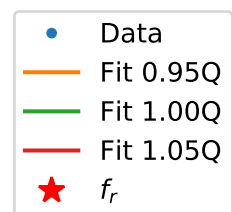$\tau = (36.21821425665112-2.18820916410506j)$

resonance 69 at 3.4819 GHz
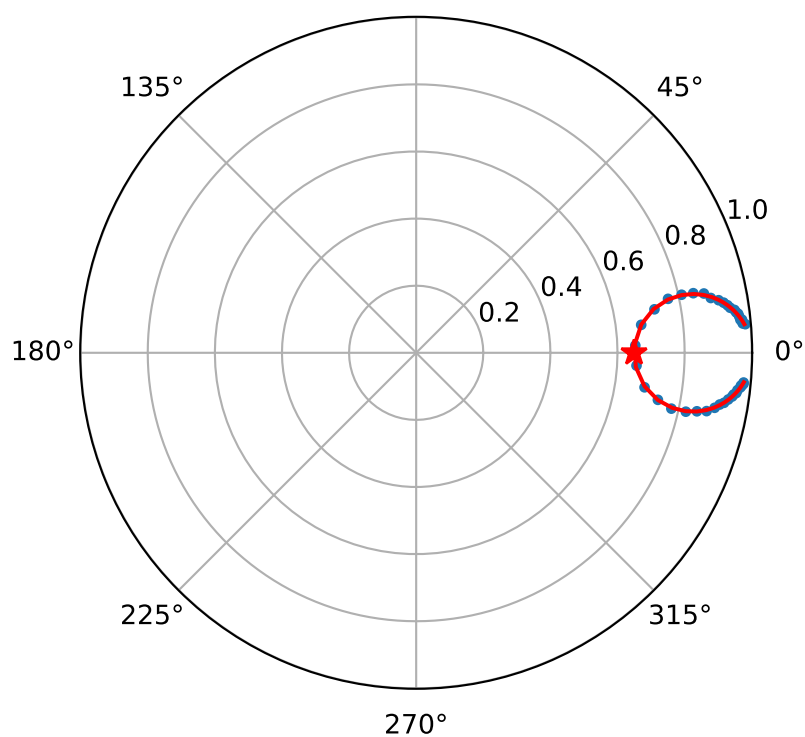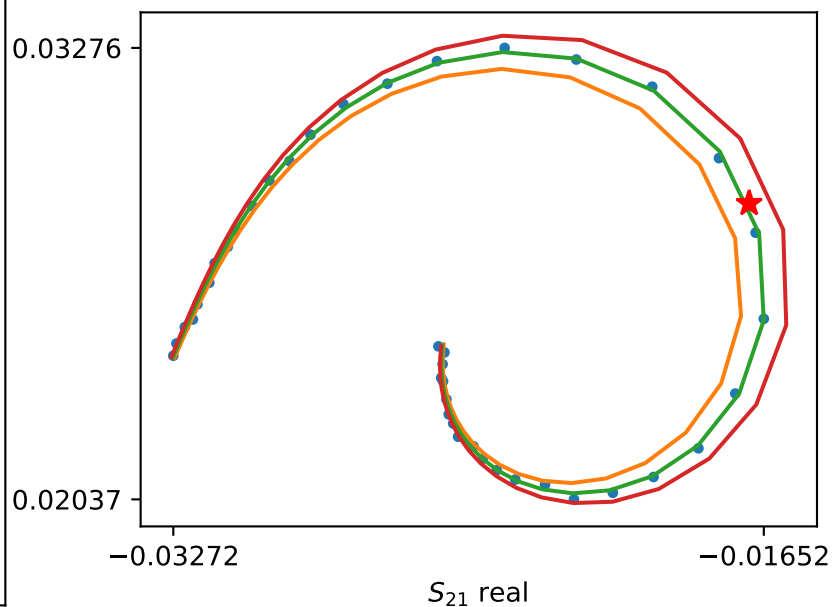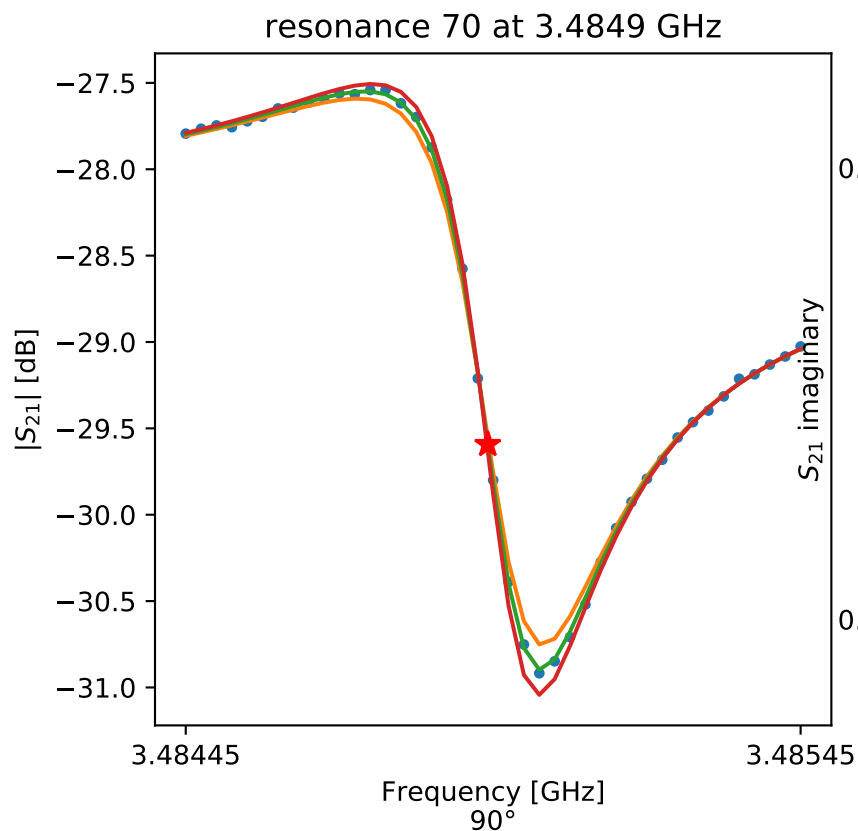
$$S_{21}(f) = ae^{-2\pi j f \tau} \left[1 - \frac{Q_r/Q_c e^{j\phi_0}}{1 + 2jQ_r(\frac{f - f_r}{f_r})} \right]$$

f_r = 3.4819130853509876
Q_r = 10410.84248011784
Q_c = 22481.687251301923
Q_i = 19389.96889590673
a = (-9.103620365133906e-07-5.859088571201365e-07j)
ϕ_0 = 0.340443103921213
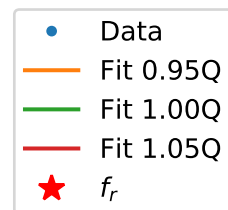τ = (34.779976060561665+0.47980308746593137j)

resonance 70 at 3.4849 GHz

$$S_{21}(f) = ae^{-2\pi jf\tau}\left[1 - \frac{Q_r/Q_c e^{j\phi_0}}{1 + 2jQ_r(\frac{f-f_r}{f_r})}\right]$$

$f_r = 3.484941204780242$
$Q_r = 13224.920297745988$
$Q_c = 37710.61185365303$
$Q_i = 20367.806847729524$
$a = (-8.93271592607015e-10-4.070432262181002e-10j)$
$\phi_0 = 1.0000530266729304$
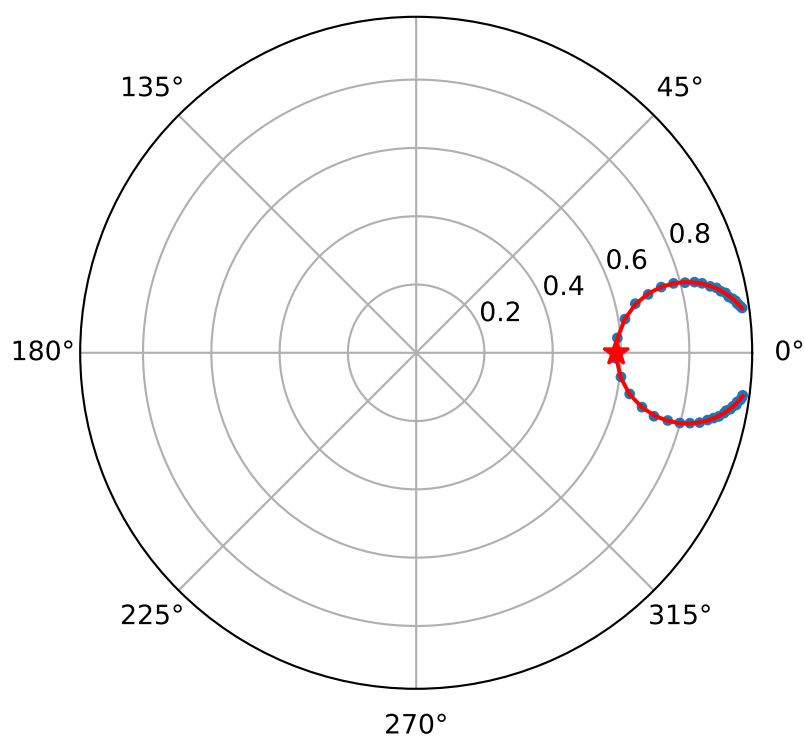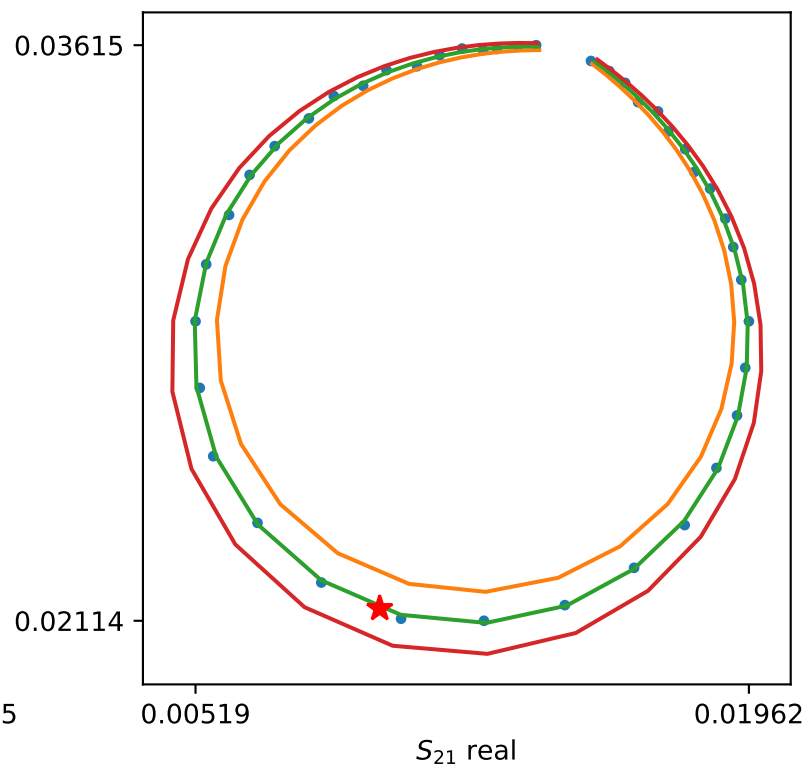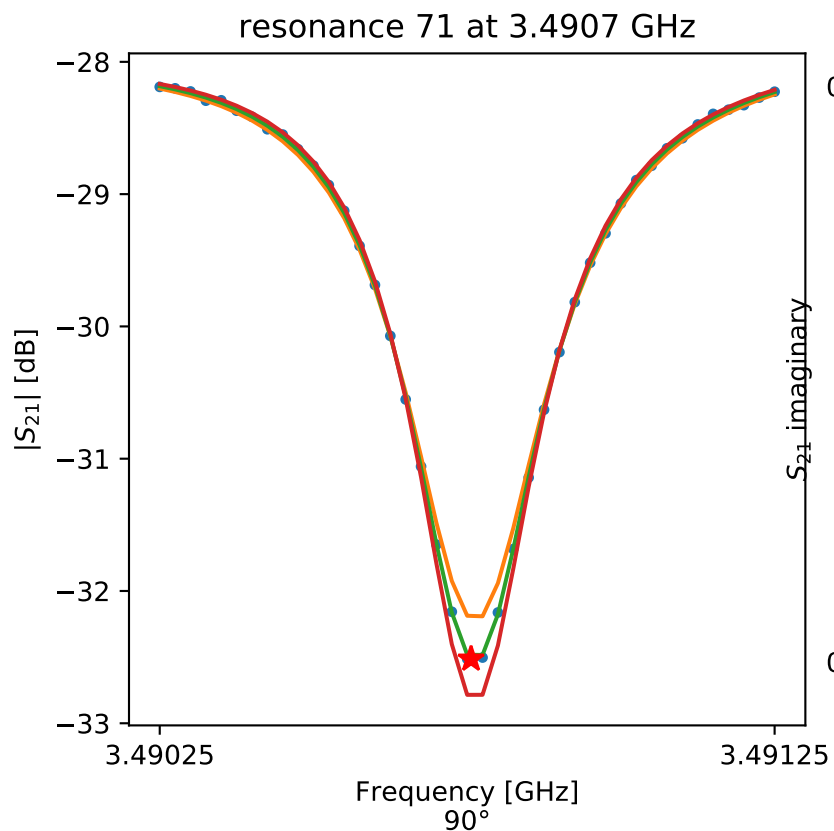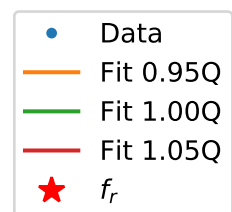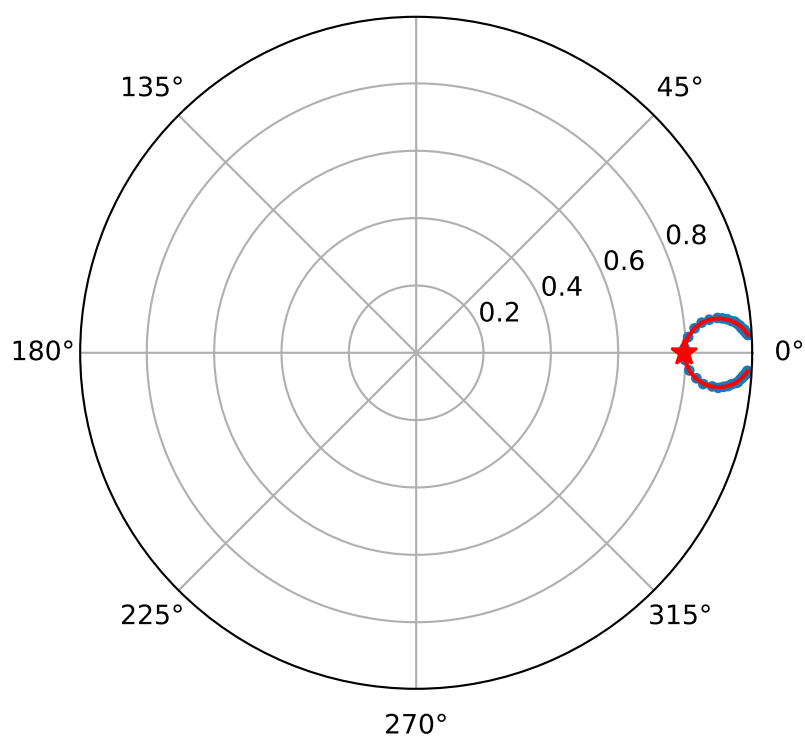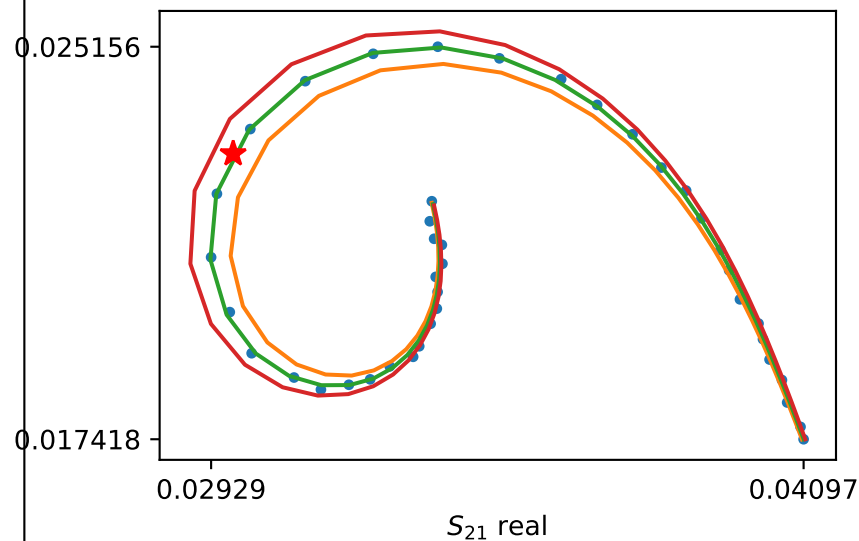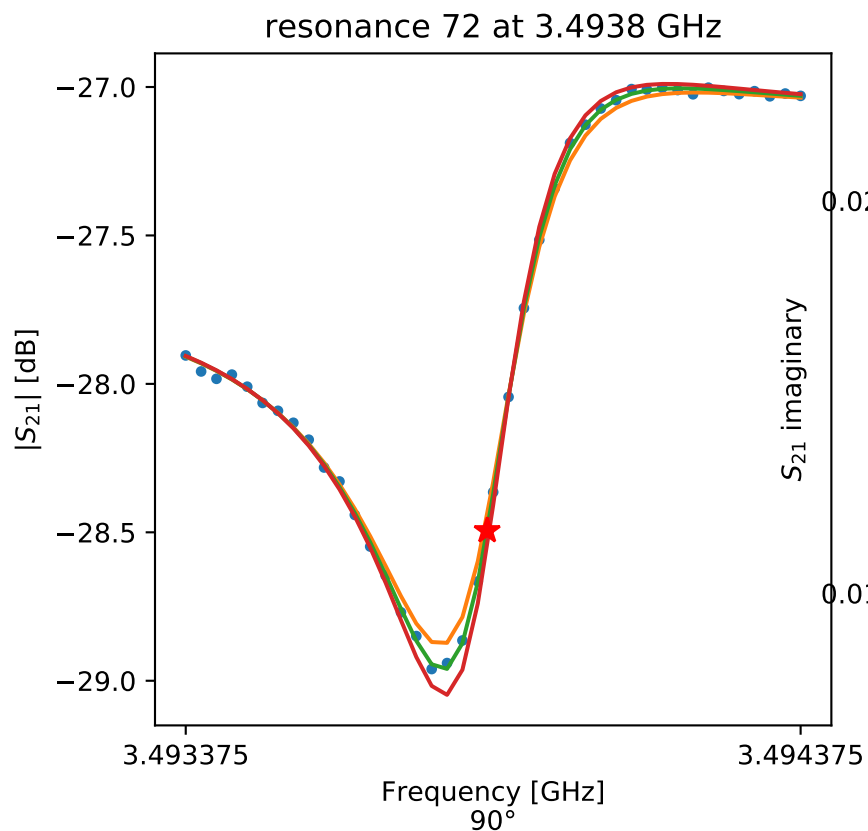$\tau = (35.919451244735576+0.7984200085477459j)$

resonance 71 at 3.4907 GHz

$$S_{21}(f) = ae^{-2\pi jf\tau}\left[1 - \frac{Q_r/Q_c e^{j\phi_0}}{1 + 2jQ_r(\frac{f-f_r}{f_r})}\right]$$

$f_r = 3.49075630702214335$
$Q_r = 10063.027075104561$
$Q_c = 24290.39823120855$
$Q_i = 17180.611399236135$
$a = (-5.890890597569383e-22-1.6670451023229715e-2$
$\phi_0 = 0.05976129675278908$
$\tau = (36.19746156128471+2.080619758811595j)$
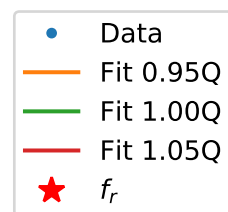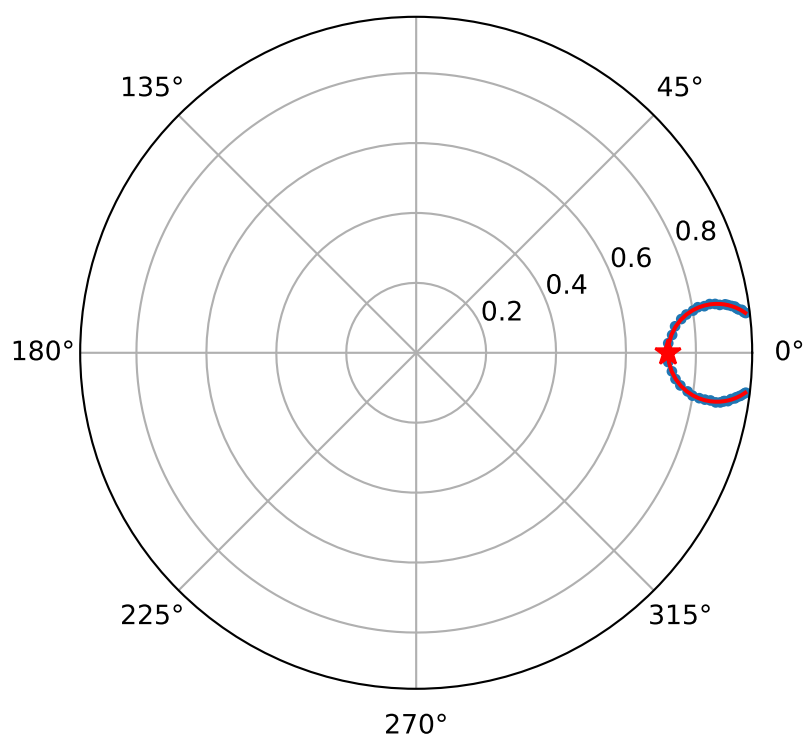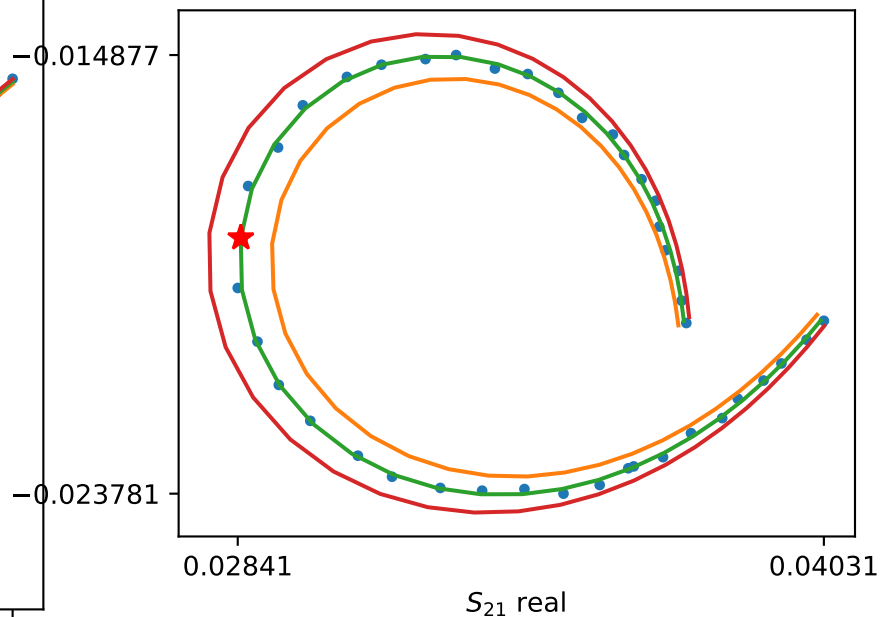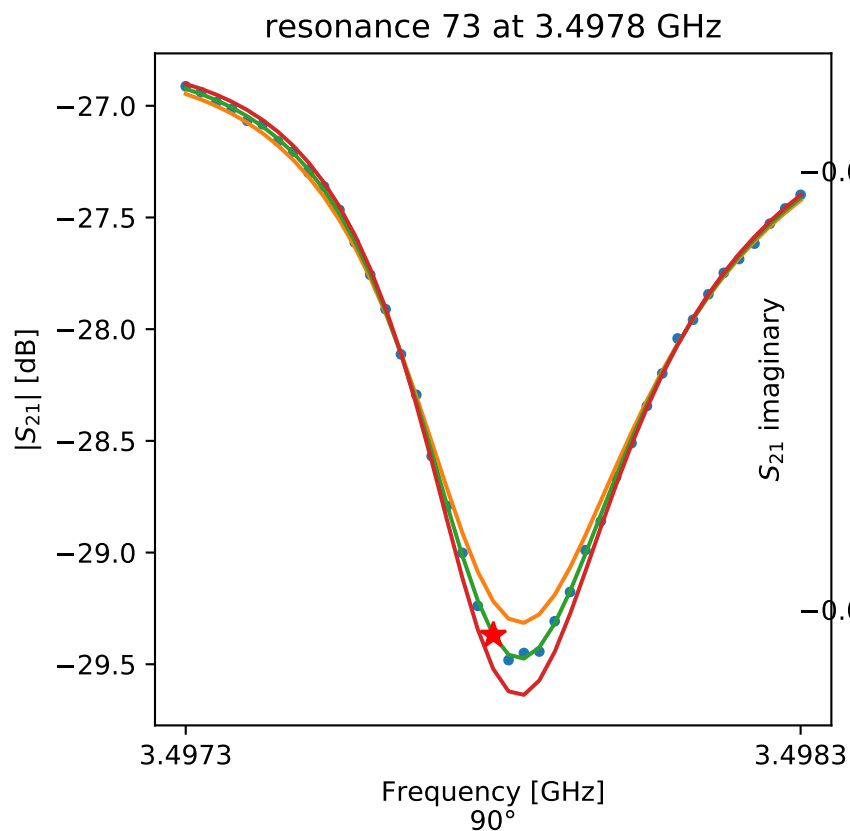
resonance 72 at 3.4938 GHz

$$S_{21}(f) = ae^{-2\pi j f \tau}\left[1 - \frac{Q_r/Q_c e^{j\phi_0}}{1 + 2jQ_r(\frac{f-f_r}{f_r})}\right]$$

f_r = 3.4938652362510974
Q_r = 12266.935702760315
Q_c = 60043.29864136622
Q_i = 15416.56246964134
a = (6.891631996443935e-29+4.052361248433559e-31
ϕ_0 = -0.8519403632698984
τ = (39.47603275943952+2.810285703772363j)

resonance 73 at 3.4978 GHz

$$S_{21}(f) = ae^{-2\pi jf\tau}\left[1 - \frac{Q_r/Q_c e^{j\phi_0}}{1 + 2jQ_r(\frac{f-f_r}{f_r})}\right]$$

$f_r = 3.49780002806418735$
$Q_r = 6768.986531901673$
$Q_c = 24181.470785585945$
$Q_i = 9400.384671392965$
$a = (5.569955969670534e\text{-}29+1.7285163108668642e\text{-}2$
$\phi_0 = 0.29549701655698934$
$\tau = (41.20369199094398+2.818170196280622j)$

resonance 74 at 3.5032 GHz
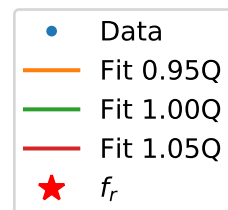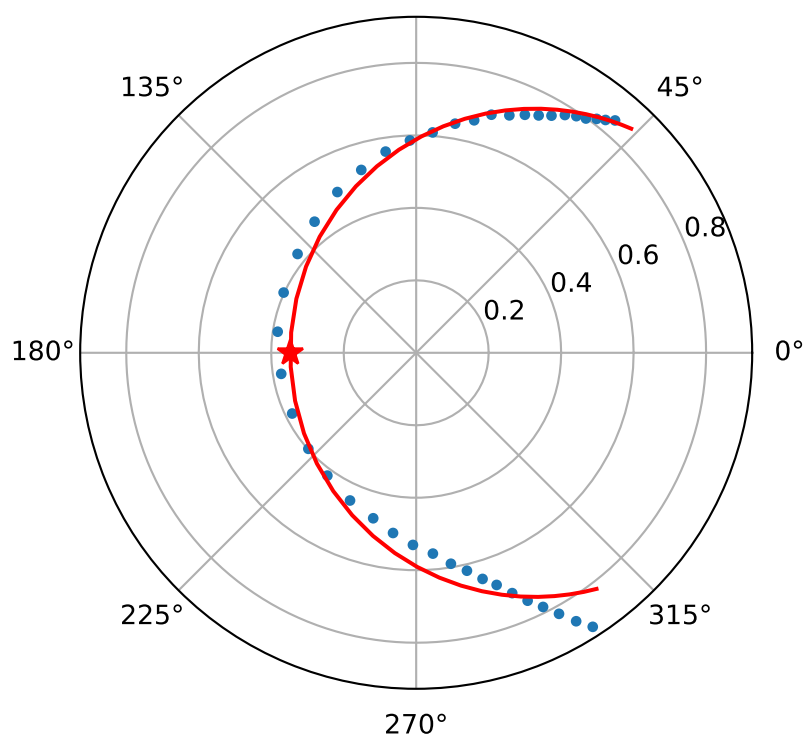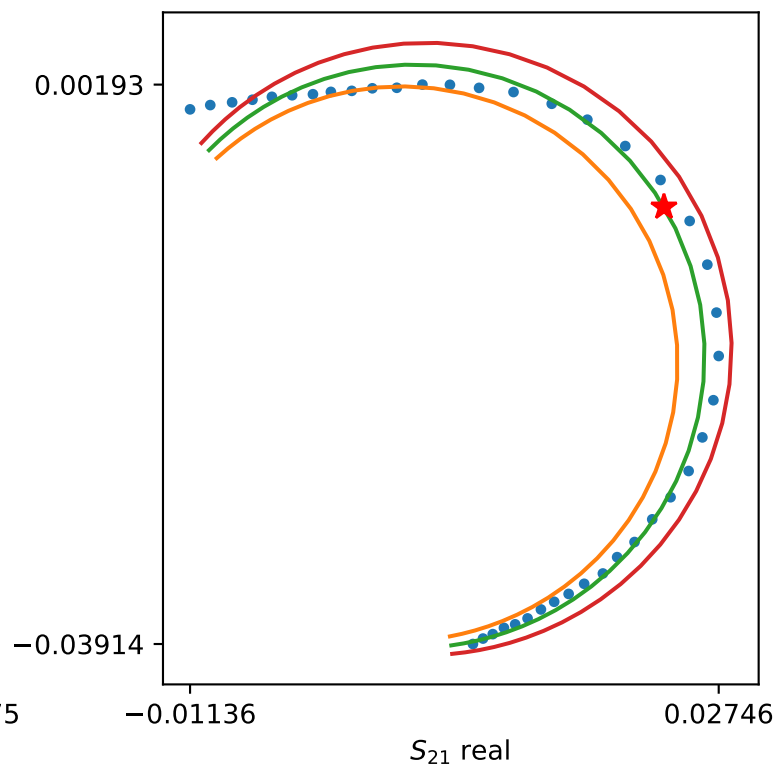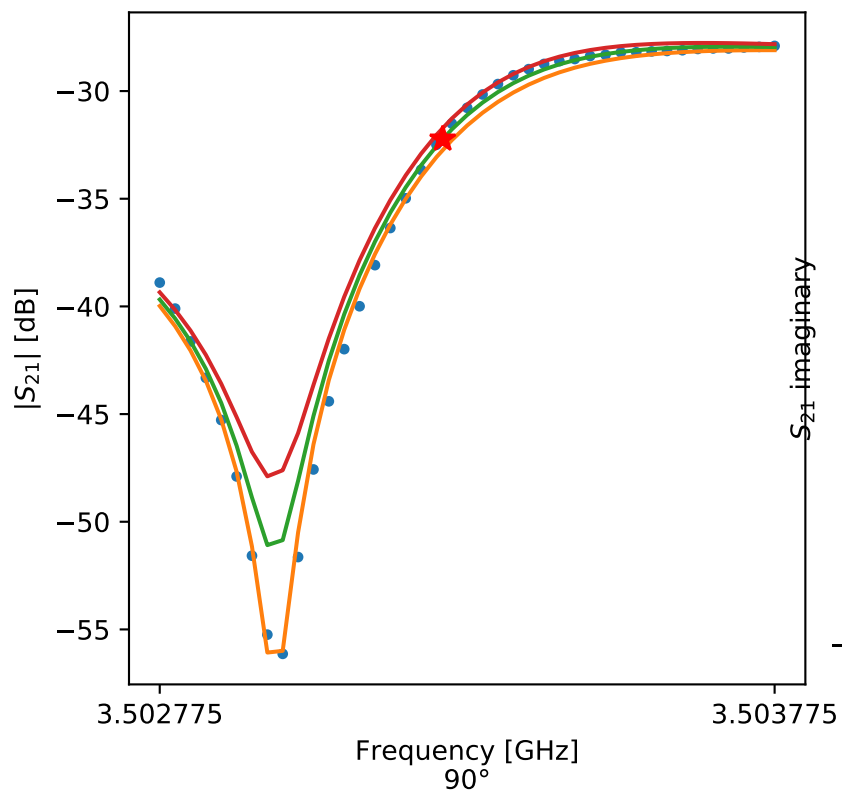
$$S_{21}(f) = ae^{-2\pi jf\tau}\left[1 - \frac{Q_r/Q_c e^{j\phi_0}}{1 + 2jQ_r(\frac{f-f_r}{f_r})}\right]$$
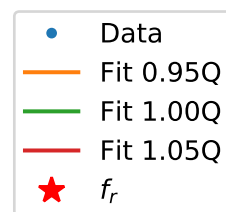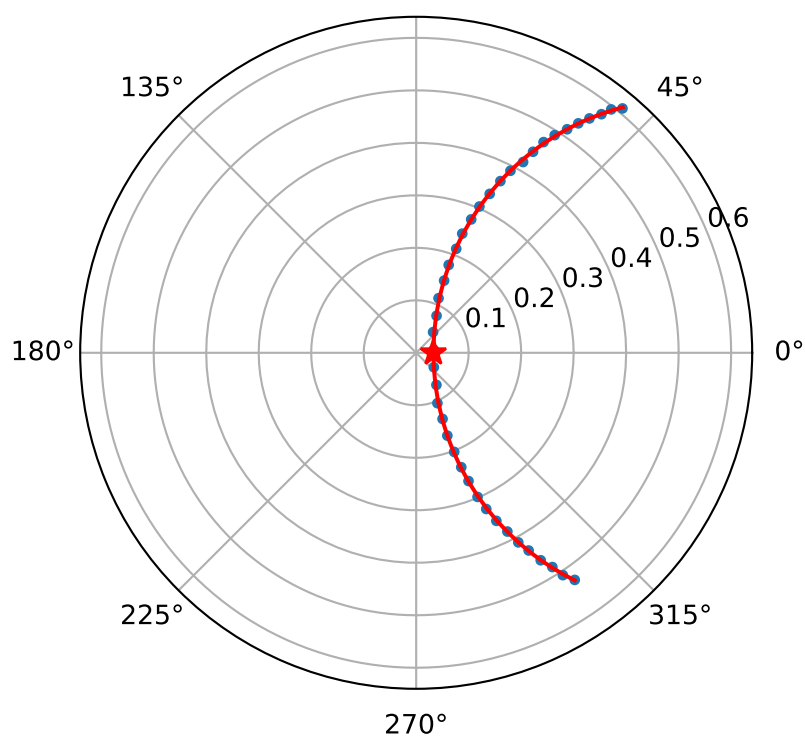
f_r = 3.50323521623175226
Q_r = 4935.71676091652
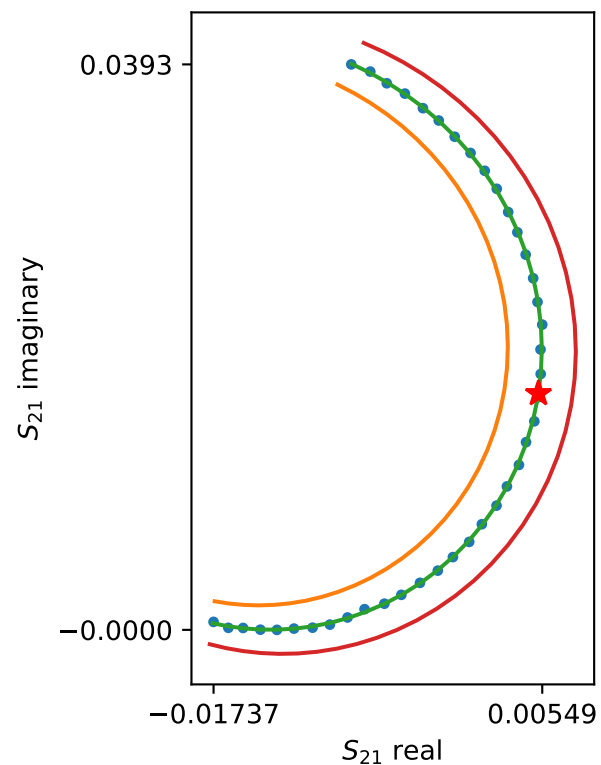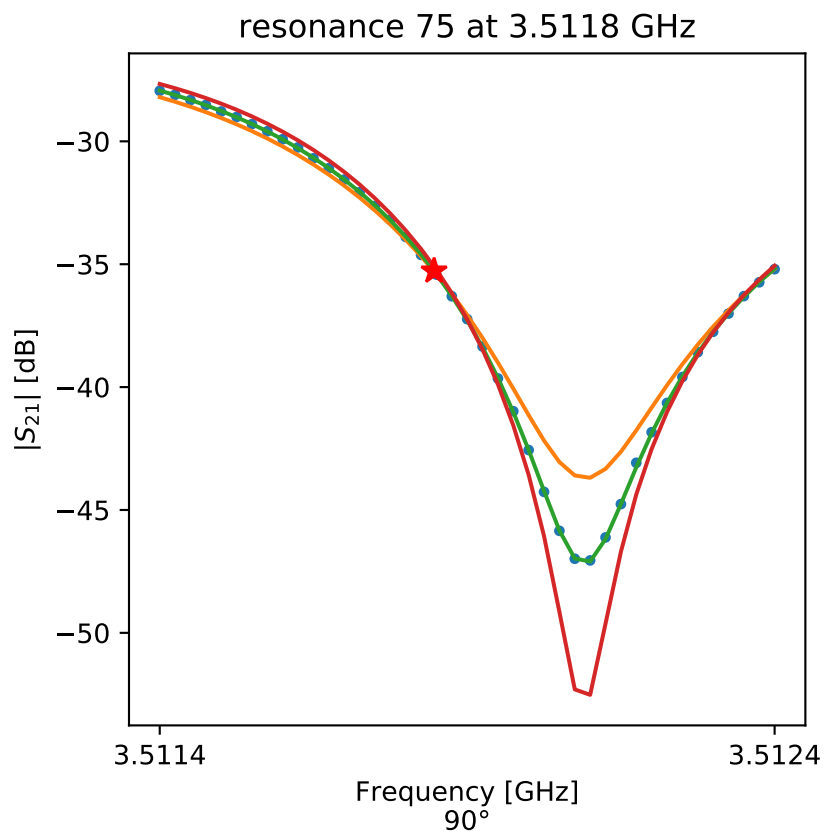Q_c = 3663.388540163751
Q_i = -14211.30799781985
a = (-2.7549750006219124e-20-5.97826556962105e-20j)
ϕ_0 = -0.6056960317709725
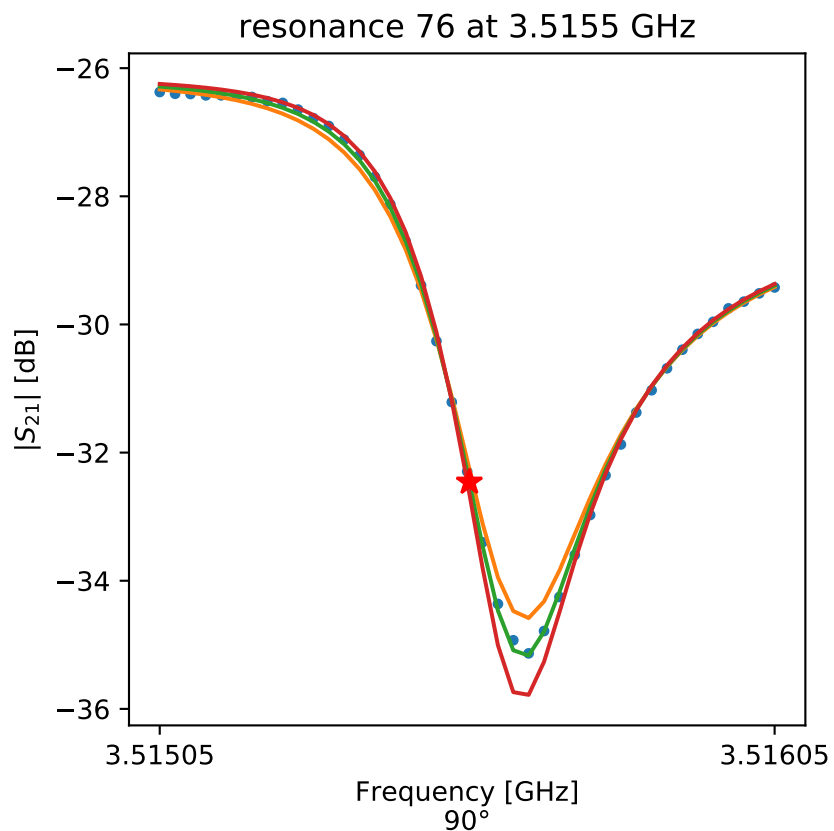τ = (4.8396820687349853e-23+1.8496131544648493j)

resonance 75 at 3.5118 GHz

$$S_{21}(f) = ae^{-2\pi jf\tau}\left[1 - \frac{Q_r/Q_c e^{j\phi_0}}{1 + 2jQ_r(\frac{f-f_r}{f_r})}\right]$$

f_r = 3.5118461807902004
Q_r = 2444.858858446532
Q_c = 2527.737926699744
Q_i = 74566.02242489162
a = (-3.650173173837432e-18-2.861706141663944e-19j)
ϕ_0 = 0.35587249780834795
τ = (43.02707845537138+1.6830919357037553j)

resonance 76 at 3.5155 GHz
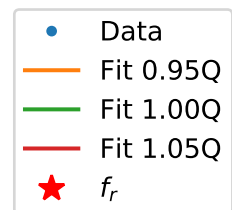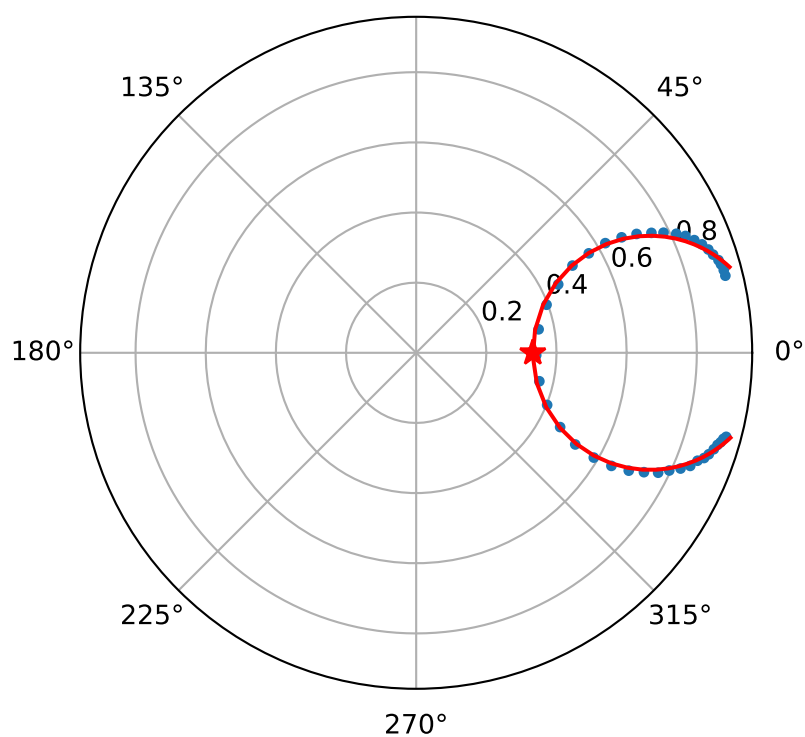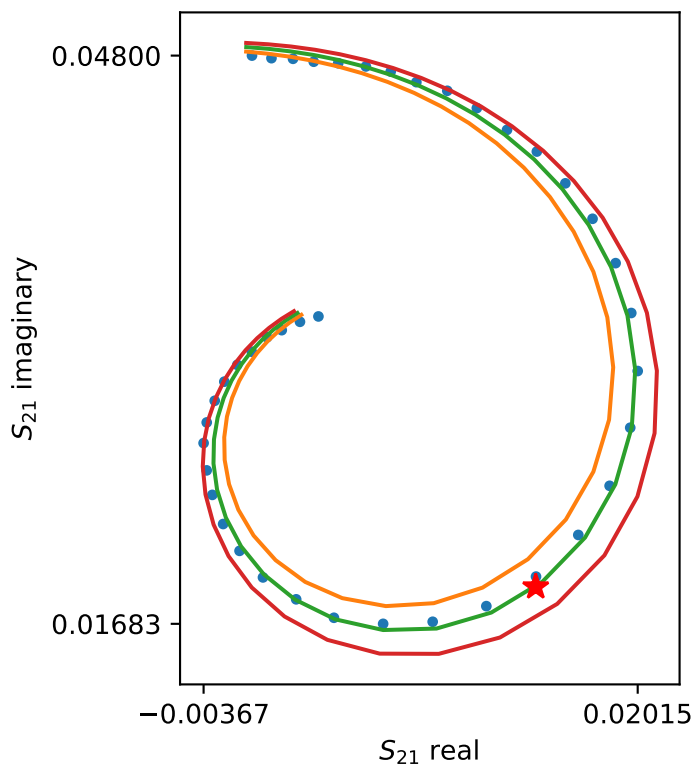
$$S_{21}(f) = ae^{-2\pi jf\tau}\left[1 - \frac{Q_r/Q_c e^{j\phi_0}}{1 + 2jQ_r(\frac{f-f_r}{f_r})}\right]$$
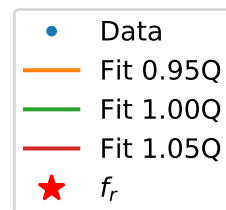
f_r = 3.5155535283176857
Q_r = 8122.618378096566
Q_c = 12167.943554789126
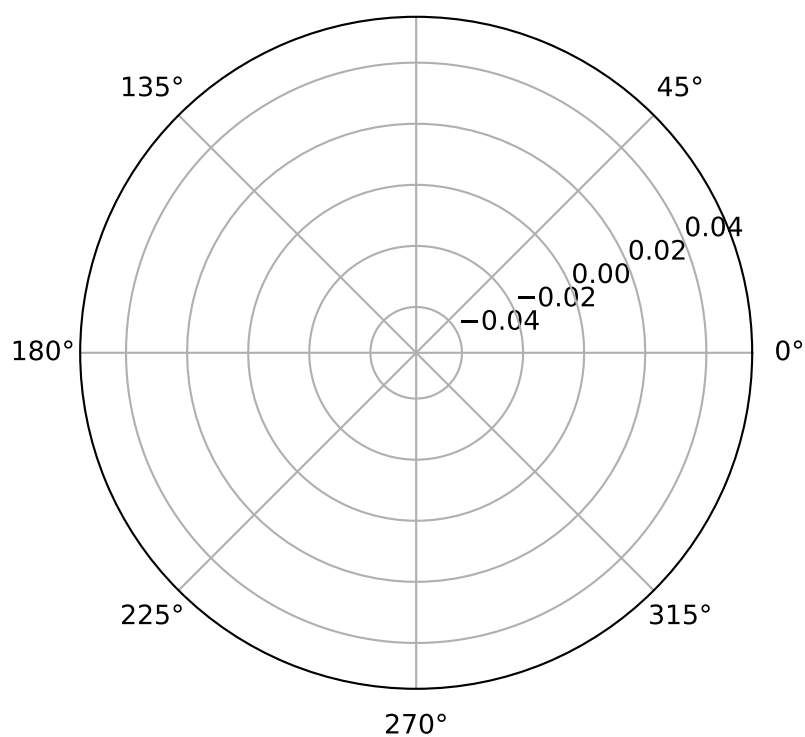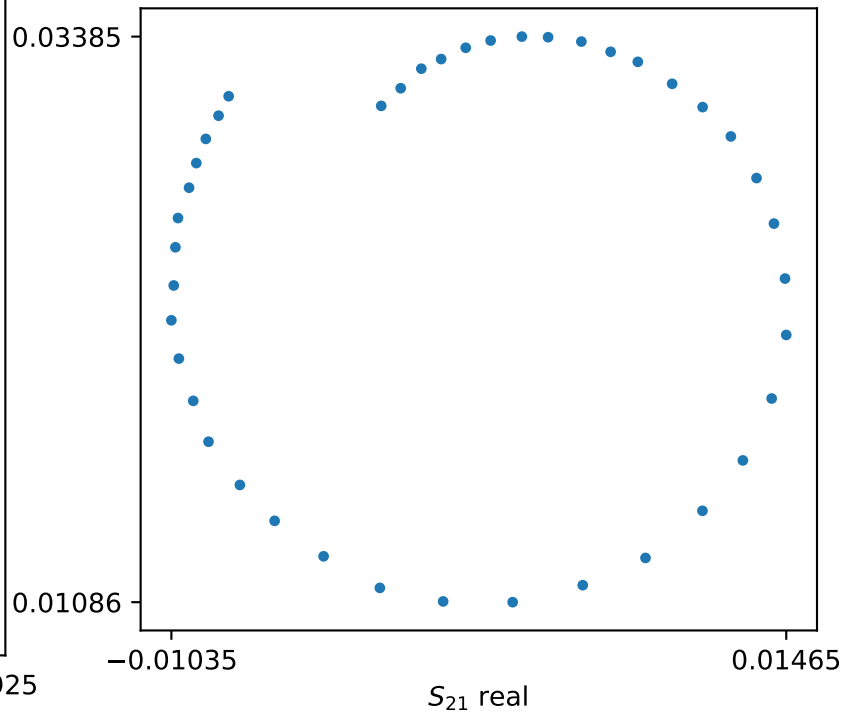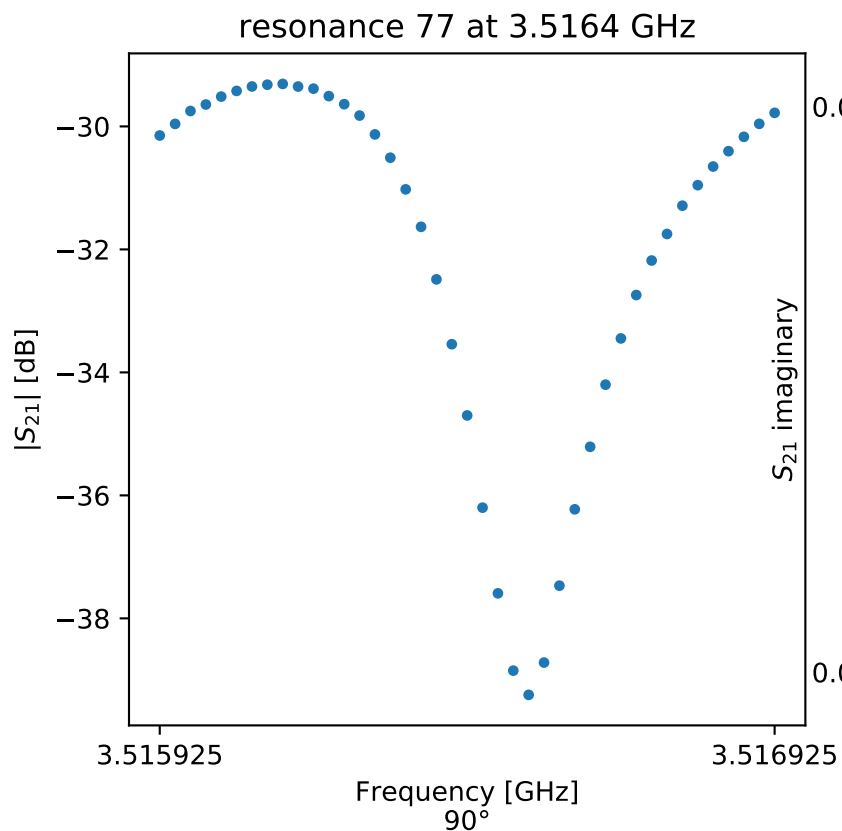Q_i = 24432.04380978325
a = (-4.0438397455062457e+105+4.850172075347357...
ϕ_0 = 0.5308552844720512
τ = (82.20919068988536-11.262770753093696j)

resonance 77 at 3.5164 GHz

$$S_{21}(f) = ae^{-2\pi jf\tau}\left[1 - \frac{Q_r/Q_c e^{j\phi_0}}{1 + 2jQ_r(\frac{f - f_r}{f_r})}\right]$$

$f_r = 3.5164372635257655$
$Q_r = 7965.77158781019$
$Q_c = 10329.817077753818$
$Q_i = 34806.844341734715$
$a = 0j$
$\phi_0 = 0.4591228674180663$
$\tau = (52.58691034068004 + 50.98614058590758j)$