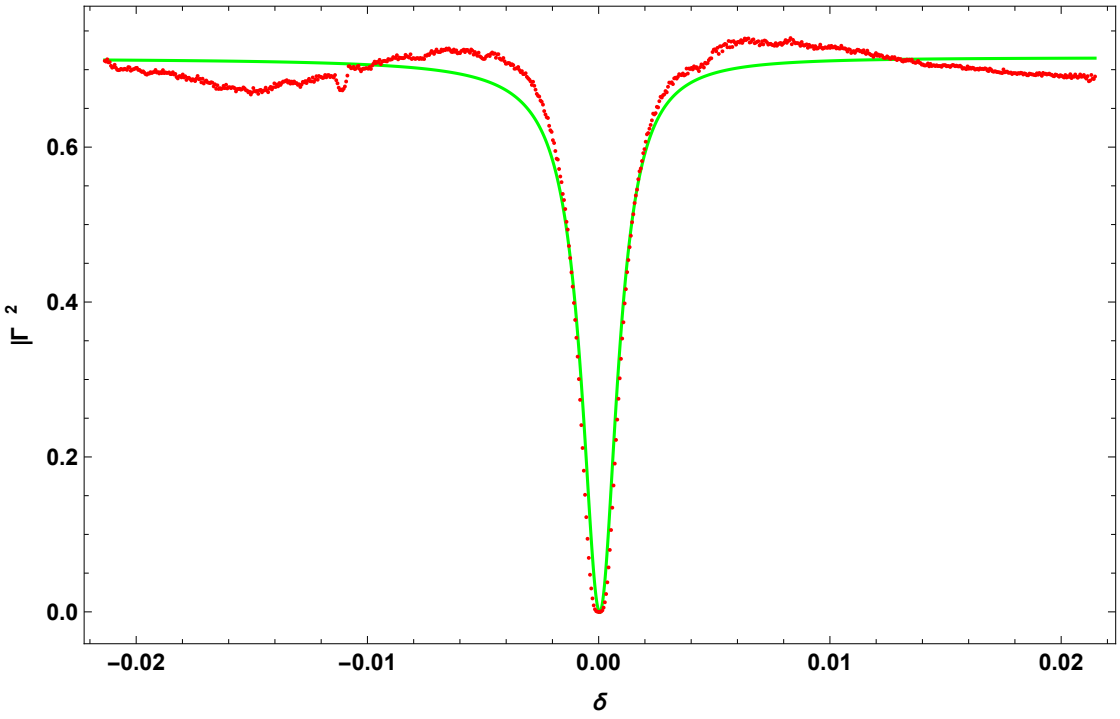
In[1004]:=
```
ClearAll["Global`*"]
SetDirectory["/Users/lisaleemcb/ADMX/ouroboros/code/"];
(*the files in Users/baker/My Documents/data/10_9_13/TUNING
 are dB files and the Q script is made for re/im files. *)
fname = "../measurements/CAL_STRONG_S11.S1P";

file = Drop[Import[fname, "Table"], 12];
dataraw = file;
data = dataraw;
f = ToExpression[data[[All, 1]]];
S11dB = ToExpression[data[[All, 2]]];
S11ang = ToExpression[data[[All, 3]]];
(*S11Abs=Table[Abs[S11RE[[x]]+i S11IM[[x]]],{x,1,Length[S11RE]}];*)
Z0 = 50;
(*S11RE=(Z0*(1-(10^(S11dB/10))^2))/
  (1+(10^(S11dB/10))^2-2*(10^(S11dB/10))*Cos[S11ang Degree]);
S11IM=2*Z0*(10^(S11dB/10))*Sin[S11ang Degree]/
   (1+(10^(S11dB/10))^2-2*(10^(S11dB/10))*Cos[S11ang Degree]);*)
S11RE = (10^(S11dB / 10)) * Cos[S11ang Degree];
S11IM = (10^(S11dB / 10)) * Sin[S11ang Degree];
pos = Position[S11dB, Min[S11dB]][[1, 1]];
fresinitial = f[[pos]];

Sparam = Table[
   {(f[[x]] - fresinitial)/fresinitial, Abs[S11RE[[x]] + j * S11IM[[x]]]^2}, {x, 1, Length[f]}];
(*Sparam=Table[{(f[[x]]-fresinitial)/fresinitial,10^(S11dB[[x]]/10)},{x,1,Length[f]}];*)
t = 2 δ;
model = ρ^2 + (d^2 + 2 d ρ (Cos[ϕ] + QL (t - t0) Sin[ϕ])) / (1 + QL^2 (t - t0)^2);

vars = FindFit[Sparam, model, {{QL, 1400}, {ρ, 0.9}, {d, 0.5}, {ϕ, π}, {t0, 0}}, δ,
  MaxIterations → 10000, Gradient → "FiniteDifference", AccuracyGoal → 10]
pmod = Plot[model /. vars, {δ, Min[Sparam[[All, 1]]], Max[Sparam[[All, 1]]]},
   PlotRange → All, Axes → False, Frame → True,
   PlotPoints → 10000, PlotStyle → Green];
Splot = ListPlot[Sparam, PlotStyle → {Red, PointSize[Small]}];

Show[pmod, Splot, PlotRange → {{Min[Sparam[[All, 1]]], Max[Sparam[[All, 1]]]}, All},
 FrameLabel → {{"|Γ|^2", ""}, {"δ", ""}},
 FrameStyle → Directive[Bold, 16, Medium], ImageSize → 600]
fres = fresinitial + fresinitial * vars[[5, 2]];
QL = vars[[1, 2]];
ρ = vars[[2, 2]];
d = vars[[3, 2]];
ϕ = vars[[4, 2]];
t0 = vars[[5, 2]];

κ = (1/((1+ρ)/d - 1));
```

$$Q0 = \left(\frac{1}{\frac{1+\rho}{d} - 1} + 1 \right) QL;$$

```
"Q0 -> " <> ToString[Q0]
"fres[MHz] -> " <> ToString[fres]
"QL -> " <> ToString[QL]
"Coupling Coefficient -> " <> ToString[κ]
```

Out[1021]= $\{QL \to -537.237, \rho \to 0.845591, d \to 0.845748, \phi \to 3.16085, t0 \to 0.000122118\}$

Out[1024]=



Out[1033]= Q0 -> -991.675

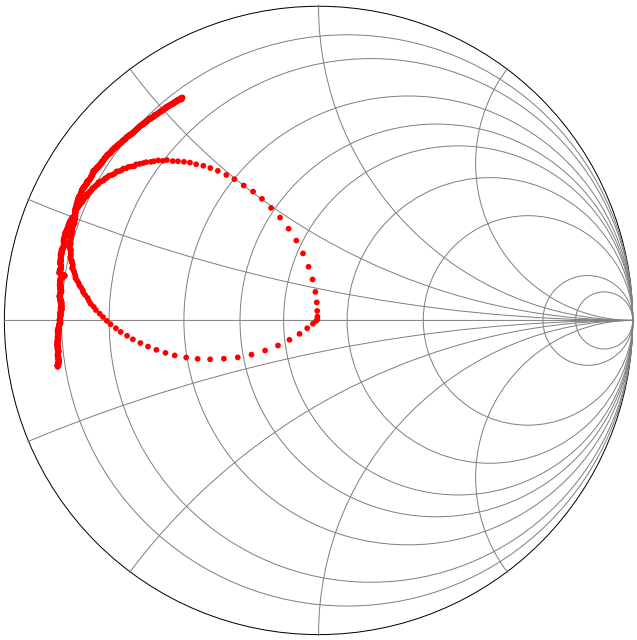
Out[1034]= fres[MHz] -> 9
2.33541 10

Out[1035]= QL -> -537.237

Out[1036]= Coupling Coefficient -> 0.845881

In[1037]:=
```
pl = ListPlot[Table[{S11RE[[a]], S11IM[[a]]}, {a, 1, Length[f]}], PlotStyle →
     {Red, Thick}, PlotRange → All, AspectRatio → Automatic, AxesOrigin → {0, 0}];

R1 = {5, 10, 20, 30, 40, 60, 100, 300, 500};
X1 = {10, -10, 100, -100, -50, 50, -25, 25};
chart = Graphics[{Circle[{0, 0}], Gray, Table[
      Circle[{1 - 1 / (1 + R1[[a]] / Z0), 0}, 1 / (1 + R1[[a]] / Z0)], {a, 1, Length[R1]}],
     Table[Circle[{1, Z0 / X1[[a]]}, Abs[Z0 / X1[[a]]]], {a, 1, Length[X1]}],
     Line[{{-1, 0}, {1, 0}}], White, Thickness[0.45],
     Circle[{0, 0}, 1.5]}, PlotRange → 1.1];
Show[chart, pl]
model
```

Out[1041]=



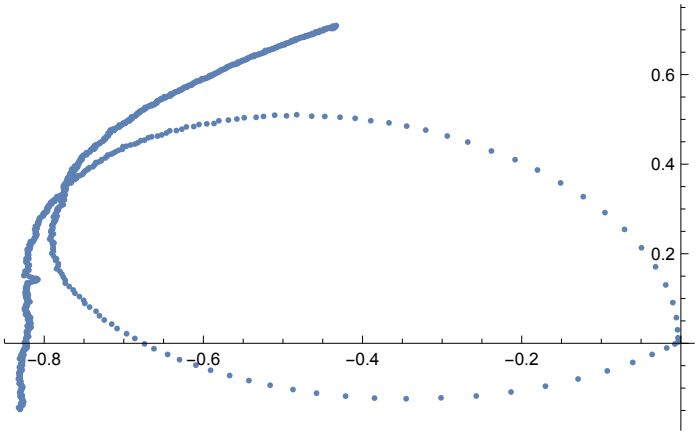
Out[1042]=
$$0.715025 + \frac{0.71529 + 1.43031\ (-0.999815 + 10.3444\ (-0.000122118 + 2\,\delta))}{1 + 288\,624.\ (-0.000122118 + 2\,\delta)^2}$$

In[1043]:=
```
Γ = Abs[Exp[i (ϕ - γ)] (ρ + d Exp[i γ] / (1 + i QL t))]^2

Smithparam = Table[{S11RE[[x]], S11IM[[x]]}, {x, 1, Length[S11RE]}];

smithvar = FindFit[Smithparam, Γ, {γ}, δ]
ListPlot[Smithparam]
Γ /. smithvar

Plot[(Γ)^(1/2) /. smithvar, {δ, -0.8, 0.8}]
```

Out[1043]=
$$e^{2\,\mathrm{Im}[\gamma]}\,\mathrm{Abs}\left[0.845591 + \frac{0.845748\,e^{i\gamma}}{1 - (0. + 1074.47\,i)\,\delta}\right]^2$$

Out[1045]=
$$\{\gamma \to -14.2349\}$$

Out[1046]=



Out[1047]=
$$\mathrm{Abs}\left[0.845591 - \frac{0.0825153 + 0.841713\,i}{1 - (0. + 1074.47\,i)\,\delta}\right]^2$$

Out[1048]=