

```

In[188]:= 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 = "../data/S11NEW.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]]];
S11ang = S11ang;
(*S11Abs=Table[Abs[S11RE[[x]]+i S11IM[[x]]],{x,1,Length[S11RE]}];*)
Z0 = 50;
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, 0.1}, {d, 0.5}, {φ, π}, {t0, 0}}, δ,
    MaxIterations → 10 000, Gradient → "FiniteDifference", AccuracyGoal → 10]
  pmod = Plot[model /. vars, {δ, Min[Sparam[[All, 1]]], Max[Sparam[[All, 1]]]},
    PlotRange → All, Axes → False, Frame → True,
    PlotPoints → 10 000, 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]];

```

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

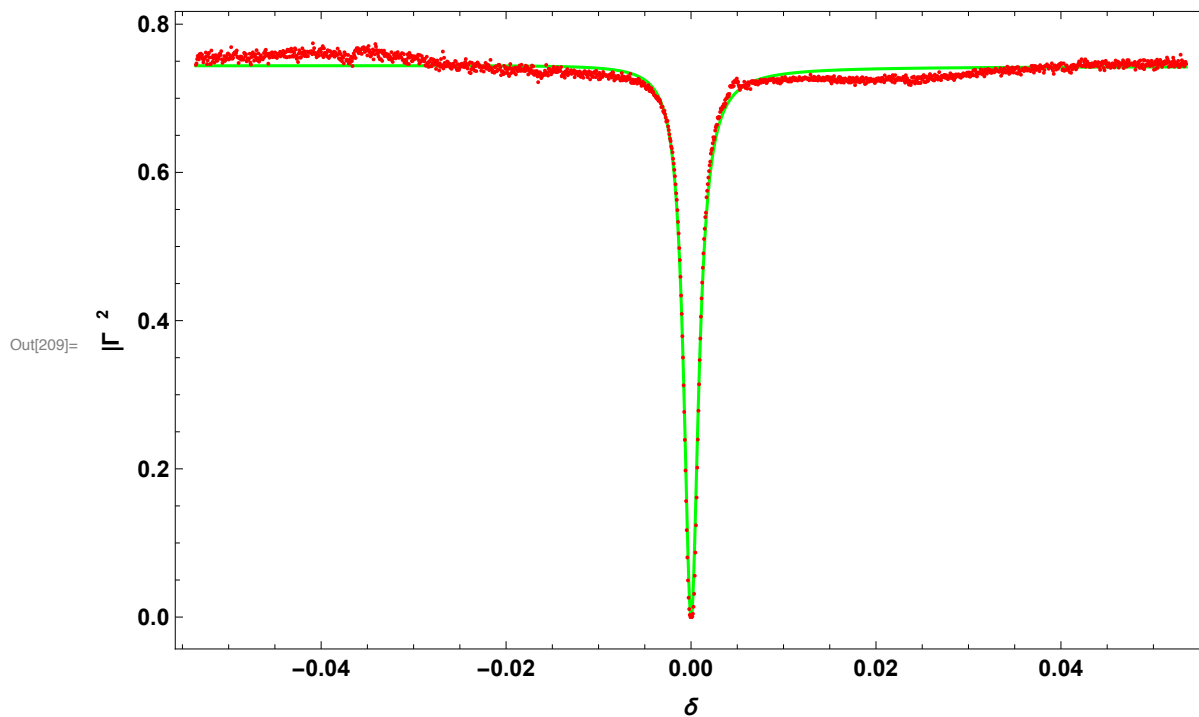
$$Q0 = \left(\frac{1}{\frac{1+\rho}{d} - 1} + 1 \right) QL;$$

```

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

```

Out[206]= {QL → 520.813, ρ → 0.862189, d → 0.86253, ϕ → 3.16971, t₀ → -0.0000337735}



Out[218]= Q₀ -> 970.182

Out[219]= f_{res}[MHz] -> 9
2.33445 10

Out[220]= Q_L -> 520.813

Out[221]= Coupling Coefficient -> 0.862824

In[222]:= {QL → 792.7282312732094`, ρ → 0.9194563177467888`, d → 0.9194738790563288`,
ϕ → 3.1354222386323944`, t₀ → 0.00005124681282787969`}

Out[222]= {520.813 → 792.728, 0.862189 → 0.919456,
0.86253 → 0.919474, 3.16971 → 3.13542, -0.0000337735 → 0.0000512468}

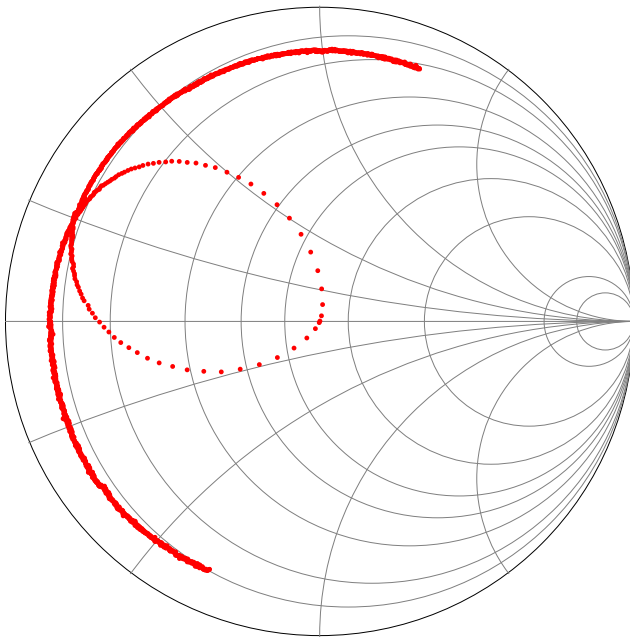
```

In[223]:= 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[227]=



$$\text{Out[228]} = 0.743369 + \frac{0.743957 + 1.48733 (-0.999605 - 14.6422 (0.0000337735 + 2 \delta))}{1 + 271246 \cdot (0.0000337735 + 2 \delta)^2}$$

In[229]=

In[230]=

In[231]=

```

In[232]:=  $\Gamma = \text{Abs} \left[ \text{Exp} \left[ i (\phi - \gamma) \right] \left( \rho + \frac{d \text{Exp} [i \gamma]}{1 + i Q L t} \right) \right]^2$ 

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

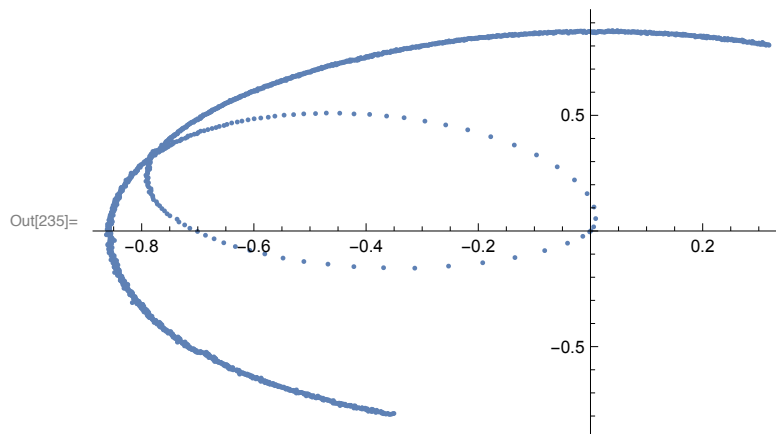
smithvar = FindFit[Smithparam,  $\Gamma$ , { $\gamma$ },  $\delta$ ]
ListPlot[Smithparam]
 $\Gamma /. \text{smithvar}$ 

Plot[( $\Gamma$ )1/2 /. smithvar, { $\delta$ , -0.8, 0.8}]

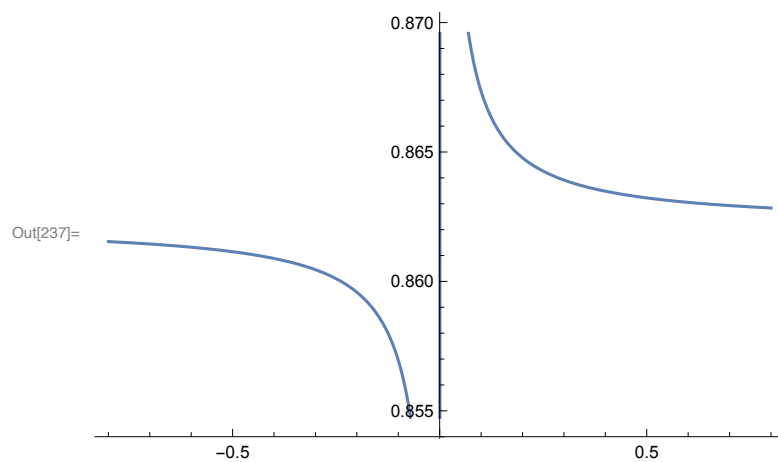
```

$$\text{Out[232]} = e^{2 \text{Im}[\gamma]} \text{Abs} \left[0.862189 + \frac{0.86253 e^{i \gamma}}{1 + (0. + 1041.63 i) \delta} \right]^2$$

$$\text{Out[234]} = \{\gamma \rightarrow 2.46345\}$$



$$\text{Out[236]} = \text{Abs} \left[0.862189 - \frac{0.671685 - 0.541107 i}{1 + (0. + 1041.63 i) \delta} \right]^2$$



In[238]:=