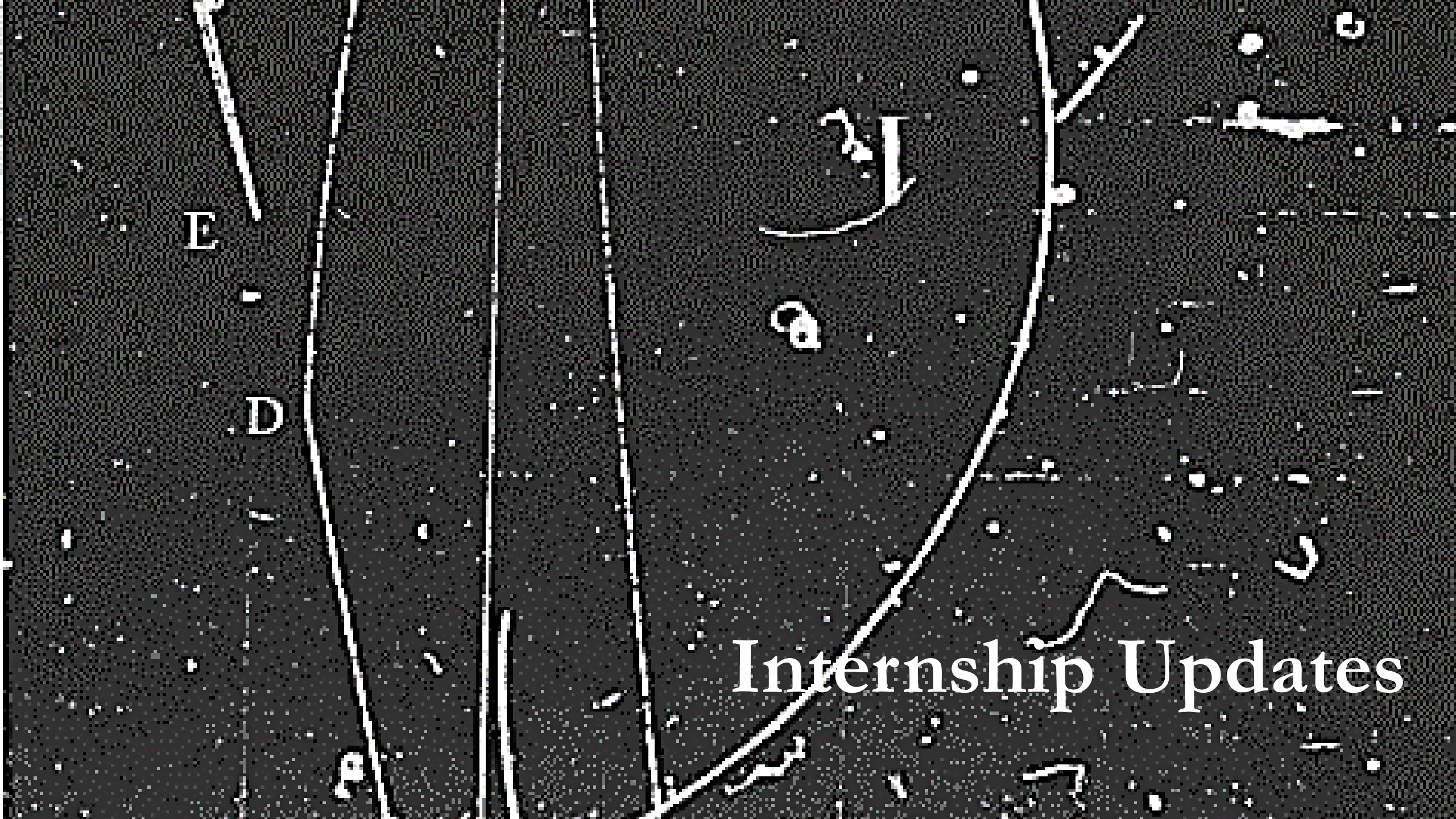
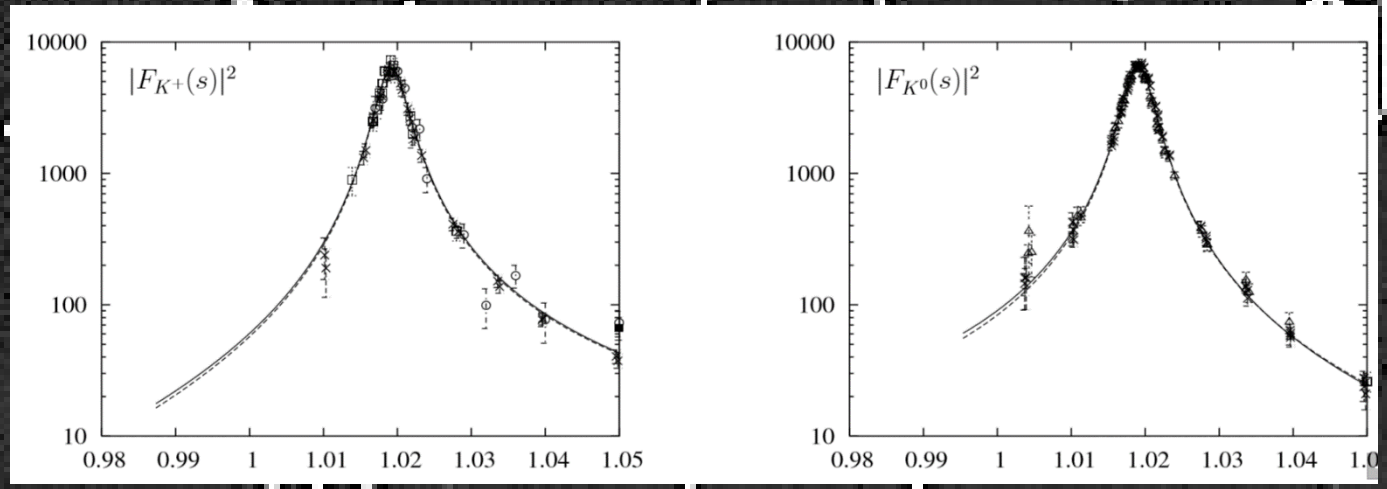
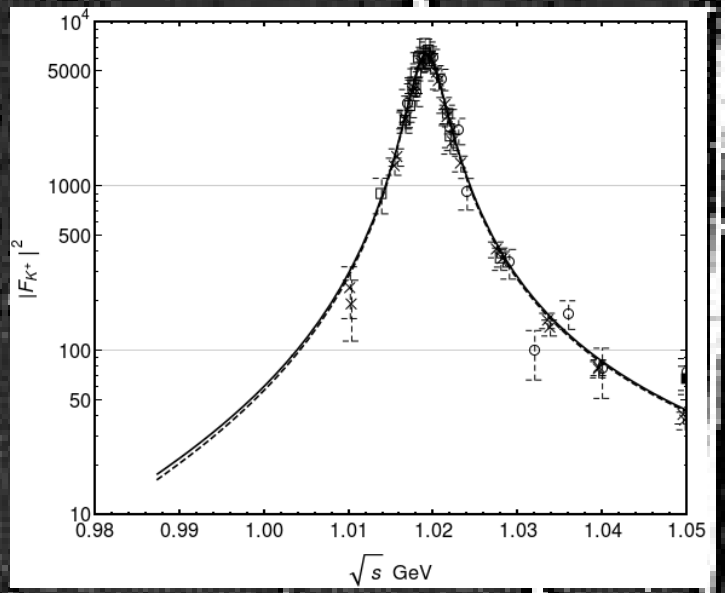
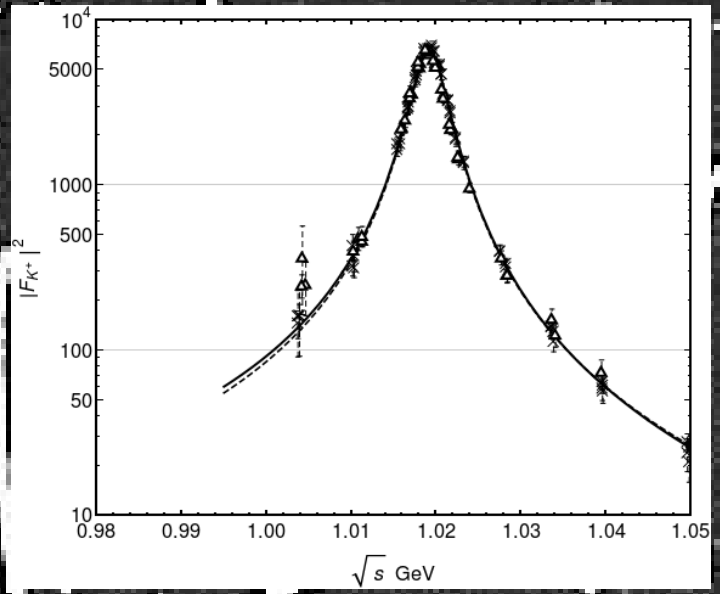


Internship Updates

Comparing Graphs








```
Show[LogPlot[{((#[[5]] & /@ {#[[1]] & /@ {data8}})) Abs[F110[1000 s]]^2,
    ((#[[5]] & /@ {#[[1]] & /@ {data8}})) Abs[F11Fit20[1000 s]]^2}, {s, 0.995, 1.05},
   PlotStyle → {Directive[Thick, Black], Directive[Dashed, Black]},
   Frame → {True, True, True, True},
   FrameStyle → {Directive[Thick, Black], Directive[Thick, Black]},
   FrameTicksStyle → Directive[Thick, Black, 15], ImageSize → 500,
   FrameLabel → {Style["√s  GeV", Black, 15], Style["|F_K+|^2", Black, 15]},
   AspectRatio → 2.5 / 3, GridLines → {None, {10, 100, 1000, 10000}},
   PlotRange → {{.98, 1.05}, {10, 10000}}],
  LogPlot[{((#[[5]] & /@ {#[[1]] & /@ {data1}})) Abs[F11Fit2[1000 s]]^2,
    ((#[[5]] & /@ {#[[1]] & /@ {data1}})) Abs[F11[1000 s]]^2}, {s, 2 mK/10^3, 1.05},
   PlotStyle → {Directive[Dashed, Black], Directive[Line, Black]},
   Frame → {True, True, True, True},
   FrameStyle → {Directive[Thick, Black], Directive[Thick, Black]},
   FrameTicksStyle → Directive[Thick, Black, 15], ImageSize → 500,
   FrameLabel → {Style["√s  GeV", Black, 15], Style["|F_K+|^2", Black, 15]},
   AspectRatio → 2.5 / 3, GridLines → {None, {10, 100, 1000, 10000}},
   PlotRange → {{.98, 1.05}, {10, 10000}}],
  ListLogPlot[(((#[[5]])) Take[#, 2] & /@#) & /@ {data1, data2, data3, data4, data5,
    data6, data7, data8, data9}, PlotStyle → Black, Frame → {True, True, True, True},
   FrameStyle → {Directive[Thick, Black], Directive[Thick, Black]},
   FrameTicksStyle → Directive[Thick, Black, 15], ImageSize → 500,
   FrameLabel → {Style["√s  GeV", Black, 15], Style["|F_K+|^2", Black, 15]},
   AspectRatio → 2.5 / 3, GridLines → {None, {0.01, 0.1, 1, 10, 100, 1000, 10000}},
   PlotRange → {{0.98, 1.05}, {10, 10000}}, PlotMarkers → {
     {Graphics[Line[{{{-.5, -.5}, {.5, .5}}, {{-.5, .5}, {.5, -.5}}}]], .025},
     {Graphics[Line[{{-.5, -.5}, {.5, -.5}, {.5, .5}, {-.5, .5}, {-.5, -.5}}]], .025},
     {Graphics[{Black,
        Polygon[{{-.5, -.5}, {.5, -.5}, {.5, .5}, {-.5, .5}, {-.5, -.5}}]}], .025},
     {Graphics[Circle[{0, 0}, 1]], .025}, {Graphics[Disk[{0, 0}, 1]], .025},
     {Graphics[{EdgeForm[{Thick, Black}], White, Polygon[{{1, 0}, {0, Sqrt[3]},
        {-1, 0}}]}], 0.025}, {Graphics[Circle[{0, 0}, 1]], .025},
     {Graphics[Line[{{{-.5, -.5}, {.5, .5}}, {{-.5, .5}, {.5, -.5}}}]], .025},
     {Graphics[{Black,
        Polygon[{{-.5, -.5}, {.5, -.5}, {.5, .5}, {-.5, .5}, {-.5, -.5}}]}], .025}}],
  Graphics[{Black, Dashed, logerrorbarnaturallong /@
    (((#[[5]])) {{#[[1]], #[[2]]}, #[[3]], #[[4]], .001} & /@data1)}],
  Graphics[{Black, Dashed, logerrorbarnaturallong /@
```

Comparing Parameter Tables

Table 2. Parameters of the kaon form factors and results of the fit to the data. Masses and widths are given in MeV. The row "Fit(1)" (Fit(2))contains the values of the constrained (unconstrained) fits

Parameter	Input	Fit(1)	Fit(2)	PDG value [26]
m_ϕ	–	1019.372 ± 0.02	1019.355 ± 0.02	1019.456 ± 0.02
Γ_ϕ	–	4.36 ± 0.05	4.29 ± 0.05	4.26 ± 0.05
$m_{\phi'}$	1680	–	–	1680 ± 20
$\Gamma_{\phi'}$	150	–	–	150 ± 50
m_ρ	775	–	–	775.8 ± 0.5
Γ_ρ	150	–	–	150.3 ± 1.6
$m_{\rho'}$	1465	–	–	1465 ± 25
$\Gamma_{\rho'}$	400	–	–	400 ± 60
$m_{\rho''}$	1720	–	–	1720 ± 20
$\Gamma_{\rho''}$	250	–	–	250 ± 100
m_ω	783.0	–	–	782.59 ± 0.11
Γ_ω	8.4	–	–	8.49 ± 0.08
$m_{\omega'}$	1425	–	–	1400–1450
$\Gamma_{\omega'}$	215	–	–	180–250
$m_{\omega''}$	1670	–	–	1670 ± 30
$\Gamma_{\omega''}$	315	–	–	315 ± 35
c_ϕ	–	1.018 ± 0.006	0.999 ± 0.007	–
$c_{\phi'}$	$1 - c_\phi^K$	-0.018 ∓ 0.006	0.001 ∓ 0.007	–
c_ρ^K	–	1.195 ± 0.009	1.139 ± 0.010	–
$c_{\rho'}^K$	–	-0.112 ± 0.010	-0.124 ± 0.012	–
$c_{\rho''}^K$	$1 - c_\rho^K - c_{\rho'}^K$	-0.083 ∓ 0.019	-0.015 ∓ 0.022	–
$c_\omega^K(1)$	c_ρ^K	1.195 ± 0.009	–	–
$c_\omega^K(2)$	–	–	1.467 ± 0.035	–
$c_{\omega'}^K(1)$	$c_{\rho'}^K$	-0.112 ± 0.010	–	–
$c_{\omega'}^K(2)$	–	–	-0.018 ± 0.024	–
$c_{\omega''}^K$	$1 - c_\omega^K - c_{\omega'}^K$	-0.083 ∓ 0.019	-0.449 ∓ 0.059	–
χ^2/d.o.f.	–	328/242	281/240	–

```
In[197]:= nlmcombined = NonlinearModelFit[data1000 /. {a_, b_, c_, d_, e_} :> {a, e, b},
            (f) Abs[Ffull[mϕ, Γϕ, 1680, 150, 775, 150, 1465, 400, 1720, 250, 783, 8.4, 1425, 215,
              1670, 315, cϕ, 1 - cϕ, cρ, cρ1, 1 - cρ - cρ1, cρ, cρ1, 1 - cρ - cρ1][Sign[s] s^2]]^2 +
            (1 - f) Abs[F0full[mϕ, Γϕ, 1680, 150, 775, 150, 1465, 400, 1720, 250,
              783, 8.4, 1425, 215, 1670, 315, 1.011, cϕ, 1 - cϕ, cρ,
              cρ1, 1 - cρ - cρ1, cρ, cρ1, 1 - cρ - cρ1][Sign[s] s^2]]^2,
          {{mϕ, 1019}, {Γϕ, 4.36}, {cϕ, 1.018}, {cρ, 1.195}, {cρ1, -.112}},
          {s, f},
          VarianceEstimatorFunction → (1 &),
          Weights → 1 / ((#[[3]] - #[[4]])/2)^2 & /@ data1000,
          Method -> "LevenbergMarquardt",
          AccuracyGoal → 4]

Out[197]= FittedModel[ f Abs[«1»]^2 + (1 - f) Abs[1/6 (-«19»/2030625 - «19»/«1» + «18»/«1» + «1» + 1/3 («1»)^2)]^2 ]
```

```
In[198]:= nlmcombined["ParameterTable"]
```

Out[198]=

	Estimate	Standard Error	t-Statistic	P-Value
mϕ	1019.31	0.0210961	48317.4	$3.964124029907240 \times 10^{-847}$
Γϕ	4.34036	0.0336891	128.836	5.81976×10^{-225}
cϕ	1.01461	0.0047631	213.015	2.49892×10^{-277}
cρ	1.19554	0.00772948	154.673	6.11672×10^{-244}
cρ1	-0.110702	0.00893692	-12.387	1.28093×10^{-27}

Upcoming Steps

- Meet with transverse kaon density group.
- Fit $\eta\varphi$ parameter.
- Verify and correct graphs and modelling for pion data.
- Evaluate more recent data points.
- Derive charge density from form factor values.

Sources

Bruch, C., Kodjamirian, A. and Kühn, J.H. "Modeling the pion and kaon form factors in the timelike region," in *The European Physical Journal C*, 39 41-54. (2005)

Ford, Kenneth W. 1963. *The World of Elementary Particles.* Blaisdell Publishing Company, New York. (24)

Mecholsky, Nicholas. 2016. "Kaon Form Factor and Transverse Charge Density." Mathmatica Notebook. (June 17th)

The End