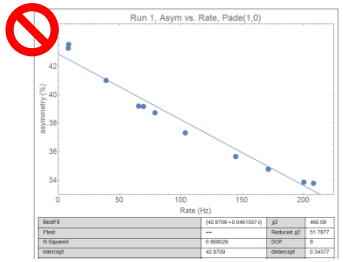
Summary of Ao extrapolation

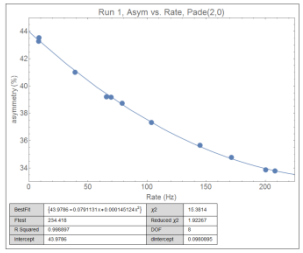
Feb 3 2017

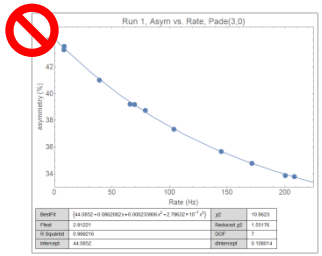
Pade

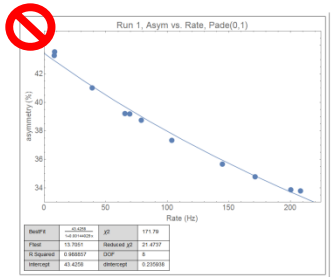
- First use Pade to determine the Pade orders that are not rejected by the F test – put in as many orders as makes sense for A(t), A(R) and R(t)
- Details in file in Jan 17 2017 meeting wiki

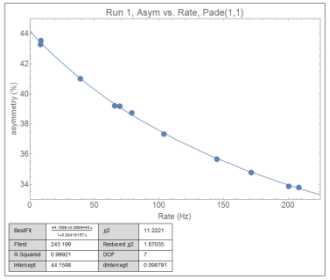
Old data presentation:
Pade orders, run 1: Asym vs. Rate

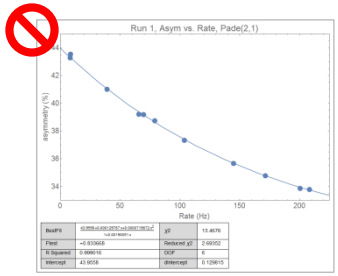


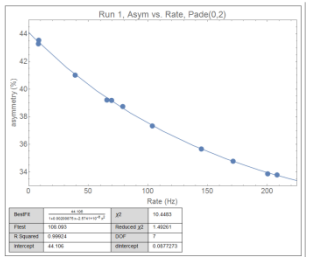


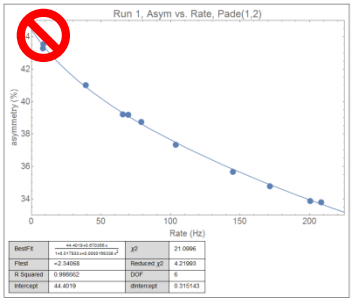


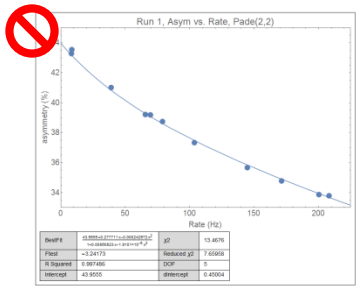


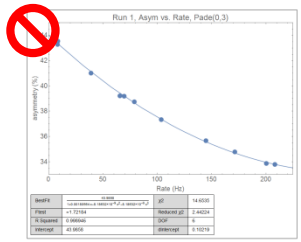












Same data, new look

Pade Analysis summary

	Pade(0,y)	Pade(1,y)	Pade(2,y)	Pade(3,y)
Pade(x,0)		43.83(14),n/a,2.5	**44.05(13),8,1.3**	44.26(16),3,1.04
Pade(x,1)	**44.04(10),8,1.3**	**44.10(14),6.6,1.72**	43.78(21),1.6,3.8	
Pade(x,2)	44.09(13),0.3,1.4	45.(23),0.74,1.8		

A(t) Run 1

Ao, Ftest, reducedχ2

	Pade(0,y)	Pade(1,y)	Pade(2,y)	Pade(3,y)
Pade(x,0)		43.87(34), n/a, 52	43.98(09) 234,1.9	44.08(11),2.9,1.5
Pade(x,1)	43.43(24),13,21	**44.16(10),243,1.9**	43.96(13),-0.8,2.7	
Pade(x,2)	**44.11(09),106,1.5**	44.40(32),-2.3,4.2	43.96(45),-3.2,7.6	
Pade(x,3)	43.97(10),-1.7,2.4			

A(R) Run 1

Ao, Ftest, reducedχ2

	Pade(0,y)	Pade(1,y)	Pade(2,y)	Pade(3,y)
Pade(x,0)		n/a,3.0	**17.3, 0.99**	1.8,0.8
Pade(x,1)		**14.1,1.26**	1.11,1.23	
Pade(x,2)		0.8,1.3	0.005,1.23	

R(t) Run 1

Ftest, reducedχ2

Summary: Pade orders not rejected

For Asy. vs. Thickness:

(2,0), (0,1), (1,1) *(1,0) bad by eye, χ2*

For Asy. vs. Rate:

(1,1), (0,2) *(2,0) outlier, incr. w/rate unphysical*

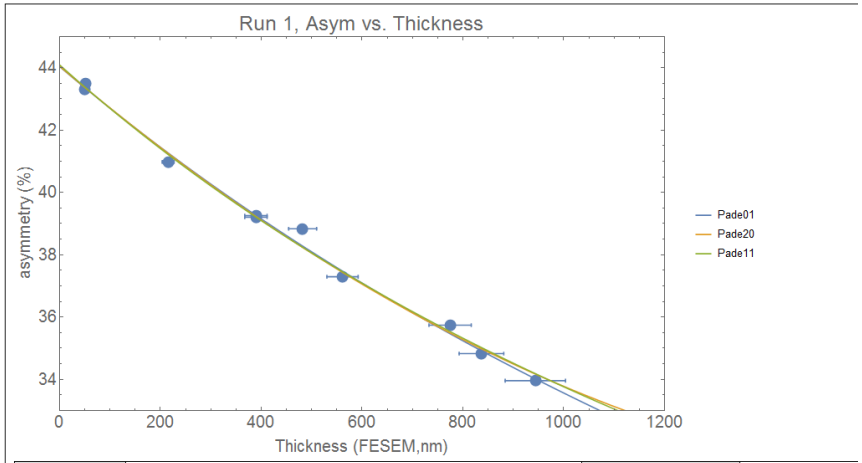
For Rate vs. Thickness (*=forced zero)

(2,0)*, (1,1)* *(1,0) bad by eye, χ2*

Theory suggested fits: in red

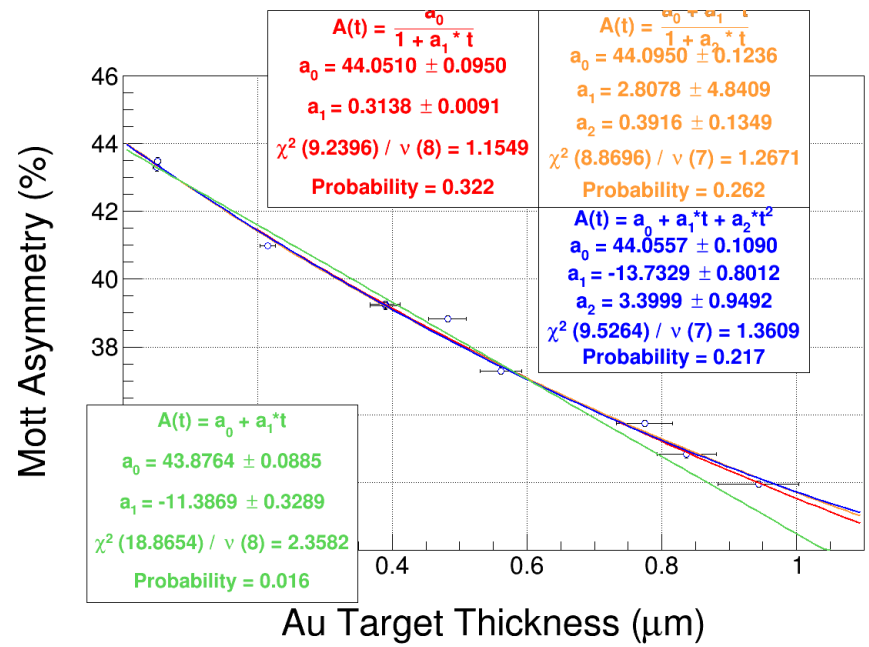
Next: Use allowed Pade orders to fit

- Check Root with mathematica to verify we understand what Root is doing with dx, fitting
- Details in files in January 17 2017 meeting wiki page
- Use Root values, microns for thickness



Pade01	$\frac{44.0395}{1+0.000312289\,x}$	Reduced $\chi 2$	1.62572
Pade20	$44.0492 - 0.0137301\,x + 3.45486\times10^{-6}\,x^2$	Reduced $\chi 2$	1.36746
Pade11	$\frac{44.0928+0.00336456\,x}{1+0.000405728\,x}$	Reduced $\chi 2$	1.27408

mathematica



Root

Root vs. Mathematica Analysis A(t) Run 1&2

A vs. T	ao	Δao	a1	a2	b1	Chi sq	
Pade (2,0)	44.0557	.1090	-13.76	3.4		1.36	Run 1
Pade(1,1)	44.095	.124	2.8		0.39	1.27	Run 1
Pade (0,1)	44.05	0.095			0.31	1.15	Run 1
Pade (2,0)	44.1216	.1222	-13.99	3.74		1.29	Run 2
Pade(1,1)	44.175	.1393	4.8		0.45	1.17	Run 2
Pade (0,1)	44.09	0.1006			0.3136	1.14	Run 2

Root

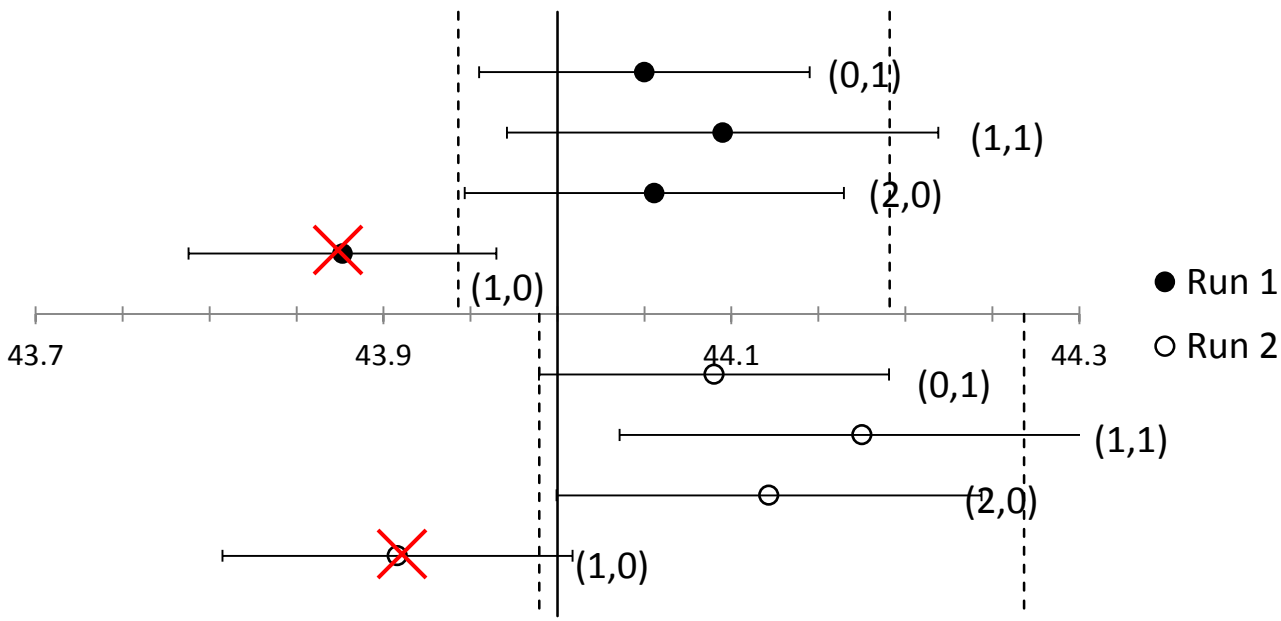
A vs. T	ao	Δao	a1	a2	b1	Chi sq	
Pade (2,0)	44.05	.13	-13.7	3.45		1.37	Run 1
Pade(1,1)	44.09	.14	3.36		.406	1.27	Run 1
Pade (0,1)	44.04	.101	0.31			1.15	Run 1
Pade (2,0)	44.12	.14	-14.0	3.85		1.29	Run 2
Pade(1,1)	44.18	.152	5.6		0.47	1.18	Run 2
Pade (0,1)	44.08	.113			0.31	1.14	Run 2

Mathematica

Extremely good agreement on parameters and chi squared

Root Analysis A(t) Run 1&2

A vs. T	ao	Δao	a1	a2	b1	Chi sq	
Pade (2,0)	44.0557	.1090	-13.76	3.4		1.36	Root
Pade(1,1)	44.095	.124	2.8		0.39	1.27	Root
Pade (0,1)	44.05	0.095			0.31	1.15	Root
Pade (2,0)	44.1216	.1222	-13.99	3.74		1.29	Rt run2
Pade(1,1)	44.175	.1393	4.8		0.45	1.17	Rt run2
Pade (0,1)	44.09	0.1006	-11.36		0.3136	1.14	Rt run2



Run 1 Ao(t)= 44.07(12)
Run 2 Ao(t)= 44.13(14)

Open question:
Δao for average?

Pade (1,0) shown but not used to find mean

Root vs. Mathematica A(R) Run 1&2

A vs. R	Ao	dAo	Chi squared	Run
~~Pade (2,0)~~	~~43.96~~	~~0.08~~	~~1.65~~	~~Run 1~~
Pade (1,1)	44.08	0.09	1.12	Run 1
Pade (0,2)	44.05	0.09	1.19	Run 1
~~Pade (2,0)~~	~~43.99~~	~~0.093~~	~~3.00~~	~~Run 2~~
Pade (1,1)	44.18	0.11	**1.71**	Run 2
Pade (0,2)	44.11	0.100	**2.00**	Run 2

Root

Still working to determine why there is disagreement on the χ2 values here when they agree on A(t) so well – which code off?

A vs. R	Ao	dAo	Chi squared	Run
~~Pade (2,0)~~	~~43.93~~	~~.113~~	~~2.16~~	~~Run 1~~
Pade (1,1)	44.07	.109	1.497	Run 1
Pade (0,2)	44.036	.103	1.56	Run 1
~~Pade (2,0)~~	~~43.96~~	~~.19~~	~~4.28~~	~~Run 2~~
Pade (1,1)	44.17	.169	**2.54**	Run 2
Pade (0,2)	44.09	.167	**2.95**	Run 2

Mathematica

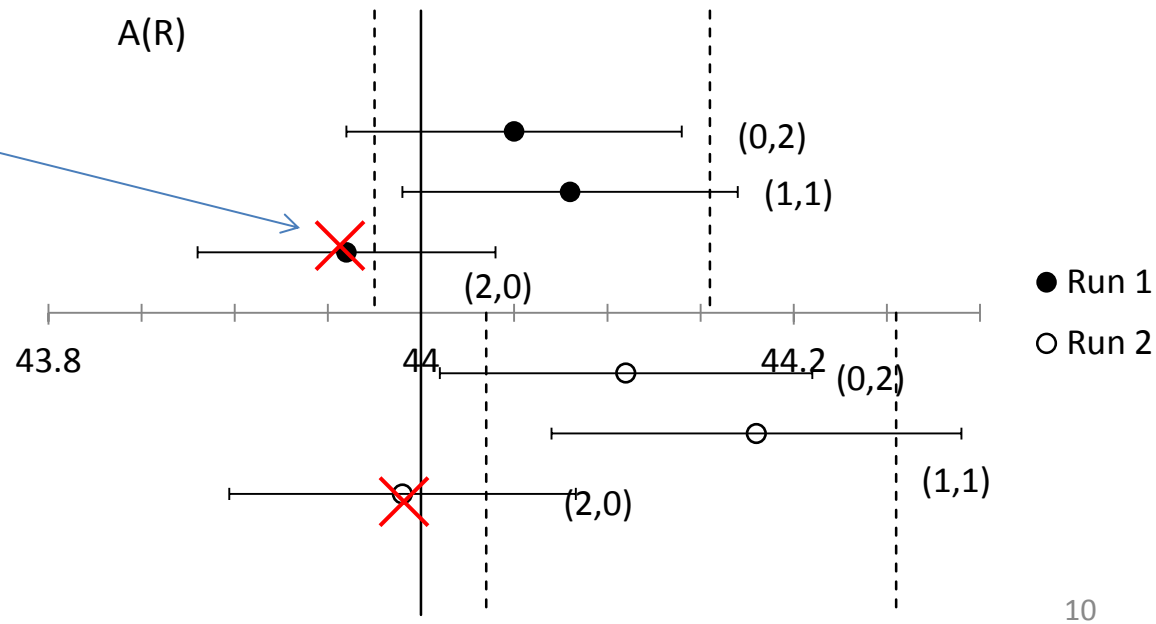
Root Analysis A(R) Run 1&2

A vs. R	Ao	dAo	Chi squared	Run
~~Pade (2,0)~~	~~43.96~~	~~0.08~~	~~1.65~~	~~Root, 1~~
Pade (1,1)	44.08	0.09	1.12	Root, 1
Pade (0,2)	44.05	0.09	1.19	Root, 1
~~Pade (2,0)~~	~~43.99~~	~~0.093~~	~~3.00~~	~~Root, 2~~
Pade (1,1)	44.18	0.11	**1.71**	Root, 2
Pade (0,2)	44.11	0.100	**2.00**	Root, 2

Questions:
should we eliminate Pade (2,0)?
(again, ΔAo =?? Max? Range?)
Why discrepancy Root/MM?

Without Pade(2,0)

Run 1 Ao(R)= 44.06(09)
Run 2 Ao(R)= 44.15(11)



Root vs. Mathematica

R vs. T	a1	Δa1	a2	b1	Chi sq	
Pade (2,0)	143.01	6.9	41.3		0.50	Root
Pade(1,1)	144.41	6.1		-0.23	0.47	Root
Pade (2,0)	130.65	6.4	43.36		0.84	Rt run2
Pade(1,1)	132.15	5.6		-0.26	0.88	Rt run2

R vs. T	a1	Δa1	a2	b1	Chi sq	
Pade (2,0)	143.5	5.1	39.7		0.54	MM1
Pade(1,1)	144.74	4.3		-0.22	0.498	MM1
Pade (2,0)	131.195	4.9	41.69		0.56	MM2
Pade(1,1)	132.52	4.0		-0.25	0.50	MM2

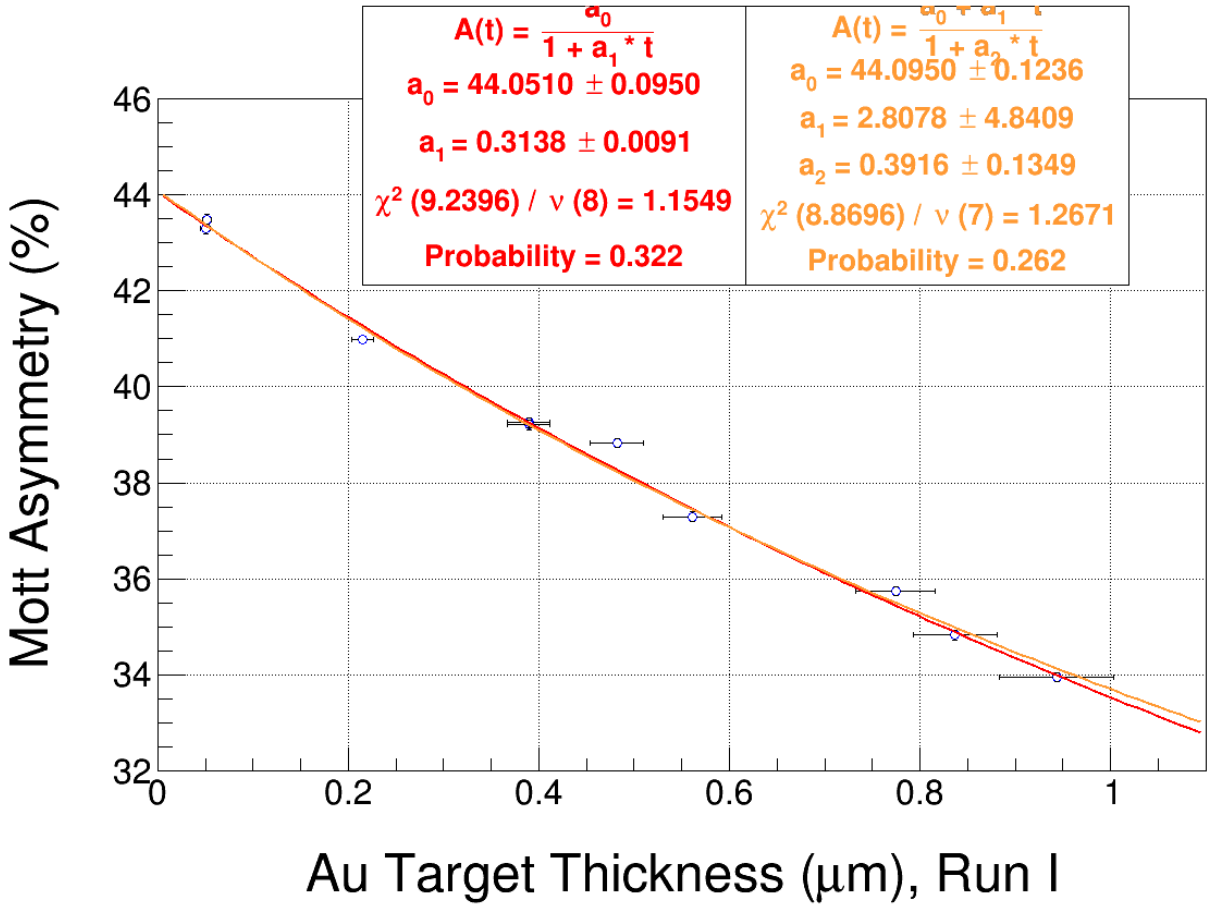
Pretty good agreement Root vs. MM

What to say about this?
Compare the Pade(2,0) to the values predicted by GEANT4????

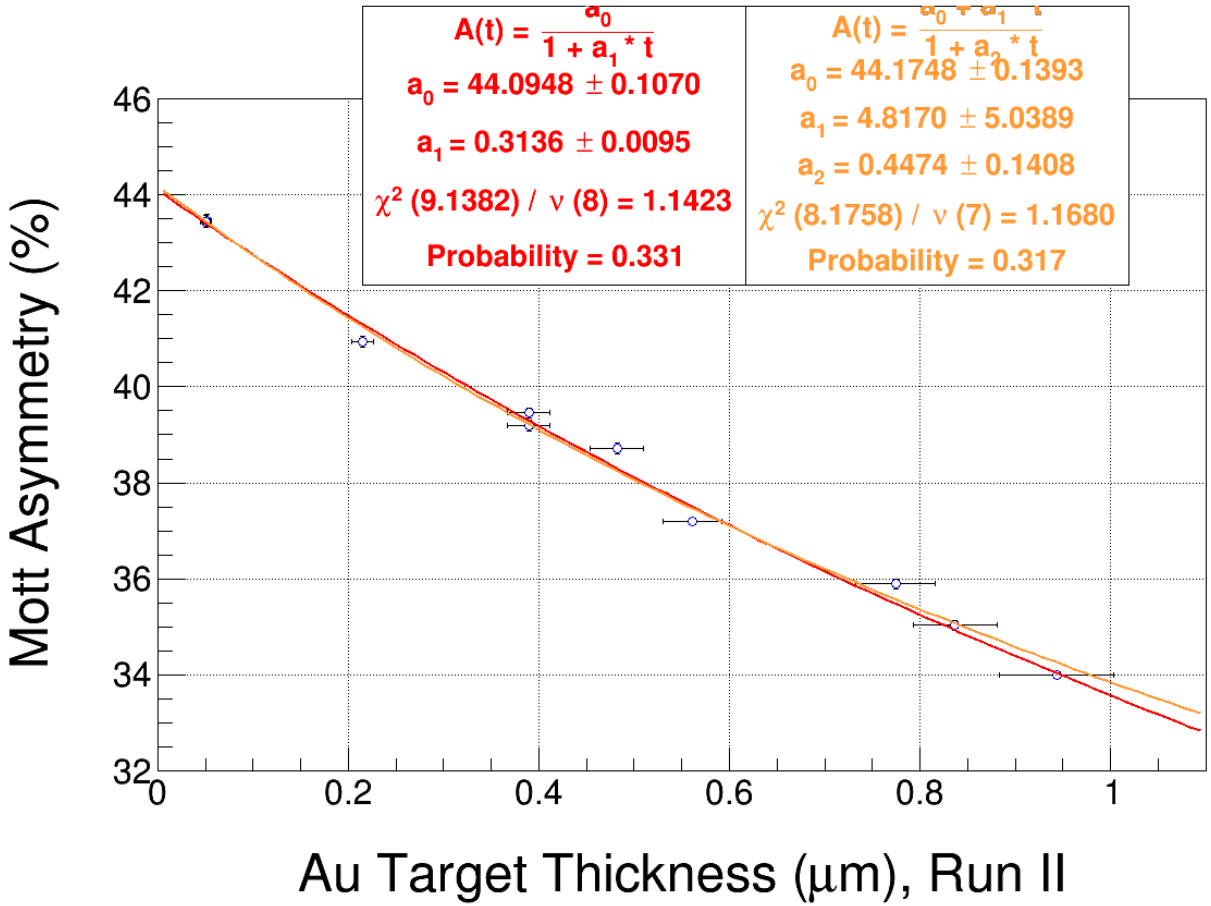
Summary

- Analysis “final” A(t), A(R), R(t), -0.5-2σ, no bkg.
- Pade analysis to find non-rejected Pade orders
- Root & mathematica fits compared
  - use Root fits? Why the discrepancy in A(R)?
  - Use microns as units rather than nm (done)
- Compare R(t) experimental fit results to GEANT4 predictions??

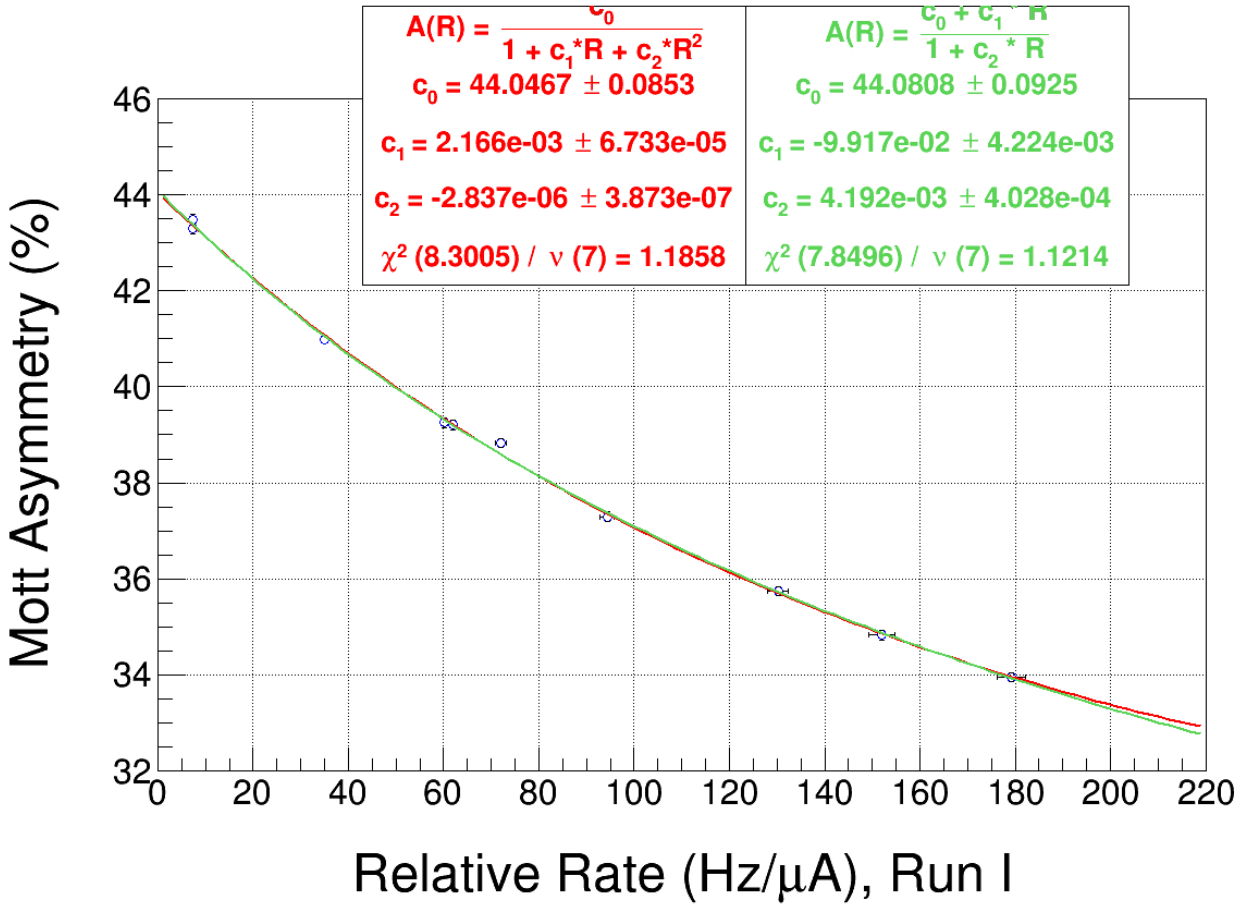
A(t), Run 1


$A(t) = \frac{a_0}{1 + a_1 * t}$
$a_0 = 44.0510 \pm 0.0950$
$a_1 = 0.3138 \pm 0.0091$
χ^2 (9.2396) / ν (8) = 1.1549
Probability = 0.322
$A(t) = \frac{a_0 + a_1 * t}{1 + a_2 * t}$
$a_0 = 44.0950 \pm 0.1236$
$a_1 = 2.8078 \pm 4.8409$
$a_2 = 0.3916 \pm 0.1349$
χ^2 (8.8696) / ν (7) = 1.2671
Probability = 0.262
Mott Asymmetry (%)
Au Target Thickness (μm), Run I
46
44
42
40
38
36
34
32
0
0.2
0.4
0.6
0.8
1

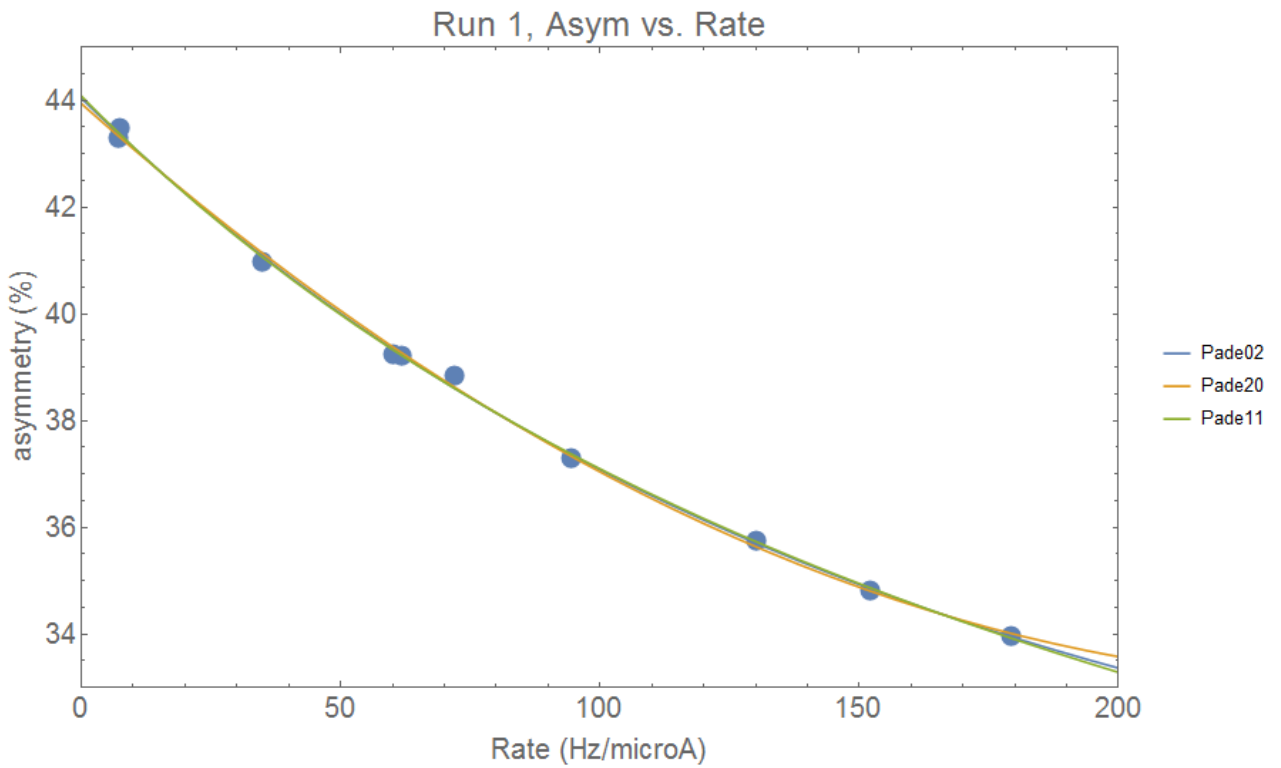
A(t) Run 2


$A(t) = \frac{a_0}{1 + a_1 * t}$
$a_0 = 44.0948 \pm 0.1070$
$a_1 = 0.3136 \pm 0.0095$
χ^2 (9.1382) / ν (8) = 1.1423
Probability = 0.331
$A(t) = \frac{a_0 + a_1 * t}{1 + a_2 * t}$
$a_0 = 44.1748 \pm 0.1393$
$a_1 = 4.8170 \pm 5.0389$
$a_2 = 0.4474 \pm 0.1408$
χ^2 (8.1758) / ν (7) = 1.1680
Probability = 0.317
Mott Asymmetry (%)
46
44
42
40
38
36
34
32
0
0.2
0.4
0.6
0.8
1
Au Target Thickness (μm), Run II

A(R) Run 1


A(R) = c0 / (1 + c1*R + c2*R2)
c0 = 44.0467 ± 0.0853
c1 = 2.166e-03 ± 6.733e-05
c2 = -2.837e-06 ± 3.873e-07
χ2 (8.3005) / ν (7) = 1.1858
A(R) = (c0 + c1 * R) / (1 + c2 * R)
c0 = 44.0808 ± 0.0925
c1 = -9.917e-02 ± 4.224e-03
c2 = 4.192e-03 ± 4.028e-04
χ2 (7.8496) / ν (7) = 1.1214
Mott Asymmetry (%)
Relative Rate (Hz/μA), Run I
46
44
42
40
38
36
34
32
0
20
40
60
80
100
120
140
160
180
200
220

A(R) run 1 mathematica



In[45]:= `PlotPade02[{"ParameterTable"}]`

Out[45]=

	Estimate	Standard Er
a0	44.0363	0.103692
b1	0.00215479	0.000075356
b2	-2.77754×10^{-6}	4.10445×10

In[46]:= `PlotPade20[{"ParameterTable"}]`

Out[46]=

	Estimate	Standard Error
a0	43.9349	0.113091
a1	-0.0861462	0.00302033
a2	0.000171839	0.0000159944

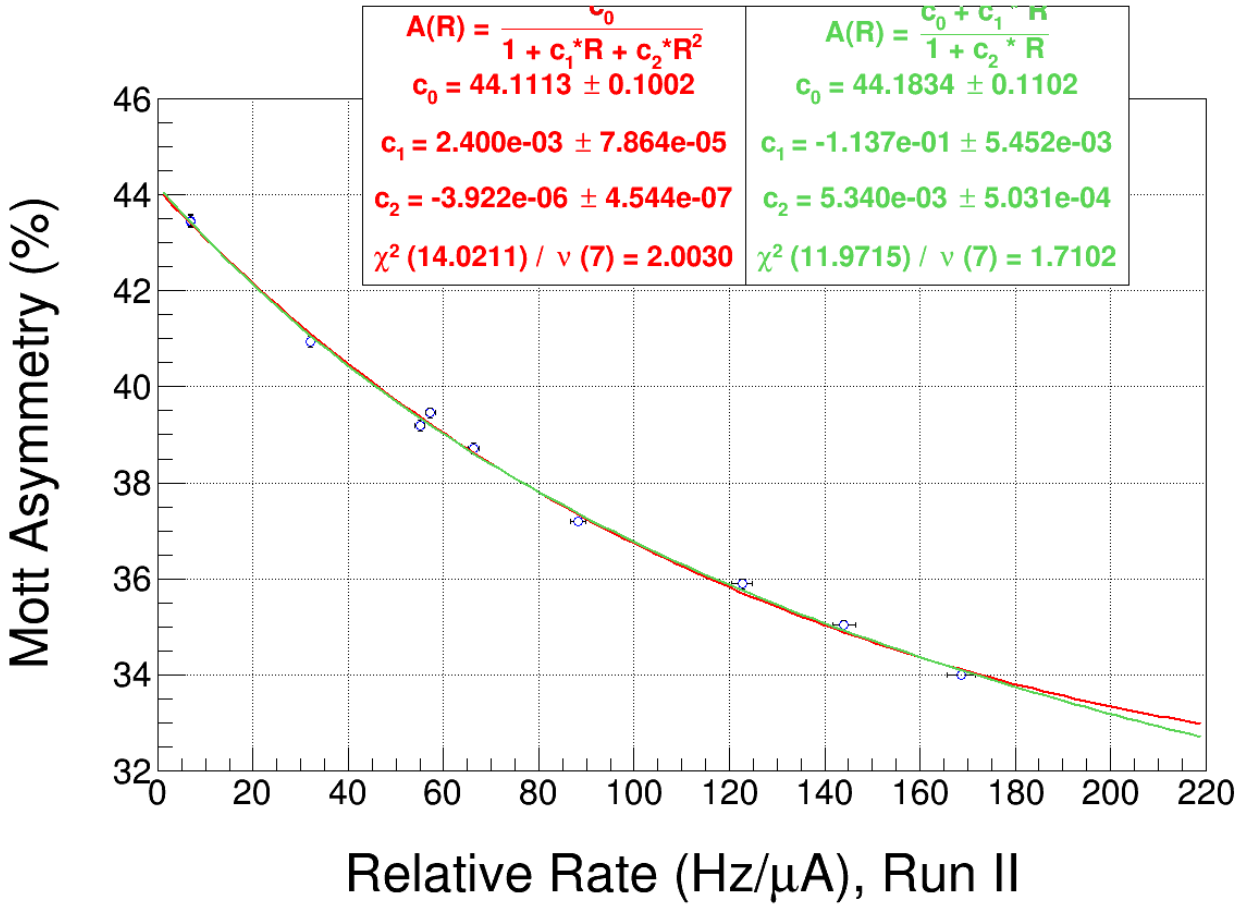
In[47]:= `PlotPade11[{"ParameterTable"}]`

Out[47]=

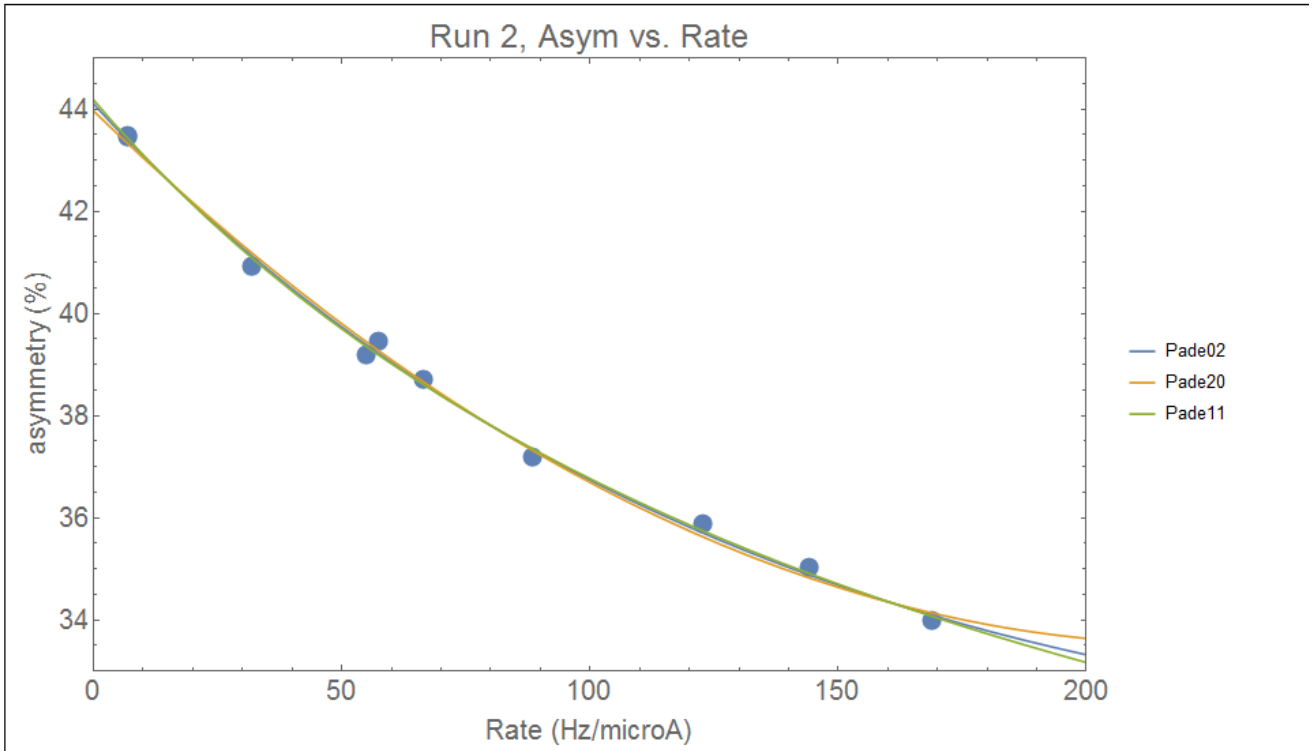
	Estimate	Standard Error
a0	44.0748	0.108656
a1	0.0844463	0.0140226
b1	0.00415783	0.000409407

Pade02	$\frac{44.0363}{1+0.00215479\,x-2.77754\times10^{-6}\,x^2}$	Reduced $\chi2$	1.56382
Pade20	$43.9349 - 0.0861462\,x + 0.000171839\,x^2$	Reduced $\chi2$	2.16399
Pade11	$\frac{44.0748+0.0844463\,x}{1+0.00415783\,x}$	Reduced $\chi2$	1.49785

A(R) Run 2


$A(R) = \frac{c_0}{1 + c_1 * R + c_2 * R^2}$
$c_0 = 44.1113 \pm 0.1002$
$c_1 = 2.400e-03 \pm 7.864e-05$
$c_2 = -3.922e-06 \pm 4.544e-07$
χ^2 (14.0211) / ν (7) = 2.0030
$A(R) = \frac{c_0 + c_1 * R}{1 + c_2 * R}$
$c_0 = 44.1834 \pm 0.1102$
$c_1 = -1.137e-01 \pm 5.452e-03$
$c_2 = 5.340e-03 \pm 5.031e-04$
χ^2 (11.9715) / ν (7) = 1.7102
Mott Asymmetry (%)
Relative Rate (Hz/μA), Run II
46
44
42
40
38
36
34
32
0
20
40
60
80
100
120
140
160
180
200
220

A(R) Run 2 Mathematica



Pade02	$\frac{44.0948}{1+0.00238883\,x-3.86058\times10^{-6}\,x^2}$	Reduced $\chi2$	2.95104
Pade20	$43.9587 - 0.0937688\,x + 0.000210893\,x^2$	Reduced $\chi2$	4.2811
Pade11	$\frac{44.1744+0.120627\,x}{1+0.00529568\,x}$	Reduced $\chi2$	2.54385

PlotPade02[{"ParameterTable"}]

	Estimate	Standard Error	t
a0	44.0948	0.167453	2
b1	0.00238883	0.000121298	1
b2	-3.86058×10^{-6}	6.70129×10^{-7}	-

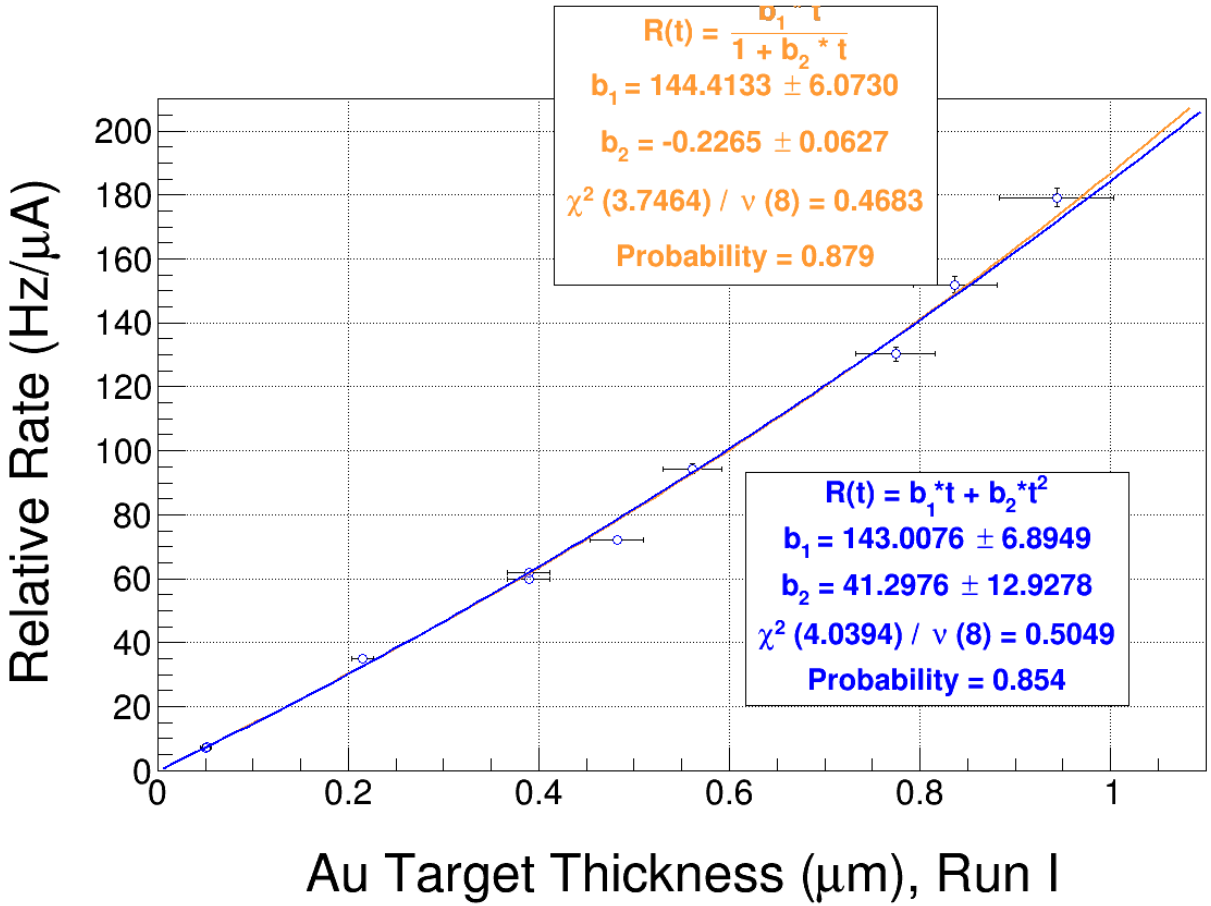
PlotPade20[{"ParameterTable"}]

	Estimate	Standard Error	t- St
a0	43.9587	0.186907	235.
a1	-0.0937688	0.0049633	-18
a2	0.000210893	0.0000267611	7.88

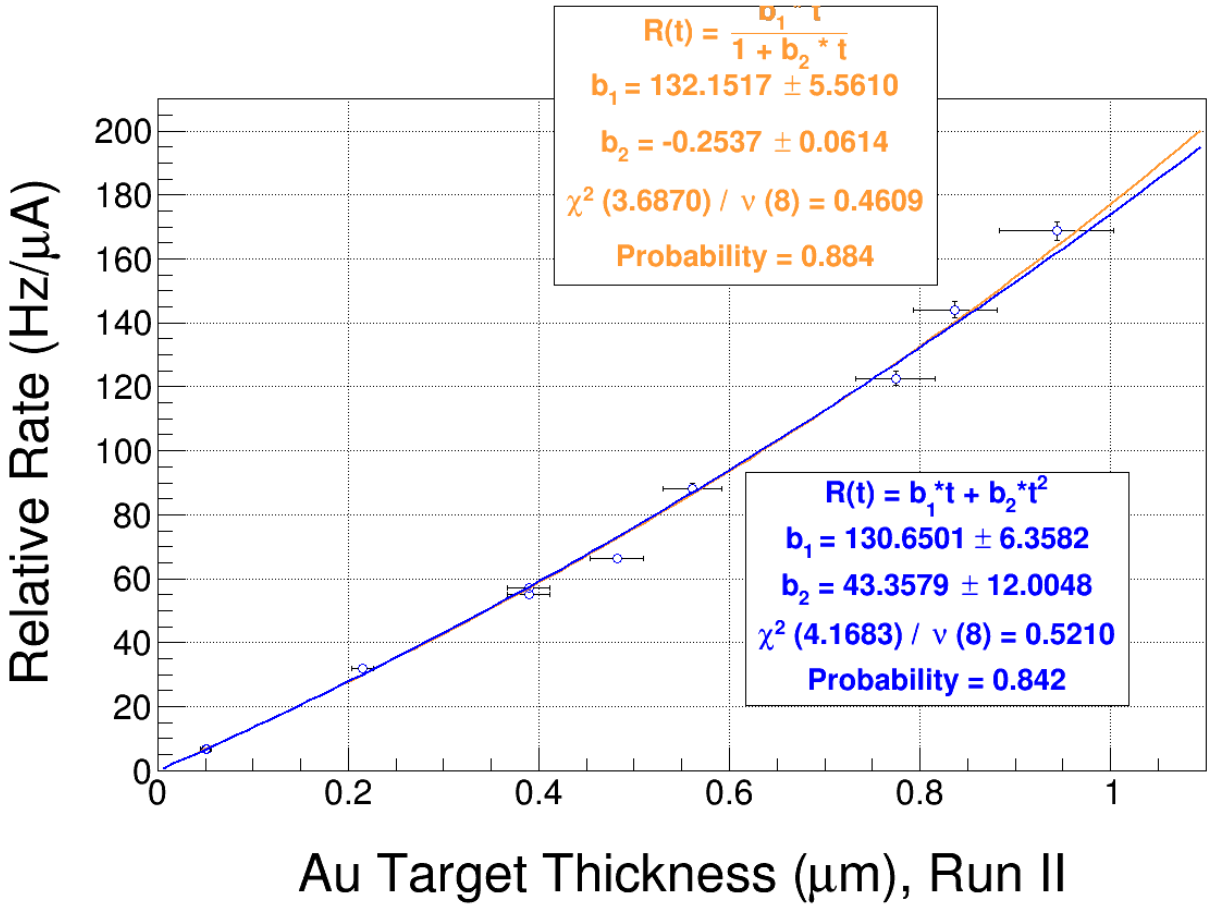
PlotPade11[{"ParameterTable"}]

	Estimate	Standard Error	t- Sta
a0	44.1744	0.169683	260.3
a1	0.120627	0.0227844	5.294
b1	0.00529568	0.000666788	7.942

R(t) Run 1


R(t) = b1 * t / (1 + b2 * t)
b1 = 144.4133 ± 6.0730
b2 = -0.2265 ± 0.0627
χ2 (3.7464) / ν (8) = 0.4683
Probability = 0.879
R(t) = b1*t + b2*t2
b1 = 143.0076 ± 6.8949
b2 = 41.2976 ± 12.9278
χ2 (4.0394) / ν (8) = 0.5049
Probability = 0.854
Relative Rate (Hz/μA)
Au Target Thickness (μm), Run I
0
20
40
60
80
100
120
140
160
180
200
0
0.2
0.4
0.6
0.8
1

R(t) Run 2


R(t) = b1 * t / 1 + b2 * t
b1 = 132.1517 ± 5.5610
b2 = -0.2537 ± 0.0614
χ2 (3.6870) / ν (8) = 0.4609
Probability = 0.884
R(t) = b1*t + b2*t2
b1 = 130.6501 ± 6.3582
b2 = 43.3579 ± 12.0048
χ2 (4.1683) / ν (8) = 0.5210
Probability = 0.842
Relative Rate (Hz/μA)
Au Target Thickness (μm), Run II
0
20
40
60
80
100
120
140
160
180
200
0
0.2
0.4
0.6
0.8
1