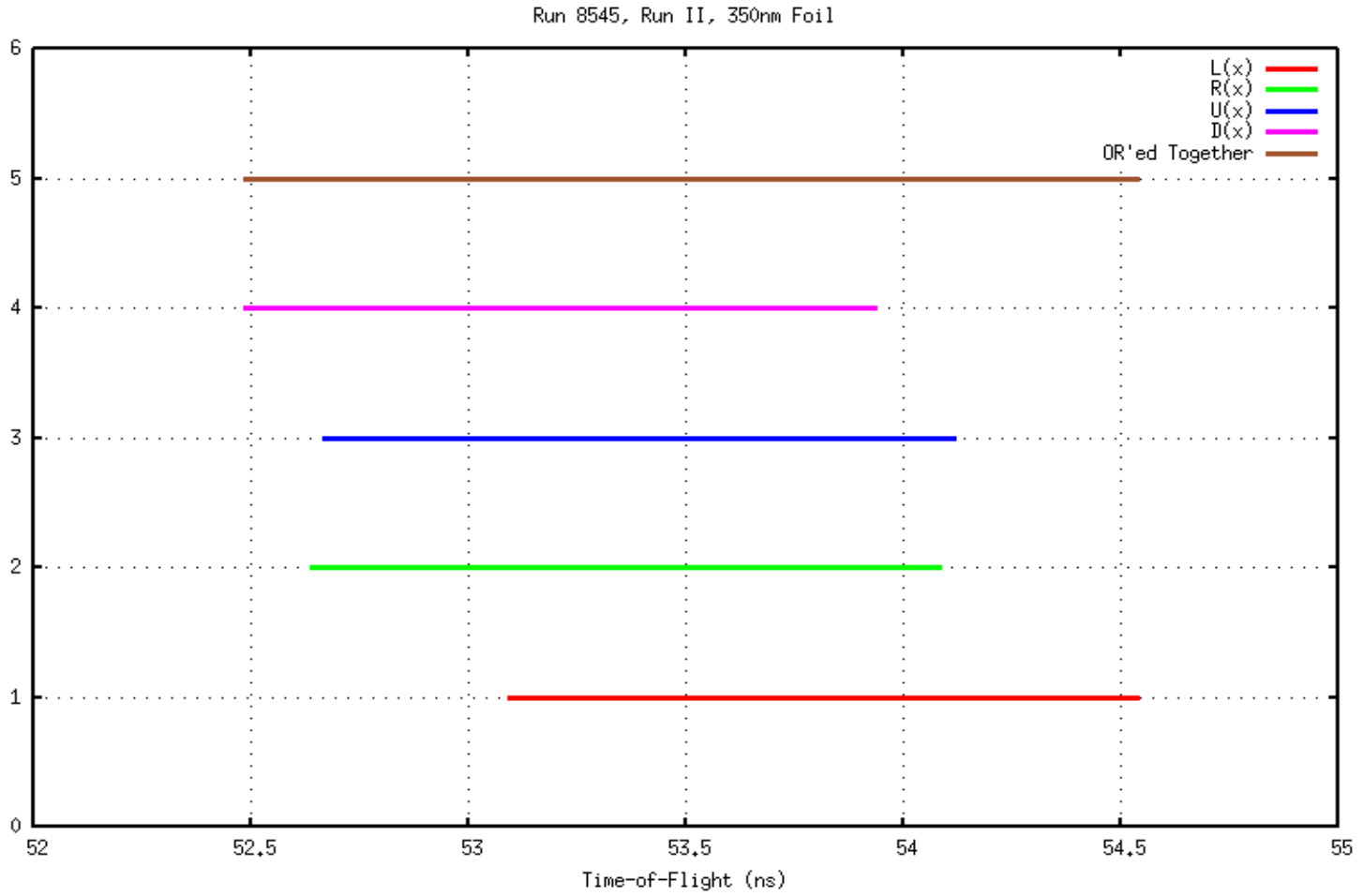
Mott Analysis Update, 5/17/17

1) Detector-dependent Time-of-Flight cut windows vs
   "OR'ed" Time-of-Flight window
2) New Rate corrections – drift, stability – following Joe's recipe
3) Rate Sensitivity to choice of ToF and E cuts Study – Final rate systematic correction?
4) Latest, (final?) Run I and II Rates and Asymmetry Tables for vs
   Foil Thickness runs
5) What else needs to be done for the paper?

Detector Dependent ToF Window

When cutting on ToF, previous versions used a *common* ToF-window, built by “OR”ing together LRUD windows (brown)



Better – when cutting on ToF, use detector-specific ToF-cuts

Detector Dependent ToF Window

What events are we cutting away that we weren't before?

Run 8545		Left Detector		Right Detector		
# of Events Leftover	Uncut L+R	ToF-Cut	E-Cut	ToF-Cut	E-Cut	Asymmetry
Common ToF-cut	518827	226560	223245	231132	227747	39.05 +/- 0.21
Detector Dependent	518827	221413	218192	221030	217784	39.05 +/- 0.22
Difference	0	5147	5053	10102	9963	40.11 +/- 1.25

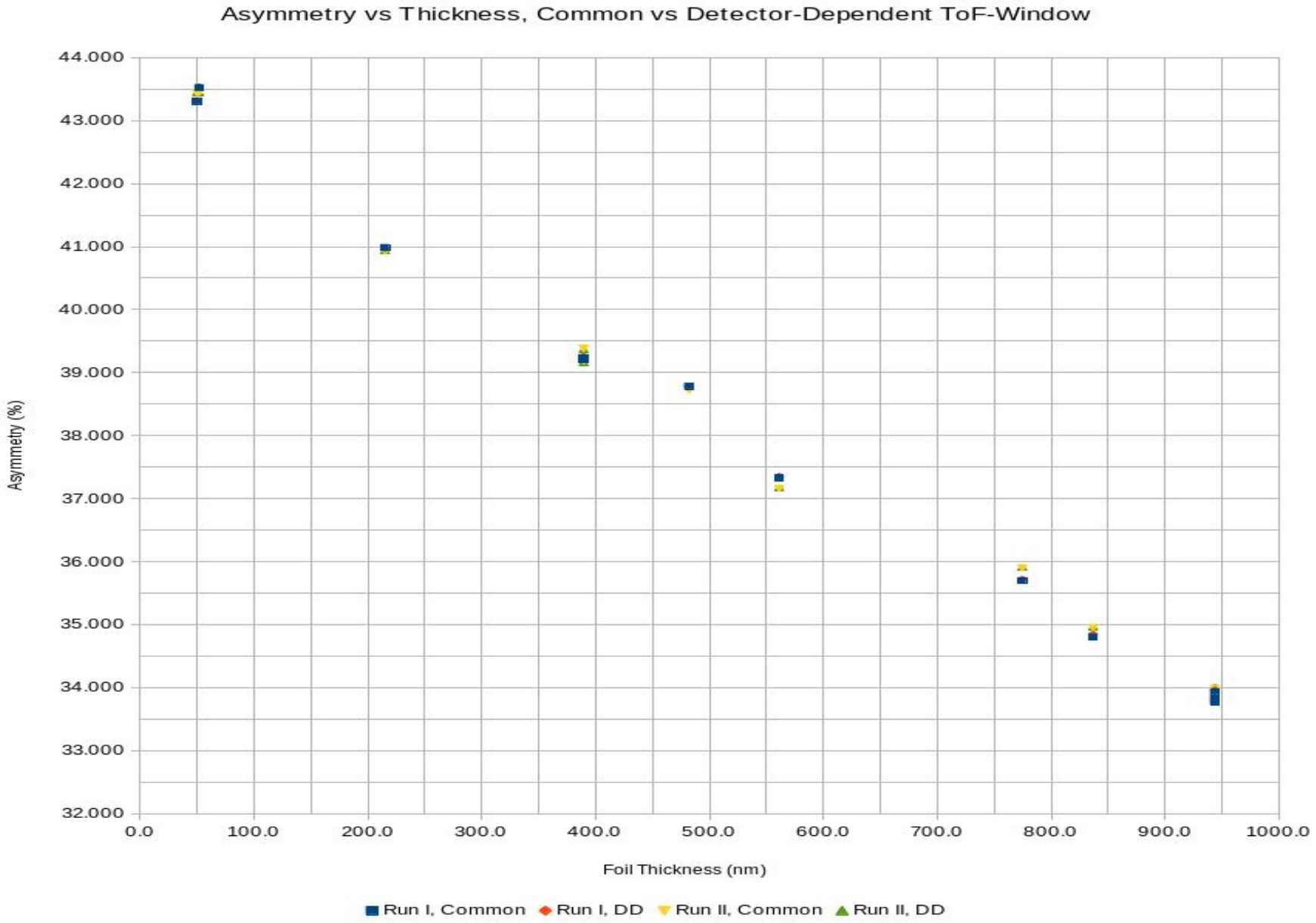
Events that carried analyzing power but didn't fall within our cuts. If we want to re-introduce these events, widen ToF cuts

Detector Dependent ToF Window

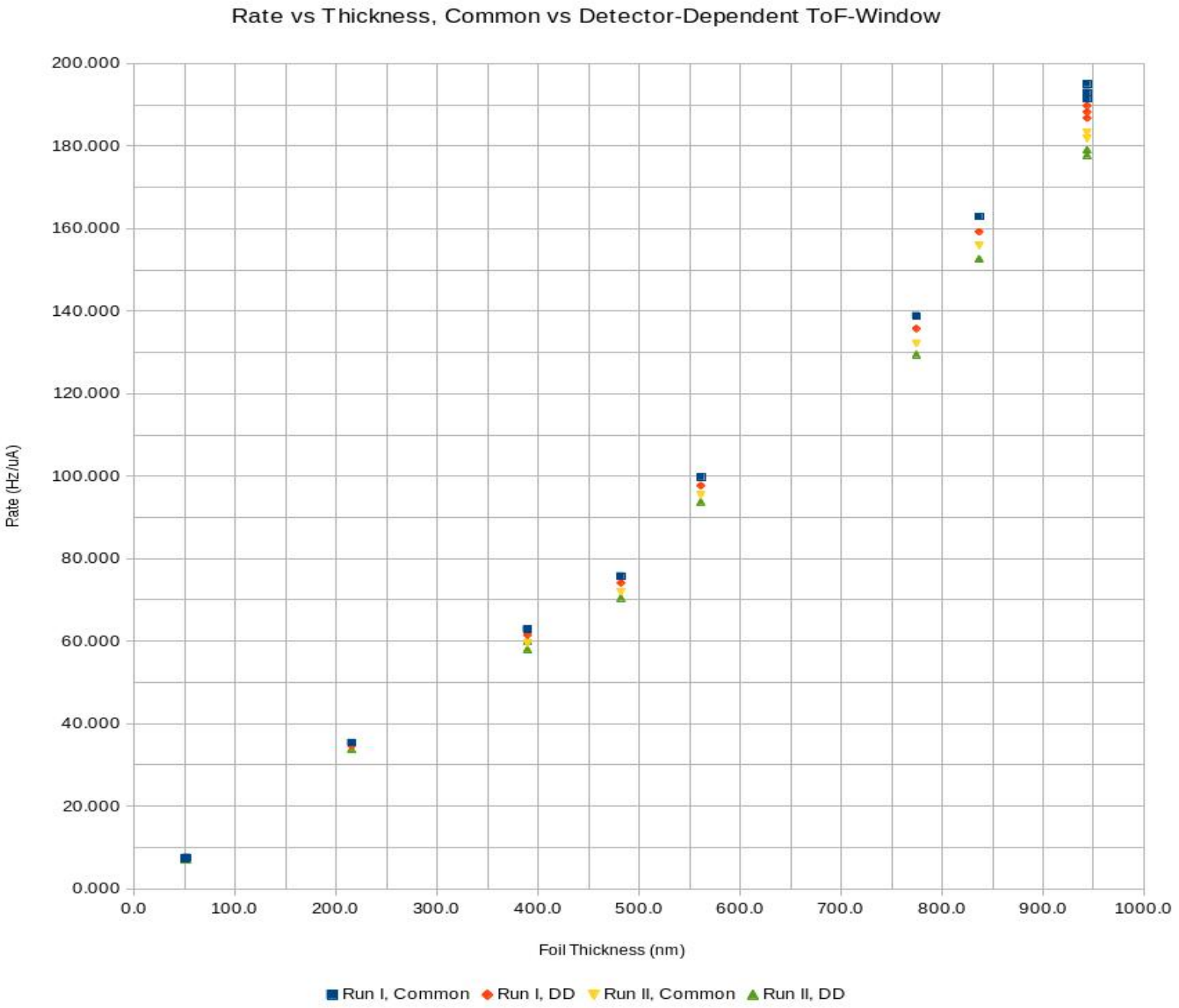
Effect on Fits, Asymmetries, and Rates in Runs I and II?

- Fits: no difference in ToF fit; E-fit means the same, sigmas change by < 2 channels, binning is 10Chan/Bin
- Asymmetries: all changes fall within uncertainty
- Rates: because we are cutting away a ~few percent more events, Rates decrease on average by ~2%

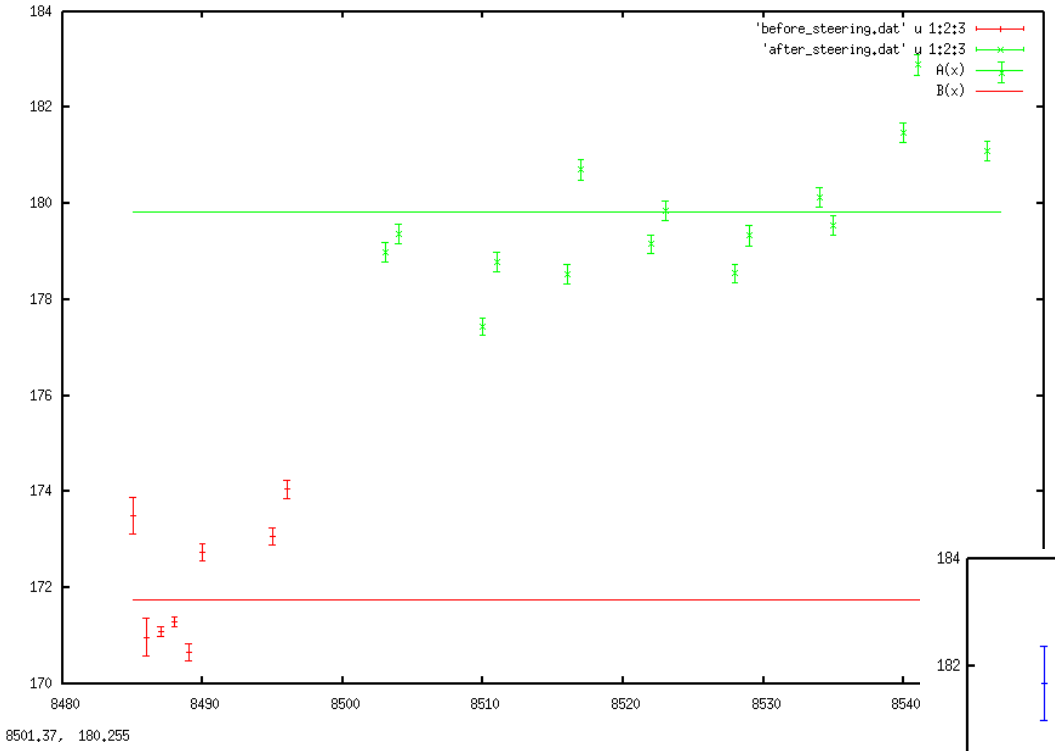
Detector Dependent ToF Window



Detector Dependent ToF Window



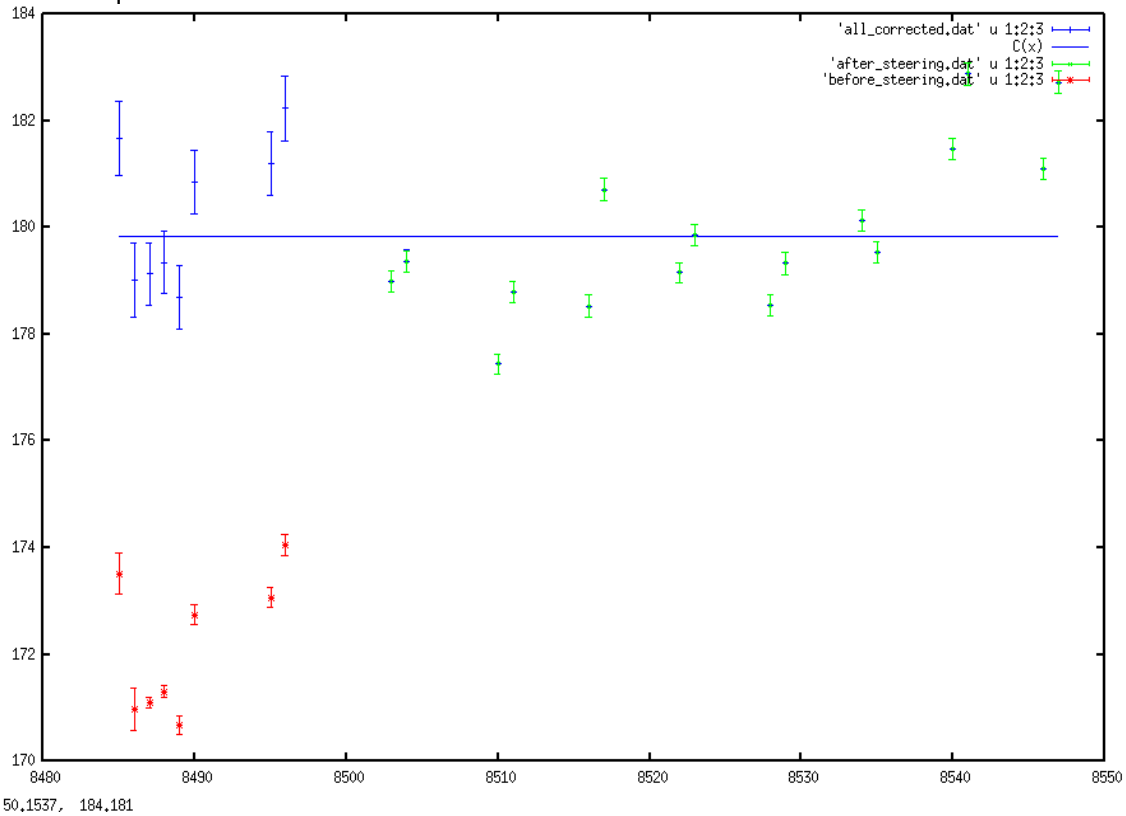
Rate Corrections – Run II Stability



Runs taken when scraping = red
After steering corrections = green

Plotting Rate vs Run # from Run II

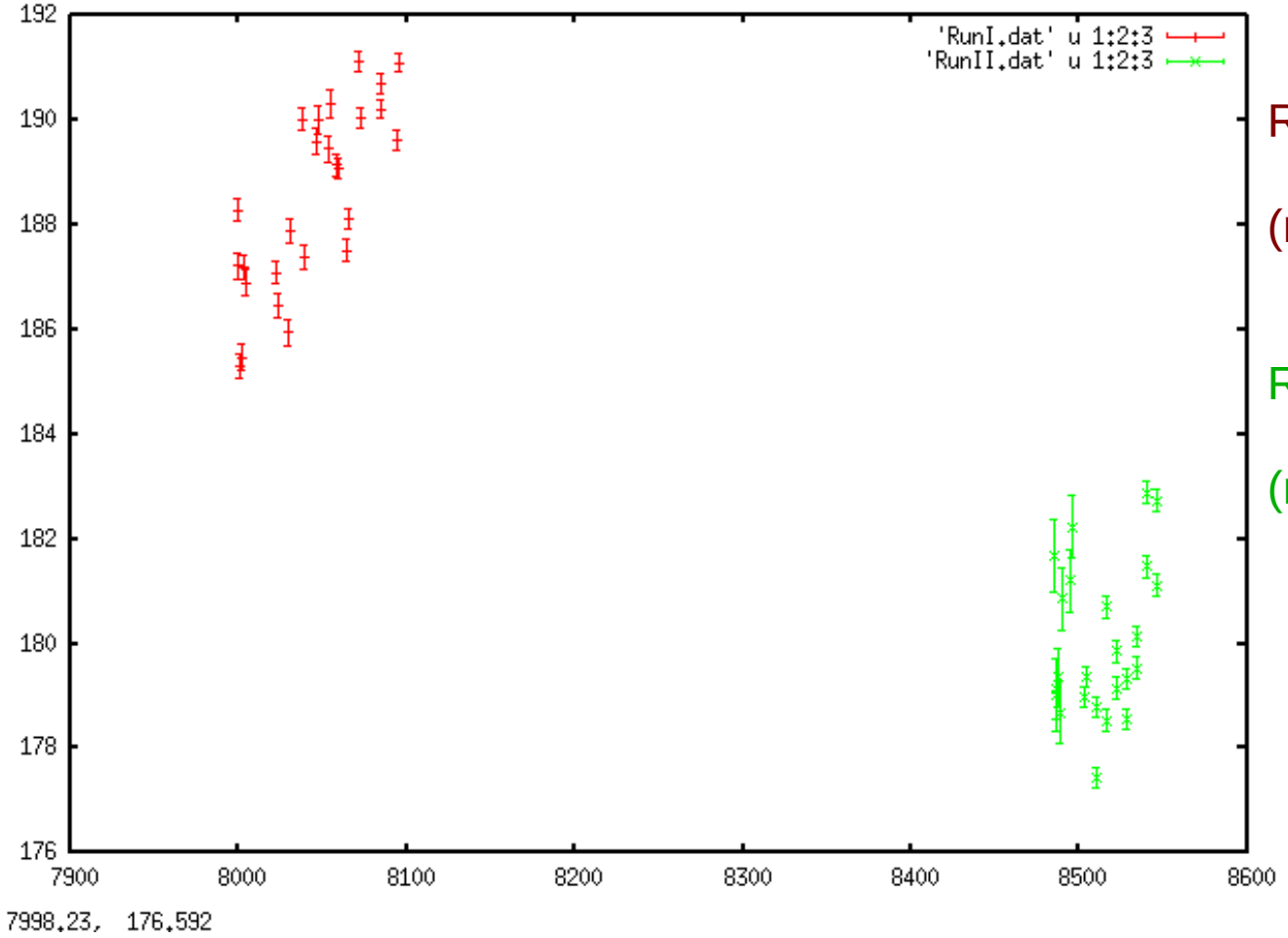
Average of before and after steering found, stability correction =
After / before = 1.0470 +/- 0.0033



Rates corrected

Run	Original Rate	Corrected Rate		
#	R	dR	R'	dR'
8485	173.5109	0.3806	181.6659	0.6976
8486	170.9714	0.3878	179.0071	0.6951
8487	171.0885	0.1023	179.1296	0.5747
8488	171.2985	0.1066	179.3495	0.5762
8489	170.6653	0.1738	178.6866	0.5919
8490	172.7393	0.1825	180.8581	0.6012
8495	173.0682	0.1821	181.2024	0.6021
8496	174.0514	0.1933	182.2318	0.6090

Rate Corrections – Drift



Run I – red

(max-min)/(max+min) = 1.55%

Run II – green

(max-min)/(max+min) = 1.51%

Rate Corrections

	Run I Drift Correction	Run II Stability Correction	Run II Drift Correction
Previous	0.0132	1.0379 +/- 0.00083	0.0147
Updated (April 2017)	0.0155	1.0470 +/- 0.0033	0.0151

Rate Sensitivity to Choice of Cuts

- Set of individual runs with different foil thicknesses chosen from Run II Asymmetry vs Thickness runs – 10 + 1 stability = 11 total
- Rates then normalized by 1um-Foil-Stability-run's rate
- Nominal cuts ::: ToF[-2 : +2] and E[-0.5 : +2]
- Nominal cuts then varied in steps of +/-10%, up to +/-30% everywhere, +/-50% when E or T-cut held nominal

  ie ToF +20% = [-2.4 : +2.4]; E -30% = [-0.125 : +1.625]

  => The Grid

Rate Sensitivity to Choice of Cuts

Larger E Window ↑

39.07	1.005	39.03	1.004	38.94	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	38.68	0.995	38.74	0.996
32.47	1.011	32.30	1.005	32.25	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	32.12	1.000	32.16	1.001
33.22	1.007	33.11	1.004	33.07	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	33.21	1.007	33.25	1.008
19.08	1.018	18.89	1.008	18.82	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	18.64	0.995	18.66	0.996
3.98	1.013	3.97	1.010	3.95	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	3.91	0.997	3.92	0.998
4.02	1.020	3.99	1.012	3.96	1.006	3.94	1.000	3.92	0.995	3.90	0.990	3.90	0.990
100.00		100.00		100.00		100.00		100.00		100.00		100.00	
Average	1.011	Average	1.007	Average	1.003	Average	1.000	Average	0.998	Average	0.997	Average	0.998
Std Dev	0.0068	Std Dev	0.0037	Std Dev	0.0030	Std Dev	0.0009	Std Dev	0.0038	Std Dev	0.0045	Std Dev	0.0047

T -1.4 : +1.4 E: -0.625 : +2.125		T: -1.6 : +1.6 E: -0.625 : +2.125		T: -1.8 : +1.8 E: -0.625 : 2.125		T: -2 : +2 E: -0.625 : 2.125		T: -2.2 : +2.2 E: -0.625: +2.125		T: -2.4 : +2.4 E: -0.625 : +2.125		T: -2.6 : +2.6 E: -0.625 : +2.125	
98.52	0.997	98.92	1.001	98.59	0.997	98.95	1.001	98.88	1.000	98.52	0.997	98.54	0.997
84.72	1.010	84.32	1.005	83.88	1.000	83.97	1.001	83.74	0.998	83.65	0.997	83.63	0.997
72.76	1.016	72.24	1.009	71.80	1.003	71.70	1.001	71.62	1.000	71.61	1.000	71.63	1.001
52.82	1.011	52.72	1.010	52.57	1.007	52.24	1.000	51.92	0.994	51.91	0.994	51.90	0.994
39.13	1.007	39.06	1.005	38.96	1.002	38.86	0.999	38.67	0.995	38.73	0.996	38.76	0.997
32.49	1.011	32.32	1.006	32.23	1.003	32.13	1.000	32.08	0.998	32.12	1.000	32.13	1.000
33.24	1.007	33.15	1.005	33.08	1.003	33.06	1.002	33.20	1.006	33.20	1.006	33.25	1.008
[illegible]	[illegible]	[illegible]	[illegible]	18.86	1.006	18.75	1.001	18.66	0.996	18.68	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	3.95	1.006	3.93	1.001	3.91	0.996	3.91	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	3.97	1.006	3.94	1.001	3.92	0.995	3.90	[illegible]	[illegible]	[illegible]
[illegible]		[illegible]		100.00		100.00		100.00		100.00		[illegible]	
[illegible]	[illegible]	[illegible]	[illegible]	Average	1.003	Average	1.001	Average	0.998	Average	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	Std Dev	0.0030	Std Dev	0.0008	Std Dev	0.0037	Std Dev	[illegible]	[illegible]	[illegible]

← Smaller ToF window | **Larger ToF window →**

T: -1 : +1 E: -0.5 : +2	← - 10 %	T: -1.2 : +1.2 E: -0.5 : +2	← - 10 %	T -1.4 : +1.4 E: -0.5 : +2	← - 10 %	T: -1.6: +1.6 E: -0.5 : +2	← - 10 %	T: -1.8: +1.8 E: -0.5 : +2	← - 10 %	T: -2 : +2 E: -0.5 : +2	-> + 10%	T: -2.2 : +2.2 E: -0.5 : +2	-> + 10%	T: -2.4 : 2.4 E: -0.5 : +2	-> + 10%	T: -2.6 : +2.6 E: -0.5 : +2	-> + 10%	T: -2.8 : +2.8 E: -0.5 : +2	-> + 10%	T: -3 : +3 E: -0.5 : +2	
99.01	1.002	99.40	1.005	98.59	0.997	98.94	1.001	98.61	0.998	98.86	1.000	98.86	1.000	98.55	0.997	98.56	0.997	98.53	0.997	98.53	0.997
84.30	1.005	84.77	1.011	84.69	1.010	84.33	1.006	83.94	1.001	83.87	1.000	83.71	0.998	83.66	0.997	83.63	0.997	83.57	0.996	83.59	0.997
73.50	1.027	73.38	1.025	72.80	1.017	72.24	1.009	71.80	1.003	71.59	1.000	71.65	1.001	71.66	1.001	71.65	1.001	71.62	1.000	71.63	1.000
53.68	1.028	53.39	1.022	52.86	1.012	52.77	1.010	52.62	1.008	52.22	1.000	51.94	0.994	51.91	0.994	51.93	0.994	51.88	0.994	51.88	0.993
40.06	1.031	39.28	1.010	39.13	1.007	39.05	1.004	39.00	1.003	38.88	1.000	38.70	0.996	38.76	0.997	38.79	0.998	38.76	0.997	38.77	0.997
32.22	1.003	32.17	1.001	32.52	1.012	32.32	1.006	32.29	1.005	32.13	1.000	32.11	0.999	32.16	1.001	32.18	1.001	32.16	1.001	32.16	1.001
33.35	1.011	33.41	1.013	33.24	1.007	33.11	1.004	33.07	1.002	32.99	1.000	33.20	1.006	33.22	1.007	33.25	1.008	33.23	1.007	33.24	1.007
19.29	1.030	19.20	1.024	19.13	1.021	18.93	1.010	18.87	1.007	18.74	1.000	18.66	0.996	18.69	0.998	18.69	0.998	18.68	0.997	18.69	0.997
4.07	1.038	4.06	1.033	3.97	1.011	3.96	1.008	3.95	1.006	3.93	1.000	3.91	0.996	3.91	0.997	3.91	0.996	3.91	0.995	3.90	0.992
4.08	1.035	4.05	1.027	4.02	1.021	3.99	1.013	3.97	1.007	3.94	1.000	3.92	0.996	3.90	0.989	3.90	0.989	3.89	0.987	3.90	0.991
100.00		100.00		100.00		100.00		100.00		100.00		100.00		100.00		100.00		100.00		100.00	
Average	1.021	Average	1.017	Average	1.012	Average	1.007	Average	1.004	Average	1.000	Average	0.998	Average	0.998	Average	0.998	Average	0.997	Average	0.997
Std Dev	0.0141	Std Dev	0.0106	Std Dev	0.0072	Std Dev	0.0038	Std Dev	0.0032	Std Dev	0.0000	Std Dev	0.0036	Std Dev	0.0046	Std Dev	0.0049	Std Dev	0.0052	Std Dev	0.0048

T -1.4 : +1.4 E: -0.375 : +1.875		T: -1.6 : +1.6 E: -0.375 : +1.875		T: -1.8 : +1.8 E: -0.375 : +1.875		T: -2 : +2 E: -0.375 : +1.875		T: -2.2 : +2.2 E: -0.375 : +1.875		T: -2.4 : +2.4 E: -0.375 : +2.125		T: -2.6 : +2.6 E: -0.375 : +2.125	
98.37	0.995	98.78	0.999	98.45	0.996	98.83	1.000	98.80	0.999	98.36	0.995	98.42	0.996
84.64	1.009	84.22	1.004	83.86	1.000	83.89	1.000	83.69	0.998	83.53	0.996	83.59	0.997
72.81	1.017	72.27	1.009	71.80	1.003	71.62	1.000	71.67	1.001	71.63	1.000	71.61	1.000
52.90	1.013	52.80	1.011	52.64	1.008	52.29	1.001	51.95	0.995	51.89	0.994	51.91	0.994
39.13	1.007	39.07	1.005	39.00	1.003	38.89	1.000	38.73	0.996	38.75	0.997	38.78	0.997
32.49	1.011	32.30	1.005	32.27	1.004	32.14	1.000	32.14	1.000	32.15	1.000	32.16	1.001
33.20	1.006	33.09	1.003	33.04	1.002	33.00	1.000	33.19	1.006	33.17	1.005	33.20	1.006
19.12	1.021	18.93	1.010	18.86	1.007	18.75	1.001	18.66	0.996	18.68	0.997	18.70	0.998
3.96	1.009	3.96	1.008	3.94	1.004	3.92	1.000	3.91	0.996	3.91	0.996	3.91	0.995
4.01	1.019	3.98	1.011	3.96	1.005	3.94	0.999	3.92	0.994	3.89	0.987	3.89	0.986
100.00		100.00		100.00		100.00		100.00		100.00		100.00	
Average	1.011	Average	1.007	Average	1.003	Average	1.000	Average	0.998	Average	0.997	Average	0.997
Std Dev	0.0074	Std Dev	0.0039	Std Dev	0.0034	Std Dev	0.0006	Std Dev	0.0036	Std Dev	0.0048	Std Dev	0.0052

T -1.4 : +1.4 E: -0.25 : +1.75		T: -1.6 : +1.6 E: -0.25 : +1.75		T: -1.8 : +1.8 E: -0.25 : +1.75		T: -2 : +2 E: -0.25 : +1.75		T: -2.2 : +2.2 E: -0.25 : +1.75		T: -2.4 : +2.4 E: -0.25 : +1.75		T: -2.6 : +2.6 E: -0.25 : +1.75	
98.39	0.995	98.81	1.000	98.44	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	98.31	0.994	98.37	0.995
84.66	1.009	84.31	1.005	83.78	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	83.55	0.996	83.58	0.997
72.91	1.018	72.32	1.010	71.82	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	71.68	1.001	71.67	1.001
53.00	1.015	52.92	1.013	52.68	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	52.01	0.996	52.04	0.996

Smaller E Window ↓

Rate Sensitivity to Choice of Cuts

- Stability-run-normalized rates in grid for each different set of cuts, then, divided by the set of rates with nominal cuts

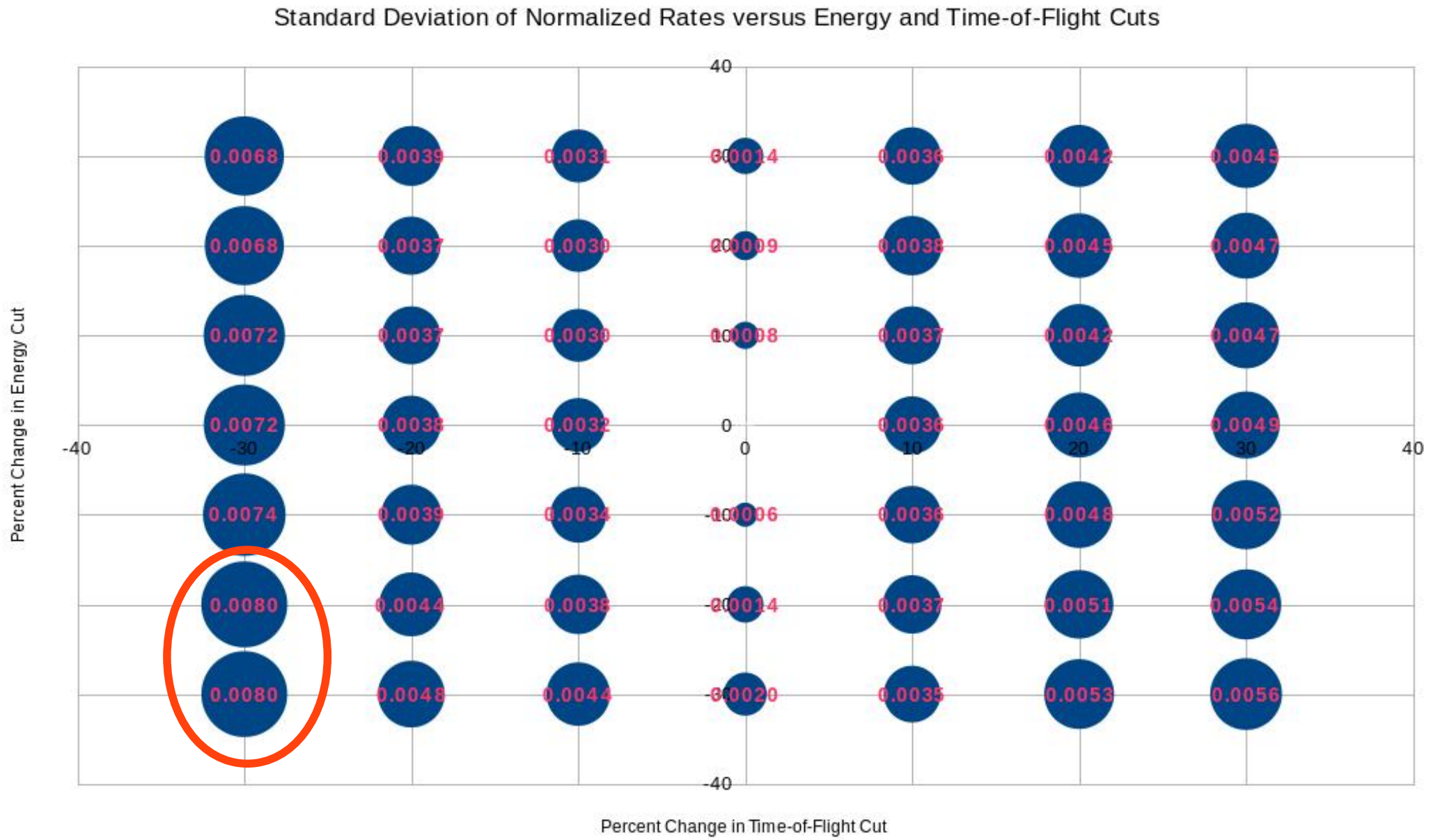
T: -2 : +2		T: -2.2 : +2.2		
E: -0.625 : 2.125		E: -0.625: +2.125		E:
98.95	1.001	98.88	1.000	
83.97	1.001	83.74	0.998	
71.70	1.001	71.62	1.000	
52.24	1.000	51.92	0.994	
38.86	0.999	38.67	0.995	
32.13	1.000	32.08	0.998	
33.06	1.002	33.20	1.006	
18.75	1.001	18.66	0.996	
3.93	1.001	3.91	0.996	
3.94	1.001	3.92	0.995	
100.00		100.00		
Average	1.001	Average	0.998	
Std Dev	**0.0008**	Std Dev	**0.0037**	
T: -2 : +2	-> + 10%	**T: -2.2 : +2.2**	-> + 10%	
E: -0.5 : +2		**E: -0.5 : +2**		
98.86	1.000	98.86	1.000	
83.87	1.000	83.71	0.998	
71.59	1.000	71.65	1.001	
52.22	1.000	51.94	0.994	
38.88	1.000	38.70	0.996	
32.13	1.000	32.11	0.999	
32.99	1.000	33.20	1.006	
18.74	1.000	18.66	0.996	
3.93	1.000	3.91	0.996	
3.94	1.000	3.92	0.996	
100.00		100.00		
Average	1.000	Average	0.998	
Std Dev	**0.0000**	Std Dev	**0.0036**	

Every black font white bg number divided by the corresponding black font/grey bg number, producing the blue font number to the right

- Then, standard deviation (of sample), calculated

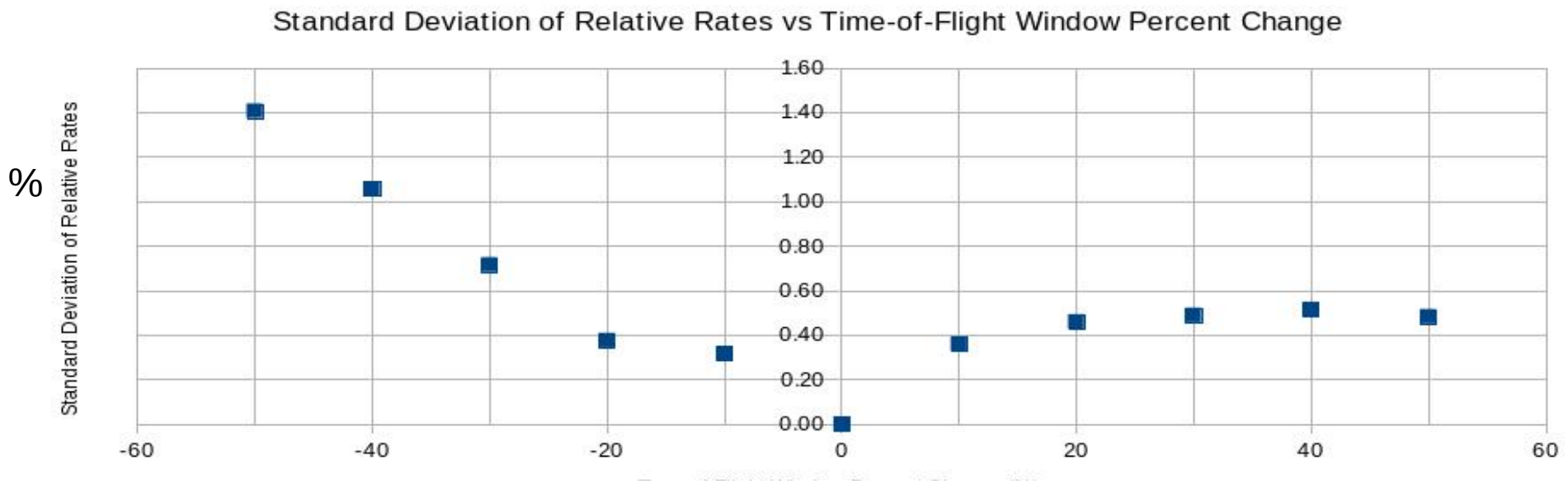
- Decided to vary +/- 30% in E and ToF, and then largest standard deviation chosen as systematic uncertainty on rates due to our choice of cuts = 0.8%

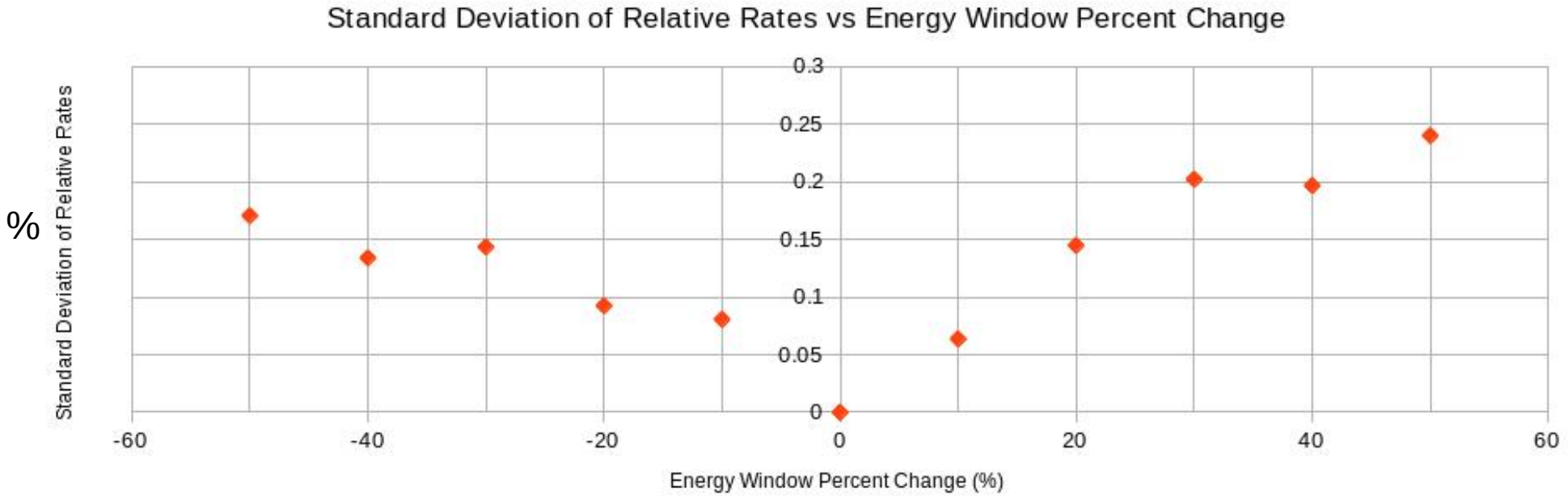
Rate Sensitivity to Choice of Cuts



Rate Sensitivity to Choice of Cuts

0.8% Correction determined





Rate Sensitivity to Choice of Cuts

Holding One Cut Window Nominal, Standard Deviation of Relative Rates			
Energy Cut Nominal [-0.5 : +2]		ToF Cut Nominal [-2 : +2]	
ToF – 50% [-1 : +1]	ToF + 50% [-3 : +3]	E – 50% [+0.125 : +1.375]	E + 50% [-1.125 : +2.625]
1.4%	**0.5%**	**0.2%**	**0.2%**

0.8% Correction using +/- 30% bounds on cuts

Possible Issues with this approach –

- Choice of 10+1stability runs biasing results?
- Only done for Run II, need to be redone for Run I?
- +/- 30% insufficient? Perhaps only consider + up to X%?

Updated (Final?) Run I Asymmetry and Rates Table

Low/ high	#	T_o [nm]	T [nm]	dT [nm]	A [%]	dA [%]	R_final [Hz/uA]	dR_final [Hz/uA]
low	15	1000	943.7	59.8	33.963	0.092	186.769	3.751
low	3	870	836.8	44.2	34.846	0.089	159.211	3.306
low	4	750	774.6	41.9	35.720	0.093	135.752	2.723
low	2	625	561.2	31	37.352	0.096	97.702	1.906
low	5	500	482	27.7	38.786	0.095	74.123	1.423
low	14	350	389.4	22.1	39.255	0.103	61.497	1.155
high	8	350	389.4	22.1	39.233	0.096	61.530	1.121
high	1	225	215.2	11.7	40.973	0.084	34.650	0.629
high	12	50	*50*	*5*	43.298	0.103	7.240	0.131
high	13	50	52	4.7	43.533	0.101	7.420	0.135
low	15	1000	943.7	59.8	33.780	0.070	188.245	3.765
high	15	1000	943.7	59.8	33.844	0.060	189.740	3.771

Updated (Final?) Run II Asymmetry and Rates Table

#	T_o [nm]	T [nm]	dT [nm]	A [%]	dA [%]	R_final [Hz/uA]	dR_final [Hz/uA]
15	1000	943.7	59.8	33.972	0.083	179.708	3.480
3	870	836.8	44.2	34.954	0.102	152.667	2.959
4	750	774.6	41.9	35.910	0.104	129.469	2.508
2	625	561.2	31	37.167	0.087	94.607	1.834
5	500	482	27.7	38.771	0.105	70.454	1.367
14	350	389.4	22.1	39.156	0.108	58.046	1.127
8	350	389.4	22.1	39.360	0.107	60.092	1.165
1	225	215.2	11.7	40.933	0.106	33.813	0.655
12	50	*50*	*5*	43.446	0.120	7.057	0.126
13	50	52	4.7	43.432	0.119	7.084	0.126
15	1000	943.7	59.8	34.005	0.051	179.840	3.485

What Else Needs to be done for Paper?

In order of perceived priority...

1) Analysis code tech note (draft on wiki under today's meeting)
2) Finalize Run I and II Asymmetry + Rate vs Thickness and begin fit-a-thon (perhaps we are already ready)
    - Revisit rate senstivity to cuts? Refine methodology?
    - Other possible sources of unaccounted error?
3) Run I and II Asymmetry vs Thickness results w/ToF-cut versus w/Out ToF-cut; determine dilution #? function?
4) What else...