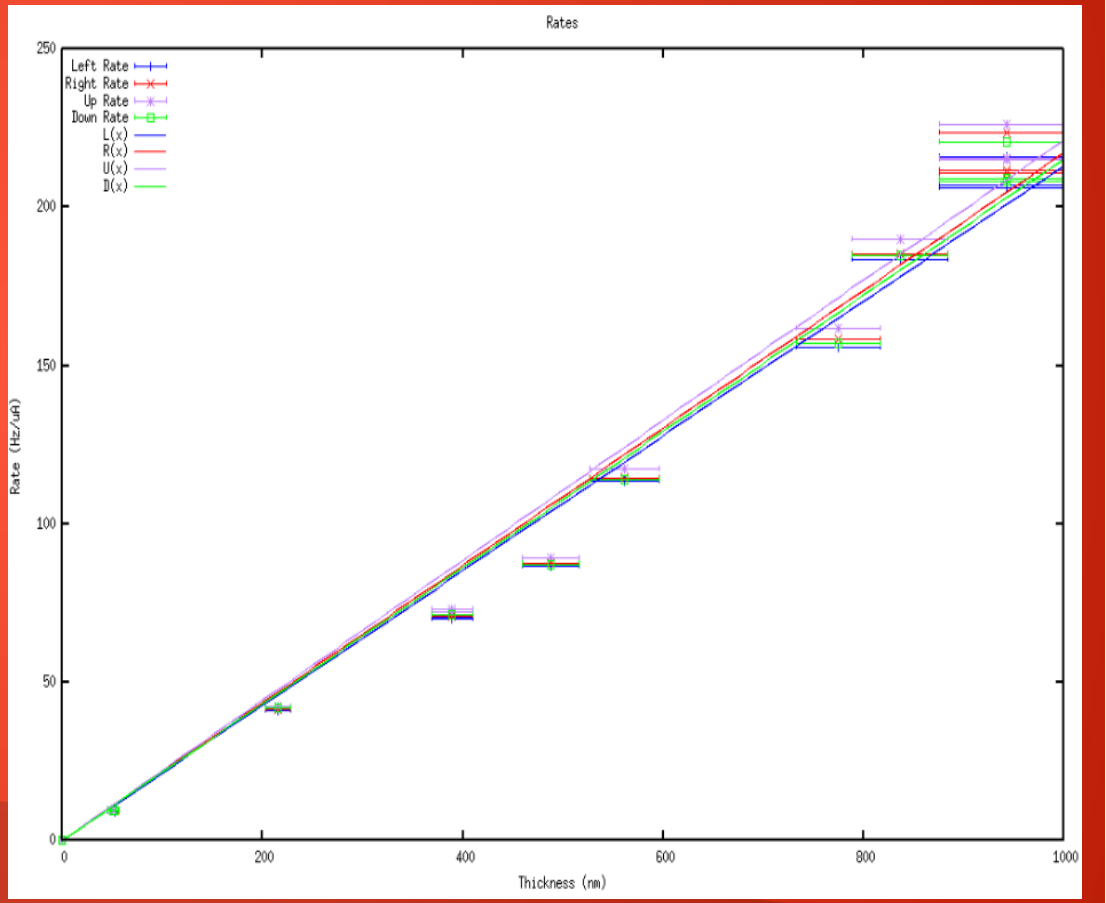
Calculating Rates and dR

to first order...

$$R_{LRUD} = \frac{N_{goodevents}}{T * I}$$

$$\sigma^2_{R_{LRUD}} = R^2_{LRUD} * [\frac{1}{N_{goodevents}} + (\frac{\sigma_I}{I})^2 + (\frac{\sigma_T}{T})^2]$$

$$R = A * T + B * T^2$$



Adjustments to R

- Account for DAQ downtime, same for all four detectors
  - N_triggers/N_accepted > 1
- Account for unique detector electronics downtime, dR_trigger

$$dE\_Rate_{LRUD} = dE_{LRUD}/Runtime$$

$$dR_{trigger\,LRUD} = dE\_Rate_{LRUD} * 100ns (= coincidence\_window)$$

$$R_{LRUD} = \frac{N_{goodevents}}{T * I} * \frac{N_{triggers}}{N_{accepeted}} * \frac{1}{1 - dR_{trigger_{LRUD}}}$$

Adjusment to dR

$$R_{LRUD} = \frac{N_{goodevents}}{T * I} * \frac{N_{triggers}}{N_{accepeted}} * \frac{1}{1 - dR_{trigger_{LRUD}}}$$

$$\sigma^2_{R_{LRUD}} = R^2_{LRUD} * [\frac{1}{N_{goodevents}} + \frac{1}{N_{triggers}} + \frac{1}{N_{accepted}} + (\frac{\sigma_I}{I})^2 + (\frac{\sigma_T}{T})^2]$$

- For all N, $\sigma_N = \sqrt{N}$
- dI taken from calibration of Mott scaler vs BCM0L02
- dT determined from stability of DAQ clock scaler –
  - dT = stability of clock / clock rate
  - 100 Hz / 121340 Hz = 0.000824

Determining dI

- Plot BCMScaler (counts) in Mott DAQ against calibrated EPICS BCM0L02 readback
- Remove points where scaler is counting still, but beam is off; beam is on, scaler not counting
- Fit straight line and determine Scaler count vs BCM0L02 calibration, determine scaler vs bcm error

BCMScaler = m * BCM0L02 + b BCM0L02 = I_0L02

BCMScaler = S (counts) / T (runtime in second)

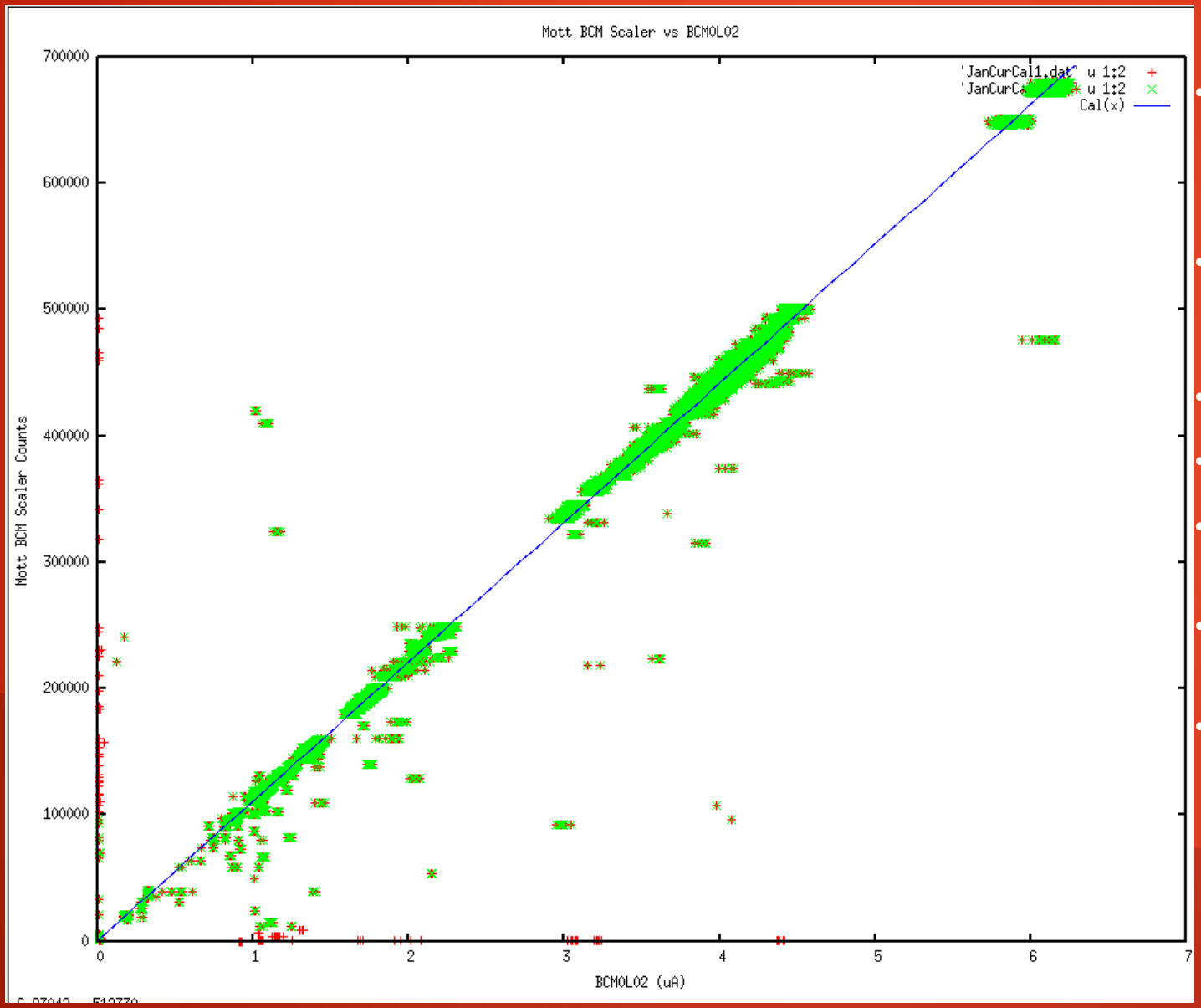
$$I_{0L02} = \frac{1}{m} * (\frac{S}{T} - b)$$

$$\sigma^2_{I_{0L02}} = \frac{1}{m^2 T^2}\left[S + T^2\sigma_b^2 + T^2 I^2 \sigma_m + \frac{S^2}{T^2}\sigma_T\right]$$

$$\sigma_I = \sigma_{I_{0L02}} + \alpha$$

Where alpha is absolute uncertainty in BCM0L02 ~1%

BCMScaler vs 0L02 Calibration



- Red points are all data for asymmetry vs thickness and asymmetry vs deadtime studies (runs 7968 – 8095)
- Green points are cuts on zero current, scaler still counting and current, scaler not counting
- Blue line is fit to green data
- BCMScaler = BCM0L02 * m + b
- m = 110129 +/- 6.259 (0.005683%)
- b = 1136.43 +/- 17.24 (1.517%)

Some Rate Calculations

Foil #	Thickness (um)	Run	Run Time (s)	dT (s)	Current (uA)	dI (uA)	N_Trig	N_Acc	deadtime_DAQ Correction	LEFT Rate (Hz/uA)	DR (Hz/uA)	dE Rate	Electronics Deadtime Correction
15	1.00,	7999	599.66	0.0008241	0.998606	0.0501377	1336493	1136309	1.17617	241.079	12.1079	12027.9	1.00121226
	Low-thickness	8000	512.041	0.0008241	1.04832	0.0526324	1199354	1012190	1.18491	242.084	12.1586	12486.1	1.0012511
		8001	545.128	0.0008241	0.988112	0.049616	1204798	1026189	1.17405	241.716	12.1416	11536.1	1.00115111
		8002	513.427	0.0008241	1.03871	0.0521512	1191918	1007436	1.18312	241.656	12.1374	12528.3	1.00125109
		8003	545.751	0.0008241	0.980416	0.0492308	1196898	1020439	1.17292	242.009	12.1567	11812.3	1.0011811
		8004	523.551	0.0008241	1.03511	0.0519703	1210556	1024103	1.18206	240.921	12.1004	12199.6	1.0012211
									1.17887167	241.575887	4.953564243	12098.3833	1.00121129

$$I_{0L02} = \frac{1}{m} * (\frac{S}{T} - b)$$

100 Hz/ 121340 Hz

$$R_{LRUD} = \frac{N_{goodevents}}{T * I} * \frac{N_{triggers}}{N_{accepted}} * \frac{1}{1 - dR_{trigger_{LRUD}}}$$

$$\frac{N_{trigger}}{N_{accepted}}$$

$$\frac{1}{1 - dR_{trigger_{LRUD}}}$$

$$\sigma^2_{I_{0L02}} = \frac{1}{m^2 T^2} \left[S + T^2 \sigma_b^2 + T^2 I^2 \sigma_m + \frac{S^2}{T^2} \sigma_T \right]$$

$$\sigma_I = \sigma_{I_{0L02}} + \alpha$$

Alpha here was taken as 5%

$$\sigma^2_{R_{LRUD}} = R^2_{LRUD} * [\frac{1}{N_{goodevents}} + \frac{1}{N_{triggers}} + \frac{1}{N_{accepted}} + (\frac{\sigma_I}{I})^2 + (\frac{\sigma_T}{T})^2]$$

	FESEM	error					
	(nm)	(nm)	Mott Asym	error		Rate	
Foil Batch	T	dT	A	dA	DAQ Correction	Average	dR
5385	943.71	78.19	33.77	0.08012	1.18	246.00	2.533
3057	836.76	48.76	34.62	0.07821	1.14	209.30	2.154
5134	774.57	44.33	35.62	0.08171	1.14	178.30	1.835
7028	561.18	37.24	37.25	0.08404	1.13	128.66	1.323
5275	487.58	28.78	38.61	0.0825	1.12	97.74	1.004
5613	389.44	22.21	39.18	0.08968	1.14	81.18	0.834
5613	389.44	22.21	39.18	0.08289	1.16	82.58	1.037
7029	215.17	12.57	40.96	0.07224	1.12	46.50	0.476
no sibling	*50.00*	*5.00*	43.22	0.08872	1.05	9.70	0.086
6809	52.03	5.99	43.51	0.08716	1.05	9.93	0.088
5385	943.71	78.19	33.64	0.06144	1.19	248.55	1.981
5385	943.71	78.19	33.73	0.05195	1.14	250.32	1.994
T	dT	A	dA	Left	dR	Right	dR
943.71	78.19	33.77	0.08012	241.58	4.954	247.03	5.065
836.76	48.76	34.62	0.07821	206.75	4.241	208.72	4.281
774.57	44.33	35.62	0.08171	175.67	3.602	178.48	3.659
561.18	37.24	37.25	0.08404	127.27	2.608	128.25	2.628
487.58	28.78	38.61	0.0825	96.52	1.977	97.74	2.002
389.44	22.21	39.18	0.08968	80.09	1.640	81.23	1.663
389.44	22.21	39.18	0.08289	81.47	2.041	82.31	2.062
215.17	12.57	40.96	0.07224	45.93	0.939	46.26	0.946
50.00	*5.00*	43.22	0.08872	9.53	0.169	9.69	0.172
52.03	5.99	43.51	0.08716	9.76	0.173	9.92	0.176
943.71	78.19	33.64	0.06144	244.35	3.881	249.64	3.965
943.71	78.19	33.73	0.05195	244.12	3.876	252.81	4.014
T	dT	A	dA	Up	dR	Down	dR
943.71	78.19	33.77	0.08012	251.90	5.165	243.89	5.083
836.76	48.76	34.62	0.07821	214.02	4.390	207.97	4.327
774.57	44.33	35.62	0.08171	182.53	3.742	176.76	3.683
561.18	37.24	37.25	0.08404	131.54	2.695	127.71	2.656
487.58	28.78	38.61	0.0825	99.58	2.040	97.21	2.015
389.44	22.21	39.18	0.08968	82.70	1.693	80.78	1.674
389.44	22.21	39.18	0.08289	83.93	2.103	82.69	2.087
215.17	12.57	40.96	0.07224	47.22	0.966	46.62	0.960
50.00	*5.00*	43.22	0.08872	9.81	0.174	9.77	0.173
52.03	5.99	43.51	0.08716	10.05	0.178	10.00	0.178
943.71	78.19	33.64	0.06144	254.06	4.035	246.52	3.975
943.71	78.19	33.73	0.05195	255.54	4.057	249.36	4.008

Rate vs Target Thickness