

DAQ Speed and Run2 Estimates

April 3, 2015

Summary of FADC Development for Faster Performance

Name	Readout	Trigger
Scalers	Scaler S1 (helicity gated), S2 (un-gated)	Delayed nT_Settle
Mott_Sample	Mott FADC (Mode=1), S1, S2, TDC	Mott Detector
Mott_SemiInt	Mott FADC (Mode=7), S1, S2, TDC	Mott Detector
PEPPo_Int	INT FADC, S1, S2	nT_Settle
SemiIntFast	Mott FADC (Mode=7), BlockLevel=1	Mott Detector
SemiIntBlock	Mott FADC (Mode=7), BlockLevel=50	Mott Detector
SampleBlock	Mott FADC (Mode=1), BlockLevel=50	Mott Detector

For DAQ to be faster:

- I. No Readout of CAEN V775 TDC or SIS3801 Scalers; only FADC readout
- II. Use block readout

Beam Test (Goal: Can we use FADC timing)

- February 9, 2015:

- Run 8225: Mott_Semilnt, Deadtime = 28% at 5.1 kHz
- Run 8227: SemilntFast, Deadtime = 17% at 5.1 kHz
- Run 8228: **SemilntBlock, Deadtime = 1% at 5.1 kHz**

Problem handling
periodic signals

JLab expert changed FADC firmware

- March 17, 2015:

- Mott Run 8312: Mott_Semilnt, FADC Delay: Ch8=0,CH9=0,Ch11=4
- Mott Run 8313: Mott_Semilnt, FADC Delay: Ch8=0,CH9=2,Ch11=4

Still analyzing but problem
may not be solved yet

- Mott Run 8315: Mott_Sample, Deadtime = 32% at 5.5 kHz
- Mott Run 8316: **SampleBlock, Deadtime = 4% at 5.5 kHz**

The other option is
to readout the raw
data and calculate
timing in analysis
(raw data files will
be larger)

Remaining Challenges and Plans

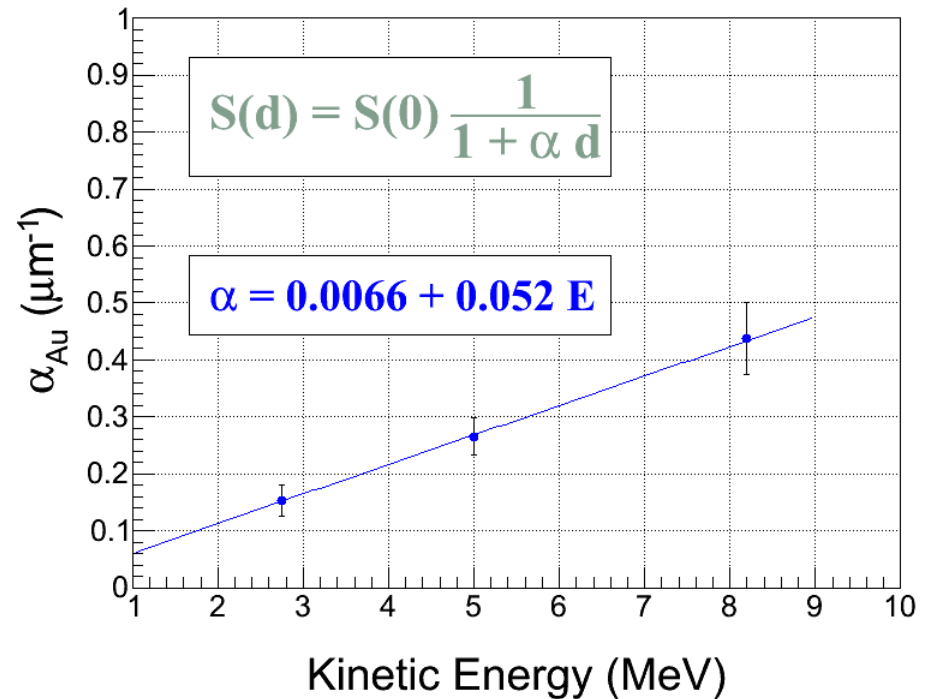
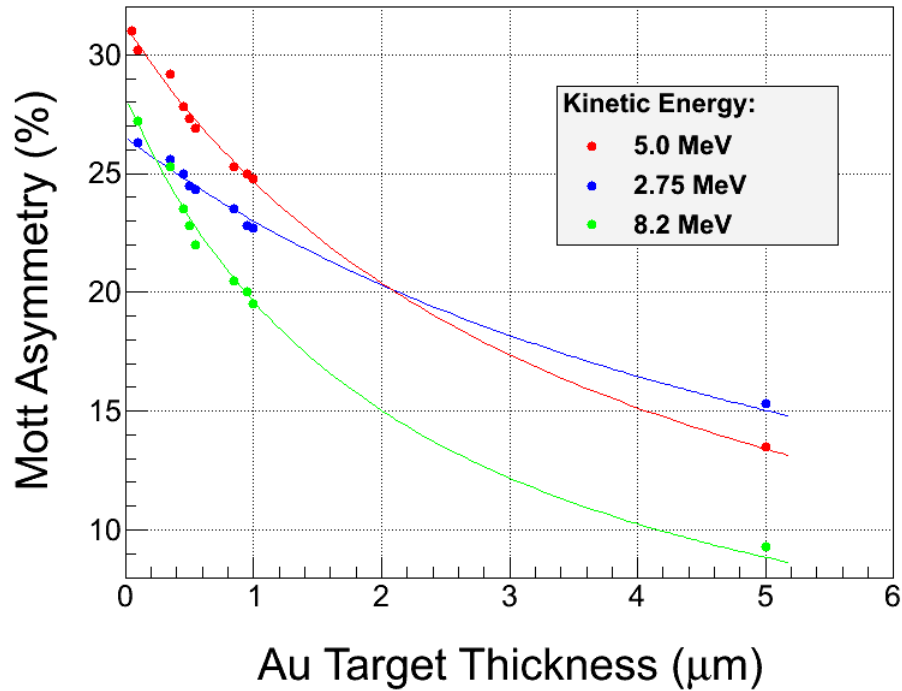
- Show that we can use FADC timing, either:
 - Timing is done in firmware, or
 - Timing is done in analysis
- Otherwise: Keep using TDC but figure out a way to run faster or upgrade to new TDC
- For scalers: we can upgrade to new JLab scalers we have
- **Change decoder to be able to decode Blocked data**

Au Estimates

Estimates Assumptions

- DAQ Rate limit = 2 kHz, Deadtime = 15%. Note that any systematic errors due to deadtime cancel to all orders in cross-ratio method – Measured in Run1
- Current Limit of 5 μA
- Dump rate = 100 Hz/ μA per detector:
 - Measured during Run1 5 MeV data at
 - Discriminator Threshold was 25 mV (or energy of about 1.25 MeV)
 - Dump Dipole Magnet was at +5A

Target Thickness Extrapolation



3 MeV

T(um) = 0.05 I (uA) = 2.89021
T(um) = 0.05 I (uA) = 2.89021
T(um) = 0.225 I (uA) = 1.16689
T(um) = 0.35 I (uA) = 0.818349
T(um) = 0.35 I (uA) = 0.818349
T(um) = 0.5 I (uA) = 0.602424
T(um) = 0.625 I (uA) = 0.493839
T(um) = 0.75 I (uA) = 0.418421
T(um) = 0.87 I (uA) = 0.364919
T(um) = 1 I (uA) = 0.320521

Elas(Hz) = 843.917
Elas(Hz) = 843.917
Elas(Hz) = 1533.25
Elas(Hz) = 1672.66
Elas(Hz) = 1672.66
Elas(Hz) = 1759.03
Elas(Hz) = 1802.46
Elas(Hz) = 1832.63
Elas(Hz) = 1854.03
Elas(Hz) = 1871.79

Dmp(Hz) = 1156.08
Dmp(Hz) = 1156.08
Dmp(Hz) = 466.754
Dmp(Hz) = 327.34
Dmp(Hz) = 327.34
Dmp(Hz) = 240.97
Dmp(Hz) = 197.536
Dmp(Hz) = 167.368
Dmp(Hz) = 145.968
Dmp(Hz) = 128.208

Tot(Hz) = 2000
Tot(Hz) = 2000
Tot(Hz) = 2000
Tot(Hz) = 2000
Tot(Hz) = 2000
Tot(Hz) = 2000
Tot(Hz) = 2000
Tot(Hz) = 2000
Tot(Hz) = 2000
Tot(Hz) = 2000

Tim (h) = 0.642548
Tim (h) = 0.642548
Tim (h) = 0.373913
Tim (h) = 0.356321
Tim (h) = 0.356321
Tim (h) = 0.354643
Tim (h) = 0.359231
Tim (h) = 0.366475
Tim (h) = 0.374954
Tim (h) = 0.385279

N_elas(M#) = 1.95213
N_elas(M#) = 1.95213
N_elas(M#) = 2.06388
N_elas(M#) = 2.14561
N_elas(M#) = 2.14561
N_elas(M#) = 2.24578
N_elas(M#) = 2.331
N_elas(M#) = 2.41781
N_elas(M#) = 2.50264
N_elas(M#) = 2.59619

5 MeV

T(um) = 0.05 I (uA) = 4.27389
T(um) = 0.05 I (uA) = 4.27389
T(um) = 0.225 I (uA) = 2.83363
T(um) = 0.35 I (uA) = 2.28388
T(um) = 0.35 I (uA) = 2.28388
T(um) = 0.5 I (uA) = 1.85258
T(um) = 0.625 I (uA) = 1.60068
T(um) = 0.75 I (uA) = 1.40908
T(um) = 0.87 I (uA) = 1.26385
T(um) = 1 I (uA) = 1.13691

Elas(Hz) = 290.443
Elas(Hz) = 290.443
Elas(Hz) = 866.548
Elas(Hz) = 1086.45
Elas(Hz) = 1086.45
Elas(Hz) = 1258.97
Elas(Hz) = 1359.73
Elas(Hz) = 1436.37
Elas(Hz) = 1494.46
Elas(Hz) = 1545.23

Dmp(Hz) = 1709.56
Dmp(Hz) = 1709.56
Dmp(Hz) = 1133.45
Dmp(Hz) = 913.552
Dmp(Hz) = 913.552
Dmp(Hz) = 741.032
Dmp(Hz) = 640.272
Dmp(Hz) = 563.633
Dmp(Hz) = 505.542
Dmp(Hz) = 454.765

Tot(Hz) = 2000
Tot(Hz) = 2000
Tot(Hz) = 2000
Tot(Hz) = 2000
Tot(Hz) = 2000
Tot(Hz) = 2000
Tot(Hz) = 2000
Tot(Hz) = 2000
Tot(Hz) = 2000
Tot(Hz) = 2000

Tim (h) = 1.59739
Tim (h) = 1.59739
Tim (h) = 0.585837
Tim (h) = 0.497104
Tim (h) = 0.497104
Tim (h) = 0.460941
Tim (h) = 0.452252
Tim (h) = 0.45293
Tim (h) = 0.458846
Tim (h) = 0.469088

N_elas(M#) = 1.67022
N_elas(M#) = 1.67022
N_elas(M#) = 1.82756
N_elas(M#) = 1.94428
N_elas(M#) = 1.94428
N_elas(M#) = 2.08911
N_elas(M#) = 2.21378
N_elas(M#) = 2.34206
N_elas(M#) = 2.46861
N_elas(M#) = 2.60946

8 MeV

T(um) = 0.05 I (uA) = 4.75761
T(um) = 0.05 I (uA) = 4.75761
T(um) = 0.225 I (uA) = 4.06748
T(um) = 0.35 I (uA) = 3.6856
T(um) = 0.35 I (uA) = 3.6856
T(um) = 0.5 I (uA) = 3.31241
T(um) = 0.625 I (uA) = 3.05466
T(um) = 0.75 I (uA) = 2.83413
T(um) = 0.87 I (uA) = 2.65044
T(um) = 1 I (uA) = 2.47654

Elas(Hz) = 96.955
Elas(Hz) = 96.955
Elas(Hz) = 373.009
Elas(Hz) = 525.76
Elas(Hz) = 525.76
Elas(Hz) = 675.034
Elas(Hz) = 778.134
Elas(Hz) = 866.348
Elas(Hz) = 939.826
Elas(Hz) = 1009.38

Dmp(Hz) = 1903.05
Dmp(Hz) = 1903.05
Dmp(Hz) = 1626.99
Dmp(Hz) = 1474.24
Dmp(Hz) = 1474.24
Dmp(Hz) = 1324.97
Dmp(Hz) = 1221.87
Dmp(Hz) = 1133.65
Dmp(Hz) = 1060.17
Dmp(Hz) = 990.616

Tot(Hz) = 2000
Tot(Hz) = 2000
Tot(Hz) = 2000
Tot(Hz) = 2000
Tot(Hz) = 2000
Tot(Hz) = 2000
Tot(Hz) = 2000
Tot(Hz) = 2000
Tot(Hz) = 2000
Tot(Hz) = 2000

Tim (h) = 6.03289
Tim (h) = 6.03289
Tim (h) = 1.80348
Tim (h) = 1.40592
Tim (h) = 1.40592
Tim (h) = 1.2193
Tim (h) = 1.15202
Tim (h) = 1.123
Tim (h) = 1.11646
Tim (h) = 1.12472

N_elas(M#) = 2.10571
N_elas(M#) = 2.10571
N_elas(M#) = 2.42176
N_elas(M#) = 2.66104
N_elas(M#) = 2.66104
N_elas(M#) = 2.96305
N_elas(M#) = 3.22713
N_elas(M#) = 3.50247
N_elas(M#) = 3.77741
N_elas(M#) = 4.08697

Dump Event Suppression

- Increase Discriminator Threshold – Tested in Run1
- Study Dump dipole (+5A, 0A, +5A) – Tested in Run1 (for thinner foils, 0A or -5A may yield lower dump rate)
- Laser timing veto – Tested on February 9, 2015

Note: Dump rate depends on electron energy ($\sim 1/E$)

Run2 Strategy

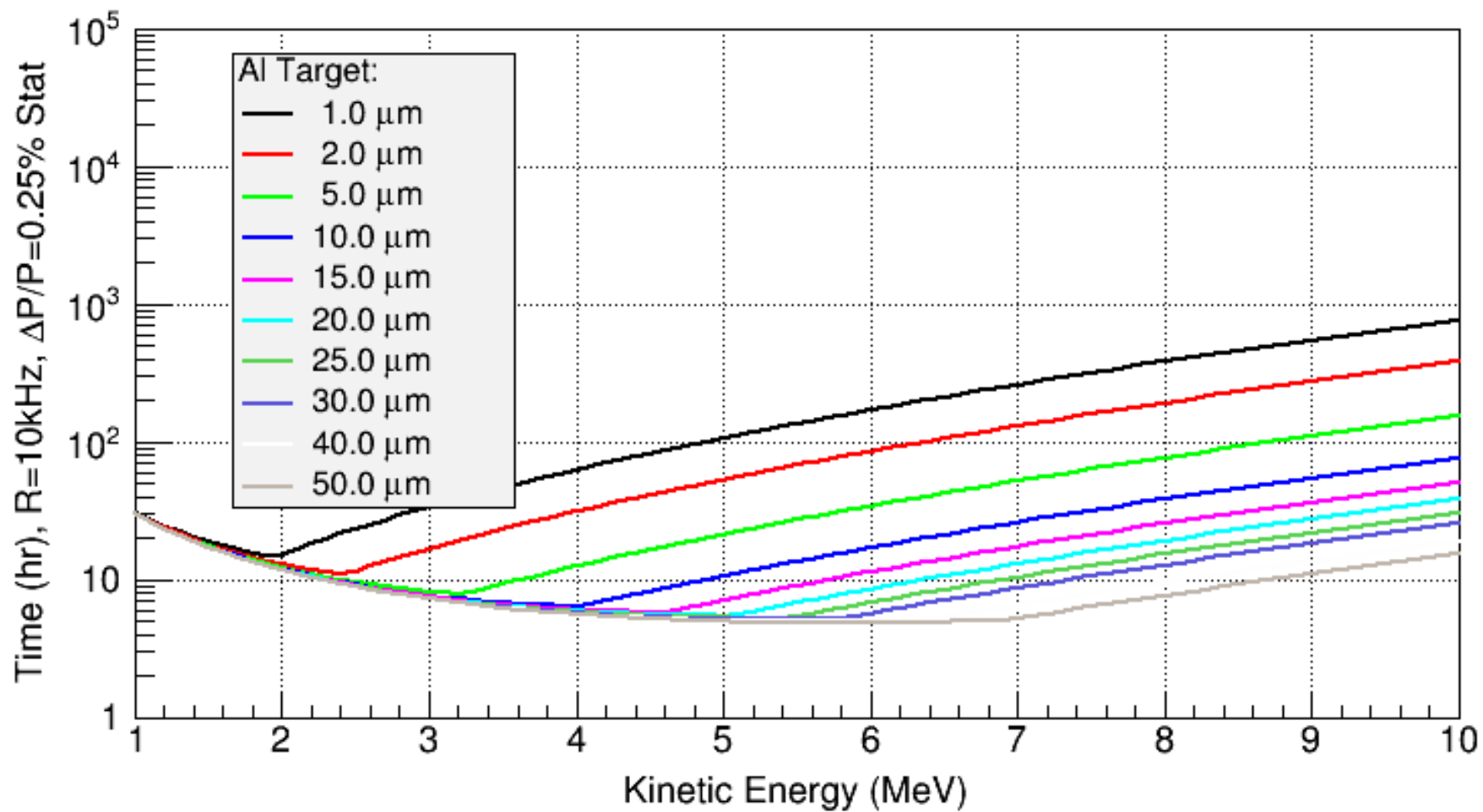
- At 3 MeV:
 - Dump events will be higher due to energy
 - Increase Discriminator Threshold
 - Thick foils will benefit from faster DAQ but very little reduction in overall time required for Run2. Here DAQ speed will help with systematic studies, e.g., many short runs with very high statistics for stability study.
- At 8 MeV:
 - Dump events will be lower due to energy
 - Elastic rate is too low to benefit from faster DAQ
 - Suppress dump events will reduce deadtime
 - Will run at about 5 μA (31 MHz) for all foils (current limited)

What is a reasonable current limit? Run1 was 5 μA

AI Estimates

Al Estimates Assumptions

- DAQ Rate limit = 10 kHz
- Current Limit = 40 μA
- Dump rate = 10 Hz/ μA per detector
- Target Thickness Extrapolation: $\alpha = 0$



KE = 3 MeV

T(um) = 1	I (uA) = 40	Tim (h) = 33.0332
T(um) = 2	I (uA) = 40	Tim (h) = 16.5166
T(um) = 5	I (uA) = 32.5581	Tim (h) = 8.11673
T(um) = 10	I (uA) = 17.4129	Tim (h) = 7.5882
T(um) = 15	I (uA) = 11.8845	Tim (h) = 7.41202
T(um) = 20	I (uA) = 9.02061	Tim (h) = 7.32393
T(um) = 25	I (uA) = 7.26895	Tim (h) = 7.27108
T(um) = 30	I (uA) = 6.08695	Tim (h) = 7.23584
T(um) = 40	I (uA) = 4.59317	Tim (h) = 7.1918
T(um) = 50	I (uA) = 3.68809	Tim (h) = 7.16537

KE = 5 MeV

T(um) = 1	I (uA) = 40	Tim (h) = 105.241
T(um) = 2	I (uA) = 40	Tim (h) = 52.6204
T(um) = 5	I (uA) = 40	Tim (h) = 21.0482
T(um) = 10	I (uA) = 40	Tim (h) = 10.5241
T(um) = 15	I (uA) = 40	Tim (h) = 7.01605
T(um) = 20	I (uA) = 38.6771	Tim (h) = 5.44202
T(um) = 25	I (uA) = 31.9297	Tim (h) = 5.27363
T(um) = 30	I (uA) = 27.1868	Tim (h) = 5.16138
T(um) = 40	I (uA) = 20.9599	Tim (h) = 5.02105
T(um) = 50	I (uA) = 17.0539	Tim (h) = 4.93686

KE = 8 MeV

T(um) = 1	I (uA) = 40	Tim (h) = 378.985
T(um) = 2	I (uA) = 40	Tim (h) = 189.492
T(um) = 5	I (uA) = 40	Tim (h) = 75.7969
T(um) = 10	I (uA) = 40	Tim (h) = 37.8985
T(um) = 15	I (uA) = 40	Tim (h) = 25.2656
T(um) = 20	I (uA) = 40	Tim (h) = 18.9492
T(um) = 25	I (uA) = 40	Tim (h) = 15.1594
T(um) = 30	I (uA) = 40	Tim (h) = 12.6328
T(um) = 40	I (uA) = 40	Tim (h) = 9.47461
T(um) = 50	I (uA) = 40	Tim (h) = 7.57969