First Pass Analysis of Run 1 Data Set

Mott Meeting

Joe Grames

April 24, 2015

Select representatives:

- one run per foil (1, 2, 3, 4, 5, 8, 12, 13, 14, 15)
- either high or low threshold
- beam current not held constant
- waveplate **out** for all runs

Run Parmameters					
Thresh	***Run***	***foil***	***T [um]***	***I [uA]***	***IHWP***
high	8086	13	0.050	4.100	OUT
high	8074	12	0.050	4.400	OUT
high	8066	1	0.225	4.200	OUT
high	8060	8	0.350	4.100	OUT
low	8048	14	0.350	1.700	OUT
low	8040	5	0.500	1.350	OUT
low	8034	2	0.625	1.200	OUT
low	8024	4	0.750	1.000	OUT
low	8013	3	0.870	0.900	OUT
low	8031	15	1.000	1.000	OUT

Goals

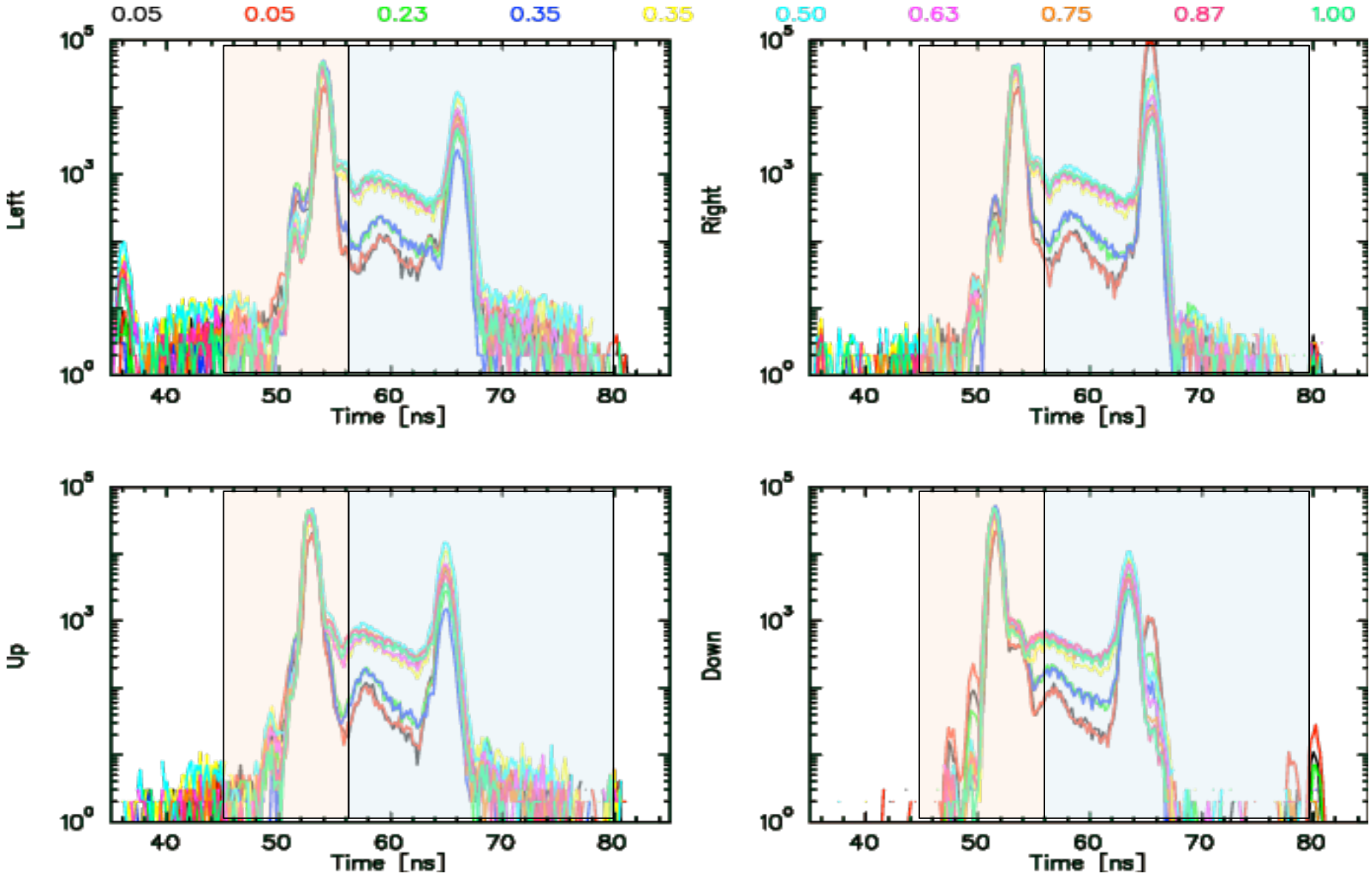
1. Identify trends in time histogram
2. Explore asymmetry vs. energy histogram
3. Generate suggestions for FullAnalysis program

Generate off-line text files:

- Decoder creates root file
- FullAnalysis
  - Analysis program
  - Generate text files
    - U/D/L/R time histogram
    - U/D/L/R energy histogram with interval cut [T1-T2]

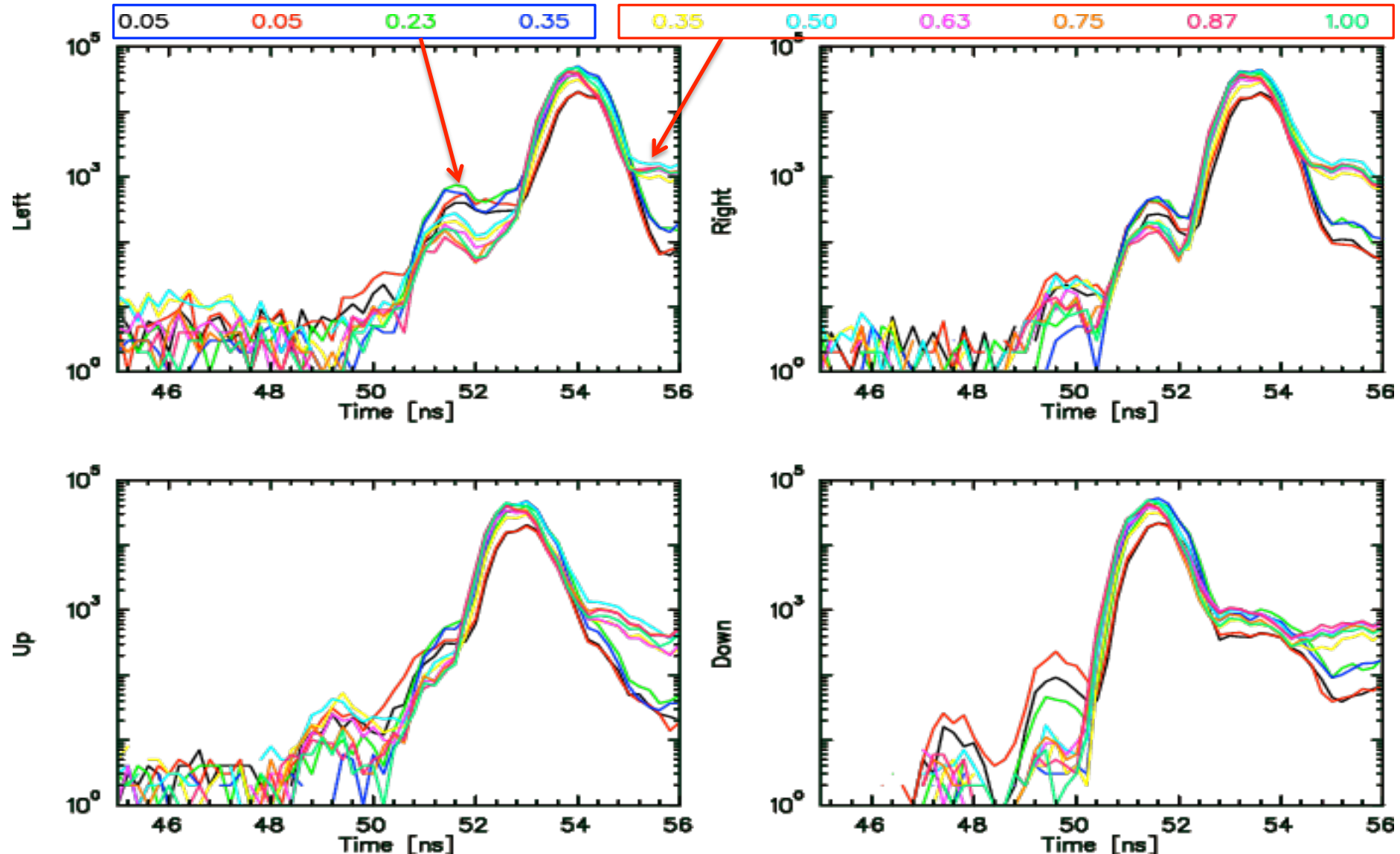
ALL foils have many features in time:

- Few ns variation in timing between four detectors e.g. elastic peak is 51-54 ns
- Choose two regions including Elastic Region 45-56 ns and Dump Region 56-80 ns
- Dump Region has strong scaling with threshold



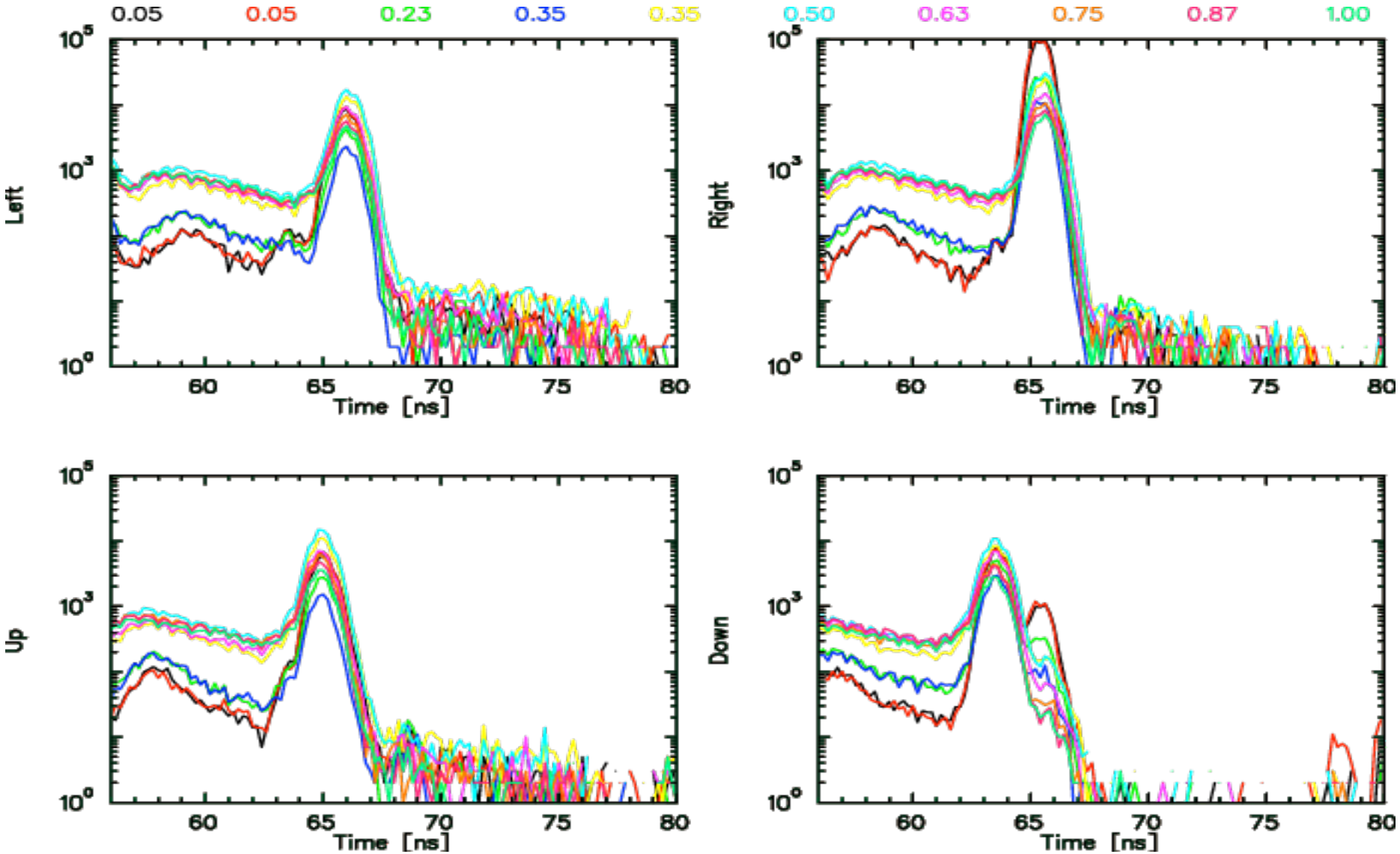
Elastic Region 45-56 ns

- Pre-events : about 1.6-2.4 ns (varies w/ detector) and about 4 ns (same)
- Post-events : about 2 ns
- Pre-events favor high threshold (higher energy) by about beam intensity 4:1 => before target?
- Post-events favor low threshold (lower energy) and opposing intensity => loss near target?



Elastic Region 56-80 ns

- Dump events follow elastic by about 12ns
- Dip occurs 3-4 ns after elastic peak => 8 deg scattering angle to pipe ID?
- Down also has events about 14ns after elastic peak
- Right has more dump events than others => dipole breaking symmetry?



Explore asymmetry vs. energy histogram

Use FullAnalysis with timing cuts to generate energy histograms

- Full Range : 10-85 ns
- Elastic Region : 45-56 ns
- Dump Region : 56-80 ns

Generate single-arm spectra (L/R/U/D) for each representative foil

- Normalized energy spectra by helicity (red/blue)
- **Energy binned** asymmetry (black) in bins of 10 channels
- **Energy integrated** asymmetry (green) from each bin to final bin = 1300

Collect plots for each time cut into a PDF and post on wiki

- **Mott_energy_10_85.pdf** (all events)
- **Mott_energy_45_56.pdf** (essentially the elastic result)
- **Mott_energy_56_80.pdf** (analyzing power of the late and dump events)

Please review PDF files in advance of the meeting.

Energy Integrated Asymmetry Comparisons

Energy integrated asymmetry from each bin to final bin = 1300

Mott_Asym_All.pdf

- One page for each foil
- Plots All (10-85ns), Elastic Region (45-56ns), Dump Region (56-80ns)

Mott_Asym_Elastic.pdf

- One page for each foil
- Plots (Elastic-All)/All*100% for UP and DOWN only

Please review these PDF files in advance of the meeting.

Conclusions

Time Domain

- Pre-elastic : sign of clipping on collimator?
- Elastic peak: reference for equivalent timing cuts?
- Dip: +8 deg cutoff in solid angle?
- Dump dipole: off for most easily understood systematics?
- Dump peak: why so clean?

Energy Integrated Asymmetry

Threshold

- Low: late dump events exasperates rate; can mitigate with hardware TOF veto
- High: can be used to mitigate rate, w/ no impact; or use hardware TOF veto

Elastic Timing Cut

- Non-zero and grows from very small energies (MS energy loss, efficiency)
- “Flat” in elastic region; depends on exact energy integration

Dump Timing Cut

- <E/2 : asymmetry consistent with zero
- >E/2 : asymmetry non-zero, grows w/ energy; but rate is very low

499MHz vs. 31MHz

- Elastic Region cut underestimates asymmetry by <0.25%

Suggestions

Analysis Program

Develop 2-D (Time vs. Energy) Histogram

- Generate a surface plot of Asymmetry and Asymmetry Uncertainty
- Physics and Instrumental by Super-Ratio
- Energy and time corrections necessary to ensure equivalent cuts
- Integrated asymmetries based upon common energy and time cuts

Develop Batch Processing

- Process group of jobs
- Generate summary report and statistical sum

Future Running and Systematics

Operational

- Set dump dipole off to recover detector symmetry
- Add permanent hardware TOF switch for events downstream of target foil
- Increase energy discriminator threshold

Systematic

- Explore and improve Elastic Region time features
- Use 31MHz to characterize dilution of 499MHz with high fixed discriminator threshold