Neutron TOF Calibration and D_2O Asymmetry from March2011 Run

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April 6, 2011

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Outline

- Golden Run-list
- Calibrating Neutron TOF
- Neutron TOF and Energy Spectra
- D_2O Asymmetry and Beam Polarization
- Summary

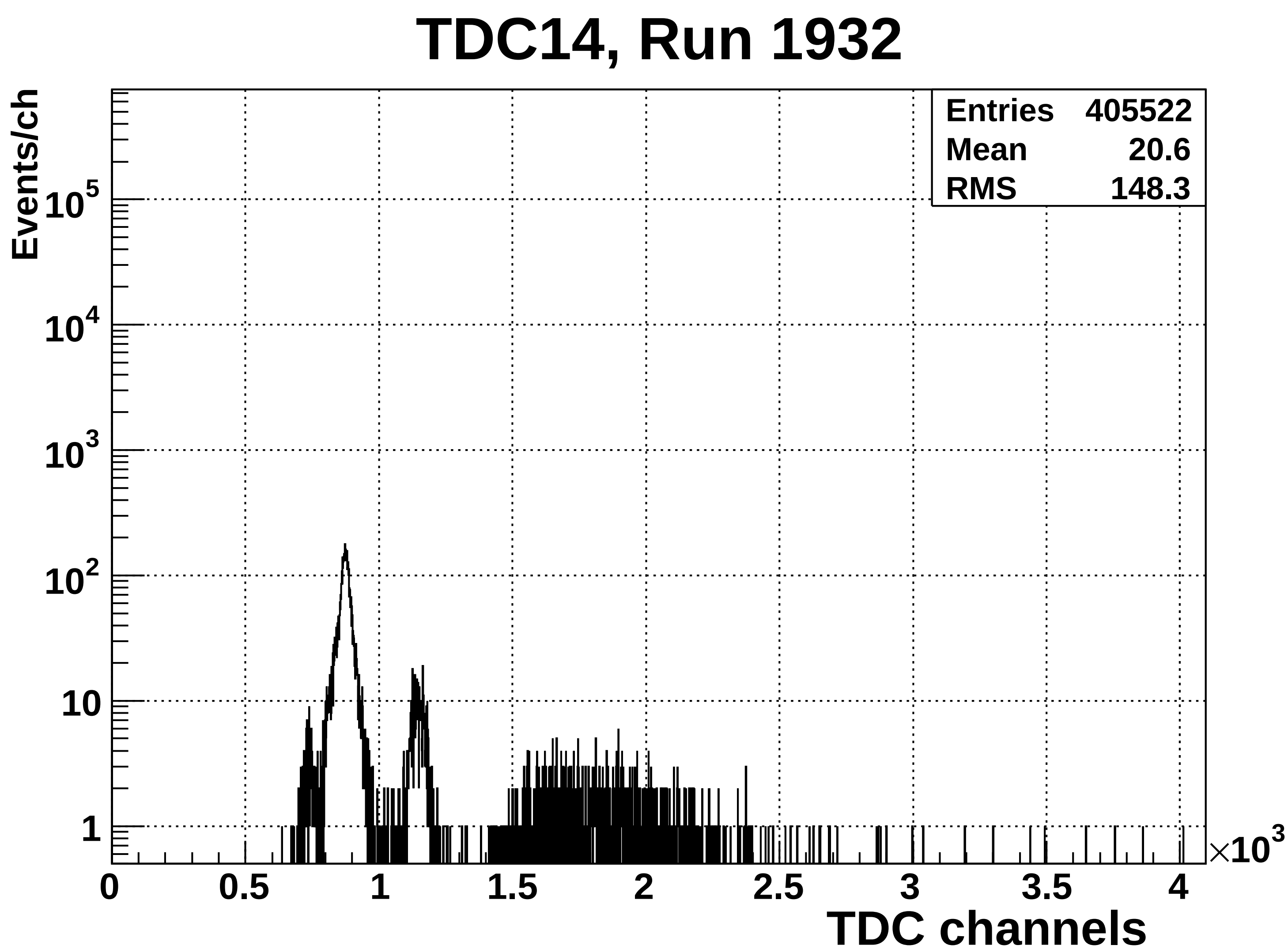
Golden Run-list

Run	Date	Target	Rad.	Kicker	Comment
1930	3/7	none	In	95A (up)	No Det. Pb γ-flash Cal.
1931	3/7	D_2O	In	95A (up)	No Det. Pb γ-flash Cal.
1932	3/7	D_2O	In	95A (up)	4” Pb in front of Dets
1934	3/7	D_2O	In	105A (down)	
1935	3/7	D_2O	In	95A (up)	
1936	3/7	D_2O	In	105A (down)	
1937	3/7	D_2O	In	0A (off)	
1938	3/8	D_2O	In	105A (down)	removed PS from beamline...
1939	3/8	D_2O	In	105A (down)	add Pb tunnel to Natalia
1940	3/8	D_2O	In	105A (down)	add Pb wall upstream of Nat.
1941	3/8	D_2O	In	95A (up)	

Golden Run-list (Continued)

Run	Date	Target	Rad.	Kicker	Comment
1944	3/8	D_2O	In	105A (down)	
1945	3/8	D_2O	In	95A (up)	
1946	3/8	D_2O	Out	95A (up)	
1947	3/8	H_2O	In	95A (up)	
1948	3/8	H_2O	In	105A (down)	

Sample Raw TDC Spectra for Irina



Calibrating Neutron Time of Flight (TOF)

- Use special runs 1930 and 1931 to find the γ-flash associated with target-only (*no Pb in front of Dets for these runs)*
  - –run 1931 (with target) gives TDC channel/time for γ-flash
  - –run 1930 (no target) convinces us that γ-flash is from target...

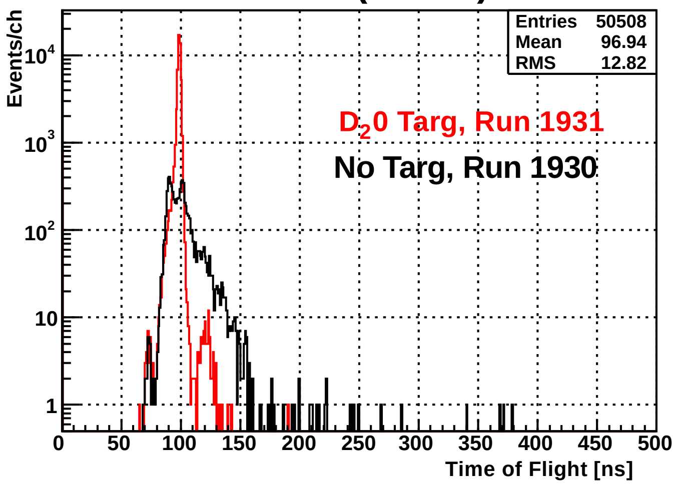
- Was told that TDC full range was 500ns for all runs in the list, thus:

$$\frac{2^{12}}{500\text{ns}} = 8.192 \text{ channels/ns conversion factor} \tag{1}$$

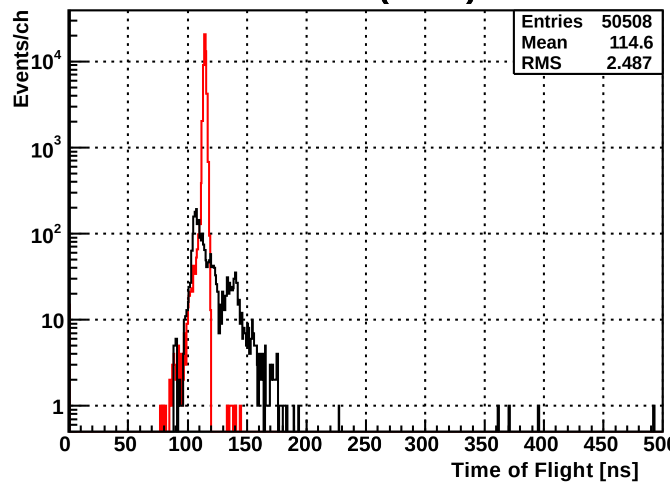
- The idea here is to convert TDC units (channels) to time (ns), determine the time of the γ-flash, and then subtract this time from all events...

TOF Calibration Plots (Log Scale)

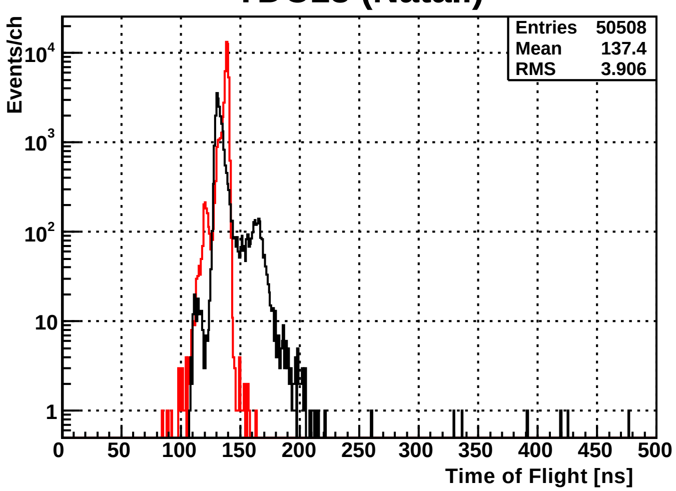
TDC15 (Polina)



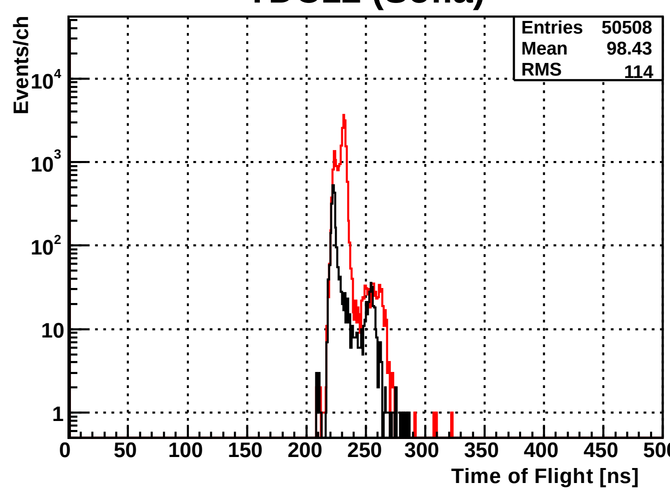
TDC14 (Irina)



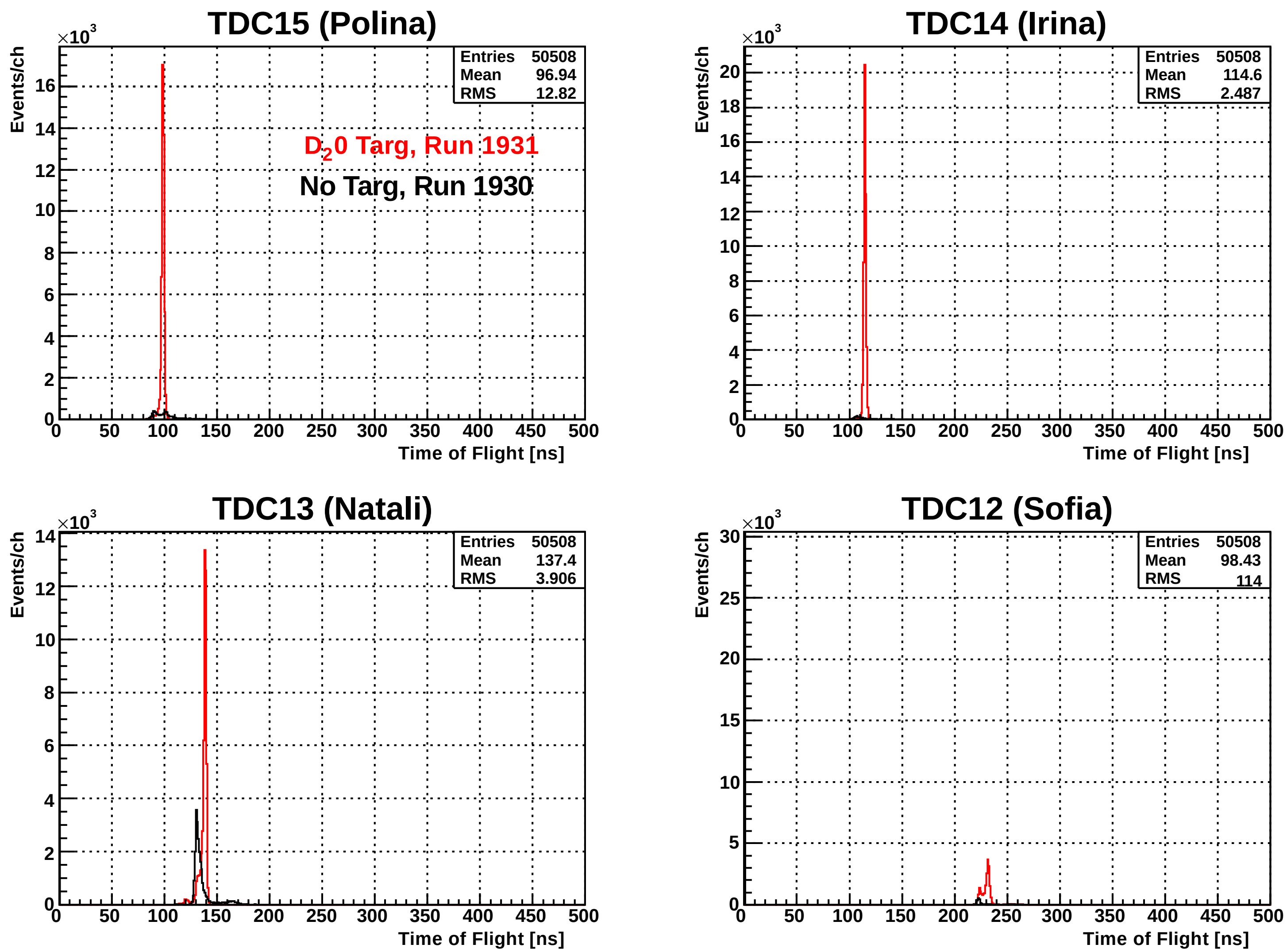
TDC13 (Natali)



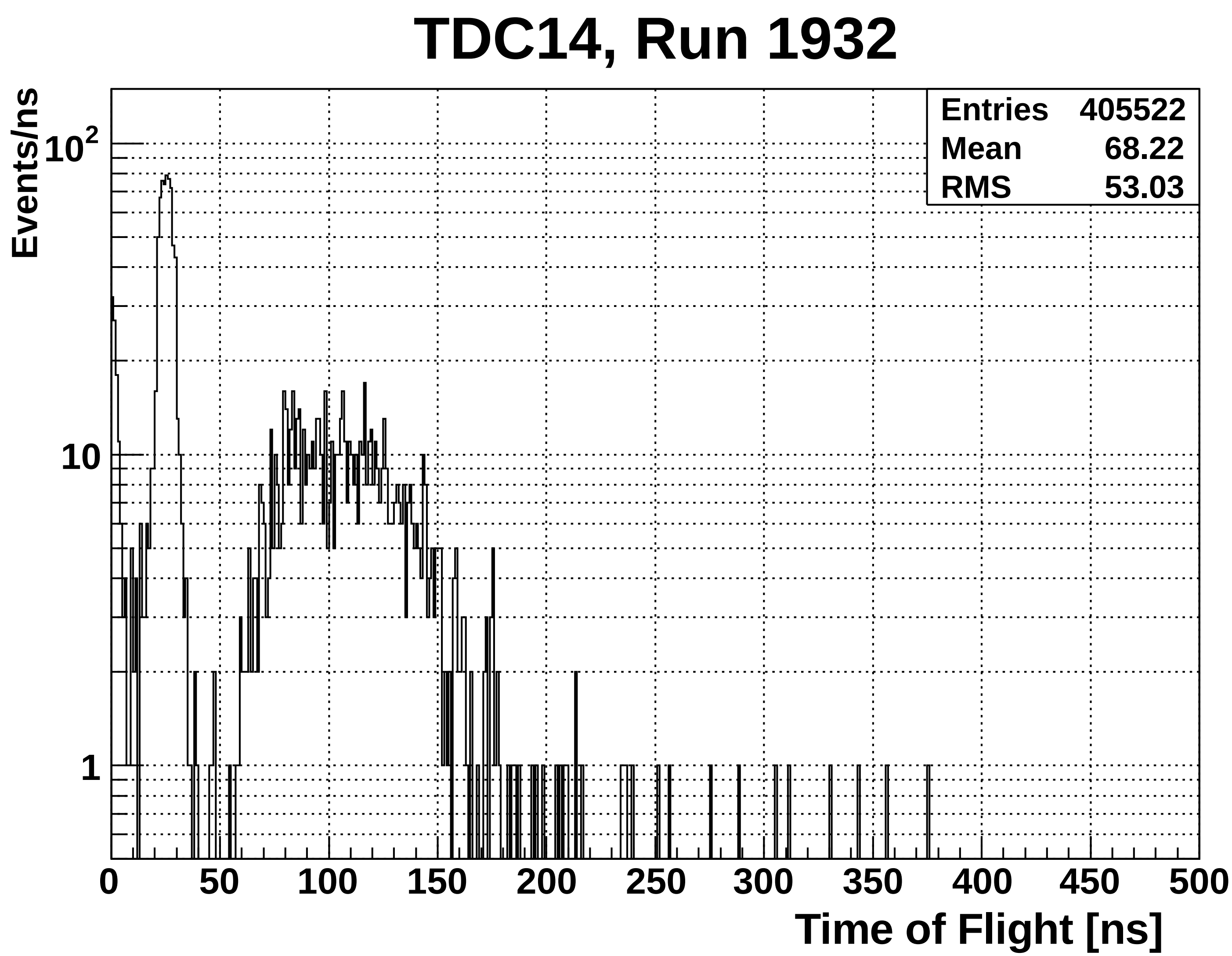
TDC12 (Sofia)



TOF Calibration Plots (Linear Scale)



Sample Calibrated TOF Spectra for Irina



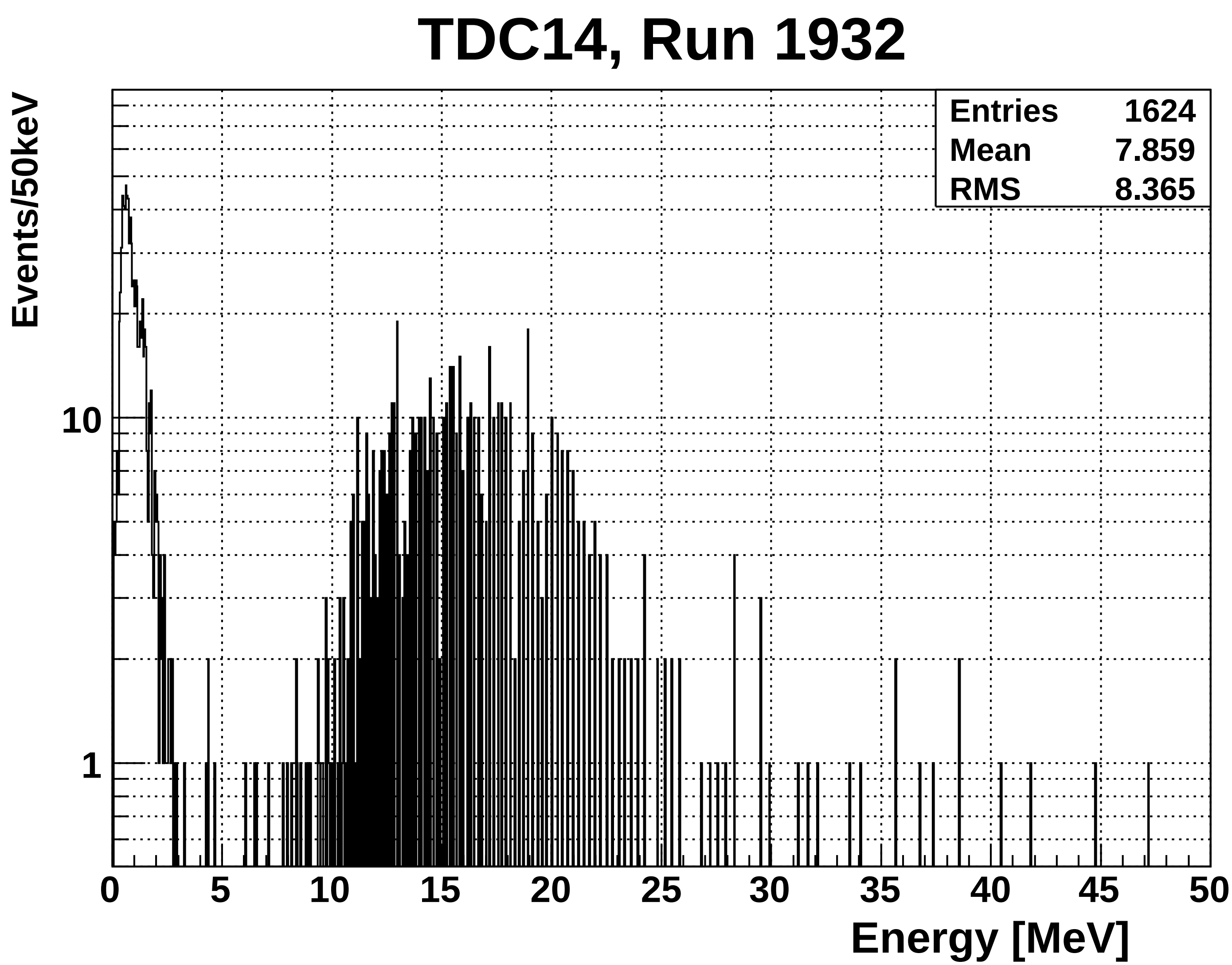
Converting TOF to Neutron Energy

- Using target-to-detector distances in wiki:
  - –Polina is 148.3 cm from target (top, beam-left det)
  - –Irina is 135.5 cm (middle, beam-left det)
  - –Natalia is 130.5 cm (lower, beam-left det)
  - –Sofia is 153 cm (lower, beam-right det)
- Combined with time of flight from histograms, can calculate velocity = distance/time
- Then use velocity to calculate energy (kinetic energy since not relativistic)

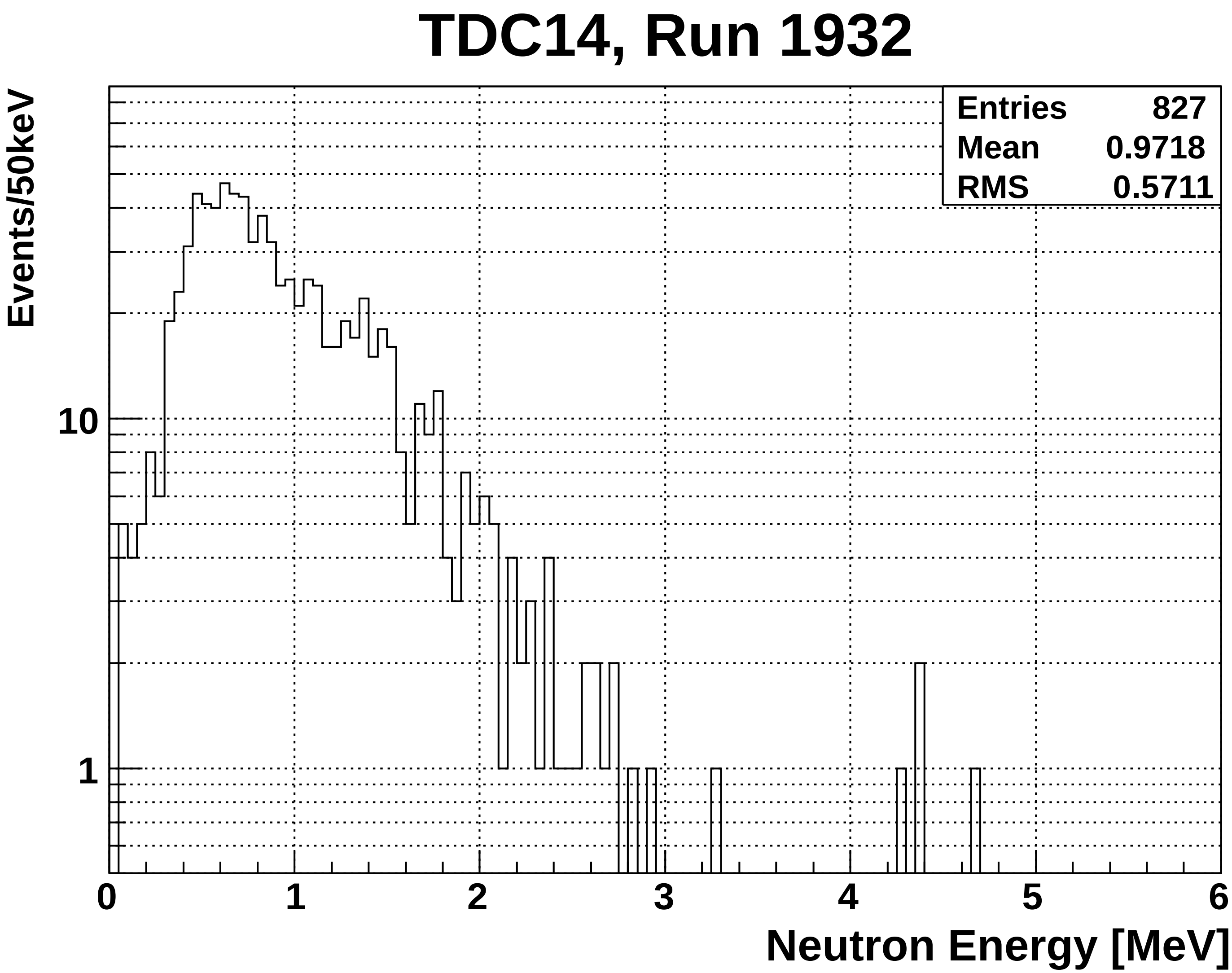
$$\text{Energy} = \text{K.E} = (\gamma - 1)mc^2 \tag{2}$$

$$\text{where } \gamma = (1 - (v/c)^2)^{-1/2} \text{ and } mc^2 = 939.6 \text{ MeV} \tag{3}$$

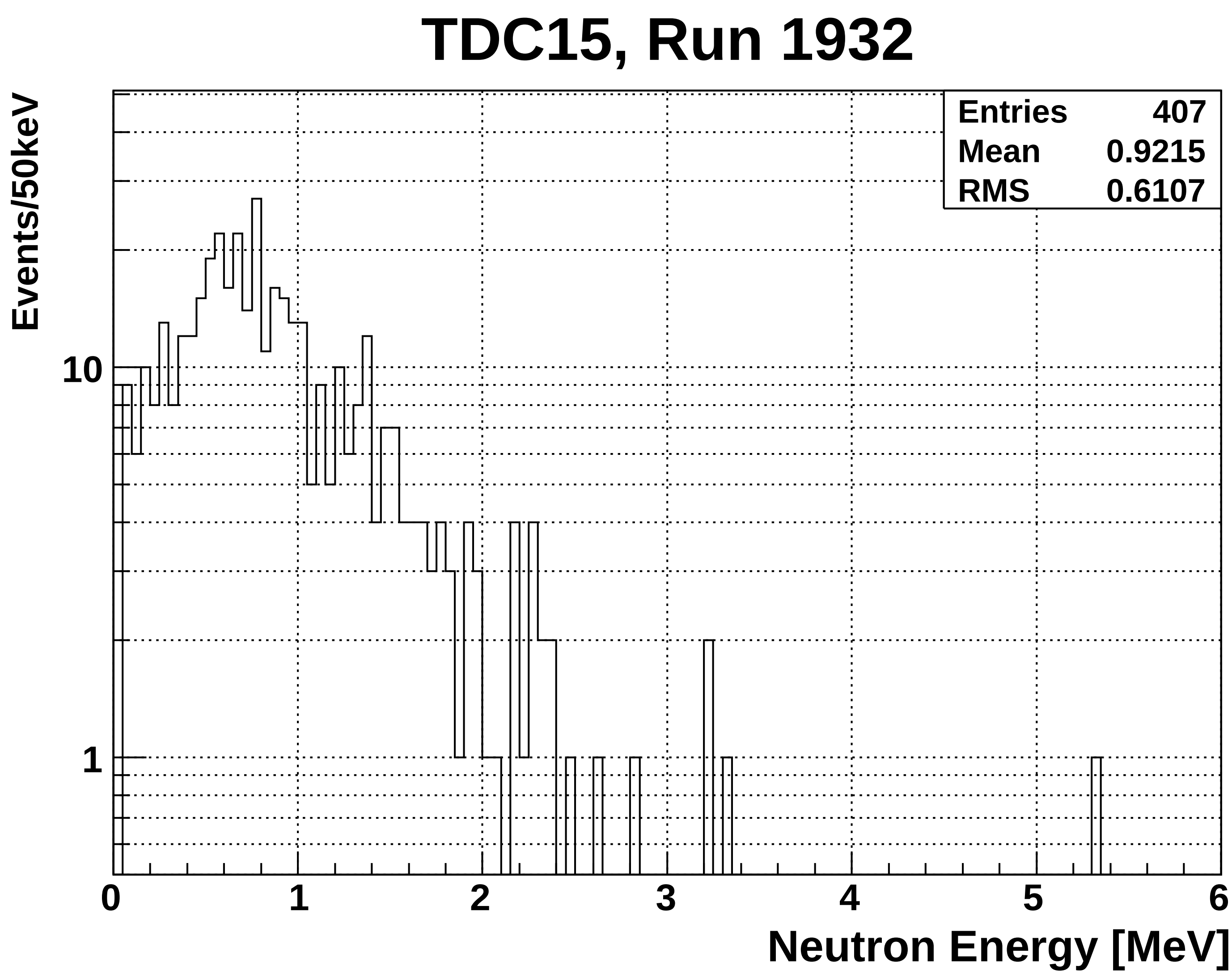
Sample Energy Spectra for Irina



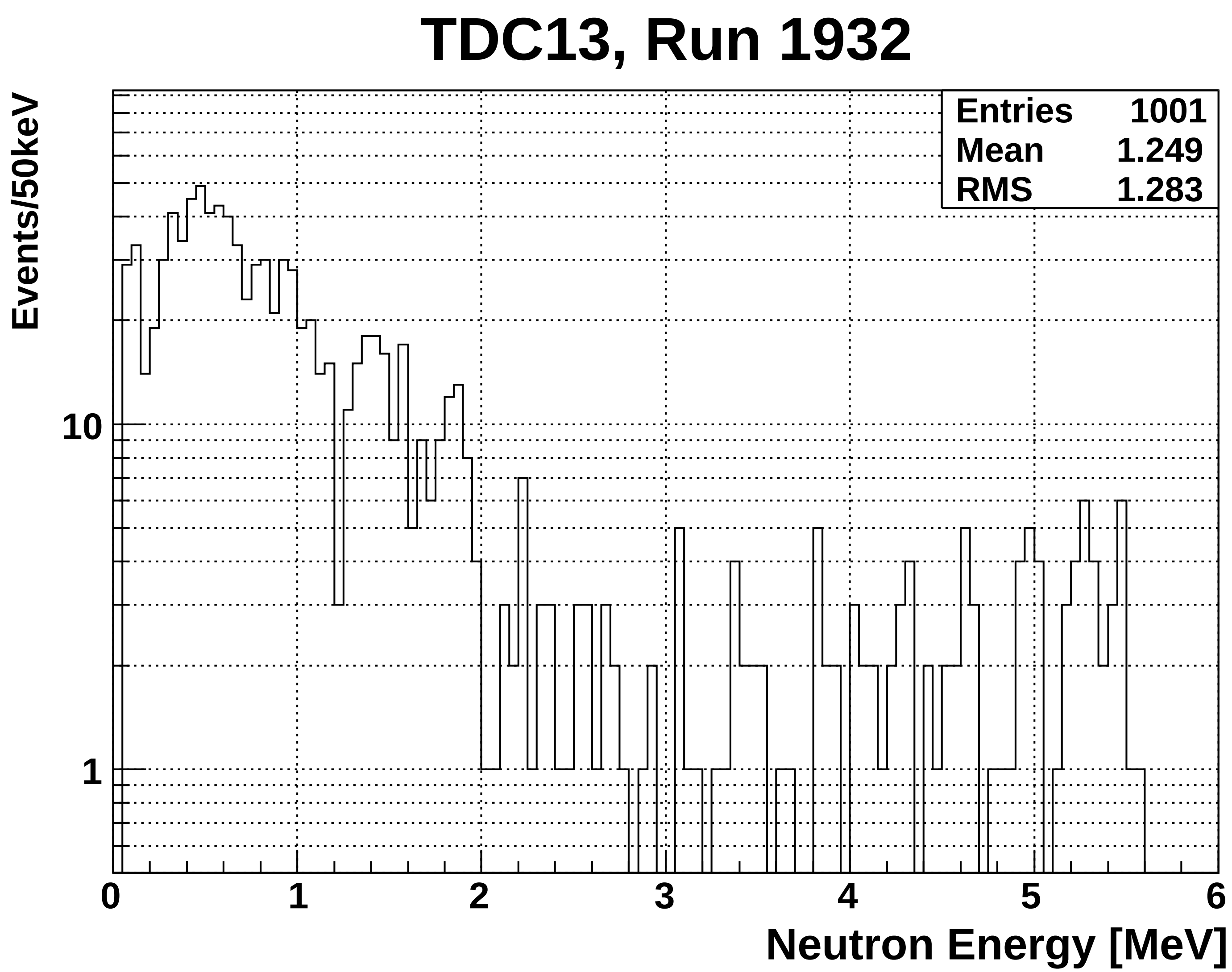
Sample Energy Spectra for Irina (Neutrons Only)



Sample Energy Spectra for Polina (Neutrons Only)



Sample Energy Spectra for Natalia (Neutrons Only)



Calculating D_2O Asymmetry

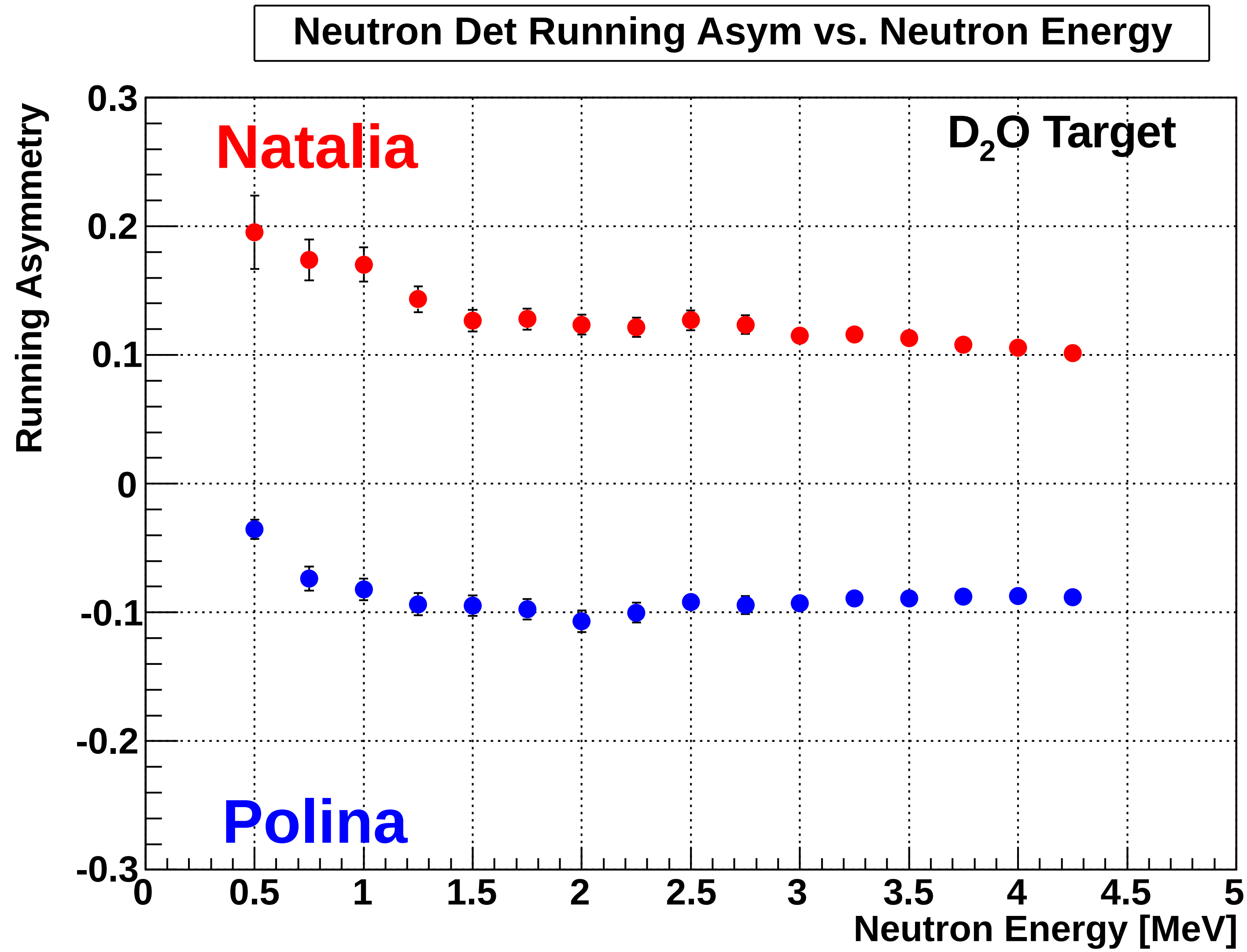
- Separately combine all statistics from kickerUp and kickerDown runs
- Normalize neutron counts (in Natalia and Polina) using neutron counts in Irina
- Calculate individual asymmetry for Polina and Natalia

$$\text{Asymmetry} = \frac{\sigma^{+}_{N/P} - \sigma^{-}_{N/P}}{\sigma^{+}_{N/P} + \sigma^{-}_{N/P}} \tag{4}$$

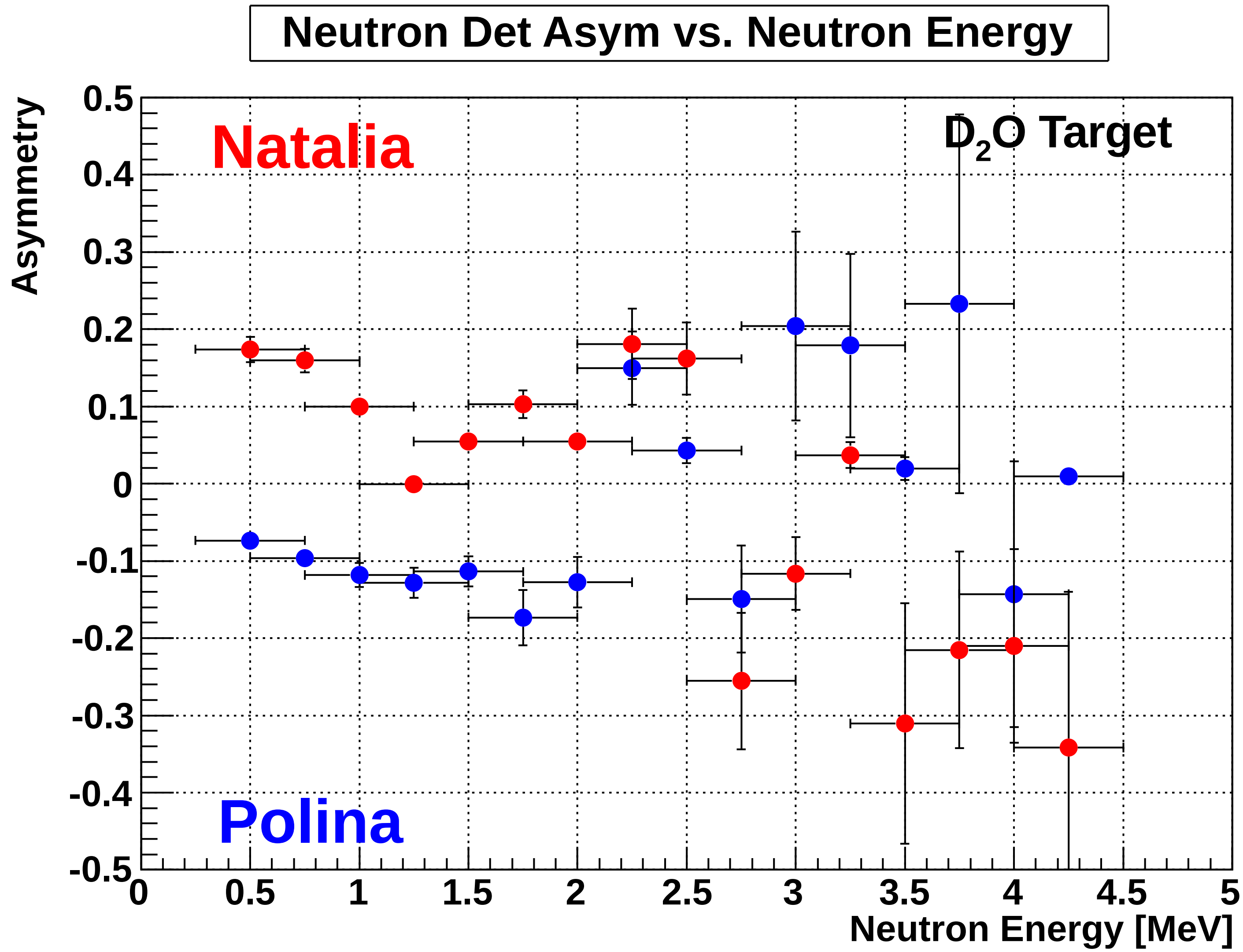
$$\text{where } \sigma^{\pm}_{N/P} = \frac{N^{\pm}_{N/P}}{N^{\pm}_{I}} \tag{5}$$

- Do this for individual energy bins (as a function of neutron energy) as well as for all energies combines

Asym. Integrated over all Energies (cut: TOF > 40ns)



Asymmetry as a function Energy (cut: TOF > 40ns)



Summary

- Measured Asymmetry = Theoretical Asymmetry $\times$ Beam Polarization
- Both Natalia and Polina give consistent and opposite sign results, as one would expect...
- Integrating Asymmetry betwen 0.200MeV and 2.00 MeV gives the following results: A_P = -0.100329 +/- 0.00782 and A_N = 0.127106 +/- 0.00787
- Beam Polarization was about 10% $\pm$ 0.8%