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

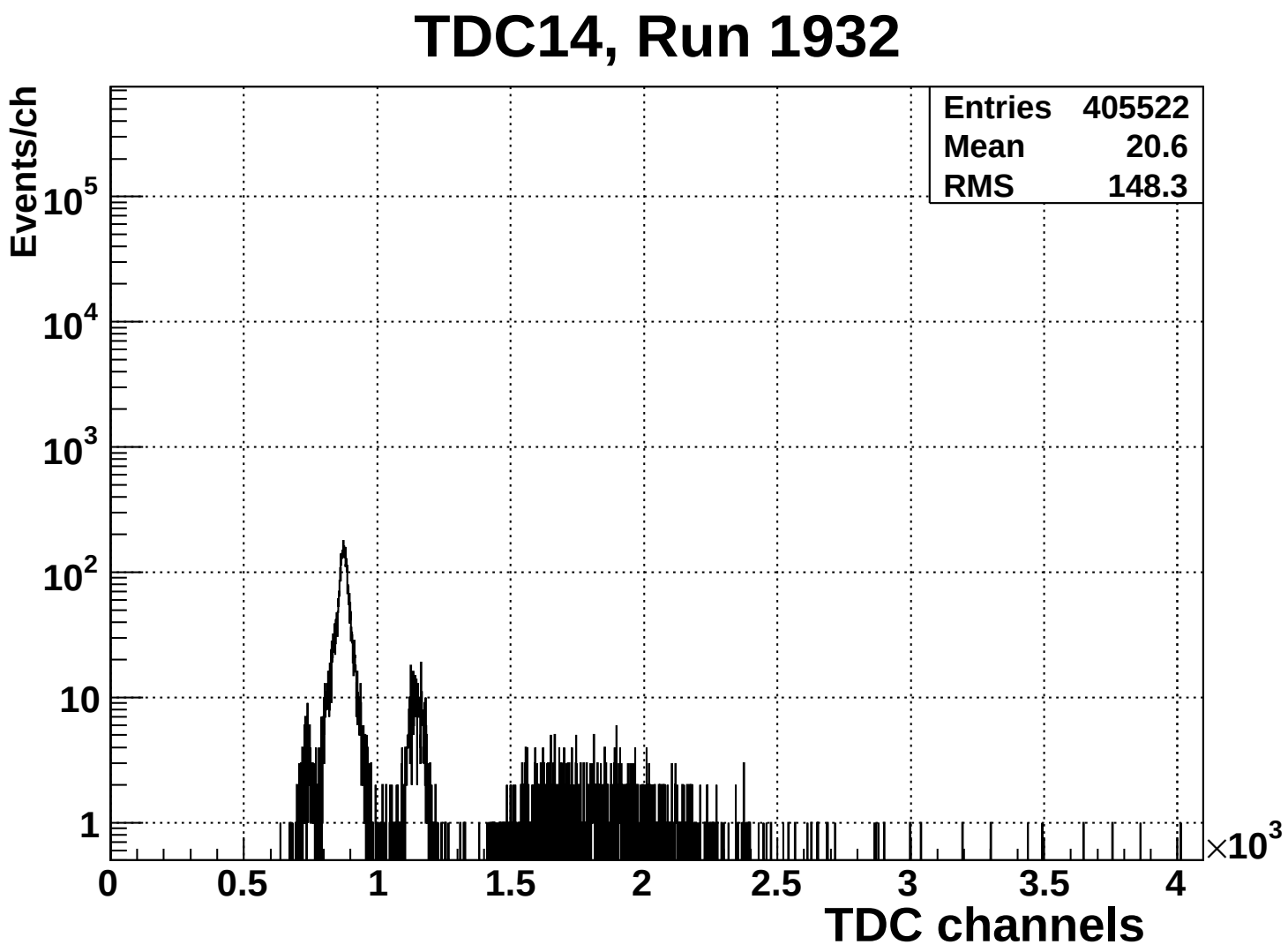
Golden Run-list

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



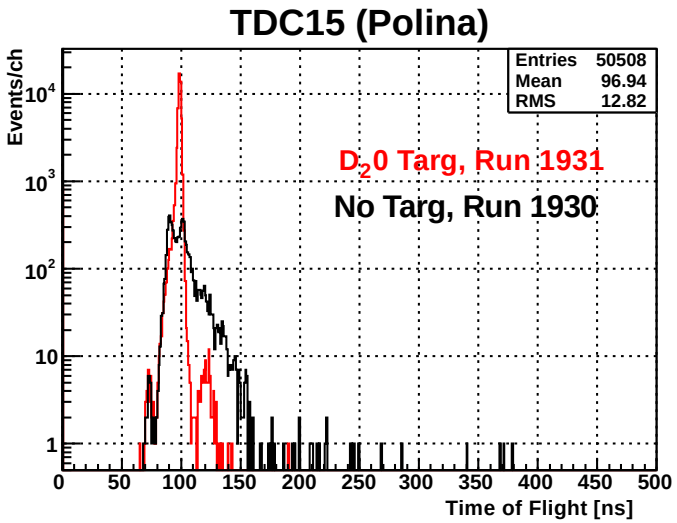
Calibrating Neutron Time of Flight (TOF)

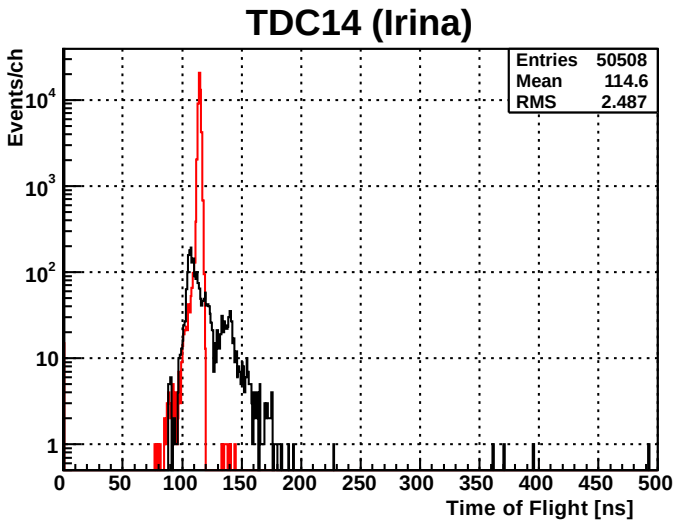
- Use special runs 1930 and 1931 to find the γ-flash associated with target-only (*no Pb in front of Dets for these runs)*
  - –run 1931 (with target) gives TDC channel/time for γ-flash
  - –run 1930 (no target) convinces us that γ-flash is from target...
- Was told that TDC full range was 500ns for all runs in the list, thus:

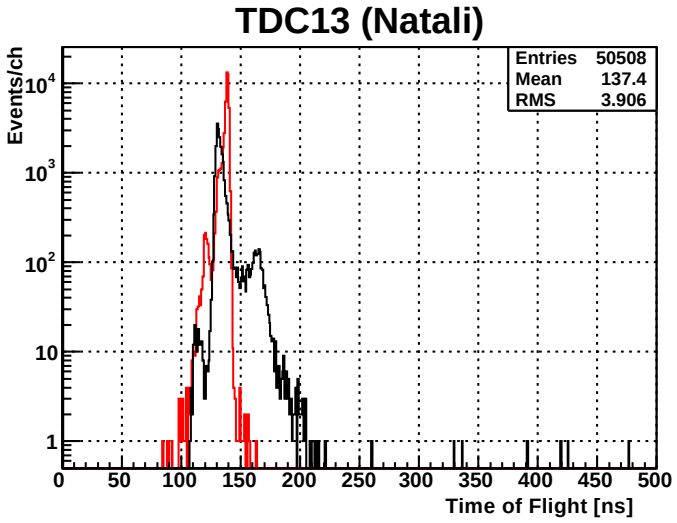
$$\frac{2^{12}}{500\text{ns}} = 8.192 \text{ channels/ns conversion factor} \qquad (1)$$

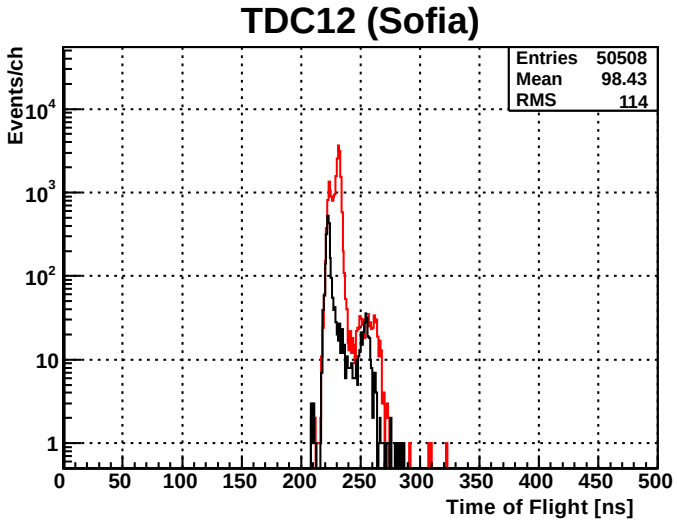
- The idea here is to convert TDC units (channels) to time (ns), determine the time of the γ-flash, and then subtract this time from all events...

TOF Calibration Plots (Log Scale)

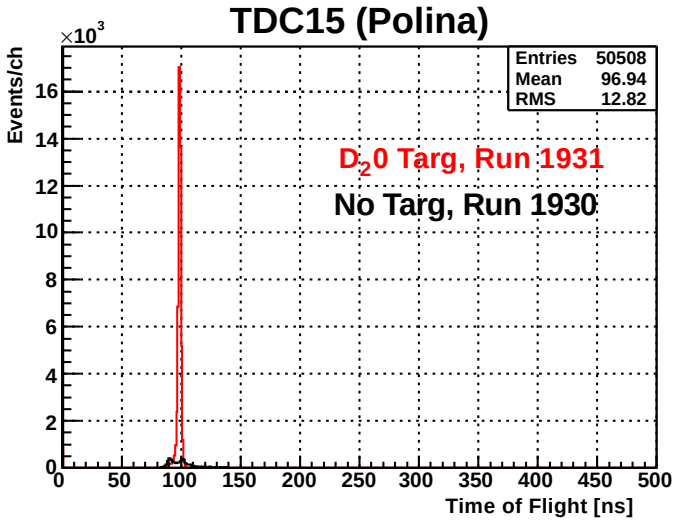


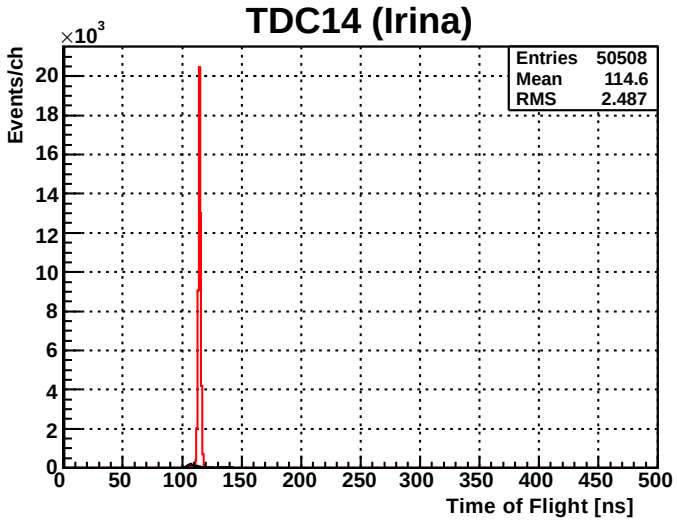


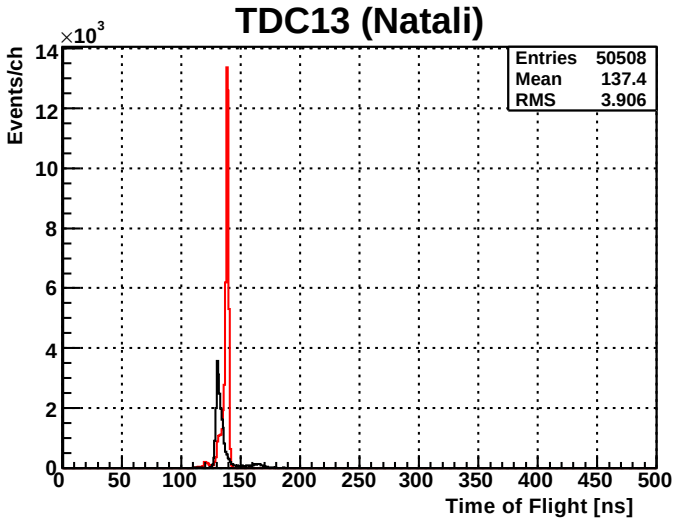


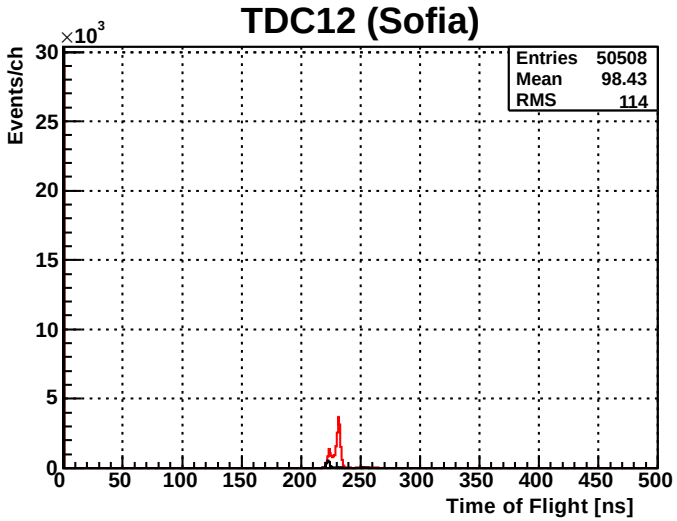


TOF Calibration Plots (Linear Scale)

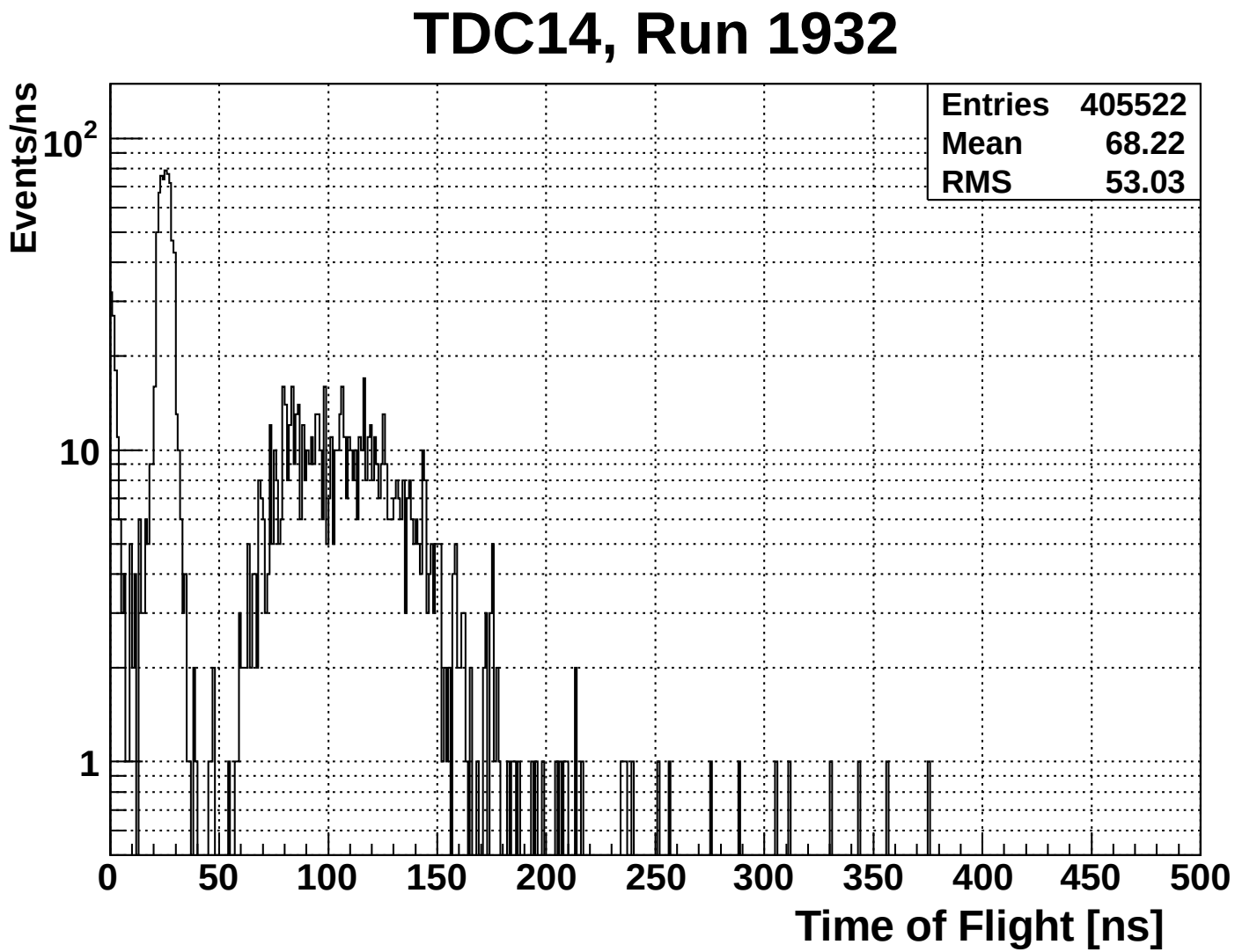








Sample Calibrated TOF Spectra for Irina



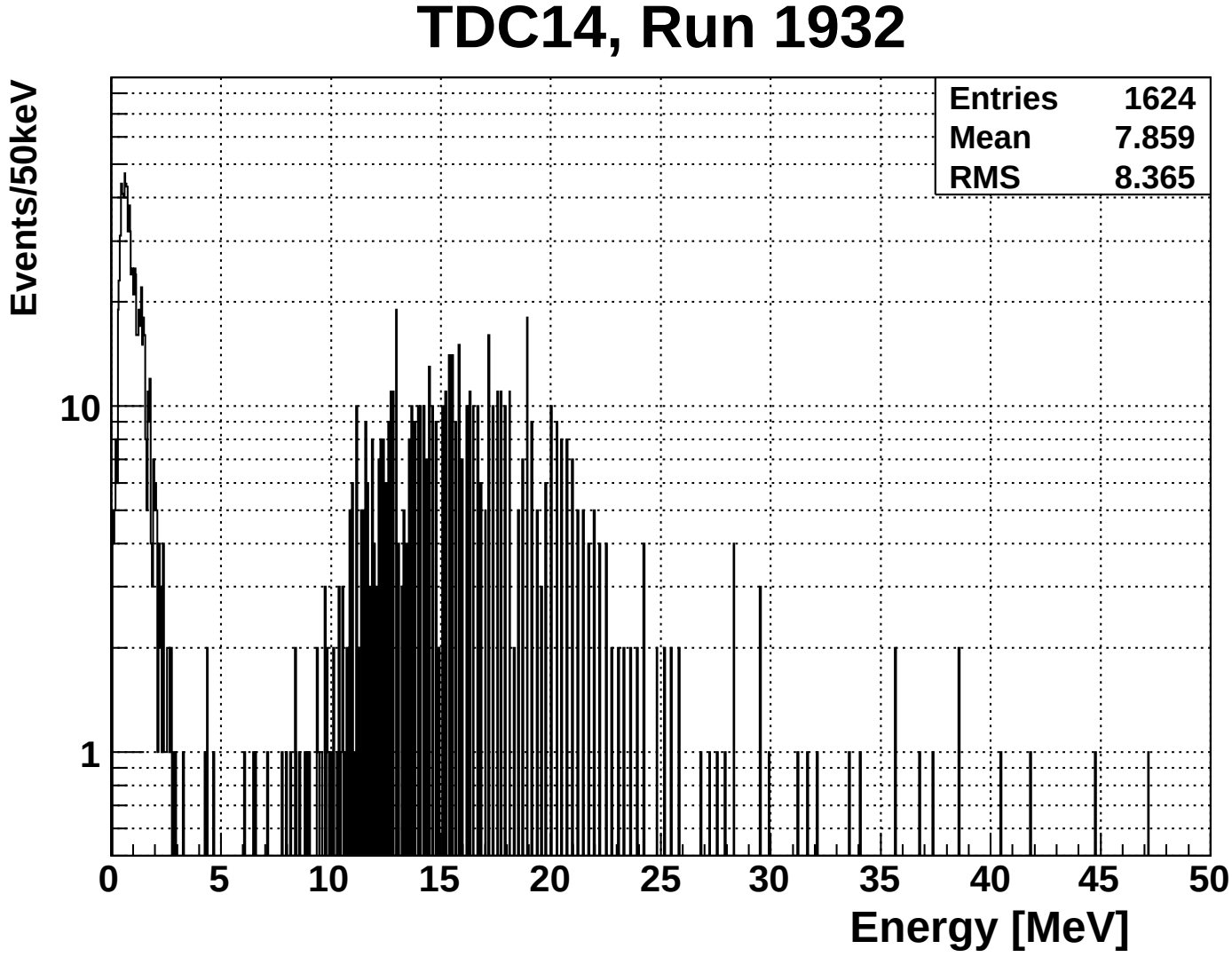
Converting TOF to Neutron Energy

- 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)

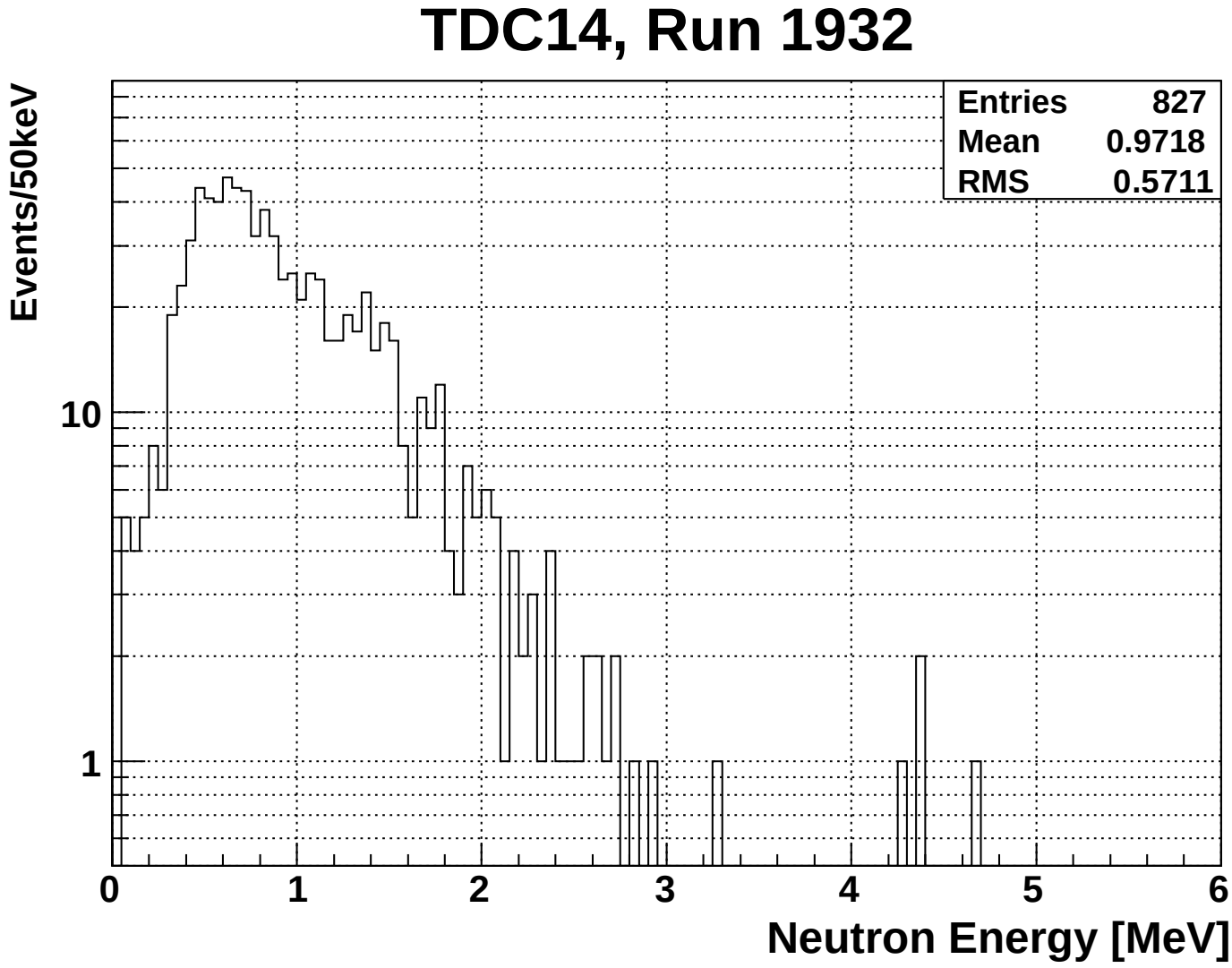
$$\text{Energy} = \text{K.E} = (\gamma - 1)mc^2 \tag{2}$$

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

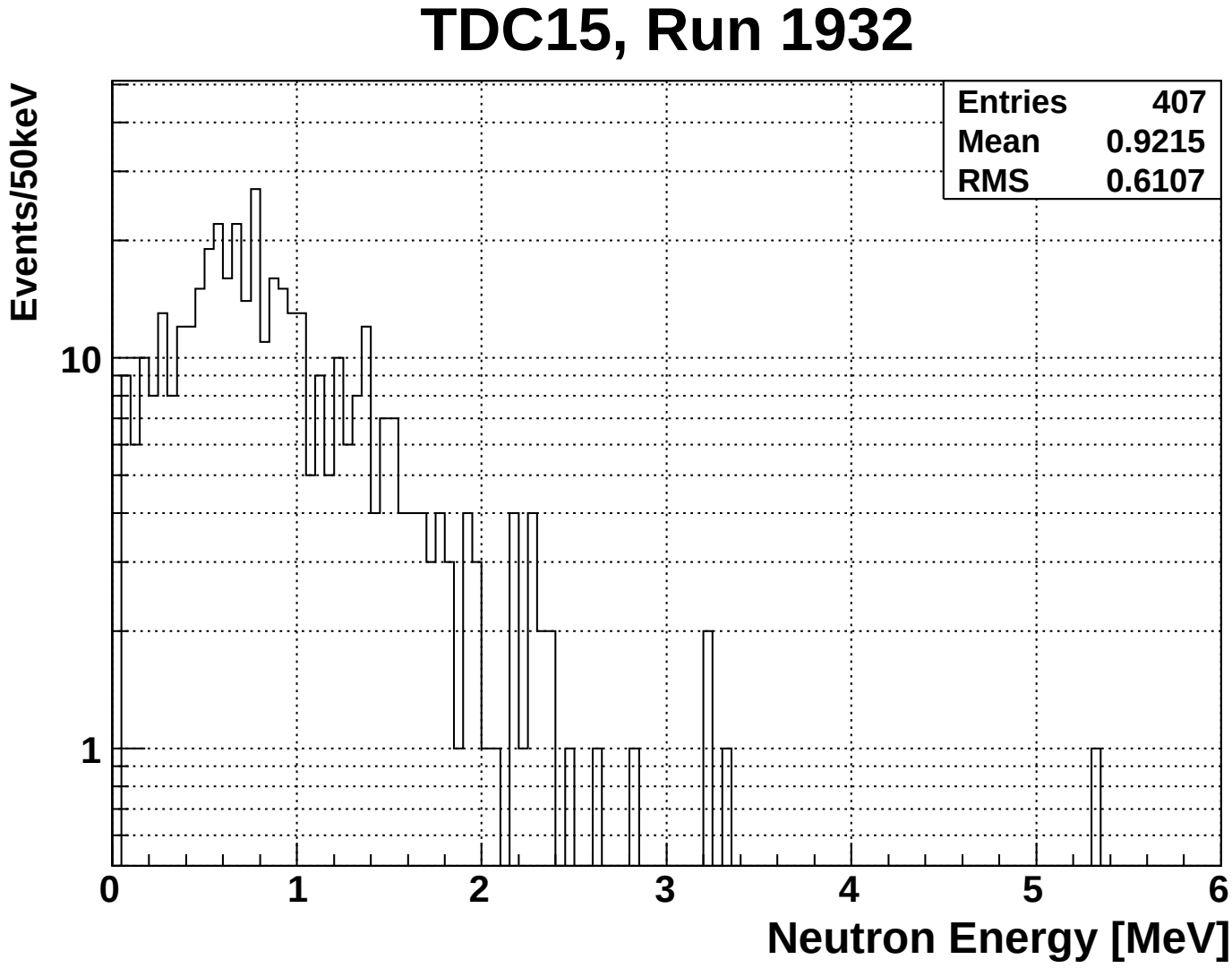
Sample Energy Spectra for Irina



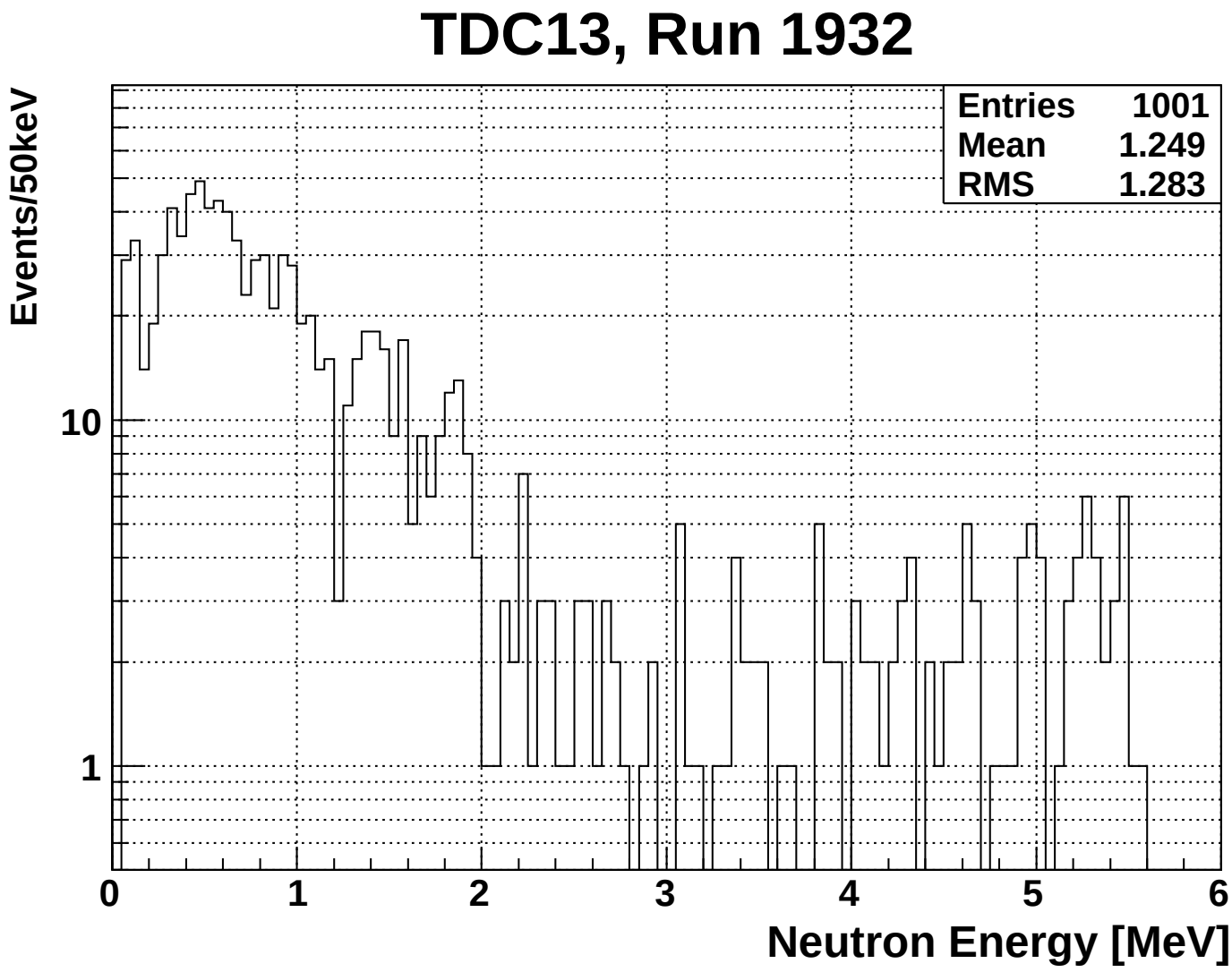
Sample Energy Spectra for Irina (Neutrons Only)



Sample Energy Spectra for Polina (Neutrons Only)



Sample Energy Spectra for Natalia (Neutrons Only)



Calculating D_2O Asymmetry

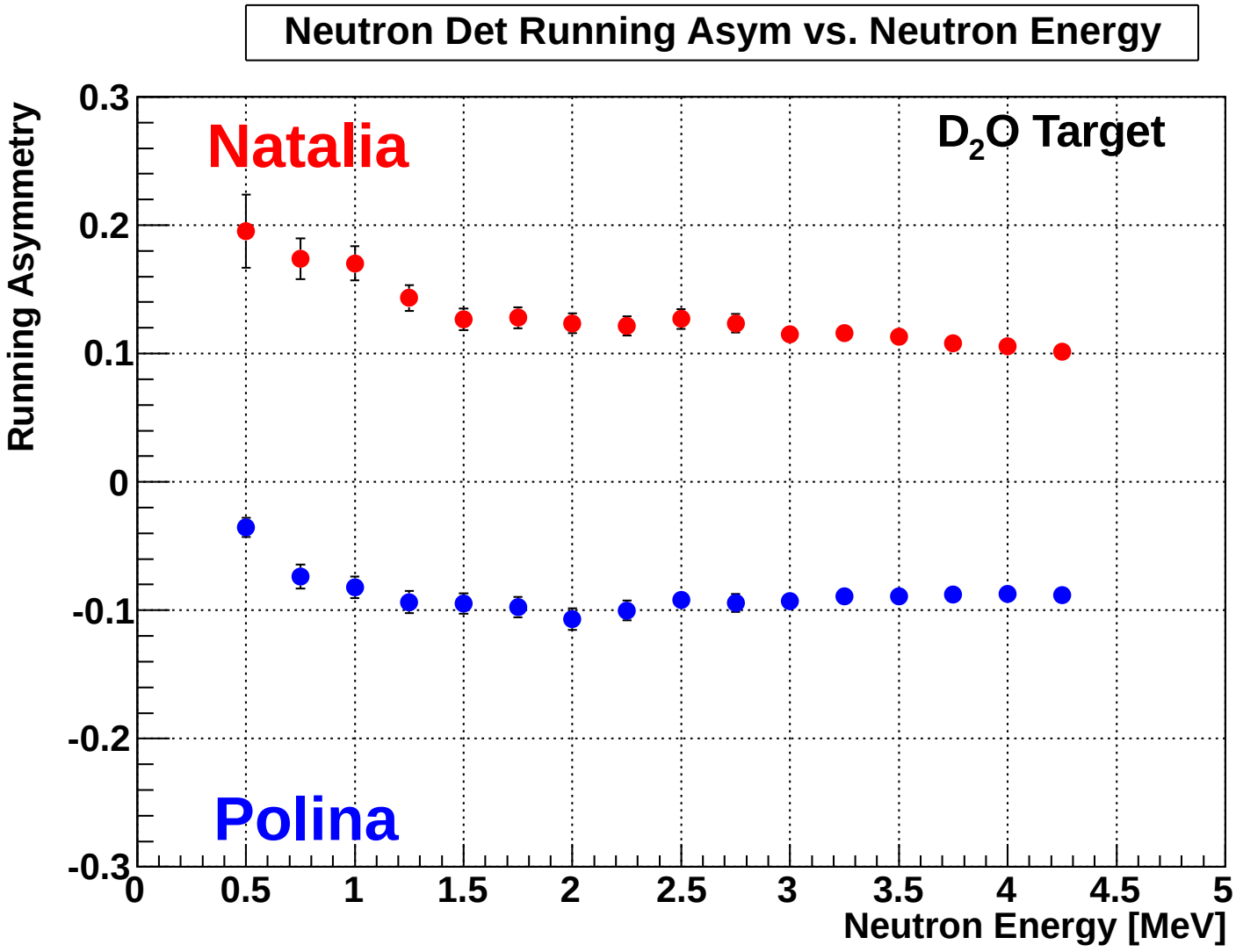
- Separately combine all statistics from kickerUp and kickerDown runs
- Normalize neutron counts (in Natalia and Polina) using neutron counts in Irina
- Calculate individual asymmetry for Polina and Natalia

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

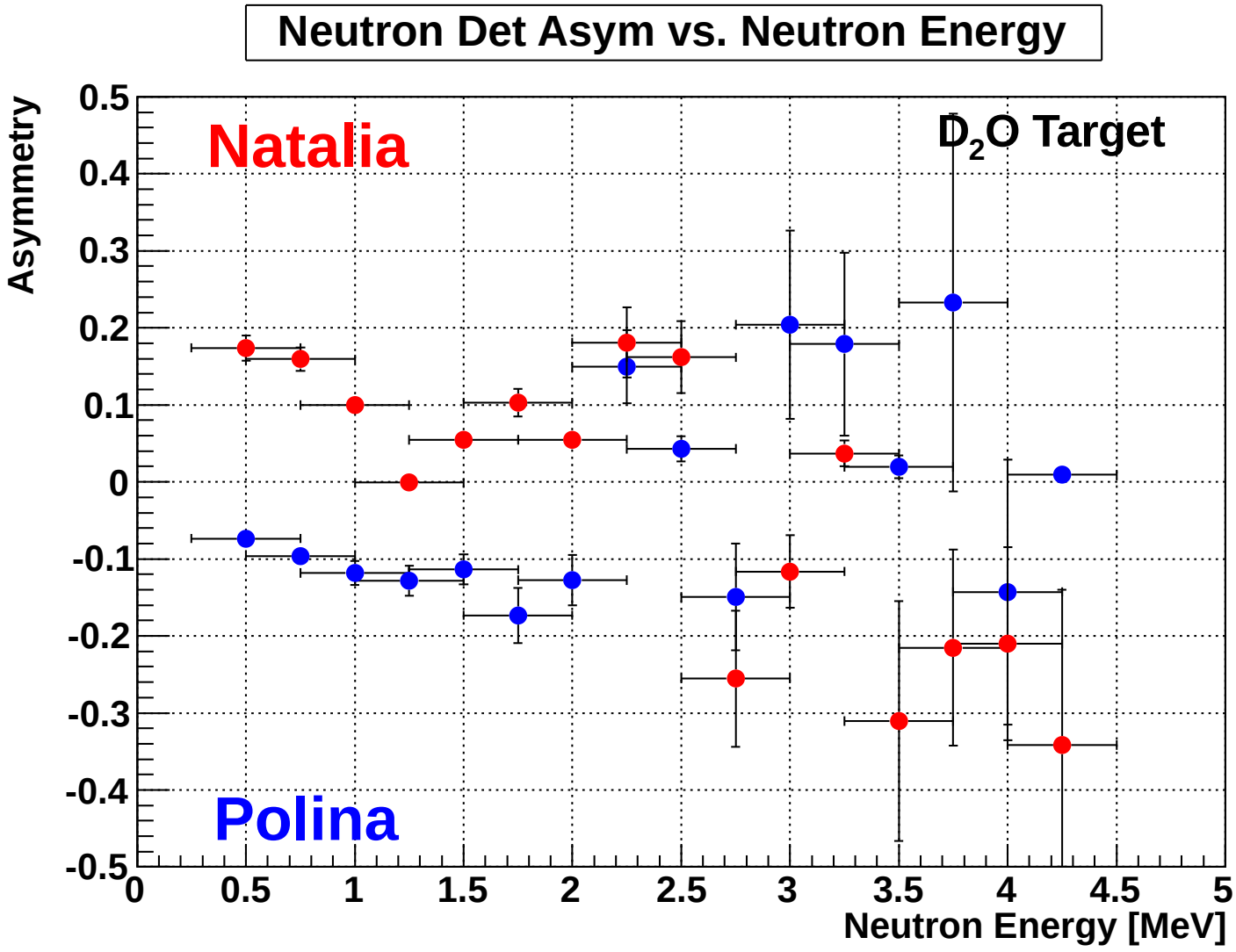
$$\text{where } \sigma^{\pm}_{N/P} = \frac{N^{\pm}_{N/P}}{N^{\pm}_{I}} \tag{5}$$

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

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
- Assuming no/very little background dilution, beam polarization was about 10% $\pm$ 0.8%