1. The lab has a number of charge sensitive preamplifiers that can be set to an output gain of 1.00 V per 100 MeV of deposited charge. What are the ENC and S/N ratio for the most intense alpha particle from $^{241}$Am decay for one of these preamps if the white noise was found to be 10 mV?

2. What is the difference in processing time between a 0.75 V and a 7.5 V signal that is converted in a 400 MHz Wilkinson-style 13-bit ADC that has a 0 to 10 V range?

3. The Silena 4418 ADC provides a maximum of eight coincident channels of 12-bit data encoded into 16-bit words with various pieces of information in the other bits. The data is readout is carried out in a block transfer with two header words followed by up to eight data words according to the pattern given below. What are the valid data values and valid channel numbers (everything in decimal notation) from the following five word block: 33537, 13, 4108, 8199, 18399

4. The time-of-flight (ToF) of nuclei through the second half of the A1900 fragment separator is routinely measured at the NSCL to identify secondary beams. The ToF
is measured between a scintillator mounted on a PMT in the center of the device and a silicon PIN detector at the focal plane that are 20.97 m apart. The electronic measurement uses a logic pulse created from the anode signal of PMT by a constant-fraction discriminator (CFD) and a signal from the PIN signal from by a charge-sensitive preamplifier and timing-filter-amplifier that create a logic pulse in a second CFD. Finally, the actual measurement is made by with a 2048 channel time-to-digital convertor (TDC) with the full-scale set to 100 ns.

(a) What is the expected time resolution (in ns) for the ToF measurement if the anode pulse has a rise time of 3.5 ns, a pulse height of 1.5 V riding on a noise level of 21 mV, while the TFA circuit was set for $\tau = 100$ ns and produced a signal to noise ratio of 162. (Hint: the text gives expressions for shaped pulses.)

(b) The signals travel from the detectors to the electronics over the same length cables. The logic signal from the scintillator CFD is usually delayed such that it comes after the PIN CFD signal and the difference is converted to exactly 1/2 of full-scale by the TDC. How much delay is needed if the particles are traveling through the separator at $\beta=0.25$?