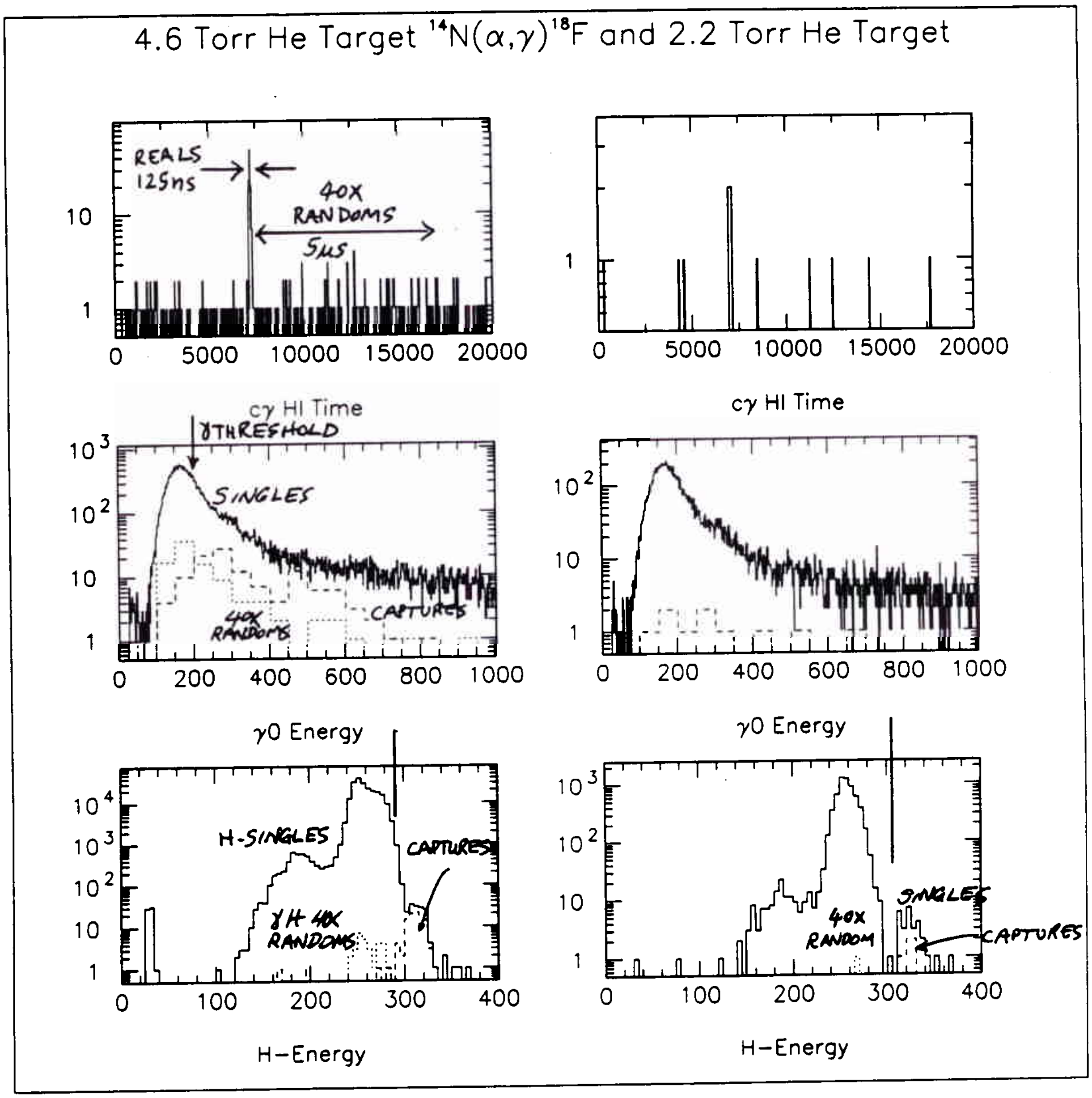
Expected Backgrounds in (a,g) Capture Experiments

The usual measure of background is the suppression factor, defined as Rl/(e*Rb), where Rl is the leaky beam rate, e is the detection efficiency, and Rb is the incident beam rate. The 12C(a,g)16O experiment proposes to measure cross sections down to 0.1nb = 10^-34 cm^2, which will require a suppression factor of 10^-34 * rho, where rho is the target density in atoms per cm^2. Assuming a 10 cm long He target of pressure 10 Torr, rho = 4X10^18 cm^-2, and therefore the desired suppression factor is 10^-34 * 4X10^18 = 4X10^-16. This suppression factor is smaller than the 10^-15 factor we needed for the 15O(a,g)19Ne experiment, and therefore would represent Dragon's biggest challenge.

The 14N(a,g)18F runs of Oct. 9 have similar kinematics to the proposed (a,g) measurements and so offer an opportunity to determine suppression factors under similar conditions to those expected in the proposed experiments. The figure below shows the analyzed spectra for two different gas target pressures, 4.6 Torr in the left column and 2.2 Torr on the right. The bottom spectra are end-detector pulse-heights with cuts as shown in the upper spectra, which cuts select real and random coincidence times and impose a gamma-energy threshold. The "singles" spectra show large leaky-beam peaks, the high-energy tails of which extend under the "capture" peaks. The amount of overlap was computed by integraging the "singles" peaks over the region of the capture peak, to the right of the vertical lines, and then scaling down these numbers of events by the ratios of "singles" to "randoms" counts in the spectra to the left of the lines. This extrapolation procedure makes up for the vanishing statistics of the randoms' data in the regions of the capture peak, due to limited integrated-beam in these runs.



The following table gives the factors contributing to the suppression factor for the two runs.

Run#	time (s)	P (T)	FC4 (enA/4+)	Beam (10^12)	Randoms	Scale (10^-6)	Leaky (10^-3)	Supression (10^-15)
6946	4756	4.6	5.0	3.7	1044	3.6	2.8	9
6947	1757	2.2	4.4	1.2	3	4..2	1.3	0.09

The "Suppression" in the first (i.e. worse) run is for a target pressure closer to the 10 Torr proposed for 12C+He, and so is the one we should use for planning the experiment.

There is a discrepancy of about a factor of 25 between the above-measured suppression factor and the one needed for the 12C+He experiment. This discrepancy can probably be made up by tightening the coincidence resolving time using the expected time of flight calculated event-by-event from the measured end-detector energy, and by reducing the singles rate in the gamma array using an r.f. time condition. These additional features could be added to the Analyzer software without much difficulty, and tested on the existing data 14N+He data.

Joel Rogers
TRIUMF
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