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Work up to June 4, 2004 on 12C(α,γ)

To calculate the yield or number of detected capture events of this reaction, there are many factors that must be noted. Throughout this reaction, most of the incoming beam was in the 3+ charge state, whereas the recoil charge state was taken to be 6+. The distribution of the 6+ charge state is dependent upon the target pressure and the incoming beam energy, therefore a formula for F6+(E, P(t)) is sought. With this information,

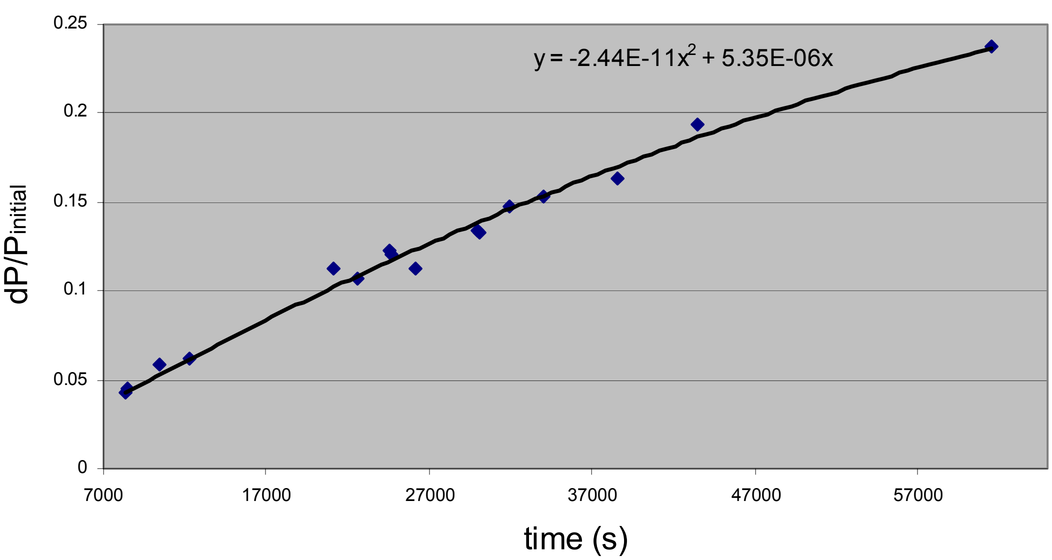
$I(t) = FCM2 / F_{6+}(E, P(t))$

can be calculated where I(t) is the beam current through the gas cell,
and FCM2 is the current after the charge separator.

There is a constant leak of the gas pressure in the target, which needs to be taken into account when dealing with helium as the gas target. For the longer runs, there was a substantial decrease in target pressure from the beginning to the end of the run. To find a formula to relate P(t) with Pinitial, it was assumed that the formula followed a standard equation of

$P(t) = Pinitial (1 - \alpha t + \beta t2)$

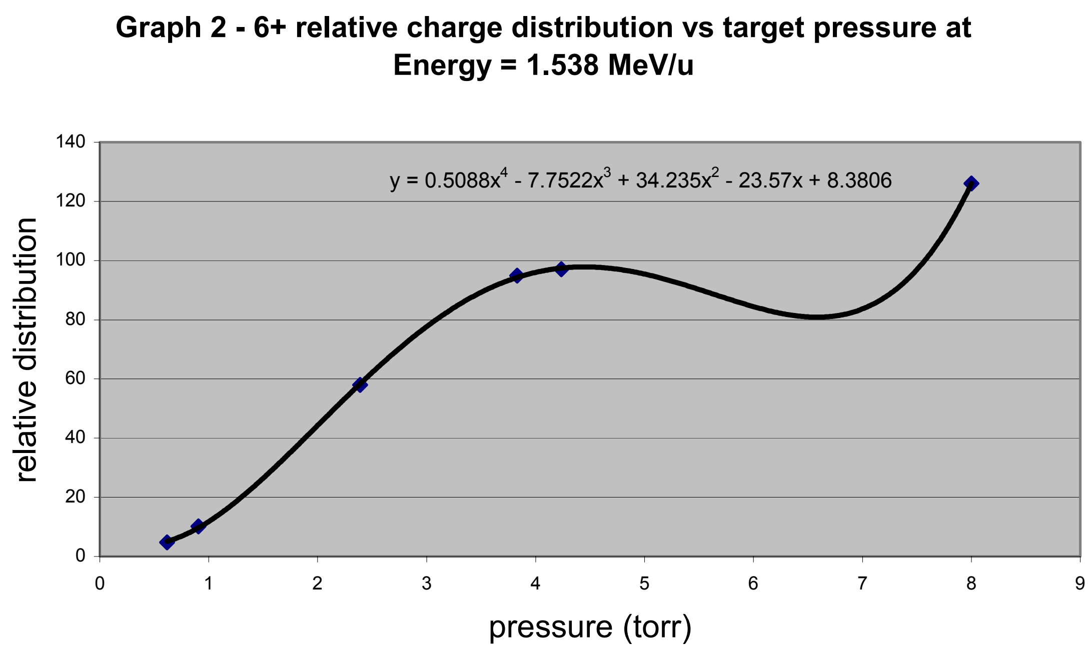
Graph 1 - [Pi - P(t)]/Pi vs time for the longer runs of $^{12}C(a,g)$



where from Graph 1 $\alpha = 0.00000535$,
and $\beta = 0.0000000000244$

This data was taken from runs #12025-12128 and can be found in the excel file labeled dP vs time in the Carbon Project folder.

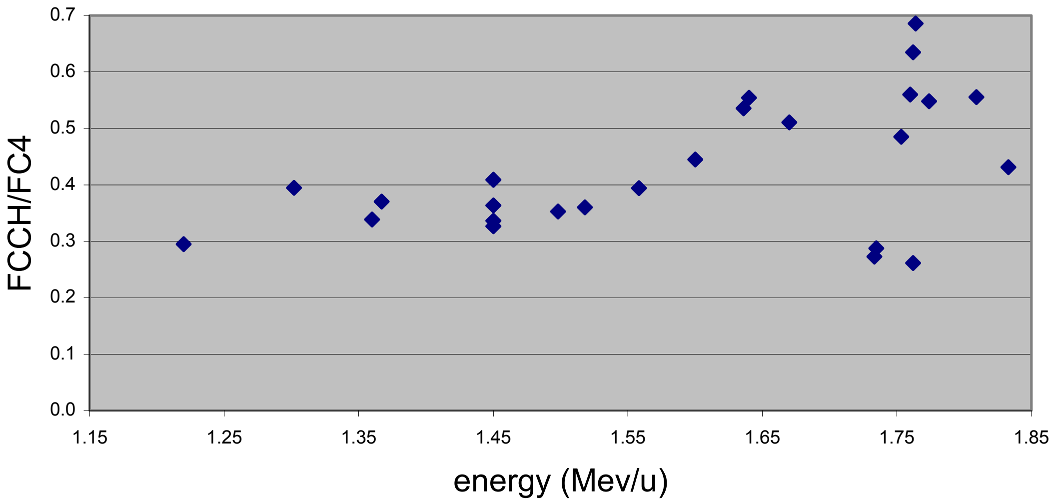
To show how the 6+ charge distribution depends on pressure, data was collected from Figure 16 from the EEC June 2004 report, which was a collection of distribution vs pressure at a constant energy. See Graph 2. This data can be found in the same source as Graph 1.



As can be seen from Graph 2, the fit is not ideal; the line should level off as the pressure increases instead of the dip that is seen. But as the range of pressure in the gas target of DRAGON is so limited (2.9-4.4 Torr), this does not need to be considered.

Looking for a formula for how the 6+ charge state distribution depends on energy has proven to be quite a bit more difficult. The data collected from the two faraday cups, FC4 and FCCH, is inconsistent. This is most likely due to a loss of transmission of the beam through the target, causing the ratio between the two cups to be unstable. An attempt was made to find a linear relationship between the ratio of the two cups and energy, while keeping pressure constant. Graph 3 shows this relationship for a target pressure of 3.9-4.1 Torr. The data for this graph can be found in the excel file named distribution vs energy, under the folder titled Carbon Project.

Graph 3 - 6+ charge state distribution vs energy with a pressure of 3.9-4.1 Torr



It can be seen that there is a great spread of ratios within a particular energy. The three points that have a ratio of less than 0.3 in the 1.75 Mev/u range appear to be due to a large loss in transmission beam through the target, around 40%. This was noted on page 168 of the DRAGON Logbook #8. It is clear that the ratio does increase with energy, but more work is needed to be done to find a convincing formula. Once this is found, than a formula for $F_{6+}(E, P(t))$ can be found, which would lead to a value for I(t).

Work up to June 14, 2004

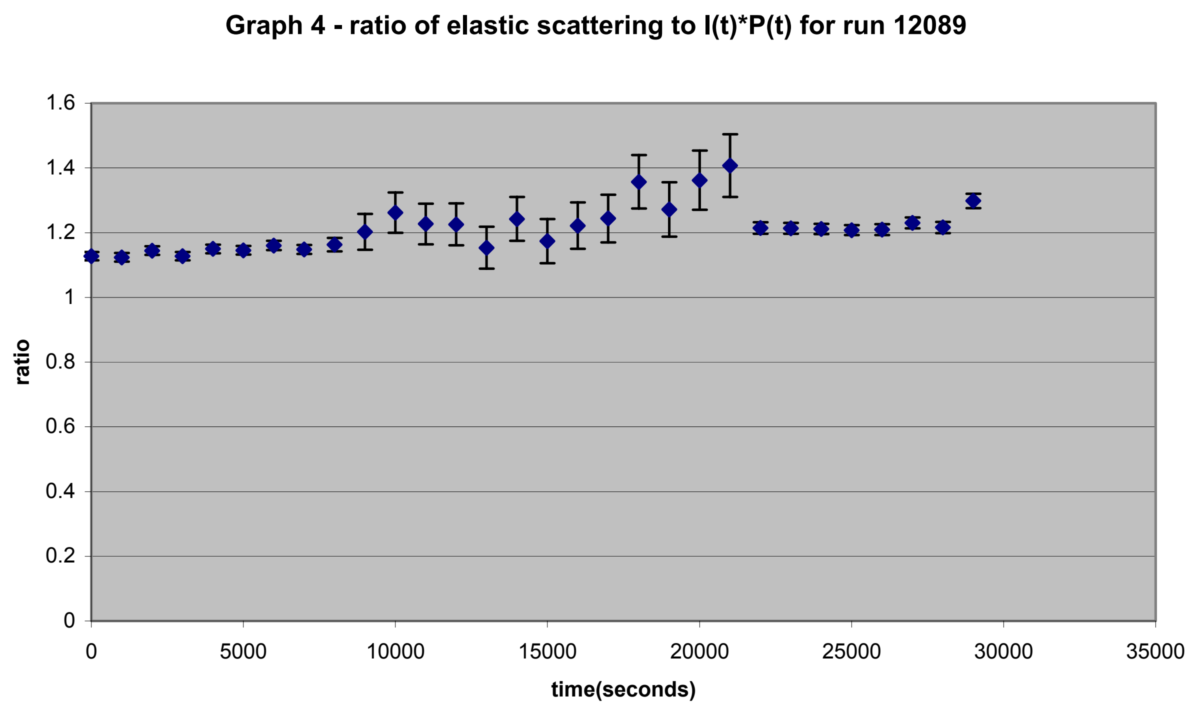
Although a formula has not yet been derived for $F_{6+}(E, P(t))$, a C++ program was written to calculate an average I(t) for every 500 seconds when imputing the following parameters: initial pressure, beam energy, and length of run. The values of FCM2 are inputted from a (nova) file that must be given as well. This program, called FCM2revised.cxx can be found under the koraas directory in isdaq04 home/dragon. A temporary equation for $F_{6+}(E, P(t))$ has been chosen, which is

F_{6+} = 0.5 - 0.2 * (1-pressure/4.2) - 0.1 * (1-energy/1.8);

When a new equation has been found, the existing equation can be easily replaced. The output of the program consists of a list of the average I(t) for each 500 seconds along with the average P(t) and the product of the two.

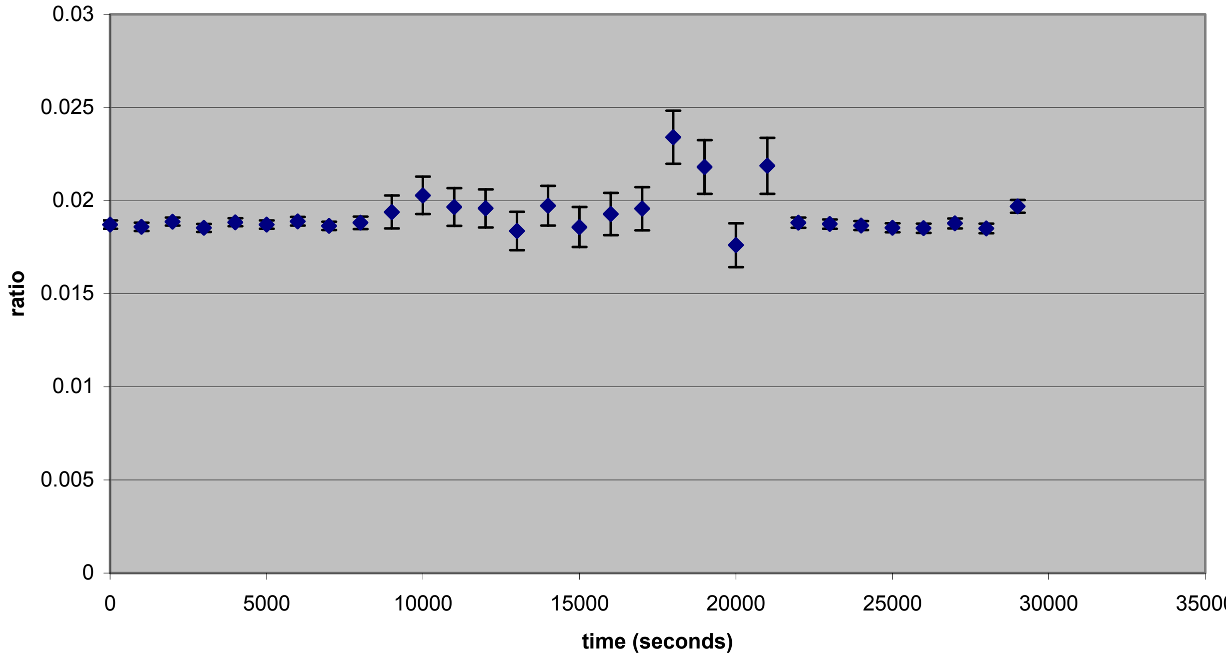
The program was then used to look at the data from the elastic scattering monitors. Ideally, the ratio of FCM2 to the counts in the elastic scattering monitor should remain a constant, but as the pressure in the target decreases, the charge state distribution changes and therefore the ratio also changes. It was thought that if the change in the charge state distribution was taken into account, then we could find a ratio with the elastic scattering monitor that remained constant. To do this, a ratio of the output of the program, I(t)*P(t), and the elastic scattering monitor was calculated. This was plotted along with the FCM2 ratio with the hopes that the plot of I(t)*P(t) would turn out a flat ratio.

As it turns out, the plot of the ratio of elastic scattering counts to FCM2 had a smaller scattering of ratios compared to the I(t)*P(t) ratios. This can be viewed by looking at Graphs 4-6. Graph 6 is a direct comparison of the two ratios done by multiplying the values for the ratio of FCM2 to elastic scattering by 62.5. This value was found by finding the quotient between the weighted mean of both ratios.

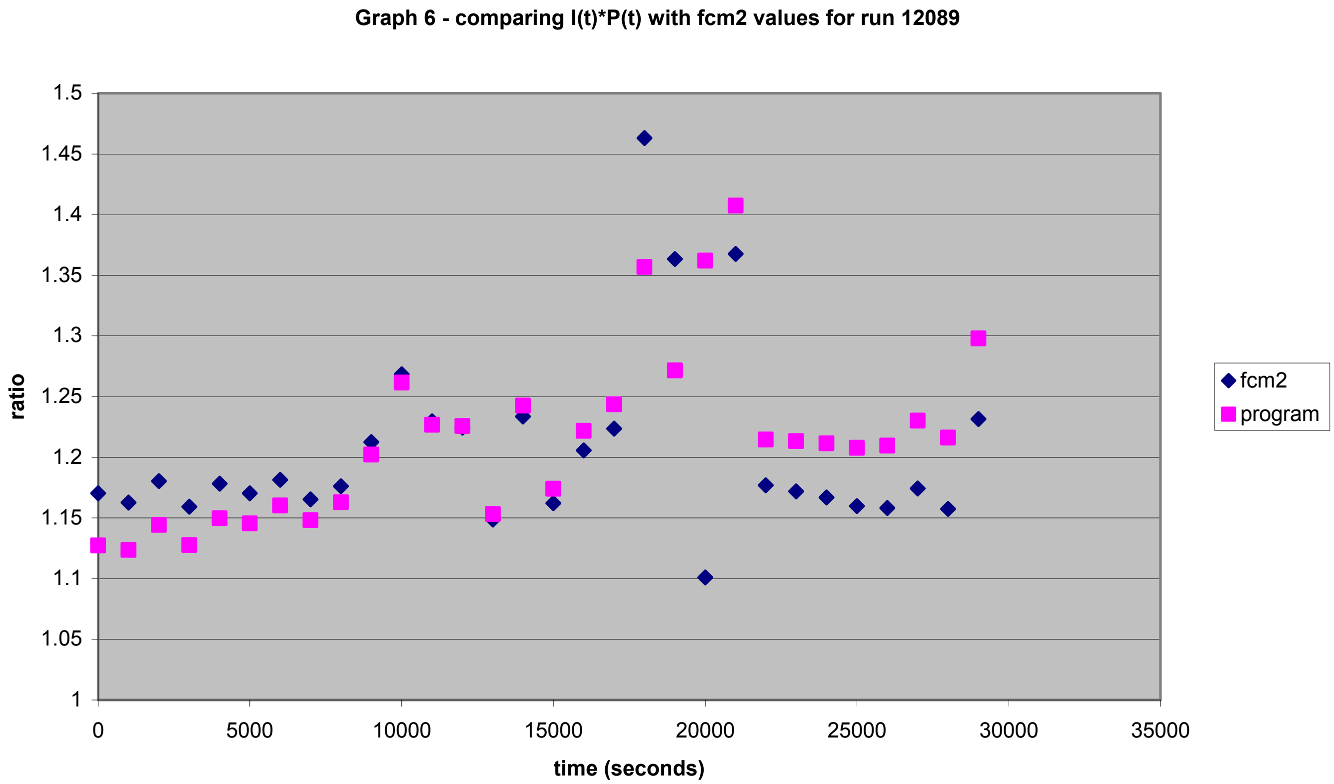


Graph 4 – it can be seen that the peak in the middle of the graph has a larger error because the beam was at a minimum at the time. With less statistical counts, the error increases.

Graph 5 - ratio of fcm2 to elastic scattering for run 12089



Graph 5 – Again, this graph has a peak with large error bars in the middle because of a loss of beam during the middle of the run. It can be seen that ignoring 9000-21000 seconds, the ratio is kept very constant.



Graph 6 – As can be seen in the direct comparison of the two ratios, it appears as though the FCM2 ratio stays relatively flat, while the I(t)*P(t) ratio as calculated in the C++ program tends to increase as the run progresses.

It is surprising that the FCM2 ratio remains constant even after an eight-hour run, where the pressure drop is quite noticeable. To improve the ratio consistency of the values calculated by the computer program, a better formula for calculating $F_{6+}(E, P(t))$ will need to be derived.