Early problems and solutions with the analysis of ^{21}Na(p,γ)^{22}Mg

Aaron Bebington
March 5, 2003

In the course of analysis of the ^{21}Na(p,γ)^{22}Mg data from Nov/Dec 2002, difficulties were encountered in distinguishing recoil and leaky beam peaks. In an effort to distinguish the two peaks, a relationship between ion energy and peak position was determined.

The energy out of the target was used as the energy of the ion. This was calculated using:

$$E_{out} = 482.3 \left[\frac{q_{out} \times B}{A}\right]^2 \tag{1}$$

where B is the NMR reading in units of kG, and A is the atomic mass. E_{out} is derived in keV/u, and E_{ion} was derived by multiplying E_{out} by u.

Pulse position was determined by inspecting H-energy spectra in PAW++.

Energies of the recoil beams, and the alpha calibration, were also determined.

Data was not only taken from runs involving ^{21}Na, but from earlier ^{21}Ne, ^{20}Ne, ^{24}Mg runs and their recoils, (^{22}Na, ^{21}Na, ^{25}Al, respectively), at different energies.

For some runs, ODB files were not available, so it was necessary to rerun the mid files in NOVA. The NOVA analysis program has a pedacorrection that resulted in energy channel numbers that were different from PAW++ by some factor. Using the gain and offset numbers for PAW++, NOVA was corrected.

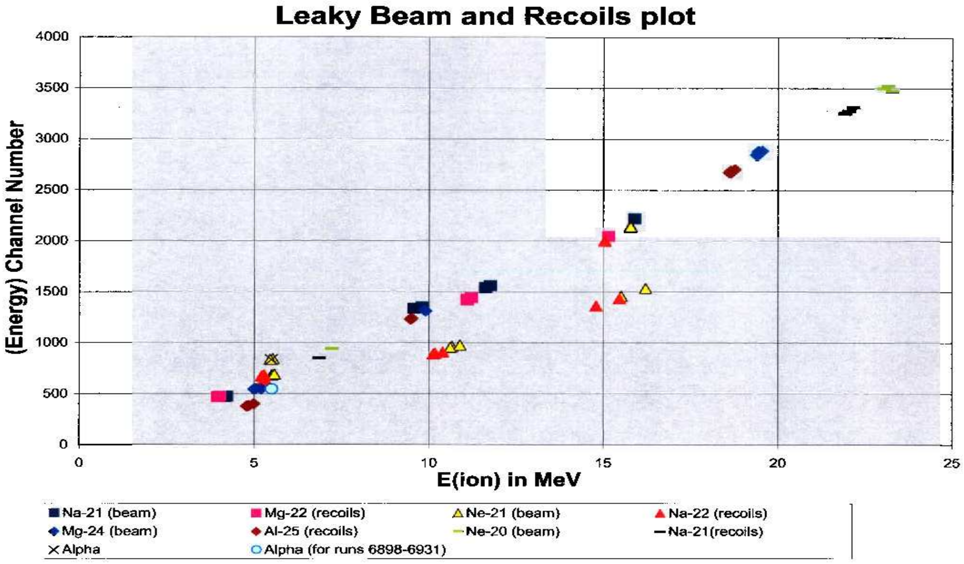

Figure 1: Initial plot of the energy channel number versus the ion energy

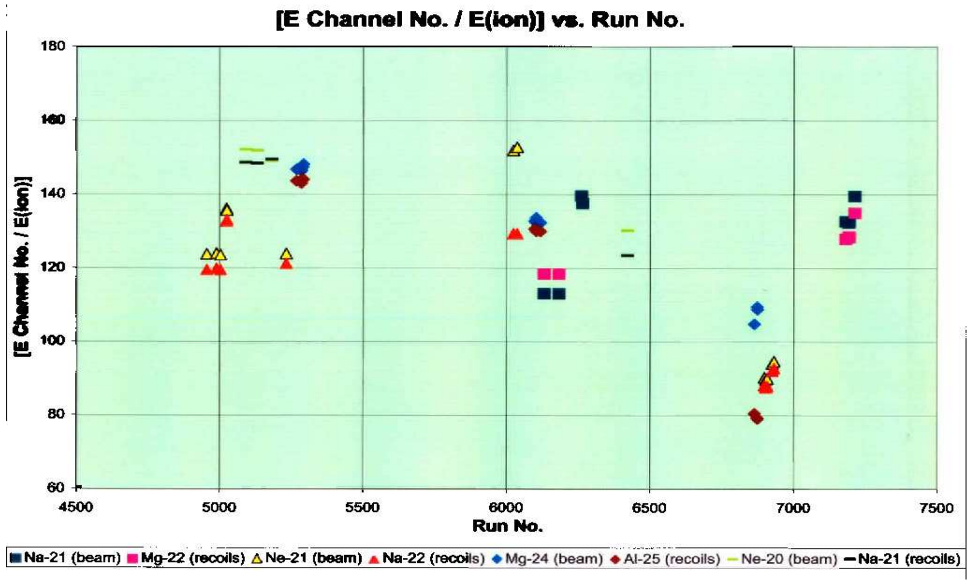

Figure 2: Second plot which shows the observed discrepancy in the runs between 6800 and 7000

Once plotted, it was found that five of the ^{21}Ne runs (6898-6931) did not seem to follow the general trend (see Figure 1). In addition, the alpha source peak was not at the expected energy channel.

To determine if the observed discrepancy was dependant on the time of the run, channel number divided by ion energy was plotted versus run number.

A dip from the trend was observed for the questioned ^{21}Ne runs, and also two of the ^{24}Mg runs. From this dip, a change was inferred to have occurred sometime between runs 6800 and 7000. There was no change in the detector until run 7172, so the DSSSD could not be responsible.

The solution: an error in the gain and offsets used in PAW++ for those runs. Looking at the odb file for run 6925, we found that the gains and offsets were different to the usual PAW++ files. Instead, the mid files were rerun in NOVA, with the original settings, to find the correct energy channel number of the peaks. (See Figure 3).

The corrected data is presented in Tables 1-5.

A line of best fit was determined, (the equation of the line

$$y = 154.6x - 184.31 \tag{2}$$

can be used to find the correct energy spectrum at a specific energy) (See Figure 4).

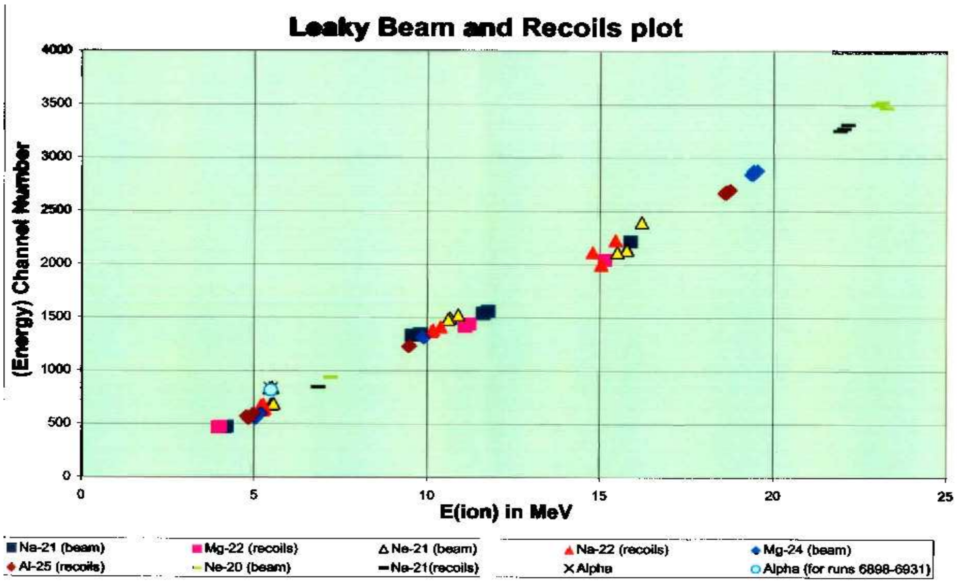

Figure 3: Corrected graph, taking into account the change of gain and offsets in PAW++, for runs between 6800 and 7000.

Run No.	E (MeV)	Chan No.	(Chan No.)/E	E (MeV)	Chan No.	(Chan No.)/E
6132	4.21	476	113.0641	4.02	476	118.408
6184	4.15	469	113.012	3.96	469	118.4343
6262	9.56	1335	139.6444			
6266	9.8	1348	137.551			
7181	11.63	1543	132.6741	11.1	1420	127.9279
7192	11.62	1538	132.358	11.09	1426	128.5843
7193	11.76	1560	132.6531	11.22	1441	128.4314
7212	15.88	2216	139.5466	15.15	2045	134.9835

Table 1: ^{21}Na (beam) on the left, ^{22}Mg (recoils) on the right

Run No.	E (MeV)	Chan No.	(Chan No.)/E	E (MeV)	Chan No.	(Chan No.)/E
4955	5.5	681	123.8182	5.25	628	119.619
4989	5.5	682	124	5.25	630	120
5003	5.51	681	123.5935	5.26	629	119.5817
5024	15.77	2147	136.6373	15.04	1997	132.7793
5025	15.77	2139	135.6373	15.04	2003	133.1782
5233	5.57	690	123.8779	5.31	644	121.2806
6024	5.53	840	151.8987	5.28	683	129.3561
6037	5.46	834	152.7473	5.21	674	129.3666
6898	10.66	1496	140.3377	10.17	1384	136.0865
6902	10.89	1525	140.0367	10.39	1414	136.0924
6907	10.61	1484	139.868	10.12	1369	135.2767
6925	15.5	2116	136.5164	14.79	2116	143.0696
6931	16.2	2397	147.963	15.45	2229	144.2718

Table 2: ^{21}Ne (beam) on the left, ^{22}Na (recoils) on the right

Run No.	E (MeV)	Chan No.	(Chan No.)/E	E (MeV)	Chan No.	(Chan No.)/E
5091	23.14	3521	152.1608	22.03	3275	148.6609
5131	23.02	3496	151.8679	21.92	3254	148.4489
5182	23.27	3470	149.119	22.15	3312	14.526
6421	7.21	939	130.2358	6.86	847	123.4694

Table 3: ^{20}Ne (beam) on the left, ^{21}Na (recoils) on the right

Run No.	E (MeV)	Chan No.	(Chan No.)/E	E (MeV)	Chan No.	(Chan No.)/E
5268	19.37	2844	146.825	18.59	2671	143.6794
5285	19.42	2843	146.3955	18.64	2667	143.0794
5288	19.42	2868	147.6828	18.63	2686	144.1761
5290	19.54	2881	147.4411	18.76	2701	143.9765
5292	19.43	2879	148.1729	18.64	2686	144.0987
6098	9.89	1313	132.7604	9.49	1240	130.6639
6104	9.86	1318	133.6714	9.46	1230	130.0211
6119	9.9	1310	132.3232	9.5	1235	130
6863	5.19	600	115.6069	4.98	600	120.4819
6873	4.98	575	115.4618	4.78	575	120.2929
6874	5.04	550	109.127	4.84	550	113.6364

Table 4: ^{24}Mg (beam) on the left, ^{25}Al (recoils) on the right

E (MeV)	Chan No.
5.49	832

Table 5: Alpha Source

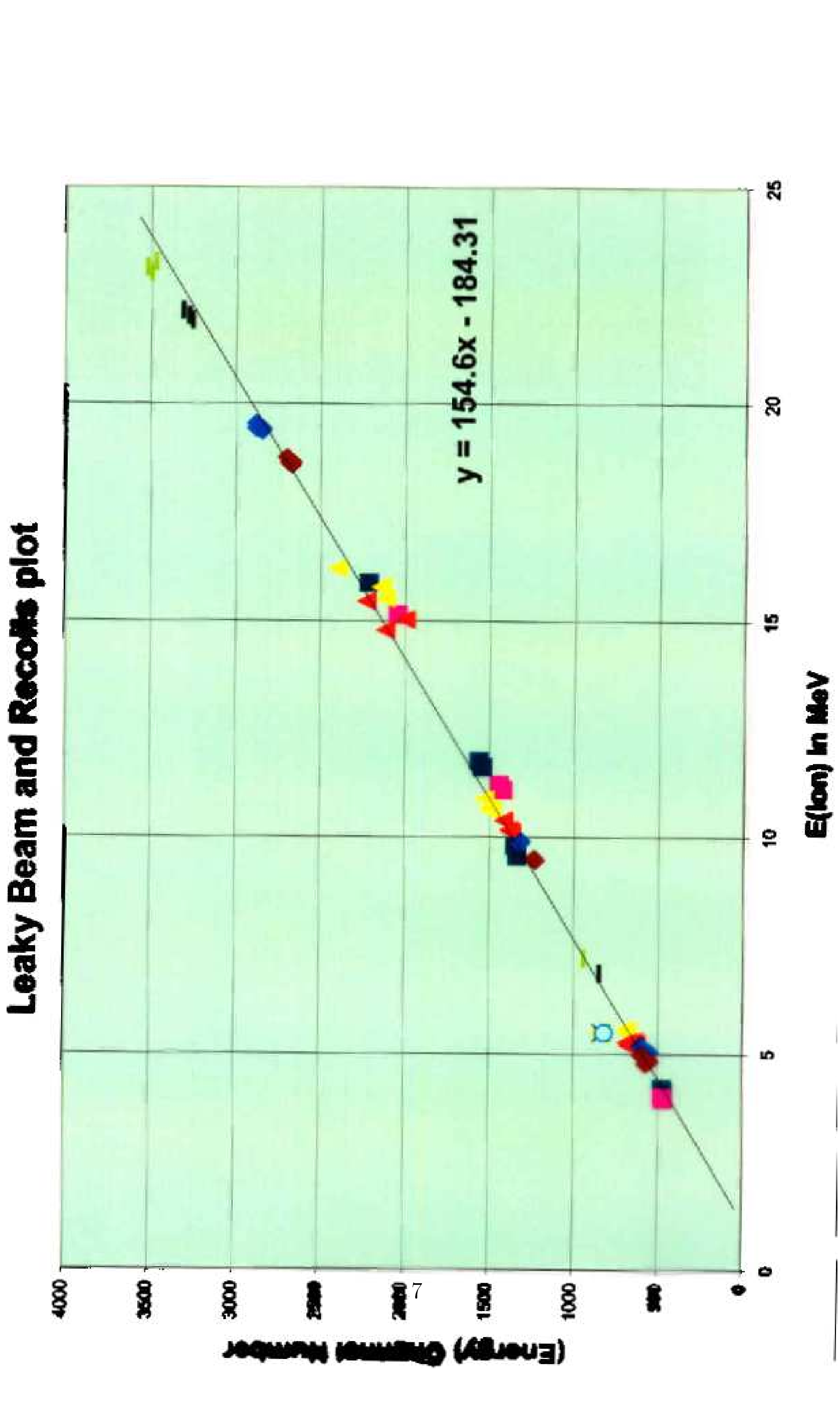

Figure 4: The corrected graph, with a line of best fit and equation of the best fit line.