MEMO Sept. 16, 2003

To: John D'Auria cc: L.Buchmann, B.Davids, D.Hutcheon, & A.Olin

From: Joel Rogers

Re: Tuning DRAGON

At last week's meeting it was agreed to do the next 12C(a,g)16O run with a DSSSD detector at the Mass Slit position. This memo proposes a measurement technique which will tune DRAGON to the optimum acceptance configuration by changing the magnets Q1-Q5 and SX1-SX2 one-at-a-time. The need for this tuning is dictated by the observed acceptance losses in the previous data and also by my belief that the GIOS-simulated tunes may not be accurate, especially at locations where the 2nd-order aberrations are predicted to be large.

GIOS simulations have been used to test the proposed tuning procedure, not to dictate the final magnet settings. A starting-point for the tuning was determined by GIOS, imposing the condition that the recoil-beam envelope be as small as possible relative to the "squeeze-points", Q1-exit, MD1, Q3, Q5, ED1, ED1-exit, and Mass-slit. The envelope for this "Broad" tune is shown as the 3rd column of Table I, over. 1st- and 2nd-order aberrations have been added as described in my last week's memo (Sept. 8, 2003). When a magnet setting is increased in GIOS, the envelope expands to limit at one of the squeeze points. When the same setting is decreased, a limit occurs at a different squeeze point. The range of settings between these two limiting cases is different for each magnet, and typically plus-minus 5% at the chosen simulation energy, Ecm=2.68 MeV.

It is proposed to determine the range of variation over which the acceptance is constant for each of the 7 focusing magnets in the first 1/2 of the DRAGON. This data has two uses: (1) By setting each magnet at the midpoint of its measured range, the acceptance is maximized, which is the first step toward lowering the beam energy, and (2) the settings can be compared with GIOS predictions to test GIOS and prepare to similarly tune the 2nd half of DRAGON, at some future date. Accomplishing only the first objective should allow us to acquire reliable 12C(a,g) data at least down to an energy of Ecm=2.68 MeV, and lower if the measured magnet ranges are large.

To test the proposed procedure, Q2 was varied in GIOS by +-5%. The resulting GIOS-predicted envelope is shown in columns "4" and "5" of Table I. The predicted size of the recoil's envelope just equals the size of the squeeze-point at ED1 for -5% and at Q3 for +5%. The acceptance is therefore predicted to be 100% for values of Q2 within +-5% of the "Broad" tune value. Any larger variation of Q2 is predicted to have a loss, as measured by a decrease in the DSSSD singles rate. Other magnets were also varied in GIOS, which resulted in various other points of loss, but each variation exhibited a "flat" region of acceptance within a few percent of the nominal magnet's setting. The order of variation tested was from upstream to downstream for the 5 quads, followed by SX1 then SX2. Other orders of variation will be investigated in the near future.

The proposed procedure does not rely on the simulation's correctness, but only on the general behavior of the simulation, insofar as it predicts a flat region for some range of magnet settings. If the simulation is correct in predicting this general feature of the DRAGON tune, the tuning procedure should result in an optimum tune and therefore the lowest possible range of beam energy over which the 12C(a,g) experiment can be reliably run with the first stage alone.

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 c12/y1608037q5d40a20.gios = 12C(a,g)16O @ Ecm=2.68 BROAD 1st 1/2
 CALCULATION  ORDER 2 2 ;
 REFERENCE PARTICLE  8.037  16.0  5.0 ;
 P X 0.0025 .020 ;
 P Y 0.0025 .020 ;
 D P 0.  0.040 ;
 P = 1.05 ; Fractional variation
 A =  -0.133  ; Q1
 B =   0.129 * P ; Q2
 E =   0.132  ; Q3
 F =  -0.153  ; Q4
 G =   0.0734 ; Q5
 U =   0.027  ; SX1
 W =  -0.0068 ; SX2
 C =   B * 0.0529  ; SXQ2
DRIFT LENGTH 1.06885 ;
F  F  3  ;
M  Q  0.2523  =A  0.053975 ; Q1
F  F  3  ;
DRIFT LENGTH 0.17 ; to transition piece
P  N ; Q1 exit envelope (4" circle)
DRIFT LENGTH 0.086925 ;
F  F    ;
M  M  0.33385 =B  =C 0.0 0.07935 ; Q2
F  F    ;
DRIFT LENGTH .638075 ;
P  N  ; MD1 entrance envelope (6" circle)
F  F  1  5.8  0 ;
M  S  1.000 50  .05 ; MD1
F  F  1  5.8  0 ;
DRIFT LENGTH 0.3079 ;
P  N  ; Charge Slit
DRIFT LENGTH .7109 ;
M  M  0.1941  0.0 =U 0.0 0.0795 ; SX1
DRIFT LENGTH 0.1581 ;
P  N  ; Q3 entrance envelope (6" circle)
F  F  3  ;
M  Q  0.3338 =E   0.079375 ;
F  F  3  ;
DRIFT LENGTH 0.2162 ;
F  F  3  ;
M  Q  0.3338 =F   0.079375 ;
F  F  3  ;
DRIFT LENGTH 0.2162 ;
P  N  ; Q5 entrance envelope (6" circle)
F  F  3  ;
M  Q  0.3338 =G   0.079375 ;
F  F  3  ;
DRIFT LENGTH 0.1581 ;
M  M  0.1941  0.0 =W 0.0  0.0795 ; SX2
DRIFT LENGTH 0.8059 ;
F  (X,AA) ;
F  (X,AD) ;
P  N  ; ED1 entrance
F  F  3  ;
E  S  2  20  0.05 ;
F  F  3  ;
P  N  ; ED1 exit
DRIFT LENGTH 1.05 ;
P  N  ; SLITM
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From Page No.

Project No. Book No. TITLE

# TABLE I

## SIMULATED MAGNET ERROR LIMITS ±5%

| ① | ② | ③ | ④ | ⑤ |
|---|---|---|---|---|
| | MAXIMUM ENVELOPE mm×mm | Ecm = 2.68 MeV BROAD TUNE GIOS ENVELOPE (X-1st + X-2nd) × (Y-1st + Y-2nd) mm × mm | BROAD TUNE BUT WITH Q2 − 5% GIOS ENVELOPE | BROAD TUNE BUT WITH Q2 + 5% GIOS ENVELOPE |
| Q1ex | 50×50 | (48+0)×(19+0) | ← same | ← same |
| MD1 | 76×50 | (45+4)×(15+2) | (49+7)×(14+2) | (42+3)×(16+2) |
| CSLIT | 50×50 | (13+8)×(19+4) | (13+8)×(16+3) | (14+8)×(21+3) |
| Q3 | 76×76 | (54+12)×(20+5) | (47+12)×(17+5) | (62+14)×(24+5) |
| Q5 | 76×76 | (49+10)×(30+10) | (50+7)×(24+9) | (49+12)×(35+7) |
| ED1 | 50×76 | (35+5)×(11+9) | (43+7)×(11+8) | (26+7)×(14+9) |
| ED1ex | 50×76 | (21+7)×(9+9) | (32+10)×(11+8) | (11+5)×(7+5) |
| MSLIT | 25×25 | (7+11)×(11+11) | (10+13)×(11+9) | (18+8)×(10+14) |

Witnessed & Understood by me.

Date

Invented by

Recorded by

Date 16 Sep 03

Joel

To Page No.