MEMO

September 8, 2003

To: John D'Auria

cc: L.Buchmann, B.Davids, D.Hutcheon, A.Olin

From: Joel Rogers

Re: GIOS Acceptance Calculations

For some weeks I have tried to improve the EMS tune to get 100% acceptance for the 12C(a,g)16O experiment. Although with some compromise, I believe I have a solution that is worth trying in an actual experiment. Here is a summary of my progress to date. I optimized the tune in two steps: (1) The 1st-order envelopes were squeezed at points where GIOS said there were losses. Then (2) the 2nd-order contributions were minimized using the GIOS "Fit" command to minimize the (X,AA) and (X,AD) aberrations at ED1, Q6(exit), Q8, ED2, and ED2(exit). These two adjustments fixed the first 8 quads and the 4 sextupoles. This tune, which I call "Broad Acceptance Tune" (or Broad tune for short), is compared to the standard tune in Table I. The losses shown here in the standard tune at Q5, ED1, Q6(exit), and ED2 are fixed, but the Broad tune still has losses at ED2(exit) and Q9-10.

According to GIOS, it would be possible to get 100% transmission if we enlarged the exit flange from ED2 and also replaced Q9 and Q10 with bigger quads. How much bigger is a question, since the simulations are not expected to be accurate in this region where the 2nd-order terms are bigger than the 1st-order terms. A less-expensive solution would be the following:

We mount a DSSSD detector at a position just downstream of the mass slits, replacing the FCM Faraday cup. We validate the simulation by measuring the recoil singles rate in the DSSSD, while varying the quads and sextupoles in the EMS one-at-a-time. We expect a flat-topped acceptance curve similar to the one obtained for the gamma detector, published as Fig. 3 of our NIC paper, a copy of which is attached. The presence of a flat portion for each magnet, and the measured width of each such acceptance curve compared with the width predicted by GIOS, will be used to validate GIOS. If the widths agree, GIOS is validated. In which case GIOS predictions for the remainder of the EMS could be used with confidence for improving Q9 and Q10. If the widths do not agree, the first-stage of the separator can still be used with confidence to measure 12C(a,g)16O, as long as some flat portion exists for each magnet.

Joel

TABLE I

8.037 MeV ^{16}O, D = 0.04, A = B = 0.02 r

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TITLE DRAGON GIOS SIMULATIONS

		MAXIMUM ENVELOPE X(mm) x Y(mm)	STANDARD TUNE 1st ORDER* (mm x mm)	2nd ORDER** (mm x mm)	BROAD ACCEPTANCE TUNE 1st ORDER* (mm x mm)	2nd ORDER** (mm x mm)	TOTAL (mm x mm)
1	Q1(exit)	50 x 50	49x18	0x0	49x18	0x0	49x18
2	MD1	76x50	47x10	7x2	49x10	4x2	53x12
3	CSLIT	50x50	13x9	9x3	13x10	9x3	22x13
4	Q3	76x76	56x19	14x5	50x20	14x6	64x26
5	Q5	76x76	64x31	13x12	52x35	10x11	62x46
6	ED1	50x76	49x17	11x12	40x21	9x13	49x54
7	'SLIT	50x50	4x11	2x19	8x10	3x25	11x35
8	Q6(exit)	50x50	46x14	7x19	36x12	4x26	40x38
9	MD2	76x50	51x14	5x14	37x16	4x27	41x43
10	Q8	76x76	49x9	13x10	58x10	4x6	62x16
11	ED2	50x76	46x22	14x42	42x16	5x48	47x64
12	ED2(exit)	50x76	38x43	14x83	35x33	6x89	41x122
13	Q9	67x67	20x59	15x111	18x46	9x123	27x169
14	Q10	67x67	23x38	21x72	22x28	15x71	37x99
15	FSLIT	50x50	6x5	7x7	7x11	6x26	13x37

* max(|X,A|, |X,D|) + |X,X| × |Y,Y| + |Y,B| ≡ 1st ORDER

** |X,XA| + |X,XD| + |X,AA| + ½|X,AD| + |X,DD| × |Y,YA| + |Y,YD| + ½|Y,BA| + ½|Y,BD| ≡ 2nd ORDER

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Witnessed & Understood by me.	Date	Invented by / Recorded by	Date	
			8 Apr 03	Joel

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c12/std16O8037q5d40a20.gios = 12C(a,g)16O @ Ecm=2.68 Scaled std
 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 ;
 S = 1.512 ;
 A =  -0.0943 * S ; Q1
 B =   0.0864 * S ; Q2
 E =   0.0788 * S ; Q3
 F =  -0.1040 * S ; Q4
 G =   0.0573 * S ; Q5
 H =  -0.0509 * S ; Q6
 I =   0.0731 * S ; Q7
 J =   0.0542 * S ; Q8
 K =  -0.0419 * S ; Q9
 L =   0.0469 * S ; Q10
 U =   0.0177 * S ; SX1
 W =   0.0037 * S ; SX2
 X =   0.0035 * S ; SX3
 Y =   0.0158 * S ; SX4
 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 ;
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```
c12/w16O8037q5d40a20.gios = 12C(a,g)16O @ Ecm=2.68 BROAD TUNE
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 ;          ratio to std
A =  -0.142  ; Q1        1.00
B =   0.126  ; Q2        .96
E =   0.132  ; Q3        1.11
F =  -0.158  ; Q4        1.00
G =   0.0816 ; Q5        .94
H =  -0.0659 ; Q6        .94
I =   0.111  ; Q7        1.00
J =   0.0696 ; Q8        .85
K =  -0.0700 ; Q9        1.10
L =   0.0781 ; Q10       1.10
U =   0.033  ; SX1       .12
W =   0.0136 ; SX2       3.7
X =  -0.0021 ; SX3       -.60
Y =  -0.0056 ; SX4       -.35
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
(1) 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 ;
(2) 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 ;
(3) P  N  ; Charge Slit
DRIFT LENGTH .7109 ;
M  M  0.1941  0.0 =U 0.0 0.0795 ; SX1
DRIFT LENGTH 0.1581 ;
(4) 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 ;
(5) 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) ;
(6) P  N  ; ED1 entrance
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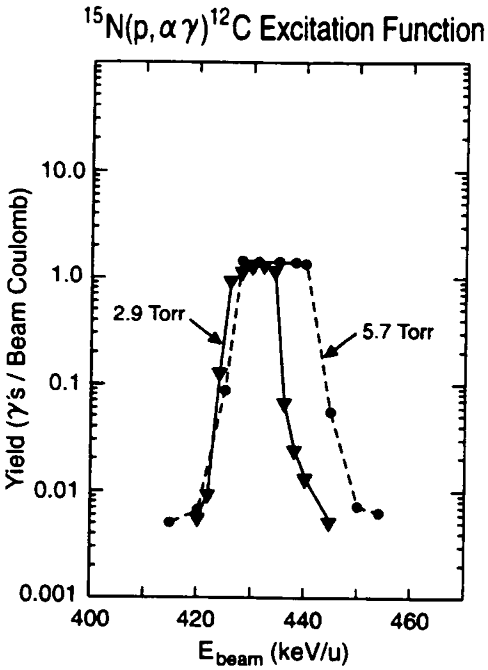

Figure 3. Narrow resonance yield-curve. The shape of the 4.4 MeV γ-ray yield curve is a characteristic of thick target.

overlap between leaky-beam and recoil-regi
eventually limit DRAGON's performance.
resonances has been quantified by computir
$N_l/(N_b \cdot e)$, where N_l is the number of leaky
beam particles, and e is the efficiency of
if the coincidence mode is used. The dat
gives a suppression factor of 10^{-9} with EMS
suppression factor improves to 10^{-13}, good e
proposed for DRAGON.

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Shotter, Frank Strieder, and Hermann Wollni
Andre Amaudruz, Peter Machule. Doug Pre
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3. C. Rolfs et al., Nucl. Phys. A 191 (1972)
4. N. Bateman et al., Phys. Rev. (2001) 03

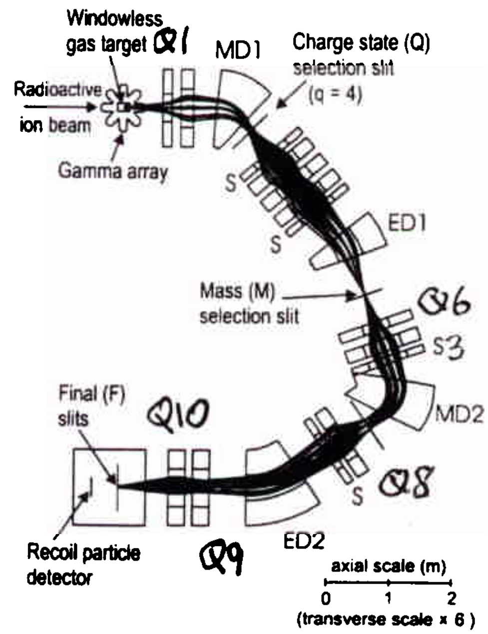

Figure 1. Dragon layout with simulation of typical ion trajectories.

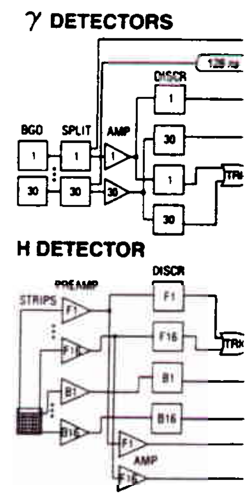

Figure 2. Block d
quisition electron

Initial measurements to study the operation of the gas
performed with a variable-energy ^{15}N beam. The emission
from a narrow resonance at 428 keV/u in the $^{15}N(p,\alpha\gamma)^{12}C$
function of beam energy. The resulting excitation function
different target gas pressures. As the beam energy increases
increases sharply at the energy of $\sim$ 425 keV/u, i.e. when th
the upstream aperture of the target. It then remains co
further, up to the energy when the resonance occurs nea
the target. Then the yield falls sharply to a background le
than the value it had when the resonance was contained
apertures. Such thick-target yield curves have the useful
yields can be determined from them, even without precis
energy and/or target gas pressure.

The first radioactive beam time available in the DRAGO
a reaction of astrophysical interest, namely the resonant rad
on hydrogen to form the E_{cm} = 212 keV in ^{22}Mg [3,4]. Figu
energy spectrum of counts in the end detector. The peak i
"leak" through the separator. Figure 4c shows the end-detec
ray coincidence requirement. The vertical scale of Fig. 4c
than Fig. 4a, showing the essential role that the gamma co
the recoils' signal from leaky beam background. Figures. 4b
showing that all the recoils are detected well inside the 5 cm w
events have been effectively separated from the recoils for t

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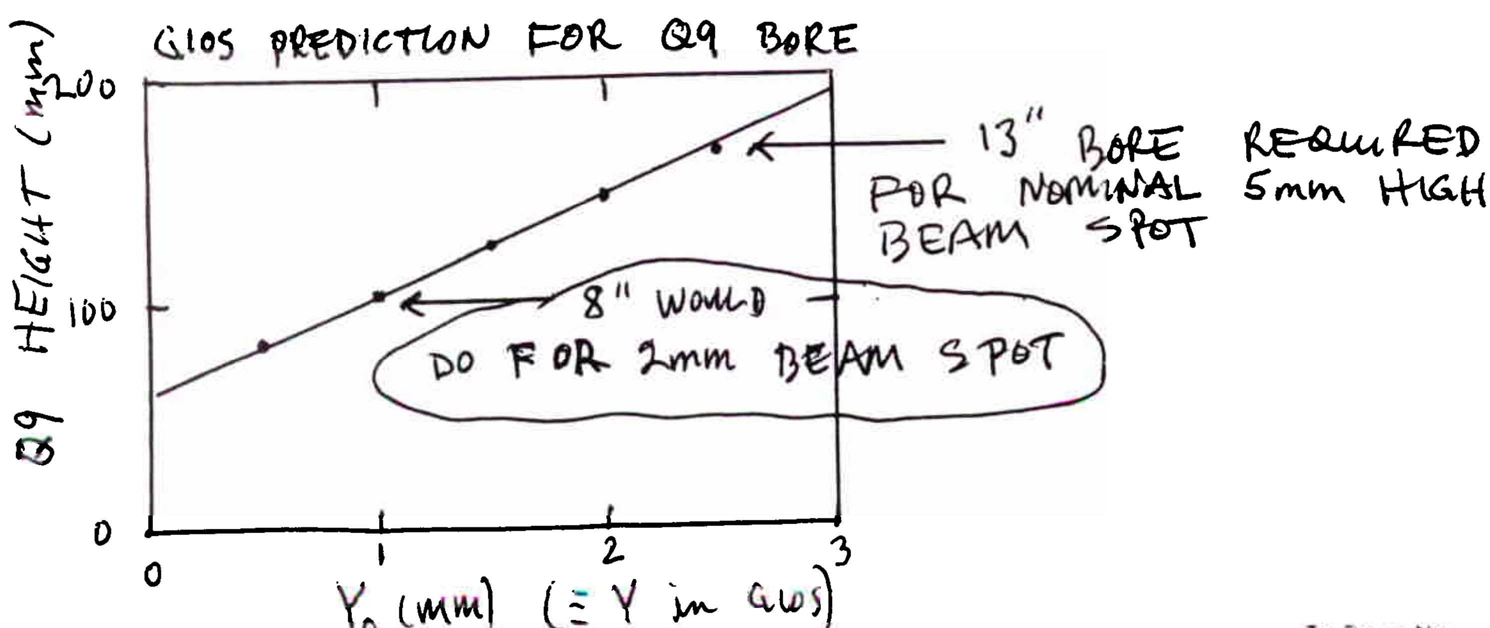
From Page No. __ Try searching Q1 Q2 in scale

0815 Upr v. gios SX V → (-.033 0136 -0021 -0056) Q9 ×46×+129
Q1 ×S(V) Q2×S(V) SX 7 (+033, 0131, -0021, -0058
Q1 Q2 → -.141, .125 NC Q9 = ×47+× 125
Try lone Q2 search (again) Q2 .125(NC) 46 ×128 worse NC

9 sep 03
Plot Y envelope vs Y∅. cp w1608... → x1608...

Q9 "Broad"		YY	YB	YYA	Y YD	½ Y BA		½ Y BD	Σ	Y(F)
Y∅ = 2.5 mm		12	34	54	43	14	←26→	12		169 ✓
Q9	2.0	10	34	43	35	14		12		148
Q9	1.5	7	34	33	26		26+34=60			126
FS		1	9	7	6	4		1		28
Q9	1.0	5		22	17		60			104
FS		.6		4	4		14			23
Q9	0.5	2.4		11	8.6					82
FS		.3		2.2	2					19



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