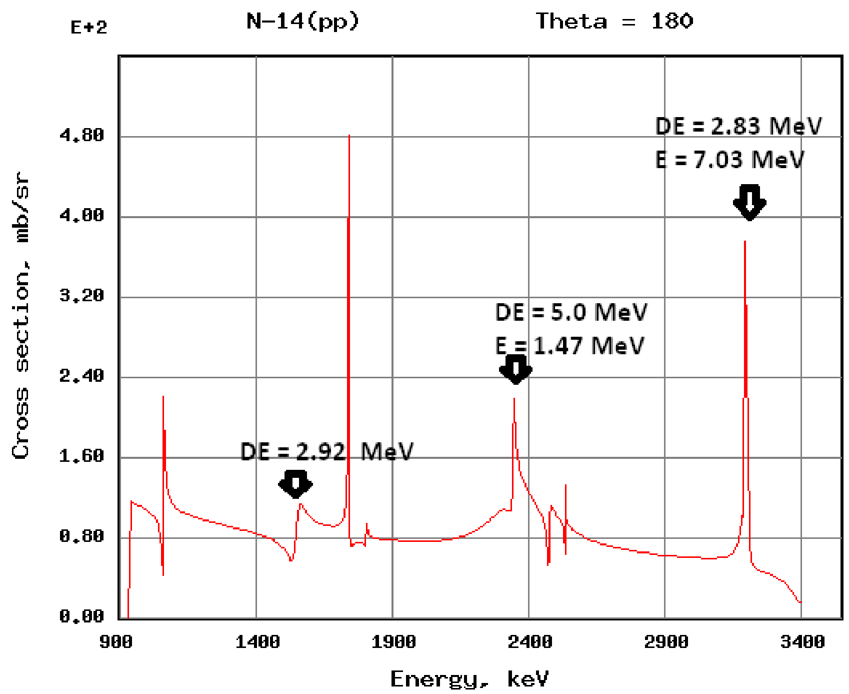
E744 - Beam Tuning – Check list

Version: Wednesday, May 23, 2018

Expected	Measured
SPIRAL1 beam, 14N4+ at E= 7.67 MeV/u B rho = 1.39852 Tm Intensity < 1 nAe (gas profilers)	
Qpole of LISE inverted? OK Optics? RMN probe set for low B rho OK Gas profilers set for low energies OK	
Alignment of the beam up to D6 Last profiler PR62Gas Brho 1 = Brho2 = 1.39852 Tm D3P1 = 247.1 A D3P = 320.1 A	
Insert stripper foil 80 µm carbon Measure charge state distribution E=107.19 MeV 14N7+ B rho1= 0.79826 Tm D3P1= 140.8 A 14N6+ Brho1= 0.93132 Tm D3P1= 164.3 A 14N5+ Brho1= 1.11761 Tm, D3P1= 197.3 A	
14N5+ Brho1=Brho2= 1.11761 Tm D3P=254.9 A	

Use pepper-pots to reduce beam intensity ~ 10^3 pps Insert SiD4 Measure ED4 versus TSID4HF Calibration E = 107.19 MeV position channels = ch Counting rate = pps Insert degrader Al 30 µm Calibration E = 90.41 MeV position channels = ch	
Insert CATS. Measure ED4 versus T_CATS_HF Efficiency CATS = %	
Insert MCP Measure ED4 versus T_MCP_HF Efficiency MCP = %	
CATS (1.2+0.9+0.9+1.2 um Mylar+ 2 cm isobutan 6 mbar). Energy after CATS = 7.5414 MeV/u Change B rho3 (7+) = 0.79231 Tm	
Insert E1D6 and then E2D6 Transmission D4-D6 = ……………..% (taking into account the charge state distribution) See E1D6_TE1D6HF, E1D6_TCATSHF, E2D6_TE2D6HF	
Without target, see the beam on Must2 at zero degree.	

Tantalum thickness = 34 µm After beam catcher E = 28.865 MeV Center the beam…	
Insert 187 µm CH2 target, position 6 In principle the beams stops in degrader, to check first. Do 14N(p,p) measurement for ~ 4 hours, With ~ 2x10^5 pps	



$^{15}_{8}O$

Δ: 2855.5 *5* S_n: 13222.3 *5* S_p: 7296.9 *5*

Q_{EC}: 2753.9 *5*

Populating Reactions and Decay Modes

- *A* ^{16}F p decay
- *B* $^{12}C(^3He,x)$
- *C* $^{12}C(\alpha,n)$
- *D* $^{12}C(^6Li,t)$
- *E* $^{12}C(^{12}C,^9Be)$
- *F* $^{13}C(^3He,n)$
- *G* $^{14}N(p,\gamma)$
- *H* $^{14}N(p,n)$
- *I* $^{14}N(p,p)$
- *J* $^{14}N(p,\alpha)$
- *K* $^{14}N(d,n)$
- *L* $^{14}N(^3He,d)$
- *M* $^{15}N(p,n)$
- *N* $^{15}N(^3He,t)$
- *O* $^{16}O(p,d)$
- *P* $^{16}O(^3He,\alpha)$
- *Q* $^{17}O(p,t)$

Levels and γ-ray branchings:

0, $1/2^-$, 122.24 *16* s, *[BCDEFGKLMNOPQ]*, %EC+%β^+=100, μ=0.7189 *8*, T=1/2

5183 *1*, $1/2^+$, 5.7 *7* fs, *[DFGKLNOP]*
γ_0 ***5182*** *1* (I_γ 100)

5240.9 *3*, $5/2^+$, 2.25 *21* ps, *[CDEFGKLMNOPQ]*, μ=+0.65 *7*
γ_0 ***5239.9*** *3* (I_γ 100) [M2+E3]: δ= –0.10 *4*

5399

6176.3 *17*, $3/2^-$, <1.74 fs, *[DFGKLMNOPQ]*
γ_0 ***6174.9*** *17* (I_γ 100) [M1+E2]: δ=+0.125 *7*

6793.1 *17*, $3/2^+$, <20 fs, *[DFGKLNP]*
γ_0 ***6791.4*** *17* (I_γ 100) [E1(+M2)]: δ=+0.02 *2*

6859.4 *9*, $5/2^+$, 11.1 *17* fs, *[CDFGKLNPQ]*
γ_{5241} ***1618.4*** *10* (I_γ 100)
[M1(+E2)]: δ=+0.04 *3*

7275.9 *6*, $7/2^+$, 0.49 *11* ps, *[CDEFKLMNOPQ]*
γ_{5241} ***2034.9*** *7* (I_γ 100.0 *12*)
γ_0 ***7274.0*** *6* (I_γ 4.0 *12*)

7556.5 *4*, $1/2^+$, Γ=0.99 *10* keV, *[FGKLMNOP]*, Γ_γ=0.042 eV, %IT=0.0042, %p=99.9958
γ_{6859} ***697.1*** *10* (I_γ<11)
γ_{6793} ***763.4*** *17* (I_γ 40.3 *11*)
γ_{6176} ***1380.1*** *17* (I_γ 100.0 *7*)
γ_{5183} ***2373*** *1* (I_γ 27.5 *11*)
γ_0 ***7554.5*** *4* (I_γ 6.1 *9*)

8180

8284.0 *5*, $3/2^+$, Γ=3.6 *7* keV, *[DFGKLP]*, Γ_γ=0.46 *6* eV, %IT=0.027, %p=99.973
γ_{6859} ***1424.5*** *10* (I_γ 2.3 *6*)
γ_{6176} ***2107.5*** *17* (I_γ 4.1 *12*)
γ_{5241} ***3042.8*** *6* (I_γ 79.3 *10*)
γ_{5183} ***3100.7*** *11* (I_γ 2.3 *2*)
γ_0 ***8281.5*** *5* (I_γ 100.0 *5*)

8743 *6*, $1/2^+$, Γ=32 keV, *[FGP]*, %IT=0.0015, %p=99.9985
γ_{6176} ***2566*** *6* (I_γ 56 *5*)
γ_{5183} ***3560*** *6* (I_γ 100 *5*)

8922 *2*, $5/2^+$, Γ=3.3 *3* keV, *[CDFGOP]*, %p=100
γ_{6859} ***2063*** *2* (I_γ 72 *8*)
γ_{6176} ***2746*** *3* (I_γ 62 *8*)
γ_{5183} ***3738*** *2* (I_γ 100 *8*)
γ_0 ***8919*** *2* (I_γ 23 *11*)

8922 *2*, $1/2^+$, Γ=7.5 keV, *[CFGOP]*, %p=100
γ_{6859} ***2063*** *2* (I_γ 20 *20*)
γ_{6176} ***2746*** *3* (I_γ 40 *20*)
γ_{5241} ***2738*** *2* (I_γ 40 *20*)
γ_0 ***8919*** *2* (I_γ 100 *50*)

8982.1 *17*, $(1/2)^-$, Γ=3.9 *4* keV, *[DFGP]*, %p=100
γ_{5183} ***3799*** *1* (I_γ 6.4 *11*)
γ_0 ***8979.2*** *17* (I_γ 100.0 *11*)

9484 *8*, $(3/2)^+$, Γ≈ 200 keV, *[GP]*, Γ_γ=9.1 *20* eV, %IT≈0.0046, %p=100
γ_0 ***9481*** *8* (I_γ 100)

9488 *3*, $5/2^-$, Γ=10.1 *5* keV, *[DFGP]*, Γ_γ=2.4 eV, %IT=0.024, %p=99.976
γ_{7276} ***2212*** *3* (I_γ 5.9)
γ_{6859} ***2628*** *3* (I_γ 4.0)
γ_{6176} ***3311*** *3* (I_γ 0.8)
γ_{5241} ***4246*** *3* (I_γ 7.6)
γ_0 ***9481*** *3* (I_γ 100)

9609 *2*, $3/2^-$, Γ=8.8 *5* keV, *[CDFGP]*, Γ_γ=5.0 eV, %IT=0.057, %p=99.943
γ_{6176} ***3433*** *2* (I_γ 2.5)
γ_{5241} ***4367*** *2* (I_γ 24)
γ_0 ***9606*** *2* (I_γ 100)

9662 *3*, $(7/2,9/2)^-$, Γ=2 *1* keV, *[CDFIP]*, %p=100

10290, $(5/2^-)$, Γ=3 *1* keV, *[DFIP]*, %p=100

11211 **10300**, $5/2^+$, Γ=11 *2* keV, *[DFIP]*, %p=100

10461 *5*, $(9/2^+)$, Γ<2 keV, *[CDEFGP]*, %IT=?, %p=?
γ_{7276} ***3185*** *5* (I_γ 61 *10*)
γ_{6859} ***3602*** *5* (I_γ<6.5)
γ_{5241} ***5219*** *5* (I_γ 100 *10*)

10480, $(3/2^-)$, Γ=25 *5* keV, *[CFGI]*, Γ_γ=0.35 *7* eV, %IT=0.0014 *4*, %p=100
γ_{6793} ***3686*** (I_γ<7)
γ_{6176} ***4303*** (I_γ<7)
γ_{5241} ***5238*** (I_γ 67 *10*)
γ_0 ***10476*** (I_γ 100 *10*)

10506 (?), $(3/2)^+$, Γ=140 *40* keV, *[GI]*, %IT=?, %p=100

10917 *12*, $7/2^+$, Γ=90 keV, *[IP]*, %p=100

10938 *3*, $1/2^+$, Γ=99 *5* keV, *[GIP]*, Γ_γ=32 *5* eV, %IT=0.032 *6*, %p=100
γ_{6793} ***4144*** *3* (I_γ<18)
γ_{6176} ***4761*** *3* (I_γ 50 *18*)
γ_{5183} ***5754*** *3* (I_γ 77 *7*)
γ_0 ***10934*** *3* (I_γ 100 *18*)

11025 *3*, $1/2^-$, Γ=25 *2* keV, *[GIP]*, Γ_γ=1.4 *4* eV, %IT=0.0056 *16*, %p=100
γ_0 ***11021*** *3* (I_γ 100)

11151 *7*, Γ<10 keV, *[DIP]*, %p=100

Figure 1 en red, energies in lab.

$^{15}_{8}$O (continued)

11218 *3*, $3/2^+$, Γ=40 *4* keV, *[GIP]*, Γ_γ=7.4 *6* eV, %IT=0.0185 *24*, %p=99.9815 *24*
γ_{6793} ***4424*** *3* ($\dagger_\gamma$<6)
γ_{5241} ***5975*** *3* ($\dagger_\gamma$16 *7*)
γ_{5183} ***6034*** *3* ($\dagger_\gamma$19 *7*)
γ_0 ***11213*** *3* ($\dagger_\gamma$100 *7*)

11565 *15*, Γ<10 keV, *[DIP]*, %p=100

11569 *15*, $5/2^-$, Γ=20 *15* keV, *[DGI]*, Γ_γ=1.9 *3* eV, %IT=0.010 *7*, %p=99.990 *7*
γ_{6793} ***4775*** *15* ($\dagger_\gamma$<5)
γ_{6176} ***5392*** *15* ($\dagger_\gamma$32 *15*)
γ_{5241} ***6326*** *15* ($\dagger_\gamma$100 *15*)
γ_0 ***11564*** *15* ($\dagger_\gamma$29 *15*)

11616 *15*, $(3/2,1/2)^-$, Γ=80 *50* keV, *[GI]*, %IT=?, %p=100

11719 *8*, Γ<10 keV, *[CDIP]*, %p=100

11748 *3*, $5/2^+$, Γ=99 *5* keV, *[GI]*, Γ_γ=10 *2* eV, %IT=0.010 *2*, %p=99.990 *2*
γ_{6176} ***5571*** *3* ($\dagger_\gamma$100 *13*)
γ_{5241} ***6505*** *3* ($\dagger_\gamma$89 *13*)

11846 *3*, $5/2^-$, Γ=65 *3* keV, *[GI]*, Γ_γ=1.4 *6* eV, %IT=0.0022 *9*, %p=99.9978 *9*
γ_{5241} ***6603*** *3* ($\dagger_\gamma$100)

11980 *10*, $5/2^-$, Γ=20 *5* keV, *[DIP]*, %p=100

12129 *15*, $5/2^+$, Γ=200 *50* keV, *[I]*, %p=100

12222 *20*, Γ=100 *50* keV, *[I]*, %p=100

12255 *13*, $5/2^+$, Γ=135 *15* keV, *[Q]*, %p=100, T=3/2

12295 *10*, *[D]*

12471 *3*, $5/2^-$,$(3/2^-)$, Γ=77 *4* keV, *[I]*, %p=100

12600 *10*, *[D]*

12800, $\Gamma\approx$ 250 keV, *[G]*, %IT=?, %p=100

12835 *3*, Γ=16 *1* keV, *[CDEI]*, %p=100

13008 *3*, Γ=215 *3* keV, *[I]*, %p=100

13025 *3*, Γ=40 *30* keV, *[BI]*, %p=?

13450, $(1/2,3/2)^+$, $\Gamma\approx$ 1000 keV, *[GIJ]*, %IT=?, %p=?, %α=?

13490 (?), $(3/2^+)$, *[I]*, %p=?

13600, $5/2^+$, *[J]*, %p=?, %α=?

13700, $3/2^-$, *[I]*, %p=100

13790, $3/2^-$, *[BIJ]*, %n=?, %p=?, %α=?

13870, $\Gamma\approx$ 150 keV, *[G]*, %IT=?, %p=100

14030 *40*, $(1/2^-,3/2^-)$, Γ=160 *20* keV, *[B]*, %n=?, %p=?

14170, $5/2^-$, *[J]*, %p=?, %α=?

14270 *10*, $1/2^+$, Γ=340 *30* keV, *[BCDHIJ]*, %n=?, %p=?, %α=?

14340, $5/2^+$, Γ=240 keV, *[BJ]*, %p=?, %α=?

14465 *10*, $3/2^+$,$5/2^+$, Γ=100 *10* keV, *[BHIJ]*, %n=?, %p=?, %α=?

14700 *40*, Γ=170 *35* keV, *[BH]*, %n=?, %p=?

14950 *40*, Γ=400 *25* keV, *[BHIJ]*, %n=?, %p=?, %α=?

15050 *10*, $(13/2^+)$, *[CDE]*

15100, $(1/2,3/2)^+$, $\Gamma\approx$ 1000 keV, *[G]*, %p=100

15450 *30*, Γ=70 *20* keV, *[B]*, %p=?, %α=?

15540 *10*, *[BD]*, %p=?, %α=?

15600 *10*, *[BD]*, %p=?, %α=?

15650 *10*, *[CD]*

15800 *10*, *[BD]*, %n=?

15900 *15*, $1/2^-$,$3/2^-$, Γ=350 keV, *[B]*, %α=?

16050 *20*, $\Gamma\approx$ 185 keV, *[BHIJ]*, %n=?, %p=?, %α=?

16100 *20*, *[B]*, %n=?, %α=?

16210 *20*, $\Gamma\approx$ 140 keV, *[BIJ]*, %n=?, %p=?, %α=?

16430 *75*, $1/2^+$, Γ=560 *100* keV, *[BH]*, %n=?, %α=?

16750 *50*, *[BP]*, %n=?

17050 *60*, $(1/2,3/2)^+$, Γ=700 *70* keV, *[BGIJ]*, %IT=?, %p=?, T=1/2

17460 *20*, *[D]*

17510 *20*, $1/2^-$,$3/2^-$, Γ=640 *120* keV, *[BD]*, %IT=?, %n=?, %α=?

17990 *50*, $1/2^-$,$3/2^-$, Γ=200 keV, *[B]*

18230 *50*, *[B]*, %n=?, %p=?

18670 *60*, $(1/2,3/2)^+$, Γ=520 *110* keV, *[BG]*, %IT=?, T=1/2

19030 *50*, Γ=1120 *300* keV, *[BO]*, %IT=?, %n=?

19570 *80*, $(1/2,3/2)^+$, Γ=780 *270* keV, *[B]*, %IT=?, T=1/2

19910 *50*, *[B]*, %n=?

20420 *70*, $(3/2,1/2)^+$, Γ=970 *240* keV, *[BG]*, %IT=?, %p=?, T=1/2

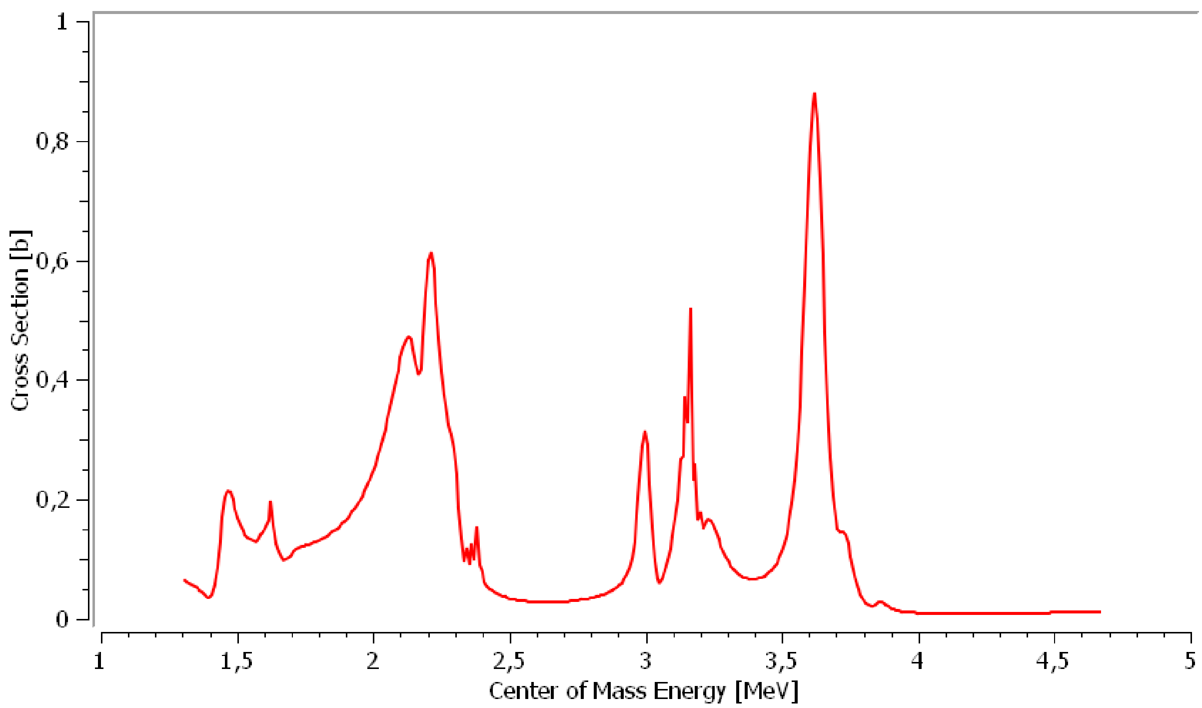
21560 *70*, $(3/2,1/2)^+$, Γ=730 *120* keV, *[BGO]*, %IT=?, %p=?, T=1/2

23800 *100*, Γ<500 keV, *[B]*, %IT=?

26000 (?), $(13/2^-)$, $\Gamma\approx$ 600 keV, *[B]*

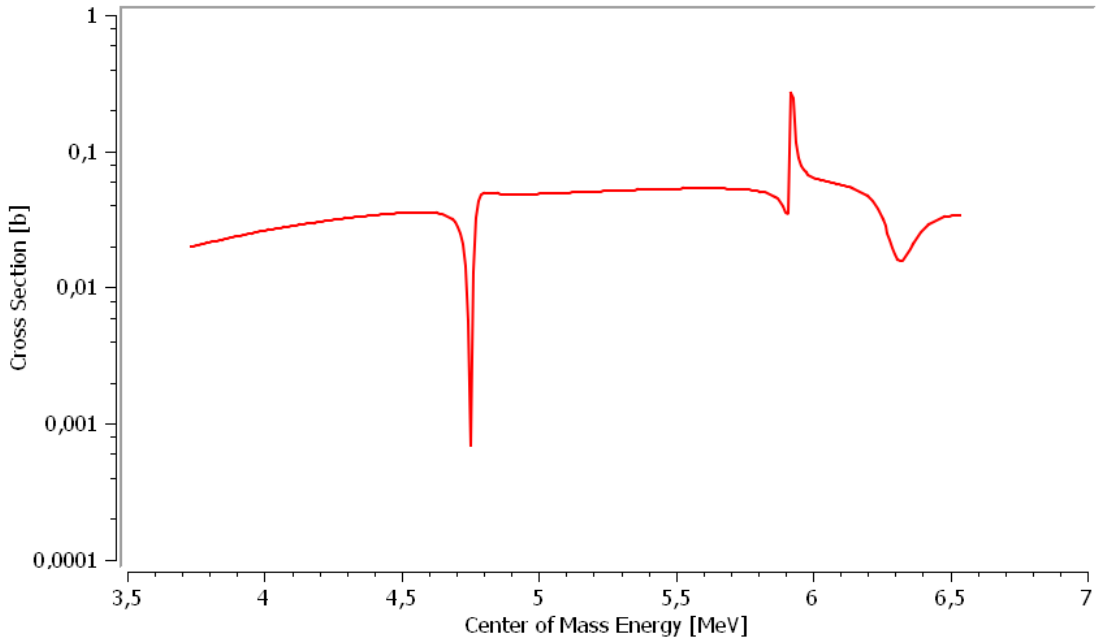
28000 (?), $(9/2^-,11/2^-)$, $\Gamma\approx$ 2500 keV, *[B]*

29000 (?), $\Gamma\approx$ 2500 keV, *[B]*

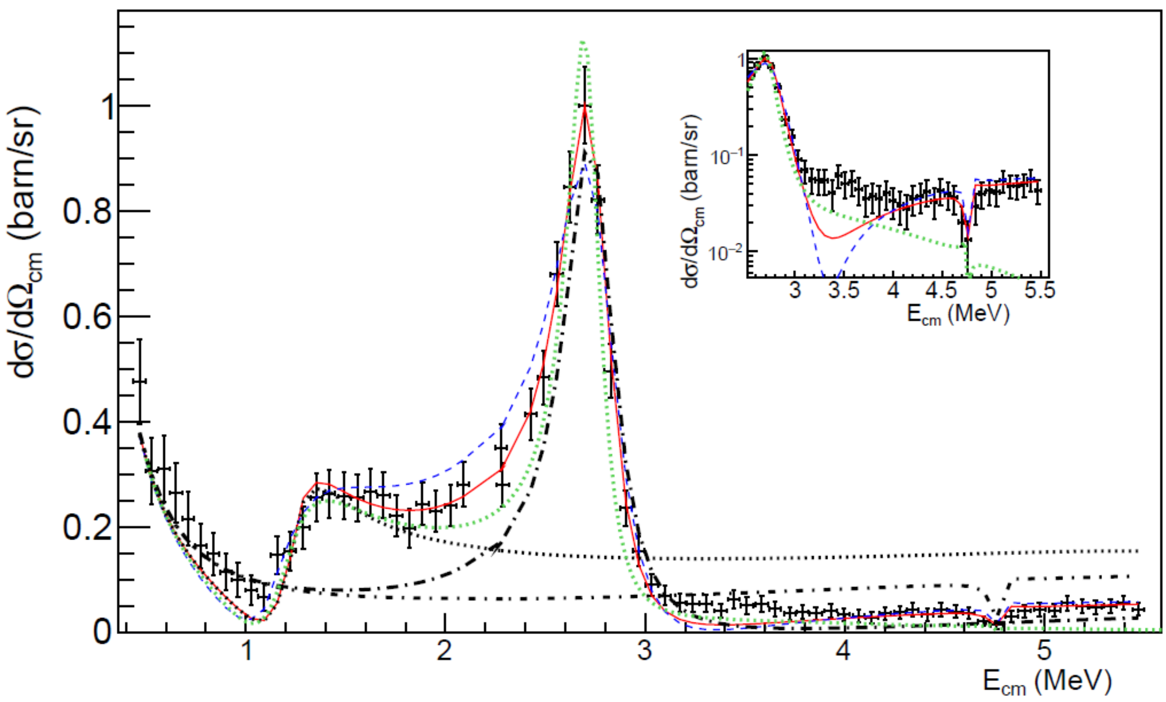


Use 14O4+ cocktail beam. at E= 7.67 MeV/u B rho = 1.39907 Tm Intensity ~ 10^5 pps Insert carbon stripper, 80 µg/cm2 After stripper, 14O8+ E=7.652 MeV/u Brho 1 = 0.6986 Tm = Brho 2 D3P = 123.1 A D3P2 = 157.7 A	
Check purity with E1D4 Calibration E = 107.18 MeV position channels = ch Counting rate = pps Insert degrader Al 30 µm Calibration E = 85.17 MeV position channels = ch	
Insert CATS. Measure ED4 versus T_CATS_HF Efficiency CATS = %	
Insert MCP Measure ED4 versus T_MCP_HF Efficiency MCP = %	
CATS (1.2+0.9+0.9+1.2 um Mylar+ 2 cm isobutan 6 mbar). Energy after CATS = 7.504 MeV/u Change B rho3 (8+) = 0.69179Tm	
Insert E1D6 and then E2D6	

Transmission D4-D6 = ……………..% (taking into account the charge state distribution)	
Insert 104 µm CH2 target, position 4 In principle the beams stops in degrader, to check first. Do 14O(p,p) measurement for ~ 6 UT, With ~ 2x10^5 pps Use gamma detectors to measure the beam current, 99% go to 2312 keV in the beta decay of 14O	



Insert carbon target, position 1 In principle the beams stops in degrader, to check first. Do 14O(p,p) measurement for ~ 4 UT	
Insert 63 µm CH2 target, position 3 In principle the beams stops in degrader, to check first. Do 14O(p,p) measurement for ~ 4 UT	
Insert 187 µm CH2 target, position 6 In principle the beams stops in degrader, to check first. Do 14O(p,p) measurement for ~ 2 UT	


dσ/dΩ$_{cm}$ (barn/sr)
0
0.2
0.4
0.6
0.8
1
1
2
3
4
5
E$_{cm}$ (MeV)
dσ/dΩ$_{cm}$ (barn/sr)
1
10^{-1}
10^{-2}
3
3.5
4
4.5
5
5.5
E$_{cm}$ (MeV)