$^{14}N(\alpha,\gamma)^{18}F$ with St. George

Team Alpha Gamma

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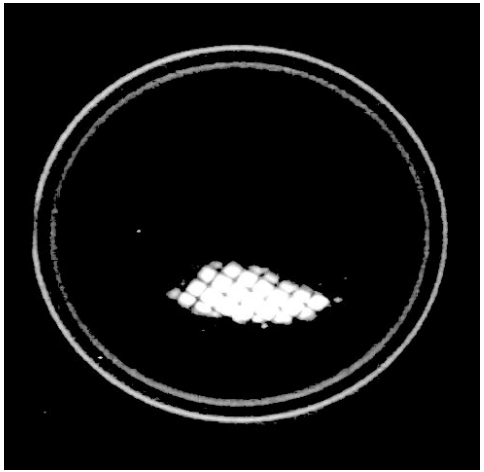
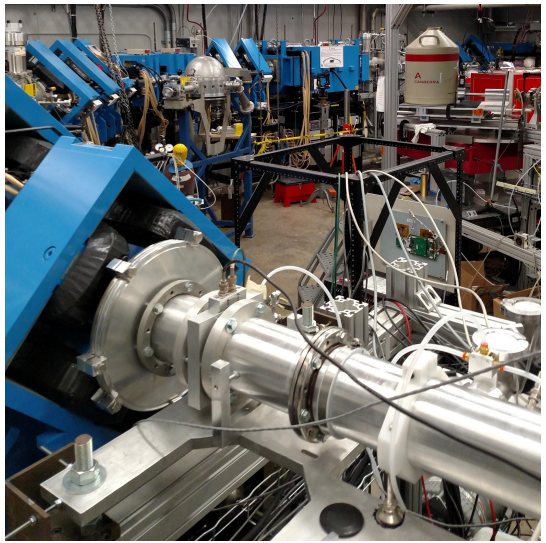


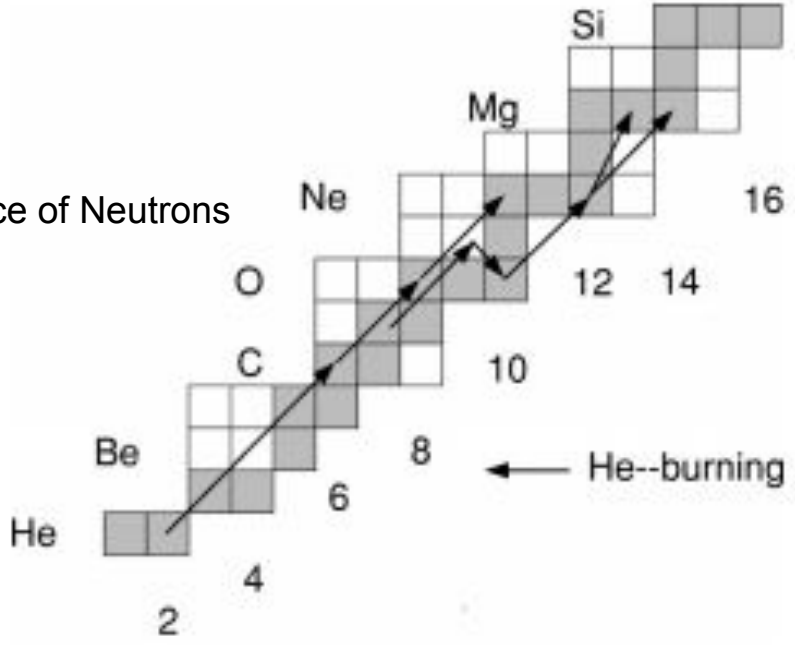


Motivation

- Hydrogen burning dominated by CNO cycle In massive stars. (H-> He)
- ^{12}C and ^{16}O abundances converted to ^{14}N.

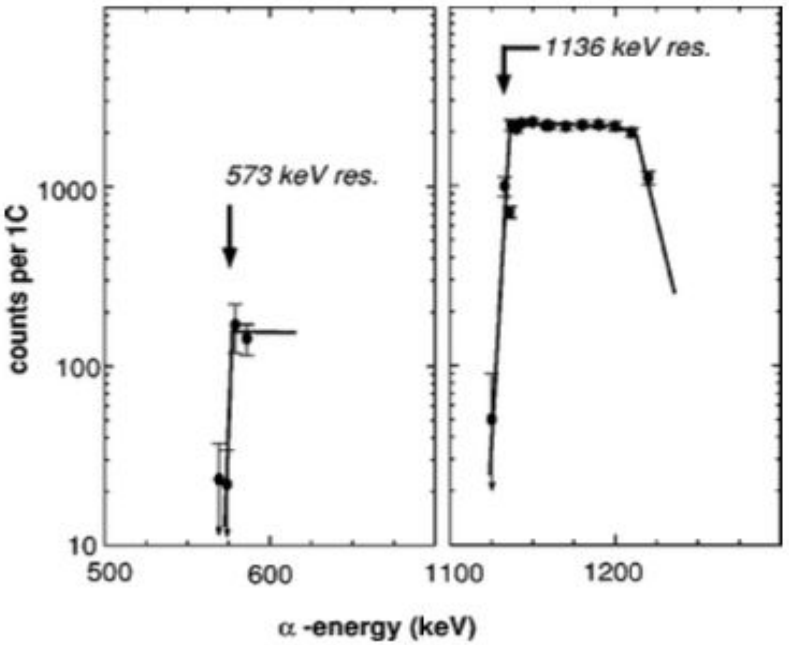
$$^{14}N(a,g)^{18}F(b,n)^{18}O(a,g)^{22}Ne$$

- ^{22}Ne produced during He burning a source of Neutrons for the s-process via $^{22}Ne(a,n)^{25}Mg$



Low Energy Resonances in $^{14}N(a,g)$

LOW-ENERGY RESONANCES IN $^{14}N(\alpha,\gamma)^{18}F$

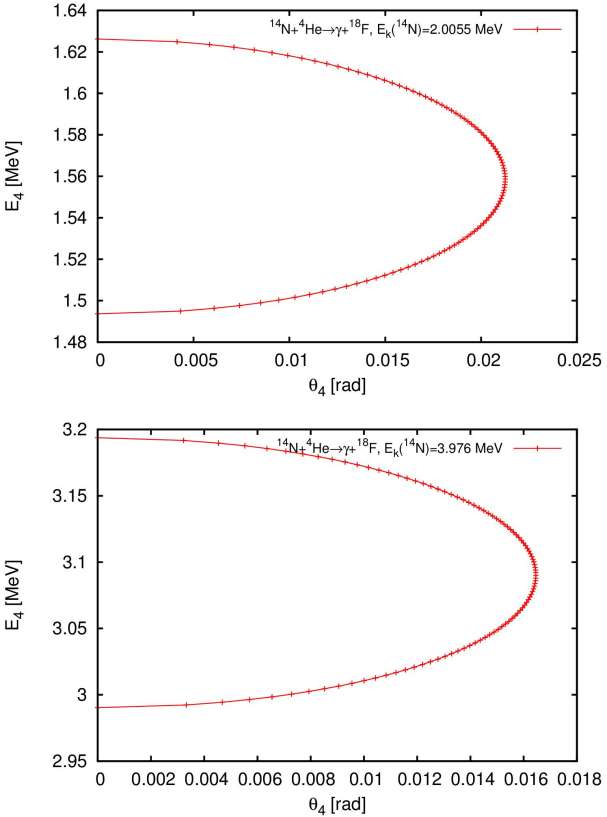


- Resonances at alpha energies of 573 keV and 1.136 keV
- E_cm = m_target/(m_beam+m_target)*E_lab
- Center of Mass energies 445.7 keV and 883.6 keV
- ^{14}N beam energies 2005.5 keV and 3976.0 keV

[Gorres *et al.* 2000] PHYSICAL REVIEW C **62** 055801

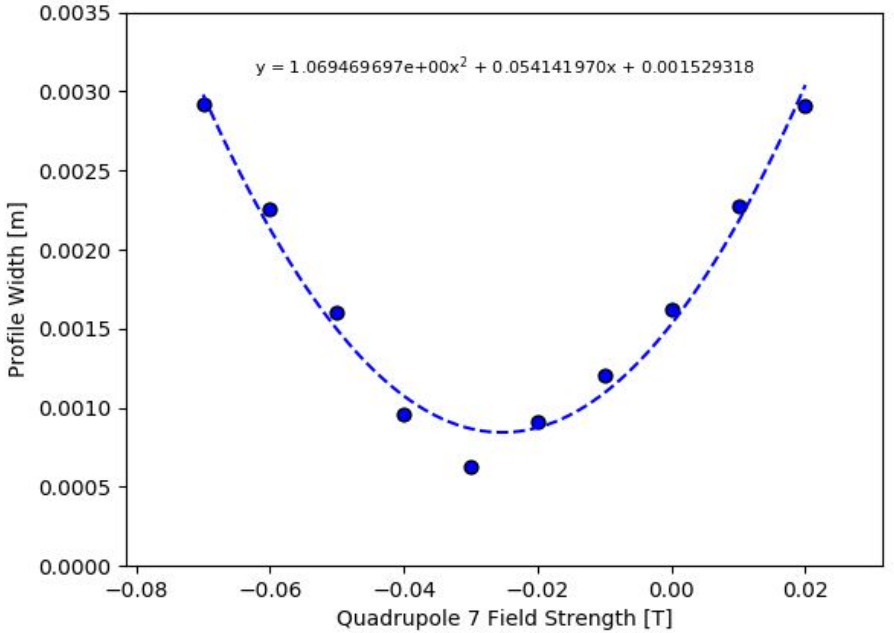
Kinematic Curves in Inverse Kinematics

- For the 445.7 keV resonance, the angular spread is ±21.2 mrad and the energy spread is ±4.3% (top)
- For the 883.6 keV resonance, the angular spread is ±16.5 mrad and the energy spread is ±3.4% (bottom)
- Both are well within the acceptance of St. George (±40 mrad, ±7.4% energy)



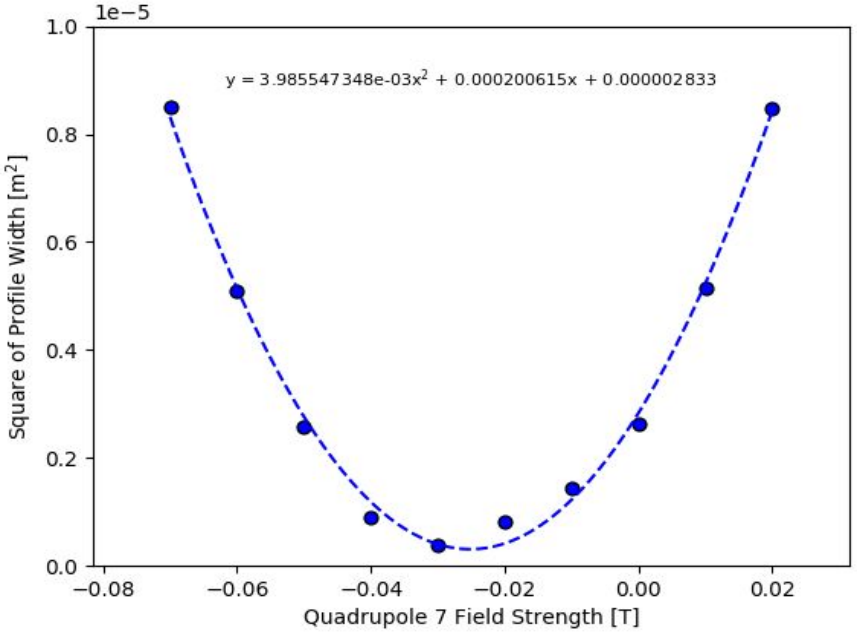
Emittance Measurement

- Describes beam size in phase space (position and momentum)
- Vary Q7 strength and record profile widths
- Unsatisfactory quadratic fit



Emittance Measurement

- Square profile width
- Now satisfactory fit
- Emittance = 2.87e-06
- To do
  - Units? mm*mrad?
  - Equations?



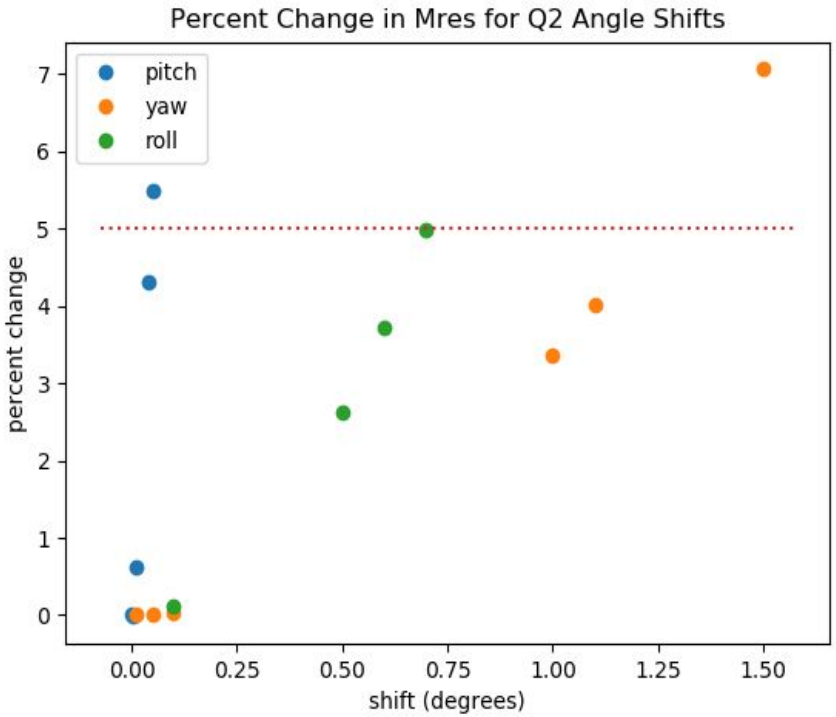
Changing Ion Optics and Mass Resolution

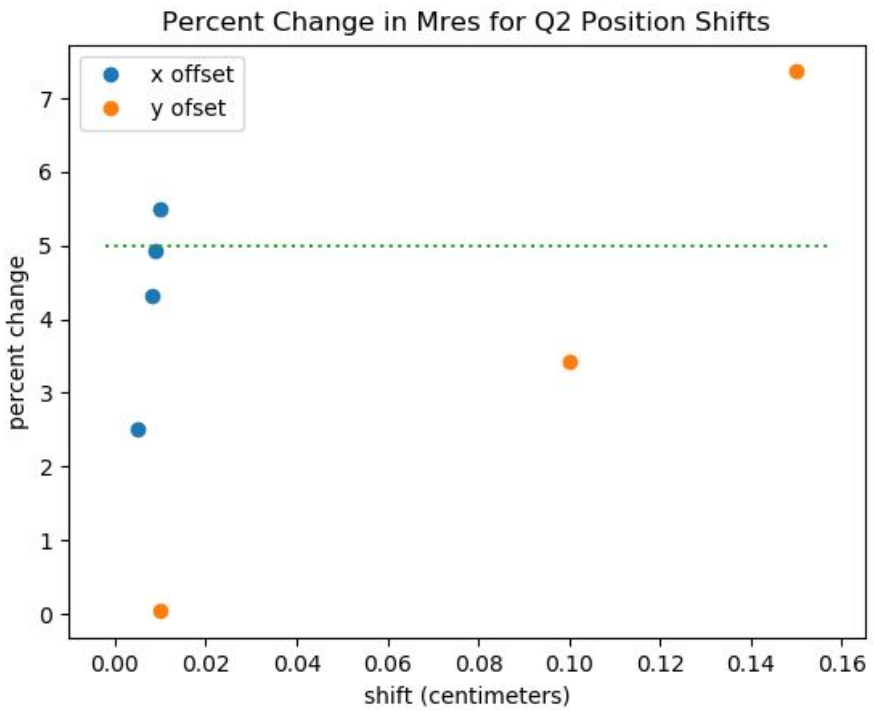
- St. George Mass Resolution
  - x = 60.1, y = 59.3
- Increase effective field length of Q2 by 3%
- St. George Mass Resolution
  - x = 19.5, and y = 19.4 (overall decrease)
- Increased field integral, so try to find optimal value of Q2 to recover mass resolution
  - Increase mass resolution, so minimize 1/(mass resolution)
- Recover mass resolution if Q2 field strength is decreased by 2.74%

```
FIT Q2 ;
UM ; CR ;
RECOIL_LINE;
OBJ := 1/ABS(MRES);
WRITE 6 'Fit Q2: ' Q2 'OBJECTIVE: ' OBJ '1/OBJ: ' 1/OBJ;
ENDFIT 1E-5 1000 1 OBJ ;
```

- No spaces around mathematical operators (at least for minus signs)
- To do
  - Investigate further why a 2.74% decrease instead of 3% decrease

Quadrupole Angle and Position Effect on Mass Resolution





Pitch and x-direction shift have largest effect.

In COSY: TA <pitch> <yaw>, RA <roll>, SA <x> <y>

Effect of Beam Size and Position on Mass Resolution

- In COSY, change beam position by calling SA <x> <y>; (before defining any quads)
- Changing <x> by ±0.5 mm drops mass resolution from ~60 to ~55
- Changing <y> by ±1.2 mm drops mass resolution from ~60 to ~55

- Change beam size with by changing <PX> and <PY>:

  SB **<PX>** <PA> <r12> **<PY>** <PB> <r34> <PT> <PD> <r56> <PG> <PZ>;

- Default is <PX> = <PY> = 1.5 mm
- Increasing beam size (both x and y) by 0.2 mm drops mass resolution from ~60 to ~55
- Decreasing beam size only increases mass resolution. Tighter focus means better mass resolution!