

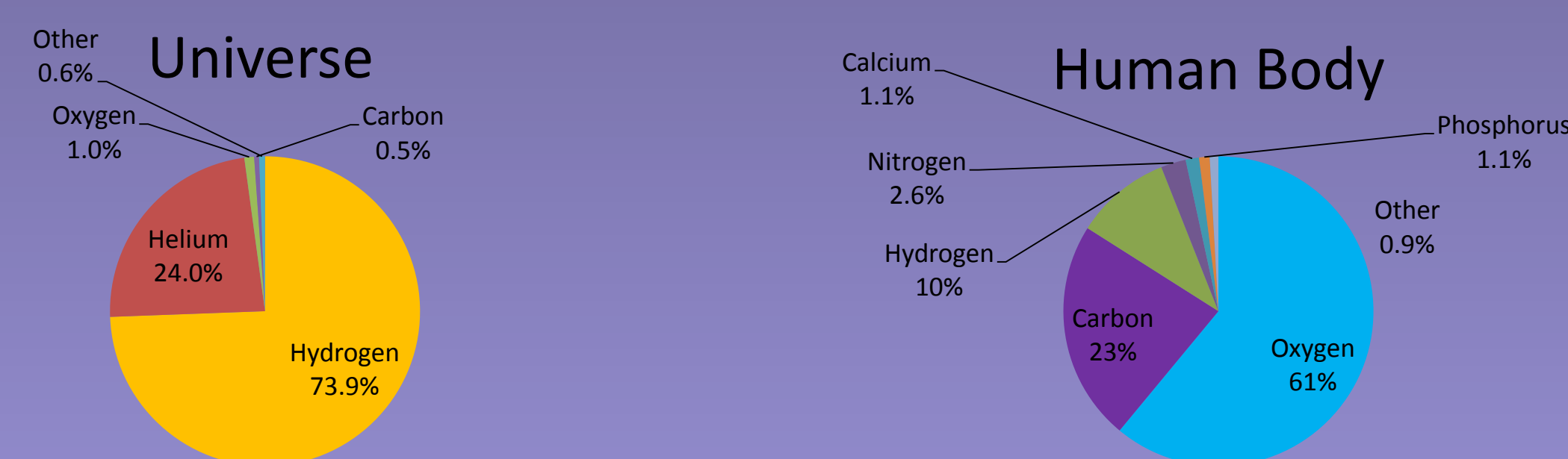
Measurement of $^{16}\text{O}(\gamma, \alpha)^{12}\text{C}$ with Bubble Chamber and Bremsstrahlung Beam at Jefferson Lab Injector

Jefferson Laboratory, Argonne National Laboratory, Fermi National Laboratory, University of Illinois

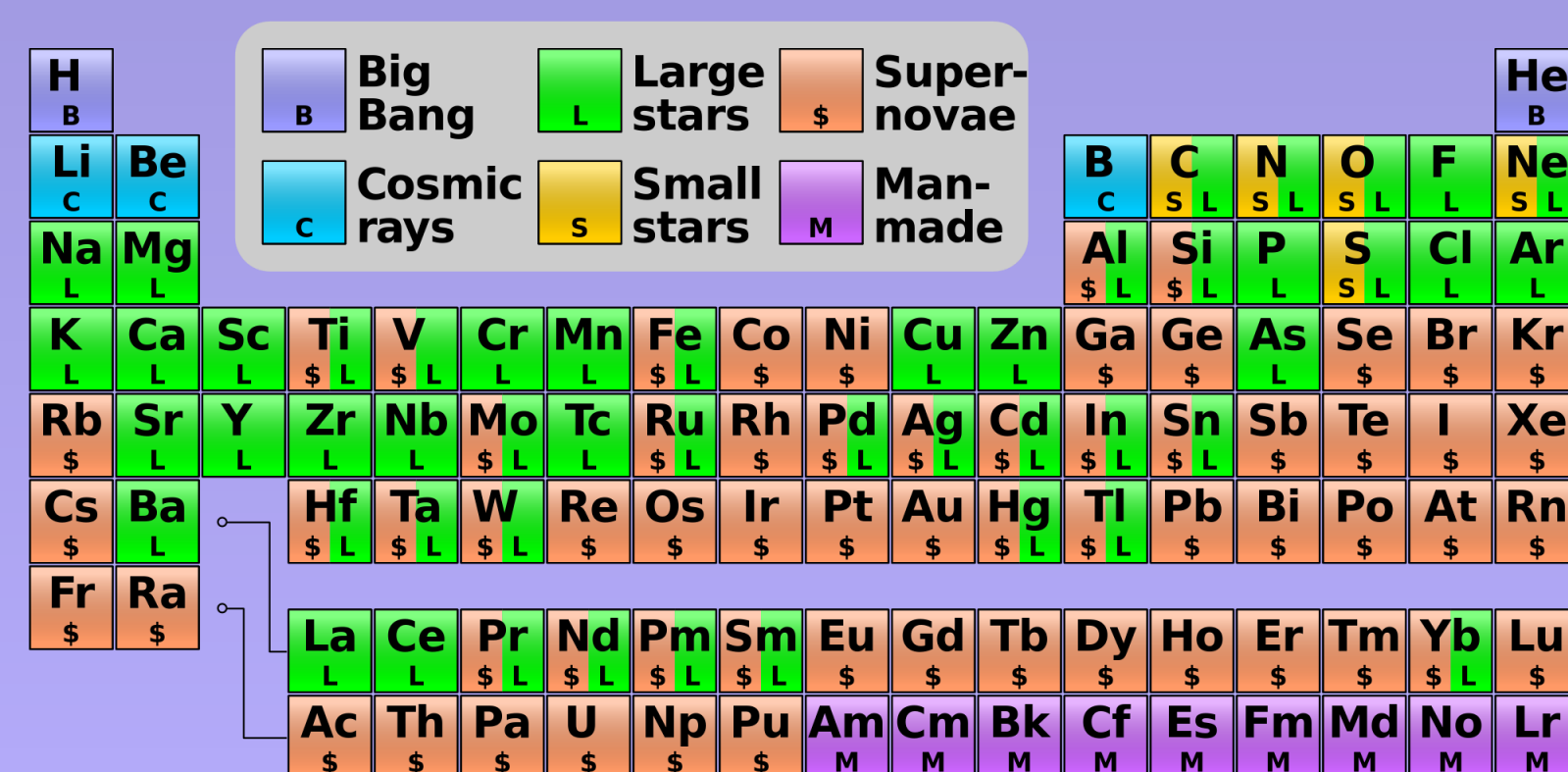


Motivation

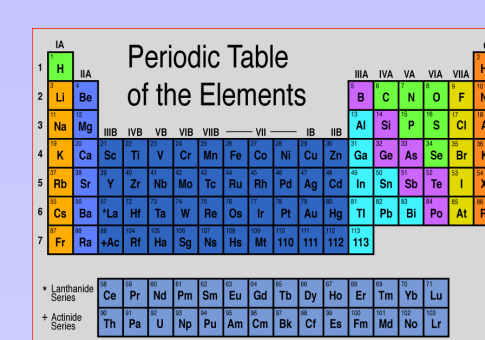
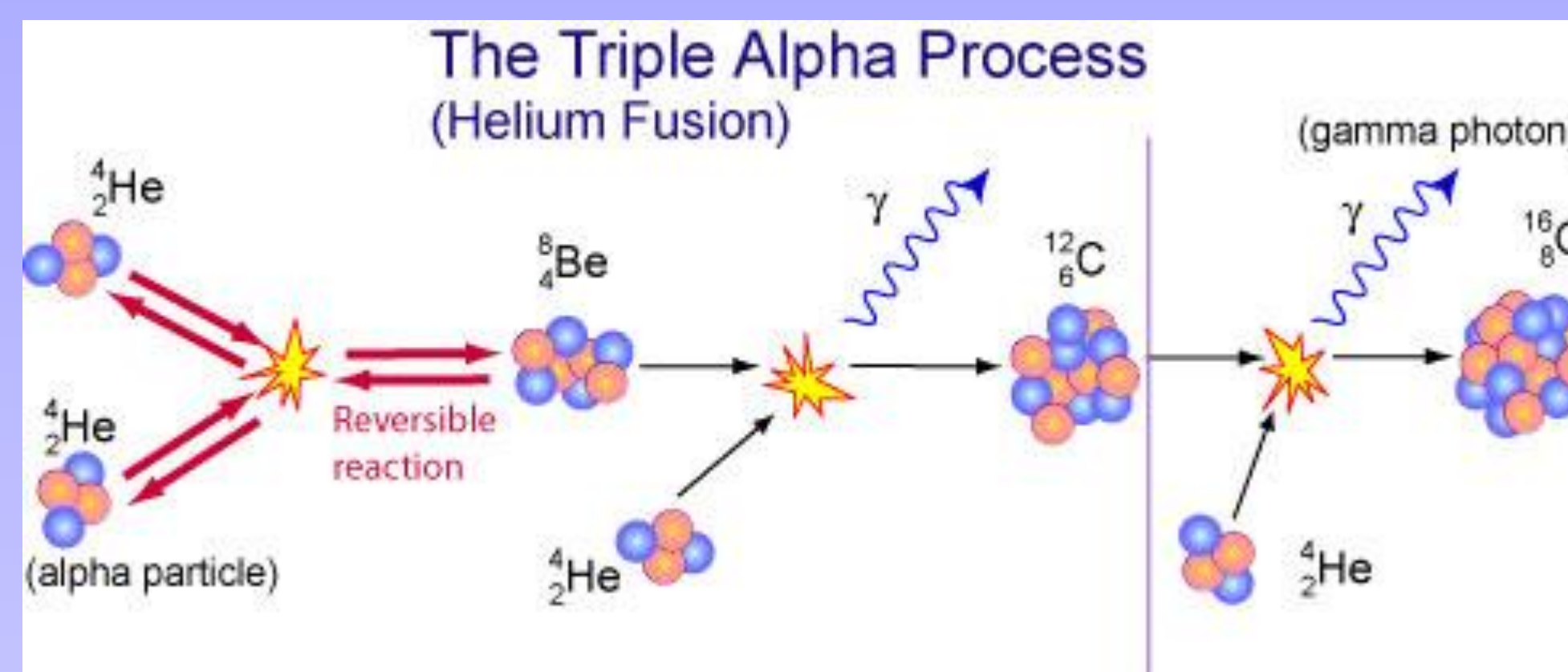
Relative Abundance of Elements by Weight



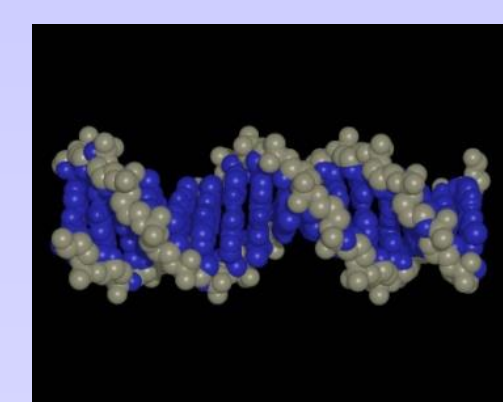
- **Big Bang Nucleosynthesis:** quark-gluon plasma \rightarrow p, n, He
- **Stellar Nucleosynthesis:** H burning, He burning, NCO cycle
- **Supernovae Nucleosynthesis:** Si burning
- **Cosmic Ray Spallation**



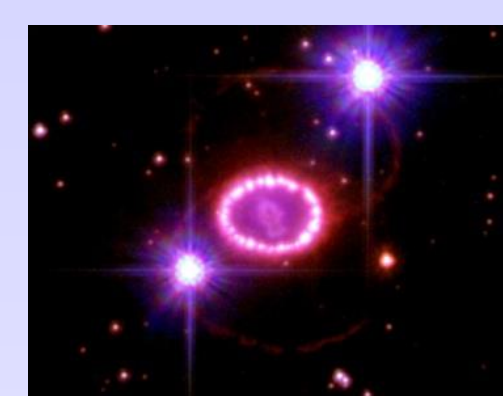
Stellar Helium Burning



Affects the synthesis of most of the elements of the periodic table

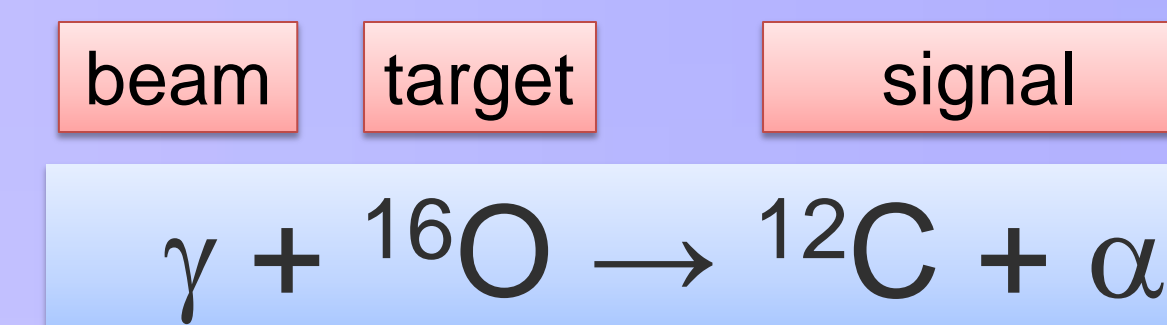
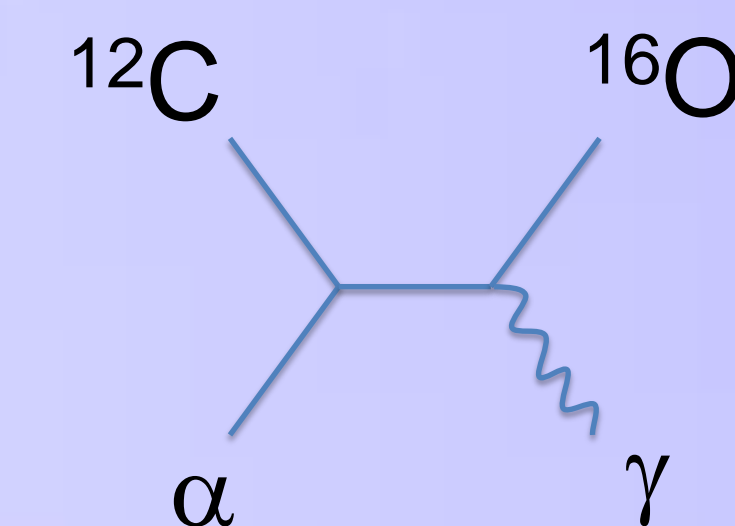


Sets the $N(^{12}\text{C})/N(^{16}\text{O})$ (≈ 0.4) ratio in the universe



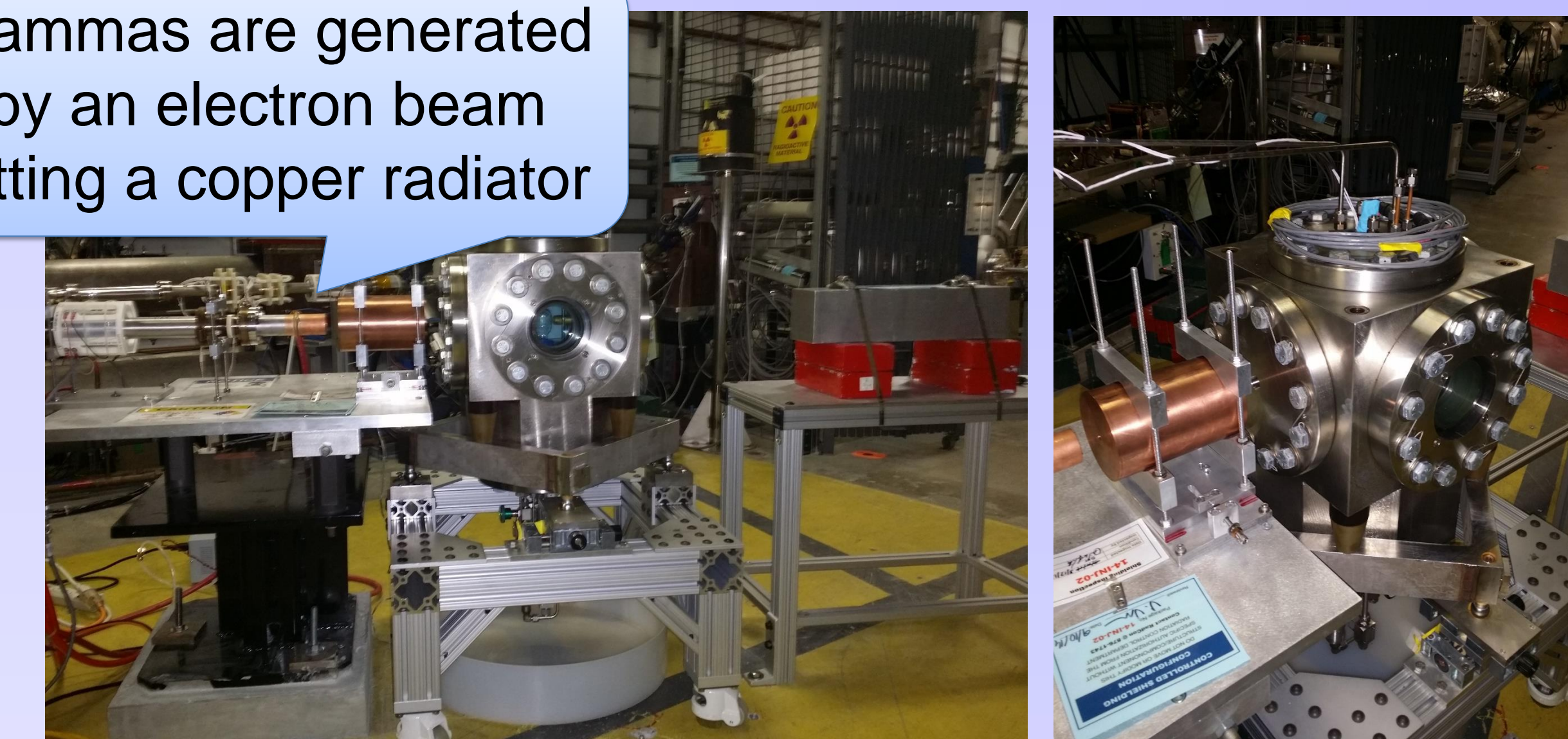
Determines the minimum mass a star requires to become a supernova

Time Reversal Reaction



- Extra gain (factor of 100) by measuring time reversal reaction
- Target density up to 10^4 higher than conventional targets. Number of ^{16}O nuclei = $3.5 \times 10^{22}/\text{cm}^2$ (3.0 cm cell)
- Solid Angle and Detector Efficiency = 100%
- Electromagnetic debris (electrons and gammas, or positrons) do NOT trigger nucleation (detector is insensitive to γ -rays by at least 1 part in 10^{11}).

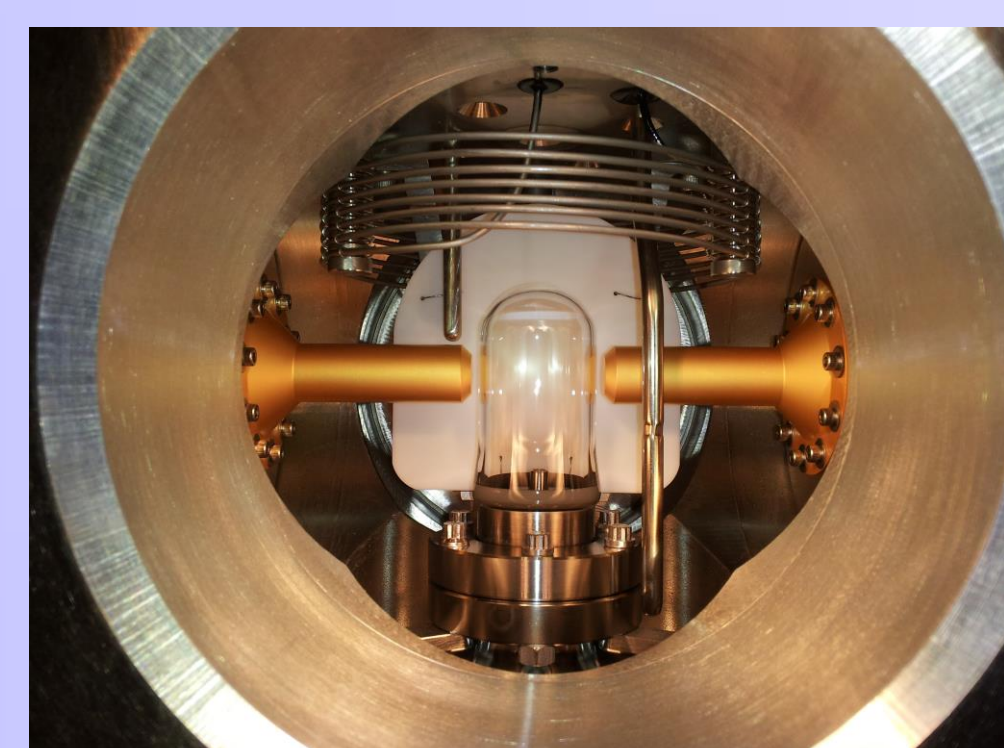
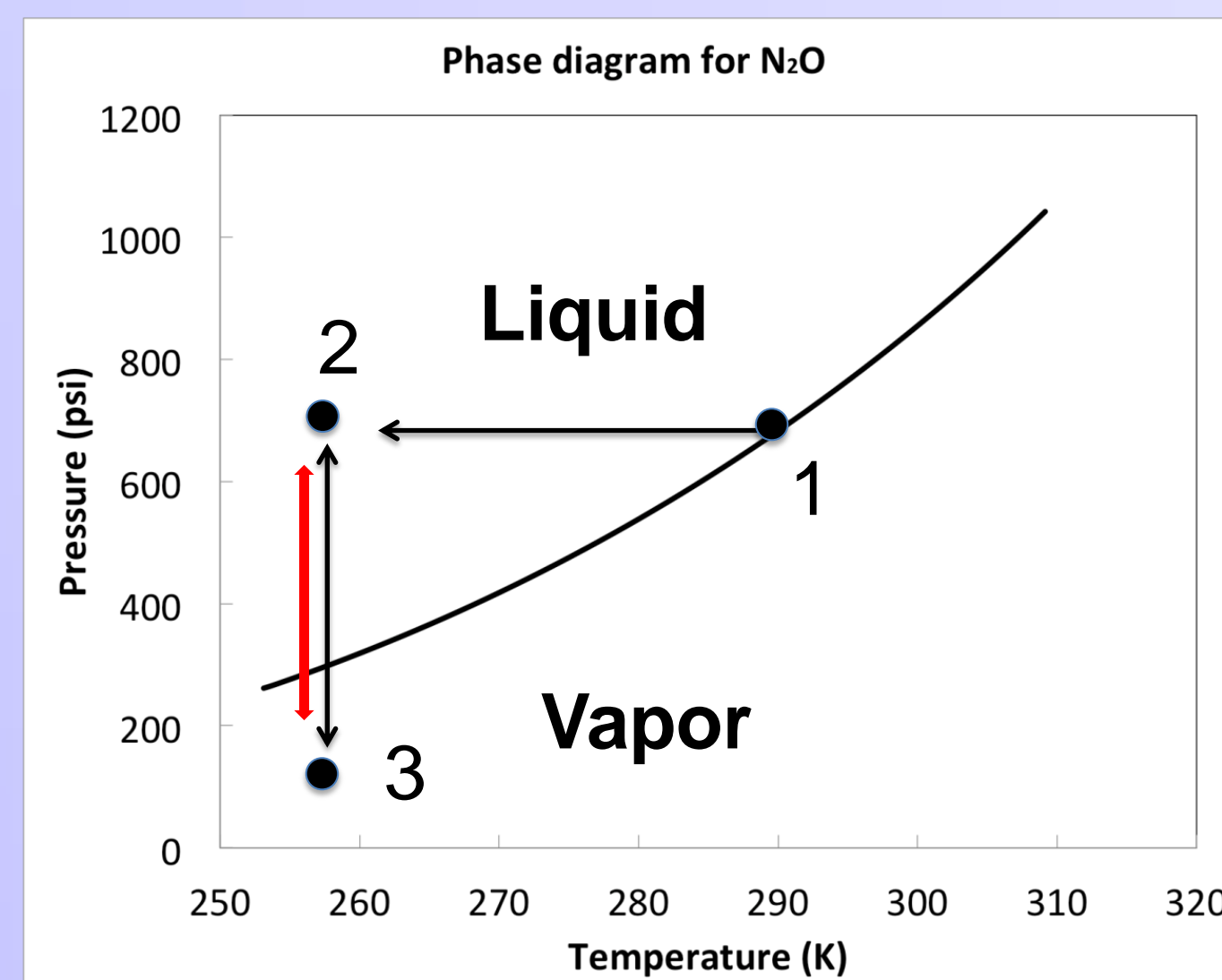
Gammas are generated by an electron beam hitting a copper radiator



Bubble Chamber

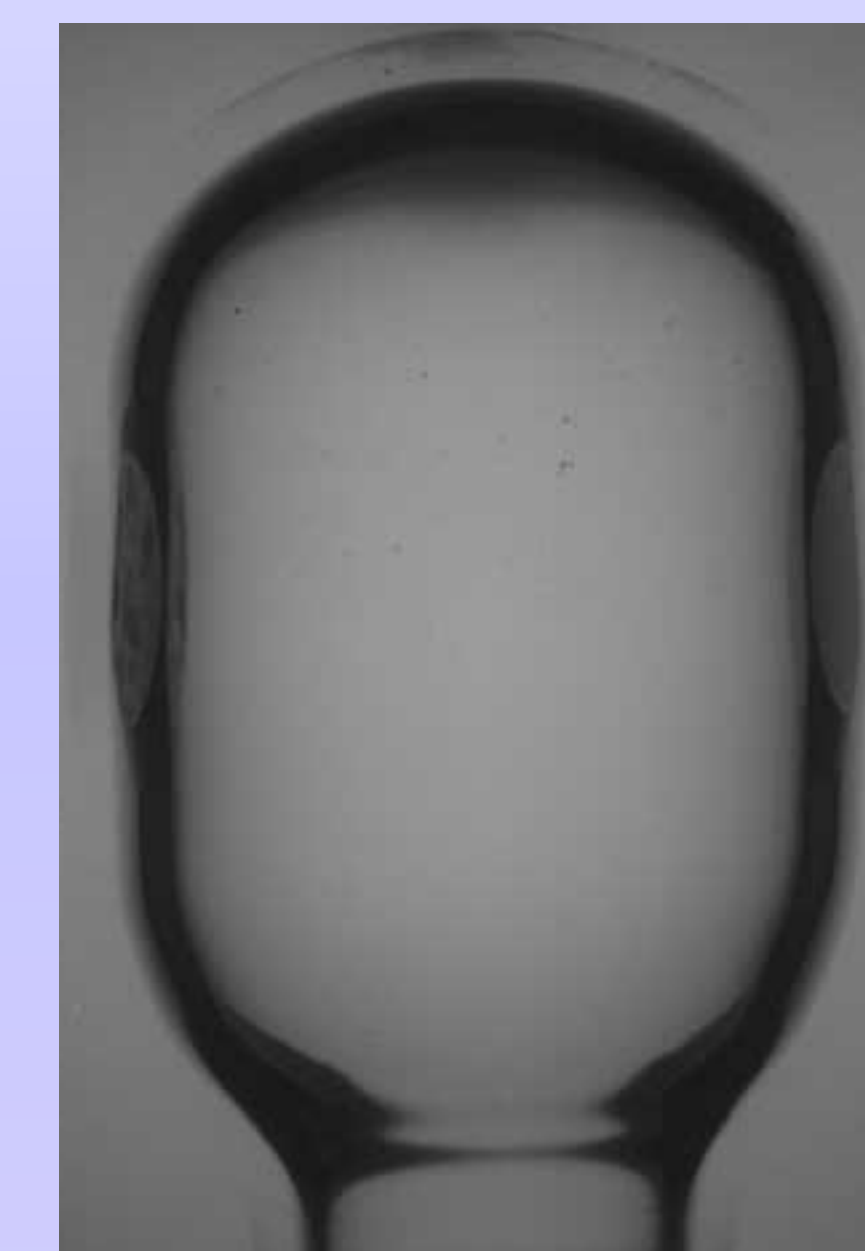
Use Nitrus Oxide (N_2O , laughing gas) as target
 $T = -10^\circ\text{C}$, $P = 20$ atm

- 1 Cell is cooled then filled with room temperature gas
- 2 Gas is cooled and condenses into liquid
- 3 Once cell is completely filled with liquid, pressure is reduced creating a superheated liquid
- 3 Nuclear reactions induce bubble nucleation
- 2 High speed camera detects bubble and repressurizes
- 3 System depressurizes and ready for another cycle



Bubbles

LabVIEW processes images from 100 Hz digital camera



Summary

- Helium – carbon fusion to form oxygen is very important reaction
- It is easier to measure the disintegration of oxygen to helium and carbon when bombarded with gammas
- At Jefferson Lab, we use electron beam to generate gammas
- These gammas hit oxygen nuclei in laughing gas
- The laughing gas is very unstable liquid and the helium and carbon will heat the small part of it and vaporize it
- The bubble generated is monitored by a camera