$^{17}O(p,\alpha)^{14}N$ STUDY AT THE LUNA ACCELERATOR

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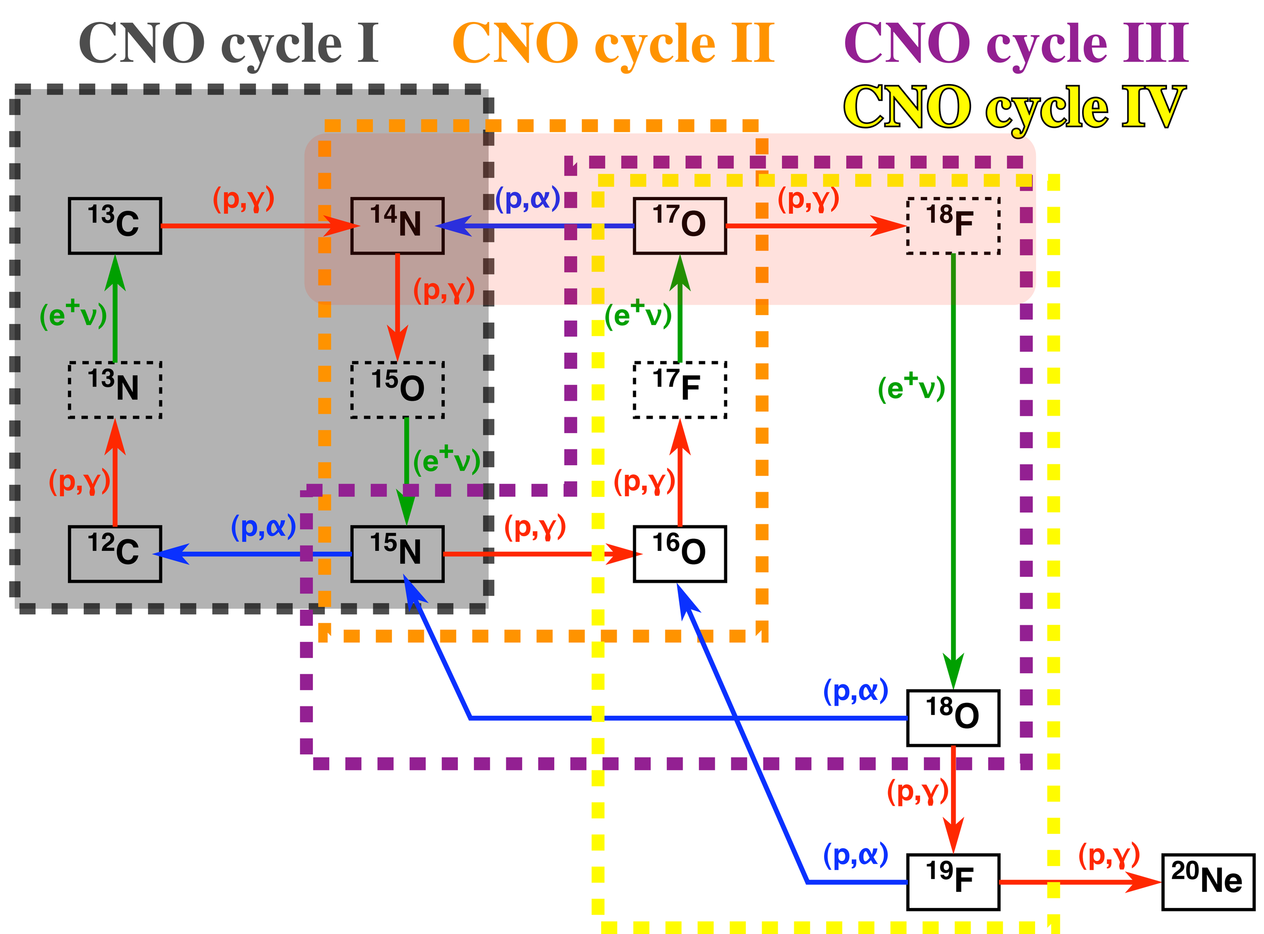
The Physical Case

Classical novae represent a frequent phenomenon in our Galaxy and have been proposed as the most significant source of ^{13}C, ^{15}N and ^{17}O isotopes in the Universe. They can also produce the short-lived radioisotope ^{18}F. The observation of these γ rays is one of the goals of satellite missions such as INTEGRAL [1] and their detection would help put constraints on current nova models [2].

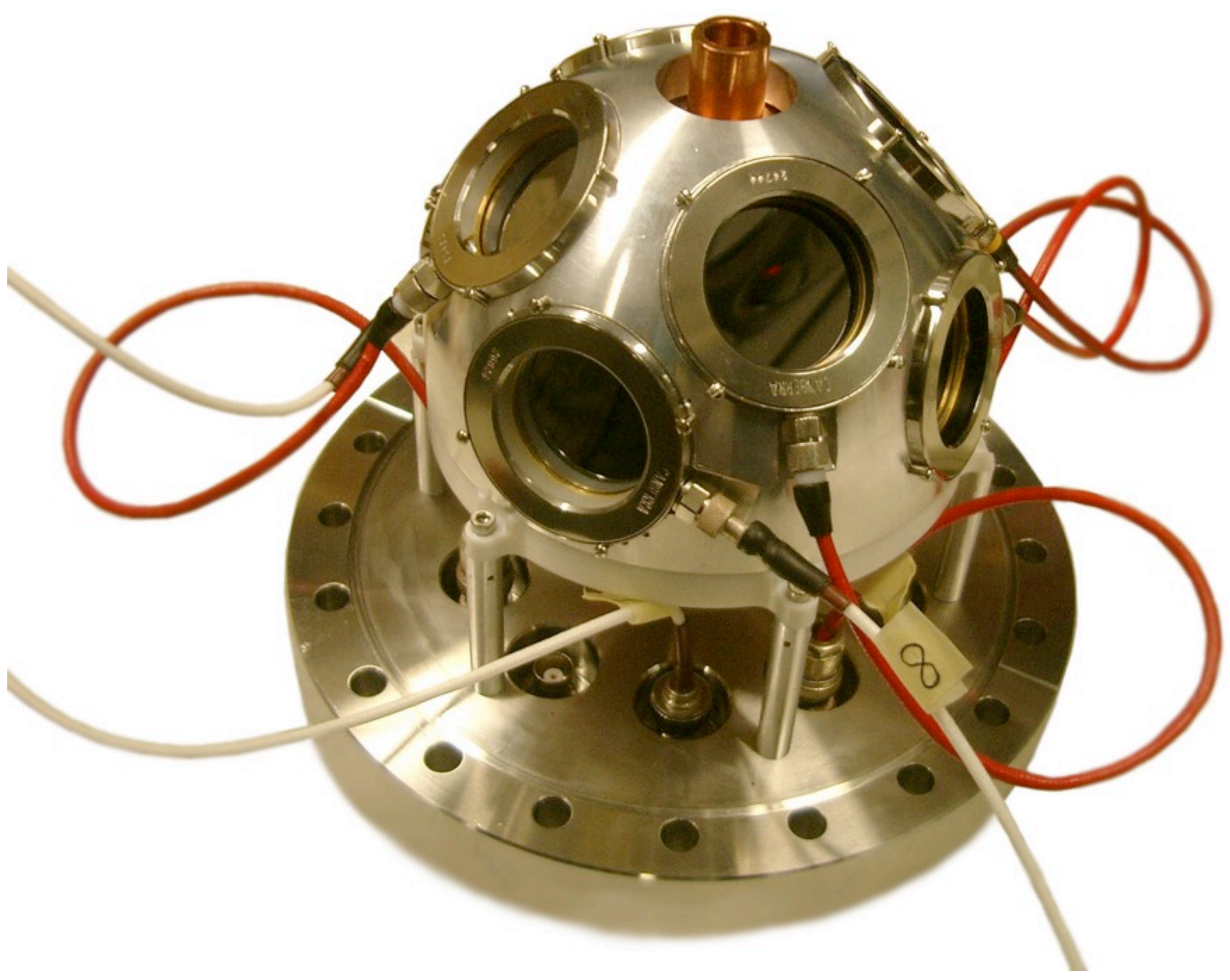
In particular, hydrogen burning of ^{17}O is believed to play a key role on the destruction of ^{17}O and on the formation of ^{18}F, mainly through the competing reaction $^{17}O(p,\gamma)^{18}F$ (Q = 5606.5 ± 0.5 keV) and $^{17}O(p,\alpha)^{14}N$ (Q = 1191.8±0.1 keV). Thus, the thermonuclear rates of both reactions should be determined with a high degree of accuracy in the temperature range T = 0.03 – 0.4 GK relevant for AGB and RBG stars and classical novae.



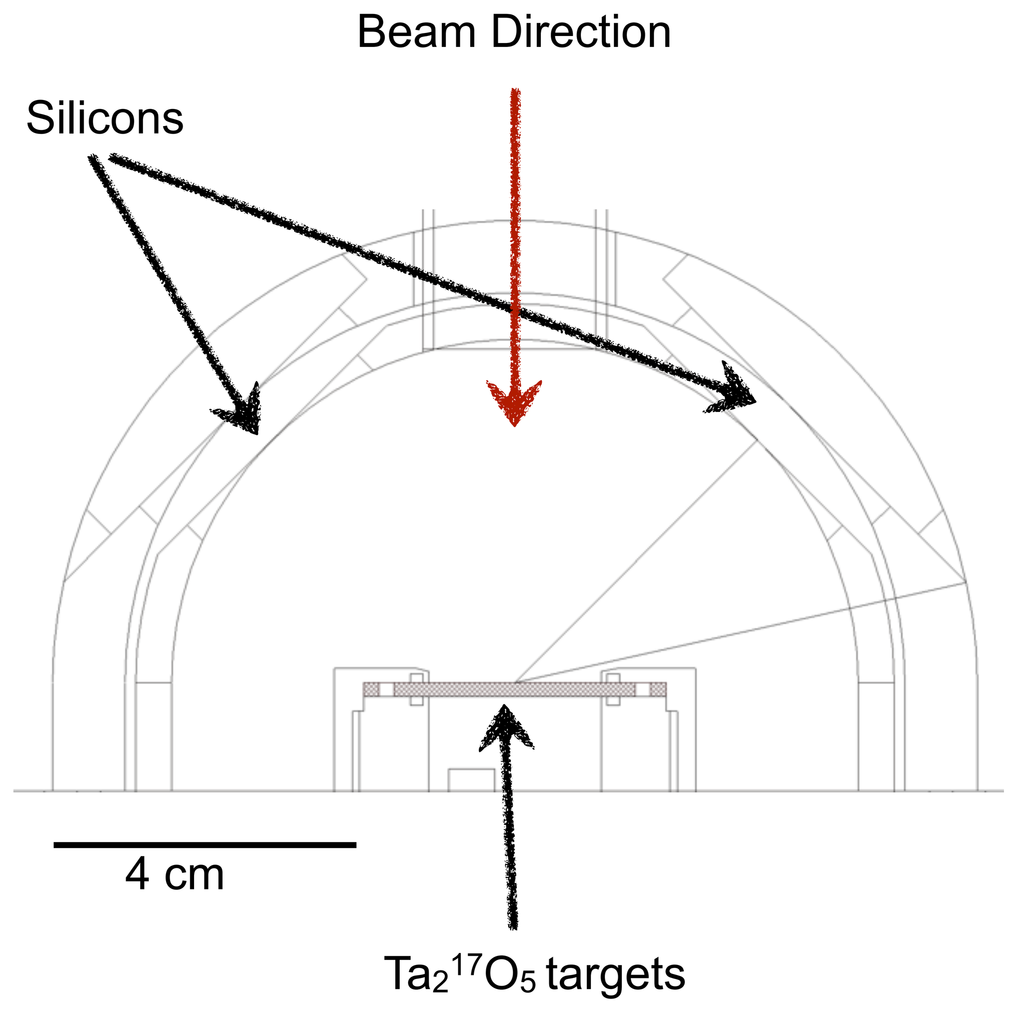
The LUNA collaboration has already studied deeply the $^{17}O(p,\gamma)^{18}F$ reaction in the framework of classical novae [3]. Its cross section has been determined in a range from 180 keV up to 400 keV in the laboratory system and also the ωγ of the resonance at 194 keV was determined with small uncertainty (2% statistics and less than 10% systematics). In 2012 it has been planned to investigate the cross section of the $^{17}O(p,\alpha)^{14}N$ by using the LUNAII accelerator and Ta_2O_5 (enriched in ^{17}O at a level of 90%) targets [4] produced at the Laboratori Nazionali del Gran Sasso.

LUNA aims to perform the challenging measurement of the 70 keV resonance for the $^{17}O(p,\alpha)^{14}N$ reaction, for which the expected reaction rate is of the order of a few reaction per hour.

The Scattering Chamber

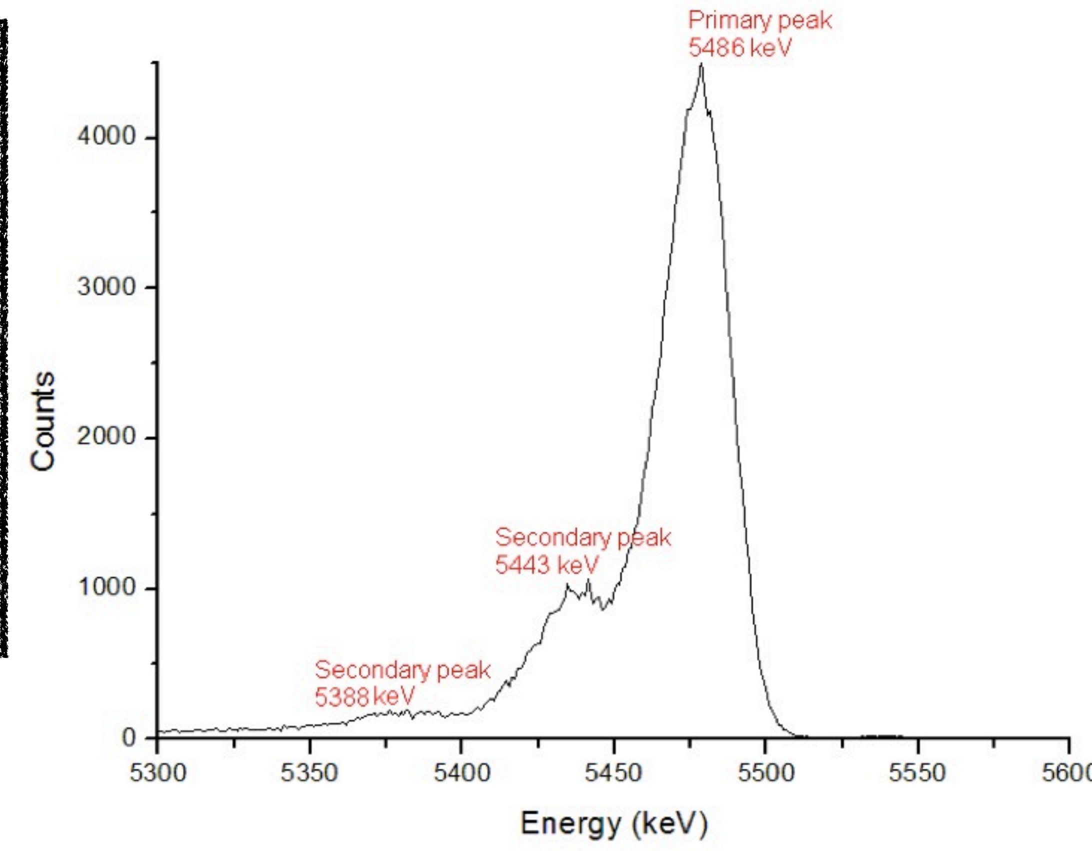


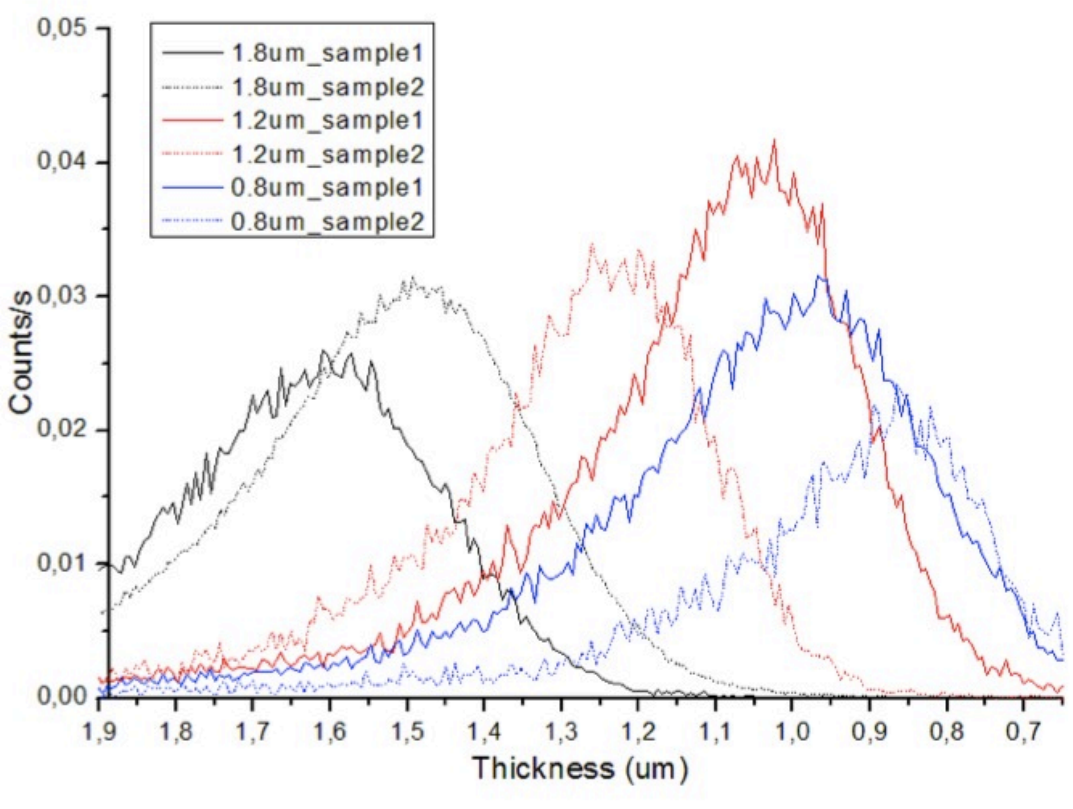
The chamber is comprised of two domes: The outer one is made from aluminum and houses the silicon detectors. The second, inner dome, is constructed from copper and directly connected to a cold trap. This is designed to reduce the deposition of carbon and nitrogen contaminants on the target surface. A bias of -300V is also applied to this dome in order to suppress the emission of secondary electrons. Eight 9 cm^2 silicon detectors are mounted to the external dome, covering 0.6π solid angle.



Future Steps for the Measurement

To avoid damage, it is mandatory to shield the Si-detectors from elastically scattered protons from the beam. However, the expected alpha particle energy from the $^{17}O(p,\alpha)^{14}N$ is approximately 1 MeV. This means that an in-depth study of the foil thicknesses is essential. Several tests have been performed to define the material, the thickness and the homogeneity of the foils.



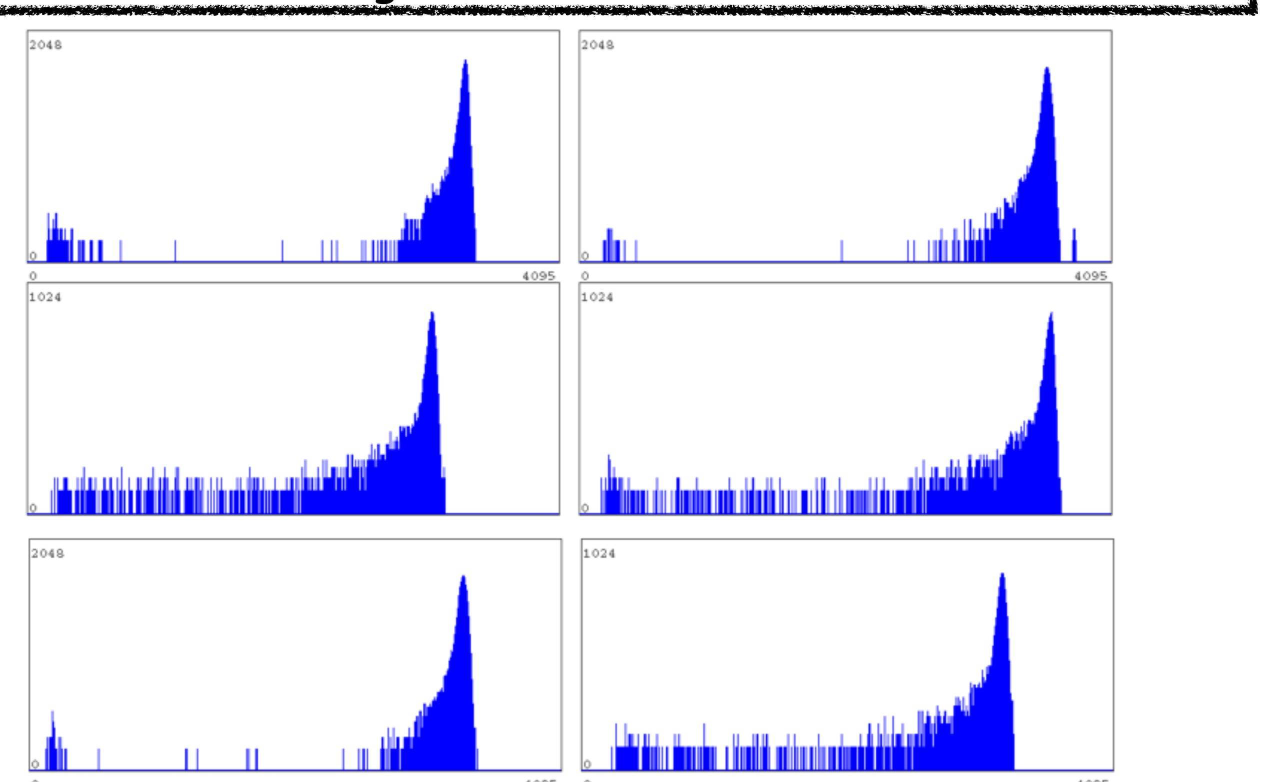


Nominal thickness	Measured thickness	Error	Minimum inhomogeneity
1.8	1.6	0.1	9%
1.8	1.5	0.1	
1.2	1.1	0.1	15%
1.2	1.2	0.1	
0.8	0.9	0.1	13%
0.8	0.8	0.1	

The first phase of the experiment is dedicated to studying the $^{18}O(p,\alpha)^{15}N$ reaction at the well-known resonance at E_R = 151 keV, with an Ta_2O_5 target enriched in ^{18}O (at level of 98%).

This study is devoted to evaluating any possible (p,alpha) contaminant reactions which may induced unexpected background, and to validate the Monte Carlo code developed to calculate the detectors efficiency.

First calibration of the detectors was performed using the ^{137}Cs from which arise conversion electrons of energy E = 624 keV and up to E = 5.4MeV using the ^{241}Am source.



References:

[1] - J. G omez-Gomar et al., Mon. Not. R. Astron. Soc. 296 (1998) 913
[2] - M. Hernanz et al., Astrophys. J. 465 (1999) 27
[3] - D. A. Scott et al., in preparation
[4] - A. Caciolli et al., submitted to EPJA

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