## David Rapagnani on behalf of the 12C12C LUNA WG

# <sup>12</sup>C+<sup>12</sup>C with LUNAMV



GIANTS XI - 20-21 Ottobre Caserta

D. Rapagnani (Unina)

## Introduction

- influences the evolution of massive stars and low mass stars in close binary systems (e.g. Type Ia supernova)
- $T_9 > 0.5$ , where  $E_{cm} \sim 1.5$  MeV
- exit channels  ${}^{23}Na+p (Q = 2.24 \text{ MeV}) - \text{open}$   ${}^{20}Ne+\alpha (Q = 4.62 \text{ MeV}) - \text{open}$   ${}^{23}Mg+n (Q = -2.62 \text{ MeV}) - \text{closed at lower energies, weak at the higher}$  ${}^{24}Mg+\gamma (Q = 13.9 \text{ MeV}) - \text{weak}$
- very low reaction cross section (<< nb) makes BIB and natural background prevent direct measurements at low energies

ERNA results presented by Liz "Direct measurements of the 12C+12C reactions cross-sections towards astrophysical energies (ERNA)"

## Status of the art

- different interpretations of indirect experimental data makes S-Factor estimate at stellar energy unreliable
- low energy direct measurements could resolve present ambiguity



## $\gamma$ channel

<sup>12</sup>C+<sup>12</sup>C $\rightarrow$  <sup>20</sup>Ne +  $\alpha$ 

γ-rays and α particles energies for excited states for  ${}^{12}C({}^{12}C, \alpha){}^{20}Ne$  (Q = 4.617 MeV)

E <sub>x</sub> (MeV)	٩ <b>ſ</b>	Main $\gamma$ transitions (MeV)		ID	E <sub>α-max</sub> (MeV) (E <sub>CM</sub> = 2 MeV)
0.0	0+			$\alpha_0$	8.6
1.63	2+	1.63 →0 <b>1.63</b>		$\alpha_1$	6.8
4.24	4+	4.24 → 1.63 <b>2.61</b>		$\alpha_2$	3.9
4.96	2-	4.96 → 1.63 <b>3.33</b>		α3	3.1
5.62	3⁻	5.62 → 1.63 <b>3.98</b>		$\alpha_4$	2.2
5.78	1-	<i>5.78 → 1.63</i> <b>4.15</b>	5.78 → 0 <b>5.78</b>	$\alpha_5$	2.0







## $\gamma$ -background



# Expected counting rate

- 150 eµA of <sup>12</sup>C<sup>+</sup> with LUNA MV (commissioning almost complete)
- 150% HPGe
- reactions/day following Tumino (left), Mukhamedzhanov (right) and non-Resonant (center) predicted cross sections
- sensitivity for different shielding setups in LUNAMV



u/g + 15 cm Pb u/g + 25 cm Pb u/g + 25 cm Pb  $+ N_2$  flush

## LUNA MV

- 3.5 MV Singletron Accelerator with ECR source
- 150 μA of high energy resolution <sup>12</sup>C beams
- high stability for long measurement runs









#### $\gamma$ measurement



under testing in LNGS



## particles detection with GASTLY

x10<sup>-3</sup>

- GASTLY under characterization underground at LUNA 400 site
- best particles and noise separation with different gas (Ar CF4) and pressures under test
- intrinsic background from vetronite identified; employment of alternative material are under study



## particles detection with nTD Si detectors

- Array of neutron Transmutation Doped (nTD) Si detectors
- Pulse shape to discriminate particles (and background!)
- No gas. No degradation of energy resolution.
- We bought **8x** MSL MSPAD 1x5 (already delivered)
- Currently designing new carrier and shorter Kapton cable
- Will also be tested and used for  $^{23}Na(p,\alpha)$  at LUNA-400





## <sup>12</sup>C target characterization

#### THE HEAT EXPERIMENT @ LNL (Hydrogen dEsorption from cArbon Targets)

- Reduce hydrogen contamination through **controlled heating** up to 1200°C
- H contamination level before/after desorption through Ion Beam Analysis:
  - $\circ$  Nuclear Reaction Analysis (NRA) exploiting <sup>2</sup>H(<sup>3</sup>He,p)<sup>4</sup>He reaction
  - $_{\odot}$  Elastic Recoil Detection Analysis (ERDA) with  $^{4}\text{He}$  beam





## Thank you for your attention!!!

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