EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH
Addendum of the Proposal INTC-P-208

Measurement of the neutron capture cross section of ^{64}Ni

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The following document is an addendum to the proposal INTC-P-208 [1], approved in 2006, concerning the measurement of the neutron capture cross-section of highly enriched samples of the stable Fe and Ni isotopes. The proposed measurements aimed at improving the existing cross section data of interest for the *s*-process nucleosynthesis in *Massive* stars and for innovative nuclear technologies.
In the past years the neutron capture cross sections of the ^{54,57}Fe, ^{58,62,63}Ni isotopes has been successfully performed at the n_TOF experimental area 1 (EAR1), the results of this work together with the astrophysical implications are reported in several publications and conference proceedings [2,3,4].
The measurement of the ^{64}Ni(n,γ) has been postponed in the past due to the cost of the sample, while now it can be performed using small quantities of ^{64}Ni, taking advantage of the higher neutron flux available in the n_TOF experimental area 2 (EAR2).

Together with the astrophysical motivations exhaustively mentioned in the original proposal [1], a further important reason for measuring neutron capture reactions of the ^{64}Ni is that the Maxwellian Averaged Cross Section (MACS) suffers for severe discrepancies, amongst the databases available in literature, as showed in Fig 1.

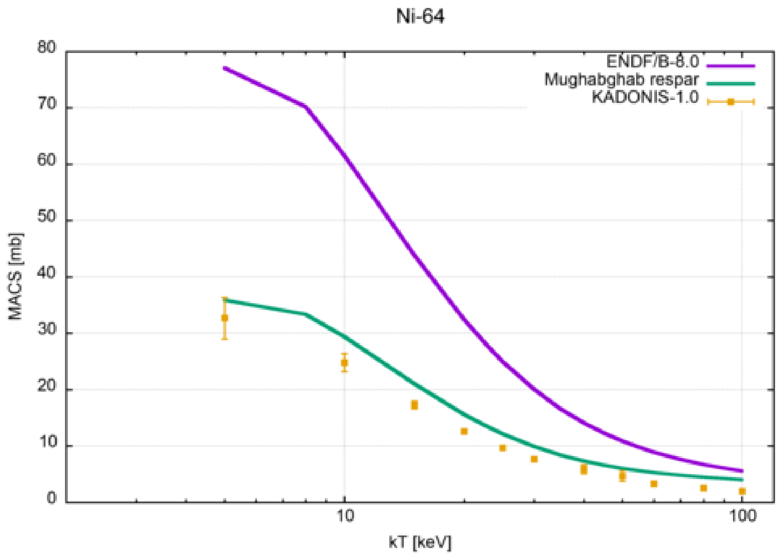

Figure 1 Comparison of the MACS calculated with different libraries.

Moreover, recent magnetic Asymptotic Giant Branch models [5] were found to be in disagreement with respect to nickel isotopic ratios measurements in presolar SiC grains (see Fig. 2). Note that other nickel isotopic ratios are well matched by theoretical models.

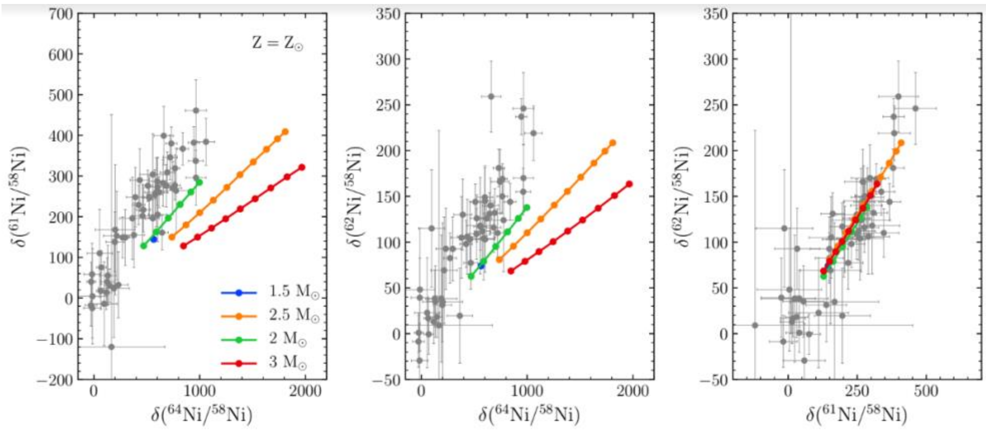

Figure 2 Comparison between theoretical AGB models and presolar grain measurements.

We propose here to measure the neutron capture reactions on ^{64}Ni isotope in EAR2. 200 mg of nickel metal powder with an enrichment of 99.33% of ^{94}Ni can be delivered by ISOFLEX [6]. This material will be used to produce a sample of 1 cm radius.
The request for the number of protons is based on the need to characterize the strongest resonances, all in the keV region, as well as to measure with good statistical accuracy the Unresolved Resonance Region. The count rate was evaluated by means of the neutron capture cross section in the ENDF/B-VIII.0 library [7], considering the efficiency of the proposed setup. The count-rate estimate, for a resolution of 3000 bins per decade, is shown in Fig. 3. The black line indicates the level of expected background, which has been estimated based on previous experiments performed in EAR2.

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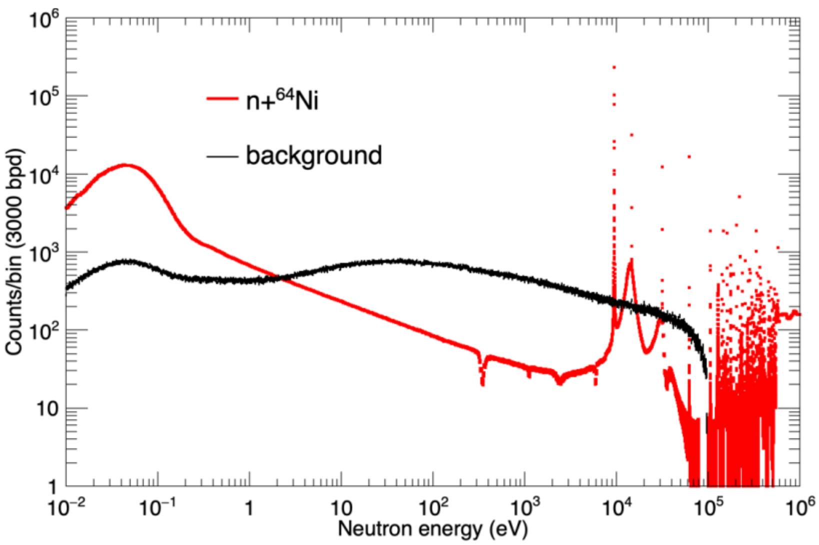

Figure 3. Expected counting rate for the ^{64}Ni using mono-isotopic sample of 200 mg in EAR2. In the calculation the neutron irradiation corresponds to an intensity of 1.0 x 10^{18} protons. The black line represents the expected background level during measurement.

From the count rate estimate the total number of counts in a resonance at approximately 100 keV is of the order of a few hundred counts, resulting in a statistical accuracy of 5% in the energetic range from thermal to 100 keV, for a number of protons of $1x10^{18}$. An additional $5x10^{17}$ protons is needed in the measurement for background determination and normalization purposes.

Summary of requested protons for EAR2: 1.5×10^{18} protons on target.

Reference

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[3] C. Lederer et al., Phys. Rev. C **89**, 025810 (2014) 10.1103/PhysRevC.89.025810

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[5] D. Vescovi, et al., ApJ Lett., 897, 25 (2020)

[6] www.isoflex.com

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