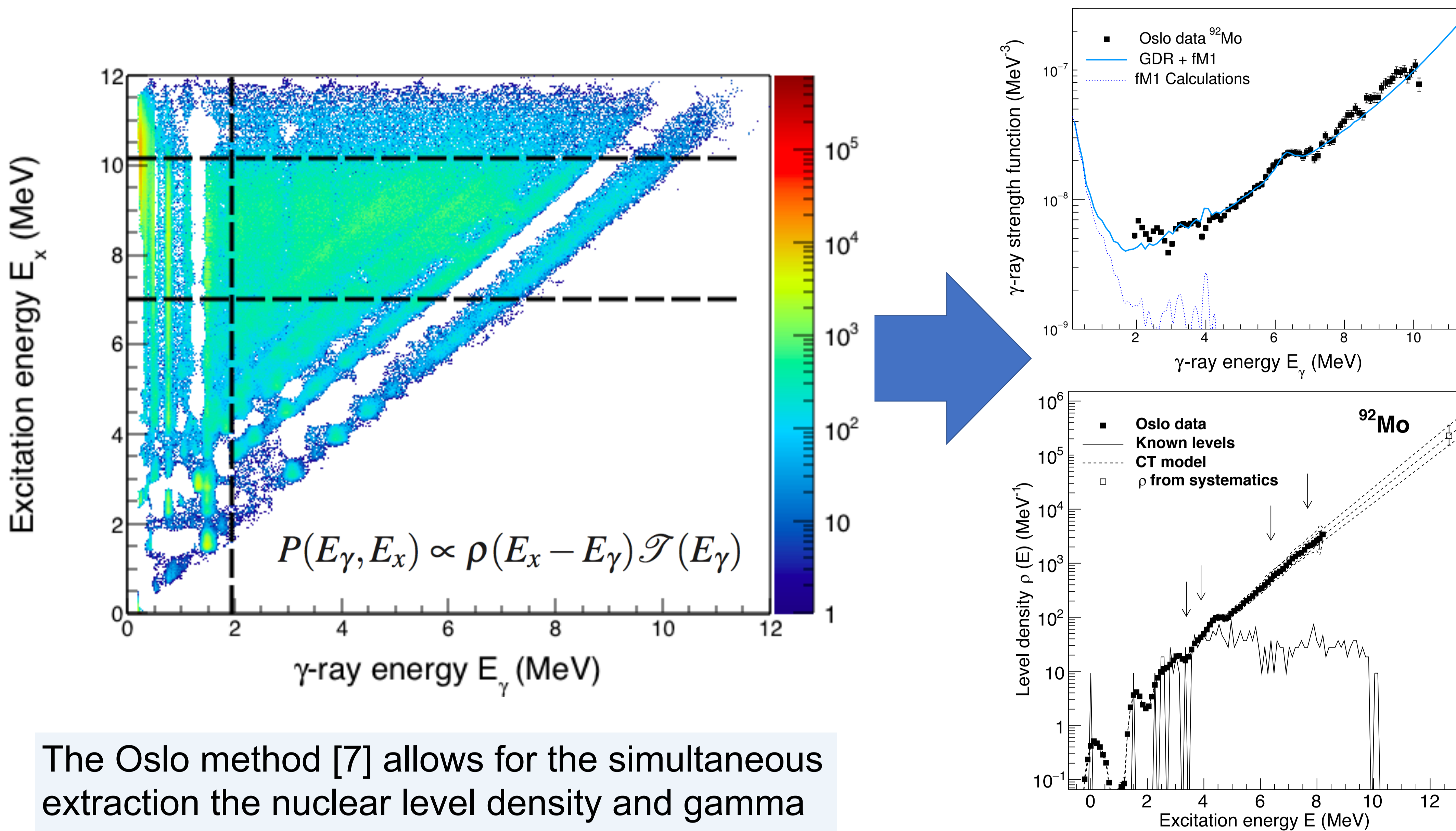


SNAPS - Studies of Nuclear Properties for Explosive Astrophysical Processes

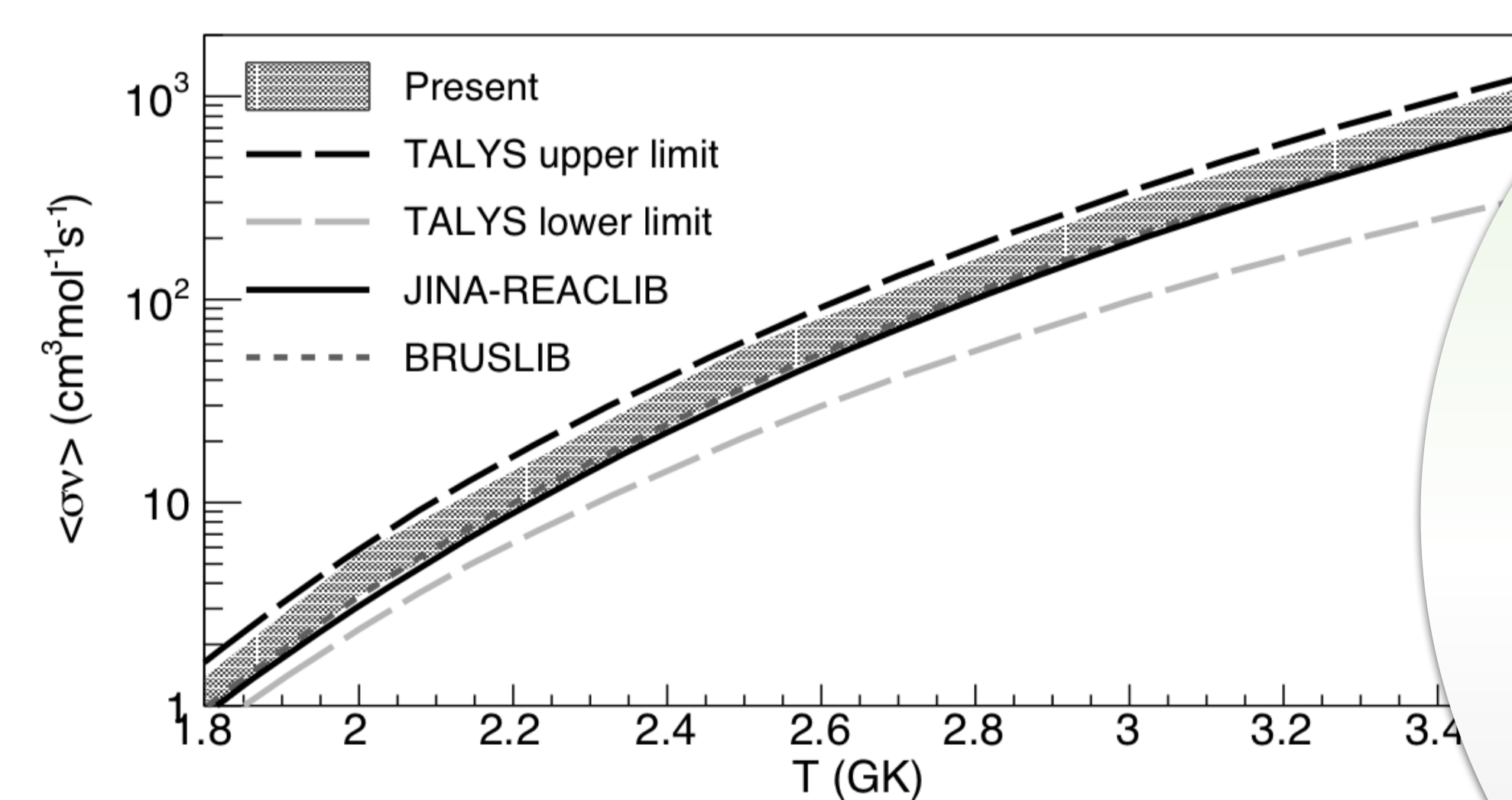
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Background: The majority of stable isotopes are either produced in the slow neutron capture process, s-process, or the rapid neutron capture process, r-process [1,2]. However, 35 stable isotopes ranging from ^{74}Se to ^{196}Hg cannot be produced by either of these processes, as they are situated on the proton-rich side of the valley of stability [3]. The term p-process was coined for a third process that can produce these so-called p-isotopes. Nowadays, the general view is that photonuclear reactions are eroding pre-existing seed nuclei to produce the p-isotopes. This γ -process is the most likely explanation for their existence. Starting out with seed nuclei, (γ, n) reactions produce more proton-rich isotopes, until the increasing neutron binding energy makes the (γ, p) and (γ, α) reactions favourable [3]. The astrophysical sites where the p-process is believed to take place include the Ne-O layers of type II supernovae and type Ia supernovae [4]. Despite its success at explaining the majority of the p-isotopes, the γ -process fails at reproducing the observed abundances of $^{92,94}\text{Mo}$ and $^{96,98}\text{Ru}$ [4]. This severe problem could be related to astrophysical aspects, such as the seed nuclei abundances, the exact details of the pre-supernova star layers and physical conditions during the explosion or simply the mechanism of production being something other than the γ -process. In addition, a major obstacle is poorly known nuclear properties of the isotopes that are included in the p-process reaction network. Sensitivity studies [5] have shown that γ -induced particle-emission reactions (γ, p) and (γ, α) are the most important ones for the nucleosynthesis of p-isotopes in the environment of a type II supernova. The main approach of SNAPS is to determine the nuclear level density and gamma strength function from particle-gamma coincidence data using the Oslo method. The project aims at key reaction rates for the p-process, but also to explore reactions that might be important for the rp-process. Nuclear reaction rates at astrophysical temperatures can be calculated using the TALYS code [6], utilizing the experimental results as input.



The Oslo method [7] allows for the simultaneous extraction the nuclear level density and gamma strength function from particle-gamma coincidence data.

Nuclear level density and gamma strength are important input to reaction cross section calculations in the statistical framework. Therefore the results can be used to place experimental constraints on reaction rates of interest for astrophysical reaction network calculations.



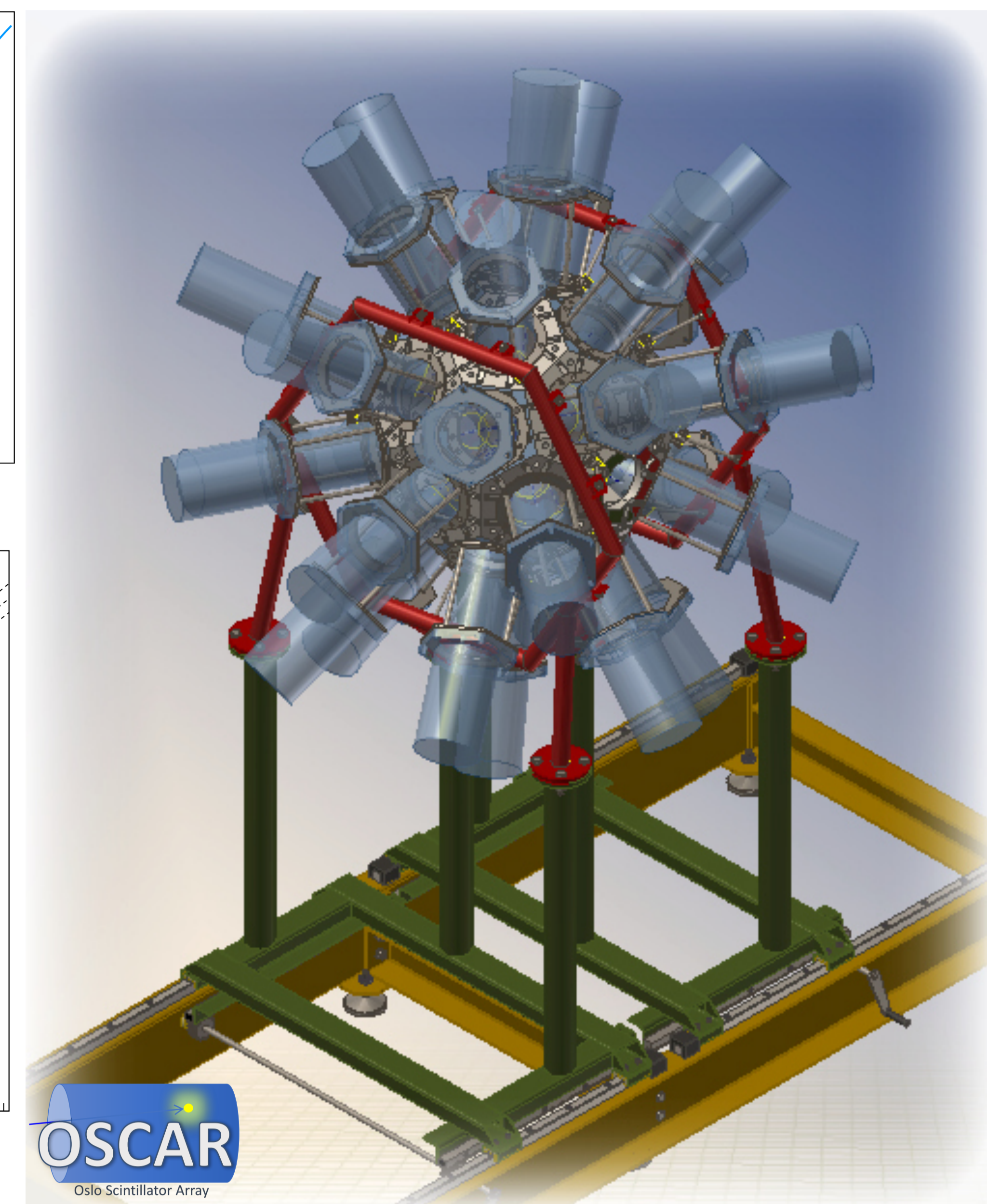
The astrophysical reaction rate of $^{92}\text{Mo}(\gamma, p)^{91}\text{Nb}$ constrained by experimental results from the CACTUS setup at UiO [8].

References:
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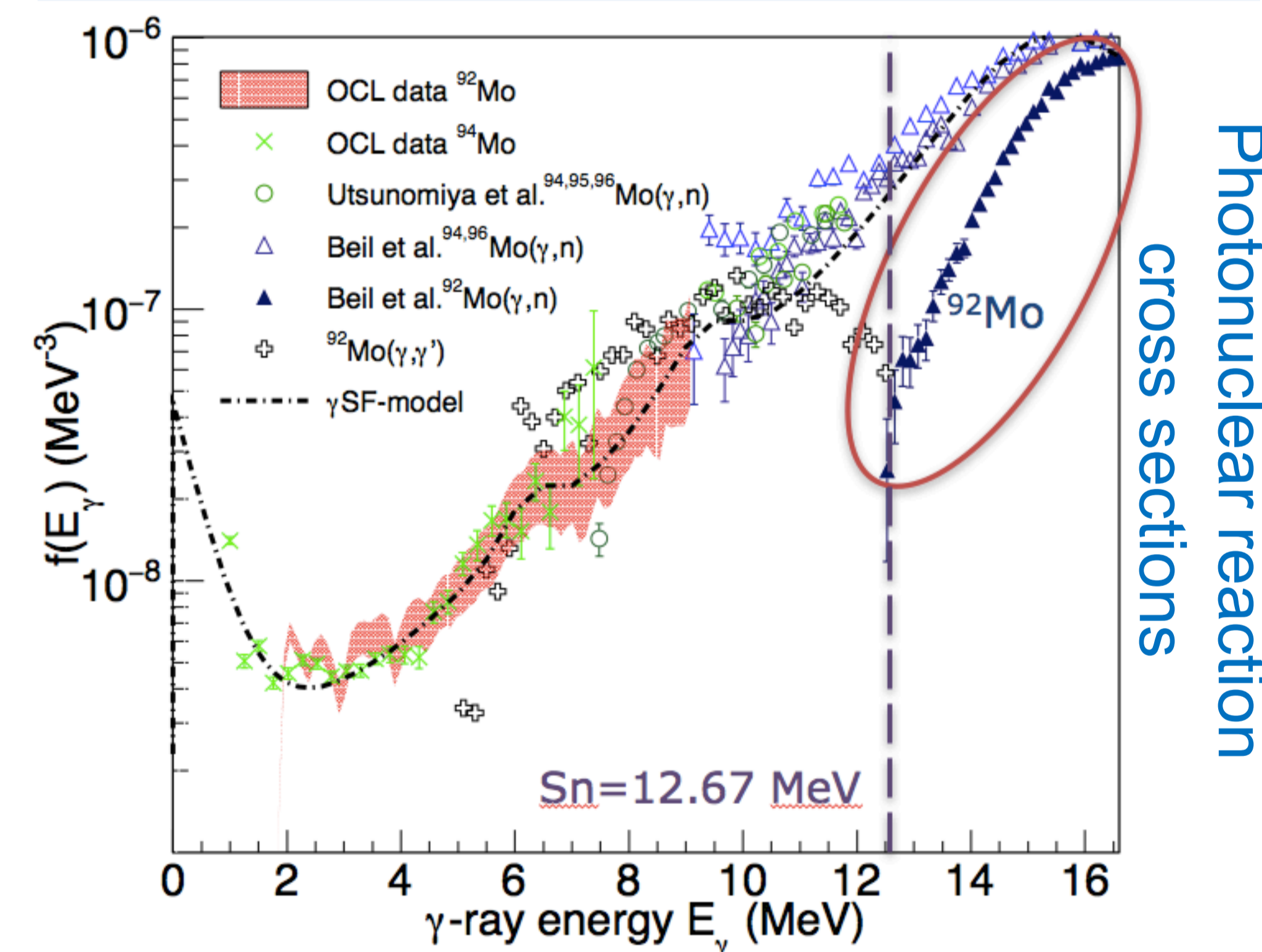
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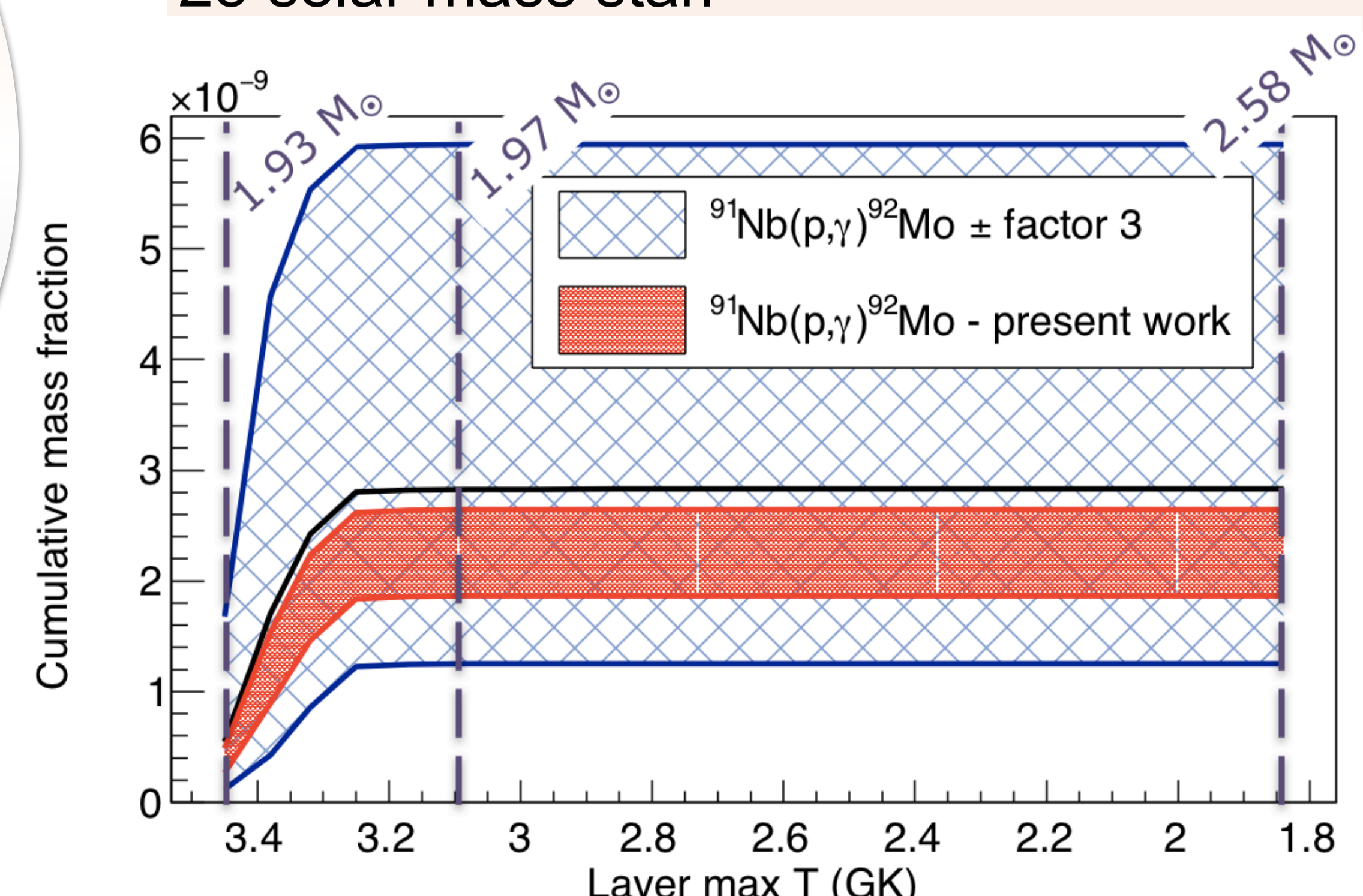
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OSCAR will consist of 30 large volume (3.5" x 8") LaBr₃(Ce) detectors. The first experiments will take place fall 2017.



In the case of the study of ^{92}Mo in Ref. [8], the reaction rate constraints obtained were used in network calculations for the scenario of a γ -process taking place in a type II supernova explosion as the shock front passes through the O-Ne layer of a 25 solar mass star.



Experiments

Reaction rate calculations

Reaction network calculations