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## Direct measurements of nuclear reactions at stellar burning energies

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Thermonuclear reactions involving charged particles play a central role in stellar evolution. Knowledge of their rates is needed to answer fundamental questions about the origin of the elements. While direct measurement approaches are a powerful tool to study nuclear cross-section, the hindering effect of the Coulomb barrier makes measurement at energies of stellar interest extremely challenging. I will introduce two novel approaches to face this long-standing issue, which are being developed thanks to my ERC starting grant EL-DAR.

I will first introduce future plans for underground measurement of nuclear reactions emitting charged particles at the deep underground accelerator LUNA-400 (INFN Gran Sasso, Italy). The cosmic silence afforded by the underground environment is key to carry out high-precision detection of extremely rare in-beam reaction events.

I will then describe the novel opportunities opened up by low-energy heavy ion storage rings such as the CRYRING (GSI/FAIR, Germany) for measurement of nuclear reactions directly at Gamow energies. I will introduce the unique technical requirements, first experimental results of the CRYRING Array for Reaction MEasurement (CARME), and near future plans.

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