Evaluation of the response function of the R3B/FAIR electromagnetic calorimeter CALIFA to high energy photons

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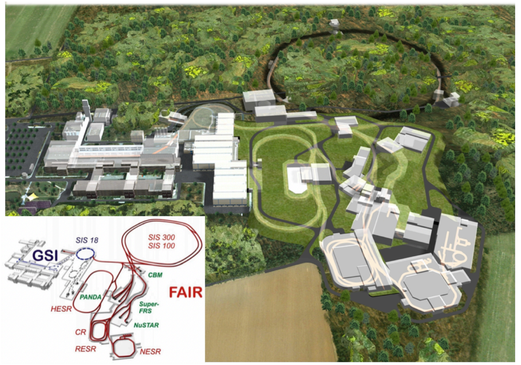
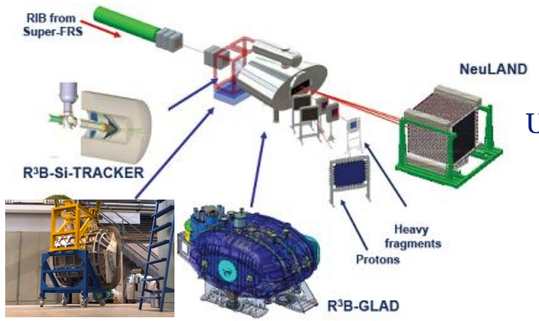
Motivation

The **Facility for Antiproton and Ion Research (FAIR)** is situated in the outskirts of Darmstadt, Germany [1].



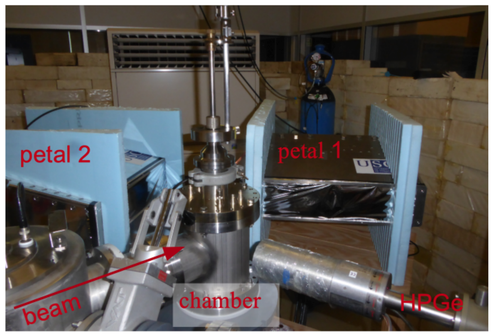
The **Reactions with Relativistic Radioactive Beams (R3B)** investigates nuclear properties of exotic nuclei close to the drip-line, focusing on nuclear structure, reaction mechanisms and nuclear astrophysics [2].



The **CALIFA (CALorimeter for In-Flight emitted γ-rays and lightly charged particles)** sits at the heart of the R3B setup.

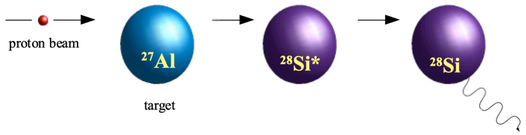
The aim of this work is to characterize the response of CALIFA modules (128 crystals) to high energy prompt γ-rays by measuring the direct decay to the ground or first excited state from resonance states emitted from ^{28}Si.

Experiment

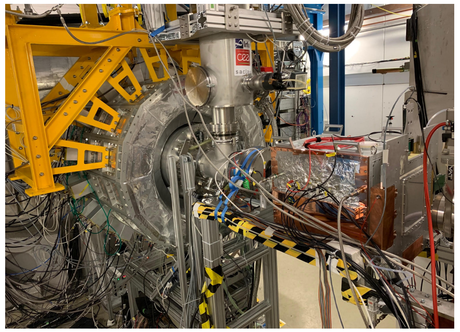


The experiment took place at the nuclear reaction line of the **3 MV Tandem accelerator of the LATR-CTN facility [5] .**

Two CALIFA petals placed placed @ 0 ° and 90 ° with respect to the beam-line. Resonance states of ^{27}Al(p,γ)^{28}Si reaction were populated using the proton beam (100 nA). **Emitted photons were detected with the CALIFA modules.**

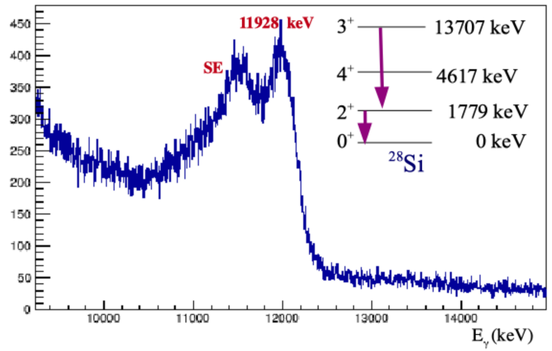


CALIFA contains in its central part: the **Barrel** 1952 CsI(Tl) detector units. The array will measuring protons up to 300 MeV, as well as photons up to 30 MeV, and work as a γ-spectrometer, a calorimeter or a hybrid detector [3, 4].

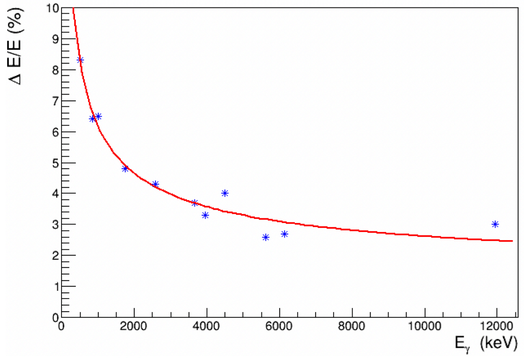


Results & Discussion

The **calorimetric response** of one of the petals is presented, showing the reconstruction of the high-energy **γ**-decay (about 12 MeV) from the populated ^{28}Si resonance, 13707 keV (3^+) [6,7,8].



The **event topography** was analyzed to obtain knowledge of the detector response at the calorimetric level. The dependence of the energy resolution was studied [8].



Discussion

- This proton capture reaction is **very suitable tool** to produce **high energy prompt γ-rays** and to evaluate detection system and the corresponding DAQ
- The measurement has clearly demonstrated CALIFA's capability to detect and resolve high energy photons of up to **12 MeV**.
- Parameters like **energy resolution** at calorimeter level, has been determined.
- **Advanced algorithms** for CALIFA event reconstruction have been developed.

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[1] http://fair-center.eu/ [2] http://www.gsi.de/r3b [3] https://edms.cern.ch/ui/file/1833500/2/TDR_R3B_CALIFA_BARREL_public.pdf [4] B. Pietras, et al., NIMA 814 (2016):56-65.
[5] www.itn.pt [6] https://nndc.bln.gpv [7] J. Brenneisen, et al., Z. Phys A 352 (1995):149-159. [8] P. Teubig et al., Basic Concepts in Nuclear Physics: Theory, Experiments and Applications. RÁBIDA 2018. 225(2019): 245-246.