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A lens for hard X-/soft γ-rays: the LAUE Project

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on behalf of the LAUE collaboration

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Abstract. The LAUE project, supported by the Italian Space Agency, is devoted to the development of a long focal length focusing lens for soft gamma-ray Astronomy (80 – 600 keV). We present the status of the project with particular reference to the apparatus developed for building and testing a Laue lens petal. The LAUE project is the result of a synergic collaboration between scientific institutions and Italian industry.

Key words. Focusing telescopes, Gamma-rays, X-rays, Laue lenses.

1. Introduction

Laue lenses, based on crystals, represent a step forward for the detection of hard X and gamma-rays from astrophysical sources, thanks to their high effective areas and focusing capability. With the HAXTEL project, we demonstrated the feasibility of Laue lenses for short focal length (FL <10 m). With the new LAUE project the lens assembling method will be strongly improved, and espected to be suitable for longer FL (>10 m). In addition for the first time, bent crystals will be used. A sensitivity of a few times 10^{-8} ph/cm^2 s keV can be achieved in 10^5 s and, thanks to the bent crystals, an angular resolution much better than 1 arcmin is expected.

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2. First Laue lens prototypes with the HAXTEL project

Within the HAXTEL project (Frontera et al. 2008; Virgilli et al. 2011), two prototypes of Laue lens were built, both based on Copper flat mosaic crystals. The focal spot obtained with the second prototype (Fig. 1), compared with the theoretical PSF is also shown.

The second prototype is improved in terms of focusing capability. The HAXTEL technology (patent pending) can be successfully suited for short focal length (< 10 m) Laue lenses.

3. Bent crystals for the LAUE project

Bent tiles of Gallium Arsenide (GaAs [220]) and Germanium (Ge [111]) crystals will be used for the project in Laue configuration. The

Fig. 1. *Left*: The second prototype built and tested in the small Larix Facility of the Ferrara University. *Right*: Focal spot of the second prototype compared with the expected PSF (black spot).

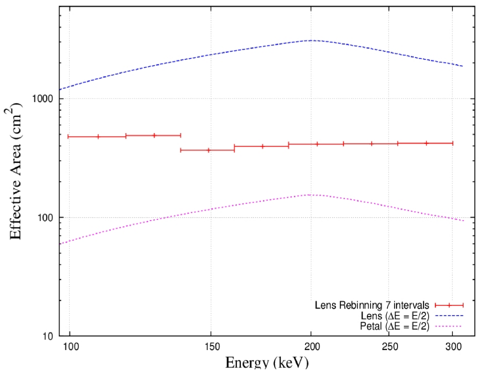

Fig. 2. Effective area for a Laue lens and for the petal, made of Ge(111) and GaAs(111) with an energy pass-band of 96 – 300 keV.

selected crystals will be delivered, respectively, by IMEM Parma and LSS Ferrara. In order to obtain the proper curvature radius of each crystal tile two different methods will be exploited. The surface grooving technique on the crystal surface is adopted by LSS Ferrara for bending Ge crystals (Guidi et al. 2011), while the surface lapping technique is adopted by IMEM Parma for bending GaAs mosaic crystals (Buffagni et al. 2012).

4. The designed lens

The designed lens is made of petals. One of them will be built as a part of the LAUE project. Due to the available X-ray source (E_{max} < 320 keV), the Laue lens petal of Laue lens will have a nominal passband of 96-300 keV. The effective area simulated for the petal and for the entire lens is shown in Fig. 2. The petal of Laue lens will be built and tested in the LARIX facility installed in the Physics Department of Ferrara.

5. Conclusions

From the already gained experience on Laue lenses, we expect to accurately build Laue lenses for space astrophysics even with very long focal lengths (up to 100 m), a goal never achieved so far.

Bent crystals appear the most suitable for our goals. As a demonstration of the validity of the adopted technology will be built a lens petal of 20 m focal length using Ge and GaAs bent crystals.

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