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CZECH TECHNICAL UNIVERSITY IN PRAGUE

TH Aschaffenburg
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# Project CATEX: X-ray monitoring of catastrophic events in the Universe

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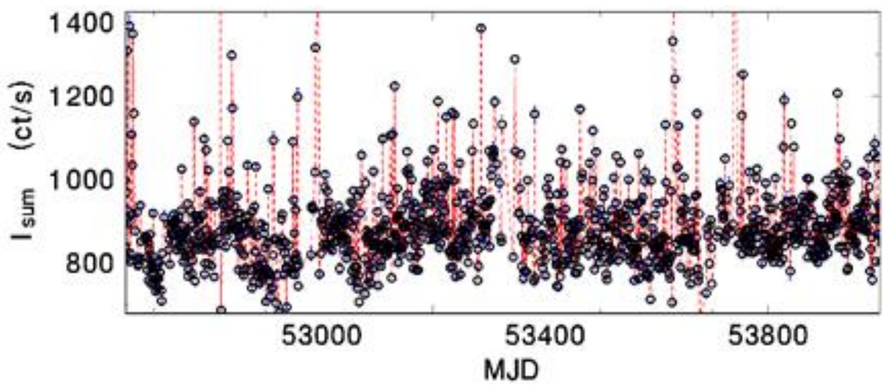
## Summary

The proposed joint German-Czech project CATEX (Catastrophic events in the Universe: the X-ray view) is a feasibility study for a novel space experiment focused on monitoring and investigation of catastrophic events in the Universe. It uses the innovative combination of an uncooled pixel detector (Timepix) and a Lobster-eye optic with optimized X-ray mirror coatings. The advantages of this kind of telescope are a wide field of view and low power consumption, together with an improvement of the detection range. The projects aim is a complex feasibility study of an advanced wide field X-ray telescope for monitoring and research of the catastrophic events - as well as of other variable and transient sources - in the Universe. This theoretical and experimental study will target all important parts of the future space system including an optimization of the mirror coatings, the design the optical module, the analysis of potential observation targets, the design of the detection system under variable vacuum conditions, the development of algorithms for processing the X-ray images of Lobster eye optics, and methods of their visualization. The results of these studies and experiments will provide new knowledge about the behavior of the individual components and can also be used for the development of advanced scientific satellite payloads for an X-ray monitoring of astronomical objects. The CATEX project proposal is currently under evaluation at the funding agencies DFG and GAČR.

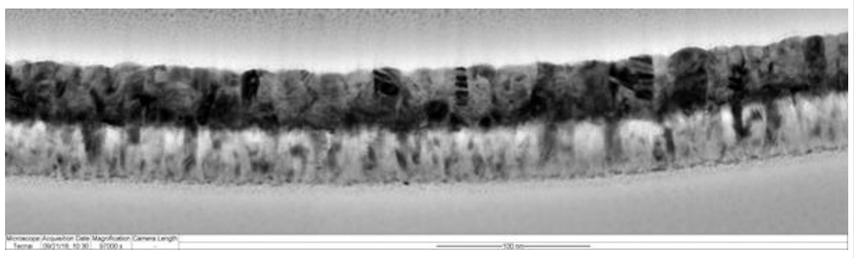
## Introduction

Modern astrophysics is based on complex, multispectral investigations of celestial sources, including space-based experiments. The problematics of an in-orbit monitoring of stars and other sky phenomena is studied in different spectral regions, covering the range from radio waves to high energy radiation. One of the problems currently studied in astronomy is an effective detection of short-time and transient sources of X-rays, for example, gamma-ray bursts, supernovae, X-ray novae or low- and high-mass X-ray binary systems around the Galactic core. The related flaring and/or eruptive phenomena appear approximately once per day and their unpredictable placement makes all-sky monitoring crucial for the observation (Stehlikova, 2019). Many transients have short and/or even very short duration making it difficult to observe them with classical X-ray telescopes. Only a sensitive all-sky monitor has a scientific potential to observe them and reveal their physical nature.

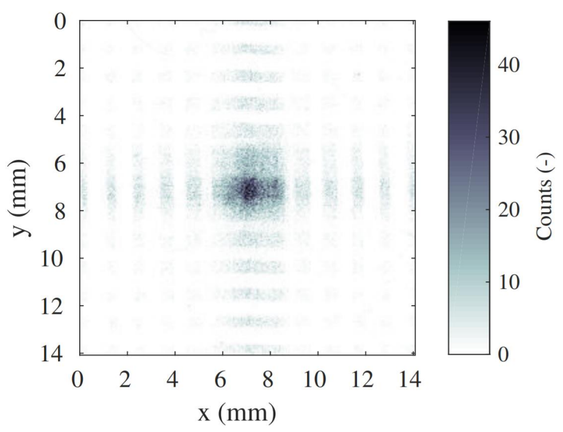



Example of activity of the very bright persistent source (LMXB) Sco X-1 in the 1.5-12 keV band. ASM/RXTE (Levine et al. 1996) data (one-day means) with the band similar to the one of the proposed lobster-eye telescope were used (modified from Simon 2014).

X-ray mirror



Microstructure of Cr-Ir coatings (TEM-picture)




## Experimental results from previous joint projects

Focal X-ray image of test lobster-eye optics with a laboratory x-ray source

## WBS structure of the CATEX project

| Work Package | Sub-Work Package |
|---|---|
| **WP 1** Astrophysical aspects | **1.1** Astrophysical justification |
| | **1.2** Astrophysical applications |
| | **1.3** Long-term evolution of high energy sources |
| **WP 2** Advanced surfaces | **2.1** Alternative reflecting substrates forming |
| | **2.2** Surface characterization |
| | **2.3** Advanced reflecting layers |
| **WP 3** Lobster-Eye X-Ray Optics | **3.1** Simulations, optimization, design |
| | **3.2** Tests in X-ray and optical regions |
| **WP 4** Lobster Eye optics simulation | **4.1** Ray-tracing of LE with different objects |
| | **4.2** Point sources identification based on combination of LE |
| | **4.3** Image reconstruction from LE optics |
| **WP 5** X-ray detector | **5.1** Design and adjustment of equipment for vacuum testing |
| | **5.2** Characterization of detector's properties under simulated space conditions |
| | **5.3** Design of algorithm for optimization of detector behavior |
| **WP 6** Fusion of X-ray and optical detector data | **6.1** Study of requirements and possibilities of application |
| | **6.2** Design of system |
| | **6.3** Algorithm for astrometrical measurement |

## Planned new experiments: Precise forming of mirror substrates

The principle of the glass forming process

## Acknowledgement

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## References

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