Coded Aperture Mask (CAM) Fabrication

Abstract

SITARE-1 is a 2U CubeSat payload being developed at IIT Bombay to demonstrate GRB detection, attitude determination, and deep-space navigation. On the top, the payload will have a Coded Aperture Mask (CAM), made of a 0.5 mm tantalum sheet, as shown in Figure 1. This design is similar to the CAM used in AstroSat/CZTI package [1]. The goal of this project is to try out different ways of processing tantalum to fabricate the CAM accurately.

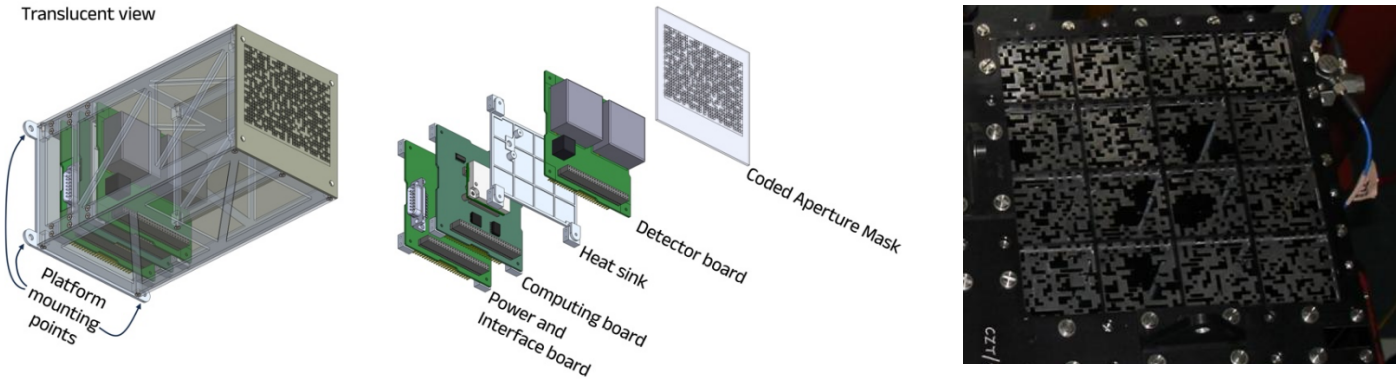

Figure 1: Left: SITARE-1 schematic [2]. Right: CAM on AstroSat's CZTI package [3].

1 Introduction

The payload houses two Cadmium Zinc Telluride (CZT) detectors, similar to those used in AstroSat/CZTI. These detectors can sense and characterise X-rays from celestial sources. To enable source localisation, a Coded Aperture Mask (CAM) — consisting of a pattern of opaque and transparent cells — is placed at a fixed distance above the detectors. For our application, we require a 2D array of solid (opaque) and open (transparent) cells, as shown on the right in Fig. 1. Tantalum is a high-density metal that is (semi)opaque to X-ray wavelengths, and is highly suitable for this application. For more information on coded aperture imaging in high-energy astrophysics, see [1, 4].

2 Requirements and Objectives

The major requirement of this project is to identify and evaluate suitable mechanical fabrication techniques for producing the Coded Aperture Mask (CAM) with high precision with an accuracy of 0.01mm. The CAM will be fabricated using tantalum sheets of 0.5 mm and 0.1 mm thickness.

The fabrication process must ensure that the 2D array of opaque and transparent cells (Figure 2) is produced cleanly, without burrs, deformation, or warping of the thin tantalum sheets. Candidate techniques may include laser-cutting, etching, milling, EDM, etc, depending on achievable tolerances and surface finish.

To aid in manufacturing, the DXF file of the cell pattern and the STEP file of the full CAM geometry will be provided. A reference pattern is shown in Figure 2.

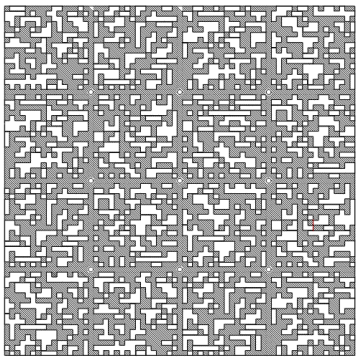

Figure 2: CAM Pattern used in AstroSat's CZTI. The edge of each pixel is 2.46mm [1].

References

[1] V. Bhalerao et al. "The cadmium zinc telluride imager on AstroSat". In: *Journal of Astrophysics and Astronomy* 38.2 (2017), p. 31. DOI: 10.1007/s12036-017-9447-8.

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[4] Jean in 't Zand. *Coded Aperture Imaging in High-Energy Astronomy*. NASA GSFC. https://asd.gsfc.nasa.gov/archive/cai/index.html. 2001.