Vibration tests on the CryoAC Detector assembly for the X-IFU Athena X-ray observatory

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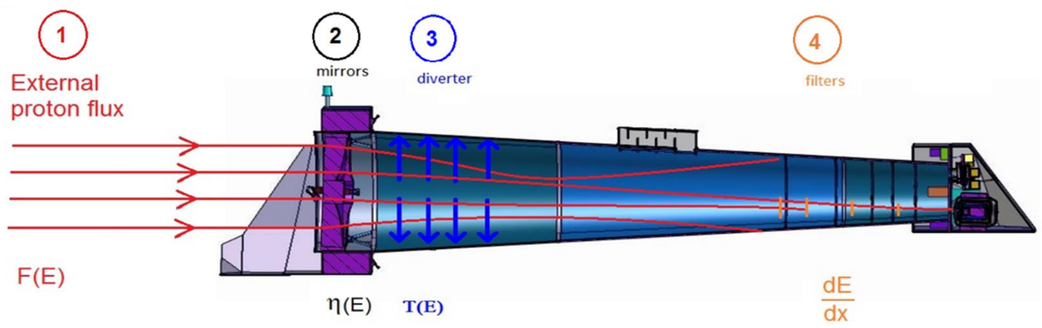
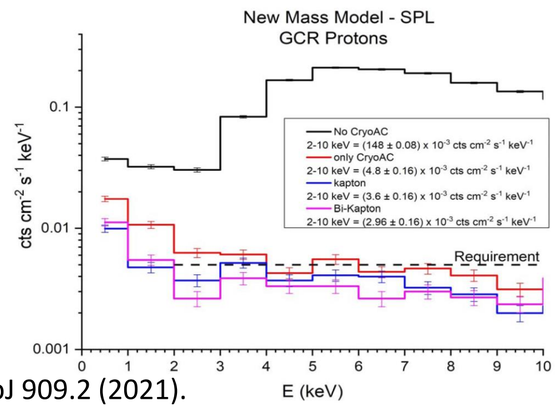
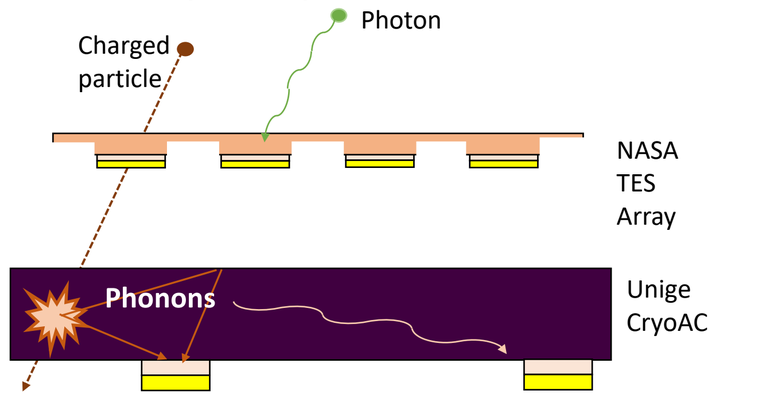
The Advance Telescope for High Energy Astrophysics ATHENA will be a space observatory to study the Universe in its hot and energetic parts. The Athena telescope will have special features. In particular, the scientific objectives require spatial resolution, broad dynamics and X-ray spectral resolution up to few eV.



Lotti S. et al.: "Review of the Particle Background of the Athena X-IFU Instrument." ApJ 909.2 (2021).

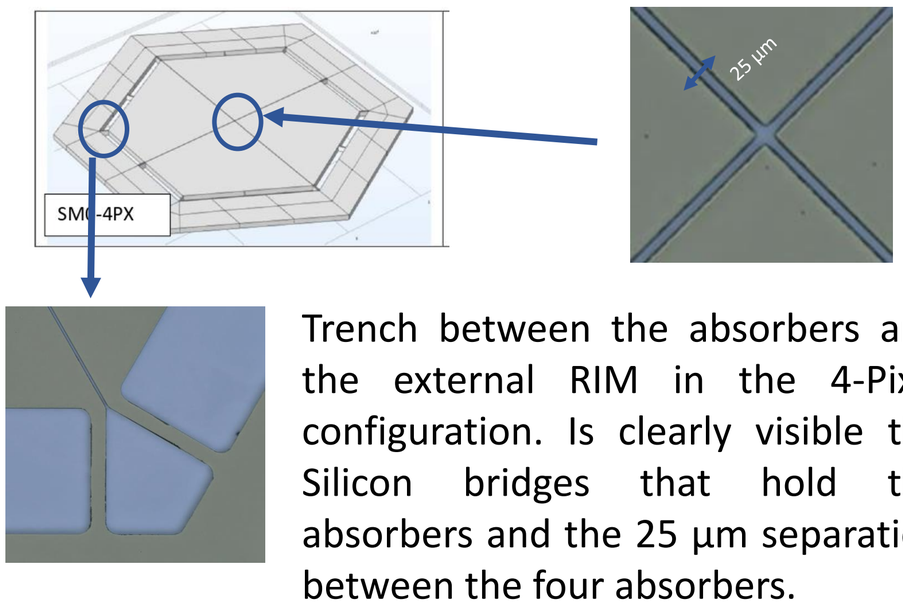




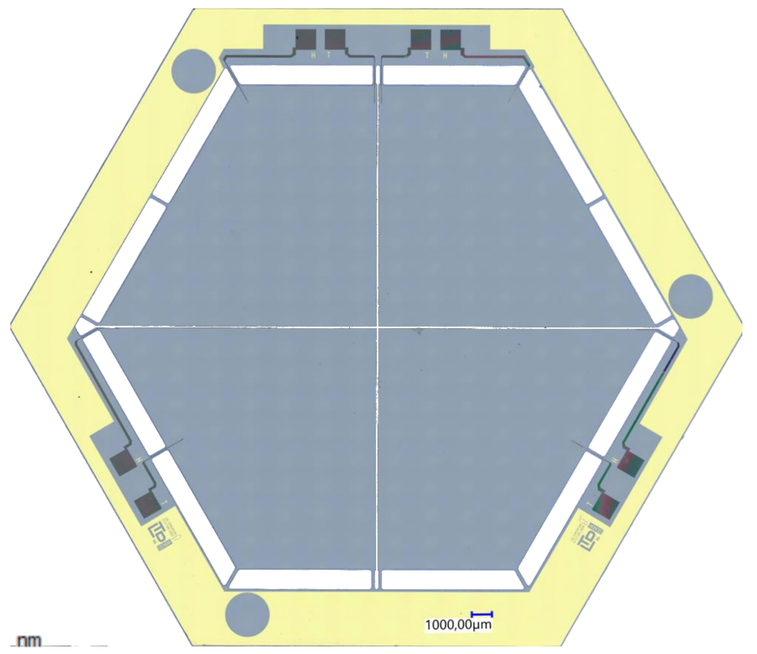
The telescope will operate around the Lagrangian point L-1 where cosmic rays will induce a background signal reducing the observational capabilities of distant or faint sources. The proposed solution is an anticoincidence detector to collect the signal given by charged particles and give a veto to the electronic in order to reject such background. Thus, vibration tests to simulate the launch are of vital interest for the mission.

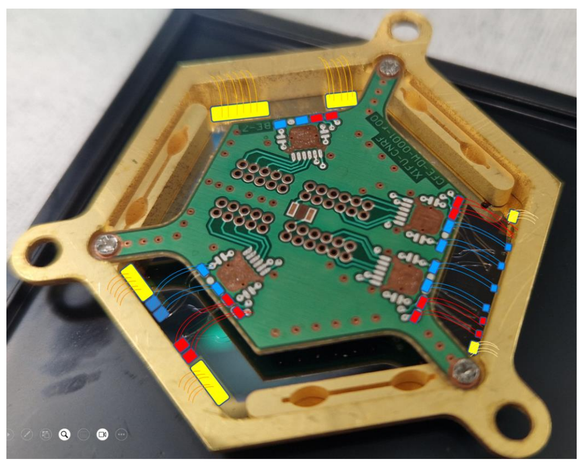
Geometry of the Detector:

4-Pixel, four different freestanding silicon absorber of 500 µm thickness separated by a narrow trench of 25 µm. Each absorber is instrumented with Ir/Au TES connected through Nb wiring. The detector is thermalized through the silicon bridges that provide the sustain to the absorbers and the thermal conductance towards the thermal bath of the gold rim, connected to the cryostat.

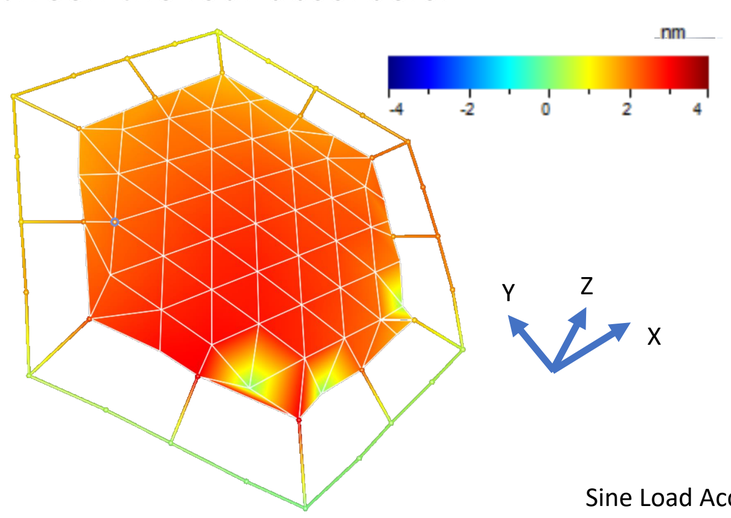


Trench between the absorbers and the external RIM in the 4-Pixel configuration. Is clearly visible the Silicon bridges that hold the absorbers and the 25 µm separation between the four absorbers.



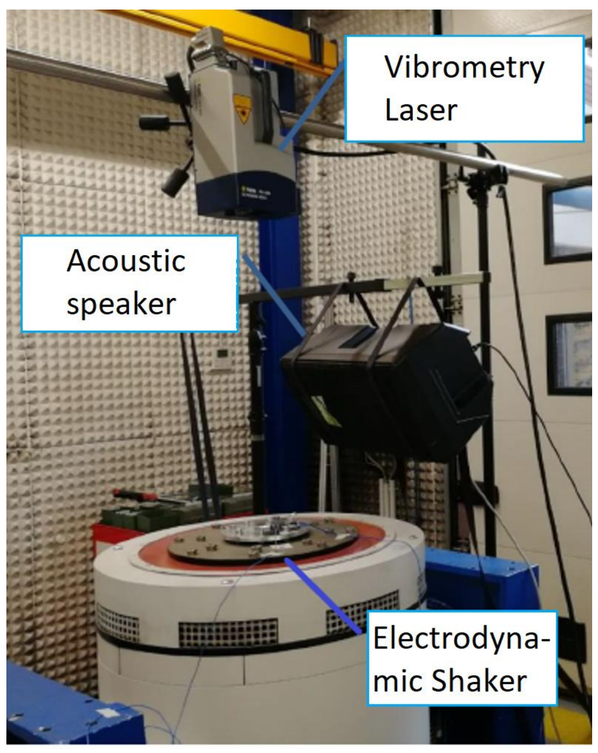


The chip is mounted on gold plated copper bracket mechanical harness and integrated with the Cold Front-End electronics through signal bondings (red and blue). The thermalization is ensured by bondings in yellow.



Displacements over an exagonal dummy detector. The first resonance of Silicon chip mounted on the bracket is at 2.1 kHz.
The assembly lowered and amplified the first resonance compared to tests based on single chip.
DOI: 10.1016/j.nima.2022.167862

Vibration Tests:



Measurement setup, samples have been accelerated with and electrodynamic shaker and displacements read by Laser together with control accelerometers to check vibration modes and couplings.
An Acoustic speaker was used to find resonances at high frequency.

Tests have been performed with the following scheme:

1. Sine Load excitation along Z
2. Random Load excitation along Z
3. Sine Load excitation along X
4. Random Load excitation along X

Before and after each vibration load have been performed a search of resonances to characterize and search for damages of the sample.

On the right the results for the excitation along Z.
In right the response of the chip acquired with the Laser. The sample replicate well the vibration given by the shaker, even if there's an amplification near the first resonance mode.
The characterizations pointed out no damages or modification of the sample. Thus, this assembly is a good candidate for the mission from a mechanical point of view.