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RADIO AMATEURS CLUB

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Rhombus-Shaped Electromagnetic Shield for LNA Protection in Radio Telescopes

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Abstract

This project addresses the challenge of electromagnetic interference affecting the Low Noise Amplifier (LNA) in radio telescopes, particularly when detecting weak signals like the 21.1 cm hydrogen line. We propose a shielding solution inspired by the geometry of heart stents, using aluminum mesh with rhombus-shaped openings. The shield was implemented in cuboid structures with two tested variations: 1 cm and 0.5 cm openings. Theoretical calculations were conducted to evaluate shielding effectiveness. Results showed that reducing the opening size improved shielding by approximately 6 dB, significantly enhancing signal clarity. The design achieves a balance between electromagnetic protection, mechanical strength, and ease of fabrication, making it suitable for sensitive, high-precision systems.

Introduction / Background

Radio telescopes are highly susceptible to electromagnetic interference, which makes it difficult to detect weak astronomical signals such as the 21.1 cm hydrogen line. In this project, we propose an electromagnetic shielding design inspired by heart stents, using rhombus-shaped mesh applied to hollow cuboid structures. Three configurations were analyzed: no shielding, shielding with 1 cm openings, and shielding with 0.5 cm openings.

System Model / Methodology

To protect the Low Noise Amplifier (LNA) of a radio telescope from external noise and interference, we designed an electromagnetic shielding system.
The structure was inspired by the flexible and durable geometry of heart stents, and implemented using a rhombus-shaped mesh for better shielding performance and structural stability.
Aluminum was used to build the shields, which were tested in three configurations:
Full shielding (no openings), shielding with a 1 cm opening, and shielding with a 0.5 cm opening.
Shielding effectiveness was theoretically calculated using the following equation:

SE = 20 log10(λ / 2a)

where:
- λ = 21.1 cm is the wavelength, calculated based on the hydrogen line frequency (f = 1.42 GHz)

using the formula:
λ = c / f, where c = 3x10^8 m/s.
- a is half the opening diameter.

After calculating the SE, the shielding efficiency (%) was computed using the following formula:
Efficiency (%) = (1 - 10^(-SE/20)) × 100

The results for each case were tabulated and compared graphically.

Table 1. Comparisons of Shielding Cases and Their Efficiency.

Shielding Case	Shielding Effectiveness (SE)	Efficiency %
No Shielding	0 dB	0%
1 cm Opening	20.5 dB	90.55%
0.5 cm Opening	26.5 dB	95.28%

Proposed Solution / Main Idea

The main proposal of this project is to design an effective electromagnetic shielding solution for a telescope amplifier, using a structure inspired by heart stents. This solution aims to reduce noise received by the LNA, improving signal clarity for astronomical observations. The shielding is implemented as a mesh in the shape of a cuboid, with two tested variations: one with 1 cm openings and another with 0.5 cm openings. The methodology involved mathematical calculations to estimate the shielding effectiveness of each design. Results showed that the 0.5 cm mesh provides significantly better protection by minimizing electromagnetic interference. This solution balances shielding performance, structural strength, and ease of fabrication, making it ideal for use in sensitive electronic systems.

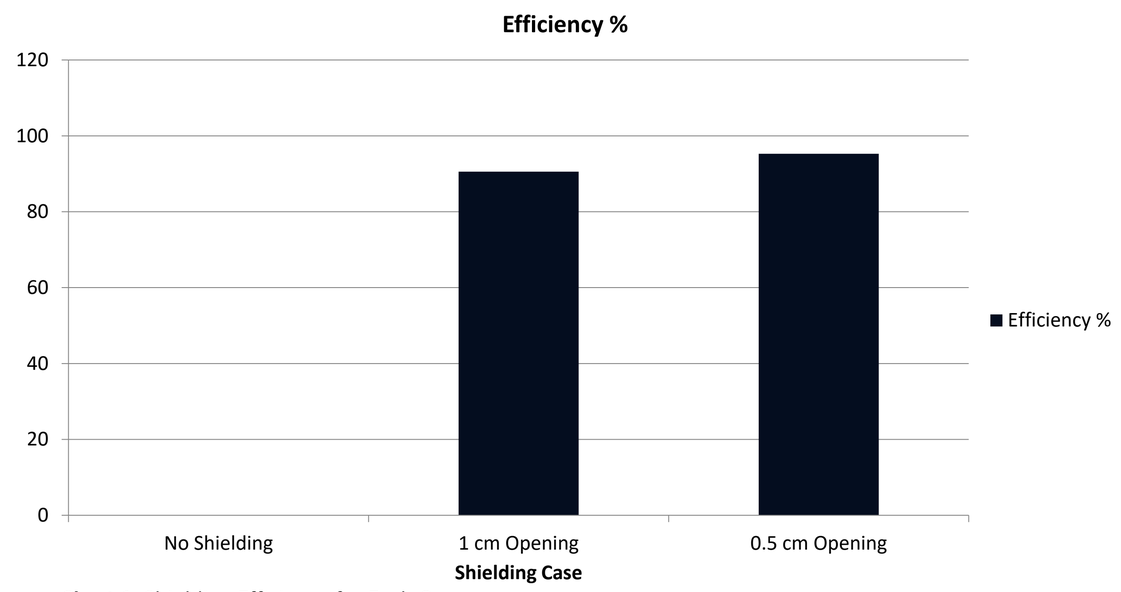


Chart 1. Shielding Efficiency for Each Case.

Results / Simulation / Discussion

The results showed a clear relationship between aperture size and shielding efficiency. In the absence of shielding, the signal was heavily affected by interference, resulting in 0% efficiency. With a 1 cm aperture, shielding efficiency improved to 90.55%, and the hydrogen line became visible. When the aperture was reduced to 0.5 cm, the efficiency increased to 95.28%, and the signal appeared much clearer. These findings confirm that small changes in the mesh design can lead to major improvements in performance, especially in sensitive systems such as radio telescopes.



Figure 1. Shielding model with 1 cm opening.

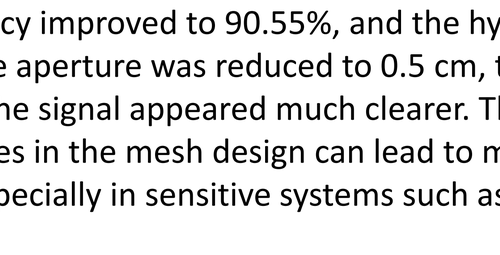


Figure 1. Shielding model with 0.5 cm opening.

Conclusions

The proposed electromagnetic shielding design, inspired by the geometry of heart stents and constructed from aluminum, proved effective in reducing electromagnetic interference. Tests showed that smaller openings (0.5 cm) significantly improved shielding efficiency, enhancing signal clarity by approximately 6 dB. This makes the design a practical and efficient solution for protecting sensitive components such as Low Noise Amplifiers (LNA). Overall, the theoretical results showed promising performance and suggest that this design could be applied effectively in real-world astronomical systems requiring precise electromagnetic protection.

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