Abstract
This project is to find the optimal configurations in order to detect and locate a gamma ray burst upon its occurrence. We alter the angles between detectors, the thickness and material of casing, and the energy range of recorded detections to determine the best detection rates and localisation ability. The data samples themselves were obtained through computer simulation of gamma ray burst detections in space. Our results indicate that an angle of 45 degrees and a casing made of iron, with the detector looking at an energy band of 60 - 350 keV yields the greatest detection rate and accuracy in localisation.

Introduction
Gamma Ray Bursts (GRBs)
Gamma ray bursts are the most powerful explosions in the universe. Occurring across the universe, they remain visible even from distant galaxies, due to their highly energetic nature. As seen in figure 1, these explosions are followed by an “afterglow”, a source of lower energy photons relative to gamma rays. After numerous efforts to provide an explanation regarding the nature of gamma ray bursts, many open questions remain. The most prominent theory as to the progenitor of short GRBs is a neutron star merger. This has received significant validation after a GRB detection following a gravitational wave on 17th August 2017.

The telescope will be capable of viewing a 19° by 19° area of the sky, and so our detector must be of equivalent accuracy or better. Since we do not know how long it takes the afterglow to appear, speed of detection and precise localisation are required, so that the WFI can view the afterglow, as close as possible to its initial appearance.

Our goal is to determine the optimal gamma ray detector configuration in relation to given restrictions and requirements, and only using up to five standard cylinder-shaped sodium iodide detectors due to heritage requirements.

Methods
Simulations
We simulate possible scenarios to find the ideal detector configuration using a simulation software called MEGAlib[2]. We would create a series of different layouts, and then implement them to get photon detection data. This data is then analysed to evaluate the effectiveness of each design.

We controlled the orientation and position of the detectors, then tested all of these configurations in an iterative manner, in order to find the optimal positions.

Results
In figure 4, all values more than a specific distance from the minimum comprise an area where we could be certain from where the burst came, to a specific percent. In this graph, that area is the darker shades of blue. As you can see, the graph dips at around 40 by 150, where we simulated the burst to come from, indicating a successful localisation.

In addition to these results, we found an increase in detector sensitivity to gamma ray bursts when using the energy range 60 - 350 keV rather than the standard 50 - 300 keV, leading to a 14.2% increase in detections per year.

Conclusions
The data suggests that we have optimal balance between localisation and detection capabilities when the detectors are tilted 45° from vertical. Steel is more effective at blocking low energy photons than aluminium which translates to an increase in localisation accuracy, whilst the obstruction drops faster at higher energy for steel, so there is a minimal decrease in GRB detection. The increase in detection in the 60-350 keV range is due to the fact that this energy range starts from the point at which the gamma-ray photon background function[3] features a large reduction in background photons, until the point where the chosen Band[3] GRB function features a similar break, and so we’ll find a large surplus of GRB photons over background photons.

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References