GIFTS

Gamma-ray Investigation of the Full Transient Sky

Alexey Uliyanov, David Murphy, Joseph Mangan,
Rachel Dunwoody, Sheila McBreen

University College Dublin

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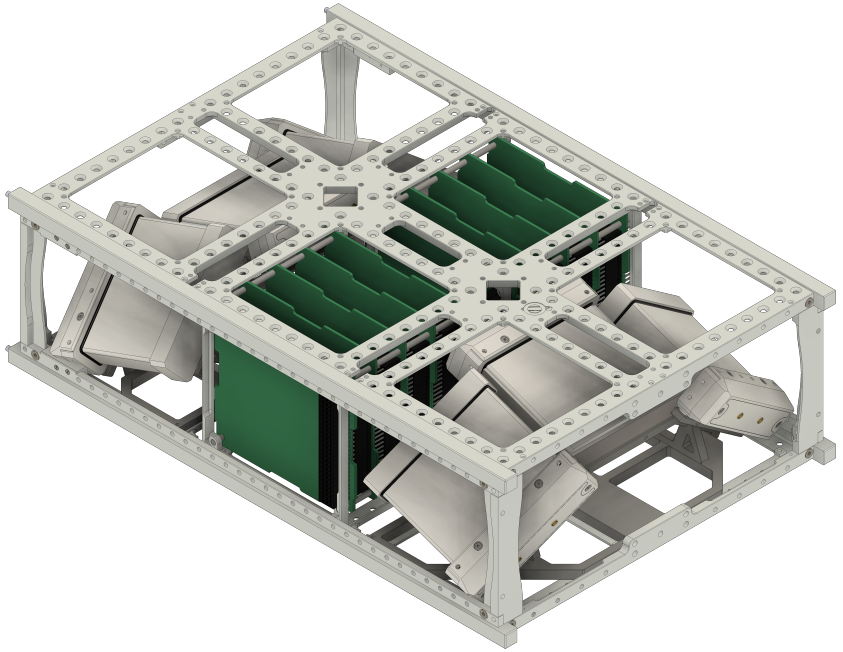
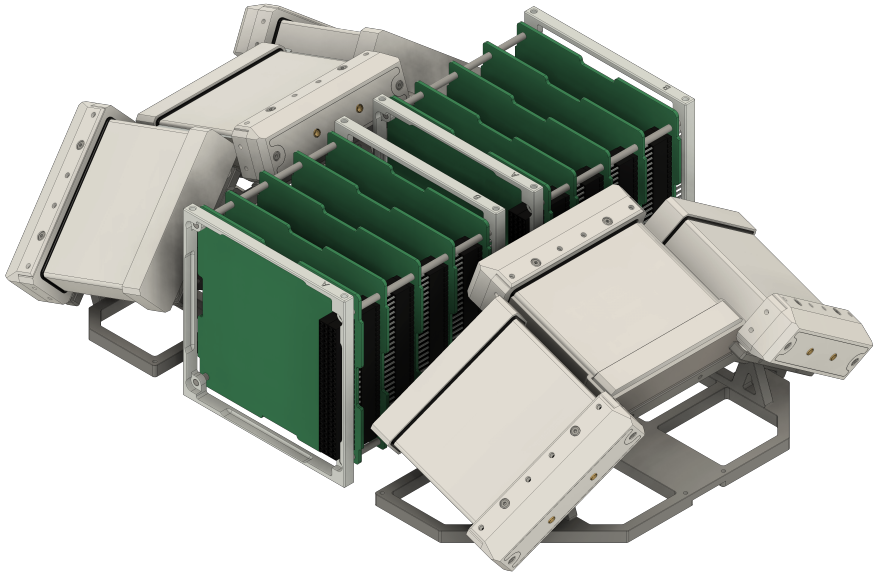
GIFTS project

- GIFTS is a CubeSat project funded by Science Foundation Ireland (PI: Sheila McBreen)
- Inspired by and similar to BurstCube – a CubeSat with a GBM-like instrument capable of GRB localisation
- Successor to the GMOD/EIRSAT-1 project (CeBr3/SiPMs/SIPHRA)
- So far the project has been focused on preliminary instrument design, simulations and detector prototyping
- Funding has now been obtained to build a complete CubeSat

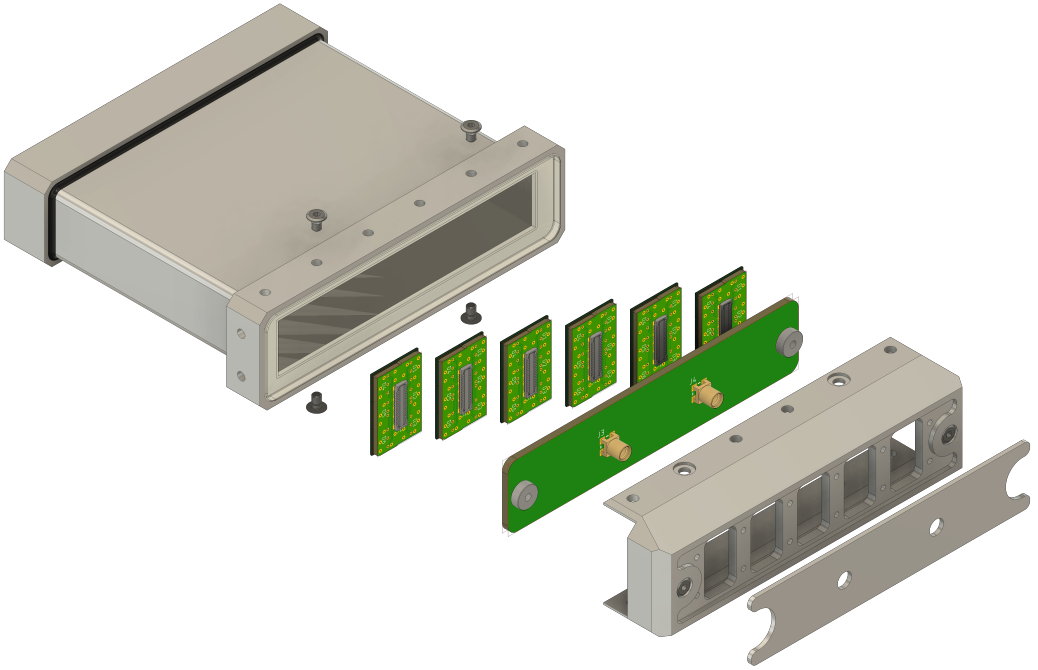
Instrument configuration





- Baseline configuration is built around the GOMspace Standard 6U platform
  - Also compatible with AAC Clyde Space structure and electronics
- Six CeBr3 detectors inclined at different angles
- The spacecraft electronics stack is placed between the two clusters to minimise obstruction of the field of view of the instrument

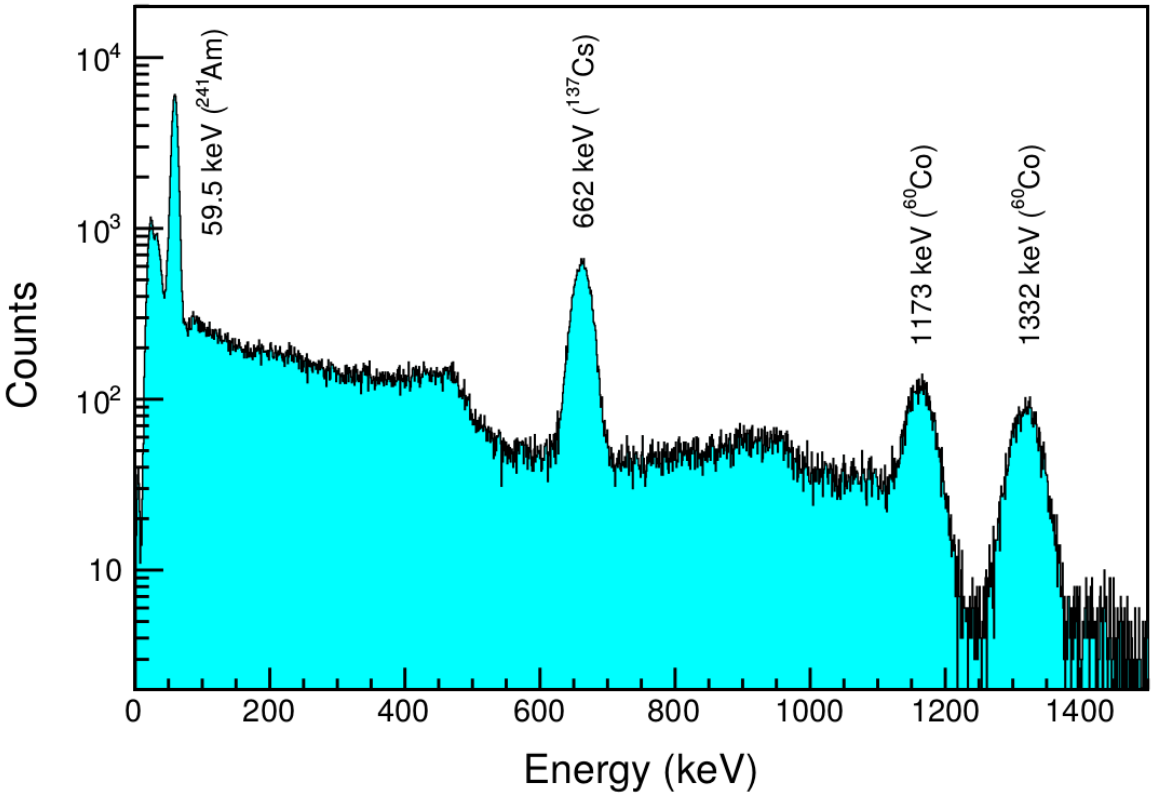
Detector module



- 70 x 68 x 13 mm CeBr3
- 1 mm thick aluminium enclosure
- 2 mm thick quartz window connected to a side of the crystal

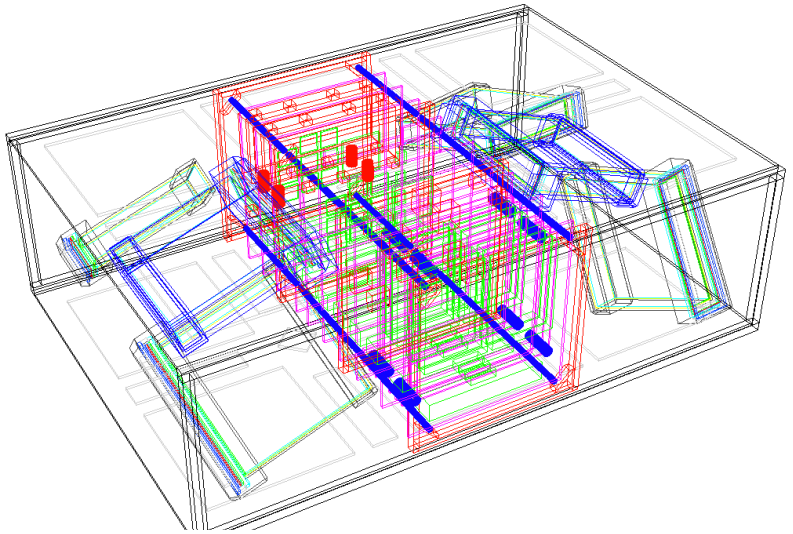
- 3x12 array of onsemi J-Series SiPMs composed of 6 separate subarrays and a carrier board
- Backshell provides array support and light-tight enclosure

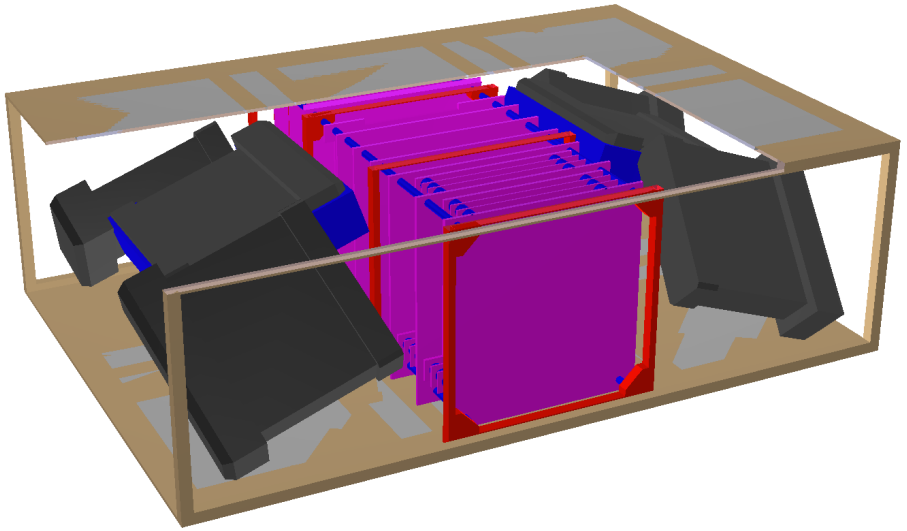
Scintillator test with a PMT and a mixed source



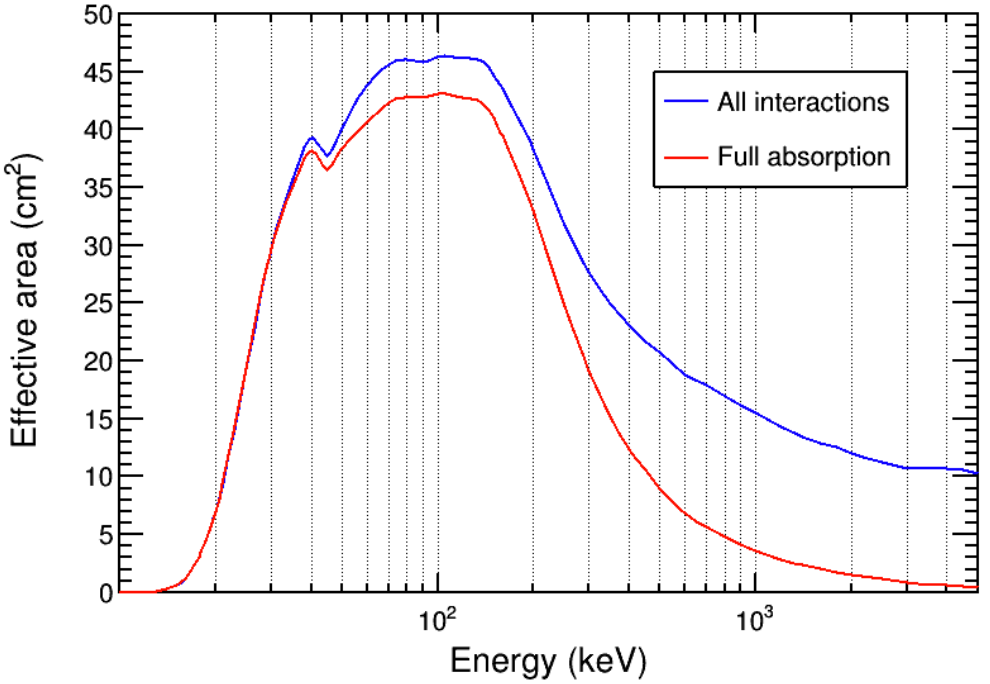
- The light output of this scintillator assembly is 10-20% lower compared to “standard” CeBr3 crystals.
- The energy resolution is 16% at 59.5 keV and 4.7% at 662 keV.
- SiPM arrays are to be built in 1-2 months.

MEGAlib simulations

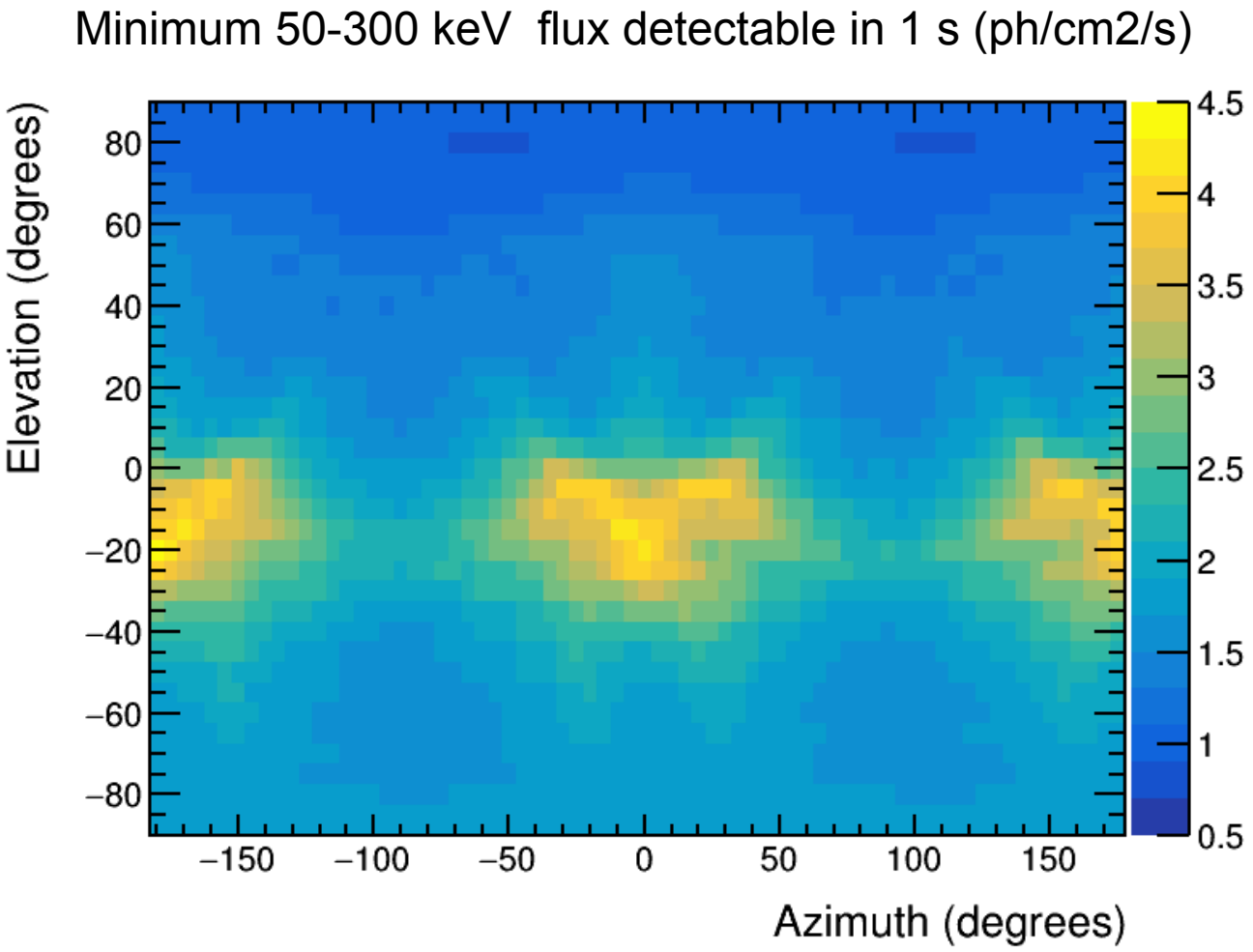




Single detector effective area is 43 cm^2 at 100 keV and $\theta = 0^o$



Expected GRB sensitivity



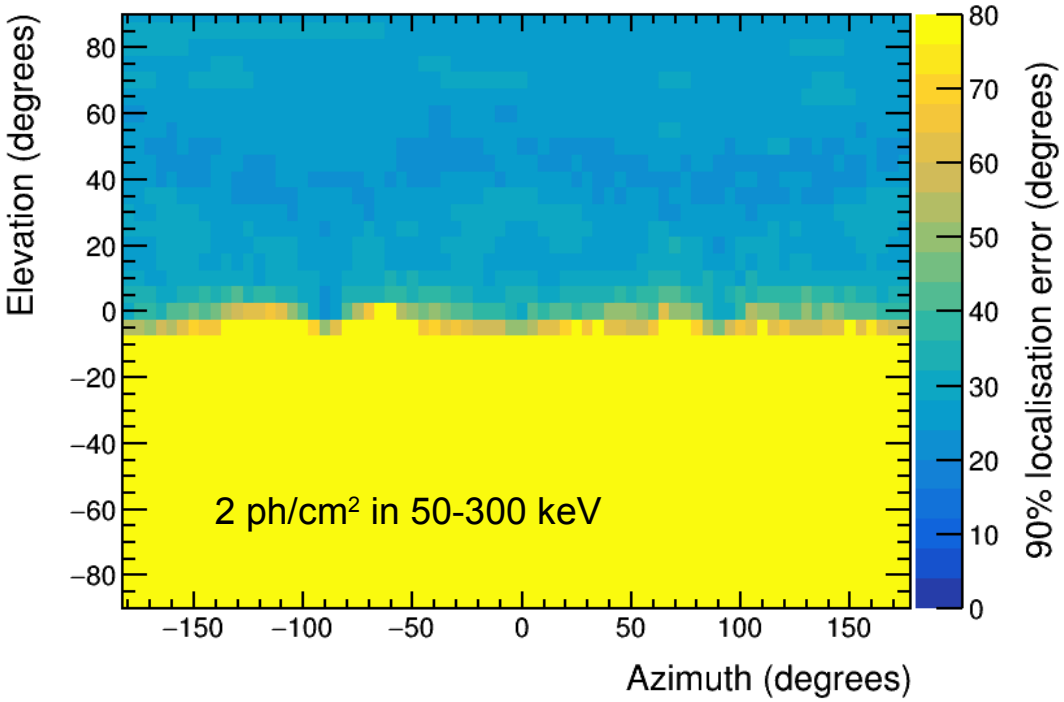
Detection threshold:
4.5σ excess rate in two detectors

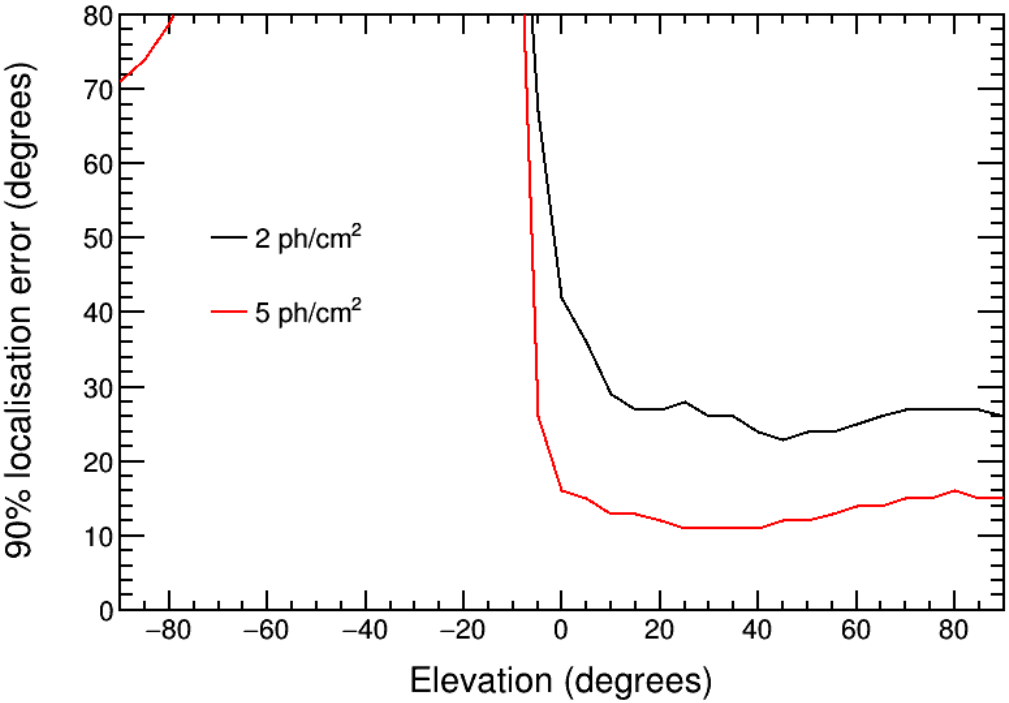
The flux detectable in 1 s:
1-2 ph/cm2/s in 50-300 keV depending on source location

Two “blind” spots just below the horizontal plane where the minimum detectable flux increases to 4 ph/cm2/s (source is facing the sides of the detectors)

GRB localisation performance

90% localisation error for a 1 second GRB





Above the instrument, the localisation error < 30° for 90% of the GRBs near the detection threshold (2 ph/cm^2) and the localisation improves for brighter bursts.

Poor localisation for GRBs below the instrument.

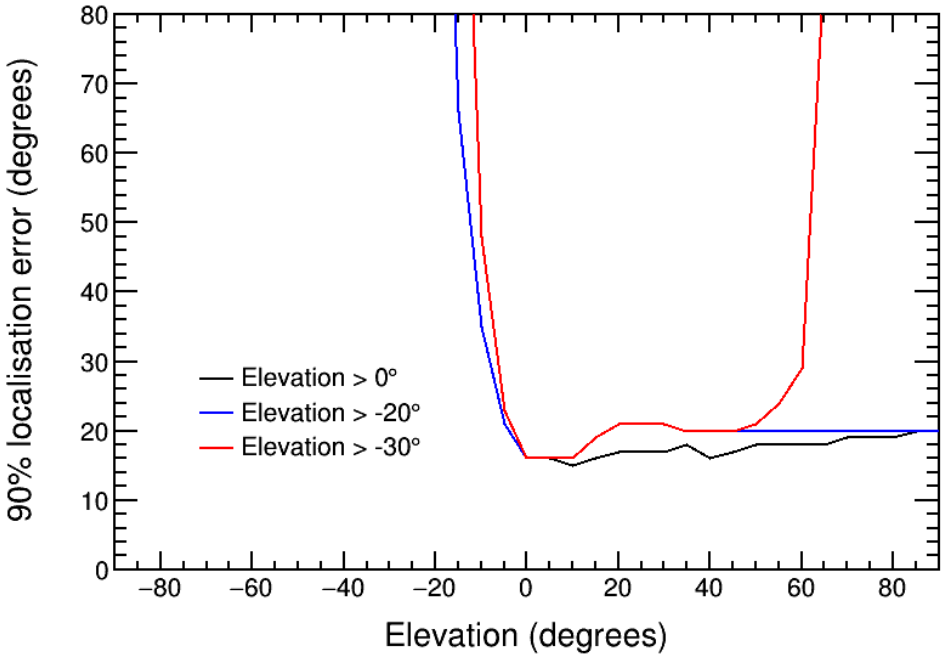
Performance summary

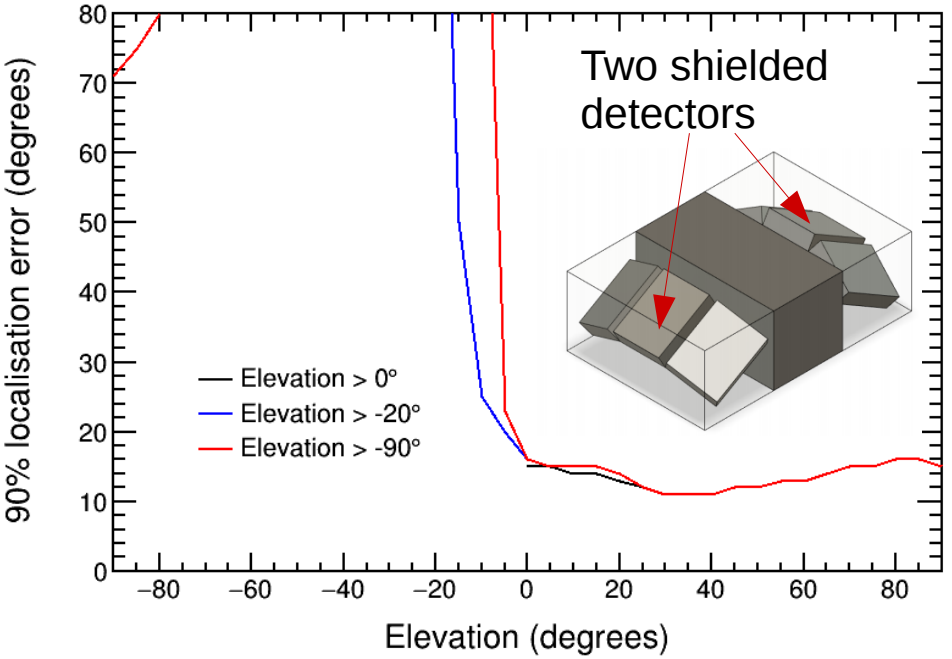
- Assuming an 80% observation uptime, GIFTS should be able to detect and localise over 70 GRBs per year including 11 short GRBs.
- In addition, it will detect a number of bursts in the sky below the satellite, however those GRBs will not be well localised.
- With improved coverage and sensitivity of the GW interferometer network in the O5 run, the expected rate of coincident GIFTS-GW detections is 0.5 to 2 per annum.

Thank you for your time!

GRB localisation with 6 detectors

1-second GRB, 5 ph/cm^2 in 50-300 keV





- Using 6 detectors helps to improve the localisation but still has issues if the GRB search is expanded to -30°.
- The problem is solved by adding 2 mm Pb shielding to the bottom and sides of the 2 middle detectors which helps to distinguish the source locations above the instrument from those below the instrument. The search field may then include the entire sky (-90° to +90°)