U.S. NAVAL RESEARCH LABORATORY

The MERGer-event Gamma-Ray (MERGR) Telescope

MERGR is designed to detect and localize Gamma-Ray Bursts (GRBs) – particularly the short GRB electromagnetic counterparts of gravitational wave detections of neutron-star binary mergers. Employing proven technology, it can be delivered on an aggressive schedule for launch by the DoD Space Test Program in 2021.

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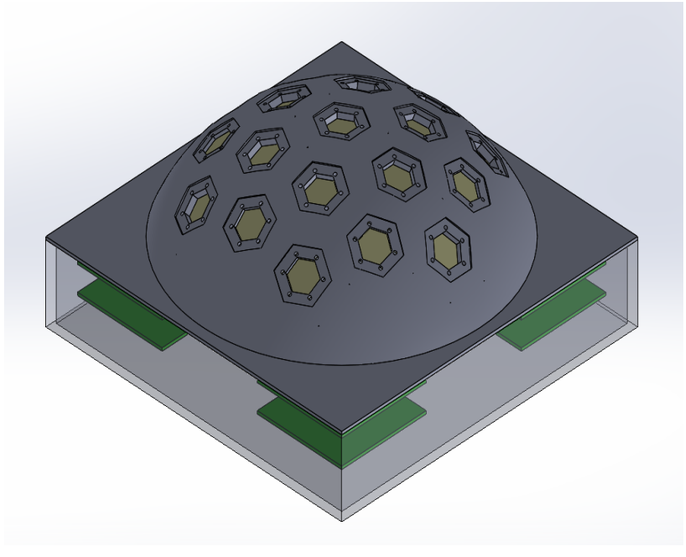
MERger-event Gamma-Ray (MERGR) Telescope

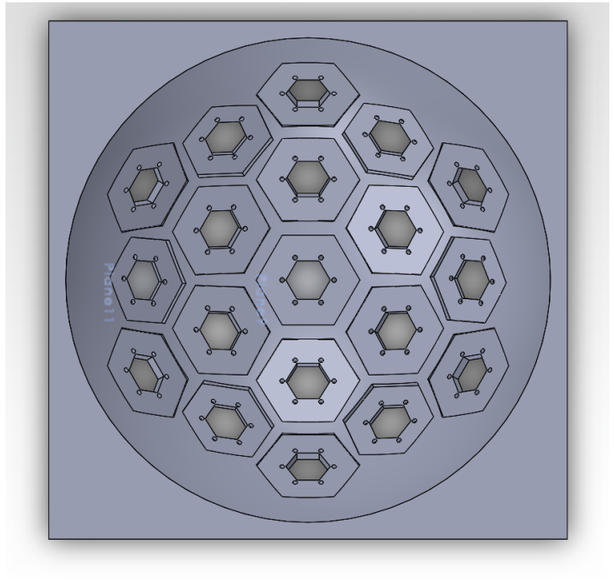
Motivation and plan

- With the announcement of GW170817, the era of gravitational wave detections of neutron star (NS) binary mergers has begun.
- MERGR will work as a standalone system or as part of a network of telescopes. It will increase γ-ray sky coverage to detect the short GRB (SGRB) counterparts of NS-binary mergers.
- To minimize cost and time to first light, MERGR is derived directly from the Strontium Iodide Radiation Instrumentation series (SIRI-1 and SIRI-2) demonstrators designed and built at NRL for the DoD Space Test Program.

Telescope Design

- MERGR consists of 19 Detector Assemblies, each with a 3.8 cm x 1.27 cm hexagonal SrI_2:Eu crystal read out by a hexagonal array of silicon photomultipliers (SiPMs).
- SrI_2:Eu has high density (4.2 g/cm^3), good stopping power, and excellent energy resolution.
- Total mass 13 kg, and total power 21 W.





Right: CAD rendering of MERGR from the instrument's zenith showing the locations of the 19 hexagonal detectors in a closely-packed dome geometry.

Left: Off-axis view showing MERGR's electronics bay.

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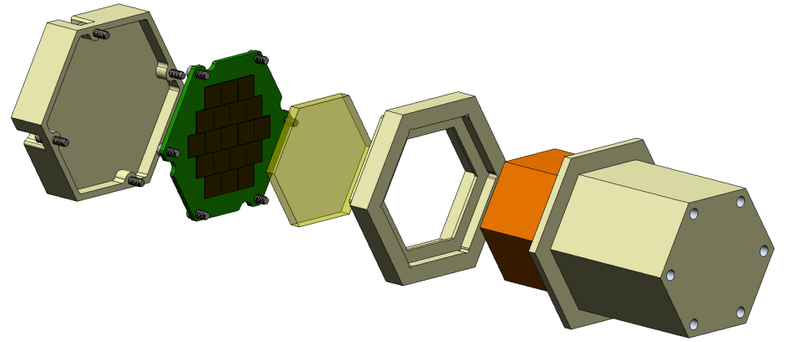
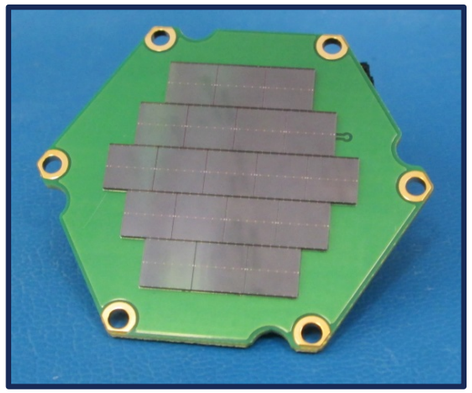
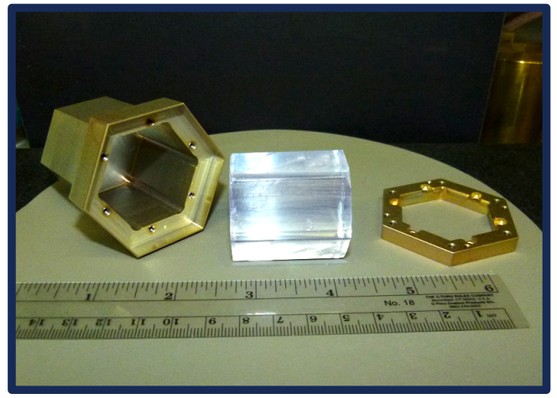
Technology readiness

- MERGR inherits directly from two instruments, SIRI-1 and SIRI-2, that we developed for DoD Space Test Program (STP) launch.
- SIRI-1 will space-qualify strontium iodide scintillators and SiPM readouts. It has been delivered to the spacecraft vendor and is scheduled for launch into LEO on STPSat-5.
- SIRI-2 is a follow-on detector array of seven SrI_2:Eu detectors for atmospheric burst monitoring, scheduled to launch into GEO in late 2018 onboard STPSat-6.
- We have proposed to design, assemble, and test MERGR to deploy by 2021. The DoD STP provides a launch opportunity and funds for its integration into the spacecraft bus, launch services, and the first year of experiment data collection.
- Using existing algorithms developed and tested at NRL, instrument flight software will provide real-time burst detections and locations, which will be transmitted to the Gamma-ray Coordinates Network for worldwide distribution.







SrI2:Eu detectors developed for use on SIRI-2. MERGR detectors would be identical, expect for thickness. (Top) Exploded CAD rendering of detector assembly. (Bottom left) 19-element SiPM array developed by NRL for read out of hexagonal crystals. (Bottom right) SIRI-2 flight model hexagonal crystal prior to installation into detector housing.

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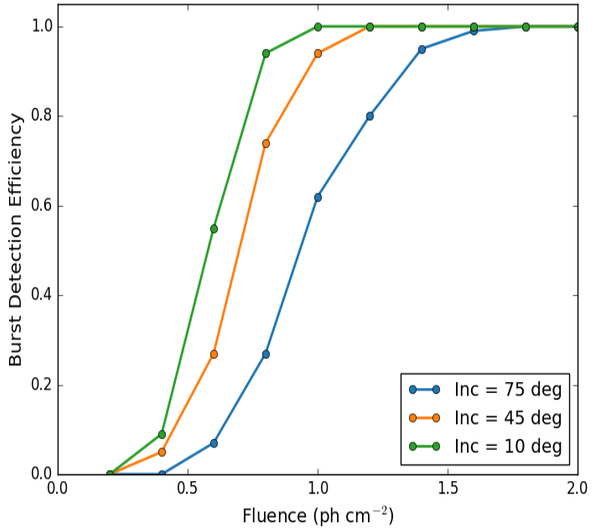
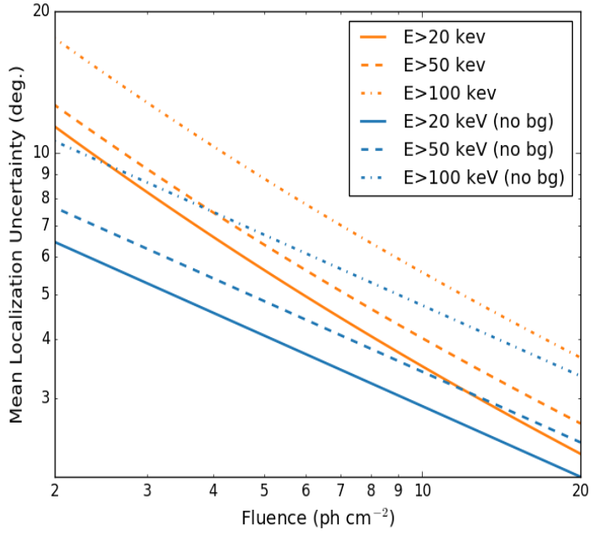
Instrument performance

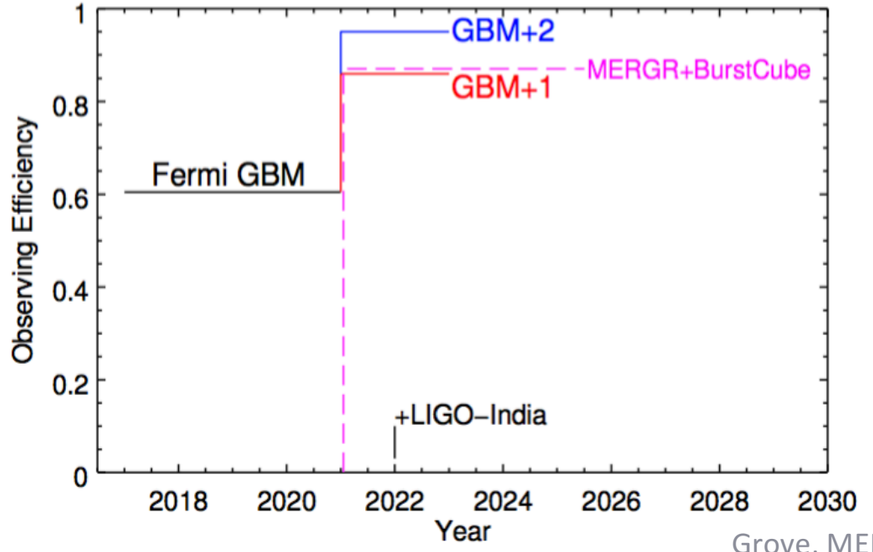
- Sensitivity to E=20 keV to 2 MeV γ-rays, with 4% spectral resolution at 662 keV. Large field of view ~6 sr (half sky).
- High detection efficiency for GRBs: 100% for fluence >1.5 ph/cm^2 within FOV (below left).
- Localizations, 68% radii of 6 deg (and <3 deg) for mean (and brightest) fluence Fermi GBM SGRBs (below right).





Increased observing efficiency

- In concert with Fermi GBM, an additional large-FOV γ-ray instrument will increase the observing efficiency (i.e. fractional sky coverage) from ~60% (black) to ~85% (red), with 40-45% overlap in sky coverage.
- Addition of a third instrument (blue) will further boost observing efficiency to ~95% of the sky with ~65-70% overlap.
- Joint MERGR + BurstCube[1] efficiency in the absence of Fermi GBM is indicated in magenta.



[1] Racusin et al., 2017, 35th ICRC, arXiv:1708.09292