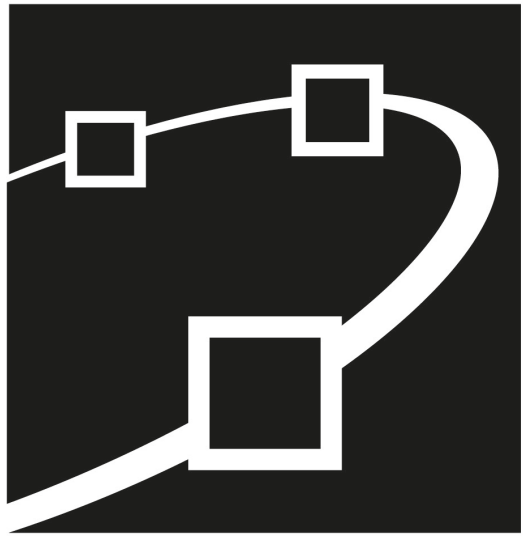


GIFTS

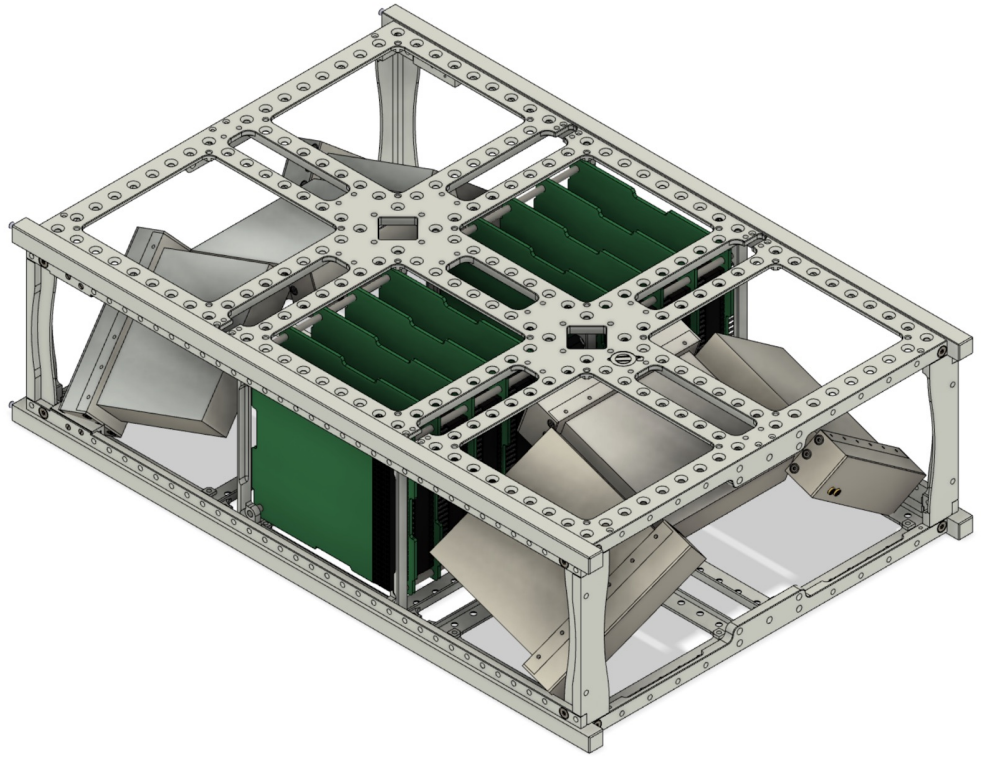
Gamma-ray Investigation of the Full Transient Sky

Cuán de Barra, Derek O'Callaghan, Alexey Ulyanov, Pádraig Mac Dermott, Sheila McBreen

Fermi Summer School – June 2024

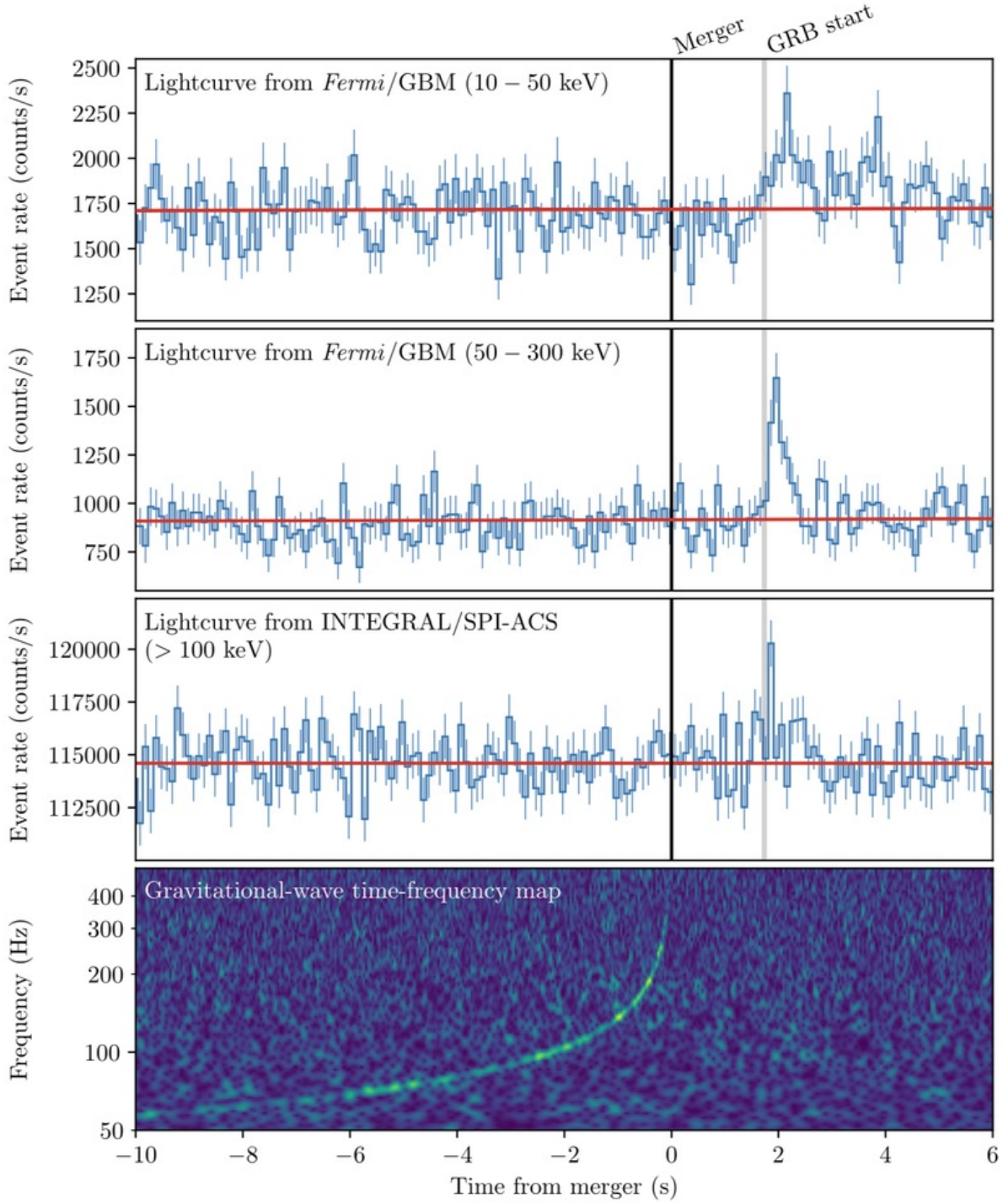
Mission Overview

- A 6U CubeSat mission designed to observe and localize transient gamma-ray events from low Earth orbit.
- Detector heritage has been developed in-house and on the *EIRSAT-1* CubeSat.
- *GIFTS* takes inspiration from a number of other missions:
  - NASA's CubeSat mission *BurstCube*
  - *Fermi* GBM
- *GIFTS* will detect ~70 GRBs per year,
  - 11 short GRBs
  - ~0.5 to 2 GRBs coincident with GW events



Science Motivation

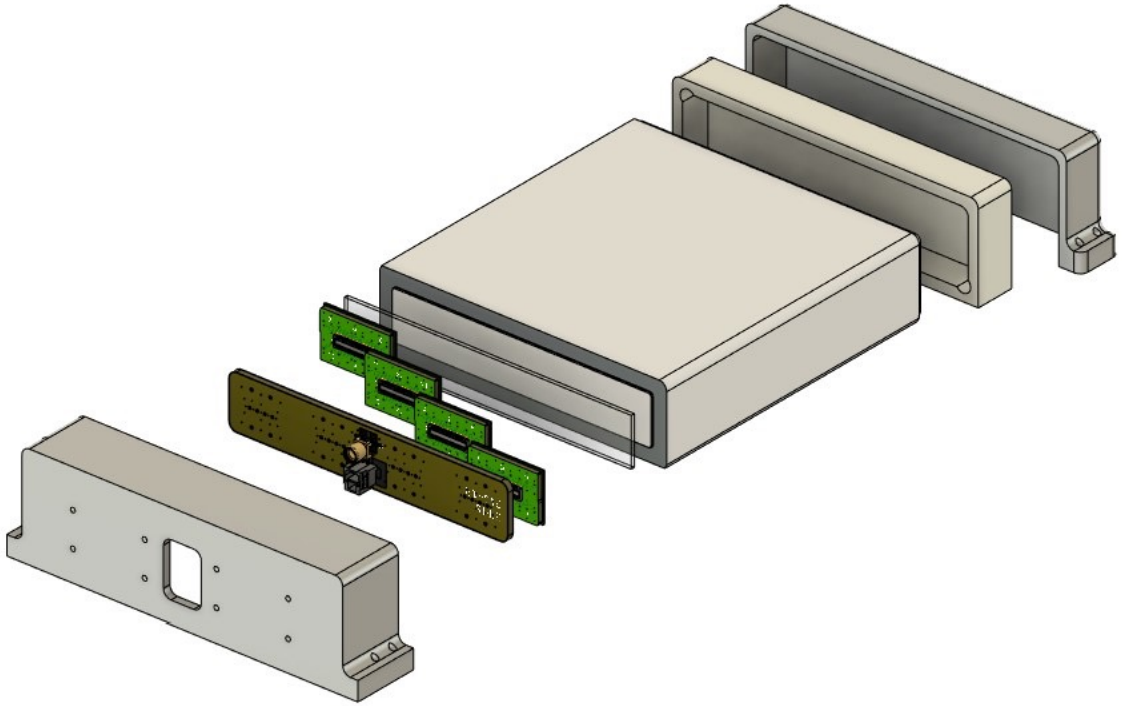
- GRB 170817A/ GW170817
- What is the future for telescopes in this energy range?
- Small satellites with comparable effective areas can increase sky coverage
- Examples include…
  - *BurstCube*
  - *HERMES*
  - *GRBAlpha*
  - *EIRSAT-1*

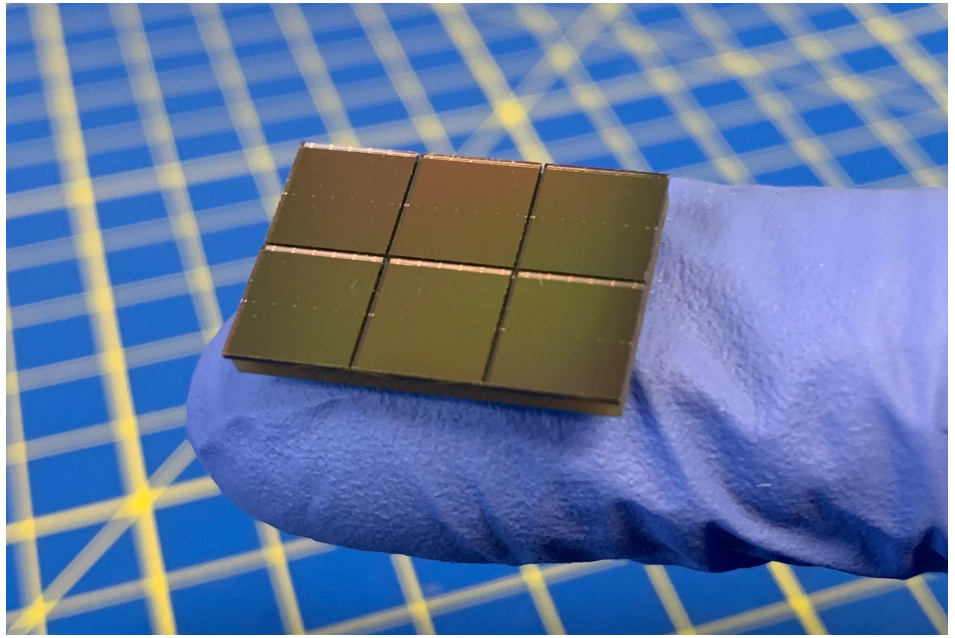


J. Perkins et al., 2020
G. Ghirlanda et al., 2024
J.Rıpa *et al., 2022*
D. Murphy., 2022

Detector Payload

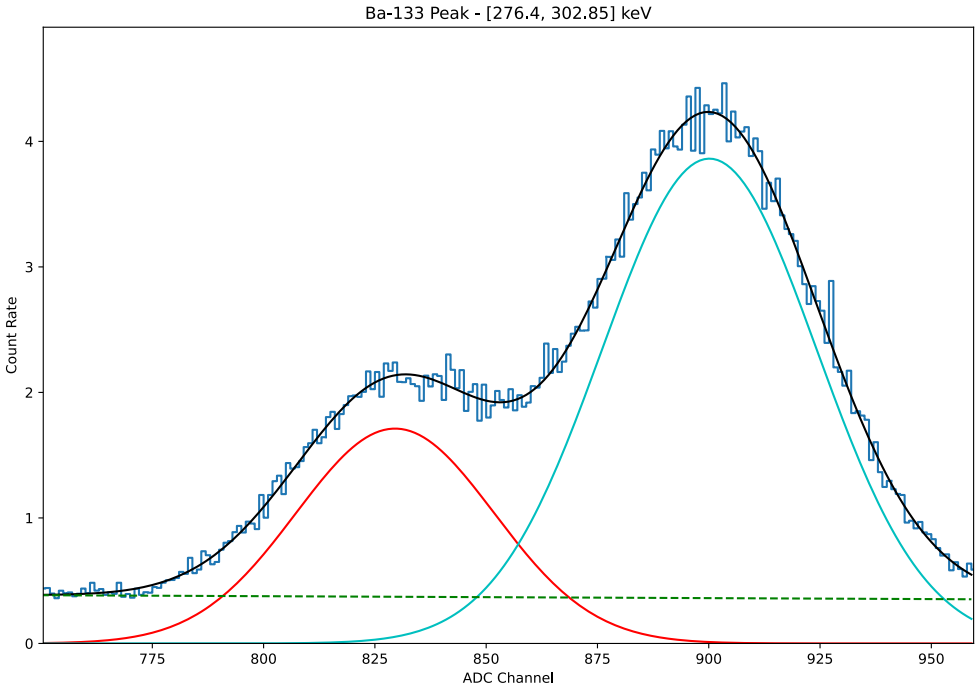
- 6 novel scintillator detectors, suitable for the 50 keV – 300 keV GRB energy range.
- Each detector consists of
  - A monolithic Scionix $CeBr_3$ scintillator crystal housed in an aluminum casing.
  - Silicon optical interface pad
  - OnSemi J-Series SiPM array
  - Readout PCB
  - IDEAS SIPHRA ASIC (x2)

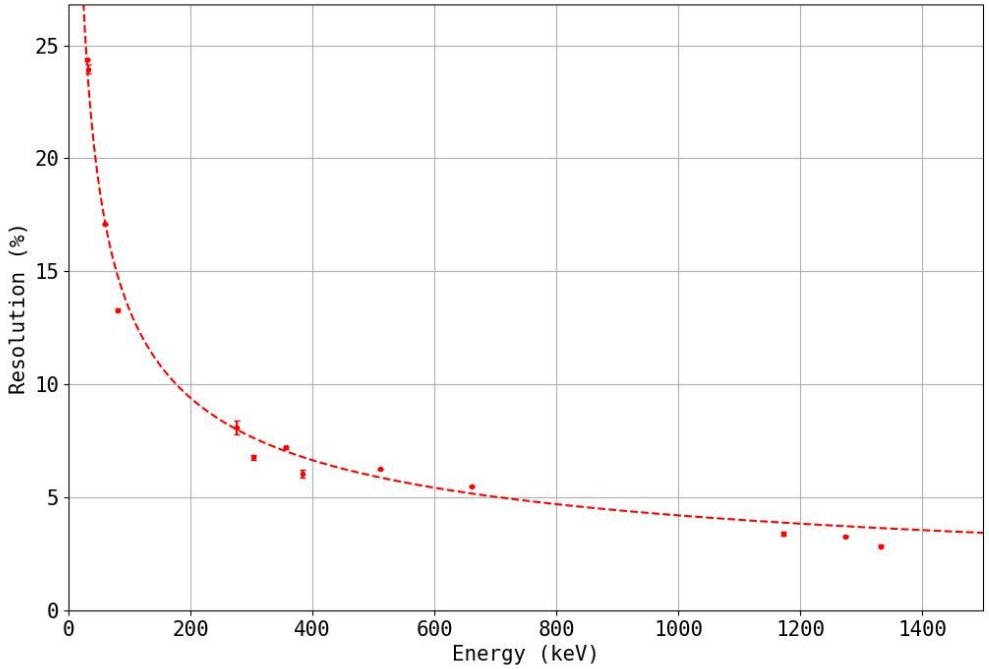


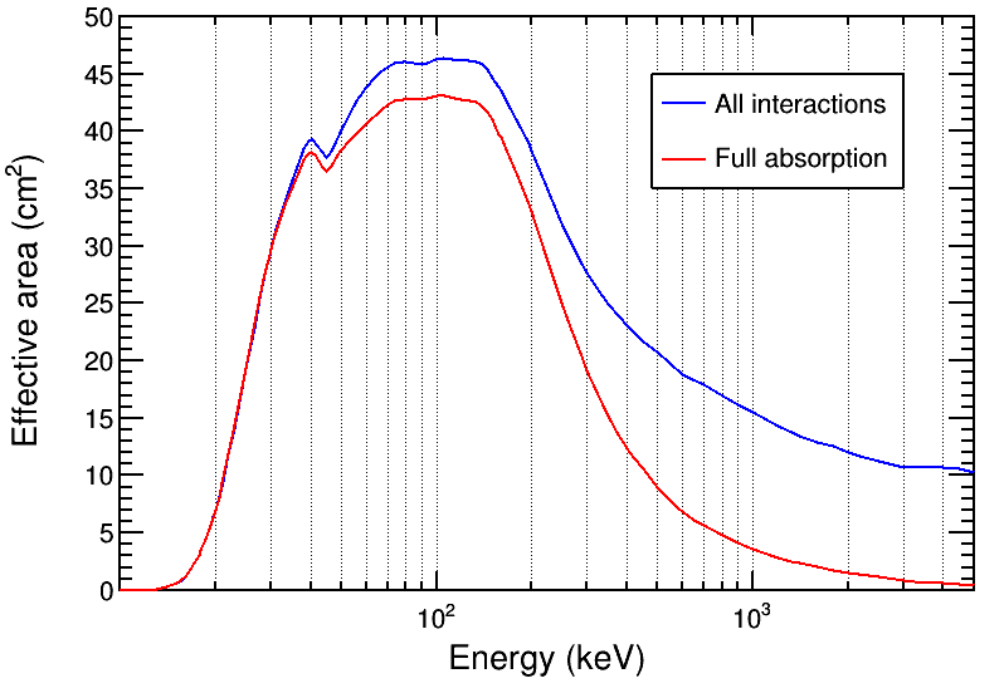


Scintillator Performance

- $CeBr_3$ has benefits for use in detector
  - High light yield (68 photons/keV)
  - Fast decay time (~20 ns)
  - Low intrinsic background
  - *GIFTS* Spectral resolution (5.5% @ 662 keV)

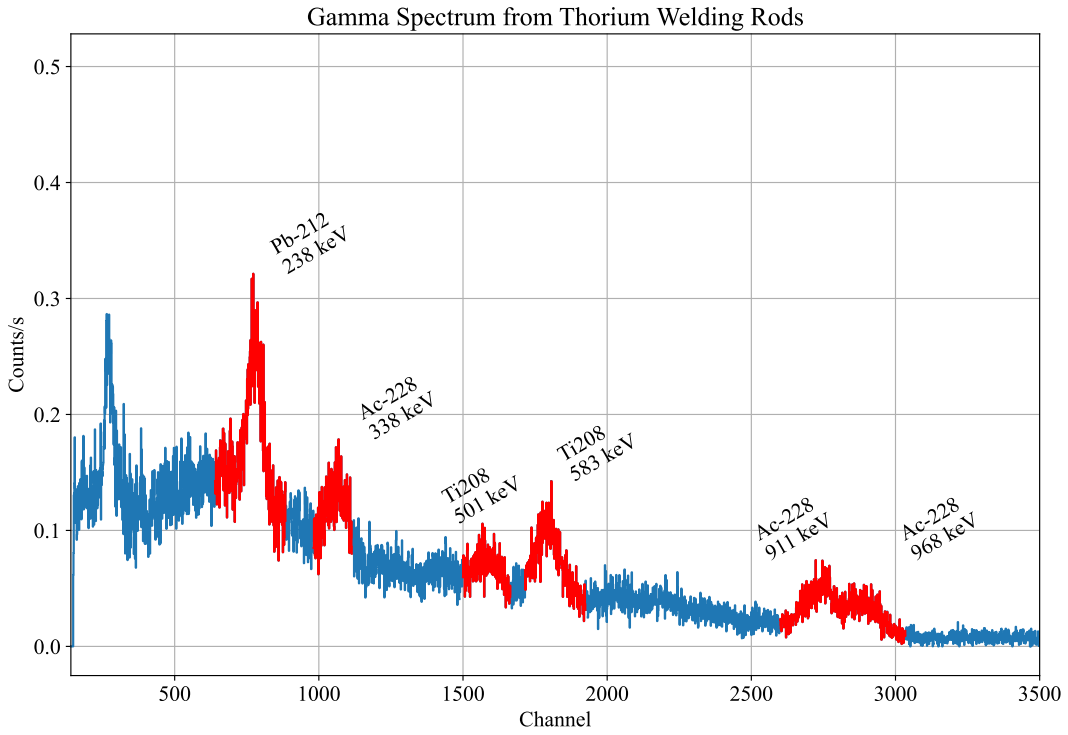


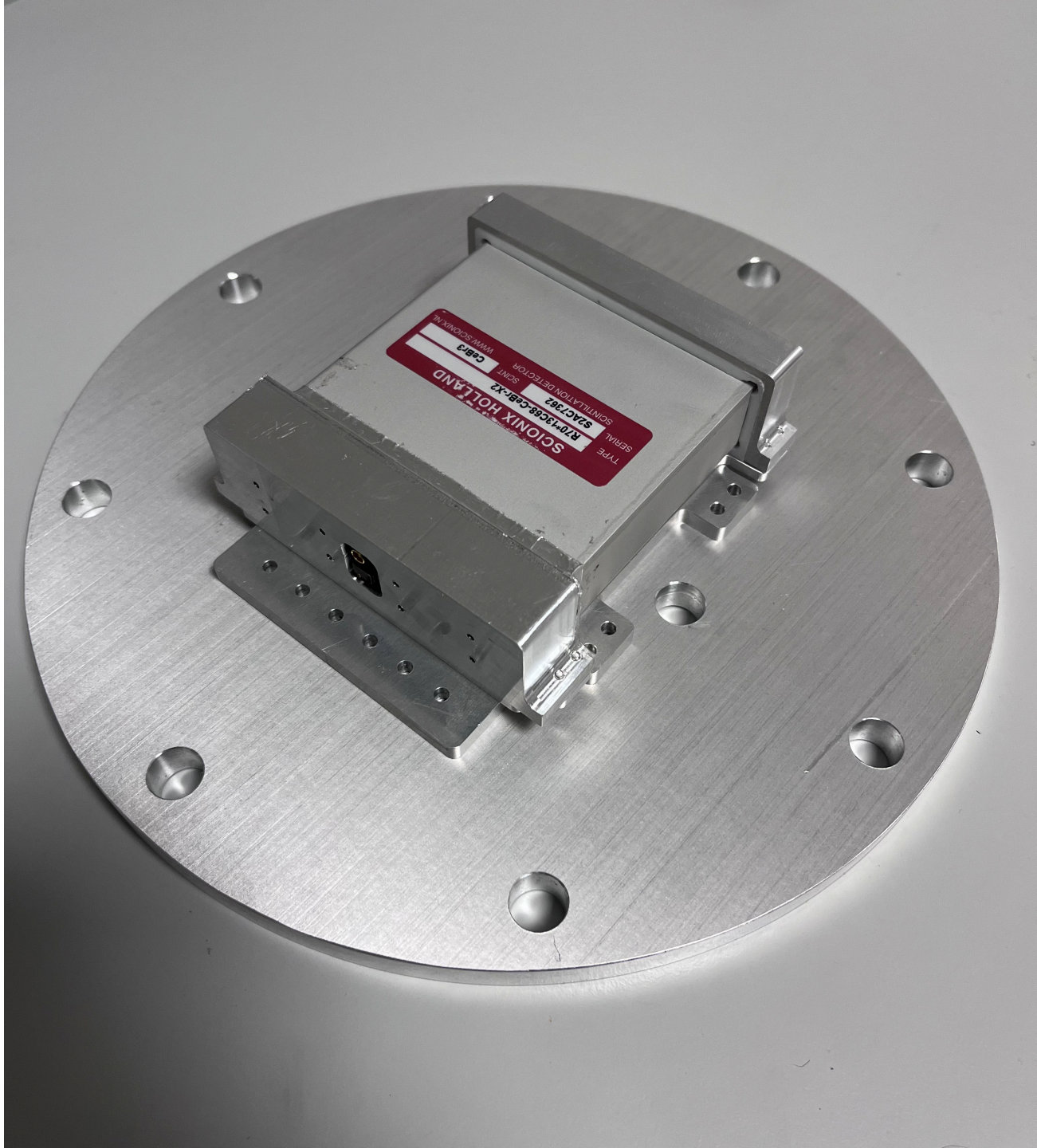




Detector Prototype

- Hot off the press!
- Developed for feasibility thermal and vibration testing
  - June 2024

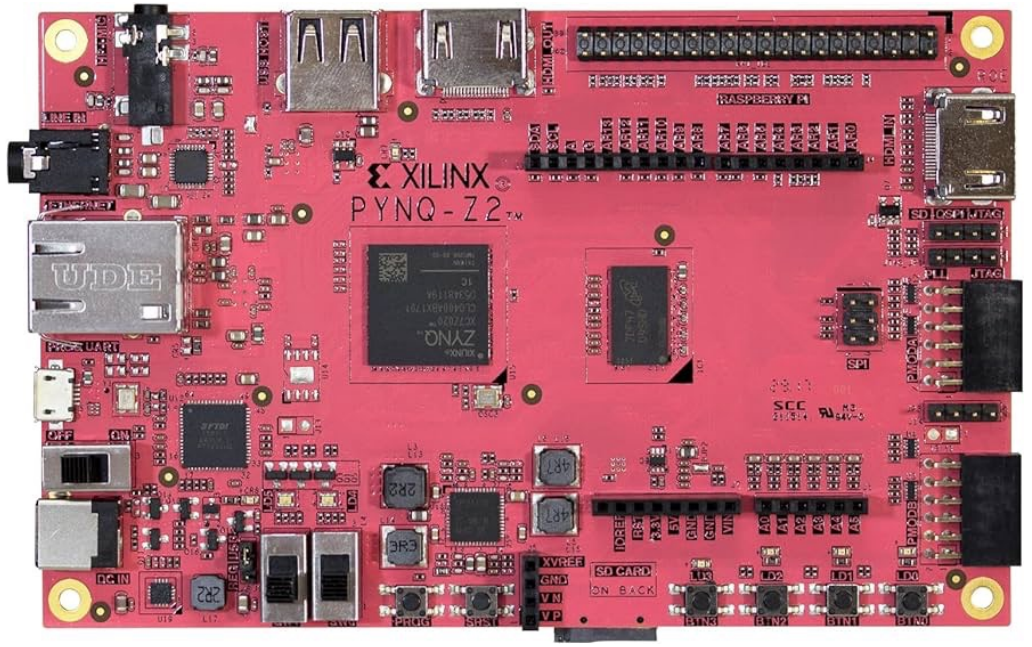




On-Board Processing

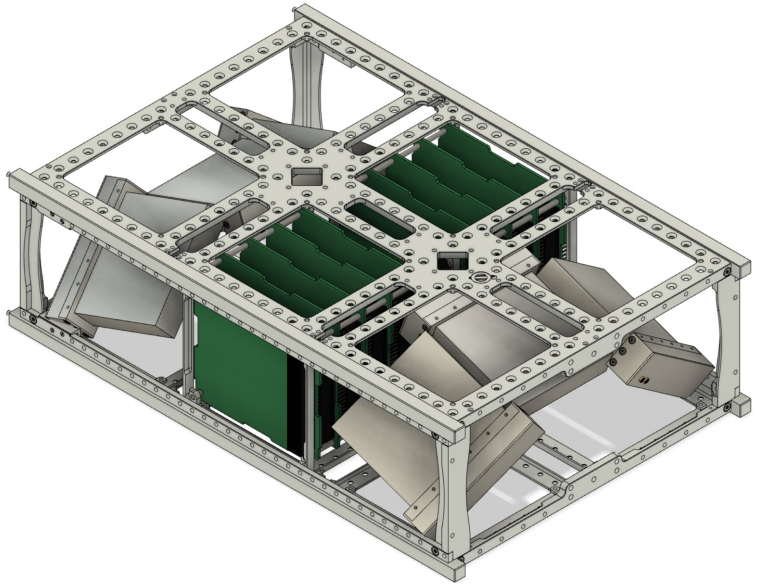
System on a Chip will perform all onboard processing

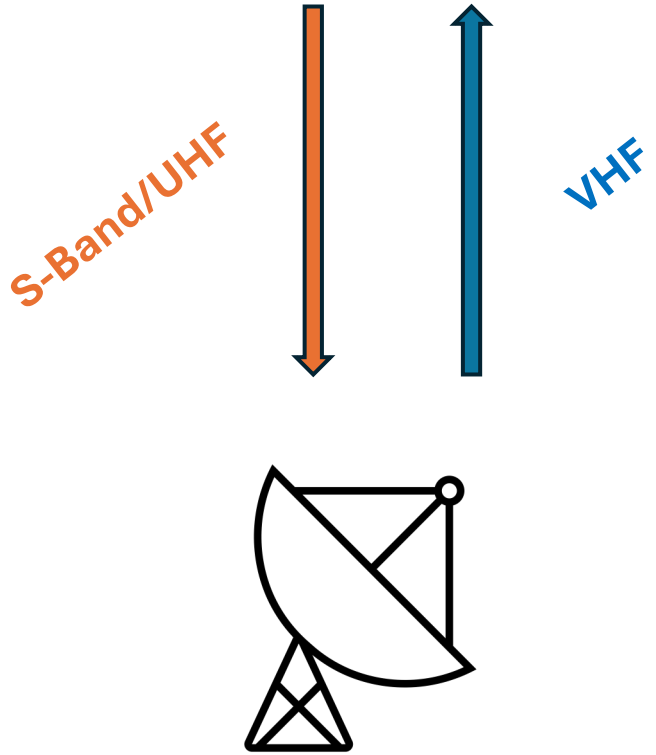
- FPGA:
  - Acquire SIPHRA ASIC data
  - Generate TTEs
  - Triggering
- Processor:
  - Source localization
  - Payload configuration/control
- Send trigger notification with localization. TTEs later.
- Currently using PYNQ-Z2 board (donated by AMD Ireland)
  - Zynq-7000 SoC XC7Z020-1CLG400C
  - TTE generation, Triggering IP blocks created with Vitis HLS
  - PYNQ overlay bitstream created with Vivado
- Corresponding board with space heritage will ultimately be used



Ground Based Processing

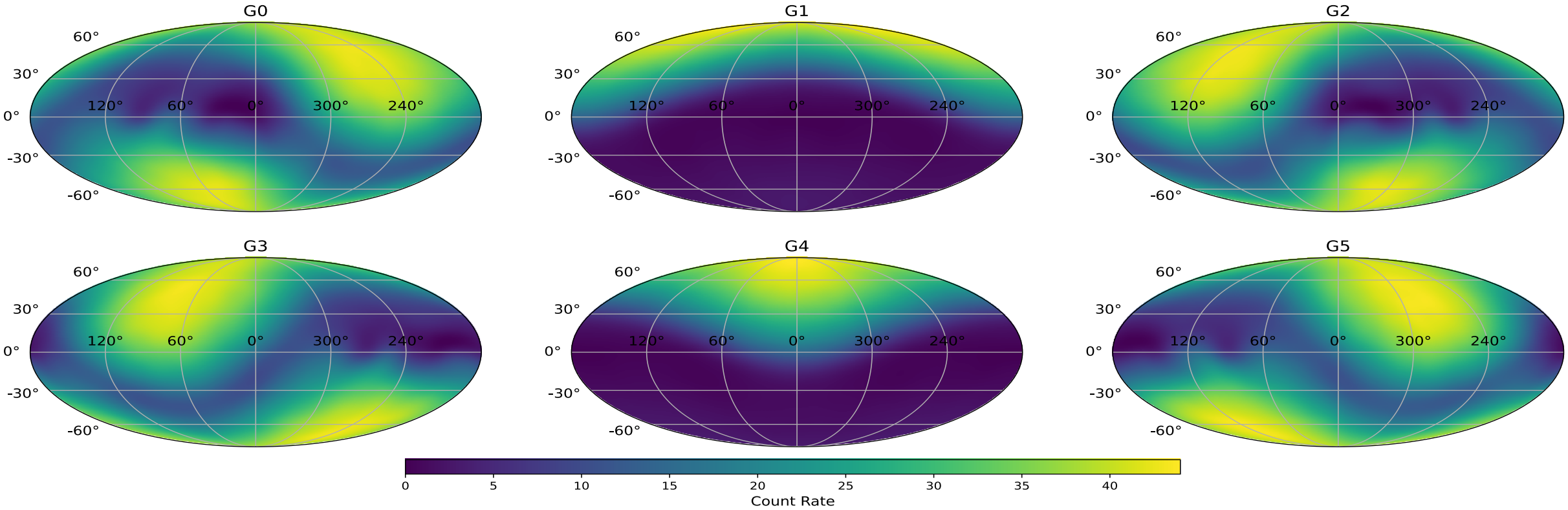
- Downlink/persist onboard data:
  - TTEs
  - Initial triggers and localizations
  - Housekeeping data etc.
  - Refined ground-based triggering and localization.
- Public GIFTS data products will be created and distributed in a new catalog.
- Focus has been on data processing.
  - Payload Control of SIPHRAs,
  - SoC processing will be implemented in Q3/4 2024.





Localization with GIFTS

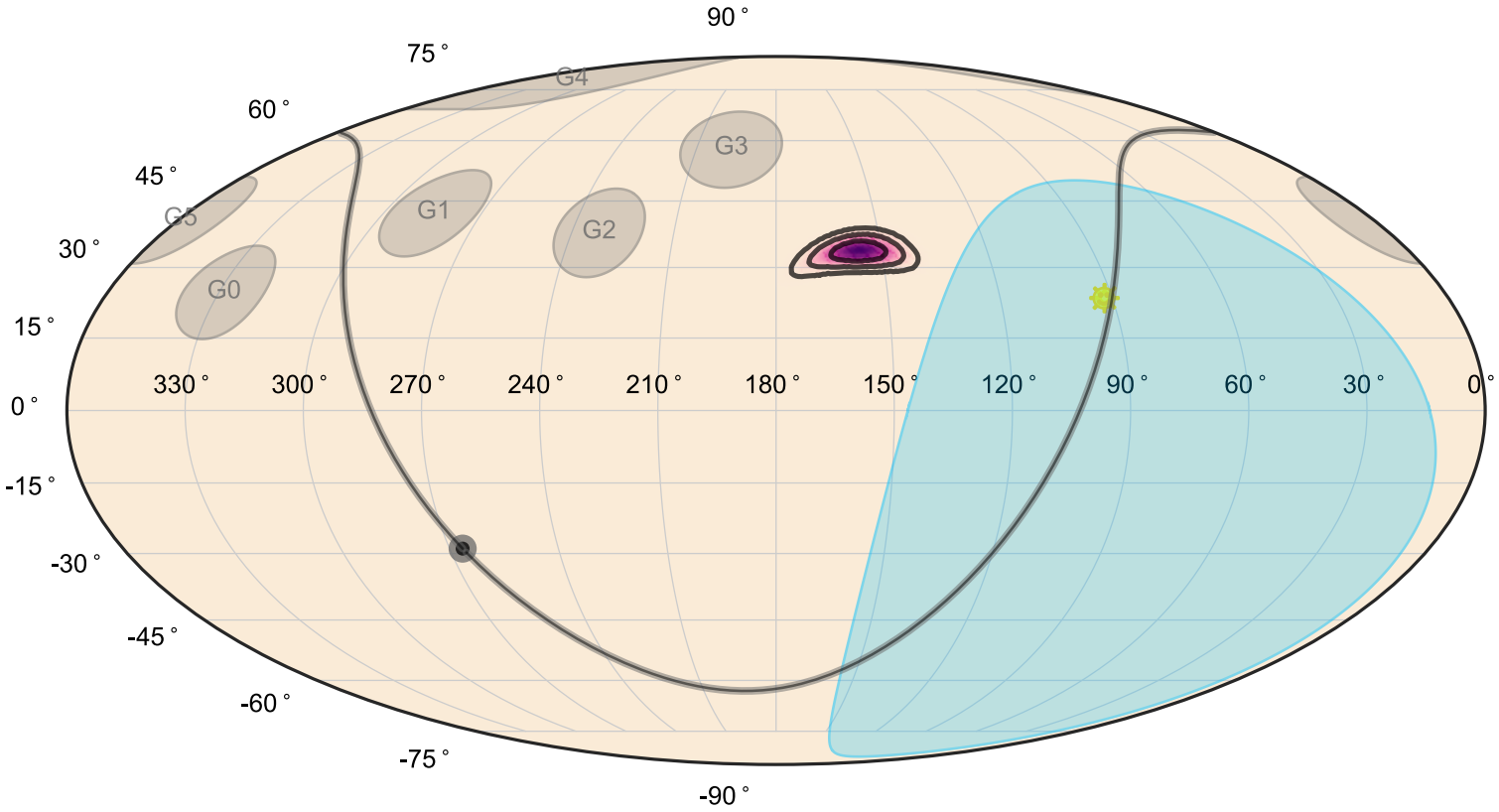
- GIFTS will perform localization via χ^2 minimization similar to GBM.
- An initial low resolution onboard localization; subsequently refined on the ground.



GIFTS Gamma Ray Data Tools

- **Example localization skymap generated using** `gdt-gifts`

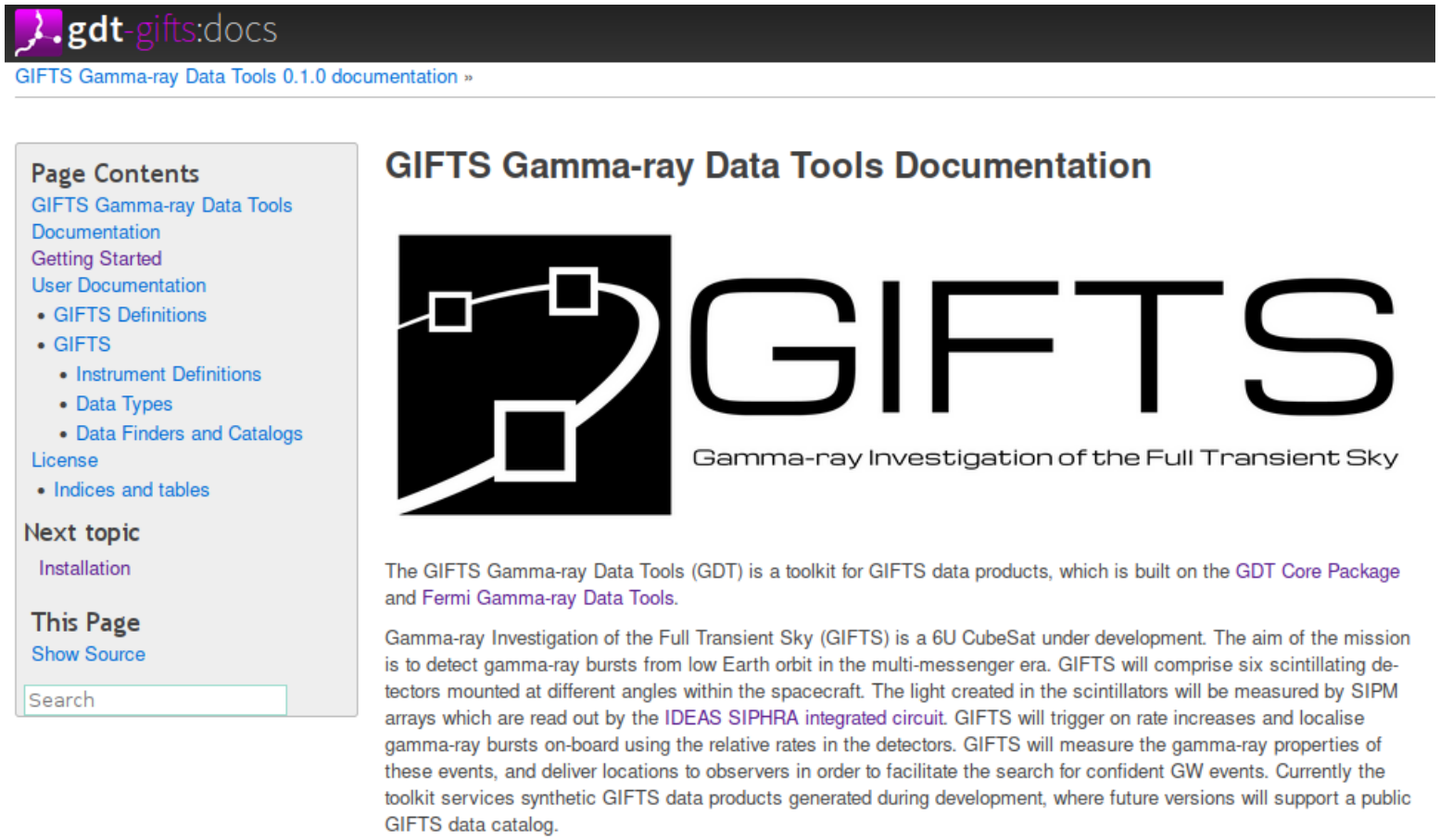
- **Builds on** `gdt-core` **and** `gdt-fermi`**:**
  - **Used for ground-based processing**
  - **Applicable to public GIFTS catalog**



A. Goldstein et al., 2023

GDT-GIFTS

- Repo and Website to be provided.



Thanks for Listening!

- Questions?

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Fondúireacht Eolaíochta Éireann
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Dá bhfuil romhainn