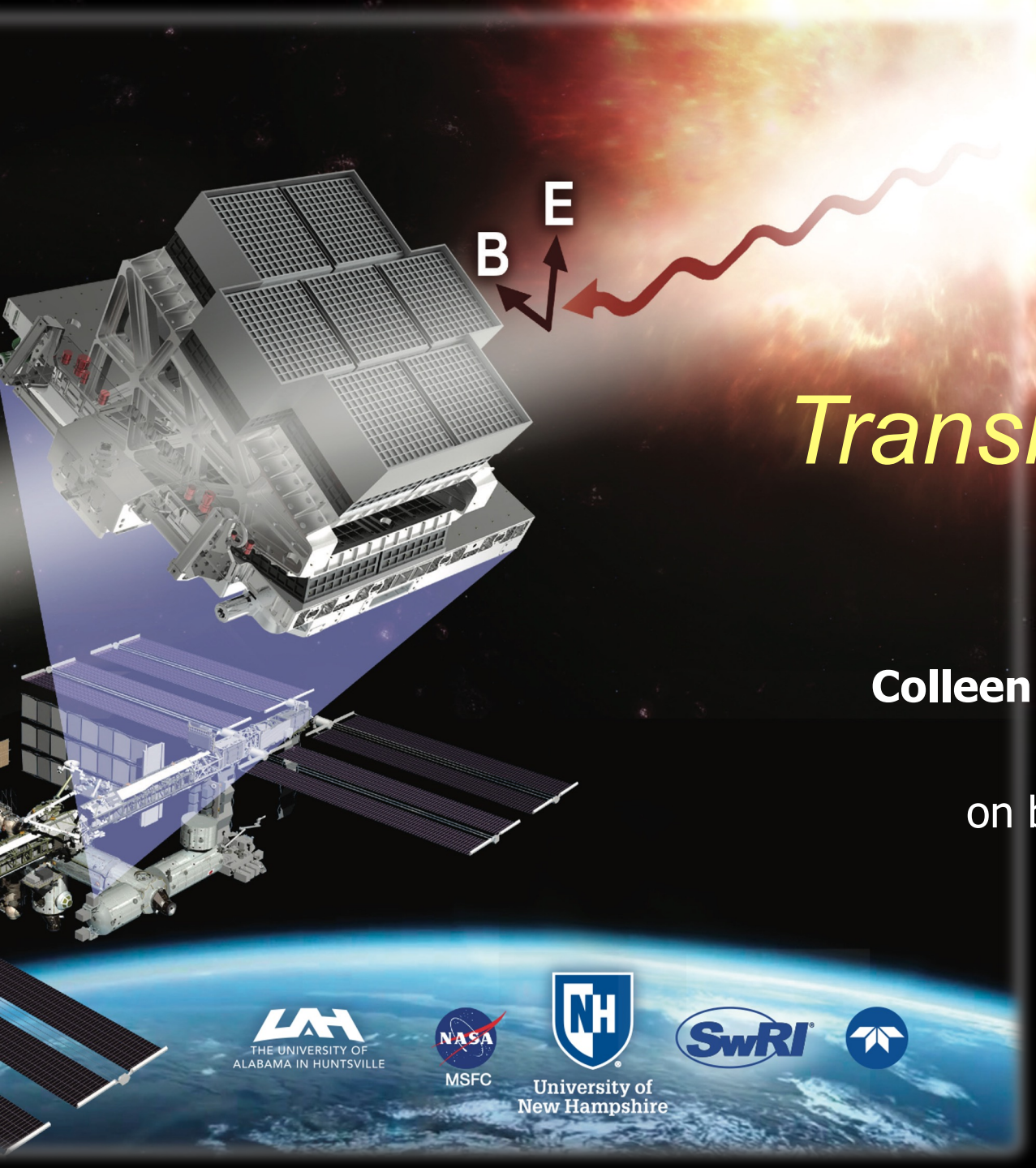

LARGE AREA BURST POLARIMETER

LEAP

Transient Science with LEAP

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on behalf of the LEAP collaboration

THE UNIVERSITY OF ALABAMA IN HUNTSVILLE

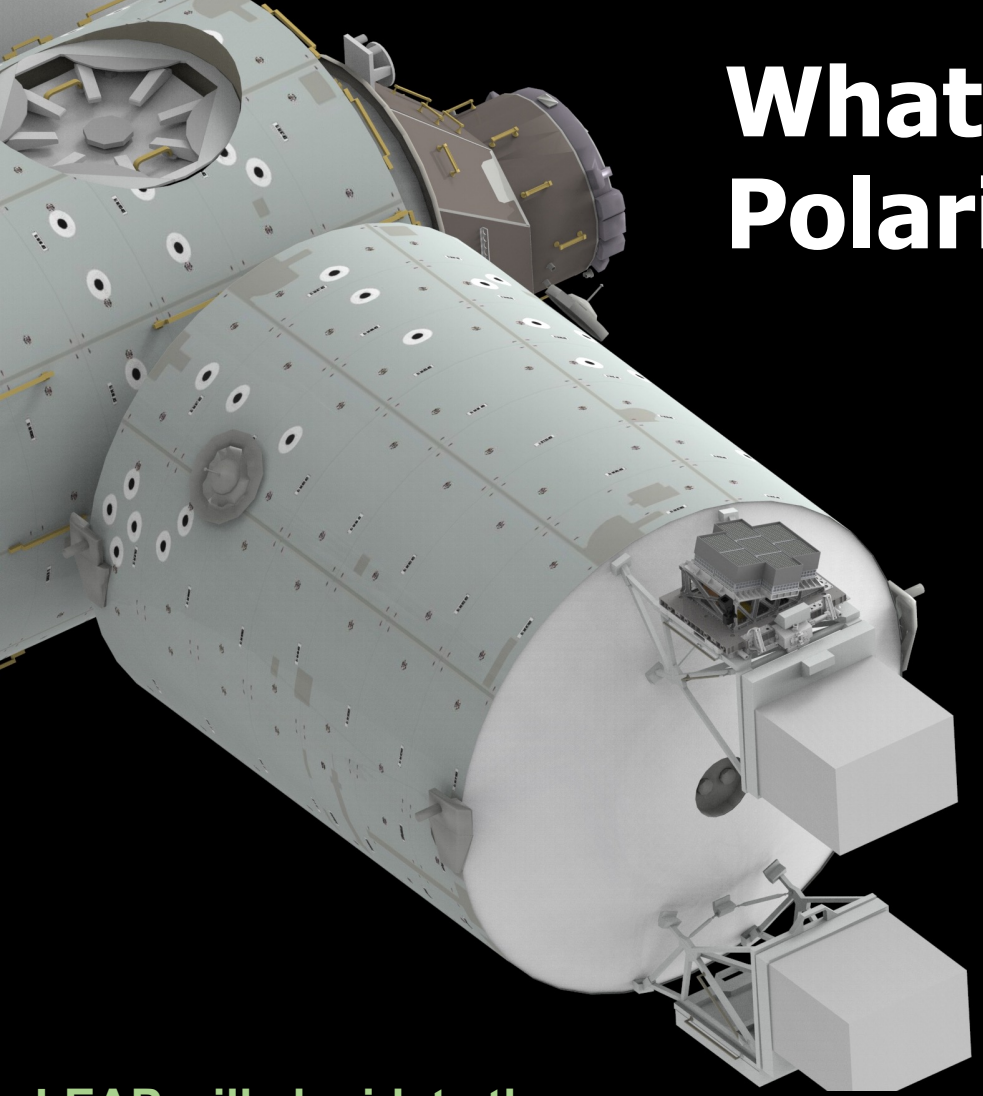
NASA MSFC

University of New Hampshire

SwRI

240th AAS Meeting
June 16, 2022

What is the LargE Area burst Polarimeter?



- Very large-area, wide-FoV Compton polarimeter **designed to cover the peak energy output of a typical GRB**
  - 50 - 500 keV polarimetry
  - 20 keV - 5 MeV spectroscopy
- Localizations <5 deg for brightest bursts
- Rapid alerts to the community within 10s of secs
- Proposed as a NASA Explorers MoO
- Externally attached to ISS
- Launch readiness date 2027
- Mission duration 3 yrs

LEAP will elucidate the nature of the prompt γ-ray emission of GRBs, by making the highest fidelity polarization measurements to date!

LEAP Science Objectives

LEAP will study the prompt emission polarization of GRBs to determine the following jet properties:

- **Magnetic Field Structure**

  Are the jet magnetic fields randomly oriented or are they oriented in some ordered fashion?

- **Composition**

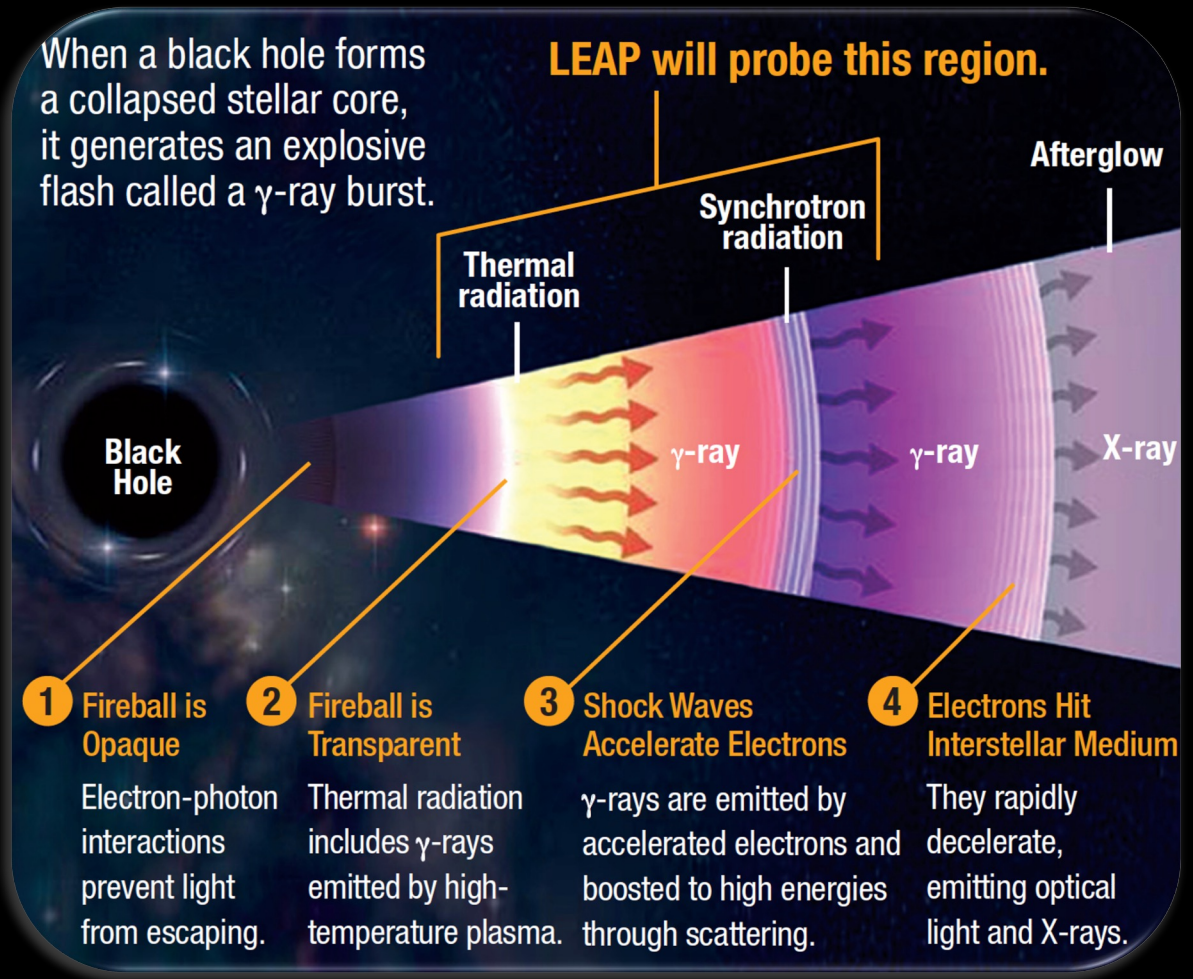
  Are jets dominated by matter or by magnetic fields?

- **Energy Dissipation**

  Is energy dissipated within the jet by internal shocks or by magnetic reconnection?

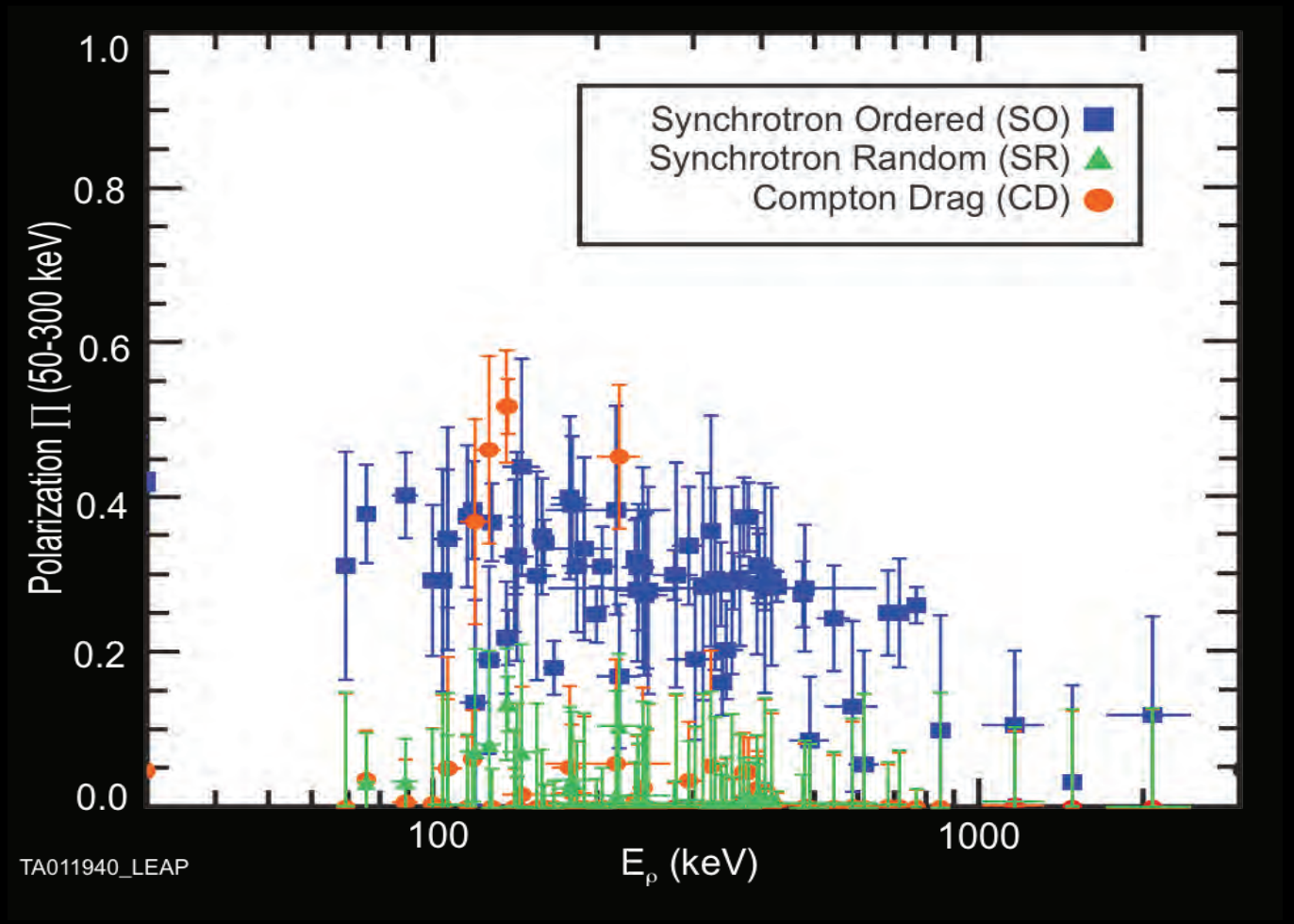
- **Emission Mechanism**

  Is the radiation mechanism synchrotron or bremsstrahlung, and is the particle distribution thermal or non-thermal?

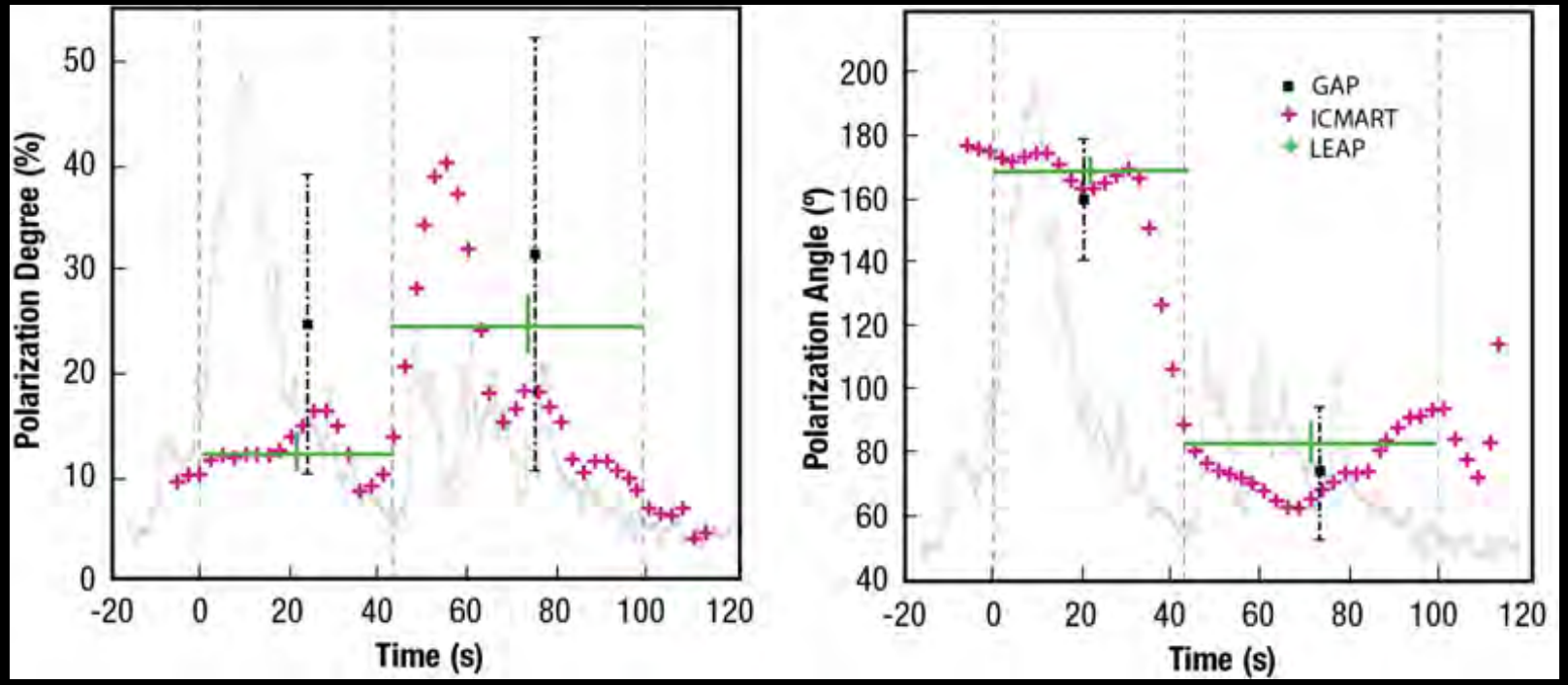


LEAP achieves its objectives with sensitive measurements of an ensemble of >65 GRBs

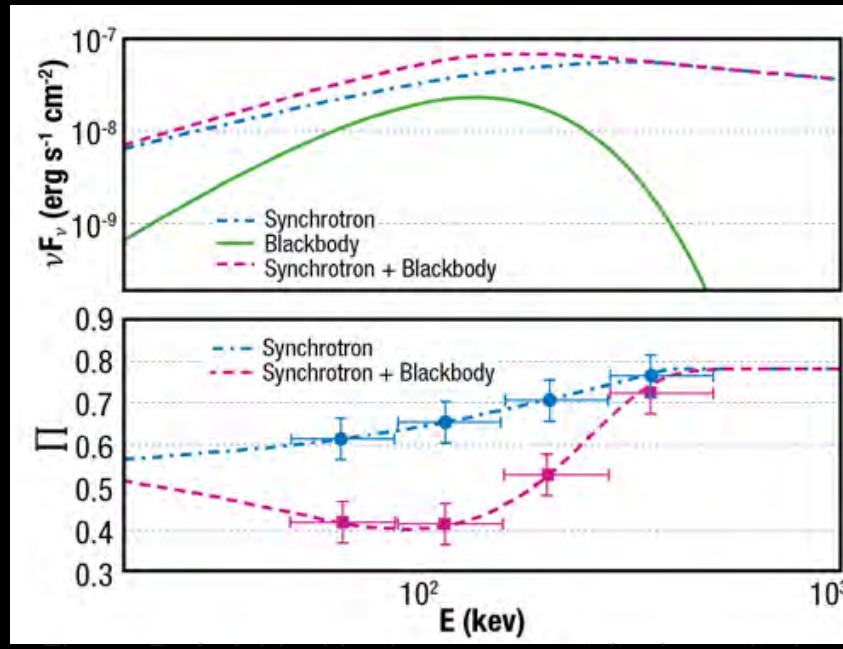
	Poynting Flux Dominated	Matter Dominated	
Objectives	Synchrotron Ordered	Compton Drag	Synchrotron Random
1. Magnetic Field	Ordered	Random	Random
2. Jet Composition	Poynting Flux	Matter	Matter
3. Energy Dissipation Mechanism	Reconnection	Internal Shocks	Internal Shocks
4. Prompt Emission Mechanism	Synchrotron	Inverse Compton	Synchrotron
Predicted Polarization Properties (50-500 keV)			
Π distribution	peaks near 40%	peaks near 0%	peaks near 0%
Π maximum	60%	85%	40%
Fraction with Π>30%	62%	17%	2%



Time- and Energy-Resolved Polarization



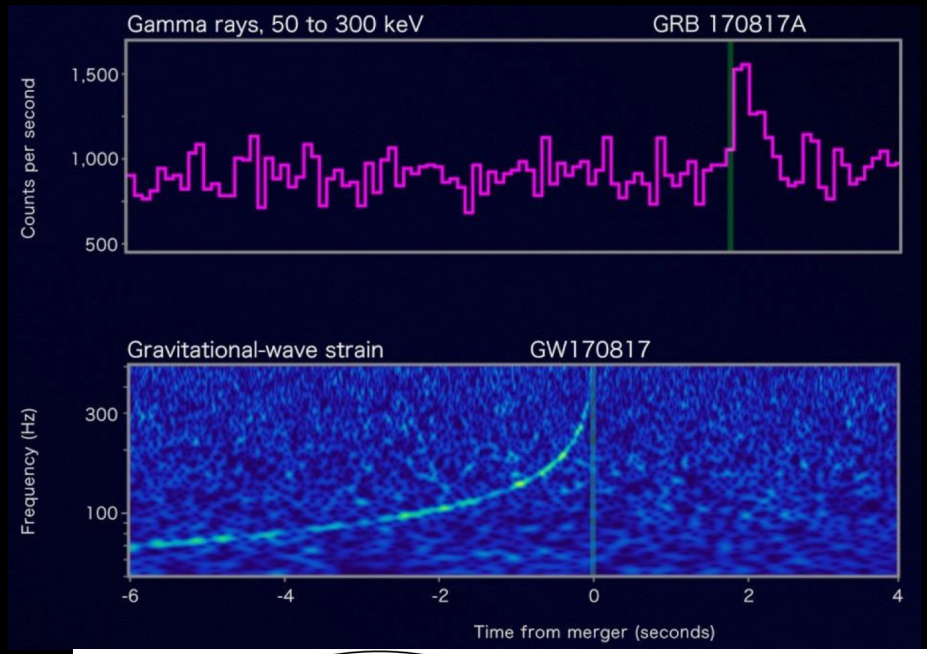
For the brightest bursts, LEAP will distinguish time dependent variations in polarization degree and angle, if present

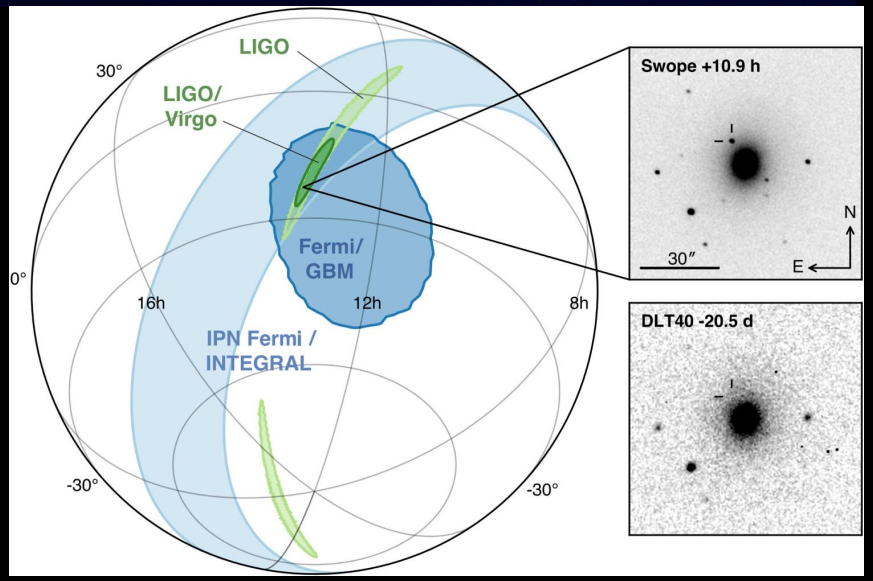


For the brightest bursts, LEAP will detect energy dependent variations due to photospheric emission

Short GRB science with LEAP

- LEAP is expected to trigger on about 80 SGRBs during its 3-year mission
- LEAP is expected to observe $3.0^{+6.4}_{-2.0}$ joint GRB/GW events per year
- LEAP will provide rapid alerts (typically <16 s) to the community to facilitate follow-up observations
- LEAP localizations will be comparable to Fermi GBM
- Joint GRB/GW detections place important constraints on jet physics and fundamental physics

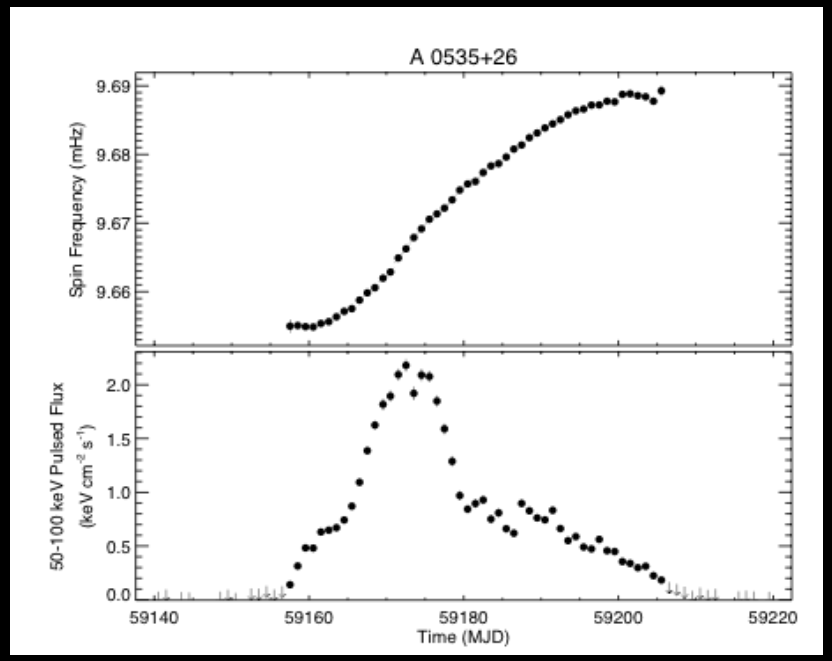




Abbot et al 2017

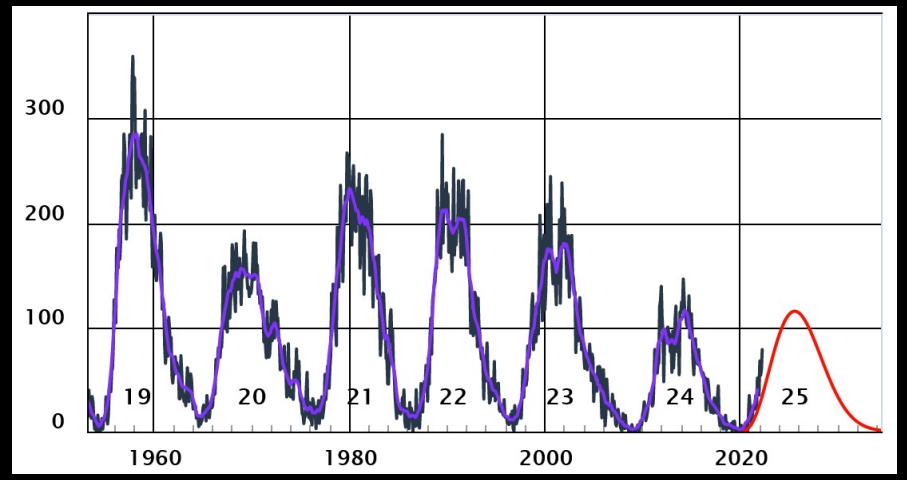
Non-GRB Transient Science with LEAP

Accreting pulsars



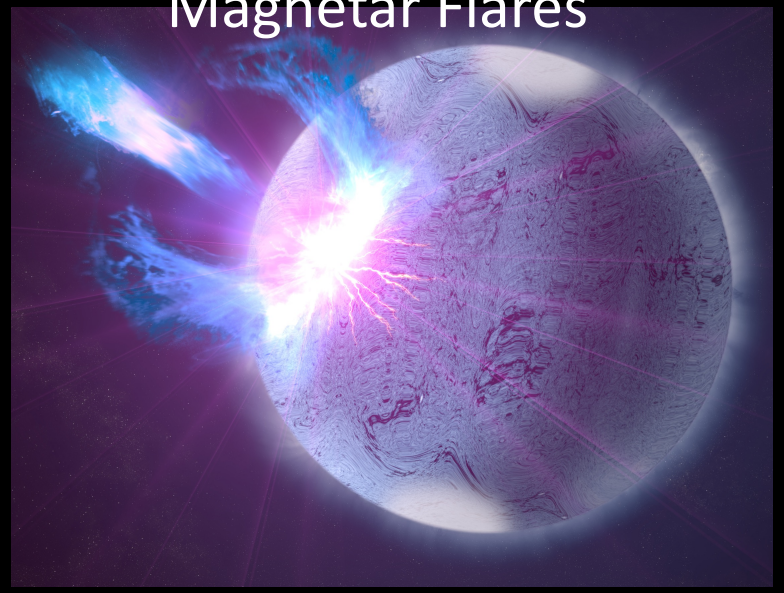
- Long term monitoring
- Phase-resolved polarization for the brightest events

Solar Flares



- Most sensitive polarization measurements to date

Magnetar Flares



- Rapid notification for correlation with FRBs
- Polarimetry for the brightest bursts

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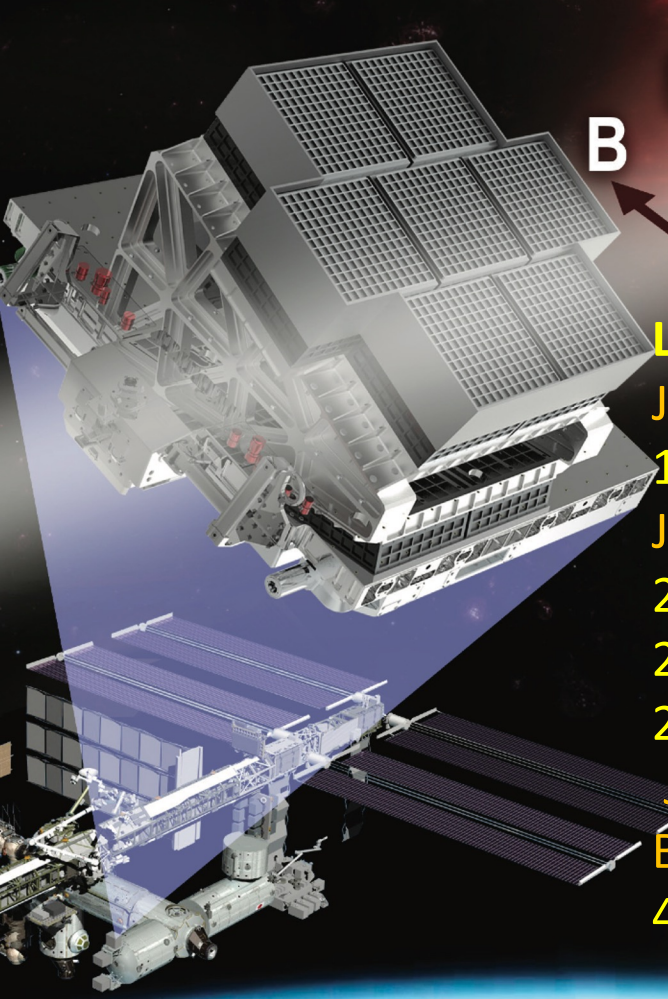

Learn More about LEAP at AAS 240:

June 13 (2:00-3:30 PM) - New Mission Concepts

127.01 [ORAL] : The LEAP Gamma-Ray Burst Polarimeter: An Overview (J. Gaskin)

June 14 (9:00 - 10:00 AM) - New Mission Concepts

206.05 [iPOSTER] : Localization Capability of the LEAP Polarimeter on ISS (A. Goldstein)

206.06 [iPOSTER] : Simulation Studies of the LEAP GRB polarimeter (M. McConnell)

206.07 [iPOSTER] : The LEAP Prototype Detector (C. Ertley)

June 16th (10:30-10:40am) - Multi-messenger View of Supernovae, Gamma Ray Bursts, and Other Transients

411.04 [ORAL]: Transient Science with LEAP (C. Wilson-Hodge) – this talk

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