BATSE:
The History and Legacy

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1973

GRBs: First Public Presentation:

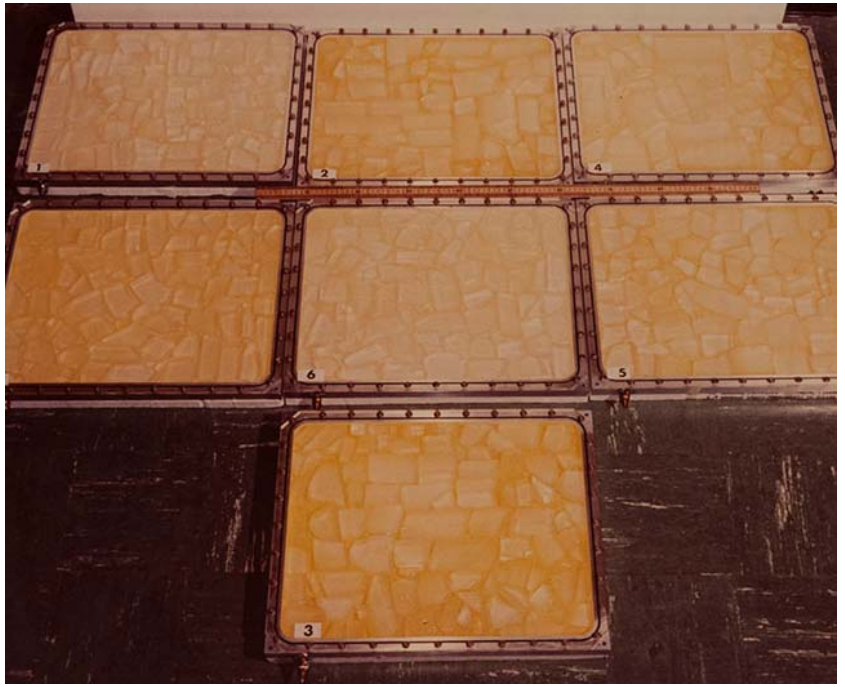
AAS Meeting – Columbus, Ohio

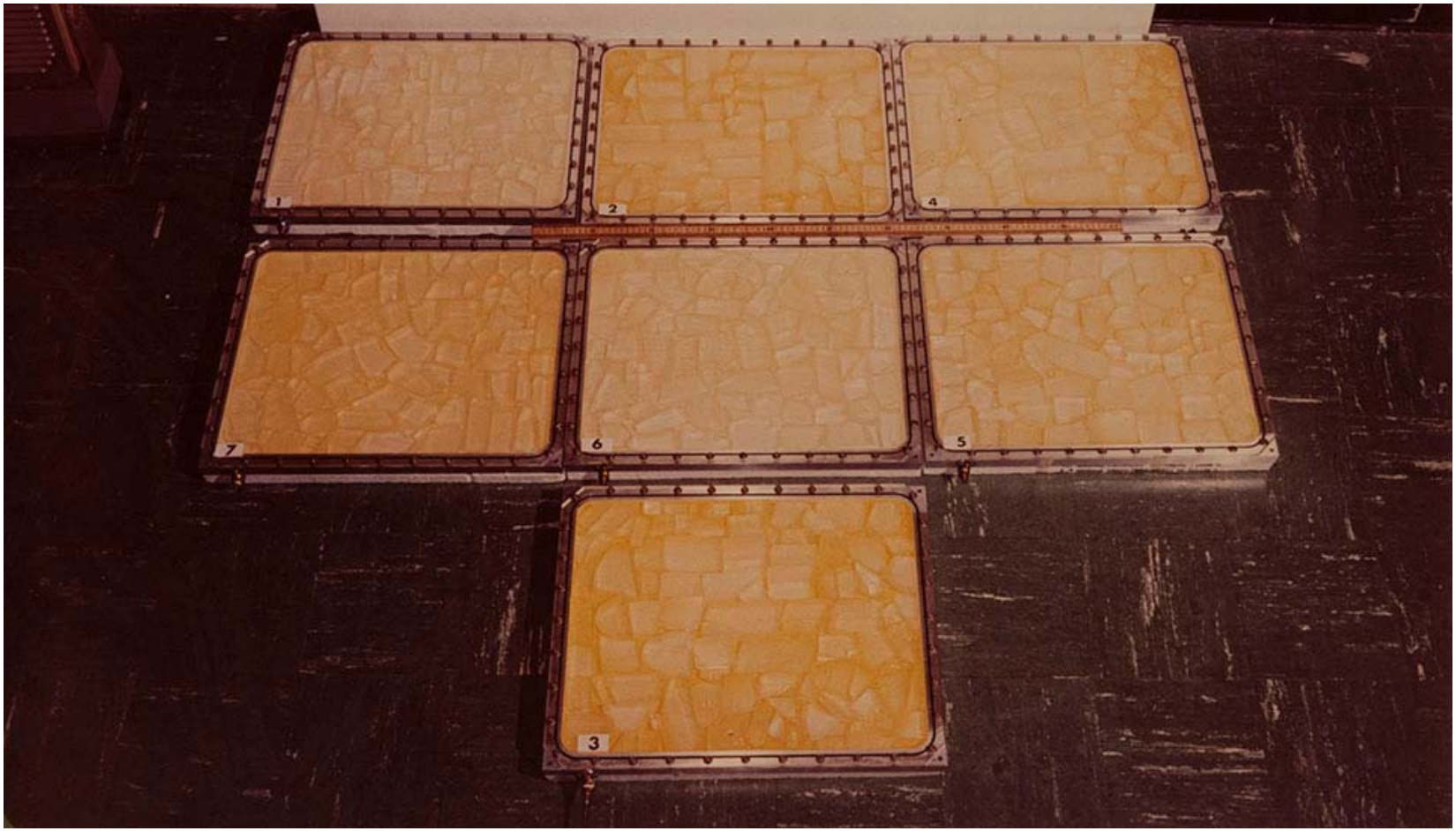
Huntsville Group - Decided to build a large-area detector balloon experiment to detect weak GRBs

1974-1977

Detector Development
&
Early Balloon Flights

A single large area detector tray made from NaI (Tl) Crystal pieces





A group of seven NaI(Tl) detector trays developed for balloon flight observations of GRBs.

Notice the variation in the amount of hydration (yellowing) of the crystals in the different trays. To our surprise, this hydration was largely reversible be pumping the interior of the trays for long periods and removing the moisture.

A group of three detectors arranged to view the same direction. The PMTs views each detector tray.

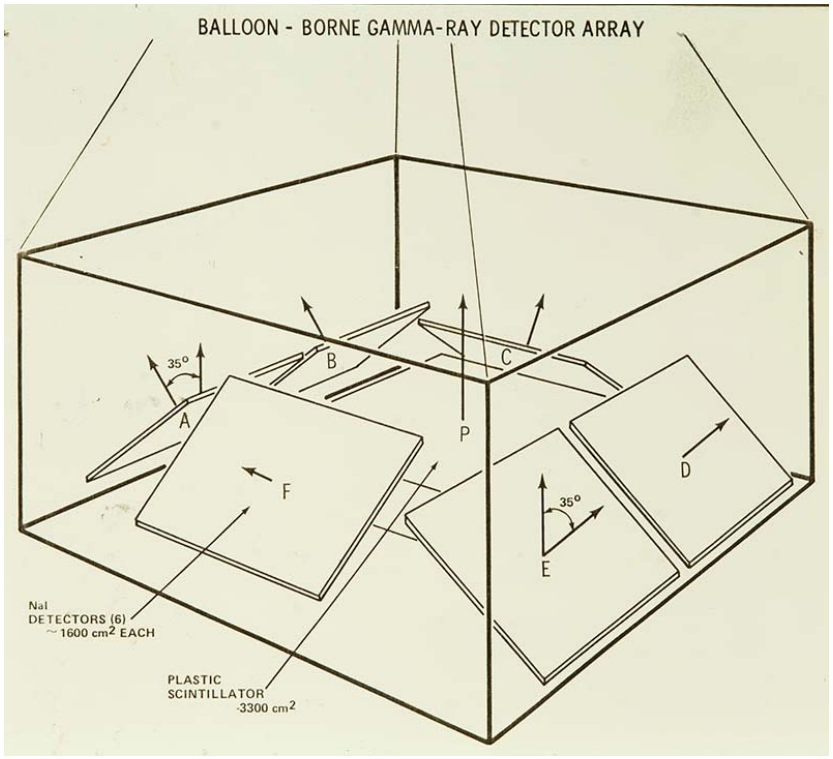


Diagram of the detectors viewing different directions on a balloon flight gondola

1977-1978

GRO Announcement of Opportunity (AO)

- **Proposed Transient Event Monitor (TEM)**
- **Twelve Detectors (Dodecahedron)**
- **Six on Top & Six on Bottom of Spacecraft**
- **Partial Selection – 6 Det.**
  - **only on bottom of spacecraft**

1979-1980

Negotiating after Approval

- TEM Name changed to BATSE
- Requested Eight Detectors

  (Octahedron - Four on top & bottom)

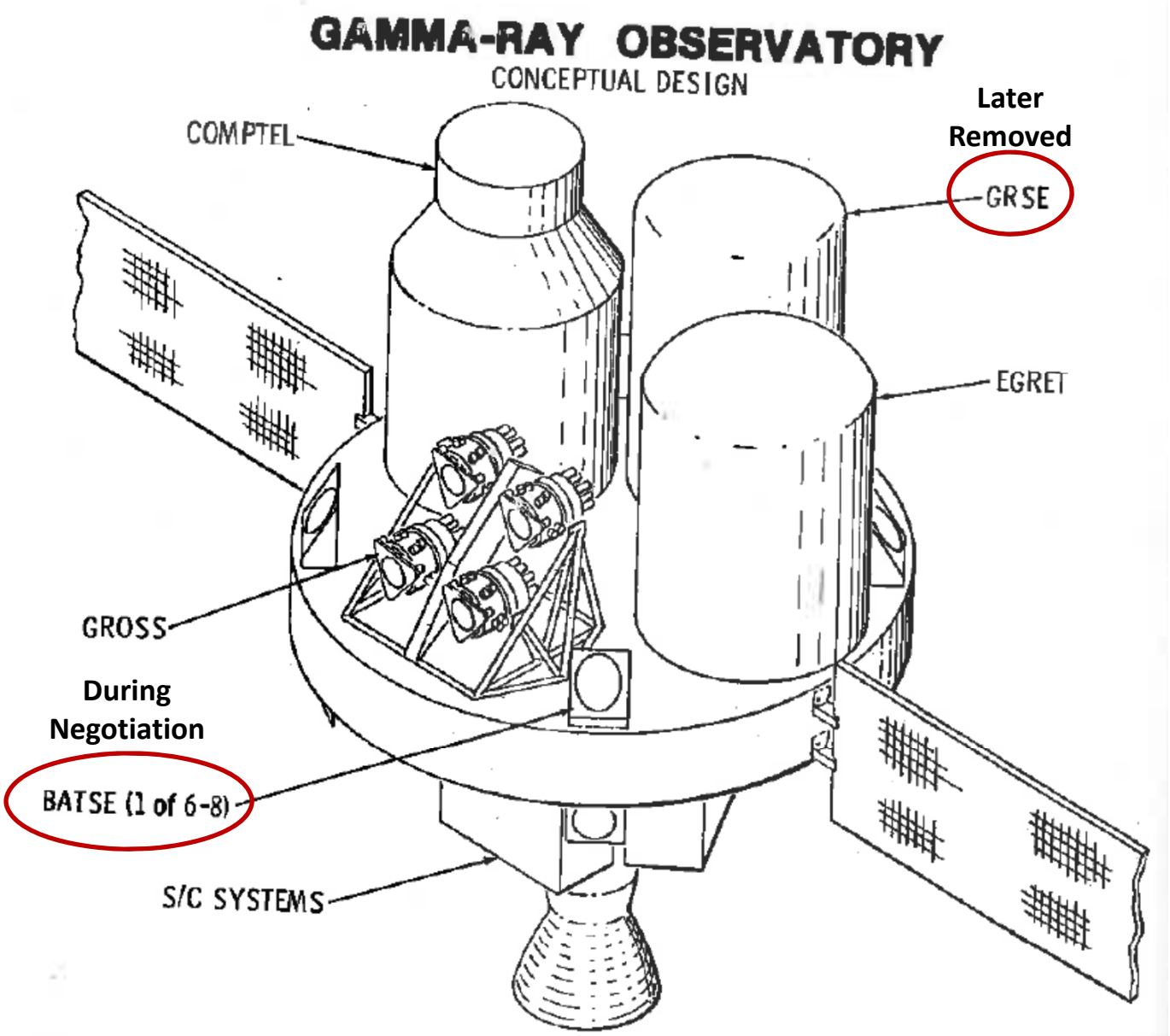
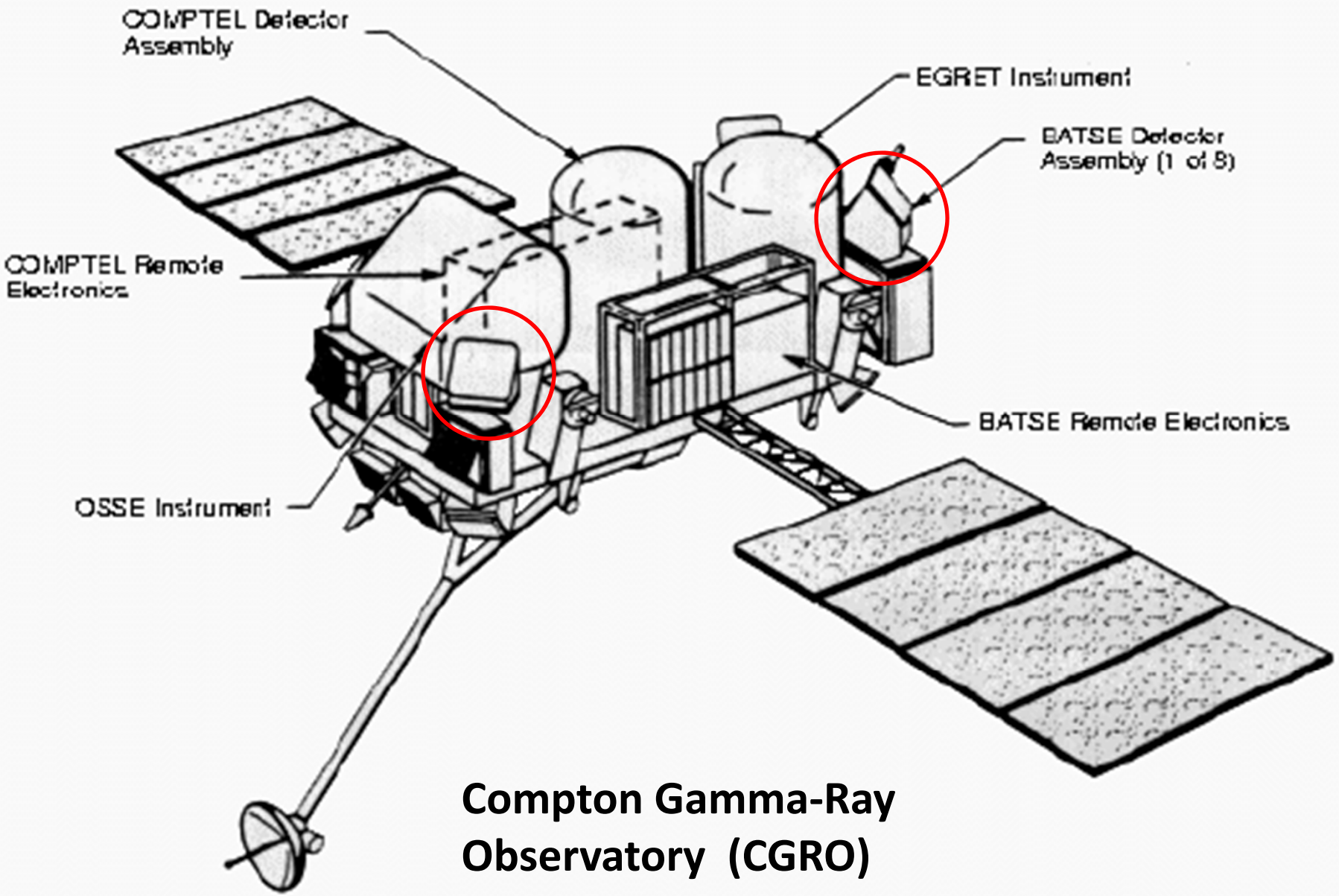


Fig. 3. Conceptual drawing of the planned Gamma-Ray Observatory (GRO) showing the four major pointed experiments and a possible configuration for the BATSE array.

1981-1982

- GRSE Experiment Removed from GRO

- Spectroscopy Detectors added to BATSE, one in each detector module

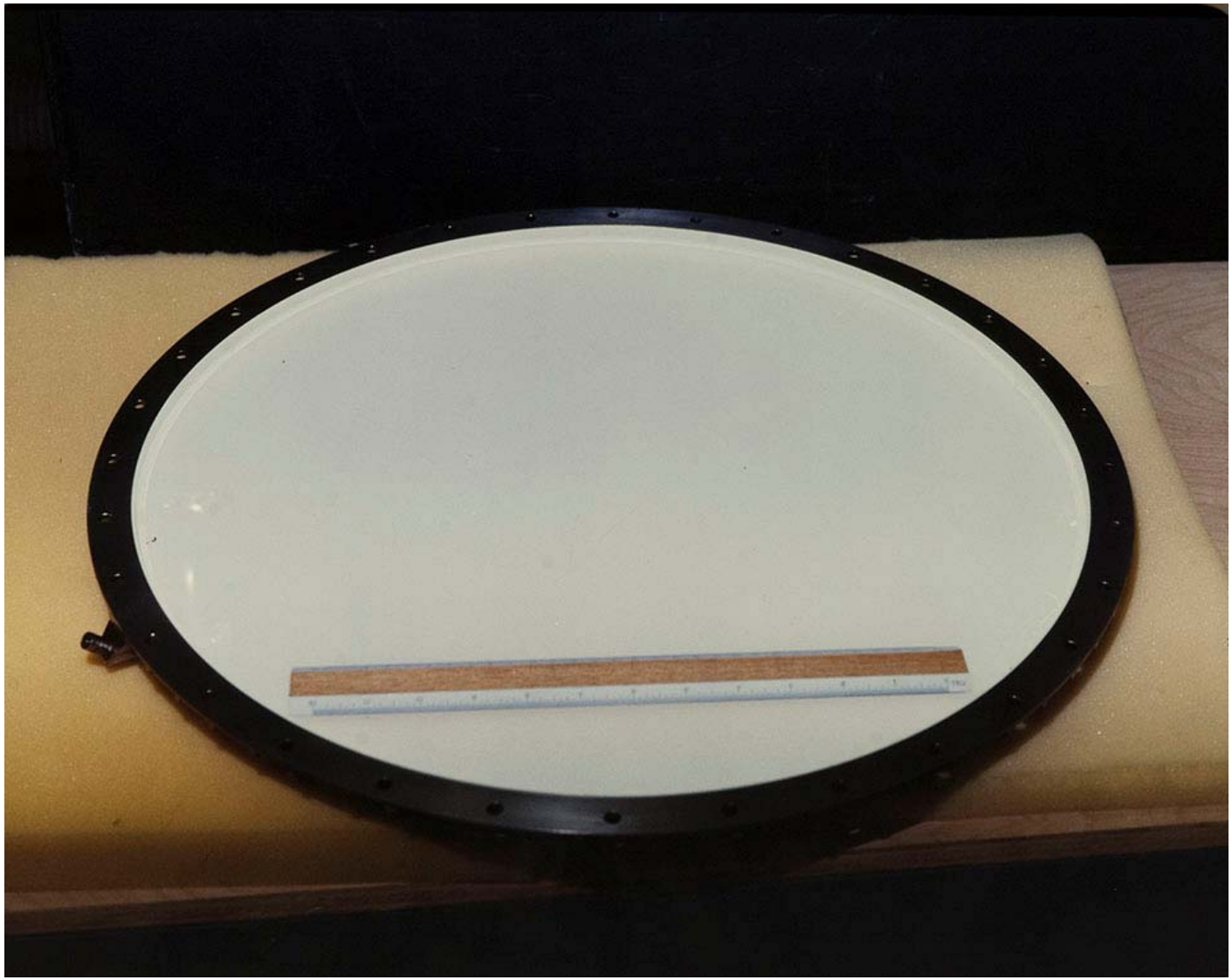


Compton Gamma-Ray Observatory (CGRO)

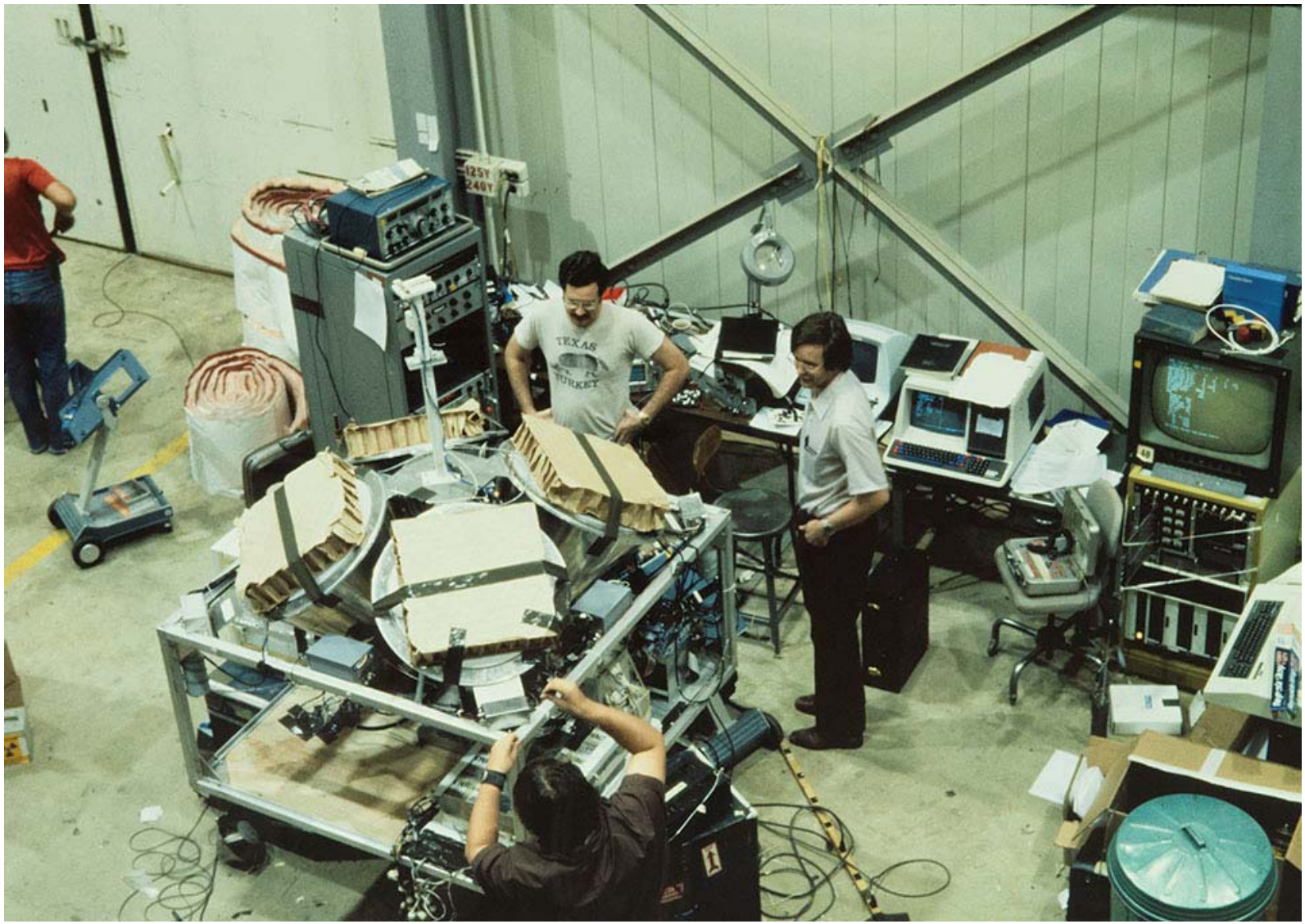
1982 – 1988

BATSE Detector Development & Balloon Flights

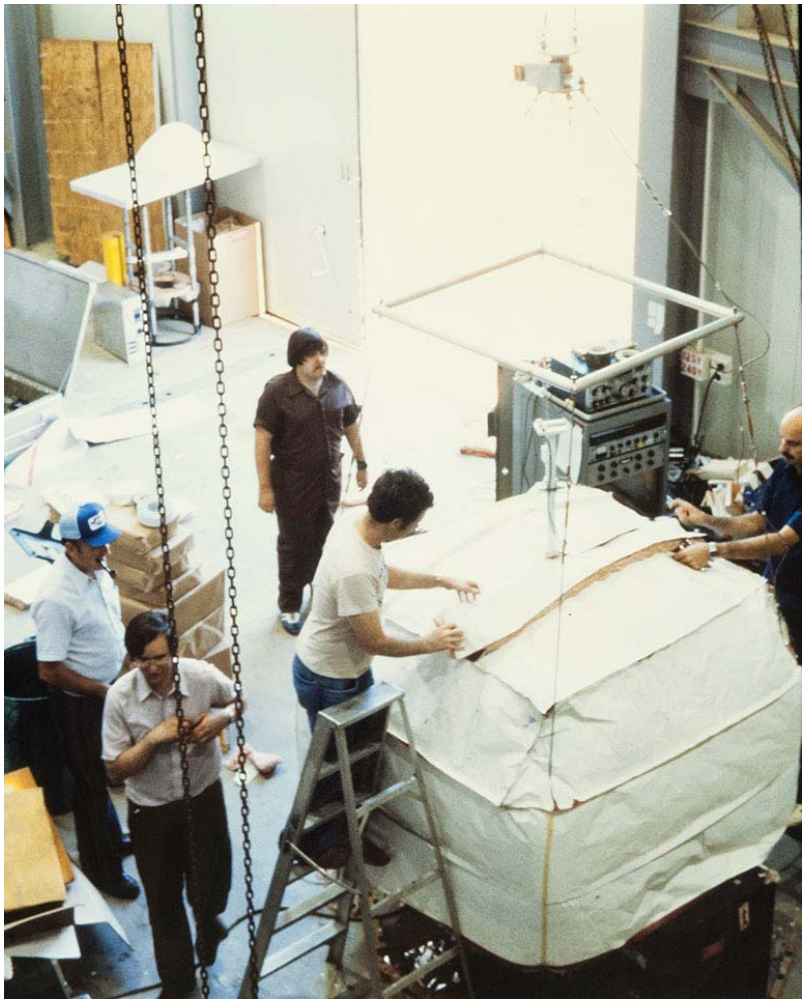
BATSE LAD NaI Detector Element: 20” dia; 2025 cm^2



Preparing Four BATSE LAD NaI Prototype Detectors on a Gondola for Balloon Flight from Palestine, TX



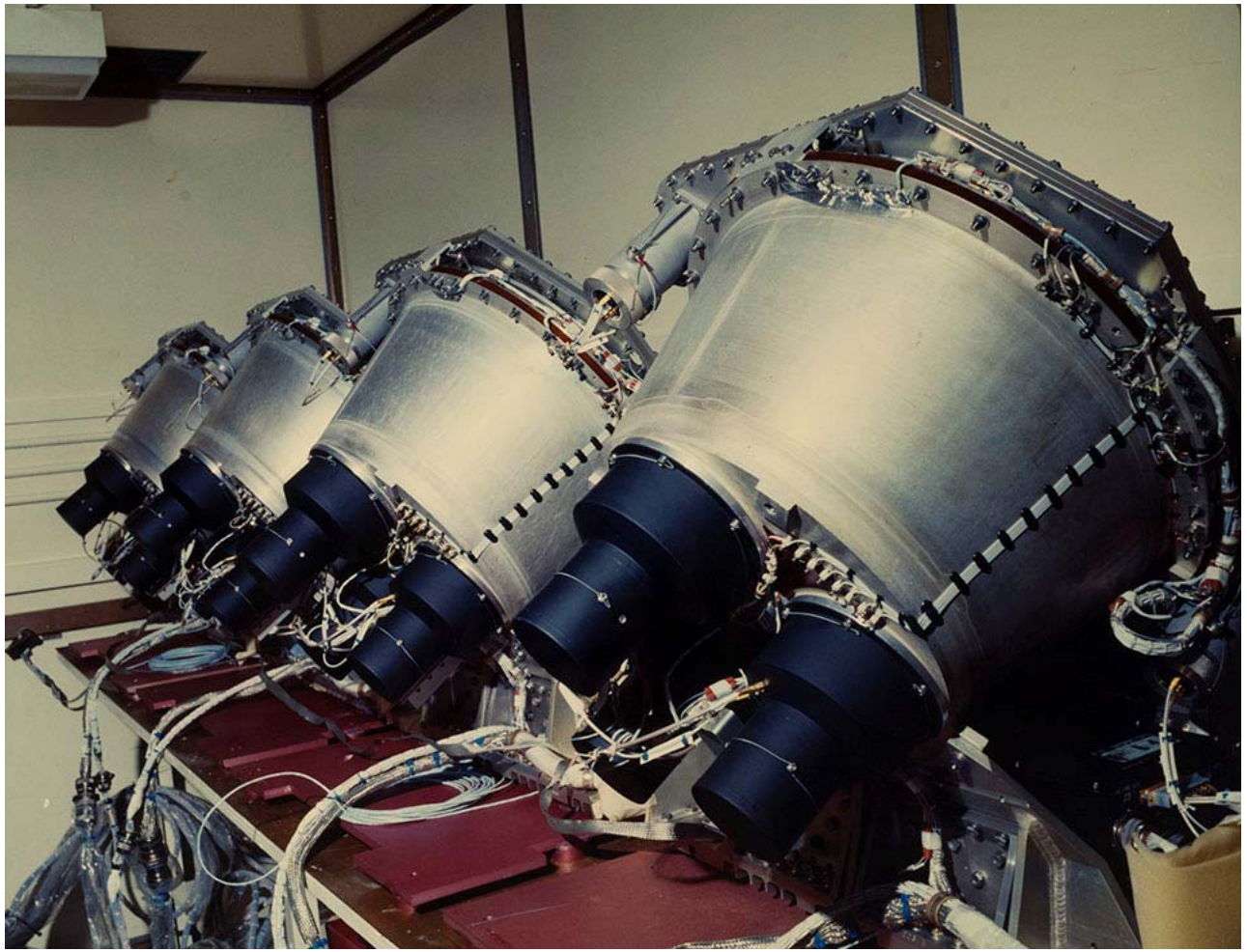
Preparing Four BATSE LAD NaI Prototype Detectors on a Gondola for Balloon Flight from Palestine, TX (cont.)



BATSE Prototype Balloon-flight Gondola about to be Launched from Palestine, TX

BATSE Detector Modules:

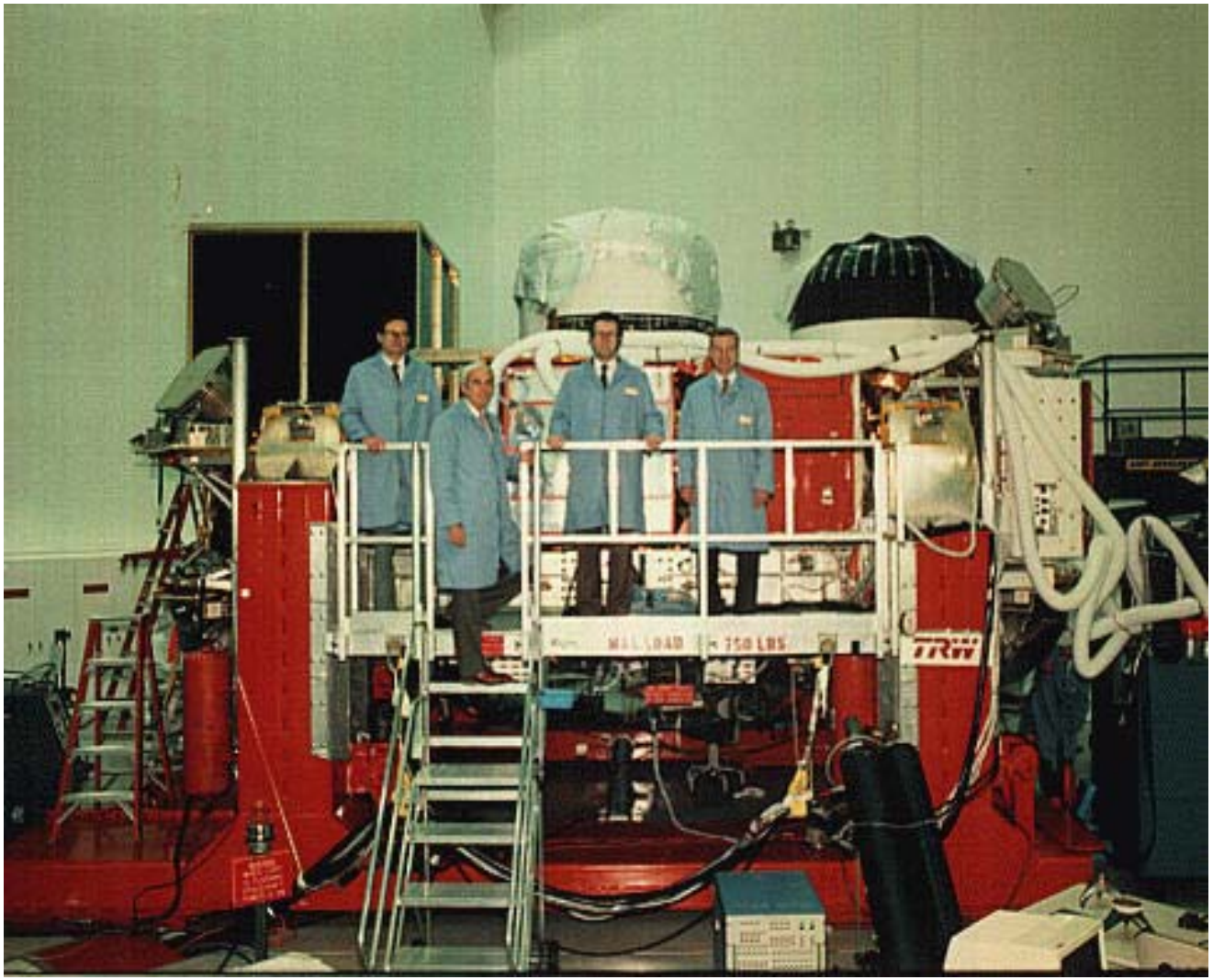
- Design, Fabrication, Testing & Calibration at NASA-MSFC: 1982 - 1989



Integration of Experiments on GRO Spacecraft in California

Radioactive Source Survey of BATSE on the GRO Spacecraft in

GRO Four P.I.s at the GRO Instruments
TRW Facility, Redondo Beach CA



April 4-5, 1991:

Launching
&
Deploying GRO

April 4, 1991

Shuttle launch,
STS-37
Gamma-Ray
Observatory (GRO)

(Operational:
re-named CGRO)

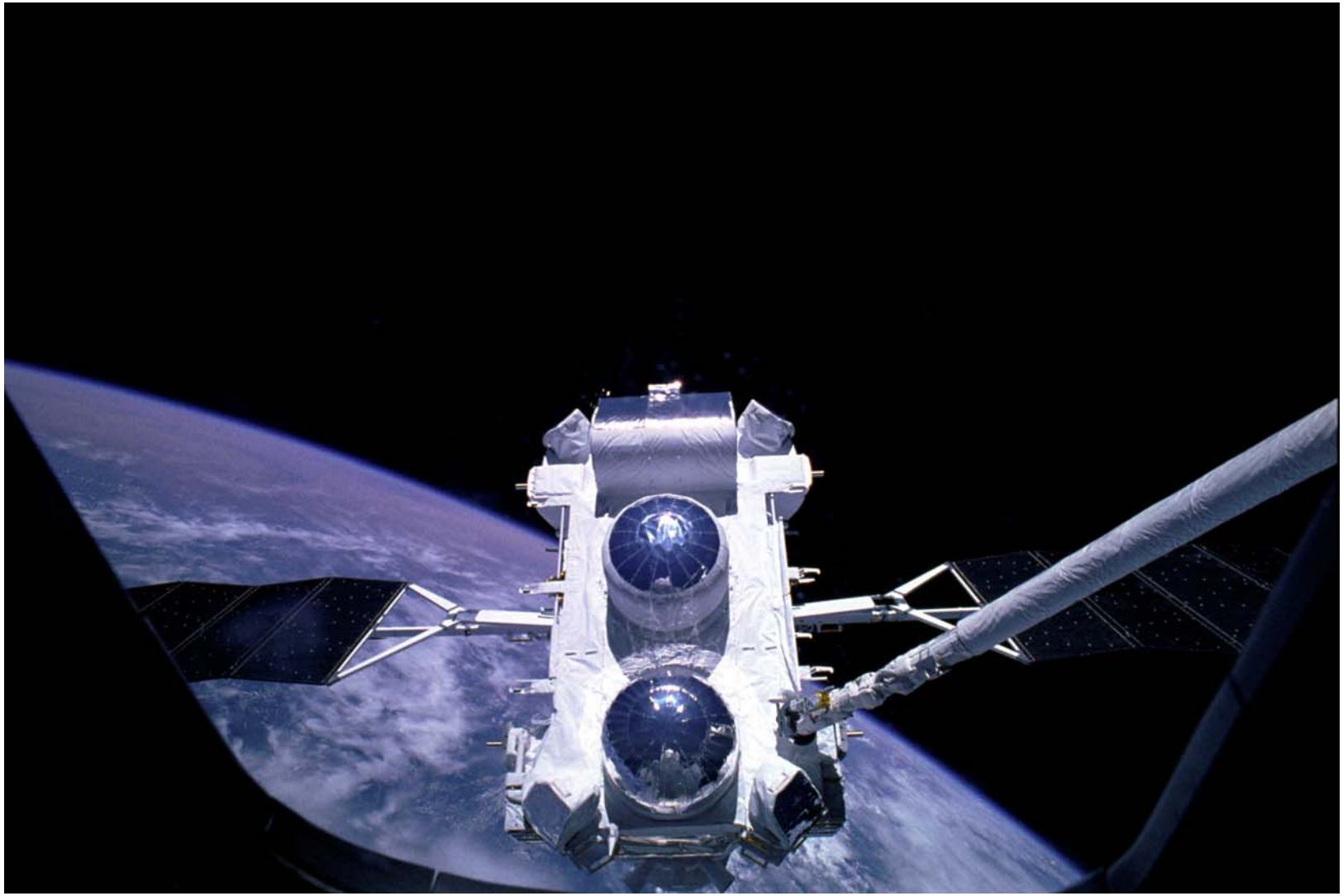
c

STS-37 Flight Crew – After GRO Deployment In Orbit

Linda Godwin Holding Flight Patch

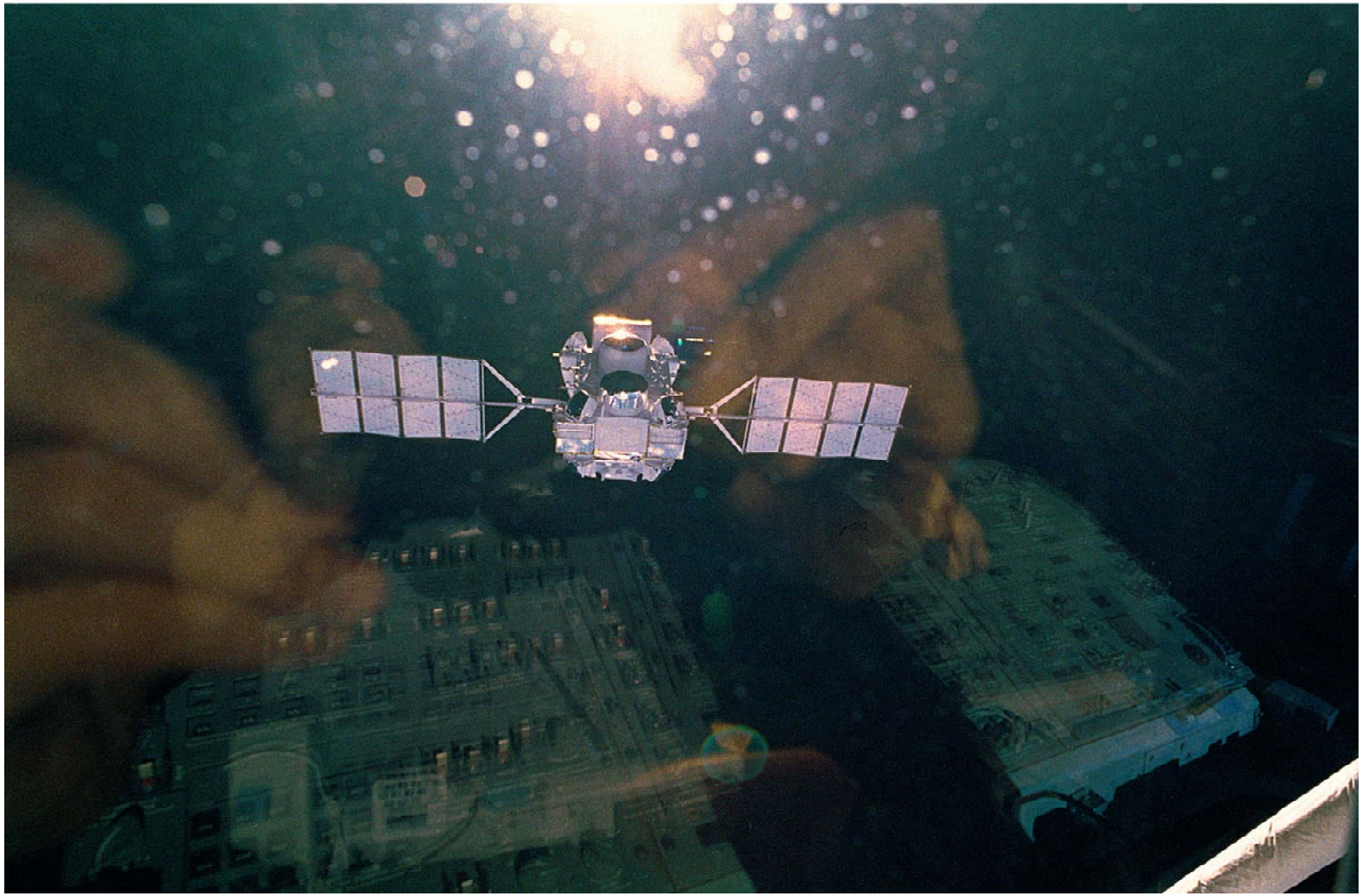
c

GRO Spacecraft – Still Attached to Shuttle Arm, Just Prior to Deployment



GRO Spacecraft Drifting Away, Just After Deployment

(Note reflection of Linda Godwin's hands holding camera)



GRO on Cover of *Nature*, Jan. 9, 1992

BATSE - Unique

First large experiment designed for GRB studies:

- **Full-sky**
- **Large area**
- **Good sensitivity for E_{peak} of most GRBs**
- **Moderate spectral capabilities – (good enough for most time/spectral correlations and time resolved spectral studies)**

BATSE (cont.)

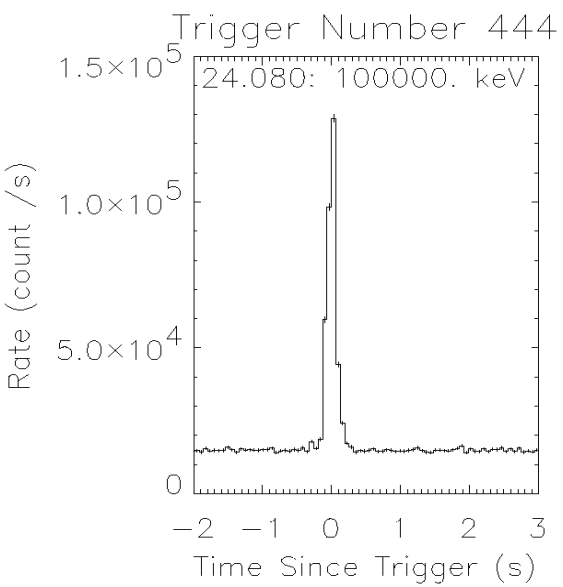
- Largest sample (2704 GRBs); full-sky, 9+ years in operation
- Well- characterized, full-sky instrument
- Likely will not be exceeded for several decades
- Led to GCN Network

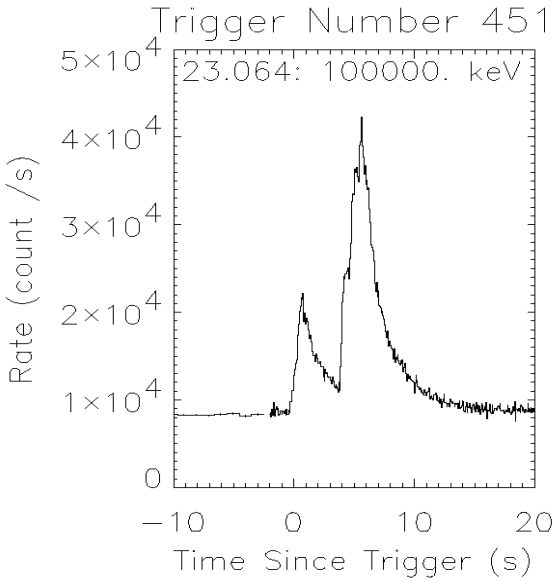
➢ Many Hundreds of Papers Based on BATSE Observations; >50 Ph.D. theses

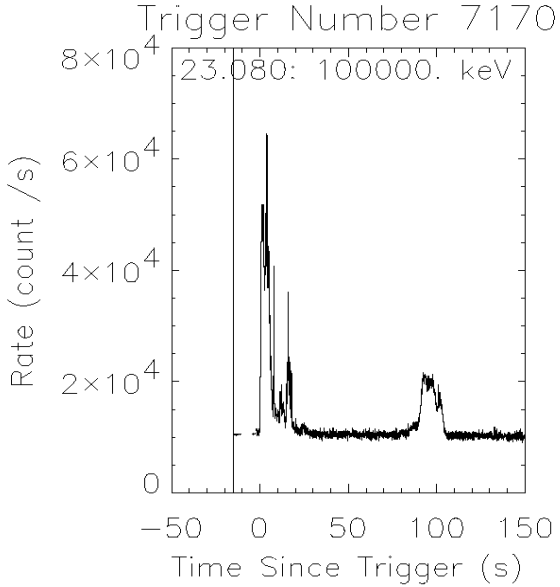
A Few Major BATSE GRB Results, 1991-2000

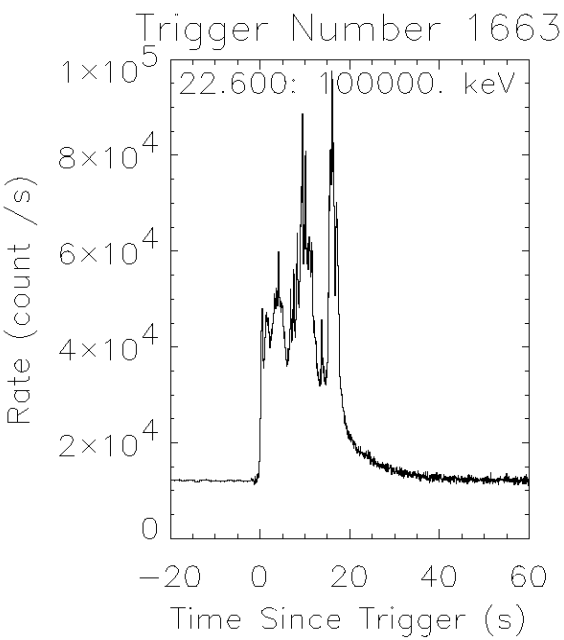
- **Global properties of GRB Distributions:**
  - **Intensity Distribution & Sky Distribution**
  - **Not consistent with any Galactic Distribution, nearby extra-gal objects, incl. large clusters**
  - **Strong Indications that GRBs were at cosmological distances (Although BeppoSAX nailed it)**
- **Comprehensive Temporal/Spectral Studies**
- **Two Populations of GRBs**
- **Rapid GRB Response: beginning of Bacodine/GCN**
  - led to breakthrough quick, wide-field observations

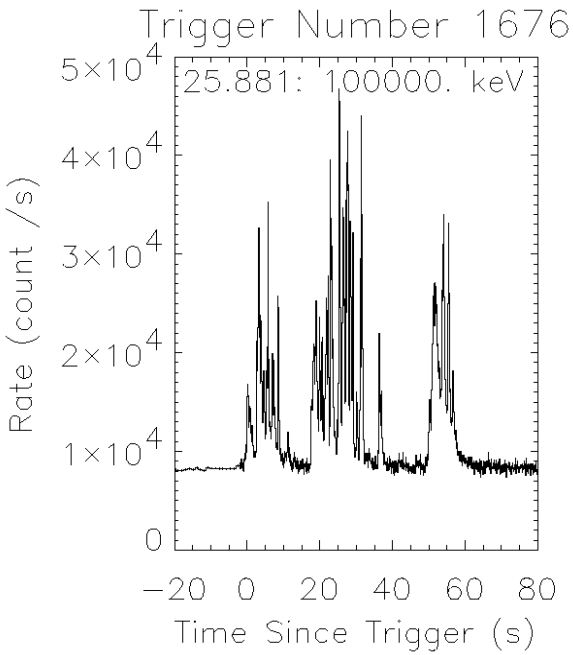
Diversity of GRB Profiles & Coupled Spectral / Temporal Properties



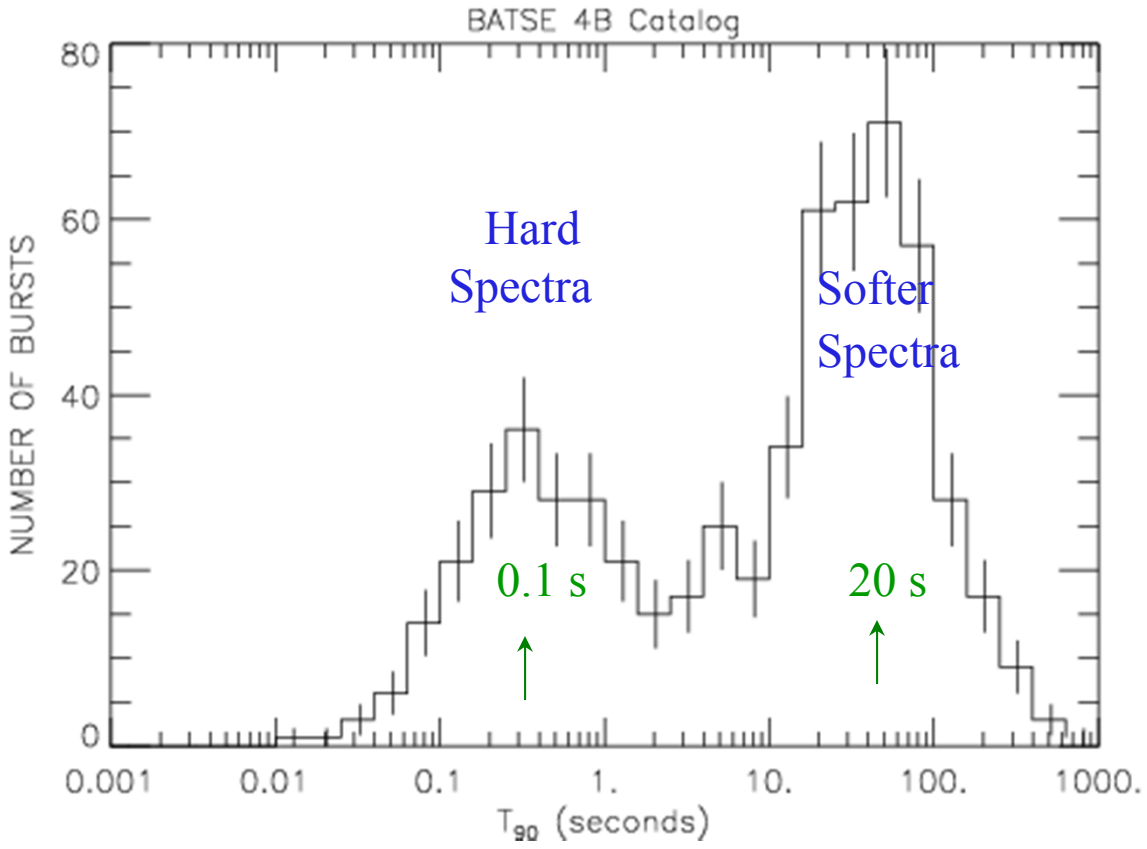


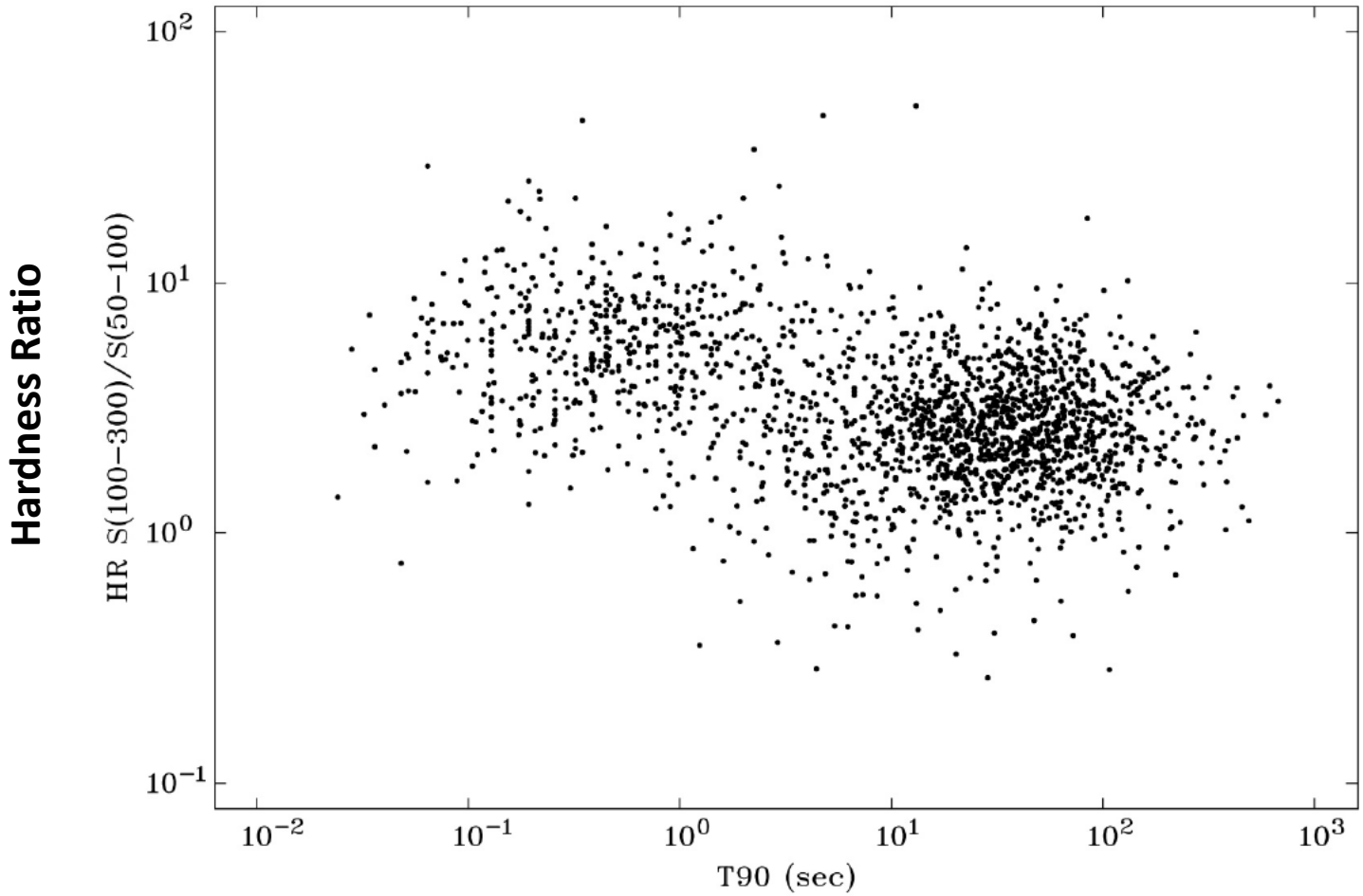






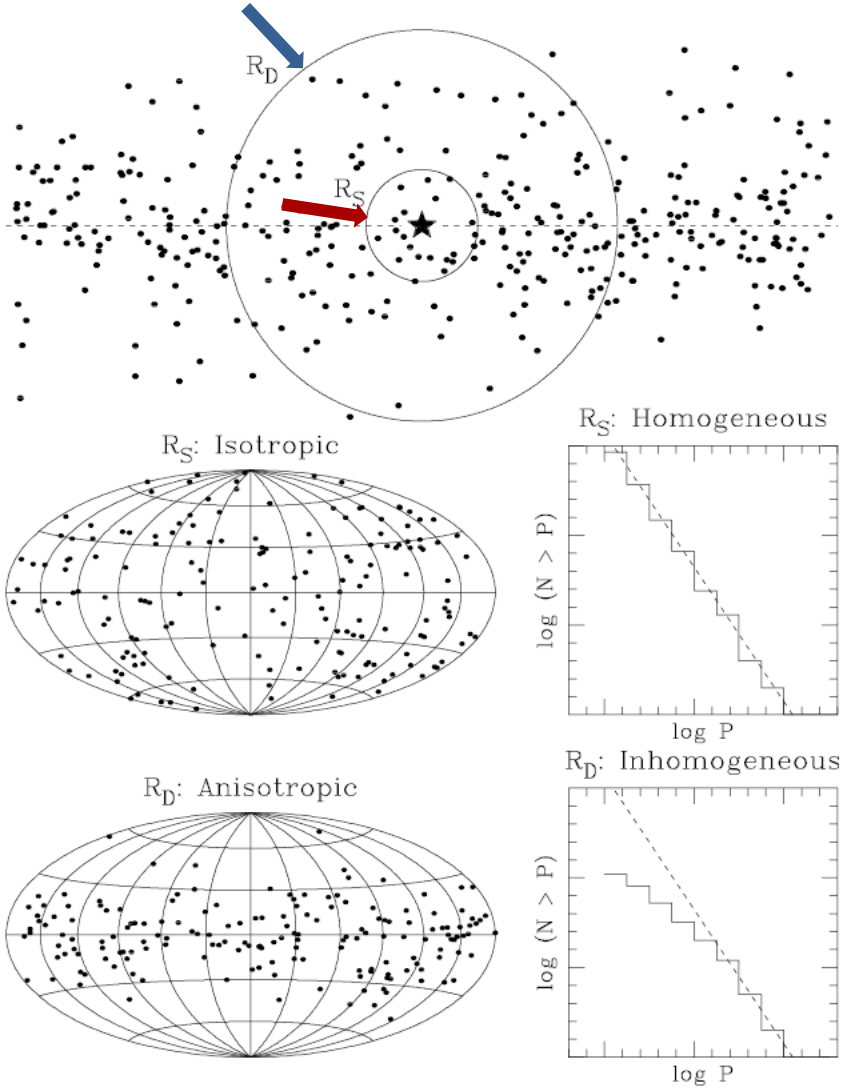
Two Distinct subclasses of γ–ray bursts: short/hard & long/soft

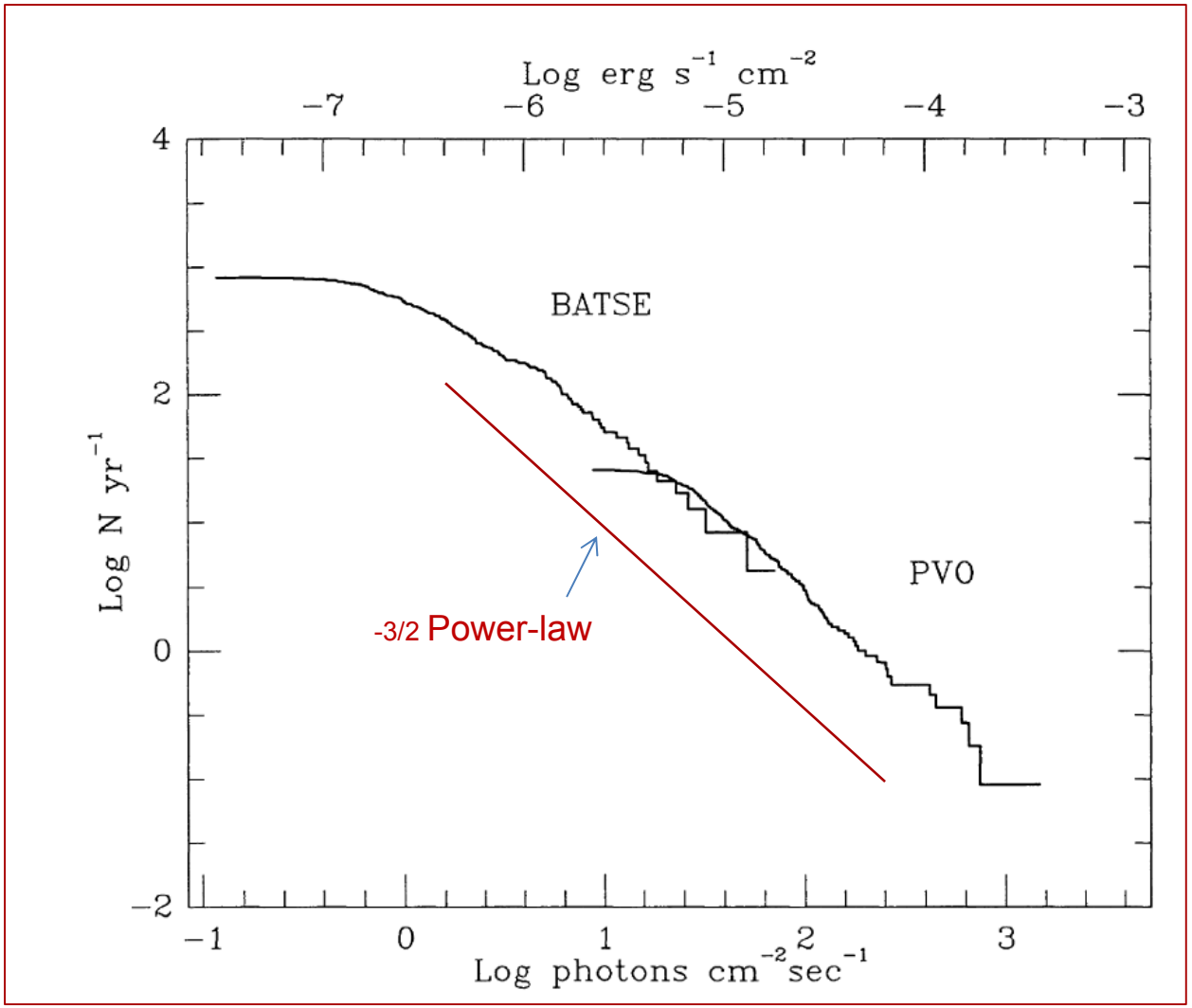



Hardness Ratio
HR S(100−300)/S(50−100)
10^2
10^1
10^0
10^{-1}
10^{-2}
10^{-1}
10^0
10^1
10^2
10^3
T90 (sec)
Duration of Gamma-ray Bursts (sec)

R_S - Galactic, Nearby

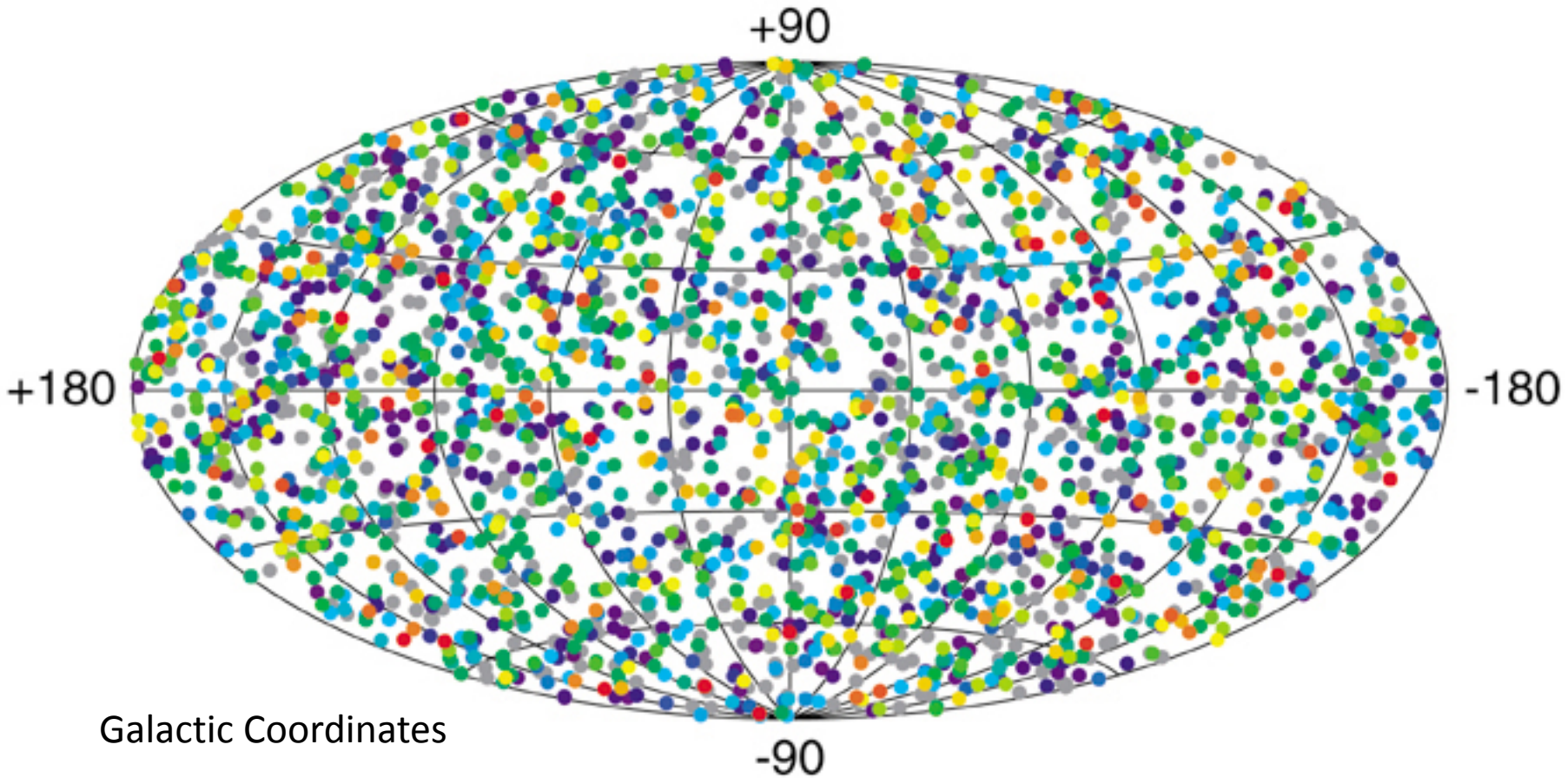
R_D - Galactic, Far away





Observed Frequency of GRBs

2704 BATSE Gamma-Ray Bursts

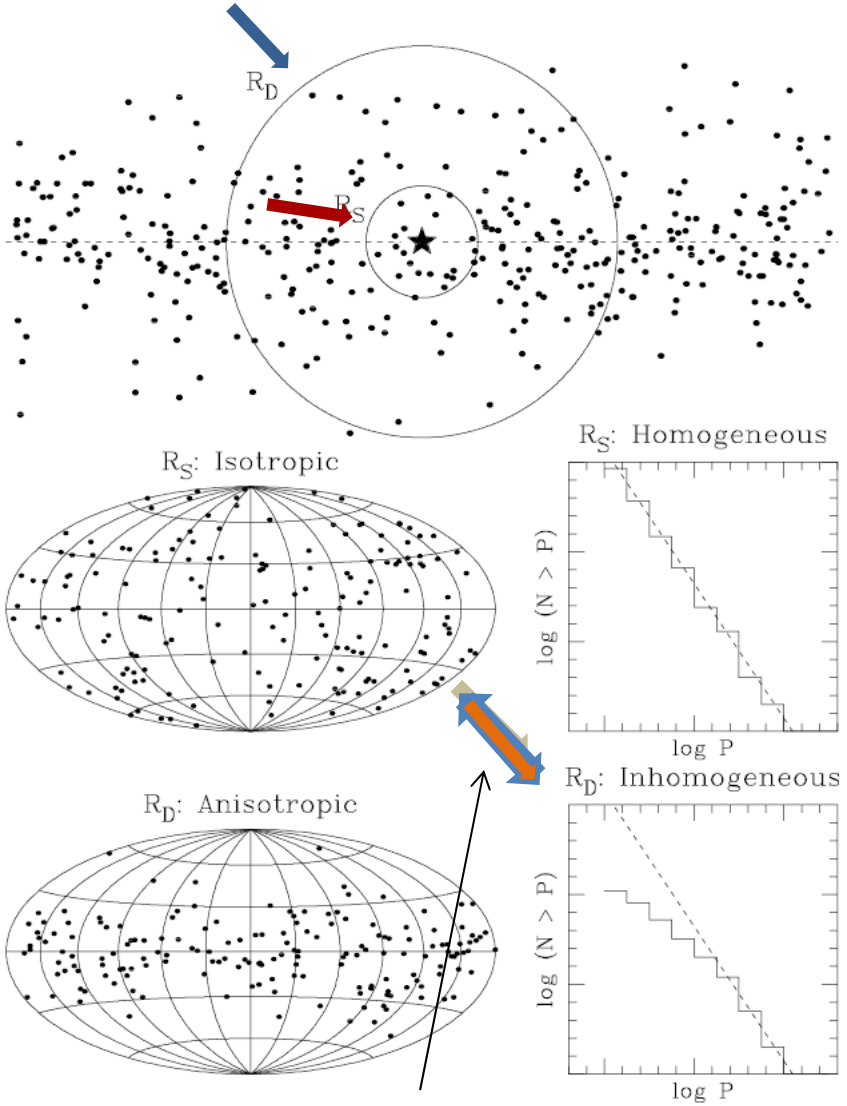


Galactic Coordinates

Apr. 1991 – May 2000

R_S - Galactic, Nearby

R_D - Galactic, Far away



Observed Distribution

i.e. Not Galactic

Some Recent Papers that use BATSE Data:

van Putten, M. H. P. M.
Discovery of Black Hole Spindown in the BATSE Catalogue of Long GRBs
2012 - Progress of Theoretical Physics, Vol. 127, No. 2, pp. 331-354

Nava, L.; Ghirlanda, G.; Ghisellini, G.; Celotti, A.
Fermi/GBM and BATSE gamma-ray bursts: comparison of the spectral properties
2011 - Monthly Notices of the Royal Astronomical Society, Volume 415, Issue 4, pp. 3153-3162

Tikhomirova, Ya. Yu.; Pozanenko, A. S.; Hurley, K. S
Search for nearby host galaxies of short gamma-ray bursts detected and well localized by BATSE/IPN
2010 - Astronomy Letters, Volume 36, Issue 4, pp.231-236

Burlon, D.; Ghirlanda, G.; Ghisellini, G.; Greiner, J.; Celotti, A.
Time resolved spectral behavior of bright BATSE precursors
2009 - Astronomy and Astrophysics, Volume 505, Issue 2, 2009, pp.569-575

Huja, D.; Mészáros, A.; Řípa, J.
A comparison of the gamma-ray bursts detected by BATSE and Swift
2009 - Astronomy and Astrophysics, Volume 504, Issue 1, 2009, pp.67-71

González, M. M.; Carrillo-Barragán, M.; Dingus, B. L.; Kaneko, Y.; Preece, R. D.; Briggs, M. S.
Broadband, Time-Dependent, Spectroscopy of the Brightest Bursts Observed by BATSE LAD and EGRET TASC
2009 - The Astrophysical Journal, Volume 696, Issue 2, pp. 2155-2169 (2009).

Horváth, I.; Veres, P.; Balázs, L. G.
The Third Group of Gamma-Ray Bursts in the Swift and BATSE Data
2009 - Baltic Astronomy, Vol. 18, p. 302-304

Some Recent Papers that used BATSE Data (cont.) :

Tsutsui, Ryo; Nakamura, Takashi; Yonetoku, Daisuke; Murakami, Toshio; Tanabe, Sachiko; Kodama, Yoshiki
Redshift-dependent lag-luminosity relation in 565 BATSE gamma-ray bursts10
Monthly Notices of the Royal Astronomical Society: Letters, Volume 386, Issue 1, pp. L33-L37

Kaneko, Yuki; González, M. Magdalena; Preece, Robert D.; Dingus, Brenda L.; Briggs, Michael S.
Broadband Spectral Properties of Bright High-Energy Gamma-Ray Bursts Observed with BATSE and EGRET
The Astrophysical Journal, Volume 677, Issue 2, pp. 1168-1183

Bosnjak, Z.; Celotti, A.; Longo, F.; Barbiellini, G.
Energetics-spectral correlations versus the BATSE gamma-ray bursts population
2008 - Monthly Notices of the Royal Astronomical Society, Volume 384, Issue 2, pp. 599-604

Ashcraft, Teresa; Schaefer, Bradley E.
Are There Any Redshift >8 Gamma-Ray Bursts in the BATSE Catalog?
2007 - The Astrophysical Journal, Volume 671, Issue 2, pp. 1896-1902

Tsuchiya, H.; Miyasaka, H.; Takahashi, E.; Shimoda, S.; Yamada, Y.; Kondo, I.; Makishima, K.; Zhu, F.; Tan, Y.; Hu, H.; and 4 coauthors
Upper limits on the solar-neutron flux at the Yangbajing neutron monitor from BATSE-detected solar flares
2007 - Astronomy and Astrophysics, Volume 468, Issue 3, June IV 2007, pp.1089-1097

Hakkila, Jon; Giblin, Timothy W.; Young, Kevin C.; Fuller, Stephen P., et al.
A Gamma-Ray Burst Database of BATSE Spectral Lag and Internal Luminosity Function Values
The Astrophysical Journal Supplement Series, Volume 169, Issue 1, pp. 62-74

Alothman, M. J.; Azzam, W. J.
Fluence correlations across the BATSE gamma-ray burst energy channels for short and long bursts
2007 - Advances in Space Research, Volume 40, Issue 8, p. 1229-1232

The End