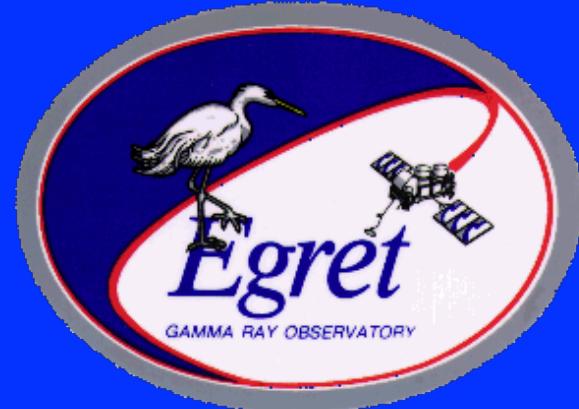


# The Legacy of EGRET on CGRO (1)



Gottfried Kanbach, MPE  
for the  
EGRET collaboration



## The 'founding' Co-PIs

R. Hofstadter (1915-1990)  
Stanford University



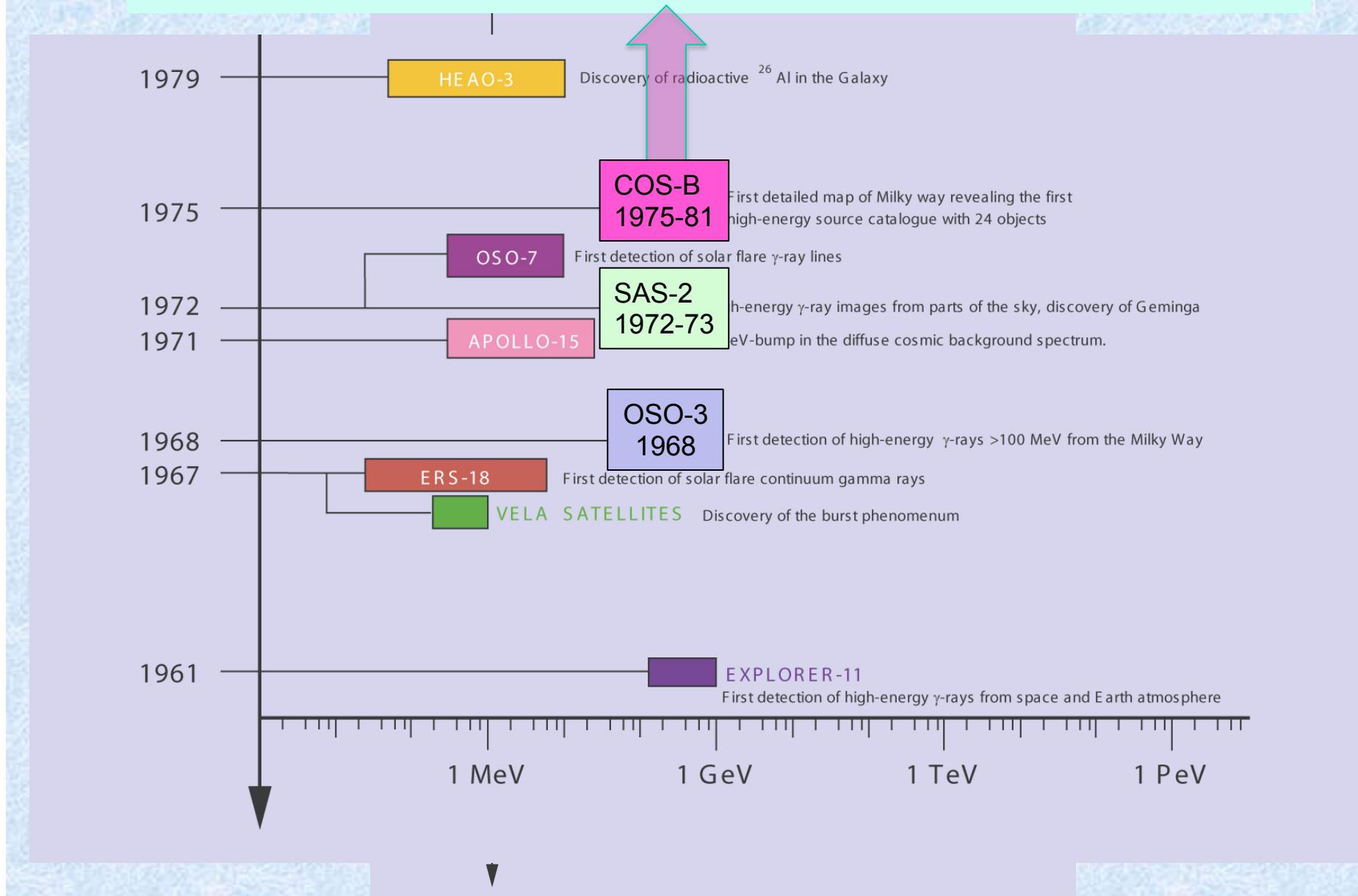
Carl Fichtel (NASA/GSFC)



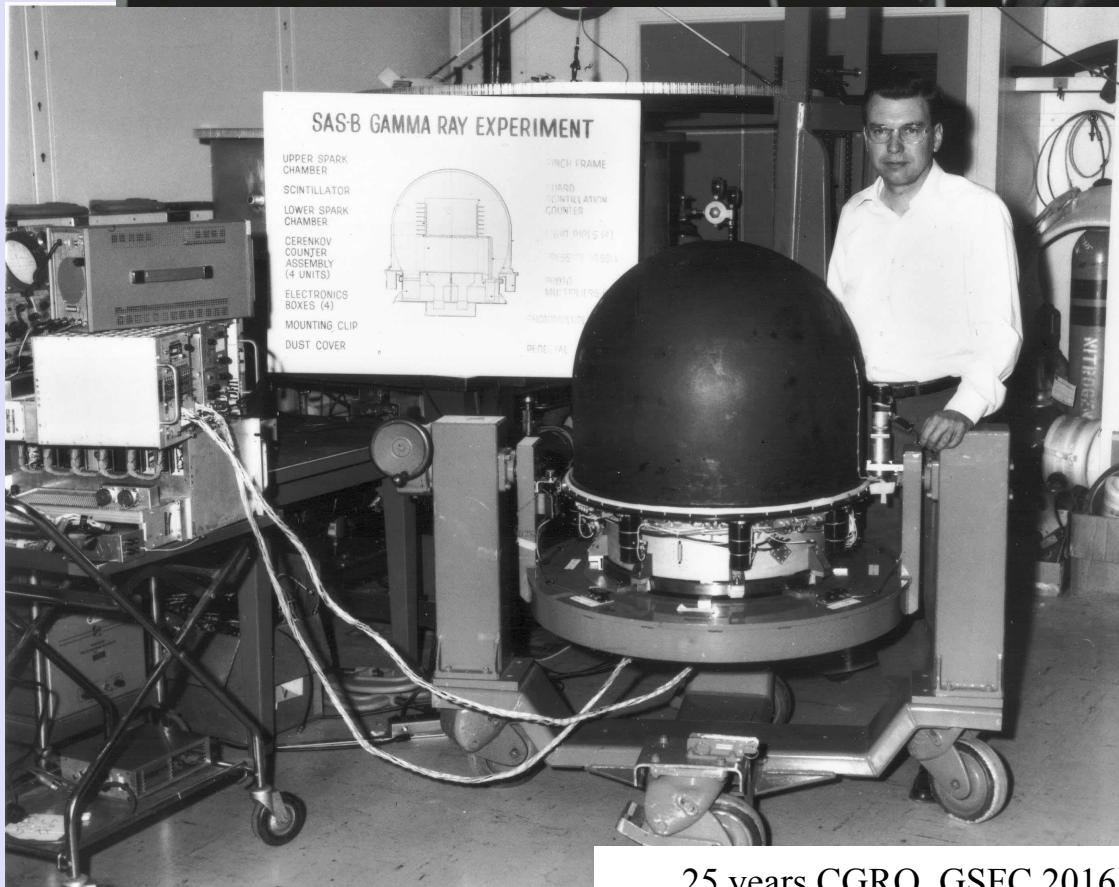
Klaus Pinkau (MPE)

25 years CGRO, GSFC 2016

# The roots of $\gamma$ -ray astronomy: 1960-1980



# GSFC: Carl Fichtel and his team

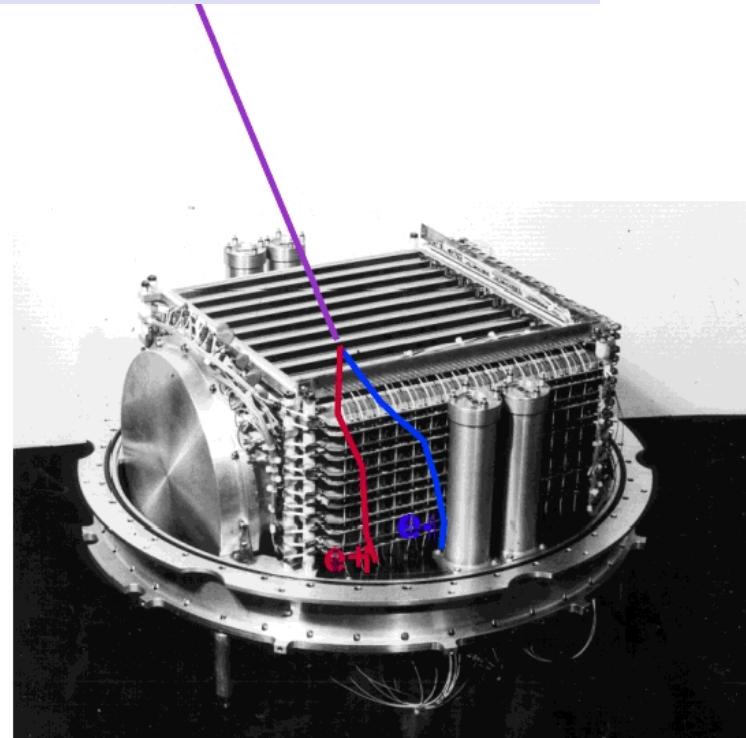


SAS-2 1972-73

25 years CGRO, GSFC 2016

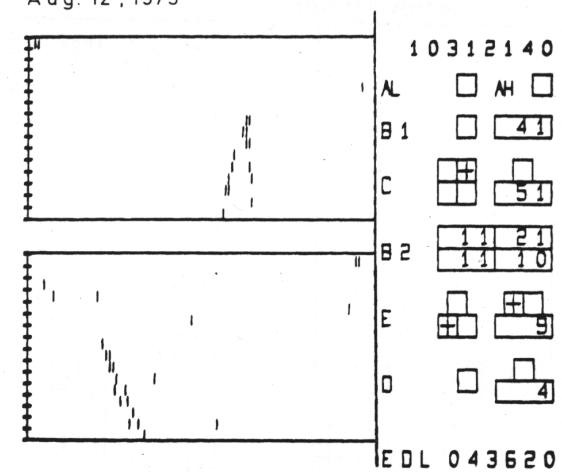
# MPE: Sparkchamber Development

Pinkau, Schönfelder, Mayer-Hasselwander, Reppin, Sommer

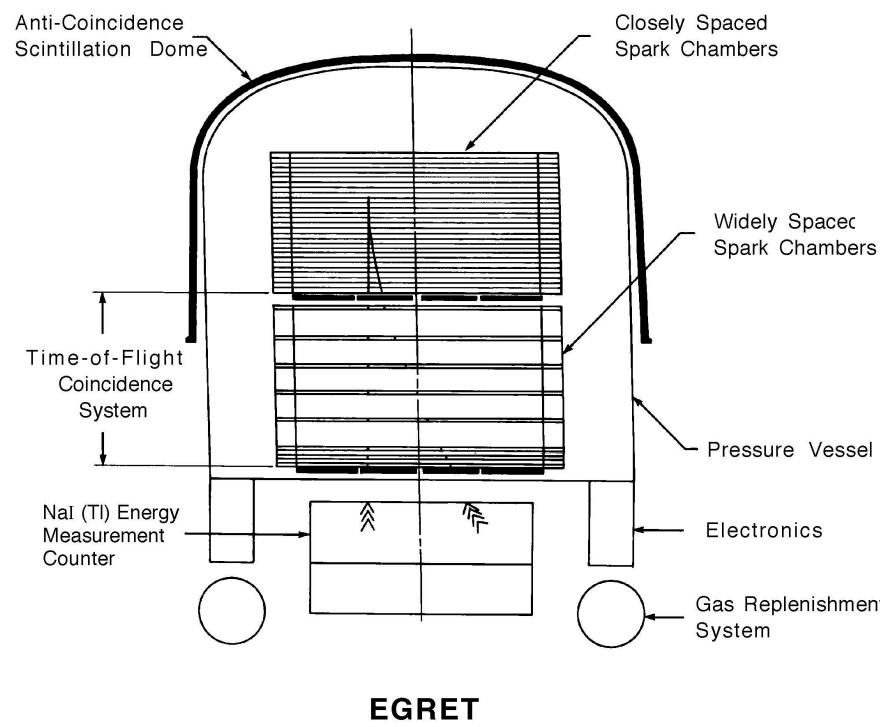
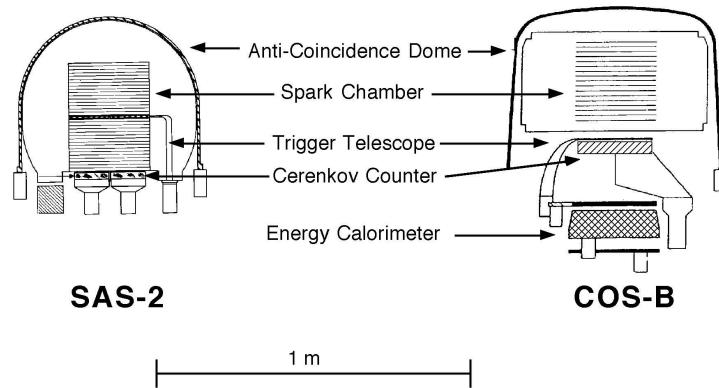


COS-B (ESO): 1975-1982

RO, GSFC 2016



## Gamma Ray Telescopes



Scaling up SAS-2 and COS-B →

Energetic Gamma-Ray Experiment Telescope (EGRET):

Energy Range: 30 MeV – 30 GeV

Sensitive Area:  $\approx 1200 \text{ cm}^2$  ( $>100 \text{ MeV}$ )

Angular resolution:  $0.1^\circ - 0.4^\circ$

Energy resolution:  $\approx 15\%$

Field of View:  $40^\circ$  dia.

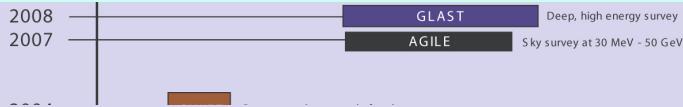


Sensitivity improvement  $\approx 30$  times



25 years CGRO, GSFC 2016

# Breakthrough: 1980-2000



1997

BEPPO-SAX

Clarifies cosmological origin of  $\gamma$ -ray bursts

1991

Compton Gamma-Ray Observatory: 1991-2000

First all sky coverage revealing important discoveries in all areas of  $\gamma$ -ray astronomy. Gamma-ray astronomy becomes an integrated part of astronomy.

1989

SIGMA

First high resolution images (13' resolution) of sky regions in the hard x-ray / soft  $\gamma$ -ray range

1987

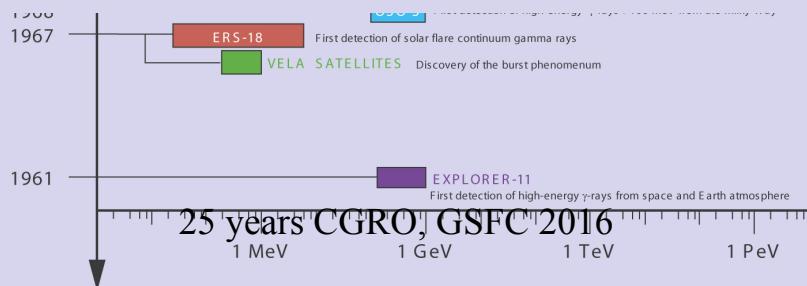
WHIPPLE

First credible detection of a TeV-gamma-ray source (Crab Nebula) by an atmospheric Cerenkov telescope

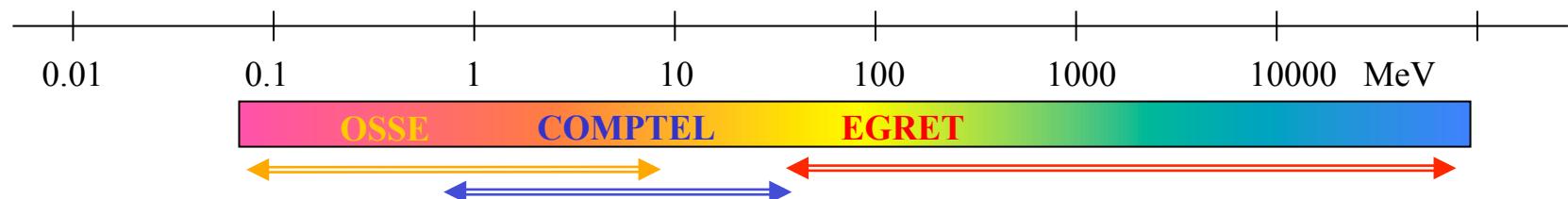
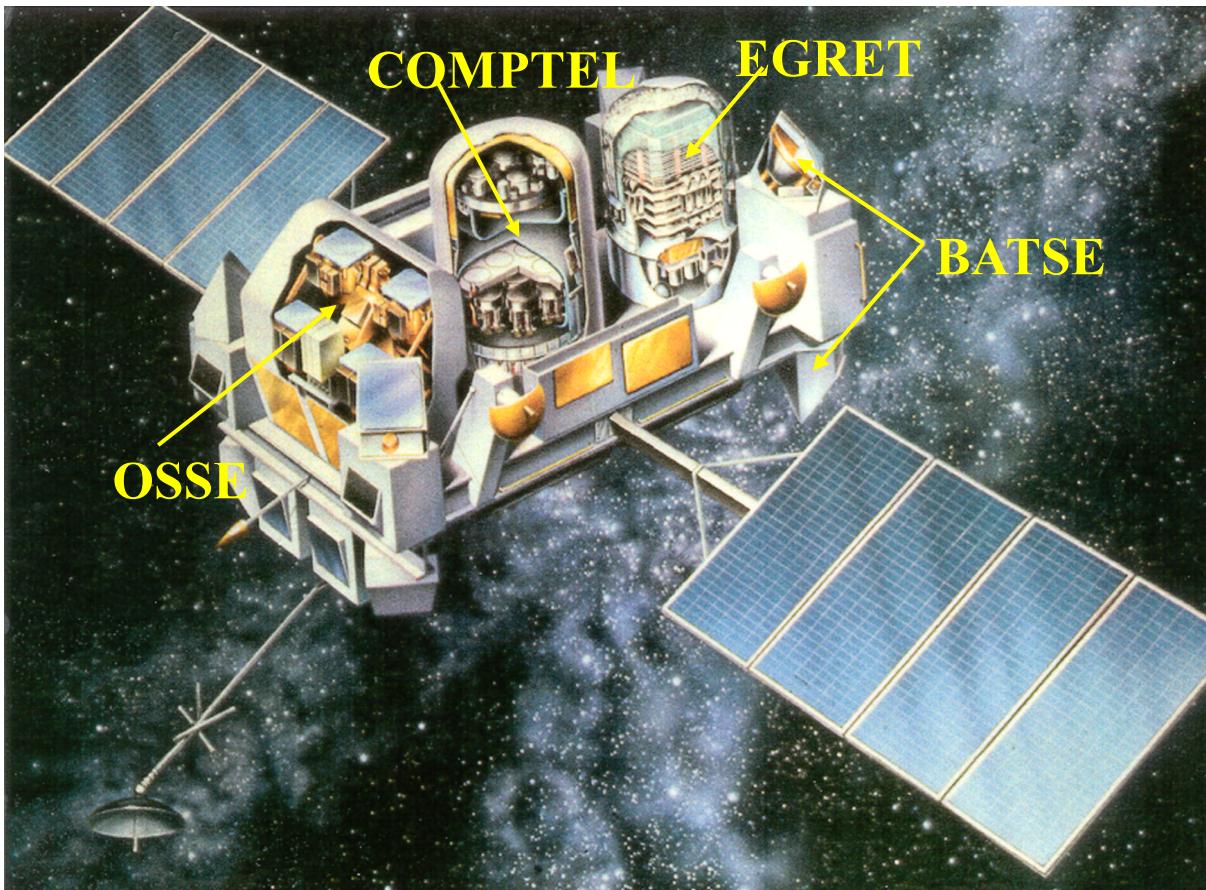
1981

SMM

Extensive studies of solar flare  $\gamma$ -ray and neutron emission, discovery of  $^{56}\text{Co}$ -lines from SN 1987a



# Compton Gamma-Ray Observatory (1991-2000): a 'Great Observatory' for a complete sky survey at high energies



25 years CGRO, GSFC 2016

# EGRET Subsystems:

Tracking detector: gas filled wire spark chamber w. trigger telescope

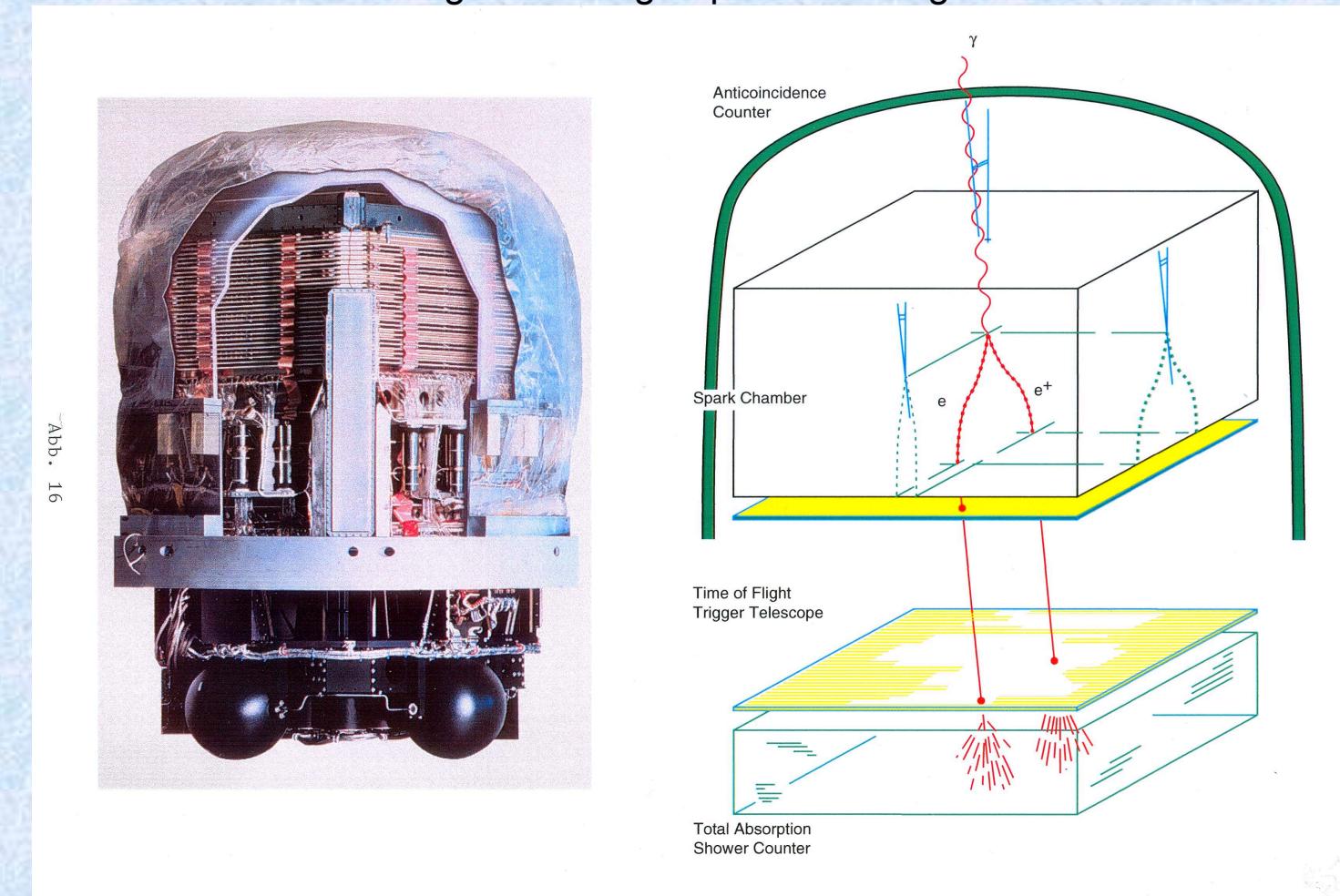
→ image pair conversion events:  $\gamma$ -ray direction

Total Absorption Shower Counter: NaI Scintillator

→ energy measurement (calorimeter)

Anticoincidence detector: plastic scintillator

→ veto shield against charged particle background



Everybody seems to be happy with the successful completion  
and calibration of the instrument (MPE, Dec 1987)



... but the launch was still about 3 years away

... finally the 5th of April 1991 arrived ...



... eagerly awaited by Gottfried, Gerry, and Corinna



GANNETT

THE SPACE COAST'S NEWSPAPER

35 CENTS

**BASEBALL'S OPENING DAY**

Cincinnati hosts Houston at 2 p.m. (WAYK, ESPN). Other TV games:  
 ■ 2 p.m.: Chicago White Sox at Baltimore (WGN).  
 ■ 8 p.m.: Milwaukee at Texas (WAYK, ESPN). Complete coverage, 1C, 8C.

LOU PINIELLA:  
Cincinnati manager.

# FLORIDA TODAY

PUBLISHED IN BREVARD COUNTY

MONDAY, April 8, 1991

**HEADLINES**

TODAY'S NEWS AT A GLANCE

**SPACE:** Next launch is a commercial Delta rocket scheduled for liftoff Friday. It will carry a Comtel Corp. communications satellite.

**WEATHER:** Early morning fog turning partly cloudy with a 40 percent chance of showers or thunderstorms. High in the mid-80s; low in the mid-to-upper 60s. Weather, 8A.

**NATION:** Author who skewers Nancy Reagan in a new book as greedy and promiscuous says she is convinced the former first lady ran the U.S. government, 3A.

**BUSH** Two of three people killed by gunshots in a back 41 hours at an electronics store were shot in the back, coroner's officials say. The third suffered "multiple gunshot wounds," 3A.

**BUSH** President Bush is preparing for another battle with Congress, labor unions and environmentalists — this time over free trade with Mexico, 4A.

**WORLD:** Three thousand people gather in Moscow for Orthodox Easter services, the first such services in decades, 4A.

**ALBANIANS** vote in runoff elections that either will grant communists unchecked power in parliament or give the opposition an important say in running the poor Balkan nation, 4A.

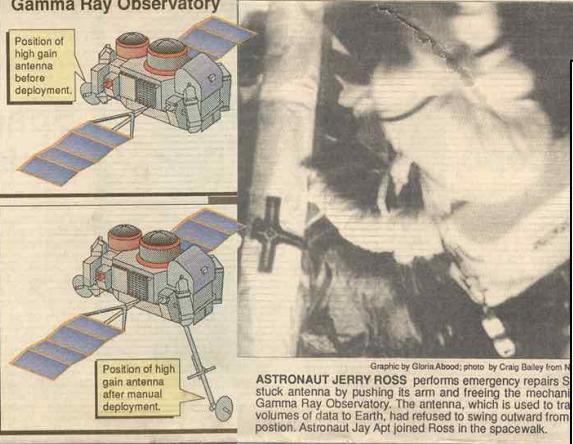
**BREVARD:** Youths accused of slaying Titusville gas station manager have conversations taped while in jail holding cell; lawyers want to keep tape from used at trial, 1B.

**Holocaust survivor** tells her story to 4B for

**High-flying repair work****Gamma Ray Observatory**

Position of high gain antenna before deployment.

Position of high gain antenna after manual deployment.

**PANEL: CENSURE LIPPMAN**

House committee votes today, 6B.

**EXERCISE**

Know your limitations, 1D.

**PROMOTION**

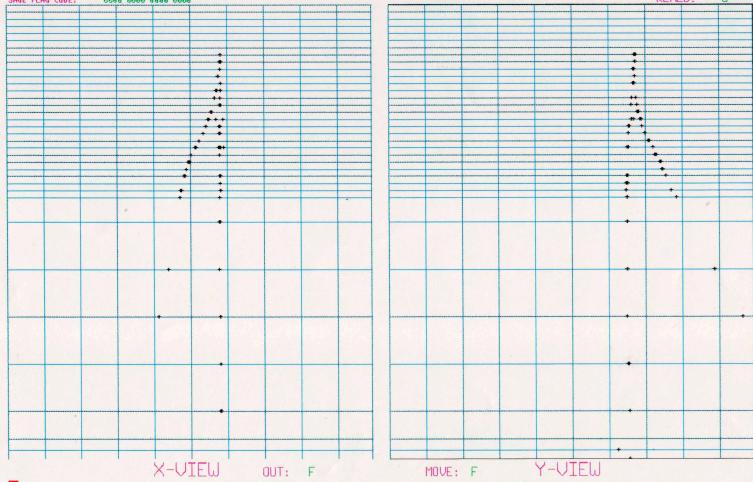
Manufacturing group touts Brevard, in Business Monday.

REP. FRED LIPPMAN:  
Faces charges.

„whole lotta shakin' goin' on“  
by Jerry Ross and GRO is  
on the way...

**First Light Gamma Ray from EGRET**

VIEW: EDIT TIME: 91/4/20 18:21:9 EVENT EDITOR PROGRAM: PDB: 261 DISP: A EVENT: 10:1000  
SINE FLAG CODE: 0000 0000 0000 0000 REMED: 0



I. Kuehne  
Bob Hartman  
Dave Thompson

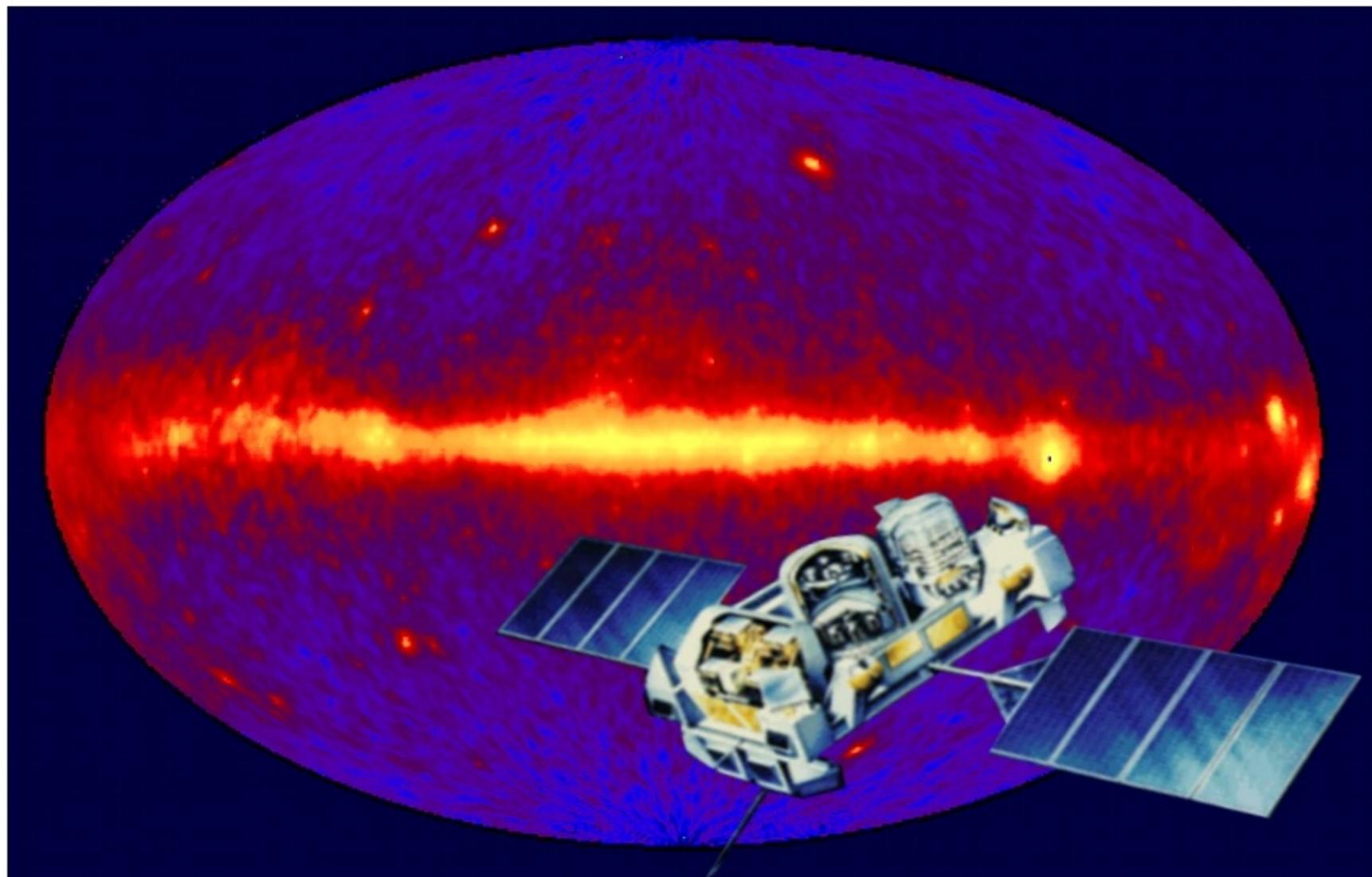
Dave Beestock  
Pat Nolan  
Ed Schmid  
Don Kniffen

John Shuster H. Roy Hulseback  
J. Motter Klein Bullock  
H. Lohman  
George L. Smith Carl Field  
C. Oon Montague  
M. Turner

... the sky survey begins with  
the first recorded  
gamma-ray

25 years CGRO, GSFC 2016

# All Sky Survey (Phase 1): Apr 1991 – Nov 1992



25 years CGRO, GSFC 2016

## **Major discoveries during Phase 1 (Apr 1991 – Nov 1992): (only a subset of all discoveries & publications)**

### **Extragalactic Sources:**

- Blazar 3C279: Hartman et al., *ApJ* 385, L1, 1992
- LMC: Sreekumar et al., *ApJ* 400, L67, 1992
- BL Lac Mkn 421: Lin et al., *ApJ* 401, L61, 1992

### **Galactic Sources:**

- 1EG Catalog: Fichtel et al., *ApJ Suppl.* 94, 551, 1994
- Geminga: Bertsch et al., *Nature* 357, 306, 1992
- PSR B1706-44: Thompson et al., *Nature* 359, 615, 1992

### **Various others:**

- GRB910503: Schneid et al., *A&A* 255, L13, 1992 ,→ more GRBs
- Solar Flare: Kanbach et al., *A&A Suppl.* 97, 349, 1993

## **Major discoveries during Phase 1 (Apr 1991 – Nov 1992): (only a subset of all discoveries & publications)**

### **Extragalactic Sources:**

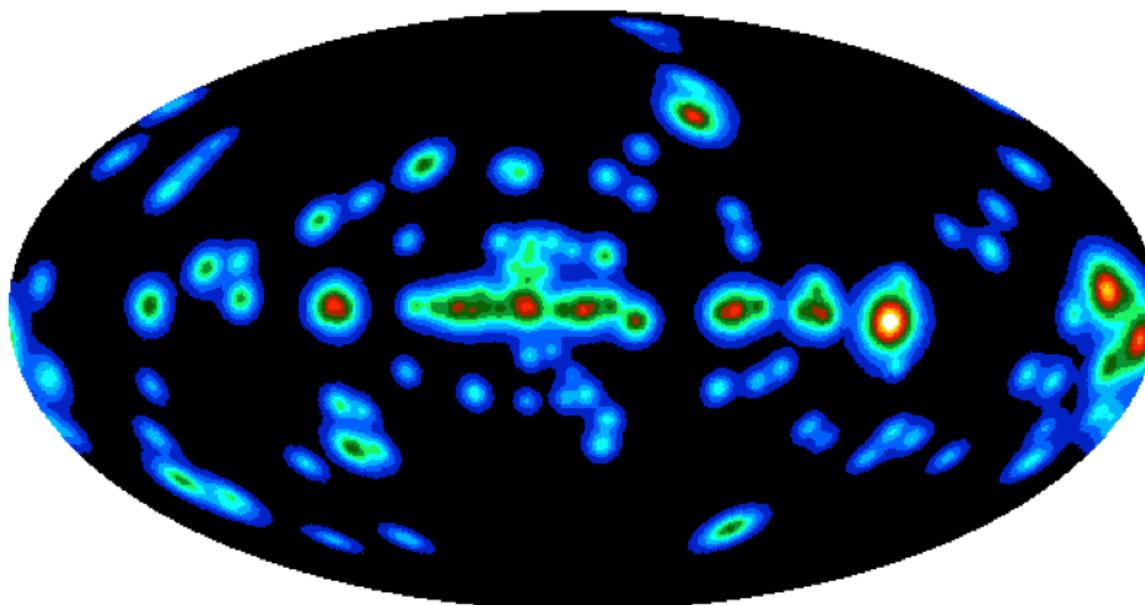
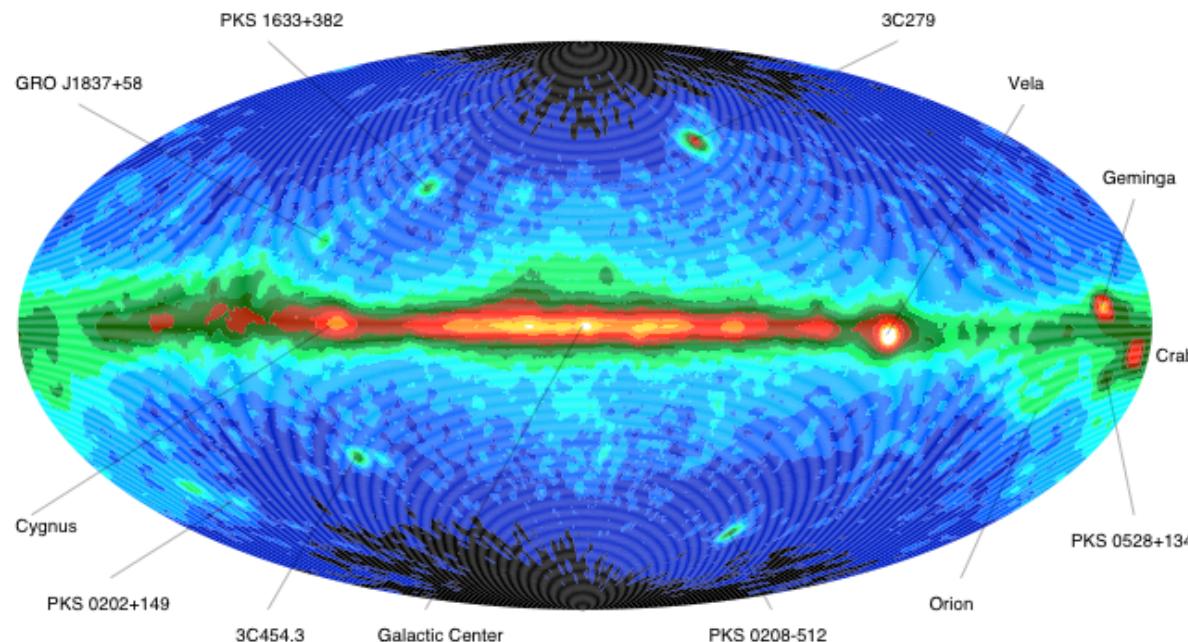
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- Solar Flare: Kanbach et al., *A&A Suppl.* 97, 349, 1993



EGRET Sky Survey  
Phase 1:  
Apr 1991 – Nov 1992

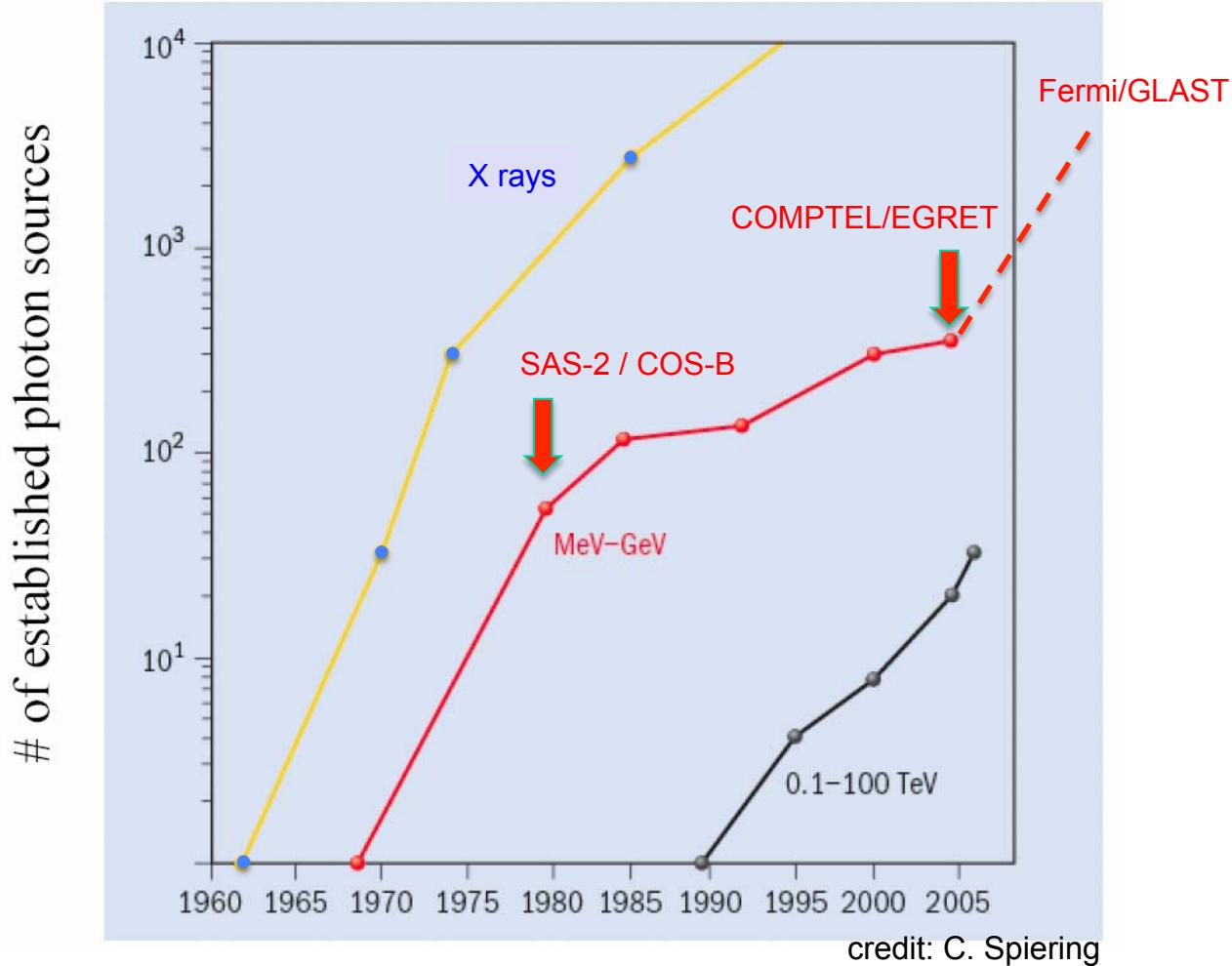
1EG Catalog:  
**~ 130 sources**  
(Fichtel et al., 1994)

Pulsars: **5**

Unidentified Sources:  
**35** at  $b > 10^\circ$   
**43** at  $b < 10^\circ$

Blazars: **44**

+ LMC, GRB,  
Solar Flares



25 years CGRO, GSFC 2016

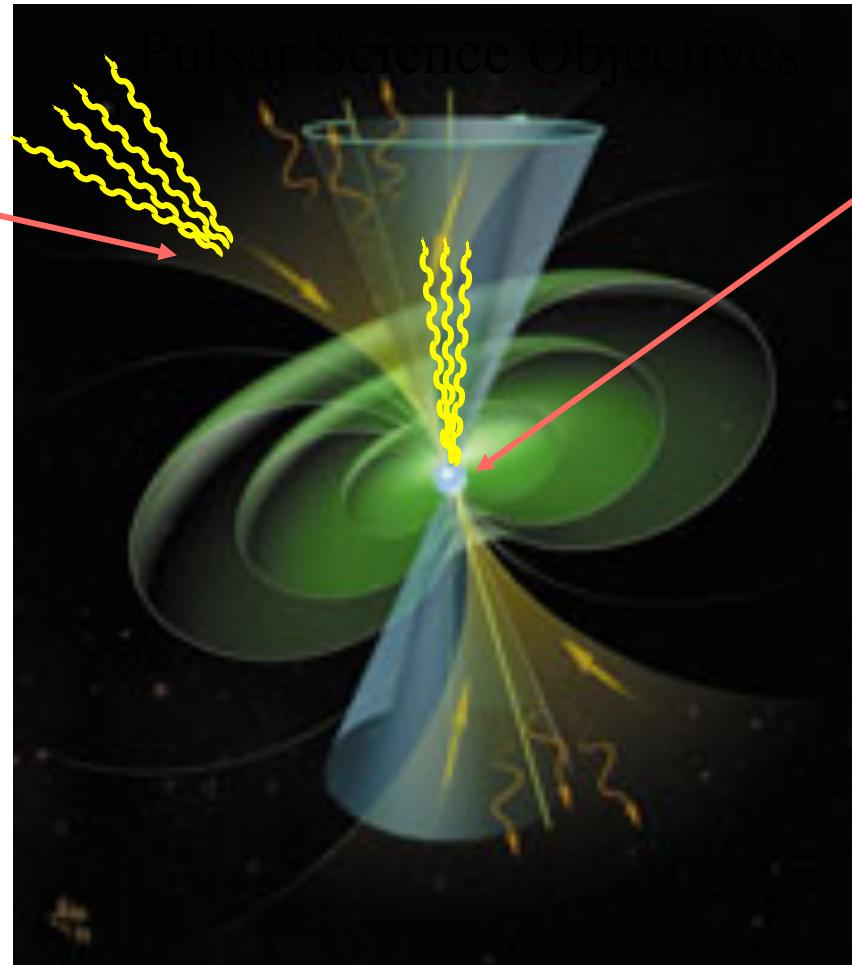
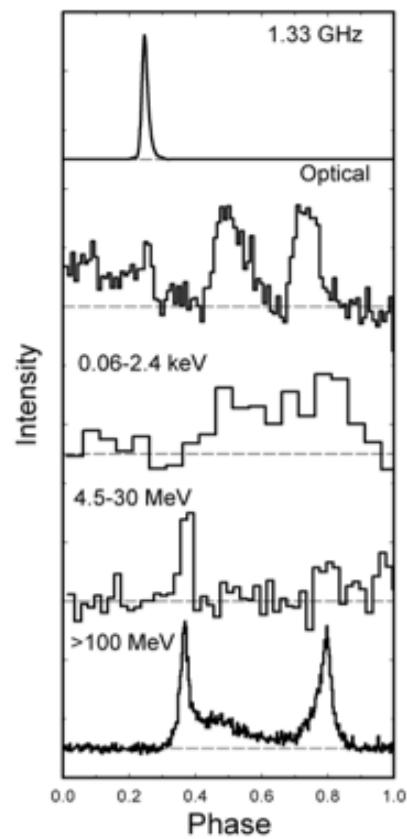
# Gamma Ray Pulsars

Outer Gap

Emission: multi- $\lambda$   
lightcurves

out of phase

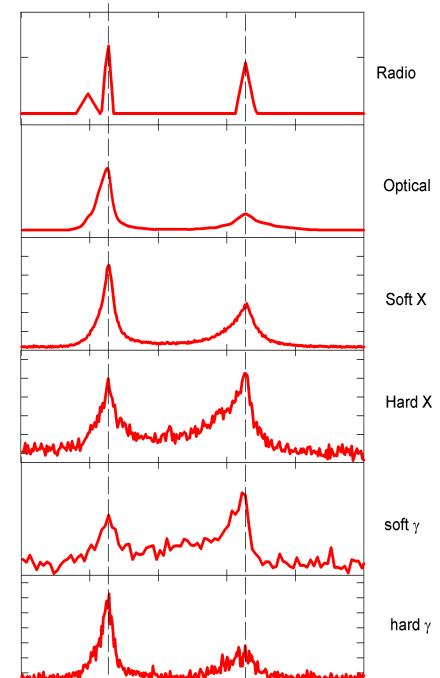
Prototype: Vela



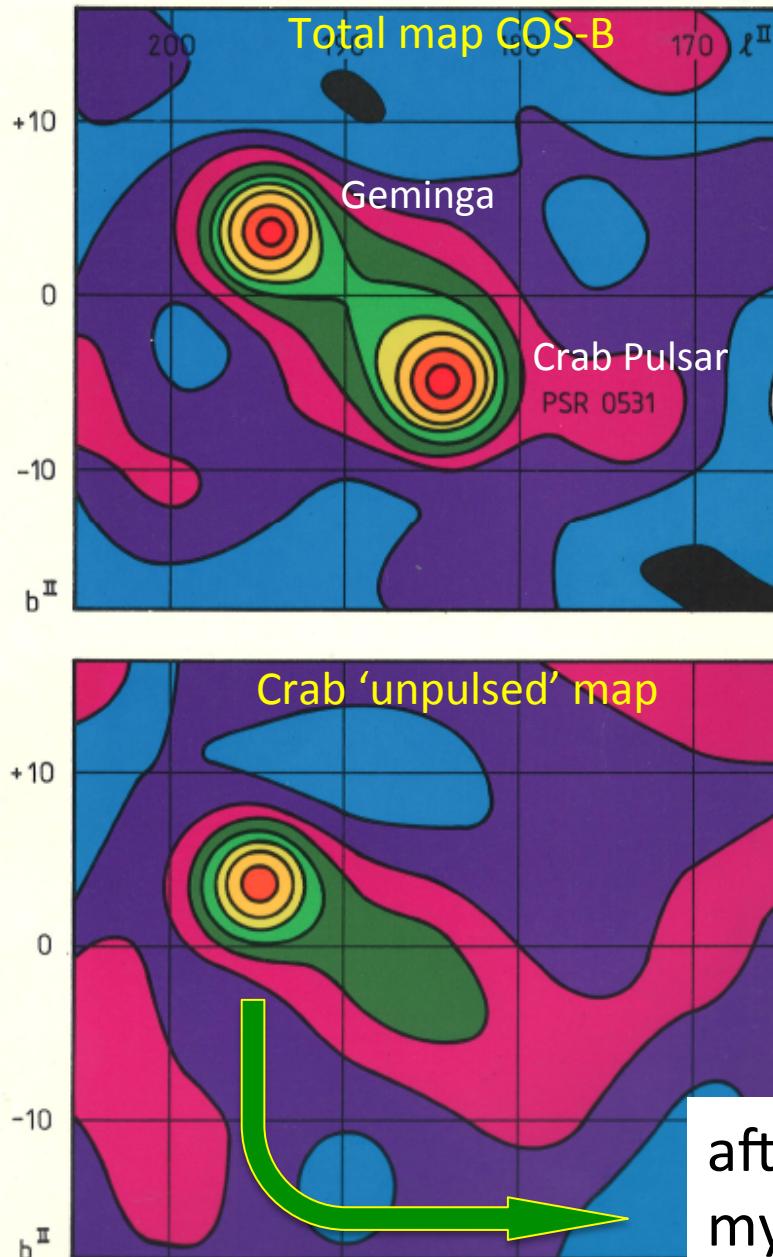
Polar Cap Emission:  
multi- $\lambda$  lightcurves

in phase

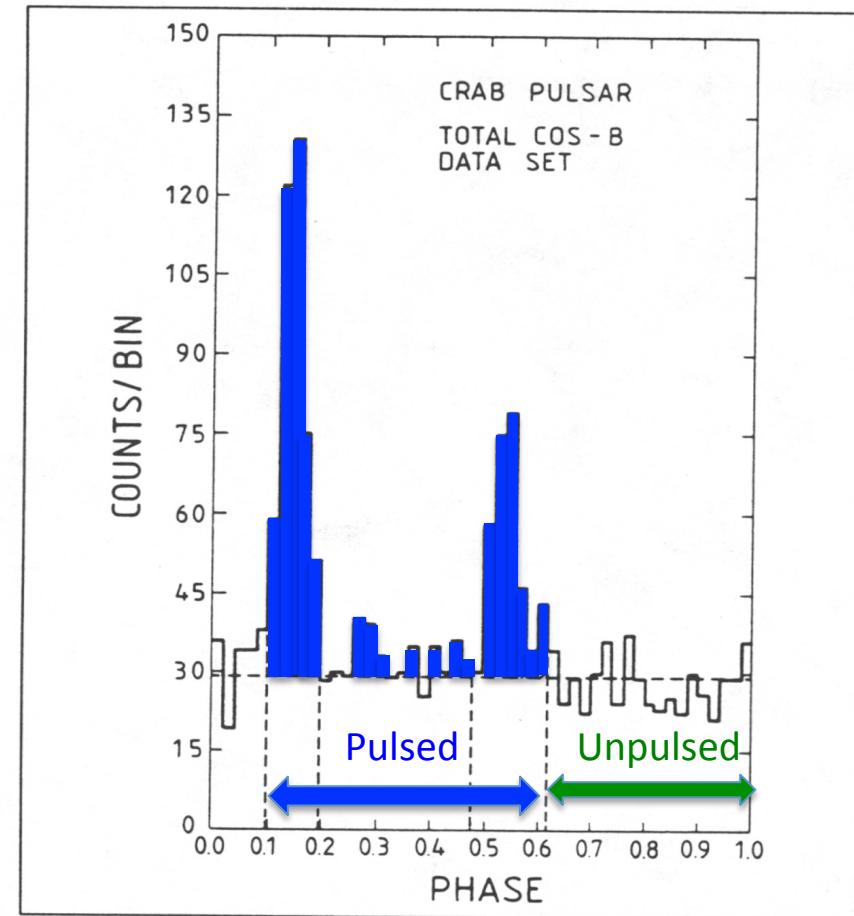
Prototype: Crab



25 years CGRO, GSFC 2016



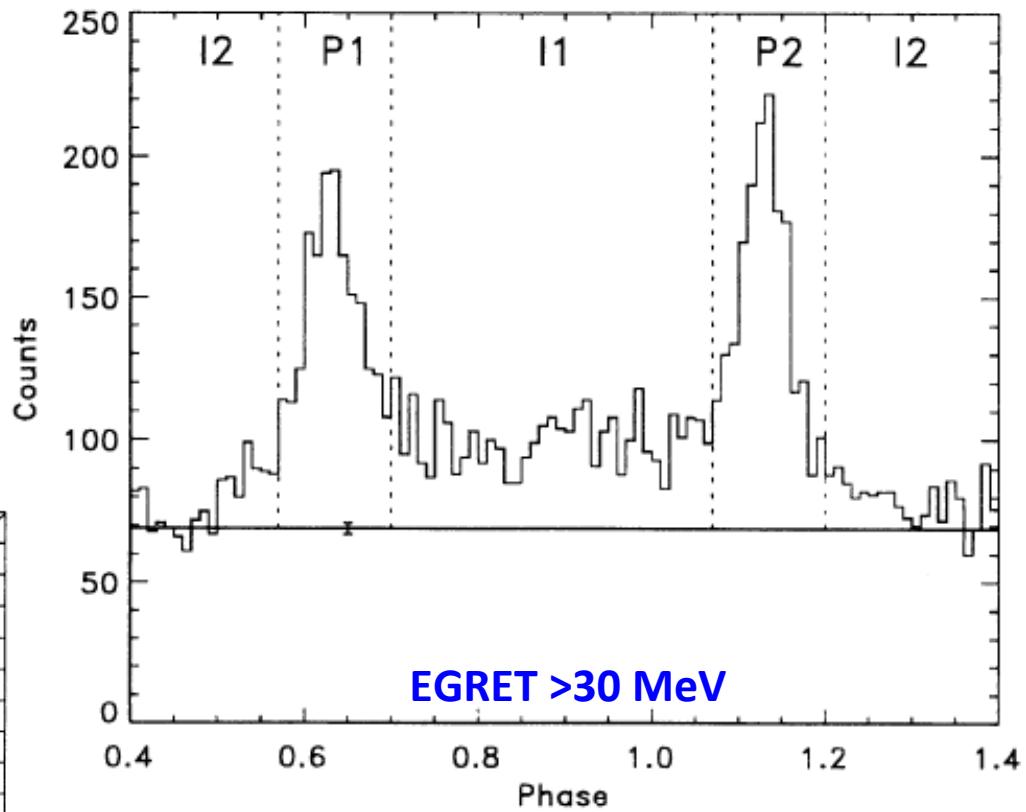
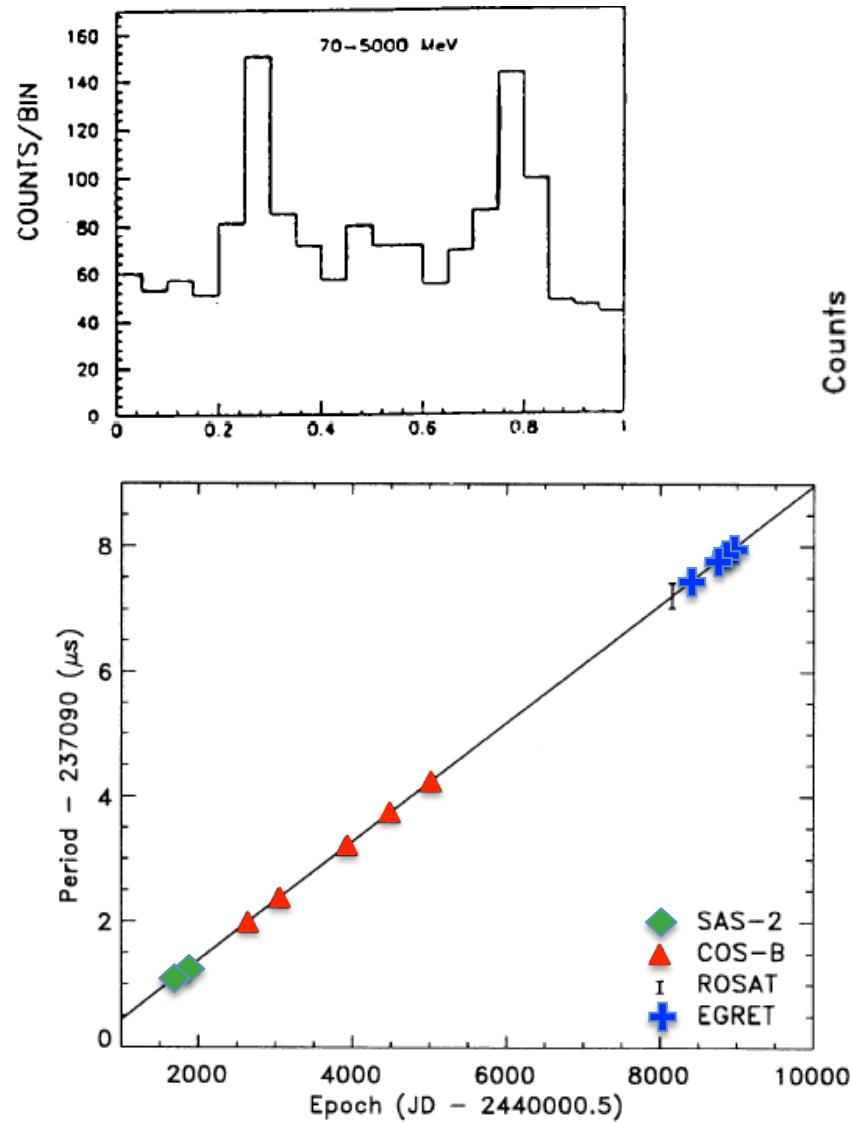
The ‘mysterious other source’ in the gal. anticenter:  
**γ195+5, ‘Geminga’, 2CG 195+4**



after ~20 years the  
mystery was solved with ROSAT & EGRET:  
it is a pulsar!

# Analysis of ROSAT and EGRET data in 1992 revealed Geminga as a pulsar with 0.237 s periodicity

Geminga in COS-B data (1975-81)

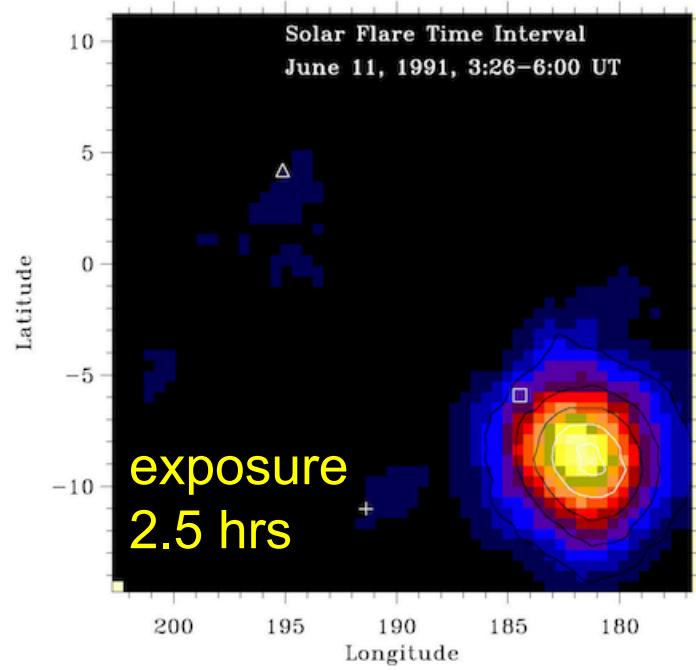
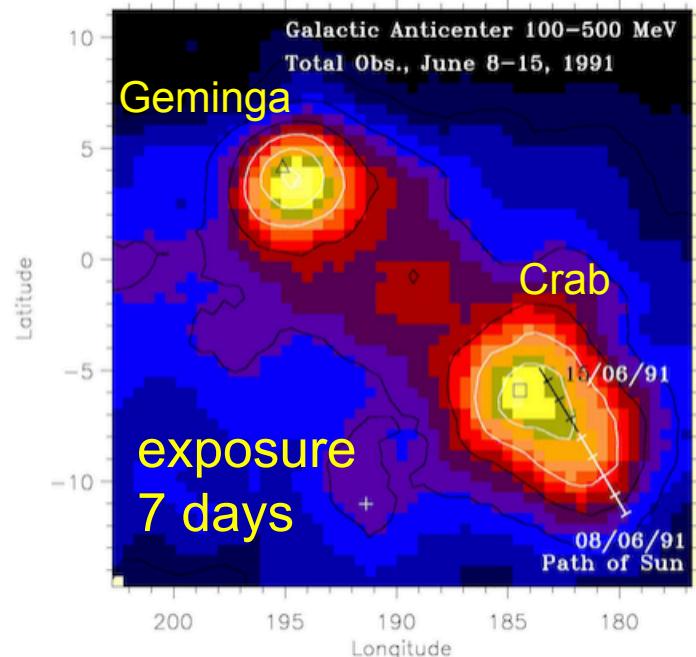


Bertsch et al., *Nature* 357, 306, 1992, 1992

Mayer-Hasselwander et al., *ApJ* 421, 276, 1994:

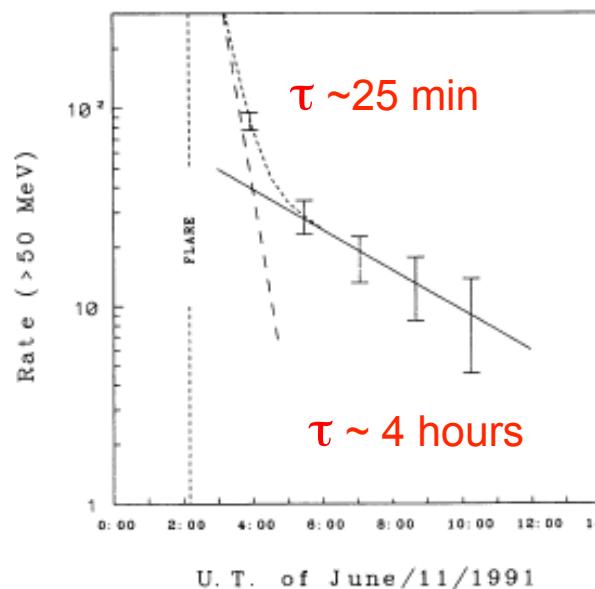
Geminga is an extremely stable 300.000 year old pulsar at a distance of 800 light-years

→Prototype of many Fermi pulsars

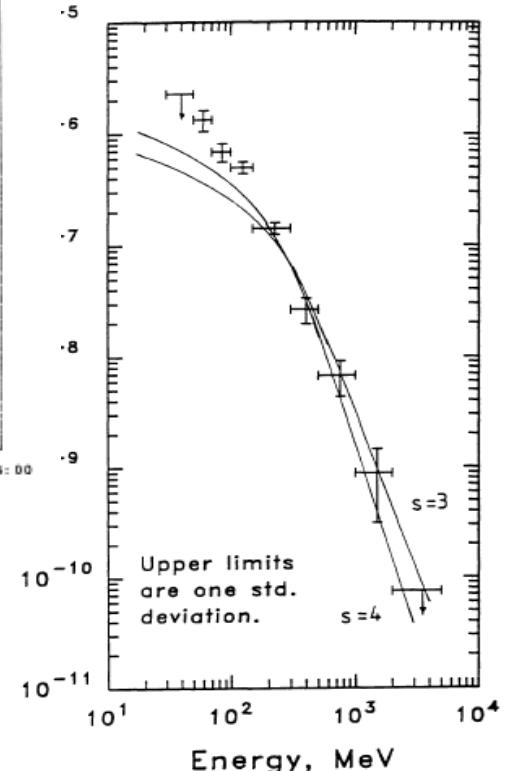


The long-duration X-class solar flare on June 11, 1991:

Time profile:  
short and long  
components



Spectrum:  
Proton ( $\pi^0$  decay)  
and Electron  
(Bremsstrahlung)



After 5 years of CGRO, party at MPE...



now... onward and upward...with Dave Thompson

25 years CGRO, GSFC 2016