Observations of Soft Gamma-ray Repeaters with Konus experiments

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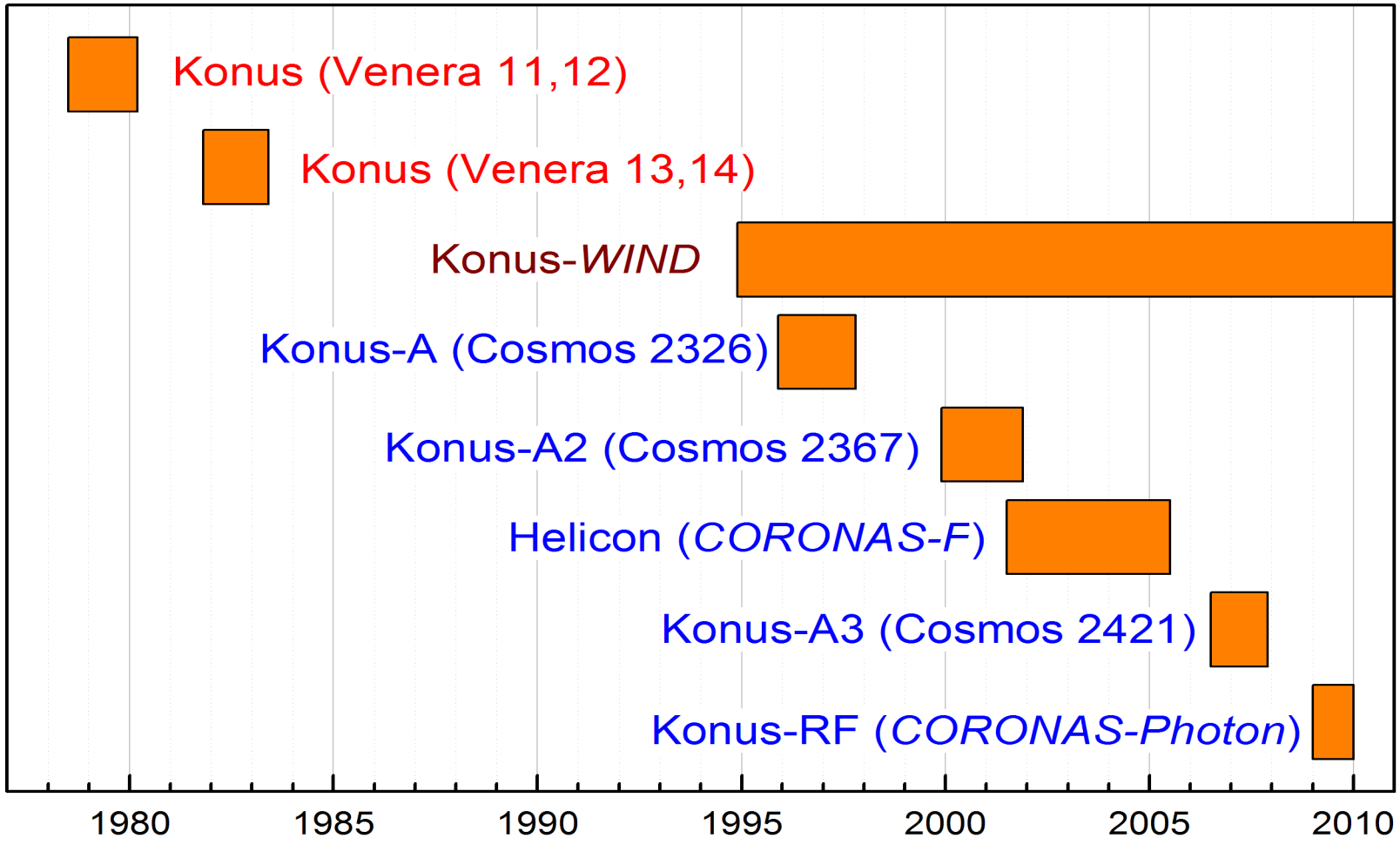
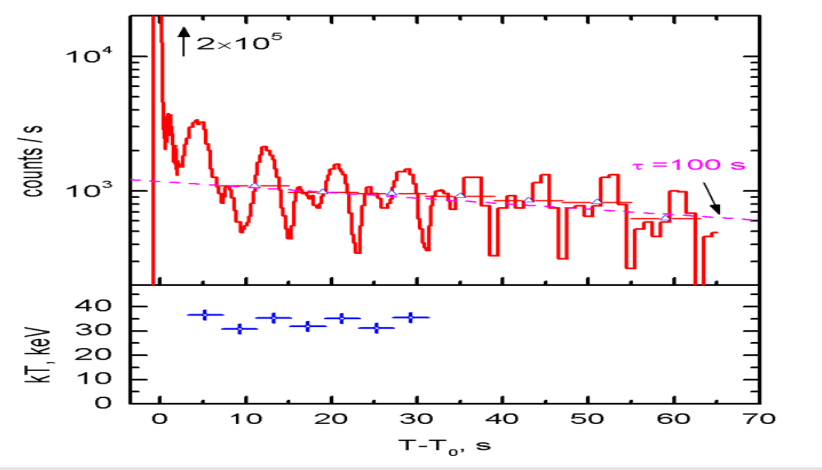
Outline

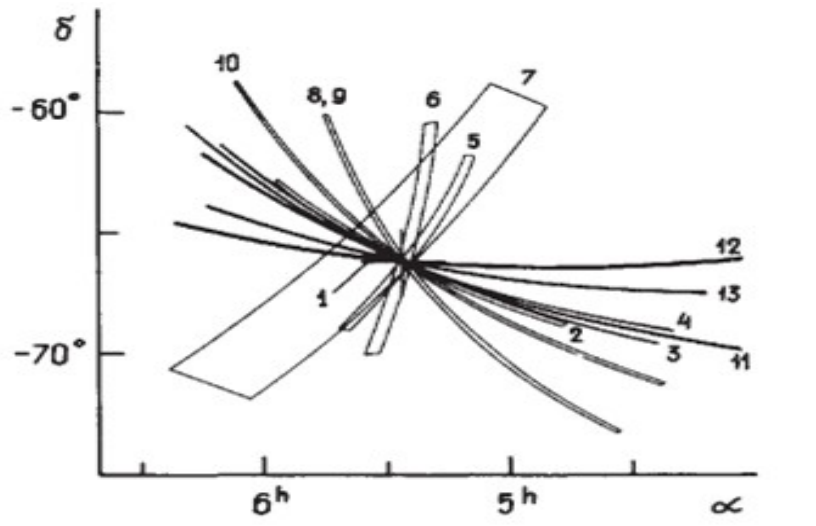
- Konus Gamma-Ray Burst experiments and SGR observations: historical review
- Second Konus SGR Catalog (1994-2009)

Konus GRB Experiments (1978-2011)



Venera Missions (1978-1983)

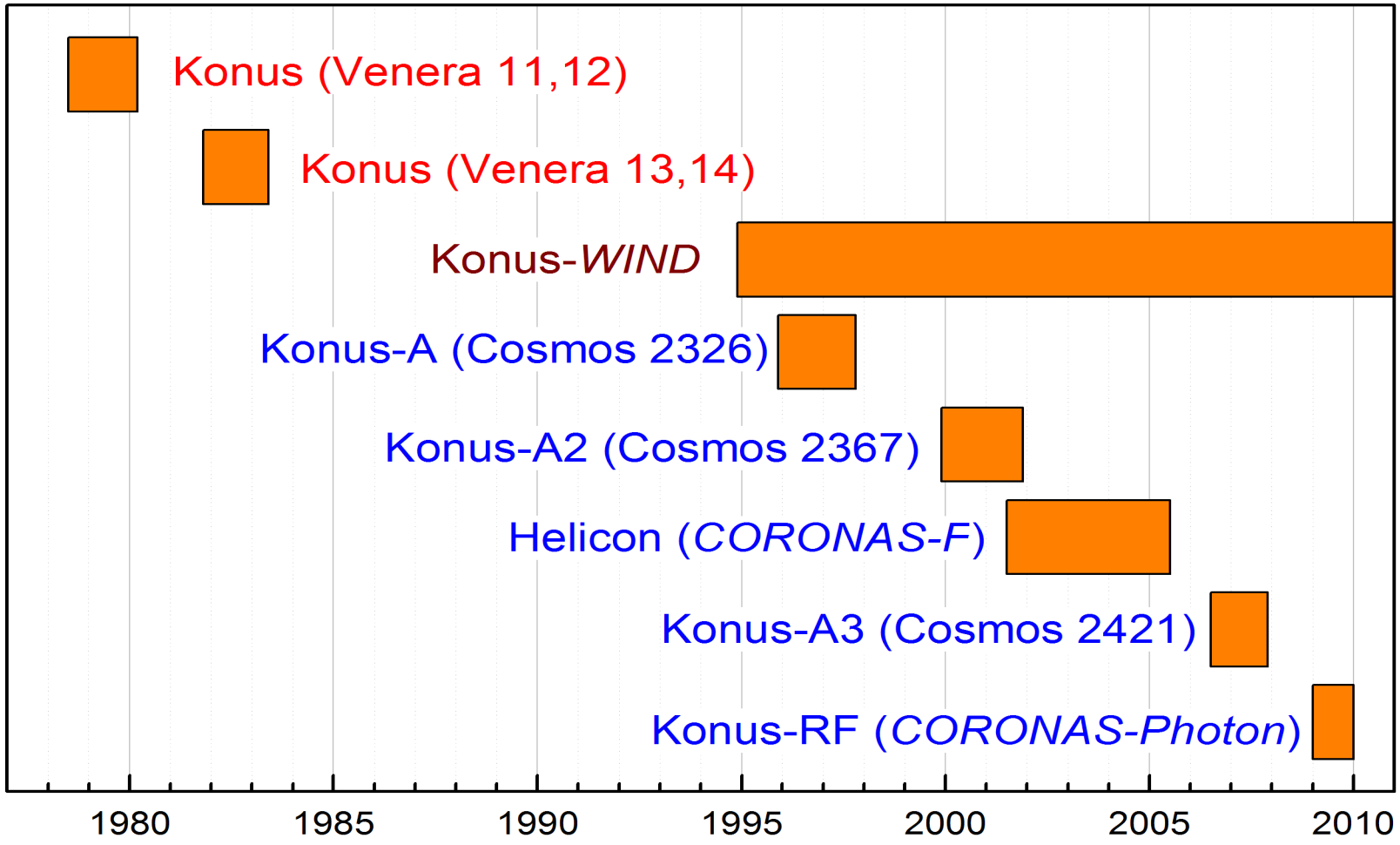




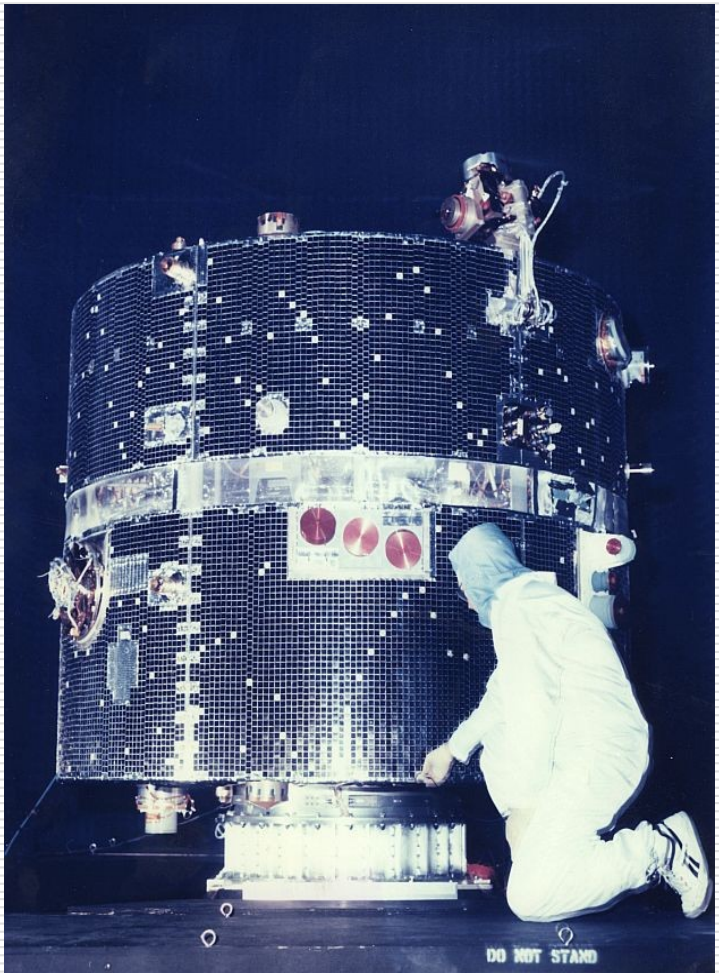
- **Konus (Venera 11,12, Venera 13-14)**
  6 NaI detectors onboard a pair of distant s/c (separation up to 60x10^6 km)
- **Giant Periodic Flare** on March 5, 1979
  (Mazets et al. 1979) followed by 16 short burst from the same source in the next few years (Golenetskii, Il'inskii & Mazets 1984)
  FXP 0526-66
  (N49, LMC, 55 kpc; Cline et al., 1982)
- **B1900+14** (3 bursts in March 1979)
- First two sources of **short recurrent bursts with soft spectra** were discovered and localized, a distinct class of sources different from other GRBs suggested (Golenetskii, Il'inskii & Mazets 1984)
- **SGR 1806-20** (Prognoz 9, ICE, SMM) Atteia et al. 1987, Laros et al. 1987, Kouveliotou et al. 1987

  Jan 7, 1979

Konus GRB Experiments

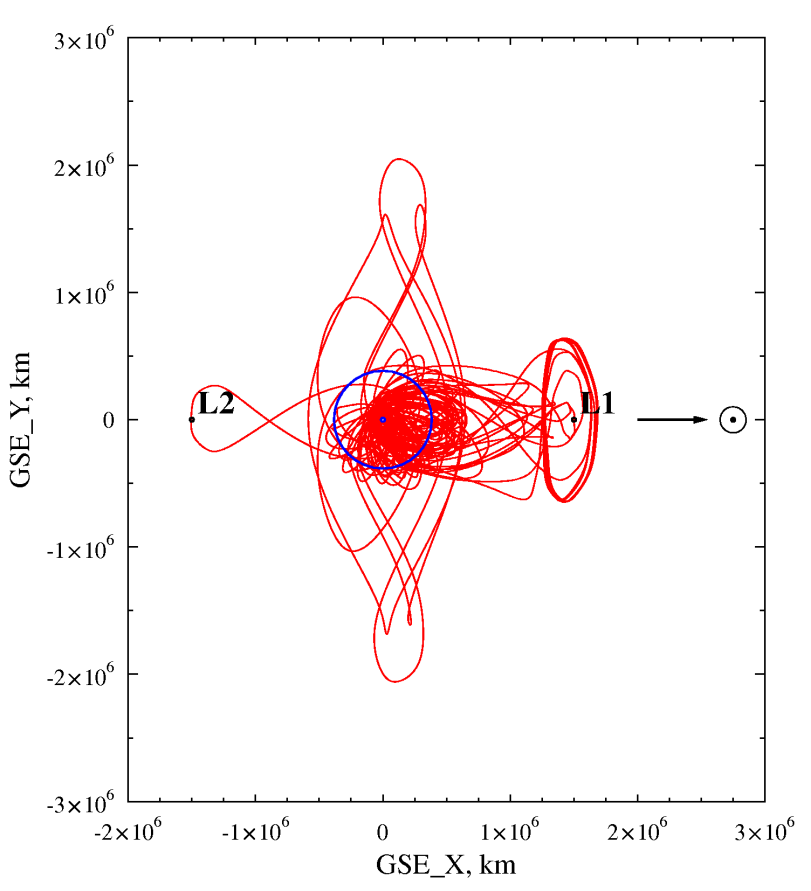


Konus-WIND GRB experiment



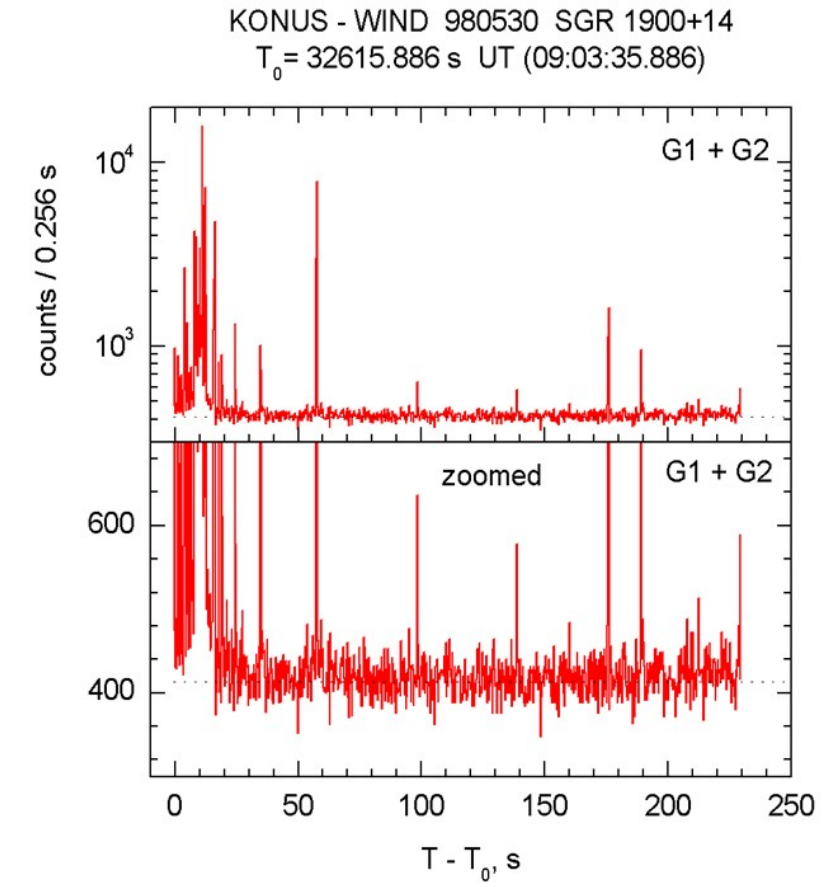
- **NASA GGS-WIND s/c**
  (November 1994 - now)
- Two **NaI(Tl)** 130 x 75 mm (5 x 3 in.) scintillation detectors
- **Al** housing, **Be** entrance window
  Lead glass shielding
- S ~ 100-160 cm^2(100 keV), 80-100 $см^2$(10 MeV)
- **Detection range**:
  10 keV – 10 MeV (1994)
  20 keV – 17 MeV (2011)
- **Detection threshold**:
  10^{-7} – 10^{-6} erg cm^{-2}

GGS-WIND orbit



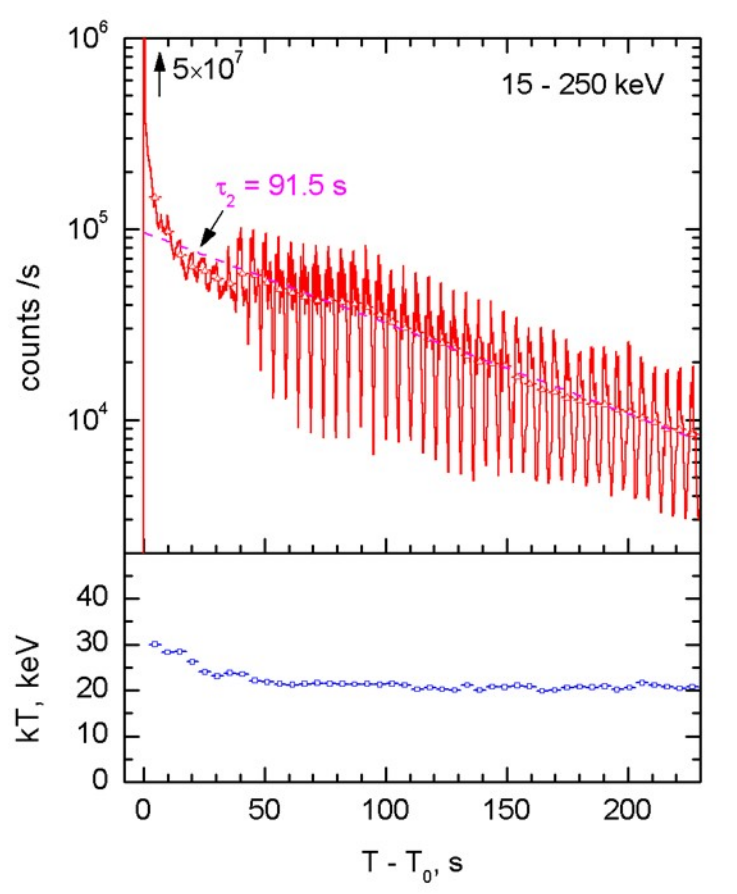
- **Far outside the Earth's magnetosphere**:
  1-1.5x10^6 km,
  up to 6 lt. seconds away
- No Earth occultation,
  no SAA passes,
  stable background
- **>6000 days** of uninterrupted observations since November, 1994
- **> 2000 GRB** triggers
- **> 250 SGR** triggers
- **> 769 Solar** triggers

Konus-WIND – SGR 1900+14



- **1998-1999 reactivation**
  40 typical short bursts + GF
- **980530 burst "series"** (cluster): multiple closely packed and partially overlapped bursts
  T > 250 s
  S > 5×10^{-5} erg cm^{-2}
  (20-200 keV)
- Three months before GF

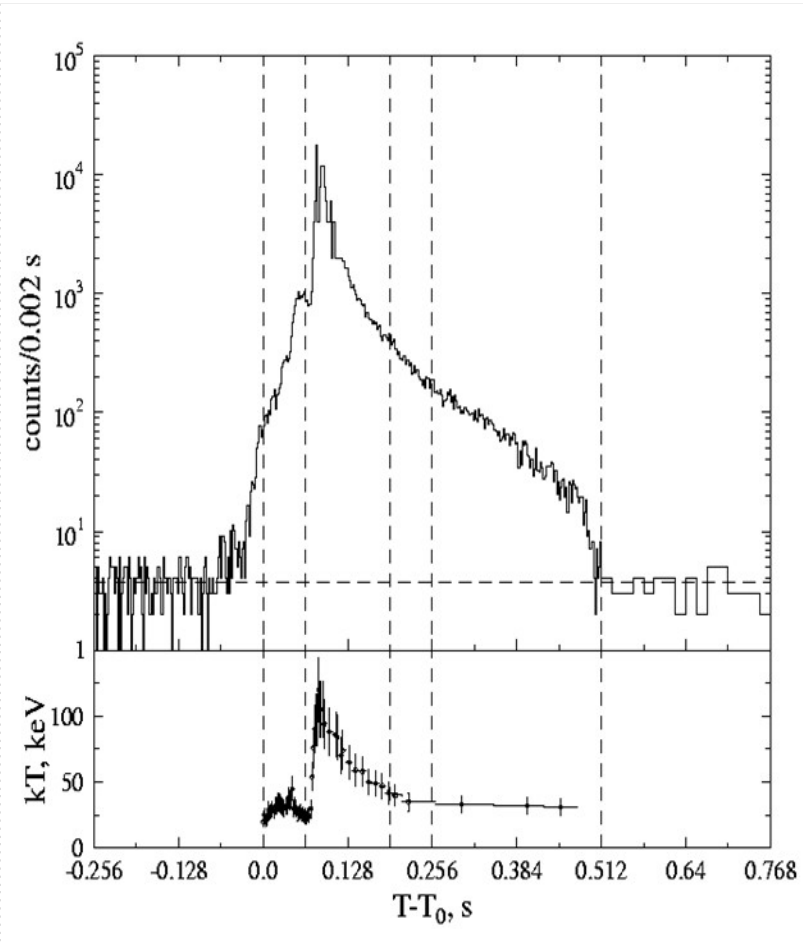
Konus-WIND – SGR 1900+14 GF



- **Giant Flare**
  Aug 27, 1998
  ~20 yrs after March 5 event
- $L_{max} > 2 \times 10^{46}$ erg s^{-1}
- $Q_{tail} \sim 1.2 \times 10^{44}$ erg

(Mazets et al. 1999)

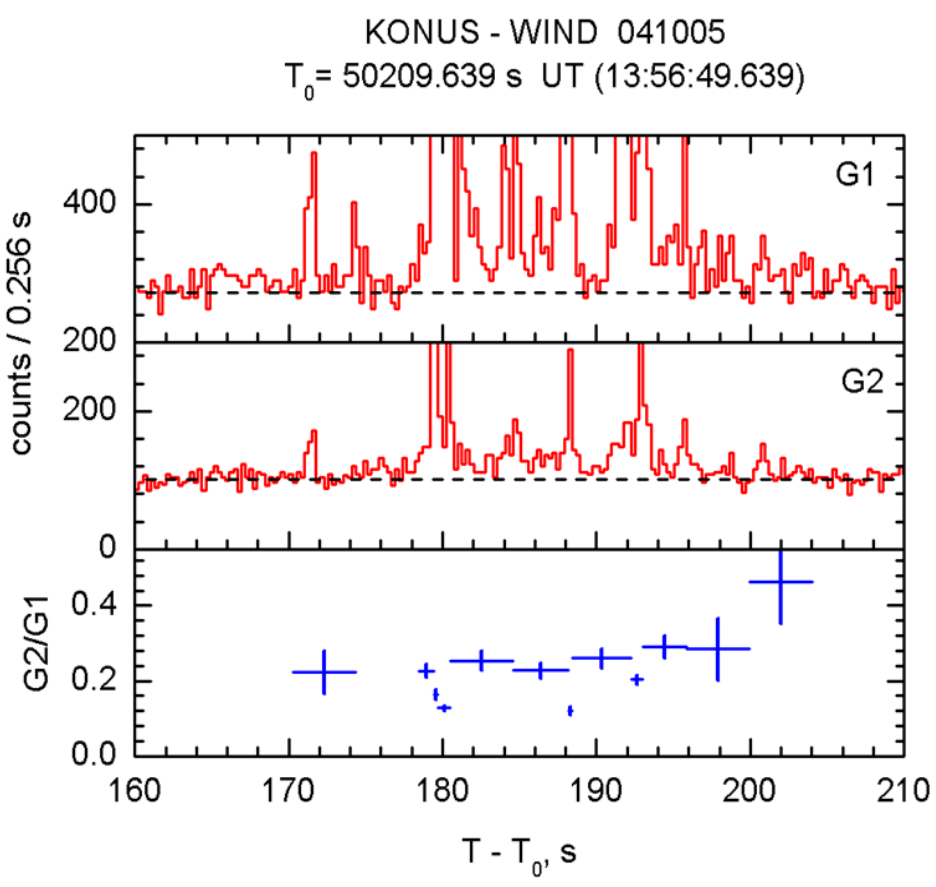
Konus-WIND – SGR 1627-41



- Discovered by CGRO and precisely localized by IPN in **1998** (*CGRO, Ulysses, Wind*; Kouveliotou et al., 1998, Woods et al. 1999, Hurley et al. 1999)
- **Konus-Wind**: 13 short bursts (Mazets et al., 1999)
- Spectral evolution
- **June 18, 1998 event**
  F_{max} = 3x10^{-2} erg cm^{-2} s^{-1}
  S = 8x10^{-4} erg cm^{-2}
  kT_{OTTB} ~100 keV

  Q ~ 1x10^{43} erg (10 kpc)
  close to GF

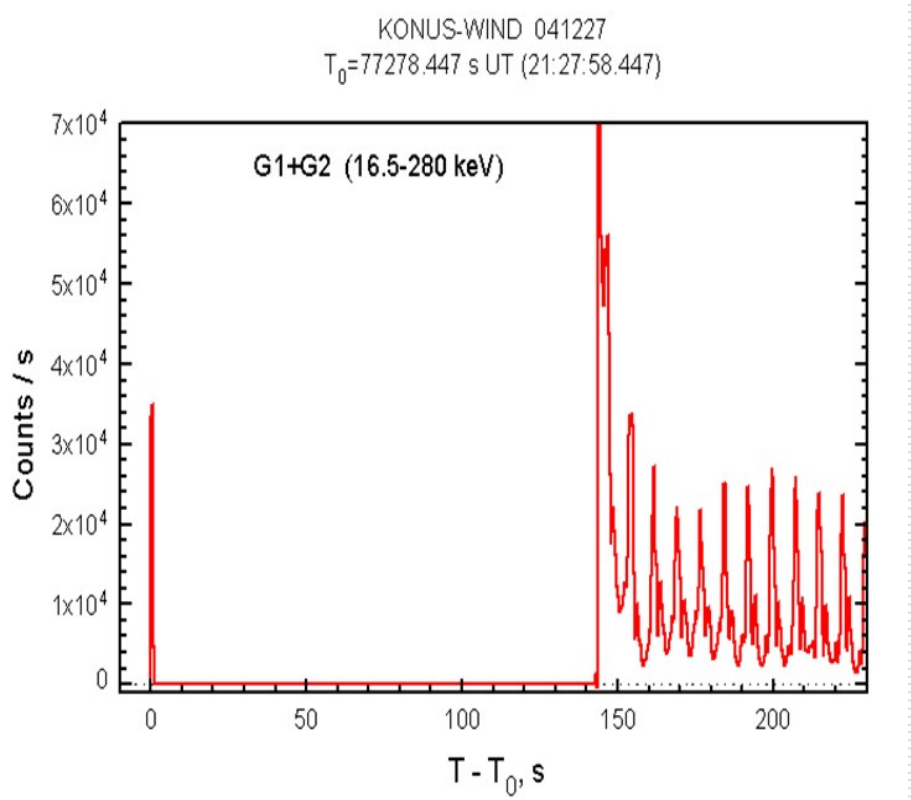
Konus-WIND – SGR 1806-20

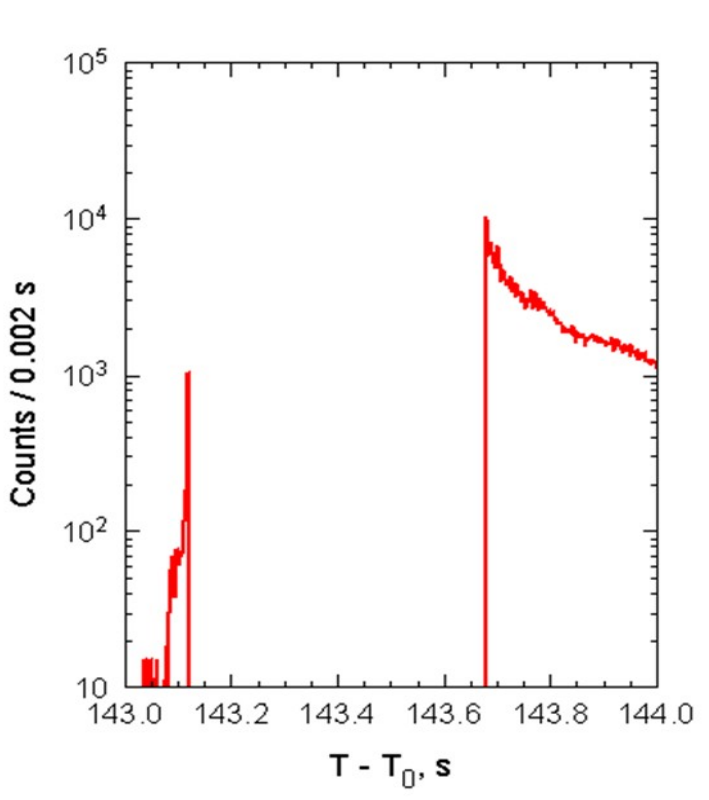


- **1996 – 2008** (126 short bursts)
- 2004 reactivation (>70 bursts)
- Several burst clusters, observed before Dec 27, 2004 (Frederiks et al. 2007)

A Giant Flare was predicted in October 2004 (Golenetskii et al., GCN #2769)

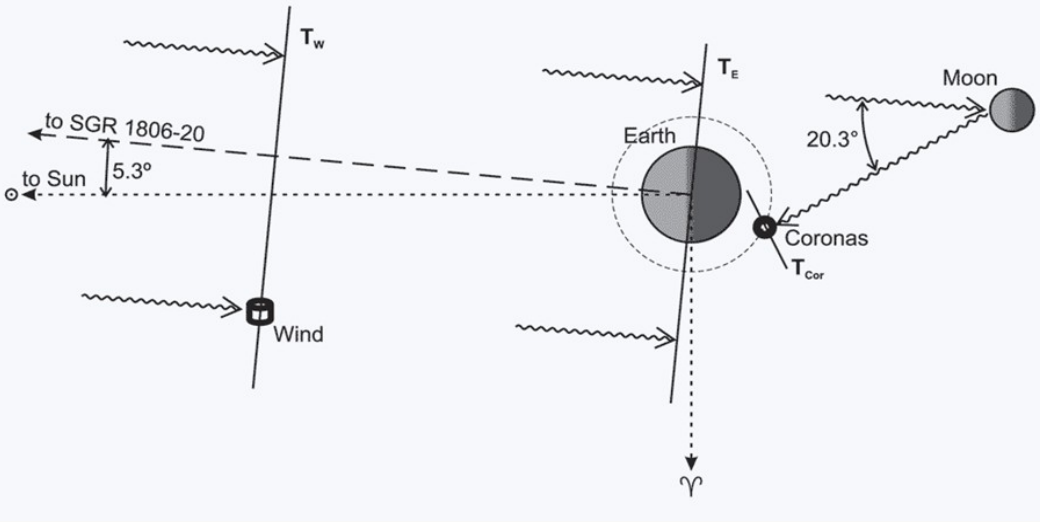
Konus-WIND – SGR 1806-20 GF





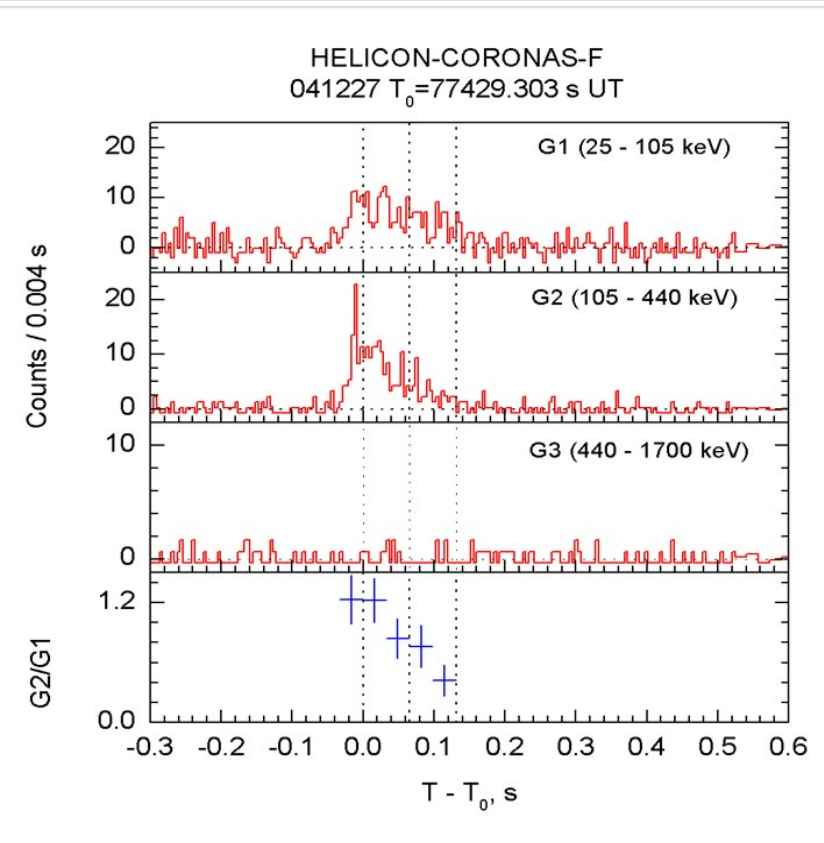
- Dec 27, 2004 Giant Flare (3rd in history and most powerful GF yet)
- KW triggered on bright short burst (precursor) at T_0-143 s (Q = 3.4×10^{42} erg)
- Initial GF pulse: **full detector saturation for ~500 ms**

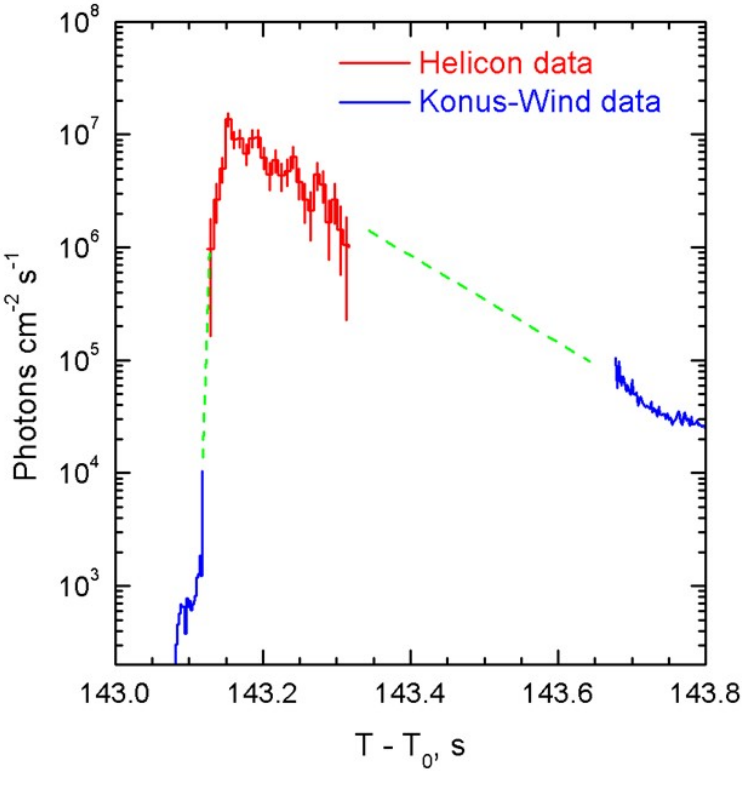
Helicon (CORONAS-F)



Helicon (CORONAS-F) detection of SGR 1806-20 Giant Flare short hard initial pulse, reflected from the Moon
(Frederiks et al., 2007)

Helicon (CORONAS-F)

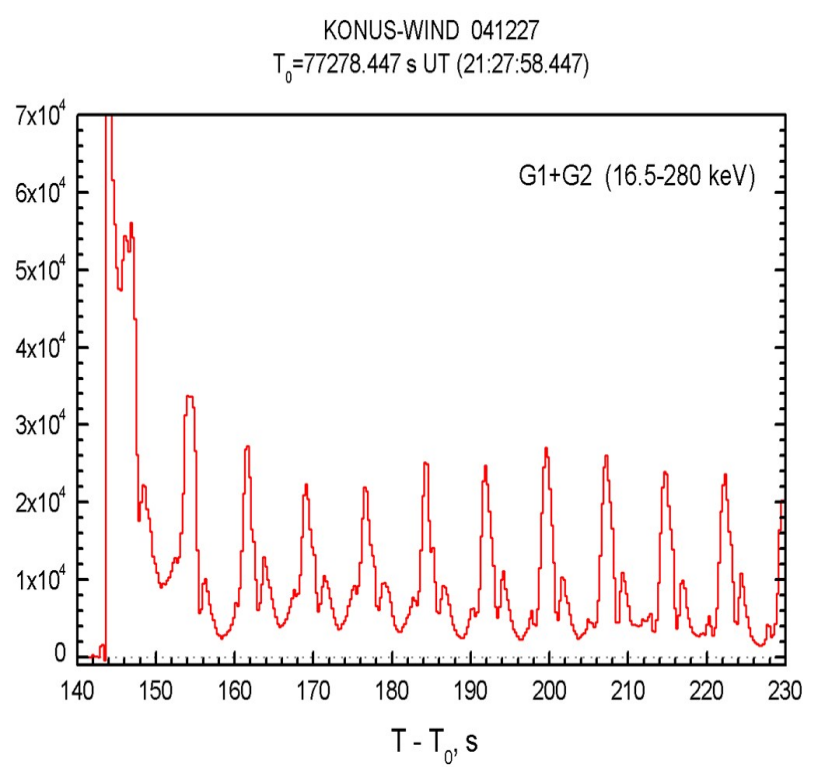


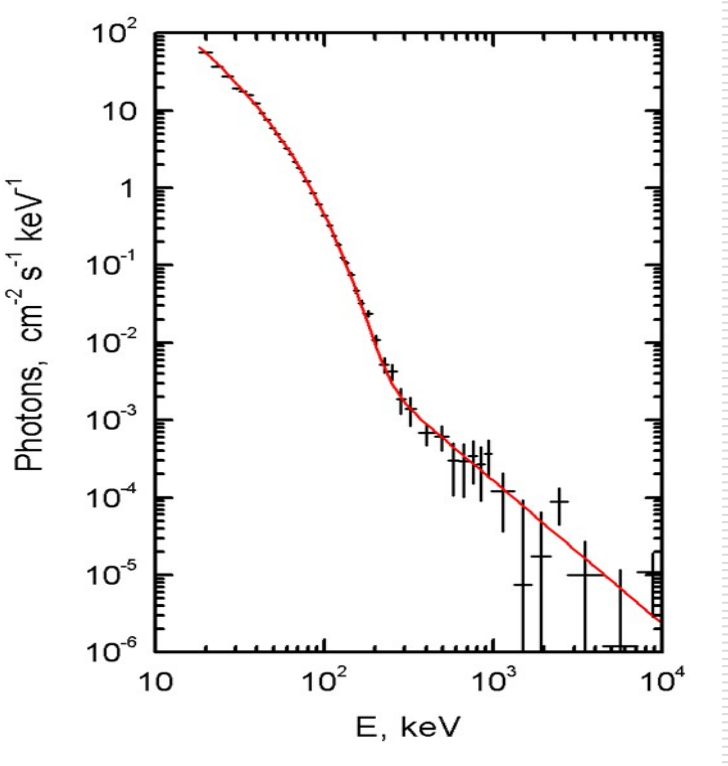


Reconstruction of the SGR 1806-20 Giant Flare initial pulse from Konus-Wind and Helicon data (Frederiks et al., 2007)

$Q = 2.3 \times 10^{46}$ erg ; $L_{max} = 4 \times 10^{47}$ erg s^{-1} (15 kpc)

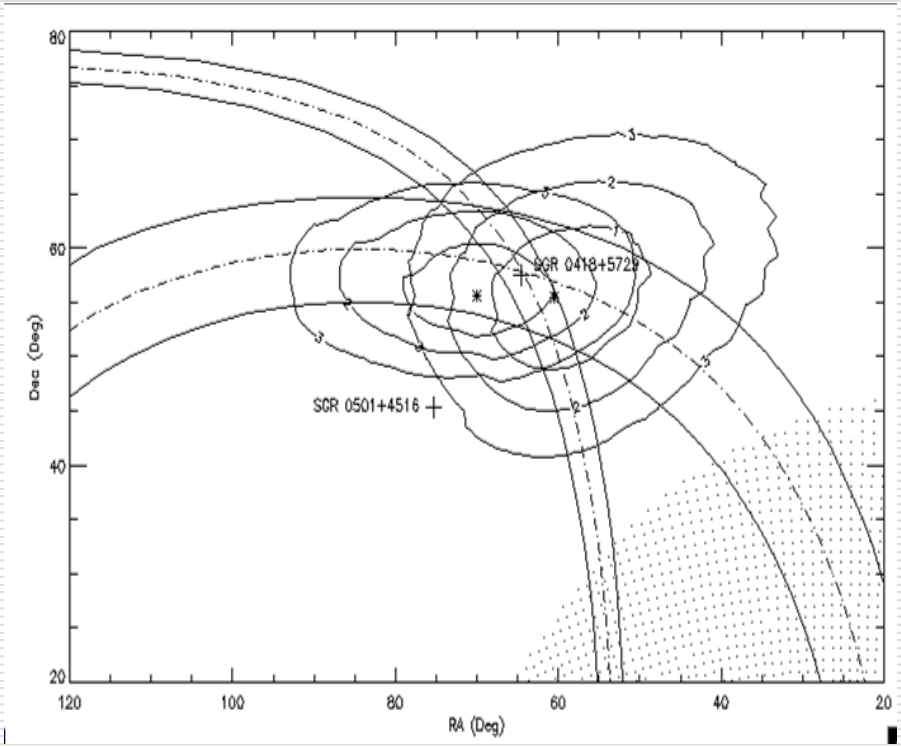
Konus-WIND – SGR 1806-20 GF tail





- P = 7.56 s
- OTTB (kT≈30 kev) + PL (1.8 ± 0.2)
- Qtail = 2.1×10^{44} (15 kpc)

“New” SGRs in Konus Experiments (2008-2009)



SGR 0501+4516

- 5 short KW bursts in Aug 2008 (Aptekar et al., 2009)

AXP 1E1547-5408

- 21 bright short KW bursts in Jan-Mar 2009

  $S \sim 2.6 \times 10^{-4}$, $kT_{OTTB} \sim 70$ keV, resembles SGR 1627-41

SGR 0418+5729 (2009, *Fem*i-GBM, *Konus*-RF, *Swift*-BAT)

Konus Catalog of SGR activity (1978-2000)

Aptekar et al. (2001) ApJSS **137,** 227-277

- Konus (Venera 11, 12, 13, 14), Konus-Wind, Konus-A
- 165 short bursts (~ 120 in the triggered mode) + 2 GFs
- Sources: SGR 0526-66, SGR 1806-20, SGR 1900+14, SGR 1627-41, and SGR 1801-23 (unconfirmed SGR)

http://www.ioffe.ru/LEA/SGR/Catalog/sgr_cat.htm

Second Konus SGR Catalog (in preparation)

- **Konus-Wind** happily continues its operation
  (~175 SGR triggers since 2000)

  Three new Ioffe Institute GRB experiments since 2000:
  Helicon (2001-2005), **Konus-A3** (2006-2007), **Konus-RF** (2009)

- **SGR 1806-20** reactivation (>100 triggers + Giant Flare since 2000),
  SGR 1900+14 (~35 short bursts since 2000)
  Newly discovered SGR were observed:
  SGR 0501+4516, **AXP 1E1547-5408**, **SGR 0418+5729**

- Re-process data obtained since 1994 with a focus on the triggered events and standard automated analysis procedures;
  Extend a set of presented parameters
  Provide online access to the burst data (light curves)

Second Konus SGR Catalog (outline)

- **Instruments and Observations**: timeline, spacecraft & observing conditions, detectors, measurements, SGR-specific constrains

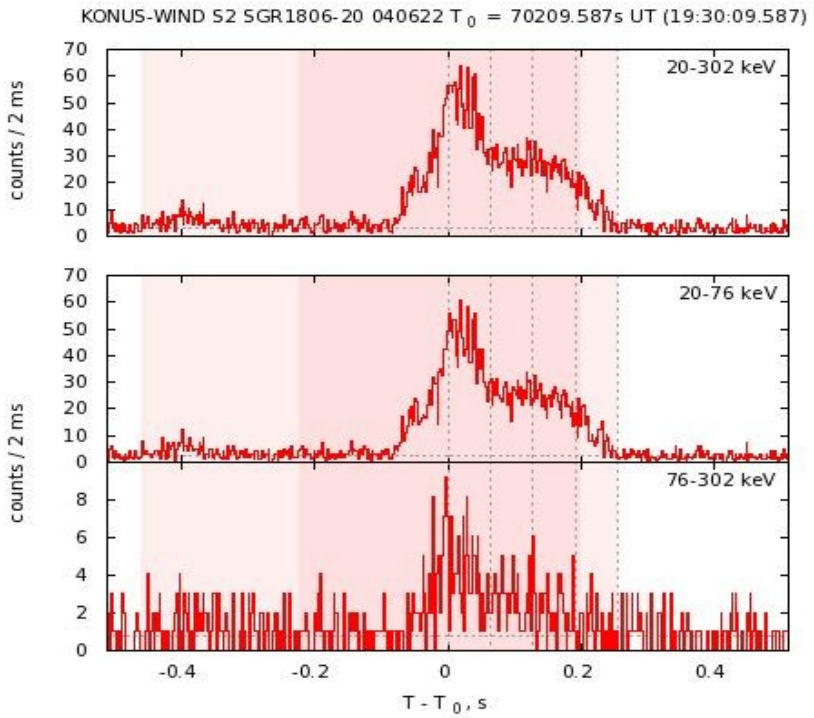
- **Data reduction procedures**: parameter definitions, temporal analysis and spectral fits, special cases

- **Data tables**:
  - general burst parameters (instrument ID, trigger time, Earth-crossing time)
  - peak and integral count rates
  - durations (T100, T90), peak count rate time
  - time-integrated and time-resolved spectral fits (OTTB & CPL models)
  - peak (2 and 16-ms) energy fluxes and total energy fluence

- **Overview** of the results and special cases (hard bursts, “long” bursts, bursts clusters (“storms”)

- **Online Supplements** (tables, plots, light curves)

Second Konus SGR Catalog (example)



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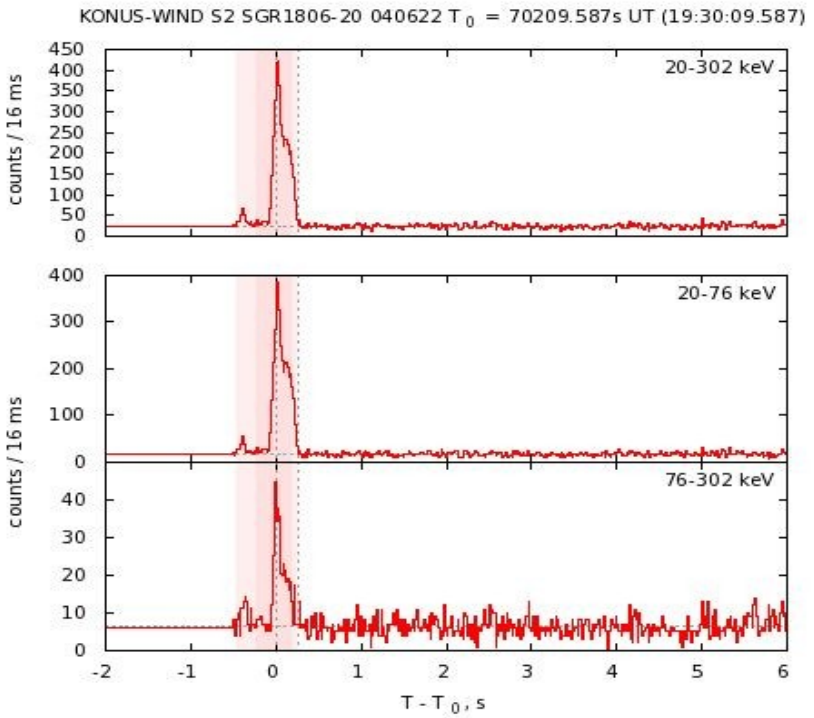

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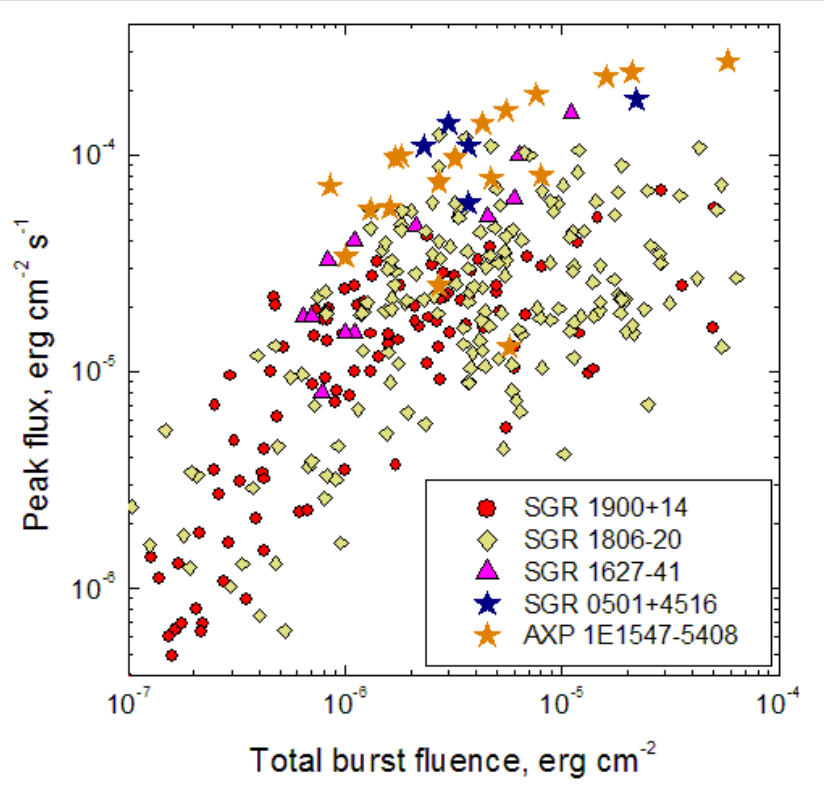
Date: 20040622
Time: 70209
T_{100}: 0.716
T_{90}: 0.422 ± 0.058

Spectra	NG1G2	Fluence	Peak flux 16ms	Peak flux 2ms	OTTB			CPL			
					E_0	χ^2	dof	α	E_P	χ^2	dof
3ch	4305.893	$(6.24 \pm {}^{0.17}_{0.17})\times10^{-6}$	$(3.78 \pm {}^{0.28}_{0.29})\times10^{-5}$	$(4.39 \pm {}^{0.82}_{0.82})\times10^{-5}$	$18.8 \pm {}^{0.986}_{0.943}$						
1–4 (0.256)	3189.158	$(6.3 \pm {}^{0.27}_{0.27})\times10^{-6}$	$(3.83 \pm {}^{0.43}_{0.43})\times10^{-5}$		$18 \pm {}^{0.896}_{0.867}$	15.1	17	$0.32 \pm {}^{0.67}_{0.758}$	$14.3 \pm {}^{3.78}_{2.8}$	12.3	16

Konus SGRs Summary (1994-2009)



- SGR 1900+14 - 75 bursts (KW+Hel)
- SGR 1806-20 - 150 bursts (KW+Hel+KA3)
- SGR 1627-41 - 14 bursts (KW)
- SGR 0501+4516 - 5 bursts (KW)
- AXP 1E1547-5408 - 21 burst (KW+KRF)
- SGR 1801-23 - 1 burst (KW)
- SGR 0418+5729 - 1 burst (KRF)

267 short SGR bursts

Concluding Remarks

- Second Konus SGR Catalog is expected in 2011
- Konus-Wind operation is confirmed until 2013
- New Konus experiments in preparation
- SGRs are welcome!