



Cosmic Gamma-Ray bursts studies with Ioffe Institute Konus experiments



R.L. Aptekar, S.V. Golenetskii, D.D. Frederiks, E.P. Mazets, V.D. Pal'shin

Ioffe Institute, Saint Petersburg, Russia

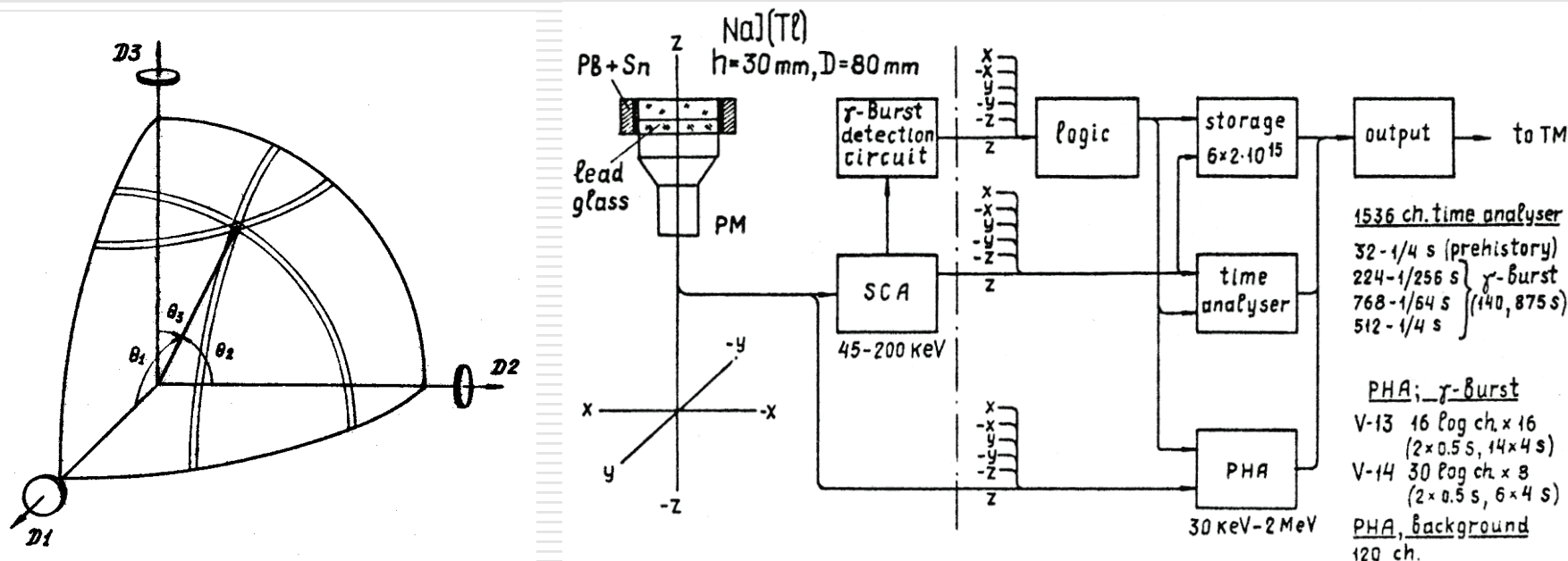
GRB 2012

-
- ❑ Study and analysis of the cosmic gamma-ray bursts from the interplanetary missions Venera 11-14 in 1979-1983: determination of the main observational features of the bursts. Soft gamma-repeaters (SGR) were discovered.
 - ❑ Russian-American Konus-Wind experiment: of many years uninterrupted observations of cosmic gamma-ray bursts and soft gamma-repeaters.
 - ❑ Konus-Wind experiment: correlative observations of cosmic gamma-ray bursts with the Konus/Helicon experiments onboard Kosmos and Coronas spacecraft. The observation of the 27 December 2004 giant flare from SGR 1806-20 was the first example of studying Moon-reflected X-ray and gamma-radiation. Giant SGR flares in the nearby galaxies M81 and M31 were discovered.
 - ❑ Russian-American Konus-Wind experiment, which has already been operating for more than 17 years, provides important and often unique data regarding the various characteristics of GRBs in the 20 keV to 15 MeV energy range.
 - ❑ Future Ioffe Institute Konus experiments
-



The Konus experiments on board the Venera 11 to 14 deep space missions in 1979 to 1983

GRB 2012



Left: determination of the source direction of a gamma burst with a system of gamma detectors with anisotropic angular sensitivity;

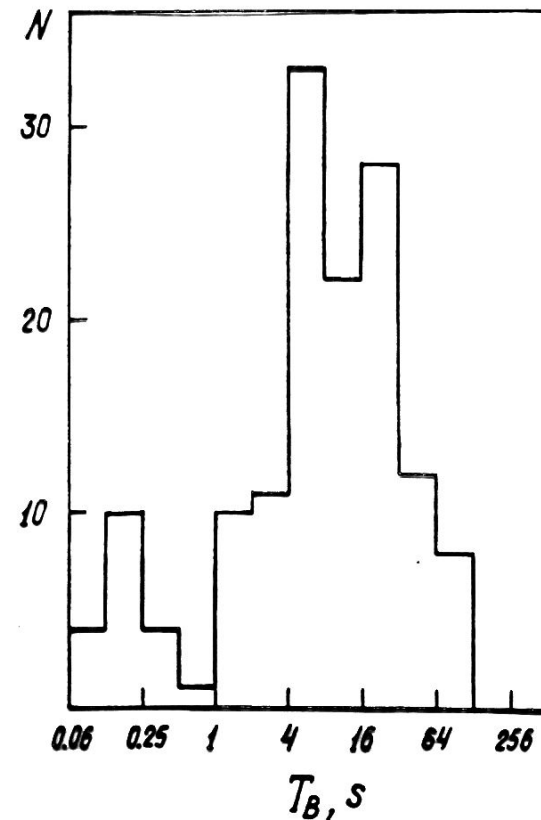
Right: Block diagram of the Konus instrumentation. A sensor system of six scintillation detectors with a close to cosine angular sensitivity pattern arranged along six axes of the spacecraft.



The Konus experiments on board the Venera 11 to 14 deep space missions in 1979 to 1983.

GRB 2012

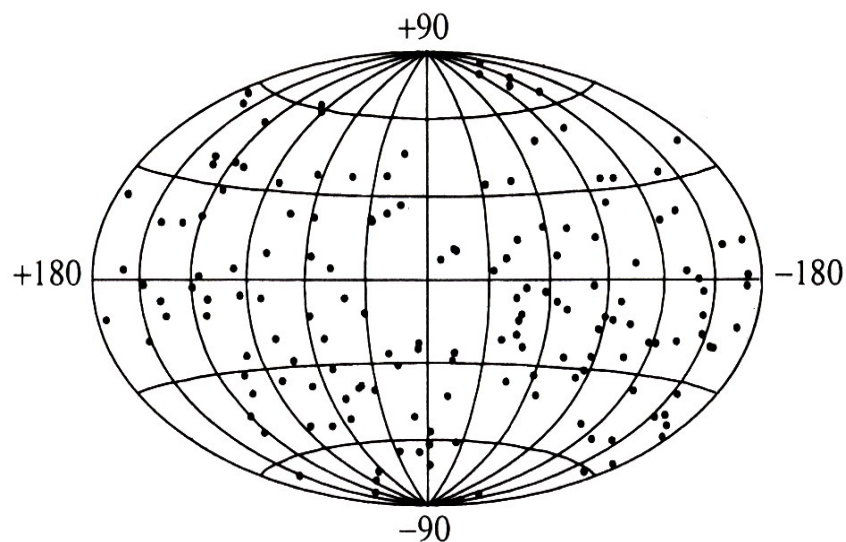
- Konus observations of GRBs revealed the existence of a separate class of short bursts, demonstrating the so-called «bimodal» duration distribution (Ap&Sp.Sci. 1981) - 143 GRBs



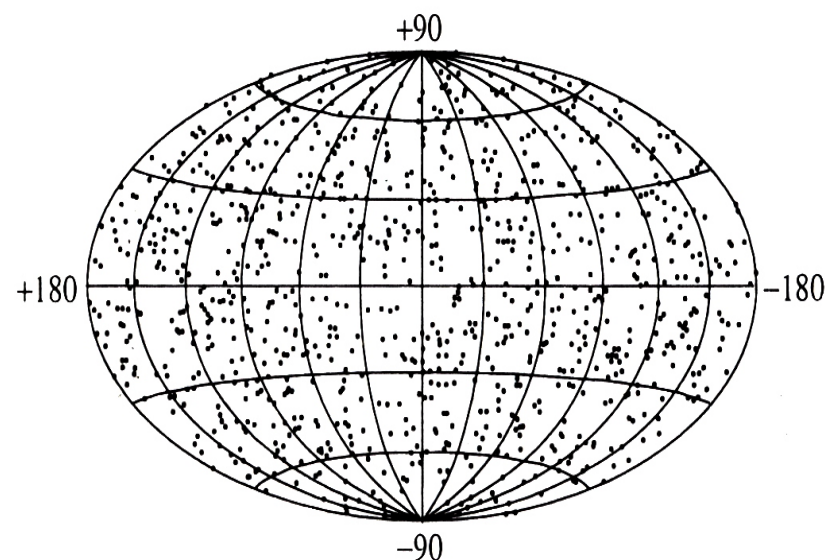


The Konus experiments on board the Venera 11 to 14 deep space missions in 1979 to 1983: it was for the first time shown that the GRB distribution over the celestial sphere is random

GRB 2012



Konus, Venera 11-14 deep
space missions,
Astrophys.Space Sci., 1988

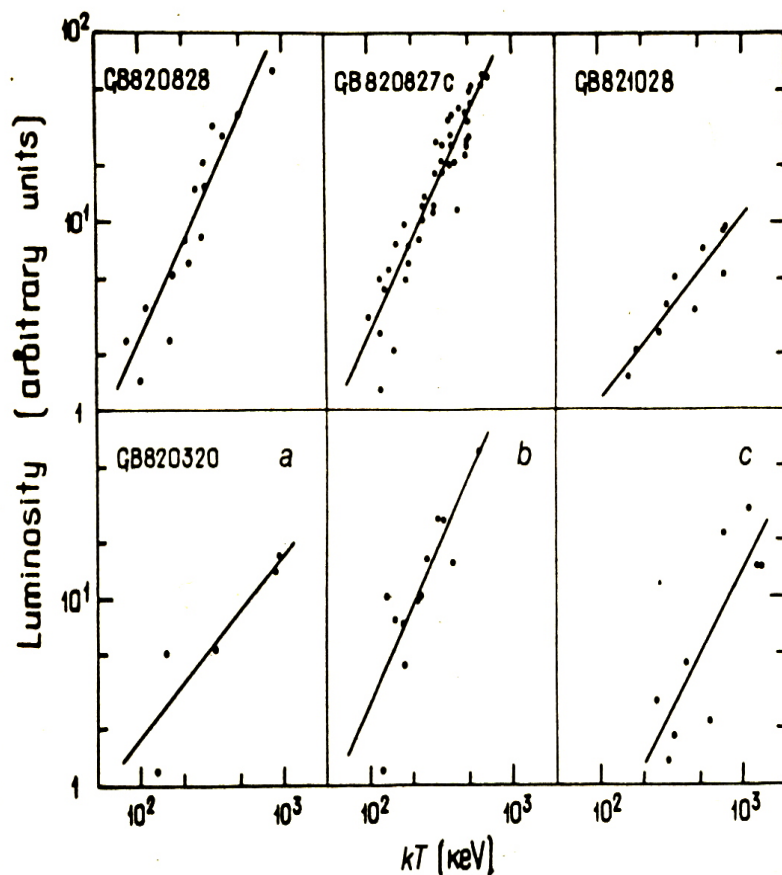


BATSE, CGRO,
Ap.J., 1996



The Konus experiments on board the Venera 11 to 14 deep space missions in 1979 to 1983.

GRB 2012

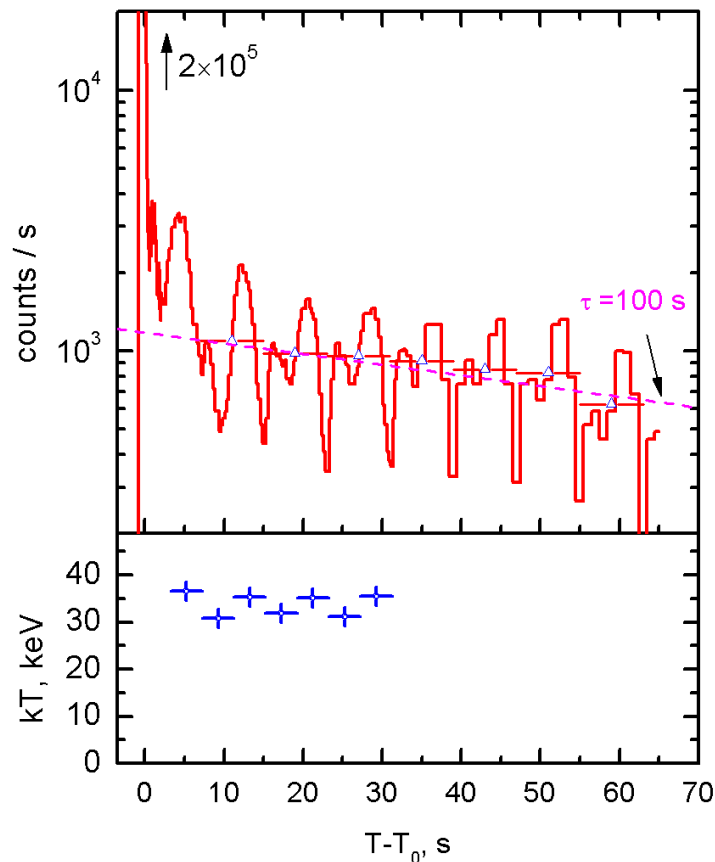


Observations on Venera 13 and 14 revealed strong hardness-intensity correlation in GRBs (Nature, 1983).

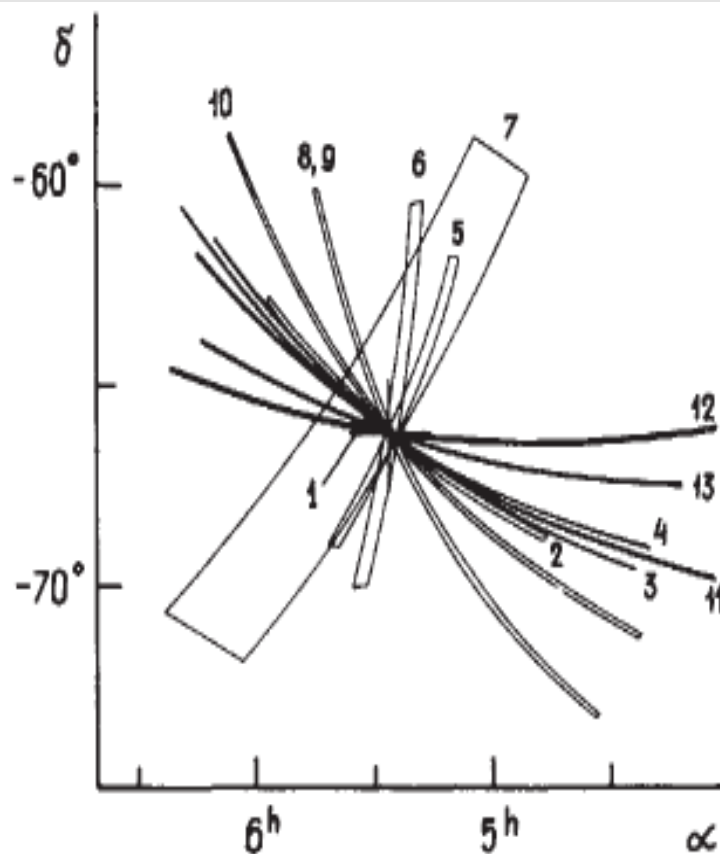


The Konus experiments on board the Venera 11 to 14 deep space missions in 1979 to 1983: soft gamma-repeaters were discovered (SGR 0525+66, SGR 1900+14).

GRB 2012



Giant flare of SGR0526-66 was observed on March 5, 1979r., Nature, 1979

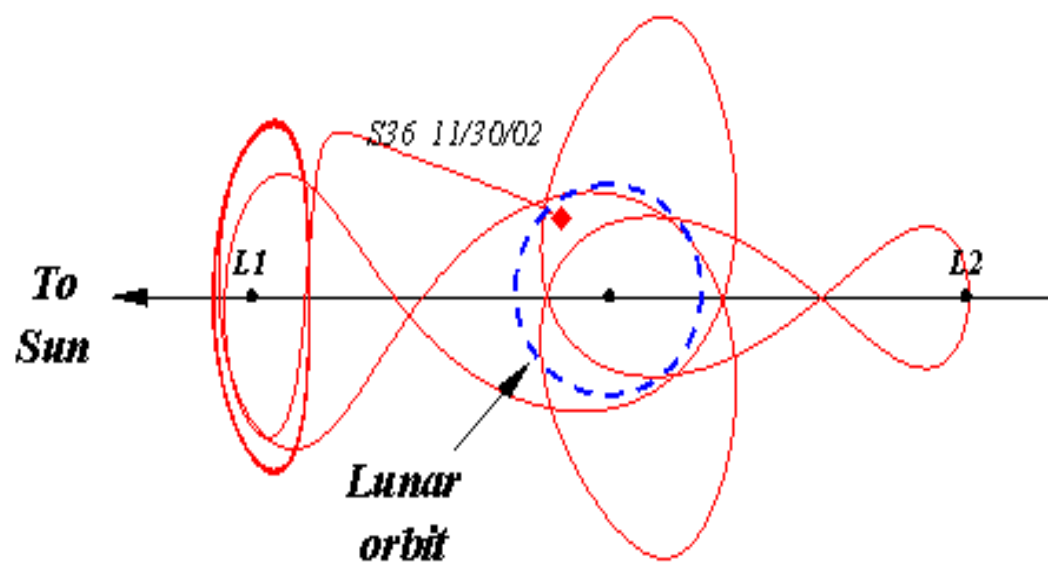
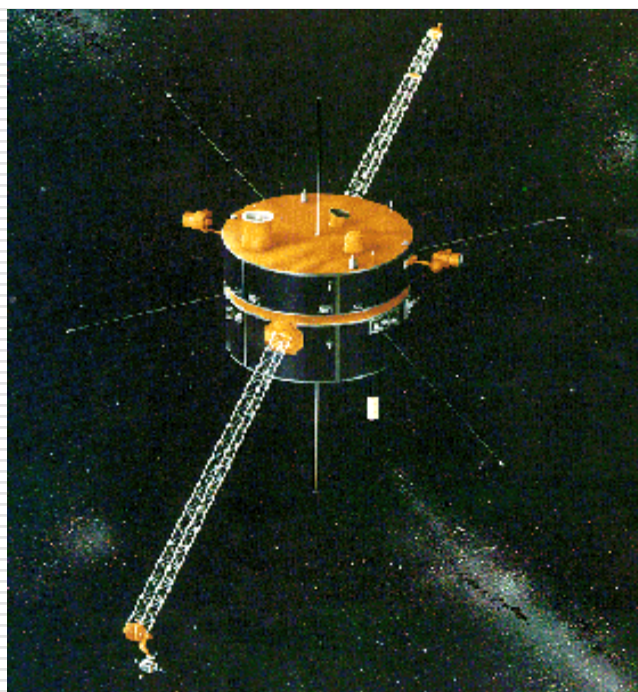


Repeated bursts from SGR0526-66, Nature, 1983



Joint Russian-American Konus-Wind experiment

GRB 2012



S/c «Wind», 1994 – up to now

The orbit of s/c excepts an interferences from radiation belts and the Earth shadowing.



Konus-Wind Gamma-Ray Burst Experiment on US GGS-Wind spacecraft



GRB 2012

-
- Two detectors S1 and S2:
NaI(Tl) 13 cm diameter, 7.5 cm height, Be entrance window.
Located on opposite faces of spacecraft, observing correspondingly the southern and northern celestial hemispheres
 - Unocculted observations of all sky
 - ~ 20 keV – 15 MeV energy range (present time)
 - ~ 100 -160 cm² effective area

Summary (1994 November – 2012 May; only triggered events):

2145 GRBs – 1782 long (83%), 363 short (17%)

248 SGRs (several clusters of bursts)

798 solar flares

145 Swift/BAT GRBs – 21% of BAT GRBs

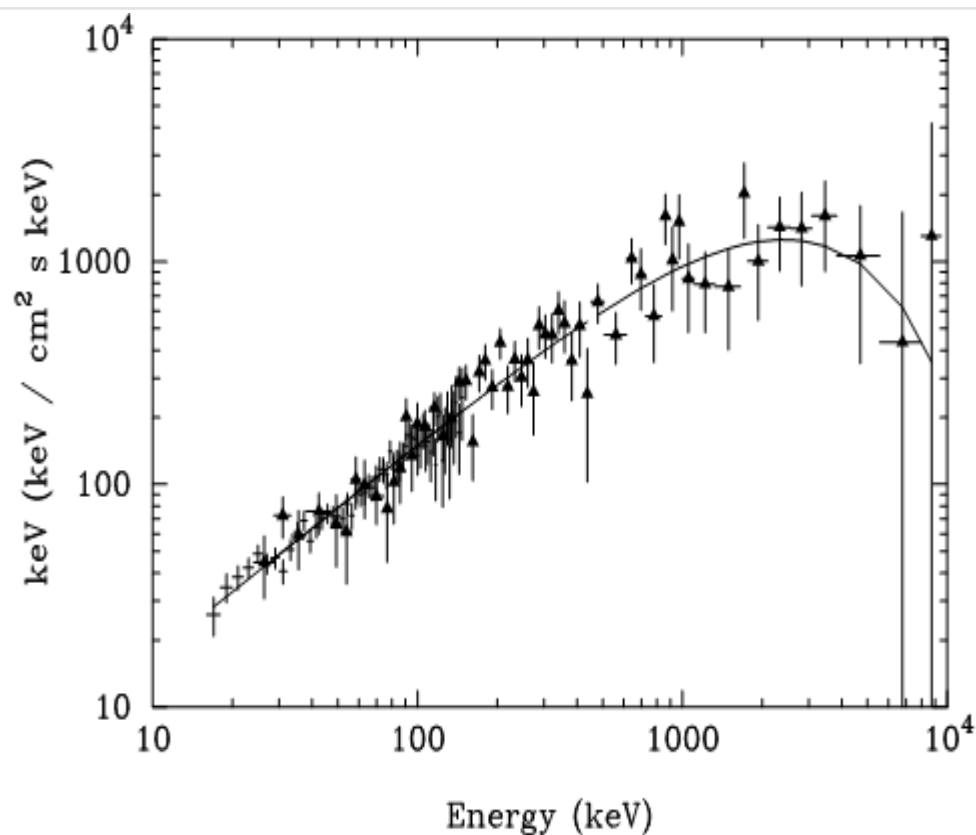
92 GRBs with measured redshift



Simultaneous observations of GRB050717 by Konus-Wind and BAT(Swift)

GRB 2012

- An intense and long GRB050717 was observed by Swift-BAT and Konus-Wind. The joint spectral fit is shown. This GRB has a record peak energy value $E_p = 2400$ keV. (Ap.J., 2006)

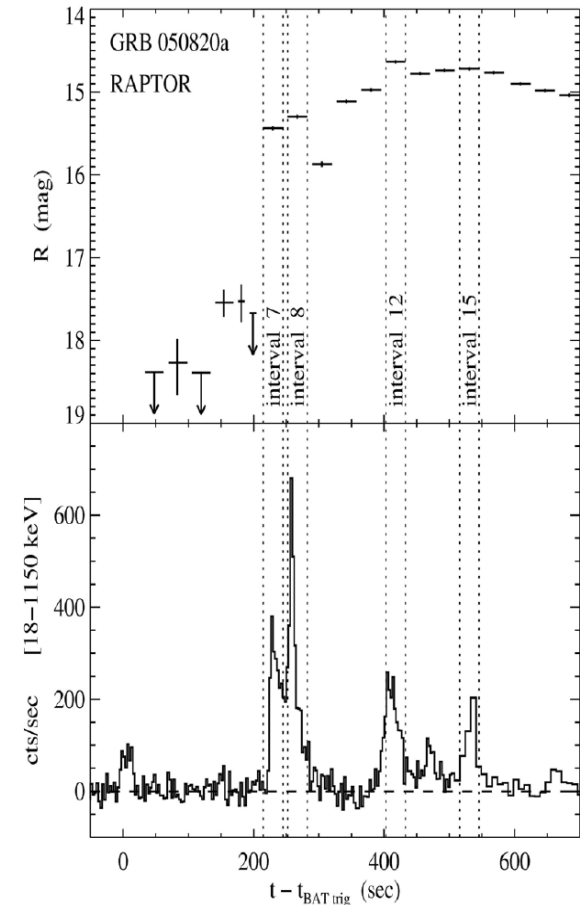




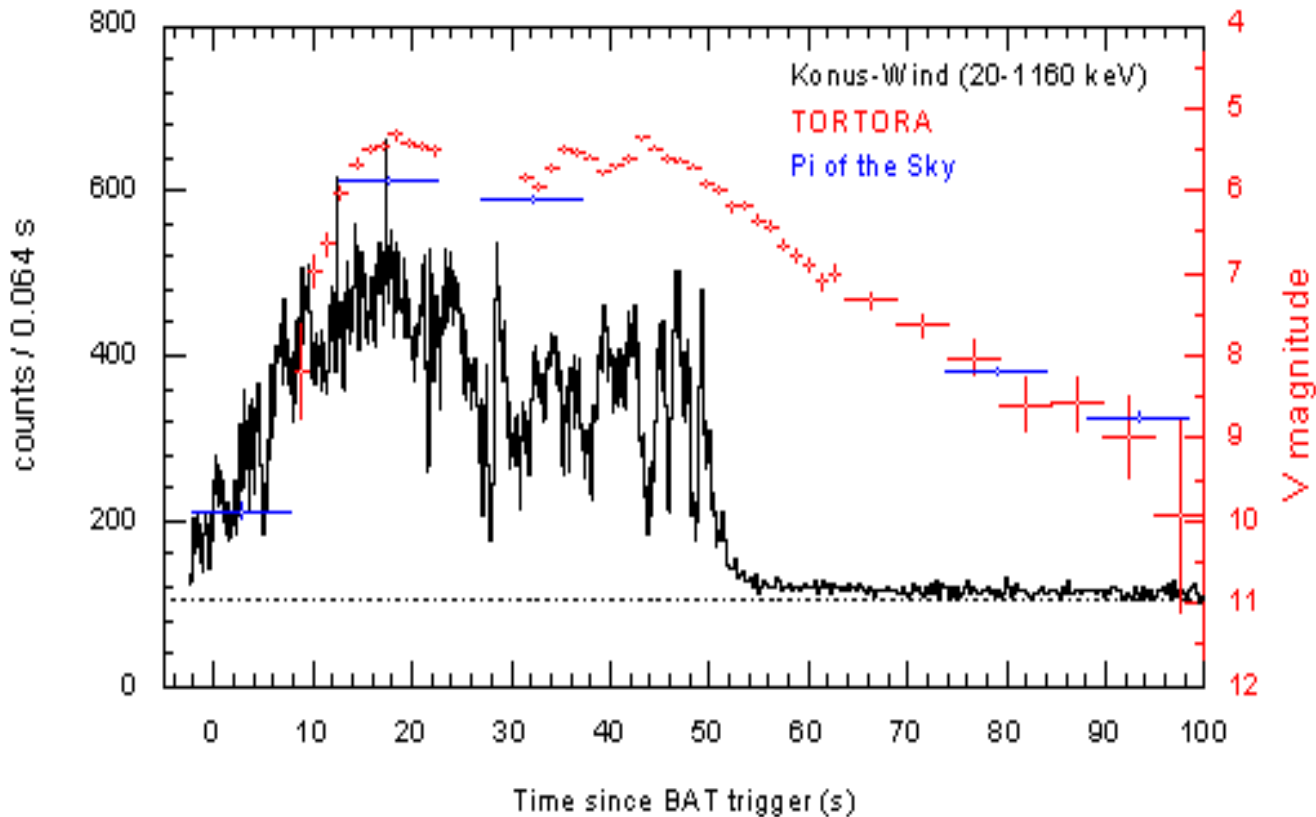
Prompt optical and gamma-radiation of GRBs

GRB 2012

Optical and gamma emission of the GRB 050820A, obtained by RAPTOR telescope of Los-Alamos Labotatory (upper picture) and by Konus-Wind experiment (low picture). Both type of radiation was detected simultaneously (Nature, 2006).



Prompt optical and gamma-radiation of GRB080319B

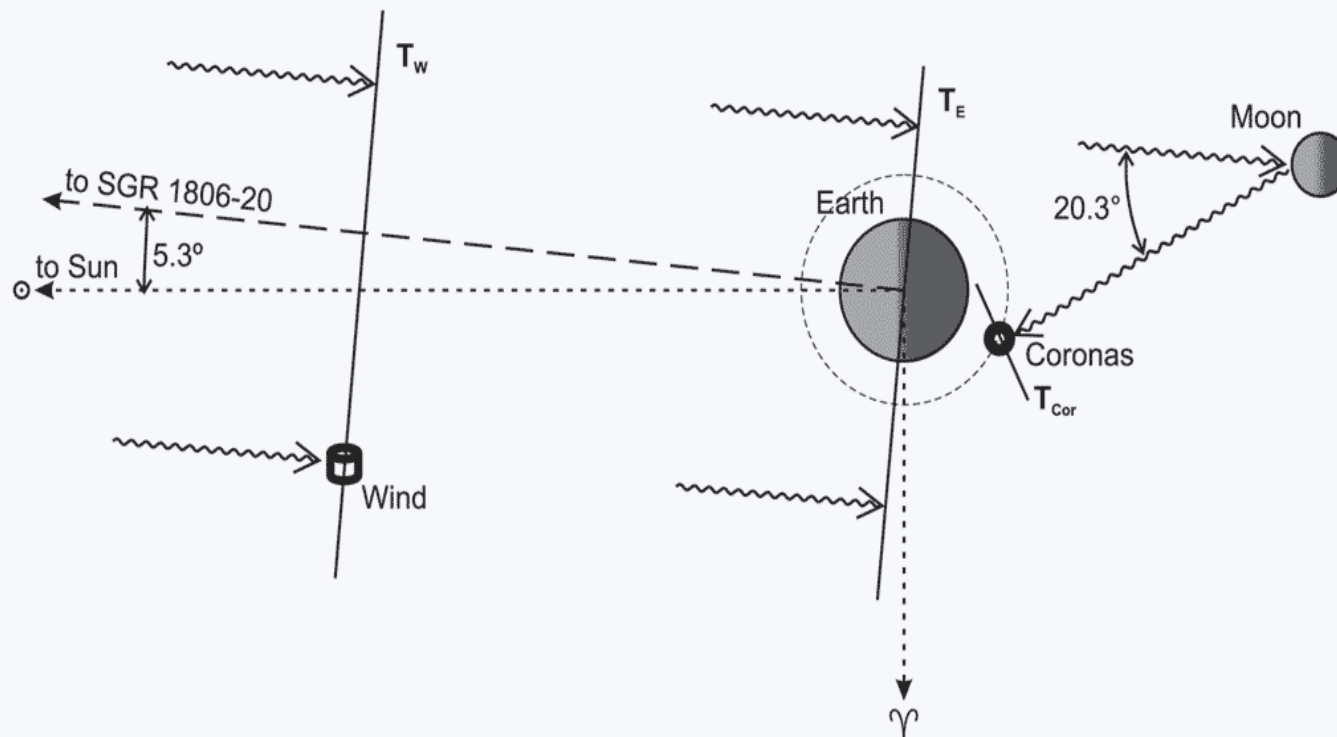


The Konus-Wind gamma-ray light curve is presented together with optical data of Tortora telescope. Optical flash begins and ends at about the same times, providing strong evidence that both originate at the same site (Nature, 2008).



Konus-Wind and Helicon (CORONAS-F) simultaneous observations of giant flare from SGR1806-20 on December 27, 2004

GRB 2012



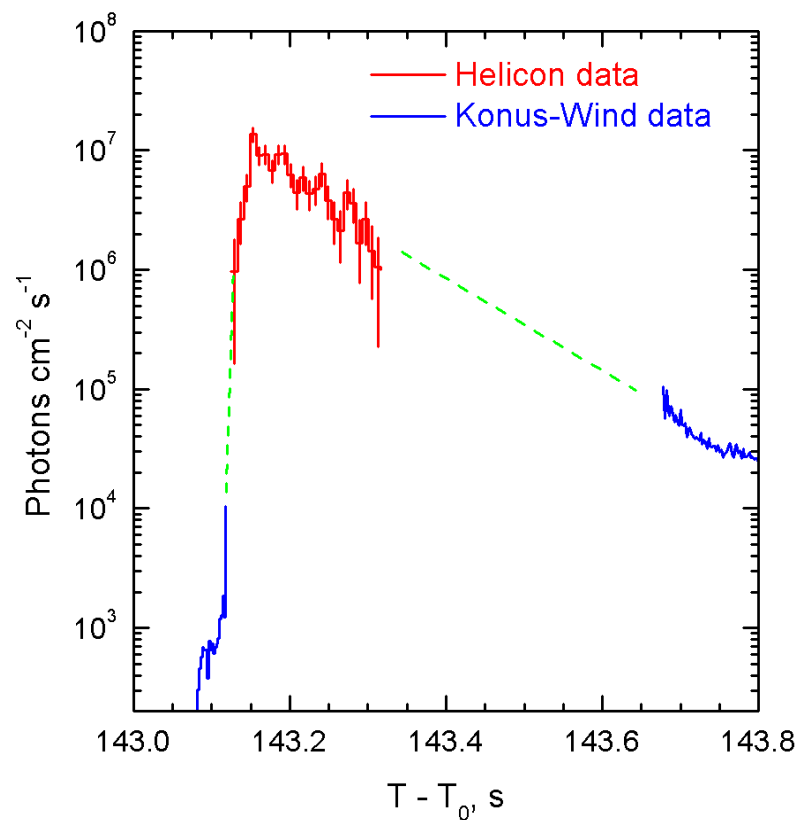
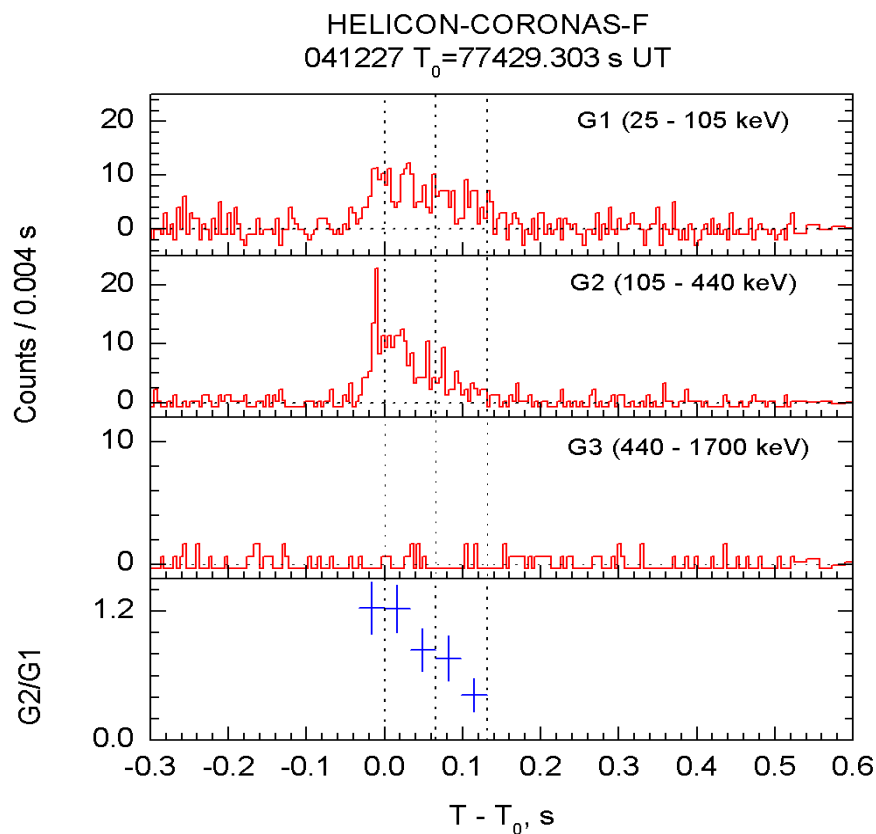
The Konus-Wind detector was evidently saturated for over 1.5 s. The Helicon detector was screened by the Earth from direct exposure of initial pulse of the giant flare, but clearly recorded its reflection from the Moon surface. It allowed, for the first time, reliably reconstructing the temporal profile of the initial pulse of giant flare and determining its energy parameters.



Konus-Wind and Helicon (CORONAS-F) simultaneous observations of giant flare from SGR1806-20 on December 27, 2004



GRB 2012



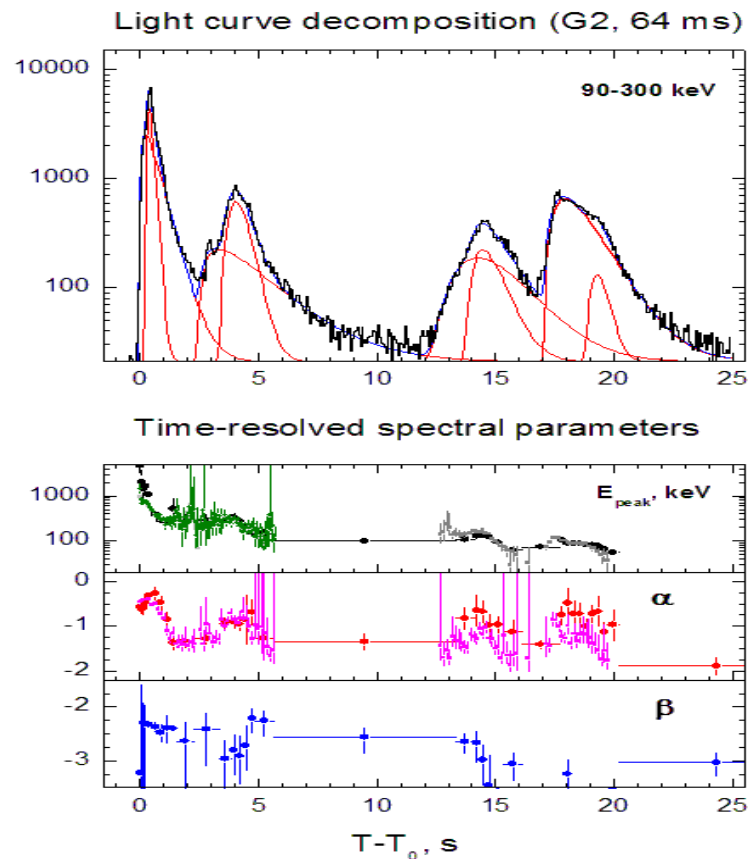
The full isotropic energy release $Q = 2.3 \times 10^{46}$ erg and the peak luminosity $L = 3.5 \times 10^{47}$ erg s^{-1} (Astronomy Lett., 2007)



Konus-Wind observation of GRB110918A: it is the most intense long GRB in the history of Konus-Wind observations since November, 1994

GRB 2012

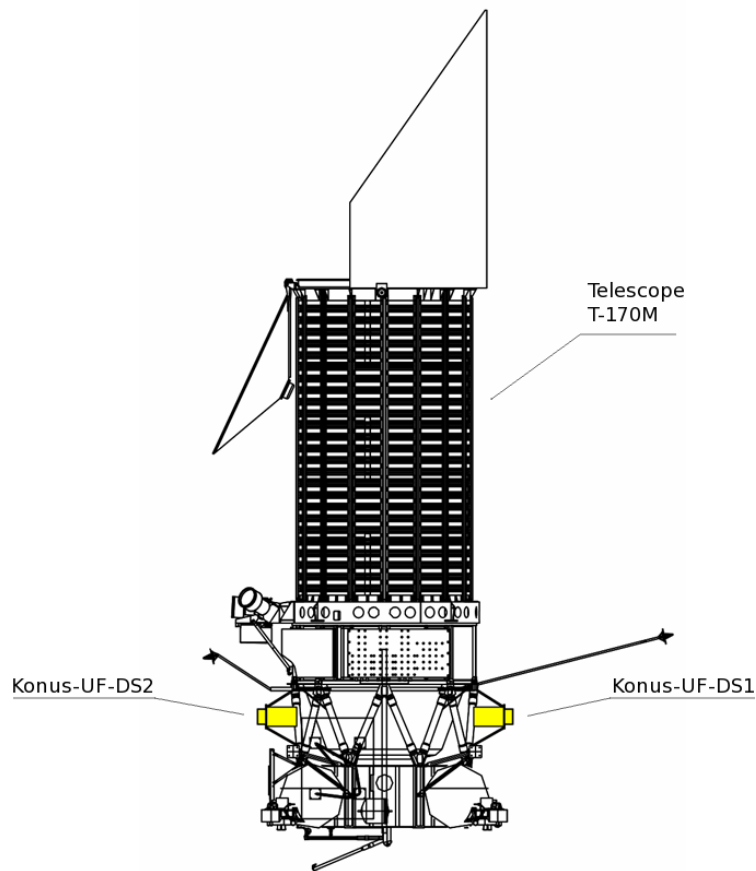
- As observed by Konus-Wind, the burst had a 20-10000 keV fluence of 7.5×10^{-4} erg/cm², and 16-ms peak flux of 8.7×10^{-4} erg/cm²/s.
- GRB were observed also by INTEGRAL (SPI-ACS), Mars Odyssey (HEND), and MESSENGER (GRNS). Localized by IPN to the 62 sq arcmin box. A bright X-ray source was found on the edge of the IPN box in Swift/XRT TOO observations which were started ~ 1.5 days after the trigger. Following the XRT detection, a bright optical counterpart was found (Swift/UVOT, INT, GROND, Gemini-N and more) and it's redshift was determined ($z=0.982$: Gemini-N, GTC).
- $E_{\gamma, \text{iso}} \sim 1.9 \times 10^{54}$ erg, $L_{\gamma, \text{iso}, \text{max}} \sim 4.4 \times 10^{54}$ erg/s
- The burst intensity allows a precise analysis of the light curves and a fine-scale time-resolved spectral fitting (see Figure). A detailed analysis of the Konus-Wind prompt gamma-ray detection, together with the refined IPN localization and results of the ~ 50 days-long afterglow monitoring by Swift/XRT and Swift/UVOT can be found soon in the forthcoming paper (Frederiks et al., 2012, in preparation).





Konus-UF is one of the future Ioffe Institute experiments in the field of GRB study. It is planned that Konus-UF will be installed on board the Spektr-UF/World Space Observatory (WSO-UV)

GRB 2012

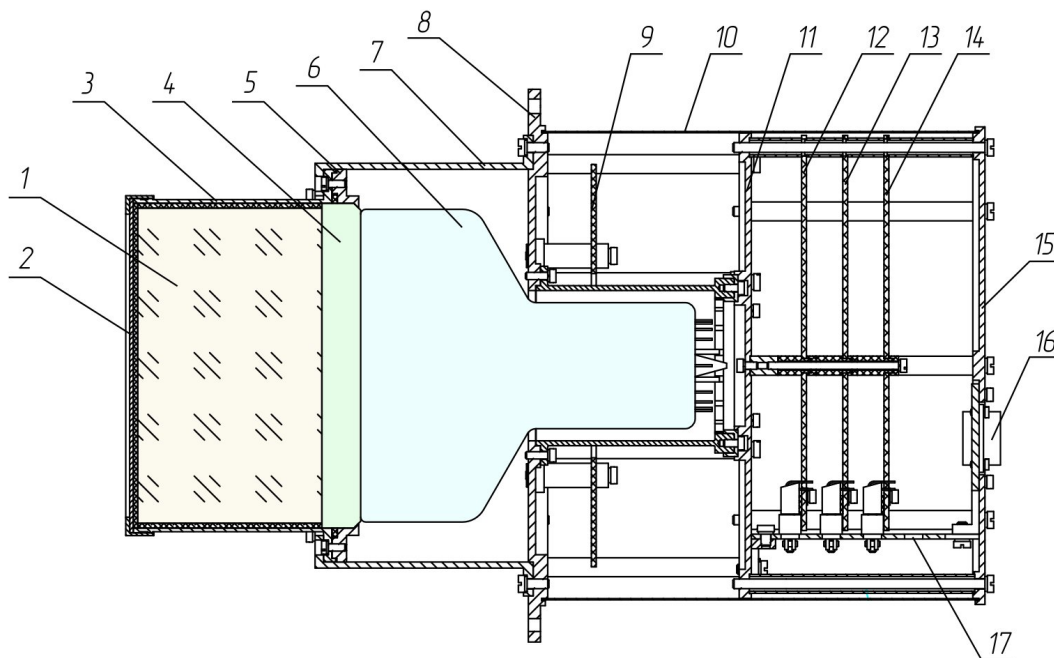


- The Konus-UF instrument consists from two detectors units Konus-UF-DS1 and Konus-UF-DS2 and electronic unit Konus-UF-BE.
- The each Konus-UF detector will be allocate such manner in order to observe the half of hemisphere.
- The energy range of Konus-UF instrument is from 10 keV up to 15 MeV.
- The instrument will have a detailed program for measuring of time and spectral characteristics of GRBs.
- It is planned that Spectr-UF mission will be launched in 2016 year.



The Konus-UF detector unit drawing

GRB 2012



The main parts of the detector: 1 – NaI(Tl) cristal 5" in diameter by 3" in hight, 2 – beryllium entrance window, 4 – lead glass, 6 – photomultiplier, 12, 13, 14 – electronic boards.



Conclusions

GRB 2012

-
- The early Konus experiments onboard the Venera 11-14 deep space missions had firstly revealed many of the basic characteristic of GRBs.
 - Joint Russian-American Konus-Wind experiment, which has already been operating for more than 17 years, provides important and often unique data regarding the various characteristics of GRBs in the 20 keV to 15 MeV energy range.
 - The Konus-UF experiment is planned for launch in 2016. It will give us an opportunity to continue very effective research into extremely explosive phenomena in the Universe.
-