

Status of RSDC

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RSDC

- *Supports the archive of all publicly available + Russian PI data*
- *Has the current OSA (OSA-11 !) + Russian INTEGRAL software installed*
- *Is used by IKI scientists, scientists from Sternberg Astronomical Institute (Moscow University), Kazan University, Ioffe Institute, Pulkovo Observatory, Lebedev Physical Institute, Moscow Engineering Physics and Moscow Technical Physics Institutes*
- *Uses Russian optical telescopes for identification (and study) of new IGR sources (RTT-150 at Turkey, 6-m telescope at Nizhnii Arkhyz, AZT33IK at Sibirya/Monds)*

RSDC

- *Supported by the Russian Academy of Sciences and Space Research Institute*
- *Archive data occupy now more than 35 Tb + 19 Tb working field (3 SUNs +1 Fujitsu servers)*
- *Garantee time exceeded, many of the disks are not working now*
- *There was possibility to use resources of the SRG Data Center (10 computer servers, 200 Tb) but it may dissaper after the launch of SRG on July 13, 2019.*
- *New server with a large HDD field was purchased:
Supermicro (CPU Intel Xeon E5-2620v4 2.1GHz Mem 32 Gb)
HDD 80 Tb (60Tb under RAID 6)*

Russian INTEGRAL theses

- *PhD - 13* (RSDC: Chelovekov, Tsygankov, Shtykovskii, Krivonos, Molkov, Karasev, Filippova, Prosvetov, others: Arefiev, Minaev, Krassilshikov, Mereminskiy, *Khorunzhev*)
- *DSc - 5* (RSDC: [Revnivtsev], Sazonov, Lutovinov, others: Bikmaev, Seifina)

Resent Russian INTEGRAL awards

- 2019 Eugene M. Churazov
elected to be *Full Member of the Russian Academy of Sciences*
- 2017 Eugene M. Churazov, Marat R. Gilfanov
A.A. Belopolsky Prize in Astrophysics by the Russian Academy of Sciences
(for their work "X-ray diagnostic of accreting flows around black holes and neutron stars in the Milky Way and other galaxies")
- 2014 Eugene Churazov
COSPAR Massey Award
(for "outstanding contributions to the development of space research")
- 2013 Sergei A. Grebenev, Alexander A. Lutovinov, and Sergei V. Molkov
F.A. Bredikhin Prize in Astronomy by the Russian Academy of Sciences
(for "Discovery and study of the origin of the Fast X-ray Transients – a new population of massive X-ray binaries")

X-ray Transient Monitoring in 2019

- INTEGRAL has identified MAXI J1749-310 to GRS 1747-312 (Grebenev, Mereminskiy, Bozzo, Ferrigno, Savchenko), ATel 13155 (2019).
- New outburst of XTE J1739-285 detected by INTEGRAL/JEM-X (Mereminskiy, Grebenev), ATel 13138 (2019).
- ZTF19abvizsw/AT2019pim, search for GRB in SPI-ACS/INTEGRAL data (Chelovekov, Pozanenko, Minaev, Grebenev), GCN Circ. 25686 (2019).
- LIGO/Virgo S190728q: SPI-ACS/INTEGRAL data analysis (Minaev, Pozanenko, Chelovekov, Grebenev), GCN Circ. 25189 (2019).
- LIGO/Virgo S190727h: possible counterpart candidate in SPI-ACS/INTEGRAL (Minaev, Pozanenko, Chelovekov, Grebenev), GCN Circ. 25171 (2019).
- INTEGRAL detects renewed activity from the microquasar XTE J1908+094 (Rodriguez, Mereminskiy, Grebenev, Cangemi, et al.), ATel 12628 (2019).
- INTEGRAL identified with SAX J1747.0-2853 a source of the X-ray outburst in the Galactic center region detected by MAXI (Mereminskiy, Grebenev, Sunyaev, Kuulkers), ATel 12578 (2019).

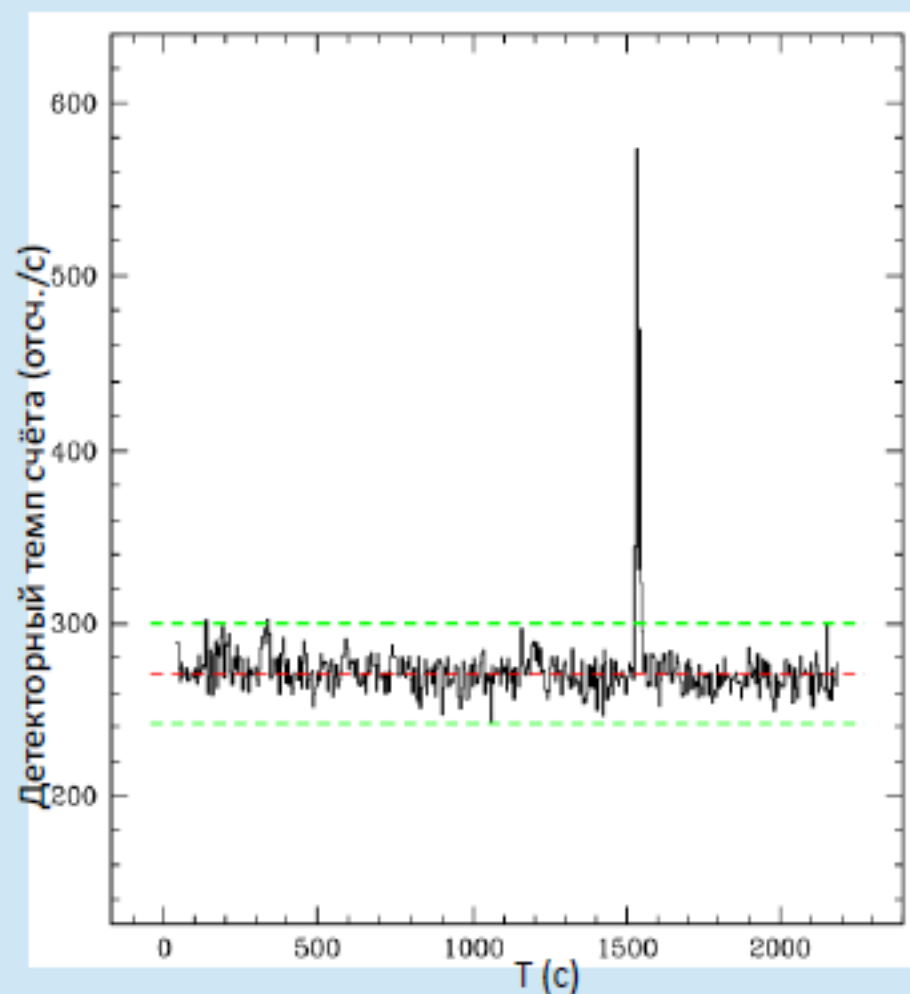
Russian INTEGRAL Papers, 2019

- **Optical identification of seven unknown X-ray sources from the INTEGRAL all-sky survey**
(Karasev, Sazonov, Krivonos, et al.), **Astronomy Letters**, v. 45, n. 12 (2019).
- **New GRBs found in the archival data of the IBIS/ISGRI telescope on board the INTEGRAL observatory**
(Chelovekov, Grebenev, Pozanenko, Minaev), **Astronomy Letters**, v.45, n.10 (2019).
- **Observation in the gamma-ray band of the second LIGO/Virgo event connected with the neutron stars merging S190425z**
(Pozanenko, Minaev, Grebenev, Chelovekov), **Astronomy Letters**, v. 45, n. 11 (2019).
- **Progressive steepening of the SNR RX J1713.7-3946 X-ray spectrum from XMM-Newton to INTEGRAL**
(Kuznetsova, Krivonos, Churazov, et al.), **MNRAS** 489, 1828 (2019).
- **Investigation of the Outburst Activity of the Black Hole Candidate GRS 1739-278**
(Bykov, Filippova, Mereminskiy, et al.) **Astron. Lett.**, 45, 127 (2019).

Russian INTEGRAL papers in 2019

Our search for GRBs in the IBIS/ISGRI archival data

Number of sessions (each of 3600/1800 s)	143 000 scws
Total exposure	405 Ms
Energy band	X: 30-100 keV G: 100-500 keV
Time bin	5 s (for search) 1 s (for analysis)
Number of detected events	230 000

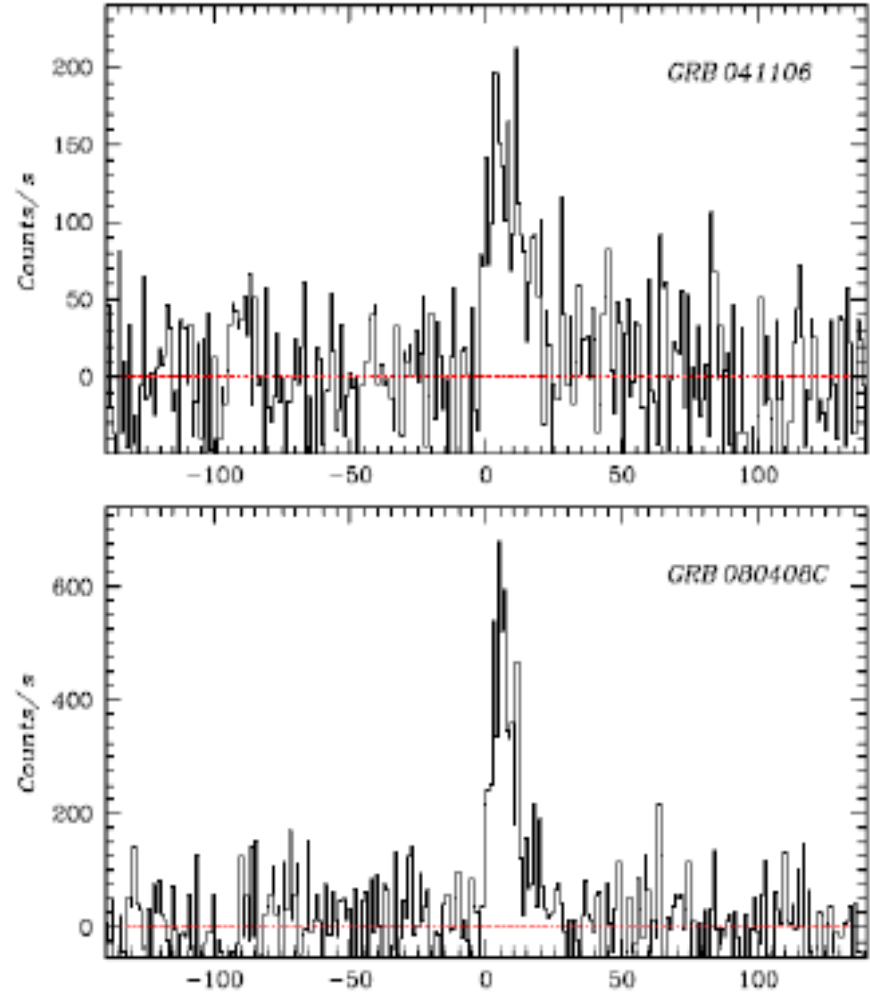


Russian INTEGRAL papers in 2019

New GRBs found within IBIS FOV

Всплеск (дата)	ΔE^a	T_0^b (UTC)	δT^b	T_c^r	T_{90}^d	C_p^e	S/N^z		F^z	Координаты ^и	
							LC	IM		R.A.	Decl.
		hh:mm:ss	с	с	с	отсч/с	σ	σ	отсч.	град.	град.
GRB 041106	X	01:06:08	1	23	39	212	5.3	8.7	2496	304.749	37.295
GRB 080408C	X	18:33:54	1	21	19	669	10.4	11.5	5331	253.382	-6.694
GRB 111130	X	18:42:15	1	21	44	465	9.9	11.5	3721	345.757	48.929
	G	18:42:20	1	19	40	259	6.3	—	1604		
GRB 131107	X	07:53:57	1	14	42	248	7.2	11.3	1794	123.378	-16.632
GRB 150803	X	08:32:28	1	12	19	344	9.3	7.6	1776	254.055	27.121
	G	08:32:28	1	6	9	158	4.5	—	502		
GRB 160418B	X	04:20:43	5	214	179	75	3.8	7.8	1204	291.830	-44.660
GRB 161209	X	02:07:42	1	17	15	1193	17.3	26.6	9474	193.437	3.072
	G	02:07:48	1	15	25	289	4.1	—	1878		

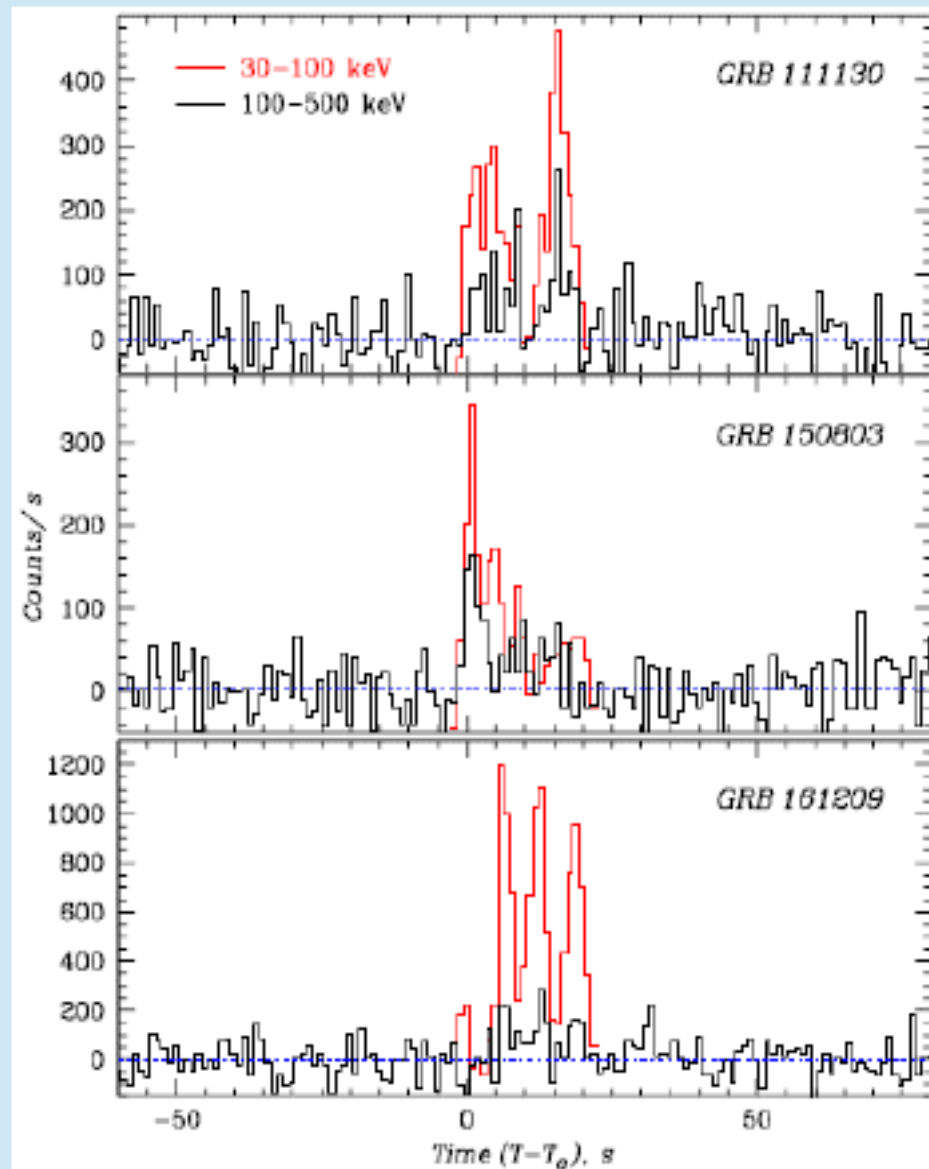
New GRBs found within IBIS FOV



Russian INTEGRAL papers in 2019

Detection of GRBs in the
hard 100–500 keV band

GRB 111130 and GRB 161209 are just
very bright, but GRB 150803 is
extremely hard

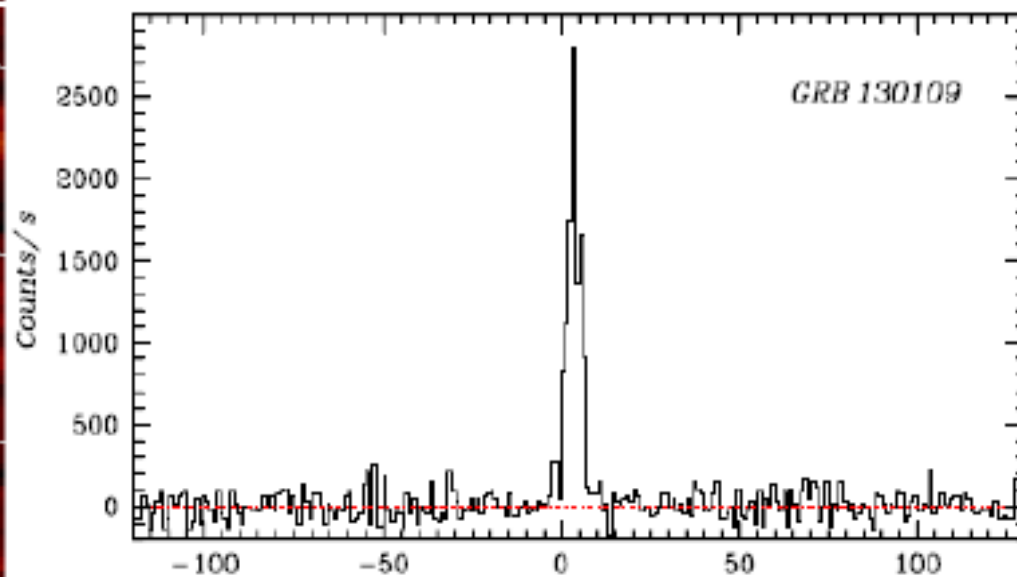
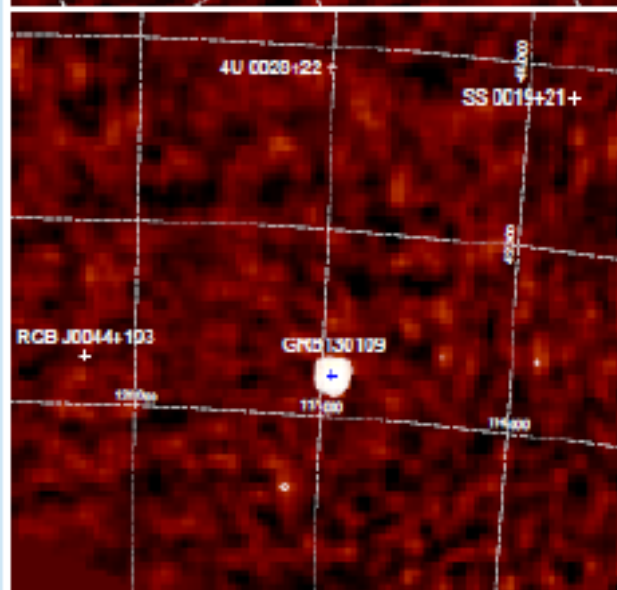
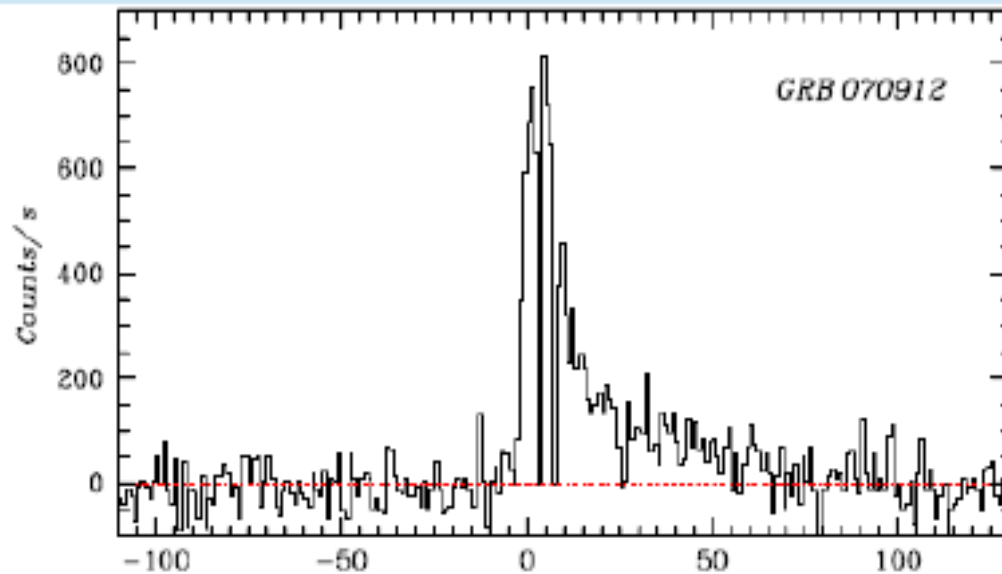
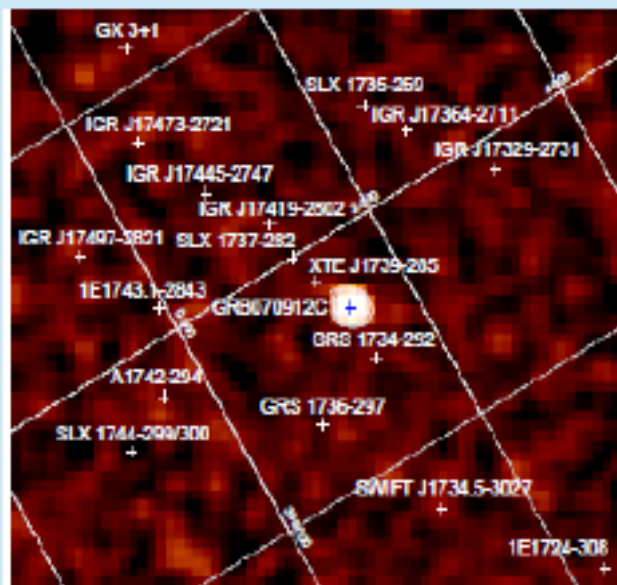


Russian INTEGRAL papers in 2019

Localization of previously known GRBs

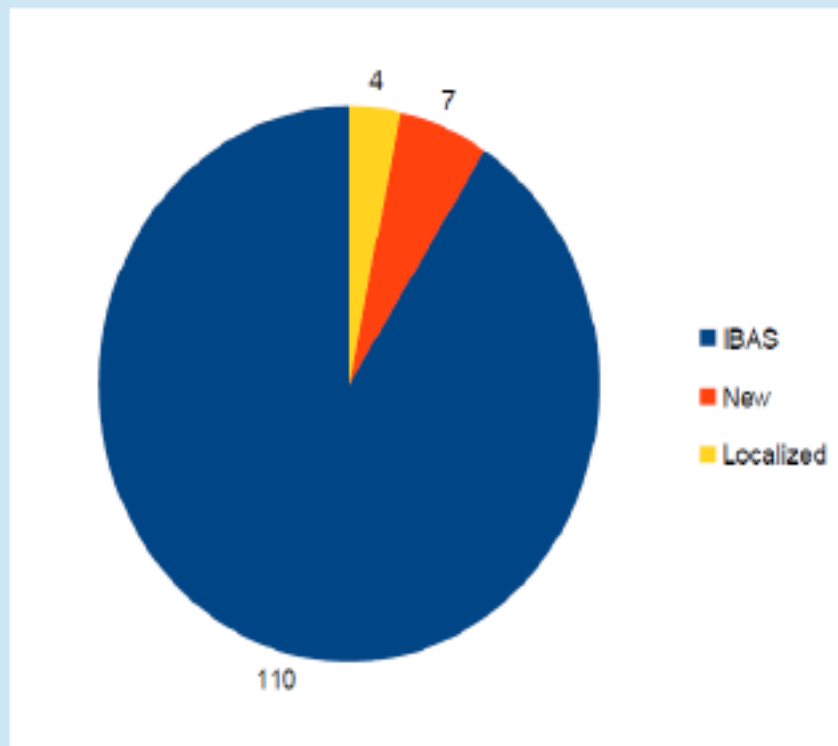
Всплеск (дата)	ΔE^a	T_0^b (UTC)	T_c^b	T_{90}^b	C_p^d	S/N^e		F^j	Координаты ³		Миссия ^h
						LC	IM		R.A.	Decl.	
		hh:mm:ss	с	с	отсч/с	σ	σ	отсч.	град.	град.	
GRB070912	X	07:32:21	27	41	816	19	14.5	11238	264.608	-28.706	ASIJK ^k
	G	07:32:21	13	36	390	10	—	3280			
GRB130109	X	04:56:25	7	9	2787	35	19.5	9770	8.180	19.085	K
	G	04:56:25	9	17	726	9	—	2751			
GRB150704	X	02:14:09	9	34	1231	21	14.2	6815	311.343	37.927	<u>K</u>
	G	02:14:09	8	15	498	9	—	2126			
GRB180108	X	10:15:37	31	52	734	11	8.4	9240	58.711	-46.267	K

Russian INTEGRAL papers in 2019



Russian INTEGRAL papers in 2019

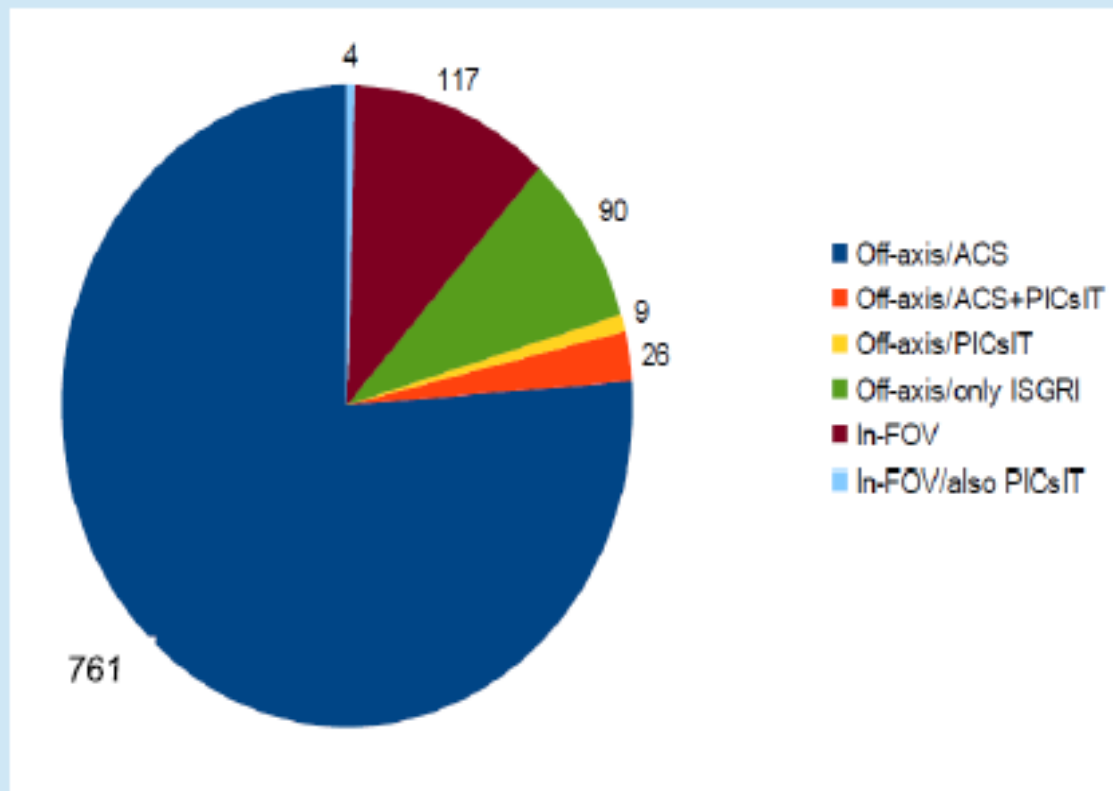
GRBs found within IBIS FOV



7 new GRBs and 4 known but newly localized GRBs add 10% to the GRBs found by IBAS within IBIS/ISGRI FOV

Russian INTEGRAL papers in 2019

GRBs found by IBIS/ISGRI

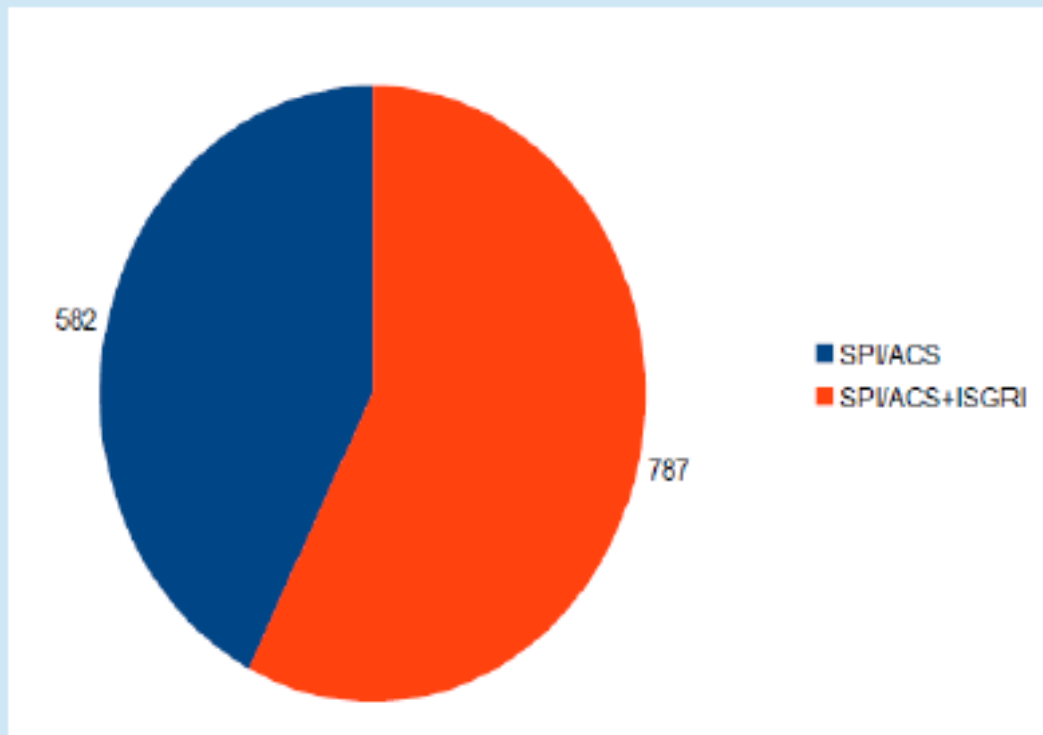


1010 GRBs in total (121 in FOV and 889 outside FOV)

There is a significant fraction of off-axis ISGRI GRBs (~90) not detected by SPI/ACS.

Russian INTEGRAL papers in 2019

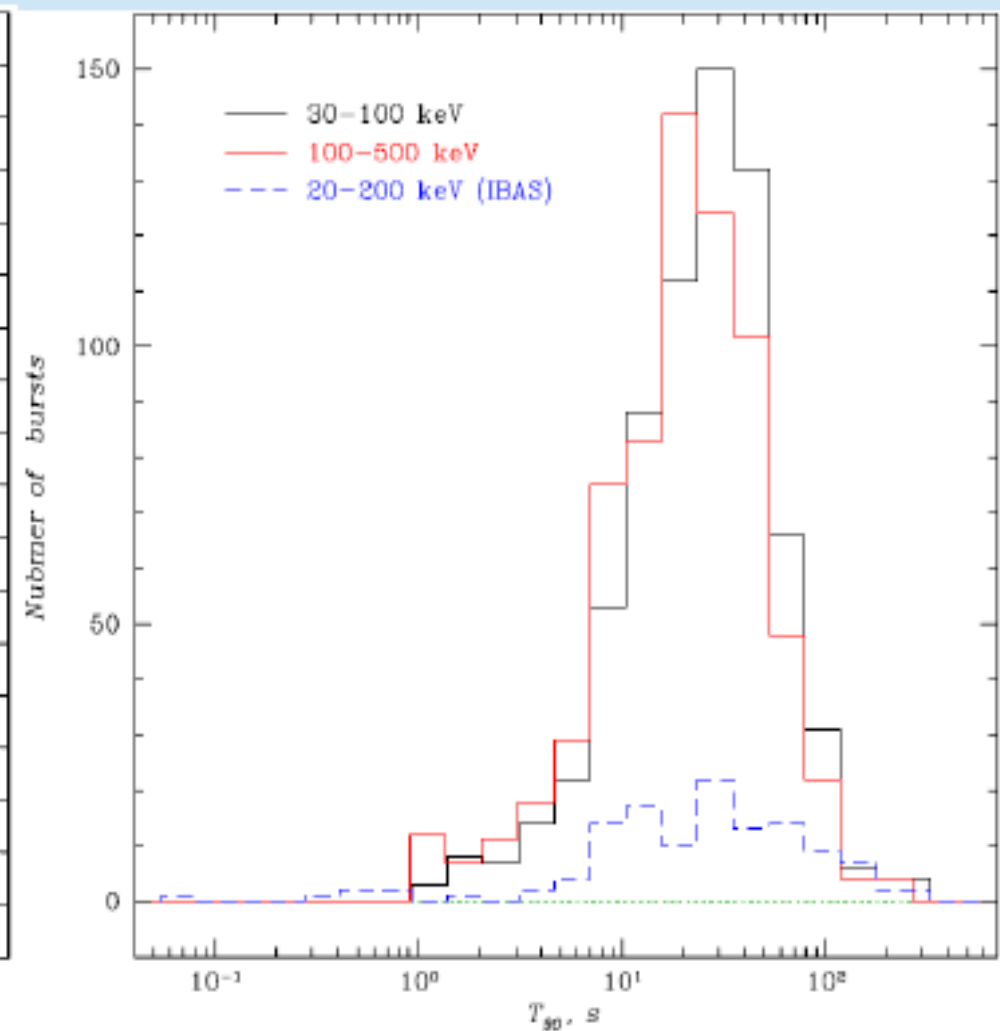
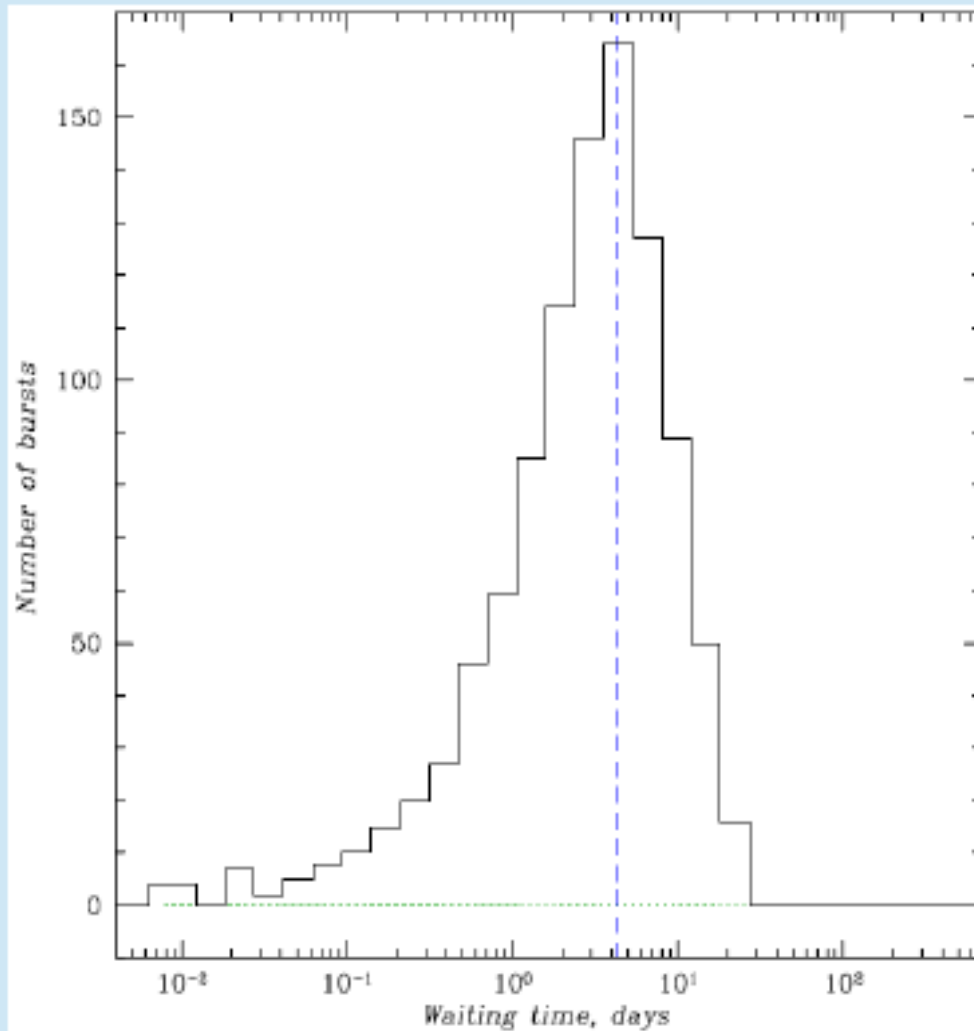
GRBs found by IBIS/ISGRI



Fraction of off-axis ISGRI events among GRBs detected by SPI/ACS

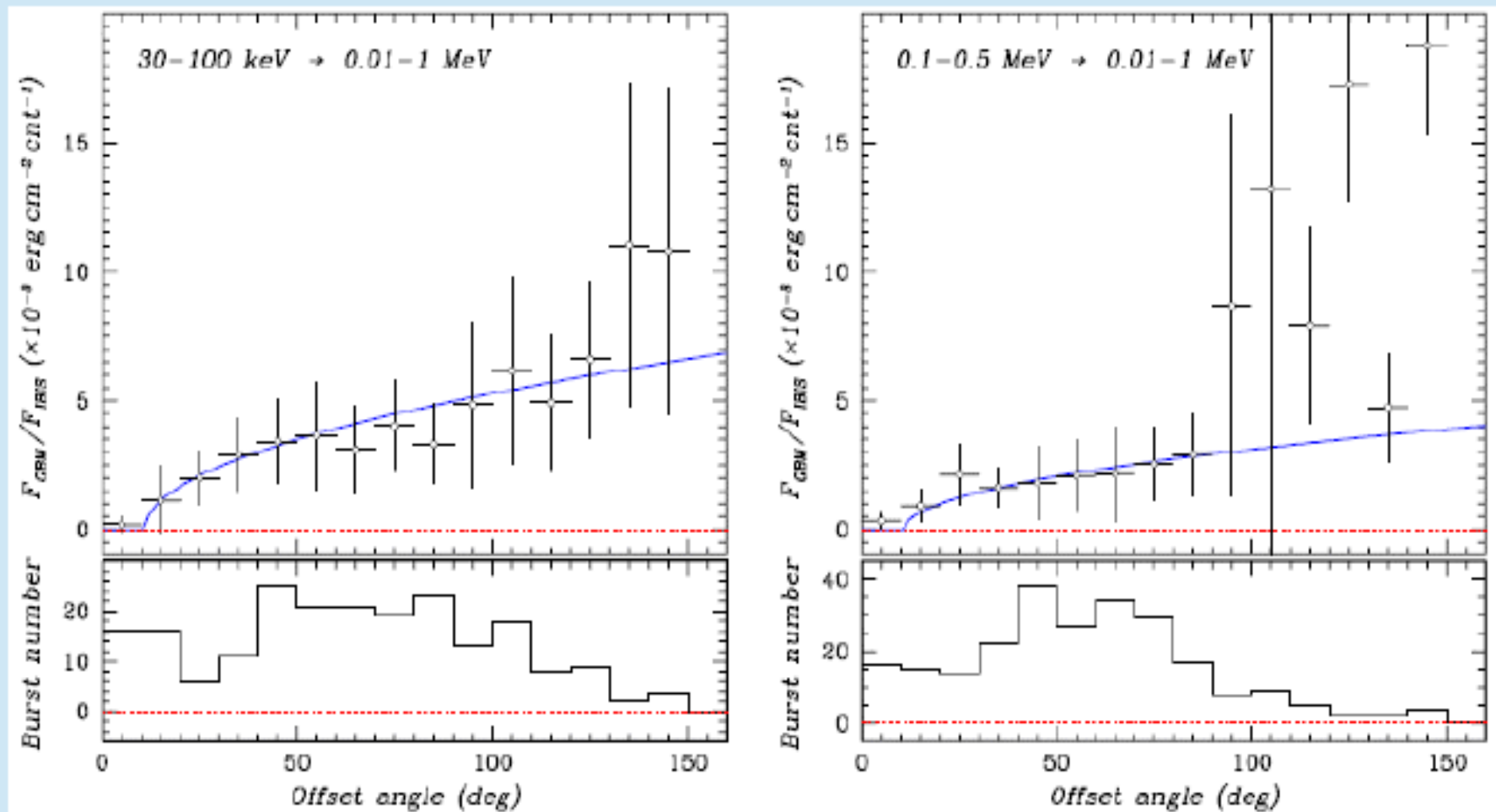
(1369 ACS selected events with $T_{90} > 1$ s, $S/N > 3$, $C_p > 100$)

Russian INTEGRAL papers in 2019



Russian INTEGRAL papers in 2019

Observing off-axis GRBs by IBIS/ISGRI



Russian INTEGRAL papers in 2019

CONCLUSIONS - 1

- 11 new well localized (<2 arcmin) GRBs were detected that is 10% of all IBAS events (7 completely new and 4 newly localized ones)
- Large amount (~ 890) of GRBs were detected outside IBIS FOV, they were previously observed by at least one other mission (110 bursts - by only one mission, mainly SPI/ACS or KONUS/Wind)
- This amount (890) is of about 2/3 of SPI/ACS GRB events (1369) detected in the same time interval, that shows a very high sensitivity of IBIS/ISGRI to off-axis bursts.
- 90 bursts of 890 were indeed not registered by SPI/ACS, that shows importance of studying the GRB population detected by IBIS/ISGRI

Russian INTEGRAL papers in 2019

CONCLUSIONS - 2

- The total catalogue of GRBs detected by IBIS/ISGRI is compiled, it has 1100 events and located at <http://hea.iki.rssi.ru/integral/ibisgrbs>
- Note that there is still a huge amount of IBIS/ISGRI events that does not coincide with any known GRB and were not in the IBIS FOV
- It is necessary to monitor IBIS/ISGRI in real time for off-axis events. This may provide us with some GRBs not detected by SPI/ACS (and with spectral information on all GRBs !)
- Comparing the catalogue with that of Fermi/GBM we selected a sample of the events seen by both the missions and calibrated the flux of GRBs detected by IBIS/ISGRI strongly off-axis (outside its FOV). This calibration dependence can be used to estimate the flux from X-ray/gamma-ray counterparts of the LIGO/VIRGO GW events.

Gamma-ray observations of S190425z

- LIGO/Virgo S190425z: INTEGRAL SPI-ACS prompt observation (Minaev, Pozanenko, Chelovekov, Grebenev), **GCN Circ. 24170 (2019)**.
- LIGO/Virgo S190425z: INTEGRAL IBIS prompt observation (Chelovekov, Pozanenko, Minaev, Grebenev), **GCN Circ. 24181 (2019)**.

НАБЛЮДЕНИЕ В ГАММА-ДИАПАЗОНЕ ВТОРОГО СВЯЗАННОГО СО СЛИЯНИЕМ НЕЙТРОННЫХ ЗВЕЗД СОБЫТИЯ LIGO/VIRGO S190425Z

© 2019 г. А. С. Позаненко^{1,2*}, П. Ю. Минаев¹, С. А. Гребенев¹, И. В. Человеков¹

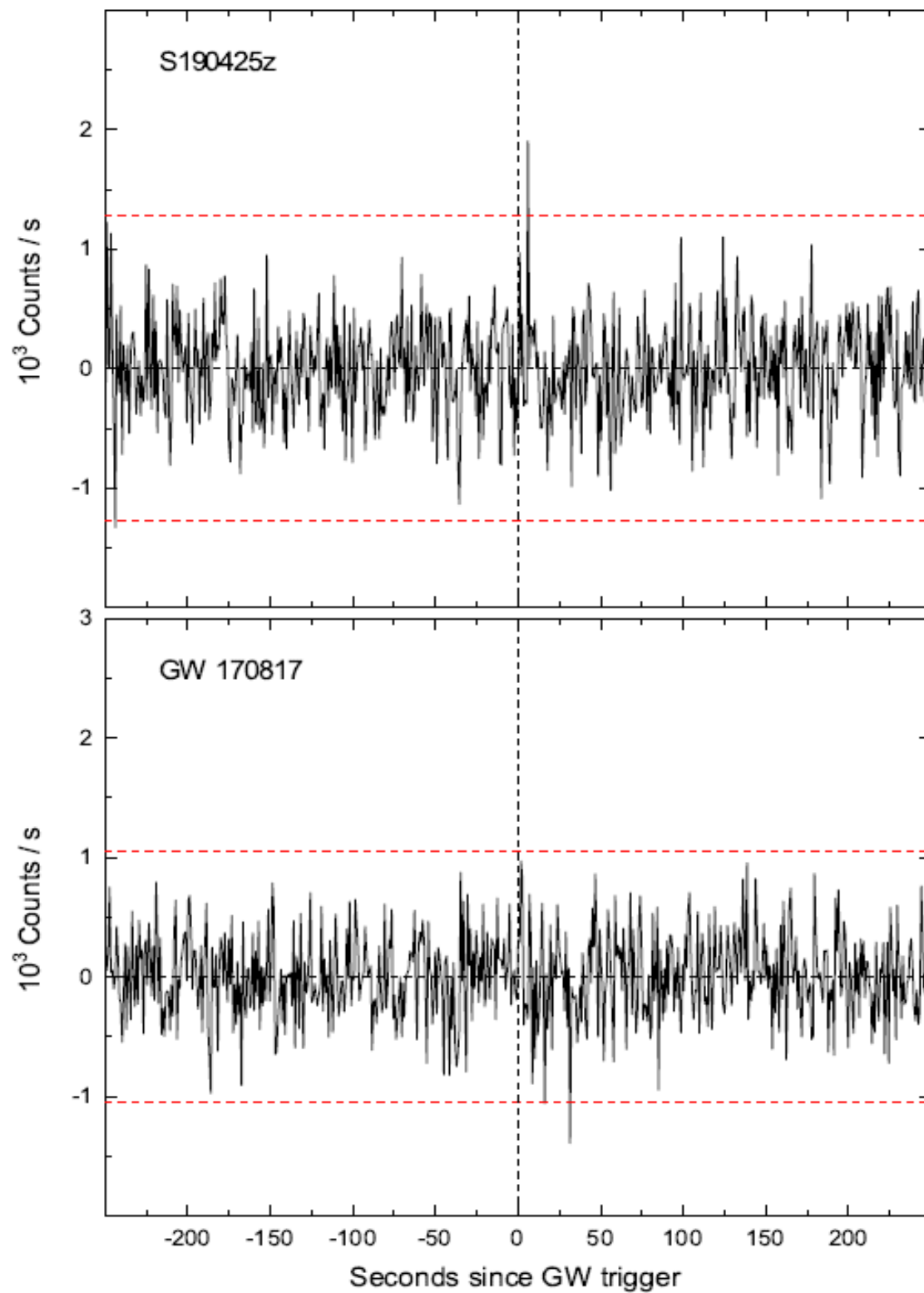
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S190425z

*SPI/ACS, 0.85-s bins,
 $S/N=4.4$*

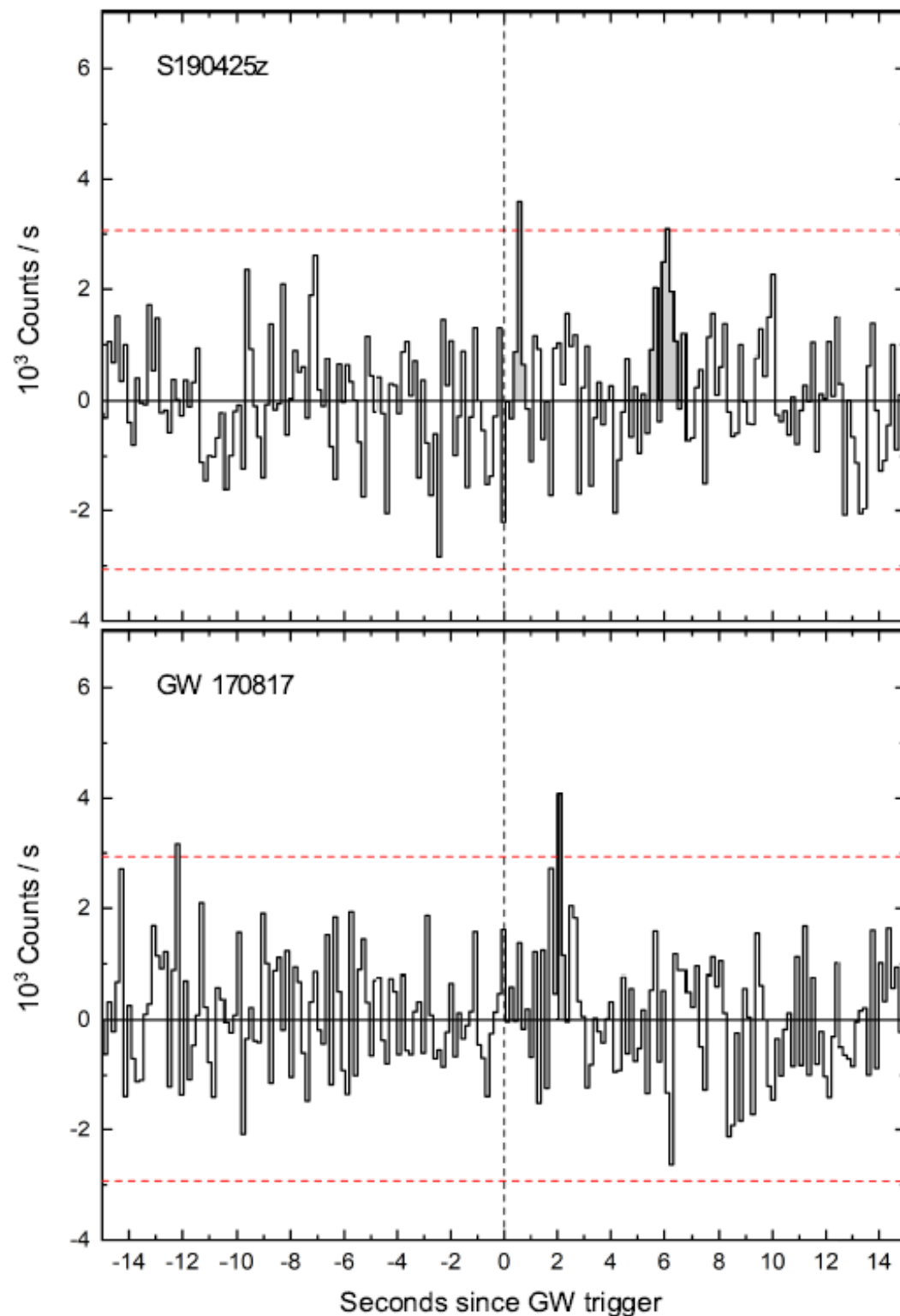


S190425z

*SPI/ACS, 0.15-s bins,
S/N=3.6*

(but 198 positive and
139 negative such
deviations in the 125 ks
light curve — short
events connected with
charged particles).

For GRB170817A
(S/N=4.6, bins 0.1s,
65 positive, 3 negative
deviations for 155 ks)



Russian INTEGRAL papers in 2019

Событие	GRB 190425		GRB 170817A
Импульс в профиле события	первый	второй	первый
Начало импульса T_i^a	0.44	5.54	2.00
Максимум скорости счета T_m^a	0.54	5.94	2.05
Бинирование N_i^b	5	17	2
Длительность ΔT_i^b	0.25	0.85	0.10
Интегральное число отсчетов C_i в импульсе i	700 ± 200	1600 ± 370	570 ± 120
Значимость (отношение S/N), σ	3.5	4.4	4.6
Вероятность ^Г	2.3×10^{-4}	5.4×10^{-6}	2.1×10^{-6}
FAR, событий/с ^Д	1.4×10^{-3}	2.7×10^{-5}	4.2×10^{-4}
Консервативная вероятность ^е	3.5×10^{-3}	8.5×10^{-4}	4.8×10^{-3}

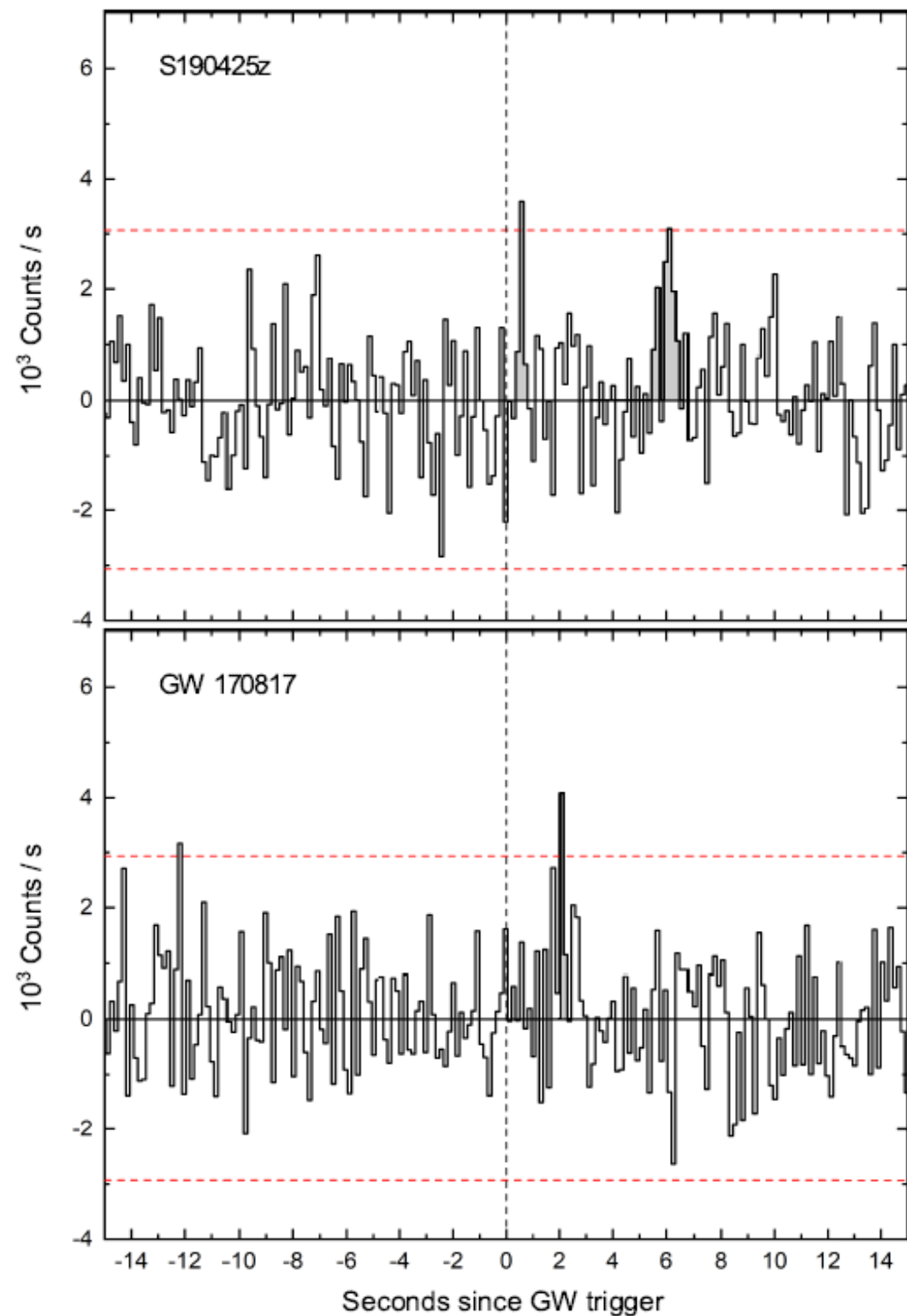
Very conservative probability of false events (*Blackburn et al, 2015*)

$$P = \text{FAR} \times \ln(1 + T_{\max}/T_{\min}) dT,$$

S190425z

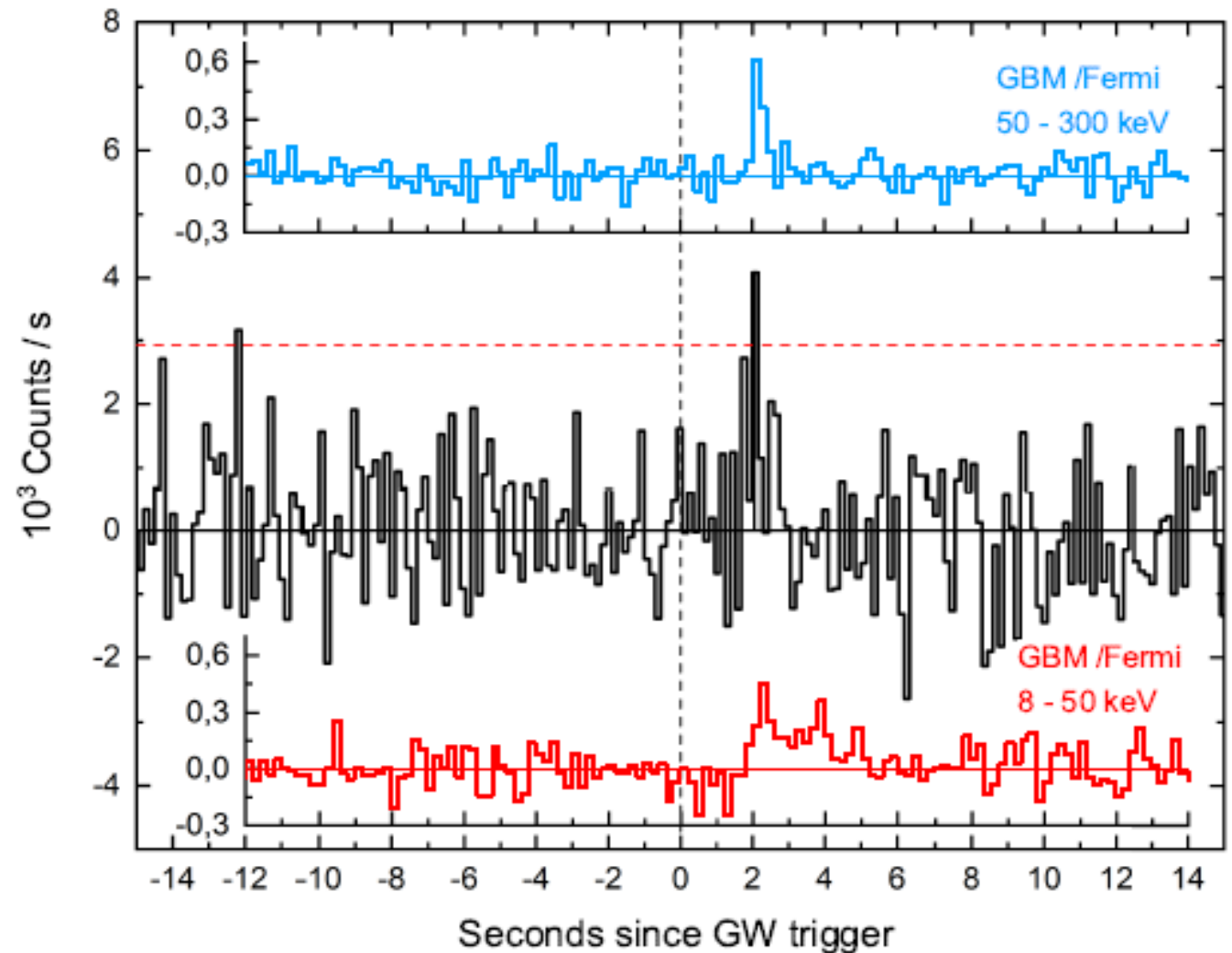
SPI/ACS, 0.15-s bins

*the burst of 2 peaks,
lasted ~6 s*



GW170817 and GRB 170817A

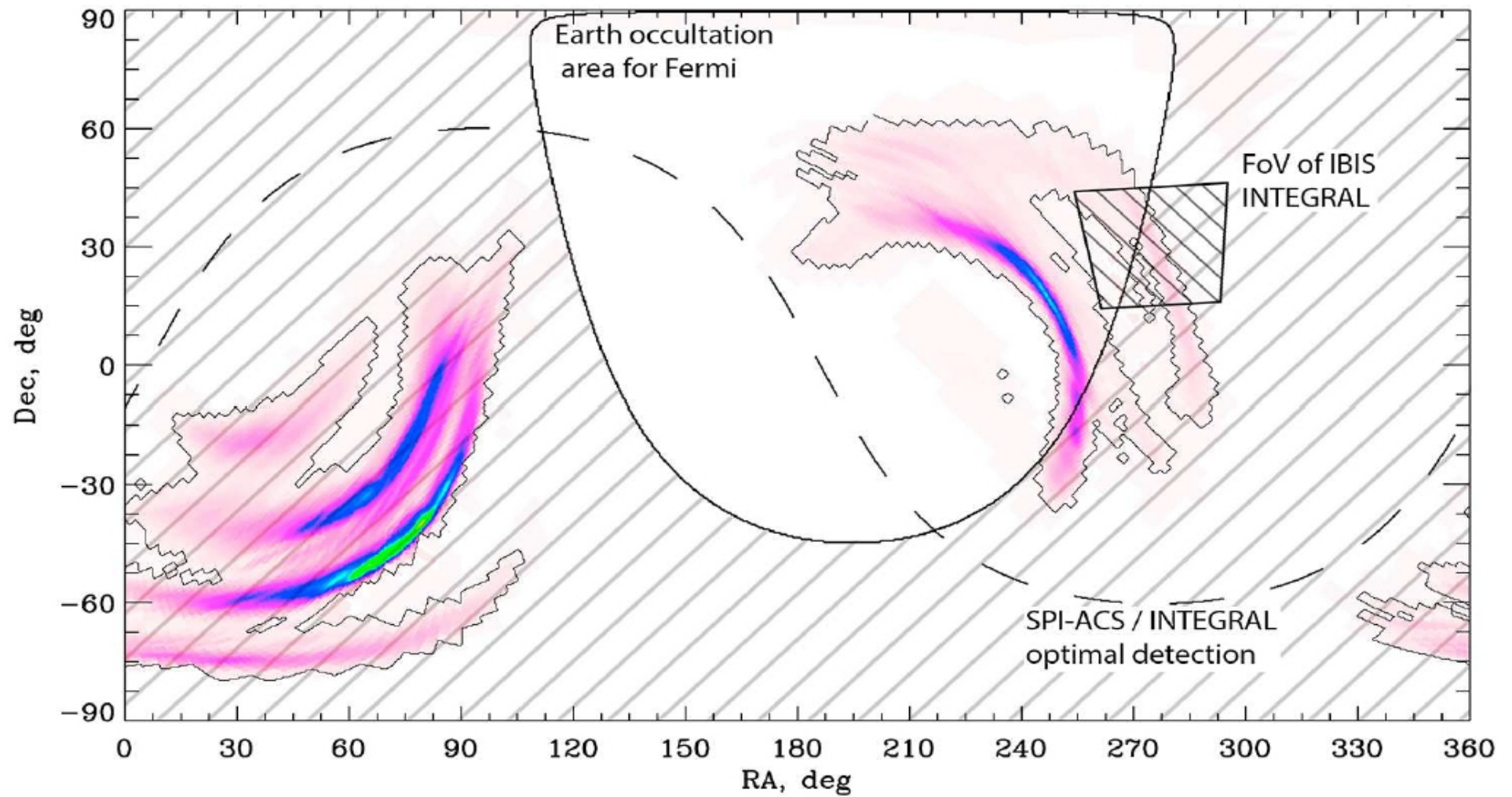
GRB170817A
also *lasted 6s*
since GW
trigger



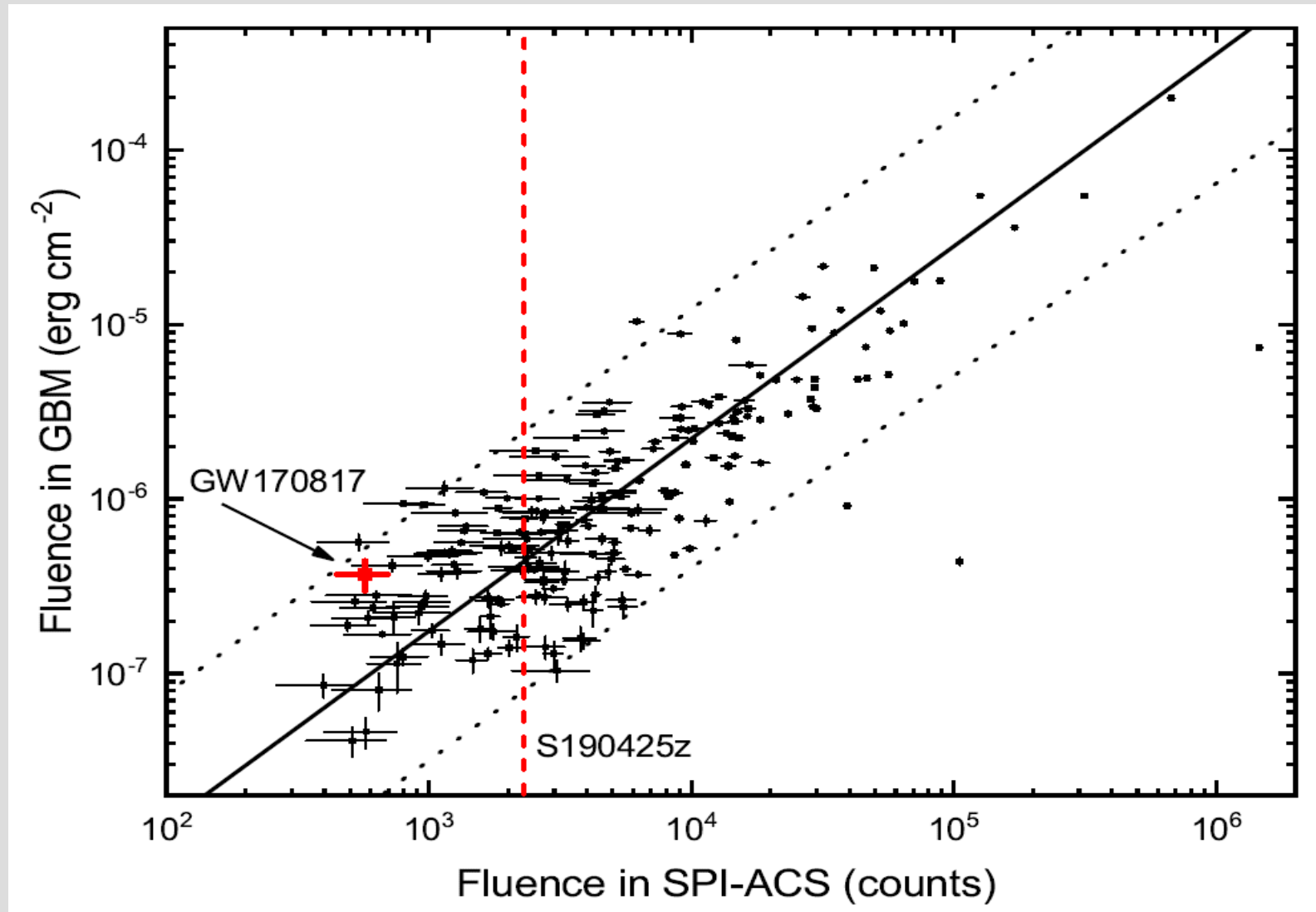
Parameters of GRBs associated with 2 GW BNS events

Событие LIGO/Virgo	S190425z	GW 170817	
Момент T_0^a	2019-04-25 08:18:05	2017-08-17 12:41:04	
Расстояние до источника, Мпк	156 ± 41	40 ± 8	
Область локализации ^б , 90%	7461	16	
Угол к оси детектора SPI-ACS	$26^\circ - 60^\circ$	105°	
Гамма-всплеск	GRB 190425	GRB 170817A	
Импульс в профиле события	первый+второй	первый	первый+второй
Эксперимент	SPI-ACS	SPI-ACS	<i>Fermi</i> /GBM ^в
Начало события ^г , с	0.44	2.0	1.7
Полная длительность ^г , с	6.0	0.1	4.1
Интегральное число отсчетов	2300 ± 420	570 ± 120	—
Значимость (отношение S/N), σ	5.5	4.6	8.7
Вероятность ^д	1.9×10^{-8}	2.1×10^{-6}	1.7×10^{-18}
FAR ^е , событий/с	6.4×10^{-5}	4.2×10^{-4}	—
Совместная вероятность ^ж	1.6×10^{-4}	4.8×10^{-3}	—
Интегральный поток $F^з$	$8.0 \times 10^{-8} - 2.4 \times 10^{-6}$	$1.7 \times 10^{-8} - 5.2 \times 10^{-7}$	$(2.1 \pm 0.3) \times 10^{-7}$
Энерговыделение $E_{\text{iso}}^и$	$2.2 \times 10^{47} - 6.7 \times 10^{48}$	$3.8 \times 10^{45} - 1.2 \times 10^{47}$	$(4.7 \pm 0.7) \times 10^{46}$

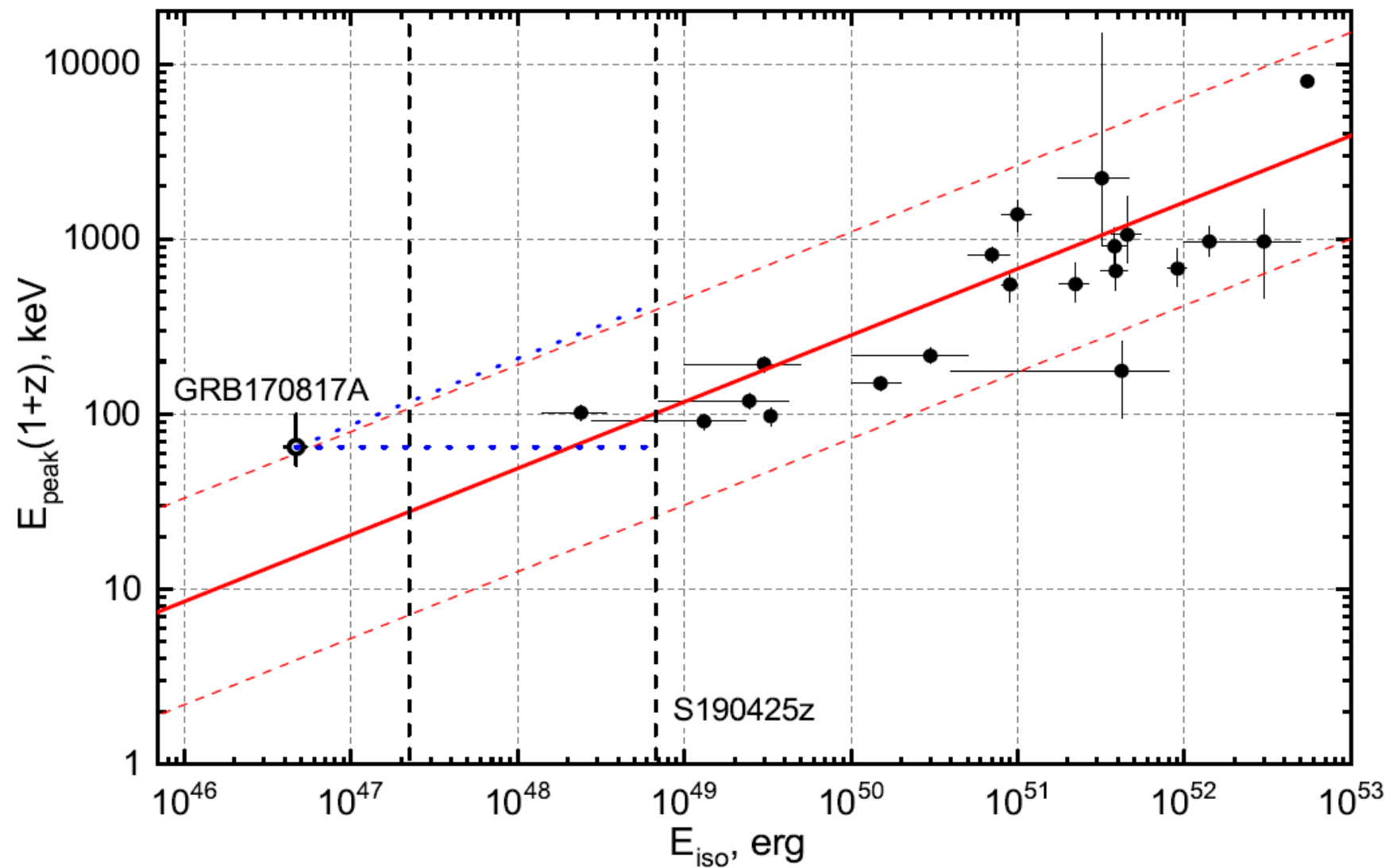
S190425s localization



FERMI/GBM-SPI/ACS short burst relation



2 GW-GRBs at Amati's diagram



SRG Mission

RSDC scientists are strongly involved in work with data coming from SRG mission, launched on July 13, 2019



Preparing for the launch

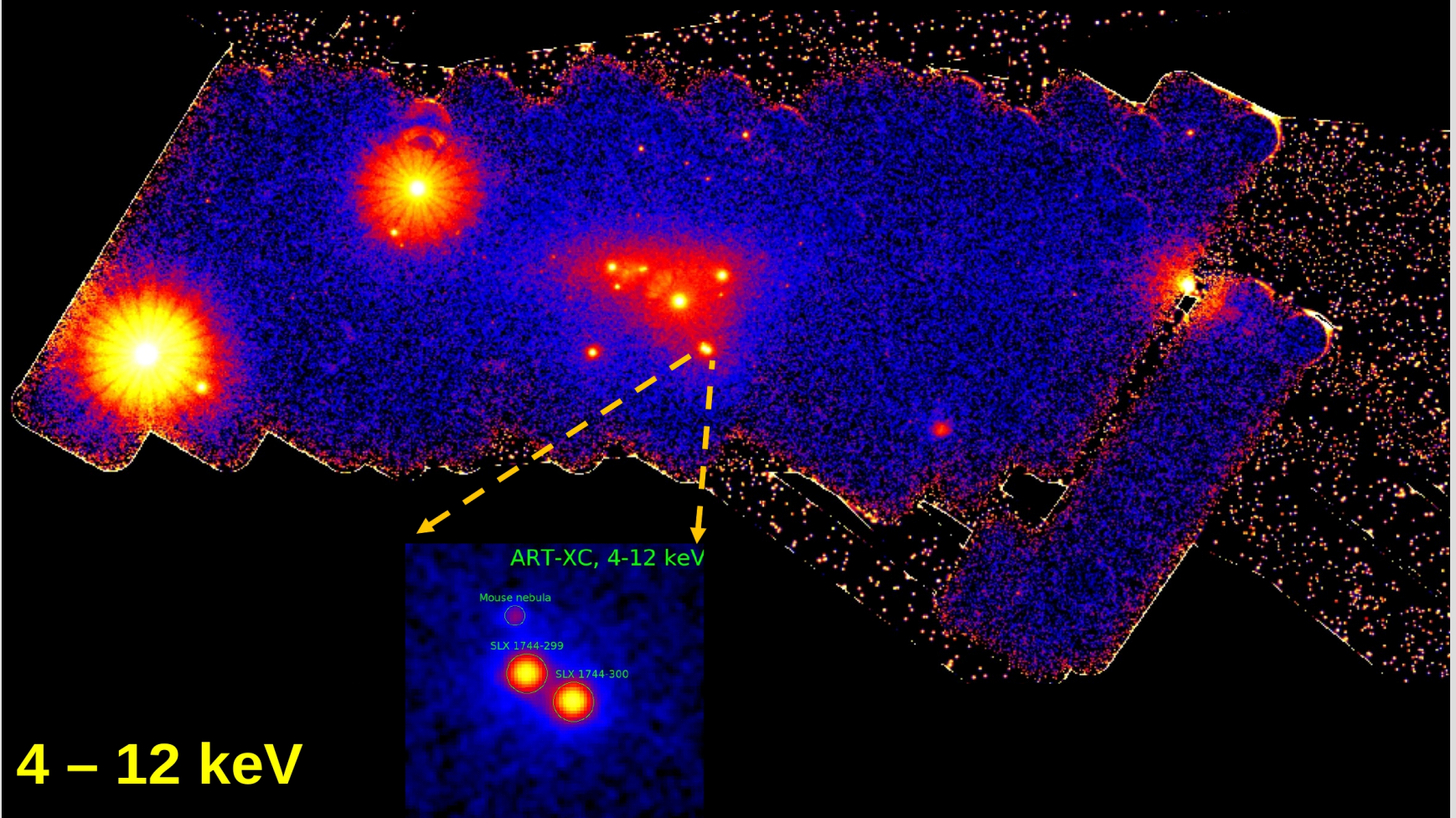
SRG Mission launch



SRG Mission first results



ART-XC Galactic Center survey



SRG Mission first results

Участок близкой галактики Большое Магелланово Облако



THANK YOU!