REFOS solar miniature X-ray spectrophotometer: results and prospects.

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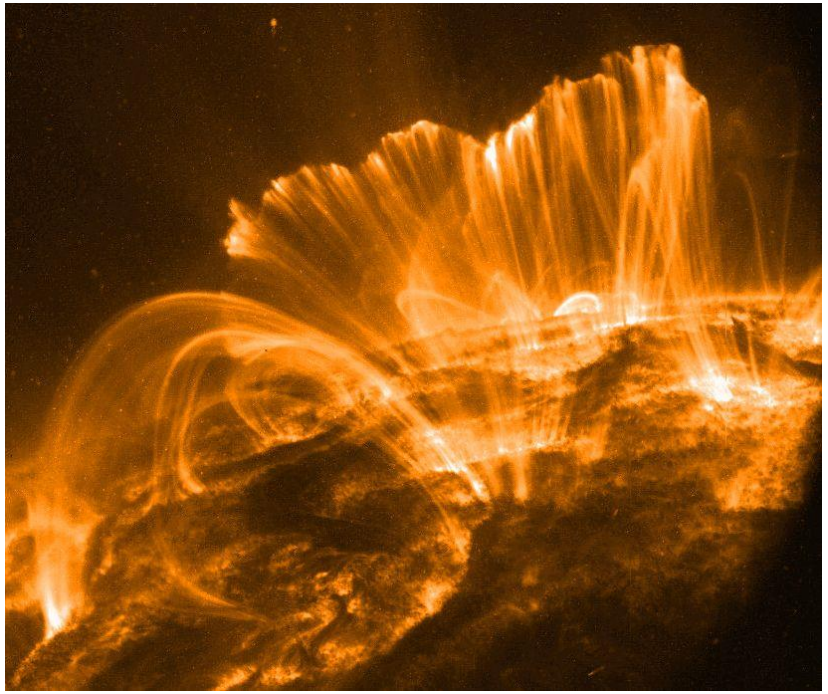
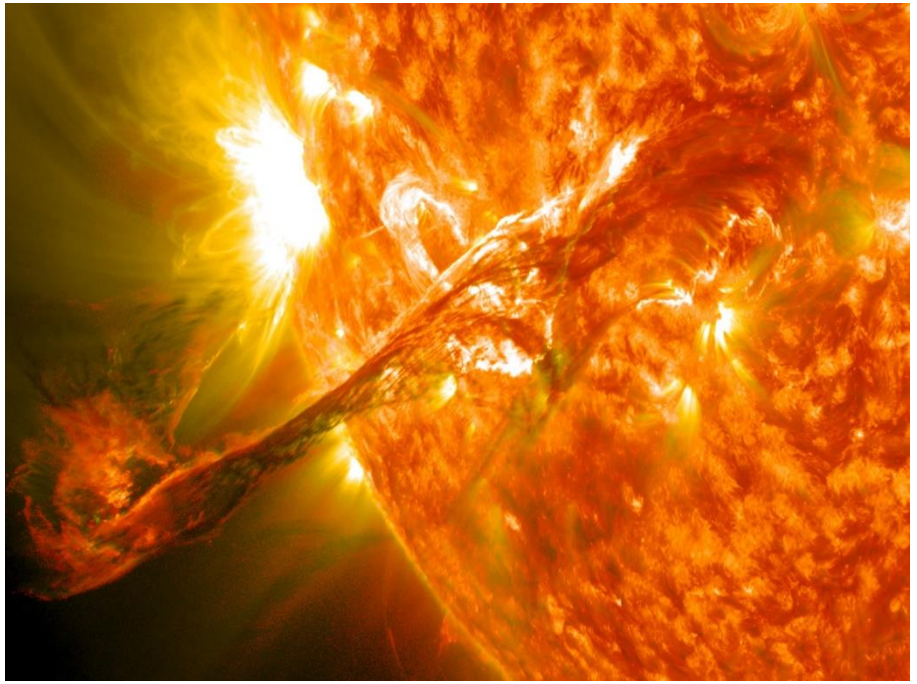
Fundamental tasks of Solar physics





Mechanisms of transportation of energy and matter from the photosphere to corona,

Generation and acceleration of the solar wind,

Nature of the solar flares,

Nature of the cycles of solar activity

Sun and the space weather

The sun and its activity are **the main (only one)** factor determining the change in the state of the Earth's magnetic field and ionosphere, as well as the radiation state of near–Earth space, where spacecraft operate.

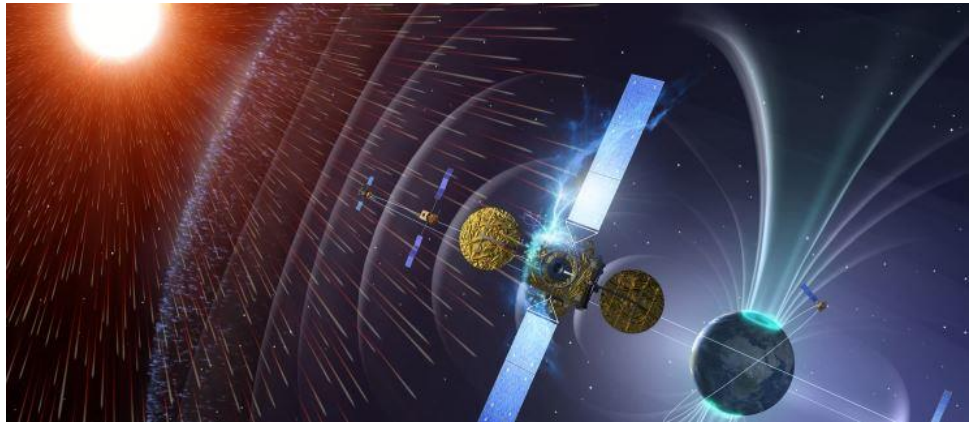
Propagation times of impacts from the Sun :

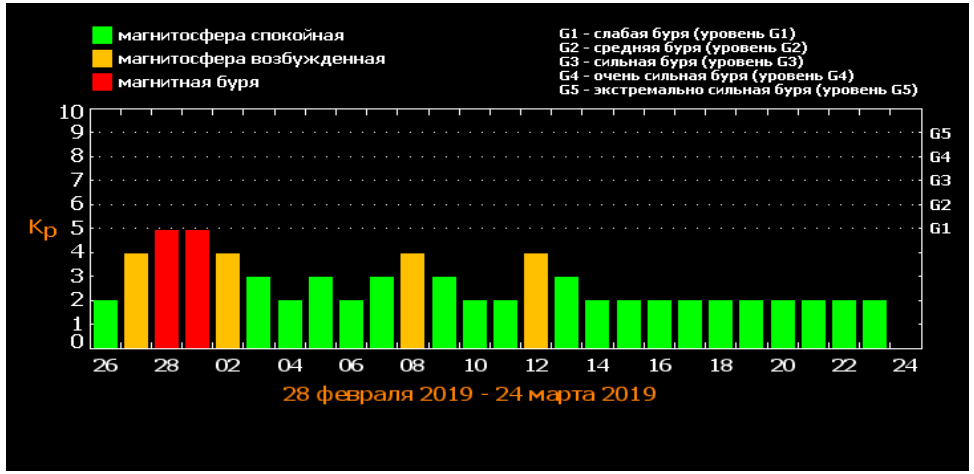
Particles – from hours to days.

Plasma – from 1.5 to 4 days.

Long–term factors (the structure of active centers) are active for a month or more.

This makes it possible to forecast space weather in the short and medium term.





Modern problems of space observations of the Sun

Scientific observatories:

- Currently, there are 7 solar stations operating, the first one was launched in 1996, the last one in 2022.
- Monitoring of the Sun provides just 1 of the (SDO)
- There are no Russian observatories
- There are no plans to launch new stations until 2030.

The main problem is the high cost, high level of competition with other space research, and long project preparation time.

Modern problems of space observations of the Sun

Observatories for space weather prediction:

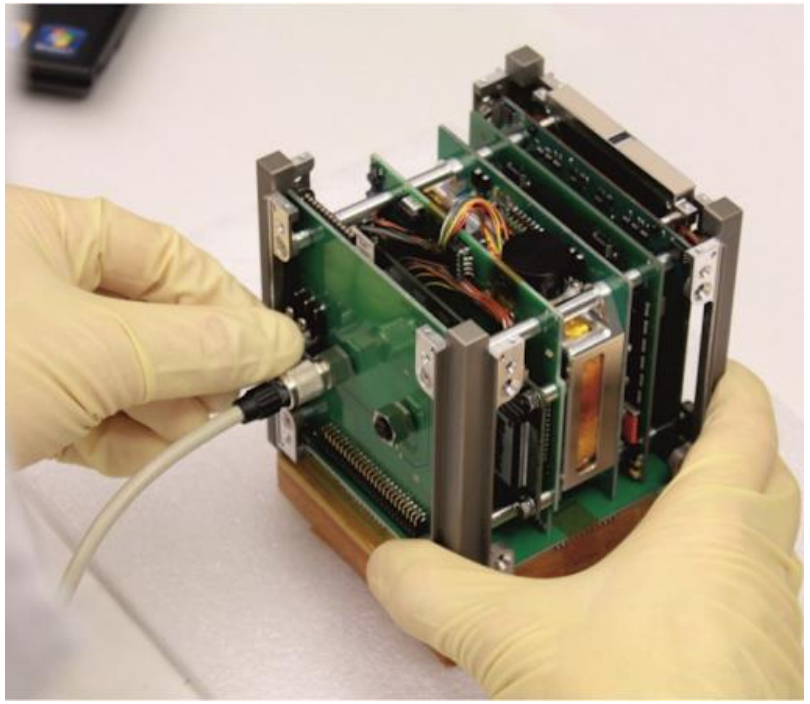
- There are on specialized spacecrafts,
- The instruments for monitoring solar activity is placed on the US GOES spacecrafts, and very limited on the Russian Electro-L spacecrafts (L-alpha and X-ray monitors)
- It is planned to launch the Russian platform on the Electro-M spacecraft (after 2030)

The main problems are high cost, high degree of refinement, and formalization of work.

~ 1 000 000 000 $

Motivation for using cubesats for the monitoring the Sun

- The reduction in the number of large space observatories, their high cost, and the long time required to prepare and test equipment for them
- Fast implementation time, low cost
- The possibility of creating and maintaining a specialized grouping cubesats
- The development of new technology that allows the miniaturization of experimental installations



Bortnik foundation:
3U – 40 000$
6U – 90 000$
Production of 9-12 months

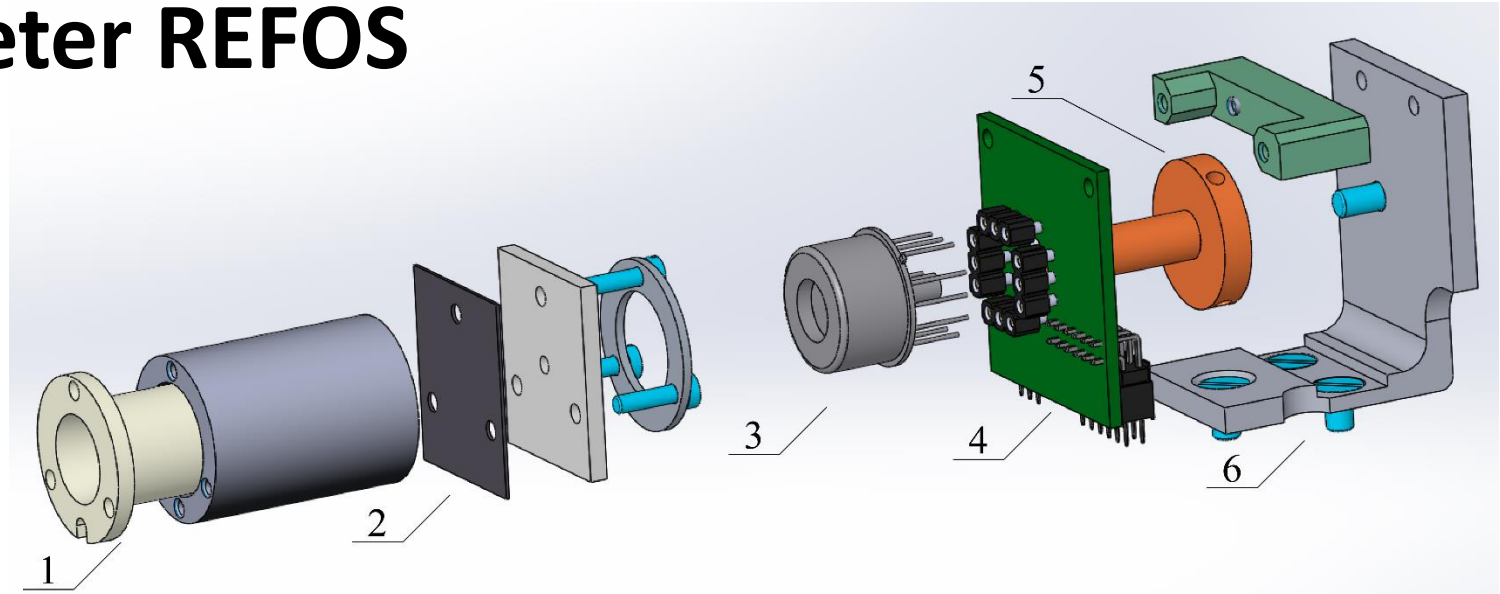
Limitation on the use of equipment for cubesats

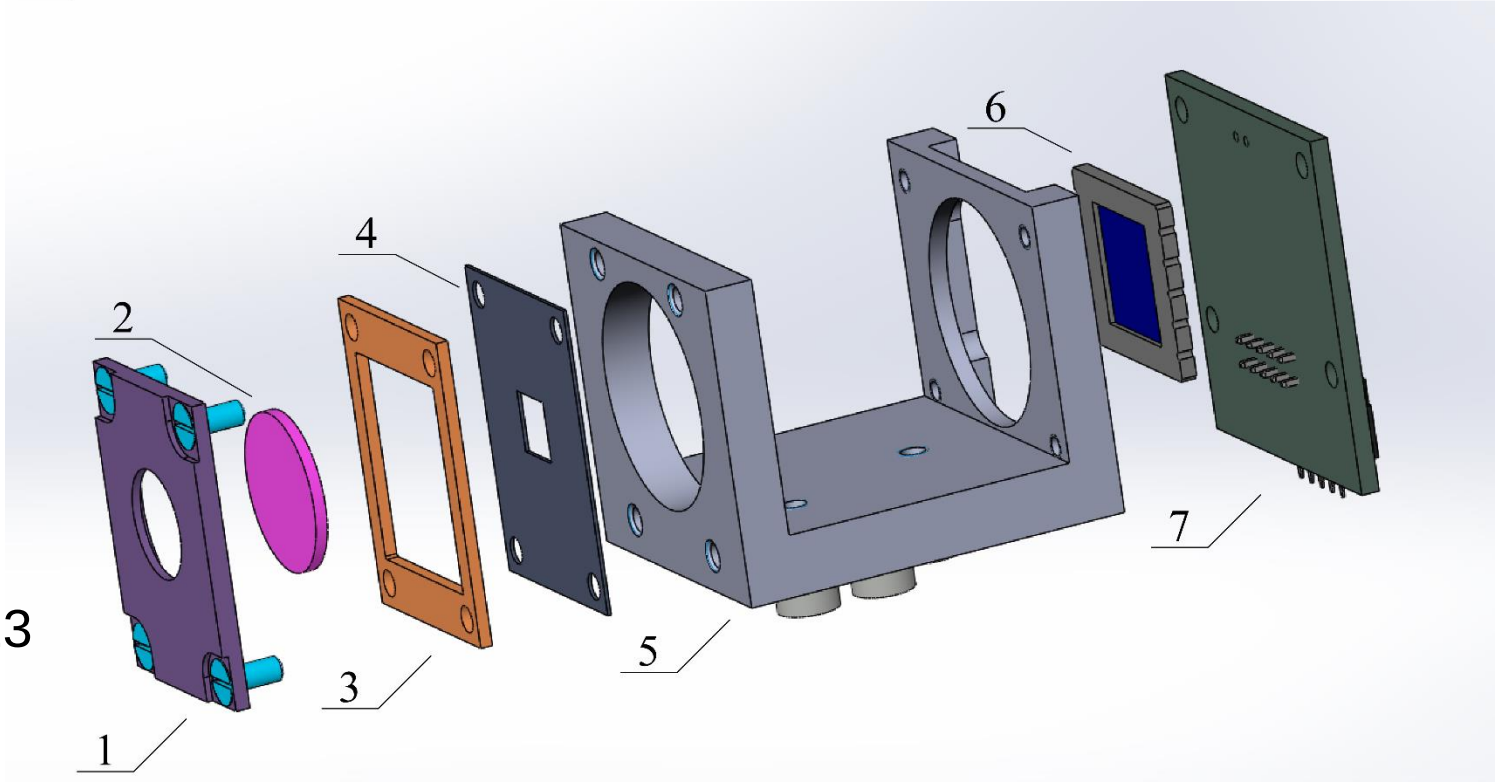
- Small dimensions and low mass
- Low accuracy of orientation and poor stabilization
- Low telemetry
- Delay with download information

X-ray spectrophotometer REFOS for “Impuls” cubesat

X-ray spectrophotometer REFOS

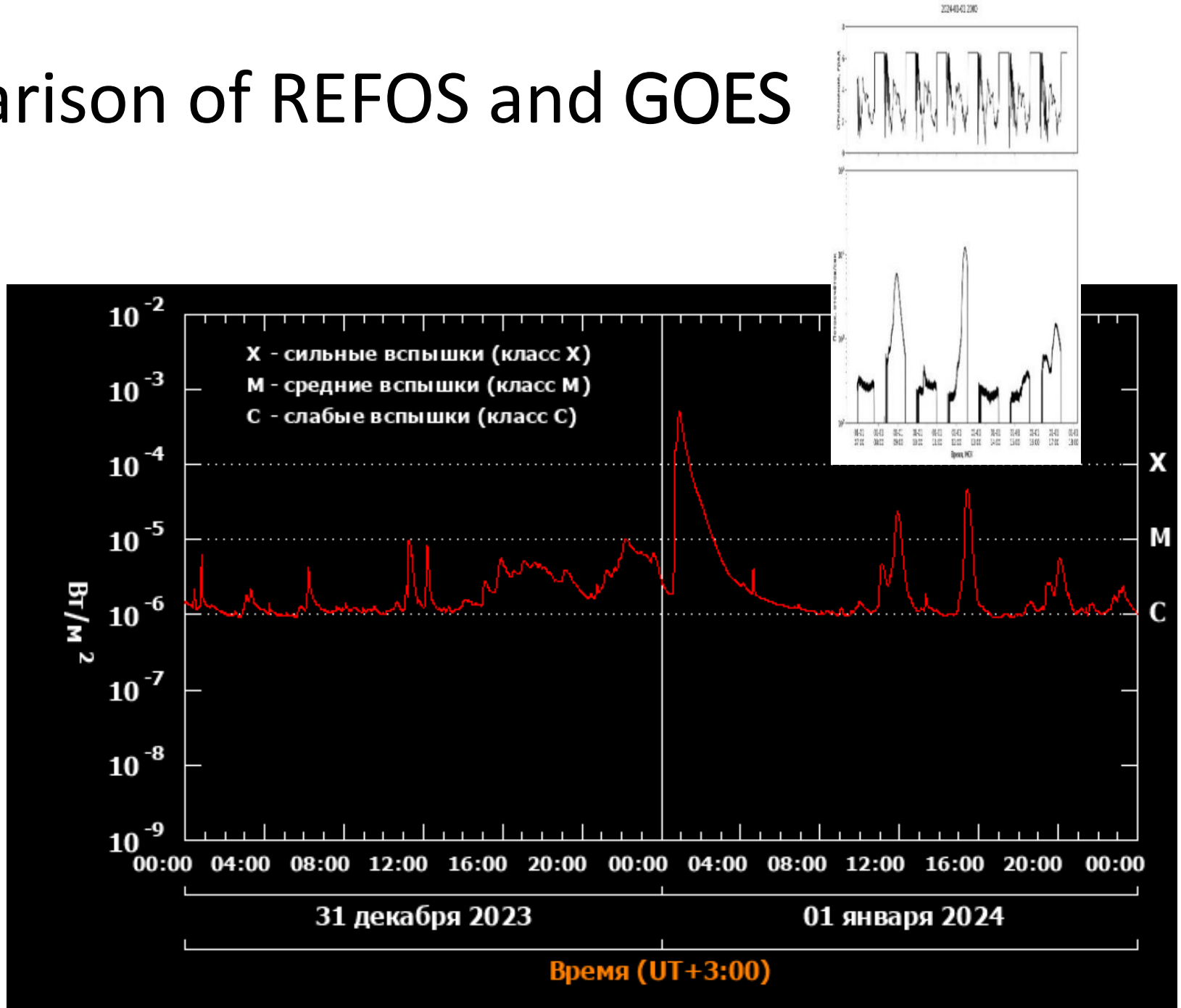
Parameter	
Sensor	AMPTEK
Energy range	1-30 KeV
Energy resolution	0,130 KeV at 4 KeV
Field of view	7 degrees
Cadence	0,5…5 sec
Mass	0,5 kg
Daily volume of data	1 Mb
Power	2 W
Dimension	80 x 80 x 40 mm



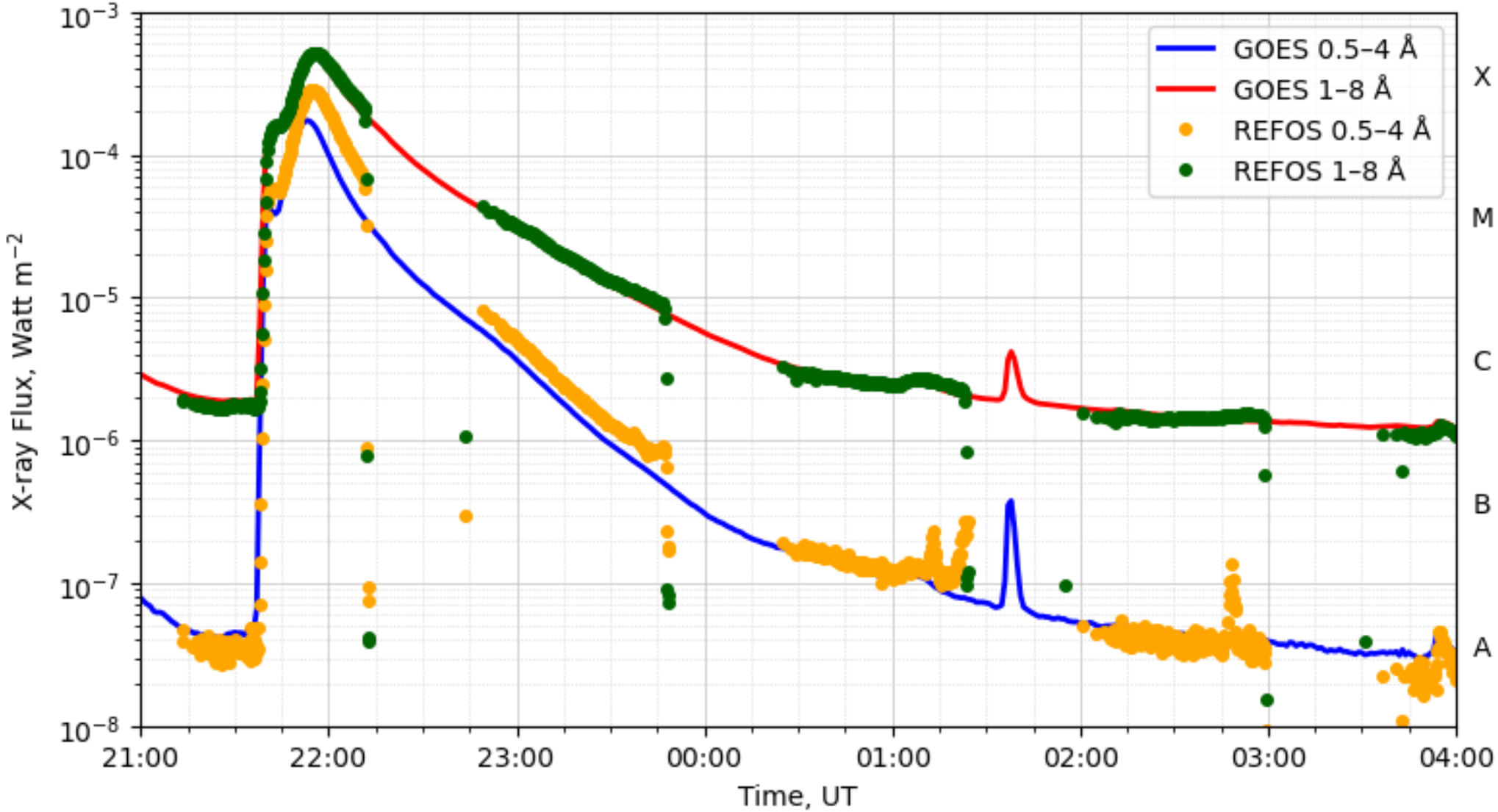


- Launch: 24 of June 2023
- Start of observation: 23 of October 2023

Data comparison of REFOS and GOES



Flare X5.0 31.12.2023



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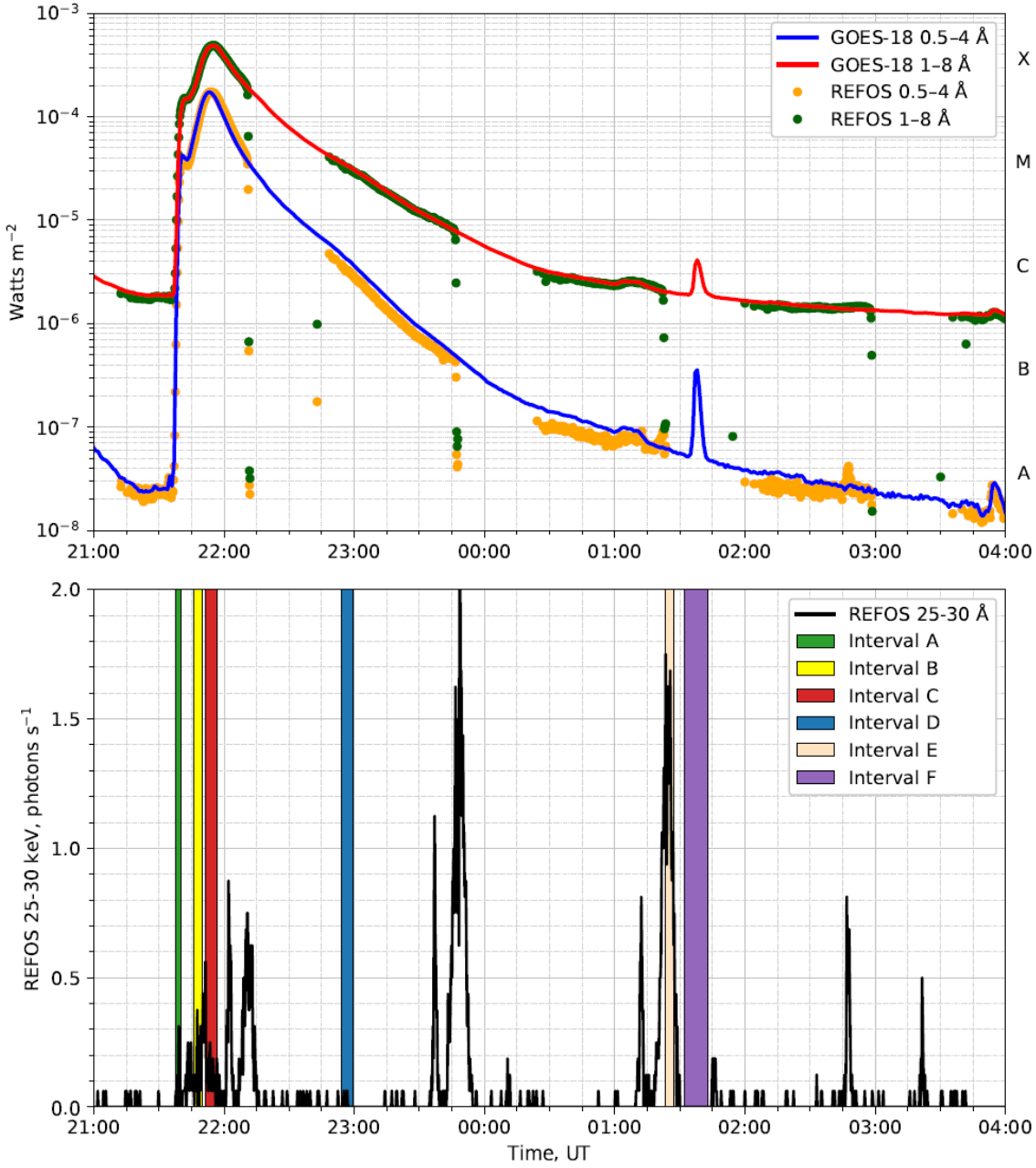
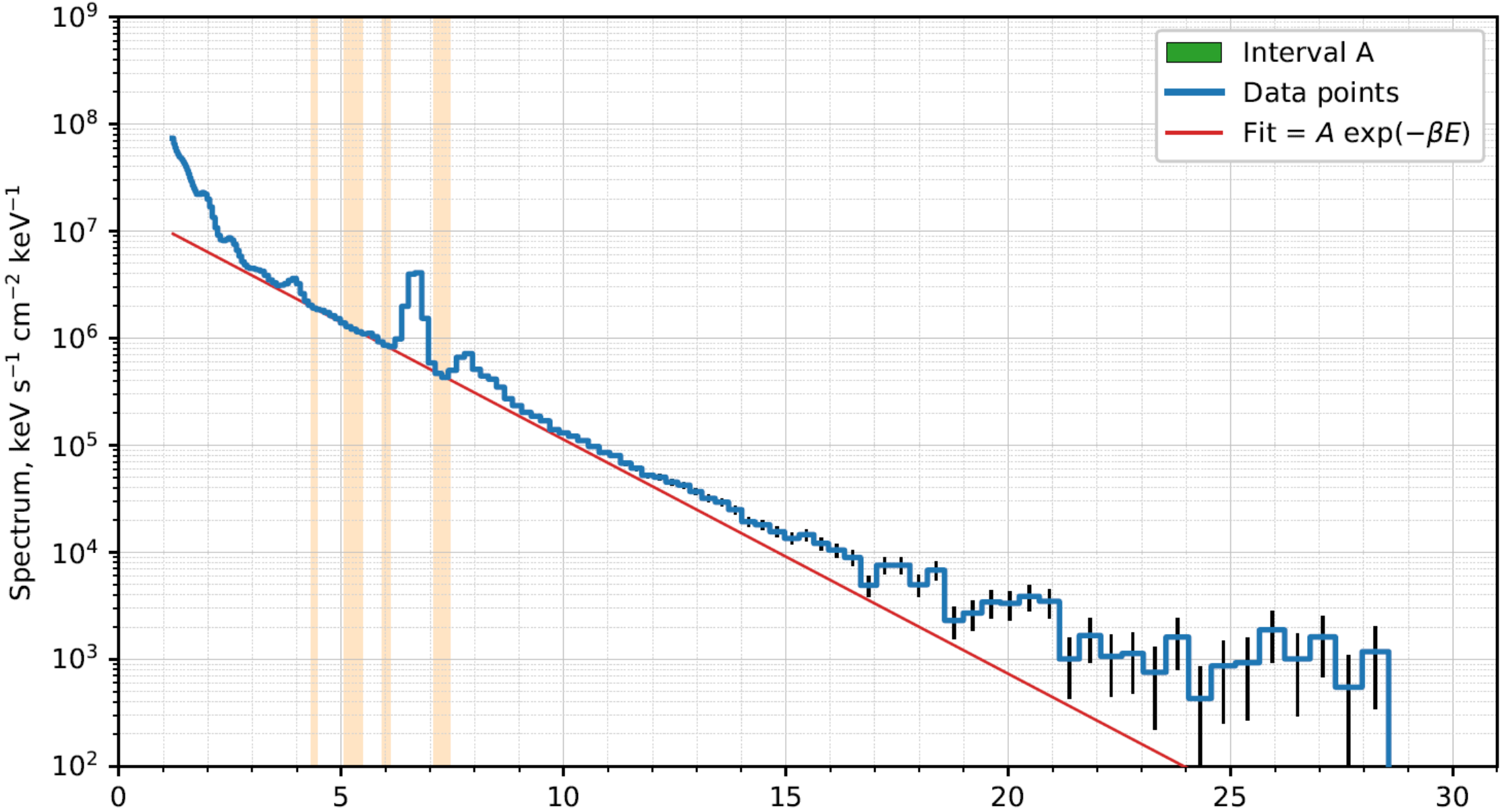
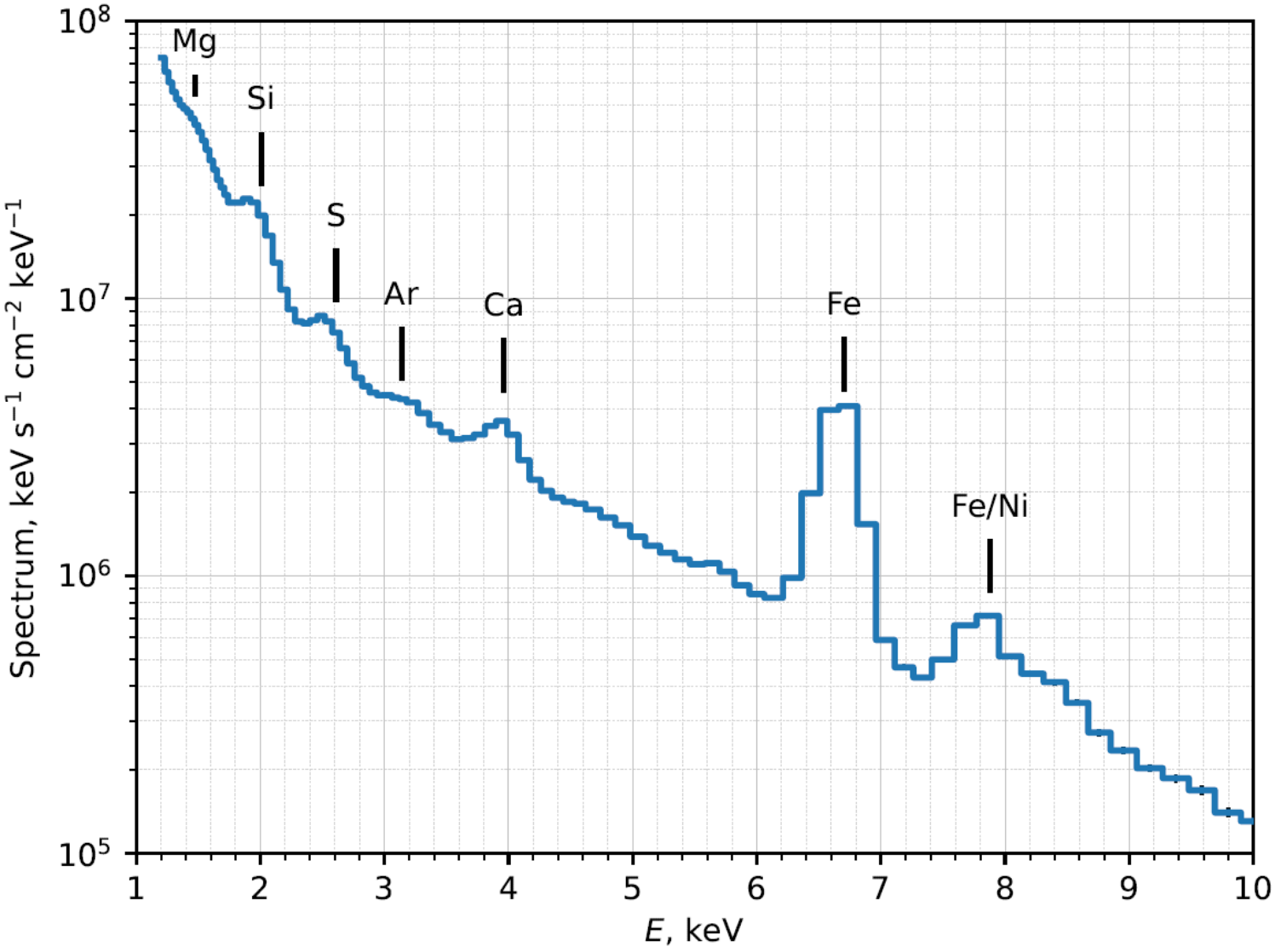


Flare X5.0 31.12.2023, inclination phase



Flare X5.0 31.12.2023, maximum phase, spectral lines



Conclusion

- Cubesats can be used as an inexpensive and operational platform for instruments for fundamental and applied research.
- Significant scientific experiments can be carried out on cubesats.
- It is possible to create an cubesats grouping as an alternative/complement to large integrated stations for scientific research and/or space weather forecasting.

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Космическая погода – XRAS.RU

https://t.me/lpixras

Официальный канал лаборатории солнечной астрономии ИКИ РАН. Сайт — https://xras.ru. Тут размещаются сведения о космической погоде, наши комментарии к событиям в области науки, а также просто то, что кажется нам интересным.

РКН: https://clck.ru/3Mh78P