# Joint Observations of Solar Flares by Konus-Wind and SolO/STIX

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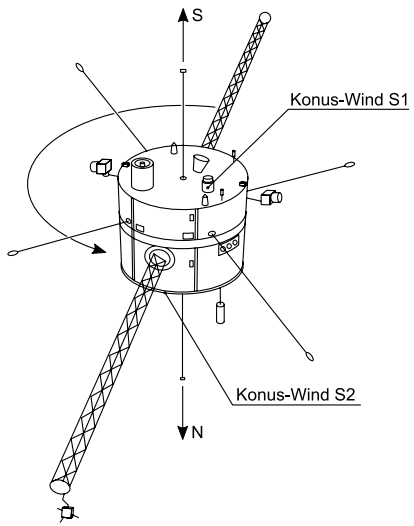
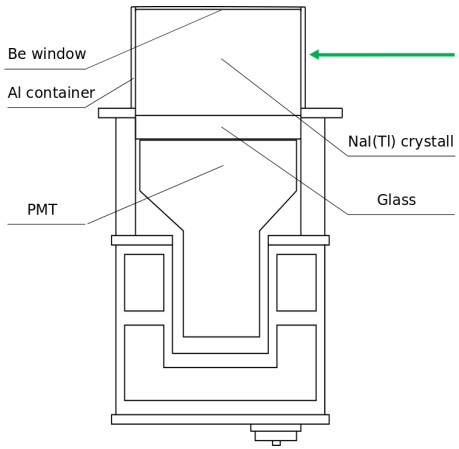
# Konus-*Wind* instrument

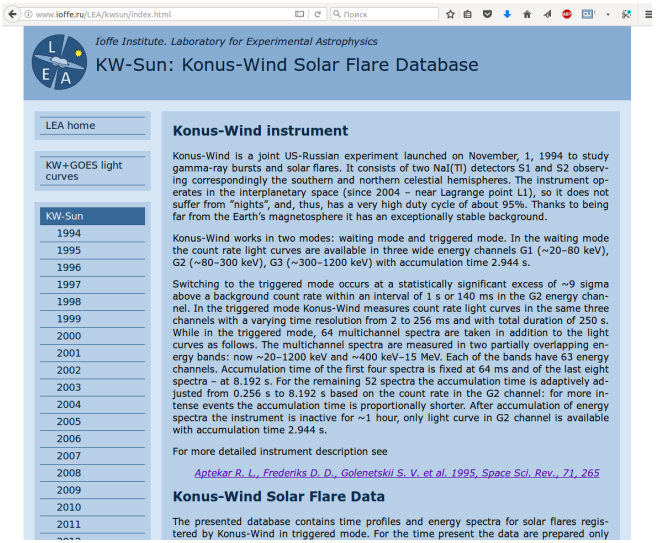


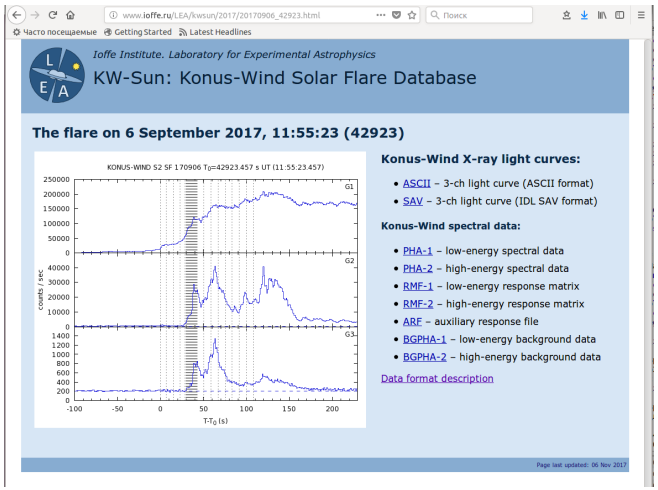




- Konus-Wind is a joint Russian-US experiment for gamma-ray burst and solar flare studies in hard X-ray and soft gamma-ray ranges (Aptekar et al., 1995).
- Operates since November 1, 1994 till present time.
- Two detectors S1 and S2
  NaI(Tl) 13 cm x 7.5 cm are located on opposite faces of the Wind spacecraft, observing correspondingly the southern and the nothern ecliptical hemispheres.
- Incident angle for solar flare emission is 90°.
- Continuous observations of all sky.
- $\sim$ 20 keV–15 MeV energy range (present time).
- Since July of 2004 is orbiting around L1 at $\sim$5 light seconds from Earth.
- Doesn't suffer from "nights".
- Exceptionally stable background.

# Konus-*Wind* instrument

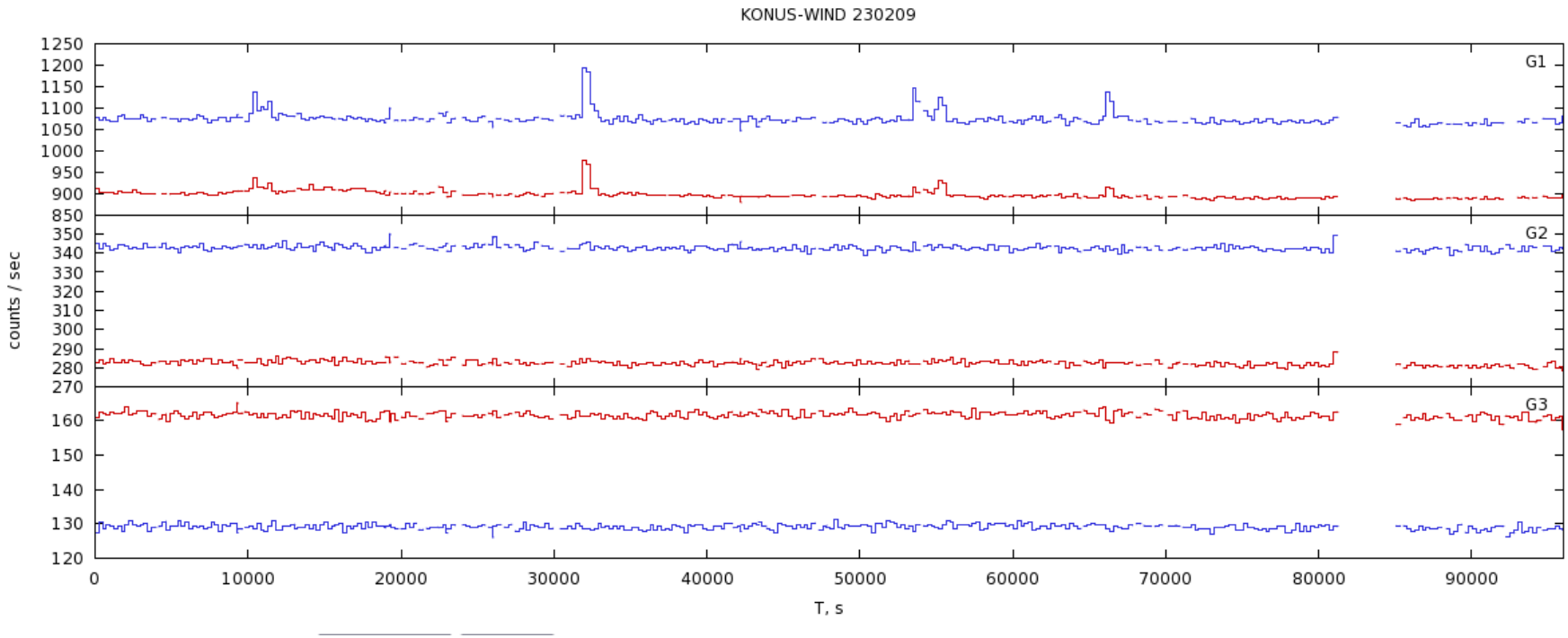
- Waiting mode: Time profiles: G1 (∼20–80 keV), G2 (∼80–300 keV), G3 (∼300–1200 keV) with temporal resolution 2.944 s.
- Triggered mode:
  - Time profiles in the same 3 channels with resollution varying from 2 to 256 ms, total duration ∼240 s.
  - 64 multichannel spectra in two partially overlapping energy ranges ∼20 keV–15 MeV.
    Accumulation time of multichannel spectra varies from 64 ms to 8.192 s.
- After accumulation of energy spectra the instrument is inactive for ∼1 hour, only count rate curve in G2 channel is available with accumulation time 3.6 s.
- KW-Sun database is available via http://www.ioffe.ru/LEA/kwsun. It contains data on >1000 solar flares registered by Konus-*Wind* in the triggered mode (Lysenko et al., 2022).



# Konus-*Wind* waiting mode data

- More than 13,000 solar flares are registered in the waiting mode.
- We plan to publish waiting mode data.
- Now waiting mode data are available on request
  alexandra.lysenko@mail.ioffe.ru

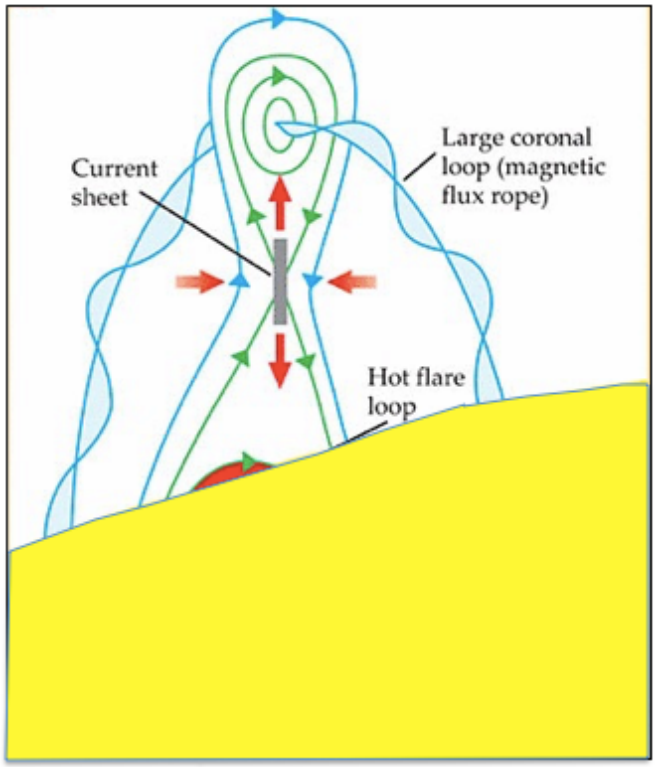



S1 detector (red), S2 detector (blue)

# The prospects of joint solar flare observations by Konus-Wind and SoLO/STIX

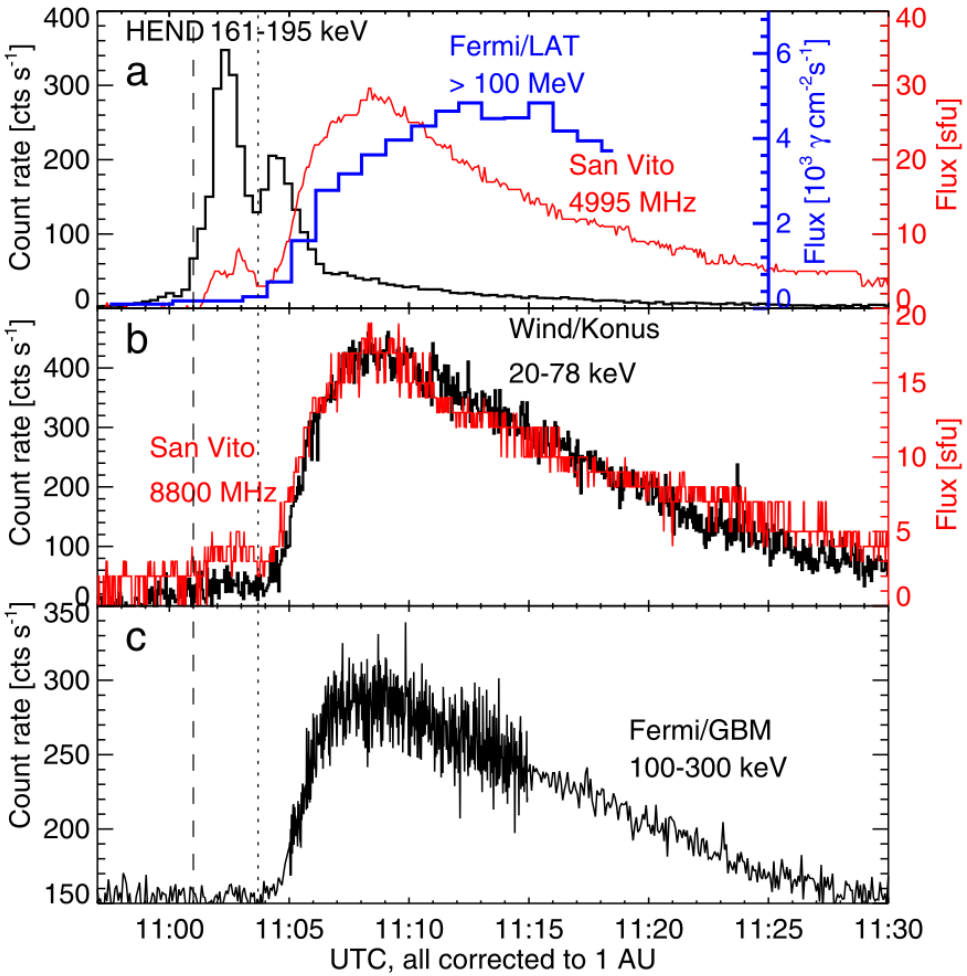
- Studies of solar flares in a wider energy range (up to 15 MeV in the triggered mode).
- Stereoscopic studies of solar flares, first of all, partially occulted and behind-the-limb flares.
- Systematic search for behind-the-limb flares.

- Footpoints of partially occulted flares are located on the far-side of the Sun at longitudes $<10^0$.
- Behind-the-limb flares can be located at longitudes up to $\sim 45^0$ on the far-side.
- A terrestrial observer sees hard X-ray emission from the corona (for the most part).



# Stereoscopic observations of behind-the-limb flares

- Behind-the-limb flare SOL2014-09-01 with footpoint at $\sim 45^0$ behind the limb;
- Spiky time profile in hard X-ray range from the footpoints (HEND/Mars-Odyssey);
- Smooth time profiles in X-ray range observed from the Earth (Konus-Wind, Fermi-GBM);
- The origin of smooth emission – ? (Ackermann et al., 2017; Grechnev et al., 2018; Jin et al., 2018; Petrosian, 2018; Carley et al., 2017)



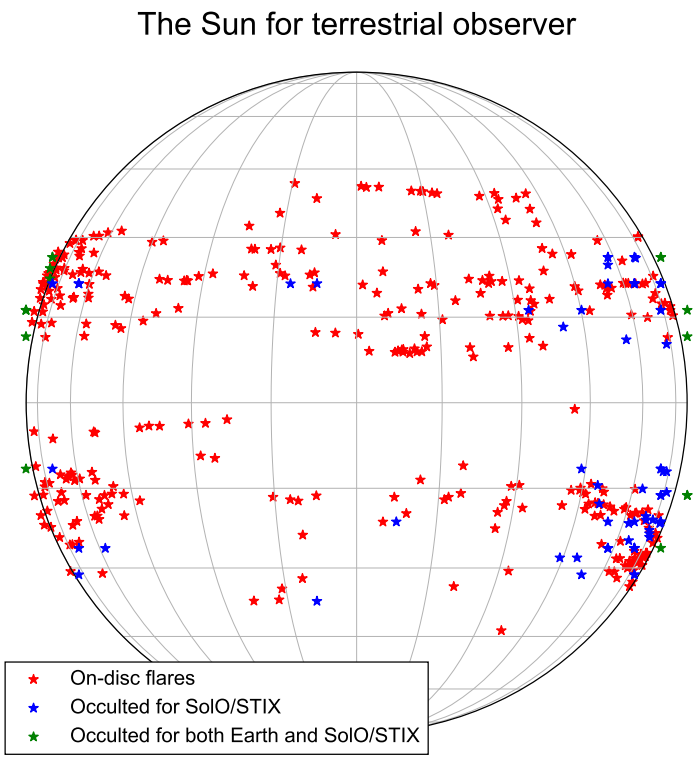

Grechnev et al., 2018

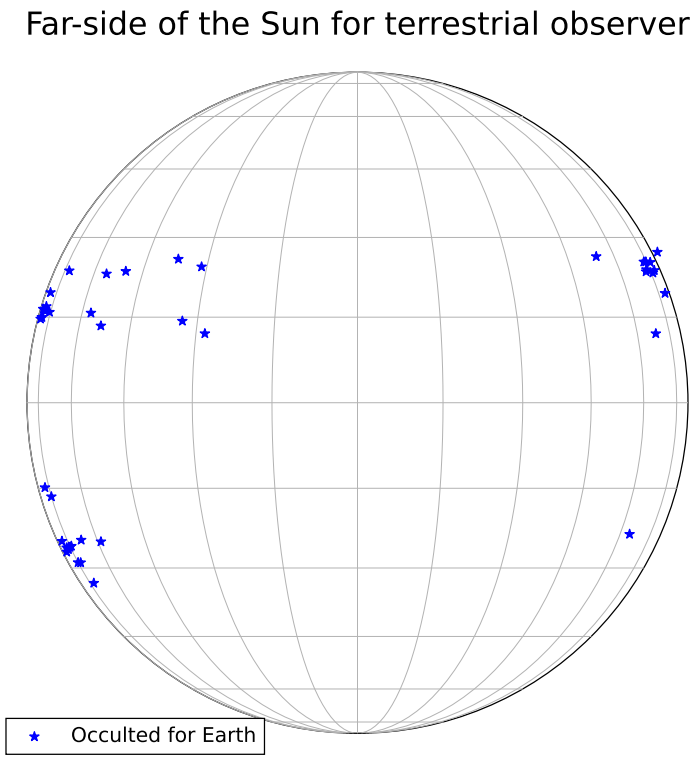
Behind-the-limb solar flare observed by SolO/STIX – Pesce-Rollins et al., 2022.

- Thanks to the stable background and almost continuous all-sky observations, Konus-Wind waiting mode data are very suitable for automated search of transient events, in particular, joint observations with other instruments.
- For the search we used list of flares with known locations observed by SolO/STIX[1]. This list contains ∼6000 flares between February, 2021 and April, 2023.
- Automated search yielded ∼500 jointly observed flares. This flare list is available online http://www.ioffe.ru/LEA/kw_stix/.

[1] https://github.com/hayesla/stix_flarelist_science/

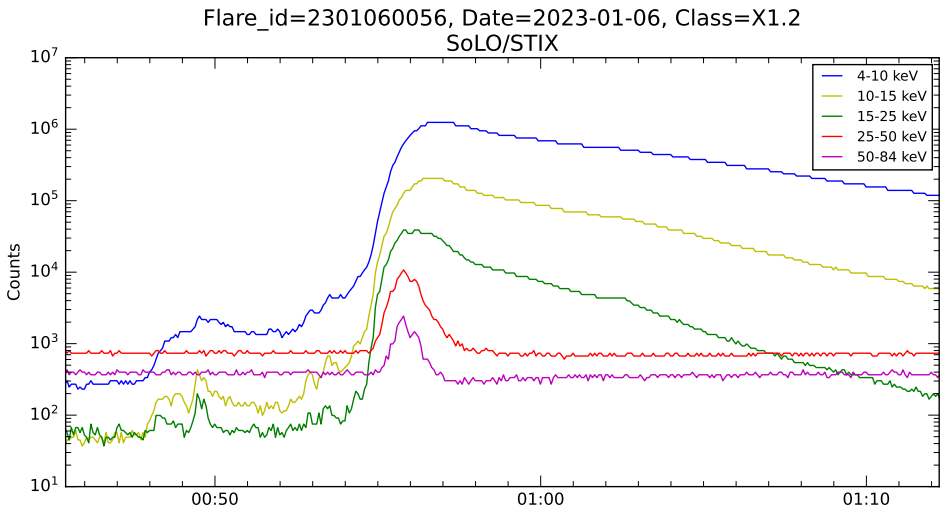
# Search results

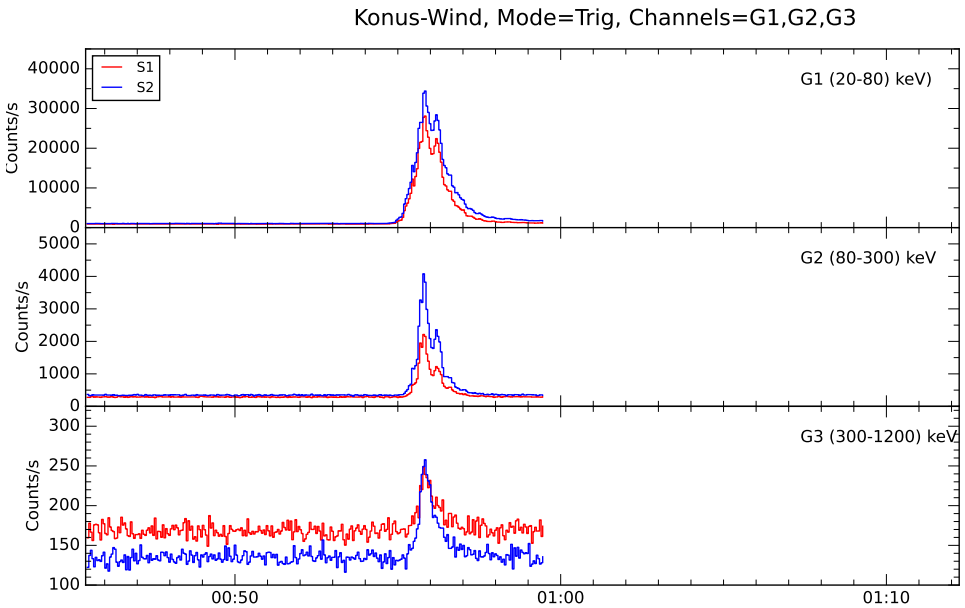


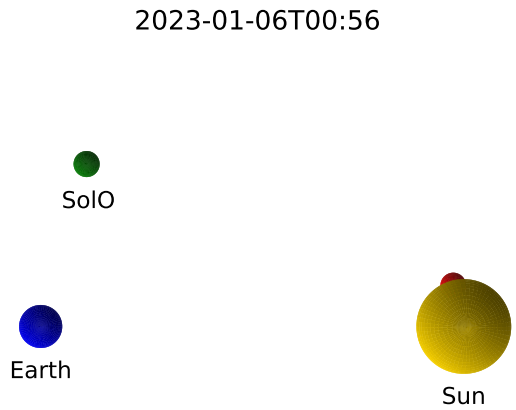




Among 483 jointly observed flares, among them 347 on-disc flares for both Konus-Wind and STIX, 75 flares occulted by solar limb for SolO/STIX, 44 flares occulted for Konus-Wind (and the Earth), 17 flares occulted for both spacecrafts.

# On-disc flare

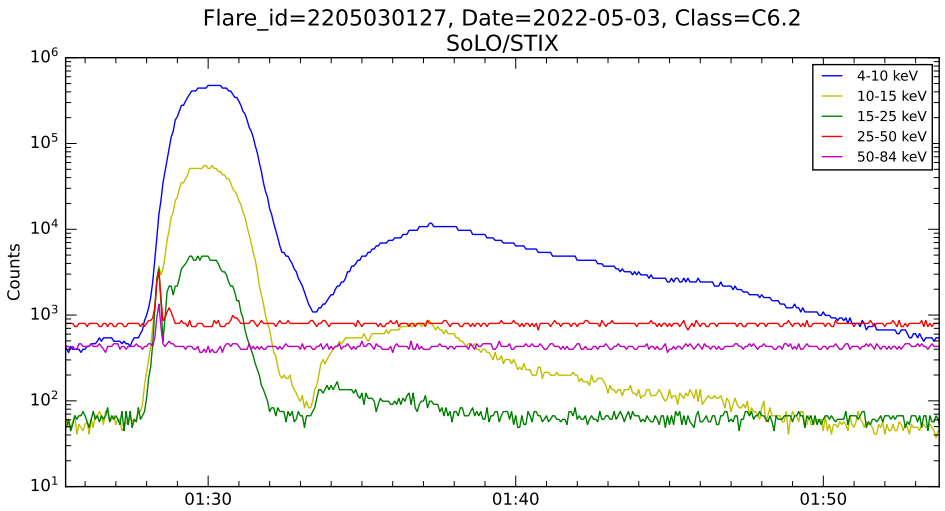


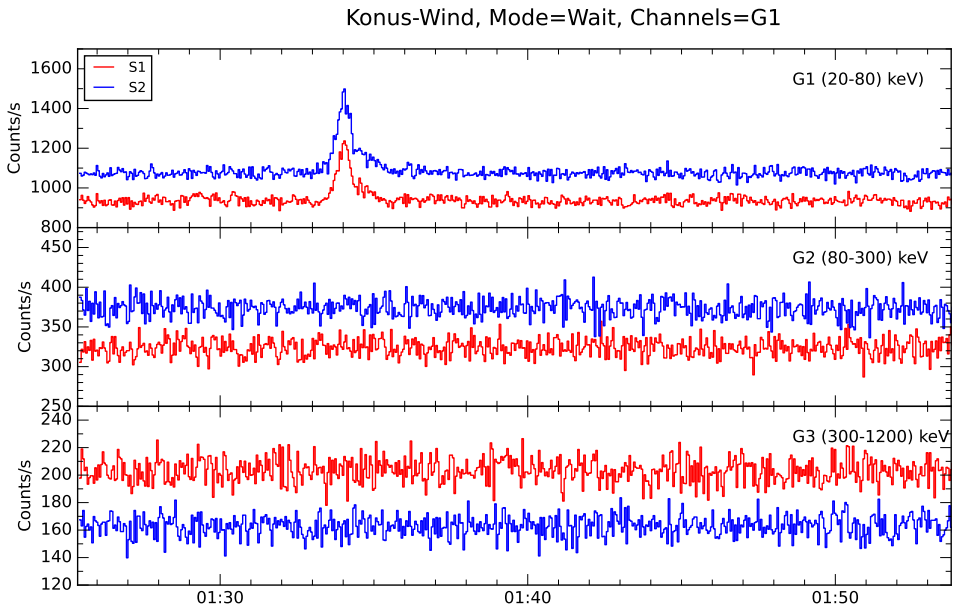



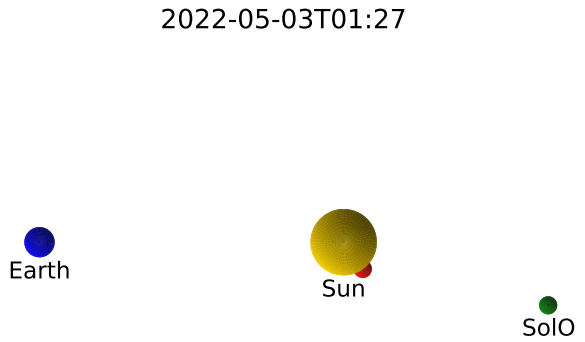




- Konus-Wind observations in the triggered mode (wide energy range, high time resolution).
- Good agreement of time profiles for both instruments.

# Behind-the-limb flare for the Earth

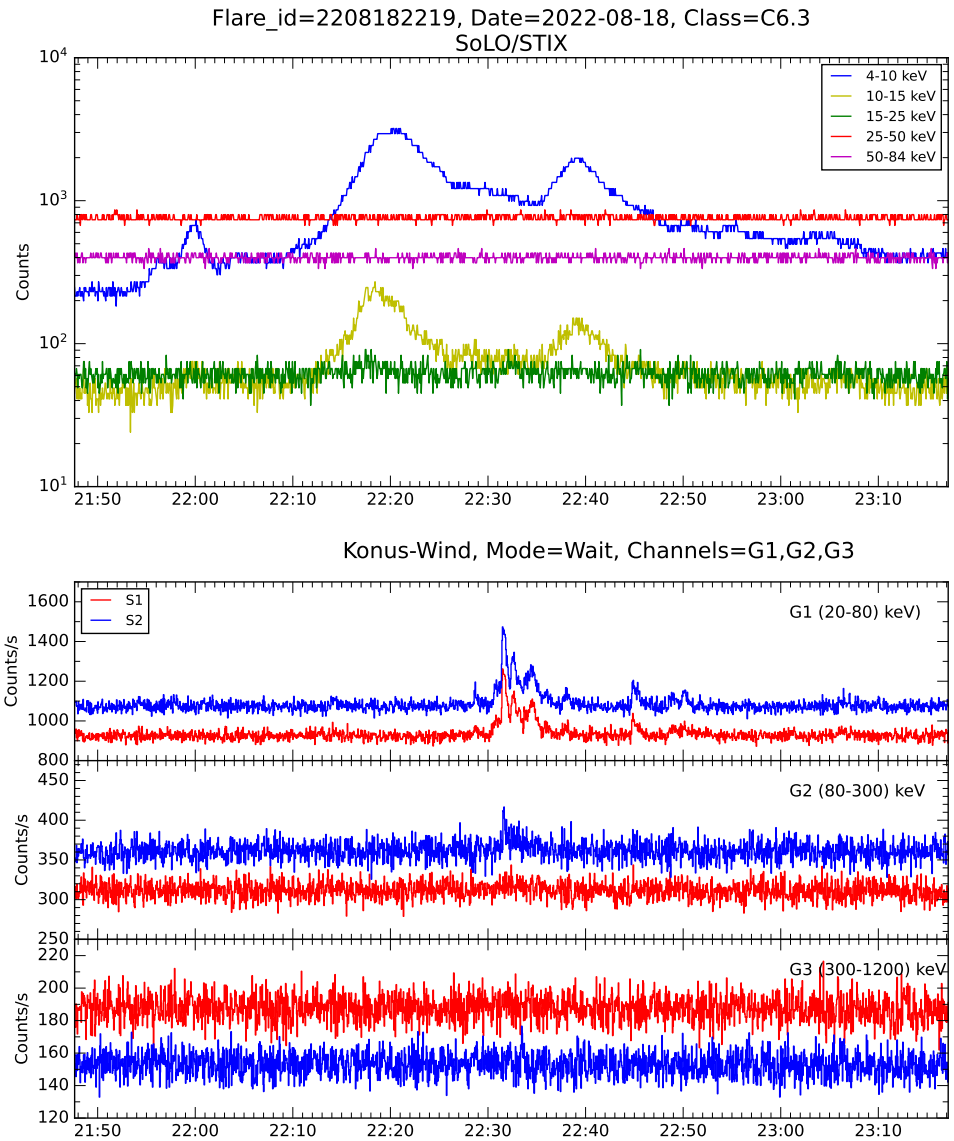


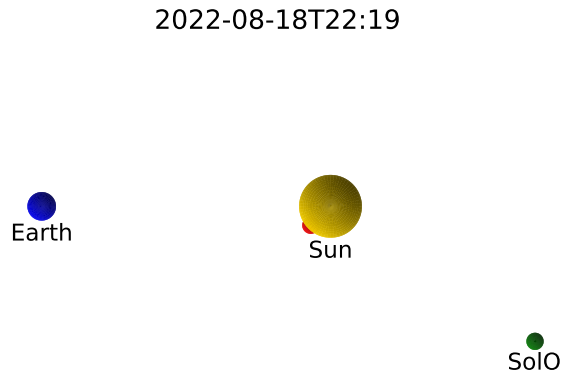




- Flare footpoints were observed by SolO/STIX.
- Coronal emission could be explored by a variety of different instruments (ASO-S, EOVSA...)
- The main role of Konus-Wind is to identify such events.

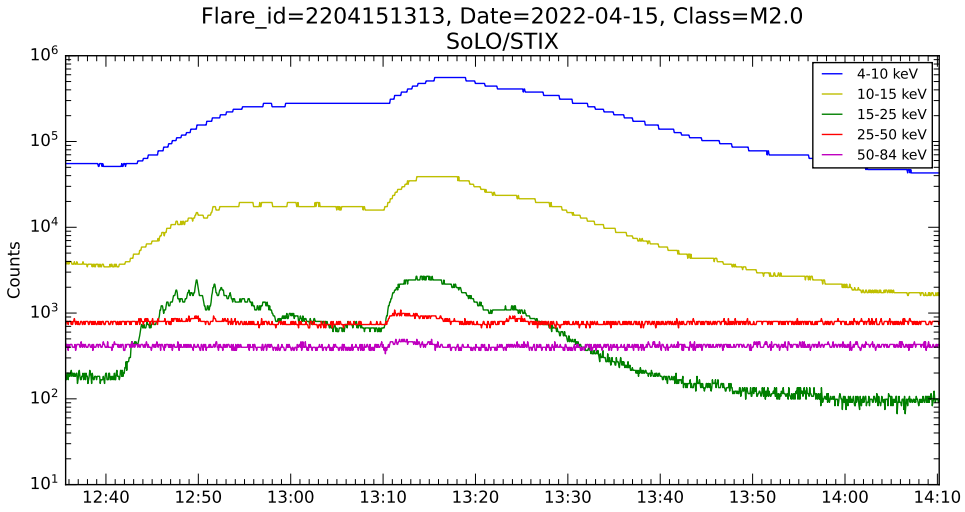
# Occulted for SolO/STIX solar flare

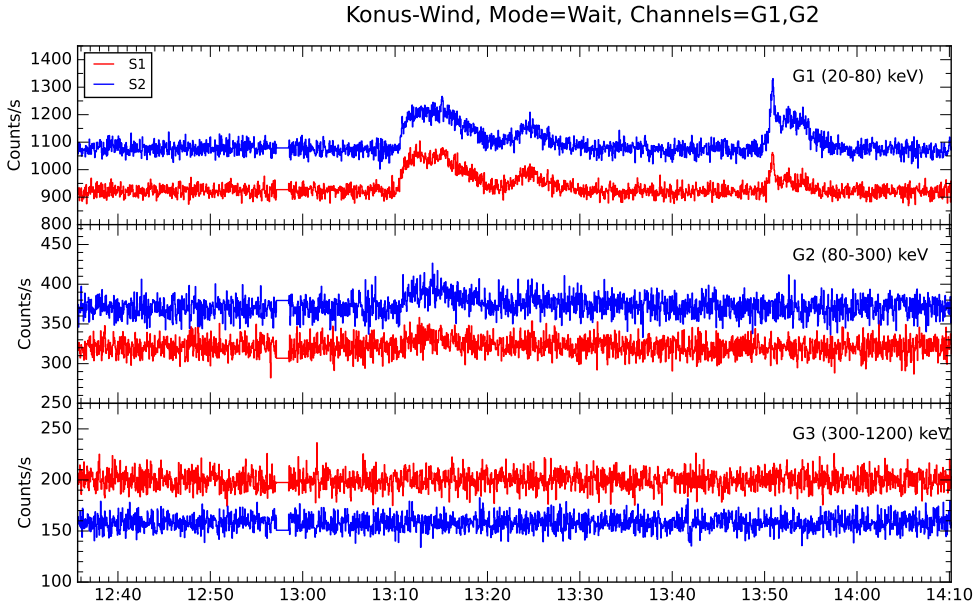



- The study of coronal emission by SolO/STIX.

# Flares occulted for both Earth and SolO/STIX





- The study of coronal emission at different angles.
- Is this valuable?

# Summary

We developed the technique for the search of solar flares jointly observed by Konus-Wind and SolO/STIX. The automated search yielded ∼500 jointly observed flares out of ∼6000 flares with known locations observed by Solo/STIX[2].

Joint observations can be used for:

- The solar flare study in a wide energy range (4 keV – 15 MeV), which covers the emission from thermal plasma and the emission from accelerated electrons and ions.
- Stereoscopic studies of solar flares.
- The automated search for rarely observed behind-the-limb flares.

The preliminary list of joint Konus-Wind and SolO/STIX observations is available online `http://www.ioffe.ru/LEA/kw_stix/`.

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## Thank you for attention

We thank Hualin Xiao and Andrea Francesko Battaglia for the help with SolO/STIX data.

[2] `https://github.com/hayesla/stix_flarelist_science/`

# Konus-Wind calibrations