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Heavy-ion-rich X-ray solar flares in December 2022 measured on Solar Orbiter

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Energy spectra of X-ray solar flares observed by the Spectrometer-Telescope for Imaging X-rays (STIX) onboard the Solar Orbiter consist of both thermal and non-thermal parts. The thermal part is present in all solar events. When the non-thermal part of the energy spectrum begins to dominate, we can expect detection in interplanetary space of high-energy electron beams that have escaped the coronal loops. When hard X-ray flares are detected solar type III radio bursts are registered frequently with their numerous modifications like drift pairs, U-type, and structured bursts. The e-CALLISTO simple worldwide radio antenna stations allow us to identify the existence of non-thermal components in the energy spectra of strong X-ray flares. At the same time, some X-ray flares are accompanied by ejections of energetic ions including heavy ions. The specific features in X-ray bursts responsible for events with simultaneous light and heavy particle stream generation are still unclear compared with those with electron emission only.

We present preliminary results of observations gathered in December 2022 and cross-analysis of data on energetic light and heavy particle fluxes and X-ray flare parameters. The end of 2022 was distinguished by moderate to high solar activity, the presence of three periods with enhanced proton and heavy-ion fluxes at the beginning of the month, in the middle, and on 25-26 December. We demonstrate also the presence of narrow directed electron beams detected by the Electron Proton Telescope (EPT) of EPD for selected events mentioned above, and heavy ions detected by the Suprathermal Ion Spectrograph (SIS) of EPD.