

Solar flares are among the most powerful phenomena in the Solar System. Within just a few minutes, they can release as much energy as billions of hydrogen bombs. These highly dynamic events result from sudden changes in the Sun's magnetic field near sunspots and lead to intense plasma heating to temperatures exceeding 30 million degrees Celsius, as well as to the acceleration of particles to extreme velocities. Yet, despite decades of research, we still do not fully understand how magnetic energy is converted into heat and particle motion.

The goal of this project is to develop a cutting-edge space instrument – BRAXIS (Bragg X-ray Spectrophotometer) – designed for exceptionally precise observations of solar flares. Using innovative technologies, including a novel X-ray Dopplerometer with supporting X-ray imaging, BRAXIS will, for the first time, enable absolute measurements of flow velocities, turbulence, temperature variations, and chemical composition, with sub-second time resolution.

Why is this important? Because previous instruments, though groundbreaking, were unable to detect subtle changes in X-ray spectra with the precision required to uncover key physical processes. These changes carry crucial information about phenomena such as chromospheric evaporation, the presence and properties of shock waves, the efficiency of magnetic reconnection, and coronal heating. Measuring these processes in absolute units is essential to fully understand how energy is transferred and transformed in the solar atmosphere.

The project will combine archival data analysis, plasma numerical simulations, instrument design, and its laboratory testing. Leveraging Poland's extensive experience in X-ray space instrumentation (e.g., RESIK, DIOGENES on Coronas-F, STIX on Solar Orbiter), BRAXIS is set to become a flagship instrument for future solar missions.

Ultimately, the BRAXIS project will significantly advance our understanding of solar flare physics and improve space weather forecasting, critical for satellite and astronaut safety. It will also strengthen Poland's already prominent position in international space science and space instrument construction and contribute to the development of next-generation scientific instruments.