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Assessment of beam tracking strategies for plasma spectrometers

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We have used a plasma spectrometer simulator to study the effectivity of beam tracking strategies for solar wind measurements. The goal of beam tracking strategies is to adapt the energy and angular sampling windows in real time, with the aim to maximize the velocity distribution acquisition rate while maintaining sufficient energy and angular resolution. This study was performed as part of the Phase A study for the Cold Solar Wind (CSW) instrument for the ESA M4 THOR mission candidate.

As test examples we have constructed synthetic high-cadence solar wind velocity distribution time sequences based on moment measurements by the BMSW instrument on Spektr-R (30 ms resolution). For several time periods, we have assessed the quality of various beam tracking approaches: energy tracking, angular tracking, or both, either based on the spectrometer's own data from the previous measurements, or based on data provided by another instrument (e.g. Faraday cup as foreseen on THOR). The conclusion is that beam tracking typically leads to an order of magnitude improvement in data acquisition rate, and that – for the parameters chosen for THOR – the odds of losing the beam are very low. At the same time, we have used the plasma spectrometer simulator to examine how to initialize beam tracking measurements or how to re-initialize the measurements after beam loss. A simple and robust strategy is proposed.

Such beam tracking strategies are useful also for measurements of magnetospheric plasmas. Adapting the energy window can always be beneficial. Adapting the angular window is, however, typically useful only in situations where narrow beams are encountered, e.g. to monitor precipitating or upflowing particles in the auroral regions.