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Simulation of a solar neutron spectrometer for future space missions in the inner heliosphere, from prototype calibrations to flight instrument performances

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The detection of solar fast neutrons in the energy range 1 to 20 MeV, only possible aboard future inner heliospheric missions such as Solar Orbiter and Solar Sentinels, will play a key role in understanding production and acceleration mechanisms of energetic particles generated by the Sun. To carry out such investigations with sufficient statistics and energy resolution a new concept has been studied, developed, and tested at the University of New Hampshire (Durham, NH, USA). The instrument principle relies on the detection of neutron-proton elastic scatters in at least two different detection modules filled with liquid organic scintillator. In the case of double scatters, the measurement of the time of flight, of the recoil proton energy deposits and locations allow to constrain the direction of incidence to an event circle and to determine the total energy of the incident neutron with good resolution. We report here on the simulation efforts performed to analyse the results from prototype calibration tests and to predict the performances of a flight instrument. Results are illustrated for the case of realistic solar flare and mission scenarios.