1 Experiment Summary

We propose to measure parities and the decay behavior of dipole-excited states at energies up to 5 MeV in $^{76}$Se. The experiment is the continuation of a previous experiment (February 2010), in which the dipole excitation strength distribution between 5 MeV and 9 MeV in $^{76}$Se has been scanned. We got important information on the location and strengths of the pygmy resonance from the previous experiments, which yielded parities of dipole excited states, revealed previously unobserved states, and even allowed for the direct observation of decays to lower-lying excited states. With the present proposal we intend to complete the study of the dipole strengths distribution in $^{76}$Se by the measurement of the low-lying strengths. Collective excitations of M1 (scissors mode) and E1 (quadrupole-octupole coupled states) are expected - so far mostly unobserved. In order to disentangle them the parity information to be obtained at HIGS is crucial. Knowledge of the entire collective dipole strength distribution will then allow a detailed comparison, e.g., to QRPA calculations, beyond the focus on the pygmy dipole resonance that we scanned within the previous experiment. The same calculations are used in order to obtain nuclear matrix elements of neutrino-less double-beta decay, therefore a detailed knowledge of the structure of $^{76}$Se is an important test of the model. This is in addition to the nuclear structure aspects, which include the existence and evolution of lower-lying collective dipole excitations in nuclei transitional between spherical and deformed. The new data will perfectly complement previous measurements on $^{76}$Se at HIGS, the TU Darmstadt, and the University of Kentucky.