1 Experiment Summary

We propose to measure the excitation energy difference of the parity-doublet of $1^+ / 1^-$ levels in $^{20}\text{Ne}$ at 11.26 MeV at the High Intensity $\gamma$-Ray Source (HI$\gamma$S). The doublet has been suggested [1] as one of the best known test cases for studying parity violation in atomic nuclei. The single-particle structure of these $T = 1$ dipole excitations is quite simple because they are isobaric analogue states to the structure near the ground state of $^{20}\text{F}$. The parity doublet in $^{20}\text{Ne}$ therefore offers an extraordinary opportunity to test the impact of weak interaction on nuclear structure quantitatively.

Recently, scattering of circularly polarized photons on strongly excited parity-doublets has been proposed as a promising tool for parity violation studies. The feasibility of such an experiment depends on the value of the so called effective nuclear enhancement factor $|R_N/\Delta E|$ which is proportional to the weak interaction matrix element divided by the energy splitting. For the doublet in $^{20}\text{Ne}$ an extremely large enhancement factor of $|R_N/\Delta E| = (670 \pm 7000)$ has been reported [1] making $^{20}\text{Ne}$ to an ideal test case. However, the uncertainty is large and it is thus the intention of the proposed experiment to determine $|R_N/\Delta E|$ with much higher precision. The large error of $|R_N/\Delta E|$ is mainly caused by the uncertainty of $\Delta E$ of the $1^-$ and $1^+$ parity-doublet, which is difficult to determine since the levels are very close to each other. A nuclear resonance fluorescence (NRF) experiment using linearly polarized photons at HI$\gamma$S will allow a much more precise determination of the energies due to the different azimuthal angular distributions of the $0^+ \rightarrow 1^- \rightarrow 0^+$ and $0^+ \rightarrow 1^+ \rightarrow 0^+$ transitions.

We ask for 3 days of beam time at 11.26 MeV and one setting at a nearby energy (see Experiment Description).