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Mass Determination of the Target Asteroids of the LUCY Mission

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The LUCY spacecraft was launched in 2021. The main objective of the NASA mission is to characterize several trojan asteroids. These outer solar system asteroids are located in the Lagrange points L4 and L5 of the Jupiter-Sun system. During its cruise phase Lucy will encounter asteroid (152830) Dinkinesh on November 1st, 2023. However, the flyby distance, as well as the flyby velocity, will be to large for a mass determination at such a small object. The first close flyby will be at (3548) Eurybates in August 2027, followed directly by the flyby at (15094) Polymele in September 2027. Two more flybys in the so-called Greek camp in the L4 point are at (11351) Leucus in April 2028 and at (21900) Orus in November 2028. After orbiting the Sun once more the spacecraft will reach the L5 swarm of asteroids and will flyby at the binary system of (617) Patroclus and Menoetius in March 2033. During these flybys the mass of the target asteroids shall be determined using the Doppler tracking method. Tracking data characteristics obtained from the first two years of the interplanetary cruise phase of the Lucy spacecraft will be considered. Analytic solutions for the error estimation of the mass determination have already shown that the required precision will be met. However, this analytic approach does not take into account several error sources like uncontinuous tracking, uncertainties in the initial spacecraft position and velocity for a flyby, non-gravitational forces, etc.. A numeric orbit determination using simulated Doppler data can provide the most realistic error estimation using all perturbing forces and uncertainties. A detailed consider-covariance analysis of the error of the mass determination for all flybys shall be presented.