Searching for Near Earth Objects from a Venus-like Orbit Roger Linfield[1], Jeffrey vanCleve[2], Harold J. Reitsema[3], and Robert Arentz[4], [1]Ball Aerospace & Technologies Corp. (Ball Aerospace & Technologies Corp., Mail Code RA-4, P.O. Box 1062, Boulder, CO 80306; rlinfiel@ball.com), [2]Ball Aerospace & Technologies Corp (jvanclev@ball.com), [3]Ball Aerospace & Technologies Corp (hreitsema@ball.com), [4]Ball Aerospace & Technologies Corp (rarentz@ball.com)

Ground-based surveys are making good progress towards the goal of cataloguing 90% of all Near Earth Objects (NEOs) with diameter >1 km. Extending the catalogue to substantially smaller objects will be challenging from the ground. Space-based telescopes can greatly accelerate the search for small NEOs, especially by observing in the thermal IR (10 micron band).

We have developed an observing model for a space-based survey, using actual engineering designs for the spacecraft, telescope, and detectors, and realistic representations of noise sources and observing cadences. Combining this model with current best estimates for the NEO orbit, size, and albedo distributions allows for our full simulation to determine the completeness level of a survey. Our spacecraft orbit, in the ecliptic plane and with perihelion and aphelion of 0.60 and 0.80 A.U., can be achieved by means of a passive, gravity-assisted Venus flyby, with no propulsive maneuvers after leaving Earth orbit.

The telescope diameters in our designs were 1.1 m for the visible option and 0.5 m for the IR option. We estimate that these two will have comparable costs. The IR option, while smaller, has the added complexity of active cooling to 70 K for the optics and 40 K for the detector. The visible telescope, while larger, operates at room temperature. It is a modified Cassegrain design with three corrector lenses, yielding a 7 square degree usable field of view. The IR telescope is a three mirror off-axis (i.e. clear aperture) combination, yielding an 11 square degree field of view.

Our simulations show that a seven year observing program would yield 87% completeness (IR telescope) or 70% completeness (visible telescope) for NEOs larger than 140 m diameter. IR observations outperform visible observations for several reasons. First, most of the energy from NEOs is in the IR band (15 – 20 times more for the low albedo objects). Second, since there are more photons per joule in the IR, shot noise averaging and background subtraction gives a higher SNR. Third, the fact that NEOs are viewed in emission in the IR, vs. reflection in the visible, makes the phase function much more favorable in the IR.

Using larger telescopes improves the completeness only mildly, because of a phasing problem. The NEOs with the longest orbital periods (4 – 8 years) spend almost all their time far from the sun, where they are quite faint in both IR and visible bands when observed from Earth or Venus orbit. These NEOs only pass perihelion once during an observing program of ~7 years. If this passage happens when the spacecraft is on the other side of the sun, the NEO will be outside the telescope field of regard and not accessible. Attaining substantially better completeness requires a second telescope in a different orbital location, either in the same orbit but ~180 degrees away (an anti-correlated location), or else on the Earth (an uncorrelated location).

With two 0.5 m diameter IR telescopes 180 degrees apart in the 0.60 × 0.80 A.U. orbit, we can get 99% completeness in seven years for >140 m diameter NEOs. With one 0.5 m diameter IR telescope in this orbit plus a 1.8 m diameter visible telescope on Earth (for example, Pan-STARRS 1), we can get 93% completeness on >140 m objects.

With these two telescope combinations, we can achieve reasonable completeness on substantially smaller objects. For NEOs with diameter >60 m and the same seven year observing program, we can achieve 81% completeness with our twin telescopes in space, and 69% completeness with the combination of space IR and visible ground telescope.