THE LUNAR EXPLORER SATELLITE MISSION. M. R. Inggs[1] and K. Gema[1], [1]Dragonfly Aerospace, 1Harwell Innovation Centre, Curie Avenue, Didcot, OX11 0QG, United Kingdom. MikeInggs@dragonflyaerospace.com

Introduction: Although the Lunar surface is well mapped, the available resolution is inadequate for landing site selection i.e. small obstacle avoidance. In addition, the Moon is a convenient optical target for the calibration of Earth Observation cameras, if the detailed albedo could be modelled, based on high resolution topographic maps. In addition, we need knowledge of the surface composition for this calibration. Dragonfly Aerospace has had a focus on low cost, small buses (below 250 kg), as well as a range of multispectral cameras. More recently designs and prototypes of L, C and X Band SAR sensors are at various stages of development, but not yet in Space. The lack of high resolution DEMs of the Moon, needed for the upcoming Lunar missions, inspired plans for a Lunar Explorer mission. Rideshare opportunities seem available, meaning a reduced cost of investment in the Lunar mission. The system proposed aims at sub 3 m posting DEMs at X Band, as well as pan / hyperspectral photography. We are partnering with Oxford Space Systems for a furlable, 3 m antenna, with low mass. This antenna is used for SAR imaging.

Mission and Timescales: We intend to map the entire surface of the moon with all sensors (see following sections). The mission will be launched in 2024 and the primary mission will be completed in 2025, 100km circular polar orbit i.e. Low Lunar Orbit (LLO).This will take 412 days. This includes imaging the entire surface twice to achieve DEM with the SAR. The spacecraft will be designed for 5 year lifetime and there will be repeat imaging after the 412 day primary mission is complete.

Other modes of the radar that will be implemented for sub-surface characterisation e.g. looking at the nadir, or, ahead / behind track for total internal refraction measurements.

Overall Concept: The bus is currently being deployed for launch in 2022 with two cameras, for an EO mission. The same bus design will be utilised for the SAR / optical Lunar mission described here, as shown in Figure 1. The large reflector and single horn will be used for imaging. The bus includes a large solid state memory, and high peak power supply for the radar sensor. Momentum wheels allow for point of optical and radar sensors, and direct X Band downlinking to Earth (1 GB/s).

Radar Sensor: A Quad polarisation X Band sensor shares a feed horn with the data downlink (not simultaneously). Although the reflector is 3m in diameter, the under-illumination of the reflector to achieve excellent sidelobe levels will allow for 1.5 m image pixels after downlinking and post processing. Swath width will be about 10 km in stripmap mode, and the momentum wheels allow for a wide range of incidence angles, as well as geophysical (Ground Penetration) modes.

Figure 1: Bus with wrapped rib reflector.

Cameras: The cameras chosen provide very high resolution optical, medium resolution hyperspectral in in visible spectrum, medium resolution short wave infrared (SWIR).i.e.

- High Resolution: 0.28m PAN / 0.56m MS, 4km swath,
- Hyperspectral: 4m, 148 bands, 4 km Swath

The cameras come from a heritage of space hardware over many years. Choice of bands is flexible to accommodate users.

Funding Model: If the journey to the moon is covered with a rideshare agreement, then the relatively low cost of the satellite and sensors can be funded as a public / private partnership. Ideally, Agencies and commercial sponsors would pay for access to the data that would then be available to the Commercial sponsors, as well as the Science Community more generally. A Slack group is being set up so that members of the Science Community and Lunar Lander contractors can contribute to fine-tuning of sensor parameters.

Conclusions: We have briefly described a Lunar Explorer mission to provide important, high resolution, DEM and surface properties information ahead of the upcoming Lunar Lander missions. Wider collaboration with sponsors and the Science Community are important, in the spirit of modern, public / private relationships.