USING HYDROCODE MODELLING TO TRACK EJECTA FROM OBLIQUE HYPERVELOCITY IMPACTS ONTO GLASS. M. C. Price[1,2] and M. J. Burchell[1]. [1]School of Physical Sciences, University of Kent, Canterbury, Kent, CT2 7NH, UK ([2]mcp2@star.kent.ac.uk).

Introduction: The *Stardust* dust collector [1] carried aluminium foils which have provided a wealth of data regarding the composition of particles from comet Wild-2 [2, 3, 4]. Identification of possible interstellar and/or interplanetary dust particle impacts on the foils located on the interstellar side of the collector have recently been published [5, 6, 7], but the analysis is complicated due to possible contaminating secondary impacts from the solar cell cover glass.

In order to help investigate possible means of distinguishing between secondary (i.e. target ejecta from the spacecraft) and primary sources (fragments of interstellar/inter planetary dust particles) we carried out hydrocode modelling of oblique impacts of glass spheres onto glass and tracked the subsequent ejecta. The preliminary results of this modelling are presented here for an impact speed of 6.1 km s^{-1}.

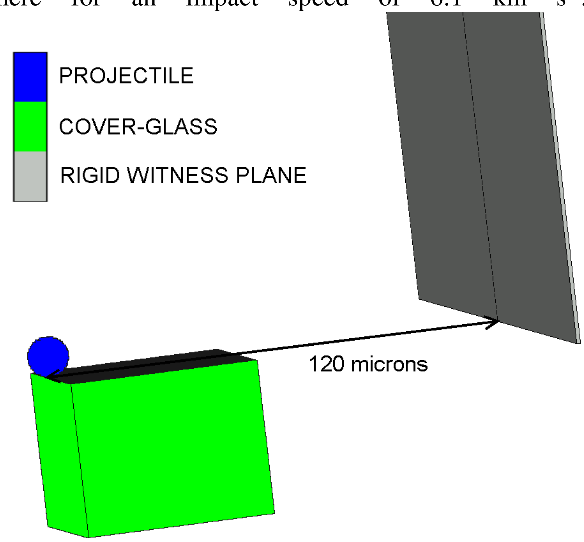

Fig 1: Diagram showing the geometry of the model. The grey plane acts as a rigid witness plate.

Modelling methodology: We used *Ansys'* AUTODYN (version 13) hydrocode [8] to perform the modelling and, in order to track both target and projectile fragments, the model was constructed using over 500,000 SPH particles. Both projectile and target were modelled as 'float glass' using a strength model and equation-of-state described in full in [9] and [10]. A user subroutine was written to stop the particles at a fixed distance (120 microns) downrange of the impact point. This defines a rigid plane (referred to as the witness plane) which enables the ejecta pattern to be examined. Fig. 1 shows the geometry of the model. The grey plane is the witness plane and all results are shown looking face-on to this plane. The projectile is modelled as a ten micrometre diameter sphere.

Results: Figures 2 i), ii), iii) and 3 i), ii), iii) (on the next page) show the outcomes of the simulations. The diagrams show the ejecta patterns of the target (right panel) and the projectile fragments (left panel) at three impact angles: 5°, 15° and 25° respectively (where 90° would be perpendicular to the target's surface). The numbers on the axes are in micrometres and are distances from the impact point. The colour bar represents the velocity (in km s^{-1}) at the time the particle crossed the witness plane, and thus indicates the impact velocity. Note the difference in size scales between Fig. 2) i), 2) ii) and 2) iii) and similarly for Fig. 3.

Discussion: These results indicate that the areal distribution of target particles overlaps significantly with that of the projectile fragments. So it is not possible to separate projectile fragments and target ejecta based solely on geometric location. However, the modelling does indicate that secondary ejecta from the target is travelling at a velocity a factor of (approximately) five less than the projectile material and this may be a possible way of identifying impactors because crater morphology changes as a function of impact speed and projectile size [11, 12]. It is acknowledged that the material models currently do not include the effects of melting or particle coalescence which may affect the outcome of the simulations. Thus it is not clear to what degree in reality projectile and target materials will be separate when they cross the witness plane.

Conclusions and ongoing work: Hydrocode modelling may be a useful tool in helping to constrain the origin of the impactor craters found on the *Stardust* interstellar collector and further modelling is ongoing investigate a wider range of impact speeds and impact angles. Results from experimental work looking at secondary ejecta from solar cell cover glass are about to be published [13] and further experiments are ongoing at the Univ. of Kent that will assist in the ISPE and help in validating the models presented here.

References: [1] Brownlee D. E. et al. (2006). *Science,* 314, 1711. [2] Kearsley A. T. et al. (2008). *MAPS,* 43, 41. [3] Leroux H. et al. (2008). *MAPS,* 43, 143. [4] Price M. C. et al. (2011). *MAPS,* 45, 1409. [5] Stroud R. M et al. (2012). *LPSC XXXXIII,* these proceedings. [6] Westphal A. J. et al. (2011) *LPSC XXXXII,* Abstract #2083. [7]. Stroud R.M. et al. (2011) *74th MetSoc* Abstract #5118. [8] Hayhurst C. J. & Clegg R. A. (1997). *IJIE*, 20, 1. [9] Richards M. et al. (1999). *Proc. 18th Int. Sym. on Ballistics,* paper #89. [10]. Price M. C. et al. (2012). *MAPS,* DOI: 10.1111/j.1945-5100.2011.01300.x. [11] Kearsley A. T. et al. (2007). *MAPS,* 42, 191. [12] Kearsley A. T. et al. (2006). *MAPS,* 41, 167. [13] Burchell et al. (2012). *MAPS,* DOI: 10.1111/j.1945-5100.2011.01294.x.

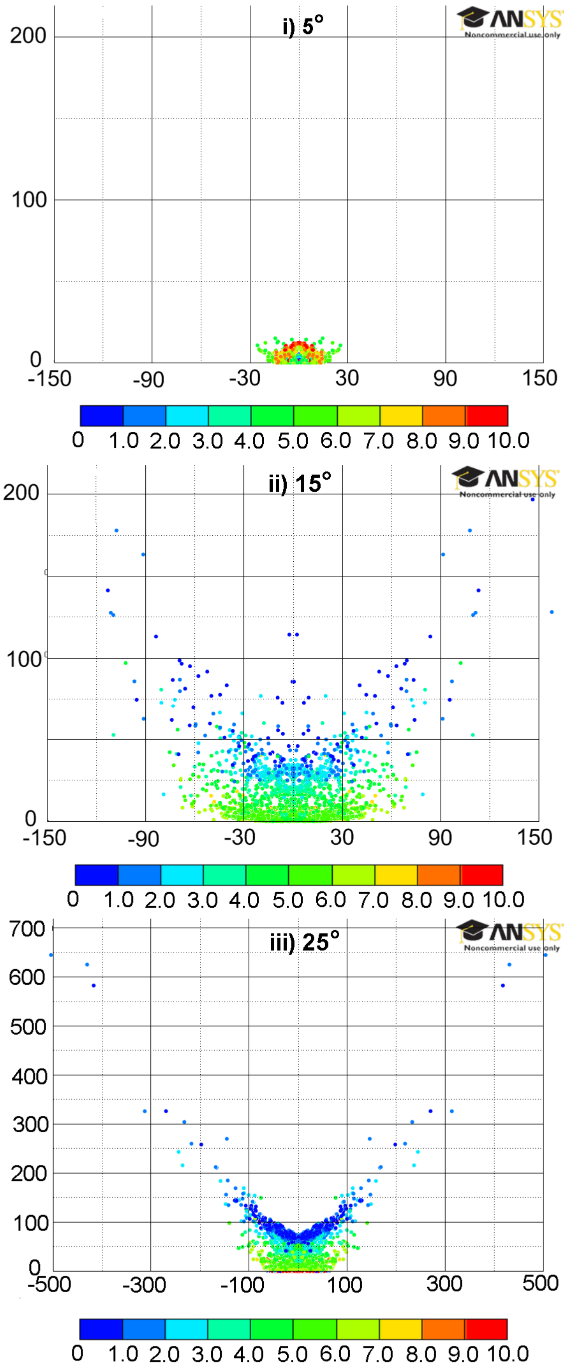

Fig. 2: Spatial distribution of projectile fragments on a witness plane 120 micrometres from the projectile impact point for an impact angle of **i)** 5°, **ii)** 15°, **iii)** 25°. Numbers on the axes are perpendicular distances (in micrometres) from the impact point. Colours correspond to absolute velocities at the witness plane position in km s^{-1}.

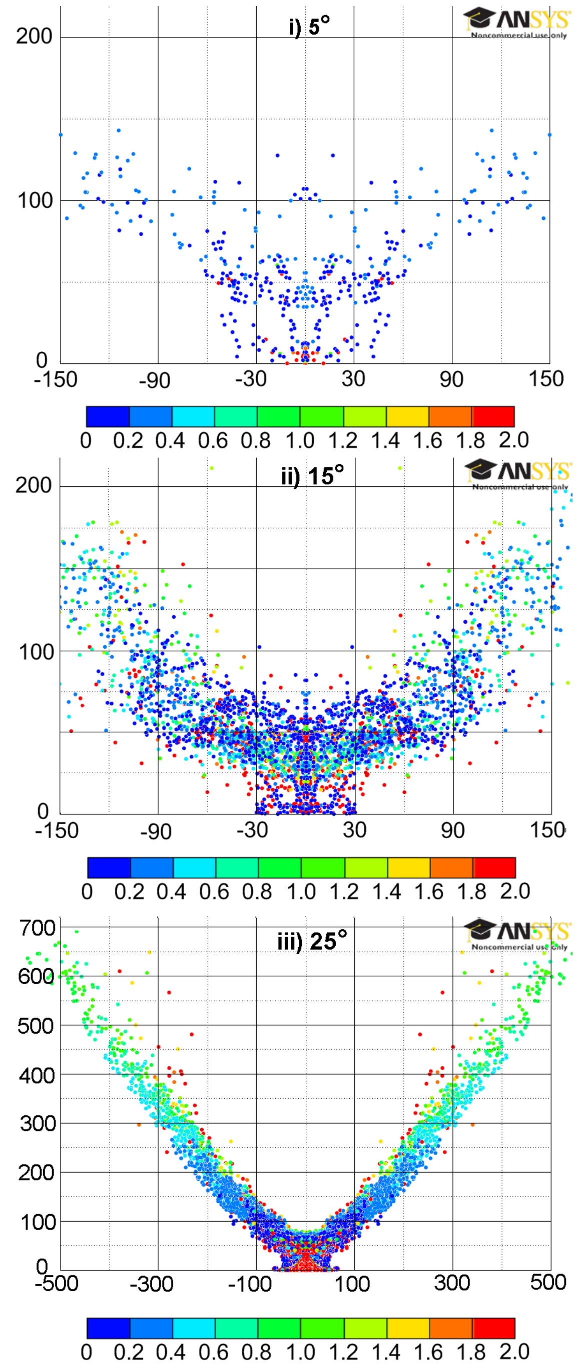

Fig. 3: Spatial distribution of target fragments on a witness plane 120 micrometres from the projectile impact point for an impact angle of **i)** 5°, **ii)** 15°, **iii)** 25°. Numbers on the axes are perpendicular distances (in micrometres) from the impact point. Colours correspond to absolute velocities at the witness plane position in km s^{-1}.