STARDUST's Comet Wild 2 and Contemporary Interstellar Stream Sample Status.

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Introduction: STARDUST, NASA's 4th Discovery Mission, has the primary objective of collecting and returning to Earth coma samples from 81P/Wild 2 and the secondary objective of collecting dust samples from the contemporary interstellar stream [1]. The spacecraft was launched on February 7, 1999 and encountered comet Wild 2 on January 2, 2004 with the closest approach at 19:21:32 UTC and a closest approach distance of 236.4 ± 1 km [2]. STARDUST's Sample Return Capsule, containing the collected dust samples, is to be released from the spacecraft on January 14, 2006, at 5:57 UTC or 10:57 PM MST and will enter the atmosphere 4 hrs later for a direct landing. The peak heating of the capsule's ablative shield will occur in 0.9 minutes after entering the upper atmosphere. The drogue chute will be deployed 1.3 minutes later, and the capsule will land in the Utah Test and Training Range in 12.4 more minutes or at 3:09.4 AM MST.

Wild 2 Samples: After 5 years of space flight and in its third and final orbit around the Sun, STARDUST spacecraft reached a position that allowed it to be overtaken by Wild 2 at a relative encounter speed of 6.12 km/s. This extraordinary orbit design gives STARDUST an extremely low cometary encounter speed which enabled a significant decrease in the peak shock stress upon impact to preserve higher degree of intact capture. Although the sample collection subsystem did not indicate the number of samples captured in situ, four other in situ investigations were in operation during the flyby: the Comet and Interstellar Dust Analyzer (CIDA) [3], the Dust Flux Monitor Instrument (DFMI) [4], the Navigation Camera (NavCam) [5] and two-way Doppler and spacecraft attitude control system as Dynamic Science [6]. These in situ instruments and preflight dust modeling prediction of the number of Wild 2 dust samples have been reported [7].

The CIDA's instrument event rate data [8] in Figure 1 indicates significant dust impacts began at 487 s before and ended 712 s after the closest Wild 2 encounter (aside for small events at 5766 s before and 7570 s after the closest encounter). The dust collection had duration of almost 20 minutes with a central peak of almost 7 minutes. The DFMI instrument, however, indicated somewhat different dust event timings and fluxes [9]. There were seven distinct peaks of dust events as shown in Figure 2. The predominate number of dust events took place after the closest Wild 2 encounter beginning at 63 s

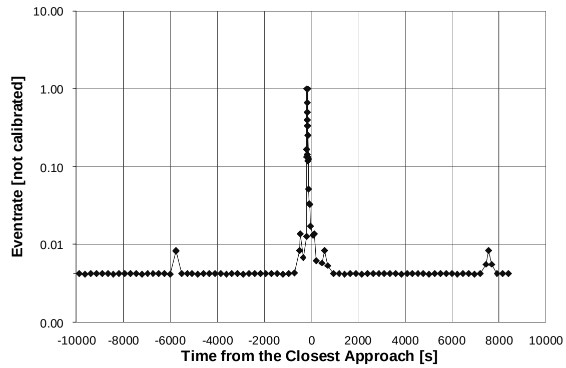

Figure 1. CIDA Dust Event Rate Data at the Closest Wild 2 Encounter

before and ending at 718 s after the closest approach. Only the first clusters coincided with CIDA. The durations of the dust events were: 20 s, 15 s, 26 s, 23 s, 10 s, 31 s and 19 s respectively with total dust collection duration of about 2.4 minutes.

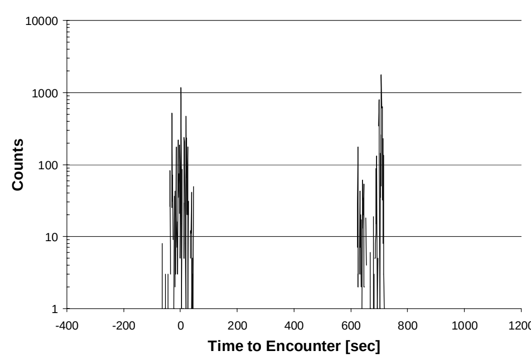

Figure 2. DFMI In Situ Data at the Closest Wild 2 Encounter

The NavCam showed that dust-jets emanated nearly around the entire perimeter of the Wild 2 nucleus, which indicated that it was very active during the encounter but the camera provided no quantitative dust timing information. Because the two-way Doppler tracking was orthogonal to the spacecraft trajectory, no spacecraft deceleration due to dust impacts could be observed.

The CIDA and DFMI instruments provided somewhat different dust event times and dust durations as well as significantly different dust counts [8, 9]. It seems the final ground truths of these in situ instruments may rest in the sample collector.

STARDUST Samples: The STARDUST sample capture media consist of silica aerogel and soft aluminum foil contained in two aluminum trays mounted back-to-back. Each tray contains 132 variable density silica aerogel cells with a total 1039 cm^2 surface area on the Wild 2 side and 1037 cm^2 surface area on the interstellar side [10]. There are also 296 exposed aluminum foils totaling 153 cm^2 on each tray. The dynamic range of capture size of aerogel capture cells ranges from a few microns to about 100 microns. The foils, on the other hand, will be better suited for much smaller particles, ranging in size from microns to submicrons in size.

Preliminary Examination: The goals of the Preliminary Examination (PE) are 1) Making a comparison of STARDUST returned samples with other extraterrestrial materials – for example, how is Wild 2 dust similar and dissimilar to other meteoritic materials? 2) Determining the abundance of interstellar material in Wild 2 samples, using H, N, or O isotopic signatures; 3) Evaluation of the capture process - how were the samples altered by the collection process? 4) Conduct an inclusive and speedy sample distribution PE – we have opened the STARDUST PE to the world's sample analysis community and plan for a quick sample distribution after sample landing.

To accomplish these goals, the STARDUST PE is organized into three tasks: 1) Retrieval (landing support, capture media removal and sample preparation), 2) Documentation (Level 1 – 4 documentations, sample inventory) and 3) Analysis (optical, bulk composition, mineralogy-petrology, isotopes, organics and foil cratering). The PE on Wild 2 samples begins on January 15, 2006, and all analyses on these samples will end on July 15, 2006. All of the Wild 2 PE publications are to be completed in September 2006.

To implement the last goal, an open solicitation of qualified analysts outside of the STARDUST Co-Is was made in 2004. There are about 120 groups of analysts from several continents involved. A fast and sequential approach in sample processing strategy has been adapted, which will make some samples available for distribution within two weeks after the Sample Return Capsule landing.

Sample Processing: The PE of the STARDUST samples will begin after the delivery of the Sample Canister to the STARDUST cleanroom located in Building 31 of Johnson Space Center on January 17, 2006. As the Sample Tray Assembly is removed from the Sample Canister, thorough photo documentation will be made for both sides of the Tray Assembly (Level 1 Documentation). After the separation of the Wild 2 and interstellar sample trays, detailed mosaic views of each of the aerogel cells and the surrounding aluminum foil will be documented (Level 2). Based on these images, the first cycle of cells and foils to be removed will be identified. The removed cells will be scanned from the sides (Level 3), which will give the best view of the capture tracks. Then the removed foils will be distributed to the foil/cratering analysis subteam. Based on the Level 3 cell documentation the detailed cell slicing plan will be determined. After optical examination (Level 4 documentation), the slices are assigned for various subsequent sample preparations: pressing particles in metallic foils, microtome slides, keystones or removing smaller grains by a Focus Ion Beam instrument.

The Wild 2 PE will be completed in six months. The interstellar samples are expected to be much smaller in size and much fewer in numbers and because the techniques to identify, remove and analyze them are yet not fully developed, the interstellar PE will be completed the following year after the Wild 2 samples.

Summary: Since the STARDUST Sample Return Capsule has not yet returned with the Wild 2 and interstellar samples to Earth, the sample status—including the number of samples, condition of the samples and their tracks—will be presented to the Lunar and Planetary Science Conference in March 2006. At that time, we anticipate that a preliminary results of the Preliminary Examination for the Wild 2 samples will be available.

References: [1] Brownlee et al., *JGR* (2003), [2] Tsou et al. *JGR* (2004), [3] Kissel J., et al., *JGR* (2003), [4] Newburn R. et al, *JGR* (2003), [5] Tuzzolino et al., *JGR* (2003), [6] Anderson J. et al. JGR (2004), [7] Tsou et al. *LPSC XXXVIII (2004),* [8] Kissel et al., *Science* (2004), [9] Tuzzolino A., et al., *Science* (2004), [10] Tsou P, et al. *JGR* (2004).