ESRF	**Experiment title:** In-situ analysis of extraterrestrial particles by X-ray microfluorescence	**Experiment number:** CH547
Beamline: ID22	**Date of experiment:** from: 25 November 98 to: 1 December 98	**Date of report:** 24/02/99
Shifts: 18	**Local contact(s):** Alexandre SIMIONOVICI	*Received at ESRF:* 01 MAR. 1999

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We used the ID22 line to analyse in-situ grains trapped inside low density polymer foam collectors, exposed outside the MIR station for nearly one year (PIE experiment). The goals of these analyses were to : i) locate the grains, that are mainly in the micron size range, inside the collectors ; ii) discriminate between orbital debris (o.d.) and particles of extraterrestrial origin (p.e.) ; iii) more specifically study this last population of grains (p.e.) in terms of size, trajectory, velocity and elemental composition. Such an investigation is a high priority in interplanetary dust research as these grains, originating either from asteroïdal or cometary parent bodies, contain information on the first stages or the evolution of the Solar System.

During our 18 shifts, we analysed 7 foam samples from the PIE mission (size of each sample : 20x25x13 mm^3). For each sample, the procedure was the following : a 2D (vertical and horizontal) mapping of the foam was performed, using a large monochromatic beam (100 to 200 µm in size, at 15 keV), that allowed us to give the positions of the trapped grains, as well as their main elemental composition. In order to better locate the grains, we then mapped the selected regions with a much smaller beam (microbeams of 10 - 20 µm) and procceeded to a more precise identification of the position and the elementary composition of the grains. The use of a microlens could then give a higher spatial resolution.

Results

The number of trapped grains varies from 3 to 9 in each of the seven samples studied, most of them being o.d. : 41 o.d. and 5 potential p.e., in a total exposed surface of 35 cm^2. The fluence of incident o.d. is much higher than expected, indicating that the space station may have crossed an important o.d. cloud, rich in Fe, Cr and Ni. We also identified Br, Cu, Pb and Zn as debris signatures. Finally, some of the identified grains contained only Au and Ni, signatures of the crossing of the impacting grains through the 100nm film covering our samples. Such signatures could be linked to Al rich grains, known to be abundant in o.d. populations and not detectable here. The o.d. are found at all depths between 2 mm and 11 mm (the detection limit), linked to the velocities of the impacting grains. In two cases, the incident grains broke inside the foam sample in two parts, that stopped at different depths.

The proportion of p.e. is in agreement with what is expected after one year of exposure. We identify them as extraterrestrial particles, on the basis of their composition : Fe, Ca, Ti, Ni, Cr, Cu and Zn, in proportions compatible with meteoritical equivalents. Si and Mg were identified in only one grain, best candidate to be of extraterrestrial origin; this was made possible by changing the incident energy to 10 keV. The p.e. candidates are all found at depths larger than 7 mm, consistent with a mean velocity higher than for o.d. We observed the p.e. candidates with a microbeam (around 2 to 5 µm), in order to map the distribution of elements inside the grains. In three cases, the p.e. grain was shown to be an aggregate constituted of µm sized particles, compatible with the structure of an interplanetary dust particle. This result shows that it will be extremely difficult to extract such aggregates from a low density matrix.

Conclusions

In our next run, by using a FZP lens of large acceptance, mappings by steps of 1,5 by 5 microns could be performed, with a flux up to three times higher than previously. We should then more concentrate on one p.e., when it is found, and show that it is possible to give its morphology (microcamera), its elementary composition, down to trace elements (microfluorescence) as well as the chemical bound for the main elements (XANES) and maybe its mineralogical caracterisation (micro diffraction).

These results have major implications concerning the extraterrestrial dust collection techniques and the possibility to analyse extraterrestrial grains trapped in a low density matrix ; in particular, they show that ESRF microbeams will play an important role in the future analyses, as they are likely to provide an essential tool for a high resolution, non destructive, in-situ analysis. This kind of analysis will, for instance, be needed for the investigation of the low density aerogel collectors of the STARDUST mission : STARDUST, that was successfully launched on the 4th of February 1999 by NASA, will bring back, in 2006, cometary grains of the comet Wild 2, trapped in aerogel.

This work will be submitted to Meteoritics and Planetary Science.