ESRF	**Experiment title:** **Investigation of Soot Particle Aggregation using Small Angle X-Ray Scattering**	**Experiment number**: SC-1540
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Shifts: 12	**Local contact(s)**: Dr. Thomas WEISS Dr. Pierre PANINE	

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In this experiment, SAXS measurements were performed on a stabilised ethylene-air diffusion flame in order to map out the distribution of particles sizes throughout the flame and to gain insight into the mechanisms for soot particle formation. A 12.46 keV, 100 µm diameter x-ray beam was used to interrogate the flame. The burner was mounted on a movable stand that allowed it to be displaced both vertically and horizontally so as to obtain a mapping of the flame. The ID02 beamline was used for these studies and measurements were made for sample to detector distances of 1.5, 5 and 10 m respectively. Data were collected along the flame centreline over heights above the burner (HAB) of between 1 and 40 mm although due to low soot concentrations in the early flame, reliable data were only obtained above 3 mm. Measurements were also taken of scattering in air and these were subtracted from the flame measurements in order to determine the scattering from the soot alone. Typical exposure times were 1 second per measurement.

The Gnom package has been used in order to obtain an inversion of the data and examples of the particle size distribution at heights above the burner of 10 and18 are shown in figures 1a,b.

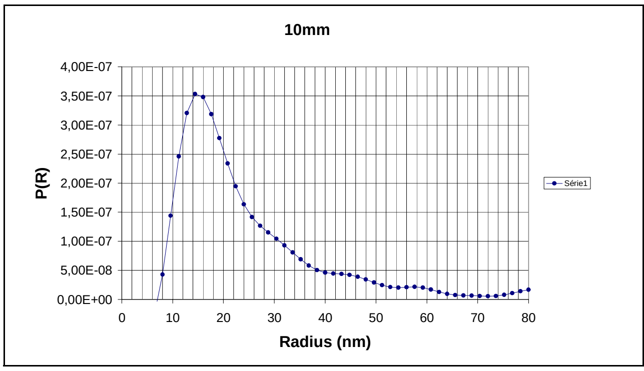

Figure 1a

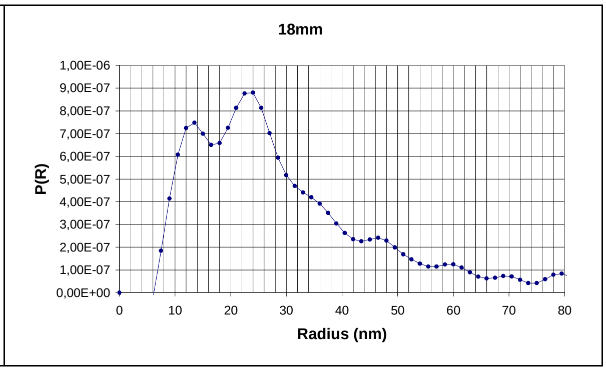

Figure 1b

It is found that there is a double peaked distribution such as that shown in figure 2b that occurs between 15 and 20 mm height above the burner. Figure 2 shows a plot of mean particle radius as a function of residence time in the flame and it can be seen that there is a rapid rise in particle radius between 20 and 30 ms (corresponding to a HAB of 10-15 mm) followed by an equally rapid decrease between 30 and 35 ms (corresponding to HAB of 15-20 mm). Also shown on the diagram are data taken using electron microscopic analysis of extracted samples (solid triangles) [1] and using Laser Induced Incandescence (solid squares) [2] where soot particles are heated in-situ with a laser and the resulting light emission detected. Both of these methods are invasive and though the general trend is similar beyond 40 ms, neither shown the rapid growth and decay of the particle radius, seen in the SAXS measurement. This could suggest that there is an inflation of the particles due to aggregation followed by a collapse to a more compact structure. The fragility of the particles during this phase would render this invisible to the invasive techniques. The overall form of the curve reflects the changing form of the soot particles due to growth and agglomeration, dehydrogenation and oxidative attack.

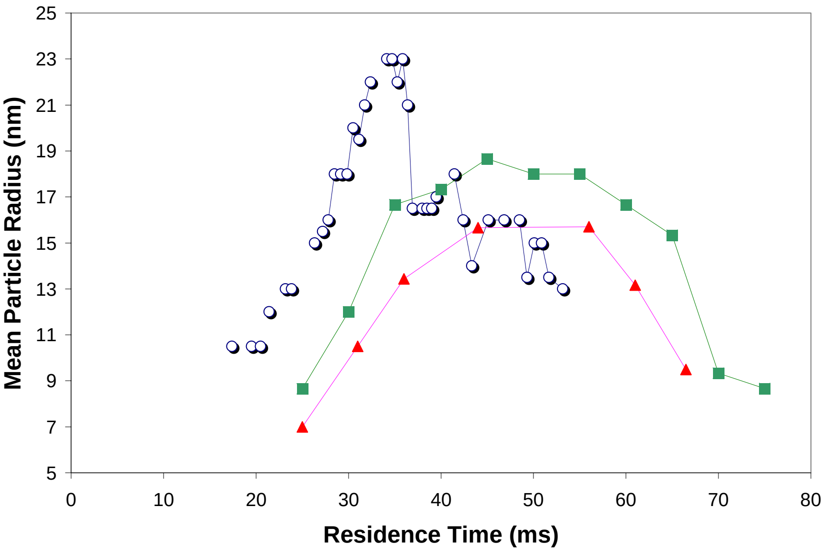

Figure 2

This work is currently being prepared for publication [3]. Future studies will investigate this process further and will examine the effects of soot reducing additives on the particle size distributions.

[1] Puri, R. et al. Combustion and Flame 92: 320 1993
[2] Vander Wal, R.L. et al. Combustion and Flame 116: 291, 1999
[3] J.B.A. Mitchell, S. di Stasio, A. Florescu-Mitchell, J. Courbe and T. Weiss (In preparation).