Development of Organic Molecule Imaging at the Louisiana Accelerator Center (OMILAC)

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In recent years MeV-Secondary Ion Mass Spectroscopy has been developed as a technique for imaging specific biomolecules. This is an extension of Plasma Desorption Mass Spectroscopy (PDMS) developed in the late 1970’s for large biomolecule mass spectroscopy (up to ~60,000 Da). MeV-SIMS instruments combine the mass spectroscopic capabilities of PDMS using a linear Time of Flight (toF) stage with the spatial resolving capability of MeV ion microprobes.

At the Louisiana Accelerator Center a 2nd generation MeV-SIMS (OMILAC) is under development. In MeV-SIMS the mass resolution is governed by the energy spread of the molecular ions resulting from the emission process and limits the mass range to about < 600 Da. A feature of OMILAC instrument is a combines linear ToF and ToF Relectron geometry in such away that the mass resolution degradation due to the finite ion energy spread is compensated out to first order allowing extending the mass range to 2000 Da. Start pulses for the ToF measurement can be obtained by (i) pulsing the molecular ion acceleration voltage applied to the sample (ii) Using a DC acceleration voltage and pulsing the primary beam, or (iii) using a Si p-i-n detector to generate a start pulse. The latter has the advantage that low beam currents can be used and every primary ion generates a start pulse. However, it has the drawback that extreme shielding against electrical pickup employing a double-shielding technique was necessary to achieve precise fast detection of heavy ions with ns resolution. The nature of most list-mode microprobe data acquisition systems cannot maintain the coincidence information that enables molecular fragmentation in MeV-SIMS to be maintained. To mitigate this a new multi-stop Time to Amplitude Converter (TAC) under development. This will facilitate coincident detection of molecular fragments for each start pulse in coincidence with the (x,y) scan position.