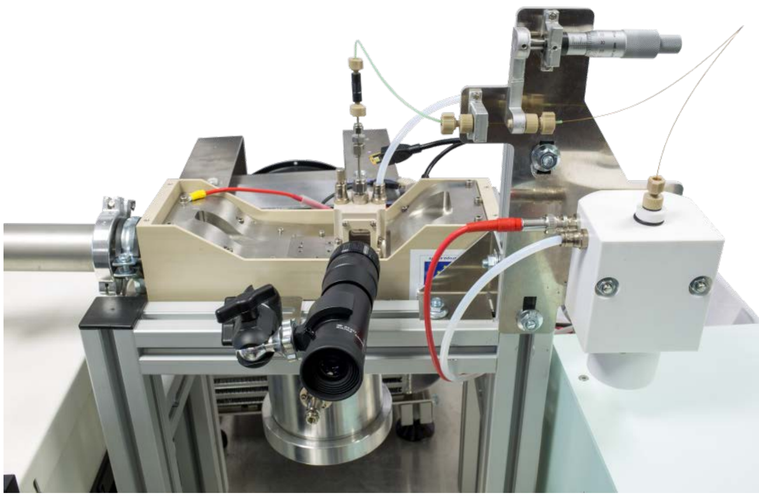
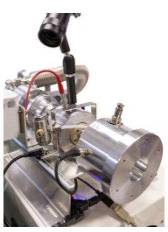
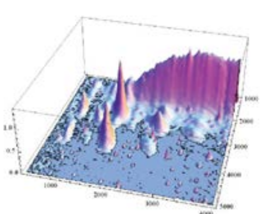
SEADM

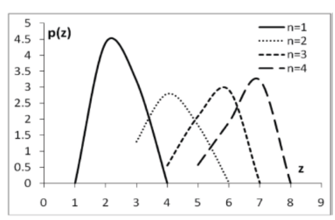
TDMA system

Tandem Differential Mobility Analyzer



High resolution, high transmission studies of nano-aerosol processes



TDMA system

DMA² : a leap into the future of nano-aerosol process studies

SEADM's Tandem Differential Mobility Analyzer (**TDMA**) enables to study a wide range of nano-aerosol processes by analyzing the change of electrical mobility experienced by the nanoparticles.
Electrical mobility is a well-proved method to elucidate structural and size characteristics of ions, and has been successfully applied for the study of processes such as **evaporation, condensation, chemical reactions, charge reduction (or charge evaporation), nucleation,** etc.

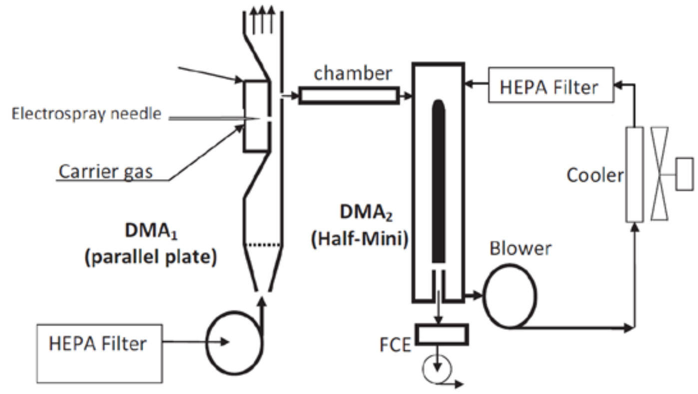


***Figure 1**: Schematic of the TDMA with Faraday Cage electrometer detection (FCE). Note how the process of study takes place in between the two DMAs.*

TDMA features the renowned DMAs first developed by SEADMs cofounder, Prof. Juan Fernandez de la Mora, from Yale, including an ultra-high resolution, high transmission parallel plate DMA (termed DMA P5 system) before the process chamber, and a suitably lighter cylindrical DMA (termed Half Mini) afterwards. The system (Fig. 1) produces particularly rich information when exploited to investigate molecular ions or small clusters, since particle diameter is in this case discrete, and a series of well defined peaks rather than a continuum mobility spectrum is obtained.

Radically innovative architecture yields

- **DMA_1:** DMA P5 system (parallel plate, Fig. 2)
- **DMA_2:** DMA Half Mini system (cylindrical, Fig. 3)
- **Electrospray** (ES) sources
- **Recirculation flow loops**
- **Electrometer:** ultra-fast, low noise faraday cage electrometer Lynx E12 (Fig. 4)
- Electronics **control rack** (Fig. 5)
- User interface **software** (Fig. 6)

***Figure 2**: DMA P5 Cell*

***Figure 3:** Half Mini Cell*

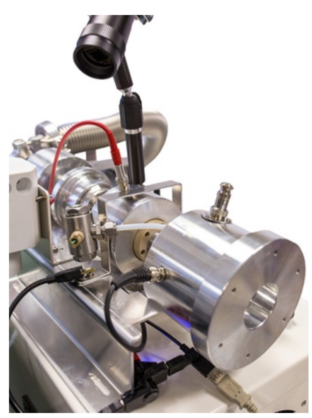


***Figure 4**: Electrometer Lynx E12*

***Figure 5:** Control Rack*

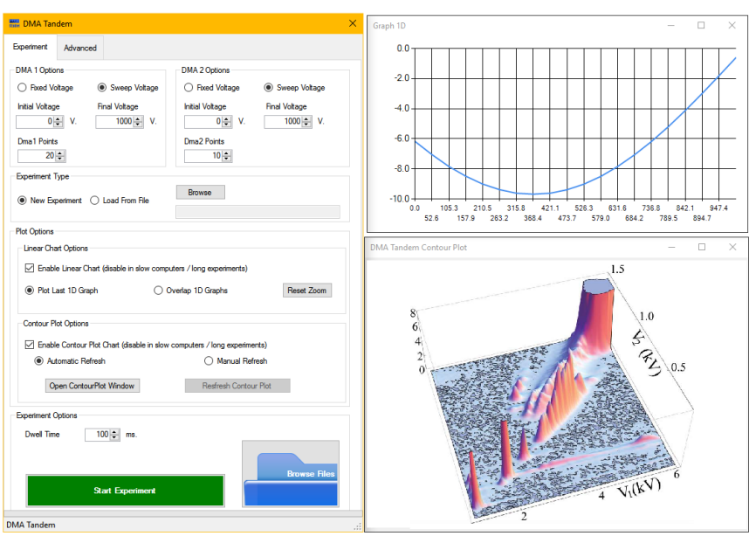


***Figure 6**: TDMA software for control and visualization*

Unique advantages

- Supercritical high flow (Re>>2000) allow **high resolution**: 80 and 30 peak voltage/FWMH for DMAs #1 and #2, respectively.
- Planar DMA P5 (DMA $_1$) allows **direct introduction of nanoparticles** at its inlet and a **significantly reduction of space charge** problem.
- DMA P5, likewise, enables operating at **high initial concentration** or **high temperatures**.
- Residence **times** are in the order of **1μs**
- Sheath air in DMA P5 **achieves interruption of kinetic processes without dilution** of the particle sample.
- **Transmitted signal in DMA P5** is thus orders of magnitude higher than in cylindrical DMAs
- Conveniently **lower cost** Half Mini DMA is provided as **DMA$_2$.**
- TDMA system is **uniquely fast:** data file available in the form of complete two-dimensional mobility maps

Examples of application:

Figure 3 shows an application of the TDMA principle for the characterization monodisperse polystyrene particles formed by electrospraying a concentrated solution of Psty-34.5k and partially neutralized by a radioactive source. Observed charge states are unusually low relative to previously studied water-soluble polymers. The study revealed that large particles are originally charged in such a fashion as to give an almost constant mobility (in air) of 0.23 cm2/V/s, implying a critical electric field for ion evaporation from a **polystyrene sphere of around 0.7 V/nm.**

The use of SEADM's TDMA system has also been applied for the **generation of monomobile molecular standards** at 1-3.5 nm size range, by means of electrospray followed by DMA, a process that is usually hindered by the formation of many clusters in different charge states z in a narrow mobility range. The TDMA proved to be uniquely useful, since many of the multiply charged ions selected in the DMA$_1$ undergo spontaneous transitions, appearing as pure species at different mobilities in DMA$_2$ (Figure 4).

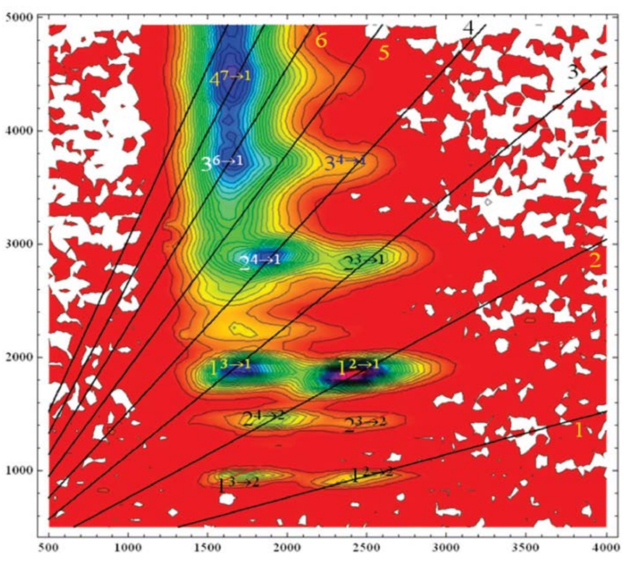


Figure 3. *2D continuous DMA² spectra of multiply charged aggregates of polystyrene. V_1 and V_2 are, respectively, in the horizontal and vertical axes. Number of monomers range from n=1-4. Charge loss is indicated as superscript. Note the high signal region at V_1≈1630 V, corresponding to a constant mobility of 0.23 cm2/V/s*

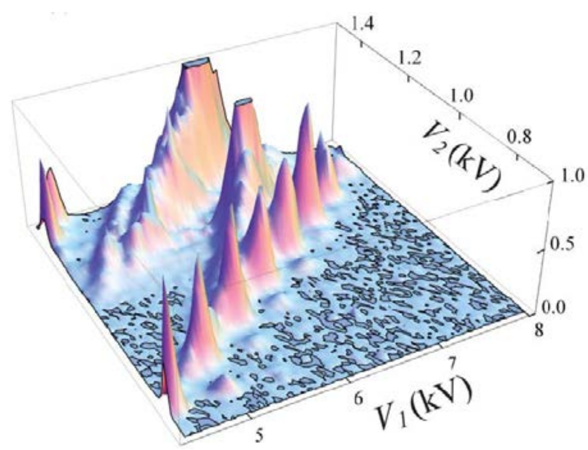


Figure 4: *Complex cluster pattern formed on electrospraying a solution of an ionic liquid with structure [A⁺B⁻]. Each of the sharp peaks seen is associated to a cluster $(AB)_n A^+_z$. The main series of peaks in the diagonal line is associated to ions undergoing no changes between both DMAs. The small peaks to their right result from evaporation of a single salt molecule, whereas peaks to their left order themselves in various lines associated to various levels of charge loss.*

TDMA system

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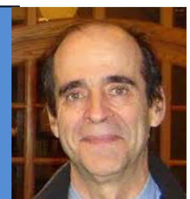
For more information:

M. Attoui, M. Paragano, J. Cuevas, and J. Fernandez de la Mora, Tandem DMA generation of strictly monomial 1-3.5 nm particle standards, Aerosol Science and Technology, 47 (5) (2013) 499-511

M. Attoui, J. Fernandez-García, J. Cuevas, G. Vidal and J. Fernandez de la Mora, Charge evaporation from nanometer polystyrene aerosols. J. Aerosol Sci. 55 (2013) 149-156

The TDMA system has been developed in collaboration with SEADM's Technical Consultant, Yale Professor Juan Fernandez de la Mora



CONTACT US, WE'D LOVE TO HEAR ABOUT YOUR APPLICATION AND SEE HOW WE CAN HELP!

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