Introduction:
Next to the laser and optical transfer system, the most important part of a laser ablation system is the ablation cell and aerosol transport system.
Early cell and transfer systems did little more than accommodate the sample and constrain the ablated material in order transfer it to the ICP. Little consideration was given to the efficiency of the transfer.

Figure 1. Schematic of a VG Elemental ‘Laser Lab’ c. 1987

Later designs allowed the sample to be larger than the sample cell and introduced the concept of contact / non cells in which the cell would sit on or hover above the sample. The goal with these laser ablation cells was to accommodate larger or more smaller samples.

Figure 2. Patent Application published in 1995 shows the ‘Hovercraft’ cell. This design was developed to attach to a robotic arm.

Other designs have included cryo cooling for specialized applications such as the analysis of frozen liquids or tissue.

Sample Cell Design and Aerosol Transfer:
Issues and Criteria [1,2,3,4,5,6] –

Cell Shape and Volume
Affects signal structure and washout

Diameter and Length of Transfer Tubing
Affects signal structure and washout

Composition and Flow Rate of Gases
Affects signal structure and washout, potential source of turbulence

Tubing Connections
Addition of ‘makeup gases’ – site of disruptive turbulence

Single Volume, Two Volume, Contact Cell
Sample size or shape

Modeling and Cell Design:
The concept of using theoretical modeling [2] and the study of computational fluid dynamics (CFD) [3,4,5,6] to predict the behavior of ablation cell and aerosol transfer systems is not new. CFD in particular can be effectively used to model how ablated material will be transported. As a consequence it is a very valuable tool in the design of laser ablation cells and transfer lines.

Figure 3. Photon Machines test model of a simple round ablation cell.

Figure 4. Photon Machines test model of a “frames” cell with design goal to create non-turbulent flow through the cell.

Two Volume Cells:
Two volume cells offer a potential advantage over both single volume and contact cells in that they have the potential to allow even the largest sample to be placed in the cell while ablation and efficient entrainment occurs in the smaller inner volume.

HELEX 2 Volume Cell
Photon Machines entered into an exclusive license with Australian National University (ANU) in 2008 to advance the HELEX 2-volume sample cell technology that was developed by Dr. Steve Eggins and his team. Rather than simplify the design, the Company captured and enhanced the original design.

Figure 5. A series of single shot analyses with trace showing U238 signal on NIST 612 glass. Photon Machines / CETAC Analyte G2 and Thermo X2 ICP-MS

Figure 6. A series of single shot analyses with trace showing U238 signal on NIST 612 glass. Photon Machines / CETAC Analyte G2 and Thermo X2 ICP-MS with ‘Squid’ smoothing interface.

Figure 7. Expanded view of single shot pulse showing washout to <1% to <700 ms with a cell configured without compromise to sample viewing.

References: