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# The TwoVol2 Ablation Cell for ESL Platform

## The Best Positional Reproducibility and Stage Return Accuracy Available

## Exploring the Benefits of the TwoVol2 Technology

Elemental Scientific Lasers is always looking for new ways to cement its reputation as the leading innovator in the field of laser ablation solid sampling, particularly in the area of ablation cell development since this area impacts the analytical result more than any other. The research and innovations of Elemental Scientific on particle transport, gas dynamics and purge cycle have been incorporated into the TwoVol2 ablation cell, the third generation two-volume cell from Elemental Scientific.

Arguably the most important performance specification for an ablation chamber is obtainable spatial reproducibility. TwoVol2, due to its novel gas flows, constant tubing curvature and Typhoon purge mechanism, yields a spatial reproducibility of < 2% RSD – within the stability specification of ICPMS instrumentation.

**Figure 1.** ESL platform

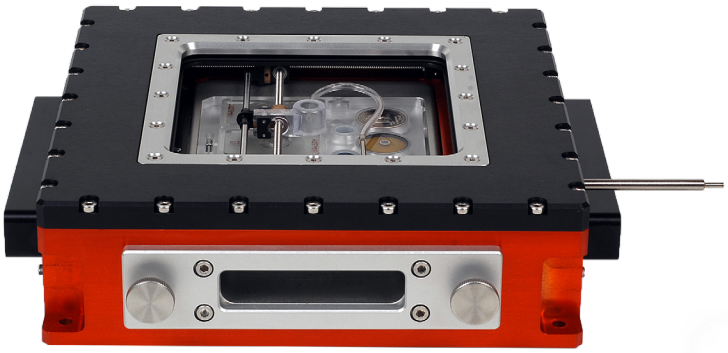

**Figure 2.** TwoVol2 ablation cell

1. ESI (New Wave Research division), 685 Old Buffalo Trail, Bozeman, Montana, 59715, USA
2. ESI (New Wave Research division), 8 Avro Court, Ermine Business Park, Huntingdon, PE29 6XS, UK

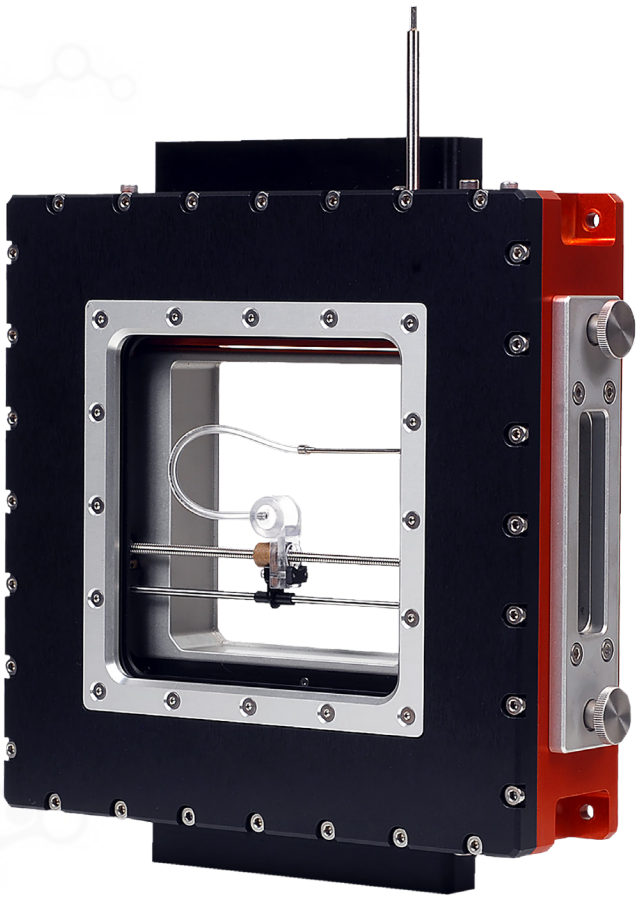

**Figure 3.** TwoVol2 ablation cell

## Benefits of the TwoVol2 ablation cell

- Spatial Reproducibility of < 2% RSD
- Tubing curvature independent of sampling position – constant curvature
- Constant cup to sample distance due to non-cantilevered cup support
- Efficient Typhoon purge mechanism
- Leak free operation
- Accessible tubing for easy replacement
- Stage reproducibility of < 1.5 µm achieved by direct mounting of cell on stage
- Complex ablation pattern capability
- Incorporated pinch valve to minimize pulse broadening and sample deposition
- Compatible with off axis, large field of view camera

## Novel Sample Chamber Insert

The ability to accommodate the sample is a fundamental requirement of any ablation cell. In two-volume cell technology this requirement is even more paramount since consistent spacing between the sample surface and cup is required. The TwoVol2 is supplied with a floating floor as standard for flexible sample accommodation.

Spring-loaded inserts are available; using a spring mechanism to position samples (pucks, thin sections and mounts) against a fixed surface to ensure consistent and reproducible focal position.

Custom inserts are available upon request.

**Figure 4.** Spring-loaded sample insert

## Cantilever-Free Stage Mounting

In many systems, the ablation chamber is mounted on a cantilever over the transmitted light and not over the stage unit that has to support its weight. This provides non-uniform support as cell position varies and can lead to variation in stage return accuracy. The new generation of cells from Elemental Scientific, including the TwoVol2, have incorporated the advances of LED miniaturization into the chamber design to allow the removal of cantilevered stages without sacrificing the ESL's super-bright transmitted light and polarizing filter. The chamber is mounted on top of the stages for consistent support and stage return accuracy, even at the extreme limits of the stage range. Figure 5 shows the torque variation of cantilevered cells compared to the torque stability of the TwoVol2.

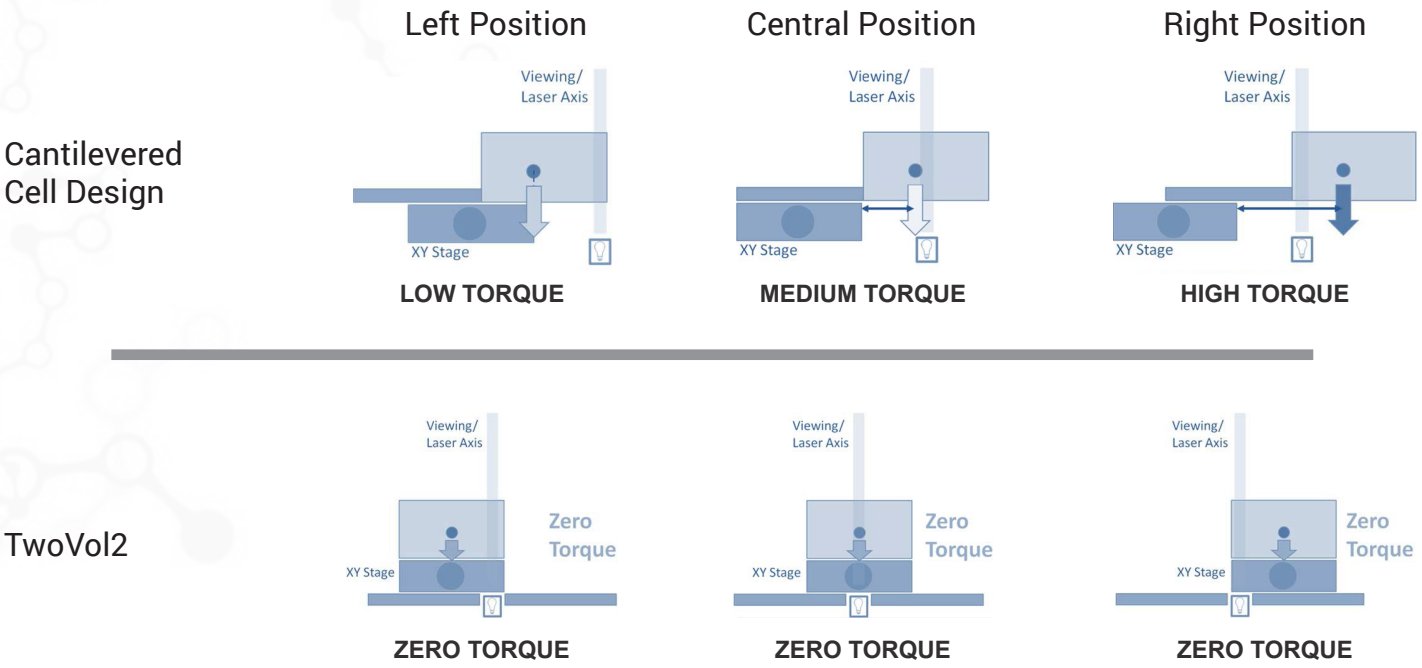


Figure 5. Cantilevered cells (top row) suffer from variable torque depending on position, whereas the TwoVol2 Cell from Elemental Scientific (bottom row) that has the stage mounted directly underneath the weight of the chamber is not affected by torque effects at all

## Cantilever-Free Cup Positioning

Some ablation cells use a cantilevered arm to direct the aerosol collection device (or cup) around the chamber. Variable torque results in changes in distance between the sample surface and the cup at different sample locations which causes inconsistent gas dynamics and a positional sensitivity dependence.

In the TwoVol2, the cup is supported evenly throughout the entire range of motion with a specially-designed internal movement system. This system also maintains constant curvature of the tubing between the ablation site and the ICP and results. This combination results in consistent gas dynamics and particle transport, and ultimately, unmatched spatial reproducibility.

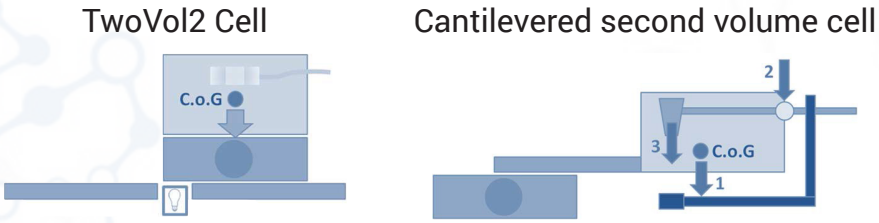


Figure 6. Variable torque in cantilevered ablation cells has a major effect on the function of the second volume – the TwoVol2 cell from Elemental Scientific (left) has zero torque and a cup that is not connected to the main stage movement, the cantilevered ablation cells (right) apply different forces onto the cup depending on cell position

## Performance Testing of TwoVol2 - Experimental

- TwoVol2 technology was tested for signal, wash-out time and positional reproducibility.
- A ESL193 equipped with TwoVol2 technology was connected to a quadrupole ICPMS via a 0.5 m length of tubing of 2 mm I.D.
- Nine NIST612 certified reference materials were positioned at various regions in the TwoVol2 cell.
- The positional reproducibility of the TwoVol2 cell was determined by performing line scan analysis on each of the individual NIST612 – a %RSD was then calculated. Parameters defined in Table 1 were employed.
- The NIST612 in the central position was used to determine the wash-out time (defined as the time taken for the signal intensity to fall to 1% of its maxima) by analysis of the signal intensity obtained from a single laser pulse using the parameters defined in Table 1.

**Table 1.** Instrumental parameters

| Laser Ablation | ESL193 with TwoVol2 |
|---|---|
| Fluence | 3 J/cm$^2$ |
| Spot Size | 50 µm |
| Scan Speed | 10 µm/s |
| He Cell Gas Flow Rate | .8 L/m |
| Repitition Rate | 20 Hz |
| Line Scan Length | 600 µm |
| **ICPMS** | **Quadrupole ICPMS** |
| Forward Power | 1400 W |
| Ar Gas Flow Rate | 0.85 L/min |
| Integration Time Per Mass | 5 ms |

## Results: Positional Reproducibility < 2% RSD

Variation in signal response from different positions in the sample chamber is detrimental for analyses. Inconsistent gas dynamics, tubing curvature, or cup/sample height can cause changes in sensitivity, washout time, oxide formation and elemental fractionation with position.

The TwoVol2 is equipped with Typhoon, the purge mechanism that enables extraordinary positional reproducibility. The magnet-free cup control maintains constant curvature to avoid variable tubing bends and is supported throughout the chamber to avoid variable cup heights. The TwoVol2 has a washout time of 700 milliseconds, which enables good spatial resolution while providing a steady signal at lower rep rates without a signal smoother.

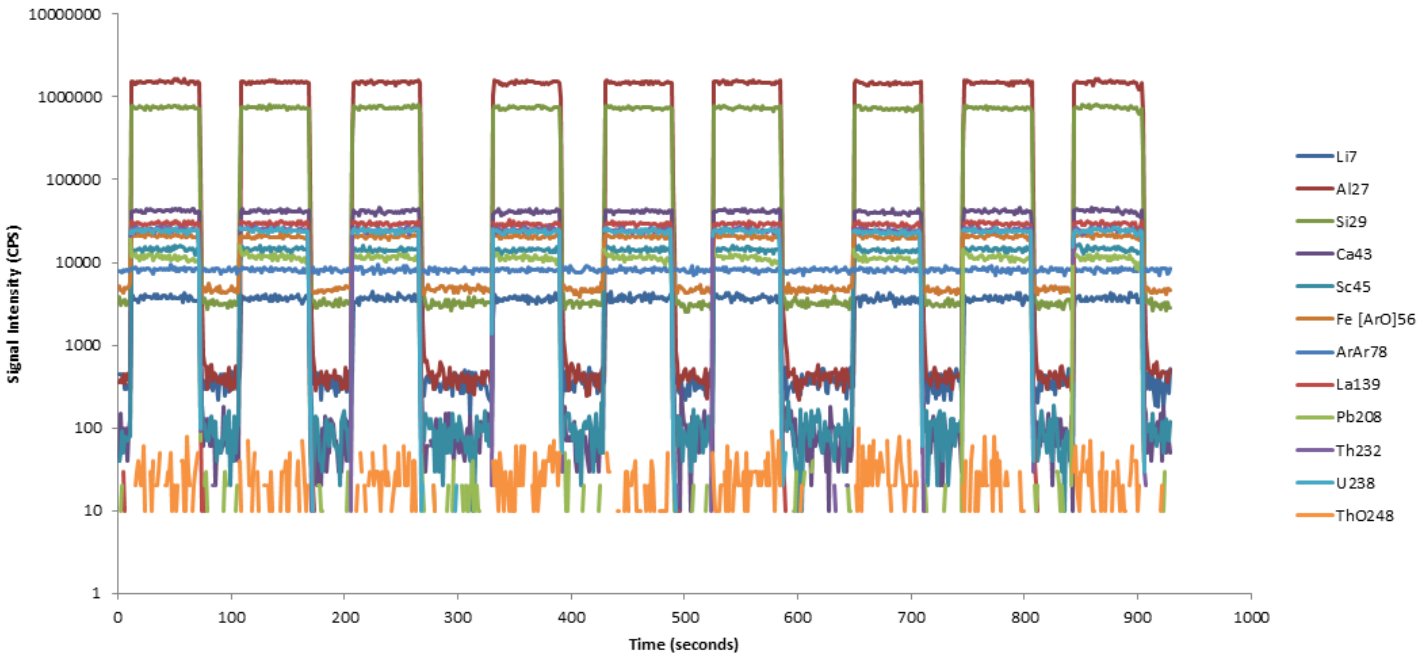


Figure 7. A chart to demonstrate the positional reproducibility of the TwoVol2 ablation chamber – the chart shows the signal intensity obtained for nine NIST612 glasses at the edges, corners and centre of the chamber

Table 2. Positional reproducibility of the TwoVol2 ablation chamber – the chart shows the %RSD obtained from consecutive analyses on nine different NIST612 throughout the chamber

| Isotope | % RSD |
|---|---|
| $^{7}$Li | 1.78 |
| $^{27}$Al | 1.53 |
| $^{29}$Si | 1.58 |
| $^{43}$Ca | 1.77 |
| $^{45}$Sc | 1.68 |
| $^{56}$Fe | 1.19 |
| $^{139}$La | 1.20 |
| $^{208}$Pb | 1.37 |
| $^{232}$Th | 1.45 |
| $^{238}$U | 1.82 |

## Results: Ratio Reproducibility < 2% RSD

The consistent curvature of TwoVol2 allows the ablated aerosol to travel an identical path, whatever the sampling position in the cell. Monitoring ratios of light to heavy elements and ratios of oxide and non-oxide forming elements at various positions in the cell can be used as a measure of spatial reproducibility performance.

The results below show that the %RSD of these ratios obtained are extremely precise: U/Pb exhibits just 0.5% RSD and Sc/Ca, La/Ca, and U/Ca are all under 1% RSD. In particular the U/Pb reproducibility makes the TwoVol2 the ideal candidate for U/Pb geochronology applications.

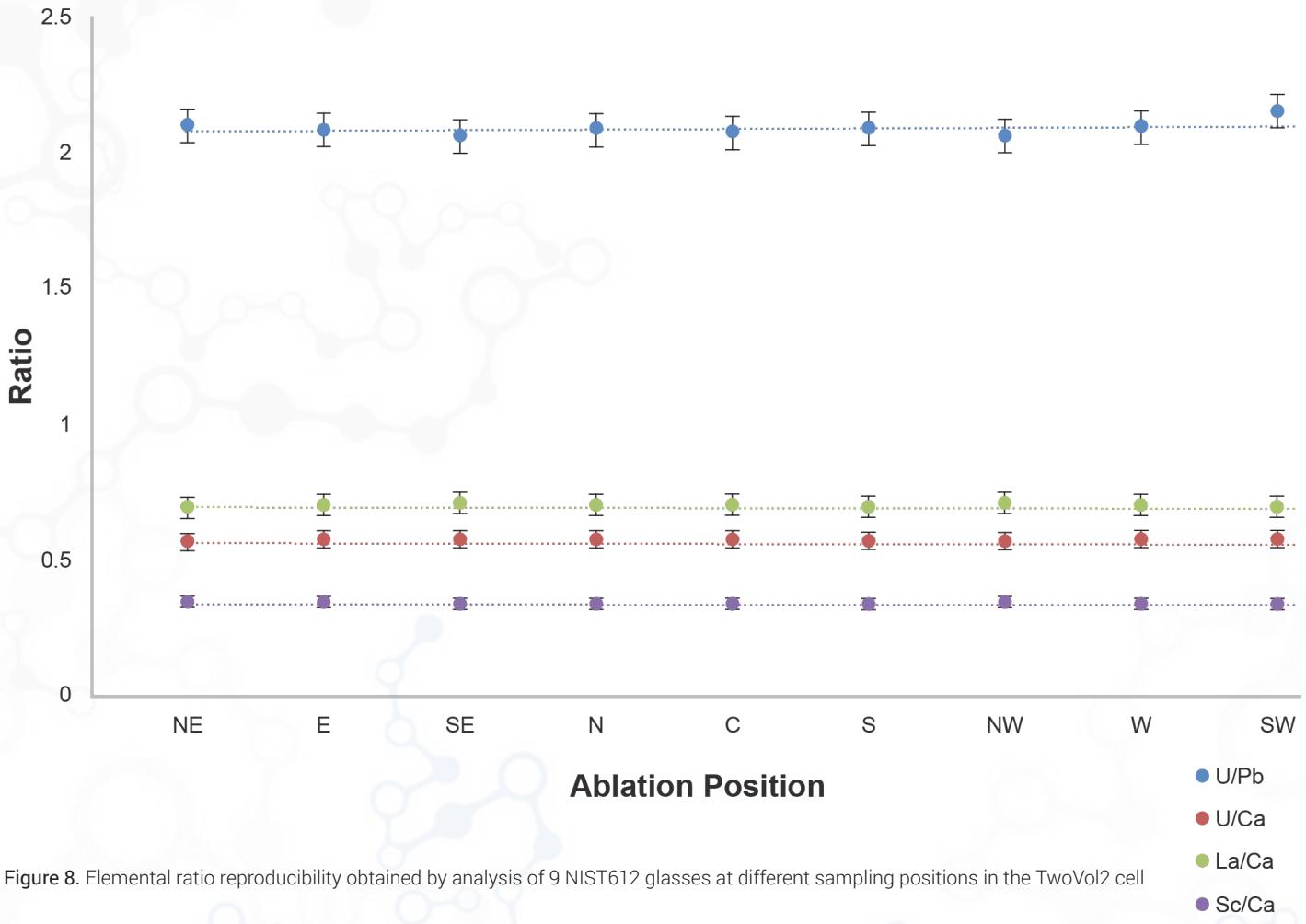


**Figure 8.** Elemental ratio reproducibility obtained by analysis of 9 NIST612 glasses at different sampling positions in the TwoVol2 cell

## Conclusions

- The TwoVol2 ablation cell has exceptional elemental and ratio spatial reproducibility. %RSDs of < 2% are achievable, which dramatically reduces the effect of sample and standard placement as an error contribution, enabling more accurate results.
- TwoVol2 offers the highest performance for any standard laser ablation chamber. The spatial reproducibility, constancy of cup height and ability to do complex patterns with high reproducibility provide flexibility for a huge range of applications.

Elemental Scientific LASERS

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