Authors: Robert. W. Hutchinson[1], Prof. David S. Wray[2], Erik Larsen[3], Katherine McLachlin[3], Ciaran O'Connor[3], Shane Hilliard[3], Leif Summerfield[3], Jay Wilkins[3]

Long term Laser Ablation System Stage Return Accuracy Sub-Micron Performance In Real Applications

Introduction

Mineral grain analysis, in particular zircon analysis, is a common application for LA-ICP-MS and the theory and methodology are well established. The high throughput nature of the analysis requires the accuracy of manual ablation and the speed of hands-off automated analysis. However, to run in this manner for hours or even days, significant confidence is needed that all ablations will run in the precise locations intended.

An error of a few microns can result in ablation occurring in the grain rim, which is frequently a difference age to the core, ruining the analysis and wasting a valuable sample. Elemental Scientific Lasers has met this challenge through evolution in sample chamber and stage design that have lead to improvements in short and long term stage accuracy. The most significant of these is ImageLock, a software-based feature which has been shown in controlled conditions to give long term stage return accuracy of < 1 µm.

Proving the performance in real laboratory conditions over a long analytical run on a real sample is important in benchmarking the performance of the NWR (now ESL) platform.

Experimental

We present results of an 8 hour study of stage return accuracy for real zircon analysis performed at The University of Greenwich using a NWR213 (now ESL213) fitted with a TwoVol2 ablation cell and Elemental Scientific's ImageLock feature. Zircons were identified in a 25 mm resin mount of sand grains by SEM analysis (pale blue) and the images were imported into the Image Import interface in Elemental Scientific's ActiveView. 100 zircons (30 to 120 µm in diameter) had a 20 µm spot placed on them. The sequence was run 10 times, totalling 1000 zircon ablations over the course of 8 hours and a stage travel distance of 1.72 m. At the end of the sequence the diameter of each ablation was measured to see if there was any broadening of the spot caused by ablations not perfectly overlapping. This was compared to the internal logging of stage position.

1. ESI (New Wave Research division), 8 Avro Court, Ermine Business Park, Huntingdon, PE29 6XS, UK
2. The University of Greenwich, Kent, ME4 4TB, UK
3. ESI (New Wave Research division), 685 Old Buffalo Trail, Bozeman, Montana, 59715, USA

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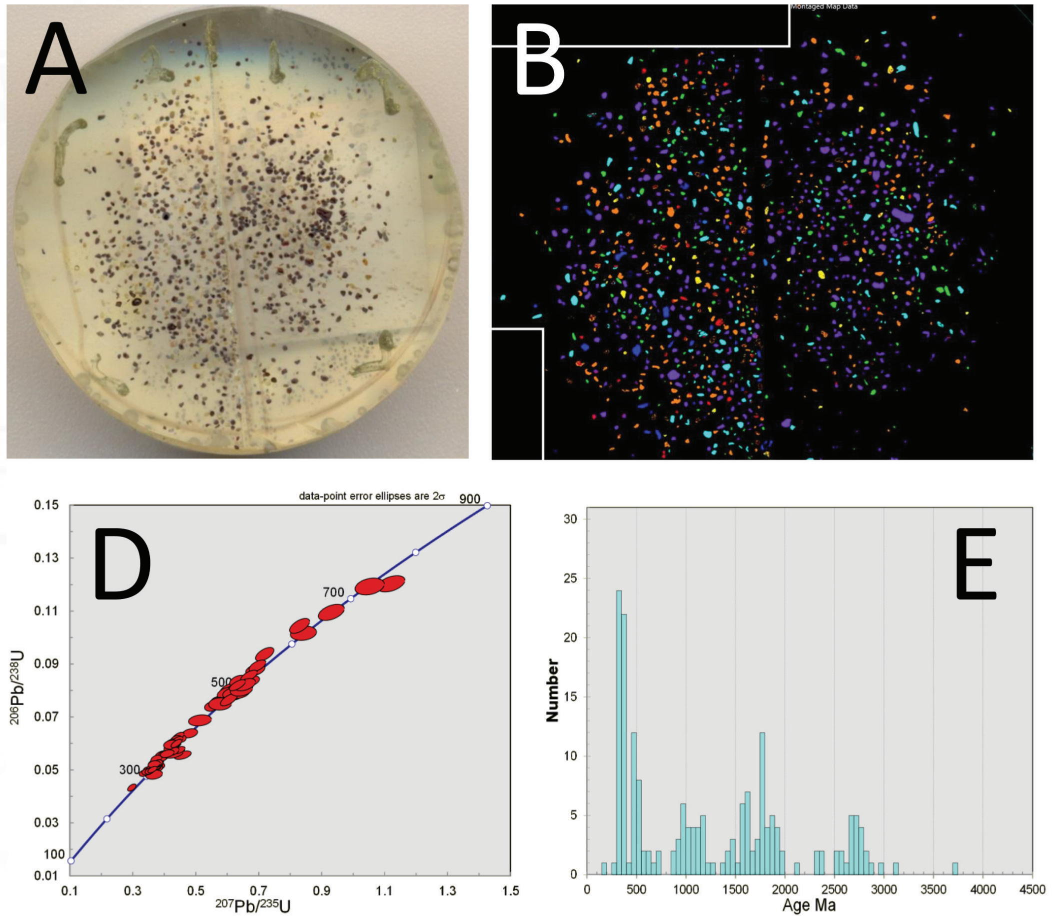
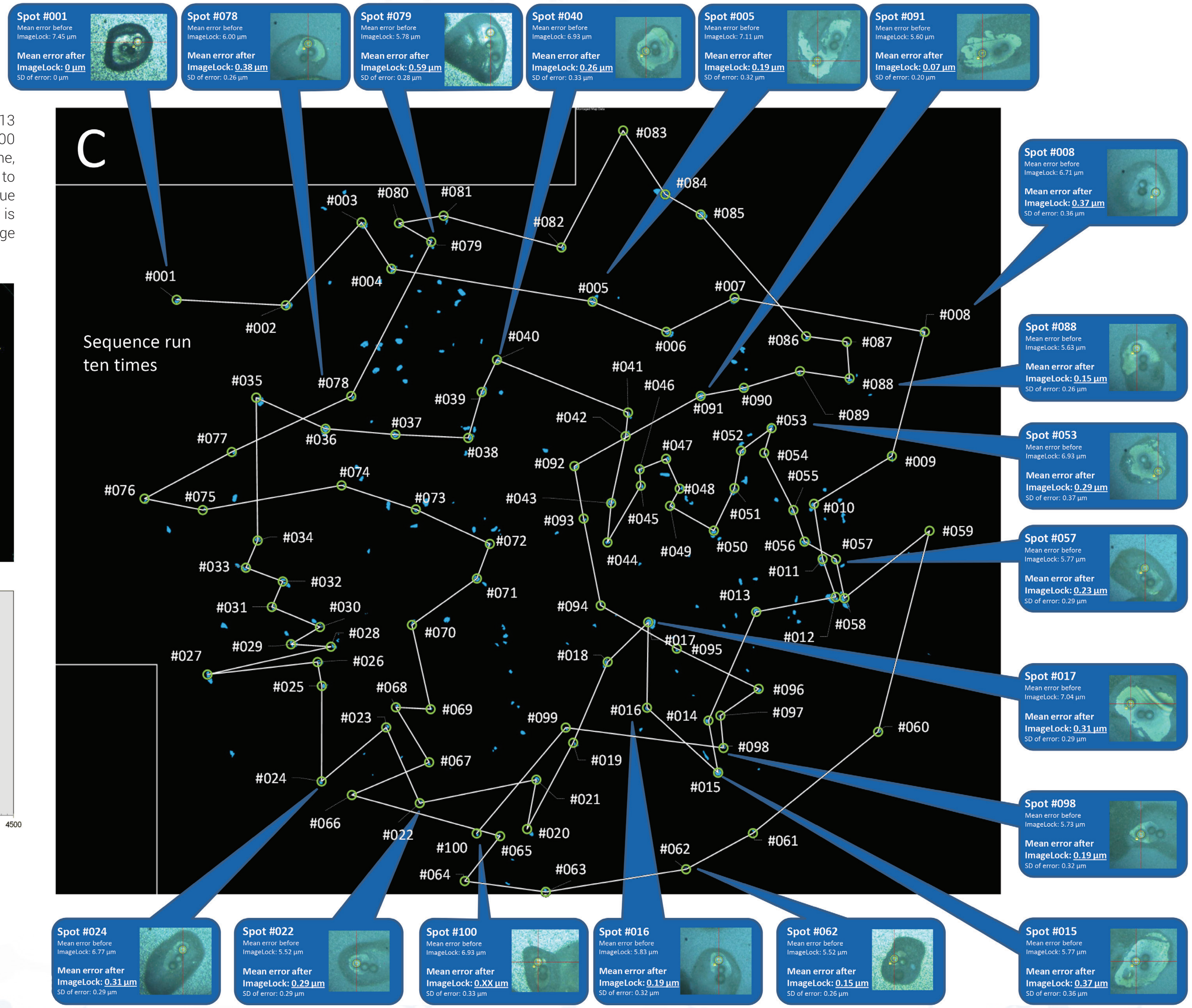
Figure 1. A 25 mm resin mount holding a range of mineral grains (A) was analyzed using a NWR213 with ImageLock. Mineralogy was performed using SEM (B) and the zircons highlighted (C). 100 zircons had 20 µm spot ablations placed on them, and the sequence was run 10 times (grey line, green rings). After the sequence was completed each ablation pit was measured in two axes to check for crater broadening and images were taken via the NWR platform's viewing system (blue callouts). No broadening could be measured in any of the craters. Real data from these samples is shown in a Concordia plot (D) and probability density plot (E). F shows the improvement in stage return accuracy with ImageLock.



F

Mean stage return accuracy before ImageLock (n=1000)	6.32 µm
SD	1.89 µm
Mean stage return accuracy after ImageLock (n=1000)	0.29 µm
SD	0.30 µm



Results

The measurements of the zircons post-analysis showed that all 100 of the ablation craters exhibited an immeasurably small deviation from 20 µm circularity, while the system log reported a mean position error of 0.29 µm with standard deviation of 0.30 µm.

Conclusions

This study shows that stage return accuracy of < 1 µm can be achieved with 100% consistency over long experiments using ImageLock on the NWR platform. A failure rate of 0% in a long term analysis of 1000 zircons is a truly remarkable achievement made possible through the ingenious manner in which ImageLock controls stage accuracy.

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Tel: 406-586-3159 | lasers@icpms.com | www.icpmslasers.com