

## Bobcat LAIR-MIR

Simultaneous Oxygen and  
Carbon Isotopic Analysis



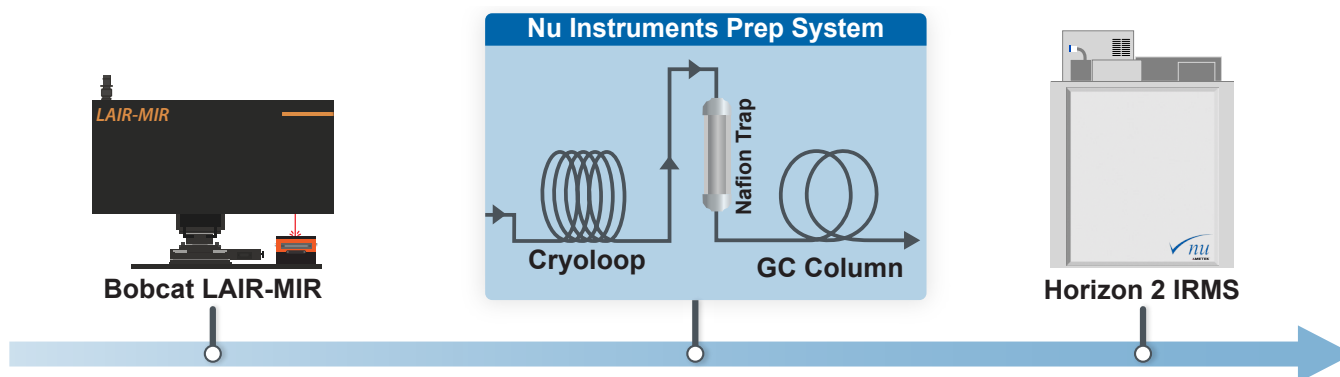
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## High Spatial Resolution Measurement of $\delta^{13}\text{C}$ and $\delta^{18}\text{O}$ in Carbonates Using Bobcat LAIR-MIR

### Synopsis

Compared to traditional digestion methods, in-situ measurement of  $\delta^{13}\text{C}$  and  $\delta^{18}\text{O}$  in carbonates by laser heating/ablation provides high-resolution temporal reconstruction of paleoenvironmental and paleoclimatic events, improving models for past and future climates. The direct solid sampling reduces sample preparation time, reduces the amount of samples required for analysis and enables

the reanalysis of samples due to the minimally destructive nature of laser techniques. Precision of  $<0.11\text{‰}$  and  $<0.30\text{‰}$  for carbon and oxygen respectively were achieved for the measurement of well characterized Carrara Marble and through the use of NCM reference gas, with analysis times as short as 180 seconds and spot sizes as small as  $180\ \mu\text{m}$ .



Schematic of combined Bobcat LAIR-MIR, sample transfer and Horizon 2 IRMS.



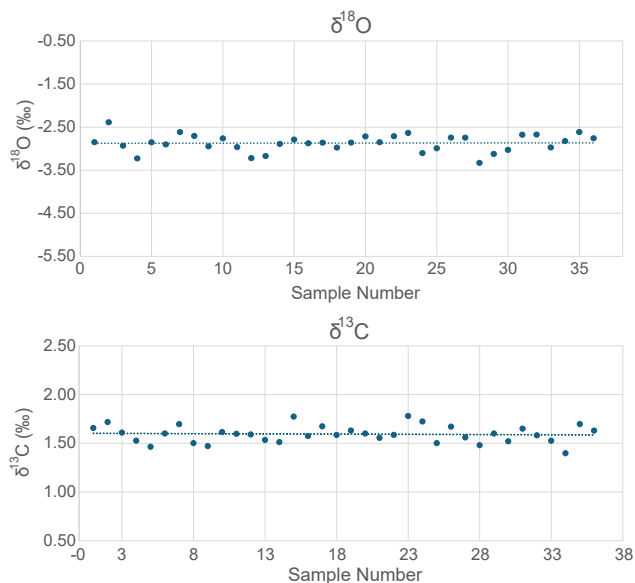
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# Bobcat LAIR-MIR performance assessment using Carrara Marble to determine Carbon and Oxygen levels

## Carrara Marble Within Sample Repeatability by LAIR-MS



The Carrara marble sample was pressed into a 5 mm pellet and loaded into the system via the quick exchange tray. The chamber was purged for <10 minutes before analysis. Laser sampling spots were chosen randomly across the sample (N = 36), with each measurement generated from a single CO<sub>2</sub> laser pulse. During ablation, released material was carried by a helium stream and collected on a cryoloop held at -192 °C for 2 minutes to ensure complete retention. The cryoloop was then rapidly warmed, allowing a second helium flow to transfer the sample through a Nafion trap, a heated GC column, and an open split into the IRMS. Each measurement required 180 seconds. Repeated analysis of standards showed excellent repeatability, 0.09‰ for Carbon and 0.19‰ for Oxygen, with no evidence of long-term drift.

## Comparison of 4 ETH Expected Values for δ<sup>13</sup>C and δ<sup>18</sup>O to Measured Values

Sample Name	ETH-1	ETH-2	ETH-3	ETH-4
Mass 44 Peak Area	1.39e-6	1.49e-6	1.70e-6	1.54e-6
δ <sup>13</sup> C Measured	2.00	-9.96	1.92	-9.94
St. Dev Measured (‰)	0.14	0.11	0.09	0.12
δ <sup>13</sup> C Expected	2.22	-9.90	2.44	-9.97
δ <sup>18</sup> O Measured	5.99	-9.31	6.44	-9.61
St. Dev Measured (‰)	0.13	0.14	0.26	0.19
δ <sup>18</sup> O Expected	4.56	-11.71	4.28	-11.92

Analysis was performed on four sample materials. Each was pressed into a 5 mm pellet and mounted on a single slide in the laser cell. Measurements were repeated for each sample (N<sub>Set</sub>=12) per set, with a total of 4 sets (N<sub>Total</sub>=48). δ<sup>13</sup>C results matched reference values within 1 SD, demonstrating a strong agreement between the two techniques across the full isotope range. Repeatability was ≤0.14 ‰ for all samples and <0.1‰ for ETH-3. δ<sup>18</sup>O measurements also demonstrated a strong agreement between the two techniques, though with a consistent offset relative to expected values, allowing application of a simple correction factor. Standard deviation ranged from 0.13 to 0.26‰, remaining within acceptable limits for this application.

## Conclusion

Bobcat LAIR-MIR and Nu Instruments Horizon 2 IRMS provide simultaneous, precise and accurate analysis of δ<sup>13</sup>C and δ<sup>18</sup>O in carbonates. Analysis of Carrara marble showed that even for the small mass of material sampled, the technique provides precision of <0.11‰ and <0.30‰ for carbon and oxygen respectively, without the need for time consuming sample preparation steps. The technique has also been shown to be both accurate and precise when comparing measured values to known values of ETH standards.

