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Rapid, continuous radiocarbon analysis of carbonate archives using laser ablation

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While high-precision radiocarbon (^{14}C) measurements of carbonaceous samples using Accelerator Mass Spectrometry (AMS) have become routine, achieving a continuous radiocarbon record for carbonate archives (e.g. speleothems, corals) still requires labor-intensive and time-consuming sample preparation. By feeding laser ablation (LA) generated CO_2/CO online into a gas source AMS, however, these archives can be sampled continuously and with minimal preparation efforts.

The LA-AMS setup installed in 2013 at ETH Zurich [1] has recently been improved in order to achieve higher signal intensities and consequently higher measurement precision as well as simpler instrumental maintenance. By redesigning the sample cell and reducing the optical path length of the laser, the fluence on the sample could be increased from previously 1-2 J cm^{-1} to now 8-23 J cm^{-1}, leading to more efficient generation of gaseous carbon from $CaCO_3$. The laser spot size was reduced from 110 µm x 680 µm to 75 µm x 140 µm, improving the overall spatial resolution of the setup. The background level of the method has been determined to have a $F^{14}C$ of 0.009 ± 0.002 and reaches a precision of less than 1% for modern samples.

To fully exploit the advantages of this unique technique, a LA-AMS specific data analysis software to disentangle [2] the quasi-continuous data stream is being developed. Features implemented include correlation of data with sampling location and plotting of all relevant measurement parameters as a function of sampling location ($F^{14}C$,