Abstract number: I13
Invited

Real-world applications of Saturated-Absorption CAvity-Ring-down Spectroscopy (SCAR)

Delli Santi M.G.[1], **Insero G.**[2], **Bartalini S.**[3,4], **Cancio Pastor P.**[4,5], **Galli I.**[4,5], **Giusfredi G.**[4], **Mazzotti D.**[4,5], **De Natale P.**[†5,6]

[1]*National Research Council - Institute of Optics, Pozzuoli, Italy*
[2]*Istituto Nazionale di Ricerca Metrologica, Torino, Italy*
[3]*ppqSense S.r.l., Campi Bisenzio, Italy*
[4]*National Research Council - Institute of Optics, Sesto Fiorentino, Italy*
[5]*European Laboratory for Non-linear Spectroscopy, Sesto Fiorentino, Italy*
[6]*National Research Council - Institute of Optics, Firenze, Italy*

[†]paolo.denatale@ino.cnr.it

Saturated-absorption cavity-ring-down spectroscopy, or SCAR, has pushed molecular detection to an unprecedented sensitivity of a few parts per quadrillion (ppq)[1]. Technology has continuously progressed in the last ten years, since its first demonstration[2] and, among other new features, took to a portable instrumentation worldwide deployable. Recently, such a unique instrument for quantifying an elusive molecule, like $^{14}CO_2$ that accounts for only 10^{-12} the total amount of carbon dioxide in the biosphere, has been applied for addressing specific problems in very different areas of science and humanities. Results will be shown for SCAR application to the precise discrimination of biogenic vs. fossil content in materials and fuels[3]; to radiological assessment of nuclear waste and nuclear power plants decommissioning[4]; to ultra-sensitive dating of archeological samples from a 4,500 years old Sumerian site[5].

Next applications aim to radiocarbon precise measurements in atmospheric samples. As is well known, carbon dioxide is the most significant anthropogenic Greenhouses Gas (GHG) in the atmosphere. The pre-industrial level of 278 ppm represented a balance of fluxes among atmosphere, oceans and land biosphere. Currently, the global averaged CO_2 mole fraction has increased up to 413 ppm[6], mainly due to emissions from the combustion of fossil fuels and cement production. Therefore, distinguishing and measuring anthropogenic vs. biogenic CO_2 in the atmosphere is the key to quantify the anthropogenic contribution to Climate Change

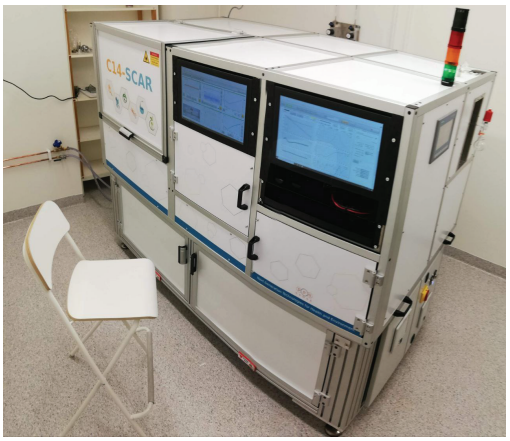

Figure 1: . New Generation of C14-SCAR spectrometer.

[1]1) Galli, I. *et al.*, *Optica* **3**, 385 (2016).
[2]2) Galli, I. *et al.*, *Phys. Rev. Lett.* **107**, 270802 (2011).
[3]3) Delli Santi, M. G. *et al.*, *Adv. Photon. Res.* **2**, 202000069 (2021).
[4]Delli Santi *et al.*, *PNAS*, under review (2022).
[5]Delli Santi *et al.*, in preparation (2022).
[6]6) WMO GHG Bulletin, no. 17, www.library.wmo.int/doc_num.php?explnum_id=10904