Advanced instrumentation for probing carbon in earth

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The Deep Carbon Observatory (DCO) is developing a diverse portfolio of advanced instrumentation for probing carbon in Earth. Technological innovation goes hand in hand with scientific discovery, and DCO made significant commitments to developing novel instrumentation at the outset of its ten-year quest to discover the quantity, movements, origins, and forms of Earth's deep carbon. Substantial progress has been made in the development of a broad suite of instruments, including:

- Ultrafast laser instrument for in situ measurements of elastic, electronic, and transport properties of carbon-bearing fluids and crystalline materials (Alexander Goncharov)
- Novel large-volume diamond anvil cell for neutron scattering (Malcolm Guthrie)
- Novel synchrotron x-ray probes for deep carbon (Wendy Mao)
- Volcanic gas analytical monitor using compact, low-power mass spectrometry for in-situ multi-species determinations (Gary McMurtry)
- Volcanic field deployment of the laser isotope ratio-meter (Damien Weidmann)
- Quantum cascade laser-infrared absorption spectrometer for clumped methane isotope thermometry (Shuhei Ono)
- Unique high-mass-resolution gas-source mass spectrometer (Edward Young)
- Combined instrument for molecular imaging in geochemistry (Andrew Steele)
- DCO high-pressure biological sampler and transporter user facility (Isabelle Daniel)

Examples of discoveries using new instrumentation include: measurement of a doubly substituted methane isotopologue, $^{13}CH_3D$, by tunable infrared laser direct absorption spectroscopy; unique nonequilibrium clumped isotope signals in microbial methane; and bonding properties of carbon in Earth's lower mantle.