

Development of a Field-Deployable Methane Carbon Isotope Analyzer



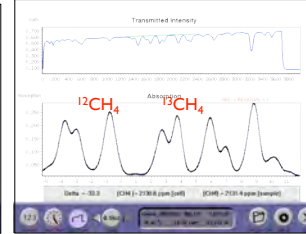
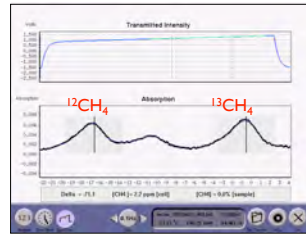
Feng Dong and Douglas Baer

Los Gatos Research, 67 East Evelyn, Suite 3, Mountain View, CA, USA (www.LGRinc.com)

Novel instrumentation has been developed for real-time measurements of methane carbon isotope ratio ($\delta^{13}\text{C}$) and mixing ratio [CH_4] in air over a very wide range of mixing ratios. This technology employs cavity enhanced absorption and near-infrared lasers, and thus does not require cryogenic components. The instrumentation, which may be operated in continuous flow and in batch injection modes, may be configured for measurements suitable for ambient air studies (Range 1: 1.5 - 2000 ppmv CH_4 in air) or biogas, mud logging and oil/gas exploration applications (Range 2: 500 ppmv - 100% CH_4 in air). A dynamic dilution system (see EGU2010-3690), automatically controlled by the analyzer is used for $\text{CH}_4 > 20$ ppmv (Range 1) and $\text{CH}_4 > 1\%$ (Range 2). Instruments may be configured with LGR's Multiport Inlet Unit, a 16-solenoid valve injector, for sampling multiple locations.

Raw data: Absorption Spectra recorded in real time

Measured spectra:
[CH_4] = 2 ppmv



Measured spectra:
[CH_4] ~ 2000 ppmv

Measurement Ranges



Range 1: [CH_4] = 1.5 - 2000 ppmv

- Dilution System: >20 ppmv CH_4 mixed w/ zero air

Applications:

- ambient air studies
- landfills
- arctic tundra studies



Range 2: [CH_4] = 500 ppmv - 100%

- Dilution System: $>1\%$ CH_4 mixed w/ pressurized air

Applications:

- Mud logging
- Oil/gas exploration
- Biogas

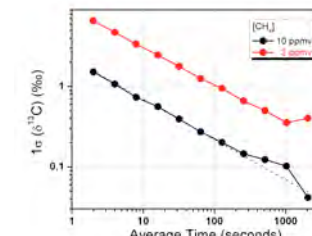
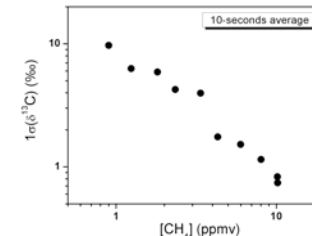
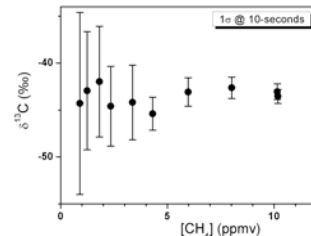


Options (for both Ranges):

- Multiport Inlet Unit: Autosample up to 16 locations
- Syringe injection (manual)



Performance ([CH_4]: 1.5 - 10 ppmv)

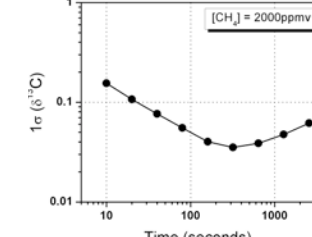
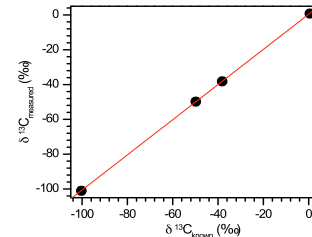
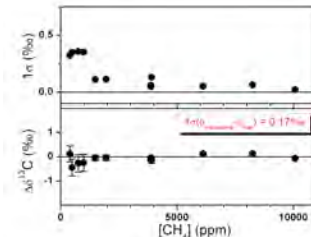


- $\delta^{13}\text{C}$ precision (10 seconds) for 1-10 ppmv
- $\delta^{13}\text{C}$ linear (concentration independent)

- $\delta^{13}\text{C}$ precision (10 secs) for [CH_4]=1-10 ppmv
- $\delta^{13}\text{C}$ precision improves with increasing [CH_4]

- $\delta^{13}\text{C}$ precision (2 ppm): 1 ‰ (100 sec)
- $\delta^{13}\text{C}$ precision (10 ppm): 0.2 ‰ (100 sec)

Performance ([CH_4]: 500 ppmv - 1%)

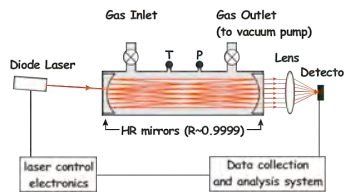


- [CH_4] precision better than 0.5 ‰ (10 sec)
- $\delta^{13}\text{C}$ stability better than 0.2 ‰ (10 sec)

- Comparison with known CH_4 /air mixtures
- $\delta^{13}\text{C}$ accurate to better than ± 0.2 ‰

- $\delta^{13}\text{C}$ precision better than 0.2 ‰ (10 sec)
- $\delta^{13}\text{C}$ precision better than 0.1 ‰ (1000 sec)

Cavity Enhanced Laser Absorption



- Direct - no pretreatment
- Path-length enhancement $L_{eff} = L / (1-R) \sim 3-50$ km
- Robust - easy to use
- Near-IR telecom components
- Measurements at 1 Hz
- Inexpensive (relatively)
- 150 W - field ready

Conclusions

Novel instrumentation reports $\delta^{13}\text{C}$ and CH_4 in real time over wide range of mixing ratios (from typical ambient levels to 1%; up to 100% may be recorded with dynamic dilution system). These systems weigh 27 kg and consume 150 W of power and thus enable direct measurements in the field -- not possible with present IRMS technology.

- High $\delta^{13}\text{C}$ precision (better than 0.5 ‰)
- No consumables, no cryogenics
- No sample treatment
- Low power: 150 watts
- Continuous flow
- Option: discrete injection (via syringe)

Instrumentation configured for particular ranges:

Measurement range 1:

- 1.5 - 500 ppmv (>20 ppmv with dynamic dilutor)

Measurement range 2:

- 500 ppmv - 100% ($>1\%$ with dynamic dilutor)