Introduction to the Fundamental Measurment Principles of the Instruments used to Meassure Fluxes of Heat, Energy, and Greenhouse Gasses

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CAMPBELL SCIENTIFIC

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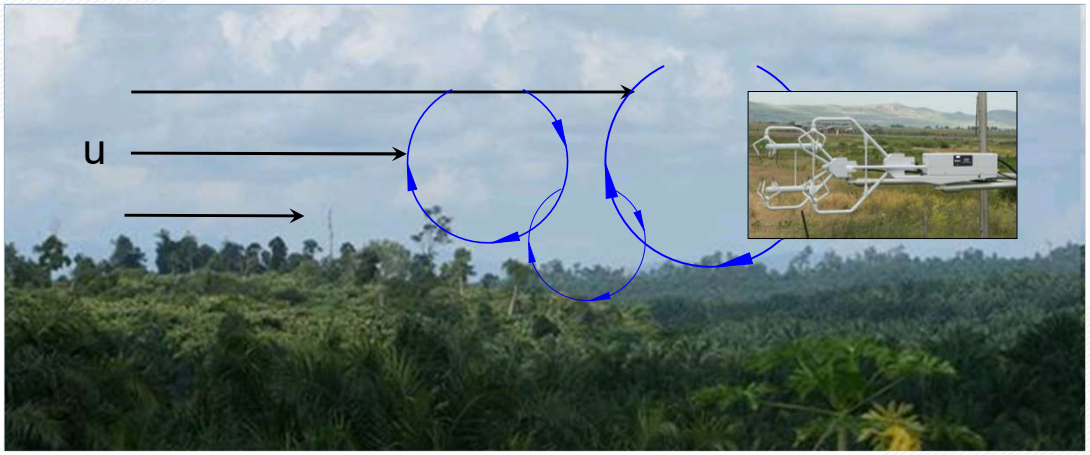
Eddy-Covariance



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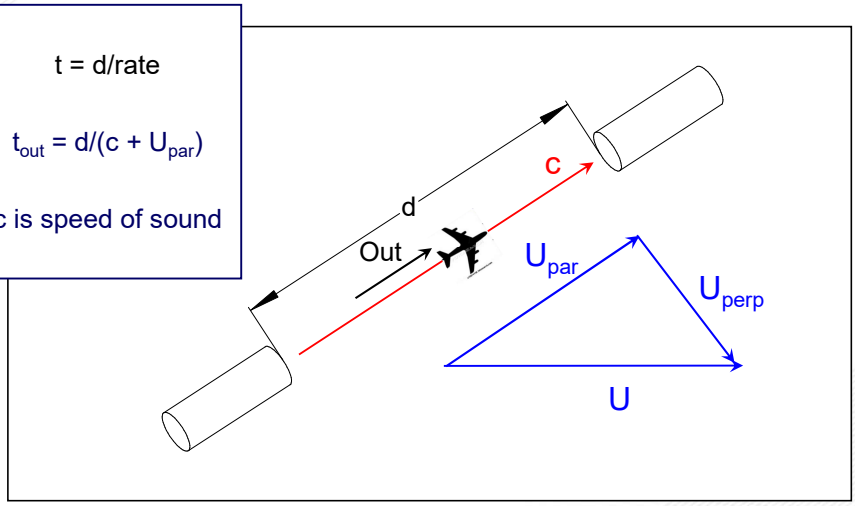
Sonic Anemometer Measurement Principles

t = d/rate

$t_{out} = d/(c + U_{par})$

c is speed of sound



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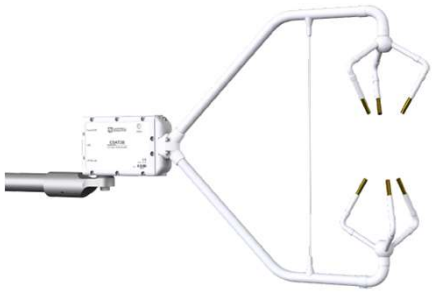
Sonic Anemometer Measurement Principles



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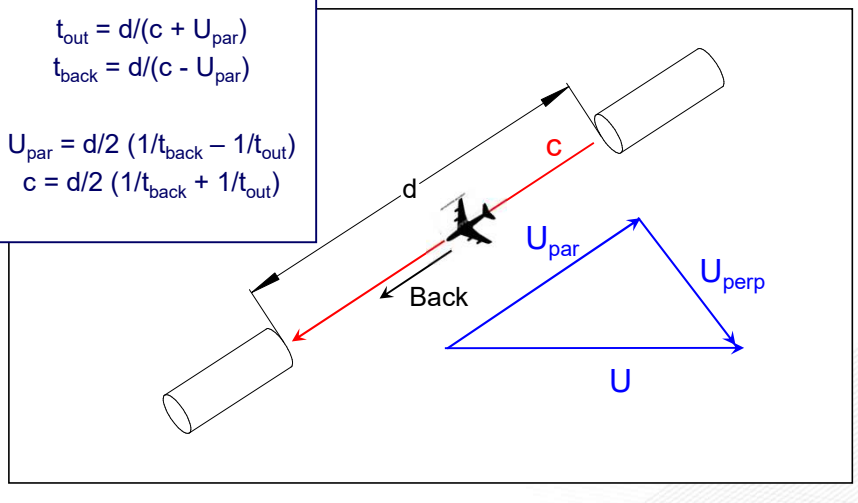
Sonic Anemometer Measurement Principles

$t_{out} = d/(c + U_{par})$
$t_{back} = d/(c - U_{par})$

$U_{par} = d/2\ (1/t_{back} - 1/t_{out})$
$c = d/2\ (1/t_{back} + 1/t_{out})$



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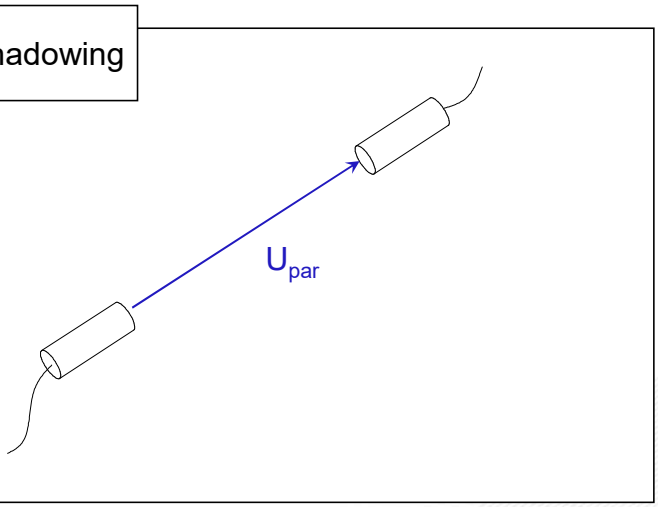
Sonic Anemometer Measurement Principles

Transducer Shadowing



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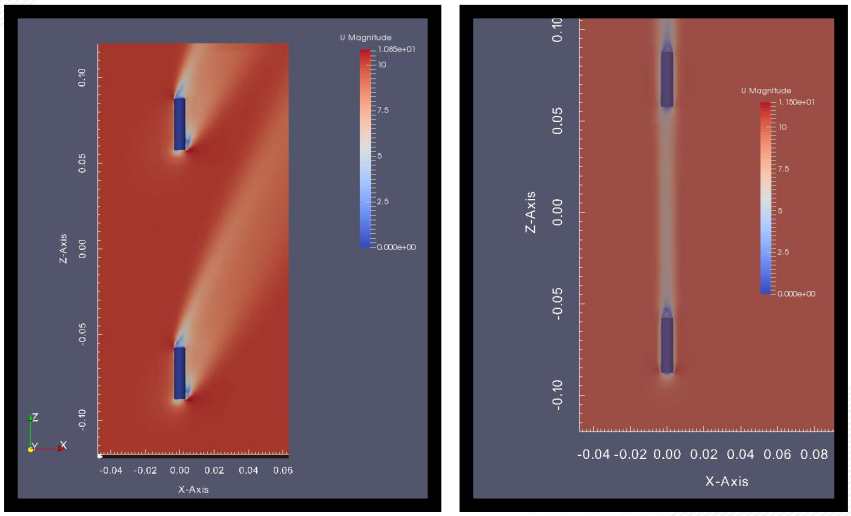
Sonic Anemometer Measurement Principles



*Courtesy of Rex Burgon, CSI

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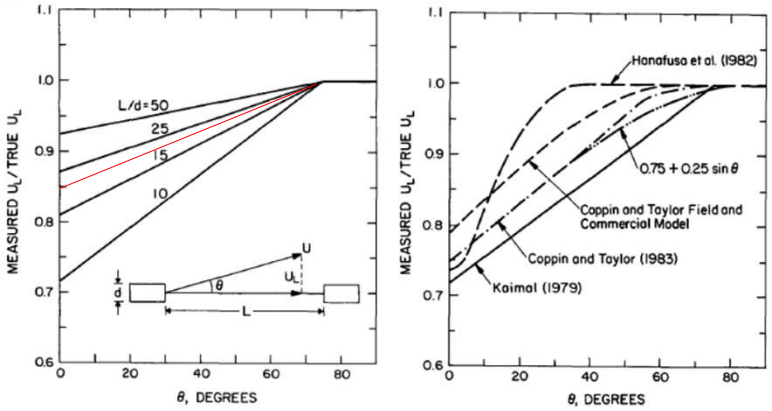
Sonic Anemometer Measurement Principles



- Shadowing varies with angle of attack
- For shallow angles of attack, shadowing varies with turbulence.

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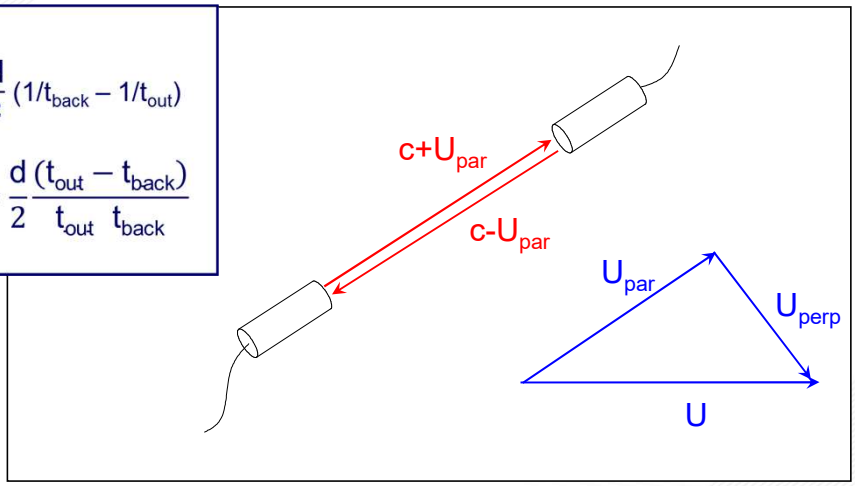
Sonic Anemometer Measurement Principles

$$U_{par} = \frac{d}{2}(1/t_{back} - 1/t_{out})$$

$$U_{par} = \frac{d}{2}\frac{(t_{out} - t_{back})}{t_{out}\ t_{back}}$$



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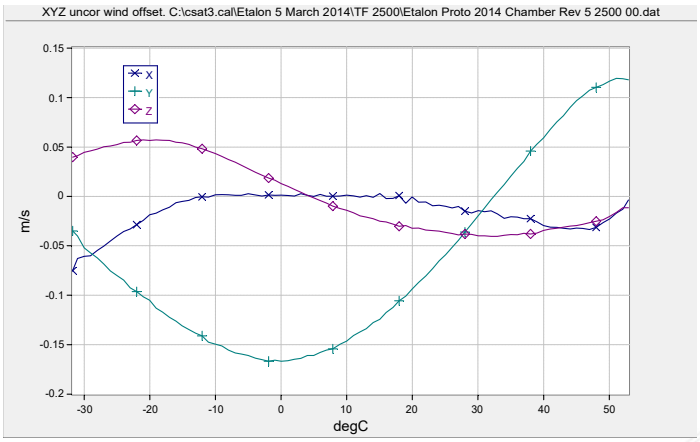
Sonic Anemometer Measurement Principles



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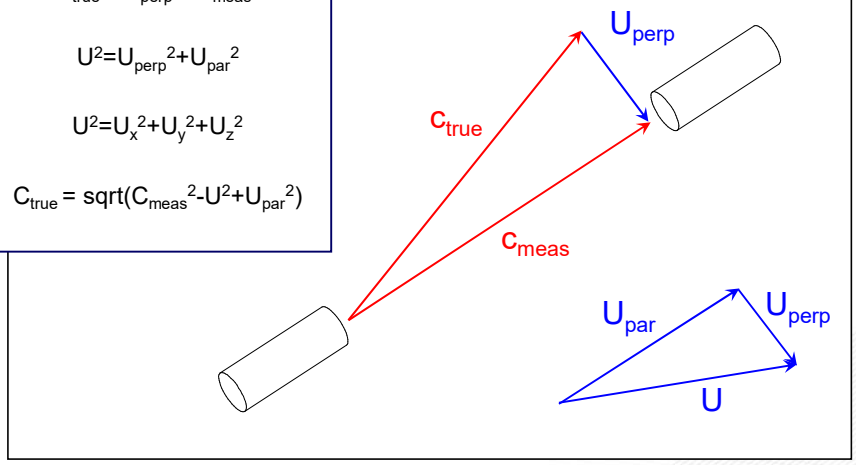
Sonic Anemometer Measurement Principles

$C_{true}^2=U_{perp}^2+C_{meas}^2$

$U^2=U_{perp}^2+U_{par}^2$

$U^2=U_x^2+U_y^2+U_z^2$

$C_{true} = sqrt(C_{meas}^2-U^2+U_{par}^2)$



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Sonic Anemometer Measurement Principles

- The speed of sound is corrected for the crosswind effects in real-time
- There is no need to apply any post processing correction like Schotanus et al. (1983) or Liu et al. (2001)

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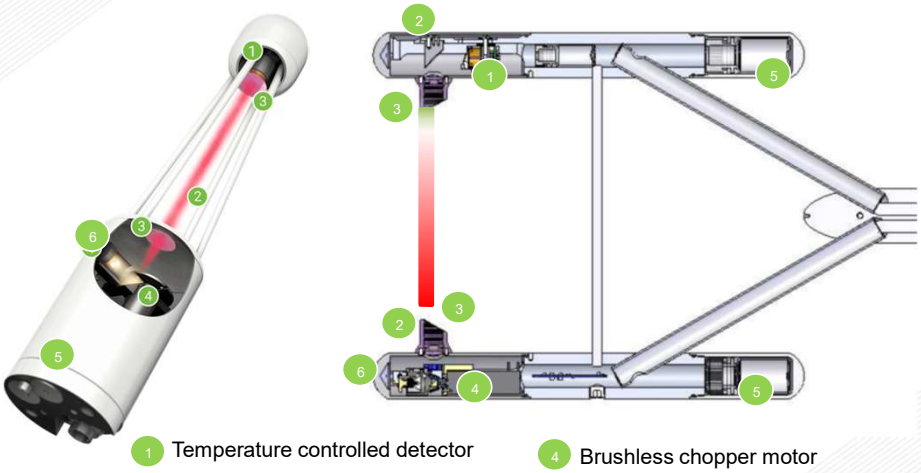
ES1 Edward Swiatek, 8/19/2021

Gas Analyzer Measurement Principles



1. Temperature controlled detector
2. Precision optical components
3. Scratch resistant windows
4. Brushless chopper motor
5. CO_2 and H_2O scrubbers
6. Infrared source

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Gas Analyzer Measurement Principles

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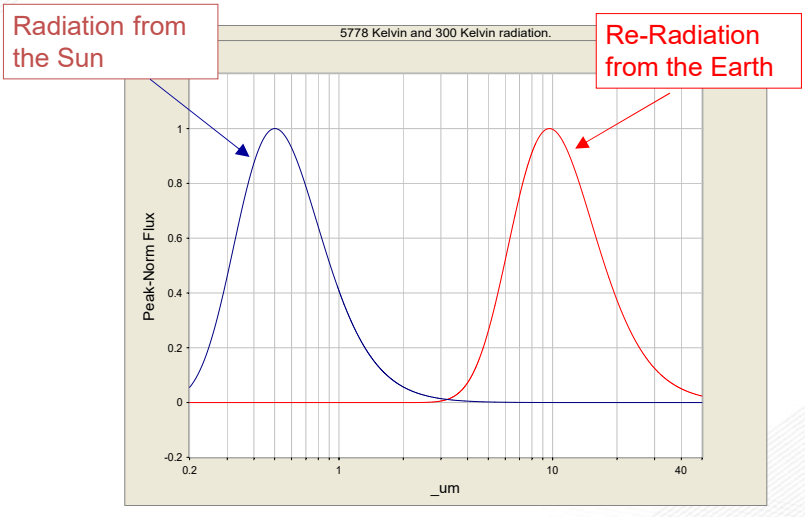
Gas Analyzer Measurement Principles



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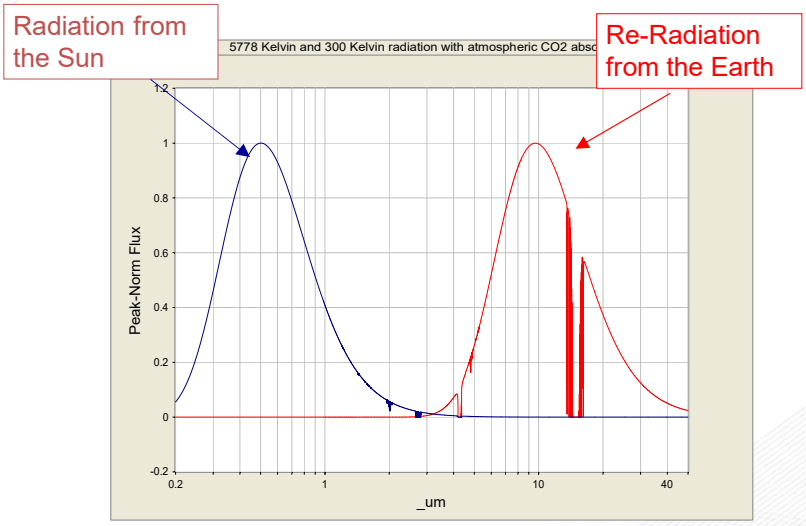
Gas Analyzer Measurement Principles



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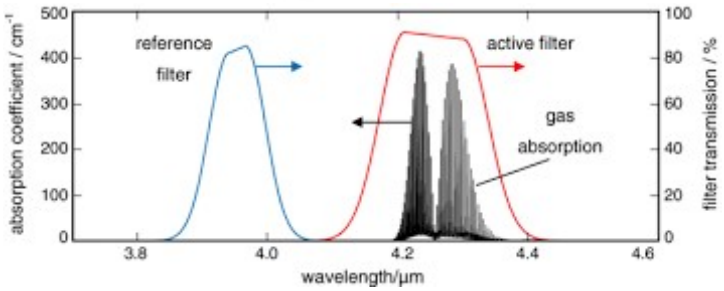
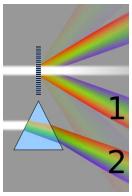
Gas Analyzer Measurement Principles



Dispersive



Non-dispersive

Filter Wheel

- CO_2 active (absorbing)
- CO_2 reference (non-absorbing)
- H_2O: active (absorbing)
- H_2O: reference (non-absorbing)

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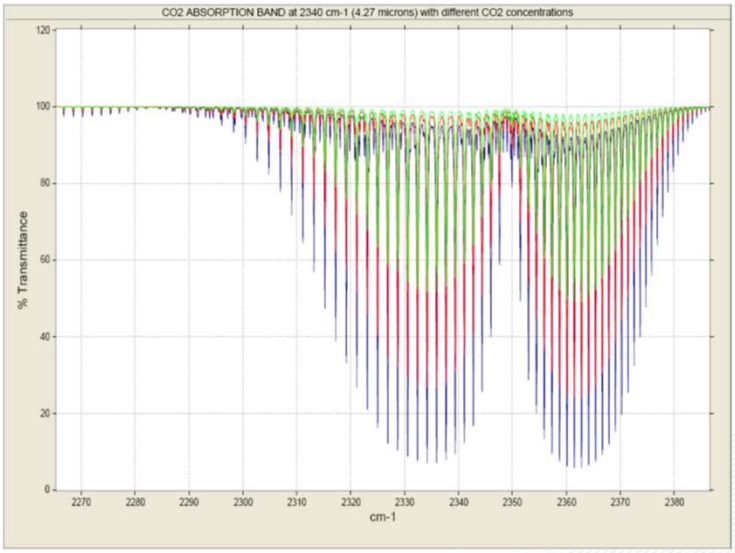
Gas Analyzer Measurement Principles



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Profile System Measurement Principles

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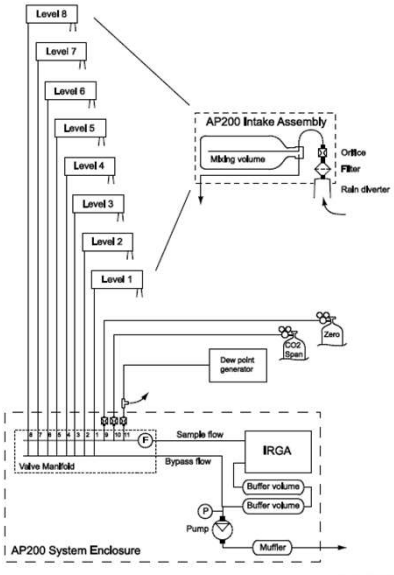
Profile System Measurement Principles



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Trace Gas (CH_4/N_2O) Measurement Principles

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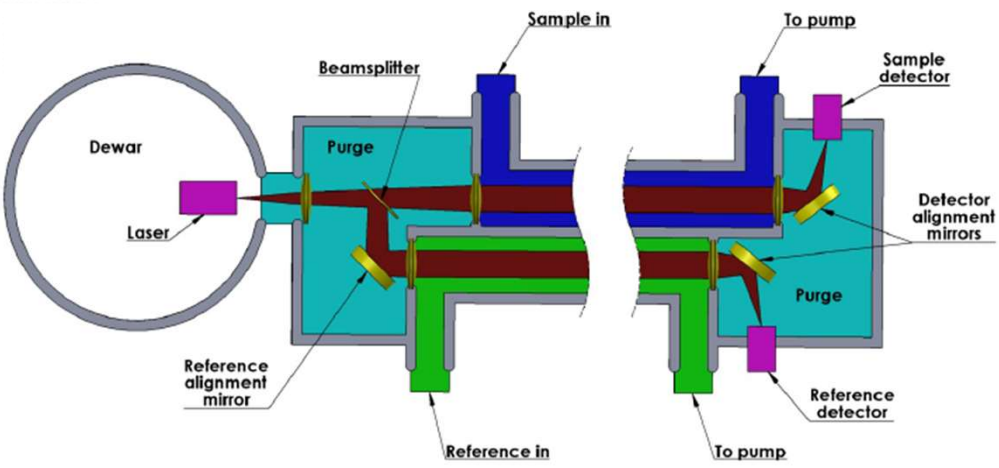
Trace Gas (CH_4/N_2O) Measurement Principles



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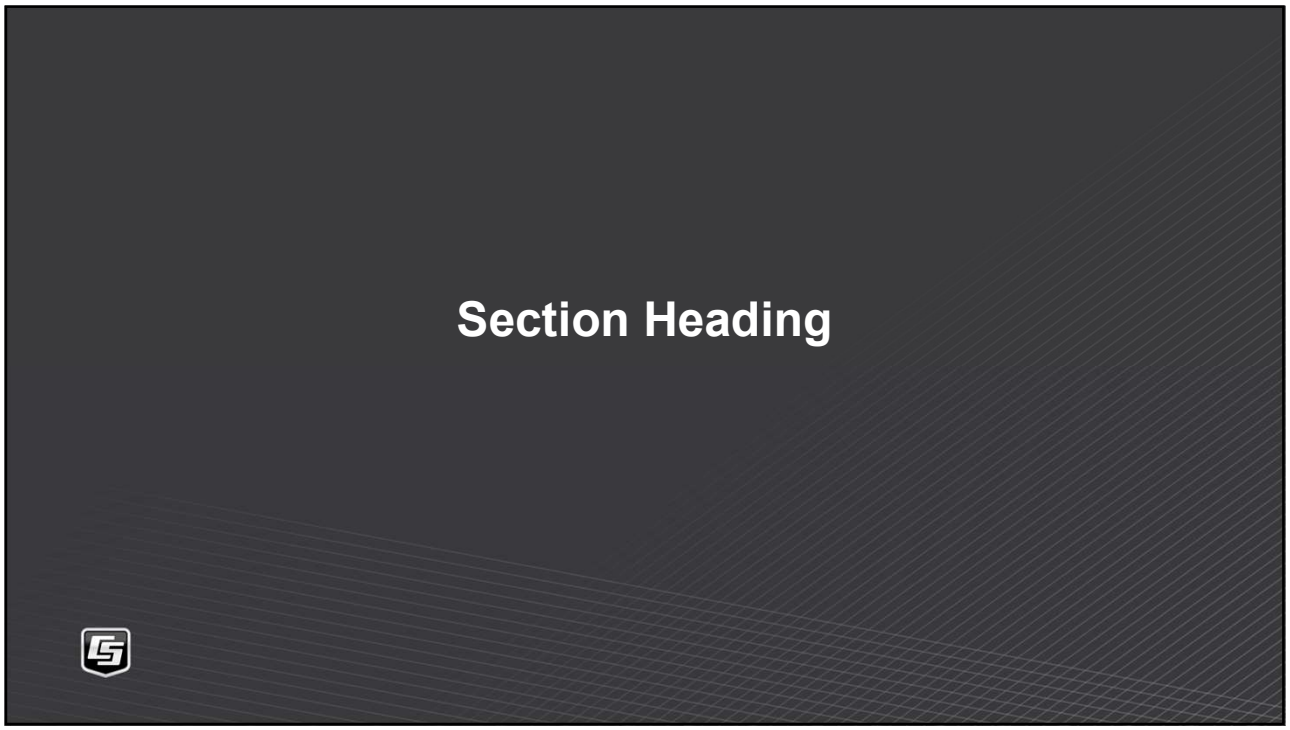

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