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The Challenges of Long-Range Automated Detection and Quantification using OGI

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EyeCGas® Product Line

Fixed

EyeCGas® 24/7

EyeCGas® 24/7 PRO

Handheld

EyeCGas® Mini

EyeCGas® 2.0

Alert & Quantification Software

EyeCSite®

OPGAL EyeCGas®

EyeCGas® 2.0

➢ Versatility:

- ✓ Over 400+ hydrocarbon compounds
- ✓ Replaceable spectral filters:
  - Standard (~3.3µm)
  - Heavy Hydrocarbons (~3.4µm) for improved detection
  - CO2 (~4.3µm)

➢ Sensitivity:

- ✓ The most sensitive OGI (NETD≤10°mK@25 °C)
- ✓ Detect 0.35 g/hr. leak of methane
- ✓ Certified to meet EPA OOOOa by 3rd party

EyeCGas® Mini (Uncooled)

- **Different model for different gases:**
  - ✓ CH4 (Natural Gas, LNG)
  - ✓ SF6 & NH3
- **Ideal choice for medium/large gas leaks**
  - ✓ CH4 – Minimal leak rate 10 g/hr - (NETD≤50°mK@25 °C)

EyeCGas® 24/7 Fixed Solution (Uncooled)

➢ Medium to large detection capability:

- ✓ Methane
- ✓ NETD≤20°mK@30 °C
- ✓ Optics: 12°x 9°, 18° x13°, 31° x23°

EyeCGas®

EyeCGas® 24/7 PRO Fixed Solution (Cooled)

➢ Versatility:

- ✓ Over 400+ hydrocarbon compounds
- ✓ Improved detection and quantification capabilities for C3+ alkanes and most hydrocarbons
- ✓ Long range enhancement
- ✓ Optional PT to monitor multiple areas

➢ Sensitivity:

- ➢ The most sensitive OGI (NETD≤10°mK@25 °C)

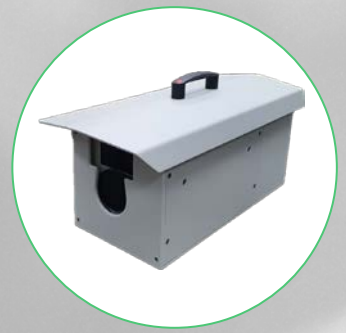
EyeCGas®

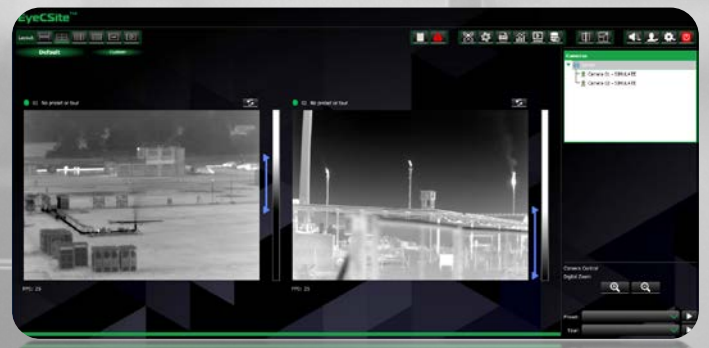
EyeCSite® Quantification & Alert Software

- Monitoring, Alert & Quantification System
- Design to work with the EYECGAS® products Family
- Sophisticate but User Friendly

Is putting it all together that simple?

Simple can be harder than complex: You have to work hard to get your thinking clean, to make it simple. But its worth it at the end, because once you get there, you can move mountains. – Steve Jobs





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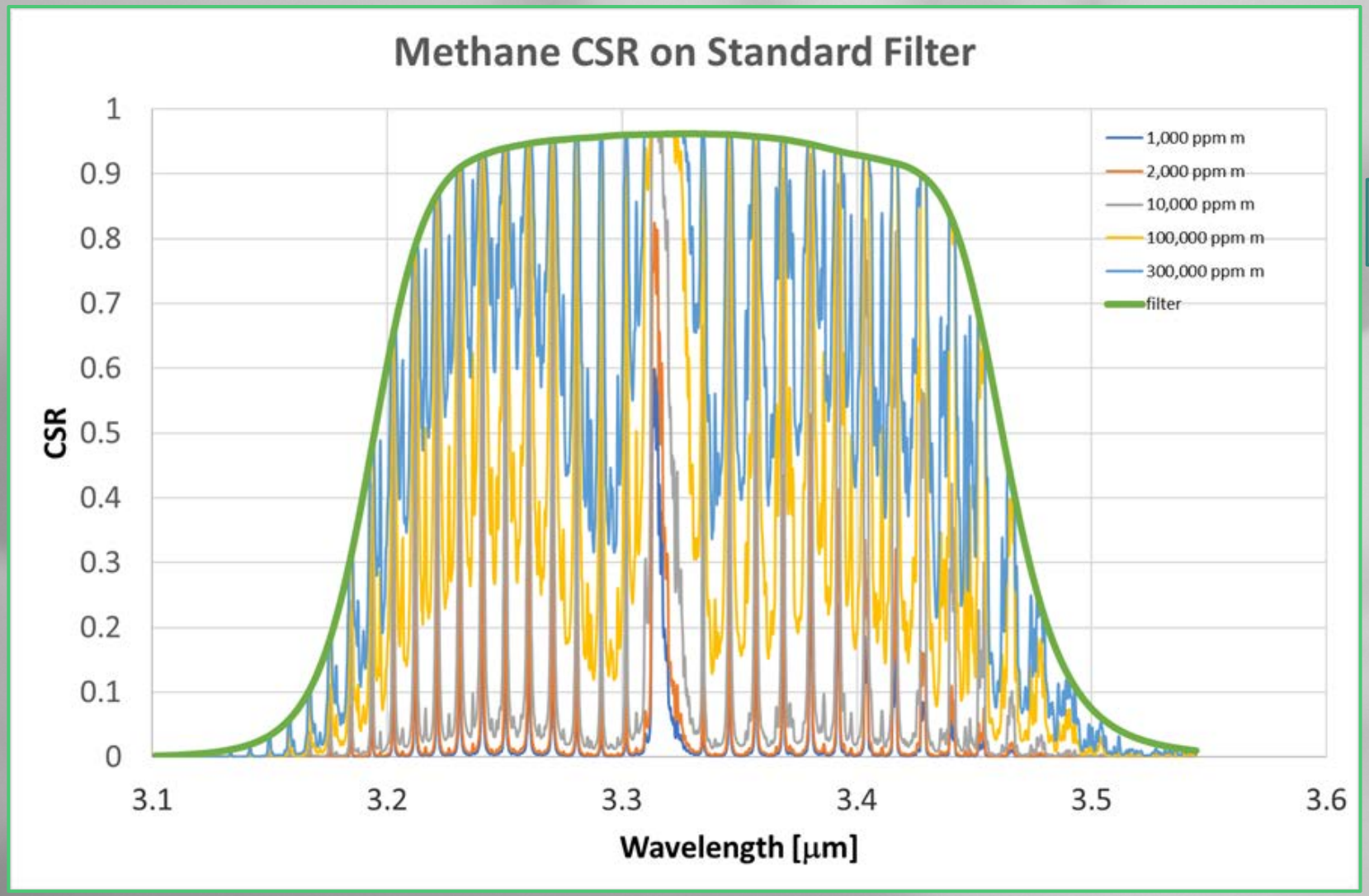
PHYSICS: DOUBLE LAYER ATMOSPHERIC MODEL

$$\Delta I = I_{no\ gas} - I_{gas} = \underbrace{\tau_a}_{\text{Range}} \left[\underbrace{\left[L(T_b) - L(T_g)\right]}_{\Delta T} \int_{\lambda_1}^{\lambda_2} \left[\underbrace{\left(1 - \tau_g(\lambda)\right)}_{\text{Compound}} \cdot \underbrace{t(\lambda)}_{\text{Filter}} \right] d\lambda \right]$$

COMPOUND SPECIFIC RESPONSE SPECTRUM



$$\tau_g(\lambda) = exp\left[-\alpha_g(\lambda) C_g L_g\right]$$

$$\left(1 - \tau_g(\lambda)\right) \cdot t(\lambda)$$

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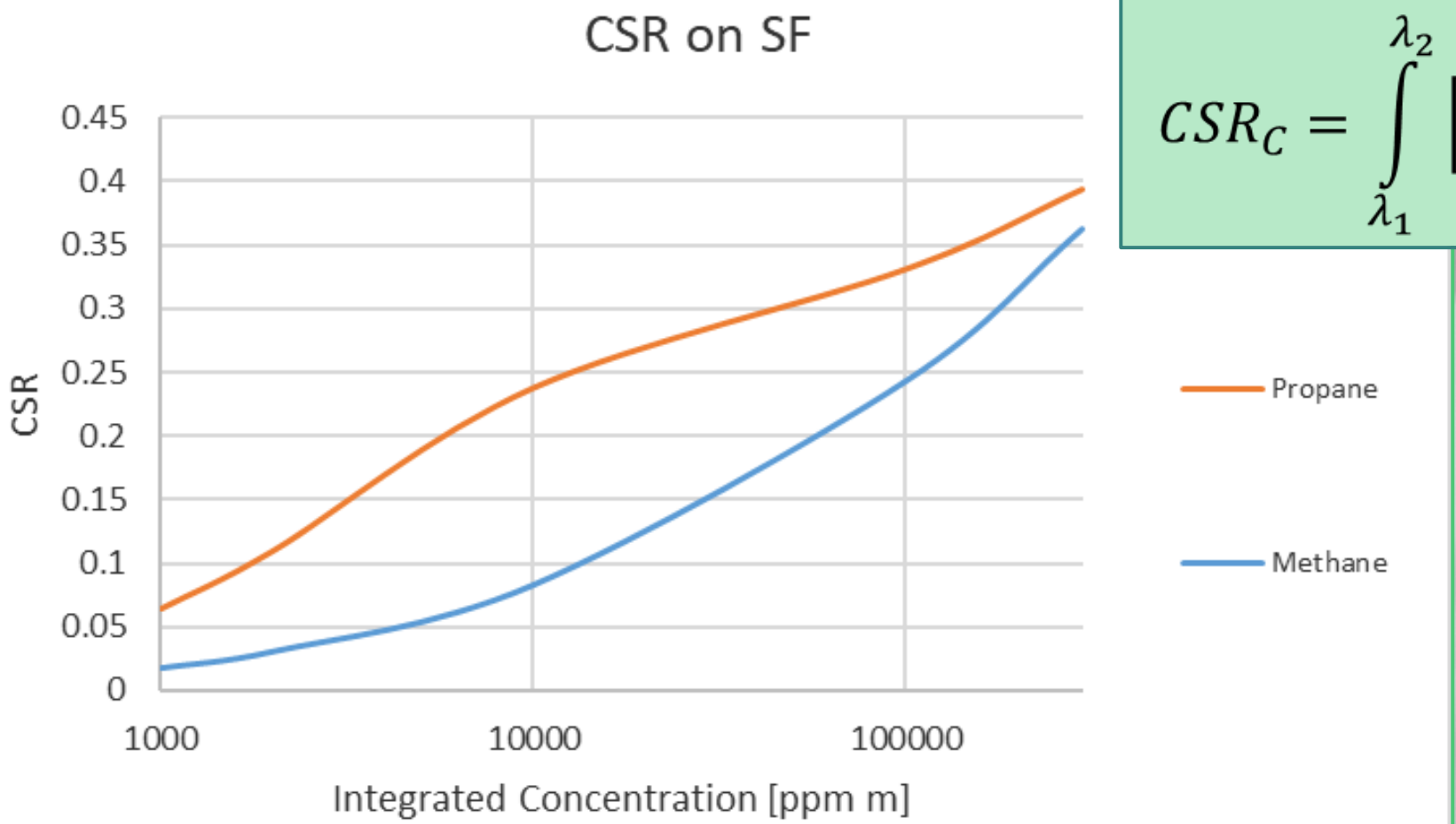
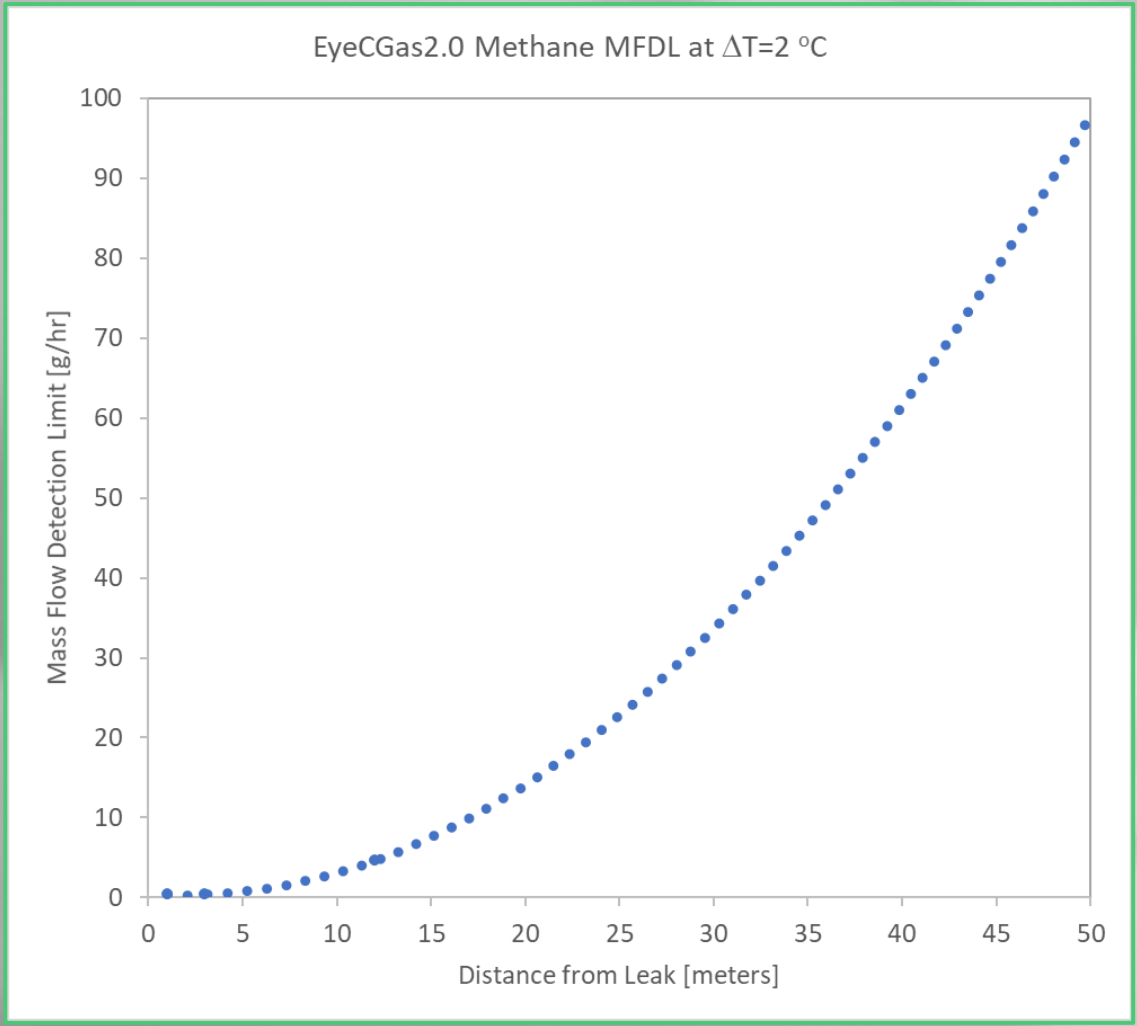
COMPOUND SPECIFIC RESPONSE CURVE



$$CSR_C = \int_{\lambda_1}^{\lambda_2} \left[\left(1 - \tau_g(\lambda)\right) \cdot t(\lambda)\right] d\lambda$$

RANGE



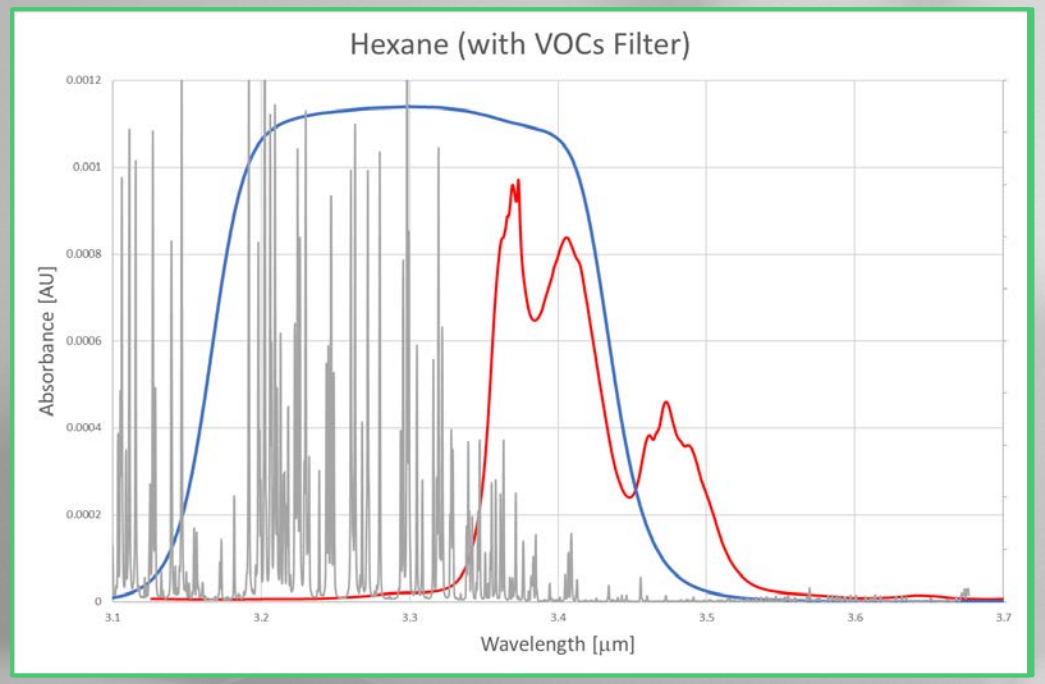
$$\tau_a(\lambda) = exp[-\alpha_a(\lambda)C_aL_a]$$

- L_a – foreground air layer thickness:

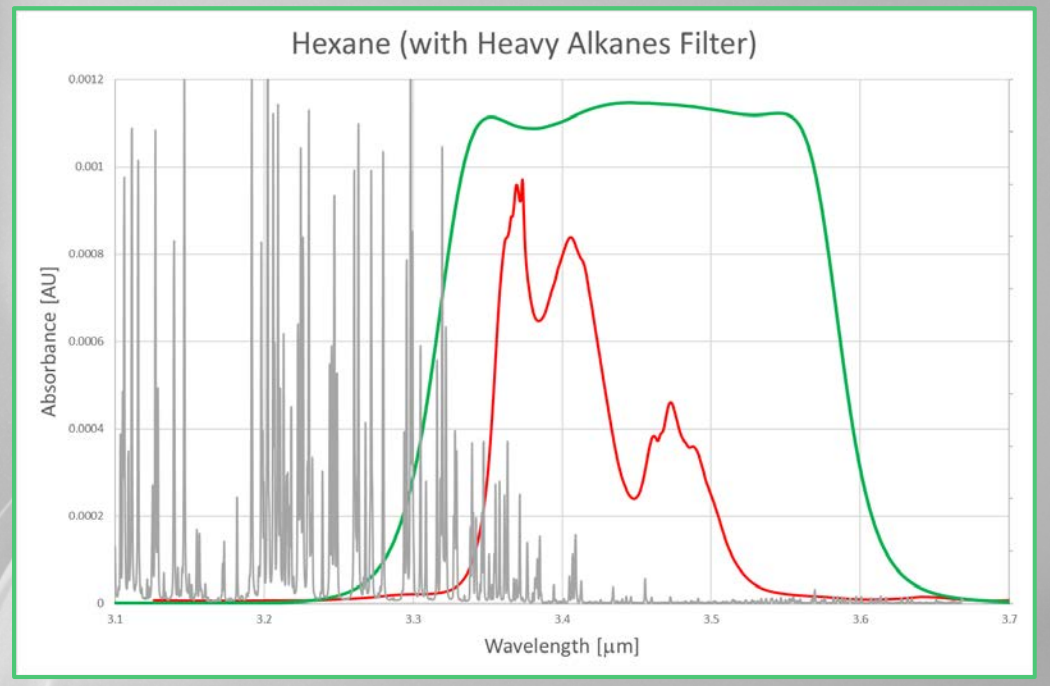
RANGE

- α_a – extinction coefficient of foreground air layer
- C_a – concentration of homogeneous gas and aerosol layer

VOCs AT LONG DISTANCE



EyeCGas VOC Standard Filter



EyeCGas with "Higher Carbon" Long Range Filter

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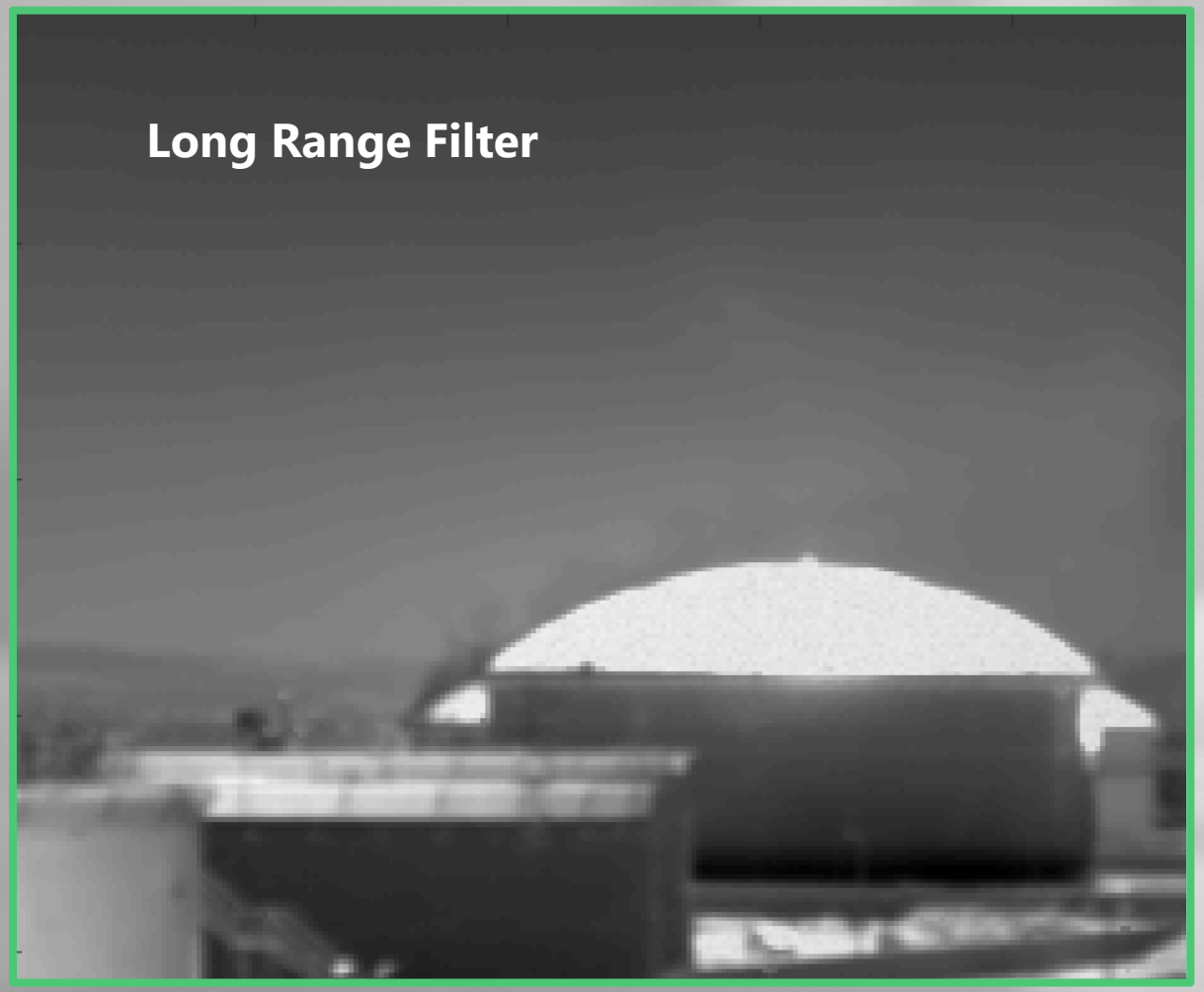
LONG-RANGE FILTER VS. STANDARD FILTER



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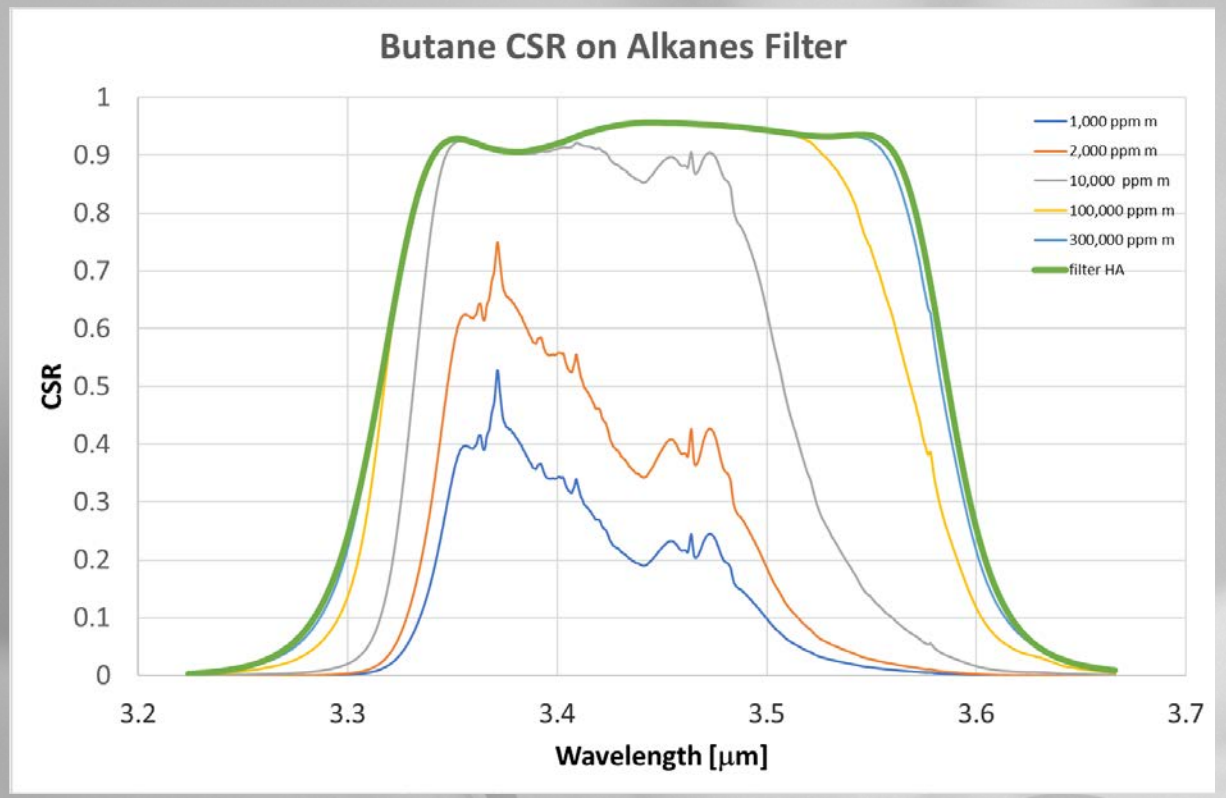
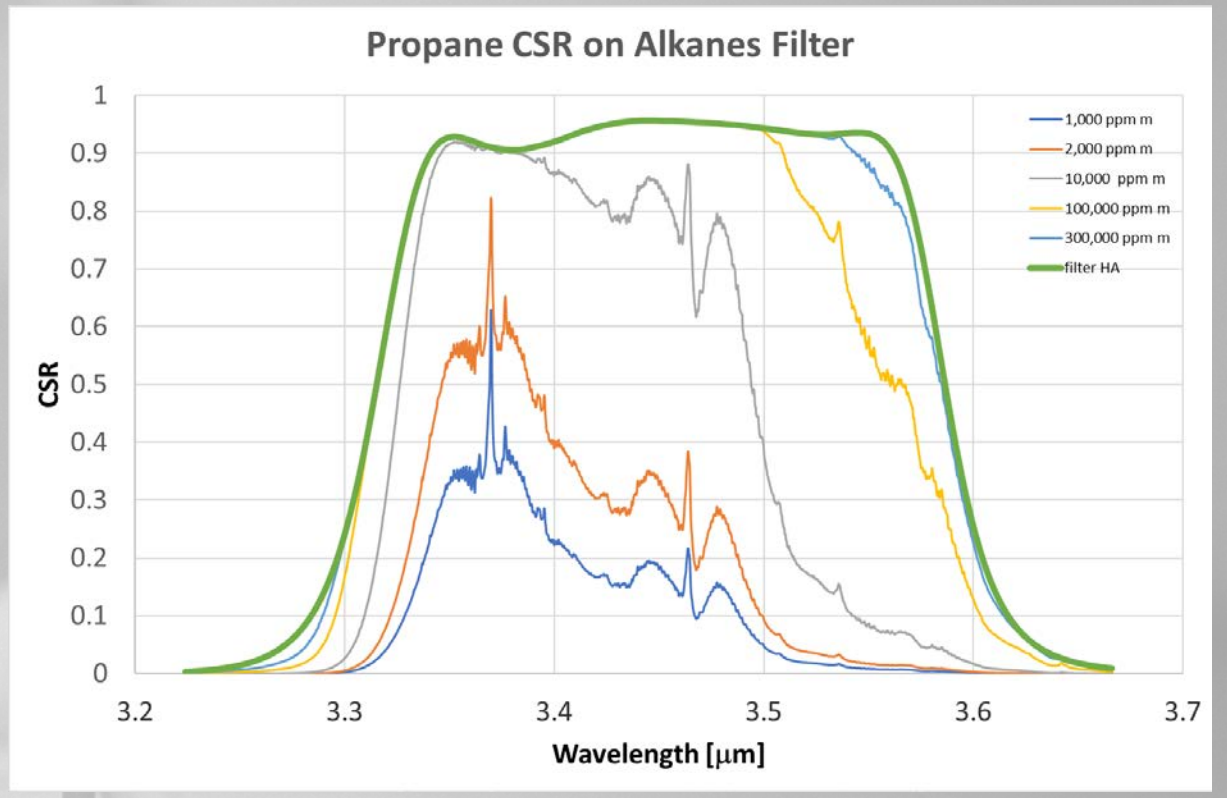
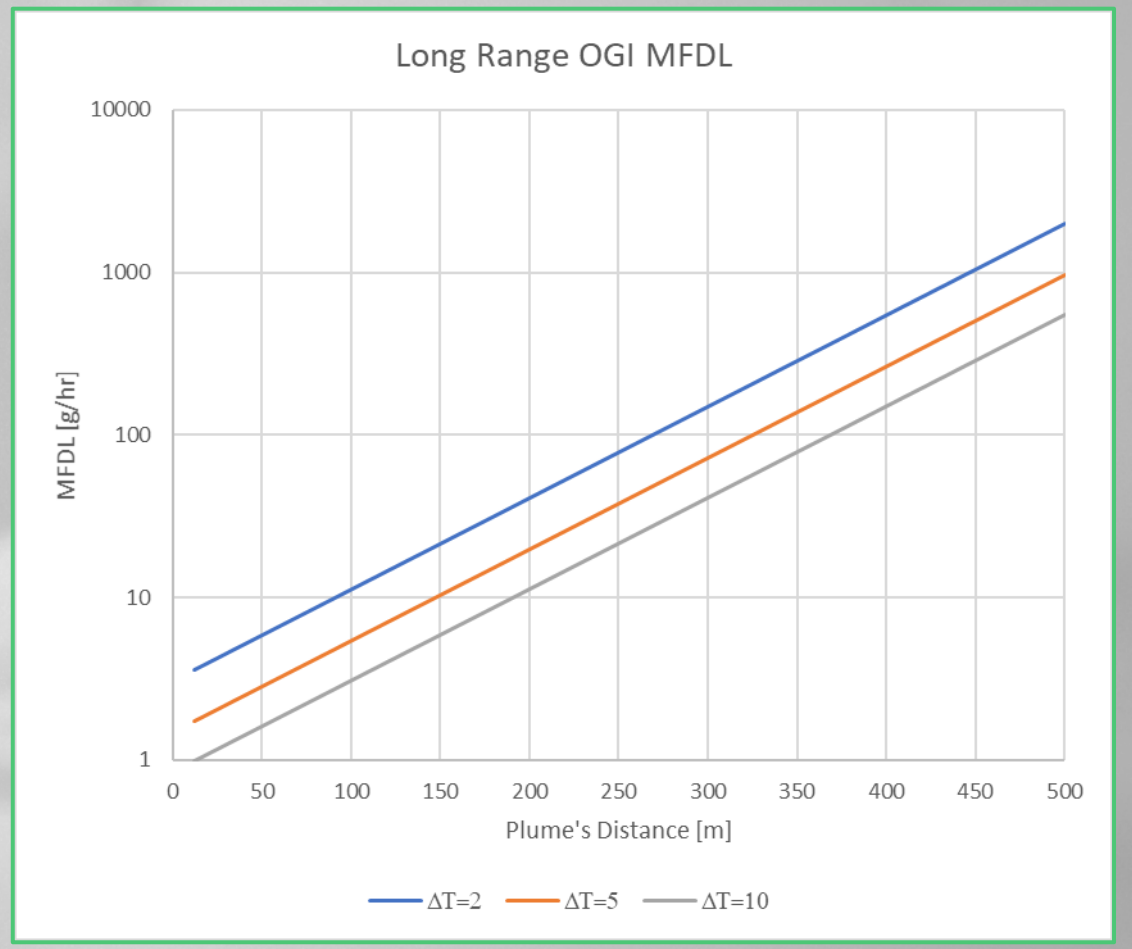
CSR SPECTRUM ON LONG RANGE OGI





AUTOMATED MFDL OF BUTANE WITH LONG RANGE OGI

- **Reliable automated MFDLs are almost 10 times greater than "human in the loop" MFDLs**
- **Opgal has developed a proprietary atmospheric model for calculating $\tau_a(\alpha_{vis}, \alpha_{wv}(RH, T, P), L)$**
- **MFDL at different ranges cab be calculated using the modelled τ_a, cloud coverage and sun elevation angle**



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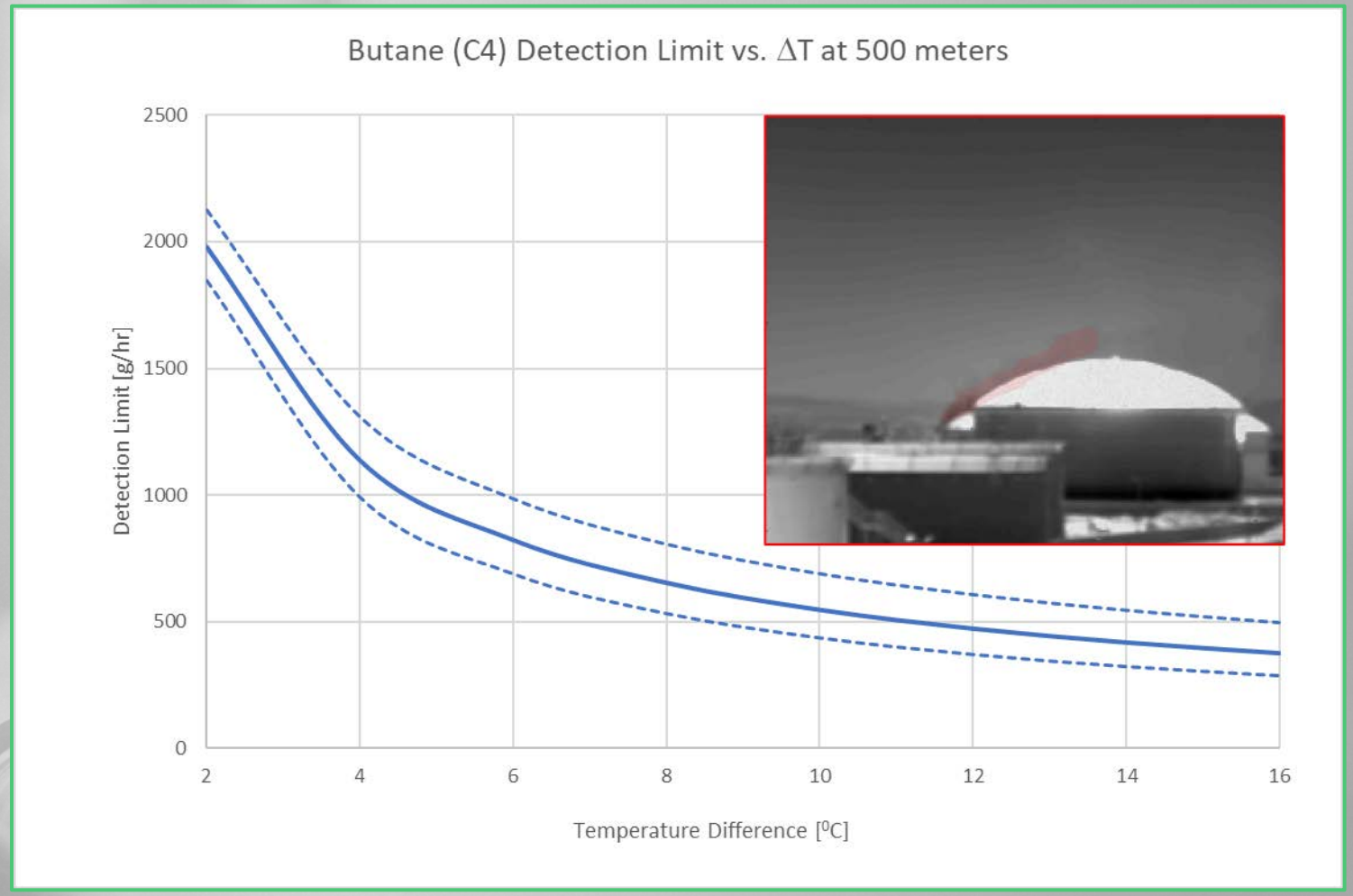
LONG-RANGE DETECTION OF C3+ ALKANES

- Opgal's in-house controlled release experiments established a mathematical relationship between MFDL and ΔT
- At 0.5 kilometer our calculated weighted extinction coefficient α_a was calculated to be $\alpha_a(30^oC, RH = 65\%) = 0.0013\ [m^{-1}]$
- A leak of several Kg/hr was detected from a tank 550 meters away



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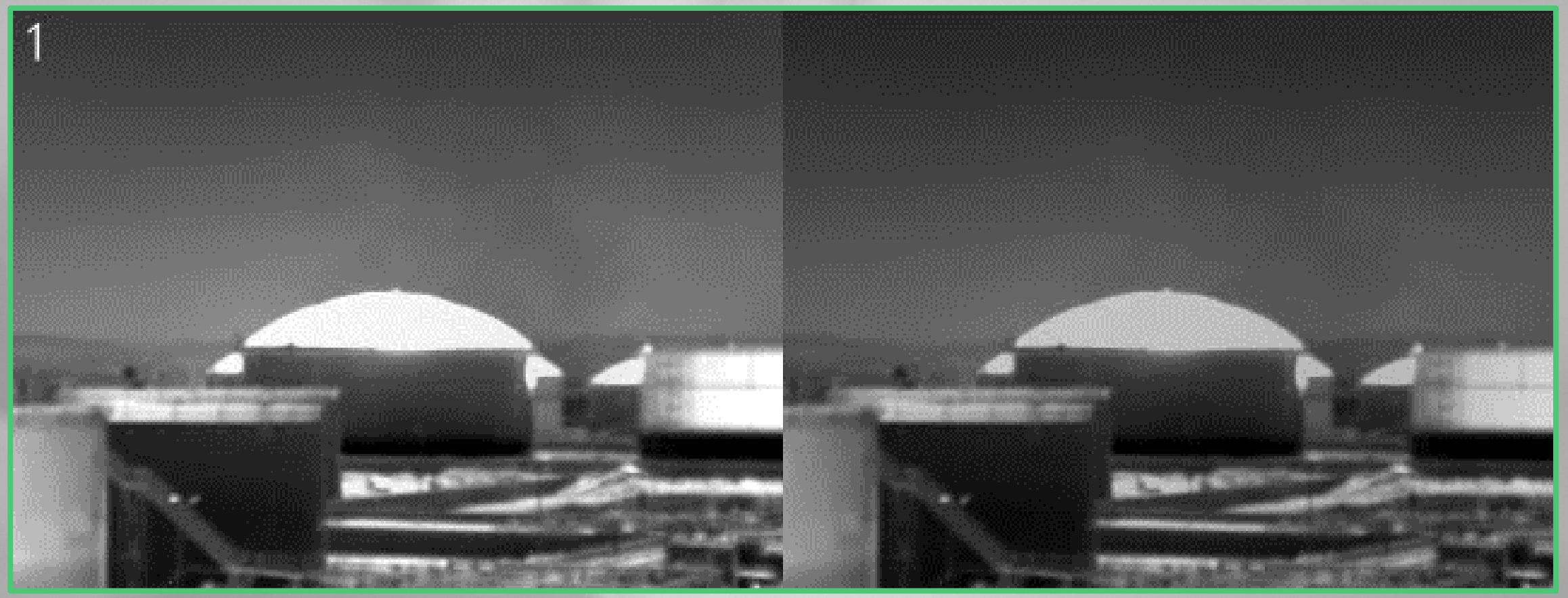
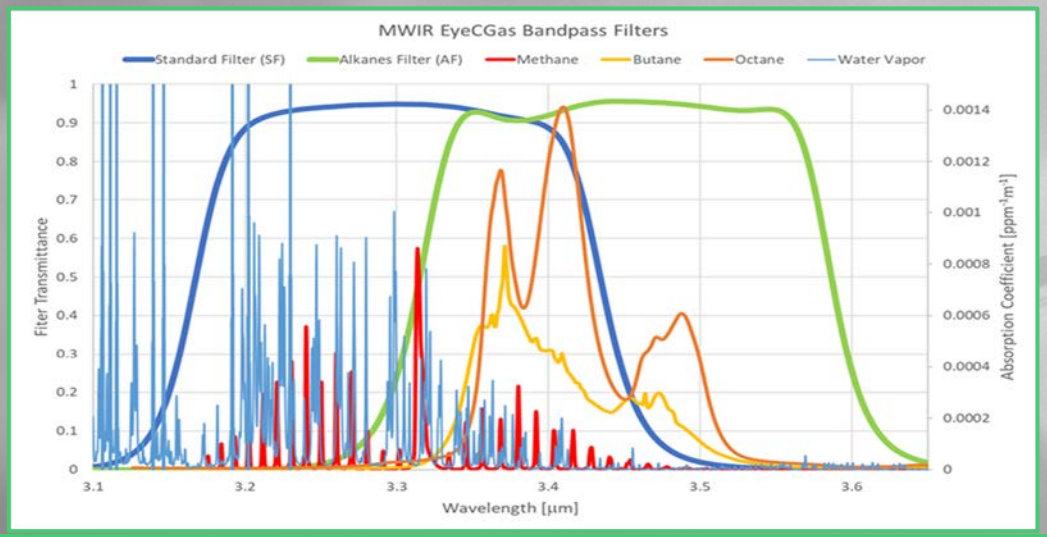
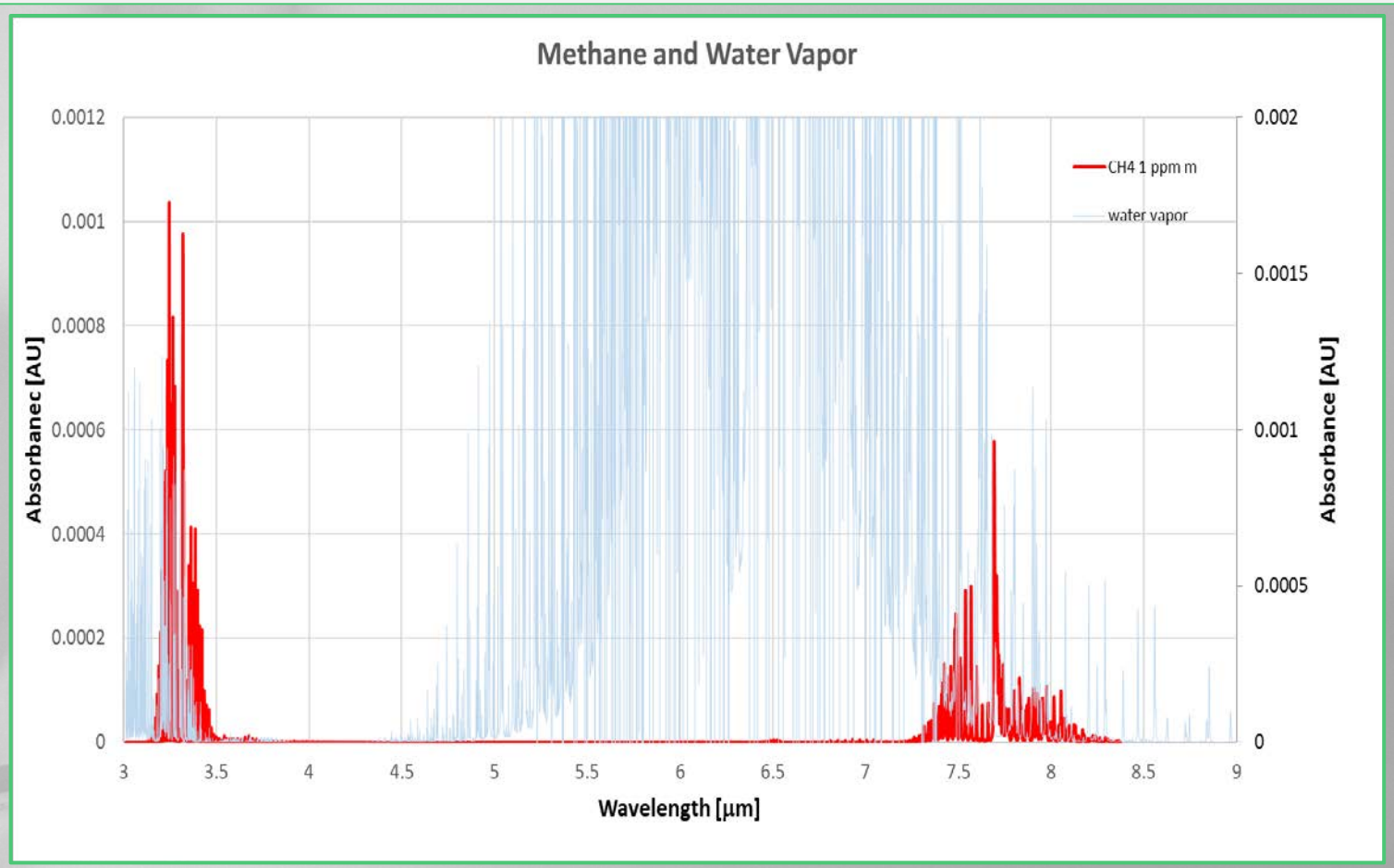
AUTOMATED DETECTION FOR 500 METERS



METHANE LONG RANGE DETECTION

- Water vapor CSR (absorption) is 4 times greater on SF than on LR filter
- Water vapor CSR on LWIR filter is about 10 times greater than on LR filter





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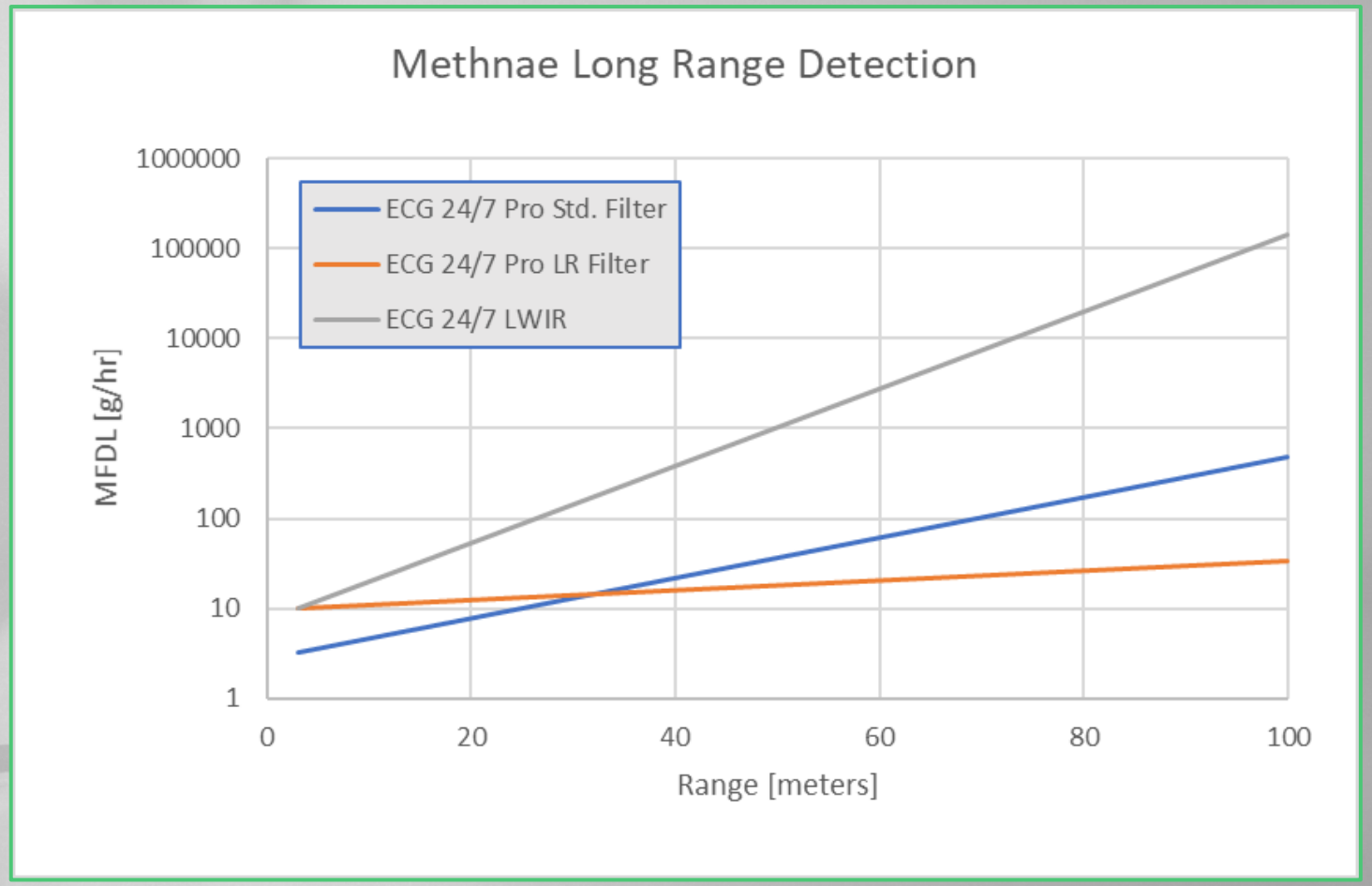
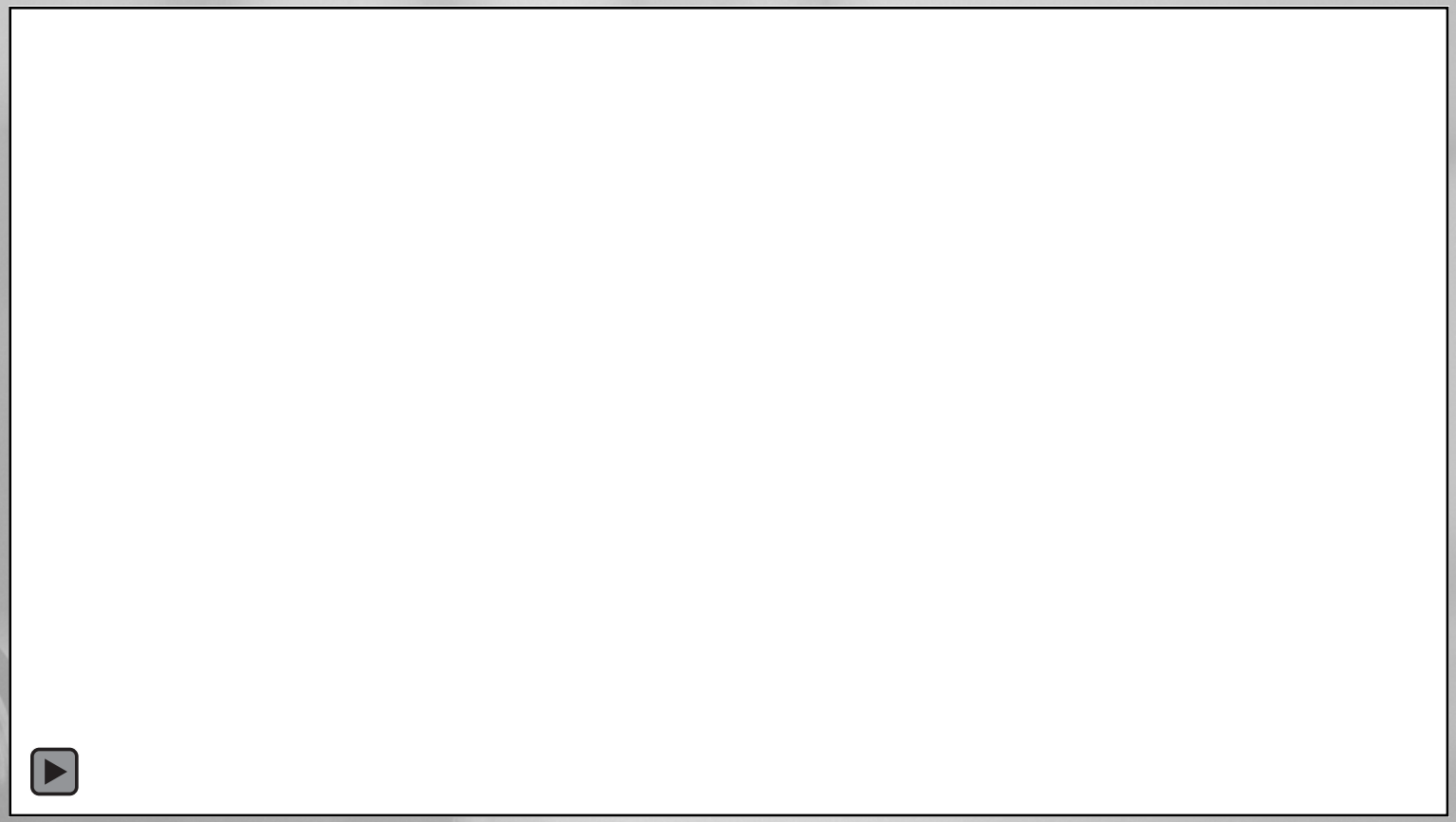
METHANE LONG RANGE DETECTION

- In short range, up to 20-meter range, all cameras can detect leaks of less than 100 g/hr in most environmental conditions
- Longer than 20-meter range, the long range cooled OGI camera has a clear advantage
- At only 100-meter range, the long-range OGI camera is about 10 times more sensitive than the short range for detecting methane leaks and 1000 times more sensitive than the uncooled OGI camera



NATURAL GAS VENTING ~10KM



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Thank you!