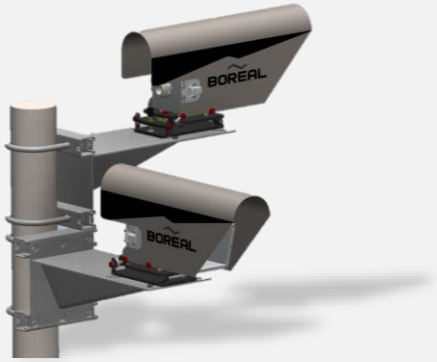
BOREAL

Open Path (OPX) Head Assembly

Laser Based – Open Path Gas Detection

Enhanced Sensing Element



Two (2) Open Path (OPX) Heads are shown mounted on pole

Large Area Coverage
Great for enclosed, congested, or open areas

Fast Speed of Response
New and independent result every second

No Sensor Poisoning + Over Ranging
Ideal for frequent and/or constant gas exposures

Fail Safe Operation + SIL2 Suitable
Diagnostics with no undisclosed failure modes

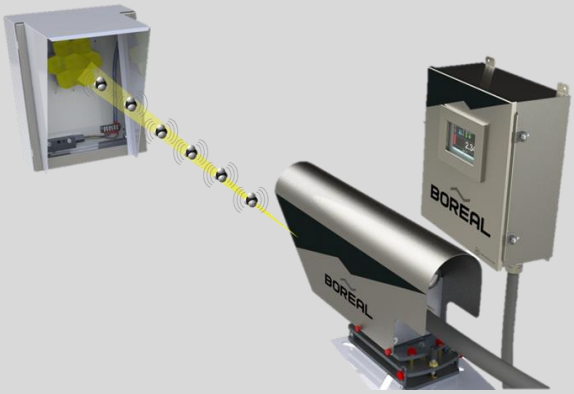
Where and Why is it Used?

Capital and Operational Cost Savings
Especially if replacing 3-4 Fixed Point Detectors

Thrives Where Others Do Not Survive
Ideal for challenging monitoring applications

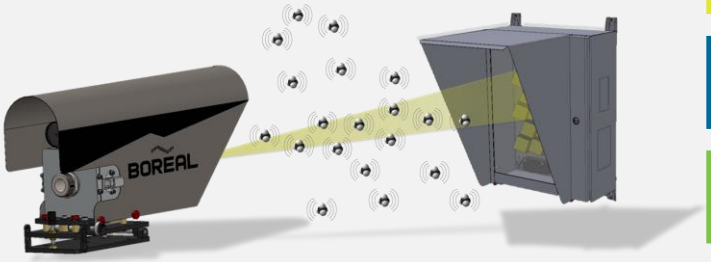
Need for Enhanced Detection Capabilities
Early Detection + Rapid Intervention = Saving Lives

Hazardous Area Certified for Industrial Use
(A)Ex ib IIC T5 Tamb <70°C Gb (C1 Div1, G: A,B,C,D)



Open Path (OPX) Head/Retro-Reflector shown with the Field Mounted - GasFinder3-MC

About Tunable Diode Laser (TDL)



Target Gas Molecules shown passing through the Active Measurement Path

Laser Light is the Sensing Element
Class 1 Eye Safe: Near Infrared (NIR) laser light

This Counts Target Gas Molecules
As the pass through the Active Measurement Path

Quantifiable Volumetric Measurement
It knows which gas and how much is detected

No Cross Interference + No False Alarms
This only detects the specific target gas of interest

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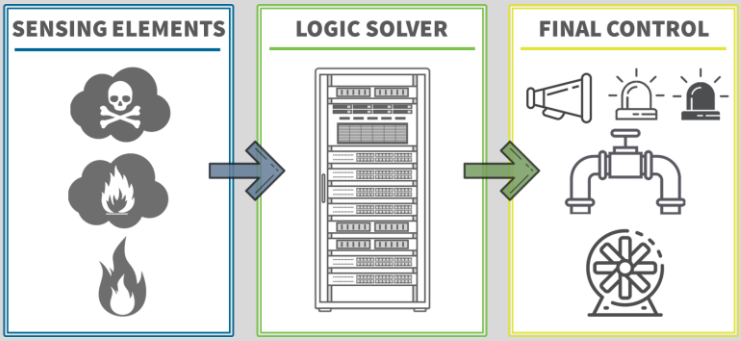
Fire & Gas Safety (FGS) System

Reference: Center for Chemical Process Safety (CCPS) – Continuous Monitoring for Hazardous Releases



1st Function: Detect the Hazard
With Sensing Elements (e.g. Gas Detectors)

2nd Function: Confirm Loss of Containment
With Logic Solvers (e.g. DCS, PLC, SSC)

3rd Function: Initiate Executive Action
With Final Control Elements (e.g. Horns, Strobes)

No Recovery Action Until a Leak is Detected
Early detection and rapid intervention saves lives

The *Center for Chemical Process Safety* strongly recommends that **"the response time for toxic [gas detectors] should be within 30 seconds of initiation analysis"** to allow the FGS System sufficient time to perform intended Recovery Actions.

Detector's Area of Influence

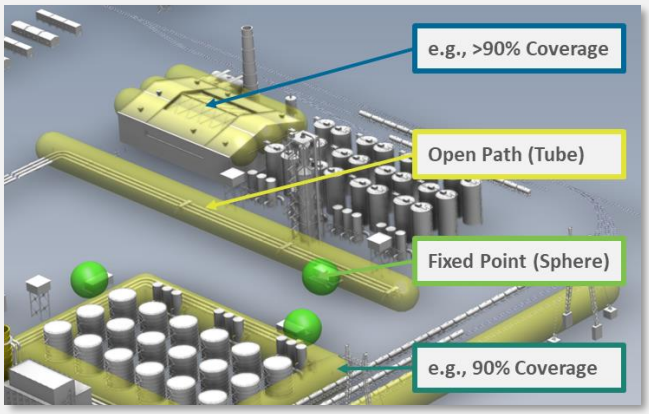
Reference: ISA TR84, CCPS – Continuous Monitoring for Hazardous Releases , & Fire & Gas Mapping Software Vendors

Visualizing the Area of Influence
Open Path (Yellow Tube) & Fixed Point (Green)

Probability of Detection Dictated By
Detector type, # of detectors, and placement

Geographic Gas Detection Coverage
Fraction of geometric area needing coverage

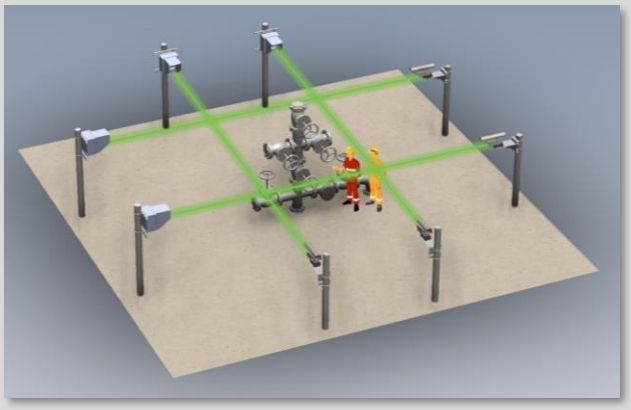
Open Path Gas Detector Feasibility
Best option if replacing >3-4 Fixed Point Detectors



Typical to assume a 5m (15ft) radius around an Open Path (Yellow) or Fixed Point (Green) Detector

Typical Mounting Height

Reference: ISA TR84, Shell DEP 30.20.11, BP-CRT-AK-35-85, and CCPS– Continuous Monitoring for Hazardous Releases



Typical to mount 2m (7ft) to 4m (13ft) above grade

Mount Above Peoples Head Height
Avoid beam block & monitor the breathing zone

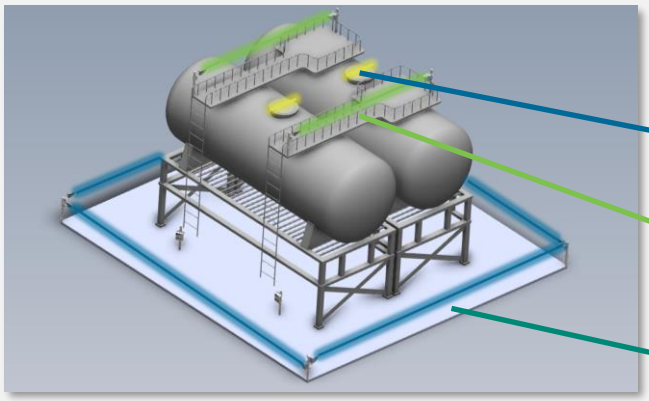
Geographic Area of Influence
Assumed to cover from grade to 5m above path

Plume in Enclosed/Congested Areas
Typical to assume plume size of 5-10 m (15-30ft)

Plume Size in Open Areas
Typical to assume plume size of 10-20m (30-60 ft)

Path Placement Strategies

Reference: Shell DEP 32.30.20.11



By utilizing multiple strategies, you can significantly increase your probability of detection

Increase your Probability of Detection
Detector type, quantity, and placement matter

Option #1: Equipment Specific Monitoring
Purpose: Fast Localized Leak Detection

Option #2: Area Monitoring
Purpose: Locate where personnel are present

Option #3: Perimeter Monitoring
Purpose: Best area coverage/odds of detection

Enhanced vs. Traditional

Question: Which Detector Type is the right selection for your application?

	FAIL-SAFE DESIGN	DRIFT	RESPONSE TIME	AREA COVERAGE	SENSOR LIFESPAN	MAINTENANCE	CONSUMABLES	POISONING
LASER BASED – OPEN PATH GAS DETECTORS	Yes	N/A	1 sec	Up to 500m	15-20 years	N/A	N/A	N/A
TRADITIONAL - FIXED POINT GAS DETECTORS	No	Yes	10-90 sec	1 sq. in.	6-24 mths	≥ 30 days	Yes	Yes

Note: Traditional – Fixed Point Gas Detectors (T-FPGD) are Electro-Chemical Sensors and Catalytic Bead Sensors

Major Points of Emphasis

Fail-Safe Design and Operation
Diagnostics with no undisclosed failure modes

No Measurement Drift
Internal Reference Cell maintains “Line-Lock”

Fast Response Times
New and independent sample every single second

Large Area Coverage
Detect over 5–500 m (15-1,500ft) path lengths

Long Sensor Life Span
10-year warranty on light source (i.e. laser)

Minimal Maintenance Burden
No calibration or intervention available/required

No Consumables
No replacement sensor or calibration gas required

No Sensor Poisoning or Fouling
Laser is not damaged by gas, heat, or humidity

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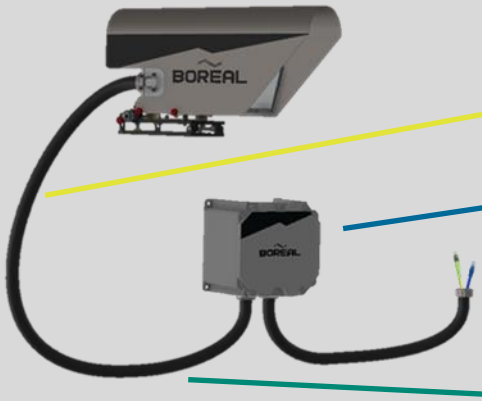
Cabling Options

Note: Cables come pre-terminated and therefore are ordered to specific lengths required from the installation.



Open Path (OPX) Head shown with Cable in Flex Conduit and a Measurement Head Junction Box

Allowable Lengths of Cabling to GasFinder
Installation range from 5 – 300 m (15 – 1,000 ft)

Measurement Head Junction Box
Allows for easy access to use Alignment Kit tools

Specific Cabling Used
Single Mode Fiber Optic and CAT6/5e Cabling

Cable Jacketing Options
Flex Conduit (<30m) & Standard or Armored (>30m)

Open Path (OPX) Head

Note: The Open Path (OPX) Head is to be used with one of the GasFinder3 Series of Field Mounted or Rack Mounted Analyzers

Forms the Active Measurement Path
With the Open Path (OPX) Head + Retro-Reflector

Easily Obtain + Maintain Alignment
Align with one hand without needing hand tools

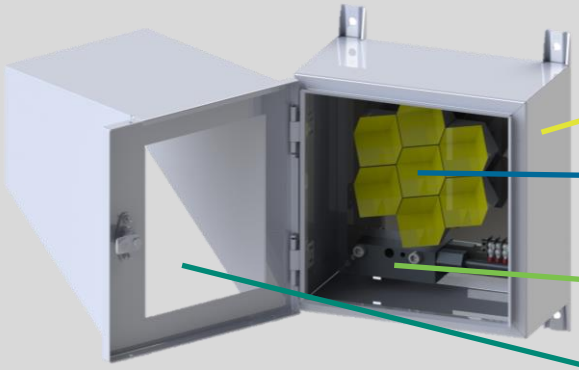
Superior Tolerance to Vibration
Due to the integrated laser beam from Retro-Array

High Laser Power + Tight Collimation
Optimized for use in short, medium, or long paths

Open Path (OPX) Head shown above

Retro-Reflector

Note: Retro-Reflector Assembly is configured to meet the needs of the individual path and application



The door of the Retro-Enclosure shown open to highlight the components

Retro-Enclosure + Rain/Dust Hood
Stainless Steel or Fiberglass Reinforced Plastic

Retro-Array
Cornercube Retro-Arrays return the Laser Light

Retro-Heater
Stops build-up of condensation on Retro-Window

Retro-Window
Lexan, Mylar, or Teflon keeps the Retro-Array clean

I-Beam Mounting Structure

Note: Does not include U-Bolts or other hardware to affix to a mounting structure.

I-Beam Mounting Structure (accessory) used for affixing the Open Path (OPX) Head to a Pole

Enables Mounting to Vertical Surfaces
Allows for I-beam or wall mounting arrangements

Using a Post or Pile as a Mount
Enables cylindrical mounting arrangements

Horizontal Range of Motion
Allows for selecting optimal angle of alignment

Open Path (OPX) Head Hardware
Includes hardware to a fix Open Path (OPX) Head

Alignment Kit

Note: While the Alignment Kit is not required to perform alignment, it is a very useful and recommend accessory

Optical Multi-Meter
Includes Laser Power Meter and Visible Laser

Remote Light Meter (RLM)
Provides indication of laser intensity for alignment

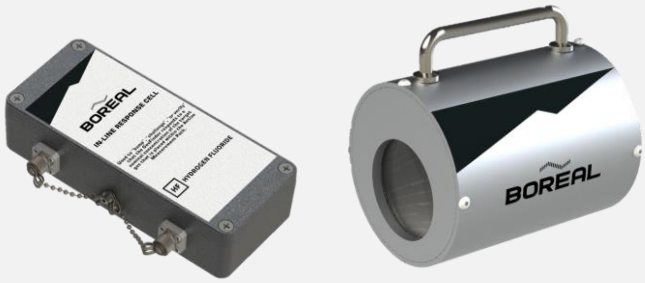
Fiber Cleaning Tape
To ensure FC/APC (Fiber) Connectors remain clean

Other Useful Components
IR Card, Grey Tape Retro-Arrays, & Connectors

Contents of the Alignment Kit

Response Cell Options

Note: There is no field calibration required or available



In-Line Response Cell shown on the left and Response Cell shown on the right

“Bump”, “Challenge”, & “Verify”
That GasFinder responds to actual target gas

End-to-End Verification
See response within Active Measurement Path

Ease of Use Design
The handle and Retro-Flap provide easy handling

Target Gas Availability
HF is only available in the In-Line Response Cell

Open Path (OPX) Head

Cross Sectional Diagram and Overview of Components of the Open Path (OPX) Head

Rain/Dust Hood
Prevents accumulation of debris on the window

Alignment Scope
Provides technician with alignment positioning

Optical Bench Terminations
Single Mode Fiber Optic and CAT6/5e Cabling

X-Y Aiming Mount
No tools required for perform one handed activity

Optical Bench (Transceiver)

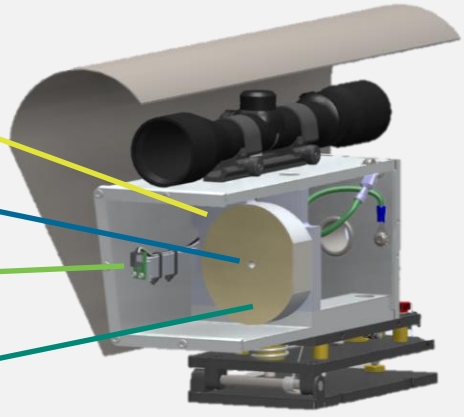
Note: This optical configuration is called a bi-static as it contains both the sending and receiving optics on one side

Optical Bench
Removable from enclosure for easy terminations

Launch Optics
The collimated beam is launched via this hole

Photodiode
Converts the laser light to a small electrical signal

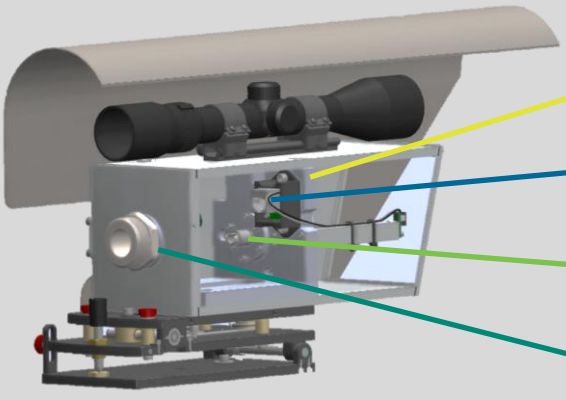
Collecting Optics
Returned laser light is focused on the photodiode



Cross Sectional Diagram and Overview of the Components of the Optical Bench

Cabling Connections

Note: The Open Path (OPX) Head is a passive device and does not require power to operate.



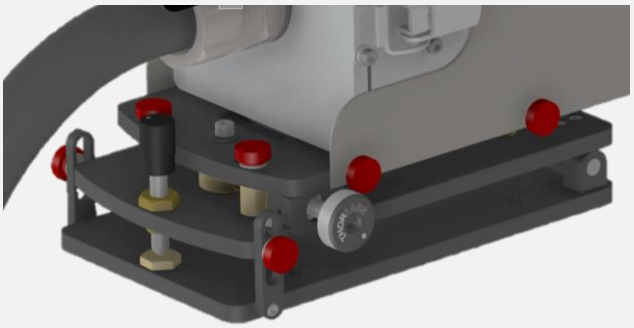
Optical Bench
Removable from enclosure for easy terminations

RJ45 Connector for CAT6/5e Cable
Includes the Photodiode Amplifier Board

FC/APC Connector for Fiber Optic Cabling
Used with Single Mode Fiber Optic Cabling

Path Cable Connection
Fitting and Cabling included within Assembly

X-Y Aiming Mount



Cross Sectional Diagram and Overview of Components of the Open Path (OPX) Head

No Tools Required for Alignment
Alignment can be done one handed

Fine Adjust Ideal for Long Path Lengths
Small movements enable for optimal alignment

Vertical and Horizontal Fine Adjustment
Easily obtain optical alignment with the X-Y Mount

Locking Set Screws
Tighten red Set Screws to lock alignment in place

Alignment Scope

Alignment Scope is Permanently Mounted
Open Path (OPX) Head has an Alignment Scope

Align while Operational
No need to inhibit the operation for alignment

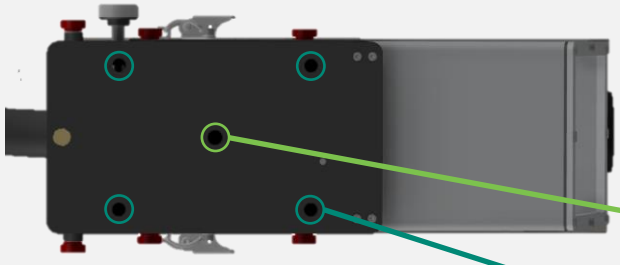
Optical Zoom/Power on Alignment Scope
Helps the end-user to focus on the Retro-Reflector

Includes Scope Cap/Covers
Scope Caps/Cover help to keep the optics clean

Cross Sectional Diagram and Overview of the Components of the Optical Bench

Mounting/Hardware Options

Note: See the General Arrangement Drawings for specific dimensions



Bottom View of the Open Path (OPX) Head showing the hole sizes on the X-Y Mount

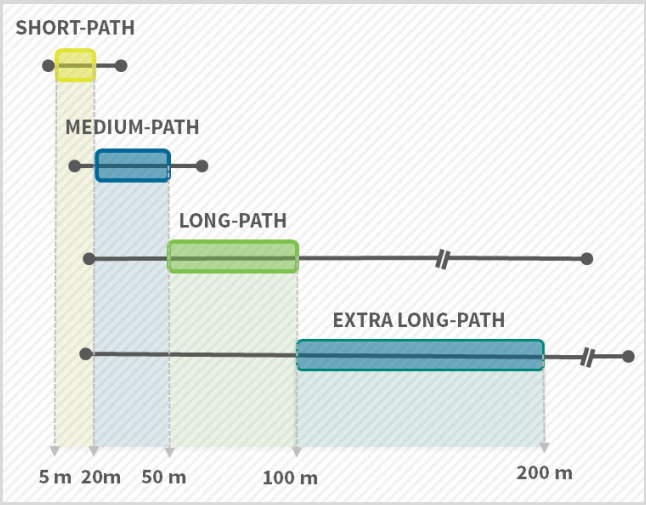
Bottom Mount Design
Provides stable footing for Open Path (OPX) Head

Ideal for Long Path Lengths
Path lengths ranging 5-500 m (15 – 1,500 ft)

One (1) 3/8” – 16 Threaded Hole
Use on either I-Beam Mounting Structure or Tripod

Four (4) 0.281” Thru Holes
Enables end-user to directly mount to flat surface

Select a Path Length Range



Note: These Path Length Ranges have been provided to help the End-User confidently select a suitable Retro-Reflector.

Short-Path (IMOS Array)
Suggested Path Length: 5-20 m (15-60 ft)
Functional Path Length: 5-30 m (15-90 ft)

Medium-Path (Wafer Array)
Suggested Path Length: 20-50 m (60-150 ft)
Functional Path Length: 10-60 m (30-180 ft)

Long-Path (Cornercube Array)
Suggested Path Length: 50-100 m (150-300 ft)
Functional Path Length: 20-350 m (60-1,050 ft)

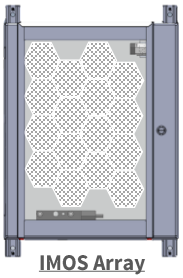
Extra Long-Path (Cornercube Array)
Suggested Path Length: 100-200 m (300-600 ft)
Functional Path Length: 20-500 m (60-1,500 ft)

Retro-Reflector Options

Suggested Path Length: Consideration has been given to optimizing the ability to obtain & maintain optical alignment.

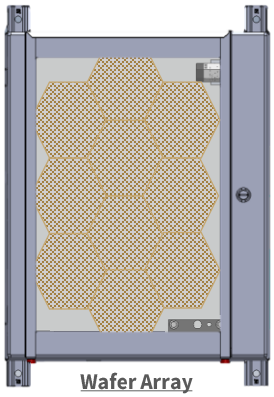
Short-Path
5-20 m (15-60 ft)
Small Retro-Enclosure will be fully populated with IMOS Retro-Arrays.

Mounting Structure:
Suggested Sizing
>4” Post @ 7’ Height
>6” Post @ 13’ Height


IMOS Array
Small SST Retro-Enclosure

Medium-Path
20-50 m (60-150 ft)
Large Retro-Enclosure will be fully populated with Wafer Retro-Arrays.

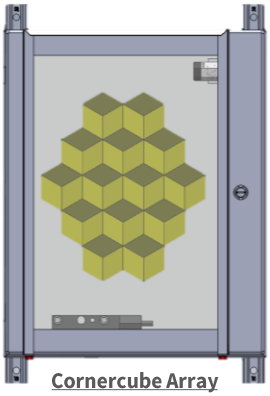
Mounting Structure:
Suggested Sizing
>6” Post @ 7’ Height
>8” Post @ 13’ Height


Wafer Array
Large SST Retro-Enclosure

Functional Path Length: The range of suitable Returned Laser Light (Rx) without consideration of ideal Alignment Stability.

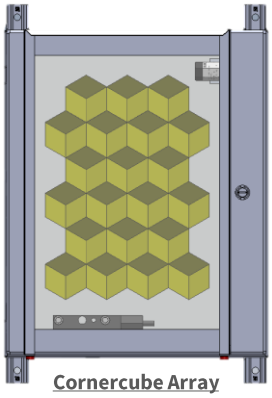
Long-Path
50-100 m (150-300 ft)
Large Retro-Enclosure will be partially populated with Cornercube Retro-Arrays.

Mounting Structure:
Suggested Sizing
>8” Post @ 7’ Height
>10” Post @ 13’ Height


Cornercube Array
Large SST Retro-Enclosure

Extra Long-Path
100-200 m (300-600 ft)
Large Retro-Enclosure will be fully populated with Cornercubes Retro-Arrays.

Mounting Structure:
Suggested Sizing
>10” Post @ 7’ Height
>12” Post @ 13’ Height


Cornercube Array
Large SST Retro-Enclosure

Suggested Mounting Structure: End-User to confirm the Mechanical Suitability with their own Geo Technical and Wind-Loading Study.

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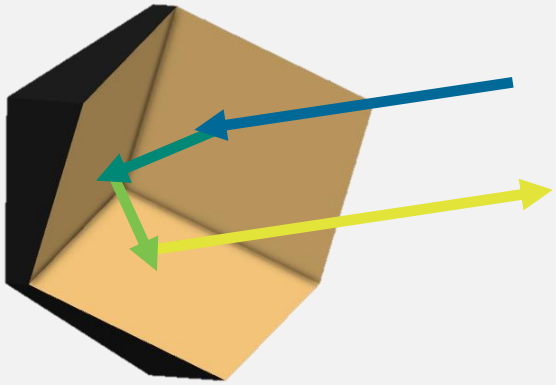
Cornercube Retro-Reflector

Note: Cornercube has a tolerance of 30 arc-seconds



Regardless of the angle of incidence, the laser light is always returned back in the direct it came

The Cornercube Returns the Laser Light
Back to the Open Path (OPX) Head for analysis

The Laser Light is Always Reflected 180°
Due to the orientation of the three faceted mirror

A Group of Cornercubes forms a Retro-Array
To provide a larger target for the laser beam to hit

It is Common to Oversize the Retro-Array
To provide even better alignment stability

Retro-Enclosure Options

Note: See the General Arrangement Drawings for specific enclosure dimensions

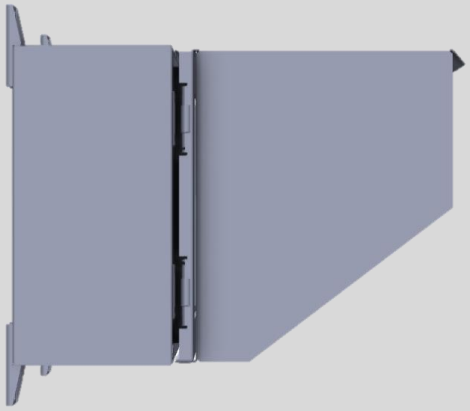
Small Retro-Enclosure
Used for Short-Path Lengths Only

Large Retro-Enclosure
For Medium, Long, and Extra Long-Path Lengths

304 Stainless Steel (SST)
Popular option for industrial applications

OR

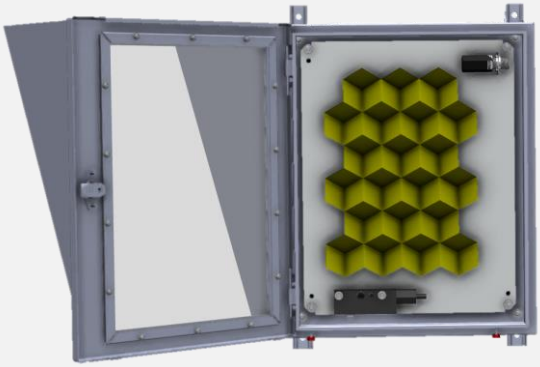
Fiberglass Reinforced Plastic (FRP)
Most often used in light industrial applications



The Retro-Enclosures include Mounting Clips

Retro-Heater Options

Note 1: Retro-Enclosure does not have any pre-drilled holes
Note 2: Heater and Thermostats are left with flying leads



Retro-Heater (Bottom) and Thermostat (Top) shown in a Large Stainless Steel Retro-Enclosure

Recommended for Outdoor Installations
Keeps condensation from building on the window

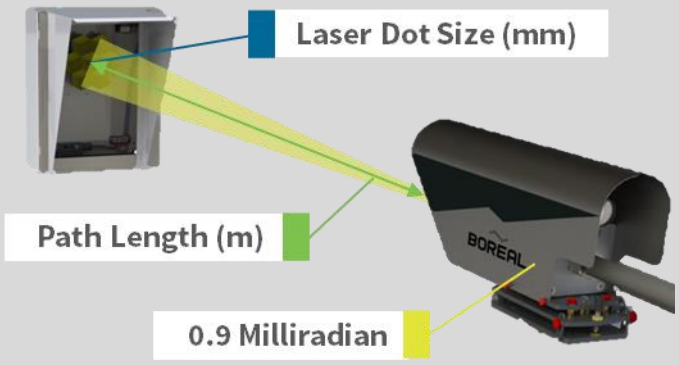
Hazardous Area Heater & Thermostat
End-User to wire as per local electrical standards

24 VDC Powered Retro-Heater (25W)
Includes a 40°C (104°F) Thermostat

OR

110-240 VAC Powered Retro-Heater (50W)
Includes a 40°C (104°F) Thermostat

Calculating the Laser Dot Size



Laser Dot Size Calculation:
0.9 Milliradians x __m Path Length = __mm Dot Size

Note: The returning laser beam will always have a dot size of 140mm (5.5") enter the collecting optics at the OPX Head

The Laser Light Emitted is Collimated
The laser dot will grow the further it travels

Collimated to 0.05 Degrees (0.9 Milliradian)
Using Milliradian allows for easier calculations

Formula for Calculating Laser Dot Size
0.9 Milliradians x Path Length (m) = Dot Size (mm)

Important for Procurement and Design
To ensure that alignment stability is maintained

Design of a Mounting Structure

Important Design Goal
Ensure optical alignment is always maintained

Laser Beam Size vs. Retro-Array Size
Will provide you with support movement tolerance

Think of Diurnal/Seasonal Temp. Changes
Metal structures can expand and contract

Consider Geotechnical + Wind Loading Data
When designing your mounting structure

Note: It is important to have platform separation between Open Path (OPX) Head and personnel support (e.g. platform)

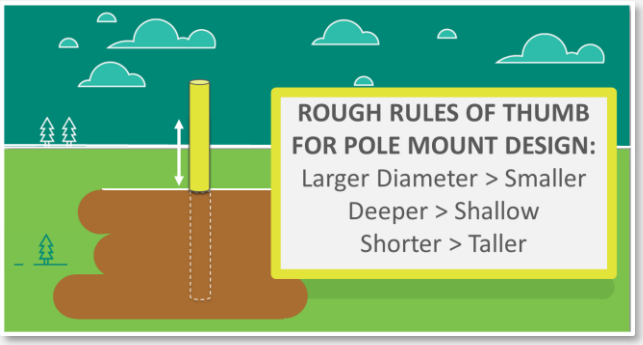
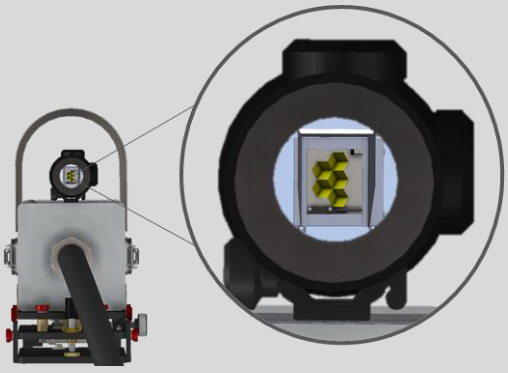


Image above highlights some basic concepts that enable for a solid mounting structure

Tolerance to Beam Block



If the Retro-Reflector is visible through the Alignment Scope, there is enough Returned Laser Light (Rx) to function

Note: For falling mediums like rain and snow, the fast sampling speed helps to better operate through opacity

Operates Through Rain, Snow, Fog, Etc.
Functional test validates up to 97% Beam Block

Light Level (Rx) Reading (Transmittance)
Quantify how much Laser Light has been returned

Beam Block = Specific Inhibition State
2.7 mA for Analog Loop and Exercise Enabled Relay

Beam Block Time Delay (0-300 Seconds)
Used to overcome transient mediums like steam

Open Path Unit of Measure

Note: For path lengths over 5m, it is most common for PLC/DCS's to use the Path Integrated Concentration (ppm-m).

Ambient Methane Example:
2 ppm Methane x 50 m Path Length =
100 ppm-m Path Integrated Concentration

Function: Target Gas Molecule Counter
Throughout the Laser's Active Measurement Path

Path Integrated Concentration (ppm-m)
Sum of total concentration over entire path length

Unable to Spatially Resolve Concentration
Location and density of plume in path is unknown

Parts Per Million – Meter (ppm-m)
Concentration represented over a 1 m equivalent

Growth and Travel of Plumes

Unpredictability of Plumes Vector
From varying weather or process conditions

Detector Siting Relative to Source
It is seldom appropriate to mount close to source

Momentum Jet when Under Pressure
Set detectors back to maximize contact w/ plume

Plume Travel in Low Wind Conditions
Plume may travel >30m (>100ft) in 15-30 seconds

Reference: Center for Chemical Process Safety – Continuous Monitoring for Hazardous Releases

Glycerine Smoke Machine released through a 1/16" Orifice under 100 PSI of Pressure

Setting Alarm Thresholds

Note: The goal for Path Integrated Alarms Thresholds is to alarm at similar levels as that of Fixed Point Gas Detectors.

Alarm Threshold (ppm) x Assumed Plume Size (m)
= Path Integrated Alarm Threshold (ppm-m)

Use Point Gas Detection Alarm Thresholds
Use NIOSH, OSHA, IDLH thresholds as a start

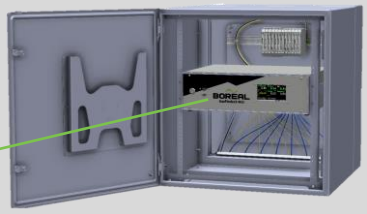
Select an Assumed Plume Size
Typical to start with a 10 m (30 ft) Assumed Plume

Path Integrated Alarm Threshold
e.g. 10 ppm NIOSH x 10 m Plume = 100 ppm-m

Remember About Enhanced Performance
Area coverage, Speed of response, and low MDL's

Next Step: Pick your GasFinder

GasFinder3-MC
(Field Mount)



GasFinder3-MCr
(Rack Mount)

Click on the Images above to visit the respective Webpages

Two (2), Four (4), or Eight (8) Channels
Enables the use of multiple Measurement Heads

No Calibration + No Intervention
Due to Internal Reference Cell & Fail-Safe Design

Certified for use in Hazardous Areas
(A)Ex ib Gb IIC T4 Tamb <65°C (C1 Div2, G: A,B,C,D)

HART 7, Relay, and MODBUS Outputs
24 VDC @ 20 Watts with 4A Cartridge Fuse

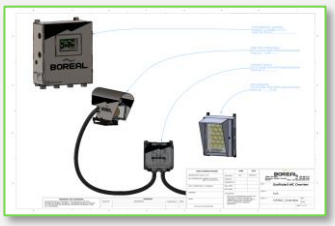
Take a Look at these Resources

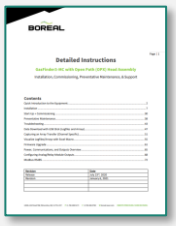
Visit our Website
Where there is much more you can read about

Instrument Data Sheets
Invaluable resource for designing the installation

General Arrangement Drawings
Where there is much more you can read about

Detailed Instructions
Step-by-step guide through installation + support





Click on the Image above to access these Resources

Detectable Gases with TDL

Note 1: Other temperature and detection ranges may be available
Note 2: Detection ranges shown below are at ambient temperatures

HF — Hydrogen Fluoride
HFL: 0.4 - 250 ppm-m
HFH: 1 - 1,000 ppm-m

H_2S — Hydrogen Sulfide
H2SL: 100 - 100,000 ppm-m
H2SH: 1,000 - 500,000 ppm-m

CH_4 — Methane
CH4L: 2 - 8,500 ppm-m
CH4H: 100 ppm-m - 10 LEL-m

CO_2 — Carbon Dioxide
CO2L: 120 - 80,000 ppm-m
CO2H: 1,000 - 500,000 ppm-m

CO — Carbon Monoxide
COL: 8 - 8,500 ppm-m
COH: 250 - 500,000 ppm-m

NH_3 — Ammonia
NH3L/H: 8 - 6,500/15,000 ppm-m
NH3UH: 0.4 – 100%-m

HCN — Hydrogen Cyanide
HCN: 8 - 2,500 ppm-m

HCl — Hydrogen Chloride
HCl: 2 - 2,500 ppm-m

C_2H_4 — Ethylene
C2H4: 20 - 15,000 ppm-m

C_2H_2 — Acetylene
C2H2: 4 - 2,500 ppm-m

O_2 — Oxygen
O2: 2,500 - >1,000,000 ppm-m

H_2O — Water Vapor
Various Ranges Available

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