This training course discusses the correct use of Infrared (IR) Optical Beam Smoke Detectors for the protection of lives, equipment and property.

The course covers the Principles of Operation and Use of Beams.

For specific applications, Optical Beams can be important elements of a well-engineered automatic fire system and can overcome the problems and limitations of other types of smoke detectors.

This training material provides information to assist the Fire System Designer and Installer in achieving a successful Optical Beam Smoke Detector installation.

The appropriate local installation standards and legislation in effect at the time of installation must be adhered to and take precedence over any statements made or implied by this training material.

FFE cannot take responsibility for the installation commissioning or maintenance of products.

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Agenda

- What are beam detectors, and how do they work?
- Where are beam detectors used?
- Why choose a beam detector, and why choose Fireray?
- Which Fireray should you choose for your application?
- How to install, use and get the best out of your Fireray

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What are beam detectors, and how do they work?

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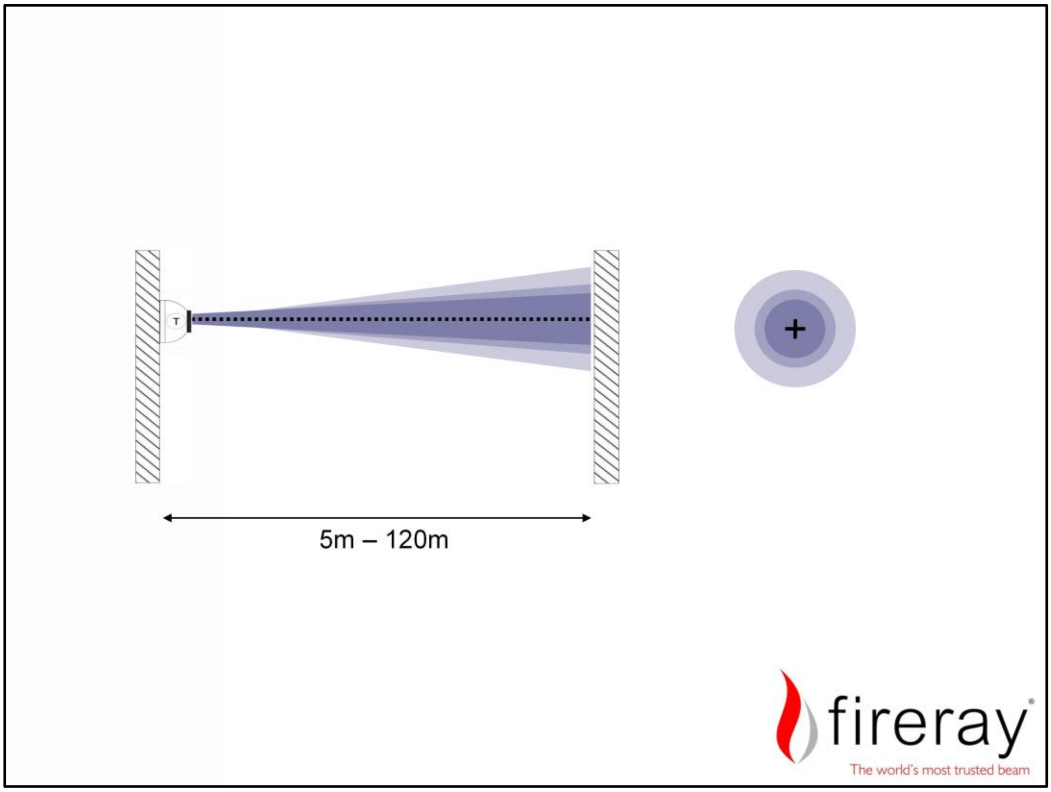


An Optical Beam Smoke Detector is a device that monitors the amount of obscuration present in an open area. It does this by transmitting a beam of infrared light across the area to be protected, and monitoring the amount of light that is received after it has passed through the area. If the light received falls below a predetermined level it is decided that the obscuration (by smoke) has increased to such a level that a Fire must be signalled to the Fire Alarm Control Panel (FACP).

A good visualisation of the infrared beam uses the analogy of a torch. Like a torch beam, the IR beam expands with distance and its intensity drops with range and distance from the axis. Torch beams can be crossed without scattering, the same as infrared Optical Beams.

Infrared light is used for two key reasons:

1 It is attenuated/diffused by the smoke particles and also the heat haze caused by a fire

2 It is invisible to the human eye, which makes it less obtrusive, since there is no constant visible flashing of light

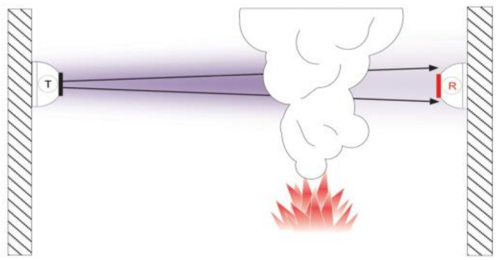
An Optical Beam comprises a Transmitter, Receiver and Control Unit.

The Transmitter is an infrared light source that projects an invisible light beam over the area to be protected toward the Receiver.

The Receiver contains a photosensitive sensor that forwards the signal to a Control Unit.

The Control Unit, which can be a separate or an integrated unit analyses the signal information and communicates with the Fire Panel on the status of the Optical Beam.

Principle of Operation



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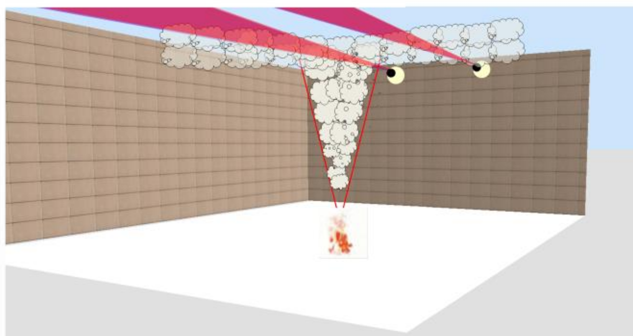
If smoke obscures the light path from Transmitter (T) to Receiver (R) above a preset level, a Fire condition is signalled.

Smoke Behaviour



Siting and positioning of Optical Beams is best understood when the general behaviour of smoke can be pictured.

Smoke detectors depend on convection to transport smoke to the detector. Since in a building the greatest concentration of smoke will generally form at the highest parts of the enclosed area smoke detectors need to be sited near the ceiling. As smoke rises, it becomes diluted with clean, cool air, which is drawn into the plume. The size of fire required in order to operate smoke detectors increases rapidly as the height of the ceiling above the fire increases. Optical Beams are less affected by ceiling height than point-type detectors, since the increased size of plume will involve a greater proportion of the detector's path length of the Optical Beam and help to alleviate the effects of reduced smoke density.

Where are Beam Detectors used?

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Optical Beams are used for ‘wide area’ smoke detection, enabling coverage of a large area cost effectively. An Optical Beam can cover a wide area, equivalent to many point detectors. The user gains in lower cabling time, lower cost, less obtrusive wiring and reduced maintenance.

Also, Optical Beams are well suited to environments with high ceilings, where dust/dirt are present due to the compensation feature and also in areas vulnerable to temperature extremes due to wide operating range.

An Optical Beam Smoke Detector is the best choice for taller spaces since the smoke plume at height involves a greater proportion of the detector's path length than with point type detectors. Other detection devices have limitations on the maximum operating height.

Why choose a Beam Detector?

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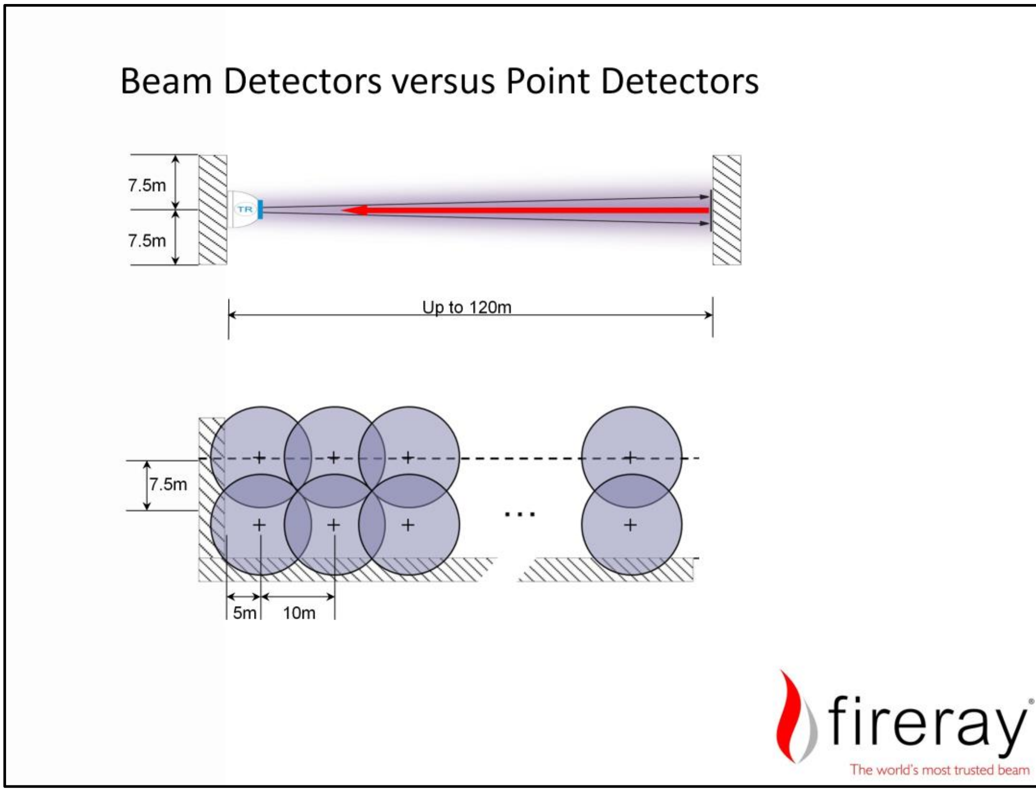

In addition to the limitations of point detectors in buildings with high ceilings (point detectors are typically only recommended for use up to 12m), Optical Beam Detectors also offer an advantage of the area they can cover with one Optical Beam.

In accordance with BS5839-1, a point smoke detector covers a radius of 7.5m with 10m between detectors, an area of 100sqm per detector – hence approx. 15 units are required to cover 1500m^2. One Optical Beam can cover an area of 1500m^2. All the point smoke detectors require individual connection and testing in the ceiling, whereas the Optical Beam parts are easily accessible along the building walls only.

Beam Detectors versus Point Detectors

- Cabling required to each point detector
- Access required for maintenance
- Intrusive installation - no good for ‘ornate ceilings’
- Height restriction

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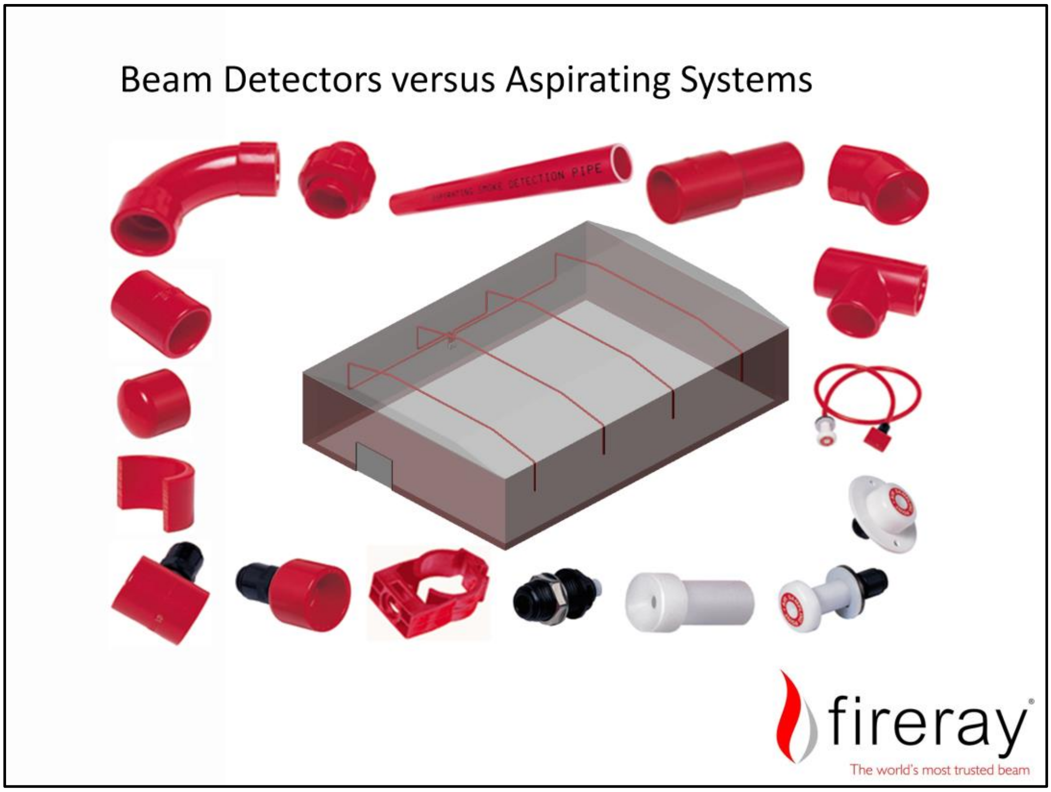

Aspirating detector systems cover the same kinds of areas as beam detectors, however have significant drawbacks related to the amount of equipment required to implement such a system.

Beam Detectors versus Aspirating Systems

- High purchase cost
- High installation cost
- Very intrusive installation
- Not suitable for dirty environments without installing extra equipment and performing extra maintenance
- Can be easy to get installation and set-up wrong (hole size, spacing, fan speed)
- Must use smoke to test, whereas beam can be tested with simple filter

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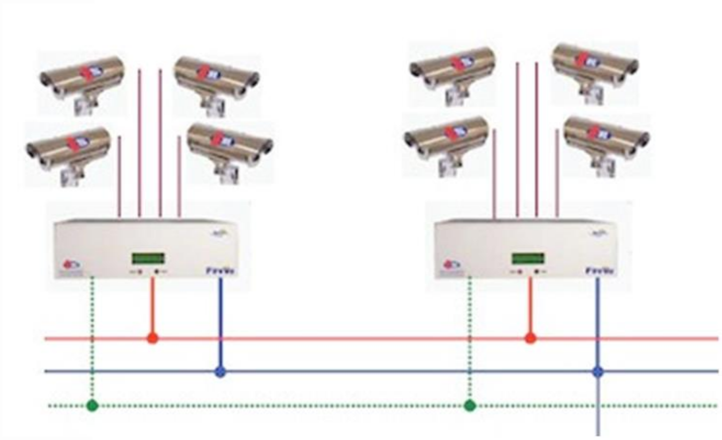
Beam Detectors versus Video Smoke Detection



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Beam Detectors versus Video Smoke Detection

- Expensive
- Complicated
- Requires line of sight to the source of smoke
- Ambient light conditions can cause false alarms
- Not covered by a current EN54 standard so may not be possible to use as primary detection type

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Why choose Fireray Beam Detectors?

- Designed, built, tested and supported from head office in UK
- Technical support is delivered by engineering team
- International reach – 80% of our products are exported
- Proven track record in the beam detector industry – we've been doing this for over 40 years!

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Which Fireray should you choose in your application?

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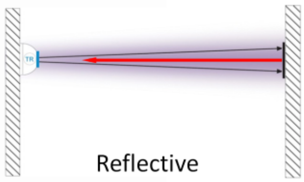
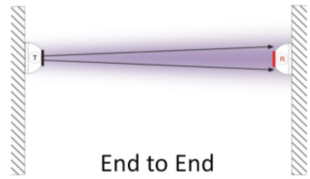
Which type of Fireray should you use?





Reflective

- Cheaper installation costs as wiring needed at only one end of the building
- Simpler alignment as only one end needs aligning
- Must have good line of sight between detector and reflector
- Must be no reflective surfaces in or around the beam path

End to End

- Can be used with narrow line of sight
- Small size of detector means it is easily hidden away, so building aesthetics are unaffected
- Dust does not affect the system as much, because there fewer surfaces through which the light passes

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Reflective Fireray

- Reasons to choose Fireray5000
  - Laser-assisted, automatic alignment – extremely fast (< 2 minutes)
  - Low level alignment and access to system parameters
  - 'AutoOptimise' compensation for building movement

- Reasons to choose Fireray50/100R
  - Small, self-contained
  - Cost-effective
  - User familiarity and very trusted!

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End-to-End Fireray

- Reasons to choose Fireray3000:
  - One-person alignment
  - Sunlight rejection with Ambient Light Cancellation (ALC) technology
  - Low level access to system parameters

- Reasons to choose Fireray2000 Exd:
  - Special applications where ATEX rating is required, such as:
  - Flammable liquid/gas/powder stores
  - Distilleries
  - Power stations

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How to install, use and get the best out of your Fireray

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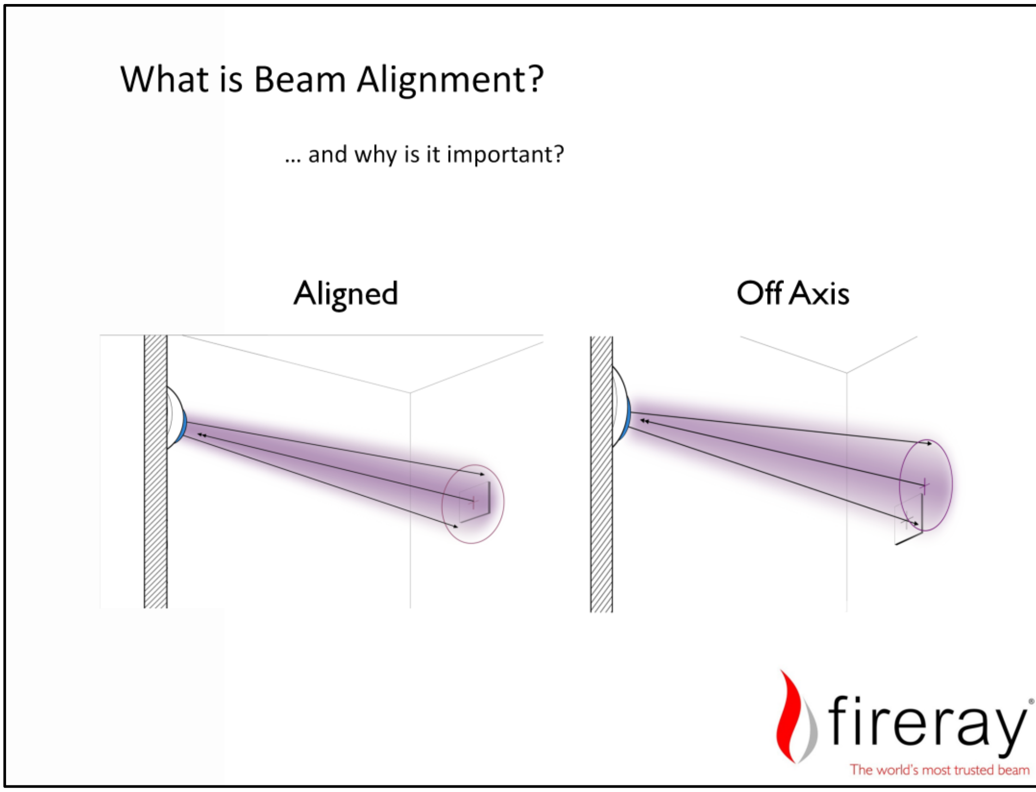

It is very important that the optical beam is aligned centrally on the reflector/receiver, as this will ensure that any slight movement in the building is tolerated. Whilst a detector that is aligned slightly off-centre (as in the second picture above) will operate correctly – in that it will detect smoke correctly – any movement will take the optical beam off the reflector/receiver (causing signal reduction leading to false alarms), or closer to the centre of the reflector/receiver (causing an increase in signal, potentially leading to reduction in sensitivity and signal-high faults).

If the alignment procedure is followed correctly, it is easy to get good alignment on even a manually adjusted beam (i.e. Fireray50/100R and Fireray3000). With its automatic alignment function, Fireray5000 guarantees central alignment every time.

Three Golden Rules

1. Secure mounting to a rigid structure
2. Clear line of sight – during installation and throughout the life of the beam
3. Suitable environment

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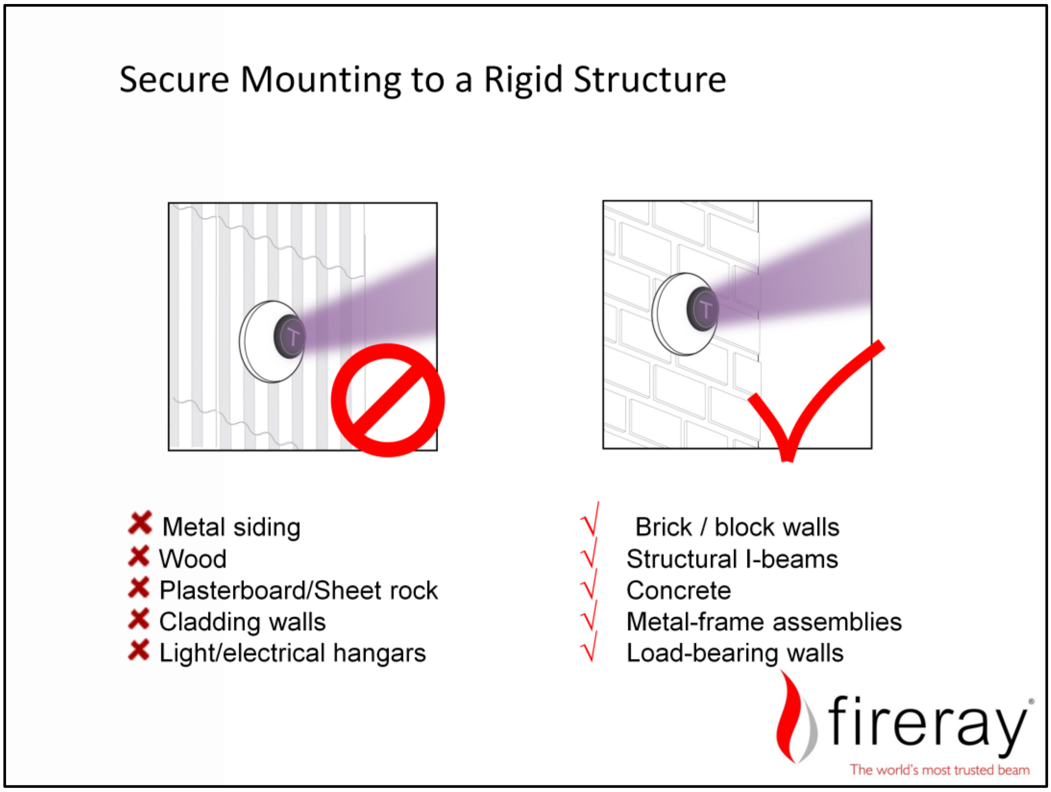
If the Three Golden Rules are followed, then installation and alignment will be easy and operation will be free of problems for many years!

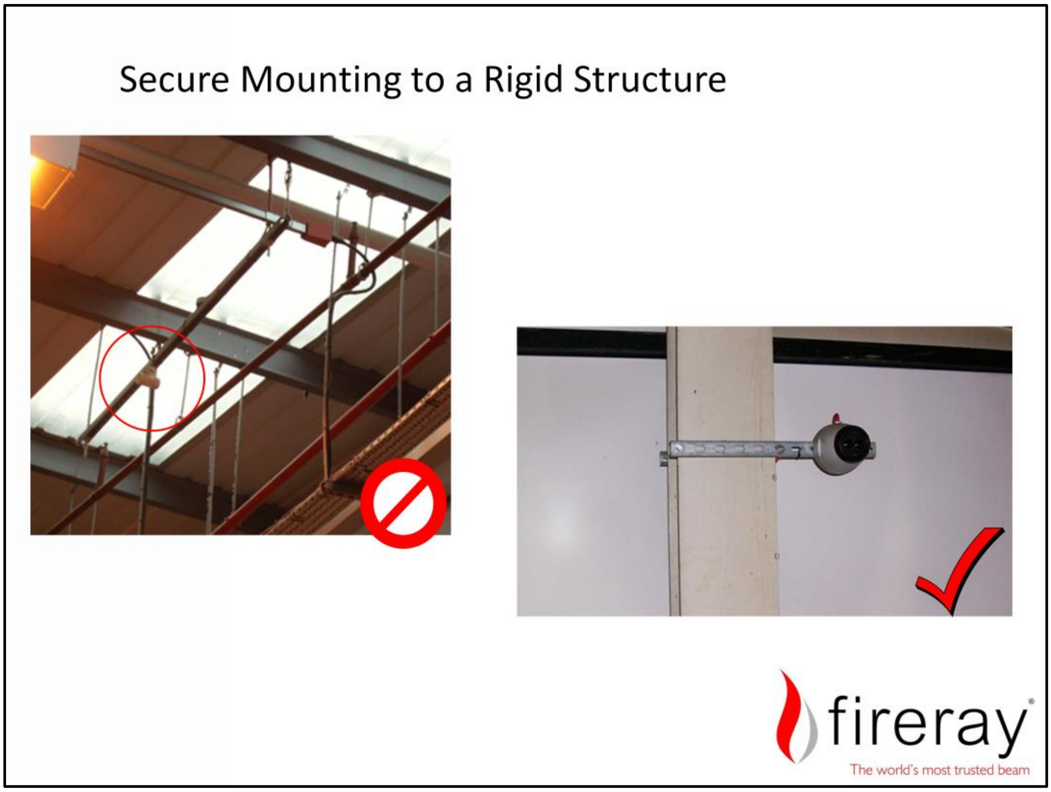


An Optical Beam installed and commissioned correctly will function reliably, as long as it is properly maintained.

Using the torch analogy, you can see that small rotations of the Transmitter will cause large movements of the beam at a distance, so Optical Beams must be mounted on stable surfaces as suggested above, to limit misalignment.

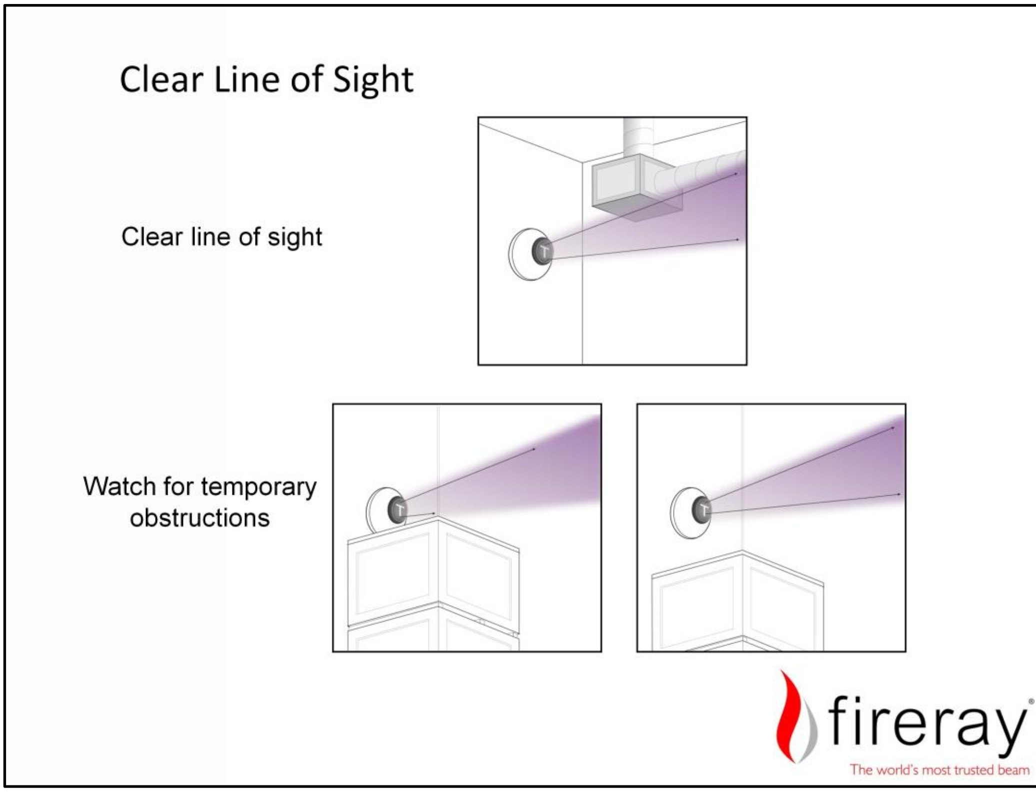
When it is not possible to mount directly onto a suitable surface such as brick/block walls, structural I-beams etc. secure and rigid metal-frame assemblies should be used. These can be checked for stability by viewing how far the spot from a laser pointer moves when the structure is displaced.

If only one end wall of the building is very rigid, prefer to mount the Transmitter (Projected) or Transceiver (Reflective) on the most rigid surface.



The first photograph is of our older Fireray2000, where it is clear to see that the detector head has been mounted to a metal rod which is in turn hanging from a ceiling support. Such a mounting will make it almost impossible to align the detector head correctly as this mounting will move very easily.

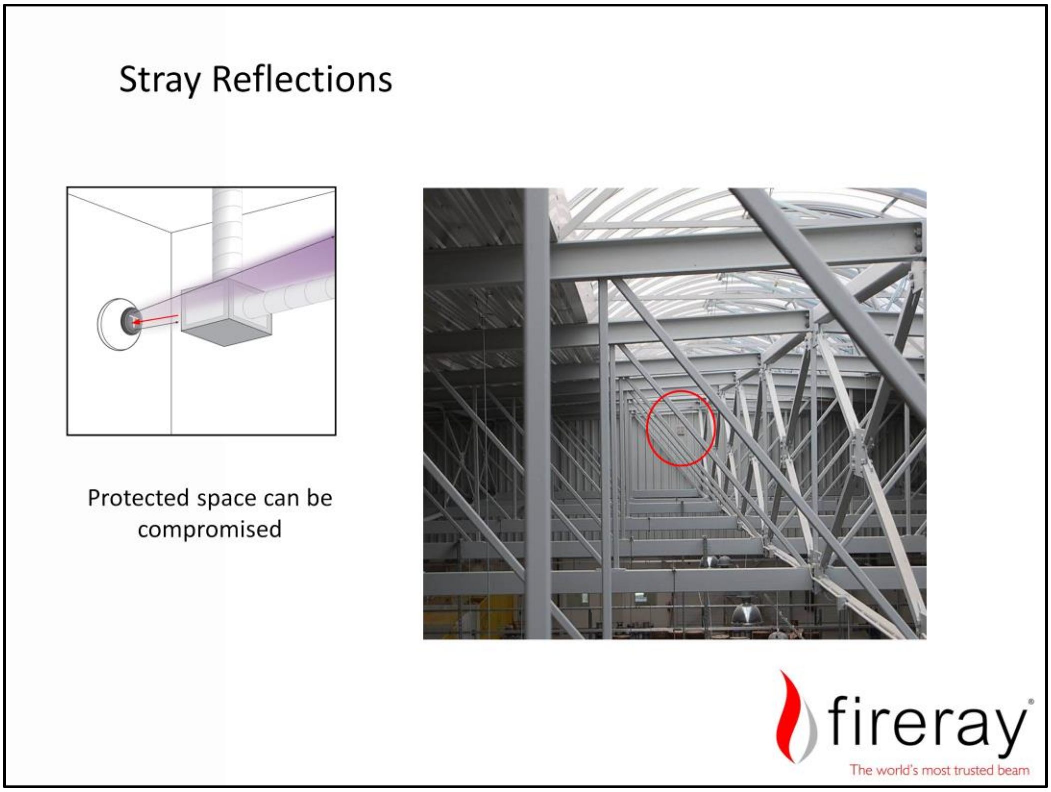
The second photograph shows a Fireray5000 detector head mounted to a vertical girder, using 'unistrut'. This is a very secure and stable mounting.



A Beam is an obscuration device and so needs a clear line of sight between the Transmitter and Receiver or Reflector to work effectively. An obstruction during Beam alignment can make a Reflective or Projected Optical Beam difficult to align.

Movement of obstructions into the line of sight of an installed Optical Beam can cause false alarms as the received signal is varying. So, the positioning of Optical Beams should be assessed for any activity that may cause a blockage during operation.

One need not be concerned about temporary obscuration of the Beam by insects on the Beam optics or by birds flying in the Beam path, since these are small and the delay before a Trouble (Fault) or Fire is signalled allows the obstruction to pass. In some Fireray Beams, this value can even be varied to suit.



In the figure, imagine a reflective object partly in the line of sight of the Beam. With a Reflective Beam, there is a possibility that stray reflections can return to the Receiver, potentially affecting the stability of the received signal and leaving some of the area unprotected. Hence, we recommend a clear line of sight for a Reflective beam of 1m diameter. Confirming correct alignment of a Beam with cover up tests of the Reflector is a sound way of ensuring the whole area is protected.

A smaller clear line of sight is often possible with a Reflective Beam depending upon positioning, the reflectivity and position of obstructions and range – consult FFE for further advice.

With a Projected Beam, any stray reflections return harmlessly to the Transmitter, having no effect on the signal. As a result, Projected Beams are a great choice for operating through narrow gaps. If the Receiver is positioned within the central area of the transmitted cone of light, the line of sight for a Projected Beam can theoretically be as small as the Receiver diameter. We recommend a reliable clear line of sight for a Projected beam of 0.6m diameter, but much smaller clear lines of sight down to the theoretical minimum are possible – consult FFE for advice on your specific installation.

Environment - Sunlight

Direct sunlight can blind the receiver
Place the receiver facing away from the sun
Use the Fireray3000 as it has ALC

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Beams are highly tolerant to ambient sunlight since they discriminate between the wanted Beam infrared signal and the infrared content in ambient sunlight by electronically filtering out the unwanted a.c. frequencies. But, just like the human eye, Beams cannot tolerate strong sunlight, directly into the Receiver as they can saturate.

Careful positioning of the Receiver taking into account the position of the sun and its movements throughout the day and seasons is recommended. Alternatively, a Projected system is a good choice as one can point the Transmitter towards the sun as it cannot be saturated.

Also, heat haze rising from sources of heat can distort and attenuate the infrared light Beam causing the received signal to fluctuate. If the fluctuations get too big, false alarms will be generated. Take care with positioning.

Environment - Lighting

Lighting with high infra-red content (e.g. sodium lamps) can cause problems – use Fireray3000 as it has ALC

Any lamps with very high infra-red light content, such as sodium lamps (as seen in the photograph), can cause issues when close to reflectors or detectors. The ALC function of the Fireray3000 means that this detector can be installed even in the presence of such lighting.

Incandescent lamps, camera photoflash sources and fluorescent tubes can also emit infrared light but normally not enough to cause detectors any issues.

Environment - Condensation

- Will cause signal strength reduction, ultimately resulting in false alarms
- Fireray heaters are now available for condensing environments:



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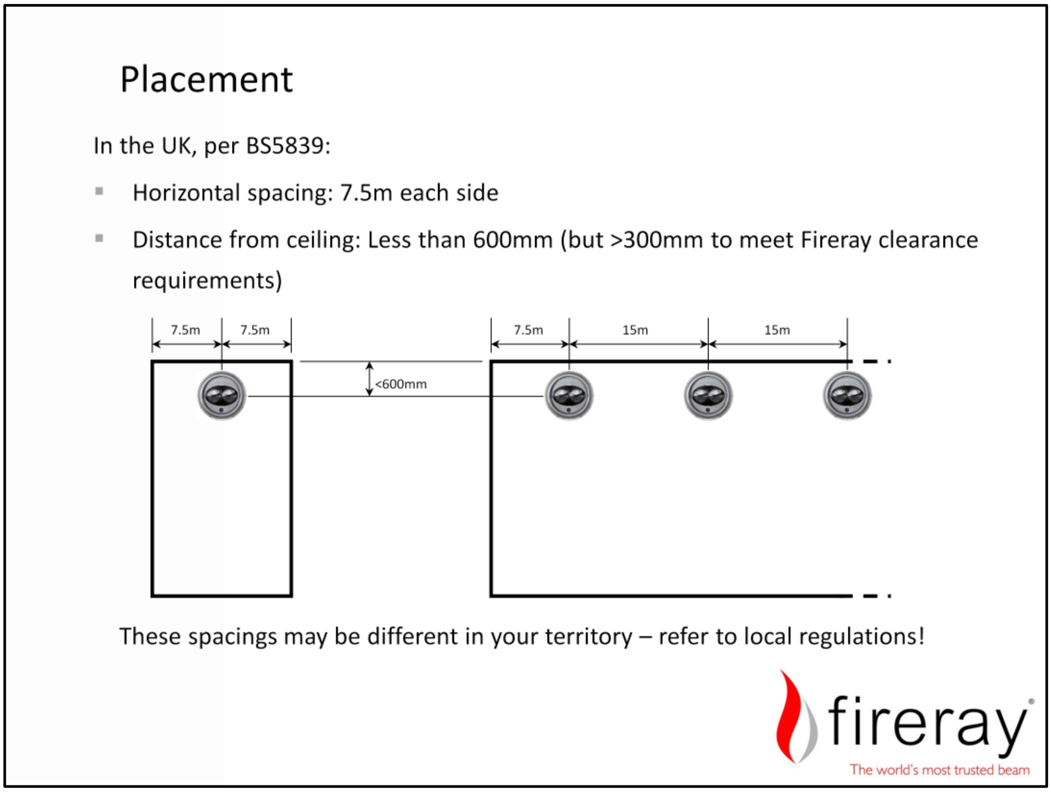
Fireray heaters work by blowing warm air across the lenses of the detectors to prevent condensation forming. They are available for the Fireray50/100, Fireray3000 and Fireray5000.

The prism heater uses the existing prism mounting plate accessory and adds a heater mat to the back surface to give an even heating of the prisms.

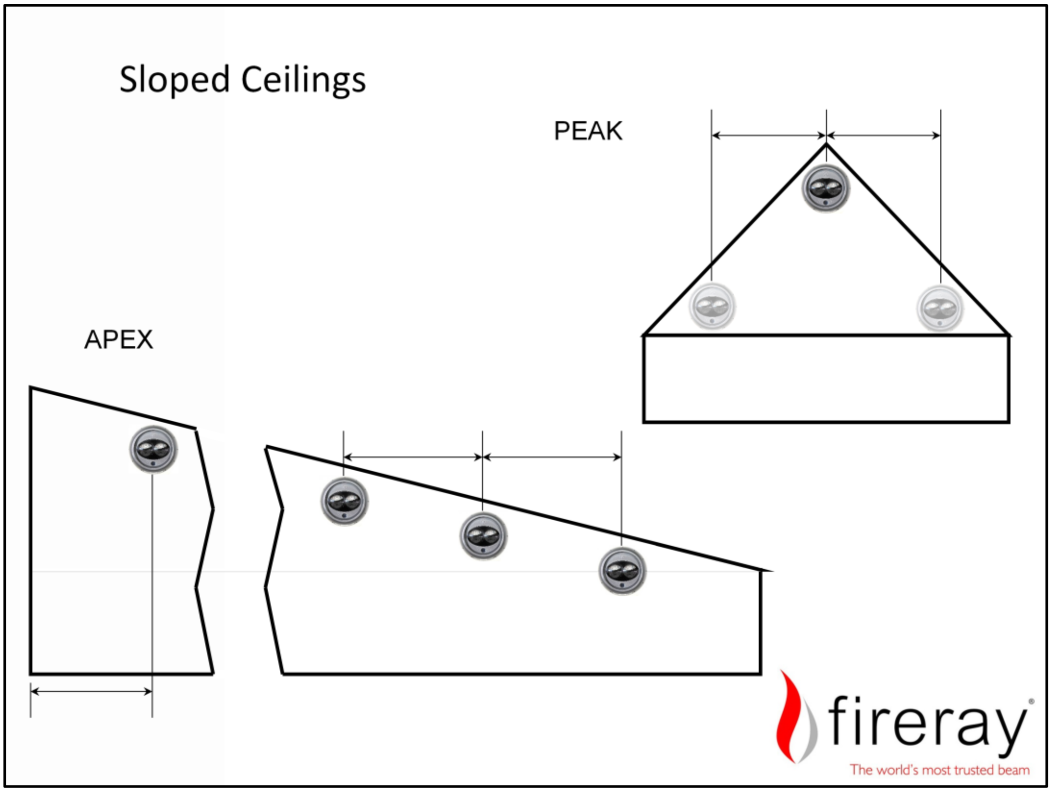


Optical Beams are only sensitive to smoke between the Transmitter and Receiver, hence they should be mounted on the end wall or close to it.

Width of coverage is generally 7.5m either side of the Beam, hence beam spacing is 15m and Beams should be 7.5m from side walls. Again, width of coverage is governed by local installation guidelines.

Beams should be mounted a distance down from the ceiling according to local guidelines.

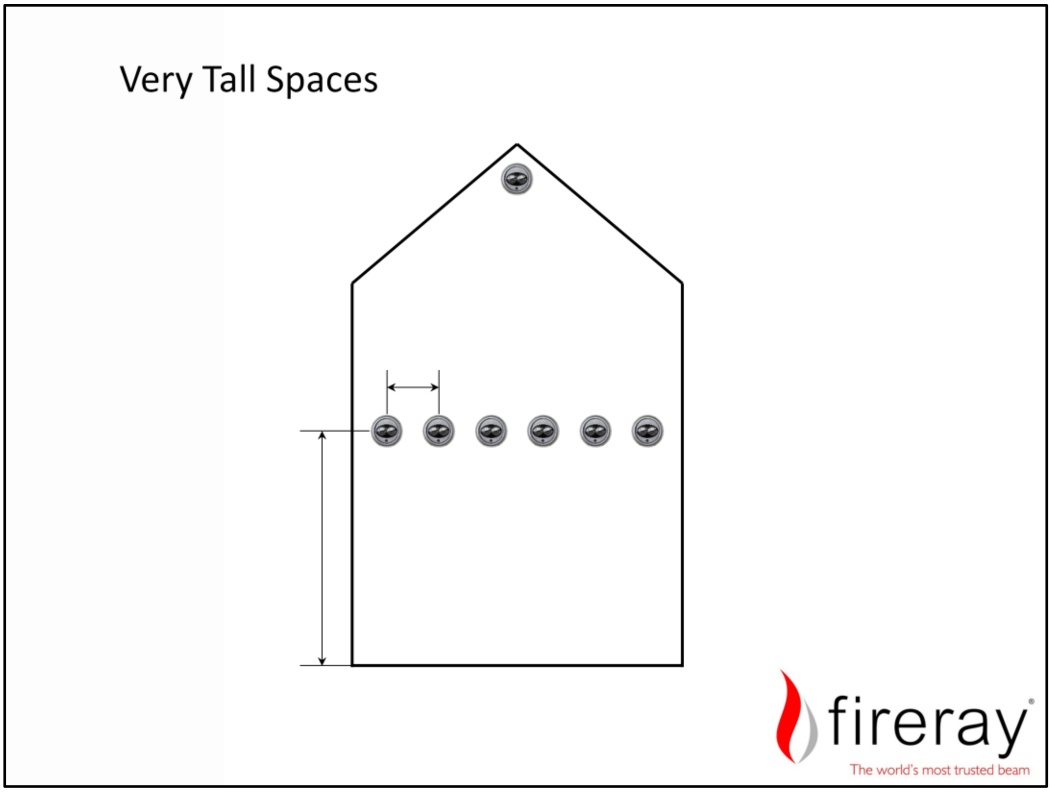
The maximum range of each FIRERAY Optical Beam Smoke Detector is set by design and testing considerations, and by approvals.



In the following example dimensions from BS5839-1 are used.

In a non-symmetrical roof the apex detector covers a width *greater* than 7.5m each side. Add 1% per degree of roof angle to the 15m width coverage of the apex beam. Beams not at the apex have the standard 15m width cover only (up to maximum 25 degrees). The apex Beam must be at least 500mm from the wall and can be moved a further amount horizontally using a tolerance calculated from the maximum allowed drop of 600m and depending upon the roof angle. If the roof drop is less than 600mm it can be considered as a flat ceiling.

In the symmetrical peak roof, place a detector at the apex within 300 to 600mm drop. Detectors either side of the apex Beam benefit from a greater width than standard based upon adding 1% per degree of roof angle to the 15m width coverage (up to maximum 25 degrees). Further Beams outside of the central three use the standard 15m coverage.



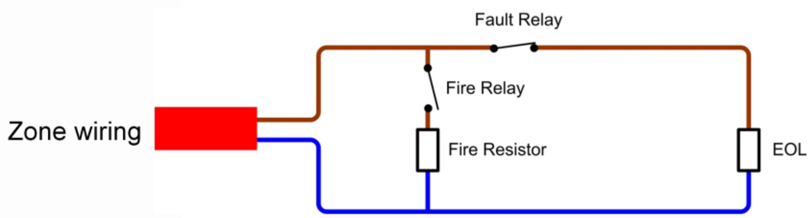
To give more rapid detection, ‘supplementary’ detection can be used to detect the rising smoke plume. Optical Beams are placed in a plane at lower level below the lowest expected stratification level, but more closely spaced. This principle applies regardless of the shape of the roof. The supplementary detectors are spaced at 25% of their height from the possible source of fire, usually taken to be the floor. Take care when spacing Beams closely in case of crosstalk, as discussed later in this training.

The Fireray5000 Multi-Head Reflective Beam detector is a particularly good choice for supplementary detection arrangements as four detector heads are controlled from one low-level system controller. In addition, depending upon local installation codes, Beams can be arranged to give volumetric coverage of a three dimensional volume to provide the required speed of detection.

If an Optical Beam is placed in an Atrium near glass or polished surfaces, the Receiver or Reflector can be offset from the line of sight and angled back to the Transmitter to avoid stray reflections.

Connection to a Conventional Fire Alarm Panel

Our standard interface to the Fire Panel is through Fire and Fault relays
We do not supply the Fire Resistor or End of Line (EOL) component



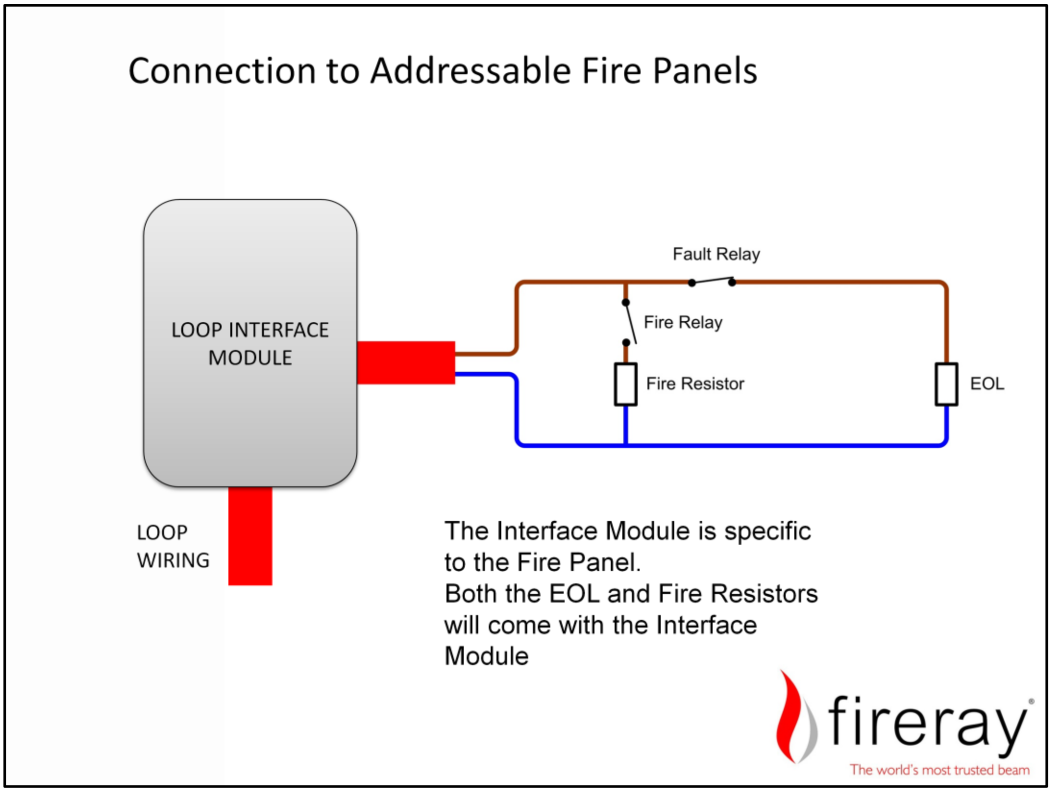
A conventional fire alarm control panel (FACP) works by monitoring the current conducted through a zone via the End of Line component (EOL) and the various devices connected to that zone.

Most panels will use a zone voltage of 24V DC, which when applied to a typical EOL value of 6800ohm will give a current of 3.5mA. This is the ‘normal’ state. If the zone wiring becomes damaged so that no current can flow, then the FACP will see this condition and signal an ‘open circuit’ fault.

Fireray detectors take advantage of the ‘open circuit’ fault to indicate faults to the FACP (e.g. compensation fault, rapid obscuration etc). They do this by opening the fault relay which prevents current being passed through the EOL in the same way that damaged wiring will.

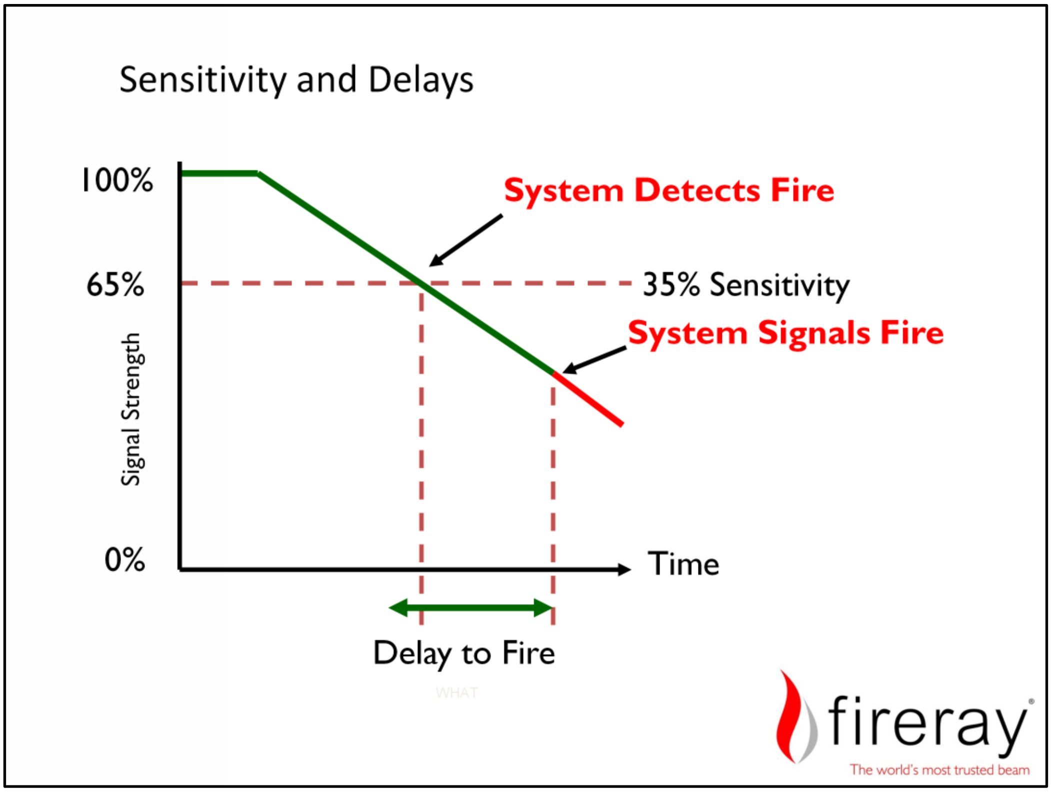
If a detection device wants to signal to the FACP that it has activated, it will connect a Fire Resistor (or the equivalent) across the zone which adds further current to that already conducted by the EOL. For a typical Fire Resistor value of 680ohms, the extra current consumed will be 35mA (i.e. a factor of ten above the ‘normal’ state).

The values for EOL and Fire Resistor used above are for example only – Each FACP will have its own values and for this reason we do not supply these components with our detectors. In the USA, the Fire Resistor is typically a short circuit.



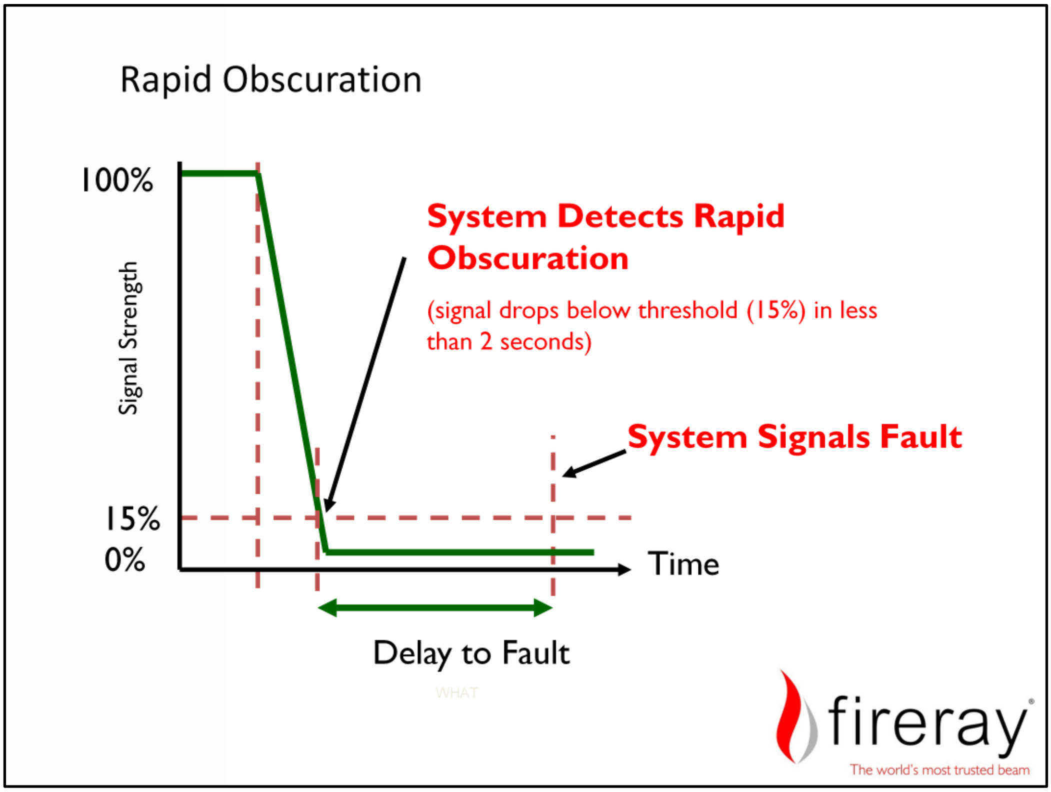
It is possible to take advantage of the individual pairs of Fire and Fault relays for each detector on an Analogue Addressable FACP by connecting a loop interface module to each pair of relays. In this way, each detector can be addressed individually by the FACP.

Loop interface modules (also called switch monitors or zone monitors) connect to the Fire and Fault relays in the same way as a conventional FACP does.



Fireray50R and Fireray100R have sensitivity thresholds of 25%, 35% and 50%, whereas Fireray3000 and Fireray5000 have thresholds selectable anywhere between 10% and 60%.

Fireray50R and Fireray100R have fixed delays of 10s, whereas Fireray3000 and Fireray5000 have programmable delays between 2s and 30s


Rapid Obscuration
100%
Signal Strength
15%
0%
Time
System Detects Rapid Obscuration
(signal drops below threshold (15%) in less than 2 seconds)
System Signals Fault
Delay to Fault
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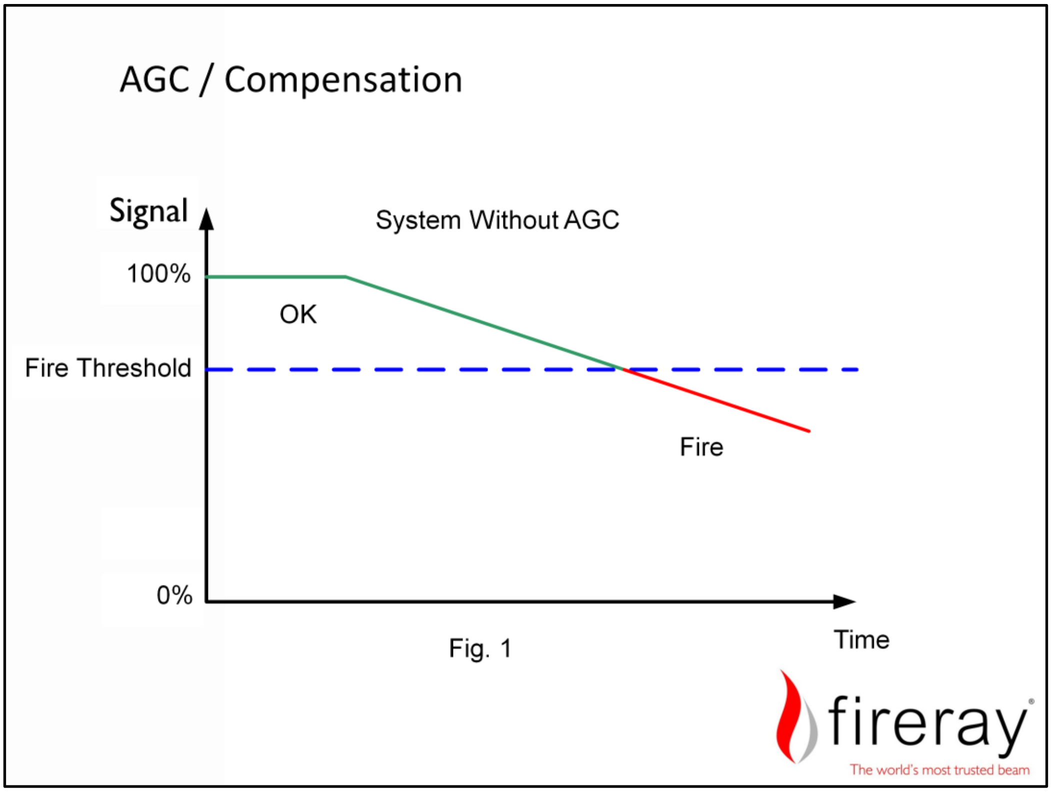

Automatic Gain Control (AGC), as its name suggests, changes system gain to compensate for slow changes in signal level. Such signal level changes may come from gradual dust build up on the Beam lenses and/or from gradual movement of the building, either of which can reduce the signal received by the detector. AGC occurs automatically and does not require user involvement.

In a motorised Beam, when system gain has reached a set value, the Beam will steer itself automatically to restore good alignment.

The value of AGC can be viewed by the user on Beams that have a user interface, to indicate when cleaning may be required.

AGC / Compensation

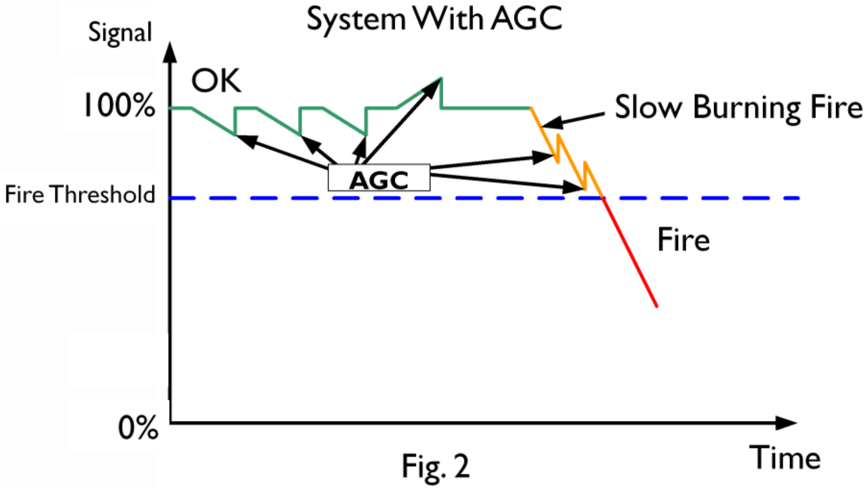

Fig. 2

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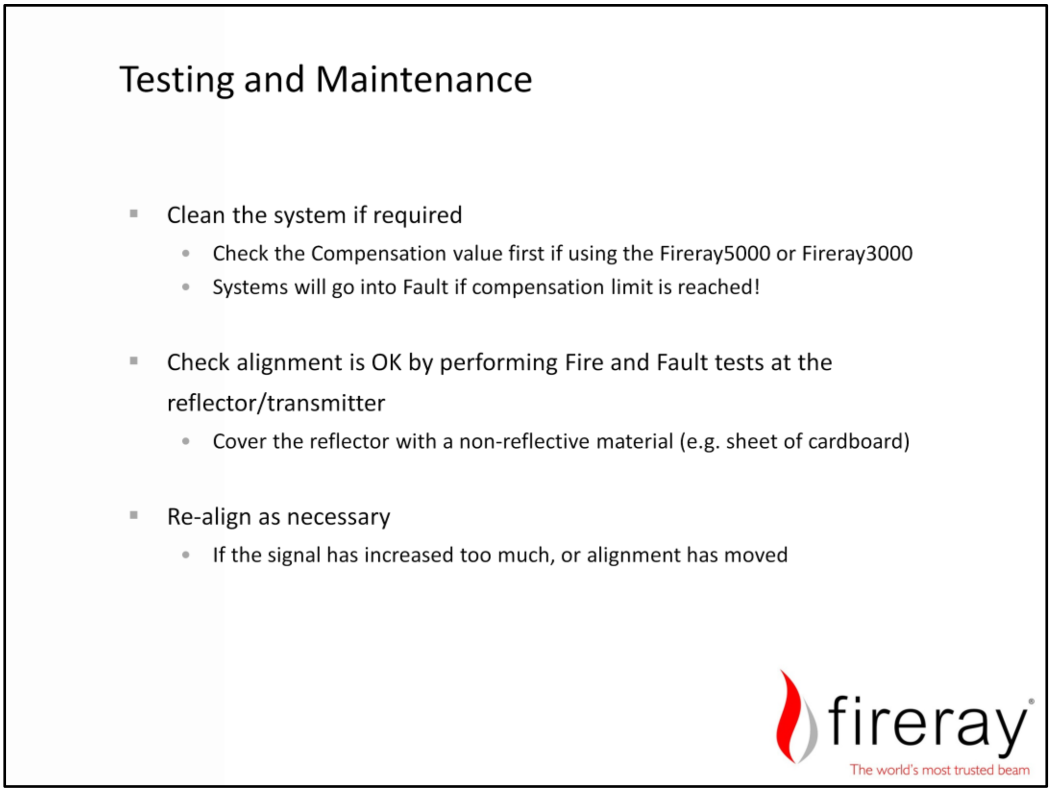

Optical Beams are low-maintenance after successful commissioning, however routine checks and cleaning are recommended to ensure satisfactory functioning of the system.

Before maintenance, notify the relevant authorities that Optical Beams will be temporarily out of service and disable the zone or system to ensure fire services are not inadvertently dispatched.

The system should be cleaned during regular maintenance. Refer to the particular product's installation guide for more detailed information. In general, use a lint-free cloth or lint-free feather duster to gently wipe lenses (and Reflectors) taking care not to disturb alignment. Confirm alignment remains satisfactory after cleaning with Trouble (Fault) and Fire tests.

Special servicing will be required:

- After a fire
- If an unacceptable rate of false alarms is experienced
- When a new maintenance organisation is contracted
- Following long periods of disconnection

Technical Support

- See FFE website for a range of documents and videos

  www.ffeuk.com

- Technical Support:

  Technical@ffeuk.com

  +44 (0)1462 444 783

- Sales Support:

  sales@ffeuk.com

  +44 (0)1462 444 740

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FFE Technical Support covers:

-helping you select the right type of Optical Beam and advising you of good installation practice

-providing telephone support throughout your installation

-troubleshooting if any issues arise after installation

We first work with you by phone and email, discussing your data, photos etc. then we can arrange a site visit if necessary

Call or email us to speak with one of our Engineers or with our Sales Managers.

We offer flexible, modular training courses on Beams in general and our wide range of Beam products in particular

Courses can be arranged with the appropriate Sales Managers with an Agenda to suit your requirements

In the UK, courses are usually delivered in our Hitchin office utilising the training room and 27m demonstration area