

# **FIRE**RAY®

## **Optical Beam Smoke Detectors**



## **Introduction**



**FIRE**RAY® - The leading light in smoke detectors

[www.ffeuk.com](http://www.ffeuk.com)

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.

## FIRE FIGHTING ENTERPRISES Ltd



- Company founded in 1974
- Part of Halma plc since 2000, Halma turnover nearly £1/2bn
- All products designed and manufactured in Hitchin
- Employs 40 people
- Annual turnover over £ 8m
- 75% of sales are to export markets
- Export to over 80 countries globally
- Market leader with a million Optical Beam Smoke Detectors sold worldwide

FFE manufacture a *complete* range of Optical Beams



In addition to a complete range Optical Beam Smoke Detectors (Projected, Reflective, motorised, explosion proof and analogue addressable), FFE manufacture vibration switches for protection of rotating plant and reciprocating machinery in industrial and hazardous environments.

FFE also manufactures hand-held, aircraft cabin and cargo fire extinguishers and aircraft automatic lavatory extinguishers.

FFE has a dedicated training area for all of the company's Optical Beam products.

All FFE Optical Beams are covered by three or five-year warranties (FIRERAY5000 and FIRERAY3000 warranties are *five* years).

## OPTICAL BEAM 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.

Fire Fighting Enterprises cannot take responsibility for the installation (beam positioning and mounting), commissioning or maintenance of products.

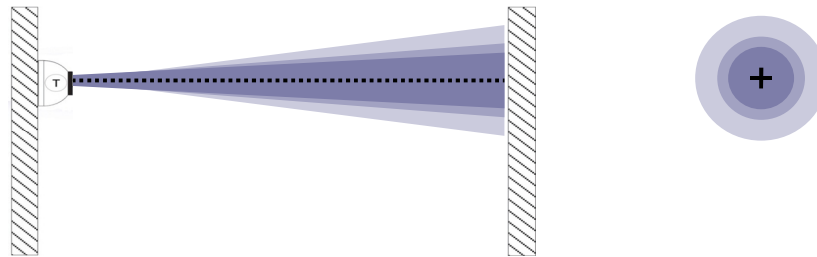


## AGENDA

- WHAT is an Optical Beam Smoke Detector?
- WHERE is an Optical Beam used?
- SPECIFYING an Optical Beam
- INSTALLING an Optical Beam
- COMMISSIONING an Optical Beam
- MAINTAINING an Optical Beam



## WHAT IS AN OPTICAL BEAM SMOKE DETECTOR?



..... + Infra-red light Optical Beam axis and centre



An Optical Beam Smoke Detector is a device that monitors the amount of Infrared light transmitted from a light source to a photosensitive Receiver across an open area to be protected. If obscuration of the Optical Beam path exceeds a set value due to smoke, the Optical Beam signals to a Fire Panel

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

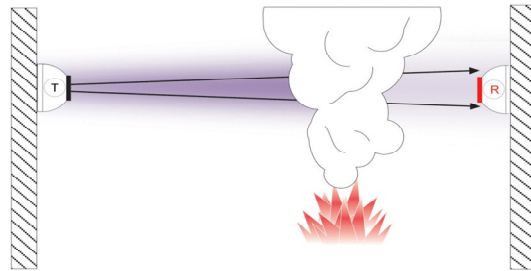
An Optical Beam comprises a Transmitter, Receiver and Control Unit.

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



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

Sudden and total obscuration of the IR beam is not a typical smoke signature, hence this is seen as a Trouble (Fault) condition.

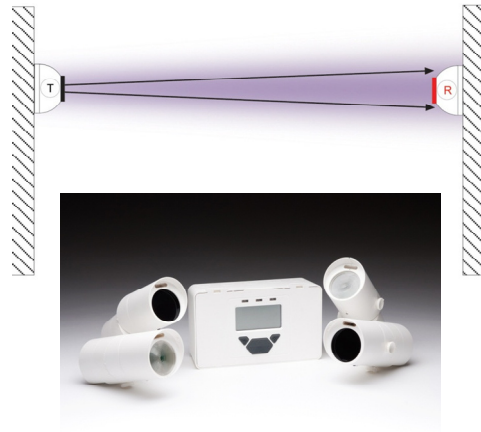
Also, very small and slow changes in obscuration are not typical of smoke and may occur due to the build-up of contamination on the system lenses and/or Reflectors. Slow changes in received signal can also occur due to building movement. Hence, an Optical Beam can compensate for such changes by varying gain.

A motorised Optical Beam can compensate for building movement by realigning the system to achieve the correct received signal. The rate of compensation is carefully controlled so that a slow burning fire will be recognised.

## TYPES OF BEAM SMOKE DETECTOR

### PROJECTED (END TO END)

FIRERAY 3000



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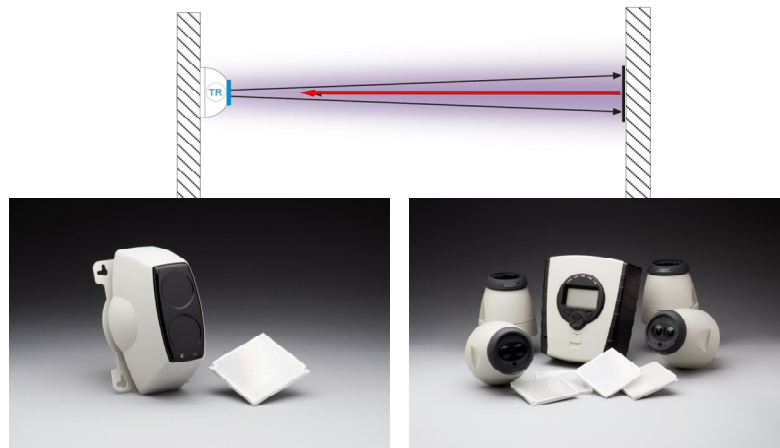
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## TYPES OF BEAM SMOKE DETECTOR

### REFLECTIVE

FIRERAY 50/100 and FIRERAY 5000



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## SPECIAL APPLICATIONS

Category 2 (old zone 1)  
Refineries  
Mills  
Munitions factories and stores  
Flammable liquid stores  
Flammable gas stores  
Flammable powder stores  
Industrial plants and warehouses  
Power stations



**FIRE RAY 2000EExd**

**ATEX APPROVED** 



EExd is safe for use in flammable liquid and gas stores, but may not be the optimum detector for detecting fires from such combustibles if they create colourless smoke e.g. alcohol fires.

Note that like point smoke detectors, Optical Beams are unsuitable for use outdoors, where smoke behaviour is impossible to predict. Also, outdoor environmental conditions such as rain, snow, sleet, fog and dew can interfere with the proper operation of the Optical Beam device as it works on the principle of obscuration.

## INTERNATIONAL APPROVALS



The Fireray range of Beams are widely approved by all the internationally recognised authorities as shown such as CE mark, VdS, LPCB, UL (North America), ULC (Canada), FM (North America), CFE (China), KFi (Korea), NF/CNMIS (France), SBSC (Sweden), BOSEC (Belgium). Check individual product certifications for details, which can be downloaded from our website [www.ffeuk.com](http://www.ffeuk.com).

## WHERE ARE BEAM SMOKE DETECTORS USED?

STABLES  
AIRPORTS  
SPORT / LEISURE CENTRES

MANUFACTURING PLANTS  
WAREHOUSES  
HANGERS

MOSQUES  
MUSEUMS  
HISTORIC BUILDINGS

CONFERENCE / EXHIBITION CENTRES  
SHOPPING MALLS  
ATRIUMS

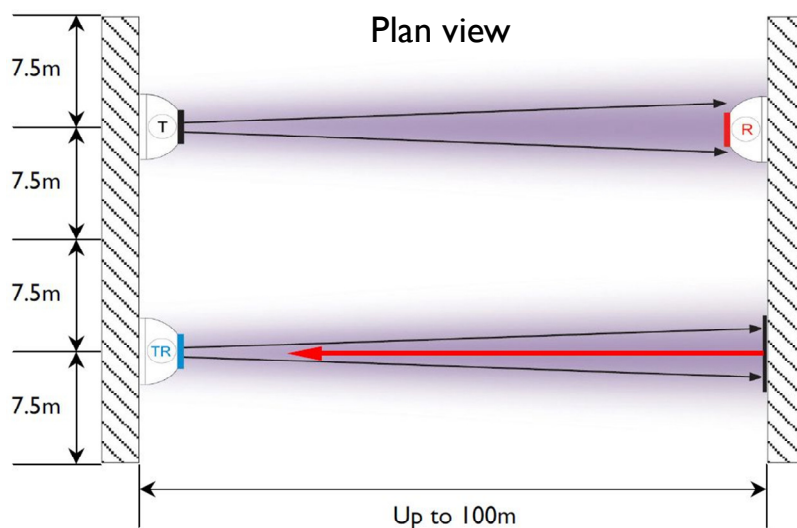


Optical Beams are used for ‘wide area’ smoke detection, enabling coverage of a large area cost effectively. An Optical Beam can cover a wide area, equivalent to many point detectors. The user gains in lower cabling time, lower cost, less obtrusive wiring and reduced maintenance.

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.

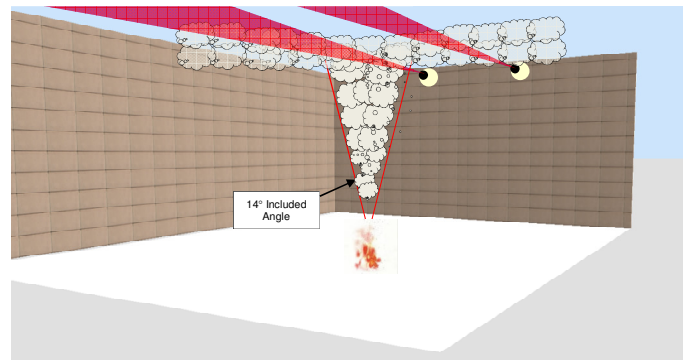
## SPECIFY AN OPTICAL BEAM SMOKE DETECTOR



Optical Beams generally operate up to 100m range, although the Fireray3000 can operate to 120m.

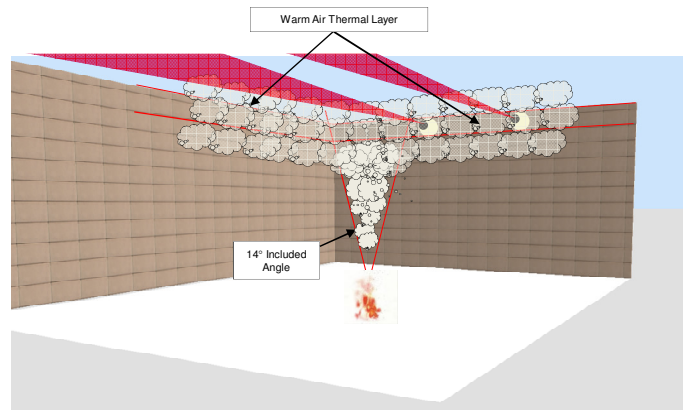
Optical Beam Smoke Detectors generally have a width of coverage of 7.5m either side of the beam axis when used under flat ceilings. The width of coverage is governed by local installation guidelines.

## SMOKE BEHAVIOUR



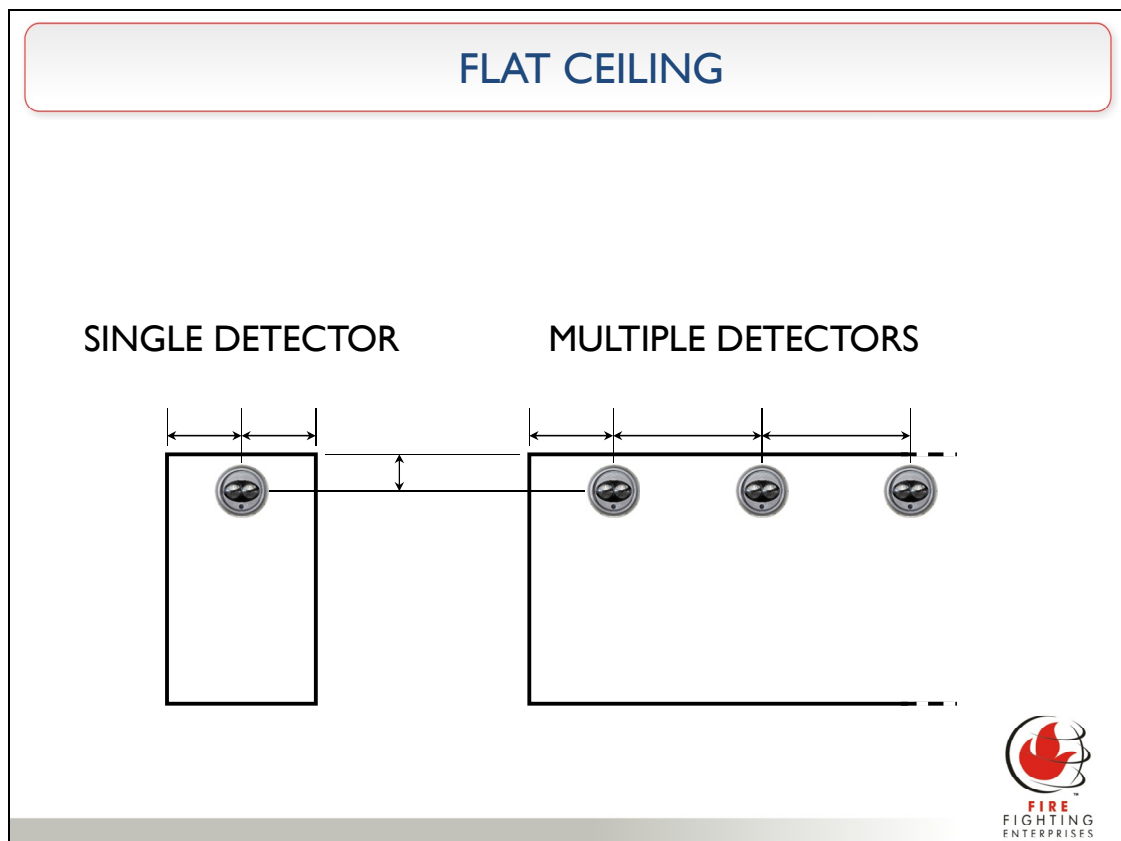
Siting and positioning of Optical Beams is best understood when the general behaviour of smoke can be pictured. Smoke detectors depend on convection to transport smoke to the detector. Since in a building the greatest concentration of smoke will generally form at the highest parts of the enclosed area 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.

## STRATIFICATION



In a smoke plume, surrounding air is drawn into the plume and cools it. The plume may cool so much that if the air near the ceiling is higher temperature, the plume will spread out to form a smoke layer *before* it reaches the ceiling, as though there were an "invisible ceiling". This is known as stratification and, at this stage of the fire growth, the smoke and hot gases will not operate ceiling mounted detectors, regardless of their sensitivity. As it is difficult to predict the level at which stratification occurs, supplementary detection can be provided at lower levels to detect a stratified layer and/or the plume of hot gas, since the supplementary detectors are placed at narrower spacings.

Since Optical Beams are generally mounted between 300-600mm from the ceiling, whereas point-type smoke detectors are at the ceiling, the Optical Beam already has an advantage in detecting a possible stratification layer.



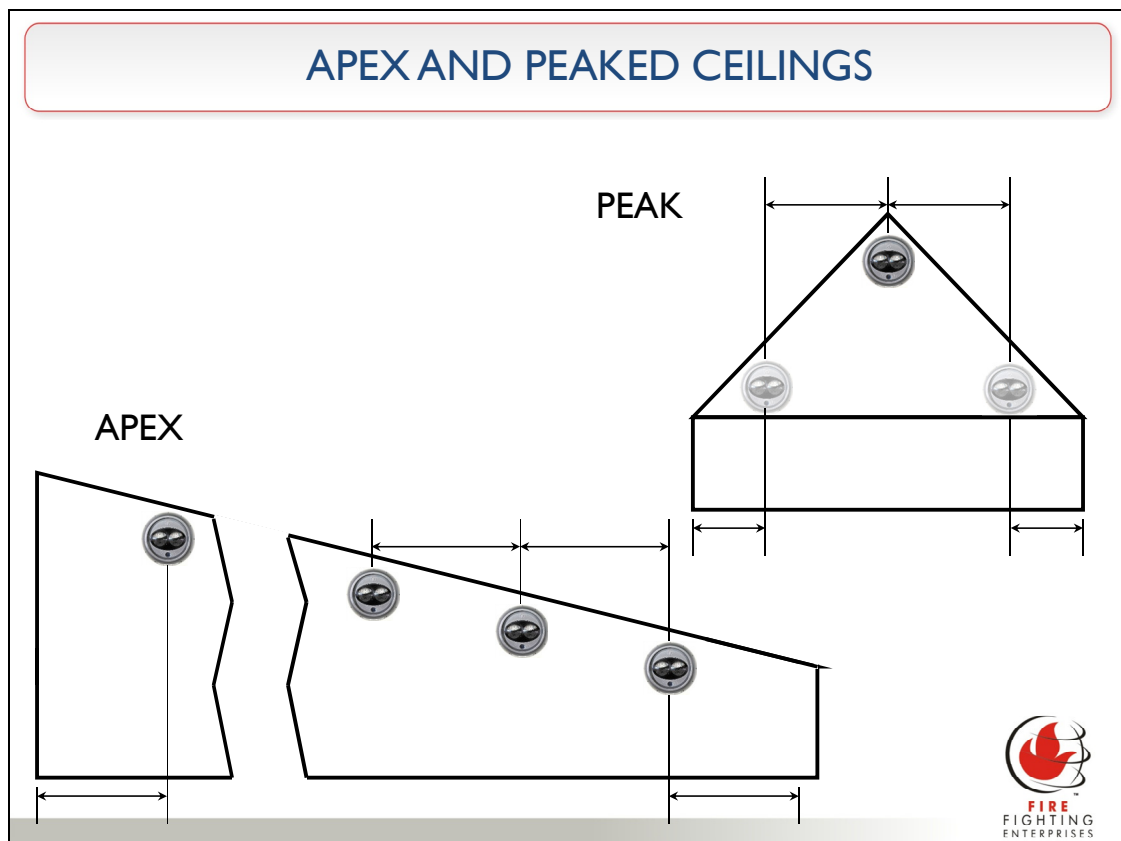
Optical Beams are only sensitive to smoke between the Transmitter and Receiver, hence they should be mounted on the end wall or close to it.

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.

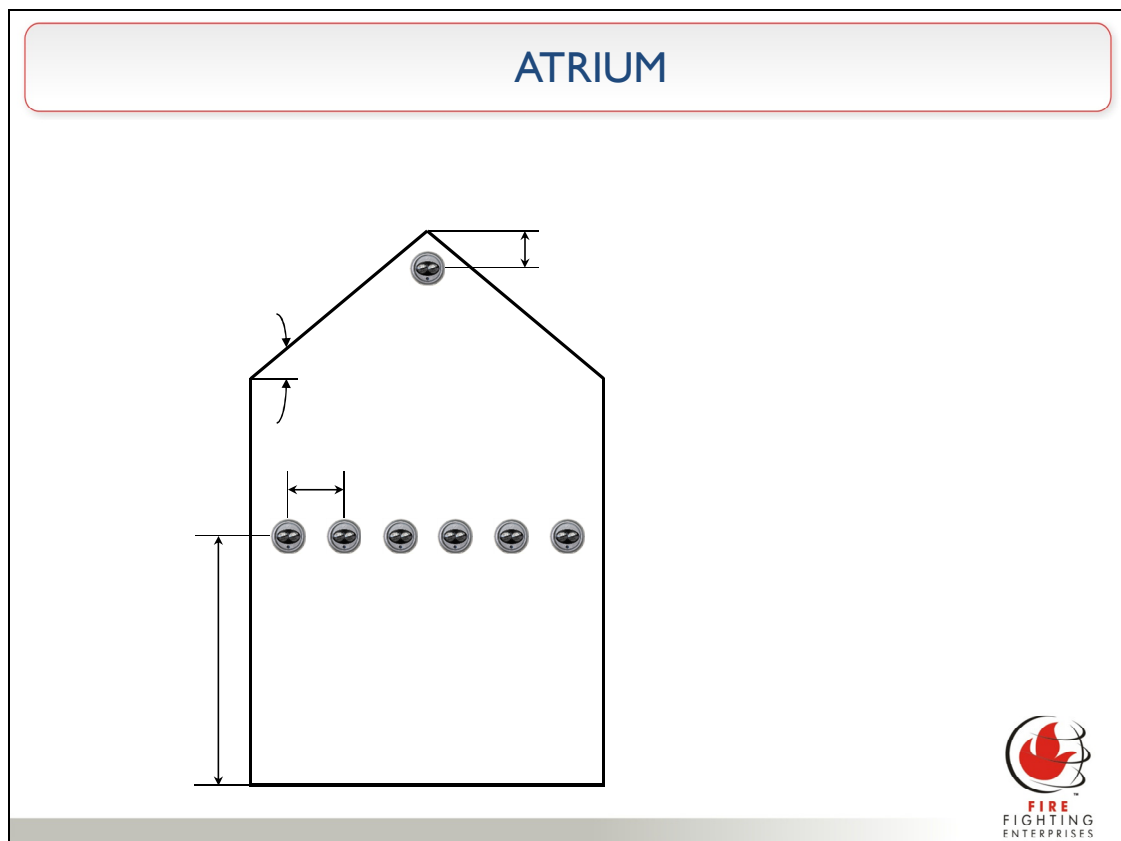
## APEX AND PEAKED CEILINGS



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 600mm 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.

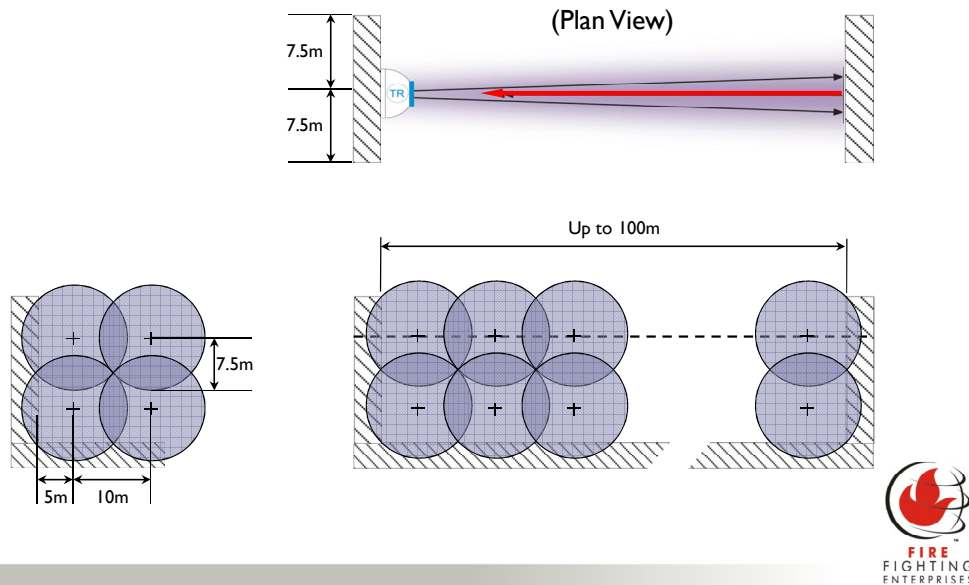


To give more rapid detection, ‘supplementary’ detection can be used to detect the rising smoke plume. Optical Beams are placed in a plane at lower level below the lowest expected stratification level, but more closely spaced. This principle applies regardless of the shape of the roof. The supplementary 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.

## COMPARISON WITH POINT-TYPE SMOKE DETECTORS

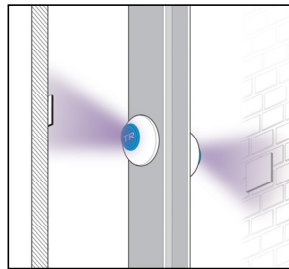
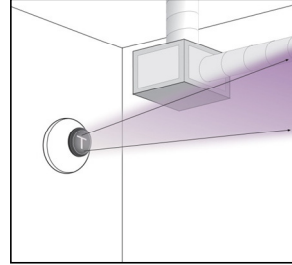
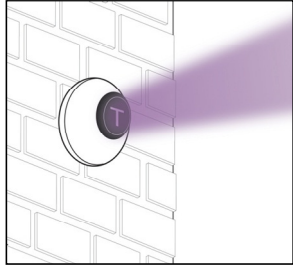


In areas of high air velocity, smoke can be blown away from a point smoke detector's detecting chamber, reducing its performance. Since Optical Beams detect along a line, they are less susceptible to air circulation.

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.

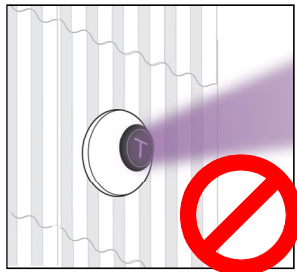
In accordance with BS5839-1, a point smoke detector covers a radius of 7.5m with 10m between detectors, an area of 100sqm per detector – hence approx. 15 units are required to cover 1500m<sup>2</sup>. One Optical Beam can cover an area of 1500m<sup>2</sup>. All the point smoke detectors require individual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

## GOLDEN RULES

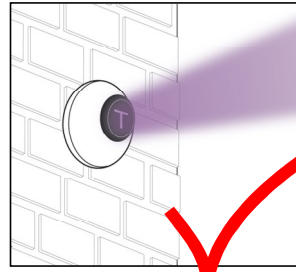


An Optical Beam is a simple and versatile solution for wide area detection. By choosing the right type of Fireray for the job and following a few simple, golden rules a reliable and effective fire detection solution can be achieved.

## RIGID MOUNTING



- ✘ Metal siding
- ✘ Wood
- ✘ Plasterboard/Sheet rock
- ✘ Cladding walls
- ✘ Light/electrical hangars



- ✓ Brick / block walls
- ✓ Structural I-beams
- ✓ Concrete
- ✓ Metal-frame assemblies
- ✓ Load-bearing walls



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

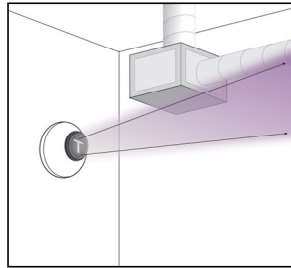
Using the torch analogy, you can see that small rotations of the Transmitter will cause large movements of the beam at a distance, so Optical Beams must be mounted on stable surfaces as suggested above, to limit misalignment.

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.

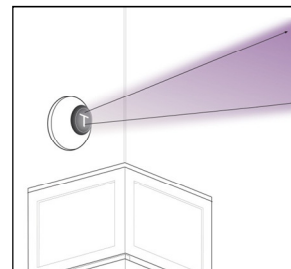
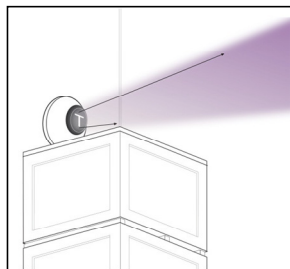
If only one end wall of the building is very rigid, prefer to mount the Transmitter (Projected) or Transceiver (Reflective) on the most rigid surface.

## CLEAR LINE OF SIGHT

Clear line of sight



Watch for temporary obstructions

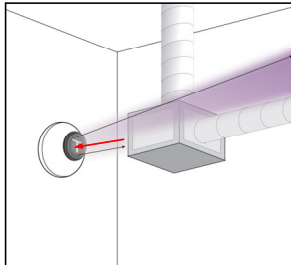


A Beam is an obscuration device and so needs a clear line of sight between the Transmitter and Receiver or Reflector to work effectively. An obstruction during Beam alignment can make a Reflective or Projected Optical Beam difficult to align.

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.

## STRAY REFLECTIONS



Protected space can be compromised

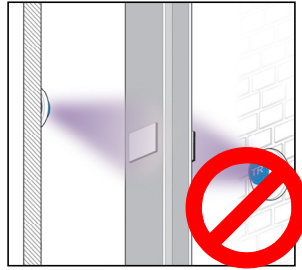


In the figure, imagine a reflective object partly in the line of sight of the Beam. With a Reflective Beam, there is a possibility that stray reflections can return to the Receiver, potentially affecting the stability of the received signal and leaving some of the area unprotected. Hence, we recommend 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.

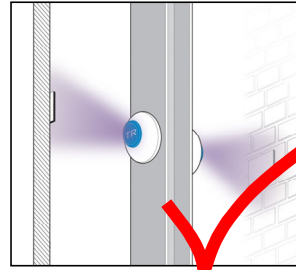
A smaller clear line of sight is often possible with a Reflective Beam depending upon positioning, the reflectivity and position of obstructions and range – consult FFE for further advice.

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.

## OPTICAL CROSSTALK



Mounting reflectors back to back creates a possibility for crosstalk



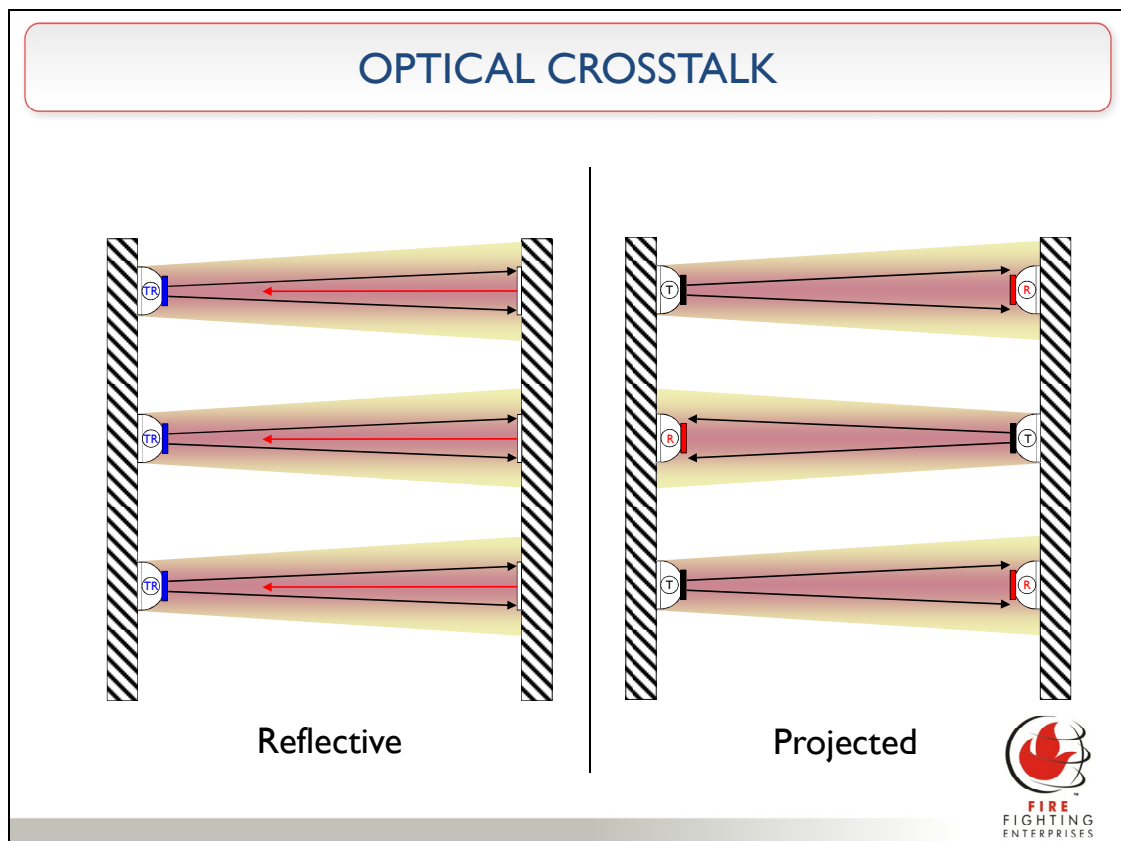
Transmitters should be positioned back to back



When light from another Beam falls on a Receiver, this is called 'crosstalk'. This can cause false alarm or Trouble (Fault) conditions. Since beams pulse their infrared signal, such conditions can be periodic.

When a long range needs to be covered by using Beams in line, mount Reflective Transceivers back to back as shown on the right, so that light from one beam is transmitted away from the beam behind.

If the situation demands that Reflective Beams are pointed towards each other, as shown on the left, ensure the central pillar region shadows the Transceiver by using a baffle board or similar.



When using Reflective Beams side by side, to cover a wide area, place Transceivers on the same wall so that the transmitted light from one Beam cannot fall into the Receiver of an adjacent Beam.

When using Projected Beams side by side covering a wide area, place Transmitters and Receivers on alternate sides as shown to avoid crosstalk. If Transmitters need to be placed on the same wall, due to wiring constraints, crosstalk becomes more of a risk as the Beam pitch reduces and at longer ranges. This only becomes a concern when beam pitch is below 5m. Consult FFE with the intended geometry.

## SUNLIGHT



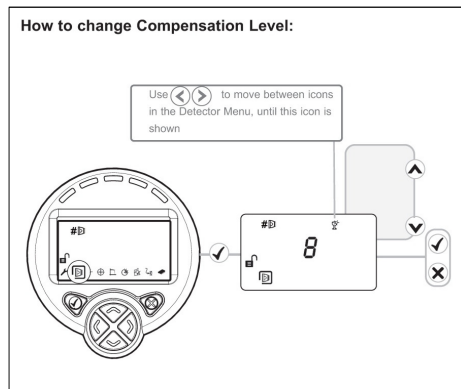
Beams are highly tolerant to ambient sunlight since they discriminate between the wanted Beam infrared signal and the infrared content in ambient sunlight by electronically filtering out the unwanted a.c. frequencies. But, just like the human eye, Beams cannot tolerate strong sunlight, directly into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

Standard incandescent lamps, sodium lamps and camera photoflash sources also may contain IR, however normal fluorescent lamps emit very little infrared light.

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.

## CLEVER STUFF



AGC



Using 'delays'



Beams include advanced features that benefit the user in terms of reliability and ease of use.

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 alignment. 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.

Beams signal fire or Trouble (Fault) conditions after 'delay' times. In some Beams, these can be user set up to 30 seconds to cater for temporary obstructions such as large flying birds or when there is a temporary puff of unwanted smoke, such as from a passing vehicle.

## CLEVER STUFF



Automatic alignment



Testing



Beams such as Fireray3000 and Fireray5000 contain a visible laser to aid rapid, initial alignment. In seconds a good starting position for optimal alignment can be found. In Fireray5000, this is the starting point for the world's fastest and most reliable automatic alignment to take place. The Fireray5000 runs through a series of movements and adjustments to optimise direction and power.

Testing a Beam is simple using the familiar graduated test filter, or if this is not available, Beams are versatile and can be tested in Fire and Trouble (Fault) with any non-reflective card. There is no need for a special wavelength-specific filter.

## TESTING AN OPTICAL BEAM SMOKE DETECTOR

To confirm successful alignment

- Conduct a **Trouble (Fault) test** by fully covering the Receiver (Projected) or Reflector (Reflective) with non-reflective material or by using the test filter
- Conduct a **Smoke test** by slowly obscuring the Receiver (Projected) or Reflector (Reflective) with non-reflective material

This ensures successful alignment



In the Trouble (Fault) test, the Optical Beam will indicate a Trouble (Fault) condition after the Delay to Fault time, close the Trouble (Fault) relay and light the Trouble (Fault) indicator. Removing the obstruction will return the Optical Beam to normal operation.

Note: In Reflective Optical Beams, if the Trouble (Fault) condition does not occur or a Fire condition results, it is likely there is a reflective obstruction. Check and realign the Optical Beam.

In the Smoke test, an Optical Beam will indicate a Fire condition after the Delay to Fire time, close the Fire relay and light the Fire indicator. Removing the obstruction will return the Optical Beam to normal operation, so long as the device is not set to latched mode. If latched, a reset will be required.

Note: If the Beam is partly aligned to the Reflector and partly on a reflective object, the Trouble (Fault) test will return the reflective object's signal strength. If this signal is above the fault threshold, a Fire condition will result.

## COMMISSION AN OPTICAL BEAM SMOKE DETECTOR

To verify the system operates correctly

- Have the Optical Beams been installed correctly, electrically and structurally?
- Are the Optical Beams aligned correctly with no obstructions or reflections?
- Do the Optical Beams respond correctly to Trouble (Fault) and Smoke tests?
- Are Trouble (Fault) and Smoke tests reported correctly at the Fire Panel?



Optical Beam Smoke Detectors installed as part of an automatic fire alarm system need to be commissioned and set to work before they are formally handed over to the purchaser.

## MAINTAINING AN OPTICAL BEAM SMOKE DETECTOR

To ensure the system continues to operate correctly:

- Routinely check for visual damage
- Check installation remains mechanically and electrically sound
- Check there have been no major changes to the environment such as line of sight, obstructions, reflections, strong light sources etc.
- Clean the system
- Confirm system operation with Trouble (Fault) and Fire tests



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

## OUR SUPPORT

See FFE Website for a range of documents and video

- [www.ffeuk.com](http://www.ffeuk.com)

Sales Administration Support

- Email: [sales@ffeuk.com](mailto:sales@ffeuk.com)
- Telephone: 01462 444740

Technical Support (outside US)

- Email: [technical@ffeuk.com](mailto:technical@ffeuk.com)
- Telephone: 01462 444783

Technical Support (inside US)

- Email: [technical@ffeuk.com](mailto:technical@ffeuk.com)
- Telephone: 866-FIRERAY  
(= 1-866-347-3729)



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

## CONCLUSION

**FIRERAY** optical beam smoke detectors could be the detector of choice as they are an efficient and economical way of protecting lives, equipment and properties where:

- √ Areas are wide
- √ Ceilings are high
- √ Cost of installation and servicing need to be low
- √ Architecture cosmetics / aesthetics are important
- √ Ceilings are ornate



**FIRERAY**



**FIRE**  
FIGHTING  
ENTERPRISES

**THANK YOU**

