

Santa Lucia Tunnel – Italy Linear Heat Detection System



The Scenario

With a length of 7.8 km, the Santa Lucia tunnel is the longest three-lane tunnel built in Europe and one of the five largest in the world by overall size. This prestigious infrastructure project, from Calenzano to Barberino del Mugello (FI), can reduce travel time by 30%, with an overall saving of 1.5 million hours per year for the benefit of motorists and the environment.

Equipped with advanced high-tech systems for fire safety and real-time control of the infrastructure and roads, it was excavated with the aid of the largest cutter ever used in Europe. The tunnel owner is Autostrade per L'Italia and maximum attention was also given to environmental sustainability, both with regard to the project of the work and to the methods of construction and disposal of waste materials. A key element of the reduction in environmental impact was the change in the original tunnel design from nine tunnels to a single archway.

Client Requirements

Accidents in tunnels can have serious consequences. When an explosion occurs in an enclosed system, the fire can spread all around rapidly and escape is difficult. Dust, gas or even both can be present in the tunnel and can potentially be responsible for an explosion. The high-temperature surface of diesel engines or electrical motors; hot exhaust gases and sparking electrical devices can all cause issues with conventional smoke detection systems.

The Galleria Santa Lucia is 7.8 km in length, with a width of 13.5m occupied by 3 lanes and a height of 9.5m. The sensing cable is installed at a height of 7.2m.

In line with the other high specification technical requirements of this project. The operator was looking for a high-specification system with the following features:

- Rapid detection
- Robust system
 - Not affected by exhaust gases or other particulates in the tunnel
 - High reliability with a fully redundant configuration
- Seamless integration with the fire detection and control system



Figure 1 - The tunnel excavation cutter



What Did We Do?

RAET SRL is a leading expert in road automation and worked with the operator to support the customer to design a system that met all of the requirements.

Given the overall requirements and the length of the tunnel, RAET made the decision early on to go with a fiber optic-based Linear Heat Detection system. This provides full coverage over the entire length of the tunnel with measurement points every 1m.

Rapid Detection

RAET reviewed the fiber optic LHD systems available and chose the Bandweaver FireLaser LHD. One of the key factors that influenced their decision was the rapid measurement time. All the FireLaser systems are approved to EN54-22 to detect every 5 seconds at distances up to 10km across 4 channels. In comparison, other systems available take up to 30 seconds per channel to detect.

Robustness of System

Unlike conventional smoke detection systems, fiber optic linear heat detection systems are not affected by particulates in the air and have no vents, orifices or moving parts and so do not require any ongoing cleaning or maintenance programs.

The systems can be configured in multiple zones according to the operators' requirements. The zones are configured in the software and so there is maximum flexibility. Each zone can be programmed individually using smart alarms which can be configured according to the environment of that zone meaning false alarms can be kept to a minimum.

With regards to redundancy, the requirements were for full redundancy in the event of either damage to the detection cable or issues with either of the controllers. The key to the design was to use the multi-channel functionality of the FireLaser LHD systems. Because there were 2 detection cables on the tunnel roof, it allowed the redundancy to be achieved with 3 controllers.

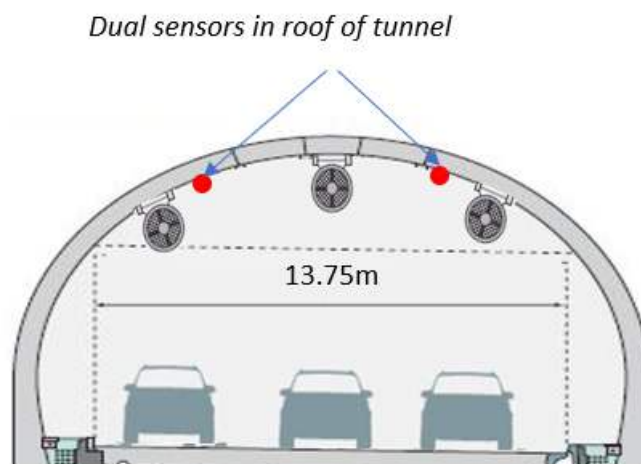


Figure 2 -Position of detection cables in the tunnel roof





System Design

The project was designed by SPEA, which is the Autostrade project engineering division. Based on the design the 7.8km length of the tunnel was divide into 982 zones which corresponded to the sprinkler system.

For detection, the tunnel used 3 different detection systems.

1. Fiber Optic Linear Heat Detection system
Alarm levels 50°C, rate or rise 9°C
2. Video flame detector
3. Optical beam Smoke detector

For the Santa Lucia tunnel the customer wanted the detection and suppression system to be fully automated. The logic implementer was that all 3 alarms must alert in order to trigger the sprinkler. However, only the FireLaser has the precise position to trigger the specific sprinkler. The FireLaser integrates using relays to activate the alarm and Modbus to provide the precise location

The FireFiber AT cable is a high-strength cable which is lightweight, flexible, and easy to install. As standard it contains 2 fibers within each of the cables to allow the redundancy to be achieved with a single cable run (in this case the second fiber was not required).



Figure 3 - FireFiber AT detection cable

The schematic below shows the positioning of each of the detection units and the path of the sensing cables required to enable the fully redundant configuration.



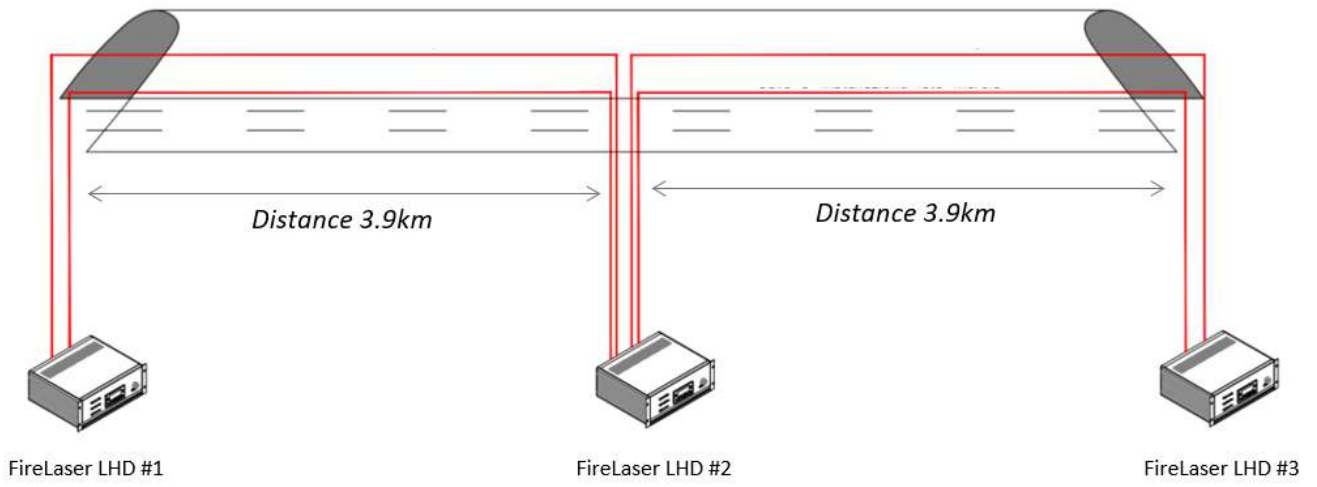


Figure 4 - Redundant configuration of FireLaser LHD systems within tunnel

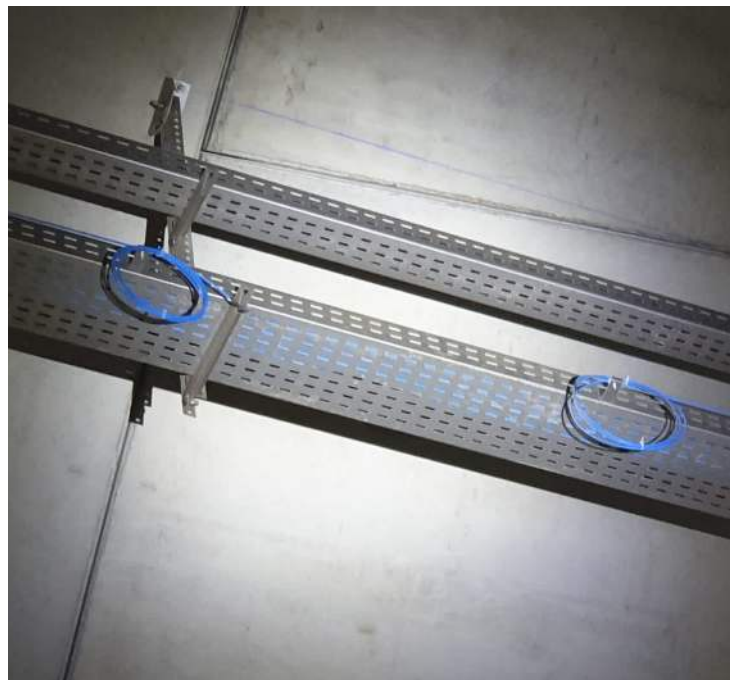


Figure 5 - FireFiber AT installed at ceiling level

System Commissioning & Testing

The system was commissioned and tested by RAET and took 3 weeks. Overall it went smoothly. One of the key challenges was in the calibration and configuration of the smart zones.

The cable was secured at the ceiling every 1m. the zones were originally planned with this 1m in mind. However, in the installation there was approximately 3% sag in the cable lengths.

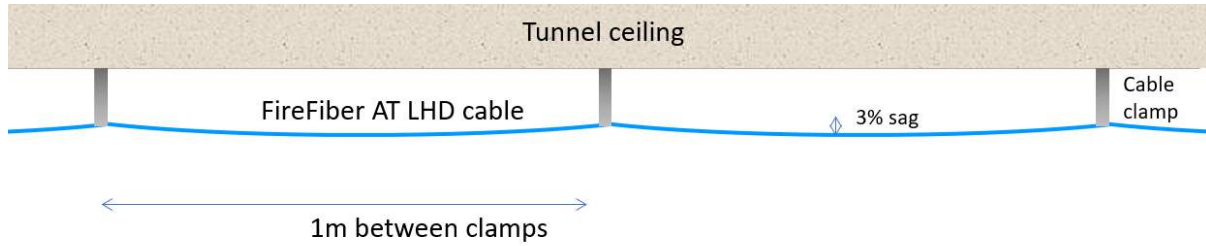


Figure 6 - Example of cable sag

This meant that the zones needed to be recalibrated. As the FireLaser smart zones are fully configurable this was not an issue. RAET took reference points along the cable using cold sprays and recalibrated the zones to match the sprinkler system. The commissioning was signed off by DBA group who specialise in consulting and engineering for mission critical infrastructure.



Figure 7 - The FireFiber in the control room / RAET & Autostrade personnel



Benefits To the Client

The Bandweaver system complied with the operator's high specification requirements. Some of the key following benefits and advantages to the end user include:

- **Early detection of even a small fire:** Bandweaver LHD systems are approved to operate with a measurement time of 5 seconds which is considerably quicker than the alternatives. With the smart alarms (including rate of rise and deviation alarms), the system can detect fires at a very early level without risk of false alarms. This is evidenced by the fact that the FireLaser can pass the fire pan test to even the strictest requirements.
- **Complete Coverage:** The distributed nature of the fiber optic system provides measurements every 1m along the length of the cable providing complete and continuous coverage with no blind spots or gaps in the protection.
- **Reliable and robust system:** The system was configured in a loop configuration which means that there is a level of redundancy even if the cable is damaged. Also, it is not affected by any dust, particulates, or moisture in the air. For example, the electrically based system is affected adversely by moisture.
- **Low Cost of Ownership:** Fiber optic cables are completely passive and have no moving parts, they are non-corrosive and immune to electromagnetic interference and typically have lifetimes of more than 30 years and so carry a very low cost of ownership and no maintenance

About Bandweaver Technologies

With an installed base of over 60,000km and 8,000 systems installed worldwide, Bandweaver's vision is to be the first choice for integrated distributed fiber optic sensing solutions across the globe. Since 2002, Bandweaver has been committed to delivering reliable, innovative, client-centric, and value-added products and services, via a dedicated and talented team of people.

Bandweaver manufactures and distributes advanced fiber optic monitoring sensors and integrated technologies, enabling customers to monitor, secure and keep personnel and critical assets safe.

With quality and excellence as fundamental elements of Bandweaver's portfolio, the business is continuously developing its range of technologies, including Distributed Temperature Sensors (DTS), Distributed Acoustic Sensors (DAS) and integrated smart intelligent software solutions. Bandweaver provides solutions for Security, Fire, Power, and Pipelines.

For further information please contact our global team at info@bandweaver.com

