SUR LA VOIE
DU GIU

Obstacle detectors at level crossings : experimental feedback and conditions for success

O CAZIER on behalf of the French research group on LX safety:

Virginie TAILLANDIER (RFF), Olivier CAZIER (RFF),
Françoise BLONDEL (SNCF), Jean-Luc BALACEY (SNCF)
Régis AIGOUY (SNCF); Yves BALESTRA (SNCF)

- **Level crossing accident feedback**
- **International benchmark on obstruction detection**
- **The French case: why our old experiments in obstacle detection were not successful**
- **Our new project to introduce obstacle detection**
- **Other research trends**

Level crossings accidents feedback

19000 crossings in France, around 13000 with significant road and rail traffic

More than 3000 LX are crossbuck only, with train speeds under 140 km/h and a small road traffic, 9000 LX are automatic half barriers (AHB), 600 are 4 quadrant gates.

The French railways have records of all accidents and most incidents at our level crossings since the origins of railways, but only the last 35 years are on computer files, and we used for our feedback the last 25 years.

AHB in Normandy
Photo O Cazier, RFF

4 quadrant Gate in Normandy
Photo O Cazier, RFF

French Crossbuck
Photo F Goglins

Level crossings accident model

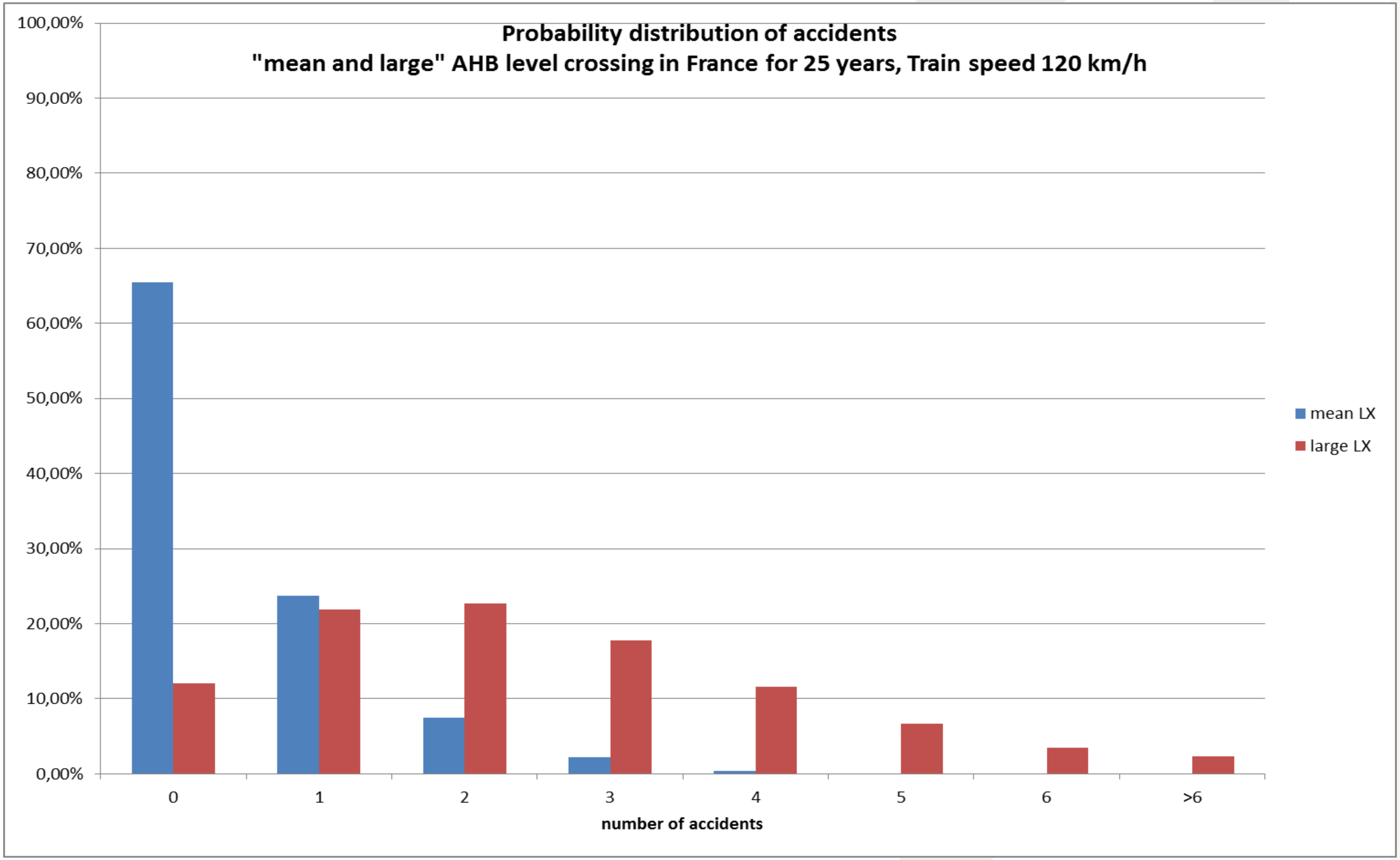
Vehicles Accidents at level crossings in France can be modelled with a quite simple statistical law (A type II Binomial negative law, a variant of Poisson law with a slight overdispersion)

The expected value λ t (expected number of accidents for a given time interval of t) is a function of V(number of cars/day),T (number of trains./day), and, for AHB, maximum train speed.

Accident rate for crossbuck crossings is, for the same conditions, 7 times higher than for AHB, and accident rates for AHB 1.8 times greater than for 4 quadrant gates.

AHB accident rate decreases with maximum train speed, but the death rate doesn't .

With Poisson type statistical distribution, the variance (dispersion) of accidents is rather important, and twins level crossings can have a very different accidentology.


Probability distribution of accidents
"mean and large" AHB level crossing in France for 25 years, Train speed 120 km/h
100,00%
90,00%
80,00%
70,00%
60,00%
50,00%
40,00%
30,00%
20,00%
10,00%
0,00%
0
1
2
3
4
5
6
>6
number of accidents
mean LX
large LX

Using the model

Using our model, we found that a small minority of LX had a greater number of accidents than predicted by a simple Poisson law. We had a closer look, and found that these « accident prone » crossings fell into two categories:

- **Level crossing on very simple country surroundings, on rather small railway lines, usually in a long road alignment (with perhaps a curve at the LX)**
- **Level crossing in very complicated urban surroundings, with road crossings near the LX, lot of road signs, advertisements, etc**

Type 1 level crossing

Type 2 level crossing

Interpretation of results

Most accidents at LC involve frequent users of the LX, and the main accidents causes are traffic laws violations, attention lapses and driving errors

Accident rates decreases from crossbuck to AHB and 4 quadrants gates mainly because it’s physically more difficult to force the crossing.

Accident rates at AHB decreases with train speed because road users are more frightened… and less prone to violate trafic laws.

On type 1 level crossings, attention lapses are important, and people don’t notice, or notice le LX too late….

On type 2 Level crossings, driver errors are important, drivers have too much information and they don’t prioritize the right one…

Our conclusions:

- Upgrade crossbuck to AHB
- Close LX if possible. If not, improve them (upgrading AHB fo 4 quadrant if there is a traffic violation risk, improve conspicuity of type 1, improve road signalling in type 2)
- Reopen the old files on Obstacle detection…

Obstacle detectors in use in the world
examples from JR Central, JR East, TRV, NR...

Obstacle detection at level crossings a very long history

40 to 50 years ago, many networks tested obstacle detectors at level crossings:

France , Japan, Sweden, Germany….

Sweden adopted obstacle detectors on a limited basis (80 systems in use since 30 years) and Japan developped massively obstacle detectors (4000 systems on JR East alone)

The other countries, including France, abandonned the experiment.

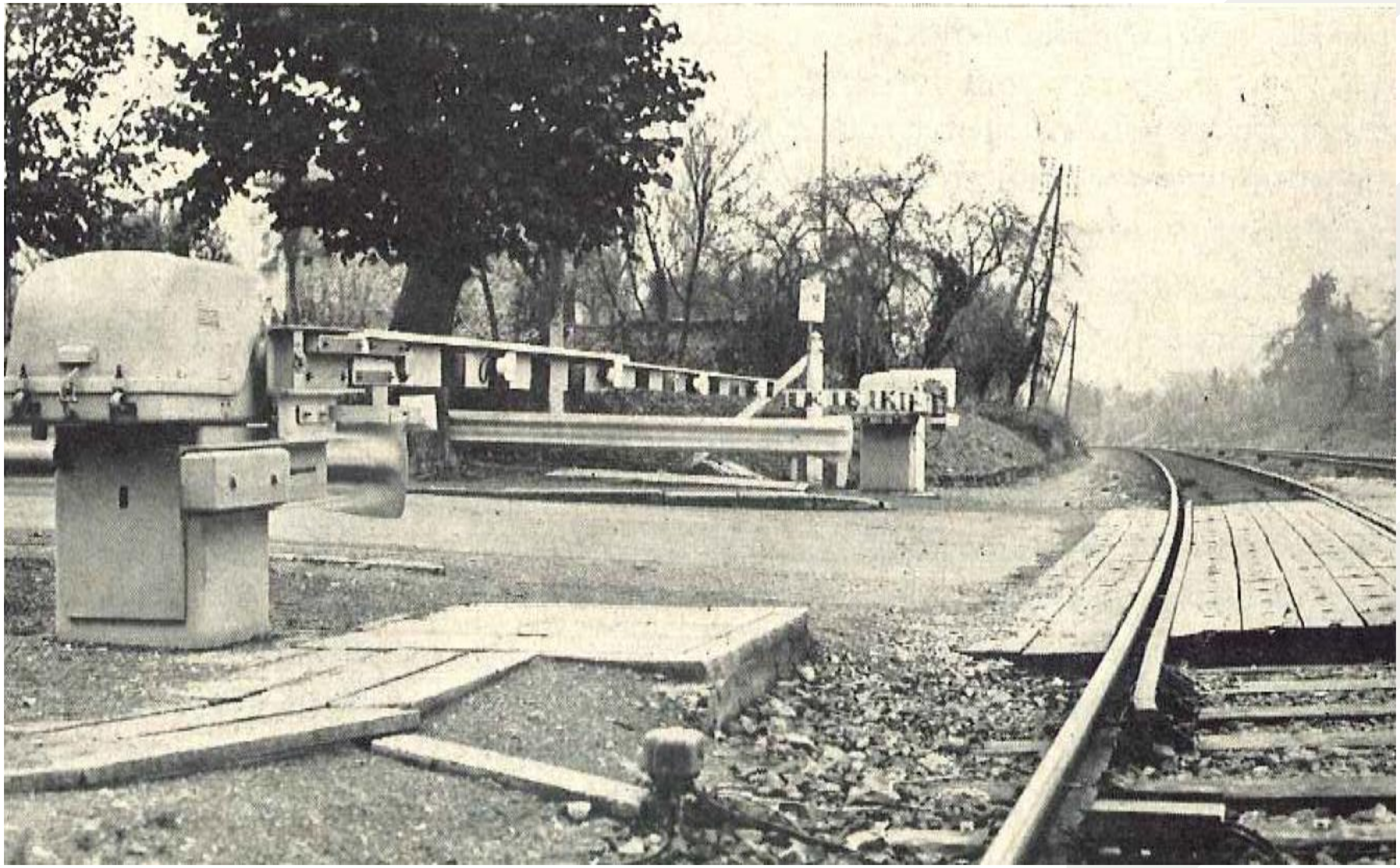
From 1965 to the last few years, OD were only used in Japan and Sweden.

Since 2005, OD have made a revival in many countries: Germany, GB, Italy, Benelux, France…

Our benchmark has shown us that in most countries, OD where performing well and accident reduction was greater than 80% on equipped crossings.

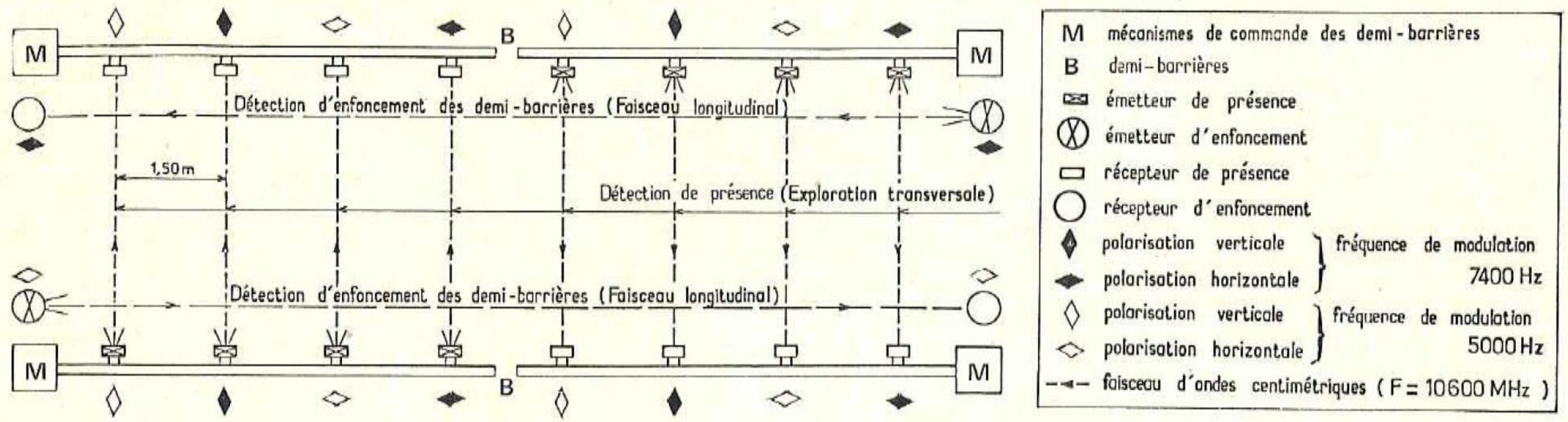
OD can be an important improvement, but first we have to understand why our old experiments were not successful…

An early exemple of OD: the french experiments in the 60's



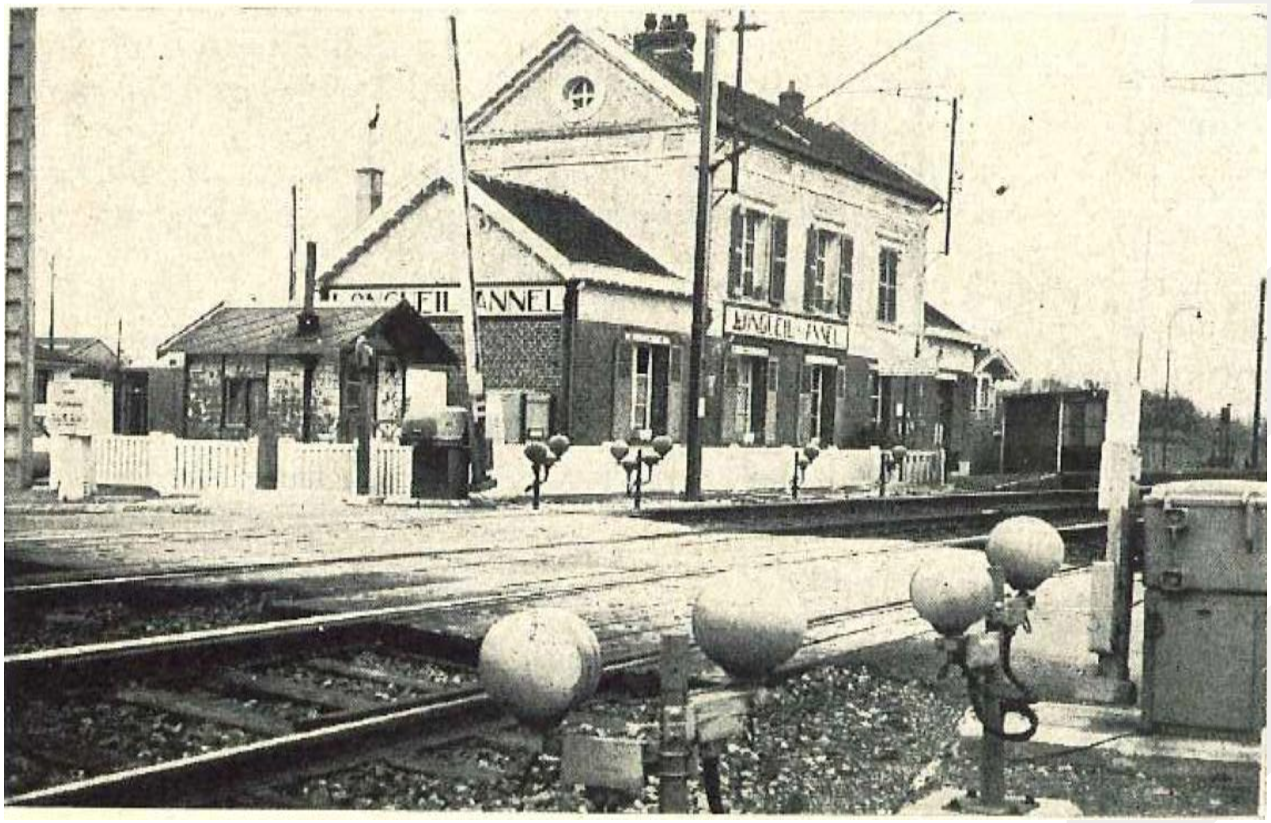
An early exemple of Obstacle detector

Fig. 1 — Disposition des faisceaux de micro-ondes (1[re] expérimentation)

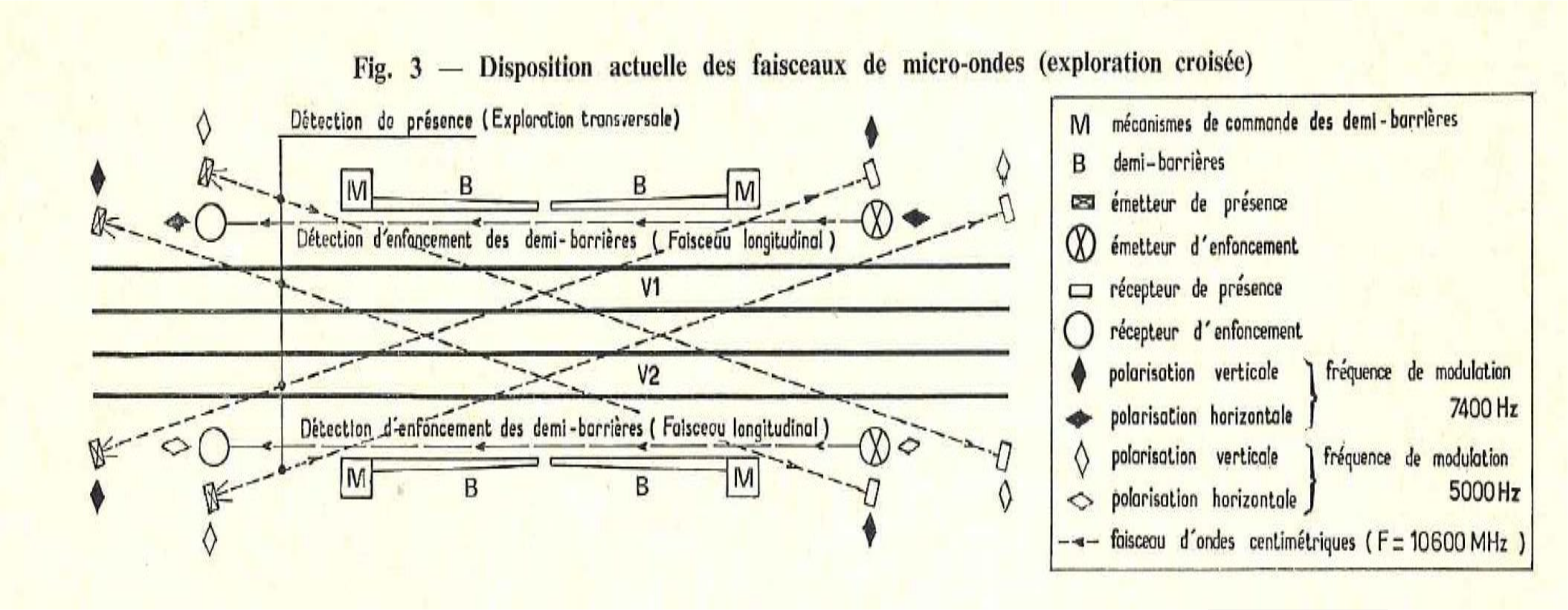


Multiple microwaves radars on the barriers
2 radars // to the tracks (to detect broken barriers)
Only on 4 quadrant gates

An exemple of « improved » obstacle detector



An exemple of « improved » obstacle detector



But aften 12 years of experiment, these obstacle detectors where dismantled in 1980

Why our old experiments were not successful?

At the end of the sixties, fixed beams microwaves radars were a new technology, costly, cumbersome and using a lot of energy.

Their reliability was poor.

To be sure to stop all trains (including freight trains with a long braking distance) you need to increase the length of the LX closure time.

Increasing the LX closure time is not possible with AHB, our more common LX type, since we need a very short closure cycle to master the risk of traffic violations

Moreover, it was the beginning of the reign of « queen automobile », at this time, increasing the LX cycle time was impossible, a crime of « lèse majesté »…

Why our old experiments were not successful?

The main reasons:

- Immature technology
- Immature public opinion: when (almost) everybody was happy if cars killed only 10 000 people /year, delaying cars 10-15 seconds at a LX to save perhaps 100 people was not acceptable
- Reliability: without modern electronics, false alarms were too numerous and degraded regularity.

But times have changed: Today, deaths by accident are less and less tolerated by french public opinion, road safety has greatly improved (3000 deaths/year), and speed is limited to 50km/h or lower in towns, to 90 km/h in the country

Our new OD project

- 6 tests sites, 3 in urban environment (to investigate the risk of faillure related to dust and aerosols), 3 in continental environment (to investigate the risks of failure related to snow and heavy rail)
- only using mature technologies
- On 4 quadrant gates (or LX upgraded to 4 quadrant gates)
- Devlopment of a special device to warn approching trains of an obstruction
- Train warning only if there is still an obstacle when all the four gates are closed.
- Time between beginning of LX cycle and train arrival increased to 55s minimum to allow for an emergency stop of all trains types.

Other research trends in LX Safety in France

New research trends in collaboration with French research institutes (ONERA, IFSTTAR…) and the road safety authorities:

- **« fundamental » research**
  - Intelligent trains equipped with HF radar
  - Analytical modelling of LX risks using Petri nets and advanced mathematical techniques
  - Improving knowledge of pedestrian behaviour at level crossings
- **Engineering research:**
  - Improving the use of existing statistical models and on- site enquiries to detect accident prone LX
  - Improving the uses of law enforcement devices
  - Improving conspicuousness of existing level crossings (mainly on rural zones)
  - Improving ergonomy of urban level crossings