



# Open magneto inductive detectors for metallic ropes: analysis and experimental results

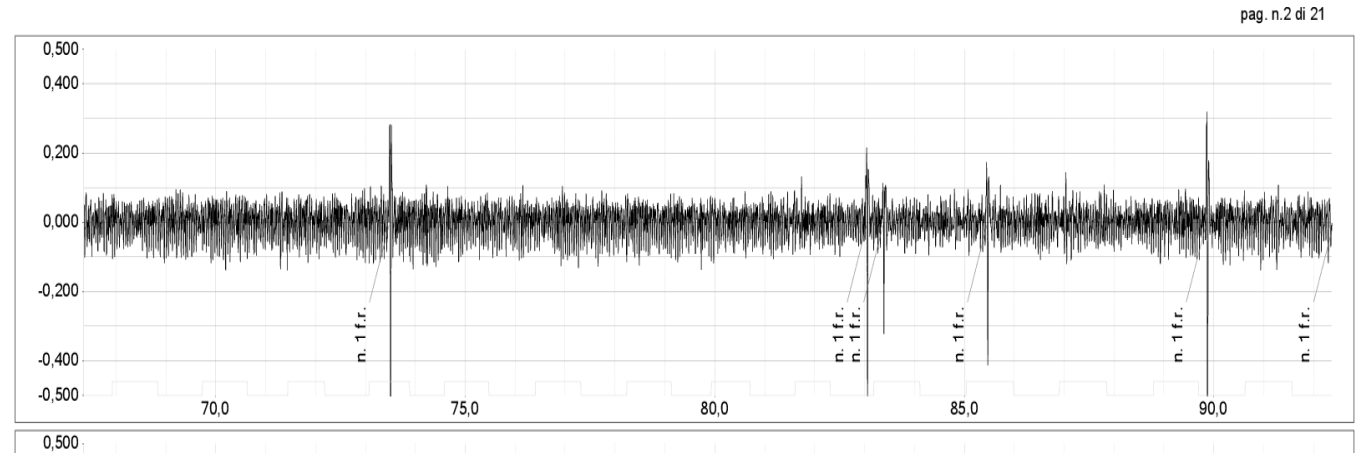
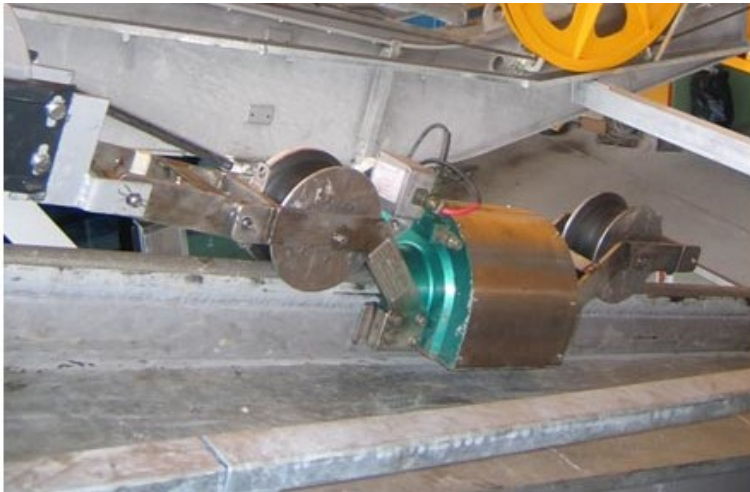
Aldo Canova, Regina Lamedica, Ezio Santini, Andrea Cernigoi, Boris Susic, Ettore Pedrotti

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Magneto inductive detectors are specifically constructed to :

- Reduct the risk of injury during ispective operations
- Reduce o eliminate «not inspected» lenght

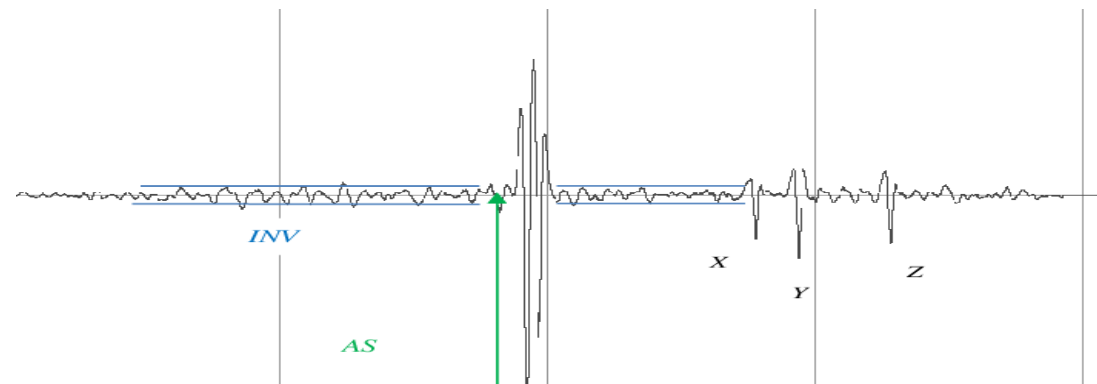
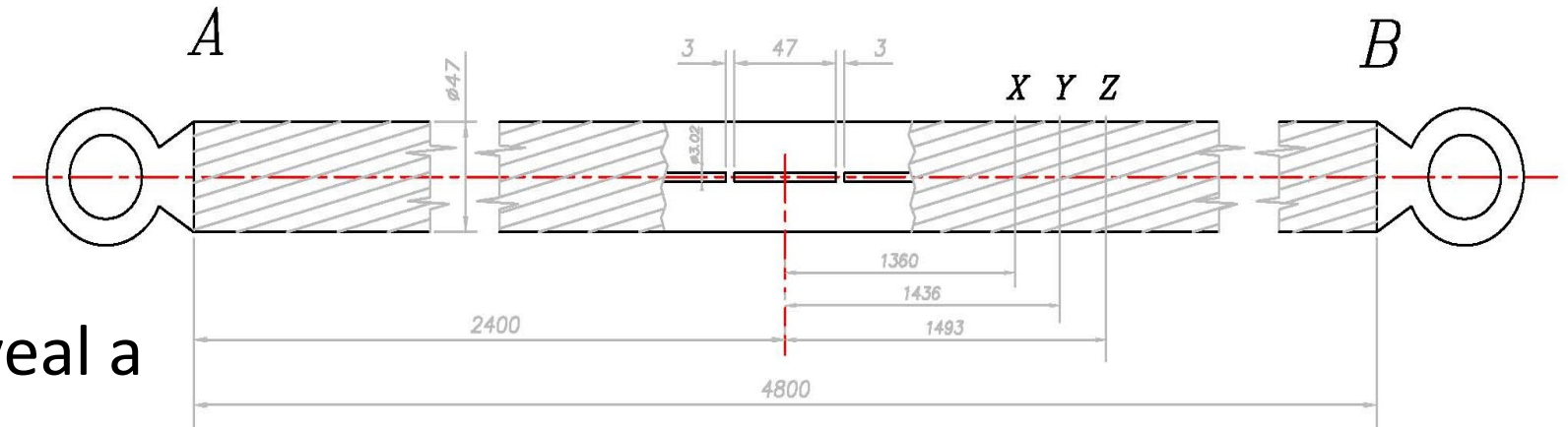




Italian law requires  
UNI EN 12927-8 test.

Authorized detectors must reveal a double defect in the rope core with defined SN ratio.  
Open detectors normally is able to pass the test.

IS THIS THE WORST CASE?





## Schematization of a magneto inductive test system

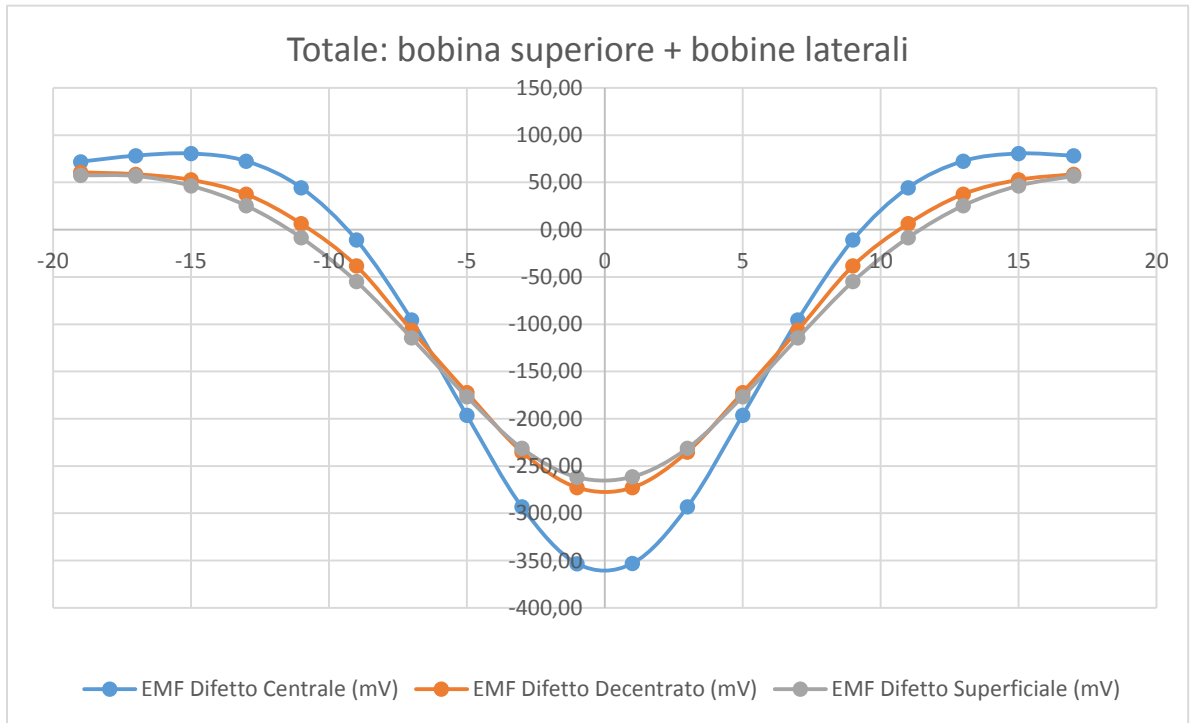
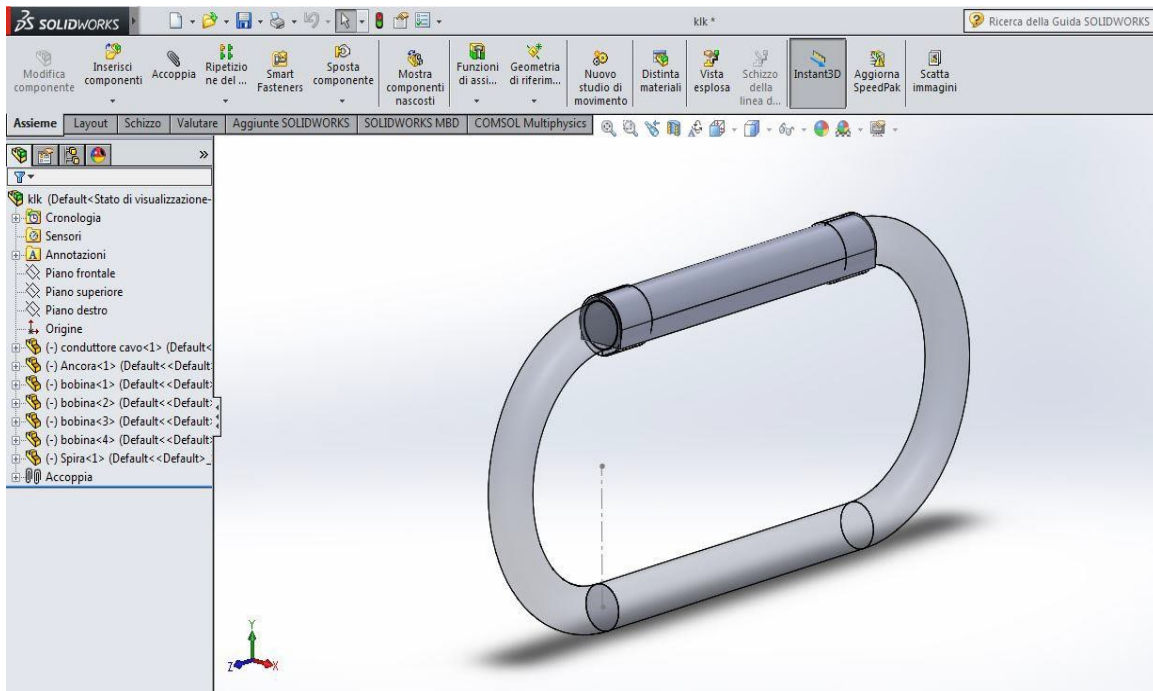
Magnetic field generation: request for magnetic saturation of the rope

Scattered field detection (sensors): The sensors can not be disposed physically all around the rope.





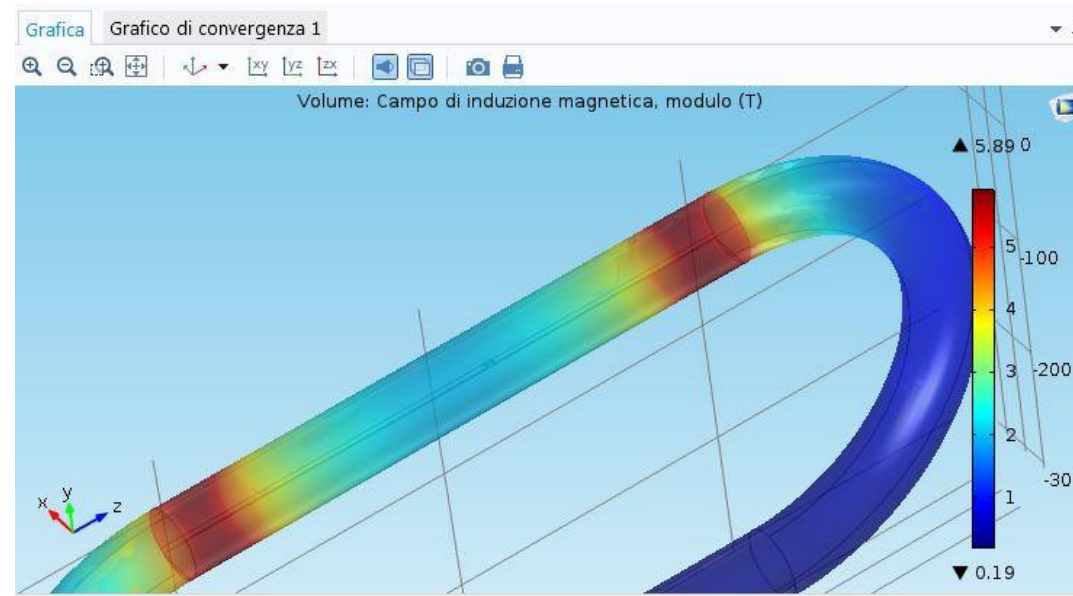
## First part: Numerical simulation result





First part: magnetic rope saturation.

The first work (*Ezio Santini*<sup>2</sup>) suggests a magnetic field value of 2 T to reach the rope magnetic saturation.



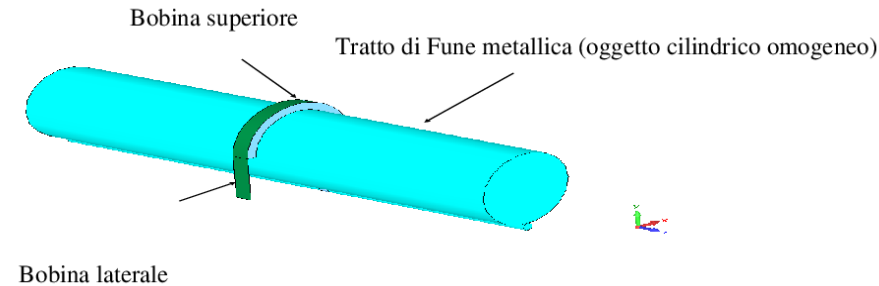
This value became a project request for the detector.

In this situation the aspected relative magnetic permeability is around 30.



First part: detection of the scattered magnetic field and «worst case» identification.

The second work (*Aldo Canova*<sup>1</sup>) identify the worst case for the open detector detection system.



In the hypothesis of a saturated rope, it investigates about the performance of a three-sensor system positioned over a 270° range.

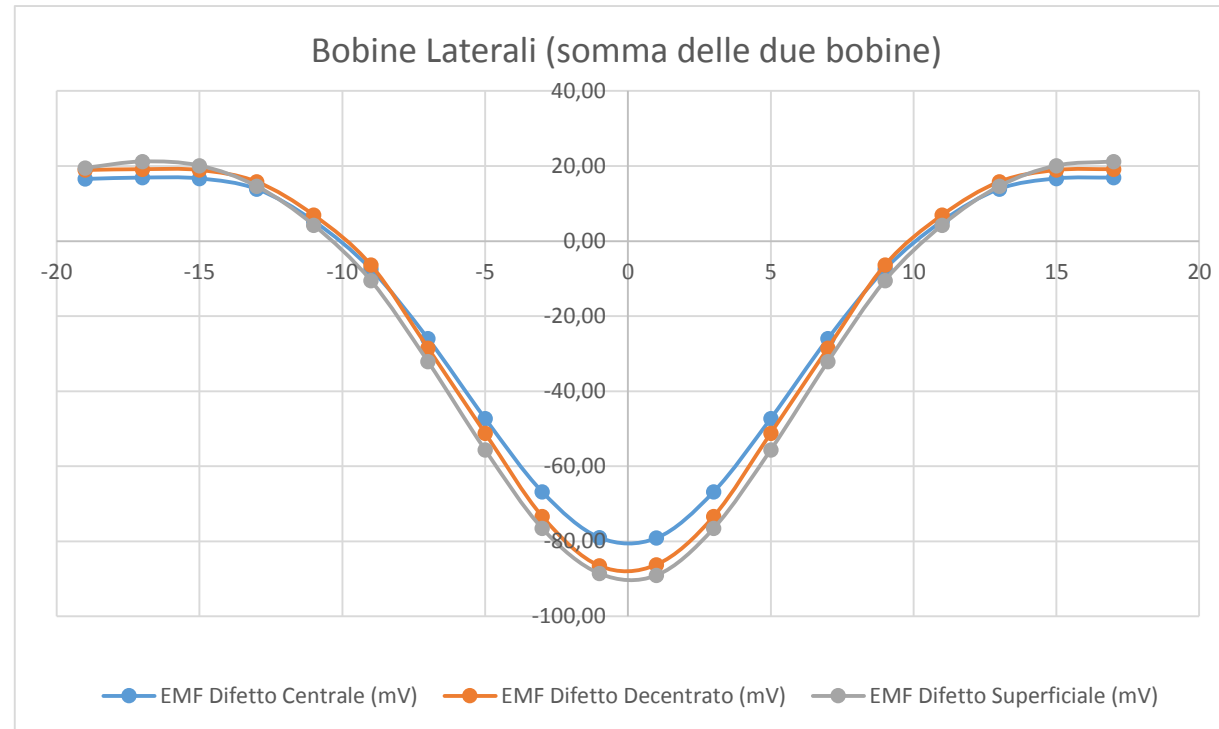
In the first simulation, the defect is positioned in the center of the rope.

The test is similar to the UNI 12927 standard request.

In the second simulation the defect is moved along a diameter until an external position.



This figure illustrates the response of the lateral part of the sensor. There is no practical difference when the defect is moved.

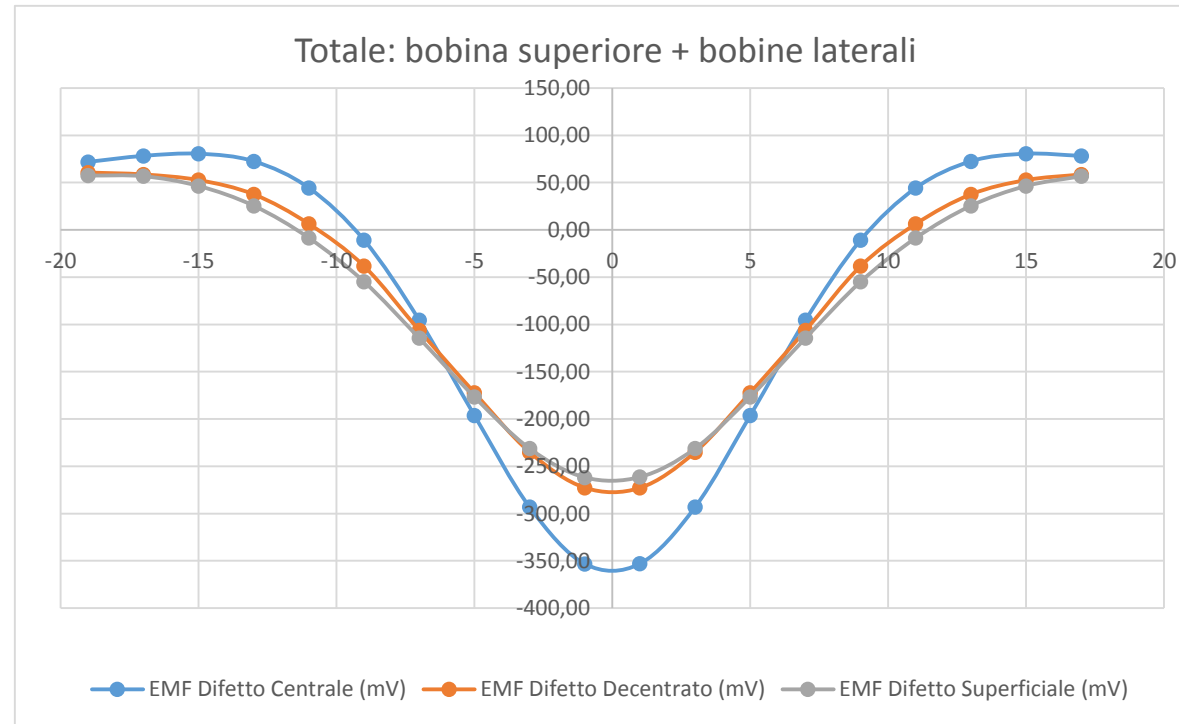






This figure illustrates the total response of the sensor. The author demonstrates that:

- 1) The output of the sensor decreases when the defect is moved from the central position;
- 2) The worst case is a superficial defect in the opposite face respect to the field generator



3) The defect is detected anyway with a 30% output decrement.



Second part:

## Experimental validation test

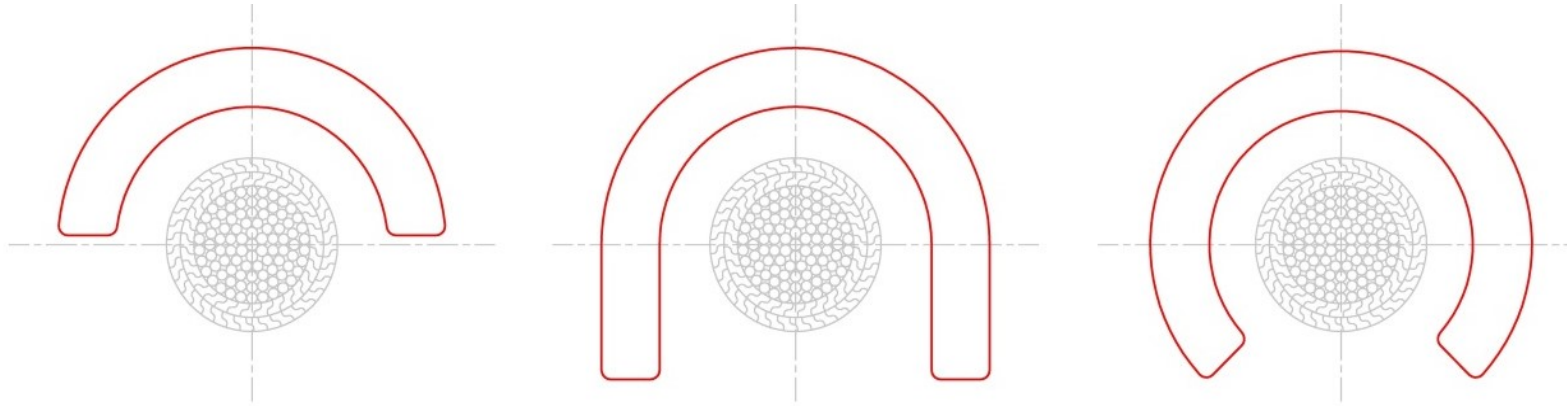
An experimental validation of the numerical result was requested. Two independent Italian laboratories specialized in detector convalidation were appointed to define and construct a test.

- 1) La.T.I.F Technological Laboratory, Province of Trento
- 2) Laboratorio n.d.t. « Di Santolo », University of Trieste

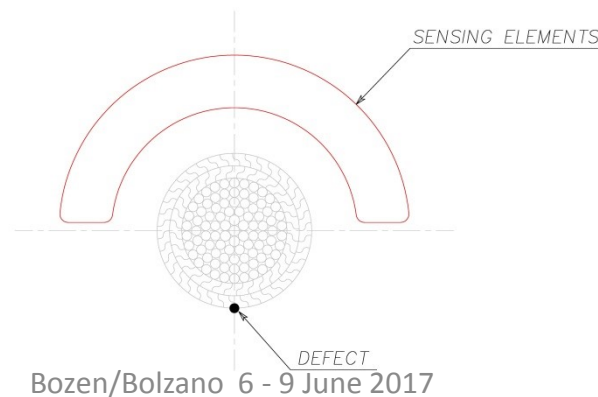




Definition of open detector: test head whose sensors enveloping the rope less than 75%.



The theoretical analysis confirms that the worst position is in the most distant point from the sensors:





The creation of a certain number of «test ropes» was necessary to achieve experimental validation test.

The rope is a 6-meter part of a commercial rope with the realizations of artificial defects in the «worst case» position. The defect cause a local section loss of 0.5 % and 0.9%.

Denominazione	Diametro Fune [mm]	Sezione metallica fune [mm <sup>2</sup> ]	Sezione metallica interruzione (filo Z) [mm <sup>2</sup> ]	Percentuale filo esterno [%]
17LA00009	51	1724	10,15	0,6
17LA00010	63	2635	14,20	0,5
17LA00011	64	2673	24,00	0,9

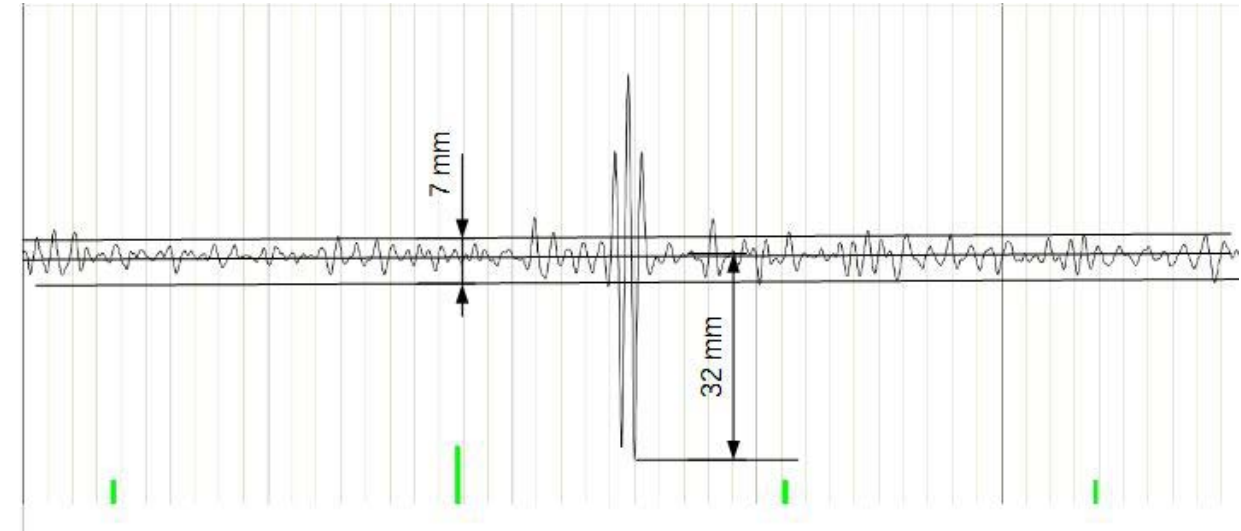
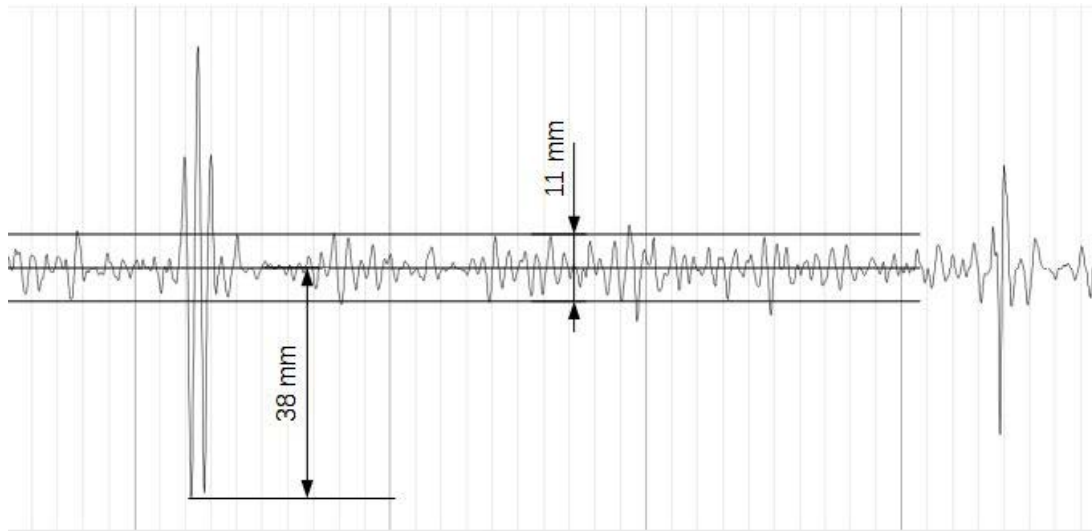
Laboratory 1

Denominazione	Diametro Fune [mm]	Sezione metallica fune [mm <sup>2</sup> ]	Sezione metallica interruzione [mm <sup>2</sup> ]	Percentuale rispetto la sezione della fune [%]
1_64_UNI	64	2650	13.51	0.5
2_64_EST_A	64	2650	18.80	0.75
2_64_EST_B	64	2650	12.40	0.5

Laboratory 2



The first laboratory test a new construction detector about a typical range of ropes. In figure, the result about a 51 mm and 64 mm diameter rope. The double peaked signal in the centre corresponds to the artificial perimetral defect.



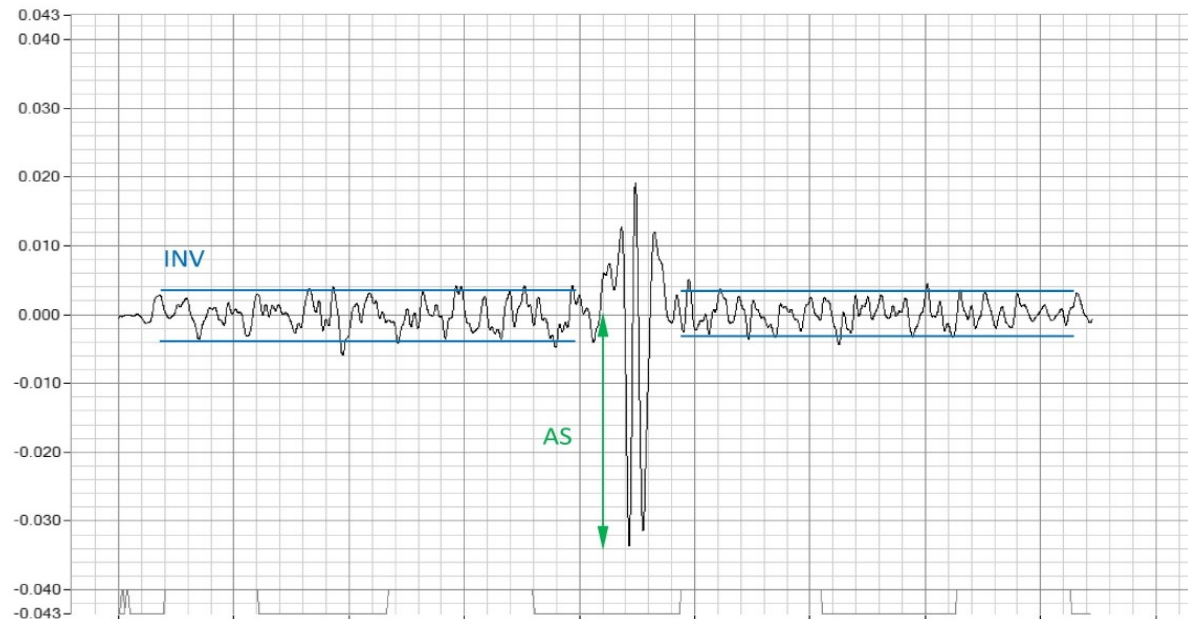
The test results was a SN ratio (in the UNI 12927 definition)  $\geq 2$  in all inspected cases.





The second Laboratory make a comparative work between a «closed» detector as previously defined and a typical «open» detector.

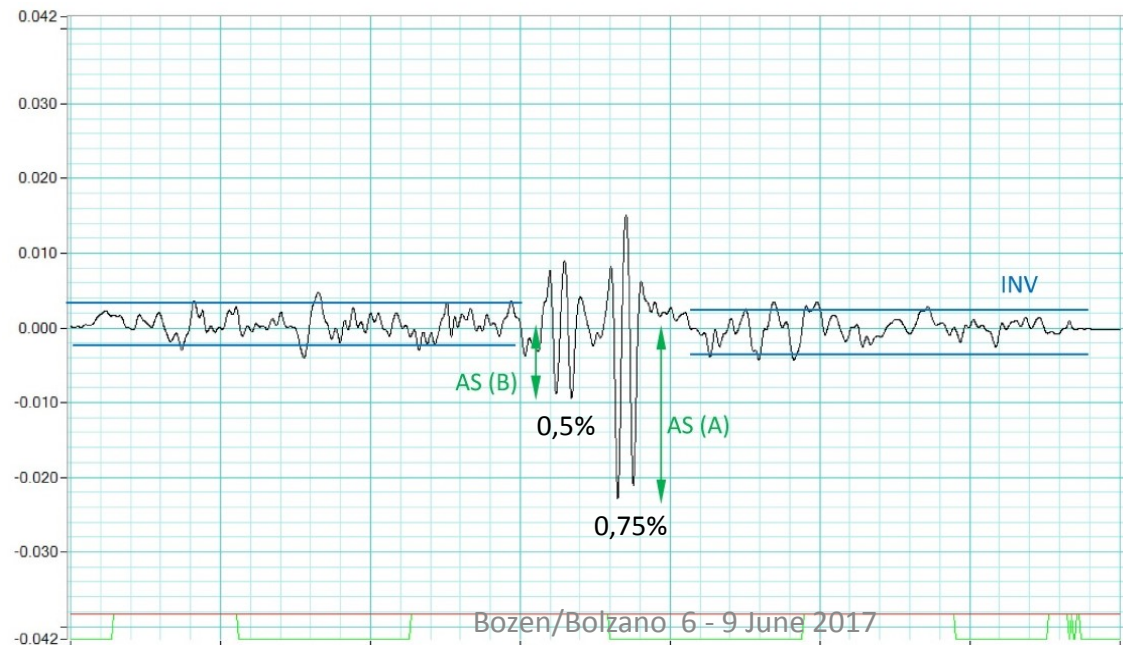
The first picture illustrates the result of the open detector on a UNI 12927 test. The detector obtains a positive result (63 mm diameter rope).





The second picture illustrates the result of the open detector on a pair of external defects that realizes 0.5% and 0.75 % section loss. The defects were located ed in the «worst case» position.

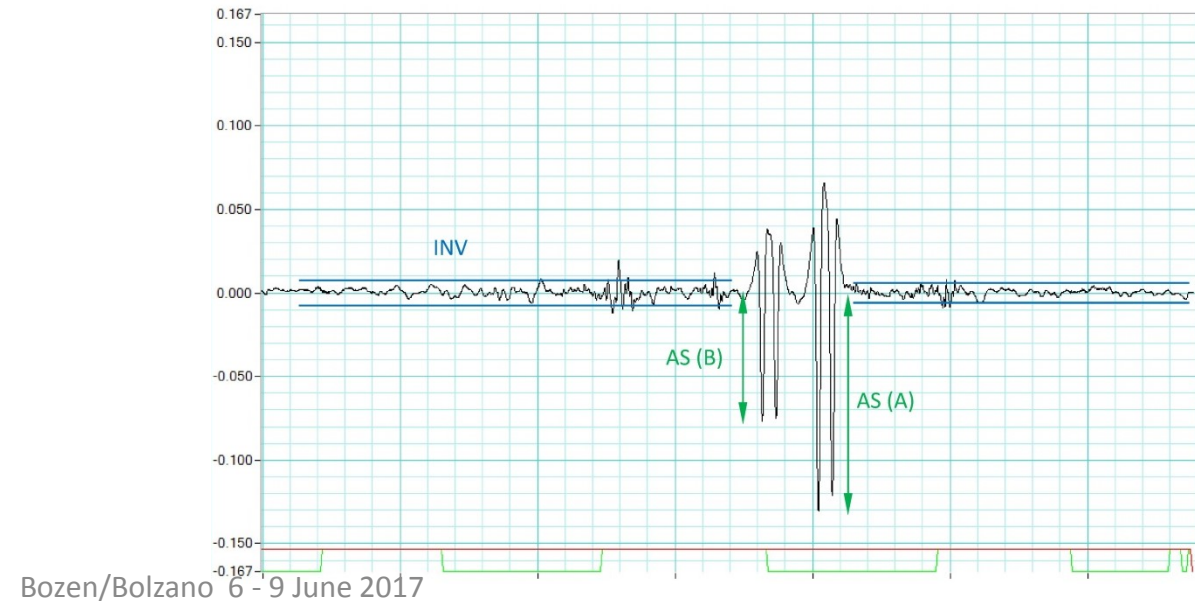
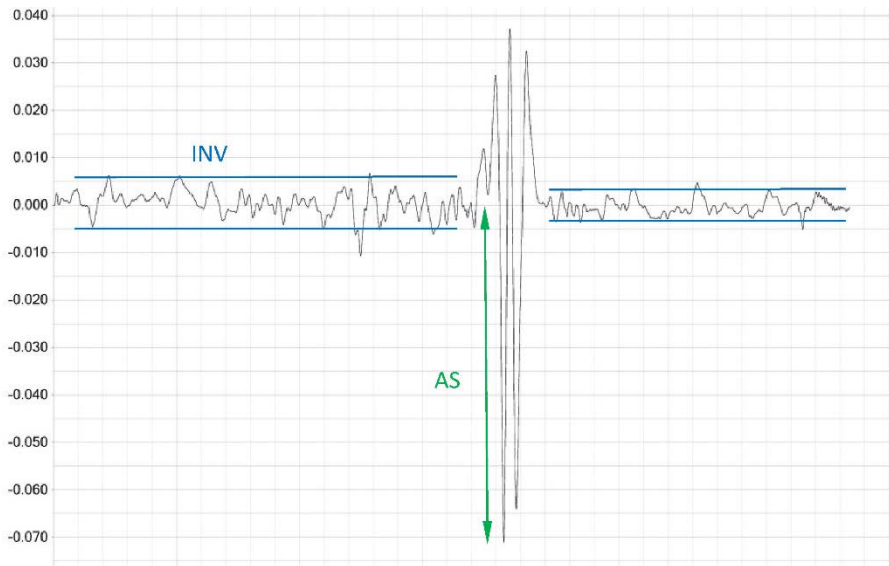
The detector provides sharp and clear signals in both conditions.





The third couple of pictures illustrates the result of the closed detector in the same previous test conditions.

The detector obtains a positive result in UNI 12927/8 terms in all conditions.





## The second laboratory conclusion

1. external defects certainly represent a valid auxiliary test for the verification of the «open» detector; these tests may be integrated with the aid of the test leads.
2. The two tested detectors provide reliable indications in the defined configurations:
  - 1) Central defect;
  - 2) External defect 0.75%
  - 3) External defect 0.5%

## General conclusions

- The experimental results performed independently in separate laboratories confirm the theoretical predictions.
- The theoretical works, in accordance with experimental results, indicate the far external defect as the worst case for «open detectors» and all the tested devices were able to sharply detect such defects
- the result of the inspection can be considered reliable if:

TESTED DEVICES

TRAINED AND CERTIFIED PERSONNEL

VALIDATION OF PROCEDURE

The development of techniques for the control of the ropes are an important tool to ensure the safety of the ropes, whose responsibility is still on direttore dell'esercizio.





## About the authors

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