

# **Στοχεύοντας στην Διαπίστευση του Εργαστηρίου Ηλεκτρονικών Αισθητηρίων του Εθνικού Μετσόβιου Πολυτεχνείου Σύμφωνα με το ISO 17025**



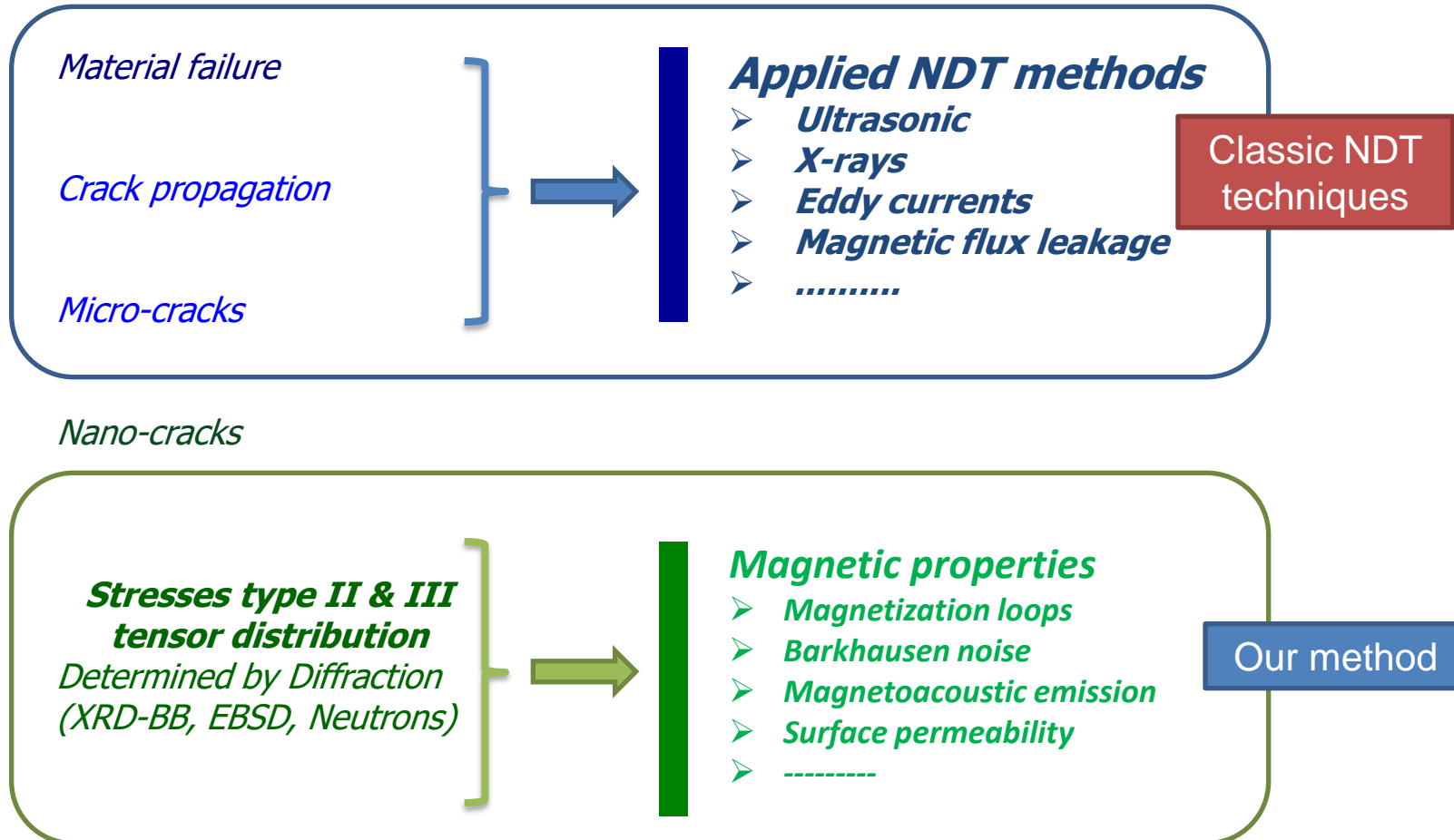
Εθνικό Συνέδριο Μη-Καταστροφικών Δοκιμών  
Εθνικό Ίδρυμα Ερευνών – Παρασκευή 11/11/2016

# Accreditation

- Stress monitoring in steels
  - Market size
  - Standardization & procedures
  - Inter-laboratory comparison tests
- Magnetometer calibration
  - Market size
  - Standards to be followed
  - Inter-comparisons

# Break through in Steel Stress Monitoring

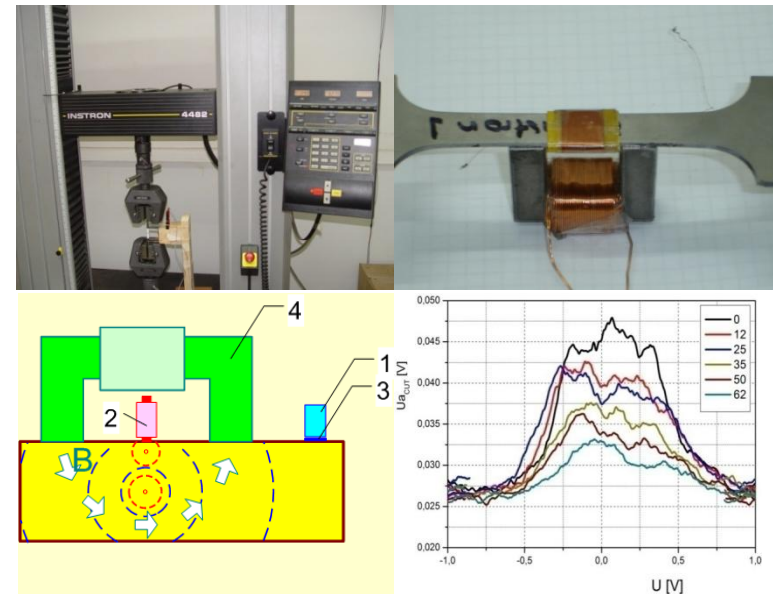
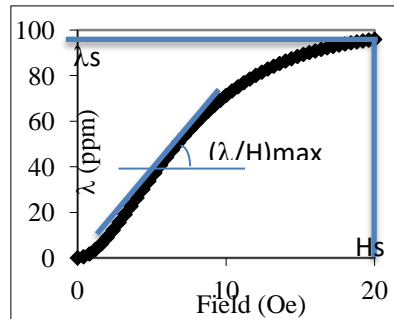
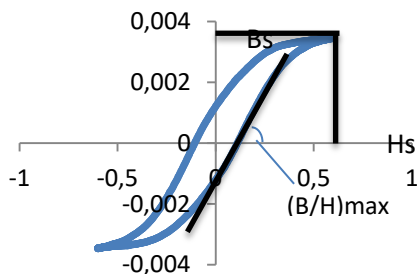
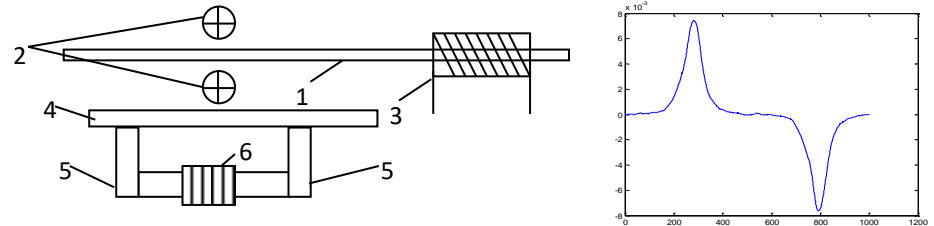
## Principles & Vision



➔ best value for money!

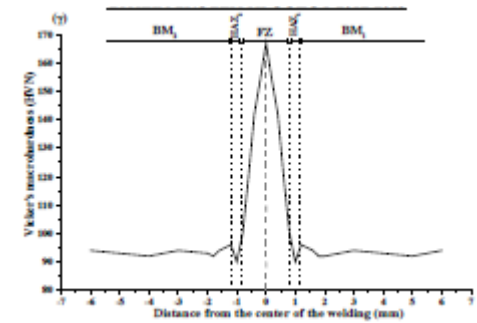
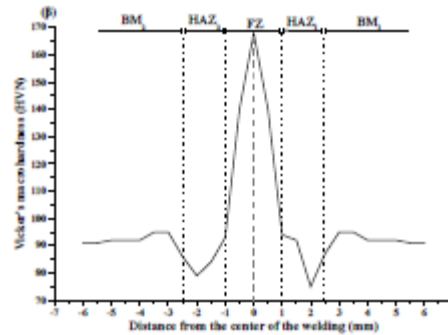
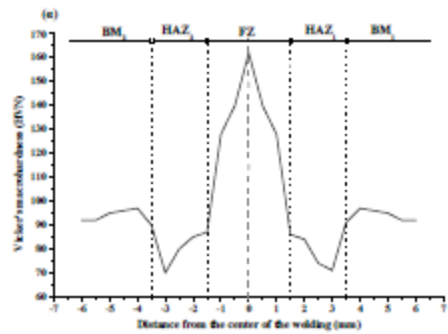
# Measuring magnetic properties

- Surface properties
  - Surface permeability
- Bulk properties
  - Bulk permeability
  - Magnetoacoustic emission

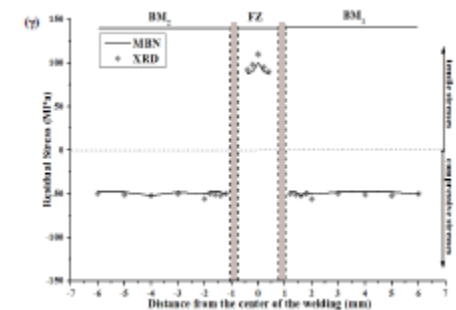
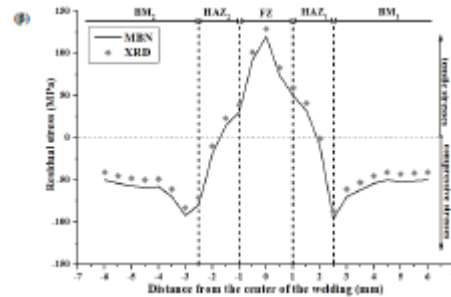
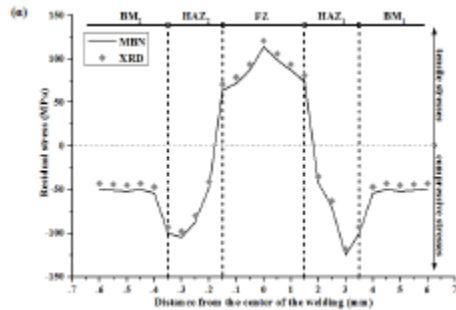


**Patented technology**

# Micro-hardness across welding



# Magnetics vs stress components across welding



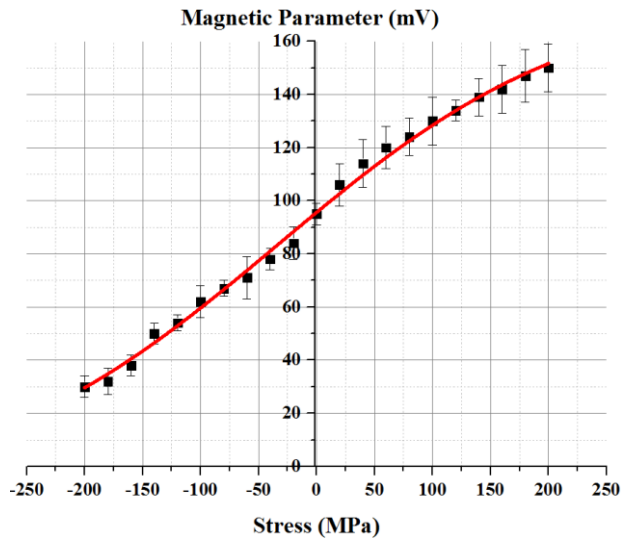
TIG

Plasma

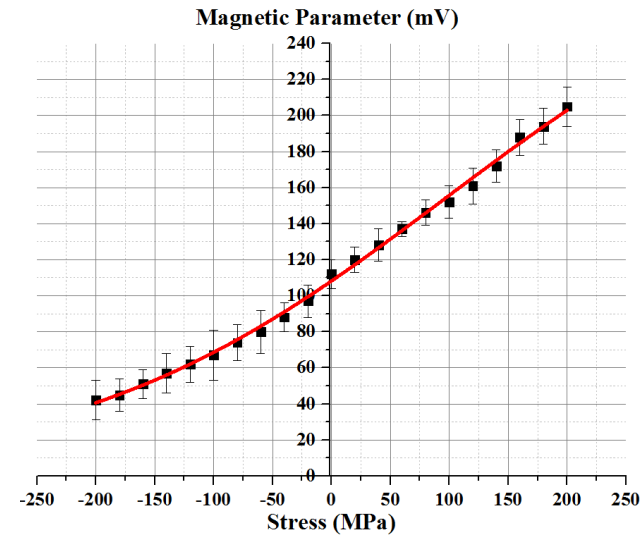
EBW

Measurements in AISI 1008 steel

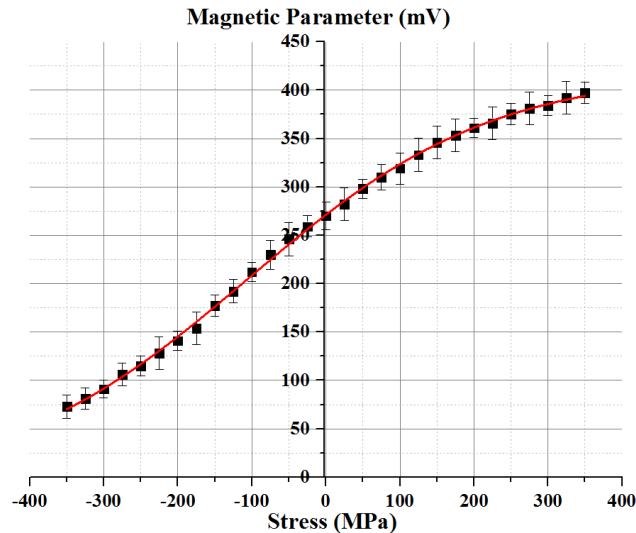
# Magnetic Stress Calibration Curves (MASCC)



Steel 37



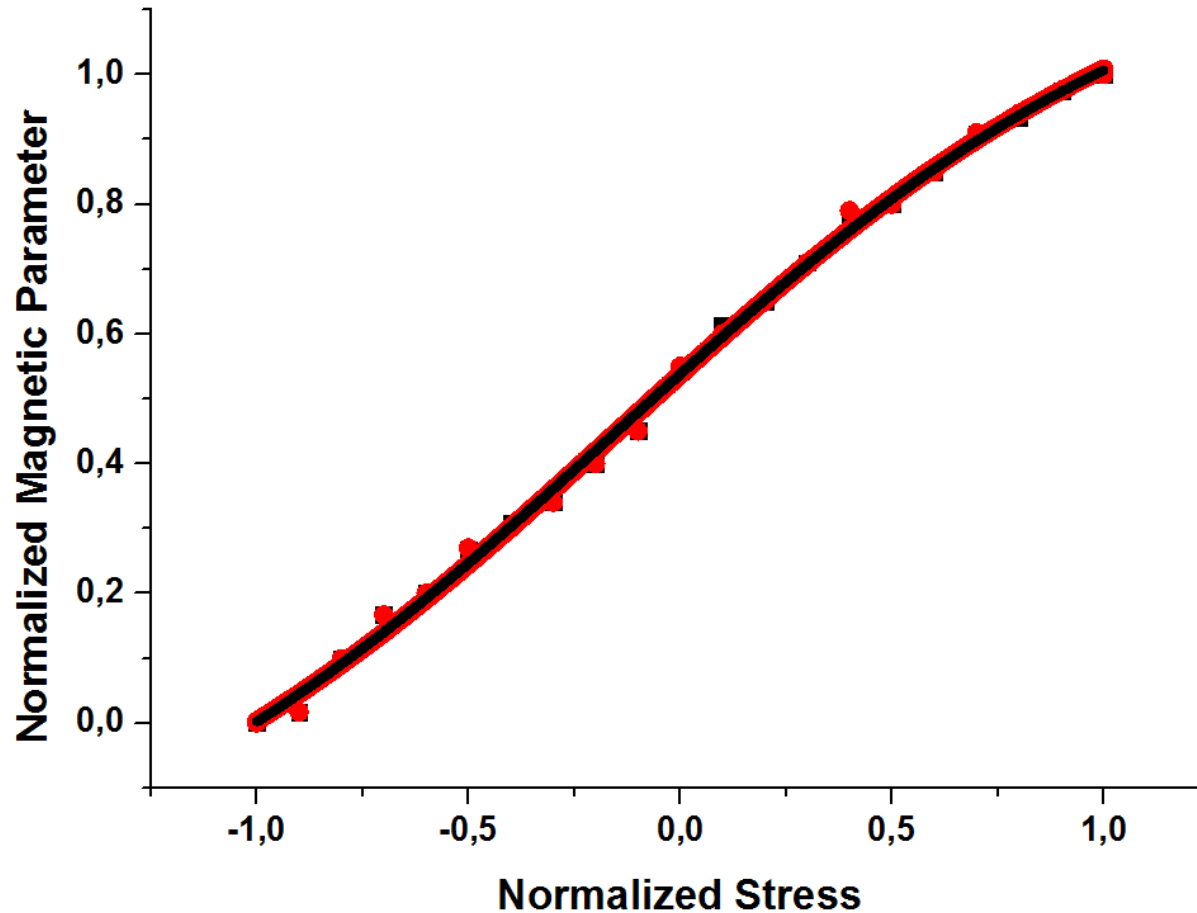
AISI 1008



ANSI 4130

**We have concluded the calibration curves of 17 types of steels out of the 42 most important existing ones**

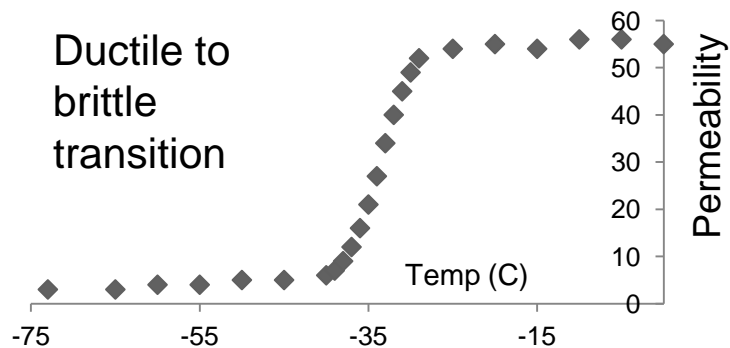
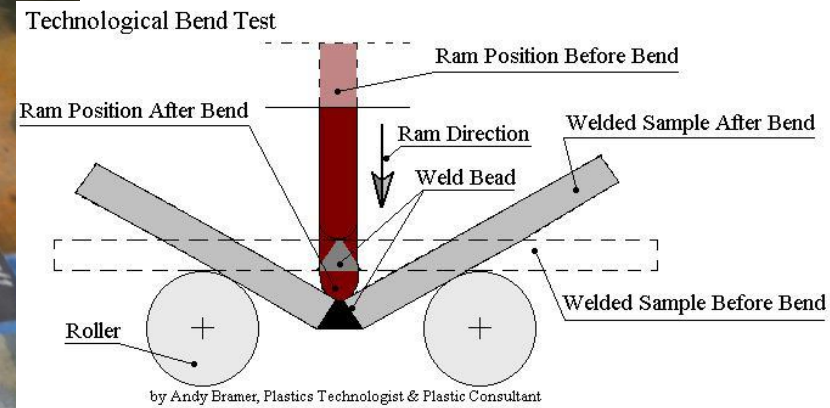
# Universal law of stress dependence on magnetic properties!



Normalized permeability with its maximum and  
normalized stress with yield point

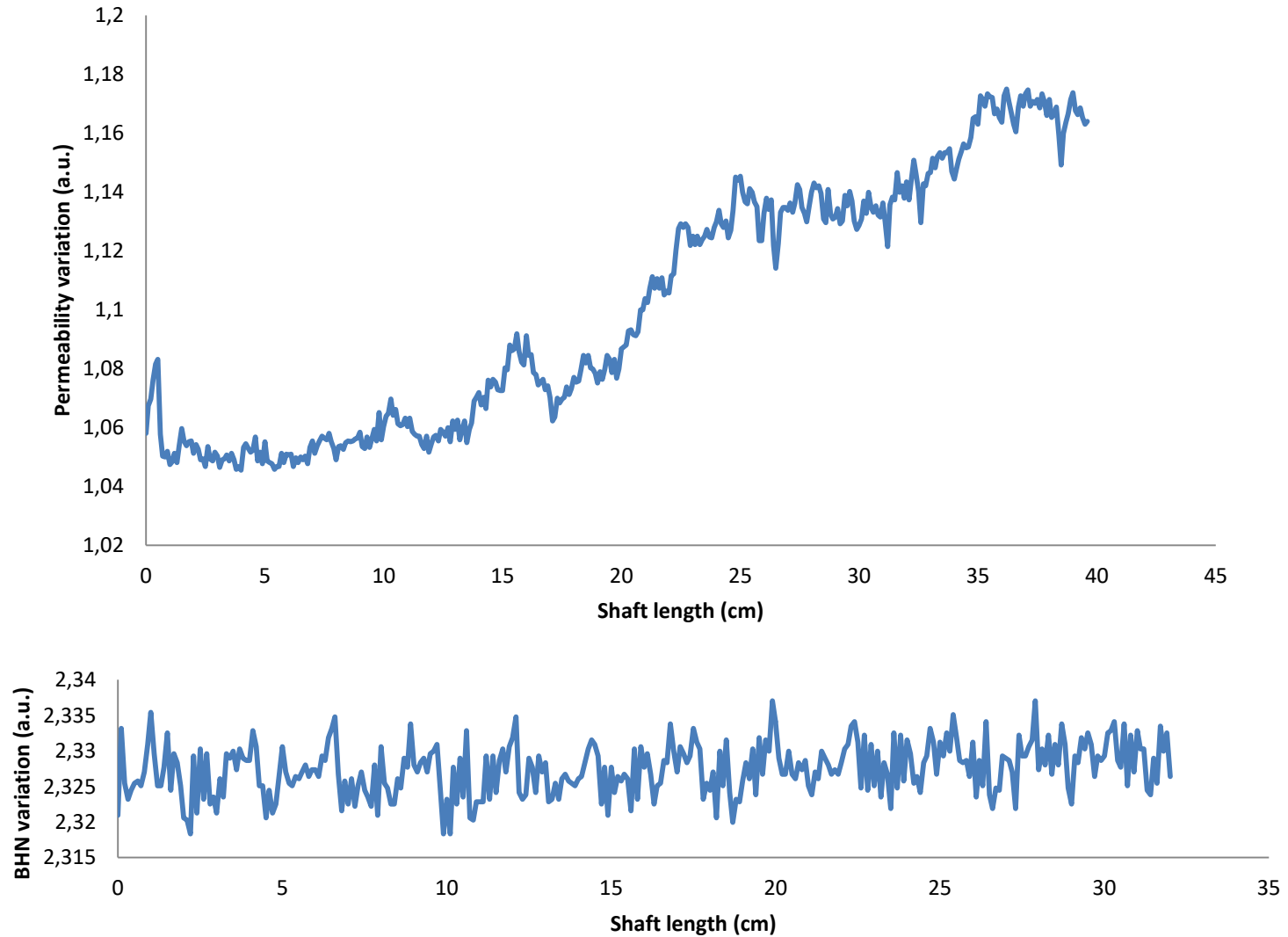
# Example of Application

## Quality control in Corinth Pipe Works: DWTT Drop Tower





# Applications: stress fields in marine shafts



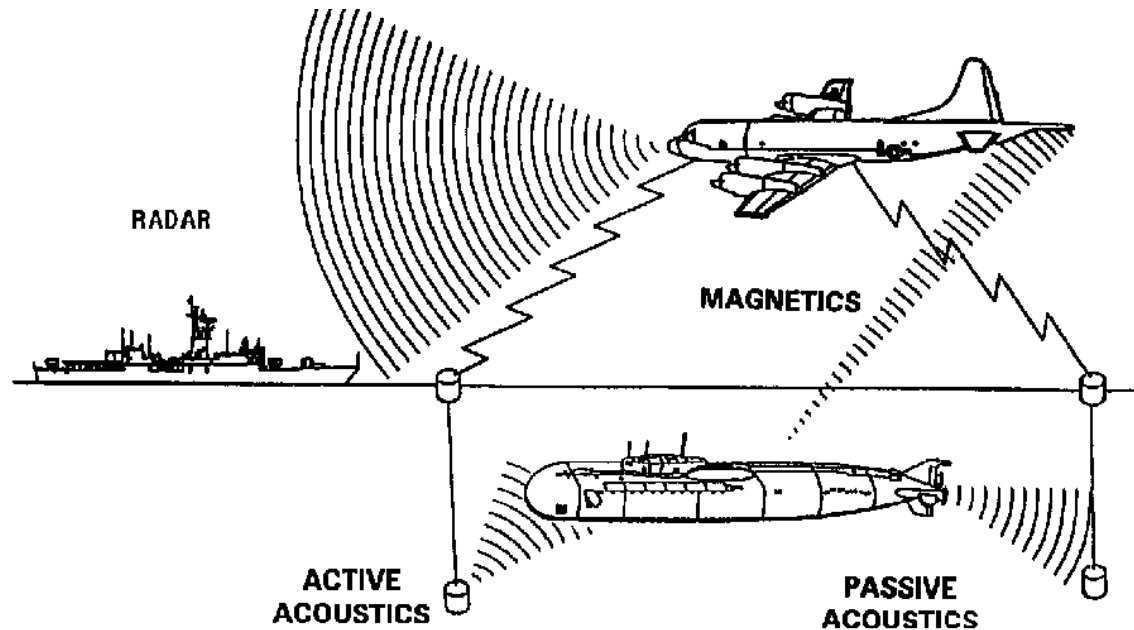
# Our current advances

- Ability to monitor residual and hydraulic stresses in the elastic region in the bulk of the steel – TRL 8 with industrial demos
- Having correlated 17 types of steels up to this moment, out of the 42 most interesting types for industrial applications
- Ability to monitor residual and hydraulic stresses in the plastic deformation region in the bulk of the steel – TRL 5
- Inter-comparison tests between different magnetic techniques, leading to our magneto-acoustic method and device
- Substantial improvement of the laboratory stress monitoring methods (XRD-BB & ND), targeting and reaching an uncertainty of 1%
- Theoretical explanation of the stress correlation with magnetic properties, exceeding the limits of the elastic region towards the UTS
- **Inter-laboratory comparison tests with INRIM, NPL, PTB**
- ➔ Patent submitted on February 2016 concerning the monitoring instrument

# Market size in stress monitoring

- Steel manufacturers: half group for full time monitoring
  - Energy (PPC): one group for full time monitoring
  - Oil & Gas: half group for full time monitoring
  - Transport: one group for full time monitoring
  - Constructions: half group for full time monitoring
- ➔ 3,5 groups for full time monitoring
- ➔ Collaboration with a large strategic partner
- ➔ Discussion with PPC

# Necessity of magnetometer calibration



Magnetic and anti-magnetic sensing methods are the most vital tool  
in the new generation of anti-submarine warfare  
(info: DARPA)

# The Hellenic situation

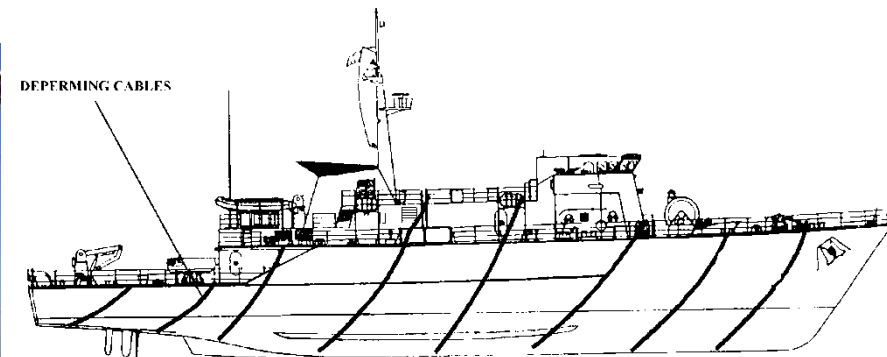


- The Aegean sea can be considered as a huge aircraft carrier to implement several local magnetometry stations to perform anti-submarine war
- Apart from that the Hellenic Navy can carry on-board such sensitive magnetometer systems in its territory
- Apart from that, there are needs in aeronautical applications

# De-perming - degaussing



The anti-magnetic sensing is also an important defensive tool, operationable due to magnetometers: the more sensitive the magnetometer, the most heavy weapon it is



**All these technologies do not exist in the Hellenic Navy, although being common practice in neighboring navies, and of course in the US Navy**



# Civil applications



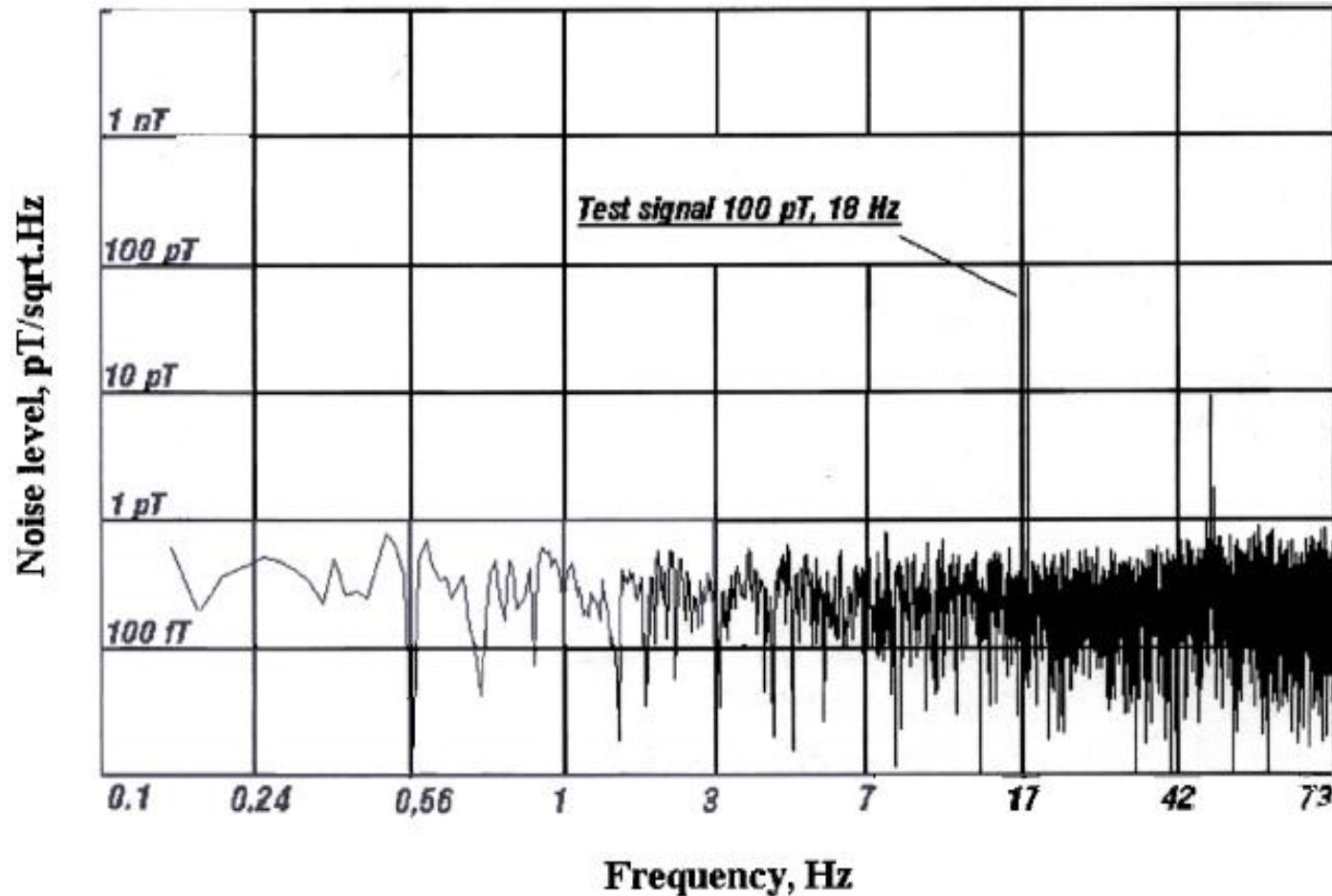
Magnetometry in civil applications can find several applications: volcanic and seismic observatories, space navigation, channel unmanned navigation, gas & oil, compasses etc.

Our group is targeting the development of precise magnetometer calibration, based on magnetic effects

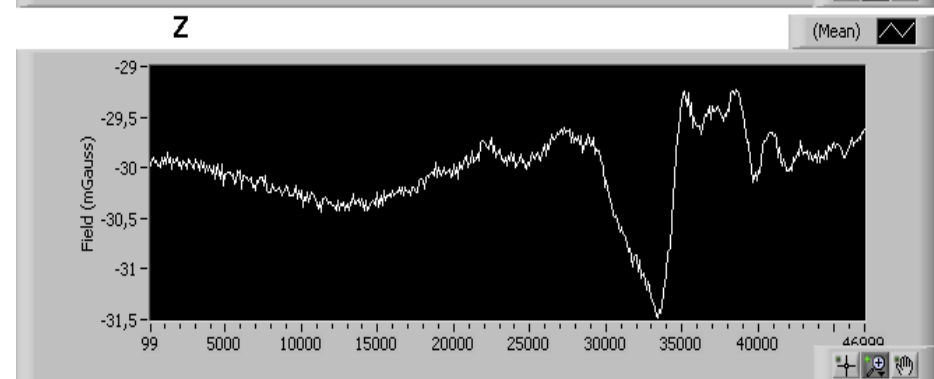
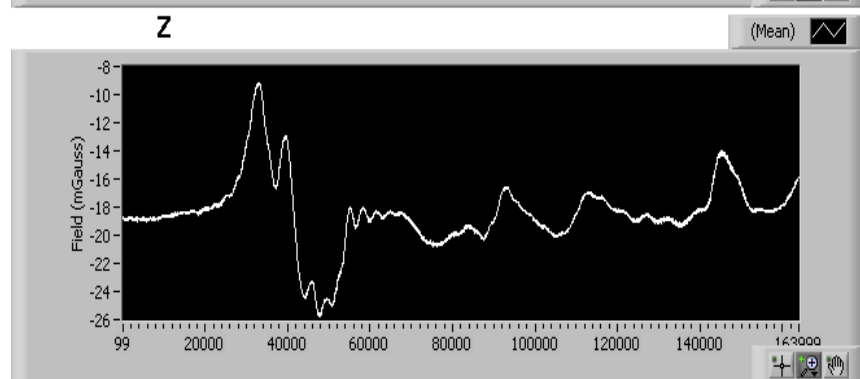
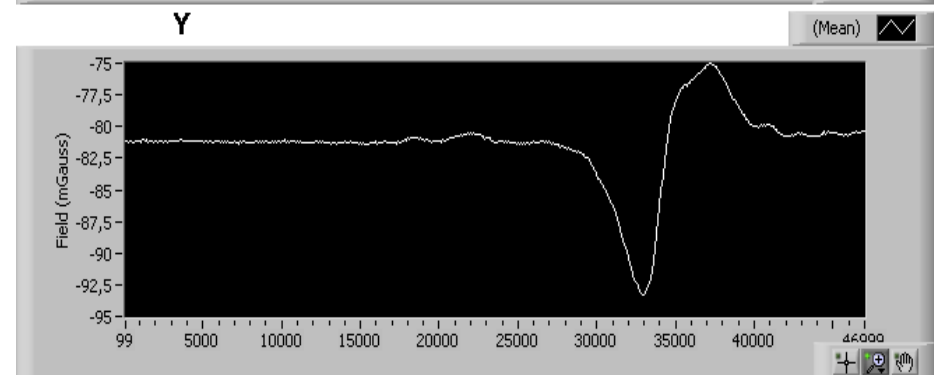
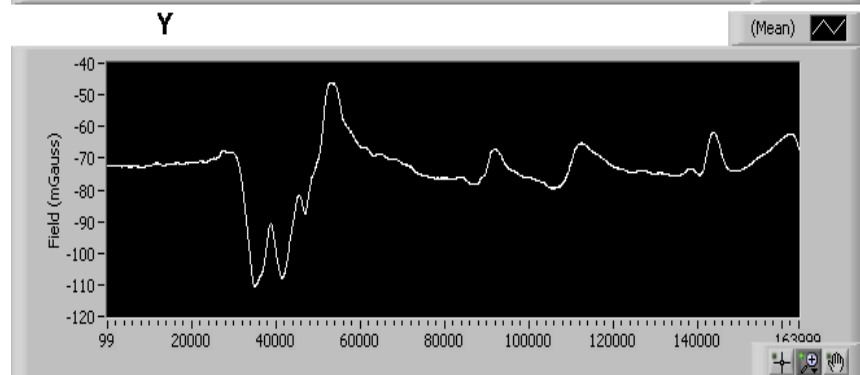
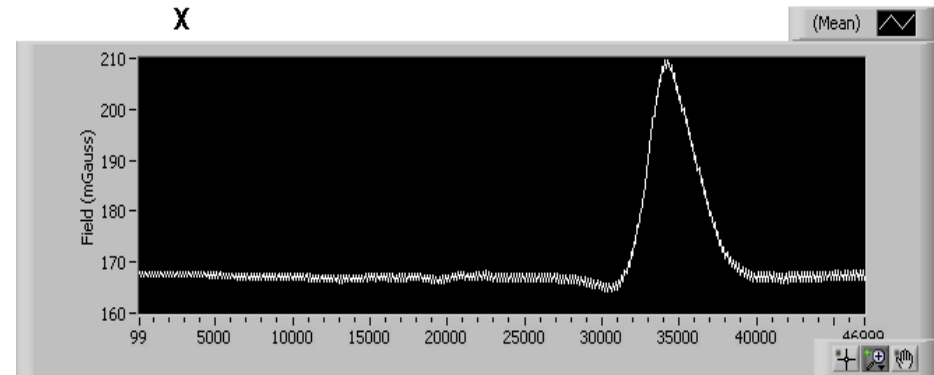
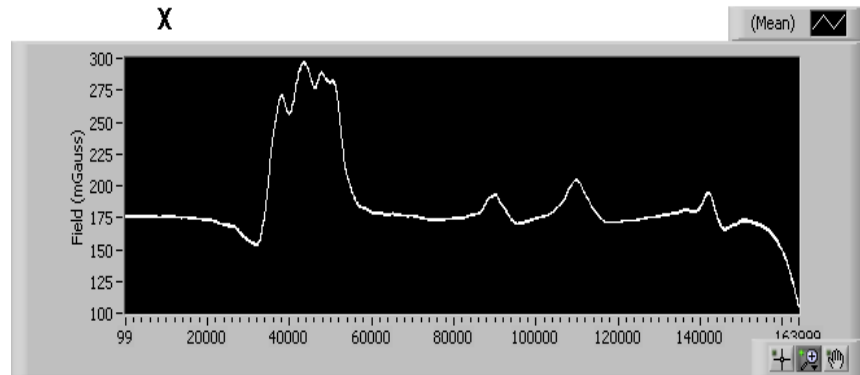




...following sub-pT sensitivity in measurements



# Implemented systems in Naval & Civil Applications



# Basics on Accreditation & Market Size

- **Inter-laboratory comparison tests with NPL, INRIM & PTB**
- Considering the Hellenic Navy, more than 1,000 magnetic observatories can be installed in the Aegean sea, counting the on-board systems, Degaussing stations etc.
- Considering the global market of magnetometry in civil applications (counting only volcanic and seismic observatories, as well as gas & oil applications, a market of 100,000 systems is visible, offering ~1,000 systems for calibration per year

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