

GMR sensors and Eddy Current technique applied to cavities

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Outline:

In the last two months some improvements have been achieved about:

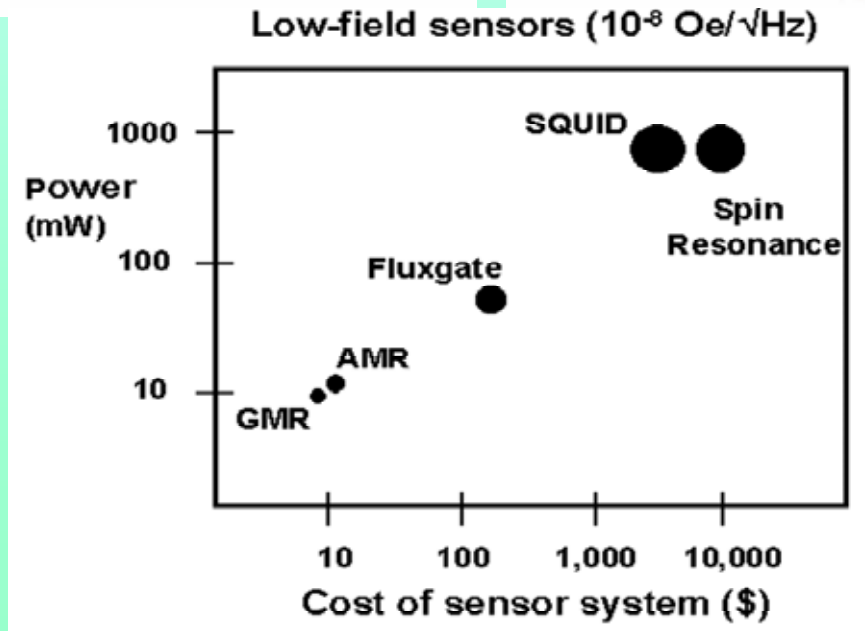
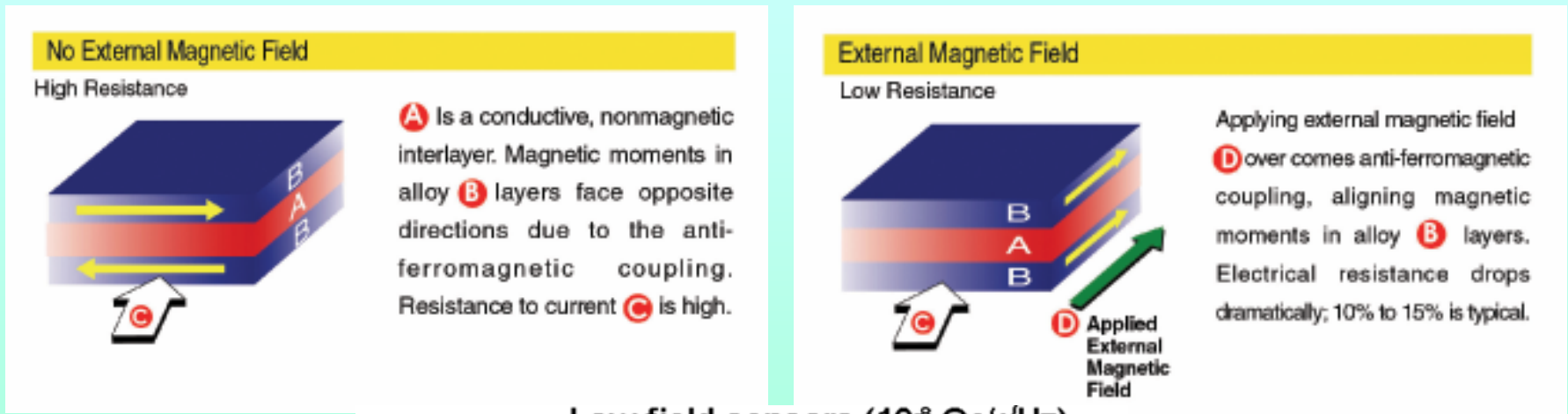
- Ongoing Electropolishing monitoring using a GMR (Giant Magneto-Resistance) 2nd order gradiometer
- Detection of sub-millimetric defects on Nb surface using Eddy Current induction coil

Typical Magnetic sensors characteristics in unshielded environment

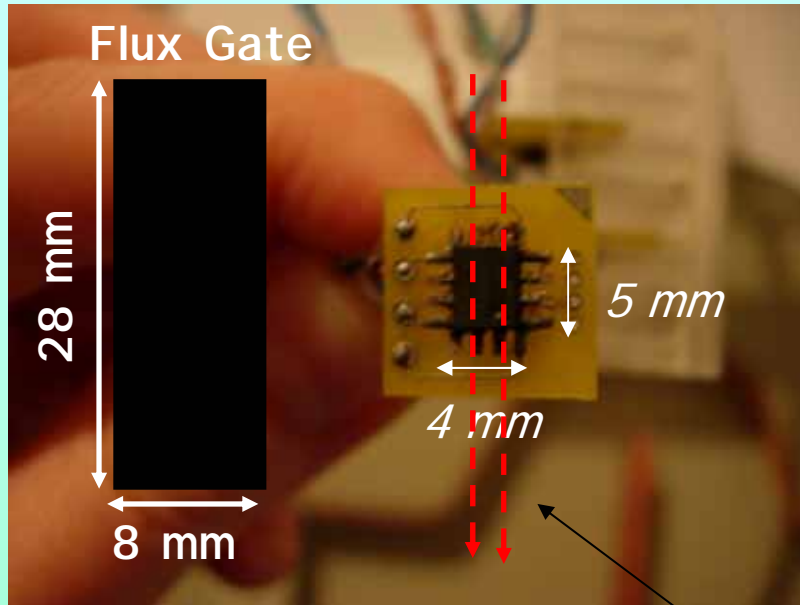
Sensor	Range	Sensitivity
Hall probe	$\pm 10 \text{ mT}$	$0.8 \text{ } \mu\text{T} / \sqrt{\text{Hz}} @ 1\text{Hz}$
Flux Gate	$\pm 70 \mu\text{T}$	$10 \text{ pT} / \sqrt{\text{Hz}} @ 1\text{Hz}$
GMR	$\pm 50 \mu\text{T}$	$0.1 \text{ } \mu\text{T} / \sqrt{\text{Hz}} @ 1\text{Hz}$
SQUID	$\pm 1 \mu\text{T}$	$0.3 \text{ pT} / \sqrt{\text{Hz}} @ 1\text{Hz}$

GMR working principle

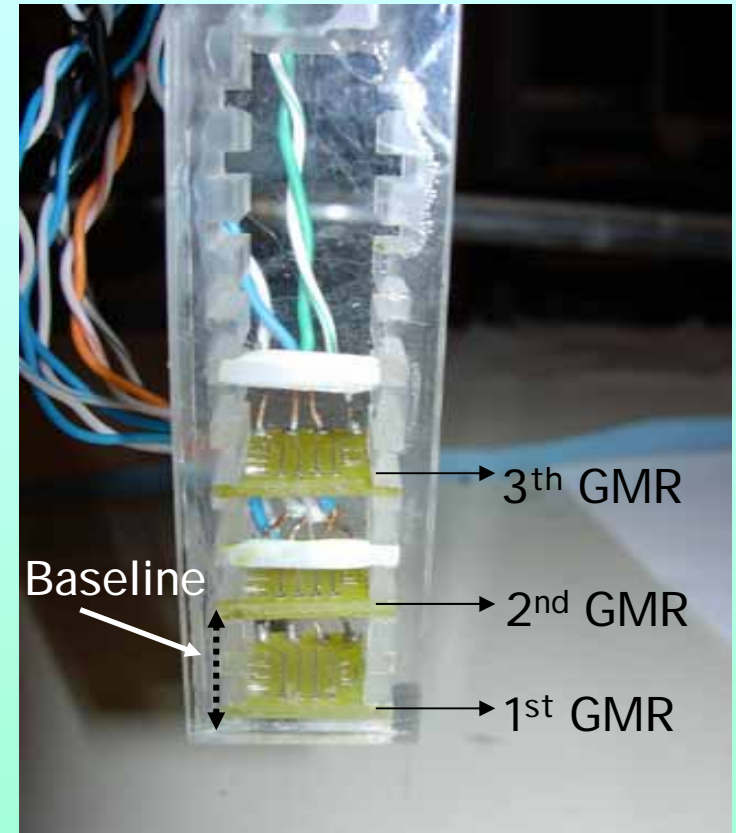
1988 - "Giant Magneto Resistive" effect - a large change in electrical resistance (from 10 to 20%) that occurs when thin, stacked layers of ferromagnetic and non-magnetic materials are exposed to a magnetic field.



Single GMR magnetometer chip



The in plane component of the measured Magnetic field



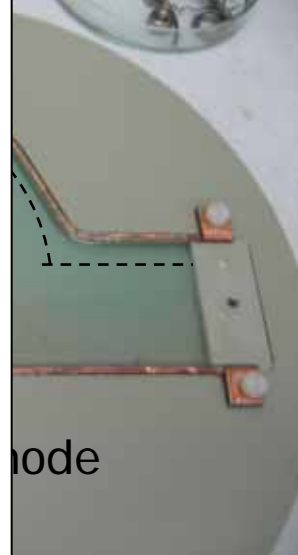
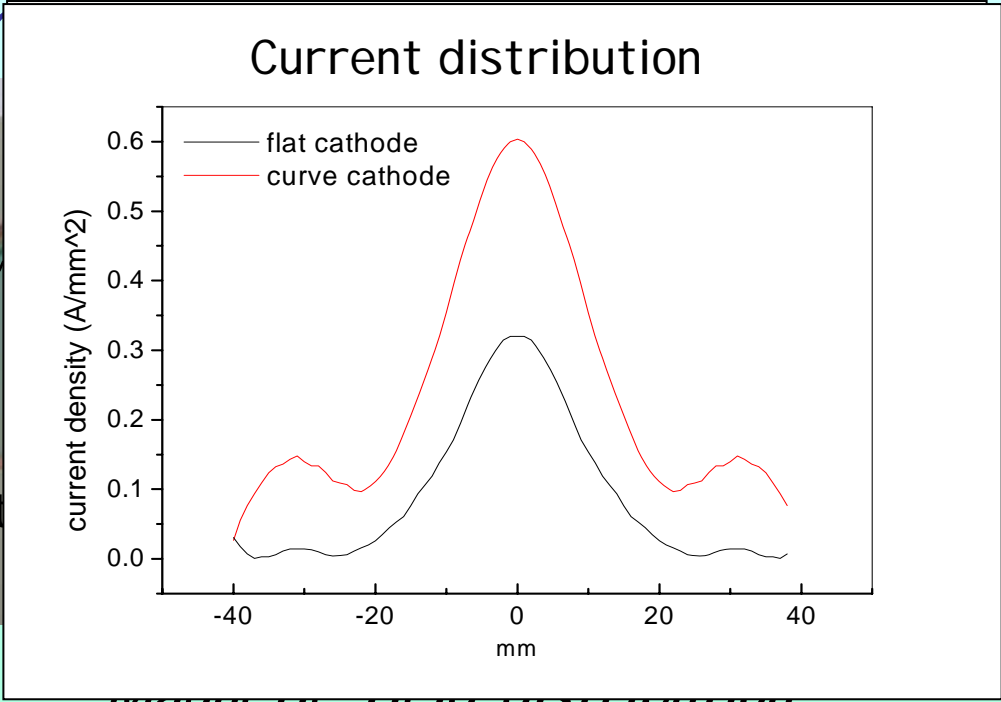
GMR 2nd order electronic gradiometer. It detects the in plane magnetic field component reducing the environmental noise. The baseline is 13mm.



.....two moulds

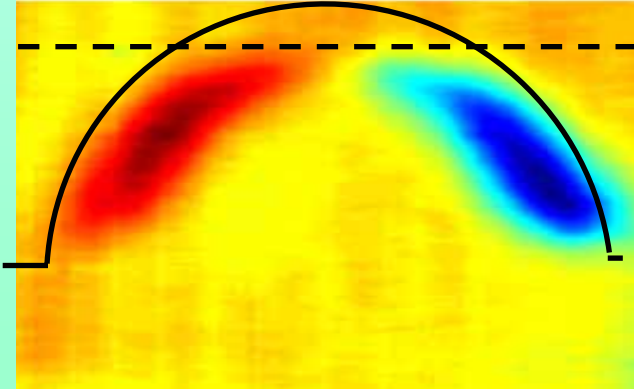


Flat

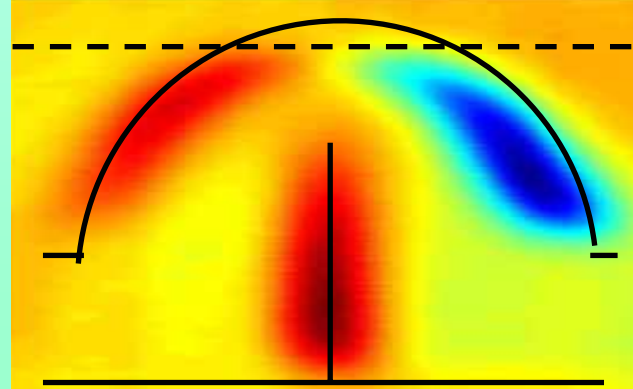


Curve cathode

Magnetic field distribution



Line-scan



Magnetometry demonstrates that the shaped cathode guarantees a better elettropolishing than the flat cathode!

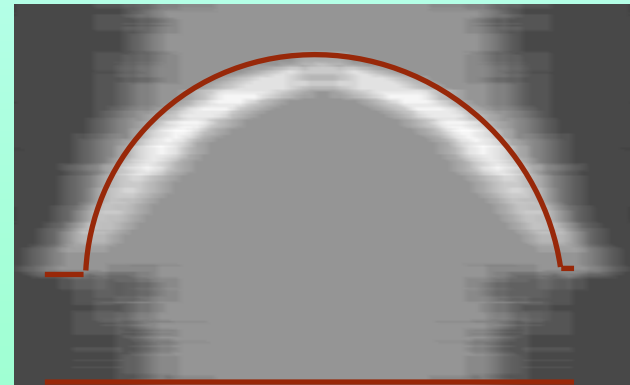
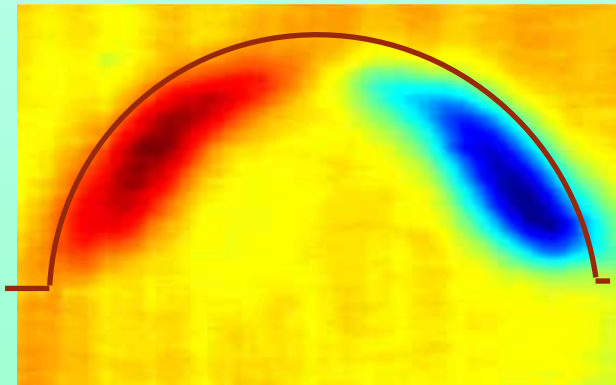
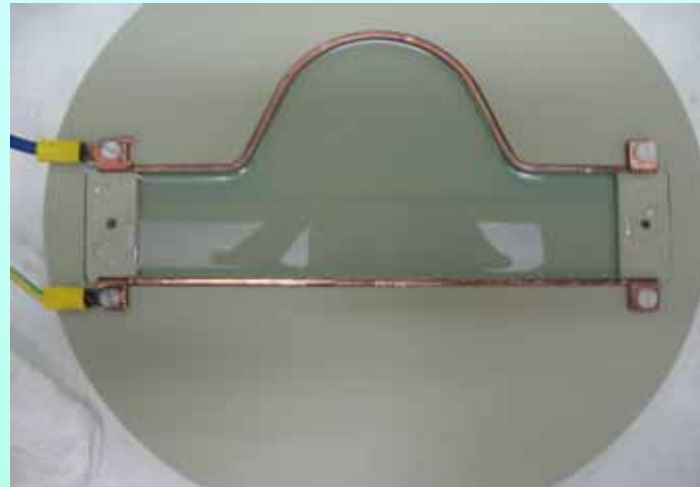
.....Now

Solution :

55% Phosphoric acid

45% n-buthanol

Electrode material: Copper



The GMR graiometer probe is able to reproduce the geometry of the cavity-shaped electrode with high spatial resolution!

GMR 2nd order gradiometer to detect defects on Niobium surface

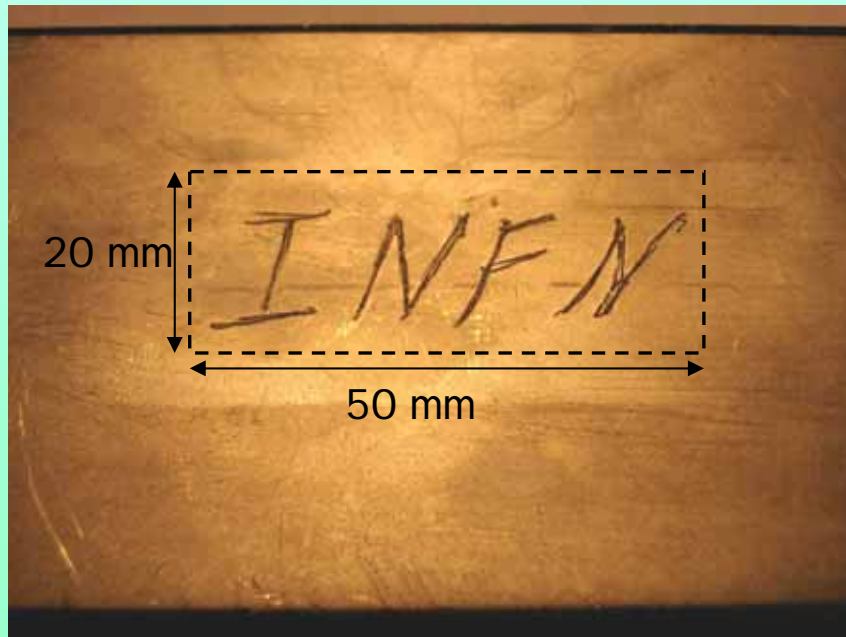


Artificial sub millimetric scratches (less than 0.1mm) have been produced on the Nb surface

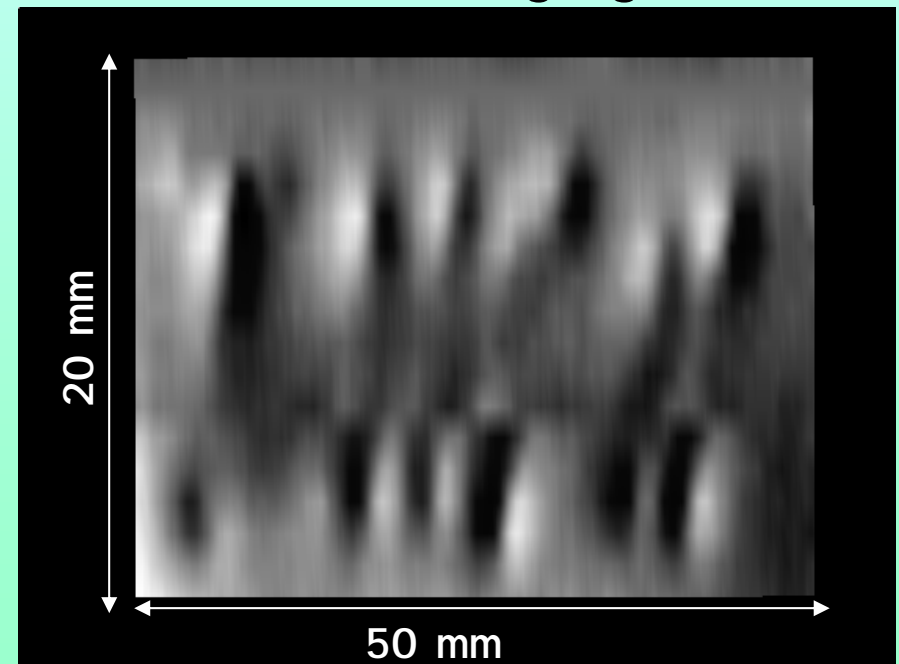
Injected current technique at frequency of 3.6KHz has been applied.

Actually the GMR electronic detection stage works at frequency below 100kHz.

Test sample



GMR imaging

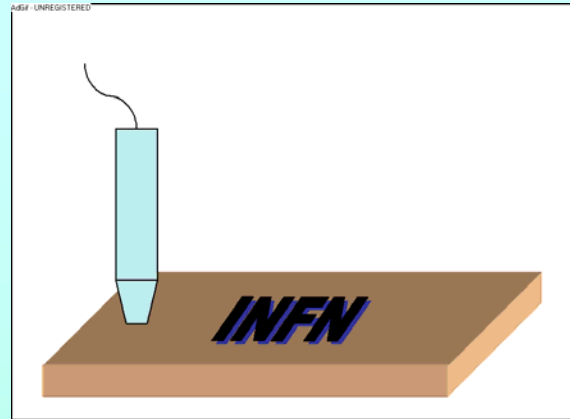




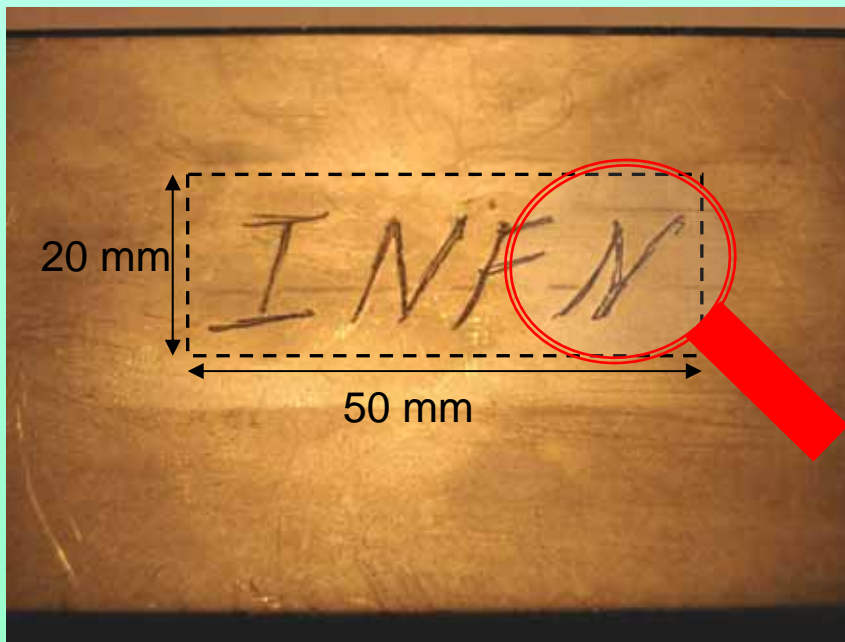
.....two months ago

Eddy current technique using
ELOTTEST B300

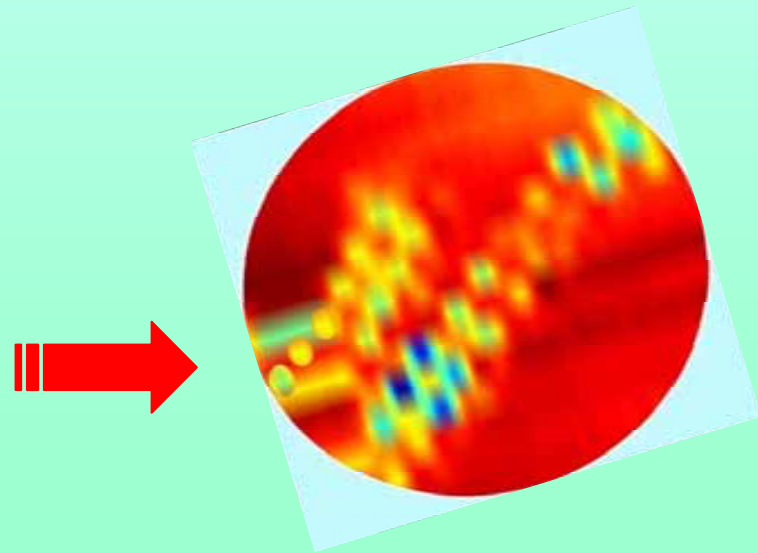
Working frequency= 1.4MHz



Test sample



Eddy Current induction coil imaging

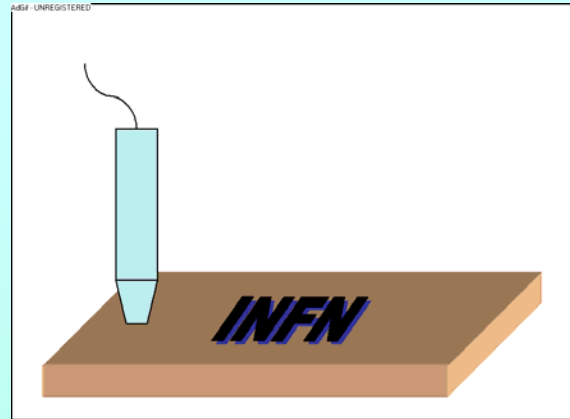




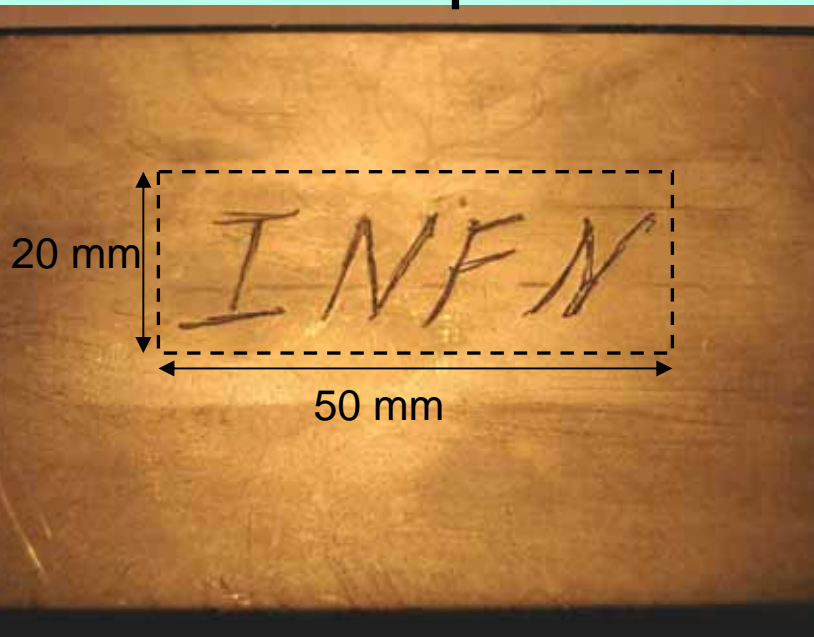
.....Now

Eddy current technique using
ELOTTEST B300

Working frequency= 3MHz



Test sample



Eddy Current induction coil imaging

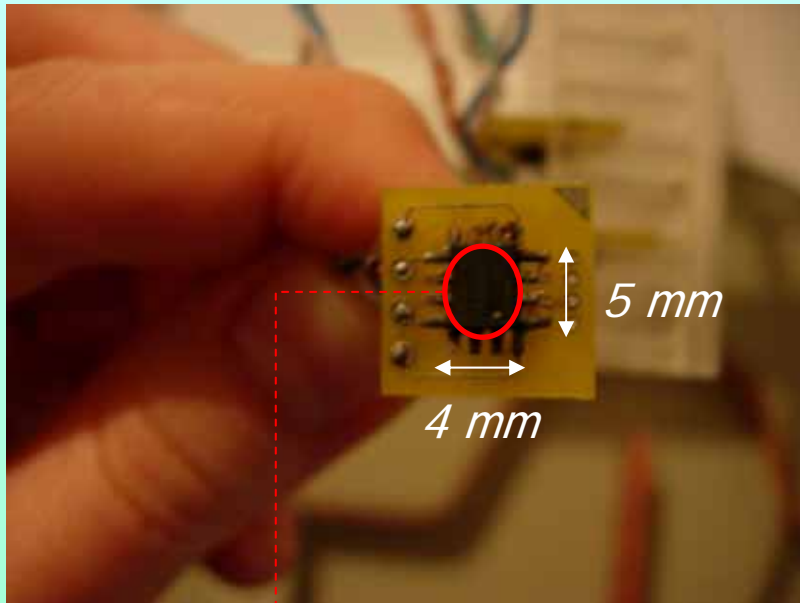


Eddy current technique detects even
the depth due to the indenter pressure!

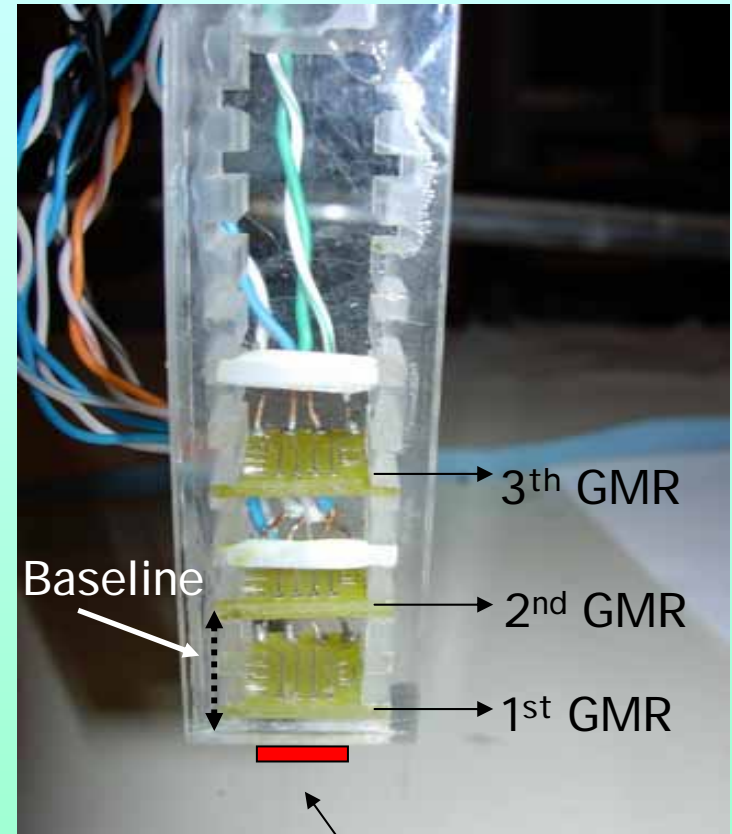
Eddy Current based on GMR 2nd order gradiometer



Single GMR magnetometer chip

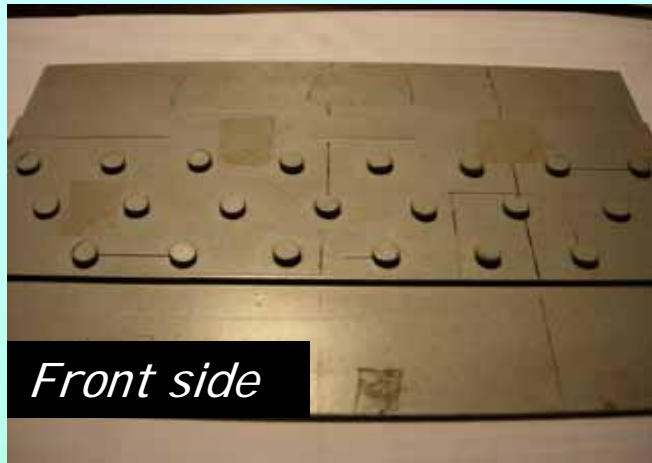


Circular excitation coil to induce eddy current into the specimen



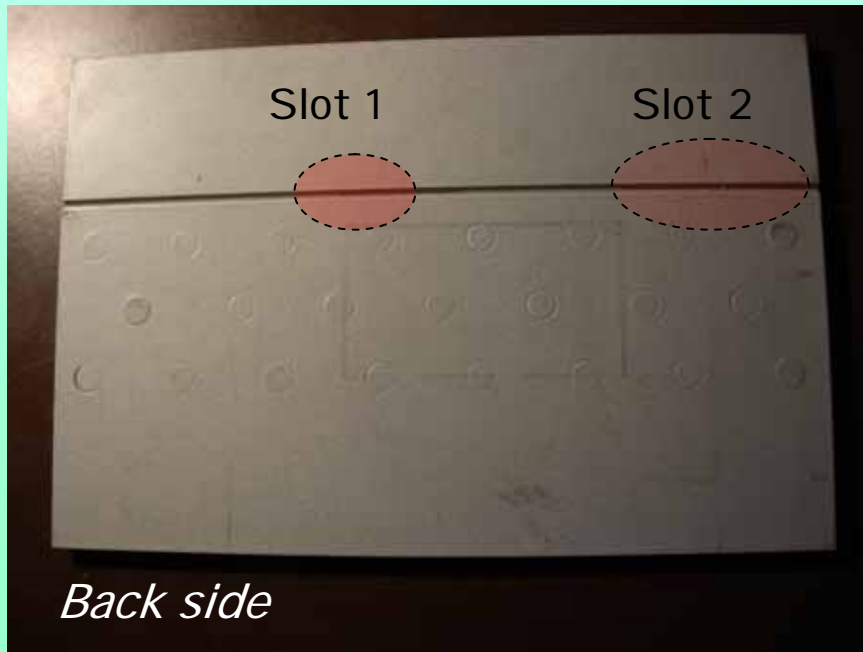
Excitation coil position

Eddy Current based on GMR gradiometer: (Just an example of what can be done)

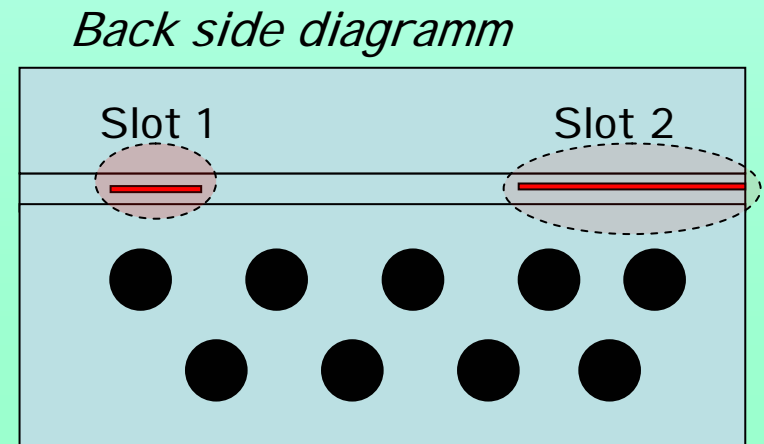
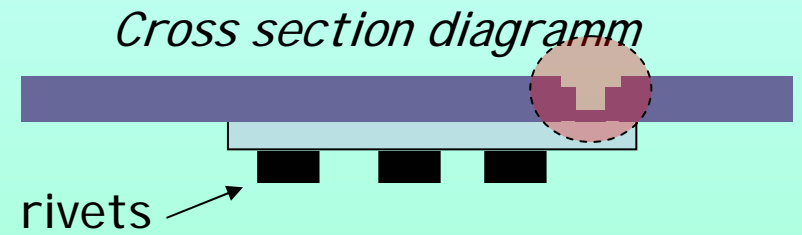


Front side

- The potentiality of the GMR Eddy Current probe has been tested using a AL-Ti alloy muck up
- The slots have a width less than 0.1 mm



Back side



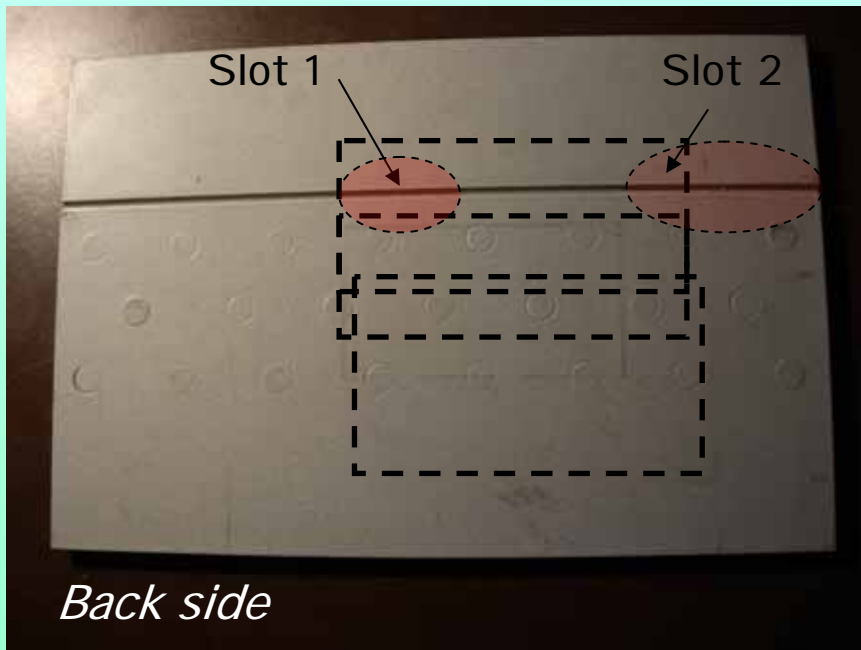
Eddy Current based on GMR gradiometer:



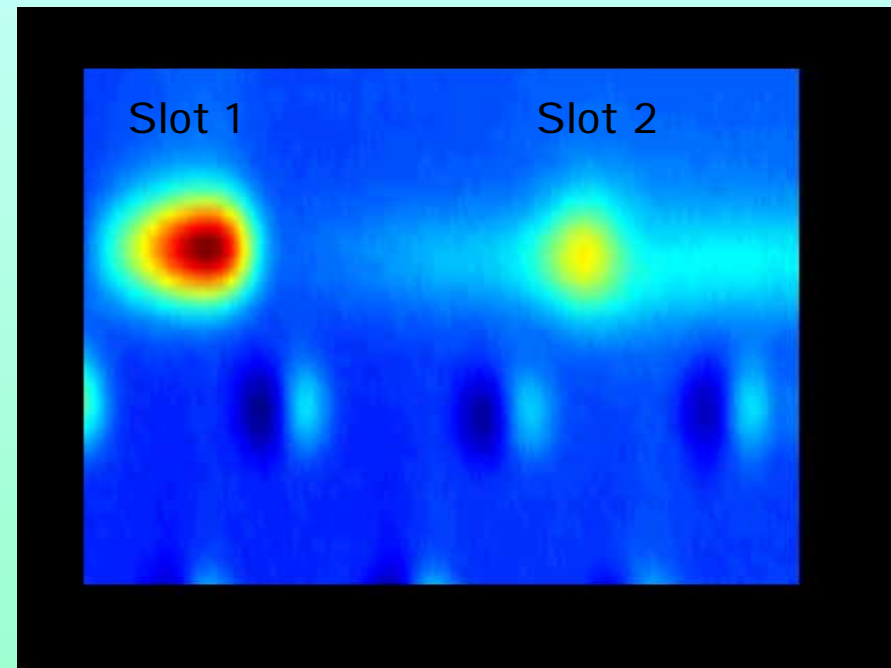
(Just an example of what can be done)

The operating frequency of induction coil is 4.6kHz

Test sample



GMR imaging



In plane component of magnetic field

Work in progress

- Development of a new GMR signal amplifier and filtering electronic stage.
- Development of electronic psd (phase sensitive detection) for high frequency eddy current measurements of the GMR probe (actually the working frequency ranging between 1KHz and 100KHz).
- Monitoring of ongoing electropolishing in cell with shaped cathode using GMR 2nd order gradiometer.



QuickTime Movie