



**HAL**  
open science

# Adaptive mesh refinement for eddy current testing finite element computations

Laurent Santandrea, Yayha Choua, Yann Le Bihan, Claude Marchand

► **To cite this version:**

Laurent Santandrea, Yayha Choua, Yann Le Bihan, Claude Marchand. Adaptive mesh refinement for eddy current testing finite element computations. Sixth International Conference on Computation in Electromagnetics (CEM 2006), Apr 2006, Aachen, Germany. 2006, Proceedings - Sixth International Conference on Computational Electromagnetics, CEM 2006. hal-01547509

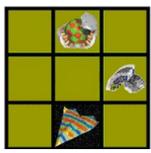
**HAL Id: hal-01547509**

**<https://hal.science/hal-01547509>**

Submitted on 26 Jun 2017

**HAL** is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.



# Adaptive mesh refinement for eddy current testing finite element computations



Laurent SANTANDREA, Yayha CHOUA, Yann LE BIHAN, Claude MARCHAND

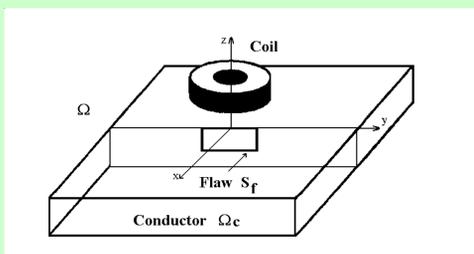
Laboratoire de Génie Électrique de Paris / SPEE Labs, CNRS UMR 8507, Universités ParisVI et Paris XI, Supelec, Plateau de Moulon 91192 - Gif sur Yvette - France

E-mail: santandrea@lgep.supelec.fr

## Introduction

This paper deals with an adaptive mesh refinement method applied to 3D eddy current non-destructive testing computations by finite element method. The principle of Ligurian is used as error estimator and applied in a general computation processing loop. This work takes place within the framework of the development of a non-destructive computer-aided numerical simulation environment. It has been applied to the TEAM Workshop Problem 15.

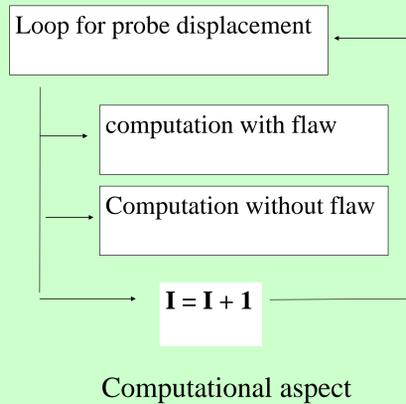
## Eddy Current Testing (ECT) Problem



ECT-NDT configuration

Excessive computational time

Ref ISEM



Computational aspect

## Error estimation

**Ligurian approach** : minimize the error in the magnetic constitutive law which describes the relationship between B and H.

In harmonic linear case the energy density error  $\lambda_m$  is defined as

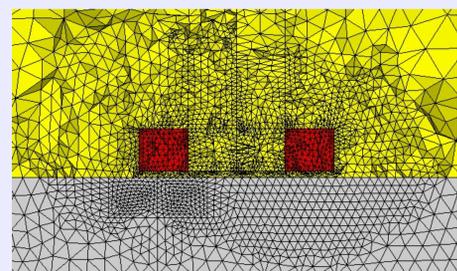
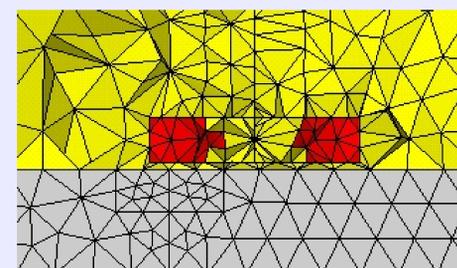
$$\lambda_m = 2 \left( \frac{\mathbf{B}_1^2}{2\mu} + \frac{\mu}{2} \mathbf{H}_1^2 - \mathbf{H}_1 \mathbf{B}_1 \right) + 2 \left( \frac{\mathbf{B}_2^2}{2\mu} + \frac{\mu}{2} \mathbf{H}_2^2 - \mathbf{H}_2 \mathbf{B}_2 \right)$$

with  $\mathbf{H} = \mathbf{H}_1 + i\mathbf{H}_2$  and  $\mathbf{B} = \mathbf{B}_1 + i\mathbf{B}_2$

For each element, the local magnetic Ligurian estimator can be written as :

$$\lambda_{mi} = \int_{K_i} \lambda_m(\mathbf{B}, \mathbf{H}) dK_i$$

## Results



## Mesh modification

The refinement indicator  $L_i$  is computed as

$L_i =$	0 if $\lambda_{mi} \leq \lambda_{th}$ element i is not split
	1 if $\lambda_{mi} > \lambda_{th}$ element i is split

Two general kinds of mesh modification are possible : h-type and p-type.

The list of elements to be split is then introduced in the ANSYS mesh generator which produces the refined mesh. The "erefine" command is then used in an ANSYS batch script.

## Conclusion

Computational time saving is quasi-proportional to processors number and can be better with a true multi-processors architecture. The proposed method can be used of course with a single hyper-threaded processor such as Pentium III and Pentium 4 processors to exploit parallelism. This technique is well adapted to the ECT problem which is easily divisible in independent problems.