



**HAL**  
open science

# Numerical simulation of peen forming induced deformations: modeling and experimental validation

Florent Cochenec, Emmanuelle Rouhaud, Lionel Roucoules

## ► To cite this version:

Florent Cochenec, Emmanuelle Rouhaud, Lionel Roucoules. Numerical simulation of peen forming induced deformations: modeling and experimental validation. European Conference on Residual Stresses (ECRS-8), Jun 2010, Riva del Garda, Italy. hal-00952567

**HAL Id: hal-00952567**

**<https://hal.science/hal-00952567v1>**

Submitted on 15 Feb 2022

**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.



Distributed under a Creative Commons Attribution - NonCommercial 4.0 International License



F. Cochenec<sup>1\*</sup>, E. Rouhaud<sup>2</sup>, B. Flan<sup>3</sup>, L. Roucoules<sup>4</sup>

<sup>1</sup> LBMS, EA CNRS 4325, Université de Bretagne Occidentale, 29285 Brest, France.

<sup>2</sup> ICD-LASMIS, FRE CNRS 2848, Univ Tech Troyes, 10010 Troyes, France.

<sup>3</sup> SISSON LEHMANN – Norican group, 08000 Charleville-Mezieres, France.

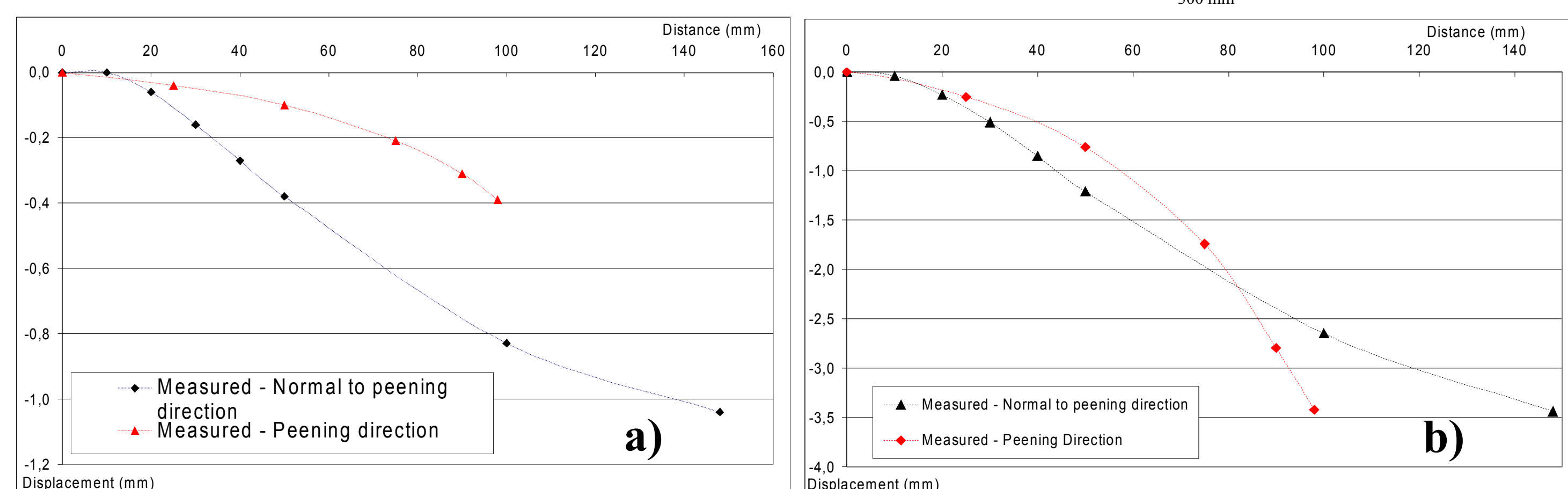
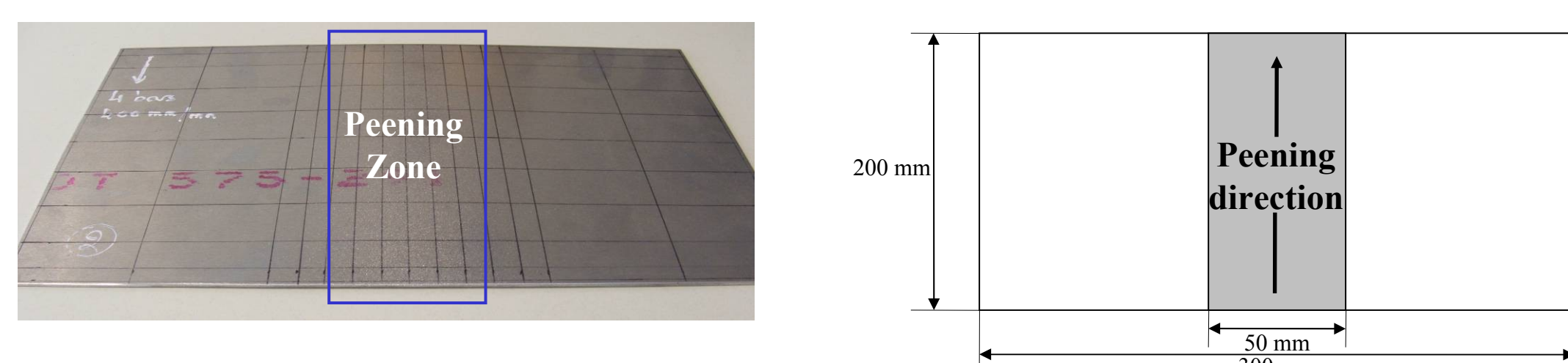
<sup>4</sup> LSIS, UMR CNRS 6168, ENSAM, 13617 Aix-en-Provence, France.

## CONTEXT

- Experimental and numerical study of the peen forming process: *study of the deformation mechanisms involved in shot-peening.*
- The scope of the work is to identify data that permit to *simulate the peen forming process.*
- The choice of **plastic strains as process data** is made. The plastic strains induced by the impacts are identified on simple cases and then numerically introduced in a Finite Element program to predict the deformation of more complex parts.

## EXPERIMENTAL CASES

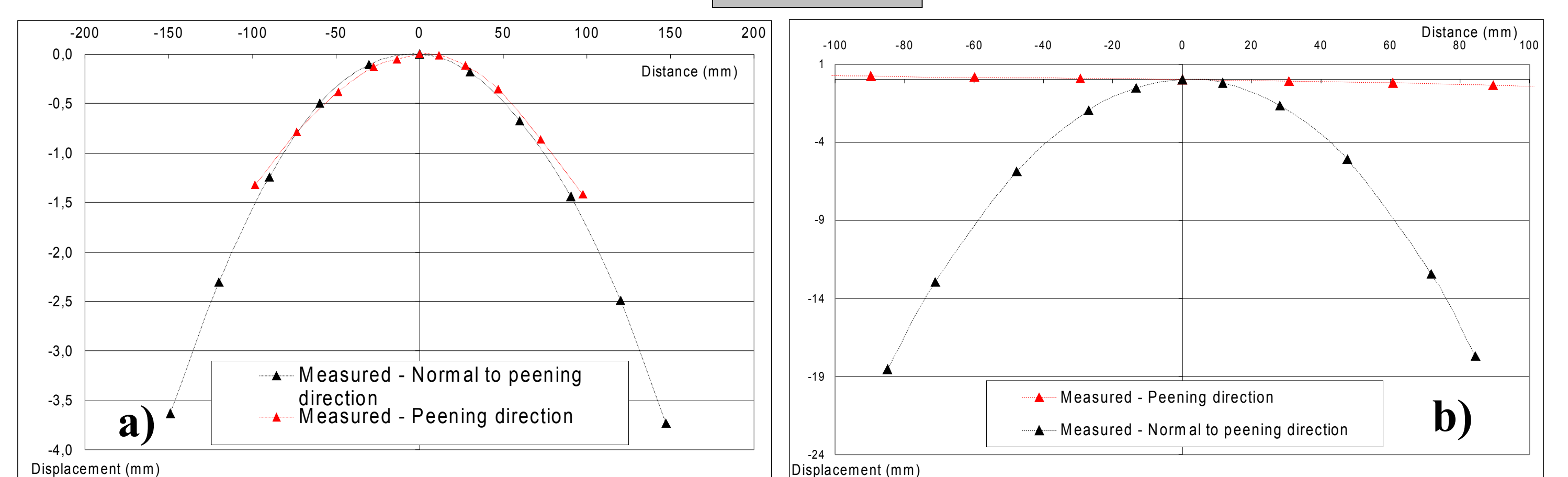
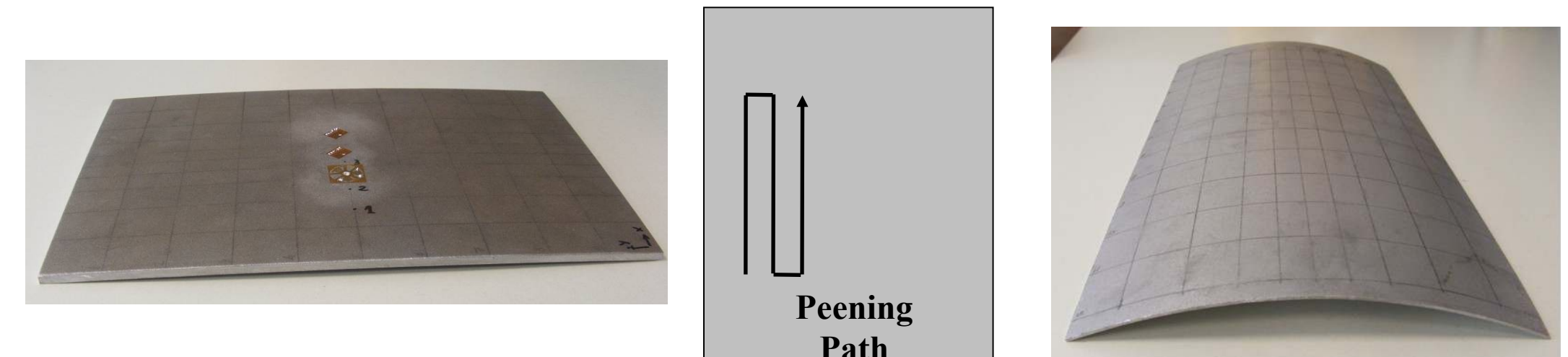
### Partially shot-peened aluminum 2024T3 alloy plates



Measured displacements after shot-peening (3-axial measuring machine)

a) 5 mm thick specimen b) 2 mm thick specimen

### Totally shot-peened aluminum 2024T3 alloy plates



Measured displacements after shot-peening (3-axial measuring machine)

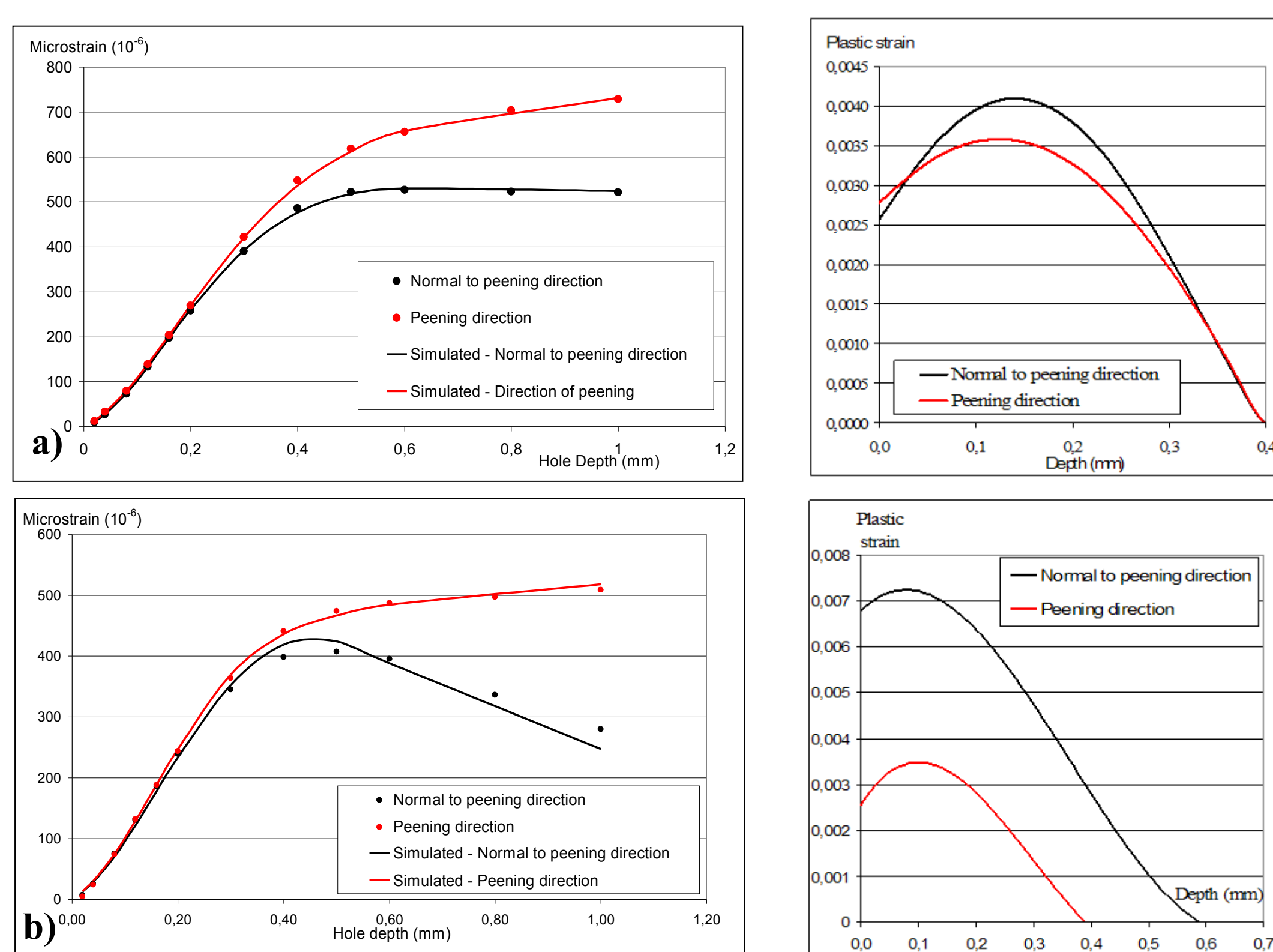
a) 5 mm thick specimen b) 2 mm thick specimen

- No influence of the peening path on global deformations for relatively thick specimens.
- Huge influence of the peening path on global deformations for thin specimens (cylindrical form depending on peening direction).

## NUMERICAL SIMULATION

### Incremental Hole Drilling results

- Classical method using strain gages.
- Model based on eigenstrains theories. Elastic FE problem with initial strains.
- Numerical model coupled to optimization program to identify plastic strains.
- Plates supposed to be free of external constraints during drilling.



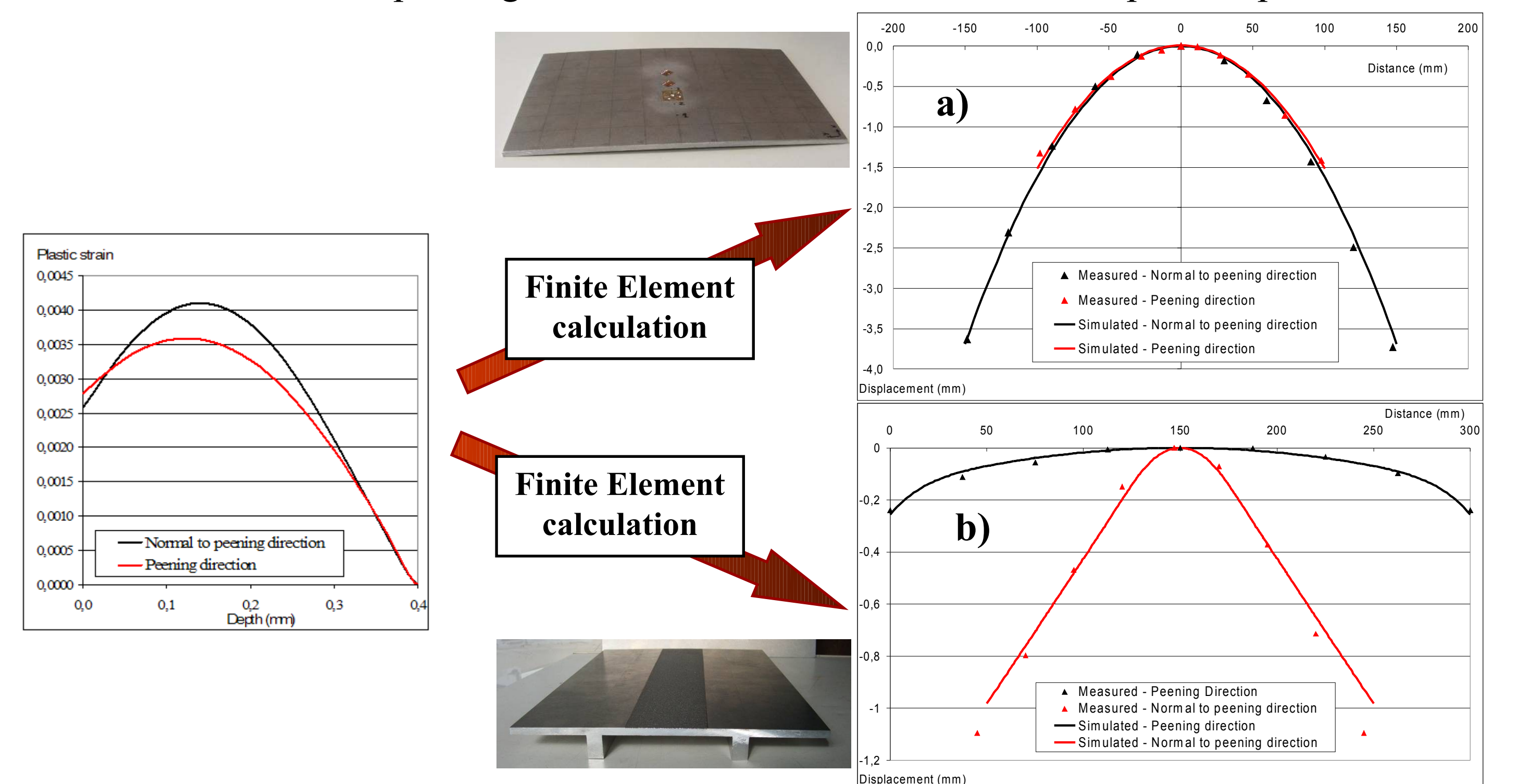
Numerical results – Partially shot-peened plates

a) 5 mm thick specimen b) 2 mm thick specimen

- Nearly equi-biaxial plastic strain field identified in 5 mm thick specimen.
- Plasticity oriented in the normal to peening direction in 2 mm thick specimen.
- Non realistic modeling of the boundary conditions of the 2 mm thick specimen: measured microstrains evolution do not correspond to the theoretical one.

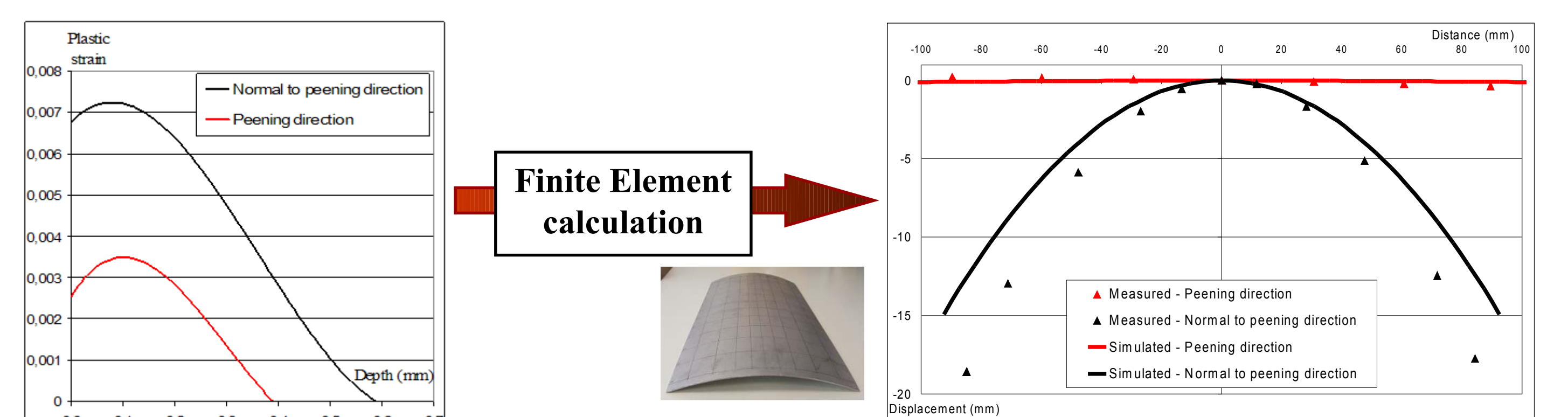
### Application to peen forming simulation

- Identified plastic strains as process data.
- Simulation of the shot-peening of the same materials, with the same process parameters.



Numerical results – 5 mm thick specimens

a) totally shot-peened plate b) stiffened panel



Numerical results – 2mm thick totally shot-peened plate

## CONCLUSION

- Measurements show the influence of the shot-peening path on the global deformations.
  - Negligible for relatively thick specimens.
  - Appreciable for relatively thin specimens.
- Peen forming simulation gives good results for these first application cases.

## FURTHER WORK

- Investigation of the deformation mechanisms of thin metallic parts.
  - To give a better understanding of the influence of the shot-peening path.
- Application to more complex geometries.
  - To fit the industrial needs (large aeronautical stiffened panels).