



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

Florent Cochennec, Emmanuelle Rouhaud, Lionel Roucoules

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F. Cochennec<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-Mézières, France.

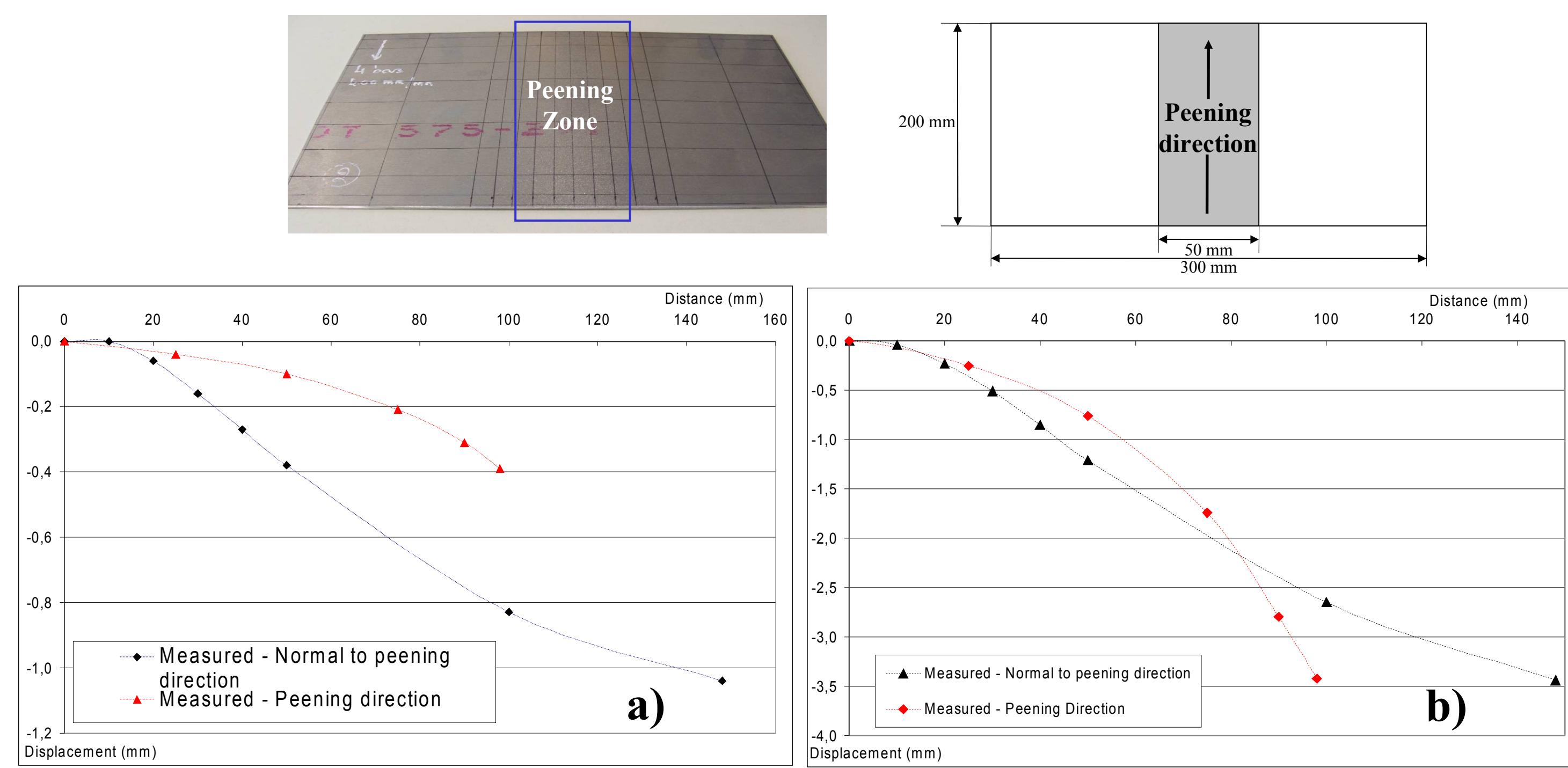
<sup>4</sup>LSIS, UMR CNRS 6168, ENSAM, 13617 Aix-en-Provence, France.

## 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

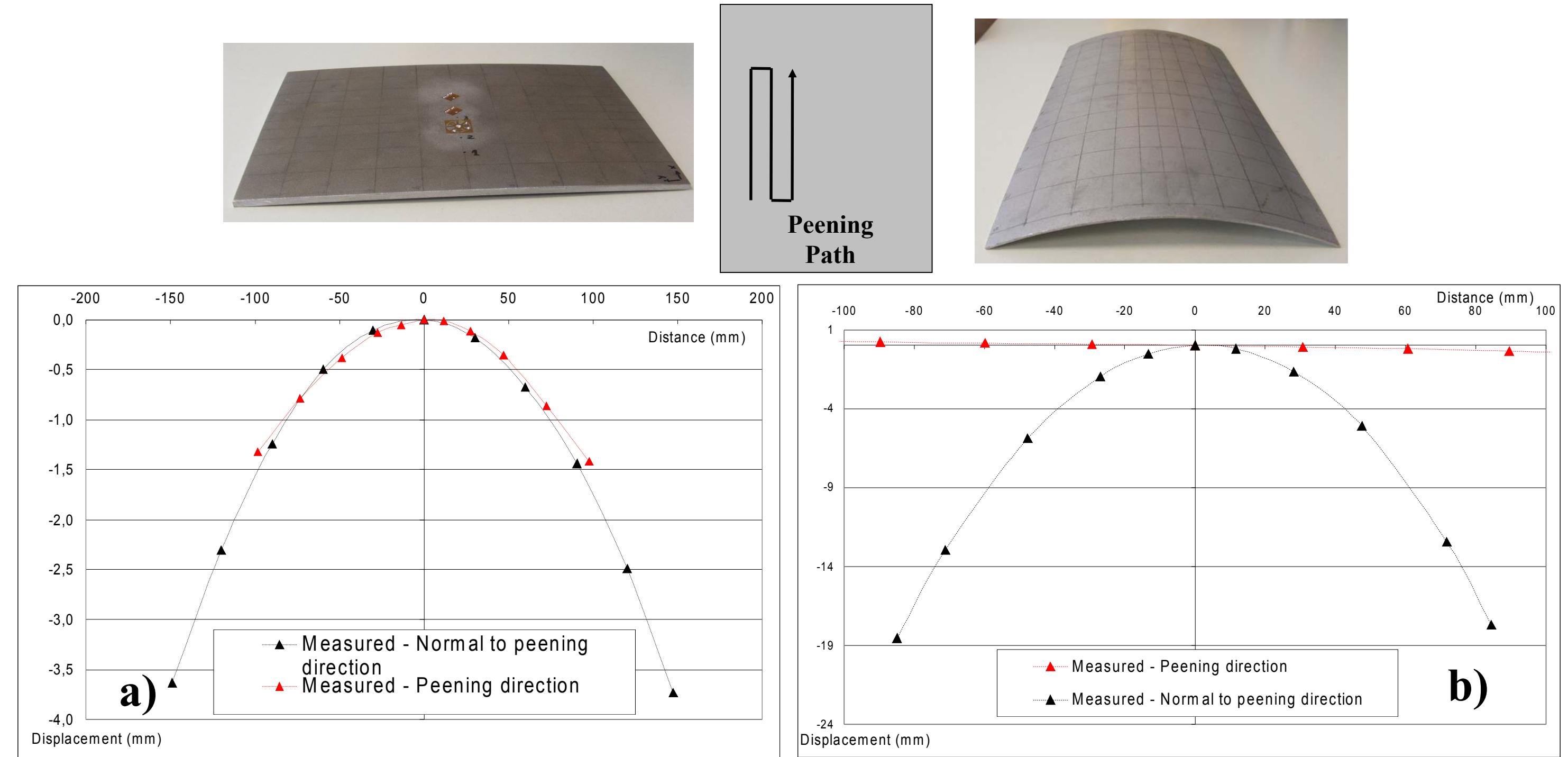
### Partially shot-peened aluminum 2024T3 alloy plates



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



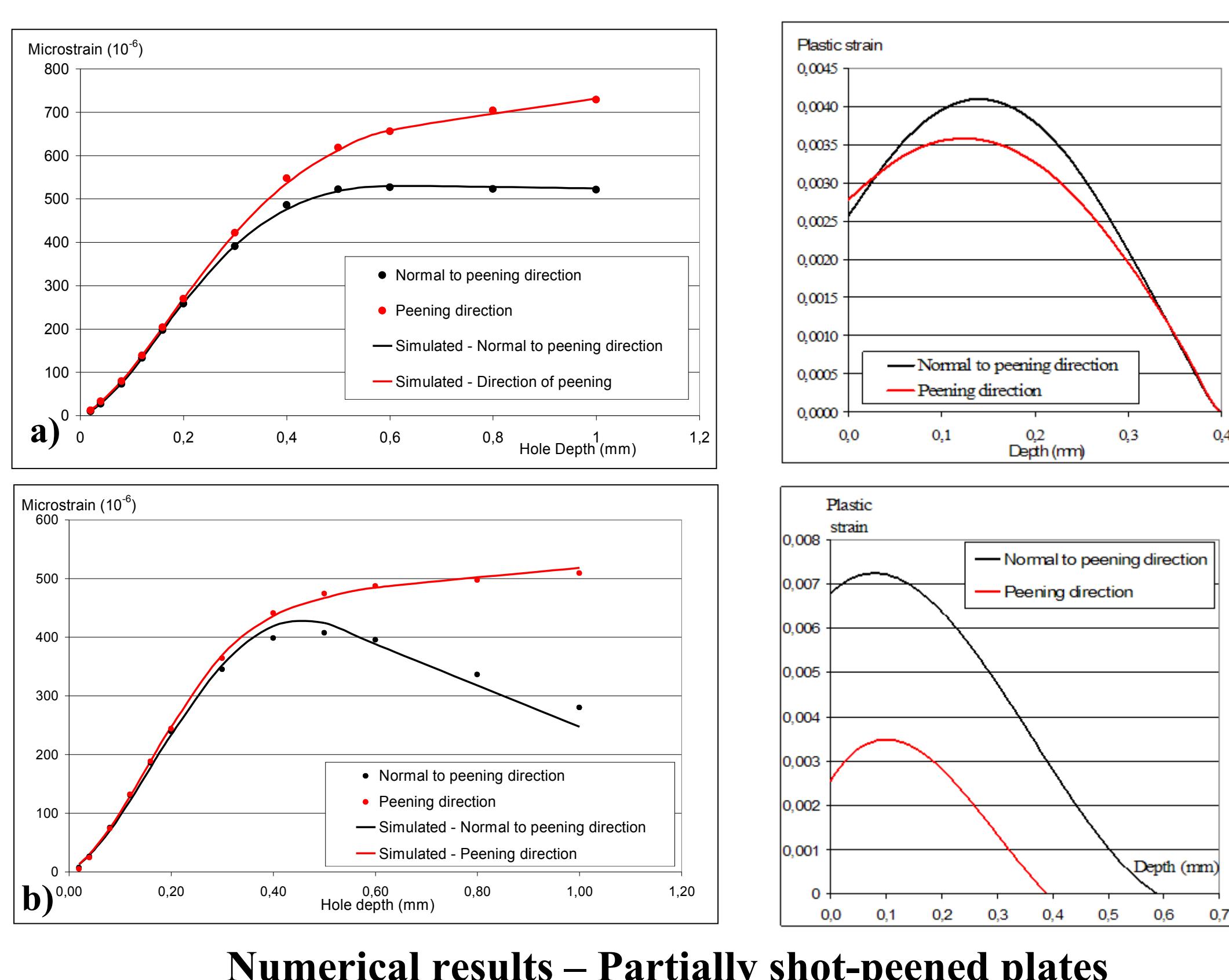
Measured displacements after shot-peening (3-axial measuring machine)

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

## 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.

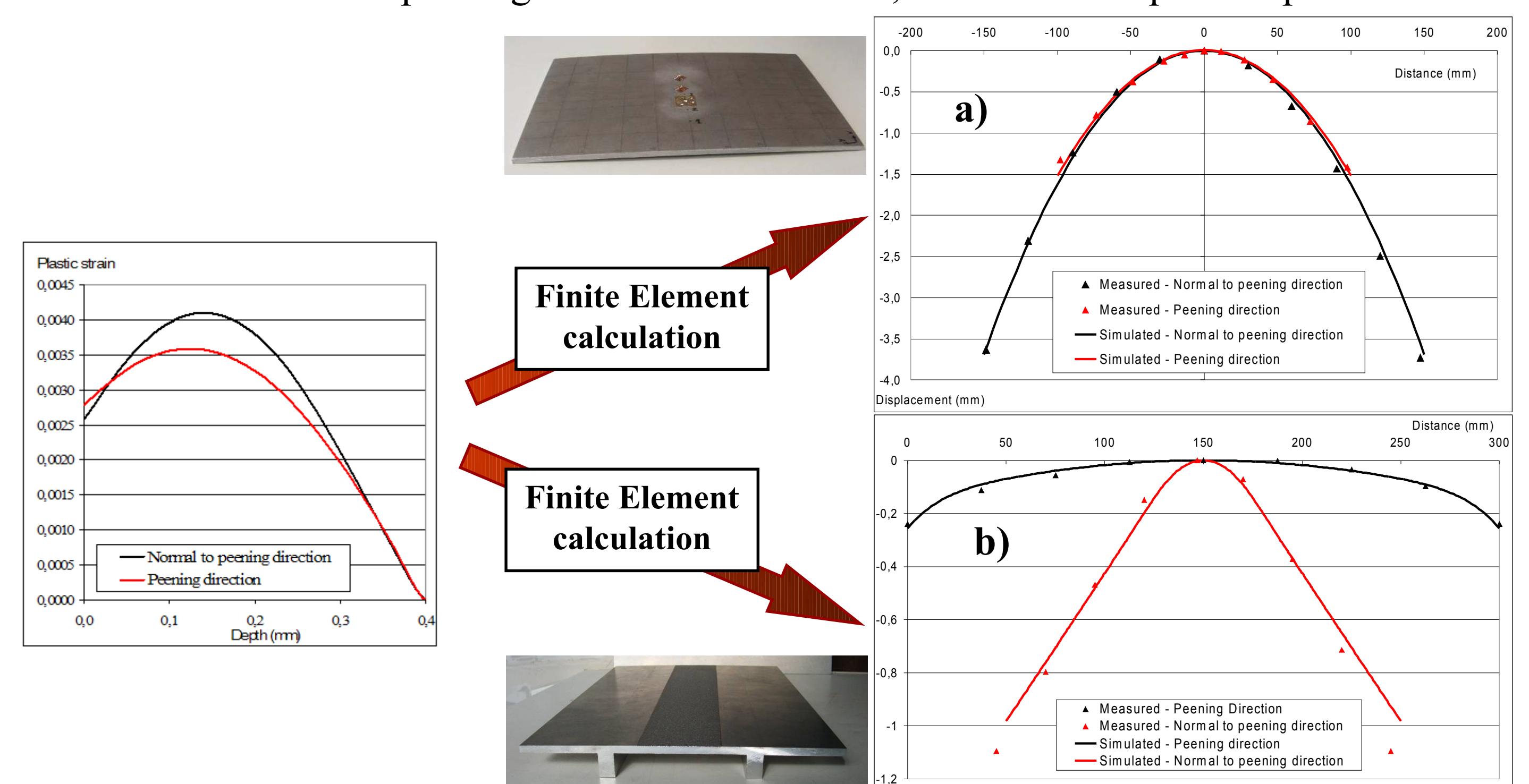


Numerical results – Partially shot-peened plates  
a) 5 mm thick specimen      b) 2 mm thick specimen

- 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.

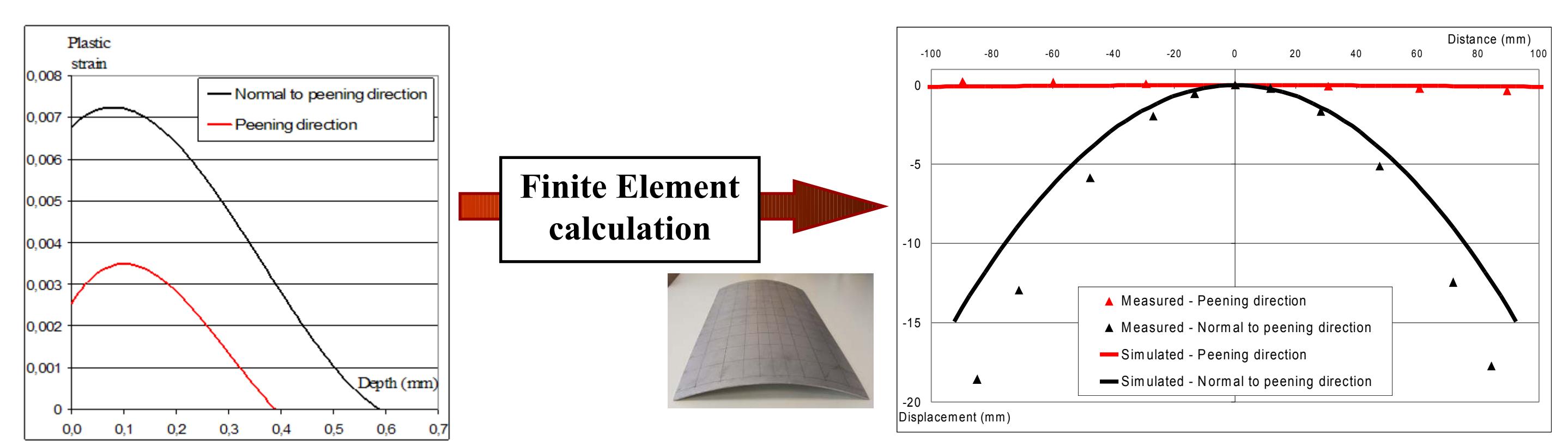
### Application to peen forming simulation

- 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).