



Development of an optical method to measure deformations of nuclear fuel cladding

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CEA/CAD/DEN/DEC/SA3C/LAMIR

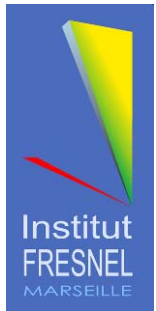
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Summary

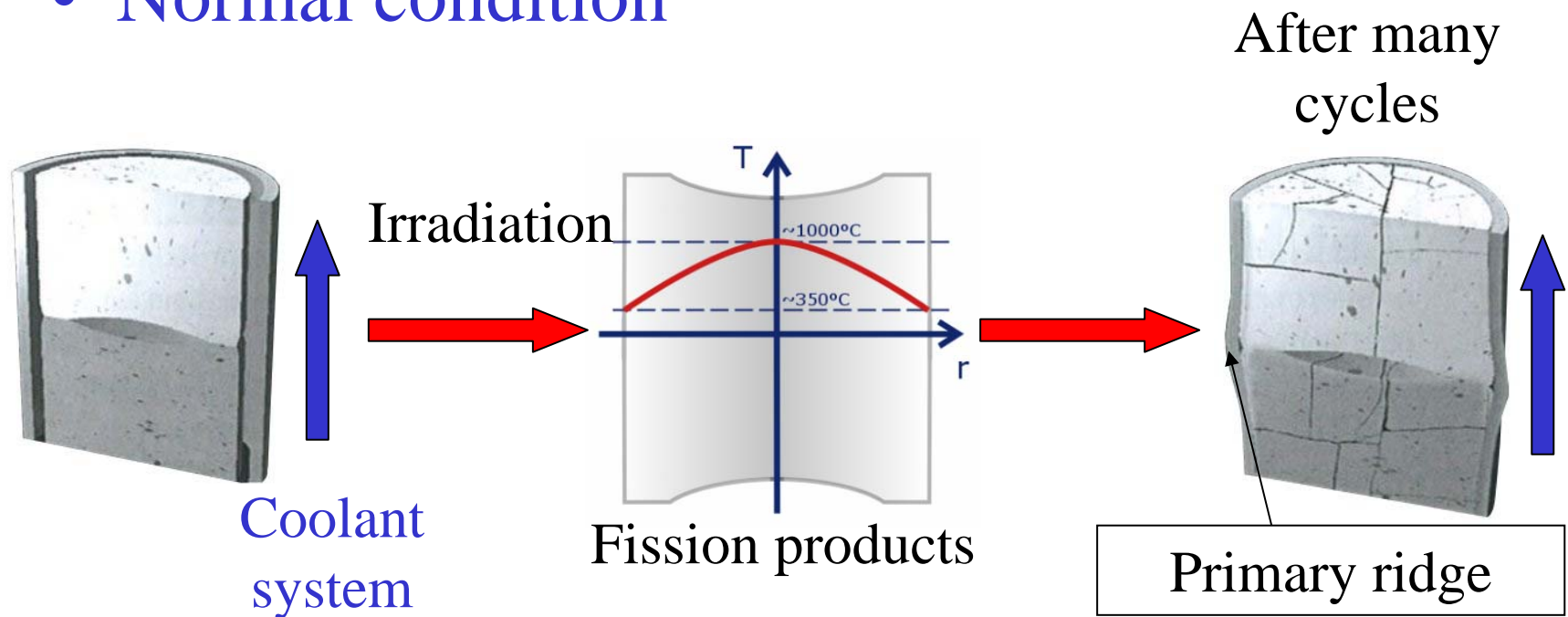
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- 1. Context**
- 2. Speckle interferometry**
- 3. Application**
- 4. Conclusion**

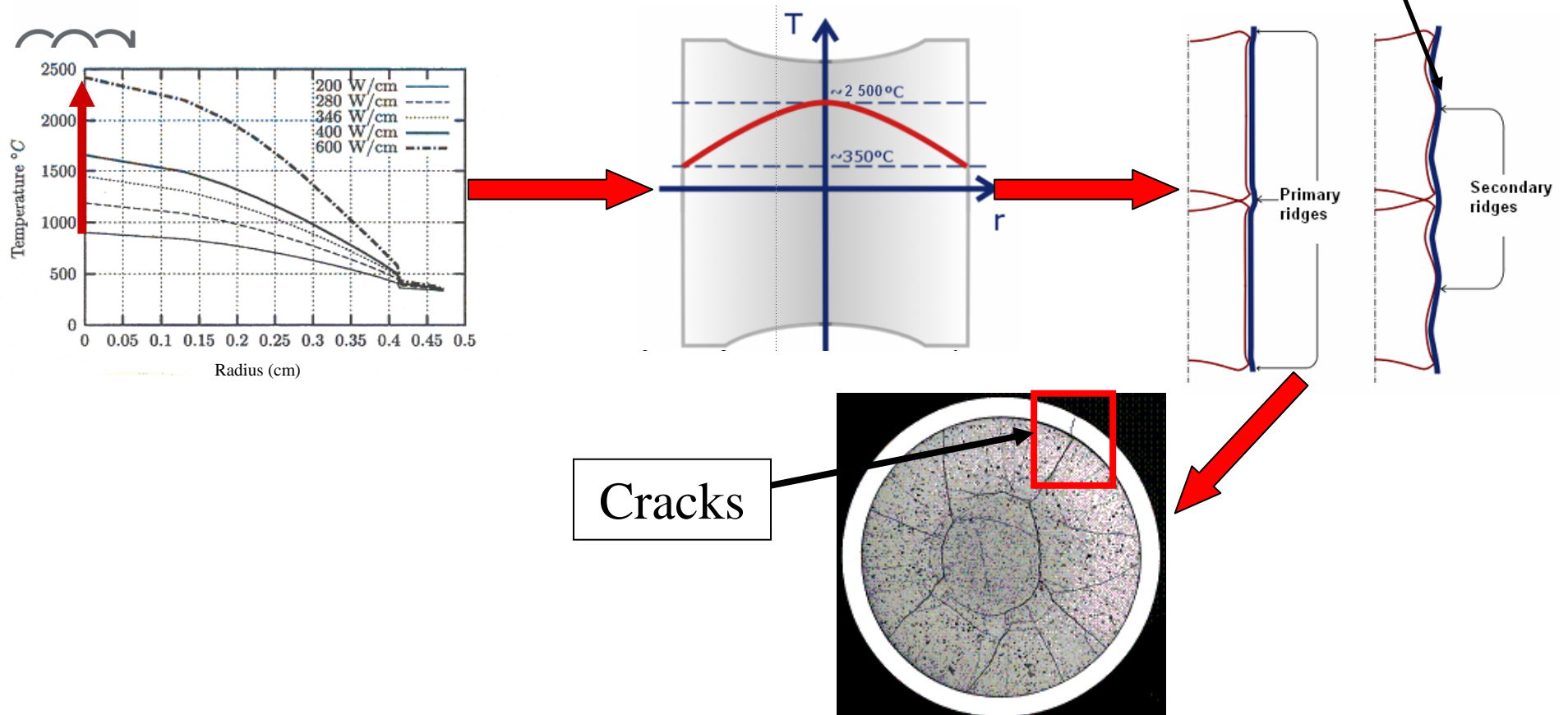
1. Context

- PWR (ceramics UO₂ or MOX)
- Normal condition



1. Context

- Transient power



Only Material Test Reactor (MTR)

1. Context

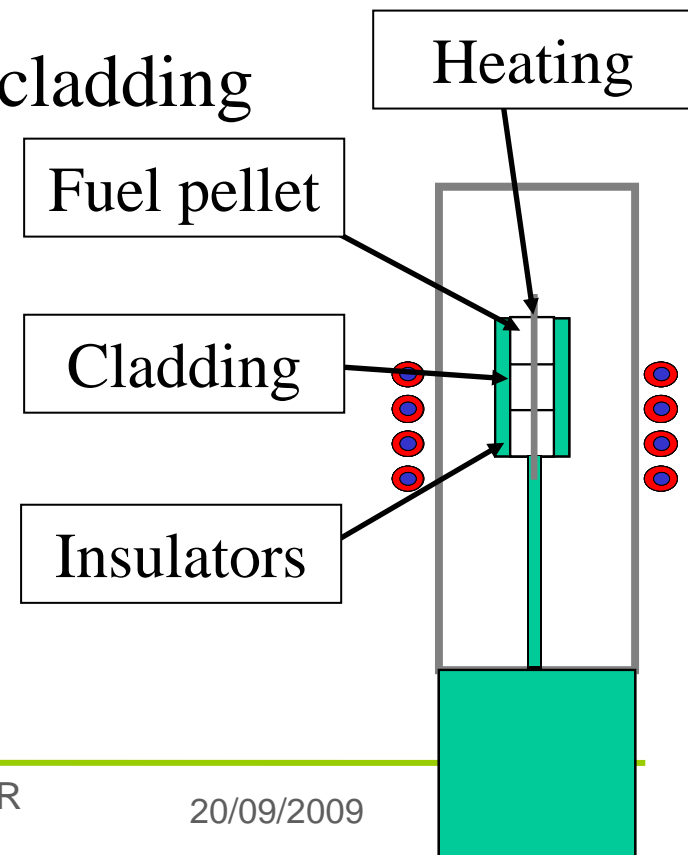
- CEA new device

- Induction oven

- Same thermal conditions as in reactor
- Create deformation on cladding

- Subject of the study

To measure in real time the deformation of the external face of the clad



1. Context

- Specification

- Real time measurement
- High temperature of the cladding
- Electromagnetic fields
- Hotlab chamber : lack of space
- Deformation : magnitude from few to hundreds μm , circumferential

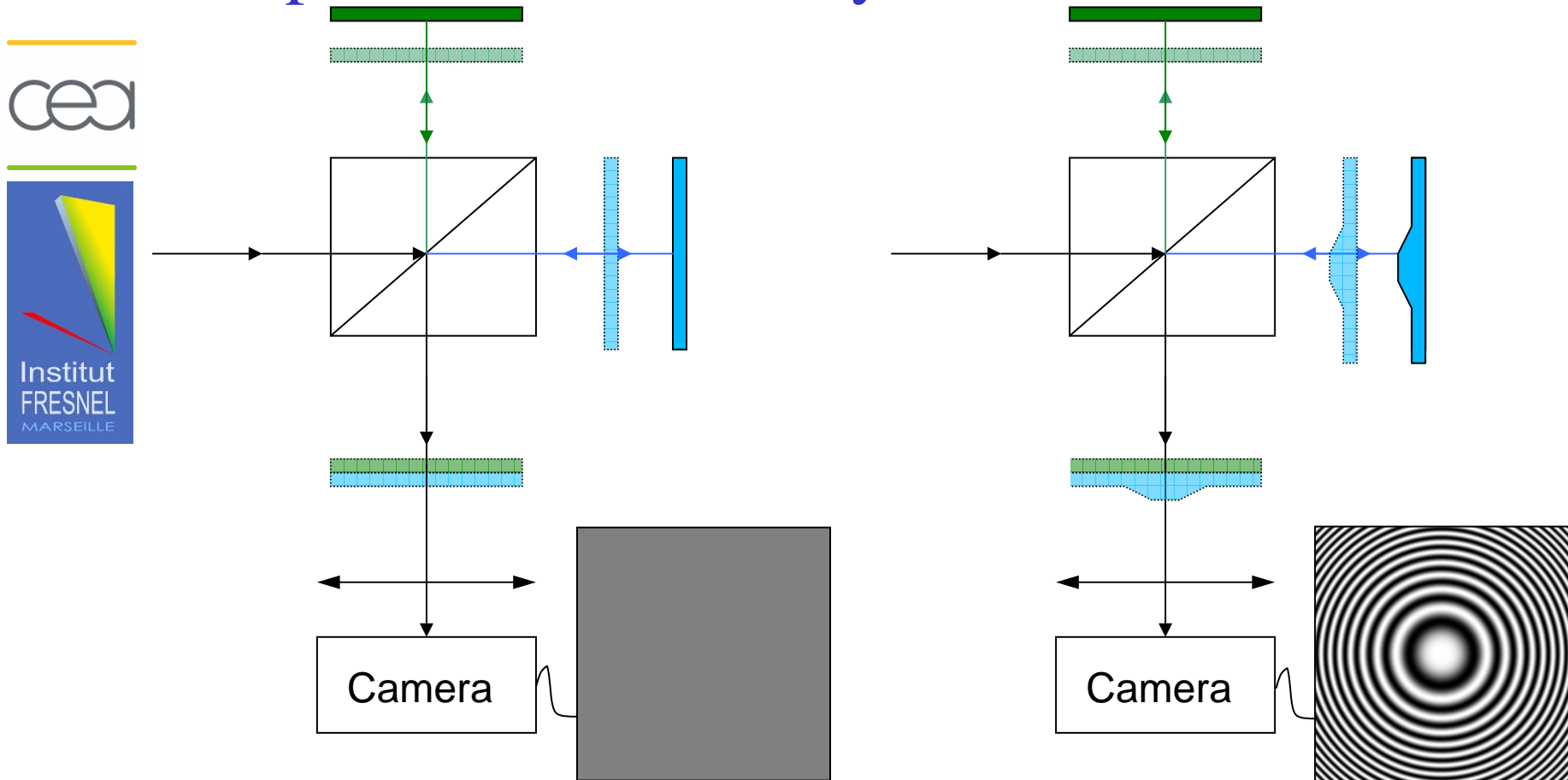
- State of the art : Optical methods

 Measurement of the cladding deformation by Speckle interferometry



2. Speckle interferometry

- Optical interferometry



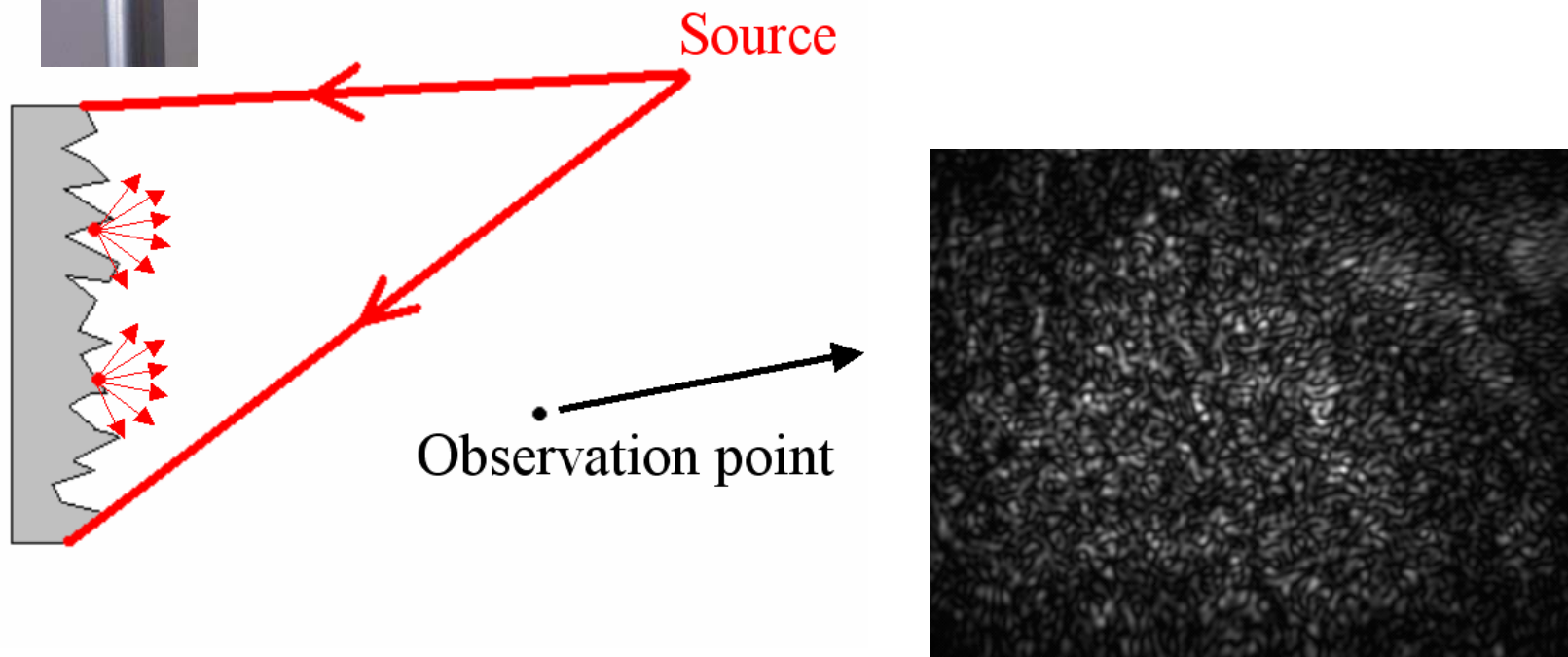
Comparison between two states : measure of displacement

2. Speckle interferometry

- Speckle Pattern

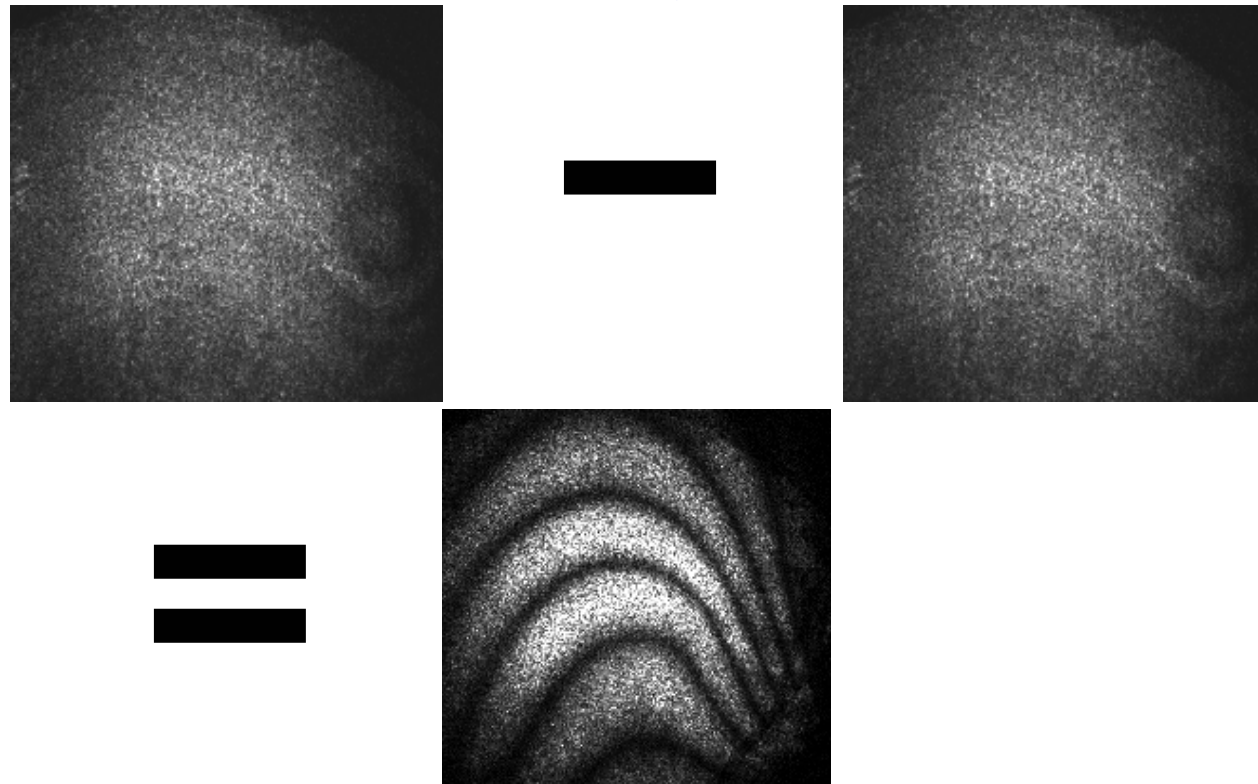


→ Cladding = rough surface



2. Speckle interferometry

- Speckle interferometry

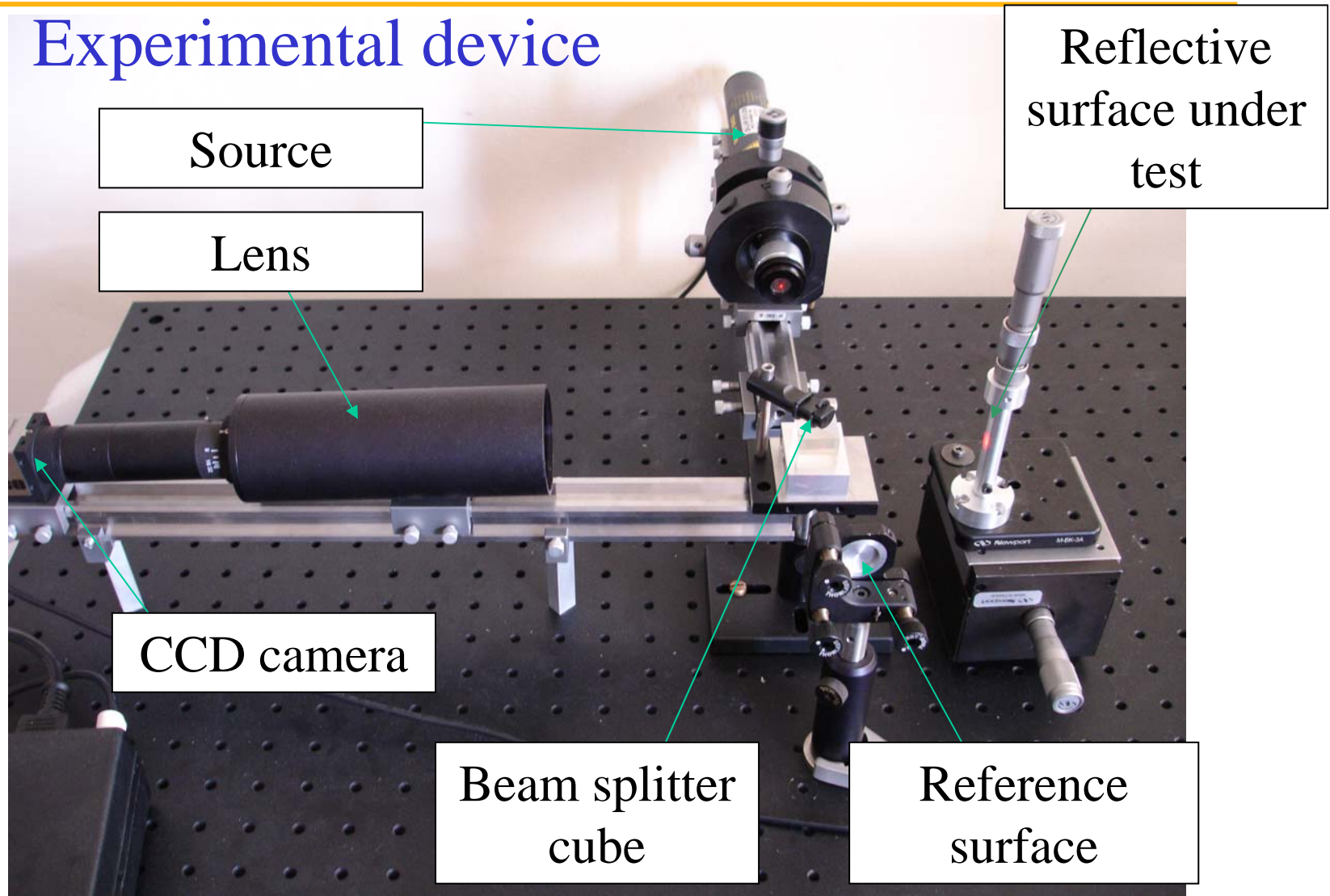


Fringes : access to the deformation

➔ Fringes are lines of level

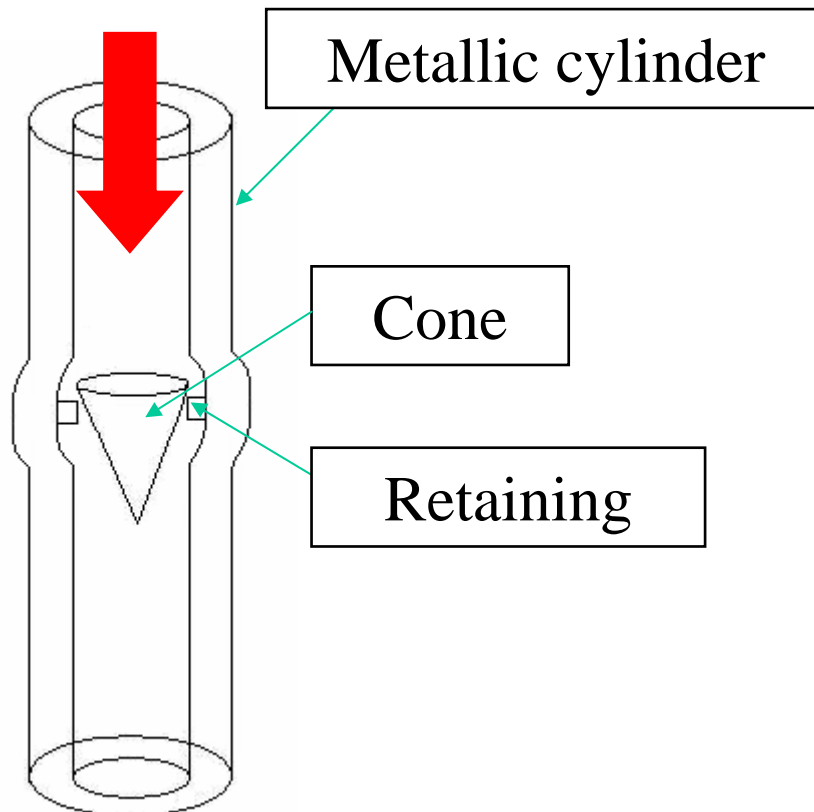
3. Application

- Experimental device



3. Application

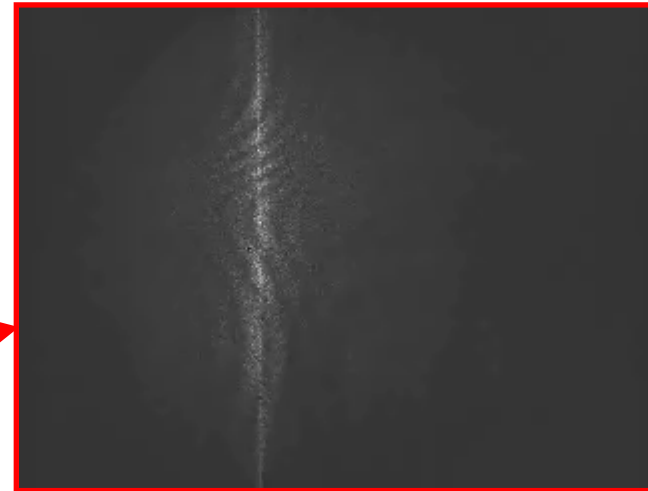
- Deformable cylinder



3. Application

- Results

- Same constraint
- Range : 0° to 180°
- One measure each 10°

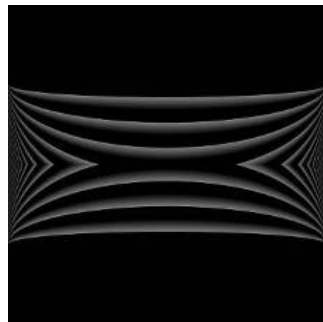
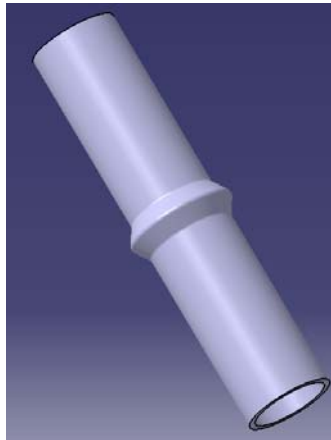


3. Application

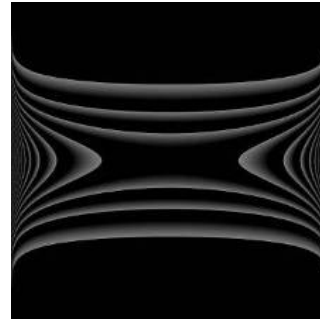
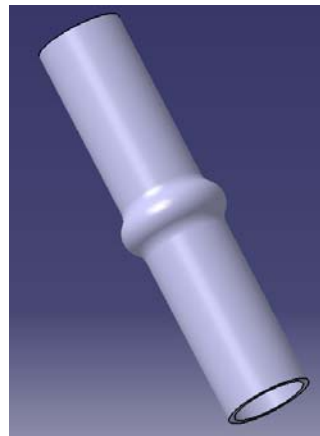
- Is it a deformation ?
 - Modeling deformation on a tube



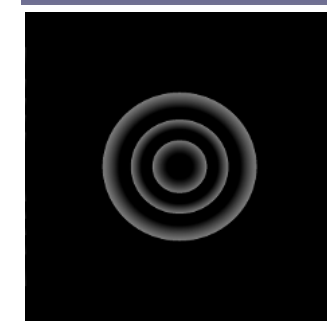
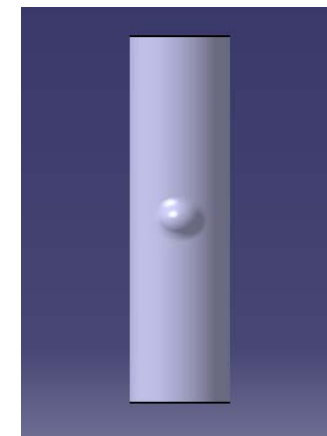
Triangular



Gaussian

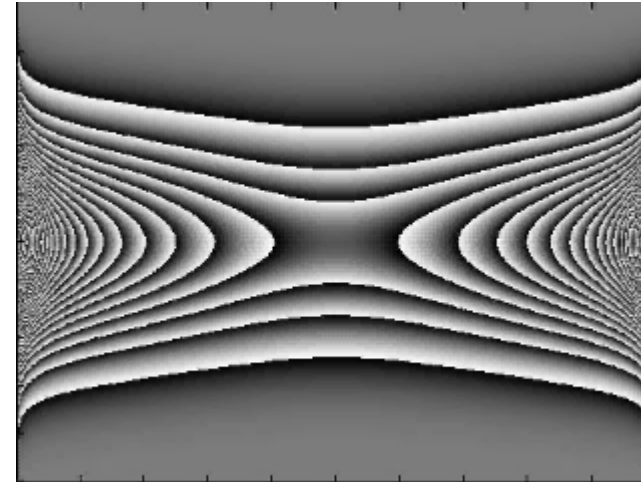
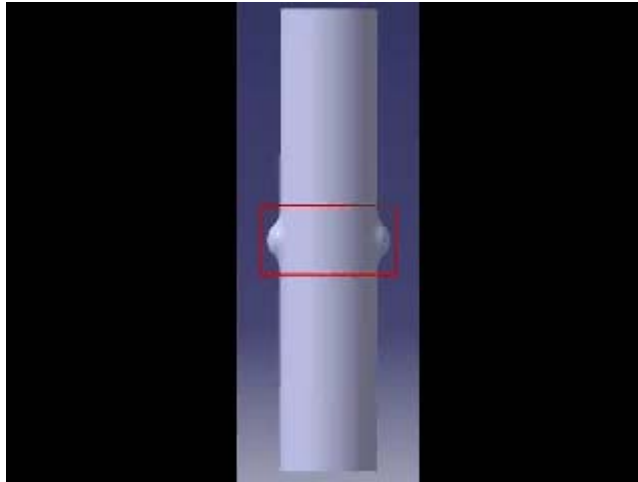


Bulge



3. Application

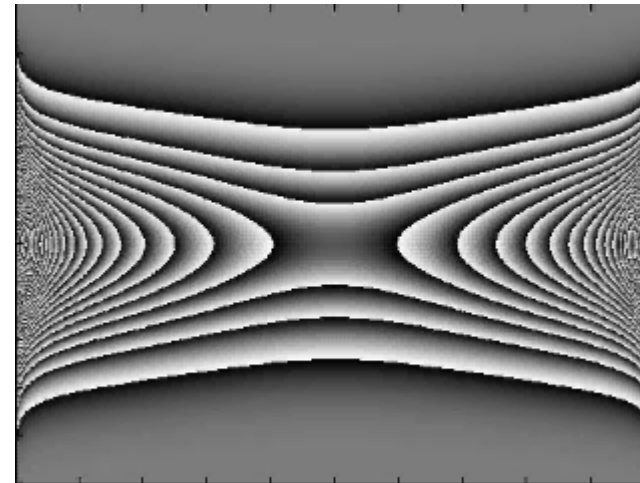
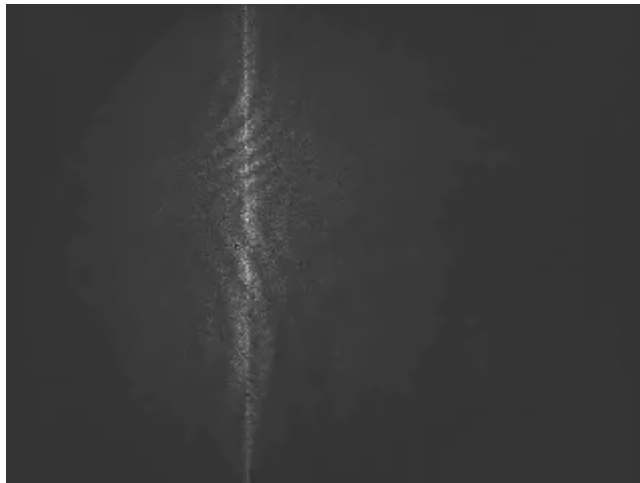
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3. Application

- Comparison

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Not a circumferential deformation !

At least 2 contact points

4. Conclusion

- Speckle interferometry works
 - Feasibility test are finished
 - Good resolution for our application
 - Problems : thermal condition, vibration
- Perspectives
 - Absolute value of displacement
 - Phase shifting analysis
 - Hotlab cells constraints



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Thanks for your attention