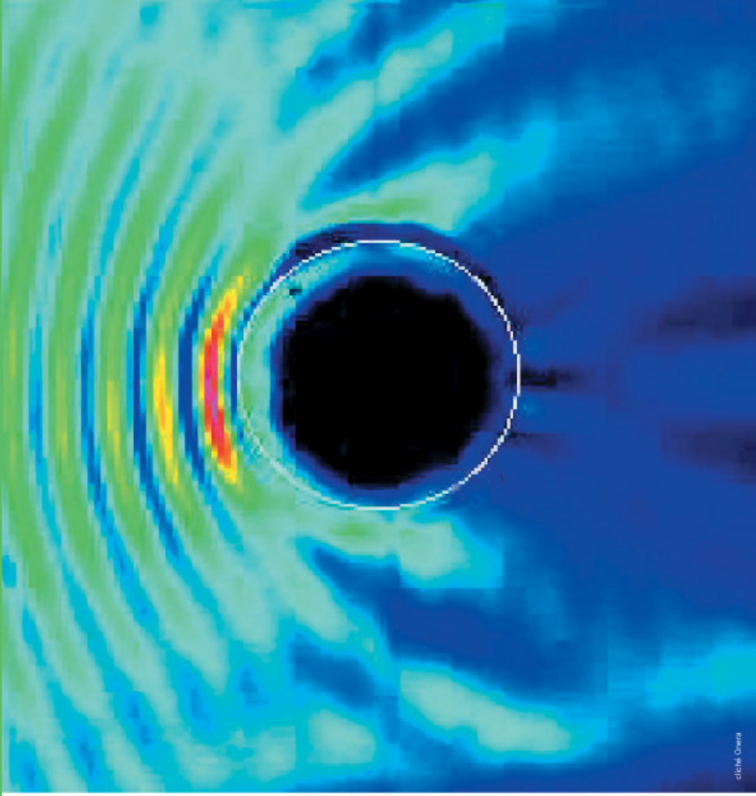
Département EEA
(Électronique, Électrotechnique, Automatique),
avec le concours du LMT
(Laboratoire de Mécanique et de Technologie)

Département DMSE
(Mécanique du Solide et de l'Endommagement)

École Normale Supérieure de Cachan
Formation Continue et Développement
61, av. du Président Wilson, 94235 Cachan Cedex

Conception graphique : Atalante/Paris



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The Multiple Applications of Infrared Thermography, a Tool for Measurement, Characterization and Monitoring

A 3.5 - Day Short Course
to be held at the Continuing Education
Dept of École Normale Supérieure
of Cachan (Paris) March 15-18, 2004

THIRD DAY PROGRAM

9H00 – 17H00

Application to Non-Destructive Evaluation
Application to Electromagnetic Phenomena Characterization (part I)

Application to Non-destructive Evaluation

- Passive thermography – Active thermography
- Introduction to pulsed stimulated thermography
- Application of pulsed stimulated thermography to thermally resistive defects
- Non-destructive evaluation of ceramic composite materials, bonding and corrosion
- Characterization of coatings
- Modulated thermography
- Photothermal camera
- Ultrasonic vibrothermography

Application to Electromagnetic Phenomena Characterization (Part I)

- Principle, history, the EMIR® technique
- Optimization of the photothermal transducer
- Interest of lock-in detection
- Measurement of the intensity of electromagnetic fields
- Measurement of the phase of electromagnetic fields by interferometry
- Vectorial characterization of electromagnetic fields

Practical Demo : application to electromagnetic phenomena

- Presentation of a typical EMIR® configuration
- Field characterization at the entrance of a wave-guide
- Field-object interaction

FOURTH DAY PROGRAM

9H00 – 12H00

Application to Electromagnetic Phenomena Characterization (part II)
Application to Environmental Problems
Extra information to go forward

Application to Electromagnetic Phenomena Characterization (part II)

- Application to non destructive evaluation
- Application to compatibility problems

Application to Environmental Problems

- Application of thermography to icing phenomena
- Application to lightning phenomena
- Application to buried mines detection
- Application to cellular phone problems
- Application to gas detection

Extra information to go forward

- Books and proceedings, web sites, next conferences on IR thermography

COURSE OUTLINE AND DATES

FIRST DAY PROGRAM

9H00 – 17H00

Fundamental Concepts Application to Solid Mechanics

Introduction

- Welcome and presentation of the Course Instructors
- Basic concepts of thermography (radiance, emissivity, temperature...)
- Cooled and uncooled infrared photodetectors and focal-plane arrays, bolometric focal-plane arrays
- Specific problems of single detector cameras
- Infrared imagers versus infrared thermographic cameras
- Infrared cameras on the market
- Lock-in thermography

Application to Solid Mechanics

- Lock-in thermography for stress analysis
- Lock-in thermography for fatigue phenomena analysis.
  Application to steel
  Application to aluminum alloys
- "Print-thermography" for fast transient mechanical phenomena
  Crack propagation
  Instabilities in superalloys

Practical Demo: presentation of thermographic hardware and application to solid mechanics

- Presentation of CEDIP systems, in particular lock-in thermographic system
- Strain field visualization
- Detection of a dissipative phenomena during mechanical testing

SECOND DAY PROGRAM

9H00 – 17H00

Application to Fluid Mechanics and Energetics Application to Thermophysical Characterization

Application to Fluid Mechanics and Energetics

- Measurements in steady-state, pulsed and periodic regimes
- Specific problems related to wind-tunnel environment
- Theoretical basis of convective heat flux measurements
- Heat transfer rate measurements in guided wind tunnels
- Forced convection heat transfer measurement on flat plates
- Heat transfer rate measurement in free jet configuration wind tunnels
- Miscellaneous aerodynamic phenomena
- Reactive flows
- "Exotic" thermography: ultraviolet, far infrared

Application to Thermophysical Characterization

- Through-thickness thermal diffusivity measurement
- In-plane thermal diffusivity measurement
- Effusivity measurement

Practical Demo: application to Thermophysical Characterization and non-destructive evaluation

- Thermal diffusivity measurements
- Detection of delaminations in composite materials

COURSE GOALS

Used for more than thirty years, infrared thermography is not a new technique. Nevertheless, after a first booming period, it provoked disappointment to the experimenters who were not satisfied with merely nice images. The technique experienced a renewed success in the second part of the eighties thanks to the progress of the thermographic hardware and to the works of several laboratories which demonstrated that, if the application of this tool was based on physical modeling and numerical simulation it could really become quantitative and have a quasi universal use.

Today, there is no field of physics in which the thermographic technique cannot be useful: heat transfer science and energetics, but also solids and fluids mechanics, electromagnetism, non-destructive evaluation, bio-sciences and environmental sciences. Nevertheless, up-to-now the relatively high cost of infrared cameras has slowed down the diffusion of the technique. Presently, new types of focal-plane array cameras, bolometric cameras in particular, will make these apparatus cheaper. In that sense, infrared thermography is at a turning point.

In this context, the course aims to inform engineers and technicians of industry, decision-makers and research managers, academic researchers, of the extremely varied possibilities of the technique, to open up new vistas on application fields they ignore…

The course will show the services that infrared thermography can do in the domains of metrology, characterization and monitoring. This will be achieved thanks to the very numerous examples presented (more than 700 transparencies) and some experimental demonstrations in laboratory using the most recent thermographic systems. The course will emphasize data reduction procedures, image processing, the important role of physical models, and existing specialized information sources.

About the Instructors

DANIEL BALAGEAS, SENIOR RESEARCHER AND DEPUTY HEAD OF THE STRUCTURES AND DAMAGE MECHANICS DEPARTMENT OF ONERA, CHÂTILLON, FRANCE
Daniel Balageas has 35 years experience in aerospace research and more than 15 years experience in infrared thermography. Author of more than 80 publications or communications on infrared thermography, he founded the QIRT (Quantitative Infra Red Thermography) Conference in 1992 and is the chairman of the QIRT International Working Group. Since 1999, he is a part-time associate professor at the Ecole Normale Supérieure of Cachan.

PIERRE BREMOND, INDUSTRIAL SALES AND PRODUCT MANAGER OF CEDIP, CROISSY-BEAUBOURG, FRANCE.
Pierre Bremond has 23 years experience in research then marketing in thermography. He obtained a PhD of Mechanics in 1982, developing at CNRS a thermal stress analyser applied to crack mechanics. He joined SNECMA as a test engineer working on the development of new measurement technologies in IR signature, stress and temperature analysis using IR cameras. From 1987 to 1997 he worked for AGEMA and ADDITIONAL as sales engineer and participated to the French training centre. He joined CEDIP in 1998 as a product manager to sale and aid in product design and development for stress analysis systems.

JEAN-CLAUDE KRAPEZ, RESEARCH ENGINEER AT THE STRUCTURES AND DAMAGE MECHANICS DEPARTMENT OF ONERA, CHÂTILLON, FRANCE
Jean-Claude Krapez has 17 years experience in infrared thermography, photothermal radiometry, and in non-destructive characterization. He joined ONERA in 1992 after having spent 6 years in Canada working in these fields. He is involved in the development of new measurement methods using thermography, shearography, as well as in thermal transfer modeling (conduction, radiation). He is the author of more than 90 papers or communications on infrared thermography and photothermal radiometry.

PATRICK LEVESQUE, RESEARCH ENGINEER AT THE STRUCTURES AND DAMAGE MECHANICS DEPARTMENT OF ONERA, CHÂTILLON, FRANCE
Patrick Levesque (Dr.-Ing., Dr. es-sciences) joined the Physics Dept. of ONERA in 1988 to work in the field of Electromagnetism. At the beginning of the nineties he developed the Electro Magnetic-InfraRed techniques (EMIR®) which allows to visualize quantitatively electromagnetic fields using infrared thermography. He is currently applying the technique to several fields, in particular non-destructive evaluation and electromagnetic compatibility.

JEAN-LUC TISSOT, TECHNICAL DIRECTOR OF ULIS CO.,VEUREY-VOROIZE, FRANCE
Jean Luc Tissot has 25 years experience in infrared focal plane arrays. He joined the Infrared Laboratory of CEA/LETI in 1979 to take part in the development of HgCdTe based 2nd generation IRFPA technology that was transferred to Sofradir.
In 1986 he took the head of the silicon technology line in order to develop a new CCD technology for infrared and visible applications. In 1992, he was in charge of the development of uncooled infrared detector. In 1999, he became head of Imaging sensor technologies Programs at CEA/LETI. In 2002, he joined the new ULIS Company, a spin-off of Sofradir, as the Director of R&D Division for Uncooled microbolometer industrialization.

Location, Lodging and Transportation Information

The course will be held at the Ecole Normale Supérieure of Cachan (Paris). Attendees are responsible for their own transportation and lodging. Further details including the exact location and recommended hotels (loadable files: access.pdf and hotels.pdf) are available at: www.fcd.ens-cachan.fr/formation/salarie.htm

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REGISTRATION FORM

The Multiple Applications of Infrared Thermography, a Tool for Measurement, Characterization and Monitoring.

Ecole Normale Supérieure de Cachan,
March 15 – 16 – 17 – 18, 2004

Conference fees :
☐ Companies* : 1100 Euros
☐ Academics : 770 Euros

Registration is completed by sending a purchase order (only for French institutions)or a check to the benefit of “Agent comptable de l’ENS Cachan”.

*Sur convention de formation continue (only for French firms)
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NAME :
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Both form and payment must be sent
before February 29, 2004 to :

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