QIRT'Applications *i*-short-course

Why an *i*-short-course?

Attending a short-course is time consuming and very expensive (travel, lodging and meals in addition to unproductive time), especially if the course is given far from the work site or abroad. In fact, registration fees only represent a small part of the total expense for the attendee's institution or company. Furthermore, it is not easy for the institution or company to find the time during which the personnel is away from his work structure. By adapting a course to an *i*-learning platform, these drawbacks disappear: participants follow the course on the web, according to their availability, at their own rhythm, both at home and at work. This flexibility, added to real economies of expenses and time makes *i*-learning an efficient alternative. Because more people can enroll, registration fees compare favorably to most other short-courses.

We are proud to launch the world's first *i*-short-course on IR thermography: the short-course on the Quantitative InfraRed Thermography Applications (QIRT'Applications). This course is based on our experience of a course already given live to international audiences at the ENS of Cachan (Paris). For a cost comparable to the usual registration fees of other classical short-courses, you may connect to the course site at will and follow any of the 55 lessons which make up the course. You may download and print the color plates and their comments in pdf files which are a real book of more than 800 pages full of useful references. You may also participate in a forum to ask questions and join in the discussions between fellow participants and the course authors.

Goal of the course

Used for more than 30 years, IR thermography is not a new technique. Nevertheless, after a first boom of popularity, some experimenters remained dissatisfied who felt they needed more than just visual representations. The technique experienced renewed success in the 80s and the 90s thanks to the progress made in the thermographic hardware and the research of several laboratories which demonstrated that, if the application of this tool were to be based on physical modeling and numerical simulation, it could really become the quantitative standard and be used quasi universally. There is no field of physics in which the thermographic technique is not useful: not only in the realm of heat transfer science and energetics, but also for solid and fluid mechanics, electromagnetism, NDE, bio-sciences not to mention environmental sciences.

Nevertheless, the relatively high cost of IR cameras was a drawback in the widespread use of the technique. Over the past few years, new types of FPA cameras, and bolometric cameras in particular, have made these apparatus cheaper. In this sense, IR thermography is now at a turning point.

In this context, the course aims at helping decision-makers or beginners who are looking for a camera for a given application and at showing experienced thermographers how the extremely varied possibilities of the technique allow them to widen their domain of applications.

Content and structure of the course

The *i*-short-course in its final form will be made up of more than 850 animated and audio-commented plates. Presently, more than 2/3 of the full content is available. The rest of the course will be progressively put into place over the course of the year. Video sequences are planned as well.

QIRT'Applications *i*-short-course, divided into 55 lessons, grouped into 8 chapters covering the main fields of application, emphasizes data reduction procedures, image processing, the important role of physical models, and specialized information sources. Within the tree-structure of the course, it is easy to navigate from one point to another.

The course content is given here. For each chapter the number of animated plates is given. Chapters shown in grey are presently under construction and will be made available on the web site by the end of 2006. For these, only an estimated number of animated plates is given.

Chapter 0: Introduction to the course (12 plates)

This chapter is given free as a demo in the web site of the course (**http://qirta.ens-cachan.fr)**

Chapter 1: IR thermography basis (181 plates)
- Lesson 1-0: Chapter 1 headlines
- Lesson 1-1: Radiometry refresher
- Lesson 1-2: Cooled IR detector
- Lesson 1-3: Uncooled IR detectors
- Lesson 1-4: Single detector cameras
- Lesson 1-5: Imagers versus cameras
- Lesson 1-6: Focal Plane Array cameras
- Lesson 1-7: Heat transfer refresher
- Lesson 1-8: QIRT and its applications

Chapter 2: Application to fluid mechanics (104 plates)
- Lesson 2-0: Chapter 2 headlines
- Lesson 2-1: Preliminary remarks
- Lesson 2-2: Theoretical basis on convection
- Lesson 2-3: Wind-tunnel problems
- Lesson 2-4: Guide-flow wind-tunnels
- Lesson 2-5: Free-jet wind-tunnels
- Lesson 2-6: Study of aerodynamic phenomena
- Lesson 2-7: Low-speed convection
- Lesson 2-8: Reactive flows
- Lesson 2-9: UV and far-IR thermography

Chapter 3: Application to solid mechanics (121 plates)
- Lesson 3-0: Chapter 3 headlines
- Lesson 3-1: Thermoelastic effect applied to stress imaging
- Lesson 3-2: Non linearity and irreversible phenomena

Chapter 4: Application to thermal property measurement (62 plates)
- Lesson 4-0: Chapter 4 headlines
- Lesson 4-1: Through-thickness diffusivity
- Lesson 4-2: Measurement of in-plate diffusivity
- Lesson 4-3: Measurement of effusivity

Chapter 5: Application to NDE (202 plates)
- Lesson 5-0: Chapter 5 headlines
- Lesson 5-1: Active and passive thermography
- Lesson 5-2: Introduction to pulse thermography
- Lesson 5-3: Advantage of experiment modeling
- Lesson 5-4: NDE of heat conductive materials
- Lesson 5-5: Other stimulated thermographies
- Lesson 5-6: Photothermal camera
- Lesson 5-7: Ultrasonic vibrothermography
- Lesson 5-8: Bibliography

Chapter 6: Application to electromagnetism (108 plates)
- Lesson 6-0: Chapter 6 headlines
- Lesson 6-1: Interest, principle and theory
- Lesson 6-2: Optimisation of the photothermal converter
- Lesson 6-3: Interest of the lock-in technique
- Lesson 6-4: Field intensity measurement
- Lesson 6-5: Phase measurement by interferometry
- Lesson 6-6: Vectorial measurement of fields
- Lesson 6-7: Application to NDE
- Lesson 6-8: Application to compatibility
- Lesson 6-9: Conclusions

Chapter 7: Application to environment (43 plates)
- Lesson 7-0: Chapter 7 headlines
- Lesson 7-1: Aircraft icing
- Lesson 7-2: Lightning of composites
- Lesson 7-3: Detection of buried mines
- Lesson 7-4: Radiation from cellular phones
- Lesson 7-5: Detection of gases

Chapter 8: Going further (31 plates)
- Lesson 8-0: Chapter 8 headlines
- Lesson 8-1: Chosing an infrared camera
- Lesson 8-2: Improving thermographic knowledge

Who should attend?

Everyone interested in learning more about using this remarkable technology: technicians, engineers, researchers, and business managers. Previous experience with the technology, while useful, is not required for the course. The course is particularly recommended for those who are already using any type of thermographic system, as well as for those who are just exploring the technology.

Registration

At the end of the year, when the course is complete, normal registration fees will be 1700 € (1400 € for academics). For early registration, thru December 31, 2006, registration fees are offered at a reduced rate of 1400 € (1200 € for academics). Registration allows free and permanent access to the course for one year and a maximum connection time of 150 hours. Registration before December 31, 2006 gives access for the full year 2007.

Course web site

More information is available on the course web site were you will find a free demo, registration form, and more…

http://qirta.ens-cachan.fr

Last update : June 5, 2006

Authors of the course

Daniel BALAGEAS

Daniel BALAGEAS, Adviser emeritus at the Structures & Damage Mechanics Dept. (DMSE) of ONERA, Châtillon, France.

Daniel BALAGEAS has 40 years of experience in aerospace research and more than 20 years of experience in infrared thermography. Author of more than 90 publications or communications on infrared thermography, he created the QIRT (Quantitative InfraRed Thermography) Conference in 1992 and is the chairman of the QIRT International Steering Committee. He is the creator and the editor-in-chief of the QIRT Journal. From 1999 to 2005, he was part-time Associate Professor at the ENS of Cachan where he created the short course on QIRT Applications given live four times between 2001 and 2004.

Pierre BREMOND

Pierre BREMOND, industrial sales and product manager of Cedip, Croissy-Beaubourg, France.

Pierre Brémond has 28 years of experience in research and marketing in thermography. He obtained his PhD of Mechanics in 1982, developing a thermal stress analyzer applied to crack mechanics at the CNRS. He joined SNECMA as a test engineer, working on the development of new measurement technologies in IR signatures as well as stress and temperature analysis using IR cameras. From 1987 to 1997 he worked for AGEMA and ADDITIONAL as sales engineer and participated in the French training center. He joined CEDIP in 1998 as a product manager to sales and assistance in product design and development for stress analysis systems.

Jean-Claude KRAPEZ

Jean-Claude KRAPEZ, Research Engineer at the Theoretical & Applied Optics Dept. (DOTA) of ONERA, Salon-de-Provence, France.

Jean-Claude Krapez, graduated from the Ecole Centrale of Paris with a degree in engineering and a Ph.D. in Physics has more than 22 years of experience in infrared thermography, photothermal radiometry, and NDE to his credit. He joined ONERA in 1992 after having spent 6 years in Canada working in these fields at the Industrial Materials Institute of CNRC. He was involved at ONERA/DMSE in the development of new measuring methods using thermography, shearography, as well as in heat transfer modeling. He is author of more than 90 papers or communications on infrared thermography and photothermal radiometry.

Patrick LEVESQUE

Patrick **LEVESQUE**, Research Engineer at the Structures & Damage Mechanics Dept. (DMSE) of ONERA, Châtillon, France.

Patrick Levesque (Dr.-Ing., Ph.D.) joined the Physics Dept. of ONERA in 1988 to work in the field of electromagnetism. At the beginning of the nineties, in collaboration with Daniel Balageas, he developed the ElectroMagnetic InfraRed (EMIR®): a technique of quantitatively visualizing electromagnetic fields using infrared thermography. He is currently applying this technique to several fields, in particular Non Destructive Evaluation, radiation patterns of electromagnetic sources and electromagnetic compatibility.

Jean-Luc TISSOT

Jean-Luc **TISSOT**, Technical Director of ULIS Co.,Veurey-Voroize, France

Jean Luc TISSOT has 30 years of 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 later transferred to Sofradir. In 1986 he led 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 detectors. In 1999, he became head of imaging sensor technology 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.

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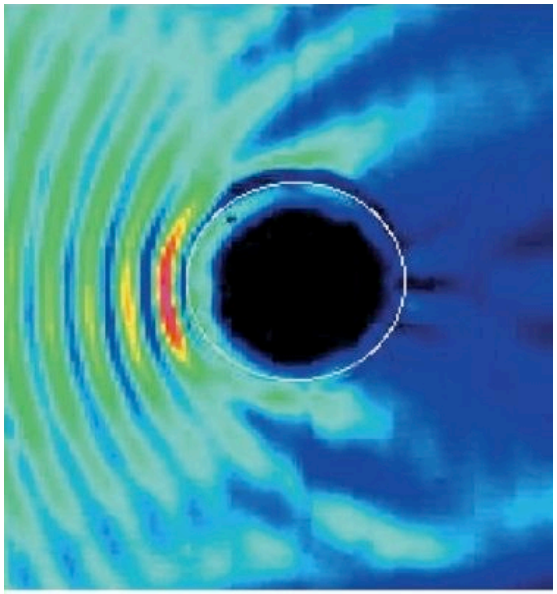
Course web site:

http://qirta.ens-cachan.fr

The web site of the **QIRT'Applications *i*-short-course** gives you the opportunity to:

- download the pdf document *"Introduction to QIRT Applications",* which is the Chapter 0 of the course. This document presents the structure, the content and the authors of the course. The QIRT concept is defined through an historical example of a thermographic experiment.
- listen to this chapter to get a better idea of the quality of the audio comments of the course and of the flexibility of the *i*-learning tool.
- view the detailed content of the course (title, number of plates, duration of audio comments of all lessons).
- ask any questions.
- register to receive by e-mail the *QIRT'Applications free Newsletter* which will inform you of the future evolutions of the course.
- fill the registration form for the course.



QIRT'Applications *i*-short-course

The Multiple Applications of Quantitative InfraRed Thermography (QIRT), a Tool for Measurement, Characterization and Monitoring