

*High Sensitivity Magnetometers
“Sensors & Applications”*

*Blainville sur mer
September 24-28, 2007*

*Pr. Ch. Dolabdjian
GREYC-CNRS UMR 6072*

Organization

- **GREYC – CNRS - UMR 6072**

(Groupe de Recherche en Informatique, Image, automatique et Instrumentation)

Organized by the GREYC (“Electronic Team !”)

The GREYC will be presented to you in the end of afternoon by “E.Grandjean” co-director..



- **CNRS**

(Centre National de la Recherche Scientifique)



GREYC Electronic team

Around 20 (researchers + PhD student)

Head of the team (*Ch. Dolabdjian...*)

- 3 main research domains
 - **Functional oxides**
 - *Materials, fabrication, design of sensor based on Functional oxides...*
 - **Bolometers**
 - *Study, development, design of high sensitivity bolometer*
 - “Infrared detection, VOC detection”
 - **Magnetometers**
 - *Study, development, design, implementation of very low magnetic noise sensor, “ $> 1 \text{ pT}/\sqrt{\text{Hz}}$ ” working at room temperature “GMI, MR, Hybrid sensor...”*
 - *Application “NDT – Biomagnetism....”*

More information, on our last research results, are presented on poster session!

Scientific Committee

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**J.Clarke (USA), P.Ripka (Czech Republic), E.Hristoforou (Greece),
H.Chiriac (Roumania), M.Schilling (Germany), I.Sasada (Japan),
J.Gieraltowski (France), V.Mosser (France), F.Alves (France),
Ch. Dolabdjian (France), D. Robbes (France), S. Saez (France), C.Cordier (France)**

Local Organizing Committee

Ch. Dolabdjian, S. Saez, C. Cordier, L. Ding

Sponsors

- **ENSICAEN (Engineer school of Caen)**
- **University of Caen - South Normandy**
- **GDR (Groupe de recherche) Ondes**

Objectives

Main objectives of this school

To give an overview of last development of high sensitivity magnetometers and their applications

- To bring together the experts of high sensitivity magnetometers*
- To show new interesting field of research !!*
- To pursue..., a real comparison and discussion, on high sensitivity sensors, that we start in this context of a thematic school, until 1999...*

Lecturers

24 “Speakers”

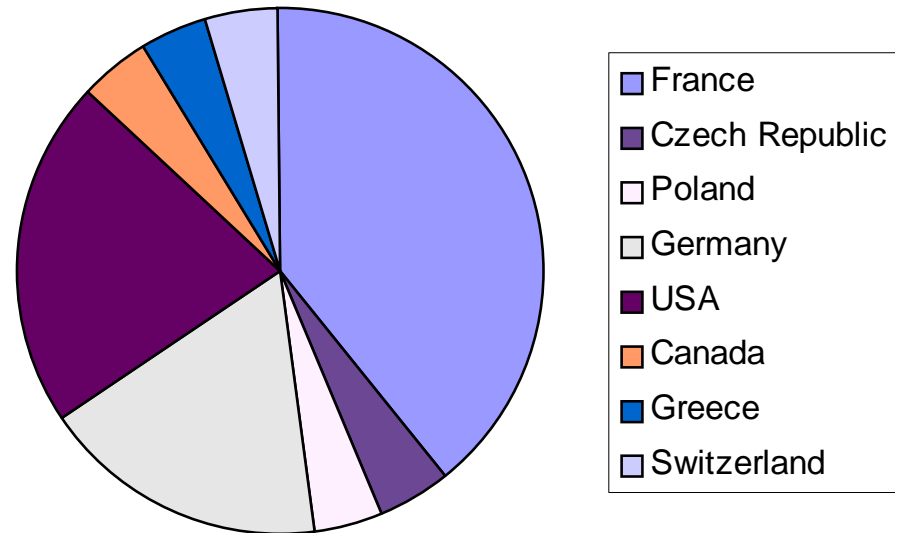
- **Origins :**

- **Europe (17)**

- 1 from Czech
 - 1 from Switzerland
 - 5 from Germany
 - 1 from Greece
 - 9 from France

- **North America (7)**

- 1 from Canada
 - 6 from USA



Program « Sensors »

- **Magnetic Sensors**
 - Magnetic Sensors Overview (D. Pappas)
- **General Use of Magnetic Sensors**
 - Specification of magnetic sensors (C. Dolabdjian)
 - Implementation “problematic” (C. Dolabdjian)
 - Noise and noise source rejection (S. Saez)

Program « Sensors »

- **Absolute Magnetometer**
 - Absolute Magnetometer (M. Romalis)
- **Relative Magnetometer**
 - Hall (R. Popovic)
 - SQUID (D. Drung)
 - Magneto-electric sensors (D. Viehland)
 - Proposal for spintronic (S. Bandyopadhyay)

Program « Sensors »

- **Relative Magnetometer**
 - Magnetostrictive Delay Lines (E. Hristoforou)
 - MagnetoInductive sensors (D. Ménard)
 - MR to Spintronic sensors (M. Tondra)
 - Hybrid sensors (M. Pannetier)
 - Magneto-optic (P. Joubert)
 - Chip scale atomic magnetometer (J. Kitching)
 - News perspectives on spintronic (M.Tondra)

Program « Applications »

- **Location, Space**
 - Magnetic anomaly detection (P. Ripka)
 - Space Magnetometry (C. Coillot)
- **NMR**
 - Introduction to low field NMR imaging (C.Fermon)
- **Non-Destructive Evaluation**
 - State of the art (A. Yashan)

Program « Applications »

- **Biomagnetism**

- Classical Methods: Challenge, Status and trends (A. Braginski)
- Applications of magnetic nanoparticles in medicine and bioanalytics (F.Ludwig)

- **Others**

- Electromagnetism Duality (D.Robbés)
- Metrological applications (D. Devoillé)
- Shielding (H. Nowak)
- Magnetic Modelization problematic (D. Premel)

All participants

*“ more than 75 ” Participants
(including speakers)*

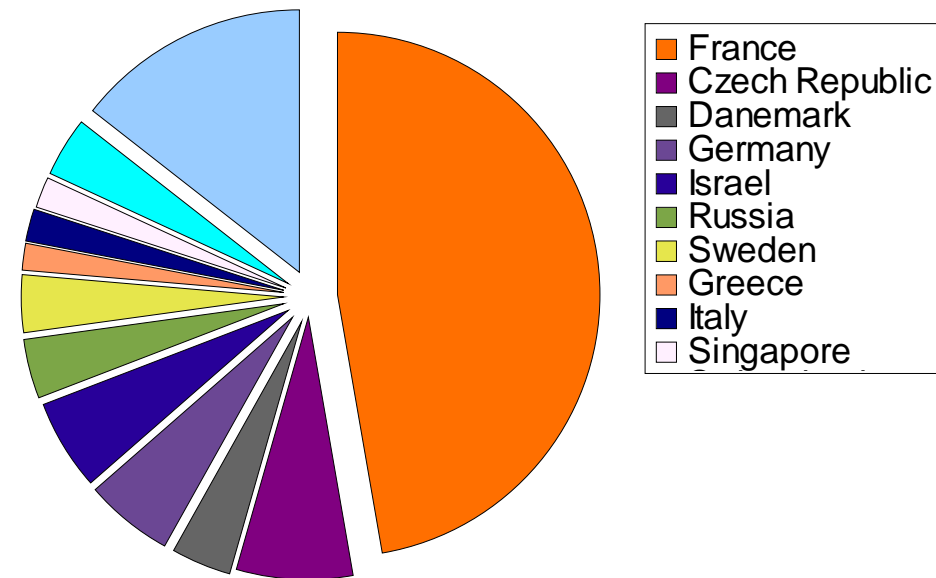
Origins

- Europe
 - 5 from Czech
 - 1 from Romania
 - 1 from Austria
 - 1 from Russia
 - 5 from Germany
 - 2 from Sweden
 - 38 from France
 - 1 from Italia
 - 3 from Greece
 - 3 from Israel
 - 7 ...
- North America
 - 5 from USA
 - 1 from Canada
- Asia
 - 1 from Singapore

Researchers ≈ 55 %

Ph.D. students ≈ 30 %

Industrials ≈ 15 %



Others statistics !

Sensor Main research on !

Flux Gate	19,2%
GMI	19,2%
Hybrid	15,4%
Superconducting sensors	15,4%
Hall sensors	11,5%
MR (GMR, AMR ...)	7,7%
Optical pumped magnetometers	7,7%
Others sensors	3,8%

Application Main research on !

Biomagnetism	27,3%
NDT	9,1%
Geomagnetism	9,1%
Space applications	9,1%
Localization	4,5%
Military applications	4,5%
Others sensors	4,5%
Paleomagnetism	4,5%
NO !	27,3%

Participants



- *Synthesis of their expectations*

*Overview and review of High Sensitivity Magnetometer,
State of the Art, knowledge of physical fundamentals, new sensors,
comparison of sensors performances, exchange of information,
smaller reliable and more efficient sensors...*

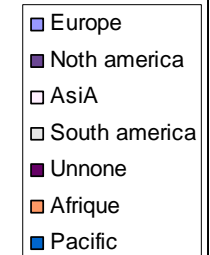
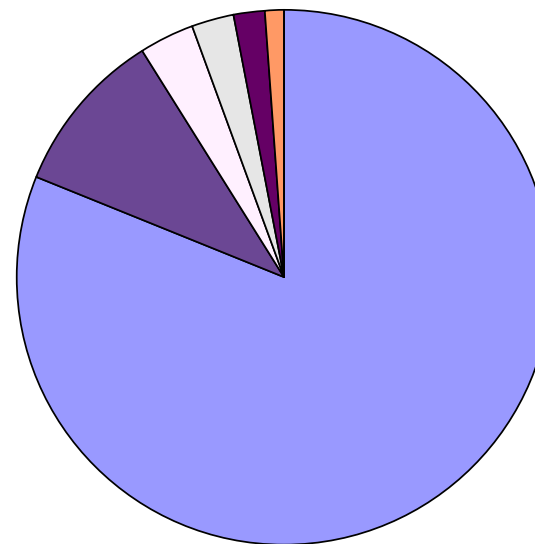
*Application problems, noise reduction methods,
possible & new applications...*

&

Probably, new collaborations...

WEB page school visits !

Europe	1999
North America	245
Asia	80
South America	62
Unknown	48
Africa	28
Pacific	1
	2463



General information



- *Site Map “Le SENEQUET”*
- *Timetable...*
- *Sightseeing tour !*



ur mer

Program (September 24-28, 2007)

Accommodation will be arranged for participants arriving on Sunday evening (after 18 h.) with dinner at 20H30-21H30.

	Monday	Tuesday	Wednesday	Thursday	Friday
<i>7h00-8h15</i>	<i>Breakfast</i>	<i>Breakfast</i>	<i>Breakfast</i>	<i>Breakfast</i>	<i>Breakfast</i>
8h30-9h10	<i>Late Arrival</i>	Absolute magnetometers M. Romalis	Magneto-optic P. Joubert	Magnetic anomaly detection P. Ripka	Metrological applications L. Devoillé
9h10-9h50		Hall sensor R. Popovic	Chip scale atomic magnetometer J. Kitching	Space Magnetometry C. Coillot	Shielding H. Nowak
<i>9h50-10h10</i>		<i>Coffee break</i>	<i>Coffee break</i>	<i>Coffee break</i>	<i>Coffee break</i>
10h10-10h50		SQUID D. Drung	New Perspectives M. Tondra	Introduction to Low field NMR imaging C. Fermon	Magnetic Modelization problematic D. Premel
10h50-11h30		Magneto-electric sensors D. Viehland	Round table: Sensors Synthesis and future trends		Round table: Applications Synthesis and future trends
11h30-12h00	Opening & Introduction C. Dolabdjian	Proposal for Spintronic FT ! S. Bandyopadhyay	<i>Lunch</i> <i>(11h30 – 13h00)</i>	<i>Lunch</i> <i>(11h30 – 13h00)</i>	<i>Lunch</i> <i>(11h30 – 13h00)</i>
<i>12h05-13 h45</i>	<i>Welcome Aperitif & Lunch</i>	<i>Lunch</i>		<i>Lunch</i>	
14h00-14h40	Magnetic Sensors - Overview D. Pappas	Magnetostrictive Delay Lines E. Hristoforou	Departure: 13H00 Sightseeing tour at St Malo <i>The Corsair City !</i>	Biomagnetism I A. Braginski	Departure: 13 H 00 To Carentan Station Train to Paris: n°3310
14h40-15h20		MagnetoInductive sensors D. Ménard		Biomagnetism II F. Ludwig	
15h20-16h00	Sensor Specifications C. Dolabdjian	MR to Spintronic Sensors M. Tondra		<i>Coffee break</i>	
<i>16h00-16h20</i>	<i>Coffee break</i>	<i>Coffee break</i>			
16h20-17h00	Implementation (FB, Ampli., Mod.) C. Dolabdjian	Hybrid Sensors M. Pannetier		ElectroMagnetism Duality D. Robbes	
17h00-17h40	Noise and Noise source rejection S. Saez	Poster session //		Poster session //	
17h40-18h00	Presentation of GREYC laboratory E. Grandjean	Experimental Magnetic sensor characterization (S.Saez/Ch.D) //		Experimental Magnetic sensor characterization (S.Saez/Ch.D) //	
18h00-19h00	Informal exchange	Informal exchange		Informal exchange	
<i>19h30-21h00</i>	<i>Dinner</i>	<i>Dinner</i>		<i>Fall school Dinner</i> <i>(20h30 – 22h00)</i>	

Poster session



- **Sensors & Applications**

- Preparation (Today... after the last talk 18h00)
- Presentation (Tuesday after 17h00)
- Presentation (Thursday after 17h00)

Experimental magnetic sensor characterization !



- **Two session (*mainly, for student !*)**
 - *Tuesday and Thursday*, after last talk until 18h00...

*You will find your name on the list !! (2*1h for each group)*

Objectives

- *Basic sensor characterization*
 - *Sensitivity, noise, linearity...*
 - *Spatial resolution*
 - *Discussion...*
- **At the same time**
 - *Informal exchanges !*
 - *poster session !*
 - *or free time !*

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18h00-19h00	Informal exchange	Informal exchange		Informal exchange	
19h30-21h00	<i>Dinner</i>	<i>Dinner</i>	<i>Fall school Dinner</i> (20h30 – 22h00)	<i>Dinner</i>	

General Information



– **Breakfast, Lunch, Dinner...**

- Breakfast “7h00 to 8h15” or later for non participant... 9h30
- Lunch “12h05 to 13h45”
- Dinner “19h30 to 20h30”

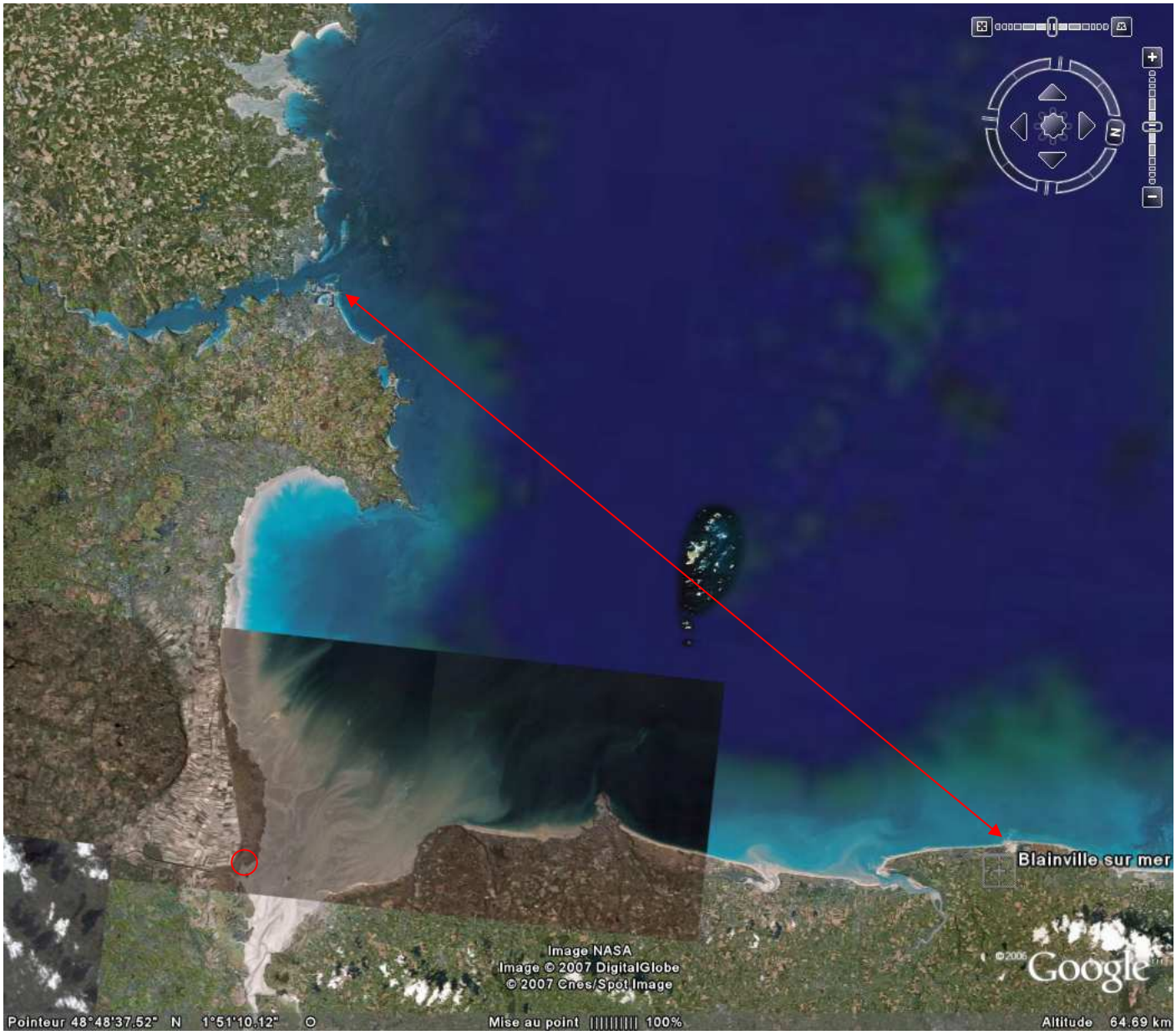
– **Messages... (See *Information Board...*)**

– ***Fall School dinner***

- Wednesday evening after the visit of *St Malo* !

– **Visit (with tourist guide) of St Malo**

- Wednesday afternoon (departure 13h00 !!! *impérative*)
- Arrival at *St Malo* around 15h30
- Around 1h30 of visit and 1h00 free time...
- Departure around 18h15 !
- ...*Mont St Michel... during the travel !*



Blainville sur mer

Image NASA
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Google

Pointeur 48°48'37.52" N 1°51'10.12" O

Mise au point ||| 100%

Altitude 64.69 km



Old city

© 2006 Google™

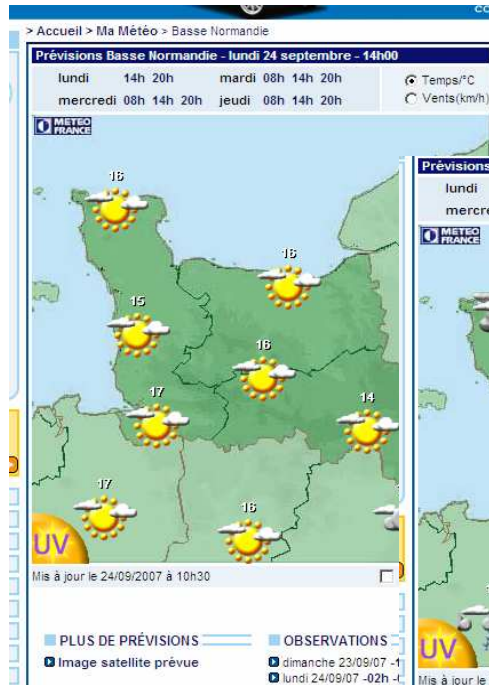
Pointeur 48°38'45.35" N 2°01'18.67" O

© 2007 Cnes/Spot-Image

Mise au point 100%

Altitude 3.11 km

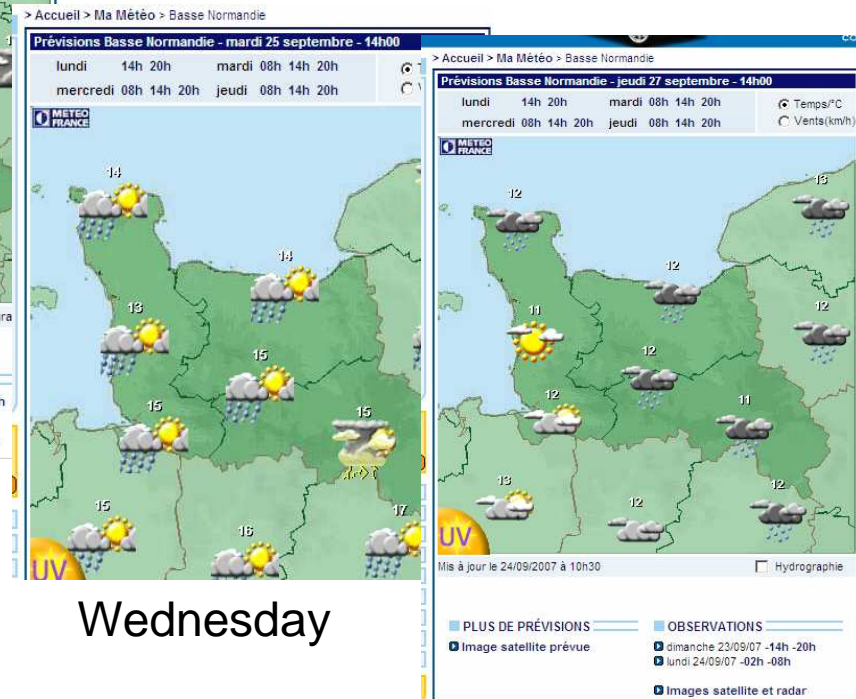
Weather of the week



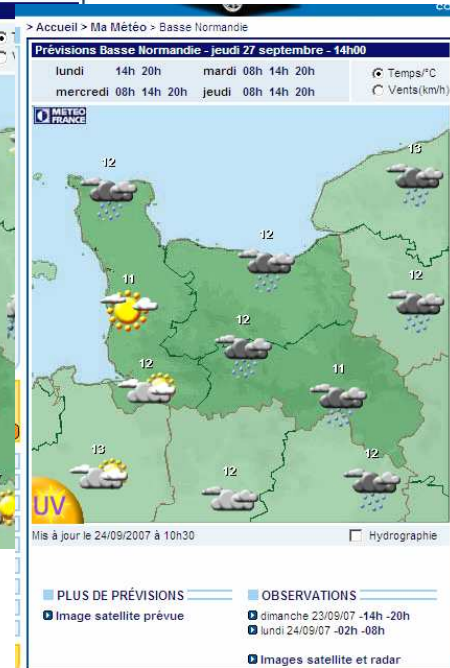
Monday



Tuesday



Wednesday



Thursday

An aerial photograph of a rural landscape. The foreground and middle ground are dominated by a patchwork of green agricultural fields, some of which are divided into smaller plots. A small town or village is visible, with a cluster of buildings and a network of roads. In the background, there are rolling hills under a clear sky. The entire image is framed by a dark blue border.

I wish to thank, again, all speakers, CNRS administration and co-worker, and you for your participation, I hope that you will have a nice week

“in our beautiful old country”

*and, it's pleasure for us, at present, to invite you to the welcome “**APERITIF**”*



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European Magnetic Sensors & Actuators conference EMSA 2008 30 June - 2 July 2008 Caen (France)



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