

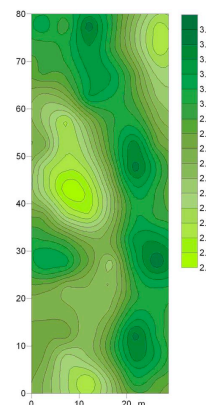
# Principles and applications of Multiplex and Dualex: innovative tools in the service of viticulture and oenology



**Zoran G. Cerovic**

CNRS, Univ. Paris-Sud, Orsay, France

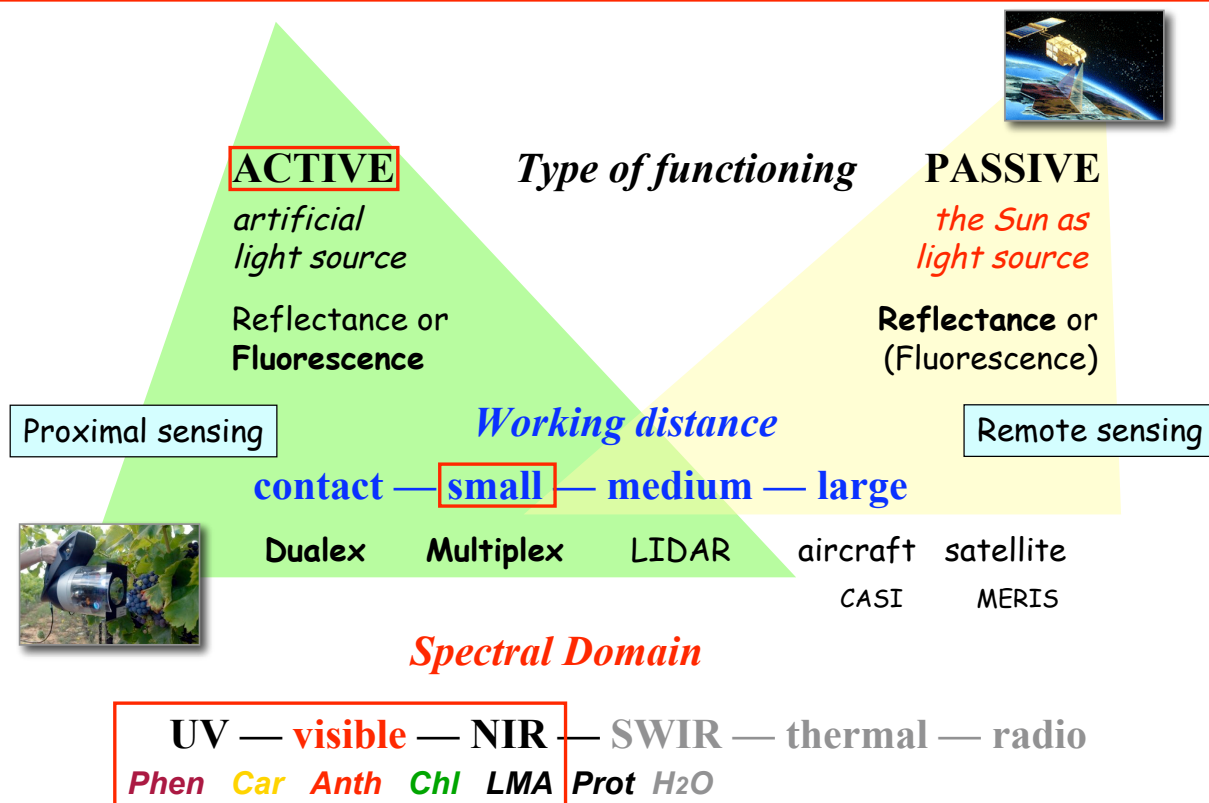
zoran.cerovic@u-psud.fr



© ZG Cerovic '11

Cerovic, Logroño, Jornada Técnica, 3 de Mayo 2011

## Remote & proximal sensing of vegetation in the field



© ZG Cerovic '11

Cerovic, Logroño, Jornada Técnica, 3 de Mayo 2011

# Layout of the presentation

---

*Acquiring information on the status of the vines*

- with WHAT • Dualex & Multiplex
- HOW • Hand-held vs. vehicle mounted
- WHAT • Pigments in **leaves** and **fruits**
- WHY • **Vigour** & **quality**
- what ELSE • **Diseases** & research



© ZG Cerovic '11

Cerovic, Logroño, Jornada Técnica, 3 de Mayo 2011

3

## Optical decision support tools

---

*leaf-clip*



**Dualex:**

Chlorophylls  
Flavonols



*proximal sensor : leaves and grapes*



**Multiplex:**

Chlorophylls  
Flavonols  
Anthocyanins  
(Stilbenes)



© ZG Cerovic '11

Cerovic, Logroño, Jornada Técnica, 3 de Mayo 2011

4

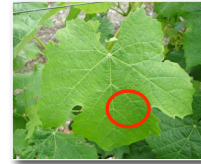
# Type of measurement

**Dualex**



hand-held

leaves



GPS  
inside

**Multiplex**



leaves

grapes on vine

harvested grapes

hand-held



vehicle-mounted



leaves

grapes on vines

harvested grapes



© ZG Cerovic '11

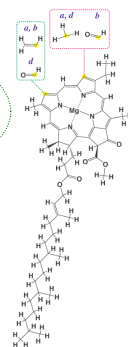
Cerovic, Logroño, Jornada Técnica, 3 de Mayo 2011

5

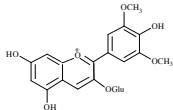
# Pigments in viticulture and oenology - Optical indices

Chlorophylls in leaves & (grapes)  
≈ Nitrogen

Chlorophyll a & b



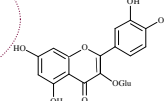
Oenin



Anthocyanins (leaves) & grape skin  
≈ Colour ≈ Phen

Flavonols leaves & grapes  
≈ Phen ≈ Light ≈ Nitrogen

Quercitrin



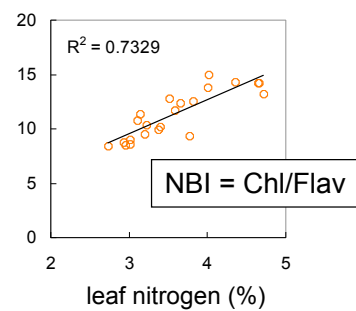
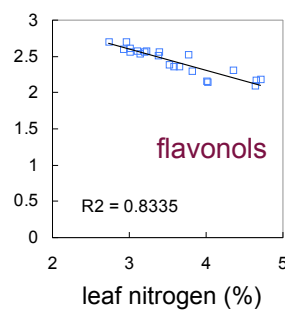
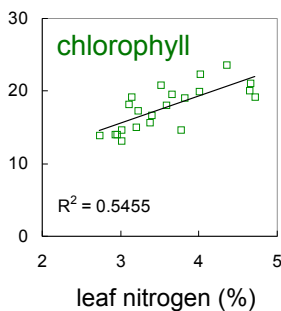
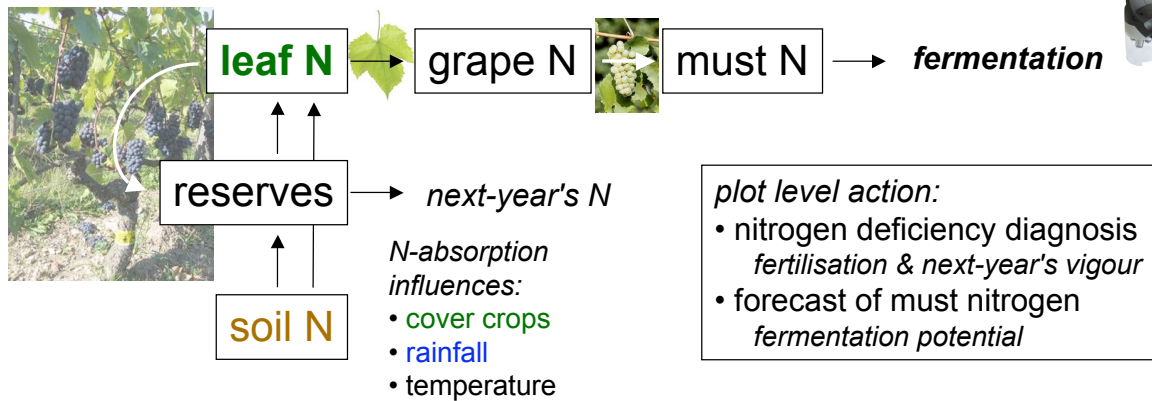
© ZG Cerovic '11



Cerovic, Logroño, Jornada Técnica, 3 de Mayo 2011

6

# Vine N-status, leaf nitrogen, nitrogen balance index (NBI)

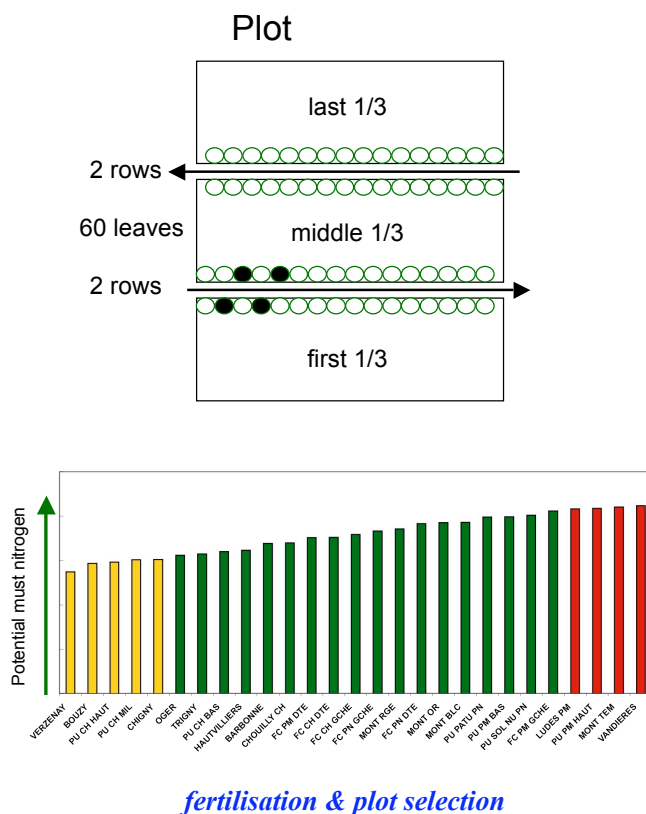


© ZG Cerovic-11

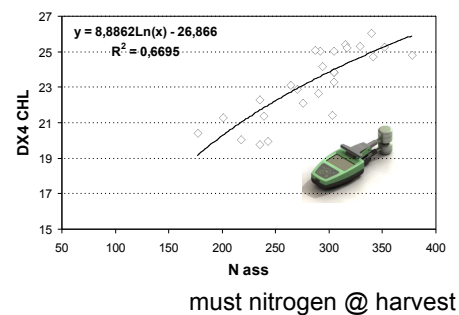
Cerovic, Logroño, Jornada Técnica, 3 de Mayo 2011

7

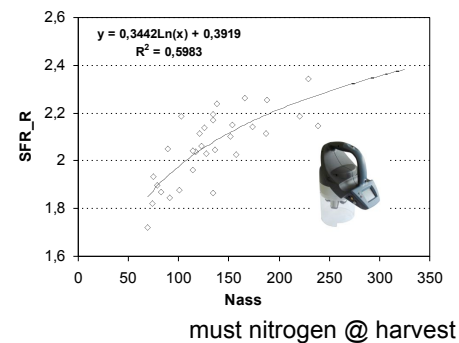
## Forecast of must nitrogen



### leaf chlorophyll @ flowering



### leaf chlorophyll @ bunch closure



© ZG Cerovic-11

Cerovic, Logroño, Jornada Técnica, 3 de Mayo 2011

8

# Vine management - zone definition & delineation



Vehicle-mounted canopy-level measurements



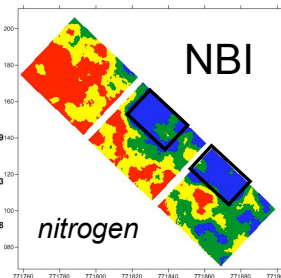
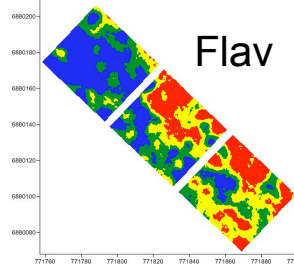
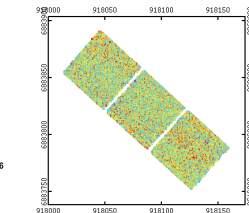
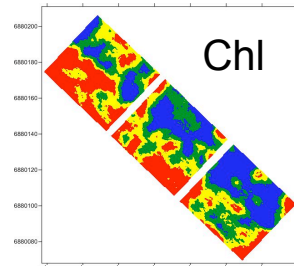
vigour  
(porosity)

plot level action:  
• fertilisation  
• vigour estimation

intra-plot action:  
• missing vines  
• plot homogenisation  
• plot fractioning  
• soil sampling & analysis  
• fertilisation

viticultural practice & zone delineation

MAP generation



susceptibility  
(disease control)

# In-season in-situ grape analysis (1) maturation kinetics



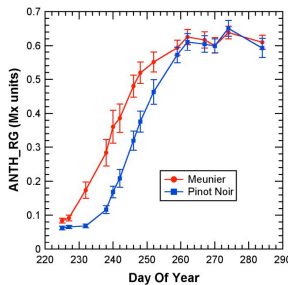
Hand-held single-grape Multiplex measurements

red - phenolic maturity

anthocyanins  
(colour)



Anth

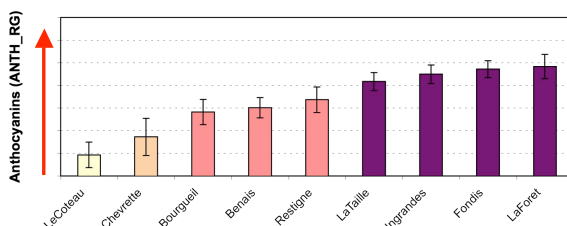
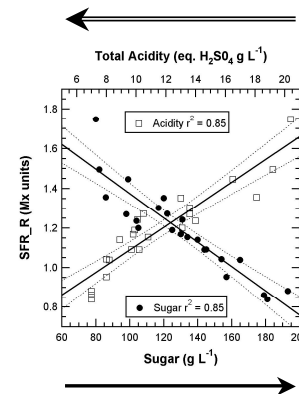
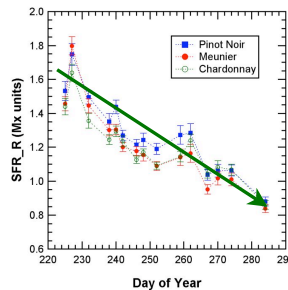


white - technological maturity

sugar & acidity



Chl



plot level action:  
• harvest date  
• plot selection  
• plot allocation



# In-situ grape analysis (2) quality zone delineation



Hand-held measurement

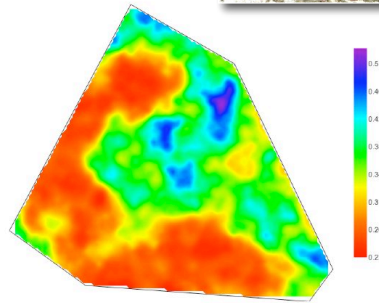
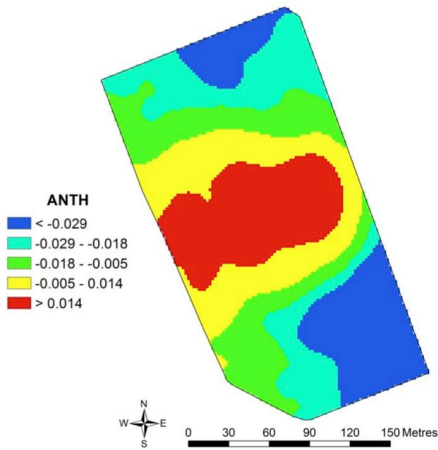


Vehicle-mounted Multiplex leaves removed



Map generation

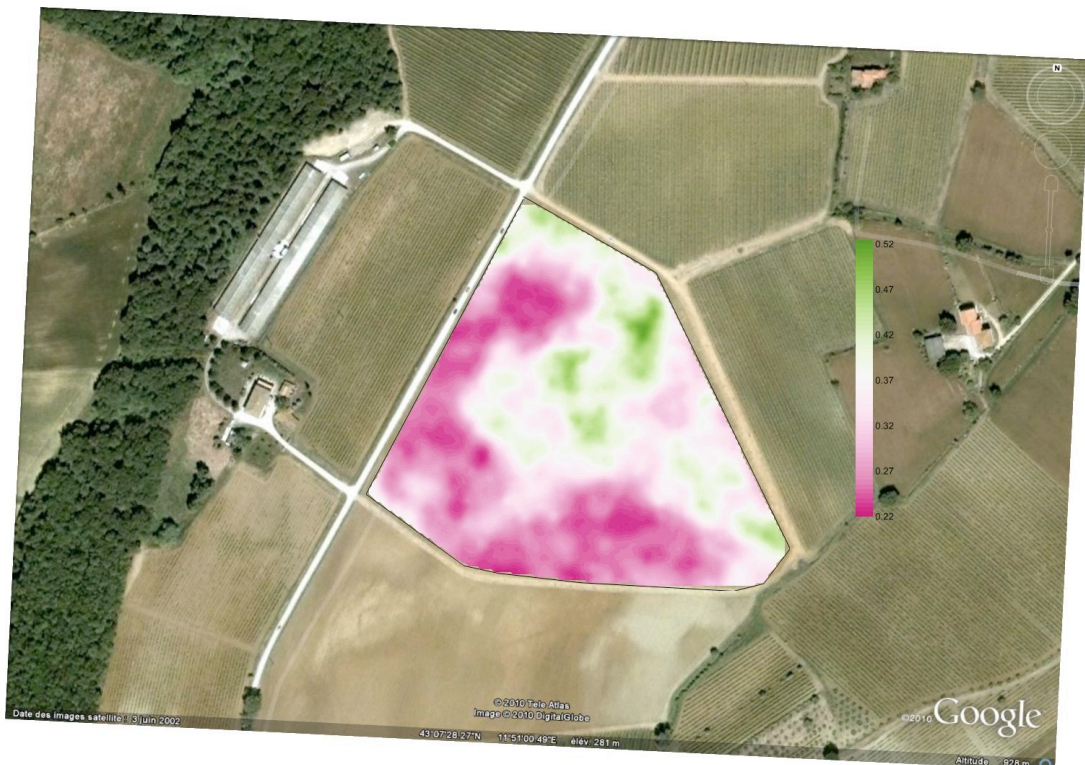
ANTH



- intra-plot action:*
- zones delineation
  - plot fractioning
  - subplot allocation
  - selective harvesting

*quality forecast & selective harvesting forecast*

# Seeing is believing



# Harvested grape analysis - diagnosis & control



**Hand-held at reception**  
single-grape measurement

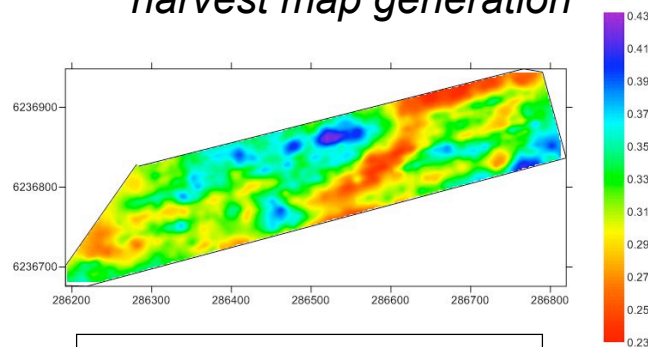


**Mounted on harvester**  
continuous measurement



- plot level action:*
- differential payment
  - practice verification
  - forecast verification
  - selection & allocation

*harvest map generation*



- intra-plot action:*
- non-grape matter estimation
  - on-the-go selective harvesting

*quality diagnosis & selective harvesting*

© ZG Cerovic-11

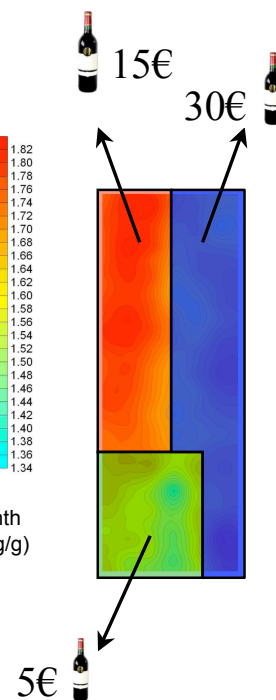
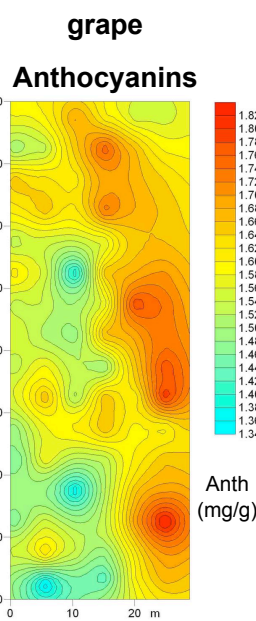
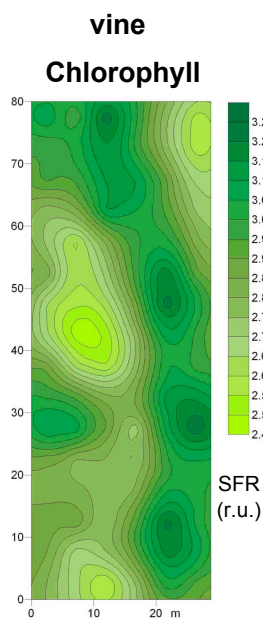
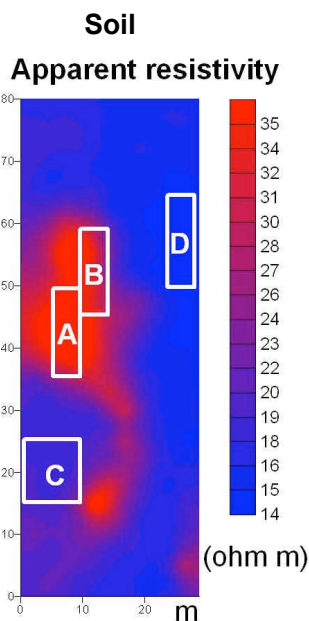
Cerovic, Logroño, Jornada Técnica, 3 de Mayo 2011

13

# Map use summary: zoning and harvest allocation



Merlot @ Château Couhins, Bordeaux





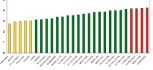







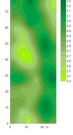





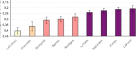















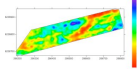


© ZG Cerovic-11

Cerovic, Logroño, Jornada Técnica, 3 de Mayo 2011

14

# FORCE-A's decision support optical tools for viticulture

<b>vegetative phase</b>					<b>nitrogen - vigour</b>	<i>fertilisation must N forecast</i>	
		leaves	  	  	<b>missing vines</b>	<i>plot management</i>	
					<b>wood disease disease outbreak</b>	<i>vine health suceptibility</i>	
		in situ			<b>zone definition</b>	<i>fertilisation soil sampling</i>	
<b>reproductive phase</b>		grapes			<b>maturation kinetics</b>	<i>plot selection &amp; allocation</i>	 
				 	<b>zone definition</b>	<i>grape-quality forecast selective harvesting</i>	
		in situ					
		harvest		 	<b>harvest diagnosis</b>	<i>plot selection grape pricing</i>	
				<b>diagnosis &amp; selection</b>	<i>diagnostic map harvest selection</i>		

© ZG Cerovic -11

[http://www.force-a.eu/fr/qualite\\_raisin.html](http://www.force-a.eu/fr/qualite_raisin.html)

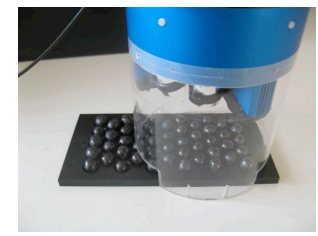
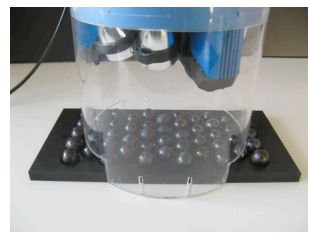


Cerovic, Logroño, Jornada Técnica, 3 de Mayo 2011

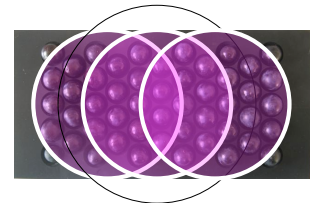
# Multiplex measurements on berries in the laboratory



**NO  
extraction  
needed**



30 or  
100 or  
200-berries  
samples



© ZG Cerovic -11

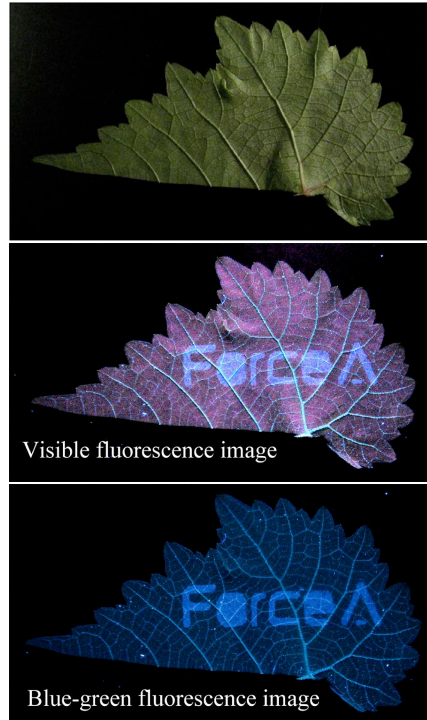
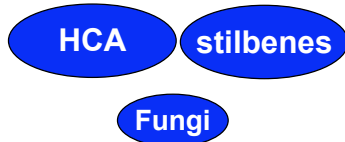
Cerovic, Logroño, Jornada Técnica, 3 de Mayo 2011



# Tools for research and new developments



**UV-excited  
"blue"  
fluorescence**



© ZG Cerovic-11

Cerovic, Logroño, Jornada Técnica, 3 de Mayo 2011

17

**Dr. Zoran G. Cerovic,**  
CNRS, Univ. Paris-Sud, Orsay, France  
zoran.cerovic@u-psud.fr



**FORCE-A**  
Centre Universitaire Paris Sud,  
Bât. 503  
91893 ORSAY Cedex  
France  
Tel : +33 (0)1 69 35 88 62  
Fax : +33 (0)1 69 35 88 97  
[www.force-a.com](http://www.force-a.com)  
[info@force-a.fr](mailto:info@force-a.fr)

© ZG Cerovic-11



[http://www.force-a.eu/fr/qualite\\_raisin.html](http://www.force-a.eu/fr/qualite_raisin.html)

Cerovic, Logroño, Jornada Técnica, 3 de Mayo 2011