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JOURNÉES ANNUELLES LIEN DE LA VIGNE

VINELINK ANNUAL DAYS

PROGRAMME 2018

Prédiction, Détection et Prévention des Risques en Viticulture : Maladies, Ravageurs et Climat

Predicting, Detecting and Preventing grapevine risks: Diseases, pests and climate

Imaging techniques for grapevine diseases detection

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Journées annuelles « Lien de la vigne » 13 Avril 2018

Disease detection: *what are we talking about?*

What purpose?
Disease (or precursor) monitoring:

- Prophylaxis
- phytosanitary treatment before or after symptoms expression
- Quality management (selective harvest).

How?

Remote sensing: Observation from sky or space.

Proximal sensing: Observation on the ground, mobile sensor.

Connected sensor: Observation on the ground, fixed sensor.

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Symptom detection : *a difficult problem*

Concern: leaves shoots berries.



Symptoms are varied:

- Color



- Shape




Sometimes not very discriminating

Confounding factors

sources: http://www.vignevin-sudouest.com/publications/fiches-pratiques

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Les capteurs optiques

Caméra multispectrale
www.hiphen-plant.com

En pratique, on utilise:

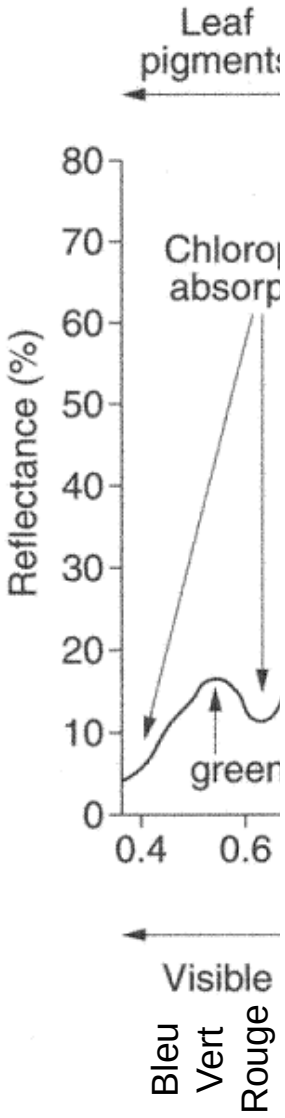
- La spectrométrie NIR (maturité)
- La fluorescence (maturité, maladie)
- L'imagerie multispectrale couleur (RGB) et infrarouge RGB+NIR.

Caméra hyperspectrale

Mais aussi (de façon émergente):

- L'imagerie hyperspectrale NIR
- L'imagerie thermique (comportement hydrique)
- La spectrométrie et l'imagerie hyperspectrale SWIR
- Le Lidar ou l'imagerie RGB+D (=>3D) ou la photogrammétrie.

Spectral behavior of vegetation



Thermal Infra Red

TeraHertz

Source: http://www.rncan.gc.ca/sciences-terre/geomatique/imagerie-satellitaire-photos-aeriennes/imagerie-satellitaire-produits/9272

Sensor carriers

2 kinds of approaches

Fixed sensors:

- Connected sensors - *1 mesure per sensor*

Mobile sensors:

- Human - *1 measure at a time,*
- Rover, tractor - *1 pixel = mm*
- UAV - *1 pixel = cm*
- (ultralight) aircraft, helicopter - *1 pixel = dm*
- Satellite - *1 pixel = m - dam*

Take into account of the flexibility and of the acquisition frequency

Vigor, Leaf area, biomass…

Very popular indices and good indicators of vine health

Several approaches:

- Multispectral remote sensing (aerial, space) of the canopy
  - Vegetation index based on Red and Near Infra Red (i.e NDVI)
- Multispectral proxi-sensing of the leaves
  - Vegetation index based on Red and Near Infra Red (i.e NDVI)
- Optical measurement of the *intercepts* of shoots
  - Estimation of shoots weight of the year

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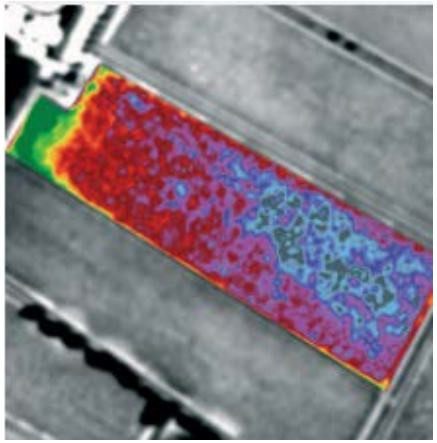
Vigor mapping*: examples*

Aerial and satellite imagery

- FarmStar Airbus Defence & Space,
  Oenoview ICV/Terranis,
  EarthLab Telespazio,
  NDVI Fruition Sciences…



Embedded infrared spectrometry

- Trimble Greenseeker

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sources: O. Garcia Comité Champagne (CIVC),

Early detection:
before visible symptoms

1/ Defining the maximal delay before treatment:

- Example: treatment possible up to 5 days after inoculation

2/ The 3 steps approach:

- Identifying (in vitro) spectral bands specific to the pathology
- Adapting the method to greenhouse then to filed and testing its robustness
- Building an ad'hoc sensor (simpler and less expansive). Testing in real life conditions

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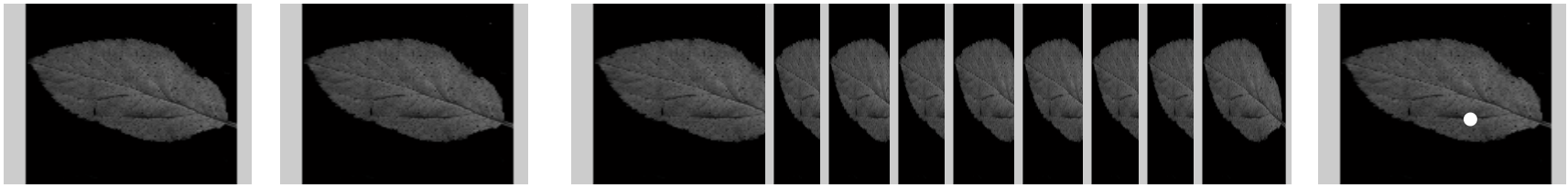
Example of early detection : *Apple scab*

Strategy:
Following the spatio-temporal evolution of the symptom on inoculated leaves



Ctifl

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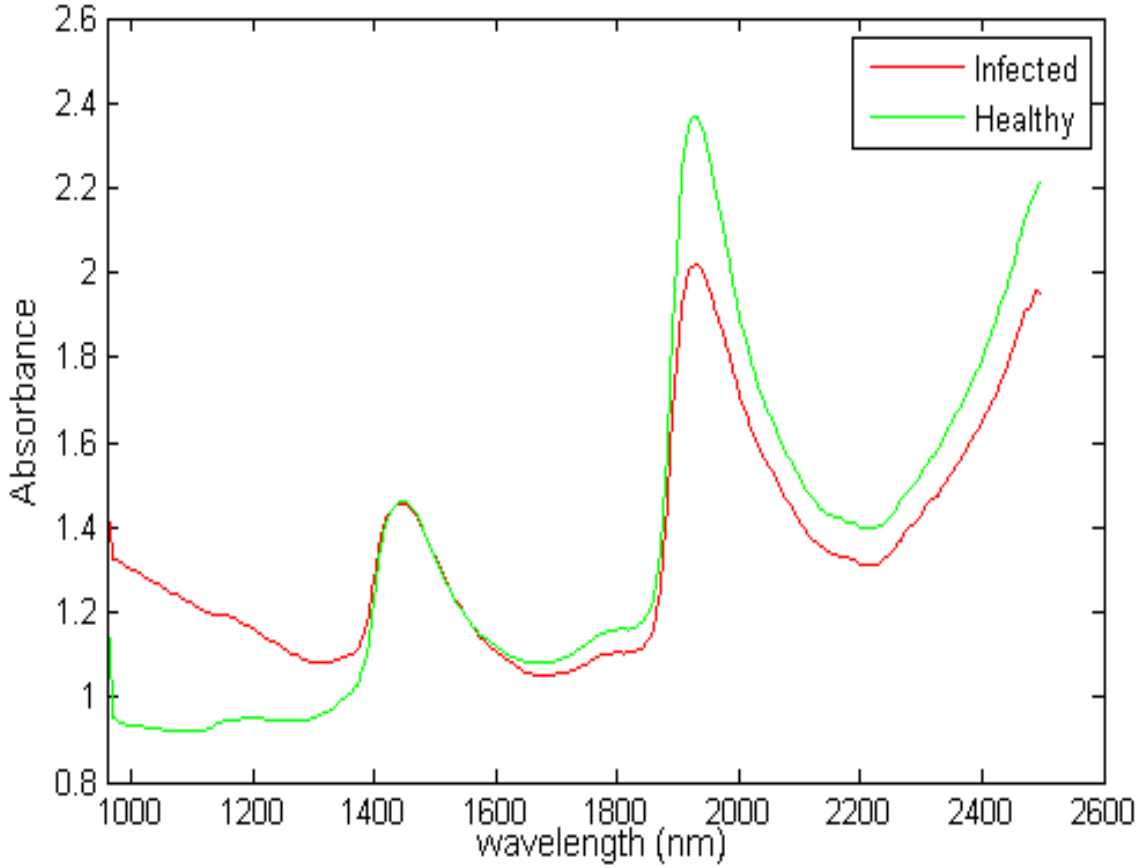
sources: Projet Aventuria, CTIFL, IRSTEA ITAP, IMS, M. Nouri

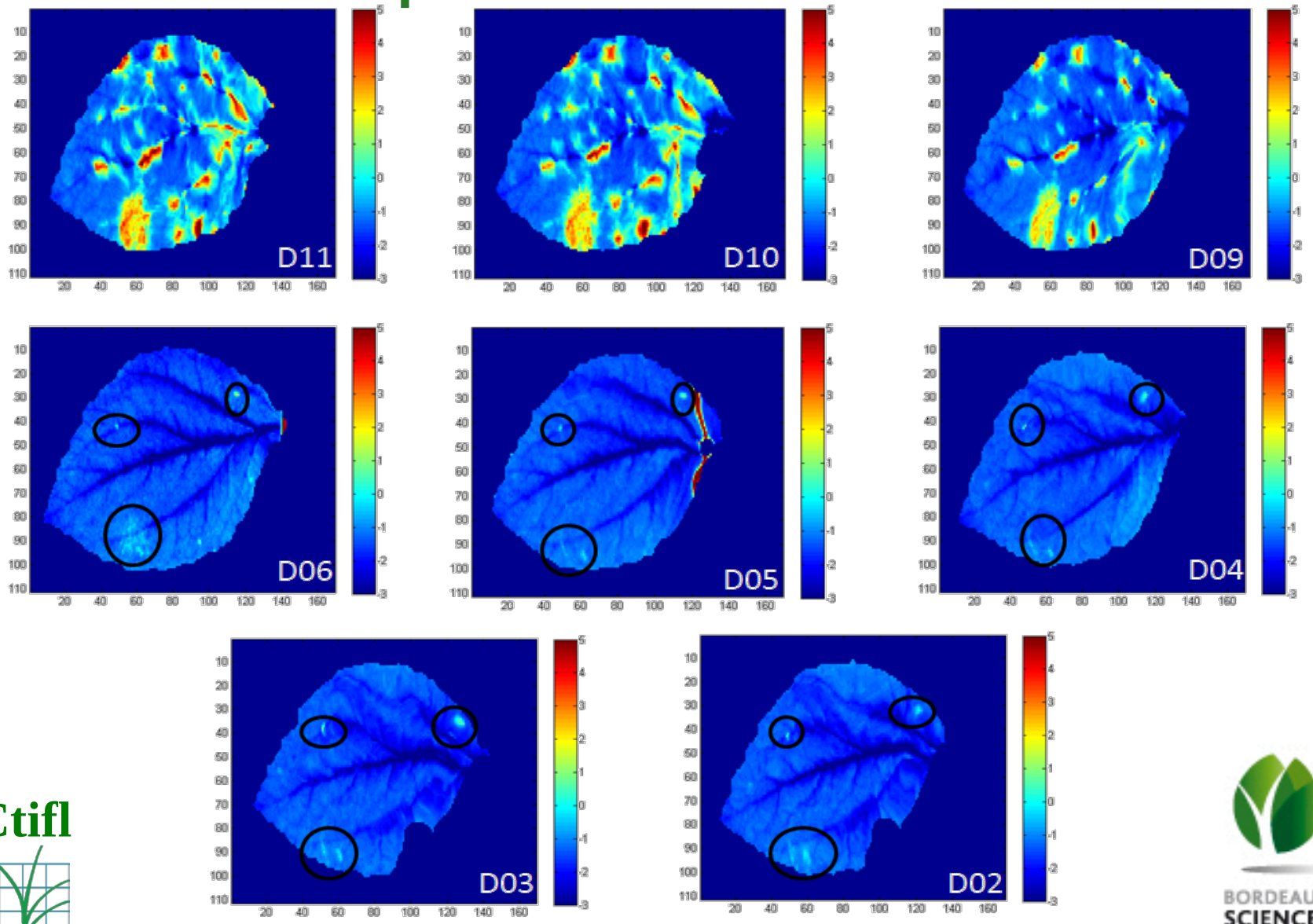
Example of early detection : *Apple scab*



Average spectral curve for healthy and inoculated leaves

sources: Projet Aventuria, CTIFL, IRSTEA ITAP, IMS, M. Nouri

Example of an inoculated leaf



Ctifl

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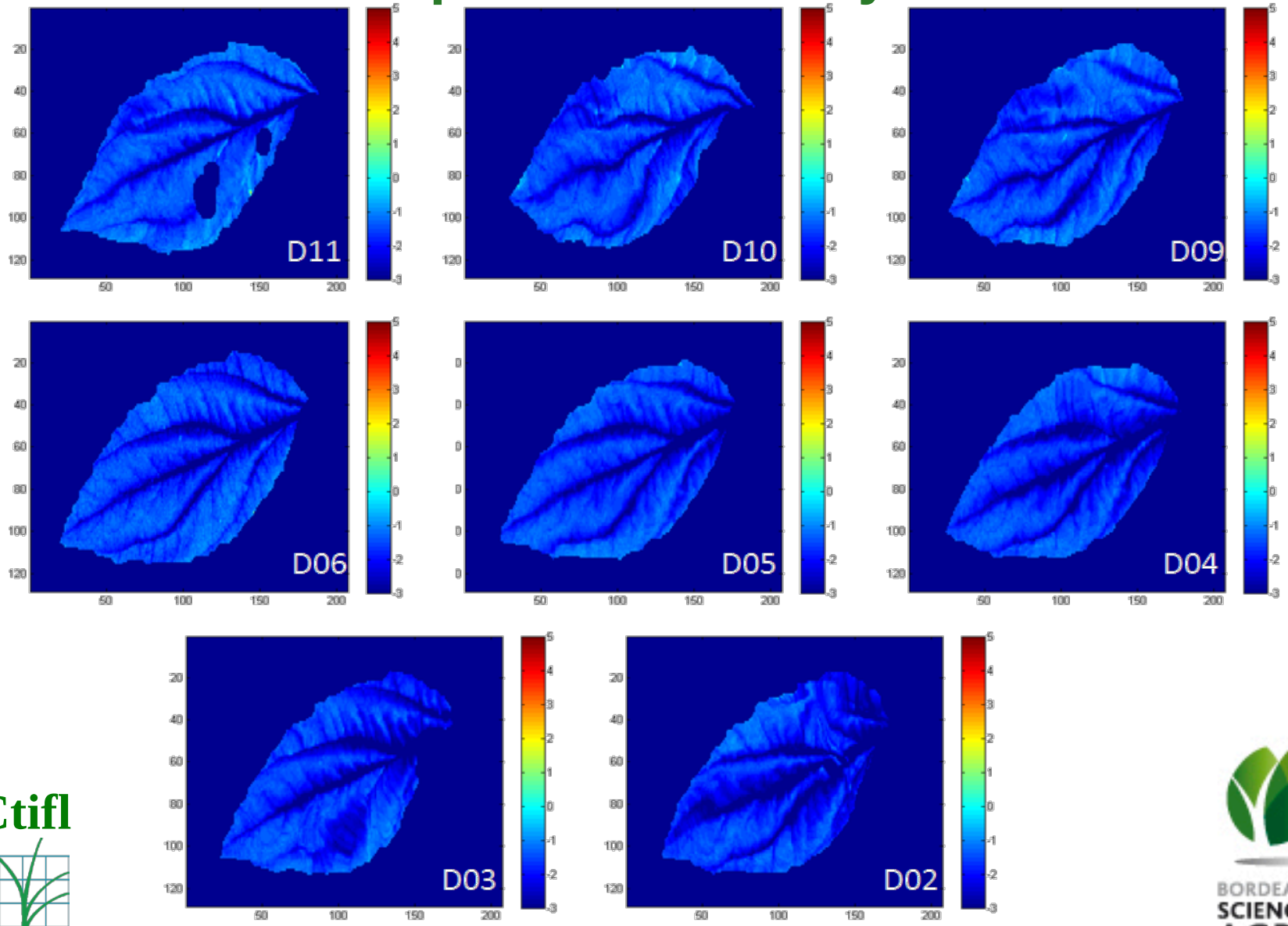
Example of an healthy leaf



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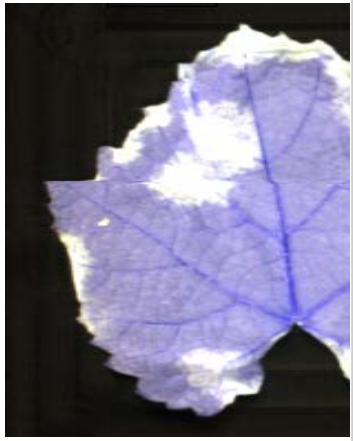
sources: Projet Aventuria, CTIFL, IRSTEA ITAP, IMS, M. Nouri

Example of early detection : *mildew*

Principle:

- Fluorimet
- Multiplex
- Detectior



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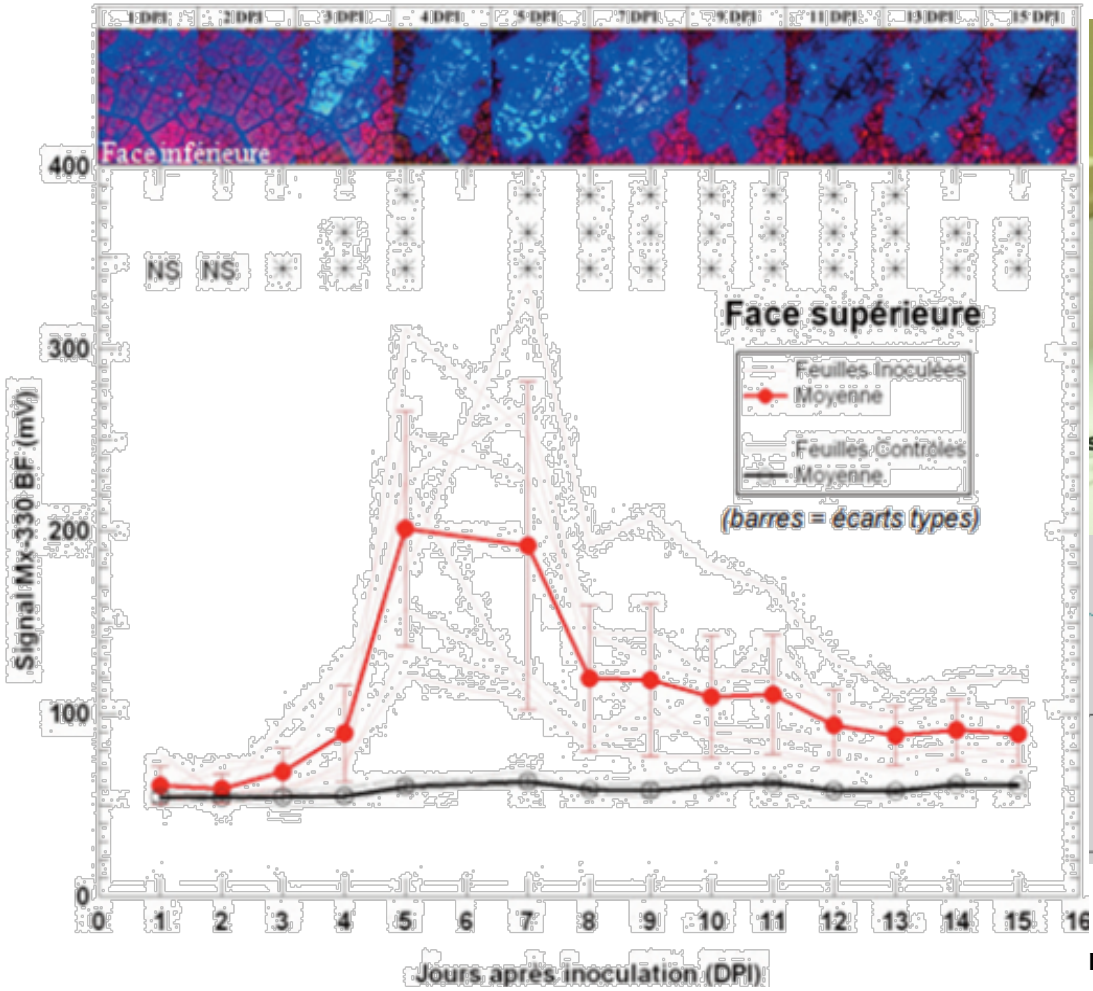

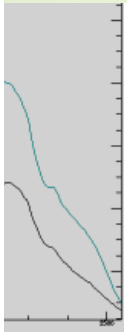

nalia)

http://www.force-a.eu/notices/MULTIPLEX_330_Francais.pdf

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Late detection:
when the symptoms are visible

At a more advanced stage of symptoms, we aim at:

- Getting objective estimation, reporting (regulatory obligation)
- Mapping and quantifying damages.
- Automatic detection for large scale monitoring

Detecting only one symptom is likely not enough.

Taking into account:

- several dates
- Spatial repartition
- …

Could make detection more reliable.

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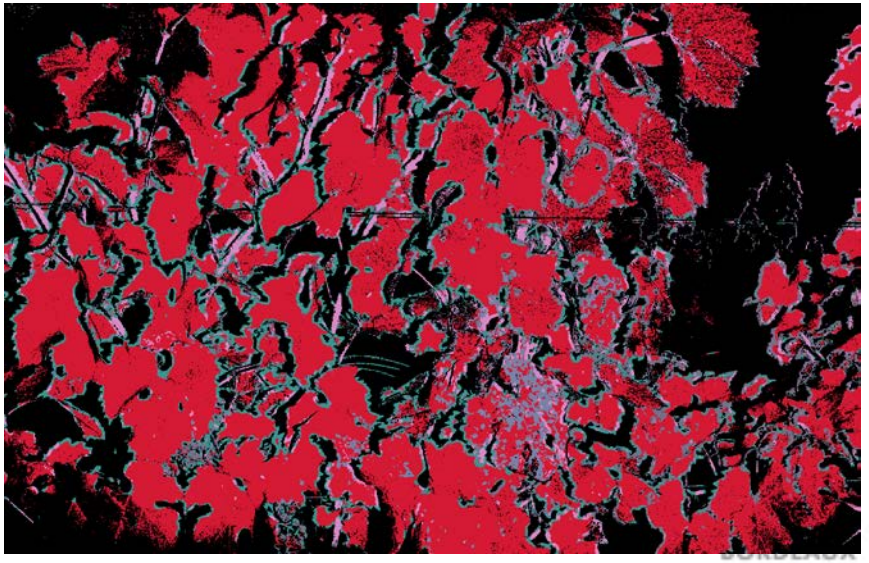
What about proxi sensing (embedded imagery)?

Initial objective: Early estimation of yield from image analysis

Autonomous device for image analysis :

- 1 camera + 1 flash light
- 1 industrial computer
- 1 GPS + 1 ultra-sound sensor



Extension:

To vine disease detection

Disease detection: *some outlooks…*

Complex problems:

- because of the variability of the situations encountered,
- because of the presence of many confounding symptoms

Promising techniques to develop?

- Fluorescence
- Hyperspectral
- Therma IR
- TeraHertz
- etc …

Progress expected on algorithms:

- Data fusion,
- Deep Learning, CNN…
  … requires huge annotated databases

Sensor carried by robots…

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