WinePAT Technology

http://www.winepat.net/

WinePAT : Facing the Complexity of Grape Quality Management and Delivering an High-throughput Device

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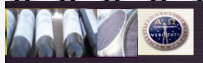
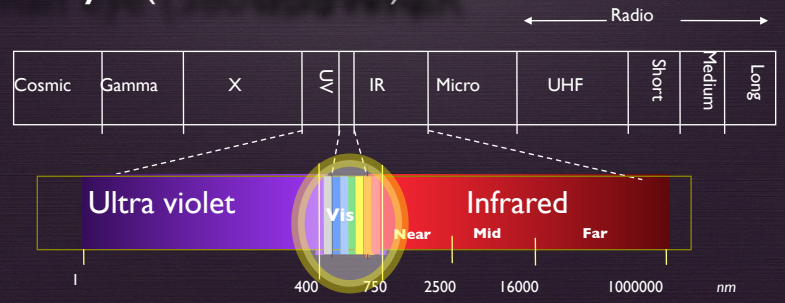


Objectives

1. Spectroscopy – Definitions
2. Spectroscopy – Holistic Measurement of Metabolism
3. Complexity and Information Processing
4. Spectroscopy Case Study : Hyperspectral monitoring

Electromagnetic Spectra

The visible portion of electromagnetic spectra
The electromagnetic spectra is classified into visible is called light and can be detected by the types according to the frequency . . .
human eye (380-750nm)IR



Photonics : Molecular Information

Spectral Information :

Intensity (photon/sec)

Physical properties :

- Particules, Probe distance
- Scattering

wavelenght (nm)

Photonics : Molecular Information

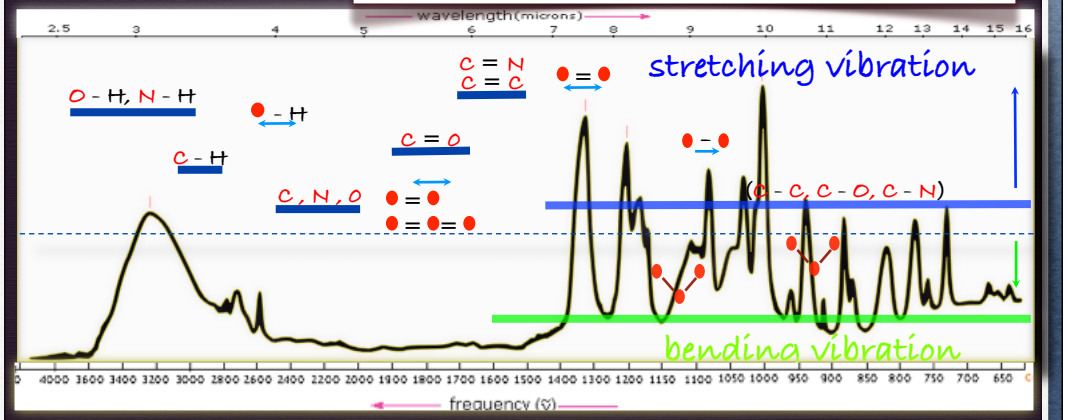
Spectral Information :

Chemical properties :"frequency changes"

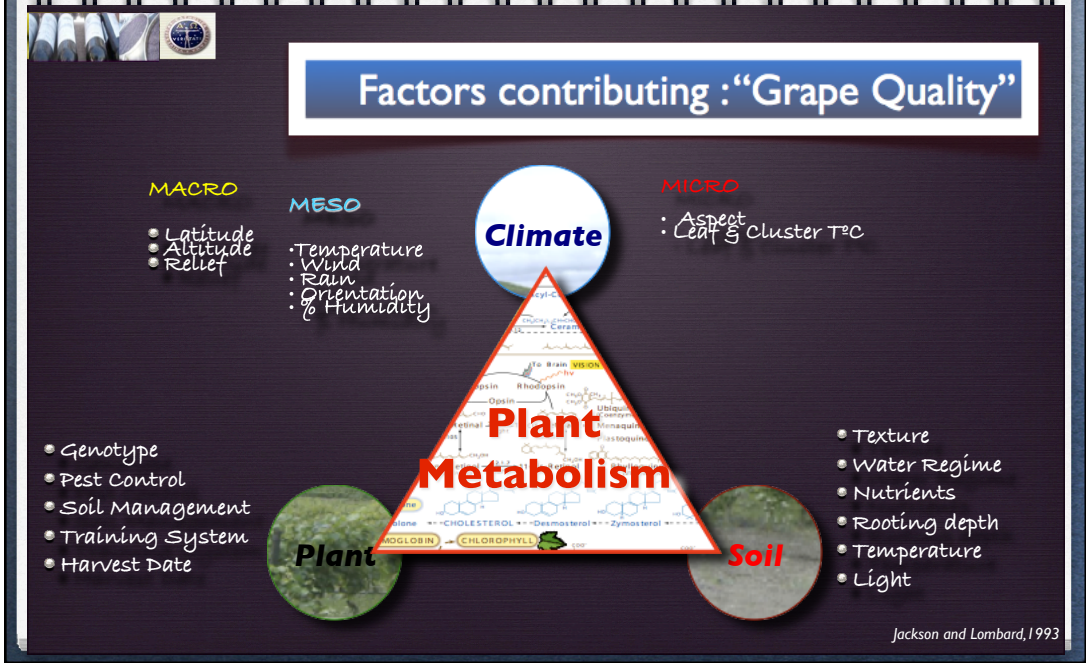
- Absortion
- Fluorescence
- Ressonance

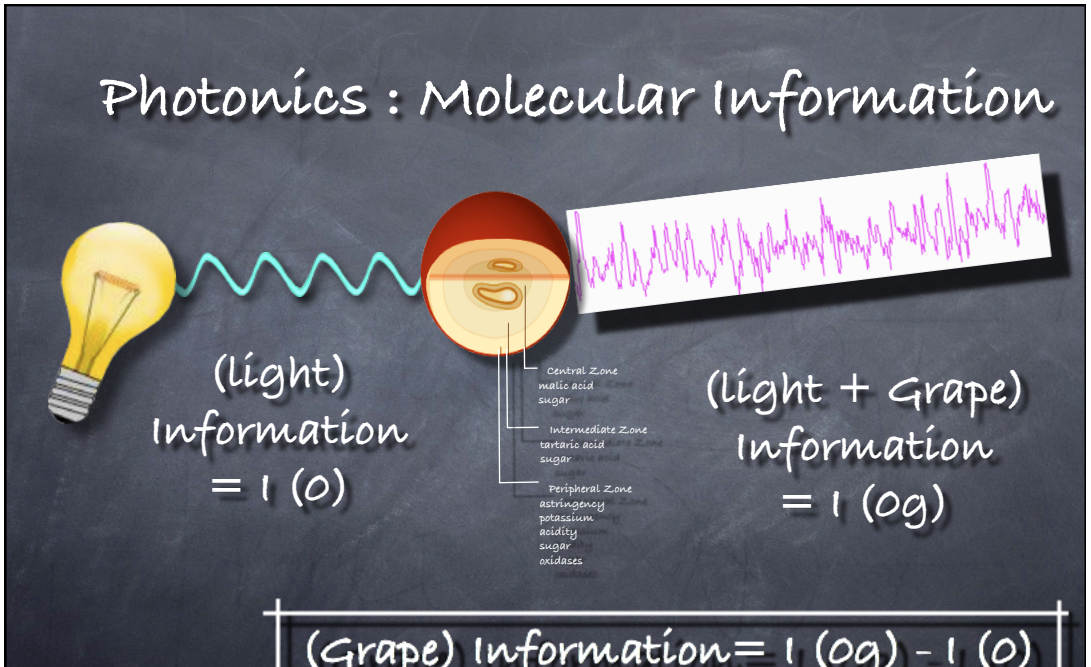
wavelenght (nm)

Photonics : Molecular Information

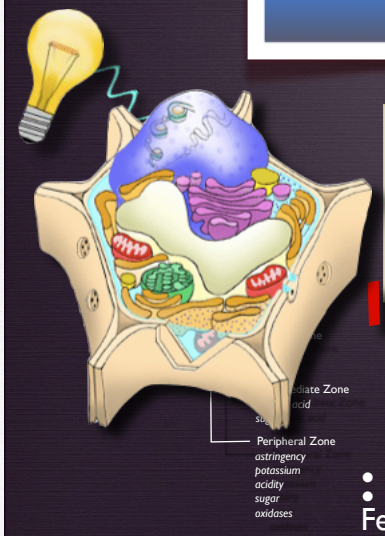


The different features (peaks) in the spectra are result


Factors contributing :"Grape Quality"
MACRO
Latitude
Altitude
Relief
MESO
·Temperature
: Wind
: Rain
: Orientation
: % Humidity
Climate
MICRO
: Aspect
: Leaf & Cluster T°C
Plant Metabolism
Genotype
Pest Control
Soil Management
Training System
Harvest Date
Plant
Soil
Texture
Water Regime
Nutrients
Rooting depth
Temperature
Light
Jackson and Lombard, 1993


Photonics : Molecular Information
(light) Information = 1 (0)
Central Zone
malic acid
sugar
Intermediate Zone
tartaric acid
sugar
Peripheral Zone
astringency
potassium
acidity
sugar
oxidases
(light + Grape) Information = 1 (0g)
(Grape) Information = 1 (0g) - 1 (0)

Photonics : Molecular Information



Metabolic Information : Holistic

Complex Fingerprinting :

- Convoluted Information
- Advanced Computational Signal Processing, Feature and Pattern Recognition

"Target Metabolites"

Selected Compounds ...

Glucose

Fructose

Malic Acid

Tartaric Acid

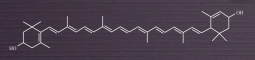
beta-carotene

Lutein

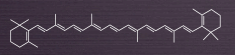
Pheophytin A

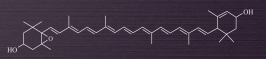
Pheophytin B

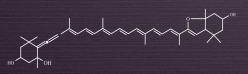
Aroma Precursors : Carotenoids

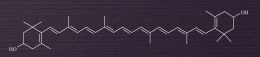
luteína 

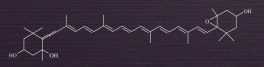
flavoxantina 

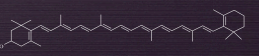
β,β-caroteno 

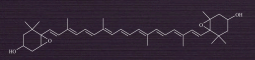
luteína 5,6-epóxido 

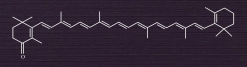
neocromo 

zeaxantina 

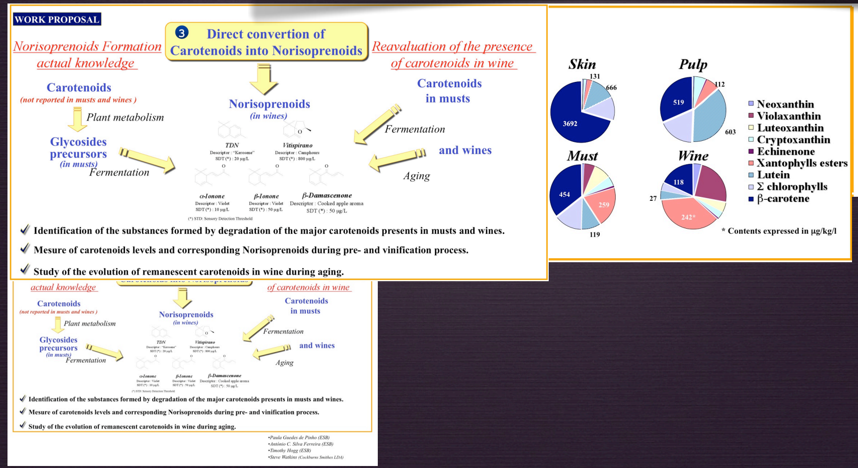
neoxantina 

β-criptoxantina 

violaxantina 

equinenona 

Why Carotenoids in grapes, musts and wines


WORK PROPOSAL
Norisoprenoids Formation actual knowledge
Direct convertion of Carotenoids into Norisoprenoids
Reavaluation of the presence of carotenoids in wine
Carotenoids
(not reported in musts and wines)
Plant metabolism
Glycosides precursors (in musts)
Fermentation
Norisoprenoids (in wines)
TDN
Vitispirano
α-Ionone
β-Ionone
β-Damascenone
Carotenoids in musts
Fermentation
and wines
Aging
Identification of the substances formed by degradation of the major carotenoids presents in musts and wines.
Mesure of carotenoids levels and corresponding Norisoprenoids during pre- and vinification process.
Study of the evolution of remanescent carotenoids in wine during aging.
Skin
Pulp
Must
Wine
Neoxanthin
Violaxanthin
Luteoxanthin
Cryptoxanthin
Echinenone
Xantophylls esters
Lutein
Σ chlorophylls
β-carotene
* Contents expressed in μg/kg/l

GUEDES DE PINHO, SILVA FERREIRA, M. MENDES PINTO, GOMEZ BENITEZ, J, e HOGG,T.; Determination of carotenoid profiles in grapes, musts and fortified wines from Douro varieties of Vitis vinifera. J. Agric. Food Chem, **2001**, 49, 11, 5484-5488.

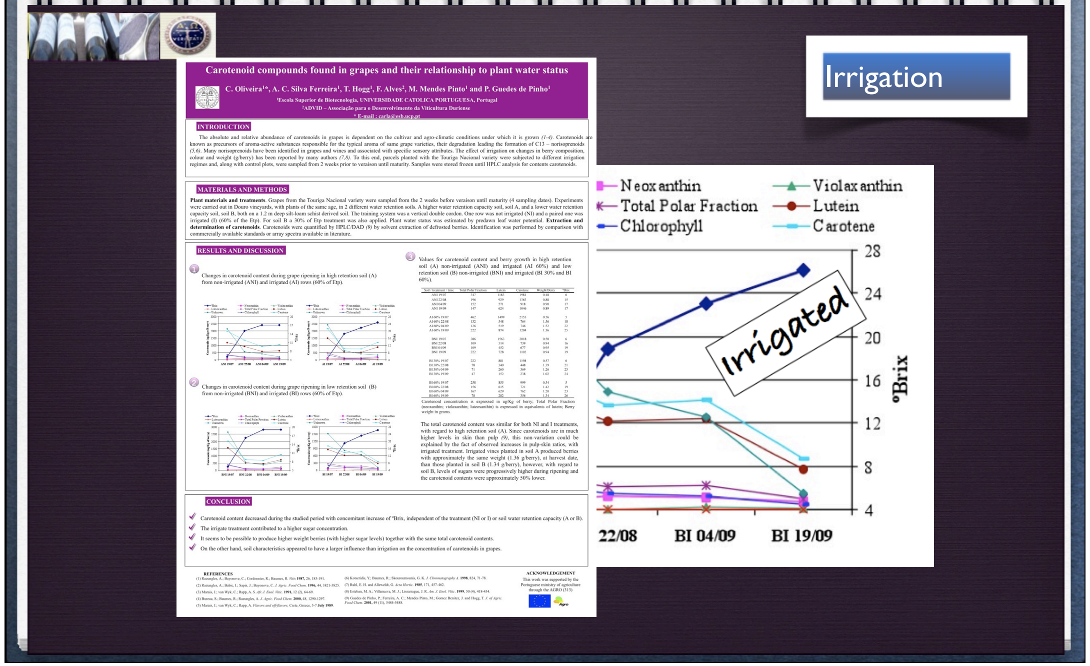
Why Carotenoids in grapes, musts and wines

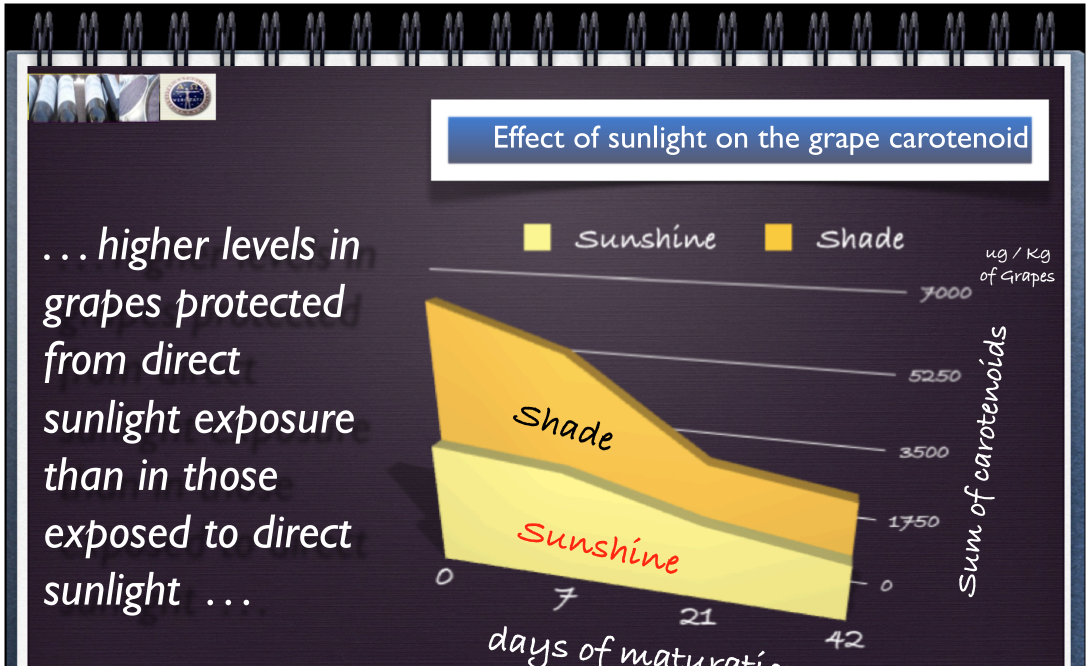
"Pool" Metabólico
GGDP
Fitoeno
Licopeno
Xantofilas cíclicas

Carotenoids are mostly synthesized from the first stages of fruit formation until "veraison" and then degraded between "veraison" and maturity to produce C_{13} - norisoprenoid compounds which have been reported as odor-active compounds responsible for typical aromas of same grape varieties ...

It is well known that carotenoid contents in plants are *related to the metabolic processes of plant cells*, which are *dependent on climatic factors, agricultural practices, light and shade*

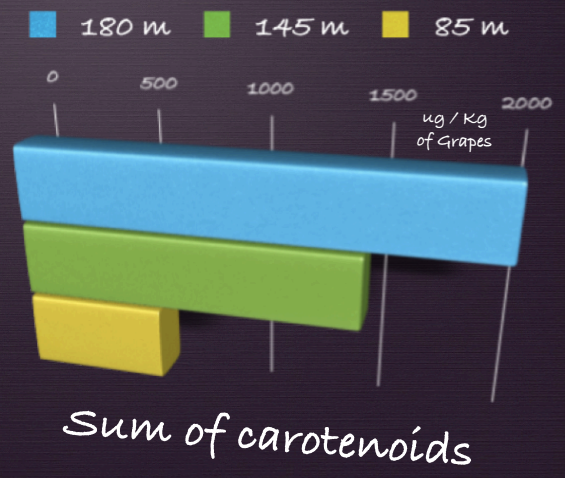
❖ Altitude


Irrigation
Carotenoid compounds found in grapes and their relationship to plant water status
INTRODUCTION
MATERIALS AND METHODS
RESULTS AND DISCUSSION
CONCLUSION
Neoxanthin
Total Polar Fraction
Chlorophyll
Violaxanthin
Lutein
Carotene
28
24
20
16
12
8
4
°Brix
Irrigated
22/08
BI 04/09
BI 19/09

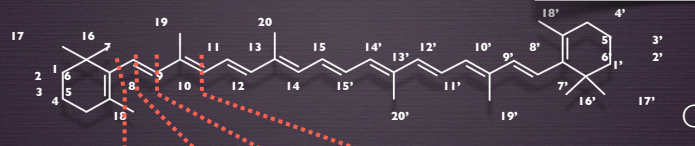

Effect of sunlight on the grape carotenoid
. . . higher levels in grapes protected from direct sunlight exposure than in those exposed to direct sunlight . . .
Sunshine
Shade
ug / Kg of Grapes
7000
5250
3500
1750
0
Sum of carotenoids
Shade
Sunshine
0
7
21
42

Effect of altitude on the grape carotenoid

... Altitude strongly affect climatic conditions due to it direct impact on T°C, humidity, and other environment factors that affect grape maturity ...



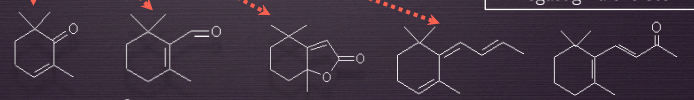
Norisoprenoids



$C_{40}H_{56}$

non-Megastigma skeleton

Megastigma skeleton



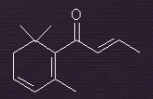
2,2,6-Trimethylcyclohexanone TCH — C9

β-cyclocitral — C10

DHC — C11

C13

Ionones



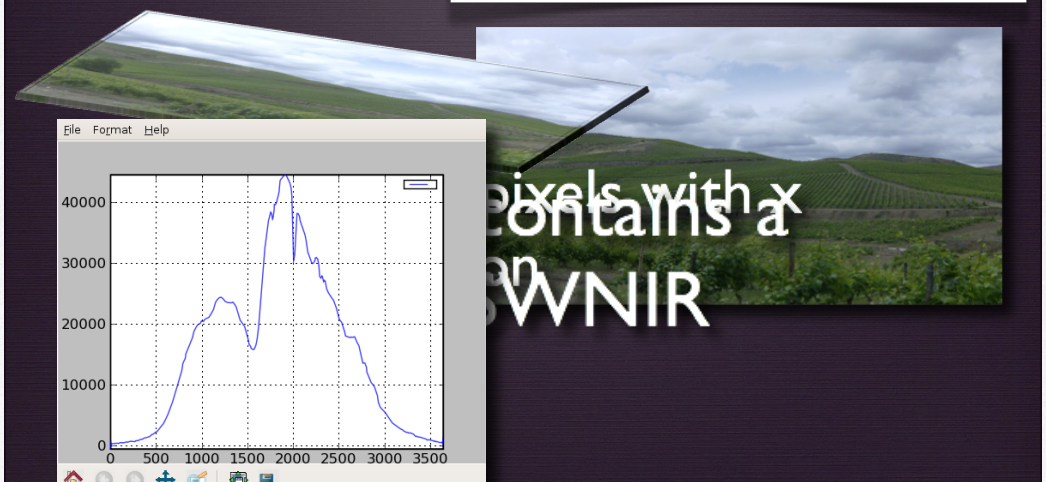
Damascones

CARLA OLIVEIRA, ANTONINA BARBOSA A. C. SILVA FERREIRA, JOAQUIM GUERRA AND GUEDES de PINHO P."Carotenoid Profile in

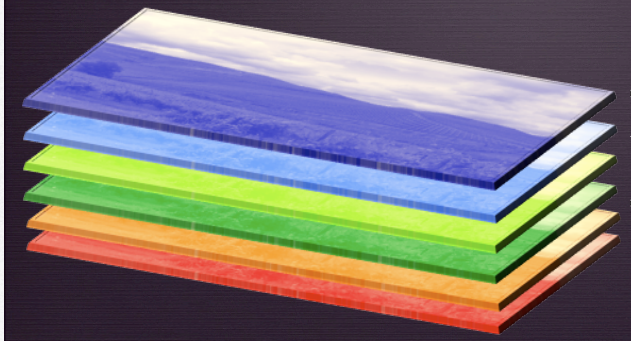
High Resolution vis-SWNIR Imaging

"Non Target Metabolites"

What is Hyperspectral Imaging?



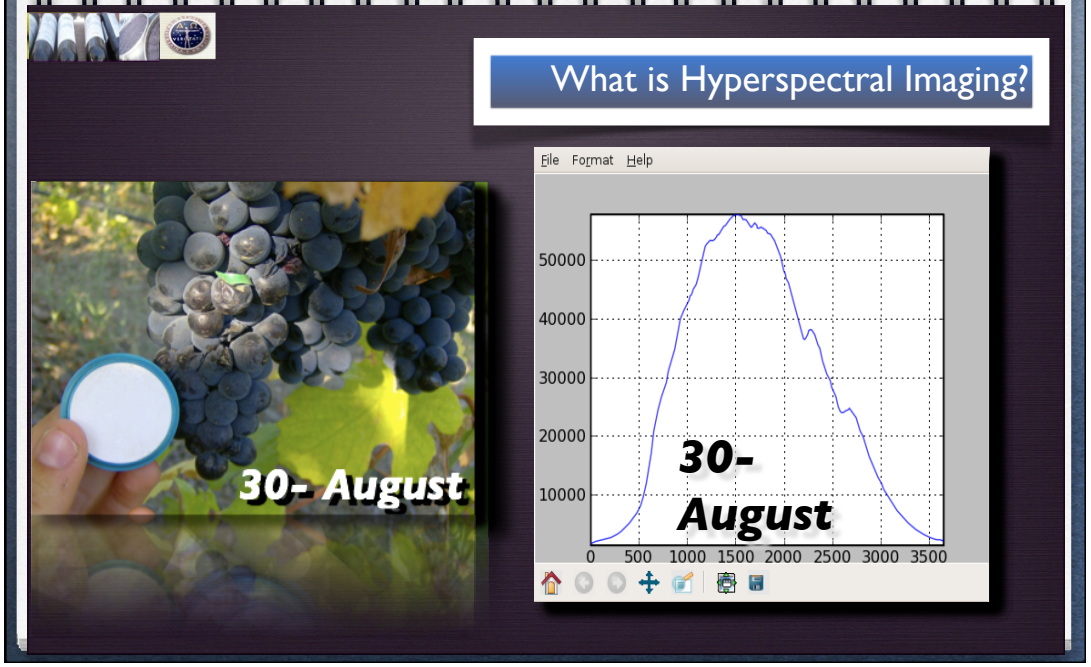
What is Hyperspectral Imaging?

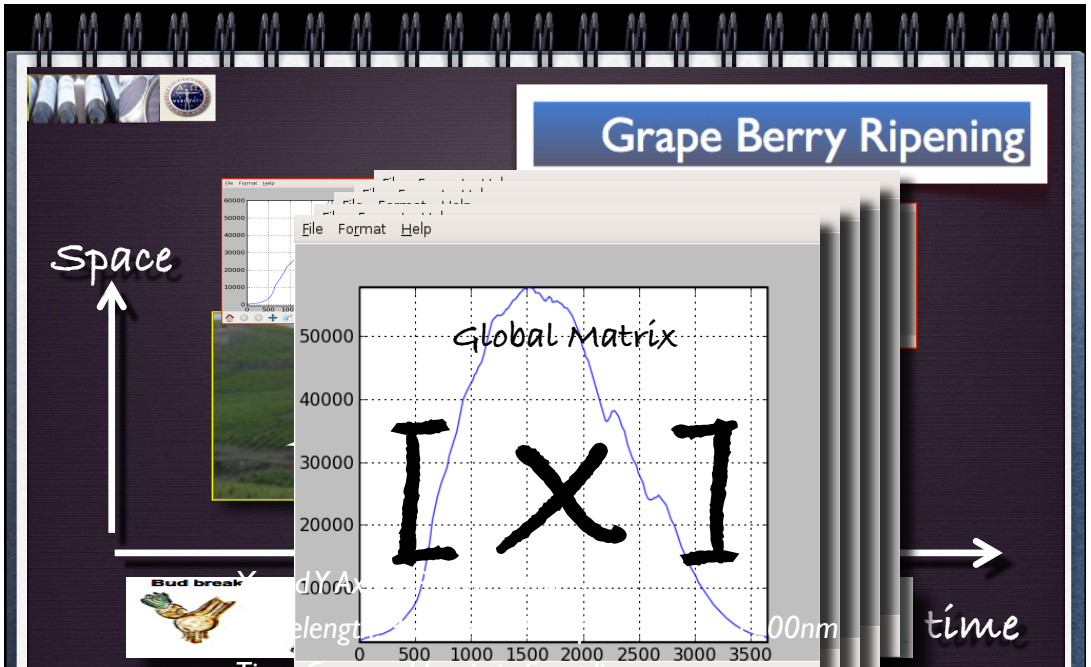


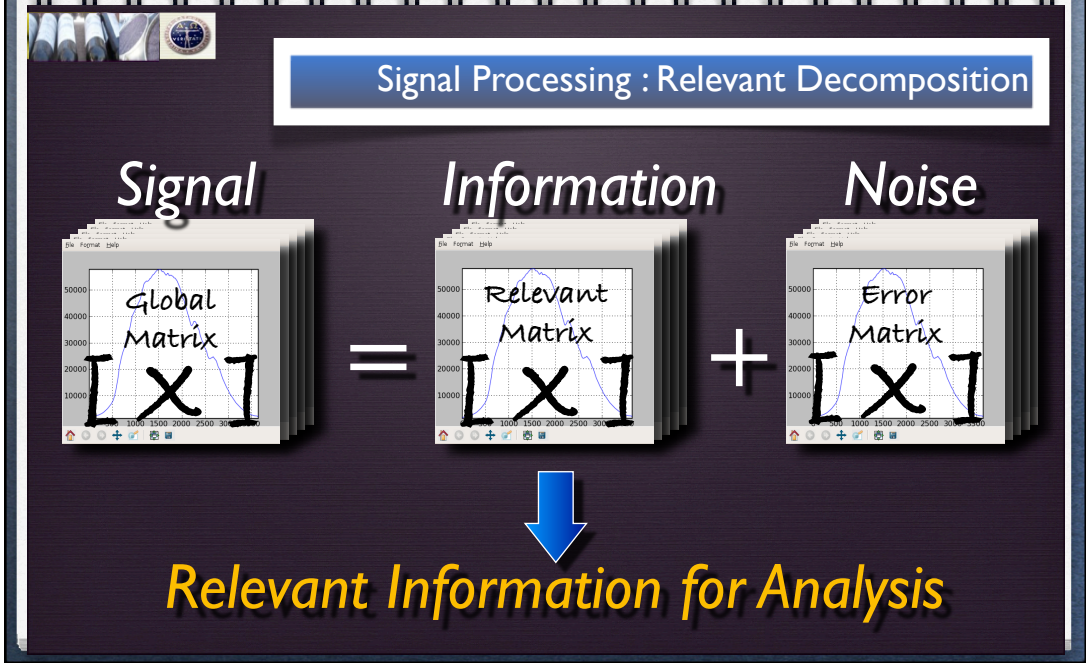
- Spacial Information for each time,
- Time Course Resolution,
- Each point of the field is a spectra,
- Allows high discrimination,
- Maturation Monitoring...

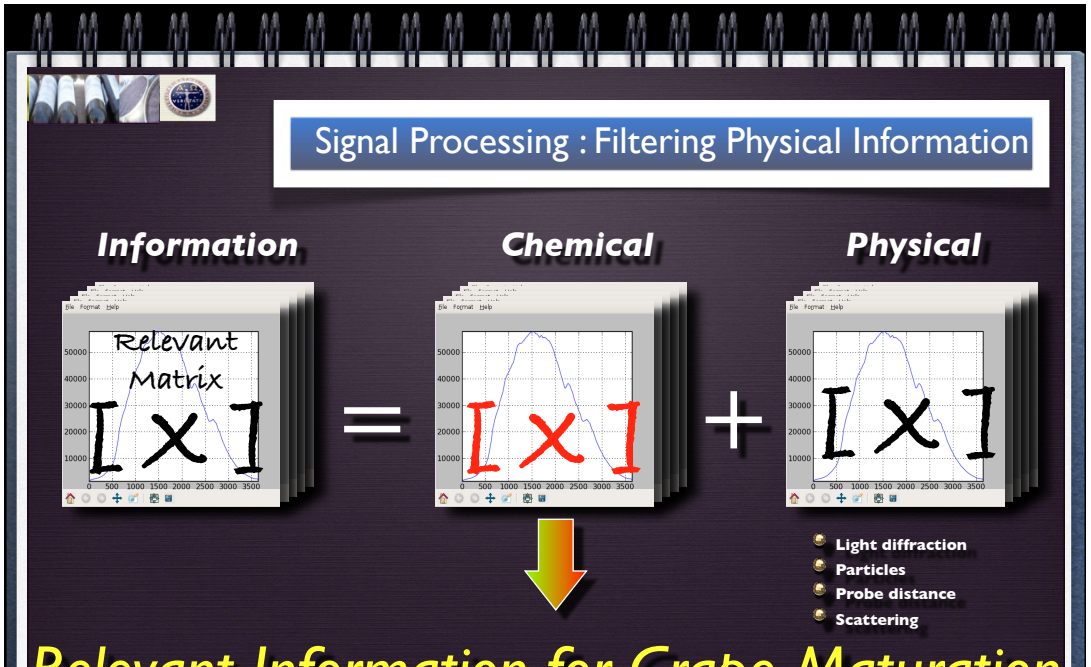
Imaging : *vis*-SWNIR

Movie Making...


What is Hyperspectral Imaging?
30- August
File Format Help
50000
40000
30000
20000
10000
0 500 1000 1500 2000 2500 3000 3500
30-
August

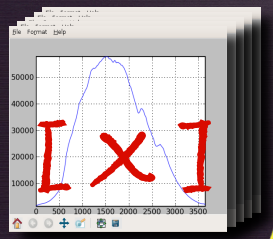

Grape Berry Ripening
Space
File Format Help
Global Matrix
I X I
50000
40000
30000
20000
0 500 1000 1500 2000 2500 3000 3500
Bud break
time


Signal Processing : Relevant Decomposition
Signal
Information
Noise
Global Matrix
[X]
=
Relevant Matrix
[X]
+
Error Matrix
[X]
Relevant Information for Analysis


Signal Processing : Filtering Physical Information
Information
Chemical
Physical
Relevant Matrix
[X]
=
[X]
+
[X]
Light diffraction
Particles
Probe distance
Scattering

Signal Processing

Chemical



Convoluted

Blind Signal Decomposition

SVD

Metabolic Fingerprint

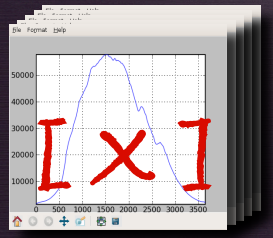
Deconvolution

Supervised Signal Decomposition

PLS

"Metabolic Fingerprinting"

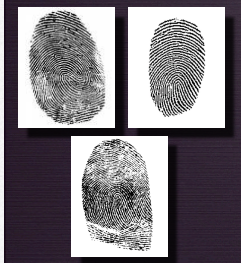
Chemical



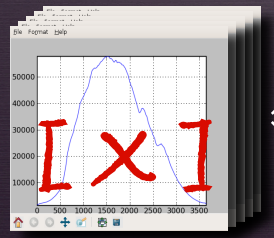
What Relevant Information Discriminates between the "metabolic fingerprints" ?

"Metabolic Fingerprinting"

Chemical



The Metabolic Fingerprints



Independent Information

Classification

Dependent Information

Independent Information - Relevant Variance

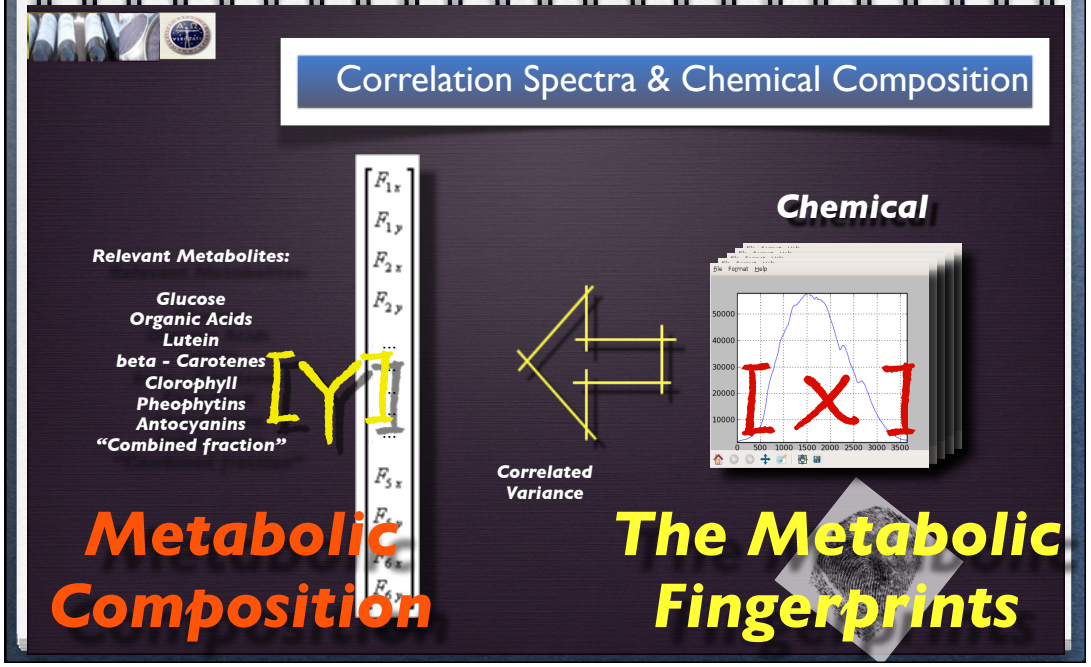
19-July

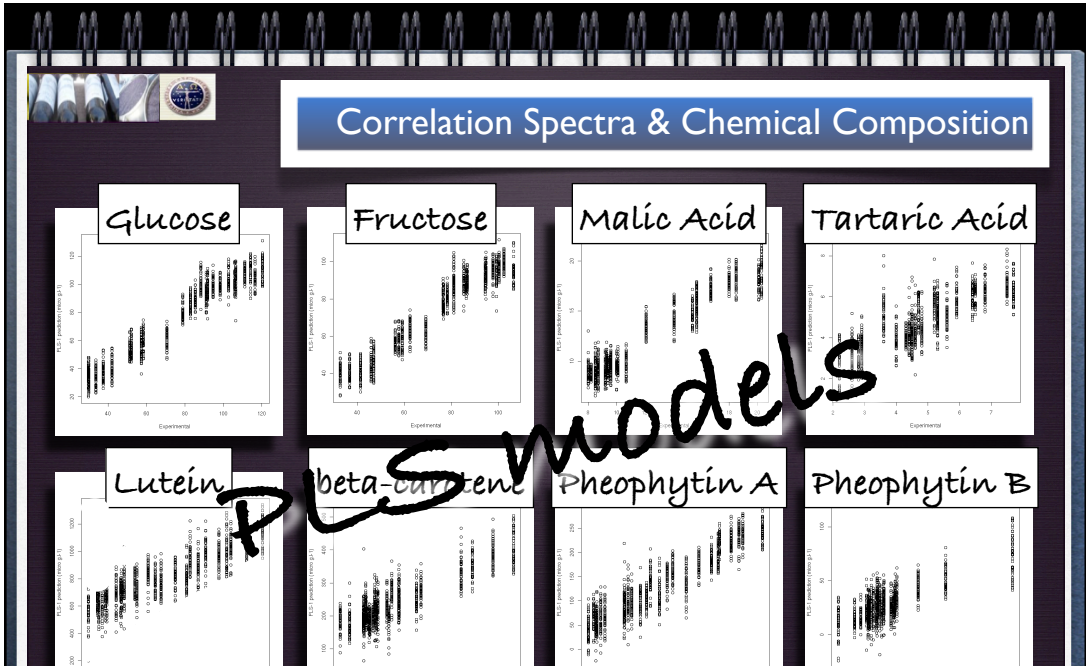
26-July

09-August

23-August

30-August


Correlation Spectra & Chemical Composition
Relevant Metabolites:
Glucose
Organic Acids
Lutein
beta - Carotenes
Clorophyll
Pheophytins
Antocyanins
"Combined fraction"
[Y]
Chemical
[1 x 1]
Correlated Variance
Metabolic Composition
The Metabolic Fingerprints


Correlation Spectra & Chemical Composition
Glucose
Fructose
Malic Acid
Tartaric Acid
Lutein
beta-Carotene
Pheophytin A
Pheophytin B
PLS models

Correlation Spectra & Chemical Composition

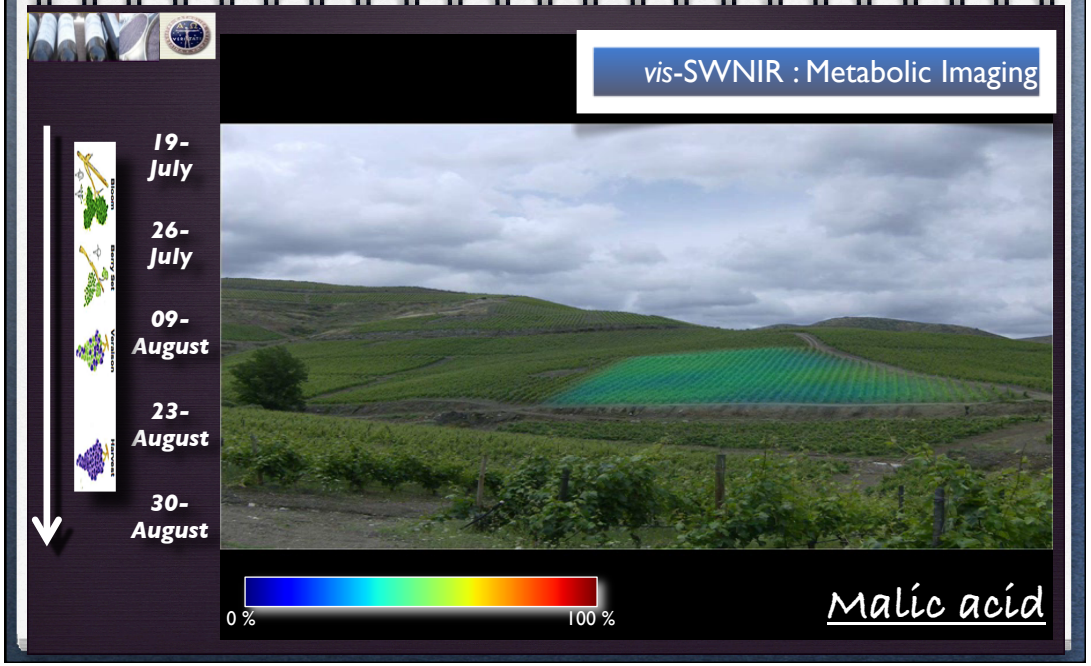
$$[Y] = \begin{bmatrix} F_{1x} \\ F_{1y} \\ F_{2x} \\ F_{2y} \\ \cdots \\ F_{5x} \\ F_{5y} \\ F_{6x} \\ F_{6y} \end{bmatrix}$$

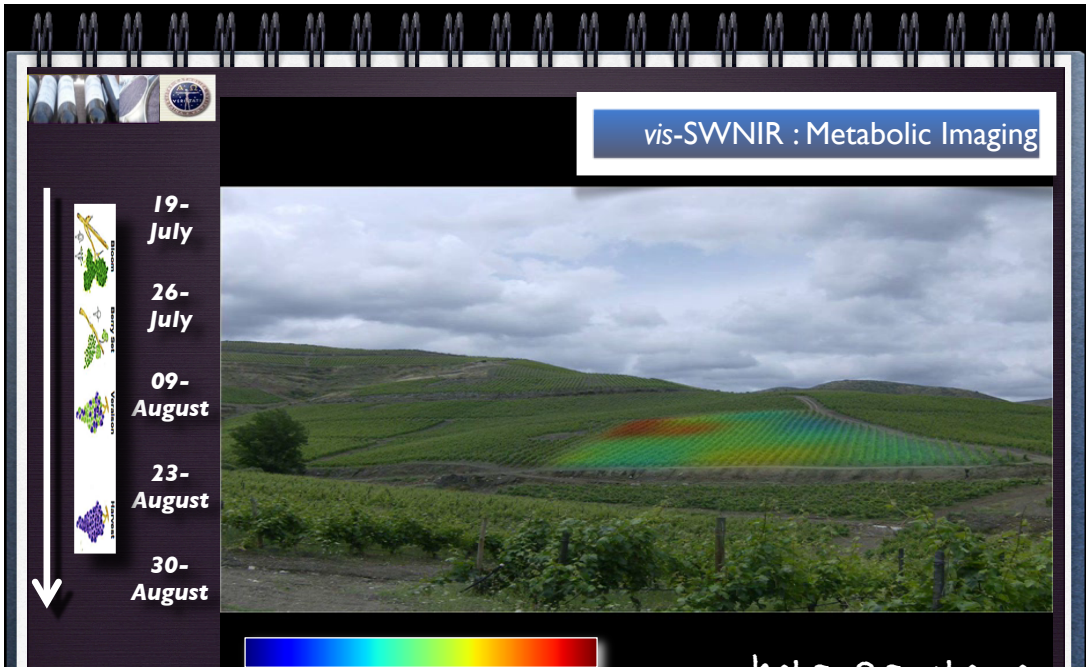
Correlated Variance

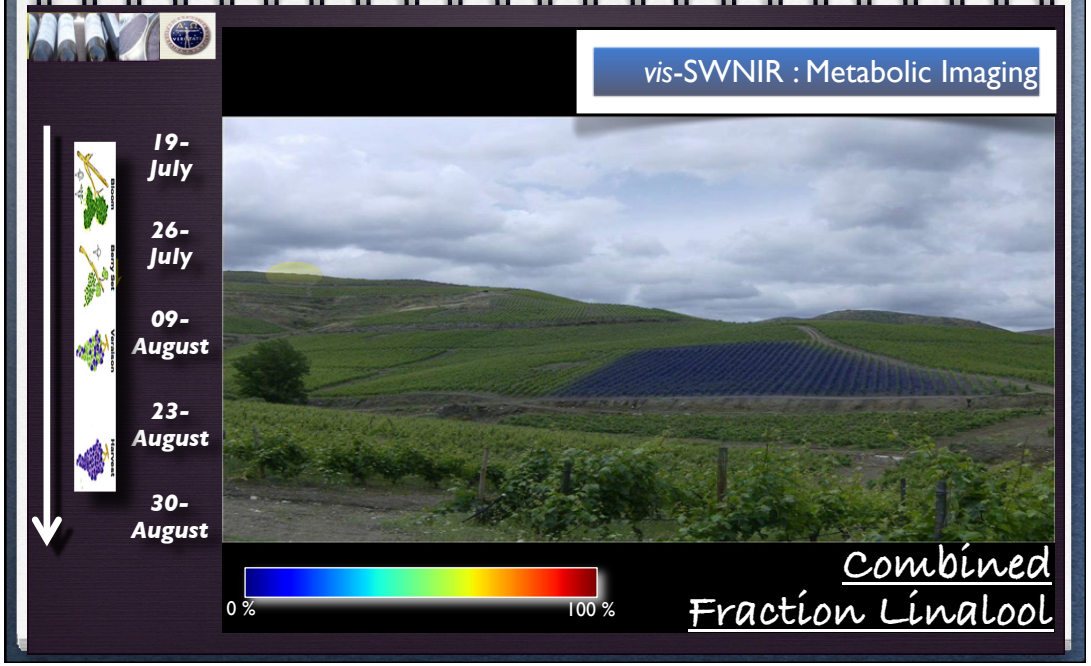
[Correlated Feature Space Coordinates] x [Co-variance Coordinates]

Rendering a Co-Variance Image for Managing Grape Maturation !!!

vis-SWNIR : Metabolic Imaging


vis-SWNIR : Metabolic Imaging
19-July
26-July
09-August
23-August
30-August
0 %
100 %
Malic acid


vis-SWNIR : Metabolic Imaging
19-July
26-July
09-August
23-August
30-August



Conclusion

- Non destructive Spectroscopy techniques coupled with signal processing are ideal tools for management of "grape quality" ;
- Non targeted approach enables the "glass to vineyard" sensory perspective ;

3. Hyperspectral monitoring allows optimization and consistence in final wine quality.