NIRS measurement at field level to measure rubber and resin content of guayule plants

(AAIC,Rochester,NY 24-28 sept. 2016)

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3 BONSAÏ ADVANCED TECHNOLOGIES // Distribution exclusive ASD & HEADWALL France

CONTENT

- Research activities on Guayule at CIRAD/UR Biowooeb
- Materials and Methods
- Résults
- Conclusion & Perspectives

Interest of NIRS measurement applied to guayule resins and rubber quantification

- Help geneticians for the search of most performing lines of guayule plants,
- Follow up field production and best time to harvest,
- Fast and accurate determination of rubber and resins production per hectare

CIRAD ACTIVITIES ON GUAYULE IN FRANCE

- Planting in Lansargues-Mauguio (2014) and Claira-Perpignan (2013). Follow-up EU-PEARLS guayule experimental field in Cartagena. Seeds collection.

- EUNARS-G commitment (2014) with ETRMA/WUR/CTTM/VERSALIS/MAPA with a target to replace 10% of NR imports from Asia (120.000 T.) by GR (200.000 ha) by 2030.

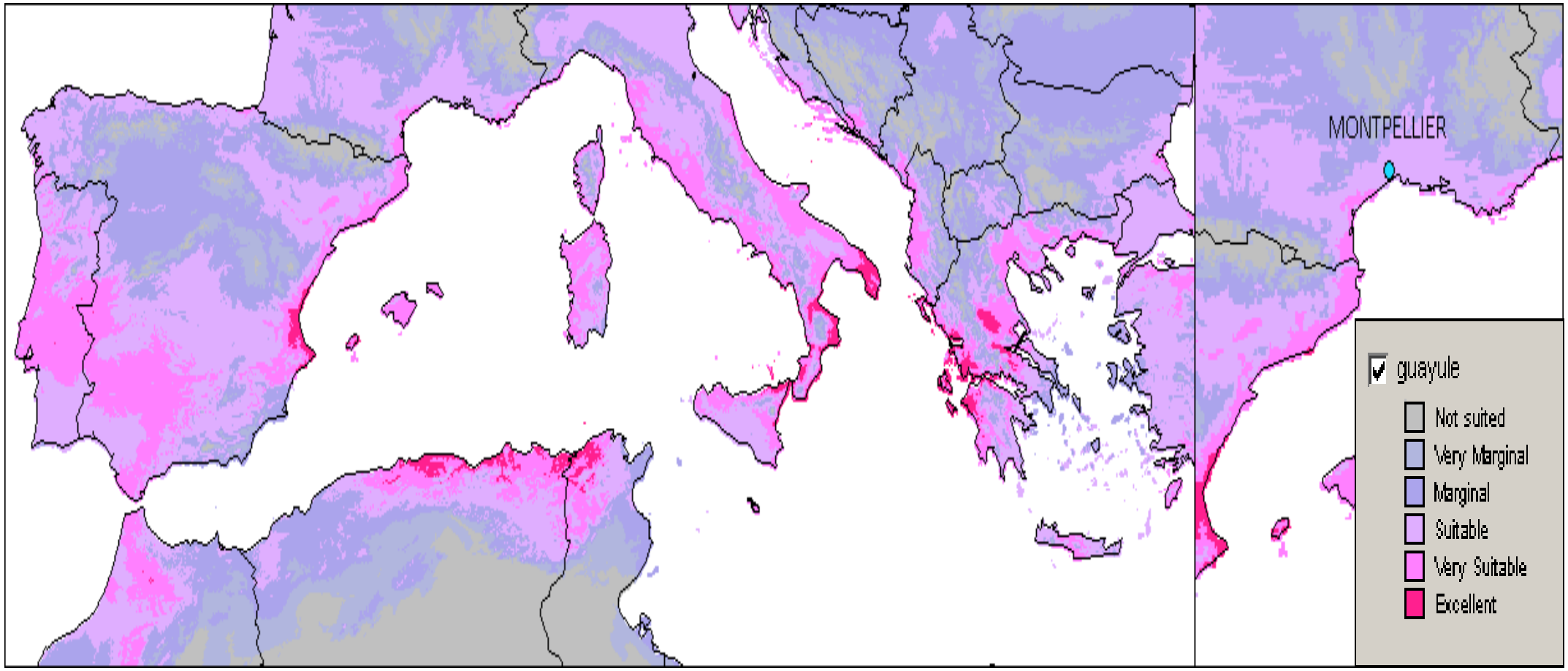
- Fast Track Innovation (FTI) project proposal (October 2016) : guayule planting (5-10 ha) in Andalucia/Huelva,Spain; building of a latex and resins extraction guayule pilot plant in 2017.

- FEADER (EU & LR regional funded) project with more guayule planting in France (>2ha) on four locations with farmers in South of France (LR and PO).

- Extension of guayule cultivation in Tunisia and Morocco (2017).

GUAYULE (*Parthenium argentatum*)

- Guayule is adapted to Mediterranean climate (South of EU and North of Africa)



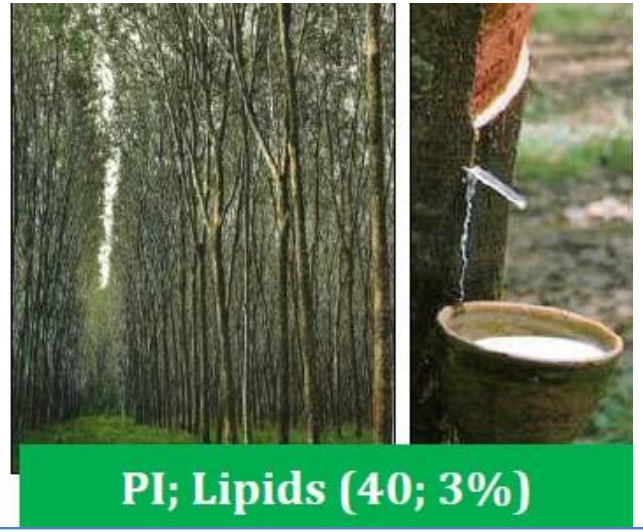
UR BIOWOOEB

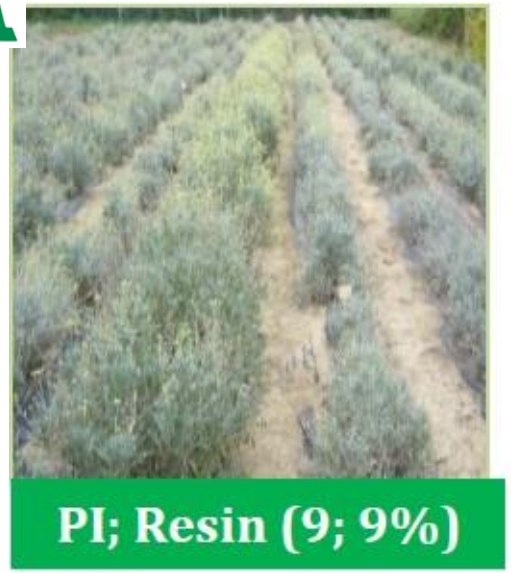
Lansargues/Mauguio
France
(2014)

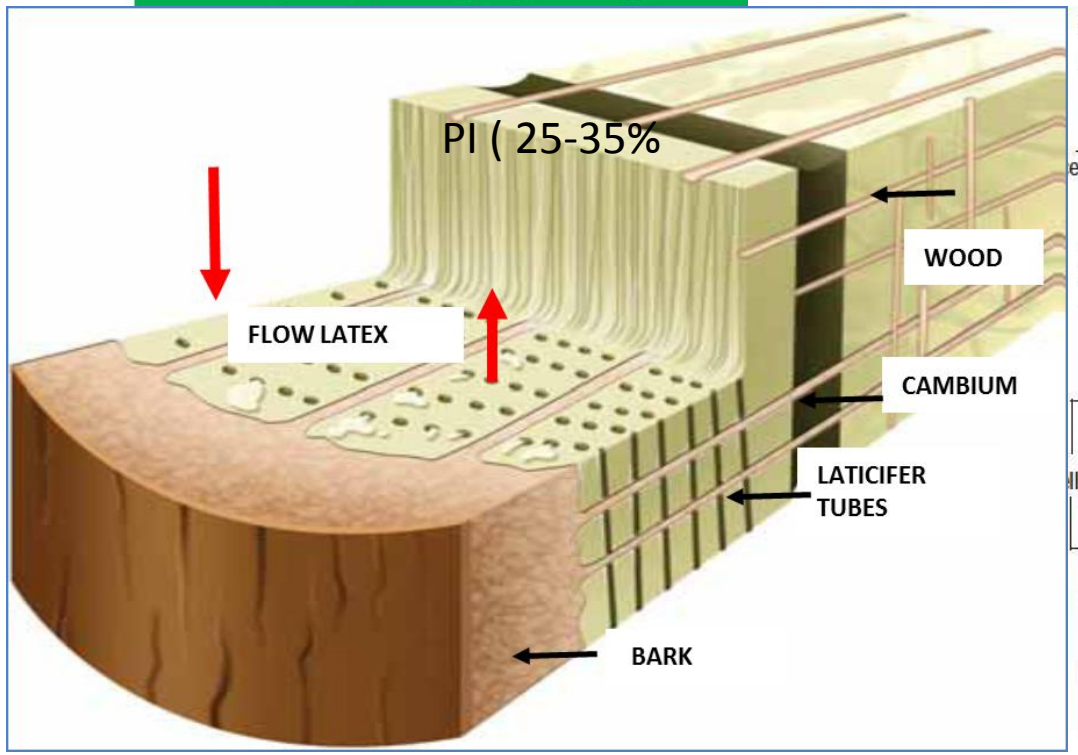
Cartagena/Spain
(EU-PEARLS)
2009

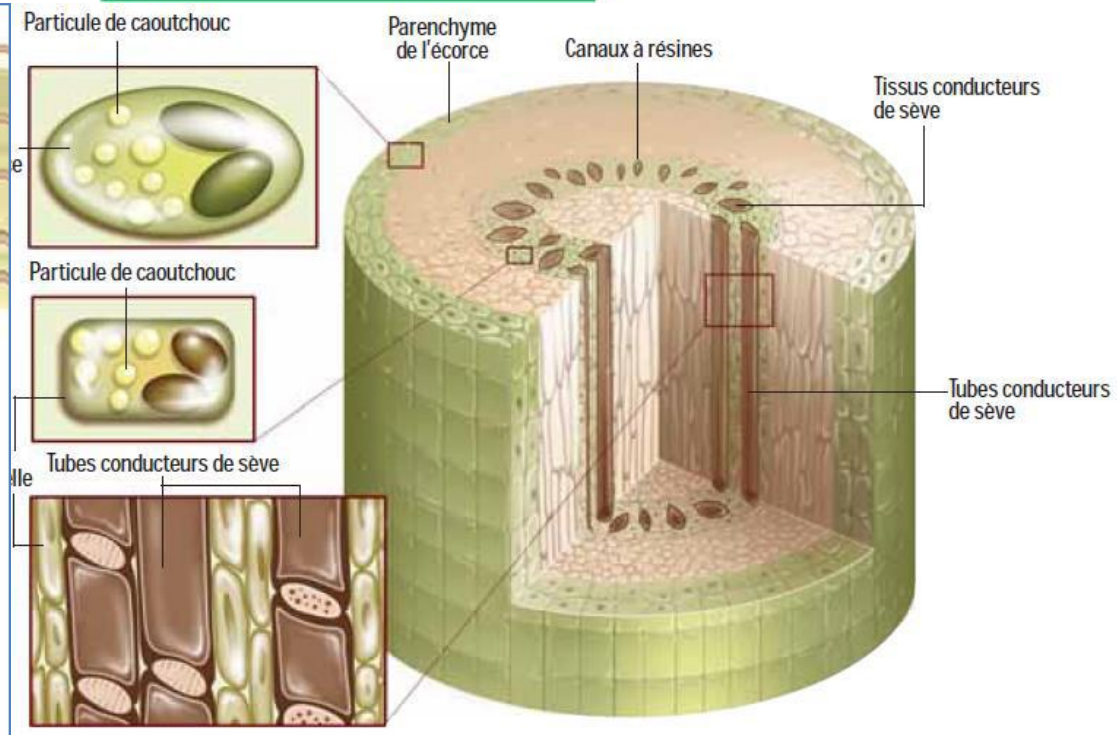
Claira/Perpignan
France
(2012)

UR BIOWOOEB


PI; Lipids (40; 3%)


PI; Resin (9; 9%)


PI (25-35%
FLOW LATEX
WOOD
CAMBIUM
LATICIFER TUBES
BARK


Particule de caoutchouc
Parenchyme de l'écorce
Canaux à résines
Tissus conducteurs de sève
Particule de caoutchouc
Tubes conducteurs de sève
Tubes conducteurs de sève

MATERIALS AND METHODS

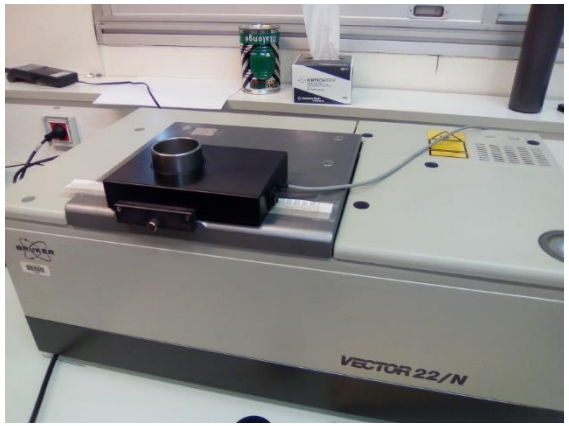
UR BIOWOOEB

TYPE OF EQUIPMENT USED

- **ASE 350 (Dionex/Thermofisher)**

Détermination of a reference method for extraction of resins and PI)

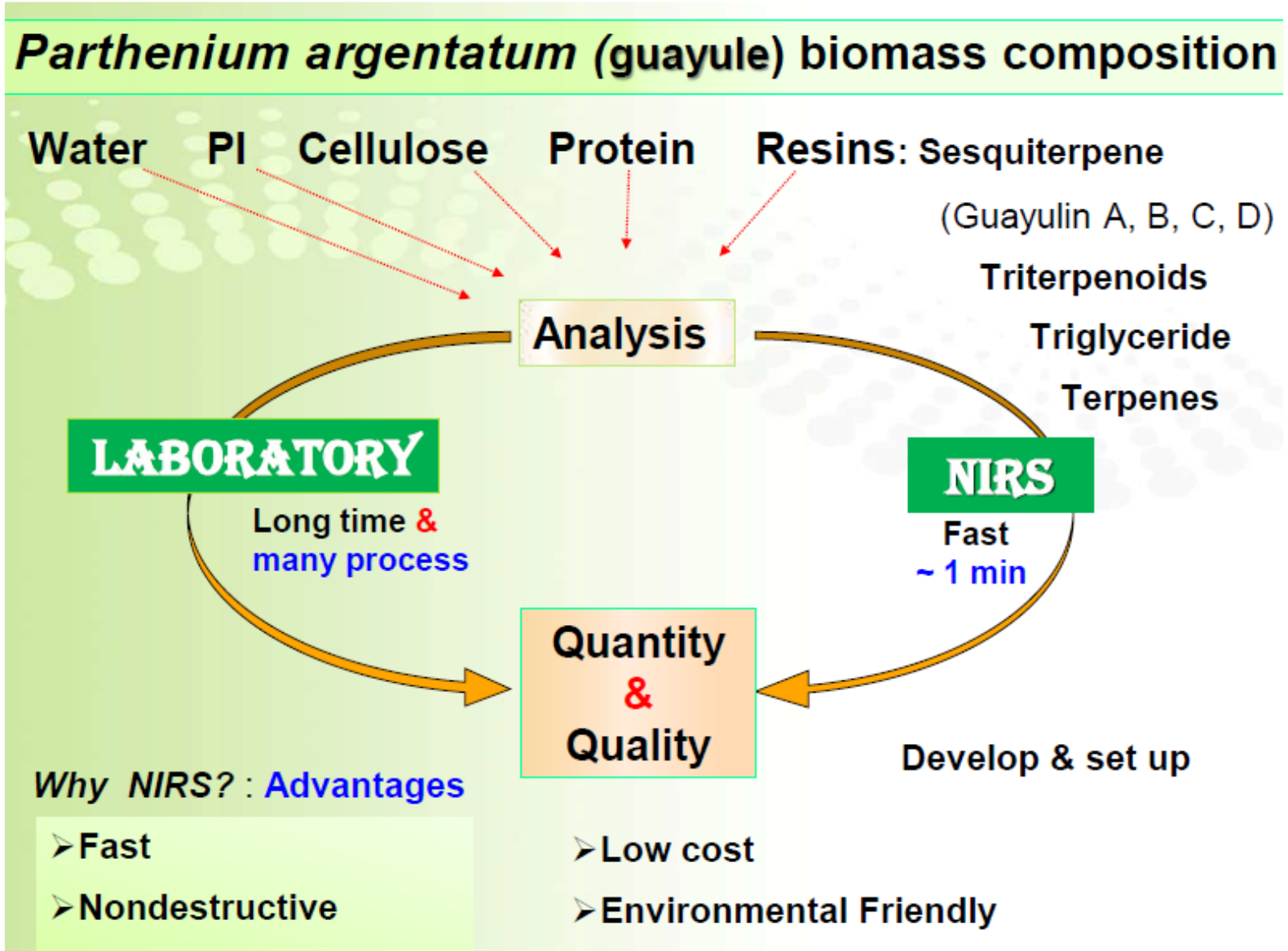
PhD Sunisa SUCHAT (2012)



- **NIRS Laboratory VECTOR V22 (Brucker)**

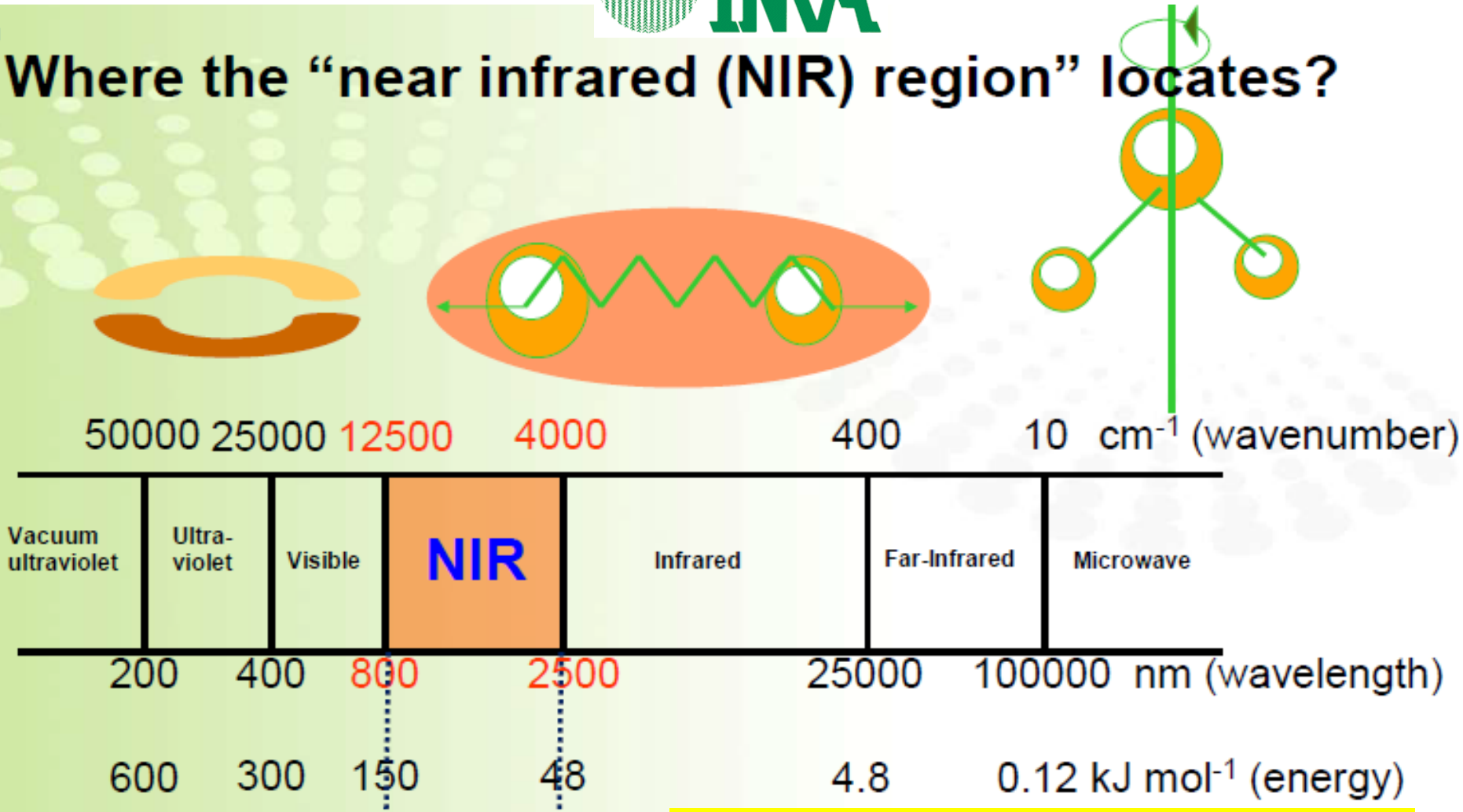
- **NIRS field portable ASD (LabSpec4)**

ADVANTAGES OF NIRS MEASUREMENT



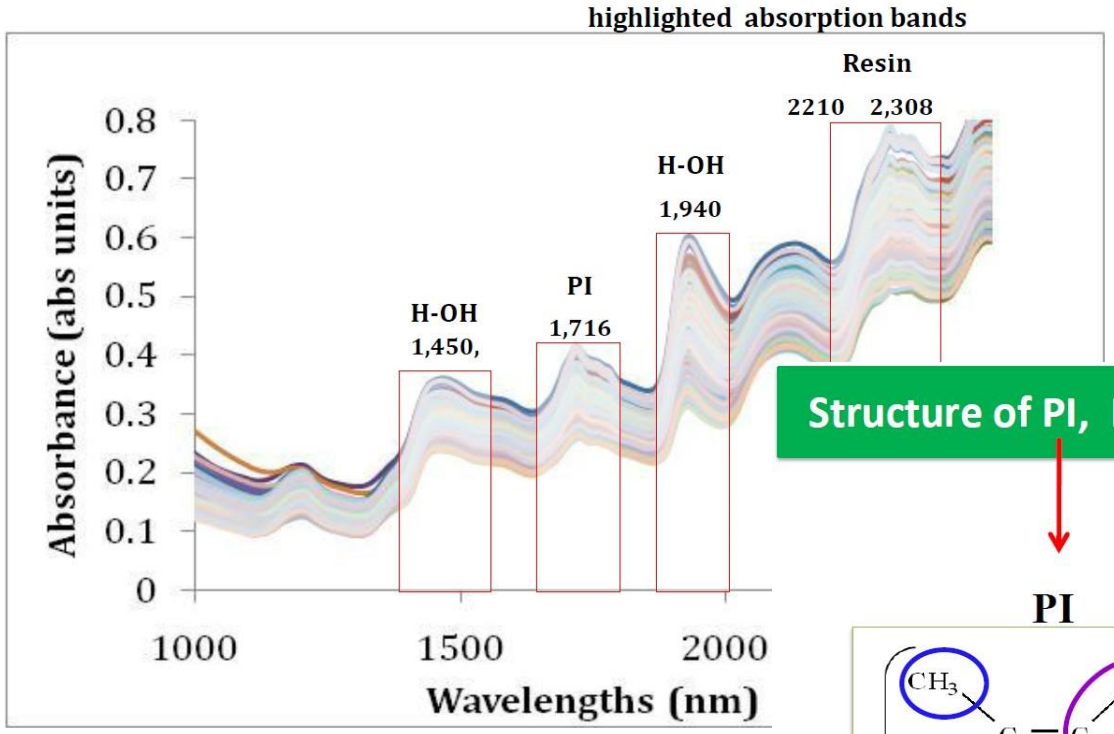
Source Phd Sunisa Suchat

Where the "near infrared (NIR) region" locates?



The NIRS method is based on the Phenomenon that functional groups such as **C-H, N-H and O-H** absorb near infrared light

Interpretation of NIRS spectra



Moisture :

1450 nm /1940 nm

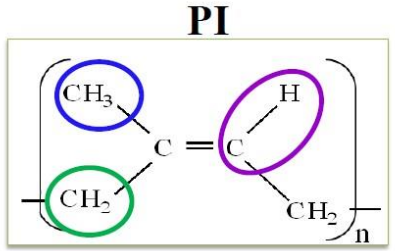
Strain of link O-H of H_2O

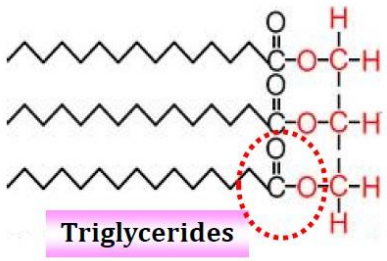
Polyisoprène :

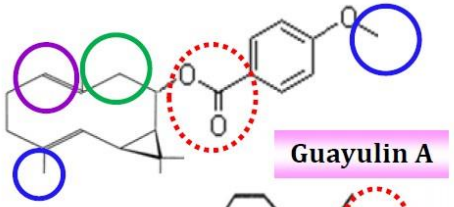
1716 nm

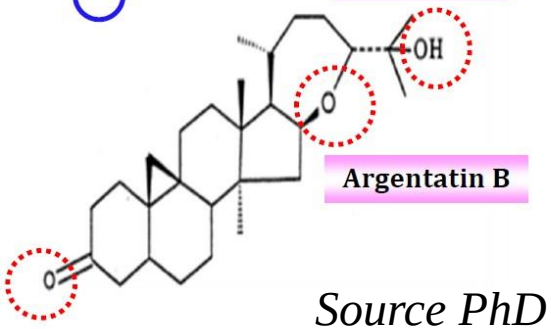
Strain of link C-H of $–CH_3$

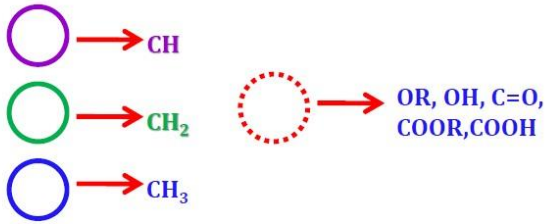
Structure of PI, Resin :











Résines :

2210 nm

Strain of the link –C=O of a carboxyle group

2308 nm

Strain and distorsion of the link –C-H of – CH_2 from a lipid

Source PhD Sunisa Suchat

METHODOLOGY

➢ **Laboratory : (Vector V22 Brucker)**

- Branches samples dried (moisture < 9%) and size particles<500µm)
- Scan reflectance mode : 400nm à 2500nm (interval 2nm)
- Average of 32 spectra with correction of light dispersion
- Calculation of seconde derivative for 5 points polynomial lissage
- PLS regression used to establish calibration curves
- SECV calculation with predicton on 25% of samples with a calibration developed with 75% remaining samples

➢ **Field and Laboratory : (ASD Labspec4)**

- Use of a reflectance probe
- 5 spectra per branche and 10 branches per plant , or 50 spectra per plant

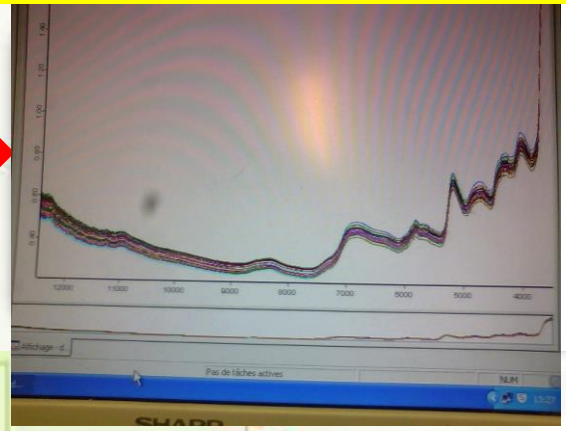
TOTAL: 70 branches selected or 350 NIRS measurements at field level to establish a model LAB NIRS /FIELD NIRS.

PRINCIPLE OF NIRS MEASUREMENT

Guayule sample
0.5mm Ground

1. NIRS analysis

Lab
Vector V22
Brucker



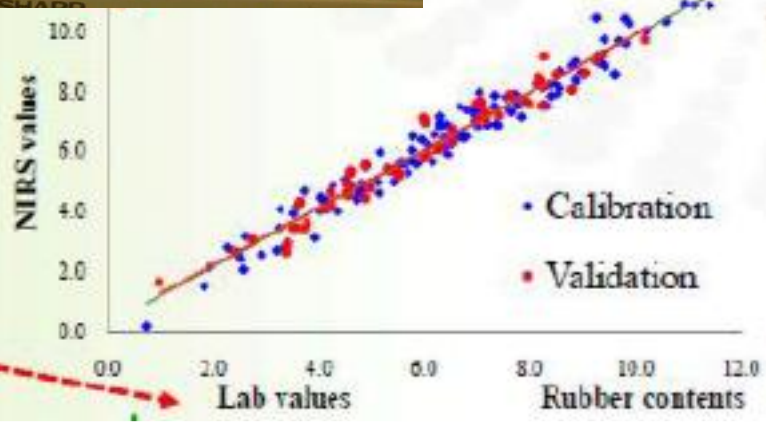
2.NIRS Field
+ 3. NIRS lab
Portable ASD (LabSpec4)

4.ASD (Dionex)

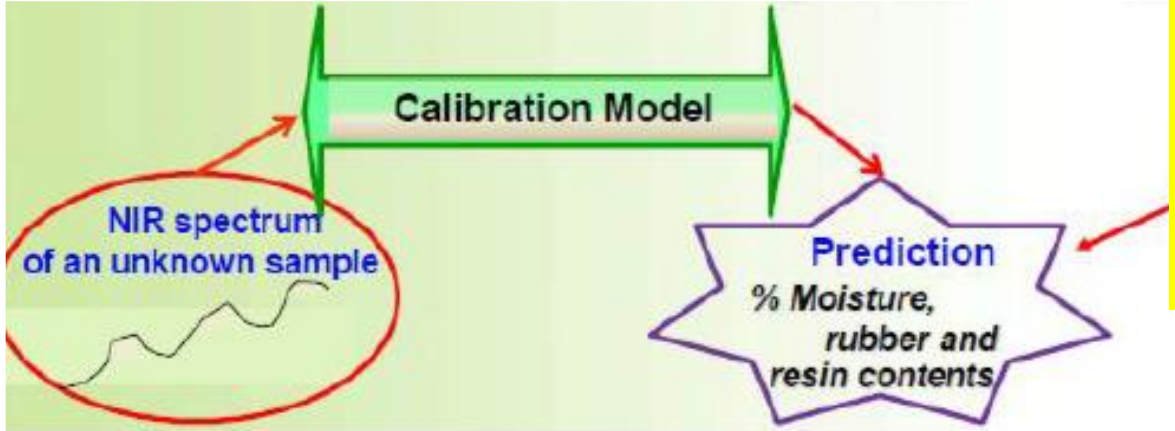
2. Reference Lab data

Extraction

Quantified by Gravimetry



5.Mathematical analysis



6. Calibration Equation, Validation

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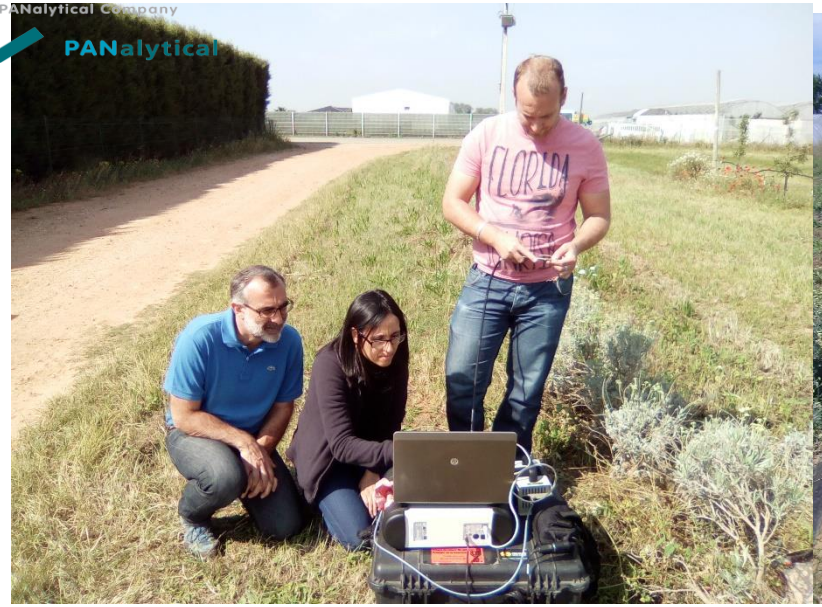

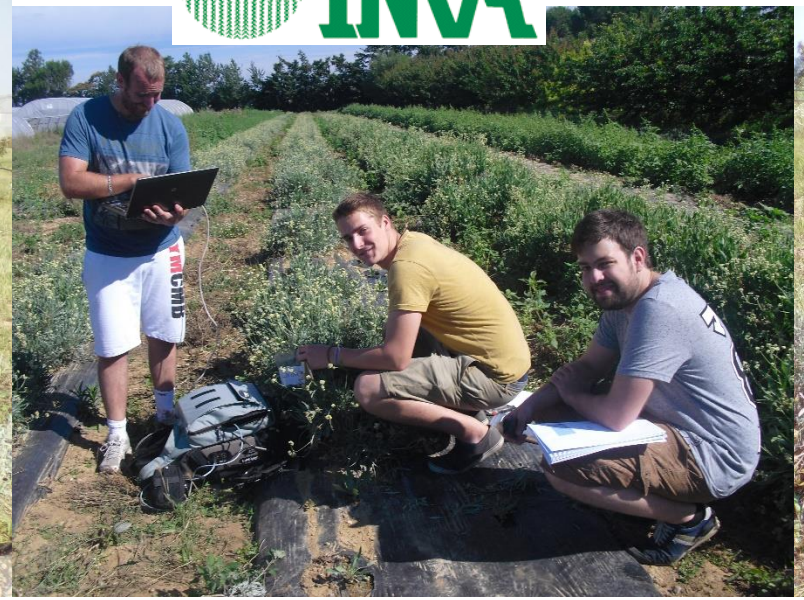

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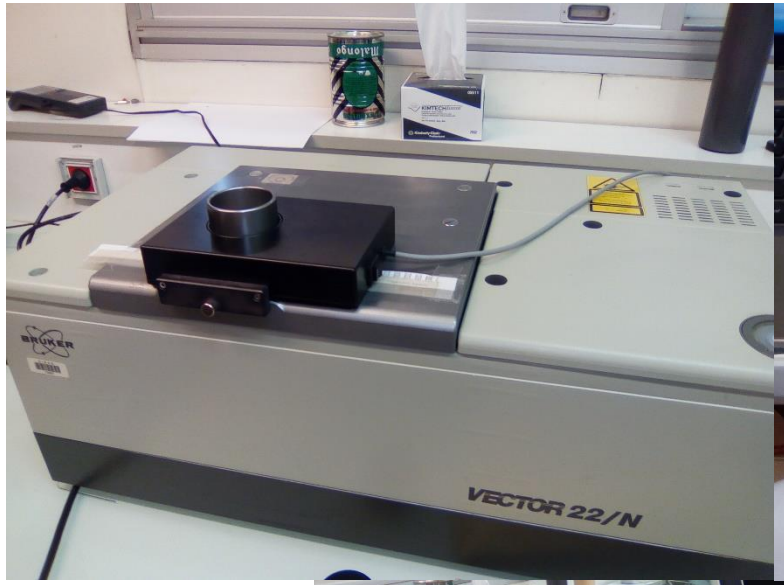
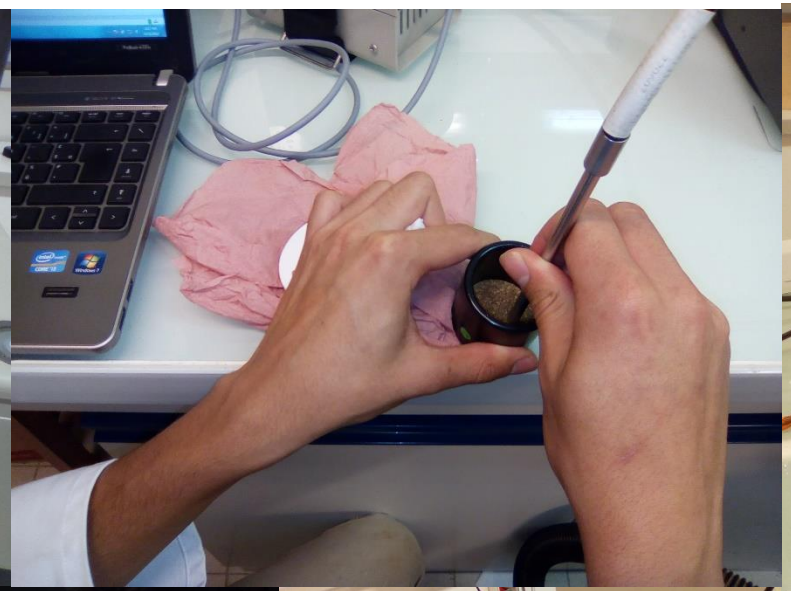
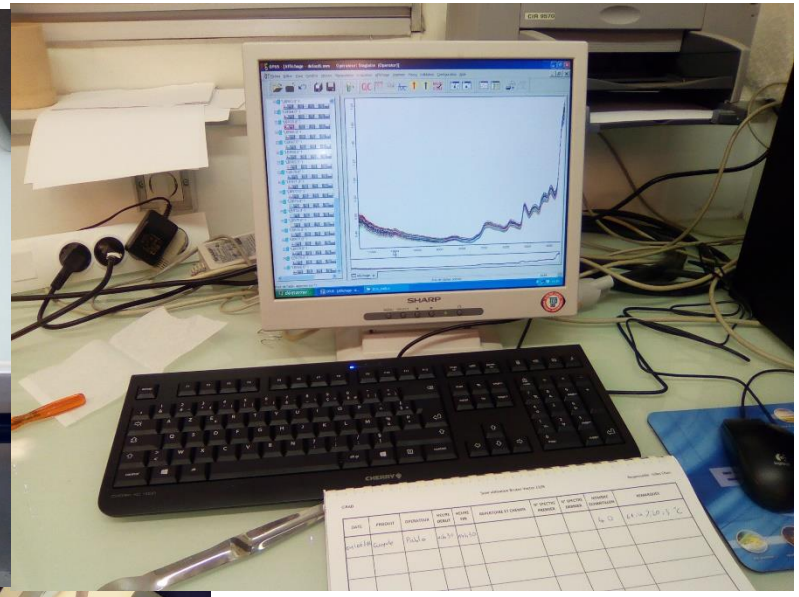
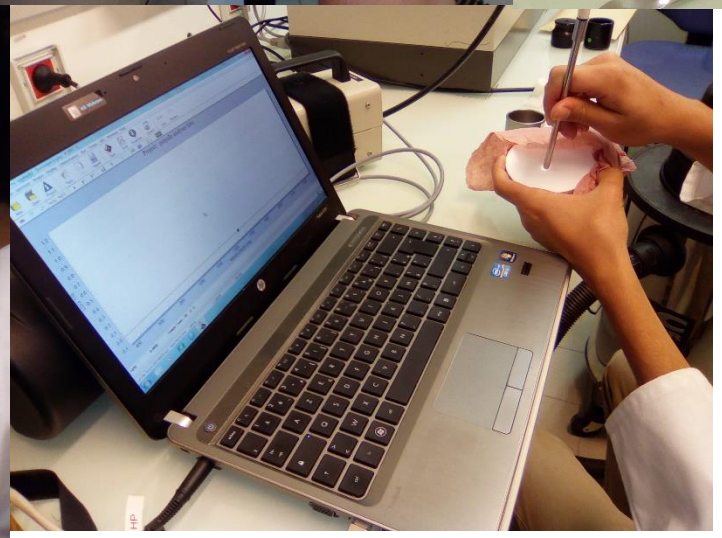
cirad









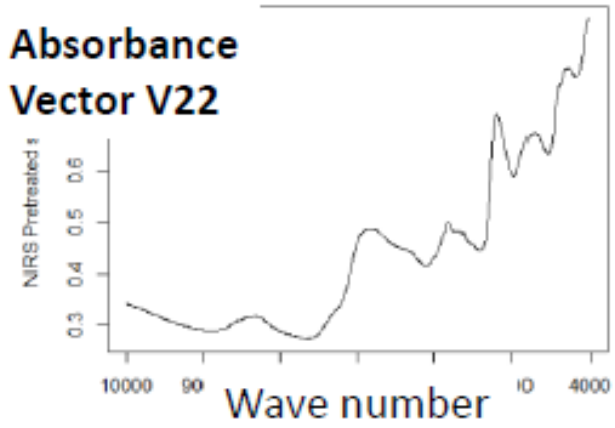
RESULTS

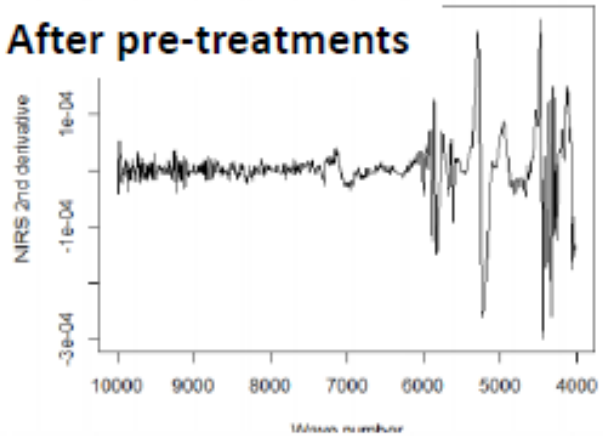
PRE-TREATMENTS OF SPECTRA

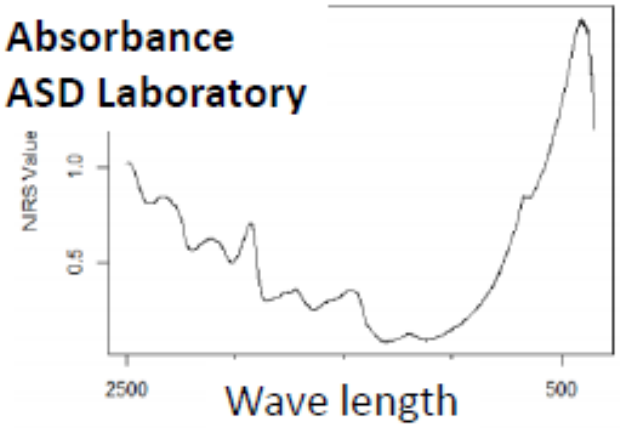
- To correct scaling differences coming from pathlength effects, scattering effects, source or detector variations, or other general instrumental sensitivity effects: SNV (standard normal variate) and Detrend
- To reduce scatter effects by removing a linear baseline shift: Second derivative (5 points polynomial)

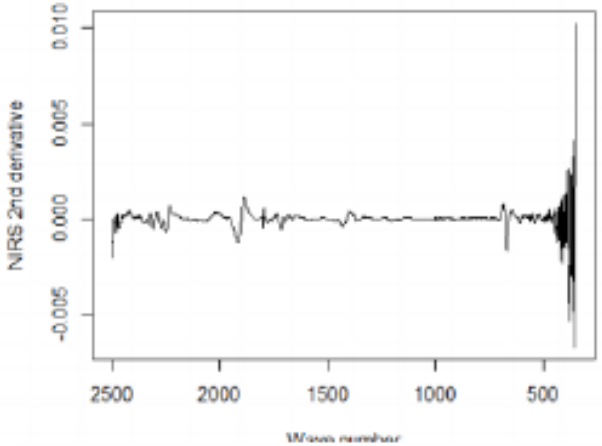
➢ Different absorbance curves between Nirs apparatus: Vector and ASD.

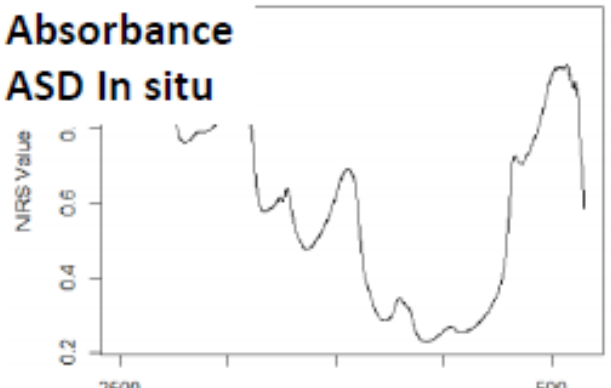
➢ Difference in spectra between laboratory measurements and field measurements with ASD.

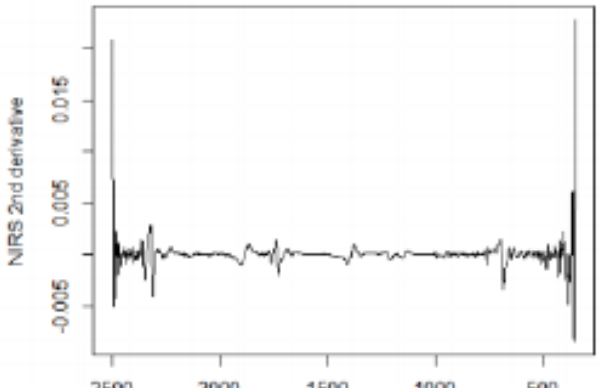












UR BIOWOOEB

Calibration and validation: RESIN

Resin content between 4% to 12%

Vector V22

- 206 samples, $R^2 = 0.96$
- Error of cross validation: RMSECV = 0.81

⇒ Resin content = predicted value ± 0.81

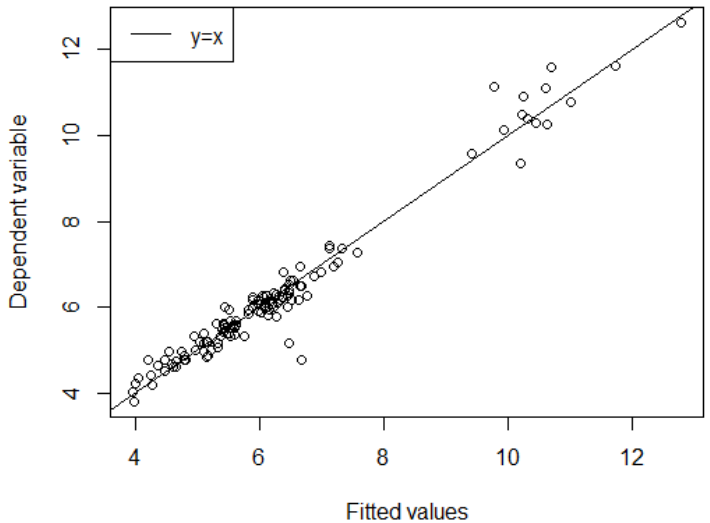
ASD Laboratory

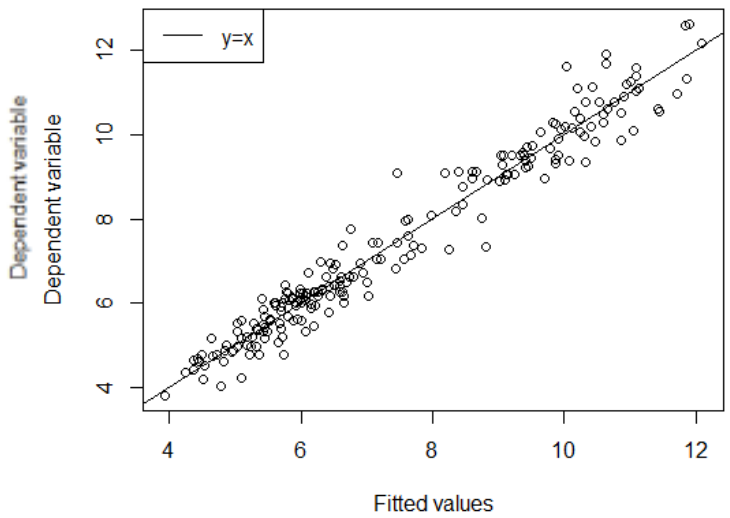
- 123 samples, $R^2 = 0.96$, RMSECV = 0.77

ASD In situ

- 123 samples, $R^2 = 0.96$, RMSECV = 0.85

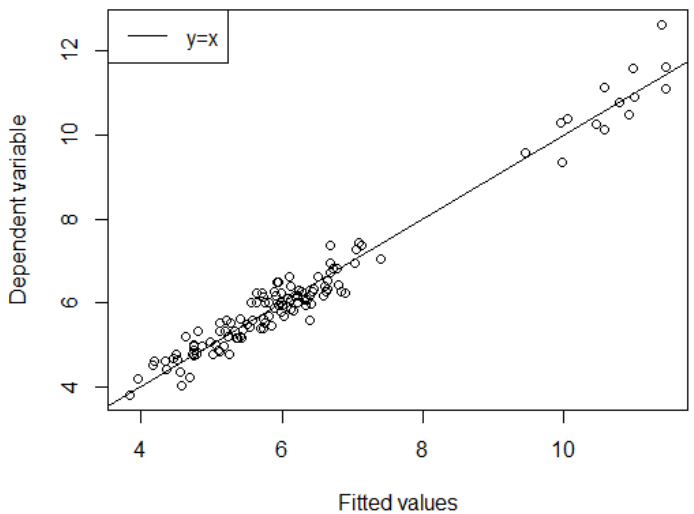
Vector V22





ASD Laboratory

ASD In situ



UR BIOWOOEB

Calibration and validation: POLYISOPRENE

Polyisoprene content between 3% to 10%

Vector V22

- 174 samples, $R^2 = 0.82$
- Error of cross validation: RMSECV = 1.03

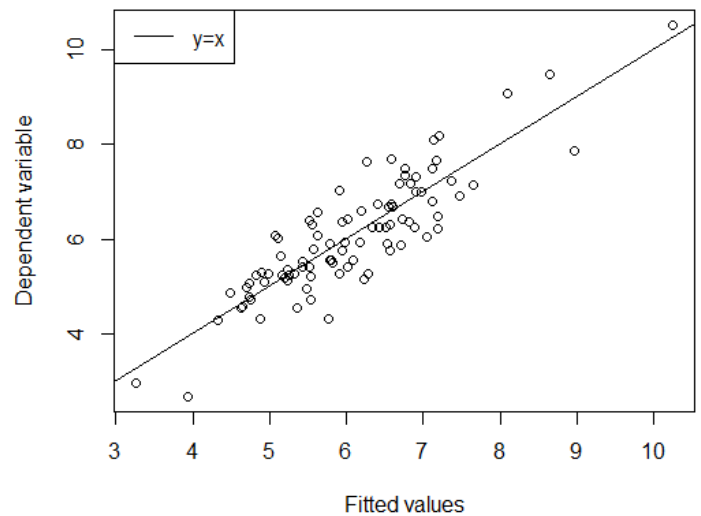
ASD Laboratory

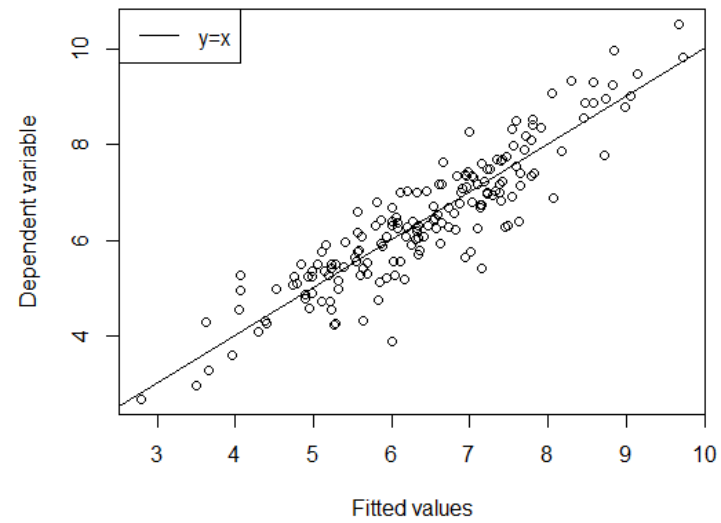
- 91 samples, $R^2 = 0.77$, RMSECV = 0.83

ASD In situ

- 91 samples, $R^2 = 0.89$, RMSECV = 1.24

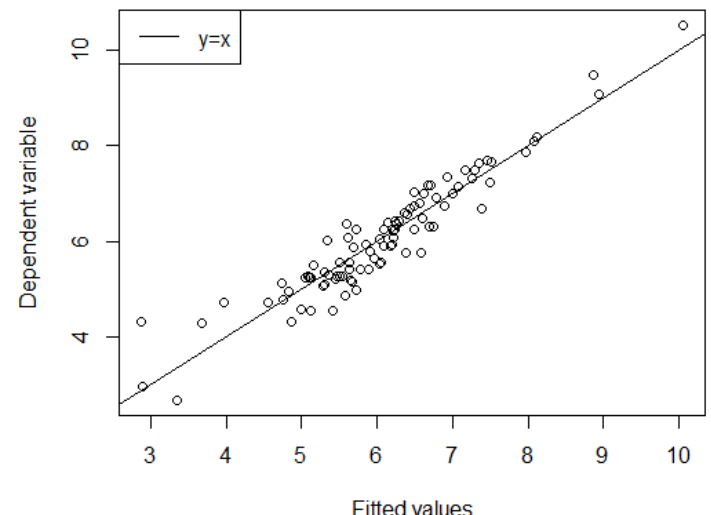
Vector V22





ASD Laboratory

ASD In situ



SUMMARY

- Identical results for the resin content: same R^2 0.96 with an error of about 0.80
- Efficiency of models for polyisoprene is less than those for resin: R^2 between 0.77 to 0.89 with an error between 0.8 to 1.2
- Polyisoprene models built with a low number of samples, and/or the reference values with ASE 350 are difficult to assess

	Number of samples	Model variables	Calibration	Cross validation
Vector V22	N	LV	R^2C	RMSECV
Resin	206	5	0.96	0.81
Polyisoprene	174	4	0.82	1.03
ASD Labo				
Resin	123	7	0.96	0.77
Polyisoprene	91	3	0.77	0.83
ASD InSitu				
Resin	123	7	0.96	0.85
Polyisoprene	91	6	0.89	1.24

CONCLUSION & PERSPECTIVES

- Capability to determine by NIRS measurement , guayule resin content directly by field mesurement (non destructive and fast determination);
- Uncertainity of determination of ±0.8 for a resin content range of 4% to 12%;
- Model for polyisoprene less efficient with an uncertainity of 1,2% for a rubber content range of 3% to 10%;
- Need to increase the number of measurements to improve the data base and to build more powerful models;
- Need to investigate the best area of NIRS measurement on a guayule plant, the ffect of seasonality on NIRS measurement, the relationship between the depth of NIRS measurement and the presence of polyisoprene.