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Monitoring the pregnancy status of dairy cows using mid-infrared spectra of milk collected from milk recording

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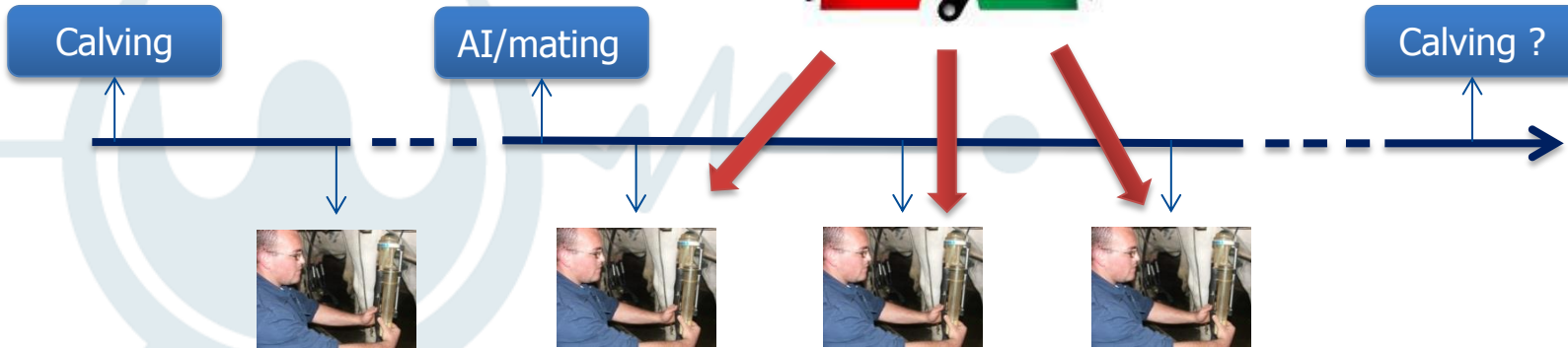


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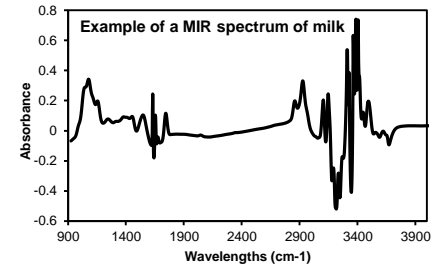
A pregnancy diagnosis ?



Monitoring of the pregnancy along the lactation



Using the monthly milk recording data ...



Mid-infrared spectrum of milk is a fingerprint of the milk composition

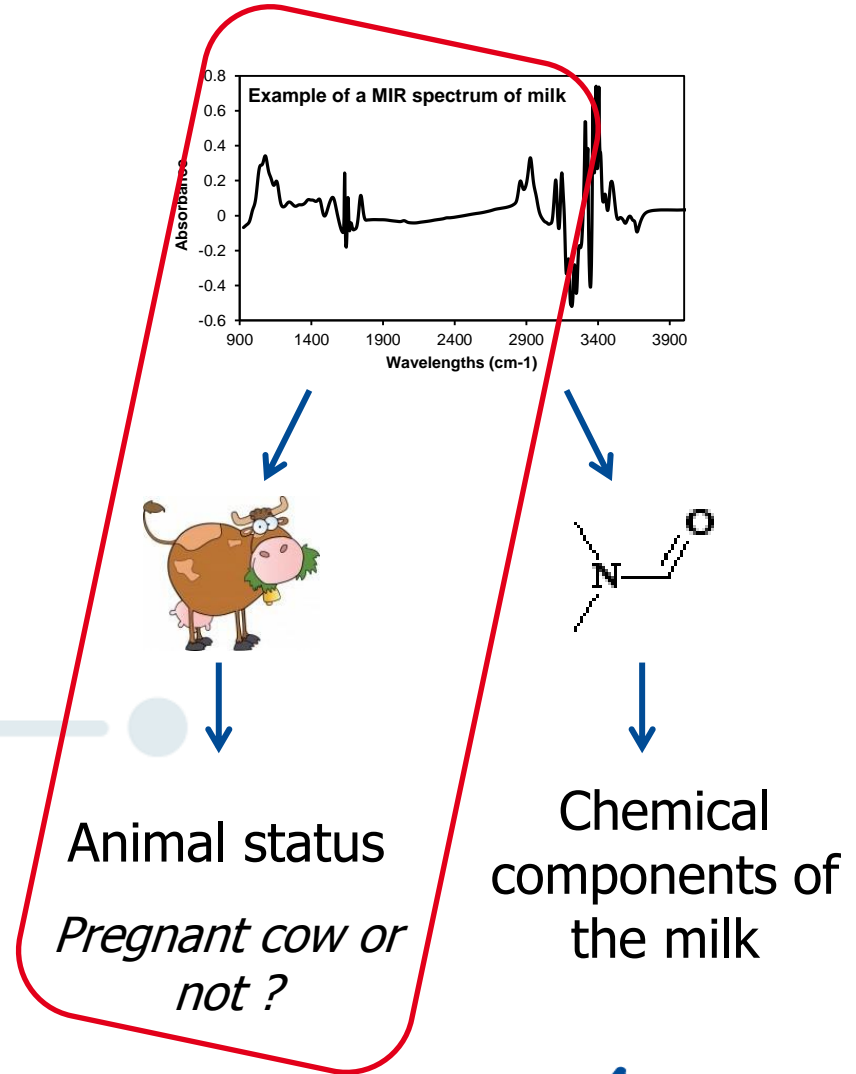
Spectra collected and stored routinely

Rapid, inexpensive and non-destructive method which is widely used

Allow for a large scale sampling

... not so easy !

1. High correlations between some wavenumbers of the spectra
2. Milk composition is influenced by several different effects and the pregnancy status is probably not the main one
3. The pregnancy status is highly linked with the lactation stage



Dealing with drawbacks by modelling them

1. High correlations between some wavenumbers of the spectra
2. Milk composition is influenced by several different effects and the pregnancy status is probably not the main one
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Transformation of wavenumbers by PCA



Estimation of various fixed and random effect for each PCs



Introduction of days in milk in the model using polynomial Legendre



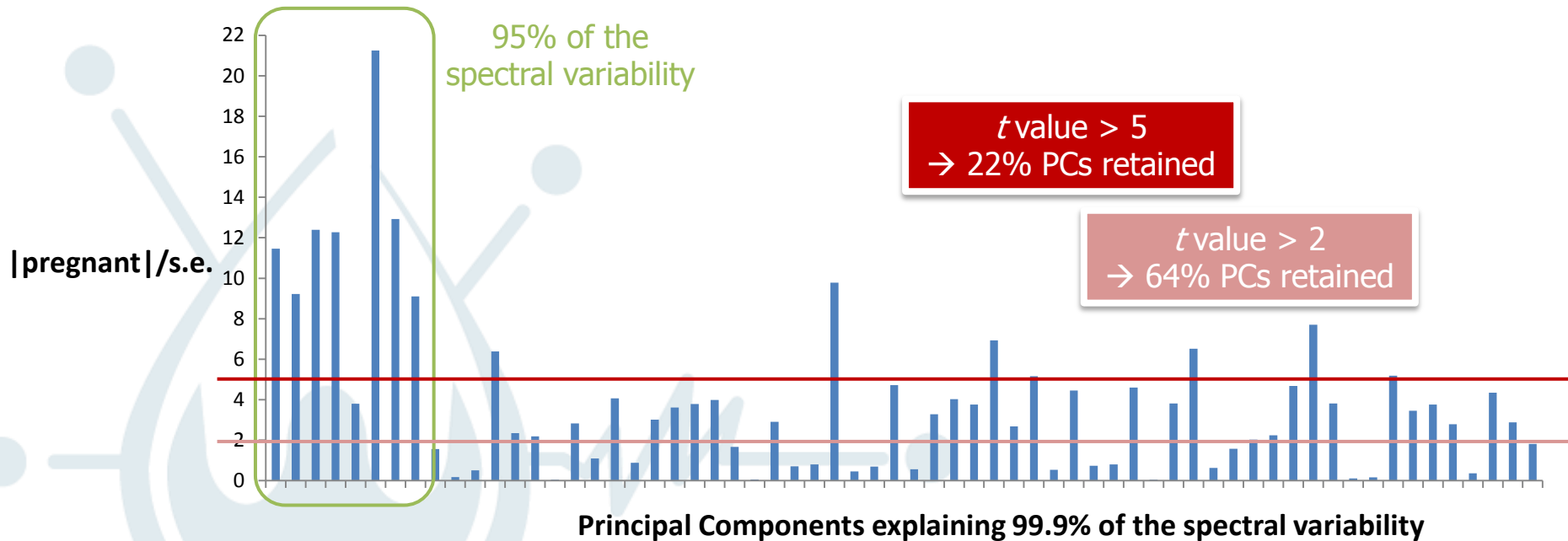
Dealing with drawbacks by modelling them

1st lactations of Holstein cows over the
last 3 years of records in the Walloon
Region of Belgium → 40,990 spectra

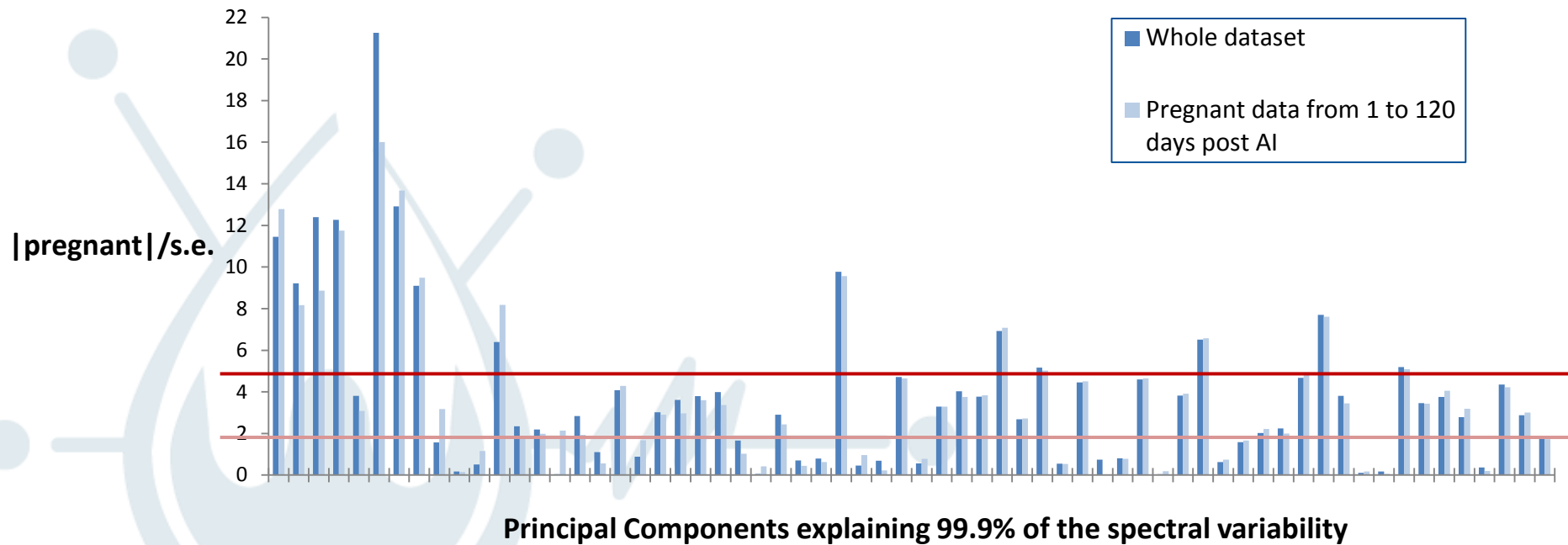
$$\hat{y} = \text{milking moment} + \text{month of TD} + \text{pregnancy status} + 2^{\text{nd}} \text{ Legendre} \\ + 3^{\text{th}} \text{ Legendre} + \text{animal} + 2^{\text{nd}} \text{ Legendre} * \text{animal} + 3^{\text{th}} \text{ Legendre} * \text{animal}$$

**What is the impact of
the pregnancy on the
spectra ?**

Significant impact of the pregnancy status on MIR spectra

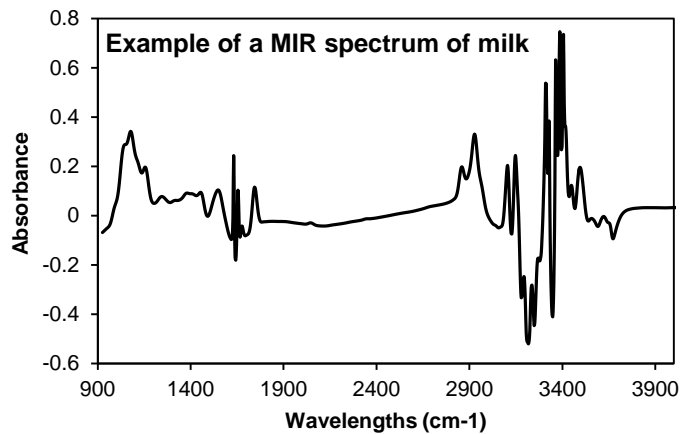


Significant impact of the pregnancy status on MIR spectra



Same trends are observed when only pregnant data from 1 to 120 days post-insemination are considered to model the pregnant effect

From theoretical concerns to a practical tool for farmers

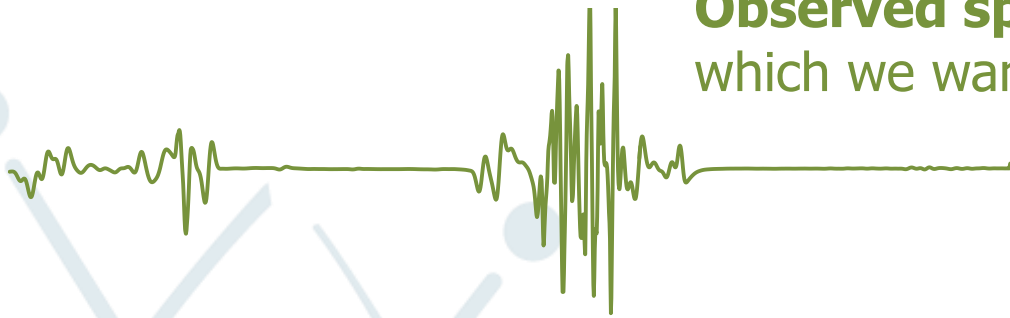


Pregnant ?

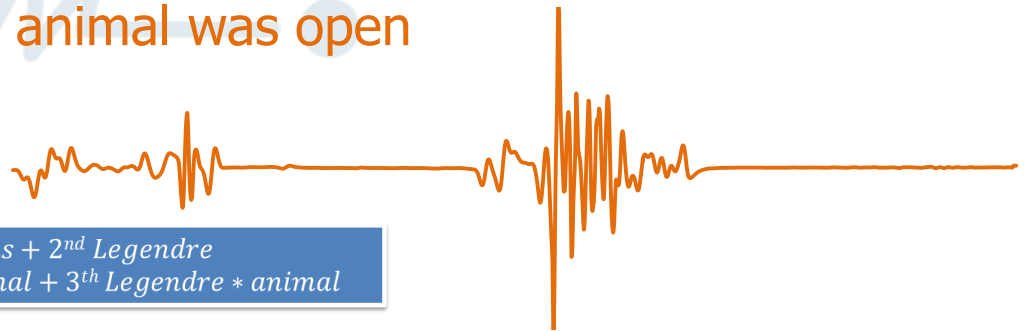


Residual spectra as an image of the pregnancy status

Observed spectrum = Milk sample on which we want to test the pregnancy

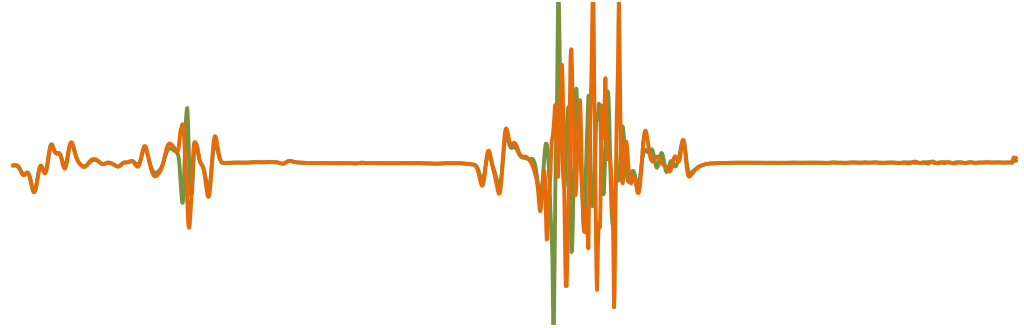


Expected open spectrum = The expected spectrum for the same day in milk if the animal was open

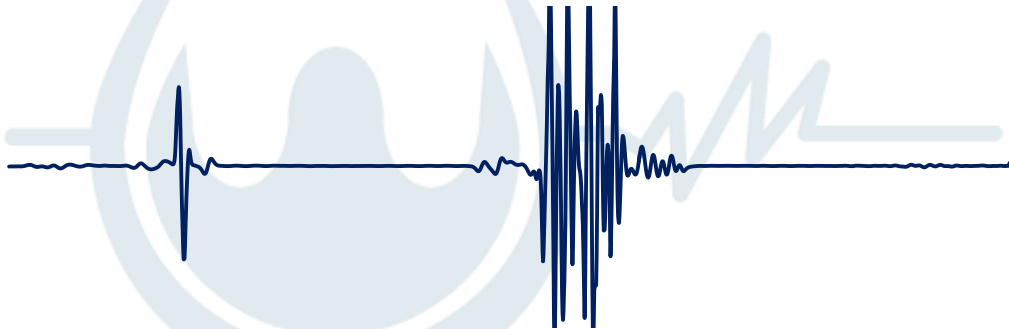


$$\hat{y} = \text{milking moment} + \text{month of TD} + \text{pregnancy status} + 2^{\text{nd}} \text{ Legendre} \\ + 3^{\text{th}} \text{ Legendre} + \text{animal} + 2^{\text{nd}} \text{ Legendre} * \text{animal} + 3^{\text{th}} \text{ Legendre} * \text{animal}$$

Residual spectra as an image of the pregnancy status

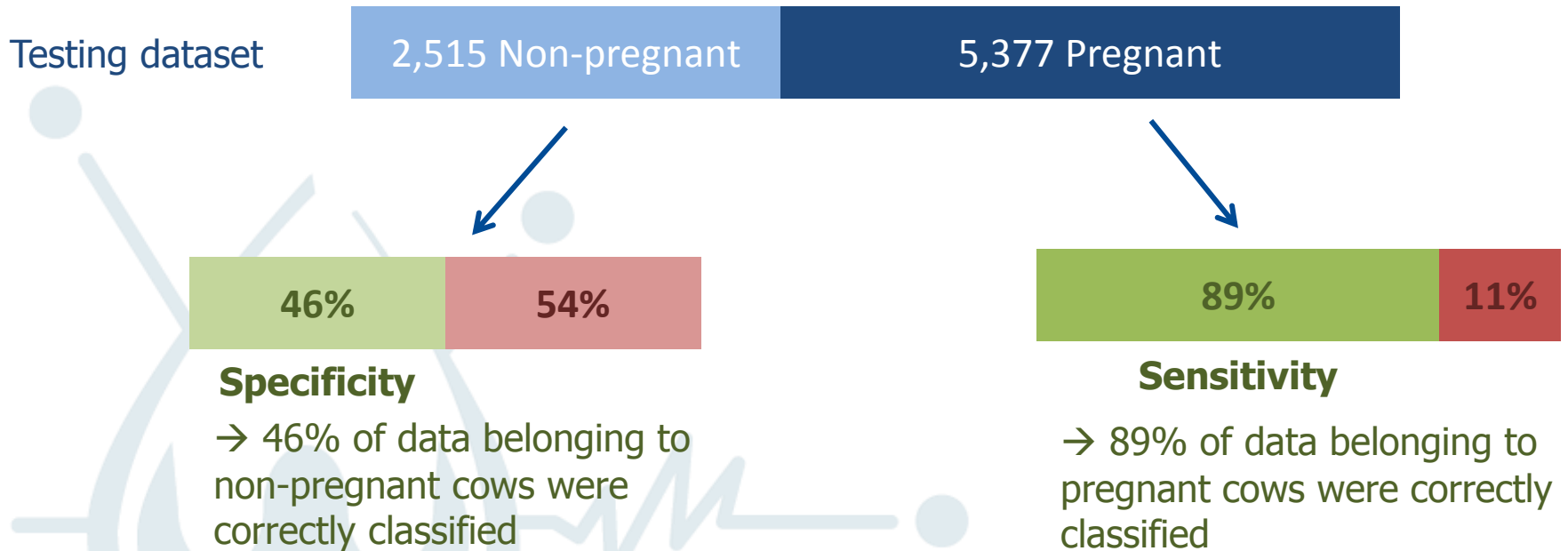


$$\text{Residual spectrum} = \text{Observed spectrum} - \text{Expected open spectrum}$$



Residual spectra are used to perform discrimination between two groups of classification (Pregnant cow and non-pregnant cow)

Applying a logistic regression on residual spectra



Average error rate of classification = 25%

Good perspectives on performances of the tool

Needs for improvement on the detection of non-pregnant cows

Tests on pilot farms are ongoing

Not yet implemented but the strategy is well define

Needs to provide an "useful" information to the farmers



Thanks to a fruitful partnership !



IDF/ISO Analytical Week and
Symposium OptiMIR
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Service Public of Wallonia SPW – DGO3

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Wallonie



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