9 - 13 October 2016, "Bridging the gaps "

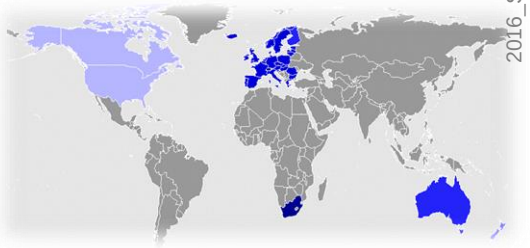
Cigarette Ignition Propensity Requirement Impact of Self-Extinguishment During Smoking on Consumer Exposure

Stéphane Colard & Thomas Verron

Context

Regulation

Implementation of Lower Ignition Propensity (LIP) regulations, e.g. in USA or Europe



Manufacturers

Developed LIP products with narrow paper bands along the tobacco rods with low porosity to restrict coal combustion

Question

What is the impact of self-extinguishment during smoking in natural conditions?

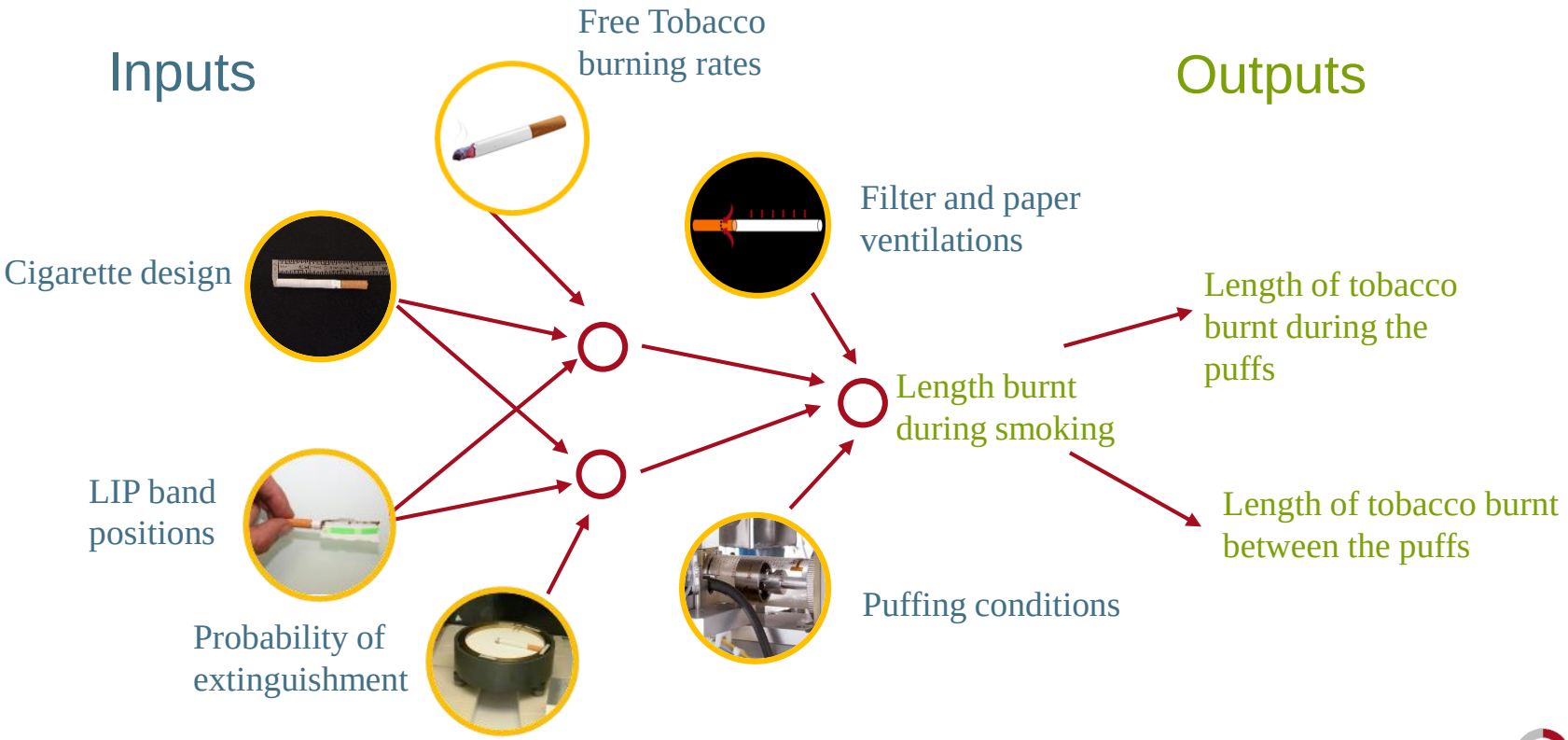
Global objective

To understand better the consequence of relighting the cigarette after it stops burning on the smoke yields the consumer is exposed to.

Part I: To develop a mathematical model reproducing each temporal phases of smoking according some key parameters:

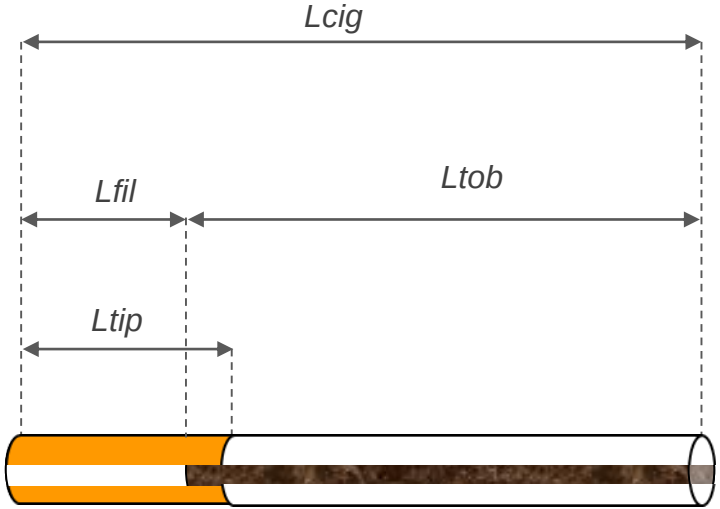
- Tobacco burning rates
- Filter and paper ventilations
- LIP band positions
- Puffing conditions
- Probability of extinguishment on each band

Mathematical model



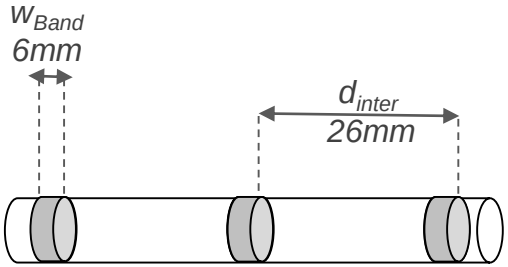
Cigarette design

Parameter	Level/Range
L_{Cig}	83mm
L_{Tip}	25mm
L_{Fil}	21mm
L_{Tob}	62mm
L_{Butt}	25mm

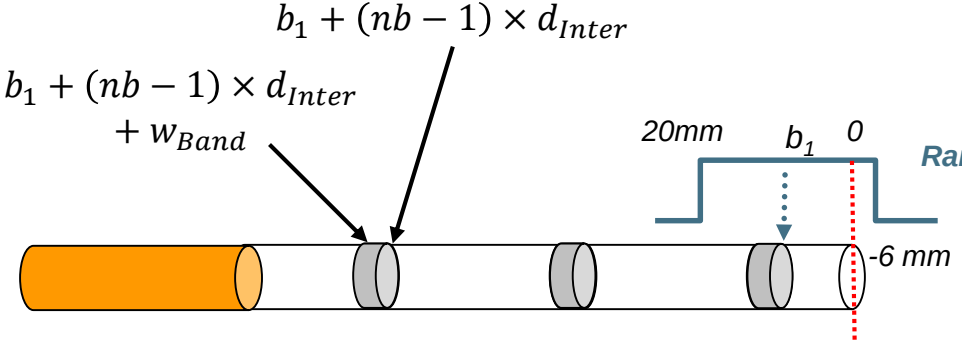


LIP Band positions

Parameter	Level/Range
w_{Band}	6mm
d_{Inter}	26mm
b_1	-6mm ; 20mm

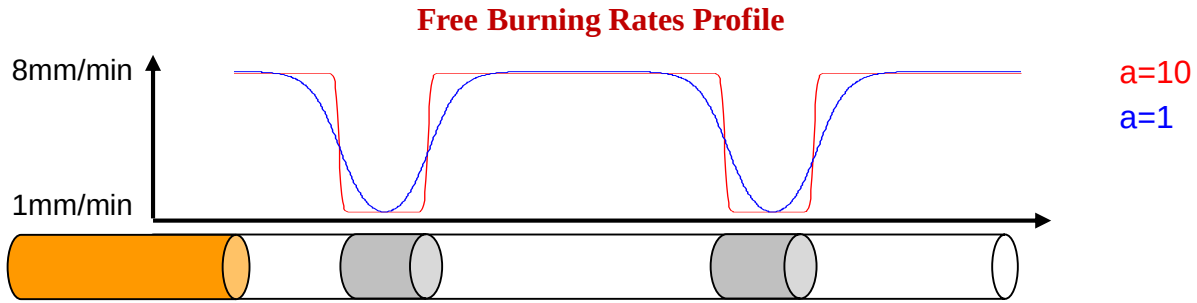


Position of the band *nb* is:



Free Tobacco Burning Rate

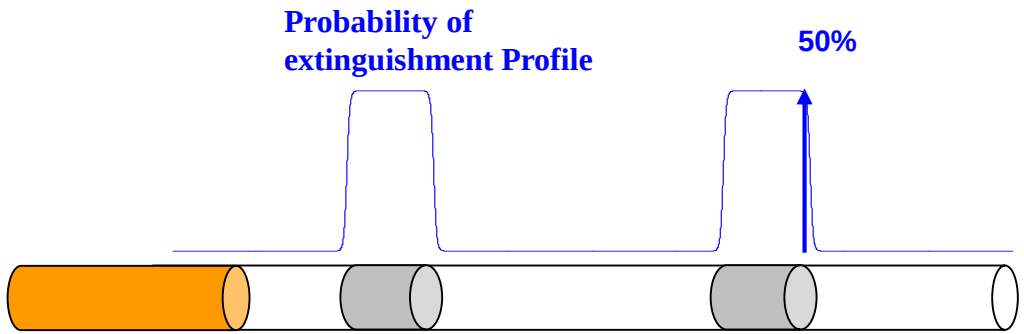
Parameter	Level
FBR_{min}	1mm/min
FBR_{max}	8mm/min
a	10mm^{-1}



$$FBR(x) = FBR_{max} - \sum_{j=1}^{nb} \frac{FBR_{max} - FBR_{min}}{[1 + e^{-a\times(x-b_1-(j-1)\times d_{Inter})}] \times [1 + e^{a\times(x-b_1-w_{Band}-(j-1)\times d_{Inter})}]}$$

Probability of extinguishment on each band

Parameter	Level
PSE_{Inter}	0%
PSE_{Band}	**50%**
a	10mm^{-1}



$$PSE(x) = \sum_{j=1}^{nb} \frac{PSE_{Band} - PSE_{Inter}}{[1 + e^{-a\times(x-b_1-(j-1)\times d_{Inter})}] \times [1 + e^{a\times(x-b_1-w_{Band}-(j-1)\times d_{Inter})}]}$$

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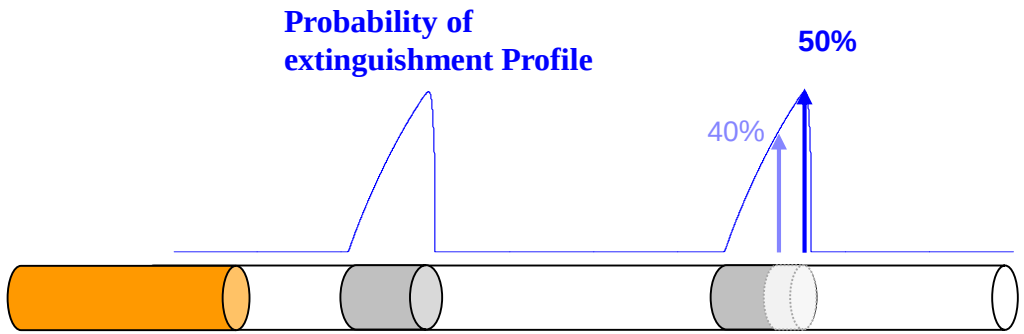
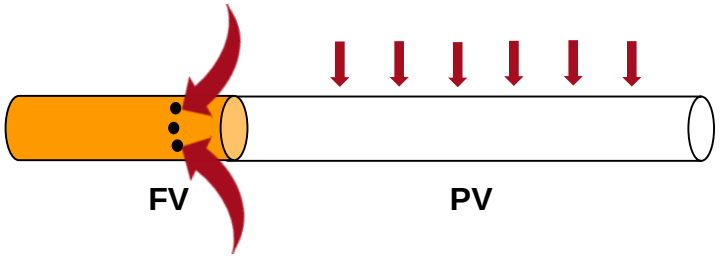


$$PSE(x) = \sum_{j=1}^{nb} \frac{\left(1-(1-PSE_{Band})^{\frac{i(x)}{6}}\right) - PSE_{Inter}}{\left[1+e^{-a\times(x-b_1-(j-1)\times d_{Inter})}\right] \times \left[1+e^{a\times(x-b_1-w_{Band}-(j-1)\times d_{Inter})}\right]}$$

Length actively smoked by puffing

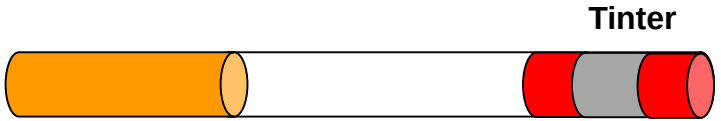
Filter & Paper Ventilation

Parameter	Level/Range
FV	30%
PV	10%



Puffing conditions

T_{Puff}	2s
T_{Inter}	60s
V_{Puff}	35ml

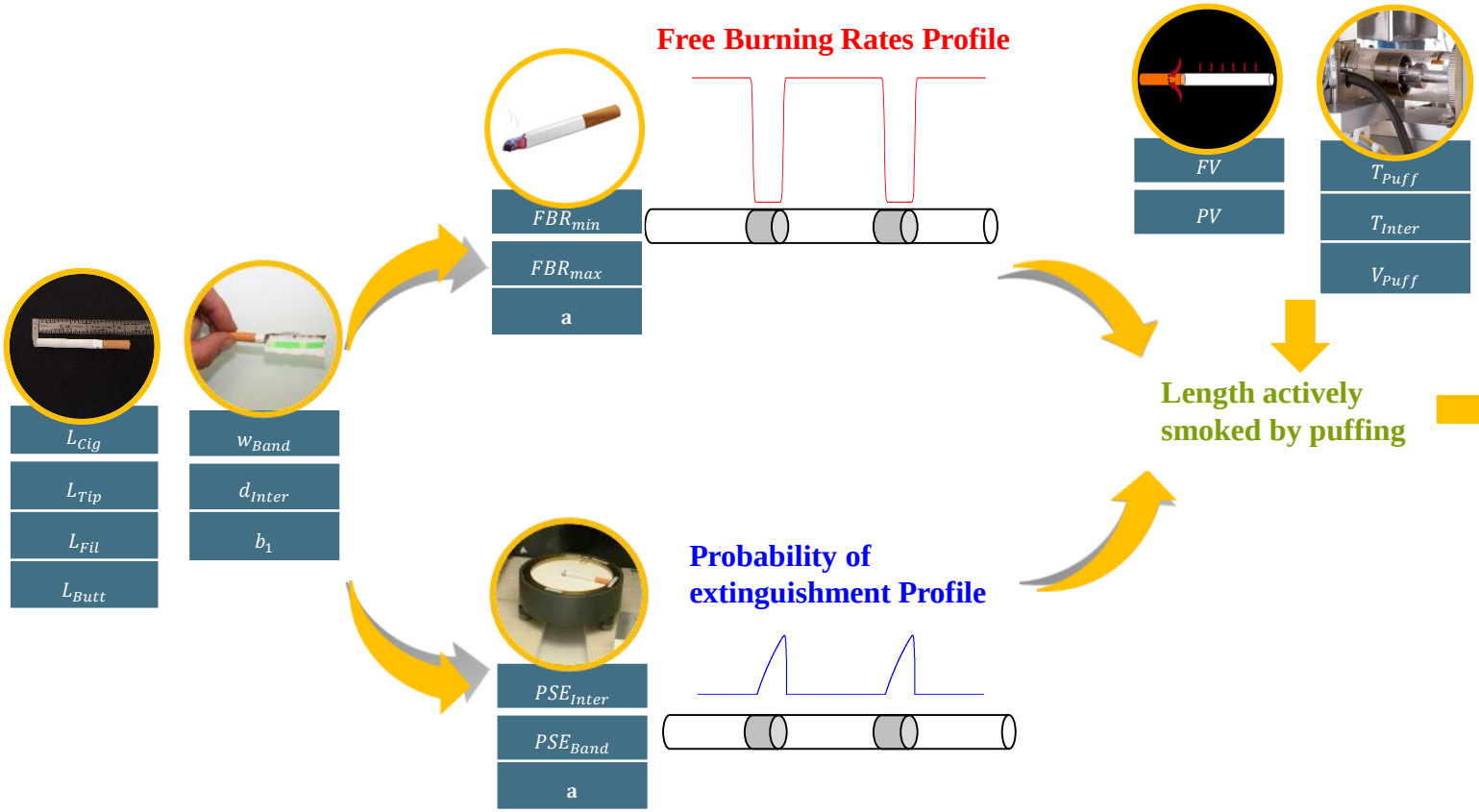


$$V_{coal}(x) = \frac{(1 - FV) \times PV \times V_{Puff}}{L_{Cig} - L_{Tip}} \times x + V_{Puff} \times (1 - FV) \times (1 - PV)$$

$$L_{activeburnt}(x) = f(V_{coal})$$

S. Colard,.Prediction Model for Cigarette Yields Derived from Data Obtained under Two Different Machine Smoking Regimes. Beiträge zur Tabakforschung International Contributions to Tobacco Research. Volume 26 No. 7 September 2015, p320-333.

Modeling approach



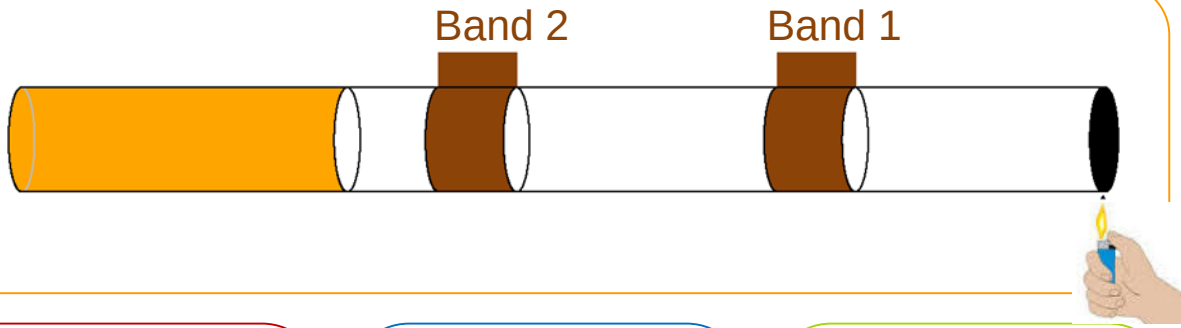
Dynamic Visual representation

Smoking regime

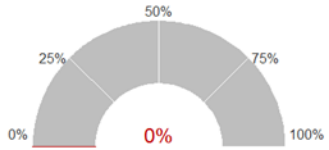
T_{Puff} = 2s

T_{Inter} = 60s

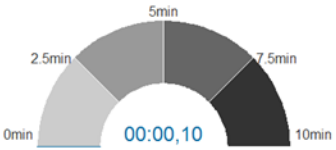
V_{Puff} = 35ml



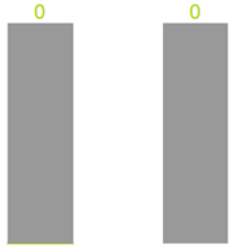
% act. Burnt



Time



Puffs



Dynamic Visual representation

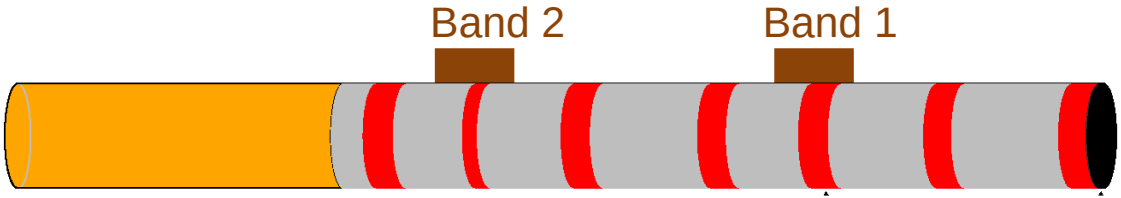
Imperial Tobacco

Smoking regime

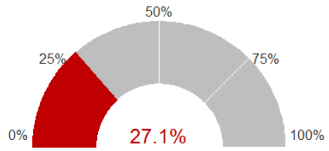
T_{Puff} = 2s

T_{Inter} = 60s

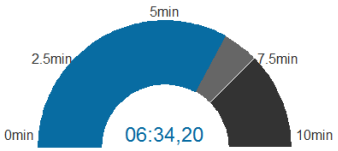
V_{Puff} = 35ml



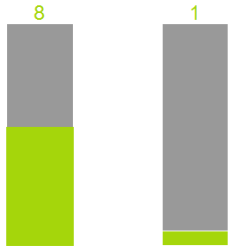
% act. Burnt



Time



Puffs



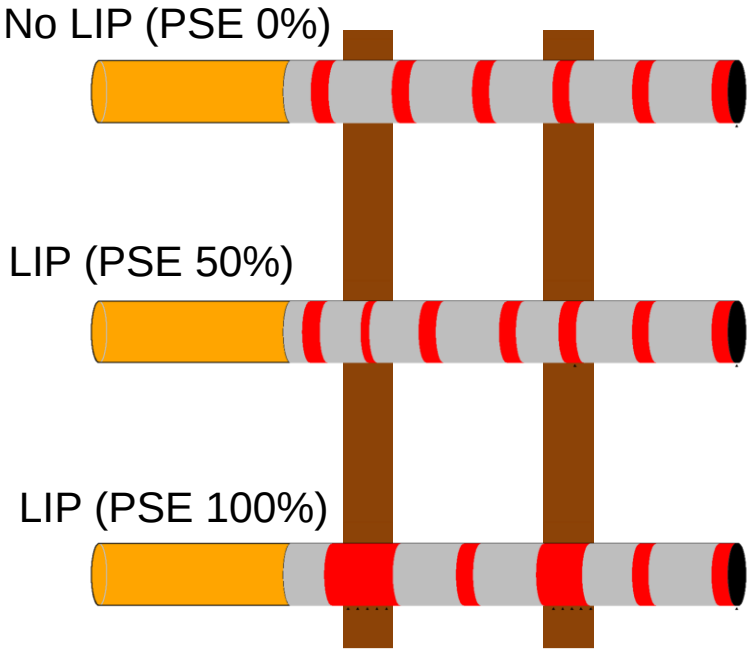
Visual representations

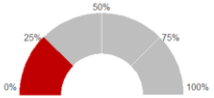
Smoking regime

T_{Puff} = 2s

T_{Inter} = 60s

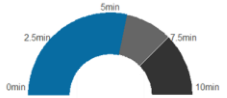
V_{Puff} = 35ml





24.9%

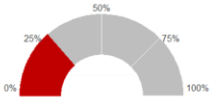
% act. Burnt



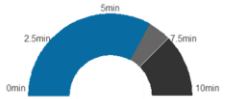
05:38:60

Time

Puffs



27.1%



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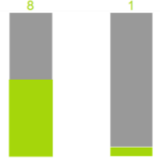
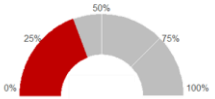
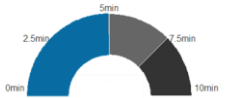




38.6%



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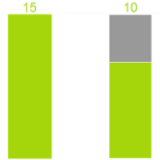
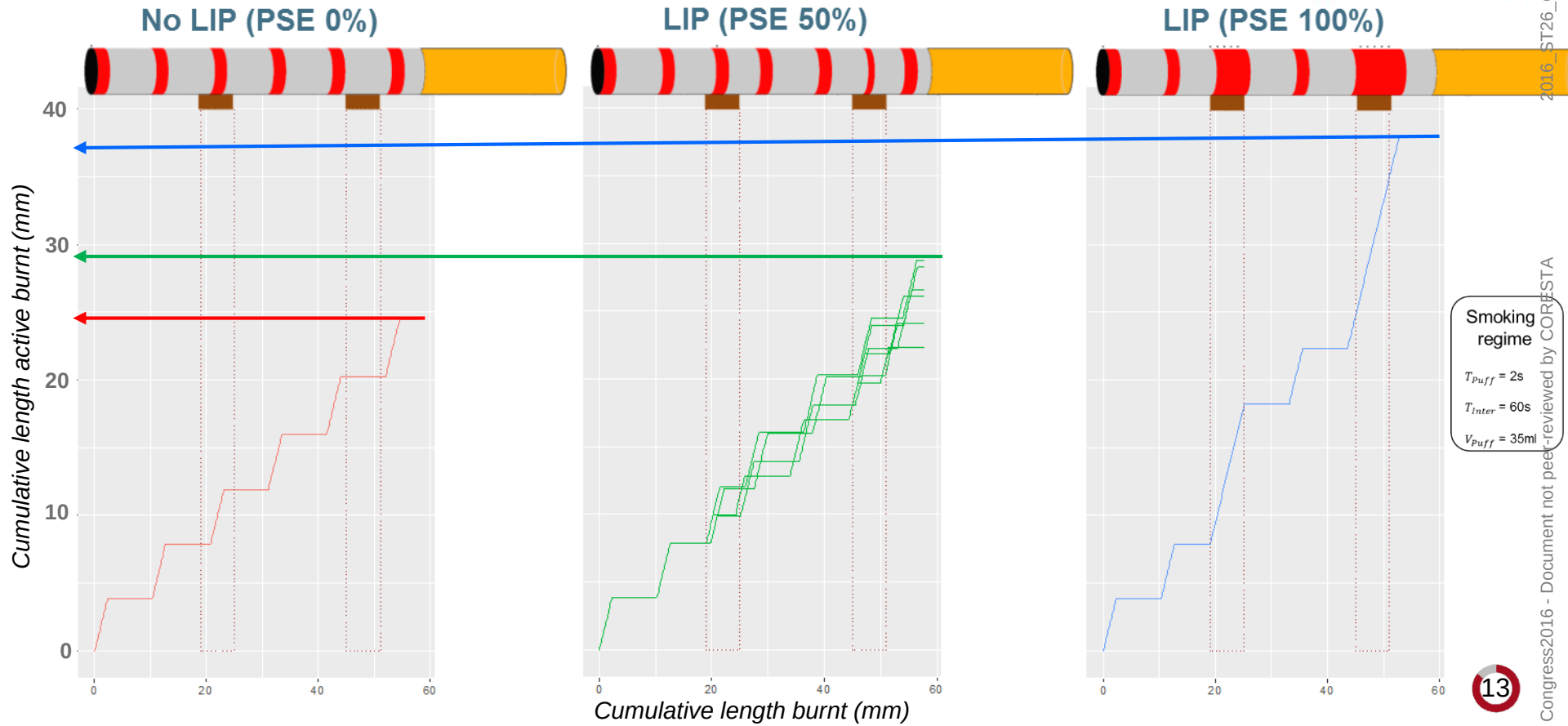


Visual representations



Conclusions

Feasibility

Reproduce each temporal phases of smoking using a mathematical model

Flexibility

Accommodate a wide range of situations by considering a set of parameters:

Tobacco burning rates during and between puffs, tobacco burning rates between and on LIP bands, puffing conditions, filter and paper ventilations, LIP band positions and probability of extinguishment on each band.

Forecasting

Assess the impact of self-extinguishment during smoking on consumer exposure by combining mathematical model with simulation

Perspectives

Impact of Self-Extinguishment during Smoking on Consumer Exposure

Part II - Simulations

Thomas VERRON and Stéphane COLARD

SEITA, Imperial Tobacco Limited

Thank you

http://www.imperialtobaccoscience.com/