REFURBISHMENT OF THE EMERGENCY VENTILATION SYSTEM INCLUDING SACCARDO NOZZLES IN THE NORTH-SOUTH RAILWAY JUNCTION OF BRUSSELS

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CONTENTS OF THE PRESENTATION

OVERVIEW OF THE NORTH-SOUTH BRUSSELS RAILWAY JUNCTION

01.

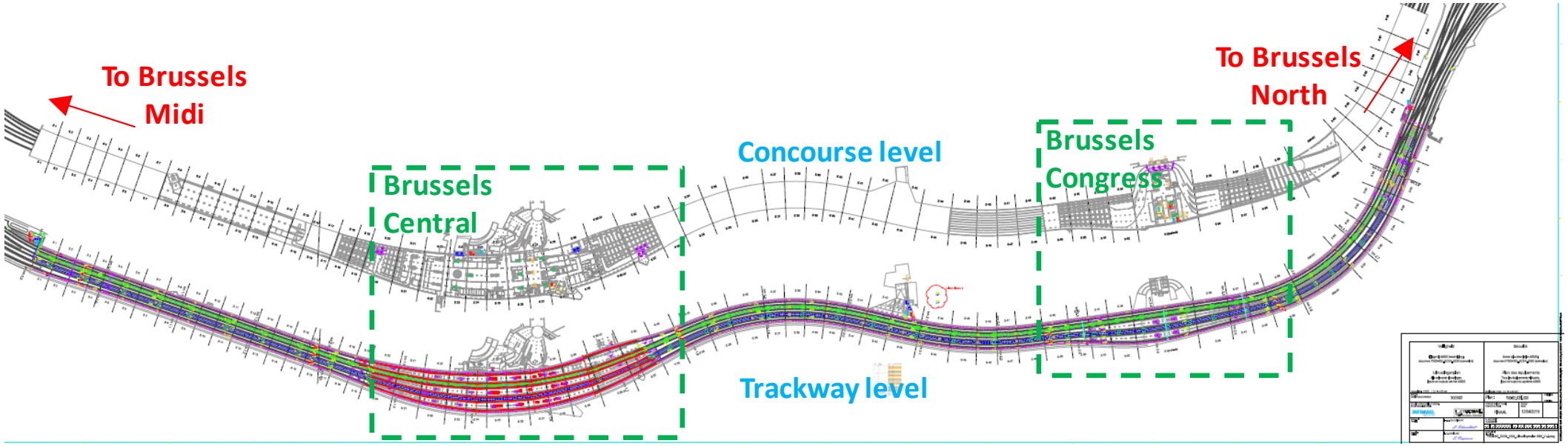
THE RAILWAY UNDERGROUND JUNCTION

Located between the North and South (Midi) railway stations of Brussels

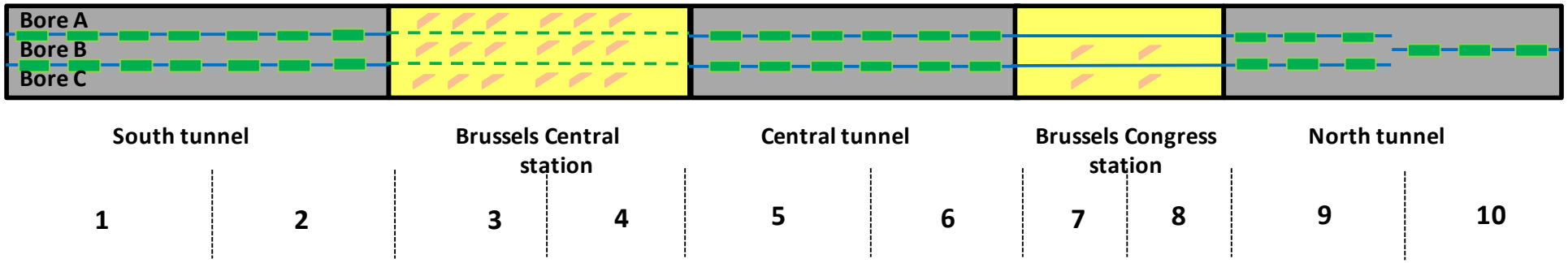
~1.9 km with two underground stations : Brussels Central and Brussels Congress

6 trackways for a high traffic flow of around 1200 trains a day (the busiest

Second level



MAIN FIRE SAFETY PRINCIPLES



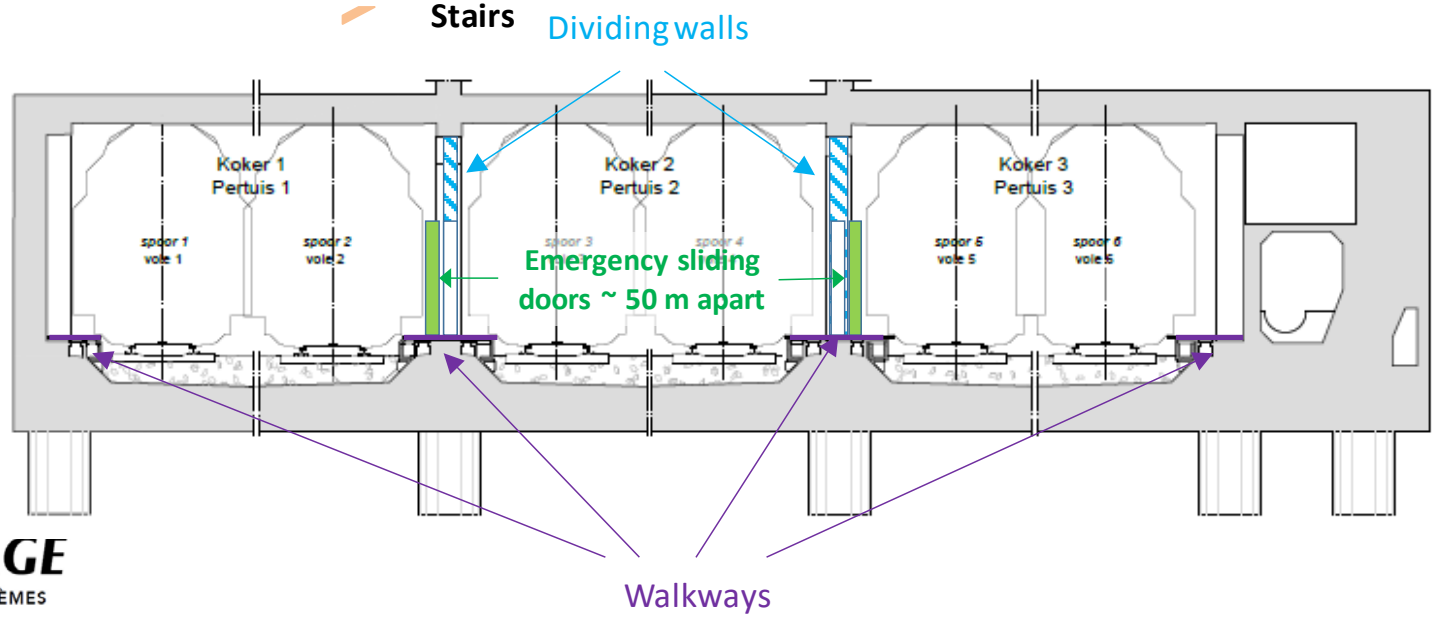
Dividing wall (Tunnels and Brussels Congress)

Smoke barriers (Brussels central)

Emergency sliding doors

Stairs

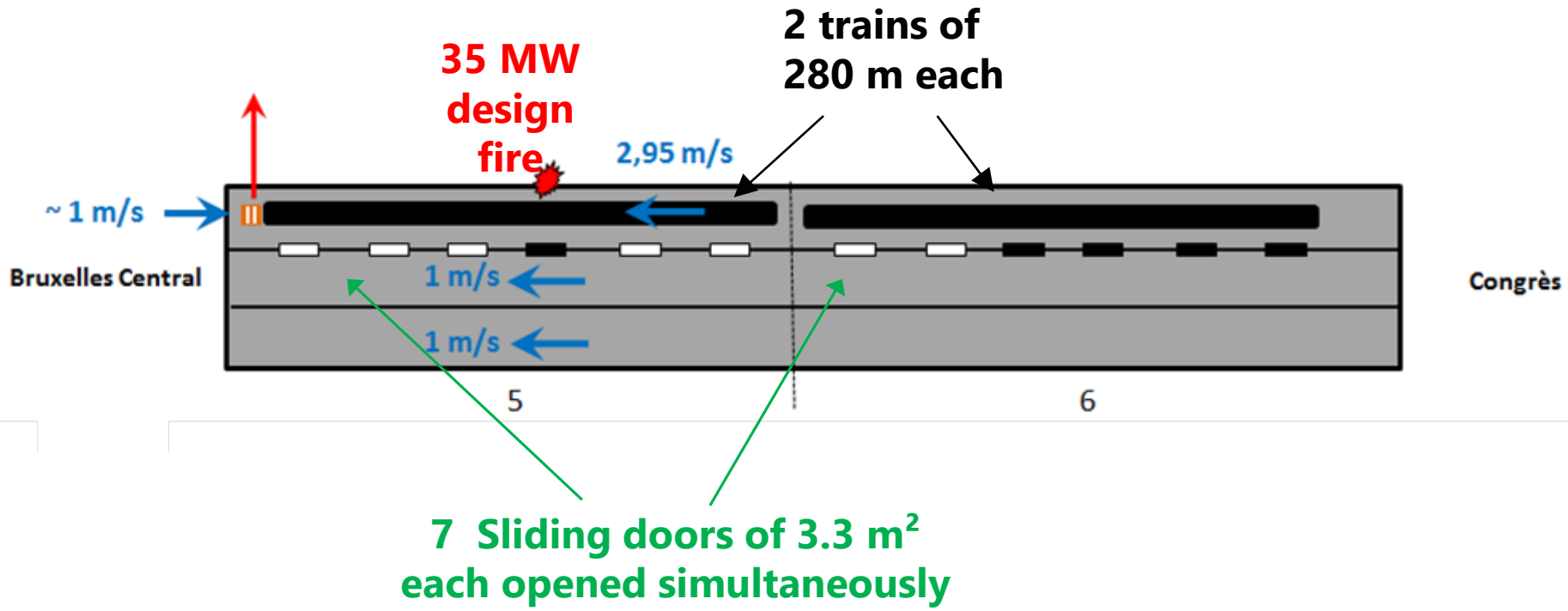
29 fire zones (17 in tunnels and 12 in stations)



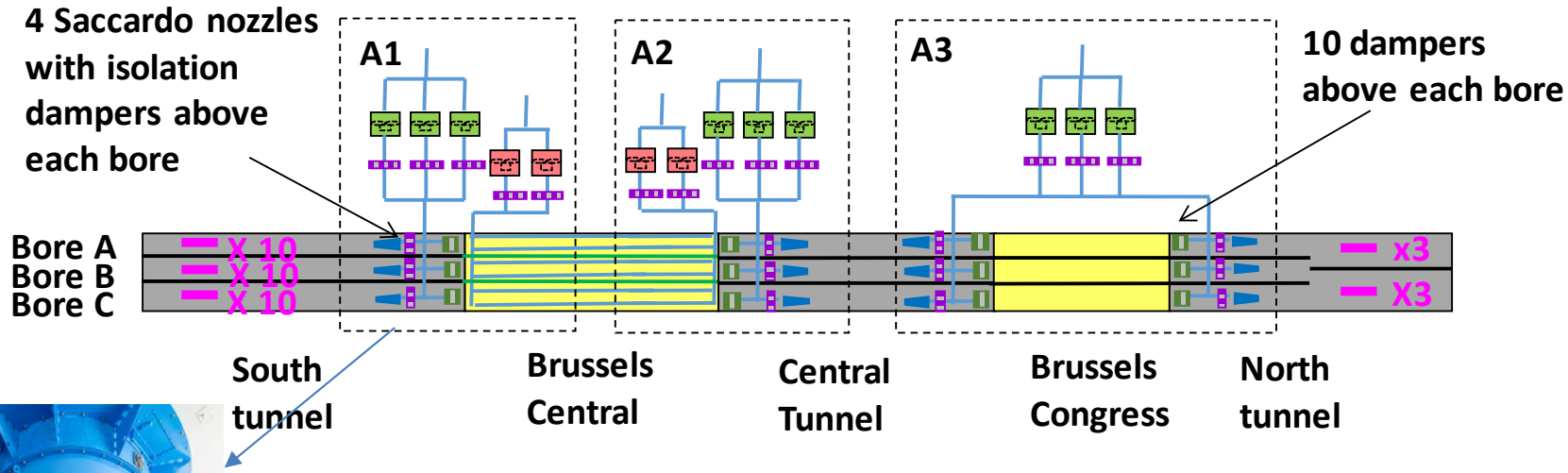
THE REFURBISHED VENTILATION SYSTEM

02.

A SET OF DESIGN OBJECTIVES AND CONSTRAINTS



OVERVIEW OF THE VENTILATION SYSTEM



- Massive extraction and supply fans -150 m3/s (L1 / L2 / L3)
- Transverse Extraction fans of Brussels Central 45 m3/s (T4 / T5)
- Jet fans (260 N in tunnel)
- Saccardo Nozzles
- Isolation damper
- Damper for massive smoke extraction

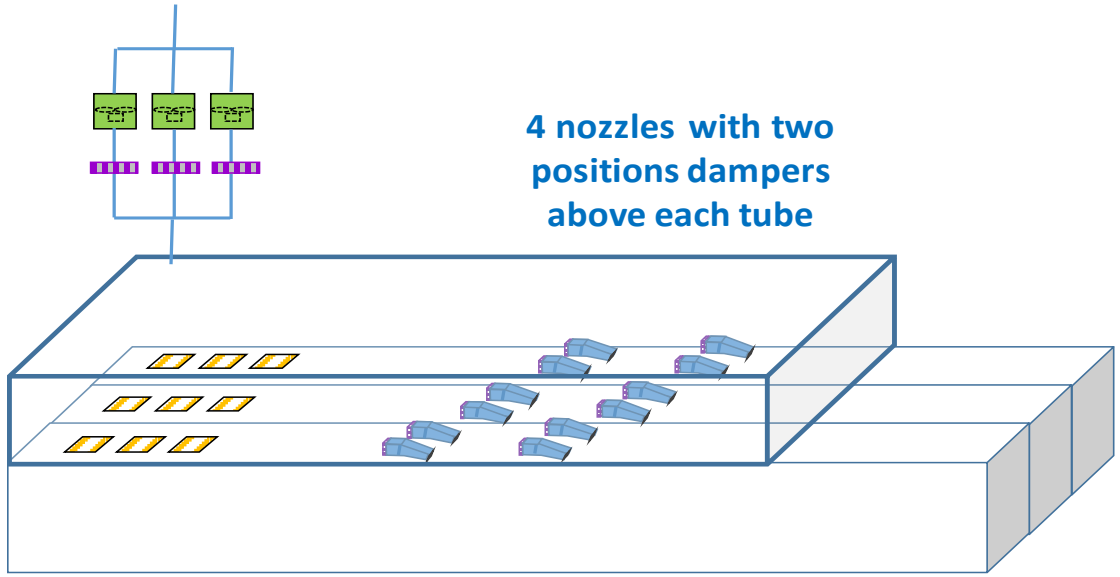
SACCARDO SYSTEM DESIGN DEVELOPMENT
SACCARDO NOZZLES CONFIGURATION

As set of 4 Saccardo nozzles with two positions dampers instead of one single nozzle with multi-positions dampers

Possibility to balance more adequately flow rates injected into each tube

Conservation of the Ejection speed and the thrust provided by each individual nozzle

Improvement of the system availability

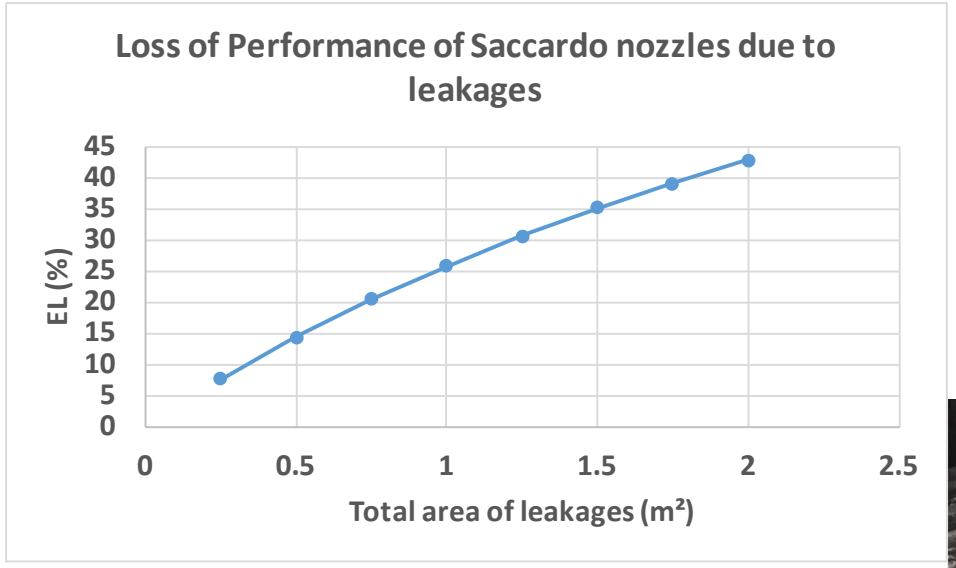


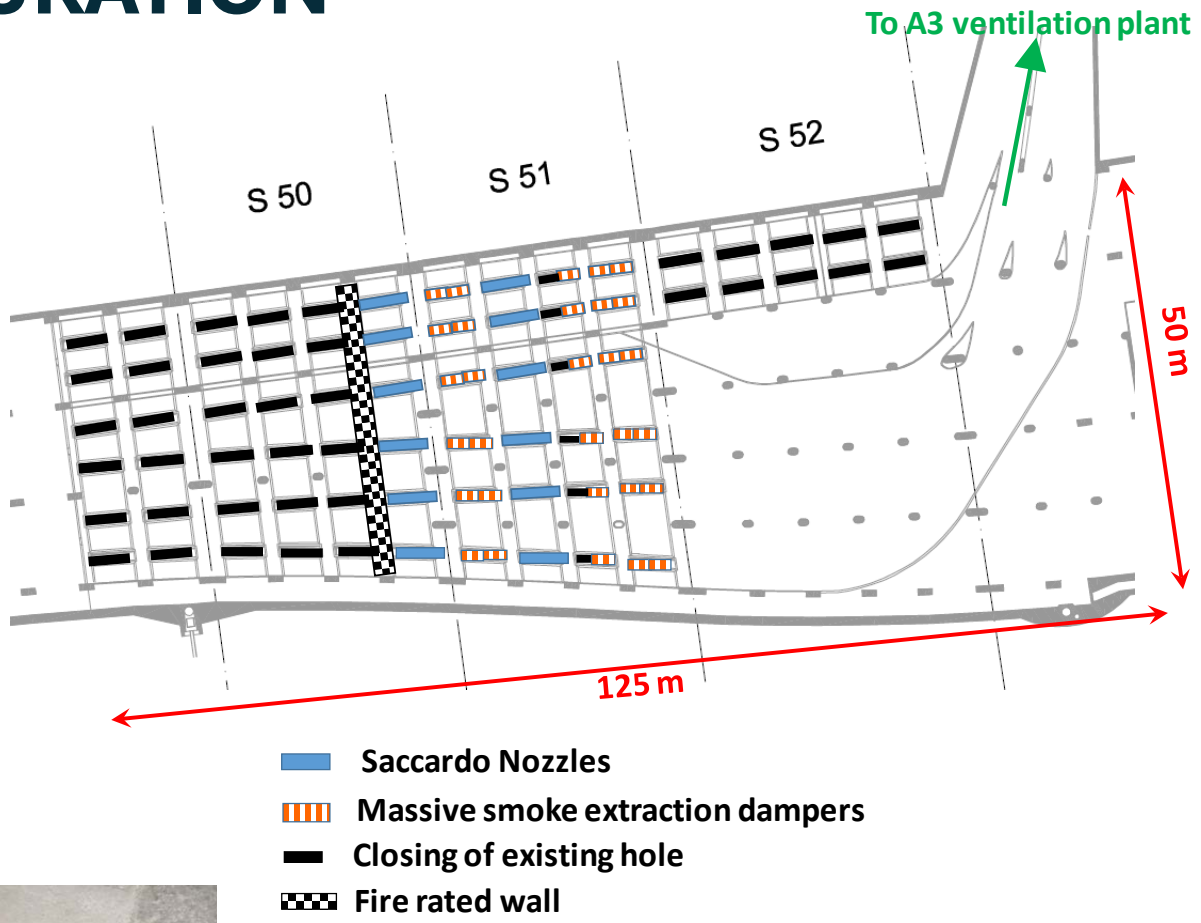
SACCARDO SYSTEM DESIGN DEVELOPMENT
SACCARDO NOZZLES CONFIGURATION

Big size plenum

Advantage : low velocity and low pressure losses inside plenums

Drawback : risk of leakages induced by the static pressure of ~900 Pa





Typical leakages observed on site before the refilling campaign

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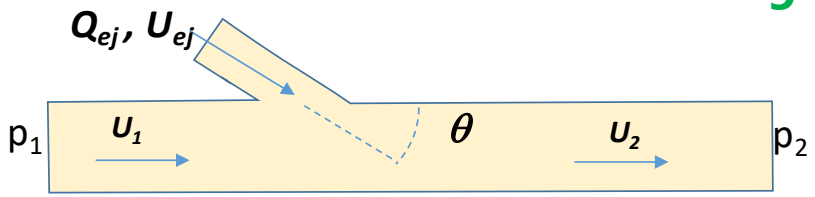
DESIGN AND TESTING

03.

METHODOLOGY FOR INTRODUCING SACCARDO INTO 1D SIMULATIONS

Saccardo normal configuration



$$(p_1 + \rho.u_1^2).A_T + \rho.Q_{ej}.u_{ej}.cos\theta.\xi = (p_2 + \rho.u_2^2).A_T + FL$$

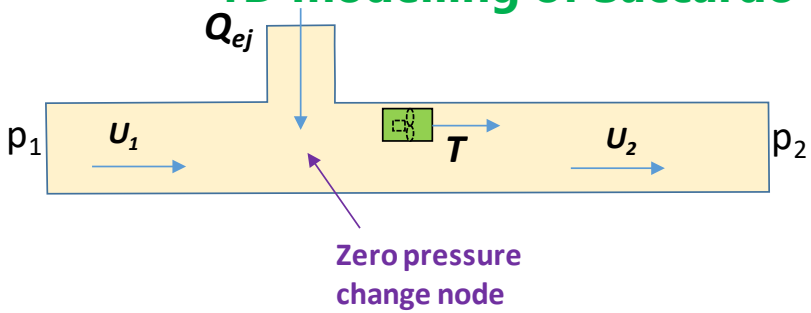
- 1st consideration : u_1 close to zero

$$(p_2 - p_1).A_T + FL = \rho.Q_{ej}.u_{ej}.cos\theta.\xi\left(1 - \frac{u_2}{u_{ej}.cos\theta.\xi}\right)$$

- 2nd consideration : $\left(1 - \frac{u_2}{u_{ej}.cos\theta.\xi}\right) \sim \left(1 - \frac{u_2}{u_{ej}.cos\theta.}\right)$

$$(p_2 - p_1).A_T + FL = \frac{\rho}{\rho_0}.\boldsymbol{\rho_0.Q_{ej}.u_{ej}.cos\theta}.\xi\left(1 - \frac{u_2}{\boldsymbol{u_{ej}.cos\theta.}}\right)$$

1D modelling of Saccardo



$$T = \frac{\rho}{\rho_0}\boldsymbol{T_0}\left(1 - \frac{u_2}{\boldsymbol{u_{ejJF}}}\right).\xi = (p_2 - p_1).A_T + FL$$

3D modeling for the evaluation of ξ

$$\rho.Q_{ej}.u_{ej}.cos\theta.\xi = DP.A_T$$

$$DP = 60\ Pa \Rightarrow \xi = 0.83$$

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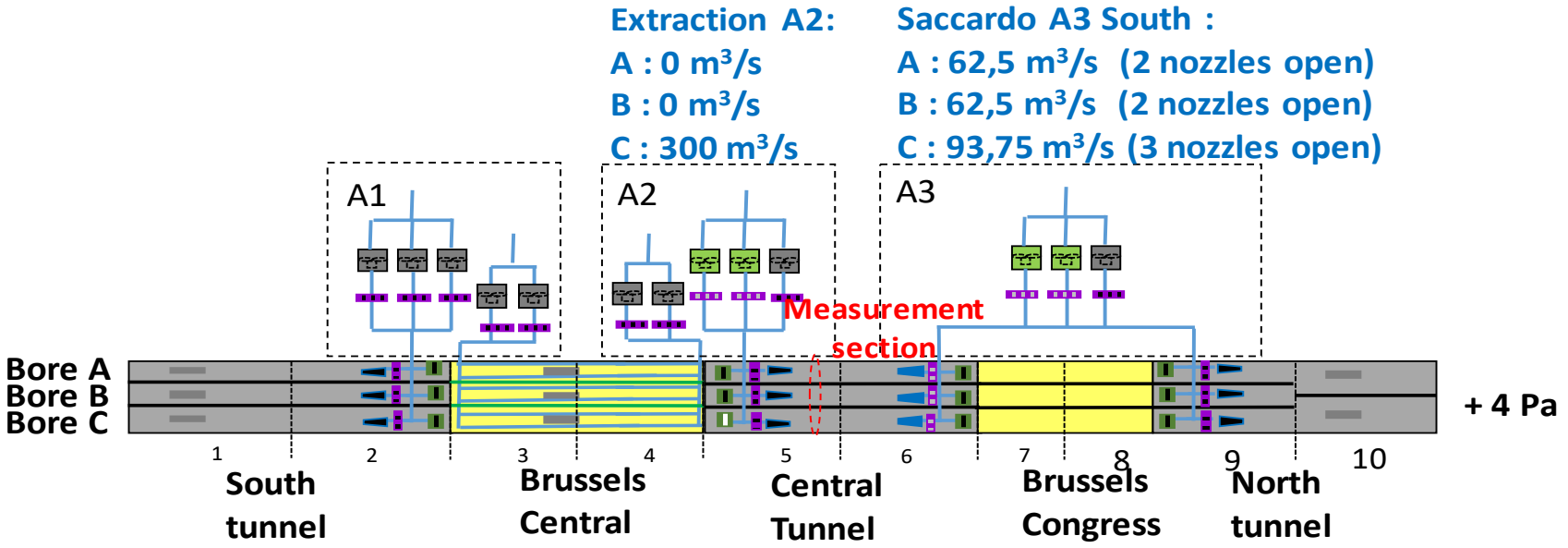
COMPARISON BETWEEN THEORETICAL RESULTS AND MEASUREMENTS

Study case – Emergency ventilation scenario in section 5 – Bore C



Measurements of longitudinal air velocity in tunnels with Log-Tchebichev log-tchebycheff methodology based on 25 points

Comparison with cold smoke 1D simulations

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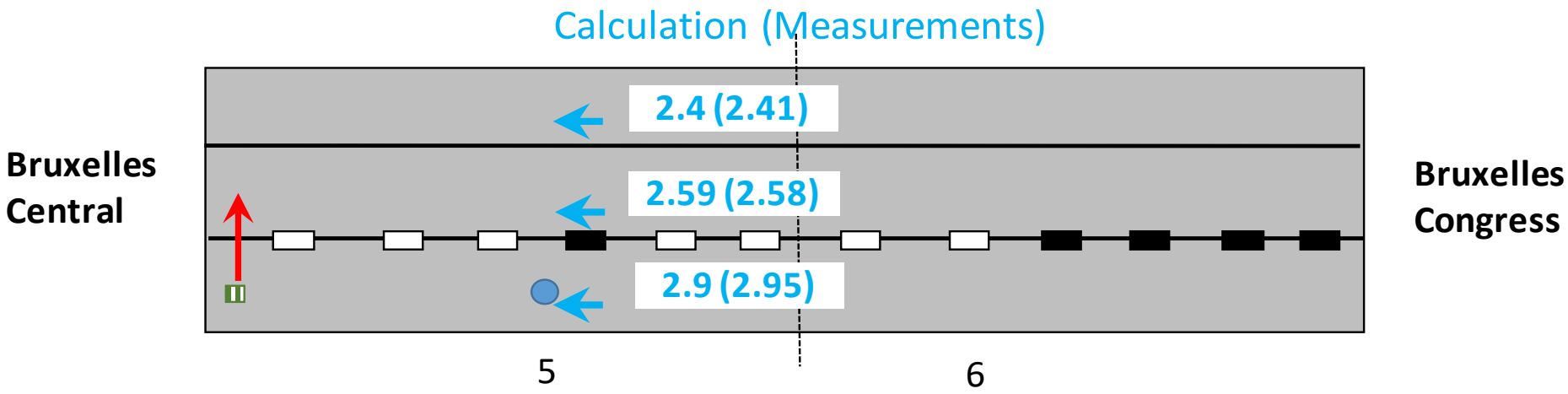
COMPARISON BETWEEN THEORETICAL RESULTS AND MEASUREMENTS

Results



Difference between the simulation and measurements of ~1.7%

04.

CONCLUSIONS

CONCLUSIONS

The North-South Brussels railway junction

- **a strategic railway underground network in Belgium**
- **a complex refurbished ventilation system**

Specific challenges for the design of Saccardo systems

- **A solution based on multiple nozzles has been developed for a performing balance of flow rates and thrust between incident and non-incident tubes**
- **Risk of leakages due to the size of ventilation plenums**

Saccardo design approach

- **Saccardo can be modelled in a 1D model under certain flow conditions by a supply shaft and a jet fan with an primary evaluation of the efficiency through 3D modelings**
- **Design approaches validated by a set of flow measurements compared with cold smoke 1D simulations**

THANK YOU FOR YOUR ATTENTION

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