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Experimental investigations and analyses of the thermal behavior of a moving pantograph's strip

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Main objectives

- Define the thermal behaviour of the pantograph strip during the motion
- Describe the influence of all the different parameters on the heat sources in the strip
- Obtain the times where the thermal configuration can generate strip degradations, premature wear and breaks

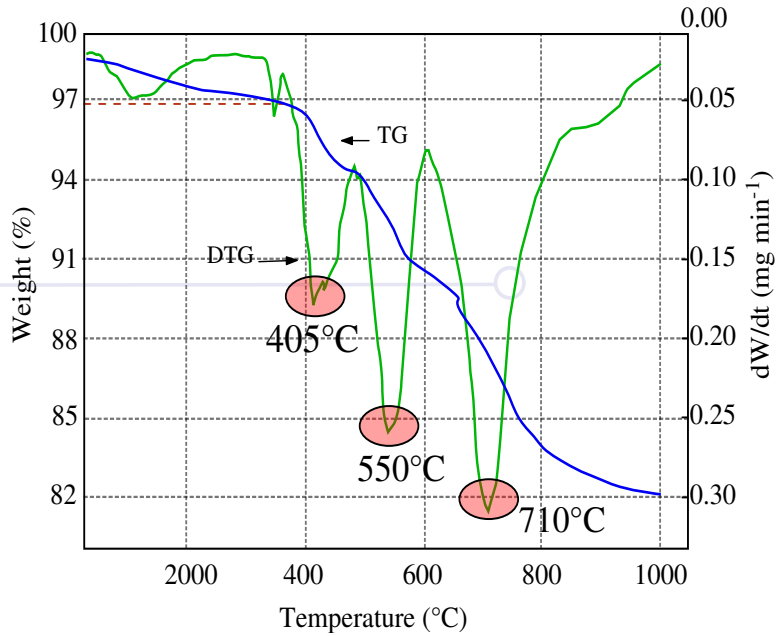

Figure: Mass losses of carbon strip with the temperature increase

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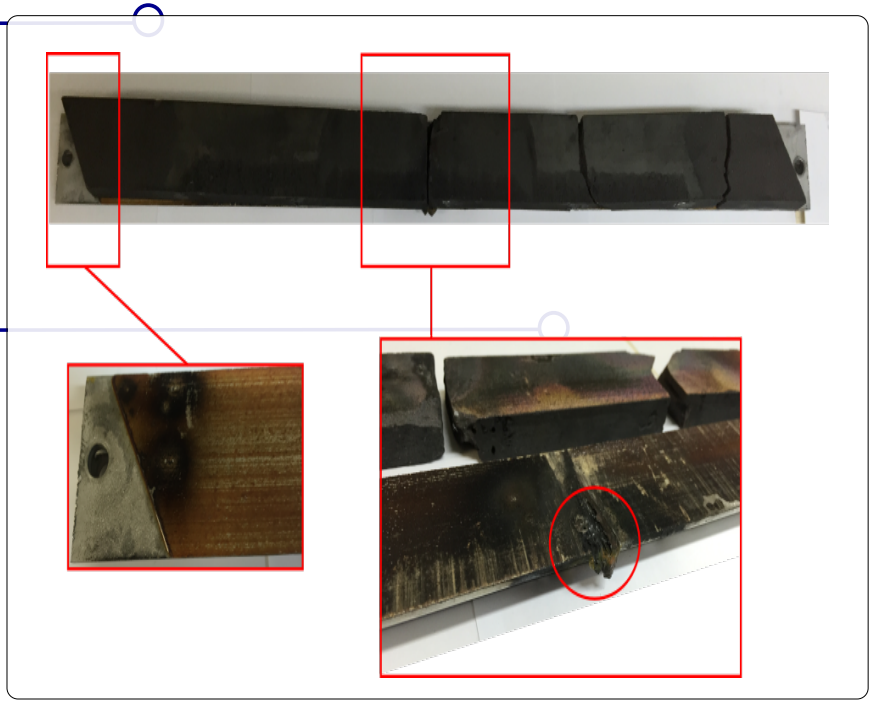
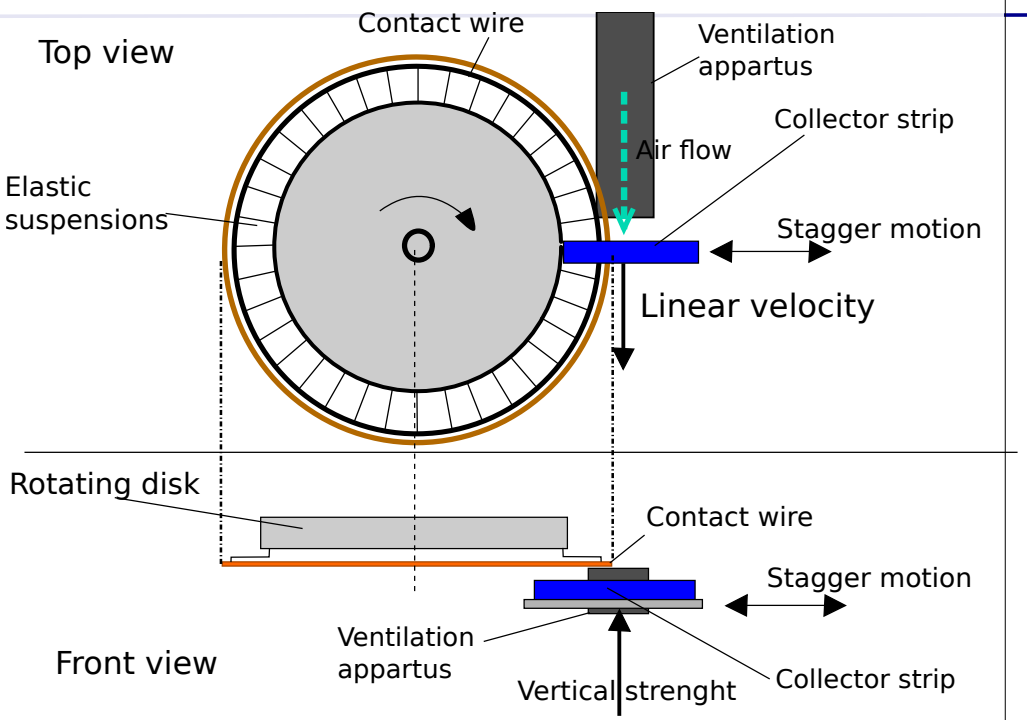


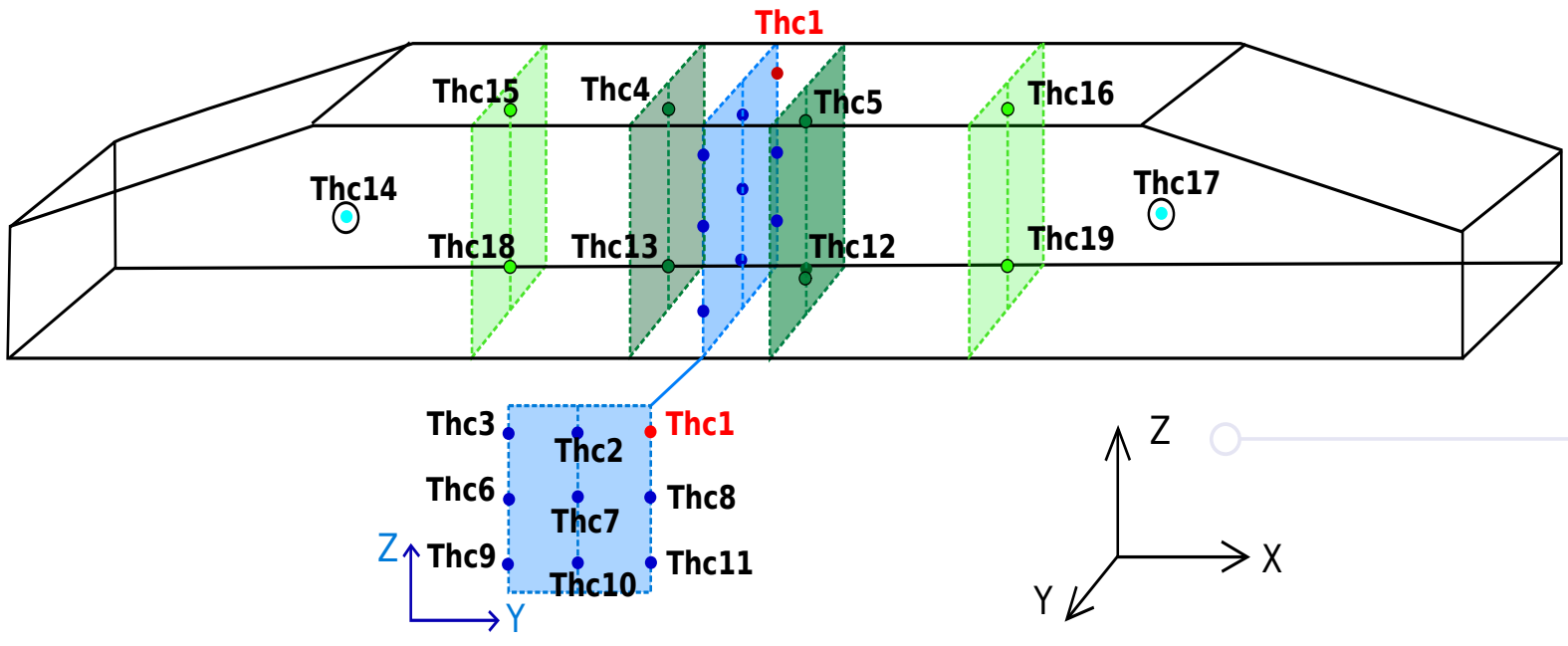
Test bench presentation

- Situated at Polimi (Politecnico di Milano)
- It can reproduce a real configuration of a pantograph/catenary system during a real travel



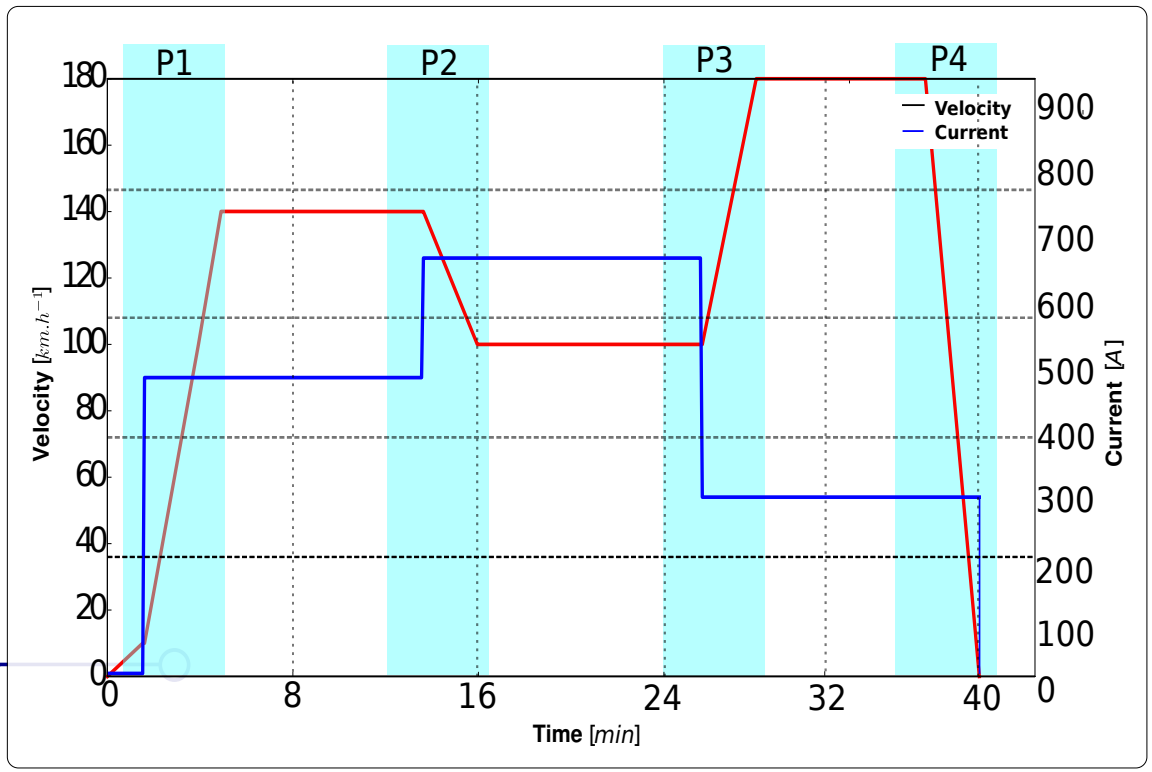
Strip instrumentation

- 19 thermocouples are inserted inside the strip at specific positions
- Electrical insulation and signal filtering are necessary



Experimental parameters

Strip impregnation	Strip thickness	Velocity	Force
32 %	32 mm	$140 km.h^{-1}$ constant	60 N
25 %	18 mm	$140 km.h^{-1}$ constant	90 N
		Variable profile	



P1: A start

P2: A positive slope

P3: A negative slope

P4: A stop

Results and interpretations: Matter change

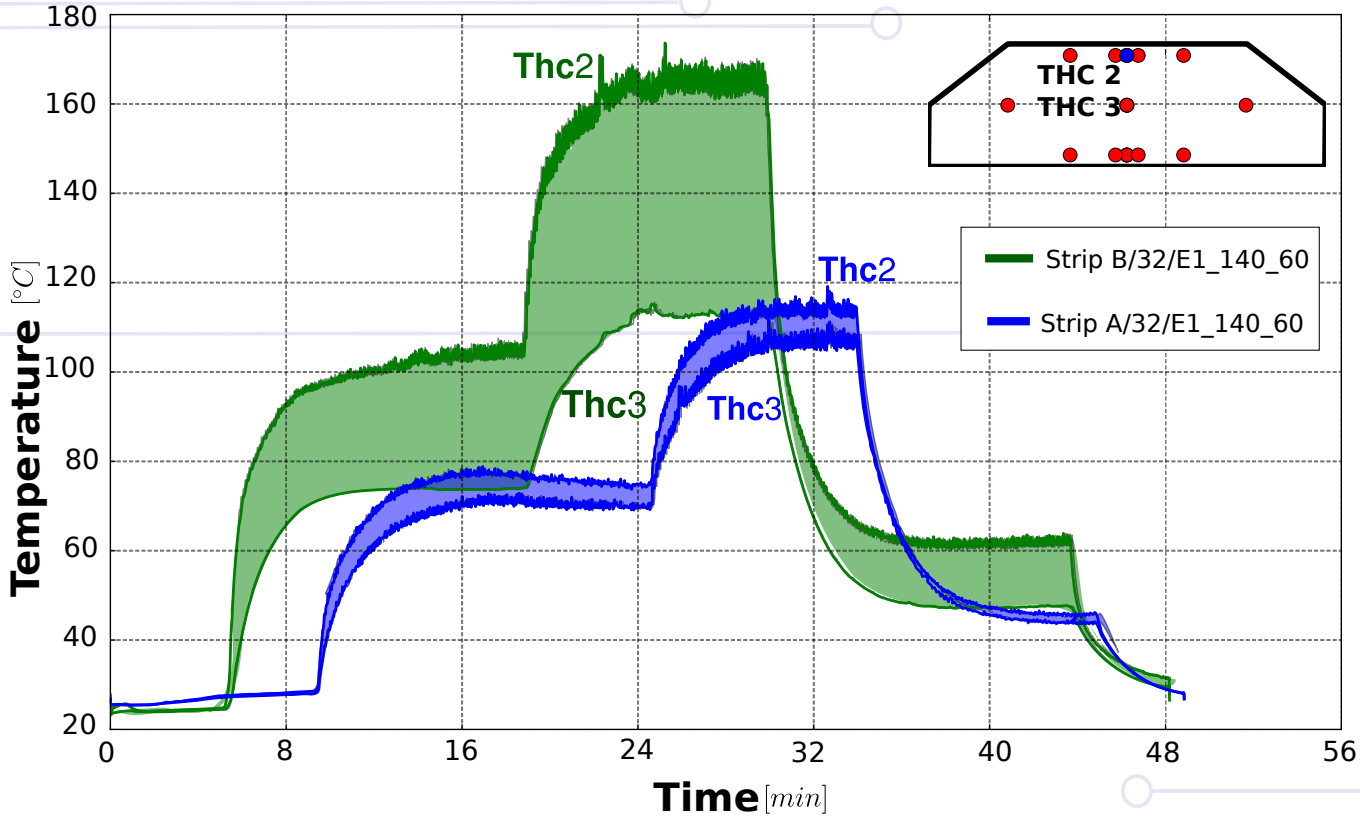
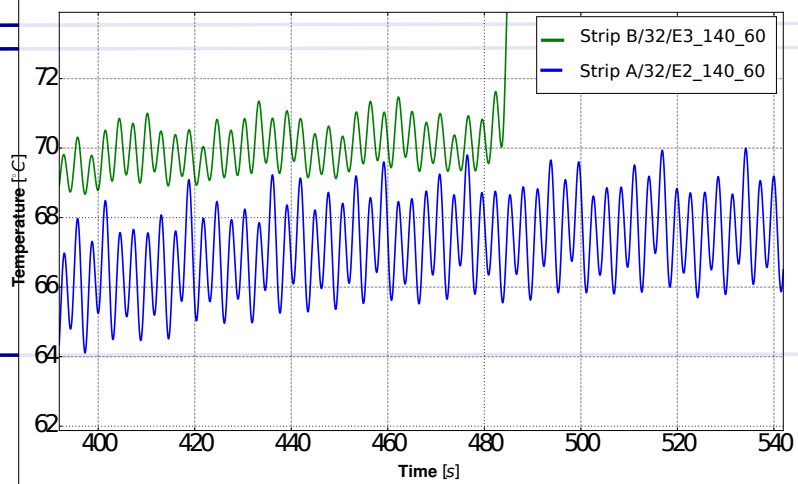
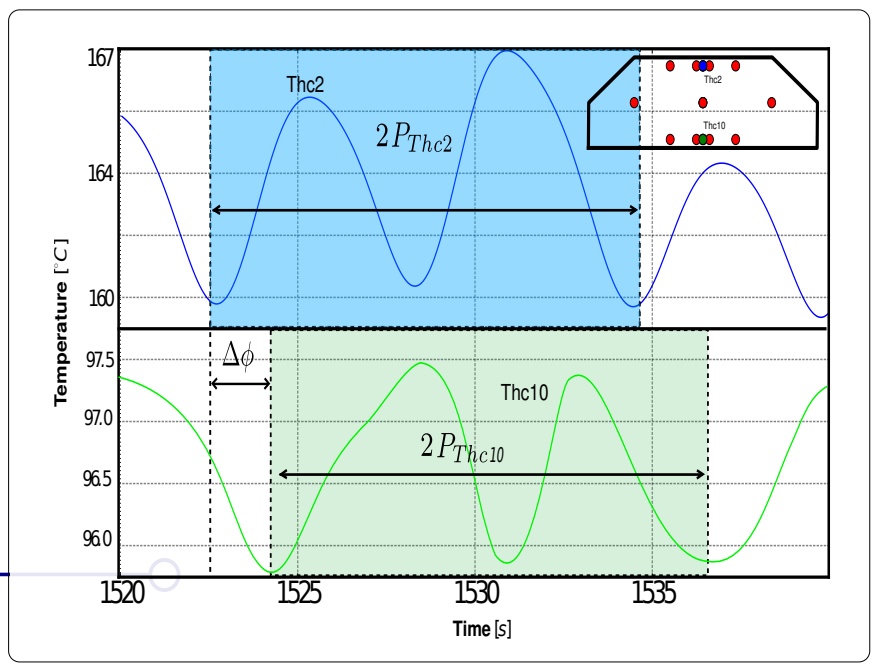


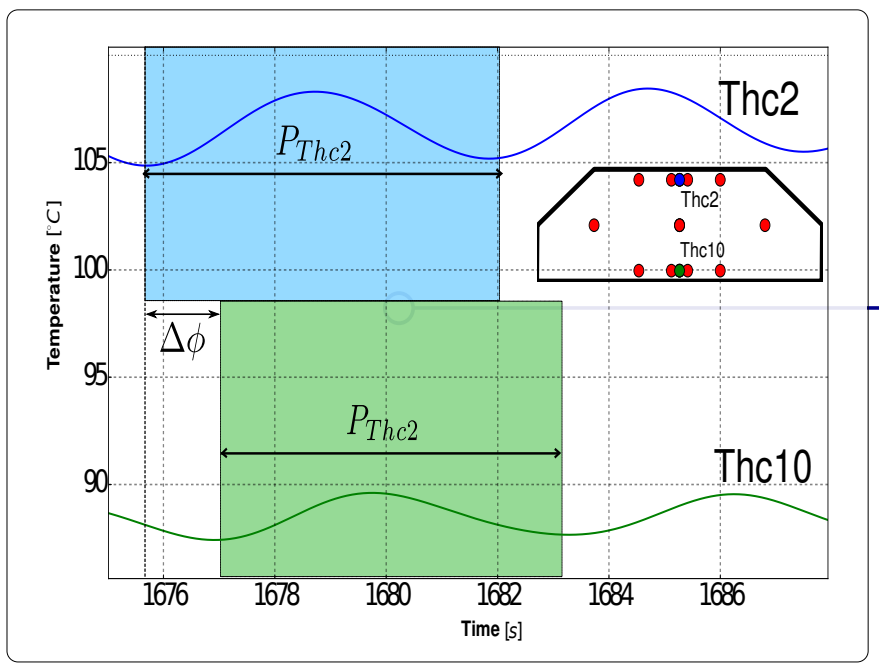
Figure: Comparison between the thermal response of the pantograph strips A and B, for thermocouples 2-3 with a velocity of $140 km/h$, a force of 60N and a normal current profile

Results and interpretations: Stagger motion



- Amplitude differences between the two strips
- Possibility to characterize the strips





Results and interpretations: Velocity profile

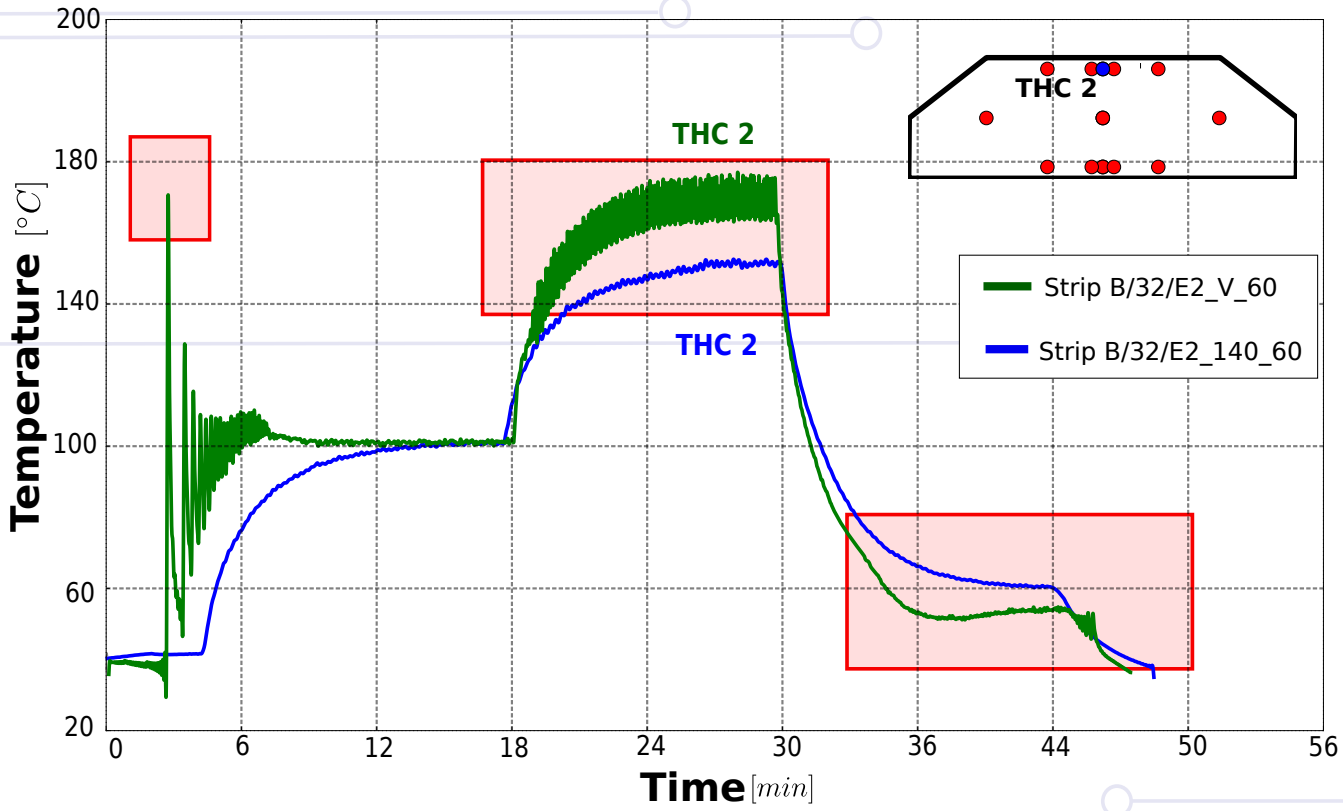
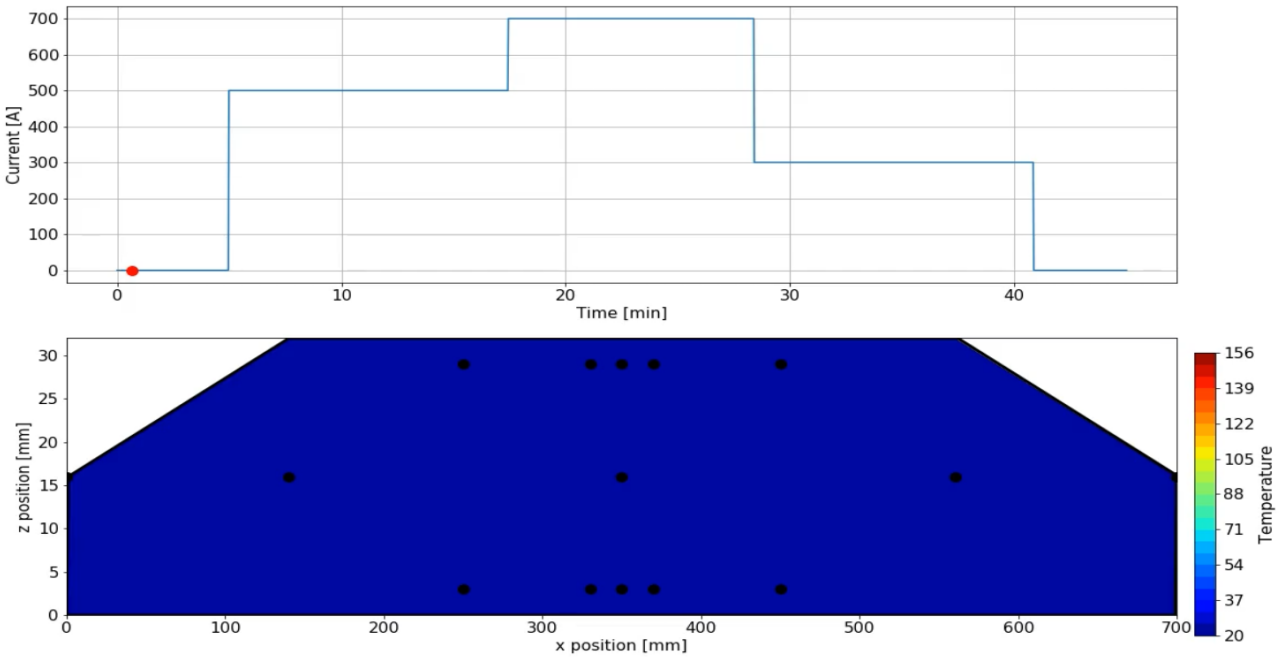


Figure: Thermal response of the pantograph strip B for the thermocouples 2 with a force of 60N and a normal current profile: Comparison between a constant velocity of $140 km/h$ and a variable profile

Thermal distribution



Conclusion

- The strip matter characteristics have an important influence on the temperature of the strip and its thermal diffusivity
- A high part of impregnated copper generates:
  - Low temperatures and high diffusivity
  - Less wear on the material, more problems on the glue joint
- A velocity change creates:
  - Temperature peaks
  - Convection variations and then cooling variations

- Possibility to understand the thermal effect with accuracy
- Possibility to control the strip validity from a thermal point a view with only two thermocouples