Profile Inversion from Accelerometer Readings

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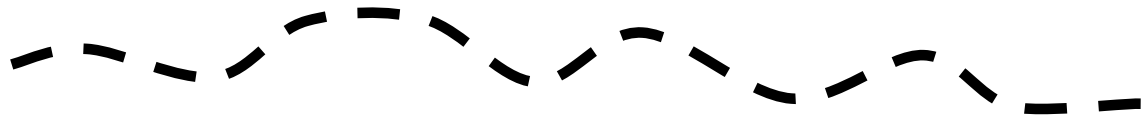
Supported by Innovation Fund Denmark

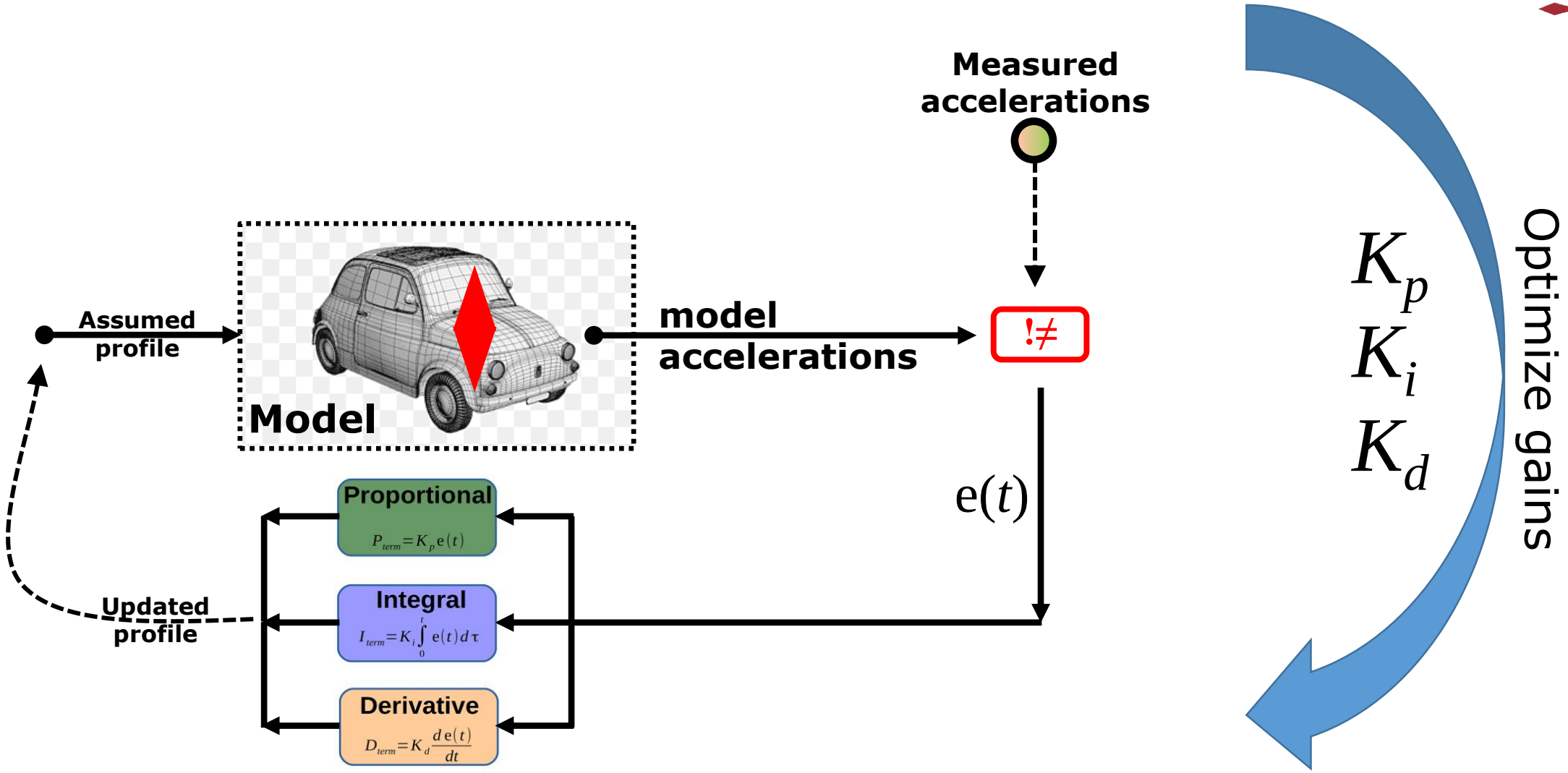
Objective

Collect accelerometer readings while driving

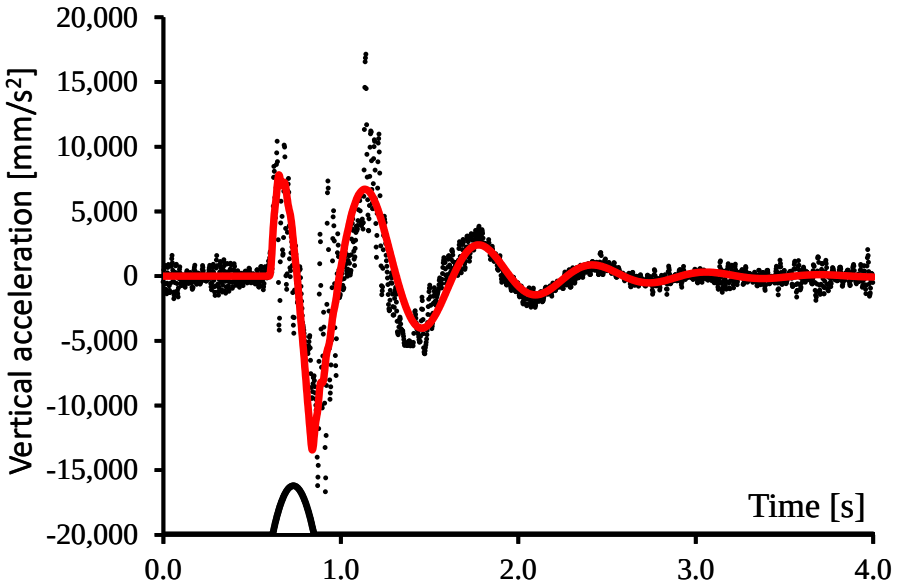
Invert the road's vertical profile

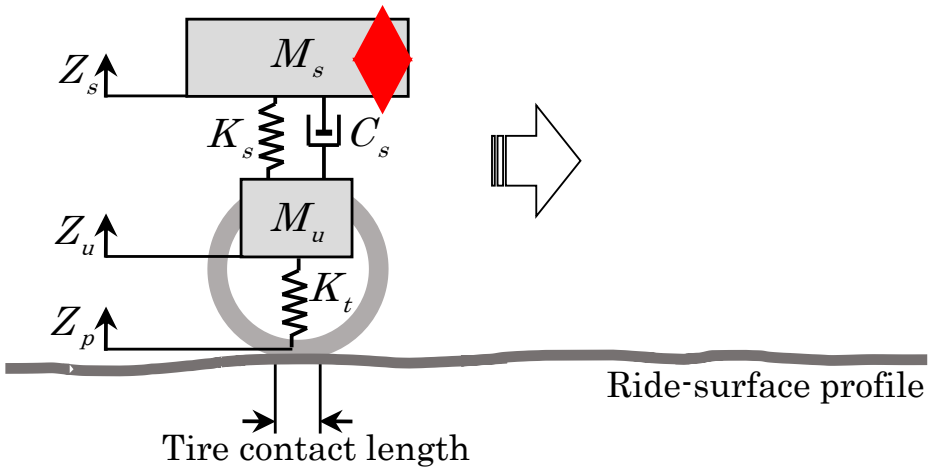


Methodology



Modeling





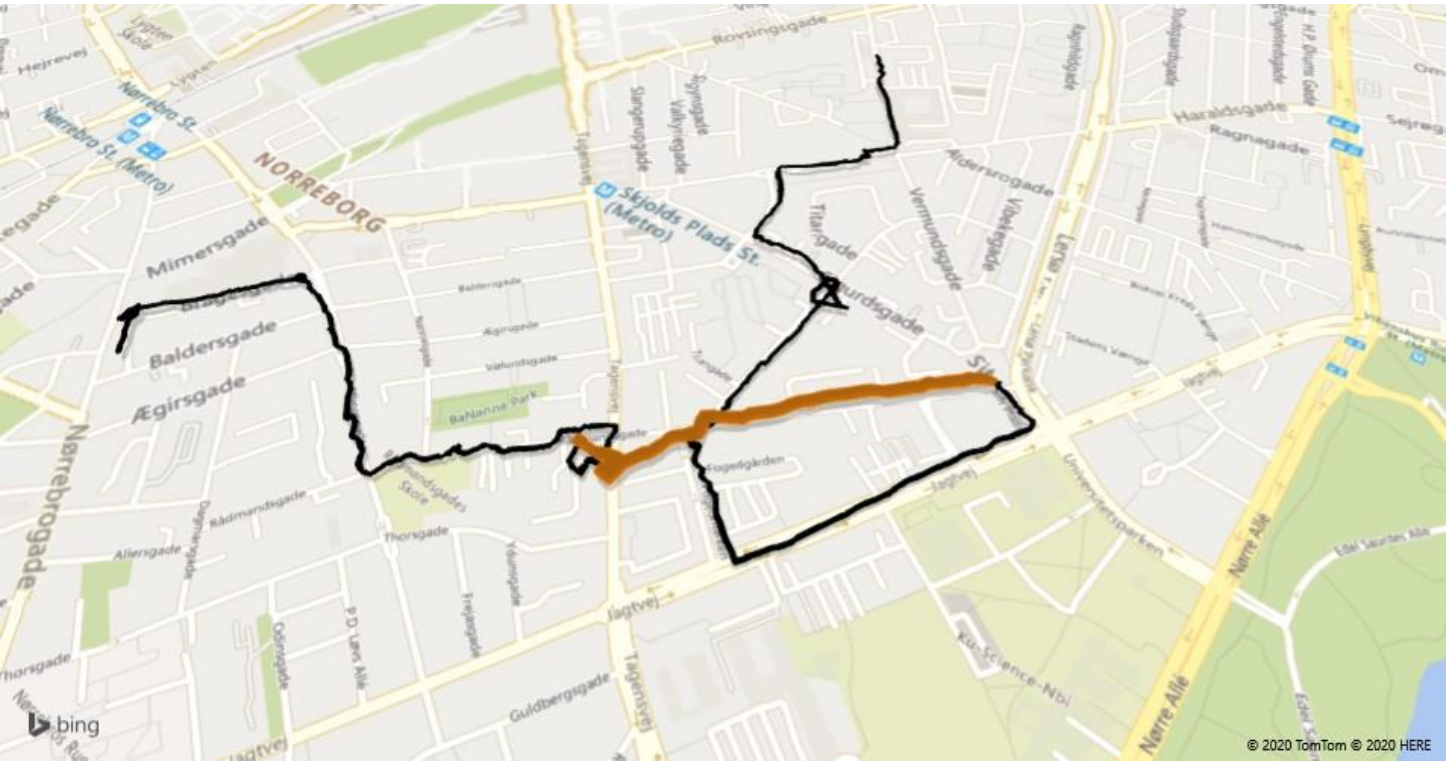
$$Z_u^+ = \begin{pmatrix} (\Delta tC+2)\left(\Delta t^2 K_1\left(Z_p - Z_u\right) - U\left(Z_u^- - 2Z_u\right) + 2Z_s - Z_s^-\right) \\ +2\Delta t^2 K_2\left(Z_s - Z_u\right) + \Delta tC\left(Z_u^- - Z_s^-\right) + 2Z_s^- - 4Z_s \end{pmatrix} \left(\Delta tC\left(1+U\right) + 2U\right)^{-1}$$

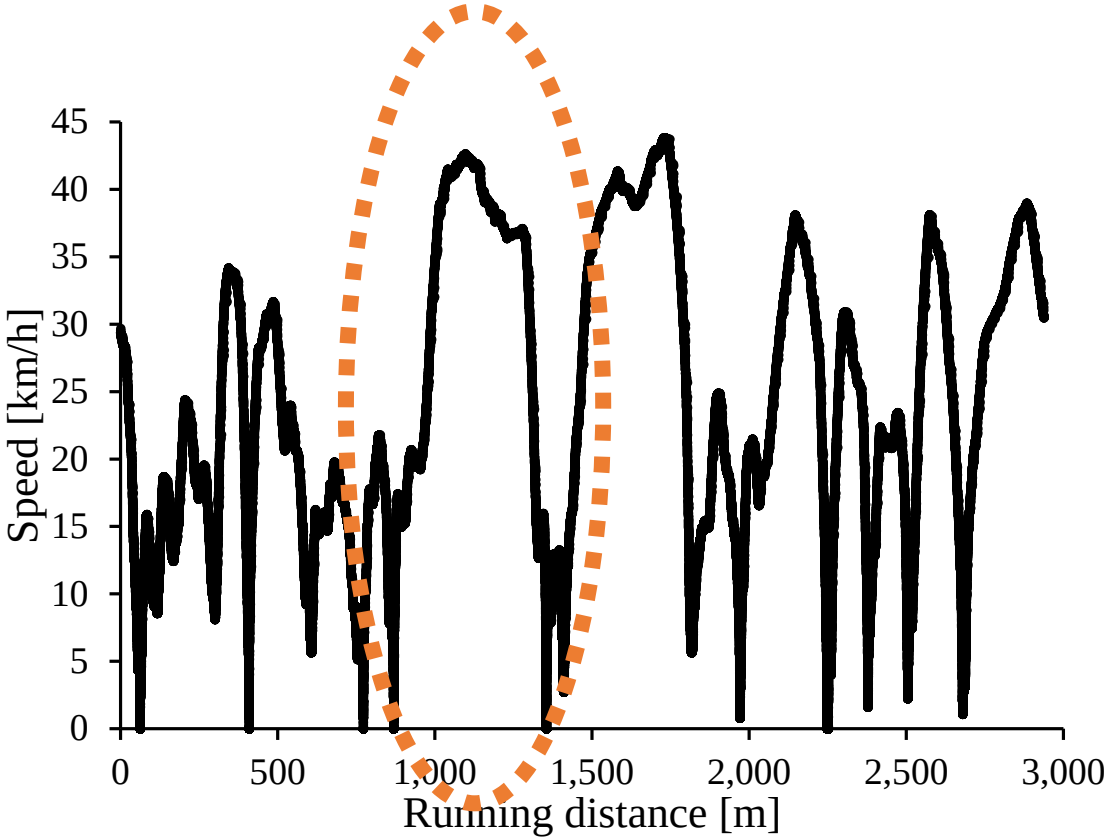
$$Z_s^+ = \Delta t^2 K_1\left(Z_p - Z_u\right) - U\left(Z_u^+ - 2Z_u + Z_u^-\right) + 2Z_s - Z_s^-$$

$$\ddot{Z}_s \approx \frac{Z_s^+ - 2Z_s + Z_s^-}{\Delta t^2}$$

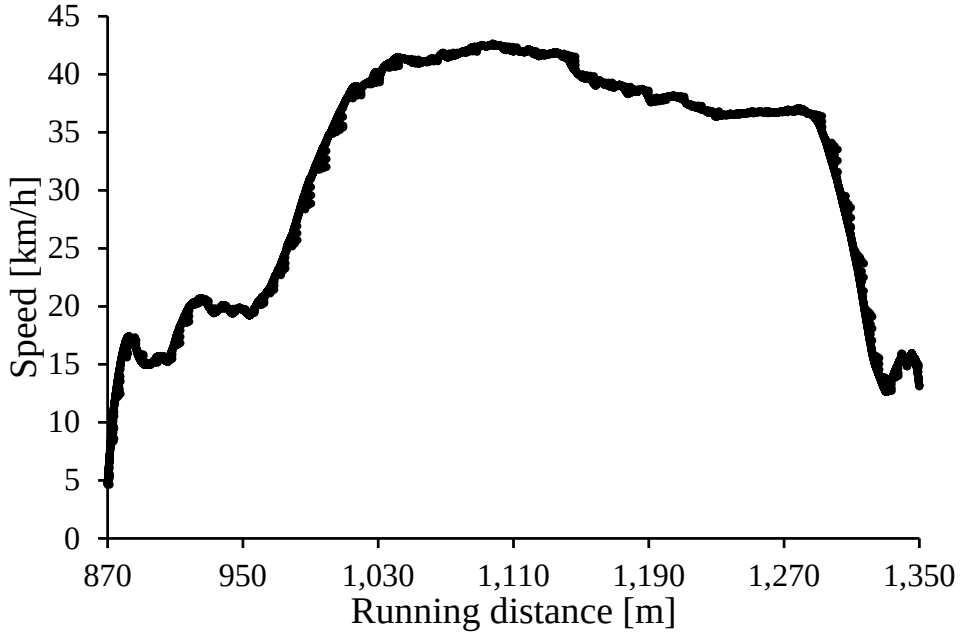
Application$_{1/2}$

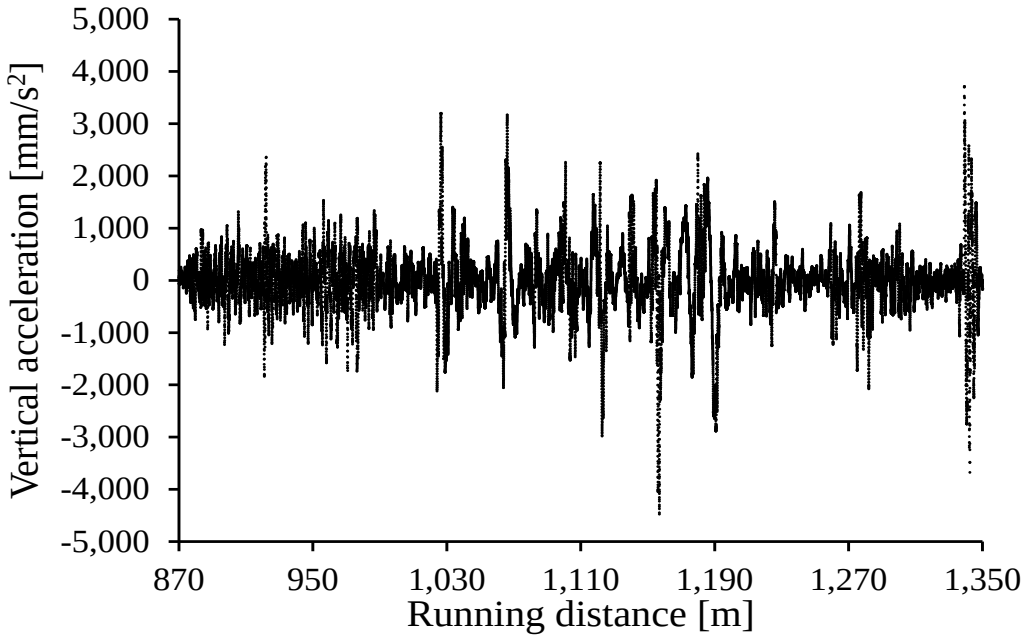
3 km trip in downtown Copenhagen (GPS data)

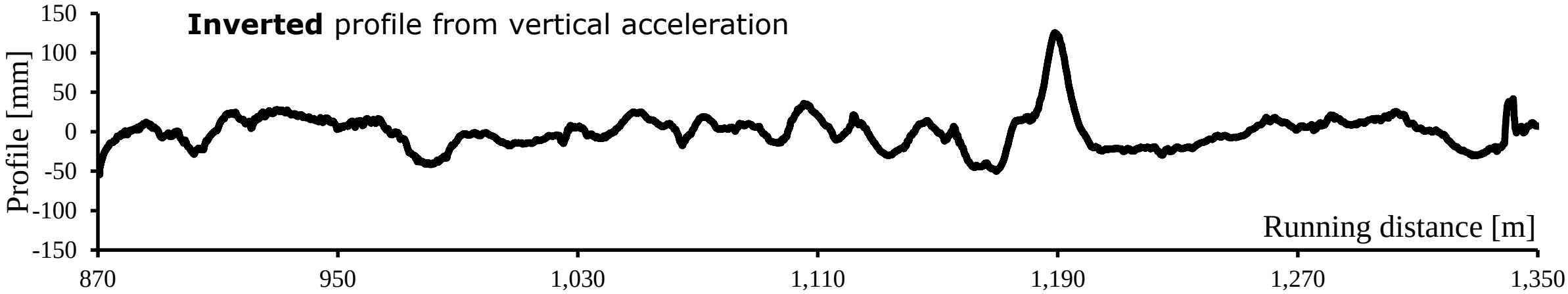




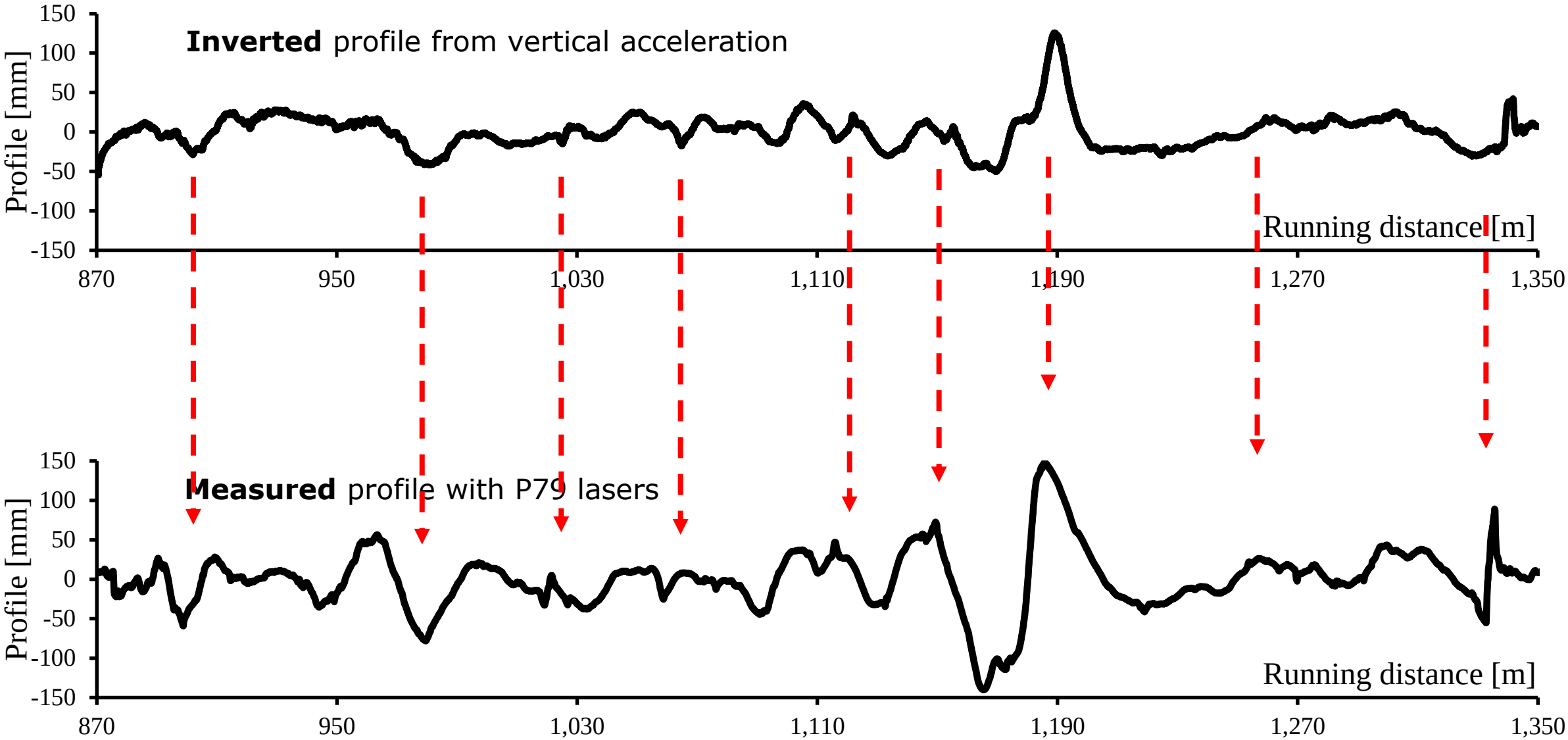
Application$_{2/2}$







Validation



Final remarks

- Profile inversion from accelerations:
  - Possible - promising results – procedure not automated (yet).
- Factors controlling accuracy:
  - More passes,
  - Accelerometer resolution,
  - Data acquisition rate,
  - Vehicle location and speed,
  - Vehicle model (quarter car →).

Thank you!