

Design and Operation of an Instrumented Full Suspension Mountain Bike

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Motivation

- Industrial bicycle design process often based on *trial-and-error*
- Multibody simulation can support the bicycle design process
- For validation, instrumented bicycles are needed
- Instrumented full suspension bicycles are rarely discussed in literature

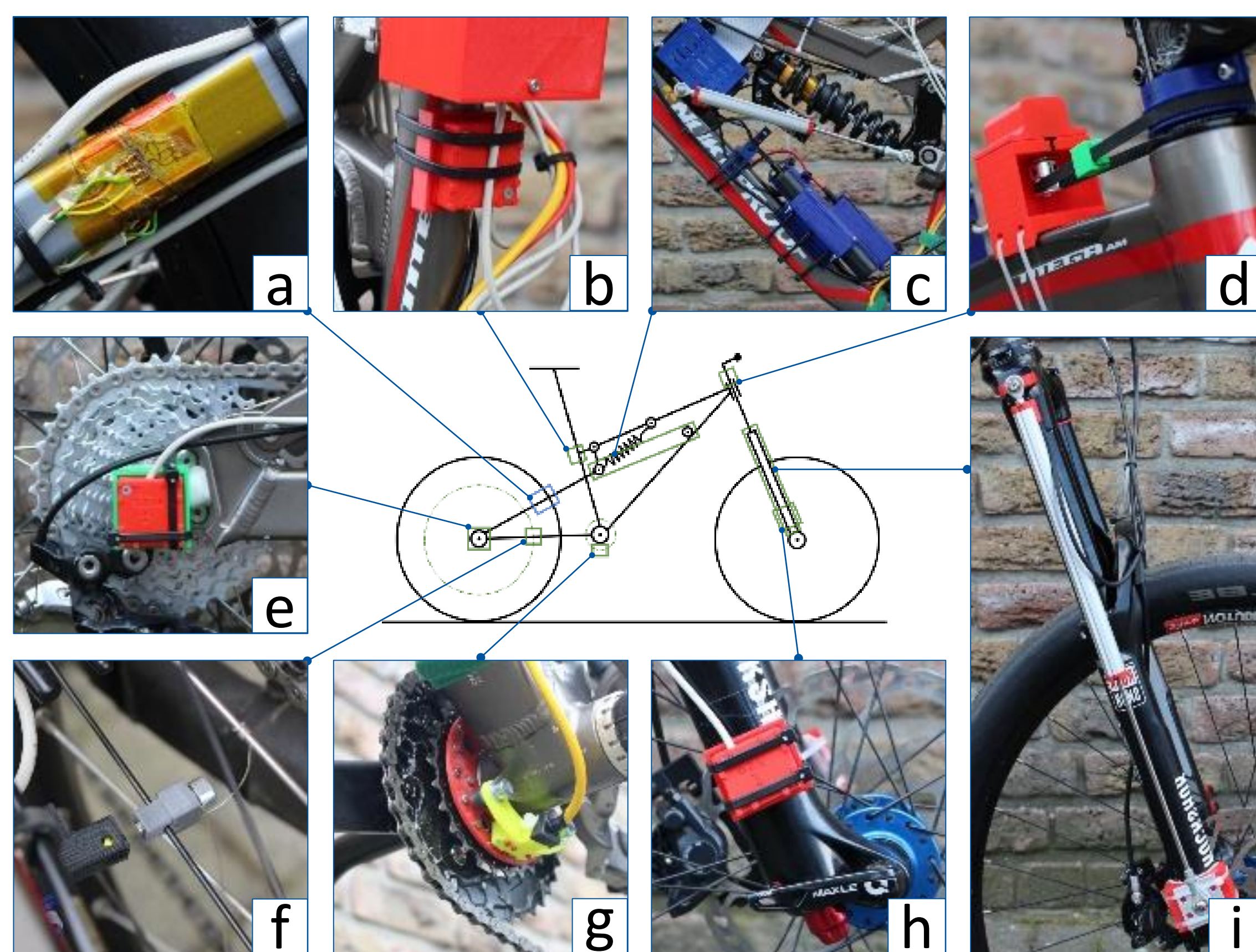


Fig. 2: Measurement equipment of the instrumented bicycle

Results and Conclusion

- Good repeatability (Fig. 3)
- Visible resonance (Fig. 3)
- Smaller rear shock travel for
 - higher weight (Fig. 4)
 - tests with chain (Fig. 4)
 - higher damping (Fig. 4)
- Relatively small effect of chain forces (Fig. 4) imply importance of inertia force excitation of the legs
- Dynamic effects play an important role, thus have to be taken into account in the bicycle design process

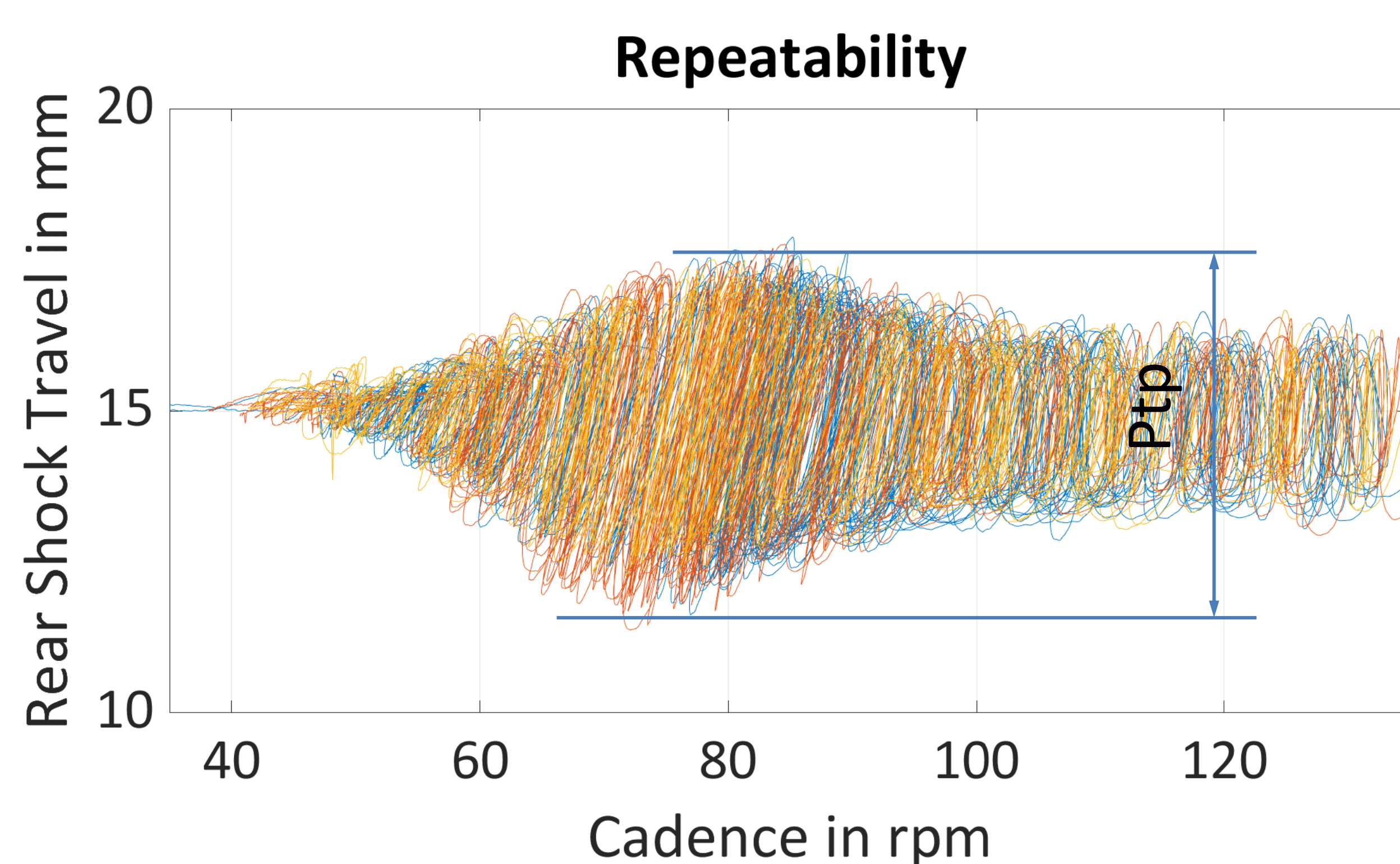


Fig. 3: System response to cadence sweep (low damping, no additional mass, with chain, rider 1)



Fig. 1: Instrumented bicycle mounted on stationary trainer

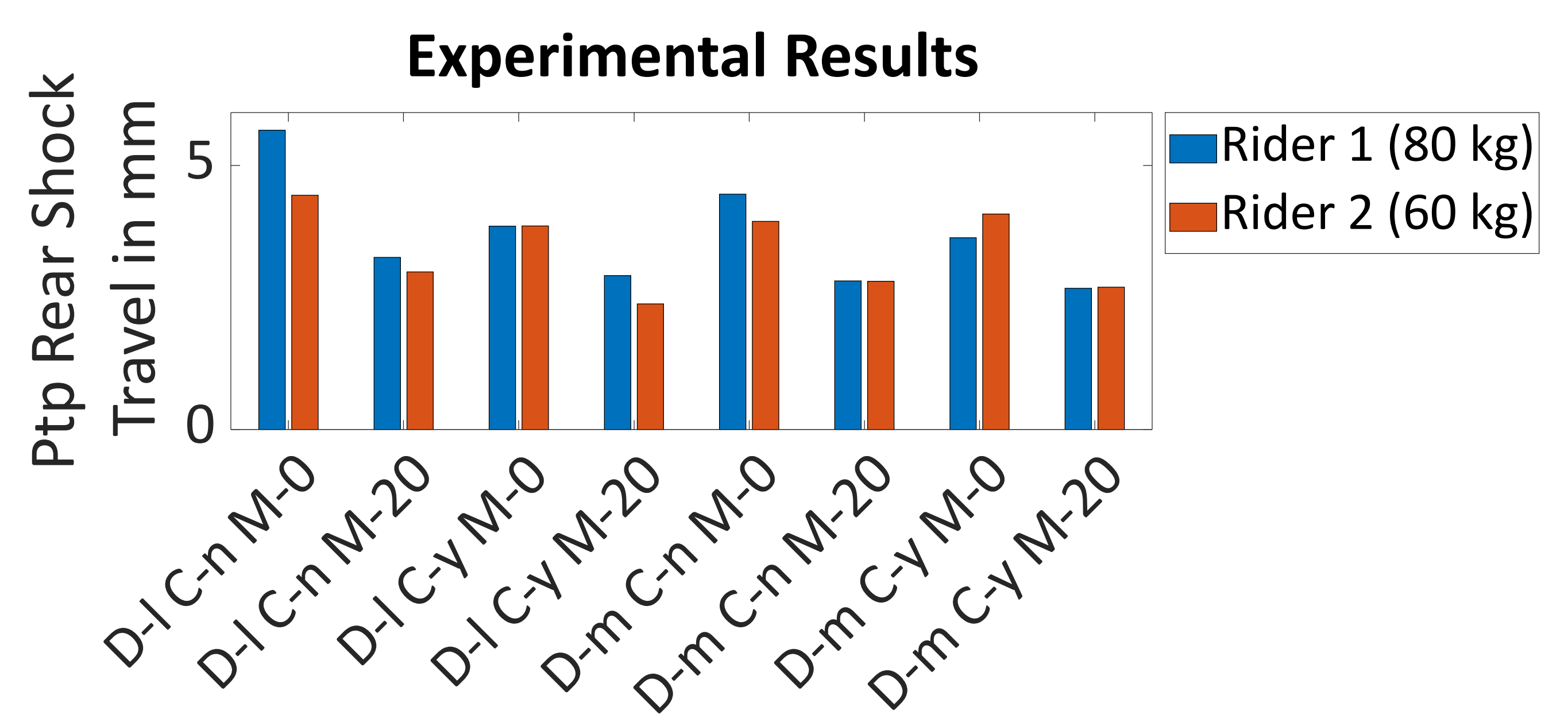
Materials and Methods

Measurement devices

- Strain gauges to measure force (Fig. 2a)
- 3-axis gyroscope to measure the lean angle (Fig. 2b)
- Linear position transducers to measure the travel of suspension elements (Fig. 2c and 2i)
- Potentiometer to measure the steering angle (Fig. 2d)
- Accelerometers to measure the acceleration of unsprung mass (Fig. 2e and 2h)
- Hall sensor to measure the speed (Fig. 2f)
- Hall sensors to measure the crank angle and the cadence (Fig. 2g)
- On-board power supply and data logging (Fig. 2c)

Experimental set-up

- Measurement of bobbing behavior while pedaling
 - With and without additional weight
 - With and without chain
 - Different damping setups
 - Different riders
- Tests performed on stationary bicycle trainer



Experimental Setup (D: Damping [medium/low];
C: Chain [yes/no]; M: Additional Mass [0 kg/20 kg])

Fig. 4: Peak-to-peak (Ptp) values from cadence sweep for different experimental setups

