

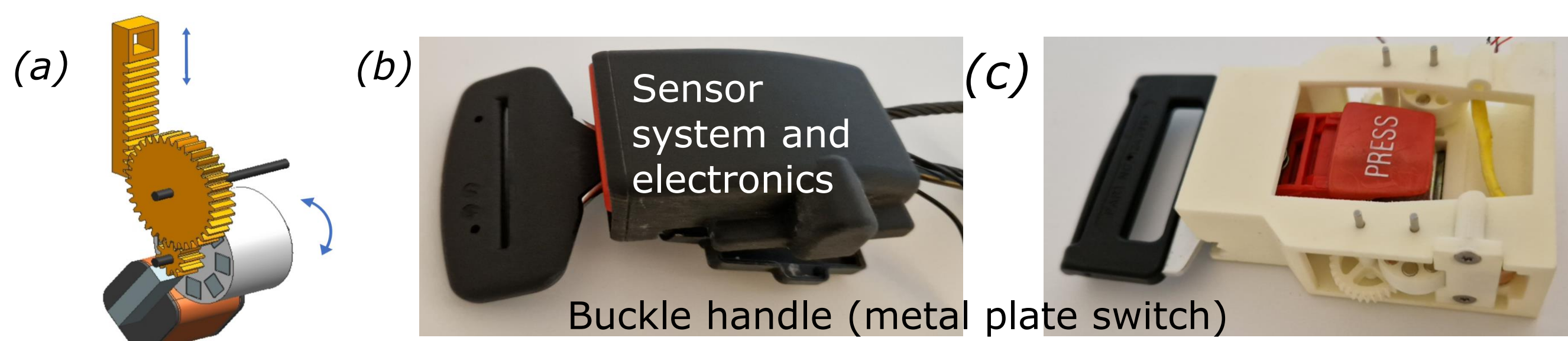
## Energy harvesting feasibility for safety buckle belt

J. Bjurström, E. Köhler, H. Staaf, T. Björnfort, D. Kolev, C. Rusu  
RISE Research Institutes of Sweden, Gothenburg, cristina.rusu@ri.se  
S. Nord, M. Andersson – Autoliv, Vårgårda, Sweden  
E. Godtman Kling - Revibe Energy AB, Gothenburg, Sweden

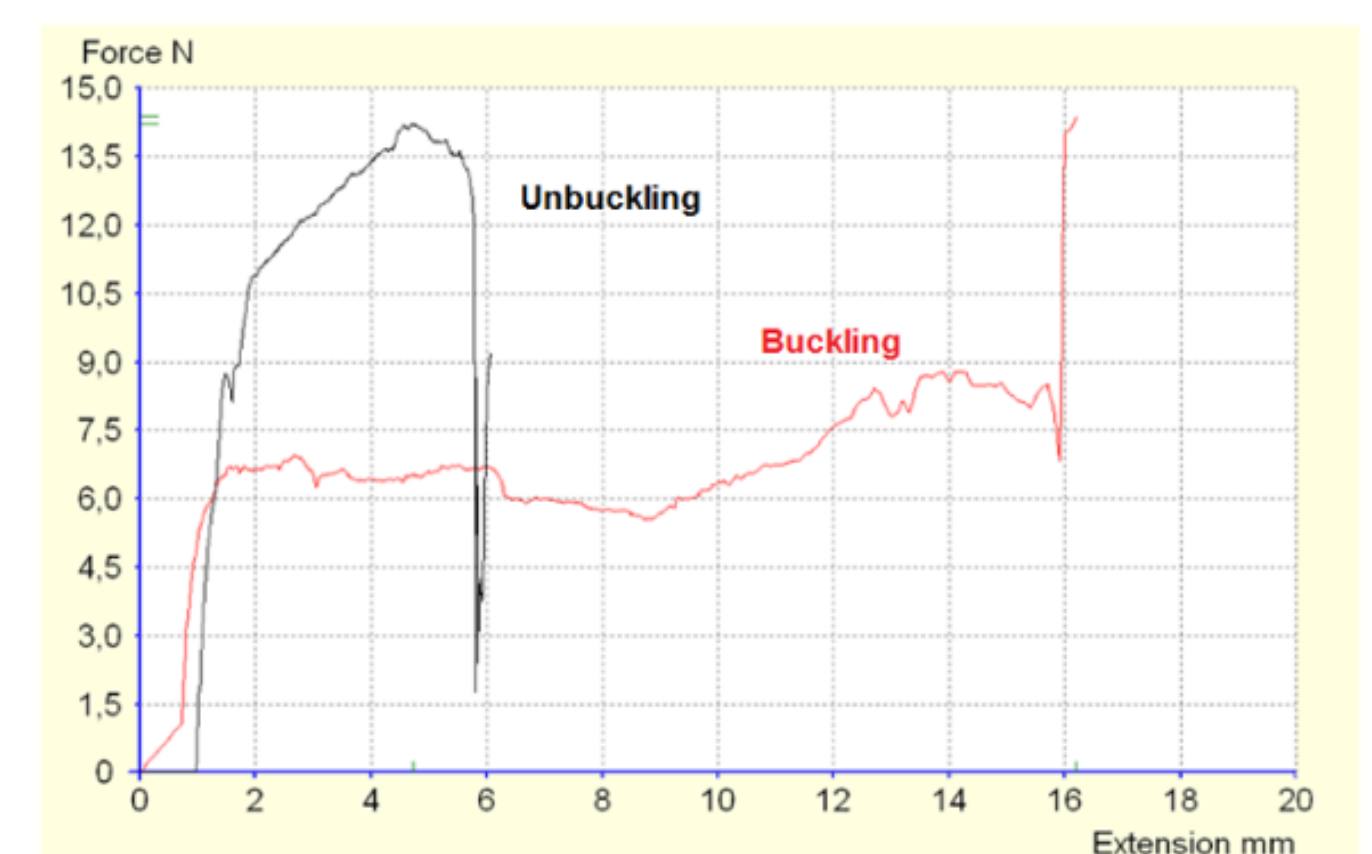
**ABSTRACT:** The potential of energy harvesting for powering a safety sensor on a belt buckle is studied. We develop an electromagnetic energy harvester converting vertical buckle-in/-out events into rotations of a circular array of magnets, varying the flux through a coil. Both measurements and simulations are performed, the later showing a potential energy of 4mJ for a single buckle-in event.

### Energy Harvester

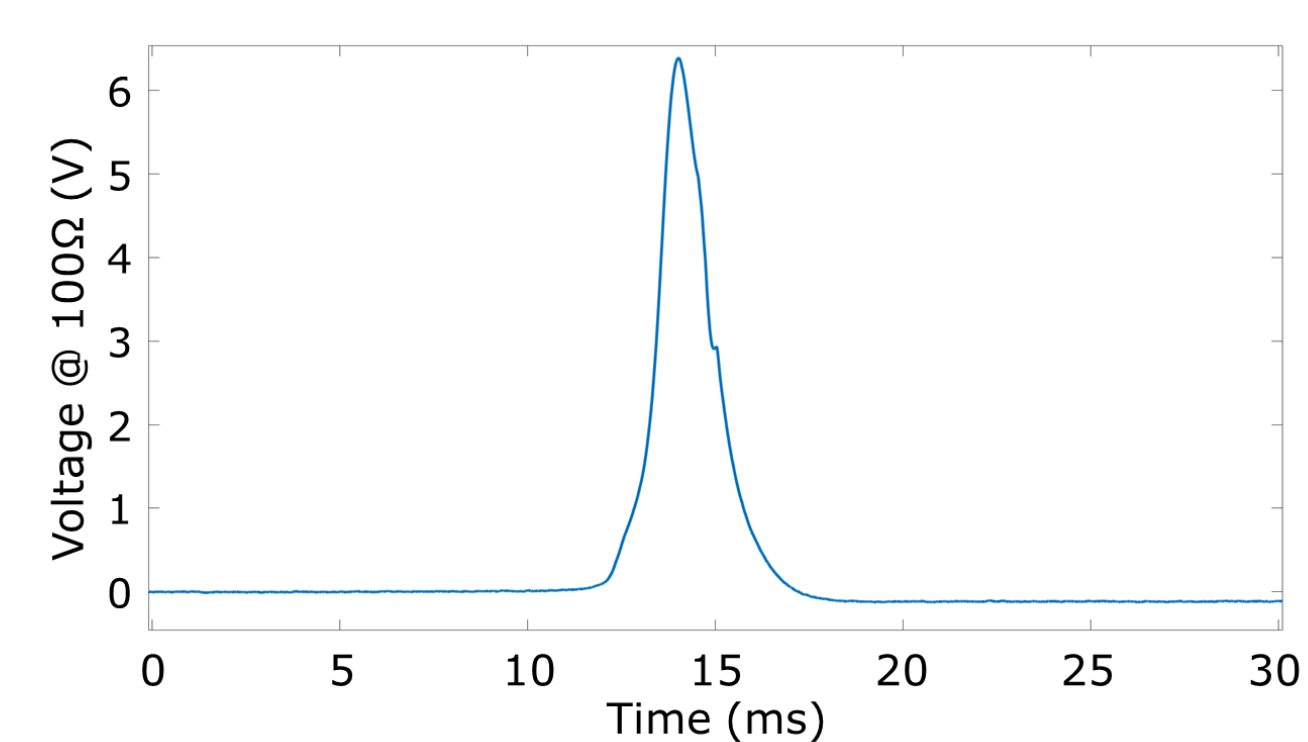
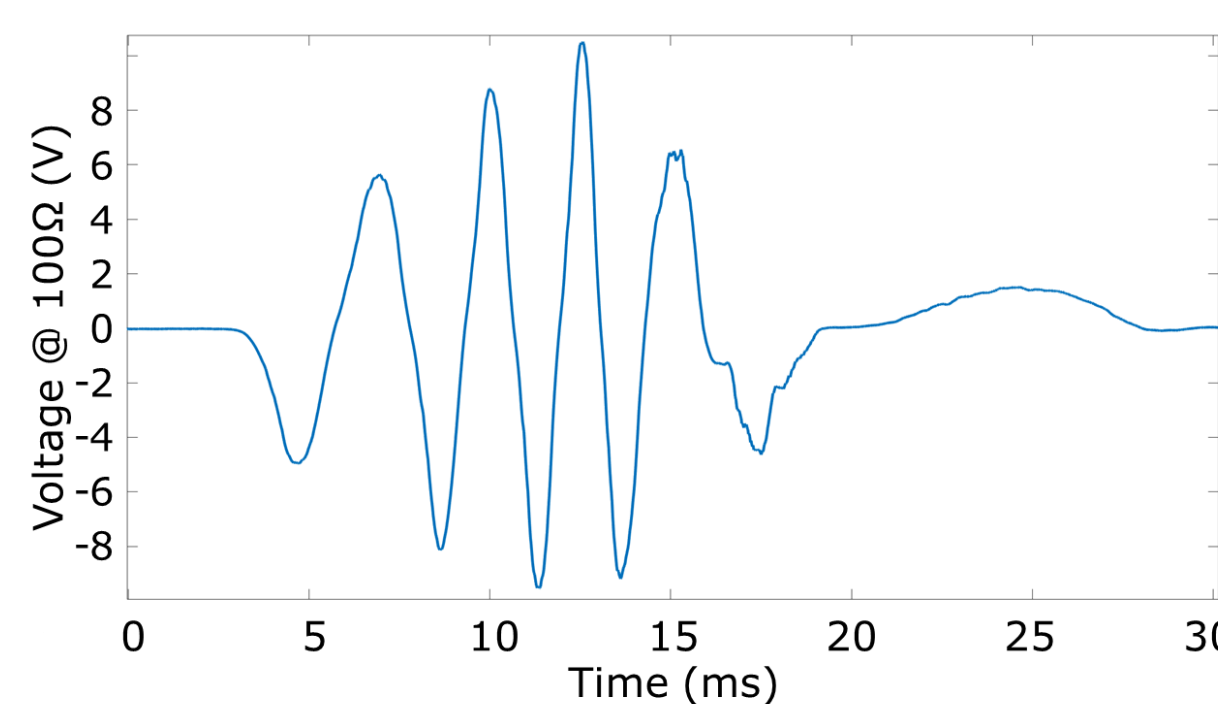
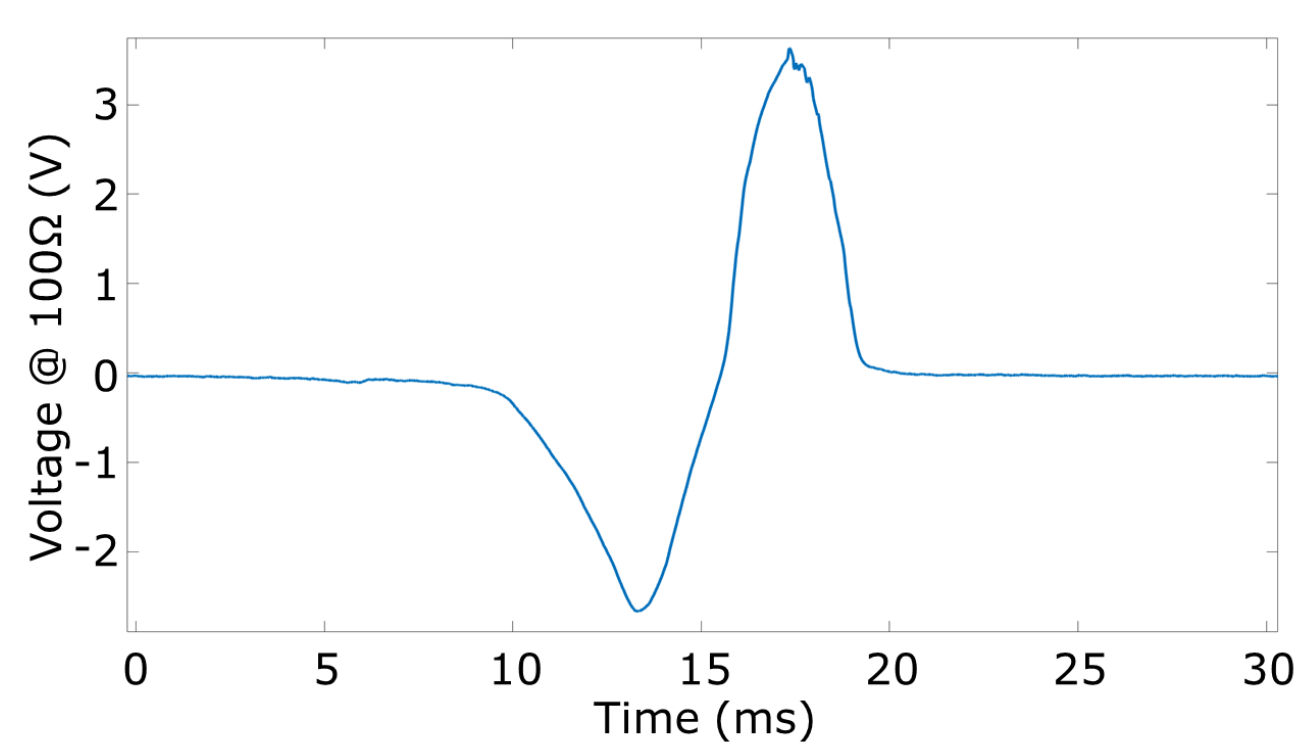
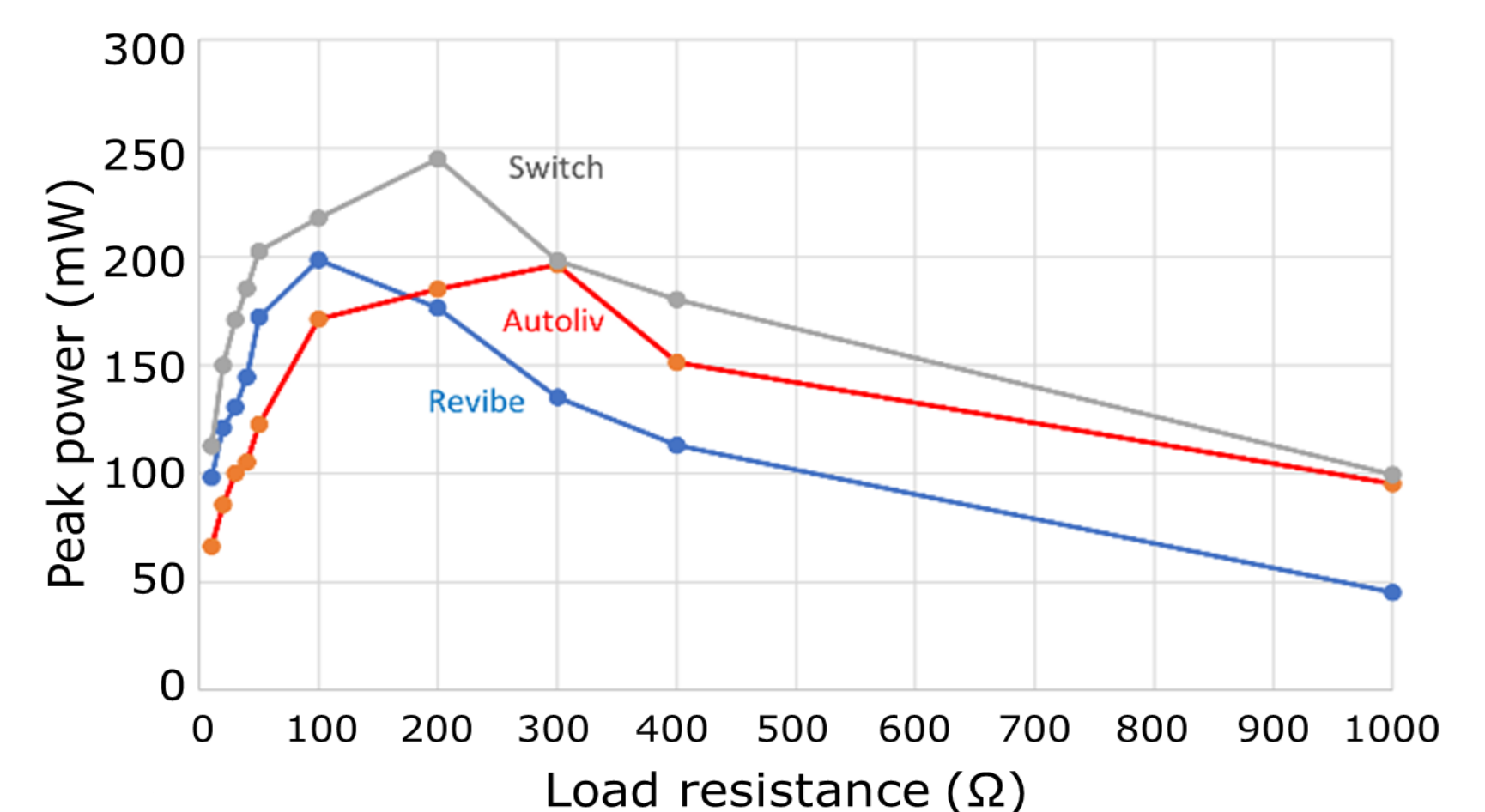
- Electromagnetic energy harvester (EH) converts vertical buckle-in/-out events into rotations of a circular array of magnets, varying the flux through a coil.
- Manual actuation of buckle for Autoliv design:
  - Average time for buckle-in/-out ca. 0,1 s
  - Maximum measured energy output for:
    - buckle-in: 300μJ
    - buckle-out: 400μJ
- Wireless energy transmission
  - 1m activation of RF RX/TX Qiachip 433MHz
  - Bluetooth® low energy evaluation board BLE-SWITCH001-GEVB



(a) Sketch mechanical transient EH using angular movement of permanent magnets in electric coil used inside buckle; (b) Autoliv, (c) Revibe Energy



Measured force and displacement required to buckle in/out of a standard belt buckle.



Typical open-circuit voltage from harvester-buckle prototype (a) Autoliv, (b) Revibe, (c) mechanical switch by using evaluation kit

### Conclusions

- Easy, robust, and elegant solution to harvest energy for safety belt.
- Dual energy harvesters would potentially produce up to 8mJ in 0.1 s.
- A buckle sensor may consume in μW range, thus buckle sensor could work continuously for up to 15 min, from a single buckle event.

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