DIEHL & EAGLE PICHER
Batterie-Systeme

Fast Activating Miniature Lithium Thionylchlorid Reserve Battery

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Overview

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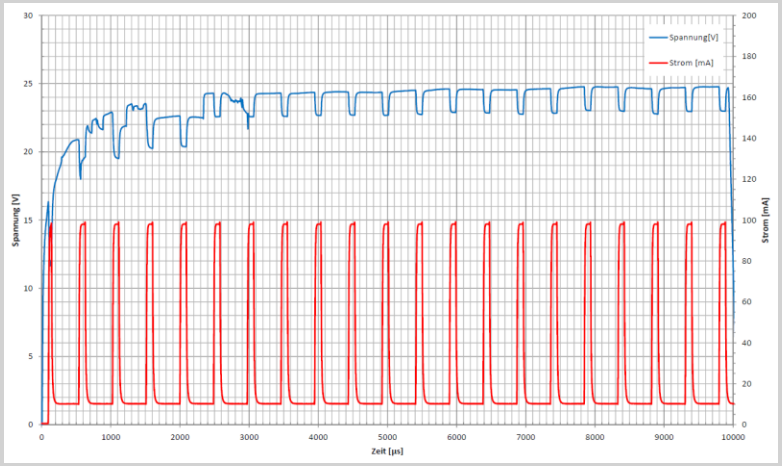
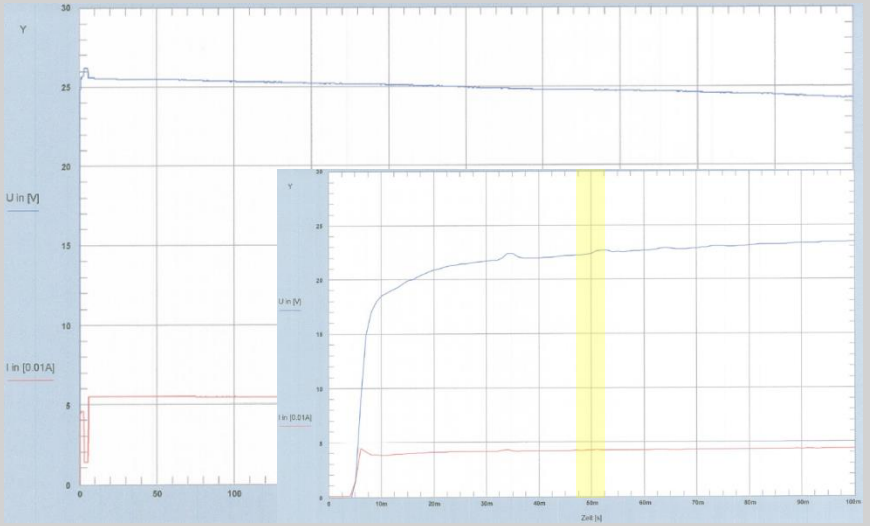
- Background
- Conceptual idea
- Design considerations
- Modelling
- Experimental set-up
- First results
- Conclusion and future work

Background

- Fast activation
  - Large caliber Power Supplies usually benign requirements, e.g.
    - MOFA, …
    - DEP14001
  - Can we make it faster



DEP 14001 „fast activation“ in medium caliber



DEP 14001 „normal activation“

Background

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- Miniaturization
  - Large calibers can afford “large” batteries

MOFA
Ø 38,1 mm
h 17 mm

DEP14001
Ø 32,17 mm
h 25,33 mm

  - Can we make it smaller

M235
Ø 5,6 mm
h 5,5 mm

Background

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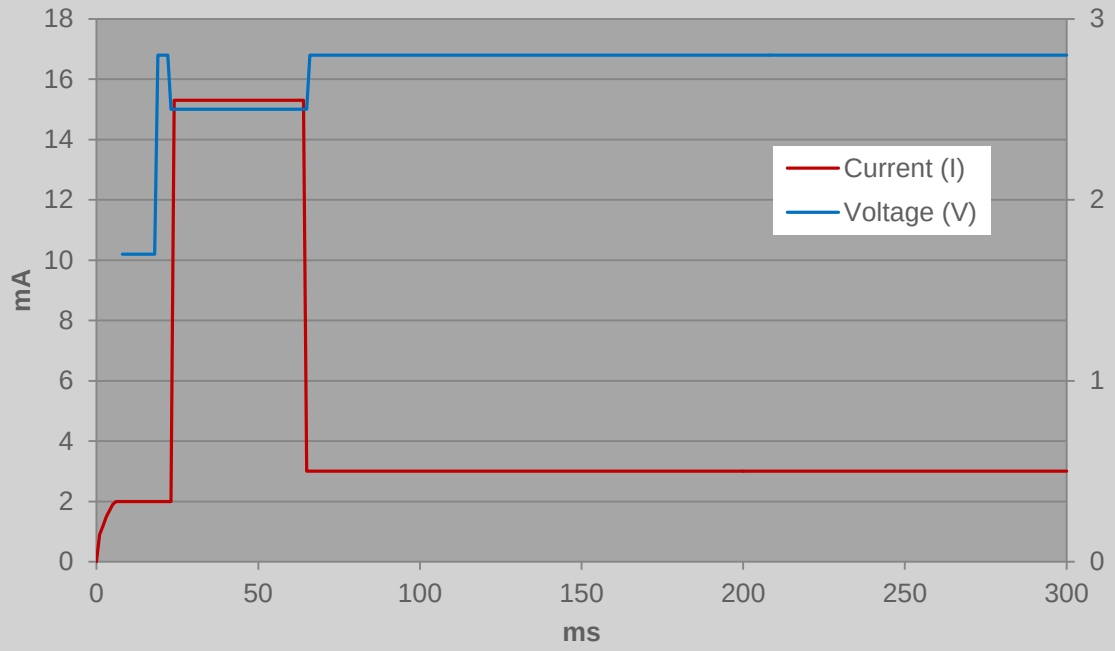
- Fast and small **and** “no spin” **and** early high current

Large caliber				**Medium caliber**
10 - 100 ms	–	rise time	–	8 ms
32 x 25 mm	–	size	–	11 x 11 mm
2900 $^{1}/_{min}$	–	spin	–	zero
n.a.	–	current	–	15 mA



Conceptual idea

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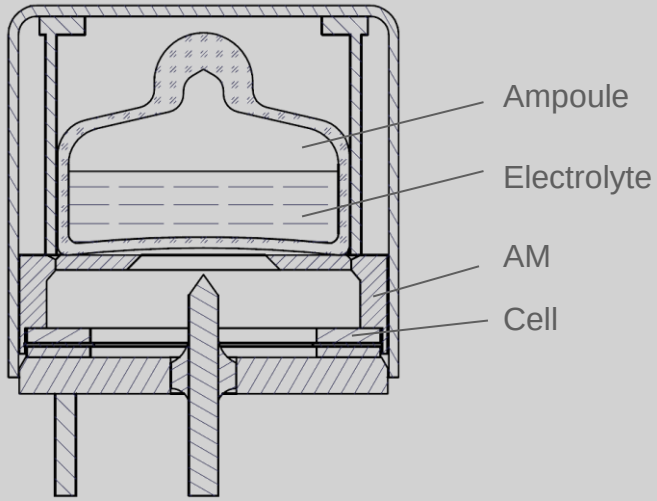
- Liquid Reserve Battery
  - “Dry cell” lithium-seperator-carbon collector
  - Same chemistry as DEP 14001
  - Electrolyte in glass ampoule
  - Support/activation system
  - Acceleration based activation (release of electrolyte)
  - Acceleration based distribution of electrolyte (ampoule on top of cell)



Design Consideration

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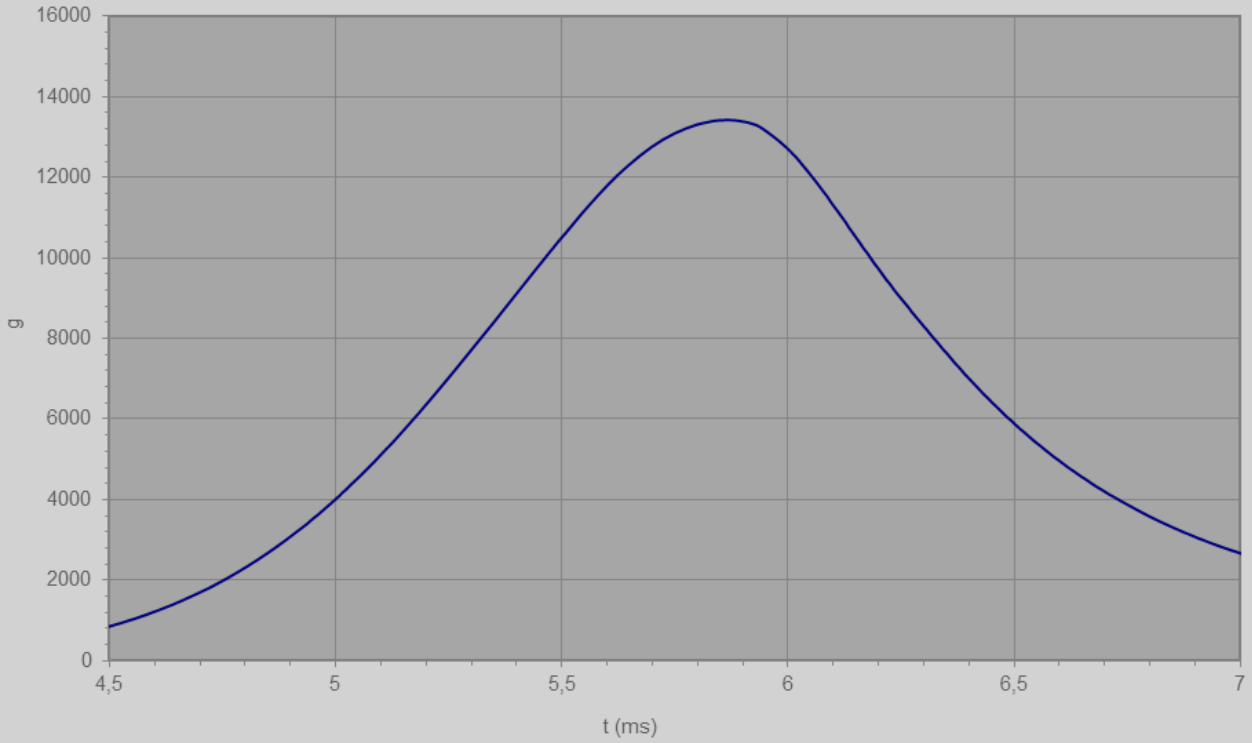
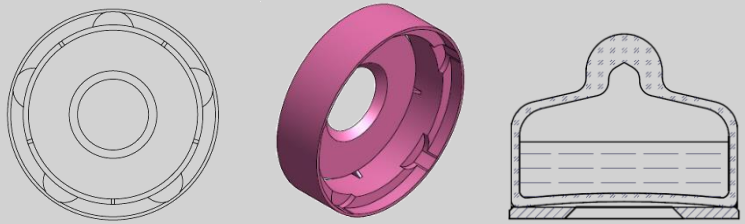
- Cell Area
- Electrolyte quantity
- Break force ↔ Drop safety
- Wetting speed



Firing acceleration

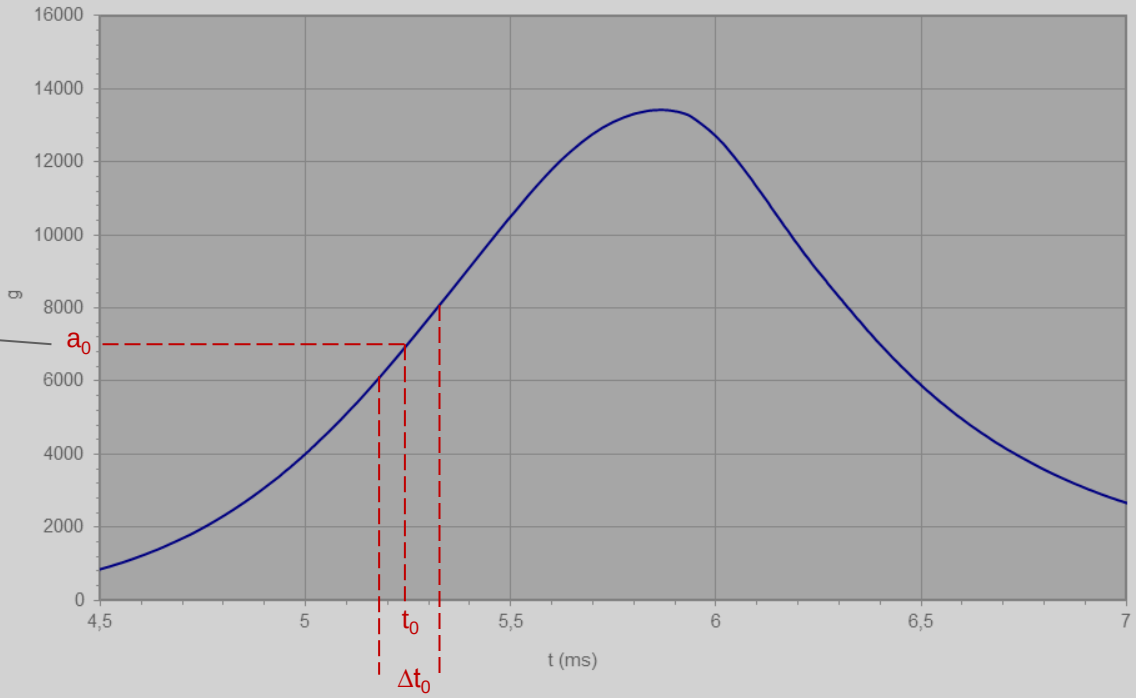
Modelling

- Cell area → Engineering calculation
- Electrolyte quantity → Engineering calculation
- Break force



Top view of support structure

$$F_{Z0} = a_0 \times m_0$$



- Drop safety
- Tolerance
- Variation t_0

Modelling

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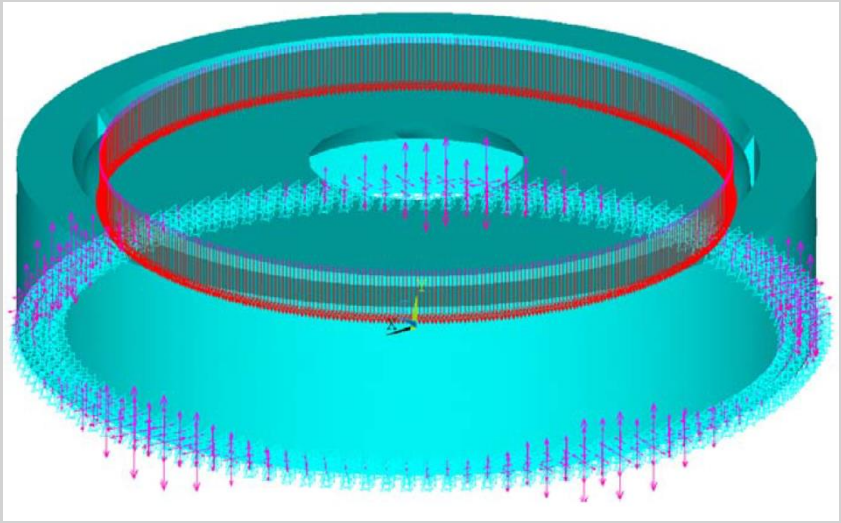
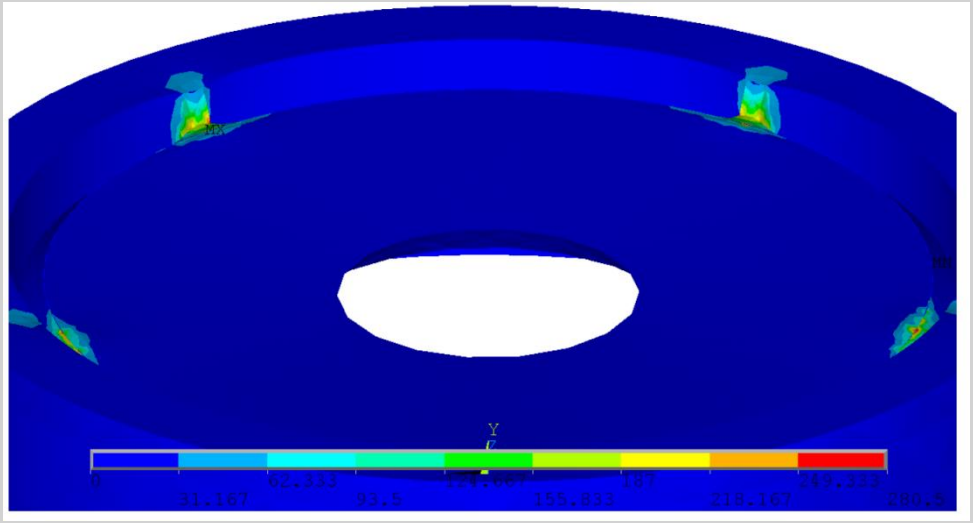
- FEM of break disk
  - Number of bridges
  - Cross-section of bridges



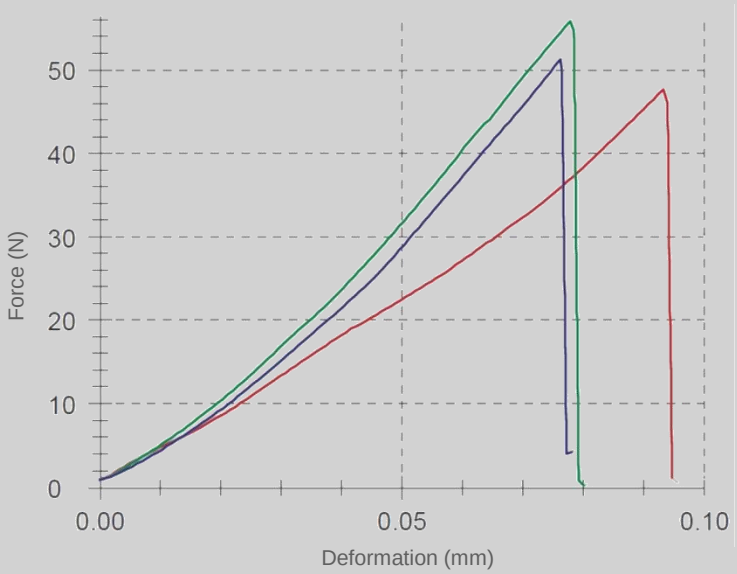
Forces

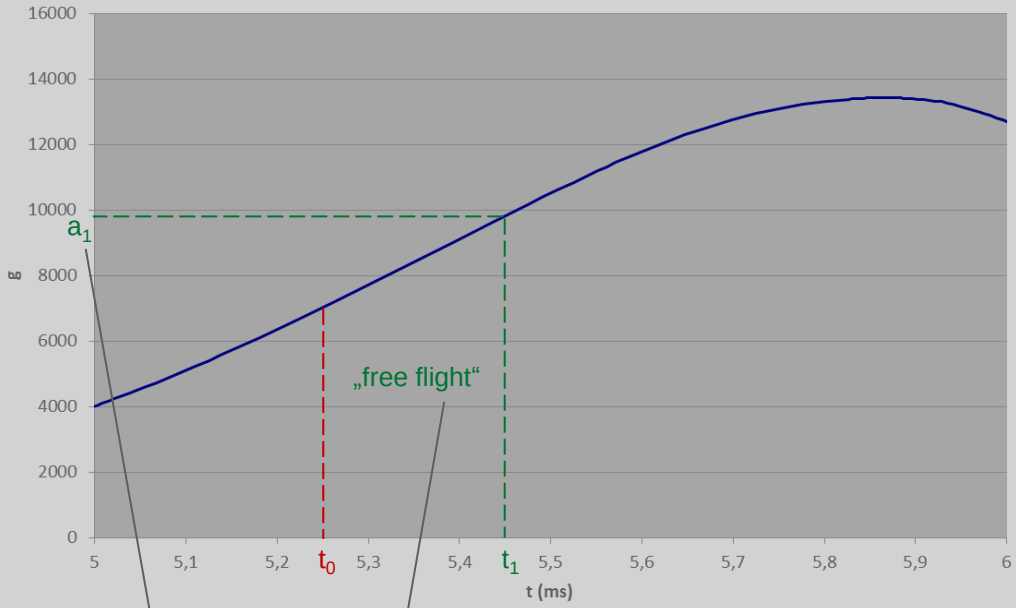


Stress

Modelling

- Breaking of glass ampoule
  - Static test
  - Engineering calculation





$$F_{z1} = a_1 \cdot m_1 + \frac{E_{Kin}}{\Delta t_1}$$

Modelling

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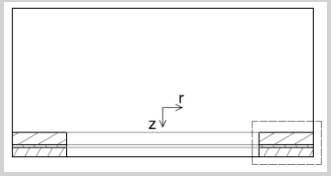
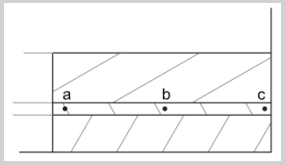
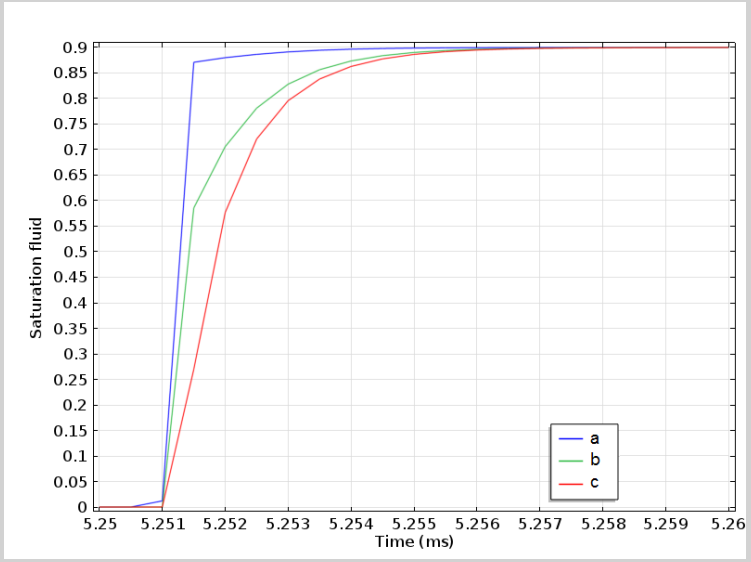
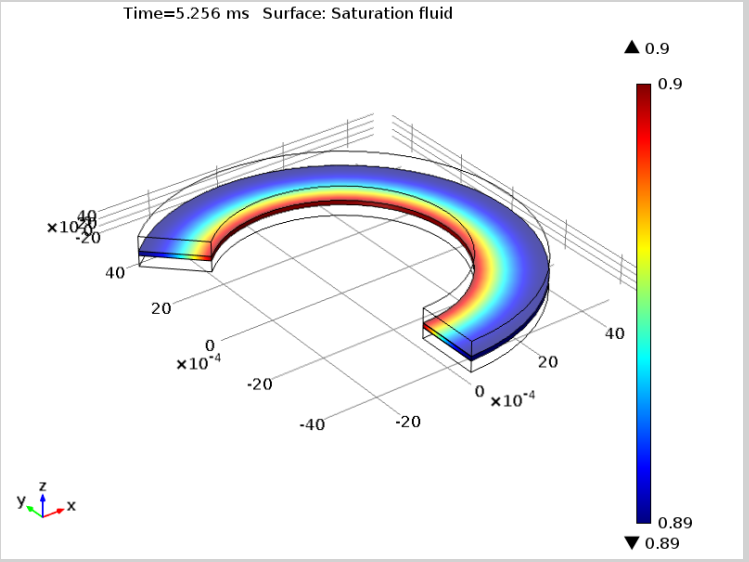
- Electrolyte Distribution
  - Simple engineering approach
  - CFD Model (Comsol Multiphysics®)









Experimental set-up

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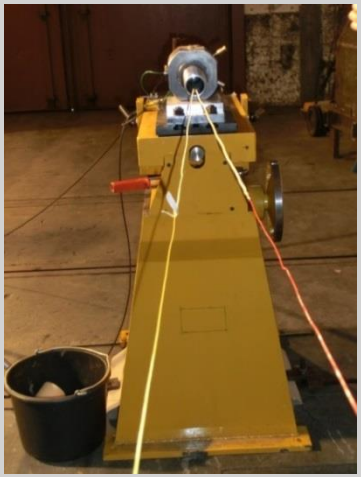
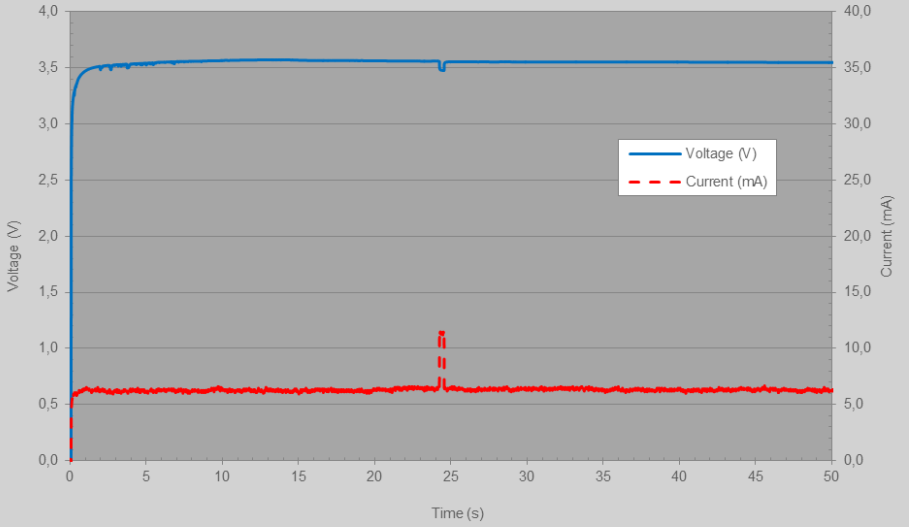
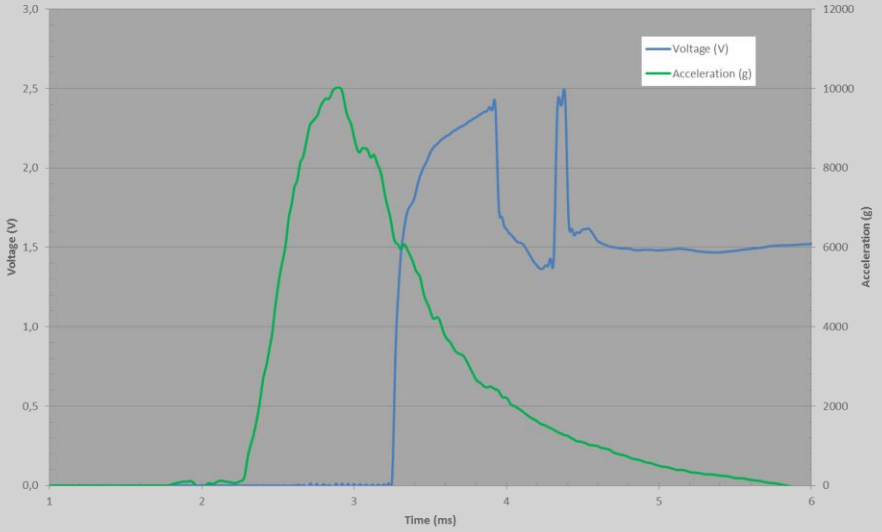
- Drop-Tower ≈ 10,000 g's, 50 - 100 µs
  - Activation
  - Total life
- 40 mm live-firing > 10,000 g's, > 100 µs
  - Activation
  - Cell flooding







Experimental set-up

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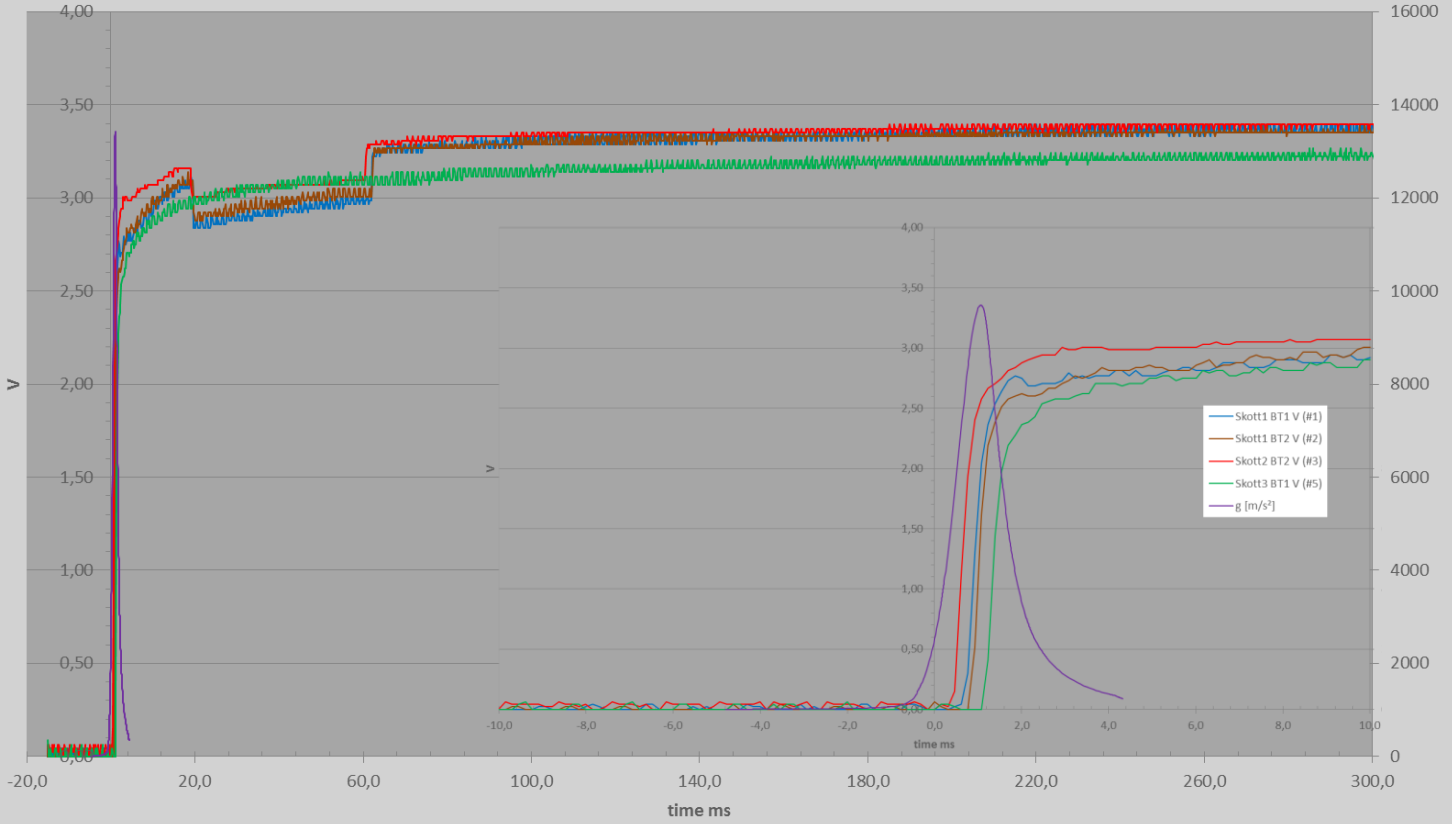
- Live-firing, target application
  - Activation
  - Cell flooding
  - Load pulse



Conclusion and future work

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- Conclusions
  - Miniaturized
  - Fast activation
  - Load pulse and life time
- Future work
  - Improvements of break disk and ampoule
  - Manufacturability
  - Qualification

Future work

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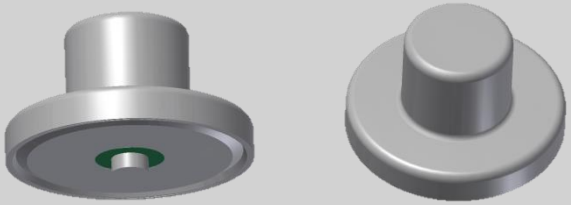
- A family of Miniature Batteries

Ø 11 mm
h 11 mm
No spin

Ø 10/11 mm
h 10/13 mm
High spin



Ø 10/20 mm
h 3/11 mm
No spin/high spin
Long life

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Thank you for your attention!

Questions?