

CTAF - Electric Traction Chain with Segmented Power Supply

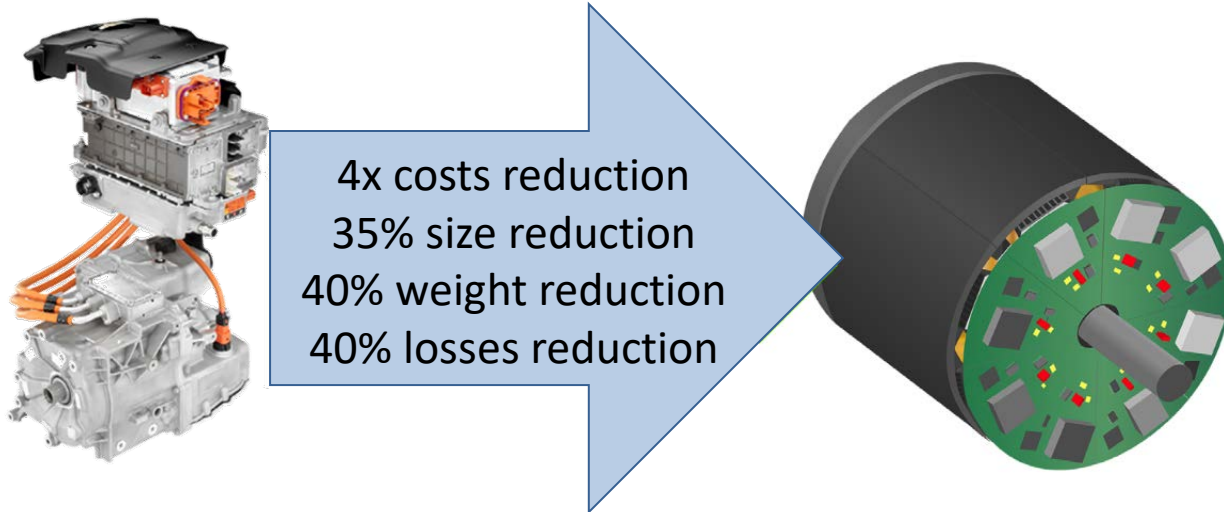
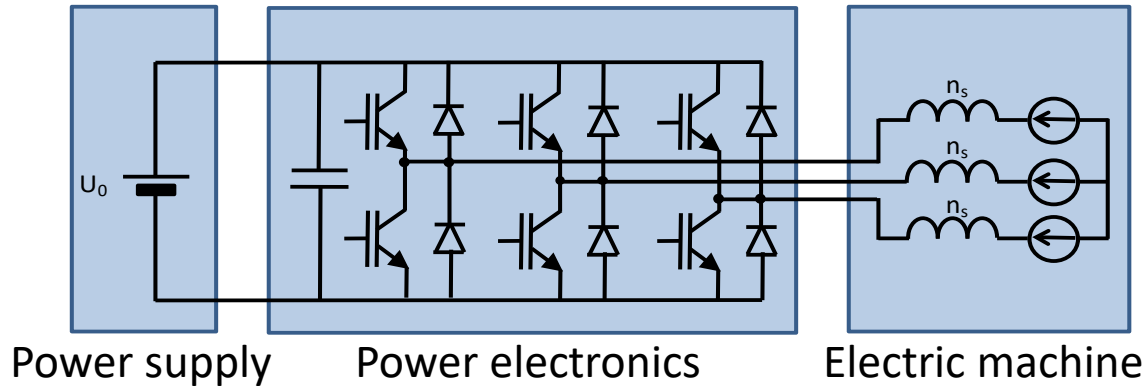
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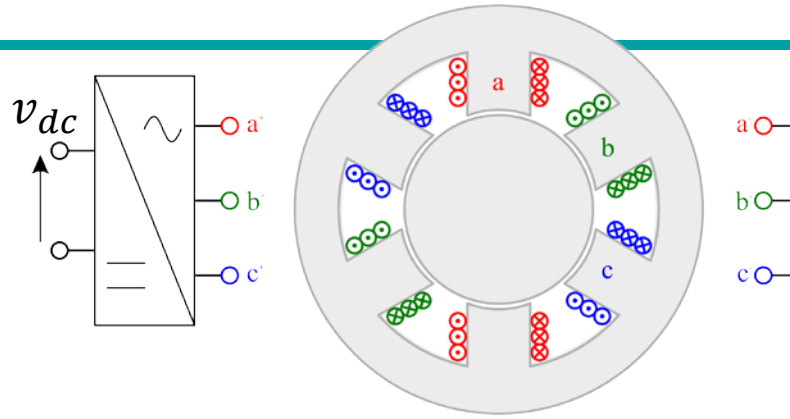
Motivation

Integration of electric traction chains

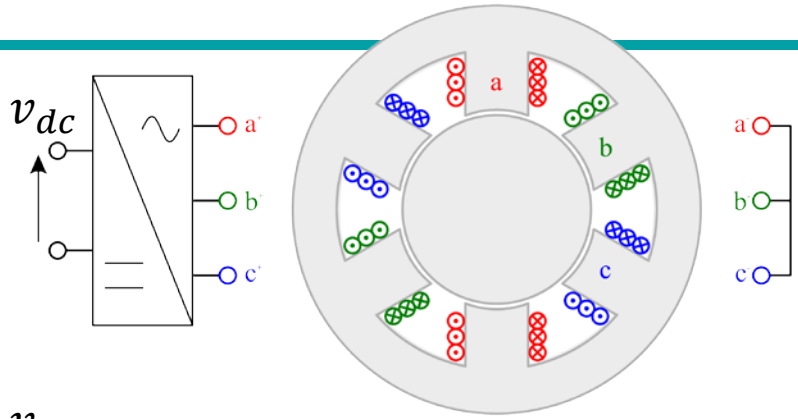


Source : Quadrennial Technology Review 2015, Plug-In Electric Vehicles, Chapter 8: Technology Assessments, U.S. Department of Energy

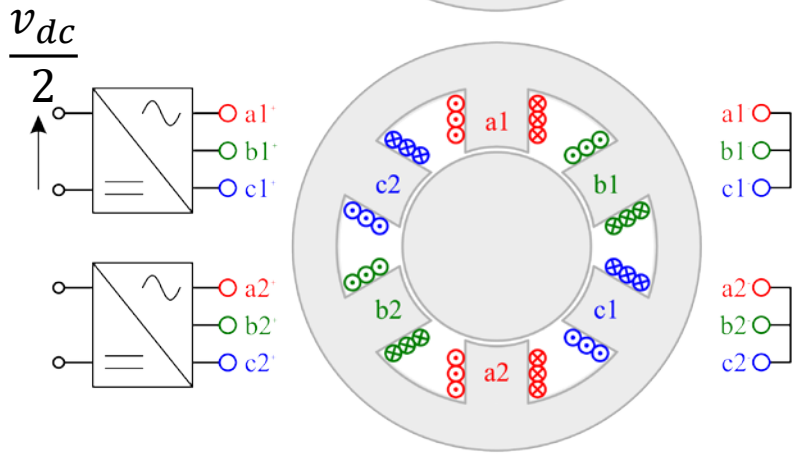
Concept



Concept



Split the windings by coil

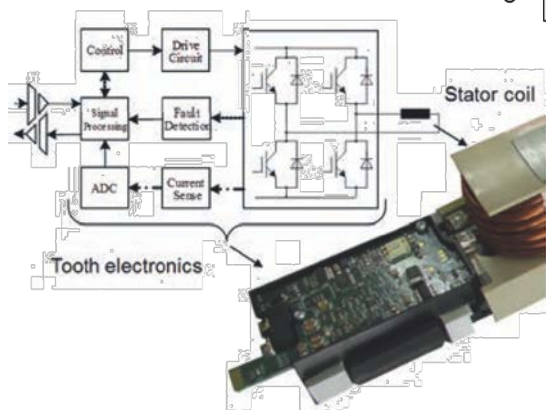


➔ Limited by the number of coils

[Wang2015] J. Wang, Y. Li and Y. Han, "Integrated Modular Motor Drive Design With GaN Power FETs," in *IEEE Transactions on Industry Applications*, vol. 51, no. 4, pp. 3198-3207, July-Aug. 2015.

Concept

Split the windings by coil



Smart Stator Tooth (SST)

©EMILE

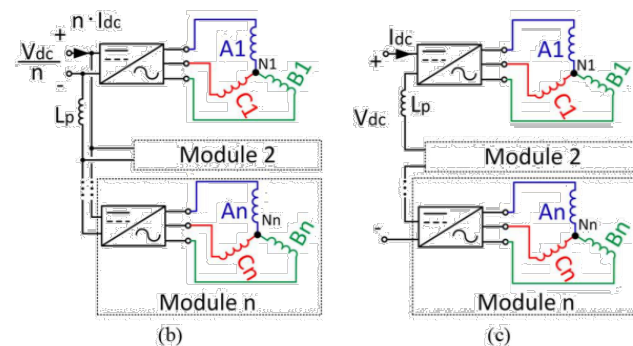
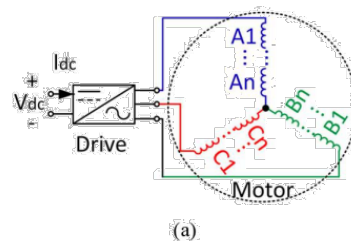
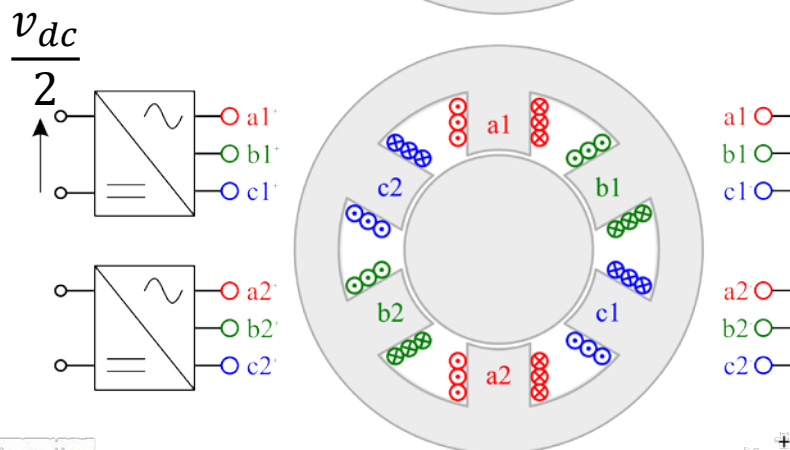
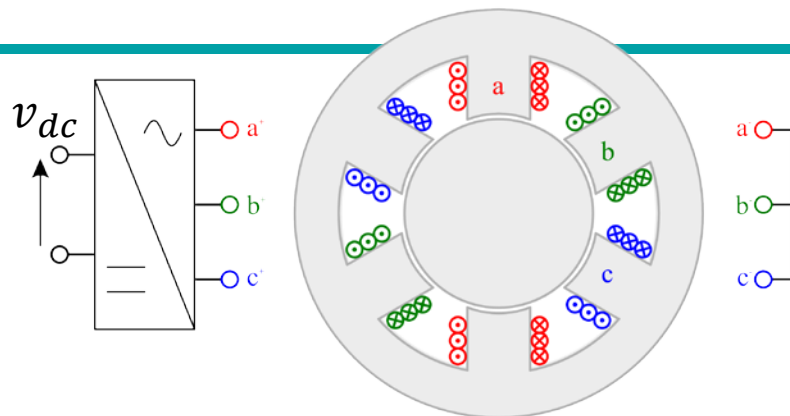


Fig. 2. (a) Conventional motor drive. (b) Conventional IMMD. (c) Proposed structure.

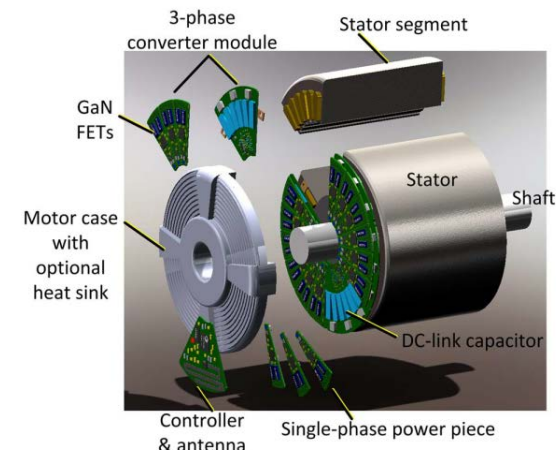
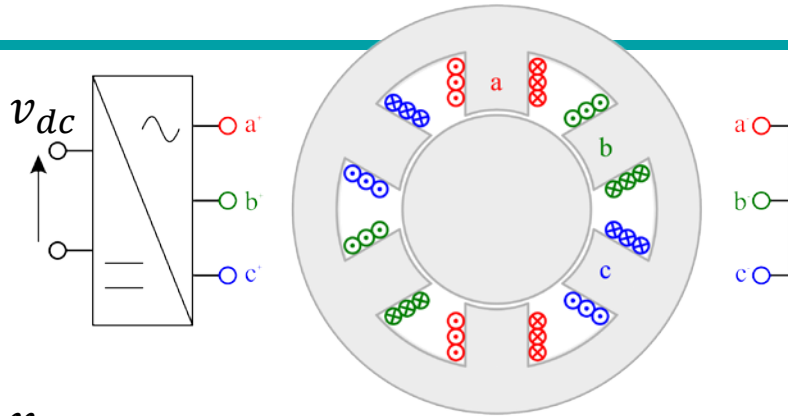


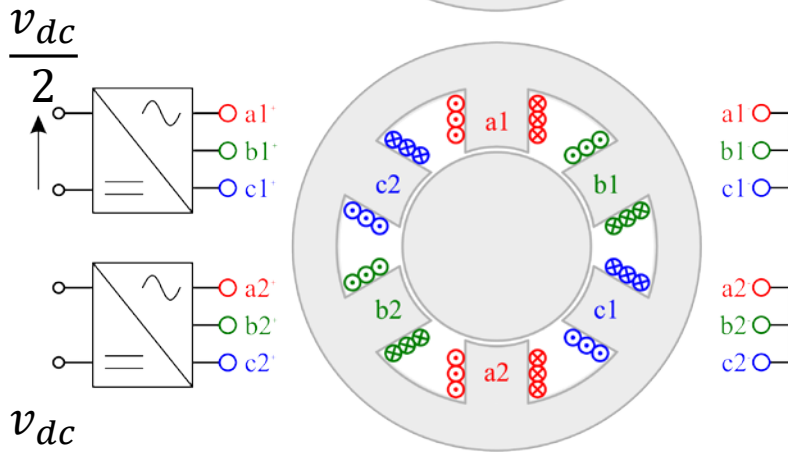
Fig. 1. Three-dimensional illustration of the proposed IMMD.

[Wang2015] J. Wang, Y. Li and Y. Han, "Integrated Modular Motor Drive Design With GaN Power FETs," in *IEEE Transactions on Industry Applications*, vol. 51, no. 4, pp. 3198-3207, 2015.

Concept

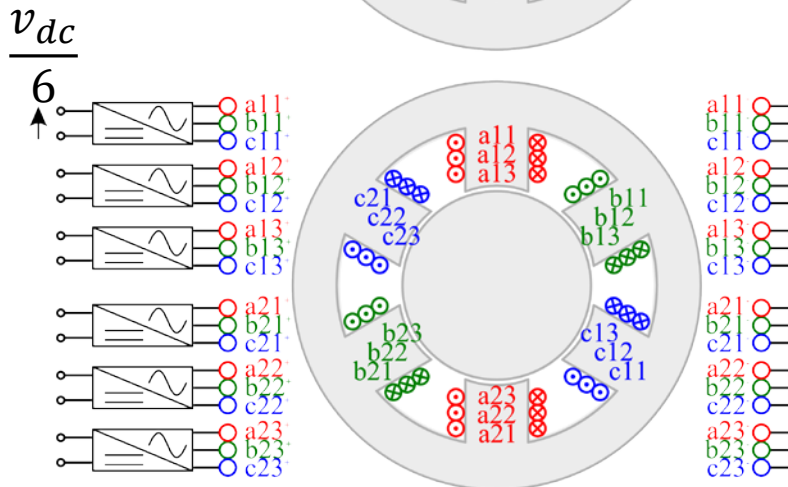


Split the windings by coil



➔ Limited by the number of coils

Split the windings by bundle of turns



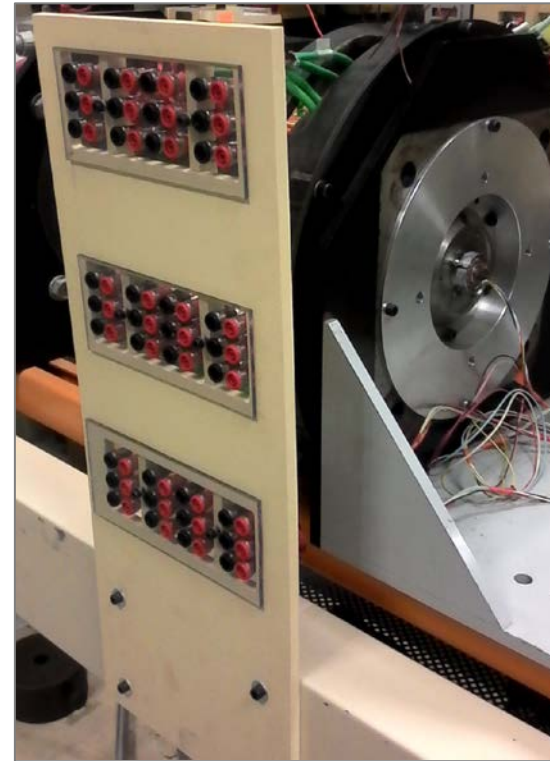
➔ Limited by the number of turns

Advantages and drawbacks

1. Low voltage traction chain
2. Improved availability rate
3. Reduced stress on the insulation
4. Multi-source power supply
5. Additional degrees of freedom
6. Low power per switch
7. Improved filling factor
8. Improved compactness
9. Suitable for wide-bandgap semiconductors

1. Large number of sensors
2. Difficulty of synchronization
3. Rethinking the control
4. Complex connections
5. Electromagnetic compatibility
6. Isolation of a defective cell
7. Consumption of copper
8. Difficulty of recycling

Overview of the collaboration



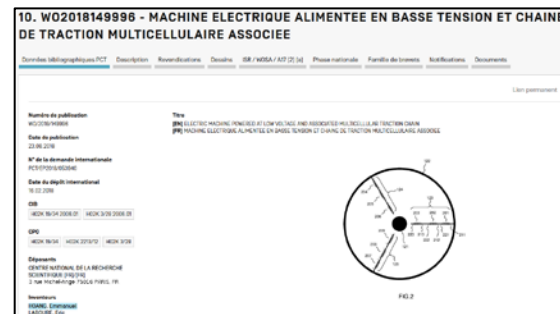
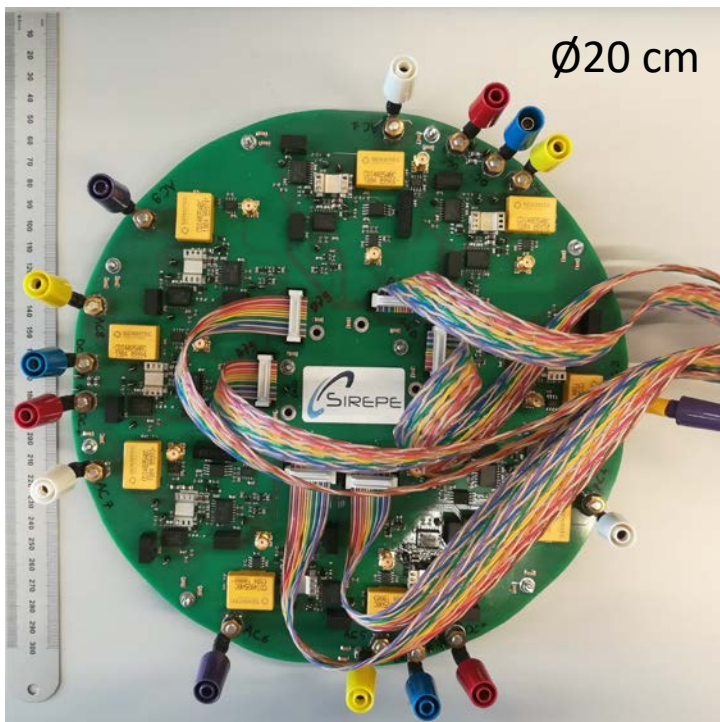
2016: **Basic principle (TRL 1)**

Drafted patent
 Built machine

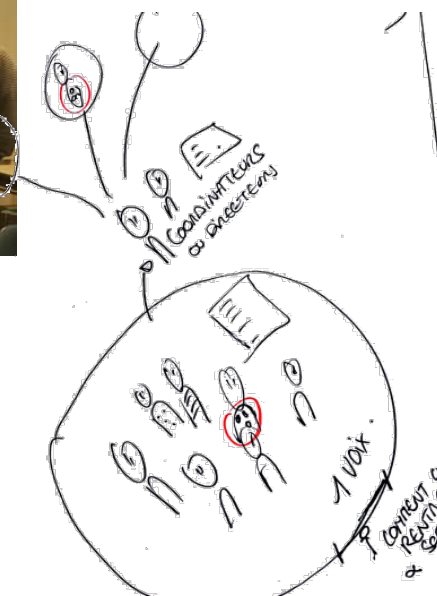
2016 TRL 1

2017

Overview of the collaboration



Aug 2018
Patent FR



End 2019: **Application formulated (TRL 2)**

Drafted patent
Built machine

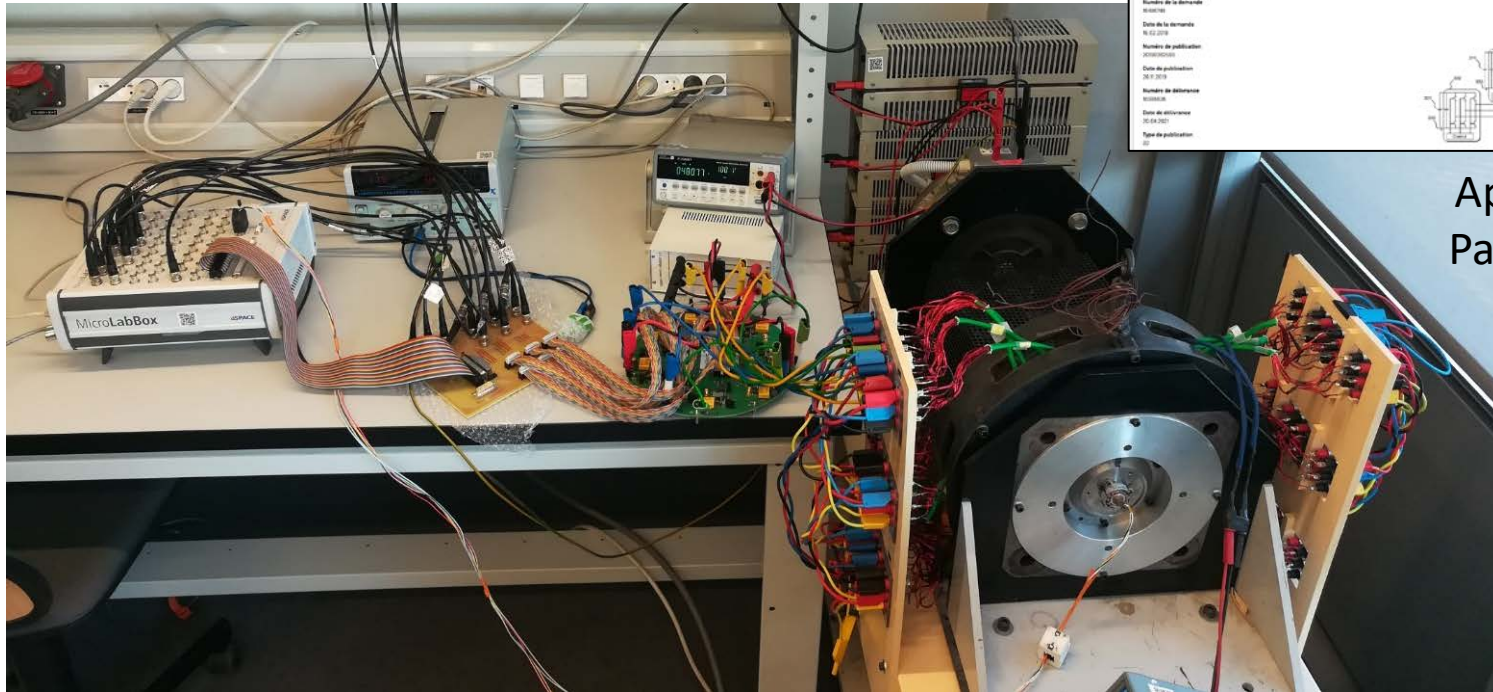
Defined scientific project
Built power electronics

2016 TRL 1

2017

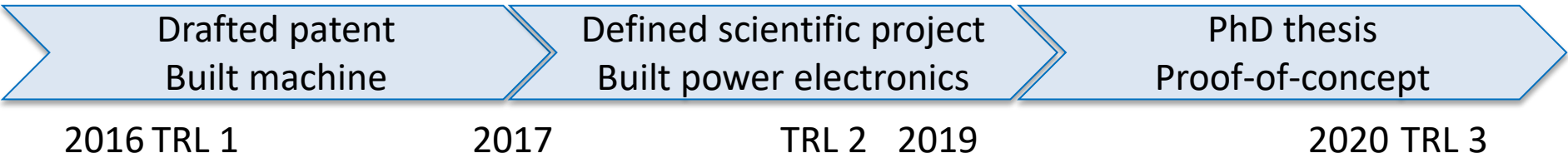
TRL 2 2019

Overview of the collaboration

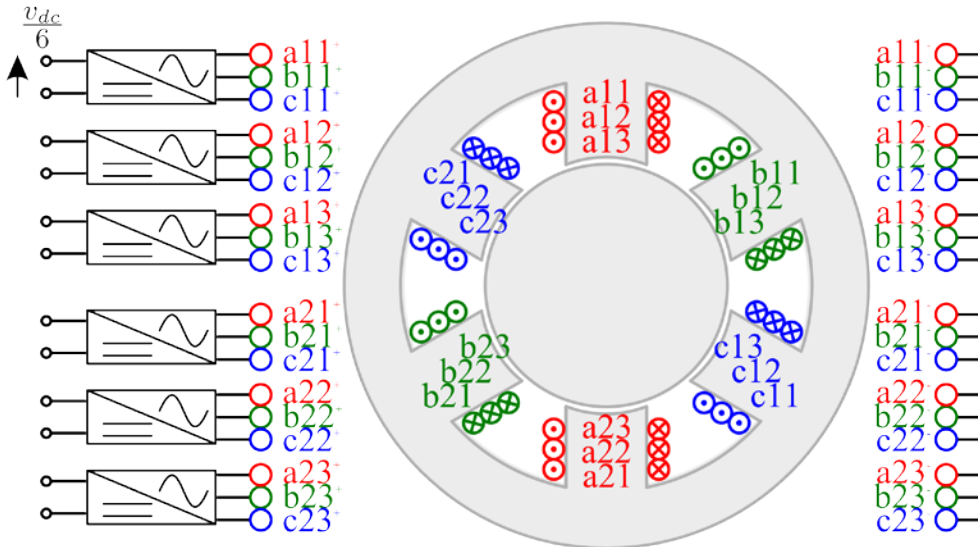


Apr 2021
Patent US

Septembre 2020: **Proof-of-concept (TRL 3)**



Conclusion



To develop the concept CTAF, competences spanning the full spectra of electrical engineering will be required, stimulating sustained collaboration between electrical machine and power electronics specialists.

Scientific and technical obstacles:

- Modeling of the traction chain
- Implementation of the hierarchical control in healthy and degraded mode
- Analysis of the degrees of freedom offered for auxiliary functions
- Study of the impact of the design and quality of the connections and sensors
- Co-optimization of the converter-machine & eco-design