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Research on IPM motors at Uppsala University



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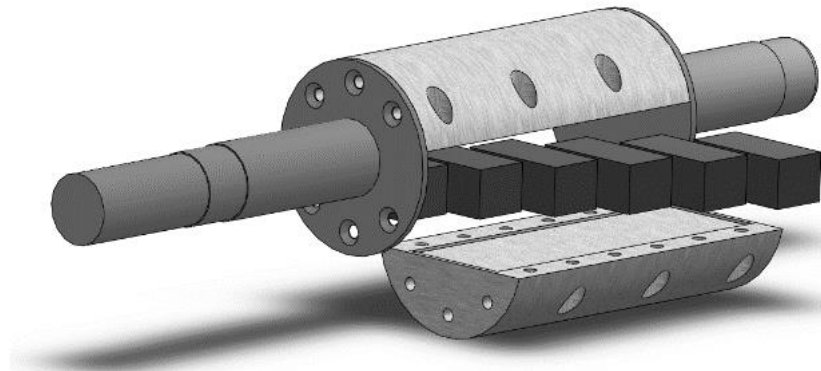
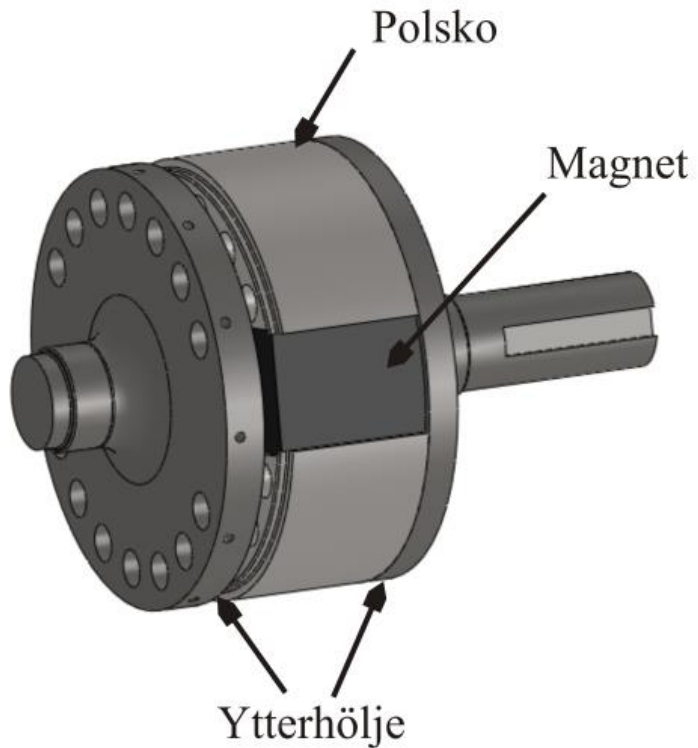
Background and specifications

- Powerful enough to drive a Volvo V40
- Simple to mount for 1st year students





The Uppsala concept

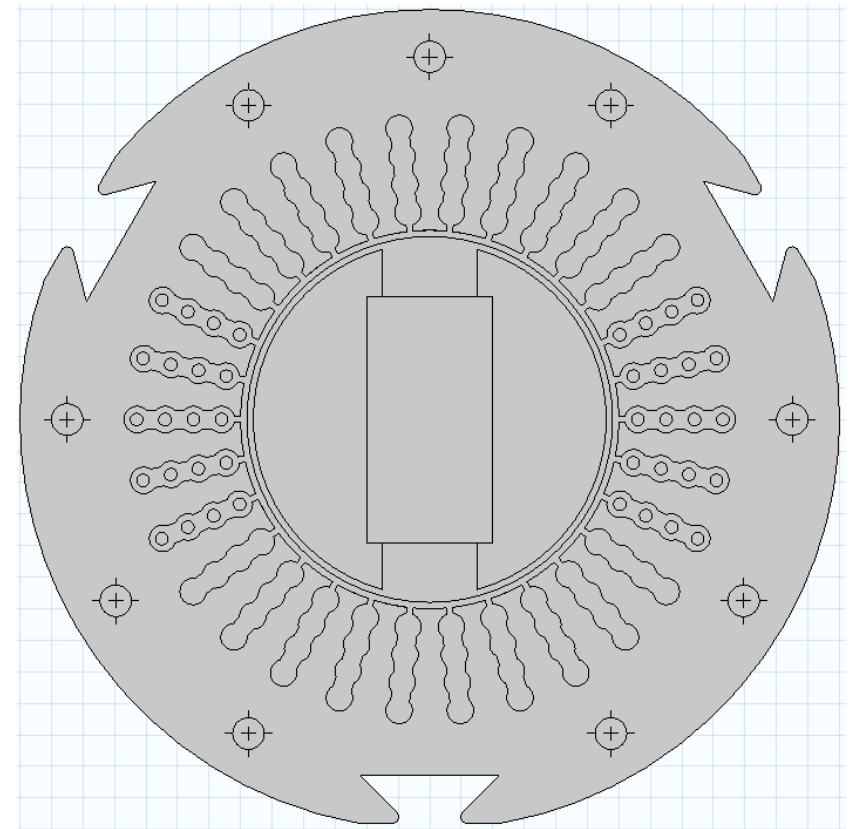


- The outer cover (Ytterhölje) is non-magnetic
- No need of epoxy to glue the magnets



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The Uppsala concept



- No flux leakage through the bridges

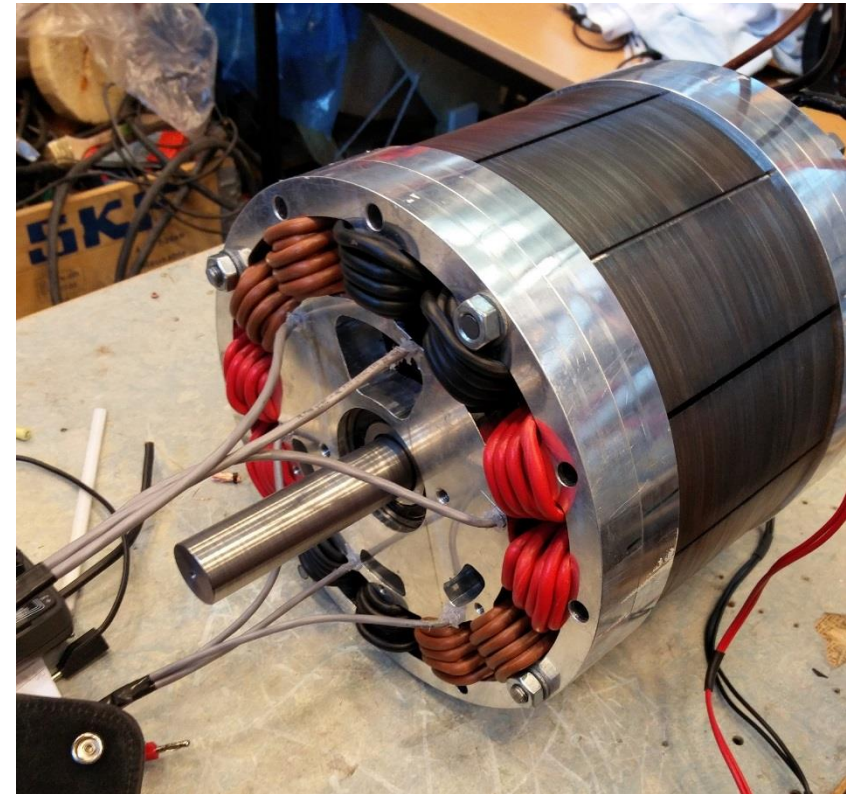


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Number of poles



2 poles and 10 poles motors



- More poles means less end windings
- More coils means thinner cables and more PVC



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The rotor

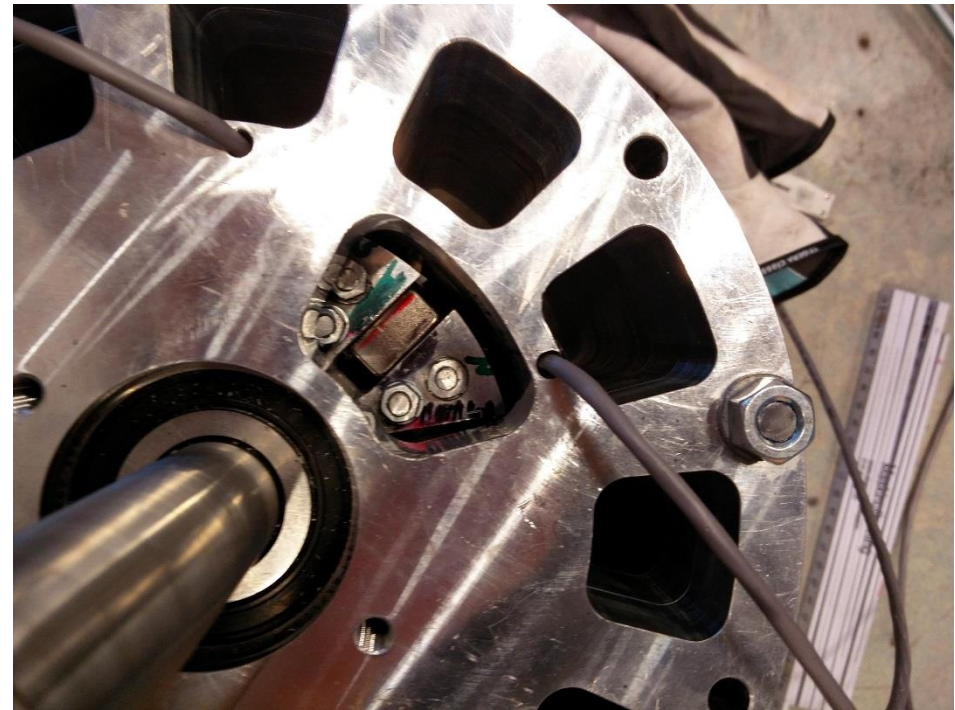
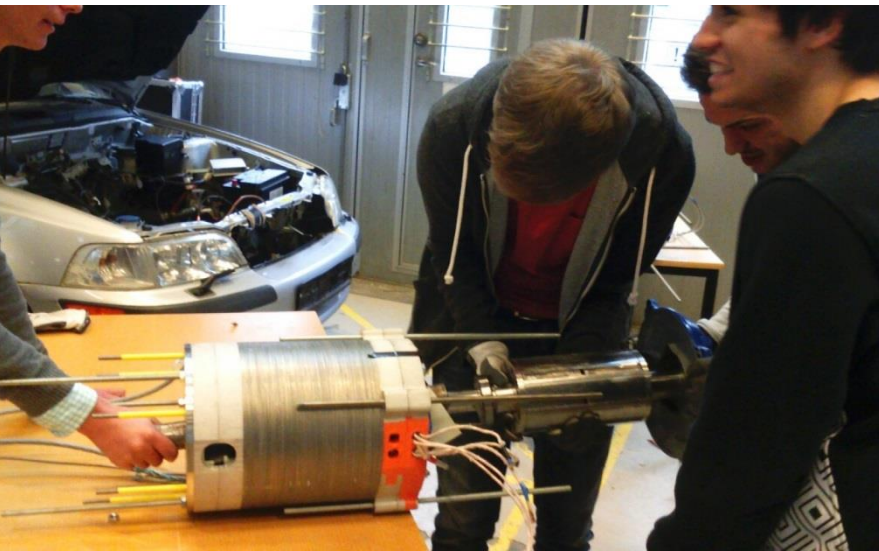


Rotor with 2 and 8 poles



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The rotor



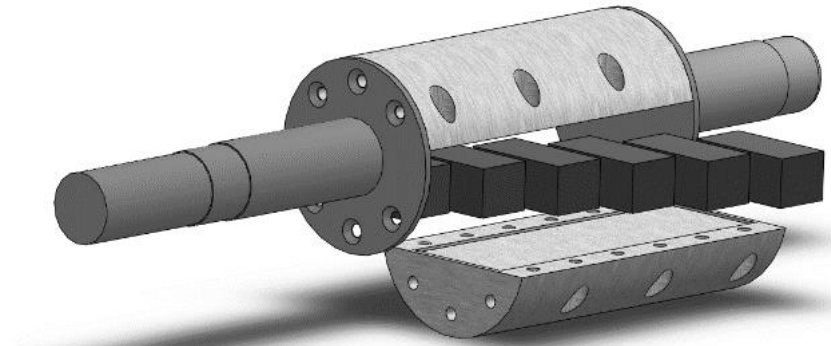
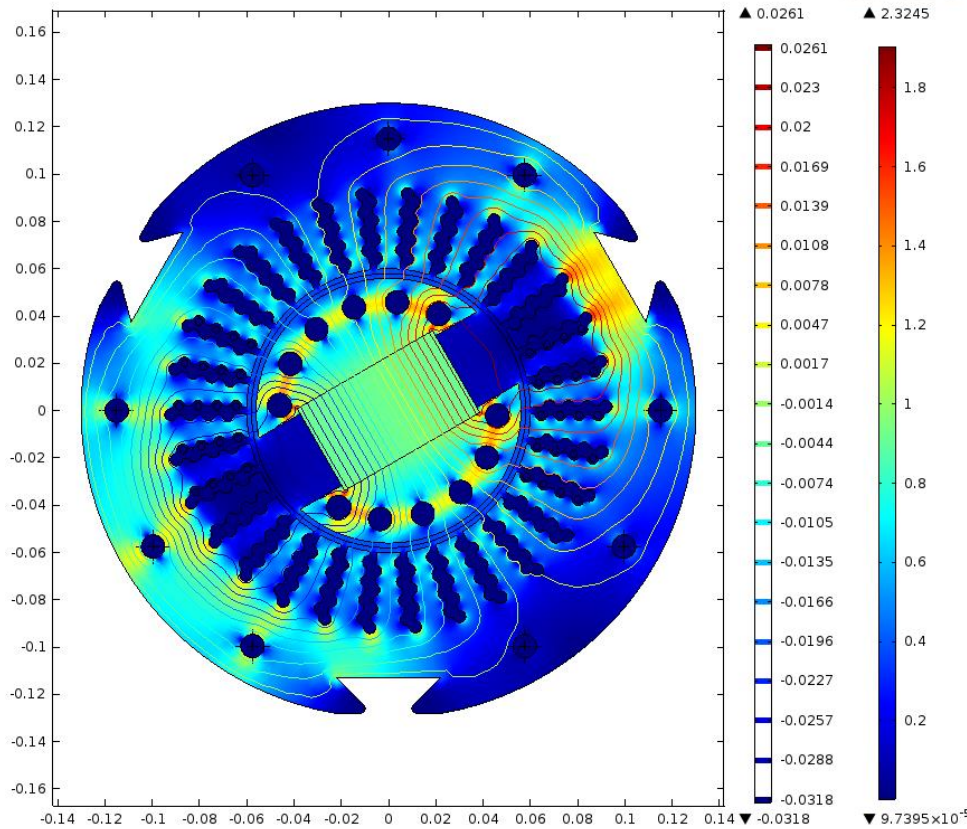
The rotor was mounted magnetized. The new version has a window in the side to insert the magnets.



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The rotor

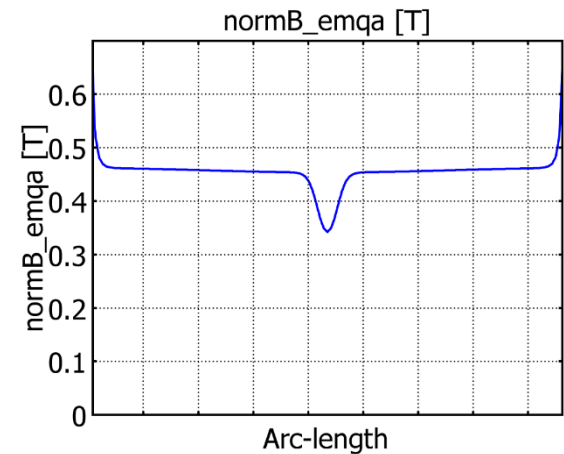
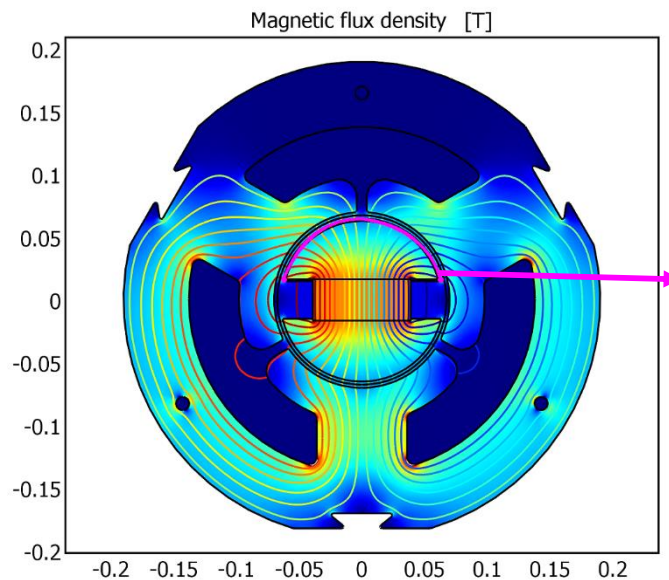
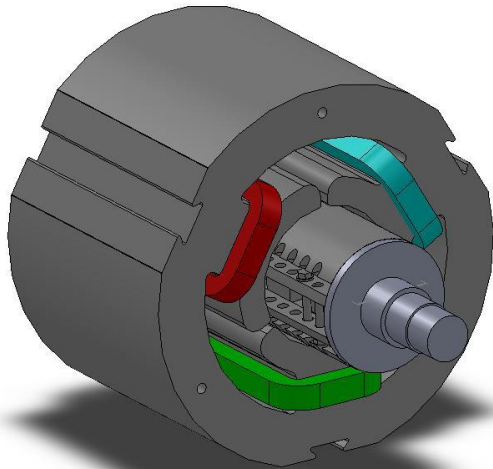
Surface: Magnetic flux density norm (T) Contour: Magnetic vector potential, z component (Wb/m)



- Solid poles suffer from tooth ripple losses



Tooth ripple calculation

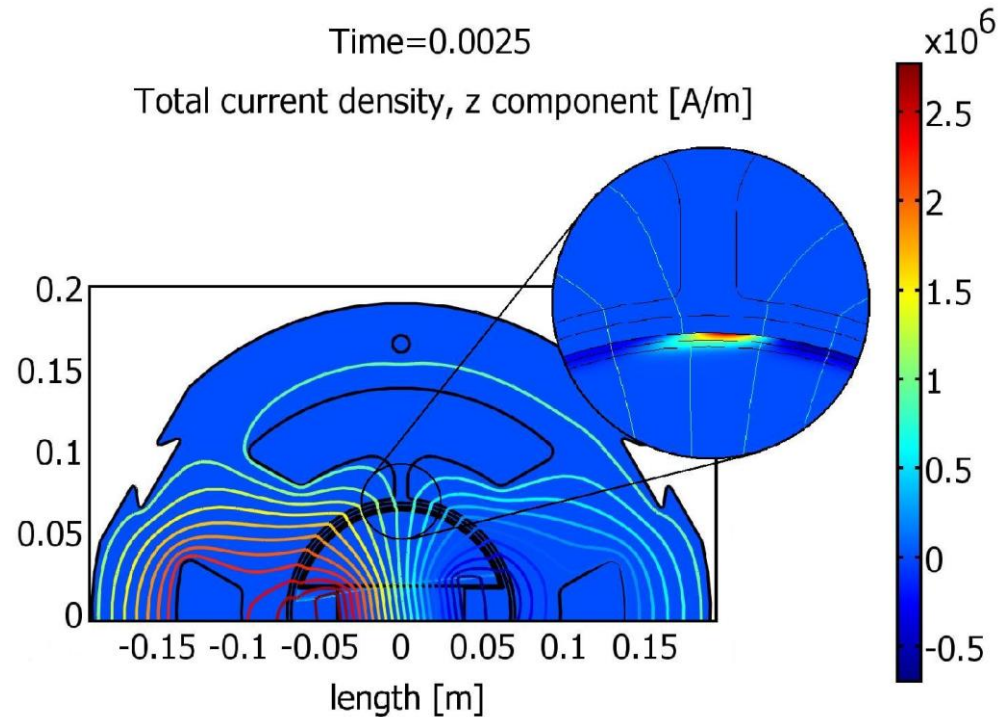
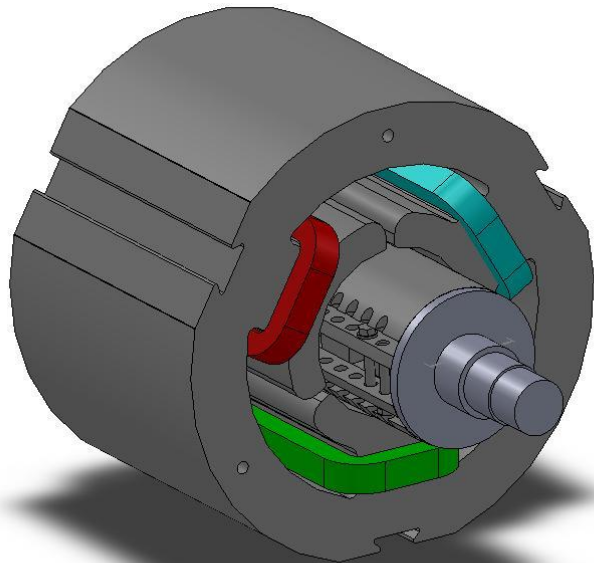


- Solid poles suffer from tooth ripple losses



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Tooth ripple calculation

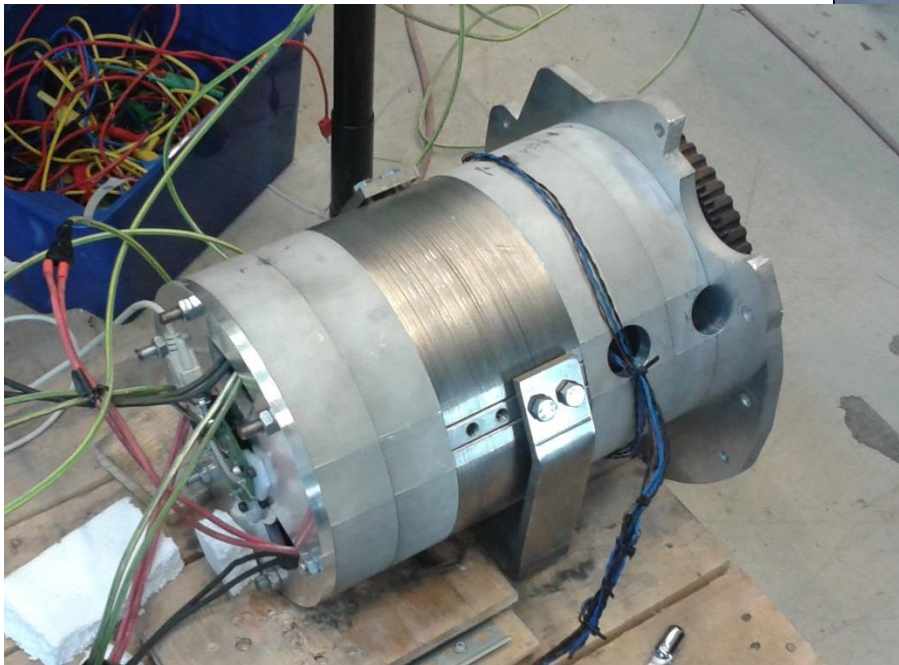


Results in: Juan de Santiago, Hans Bernhoff Calculation of Tooth Ripple Losses in Solid Poles, Electric Power Components and Systems, 2015



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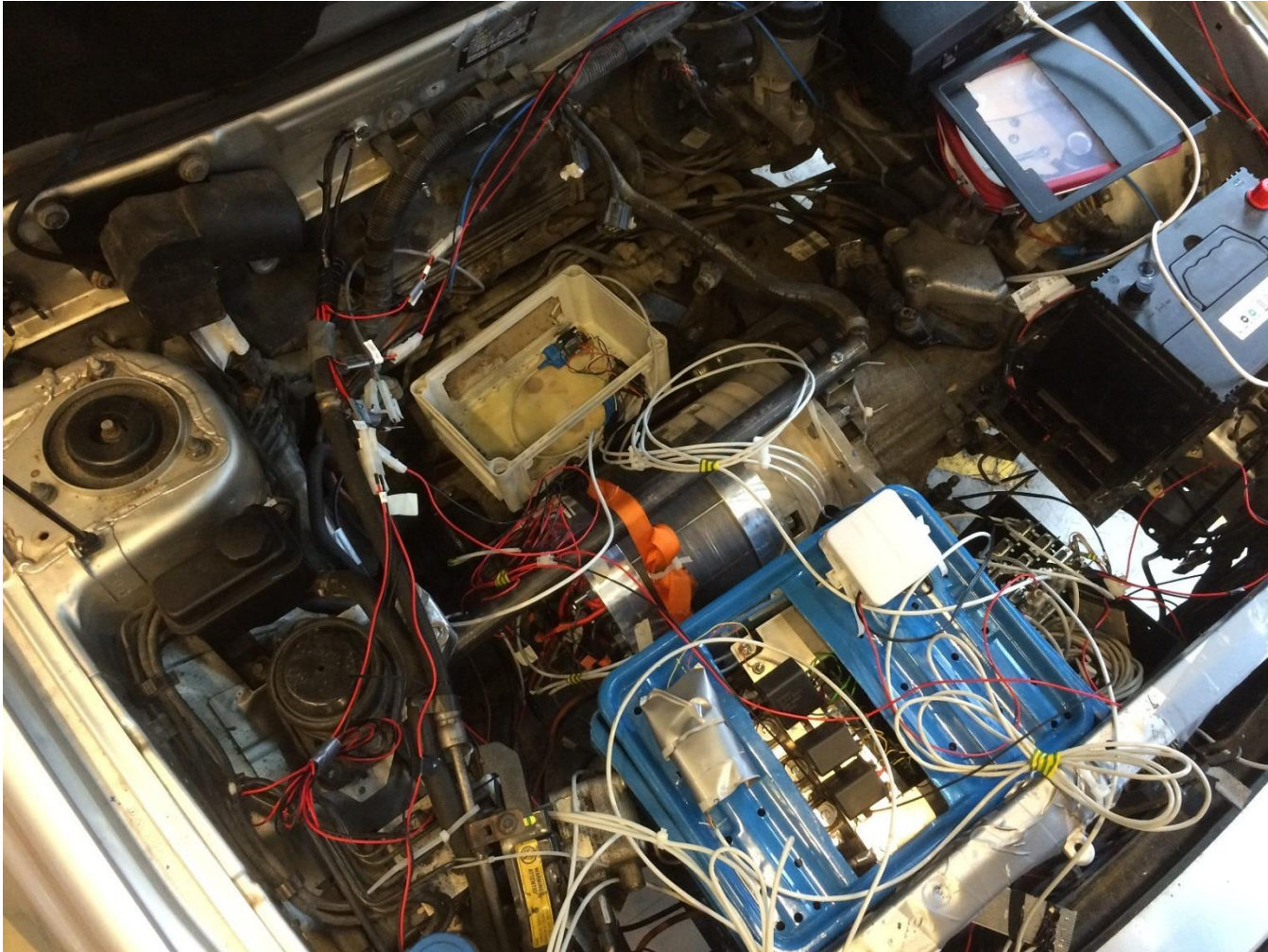
The result 2016





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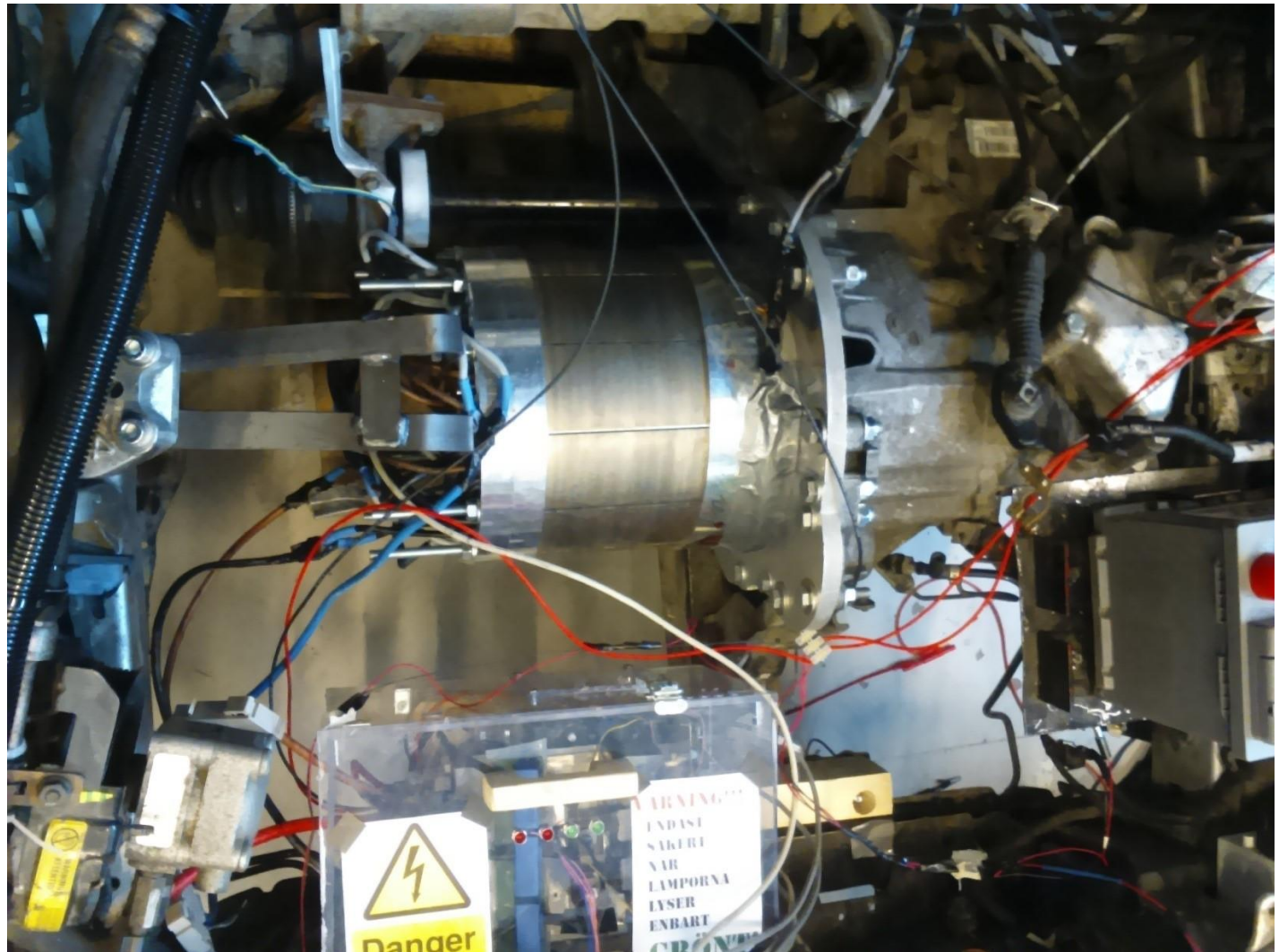
The result 2017





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The result 2018





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Improvement potential

- EMC – End windings are not encapsulated
- Airgap of 4 mm
- Simple inverter control
- Battery limited to 96 V for safety in the lab