



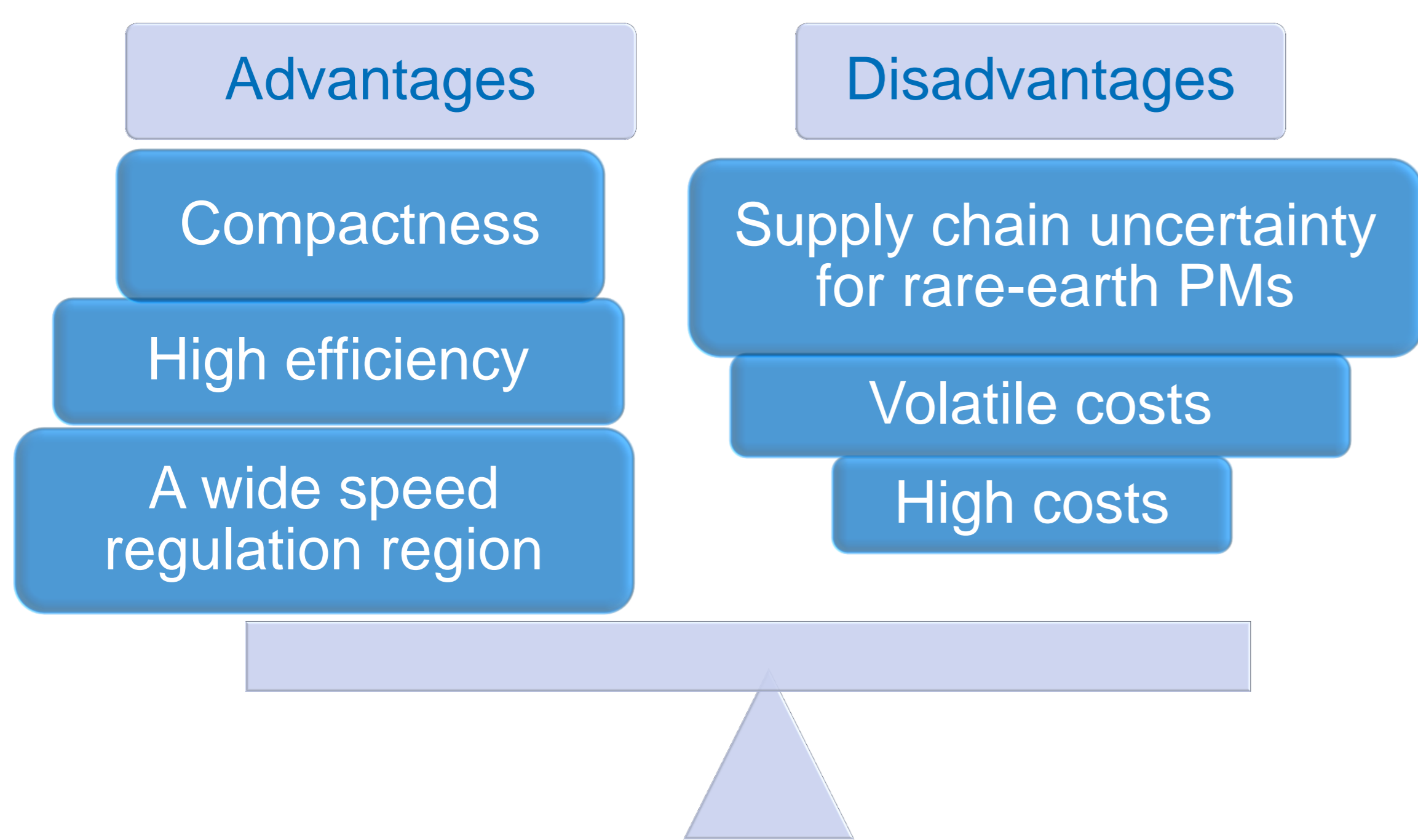
Design of a 200 kW PM SynRel Motor without rare-earth PM for electric vehicle

P3W35

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Context

- Electrical machines with rare-earth permanent magnets performances and their limits



So, less or no rare earth PMs can be considered to decrease the total cost of electrical machines

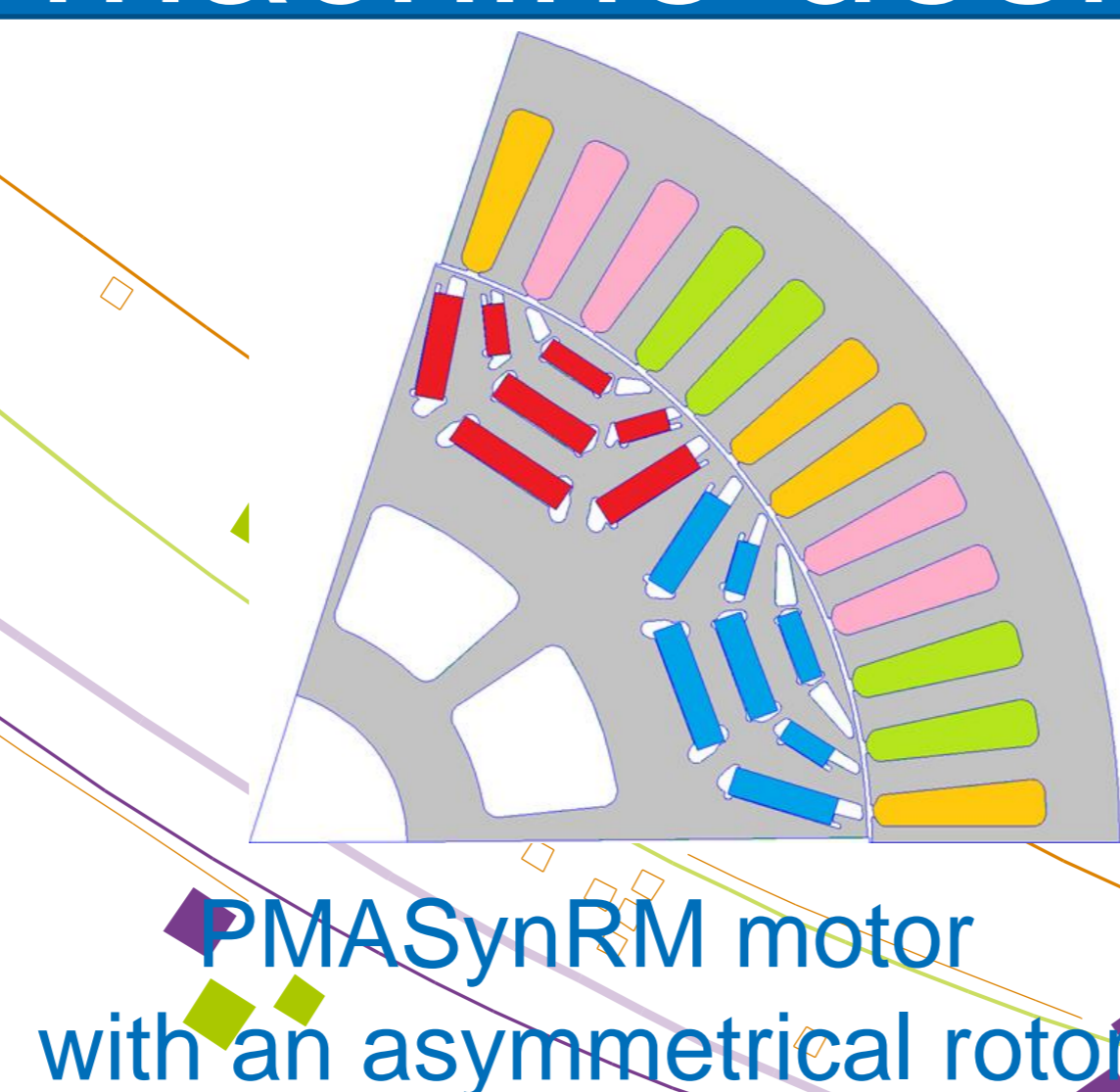
- Rare earth magnet alternatives and their limits

	Induction machine : Tesla model 3 • Copper rotor losses
	Wound rotor : Renault ZOE • Copper rotor losses
	SRM: Land Rover Defender • Vibration acoustic noises
	SynRel: not yet • Low power factor
	Reduced rare earth : BMW i3
	Other magnets (Ferrite): Chevrolet volt

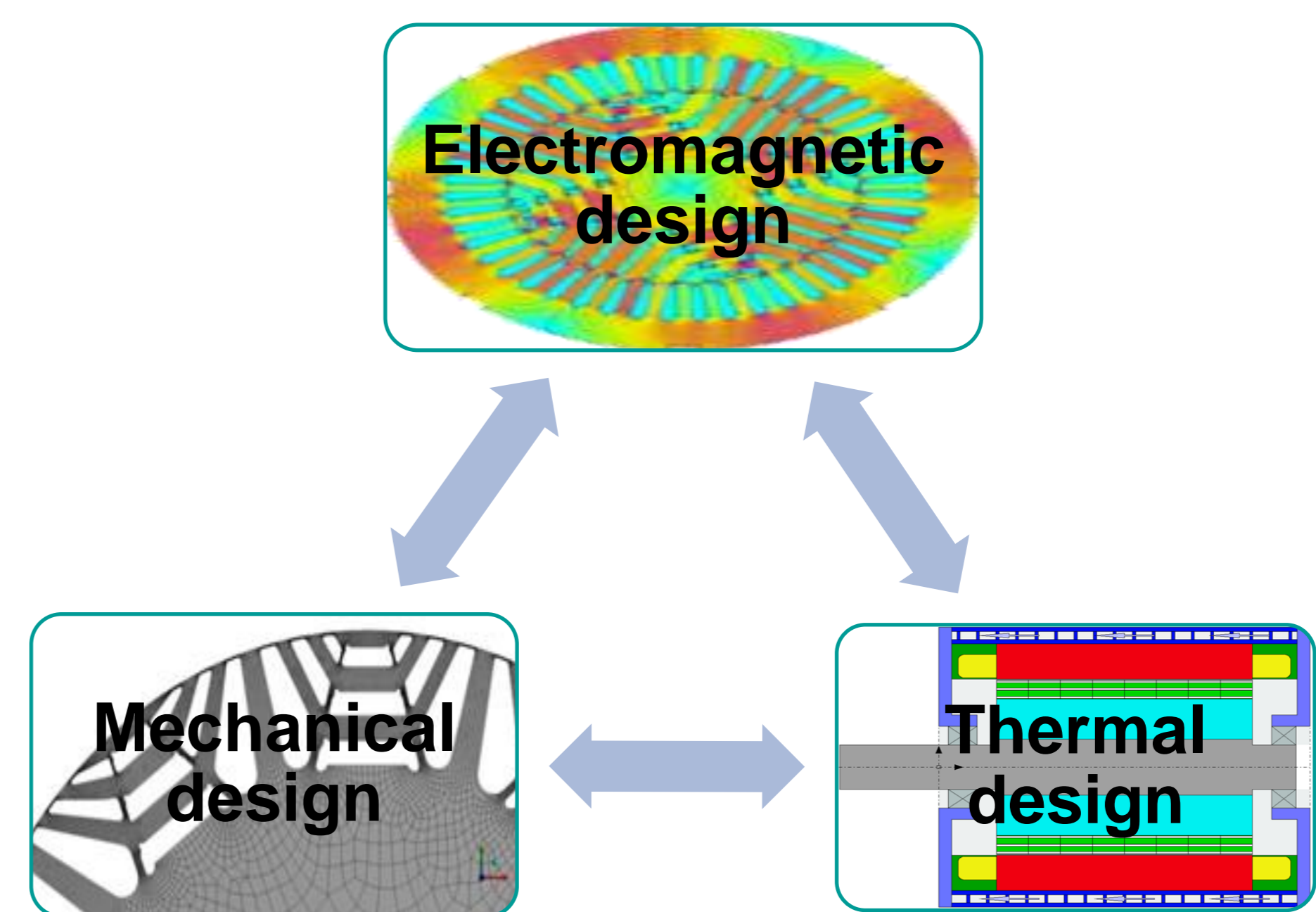
In this work in order to achieve high performance and reduce total cost of electrical machines, a novel permanent magnet-assisted synchronous reluctance machine (PMASynRM) with ferrite magnets is proposed.

Requirements and machine design

Performances	Reference
DC Voltage [V]	800
Base speed [RPM]	5000
Stator outer diameter [mm]	220
Stack length [mm]	200
Maximum torque [N.m] (30 s)	424
Maximum power [kW]	200
Maximum current [A]	590
Cooling	liquid

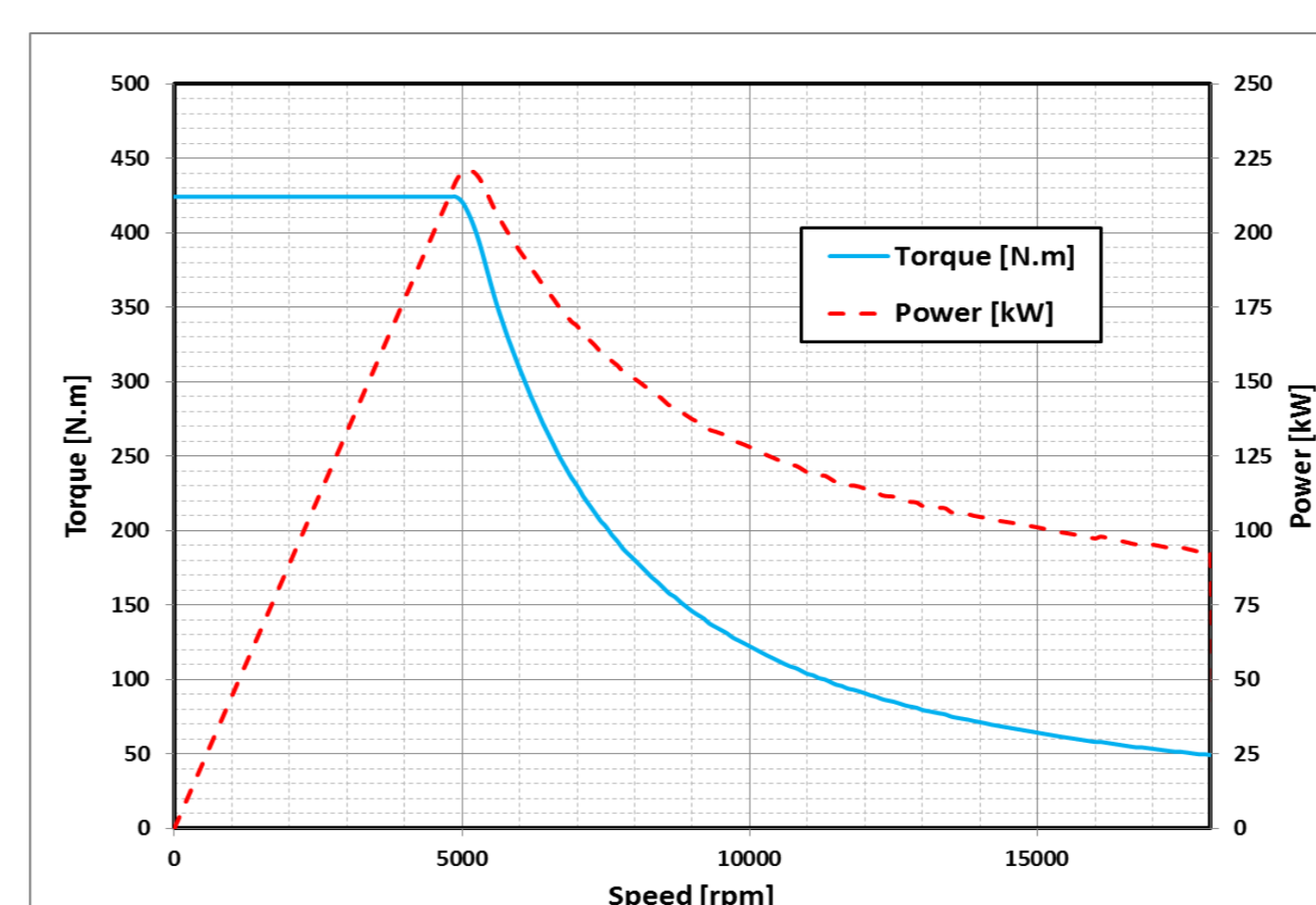


Design process

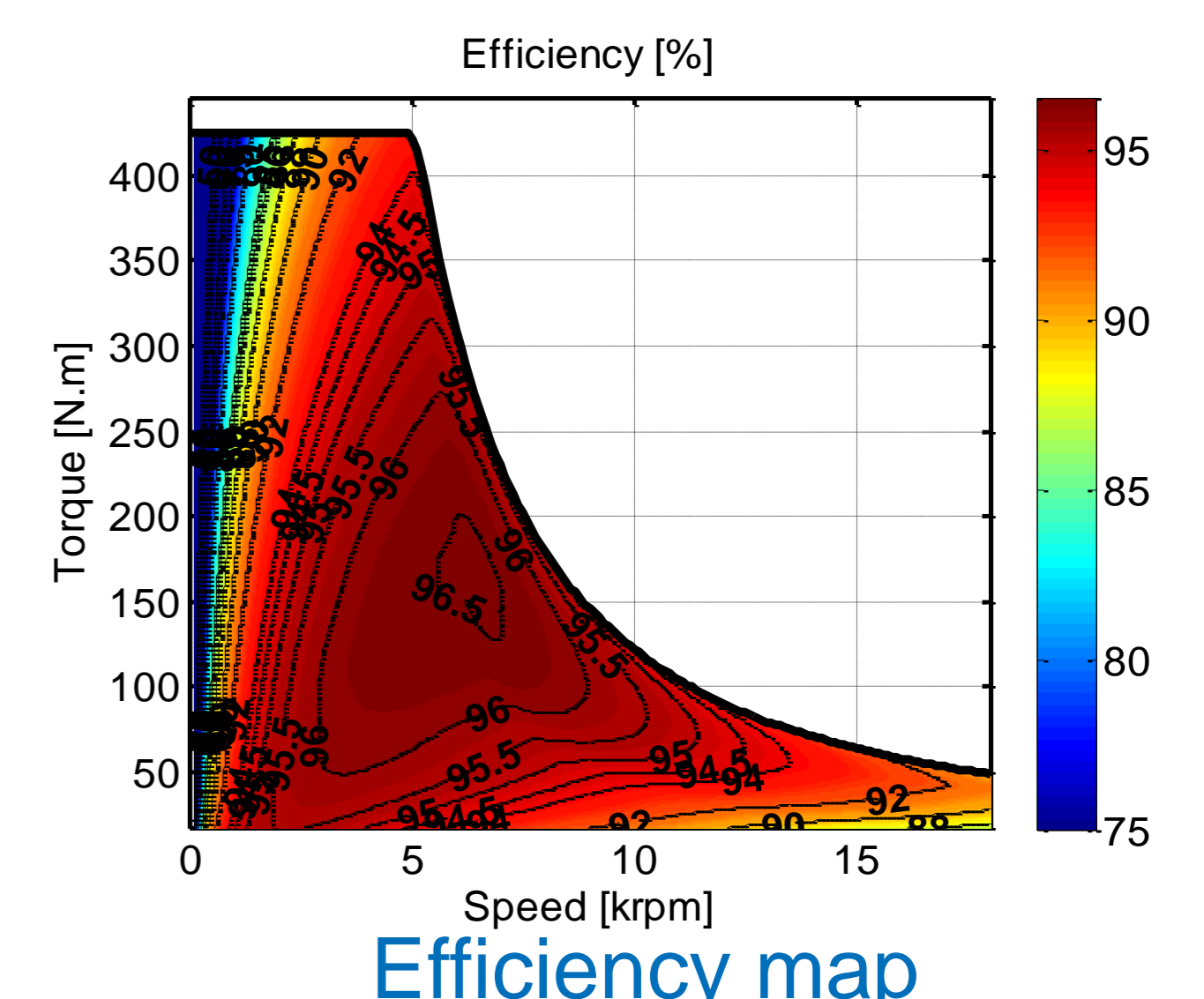


Results

- Electromagnetic performances :

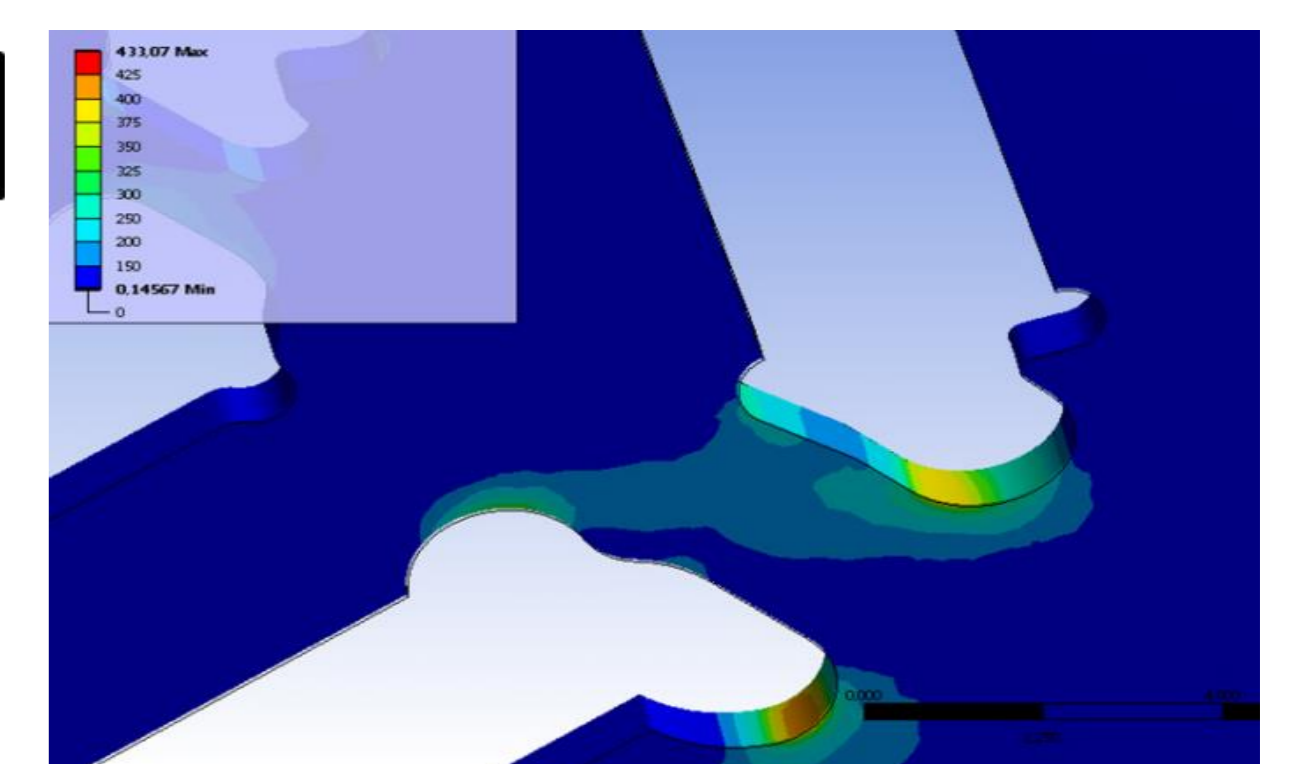
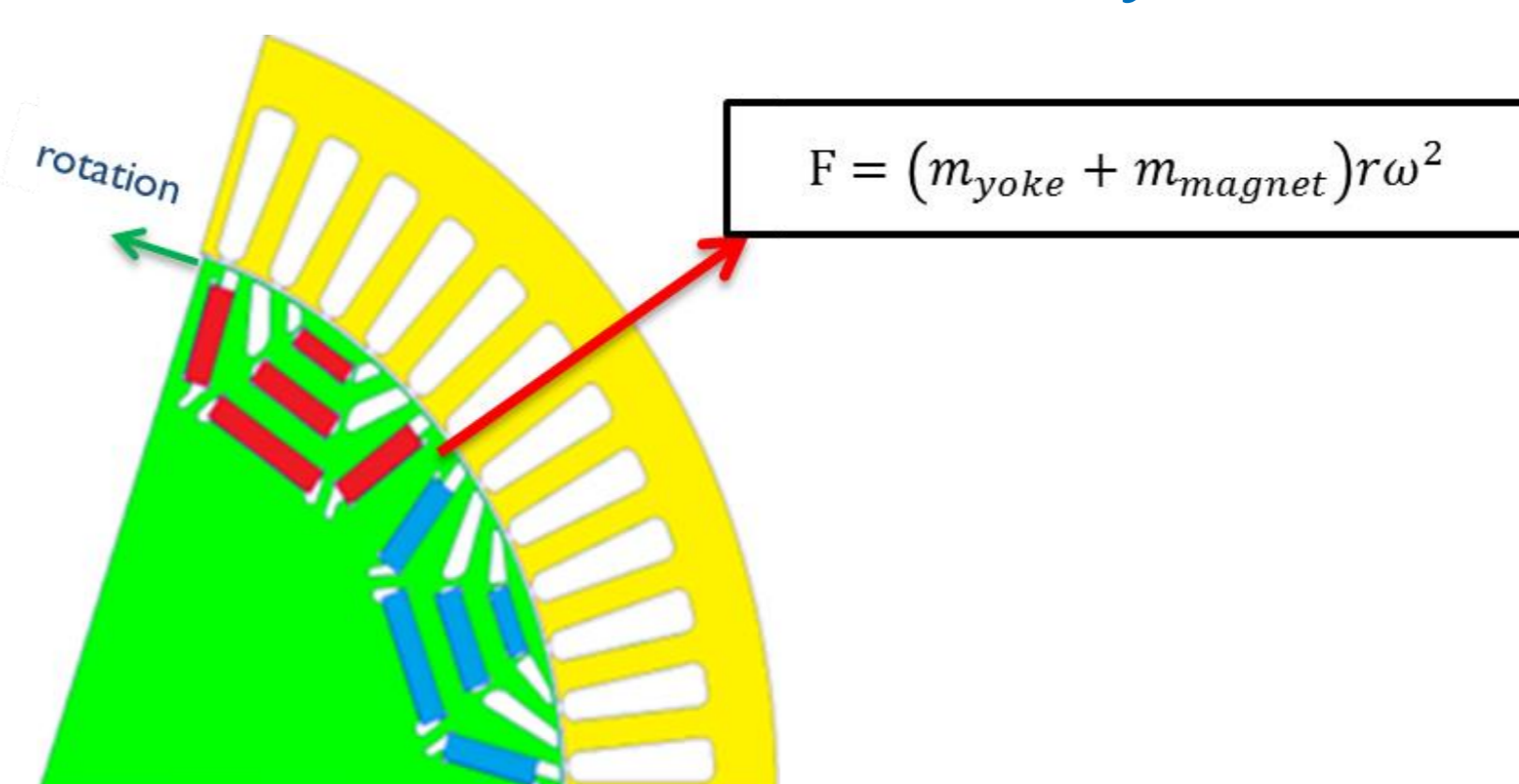


Torque and output power vs. speed



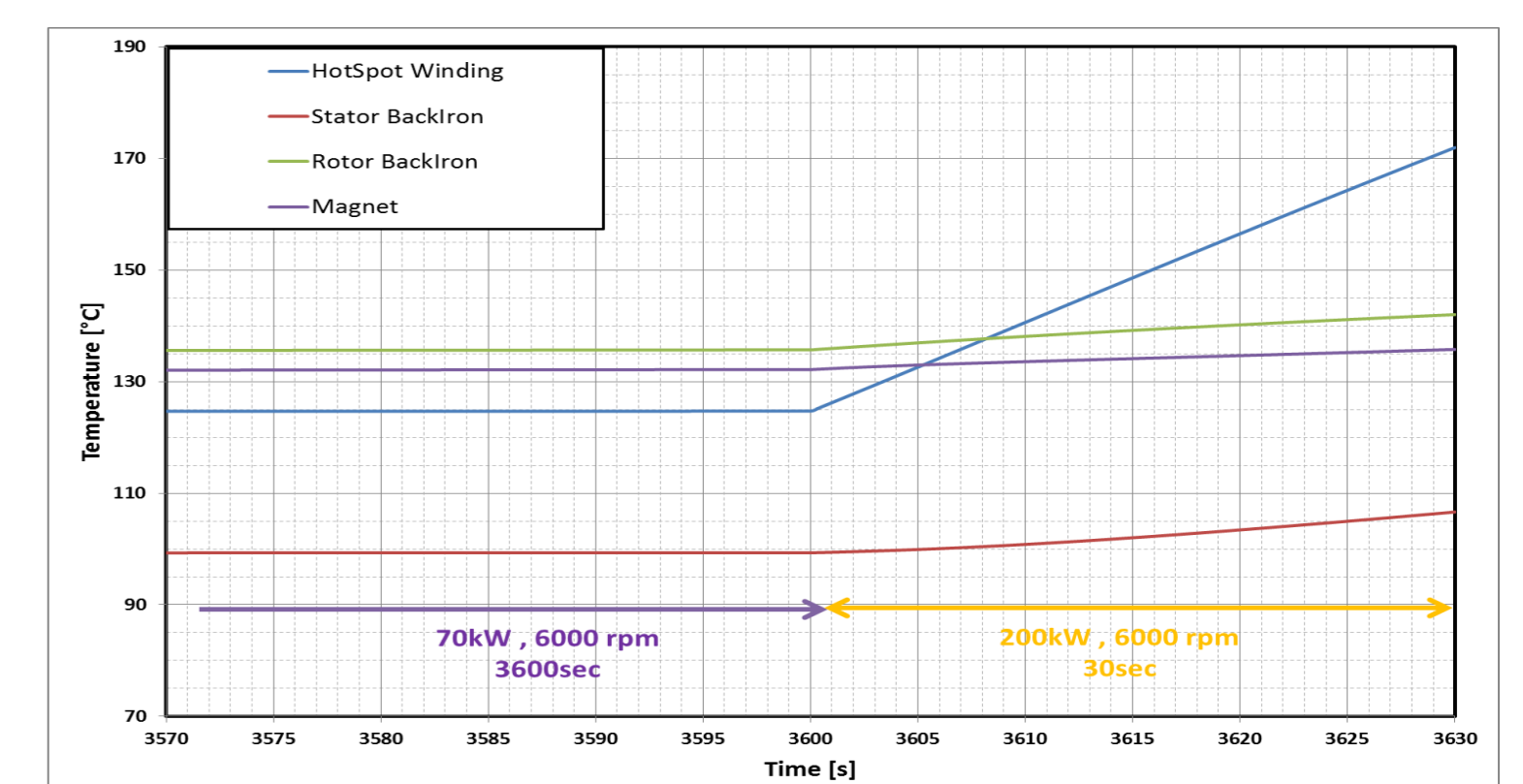
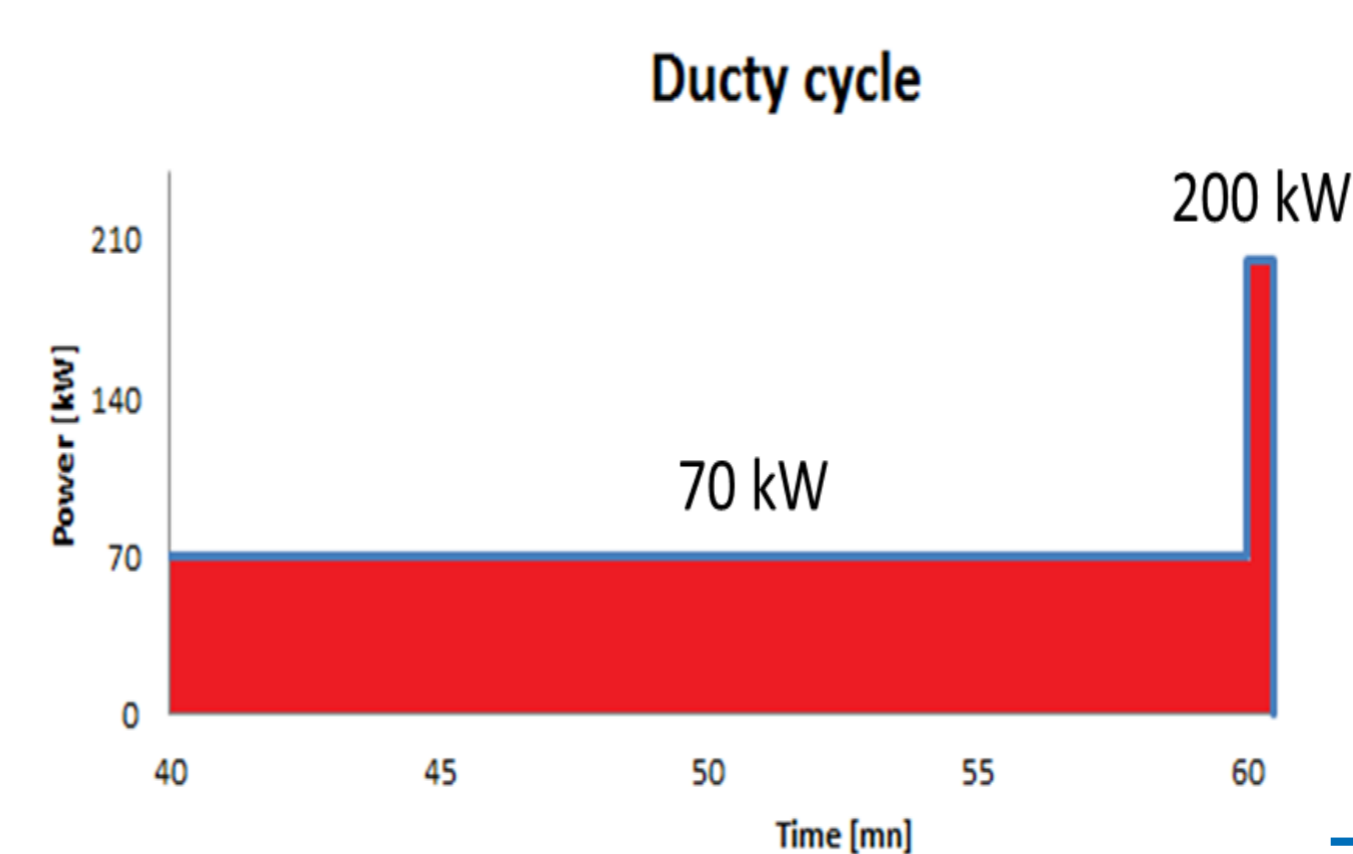
Efficiency map

- Mechanical stress analysis : Centrifugal force



Von Mises stress at the maximum speed

- Thermal design validation



Temporal evolution of the temperature

Conclusion

In this work a design of a ferrite-PMASynRM with high power is proposed. Different phenomena's such as the demagnetization behaviour, mechanical strength, thermal stress and torque ripple are analysed. This study shows that a design of PMASynRM requiring high power and high torque could be achieved using ferrite magnets.