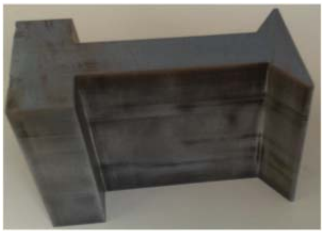
Design and construction of electrical machines at GREAH

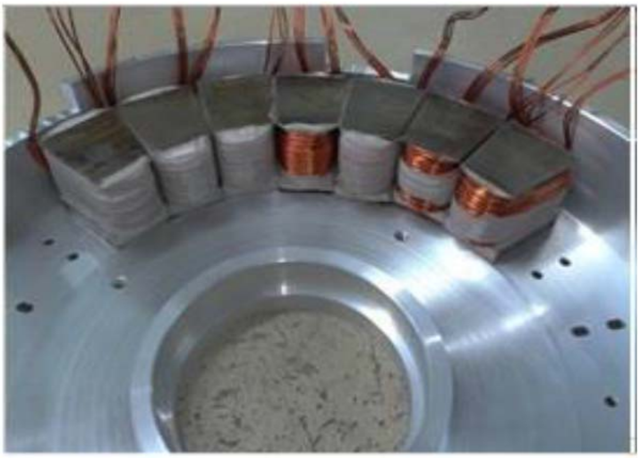
Surface mounted axial field machine

Figure 1 show photos of different part of a surface mounted axial field machine designed at GREAH for small wind-turbines (~ 10 kW, 375 rpm). This machine have an internal rotor sandwiched between two stator parts.

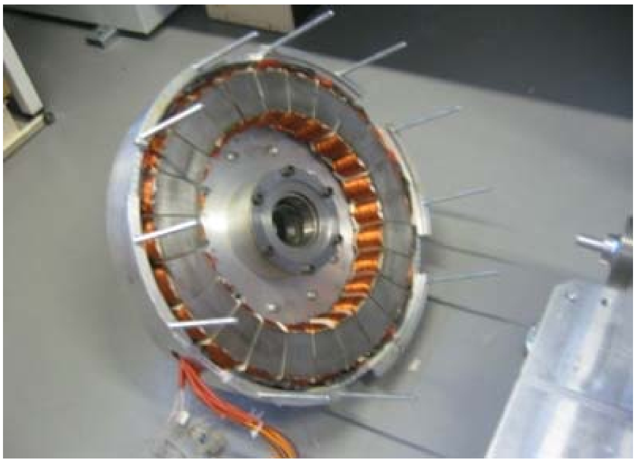
Figures 2 and 3 show the assembled machine (Figure 2), and the loading machine mounted on the test bench (Figure 3). The machine is under test.



a) Stator module



b) Stator during assembling



c) Assembled stator

d) Rotor

Figure 1. Surface mounted axial field machine.

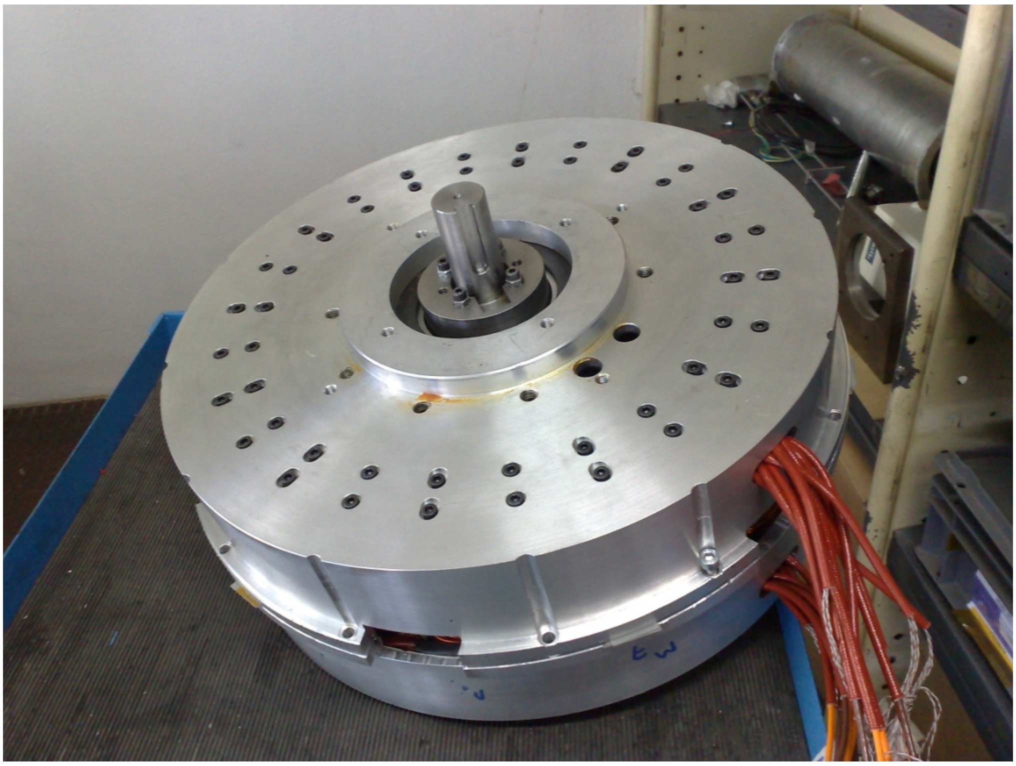


Figure 2. Assembled machine.

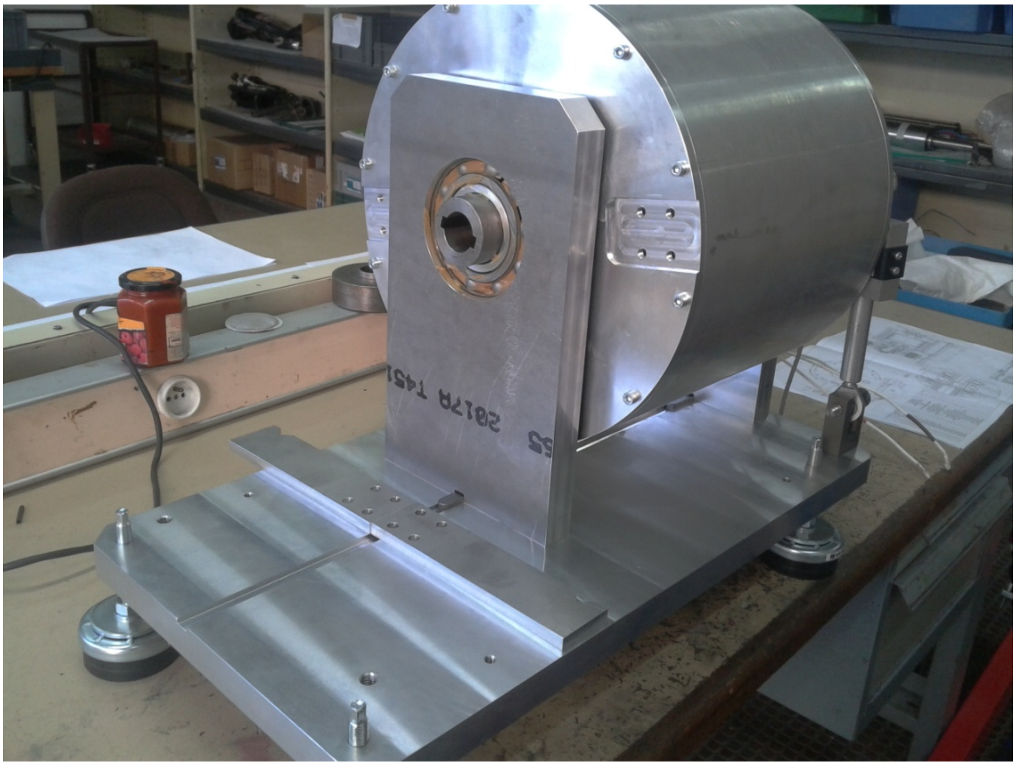


Figure 3. Test bench with loading machine.

Flux switching axial field PM machine

Figure 4 shows a 3D view of the flux switching axial field PM machine (FSAFPM) designed at GREAH. As previous machine, this FSAFPM machine has been designed for small wind-turbine application ((~ 10 kW, 375 rpm). It has same structure as previous machine: internal rotor sandwiched between two stator parts.

Figure 5 shows photos of different parts of the machine. This machine will be mounted in the same test bench shown in figure 3.

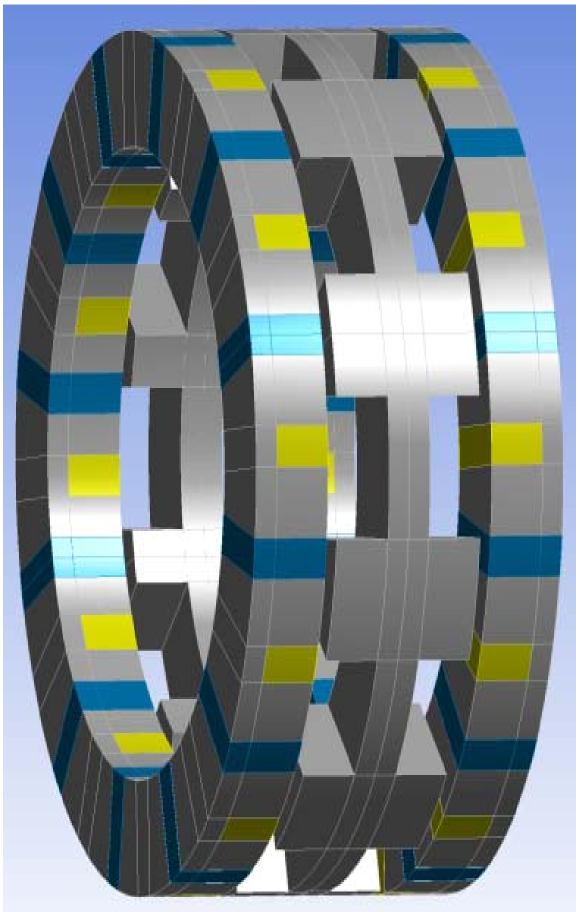
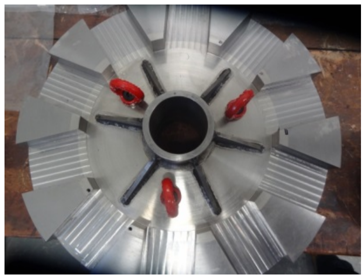
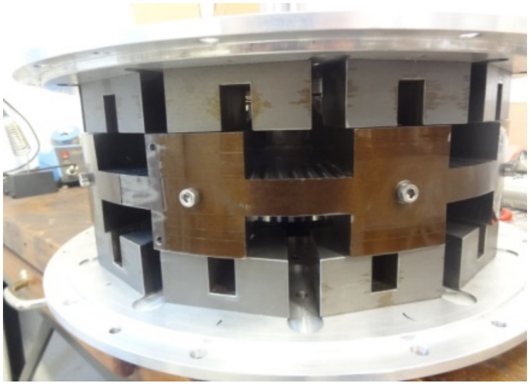


Figure 4. 3D view of the FSAFPM machine.

a) Two stator parts



b) Rotor



c) Machine during assemling

d) Assembled machine

Figure 5. FSAFPM prototype construction.

Thrust reversal for airplanes (fault tolerant radial flux PM machine) ("GREAH/SAFRAN" Project)

Figure 6 shows a thrust reverser deployed in order to decelerate the plane during landing. SAFRAN Group contacted the GREAH in order to design and electrical thrust reversal system. The designed machine had to comply with the sever constraints imposed by specifications related to airplane applications (low weight, high speed, fault tolerance). Figure 7 shows a stator photo of the designed machine. This machine is a fault tolerant double-star permanent magnet machine.

Figure 6. Thrust reversers deployed on the CFM56 engine of an Airbus A320.

Figure 7. Stator of the fault tolerant double-star PM machine.

Figure 8 shows the machine mounted on its test bench. The GREAH has designed the machine and its associated converters.

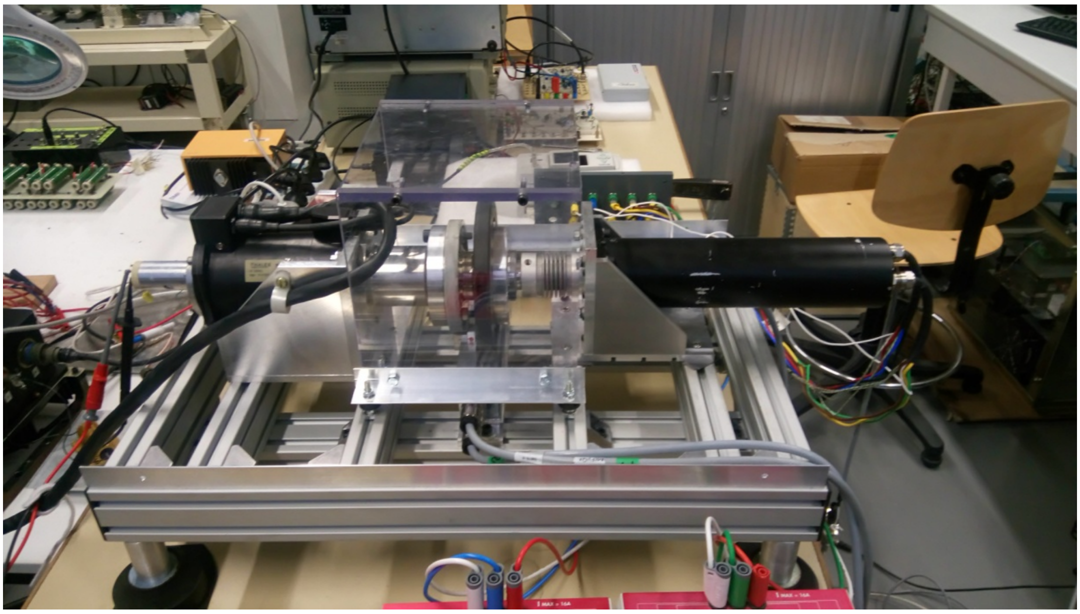


Figure 8. Test bench of the fault tolerant double-star PM machine.

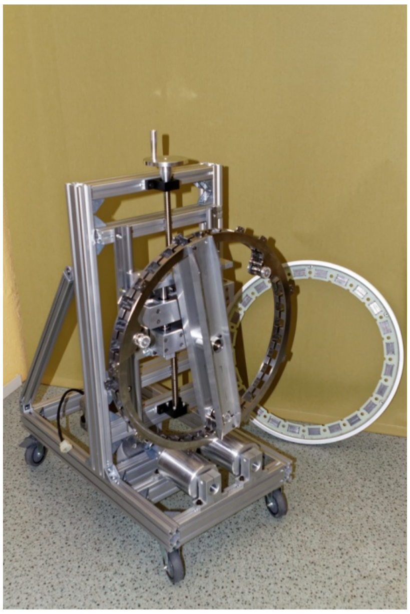
Axial field switched reluctance machine ("GREAH/Green Reasearch" Project)

Green Research a French company specialized in circular economy asked the GREAH to design an axial field switched reluctance machine for a wheel chair application. The idea was to replace the wheels of non-motorized wheel chairs by wheels equipped with low cost and robust electrical motors. The GREAH have then designed a prototype of an axial field switched reluctance machine.

Figure 9 shows photos of the designed machine.

a) Rotor

b) Rotor and stator



c) Machine mounted on the test bench.

Figure 9. Prototype of the axial field switched reluctance motor.

Design of an off-shore wind turbine multi-megawatt generator ("GREAH/AREVA" Project)

Adwen is a joint-venture created by AREVA and GAMESA. It is dedicated to the development of off-shore wind turbines. It has been recently bought by Siemens. GREAH have been contacted by Adwen in order to design the AD 8-180 wind turbine generator (figure 10). Several permanent magnet generators topologies are being studied as potential solutions. Figure 11 shows axial field machines designed for different wind turbines with different power levels.

Figure 10. Adwen 8 megawatts (AD 8-180) off-shore wind turbine.

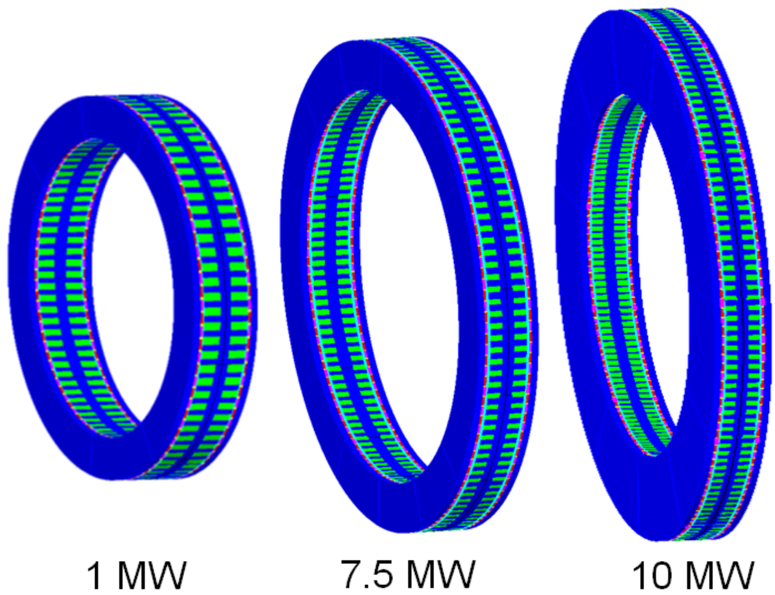
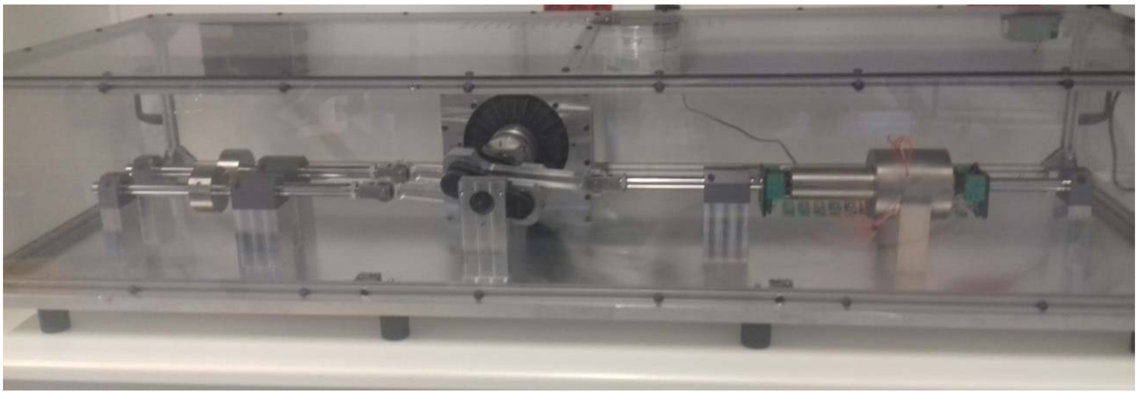


Figure 10. Axial field PM generators for wind turbines.

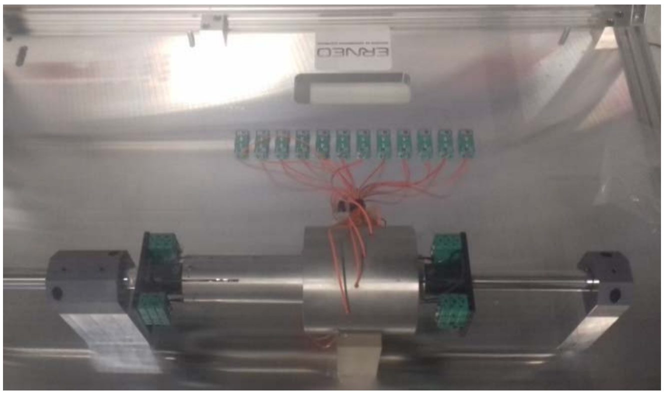
Study of thermal behaviour of linear tubular machines

Figure 11 shows photos of the experimental setup built for the study of thermal behaviour of linear tubular machines. Thermocouples are distributed over the stator and translator in order to measure temperature distributions under different operating conditions. A coil placed in the translator is used as a heat source, and the translator is driven by a rotating machine. The translator is able to reach linear speeds as high as 3 m/s.

This experimental setup has been built in the framework of a project co-funded by the region of "Normandie" (France) and the European Union, with the European regional development fund (ERDF).



a) Global view of the experimental setup



b) Zoom on the useful part

Figure 11. Test bench for the study of thermal behaviour of linear tubular machines.