

Wind Energy Research Consortium

Dakota Power, LLC

Dr. Richard (Dick) Gowen
President and CEO

Joel Lankutis
Research Engineer

Dakota Power, LLC

A Research and Development Corporation

Next Generation Lightweight Electric Drive Systems



Wind Energy Research Consortium

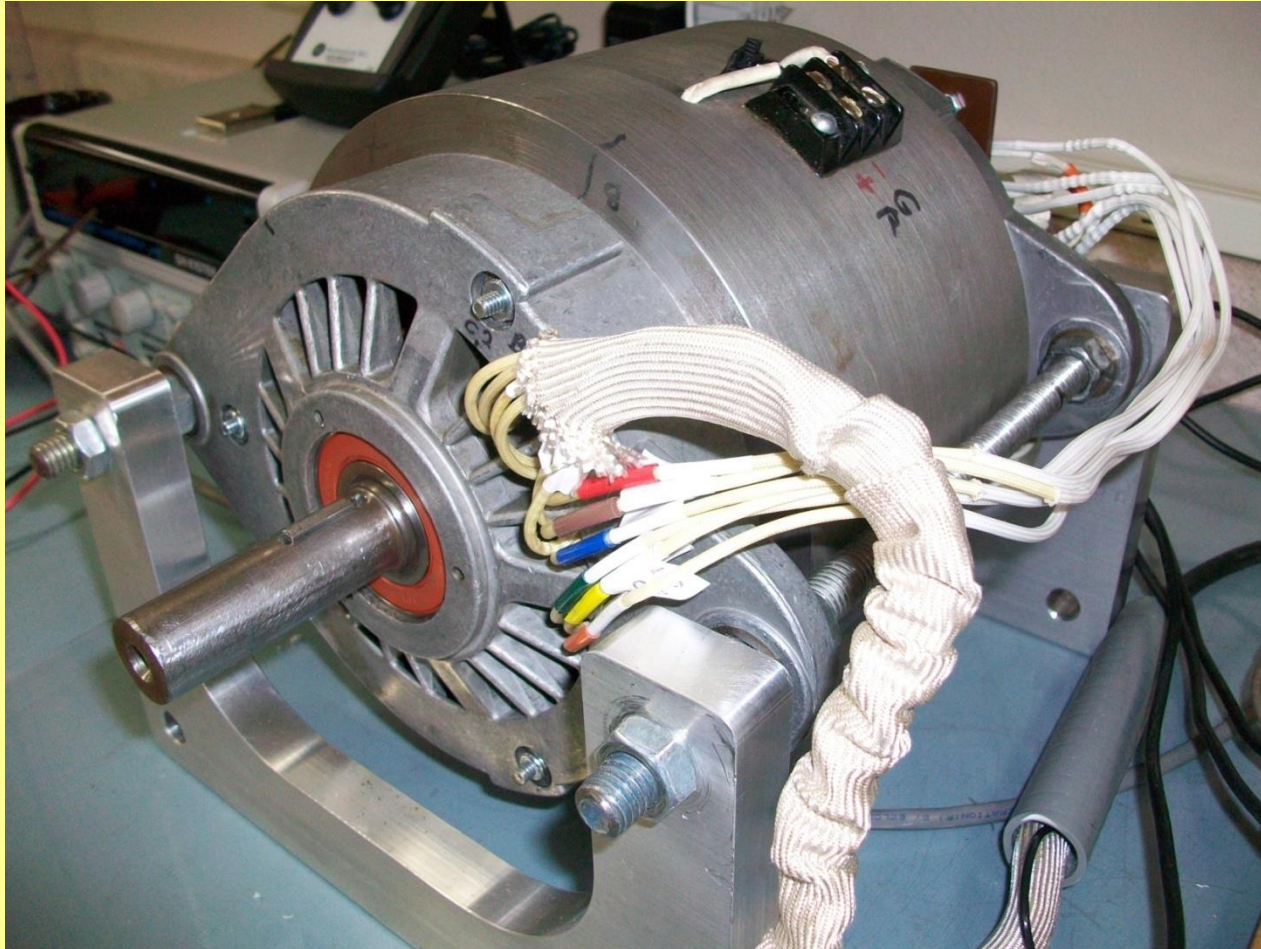
- Dakota Power Tasks:
 - Report: Alternative technologies for wind turbines
 - Tutorial: Optimizing generation from residential wind turbines
- Focus on the potential for modified switched reluctance technology
 - SRDCM
 - Compare with induction and permanent magnet turbines

Overview of Dakota Power

- Light weight high power density electric drives
- Focus R&D- How do we know?
 - Modeling and simulation software
 - Test and evaluation infrastructure
- SRM advantages:
 - High performance over wide speed range
 - Lower cost than Permanent Magnet (PM) Motor
 - High temperature operations
- SRM - an alternative to the strategic risk of further restriction of PM rare earth materials by China

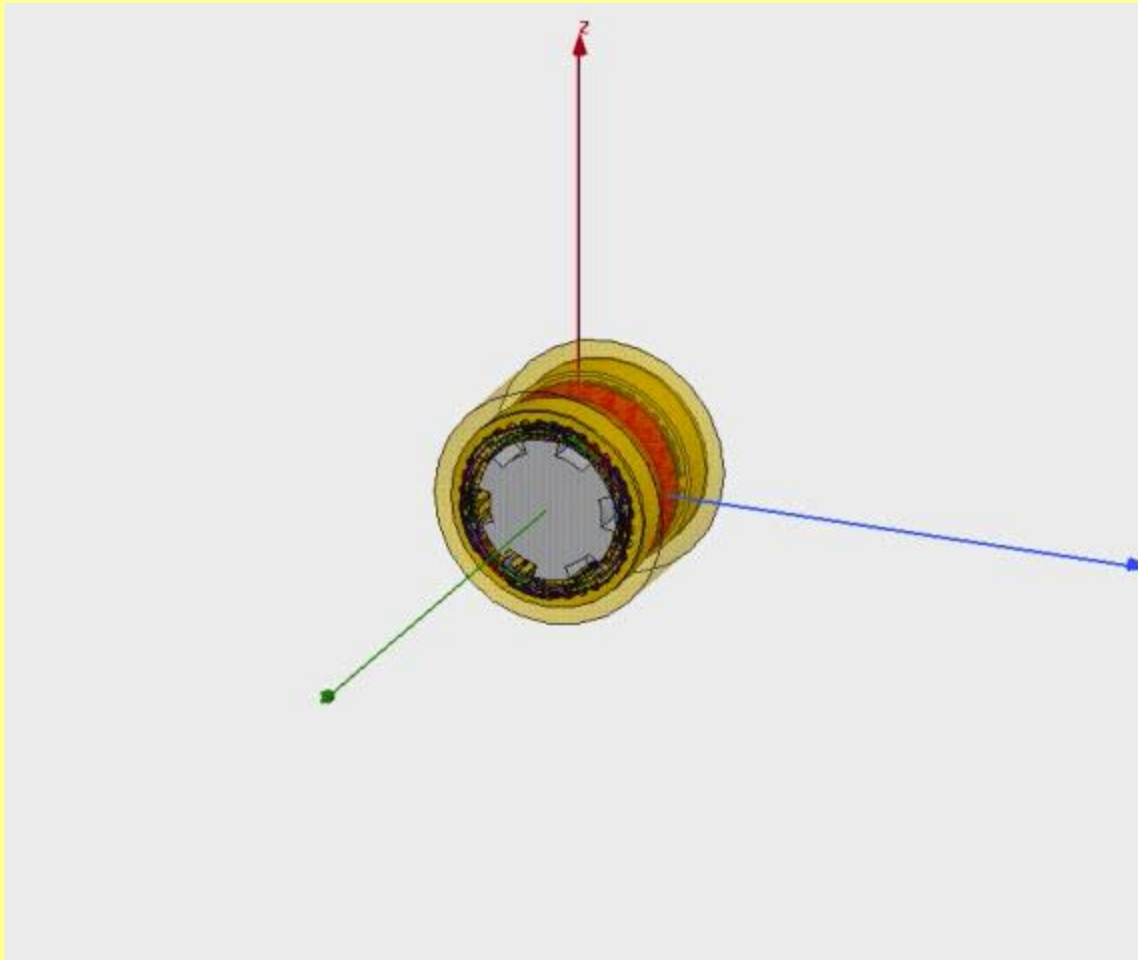
Next Generation Machine Design

SRDCM

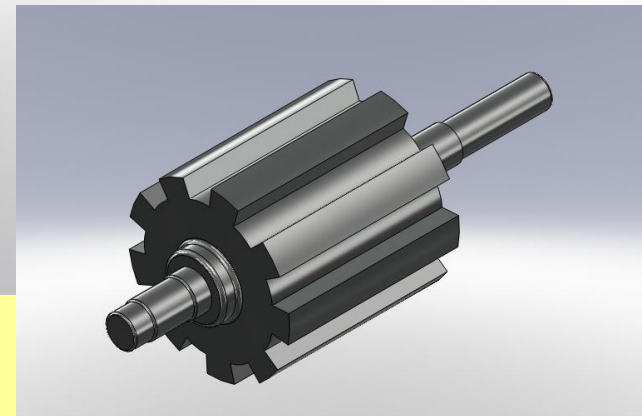


Next Generation Machine Design

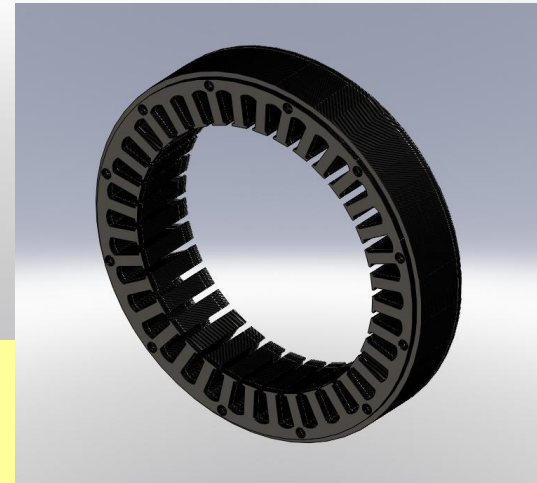
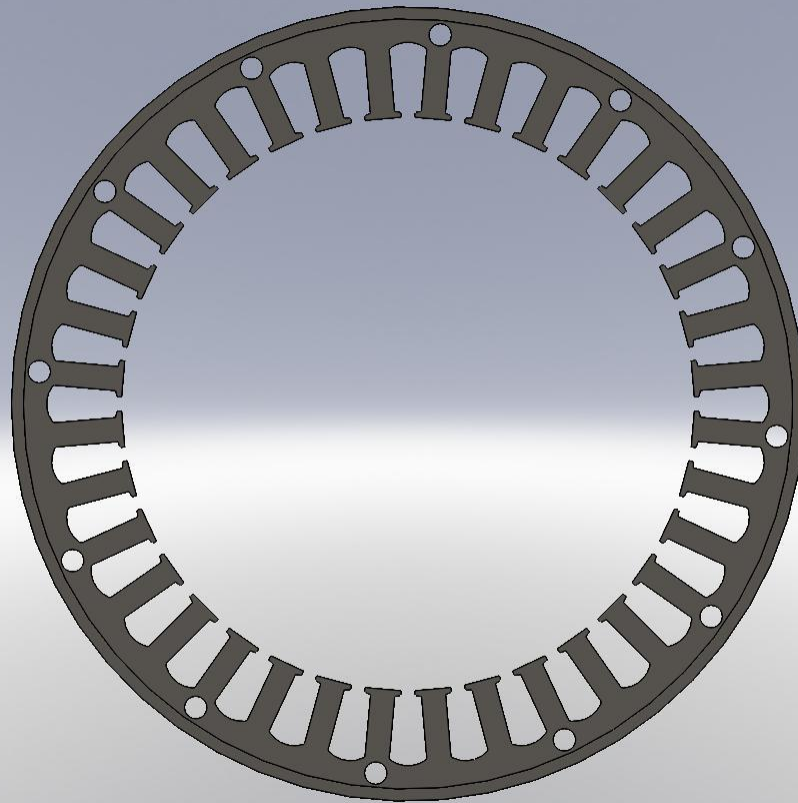
Switch Reluctance DC Machine



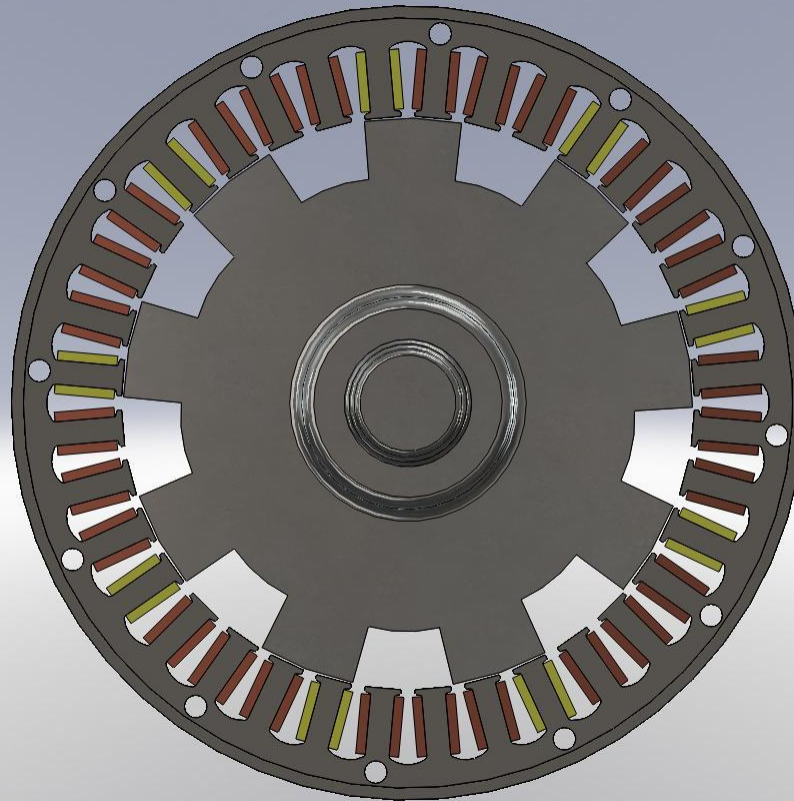
SRDCM Rotor



SRDCM Stator



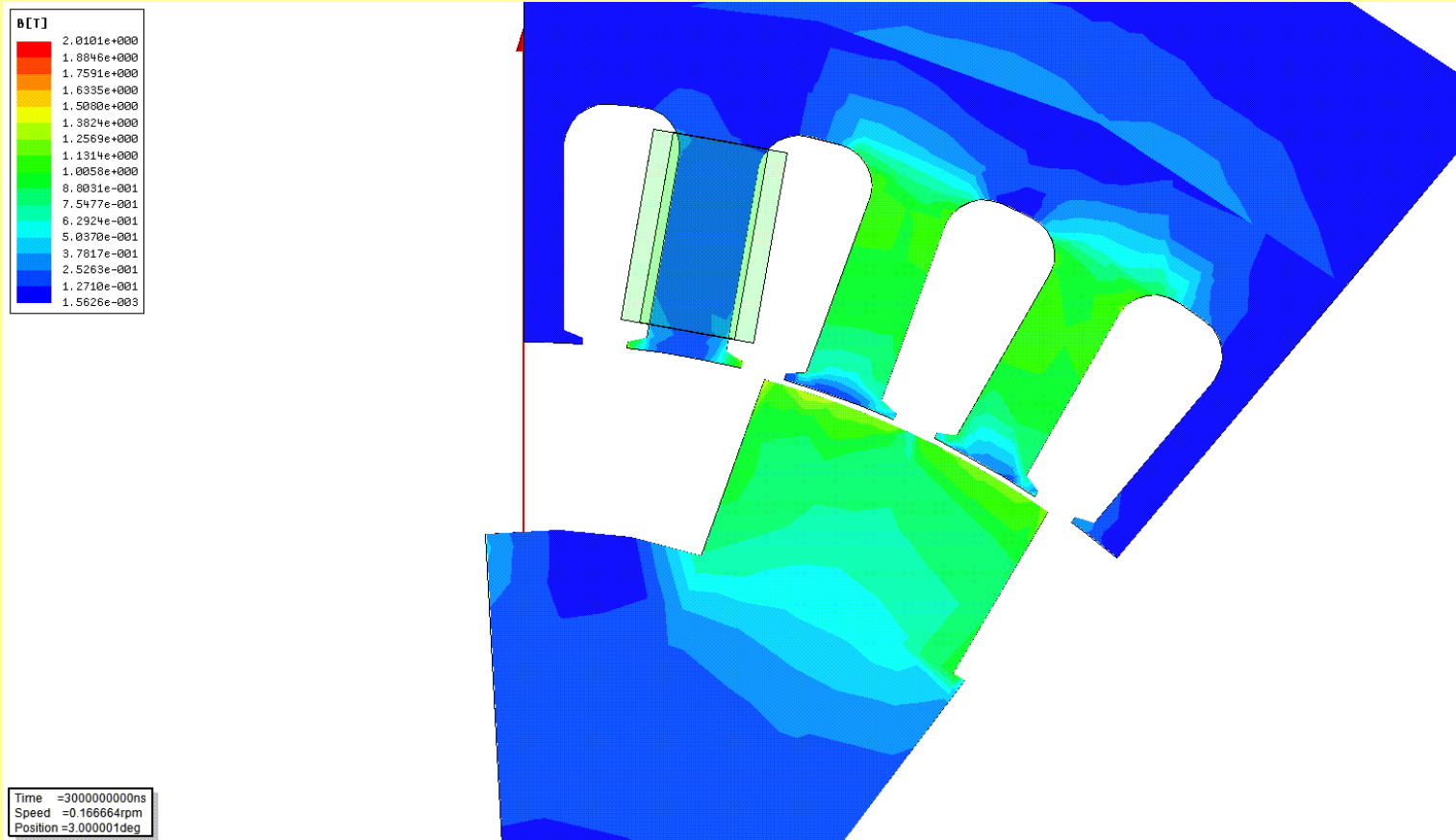
SRDCM Commutation



Commutation starts when the rotor flux is applied off and
the stator flux is applied on and the rotor flux is applied
the stator flux is applied on and the rotor flux is applied

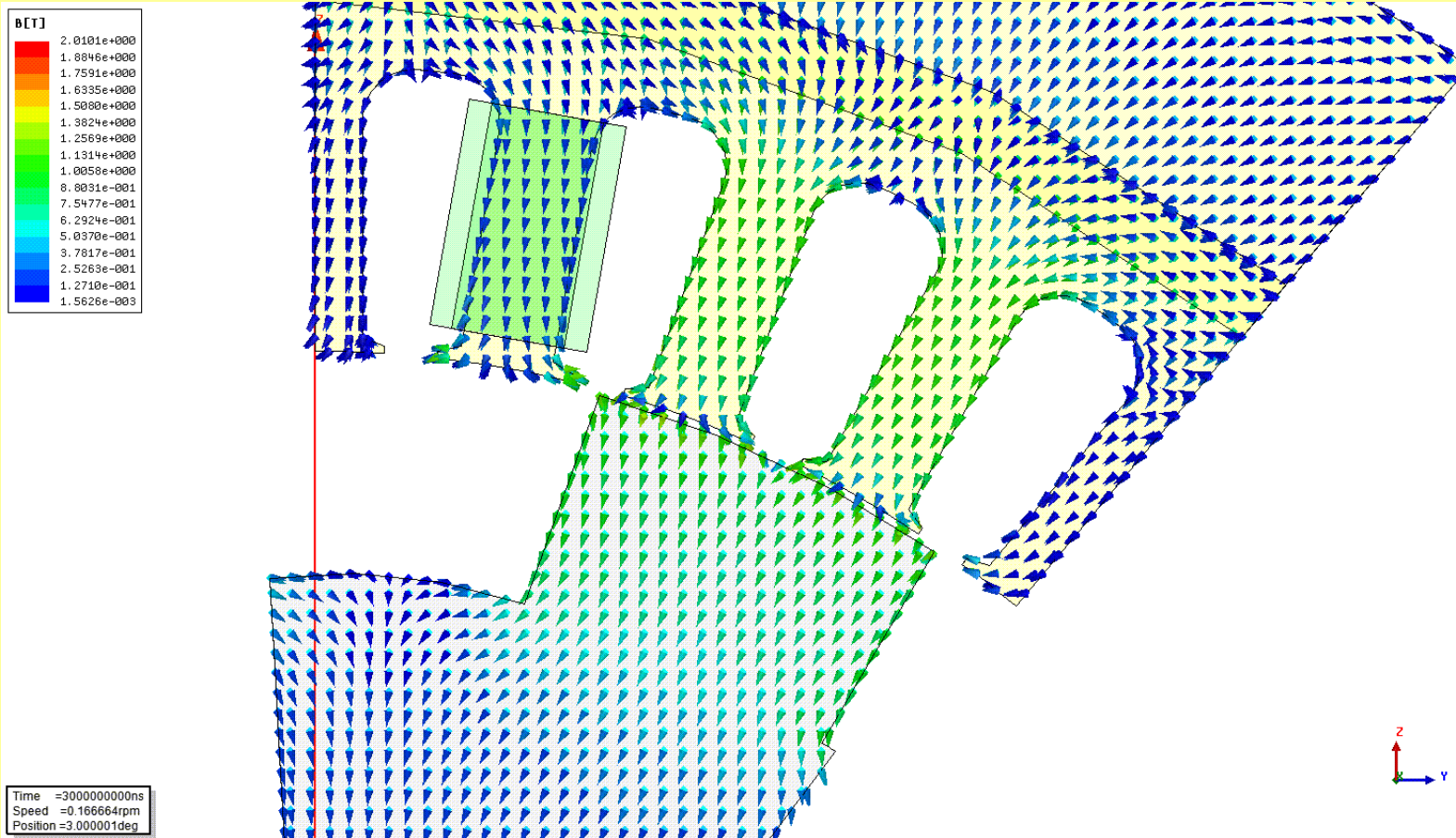
SRDCM Magnetic Fields

Maxwell Software – Field Density



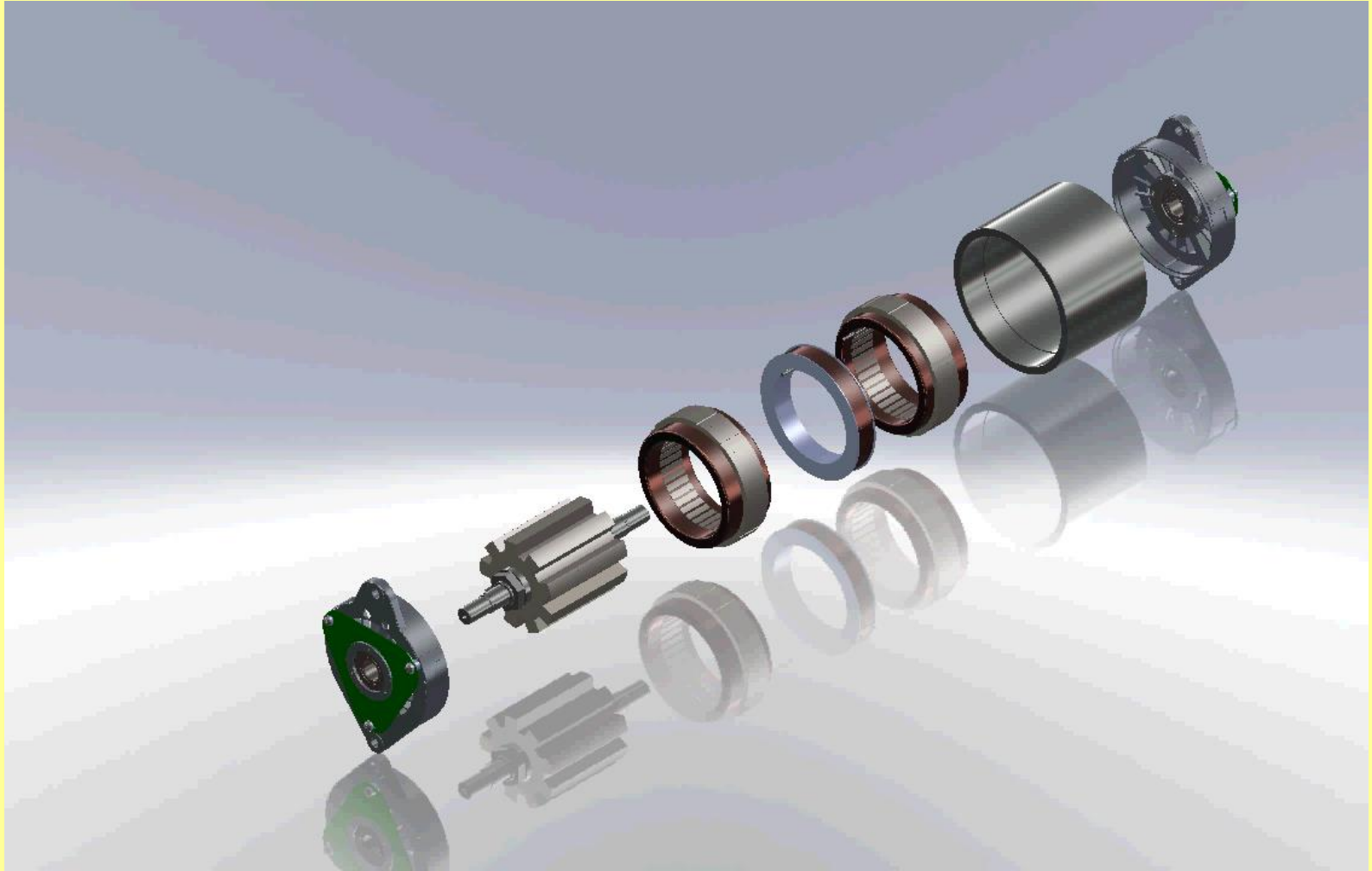
SRDCM Magnetic Fields

Maxwell Software – Flux Vectors



Next Generation Machine Design

SRDCM



Dakota Power R&D

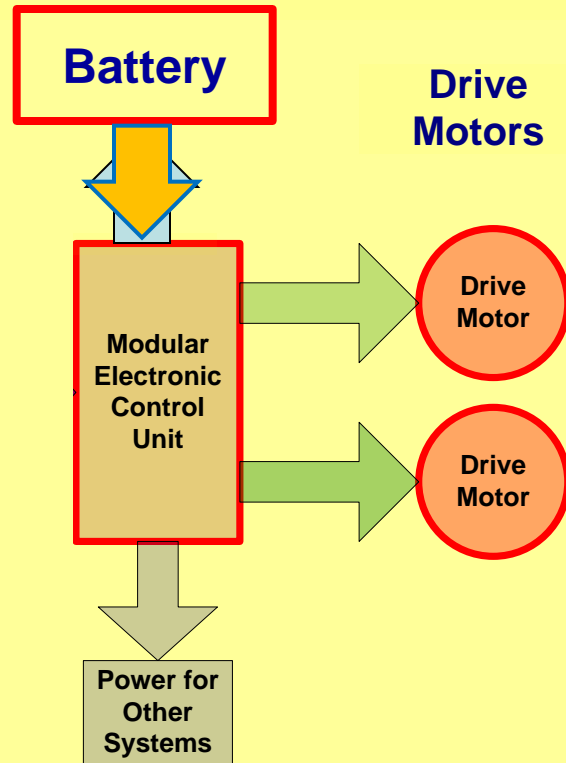
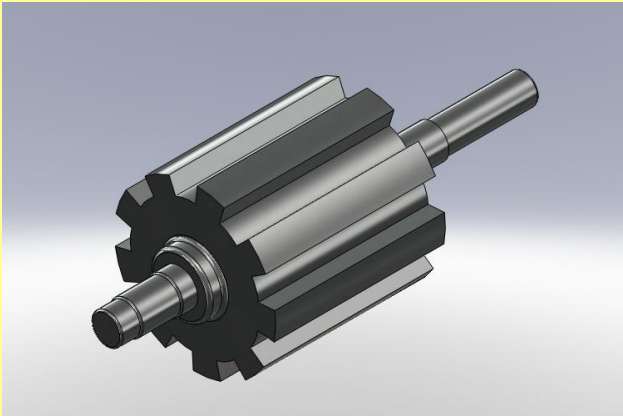
- Research and development plan for the next generation light weight electric drive systems
 - Simulations magnetic density – Maxwell Software
 - Adaptive electronic controls
 - Turbine generator
 - Test and analysis – Dynamometer Test Facility
 - Materials and manufacturing techniques

Direct Drive – Army

- Lightweight Electric Drive System
- Replace internal combustion and diesel with electric drive
- Requires both motor and generator integrated in single machine
 - Motor powers vehicle
 - Generator converts energy created by vehicle for storage

Direct Drive – Army

SR- Clean Rotor

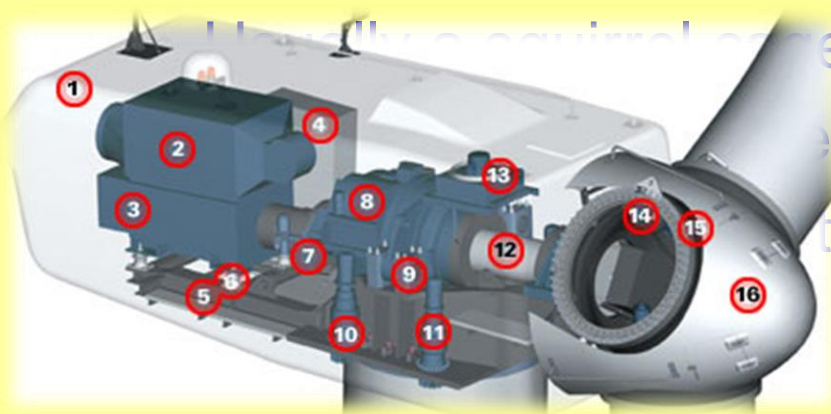


Direct Drive – Army

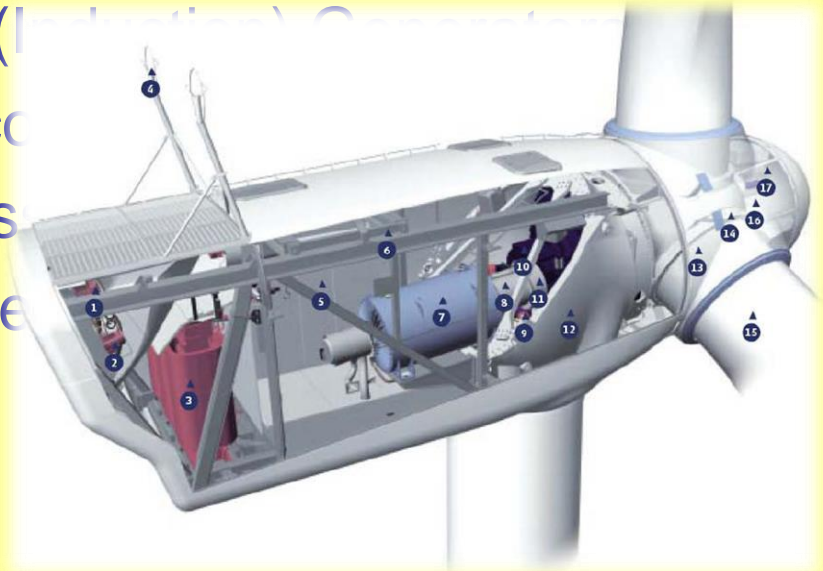
- Lightweight Electric Direct Drive System
- Replace internal combustion and diesel with electric drive
- Requires both motor and generator integrated in single machine
 - Motor powers vehicle
 - Generator converts energy created by vehicle for storage
- Reduced weight
- Opportunity for a closed system free from abrasions of sand
- Provide quiet stealth operation

Today's Wind Turbine Generators

- Geared, High-Speed Drive Trains
 - Doubly Fed Asynchronous (Induction) Generator



GE's 1.5 MW Wind Turbine



Vestas' 3.0 MW Wind Turbine

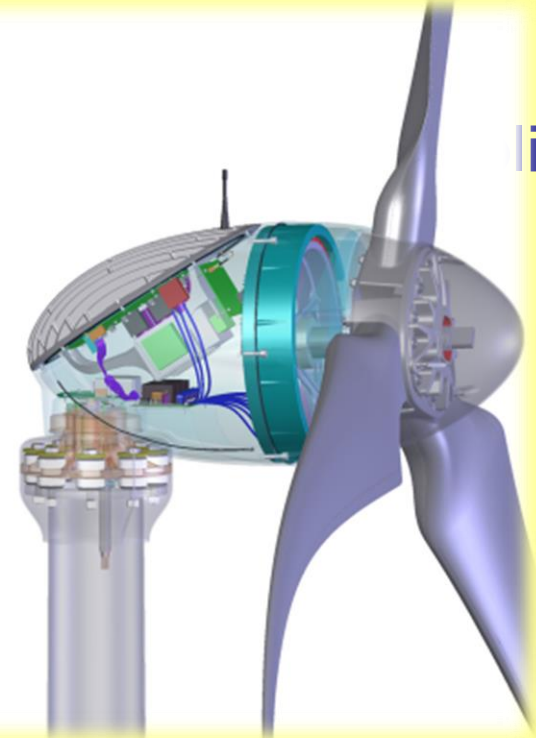
Today's Wind Turbine Generators

- Direct Drive, Low-Speed Drive Trains

- Permanent magnet synchronous low-speed generator and excitation system
- No gearbox
- No gearbox maintenance solutions



Enercon's Direct Drive
Industrial Scale Wind Turbine



Skystream 3.7
Residential Wind Turbine

lications

Direct Drive – Wind Turbines

- Removing gears reduces size and weight
- Direct drive require less maintenance – desired for off-shore installations
- Simplicity of design results in an overall increase in reliability
- Less noise for residential scale turbines when operated at lower speeds
- SRDCM potential alternative to popular PM

Comparison SRDCM and PM

- SRDCM
 - Low-speed high-torque low cost
 - High density rotor variable magnetic field
 - High temperature operation
- PM
 - Very high density rotor fixed magnetic field
 - Rare earth concerns in China



Thank you listening

May we answer your questions?

Dakota Power, LLC
3111 Lien Street
Rapid City, SD 57702
www.dplwed.com
rgowen@dplwed.com