Innovative Concepts and Initial Practice of High Power Electric Machines

Prof. Longya Xu
The Ohio State University
April, 2014

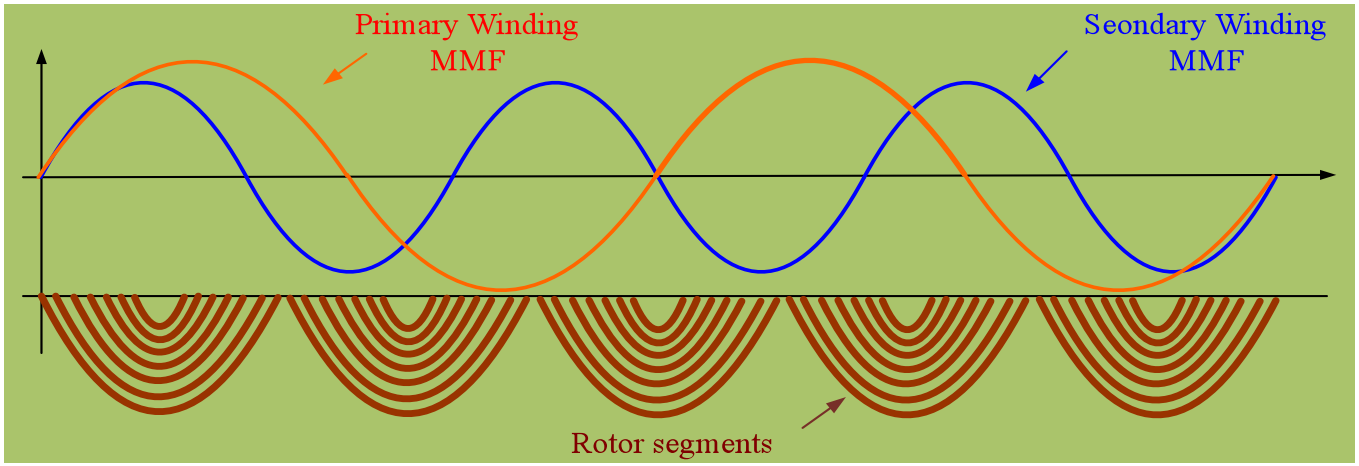
Xu.12@osu.edu Phone: (614) 292-6119

CHPPE Center for High Performance Power Electronics

THE OHIO STATE UNIVERSITY

1. *Concept of Brushless Doubly Fed Machine*

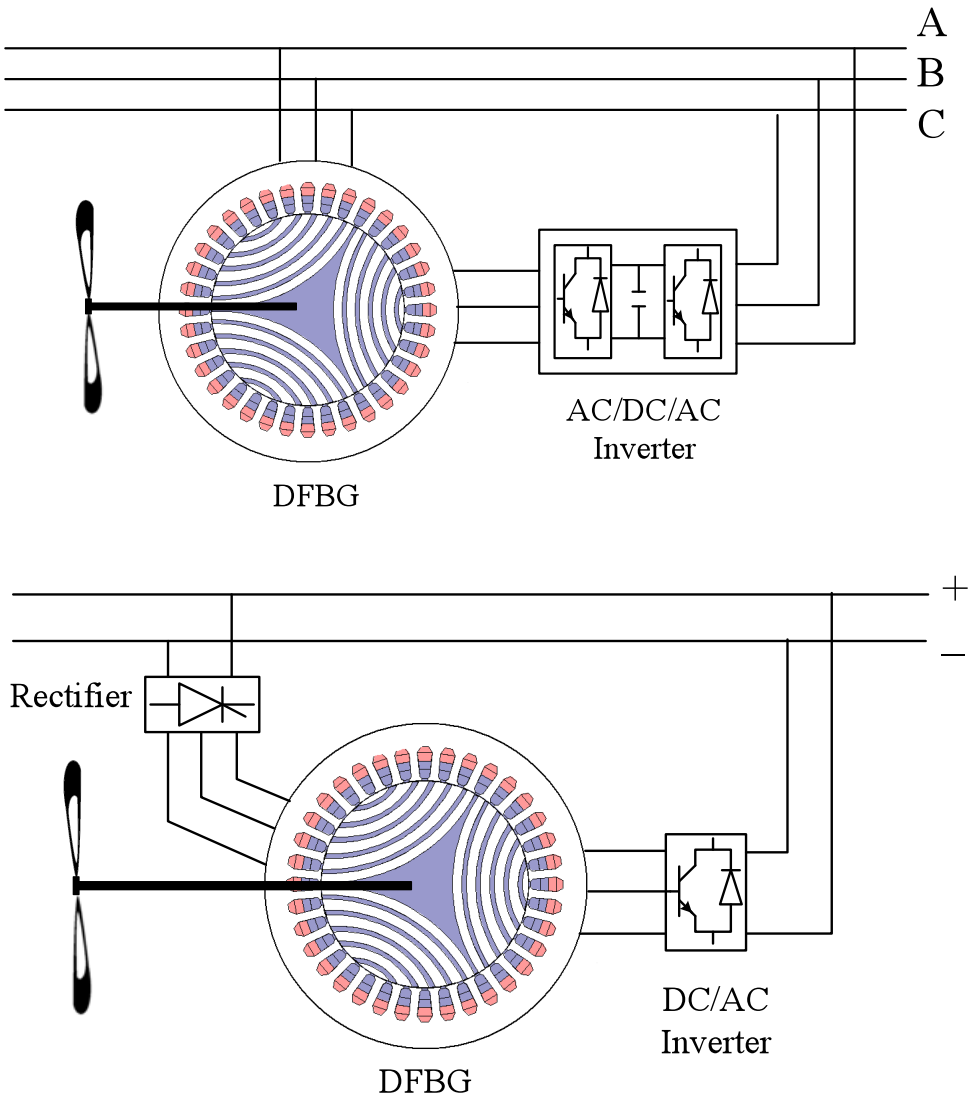
A. Conceptual Fields and Moving Modulars



B. Features and Potentials

- Dual Stator Windings—Power and control power windings
- Dual Stator Windings – HV and LV windings
- Current Free Rotor—No winding，no brushes/slip rings，and no PM
- Modular Rotor Segments—easy to make and multiply with much reduced cost

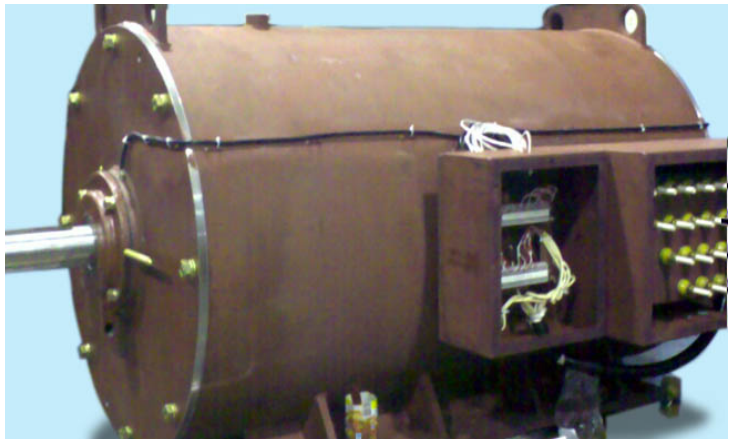
Flexible Connection to AC or DC Power Grid for high power :



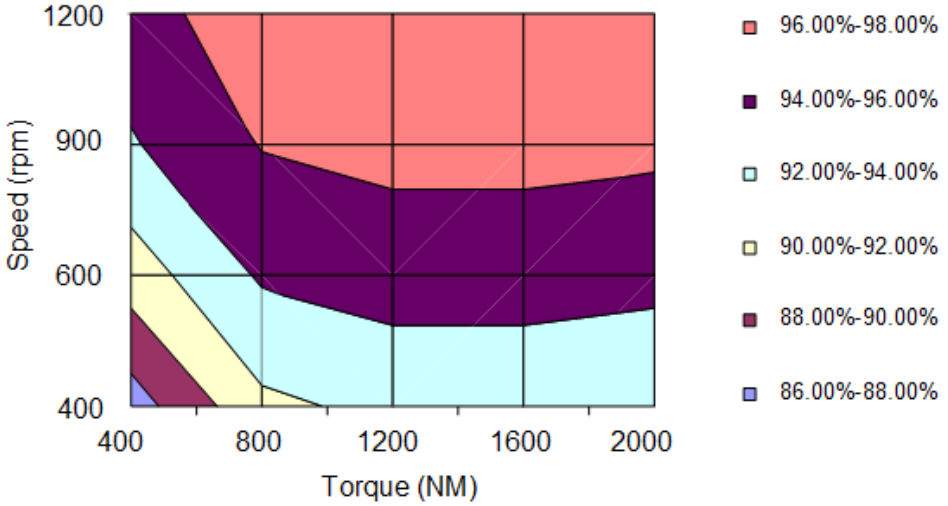
2. *Prototype and Testing Results*

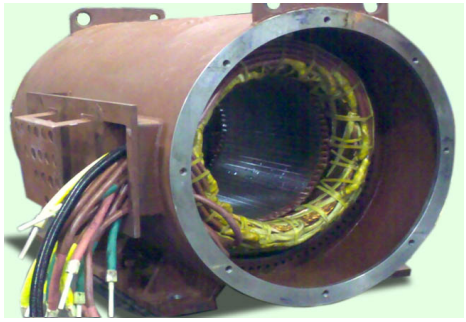
- Modeling, Designs, Prototype and Control of *Brushless Doubly Fed Machine*

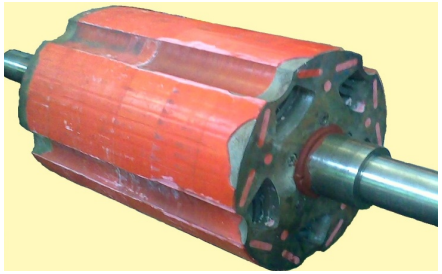
BDFM Assembly



Tested Energy Efficiency



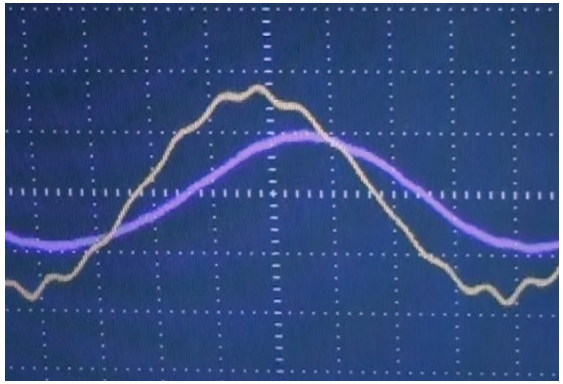




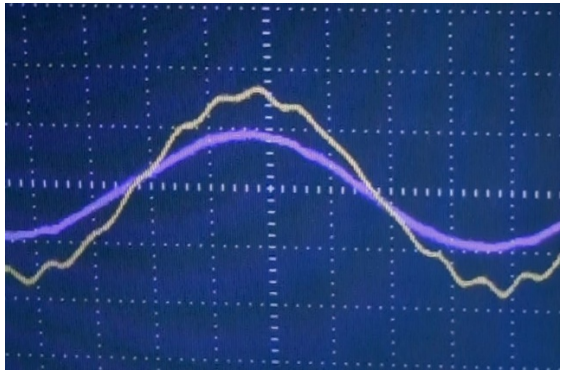
CHPPE Center for High Performance Power Electronics

THE OHIO STATE UNIVERSITY

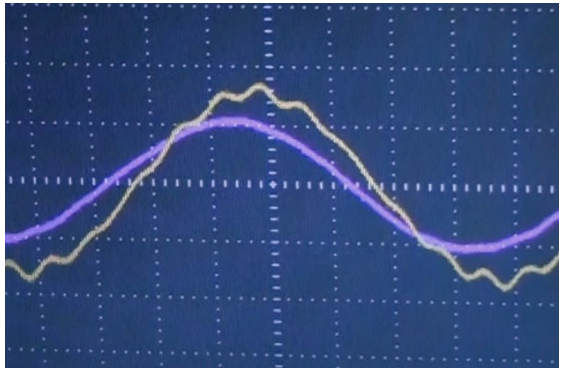
Controllable power factor:



Lagging P. F.

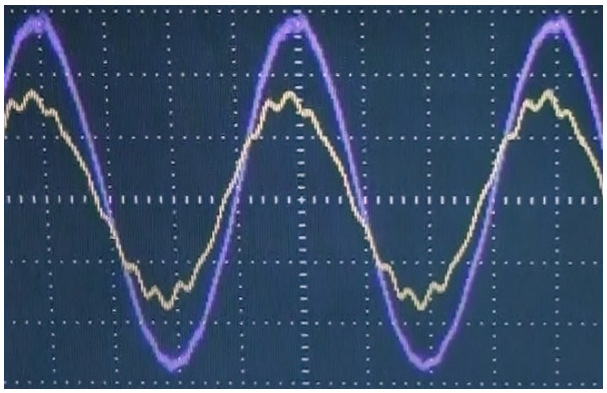


Unity P. F.



Leading P. F.

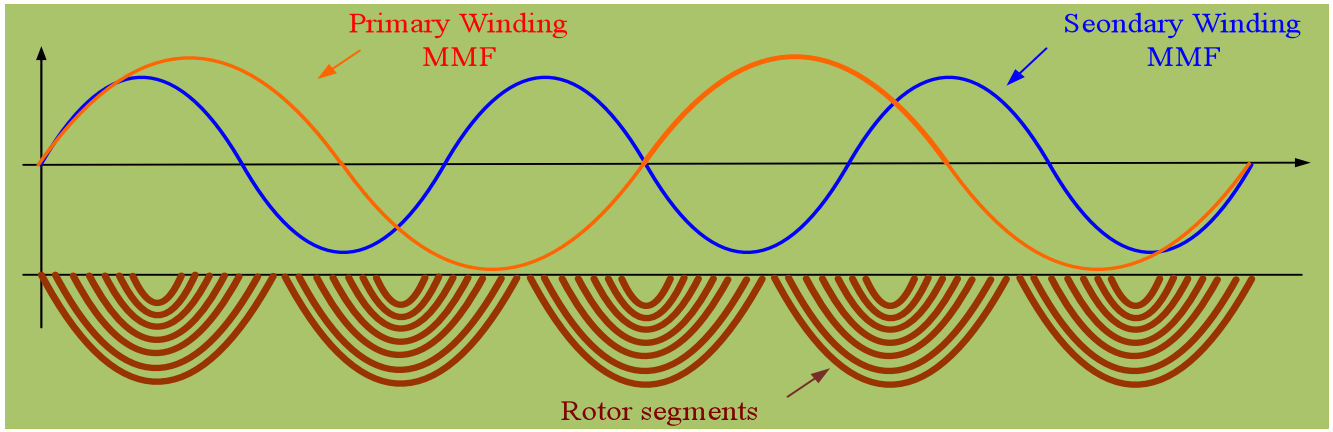
Decoupled control of active and reactive power:

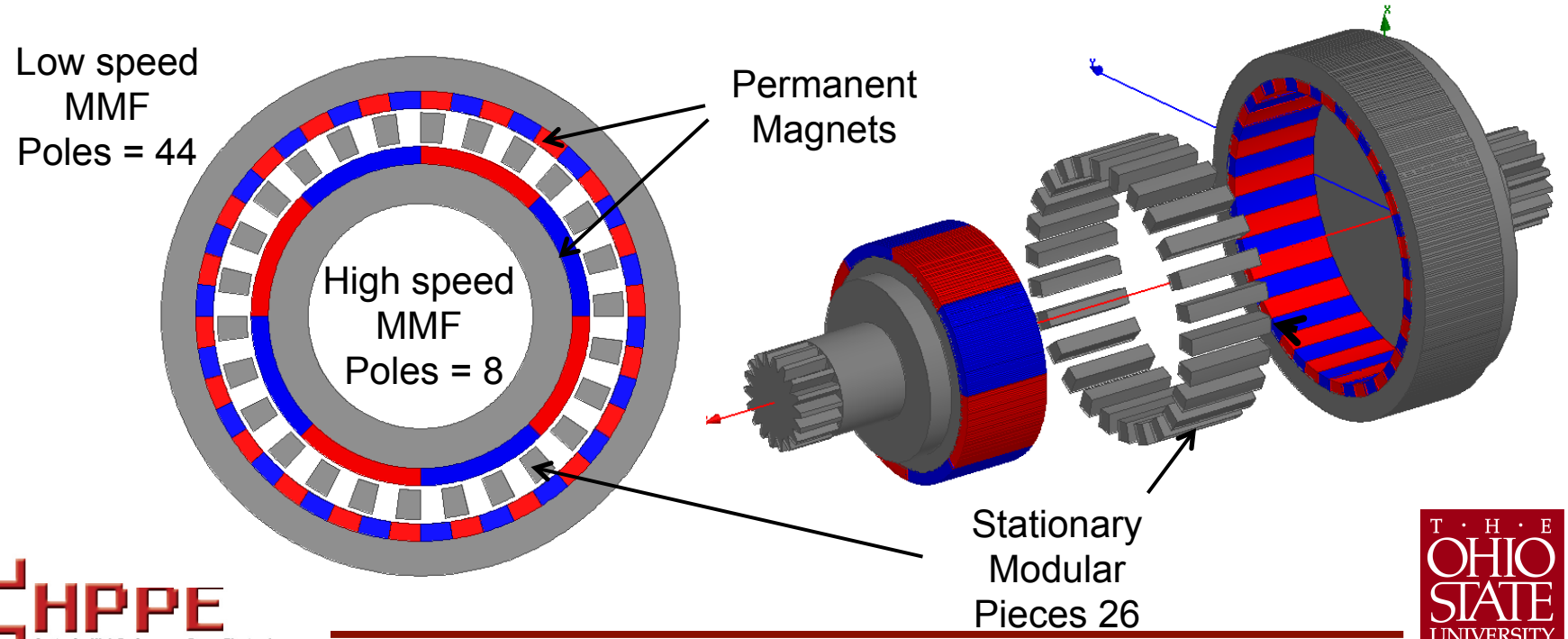


50%
Loaded

voltage –yellow traces (100v/div)
current – purple traces (50a/div)

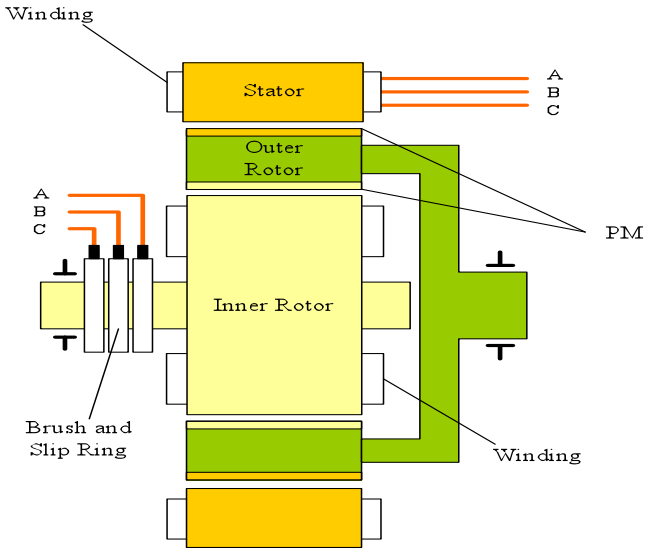
3. Concept Variation – Magnetic Gears





4. Dual Mechanical Port (DMP) Machine and Vehicle Electrification

Tested Performance	Results
Acceleration to 100km/h (s)	28.90
Maximum speed (km/h)	122.5
Slope climbing	30% slope



Schematics and Photos of DMP Machine rated 100kw/4000rpm

5. *Remarks on future HMW VSDs*

- **Innovative electromagnetic structures**
  - *Multi electrical and mechanical port electric machines*
  - *More WBG power electronics friendly*
  - *Sensor embedded and intelligent*
- **High power and high voltage machines**
  - *High strength high temperature permanent magnets*
  - *High permeability en-isotropic materials*
  - *Superconducting materials*
  - *High performance and voltage insulations*
- **WBG Power electronics and control**
  - *High temperature*
  - *High voltage and current*
  - *High speed switching*