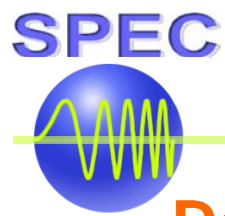


ETO Light Power Converter for FACTS & Energy Storage Applications

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North Carolina State University, Raleigh

SNL Project Manager: Stan Atcitty
DOE Manager: Dr. Imre Gyuk



FY2006 Project Objectives

Develop a modular VSC for multiple FACTS and energy storage applications with goals of achieving

1. Lower cost

- **Using lower cost power devices**
- **Reducing component parts**
- **Modular approach**

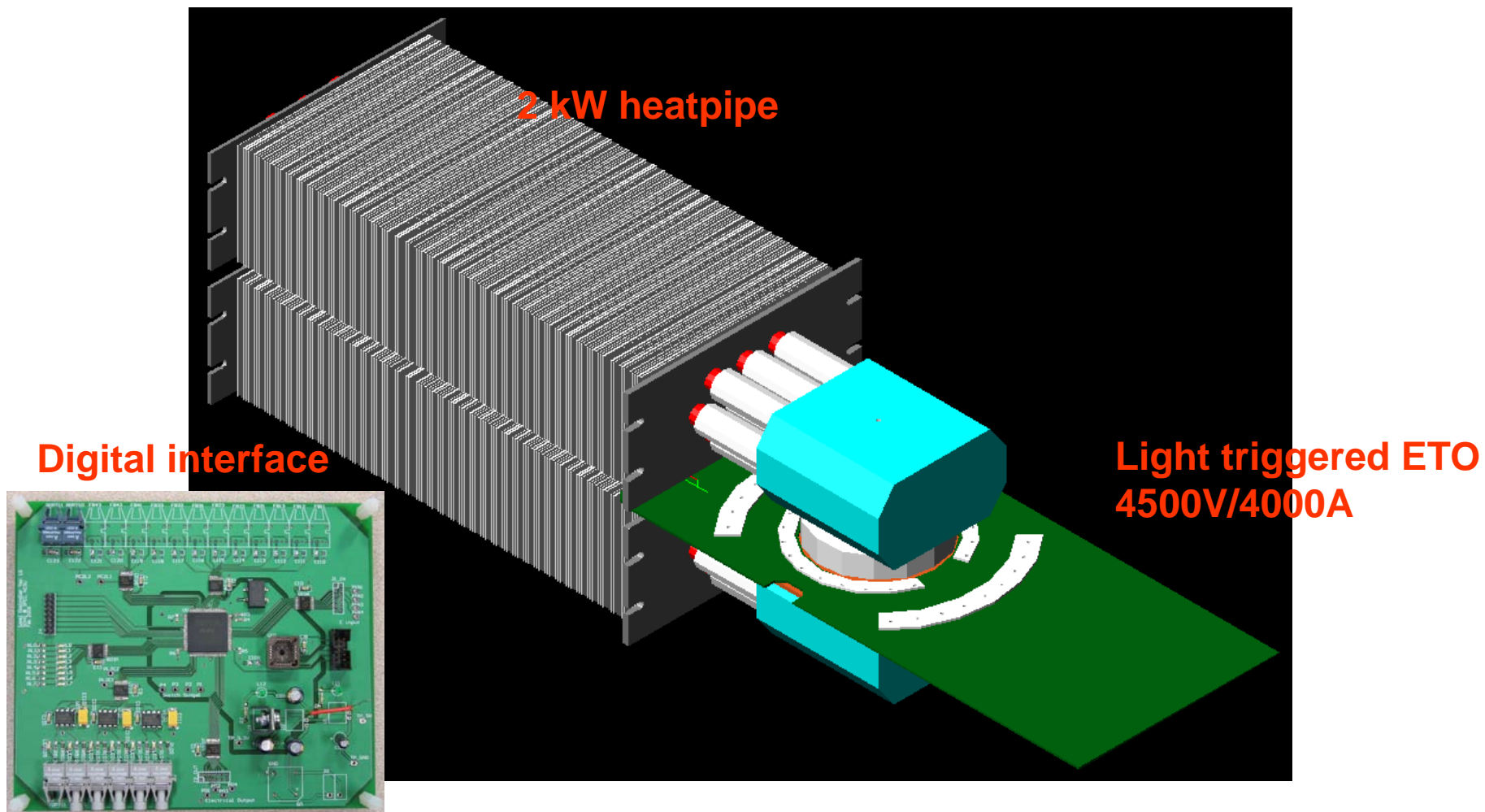
2. Higher reliability

- **Reducing components parts**

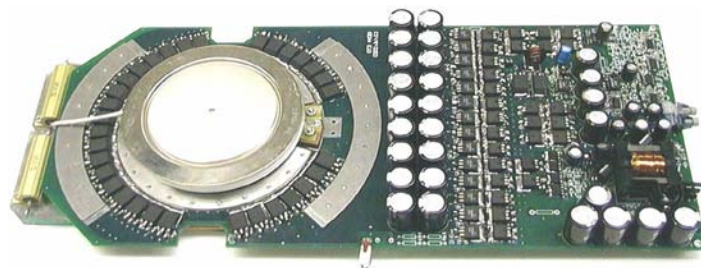
3. High power density

- **Better utilization of silicon**
- **Reducing component parts**

Based on three key technologies



Light Triggered Emitter Turn-off Thyristor



Lower cost

lower cost device based on mature GTO technology
eliminating snubbers and auxiliary power supplies

Higher reliability

eliminating auxiliary power supplies and snubber networks
light trigger interface improve noise immunity

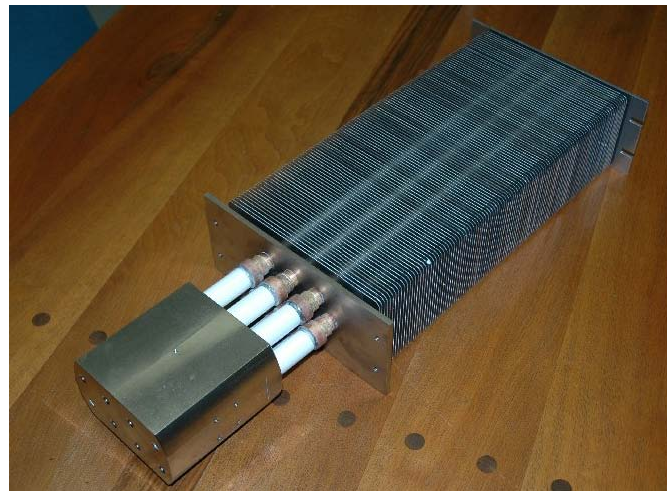
High power density

large turn-off capability (4000A) allows thermally limited VSC design

reduced parts allow compacter design

More information of the ETO has been presented in previous ESS reviews

Heatpipe Cooling System



Lower cost

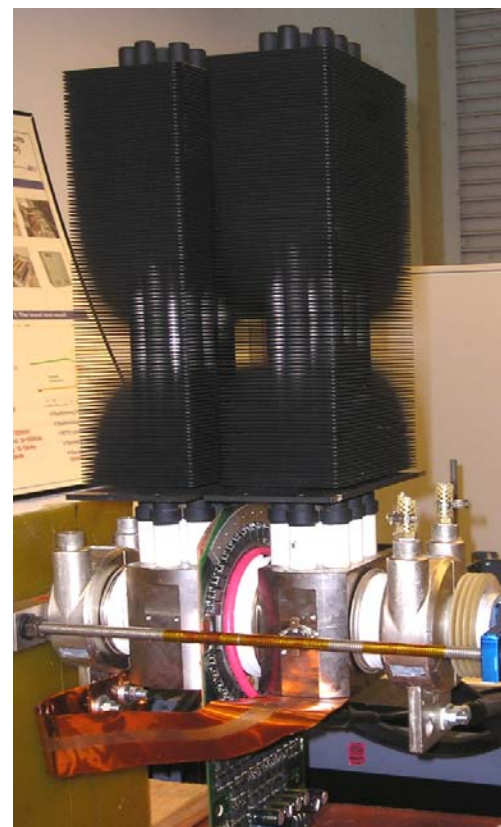
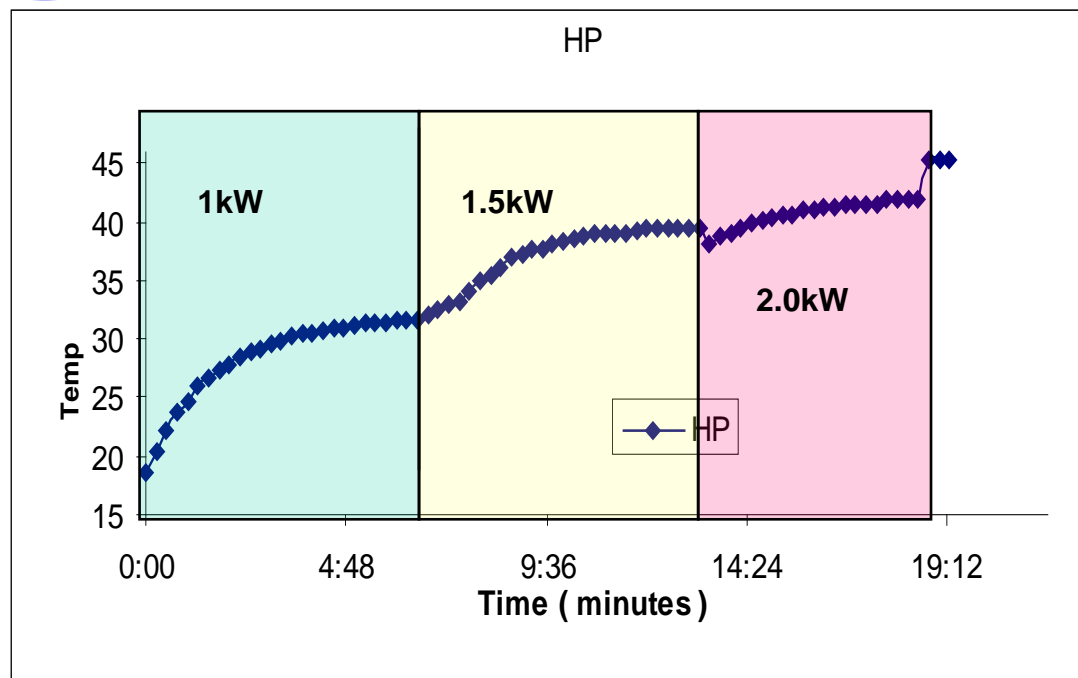
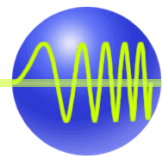
lower cost by eliminating heat exchanger and pipes in water cool system

Higher reliability

eliminating pumps, pipes and water

High power density

reduced parts allow compacter design



- Thermal resistance (junction-ambient) for the ETO with double side heatpipes is determined as **35K/kW**

- Capable of removing around **2.5 kW** of heat from ETO even at $T_a=40^\circ\text{C}$

Modular Construction and Digital Interface

Rating:

- 1.0 MVA to 2 MVA/per module
- Size ~ 0.6 cubic meter

Power Stage:

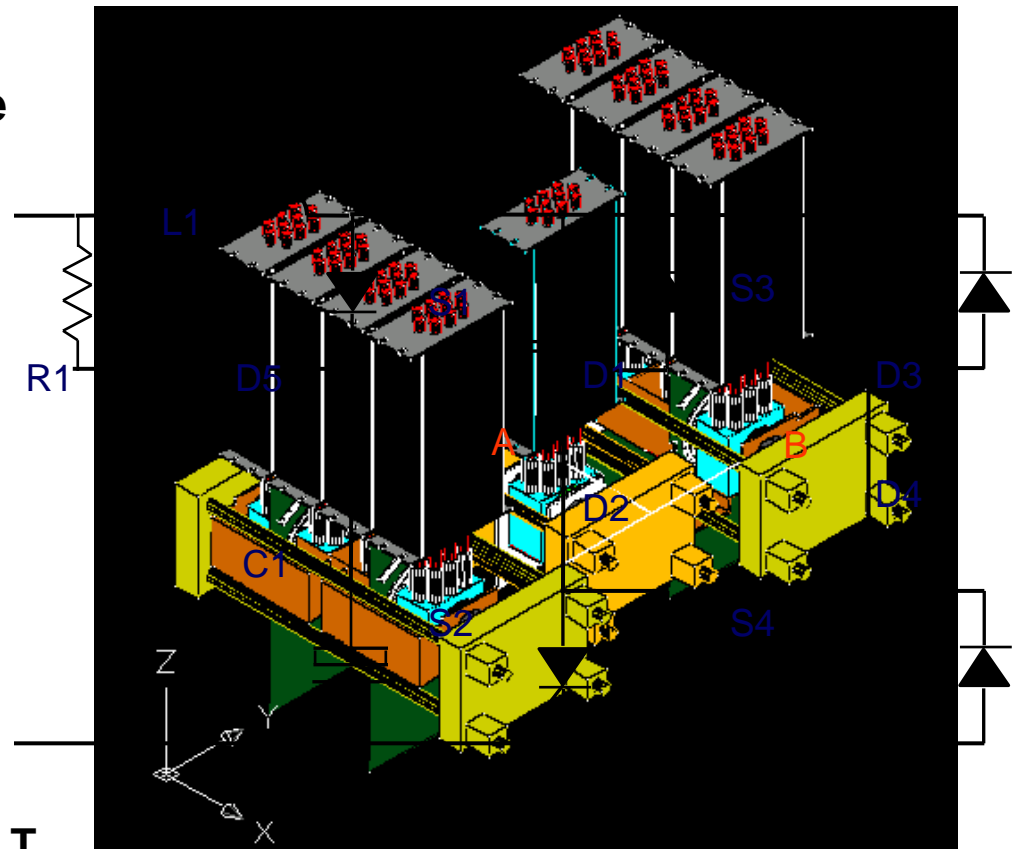
- Two VDC Ports;
- Two AC Ports;

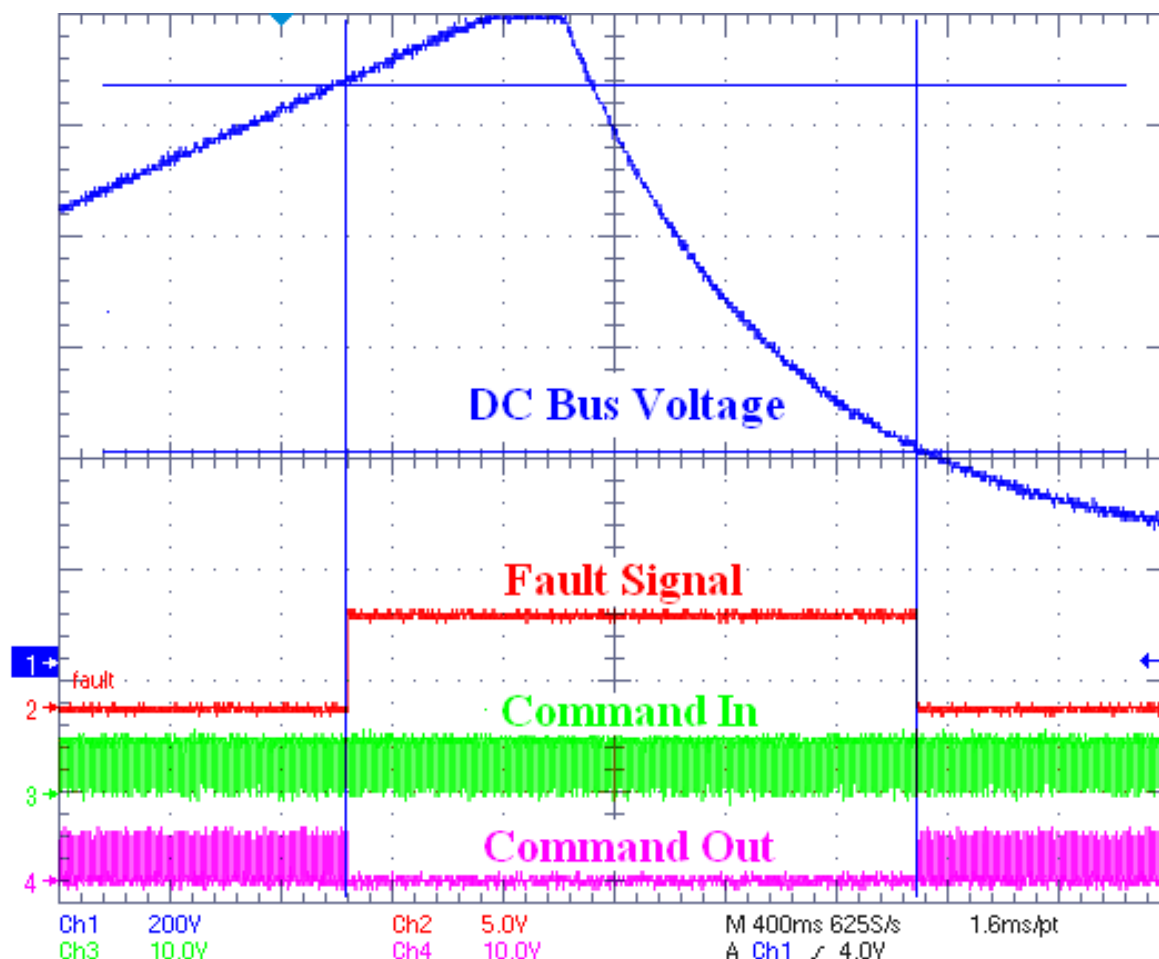
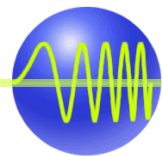
Digital Control Interface:

- One optical fiber in;
- One optical fiber out;

Intelligence:

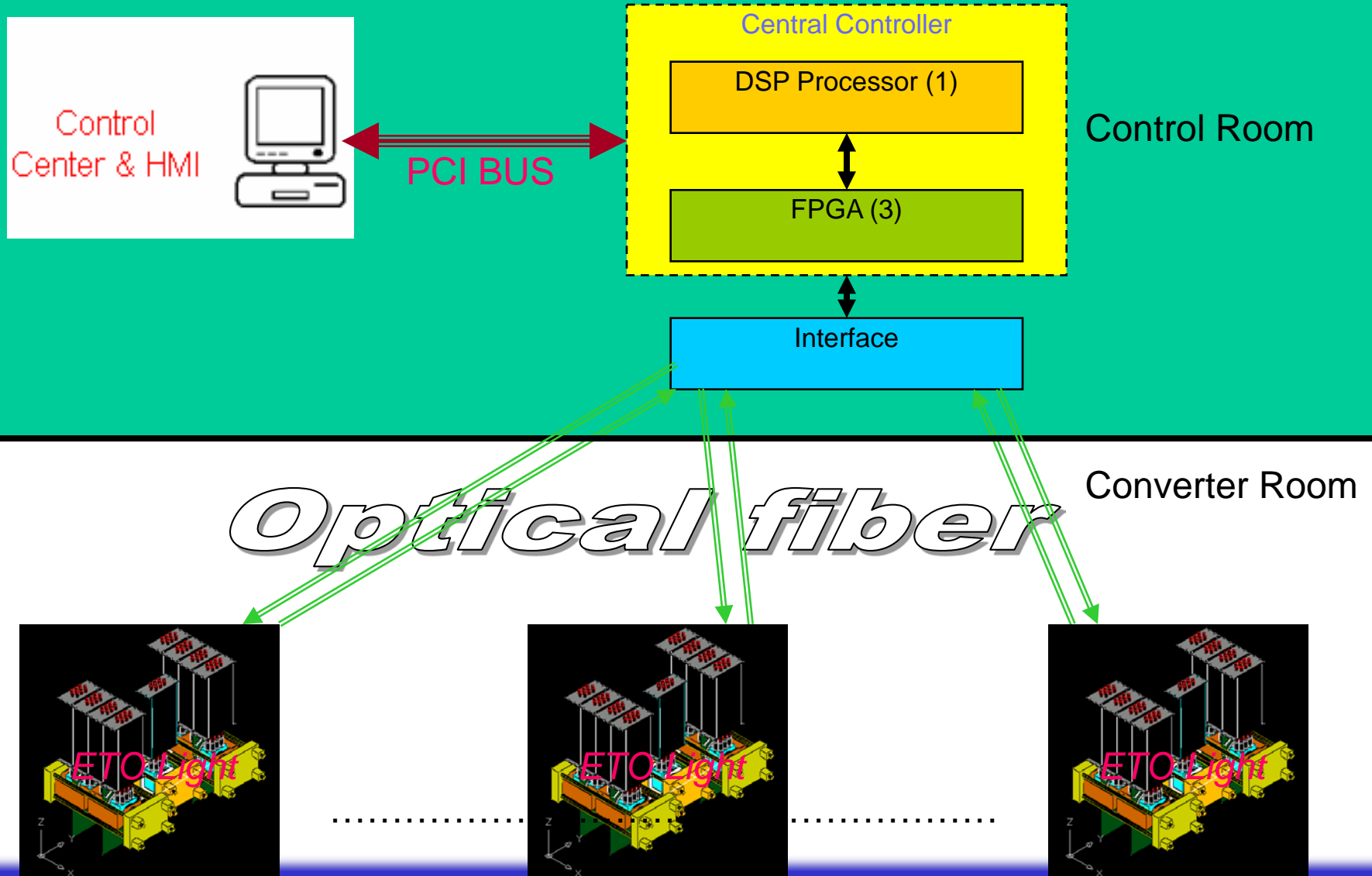
- Sensorless V, I, T sense & protections
- Programmable fail open or fail short



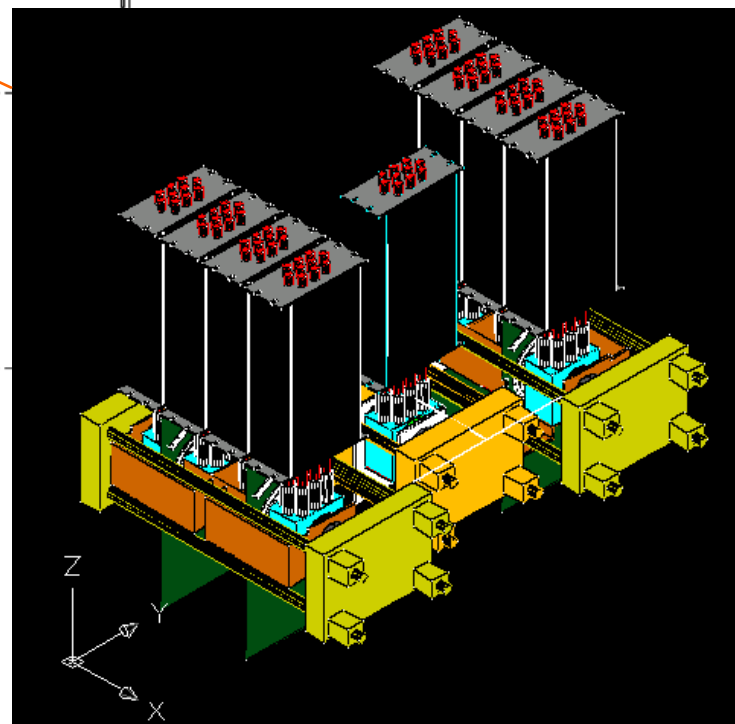
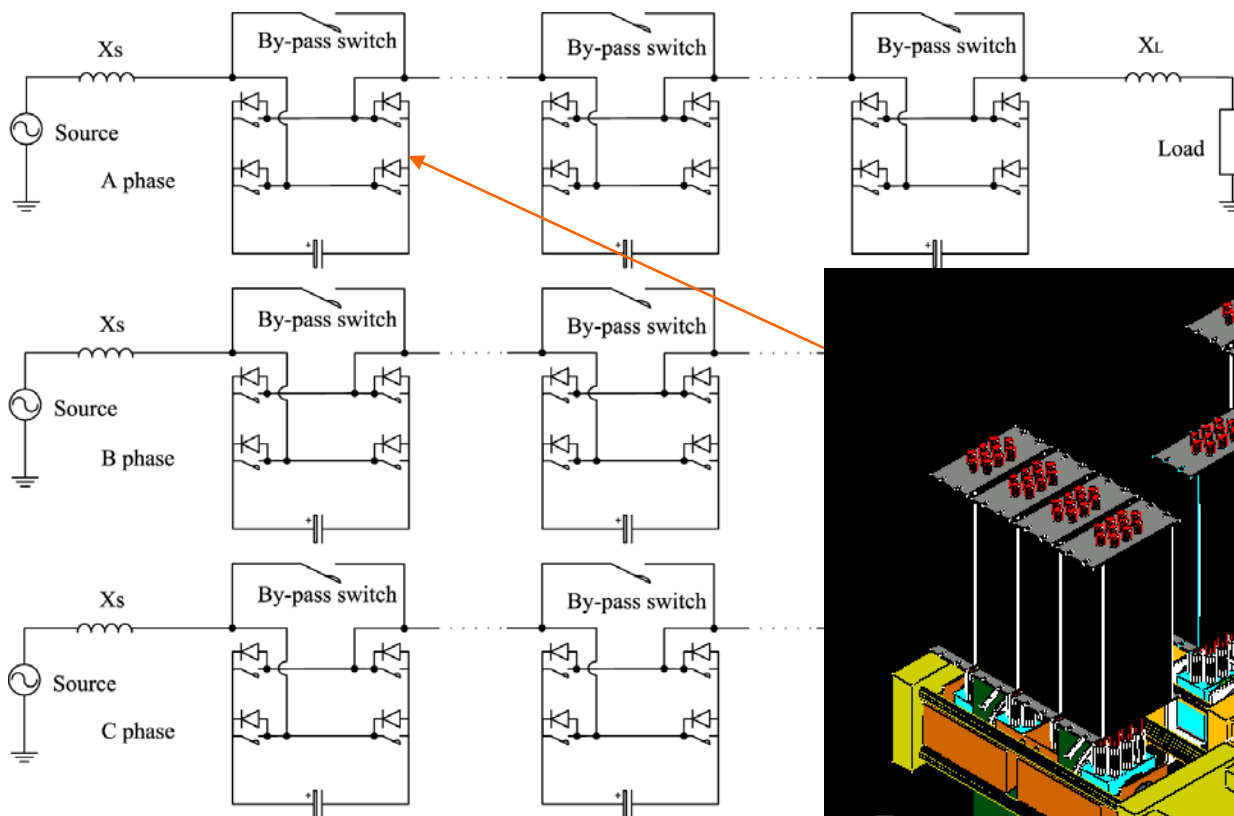


- Built-in digital controller read the voltage value from the **ETO built-in voltage sensor** and carry out the protection function

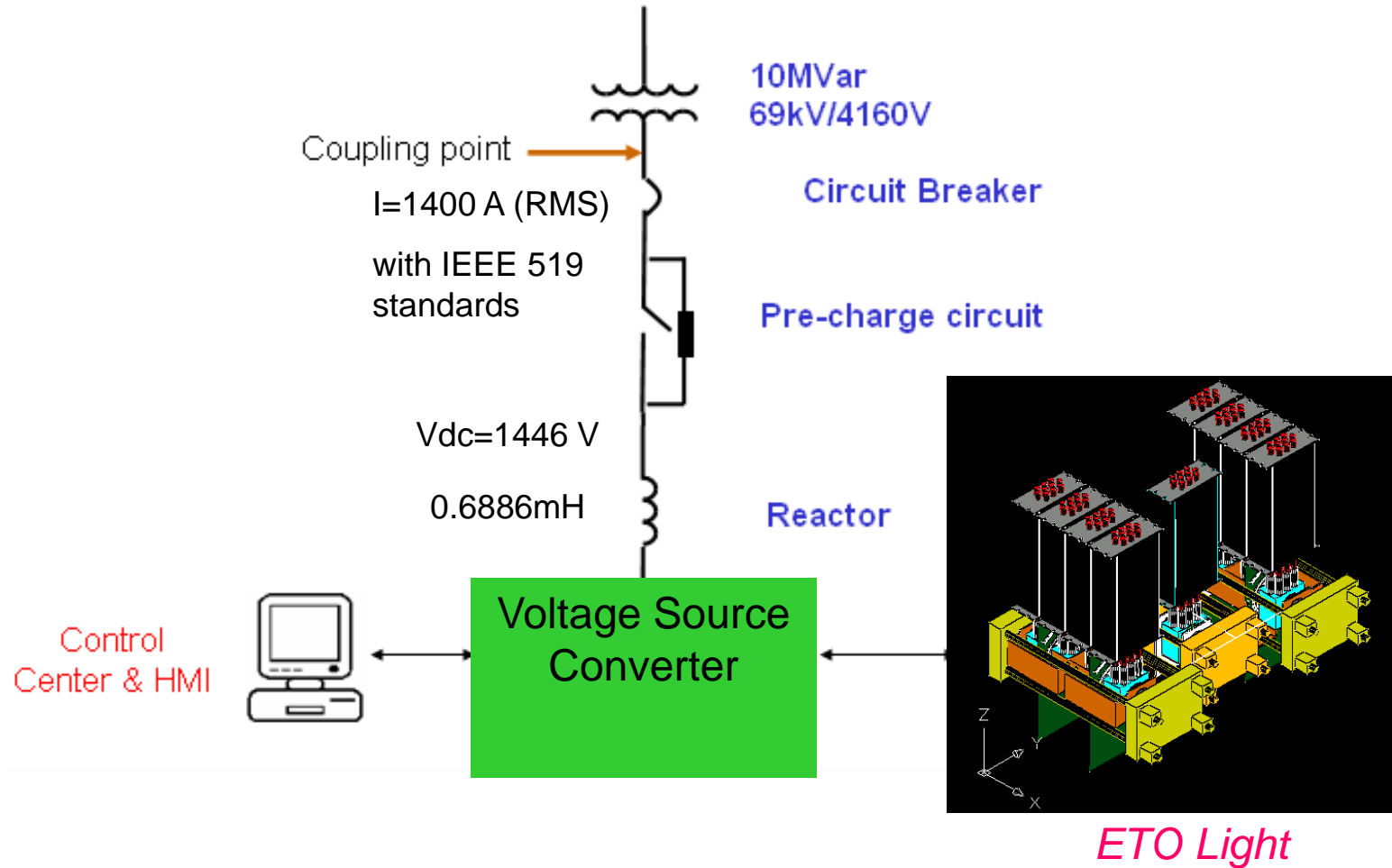
Enabling Simplified Controller Architecture

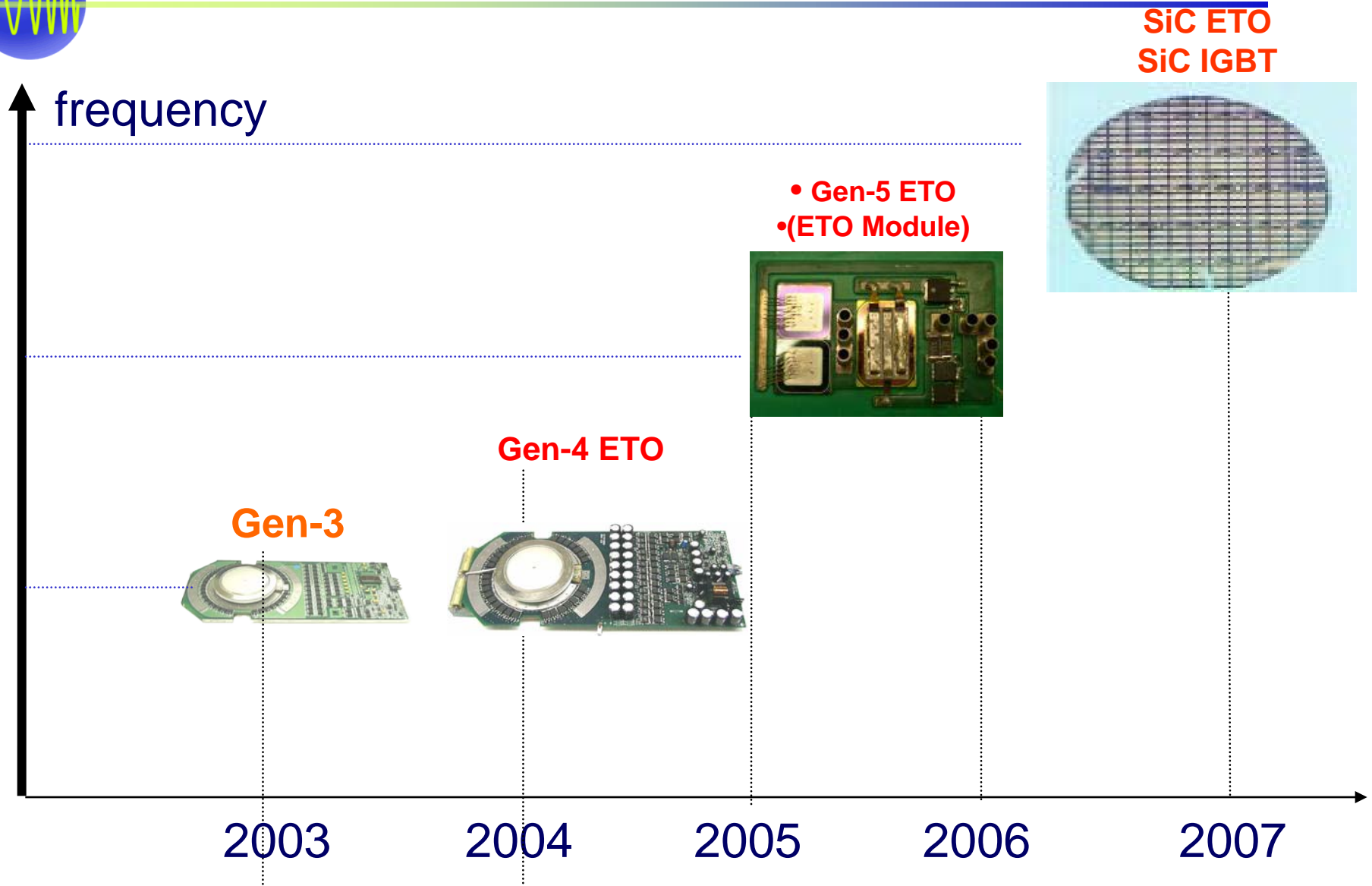
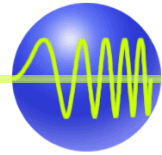


Example FACTS: A distributed power flow controller based on ETO Light™



Future Plan: 10 MVA STATCOM for Wind Farm Application





Support by DOE's Energy Storage Program has enabled the development of four generations of ETOs, and in FY 2006, has resulted in the development of ETO Light converter. ETO Light modular converter will have the following advantages:

- **Lower cost solution compared to existing solutions based on IGBT and IGCT technologies**
 - Direct material cost of *ETO Light* is estimated to be about \$40,000 excluding DC capacitors. (\$40/kVA to \$20/kVA)
 - **High power density solutions compared to existing water cooled systems**
 - 1.6 MVA/m³ to 3.2 MVA/m³
 - **Higher reliability due to significantly reduced part counts.**
-
- **Suitable to FACTS, Energy Storage, Renewable and DG applications**