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**Power Conversion Department (PCD)**  
**Status of High Availability Power Systems**  
**First Generation ATF 2**  
**Second Generation R & D Prototype**

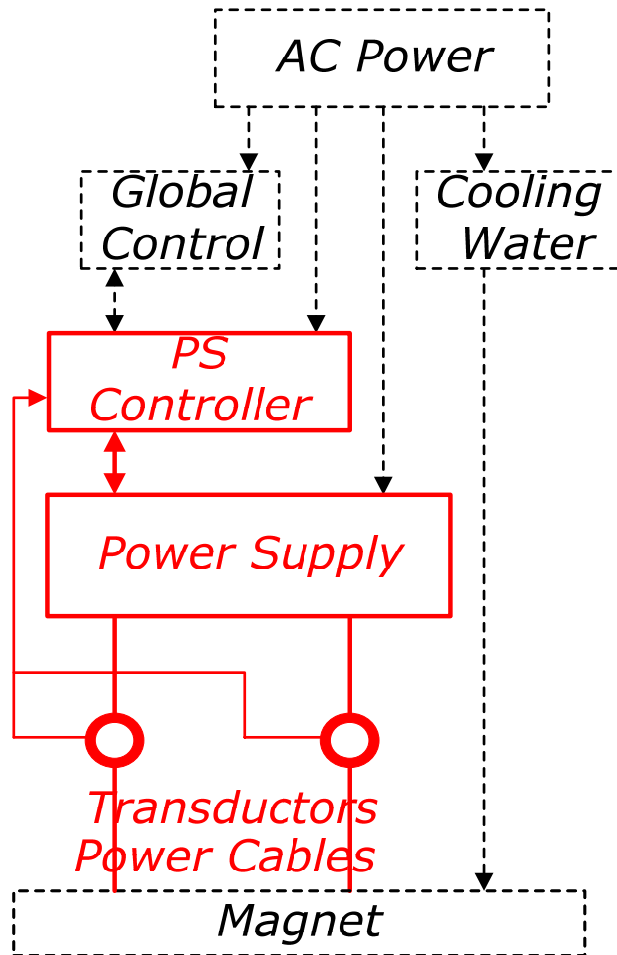
**September 27, 2007**

Paul Bellomo for Antonio de Lira, Briant Lam and Dave MacNair

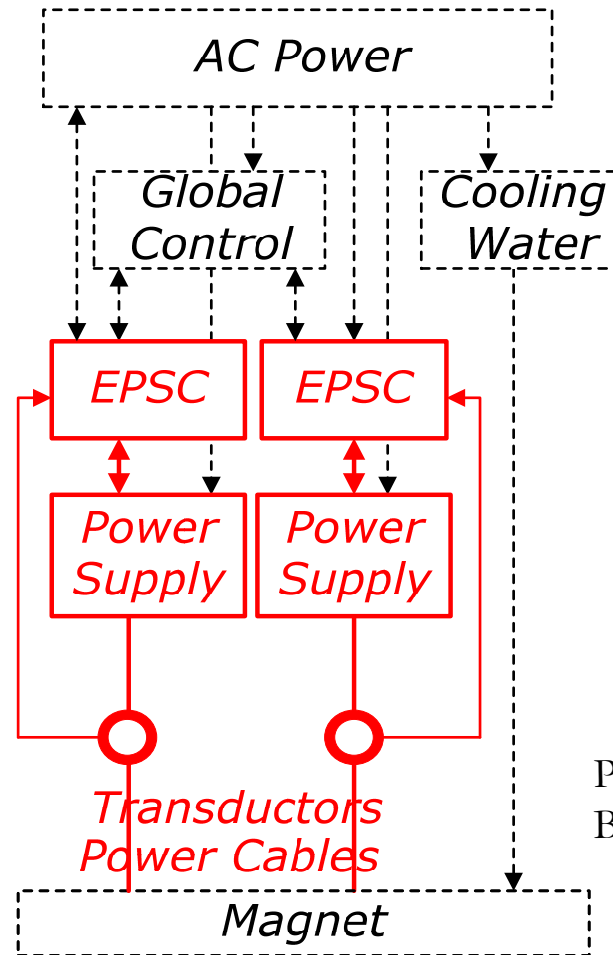
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# Why High Availability is Essential

*Nonredundant Power System*



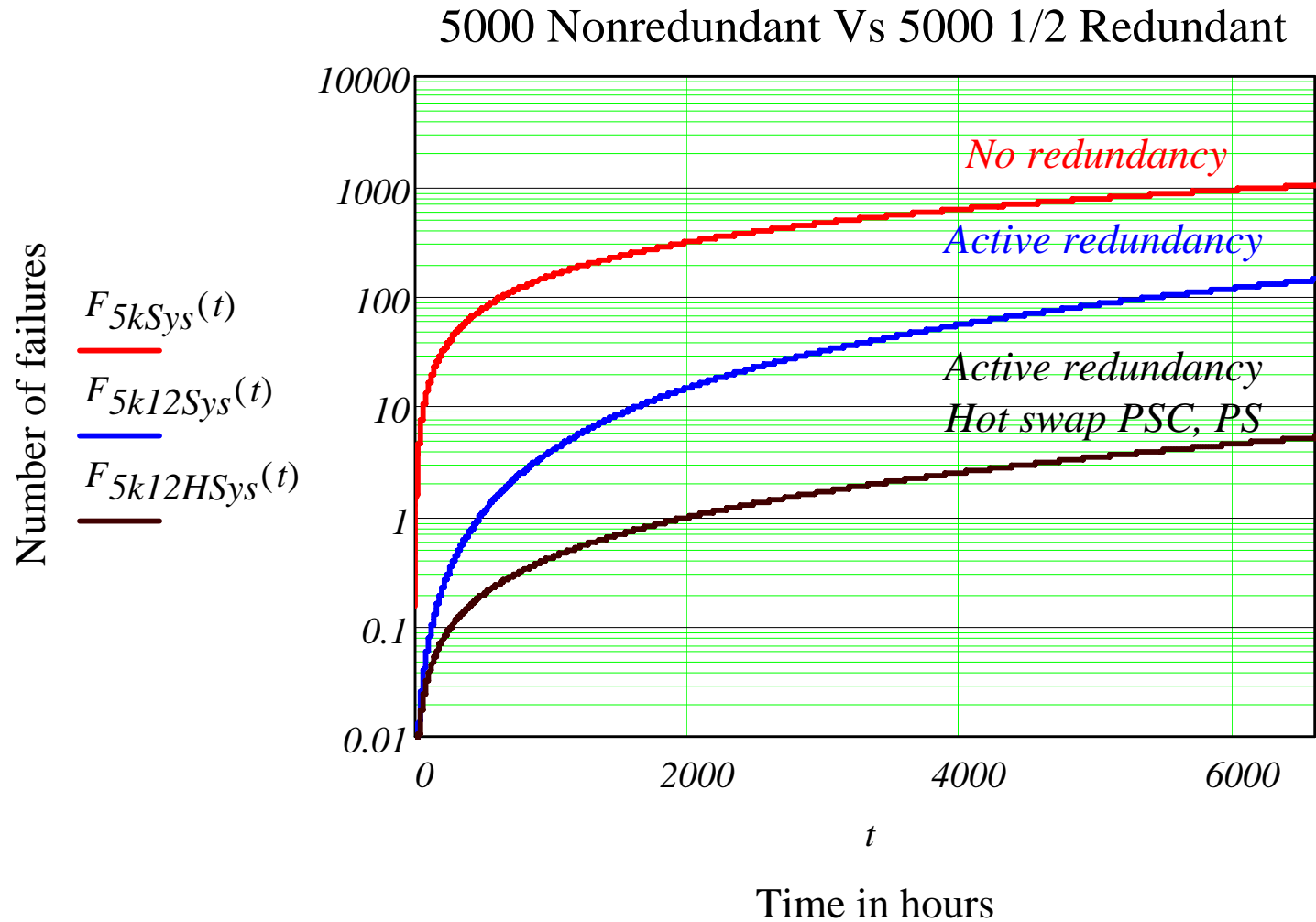
*Redundant Power System*



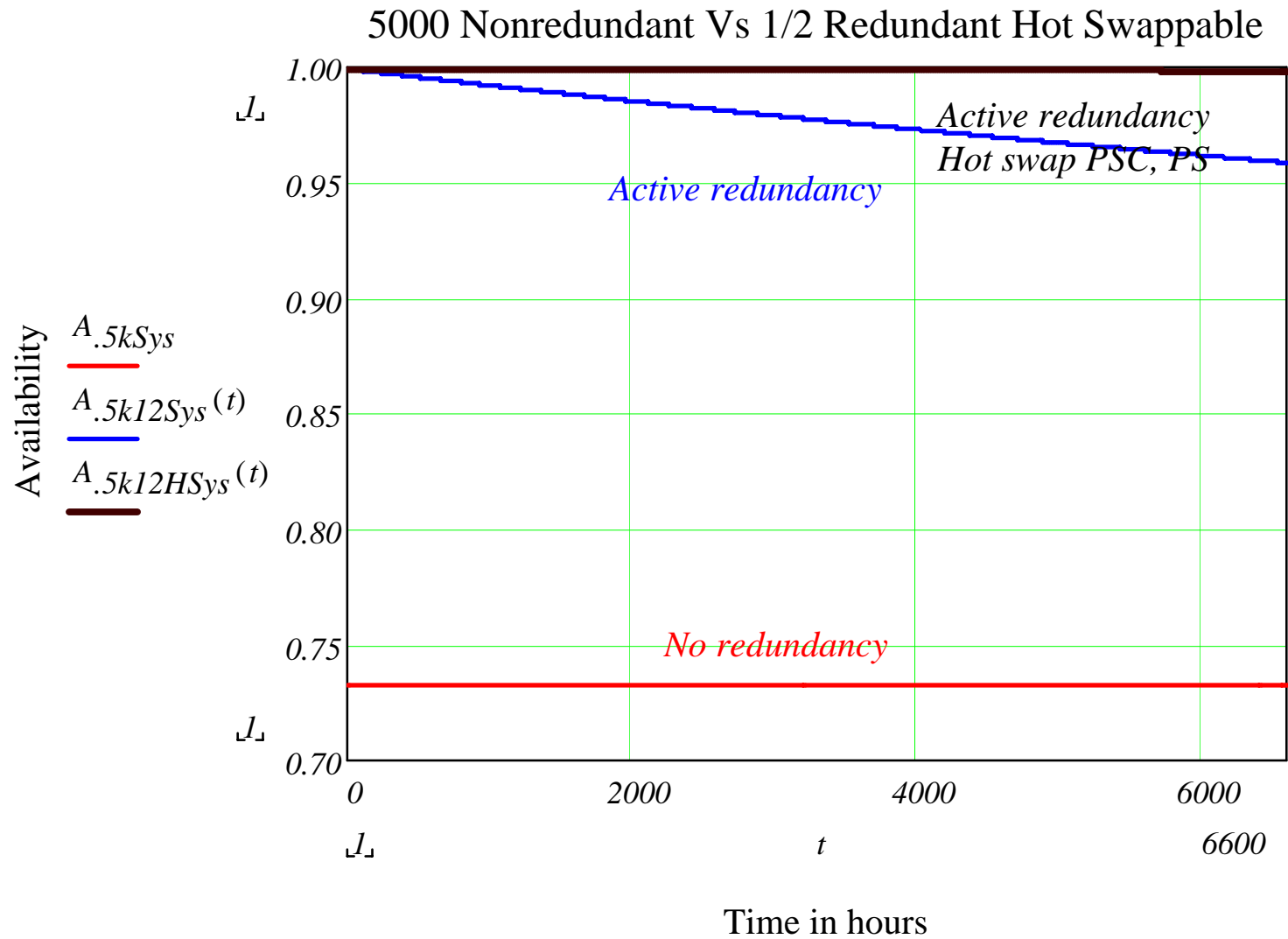
Item	MTBF (khrs)
EPSC	110
PS	60
XDTR	381.5
Cables/ Connectors	14000
MTTR = 2 hours	

PAC 2001, Chicago, IL  
Bellomo, Donaldson, MacNair

# Redundancy is Essential

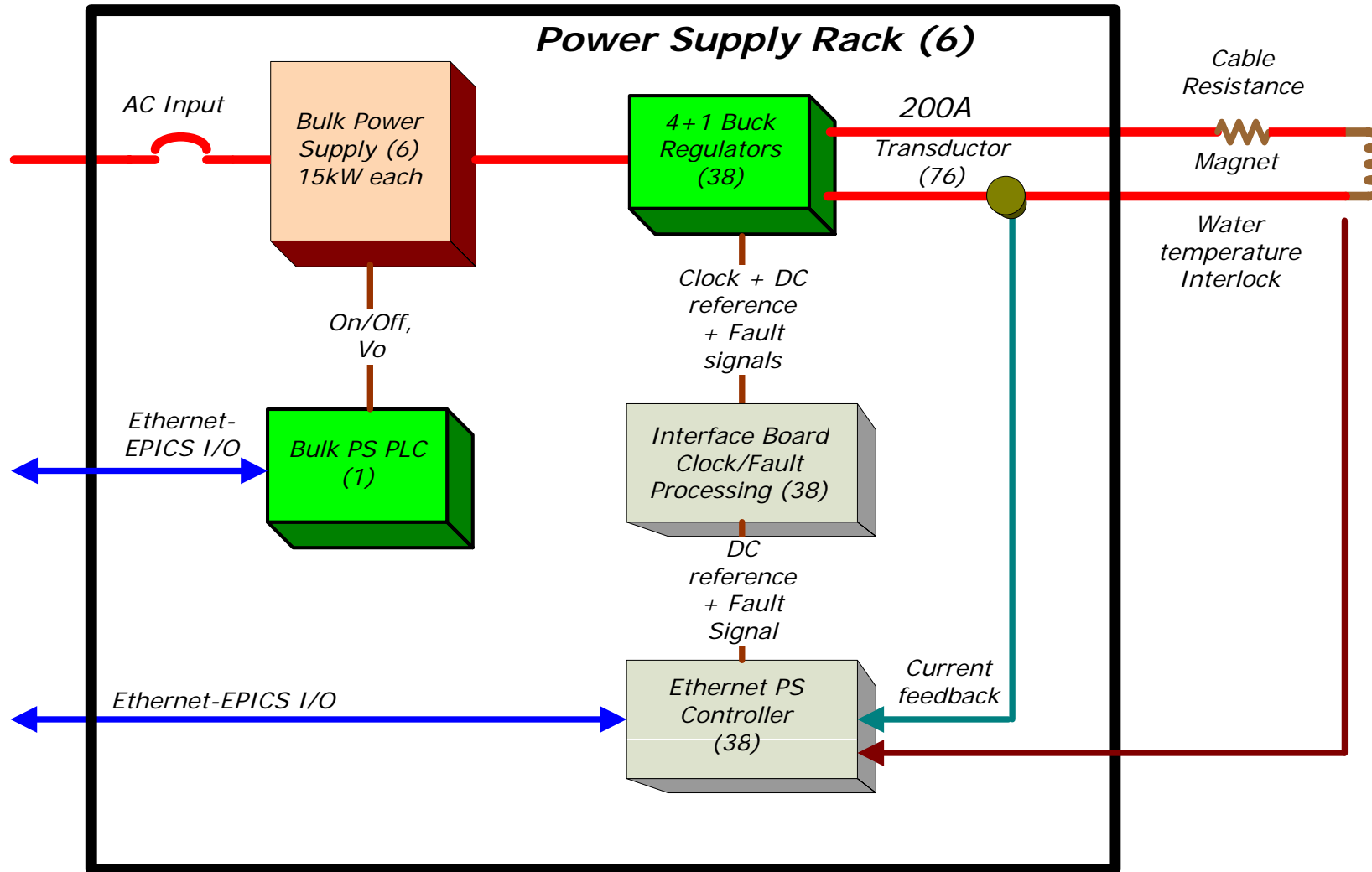


# Hot Swap is Essential

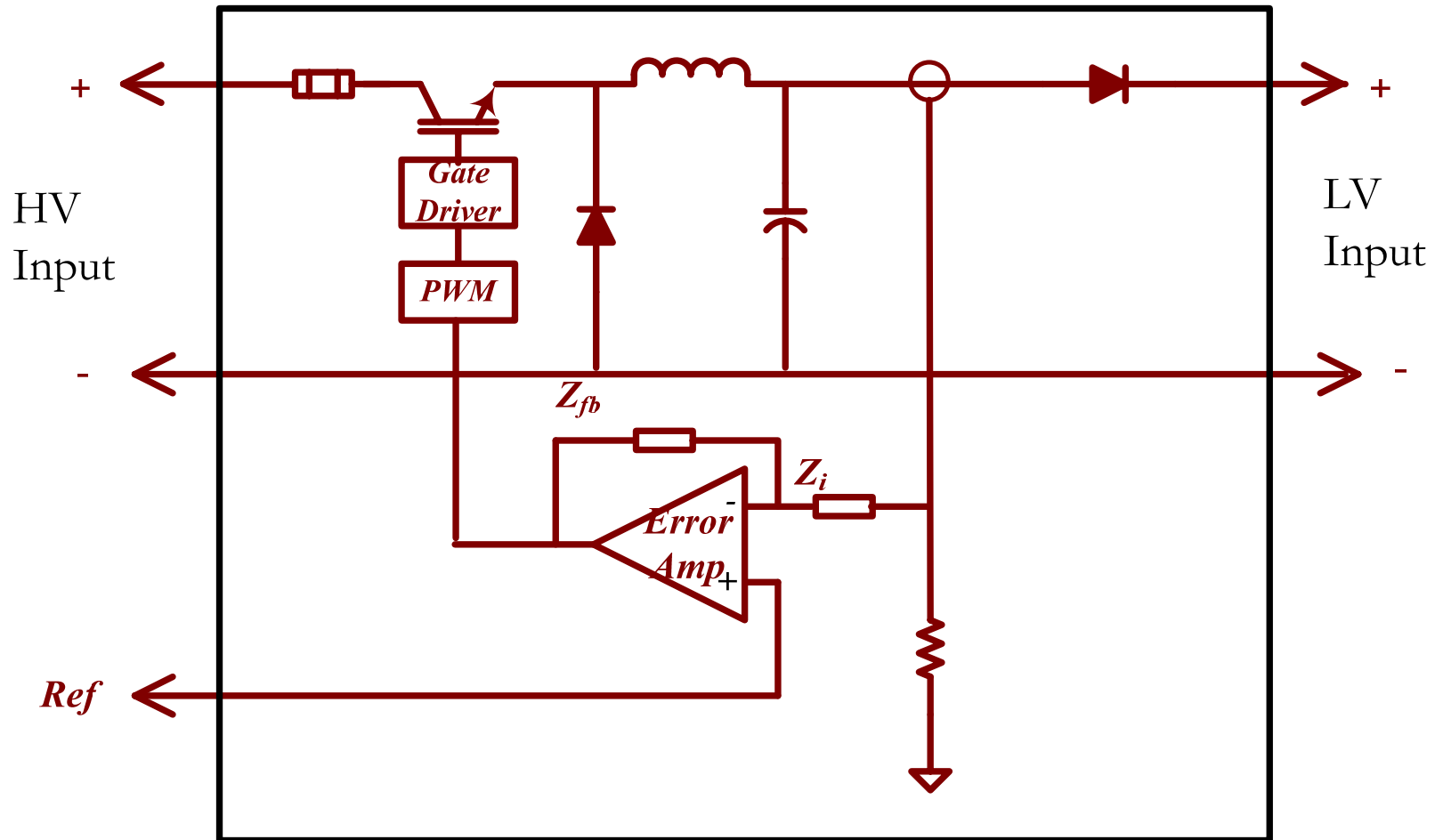


It is clear that redundancy and hot swap are needed

# ATF2 Phase 1 Concept and Demonstration

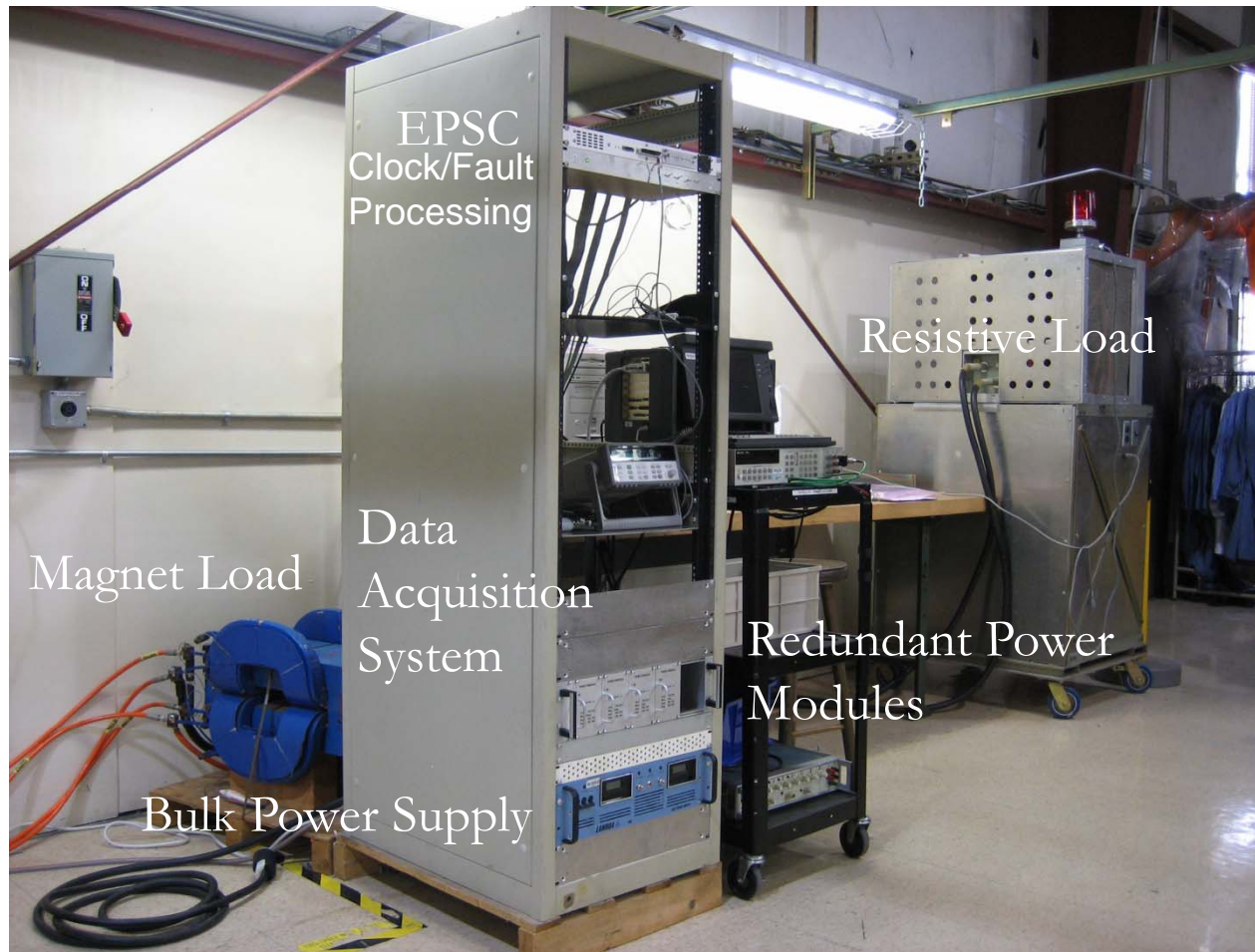


# ATF 2 Power Module Diagram



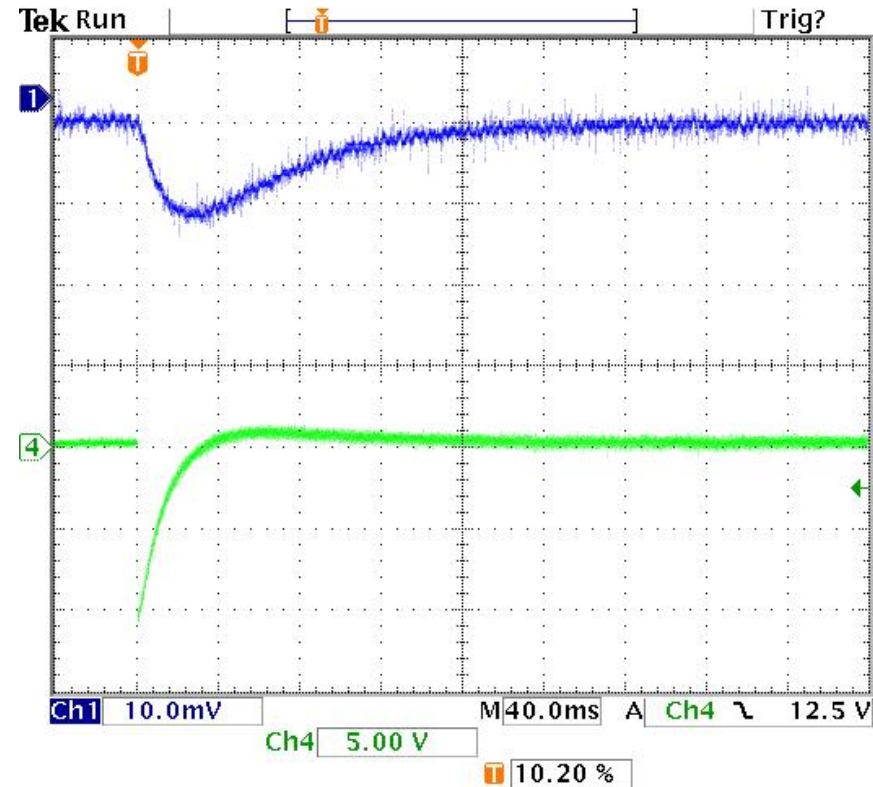
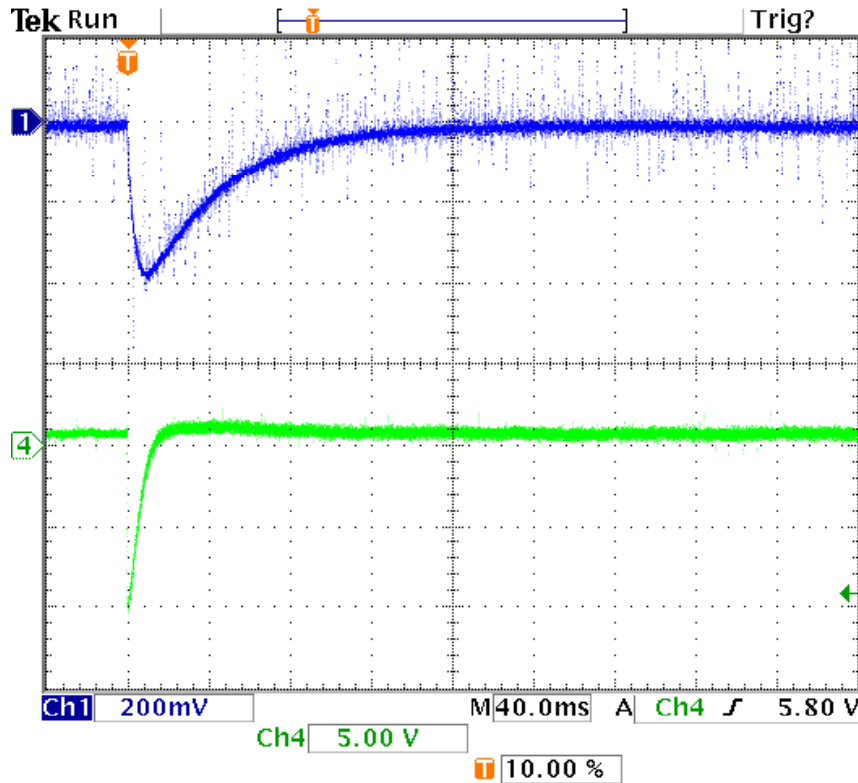
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# ATF 2 Demonstration/Test System



Demonstrated March 2006

# ATF2 Current and Field Recovery



- During power module loss measured 6A magnet current drop at 150A, 100 Gauss drop at 3.1 kGauss. 200mS recovery with no overshoot, no re-standardize needed



## ATF 2 Phase 1 Summary

Output	50A, 100A, 150A, 200A @ 40V
Ethernet control	Accomplished
Power module current sharing	< 1%
Load current stability	10-min: 3 ppm
	8-hour: 5 ppm
	Temperature < 3 ppm / C
Transient response and recovery	6 A, 100 Gauss, 200 ms
Bandwidth	25 Hz current loop > 25 Hz voltage loop

# ATF2 Phase 2 Engineering / Fabrication / Test



## ATF2 Phase 2 Engineering / Fabrication / Test



### Progress

- All parts ordered and received except for power supplies. OCEM Prototype power supply here
- Racks and components wired
- Testing of EPSC, PLC, bulk power supplies and prototype OCEM power supply complete
- Granted OCEM permission to build production power supplies
- Demonstrated system performance and remote computer control to KEK representatives in early September

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## ATF 2 Phase 2 and 3

### Phase 2 Upcoming power supply tests /events

- Power supplies arrive mid-October and complete by the end of November
- Complete testing mid-January 2008 and package for shipment to Japan

### Phase 3 Installation / Test

- Arrival in Japan end of January, first week in February
- Install and test systems and train KEK staff – complete by March 31, 2008

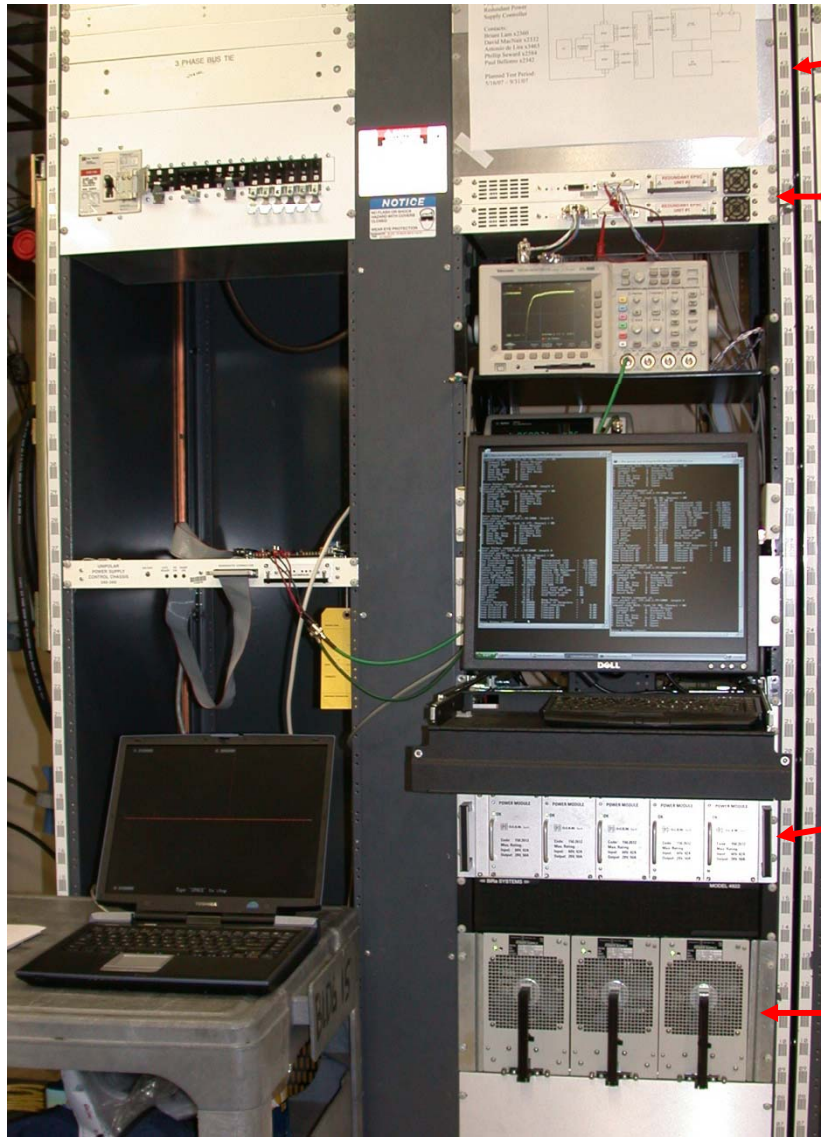
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# Second Generation HA R & D Prototype

Paul Bellomo for Antonio de Lira, Briant Lam and Dave MacNair

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# Second Generation R & D Prototype



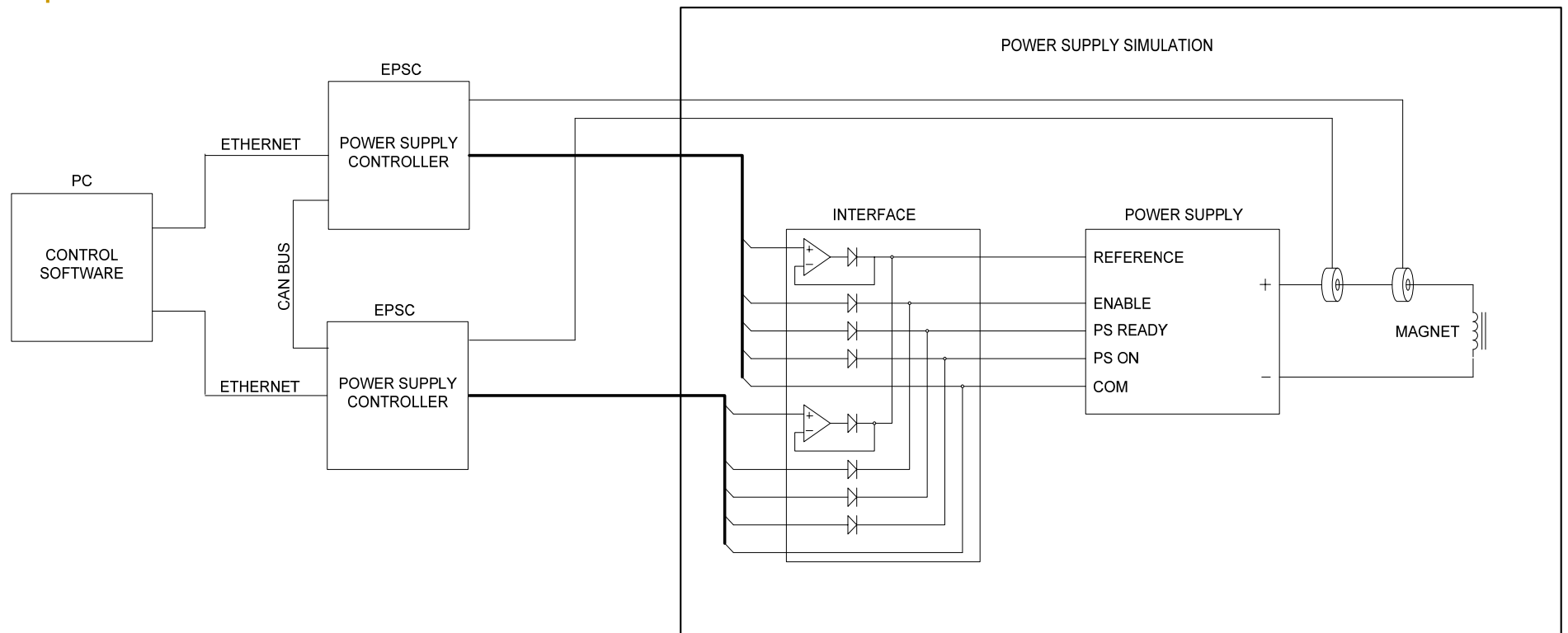
1/2 Current transducers (not visible)

1/2 Ethernet controllers

4/5 1.5kW Power Modules

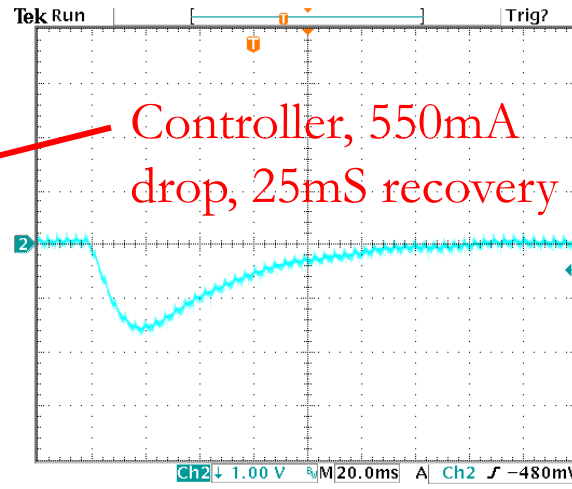
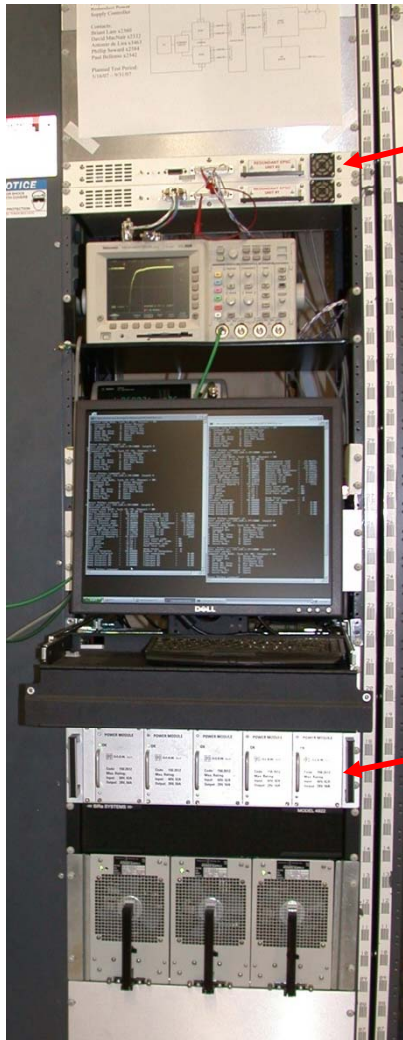
2/3 6 KW bulk power supplies

# Second Generation R & D Prototype Redundant EPSC



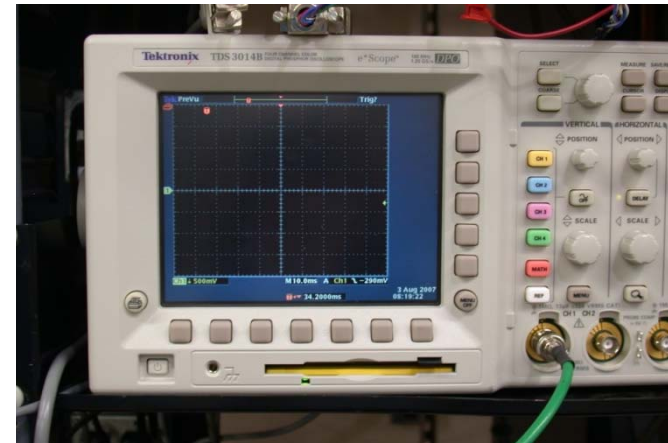
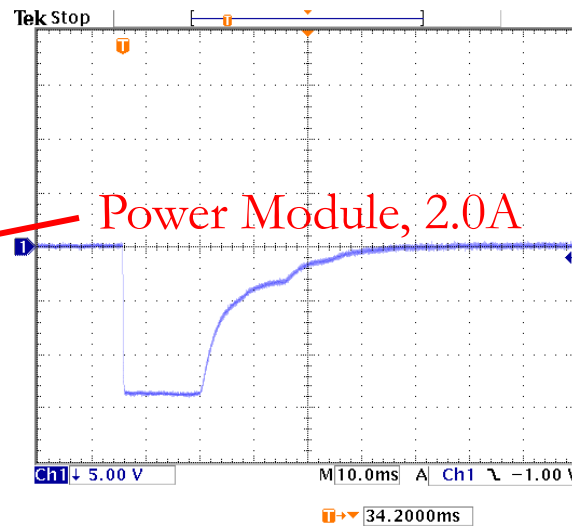
- Use existing controllers to minimize hardware purchases
- Master-slave configuration. Master is first controller turned on
- Master updates slave with desired current 120 times/sec via CAN bus digital interface
- The controllers provide a hybrid digital /analog reference to the power supplies

# Second Generation R & D Prototype Auto Recovery



Resistive/Inductive load  $L=1\text{mH}$

18 Sep 2007  
10:31:22



3 Aug 2007  
08:17:22

Bulk PS, no discernible transient



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## Second Generation R & D Prototype Plans – Last Slide

- Develop a digital interface/regulation control loop and embed control in each power module
- Develop hot-swap / isolation features into the EPSC, the power modules and bulk power supply
- Develop a high availability, parallelable bipolar power supply
- Work Package written around this program and submitted for authorization and funding through FY2010.
- The work underway by PCD is applicable to the magnet power systems needed throughout all ILC Areas
- SLAC PCD is the leader in this effort