AUTOMOTIVE INTEGRATED POWER MODULE (AIPM)

Validation Testing and Contract Manager Technical Support

Laura D. Marlino
Power Electronics & Electric Machinery Research Center
June 2003

The submitted manuscript has been authored by a contractor of the U.S. Government under contract No. DE-AC05-00OR22725. Accordingly, the U.S. Government retains a nonexclusive, royalty-free license to publish or reproduce the published form of this contribution, or allow others to do so, for U.S. Government purposes.

DOE/FreedomCAR AIPM Project

- Integrate motor drive electronics into single package
- Reduce costs, size, and weight of inverter suitable for advanced automotive use

ORNL AIPM Validation Project

- To provide technical support to AIPM Contracts Manager
- Promote use and commercialization of emerging technologies
- To provide independent evaluation of AIPM prototypes
- To validate conformance to established specifications

Electrical Testing

- Inductive load testing
- Constant speed, torque sweeps, constant torque, speed sweeps
  - Nominal voltage
  - Minimum voltage
  - Maximum voltage
- Acceleration/deceleration
- Regeneration
- Capable of running all electrical tests at elevated coolant temperatures

ORNL PEEMRC Dyne and Test Motor

DyneSystems

100 hp cont. duty, water cooled

Motoring capability

460V / 122A / 3 ph

10,000 rpm max

Road load simulations

SOLECTRIA Model AC55

Electric vehicle duty, air cooled

Induction machine

30 kW continuous (70 kW peak)

230 Nm peak torque

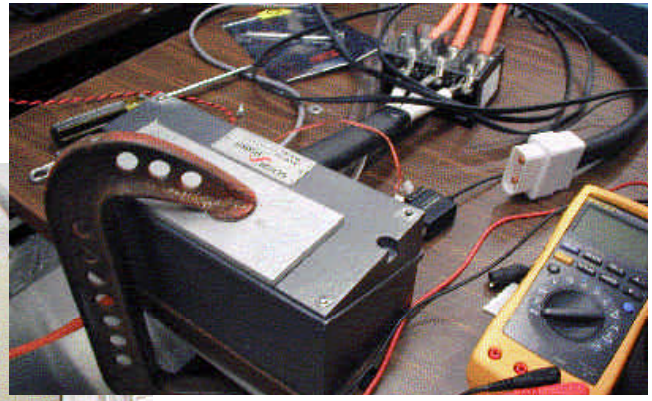
250 amps

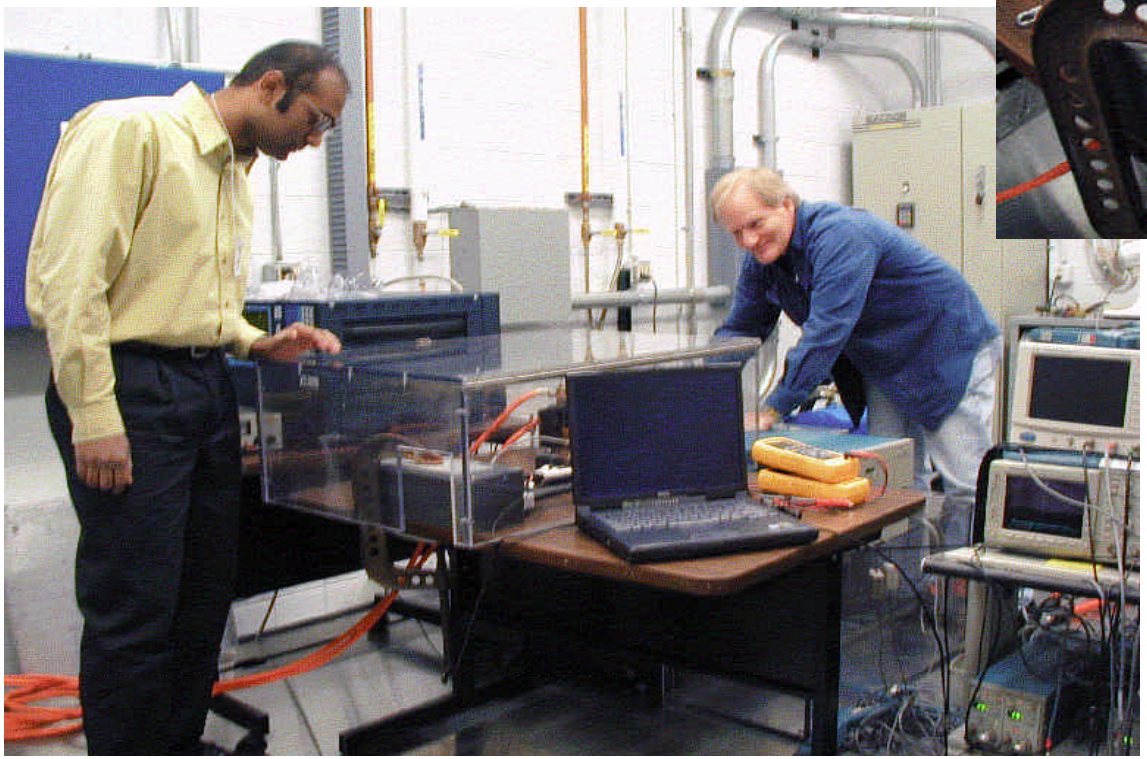
8000 rpm max

Laboratory Power Supply

- 600V, 600A DC Power Supply
- 4 quadrant operation

AIPM Test Bed





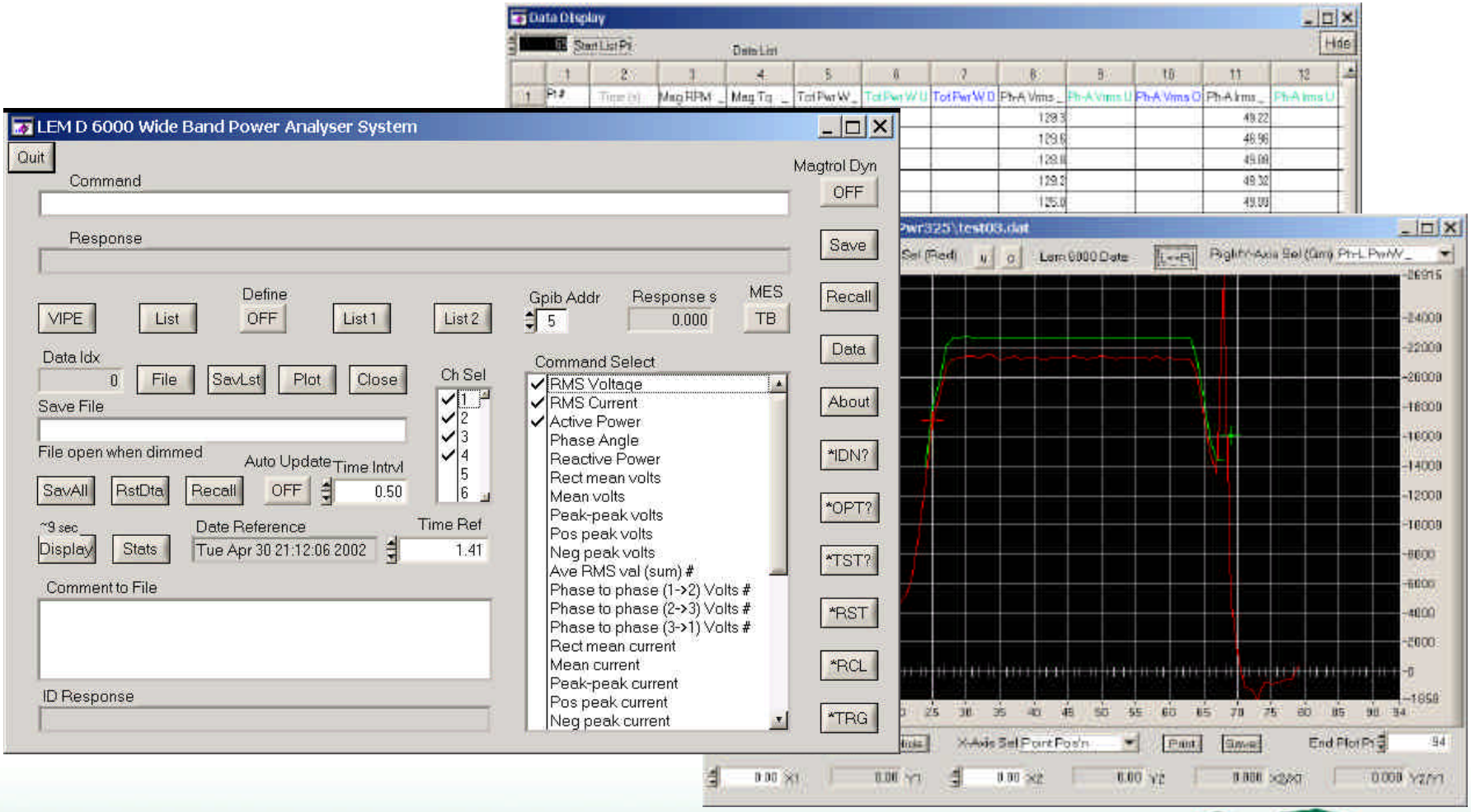
ORNL Data Acquisition System

- Configures and collects real-time data from:
  - Laboratory power meters
    - Yokogawa PZ4000 power meter [GPIB]
    - Norma LEM 6000 [GPIB]
  - DynLoc IV dynamometer [RS-232]
  - Digital and analog inputs [PCI]
    - Flow rate, temperature meters
    - Torque and speed outputs
- Compiles and saves all data to text and/or excel files
- Plots any parameters of interest

Example Parameters Available from DAS

- Average current and voltages
- RMS currents and voltages
- Positive and negative peak voltages and currents
- Form factor
- Crest factor
- Frequency
- Active power
- Apparent power
- Reactive power
- Power factor
- Phase angle
- Impedance, resistance, and reactance
- Harmonic components, distortion factor

ORNL Data Acquisition System



Environmental Testing

- Temperature Cycling
- Humidity
- EMI/EMC
- Altitude
- Splash
- Salt Spray
- Vibration
- Drop
- Shock
- Thermal Cycle

Environmental Test Facilities

Temp/Humidity Chamber

Dust Chamber

EMI/EMC Chamber

Vibration/Shaker

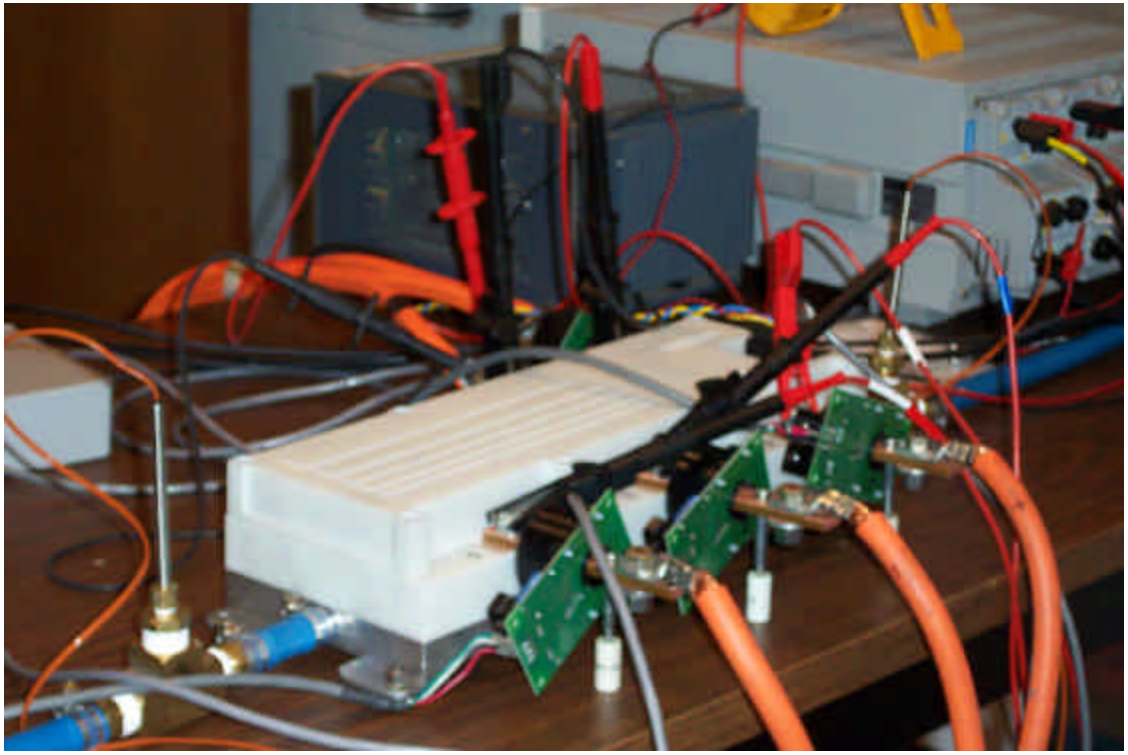
Inductive Loads

Semikron Status

- Pre-production 450v AIPM in house
  - Limited testing performed

- Alpha 42v unit received and returned
  - Testing attempted
  - Semikron will supply updated Beta version ~mid June

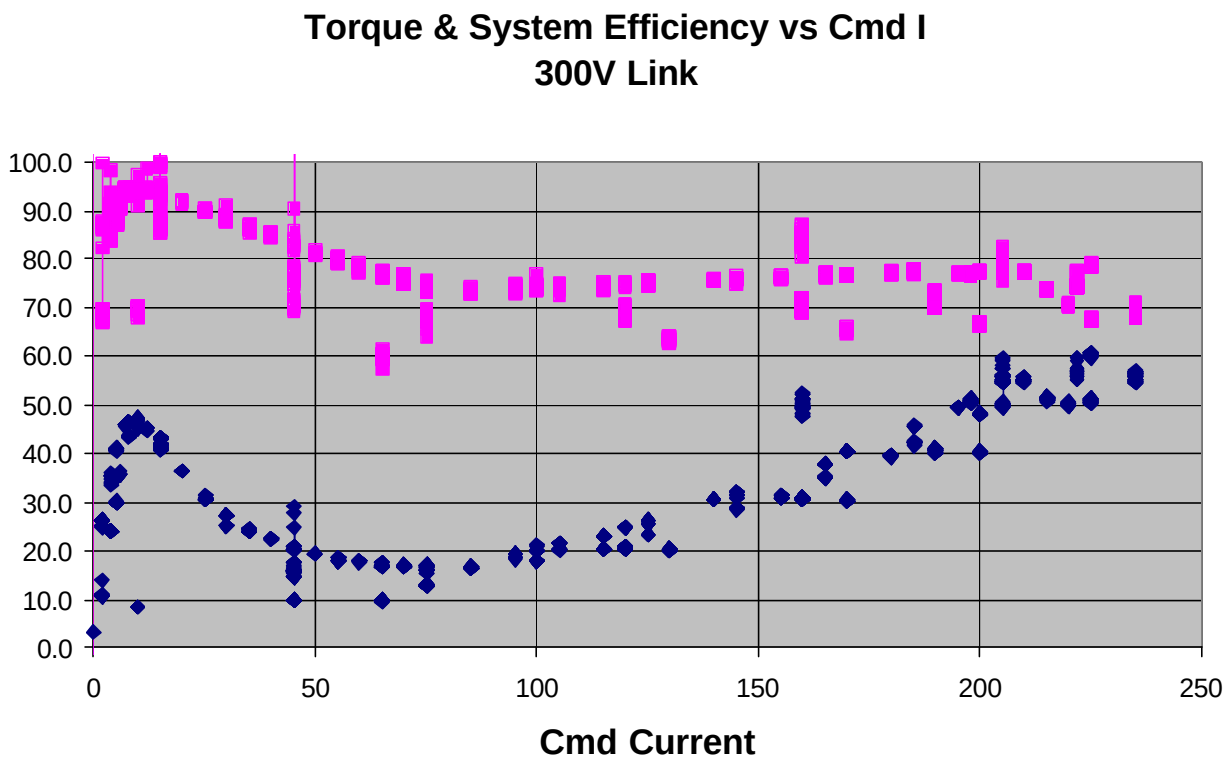
Semikron 450v AIPM



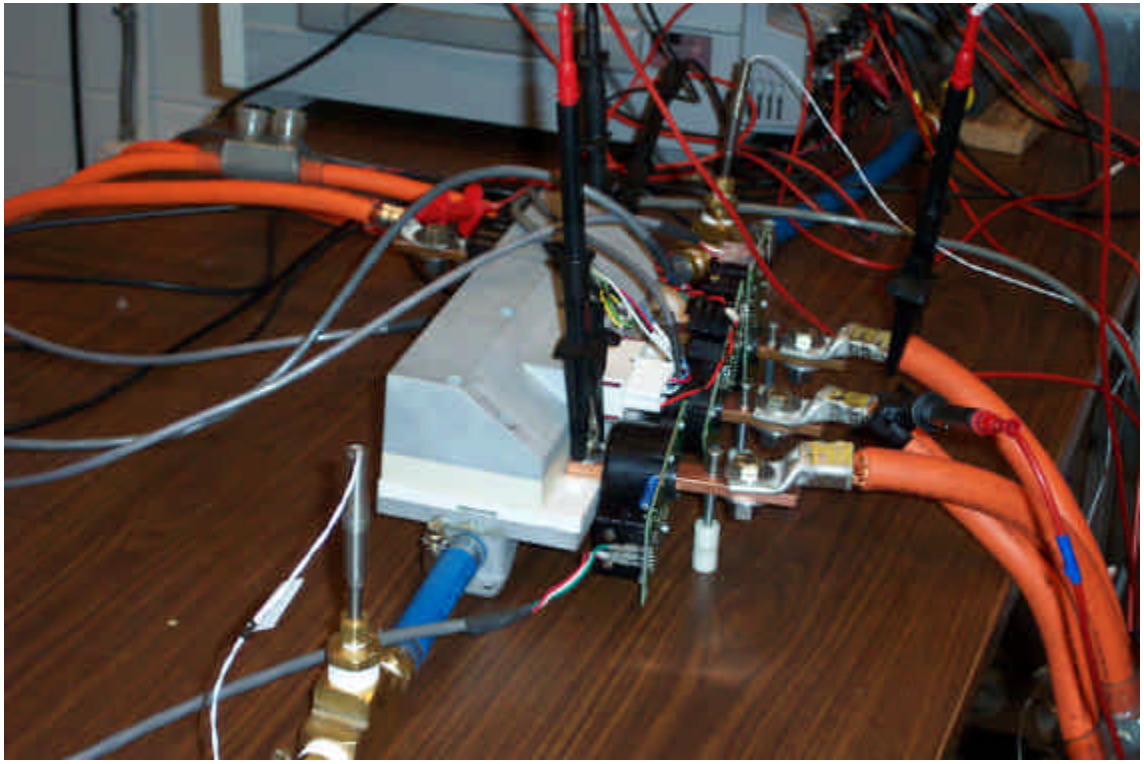
Semikron High Voltage Unit

- Inductive Load Testing
  - Successfully completed
- Speed Mode Operation
  - Major instabilities
- Torque Mode Operation
  - Instabilities in some regions
- Semikron attempting to confirm and recreate ORNL test results

Semikron High Voltage Unit



Semikron 42v Alpha Unit



Semikron 42v Alpha Unit

- Delay in testing resolved through acquisition of custom built motor from Rockwell Automation
- Built to original Elmo motor specifications
- Custom encoder

Semikron 42v Alpha Unit

- Testing attempted May 2003 in Dyne Test Cell #1
  - Controller problems-no communications with encoder
  - Unit returned to Semikron
- Semikron will build and ship updated Beta unit
  - Will resume testing upon receipt ~mid June

SPCO AIPM

SPCO Status

- Have completed build of (6) deliverables
- Expect to ship (6) units to ORNL by end of May
- Majority of units will be untested
- Controller manual not yet complete
    - Manual necessary for operation at ORNL
    - Controller software not very ‘bulletproof’

SatCon AIPM

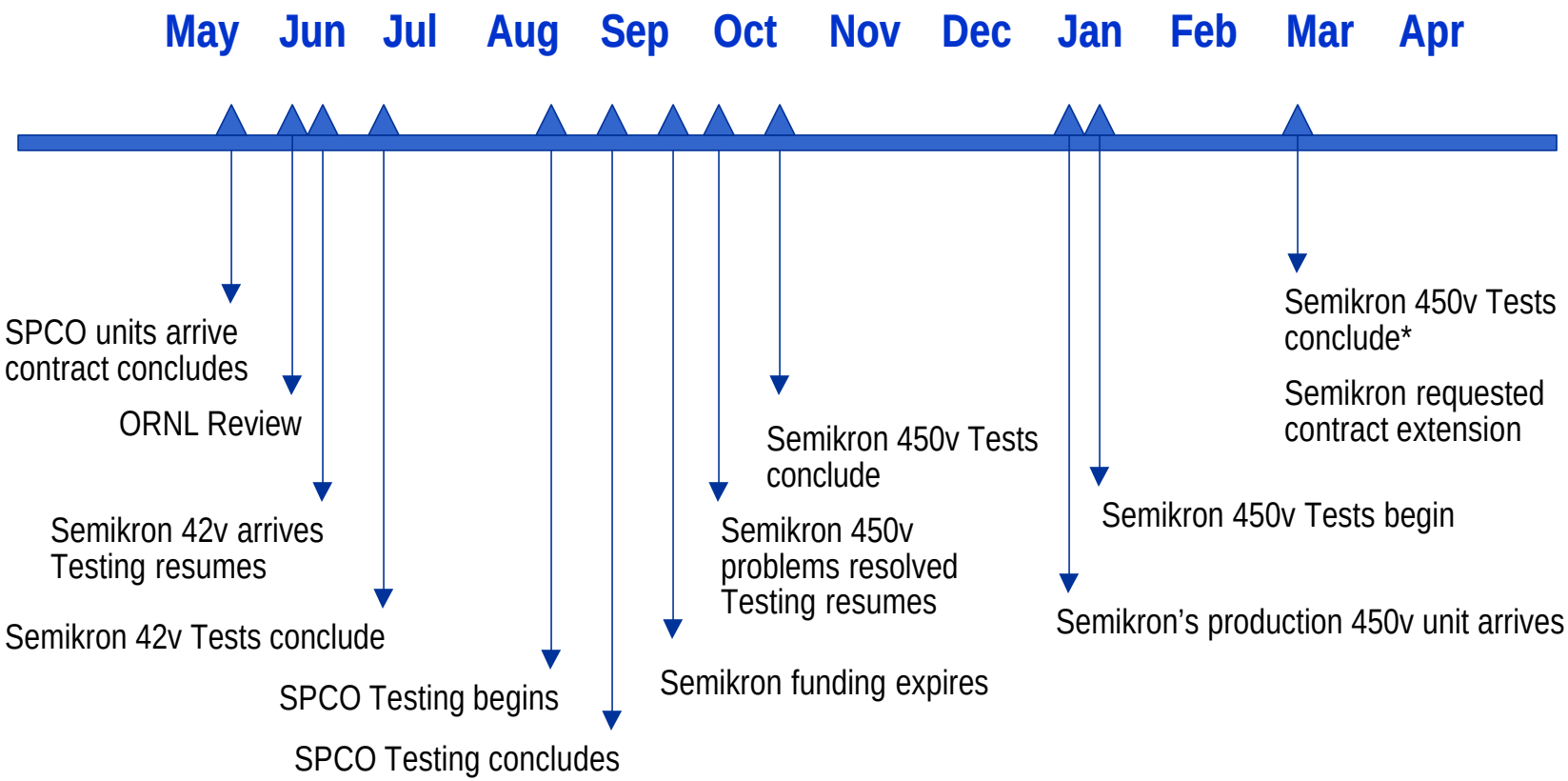
SatCon Status

- Shipped (3) units to ORNL 18 April 2003
- No controller software or cabling received with units
  - No connector pin out information
- Previous decision ‘not to test’ still in effect

Future Test Plans

- Electrical retest of Semikron pre-production 450v unit
- Electrical testing of Semikron 42v Beta unit
  - Possibility of some environmental testing
- Electrical testing of SPCO unit
- Electrical and environmental testing of Semikron production 450v AIPM

Tentative 2003-1Q 2004 Timeline



*Assumes some environmental testing