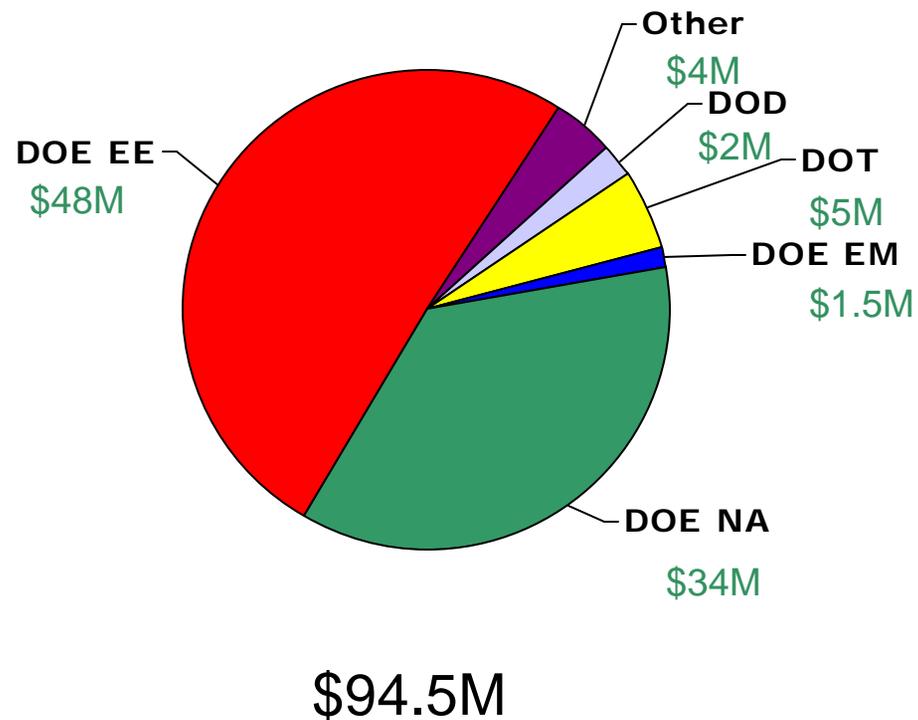


# Oak Ridge National Laboratory Transportation Research



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E-Mail: [zieglerre@ornl.gov](mailto:zieglerre@ornl.gov)**

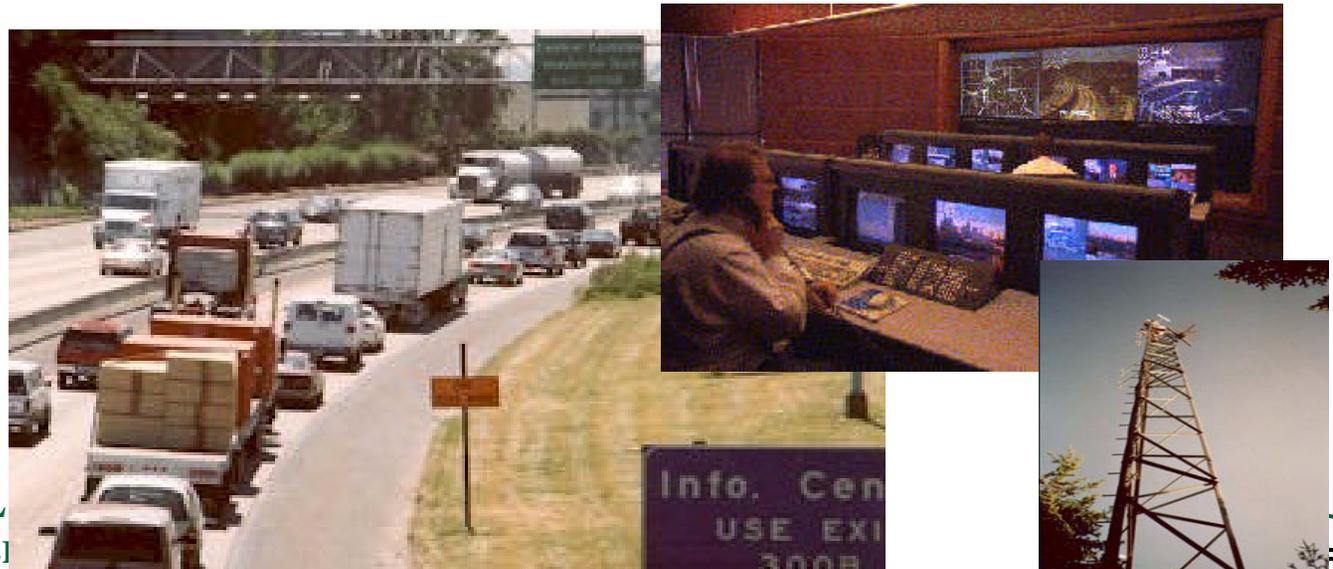
# Largest National Lab Transportation Research Program



# DOT Research Areas



- **Intelligent Transportation Systems**
  - **Infrastructure Technologies**
  - **Vehicle Based Systems**
- **Traffic Management Models**
- **Provide training, using real data and real-world scenarios**
- **Outreach and Education to Traffic Management Authorities and Fleet Operators**



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# *Military Transportation Operations Center*

- **“Command Post” Simulator**
  - Test and evaluation of transportation deployment
  - Test and evaluation of decision support tools
- **Technologies for emergency management agencies**
- **Logistics research**
- **Integration of ITS technologies**



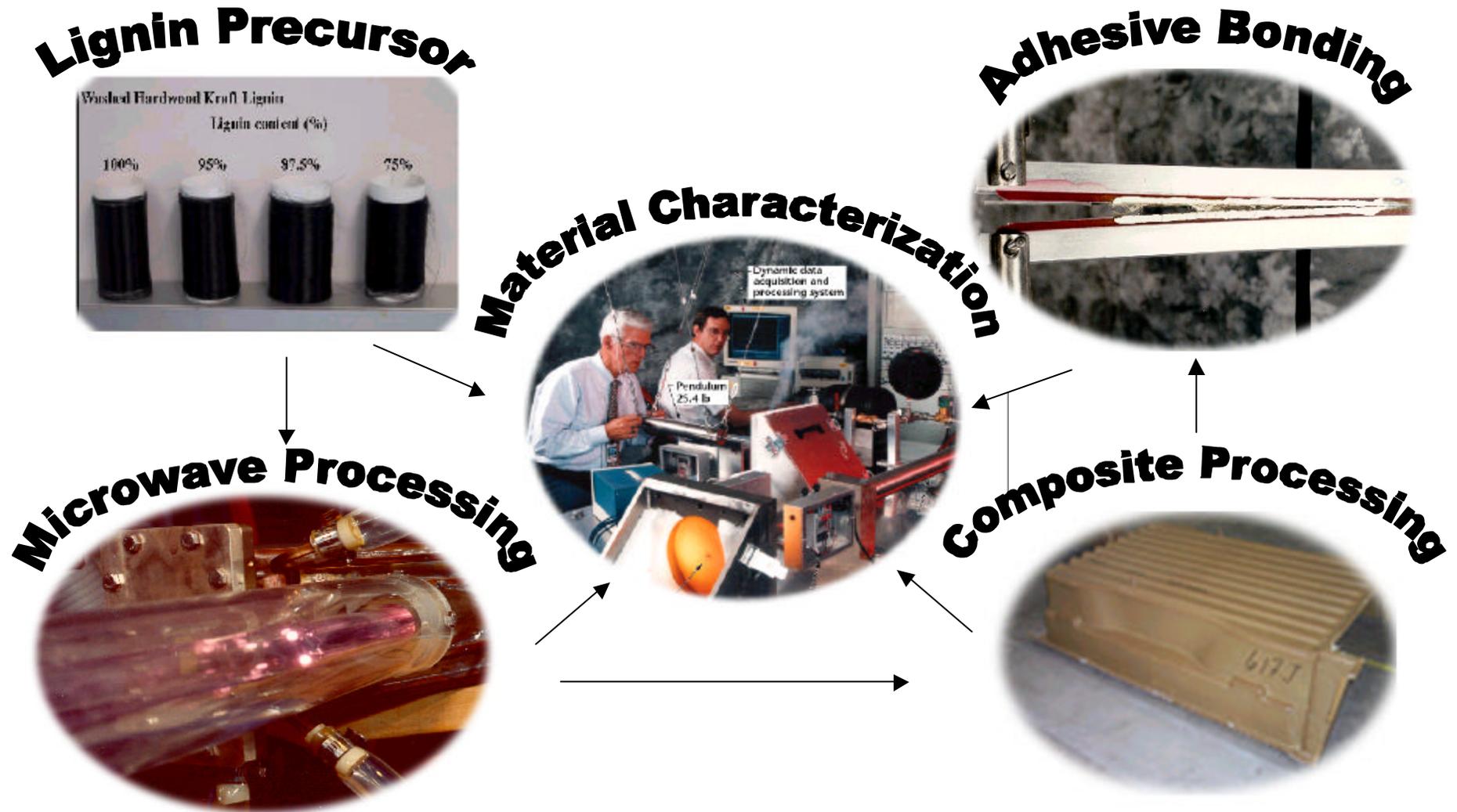
# *Materials Packaging Laboratory Evaluates Containers of All Sizes*

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- **Shipping container**
  - design
  - test
  - certification



# ORNL Performs Research in All Aspects of Polymer Composites



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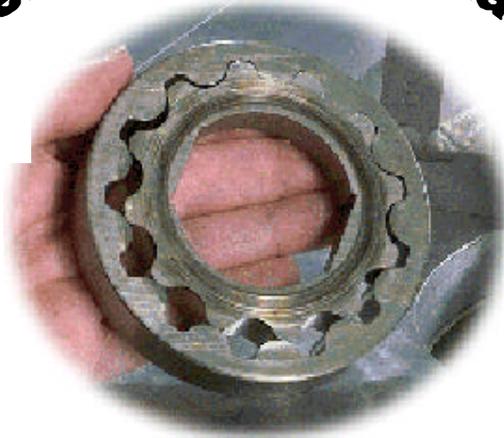
UT-BATTELLE

# Light Metals Research Covers a Broad Range of Technologies and Materials

## Aluminum Casting



## Material Characterization



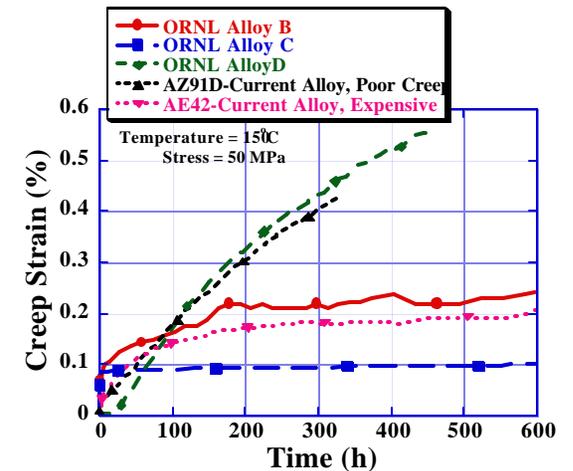
## Joining



## Aluminum Sheet



## Magnesium



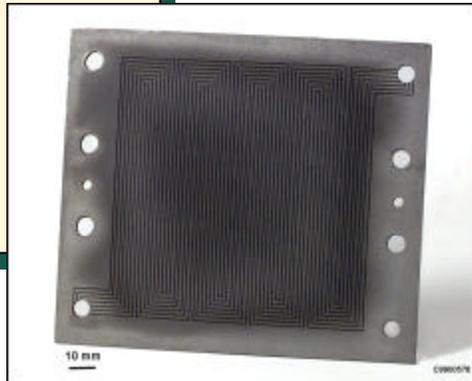
# Propulsion Materials Research Includes Fuel Cell Components

**Current Technology:** Bipolar Plates for Automotive PEM Fuel Cells are Machined Graphite

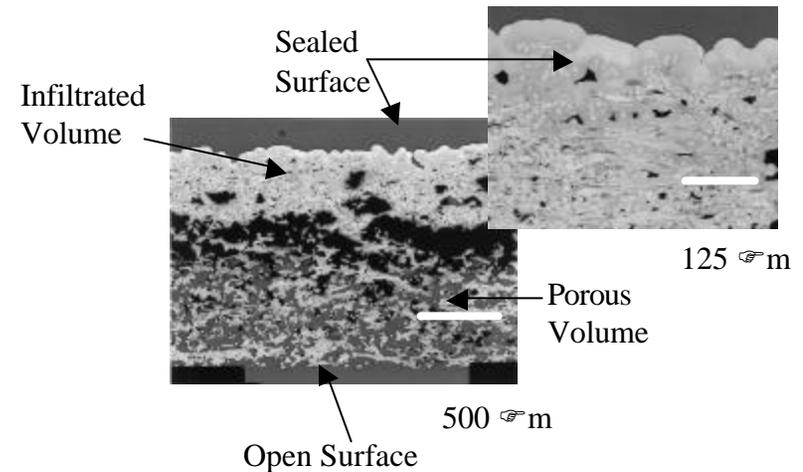
**Challenge:** Weight and Cost

**Solution:** Slurry-Molded Carbon Fiberboard, Sealed with Carbon

- *Continuous or semi-batch process*
- *Carbon does not corrode*
- *Low cost (less \$1/plate)*
- *High conductivity*
- *Impermeable*
- *2 mm thick*



*Bipolar Plate for Evaluation*



*Cross-Section of Bipolar Plate*

# Unique: Composite Research Laboratory

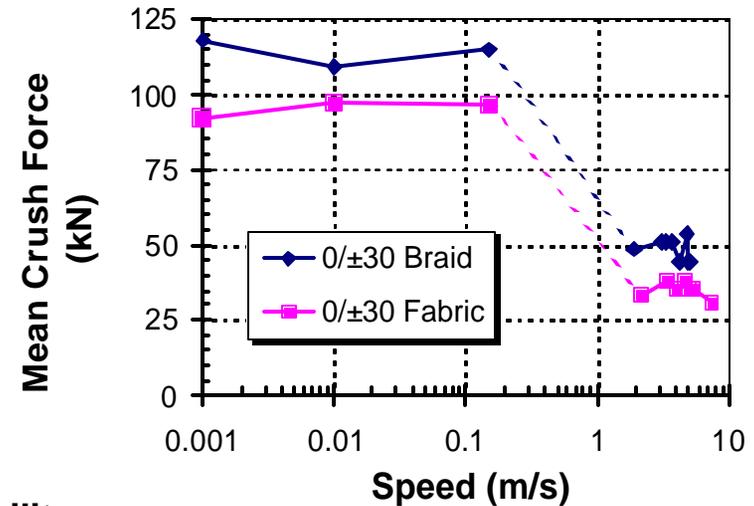
## Challenge:

- Different behaviors are observed for different rates of deformation (i.e., impact velocity)
- Transition between quasi-static and high rates not understood
- The capability does not exist for testing at intermediate rates



Partners: ACC, MTS Systems

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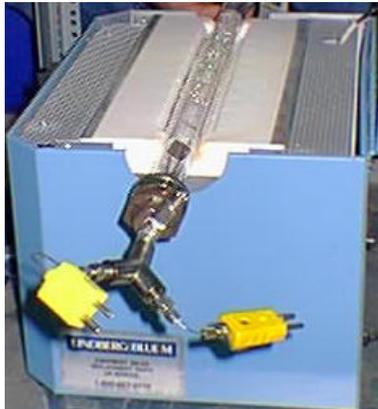
## Capability:

- >60,000 lb force
- 10-inch travel
- Constant Velocity to 8.13 m/sec (18 mph)

## Uniqueness:

- First machine capable of characterizing structural materials at constant velocity for intermediate rates and high forces

# ORNL Engine/Emissions R&D Spans Bench to Vehicle System



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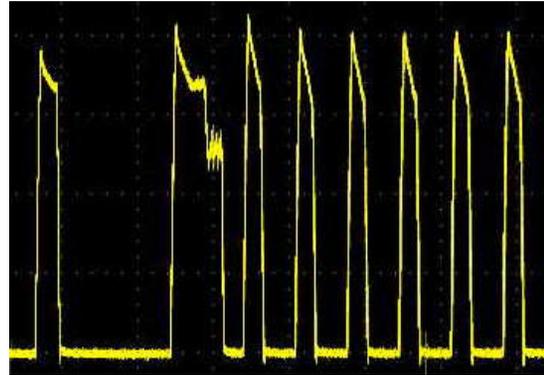


# NEW: Rapid Development Engine Control System

Full-Pass Controller Developed  
with Ricardo, Inc. . . .



Up to Eight Injections Per Cylinder Event  
(each with independent duration and timing control)



Full Control Over Turbo Wastegate, Intake  
Throttle, Fuel Rail Press., and EGR



## Full-Pass Engine Control:

– Complete electronic control of  
engine parameters

- Fuel Injection

- Fuel quantity, timing, number of injections per cycle

- Intake throttle, EGR, Wastegate,  
etc

– Unique capability within National  
Laboratories

– Benefits of “full pass” control

- Allows proper integration of engine, fuel,  
and advanced aftertreatment
- Exploration of new combustion regimes
  - Diesel HCCI
  - Other low temp combustion

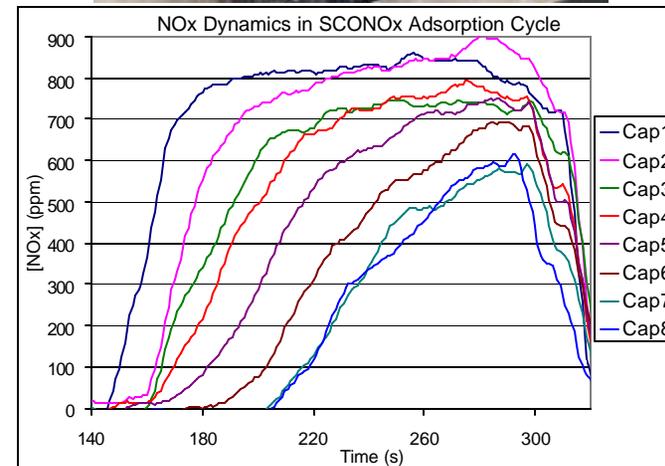
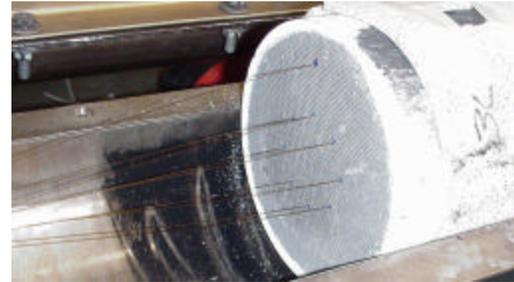
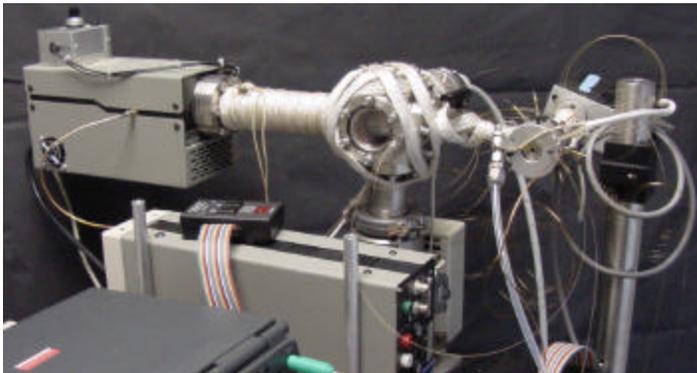
# SpaciMS : Spatially Resolved Capillary-Inlet Mass Spectrometer

## Challenge:

- Catalyst produce time-varying exhaust composition
- Exhaust-composition distribution varies through the catalyst
- Minimally invasive diagnostics are required to probe inside the catalyst

## Capability:

- Temporal and spatial resolution
- Minimally invasive
- Broad species applicability



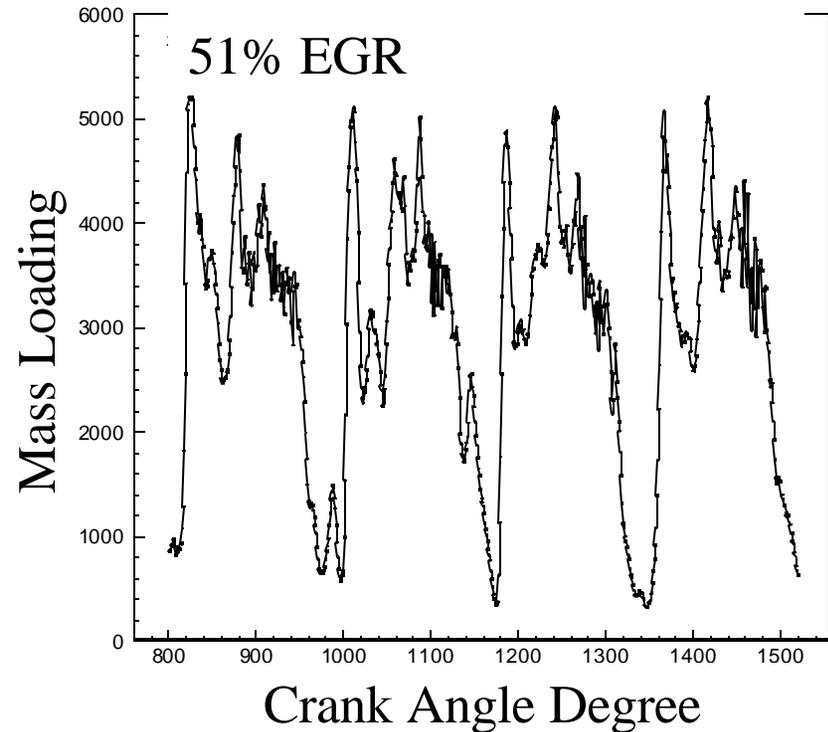
## Uniqueness:

- Providing first measurements of spatial and temporal species distributions within an operating catalyst

Partners: Cummins, Inc., EmeraChem, Inc.,  
Vacuum Technology, Inc.

# Diesel Particle Scatterometer

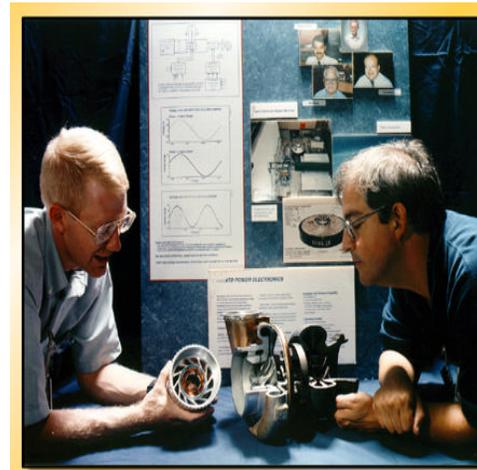
(Arlon Hunt, LBNL; John Storey, ORNL)



- Measures “smoke” at high speed; size in <1 sec
- High EGR data with VW TDI shows individual cylinder PM emissions. (1200 rpm, 1 complete cycle)

# Power Electronics & Electric Machinery Research Center

- A staff of 20 researchers (9 PhDs)
- 700 m<sup>2</sup> laboratories
- Only DOE national laboratory with an all-encompassing PEEM program.
- The Center's world-wide reputation is supported by awards, patents, publications, and recognition by professional societies, academia, industry and DOE.



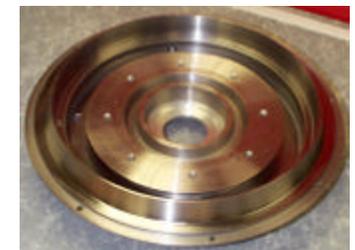
Electric Assist Turbo Charger



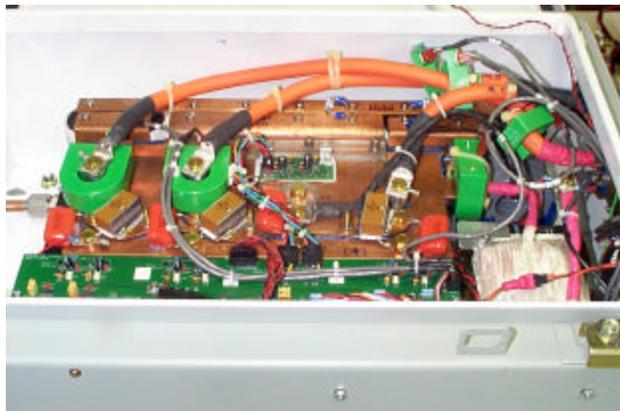
Rotor of a HSUB motor



Stator armature of a HSUB motor



Stator DC field end bracket



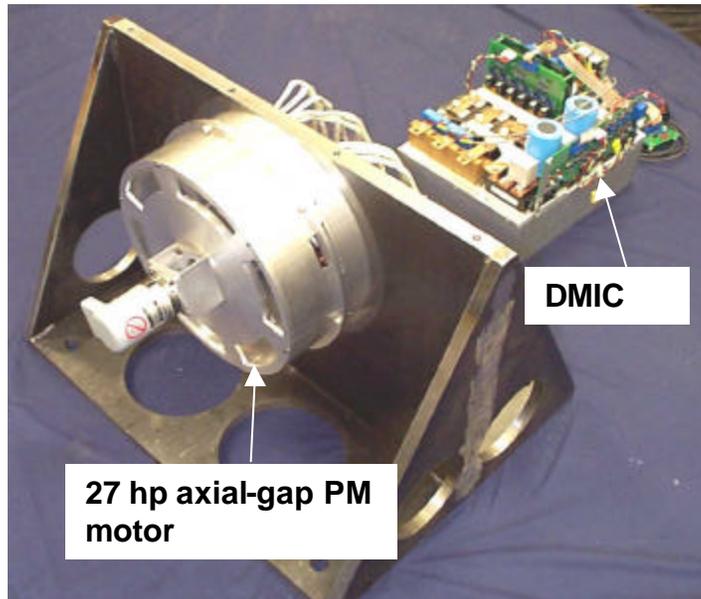
100 kW, installed on vehicle 1999

- The Center is actively involved in partnerships.
- Projects supported by DOE, DOD, and industry.
- Plurality of funding is for hybrid-electric vehicles,
- Some proprietary work.

# Unique: Controlling PM Motors to Deliver Constant Power above Base Speed

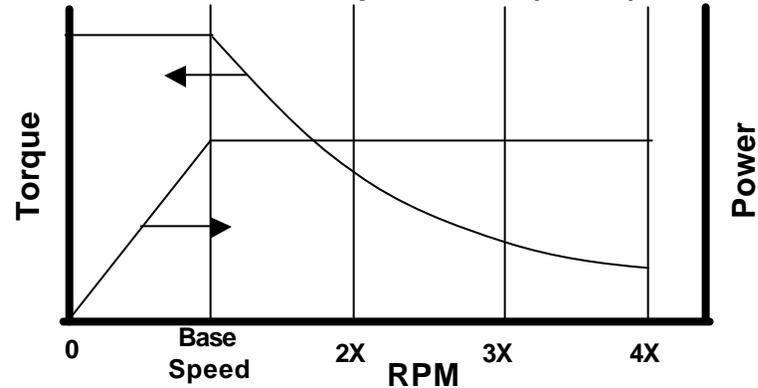
## Challenge:

- Torque Proportional to Current
- Max Current Independent of Speed
- Speed Proportional to Voltage
- Max Voltage Limited by Motor “Back-emf”
- Power = Torque x Speed
- Automotive Goal = Constant Power



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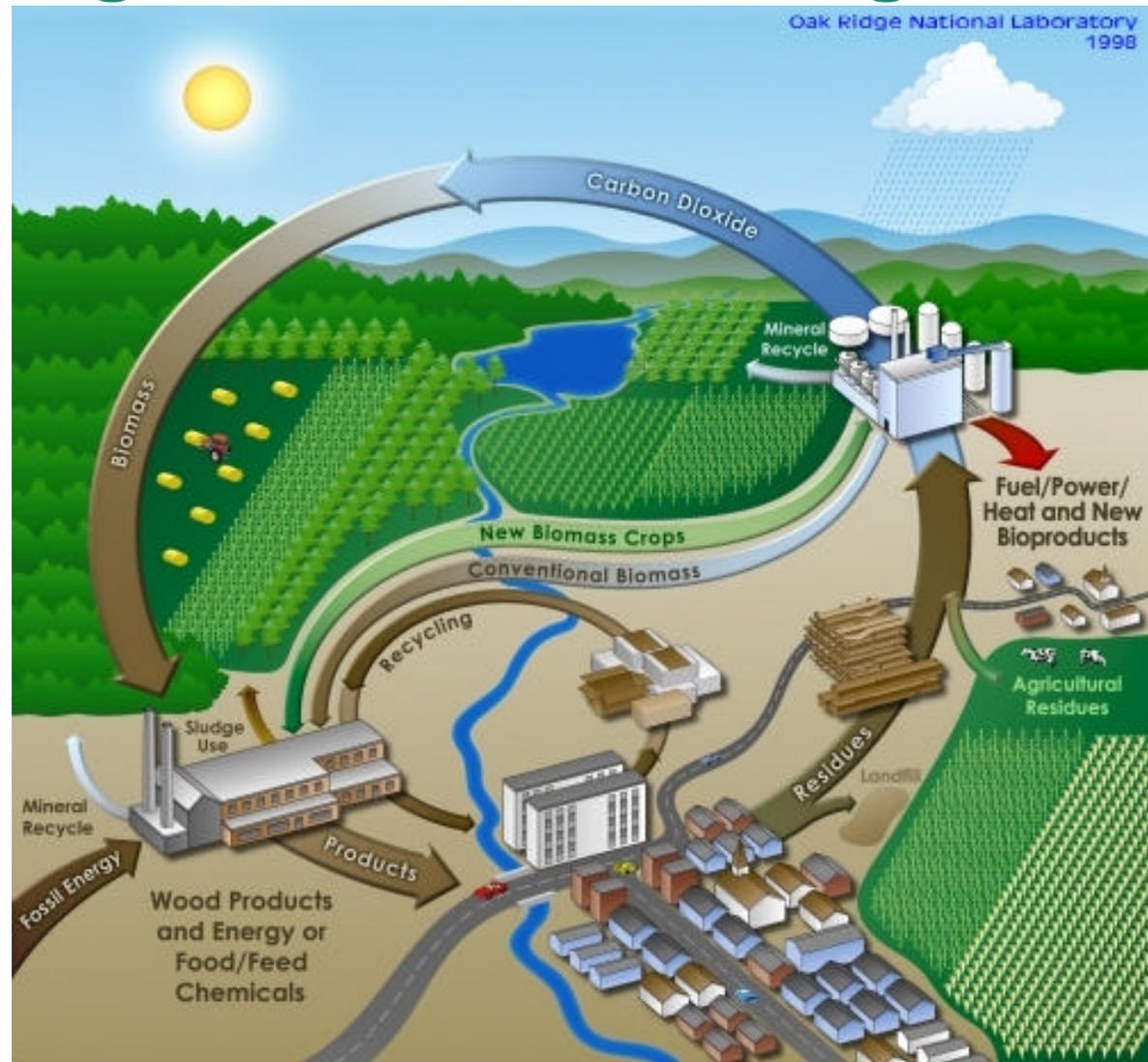
Auto companies want drive systems with a Constant Power Speed Ratio (CPSR) of 4



## Solution: Dual Mode Inverter Controller (ORNL Patent)

- Theoretically infinite CPSR (if losses are ignored)
- Lab test demonstrated a CPSR of 6
- HEV traction drive system:
  - ◆ Constant Torque to Base Speed
  - ◆ Constant Power to 4X
  - ◆ Will Not Exceed Rated Current
- Adds six inexpensive thyristors to control current
  - ◆ Enables lower cost traction drive system
  - ◆ Resolves “undesirable” vehicle operating mode
  - ◆ Improves Efficiency

# DOE's Integrated Biomass Program

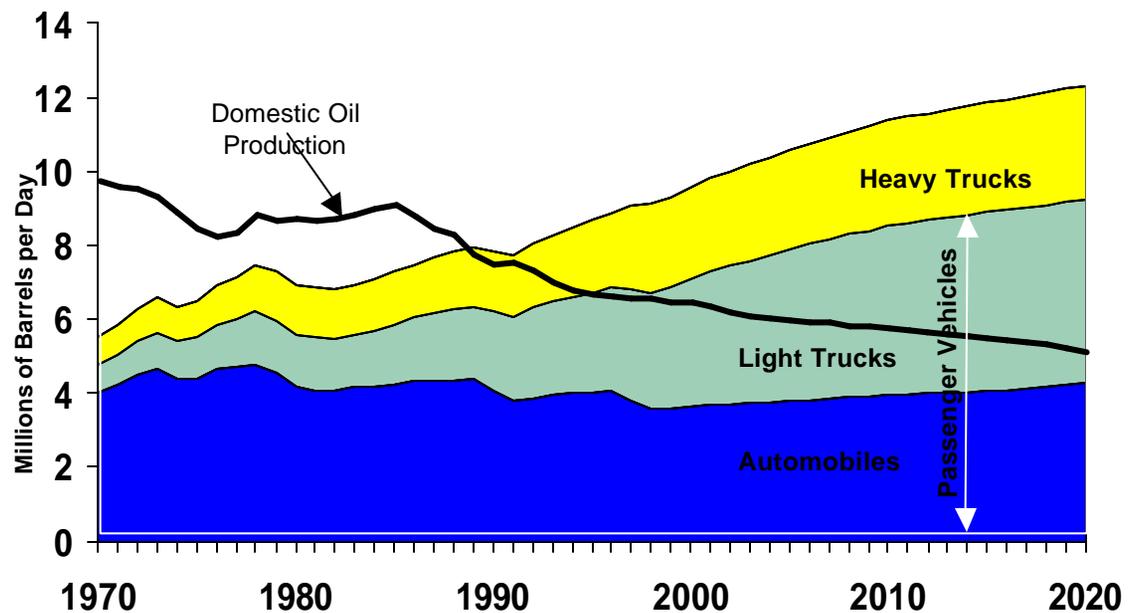


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# Transportation Policy Analysis

- Transportation energy use
- [www.fueleconomy.gov](http://www.fueleconomy.gov)
- [www-cta.ornl.gov/Publications/Tedb.html](http://www-cta.ornl.gov/Publications/Tedb.html)
- Transportation policy
- Global change issues



Source: Transportation Energy Data Book: Edition 18, DOE/ORNL-6941, September 1998, and EIA Annual Energy Outlook 1999, DOE/EIA-0383(99), December 1998

# *Designated National User Facility*

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*A Unique Transportation Research Facility*

*A Window to Transportation Research At  
ORNL and UT*

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**U. S. DEPARTMENT OF ENERGY**

