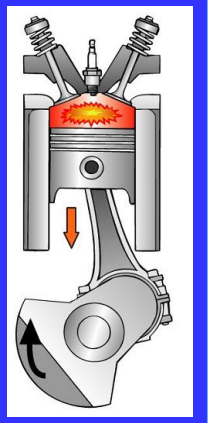


Engine Combustion & Emissions Labs

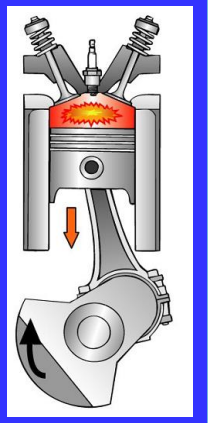
Georgia Southern University Research

Automotive Engineering
Engines and Alternative Fuels
Combustion & Emissions
Aerospace Engineering
Renewable Energy

Dr. Valentin Soloiu, Professor, Allen E. Paulson Distinguished Chair
Mechanical Engineering Dept.
College of Engineering and Information Technology (CEIT)

http://ceit.georgiasouthern.edu/engine/

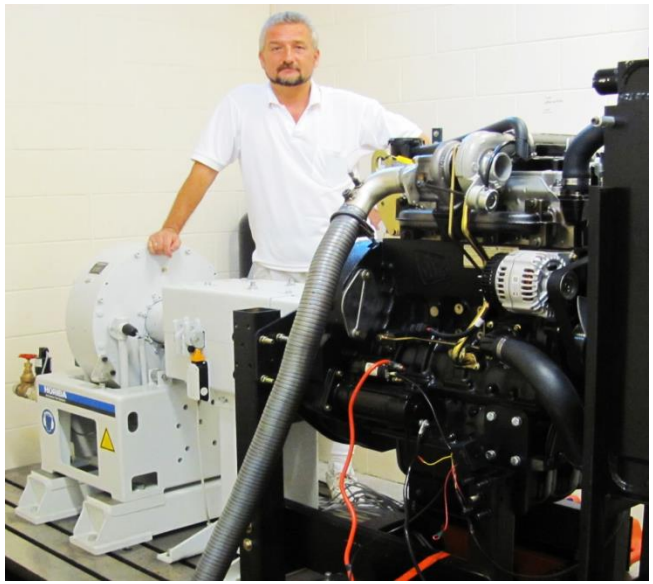
Georgia Southern University 2019

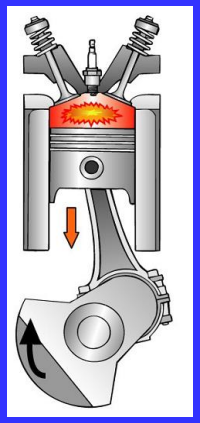


Engine Combustion & Emissions Labs

Welcome to the Engines & Alternative Fuels Combustion & Emissions Automotive & Aerospace Renewable Energy Laboratories !

Dr. Soloiu, the Paulson Distinguished Energy Chair in Georgia Southern University, will offer this virtual tour of the facilities, present the equipment, projects and teams.
He designed, built and is leading the 8000 sqf laboratories and he is glad to inform you that, this state of the art multi-million dollar facility is the most advanced in the Southeast of United States and is ready to serve to your studies.
Dr. Soloiu that will coach your journey, has 30 years experience in R&D and teaching engines, combustion and alternative fuels.
The laboratory has research contracts with: DOE, NSF, EPA, ORNL and FAA.
He has/had cooperation with Fortune 500 companies: Chrysler, AVL, New Sulzer Diesel, FEV, GE, Gulfstream, IAV, JCB, Toyota, Daihatsu, Briggs & Stratton, MTU, Citroen, Renault, Yanmar, Kubota, Great Dane, Mitsubishi Honda, Nissan, Subaru, Isuzu, Hitachi, just to name a few.
Absolutely all the MSc students that studied under his supervision have been hired immediately by Fortune 500 companies.





Engine Combustion & Emissions Labs

Georgia Southern University est. 1906

2018-130 degree programs,

BS, MS, PhD

Total enrolment: approx.28000

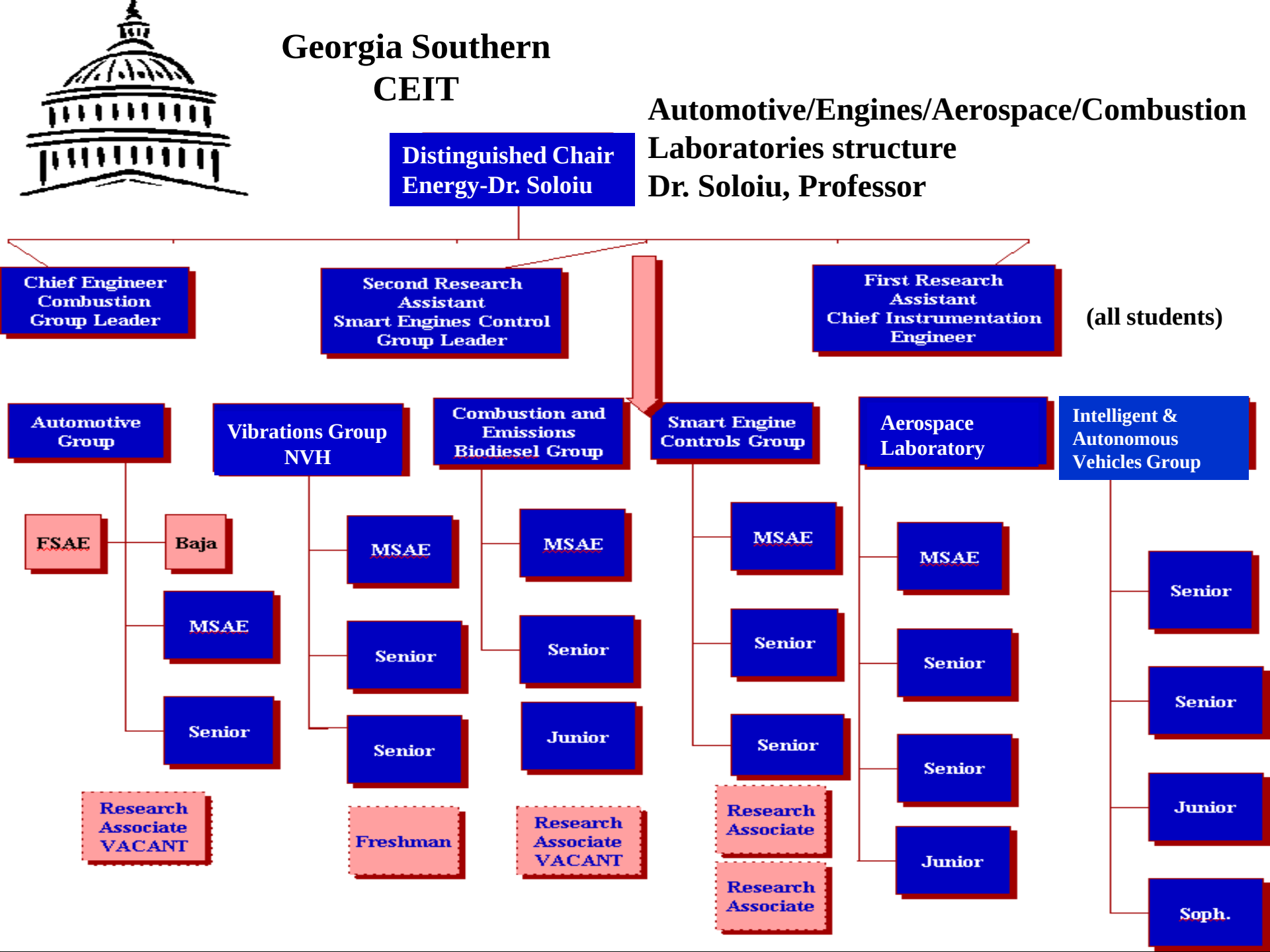
in 8 colleges

First engineering school of Georgia after Georgia Tech in Atlanta

College of Engineering and IT (CEIT)
4,000 students
Dept. Mechanical Engineering
Approx. 1,500 students in BSc
90 students in MSc program

Georgia Southern
CEIT

Automotive/Engines/Aerospace/Combustion Laboratories structure
Dr. Soloiu, Professor



Students research awards under Prof. Soloiu's supervision: 45

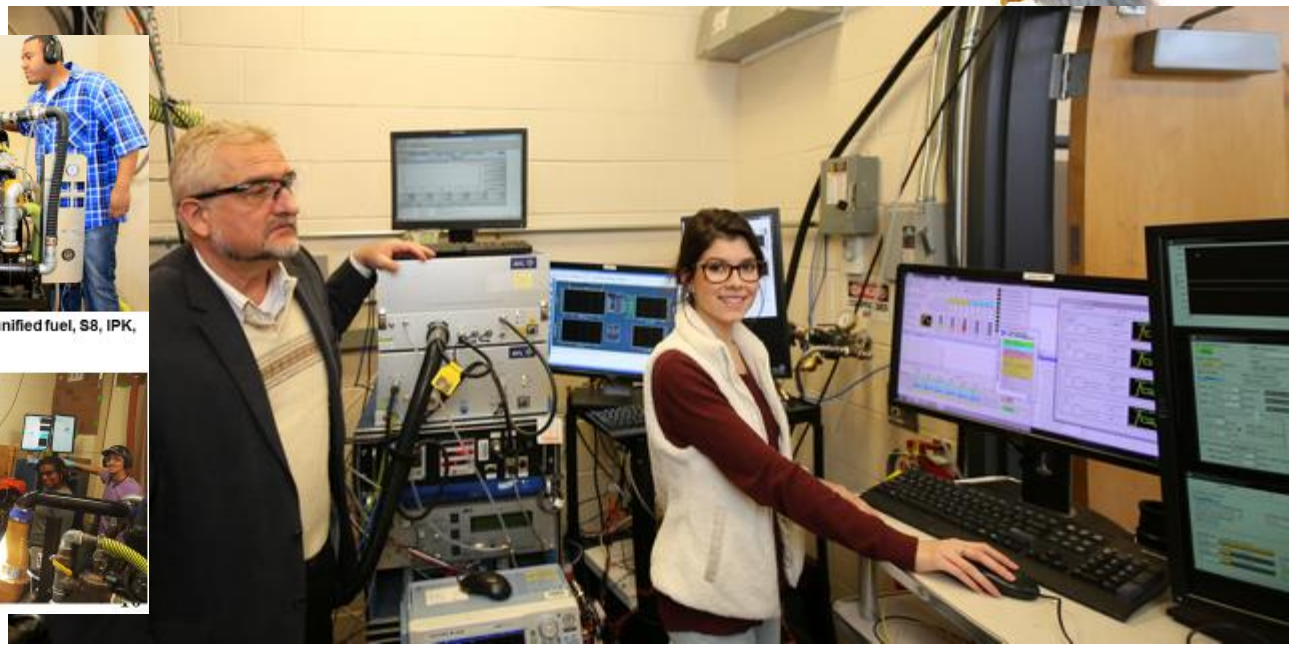
2009 First prize College of Graduate Studies, David Nelson
2010 Second prize College of Graduate Studies, Pawel Gronowski
2012 Student Employee of Year, (nominated) Georgia Southern University, Marvin Duggan
2012 First and third prize College of Graduate Studies, Marvin Duggan and Henry Ochieng
2012 Third prize at the UGA-Bioenergy Research Center Spring Retreat; Craig Jenkins
2012 Excellence in presentation, UGA, Sherwin Davoud
2012 US Army Core of Engineers Award for Engineering Excellence: Sherwin Davoud
2012 Energy and Transportation (Georgia Tech Savannah); Sherwin Davoud
2012 RICOH Sustainable Development Award; Sherwin Davoud
2012 Advancement to Georgia State Science and Engineering fair; Sherwin Davoud
2012 US Forest Service Best Integration of Social and Physical Biosciences; Sherwin D.
2012 First place Georgia Science and Engineering Fair Grand Award ISEF; Sherwin Davoud
2012 Natural Resources Conservation Service Award of Excellence; Sherwin Davoud
2012 Advanced Academy of Georgia Science Creativity Award; Sherwin Davoud
2012 Top 10 State recognition, UGA Renewable Energy Conference-2nd prize, Sherwin D.
2012 Savannah regional science and engineering fair Sherwin Davoud
2013 Second prize COGS Graduate research, Jabeous Weaver
2013 Best Graduate Poster, CEIT Alejandro Castillo, Marvin Duggan and Jabeous Weaver
2013 Runner-up Graduate Poster, CEIT, Martin Muinos and Jabeous Weaver
2013 Best Undergraduate Poster, CEIT, Sherwin Davoud, Tyler Mathis
2013 Runner-Up Undergraduate Poster, CEIT, Brian Wolfe, Scott Purser, Daniel Olender
2013 Jack N. Averitt Graduate Studies Excellence in Research (nominated) Georgia Southern University, Marvin Duggan
2013 Georgia Southern University, Student Employee of Year 2013 Marvin Duggan (out of 20,000 students)
2013 National Prize EPA-P3 Washington DC (M. Duggan, A. Castillo, B. Wolfe, S. Davoud, S. Harp and Dr. V. Soloiu)
2013 First prize EPA-P3 American Inst. of Chem. Eng. Washington DC(Duggan, Castillo, Dr. Soloiu)
2014 National Prize Vibralign- Aligning America: Emerald Simons
2015 National Science Foundation Washington DC-Graduate Research Fellowship Program: Martin Muinos
2015 Virginia Space Grant Consortium: Emerald Simons
2015 First Prize: 10th Georgia Environmental Conference, Scott Dyke
2015 First Prize: Georgia Undergraduate Research Conference: Zach Coles, Imani Augusma, Thomas Beyerl
2016 Averitt Research Award Georgia Southern University (out of 20,000 students) Martin Muinos
2016 Outstanding Graduate Student Research Scholarship and Poster Award- Martin Muinos
2017 Seven Awards (7) at SAE Automotive World Congress in Detroit 2017
2017 GSU Undergraduate research grant; Tyler Wiley
2018 Georgia Power Innovation Awards, 3rd Place: David Mothershed, Joshua Curtis, and Keith Russell
2018 John Scarano Memorial Scholarship, Sophia Fleri
2018 GSU Undergraduate research grant; Margaret Kilpatrick, Sophia Fleri
2019 ASME Petroleum Division Grant, Margaret Kilpatrick, Sophia Fleri

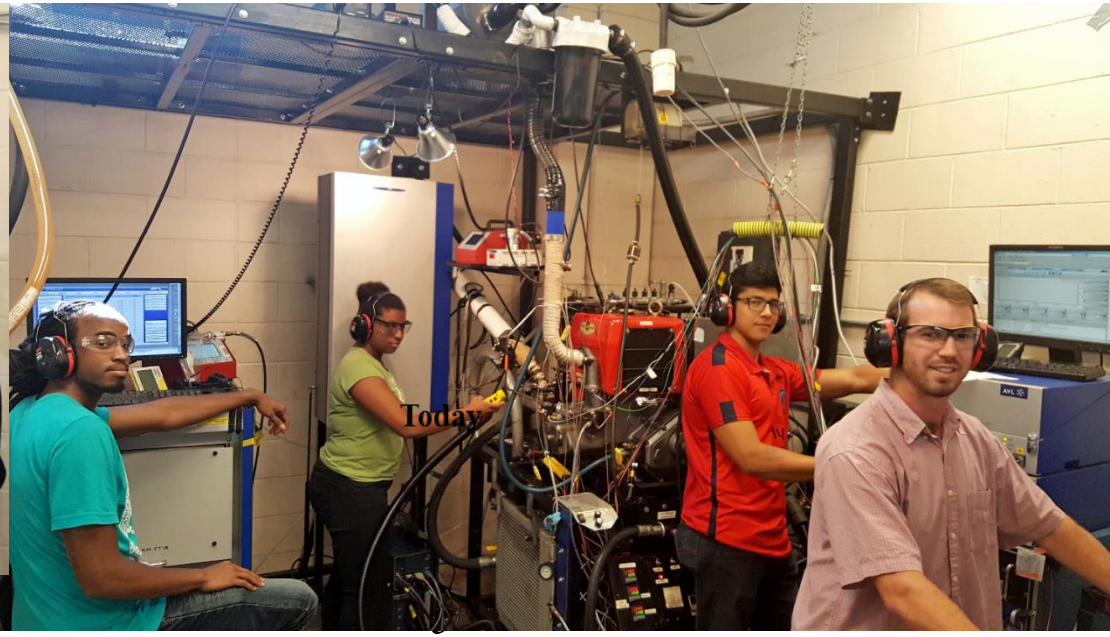
EPA National prize 2013

Automotive / Engines Laboratories

Dr. Soloiu

Applications of alternative fuels Poultry FAME, Peanuts FAME, Cotton seed oil, JP8 unified fuel, S8, IPK, butanol: combustion & emissions





Georgia S

Equipment in Automotive/Engines/Aerospace Laboratories

Dynos: Horiba-Schenk (2008) Eddy Current Dyno 250HP; Dyno controller Type SPARCe; Driveshaft K010 with shaft guard; Driveshaft Taylor; bedplate with 4 air-spring isolators; dyno 30 HP horizontal shaft, dyno 20 HP vertical shaft; dyno 10HP.

Engines: JCB-TDI, 80HP, turbocharged experimental; Single-cylinder omnivorous diesel Yanmar DI/PFI 23HP+supercharged/EGR; Single cyl experimental Kubota IDI/5HP; Single-cyl Briggs & Stratton PFI, 20HP, Gas turbine 40 Kgf

Chassis dyno: 1300-Lite 2WD EC Chassis Dyno with gas analysis system

Data acquisition systems: fast-speed data acquisition system AVL INDICOM; Drivven cDAQ-9178, Compact DAQ chassis (8 slot USB), NI 9411 6-Ch ±5-24 V, 1 MHz, Single-Ended, TTL or Differential Digital Input Module 1 electronic rack, cDAQ-9172 8, National Instruments; 1 high-speed data acquisition board (16 channels 1.25 Ms/s); NI 9222, 4-Ch, 16-Bit, 500 kS/s, Simultaneous AI C Series Module for Compact DAQ and Compact RIO, 1 high-speed data acquisition board (32 channels, 50 kS/sec 16 bit analog input NI 0205 32), NI; fast needle lift data acquisition system PU-05-159-401 AEC America; 1 converter AEC-5505; 2 Kistler 5010B dual mode charge amplifiers with RS-232, interface, 3 exhaust temperature measurement systems, Omron (20 thermocouples); 5 rotary encoders 2000P/rev+1800P/rev, high-speed data acquisition systems: Yokogawa DL850+DL750/10MS/S; 3 ECUs

NVH: Multi-Analysis capability for simultaneous measurement, High speed tachometer sampling for engine analysis FFT, CPB (1/1, 1/3, 1/12, 1/24 octave bands) and display of Loudness, Order Analysis with tachometers or AutotrackerTM, 2250 Sound Level Analyzer: CPB (1/1, 1/3 Octave Analysis), Data Logging (overall parameters & CPB), FFT, Data recording, Bldg Acoustics, Photon Analyzer Capabilities: FFT, Data recording, Wireless communication of multiple channels, Microphones: diffuse, multi, free field Beamforming dish antenna & Camera, BK Connect

Drivers and Controls: NI/Drivven 3 Channel Direct Injector (DI) Driver System, NI 9215 4 ch 16-Bit, ±10 V, 100 kS/s/Ch, Simultaneous Sampling Differential Analog, NI 9758 Port Fuel Injector Driver Module**,** Common Rail control module

Sensors: 2 clamp sensor for injection line pressure Kistler; 2 miniature piezoelectric cylinder pressure probe noncooled, Kistler; 1 miniature piezoelectric cylinder pressure through spark-plug probe noncooled, Kistler; 1 miniature piezoelectric sensor through glow-plug, Kistler; Kulitte, Setra and Omega intake and exhaust manifold sensors, 1 PCB accelerometer. Strain gages Vishay, pressure sensors calibration rig, Omega torque cells

Air-Flow meters: Meriam 40-500 SCFM, 3x10-100 SCFM, 2-22 SCFM, with 2xS320 DAQ

Fuel flow meter: AVL KMA 4000 Flex fuel, Micro Motion Flow meters 4

Instruments: MALVERN Mie He-Ne scattering spray laser, Rancimat – oxidation stability analysis, viscometer/rheometer Brookfield; Lambda probe, Paradigm biofuel analysis; Shimadzu TGA-DTA60, Parr calorimeter, pin-on disk tribometer, Shimadzu balance 0.01 mg, Shimadzu balace 4Kg±0.01gr; HHM59 Digital Clamp Meter, HHF81 4-in-1 Air Velocity Meter, HHM8229 5-in-1 Digital Multimeter, HHVB82 Omega Vibration Meter, HHSL-1 Omega Sound Level Meter, CN4316-F1-R2 Process Controller, Tektronix TDS 210 Oscilloscope, GW Instek GDS-806C Oscilloscope, GW Instek GFG-8255A Function Generator. FLIR infrared camera, Cetane Number Herzog ID 510

Gas analysis: AVL SESAM FTIR (5 channels/25 species each), MKS FTIR Multigas (20 species) AVL 483 Micro soot sensor, AVL PM Sampler 472, AVL smokemeter/soot 415S, Horiba MEXA-584L portable Otto gas analyzer, CO, HC, C02 (nondispersive infrared: NDIR) and air-to-fuel ratio (AFR) excess air ratio; Horiba MEXA-720 NOx portable analyzer with zirconia-ceramic sensor for fast-response measurements of NOx concentrations from diesel and measurement of air/fuel ratio (A/F), excess air ratio (lambda), and O2 sensor;

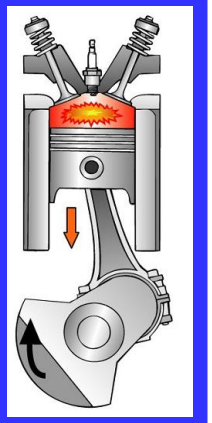
Software: AVL-FIRE; AVL Concerto, AVL INDICOM, GT-Power, ANSYS, Fluent, ADAMS, Pro-E, Chemkin, KIVA

Automotive laboratory (alternative fuels - combustion)

TEST CELL ALPHA 250 HP Horiba-Schenk dyno,

Projects: Performance of automotive engines with alternative fuels

Engine Combustion & E

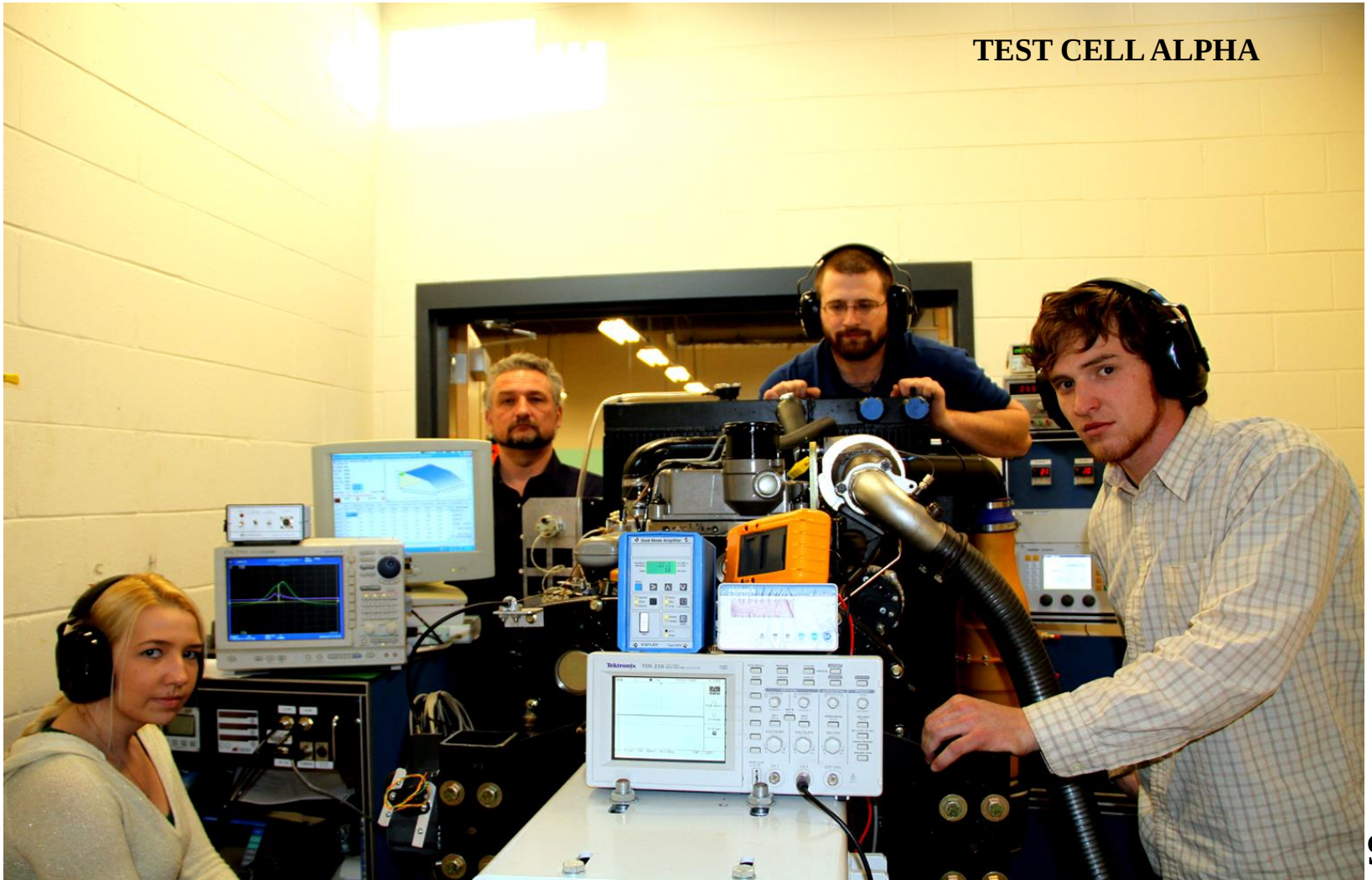


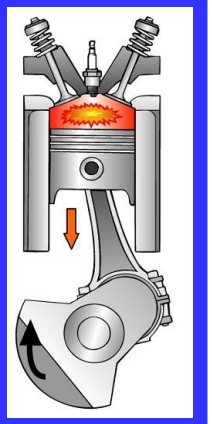
Engine Combustion & Emissions Labs

Automotive Laboratory

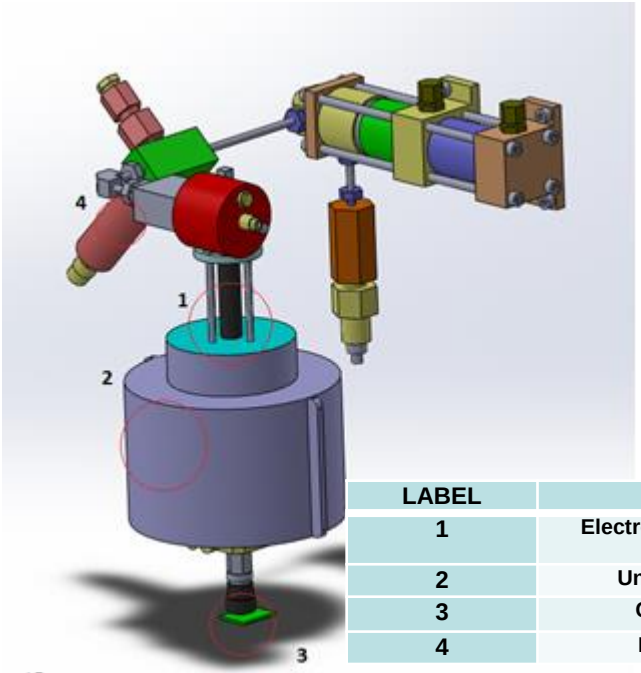
Alternative Fuels - combustion research

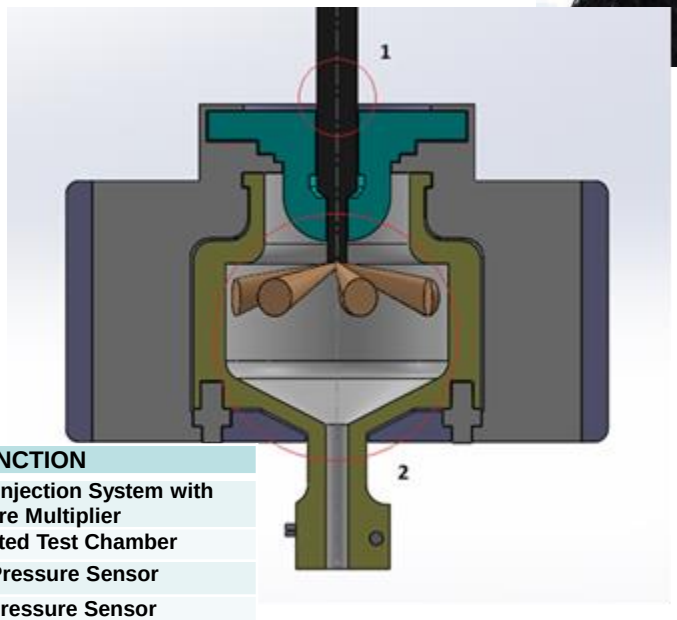
Poultry FAME, Peanuts FAME, Cotton Seed FAME, JP8, Jet A, Sasol, S8, IPK, combustion



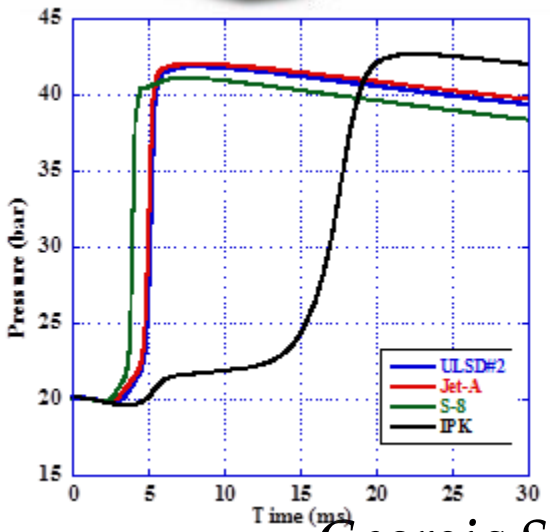


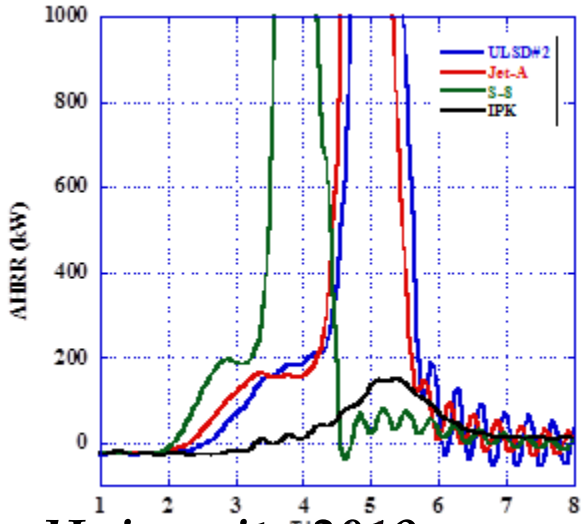
Ignition delay, LTHR and NTC studies in constant volume combustion chamber





LABEL	FUNCTION
1	Electronic Fuel Injection System with Pressure Multiplier
2	Uniform Heated Test Chamber
3	Chamber Pressure Sensor
4	Injection Pressure Sensor



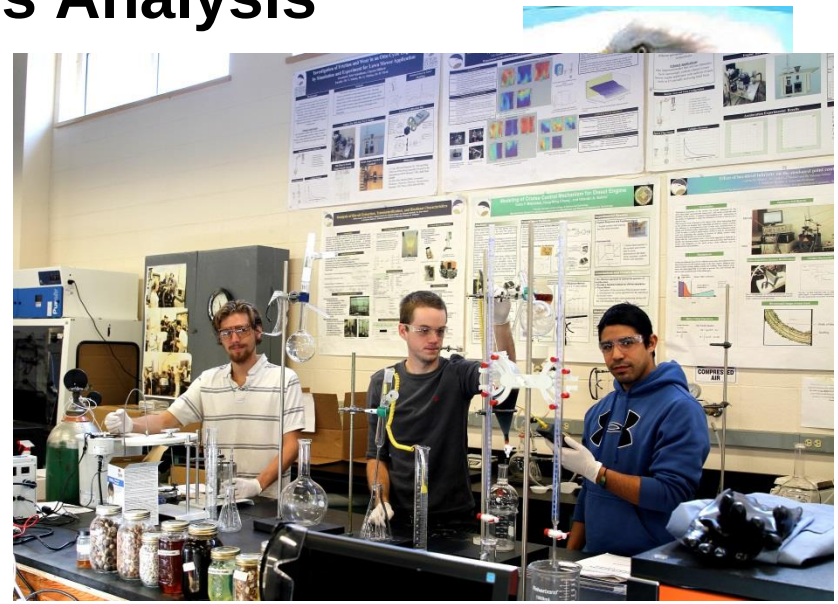


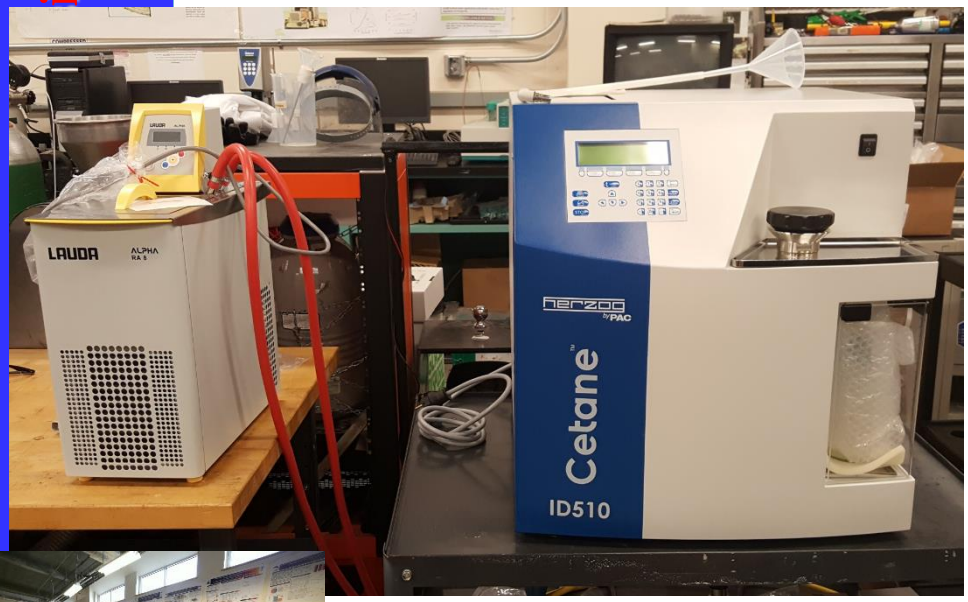
Engine Combustion & Emissions Labs

Alternative Fuels Analysis

Oxidation stability – Methrom Rancimat

TGA-DTA Shimadzu





LHV-Parr Calorimeter

Viscometer Brookfield

Cetane Number Tester

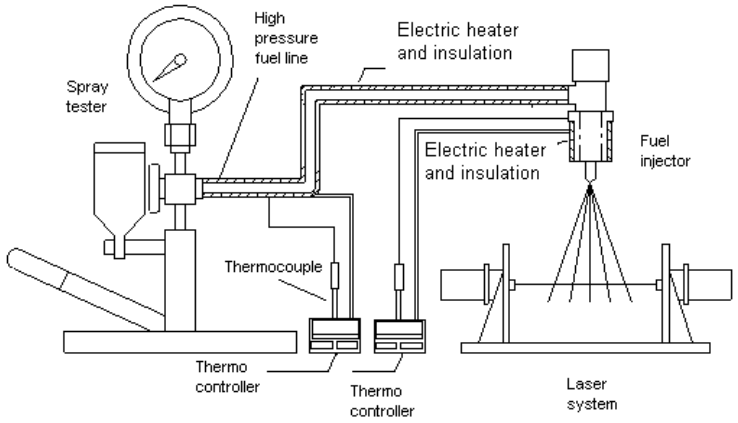
Spray tester-Bosch

Georgia Southern University 2019

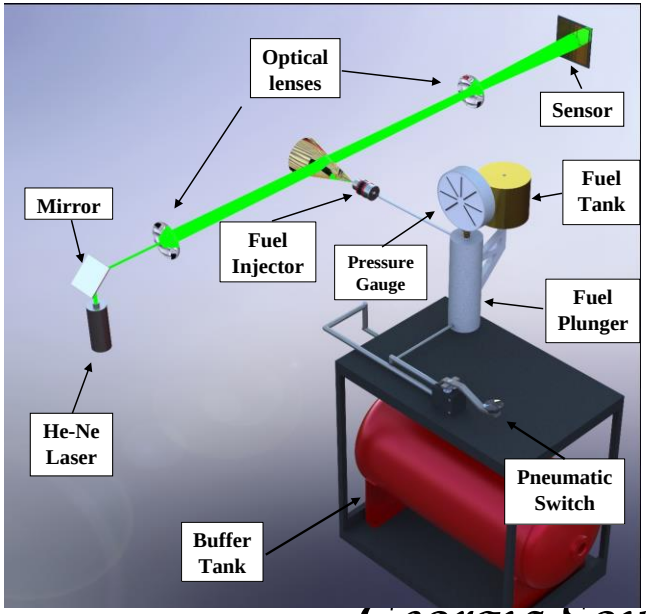
Renewable Energy and Engines Lab

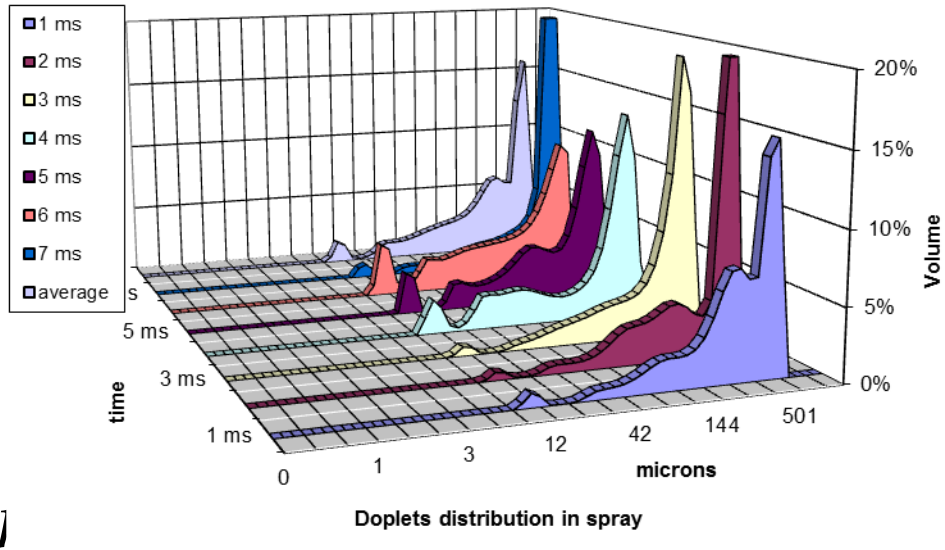
Optical Investigation Laboratory
Malvern Mie He-Ne scattering laser
Sprays development and mixture formation

Mie scattering laser research on biodiesel spray



Mie scattering laser system for spray and mixture formation investigations

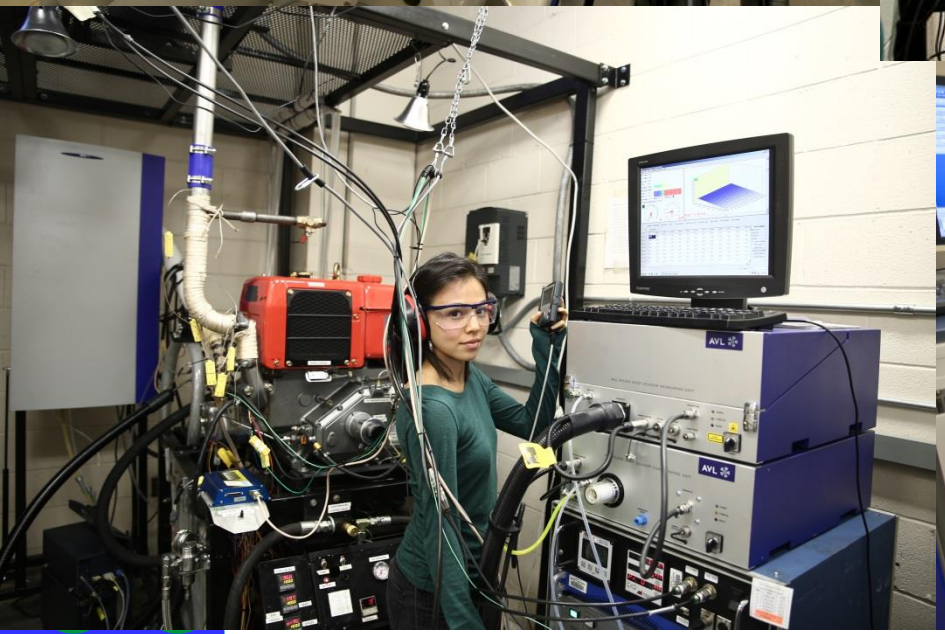




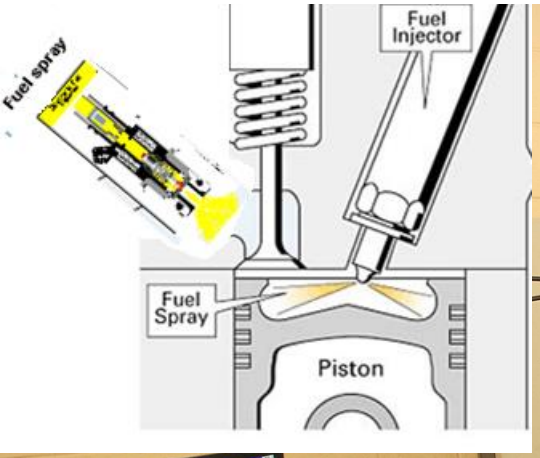
Doplets distribution in spray

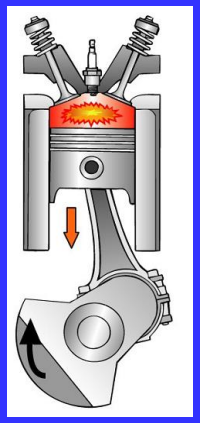
Georgia South

Systems integration
Multidisciplinary Research in Combustion & Emissions and controls, lubrication and wear, with biofuels



Advanced Engine Concept: True omnivorous engine (RCCI/LTC) (direct injection of: diesel, biodiesel, JP8, Jet-A, S8, HFO, Port injection of: gasoline, ethanol, butanol)

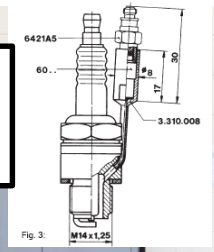




Vehicle electrification project
Extended Range Hybrid Electric Vehicle with Green Engine
Combustion investigation, ECU map development
E85 Bio Ethanol/Butanol Green EFI Single Cylinder Engine

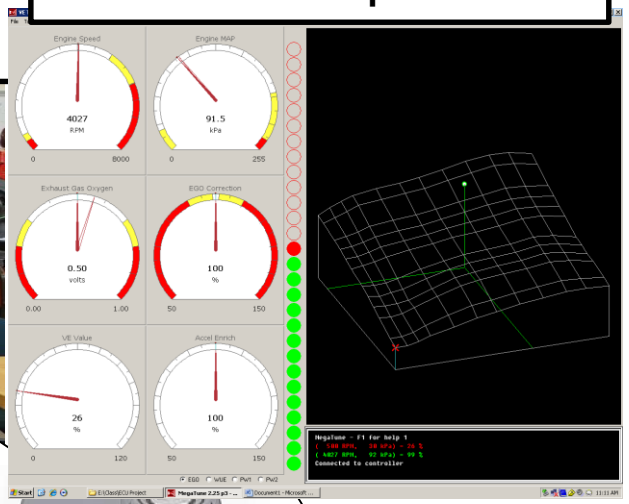
Engine Combustion & Emissions Labs

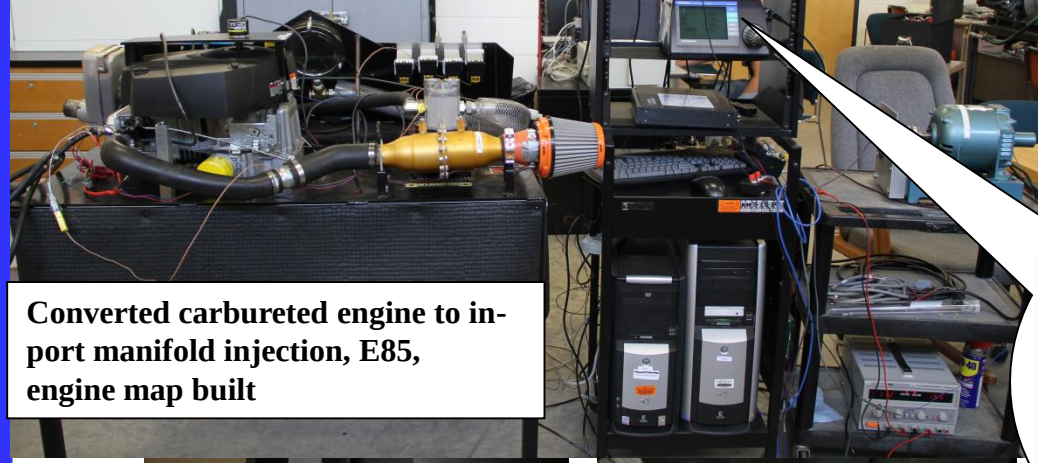
Kistler spark plug pressure sensor



high speed data acquisition system

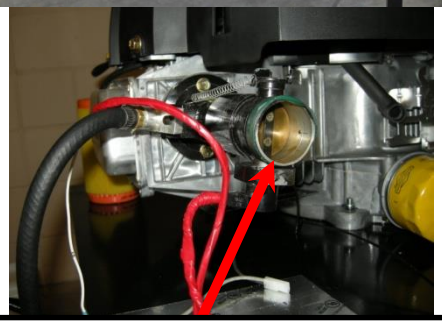
ECU development





Converted carbureted engine to in-port manifold injection, E85, engine map built

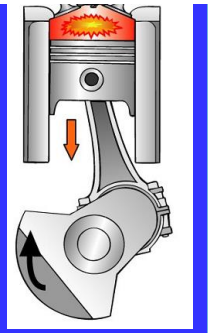
Horiba gas analysis system



New electronic fuel injector

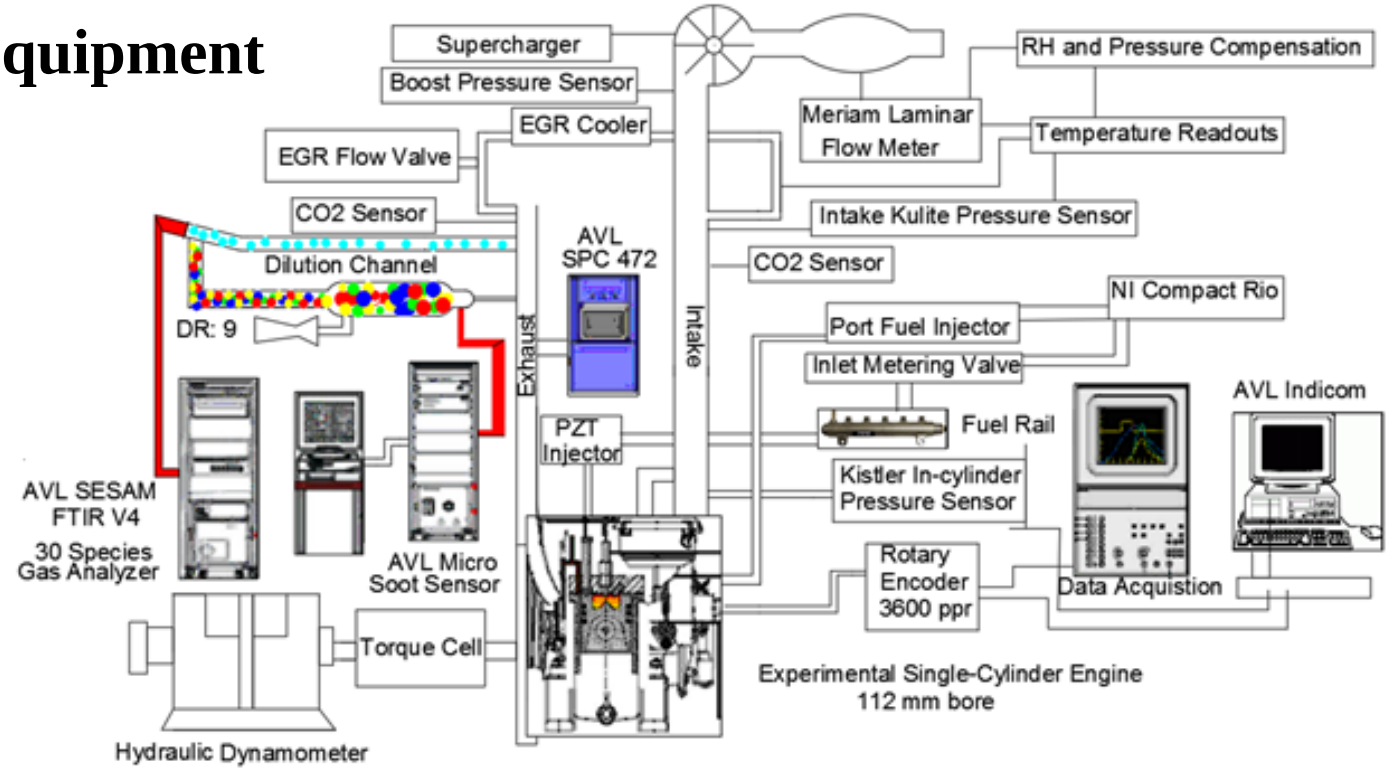
New throttle plate with electronic position sensor

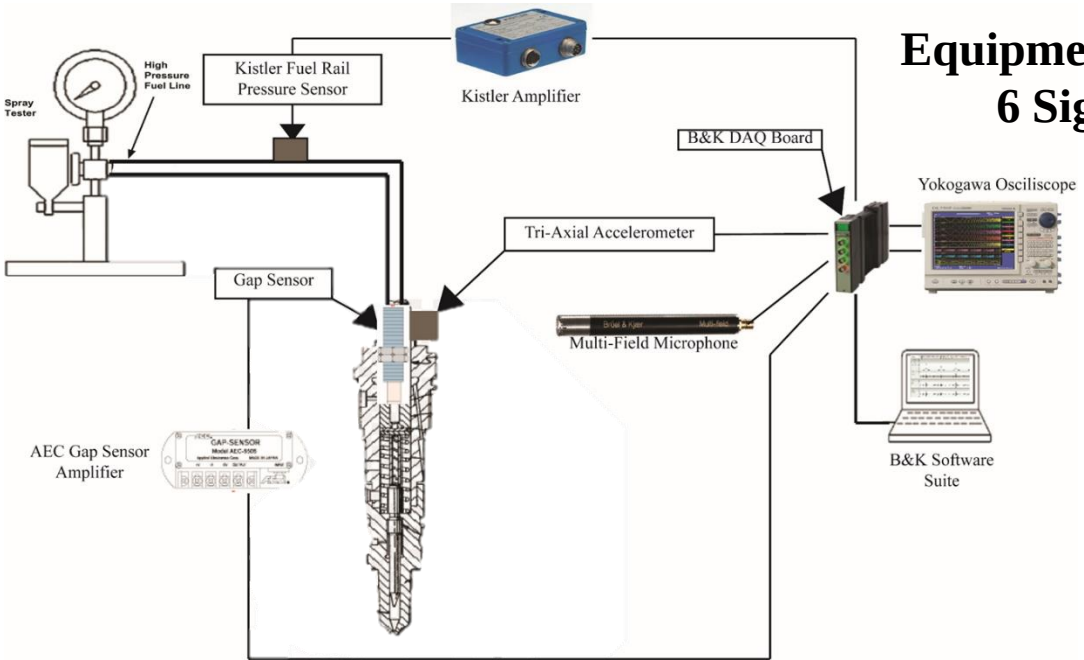
World class equipment



AVL SESAM FTIR gas analyzer, powerful tool for the development of engines, exhaust treatment devices, and fuels. This versatile, real-time gas analyzer continuously and simultaneously measures over 20 gas components

Soot and PM real time measurement concentration by AVL483 Micro soot sensor and AVL472 Smart Sampler in the exhaust to for clean vehicle development programs for engine combustion analysis, ECU calibration and after-treatment development.



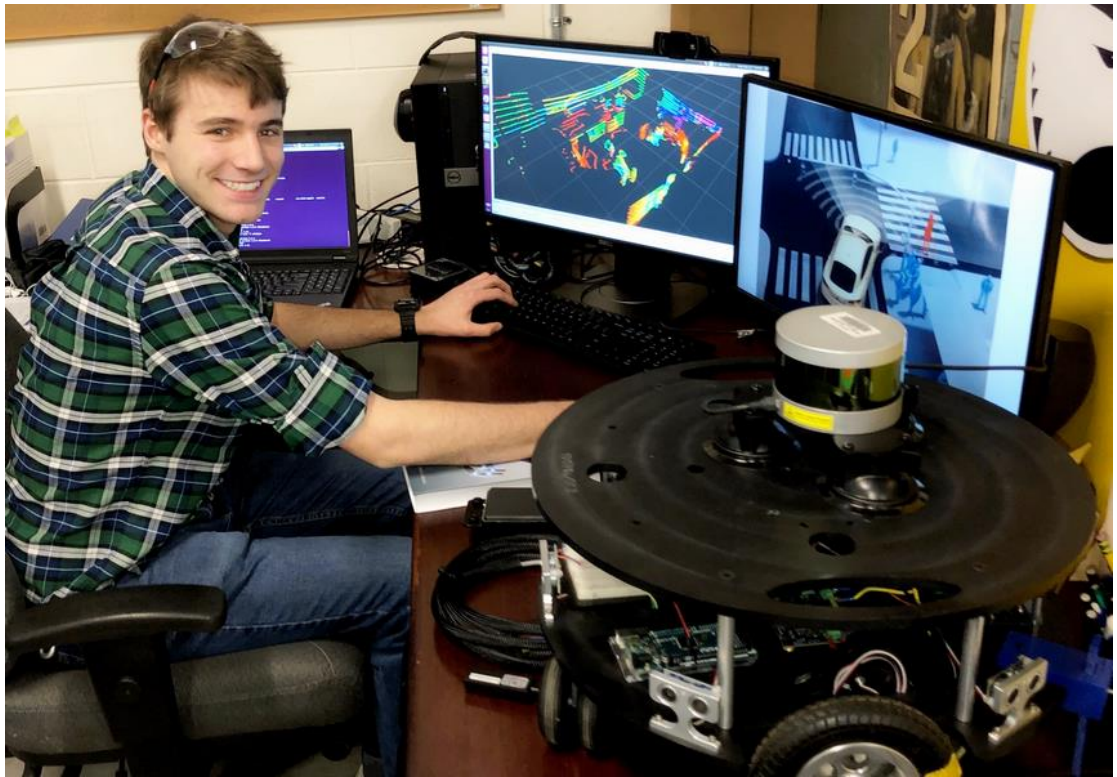


Equipment diagnostic 6 Sigma

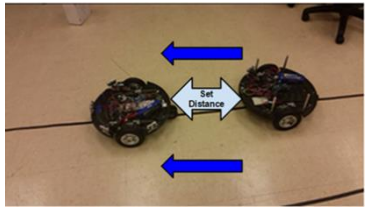
Development of a Self-Driving Intelligent Vehicle to Increase Road Safety, Lower Congestion Rates and Decrease Emissions

In this study, a sensor based intelligent vehicle platform was developed to have the capabilities to drive cooperatively and independently on the roads

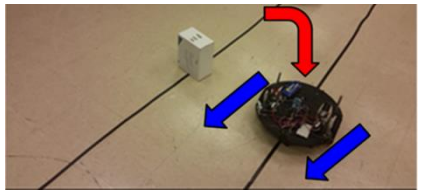
The system optimizes the human senses using sensors, and transmitter/receiver modules, to increase the human vision, feel and communication to: Increase Road Safety, Lower Congestion Rates, Decrease Emissions



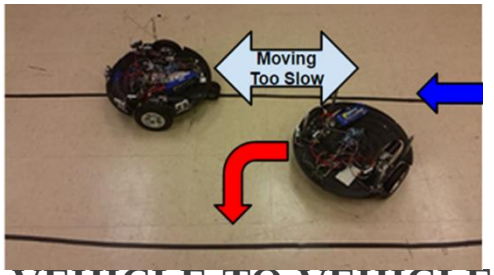
ADAPTIVE CRUISE CONTROL



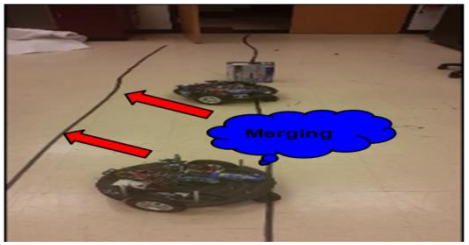
OBSTACLE AVOIDANCE

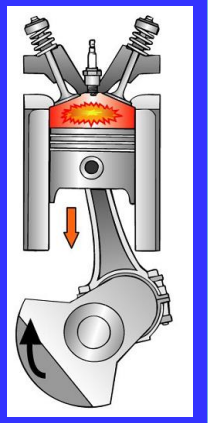


LANE KEEPING/CHANGING

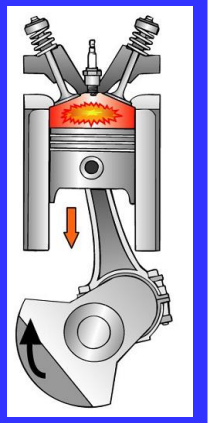


VEHICLE-TO-VEHICLE COMMUNICATION



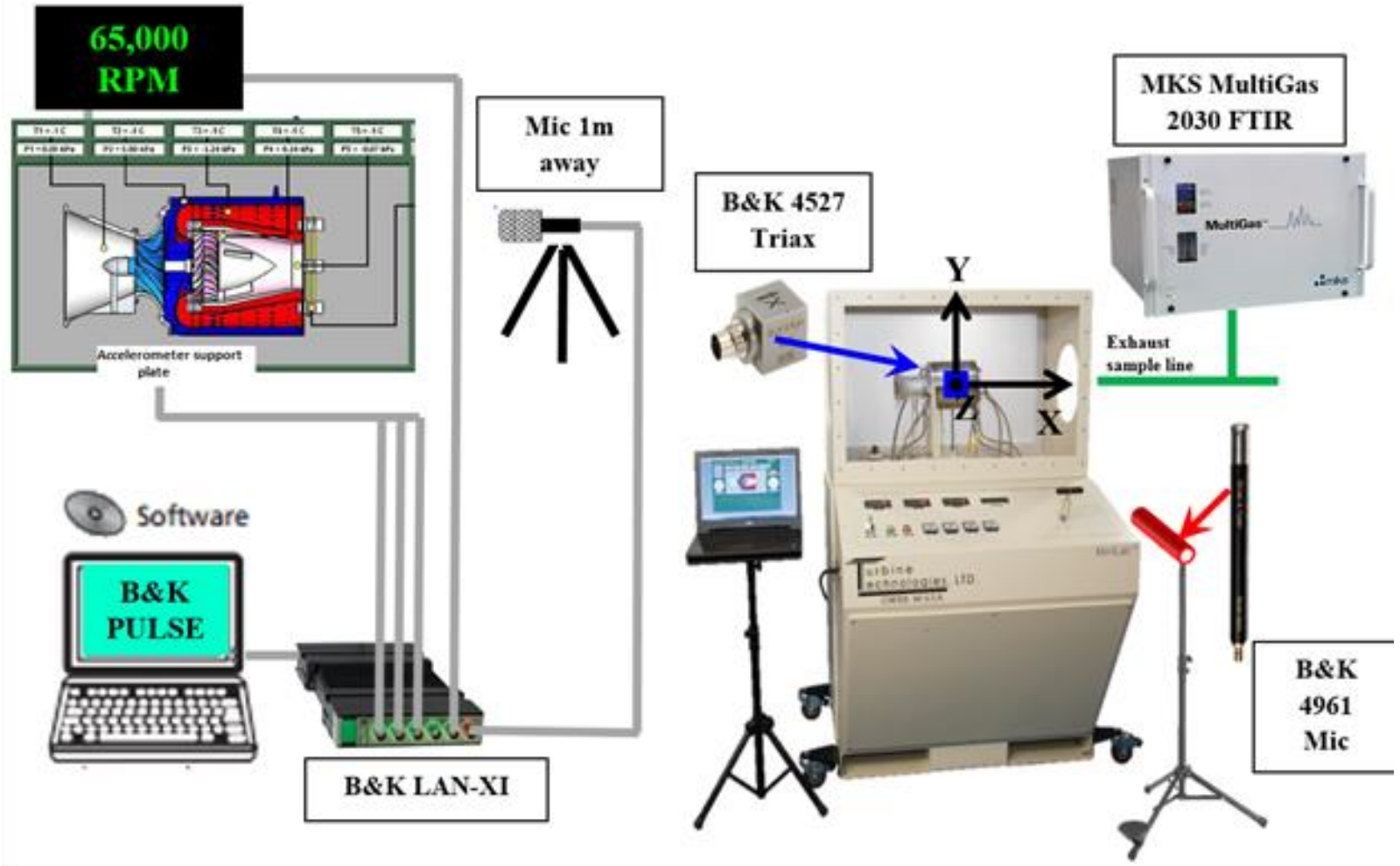


Automotive testing and calibration with alternative fuels
Chassis dynamometer



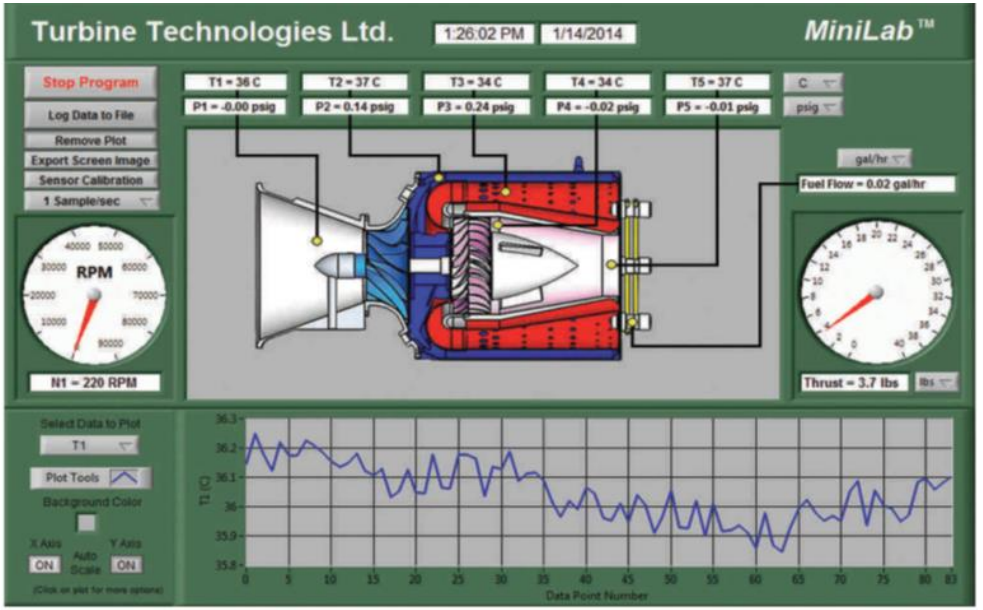
Renewable Energy and Engines Lab

Aerospace Laboratory
Experimental Apparatus Gas Turbine

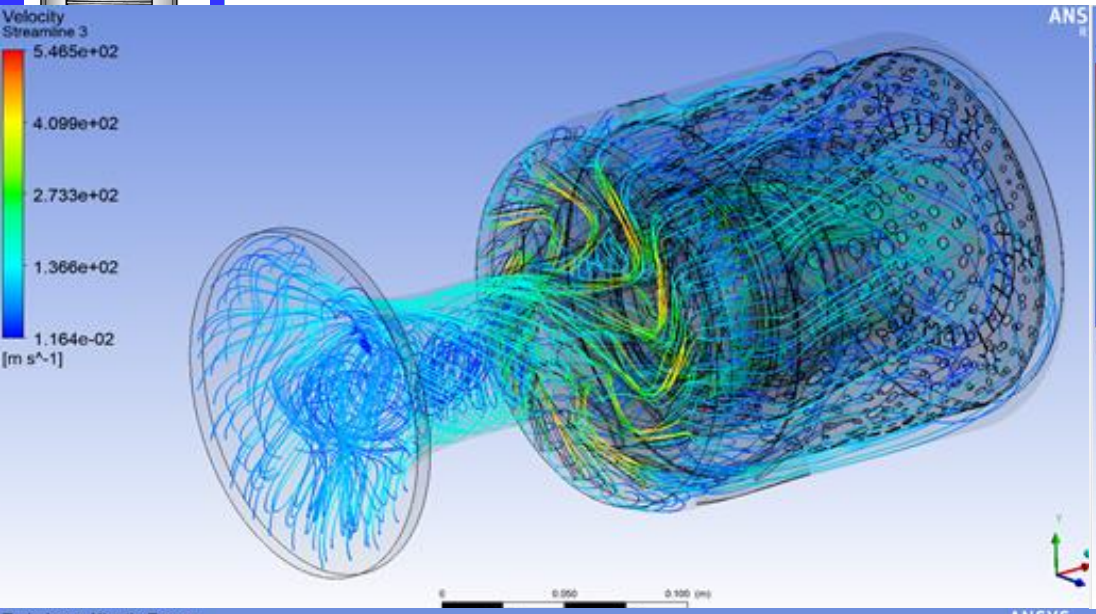


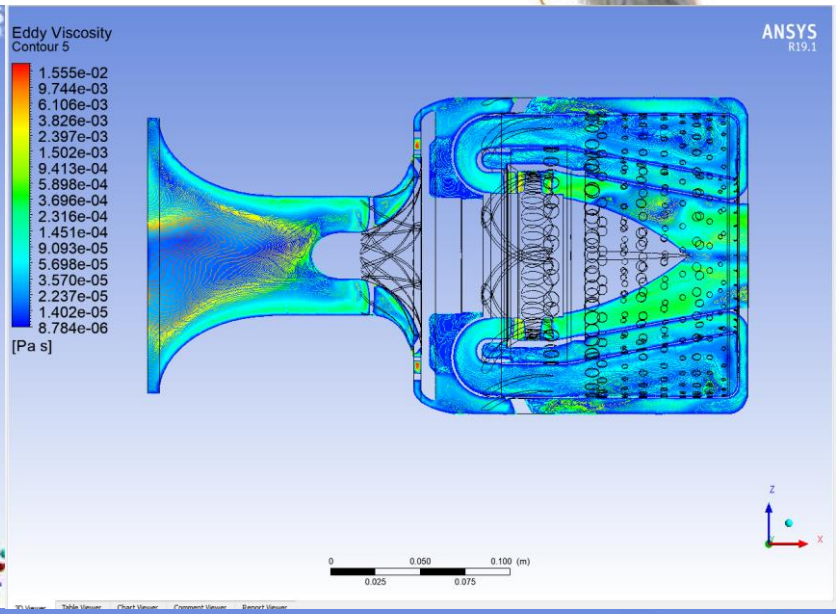
Aircraft turbine research for aerospace industry

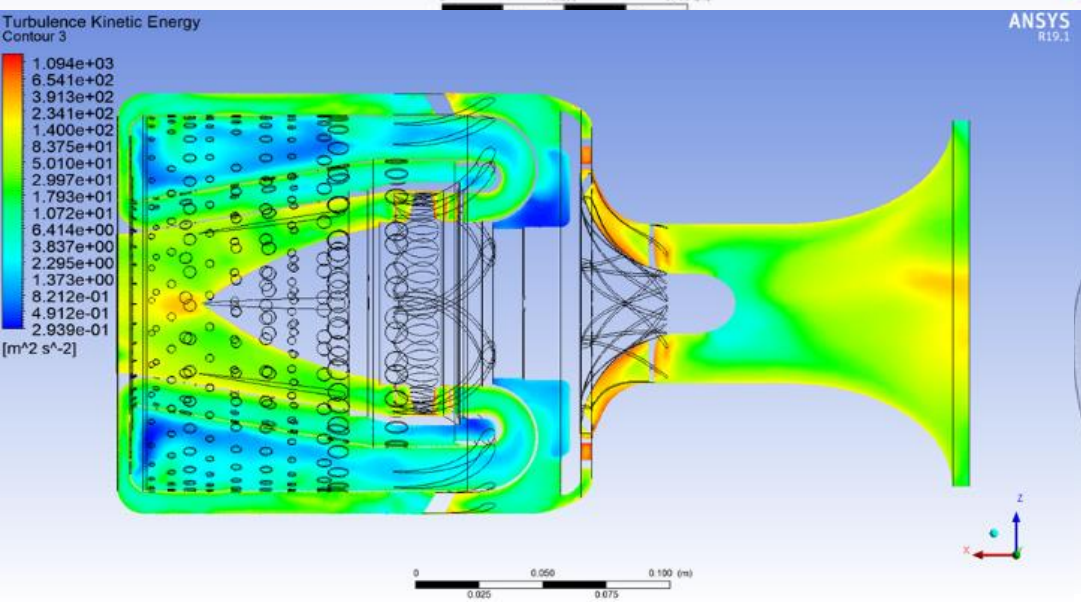
fueled by: Jet A, Biodiesel; JP8; S8, Kerosene, IPK, ULSD

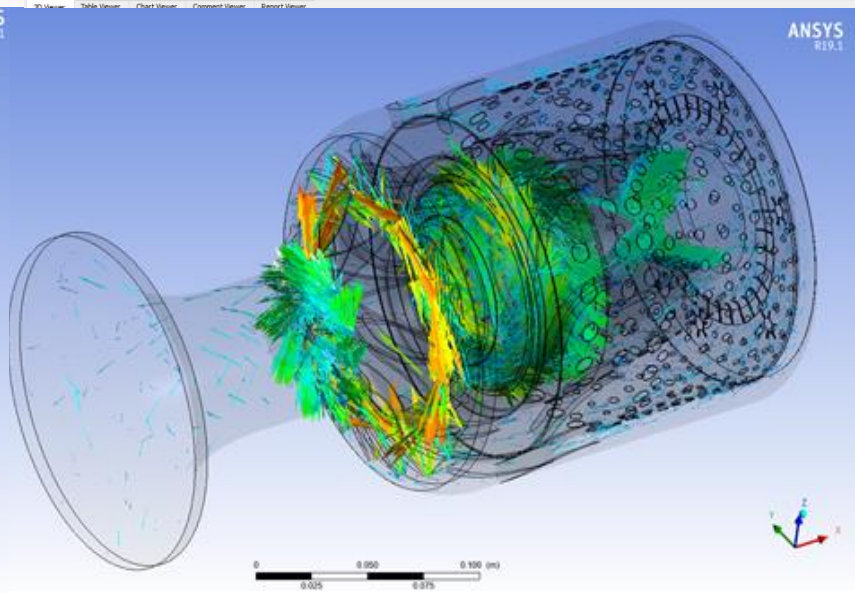


Turbojet thermodynamics simulation

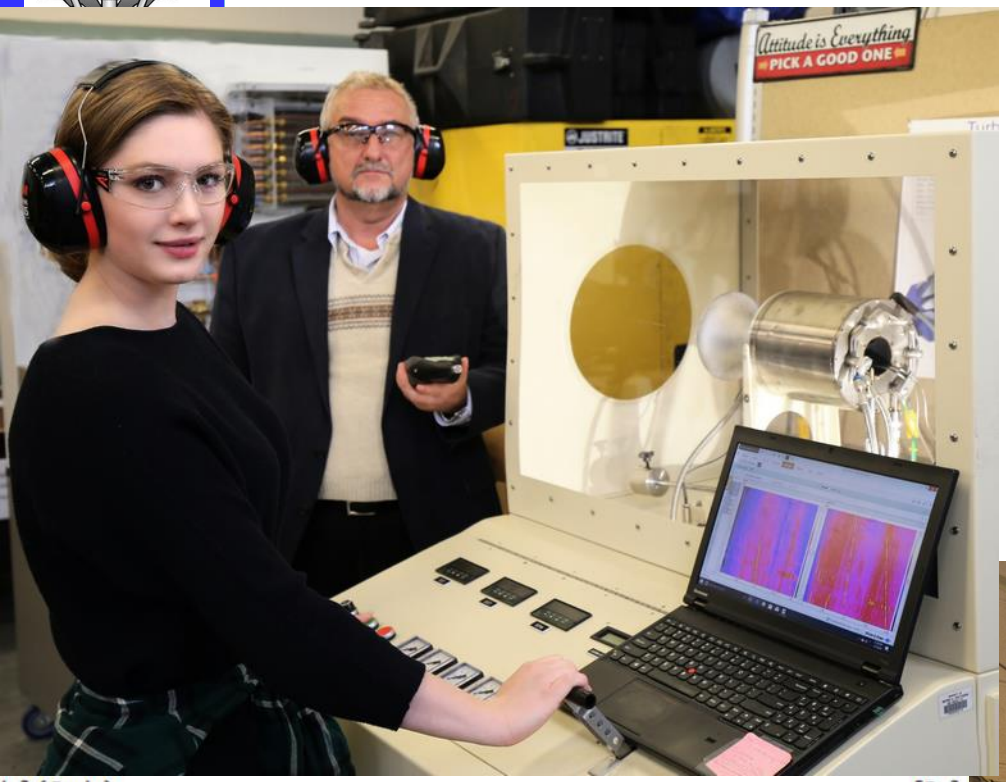


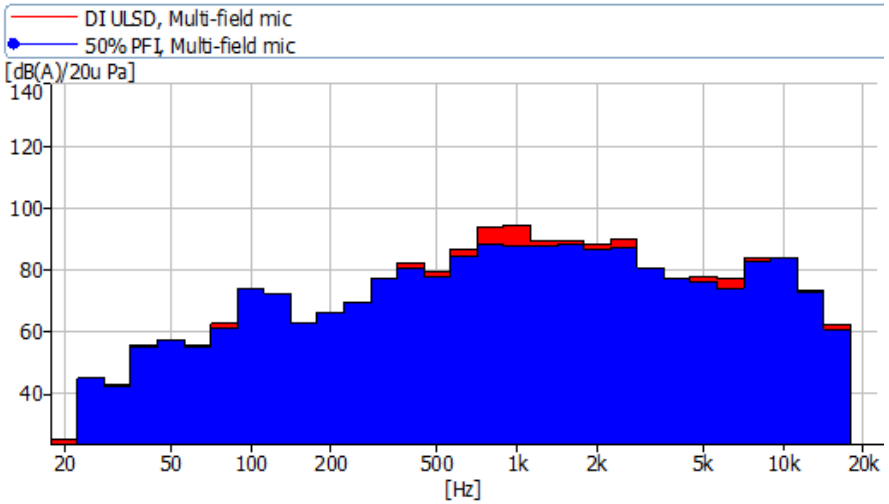


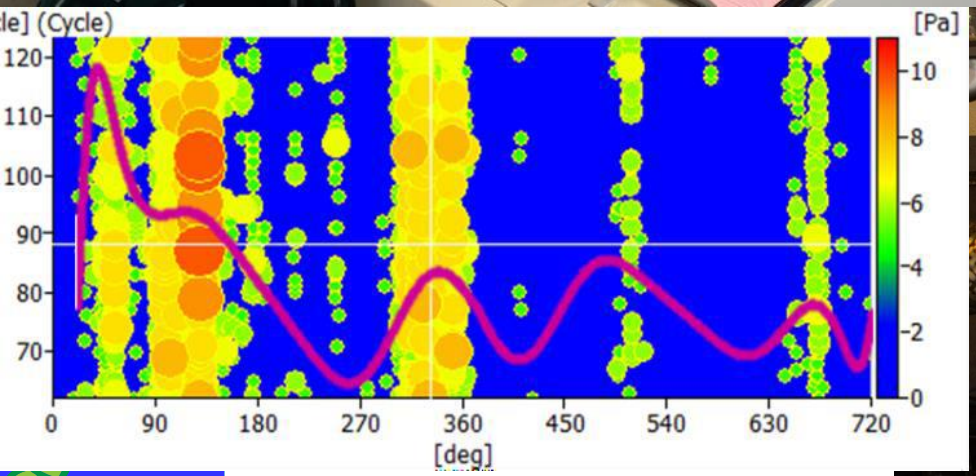


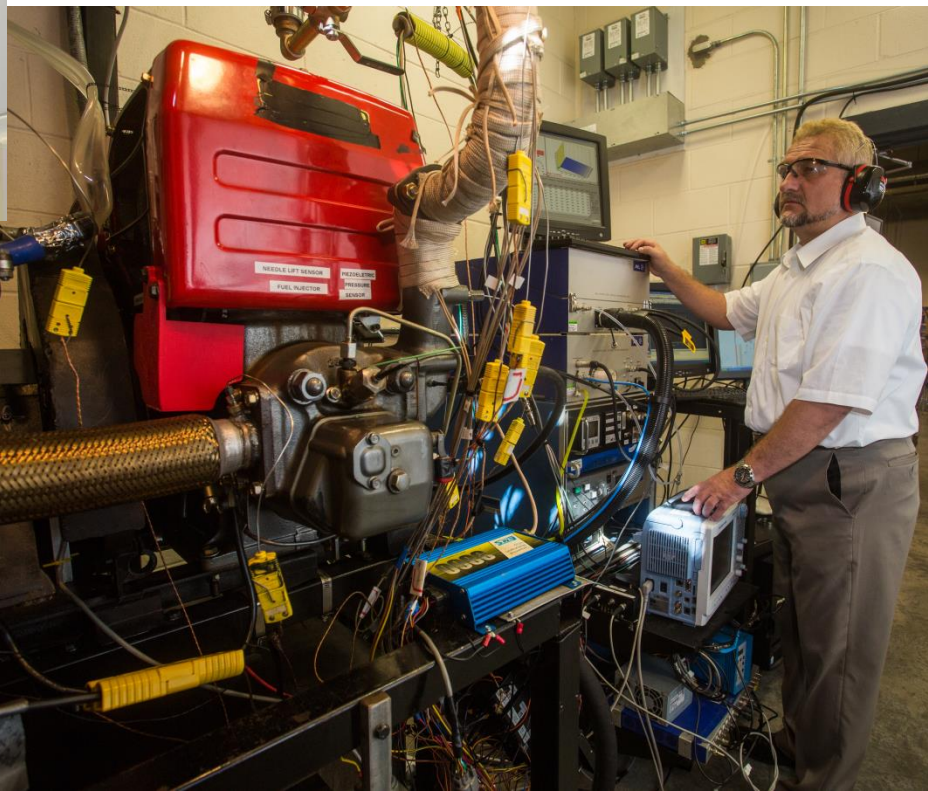


Noise, vibration & harshness (NVH) studies







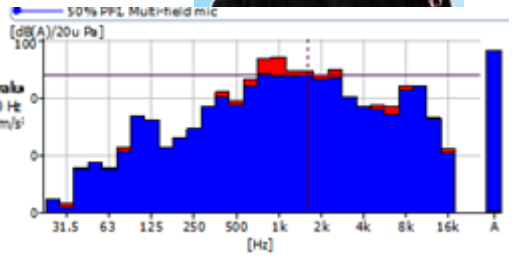


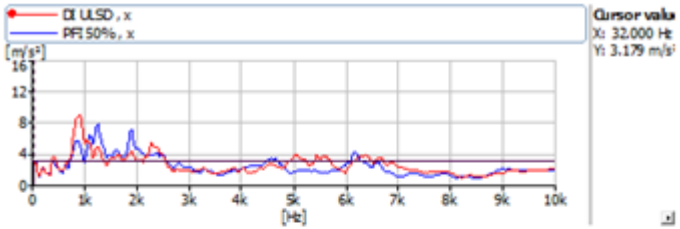
Georgia Sout

Pulse Labshop Analysis Capabilities:

NVH machinery: car & engine, gas turbine

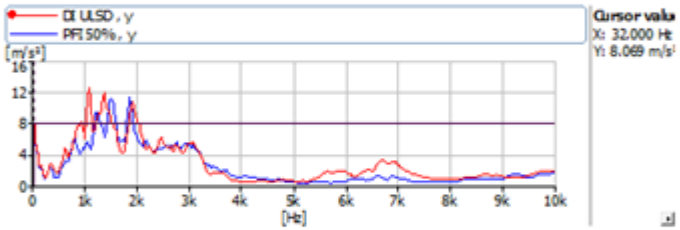
Multi-Analysis capability for simultaneous measurement
High speed tachometer sampling for engine analysis
FFT, CPB (1/1, 1/3, 1/12, 1/24 octave bands) and display of Loudness
Order Analysis with tachometers or Autotracker™ when tachometer not available
Overall parameter analysisTime capture with custom FFT and cepstrum analysis
Data recorder for capturing data for later analysis
Modal Test Consultant for modal analysis geometry, test sequence,
Display: Time, spectrum, orders, versus time, contours or rpm.

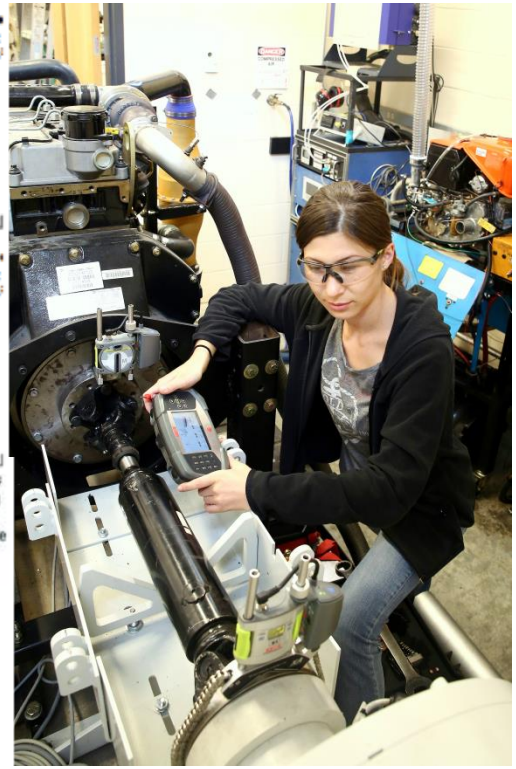




Pulse Reflex Analysis Capabilities:

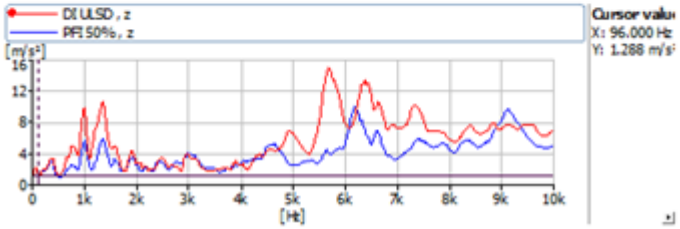
FFT, CPB (1/1, 1/3, 1/12, 1/24 octave bands)
Order Analysis with tachometer s
Sound Quality metricsCustom filtering,
Shock Response Spectrum
Engine Angle Analysis, Modal Analysis





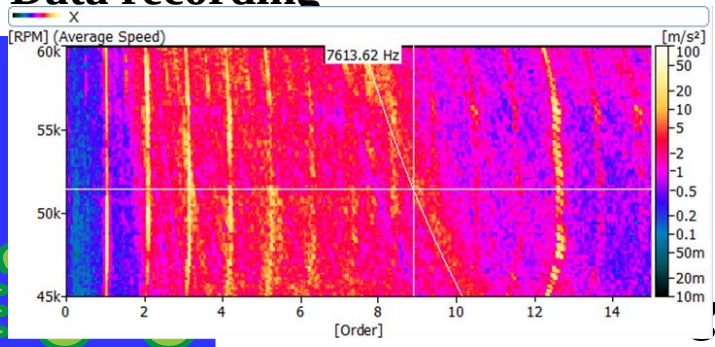
2250 Sound Level Analyzer:

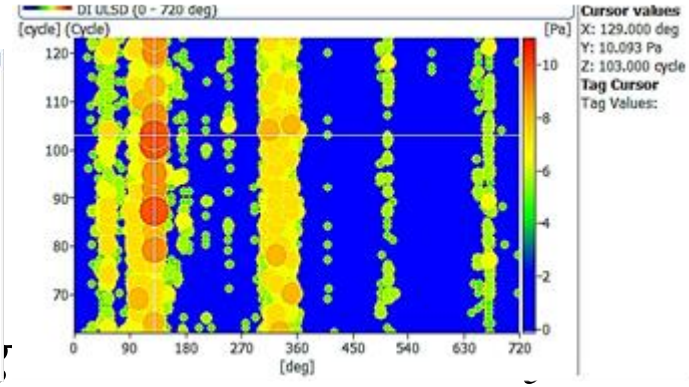
CPB (1/1, 1/3 Octave Analysis)
Data Logging (overall parameters and CPB)
FFT, Data recording, Building Acoustics

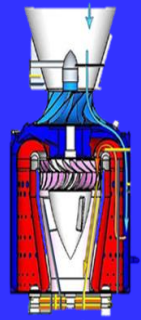


Photon Analyzer Capabilities: FFT

Data recording



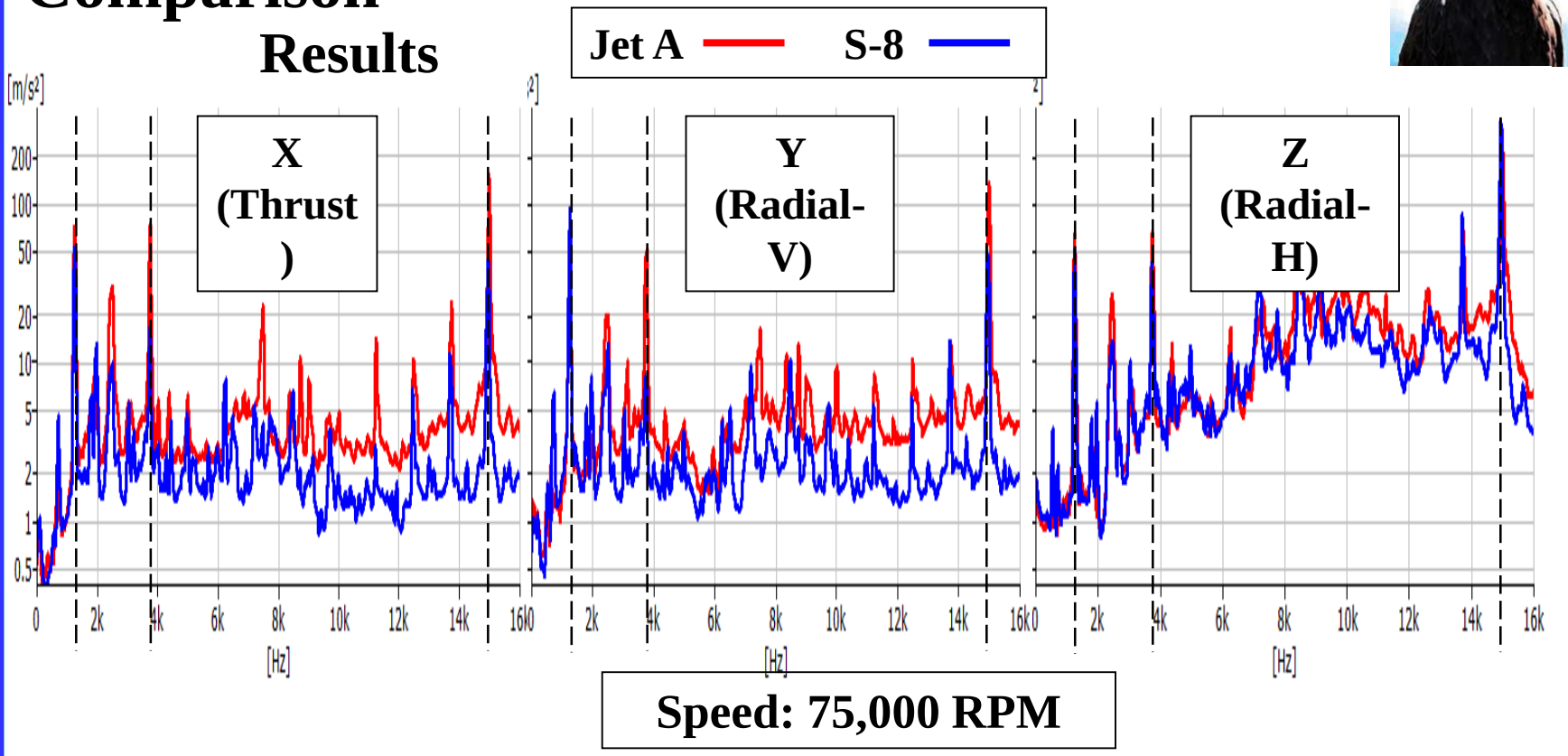




Gas turbine Laboratory

Jet engine-Baseline (Jet A) & New Fuel (S-8) Comparison

Results



Speed: 75,000 RPM

Order	1st (1.25 kHz)			3rd (3.75 kHz)			12th (15 kHz)		
Directions	X	Y	Z	X	Y	Z	X	Y	Z
Jet A	71	85	64	75	50	67	152	133	307
S-8	53	92	51	17	8	42	45	50	330

Aircraft Cockpit Sound Absorption with Various Insulation Types

http://corporatejetinvestor.com/articles/g650_guide_for_buyers_

"Providing passengers with utmost comfort"

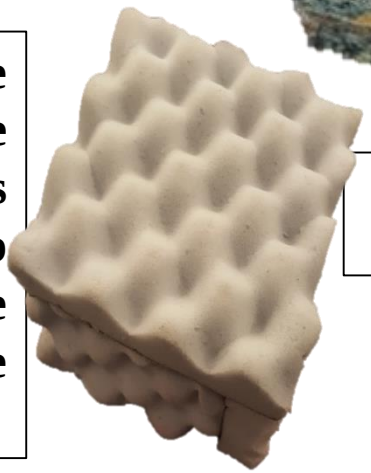
Material 1: 13lb/cu.ft

Sound Cube: 0.7lb/cu.ft

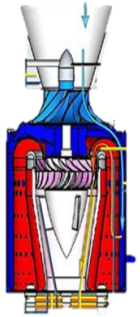
Material 3: 7lb/cu.ft

Material 4: 6lb/cu.ft

lightweight, porous melamine with an open-cell and fiber-free structure. The material is capable of constant exposure up to 300° F, short term exposure up to 482° F, and will not ignite at temperatures up to 1120° F.



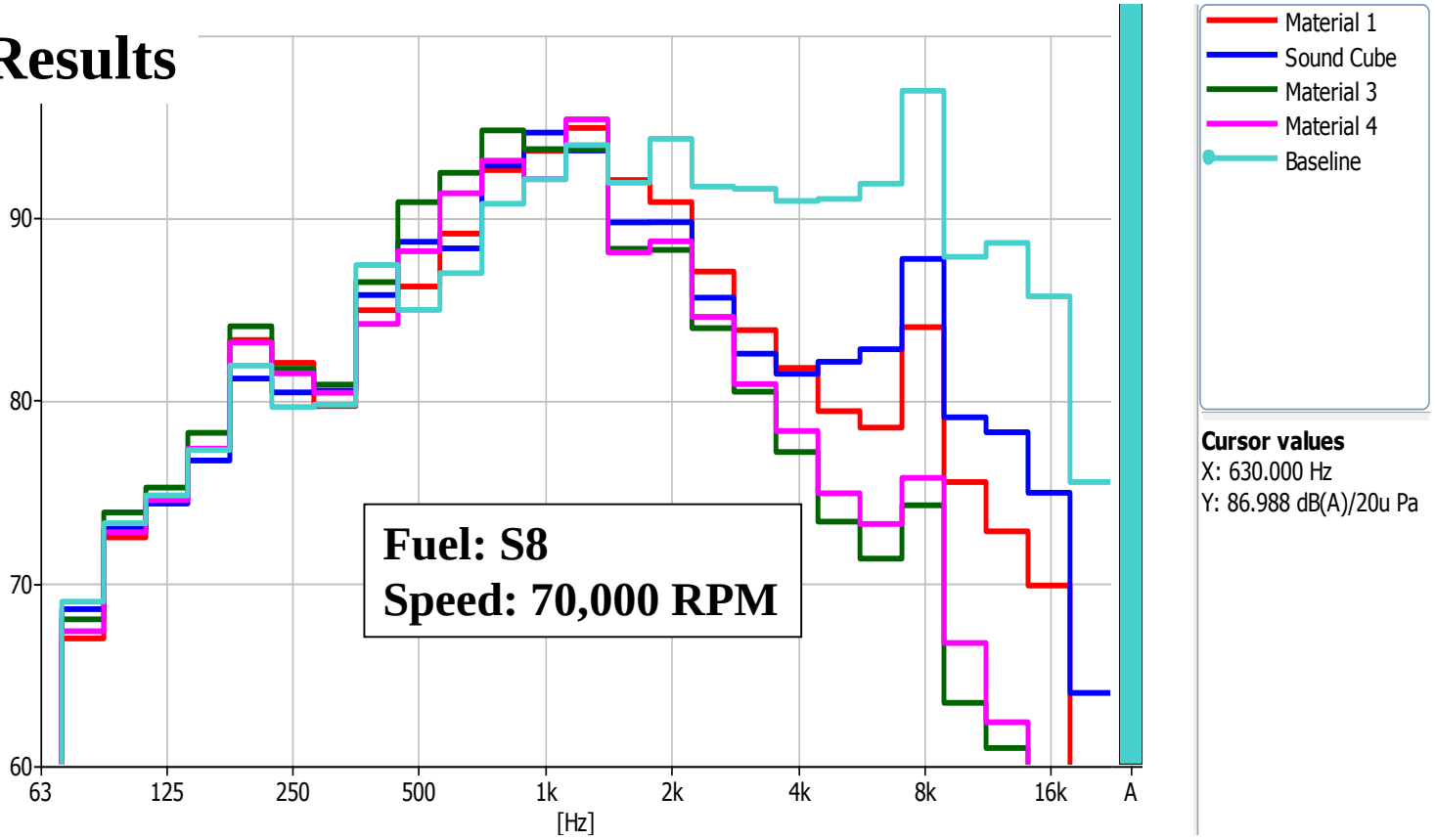
Renewable Energy and Engines Lab



Jet-engine Sound Absorption with Various Insulation

Gas turbine Laboratory

Results



	500 Hz	1 kHz	4 kHz	8 kHz
Material 1	86.3	93.7	81.8	84.0
Sound Cube	88.7	94.7	81.5	78.8
Material 3	90.9	93.8	77.2	74.3
Material 4	88.2	92.1	78.3	75.8
Baseline	85.0	92.1	90.9	97.0

dB(A)

Excitation sources for aerospace gas turbine

Gas turbine Laboratory

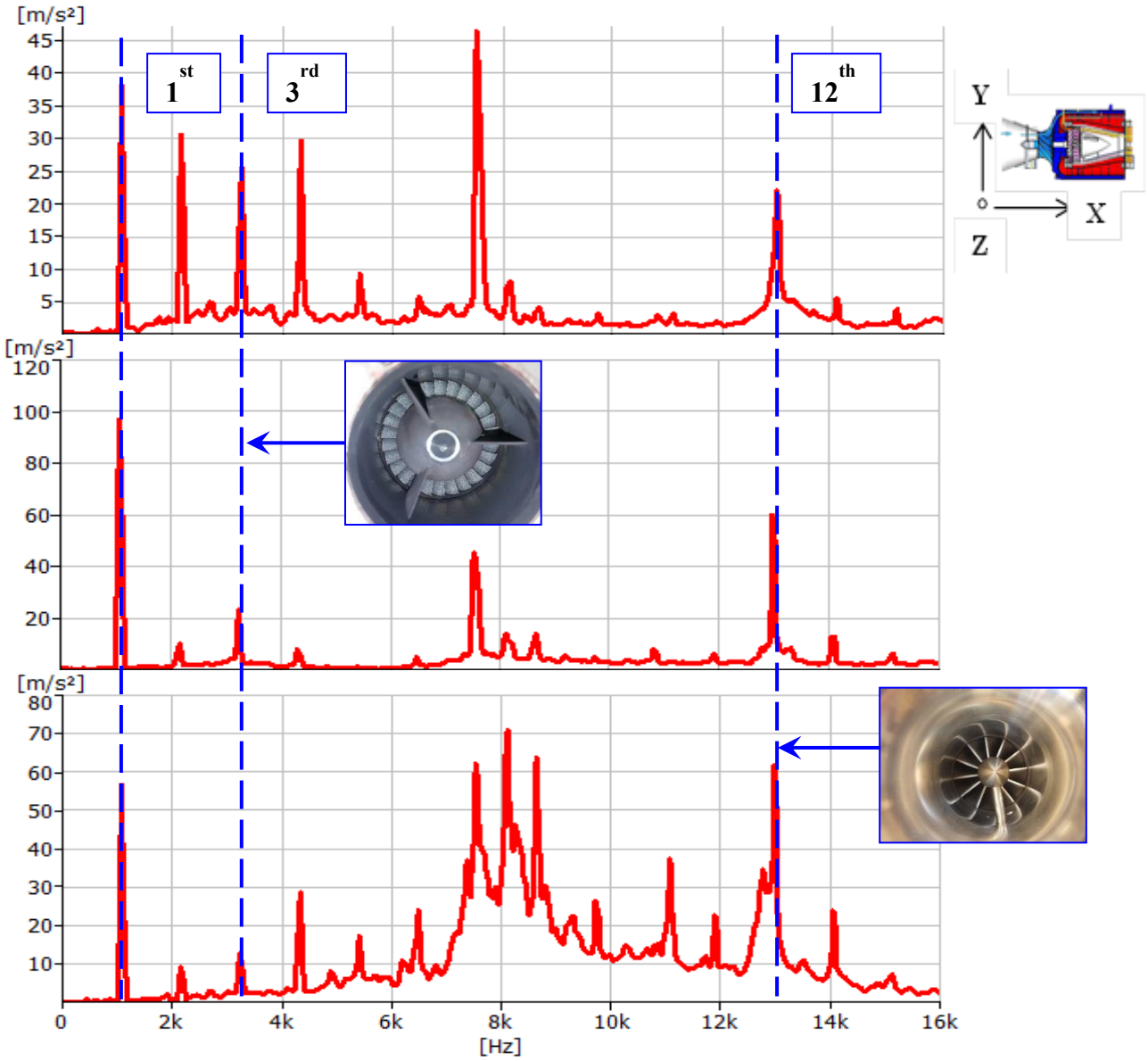
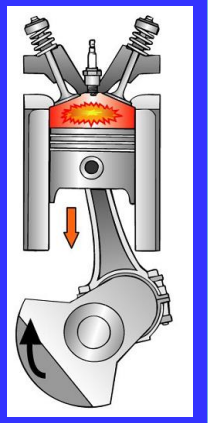
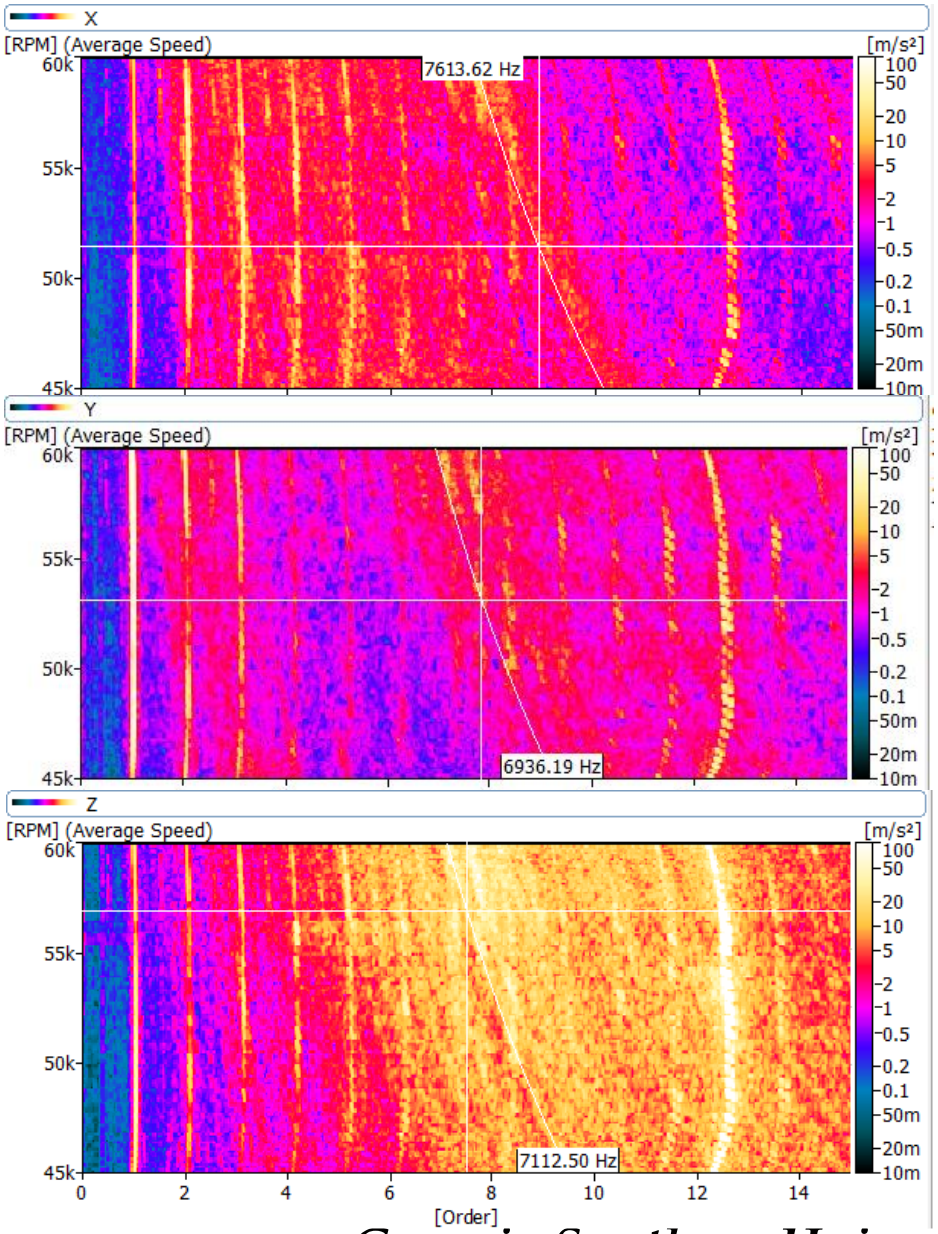


Figure 9 Vibration FFT results with Jet A at 70,000 rpm



Renewable Energy and Engines Lab

Aircraft Turbine Vibration Results



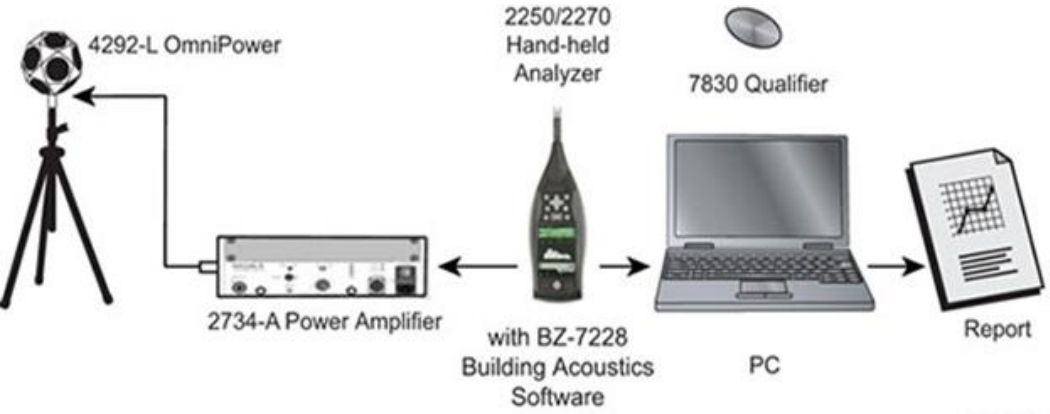
- **Fuel: S-8**
- **Speed: 44-60 KRPM**

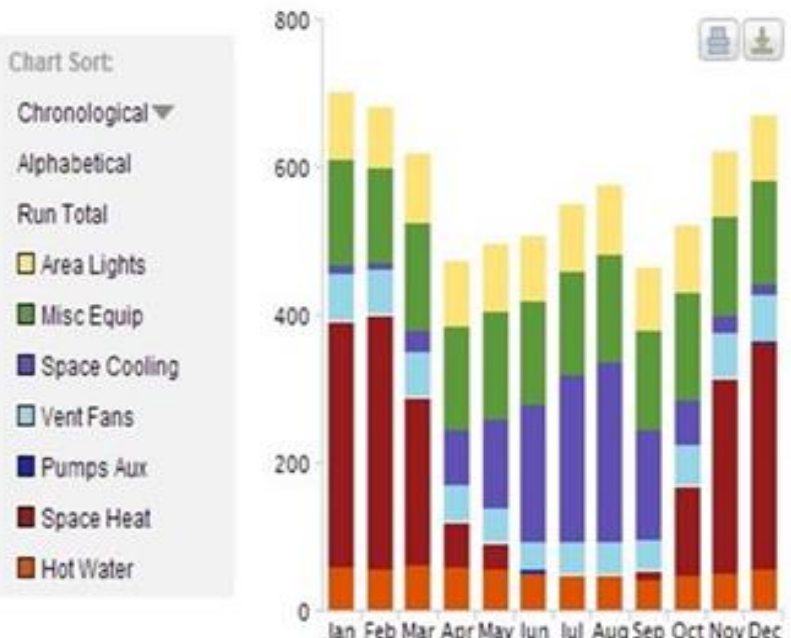
Order Analysis

- **X: Turbine axis**
- **Y: Radial-vertical**
- **Z: Radial-horizontal**

Buildings' energy performance and sustainability study

$200,000 HVAC trainers that simulate in interactive (actual pressure-temperatures regimes) of all the equipment in the building (air conditioning and heat pumps, walls radiation and furnace flames). Autodesk Revit and AutoCad, and DOE eQuest, are used, to design a Capstone project of a building (floor plans) from foundations/floors to the roof (from various materials) -with wall insulation and sidings (with various insulation scenarios), windows designs, doors, occupancy schedule and activity areas allocation, HVAC zones, water and heat consumption, sun radiation is the sky by day, hour, season and latitude/longitude in the country. Building performance simulation, the energy bills based on local rates anywhere in the country, per season/month, type of consumer, (appliances, lighting, hot water, heating-heat pump, furnace- NG/propane/electrical). Indoor emissions evaluation.





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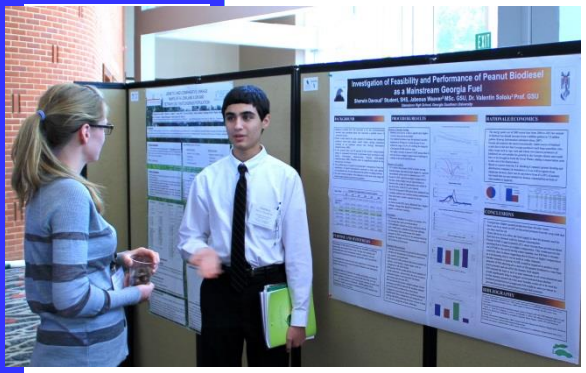
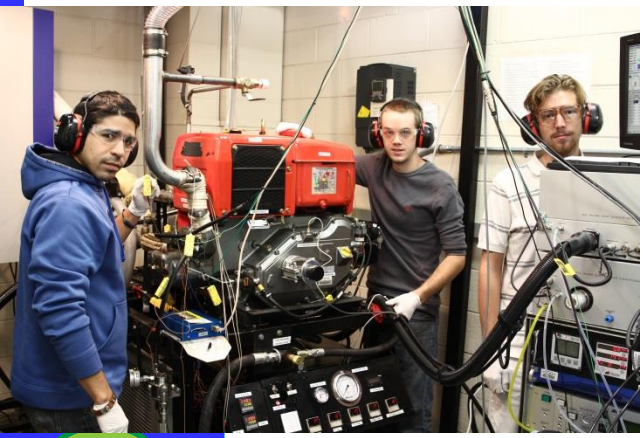


Strength of Students involvement & achievements in technologies

Multidisciplinary research serving multiple industries: renewable energy, automotive OEM, power generation, aerospace, petroleum

Theoretical & Experimental work:

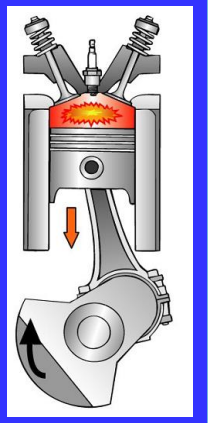
1) design
2) computer simulations
3) manufacturing
4) instrumentation
5) calibration & data acquisition
6) data processing & analysis
7) report, paper writing
8) presentation



- State of the art equipment
- Team work and promotion within the group based on research performance
- Attending company meetings and interactions
- Competiveness and challenges
- Deadlines and technical constrains
- Project management
- Recruitment opportunities

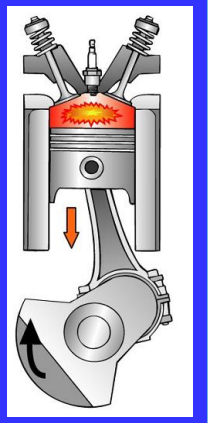
MathCAD
Kaleida Graph
Rockwell Automation
MasterCAM for Solid Works
Solid Works (Replacing Pro-E)
Ansys
Fluent
LS-DYNA
Multisim/Ultiboard
Labview
AutoCAD
Visual Studio
MatLAB/Simulink (a. Fuzzy Logic b. Neural networks c. Control Systems)
MD-Motion
QUARTUS II scheduling software
AVL FIRE, AVL Concerto

Ge *019* **The people**



Engine Combustion & Emissions Labs

We are one of the most visible and featured laboratory by TV and press of the whole Georgia Southern University



Engine Combustion & Emissions Labs

Conclusions

- GSU research has a defined niche market
- With distinct products & Integrated Energy, Automotive, IC Engines, Power & Alternative Fuels and Environmental Program
- Vision, Strategic and Management plan to achieve that
- Team and Leadership

Recent bibliography

1. Valentin Soloiu, R. Gaubert**, J Moncada*, J. Wiley*, J. Williams*, S. Harp, M. Ilie, G. Molina, D. Mothershed*, “Reactivity Controlled Compression Ignition and Low Temperature Combustion of Fischer-Tropsch Fuel Blended with n-Butanol”, *Elsevier Renewable Energy, https://doi.org/10.1016/j.renene.2018.09.047.*

2. Valentin Soloiu, J. Moncada,* R. Gaubert**, A Knowles**, G. Molina, M. Ilie, S. Harp, J Wiley*, “Reactivity Controlled Compression Ignition Combustion and Emissions using n-Butanol and Methyl Oleate”, *Elsevier Energy, Volume 165, Part B, 15 December 2018, Pages 911-924, https://doi.org/10.1016/j.energy.2018.09.181*

3. Valentin Soloiu, J. Moncada*, R. Gaubert**, M. Muiños**, S. Harp**, M. Ilie, A. Zdanowicz**, G. Molina “LTC (low-temperature combustion) analysis of PCCI (premixed charge compression ignition) with n-butanol and cotton seed biodiesel versus combustion and emissions characteristics of their binary mixtures”. – *Elsevier Renewable Energy 123 (2018)323e333,https://doi.org/10.1016/j.renene.2018.02.061*

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8. Soloiu V., Covington* A., “Performance of a Direct Injection Diesel Engine Fueled by a Heavy Oil with the Addition of Low Density Polyethylene (LDPE) Polymer”, *GTP-10-1424, ASME Journal of Engineering for Gas Turbines and Power, Transactions, April 2012, Vol 134/ 044503-1*

9. Soloiu, V., Lewis* J., Covington* A., “Oleic Methyl Ester Investigations in an Indirect Injection Diesel Engine, Combustion investigations”, *SAE Intl J. of Fuels & Lubricants. Vol. 4, Issue 1, pp. 58-75, 2011*

10. Soloiu, V., Duggan*, M., Vlcek, B., “PFI of n-Butanol and Direct Injection of Biodiesel to attain LTC for Low Emissions Idling in a Compression Engine”, *Elsevier Energy Journal, EGY-D-12-01294, 2012*