

# AOE 3054 – Experimental Methods

Syllabus

Pre-req form

LabView

# Basic Information

- William Devenport, 224E Rand., 231-4456, [devenport@vt.edu](mailto:devenport@vt.edu)
- Office hours: Randolph 224E, times TBA.
- Course website: <http://www.aoe.vt.edu/aoe3054/> - used to distribute all course materials and assignments
- Required Texts:
  - *AOE 3054 Course Manual, on the course website*
  - *AOE 3054 Online lectures, on the course website*
  - *LabView Student Edition, software package.*

# Course Objectives

- To give you the opportunity to investigate in REALITY physical phenomena you have only met in principle in other courses.
- To give you some skills you will need as a professional to solve REAL life engineering problems.
- To give you the some skills you will need to take the credit.

# Course Organization

- Classes
  - Live and once per week (usually on Mondays)
  - A few online
- Lab Periods
  - Experiment Labs
  - Instrumentation Labs

# Class Topics

## LIVE

- Introduction
- Experimental Error
- Report Writing
- Analogue Instruments
- Digital Instruments
- Spectral Analysis
- Dynamic Structures Testing
- Wind Tunnel Testing
- Materials Testing

## ONLINE

- Statistical Analysis
- Experimental Error
- Flow Measurement Techniques
- Static Structures Testing

# Next Live Class

- Next Monday (1/22/06)
- On Experimental Error
- Between now and then take the [online lecture](#) on *Statistical Data Analysis*, and read the lab manual section *Basic Concepts in Experiments*

# Course Organization

- Classes
  - Live and once per week (usually on Mondays)
  - A few online
- Lab Periods
  - Experiment Labs
  - Instrumentation Labs

# Experiments

- Flow Visualization
  - Static Response of a Beam
  - Flow Past a Circular Cylinder
  - Laser Doppler Anemometry
  - Fracture Toughness Testing
  - Aero/Hydrodynamic testing
- Once every two weeks.
  - Taught by a graduate TA
  - Groups of 2 or 3
  - You design your own goals.
  - Experiment and preparation.  
recorded in logbook
  - Will be asked to write reports on 3 of these.

# Instrumentation Lab

- Analogue Instrumentation
  - Digital Measurements
  - Spectral Analysis
  - Experimental Application
    - dynamic beam response expt.
  - Programming in LabView
- Once every two weeks.
  - Groups of 2 or 3
  - Taught by Dustin Grissom, Steve Edwards, Mark Montgomery
  - Homework problem sets.
  - Experiment and preparation recorded in logbook

# First Lab Period

- Introductory Lab
- Next week at scheduled time
- Meet your teaching assistant
- Get your experiment schedule (everyone has a different schedule)
- Try out your laptop and wireless in the lab
- Learn about how labs are run
- Get to try out experiments 1-4
- More details to come...

# Schedule

<i>Week</i>	<i>Dates</i>	<i>Laboratories (all except experiment 5 in Randolph 25)</i>	<i>Classes (2:30pm, Smyth 146, provisional list)</i>	<i>Report deadlines</i>
1	1/16-1/19		Wednesday	
2	1/22-1/26	Introductory Lab Period	Monday	
3	1/29-2/2	Experiments 1-4	Monday	
4	2/5-2/9	Instrumentation Lab	Monday	Report 1 due
5	2/12-2/16	Experiments 1-4	Monday	
6	2/19-2/23	Instrumentation Lab	Monday	Report 1 resubmit
7	2/26-3/2	Experiments 1-4	Monday	
8	3/12-3/16	Instrumentation Lab		Report 2 due
9	3/19-3/23	Experiments 1-4	Monday	
10	3/26-3/30	Instrumentation Lab	Monday/Wednesday	Report 2 resubmit
11	4/2-4/6	Experiments 5 and 7		
12	4/9-4/13	Instrumentation Lab		Report 3 due
13	4/16-4/20	Experiments 5 and 7		
14	4/23-4/27		Monday	Report 3 resubmit
15	4/30-5/4		Monday (final exam)	

# Grading...

- 45% - Homework (problem set or experiment logbook, one due every week, usually at lab time)
- 45% - Lab reports (three total, each submitted twice, due at lab time)
- 10% - Final exam.

## ...or Grading...

- 40% - Homework (problem set or experiment logbook, one due every week, usually at lab time)
- 40% - Lab reports (three total, each submitted twice, due at lab time)
- 20% - Final exam

# Some Basic Concepts

- Measurement systems
  - Calibration
  - Accuracy ...
- Dynamic Response

# X-43A Mach 10 SCRAMjet



# AOE Measurement System

Mach 4 test section with fuel injector for SCRAMjet

Amplifiers running pressure transducers to monitor flow through test section

Hot wire anemometer bridge (connected to probe in tunnel) for measuring flow injected flow

Oscilloscope to monitor hot-wire signal



Steve Edwards

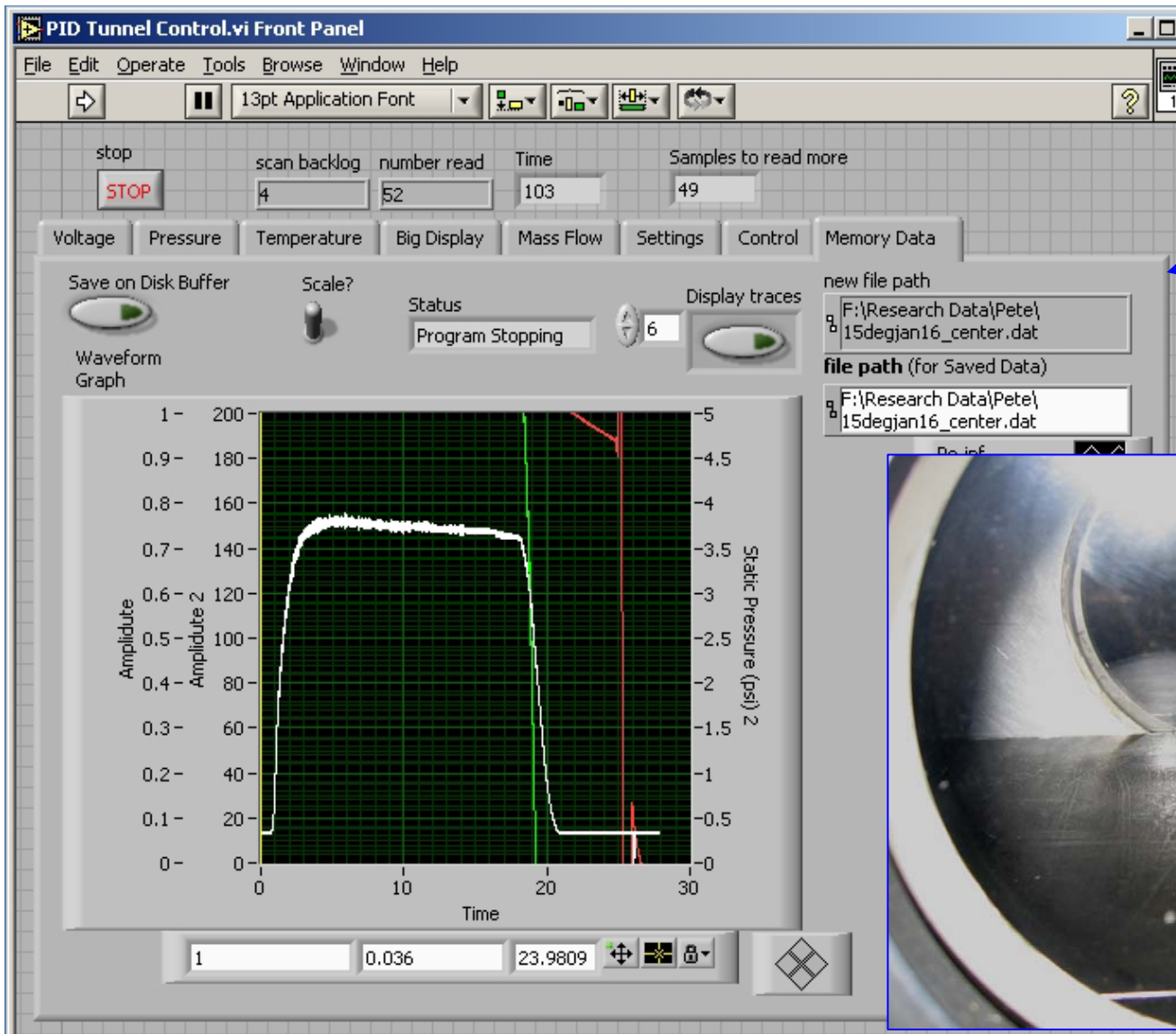
Optical system with digital camera for photographing helium injection

Helium tanks

Not visible:

- Computer data acquisition system
- LabView software code for controlling wind tunnel, getting and processing data
- Probe and injector in test section

# AOE Measurement System



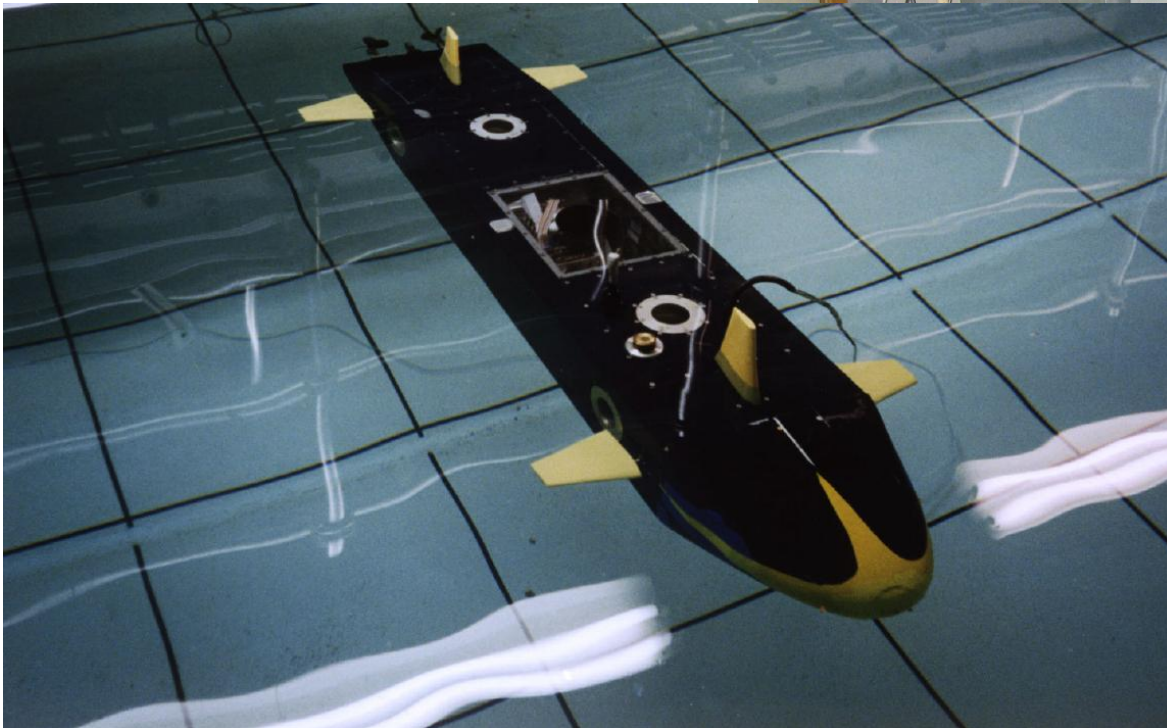
Computer data acquisition and control interface, programmed in LabView

Probe and injector in tunnel.



# AOE Measurement System

Fast AUV Propulsion  
System Test



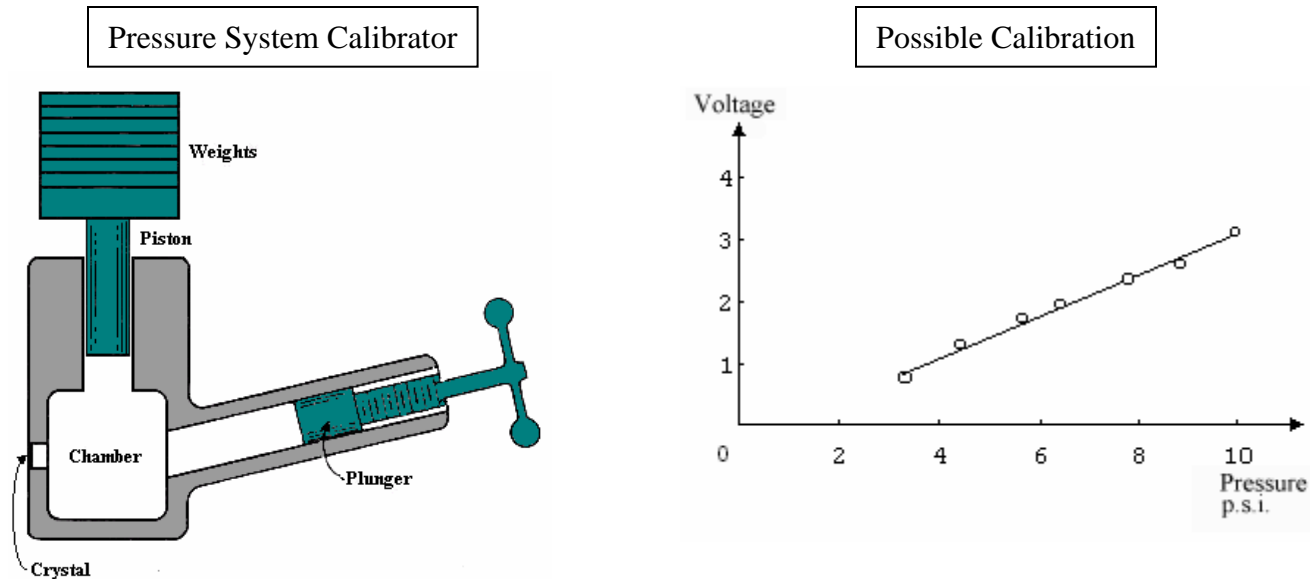
In Randolph 25

# Measurement System Terminology

- **Transducer/Sensor.** *Senses the quantity you want to measure and transforms it (usually) to an electrical signal (usually a voltage)*
- **Analogue Instrumentation.** *Power supplies, signal generators, oscilloscopes, amplifiers and other electrical instrumentation used to set up, operate and monitor sensors and the signals they generate.*
- **Data Acquisition and Control.** *Measurements with a computer, control of an experiment or facility via computer. 'Data acquisition' often abbreviated to DAQ. Measurements accomplished through an...*
- **Analogue to Digital (A/D) Converter** *(also referred to as DAQ Cards, DAQ devices, data acquisition systems, digitizers). Computer device that makes measurements of a voltage signal (say from the sensor), turning into numbers inside the computer.*
- **LabView.** *Most widely used graphical programming environment that engineers use for programming computer based measurement systems*

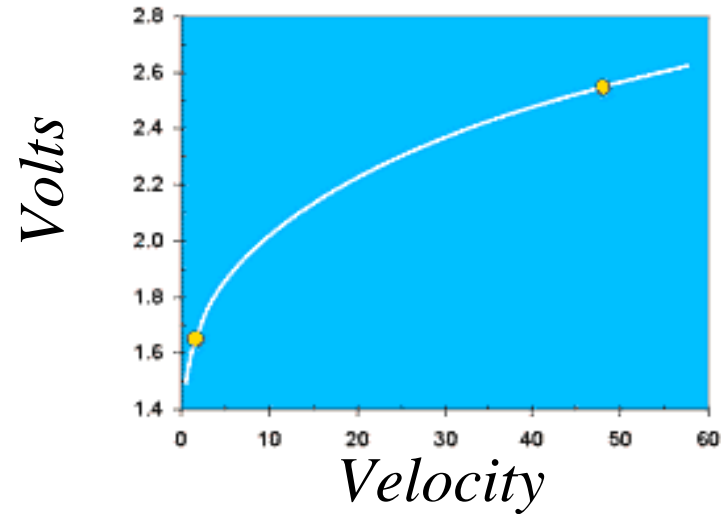
# Calibration

**Definition:** *Relationship between the output of a measurement system and the quantity it senses*

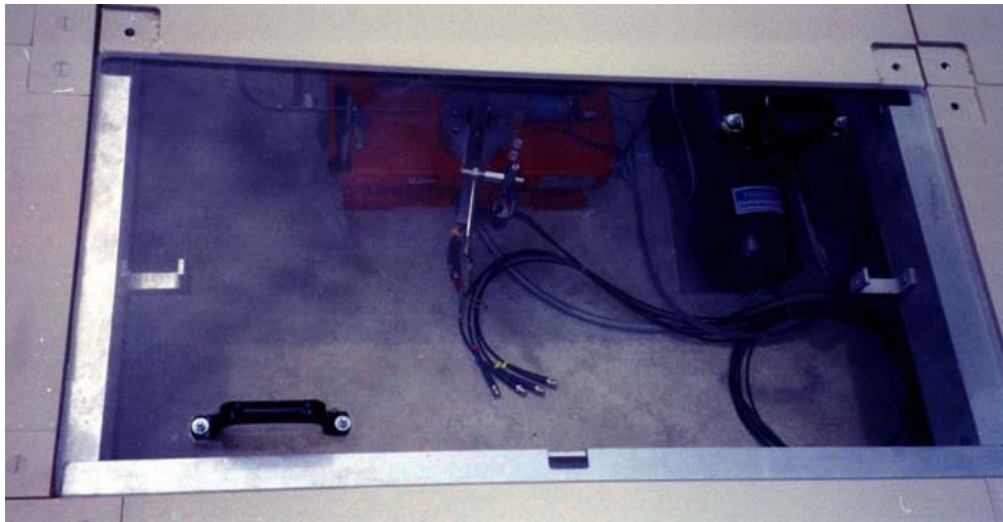


**Tip:** *Never trust a manufacturer's calibration unless you have to - they have a vested interest*

# Hot-wire calibration



West desert of Utah the  
Surface Layer Turbulence and  
Environmental Science Test  
(SLTEST)



# Accuracy...

- Accuracy (same as error):

*Difference between value indicated by measurement system and true value*

- Precision

*Resolution with which a measurement may be made*

- Repeatability

*Difference between multiple measurements of the same quantity*

- Uncertainty

*Estimated error/accuracy (most important concept, to be covered in class 6)*

## *Ideas*

- Accuracy may be improved by calibration, but not beyond the combined error due to precision and repeatability
- High precision does not imply high accuracy
- Uncertainty is the error you don't know about (errors you do know about you would correct for, so they are no longer errors)

# Dynamic Response

**Definition:** *Response of a measurement system to changes in time in the quantity being measured.*

- **Amplitude response =**  
(Amplitude of fluctuations in measurement system output)  

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(Amplitude of fluctuations in quantity being measured)  
*expressed as a function of frequency*
- **Phase response =**  
Time delay between fluctuations in quantity and  
fluctuations in output of measurement system  
*expressed as a function of frequency*

