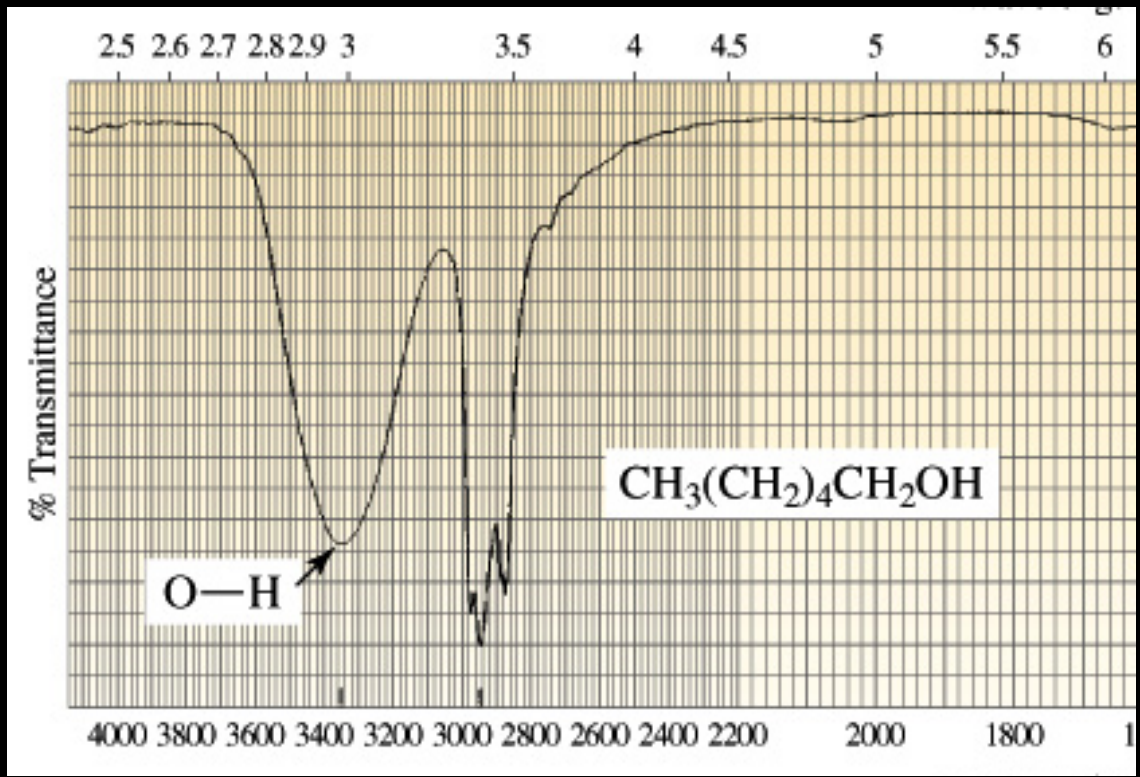
Electronic Tongue Based on Infrared Absorption



CPSC 483: Spring 2005
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Project Background

- Infrared Spectroscopy
- Fourier Transform near-IR Systems
  - Currently used in Chemistry Labs
  - Expensive

Needs Statement

- FTIR spectrometers used in today's chemistry labs cost between $28,000 and $55,000, limiting their wide-spread use.

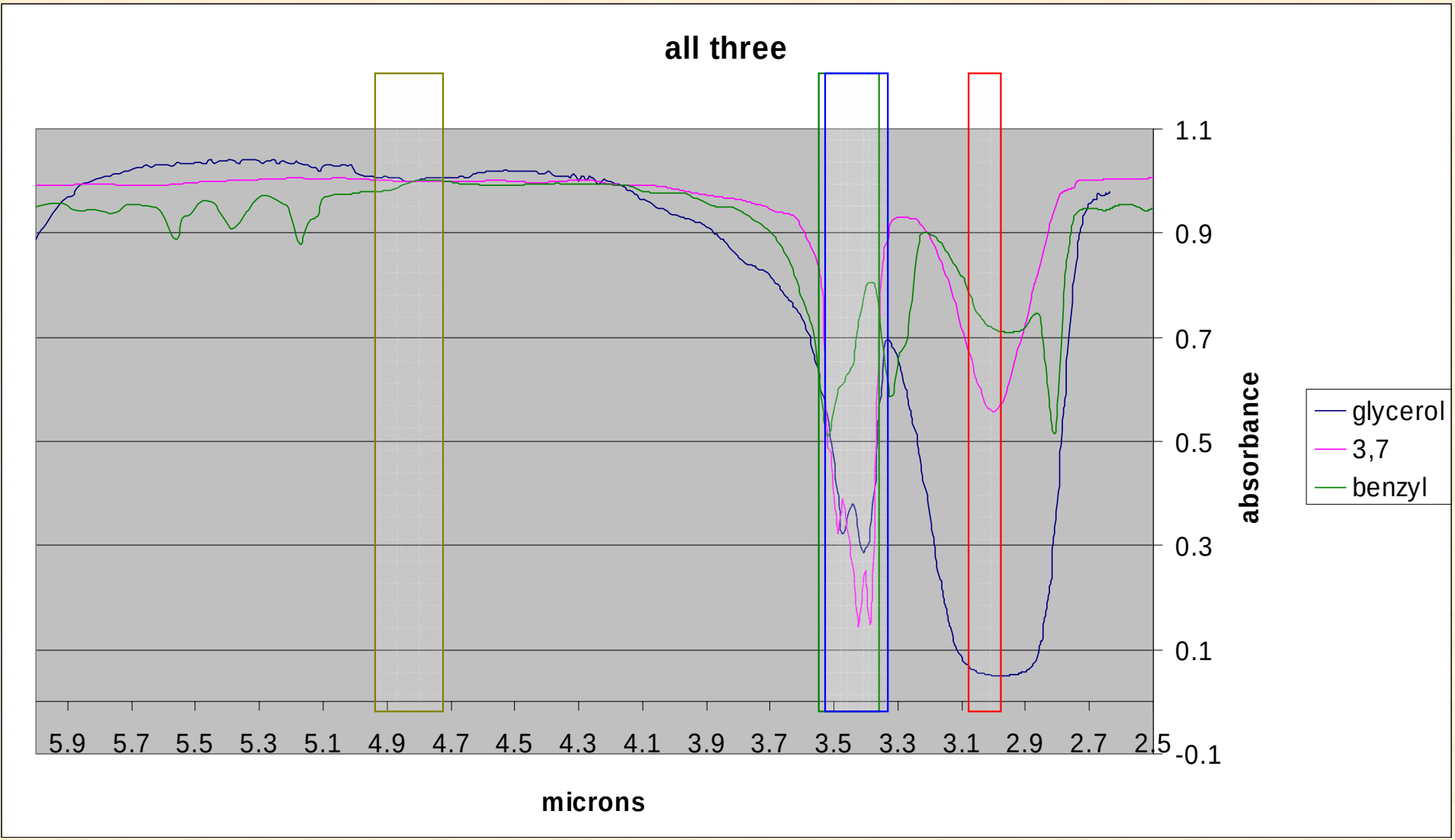
Goals and Objectives

- Goal:
  - Develop a low-cost alternative to modern FTIR spectrometers that can identify common liquids.
- Objectives:
  - Identify common alcohols accurately
  - Design should minimize outside interference
  - Stay within budget ($500)
  - Minimize manufacturing cost
  - Safe and simple
  - Produces a result in an acceptable amount of time

Literature Review

Design

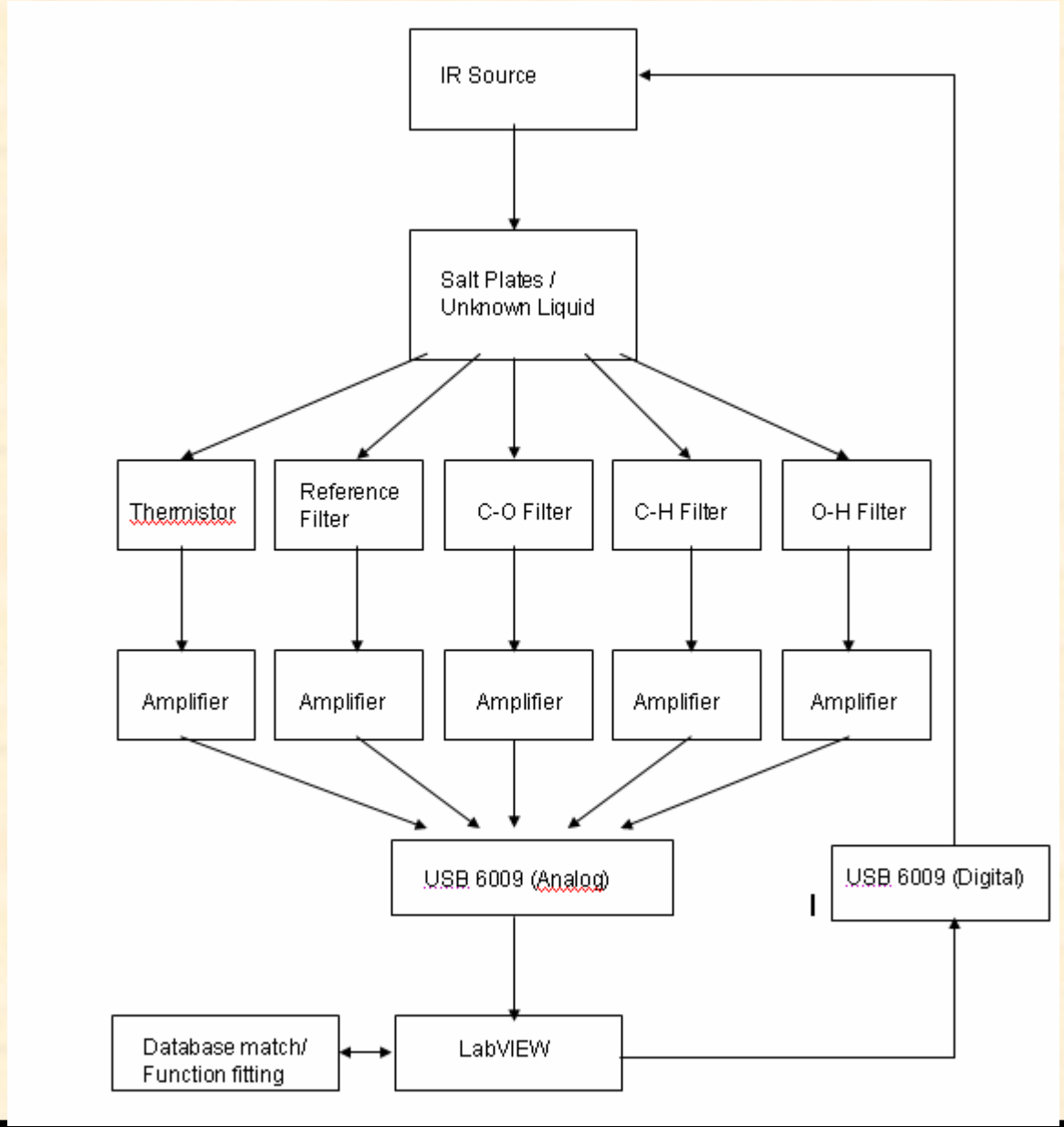
- Hardware
  - Infrared Emitter
  - Salt Plates (AgCl)
  - Thermopile Sensors
    - Filters for functional groups
      - C-H
      - H-O
  - Amplifiers


all three
1.1
0.9
0.7
0.5
0.3
0.1
-0.1
absorbance
5.9
5.7
5.5
5.3
5.1
4.9
4.7
4.5
4.3
4.1
3.9
3.7
3.5
3.3
3.1
2.9
2.7
2.5
microns
glycerol
3,7
benzyl

Design

- Software
  - National Instruments USB DAQ card
  - Database of liquids and functional groups
  - Graphical Interface
    - Graphs and/or list of identified functional groups
    - In LabView these are called Virtual Interfaces (VIs)

System Design

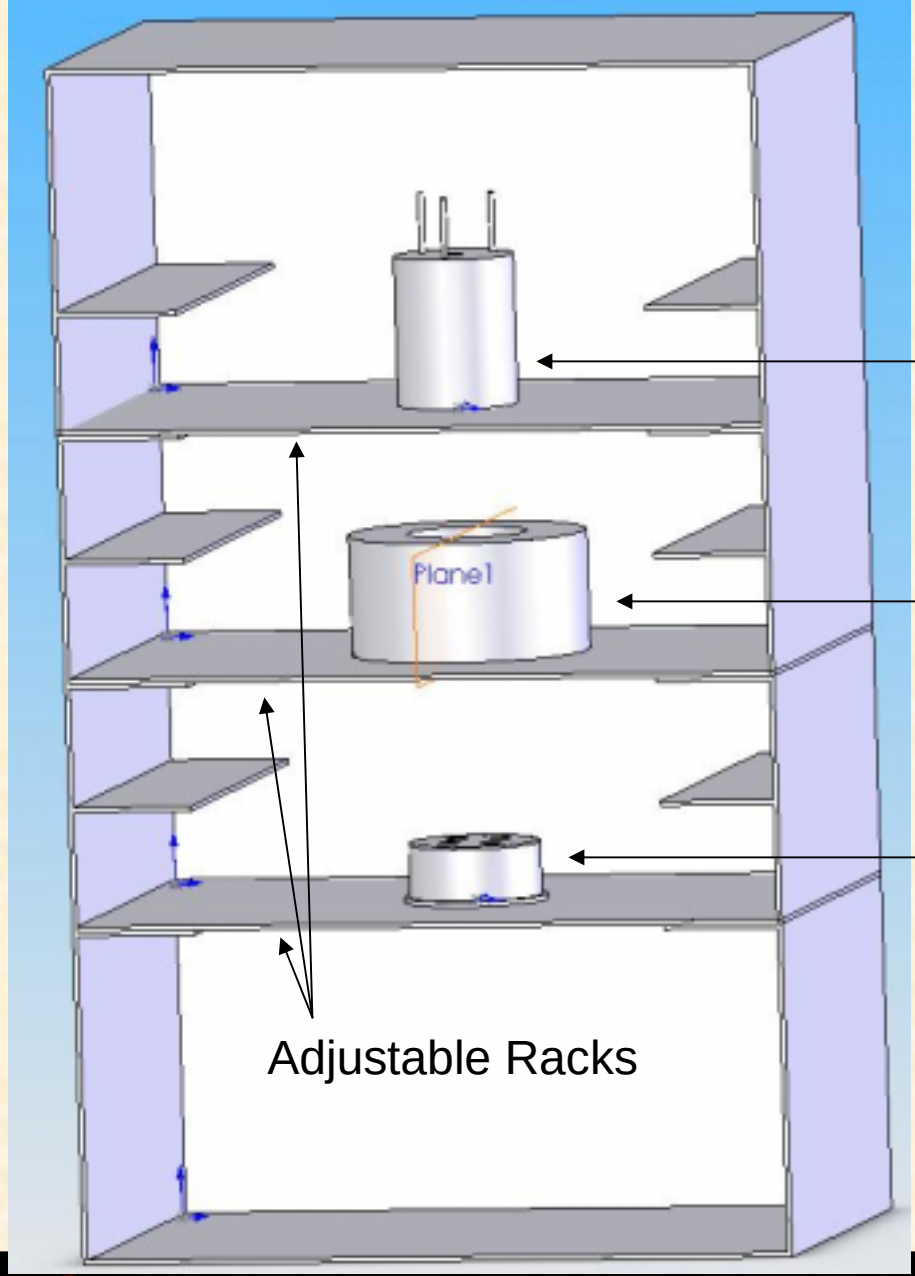


Design constraints and feasibility

- limit our identification to liquids that contain C-H and O-H bonds
- operating temperature of our device (between freezing and boiling of the substances)
- the number of frequencies we can monitor

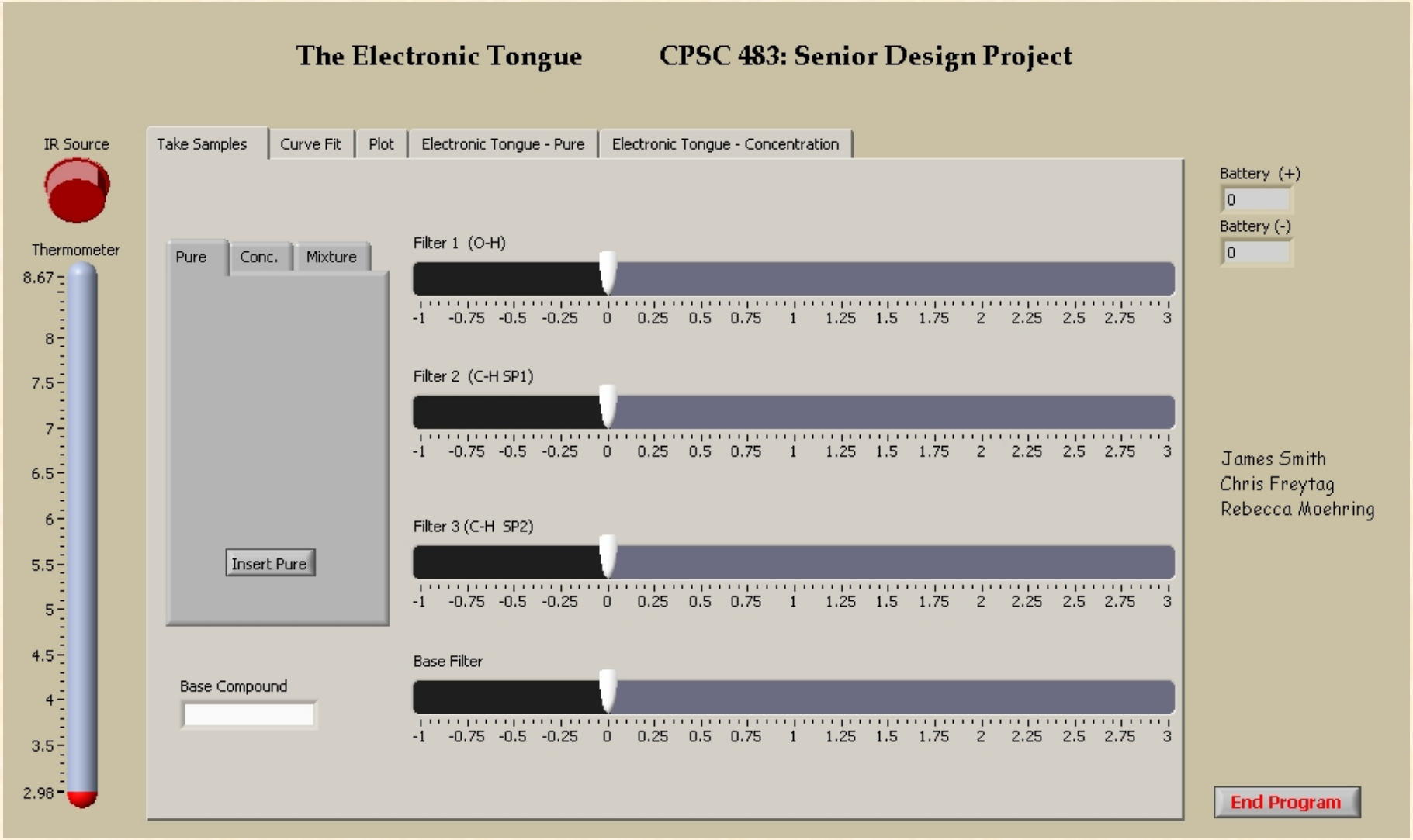
Evaluation of alternative solutions

- **Linear Variable Filter**
- **Rotary/Film strip Filter**
- **NaCl/$BaFl_2$/other Salt Plates**
- **Types of Flow Cells**



System Design

LabVIEW Front Panel



Electronic Tongue Based on IR: Final Presentation

Design Validation

- Provide our product with samples of compounds and verify that it identifies them correctly
  1. Pure Compounds
  2. Varied concentrations of a specific known compound
  3. Mixtures of compounds

Economic Analysis and Budget

- *Economical viability:*
  - Our product is extremely marketable low-cost users
  - Prototype a design for roughly $1000.00
  - Mass produce it for $400.00 per unit.
- *Sustainability:*
  - All of our parts are manufactured by multiple vendors except for the thermopile.
  - Our product will require care and cleaning.
  - Ongoing support and additions to the database
- *Manufacturability:*
  - The thermopile requires a heat sink to stabilize temperature
  - Affected by the amount of water in the ambient air

Economic Analysis and Budget

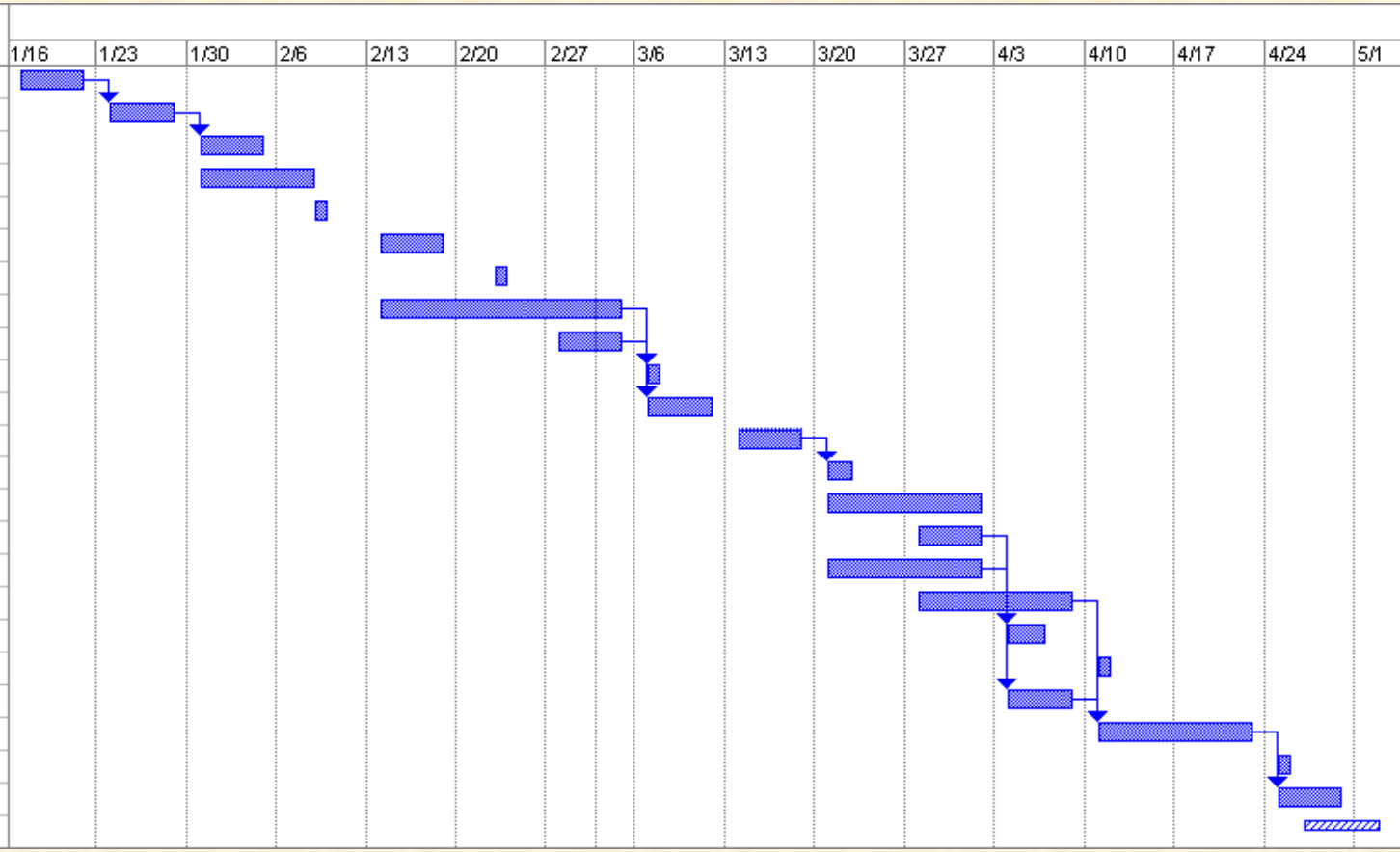
Item	Quantity	Amount ($)
Infrared Source	1	$90.00
4 Channel Thermopile	1	($155 – 30%) $110.00
Filters F3000 – 3 micron FHC1 - 3.43 micron FREF – 4.862 micron - 9.6 micron	4	$120.00
Silver Chloride Plate Kit	1	$142.00
Compound samples (rubbing alcohol, hexanol, glycerin, antifreeze, 1-propanol, water)	5	$50.00
Aluminium box Machined by Chemistry Department	1	$21.00 / hour
USB Data Acquisition Card	1	$220.00
Total (does not include USB card)		**$533.00**

Project Management and Team Work

- Chris Freytag
  - exposure to infrared sources
  - prior project in lasers
- Rebecca Moehring
  - National Instrument's LabView software
  - Database
- James Smith
  - system design and hardware
  - Aluminum box

Schedule of Tasks

ID	Task Name
1	Form teams
2	Understand project requirements
3	Research project
4	Prepare project proposal
5	Proposal
6	Order supplies
7	Bi weekly report due
8	Determine and purchase compounds
9	Prepare critical design review
10	Critical design review
11	Learn LabView
12	Spring Break
13	Design/Test Amplification Circuit
14	Design GUI in LabView
15	Test DataLogging (LabView)
16	Build Design Frame
17	Assemble Complete Design
18	Learn Output from Thermopile
19	Bi Weekly Report
20	Build Database
21	Catalog Experimental Readings
22	Bi Weekly Report
23	Finalize Project
24	Prepare Final Presentation and Report



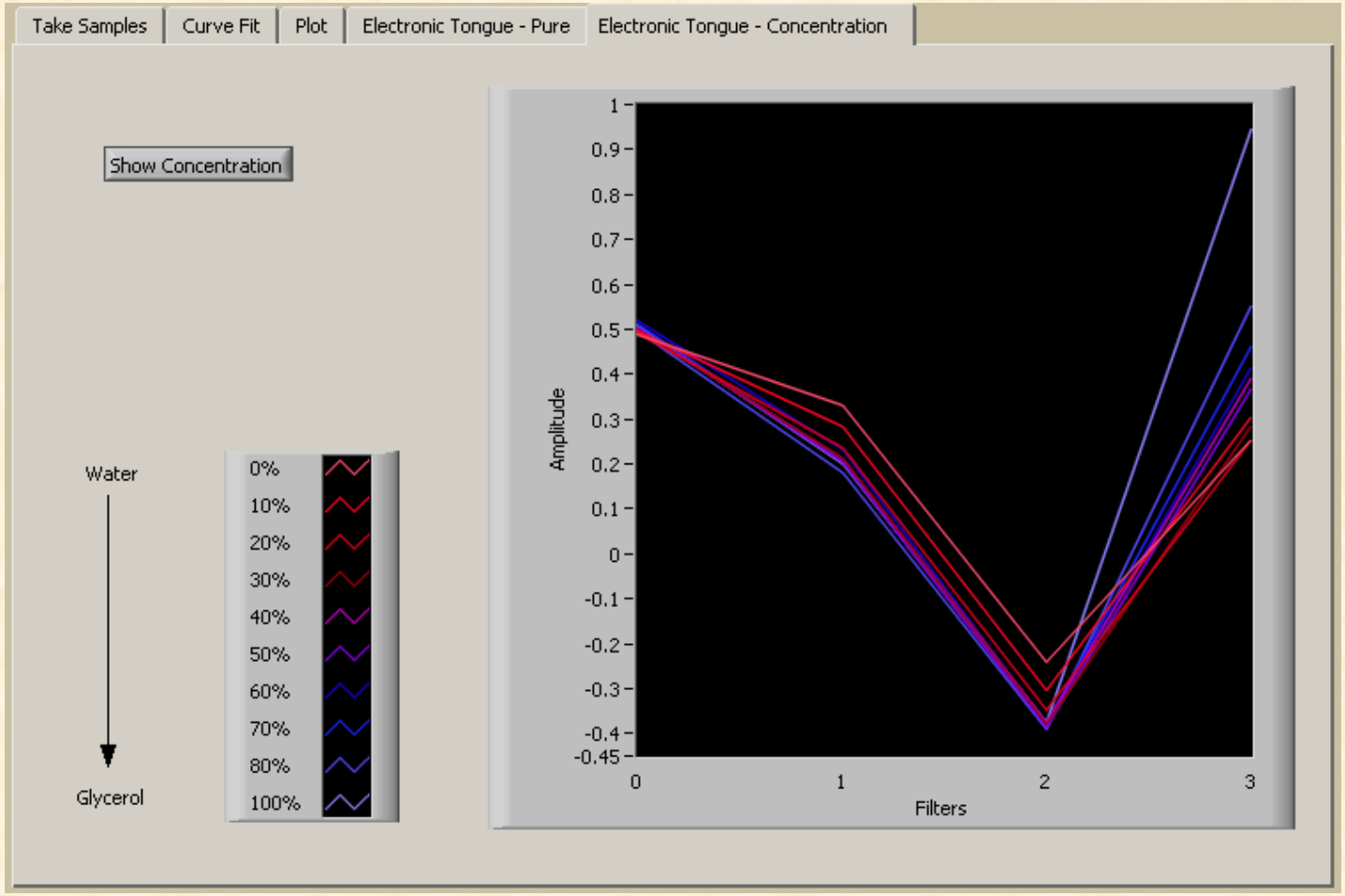
Societal Impact

- Pollution Monitoring
- Agriculture: determining compounds in soils, plant material, fertilizers and foodstuffs
- F in drinking water and other drinks
- Explosives: F, Cl, NO3 in explosive materials and combustion products
- Biomedical Laboratories: Ca, K, Cl in body fluids (blood, plasma, serum, sweat)

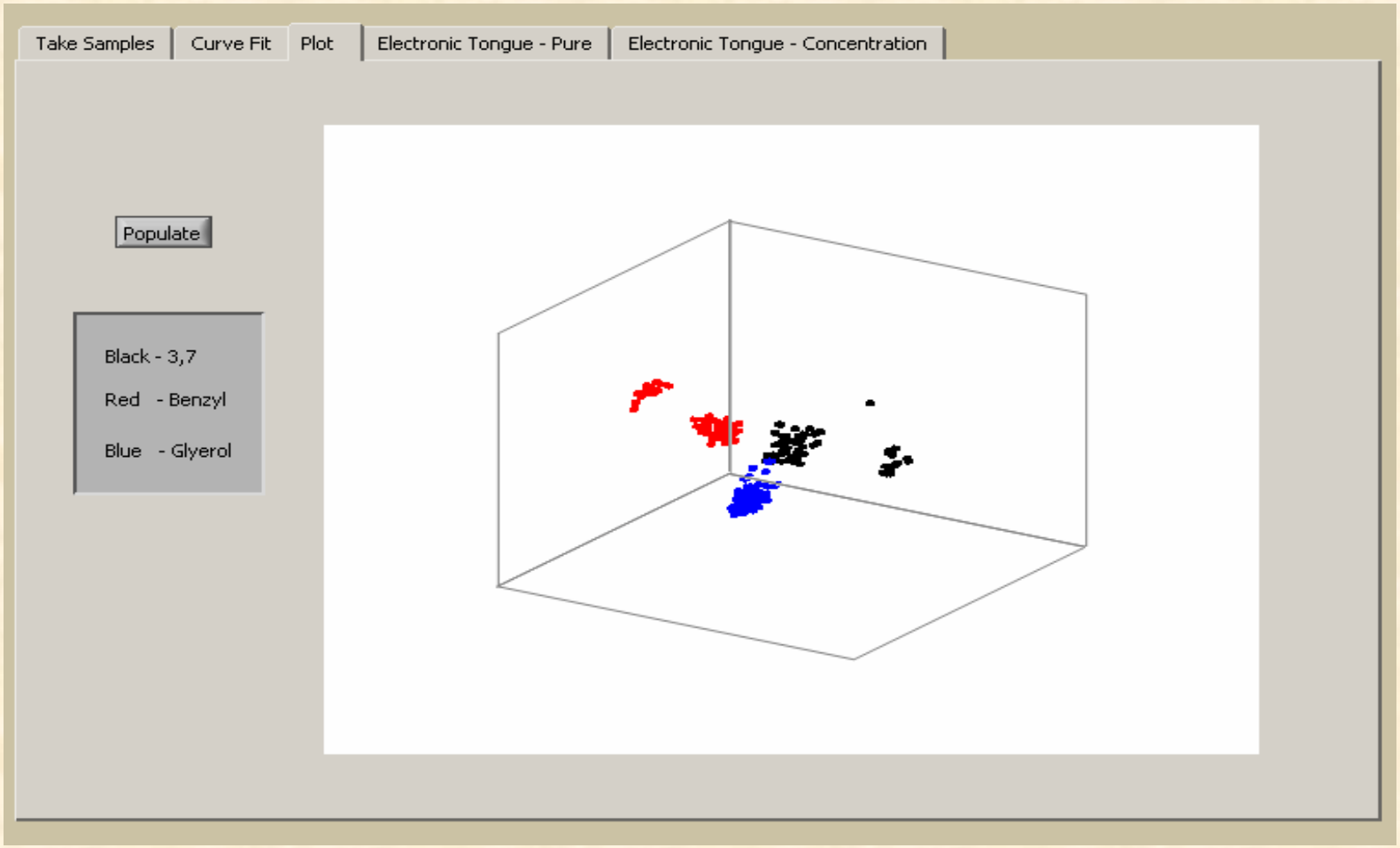
Safety and Environmental

- Environmental problems:
  - electrically-energized equipment
  - excessive noise from the IR itself
- Temperature of the infrared source
- The compounds themselves
  - hazardous fumes, gases, and vapors

Results


Take Samples
Curve Fit
Plot
Electronic Tongue - Pure
Electronic Tongue - Concentration
Show Concentration
Water
Glycerol
0%
10%
20%
30%
40%
50%
60%
70%
80%
100%
Amplitude
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
-0.1
-0.2
-0.3
-0.4
-0.45
0
1
2
3
Filters

Results


Take Samples
Curve Fit
Plot
Electronic Tongue - Pure
Electronic Tongue - Concentration
Populate
Black - 3,7
Red - Benzyl
Blue - Glyerol

Demonstration

Question and Answer