



IPRO

308

Developing the
Artificial Pancreas

IPRO DAY
PRESENTATION
05/02/08



DIABETES

Insulin:

- Regulates glucose absorption into tissues for metabolic needs

- Type 1: Deficient Insulin Production
 - Type 2: Insulin Resistance

I PRO 308

- Closed Loop
- Non-invasive
- Extraction, Measurement and administration



TEAM ORGANIZATION

Team Leader
Rohan Mathews, EE

Secretary
Kyle Laster, MBB

Research Subgroup
Shezami Khalil, BioChem

Closed-Loop Technology Subgroup
Bill Wakeman, ME

Measurement Subgroup
Walatta Mesquitta, MBB

Kyle Laster,
MBB

Walatta
Mesquitta,
MBB

Joon Park,
ME

Rohan
Mathews,
EE

Mike Tishler,
ME

Anju
Saseendran,
EE

Zak Estrada,
CpE

Richard
Hanley, CpE



TEAM ORGANIZATION

- Followed Project Plan
- Weekly team meetings
 - Reviews
 - Corrections
- Laboratory sessions
 - Monday afternoon : Measurement
 - Tuesday morning : Closed-Loop
- IPRO office to order supplies



RESEARCH

- Patent Search
- Research for other sub-committees
- **Deliverables:** Project Plan, Mid-Term Report, Code of Ethics, Poster and Abstract
- **Grant Proposal to NCIIA in lieu of Final Report** (National Collegiate Innovators and Inventors Alliance)²
- Animal Protocol





RESEARCH

Animal Protocol:

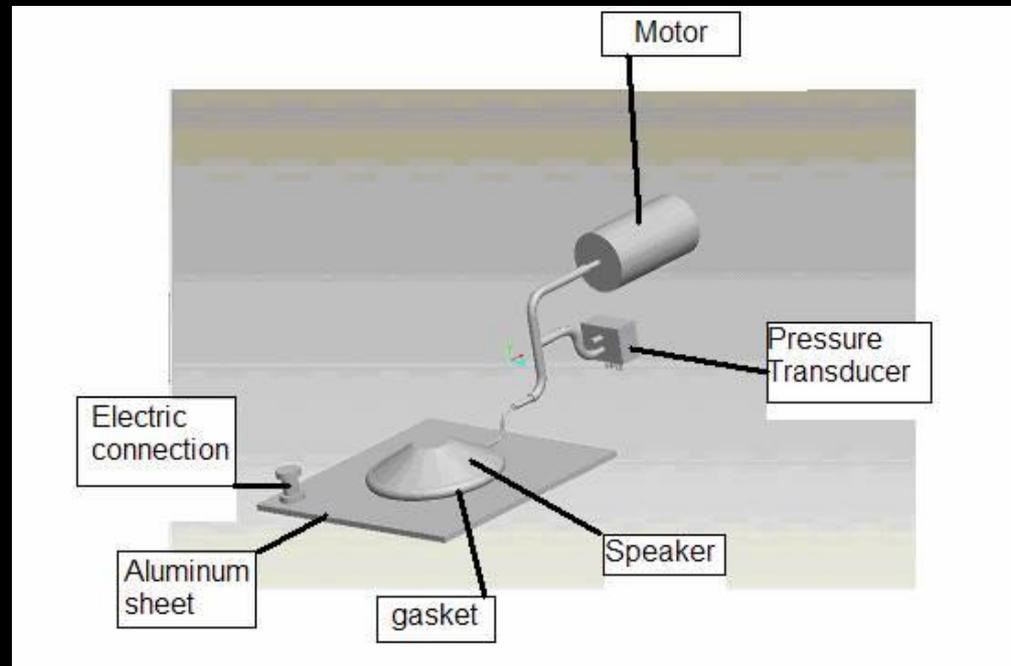
- Authorization of using live rats
- Objective of using rats
- Handling, storage and disposal of rats
- Justification of usage: anesthesia, vacuum, iontophoresis, sonophoresis



CLOSED-LOOP TECHNOLOGY

Our Old Prototype

Construction



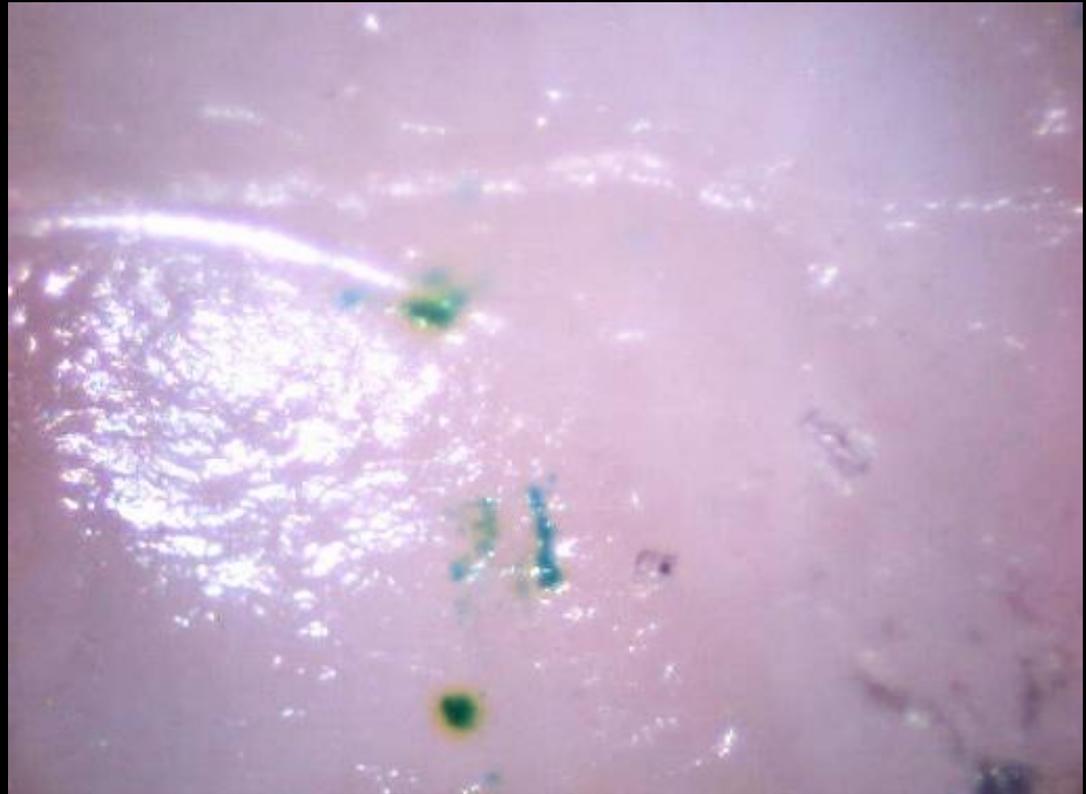
Vacuum, Sonophoresis, Iontophoresis



CLOSED-LOOP TECHNOLOGY

Testing Results

- Fluid Extraction
- Pore Enlargement
- Pore Coloration





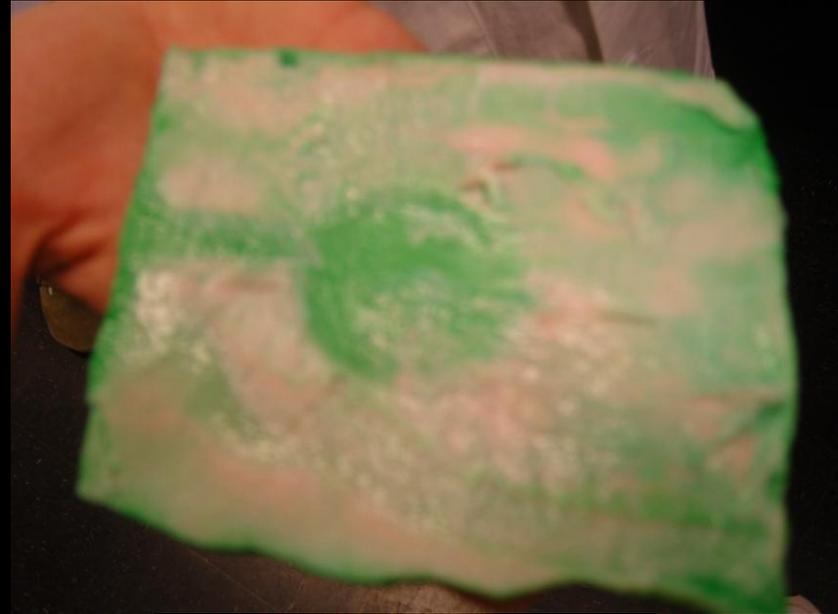
CLOSED-LOOP TECHNOLOGY

Obstacles

- Limitations with Skin

Old Prototype Limitations

- Paper Cone Speaker
- Ultra-Sound through a Vacuum

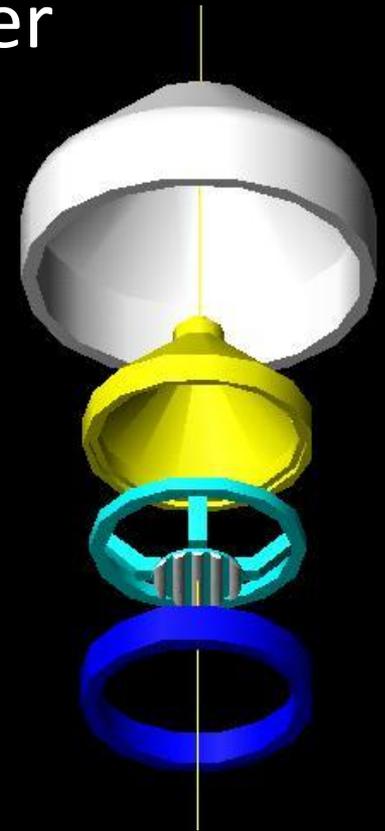
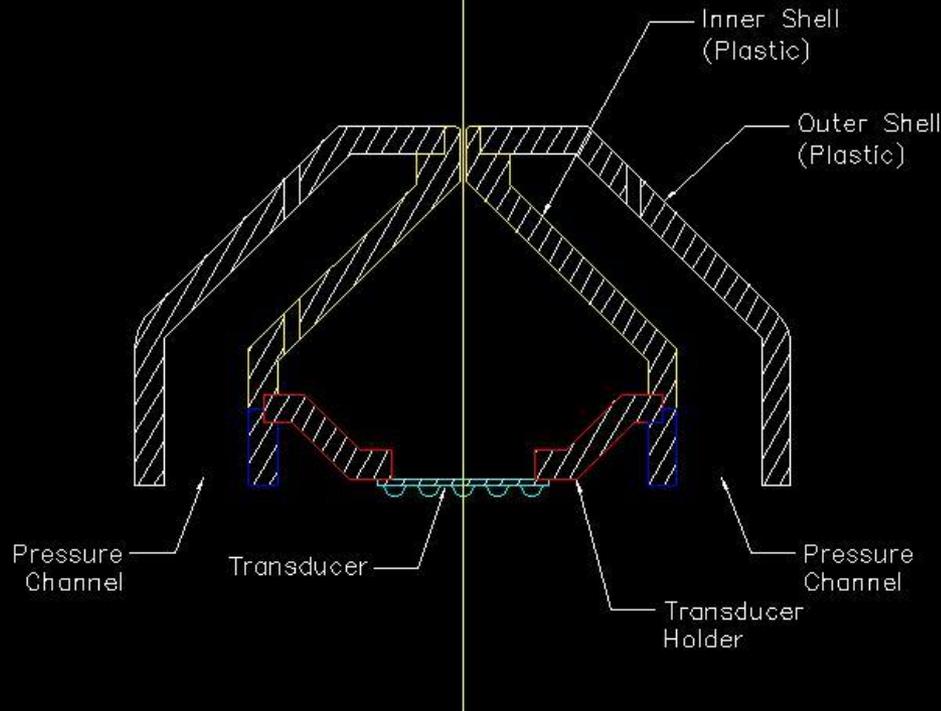




CLOSED-LOOP TECHNOLOGY

Redesign

- Transducer versus Cone Speaker



- Intimate Contact with the Skin



MEASUREMENT

- **Main goal of this subgroup was to obtain a signal that can be used by a microcomputer.**
- **This signal must be able to communicate the glucose concentration of interstitial fluid.**



MEASUREMENT

The Past

- Previous IPRO's have had many ideas for measuring concentration.
- Unfortunately all but one of the previous IPROs ran into obstacles in finding a consistent correlation with glucose concentration
- Use of Nuclear Magnetic Resonance had a great deal of potential in finding a correlation with respect to glucose concentration
- So what was the problem?



MEASUREMENT

The Problem





MEASUREMENT

The Present - Two strategies

AC Impedance

- A capacitor made from printed circuit board was created
- Interstitial fluid was used as a di-electric
- The resulting phase shift caused by the capacitor was then measured

Oxidation Reaction

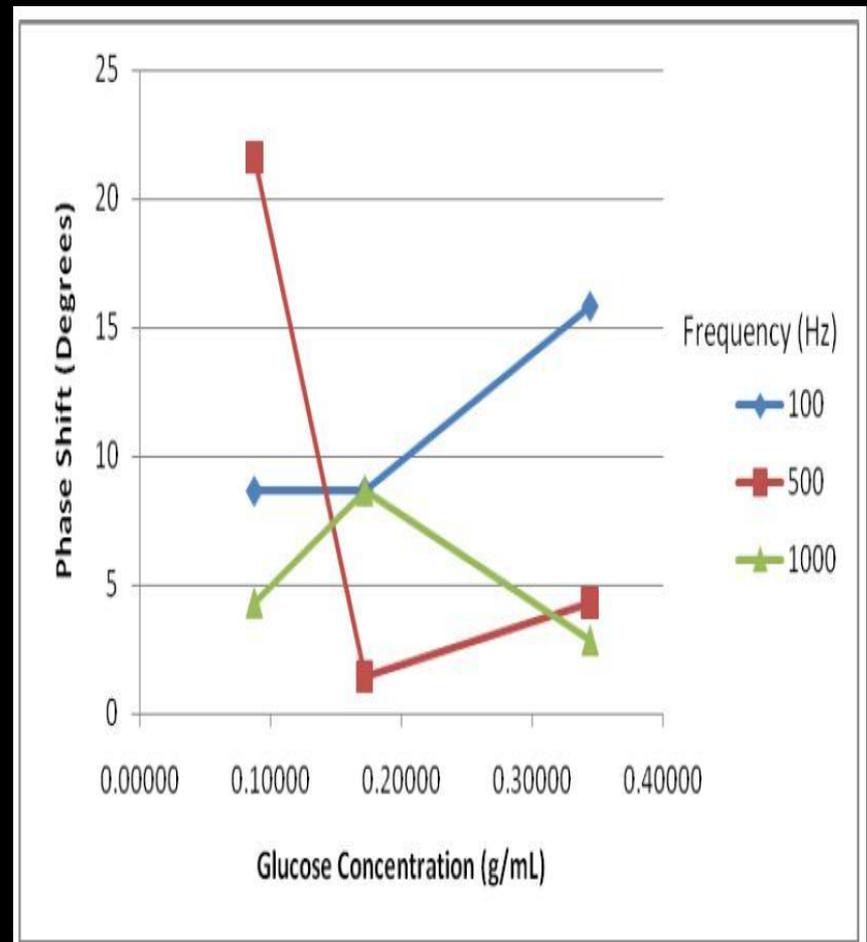
- By taking a glucose solution and oxidizing it, a certain amount of free electrons would be created
- The resulting voltage spike would then be measured



MEASUREMENT

AC Impedance Measuring

- Testing was done by creating a glucose solution of known concentration and submerging the homemade capacitor.
- What were the problems?

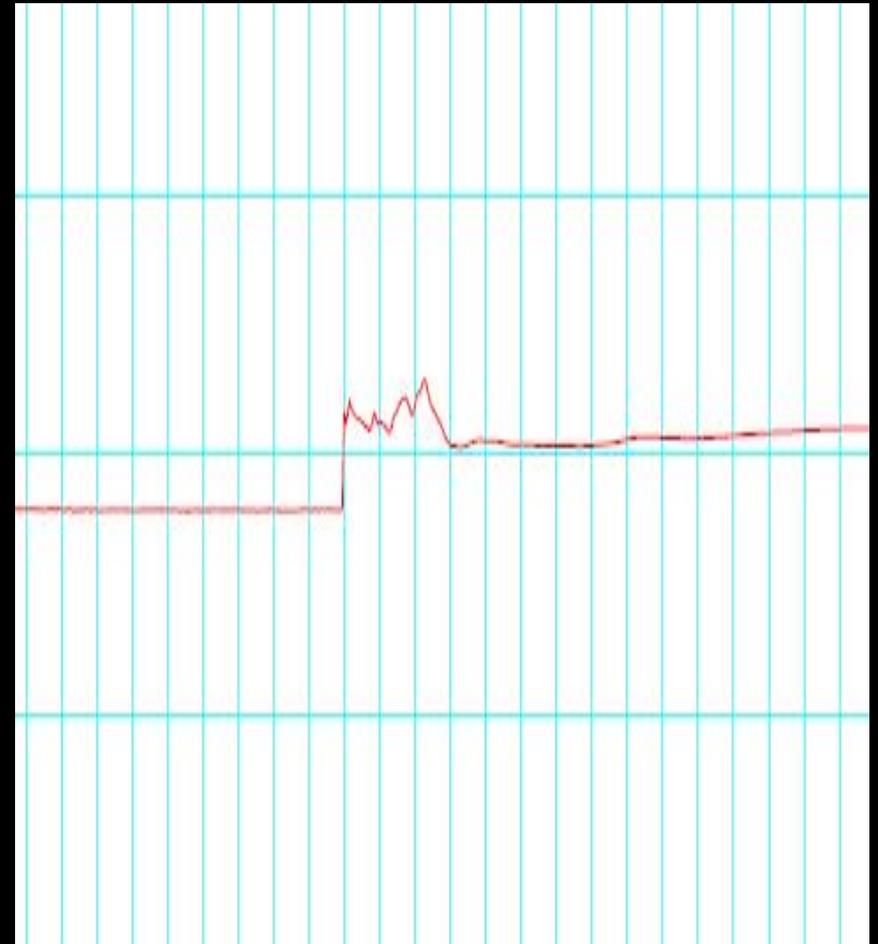




MEASUREMENT

Oxidation

- By taking a known concentration of glucose and mixing it with a known concentration of glucose oxidase a voltage spike was measured
- There were problems





MEASUREMENT

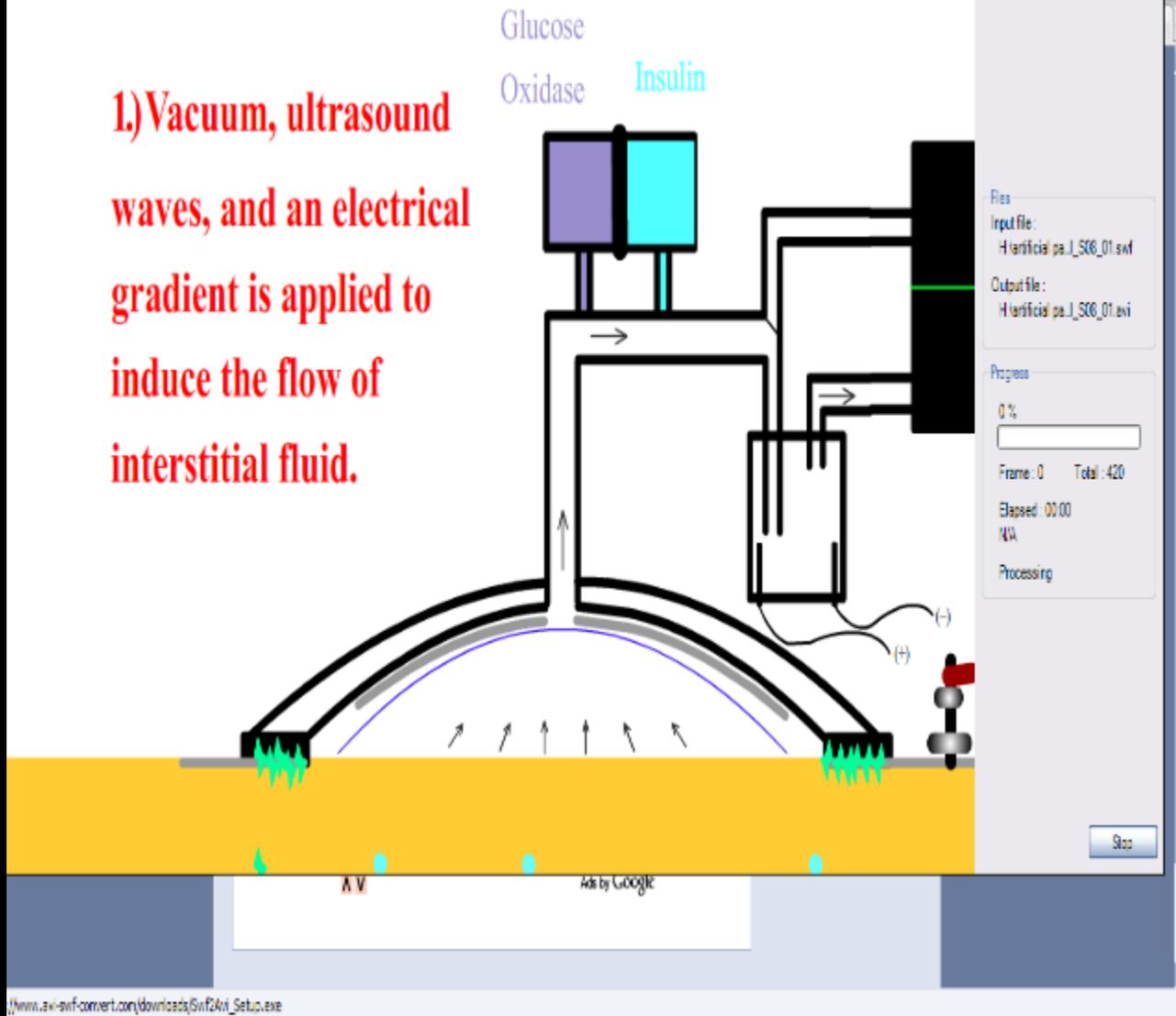
The Future

- Glucose Oxidation seem to be the most viable measurement option.
- However, injection of reactants must be standardized.
- Ideas include building a test chamber with fixed electrodes and a pump for a constant rate of reaction



THE PROCESS

1.) Vacuum, ultrasound waves, and an electrical gradient is applied to induce the flow of interstitial fluid.





Current Technology

- Testing around 6 times a day
- Multiple insulin shots
- Pump does not offer anything more than you can already do with insulin shots
- No product that measures blood sugar levels and administers insulin



What this means to Diabetics

- Less testing
- Better blood sugar control
- Lower A1C (5-7)
- Easy to use for all age groups
- Less costly than an insulin pump



Commercialization

- 21 million Americans are currently battling diabetes, and 54 million adults and children in the U.S. are on the verge of being diagnosed with diabetes*
- Fastest growing disease in the country*
- Diabetes is the fifth leading cause of death by disease in the U.S. *
- One out of three Americans, and one in two minorities, will develop diabetes in their lifetime*
- The United States spend approximately 132 billion on diabetes-related issues per year. Diabetes alone represents 11% of the U.S. health care expenditure*

*American Diabetes Association



SPECIAL THANKS TO

-Dr Dhar

-Dr Derwent

-Dr Gottlieb

-Mr Nik Rokop

-Dr Louis H. Philipson

-Mr Ferguson

-Mr Jacobius

-Mr DeBoth

-Dr Opara

Thank you!



QUESTIONS?