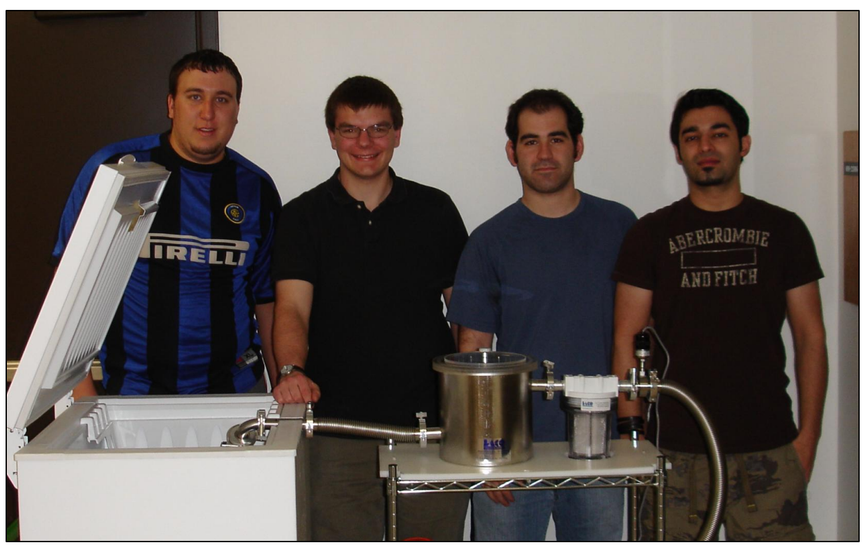
P08405—Environmental Test Chamber for the Creation of Aerogels

Customer Needs

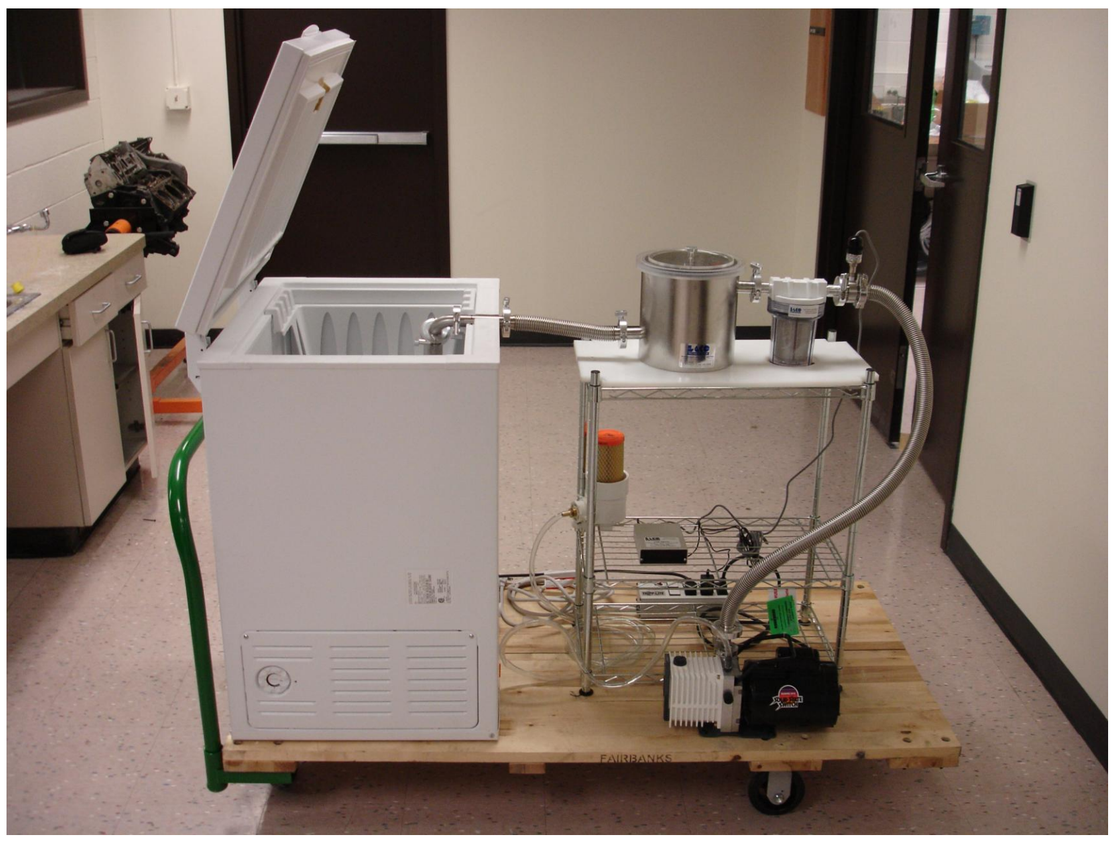
- Chamber supports a constant vacuum
- Cooling system is able to maintain sub-zero temperatures
- Chamber can withstand large temperature variation
- Vacuum system is corrosion resistant
- Temperature monitoring for chamber and cooling system
- Pressure monitoring for chamber
- System is mobile
- Specimens can be separated within chamber
- Cooling system is sustainable
- Budget constraint is satisfied
- Pump can be adapted to support a second chamber
- System will be powered by 120V



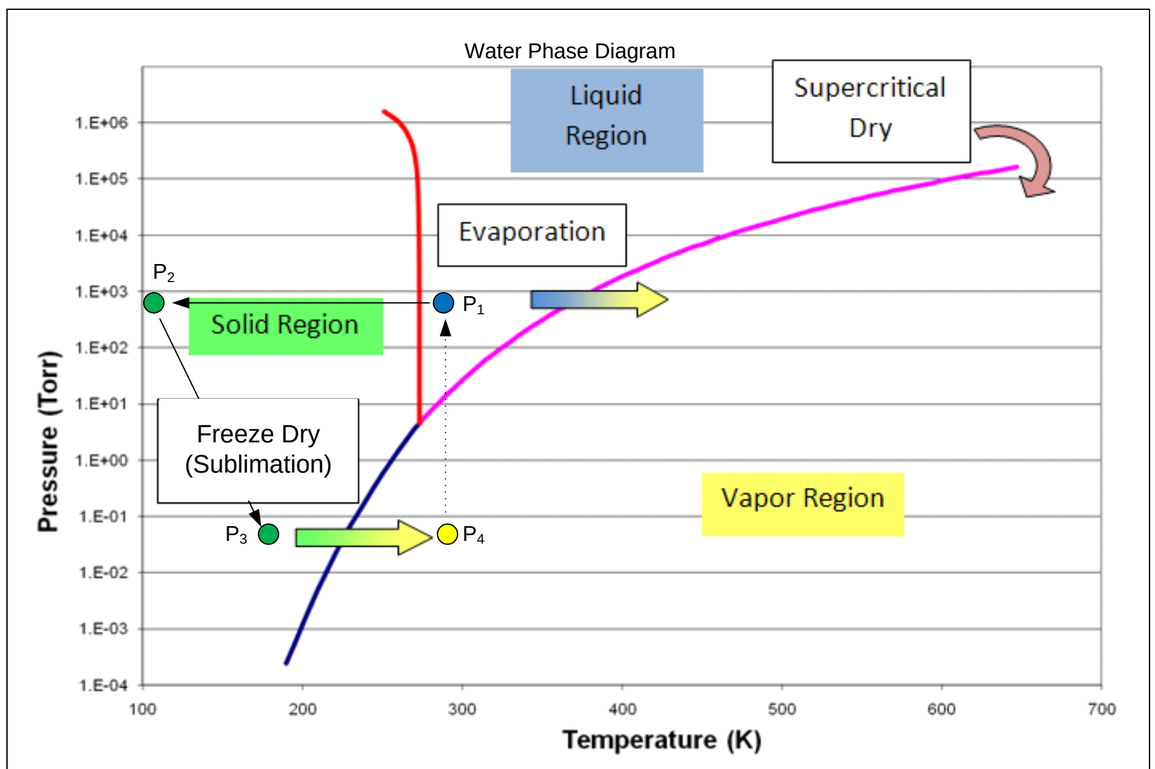
Left to Right: Matt Wavrek (ME), Forrest Svingala (ME), Rich Arlotta (ME), Kushal Kapoor (EE)

What is an Aerogel?

- An aerogel is a novel material in which the liquid phase of a liquid-solid gel is replaced with a gas. This replacement occurs without allowing the solid portion of the gel to shrink or collapse, leaving a low-density solid consisting of up to 90% porosity.
- Aerogels show great promise for:
  - Extremely low weight insulation
  - Lightweight Composites
  - Biodegradable replacement for expanded polystyrene



Creation of an Aerogel Through Freeze Drying

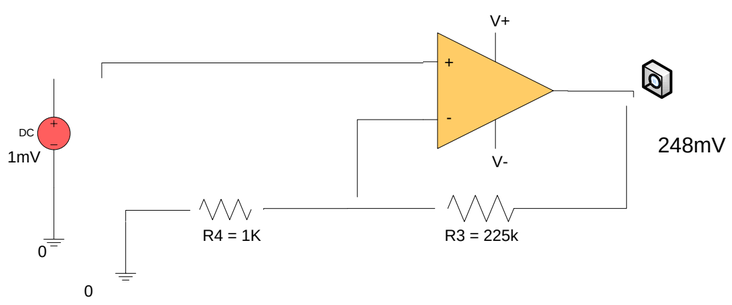


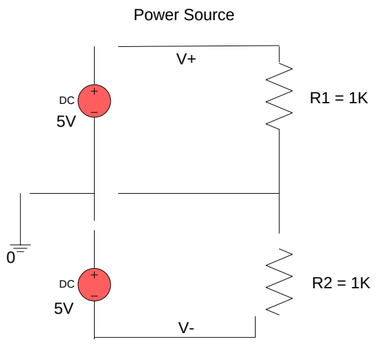
- Initial State: Liquid-Solid Gel (Point 1 on Phase Diagram)
- Freeze in liquid Nitrogen (Process from Point 1 to Point 2)
- Reduce pressure below triple point of water, while temperature increases slightly (Process from Point 2 to Point 3)
- Sustain evacuated environment for approximately 20 hours until liquid sublimes completely, creating aerogel structure (Point 4)
- Return chamber to atmospheric conditions.

Metrics and Specifications Table

Metric	Units	Marginal Value	Ideal Value	Attained
Chamber Temperature	Degrees Celsius	0	< -30	-27
Evacuated Atmosphere (Vacuum Quality)	Torr	<4 Torr	<1 Torr	0.009
Mobility	Subjective	Moderate	High	High
Corrosion Resistance	Subjective	Moderate	High	High
Chamber Size	in^3	130-200	200+	470
Chamber Pressure Accuracy	Torr	.x	.xxx	.xxx
Sample capacity	Number of Samples	1	3+	4
Temperature Monitoring Accuracy	Degrees Celsius	x	.xx	.x
Cooling System Life Cycle	Number of Uses	One Use	Reusable	Reusable
Compliance with Budget Requirements	Percentage of Budget	< 100%	75-85%	63.31%
System Voltage Requirement	Supply Voltage, Quantity	120Vx2, 240x1	120Vx1	120Vx1

Non Inverting Amplifier Circuit





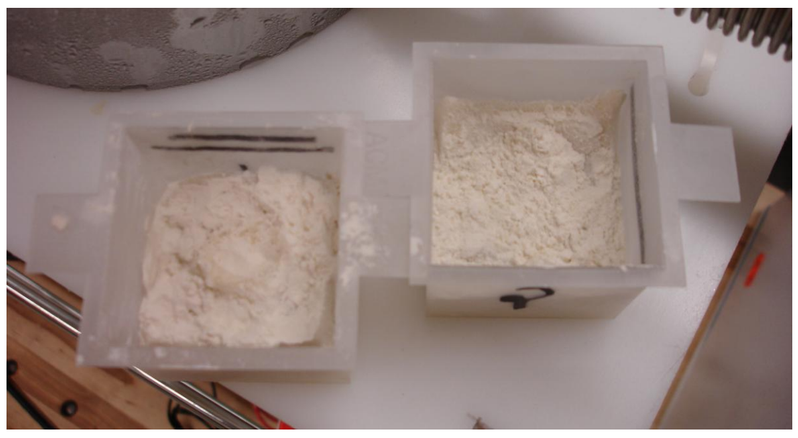
Non-Inverting Amplifier

- Signal Conditioning for K-type thermocouples performed by AD 595C
- AD 595C provides cold junction compensation, amplification and an output buffer.
- Optimal gain of 247.3 V/V
- Calibration accuracy of +/- 1 deg Celsius

P08405 Compressed Budget

Product	Cost	Percentage of Budget
Cooling System	$ 325.44	3.62
Vacuum System	$ 4,134.90	45.94
Mobility	$ 387.11	4.30
Data Logging	$ 850.16	9.45
Totals	**$ 5,697.61**	**63.31**

Desiccated samples produced during system qualification test



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