Stirling Cryocooler

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Project Description

Design and build a benchtop demonstration device that utilizes a Free Piston Stirling Cryocooler (FPSC).

Experimental model will explore thermodynamic properties of Stirling Cycle with variable inputs, to be used within Experimental Methods Laboratory (ME 495)

Client: Dr. David Trevas

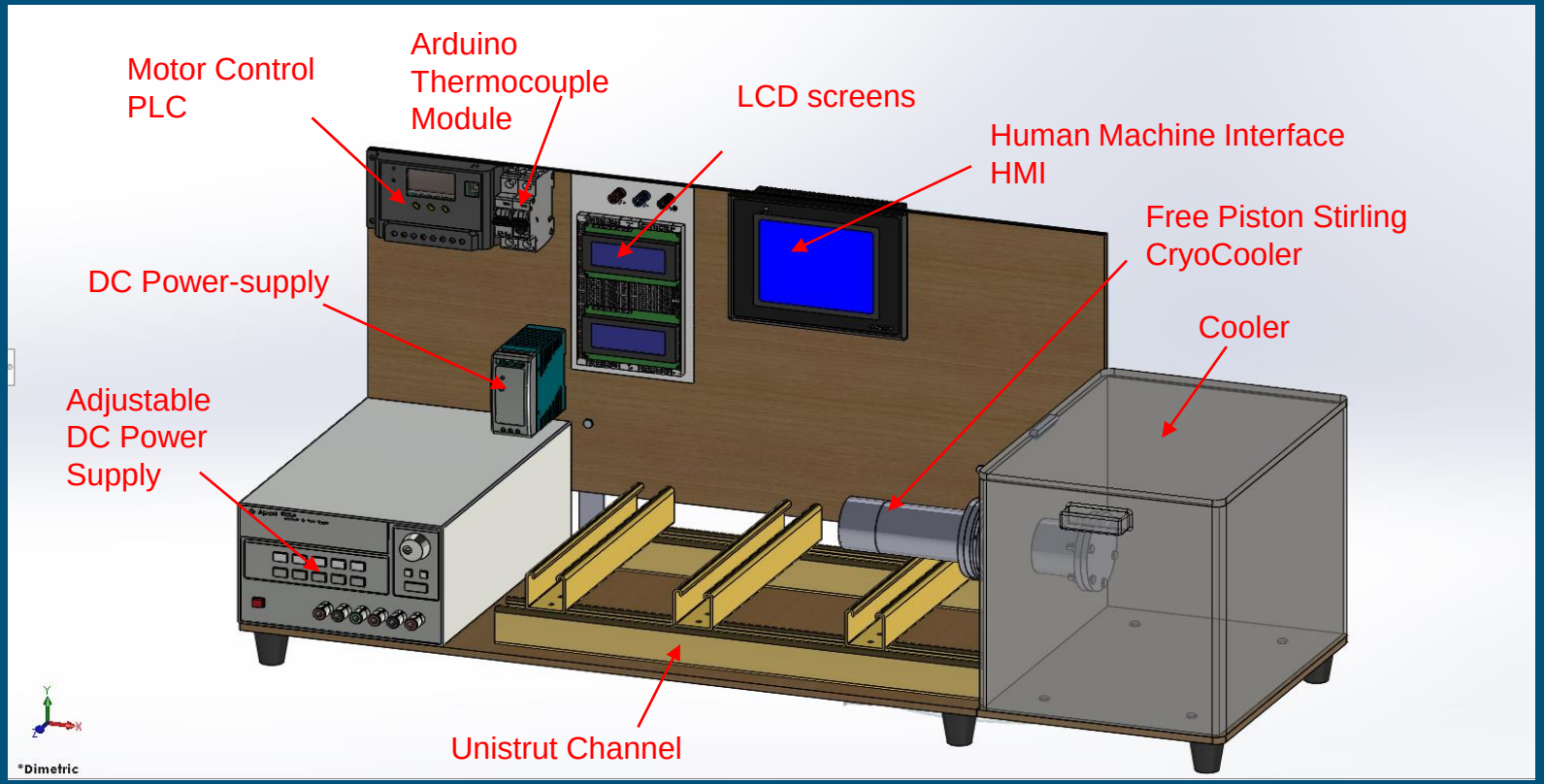
Faiez Alazmi
Oct 29 2018

Update

- Display Framework is built
- Motor controller is configured and functional
- Linear actuator (Solenoid) purchased.
- Refined Solidworks parts and created detailed shop drawings.
- Manufacturing process underway.
- Arduino thermocouples operable (can operate up to 8)

Faiez Alazmi
Oct 29 2018

Main Display Framework in SolidWorks



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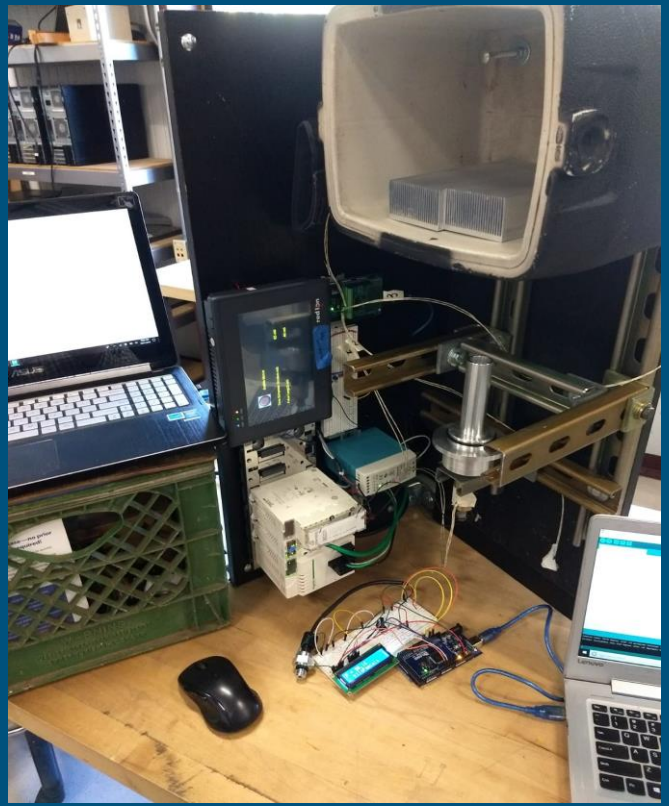
Changes Since Last Presentation



- Demonstration Framework Built
- Process Logic Controller (PLC) Installed
- Human-Machine Interface (HMI) Installed
- Arduino/K-Type Thermocouples Operable
- Arduino/Pressure Sensor in progress.
- Part Manufacturing Underway (98C)

Ahmad Althomali
Oct 29 2018

Moving Forward

Parts Manufactured so far: Inner cylinder, displacer, piston, shaft, motor mount, display assembly.

Parts That Still Need Fabrication: Outer shell, solenoid housing, cooler heatsink.

Testing Plan: Operation once assembled, Refine and adjust to meet CR's, ER's.

Contingencies: Motor mount, orientation of Piston/Cylinder.

What is Left to be done? Bolt holes/fasteners (CNC), Regenerator assembly, Displacer Assembly (magnets), Arduino interfaces, (Temp/Pressure) displays, cold chamber configuration.

John WIley
Oct 29 2018

Budget

Expense	Cost totals	Actual Cost	Total	Budget Ceiling $1500
Research and Development	$537.90	$537.90		
Parts and Materials	$447.28	$447.28	$985.18	$514.82
Donated Components (PLC, HMI)	$2089.86	$0	$3075.04	

John WIley
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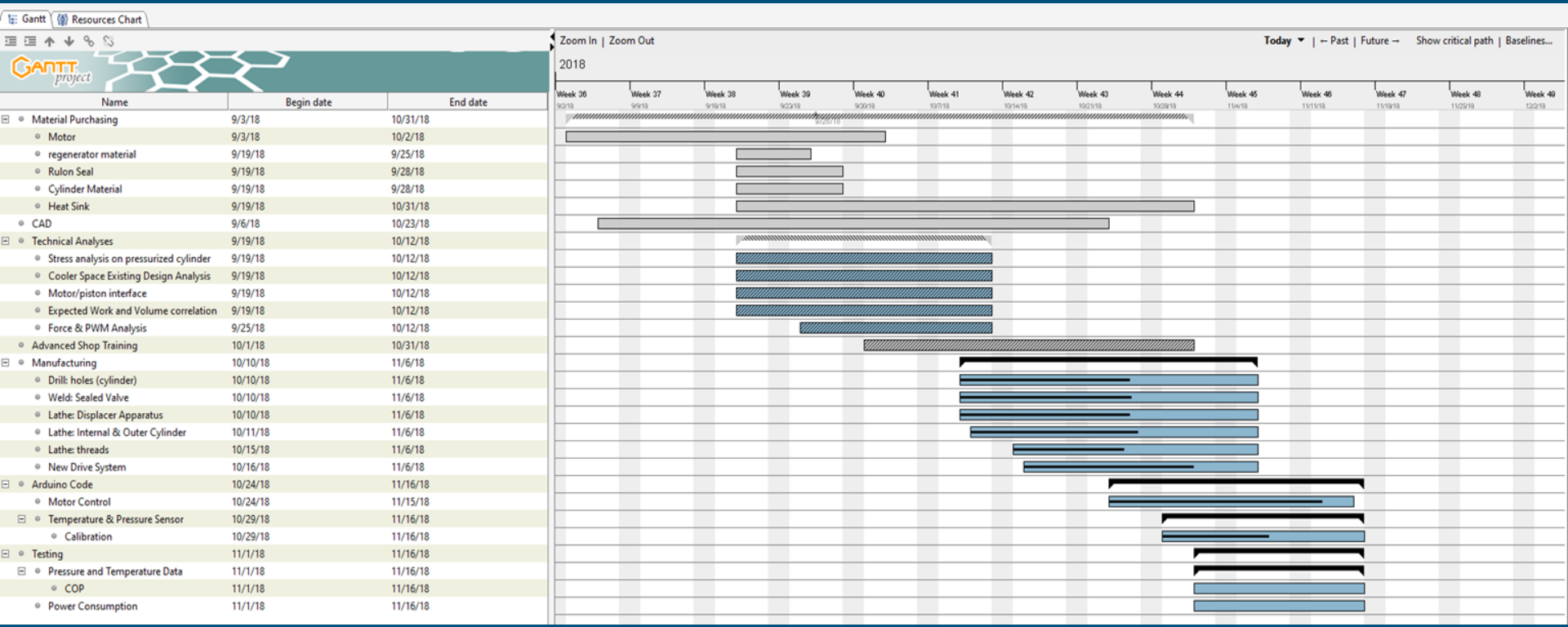
Gantt Chart



Name	Begin date	End date
Material Purchasing	9/3/18	10/31/18
Motor	9/3/18	10/2/18
regenerator material	9/19/18	9/25/18
Rulon Seal	9/19/18	9/28/18
Cylinder Material	9/19/18	9/28/18
Heat Sink	9/19/18	10/31/18
CAD	9/6/18	10/23/18
Technical Analyses	9/19/18	10/12/18
Stress analysis on pressurized cylinder	9/19/18	10/12/18
Cooler Space Existing Design Analysis	9/19/18	10/12/18
Motor/piston interface	9/19/18	10/12/18
Expected Work and Volume correlation	9/19/18	10/12/18
Force & PWM Analysis	9/25/18	10/12/18
Advanced Shop Training	10/1/18	10/31/18
Manufacturing	10/10/18	11/6/18
Drill: holes (cylinder)	10/10/18	11/6/18
Weld: Sealed Valve	10/10/18	11/6/18
Lathe: Displacer Apparatus	10/10/18	11/6/18
Lathe: Internal & Outer Cylinder	10/11/18	11/6/18
Lathe: threads	10/15/18	11/6/18
New Drive System	10/16/18	11/6/18
Arduino Code	10/24/18	11/16/18
Motor Control	10/24/18	11/15/18
Temperature & Pressure Sensor	10/29/18	11/16/18
Calibration	10/29/18	11/16/18
Testing	11/1/18	11/16/18
Pressure and Temperature Data	11/1/18	11/16/18
COP	11/1/18	11/16/18
Power Consumption	11/1/18	11/16/18

Abdulrahman Alazemi
Oct 29 2018

Individual Duties

Luis : Arduino, pressure and temperature sensor, LCD Interface coding.

Ahmad : Solid work modeling, manufacturing parts.

John : Hermetic Power Connector, manufacturing parts.

Abdulrahman : LCD Interface coding, Heat sink design/build.

Faiez : Designing the cooling vessel, Heat sink design/build.

Abdulrahman Alazemi
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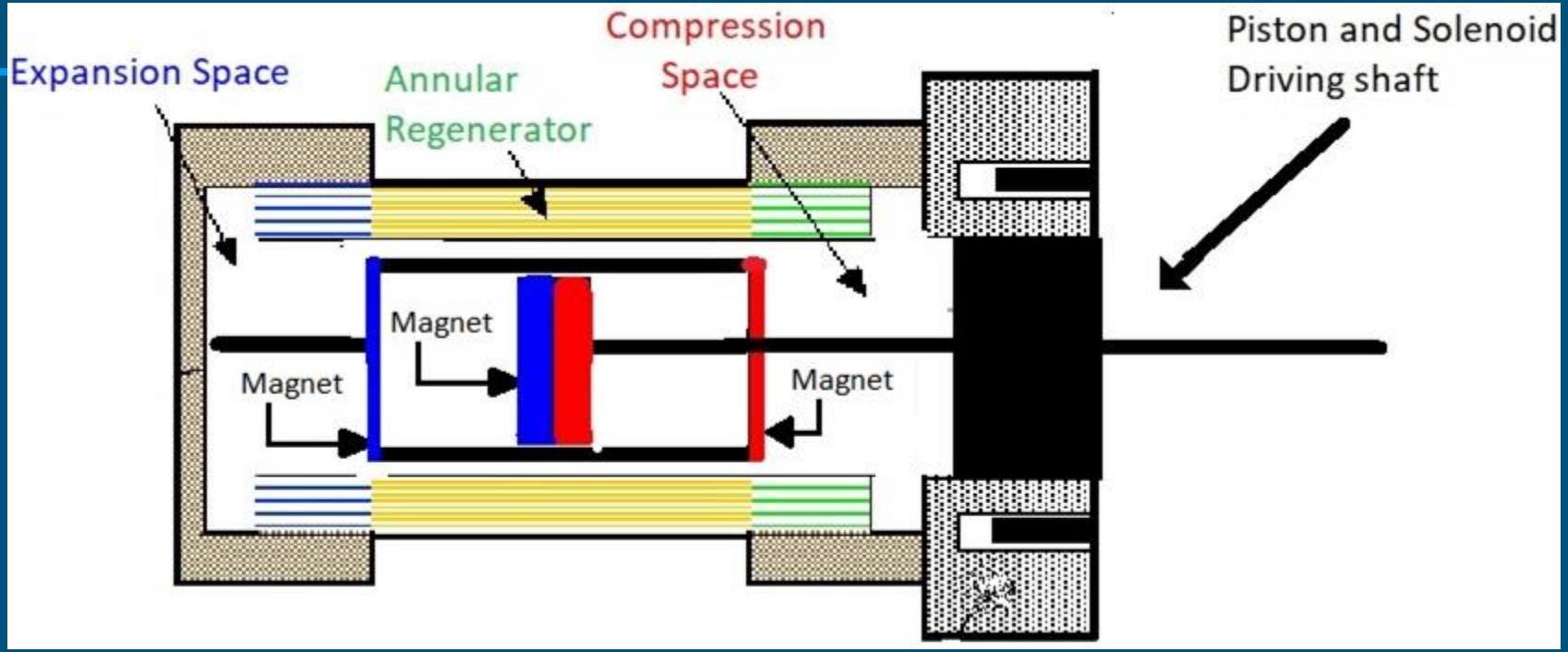
Simplified Internal Cylinder Representation



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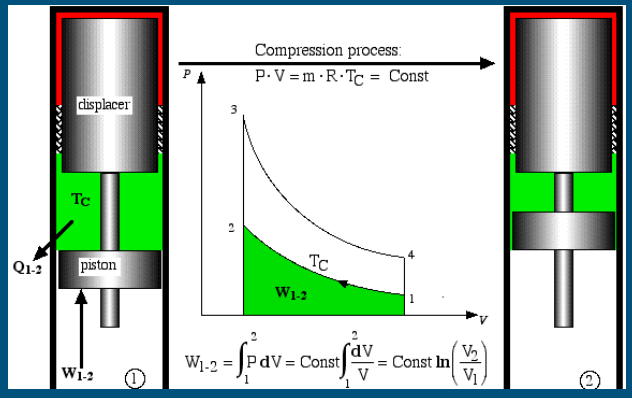
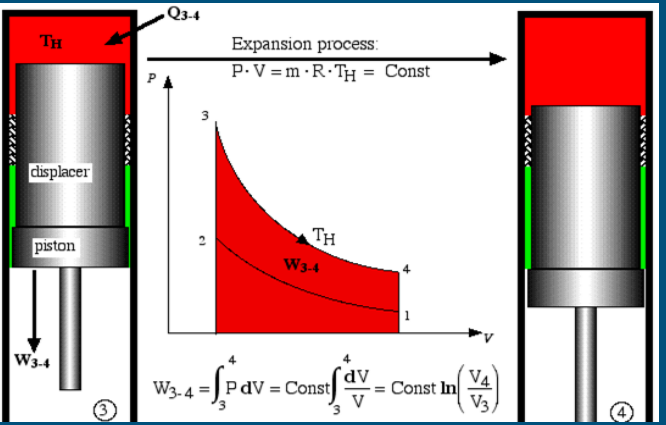
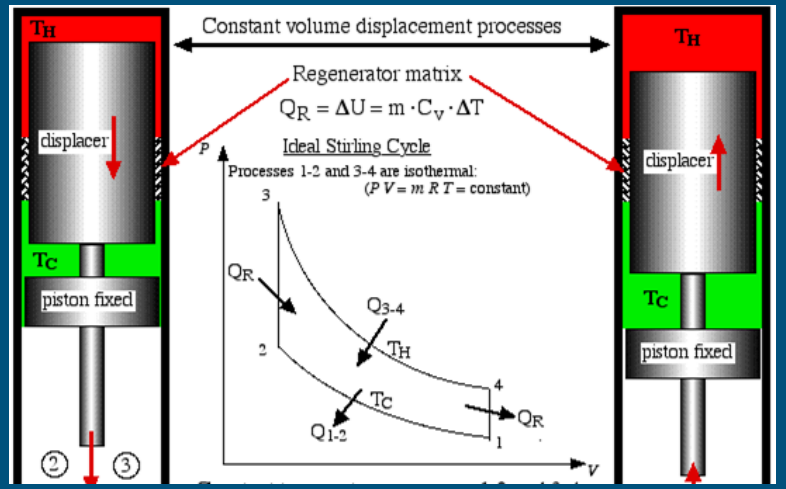
Stirling Cycle Reality







- The Stirling cycle can be idealized to approximate and comprehend the actual behavior of a real Stirling cycle.
  - These images show the discrete steps in this idealized process
- The real Stirling Cycle will have a p-V diagram that is elliptically shaped.
  - The idealized cycle isn't elliptically shaped due to:
    - Isothermal Expansion and Compression aren't really isothermal
    - Compression/Expansion & displacer displacement happen Simultaneously in a real system

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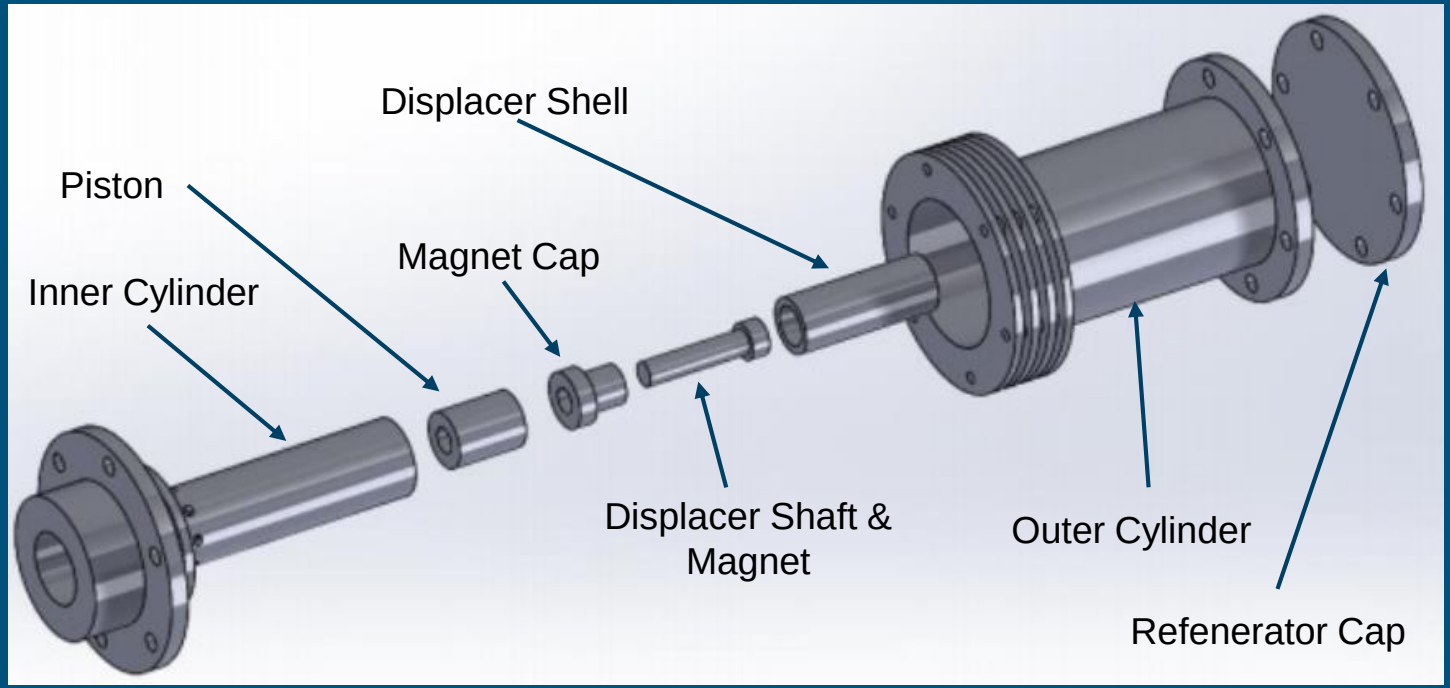
Sub-Systems



- **Original vs. Already Present in Society**
  - **Free-Piston: Magnet**
  - **Outer and Inner Cylinder: Free Piston**
  - **Solenoid: Pressure Range**

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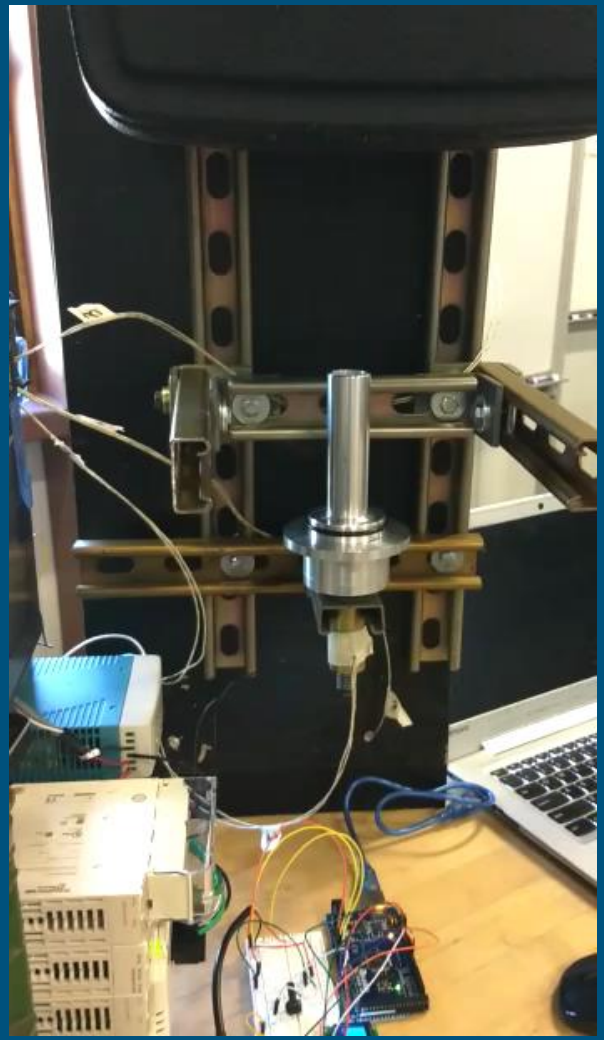
Hardware Review 2



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Questions?