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THE UNIVERSITY OF ALABAMA IN HUNTSVILLE

SURFACE ROUGHNESS EFFECTS ON MICROGRAVITY BOILING

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63rd IAC 2012
NAPLES

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Instrument Design

- Mission statement
  - To prepare an instrument for providing experimental data to better understand microgravity boiling properties related to surface roughness
- Simple design objectives
  - Multiple test samples
  - Small size to fit experimental platform
- Continuation of previous work[1]

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Why do we care?

- Plan-B
  - What if a cooling pump breaks?
  - What can we do to maximize pump-free heat transfer?

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Characterize Heat Transfer

- Measure
  - Surface Temperature
  - Fluid pressure and saturation temperature
  - Heat transfer/surface area
  - Acceleration
  - Surface roughness

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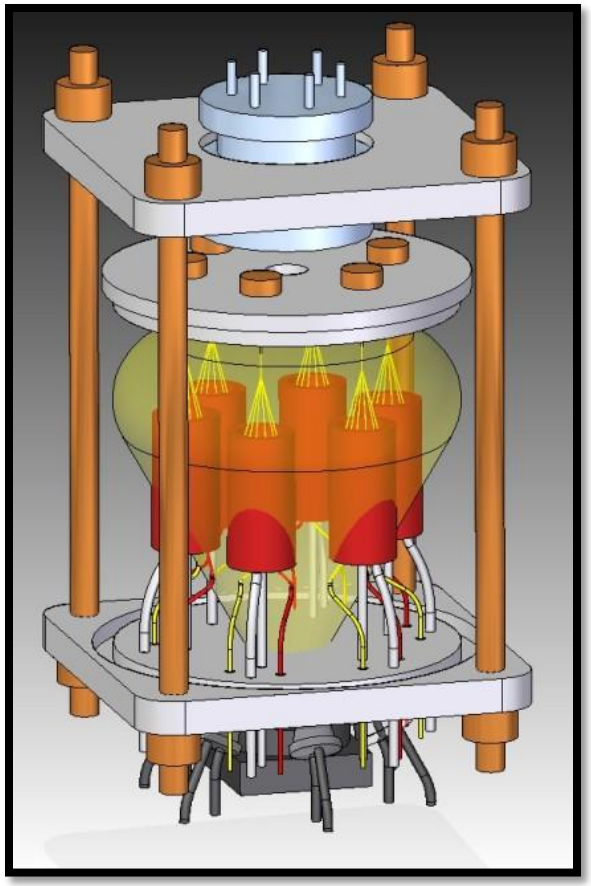
Instrument Concept Design[1]

- Chamber
  - Top
    - Pressure sensor
  - Pressure relief foam
  - Six test samples
  - Bottom
    - Wire pass-through
    - Camera view



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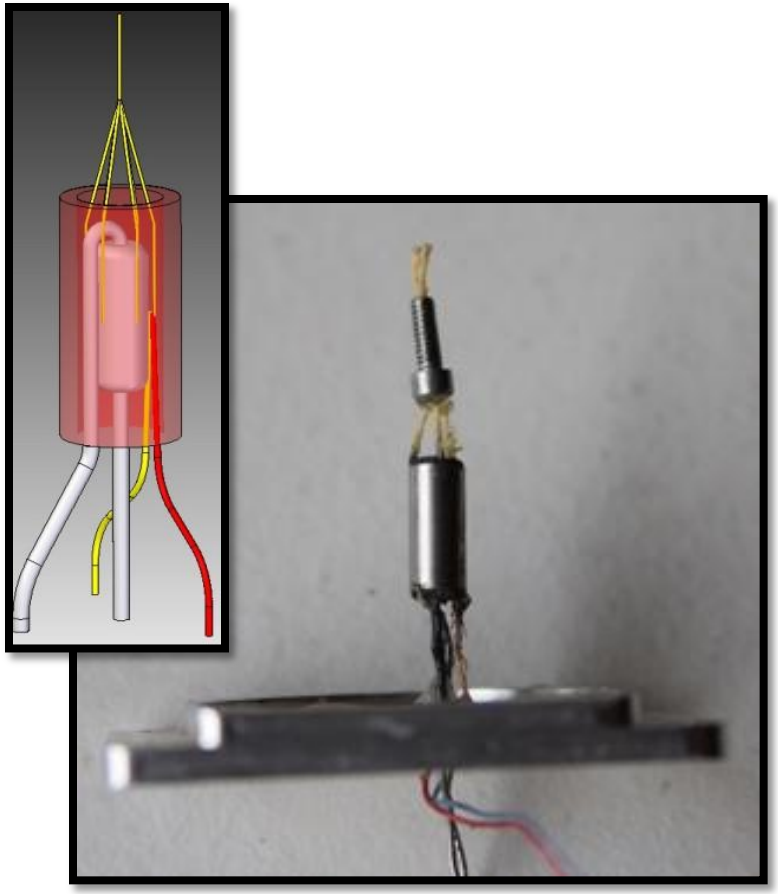
Experiment sample

- Metal Sample
- Heated resistor
- Thermocouple
- Epoxy



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Assembled under water

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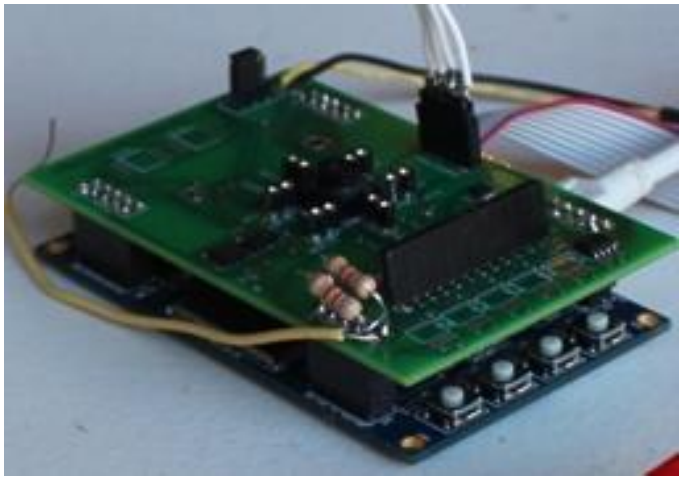
Supporting electronics

- Required measurements
  - Voltage
  - Current
  - Pressure
  - Temperature
- Additional measurements
  - Camera image
- Design hosted my a single imbedded controller



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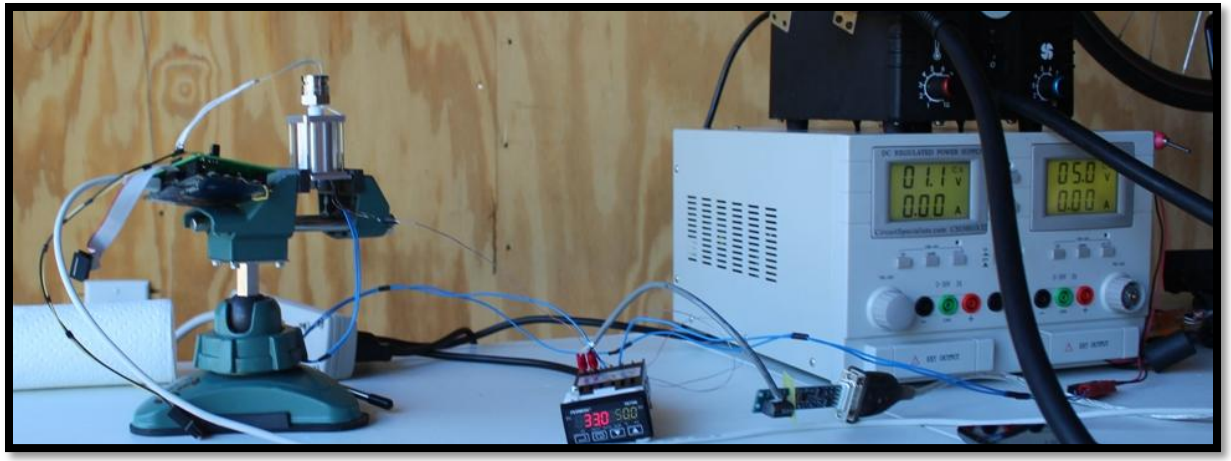
Initial testing configuration

- External measurement tools
  - power supply
  - Temperature process controller
- Imbedded controller
  - Pressure sensor



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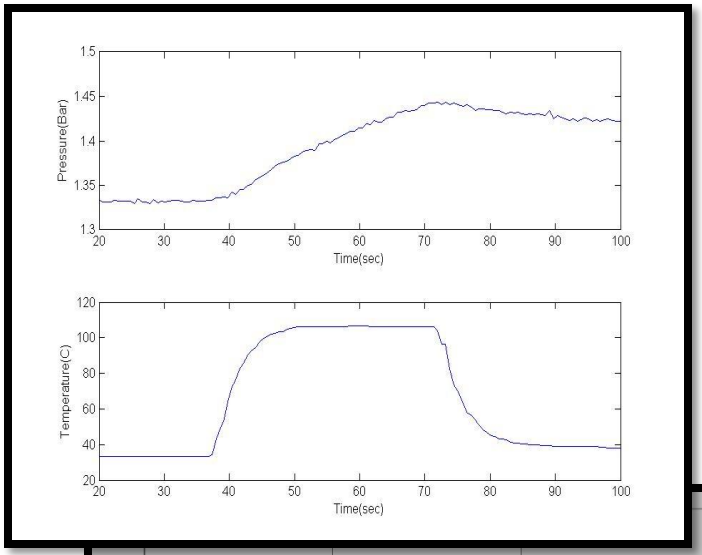
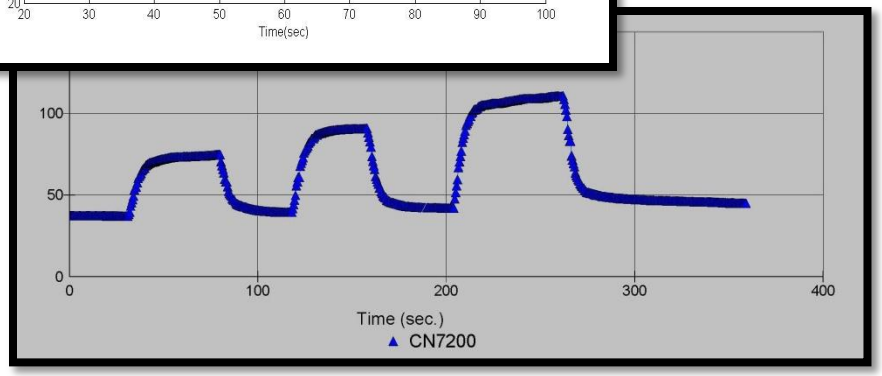
Experimental Data, sealed chamber

- Sample heating is coupled with the pressure change
- Various heat is applied to test what peak temperature is reached





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Experimental Data, open chamber

- Open Chamber
  - Controlled environment
  - No pressure change
  - Direct view of boiling
- Problems identified
  - Hot spot found

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Test Sample limits

- Insufficient conduction caused overheated core
- Unbalanced encapsulation caused hot spot
- Thermocouple placement is not reliable

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Results of initial testing

- Shows that chamber survives
- The sample reached the nucleate boiling regime
- Some simple issues are identified
  - But not show stoppers
- Imbedded controller will help automate the testing process

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Future Missions

- Parabolic flight
  - Functional testing
  - Low gravity science data set
- Orbital flight
  - Micro gravity science data set

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Sponsors

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Lockheed Martin

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References

1. Becnel, E. B. and Wessling, Francis. C. (2011). Surface Tension Effects on Microgravity Boiling. *62nd International Astronautical Congress* (pp. IAC-11-A2.2.10). Cape Town, SA: International Astronautical Federation.