Levitating Across the River Styx

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A boat ride across the river Styx with Charon at the helm is a one-way fare.

Solution: levitation

Aero-acoustic levitation

- The process of counteracting gravitational force on an object through the combined use of gas jet and sound pressure from acoustic sources to stabilize the object in a container-less field.

Context

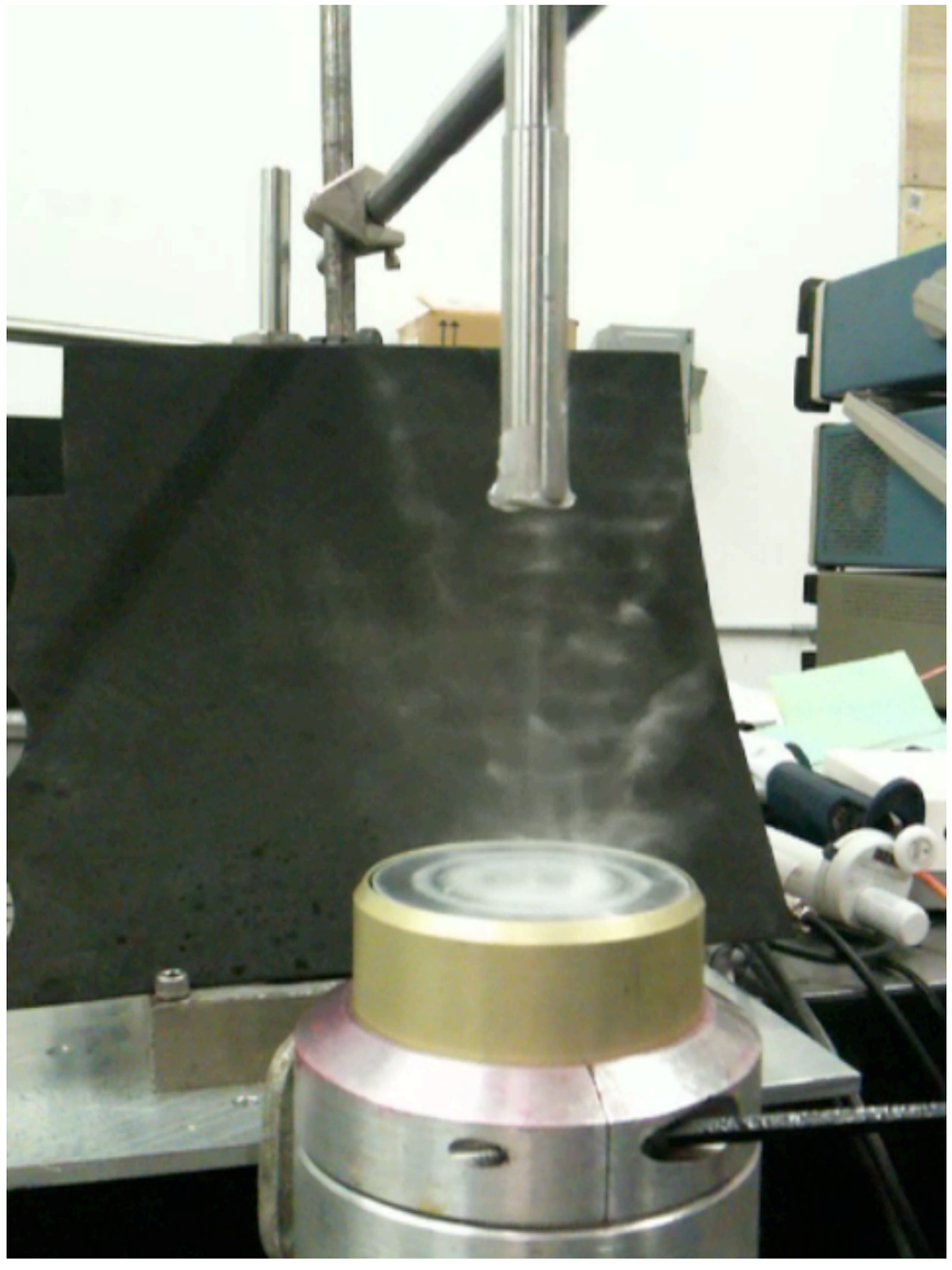
- Magnetic levitation - diamagnetic materials only
- Electromagnetic levitation (EML)
- Electrostatic levitation (ESL)
- Gas film levitation (GFL)
- Aerodynamic levitation

Use

- Container-free research and processing of solids and liquids
  - contamination-free liquid-phase processing
  - pure materials preparation
  - non-contact property measurements
  - undercooled melts and supersaturated solutions
  - heat treatment at temperatures up to 3000°K

Levitation

Can also be accomplished with a single transducer. In this example driven at a frequency of ~22kHz alcohol is sprayed onto the surface to reveal acoustic nodes and anti-nodes from a single reflector.



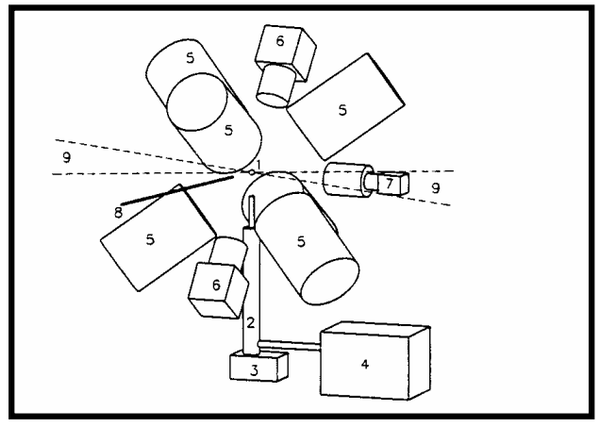
1980s-1990s

Studies into high-temperature melts leads to Containerless Research, Inc. developing their aero-acoustic levitator.

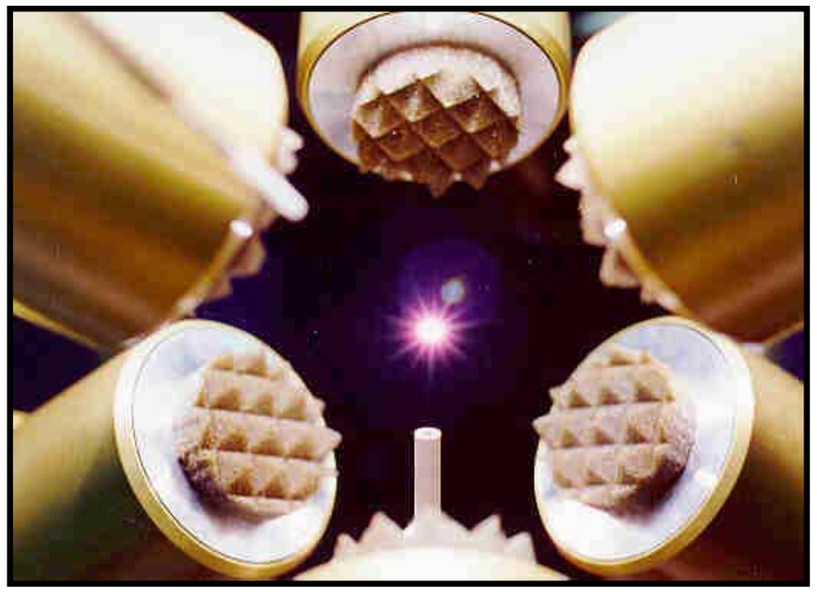
Photograph of the Aero-Acoustic Levitator showing table-top mounted levitation system and instrument rack holding acoustic power supplies, levitator controller electronics, and video monitors.

Leading to:

Stable methods for high temperature studies into material viscosity, glass fibers from non-silicate oxides, and oxygen content control in molten geological materials.



1. Levitated specimen
2. Gas flow tube
3. Translation stage
4. Flow control system
5. Acoustic transducers
6. Position sensor system (one for each axis)
7. Video camera
8. Vacuum chuck
9. Optional laser beam heating



Photograph of a 0.3-cm diameter molten aluminum oxide sample in the Aero-Acoustic Levitator. The sample is laser beam heated to a temperature of ~2700K. The sample injector is shown out of focus in the top left of the picture.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So what does all this levitation talk have to do with Plan 9?

Let alone Styx or 9p2000?

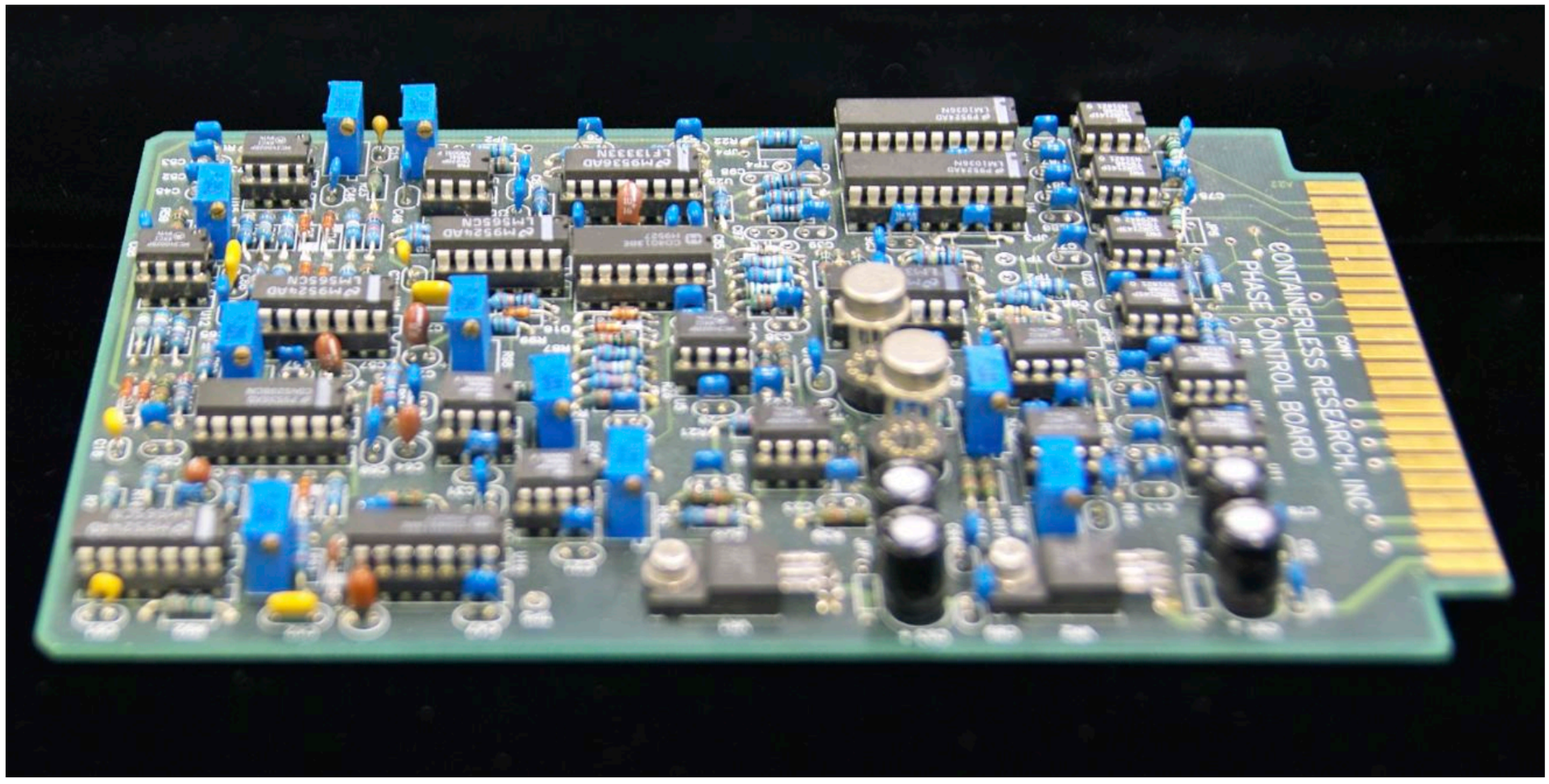
When Charon takes you across the river Styx, it's a one-way trip.

We want a bi-directional journey.

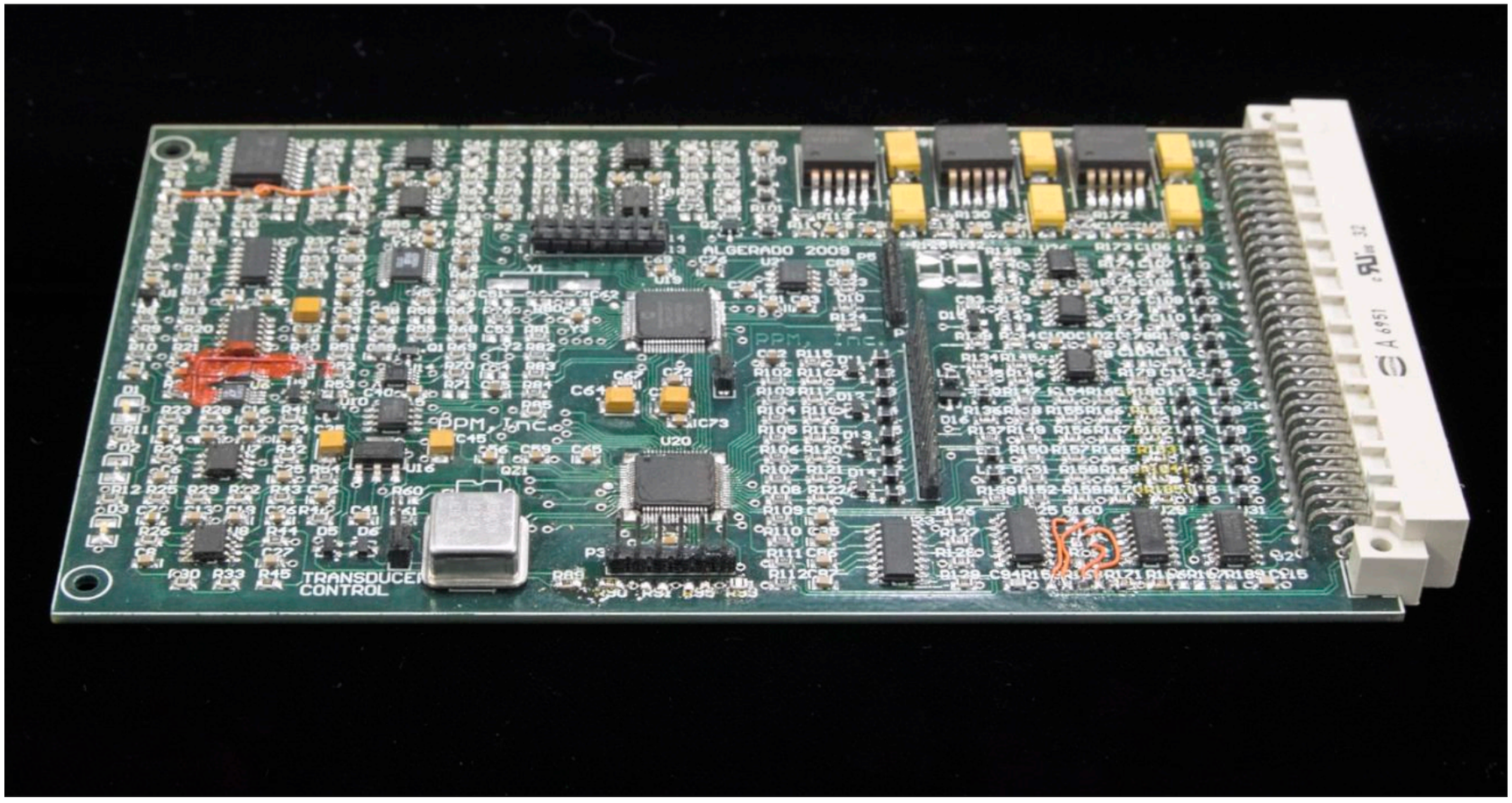
- Provide a new aero-acoustic levitator with better programable control.
- Implement 9p/Styx support on the transducer controller boards.
- Develop front end applications that can easily communicate with the distributed system of control boards running the levitator.

Control boards

- Eight boards in total
  - one connected over serial lines with a user's terminal
  - six paired with transducers
  - one modulator
- Uses a dsPIC33F



Historical influences



New prototype

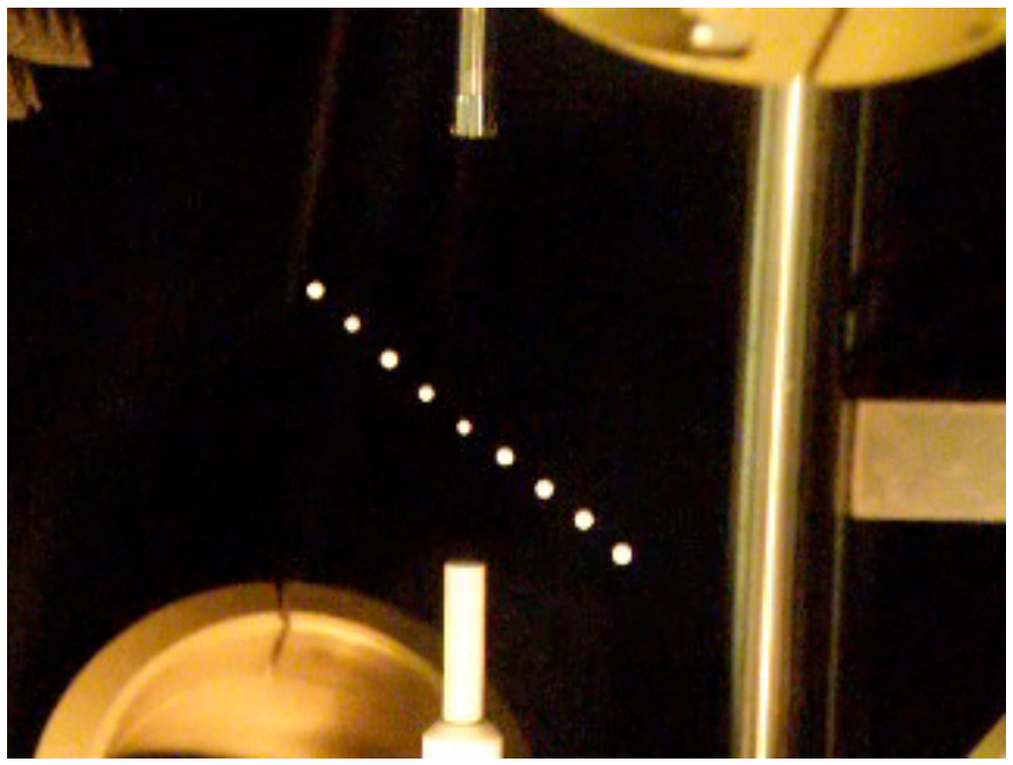
dsPIC33F speaks 9p2000

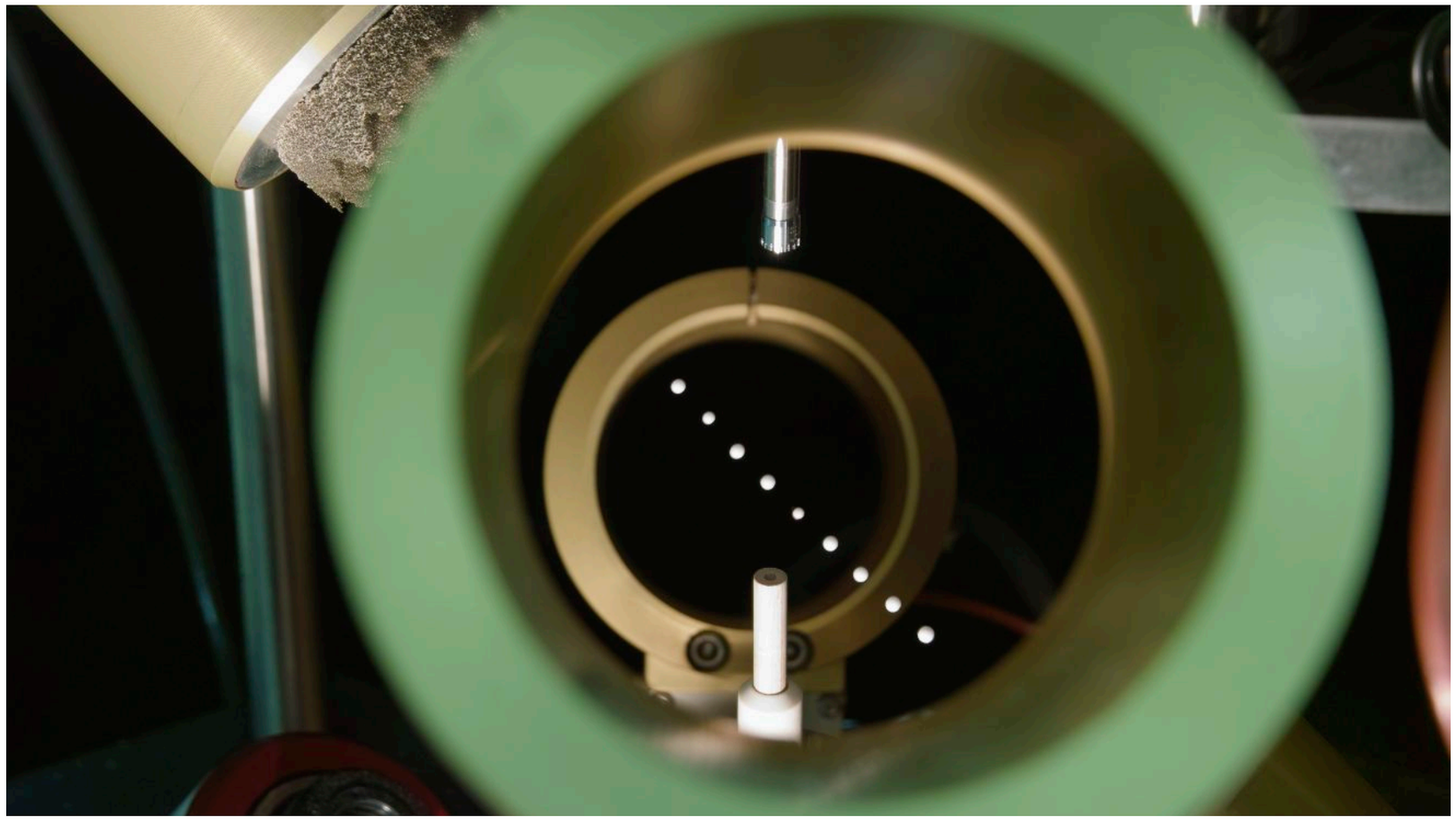
- Implemented using DMA channels to handle receiving and transmitting over the UARTs

Gaining new system control

Manually changing the phase can now be accomplished through a short program:

```
for(i in `{seq 1 15}){
  echo p+1 > /n/aal/[01]/ctl
  sleep 1}
for(i in `{seq 1 15}){
  echo p-1 > /n/aal/[01]/ctl
  sleep 1}
```





Questions?

Source images and reference material provided by

Physical Property Measurements, Inc.

http://www.ppmeasurements.com/