

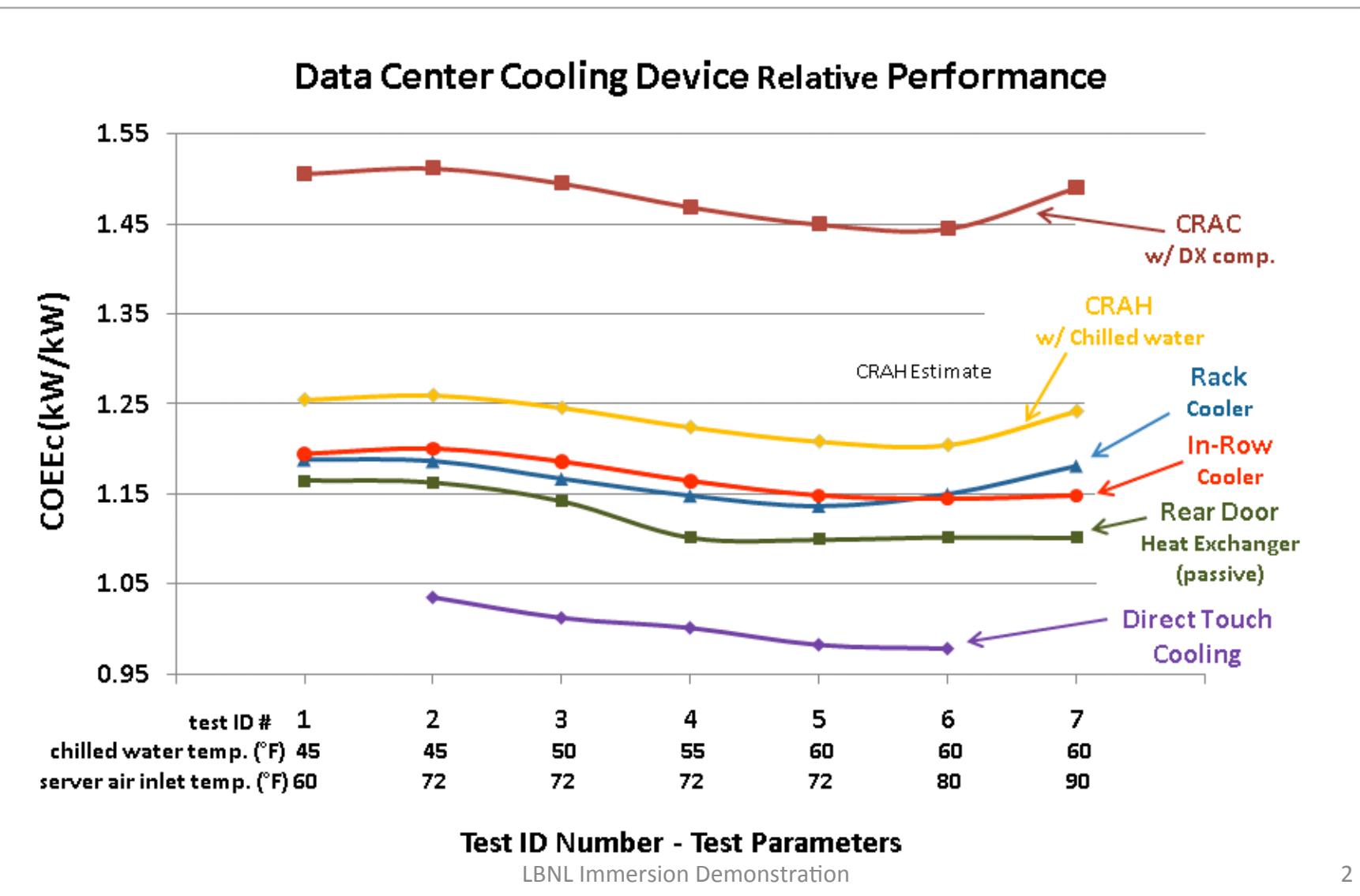


Electronics Take a Bath - Update

Bill Tschudi
Lawrence Berkeley National Laboratory
April 15, 2015
SVLG Data Center Workshop



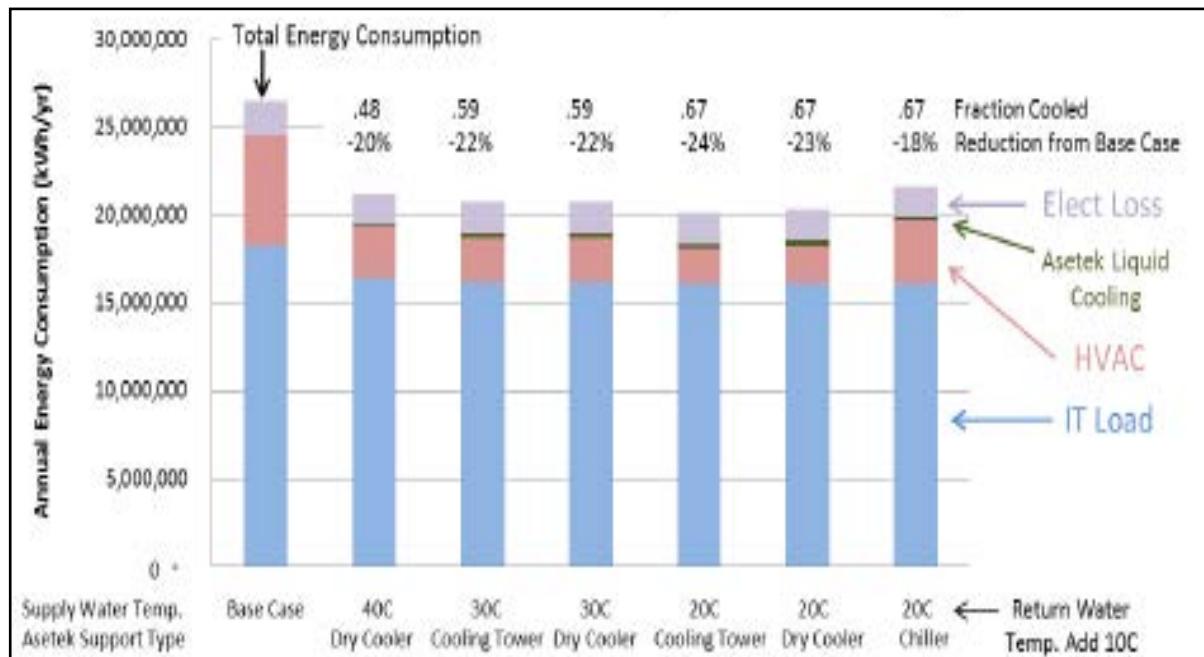
“Chill-Offs” 1&2 confirmed liquid cooling solutions are more efficient than air cooling



Direct to Chip Liquid Cooling



- Lawrence Berkeley National Laboratory Demonstration
- Rack of 38 Cisco UCS C220 M3 Servers Installed in July 2013
- Study confirms:
 - ✓ Cooling Power Savings > 50%
 - ✓ Savings > **21% of Total data center power**
 - ✓ Power savings when RackCDU connected to chilled water



LBNL Led Liquid Immersion Demonstration

Project team

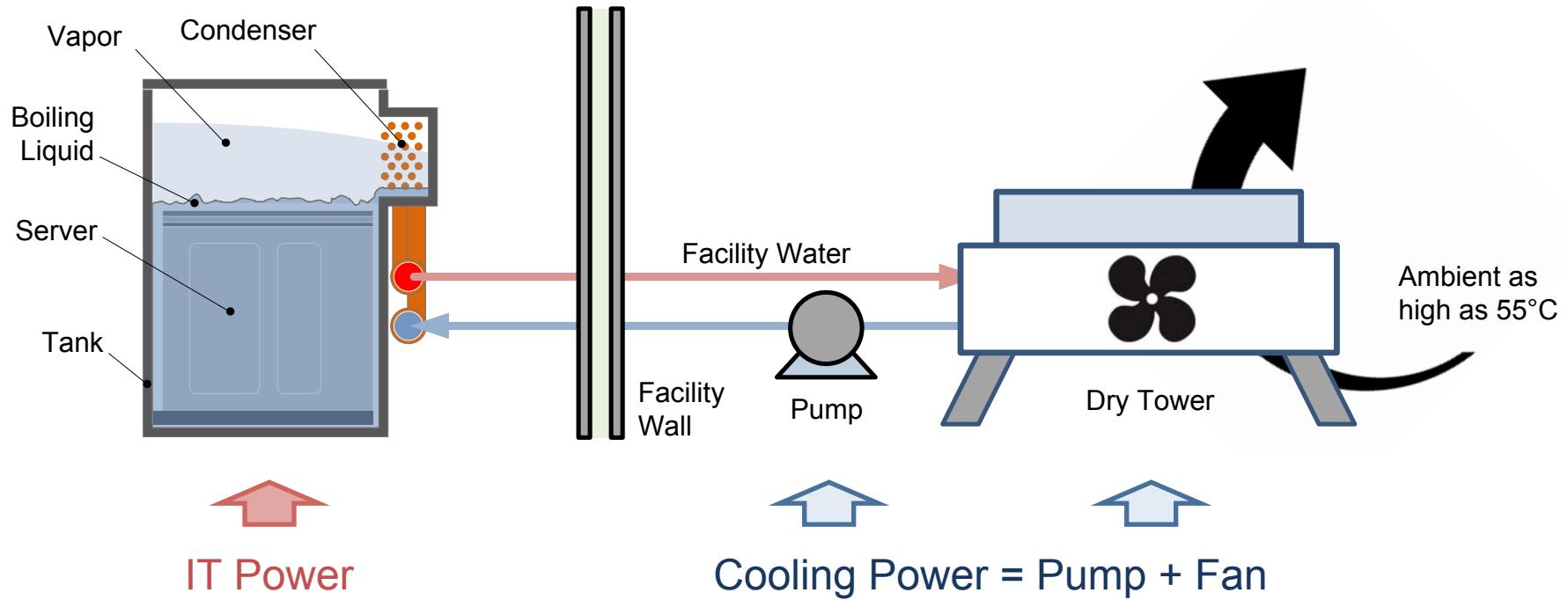


Demonstration partner

Naval Research Laboratory
Washington, DC



Open bath liquid immersion cooling



What is missing:

- chillers
- cooling towers
- water use
- raised floors
- computer room air conditioners
- earplugs!
- Server fans

Immersion cooling eliminates compressor based systems

Eliminate:

- Chillers
- CRAC units
- cooling towers
- Server fans
- Evaporative water loss

Reduce number of pumps



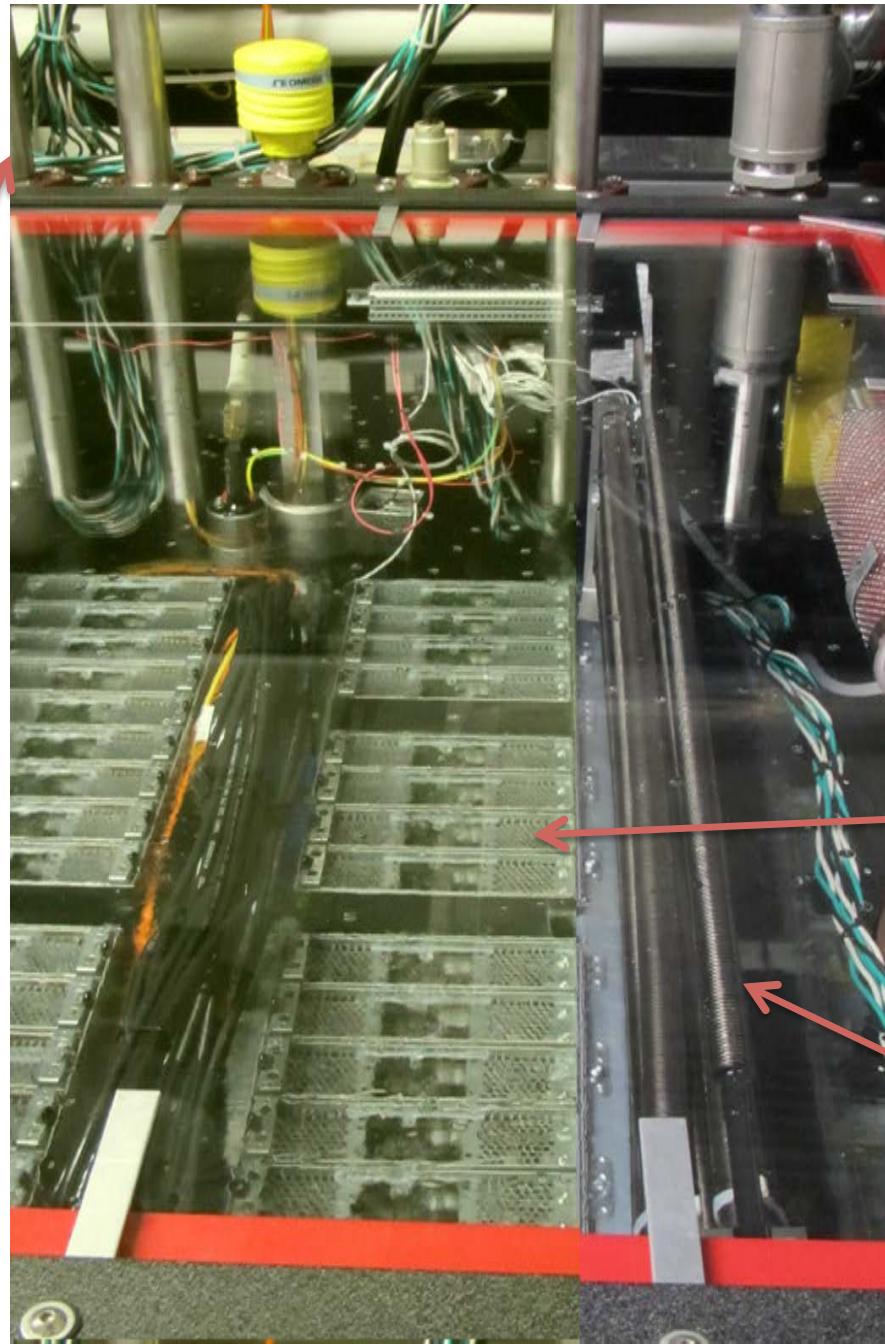
Many hours of
“Free cooling”

Simplified controls

Reduced
maintenance cost

Cooling systems can be much simpler

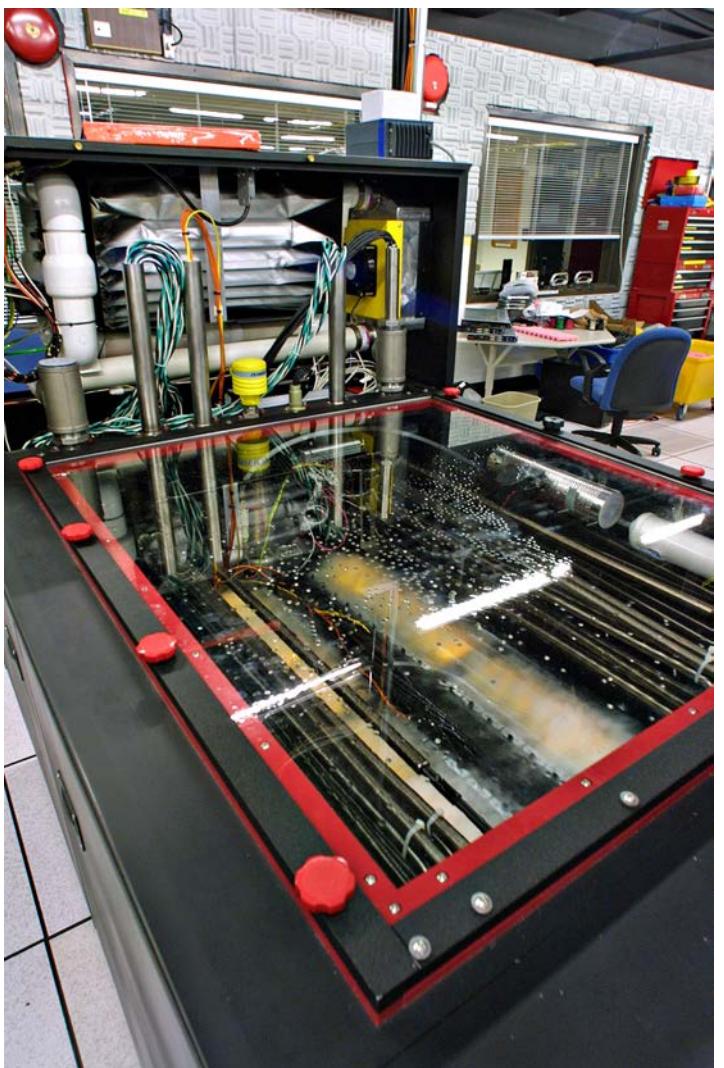
Note wiring
enters bath
above fluid
level to avoid
fluid loss



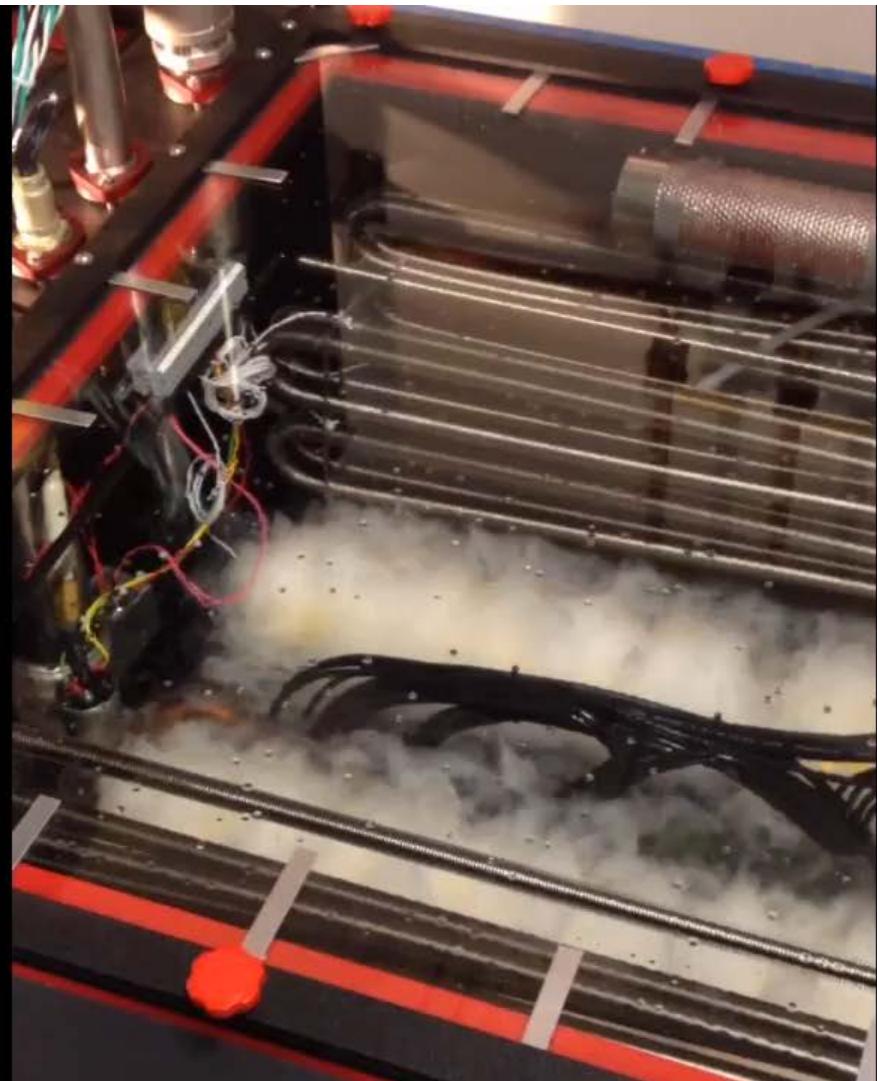
Servers installed in
immersion bath looking
through top glass cover

Condenser coils on
either side

System is off
in this photo



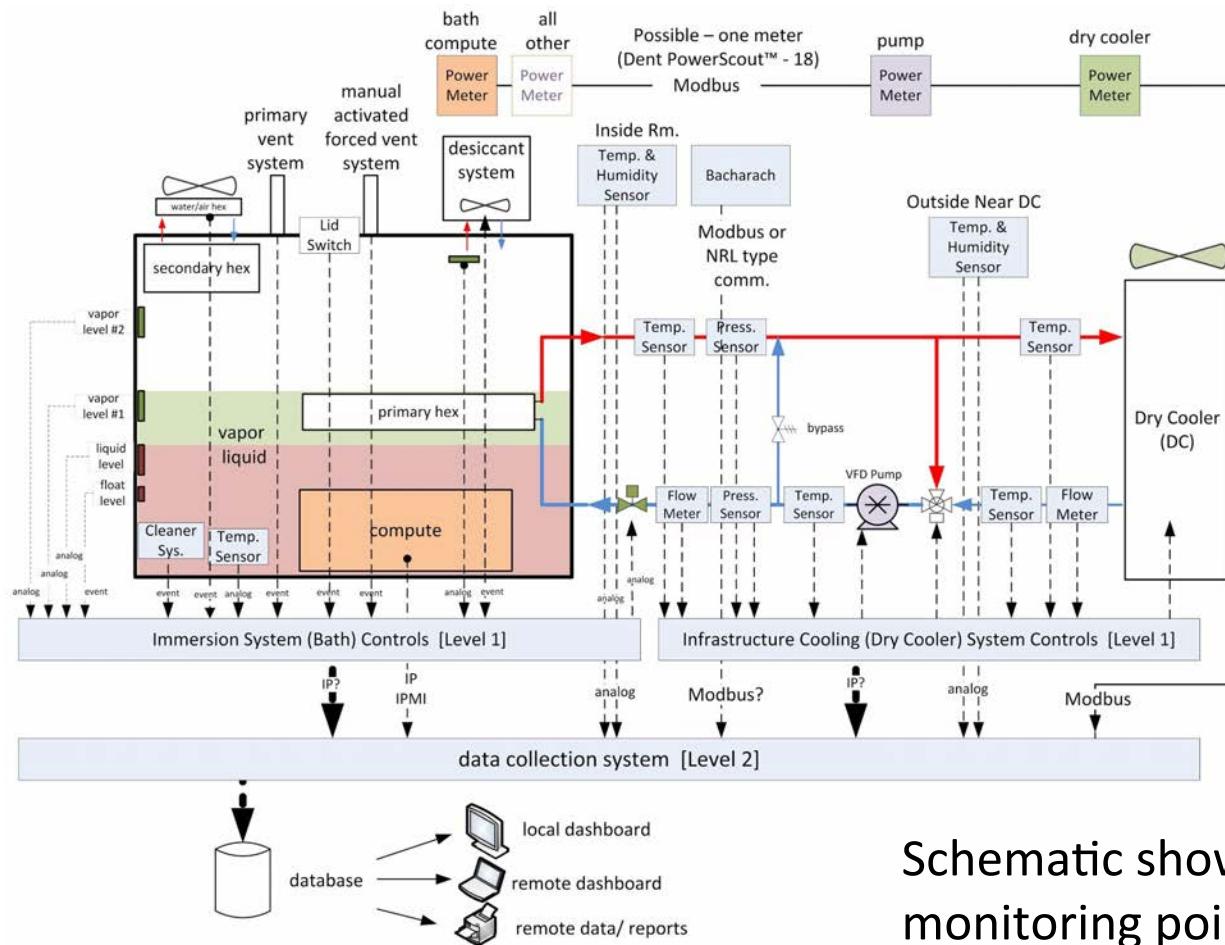
2-Phase Immersion Cooling



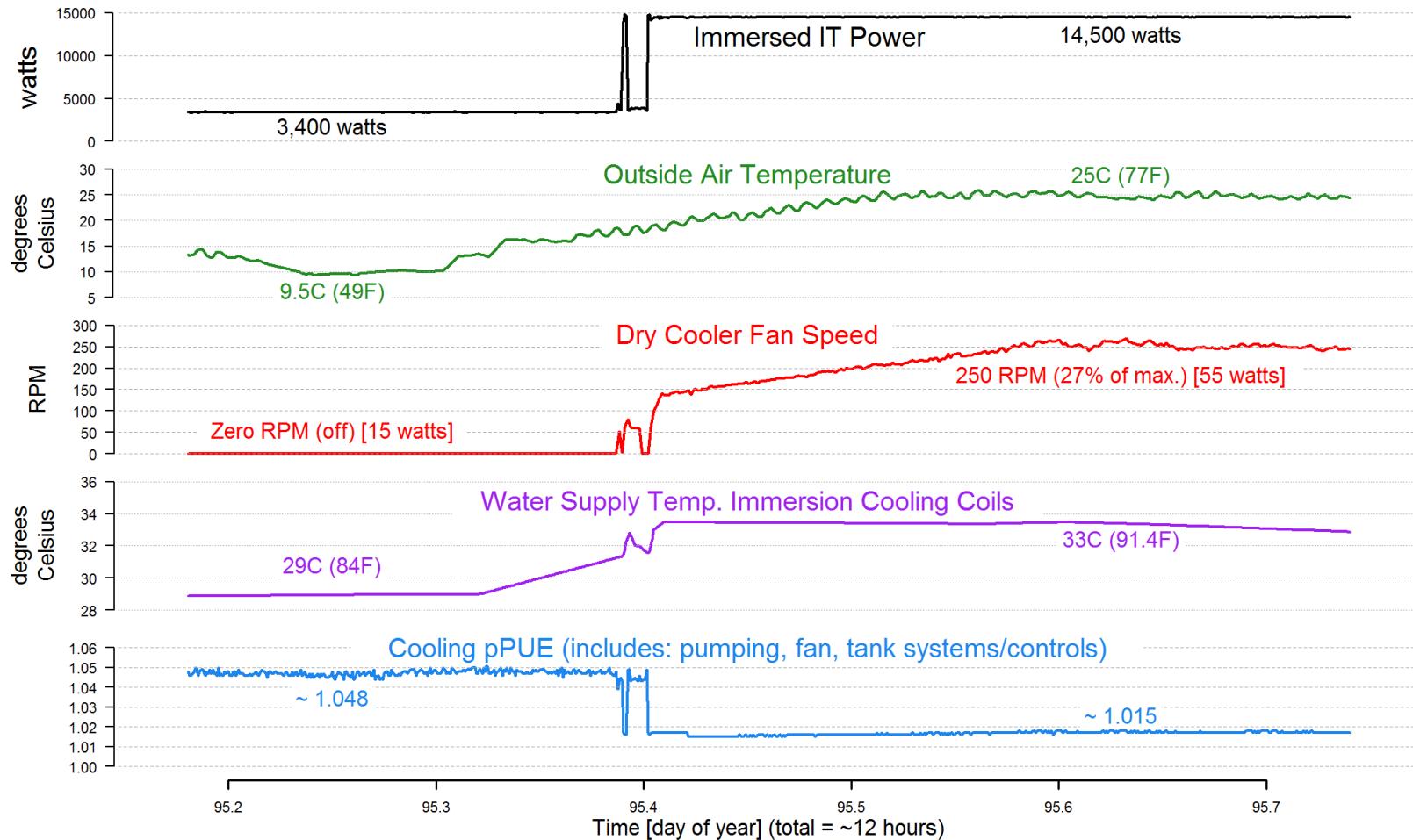
Video

System Evaluation

Data collection plan



NRL Immersion Demonstration Startup Sample Data
4/6/2015 04:20 to 4/6/2015 17:46



Energy Performance

Immersion partial PUE (cooling):

IT (in bath)+Tank controls + Dry cooler fan + Loop pump

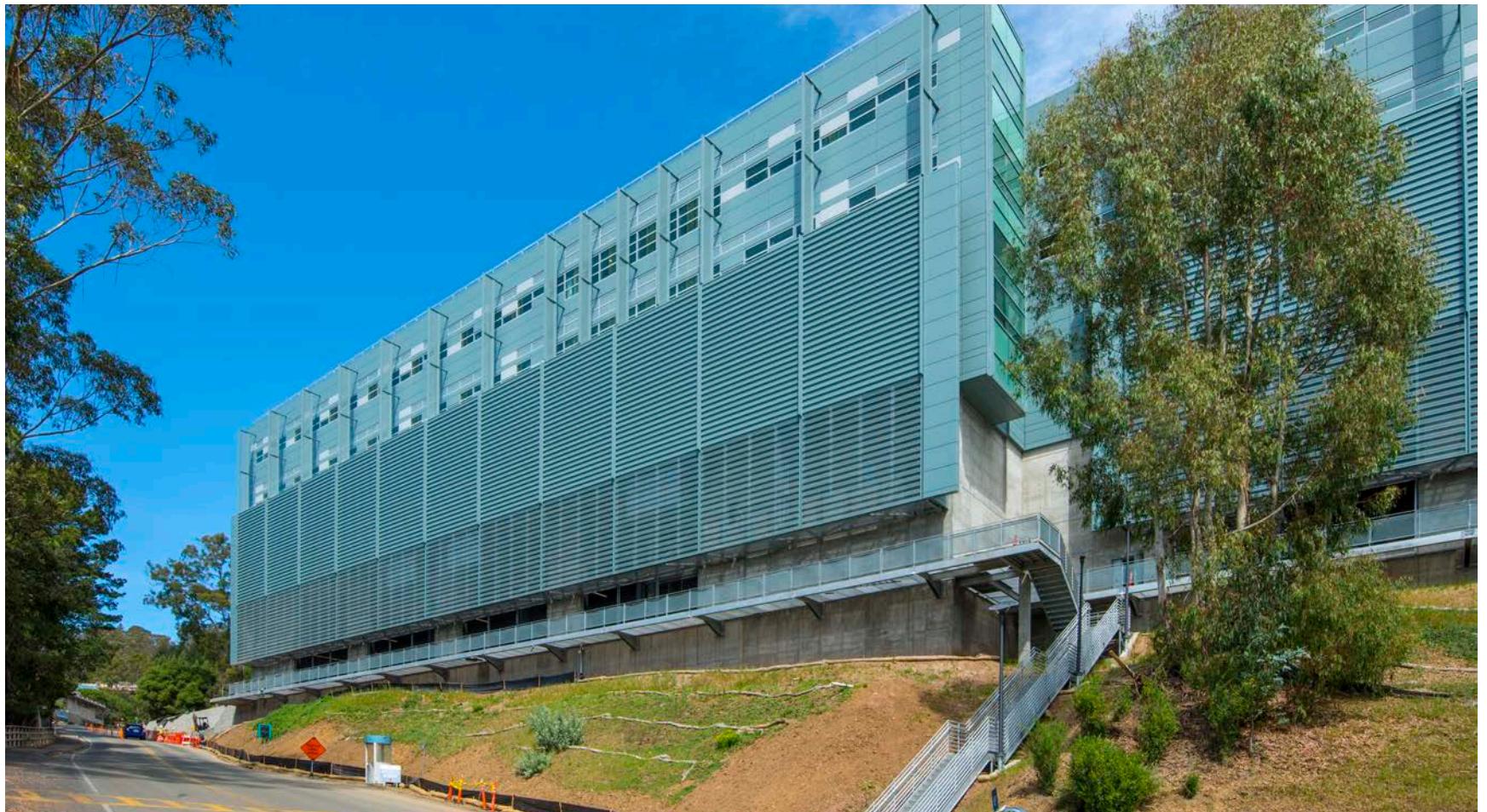
IT (in bath)

Learnings

- Contamination can cause failures in 2-phase immersion cooling systems just as in air cooled systems
- The source of contamination in immersion cooled systems is the system itself, not the outside environment. The designer therefore can control contamination.
- Boards for air cooled servers, power supplies etc. have geometries that allow impurities to accumulate eventually causing failures – fix is simple, undercoat and add boiling enhancement coatings
- Contaminants accumulate through distillation when boiling (unique to 2-phase systems).
- Strategies for combatting contamination include; eliminating contaminant, pre-cleaning, in situ scrubbing, coating/under-filling, and control of heat flow.

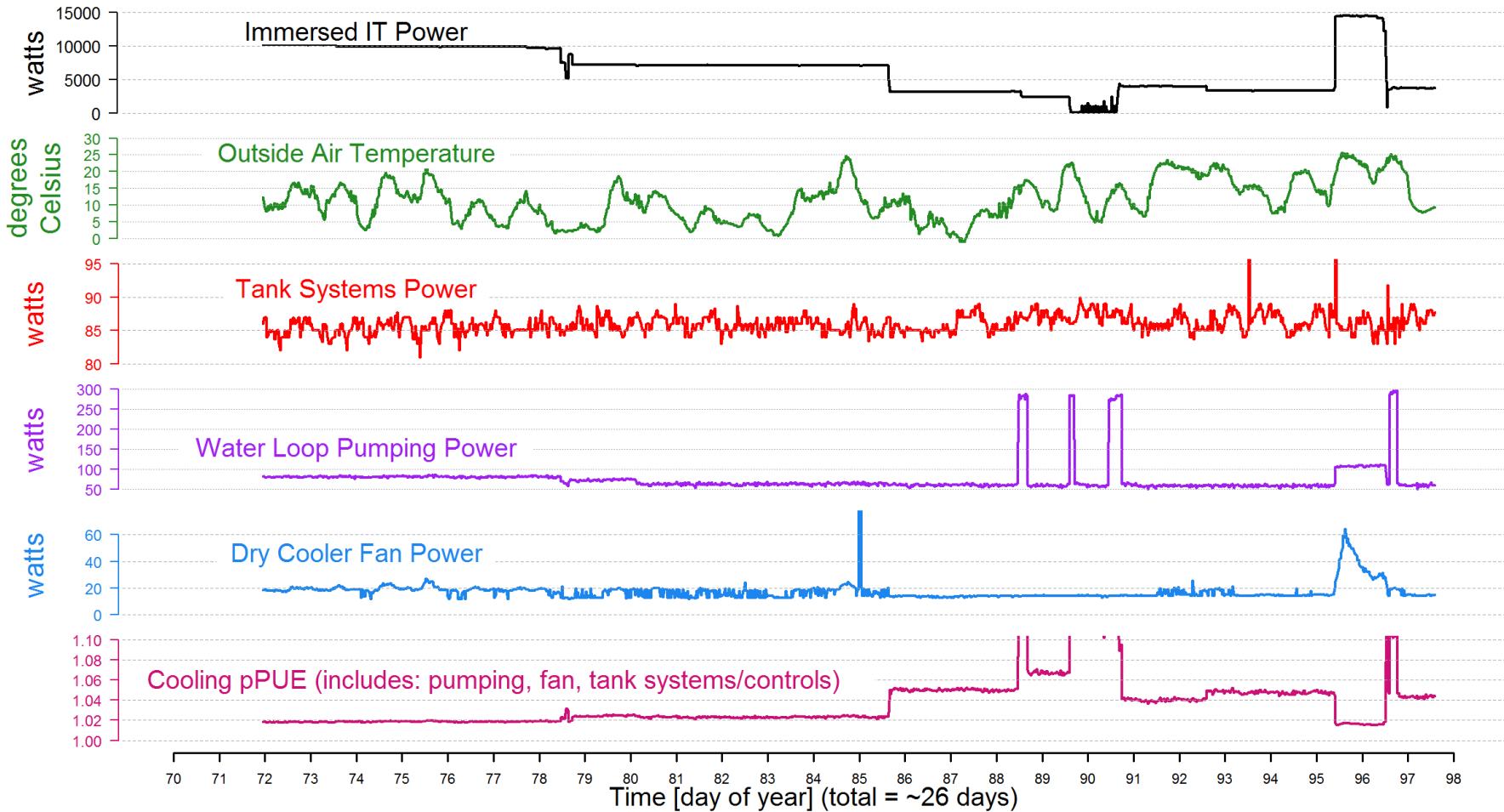
Future design

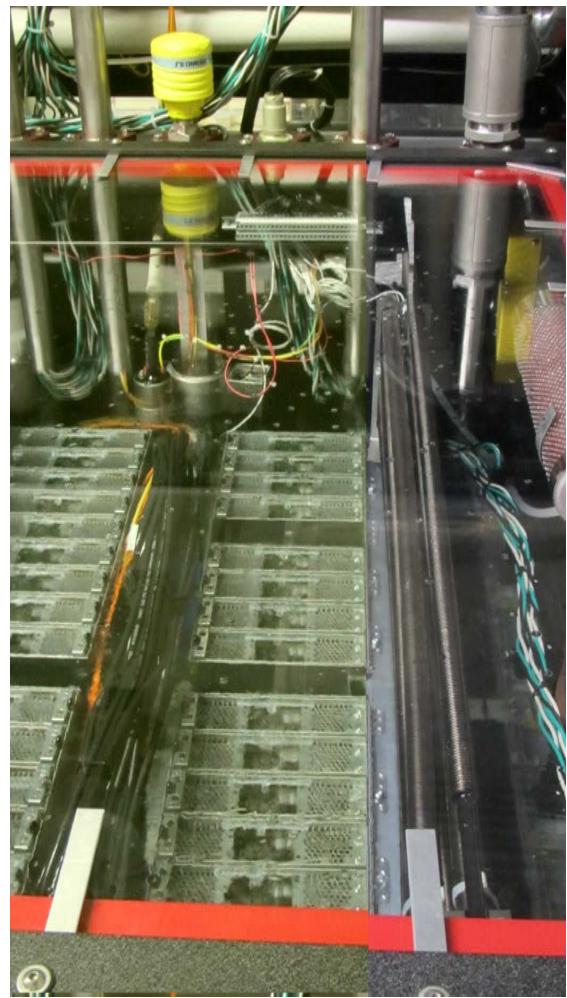
- To utilize existing air cooled designs:
 - Removal of fans
 - Add boiling enhanced coatings
 - Under-fill standard boards
 - Sealed disc drives or solid state memory
 - Preclean/scrubb
- To optimize performance:
 - Redesign boards/eliminate possible contamination sites
 - Layout enabling close, high-density equipment, while minimizing fluid required



Back up slides

NRL Immersion Demonstration Startup Sample Data
3/13/2015 23:00 to 4/8/2015 14:00 (~26 days)





OFF

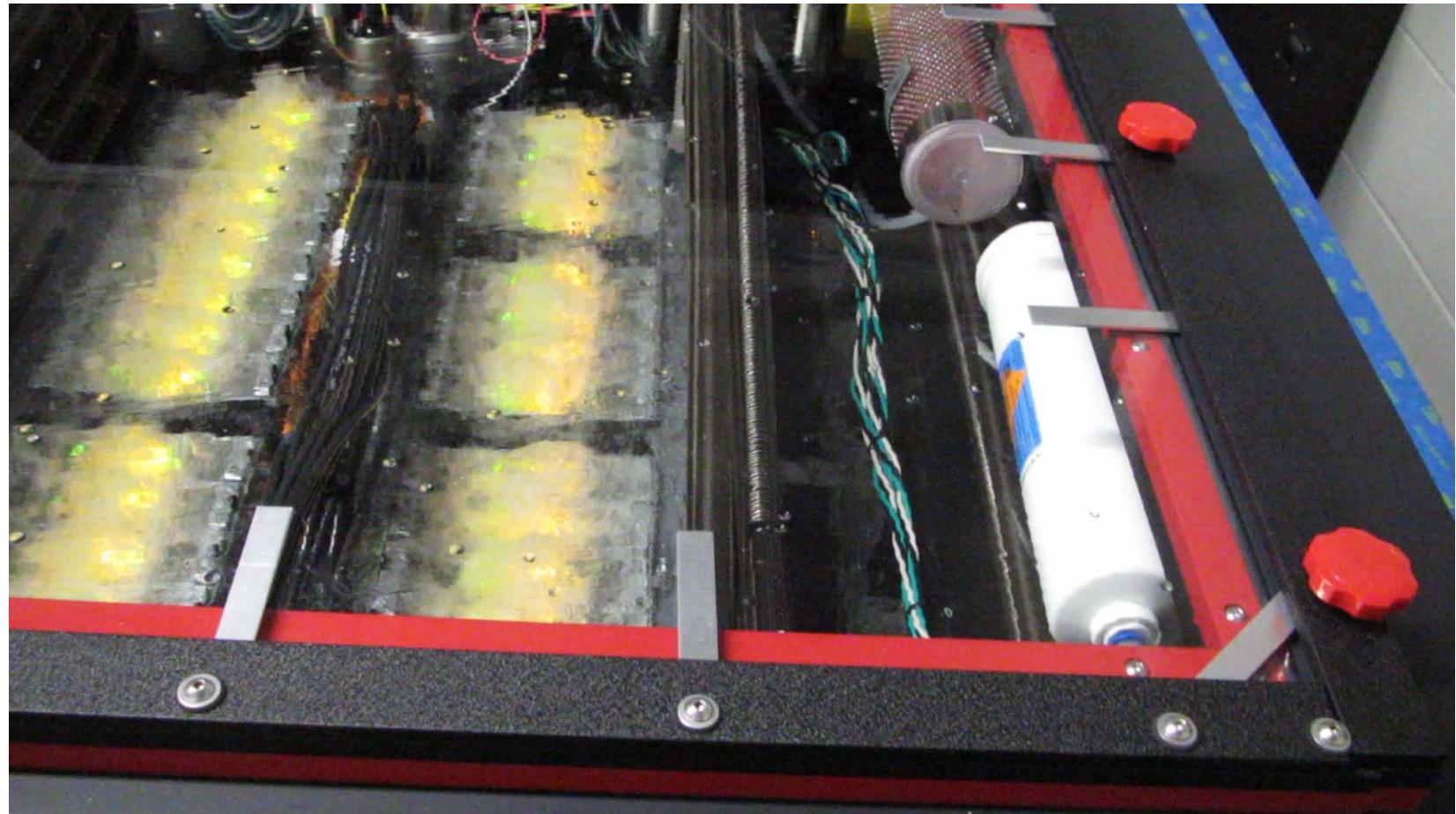


IDLE



LINPACK

Completed Immersion Tank - idle



Video of system at idle