

EcAMSat: Small Satellite to Examine E. coli's Response in Microgravity to the Antibiotic Gentamicin

National Aeronautics and
Space Administration



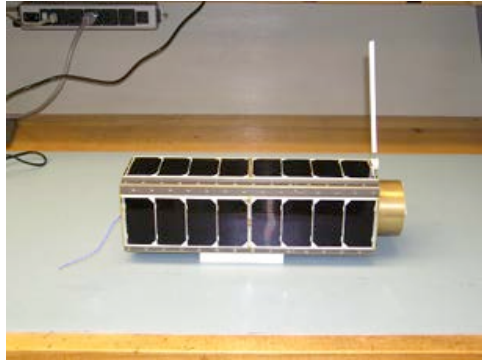
Matthew Lera
ASGSR
November 3, 2018



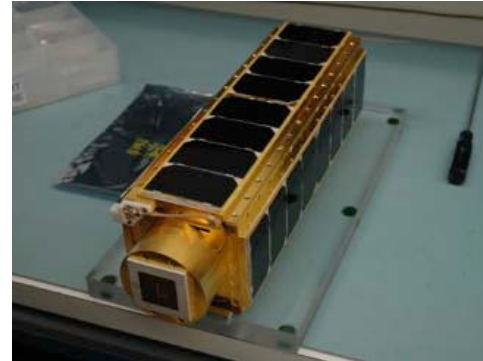
Michael R. Padgen, Matthew P. Lera, Macarena P. Parra, Antonio J. Ricco, Matthew Chin, Tori N. Chinn, Aaron Cohen, Charlie R. Friedericks, Michael B. Henschke, Timothy V. Snyder, Stevan M. Spremo, AC Matin

- **Immediate need to understand antibiotic resistance in microgravity**
 - Evidence that bacteria become more virulent and resistant than in normal gravity
 - Astronaut's immune system is compromised in microgravity
- **Model Organism: uropathogenic *Escherichia coli* (UPEC)**
 - Urinary tract infections have been reported in astronauts
 - WT and $\Delta rpoS$ mutant strains
 - Gentamicin has been used to treat UTI

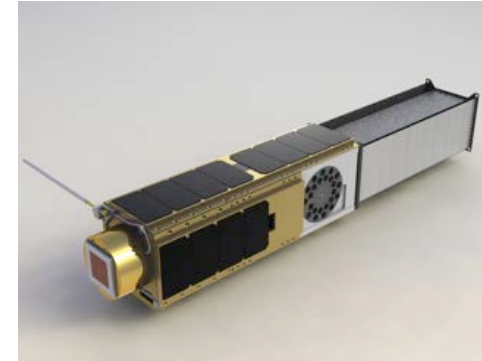
A History of Successful Bio NanoSats at Ames



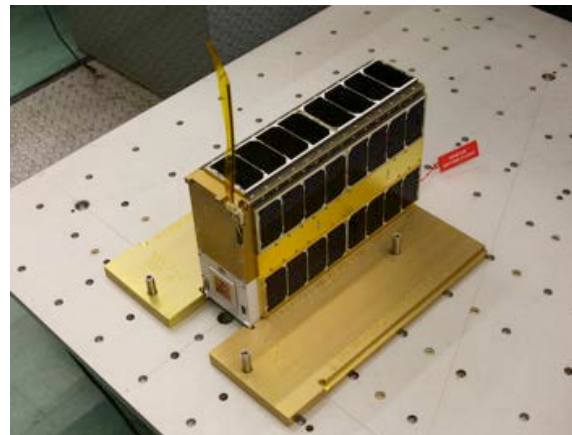
GeneSat-1 - 2006



PharmaSat- 2009

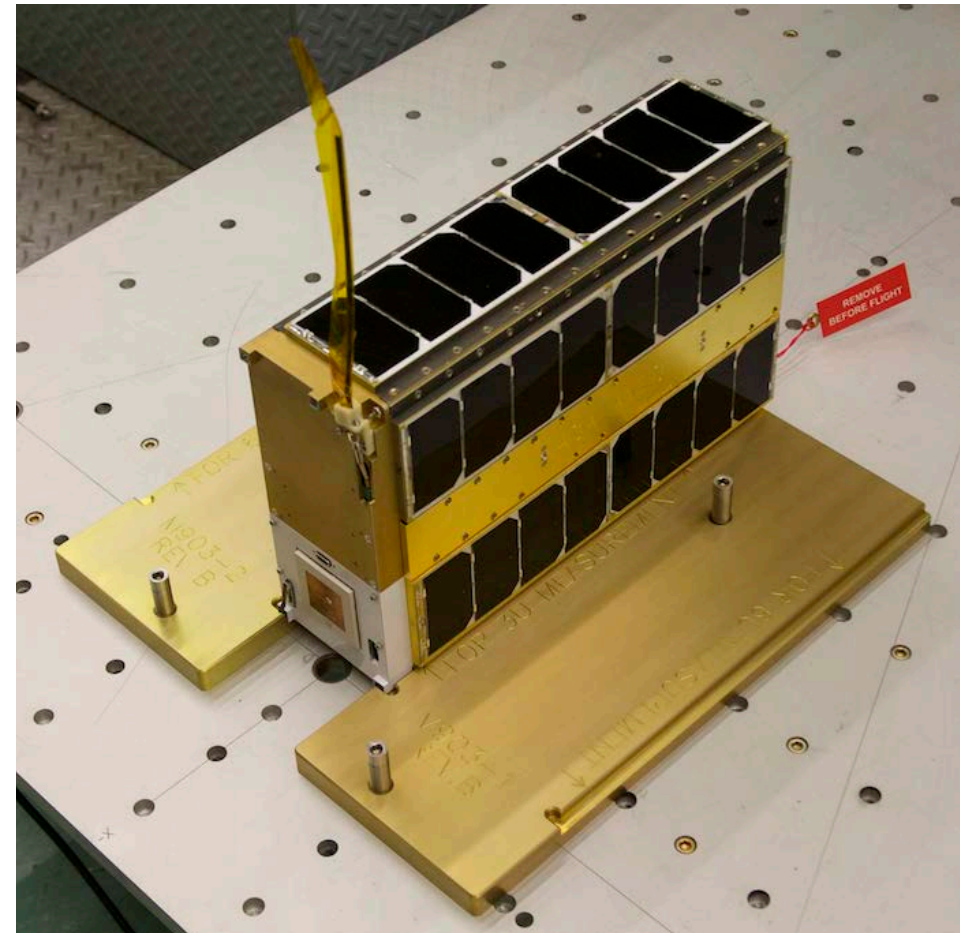


O/OREOS - 2010

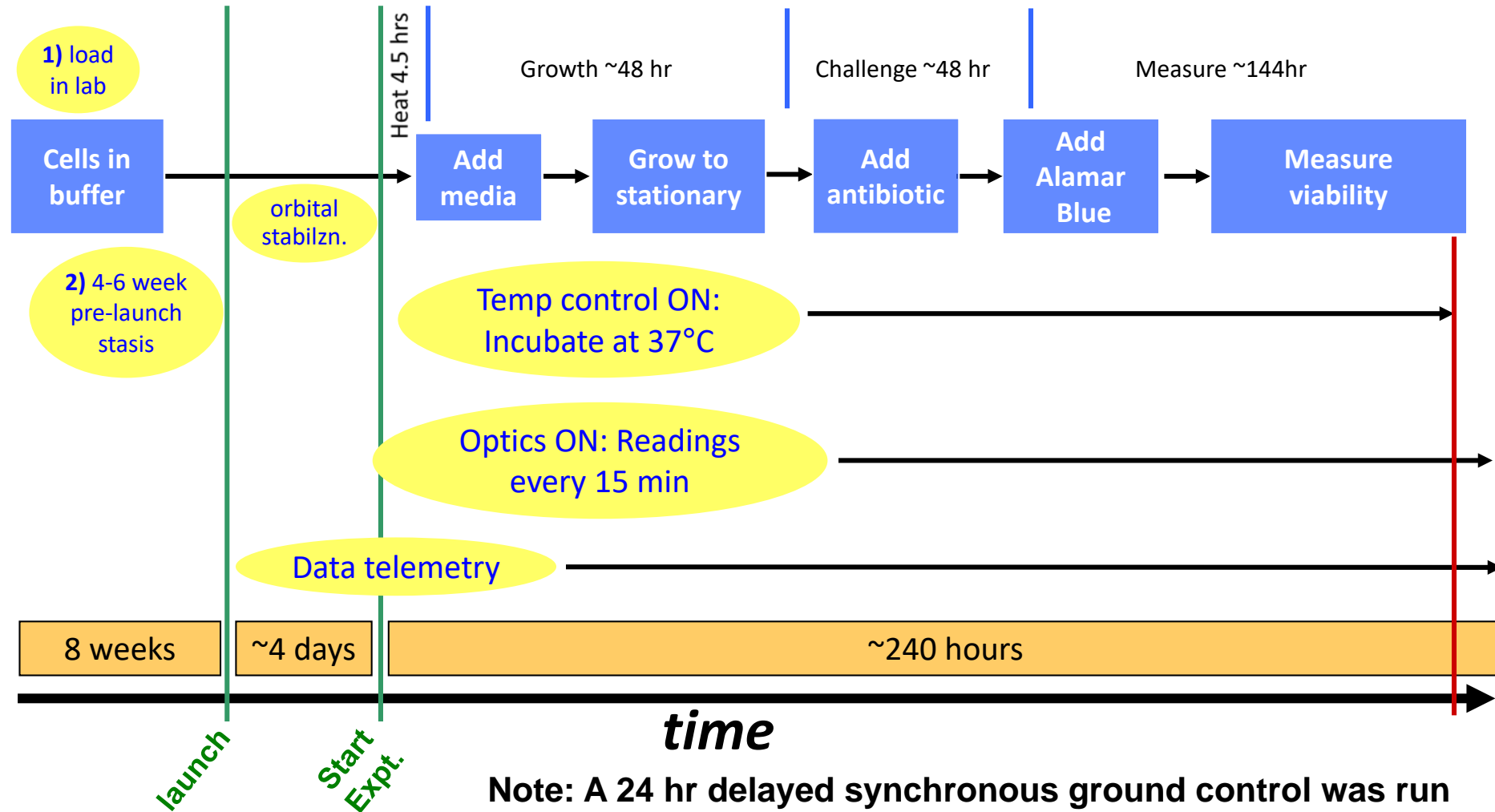


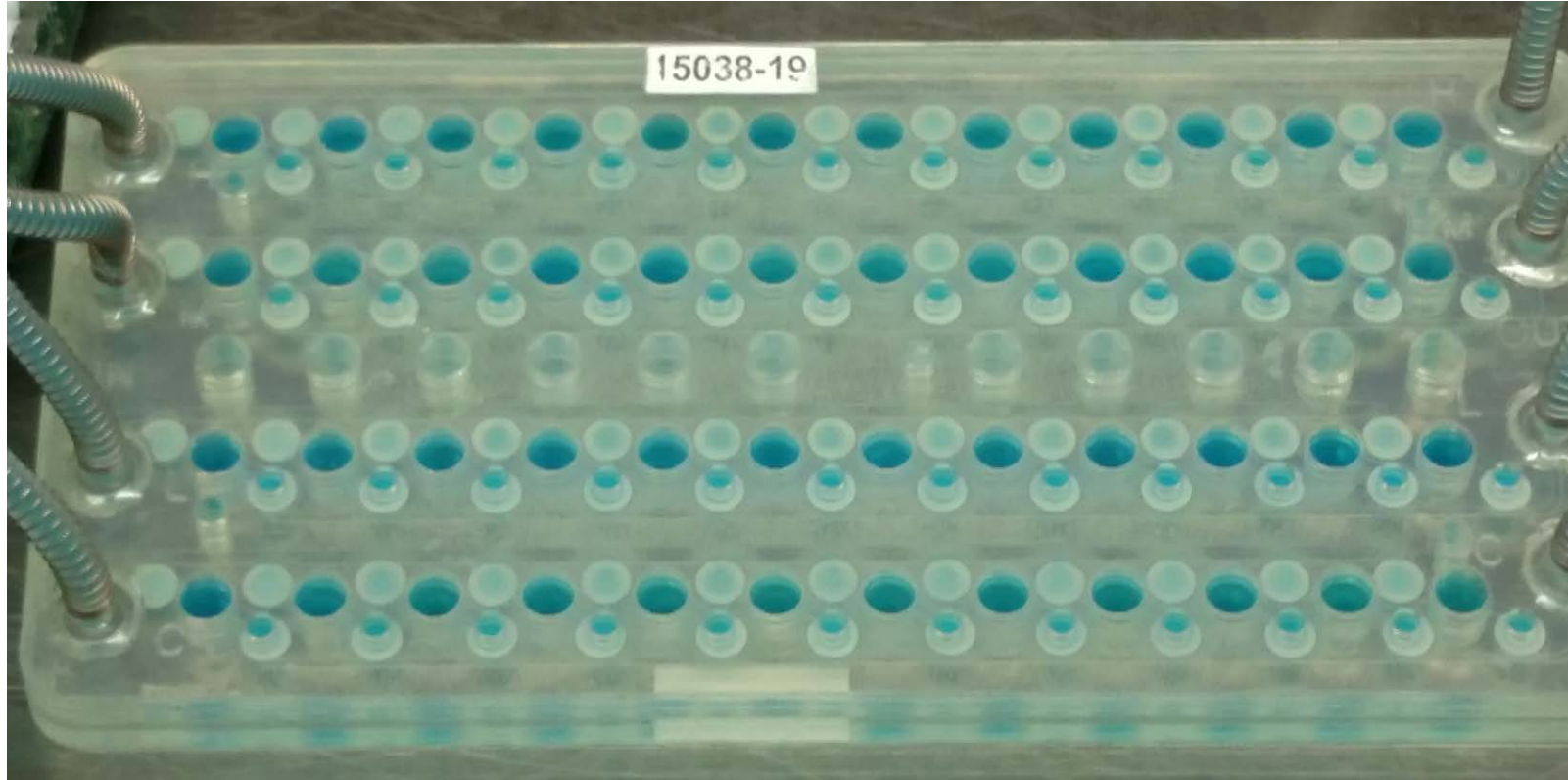
EcAMSat – 2017

- **Passive magnetic orientation**
- **UHF Beacon and S-band radio**
- **Extensive thermal power management testing and modeling**
- **Mission Ops run by Santa Clara University**

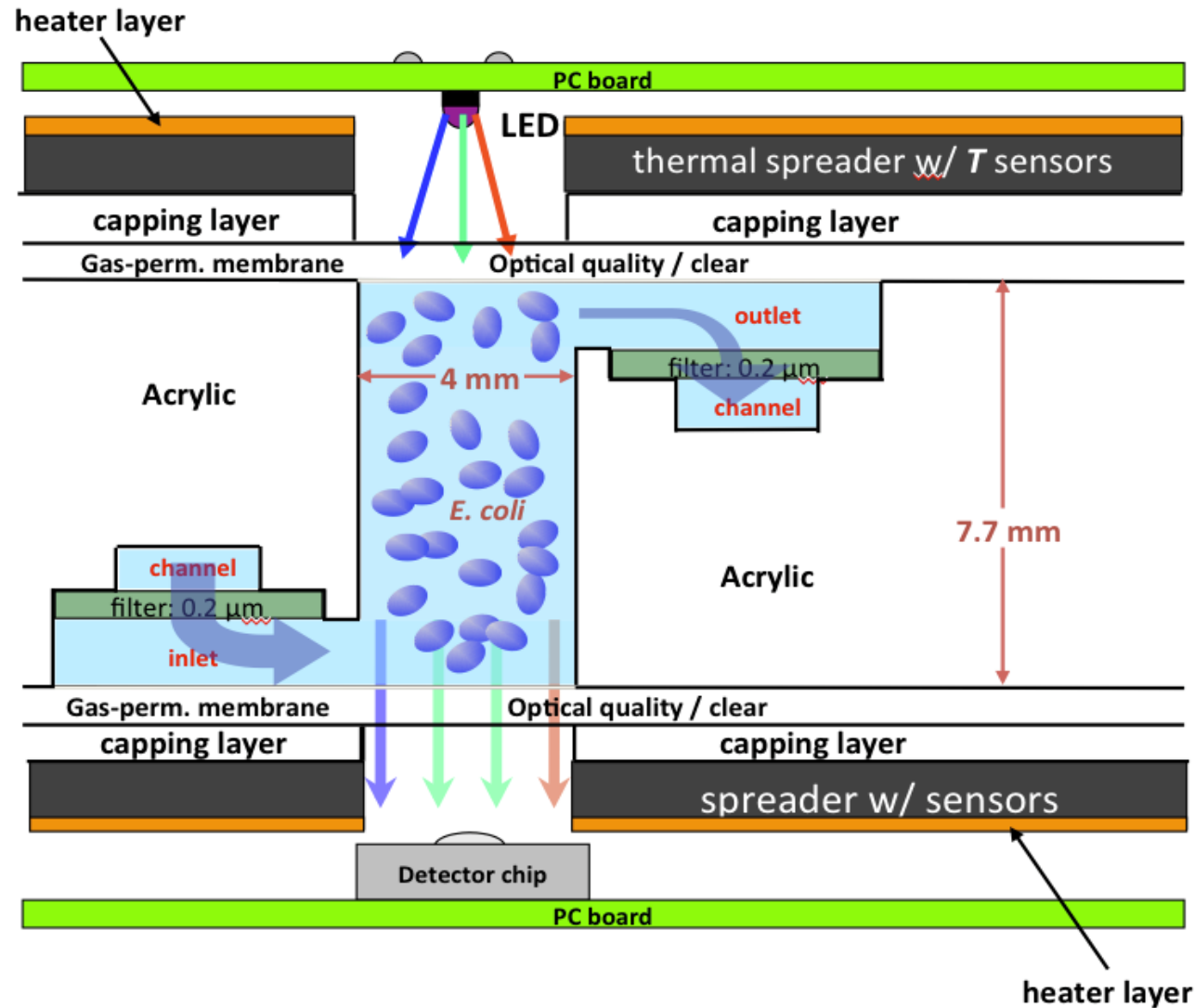


Experiment Design

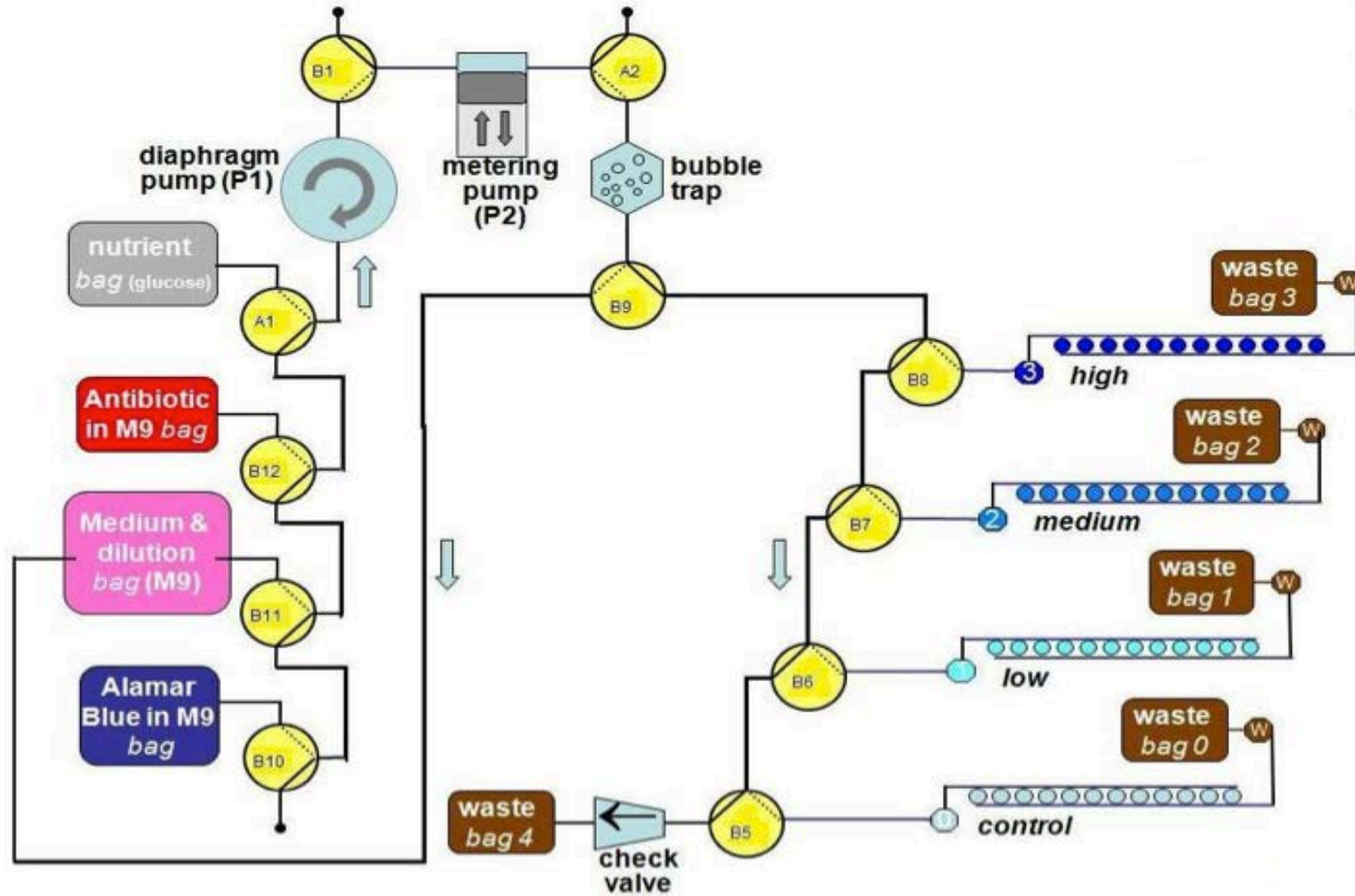




- Alternating wells loaded with WT and mutant strains
- Each bank receives different antibiotic dose

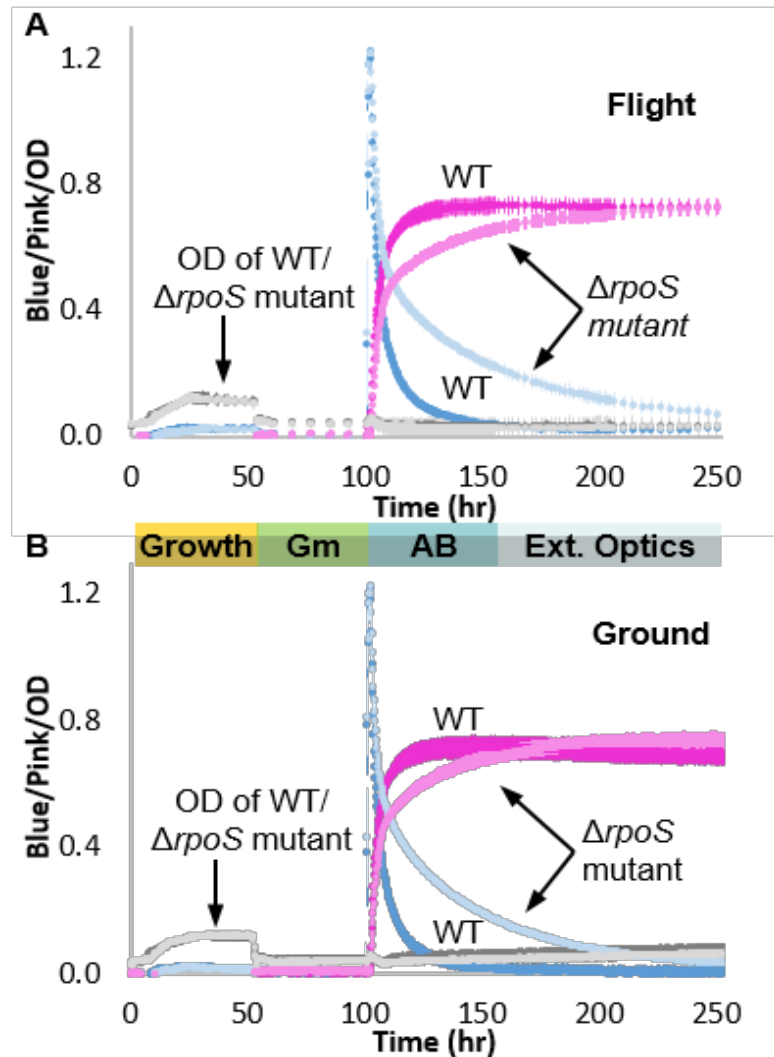


Fluidic System Schematic

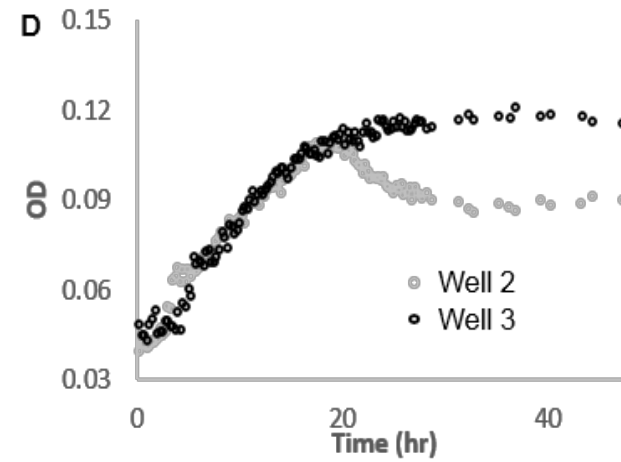
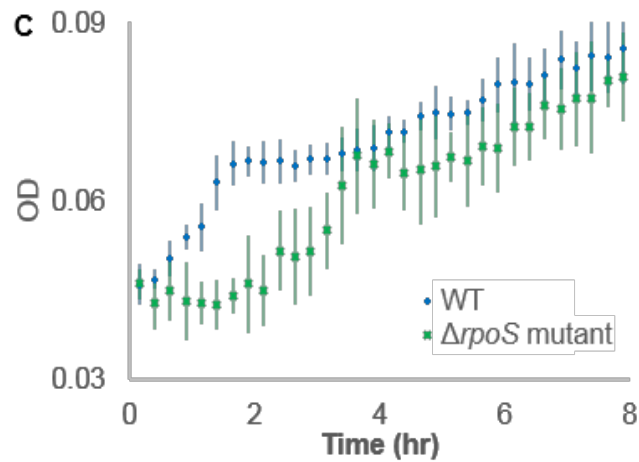
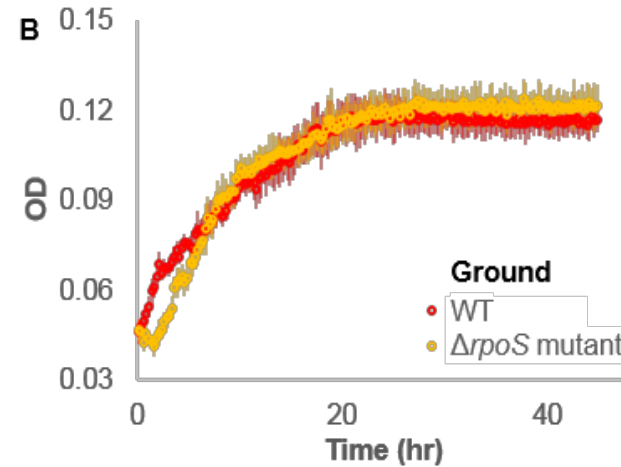
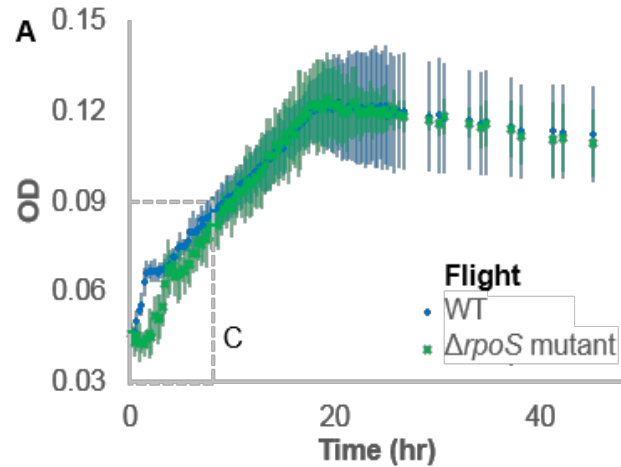




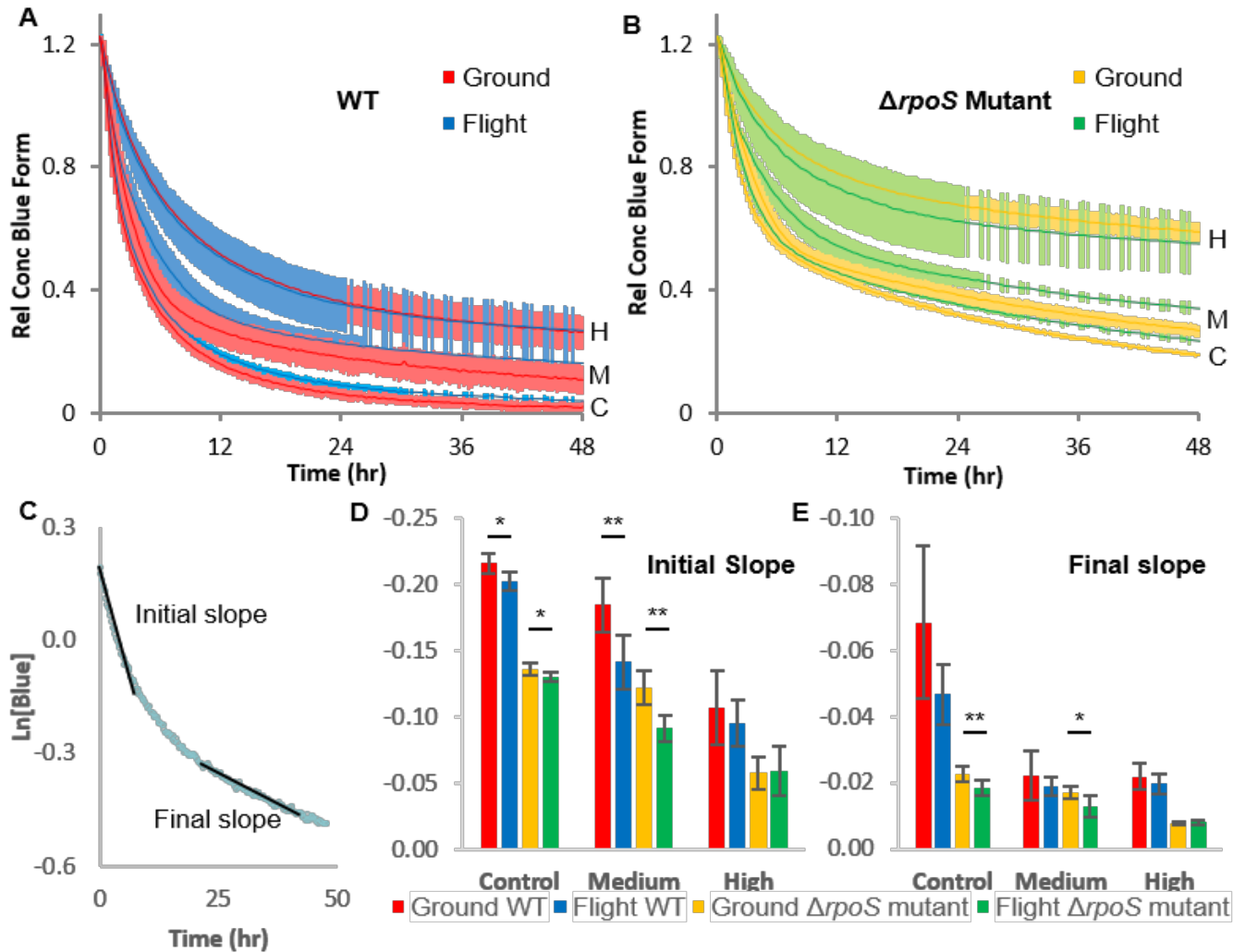
- **Launched on OA-8 mission – November 12, 2017**
- **Deployed from ISS on NanoRacks deployer – November 20, 2017**
- **Mission Ops conducted from Santa Clara University**



- The relative concentrations of the oxidized (Blue) and reduced (Pink) forms of AlamarBlue® are shown for Flight (top) and Ground (bottom).
- The cell OD throughout the experiment is also shown (gray)
- Control bank shown suggests no large differences in timing between flight and ground and no difference in baseline stress between card load and experiment initiation



- **Growth of single wells of WT and mutant in flight and ground**
- **Some wells in flight experienced a dip in OD while approaching stationary phase. Such wells were random and did not correlate to differences in AlamarBlue® reduction later in the experiment.**



- AlamarBlue® reduction shown for wildtype and mutant strains at no, medium, and high concentrations of gentamicin in flight and ground
- Averages of all banks showed a combined effect of microgravity and gentimicin on reducing AlamarBlue® reduction in the medium dose exposure
- No significant difference seen in high dose banks

- EcAMSat mission achieved full success, completing all required objectives.
- While the various stresses imposed on the cells by the payload hardware, by the antibiotic, and due to microgravity could not be completely separated, it appeared that the effect of microgravity was greatest for both strains in the medium Gm dose case.
- The largest difference between the two strains was at the high dose.
- The results demonstrate that the *rpoS* gene and its downstream products are important therapeutic targets for treating bacterial infections on Earth and in space.



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