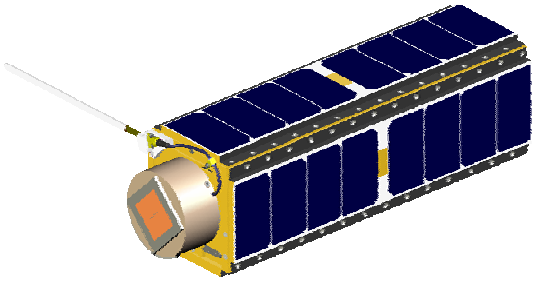
GeneSat-1
Quick Look Mission Report

Bruce Yost

Mission Manager

(650)691-0676

<byost@mail.arc.nasa.gov>



GeneSat-1 Project Team

- GeneSat-1Project M
  J. Hines
  NASA/ARC
  - Payload Segment
    C. Friedericks
    NASA/ARC
    - Technology System
      NASA/ARC
      NCSBT
      L&M Electronics
    - Biological Systems
      Sverdrup
      Lockheed-Martin
  - Space Segment
    C. Freidericks
    NASA/ARC
    - Satellite System
      NASA/ARC
      Sverdrup, ASRC Engin
      L&M Electronics
    - PPOD
      CalPoly SLO
  - MIssion Manageme
    B. Yost
    Defouw Engineerin
    - Launch Vehicle Integr
      NASA/ARC
    - Launch Servi
      - USAF/SDT
      - Orbital Scien
  - Ground Segment
    C. Kitts
    Santa Clara Univ.
    - Mission Operations C
      NASA/ARC
      Santa Clara Univ.
    - Ground Station
      Santa Clara Univ.
      SRI

ARC Engineering

JACOBS SVERDRUP

L&M Electronics

DEFOUW ENGINEERING

ASRC Engineering

LOCKHEED MARTIN
We never forget who we're working for™

Santa Clara University

CAL POLY

San José State UNIVERSITY

SRI International

GeneSat-1 Project Goals

Date: 4/20/07

Quick Look Mission Report

Presenter:
B. Yost

- Demonstrate utility of small, inexpensive spacecraft in support of NASA Exploration objectives
- Enable the capability to rapidly mature technologies to TRL 6-8
  - “System/subsystem model or prototype demonstration in a relevant environment” - (TRL 6)
- Pave the way forward for future autonomous, inexpensive missions, including lunar applications

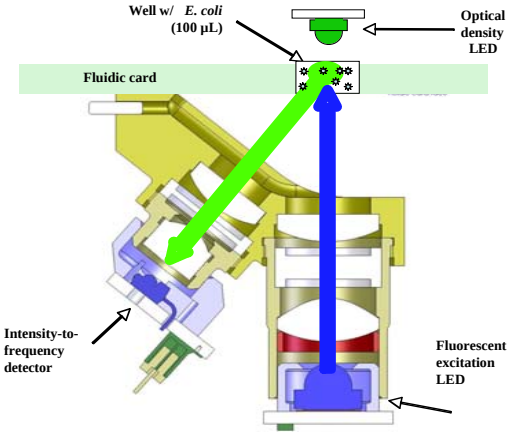
GeneSat-1 Mission Overview

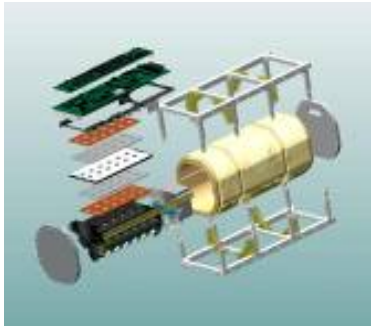
Quick Look Mission Report

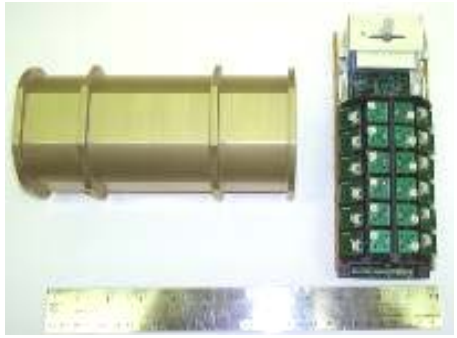
Date: 4/20/07

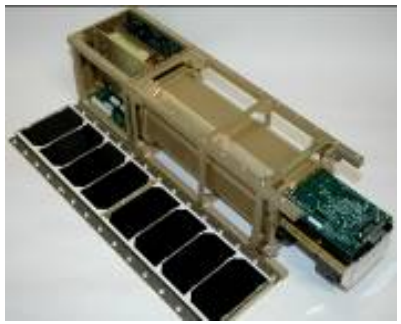
Presenter:
B. Yost

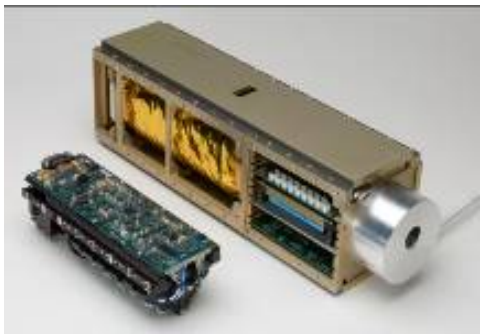
Total Mass (satellite + P-POD)	**7.1 kg (4.1+ 3 kg)**
Satellite Power (peak)	**4 - 5 W**
Satellite Volume	**3 "Cubes" (14" x 4" x 4") with beacon**
Science Data Downlink **E/PO Beacon/Data Downlink**	**~200 kB/day, ISM band (2.4 GHz)** **Amateur band (~437 MHz)**
Flight hardware Delivery	**11/13/2006**
Mission Duration **(spacecraft design life)**	**21 days** **(Experiment Duration ~ 100 hours)**
Orbit Altitude	**460 km**
Orbit Inclination	**40.5°**
Launch Vehicle	**Minotaur I (TacSat-2 Primary)**











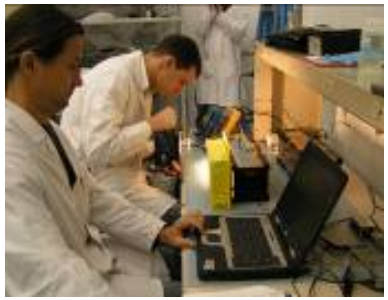
Integration Flow

Date: 4/20/07

Quick Look Mission Report

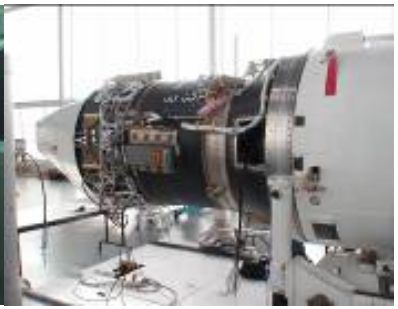
Presenter:
B. Yost

PPOD



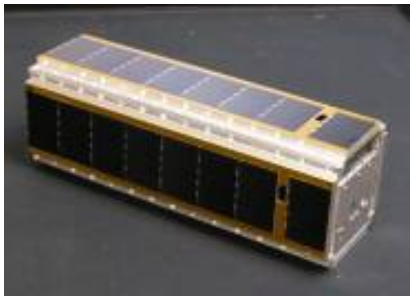
WFF Bldg. F7

WFF Bay W65



Minotaur I Upper Stage

GeneSat-1



+ GSE

Launch

WFF Pad 0B

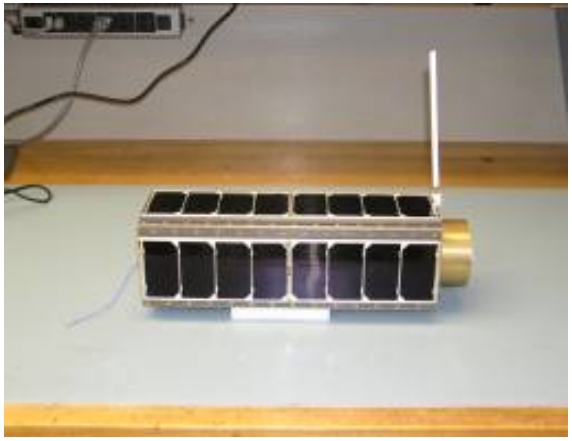
- **GeneSat-1 loaded at ARC (+ backup)**
- **Hand carry GeneSat(s), PPOD(s), & GSE to WFF**
- **Functional check (including radios)**
- **Fit check with PPOD and brackets**
- **Mount to LV**

Launch Summary

Date: 4/20/07

Quick Look Mission Report

Presenter:
B. Yost



- Launch December 16, 2006
  - Wallops Flight Facility
  - Minotaur 1 LV
  - USAF TacSat-2 primary payload
- Orbit insertion at 40.5⌗ inclination, 460 km circular
- Successful PPOD deployment
- Acquired beacon on first pass over western US (CalPoly)
  - First beacon data packets acquired by HAM operator in Iowa

Engineering Results	Date: 4/20/07
Quick Look Mission Report	Presenter: B. Yost

Satellite Bus Performance

- Temperatures were within nominal pre-flight models and predictions
- Power was adequate to execute all experiment protocols and satellite functions
- Flight software performed as designed - no resets observed
- Communications were adequate to allow for positive control of the spacecraft and experiment data downlink
- Passive attitude control system performed as designed
- PPOD deployer performed as designed

Payload Systems Performance

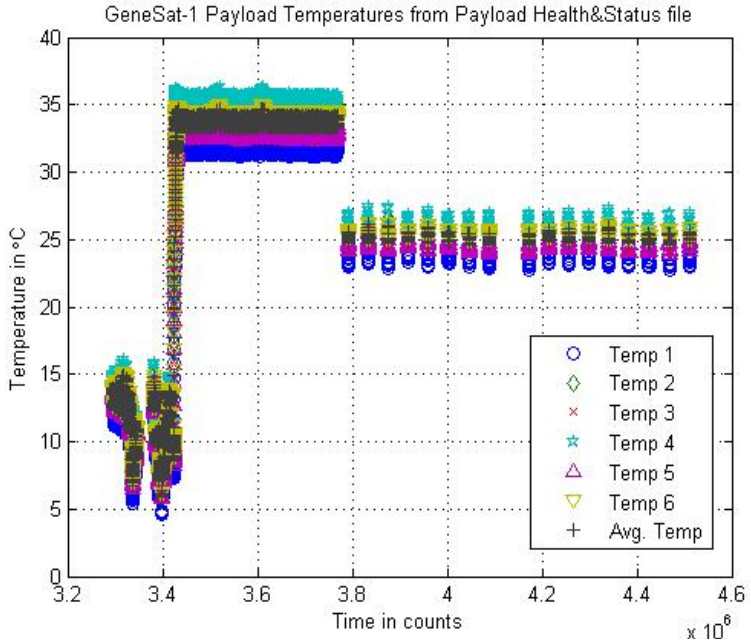
- Environmental control performed as designed allowing incubation of bacteria specimens
- Fluidics systems performed as designed
- All sensors performed as designed (temperature, RH, radiation, optical detectors)

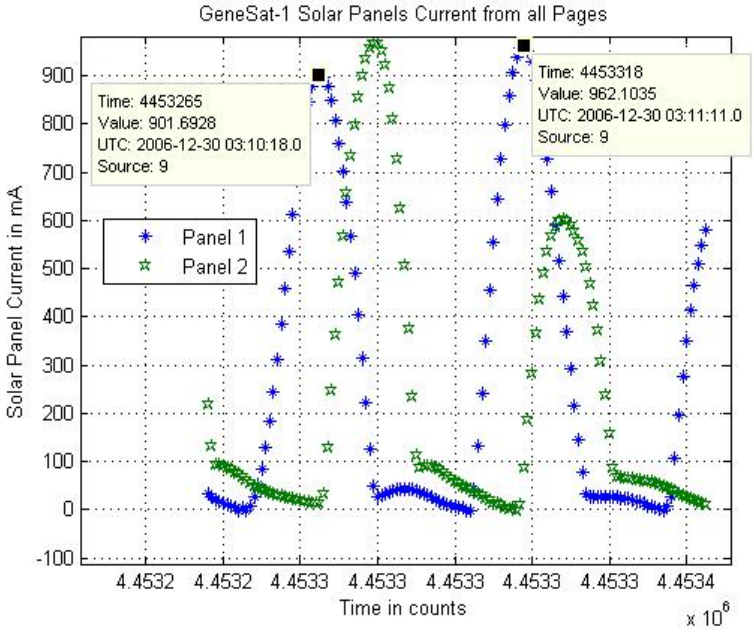
Engineering Results

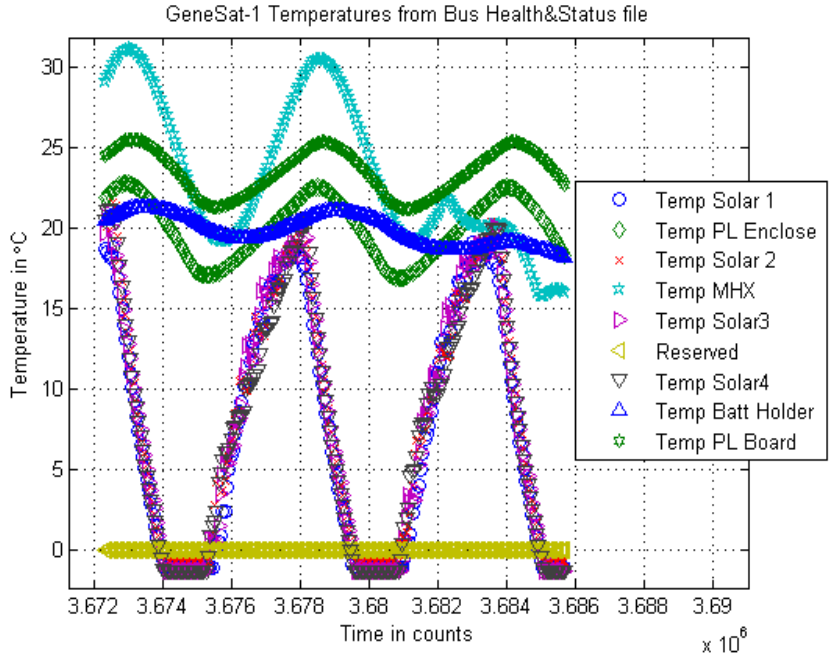
Date: 4/20/07

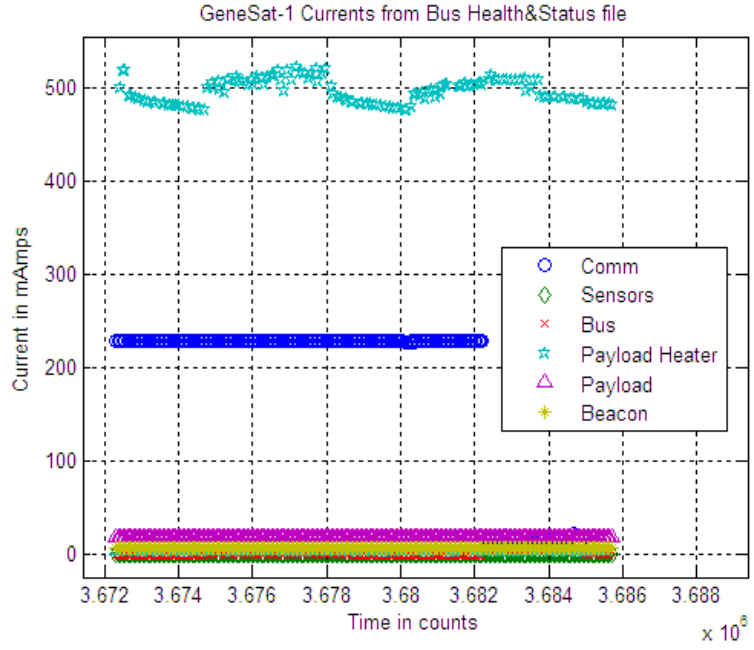
Quick Look Mission Report

Presenter:
B. Yost







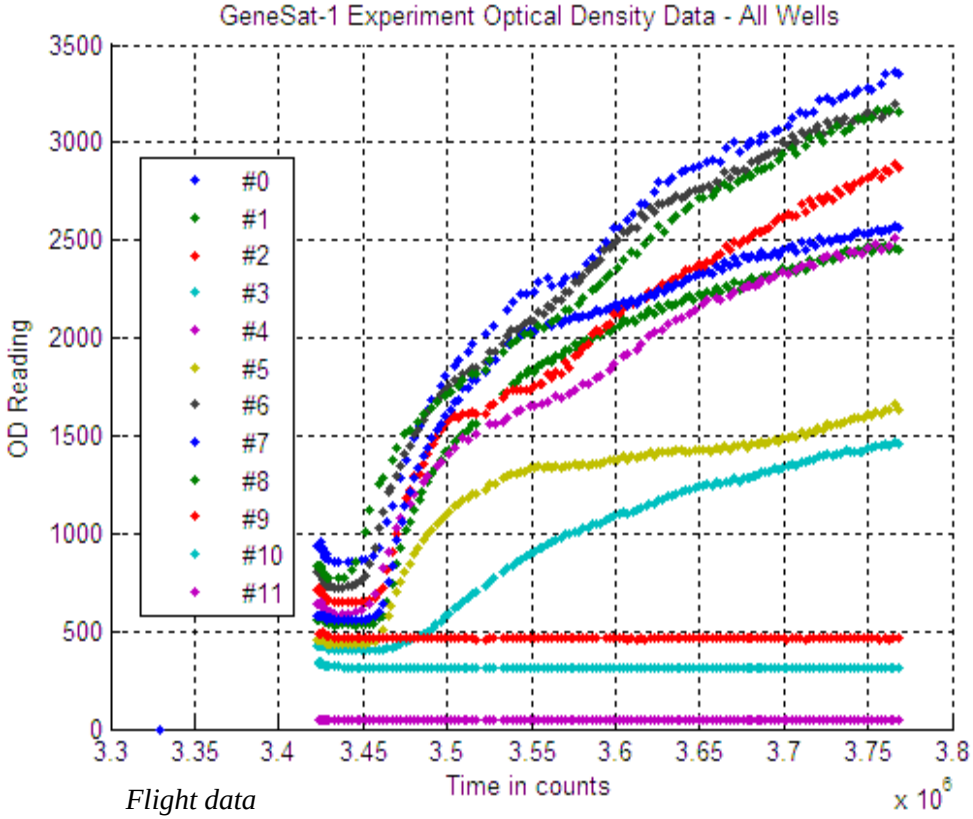


Biology Results

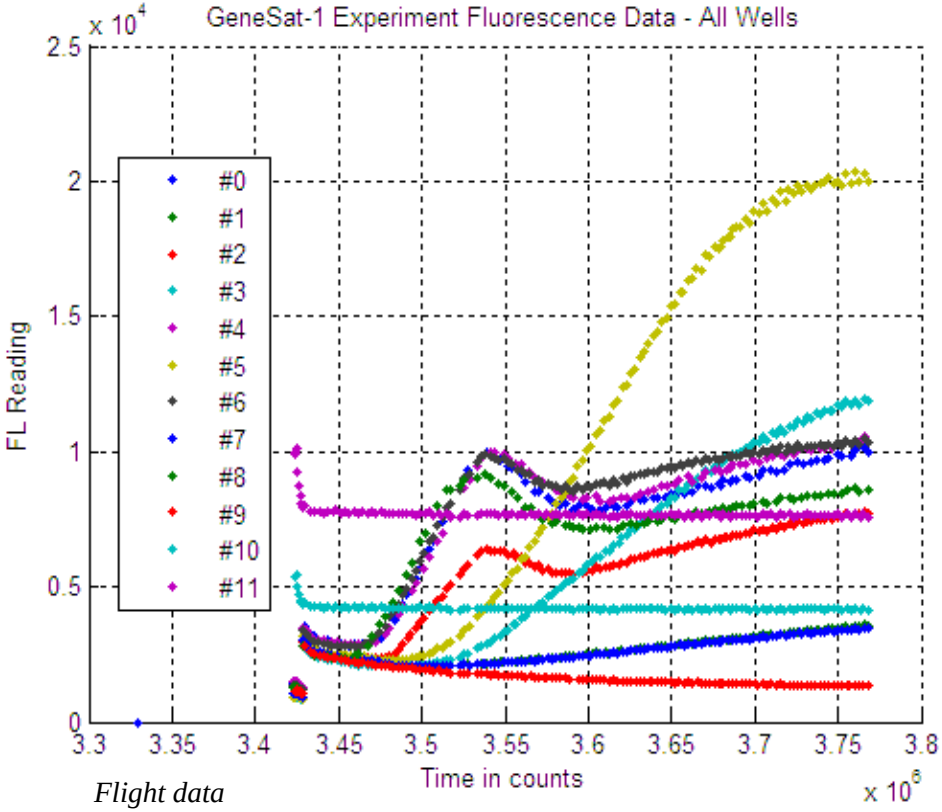
Date: 4/20/07

Quick Look Mission Report

Presenter:
B. Yost



Flight data



Flight data

- Bacteria growth (detected by optical density) occurred as expected
- Expression of GFP tag (detected by fluorescence detectors) occurred as expected
- Flight data are comparable with ground control data

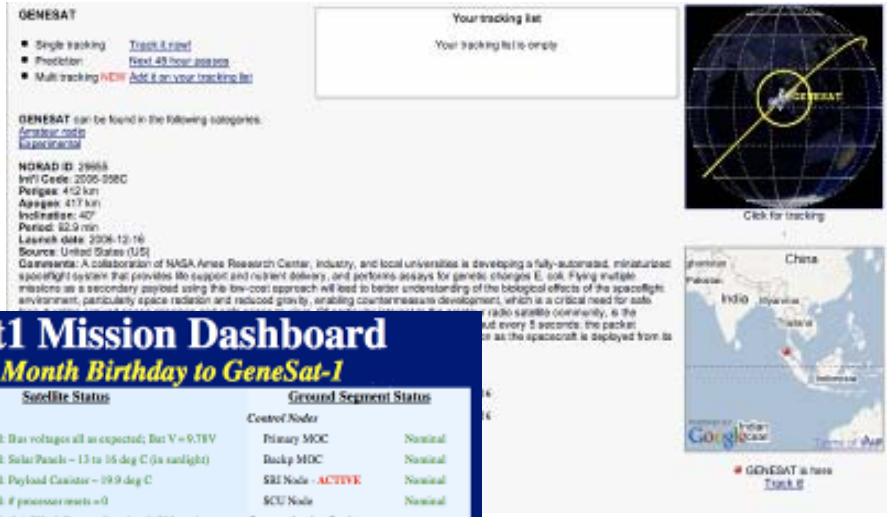
Ground Segment Status

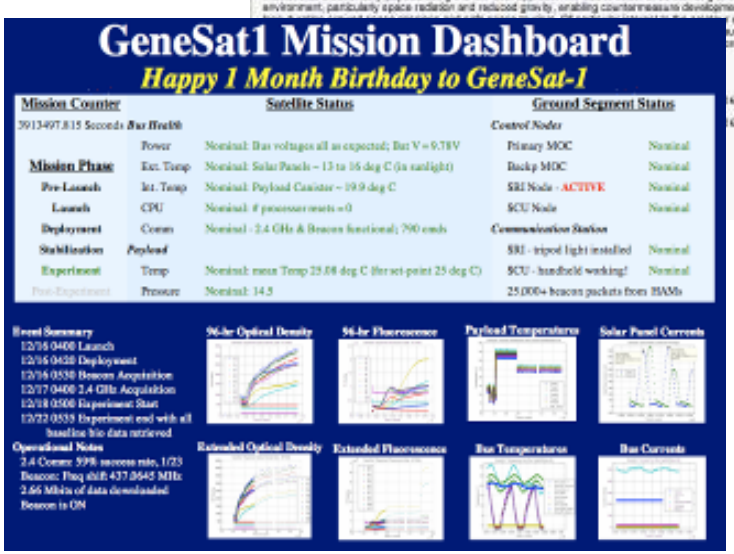
Date: 4/20/07

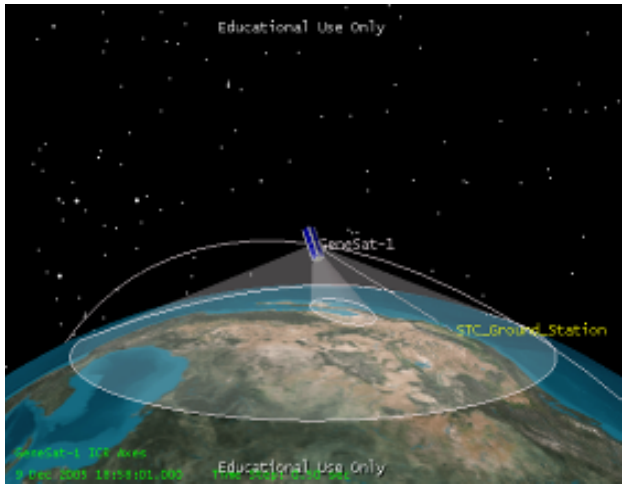
Quick Look Mission Report

Presenter:
B. Yost

- Ground station performed as designed
  - Minor issues resolved during mission
  - Spacecraft still under control
- Mission Dashboard for all to see
- HAM radio contest completed







Operations Summary

Date: 4/20/07

Quick Look Mission Report

Presenter:
B. Yost

Pre-Launch	• PPOD fit check and deploy test at VAFB • GeneSat-1 bio-loaded at ARC • GeneSat-1 integrated into PPOD at Wallops ~ L-30d • Experiment “armed” • PPOD + GeneSat-1 integrated onto LV • Encapsulation, stacking, and roll-out to Pad 0B
Launch	• GeneSat-1 “off”
Deployment	• GeneSat-1 ejection (following Minotaur CCAM) • Power switch enabled; GeneSat-1 activated • Locate (via beacon, NORAD)
Stabilization	• Establish 2-way communications with GeneSat-1 • Evaluate GeneSat-1 parameters (temps, power, µg)
Experiment Operations	• Activate experiment • Downlink and validate data
Education Mission	• Up to 6 months post-launch (ongoing)
Spacecraft Disposal	• Reentry within 1 year

Complete

Mission Success Criteria

Date: 4/20/07

Quick Look Mission Report

Presenter:
B. Yost

Criteria	Status	Comment
Satellite Autonomy	ACHIEVED	Automatic activation of satellite upon deployment, keep alive temperatures and experiment activation.
Accommodation of Advanced Sensors	ACHIEVED	Satellite accommodates sensor suite specified and operates all successfully. Also includes determination of radiation environment, and satellite rotation rates and microgravity environment.
Experiment Autonomy and Exploitation of Cellular or Microscopic Organisms	ACHIEVED	Biological systems detect growth upon experiment activation.
All technologies (sensors, satellite) ready for flight by 2006.	ACHIEVED	Qualification and testing complete for all systems.
System ready for launch and mission operations by Fall 2006.	ACHIEVED	Launch and delployment/operations began on December 16, 2006.
Fluorescent detection of GFP proteins	ACHIEVED	Optics successfully detected and recorded fluorescent signal from biological specimens.
Satellite mass <10kg	ACHIEVED	GeneSat-1 flyaway mass = 4.6 kg plus 2.25 kg for the PPOD (6.9 kg total)
Demonstrate secondary payload flight accommodations	ACHIEVED	GeneSat-1 was accommodated as a secondary payload on the Minotaur 1 launch vehicle.
Demonstrate sufficient power margin to operate experiment and satellite systems	ACHIEVED	Power margins remained positive throughout the entire phase 1 mission. Experiment data generated and downlinked.
Perform multi-redundant experiment for increased viability	ACHIEVED	Data were successfully returned form 8 independently sensed biological wells plus 2 calibration wells.

Mission Summary

Date: 4/20/07

Quick Look Mission Report

Presenter:
B. Yost

- **Flight segment performed as designed** √
- **Ground segment performed as designed** √
- **Launch segment performed as planned** √

- GeneSat-1 Team performance was exemplary
  - Interaction with launch vehicle teams was efficient and enjoyable
  - Able to fully integrate the University team members and amateur radio community
- Valuable relationships formed with USAF, NASA/WFF and other key contractors (Orbital, NEA)
  - This process is readily repeatable
- Mission Lessons Learned activity underway

Thanks to:

AFRL
The Air Force Research Laboratory

Wallops Flight Facility