Gene Sat 1

* Launched in Oct 2006
* Took three years from idea to launch
* Fully automated
* Contains onboard micro-lab systems:
  + Sensors and optical devices that monitor protein specimen on board satellite
* Purpose of the project is to further understand how space missions affect human body
* Weigghs 5kg
* Used the Minotaur I rockets (built by Northrop Grumman) to launch GeneSat I into low Earth Orbit.
  + There are three types of Minotaur. Each design to launch small satelites or other systems into different orbits
* Used E-coli as the onboard model organism

Space craft blue prints and specifications: <https://directory.eoportal.org/web/eoportal/satellite-missions/g/genesat>

* Mission requirements:
  + Autonomous flight
  + Able to carry sensors and payloads succesfully
  + Support speficif data collection and analysies (detecting levels of GFP in living creatures)
  + Investigate capabilities of small sats and broaden research on space tests and automation
* Payload: must regulate internal temp of +- 0.5 deg C. Information of space environment must be sensed and downlinked by spacecraft (space radiation, microgravity)
* 100mm x 100mm x 340mm
* Subsystems:
  + Altitude control (magnetometer, accelerometer, gyros, hysteresis rods)
  + C&DH
  + Solar Cells (4-5 Watts)
  + Secondary battery
  + Communication subsystems - Radio, antenna
  + Interface and payload subsystems
* Demarcation of bus and payload allows for independent design of each system and clear focal point for interfacing
* Interfacing of the bus and payload follow standards (what standards?)
* Structure Frame: 7075 Aluminum square tube stock serves as a thermal radiation surface for the payload and substrate for the solar cells. - can use alternate aluminum alloy with corrosion resistivity, strength, machinability for cheaper (8020?)
* Mechanical interface between the bus ad payload uses an interlocking ‘feet’ architecture.
* Bus Module Structure: PCB slots for each sub systems (C&DH, Battery, Power, Interface, etc)
* Internal communication between devices uses I2C (inter integrated circuit) protocol standard with clock rate of 100 kHz
* Solar Cells: total area of 224 cm^2 efficiency of 28.3%. Each panel (x4) provides 0.92A at perpendicular angle with the sun outputting a total of 8.2 W
* Lithiom ion Batteries: used for support with sun rays are at an angle with the solar cells. Battery pack configured to output 7.2V and capacity of 4.3 Ah
* Power flow: Power supply (solar cells or battery pack) → regulators → sensors/boards
* Attitude Control: set of permanent magnets and hysteresis rods mounted on the S/C body panel to detect Earth's magnetic field while in LEO. Uses 3-axis gyros and accelerometers, sun sensor (employed in solar cells) to detect overall microgravity
* Uses PIC18 microcontroller. Bulk memory is Flash
* Mission duration = 21 days ~ 100 hours
* Circular orbit at 460 km altitude, 40.5 degrees inclination
* Communication between satellite and ground station via S-band (2.4 Ghz) which is then relayed to MOC (Missio operation Centre) located in NASA/ARC via internet link.
  + \*\*Amateur band beacon downlink (UHF bad) available for education and outreach association → can we use this?
* The satellite payload complexity, miniaturization, and automation set a benchmark for spacecraft of this class
* Communicatio established after 2nd day of orbit. Analyse vehicle health before proceeding with biological experiments which commenced after 2 days in orbit. Experiments executed autonomously for the next 4 days. Complete baseline experiment data dowlinked to ground station
* Payload
* Pressurized, sealed vessel, cylinder containing samples, optical sensors, electrical mechanical subsystems, heaters, controllers, humidity controls, LEDs, fully autonomous,
* Consists of 12 fluidics plate with 12 custom optical units for GFP (green fluorescent protein) growth and growth rate measurements
* Fluidics assembly designed by NASA/ARC (custom fit) with pumps, valves, microchannels, fillers, membranes.
* The integrated analytics assembly sounds complicated af. We can simplify it down
* Maintained at atmospheric temperature and 90% humidity and 35 deg C +- 0.5 deg C
* Once in orbit and vehicle health is good, fluids from wells are released to mix together with sugars and react and shit
* Depending on what biological experiments we do, the electrical and mechanical subsystems on the payload will have to be accomodated
* Ground station
* Communicates with a dedicated communication station of SRI International with an 18 m parabolic antenna