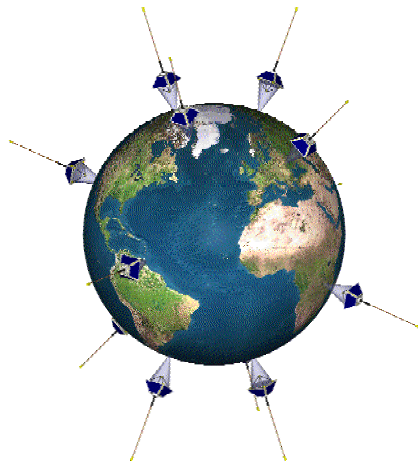


Space GNSS Activities at Surrey

Maarten (Max) Meerman
Dr Martin J Unwin
Scott Gleason



GAMBLE workshop
7-8 November
Delft, the Netherlands

SSTL Space GNSS history



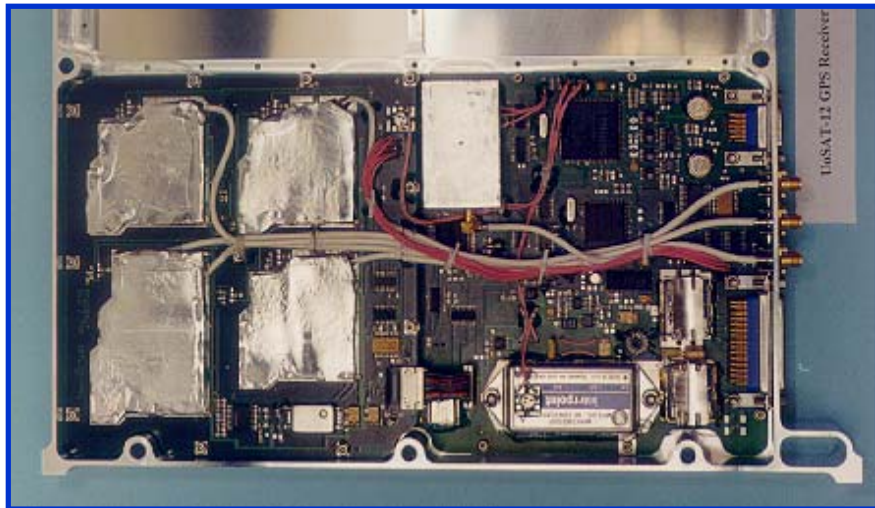
- First *microsatellite* to use GPS in space
 - PoSAT-1 (Portugal & SSTL)
 - orbit since Sept 1993
- Uses Trimble TANS II 6 channel receiver
 - Avionics receiver
 - Modified firmware
- Still operational in 2000+
 - Experiment cost ~\$20k

- First demonstration of autonomous orbit determination
 - Orbital elements generated onboard
- Similar experiments on FASat-Alfa & Bravo satellites: 1995, 1998



WWW.SSTL.CO.UK

- Designed by SSTL in collaboration with ESA
 - Jointly funded: SSTL and ESA, 1996
- Based on cots GEC Plessey (Zarlink) ASICs
 - Core parts radiation tested in programme with ESA (~10KRads)
- Low cost, rapid design
 - Flight hardware integrated in TMSAT within 12 months of contract signing



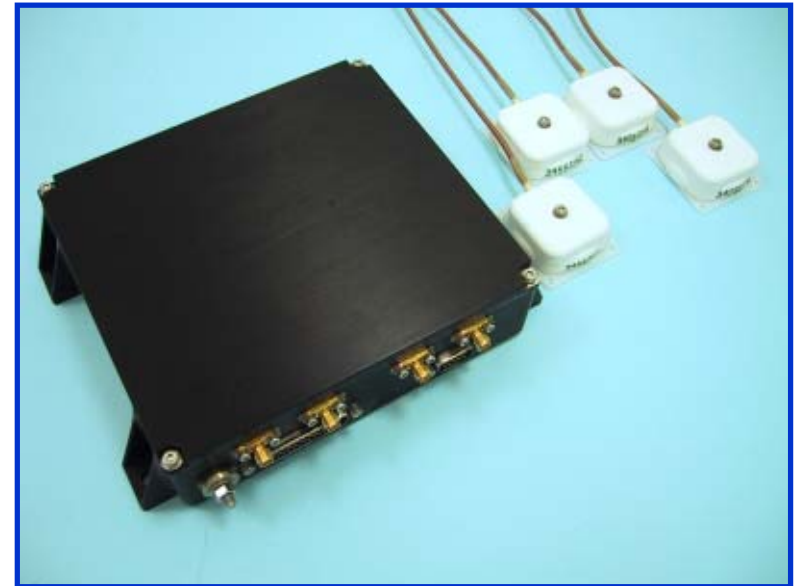
UoSAT-12 SGR-20

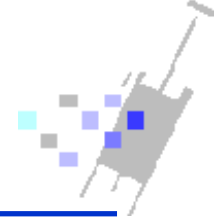
- ◆ HW & SW refinements continued
- ◆ Key demonstration on UoSAT-12 Minisat, 1999
- ◆ Autonomous operation for over 3 years
- ◆ Experiments continue



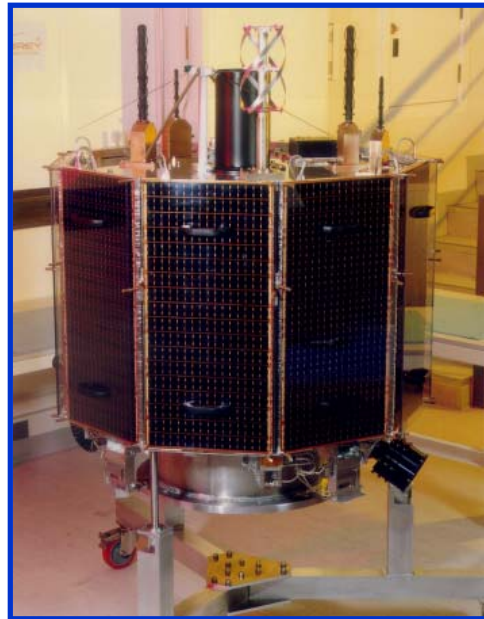
WWW.SSTL.CO.UK

- 24 channel C/A Code, 2-4 antennas, 1 kg, 6 W
- Accurate position, velocity & time
- Fast TTFF (< 4 minute cold start)
- Attitude determination: < 1 degree demonstrated
- In orbit:
 - TMSAT, Tiungsat, Tsinghua, UoSAT-12, PROBA-1
- Manufactured for:
 - Spacehab (ISS), Alsat, UK DMC, TOPSAT, Bilsat, Nigeriasat
- Selected for:
 - **OSC / NASA DART** rendezvous mission & RapidEye constellation

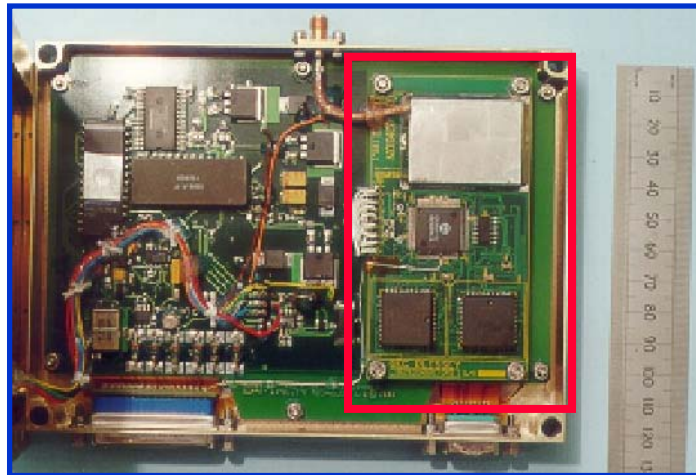




- UoSAT-12 GPS experiment still fully operational
 - Highly flexible architecture, software uploadable
 - Analytical (and numerical) estimators for orbit determination
- Achieved many milestones
 - Most satellites tracked in orbit, fastest time to first fix, etc.
- Reliable operations of COTS sub-system proven
 - Demonstrated autonomous orbit control for > 1 year

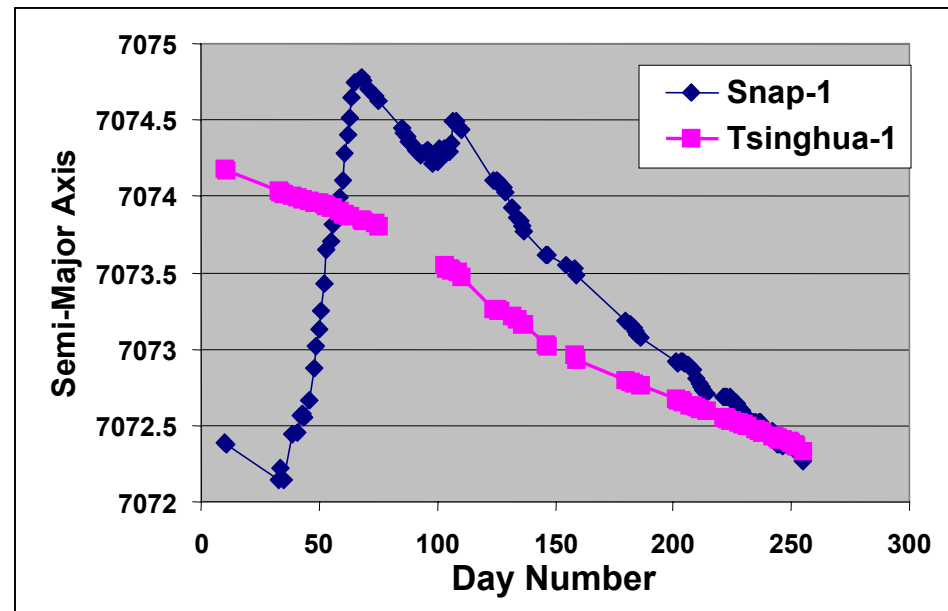


- Demonstrated 1 degree attitude determination
 - Attitude development program ongoing



- Smallest GPS Receiver flown in space
 - Based on Mitel Orion
 - Minimal peripherals
 - 50 g, 2 watts
- Flown on SNAP-1
 - 6.5 kg nanosatellite
 - Launched 2000

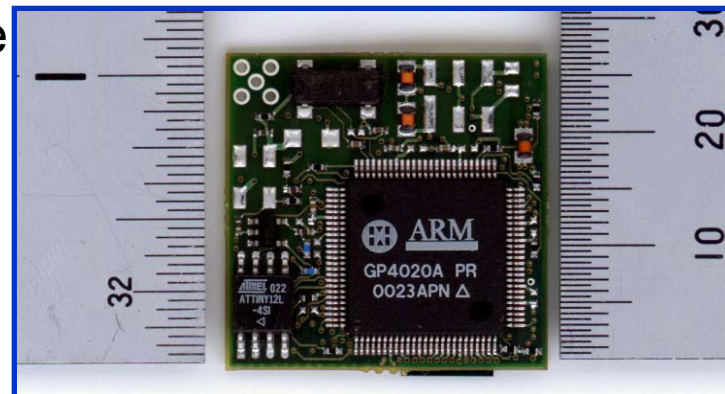
- SNAP demonstrated chasing of Tsinghua-1 (also carrying SGR)
- Orbit raised to rendezvous with satellite
- GPS used to update orbital elements
- GPS operating for 1.5+ years



Delft 7-8 November 2002



- New version of SGR-05 under design
 - Based on latest Zarlink chipset
- Comprises integrated ARM and correlator
- Smaller, low cost and v. low power: **0.5 watts**
- Radiation tests underway:
 - System tolerates Total Dose > **11 kRads (Si)**
 - SEU tests planning in collaboration with Qinetiq and ESA
- Initially single antenna design
 - Multiple





■ Mean position errors

- Along track: 1.1 meters
- Cross track: 1.0 meters
- Radial: 2.1 meters
- Total mean error: 2.8 meters; 1-sigma: 1.5 meters

■ Mean velocity errors

- Along track: 0.1 m/s
- Cross track: 0.1 m/s
- Radial: 0.6 m/s
- Total mean error: 0.6 m/s; 1-sigma: 0.1 m/s

■ Timing

- PPS aligned to within 1 microsecond of the GPS second

■ Attitude (based on ground processing)

- Roll: 0.6 degrees (1-sigma rms)
- Pitch: 0.9 degrees (1-sigma rms)
- Yaw: 0.8 degrees (1-sigma rms)

■ Mean GPS tracked: 10

Future Directions



- **Attitude Determination applications**
 - Tests on UoSAT-12, Future satellites: TOPSAT, Bilsat
- **Operation in GEO (for SSTL-Gemini mission)**
 - Physically small receiver needs little tantalum screening to achieve high radiation tolerance
- **Nanosatellite oceanographic GPS reflections, remote sensing**
 - Reflectometry experiment to be launched on UK-DMC in 2003
- **Formation Flying, Pseudolites & reception**
- **Low Cost applications of GNSS Technology using COTS technology**
 - Pushing boundary between COTS and “rad-hard” applications

Questions?

