

Considerations for the Next GNSS Array

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Scott Wetzel, Ed Aaron
Honeywell Technology Solutions Inc
Lanham, Maryland USA
scott.wetzel@honeywell.com



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ILRS Recommendations for GNSS Retroreflectors

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FROM THE ILRS WEB SITE:

http://ilrs.gsfc.nasa.gov/docs/ILRSRetroreflectorStandards_200812.pdf



ILRS Retroreflector Standards for GNSS Satellites

- Retroreflector payloads for GNSS satellites in the neighborhood 20,000 km altitude should have a minimum “effective cross-section” of 100 million sq. meters (5 times that of GPS-35 and -36)
- Retroreflector payloads for GNSS satellites in higher or lower orbits should have a minimum “effective cross-section” scaled to compensate for the R^{**4} increase or decrease in signal strength
- The parameters necessary for the precise definition of the vectors between the effective reflection plane, the radiometric antenna phase center and the center of mass of the spacecraft should be specified and maintained to support a range accuracy of better than 0.1 ppb.

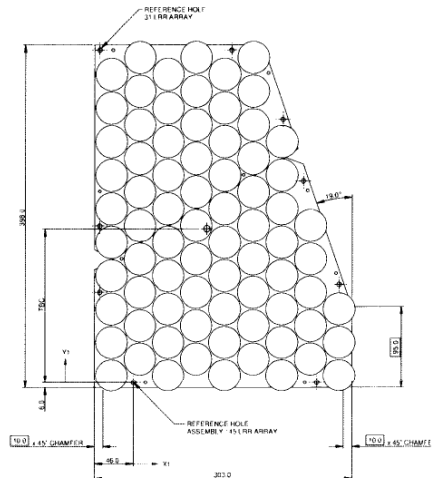
GNSS Satellites



GPS 35, 36
32 * 36 mm cubes
Al Coated Cubes
20,000 km orbit
50 deg inclination



COMPASS M1
42 * 33 mm cubes
TIR Cubes
21,500 km orbit
55 deg inclination



Extracted from of [ESA Specification Document](#)

GIOVE-A&B
72 * 27 mm cubes
Al Coated Cubes
24,000 km orbit
56 deg inclination



QZS-1GPS 35,
56 * 40.6 mm cubes
TIR Cubes
32K – 40K Km orbit
45 deg inclination



GLONASS
Various config.
19,100 km orbit
65 deg inclination

A Candidate Solution for New GNSS Satellites

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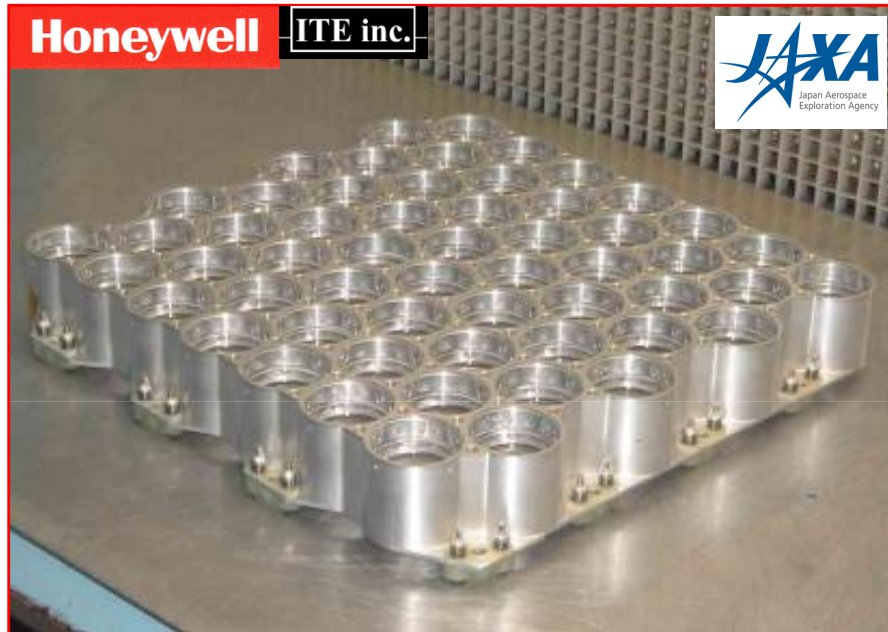


- **ETS-VIII LRA**

- 36 - 4.06 cm cube corners
- Geostationary Orbit
- Optical Cross Section – 178 million m²
- Very good results by WPLTN Stations
 - Tanegashima
 - Yarragadee
 - Changchun
 - Mt. Stromlo
 - Koganei
- Launched: Mar 10, 2007
- Suggested candidate space on GPSIII
- Proven on orbit asset
- Strong signal at GPS Altitude

A Candidate Solution for Higher GNSS Satellites

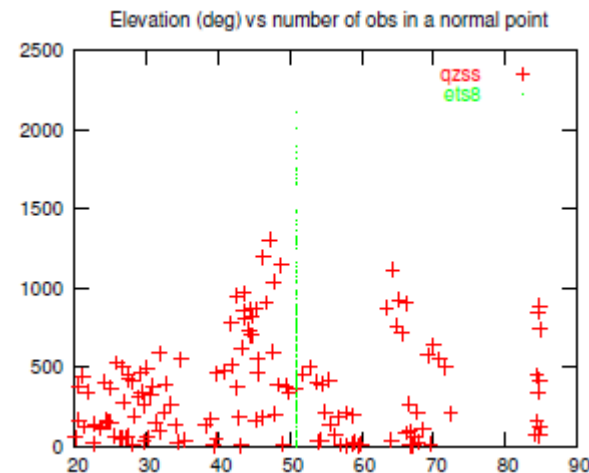
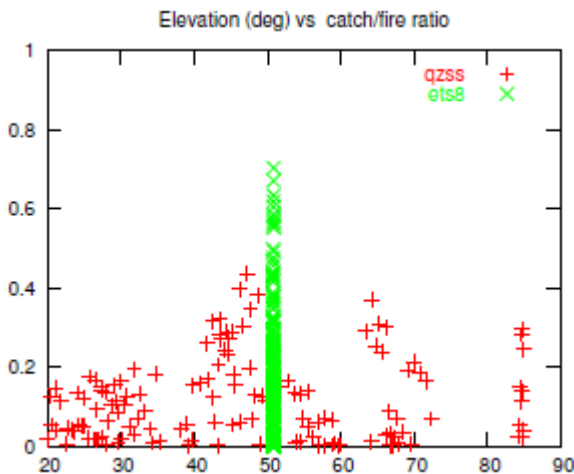
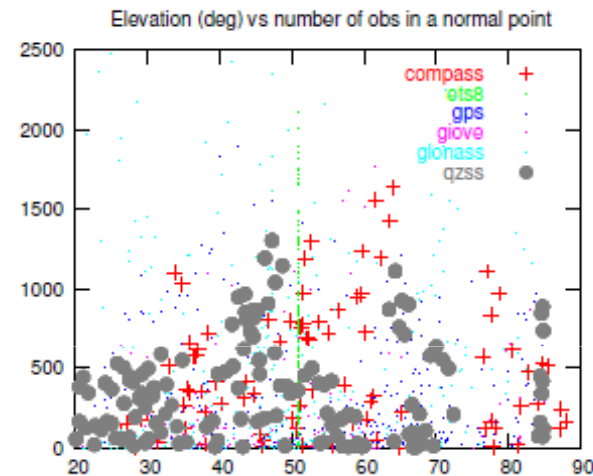
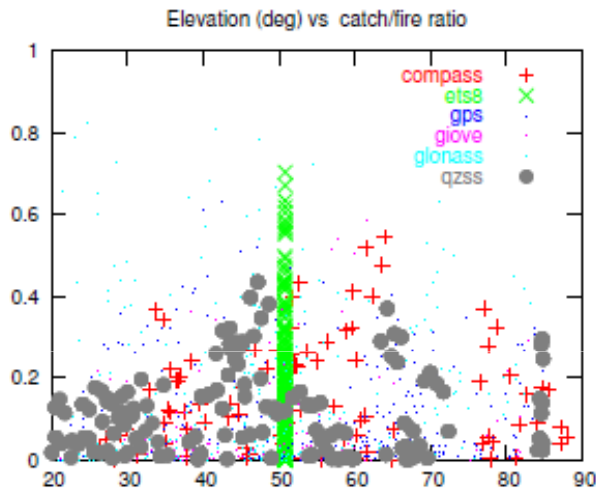
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- **QZS-1**
 - **Quasi-Zenith Satellite-1**
 - **56 * 40.6 mm cubes**
 - **Geosynchronous Orbit**
 - ◆ 32,000 – 40,000 km
 - ◆ 45 deg inclination
 - **Optical Cross Section**
 - ◆ 317 million m²
 - **Very good results by WPLTN Stations**
 - Tanegashima
 - Yarragadee
 - Shanghai
 - Mt. Stromlo
 - Koganei
 - **Launched: Sept. 11, 2010**
 - **Suggested candidate space on GPSIII**
 - **Proven on orbit asset**
 - **Not considered for GPS Altitude**

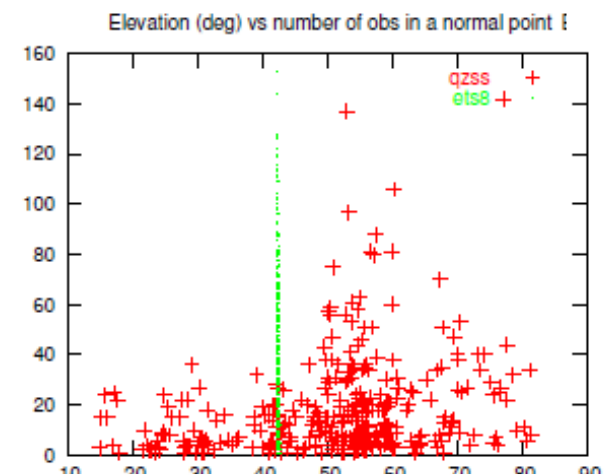
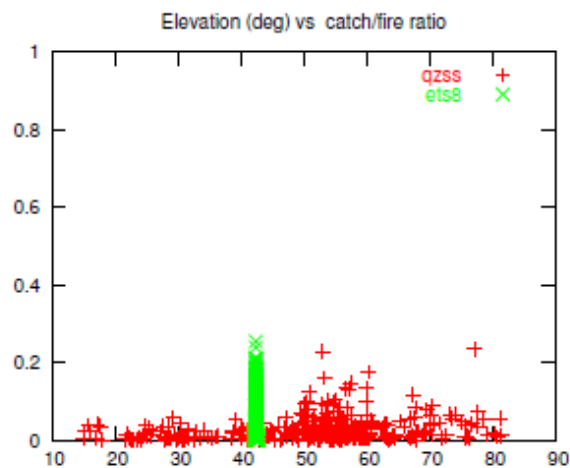
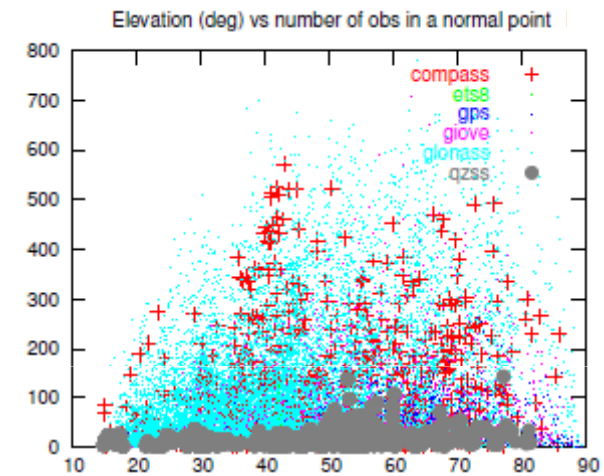
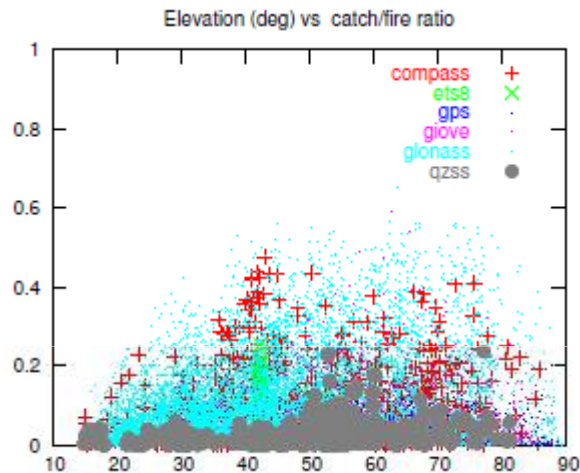
Comparison of GNSS Satellites and ETS-8

- Actual tracking results at Tanegashima of GNSS Satellites and ETS-8



Comparison of GNSS Satellites and ETS-8

- Actual tracking results at Yarragadee ETS-8 and QZS-1



Options Under Investigation for the GPSIII Retroreflector Array

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- The GPSIII Working Group continues toward securing the requirement to incorporate retroreflector arrays onto the GPS Block III satellites.
- Several very productive meetings have recently occurred with various GPS groups to meet the goal, most recently with the GPS Project on Mission Profile.
- The current suggested goal is for up to 17 retroreflector equipped GPS III satellites.
- Current retroreflector array design based on JAXA ETS-8, currently being tracked on geostationary orbit.
- ETS-8 heritage design can successfully fulfill role on GPS III with modification to meet GPS requirement.
- First launch early 2018.
- Plan is to launch 2-3 per year after.

