



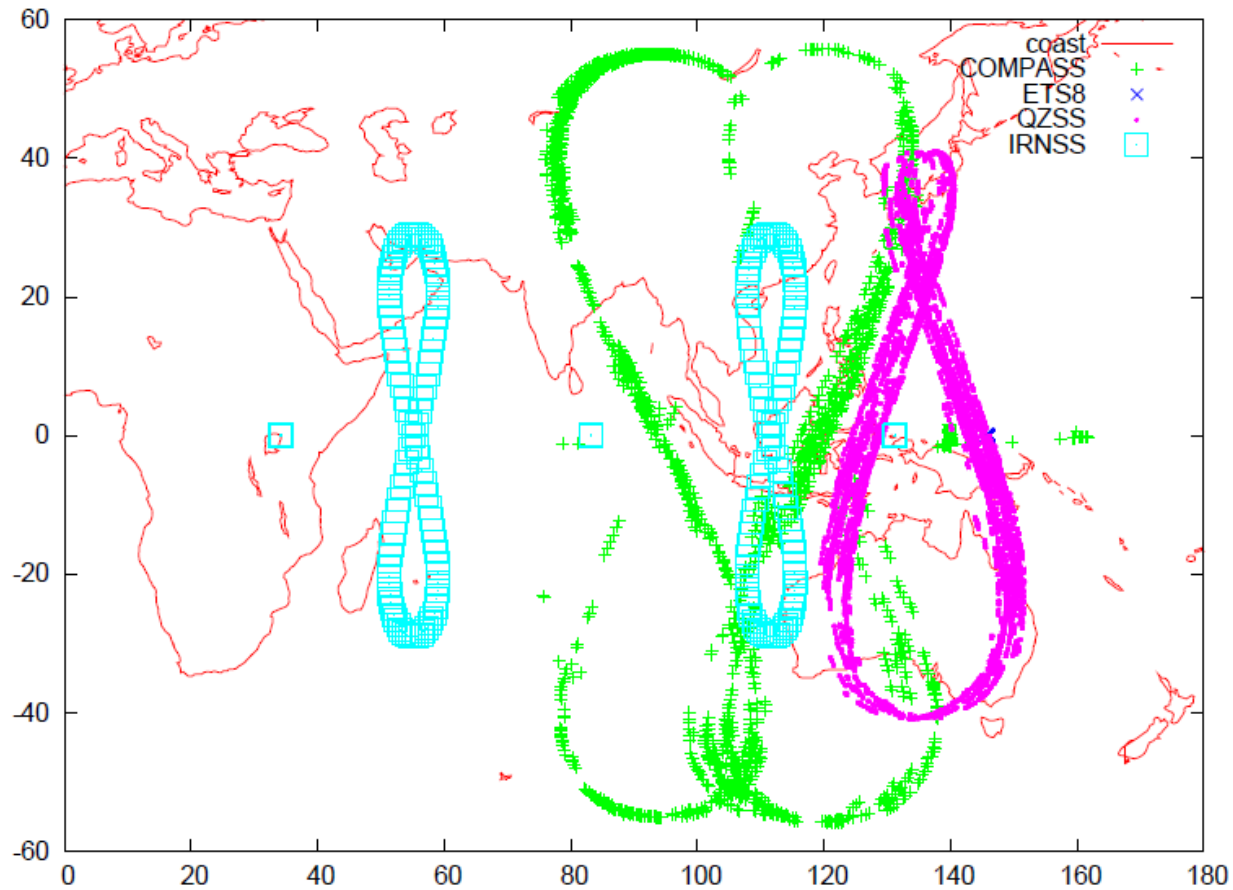
# Performance and Prediction of SLR Tracking on Regional GNSS Constellations

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# Regional Augmentation Constellations



2012 Tracking Data for QZSS and Compass – Projected for IRNSS



# QZSS / Compass / IRNSS

Constellation	Orbit Inclination (deg)	Cube Aperture Diameter (mm)	Cube Spoiling (Arcsec)	Cube Height (mm)	# of Cubes
ETS-8	0	40.64	0.5"	28.74	36
QZSS	43	40.64	0.8" +/- 0.5"	28.74	56
Compass GEO	0	33.0	0.6 +/- 0.3"	24.0	90
Compass IGEO	55	33.0	0.6 +/- 0.3"	24.0	90
IRNSS GEO	0	38.0	0.0 +/- 0.5"	29.70	40
IRNSS IGEO	29	38.0	0.0 +/- 0.5"	29.70	40

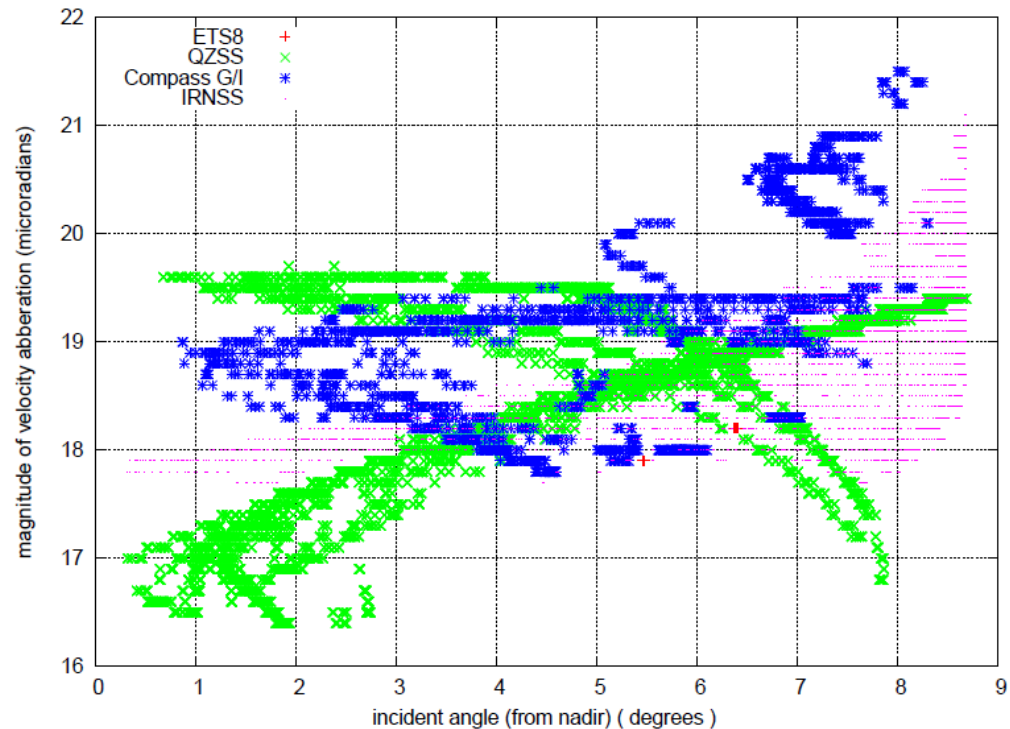
\*ALL cube specs from the Mission Support Request form Documentation or references on ILRS website



# Annulus of Interest

## Velocity aberration for all incidence angles

- ETS8/QZSS
  - 16.5 to 20 urad
- Compass
  - 18 to 21 urad
- IRNSS
  - 17.5 to 21.5 urad



Real Tracking and Planned Annulus where array is being utilized

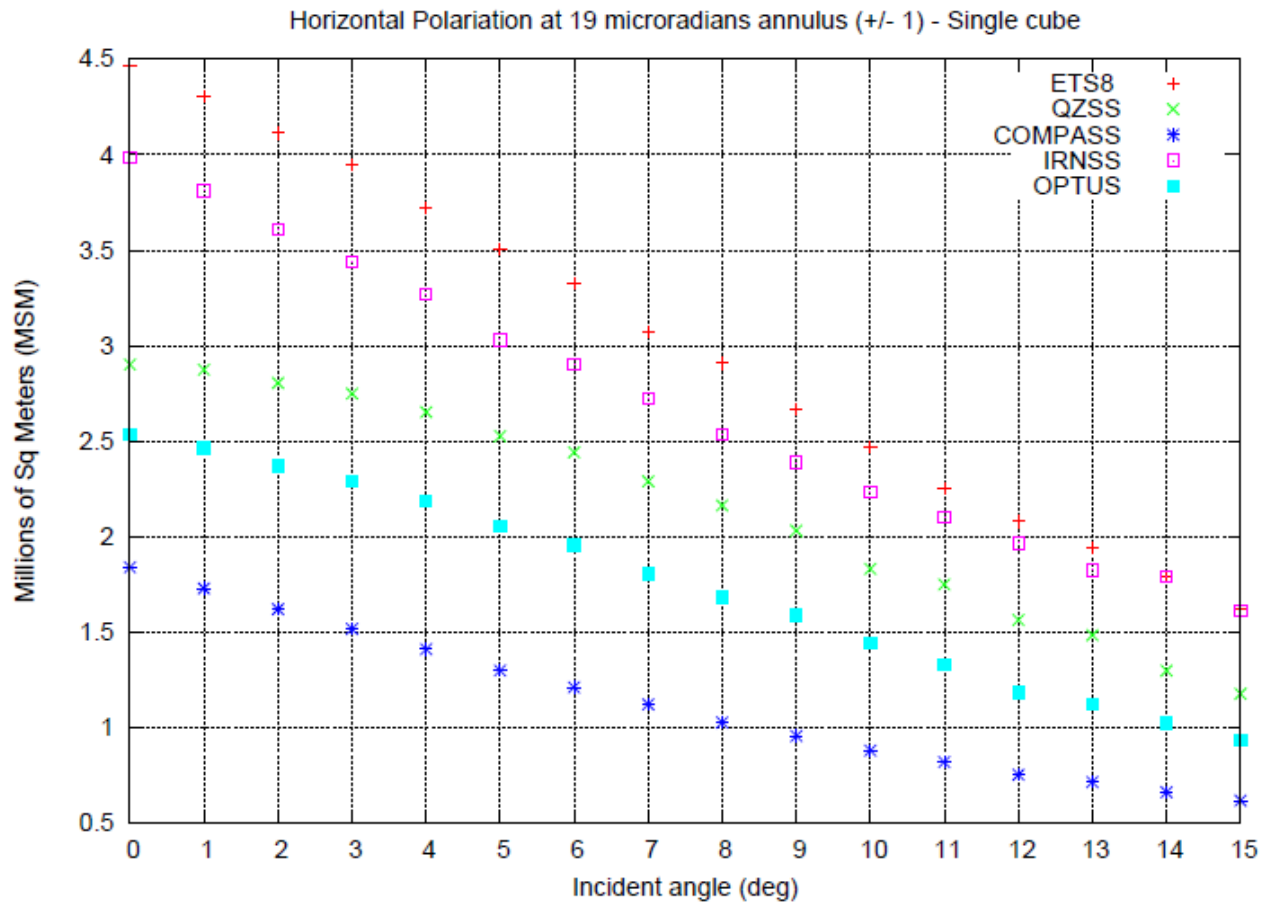


# Zemax derived Cross Sections

- Complete new set of FFDP generated for these cases
  - 64 bit version of ZEMAX and analysis tools
  - Explicit off normal incident angles (no rules of thumb)
- Linear and Circular plots for the AVERAGE performance in annulus of interest
  - single cube cross section contribution estimate
  - array cross section estimate
  - Min/Max in annulus error bars included on plots



# Horizontal Polarization: Individual Cube Contribution



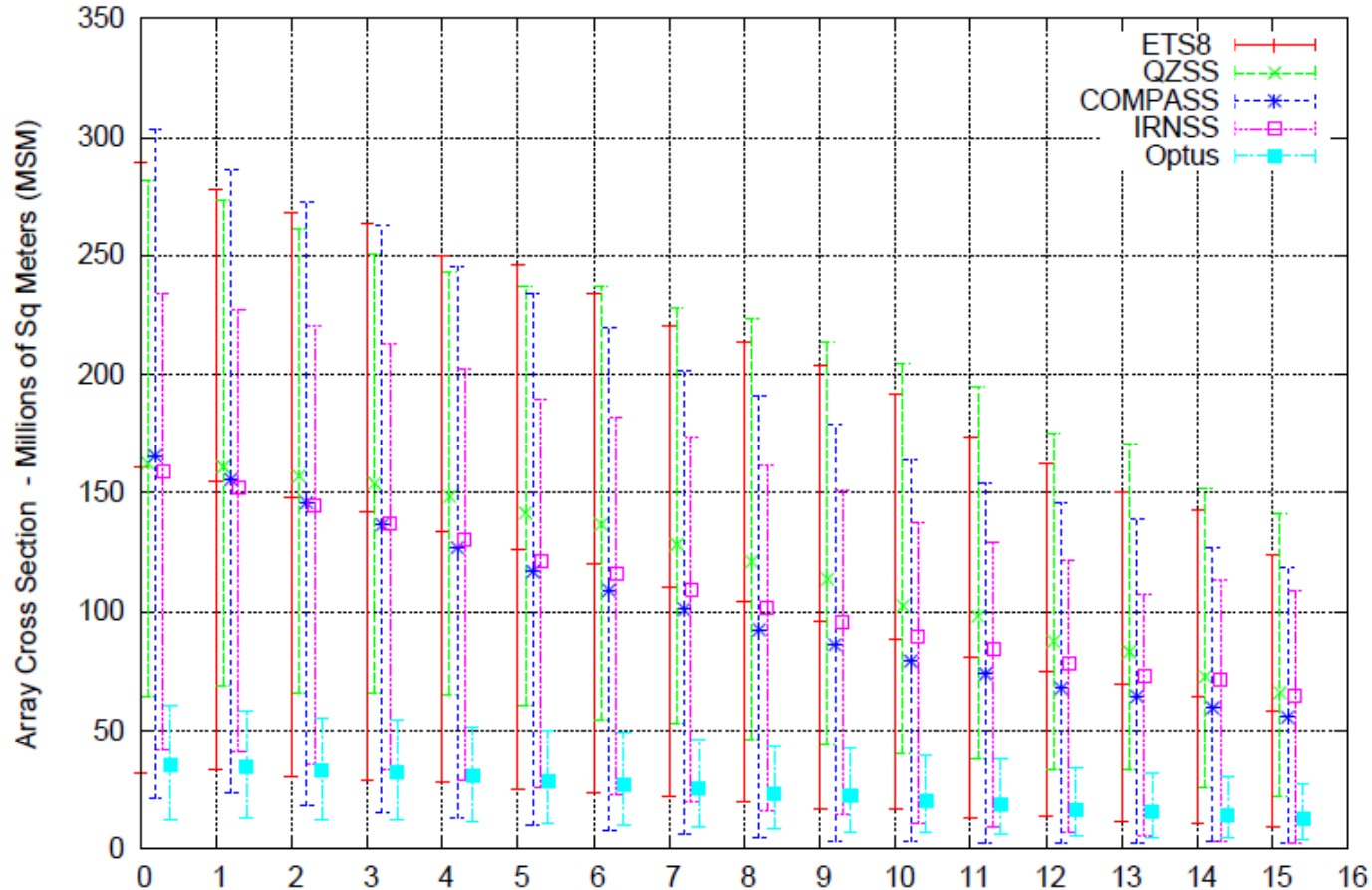
Many different Realizations all using TIR principals



# Array Cross Section Estimates

## Horizontal Polarization

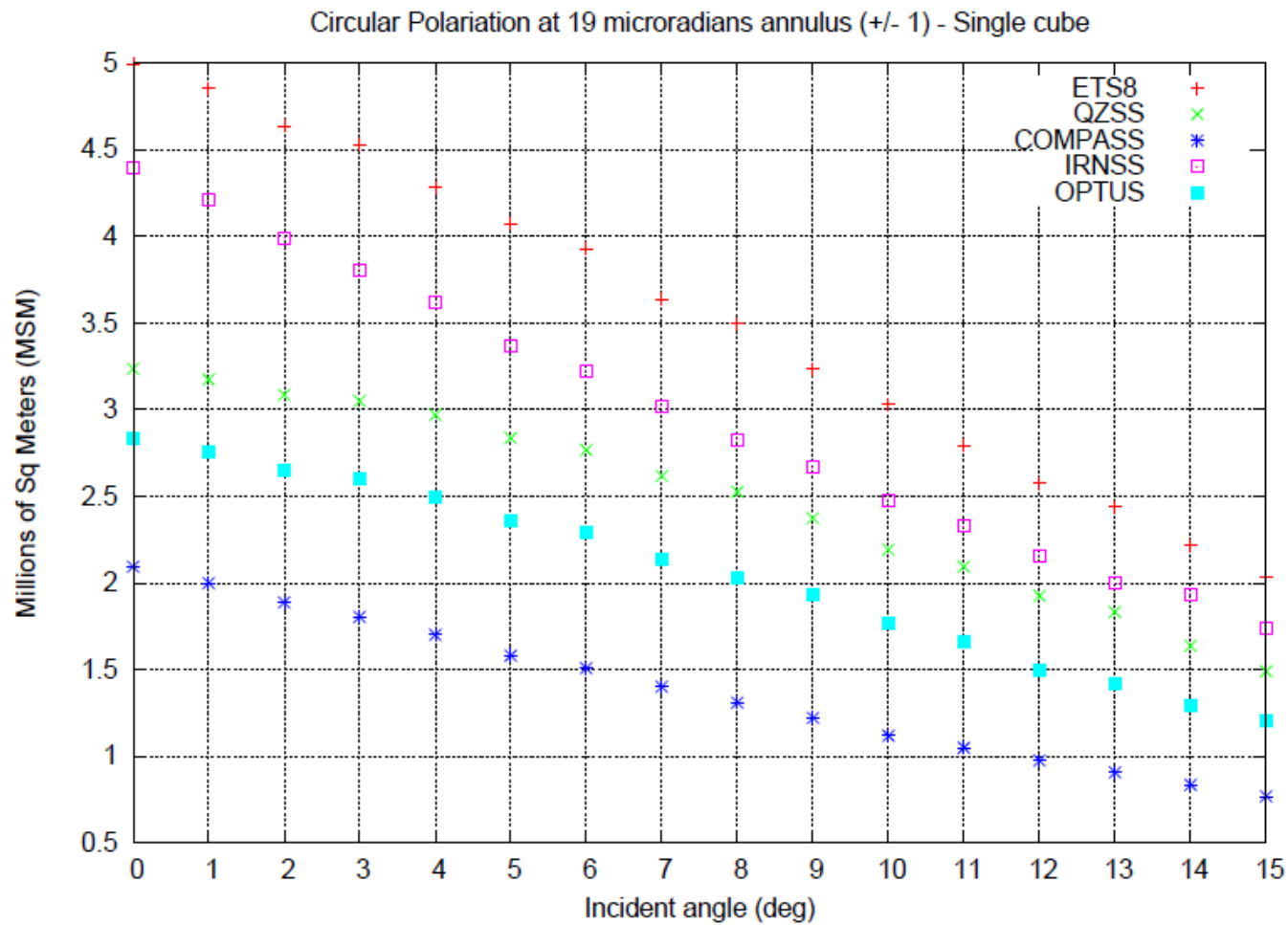
Horizontal Polarization at 19 microradians annulus (+/- 1)



Explicit Incident Angle – with Peak in annulus Min and Max



# Circular Polarization: Individual Cube Contribution



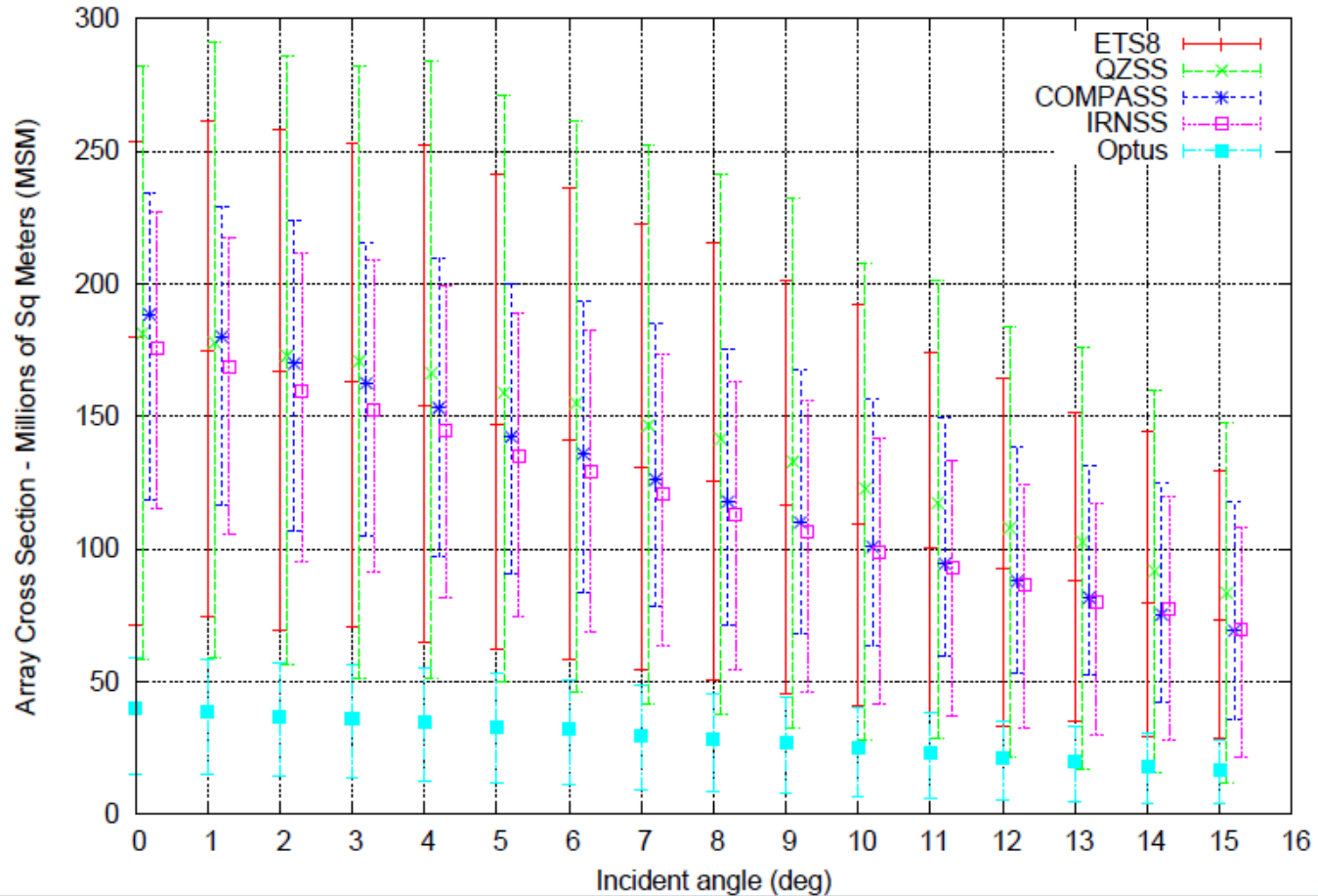




# Array Cross Section Estimates

## Circular Polarization

Circular Polarization at 19 microradians annulus (+/- 1)



Explicit Incident Angle – with Peak in annulus Min and Max



# Data on Constellations Today – 6 Pane Plots

## Koganei-7308 Example

Elevation angle vs reported obs in NP / computed fires

Elevation vs incident angle (from Nadir)

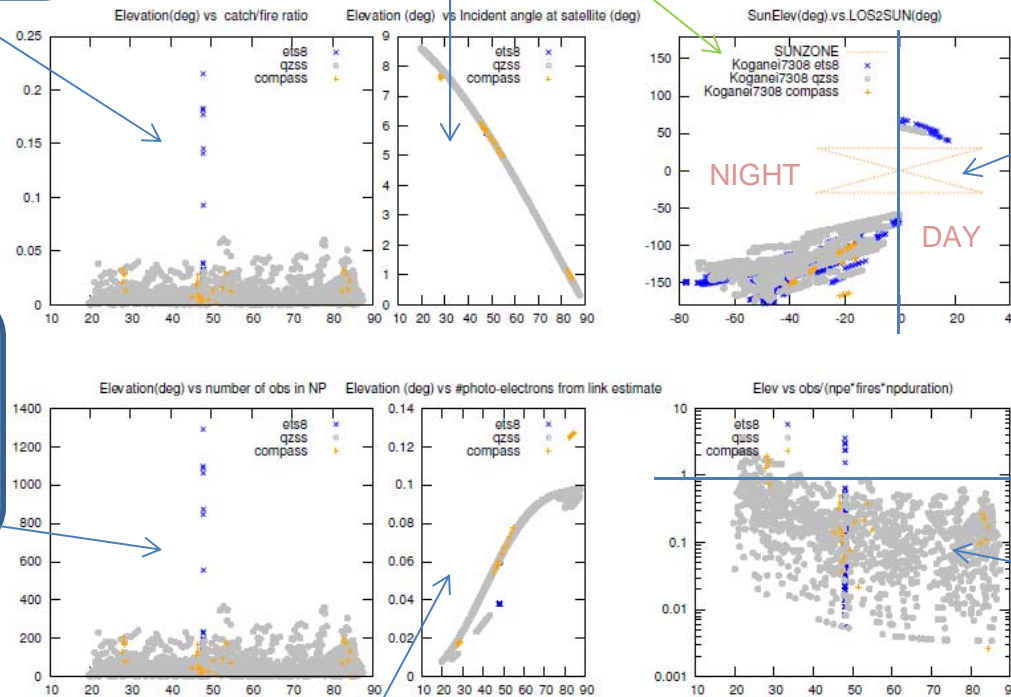
Sun Elevation (- is night, + is day)  
VS  
angle between SV and SUN  
(BIG X is 30 deg off SUN)

Elevation angle vs Reported obs in NP

Elevation vs Link Budget # Photoelectrons per fire

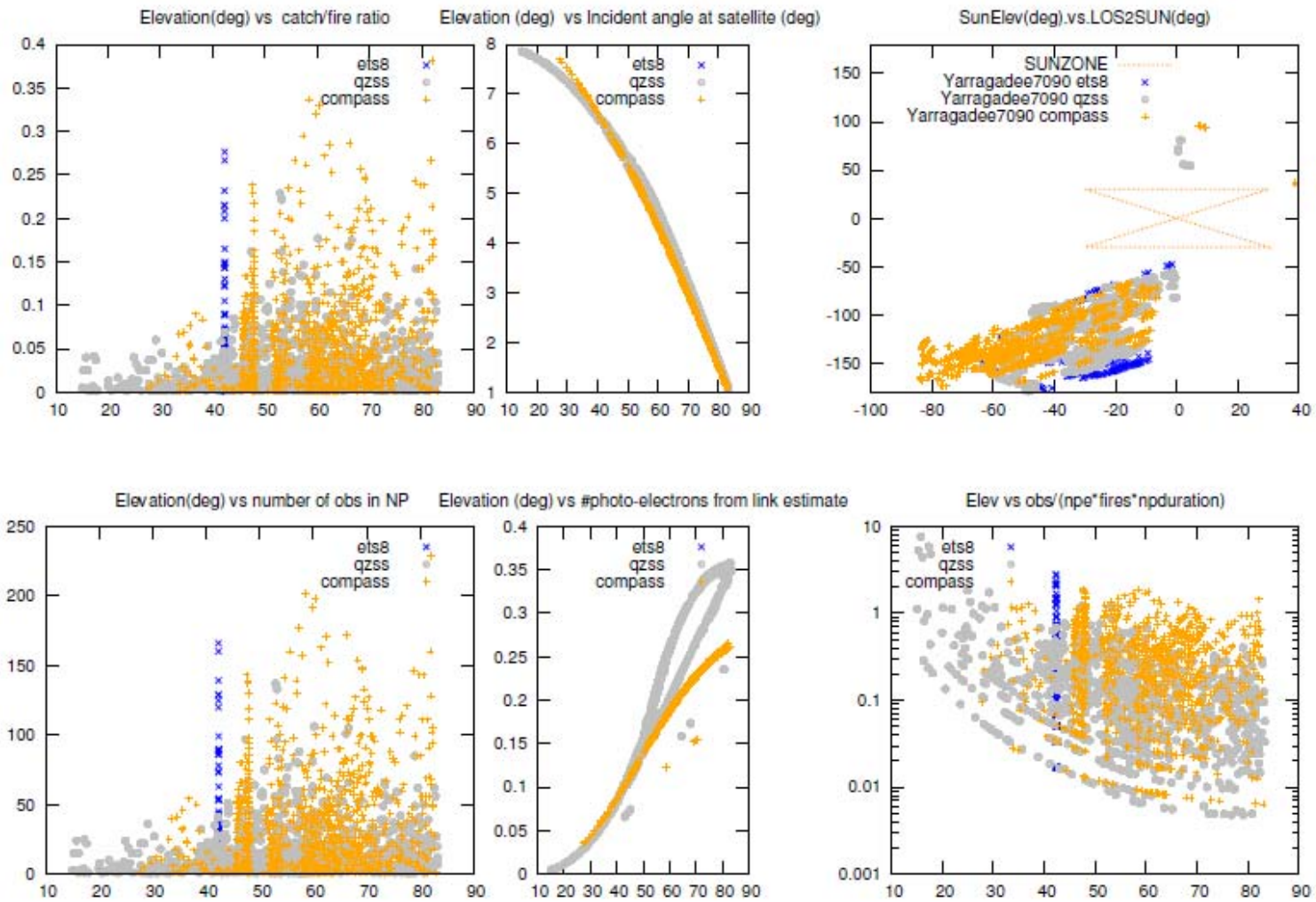
Perfect model == 1.0

Elevation vs Link Budget Accuracy



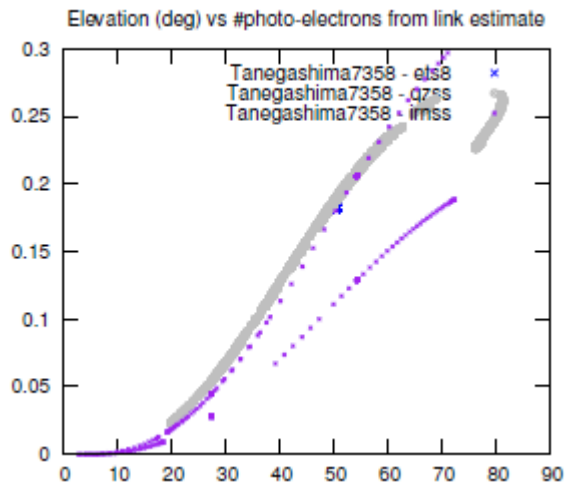
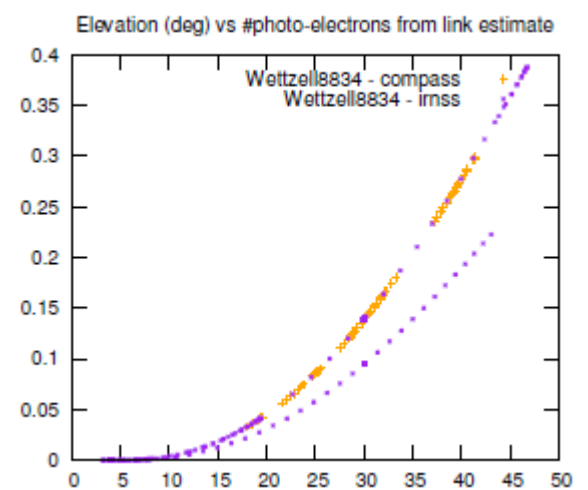
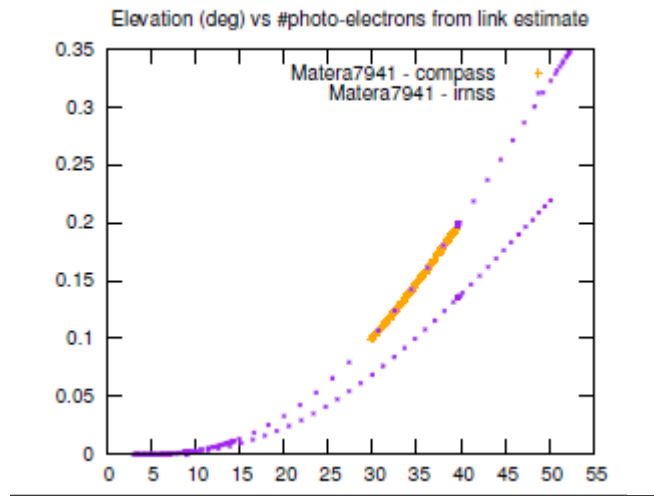
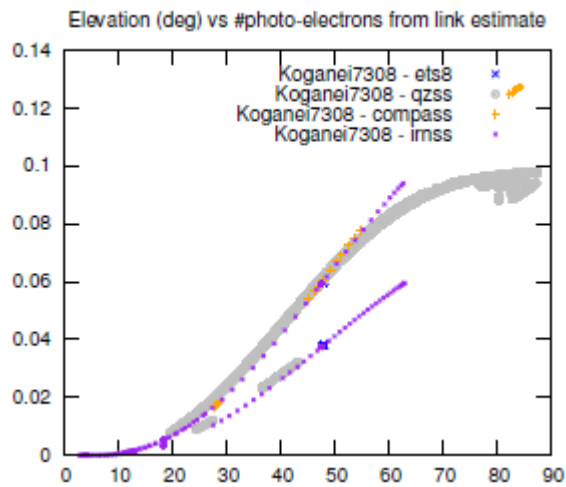


# Yarragadee Case

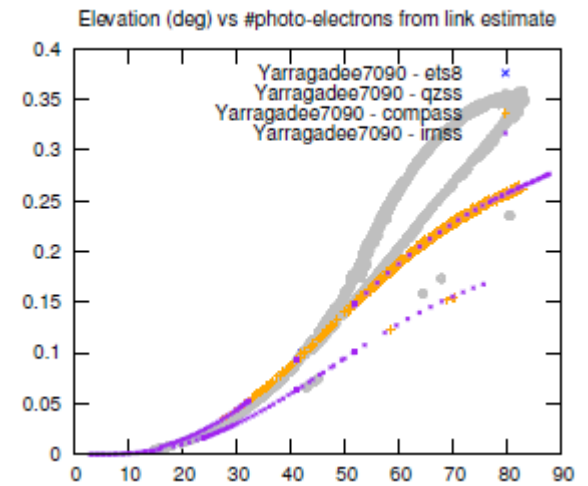




# Extension to the IRNSS Constellation



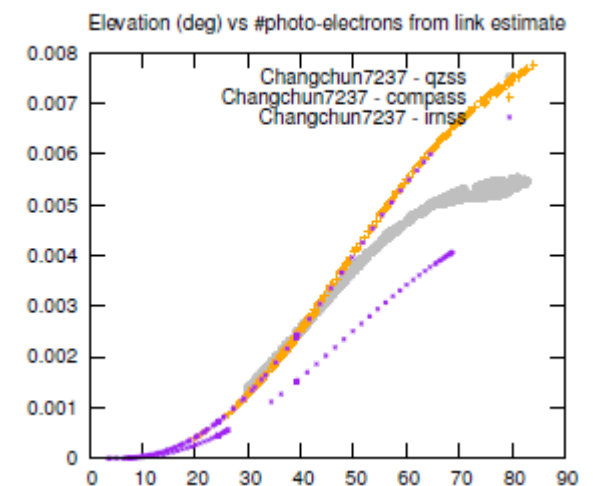
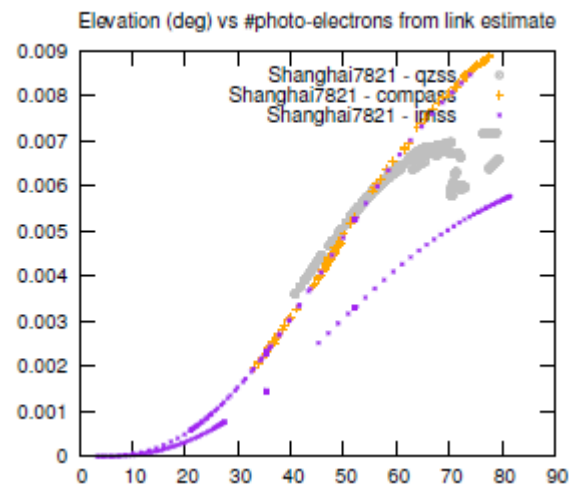
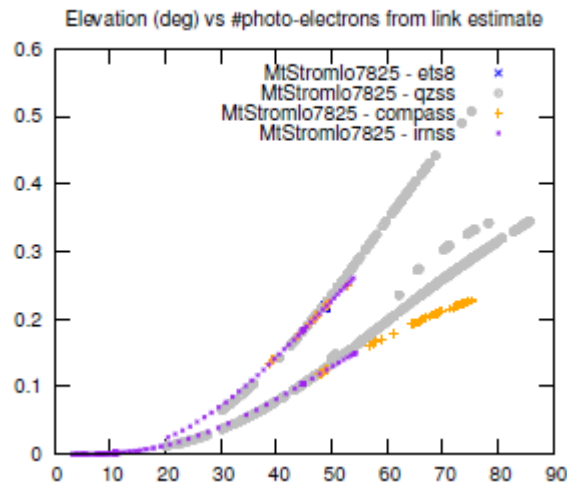
Relative performance is expected to be very similar (on average)



Hz Rate Stations



# Extension to the IRNSS Constellation



Faster Rate Stations or Lower Energy



# Conclusion

- Direct comparison of performance shown for the link budgets
  - Extrapolation for what to expect on future Regional Constellations
- All 3 constellations are targeting the same cross section
  - Vastly different cube configurations and spoiling have been implemented
- All 2012 Contributor Models are included in Backups
  - Some model improvements if better divergence, weather, NP duration (full 300 sec or truncated?), exact shots fired were available, N-sigma editing
  - Is there any tilt on the Inclined COMPASS tray?
  - Relative performance can be directly extracted
- Target Signature
  - Is there enough points per normal point for removal?
  - Is there enough data for accurate OD?



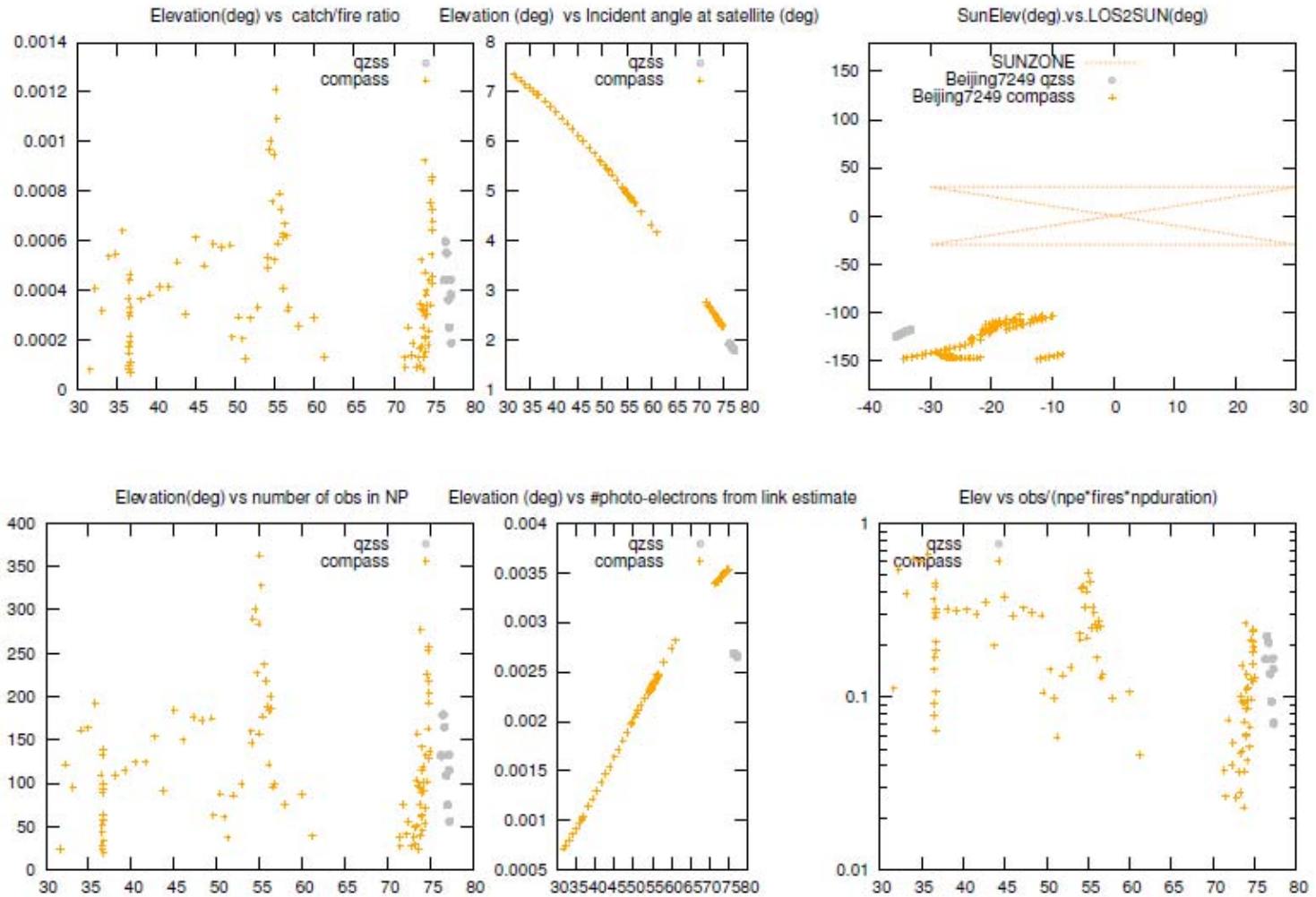
# BACKUPS

Current Constellation Performance





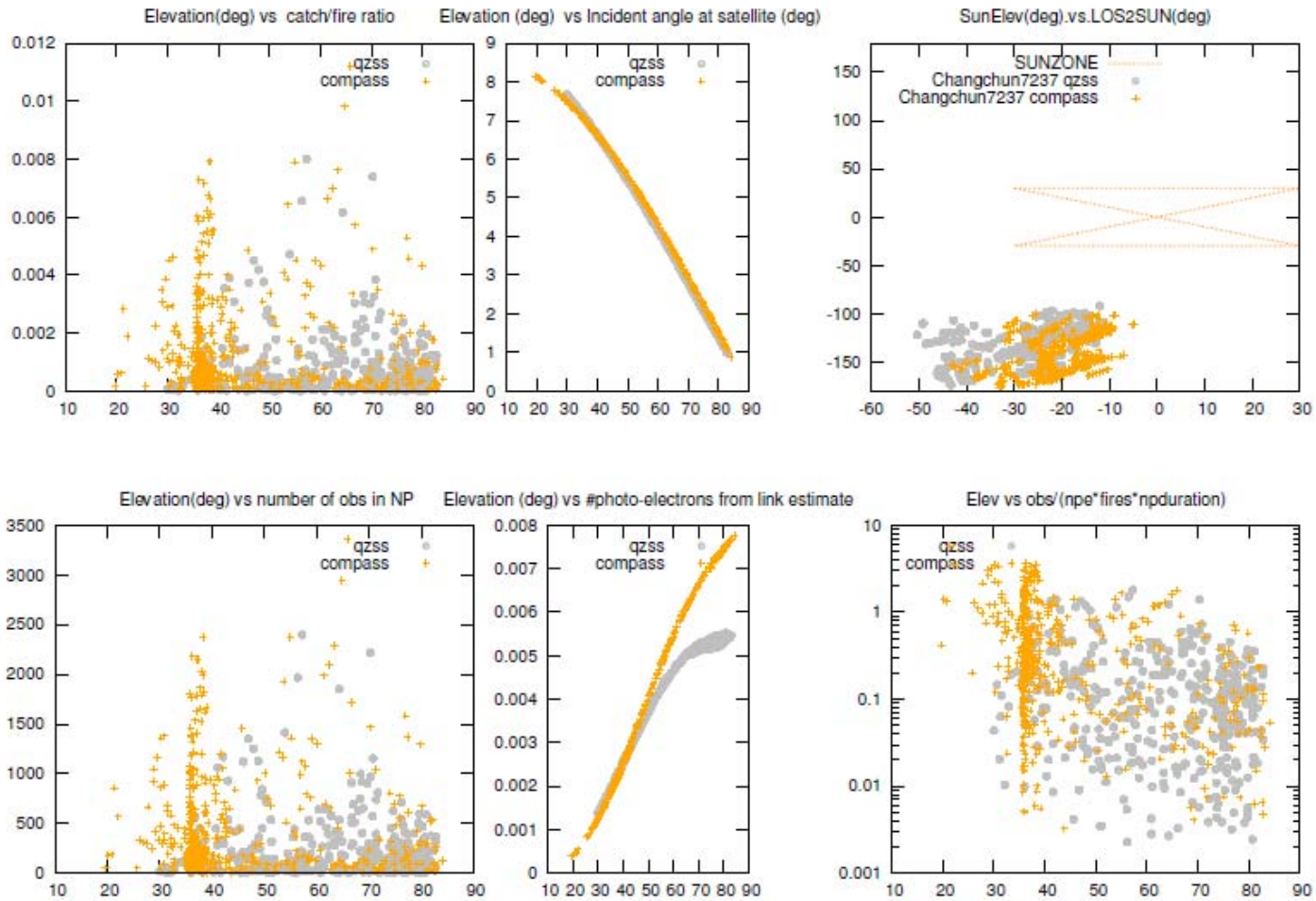
# Beijing - 7249





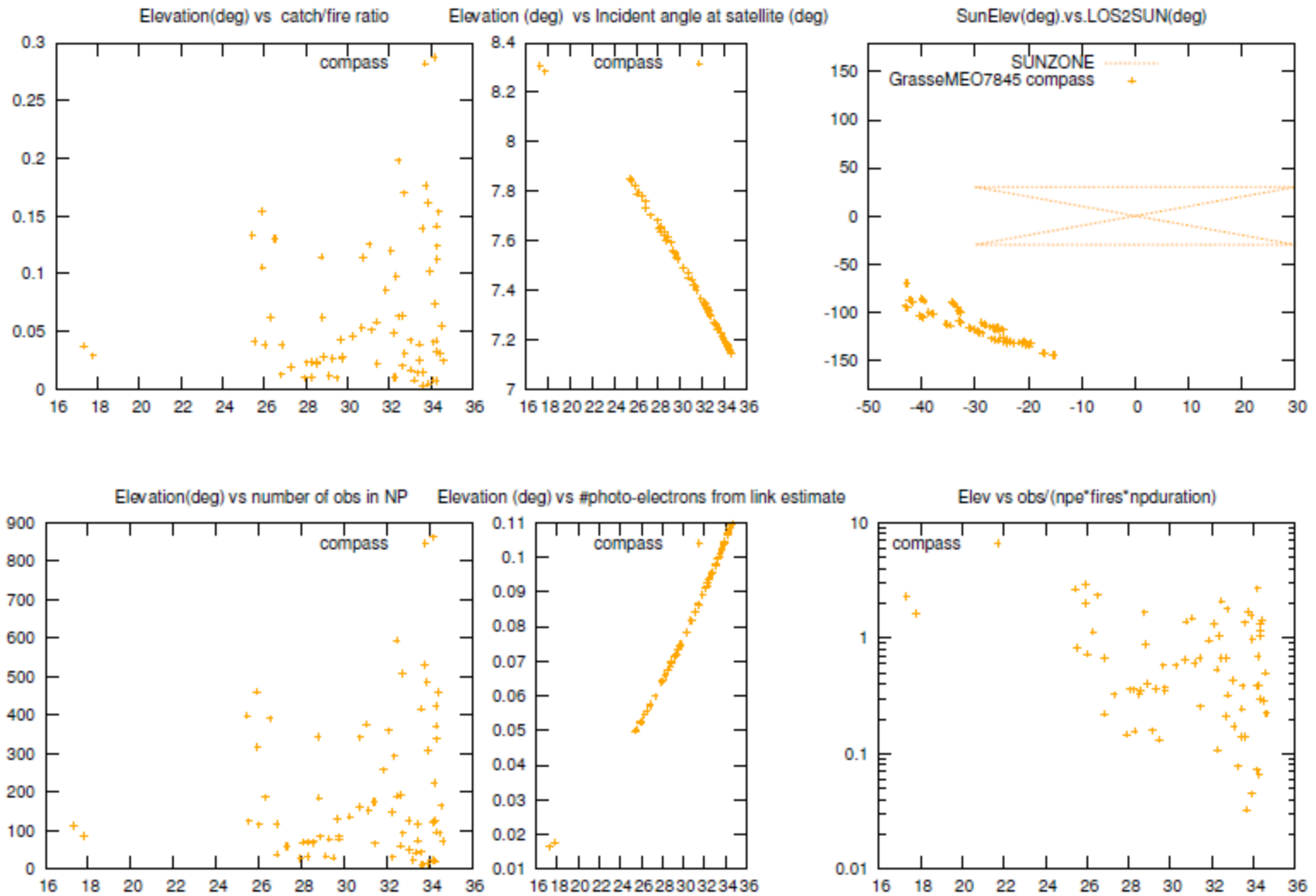


# Chang Chun - 7237



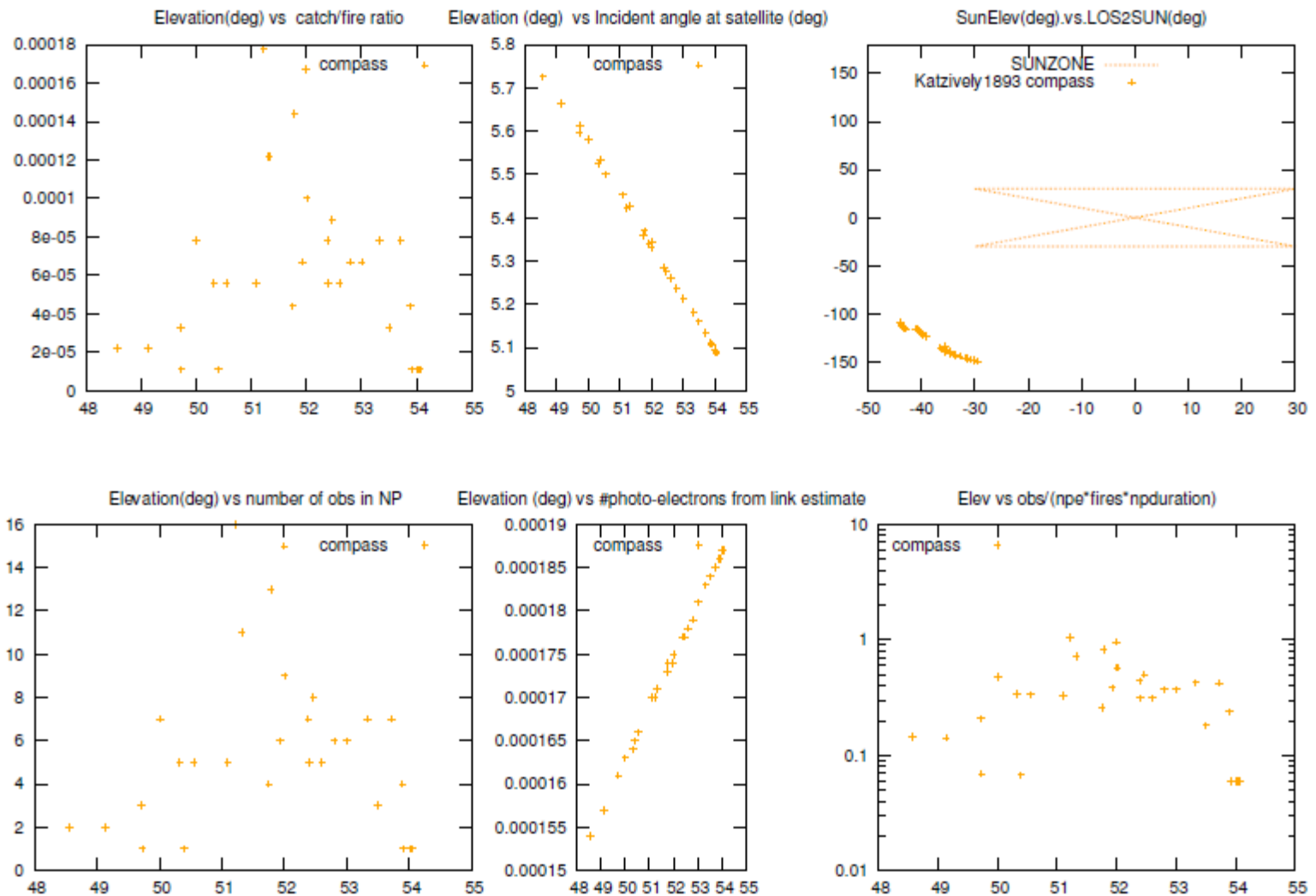


# Grasse 7845



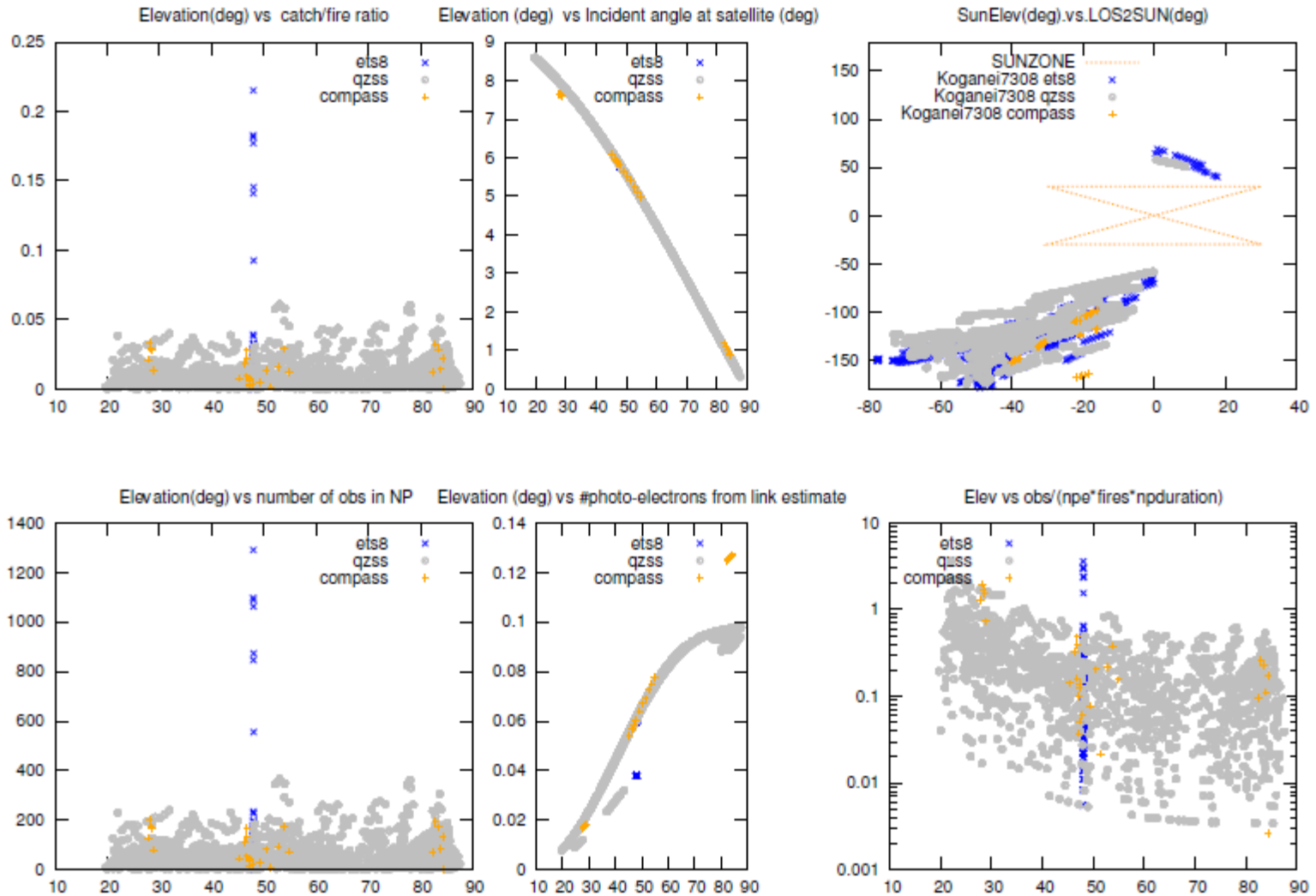


# Katzively 1893



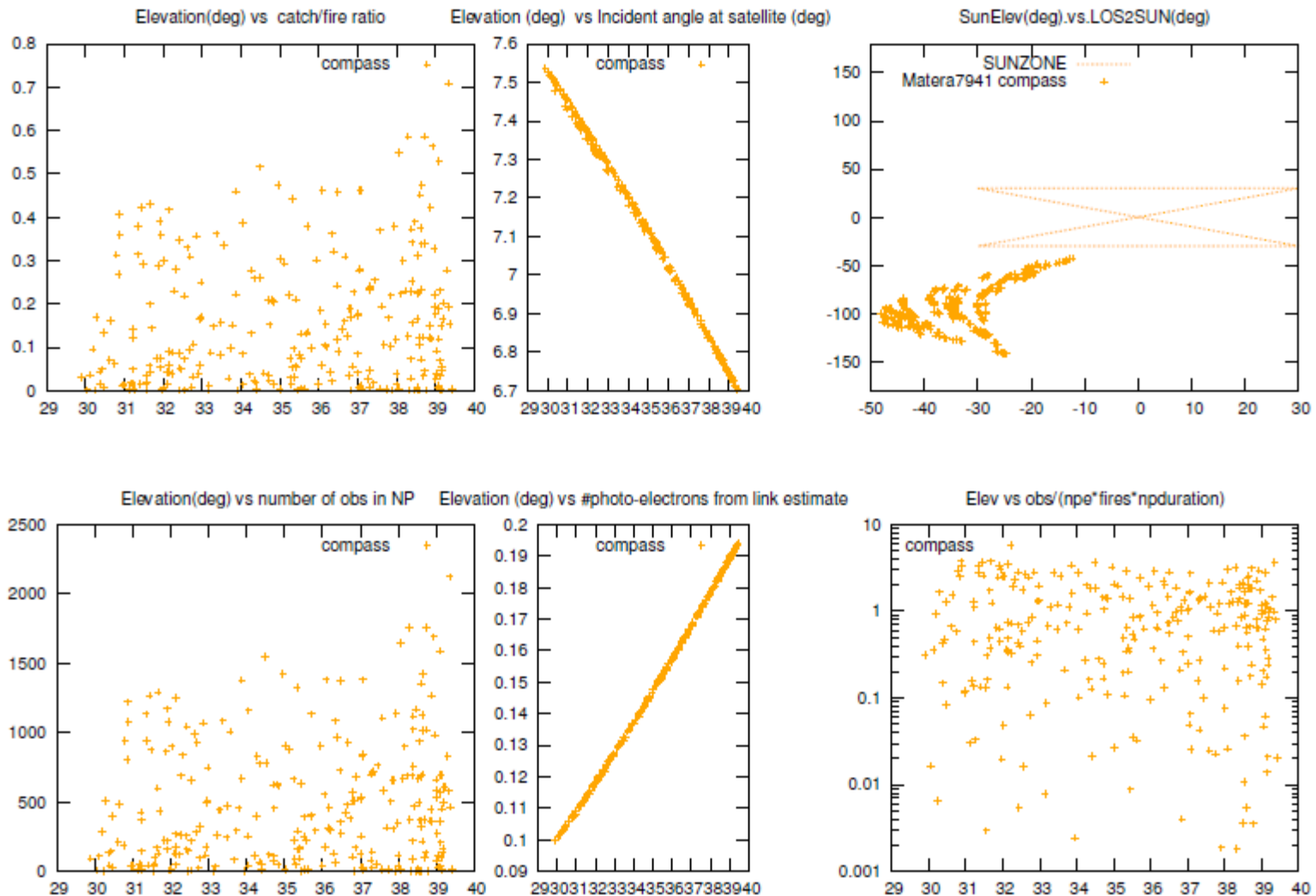


# Koganei 7308



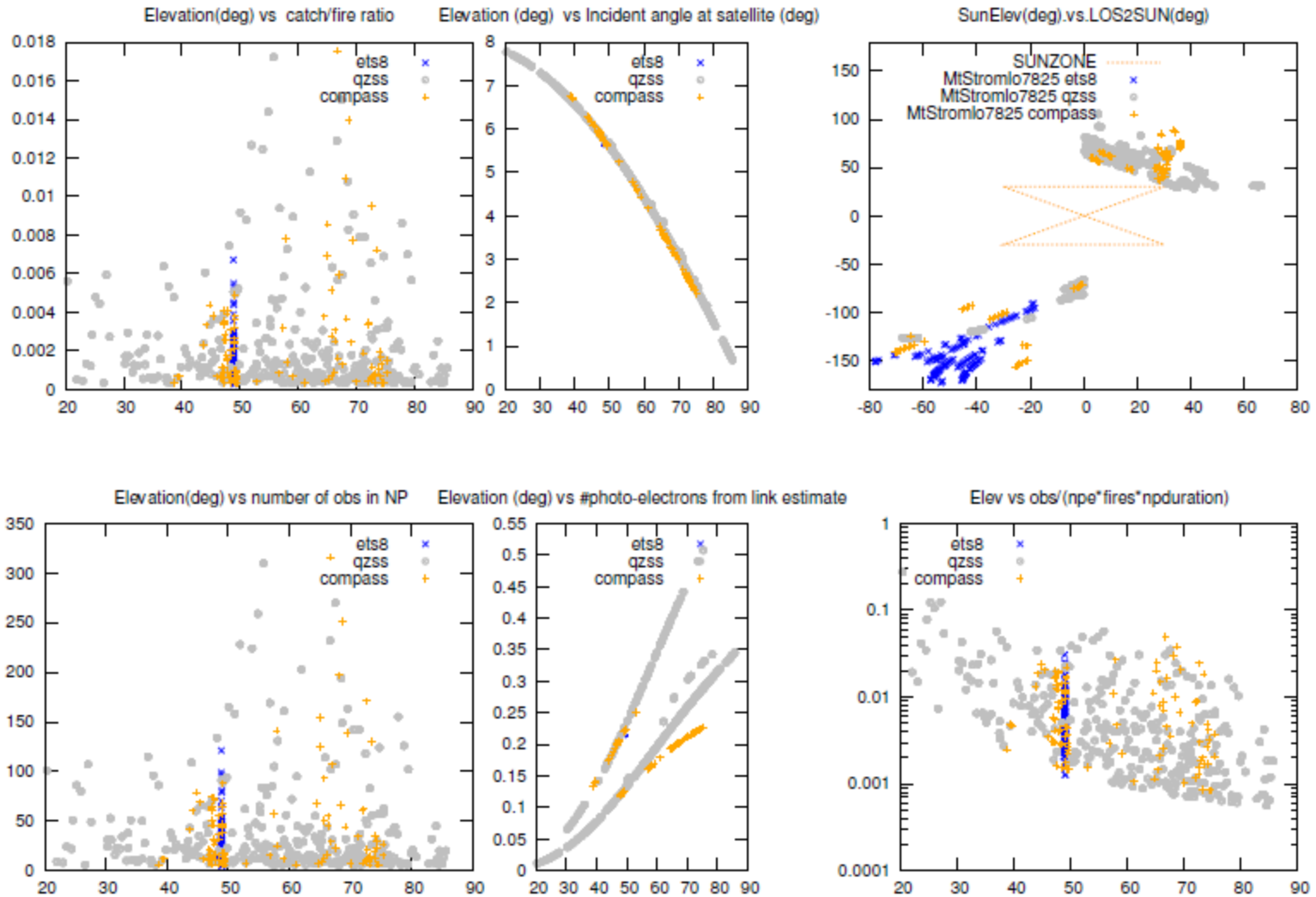


# Matera 7941



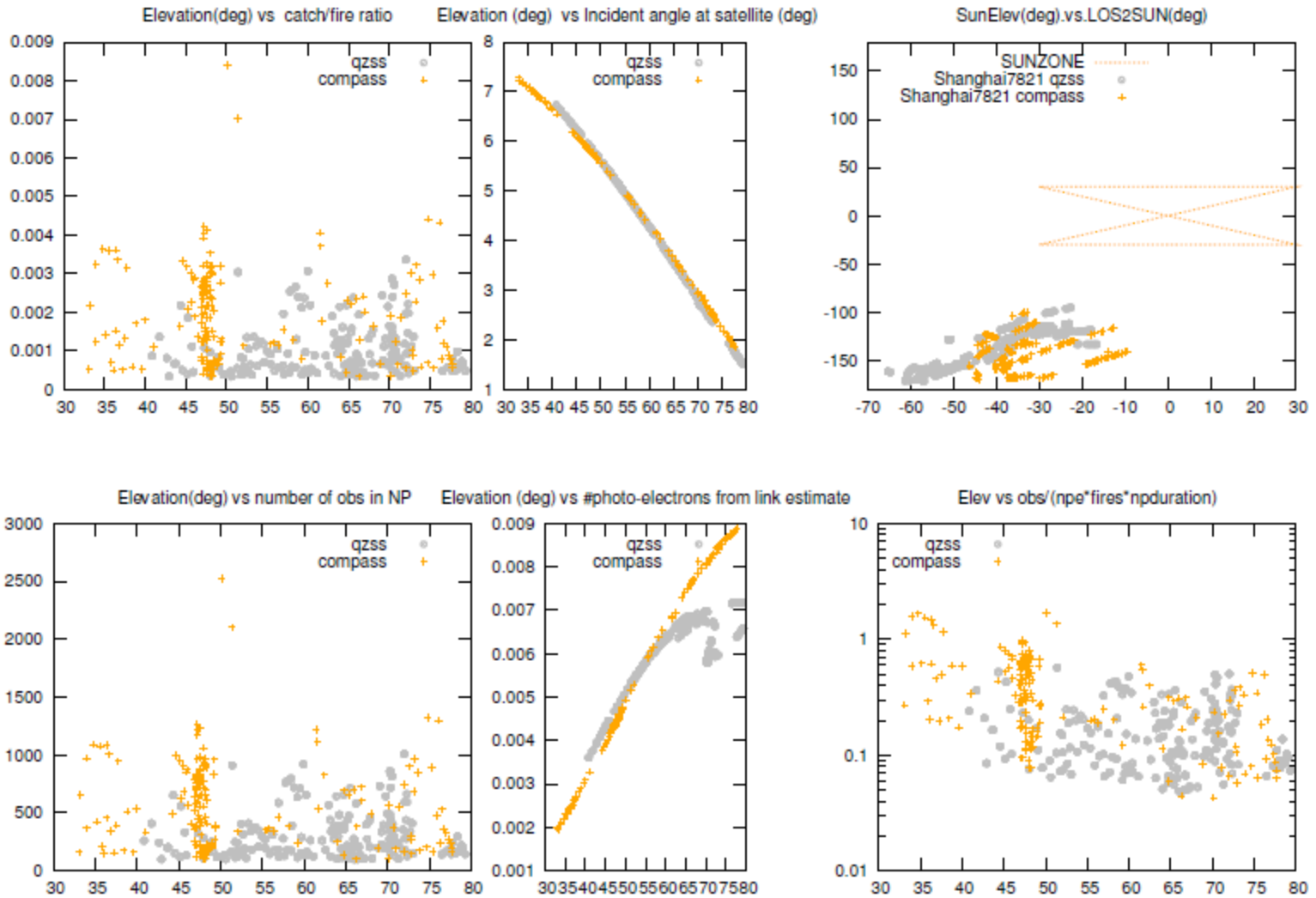


# Mt Stromlo 7825



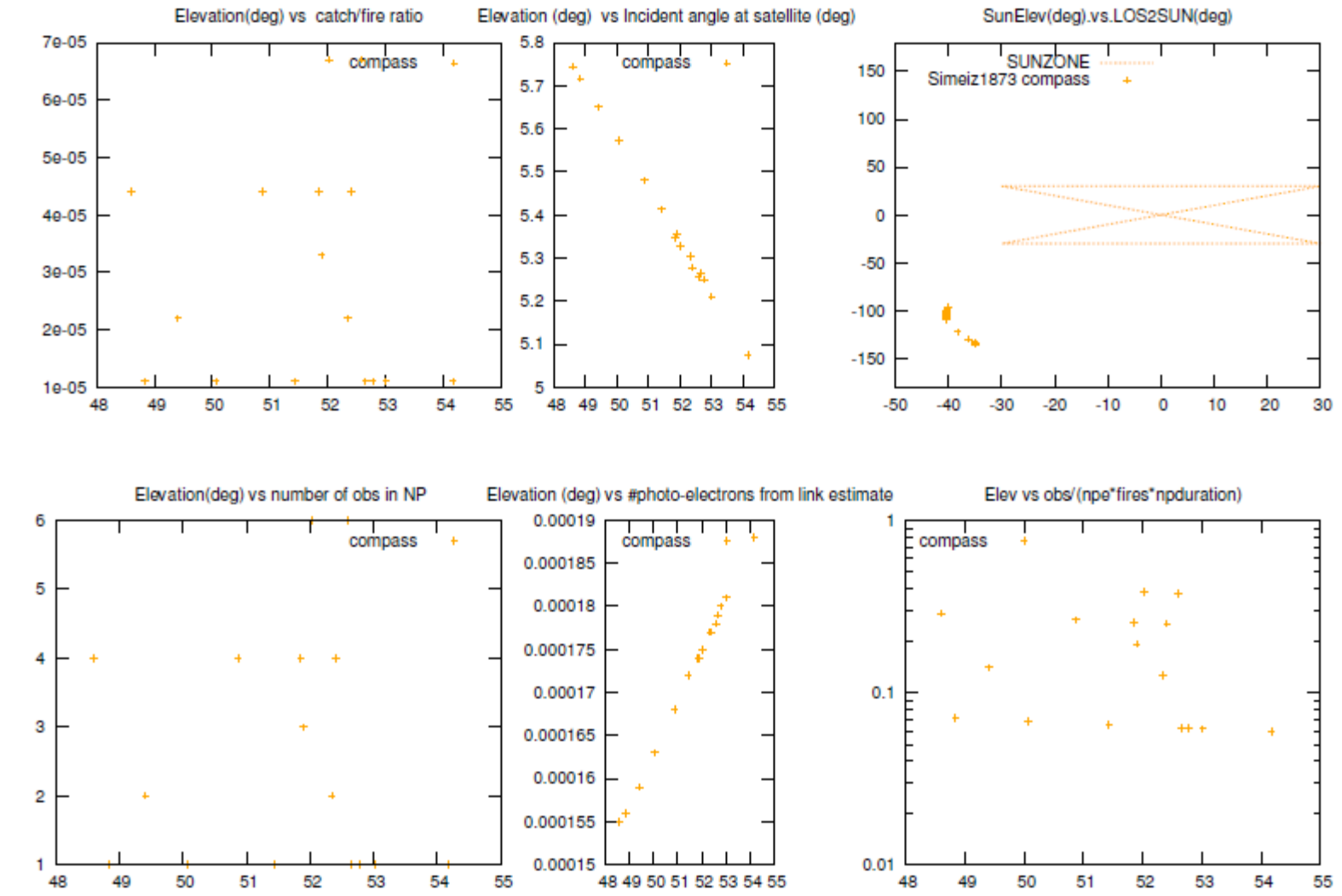


# Shanghai 7821





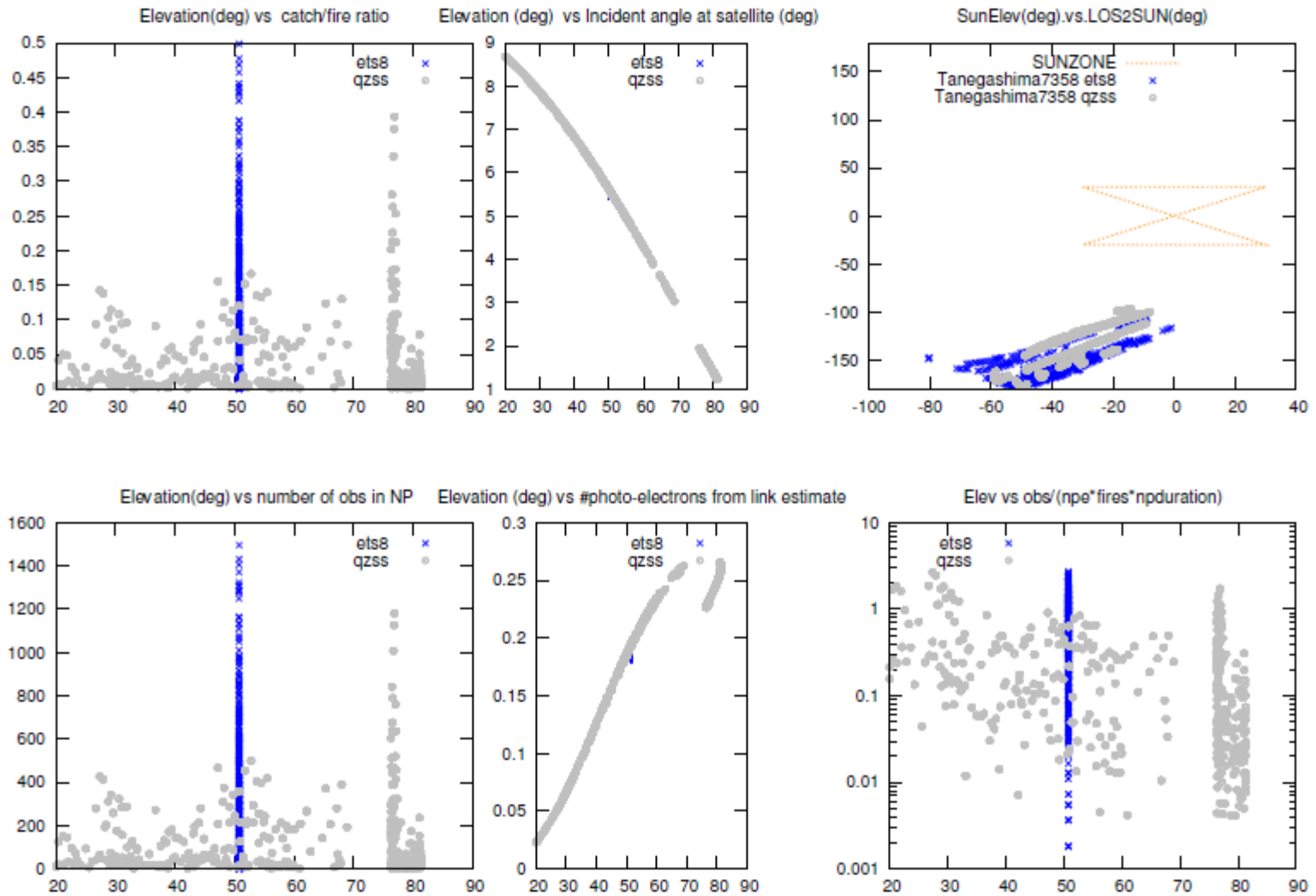
# Simeiz 1873





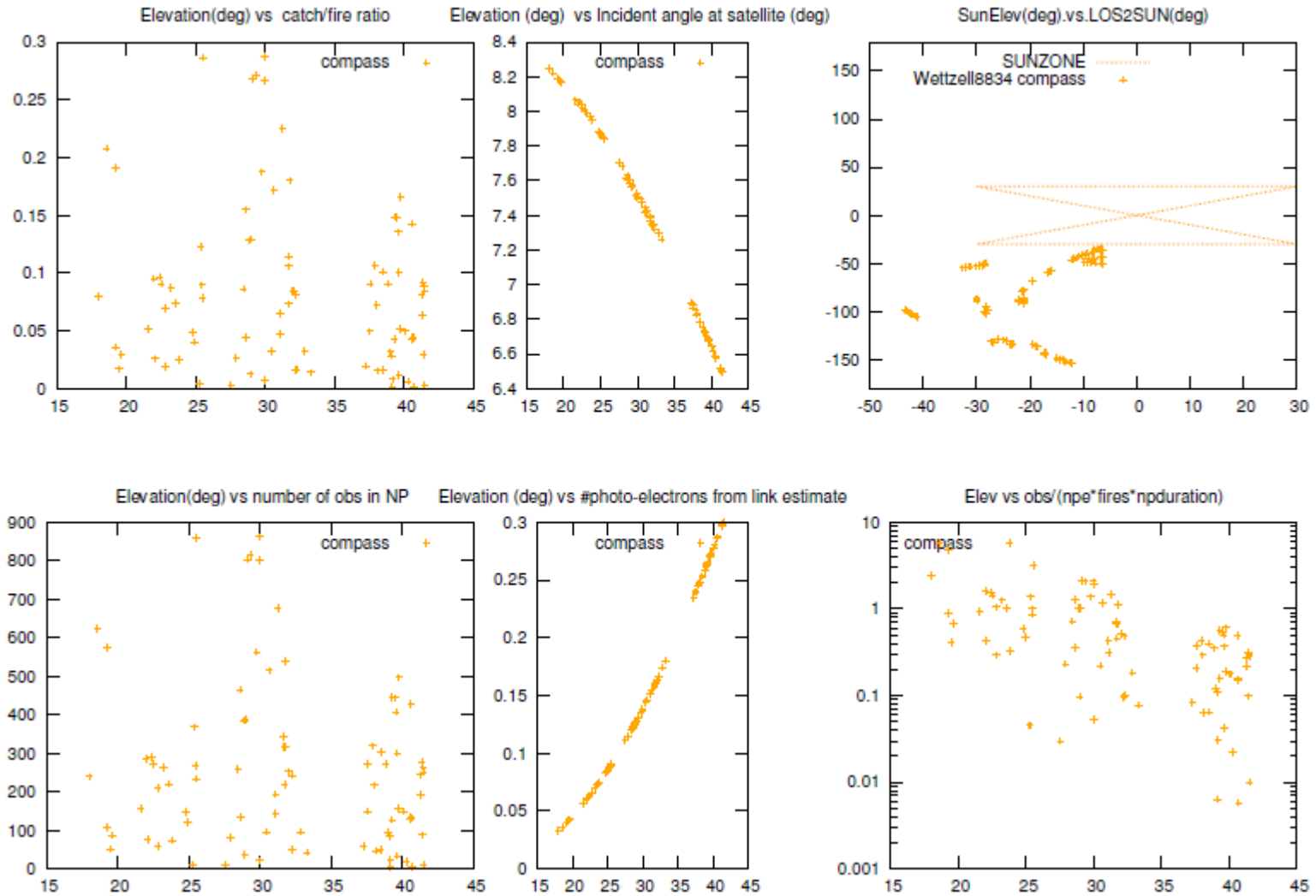


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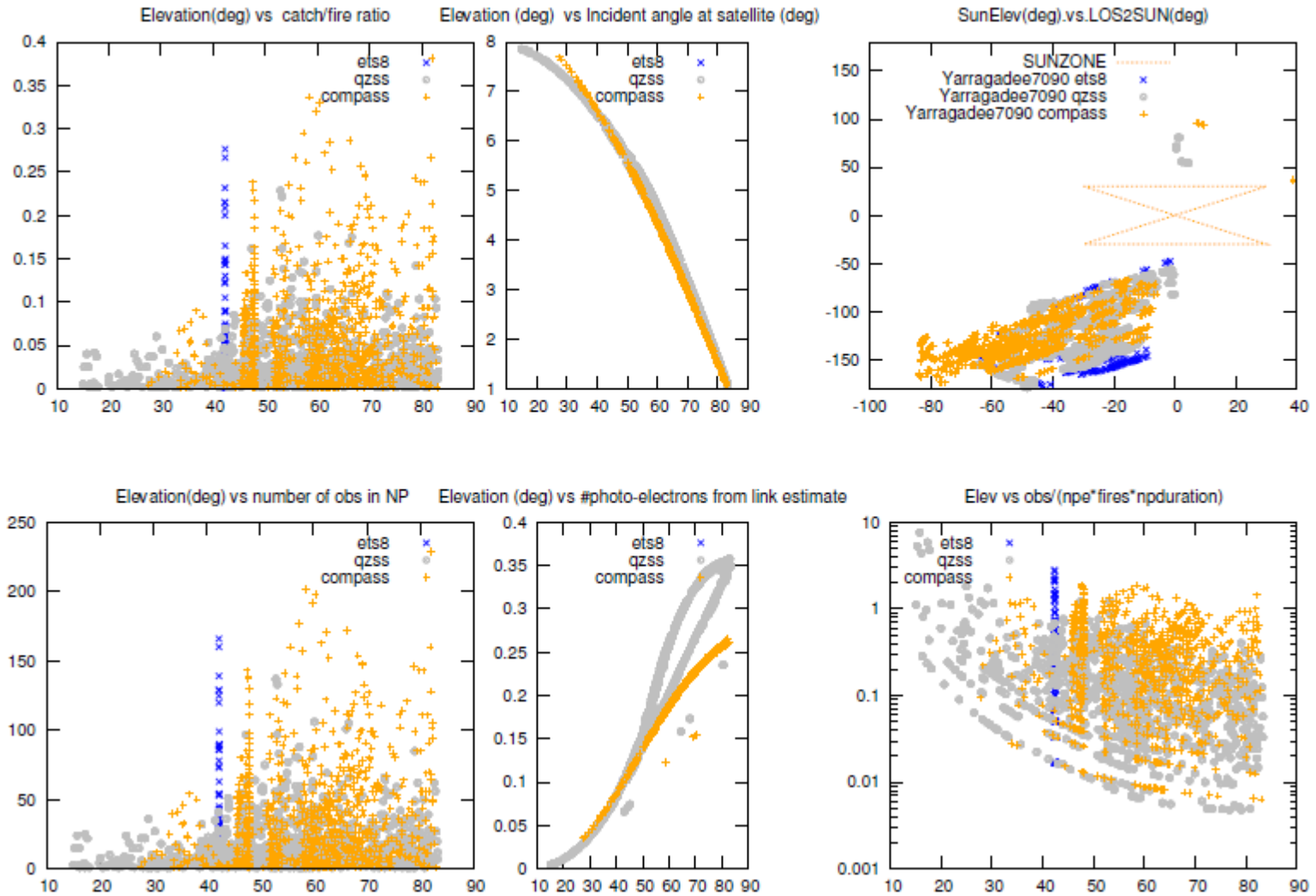


# Wettzell 8834





# Yarragadee 7090



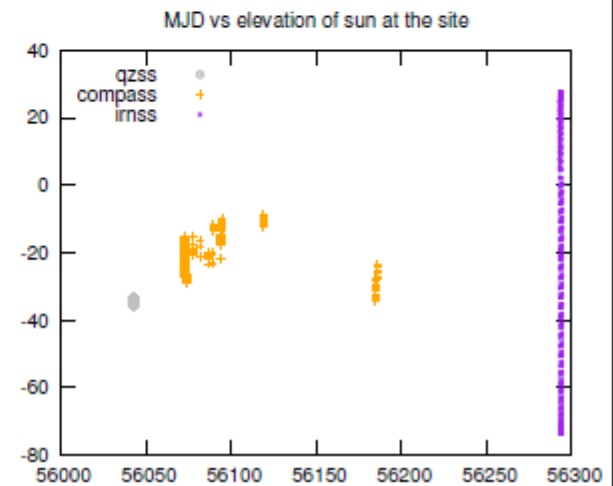
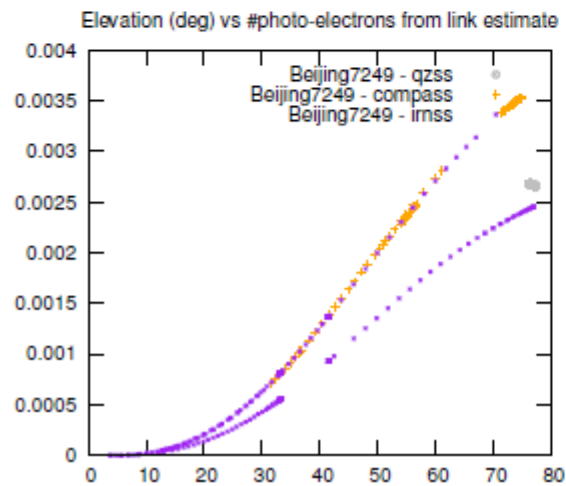
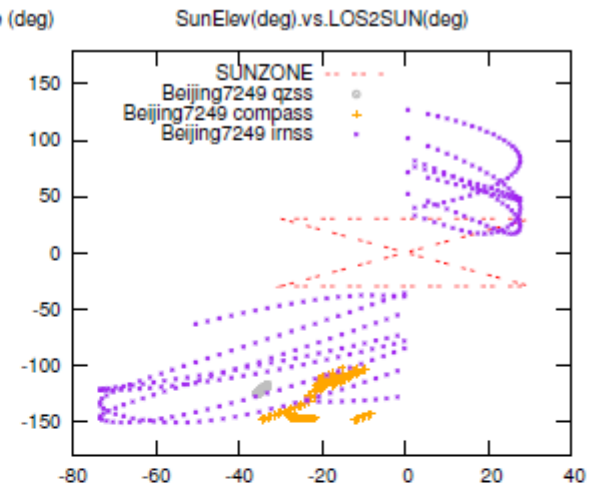
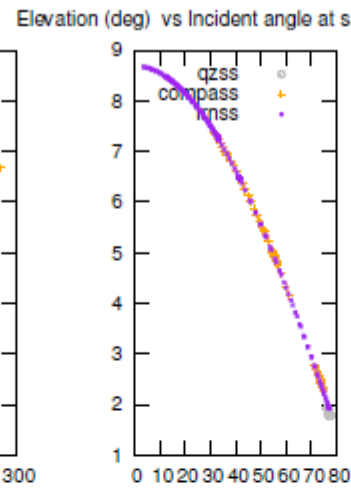
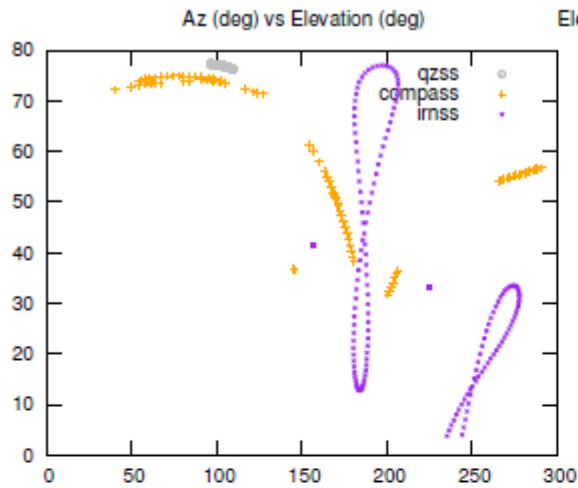


# BACKUPS

Current Performance and Future Regional Link Estimations

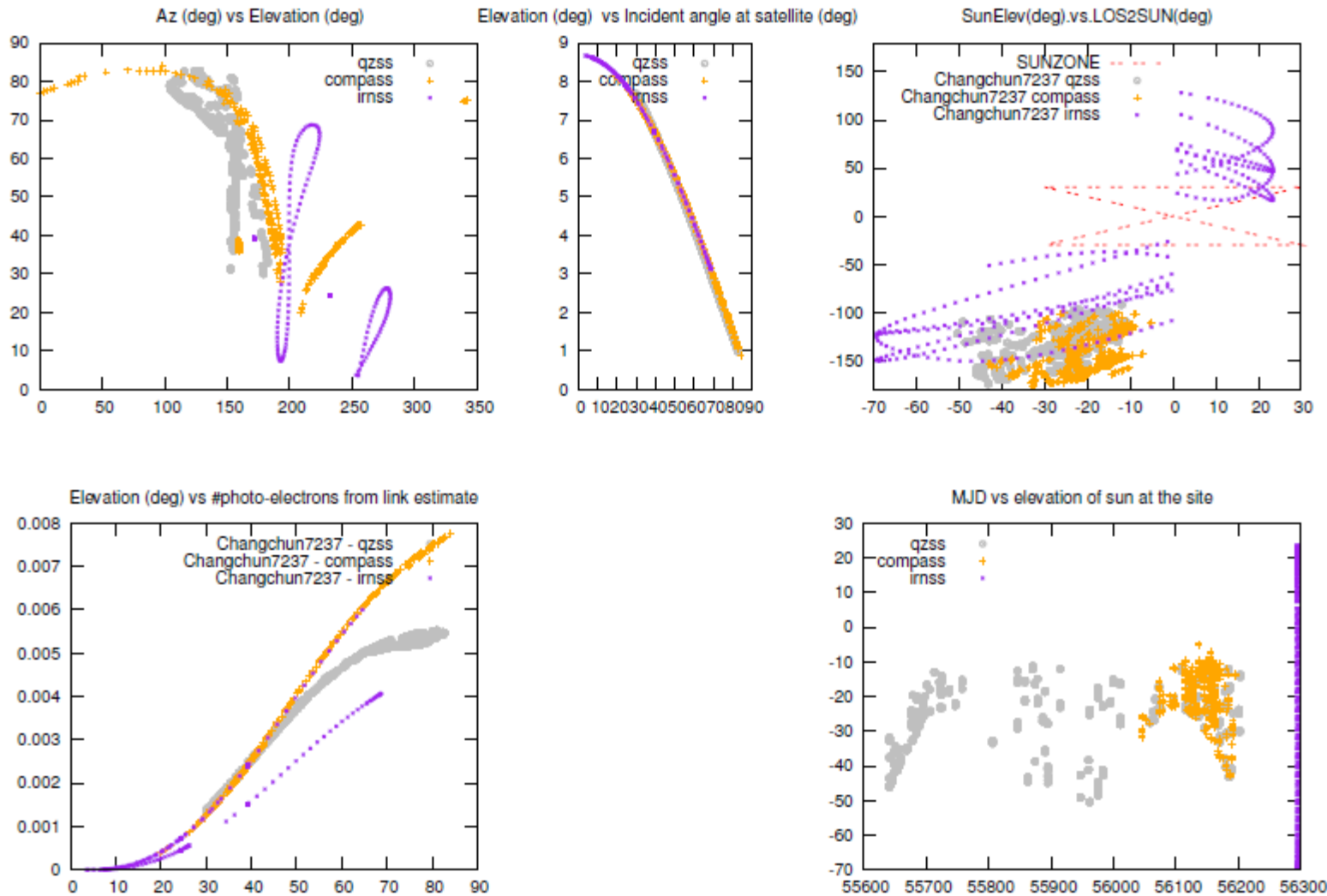


# Beijing 7249



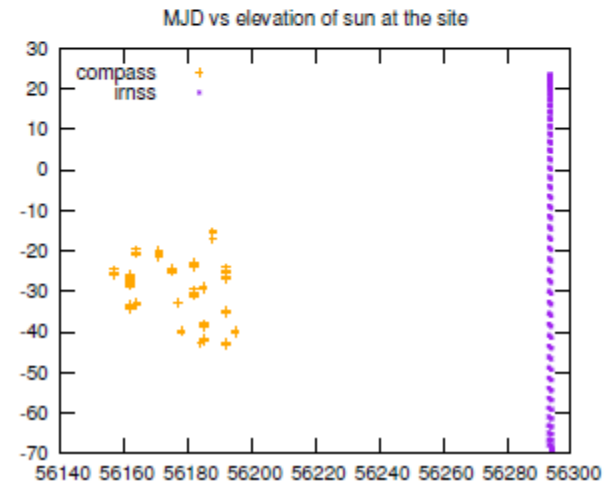
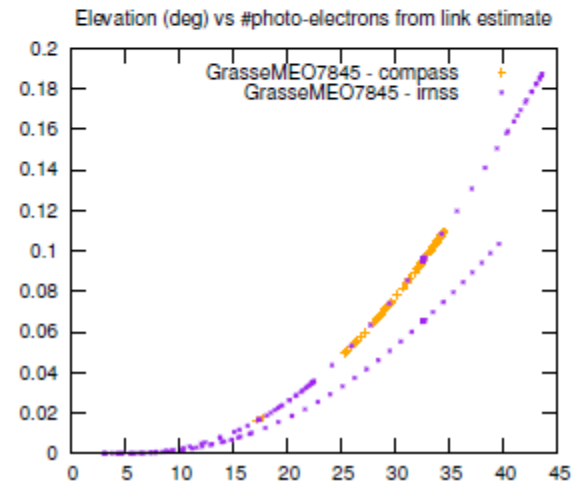
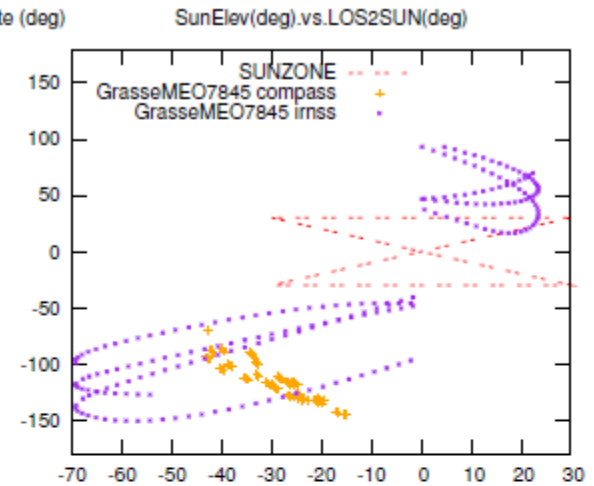
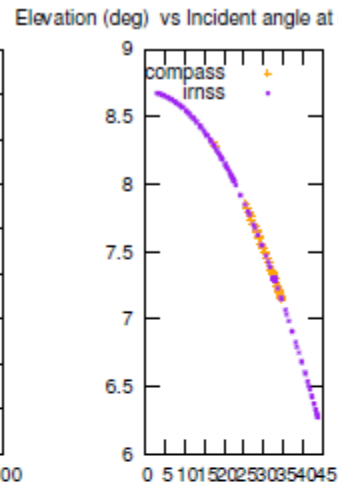
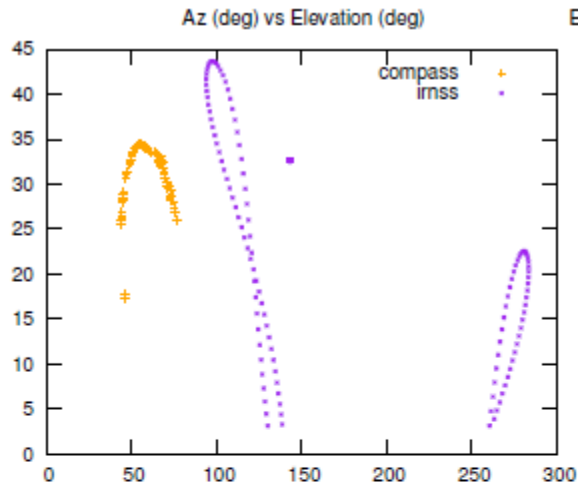


# Chang Chun 7237



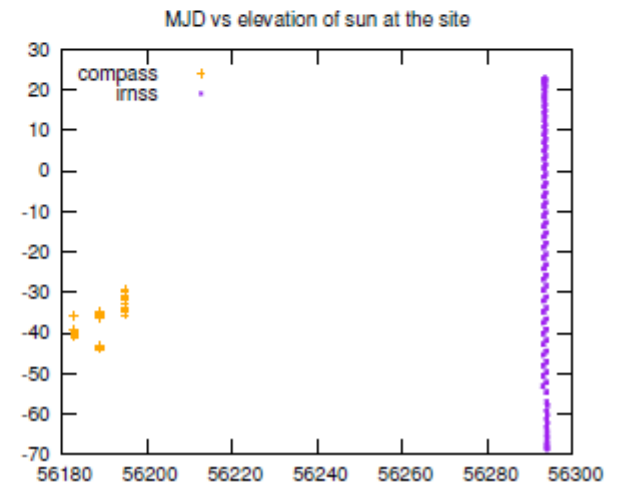
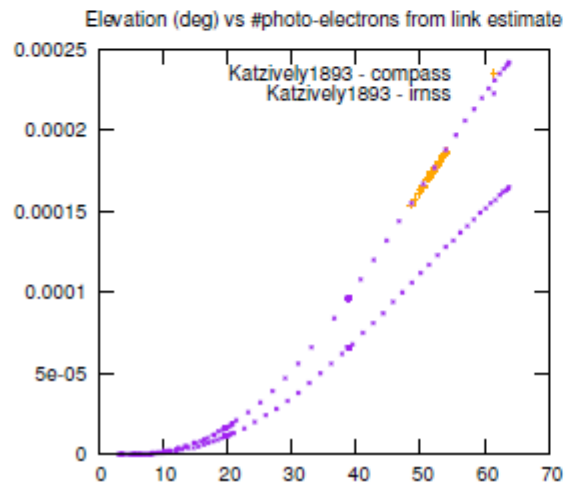
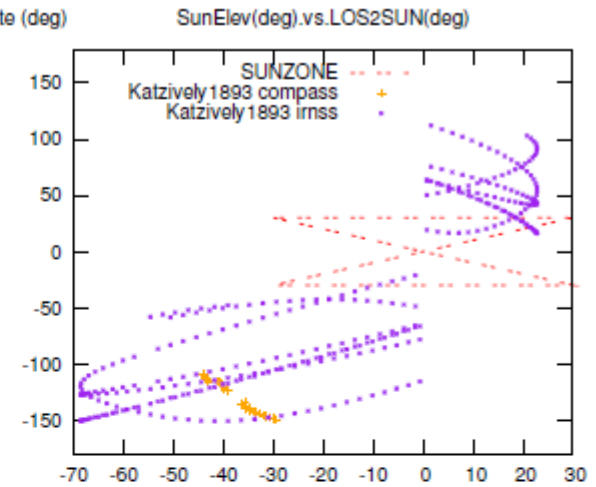
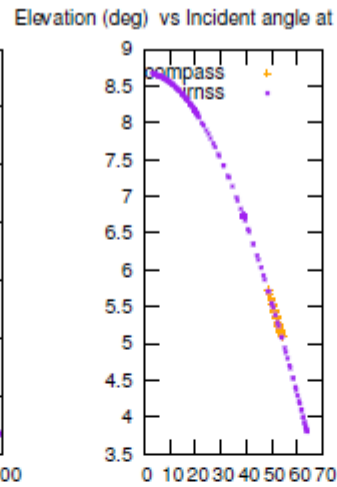
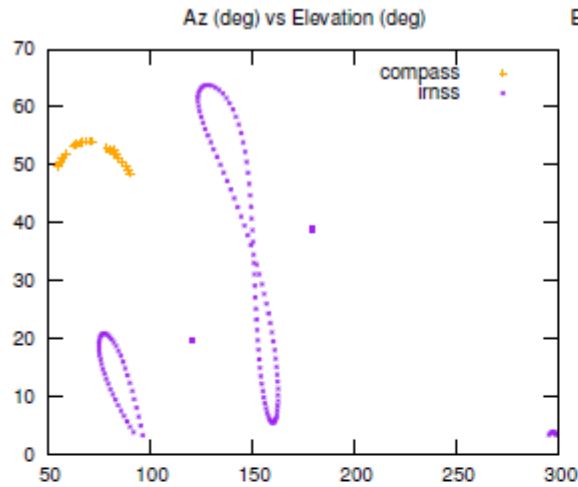


# Grasse 7845





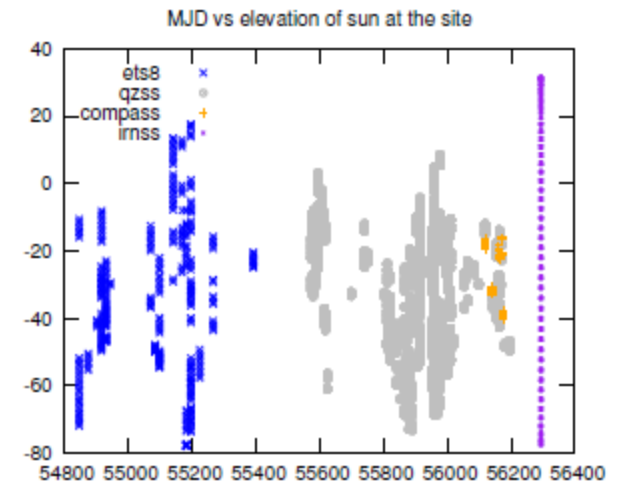
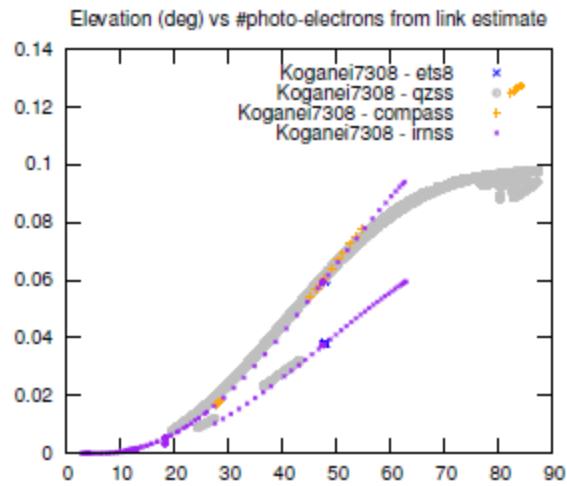
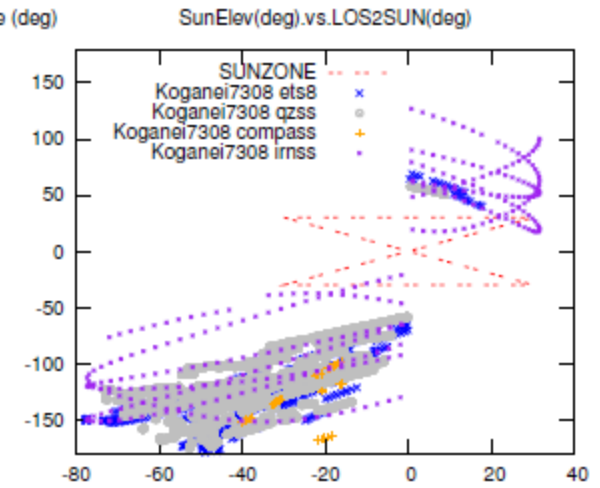
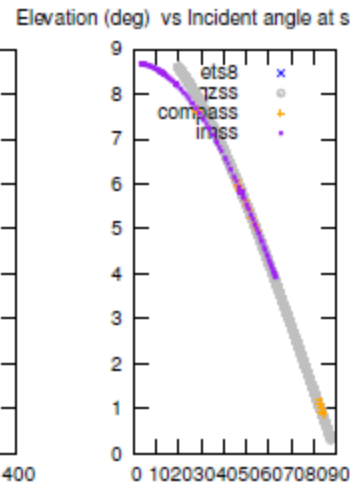
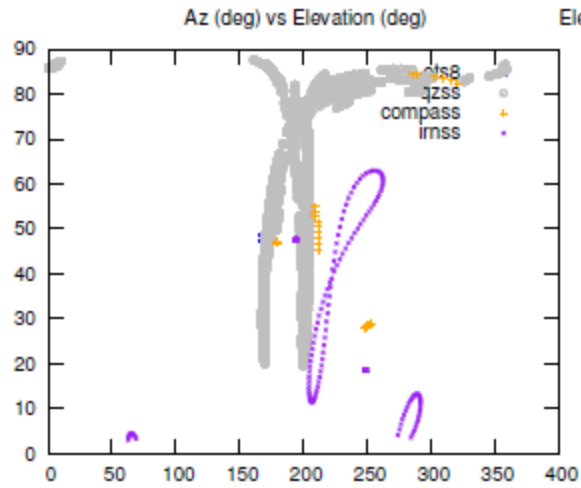
# Katzively 1893





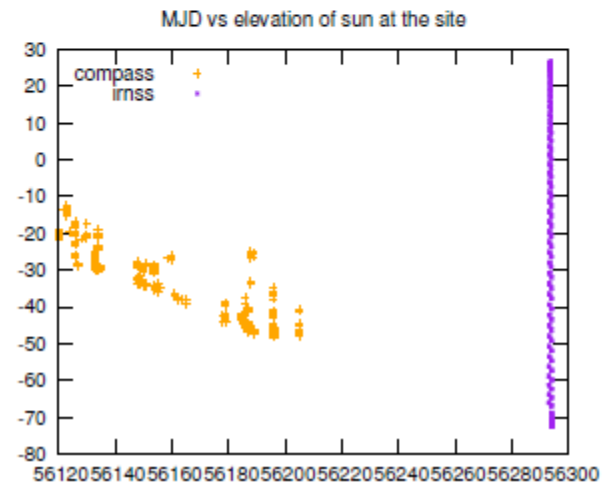
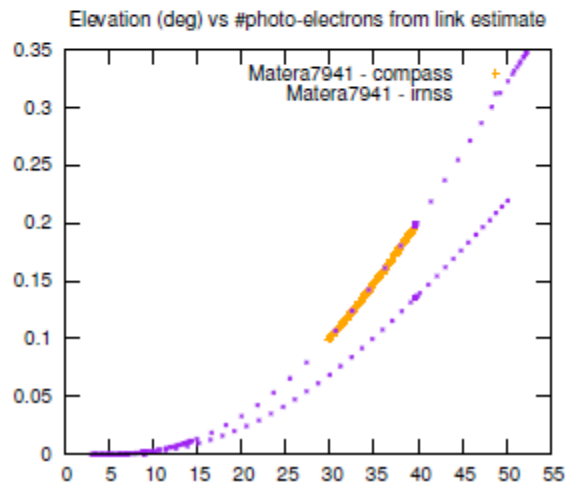
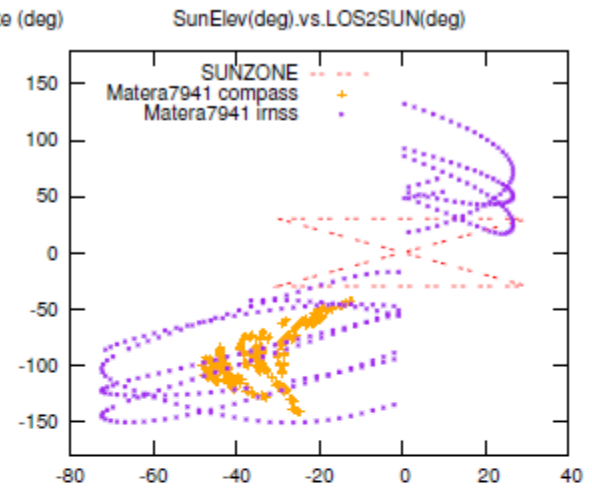
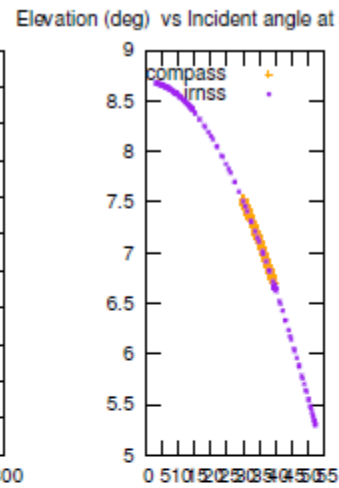
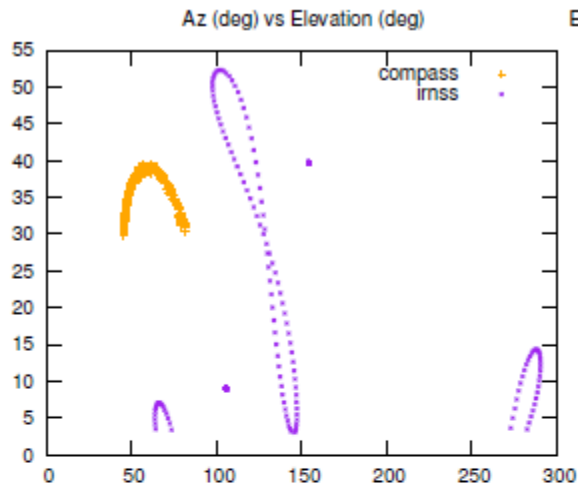


# Koganei 7308



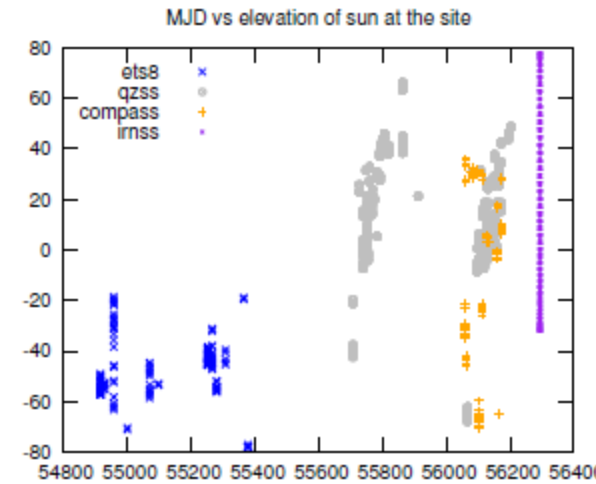
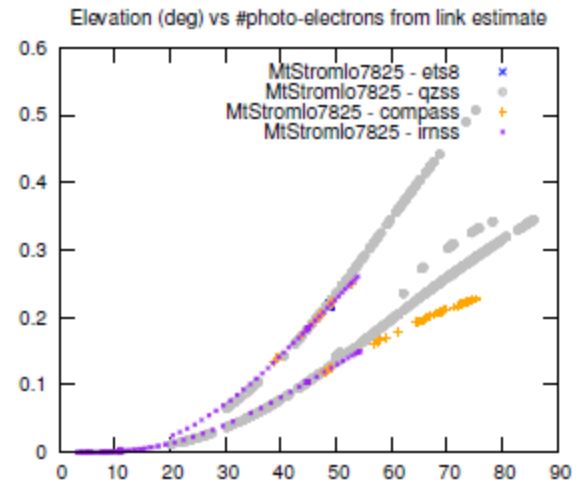
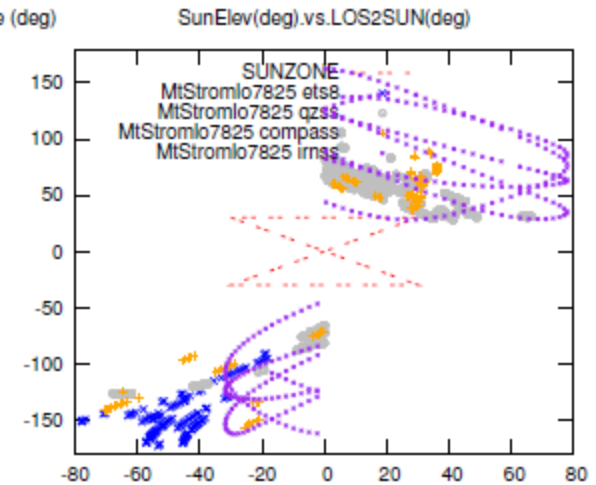
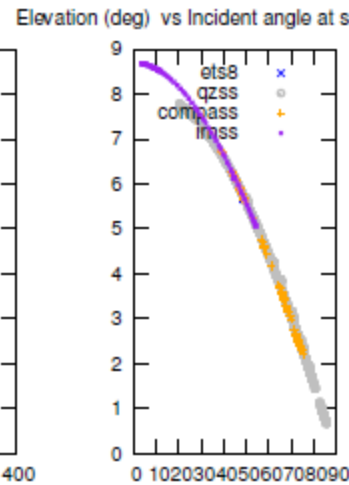
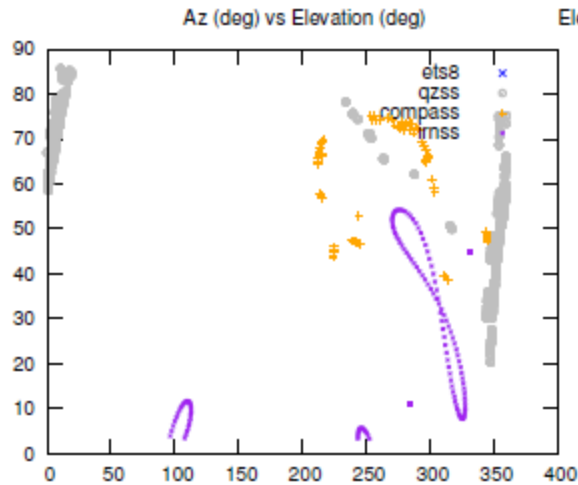


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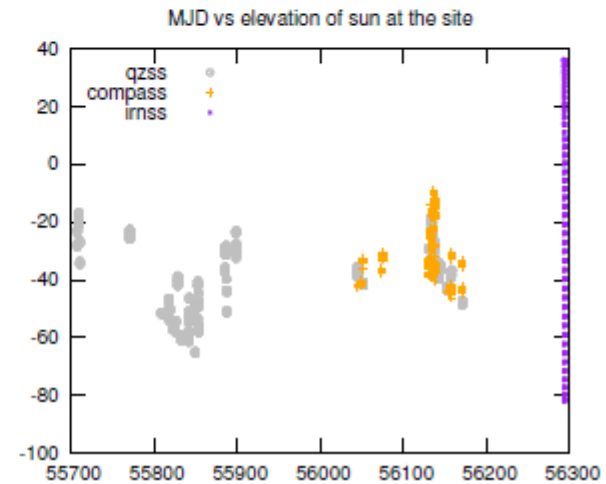
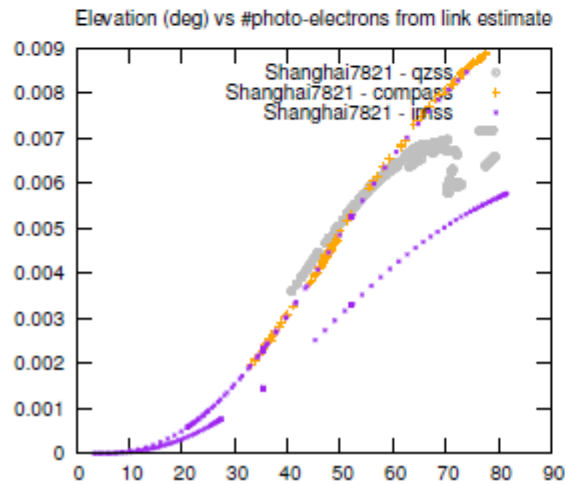
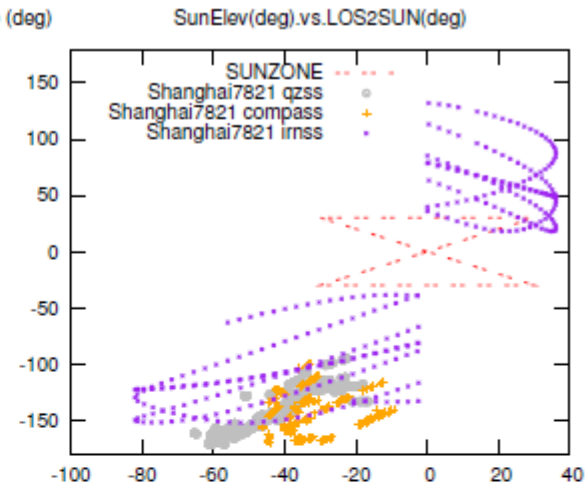
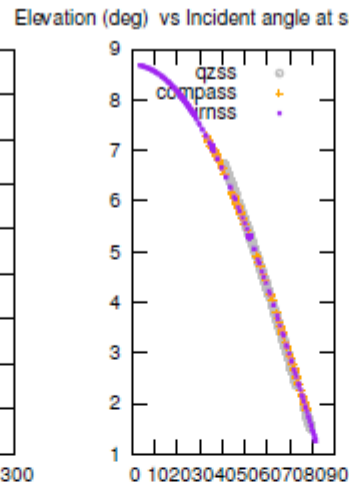
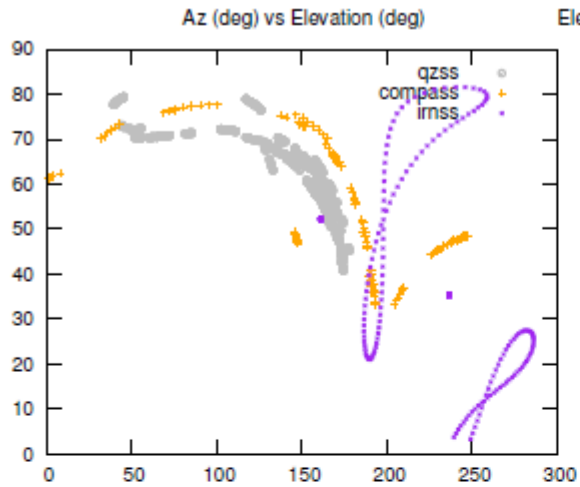


# Mt Stromlo 7825



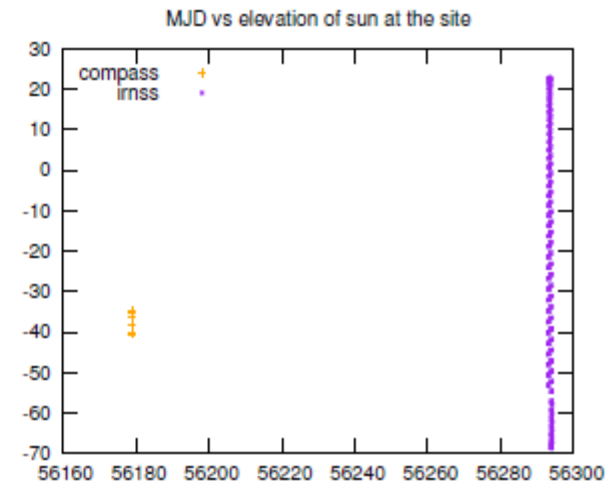
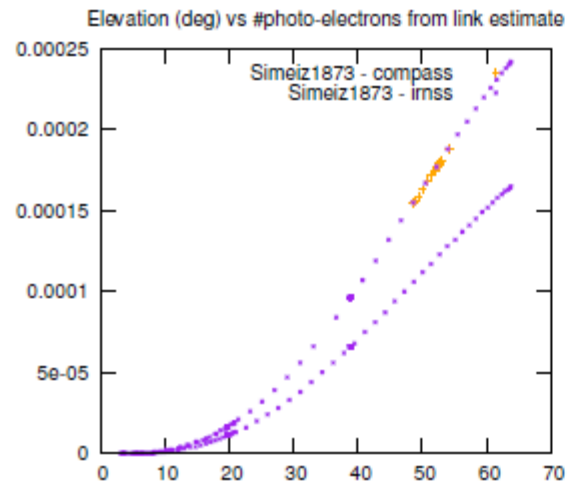
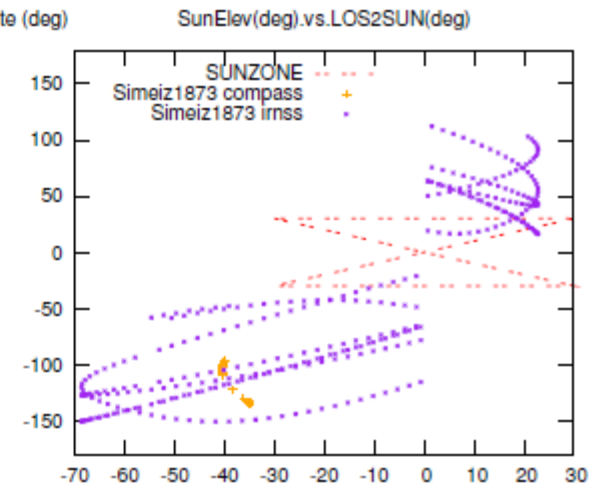
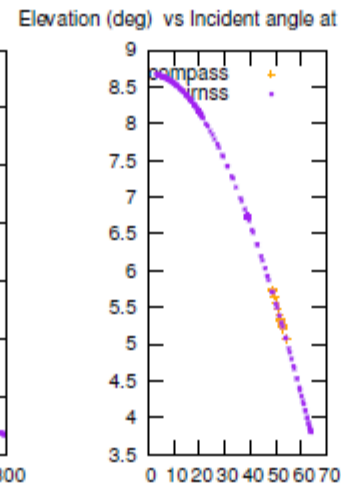
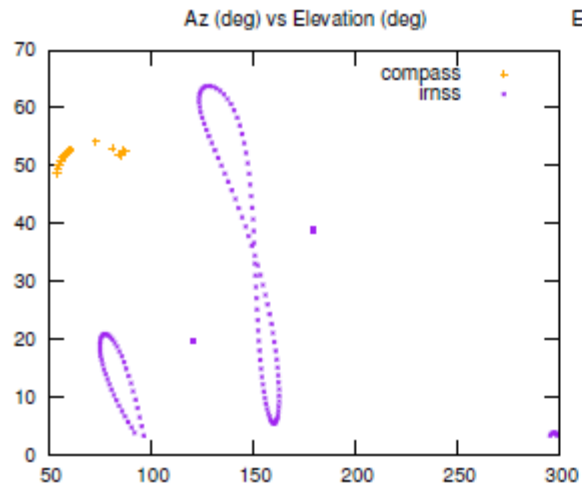


# Shanghai 7821



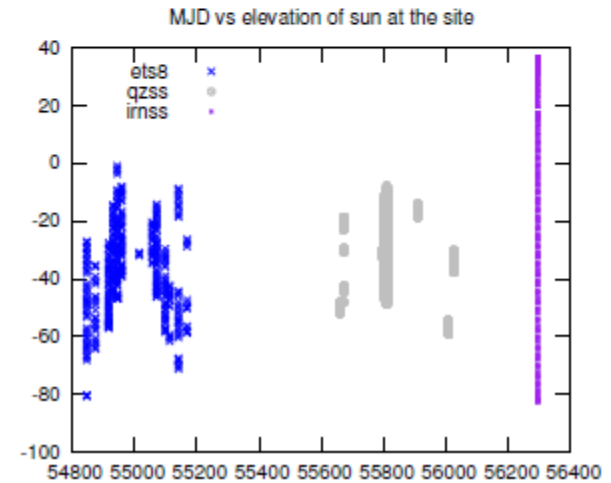
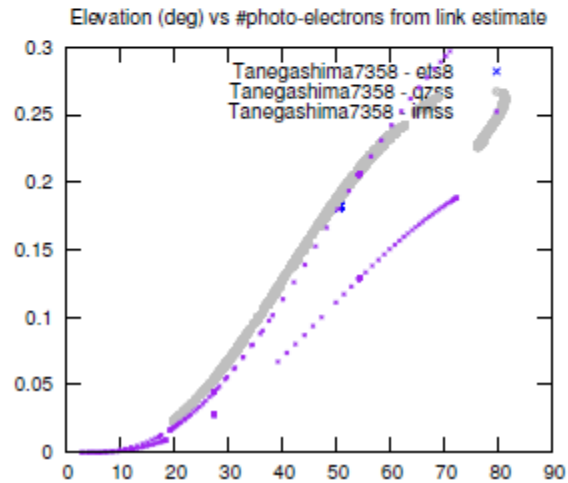
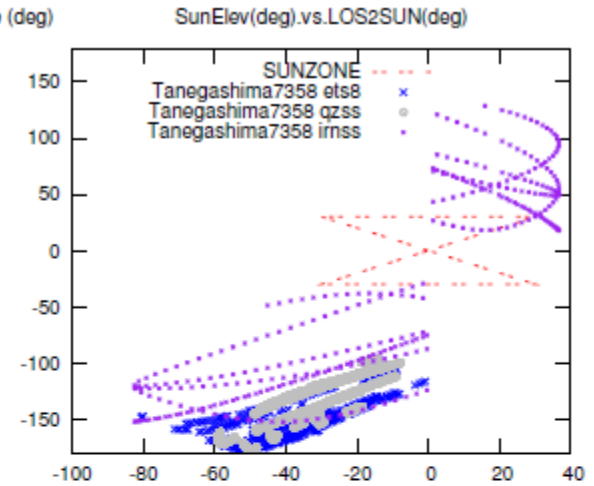
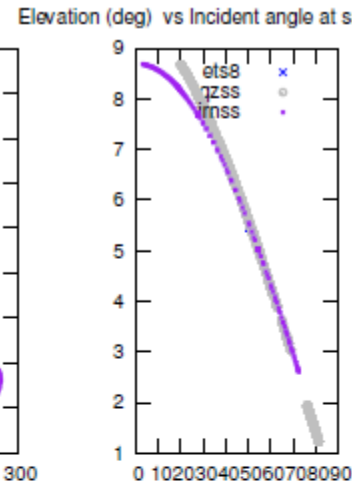
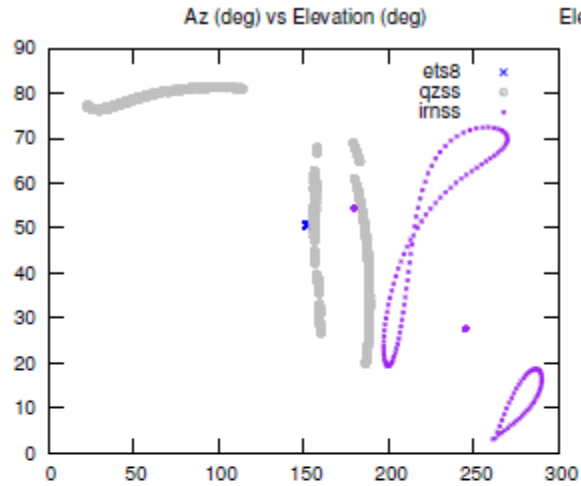


# Simeiz 1873



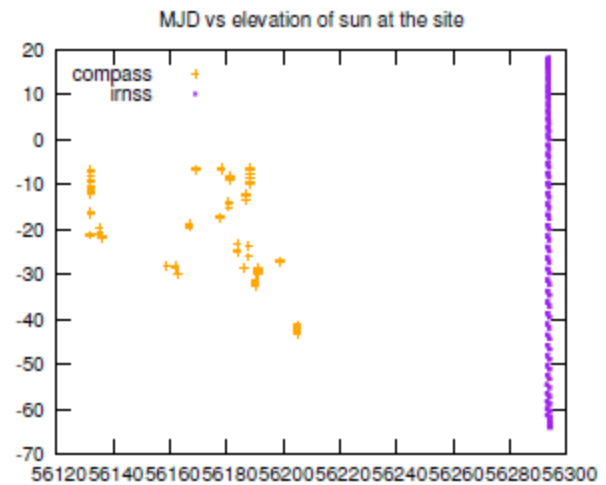
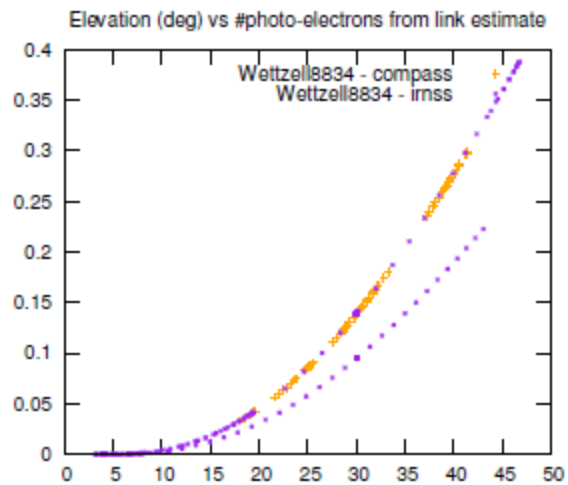
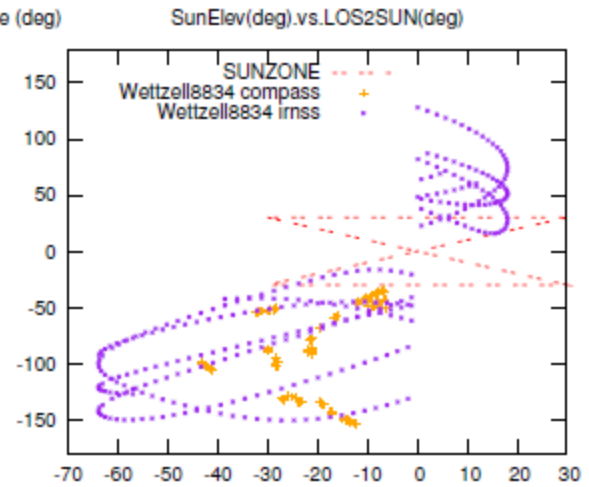
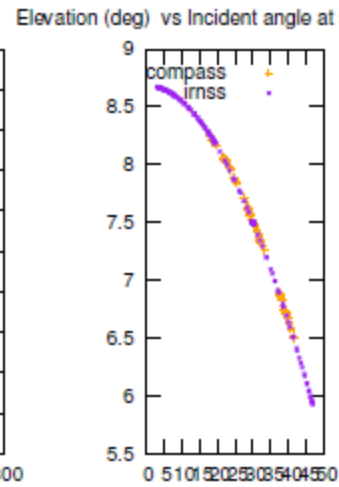
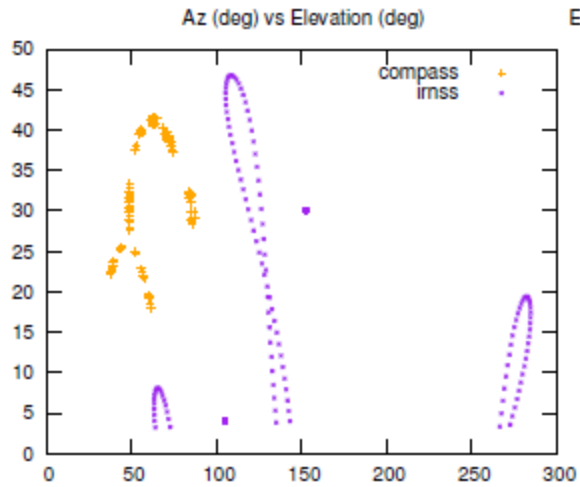


# Tanegashima 7358



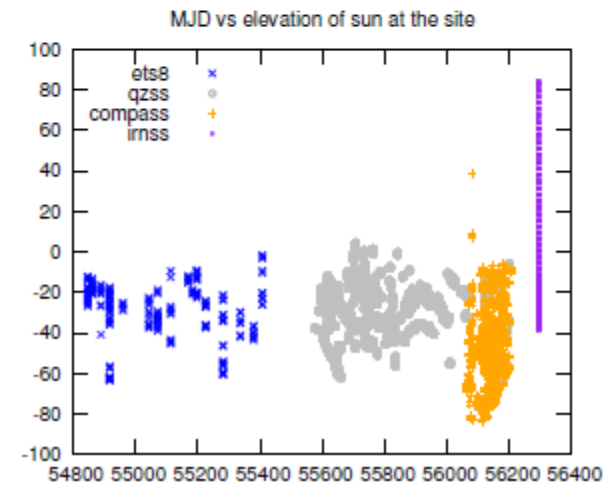
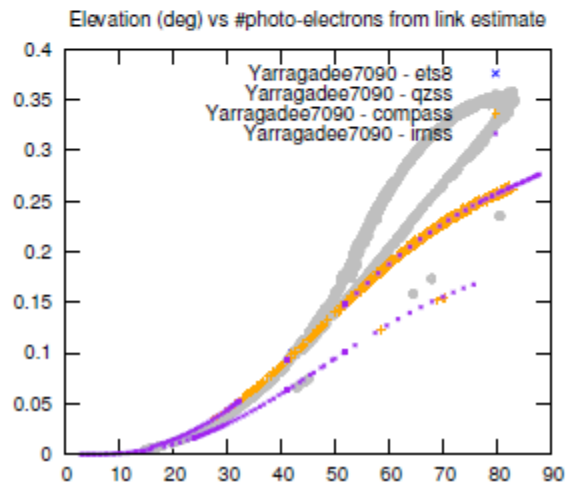
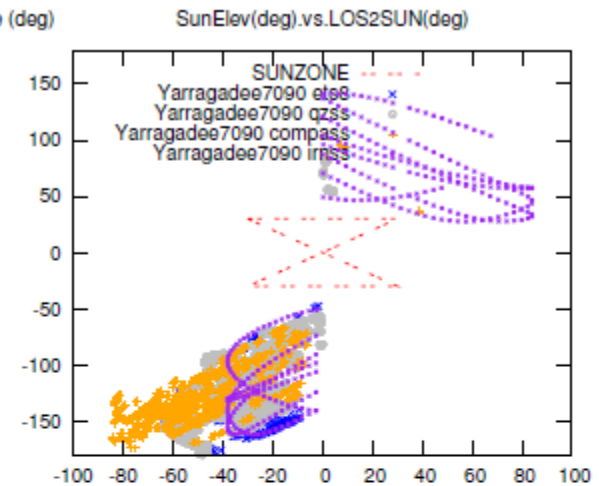
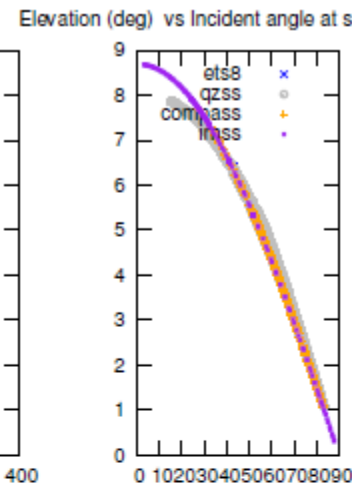
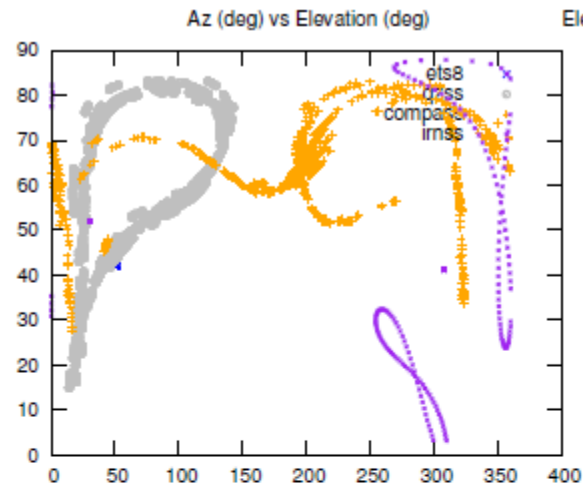


# Wettzell 8834





# Yarragadee 7090



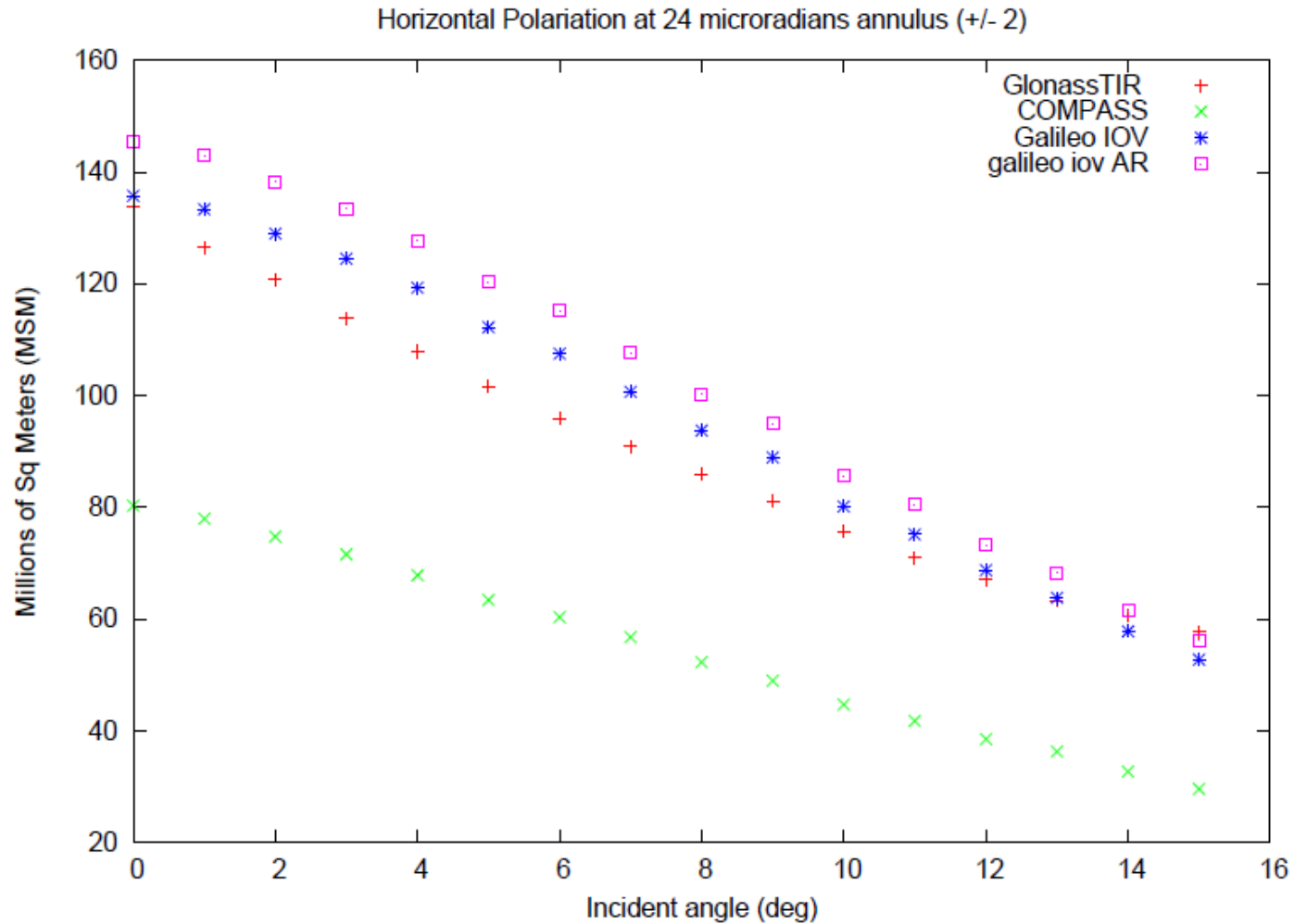




# BACKUPS

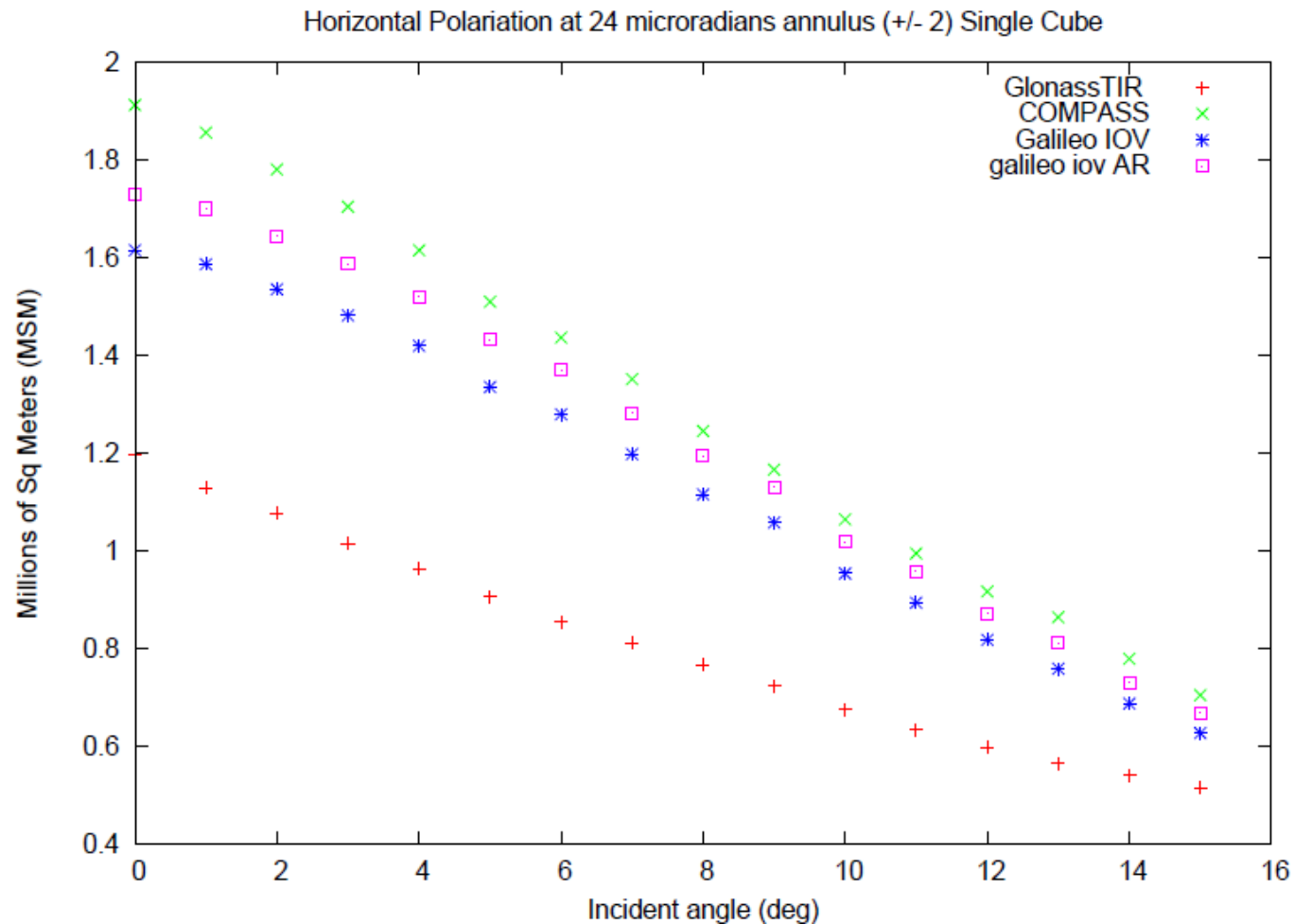


# Horizontal Polarization – Other GNSS



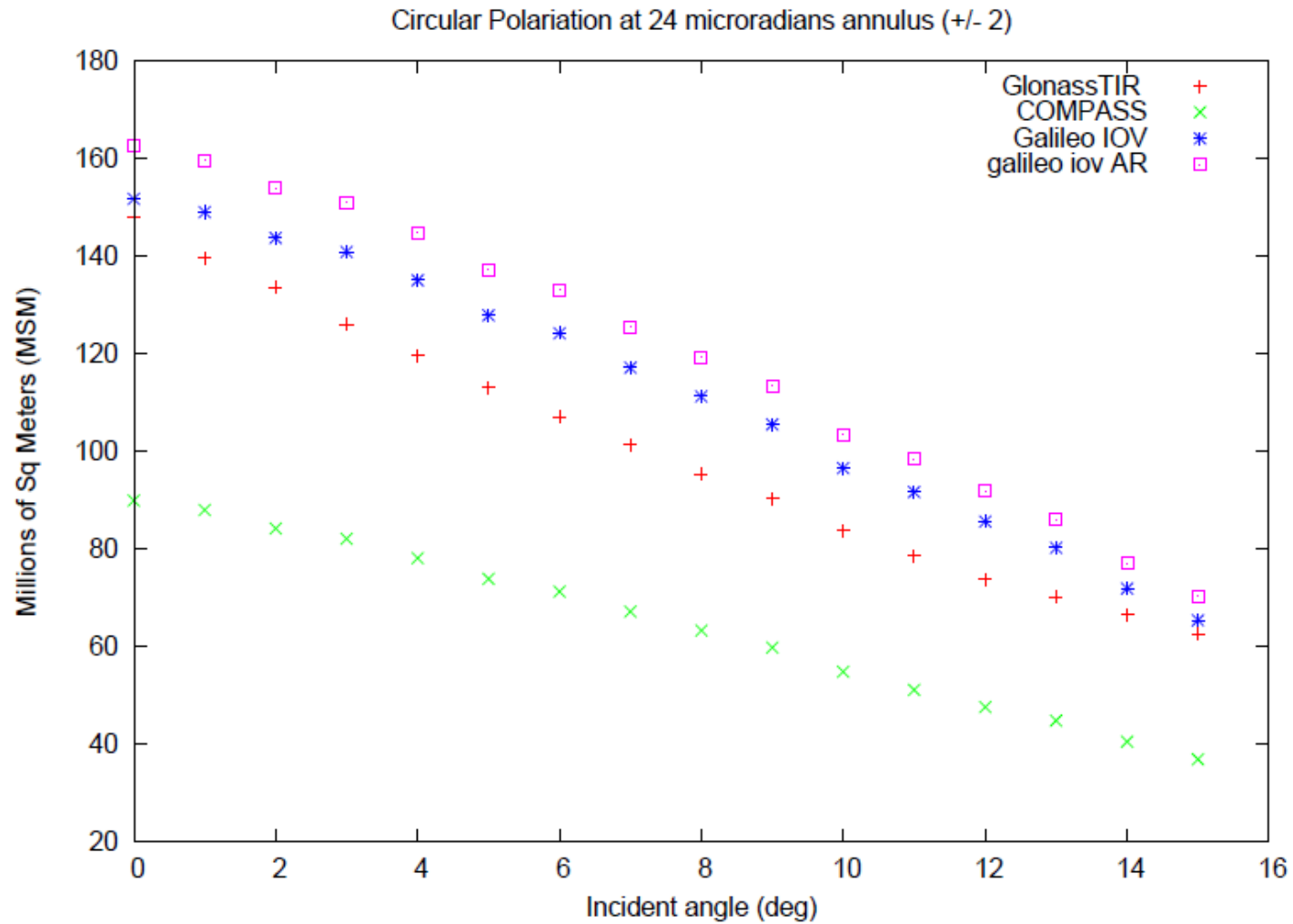


# Horizontal Polarization – Other GNSS Individual Cube Contribution





# Circular Polarization – Other GNSS





# Circular Polarization – Other GNSS Individual Cube Contribution

