

# MGA Webinar Series : 8

## GNSS Raw Data Measurement from Android Device

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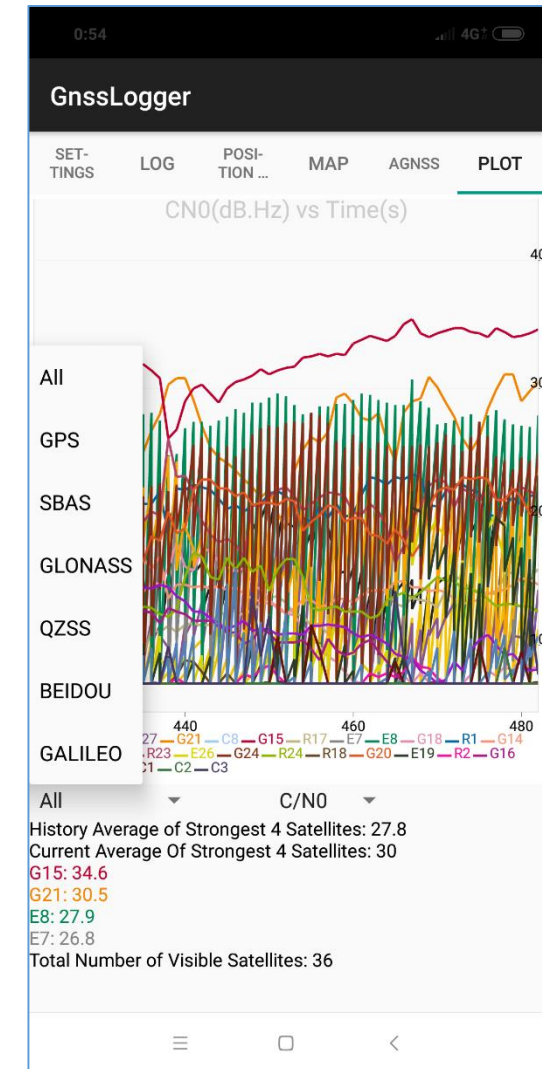
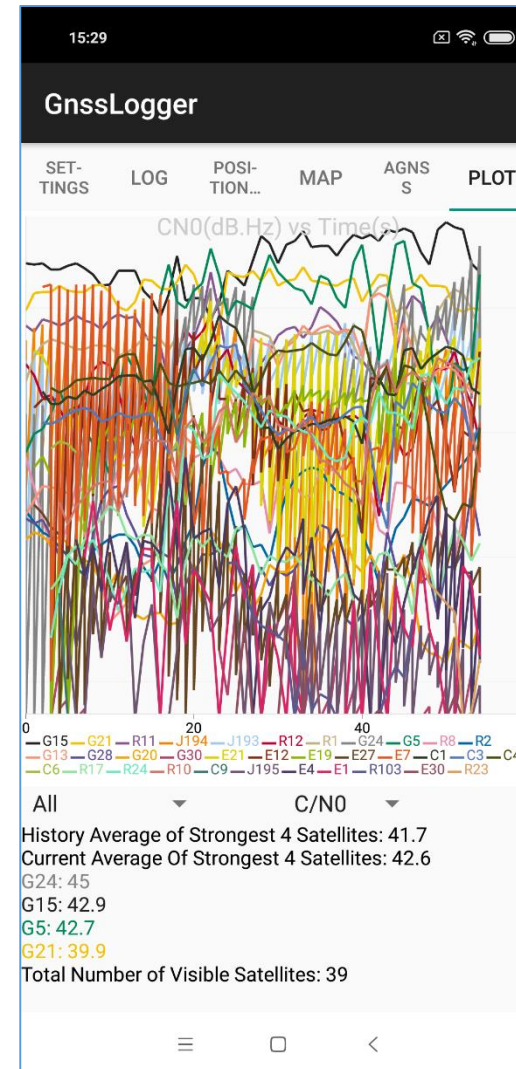
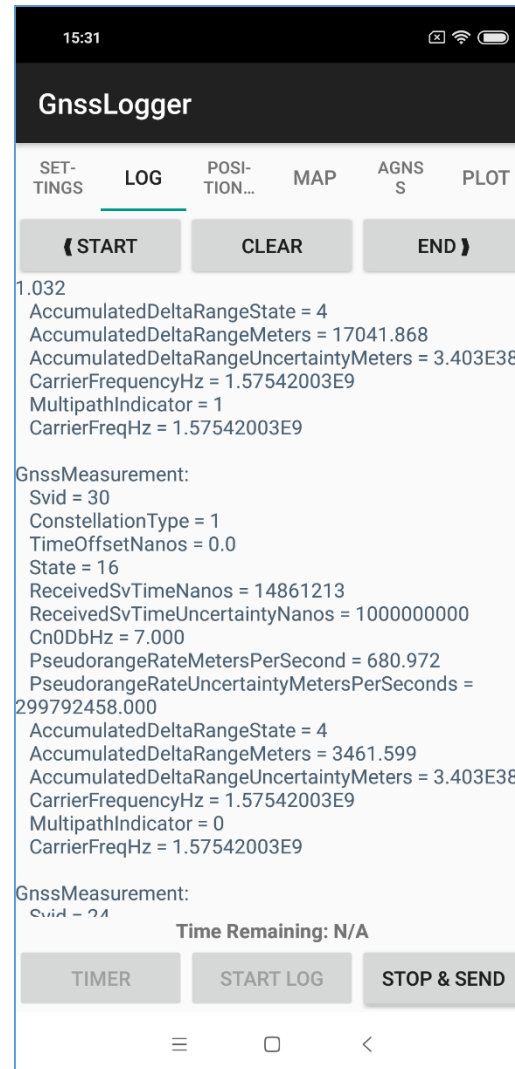
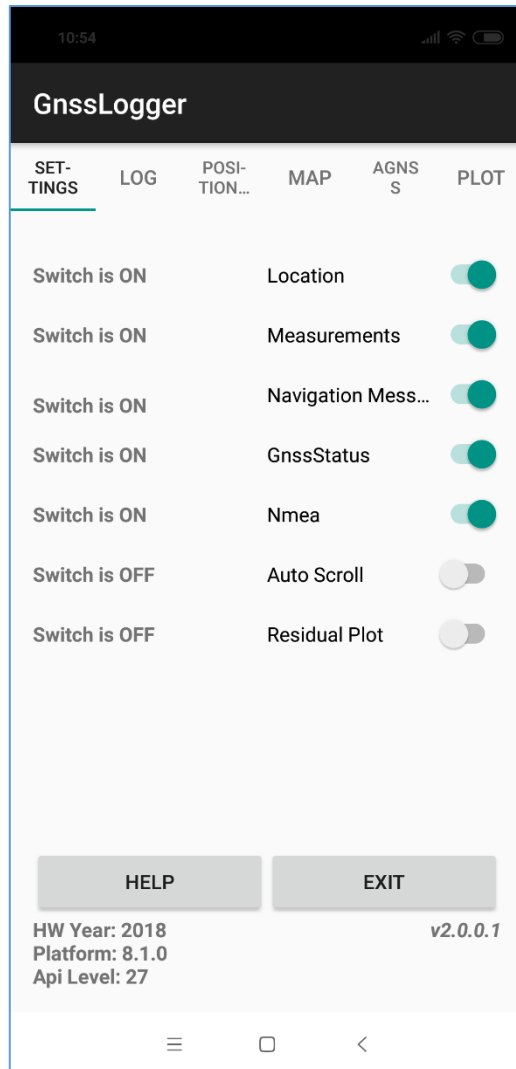
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6<sup>th</sup> Dec 2018

# Android Raw Data Logging APPs

- **GNSS Logger**
  - Logs Raw Data
  - Some devices also output AGC and Navigation Bit Data
  - Multi Band Compatible
- **Geo++ RINEX Logger**
  - APP to generate RINEX Observation File
    - [https://play.google.com/store/apps/details?id=de.geopp.rinexlogger&hl=en\\_US](https://play.google.com/store/apps/details?id=de.geopp.rinexlogger&hl=en_US)
    - Dual Frequency Compatible
- **GNSS Compare**
  - Compares position accuracy from each type of GPS and GALILEO Signal
    - [https://play.google.com/store/apps/details?id=com.galfins.gnss\\_compare&hl=en\\_US](https://play.google.com/store/apps/details?id=com.galfins.gnss_compare&hl=en_US)

# Android Raw Data Logging APP: GnssLogger



# GnssLogger: Sample GNSS Raw Data

```
Raw,148210058,6108000000,,,-1224572056418544947,0.0,1011000.0,,,0,24,0.0,51,16023402,13,38.61924362182617,-448.32047602682997,0.0021302644163370132,1,-  
2484.2876523853806,0.09621196860735094,1.57542003E9,,,,0,,1,,1.57542003E9  
Raw,148210058,6108000000,,,-1224572056418544947,0.0,1011000.0,,,0,24,0.0,16,16023363,1000000000,22.01333236694336,-448.7947882361932,2.99792458E8,6,-  
54362.39162390184,3.4028234663852886E38,1.17645005E9,,,,0,,1,,1.17645005E9  
Raw,148210059,6108000000,,,-1224572056418544947,0.0,1011000.0,,,0,2,0.0,99,448838468,42,33.2121467590332,-514.7820368047455,0.4567280495416781,4,-  
2821.165958154149,3.4028234663852886E38,1.59975002E9,,,,0,,3,,1.59975002E9  
Raw,148210059,6108000000,,,-1224572056418544947,0.0,1011000.0,,,0,12,0.0,99,451783264,33,36.38795852661133,-789.8168953823033,0.31444507671593813,4,-  
3649.9399078027736,3.4028234663852886E38,1.60143744E9,,,,0,,3,,1.60143744E9  
Raw,148210060,6108000000,,,-1224572056418544947,0.0,1011000.0,,,0,11,0.0,99,459913670,33,36.715248107910156,-  
352.6647914612738,0.0026083579286932945,1,-2248.5336107033927,0.0013041789643466473,1.602E9,,,,0,,3,,1.602E9  
Raw,148210060,6108000000,,,-1224572056418544947,0.0,1011000.0,,,0,1,0.0,17,720287,71,26.745431900024414,-150.53345126992713,0.749486332694286,4,-  
982.5725209813795,3.4028234663852886E38,1.60256256E9,,,,1,,3,,1.60256256E9  
Raw,148210060,6108000000,,,-  
1224572056418544947,0.0,1011000.0,,,0,24,0.0,99,451325376,47,31.866626739501953,540.7229232612153,0.004294544458389282,1,2792.0530589872405,0.0021472  
72229194641,1.60312499E9,,,,0,,3,,1.60312499E9  
Raw,148210061,6108000000,,,-  
1224572056418544947,0.0,1011000.0,,,0,23,0.0,17,163750,51,30.871082305908203,751.2325553423079,0.561522050942072,4,3454.136294113628,3.40282346638528  
86E38,1.60368755E9,,,,0,,3,,1.60368755E9  
Raw,148210061,6108000000,,,-  
1224572056418544947,0.0,1011000.0,,,0,17,0.0,99,450599950,39,34.2637939453125,6.408111582737082,0.4097535710026252,4,42.03919027799001,3.402823466385  
2886E38,1.60424998E9,,,,0,,3,,1.60424998E9  
Raw,148210061,6108000000,,,-  
1224572056418544947,0.0,1011000.0,,,0,8,0.0,17,490263,73,26.511377334594727,305.8143842387426,0.7594304219231991,6,1528.659101239677,3.40282346638528  
86E38,1.60537498E9,,,,0,,3,,1.60537498E9  
Raw,148210062,6108000000,,,-  
1224572056418544947,0.0,1011000.0,,,0,194,0.0,17,631661,13,38.51543045043945,39.9065635909258,0.002155878348276019,1,221.32303678571114,0.09622477557  
332045,1.57542003E9,,,,0,,4,,1.57542003E9  
Raw,148210062,6108000000,,,-  
1224572056418544947,0.0,1011000.0,,,0,195,0.0,17,934792,27,29.99894905090332,63.56321905450875,0.6032179424598567,4,356.8051378882135,3.4028234663852  
886E38,1.57542003E9,,,,0,,4,,1.57542003E9
```

# GnssLogger: Sample GNSS Raw Data, Header

# # Header Description:

# # Version: v2.0.0.1 Platform: 8.1.0 Manufacturer: Xiaomi Model: MI 8

##Raw,ElapsedRealtimeMillis,TimeNanos,LeapSecond,TimeUncertaintyNanos,FullBiasNanos,BiasNanos,BiasUncertaintyNanos,DriftNanosPerSecond,DriftUncertaintyNanosPerSecond,HardwareClockDiscontinuityCount,Svid,TimeOffsetNanos,State,ReceivedSvTimeNanos,ReceivedSvTimeUncertaintyNanos,Cn0DbHz,PseudorangeRateMetersPerSecond,PseudorangeRateUncertaintyMetersPerSecond,AccumulatedDeltaRangeState,AccumulatedDeltaRangeMeters,AccumulatedDeltaRangeUncertaintyMeters,CarrierFrequencyHz,CarrierCycles,CarrierPhase,CarrierPhaseUncertainty,MultipathIndicator,SnrInDb,ConstellationType,AgcDb,CarrierFrequencyHz

# # Fix,Provider,Latitude,Longitude,Altitude,Speed,Accuracy,(UTC)TimeInMs

# # Nav,Svid,Type,Status,MessageId,Sub-messageId,Data(Bytes)

#

# GnssLogger: Sample GNSS Raw Data, Raw Data

Raw,678357857,828940000000,,,-1227744676059580169,0.0,5.135445098385752,,,0,2,0.0,16431,1504929579420,11,42.886016845703125,-253.99448677373584,0.0013739581918343902,1,-230928.61821755476,6.869790959171951E-4,1.57542003E9,,,,0,,1,,1.57542003E9

Raw,678357858,828940000000,,,-1227744676059580169,0.0,5.135445098385752,,,0,5,0.0,16431,1504926917641,12,42.140777587890625,-299.9095448909793,0.0014970472548156977,1,-262724.97200484236,7.485236274078488E-4,1.57542003E9,,,,0,,1,,1.57542003E9

Raw,678357858,828940000000,,,1227744676059580169,0.0,5.135445098385752,,,0,6,0.0,16,828010596684,1000000000,36.201961517333984,275.3221907272733,2.99792458E8,2,1144.5147370874038,3.4028234663852886E38,1.57542003E9,,,,0,,1,,1.57542003E9

Raw,678357858,828940000000,,,-1227744676059580169,0.0,5.135445098385752,,,0,7,0.0,16431,1504921150324,19,34.20191192626953,-228.16970128013054,0.003542420221492648,1,213920.67928652398,0.09691804650992876,1.57542003E9,,,,0,,1,,1.57542003E9

Raw,678357858,828940000000,,,1227744676059580169,0.0,5.135445098385752,,,0,9,0.0,16431,1504924621121,19,34.36507797241211,587.1039666302386,0.0034764972515404224,1,468139.7243548873,0.0017382486257702112,1.57542003E9,,,,0,,1,,1.57542003E9

Raw,678357858,828940000000,,,1227744676059580169,0.0,5.135445098385752,,,0,13,0.0,16431,1504920021810,19,34.32540512084961,666.6443721854594,0.0032926779240369797,1,561690.3480669406,0.0016463389620184898,1.57542003E9,,,,1,,1,,1.57542003E9

Raw,678357858,828940000000,,,1227744676059580169,0.0,5.135445098385752,,,0,17,0.0,16431,1504916630146,20,33.56485366821289,744.6819117466221,0.003812001552432776,1,619849.6424447118,0.0019060007762163877,1.57542003E9,,,,1,,1,,1.57542003E9

Raw,678357858,828940000000,,,1227744676059580169,0.0,5.135445098385752,,,0,19,0.0,16431,1504921921584,23,31.828954696655273,735.126564052538,0.004389062523841858,1,599416.7818672012,0.09734136766110336,1.57542003E9,,,,0,,1,,1.57542003E9

# GnssLogger: Sample GNSS Raw Data, Position and NMEA

```
Fix,gps,35.850232,139.862279,37.854518,0.008482,4.000000,1543710718999
NMEA,$GPGSV,4,1,14,02,71,324,32,06,60,115,39,05,43,288,35,09,29,045,25*74 ,NMEA,$GPGSA,A,3,02,05,06,07,09,13,19,29,30,,,,,1.6,0.7,1.4*3A
,1543710720204 ,1543710720205
NMEA,$GPGSV,4,2,14,07,26,093,34,19,24,182,23,30,22,130,27,13,22,207,23*72 ,NMEA,$GNGSA,A,3,02,05,06,07,09,13,19,29,30,,,,,1.6,0.7,1.4*24
,1543710720204 ,1543710720205
NMEA,$GPGSV,4,3,14,29,11,323,22,23,04,042,,17,03,169,*4A ,NMEA,$GNGSA,A,3,67,68,69,82,83,84,,,,,,1.6,0.7,1.4*24
,1543710720204 ,1543710720205
NMEA,$GPGSV,4,4,14,06,,,39,09,,,30,30,,,36,8*68 ,NMEA,$QZGSA,A,3,01,02,03,,,,,,,,,1.6,0.7,1.4*2B
,1543710720204 ,1543710720206
NMEA,$GLGSV,2,1,07,83,80,264,26,68,65,326,32,82,37,165,23,69,32,254,33*6D ,NMEA,$IMGSA,A,3,,,,,,,,,1.6,0.7,1.4*24
,1543710720204 ,1543710720206
NMEA,$GLGSV,2,2,07,67,28,037,24,84,26,329,19,77,08,073,11*5F ,NMEA,$BDGSA,A,3,203,,,,,,,,,1.6,0.7,1.4*17
,1543710720204 ,1543710720206
NMEA,$QZGSV,2,1,05,01,83,285,31,03,41,201,33,02,07,171,22*53 ,NMEA,$GAGSA,A,3,104,109,112,119,,,,,,,,,1.6,0.7,1.4*20
,1543710720204 ,1543710720206
NMEA,$QZGSV,2,2,05,01,,,34,03,,,33,8*71 ,NMEA,$GPRMC,003159.00,A,3551.013922,N,13951.736758,E,000.0,337.0,02121
,1543710720205 8,,,A*51
NMEA,$BDGSV,1,1,02,203,38,224,23,202,20,250,*60 ,1543710720206
,1543710720205
NMEA,$GAGSV,2,1,08,104,75,259,30,112,61,159,30,119,42,045,29,109,22,236,25*6F
,1543710720205
NMEA,$GAGSV,2,2,08,104,,,34,112,,,32,119,,,21,109,,,26,1*7A
,1543710720205
```

# GnssLogger: Sample GNSS Raw Data, Navigation Bit Data

```
Nav,101,769,1,5,9,76,34,58,55,7,116,-65,67,-77,-42,88Nav,102,769,1,5,9,76,34,58,55,7,116,-65,67,-77,-42,88  
Nav,103,769,1,5,9,76,34,58,55,7,116,-65,67,-77,-42,88Nav,105,769,1,5,9,76,34,58,55,7,116,-65,67,-77,-42,88  
Nav,106,769,1,5,9,76,34,58,55,7,116,-65,67,-77,-42,88
```



# Android Raw Data Logging APP Geo++ RINEX Logger

15:32

**Geo++<sup>®</sup>**  
RINEX Logger  
2.0.0

Now supporting dual-frequency!

Stop Start

Logging... 0:00:07

Signal States

Cycle Slips (L1+E1):	15/30	50%	<div style="width: 50%;"></div>
Cycle Slips (L5+E5A):	4/9	44%	<div style="width: 44%;"></div>
Multipath (L1+E1):	5/30	16%	<div style="width: 16%;"></div>
Multipath (L5+E5A):	2/9	22%	<div style="width: 22%;"></div>

	Visible	Synced	Trackable
GPS:	L1/L5 8/2	L1/L5 6/2	L1/L5 6/2
QZSS:	3/3	2/3	2/3
GALILEO:	E1B/E1C/E5A 1/6/4	E1B/E1C/E5A 0/1/4	E1B/E1C/E5A 0/1/4
GLONASS:	L1 9	L1 4	L1 4
BDS:	3	3	3

BDS/QZSS logging is only supported in RINEX 3.03 format.

Approximate Position

Ellipsoidal		Cartesian	
Latitude:	35.8944309	X:	-3959920.54
Longitude:	139.9522123	Y:	3328400.04
Height:	69.16	Z:	3718749.27

Receiver Clock

Monitor Settings Files Info

10:58

**Geo++<sup>®</sup>**  
RINEX Logger  
2.0.0

Now supporting dual-frequency!

Stop Start

Ready 0:00:00

Header Entries

Marker Name: kashiwanoha

Marker Type: Geodetic

Observer Name: dinesh

Observer Agency Name: dinesh

Receiver Number: aa30d35f

Receiver Type: Xiaomi

Receiver Version: MI 8

Antenna Number: aa30d35f

Antenna Type: MI 8

Monitor Settings Files Info

15:38

**GNSS Compare**

NMEA

GPS L1  Activate:  Save log:

GPS L1  
Pedestrian EKF  
Relativistic path range correction  
Tropospheric correction  
Klobuchar Iono Correction  
NMEA

GPS L5  Activate:  Save log:

GPS L5  
Pedestrian EKF  
Relativistic path range correction  
Tropospheric correction  
Klobuchar Iono Correction  
NMEA

GPS IF  Activate:  Save log:

GPS IF  
Pedestrian EKF  
Relativistic path range correction  
Tropospheric correction  
NMEA

Monitor Settings Files Info

15:38

**GNSS Compare**

Galileo E1  Activate:  Save log:

Galileo E1  
Pedestrian EKF  
Relativistic path range correction  
Tropospheric correction  
Klobuchar Iono Correction  
NMEA

Galileo E5a  Activate:  Save log:

Galileo E5a  
Pedestrian EKF  
Relativistic path range correction  
Tropospheric correction  
Klobuchar Iono Correction  
NMEA

Galileo IF  Activate:  Save log:

Galileo IF  
Pedestrian EKF  
Relativistic path range correction  
Tropospheric correction  
NMEA

GPS L1  Activate:  Save log:

GPS L1  
Pedestrian EKF

Monitor Settings Files Info

# Geo++ RINEX Logger

```

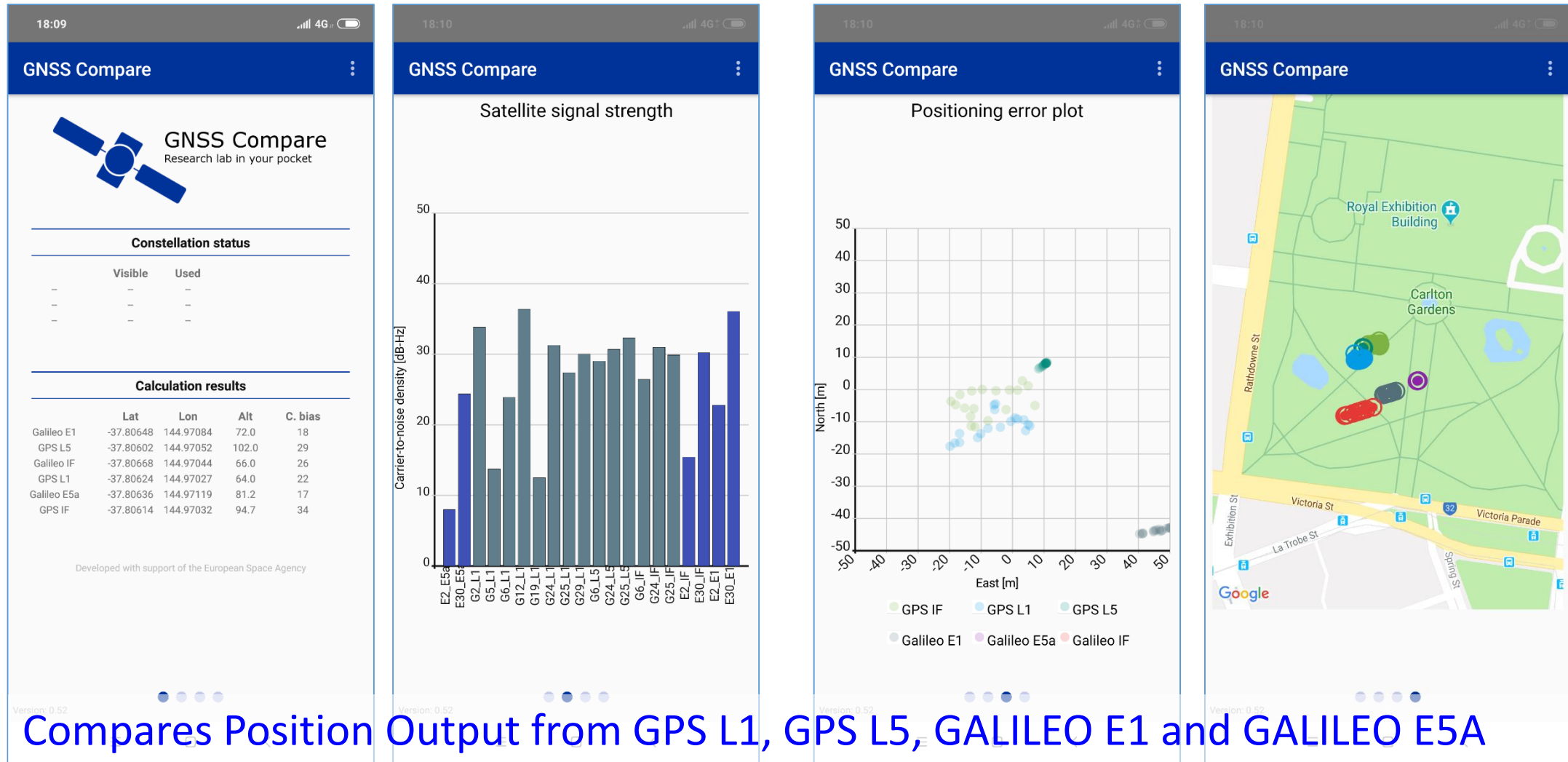
3.03      OBSERVATION DATA      M: Mixed      RINEX VERSION / TYPE
Geo++ RINEX Logger  Geo++      20181022 071442 UTC PGM / RUN BY / DATE
*****COMMENT
This file was generated by the Geo++ RINEX Logger App
for Android devices (Version 2.0.0). If you encounter
any issues, please send an email to android@geopp.de
*****COMMENT
park      MARKER NAME
GEODETTIC MARKER TYPE
dinesh    dinesh      OBSERVER / AGENCY
aa30d35f  Xiaomi      MI 8      REC # / TYPE / VERS
aa30d35f  MI 8      ANT # / TYPE
-4131685.6432 2896217.5961 -3888491.9491 APPROX POSITION XYZ
0.0000      0.0000      0.0000      ANTENNA: DELTA H/E/N
G 8 C1C L1C D1C S1C C5Q L5Q D5Q S5Q SYS / # / OBS TYPES
R 4 C1C L1C D1C S1C SYS / # / OBS TYPES
E 12 C1B L1B D1B S1B C1C L1C D1C S1C C5Q L5Q D5Q S5Q SYS / # / OBS TYPES
C 4 C2I L2I D2I S2I SYS / # / OBS TYPES
J 8 C1C L1C D1C S1C C5Q L5Q D5Q S5Q SYS / # / OBS TYPES
2018 10 22 7 15 0.0001146 GPS TIME OF FIRST OBS
24 R01 1 R02 -4 R03 5 R04 6 R05 1 R06 -4 R07 5 R08 6 GLONASS SLOT / FRQ #
R09 -2 R10 -7 R11 0 R12 -1 R13 -2 R14 -7 R15 0 R16 -1 GLONASS SLOT / FRQ #
R17 4 R18 -3 R19 3 R20 2 R21 4 R22 -3 R23 3 R24 2 GLONASS SLOT / FRQ #
G L1C SYS / PHASE SHIFTS
G L5Q -0.25000 SYS / PHASE SHIFTS
R L1C SYS / PHASE SHIFTS
E L1B SYS / PHASE SHIFTS
E L1C +0.50000 SYS / PHASE SHIFTS
E L5Q -0.25000 SYS / PHASE SHIFTS
C L2I SYS / PHASE SHIFTS
J L1C SYS / PHASE SHIFTS
J L5Q -0.25000 SYS / PHASE SHIFTS
C1C 0.000 C1P 0.000 C2C 0.000 C2P 0.000 GLONASS COD/PHS/BIS
END OF HEADER
  
```

Supports both L1 & L5

The app interface consists of a top status bar, a main header with the logo and title, and a central control area with 'Stop' and 'Start' buttons. Below this, there are sections for 'Satellite States' (Visible, Trackable, Synced), 'Approximate Position' (Geodetic and Carthesic coordinates), and 'Receiver Clock' (UTC time and date). The bottom navigation bar includes icons for Monitor, Settings, Files, and Info.

<http://www.geopp.de/logging-of-gnss-raw-data-on-android/>

# Android Raw Data Logging APP: GNSS Compare



Compares Position Output from GPS L1, GPS L5, GALILEO E1 and GALILEO E5A

# Sample Output Data from GNSS Compare: Galileo E1

```

%% Timestamp: timestamp of the logged information
%% satID: ID of the used satellited - satID[constellationSize]
%% Elev: elevation of the used satellited
%% CNO: signal strength of the used satellited
%% PR: pseudoranges of the used satellites - pseudoranges[constellationSize]
%% Inno: Kalman Filter innovation vector - gamma[constellationSize]
%% CovInno: Covariance of the innovation vector -
S[constellationSize,constellationSize]
%% EstimPos: Estimated position - x_meas[numStates]
%% CovEstimPos: Covariance of estimated position -
P_meas[numStates,numStates]
%% E: Error of the estimated position w.r.t the FINE location
%% Fl, fineLocation.Latitude, fineLocation.Longitude, fineLocation.Altitude

Timestamp,151802.965
satID,E2_E1,E3_E1,E8_E1
Elev,31.610655657172565,79.62218334355671,26.434511304778855
CNO,24.7218017578125,9.973297119140625,16.62681007385254
PR,2.5750447126294035E7,2.3339095558620986E7,2.42679284542776E7
Inno,-91.24294137954712,18.01171224936843,64.18829656392336
CovInno,12.22970286249292,14.444868432192381,12.690663461967336
EstimPos,-1538772.0345251851,6187985.963390375,147515.7288238819,-
74.3935243591933,0.5047784960376713
CovEstimPos,2.9416686630197995,15.169400083974876,0.10437474374131087
,7.460593341167593,0.16107177414031879
FL, 1.334501, 103.963689, 69.899166

Timestamp,151803.984
satID,E2_E1,E3_E1,E8_E1
Elev,31.60793506699695,79.62530160159848,26.4394654099114
CNO,24.383716583251953,9.113094329833984,18.569250106811523
PR,2.5750681578115076E7,2.3339045816195916E7,2.4267482347606793E7
Inno,-85.14420802891254,14.95177936181426,64.21592565998435
CovInno,12.229701651449918,12.83295614164091,12.69720039697161
EstimPos,-1538774.9123953995,6187978.210011118,147515.98560067688,-
79.99688261846154,0.10867092664722788
CovEstimPos,3.24440551434881,12.963002889258968,0.10430843724528373,7.
4033699984902706,0.1646876458097381

```

# Sample Output Data from GNSS Compare: Galileo E5a

```

%% Timestamp: timestamp of the logged information
%% satID: ID of the used satellited - satID[constellationSize]
%% Elev: elevation of the used satellited
%% CNO: signal strength of the used satellited
%% PR: pseudoranges of the used satellites - pseudoranges[constellationSize]
%% Inno: Kalman Filter innovation vector - gamma[constellationSize]
%% CovInno: Covariance of the innovation vector -
S[constellationSize,constellationSize]
%% EstimPos: Estimated position - x_meas[numStates]
%% CovEstimPos: Covariance of estimated position -
P_meas[numStates,numStates]
%% E: Error of the estimated position w.r.t the FINE location
%% Fl, fineLocation.Latitude, fineLocation.Longitude, fineLocation.Altitude

Timestamp,151804.991
satID,E2_E5a,E3_E5a,E8_E5a
Elev,31.605128403307823,79.62832157886312,26.444315270751627
CNO,16.289081573486328,7.0,28.23590087890625
PR,2.5750934904783495E7,2.333896305167067E7,2.4267041365011785E7
Inno,-68.4693889580667,-14.273256249725819,56.99723841249943
CovInno,12.30689118032241,12.225310385509559,12.748825664173747
EstimPos,-1538794.0330434479,6188007.218084622,147517.95980434964,-
60.513005881266054,-0.07650599828580251
CovEstimPos,3.5650609146416046,11.651952822729175,0.10983037794901221
,7.378173837050027,0.1659039590573222

Timestamp,151805.977
satID,E2_E5a,E3_E5a,E8_E5a
Elev,31.60238360235476,79.63143857156221,26.449246469580316
CNO,17.97366714477539,7.0,27.811687469482422
PR,2.5751162124187972E7,2.333894837615684E7,2.426659615772588E7
Inno,-67.31305849552155,26.573294311761856,59.239081893116236
CovInno,12.370071507207472,11.959563366594725,12.779523598584273
EstimPos,-1538796.767972425,6187998.305269976,147518.18976800854,-
64.50305773219014,0.15052998519679206
CovEstimPos,3.8782551550625617,10.76695595400356,0.10976875106489989,
7.323381205504991,0.1655885136785262

```

# Sample Output Data from GNSS Compare: Galileo IF

```

%% Timestamp: timestamp of the logged information
%% satID: ID of the used satellited - satID[constellationSize]
%% Elev: elevation of the used satellited
%% CNO: signal strength of the used satellited
%% PR: pseudoranges of the used satellites - pseudoranges[constellationSize]
%% Inno: Kalman Filter innovation vector - gamma[constellationSize]
%% CovInno: Covariance of the innovation vector -
S[constellationSize,constellationSize]
%% EstimPos: Estimated position - x_meas[numStates]
%% CovEstimPos: Covariance of estimated position -
P_meas[numStates,numStates]
%% E: Error of the estimated position w.r.t the FINE location
%% Fl, fineLocation.Latitude, fineLocation.Longitude, fineLocation.Altitude

Timestamp,151806.986
satID,E2_IF,E8_IF
Elev,31.600331705012515,26.45394837865013
CNO,20.635687828063965,21.006871700286865
PR,2.5751356947610945E7,2.4266128689324044E7
Inno,-36.301258727908134,23.8418588899076
CovInno,12.414912096895595,12.790598347487595
EstimPos,-1539135.6021293134,6187907.330222905,147761.15851517566,-
76.98333755833747,-1.2545498177828343
CovEstimPos,4.979483485938693,10.91566072767782,0.37545965944208776,7.
2979096935249945,0.17124149072750489

Timestamp,151807.982
satID,E2_IF,E8_IF
Elev,31.597603150492983,26.458894718625388
CNO,21.129629135131836,21.195557594299316
PR,2.5751580918449465E7,2.426566429794532E7
Inno,-37.94618817418814,7.6518113650381565
CovInno,12.627661334201402,12.921886508639407
EstimPos,-1539137.4731742432,6187905.216814774,147761.45753847074,-
85.06007273199538,-2.3242130689062286
CovEstimPos,5.321390125893703,11.175310803298517,0.3746353550231154,7.
242554375687705,0.17305188580421096

FL, 1.334548, 103.963698, 69.428651

```

# Sample Output Data from GNSS Compare: GPS IF

```

%% Timestamp: timestamp of the logged information          Timestamp,151812.003
%% satID: ID of the used satellited - satID[constellationSize] satID,G26_IF
%% Elev: elevation of the used satellited                 Elev,22.16309675251404
%% CN0: signal strength of the used satellited            CN0,27.370187759399414
%% PR: pseudoranges of the used satellites - pseudoranges[constellationSize] PR,2.3462714691430964E7
%% Inno: Kalman Filter innovation vector - gamma[constellationSize] Inno,26.649105709046125
%% CovInno: Covariance of the innovation vector -        CovInno,14.612919219946784
S[constellationSize,constellationSize]                   EstimPos,-
%% EstimPos: Estimated position - x_meas[numStates]      1539171.4916997314,6187946.377235158,147649.29725059884,173.36701186
%% CovEstimPos: Covariance of estimated position -       45205,5.017057874788763
P_meas[numStates,numStates]                               CovEstimPos,42.02897126567105,107.28515377289504,0.44981468969140076,
%% E: Error of the estimated position w.r.t the FINE location 21.18905070597317,0.19791212585694115
%% Fl, fineLocation.Latitude, fineLocation.Longitude, fineLocation.Altitude
Timestamp,151813.000
satID,G26_IF
Elev,22.15758607213537
CN0,27.257532119750977
PR,2.3463242909665097E7
Inno,14.858850326389074
CovInno,14.613104364130892
EstimPos,-
1539171.4908786018,6187946.3789502,147649.2972503797,182.83431188868
224,5.749231914786899
CovEstimPos,42.42897122104428,107.68515357821494,0.4498146896913976,2
1.266921424507053,0.1979121601578303

```

# Sample Output Data from GNSS Compare: GPS L5

%% Timestamp: timestamp of the logged information  
 %% satID: ID of the used satellited -  
 satID[constellationSize]  
 %% Elev: elevation of the used satellited  
 %% CNO: signal strength of the used satellited  
 %% PR: pseudoranges of the used satellites -  
 pseudoranges[constellationSize]  
 %% Inno: Kalman Filter innovation vector -  
 gamma[constellationSize]  
 %% CovInno: Covariance of the innovation vector -  
 S[constellationSize,constellationSize]  
 %% EstimPos: Estimated position - x\_meas[numStates]  
 %% CovEstimPos: Covariance of estimated position -  
 P\_meas[numStates,numStates]  
 %% E: Error of the estimated position w.r.t the FINE  
 location  
 %% Fl, fineLocation.Latitude, fineLocation.Longitude,  
 fineLocation.Altitude

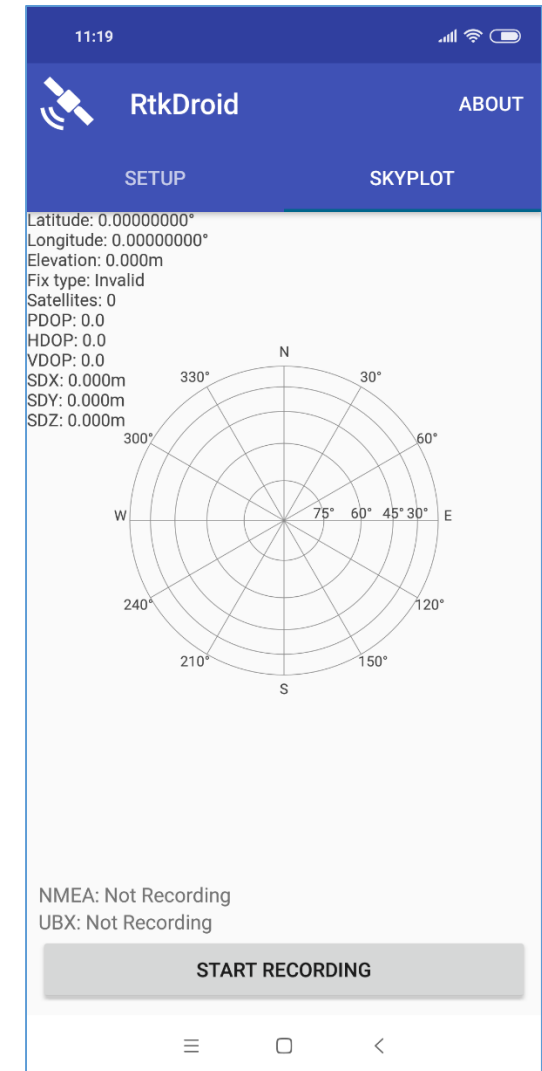
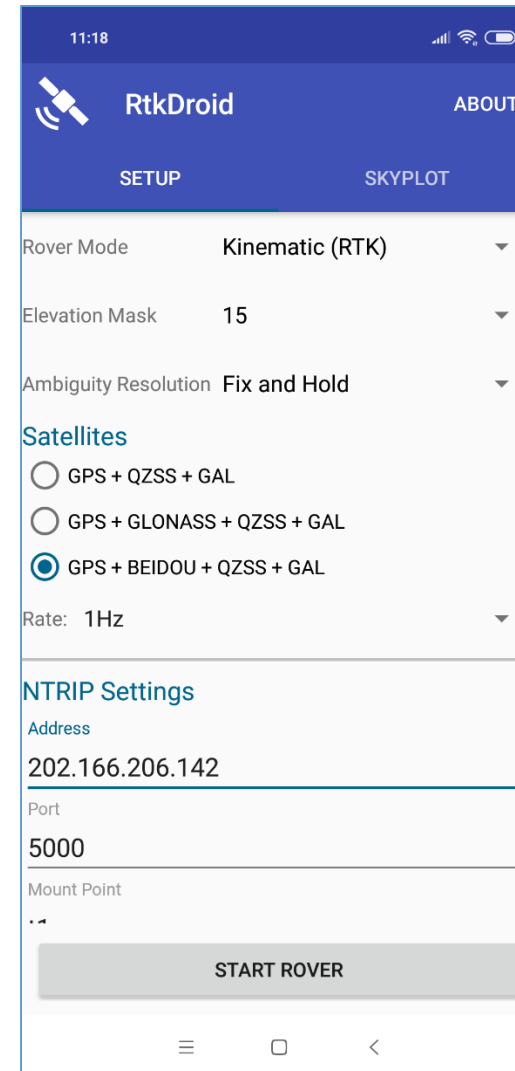
```
Timestamp,151809.994
satID,G3_L5,G8_L5,G26_L5,G27_L5
Elev,33.554008258553964,48.25266196872872,22.172884345386976,69.17191391228158
CNO,7.0,7.587594985961914,27.545879364013672,7.0
PR,2.2486976274135992E7,2.1399447049904224E7,2.3461578159287207E7,2.037386396972175
E7
Inno,-11.486417010426521,-185.52537051960826,11.411866538226604,-3.4237166941165924
CovInno,13.059042573981515,11.44264234398441,12.562314719364762,11.488008770518793
EstimPos,-1538709.1848842017,6187818.624650529,147586.2714535496,-179.64025496705435,-
3.23141724321601
CovEstimPos,1.9450529003611876,4.055592318489455,0.028066350060091515,2.698096149298
294,0.14778180419855916
Timestamp,151811.004
satID,G3_L5,G8_L5,G26_L5,G27_L5
Elev,33.555140950600425,48.26073313267819,22.16732824108486,69.17718627177668
CNO,7.0,7.698572158813477,27.744571685791016,8.866910934448242
PR,2.2486897137517832E7,2.1399212013040777E7,2.3462105801640287E7,2.037368739108773
E7
Inno,19.807740181684494,98.11360029876232,30.837399903684855,22.741700060665607
CovInno,13.031395039905892,11.432938504587097,12.659255609347586,11.494742118975221
EstimPos,-1538708.1414774146,6187814.753371424,147586.37595550265,-
166.99368733602827,0.5669135448602654
CovEstimPos,1.9732213736391175,4.107242201226502,0.02802445735602994,2.7648003911385
923,0.14775082770243753
```





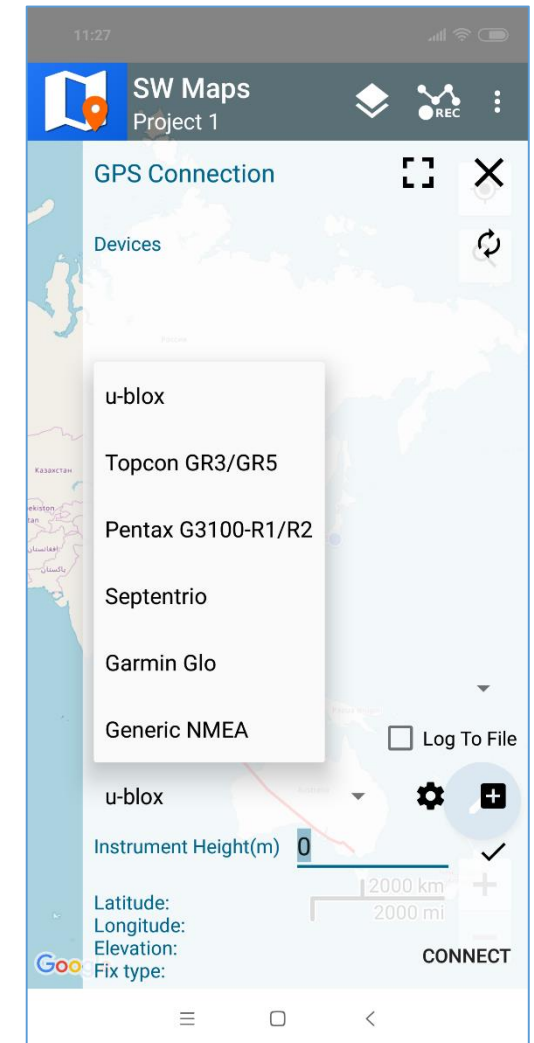
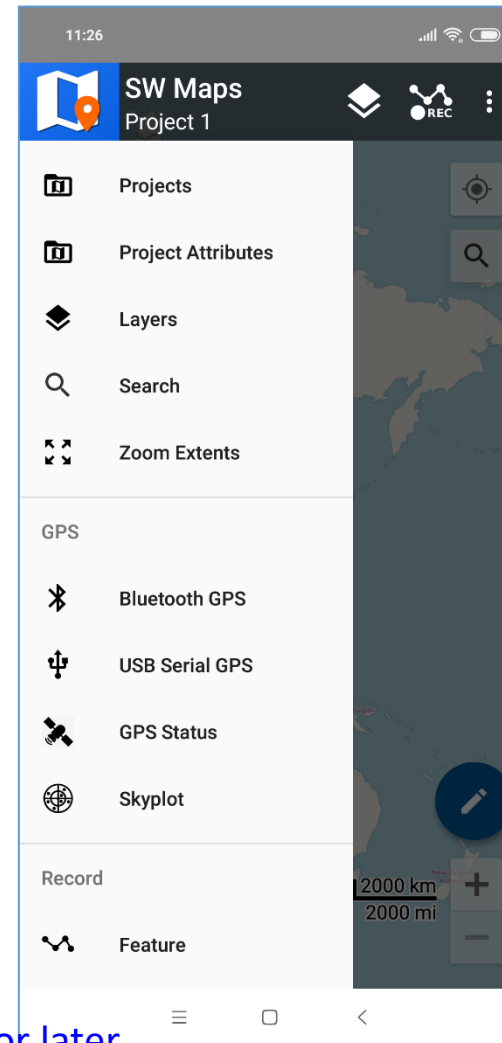
# Android Raw Data Logging APP: RTKDROID

- External GNSS Receiver can be connected to Android Device
- Base-Station is connected via NTRIP Address
- VRS Correction also supported
- Supported File Format
  - ubx (u-blox)
  - Other formats will be included if requested
    - SBF (Septentrio) will be included in near future
- Real-Time RTK
- Raw Data can be logged for Post-Processing
- Output from RTKDROID can be send to other APKs in the device



# Android APP to Input GNSS Data for GIS: SW Maps

- Excellent APP to collect GIS Data in the field
- Internal or External GNSS Receiver can be used
  - External Receiver can be connected via BT or USB Cable
- Many Popular File Formats are Supported
  - u-blox
  - Topcon
  - Trimble
  - Septentrio
  - Garmin
  - Or Any Receiver with NMEA output
  - Output from RTKDROID can be send to SW Maps



RTKDROID and SW MAPS run in many Android Devices that has OS 5.0 or later

# Android Devices Capable to Output GNSS Raw Data

Model	Android version	AGC	NAV MSG	Accumulated delta range	HW clock	L5 Support	Global systems
Vivo X21	9	no	no	no	yes	no	GPS
							GLONASS
							BeiDou
OPPO R15 Pro	9	no	no	no	yes	no	GPS
							GLONASS
							GALILEO
							BeiDou
Xiaomi Mi 8	8.1	no	yes	yes	yes	yes	GPS
							GLONASS
							GALILEO
							BeiDou
							QZSS
LG V40 ThinQ	8.1	no	no	no	yes	no	GPS
							GLONASS
							QZSS
OnePlus 6T	9	no	no	no	yes	no	GPS
							GLONASS
							QZSS
Samsung Note 9	8.1	no	no	no	yes	no	GPS
							GLONASS
							QZSS
							SBAS

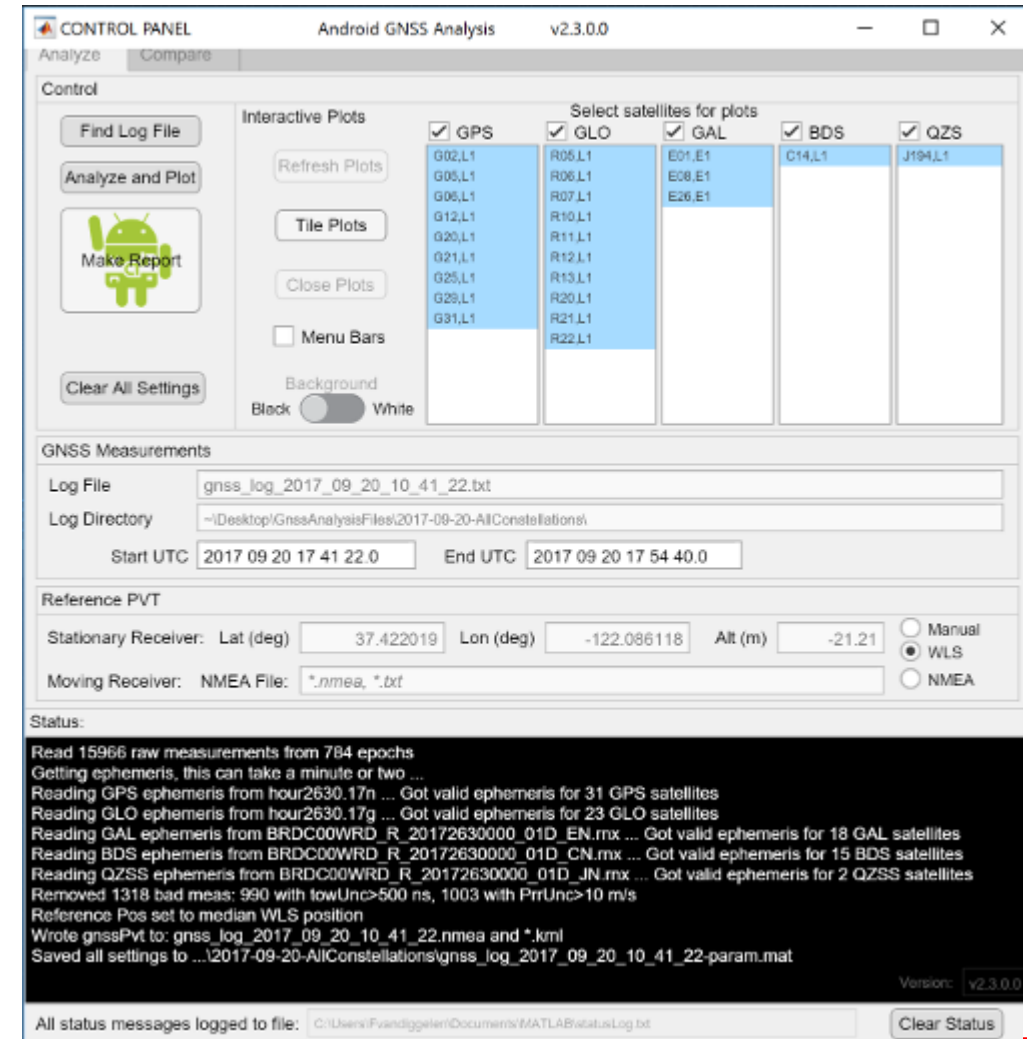
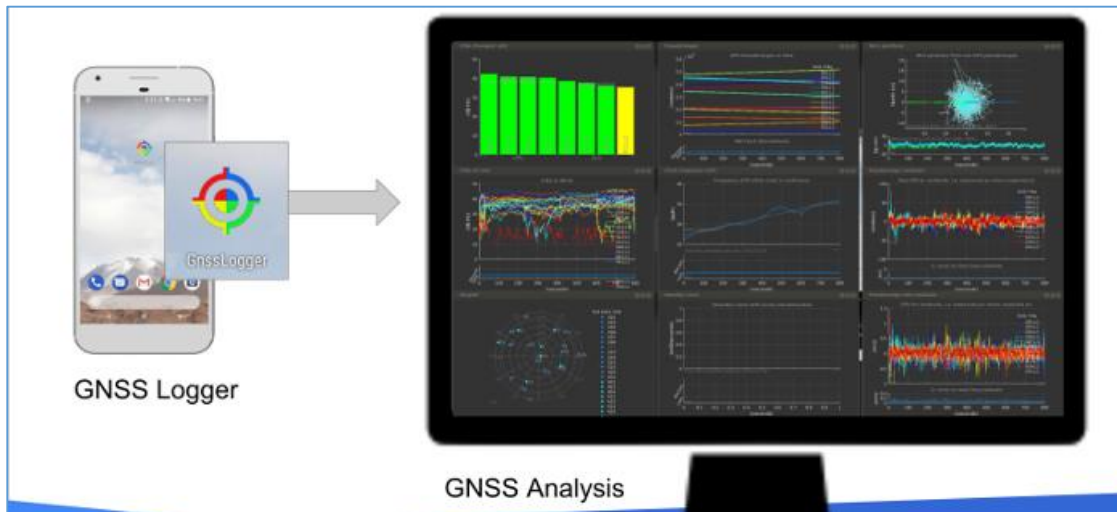
LG G7 ThinQ	8	no	no	no	yes	no	GPS
							GLONASS
Xiaomi Mix 2S	9	no	no	no	yes	no	GPS
							GLONASS
							SBAS
Huawei P20	8.1	no	yes	yes	yes	no	GPS
							GLONASS
							QZSS
Samsung Galaxy S9	8	no	yes	yes	yes	no	GPS
							GLONASS
							QZSS
Samsung Galaxy S9+	8	no	no	no	yes	no	GPS
							GLONASS
Sony Xperia XZ2	8	no	no	no	yes	no	GPS
							GLONASS
							QZSS
OPPO R15	9	no	no	no	yes	no	GPS
							GLONASS
							GALILEO
HTC U11 Plus	8	no	no	no	yes	no	GPS
							GLONASS
HTC U11 Life	8	no	no	no	yes	no	GPS
							GLONASS

See <https://developer.android.com/guide/topics/sensors/gnss> for detail list of compatible devices

# GNSS Raw Data Analysis Tool for GnssLogger

- GNSS Analysis APP

- Matlab-based Tool
- Linux, Windows, MacOS
- Version 2.6.3.0
- Release Notes:  
[https://developer.android.com/guide/topics/sensors/gnss#releaseGNSS Analysis app v2.6.3.0 release notes.](https://developer.android.com/guide/topics/sensors/gnss#releaseGNSS%20Analysis%20app%20v2.6.3.0)



The GNSS Analysis app is built on [MATLAB](#), but you don't need to have MATLAB to run it. The app is compiled into an executable that installs a copy of the MATLAB Runtime.

# Raw Measurement : Lecture Notes by Dr. Frank van Diggelen, Google Inc.

1. Raw GNSS 2. Logging Tools 3. Pseudorange 4. Analysis Tools 5. Hands-on Exercises 6. Future: Apps and Research

## Location APIs, Measurement APIs

aka Google Play Services aka Google Mobile Service  
Most Android phones have this (not China)

The diagram shows the Android software stack layers: APPLICATIONS (top), ANDROID FRAMEWORK, NATIVE LIBRARIES, ANDROID RUNTIME, HAL, and LINUX KERNEL (bottom). A green Android robot is shown to the left. Callouts point to the Applications layer for Location APIs and to the Native Libraries layer for Measurement APIs.

**Location APIs, `android.gms.location`**

- Places
- Geofencing
- Fused Location Provider (FLP)
- Fit
- Activity Recognition
- Nearby

**Measurement/Sensor APIs, in `android.location`**

- Location
- `GnssMeasurement`
- `GnssClock`

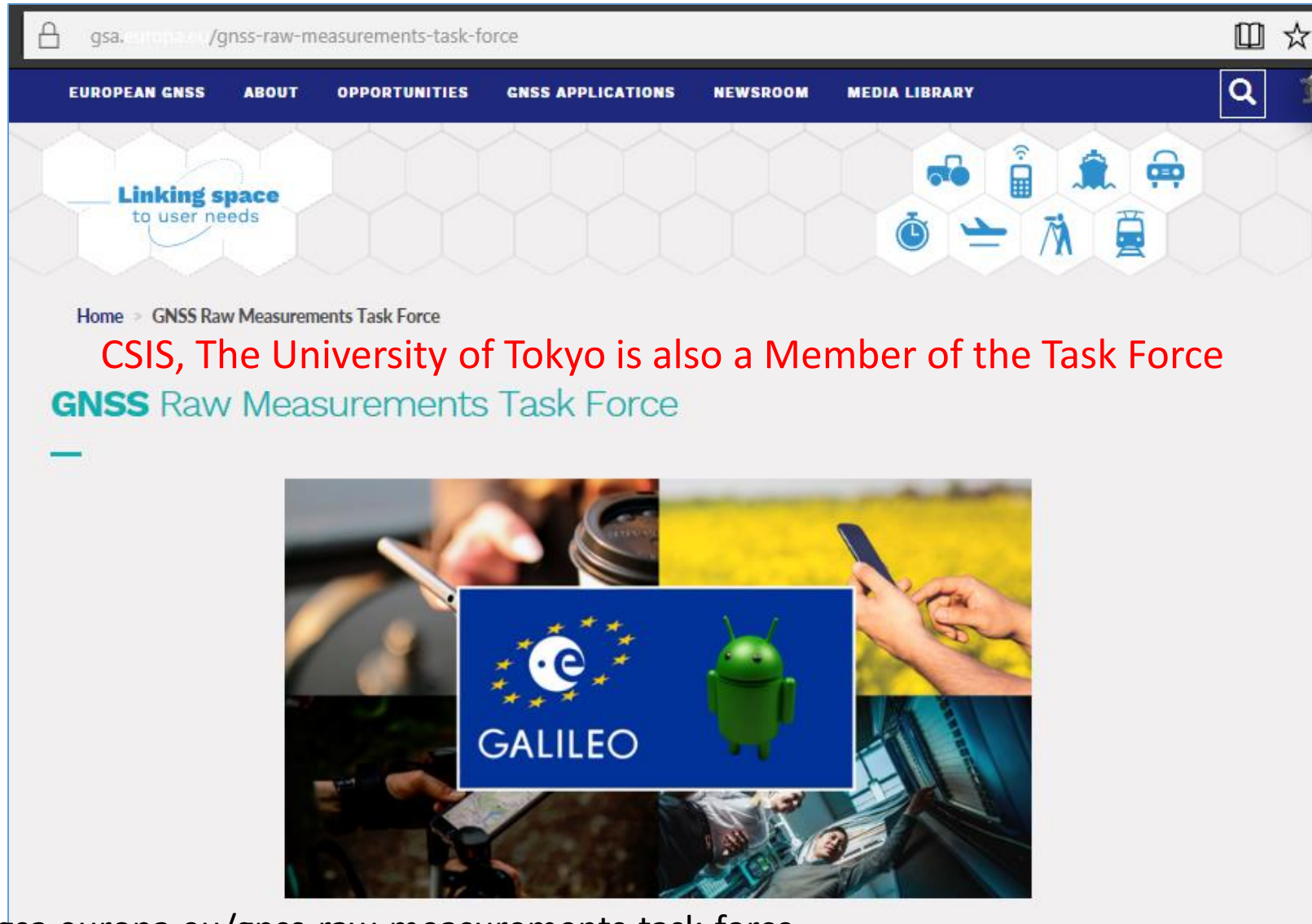
All Android phones have this

*GNSS Raw Measurements*  
All phones with:  
GNSS chips build date  $\geq$  2016  
OS  $\geq$  Android N (Nougat)

© Google 2018 4

Download the Lecture Notes from [https://home.csis.u-tokyo.ac.jp/~dinesh/GNSS\\_Raw.htm](https://home.csis.u-tokyo.ac.jp/~dinesh/GNSS_Raw.htm)

# GNSS Raw Data Measurement Task Force Members



The screenshot shows a web browser window with the URL [gsa.europa.eu/gnss-raw-measurements-task-force](https://www.gsa.europa.eu/gnss-raw-measurements-task-force). The navigation menu includes: EUROPEAN GNSS, ABOUT, OPPORTUNITIES, GNSS APPLICATIONS, NEWSROOM, and MEDIA LIBRARY. A search icon is visible on the right. The main content area features a hexagonal pattern with the text "Linking space to user needs" and a row of icons representing various applications: a tractor, a mobile phone, a train, a car, a clock, an airplane, a surveying instrument, and a bus. Below this, the breadcrumb "Home > GNSS Raw Measurements Task Force" is shown. The main heading reads "CSIS, The University of Tokyo is also a Member of the Task Force" in red, followed by "GNSS Raw Measurements Task Force" in green. A central image shows a collage of people using mobile devices, with a blue box overlaid containing the Galileo logo (a stylized 'e' with stars) and the Android robot.

<https://www.gsa.europa.eu/gnss-raw-measurements-task-force>

# GNSS Raw Data Measurement Task Force Members

Airbus Defence & Space	Industrie- und Hnadelskammer Reutlingen, Institut für Wissensmanagement und Wissenstransfer (IHK-IWW)	GeoNumerics S.L.	Ordnance Survey	Syntony+A77A46A6A61:A75
Astri Polska Sp. z o. o.	ENAC	Global Infotech Corporation	Politecnico di Torino	Ordnance Survey+A61:A75
Beuth University	Ericsson Research	Hochschule Karlsruhe (HSKA) - University of Applied Sciences	RHEA Group	Technology Centre CAS Prague
Blue Dot Solutions	European Space Agency (ESA)	Institute of Environmental Sciences and Technology (IEST)	RISE Research Institutes of Sweden AB	TeleConsult Austria GmbH
BNB-Consulting	ESSP SAS	IFSTTAR	Rockwell Collins UK	Telespazio France
CGEOS - Creative Geosensing Sprl-s	European GNSS Agency (GSA)	Ineco	Rokubun	Telespazio Ibérica
Circular Devices	Feyman Technology Inc	Infinite Dimensions Integration GmbH	Rx Networks Inc.	Thales Services
CNES	Finnish Geospatial Research Institute (FGI), Department of Navigation and Positioning National Land Survey of Finland	Istituto Nazionale di Geofisica e Vulcanologia	SAT4M2M	International University of La Rioja (UNIR)
Consejo Superior de Investigaciones Científicas	Flowscape	Joint Research Centre, European Commission	Septentrio	Universität der Bundeswehr, München
Crowdloc	GCE	Jomo Kenyatta University	Sogei S.p.A.	College & University Hrvatsko Zagorje Krapina
CS Systemes d`Information	GeneGIS GI s.r.l.	K.N. Toosi University of Technology	Space Kinetics	University of Appl. Sciences Karlsruhe, GNSS & Navigation Laboratory
Centre Tecnològic Telecomunicacions Catalunya (CTTC)	Geneq Inc	Kingston University	SpaceEXE s.r.l	University of Calgary
DDK Positioning Ltd	Geo++ GmbH	Magneti Marelli	Spirent Communications plc	University of Coimbra
DEIMOS Space S.L.U.	Geodetic Observatory Pecny	NAVBLUE	STMicroelectronics	University of Liege
	GEOFLEX	Nottingham Scientific Ltd	Swift Navigation	University of Nottingham
			University of Rijeka	
			University of Rome "La Sapienza" - Geodesy and Geomatics Division	
			<b>University of Tokyo, Center for Spatial Information Science</b>	
			University of Warmia and Mazury in Olsztyn	
			University of Zagreb	
			The United Nations Office for Outer Space Affairs (UNOOSA)	
			wawa	
			Wrocław University of Environmental and Life Sciences	



# White Paper on GNSS Raw Data Measurement



USING GNSS RAW MEASUREMENTS ON ANDROID DEVICES 3

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<http://galileognss.eu/wp-content/uploads/2018/05/Using-GNSS-Raw-Measurements-on-Android-devices.pdf>

# GNSS Raw Data Measurement from Android Devices

## Tutorial Note by Dr. Frank, Google Inc.

# User Interface of GNSS Analysis Raw Data Processing Tool

CONTROL PANEL Android GNSS Analysis v2.6.3.0

Analysis | Planning | Compare | About

Control

Find Log File

Analyze and Plot

Write Data to File

Make Report

Clear Settings ...

Analysis Plots

Refresh Plots

Tile Plots

SVIDs from measurements

GPS	GLO	GAL	BDS	QZS
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
G02,L1	R02,L1	E02,E1	C01,L1	J193,L1
G05,L1	R03,L1	E05,E1	C03,L1	J194,L1
G08,L1	R09,L1	E09,E1	C07,L1	J195,L1
G12,L1	R15,L1	E27,E1	C08,L1	J193,L5
G19,L1	R18,L1	E30,E1		J194,L5
G24,L1	R17,L1	E02,E5a		J195,L5
G25,L1	R18,L1	E05,E5a		
G29,L1	R19,L1	E09,E5a		
G31,L1	R20,L1	E27,E5a		
G08,L5		E30,E5a		
G24,L5				
G25,L5				

GNSS Measurements

Log File: gns\_log\_2018\_10\_22\_18\_22\_00.txt, Xiaomi Model: MI 8, Android 8.1.0

Directory: G:\MI8\gns\_log\10221822\

Start UTC: 2018 10 22 07 22 02.0 End UTC: 2018 10 22 07 36 01.0  iono  Tropo

Reference PVT

Stationary Receiver: Lat (deg) -37.8061098 Lon (deg) 144.9703873 Alt (m) 44.70  Manual  WLS

Moving Receiver: NMEA File: \*.nmea, \*.txt  NMEA

All plots:  Menu Bars Black  White

Status:

```

Removed measurements for 7 satellites below 5 degrees elevation
Reference Pos set to median WLS position
Wrote gnsPvt_rawPr to: gns_log_2018_10_22_18_22_00_rawPr.nmea and *.kml
Wrote gnsPvt_smPr to: gns_log_2018_10_22_18_22_00_smPr.nmea and *.kml
Computing measurement errors ...
WARNING: Speed of 48308.5997 m/s detected. If receiver was moving use Reference PVT = NMEA
Saved settings from [GNSS Measurements] panel, and [Reference PVT] panel to
...10221822\gns_log_2018_10_22_18_22_00-param.mat
Elapsed processing time for this file: 2.7 minutes
Making report, plots will appear and disappear. Please wait a few seconds ...
Your report is here: ...10221822\GnsAnalysisReport.html
    
```

(c) 2017 Google. Version: v2.6.3.0

# Test Data Site, Carlston Garden, Melbourne, Australia



# Test Data Site, Carlston Garden, Melbourne, Australia

