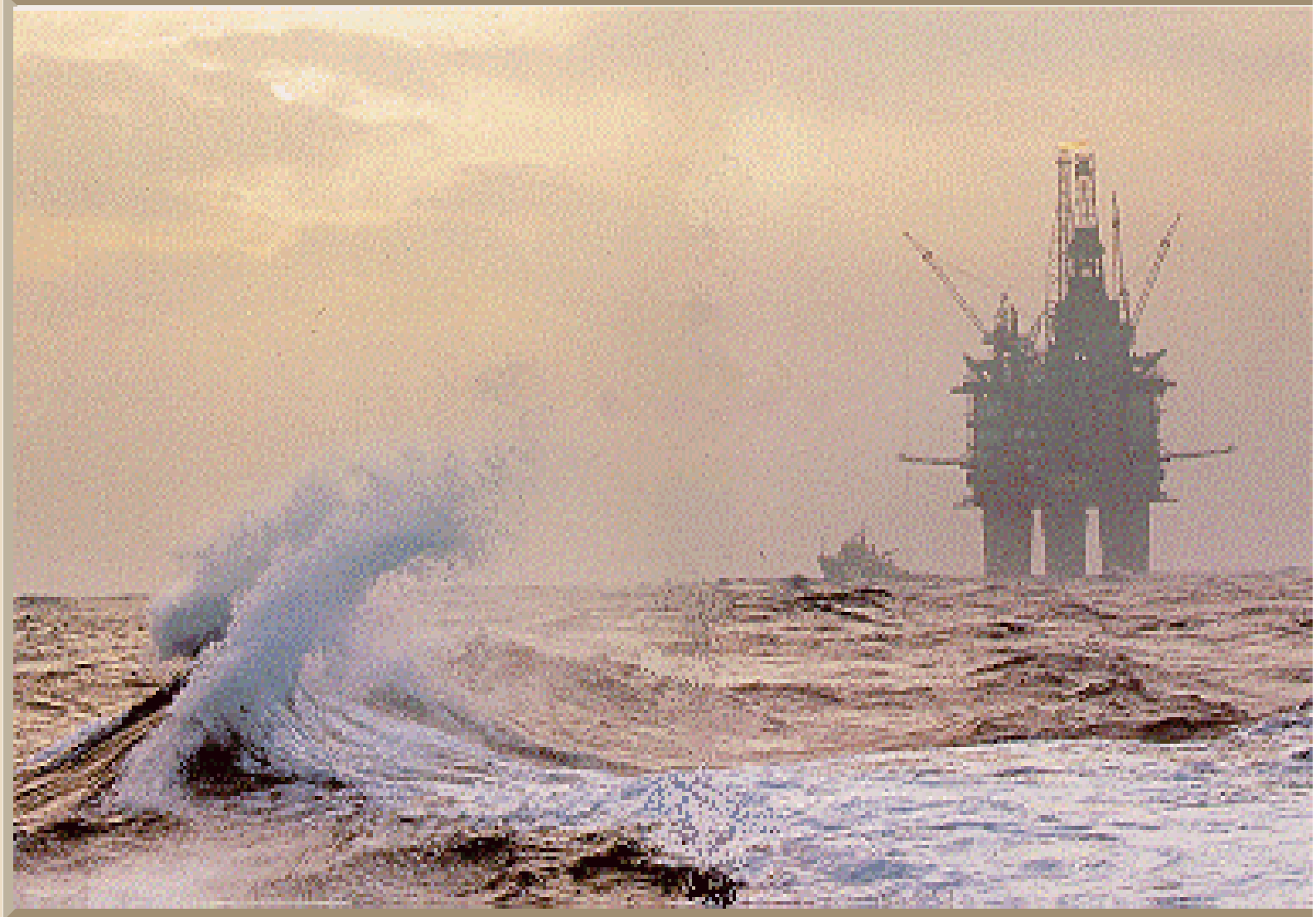
Satellite Positioning
Dynamic Positioning Conference
October 13-14, 1998

Session Index

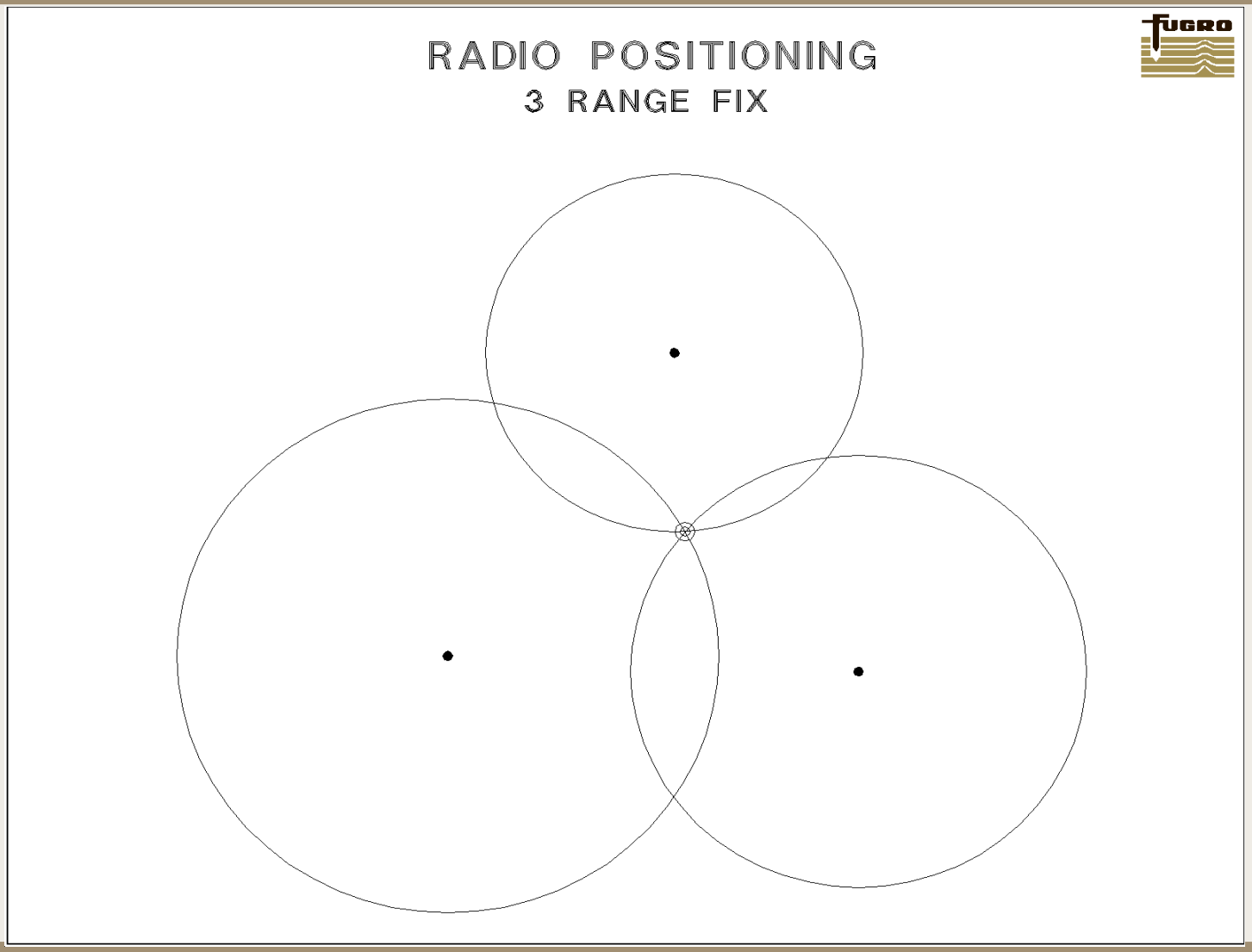
Satellite Positioning



Radio Positioning Principles

- GPS, GLONASS, Loran-C, Transit, Syledis...
- Reference Transmitters at “Known” Locations (x,y,z)
- Mobile Receivers
- Range-Range System
- Timing derived distances
- Line of Sight

Unique Position



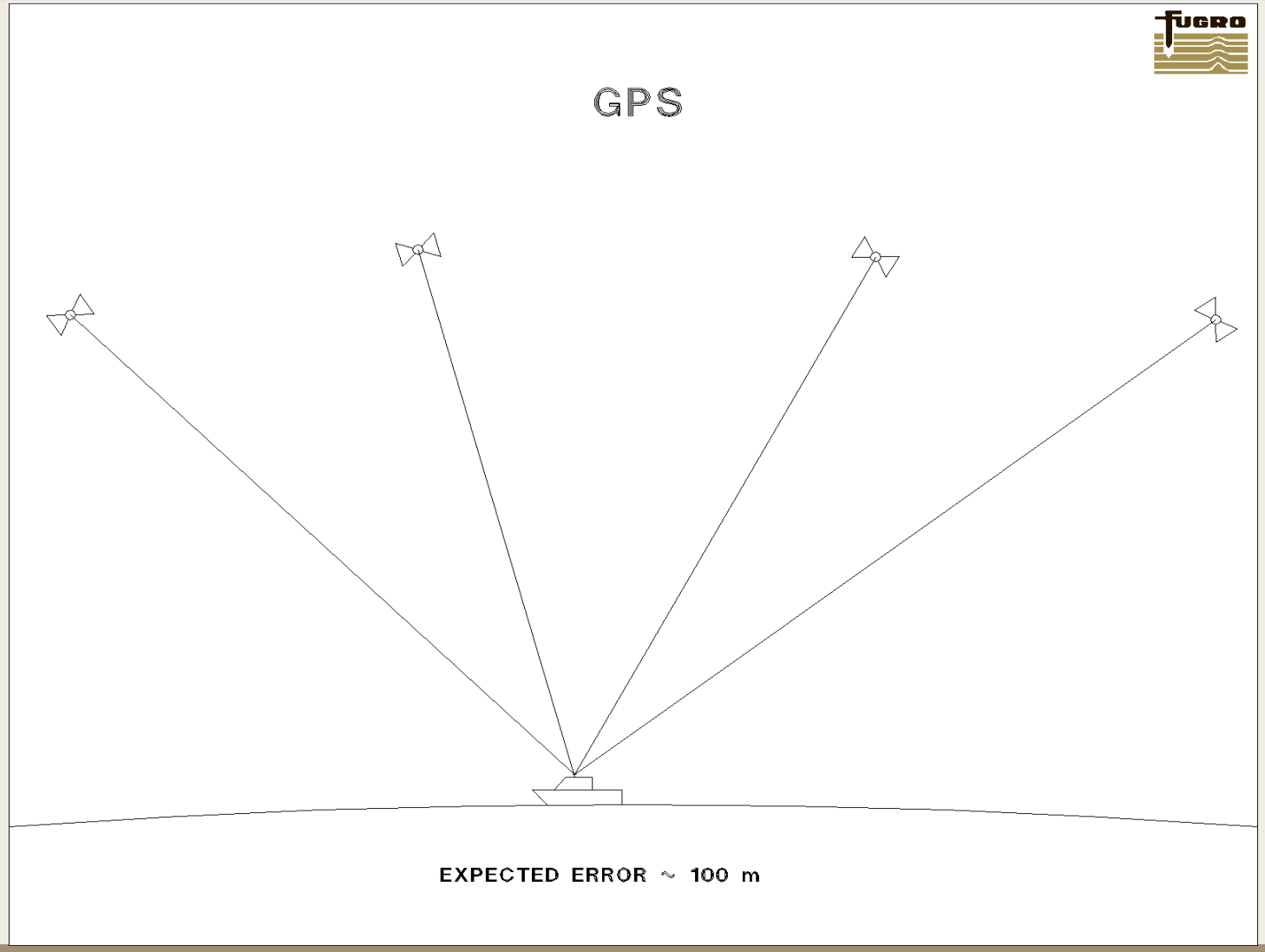
GPS

- Global Positioning System
- Satellite-based Radio Positioning System
- Operated by US Department of Defense
- Position, Velocity and Time Service
- Replaces most older US-operated systems
- 24 Operational Satellites
- 3 Spare Satellites

GPS

- 24 Hour Operations
- Master Control in Colorado Springs, CO
- 5 Tracking Stations World-wide
- Selective Availability - intentional clock errors
- Accuracy 100m (~60m without SA)
- System Availability Assurance DOD/DOT/FAA

GPS



GLONASS

- Global Navigation Satellite System
- Satellite-based Radio Positioning System
- Under Development by Russian Ministry of Defense
- Position, Velocity and Time Service
- 24 Satellites (14 currently)
- 24 hr Operations (4 hr currently)

GLONASS

- Master Control in Moscow
- 5 Tracking Stations in former Soviet Union
- Accuracy 60m (full constellation)
- System Availability???
- GPS+GLONASS Receivers

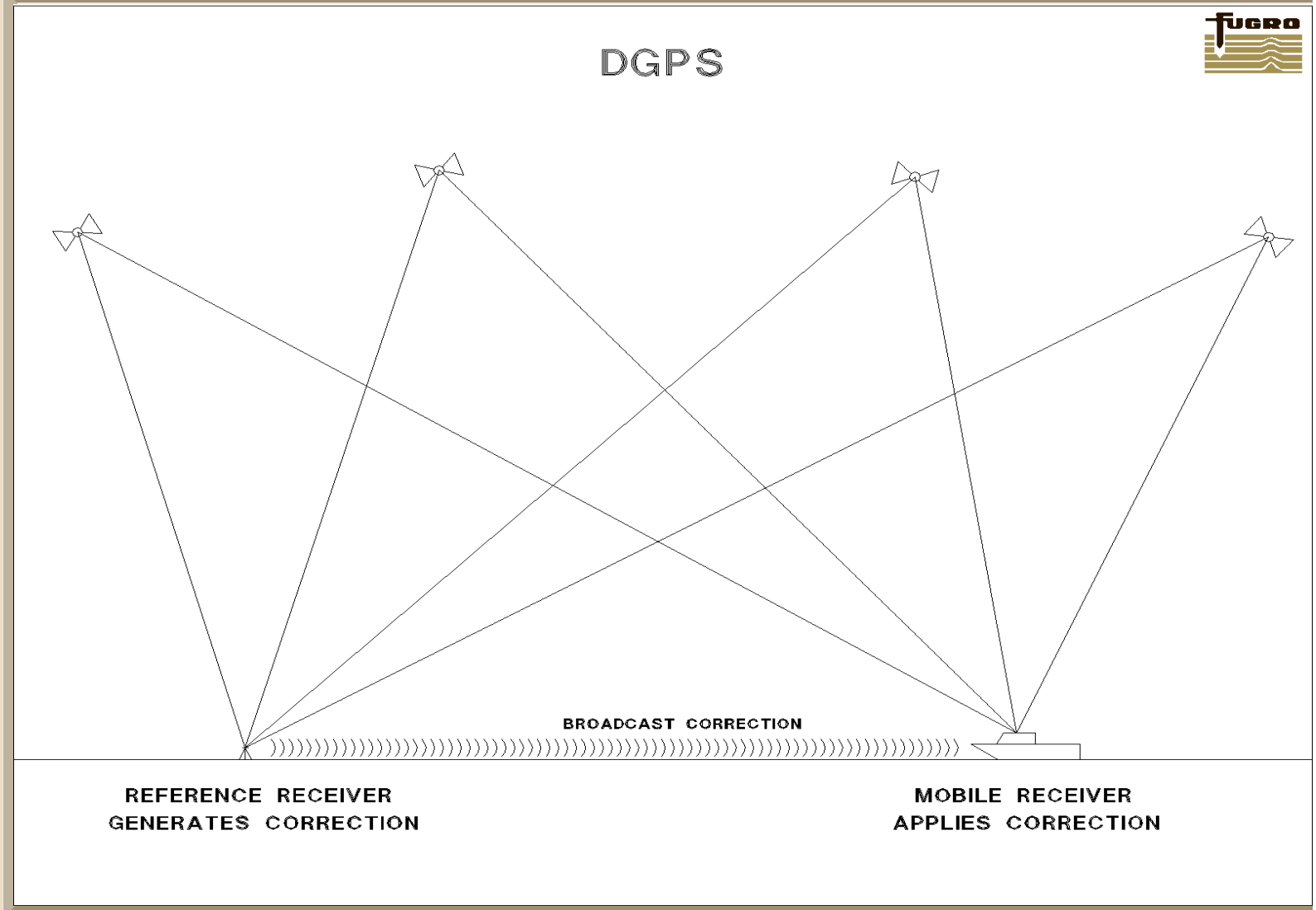
GPS/GLONASS Comparison

	GPS	GLONASS
No. Satellites	24+3	14 (Full Constellation 24)
Orbiting Planes	6	3
Inclination	55°	65.8°
Orbit Radius (km)	26,560	25,510
Period (hr:min)	11:58	11:16
Signal L1 (MHz)	1575.42	1602 + 0.5625*n*
Signal L2 (MHz)	1227.60	1246 + 0.4375*n*
Spheroid	WGS 84	PZ 90

DGPS

- Differential GPS
- Implemented to Improve Real-time GPS Accuracy
- Minimize Errors due to SA, Atmosphere and Satellite Positions (Ephemeris)
- Range Corrections (C-O)
- Corrections Applied in Near Real-Time
- Single-Site v. Wide-Area

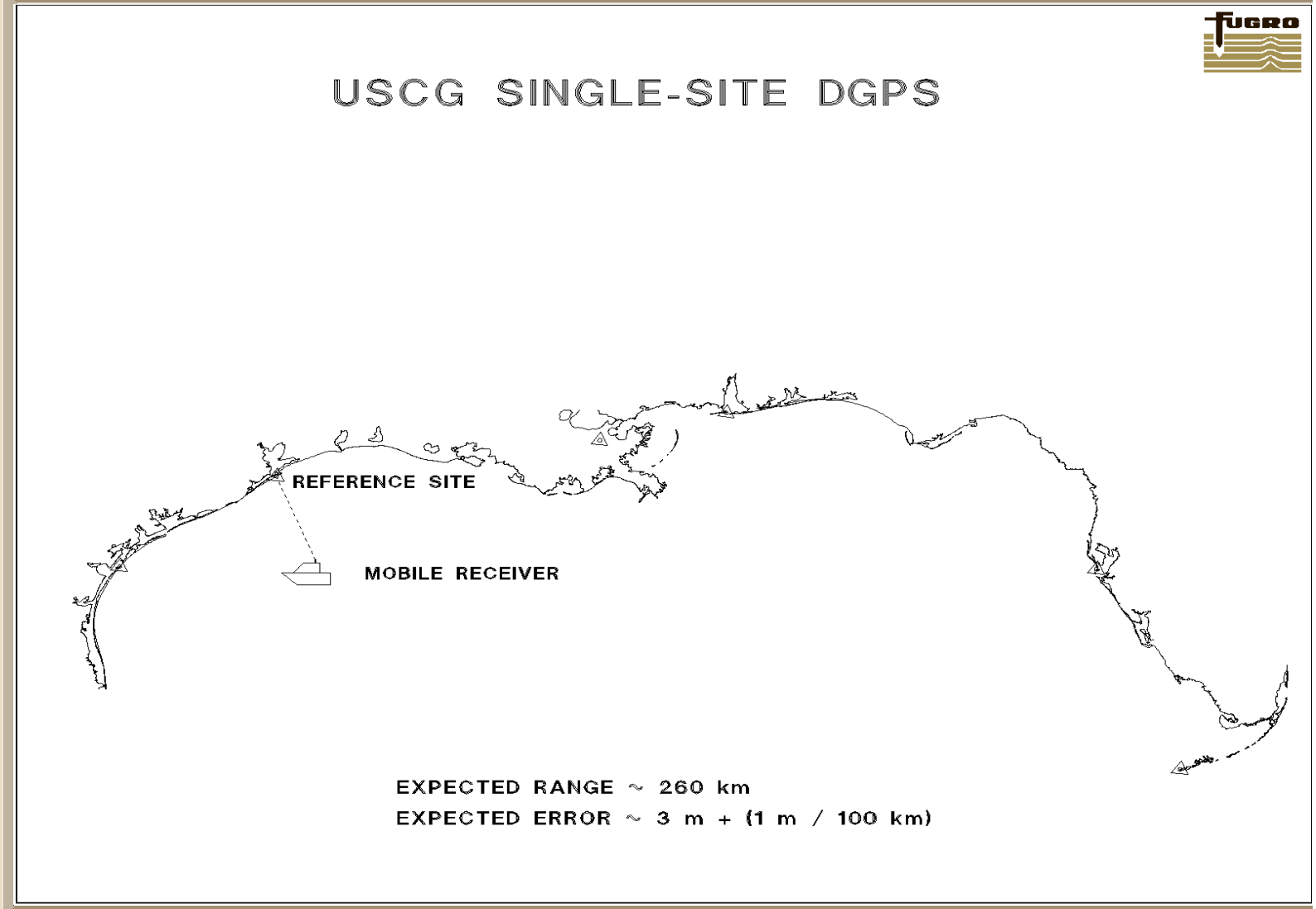
DGPS


DGPS
BROADCAST CORRECTION
REFERENCE RECEIVER
GENERATES CORRECTION
MOBILE RECEIVER
APPLIES CORRECTION

Single-Site DGPS

- Single Reference Station
- Range Corrections only
- Sub-meter Accuracy Possible near Reference Site
- Error increases with distance (1m/100km)
- Radio Telemetry
- USCG Differential GPS Navigation Service

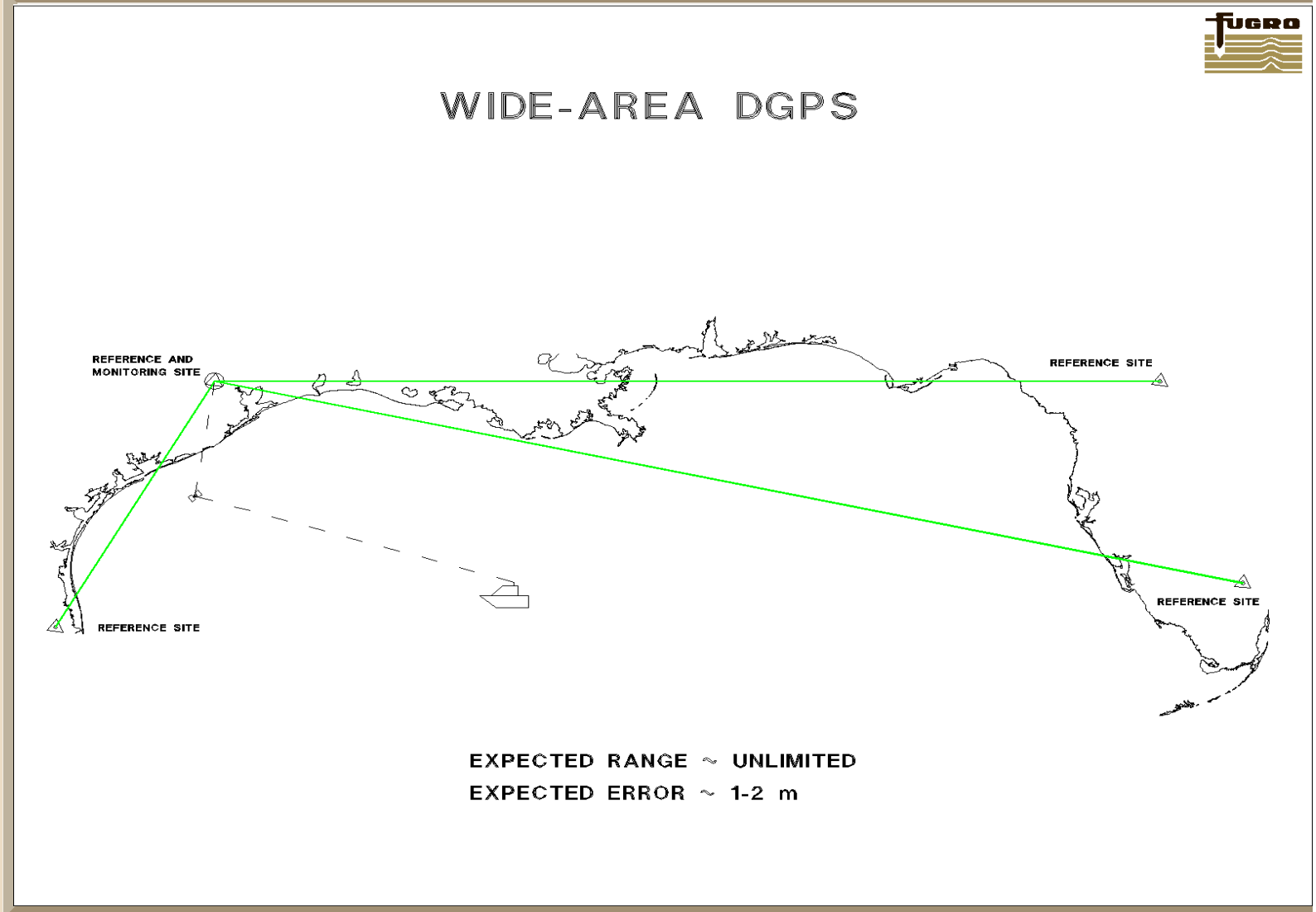
Single-Site DGPS



Wide-Area DGPS

- Multiple Reference Stations
- Optimized Solution
- Consistent, Sub-meter Accuracy
- Range, Range Rate and Atmospheric Corrections
- Satellite Telemetry
- Fugro Starfix
- Racal SkyFix

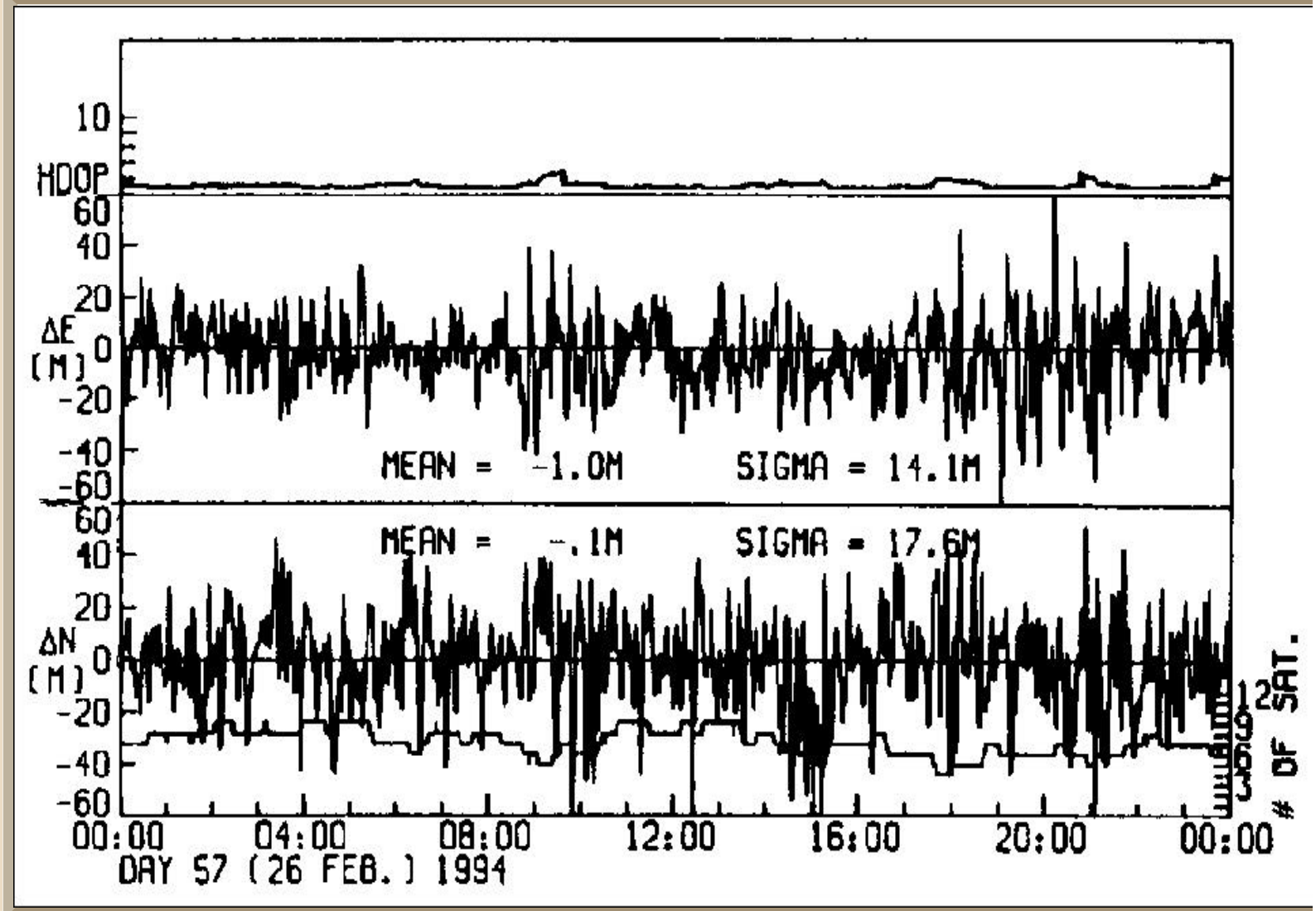
Wide-Area DGPS



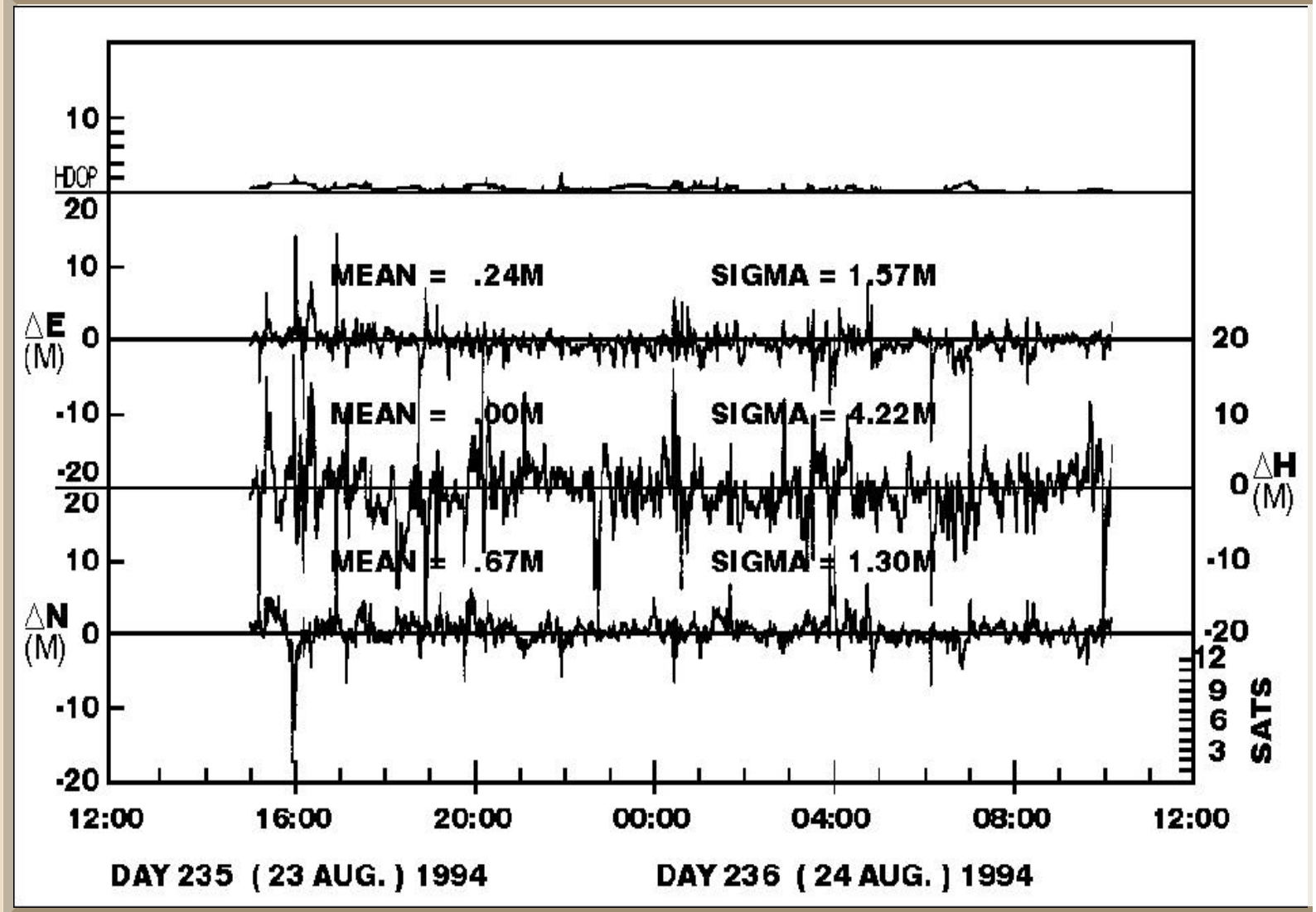
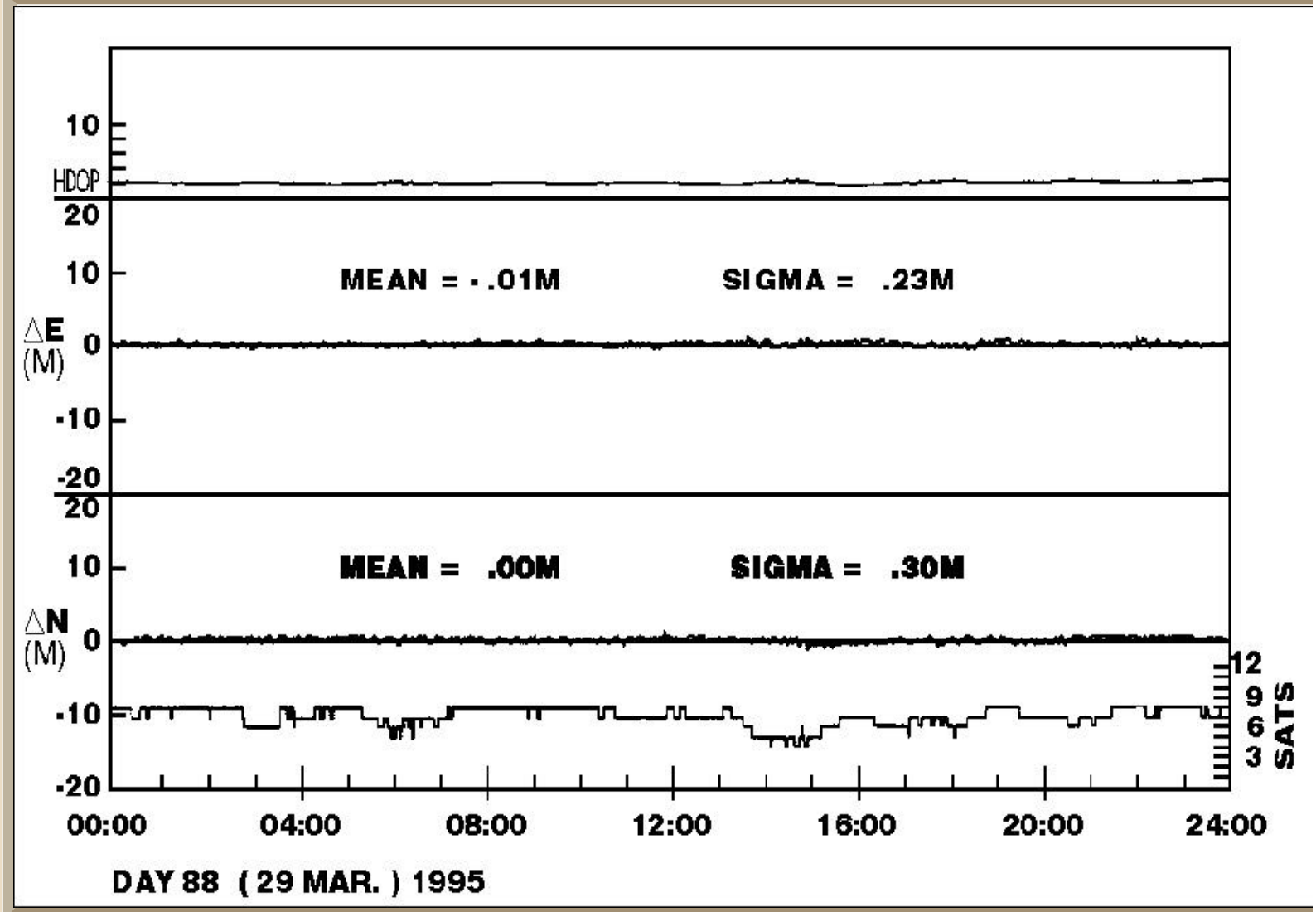
DGPS Accuracy

- Navigation, GIS, Surveying, Recreation…
- Accuracy is measured over a known point
- Stand-alone GPS ***averages*** ~ 0 m
- Standard Deviation over time
- 1m Accuracy = 1m Std. Deviation (1 ?)
- Function of receiver quality AND corrections
- Accuracy degraded in dynamic environment

Stand-alone GPS



DGPS


HDOP
10
20
MEAN = .24M
SIGMA = 1.57M
ΔE (M)
MEAN = .00M
SIGMA = 4.22M
ΔH (M)
MEAN = .67M
SIGMA = 1.30M
ΔN (M)
SATS
12:00
16:00
20:00
00:00
04:00
08:00
12:00
DAY 235 (23 AUG.) 1994
DAY 236 (24 AUG.) 1994

Sub-meter DGPS