



FIG **KUALA LUMPUR 2014** **XXV FIG Congress**
 "Engaging the Challenges, Enhancing the Relevance"
 16 - 21 JUNE 2014, MALAYSIA

PEJLITA
 CIKAP DAN LINGKUNGAN

Combining Terrestrial and GNSS Technologies for Geodetic Monitoring
 Neil ASHCROFT – Leica Geosystems Engineering Segment Manager

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Structural Monitoring Technologies

Introduction

- Monitoring Instrumentation
 - ~~Reflectors, Reference Points, Monumentation, Measurement Hut~~
- Existing Monitoring Project
 - Total Station and Meteo Sensor
- Further Additions
 - GNSS Technologies, (GPS, GLONASS, GALILEO, COMPASS)

Leica Geosystems Monitoring Instrumentation

Measurement

- Total Stations
- Prisms
- GNSS
- Tilt Sensors
- Meteo Sensors
- 3rd Party Sensors

Control

- GeoMoS Monitor

Analysis

- GeoMoS Analyser
- 3rd Party Tools

Accuracy
Repeatability
Interpretation



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Leica Geosystems Monitoring Instrumentation

Total Stations - TPS

- TPS are the fundamental basis of 3D monitoring as they enable efficient measurement of absolute 3D deformation of a large number of points over short ranges
- Provide relative precision to monitoring points from the fixed reference frame.
 - Dependant on instrument angular and distance accuracy
 - Atmospheric

GNSS Equipment – GNSS

- GNSS Equipment provides an absolute position for a single point.
- RTK Positioning provides 10mm+1PPM
- Static Positioning provides 3mm + 0.5PPM

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Existing Project PT Adaro, Indonesia



Existing Project PT Adaro, Indonesia



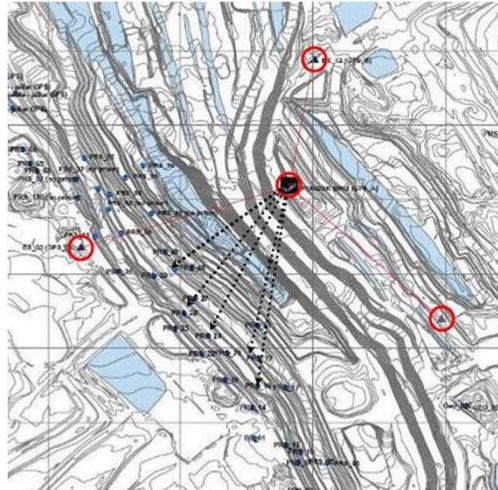
6 FIG2014

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Existing Project

Existing Equipment

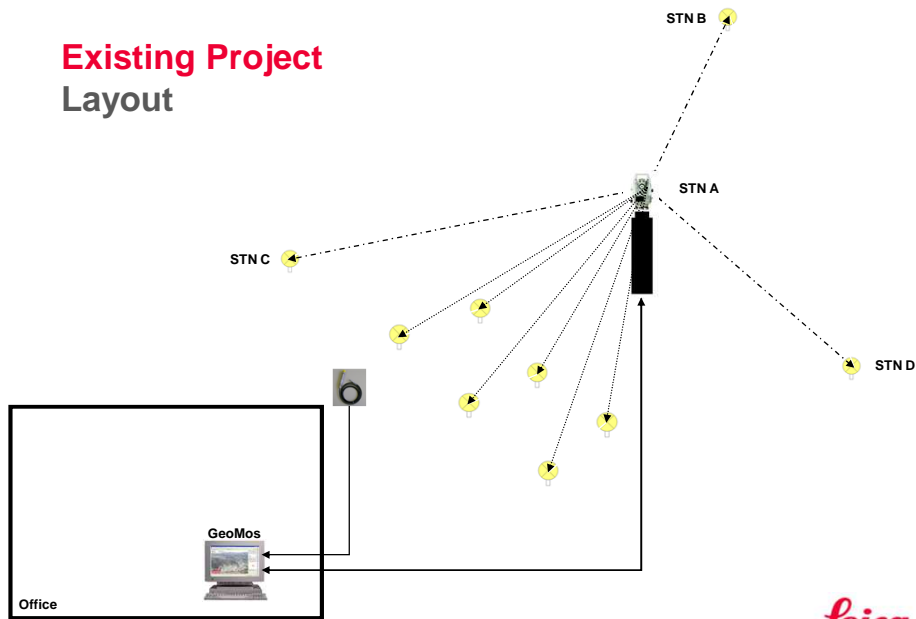
- 1 No. Automated Total Station
- 1 No. Meteo Sensor
- 30 No. Prisms
- 2 No. Pacific Crest Radios
- 1 No. Leica GeoMoS software



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Existing Project Layout



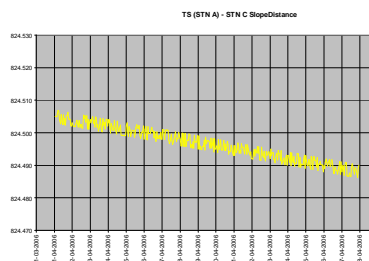
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Existing Project 1st Feb – 17th Feb 2006

Over 17 day period various observations were made:

- Free station residuals showing reference prisms were moving
- Slope distances changing over time, irrespective of atmospheric corrections.
- Significant changes in reference prism positions were shown by independent survey.

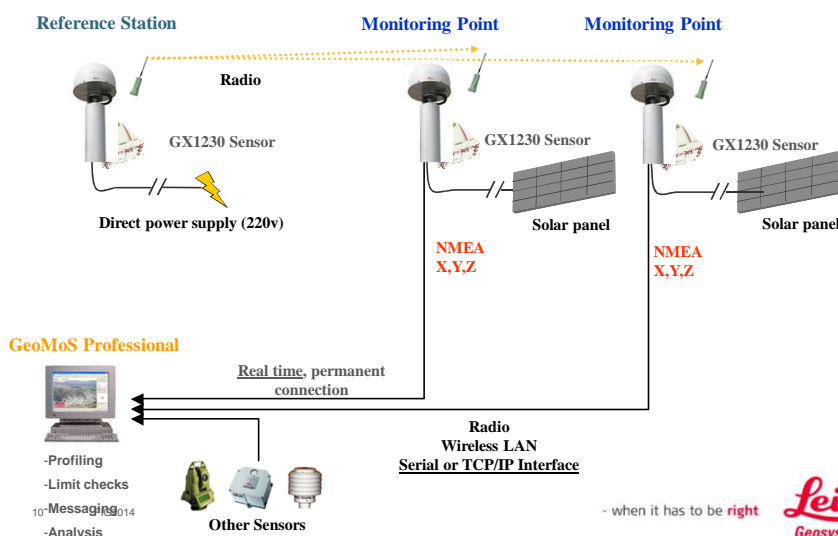


Proposal made to install a GPS system to position Total Station and Reference Prisms

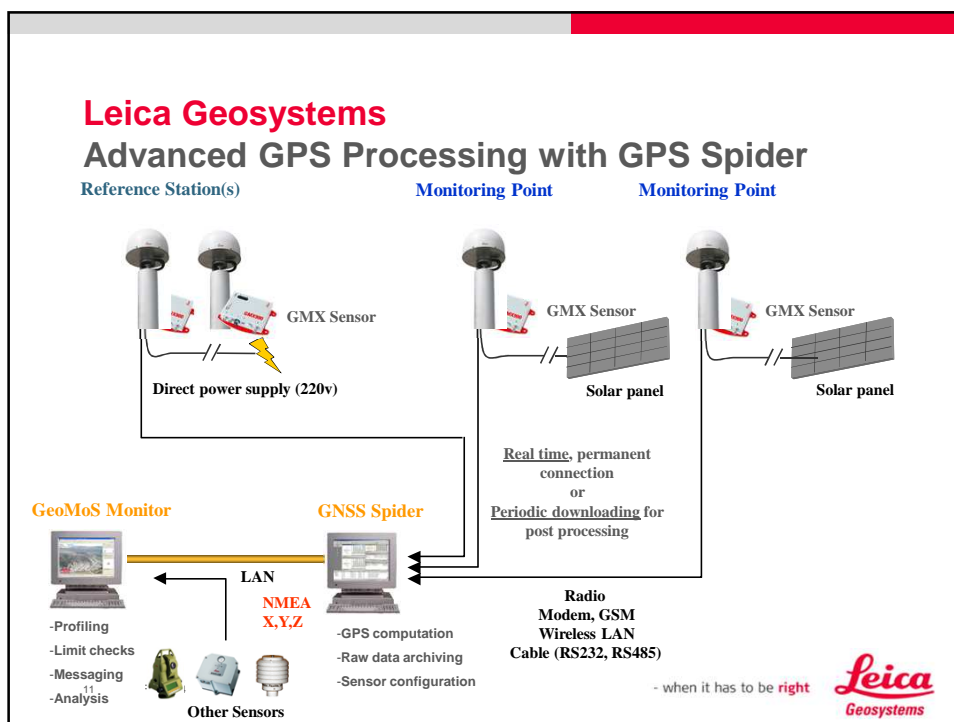
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Leica Geosystems Basic Stand-Alone GPS



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Selecting the ideal GPS monitoring receiver

Leica's new solution: the GMX902

Streamlined for high-accuracy monitoring

- Same measurement engine as GPS1200
- 24 channels L1/L2 code/phase receiver
- 20Hz data rate
- SmartTrack technology
- Compact (16.7x12.3x4.0 cm)
- Robust (IP67)
- Low power consumption (2.4W)
- Streaming raw data output
- 2 serial ports
- PPS port for synchronization of other sensors (e.g. accelerometer)
- Configuration with GPS Spider

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Hut Modification



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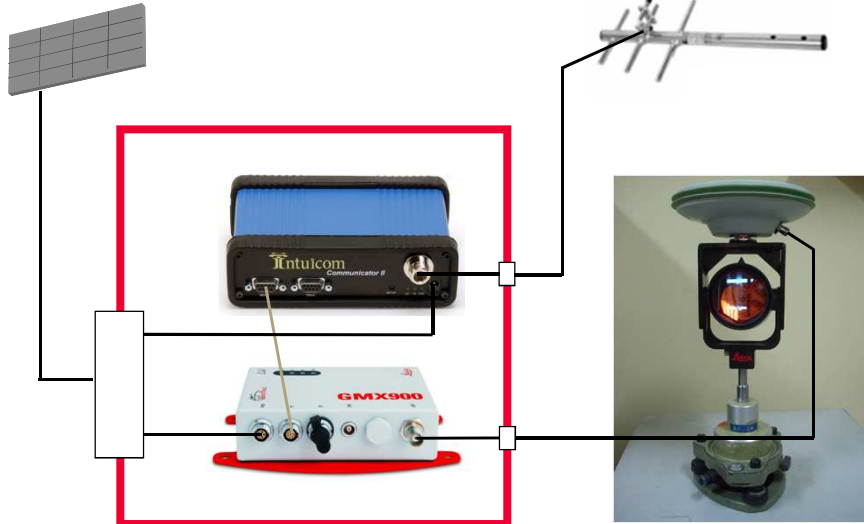
Hut Modification



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Reference Prism Modification



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Reference Prism Modification



16 FIG2014

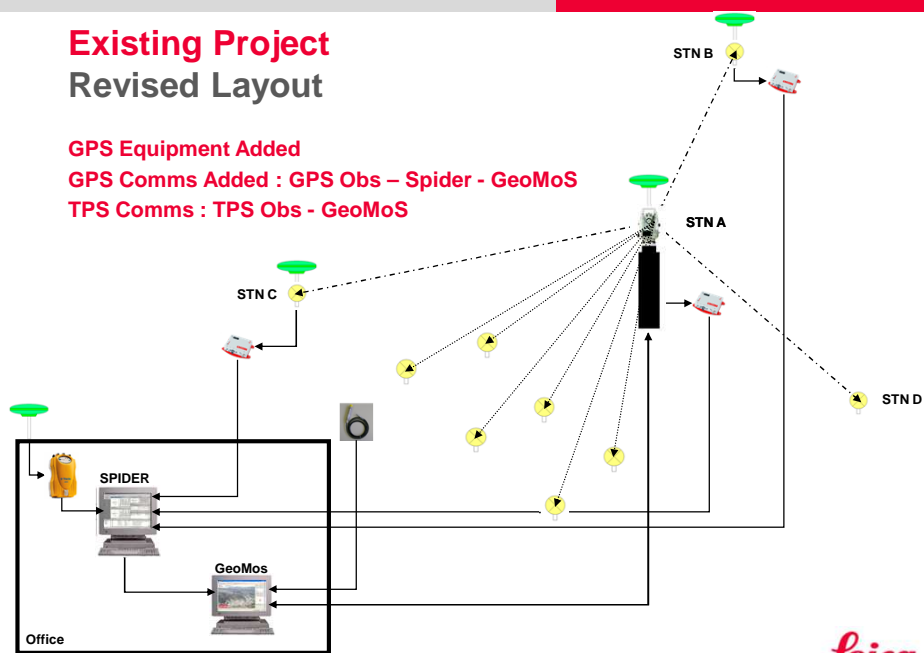
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Site Layout



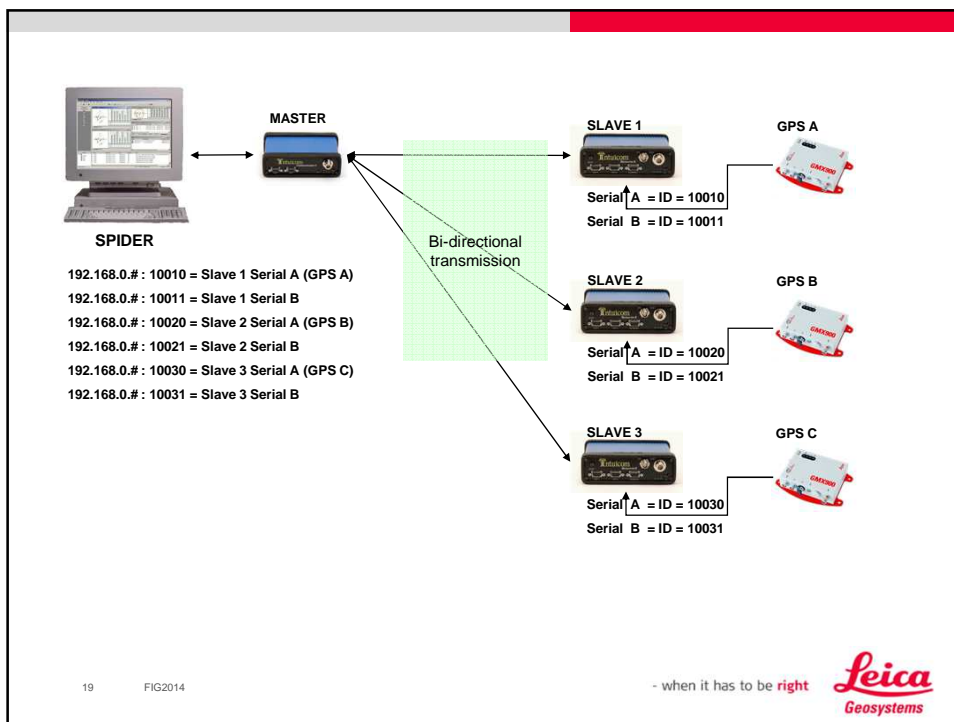
Existing Project Revised Layout

GPS Equipment Added
GPS Comms Added : GPS Obs – Spider - GeoMoS
TPS Comms : TPS Obs - GeoMoS



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Leica GPS SPIDER Software (Positioning Option)

The screenshot displays the Leica GPS SPIDER software interface with the following components:

- Management Panel:** Shows a tree view of sites and sensors. The 'Local Site Server' is selected.
- Site Details:** Displays information for selected sites (e.g., GR01, GR02, GR03, GR04, GR05).
- Tracking Sensor:** Shows real-time tracking data for selected sensors, including coordinates (Easting, Northing, UTM), height, and sensor status.
- Site Management:** A table listing sites with columns for Name, Description, PC name / IP, and Site.
- Content Panel:** A log of site operations with columns for Site, DateTime, User, Category, and Text.

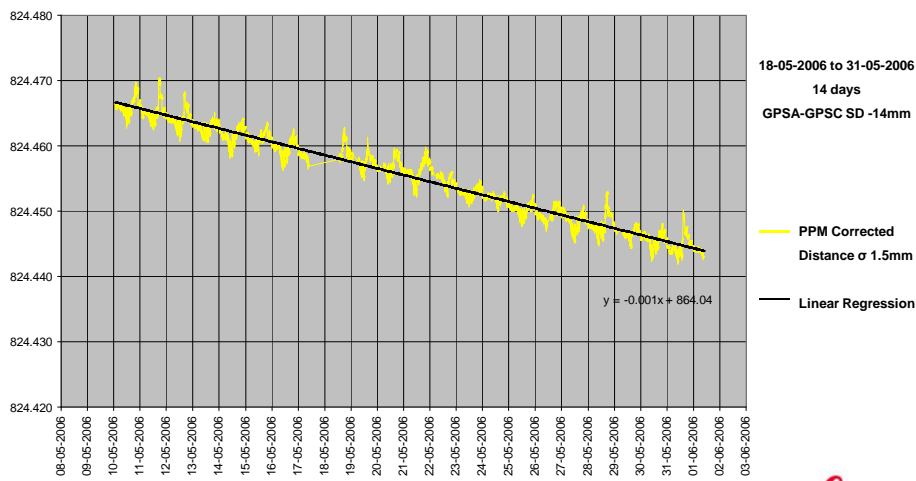
Site	Description	PC name / IP	Site
Local Network Server	My Local Network Server	AHERNOVA3001	
Local Site Server	My Local Site Server	AHERNOVA3001	

Site	DateTime	User	Category	Text
GR01	09.09.2004 11:30:22	Spider Server	Site	Site GR01: Create product RINEX finalized : C:\GPS Spider\Data\RINEX\GR01
GR02	09.09.2004 11:30:44	Administrator	Site	New positioning product grs1:grm2 created.
GR02	09.09.2004 11:31:18	Administrator	Site	New positioning product grs1:grm2 created.
GR02	09.09.2004 11:31:21	Administrator	Site	Positioning product grs1:grm2 modified.
GR02	09.09.2004 11:31:22	Administrator	Site	Positioning product grs1:grm2 modified.
GR01	09.09.2004 11:31:25	Administrator	Site	Positioning product grs1:grm1 modified.

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Slope Distance – Total Station(GPS A) to GPS C



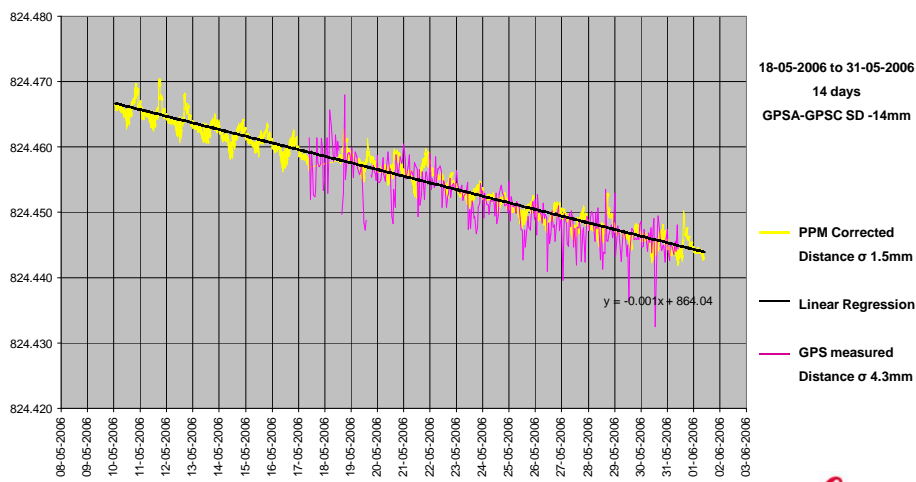
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FIG2014

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Slope Distance – Total Station(GPS A) to GPS C

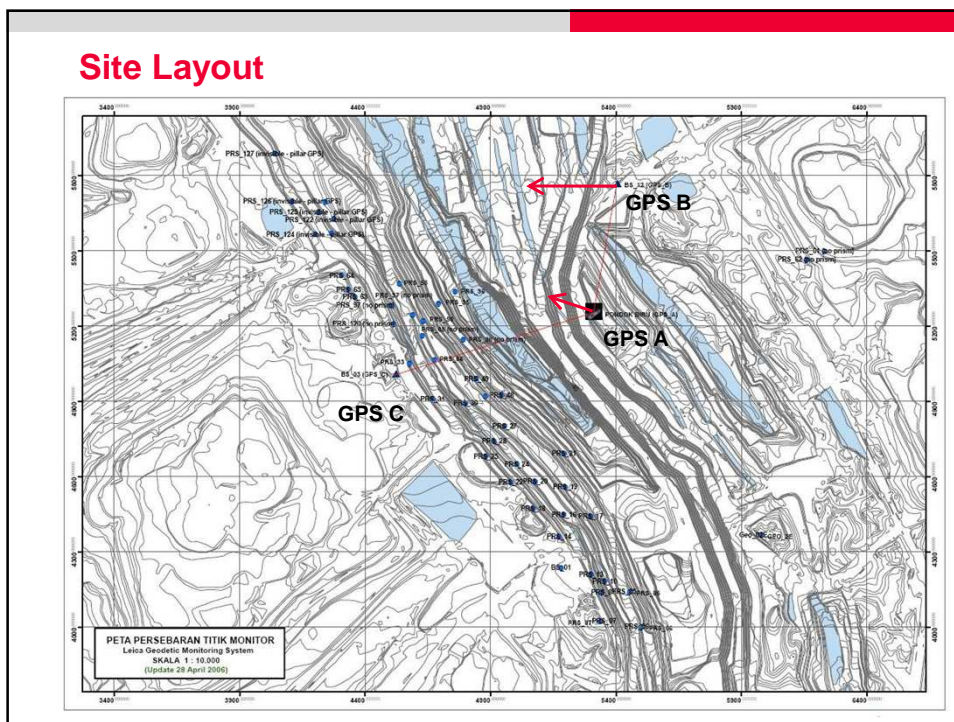
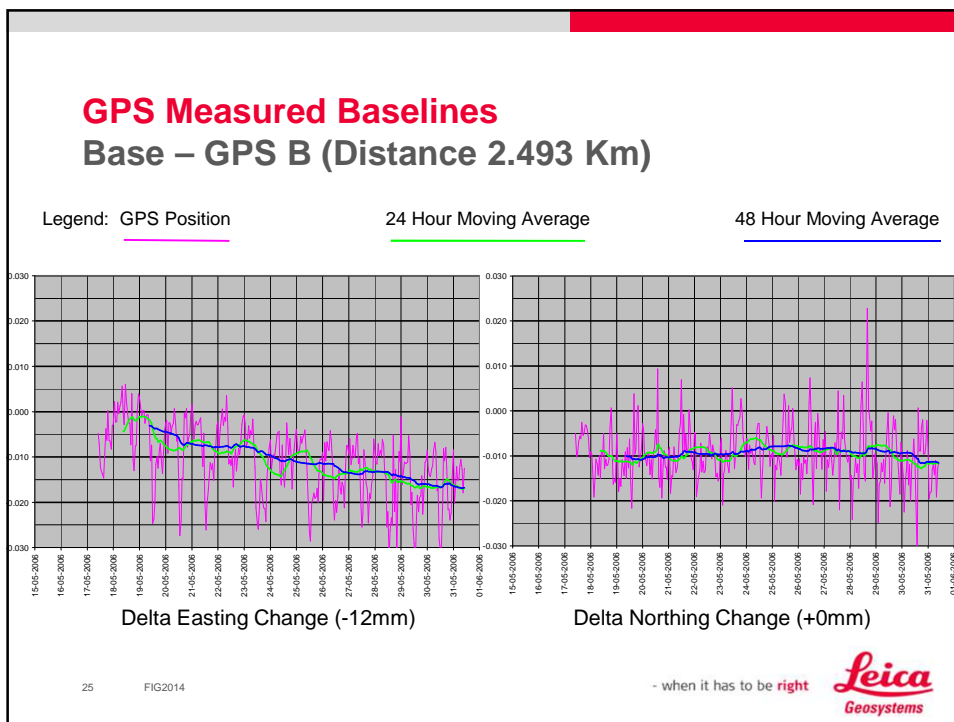


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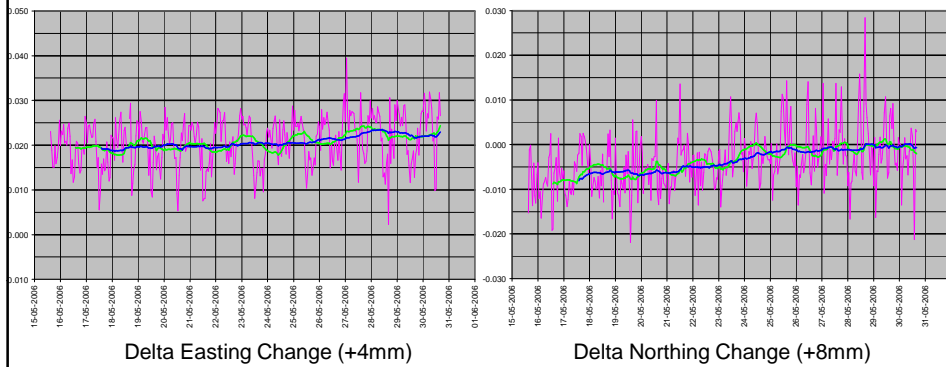


GPS Measured Baselines Base – GPS C (Distance 2.683 Km)

Legend: — GPS Position

— 24 Hour Moving Average

— 48 Hour Moving Average



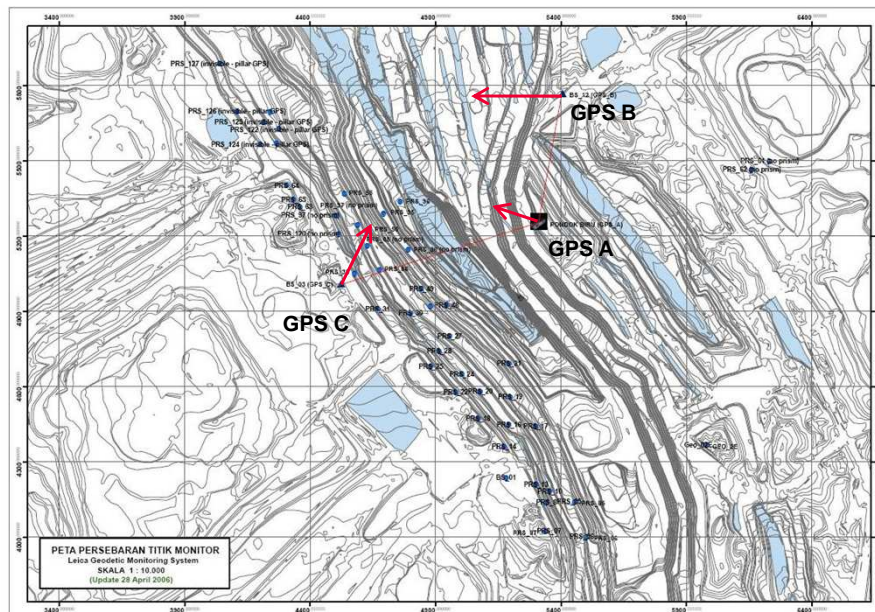
Delta Easting Change (+4mm)

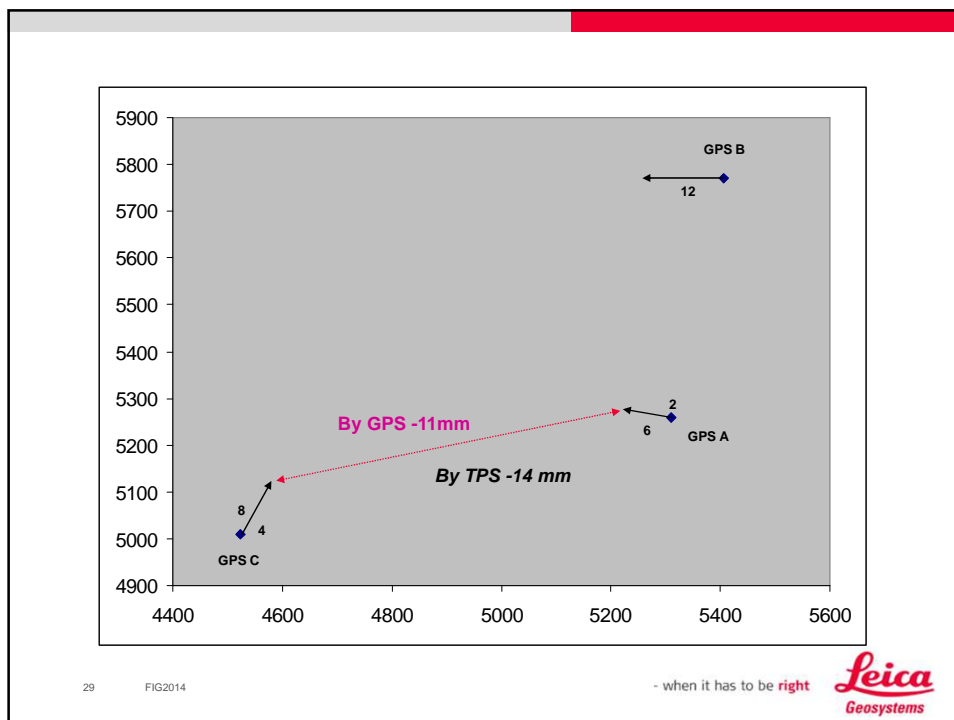
Delta Northing Change (+8mm)

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Site Layout





In Conclusion

Existing Project – TPS alone

- Significant movements were noticeable by looking at free station residuals and changes in slope distance measurements over time.

Trial Project – addition of GPS

- Direct correlation between Total Station distance measurements and GPS moving average RTK measurements.
- Prefer to use 48 hours Static survey, to achieve 2-3mm positional accuracy of total station and reference station position.
- Since system is dynamic in nature, position of reference prisms are always moving. This can translate to an inaccuracy of +/-5mm to the monitoring points. Which is acceptable in a mining environment.

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Updates...

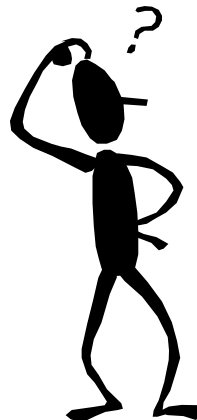


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Any Questions ?



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