塑造智慧变革

HEXAGON
海克斯康

北京
国家会议中心
2018年
9月10-12日
2018.hexagonchina.com.cn

Bridge and Tunnel Monitoring by Automatic and Manual Operation

Mr. T.N. Wong

FHKIS, FRICS, MNZIS, RISM, FInstICES

FIG, Vice President 2003-2006

HKIS President 1997/98

NZIS, Chairman of NZIS HK Branch since 2016

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目录

Project Background

The Central - Wan Chai Bypass and Island Eastern Corridor Link (CWB) is a strategic road along the north shore of Hong Kong Island targeted to alleviate the traffic congestion along the existing Gloucester Road - Harcourt Road - Connaught Road Central corridor. The need was also reaffirmed in the statutory procedures and supported in the public engagement process.

Project Management:
Highways Department

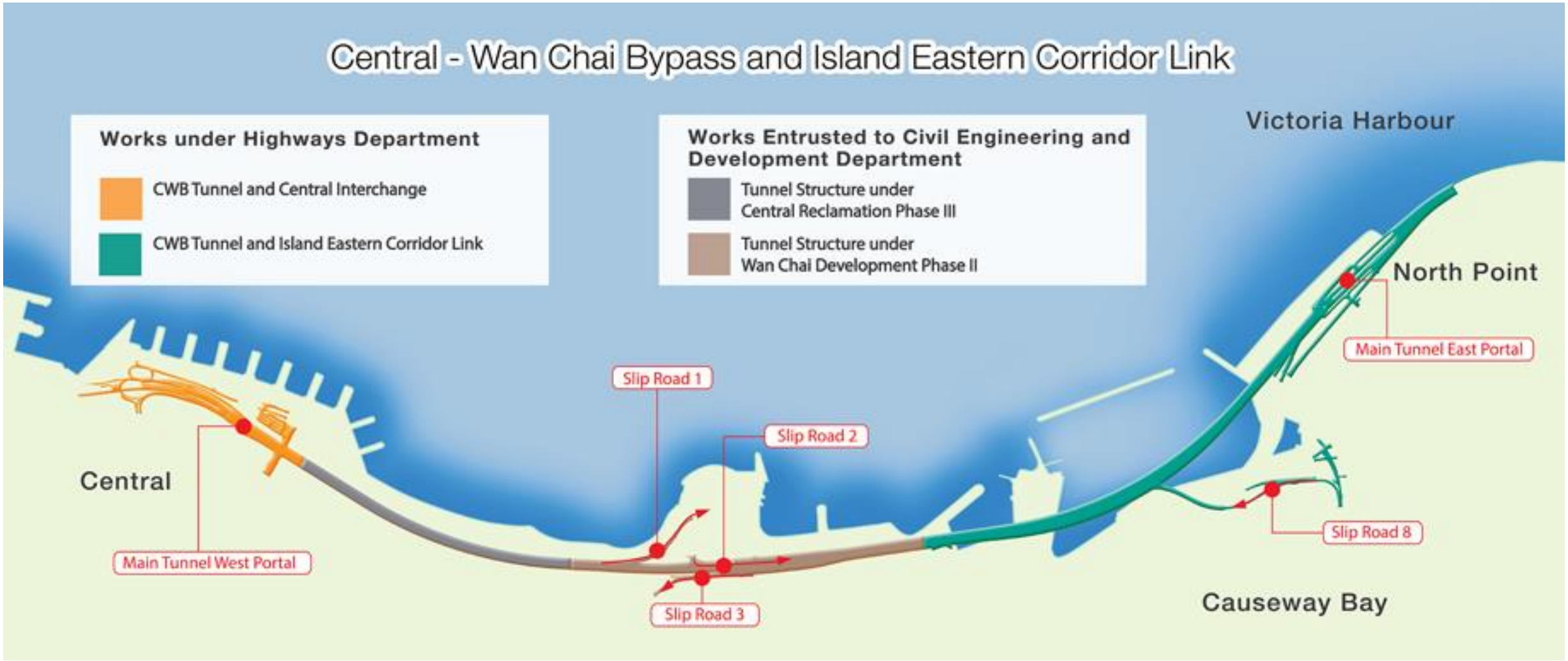
Consulting Engineers:
AECOM Asia Co. Ltd.

Estimated Project Cost:
HK$36 Billion

Construction Commencement Date:
Dec 2009

Anticipated Commissioning Date:
Late 2018 / First quarter of 2019

Project Background



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ADMS Survey – Location 1 (Temporary Setup)

We have Computer, UPS, communication device, Geomos Monitor and Geomos Analysis inside the box

ADMS Survey – Location 1 (Temporary Setup)

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ADMS Survey – Location 1 (Permanent Setup)

This is Permanent Setup

This is Temporary Setup

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ADMS Survey – Location 1 (Permanent Setup)

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ADMS Survey – Location 2

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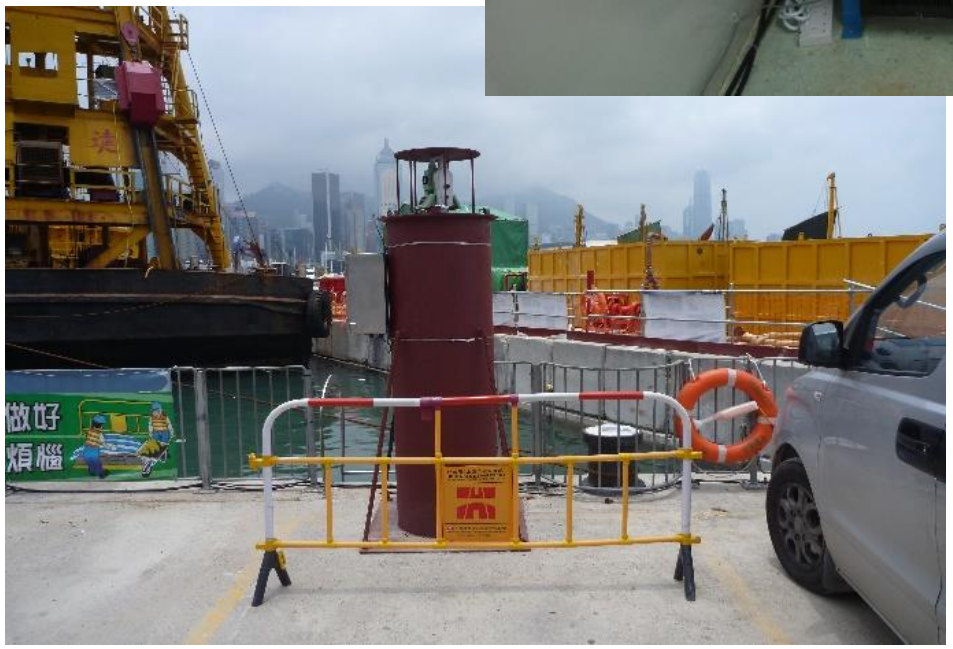
ADMS Survey – Location 2

We have Computer, UPS, Geomos Monitor and Geomos Analysis inside the box



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ADMS Survey – Location 3

ADMS Survey – Location 3

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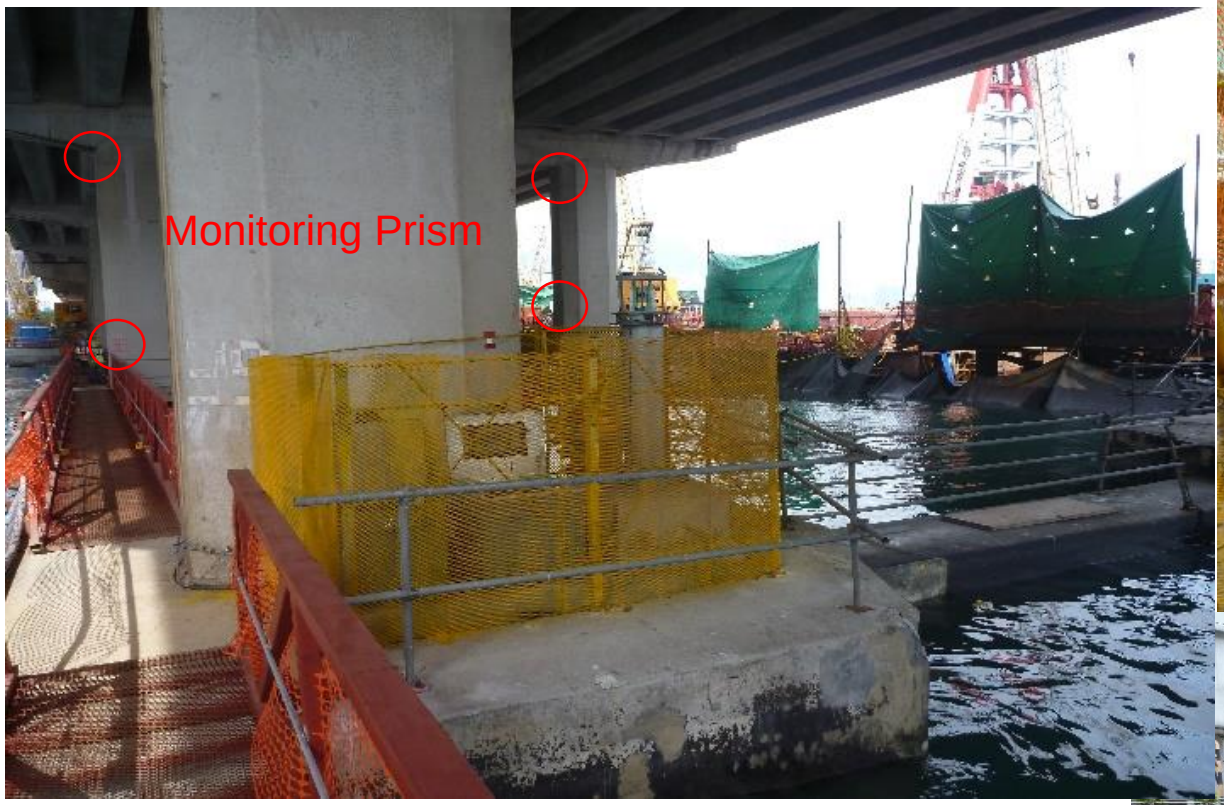
ADMS Survey – Location 4

ADMS Survey – Location 4



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ADMS Survey – Location 5 (CHT1)

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ADMS Survey – Location 5

Reference Prism

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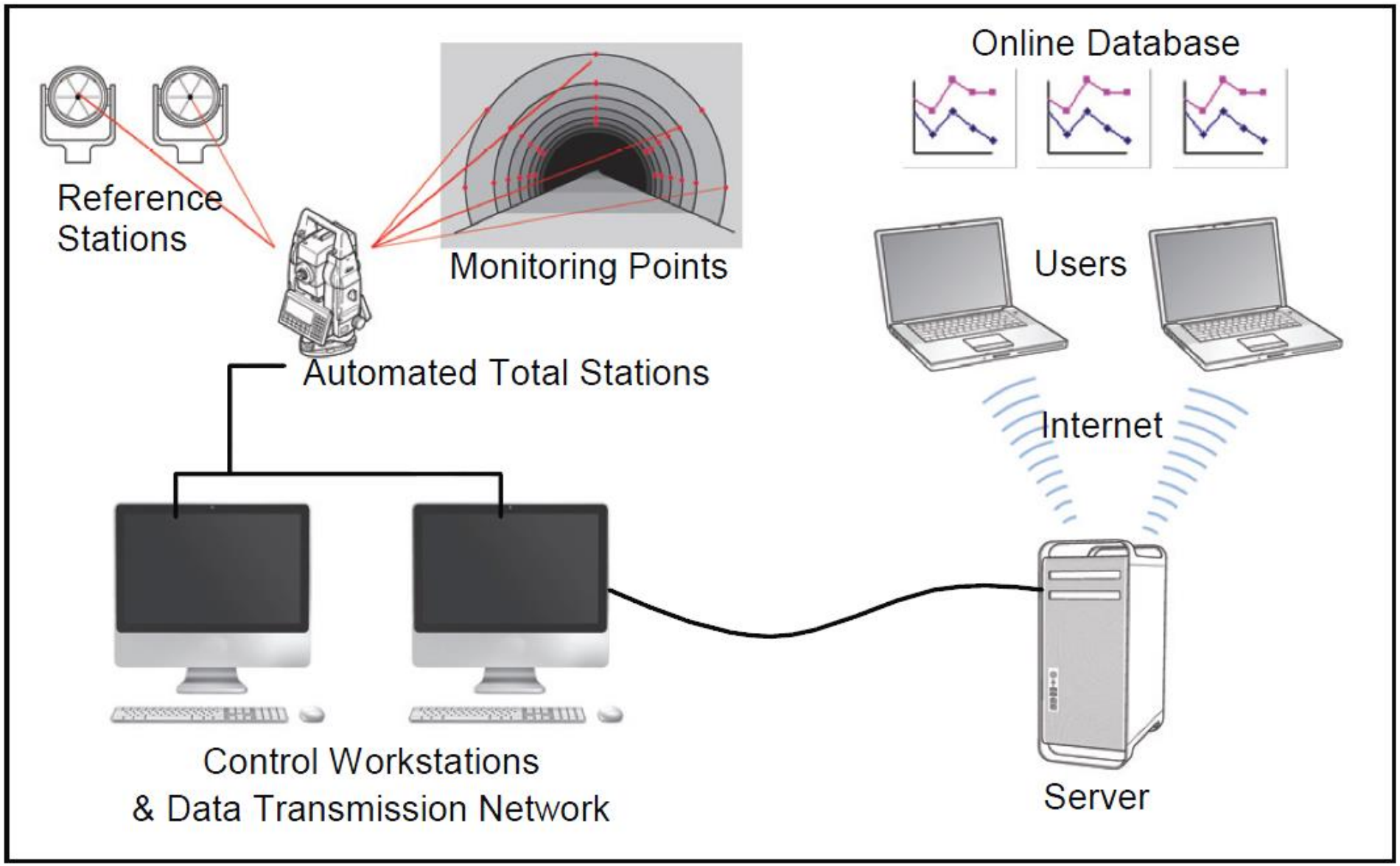
ADMS Survey – Location 5 (Components)



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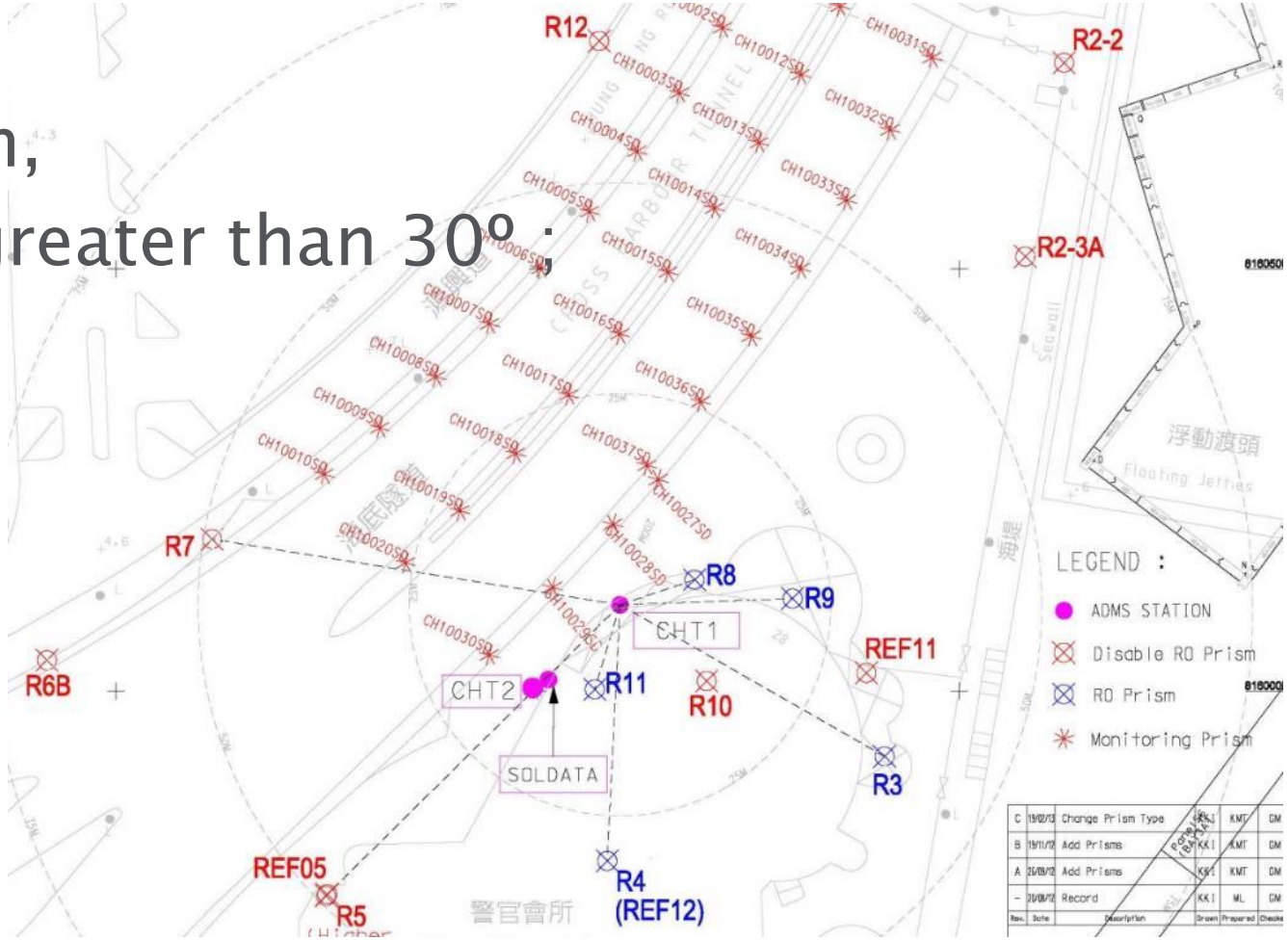
ADMS Survey – Location 5 (Network Design)

- Minimum 5 numbers of ROs
- Equal side of triangular length,
- Sizes of observation angles: greater than 30º ; less than 120º
- Coverage of Monitoring Zone



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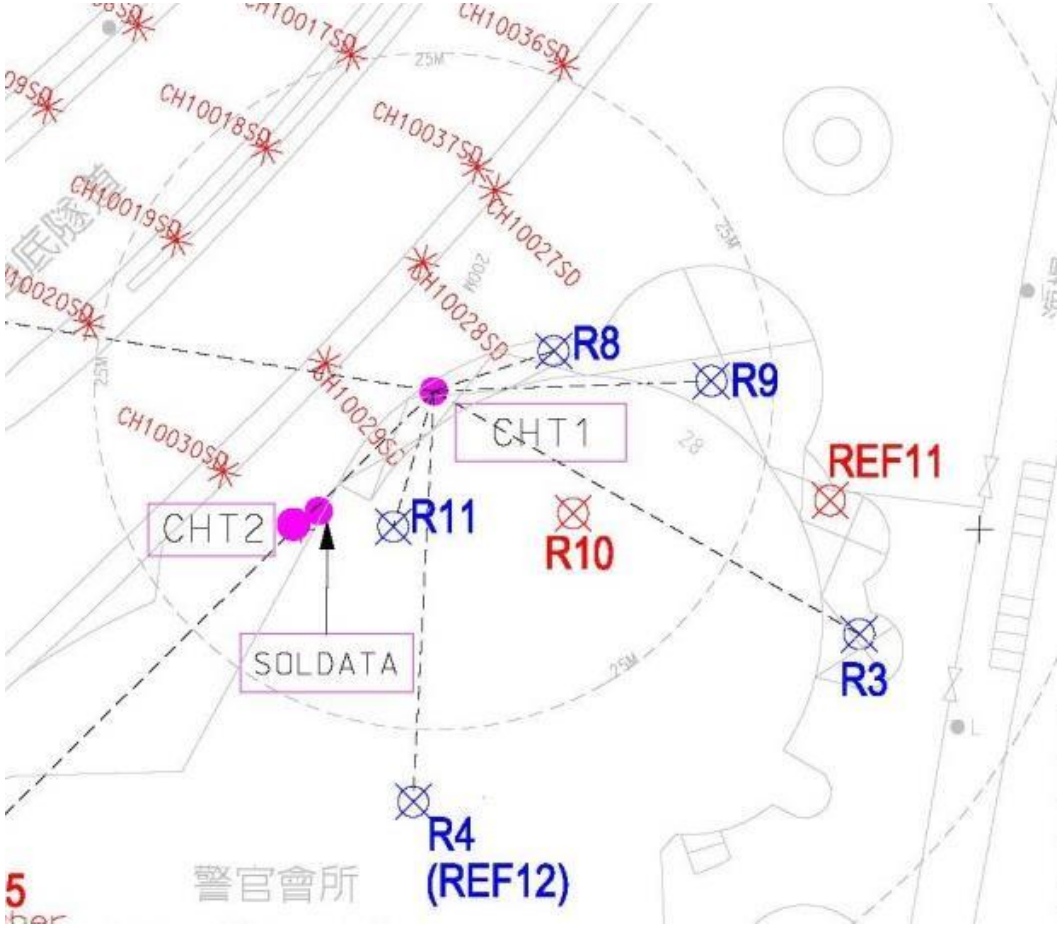
ADMS Survey – Location 5 (Freestation)

- To measure from a station point where we don't have the coordinates, to points that are defined in coordinates



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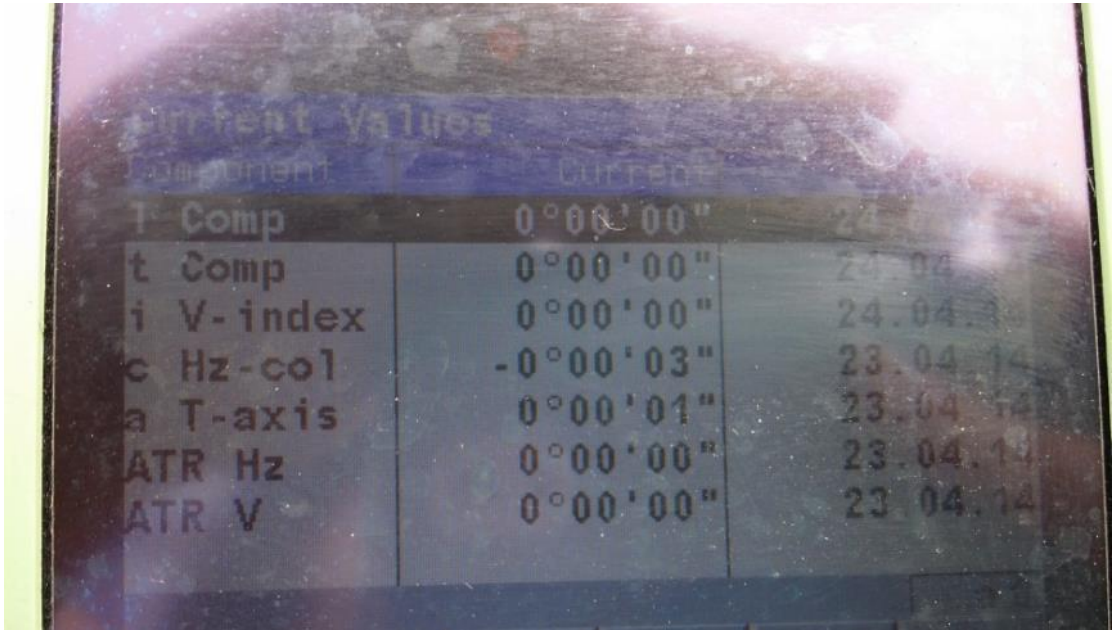
ADMS Survey – Location 5 (Independent Check)

- Verify the monitoring data on monthly basis
  →counter-check against the data produced by ADMS
- Manual Check by Conventional Survey Techniques
  - Traverse
  - Levelling

ADMS Survey – Location 5 (Quality Control)

- Maintenance/ Annual Calibration
- Cleaning of both RO and Monitoring Prisms
- Calibration of Total Station
  - Compensator Index Error
  - Vertical Index Error
  - Horizontal Collimation Error
  - ATR Hz, ATR V



l, t	Compensator longitudinal and transversal index errors
i	Vertical index error, related to the standing axis
c	Horizontal collimation error, also called line of sight error
ATR Hz	ATR zero point error for horizontal angle option
ATR V	ATR zero point error for vertical angle option

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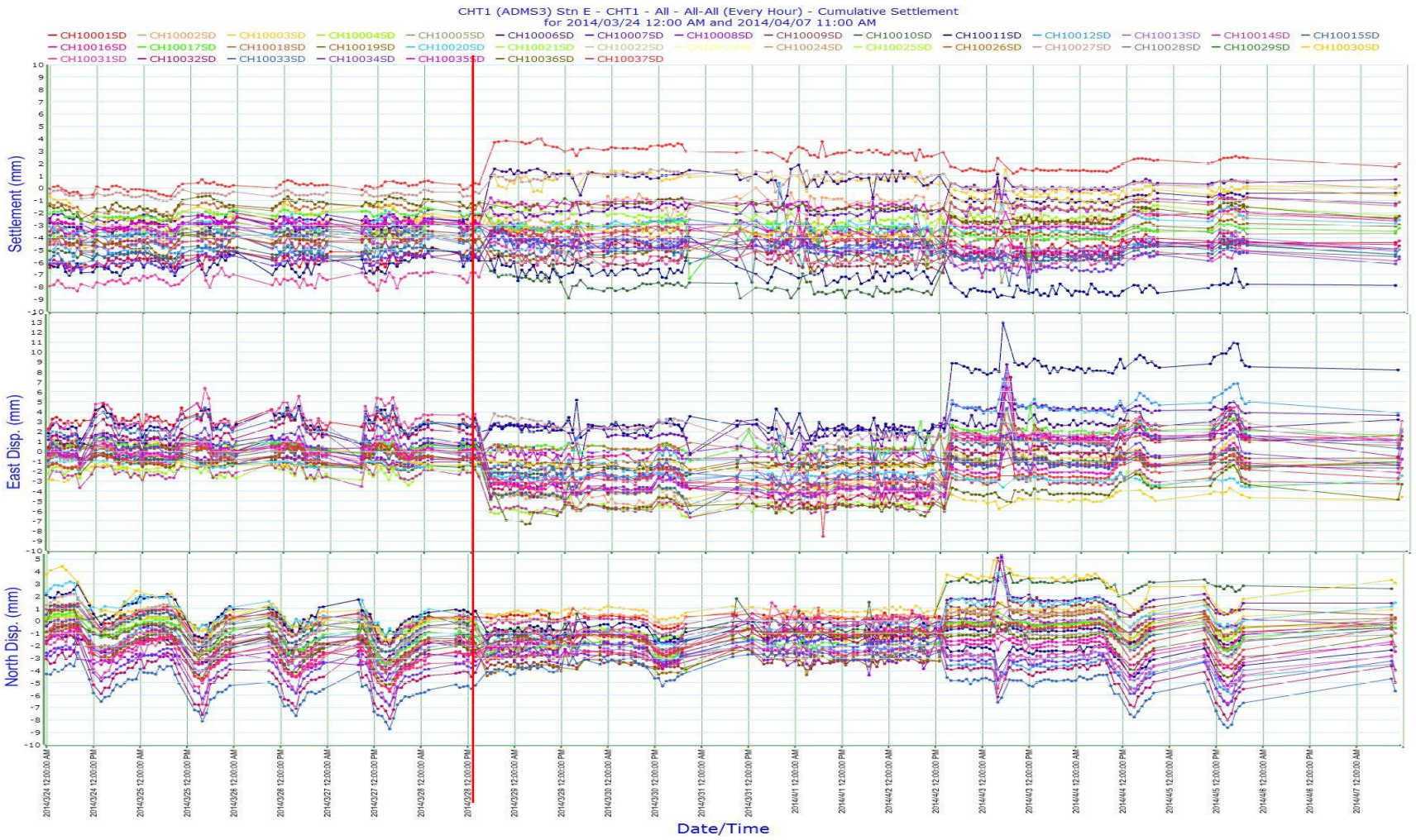
ADMS Survey – Location 5 (Implementation)

- Situation: Adding PVC Cover



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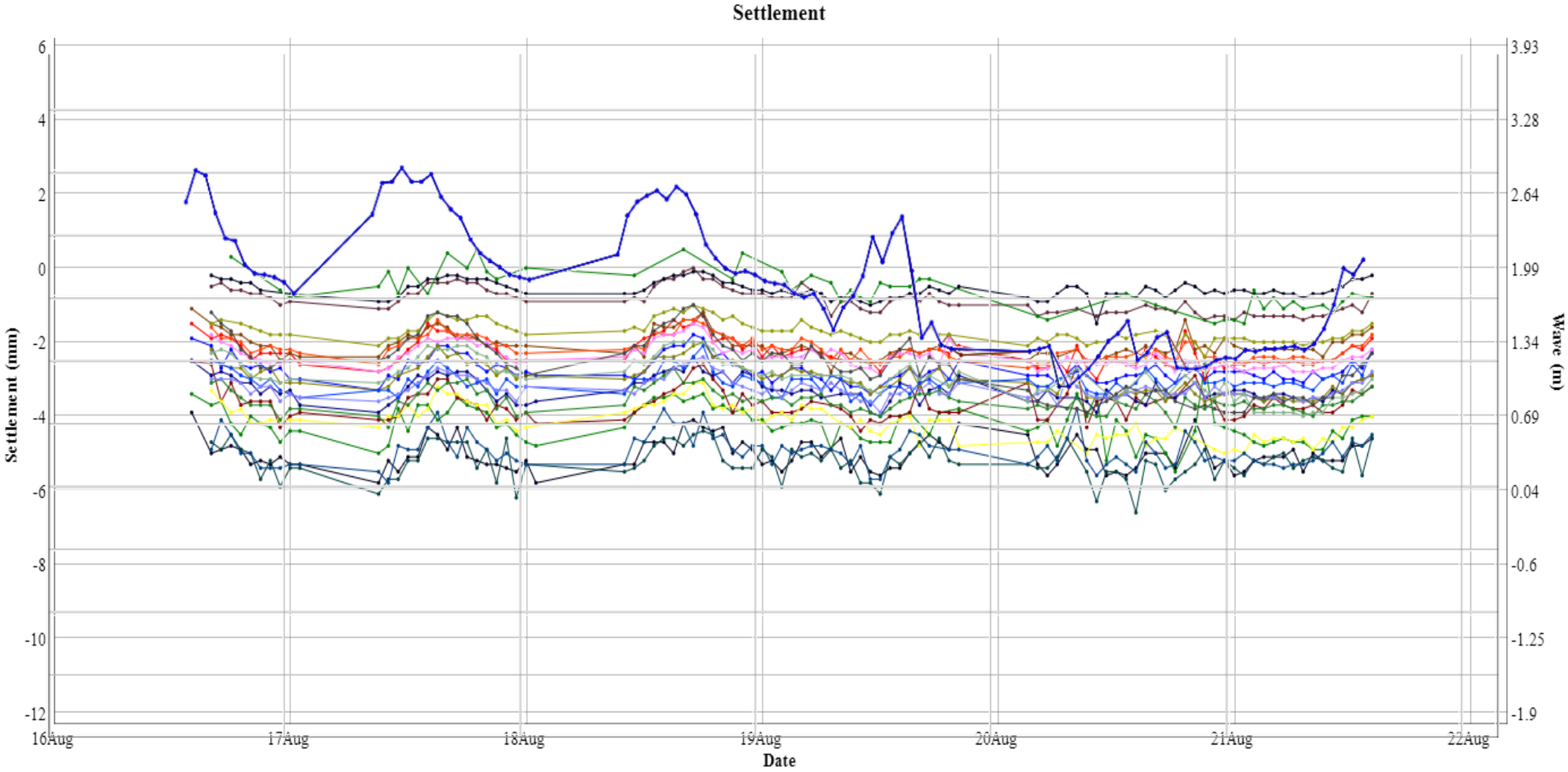
ADMS Survey – Location 5 (Implementation)

- Situation: Effect of Temperature



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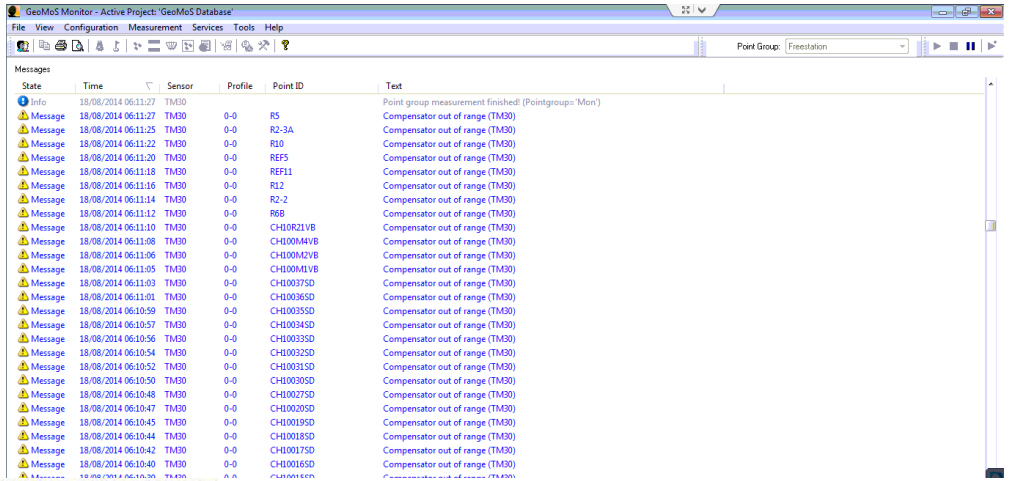
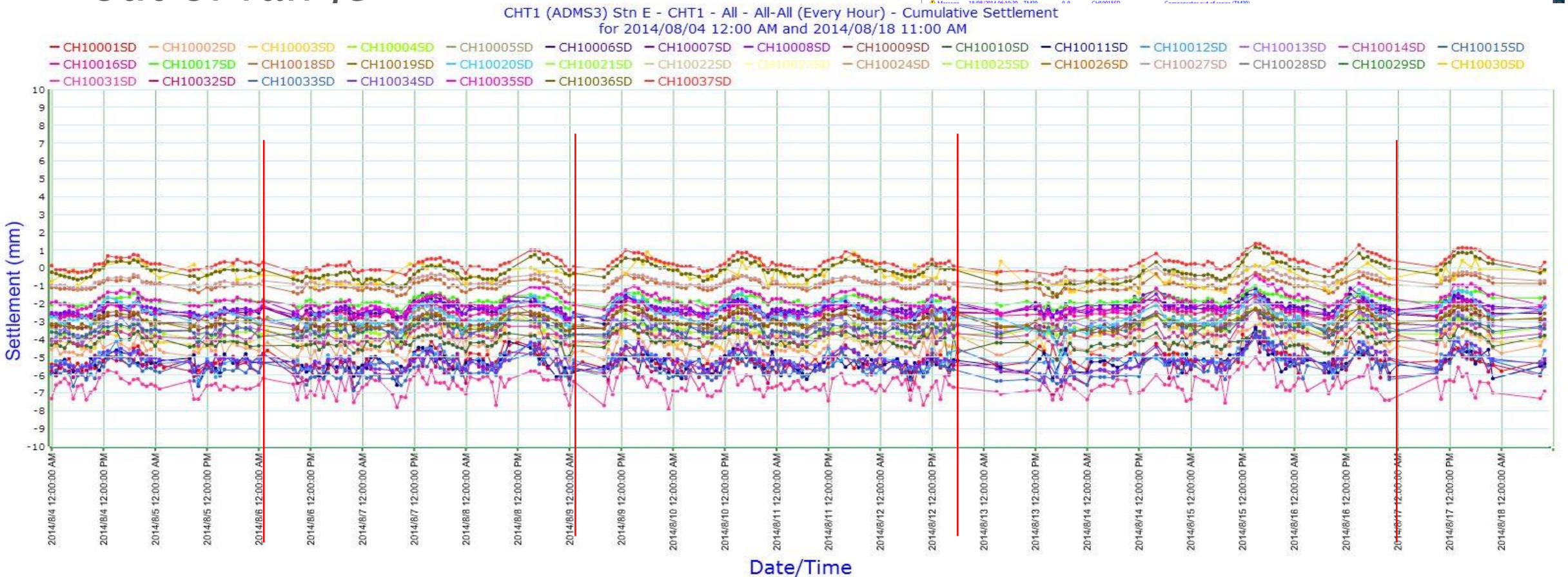
ADMS Survey – Location 5 (Implementation)

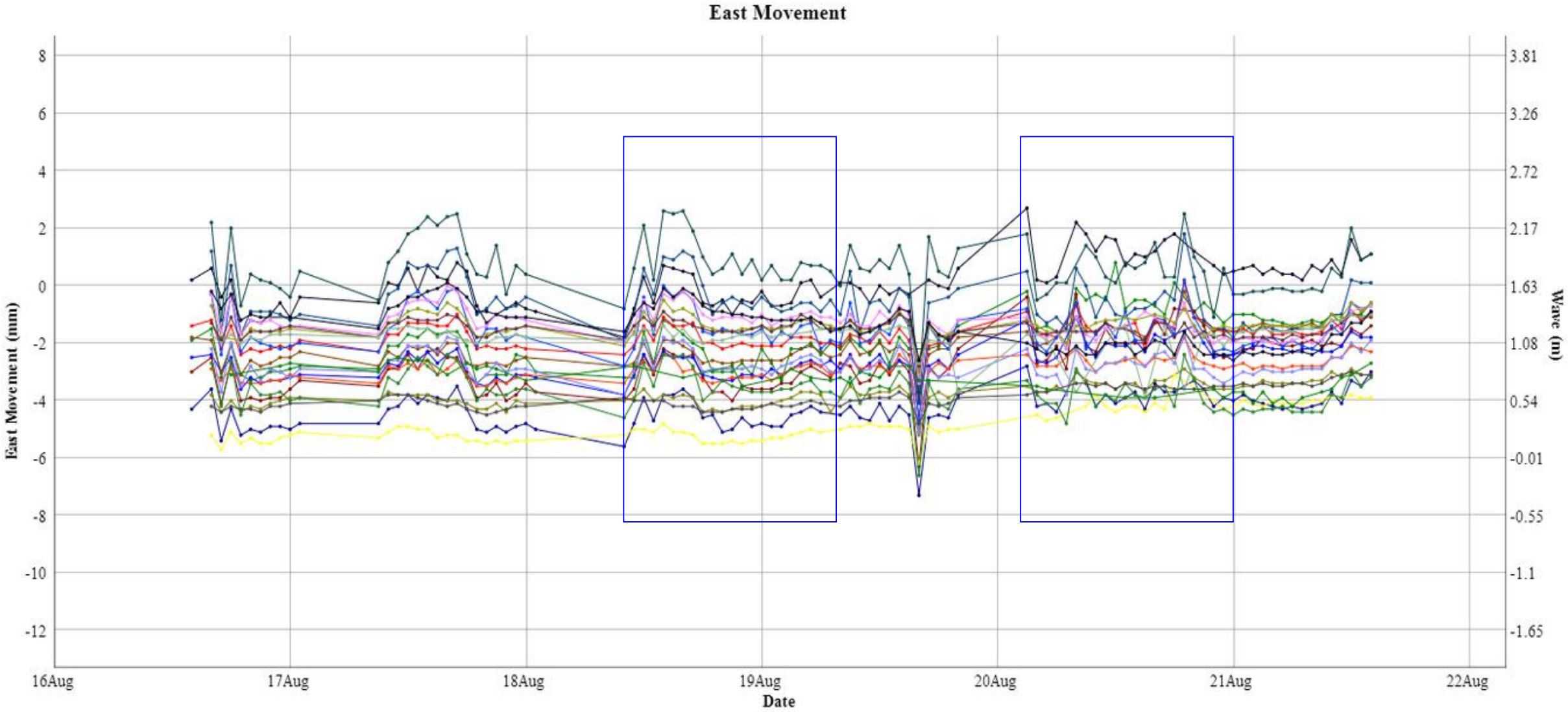
- Situation:
  Compensator out of range





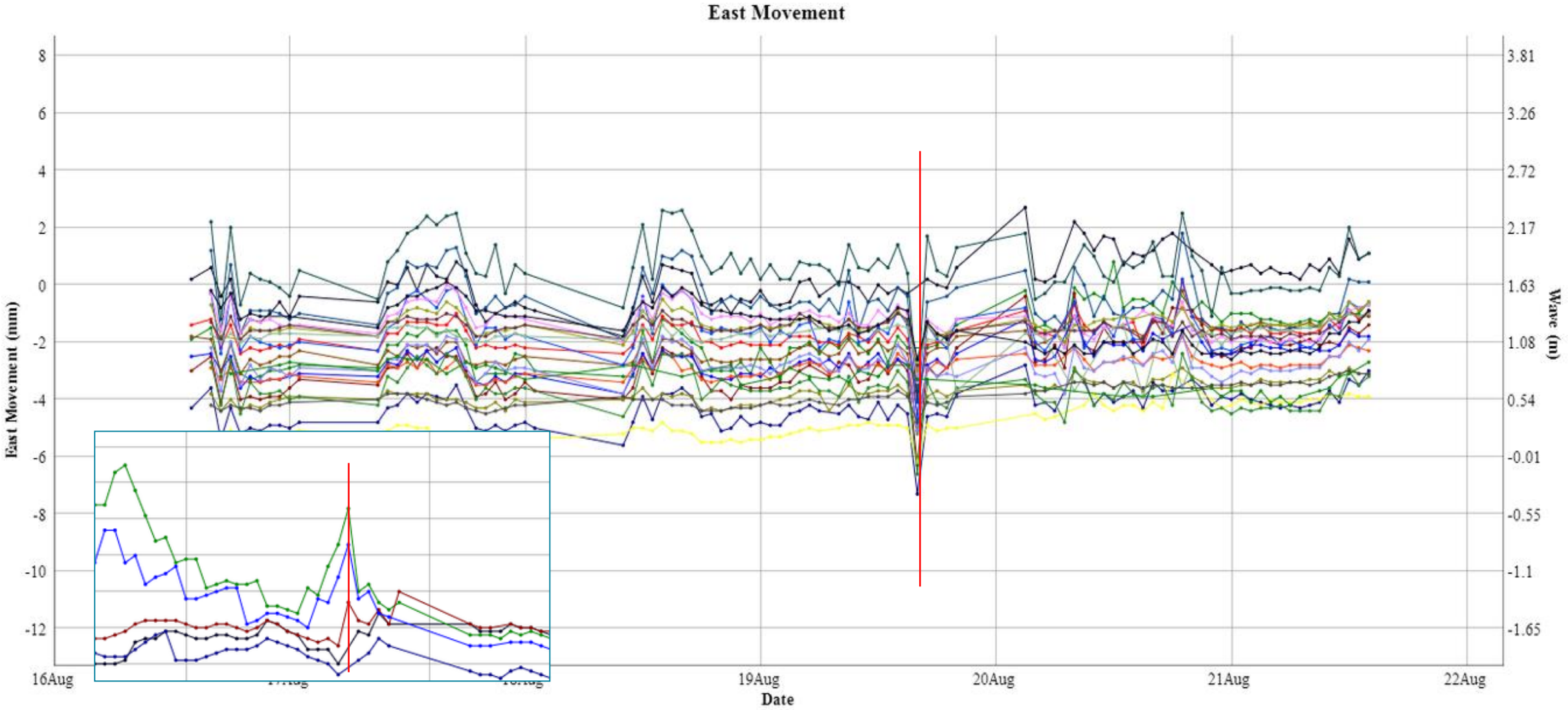
ADMS Survey – Location 5 (Implementation)

- Situation: Extreme Weather



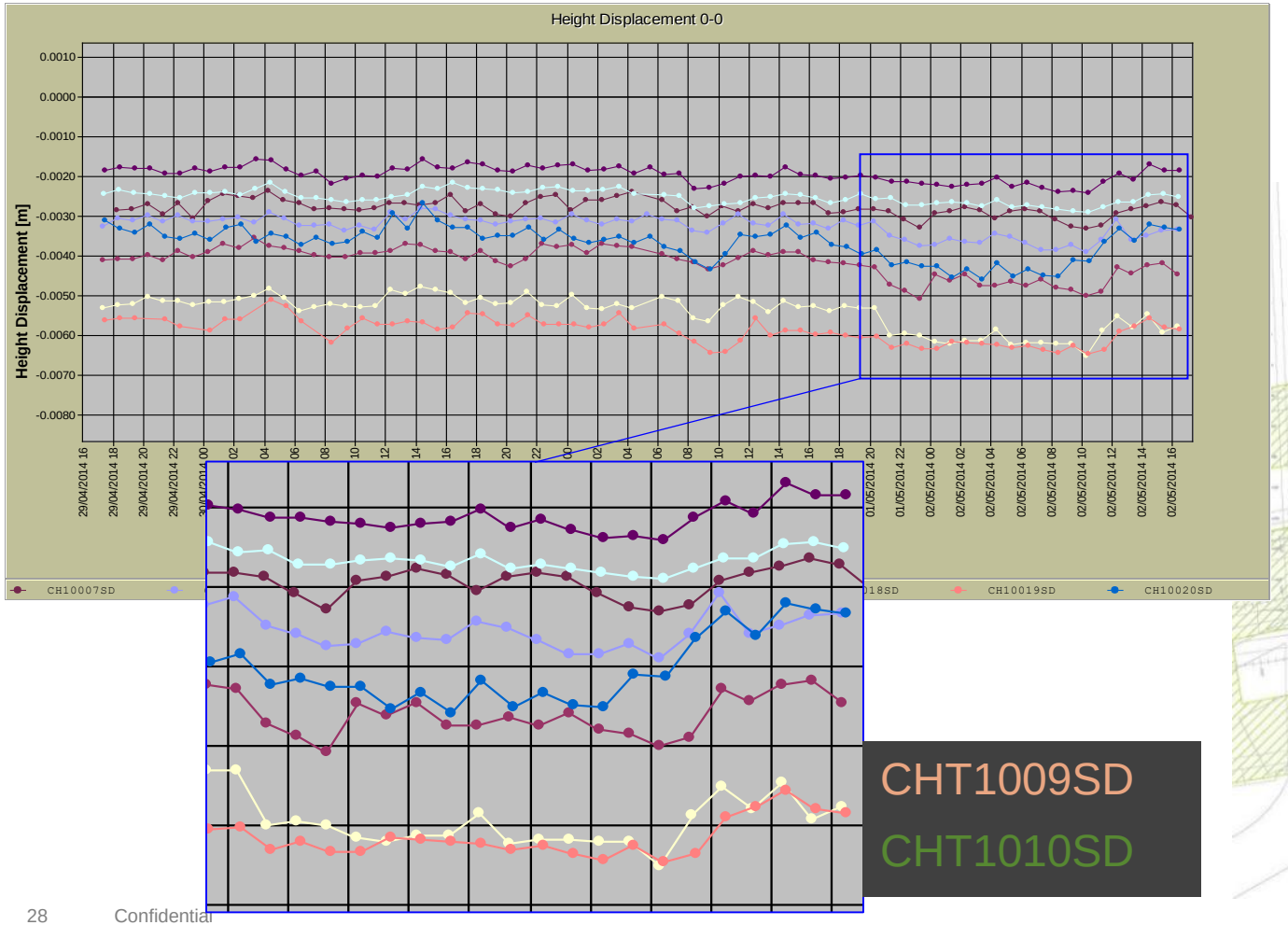
ADMS Survey – Location 5 (Implementation)

- Situation: Insufficient RO for Freestation



ADMS Survey – Location 5 (Implementation)

- Situation: Water Inflow in MT



CHT1009SD

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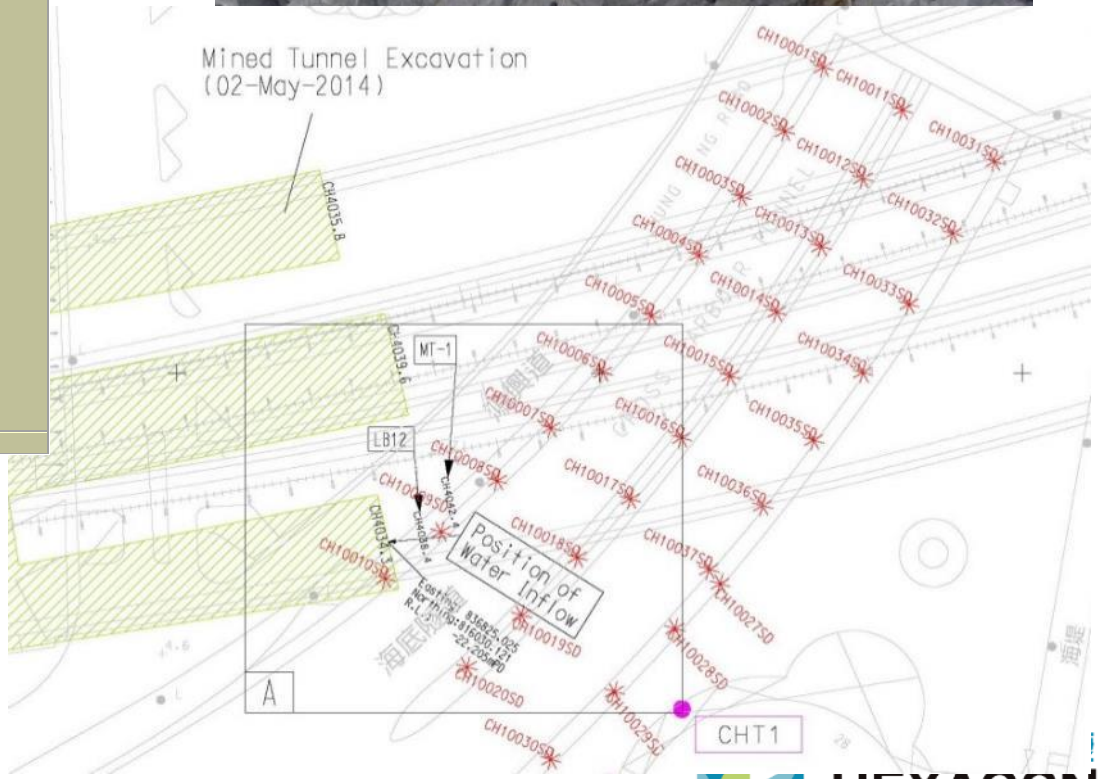

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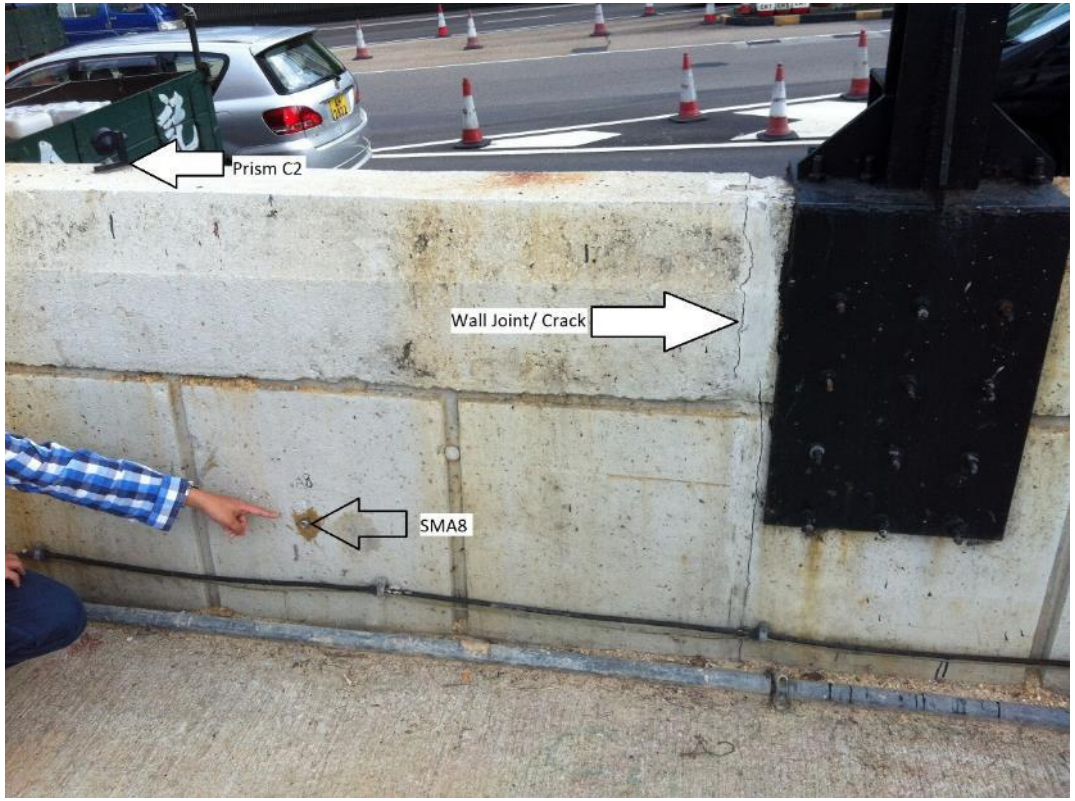
Manuel Survey Check



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Manuel Survey Check

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Manuel Survey Check

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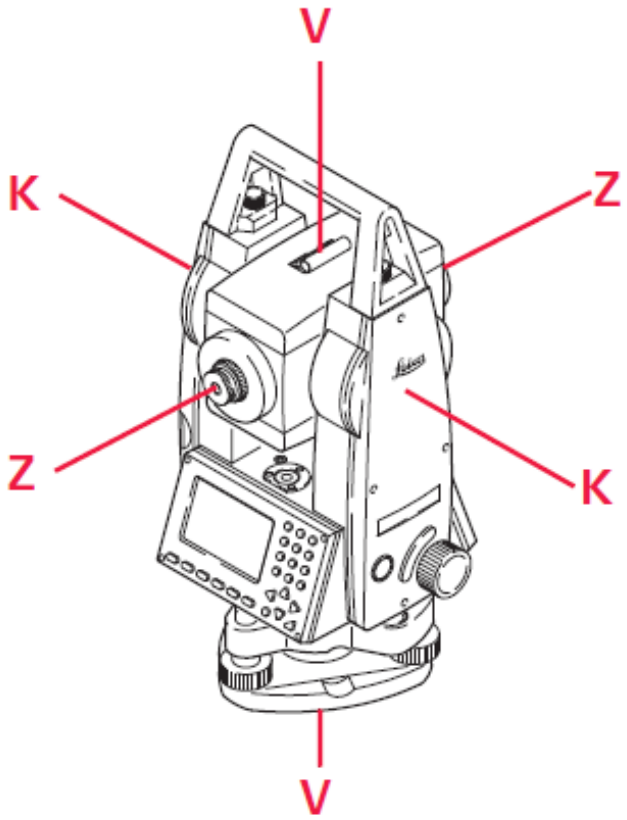
4 rounds 4 arcs precise measurement

- Face left & Face right observation
- 4 Rounds 4 arcs
- Horizontal closed (Horizontal angular closed method)

4 rounds 4 arcs precise measurement - Face left & Face right observation

a) Line of sight ZZ perpendicular to tilting axis KK
b) Tilting axis KK perpendicular to vertical axis VV
c) Vertical axis VV strictly vertical
d) Vertical-circle reading precisely zero at the zenith

- Eliminate errors



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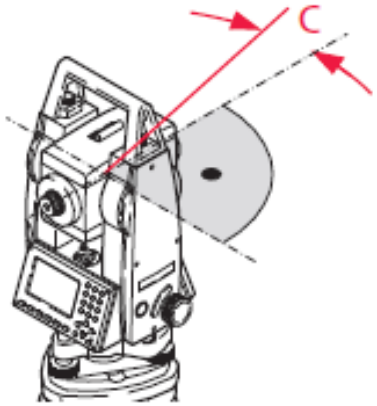
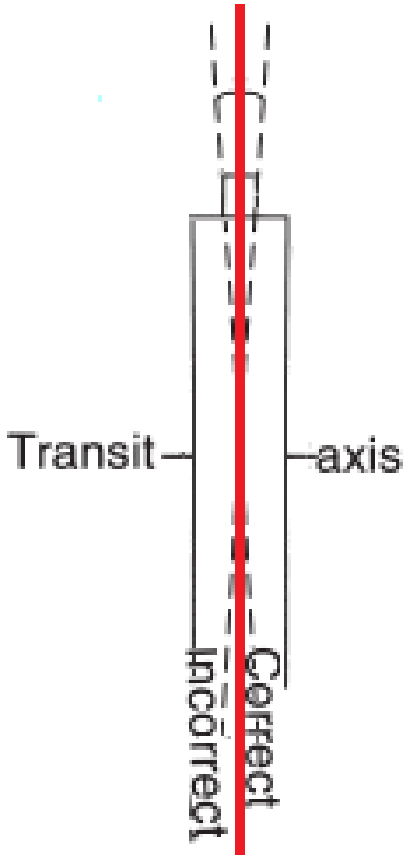
4 rounds 4 arcs precise measurement - Collimation error



Line-of-sight error (c)
(Hz collimation)



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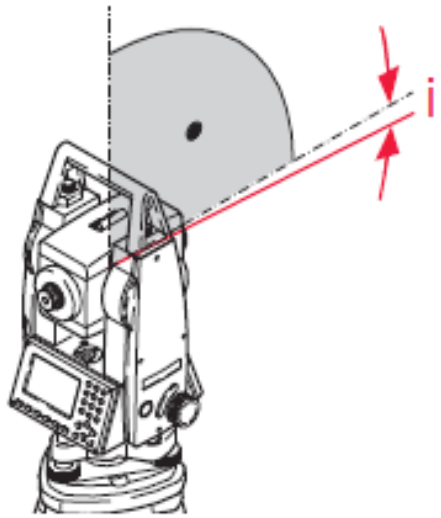
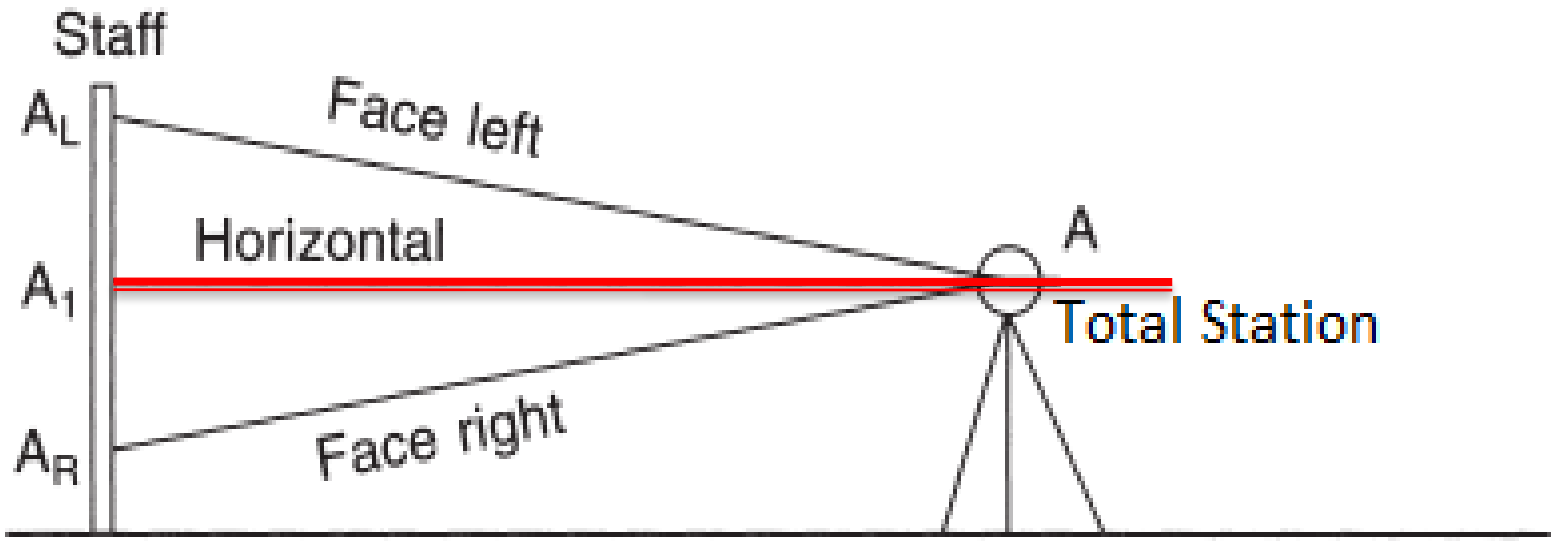
4 rounds 4 arcs precise measurement - Height-index error

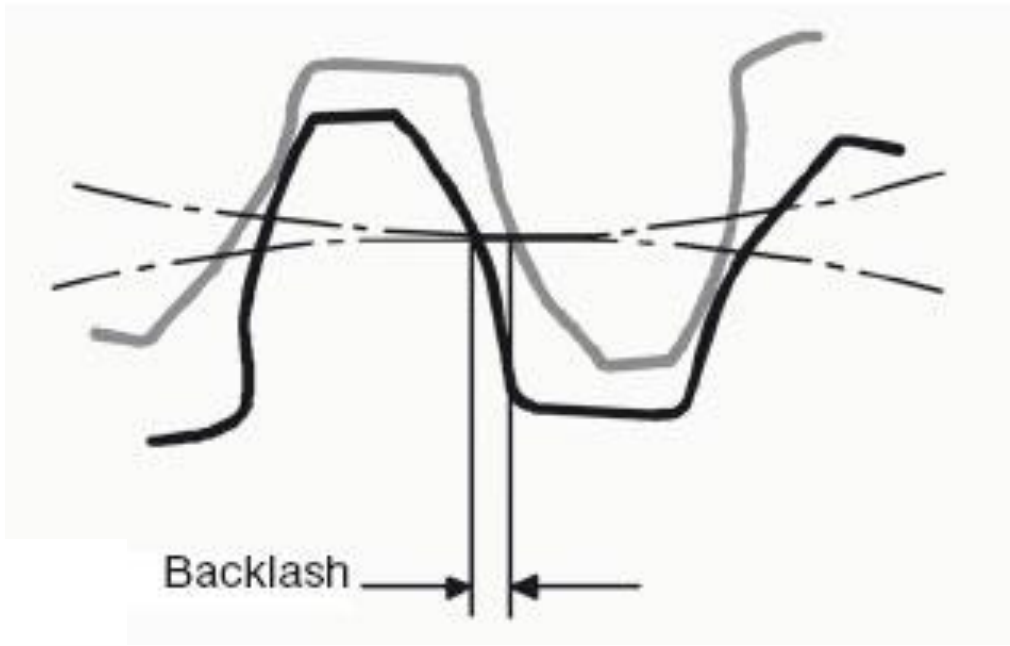


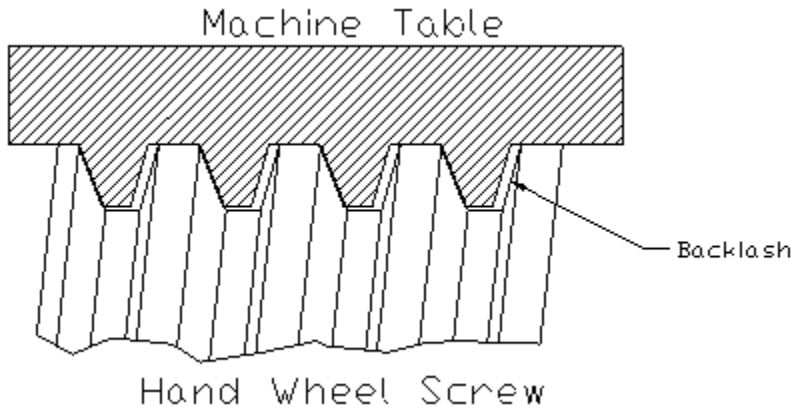
Height-index error (i)
(V index)



4 rounds 4 arcs precise measurement - Backlash

- Backlash is the clearance formed between a pair of gears.





海克斯康 HEXAGON

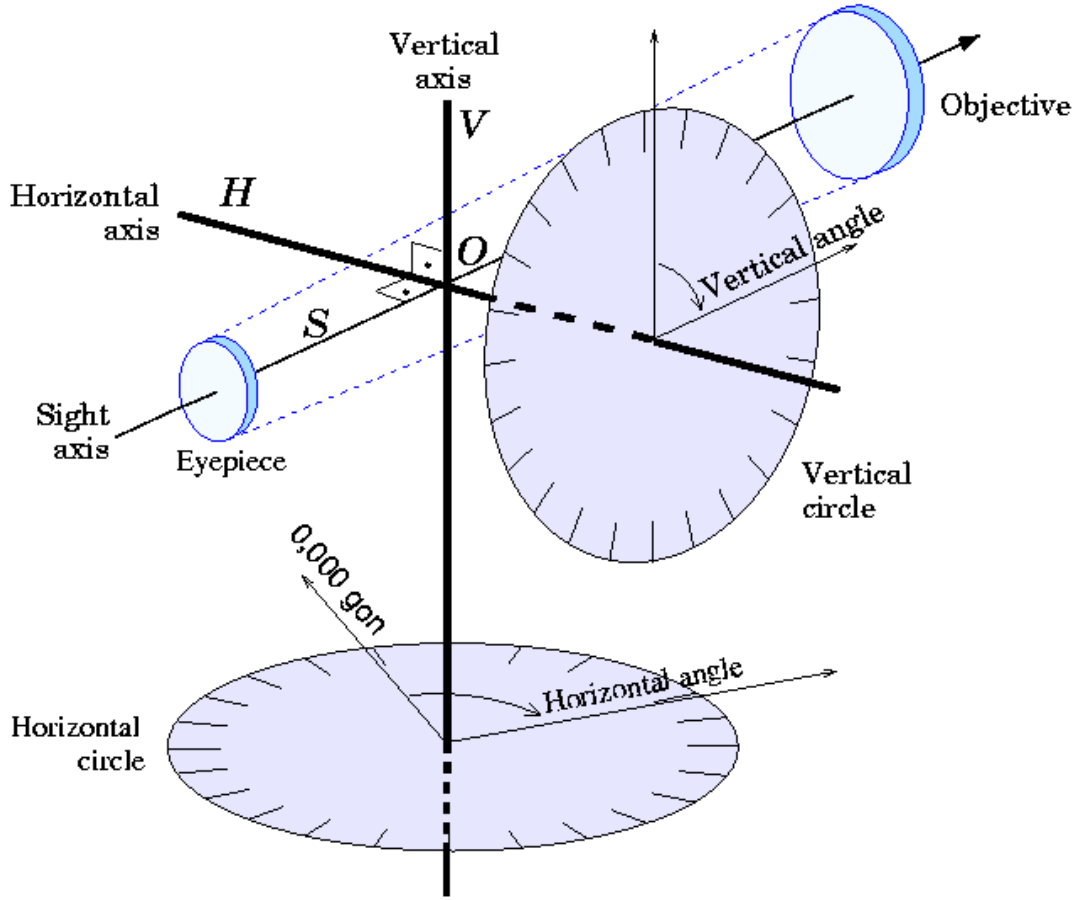
4 rounds 4 arcs precise measurement - Backlash

- Face Left observation: always turn in clockwise direction
- Face Right observation: always turn in counter-clockwise direction.

4 rounds 4 arcs precise measurement

- Eliminate Circle graduation errors
- Calculation S.Dev

$$\sigma = \sqrt{\frac{1}{N}\sum_{i=1}^{N}(x_i - \overline{x})^2}$$

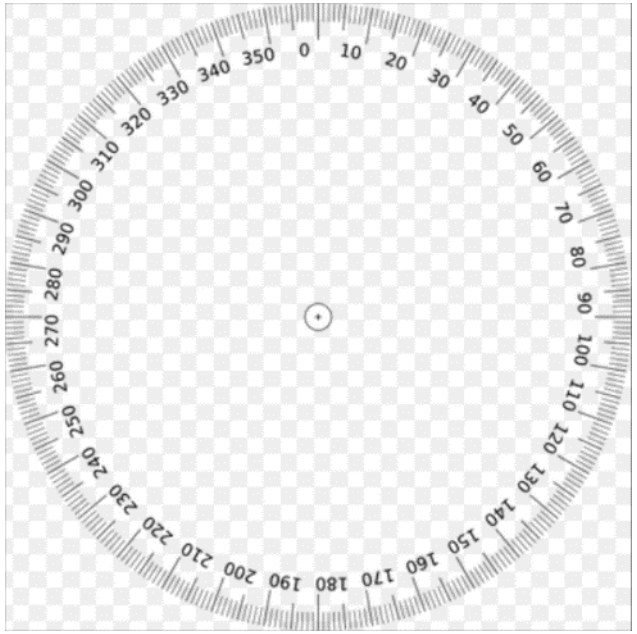


海克斯康 HEXAGON

4 rounds 4 arcs precise measurement

- Face left:
  000-00-00
  090-00-00
  045-00-00
  135-00-00

  Face Right:
  180-00-00
  270-00-00
  225-00-00
  315-00-00



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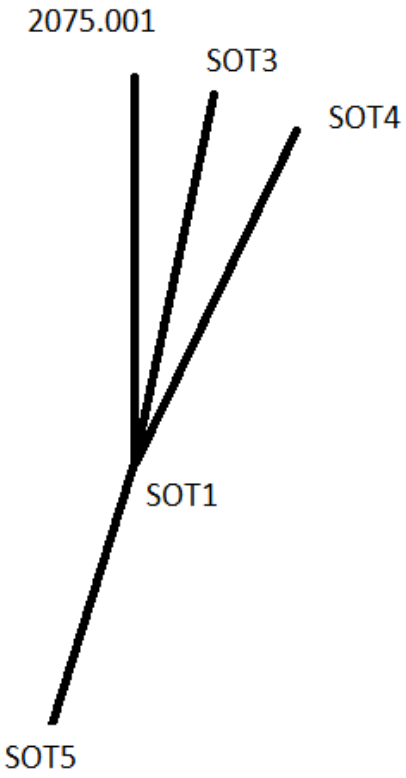
4 rounds 4 arcs precise measurement - Horizontal close

- To ensure the Total station have not been moved during the observation.
- Check to see if it is 360°

4 rounds 4 arcs precise measurement

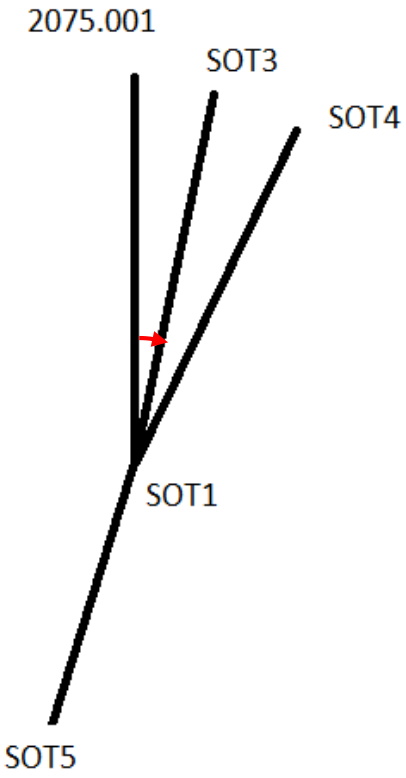
@ At STN:	SOT1	Observation (DD.MMSS)
	STN:	1L
RO	2075.001	0.0000
	SOT3	
	SOT4	
	SOT5	
	2075.001	



海克斯康 HEXAGON

4 rounds 4 arcs precise measurement

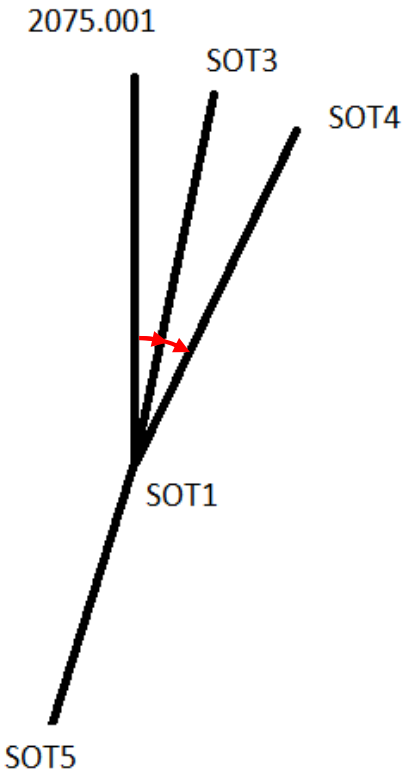
@ At STN:	SOT1	Observation (DD.MMSS)
	STN:	1L
RO	2075.001	0.0000
	SOT3	8.1649
	SOT4	
	SOT5	
	2075.001	



海克斯康 HEXAGON

4 rounds 4 arcs precise measurement

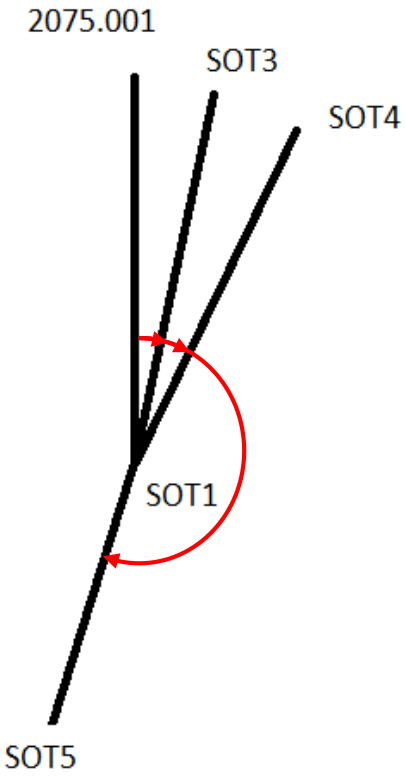
@ At STN:	SOT1	Observation (DD.MMSS)
	STN:	1L
RO	2075.001	0.0000
	SOT3	8.1649
	SOT4	22.4313
	SOT5	
	2075.001	



海克斯康 HEXAGON

4 rounds 4 arcs precise measurement

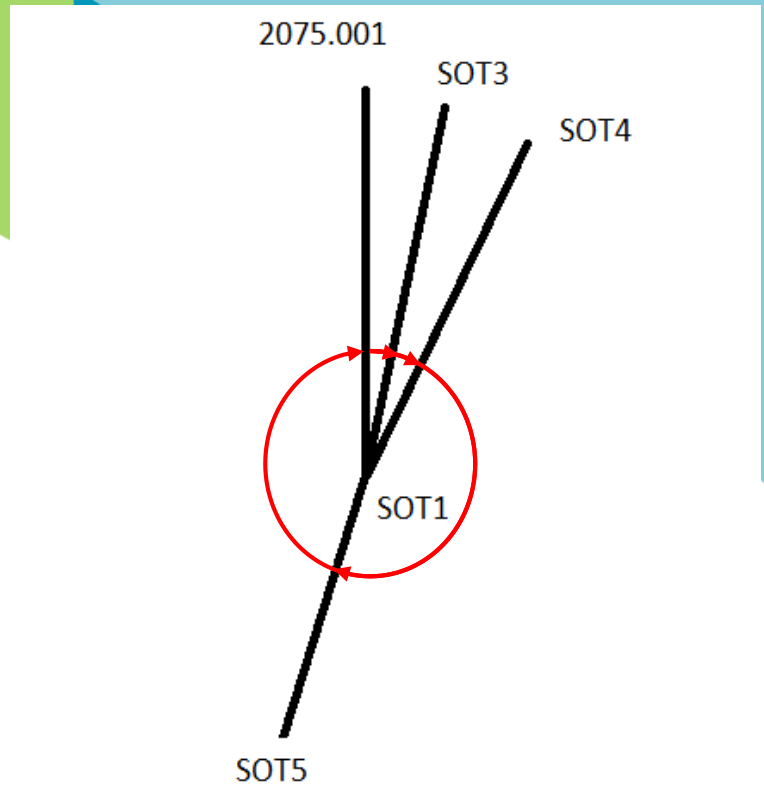
@ At STN:	SOT1	Observation (DD.MMSS)
	STN:	1L
RO	2075.001	0.0000
	SOT3	8.1649
	SOT4	22.4313
	SOT5	192.4116
	2075.001	



海克斯康 HEXAGON

4 rounds 4 arcs precise measurement

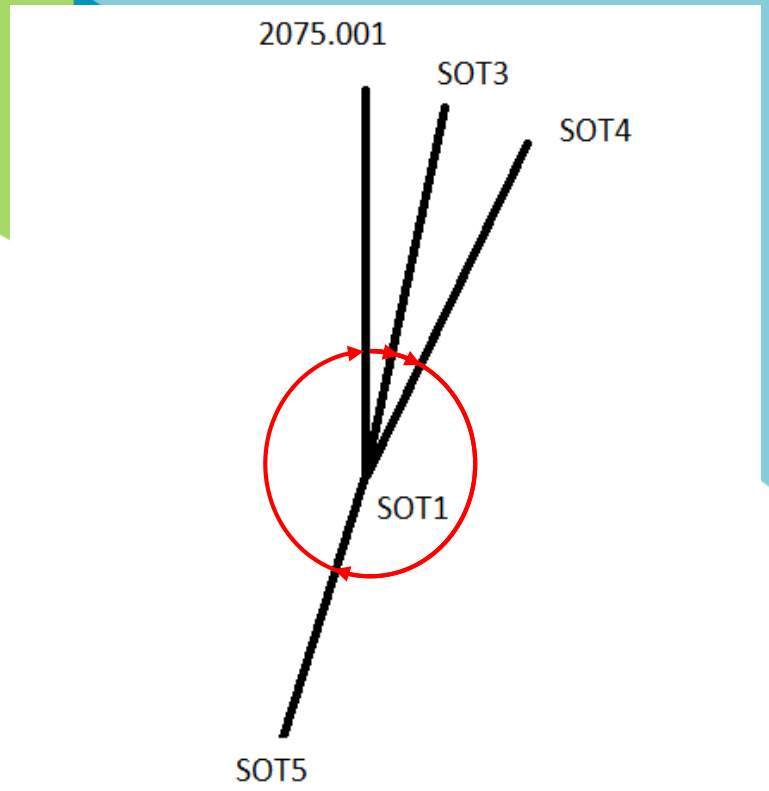
@ At STN:	SOT1	Observation (DD.MMSS)
	STN:	1L
RO	2075.001	0.0000
	SOT3	8.1649
	SOT4	22.4313
	SOT5	192.4116
	2075.001	359.5958



海克斯康 HEXAGON

4 rounds 4 arcs precise measurement

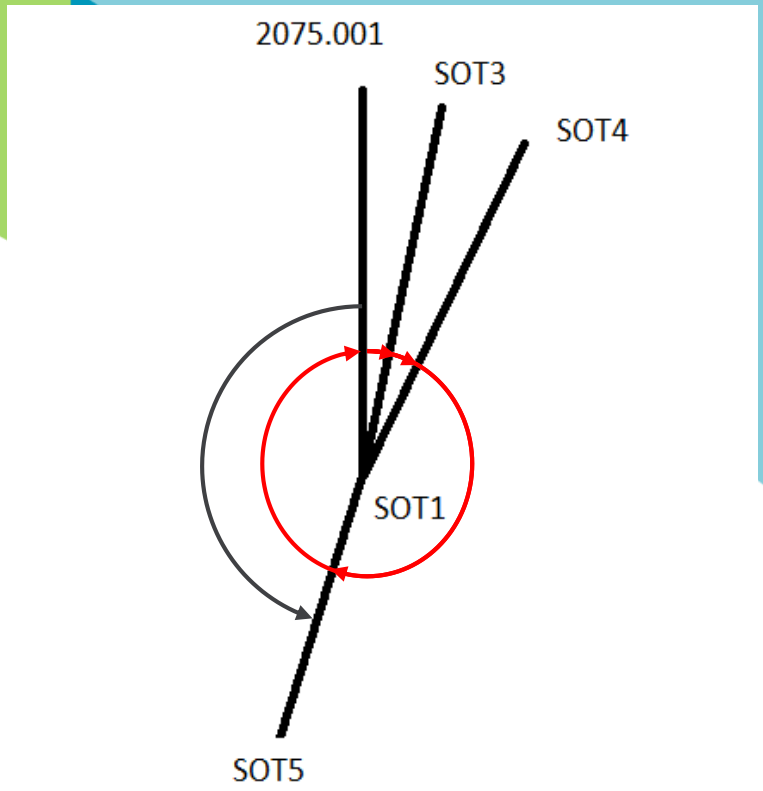
@ At STN:	SOT1	Observation (DD.MMSS)	
	STN:	1L	
RO	2075.001	0.0000	
	SOT3	8.1649	
	SOT4	22.4313	
	SOT5	192.4116	
	2075.001	359.5958	180.0002



海克斯康 HEXAGON

4 rounds 4 arcs precise measurement

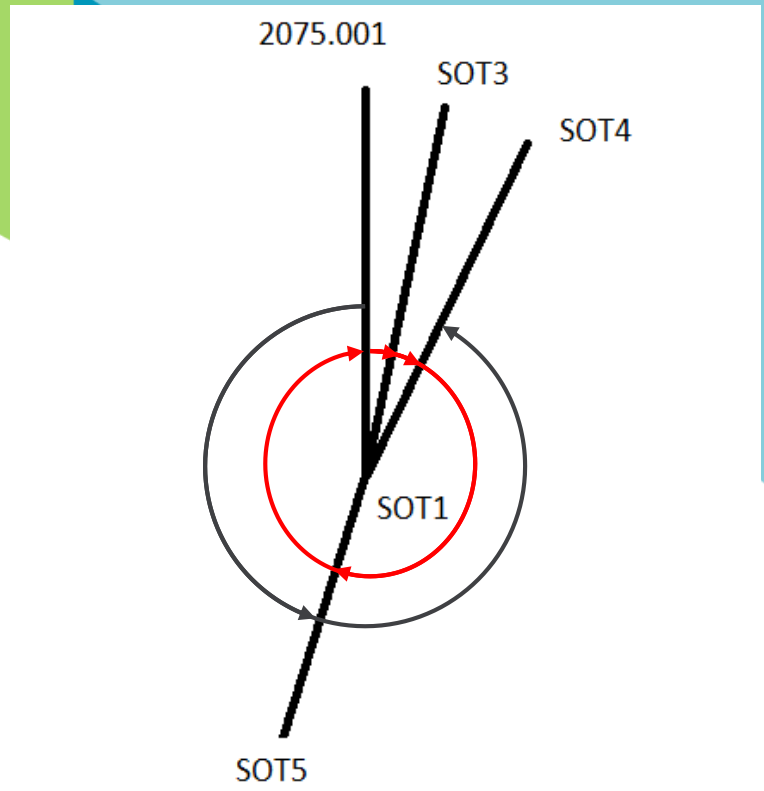
@ At STN:	SOT1	Observation (DD.MMSS)	
	STN:	1L	
RO	2075.001	0.0000	
	SOT3	8.1649	
	SOT4	22.4313	
	SOT5	192.4116	12.4116
	2075.001	359.5958	180.0002



海克斯康 HEXAGON

4 rounds 4 arcs precise measurement

@ At STN:	SOT1	Observation (DD.MMSS)	
	STN:	1L	
RO	2075.001	0.0000	
	SOT3	8.1649	
	SOT4	22.4313	202.4310
	SOT5	192.4116	12.4116
	2075.001	359.5958	180.0002



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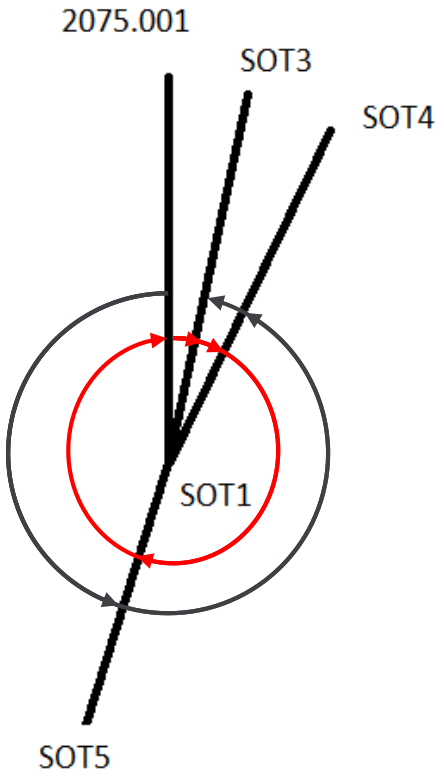
4 rounds 4 arcs precise measurement

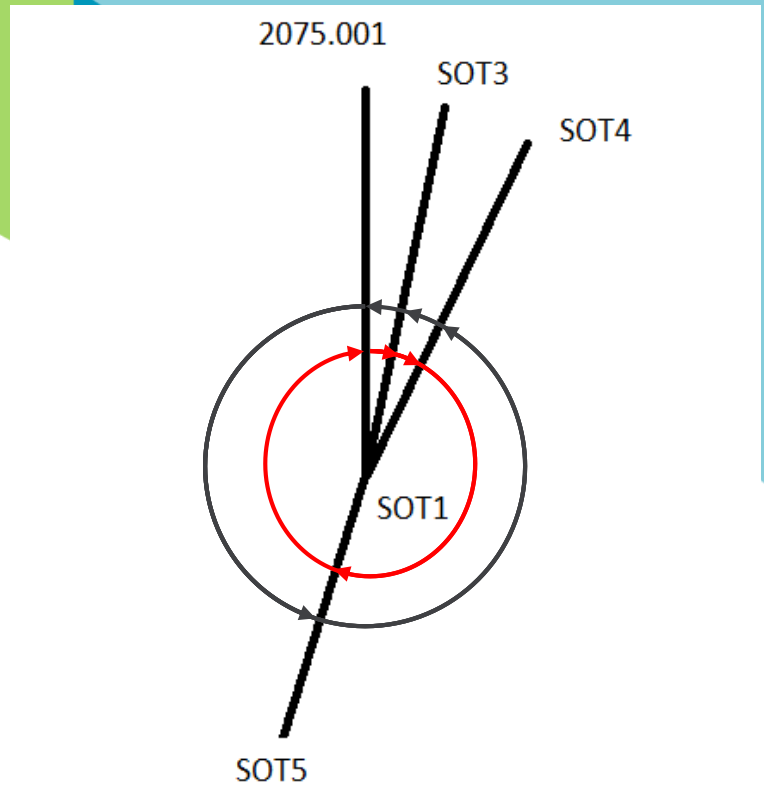
@ At STN:	SOT1	Observation (DD.MMSS)	
	STN:	1L	
RO	2075.001	0.0000	
	SOT3	8.1649	188.1639
	SOT4	22.4313	202.4310
	SOT5	192.4116	12.4116
	2075.001	359.5958	180.0002



海克斯康 HEXAGON

4 rounds 4 arcs precise measurement

@ At STN:	SOT1	Observation (DD.MMSS)	
	STN:	1L	1R
RO	2075.001	0.0000	180.0001
	SOT3	8.1649	188.1639
	SOT4	22.4313	202.4310
	SOT5	192.4116	12.4116
	2075.001	359.5958	180.0002

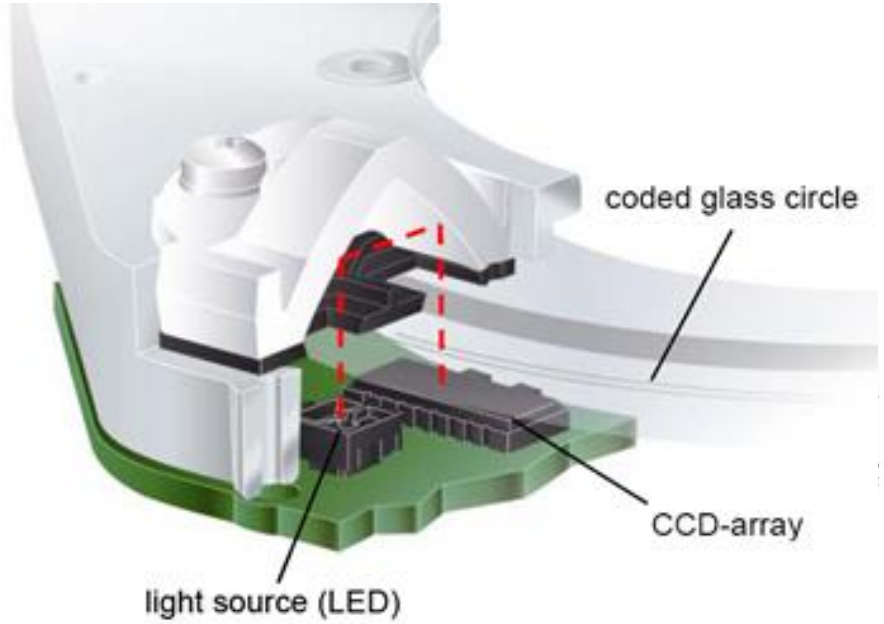


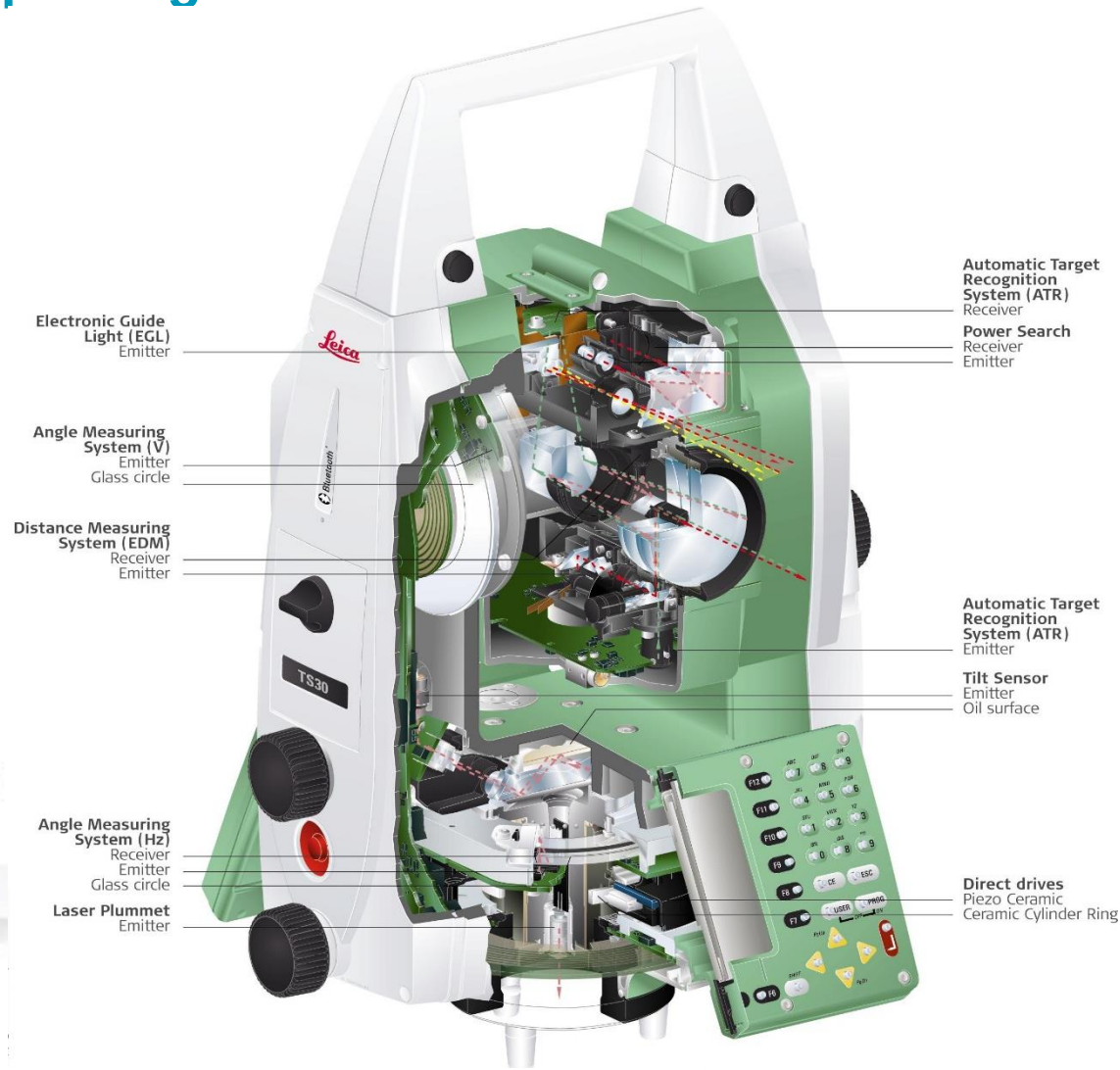
海克斯康 HEXAGON

4 rounds 4 arcs precise measurement – Quadruple angle detection in TM/S 30/50

- Quadruple angle detection
  - 4 encoders: elimination of further minor π-periodic errors
  - 5000Hz, absolute, continuous
  - Precision improvement about 30%

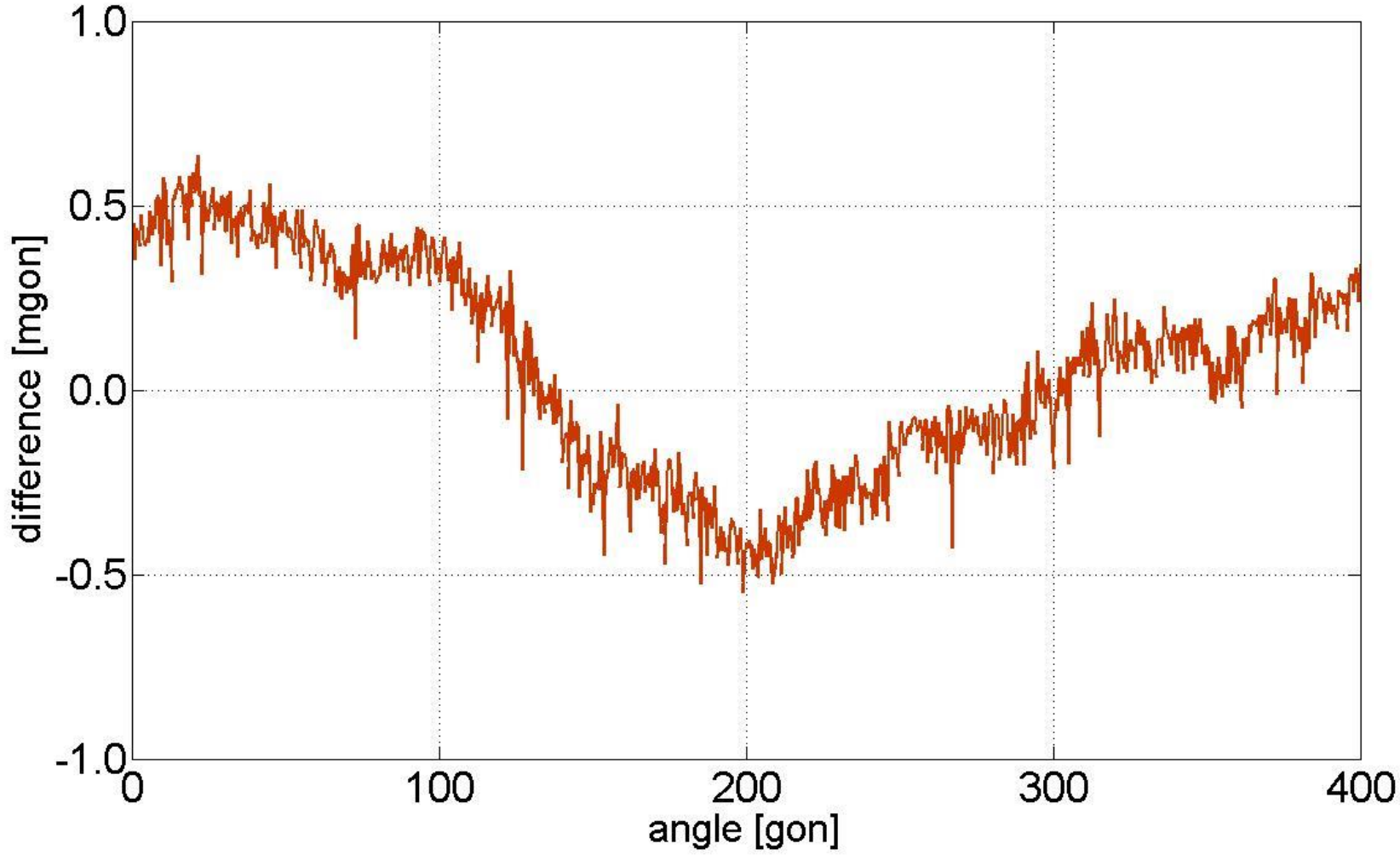
$$\sigma_{4encoder} = \frac{1}{\sqrt{2}}\sigma_{2encoder}$$





海克斯康 HEXAGON

4 rounds 4 arcs precise measurement – Quadruple angle detection in TM/S 30/50



1 Encoder
σ = 0.981“ (0.303mgon)

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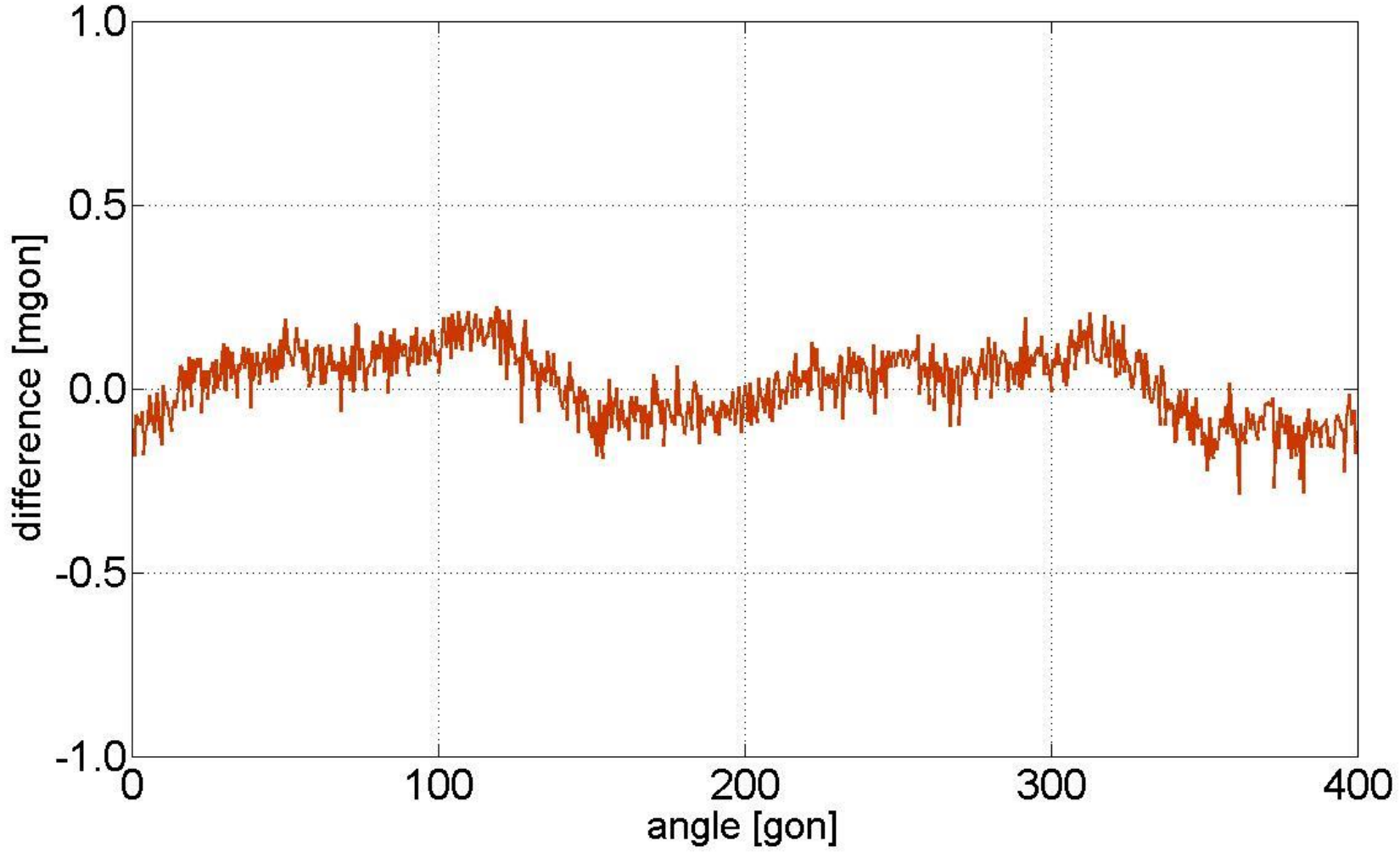
4 rounds 4 arcs precise measurement – Quadruple angle detection in TM/S 30/50



2 Encoder
σ = 0.301“ (0.093mgon)

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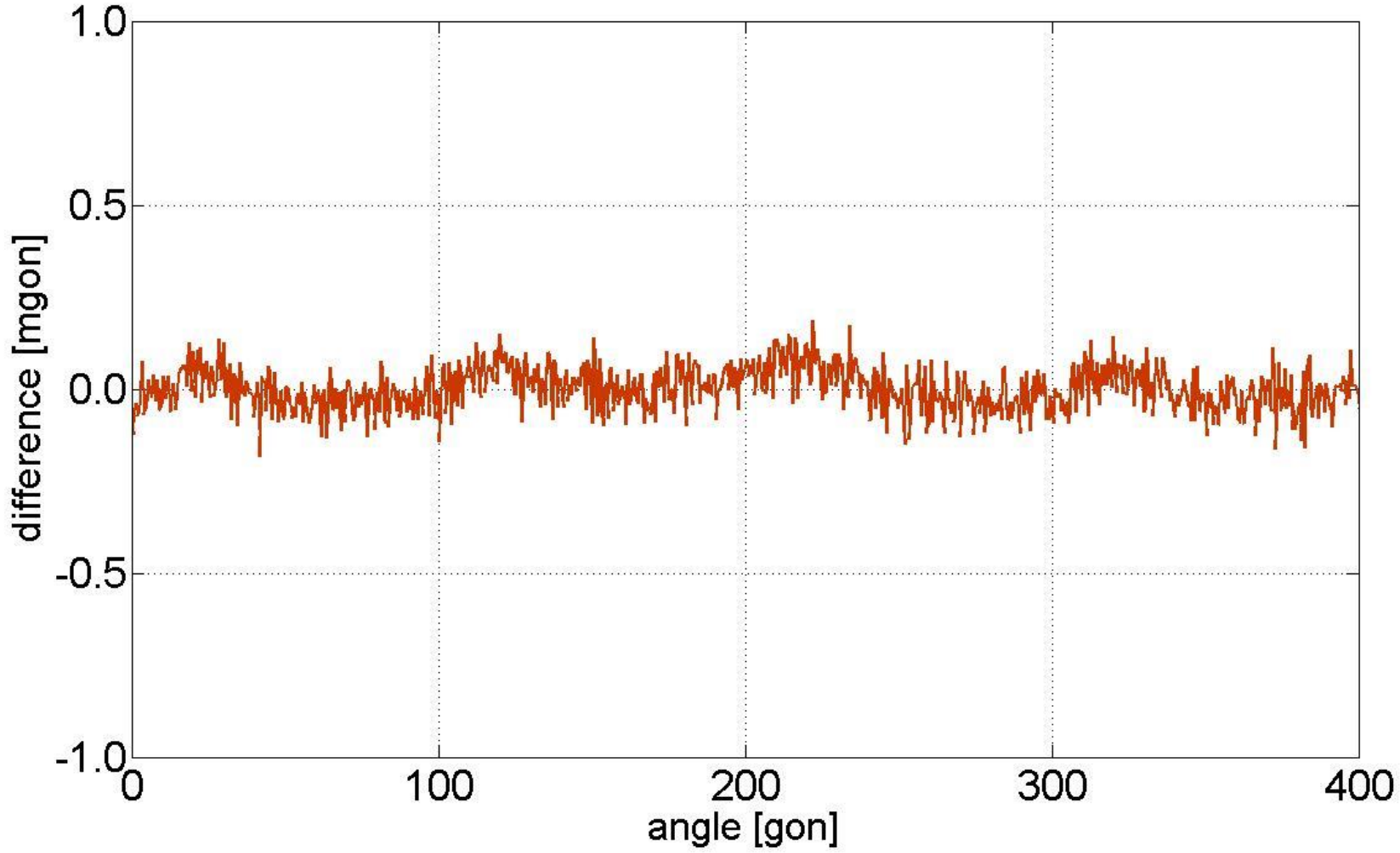
4 rounds 4 arcs precise measurement – Quadruple angle detection in TM/S 30/50



4 Encoder
σ = 0.203“ (0.063mgon)

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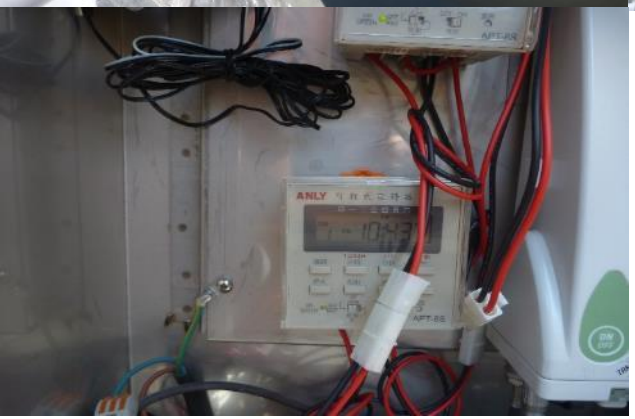
GNSS Reference Station



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Monitoring using Nivel

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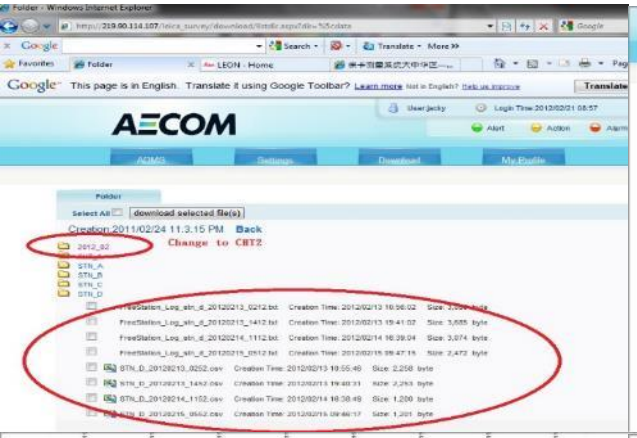
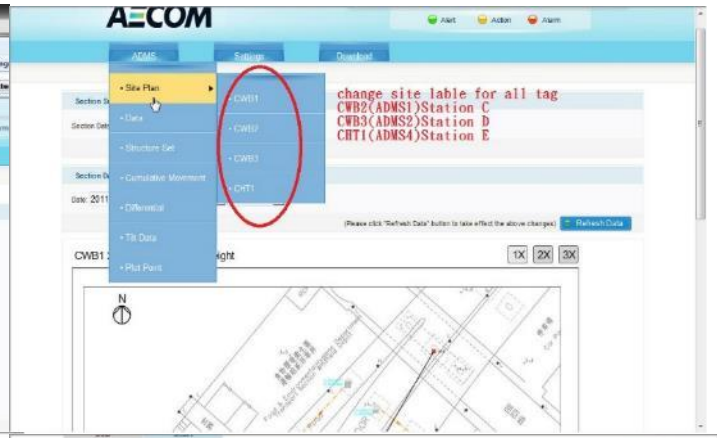
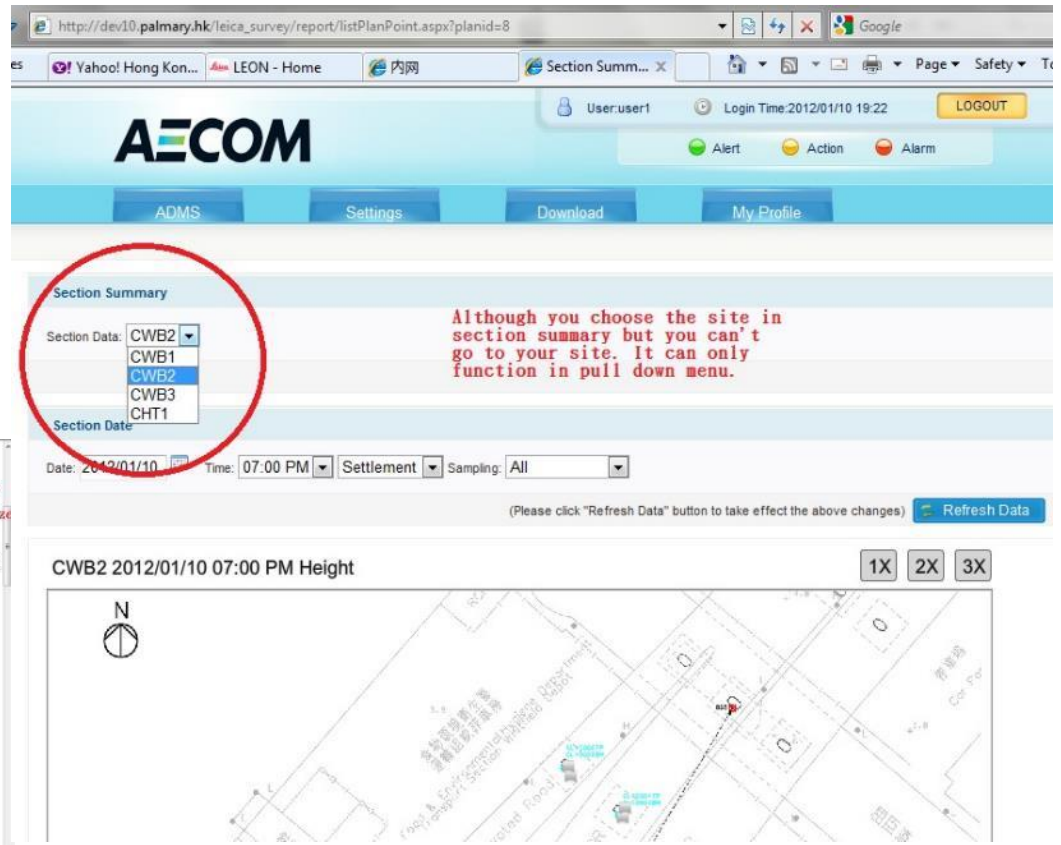
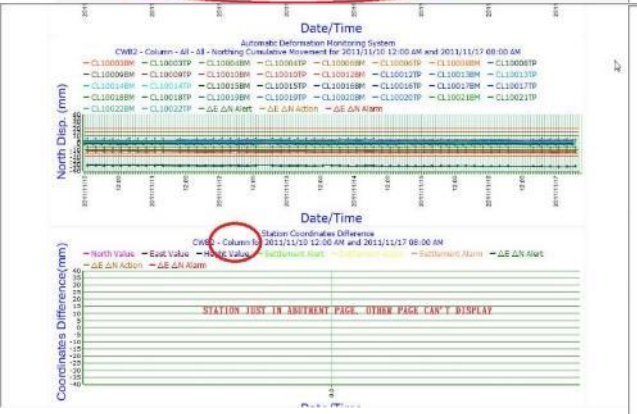
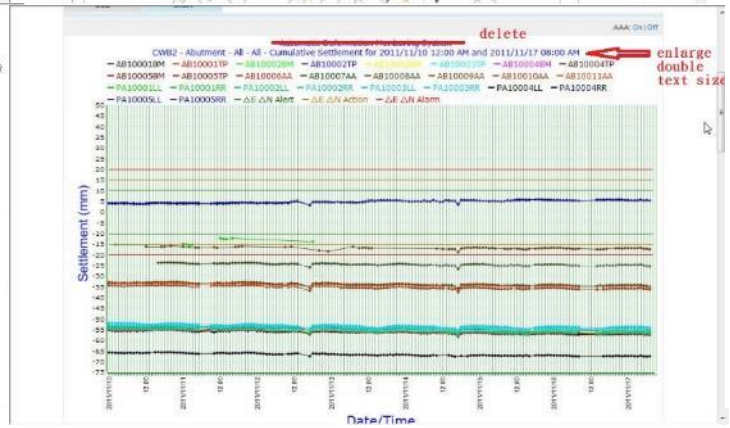
Web Interface











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谢 谢