Presented By:
Trimble Monitoring

Semi-automated Monitoring

Trimble Access Monitoring & T4D Access

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Workshop Goals

Technical understanding on
semi-automated monitoring

Clarification on the
Support process

Semi-automated monitoring

Software solutions

Trimble Access Monitoring (TAM)

TSM & Trimble Connect

T4D Access

TBC Monitoring

Agenda

01 Monitoring Overview

02 Semi-automated monitoring overview

03 Trimble Access Monitoring

04 TA Monitoring Demonstration

05 T4D Access (T4D v6.4)

01

Monitoring Overview

Monitoring with Confidence

Trimble Monitoring

Enabling **automated movement detection with confidence** for surveying and construction professionals supporting informed decisions about infrastructure.

Trimble Monitoring Family

02

Semi-automated Monitoring overview

Monitoring with Confidence

Semi-automated vs. Automated Monitoring

- Multiple visits to site are preferred
- Sensor is not fixed (e.g. tripod)
- Slow and low risk movement
- Small data sets/local storage

- Automated/remote collection and alarming
- Sensors permanently on site (e.g. pillar)
- Time sensitive movement detection
- Large datasets/local or virtual database

Increasing Project Requirements

Considerations for Monitoring System

Setup and Installation

Multiple total stations may be too expensive to have automated systems at each

Duration of the project

How long will the sensors be installed and required to collect data?

Measurement frequency

Situational monitoring i.e., after blasting operations every Wednesday

Project size

Big area vs small area i.e., Hydroelectric dam or small building construction

Survey costs

Accuracy level, labor costs, drive time to site, equipment

Workflow

What software(s) are you using to collect, process, and report on the displacement data?

Applications

Manual/Campaign-based monitoring in action

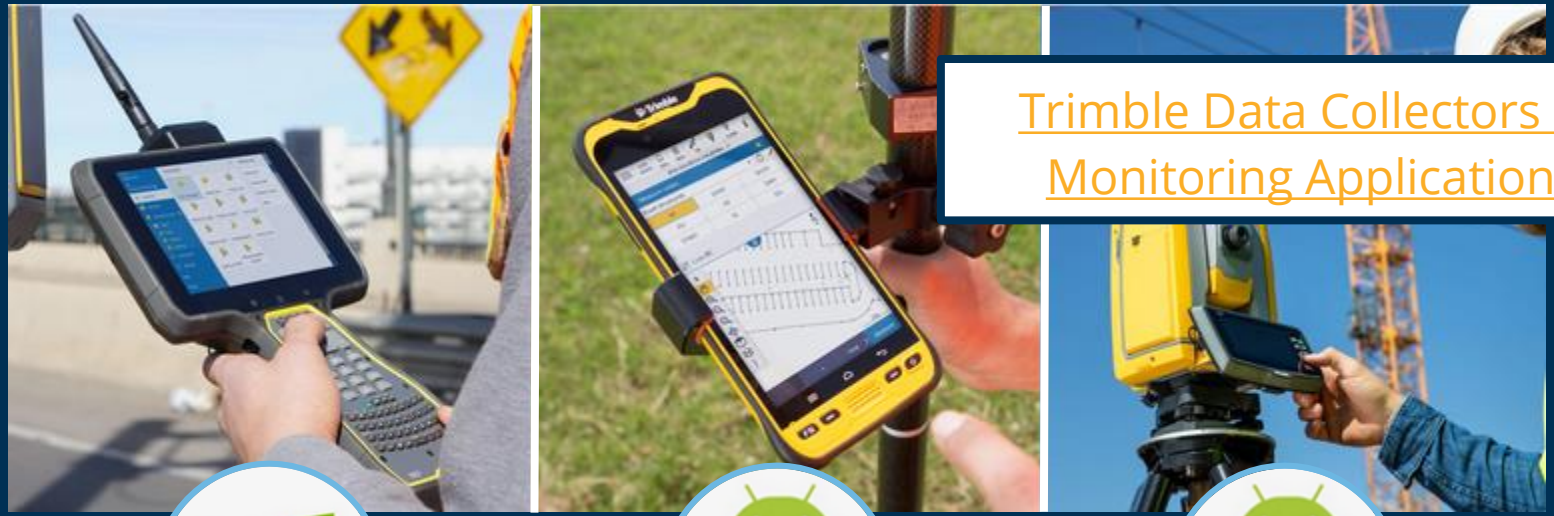
Short term construction ie. pile installation, deep excavations and shoring

Long term subsidence and trends ie. low risk slopes, dam seasonal movement

Network control and verification

Semi-automated Monitoring ecosystem

Find the right Data Controller for you

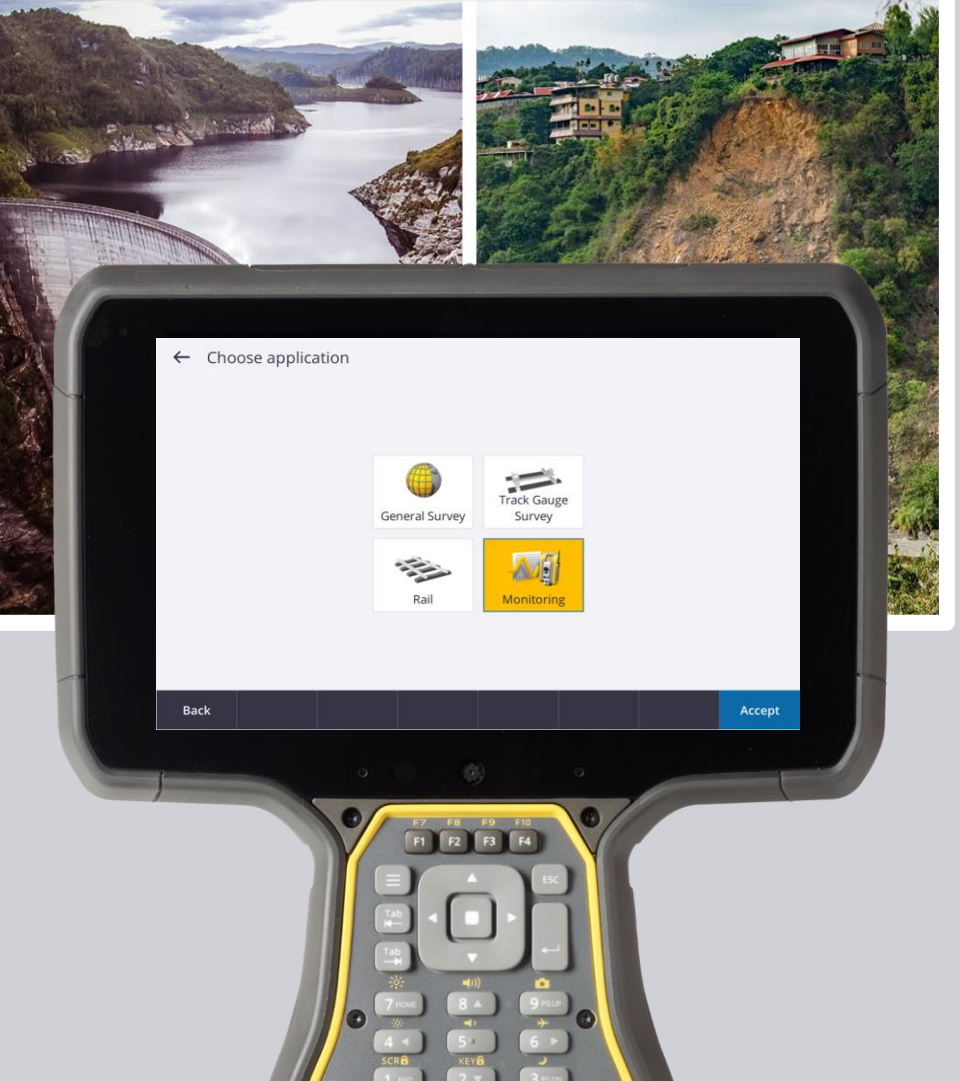


Trimble Data Collectors for Monitoring Applications

03

Trimble Access Monitoring

Monitoring with Confidence



Trimble Access Monitoring

Field software for efficient data collection and monitoring site setup

Automated data collection

Efficiently collect monitoring measurements that are less error prone.

Set up a site for a fully automated system

Define your monitoring network and targets to prepare for a fully automated system with Settop M1 and Trimble 4D Control integration.

Incorporating Scans into monitoring

Monitor large areas faster and without needing to predict movement patterns to set out appropriate targets.

Reporting and analysis

Share in-field reports and integrate with Trimble Business Center or T4D Access for a comprehensive semi-automated package.

General workflow

1. **Define station setup type**
   - Station setup/**station setup plus**/**resection**
2. **Define monitored points**
   - Import, key-in or measure
   - Prism (Autolock, FineLock, Long Range FineLock) or DR
3. **Monitoring and Scheduling**
   - Automate multiple or single epochs
   - Manually aim when necessary
4. **Reporting and Analysis**
   - View displacements and statistics during survey
   - Scatter plots and displacement charts in the field
5. **Data Exchange**
   - TBC Monitoring (.json)
   - Trimble 4D Control (.jxl)
   - Other (.csv/.jxl)

Station setup types

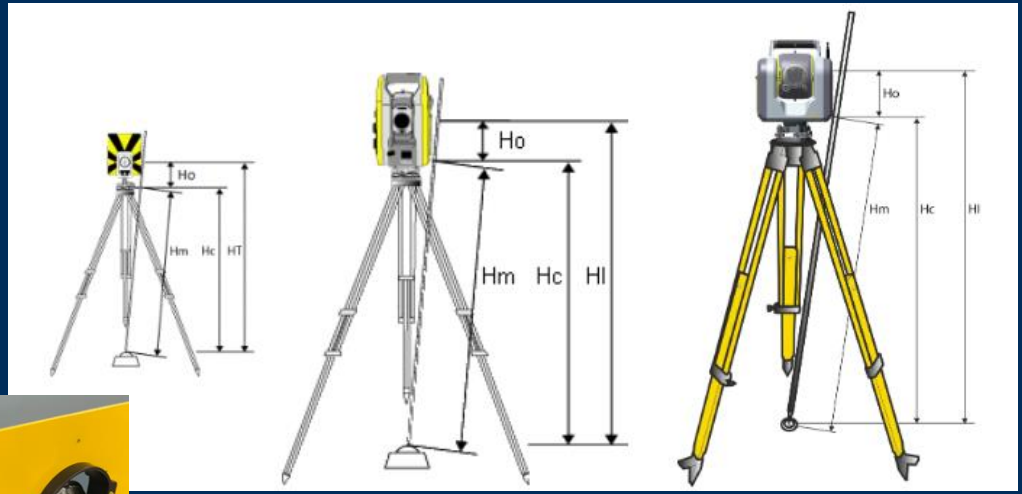
Station setup plus/resection

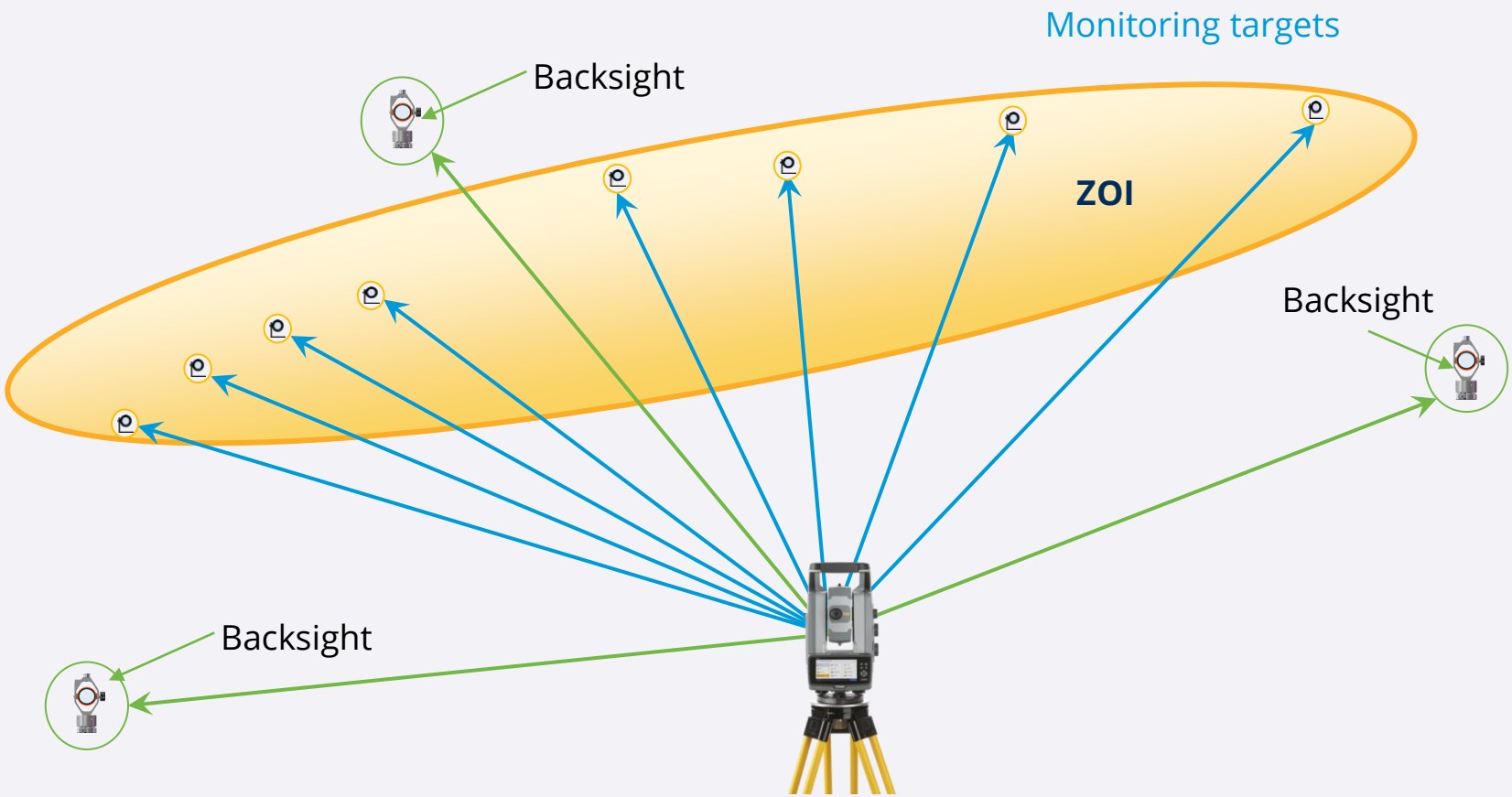
- **Station setup**
  - Station setup - **<u>Station setup plus</u> - <u>Resection</u> -** Use last
- **Site *(from a reference job)***
  - Station from reference job (*.job) → station point and all related points observed from the station are copied into the job
  - Edit reference → Station setup type and instrument height
- **Orientation**
  - Reorient to the backsight when the existing job is reopened
  - Or in new job when Station from reference job

- It is encouraged to use the same **Job** for the next measurements (additional monitoring epochs)

Instrument and prism heights

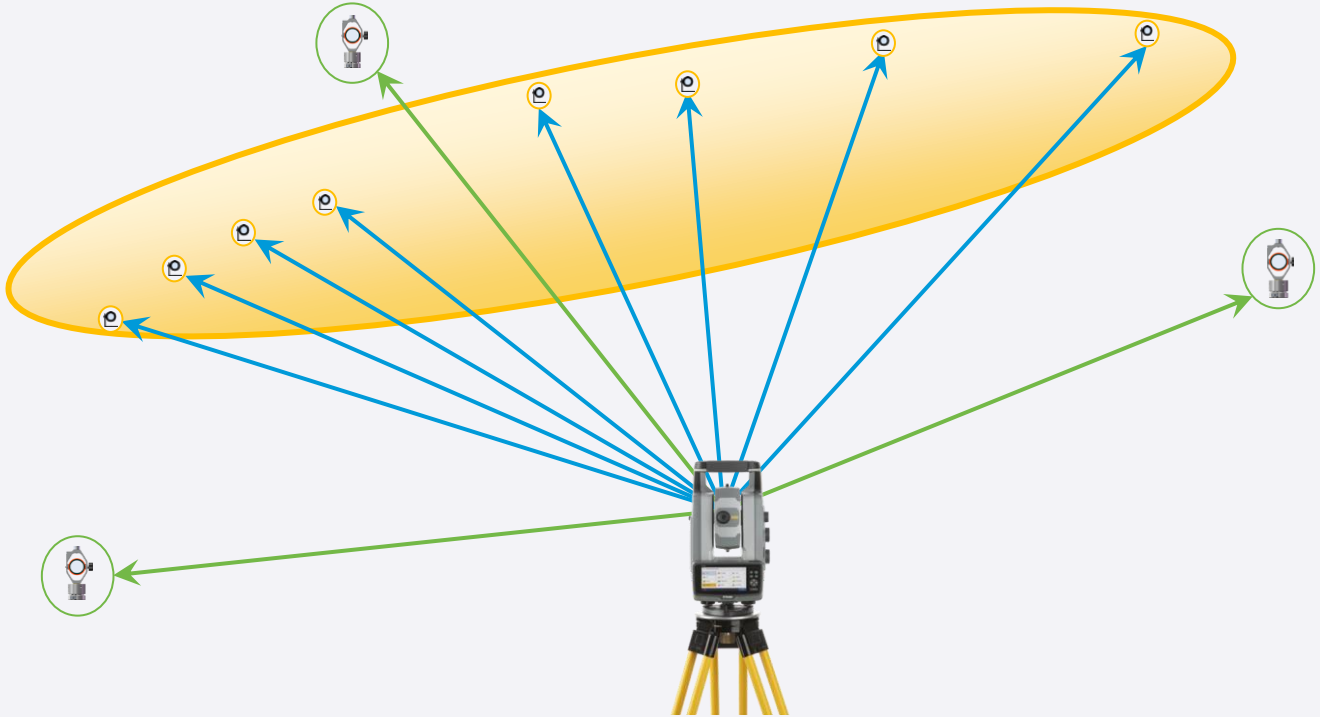
- Consistent with the method available in Trimble Access General Survey
- Target height → true height or S/SX notch
- Instrument height → true height or bottom notch S series/SX Series




Monitoring targets
Backsight
ZOI
Backsight
Backsight

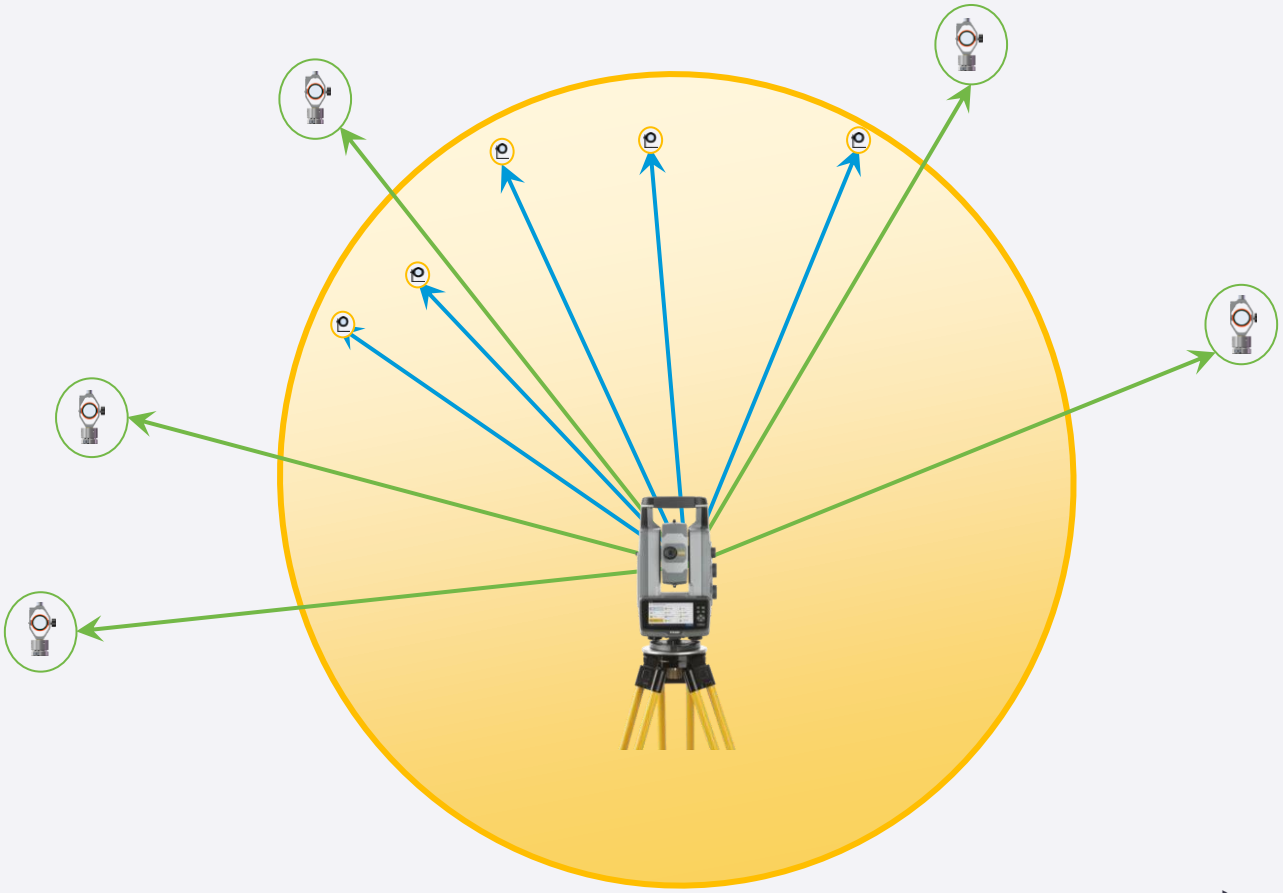
Good setup

- At least three backsights
- Backsights surround the monitoring area
- Backsights are at similar locations to monitoring targets



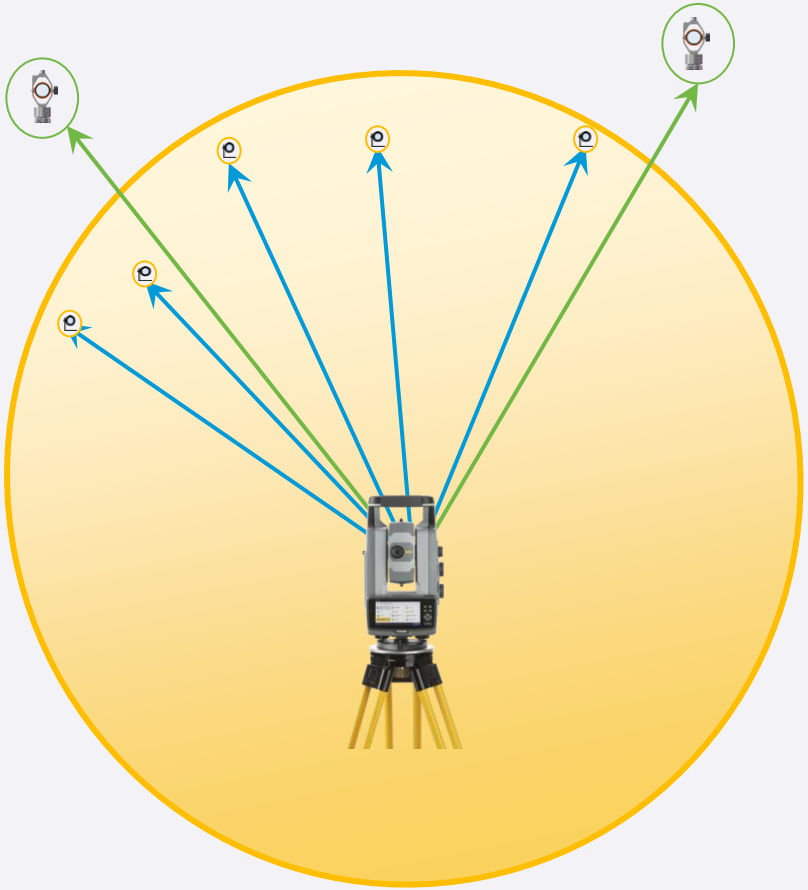
Good setup

- At least four backsights with the TS in the ZoI
- Backsights surround the monitoring area
- Backsights are at similar locations to monitoring targets



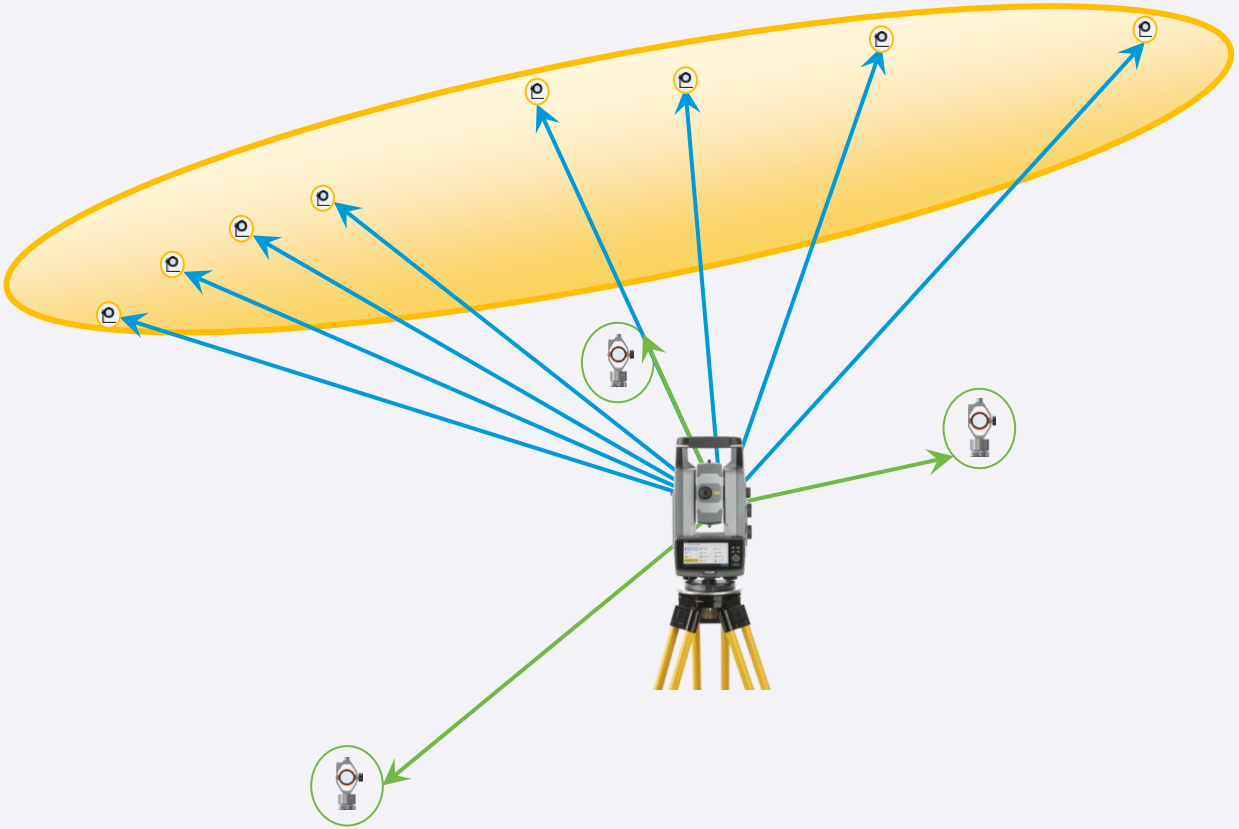
Bad setup

- ***Less than four*** backsights with the TS in the ZoI
- Backsights surround the monitoring area
- Backsights are at similar locations to monitoring targets



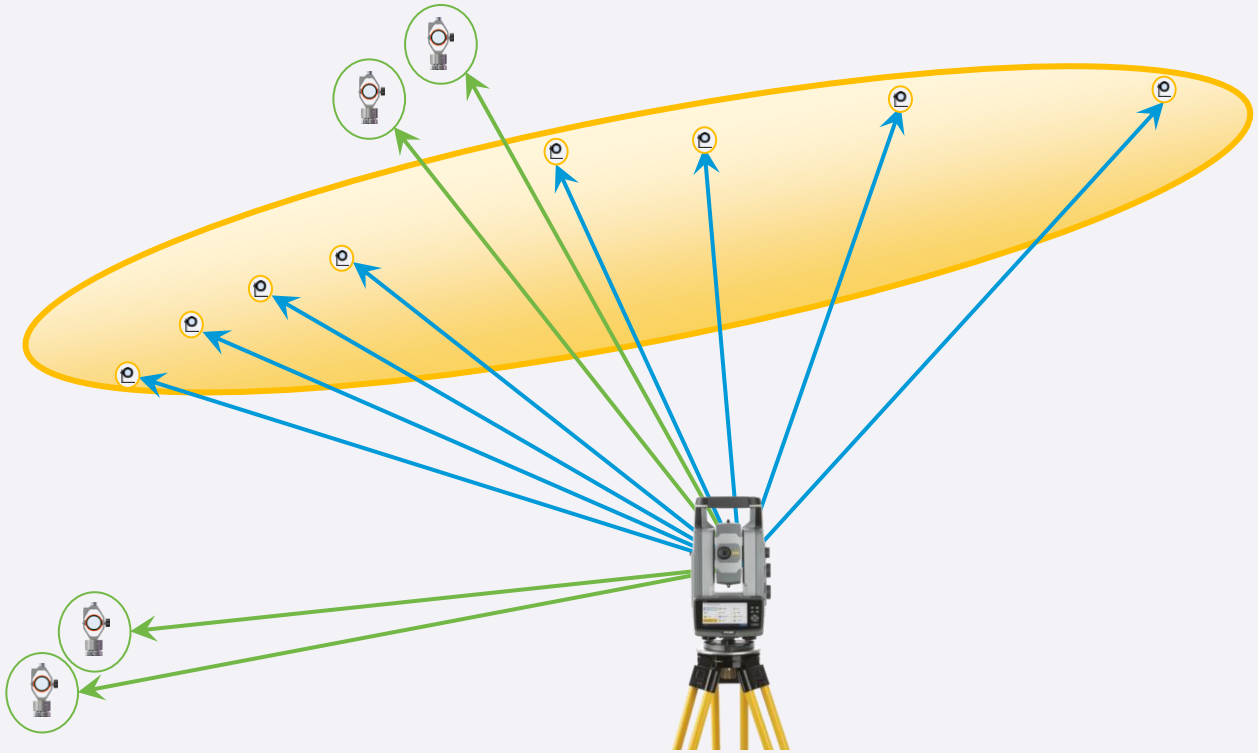
Bad setup

- At least three backsights
- Backsights ***does not*** surround the monitoring area
- Backsights ***are not*** at similar locations or distances to monitoring targets



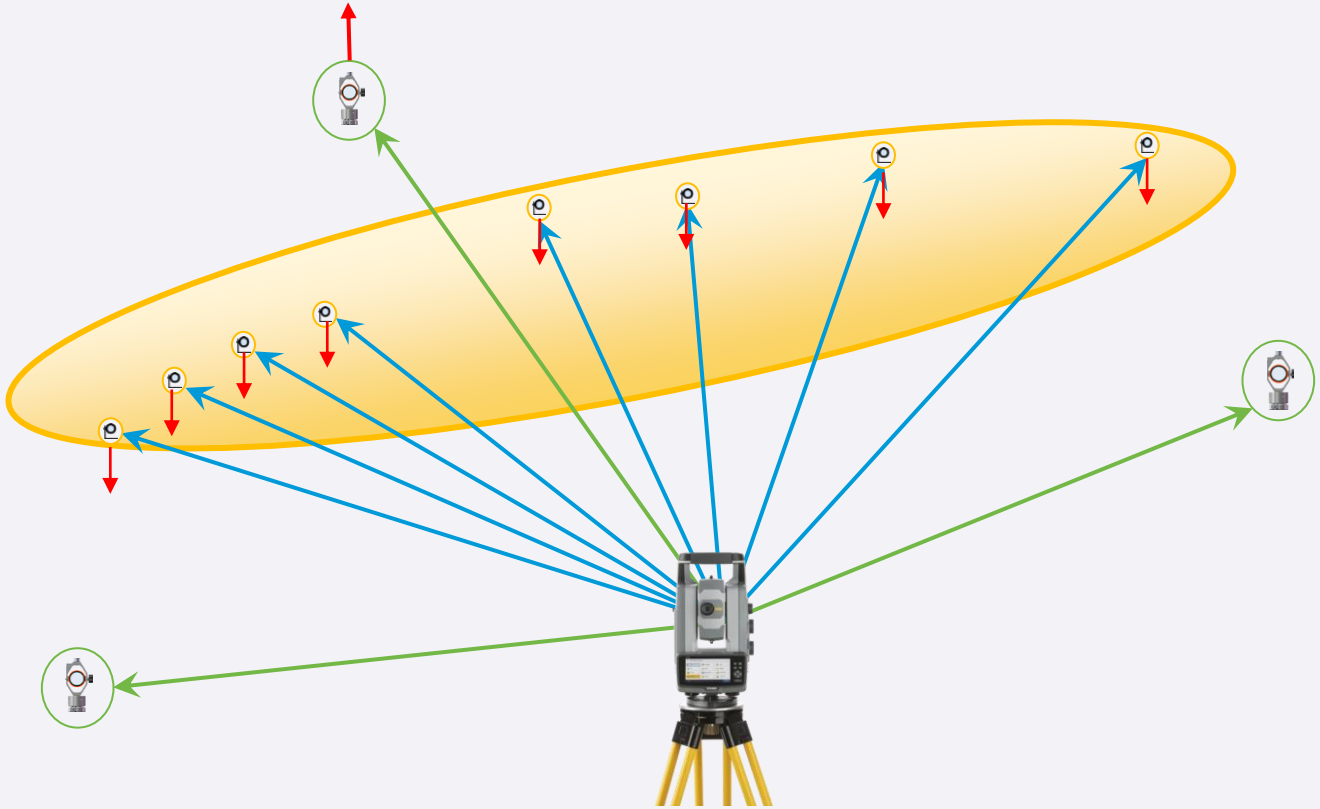
Bad setup

- Adding ***multiple backsights in similar locations*** does not improve results.



Bad setup

- Backsight moved



Best practices

Monitoring with confidence

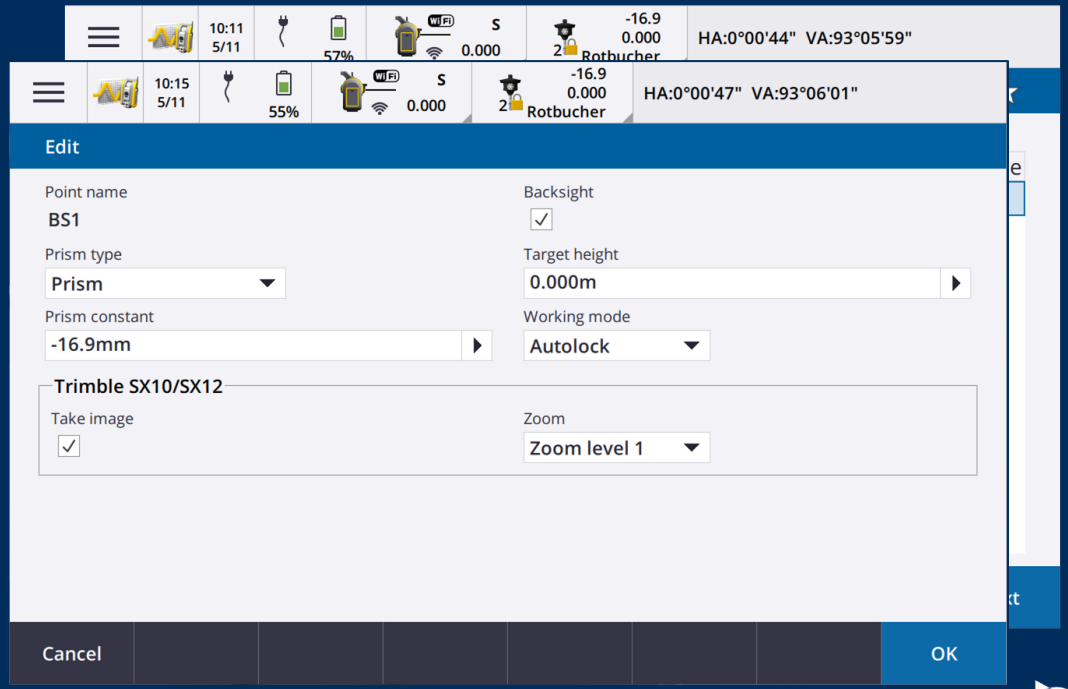
- Determine the **zone of influence** and **position backsights accordingly**
- It's easy to add more prisms and better to have **extra backsights**
- Ensure **reliable line-of-sight** to the backsights. Changes in survey geometry can have an effect on results (reason why we have displacements reported on backsights)
- **Reliable and stable mounts for prisms** and total stations (any unwanted movement will skew the results)
- Monitoring with a total station follows the same principles as surveying! **Use good survey principles and techniques and the monitoring project will be successful.**

Invest time in planning now to save problems down the road. Two hours today can save days of effort later on.

Monitoring points

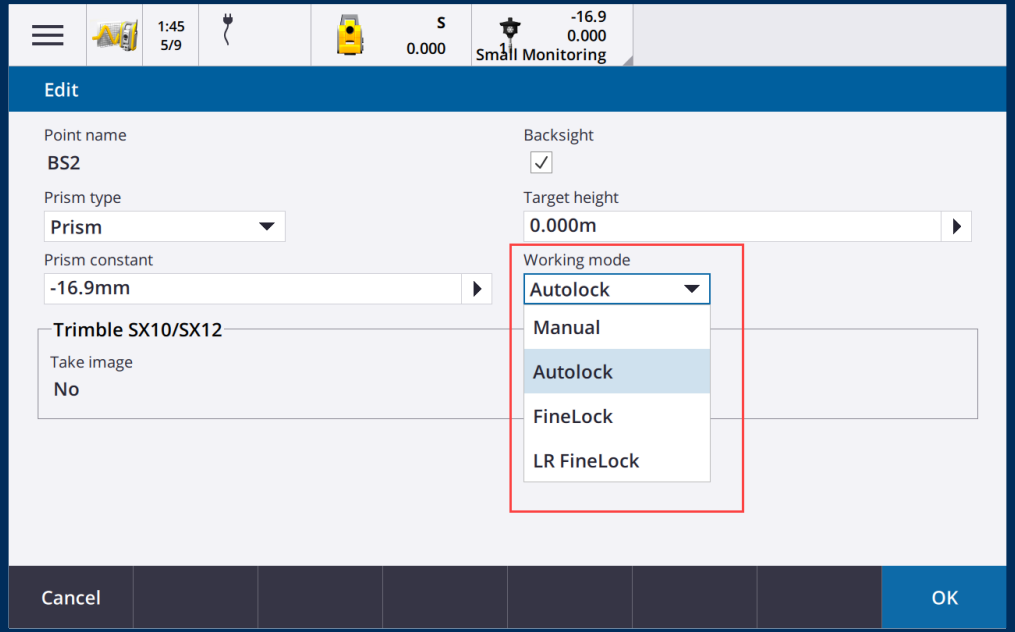
Import, key-in or measure

- **Monitoring (foresight) points**
  - Import from the reference job
  - Key in
  - Measure
  - Import from *Point list *.csv file*
    - After the attributes are defined in the options, point list can be exported
    - This can then be used for the next monitoring session if desired



Working mode

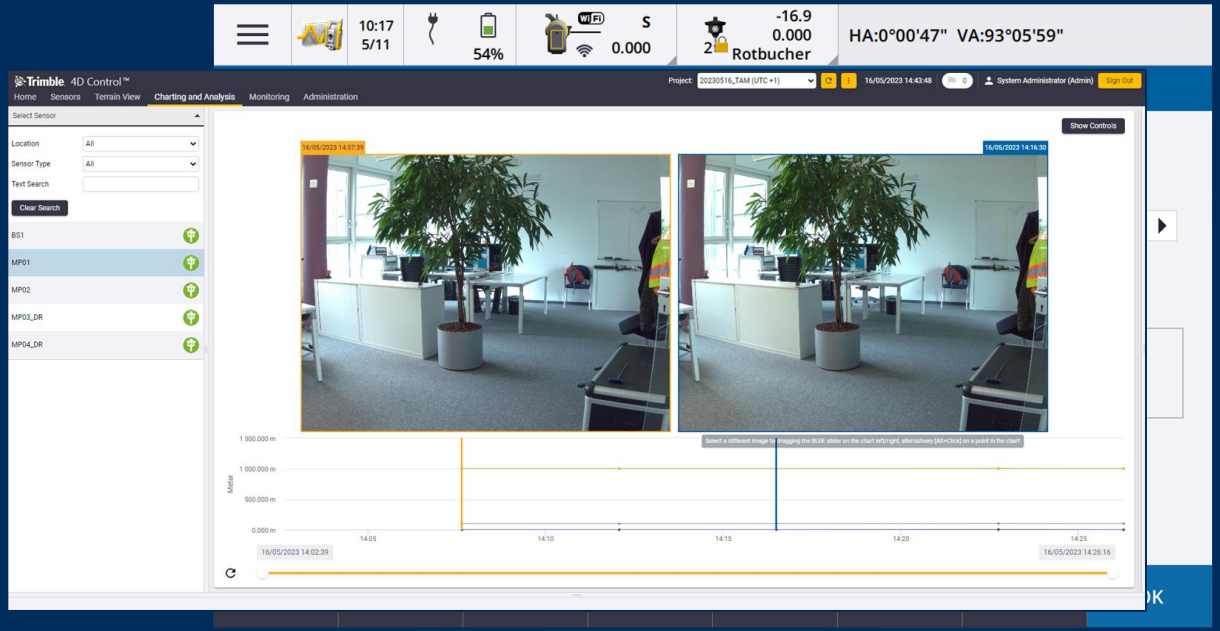
- **Manual**
  - For manual measurements such as reflector targets or DR measurements
- **Autolock**
  - Automatic prism lock for standard conditions
- **FineLock**
  - Narrower autolock field of view in areas with congested prism setup such as tunnel convergence and rail track monitoring
- **Long range (LR) FineLock**
  - Automatic prism lock at distances over 700 m such as open pit mines and dam monitoring



Images

Take image option

- When SX-instrument is being used, it is possible to take images during monitoring rounds
- These are exported as part of **Export Rounds** workflow and stored in the project folder
- Used in T4D Web for the **Visual inspection**

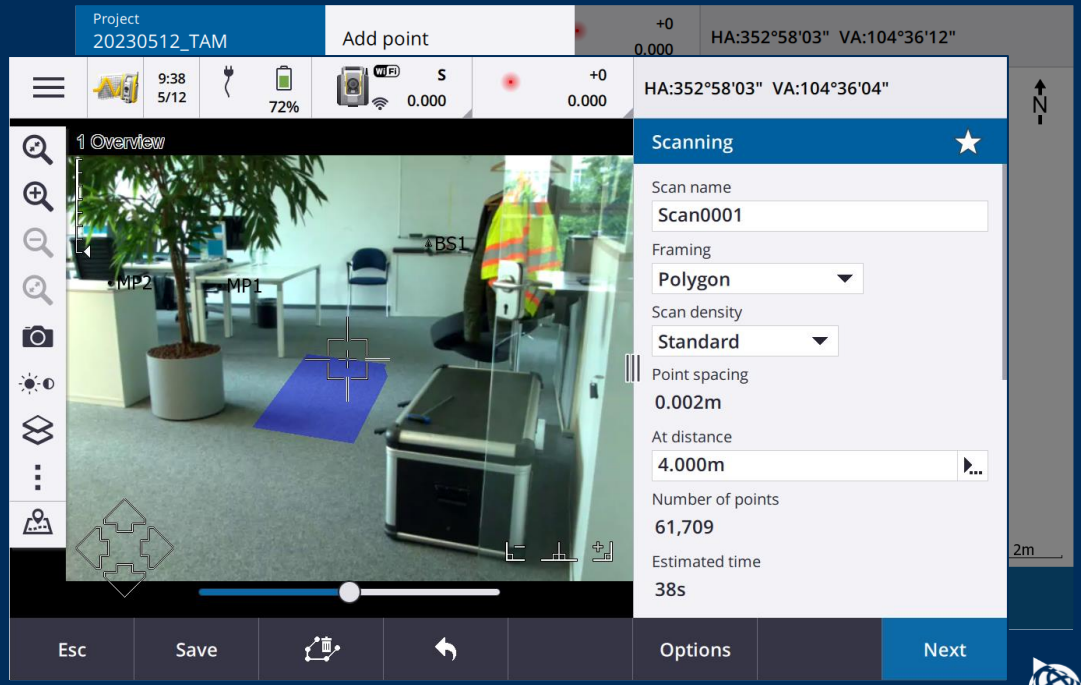


Scans

Adding scans

- Monitoring a large spatial area faster and without needing to set out targets (e.g. not possible to install)
- After the initial scan is performed, selected scan can be added into the monitoring round (after Point list definition)

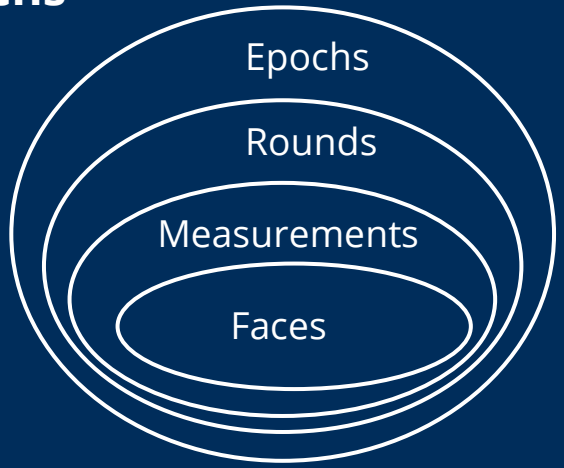
****Horizontal band and Half dome scan types are not fully supported by this version*

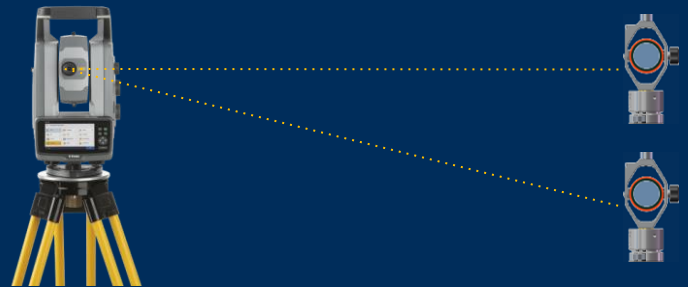


Monitoring and Scheduling

Automate multiple or measure single epochs

- Epoch is used to define how many monitoring rounds will be collected automatically
- 1 to 10 or perpetual
- **Epoch** is made of **rounds**
  ...which are made of **measurements**
    - F1/F2 (123...321 or 321...123)
    - F1...F2
    - F1 only → not recommended for T4D





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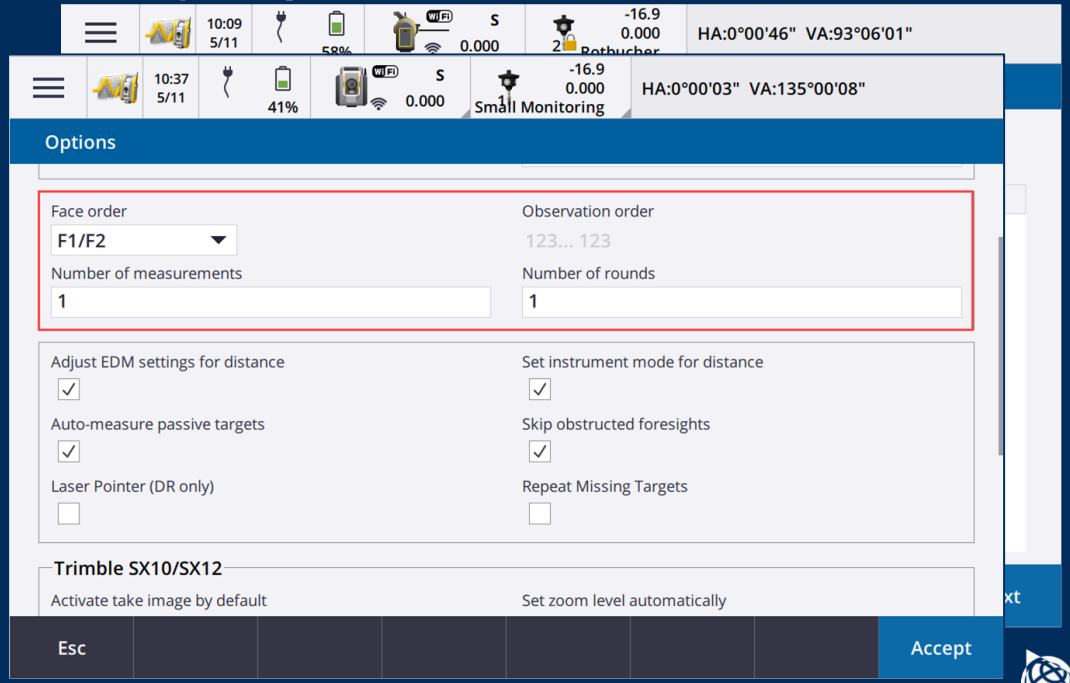
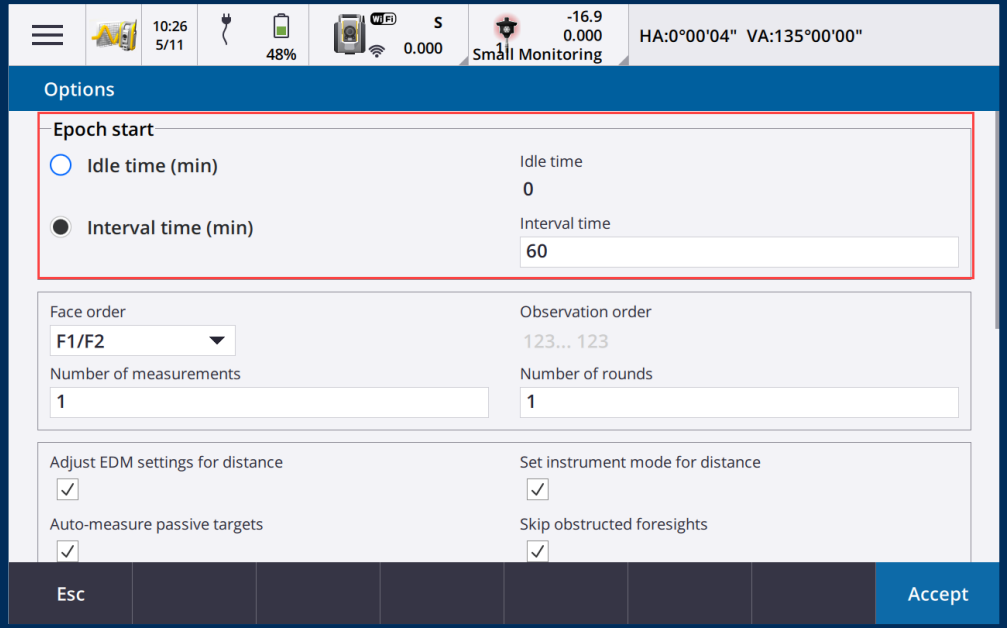


Options

Measuring time

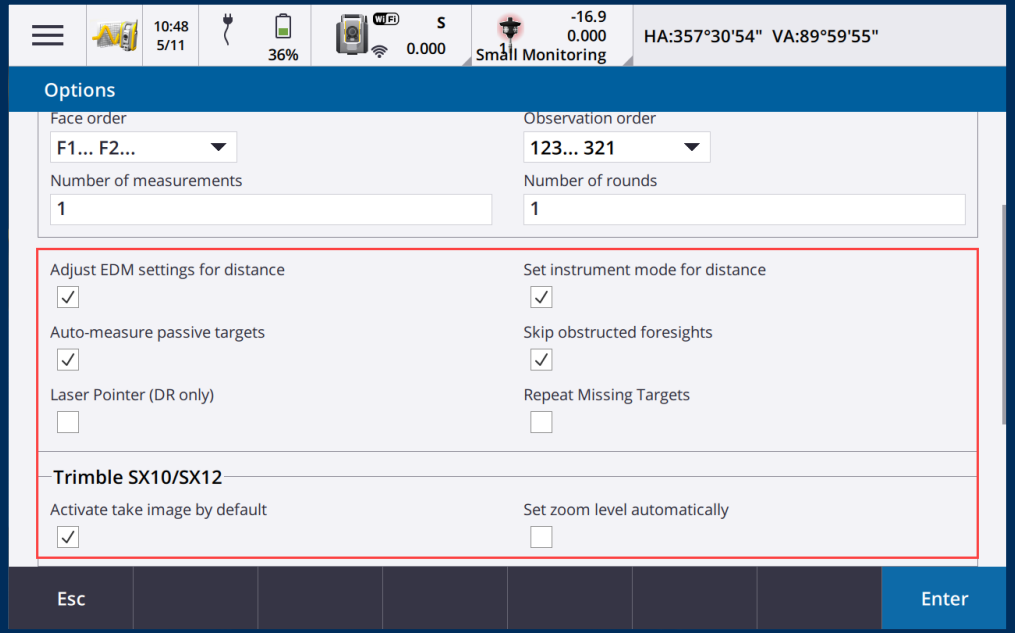
- **Idle time**
  - How long the instrument waits between epochs
    e.g. idle time=60 min; it takes 5 min for epoch to finish, 60 min after the epoch finished, the new one will start (total time 65 min)

- **Interval time**
  - Total duration of one epoch
    e.g. interval time=60 min; it takes 5 min for epoch to finish; after 55 min the next epoch will start (total time 60 min)



Options

- **Adjust EDM settings for distance** → automatically adjust the EDM setting depending on the measured distance and instrument capabilities
- **Auto-measure passive targets** → this forces the total station to automatically measure the DR targets
- **Laser pointer** → enables the laser pointer to be turned on during epoch measurement
- **Set instrument mode for distance** → automatically changes to the working best mode based on the measured distance - *Long range vs. speed*
- **Skip obstructed foresights** → foresights are automatically skipped, if measurement is not possible, such as when the prism is obstructed
- **Activate take image by default** → SX-instrument takes images of the targets no matter how it is individually defined when creating the monitoring points

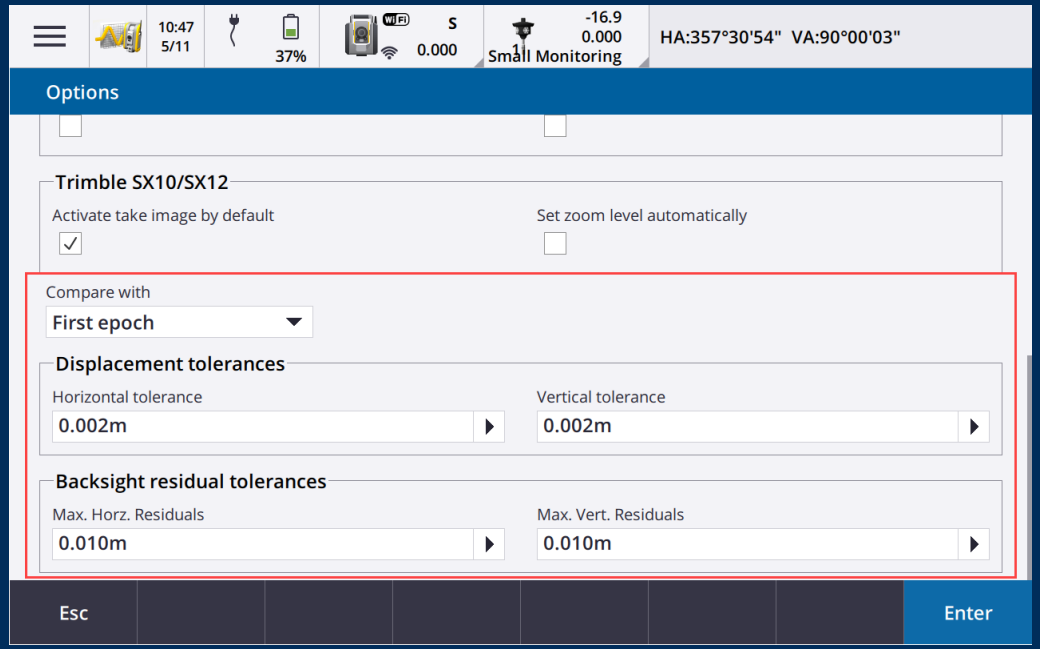


Options

Live infield results settings

- **Compare with** → how the displacements are calculated
  - First epoch
  - Previous epoch
  - First and previous epoch

- **Displacements and backsight residual tolerances**
  - can be set to trigger warnings while performing the monitoring

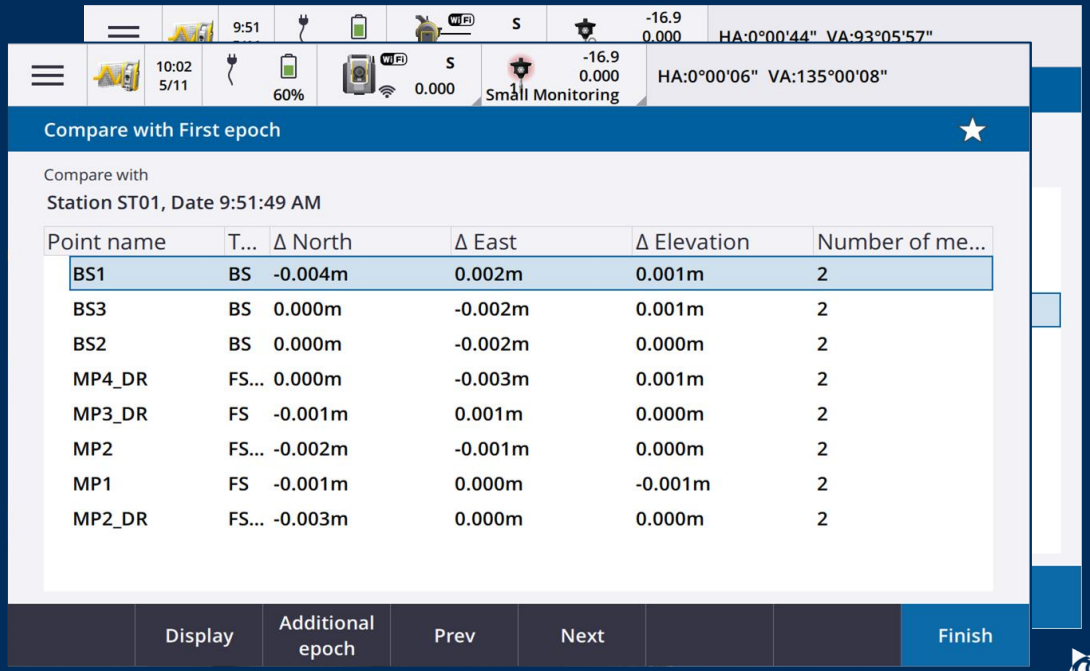


Reporting and Analysis

… during survey

- Live deltas while measuring
  - Displacements in horizontal distance
  - Elevation difference

- After all epochs are measured comparison with the first epoch is displayed
  - ΔE, ΔN, Δel



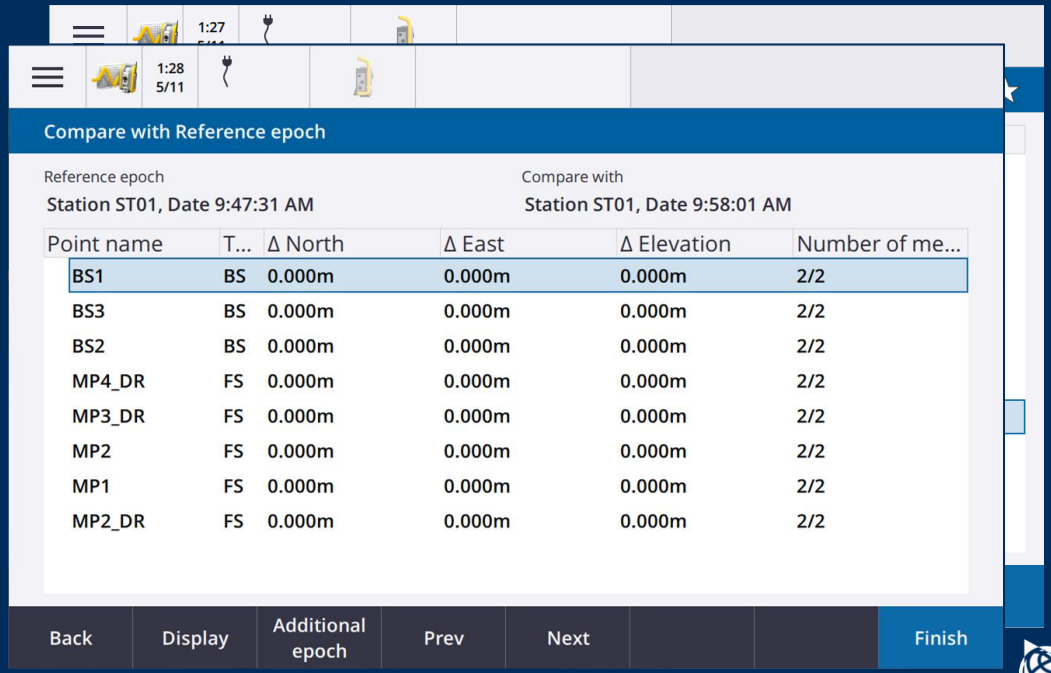
Reporting and Analysis

… after the survey has been completed

- Reports → Displacements

  → Compare desired epochs straight after all the epochs are measured
  → Add additional epoch

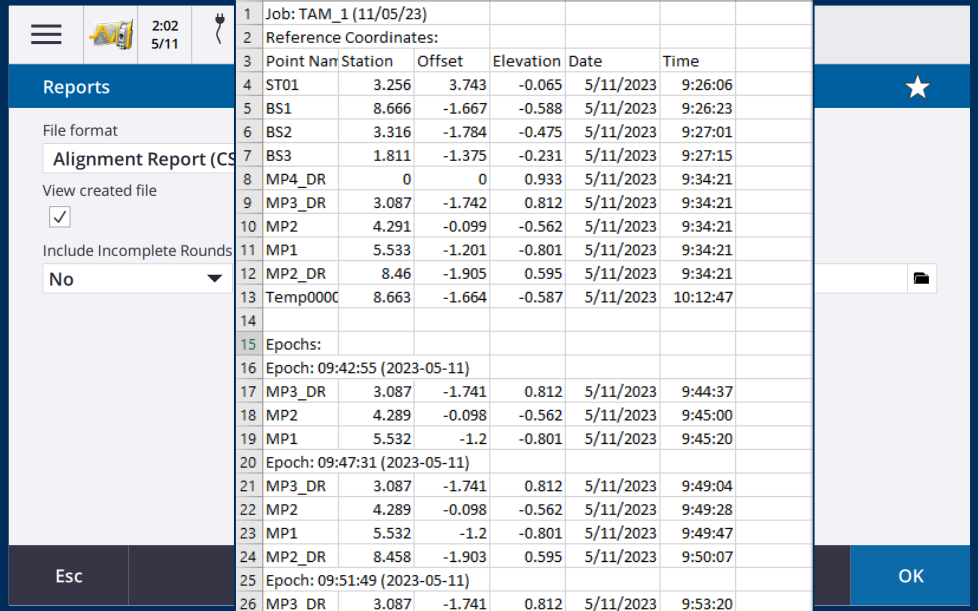
- Change between displayed results



Reporting and Analysis

… after the survey has been completed

- **Alignment report (CSV)**
  - RXL, Polyline, TXL, LandXML
- **RXL**
  - Trimble Access Roads alignment file type
  - contains a horizontal and vertical component (can also include superelevation and widening records, and additional points and strings that define geometry elements)
- **TXL**
  - Trimble Access Tunnels file type
  - contains a horizontal and vertical alignment along with templates that define the shape of the tunnel
- **Polyline**
  - continuous line composed of one or more line segments
- **LandXML**
  - file format for civil engineering design data



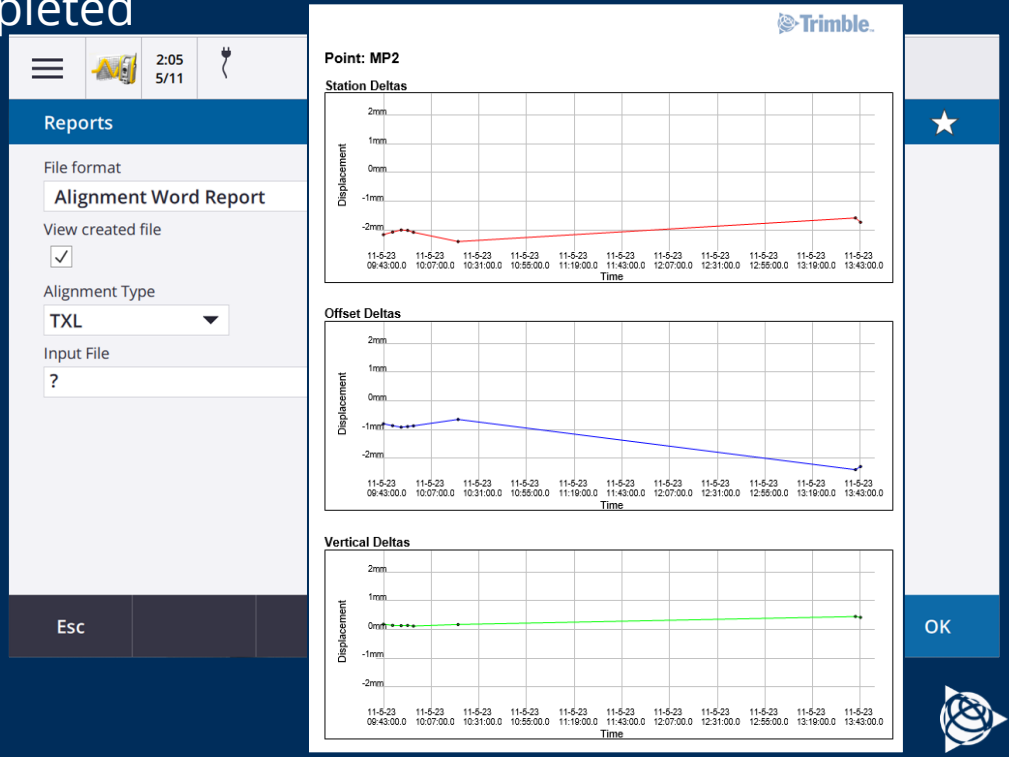
I15

	A	B	C	D	E	F	G
1	Job: TAM_1 (11/05/23)						
2	Reference Coordinates:						
3	Point Nan	Station	Offset	Elevation	Date	Time	
4	ST01	3.256	3.743	-0.065	5/11/2023	9:26:06	
5	BS1	8.666	-1.667	-0.588	5/11/2023	9:26:23	
6	BS2	3.316	-1.784	-0.475	5/11/2023	9:27:01	
7	BS3	1.811	-1.375	-0.231	5/11/2023	9:27:15	
8	MP4_DR	0	0	0.933	5/11/2023	9:34:21	
9	MP3_DR	3.087	-1.742	0.812	5/11/2023	9:34:21	
10	MP2	4.291	-0.099	-0.562	5/11/2023	9:34:21	
11	MP1	5.533	-1.201	-0.801	5/11/2023	9:34:21	
12	MP2_DR	8.46	-1.905	0.595	5/11/2023	9:34:21	
13	Temp0000	8.663	-1.664	-0.587	5/11/2023	10:12:47	
14							
15	Epochs:						
16	Epoch: 09:42:55 (2023-05-11)						
17	MP3_DR	3.087	-1.741	0.812	5/11/2023	9:44:37	
18	MP2	4.289	-0.098	-0.562	5/11/2023	9:45:00	
19	MP1	5.532	-1.2	-0.801	5/11/2023	9:45:20	
20	Epoch: 09:47:31 (2023-05-11)						
21	MP3_DR	3.087	-1.741	0.812	5/11/2023	9:49:04	
22	MP2	4.289	-0.098	-0.562	5/11/2023	9:49:28	
23	MP1	5.532	-1.2	-0.801	5/11/2023	9:49:47	
24	MP2_DR	8.458	-1.903	0.595	5/11/2023	9:50:07	
25	Epoch: 09:51:49 (2023-05-11)						
26	MP3_DR	3.087	-1.741	0.812	5/11/2023	9:53:20	
27	MP2	4.289	-0.098	-0.562	5/11/2023	9:53:43	
28	MP1	5.532	-1.2	-0.801	5/11/2023	9:54:02	
29	MP2_DR	8.458	-1.903	0.595	5/11/2023	9:54:22	

Reporting and Analysis

... after the survey has been completed

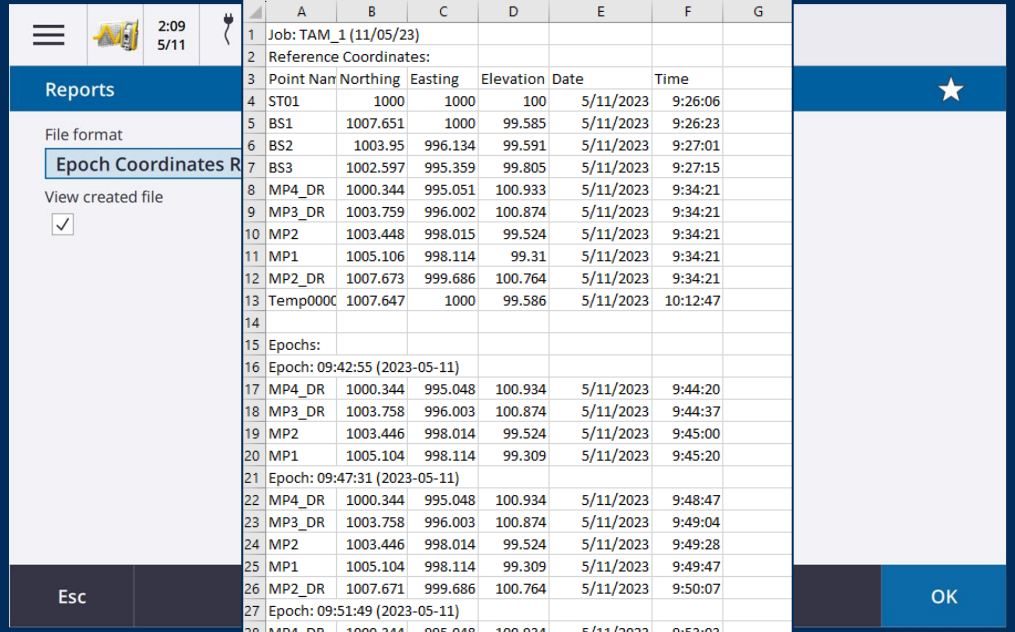
- **Alignment Word Report**
  - RXL, Polyline, TXL, LandXML
  - Containing
    - point scatter plots
    - trend graphs
    - both



Reporting and Analysis

… after the survey has been completed

- **Epoch coordinate report**
  - Containing
    - Coordinates of the reference measurement and measured epochs



H8

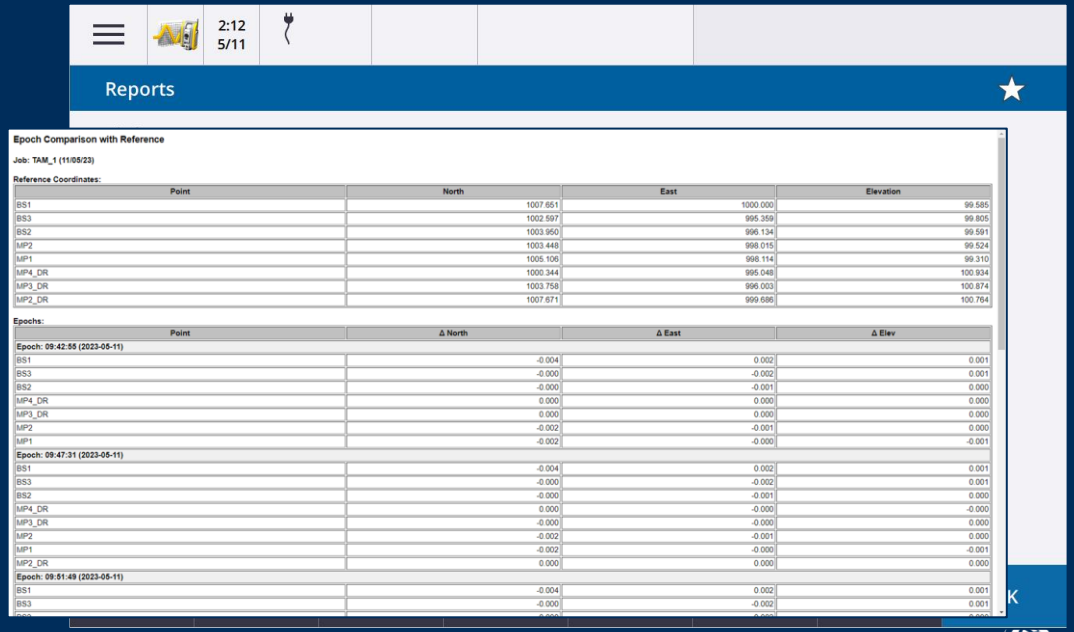
	A	B	C	D	E	F	G
1	Job: TAM_1 (11/05/23)						
2	Reference Coordinates:						
3	Point Nan	Northing	Easting	Elevation	Date	Time	
4	ST01	1000	1000	100	5/11/2023	9:26:06	
5	BS1	1007.651	1000	99.585	5/11/2023	9:26:23	
6	BS2	1003.95	996.134	99.591	5/11/2023	9:27:01	
7	BS3	1002.597	995.359	99.805	5/11/2023	9:27:15	
8	MP4_DR	1000.344	995.051	100.933	5/11/2023	9:34:21	
9	MP3_DR	1003.759	996.002	100.874	5/11/2023	9:34:21	
10	MP2	1003.448	998.015	99.524	5/11/2023	9:34:21	
11	MP1	1005.106	998.114	99.31	5/11/2023	9:34:21	
12	MP2_DR	1007.673	999.686	100.764	5/11/2023	9:34:21	
13	Temp0000	1007.647	1000	99.586	5/11/2023	10:12:47	
14							
15	Epochs:						
16	Epoch: 09:42:55 (2023-05-11)						
17	MP4_DR	1000.344	995.048	100.934	5/11/2023	9:44:20	
18	MP3_DR	1003.758	996.003	100.874	5/11/2023	9:44:37	
19	MP2	1003.446	998.014	99.524	5/11/2023	9:45:00	
20	MP1	1005.104	998.114	99.309	5/11/2023	9:45:20	
21	Epoch: 09:47:31 (2023-05-11)						
22	MP4_DR	1000.344	995.048	100.934	5/11/2023	9:48:47	
23	MP3_DR	1003.758	996.003	100.874	5/11/2023	9:49:04	
24	MP2	1003.446	998.014	99.524	5/11/2023	9:49:28	
25	MP1	1005.104	998.114	99.309	5/11/2023	9:49:47	
26	MP2_DR	1007.671	999.686	100.764	5/11/2023	9:50:07	
27	Epoch: 09:51:49 (2023-05-11)						
28	MP4_DR	1000.344	995.048	100.934	5/11/2023	9:53:03	
29	MP3_DR	1003.758	996.003	100.874	5/11/2023	9:53:20	
30	MP2	1003.446	998.014	99.524	5/11/2023	9:53:43	
31	MP1	1005.105	998.114	99.309	5/11/2023	9:54:02	
32	MP2_DR	1007.67	999.686	100.764	5/11/2023	9:54:22	

Reporting and Analysis

… after the survey has been completed

- **Epoch Reference Compare Report (Coordinates)**
  - HTML report showing reference coordinates and coordinates of the monitoring points
  - *.html file is saved in the folder (*previous file gets overwritten*)

- **Epoch Reference Compare Report**
  - HTML report showing reference coordinates and displacement information
  - *.html file is saved in the folder (*previous file gets overwritten*)



Epoch Comparison with Reference

Job: TAM_1 (11/05/23)

Reference Coordinates:

Point	North	East	Elevation
BS1	1007.651	1000.000	99.585
BS3	1002.597	995.359	99.805
BS2	1003.950	996.134	99.591
MP2	1003.448	998.015	99.524
MP1	1005.106	998.114	99.310
MP4_DR	1000.344	995.048	100.934
MP3_DR	1003.758	996.003	100.874
MP2_DR	1007.671	999.686	100.764

Epochs:

Point	Δ North	Δ East	Δ Elev
Epoch: 09:42:55 (2023-05-11)			
BS1	-0.004	0.002	0.001
BS3	-0.000	-0.002	0.001
BS2	-0.000	-0.001	0.000
MP4_DR	0.000	0.000	0.000
MP3_DR	0.000	0.000	0.000
MP2	-0.002	-0.001	0.000
MP1	-0.002	-0.000	-0.001
Epoch: 09:47:31 (2023-05-11)			
BS1	-0.004	0.002	0.001
BS3	-0.000	-0.002	0.001
BS2	-0.000	-0.001	0.000
MP4_DR	0.000	-0.000	-0.000
MP3_DR	-0.000	-0.000	0.000
MP2	-0.002	-0.001	0.000
MP1	-0.002	-0.000	-0.001
MP2_DR	0.000	0.000	0.000
Epoch: 09:51:49 (2023-05-11)			
BS1	-0.004	0.002	0.001
BS3	-0.000	-0.002	0.001

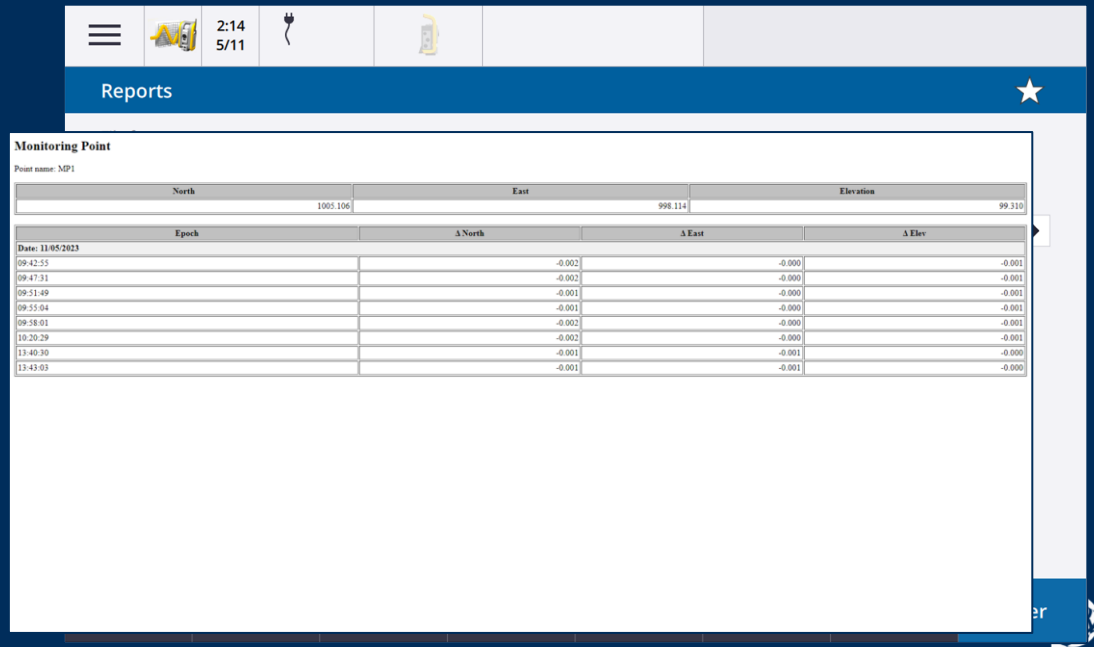
Reporting and Analysis

… after the survey has been completed

- **Point report**

  - displacement information for a single monitoring point

  - *.html file is saved in the folder (*previous file gets overwritten*)



Monitoring Point

Point name: MP1

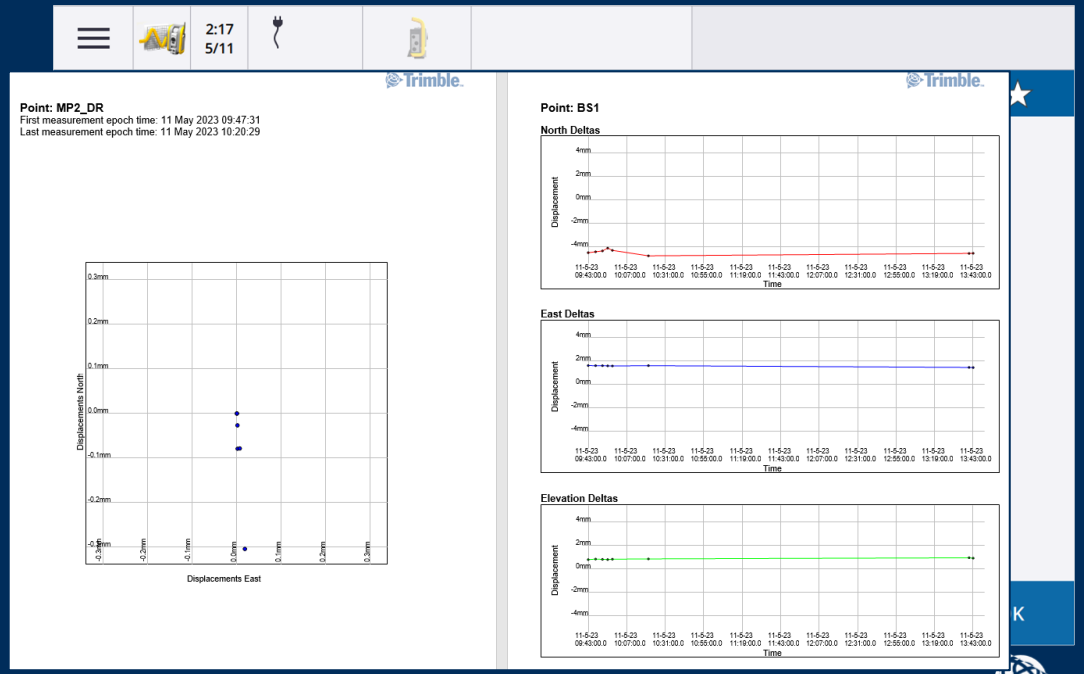
North	East	Elevation
1005.106	998.114	99.310

Epoch	Δ North	Δ East	Δ Elev
Date: 11/05/2023			
09:42:55	-0.002	-0.000	-0.001
09:47:31	-0.002	-0.000	-0.001
09:51:49	-0.001	-0.000	-0.001
09:55:04	-0.001	-0.000	-0.001
09:58:01	-0.002	-0.000	-0.001
10:20:29	-0.002	-0.000	-0.001
13:40:30	-0.001	-0.001	-0.000
13:43:03	-0.001	-0.001	-0.000

Reporting and Analysis

… after the survey has been completed

- **Word report**
  - Displacement information about every monitoring and control point
  - Containing
    - point scatter plots
    - trend graphs
    - both



Data Exchange

Trimble 4D Control

- **Export Rounds**
  - **.jxl* files
  - for further post processing in T4D

- **Export Site Setup** → **.tamsetup* file
  - Can be imported in T4D for switching to automated monitoring

- **Import Site Setup** → import the **.jxl* file from T4D Server containing the stations setup information

Data Exchange

Settop M1

- Disable instrument control
  - Disabling instrument control by Settop M1

- Send Site Setup
  - Going from semi-automated to automated monitoring
  - TA Monitoring UX > Settop M1 UX

Data Exchange

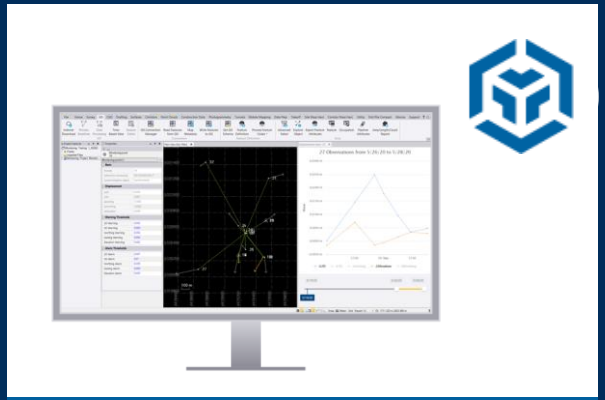
Trimble Business Center (*.json)

TRIMBLE ACCESS MONITORING

Data Collection and Scheduling

Trimble Access Monitoring

TRIMBLE BUSINESS CENTER MONITORING



Data Management, Processing, and Reporting

Trimble Business Center Monitoring

04

TA Monitoring Demonstration

Monitoring with Confidence

05

T4D Access (T4D v6.4)

Monitoring with Confidence

T4D Control Access vs. TBC Monitoring

T4D Control Access

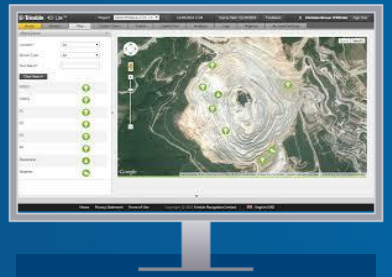
- **Entry point into the T4D** ecosystem
- **Automated and comprehensive** reporting and analysis
- **Sharing data** with stakeholders
- **Easy transition** between semi-automated and automated

TA Monitoring

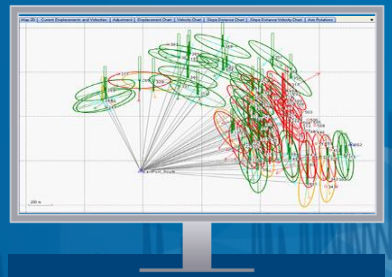
TBC Monitoring

- **Existing TBC customers** (it's just an additional module)
- **Low barrier to entry** into semi-automated monitoring
- **Monitoring alongside other workflows** like CAD, surfaces, scanning, photogrammetry

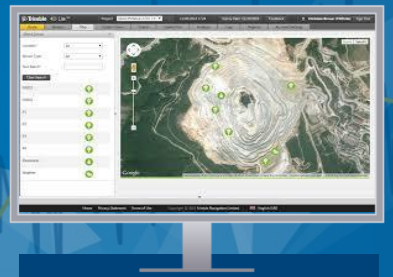
T4D Control software enables **automated movement detection with confidence** for surveying and construction professionals supporting informed decisions about infrastructure.



Sensor Management and Data Integration



Geodetic Processing and Adjustment



Comprehensive Analysis and Visualization

Conditional Alarming and Reporting

Semi-automated Monitoring

System overview

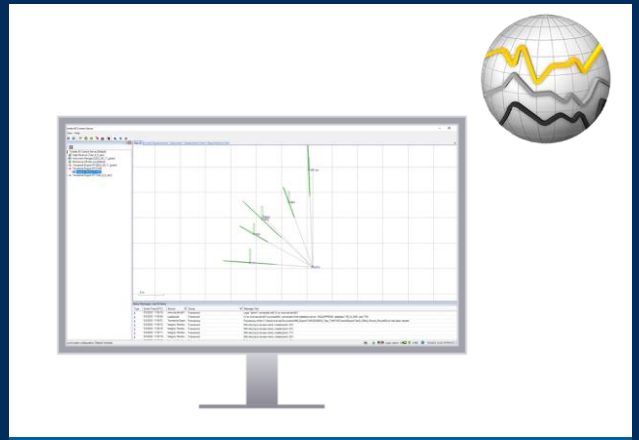
TRIMBLE ACCESS MONITORING

Data Collection and Scheduling
Total station, GNSS, DiNi

Trimble Access Monitoring field software

Data Transfer

TRIMBLE 4D CONTROL



Data Management, Processing, and Reporting

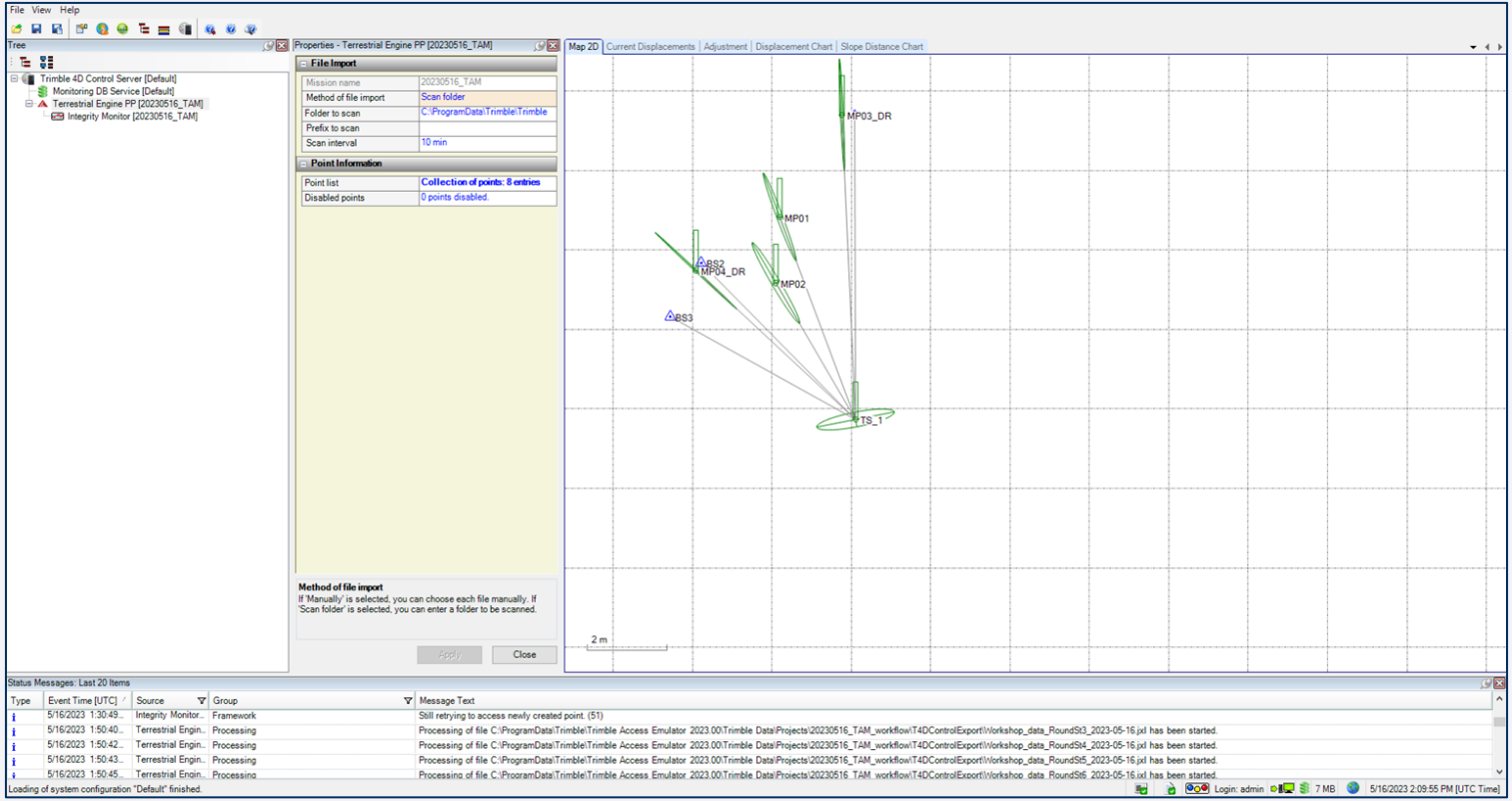
Trimble 4D Control

Workflow

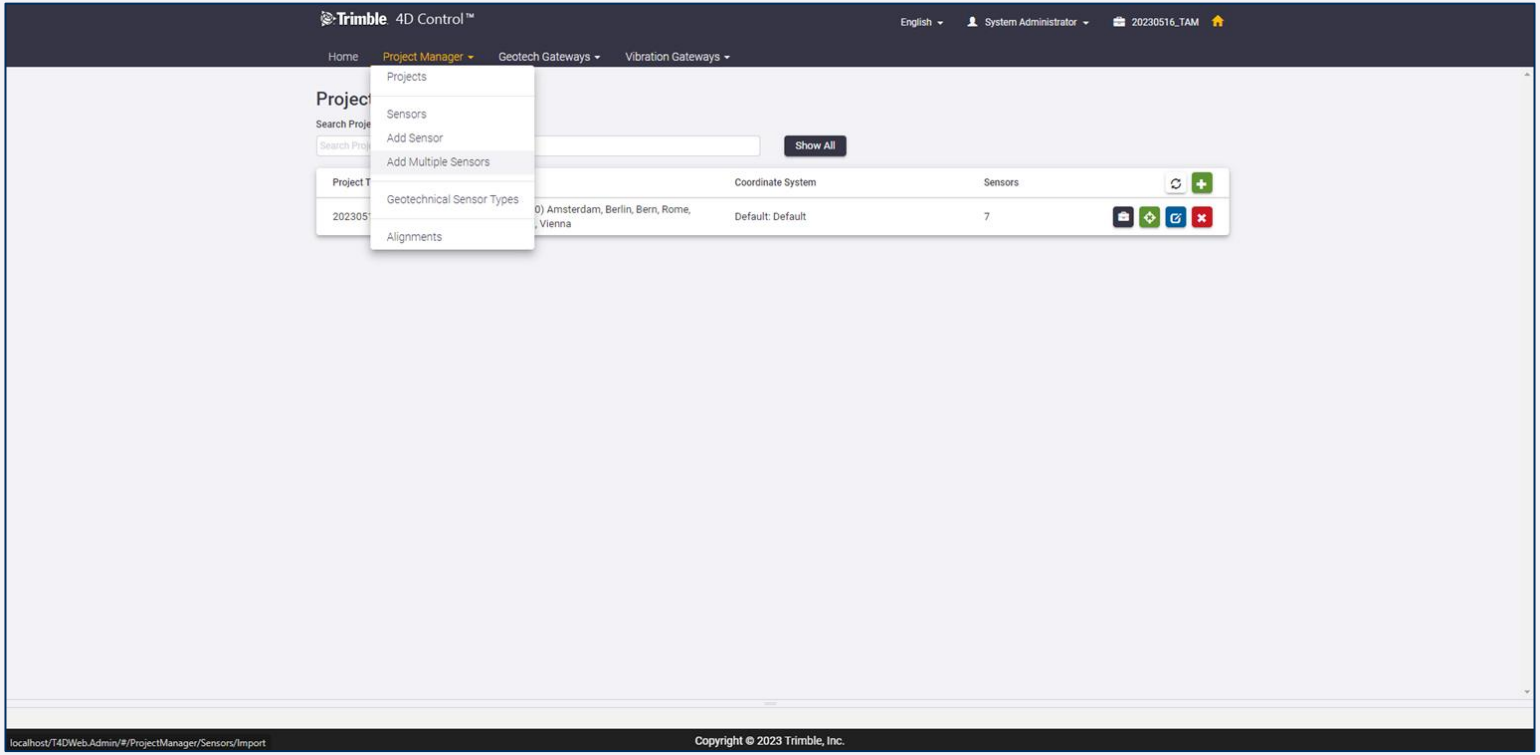
1. Set up control points and monitoring targets in Trimble Access ✅
2. Configure round and take measurements ✅
3. Export data from Trimble Access ✅

1. Import data into T4D using Terrestrial Engine
2. Add sensors in T4D Web
3. Start creating reports, alarms, and charts in T4D Web!

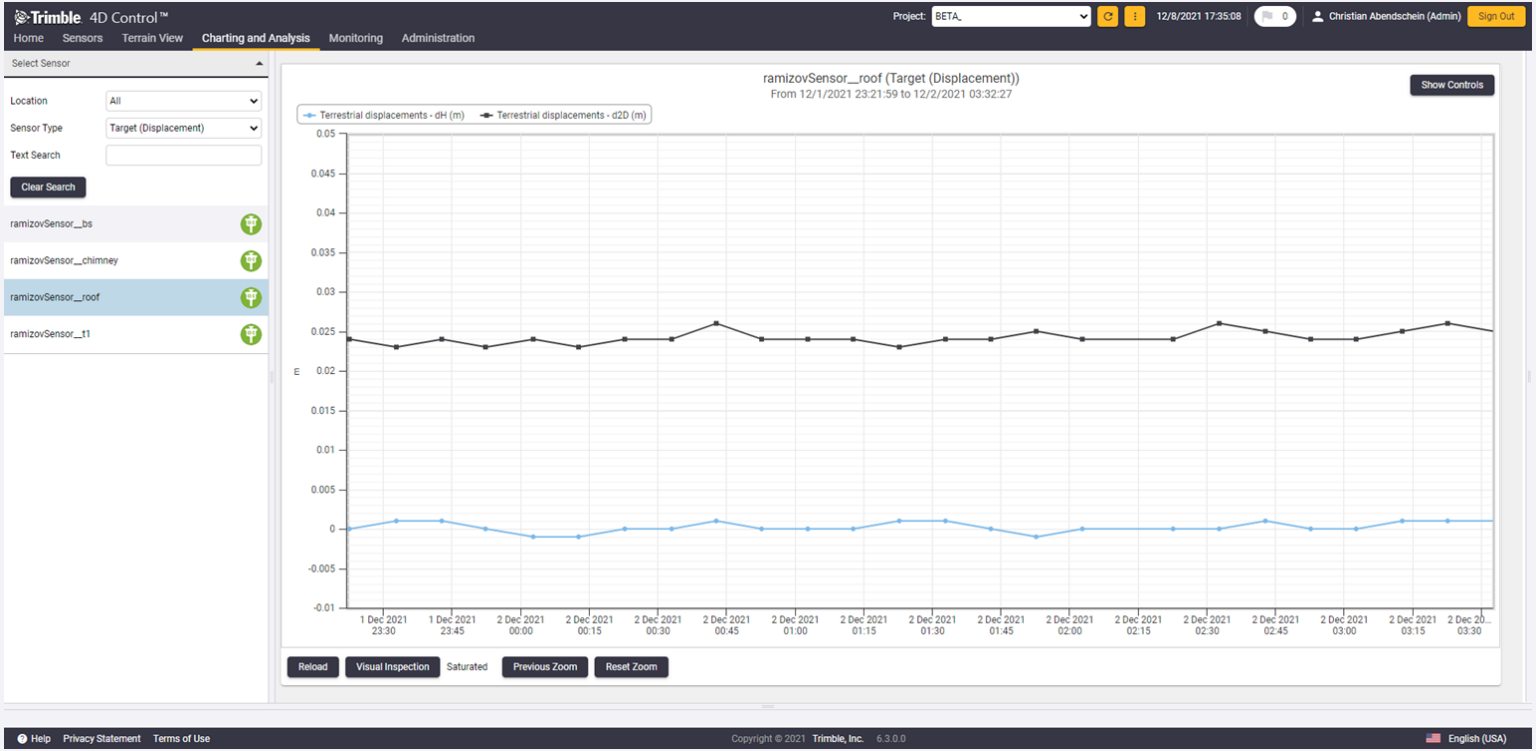
4. T4D Server - Import Data



5. T4D Web - Add (multiple) sensors



6. T4D Web - Visualize data and more



Thank You

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