Introduction
What happens to your robot that can have an effect on your accuracy?

- Transport
- Hard field handling
- Vibration & shock from construction equipment
- Extreme temperature changes
- Windy, rainy, snowy weather
Session Agenda

- Instrument care and maintenance
- Understand and improve your radio link
- Check of electronic level
- Check & adjust tribrach bubble
- Check telescope for single face measurement
- Check Tracker vs. Optics
- Check & adjust optical plumb in S-series instrument
- SurePoint, how it works

Natural Errors

- Temperature Effects
  - Extreme temperature changes
    - Let the instrument acclimate
    - Shielding from the sun
  - Wind
    - Do not collimate on windy days
- Tripod settlement
  - Let angles settle before collimation

Instrument Use & Care

- Transportation
  - Do not transport in case without the tribrach
- Manufacturer’s recommended minimum annual service calibrations
- Field calibration
  - Before the start of large projects
  - AT LEAST once every quarter
  - Tracker Collimation once per month
  - Large temperature changes
Instrument Acclimation

- Sufficient time for acclimation
  - Approx 1 minute for every 1°F

- Example...
  - 77°F transport temp.
  - 23°F outside temp.
  - 54 min. acclimation time

Robotic Radios: How they work

- Robotic radios are line-of-sight
- Always ensure you can see the instrument to maintain your radio link

Radio Shadow
  No Signal
Robotic Radios: How they work

Top View of Antenna

Signal in all directions

Robotic Radios: How they work

NO SIGNAL

SIGNAL

SIGNAL

NO SIGNAL

Checking the Electronic Level

- Level the instrument
- Note the Trunnion and Sighting values
- Turn the instrument about 180 degrees

Start position
Checking the Electronic Level

Data should be the same but with different signs

Start position

180 degrees

Note, if TCU is attached to the instrument it will give 50cc difference, but that is expected.

If you get different values, how will that affect the result?

<table>
<thead>
<tr>
<th>Difference</th>
<th>320 ft</th>
</tr>
</thead>
<tbody>
<tr>
<td>8 seconds</td>
<td>0.007 feet</td>
</tr>
<tr>
<td>160 ft</td>
<td>0.01 feet</td>
</tr>
</tbody>
</table>

Calibrate the Electronic Level

It is very important that the instrument have been powered up for about 3 minutes before you start the calibration procedure. This is to get the compensator warmed up.
Calibrate the Electronic Level

It is an automated process that takes just about 1 minute to complete.

AS EASY AS....

Level Bubble in Face 2 Display

Robot level bubble in face 2 display:
The level bubble in the face 2 display has different options depending on what you want to see.

Default start-up display:
Default display has a scale of 1:250 of the bubble.

Change scale:
With a short press on the middle key (↓) it is possible to change the scale of the bubble, from 1:250 to 1:100, 1:10 or 1:1. In the last option 1:1 it is very sensitive! In the top left corner the current scale is displayed.
Level Bubble in Face 2 Display

Digital info:
With a long press on the middle key (↓) it is possible to show digital info instead.

Why should I use this?

There is no need to level the instrument better than the first display 1:250, the compensator takes care of the minor miss leveling that might still be there.

It is much more important to calibrate the compensator regularly!

However some users still want to level the instrument very accurately, which is why these options exist.

Adjust the Tribrach Bubble

Once your S Series robot is digitally leveled, check adjust the level bubble in the tribrach.
How to check manual aiming accuracy in single face measurement

• Step 1: aim towards a target

Step 2
Change face

If it looks like this it is time to calibrate
Step 3: Calibrate if needed

**Optics Check**

![Adjust instrument](image)

*Note:* The prism must be at least 100 meters from your total station for this adjustment.

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Step 3 (Cont.): Perform Collimation

**Optics Check**

![Trunnion axis tilt](image)

*Note:* The prism must be at least 100 meters from your total station for this adjustment.

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Step 3 (Cont.): Check Collimation Results

**Optics Check**

![Trunnion axis tilt](image)
How to check aiming: Optical vs. Tracker

Difference between aiming Manually (left) and with Autolock (right).

Telescope Overview

- Coaxial optical path
- Coaxial tracker transmitter
- Coaxial tracker detector

Optical vs. Tracker Check

Step 1: Aim to prism with Tracker (Autolock) disabled
Optical vs. Tracker Check

- You can also check the HA and VA angles

### Step 2: Enable the Tracker (Autolock):

Optical vs. Tracker Check

- Compare HA and VA with data from the Autolock measurement
Optical vs. Tracker Check

Step 3: Calibrate if needed

Note:
This is an automated adjustment. Access will notify you when the process is complete.
When the adjustment is finished, re-do Steps 1 & 2 to check the results.

Laser Pointer Adjustment

Aim to a Laser adjustment plate
Laser Pointer Adjustment

Make sure you refit the plugs in the holes correctly when you are done! Internal instrument damage can result.

Bad!

Correct!!

(Will be a small dimple in the middle)

Trimble S-series instruments are equipped with a built-in optical plumb. The benefit is that it is possible to quickly check how well adjusted the optical plumb is anywhere, and before you start to do a known station with high accuracy demand.

Checking & Adjusting the Built-in Optical Plumb

Step 1: have a stable visible mark on the ground.
Step 2: Set the instrument up on a tripod so you get about 1.5 m (5 ft) instrument height. Then level the instrument over the reference point as you normally would. Here is a perfectly aimed cross-hair when looking through the optical plumb after the set-up. However, you have no idea if it is good or not, it just might look good.

Step 3: Now turn the instrument about 180 degrees. Look through the optical plumb again. If it still points correctly the optical plumb is perfectly aligned, but if it looks like the picture below it is time to adjust the optical plumb.

Step 4: Find the tools needed. In the instrument case, there is a tool kit to be used, for this adjustment it is the two smaller hex keys (the other larger hex key is to adjust the tribrach bubble).
Step 5: Adjusting the optical plumb "horizontally"

Now we are coming to the critical part. **BE CAREFUL**, do not over-tighten any screws.

To start, place the two tools as shown in the picture below.

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**Checking & Adjusting the Built-in Optical Plumb**

Which screw to start with?

In this example the cross-hair needs to be adjusted to the right. To start, release the right screw counter clockwise, then turn the screw on the left side clockwise to adjust the optical plumb to the right. Only adjust it half the way.

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Step 6: Adjusting the optical plumb "vertically"

Do the same as above but now vertically.

In this example the cross-hair needs to be adjusted "down". To start, release the bottom screw counter clockwise and then the screw in the top clockwise to adjust the optical plumb down.
Step 7: Now repeat from step 2 to check or adjust it again until you are happy. Remember to only adjust half the distance.

Checking & Adjusting the Built-in Optical Plumb

To get a feeling for how big or little the error is, the bigger circle represents about a 5mm (0.2 inch) radius, and the smaller inner circle is about a 2.5 mm (0.1 inch) radius.

Tribrach with Optical Plumb

Tribrachs with optical plummet cannot use this adjustment method. It is recommended that they are calibrated by a service provider.

Make sure the instrument is seated properly in the tribrach before use!
What should be done at the service shop?

- General rule, each year or after 3000h (about 8h/day 365days)
- Optical alignment of EDM and Tracker
- Calibration of EDM
- Calibration of servo and angle system
- Servo focus calibration and check
- Camera (Video) calibration
- Updates according to Service Bulletins
- Greasing of moving parts
- ..etc

Biggest Sources to Bad Measurements

- 3.) Bad (calibrated) instrument
- 2.) Bad Tribrach
- 1.) Bad tripod or instrument set-up

SurePoint™

- Control loop active all the time
- Always turns instrument to the current reference angle
- Reference angle only changed when
- Knobs are turned
- Position commands are given
- Instrument is turned firmly so that it enters friction mode
- If instrument is disturbed slightly it will be aimed back at target
- Buttons pushed on instrument
- Contact with instrument when looking through telescope
- Wind
Collimation error the old way

- What happens when you aim at a plumb line and turn the vertical knob?
- Old systems will only turn the vertical motor
- The aim will not follow the plumb line but the horizontal angle will be compensated for this drift

Collimation error with SurePoint™

- SurePoint™ will feed the corrections back into the control loop when the vertical knob is turned!
- SurePoint™ will use both motors and make the instrument follow the plumb line

Tilt Sensor

- Compact durable design
- Accurate and reliable
- Low power consumption
- Refresh rate of 6 Hz
- Mounted in the center of the instrument
Tilt Sensor

• Very simple principle
• A light beam is reflected in a liquid surface and the reflection is detected on an area array sensor

- Liquid
- Prism
- LED
- Photo sensor

Tilt is calculated from the center of gravity of the light distribution on the camera chip
- The figure shows an image from the tilt sensor
- The leaning of the tilt sensor is proportional to the movement of the center of mass of the light distribution

Tilt compensation the old way

• Tilt change makes the aim drift off target
• The angles are compensated
• Angles will be correct but the instrument will not aim at target

Tilt compensation with SurePoint™

- Tilt change makes the aim drift off target
- SurePoint™ corrects the position back on to the target

Summary

- Check your instruments regularly
- Field checks are necessary when working with Autolock or Robotic Total Stations
- Instruments should be calibrated annually via Service Provider
- Robotic trackers need to be field collimated regularly
- Regular maintenance will go a long way in maintaining the accuracy of your instruments