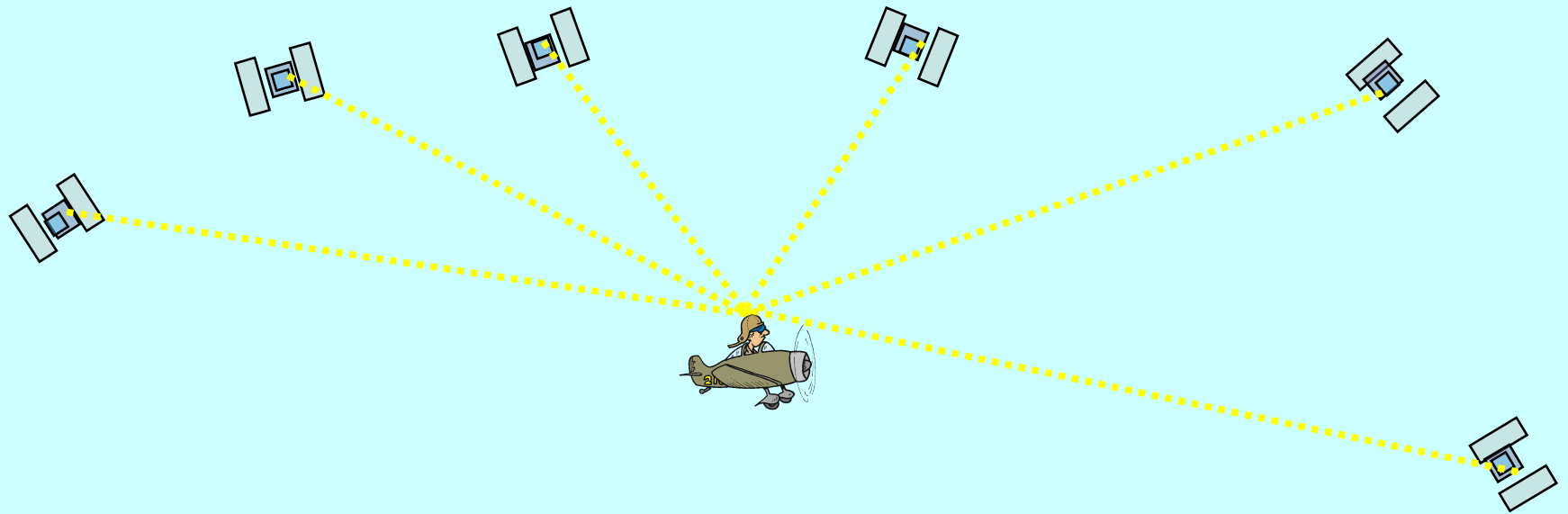


# Improving Positioning of Mobile Scanner Data

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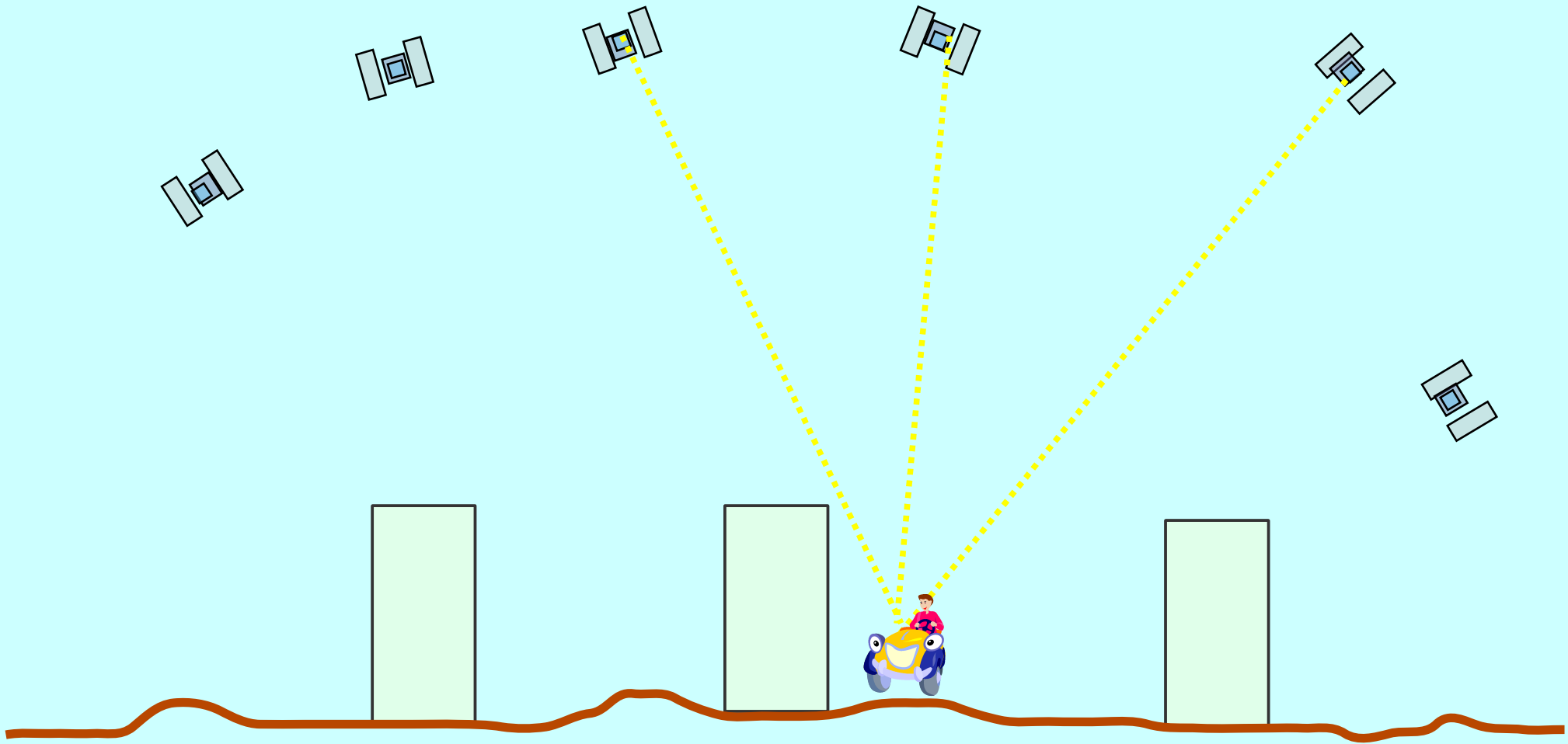
# Airborne Positioning



Fairly uniform satellite visibility

Fairly uniform positional accuracy

# Mobile Positioning



Satellite visibility varies

Positional accuracy varies

# Magnitude of Error Sources

- System calibration
  - Relatively small in project data sets if system has been carefully calibrated
- Range measurement
  - Small – 1 cm level
- Trajectory xyz
  - Dominant error source
- Trajectory hrp
  - Small when short ranges involved

# Example Trajectory RMS

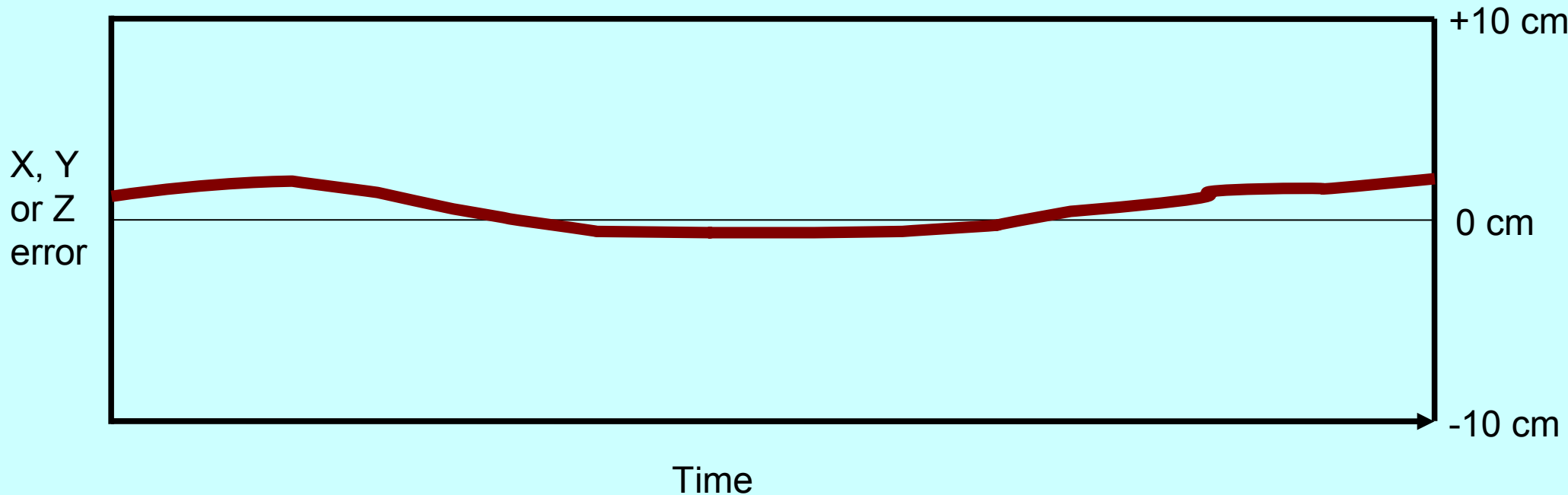
Applanix smrmsg\_xxxx.out

- Xy 0.02 – 0.20 m
- Z 0.10 – 0.30 m
- Heading 0.02 – 0.05 degrees
- Roll/pitch 0.006 – 0.008 degrees

Range	Xyz effect	Hrp effect
5 m	0.15 m	0.003 m
10 m	0.15 m	0.005 m
20 m	0.15 m	0.010 m
50 m	0.15 m	0.026 m

Assuming 15 cm xyz, 0.03 degree angular error

# Gradual Variation



- Normally error in trajectory xyz does not change rapidly
- Trajectory drifts off in one direction and stays for a number of seconds
- Good potential for fixing

# Tie lines for project data

- Use primarily paint markings on road
  - Close to scanner – shows xyz issues, hrp has minimal effect
- Collect control measurements at:
  - Corners of large, strong paint markings (Known point)
  - End points of thin, strong paint markings (Known point)
  - Centers of weaker paint lines (Known line)

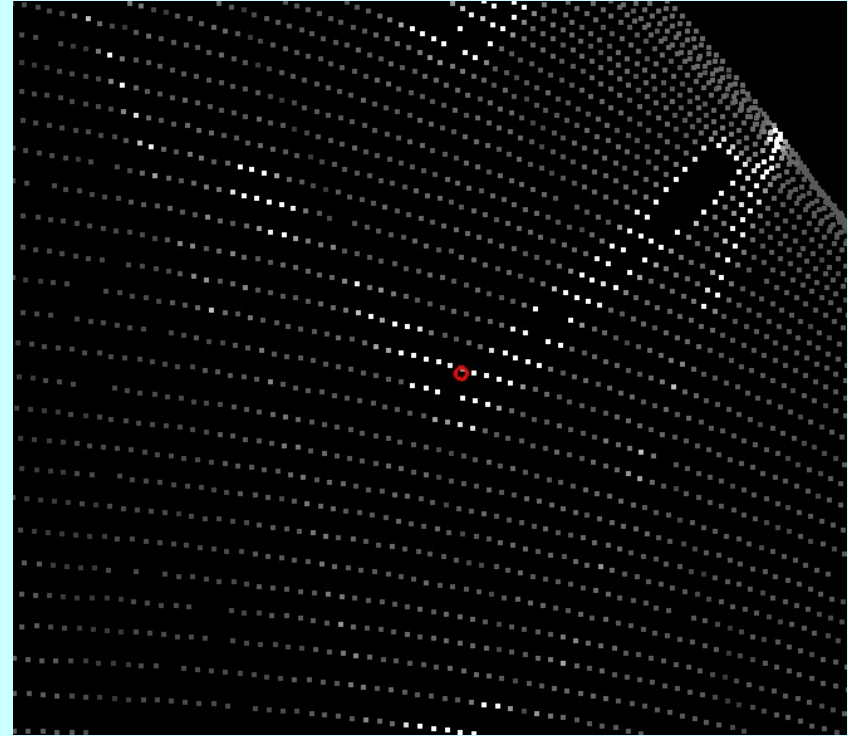
# Tie line types

- **Ground point** – point feature on ground, seen by multiple passes
- **Xy point** – xy point feature, multiple lines
- **Known point** – known xyz point on ground
  
- **Ground line** – linear feature on ground, multiple lines
- **Section line** – xyz line on terrain slope, roof or wall, multiple lines
- **Known line** – known xyz point on ground, one or multiple lines, line runs thru known point



# Ground point tie line type

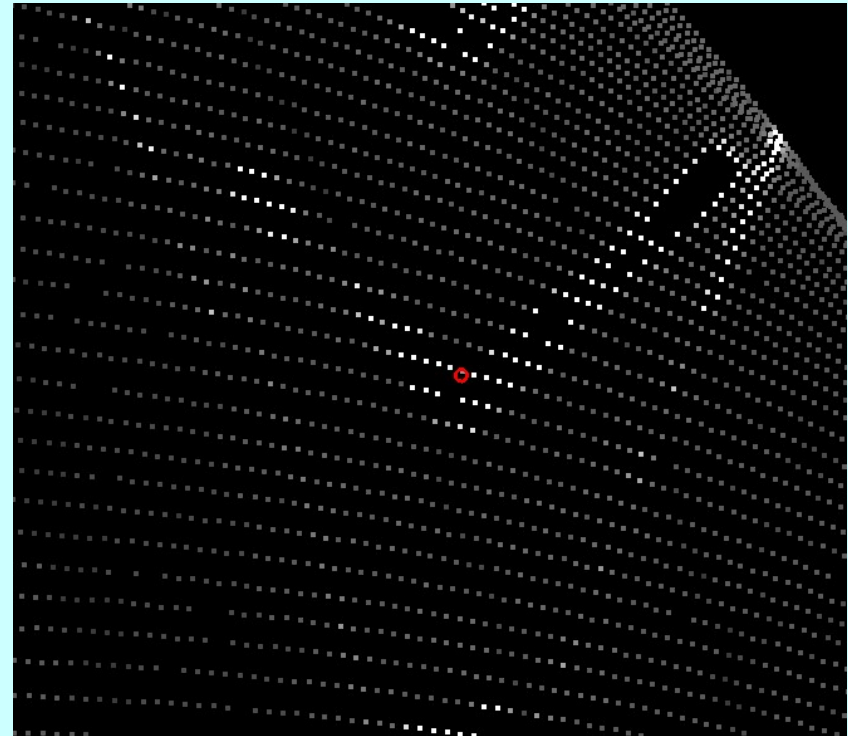
- Point feature on ground
- Seen multiple times



1. User enters approximate xy position  
Software find passes which see the location
2. User enters xy position of each observation  
Software computes z from fitted plane equation

# Known point tie line type

- Point feature on ground
- Known xyz
- Seen multiple times



1. User enters known xyz position  
Software find passes which see the location
2. User enters xy position of each observation  
Software computes z from fitted plane equation

# Ground line type

- Linear feature on ground
- Seen multiple times

## Manual

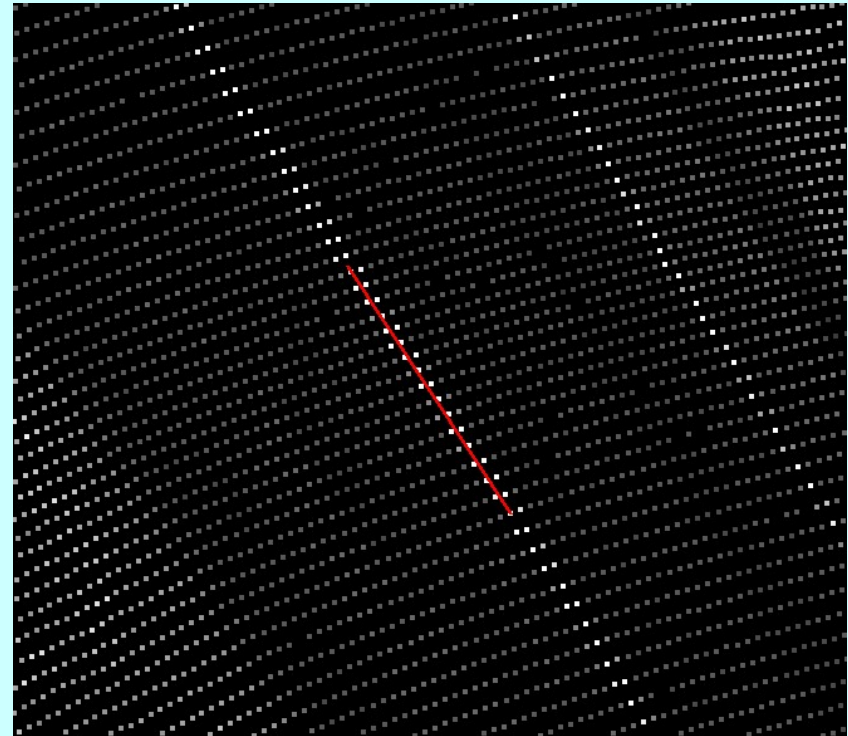
Can do anything user sees

1. User enters approx start and end xy
2. User enters start and end xy in each pass  
Software computes z from plane equation

## Auto line search

Requires bright line on darker background

1. User enters approx start and end xy



# Known line type

- Known xyz point on ground
- Seen once or multiple times
- Line runs thru known point

## Manual

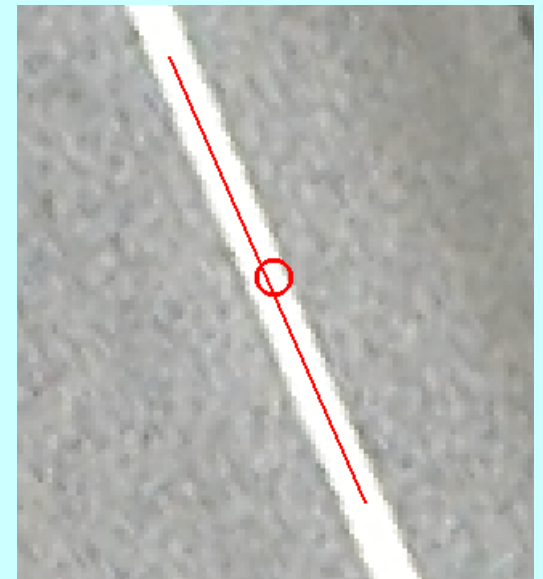
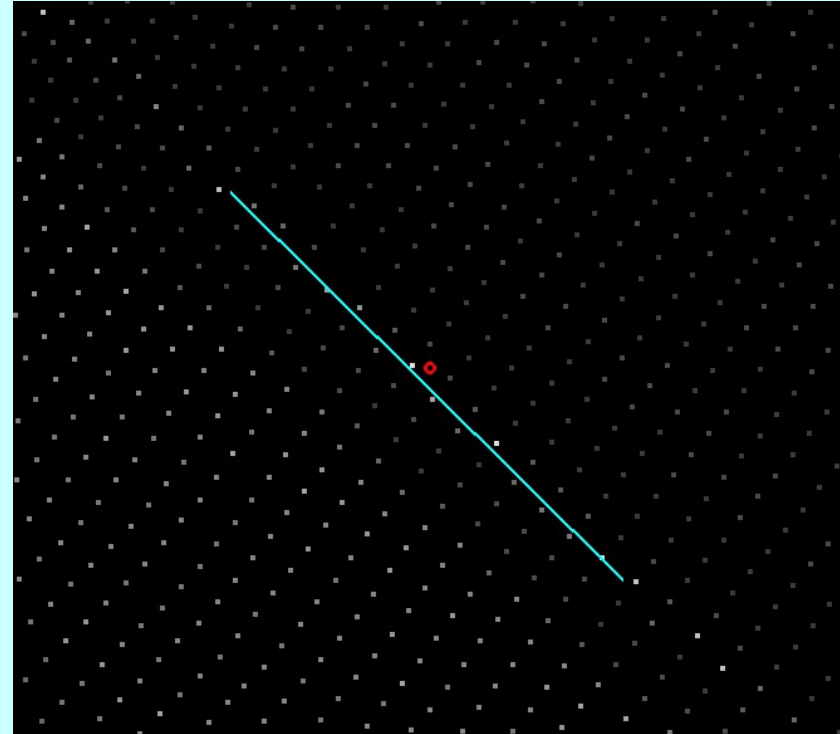
Can do anything user sees

1. User enters known xyz
2. User enters approx start and end xy
3. User enters start and end xy in each pass

## Auto line search

Requires bright line on darker background

1. User enters known xyz
2. User enters approx start and end xy

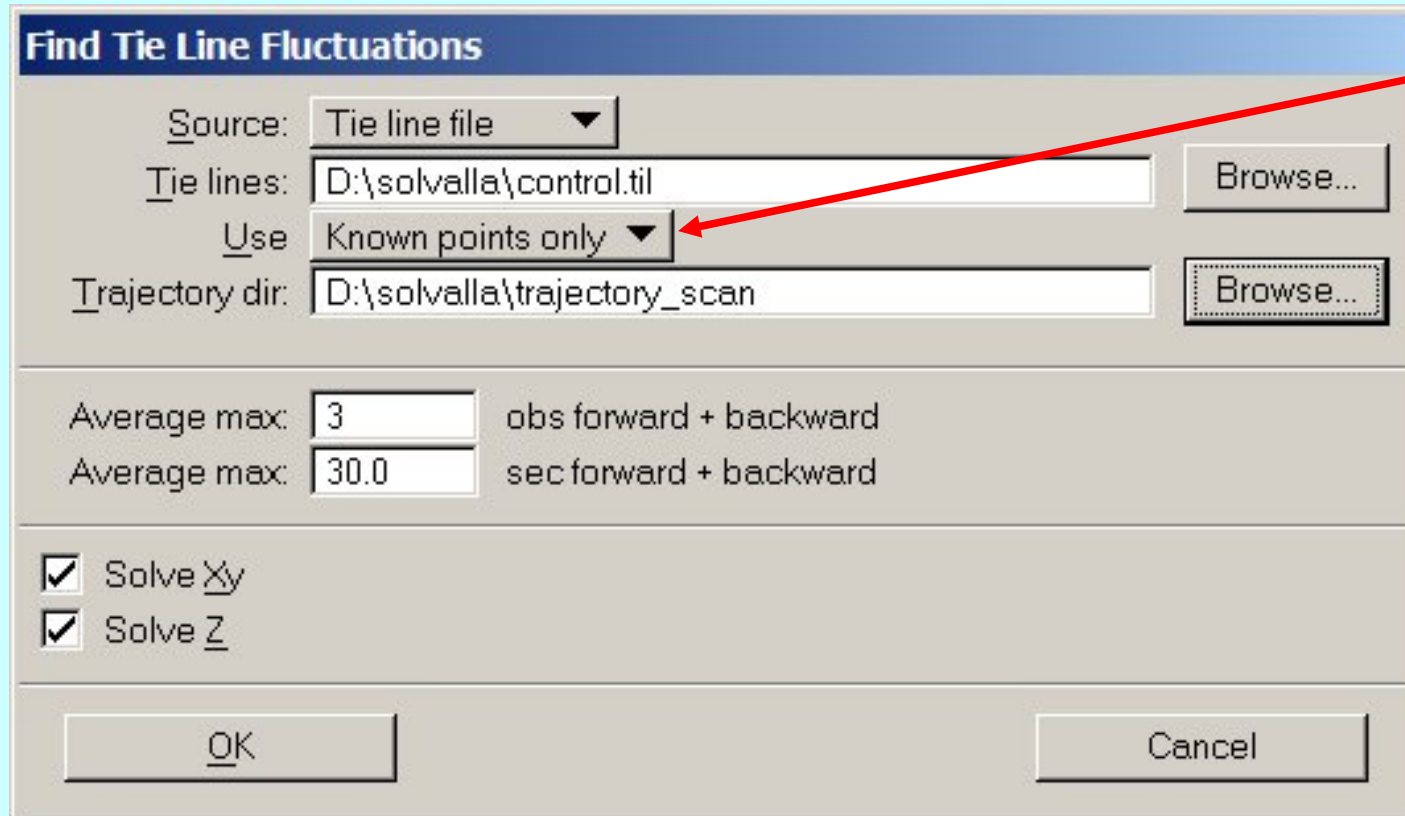


# General Project Strategy

- Collect some control measurements
- Execute LIDAR / image survey
  - Drive every place twice
- Check system calibration
- Find bad positioning
  - Display trajectory colored by RMS values
  - Compare drive passes together
- Collect control measurements at bad locations
- Adjust xyz of drive passes together and to control measurements with a fluctuating correction
  - Correction curve which changes over time
- Remove less accurate data
  - Long range measurement if short range exists

# Xyz Adjustment Procedure

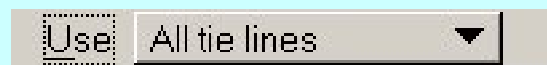
- Adjust xyz of drive passes to control measurements



The screenshot shows a dialog box titled "Find Tie Line Fluctuations". It contains the following fields and options:

- Source:** Tie line file (dropdown)
- Tie lines:** D:\solvalla\control.til (text field) with a "Browse..." button to its right.
- Use:** Known points only (dropdown menu, highlighted with a red arrow).
- Trajectory dir:** D:\solvalla\trajectory\_scan (text field) with a "Browse..." button to its right.
- Average max:** 3 (text field) with the label "obs forward + backward" to its right.
- Average max:** 30.0 (text field) with the label "sec forward + backward" to its right.
- Solve Xy
- Solve Z
- OK** (button) and **Cancel** (button) at the bottom.

- Adjust xyz of drive passes to control measurements and internal measurements



A close-up of the "Use" dropdown menu from the dialog box, showing the text "All tie lines" and a downward-pointing arrow.