



### **ADDING Azimuth Grid Bearing in MOVE3**

The grid bearing is mainly to exclude a possible rotation in the adjustment due to fix stations being close together and to get similar results for the coordinates with previous adjustments. This way you can fix the orientation of the network.

Measured gyro azimuths will do this also, but due to limited accuracy and the fact that in mines they can only be measured over short distances their effect on controlling the orientation will be limited.

**We suggest to use the computed grid bearings only if there is no other solution to better fix the orientation.** If a network is well braced then this method less applicable. For example: if there are control points at the 2 entrances of a mine, so the control points are further apart than what you would have with just one leg and an narrow entrance this is well braced.

For Mine Surveyors who run into the problem with limited fix stations, fix stations close together and in the same direction as the network one narrow leg then adding the **Grid Bearing** is the solution for you!

#### **Would Gyro shot solve this problem?**

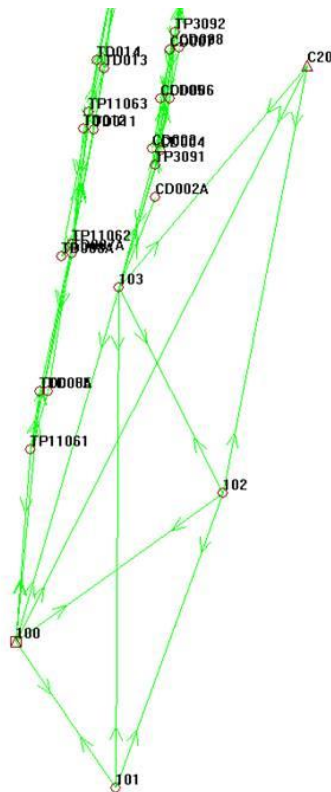
The gyro's fix the orientation of the network. This is also fixed by the known points, so there may be a conflict there (azimuths versus known coordinates).

By measuring azimuths in a mine, it is usually not possible to take long lines so to some extent before and certainly after the measurement you will again be building up uncertainty with each leg of the network. So adding a few azimuths in a large network does not bring a lot of improvement.

## Problem

If the fixed stations are at one end of the leg there is a risk that in a remeasurement you will get coordinates that are rotated.

For example if there is a short basis that is fixing the orientation of a 1 km mine network leg the solution is depending on the final solution of the orientation. So your largely dependent on the measurements at the beginning, any small difference in the orientation on this 100 m difference in East between fix station 100 and fix station C20 will lead to a 10 times as big difference in the East of the points at the end. This is a leverage of 10 times. This is also expressed in the standard deviations of the East of these points that is up to 10 cm.

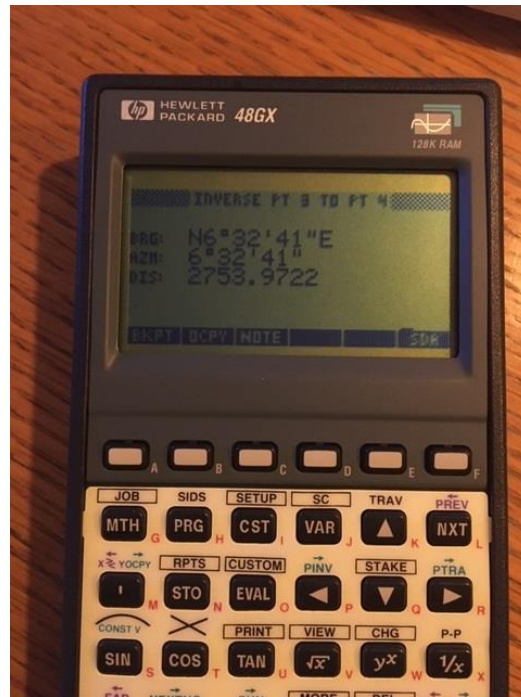


It is like a leverage, one mm difference at the one end of stations being 10 m apart can easily multiply by 100. If the leg is 1000 m long, so the 1 mm will become 10 cm. To avoid this rotation the grid azimuth can be entered to force both networks in the same orientation. To do this it would be best to take the grid azimuth between an **arbitrary fixed station** and an **arbitrary station** at the other end. Of course you should always be aware of what you are doing, and that using the grid bearing orientation will affect the final solution. From a perspective of trying to match the results of 2 separate check surveys. It seems a good option to resolve the weak orientation caused by the location of the fixed stations close together.

## How to calculate Grid Bearing for MOVE3

### After successful adjustment in MOVE3

This needs to be done by hand, or in excel using an arctan of the coordinate differences in North and East of the points. Easily you can use your cogo software in your Leica or Trimble field controller also to calculate the azimuth bearing. Or pull out your old HP calculator with survey solutions.



## Adding the Grid Bearing in MOVE3

### Observations – Edit – Insert - Azimuth

Observations

N	Instr Hgt	Target ...	Reading
48		A0	0 00 00.00
1	1.7150	1.5400 R0	0 00 00.00
2	1.7150	1.5830 R0	27 38 55.40
3	1.7150	1.5320 R0	119 06 16.20
4	1.7150	1.6960 R0	349 29 16.10
5	1.7150	1.5400 R1	0 00 00.00
6	1.7150	1.5830 R1	27 38 56.80
7	1.7150	1.5320 R1	119 06 16.70
8	1.7150	0.0000 R1	338 35 01.80
9	1.7150	1.6960 R1	349 29 17.80
10	1.5390	1.7150 R0	0 00 00.00
11	1.5390	1.6960 R0	13 24 31.10
12	1.5390	1.5830 R0	344 21 15.60
13	1.6950	1.5400 R0	0 00 00.00
14	1.6950	1.5830 R0	113 18 14.80

Or

### Double click on observation **ADD - Azimuth**

1	100	C20	1.7150	1.5400	R0	0 00 00.00	S0	392.6506	Z0	89 35 56.10	3D	C:\MOVE3 Projecten\Australi
2	100	102	1.7150	1.5830	R0	27 38 55.40	S0	154.4350	Z0	89 20 47.40	3D	C:\MOVE3 Projecten\Australi
3	100	101	1.7150	1.5320	R0	119 06 16.20	S0	107.8198	Z0	90 07 52.50	3D	C:\MOVE3 Projecten\Australi
4	100	103	1.7150	1.6960	R0	349 29 16.10	S0	224.5430	Z0	89 45 03.20	3D	C:\MOVE3 Projecten\Australi
5	100	C20	1.7150	1.5400	R1	0 00 00.00						icten\Australi
6	100	102	1.7150	1.5830	R1	27 38 56.80						icten\Australi
7	100	101	1.7150	1.5320	R1	119 06 16.70						icten\Australi
8	100	TD005A	1.7150	0.0000	R1	338 35 01.80						icten\Australi
9	100	103	1.7150	1.6960	R1	349 29 17.80						icten\Australi
10	C20	100	1.5390	1.7150	R0	0 00 00.00						icten\Australi
11	C20	103	1.5390	1.6960	R0	13 24 31.10						icten\Australi
12	C20	102	1.5390	1.5830	R0	344 21 15.60						icten\Australi
13	103	C20	1.6950	1.5400	R0	0 00 00.00						icten\Australi
14	103	102	1.6950	1.5830	R0	113 18 14.80						icten\Australi
15	103	101	1.6950	1.5320	R0	140 16 11.80						icten\Australi
16	103	100	1.6950	1.7150	R0	156 04 54.00						icten\Australi
17	102	C20	1.5820	1.5400	R0	0 00 00.00						icten\Australi
18	102	101	1.5820	1.5320	R0	188 51 11.70						icten\Australi
19	102	100	1.5820	1.7150	R0	223 17 45.70						icten\Australi
20	102	103	1.5820	1.6960	R0	322 21 26.50						icten\Australi
21	101	100	1.5310	1.7150	R0	0 00 00.00						icten\Australi
22	101	103	1.5310	1.6960	R0	34 34 24.60						icten\Australi
23	101	102	1.5310	1.5830	R0	54 06 07.30						icten\Australi
24	100	TD005A	1.7180	0.0000	R2	0 00 00.00						icten\Australi
25	100	103	1.7180	1.6280	R2	10 54 14.80						icten\Australi
26	100	C20	1.7180	1.5810	R2	21 24 56.30						icten\Australi
27	100	101	1.7180	1.4780	R2	140 31 14.50						icten\Australi
28	100	TP11061	1.7180	0.0000	R2	359 05 47.80						icten\Australi
29	TP11061	100	0.0000	1.7180	R0	0 00 00.00						icten\Australi
30	TP11061	TD005A	0.0000	0.0000	R0	183 52 37.30						icten\Australi
31	TP11061	TD007A	0.0000	0.0000	R0	187 25 11.40						icten\Australi
32	TP11061	TD005	0.0000	0.0000	R0	191 48 48.40						icten\Australi
33	TP11061	TP11062	0.0000	0.0000	R0	186 53 31.00						icten\Australi
34	TP11062	TD005A	0.0000	0.0000	R0	0 00 00.00						icten\Australi
35	TP11062	TD008A	0.0000	0.0000	R0	27 41 09.00						icten\Australi

Edit observations

Total Station: 4823 100 C20

From: 100 IH: 0.00000 m

To: C20 TH: 0.00000 m

Azimuth: A 0 0.00 00.00 dms

St Dev Abs: 0.00 03.00 dms

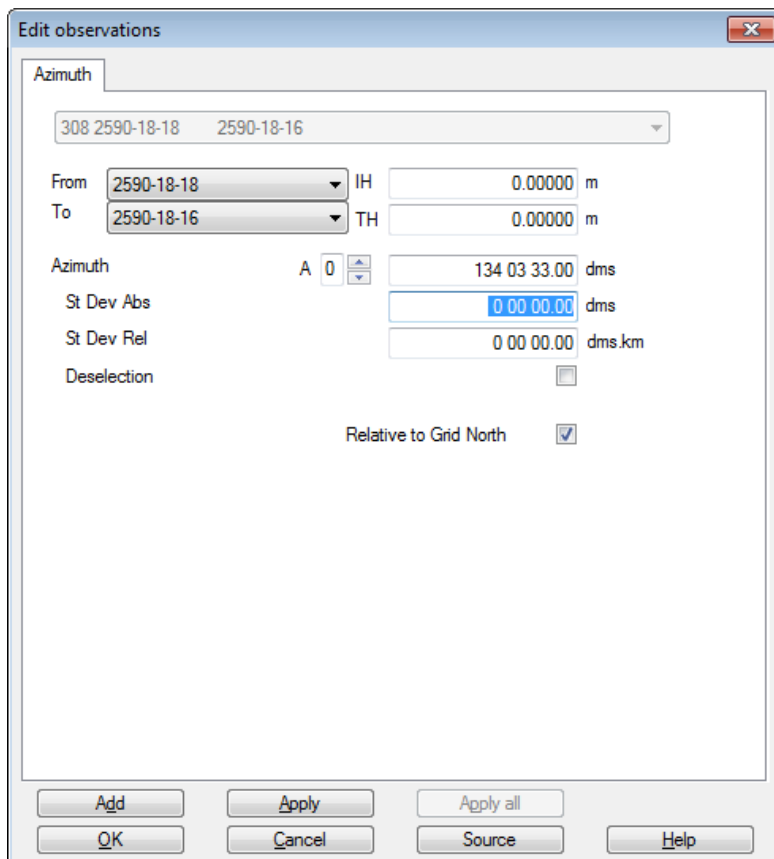
St Dev Rel: 0.00 00.00 dms.km

Deselection:

Add new observation type

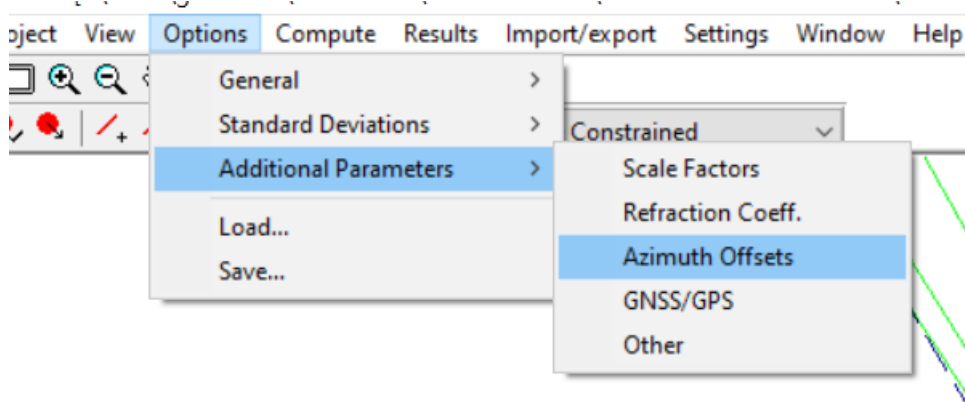
- Total station
- Direction
- Distance
- Zenith angle
- Azimuth**
- Height difference
- Geometrical relation
- Angle
- Parallelism
- Collinearity
- Distance point-line
- Perpendicular
- Perpendicular lines
- Chain and offset
- Identical stations
- Double distance
- Tape distance
- Circle radius
- GNSS/GPS baseline
- Shift vector
- GNSS/GPS coordinate
- Local coordinate

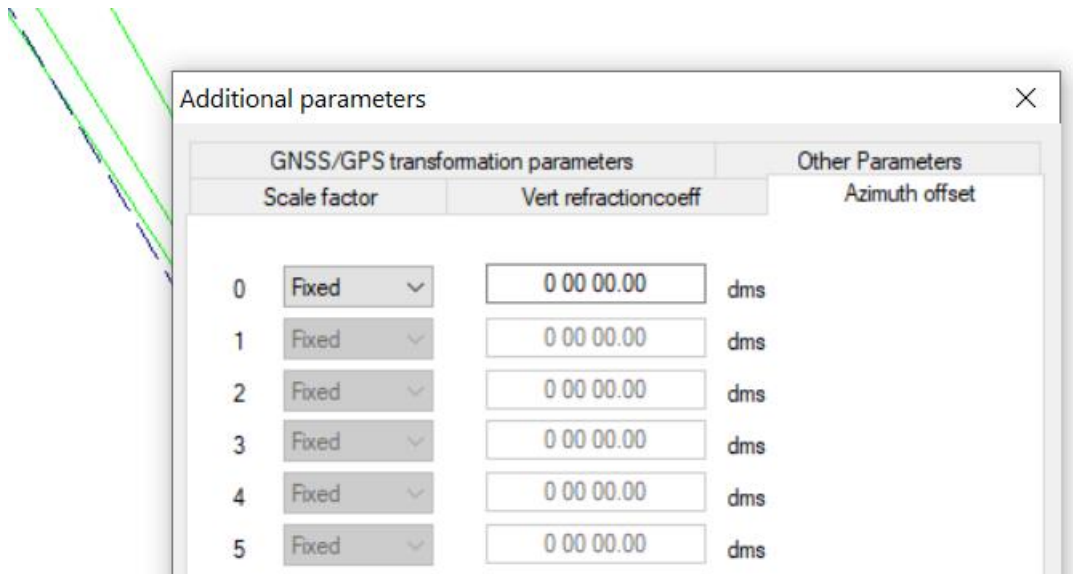
OK Cancel



Since you are adding this as a constraint, and not as an observation it would be best to use 0 St Div.

If it is a grid azimuth also check Relative to Grid North. Be sure to have the Azimuth offset fixed.





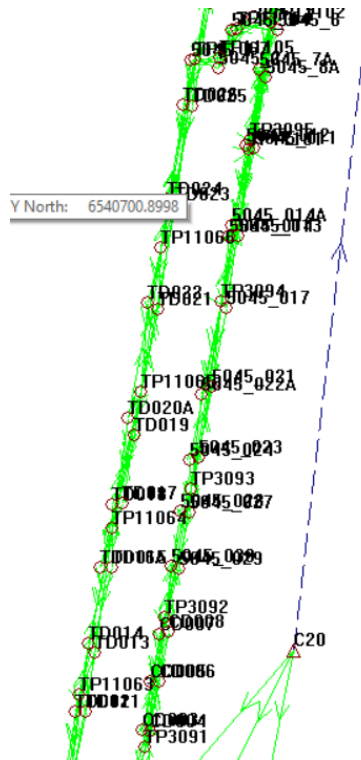
By adding the theoretical bearing of a long line as a azimuth measurement you will be able to fix the orientation of the network and get better standard deviations at the end. The largest ones will now be probably somewhere in the middle, but smaller than before.

### Question

Would adding one grid bearing observation be enough could you add more?

Usually one would be enough, especially if it is a straight leg. Maybe if you include more separate legs in the network you would like to include one for each leg.

If there is a large bend in the leg then the azimuth from the beginning to the end may not be able to avoid that there are differences at a bend.



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 MOVE3 Australia July 2021