

# DistoX calibration with TopoDroid

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# What is a “calibration”?

- Analogy: a scale



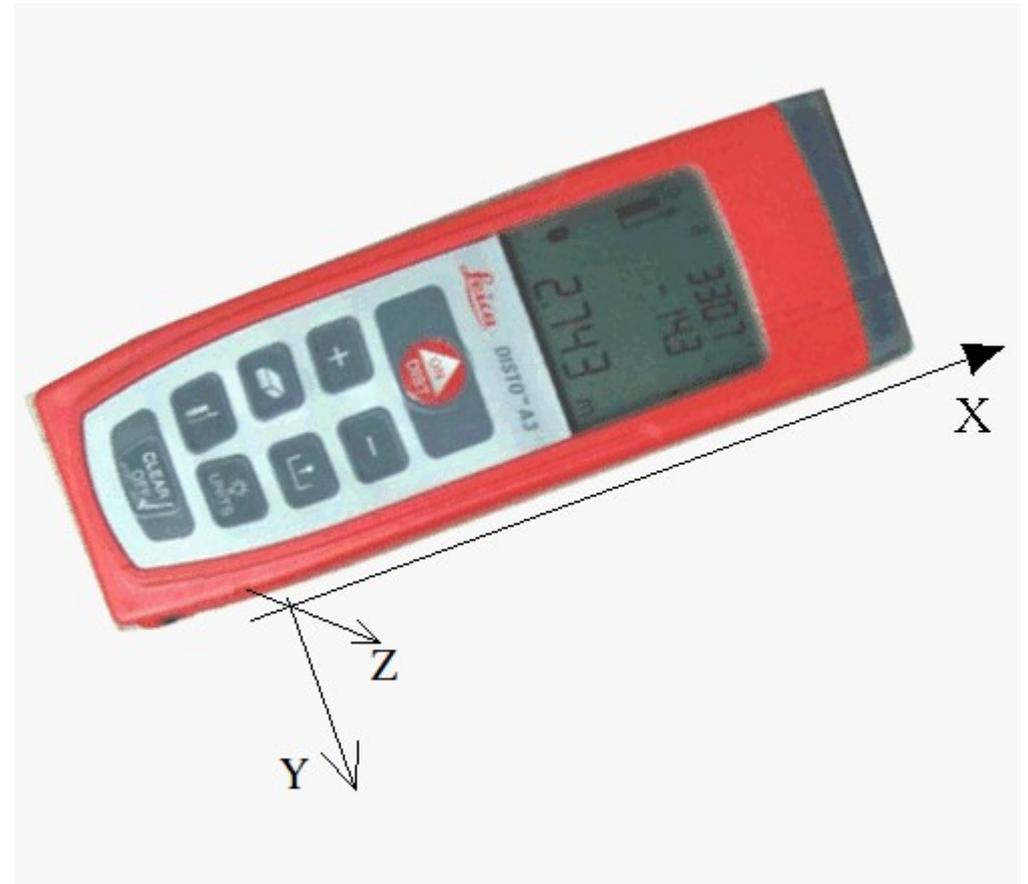
Mechanical calibration

# Why “calibration”?

- The DistoX contains tri-axial Magnetic and accelerometric sensors
- The sensors axes are not perfectly orthogonal
- the X sensor axes are not perfectly aligned with the laser direction
- sensors have different bias and gain

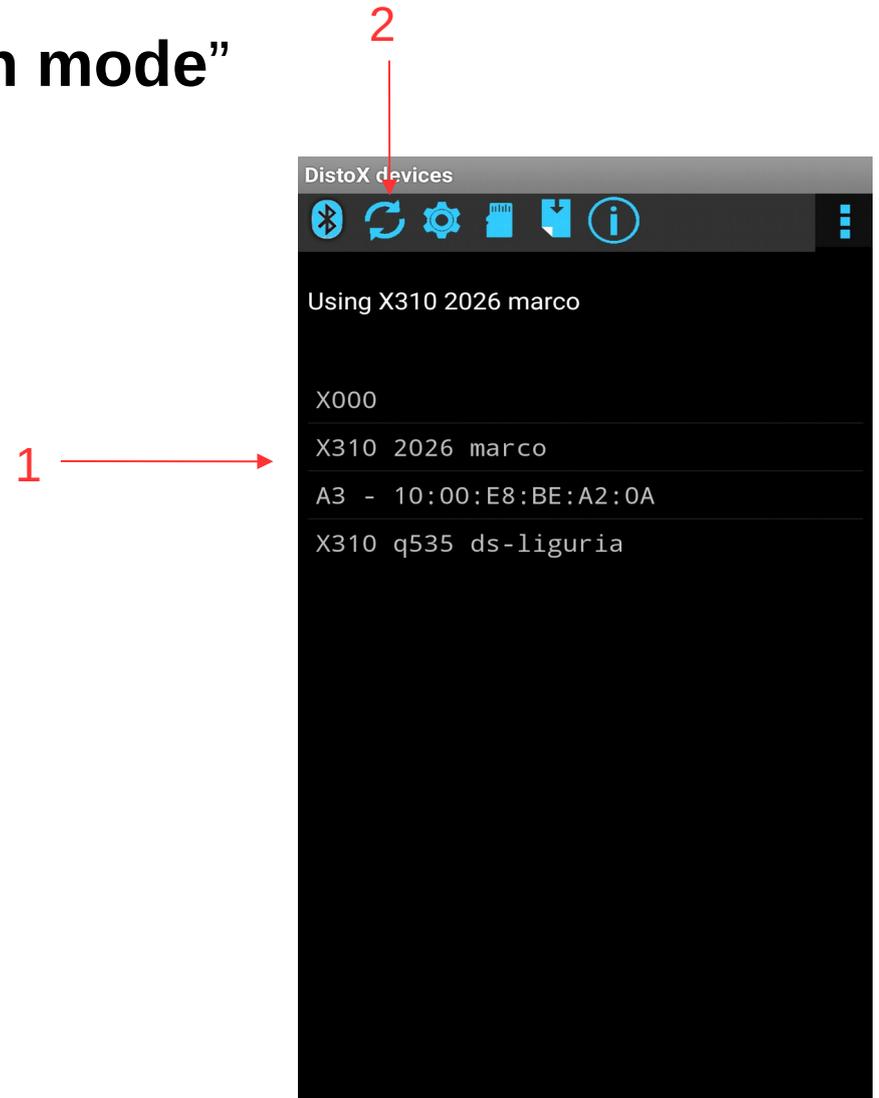
# Calibration transformation

- the DistoX calibration is a geometrical transformation that “rotate” the sensors measurements into the frame of reference of the DistoX
- 24 (or 27) numbers
- uploaded and stored in the DistoX
- automatically applied to every measurement



# How to “calibrate” a DistoX? [1]

- 1 Select the DistoX to calibrate as work device
- 2 Toggle the DistoX into “**calibration mode**”

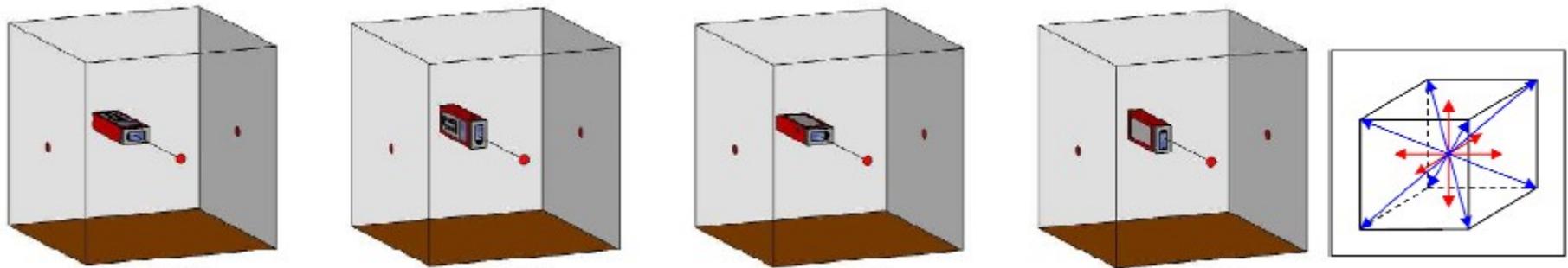


# How to “calibrate” a DistoX? [2]

- Take several measurements in directions that **covers all the azimuth and inclinations**
- For each direction **four** measurements rotating the DistoX around the laser axis by  $90^\circ$  at a time
- At a minimum (face centers and corners of a “cube”):
  - four directions in the horizontal plane, roughly at  $90^\circ$  of azimuth with one another
  - four directions at  $+35^\circ$ , and four at  $-35^\circ$ , roughly at  $90$  degrees of azimuth with one another, possibly at  $45^\circ$  of azimuth with those in the horizontal plane
  - one direction upward  $+90^\circ$ , and one  $-90^\circ$
- But you can take many more !!!

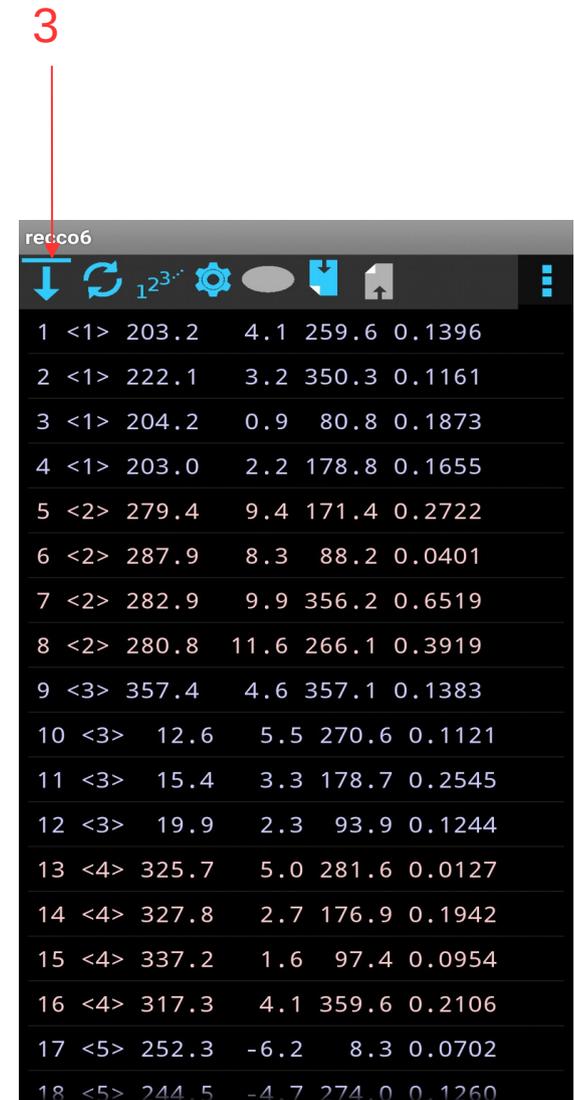
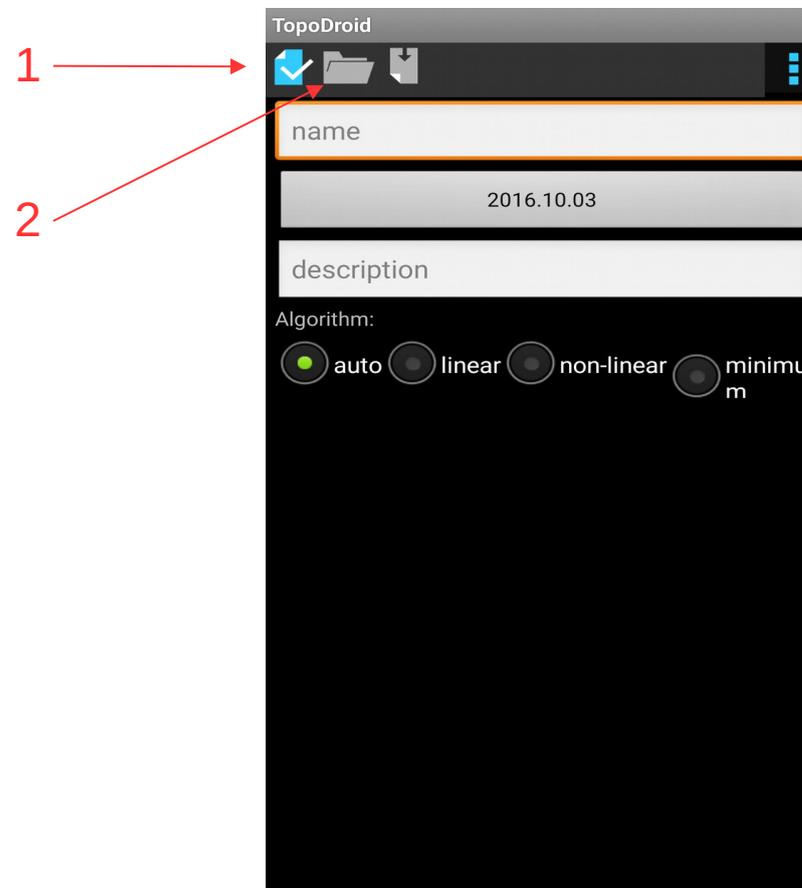
# How to “calibrate” a DistoX? [3]

- Calibration shots must be taken
  - in an environment with **constant magnetic field**: cave, wood. Not good: house, town, etc.
  - between **fixed** points: “stations”
  - enough **far apart** points (the farther the less uncertainty in the angle): 3 m
  - no need to be perfectly aligned to the “directions” of the “cube”



# How to “calibrate” a DistoX? [4]

- 1 Create a new Calibration in TopoDroid
- 2 Open it
- 3 Download the calibration shots

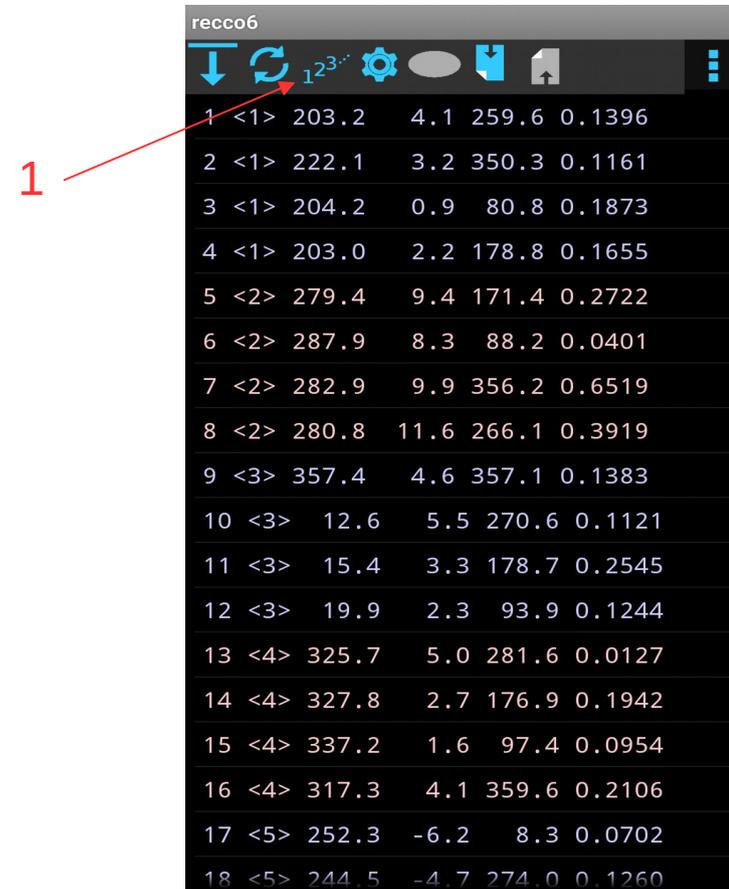


# How to “calibrate” a DistoX? [5]

1 Split the data into **groups** of four

each group corresponds to a set of four shots for a direction

N.B. TopoDroid implements other “grouping” policies, but “four per direction” is the best and the simplest: the DistoX displays the number of calibration shots and it is easy to see if this is a multiple of 4



Shot ID	Direction	Distance (m)	Angle (°)	Height (m)	Accuracy (m)
1	<1>	203.2	4.1	259.6	0.1396
2	<1>	222.1	3.2	350.3	0.1161
3	<1>	204.2	0.9	80.8	0.1873
4	<1>	203.0	2.2	178.8	0.1655
5	<2>	279.4	9.4	171.4	0.2722
6	<2>	287.9	8.3	88.2	0.0401
7	<2>	282.9	9.9	356.2	0.6519
8	<2>	280.8	11.6	266.1	0.3919
9	<3>	357.4	4.6	357.1	0.1383
10	<3>	12.6	5.5	270.6	0.1121
11	<3>	15.4	3.3	178.7	0.2545
12	<3>	19.9	2.3	93.9	0.1244
13	<4>	325.7	5.0	281.6	0.0127
14	<4>	327.8	2.7	176.9	0.1942
15	<4>	337.2	1.6	97.4	0.0954
16	<4>	317.3	4.1	359.6	0.2106
17	<5>	252.3	-6.2	8.3	0.0702
18	<5>	244.5	-4.7	274.0	0.1260

# How to “calibrate” a DistoX? [6]

- 1 **Compute** the calibration coefficients
- 2 **upload** them to the DistoX
- 3 and revert the DistoX to “normal mode”

The screenshot shows a terminal window titled 'recco6' displaying calibration data. A red arrow labeled '1' points to a gear icon in the terminal's toolbar. Another red arrow labeled '2' points to a blue 'Upload' button at the bottom of the calibration data section. A third red arrow labeled '3' points to a refresh icon in the toolbar. The calibration data is as follows:

```
103 <26> 194.1 10.2 165.3 0.0693
```

**Calibration coefficients**

bG	0.0003	0.0014	0.0137
aGx	0.9807	-0.0273	0.0068
aGy	0.0004	0.9904	0.0029
aGz	0.0268	0.0029	0.9981
bM	0.0231	-0.0782	-0.0128
aMx	1.5195	-0.0567	-0.0091
aMy	0.0288	1.4693	-0.0101
aMz	-0.0289	-0.1221	1.5336
nL	-0.0036	0.0043	0.0100

Average error: 0.2207 degrees  
Error stddev: 0.1935 degrees  
Max. error: 1.2030 degrees  
Iterations: 40

118 <30> 222.9 -0.0 81.0 0.2778  
119 <30> 221.5 0.7 183.1 0.3075  
120 <30> 222.2 2.8 265.2 0.2640

# Troubleshooting

- How can I tell whether the calibration is **good or not**?
  - The dialog with the calibration result has the histogram of the “error” of the shots: the calibration is “good” if all the bars are to the left of the red line, with most to the left of the yellow one
- How can I **exclude a shot** from the calibration computation?
  - Assign a group of “0” to it
- What if I take a **bad shot** by mistake ?
  - take other shots to complete the group of four and do not use them in the computation of the coefficients
- Can I take other groups of four shots and add them to a calibration?
  - yes

# Calibration settings

- Group policy
  - Group tolerance
- Algorithm
  - Algorithm error
  - Algorithm max. iterations
  - Min-algo params
- Raw data

# Next

- Other TopoDroid calibration functions
- Calibration checks
- Calibration validation
- Calibration algorithms
- B. Heeb's calibration algorithm