

# Tech. Note – Precision, Spatial Resolution & Repeatability

Some definitions and discussion of technical parameters

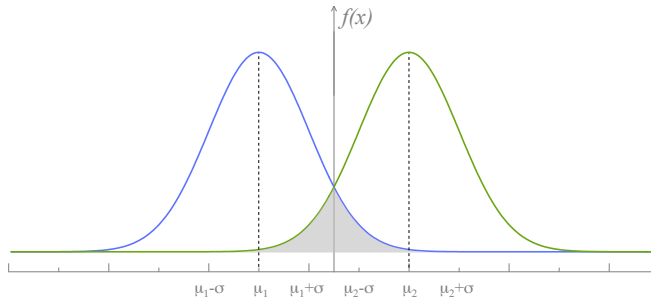
## ➔ Precision, also known Standard Deviation ( ISO standard )

Precision is the closeness of agreement between independent test results obtained under stipulated conditions. **The measure of precision is usually expressed in terms of imprecision and computed as a standard deviation of the test results.** Less precision is reflected by a larger standard deviation. [SOURCE: ISO 3534-2:2006,3.3.4]

## ➔ Spatial Resolution, discussion about the criterion

Resolution is generally defined as the smallest detectable interval between measured values. For a physical parameter whose measurement values follow a Gaussian distribution  $N(\mu, \sigma^2)$ , a significant portion of people equate the standard deviation  $\sigma$  directly with resolution, while others adopt a stricter criterion, such as  $3\sigma$ .

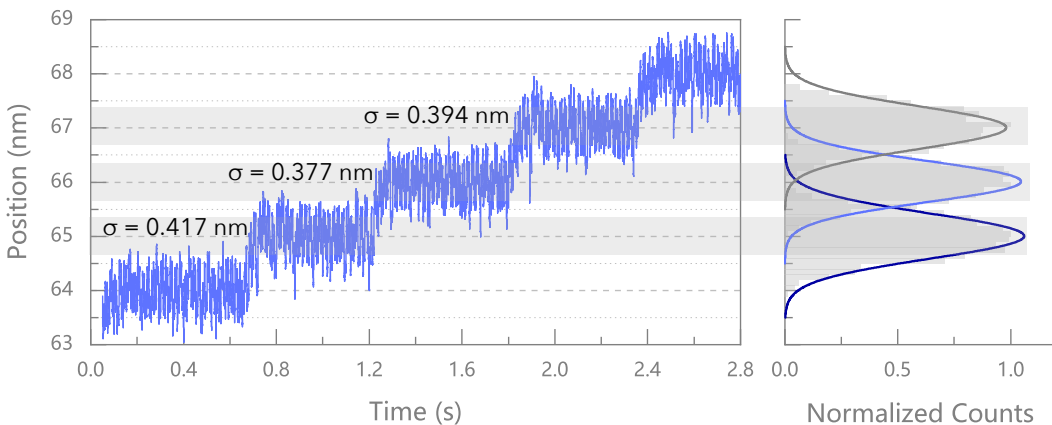
When the measured values are adjacent, the percentage of overlapping area between their Gaussian distributions determines the distinguishability of these two values, which is a critical factor in defining the resolution.



## ➔ Example, Spatial resolution of Scanner.Ultra motion

Scanner35-z.Ultra was operated at 4.2 K in a ultra low-vibration cryogenic platform (ColdTABLE) .

The data acquisition from the capacitive sensor showed the RMS noise ( $\sigma$ ) during closed-loop control was typically  $\sim 0.4$  nm. We make scanner to move step by step with 1 nm distance. It is easy to distinguish steps.



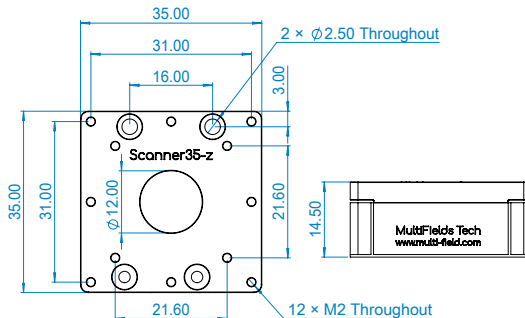


# "Closed-loop scanner series" – Scanner35-z.Ultra

Scanners with sub-nanoscale resolution capacitive displacement sensors for closed-loop control

- ➔ Features
- Compact design
  - Long travel range
  - Closed-loop control
  - High load & high force
  - Non-magnetic material

➔ Picture & dimensions



➔ Specifications

| Optional Versions ➔    | .HV (default)                                                                                                                                  | .ULT | .UHV    | .ULT.UHV |
|------------------------|------------------------------------------------------------------------------------------------------------------------------------------------|------|---------|----------|
|                        | .HV version, compatible with 1E-7 mbar<br>.ULT version, used at He3 or dilution cryogenics systems<br>.UHV version, compatible with 2E-11 mbar |      |         |          |
| 1 Footprint × hight    | 35 × 35 mm × 14.5 mm                                                                                                                           |      |         |          |
| 2 Weight               | 110 g                                                                                                                                          |      |         |          |
| 3 Work environment     | Temperature range: 1.4 ~ 400 K, Max. Magnetic field: 35 Tesla                                                                                  |      |         |          |
| 4 Option1 - 30 mK      |                                                                                                                                                | ✓    |         | ✓        |
| 5 Option2 - 2e-11 mbar |                                                                                                                                                |      | ✓       | ✓        |
| 6 Mainbody             | Pure Ti                                                                                                                                        | BeCu | Pure Ti | BeCu     |
| 7 Wires                | twisted paired wire & triax cable                                                                                                              |      |         |          |
| 8 Connectors           | 2 head pins + 1 triax connector (for each dimension)                                                                                           |      |         |          |
| 9 Scanning Axis        | Z                                                                                                                                              |      |         |          |
| 10 Travel range        | @300 K: 100 µm; @4 K: 60 µm                                                                                                                    |      |         |          |
| 11 Drive Voltage       | Max. 75 V @300 K; Max. 150 V @4 K                                                                                                              |      |         |          |
| 12 Max. Load           | 500 g                                                                                                                                          |      |         |          |
| 13 Capacitance @300 K  | 7 uF                                                                                                                                           |      |         |          |
| 14 Sensor              | Capacitive displacement sensor                                                                                                                 |      |         |          |
| 15 Resolution          | 0.5 nm                                                                                                                                         |      |         |          |
| 16 Linearity error     | Typical ~ 0.1 %                                                                                                                                |      |         |          |
| 17 Repeatability       | < 5 nm                                                                                                                                         |      |         |          |

For detail drawing and 3D model please contact us.



Scanner25-z



Scanner35-xy-Optic



Scanner35-z-Optic

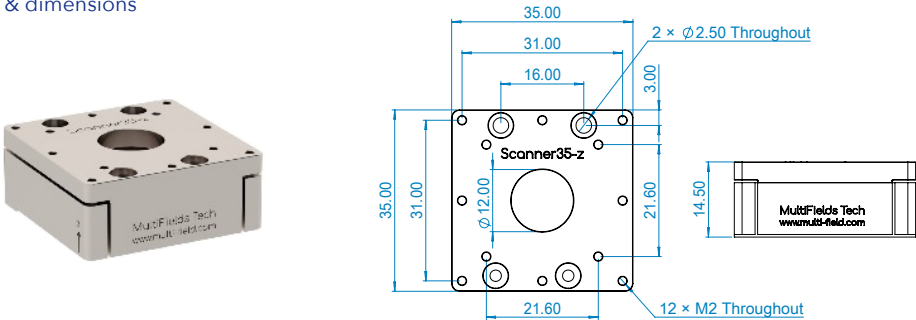
| "25mm Series"                                                                                                                                          | "35mm Series"     |                   | Series defined by size |    |
|--------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|-------------------|------------------------|----|
| Default: 1.4 K ~ 400 K; 1e-7 mbar; 35 Tesla<br>Option1 - .ULT, lowest use temperature 30 mK;<br>Option2 - .UHV, highest vacuum environment 2E-11 mbar; |                   |                   | Work Environment       | 1  |
| Z                                                                                                                                                      | X, Y              | Z                 | Scanning Axes          | 2  |
| 25 × 25 × 12 mm                                                                                                                                        | 35 × 35 × 14.5 mm | 35 × 35 × 14.5 mm | Dimensions             | 3  |
| 55 μm                                                                                                                                                  | 100 × 100 μm      | 100 μm            | Travel Range           | 4  |
| 200 g                                                                                                                                                  | 500 g             | 500 g             | Max. Load              | 5  |
| < 10 nm                                                                                                                                                |                   |                   | Repeatability          | 6  |
| Max. 75 V @300K; Max. 180 V @4K                                                                                                                        |                   |                   | Drive Voltage          | 7  |
| 0.8 nm                                                                                                                                                 | 2 nm              | 2 nm              | Resolution             | 8  |
| 2 pins                                                                                                                                                 | 4 pins            | 2 pins            | Pins                   | 9  |
| Default: Pure Ti; ULT: BeCu                                                                                                                            |                   |                   | Main Body              | 10 |
| 20 g                                                                                                                                                   | 65 g              | 65 g              | Weight                 | 11 |

# "35mm Series" – Scanner35-z-Optic

High-performance scanning stage of z direction with long travel range

- ➔ Features
- Compact design
  - Sub-nm resolution
  - 100 um travel range at room temperature
  - Ultra-high vacuum & low temperature compatible

➔ Picture & dimensions



➔ Specifications

| Optional Versions ⇨ |                      | .HV (default)                                                                                                                                  | .ULT | .UHV       | .ULT.UHV |
|---------------------|----------------------|------------------------------------------------------------------------------------------------------------------------------------------------|------|------------|----------|
|                     |                      | .HV version, compatible with 1E-7 mbar<br>.ULT version, used at He3 or dilution cryogenics systems<br>.UHV version, compatible with 2E-11 mbar |      |            |          |
| 1                   | Footprint × hight    | 35 × 35 × 14.5 mm                                                                                                                              |      |            |          |
| 2                   | Weight               | 65 g                                                                                                                                           |      |            |          |
| 3                   | Work environment     | Temperature range: 1.4 ~ 400 K, Max. Magnetic field: 35 Tesla                                                                                  |      |            |          |
| 4                   | Option1 - 30 mK      |                                                                                                                                                | ✓    |            | ✓        |
| 5                   | Option2 - 2e-11 mbar |                                                                                                                                                |      | ✓          | ✓        |
| 6                   | Mainbody             | Pure Ti                                                                                                                                        | BeCu | Pure Ti    | BeCu     |
| 7                   | Wires                | Phosphor Bronze Twisted Paired Wires, 20cm                                                                                                     |      |            |          |
| 8                   | Pin materials        | Polyster (glass fiber filled), BeCu                                                                                                            |      | Peek, BeCu |          |
| 9                   | Pins number          | 2 pins                                                                                                                                         |      |            |          |
| 10                  | Scanning Axes        | Z                                                                                                                                              |      |            |          |
| 11                  | Travel range @300 K  | 100 μm                                                                                                                                         |      |            |          |
| 12                  | Drive voltage        | Max. 75 V @300 K, Max. 180 V @4 K                                                                                                              |      |            |          |
| 13                  | Max. Load            | 500 g                                                                                                                                          |      |            |          |
| 14                  | Capacitance @300 K   | 8 uF                                                                                                                                           |      |            |          |
| 15                  | Resolution           | 2 nm                                                                                                                                           |      |            |          |
| 16                  | Repeatability        | < 10 nm                                                                                                                                        |      |            |          |

For detail drawing and 3D model please contact us.