# Inspection and Quality Control




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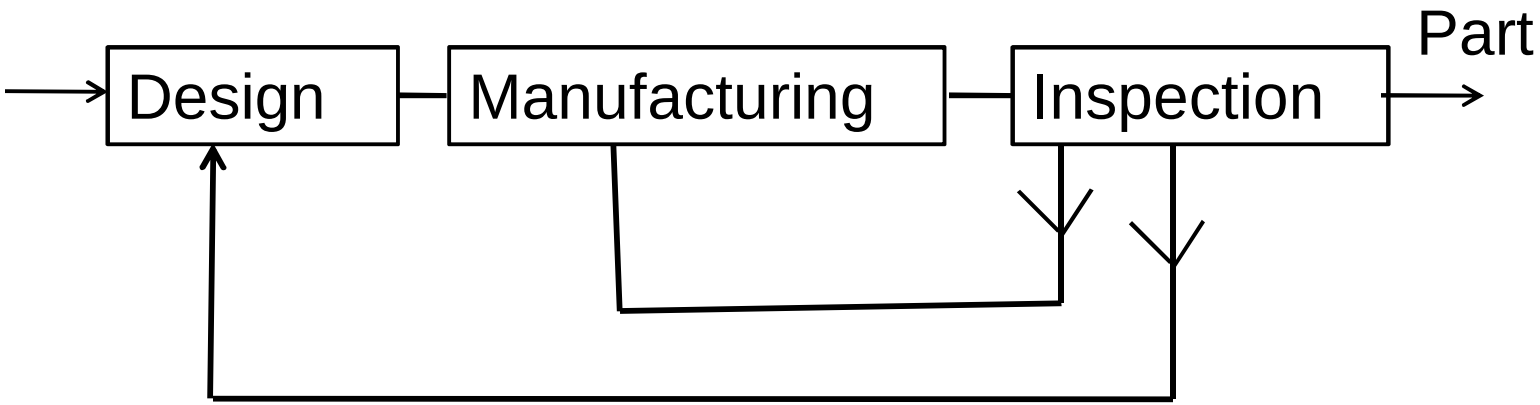
# Outline

- Need for Inspection and Quality Control
- Modes of Inspection
  - Accuracy Testing of Machine Tools
  - Part / Product inspection
  - Process Quality Control
- Basics of Metrology
  - Definitions
  - Metrology Instruments.

# Inspection

*Watchdog* of a Manufacturing Process




Product cost = *Material* + *Production* + *Inspection*

Cost of inspection is *Significantly High.*

Inspection Process is mostly manual.

# Inspection Process

## Objective

- Assess Conformity with Design Specifications
- Improve Product *Quality* and *Reliability*

## Constraints on Inspection

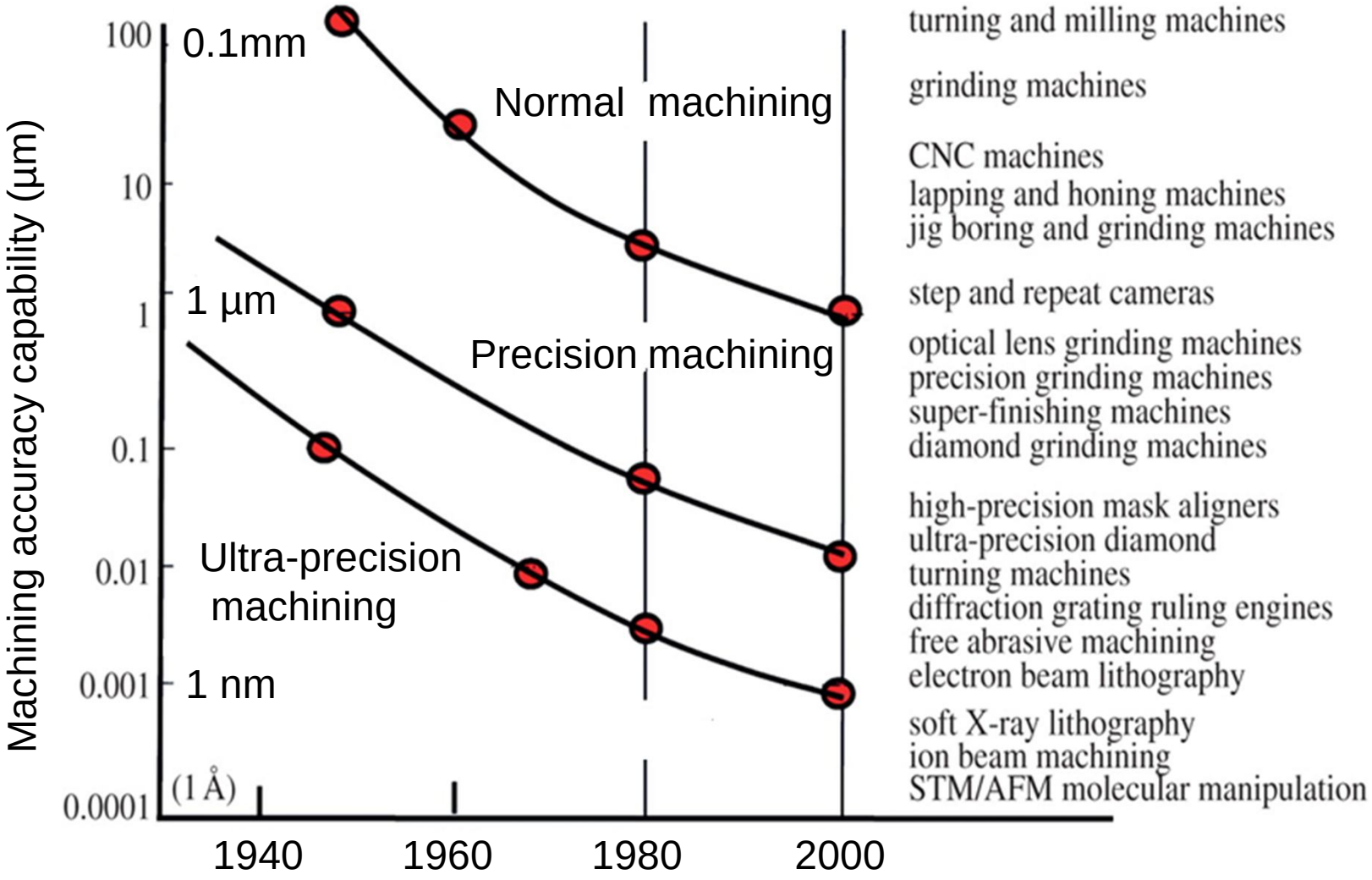
- Product Volume
- Product Cost
- Product Functional Performance

# Global Manufacturing Scenario

Challenges

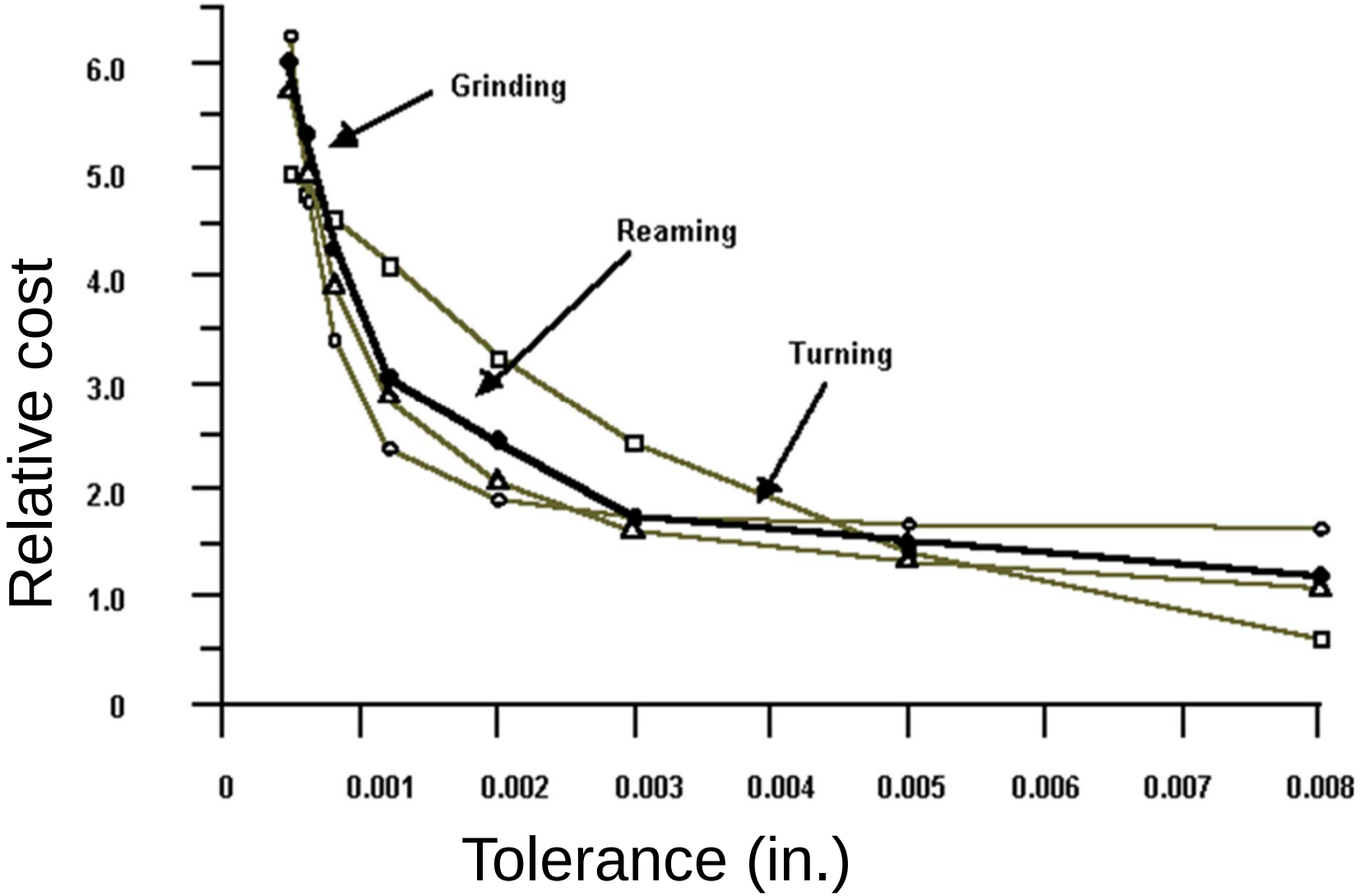
- Miniaturization
- High Precision and Accuracy
- High Productivity and Reliability
- *Shortest* Time to market
- Quick *Turn-around*

# Machining Accuracy

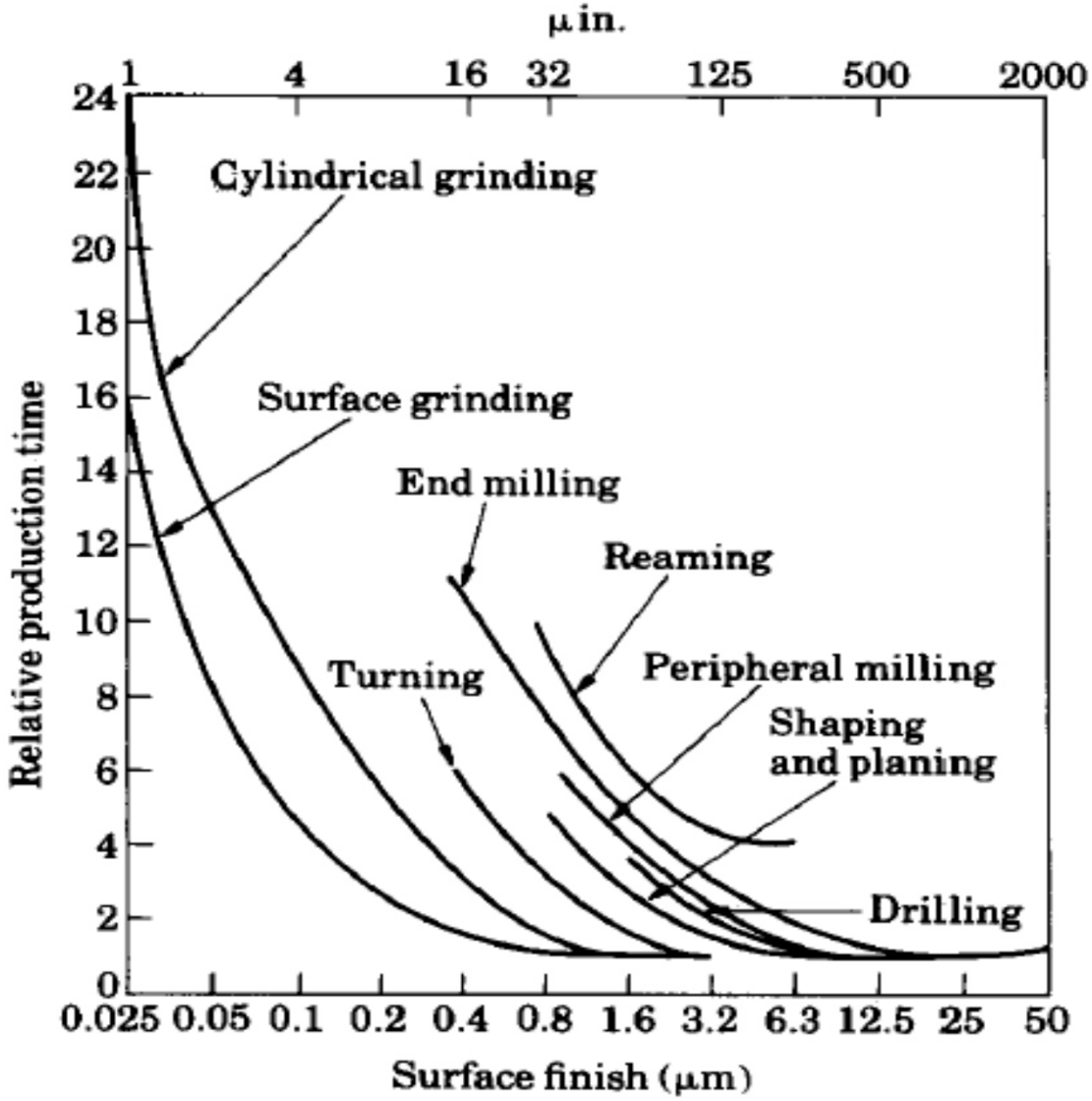



Ref: Taniguchi

# Cost – Tolerance relation



# Production Time - Surface Finish



# Stages in Product - Process Inspection

## Product Development

- Part Production and Inspection
- Assembly Testing
- Prototype Testing
  - Kinematic (No load) Testing
  - Performance Testing
- Roll Out

## Process Monitoring

- Process inspection and control

# Modes of Inspection

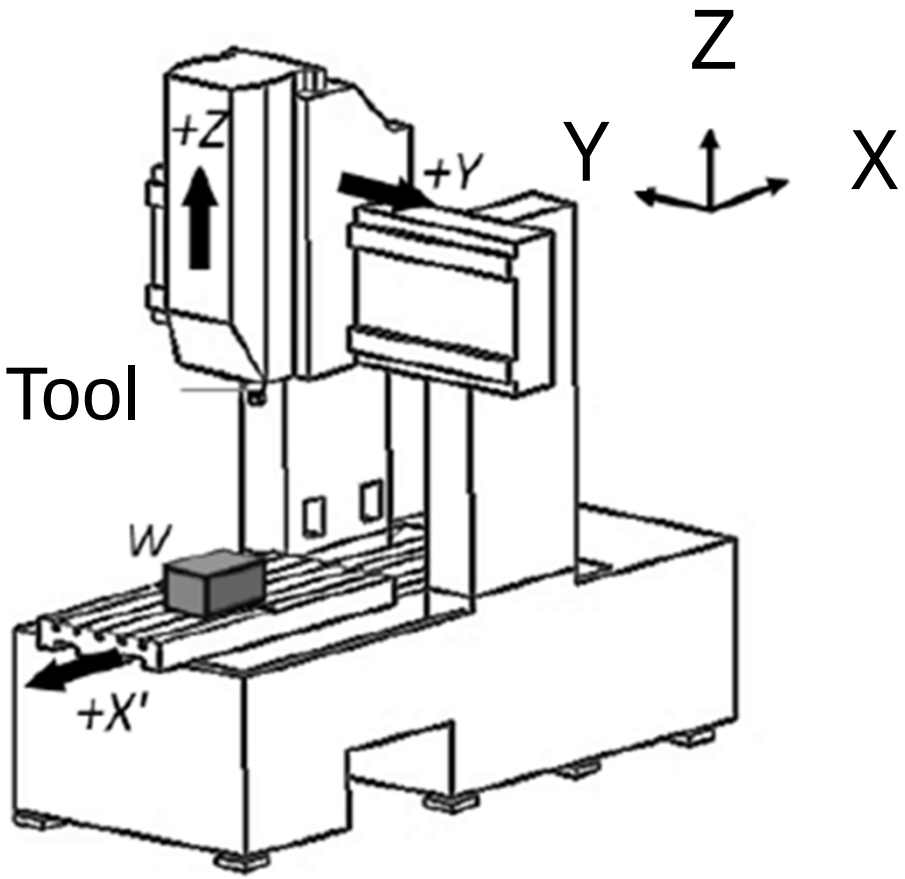
- Accuracy Testing of Machine Tools
- Part / Product inspection
- Process Quality Control

# Accuracy Testing of Machine Tools

## Objective

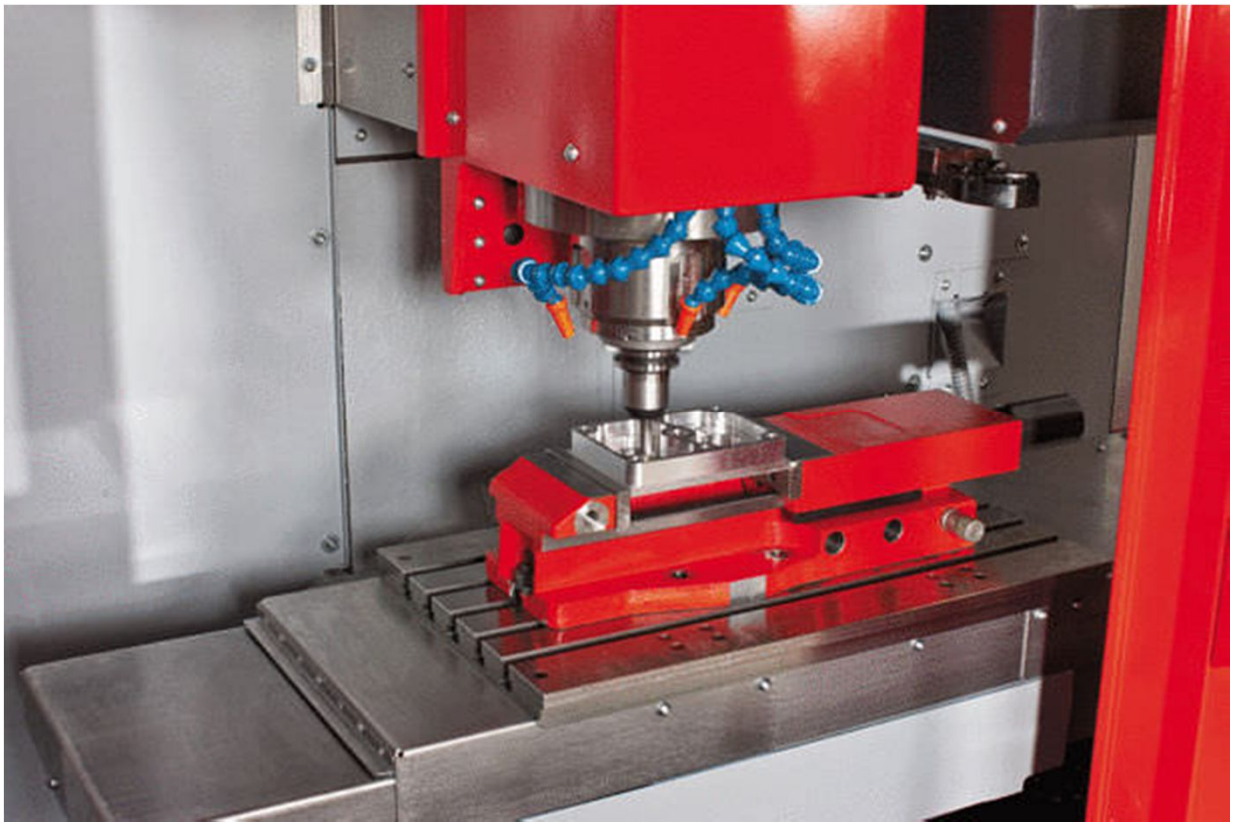
- To Test kinematic and Geometric accuracy of Machine Tool
  - Alignment, Location, Orientation errors between *Spindle, Slides, Tool/ work Holders*
- Certification, Maintenance tasks, History

# Configuration of CNC Machine



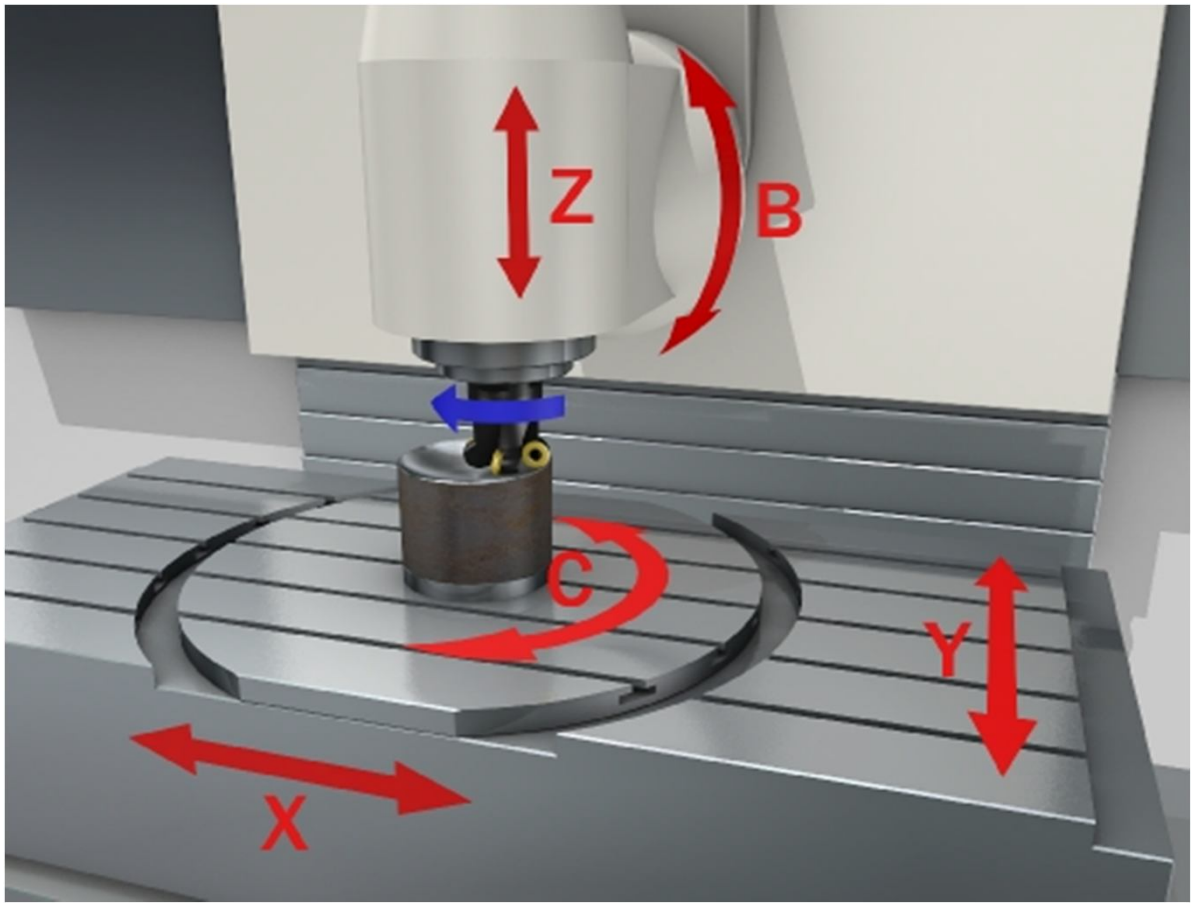

Gantry type

# 3- Axis CNC Milling Machine



X - Y - Z

# 5 – Axis CNC Milling Machine




X - Y – Z – B - C

# Precision Machine Tools

## Desirable Characteristics

- Accurate running Spindle
- Perpendicularity of Spindle with Table
- Straightness of slides (axes)
- Parallelism between axes
- Location accuracy of axes
- Angularity errors between Axes

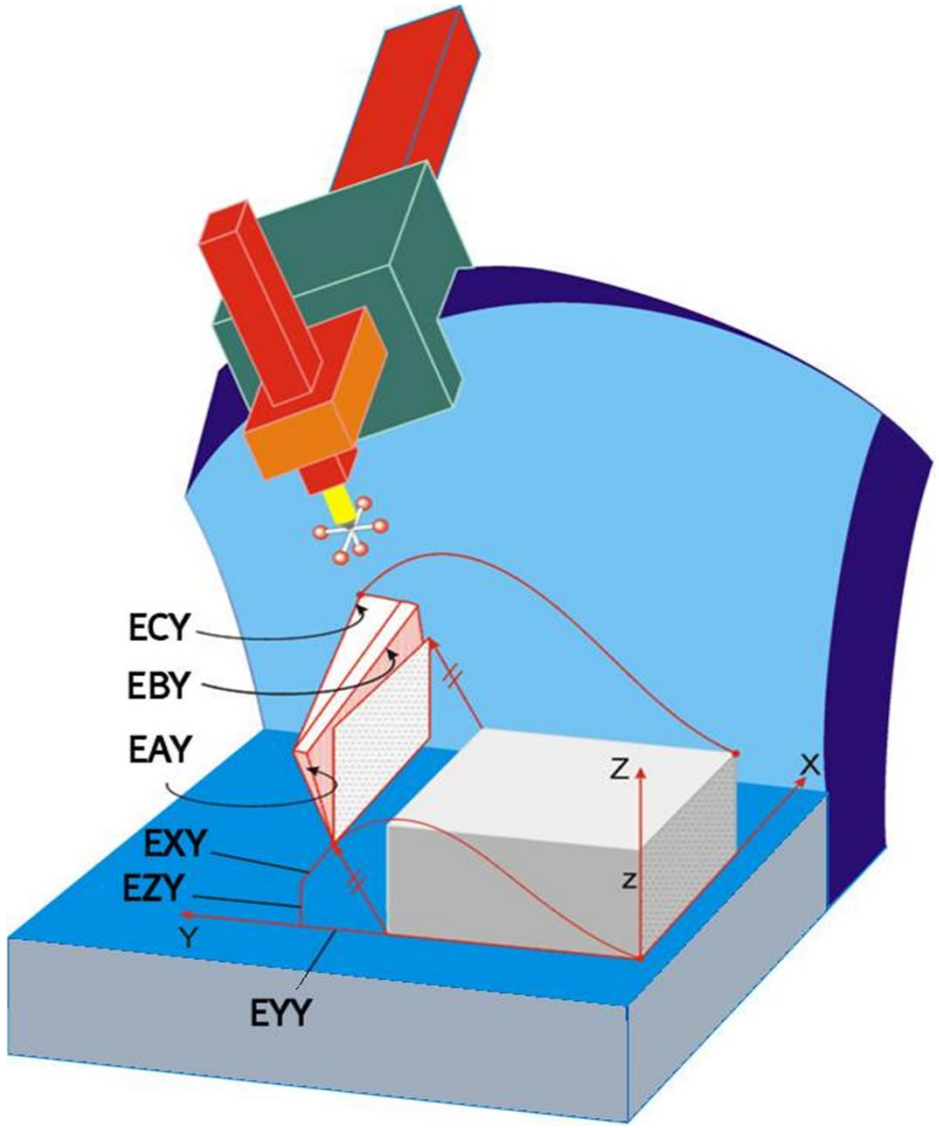
# 3 Axis CNC Machine Tool

Axes : X, Y, Z

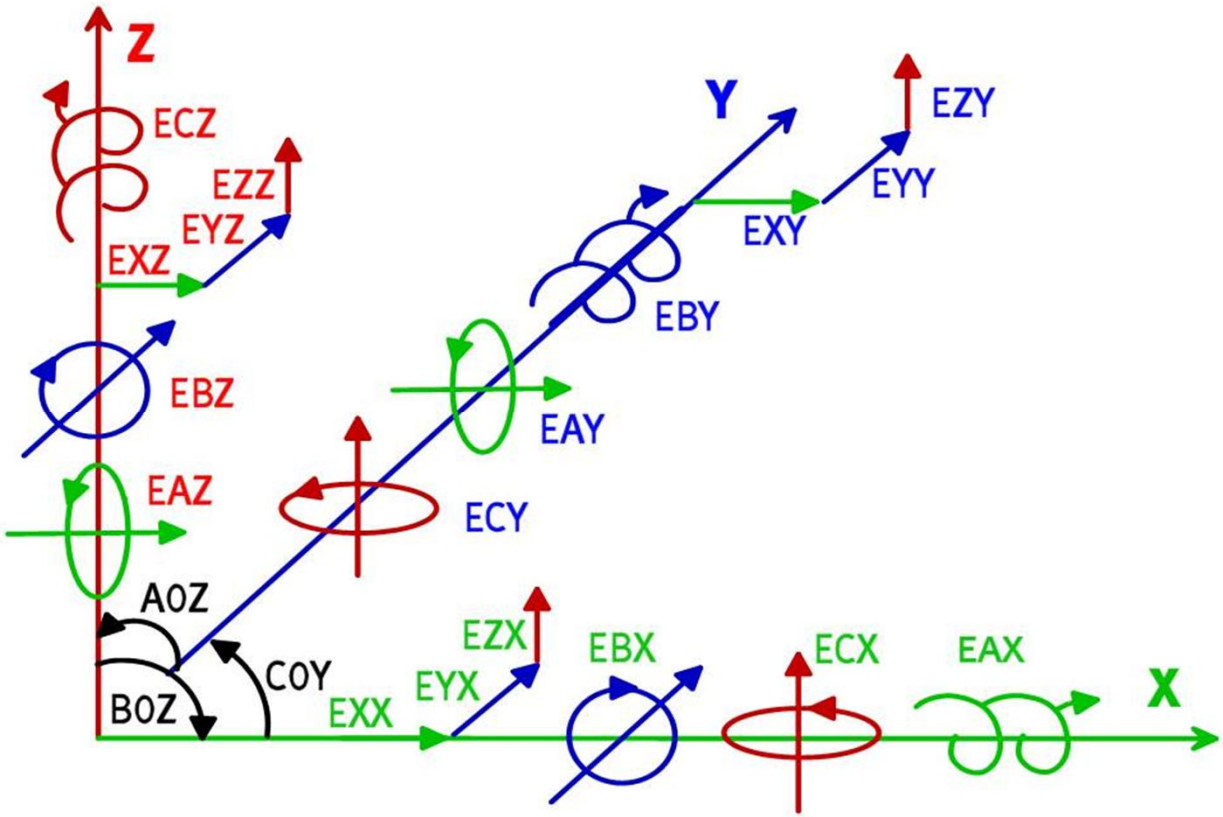
Geometric errors per axis

| | | |
|---|---|---|
| Location error | : | 1 |
| Straightness errors | : | 2 |
| Angular errors | : | 3 |
| Total no of errors for machine | : | 18 |

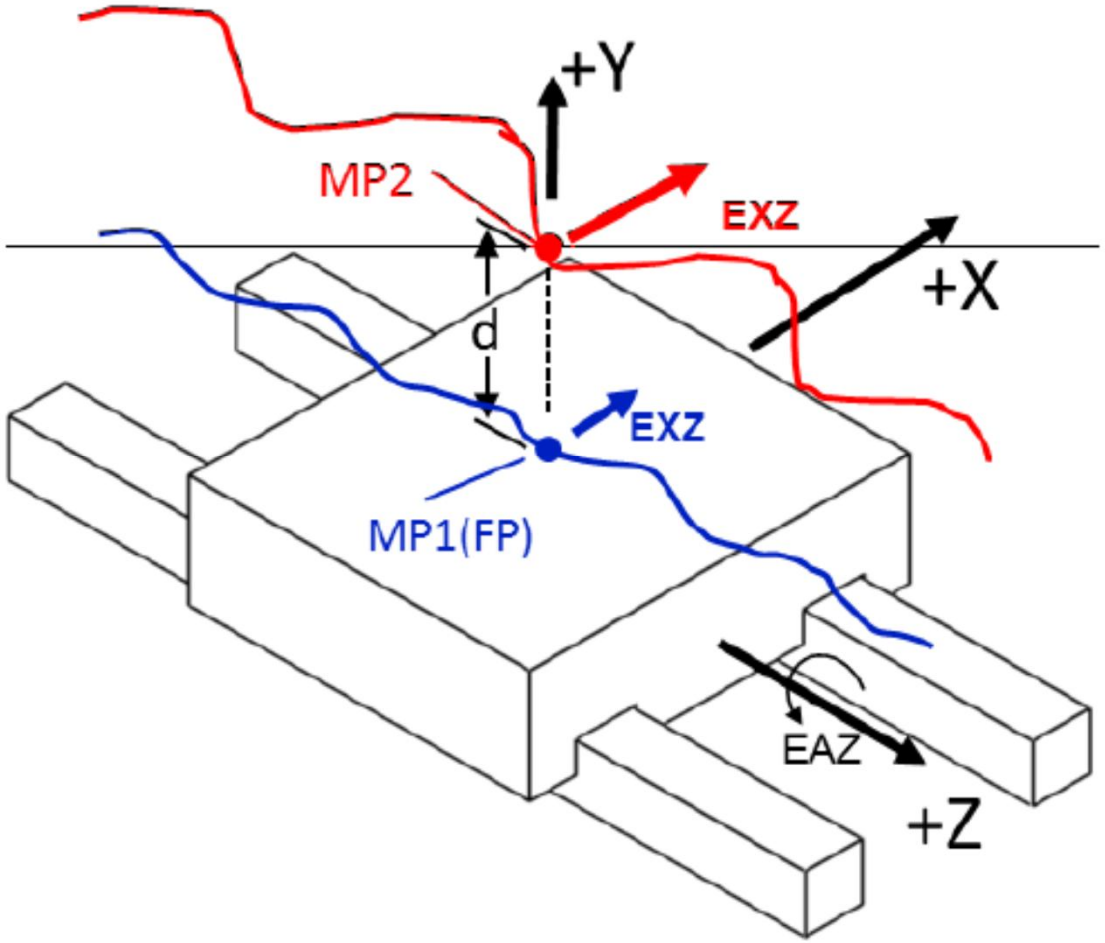
# Geometric Errors for Y axis



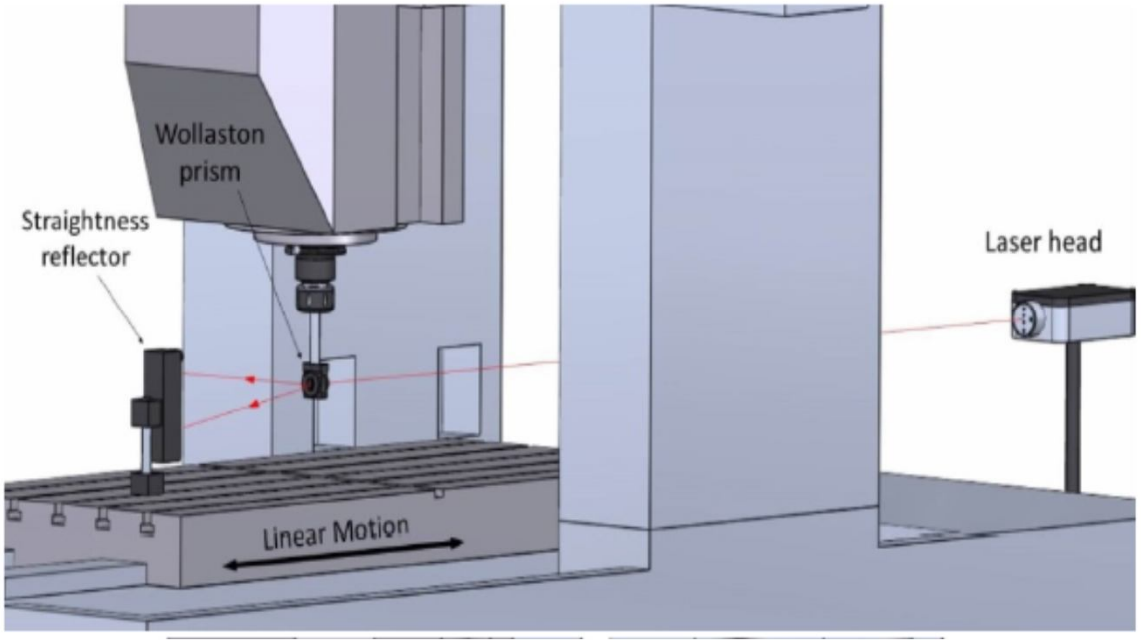
# Geometric Errors for 3 axis CNC



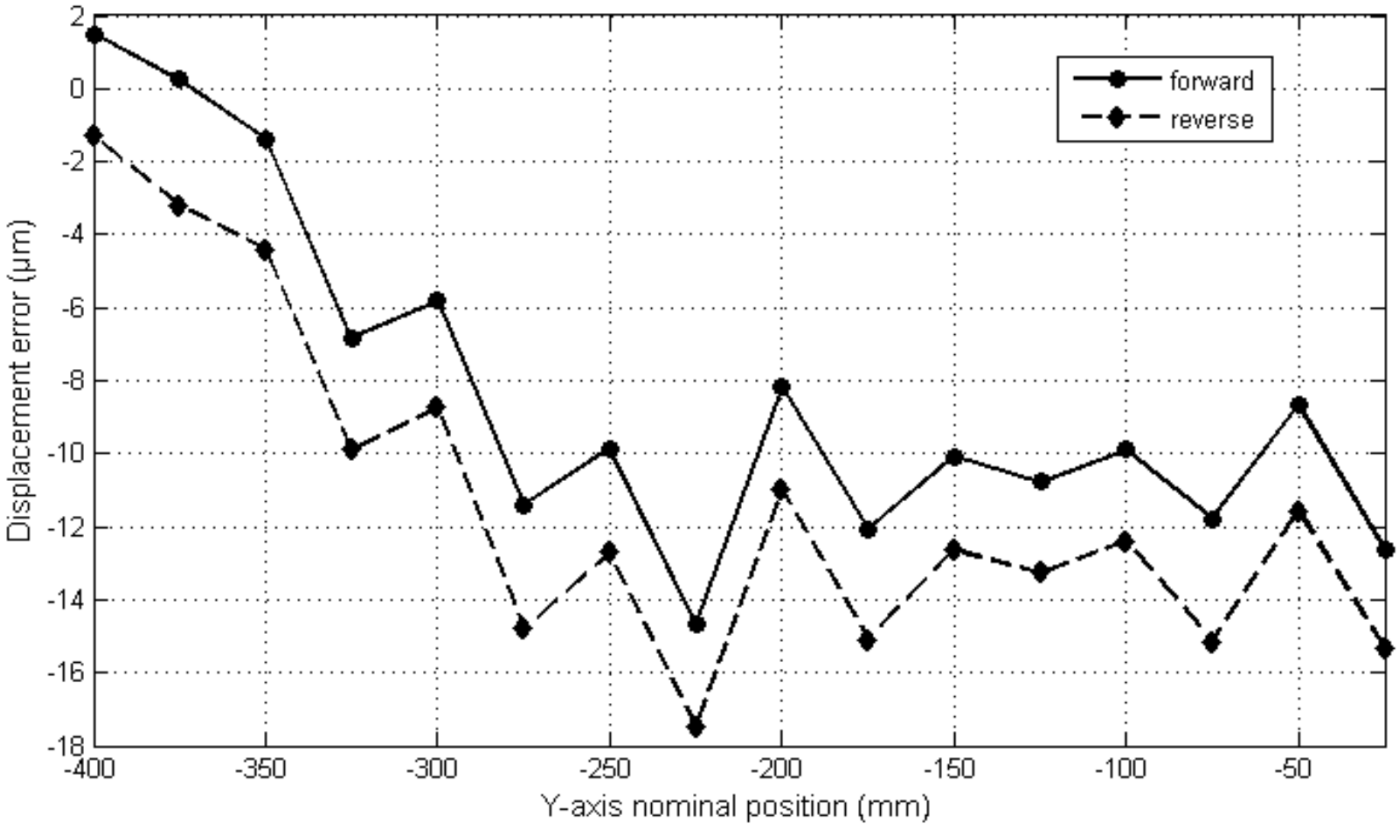
# Straightness Error of Z axis - EXZ



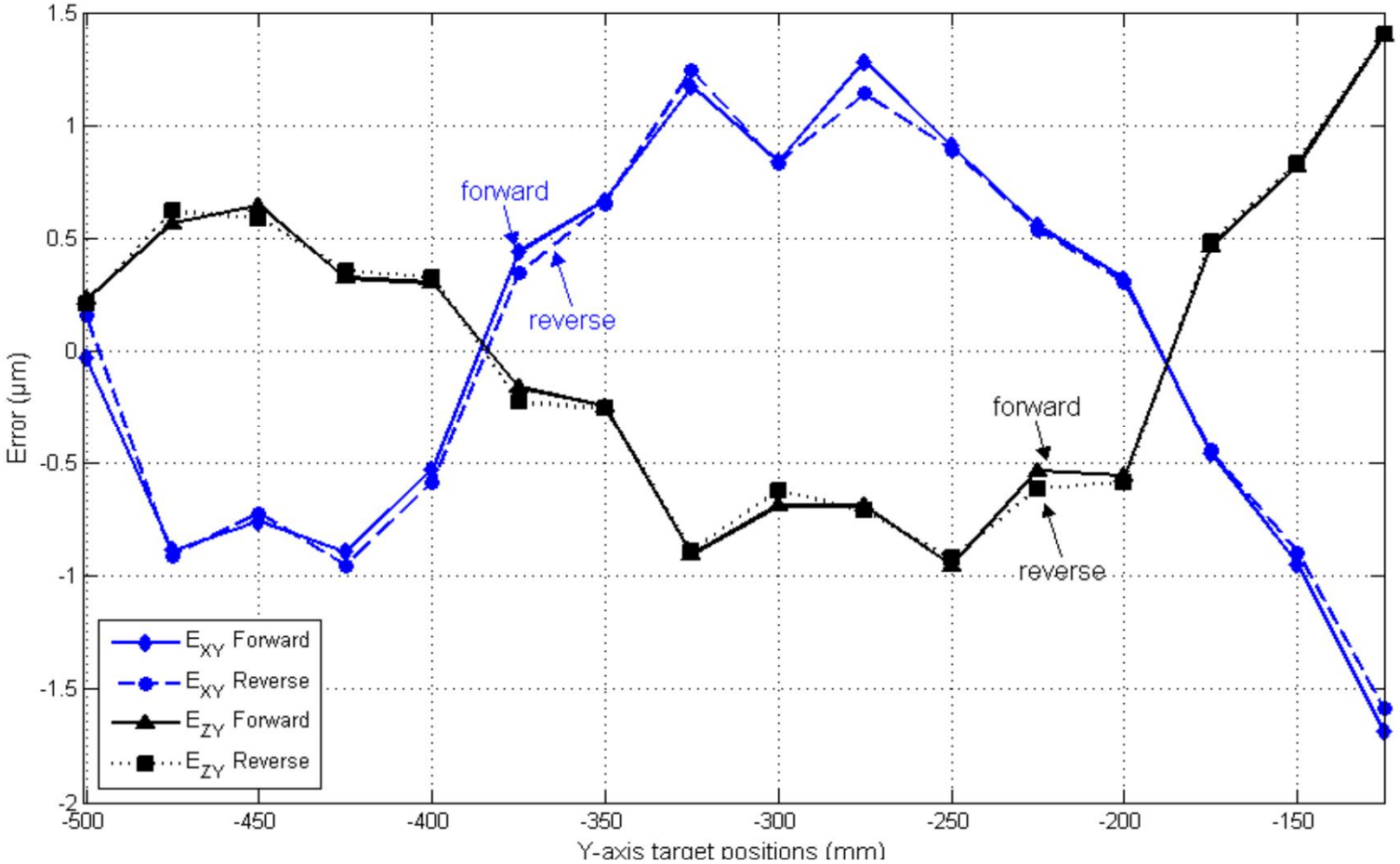
# Testing Straightness - Linear axis



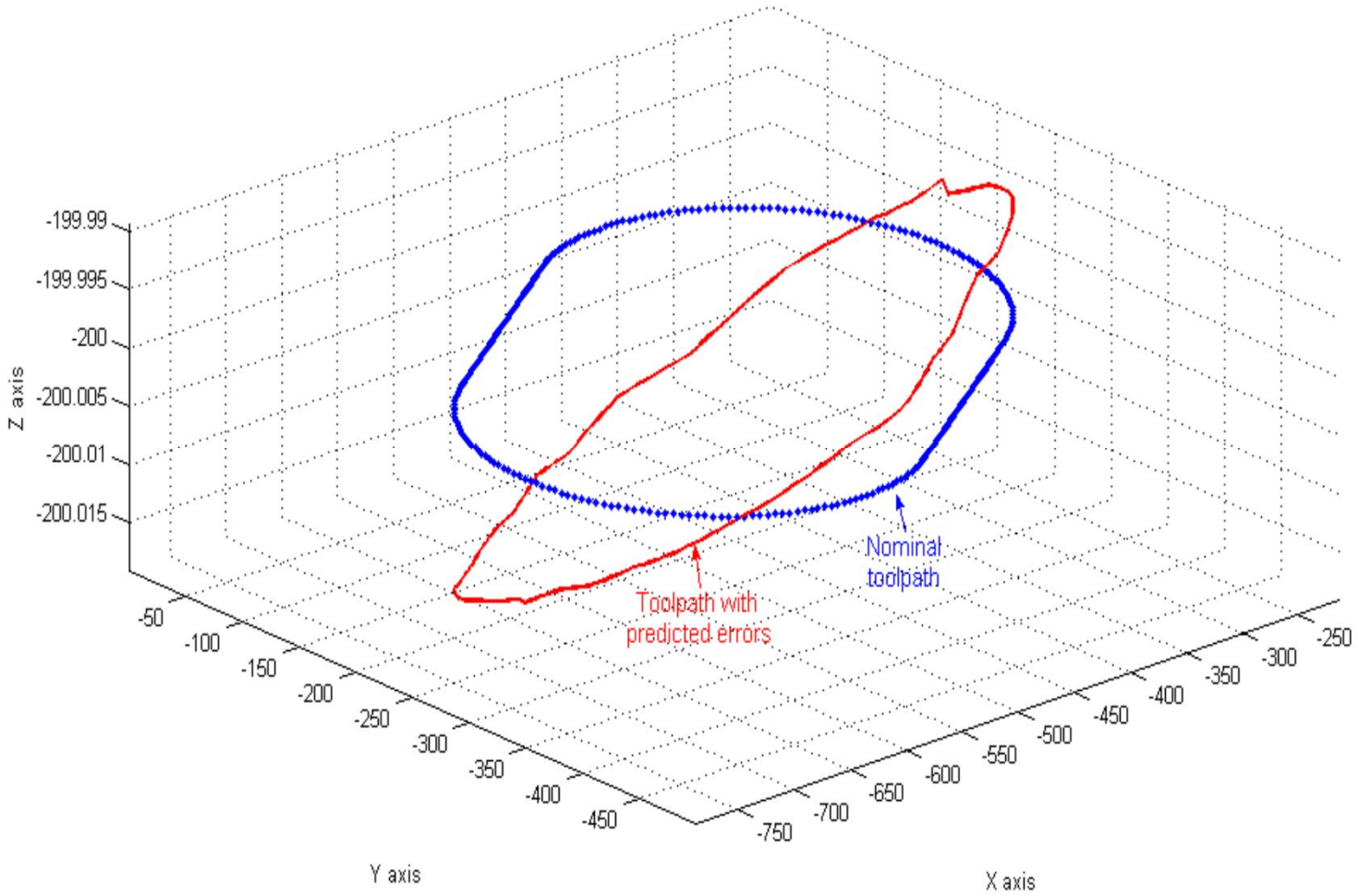
# Location Errors – Y axis



# Straightness Errors – Y axis



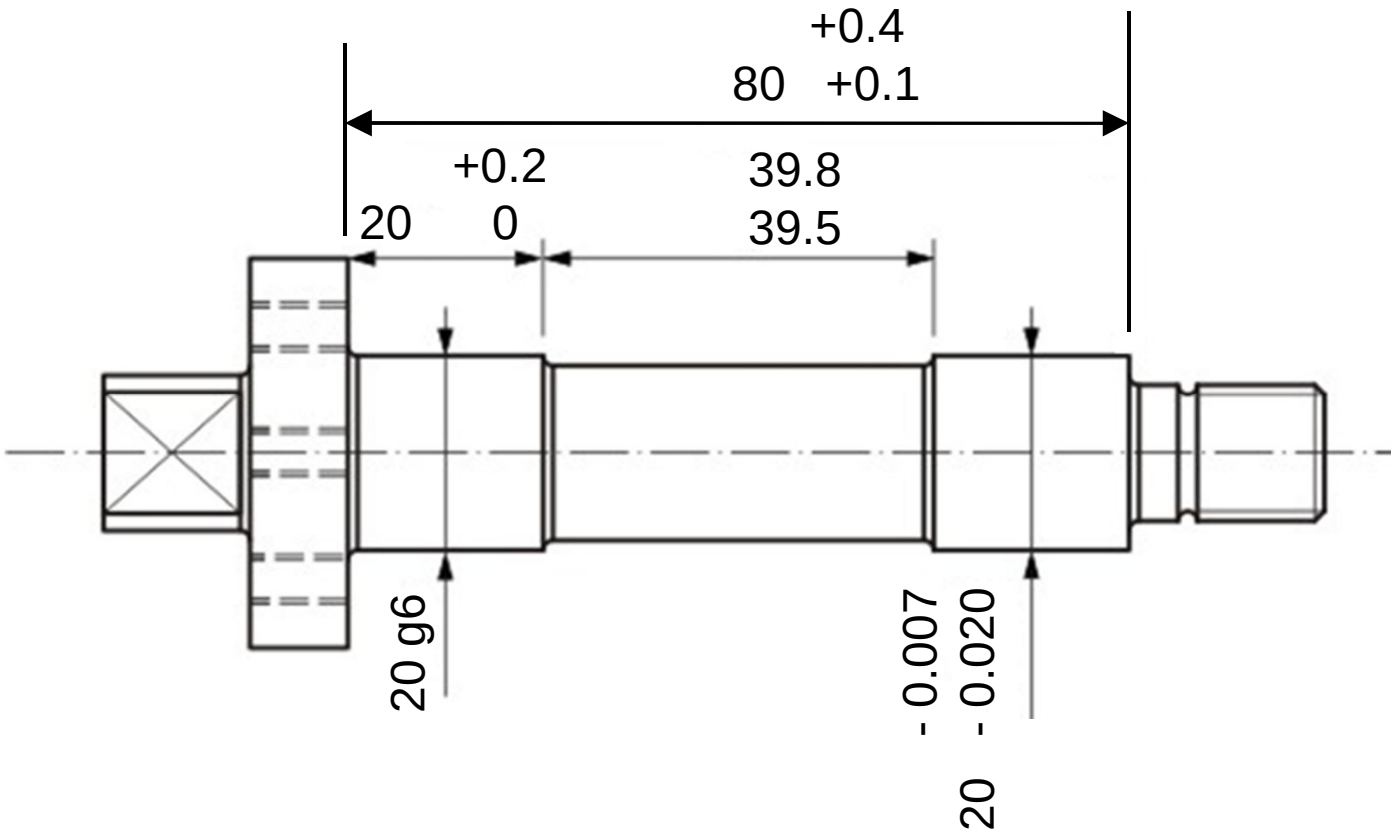
# Tool Path with Geometric Errors



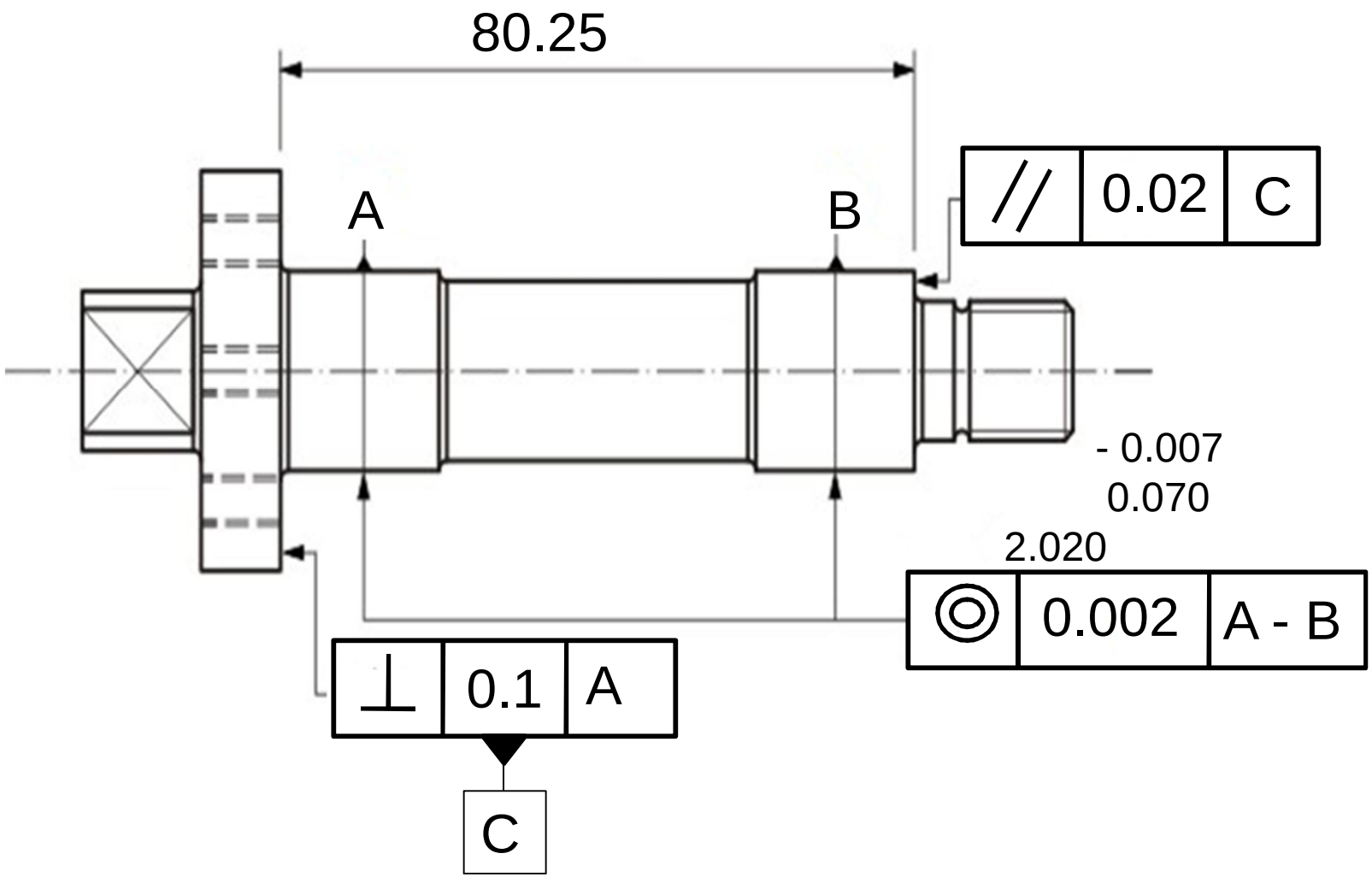
# Part Inspection

- Dimensional Tolerance
- Geometric Tolerance
  - Form
  - Orientation
  - Location
  - Position
- Surface Finish
  - Topography

# Part with Dimensional Tolerances

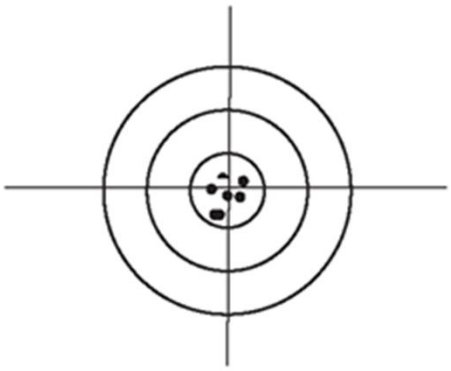


# Part with Geometric Tolerances

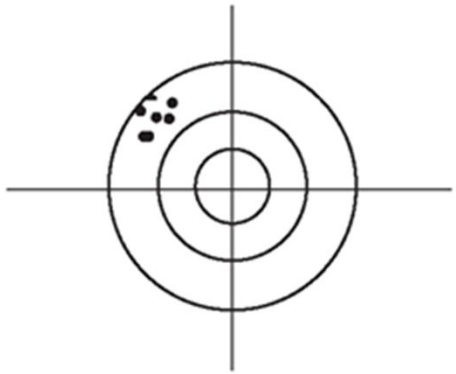


# Basics of Metrology

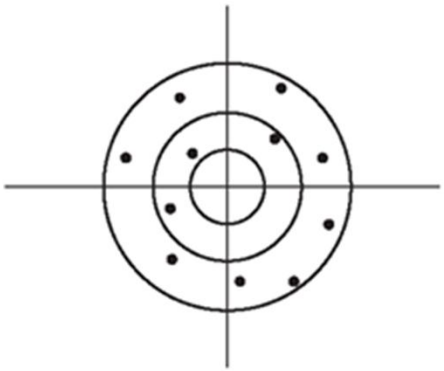
# Precision and Accuracy



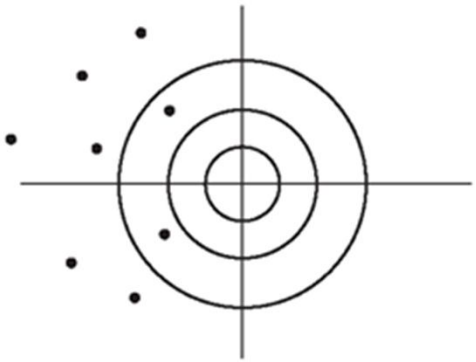
Both accurate and precise



Precise, but not accurate



Accurate, but not precise



Neither accurate nor precise