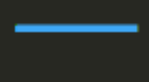
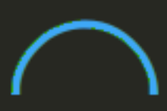
CMR

CMM Metrology Reference Guide

Featuring Zeiss CMMs & Calypso Software

ZEISS

GD&T Quick Reference

	Symbol	Name
Form		Flatness
		Circularity
		Cylindricity
		Straightness
Profile		Profile of a Surface
		Profile of a Line
Orientation		Parallelism
		Perpendicularity
		Angularity
Location		Position
		Concentricity
		Symmetry
Runout		Runout
		Total Runout

Symbol	Term
Ⓜ	AT MAXIMUM MATERIAL CONDITION (When applied to a tolerance value) AT MAXIMUM MATERIAL BOUNDARY (When applied to a datum reference)
Ⓛ	AT LEAST MATERIAL CONDITION (When applied to a tolerance value) AT LEAST MATERIAL BOUNDARY (When applied to a datum reference)

Rule #1

Size controls form

Where only a tolerance of size is specified, the limits of size of an individual feature of size prescribe the extent to which variations in its geometric form, as well as its size, are allowed. No element of a feature shall extend beyond the MMC boundary of perfect form. The form tolerance increases as the actual size of the feature departs from MMC toward LMC. There is no perfect form boundary requirement at LMC

Rule #2

Regardless of feature size

RFS automatically applies, in a feature control frame, to individual tolerances of size features and to datum features of size. MMC and LMC must be specified when these conditions are required.

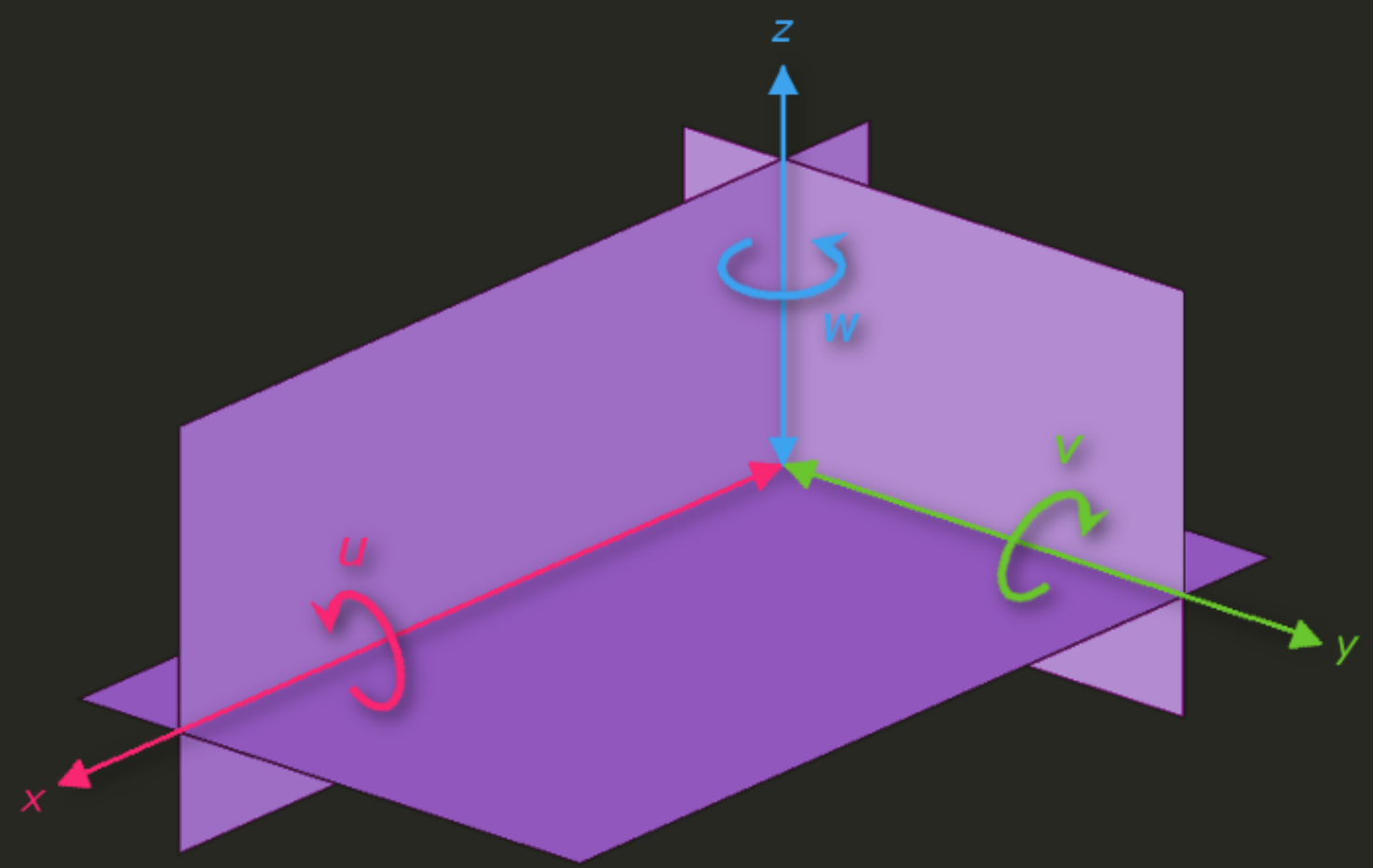
6 Degrees of Freedom

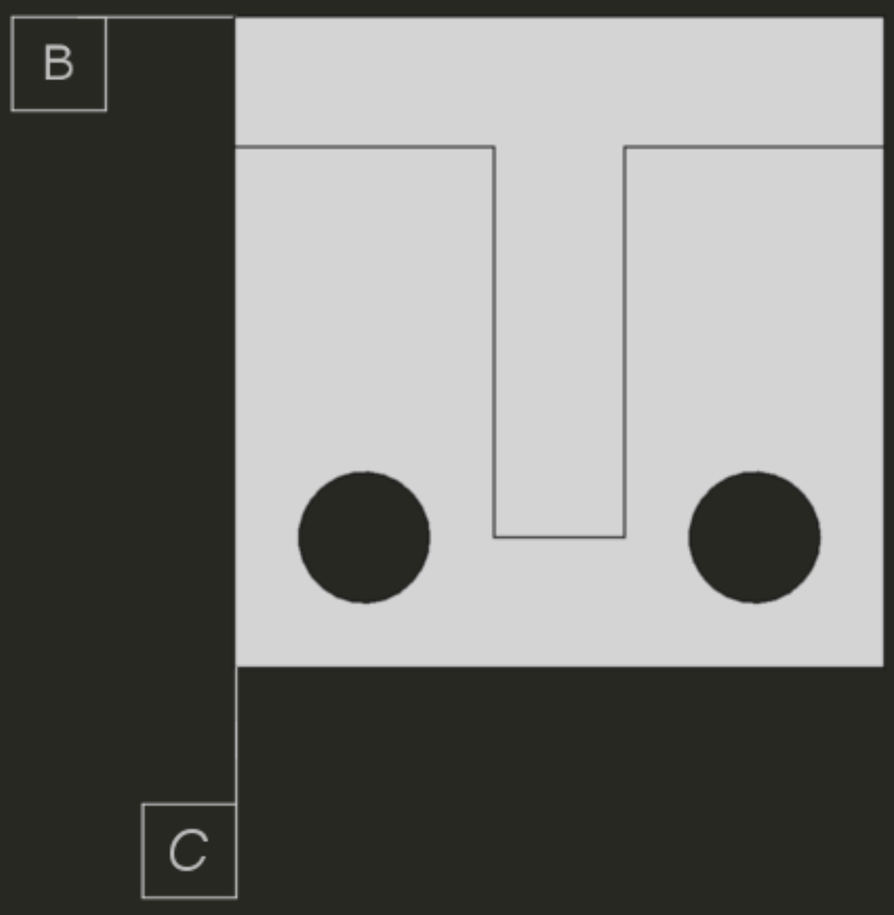
3 Translations

x = Along X Axis
y = Along Y Axis
z = Along Z Axis

3 Rotations

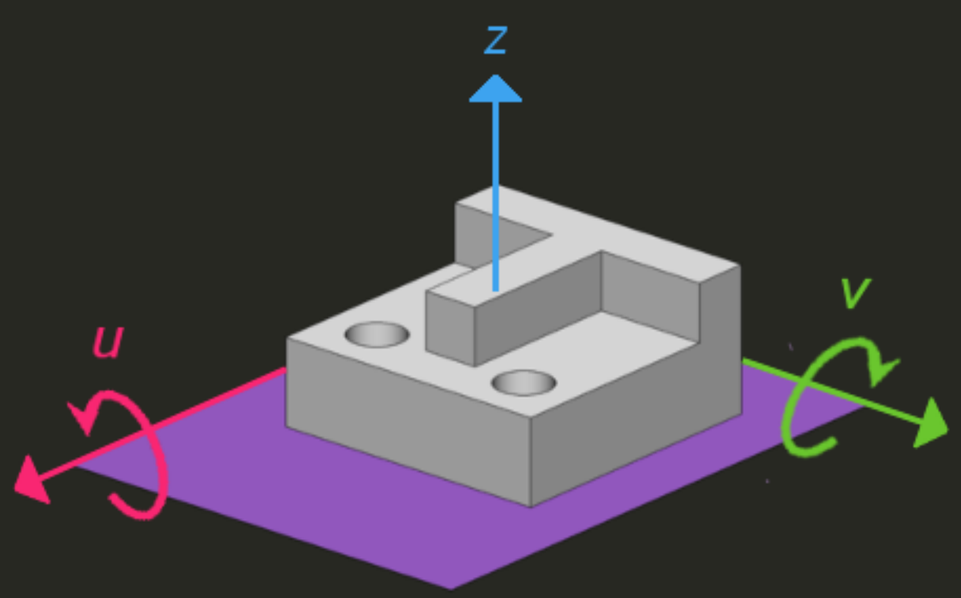
u = Around X Axis
v = Around Y Axis
w = Around Z Axis





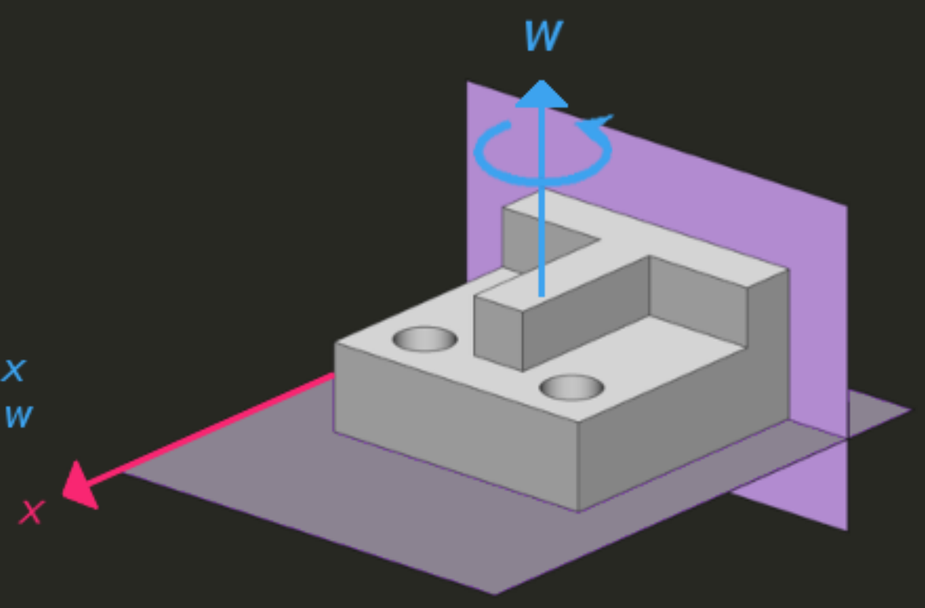
Datum A -
Controls 3 DOF

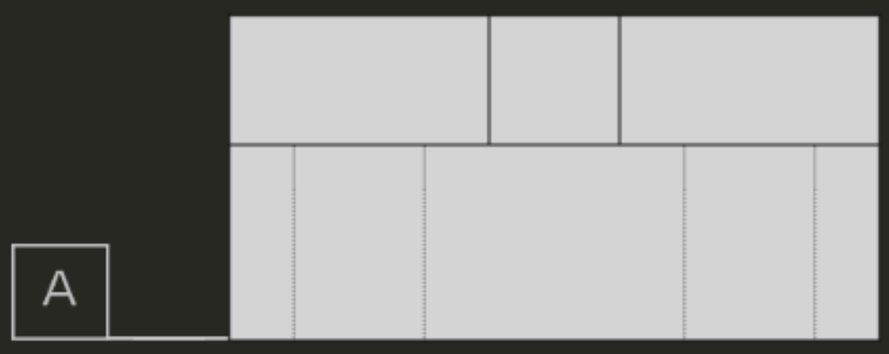
1 Translation z
1 Rotation u
1 Rotation v



Datum B -
Controls 2 DOF

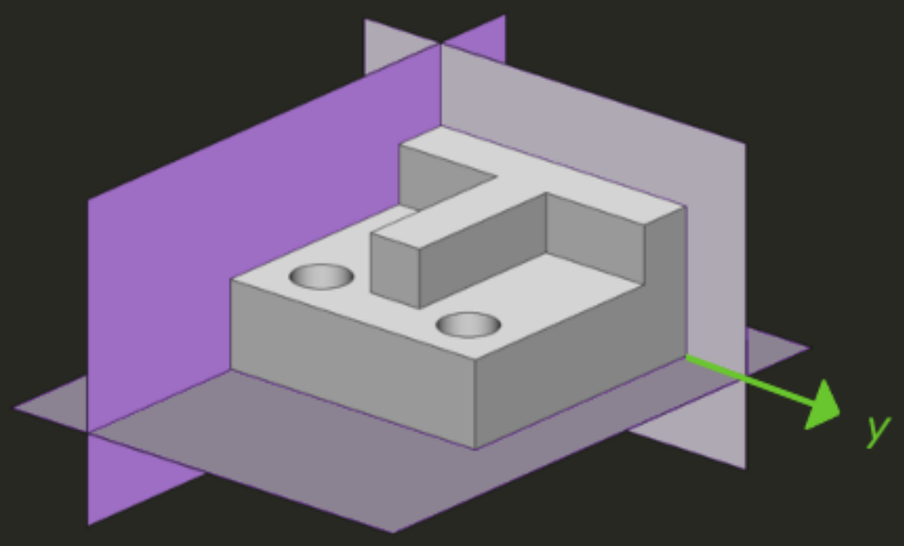
1 Translation x
1 Rotation w





Datum C -
Controls 1 DOF

1 Translation y



6 DOF - Alignments

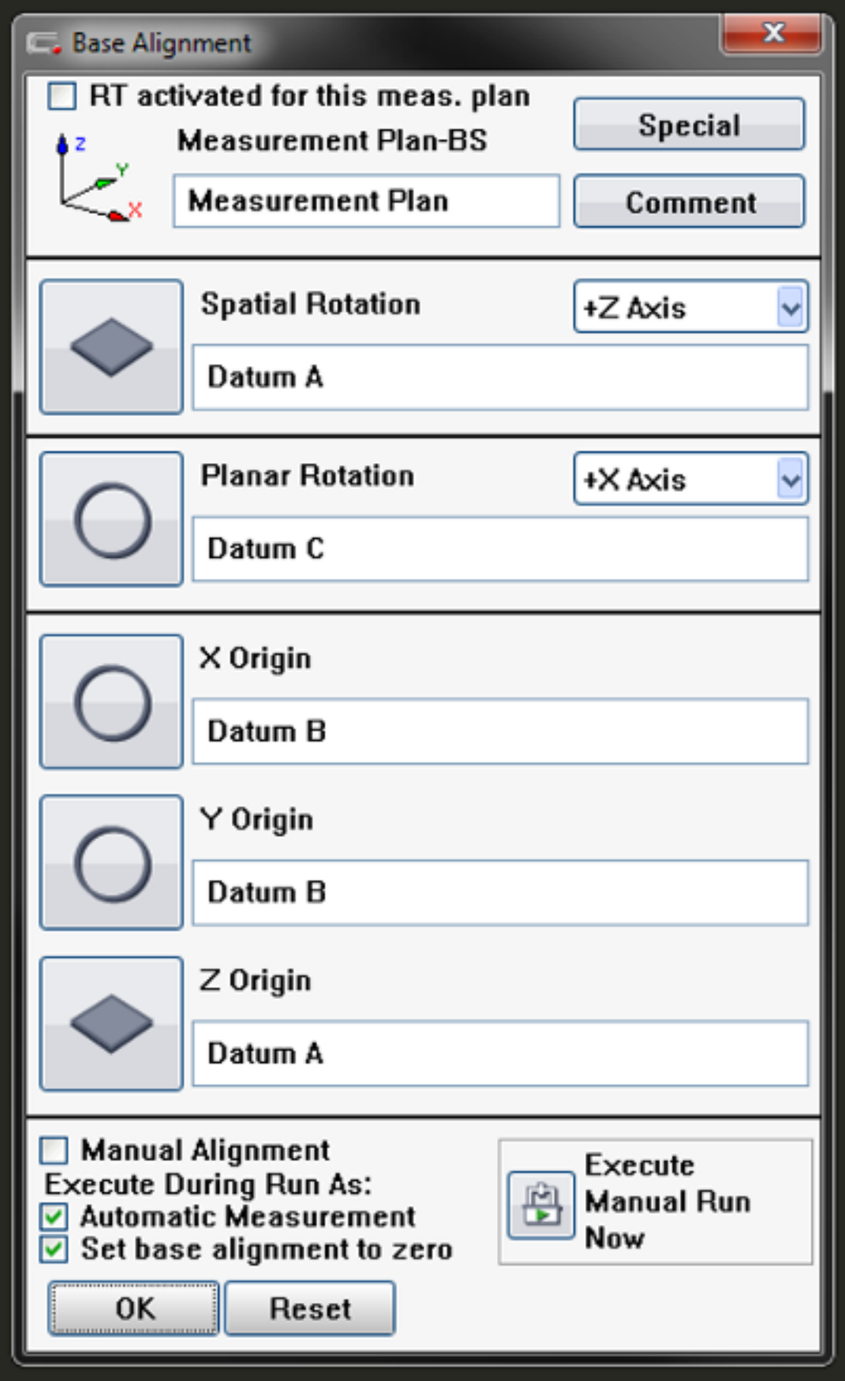
Spatial Rotation →
Controls 2 Rotations

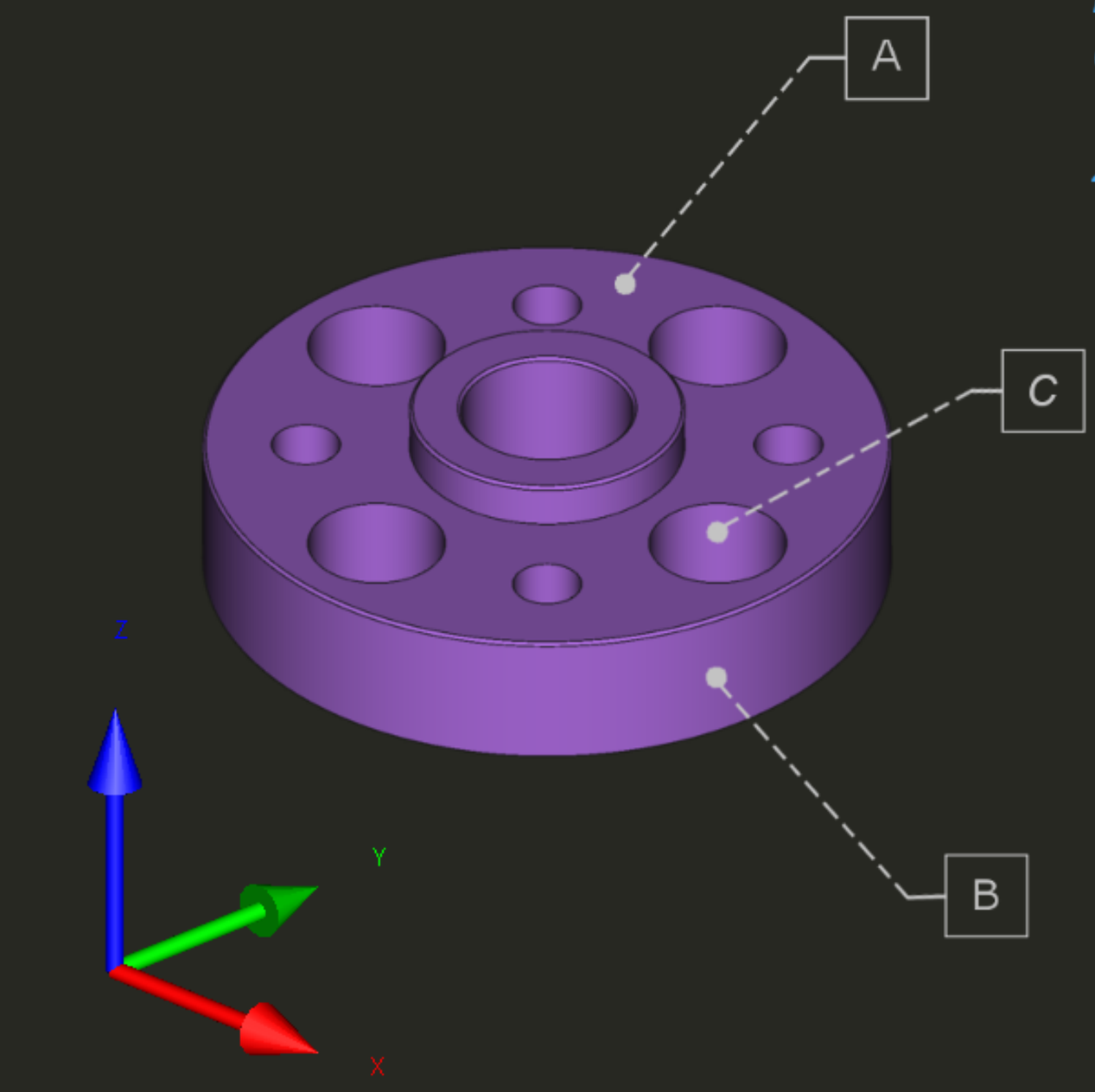
Planar Rotation →
Controls 1 Rotation

X Origin →
Controls 1 Translation

Y Origin →
Controls 1 Translation

Z Origin →
Controls 1 Translation





Datum A Controls - Spatial & Z Origin
U Rotation
V Rotation
Z Translation

Datum C Controls - Planar
W Rotation

Datum B Controls - X Origin & Y Origin
X Translation
Y Translation

Simultaneous Requirements

A simultaneous requirement is where two or more geometric tolerances apply as a single pattern or part requirement. A simultaneous requirement applies to position and profile tolerances that are located by basic dimensions, related to common datum features referenced in the same order of precedence at the same boundary conditions. In a simultaneous requirement there is no translation of rotation between the datum reference frames of the included geometric tolerances thus creating a single pattern. If such interrelationship is not required, a notation such as SEP REQT is placed adjacent to each applicable control frame

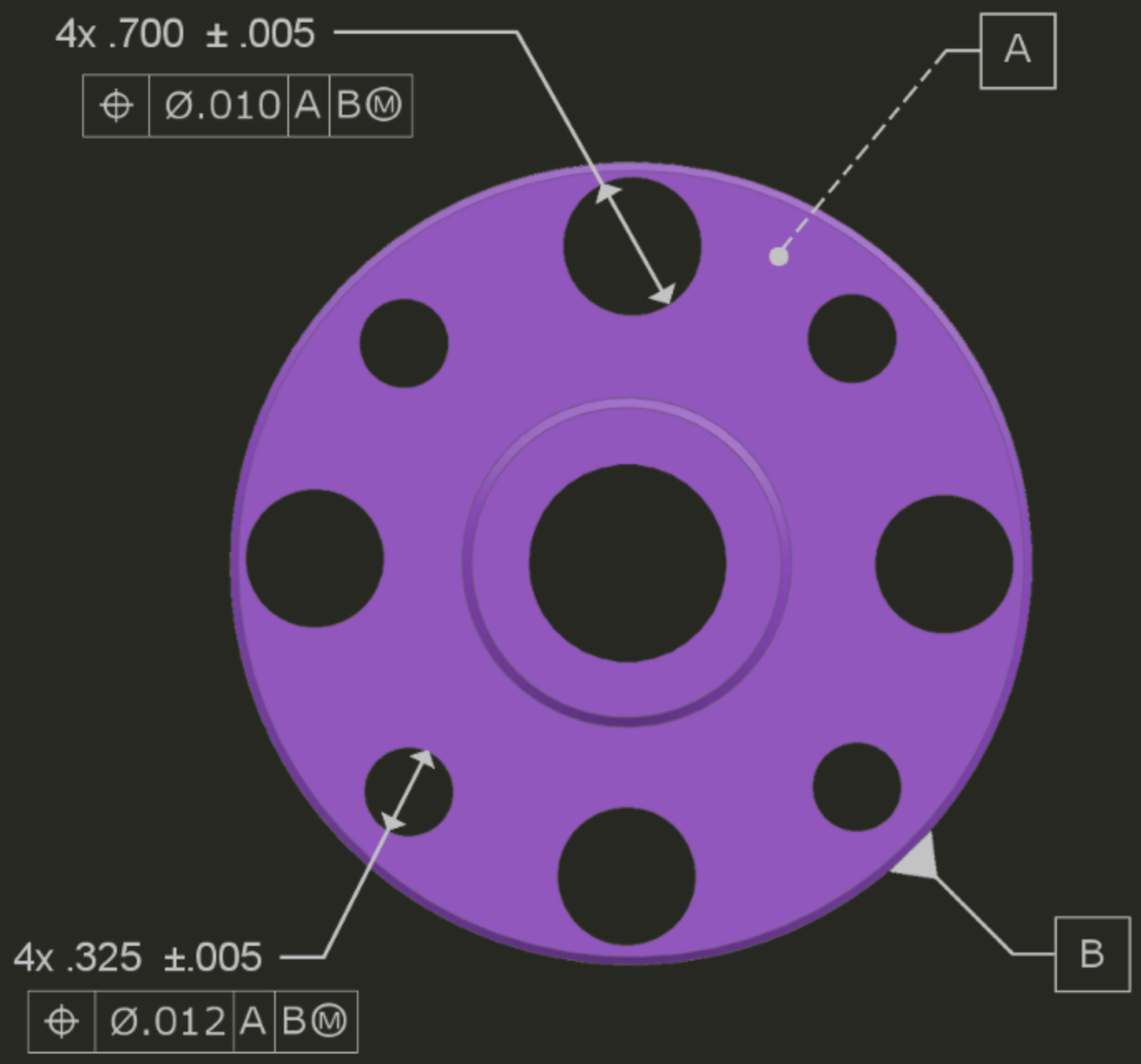
In summary, any Datum Shift or unconstrained DOF must apply to the entire pattern simultaneously

Does simultaneous requirements apply to the example below?

Same Datums..... ✔

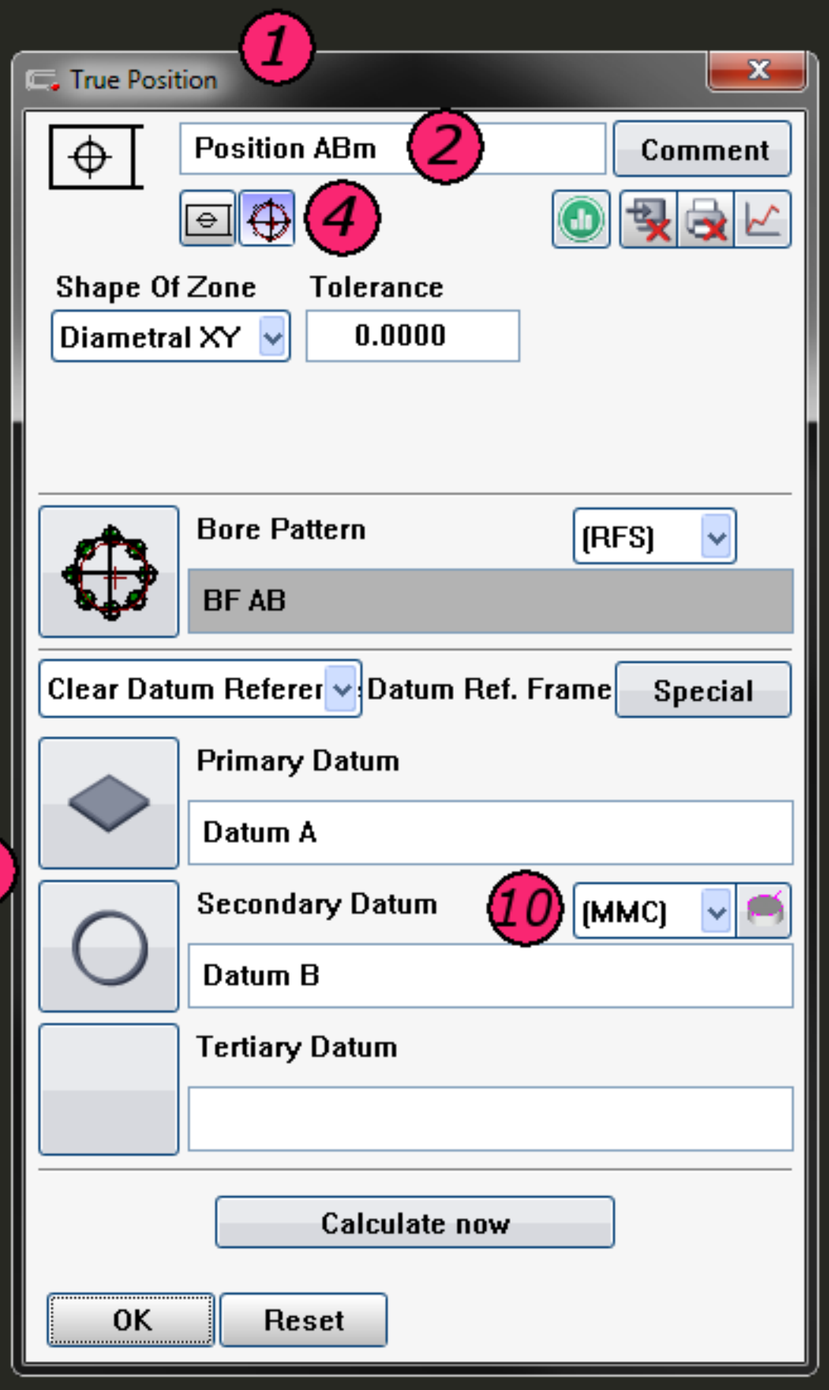
Same Order..... ✔

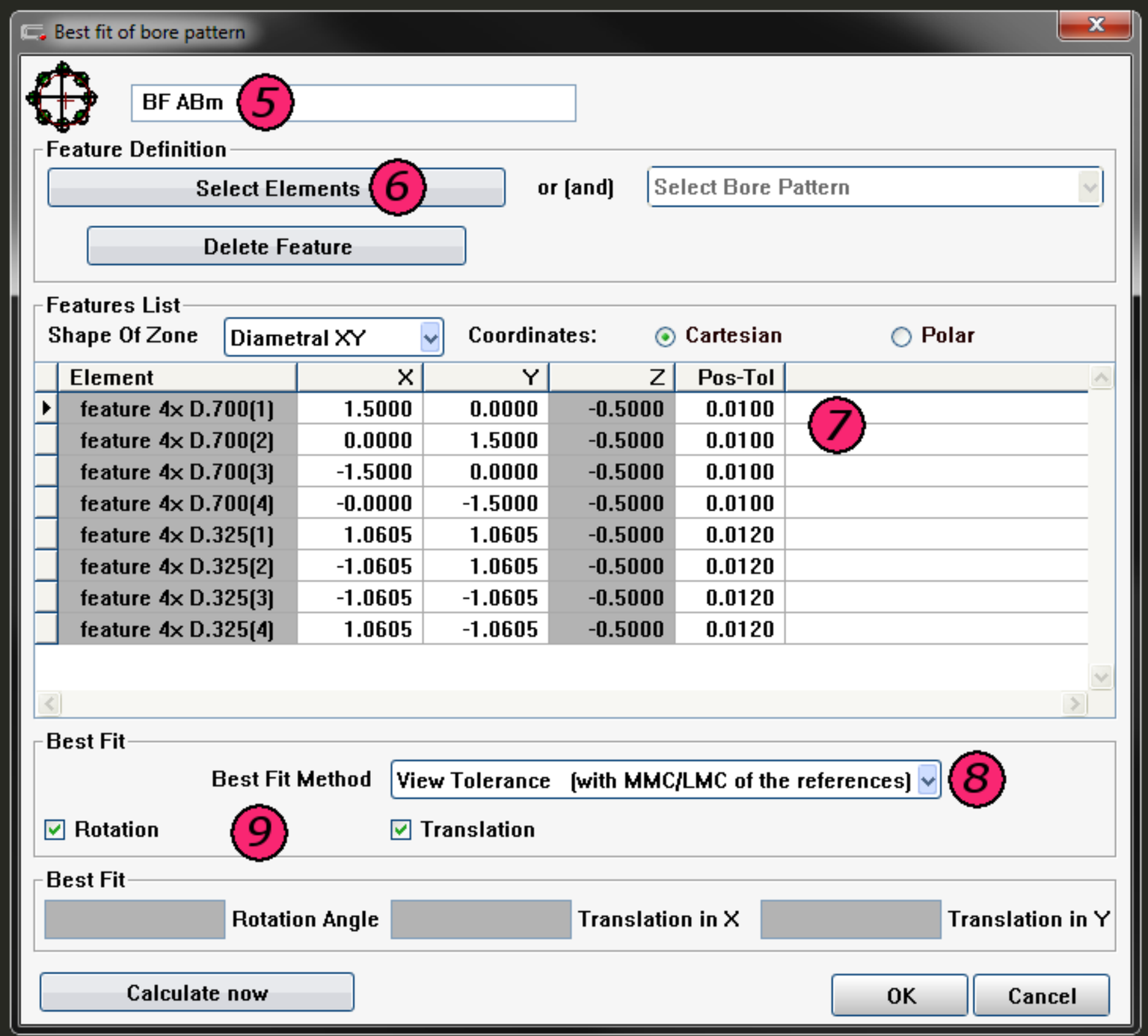
Same Boundary Conditions..... ✔



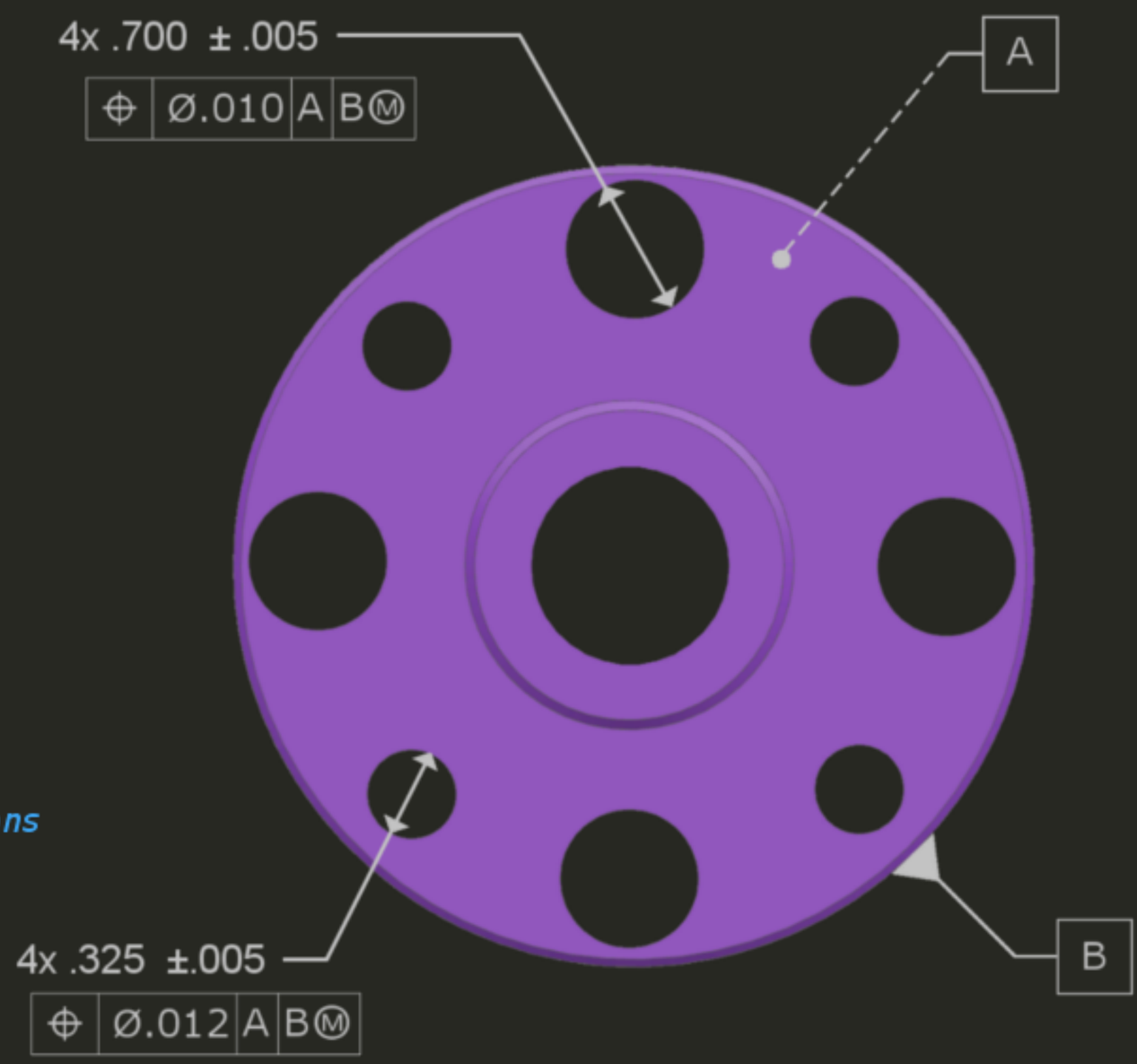
Best Fit Alignment

for Simultaneous Requirements



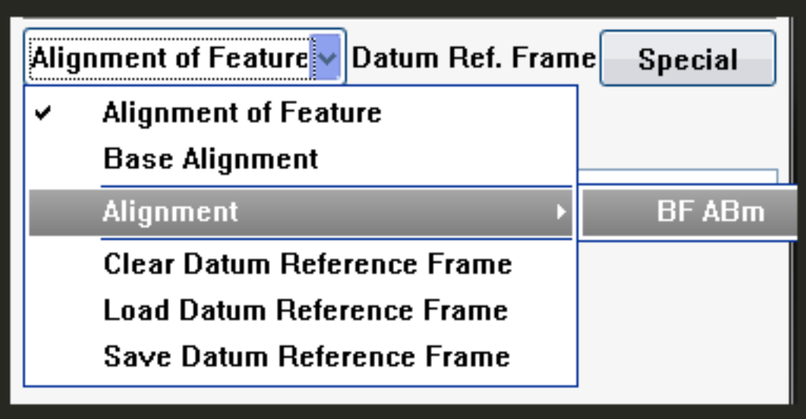


1. *Create Position Characteristic*
2. *Name Position Characteristic*
3. *Assign Datums to FCF*
4. *Select Best Fit tolerance type*
5. *Set Best Fit Alignment name*
6. *Select applicable features*
7. *Enter Position Tolerances*
8. *Select fitting method*
9. *Set permissable Degrees of Freedom*
10. *Set Datum modifiers if applicable*

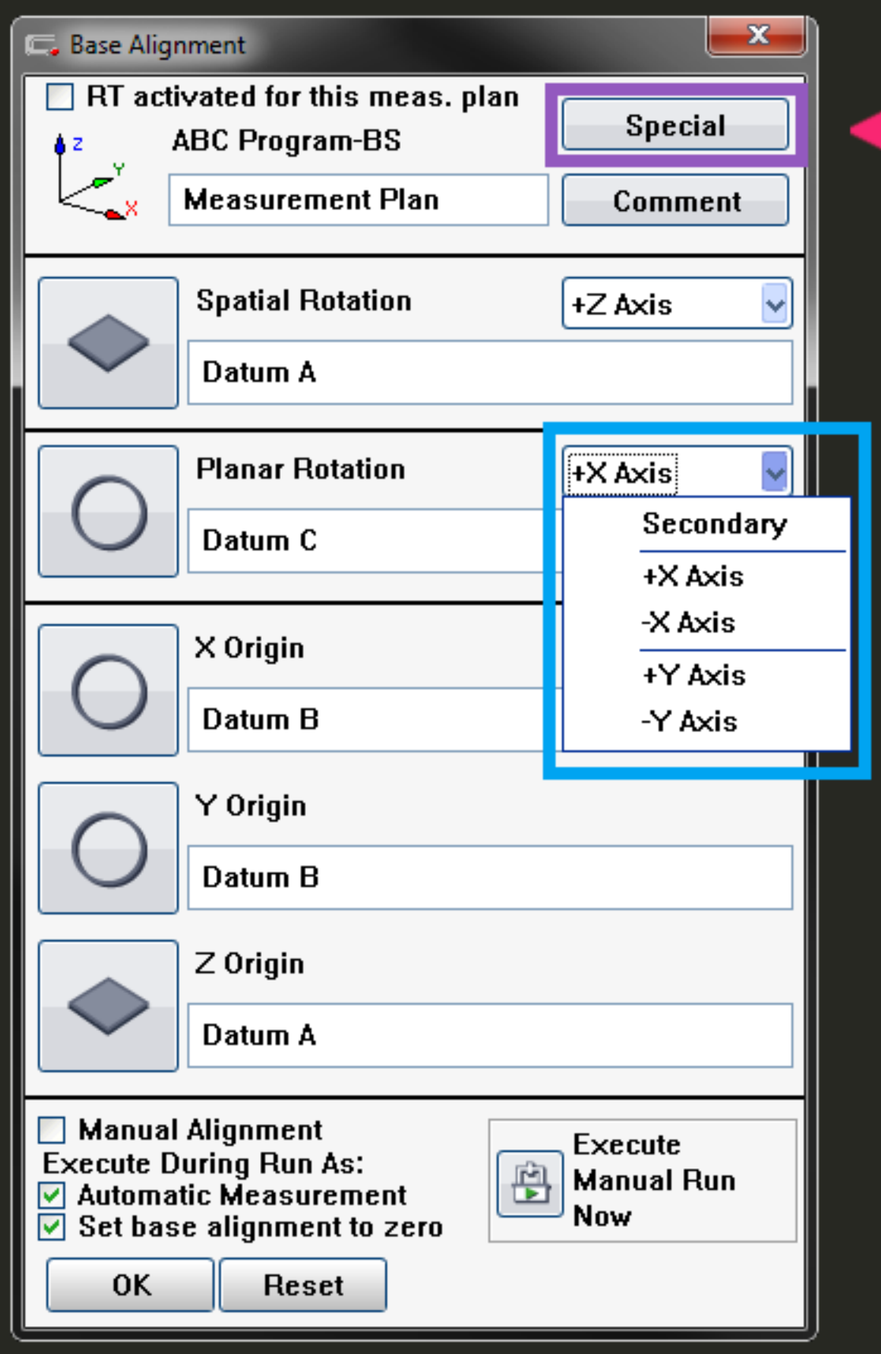


** Mask Position Characteristic created for Best Fit Alignment*

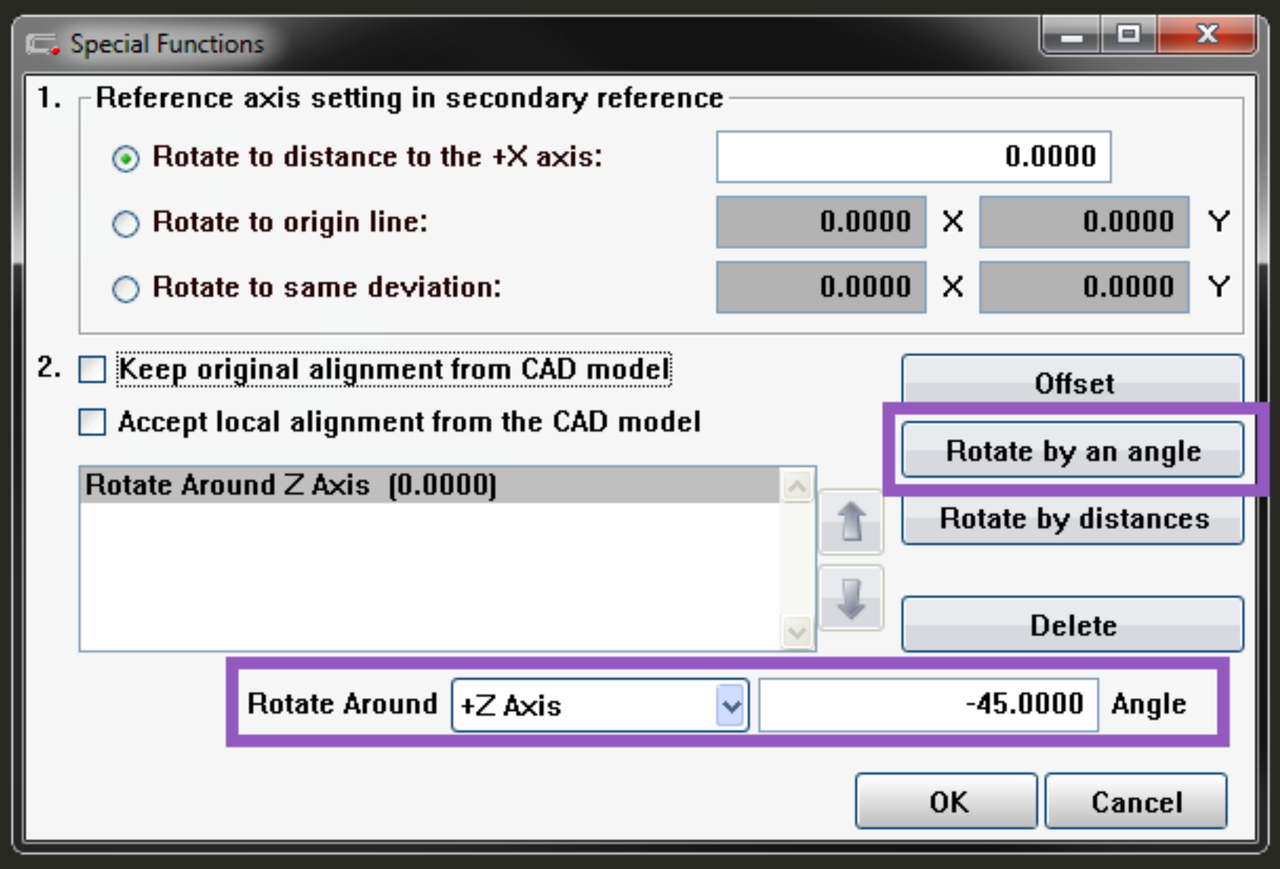
*** Select your Best Fit Alignment for individual feature Positions*



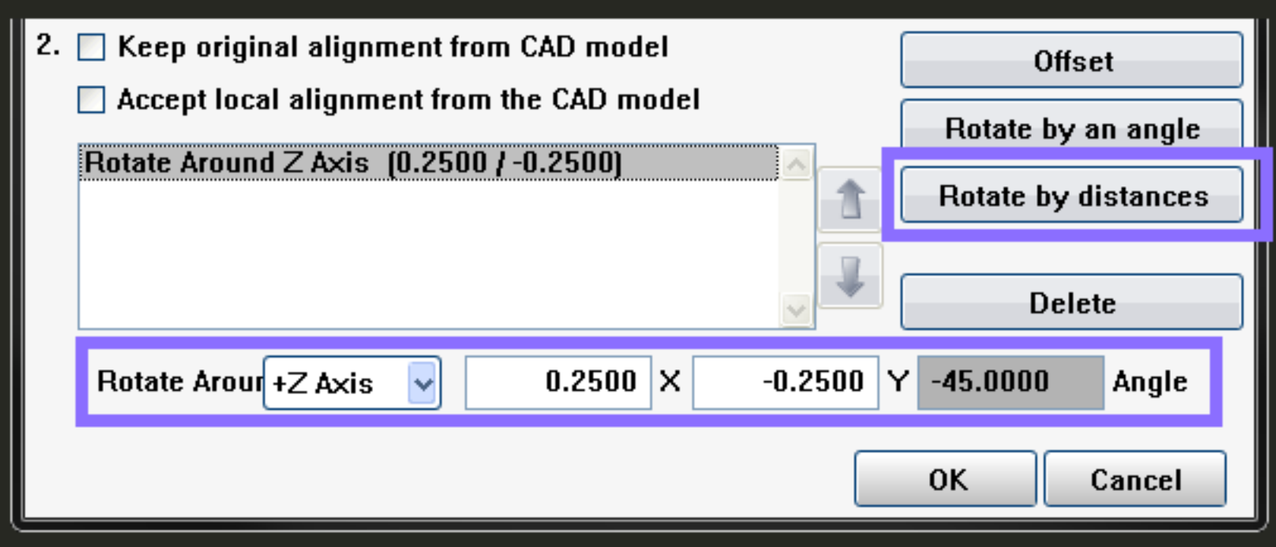
Alignments - Special



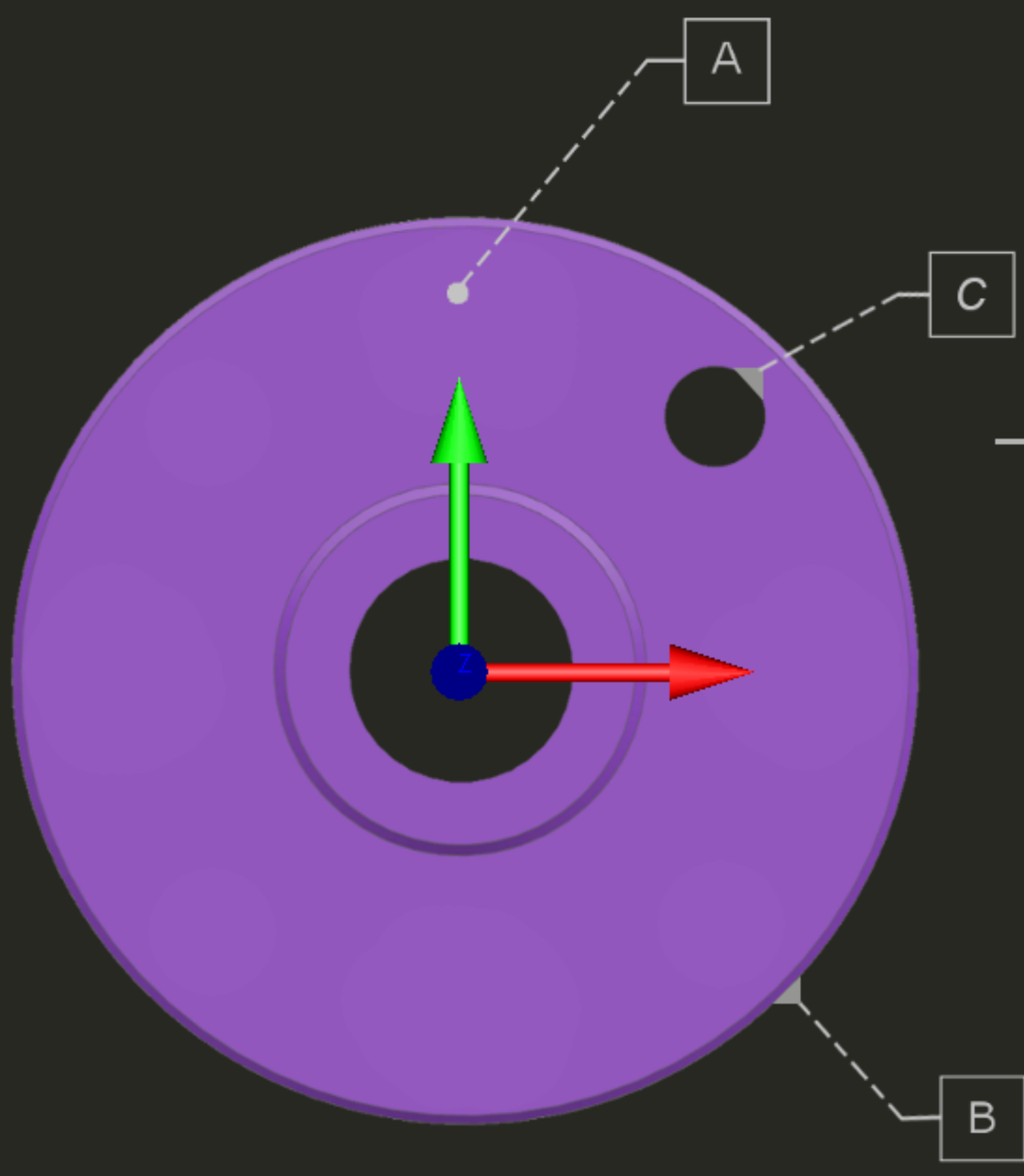
For a Planar that deviates from centerline a Special Function can be applied

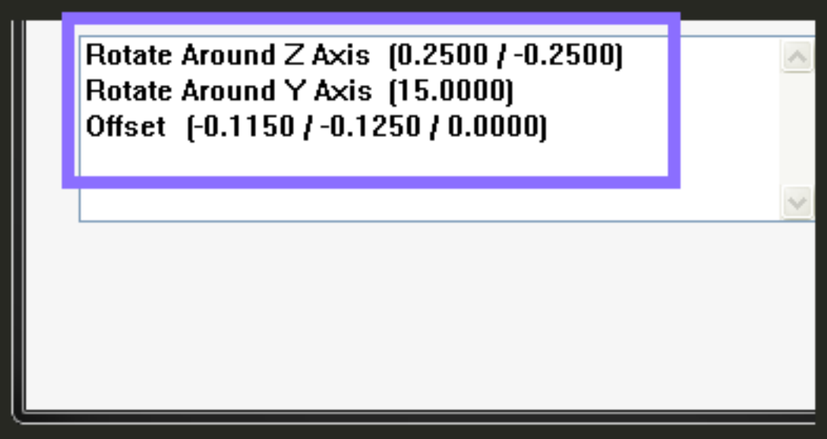


This method rotates around Z axis at a basic of 45º



Distances can also be used





***Multiple functions can be applied to the same alignment**

Evaluation - Methods

LSQ Feature

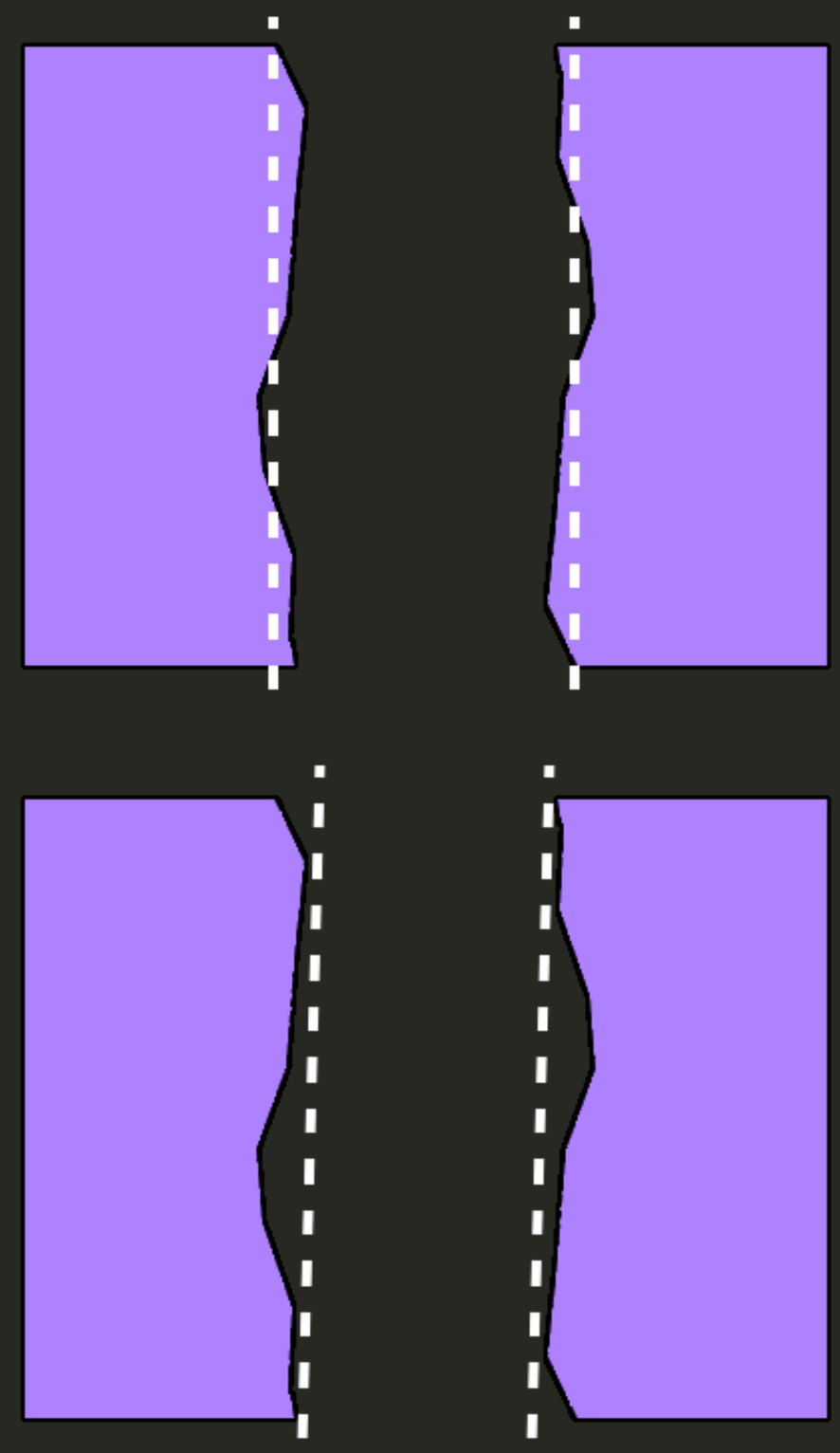
- Provides a consistent, stable result
- Consistently provides...
  - Wrong Size
  - Wrong Form
  - Wrong Location

Outer Tangential

- Provides a functional, mechanical result
- Use in place of Max Ins. & Min Circ.
- Provides an accurate result for...
  - Size
  - Location
  - Datums

Minimum Feature

- High & Low points provide result
- Provides an accurate result for...
  - Form



The Default method you should NOT use

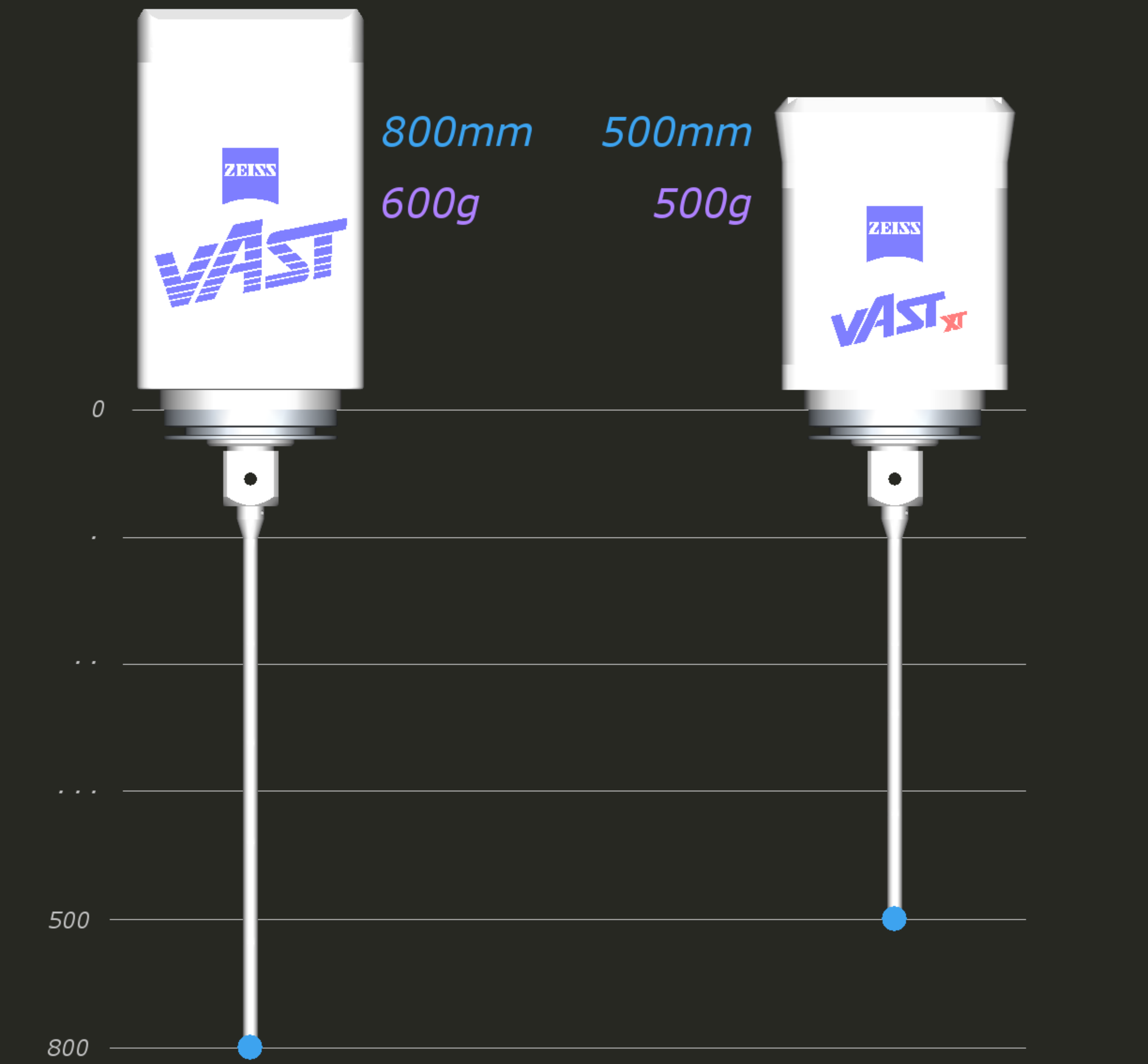
The methods you rarely use

The 2 methods you SHOULD use
- *Minimum Feature*
- *Outer Tangential*

* Profile & Runout evaluate surface not center, so fitting method may default to Minimum Feature but is irrelevant

VAST Active Threshold Values

VAST*	VAST XT*
800mm	500mm
600g	500g



*also applies to 'gold' variant

XXT Threshold Values

TL1

30-125mm

50-70mm

TL2

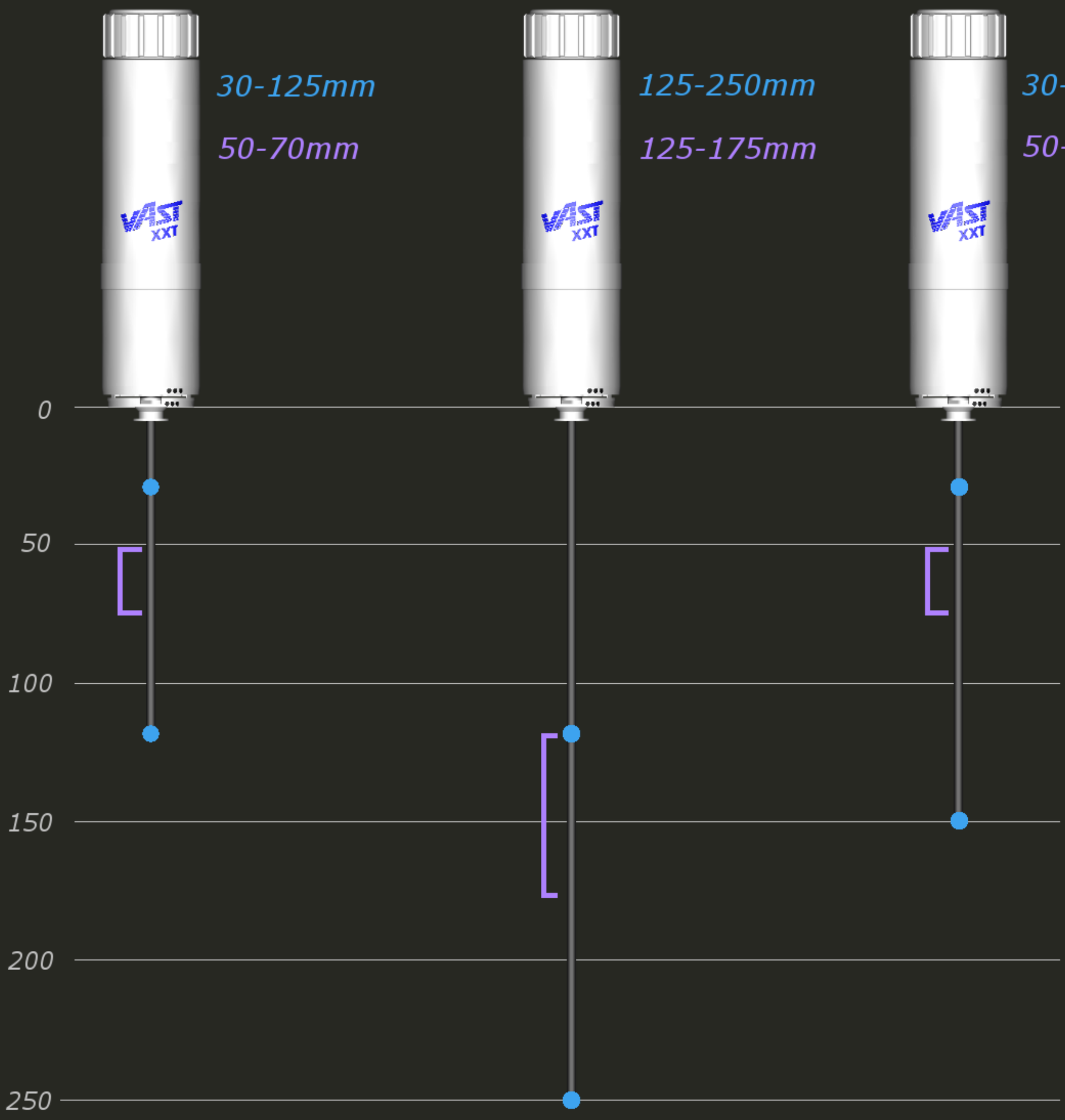
125-250mm

125-175mm

TL3

30-150mm

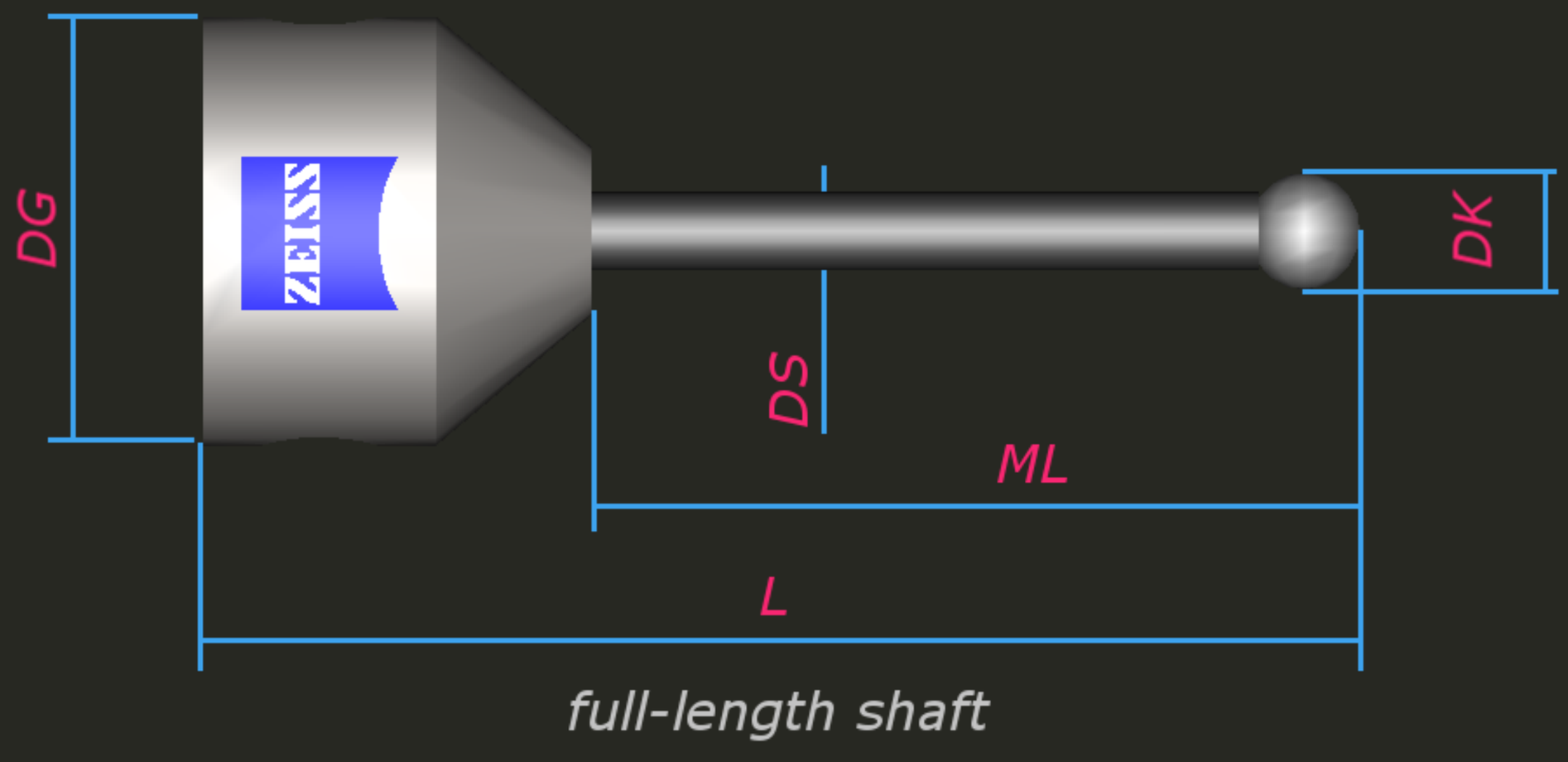
50-70mm



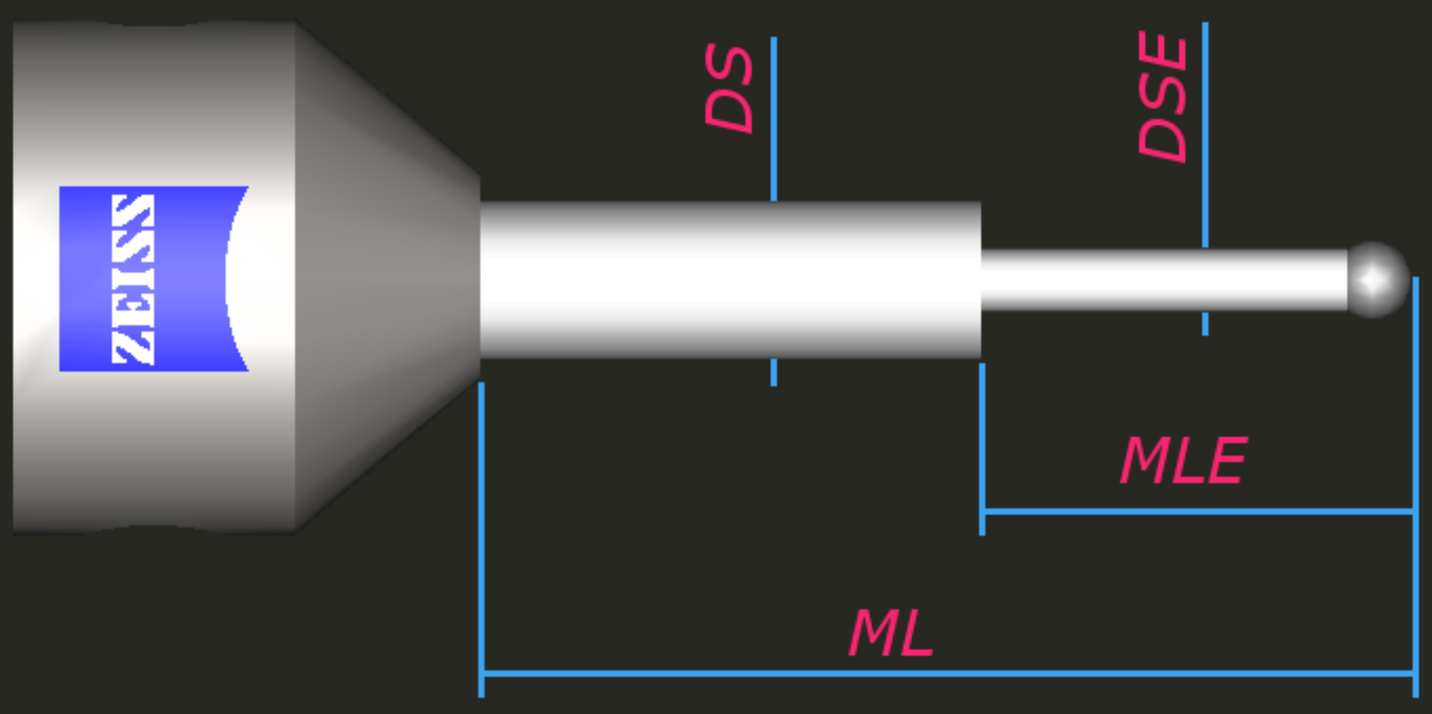
Allowable Length

Optimal Performance

Stylus Structure



full-length shaft



offset shaft

Legend		
	DK	Ball Diameter in mm
	L	Length range in mm
	ML	Measuring length in mm
	DS	Shaft Diameter in mm
	DG	Diameter of base element in mm
	MLE	Stepped measuring length in mm
	DSE	Stepped shaft diameter in mm

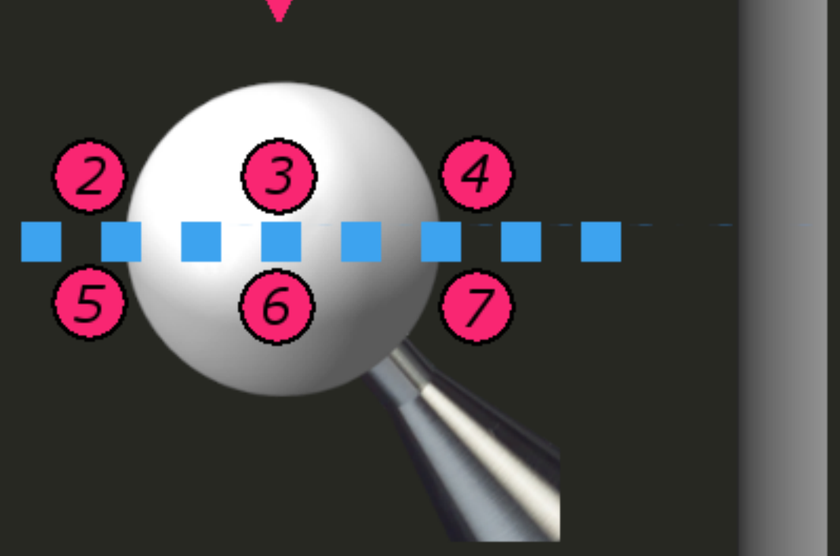
Qualification - Disk Probe

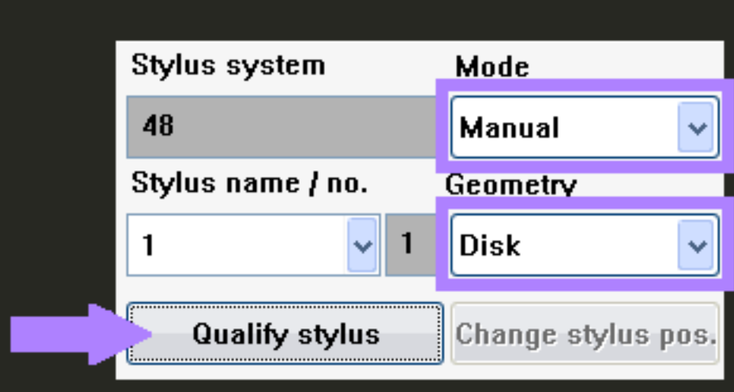
Manual Qualification of 7 points

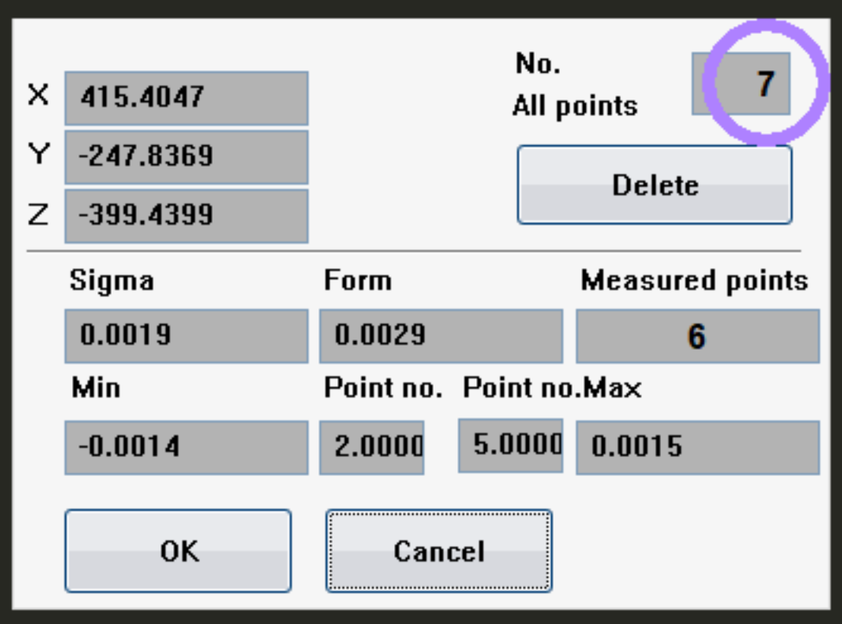
*Point 1 is taken normal to the reference sphere

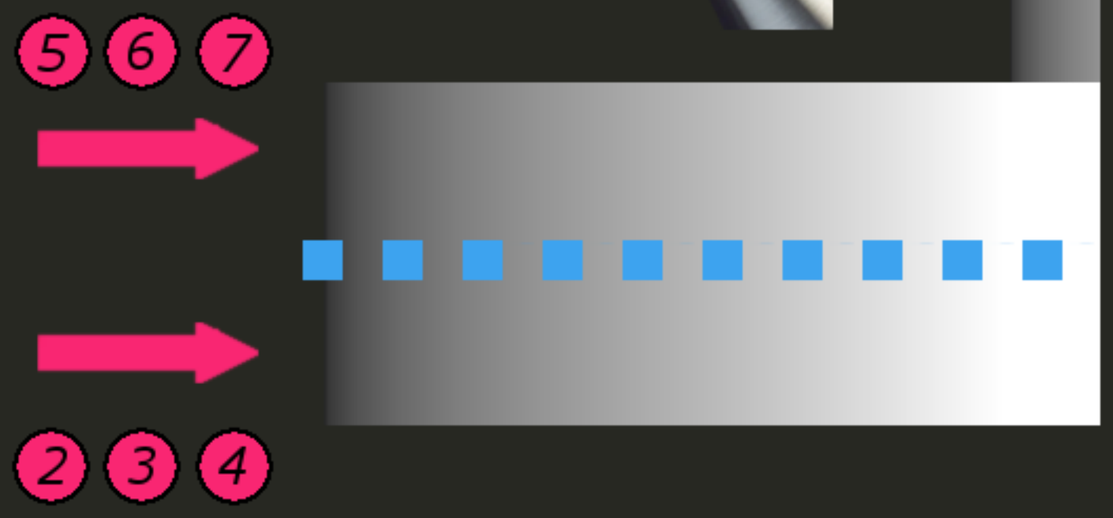
*Points 2, 3 & 4 are taken below centerline of the disk & above centerline of the reference sphere

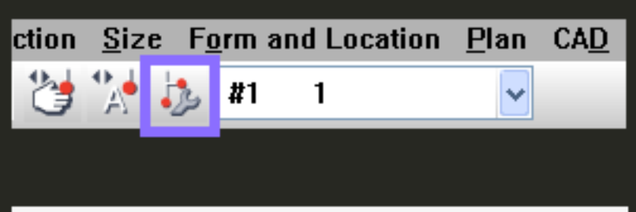
*Points 5, 6 & 7 are taken above centerline of the disk & below centerline of the reference sphere

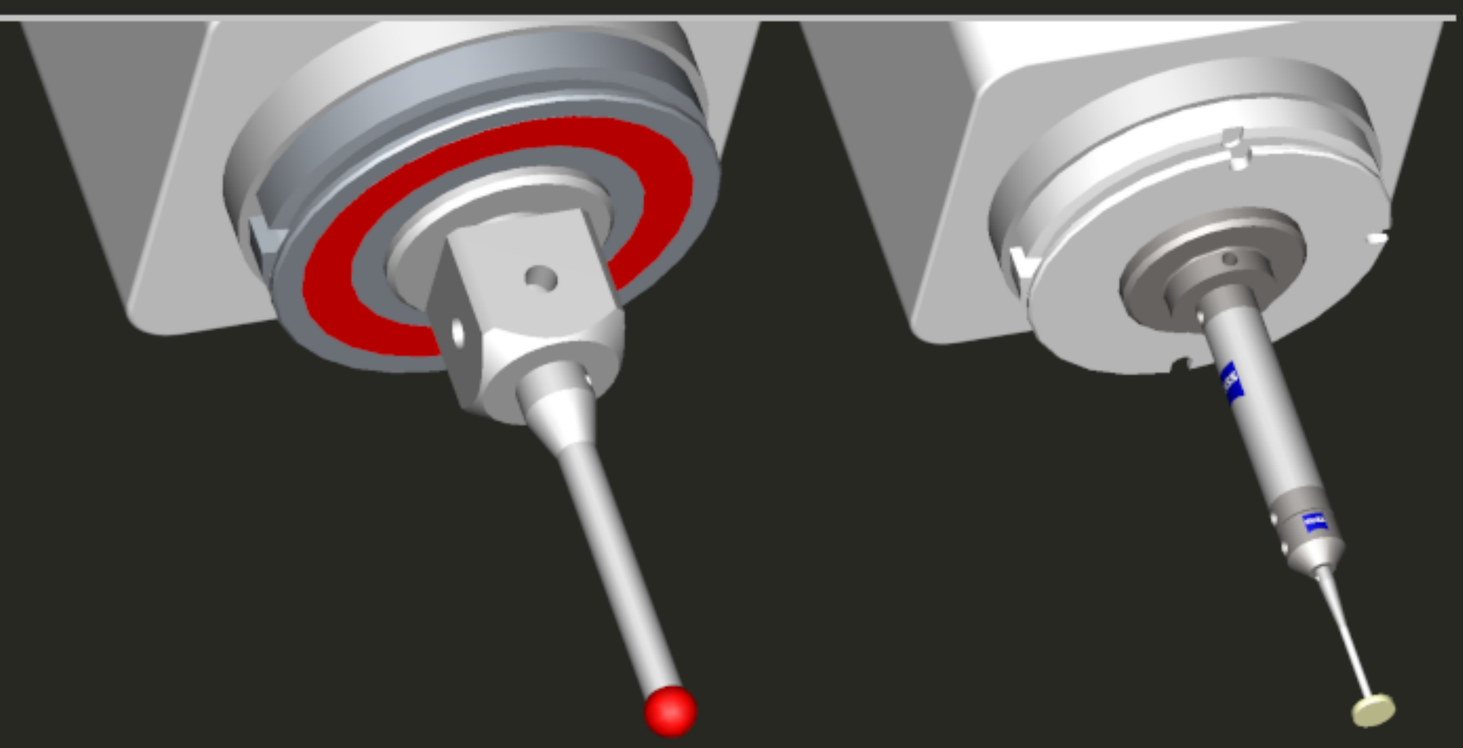


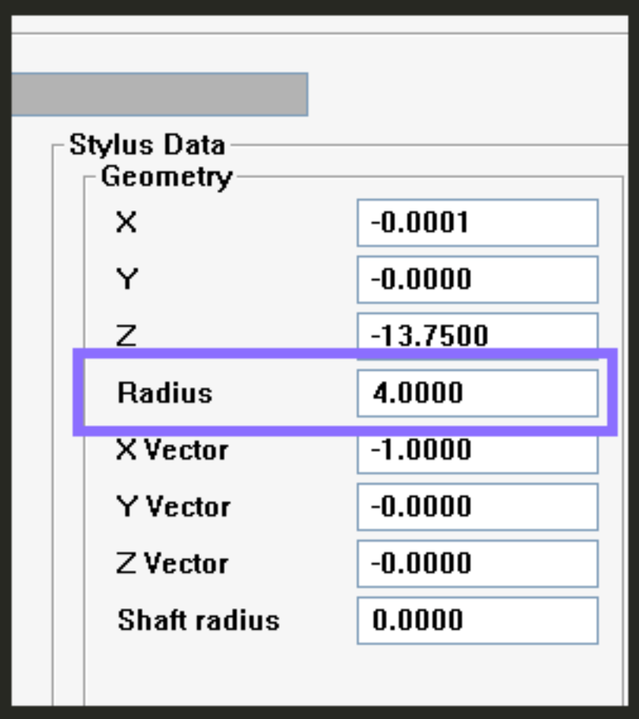








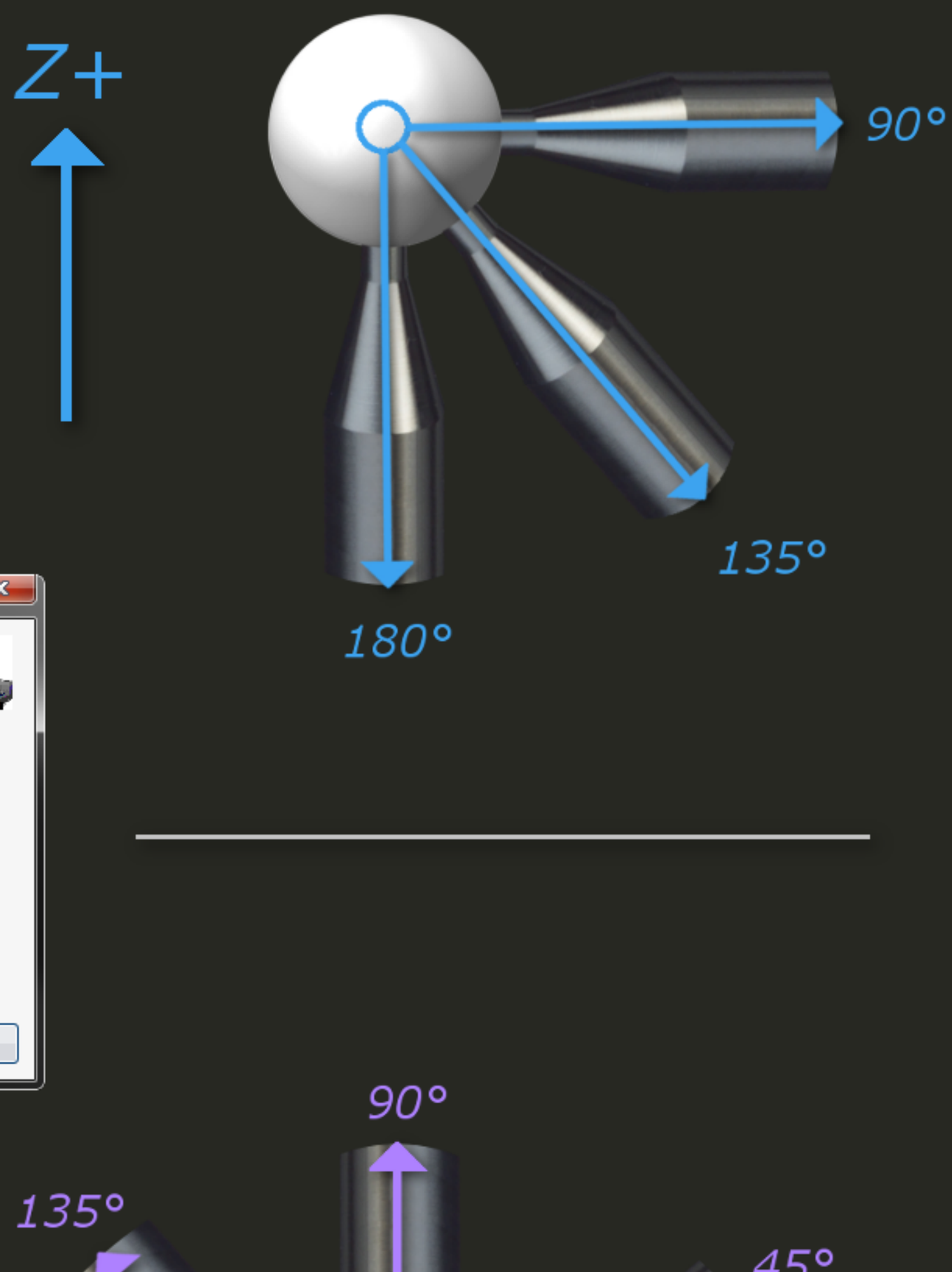


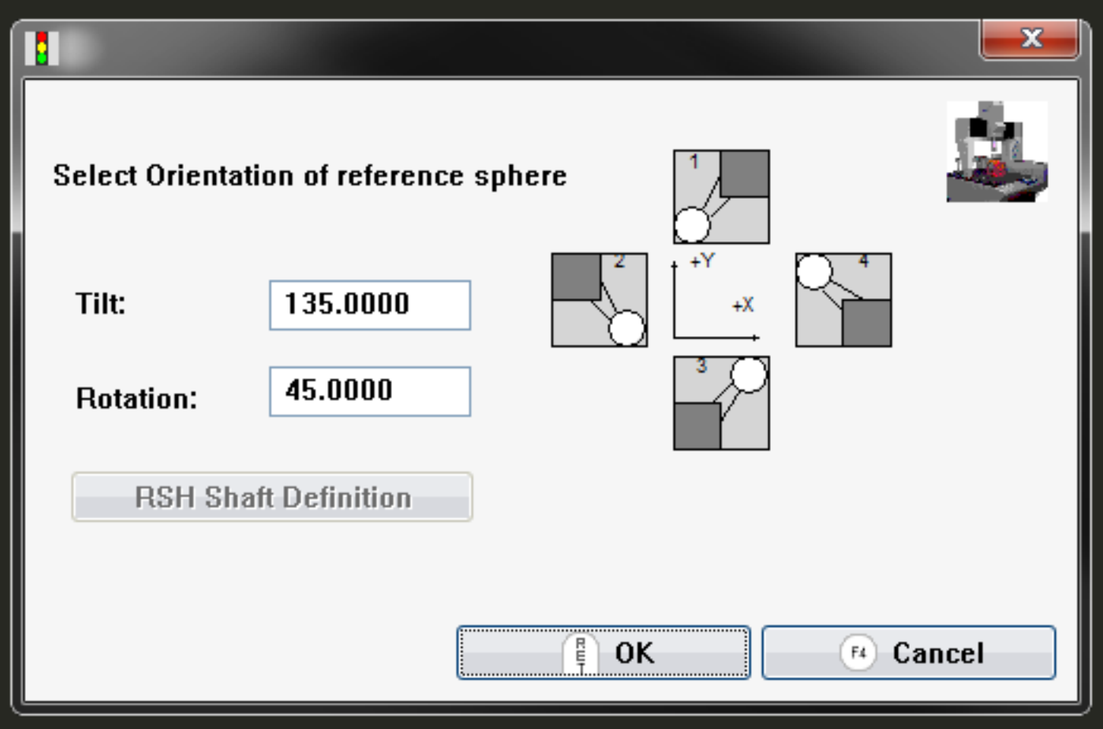


Using a ring master, compare a measured diameter using the disk probe against the master probe. Adjust the disk radius if needed in the Stylus Management Window

Reference Sphere Positions

Tilt/Inclination





Rotation