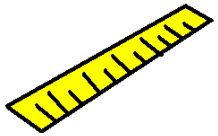
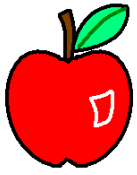


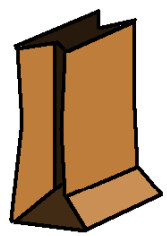


LUNCHEON LEARN

Concentricity

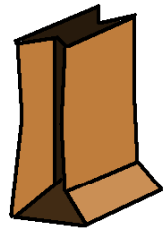
More than you ever wanted to know

LUNCHEON LEARN



So, you need to measure Concentricity?

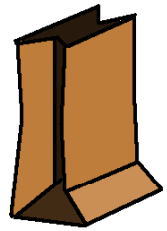
No problem, right? Just drop in a concentricity characteristic and fill in the template. You get an answer.



Easy.

So, what EXACTLY is Calypso telling us?

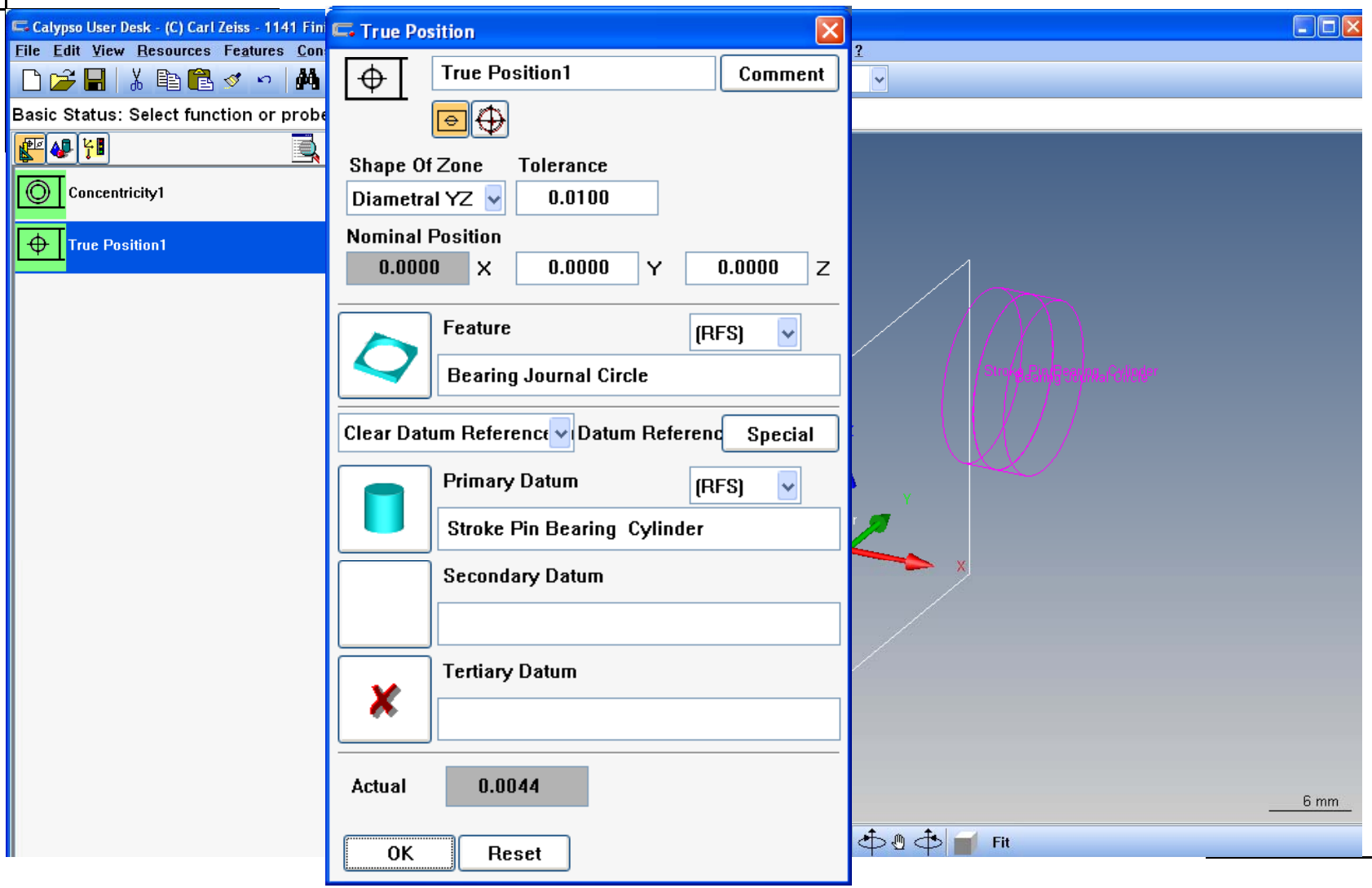
Actually, it's telling us POSITION, not Concentricity as defined in the Y14.5 standard….



You don’t believe me?

Check it out:

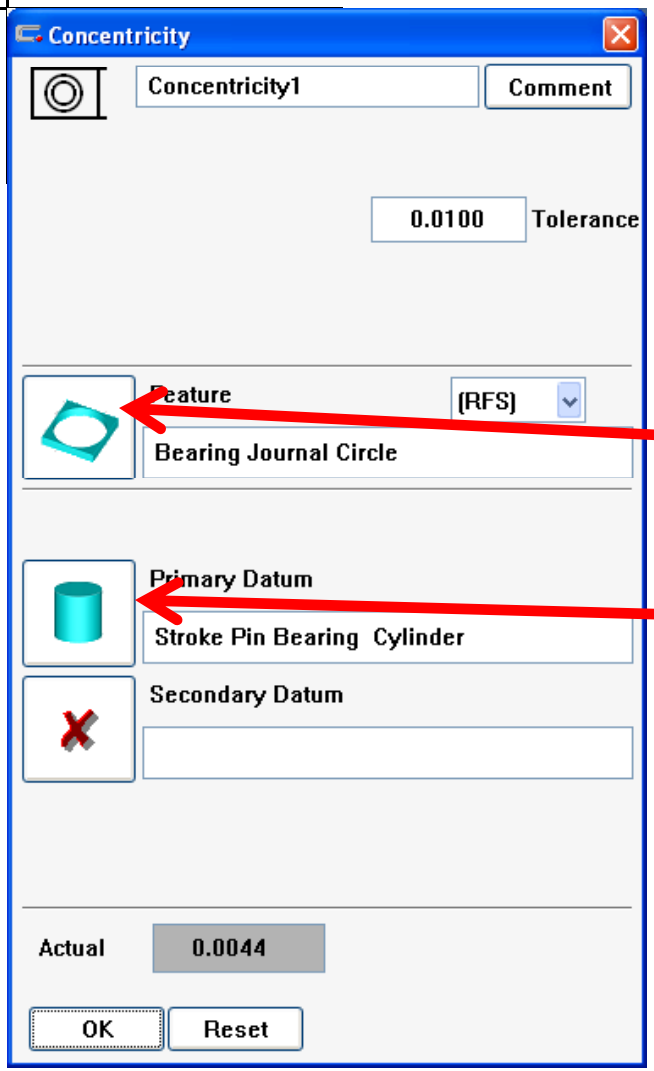
LUNCHEON LEARN

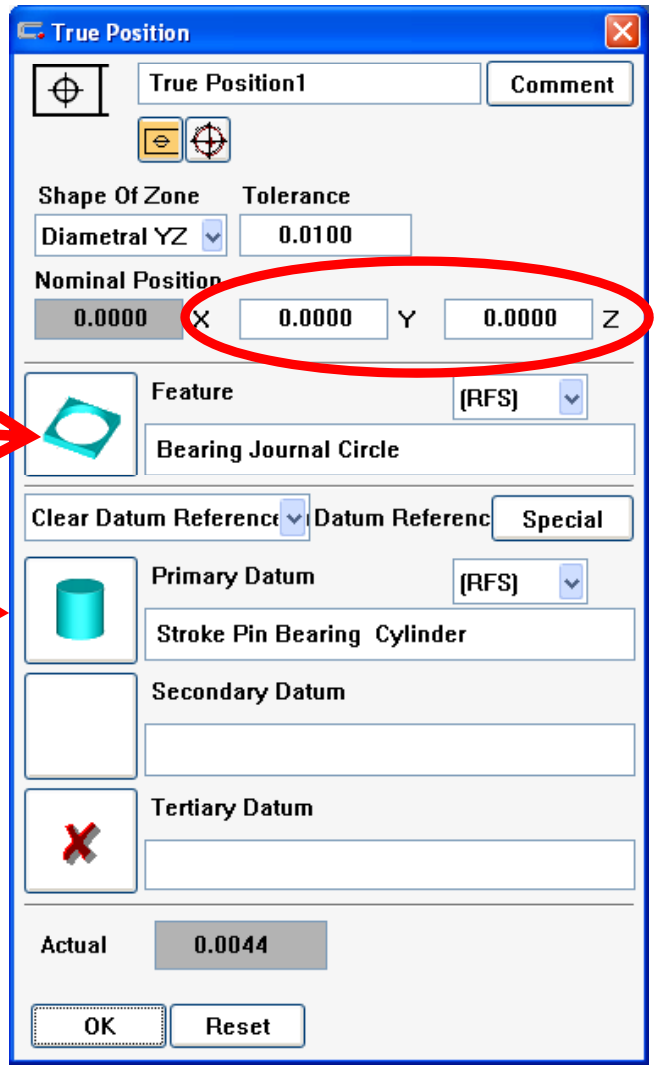


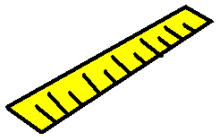
ELLISON TECHNOLOGIES

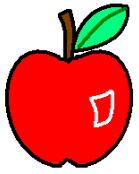
LUNCHEON LEARN

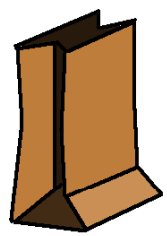
ZEISS











LUNCHEON LEARN

So is Concentricity just a special case of Position when the feature and datum happen to be on the same axis????

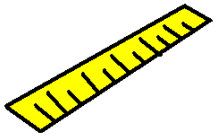
Great question.

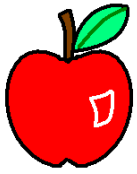
LUNCHEON LEARN

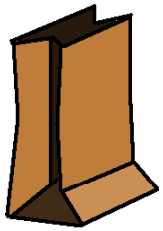
Definition Time!

"Concentr re the
median pc sed
elements c
correspondi nore radially-
disposed featu er point) of a
datum feature. pherical) tolerance
zone whose axis (er point) of the
datum feature(s). ed elements of the
feature(s) being cor lindrical (or spherical)
tolerance zones.

ELLISON TECHNOLOGIES





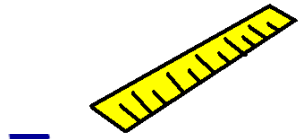


ZEISS

LUNCHEON LEARN

WAKE UP!

ELLISON TECHNOLOGIES



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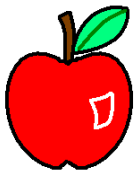
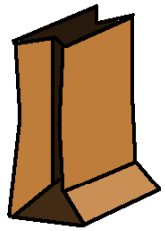




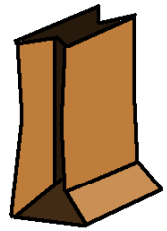
ZEISS

Calypso DOES NOT do this…

easily.

Can it be done?

Absolutely.

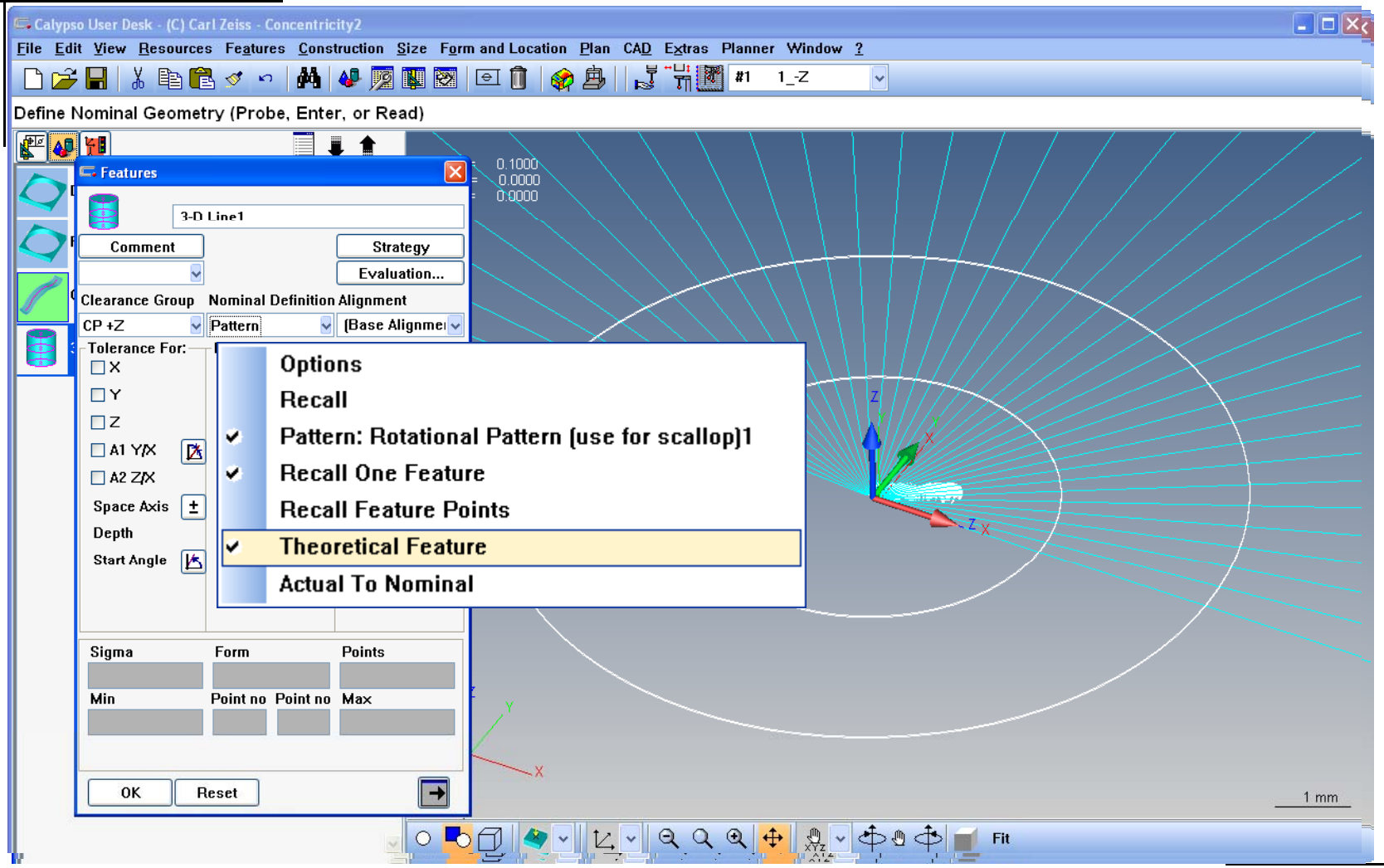


ANYTHING can be done if you have the right resources…

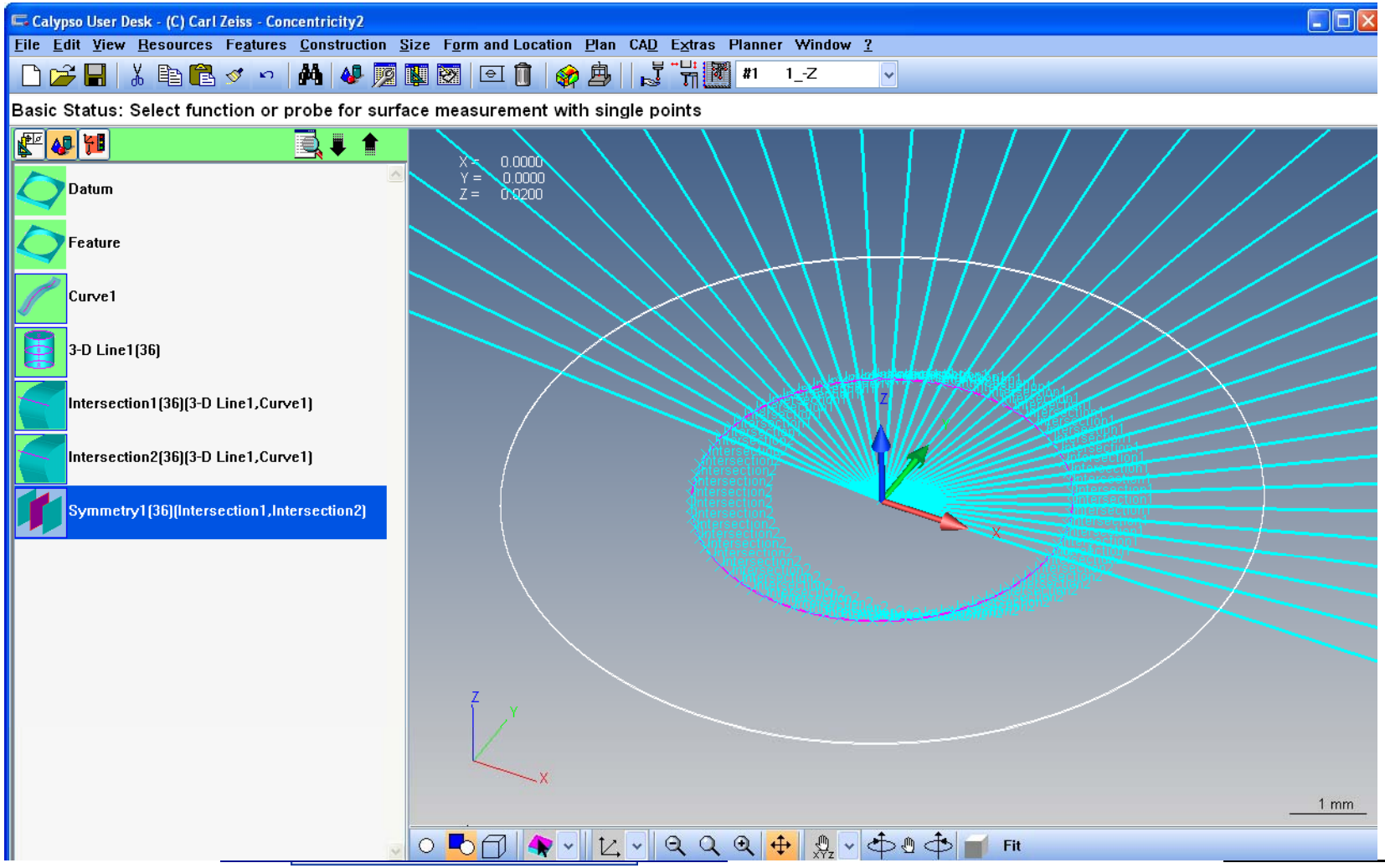
In this case, CURVE is one of those resources needed to pull this off.

Here's how to do it:

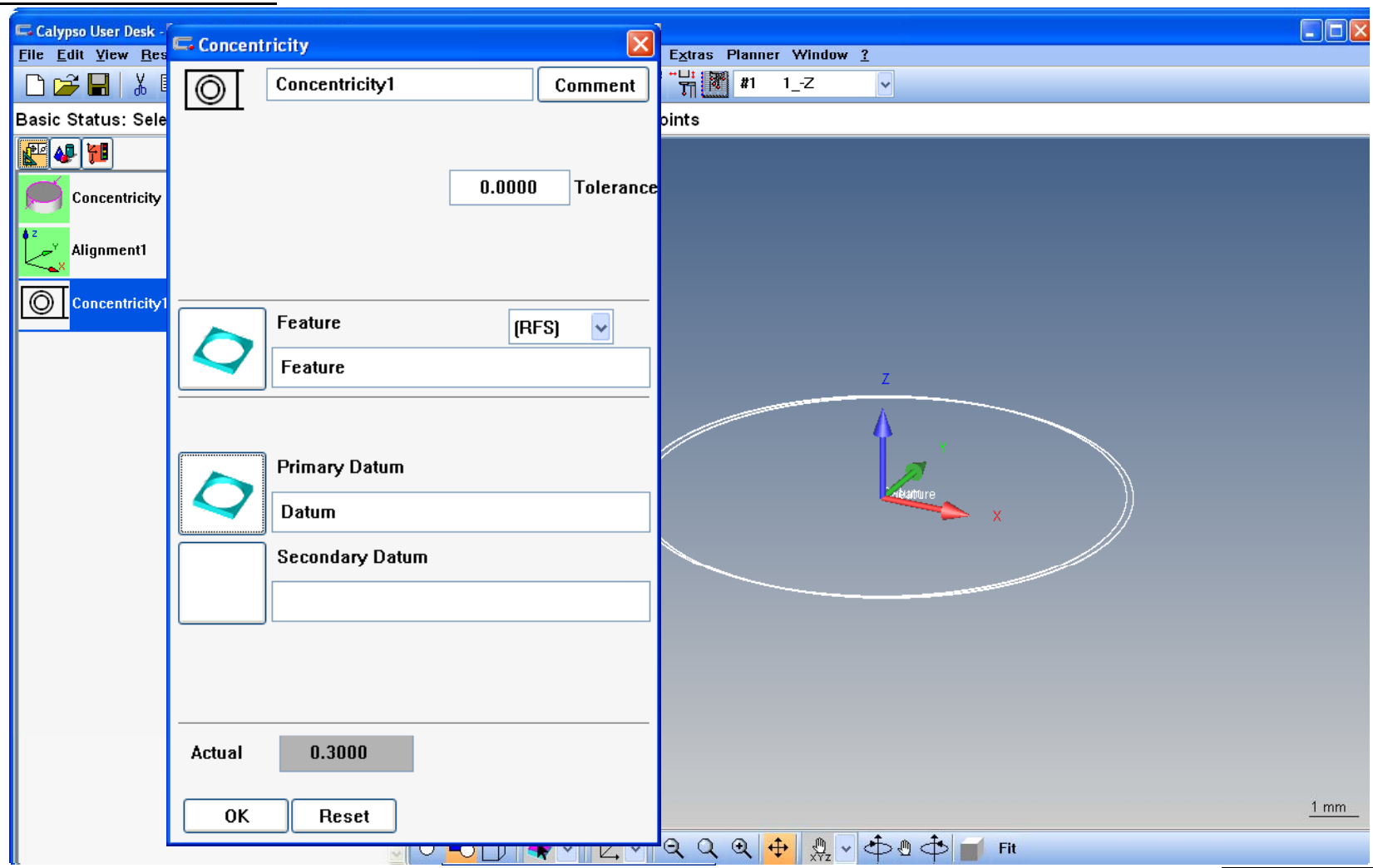
LUNCHEON LEARN

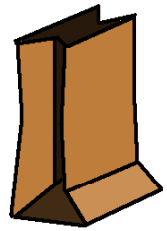


LUNCHEON LEARN



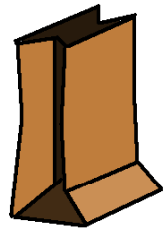
LUNCHEON LEARN





Shoooo. Lots of programming.

It’s really not THAT bad.



You could make it a macro so you never have to program it again. Just supply feature circle coords and diameter.

Go to a training class if you want to learn about macros.

Let's test it out.

First, a theoretical example to see if it makes sense.

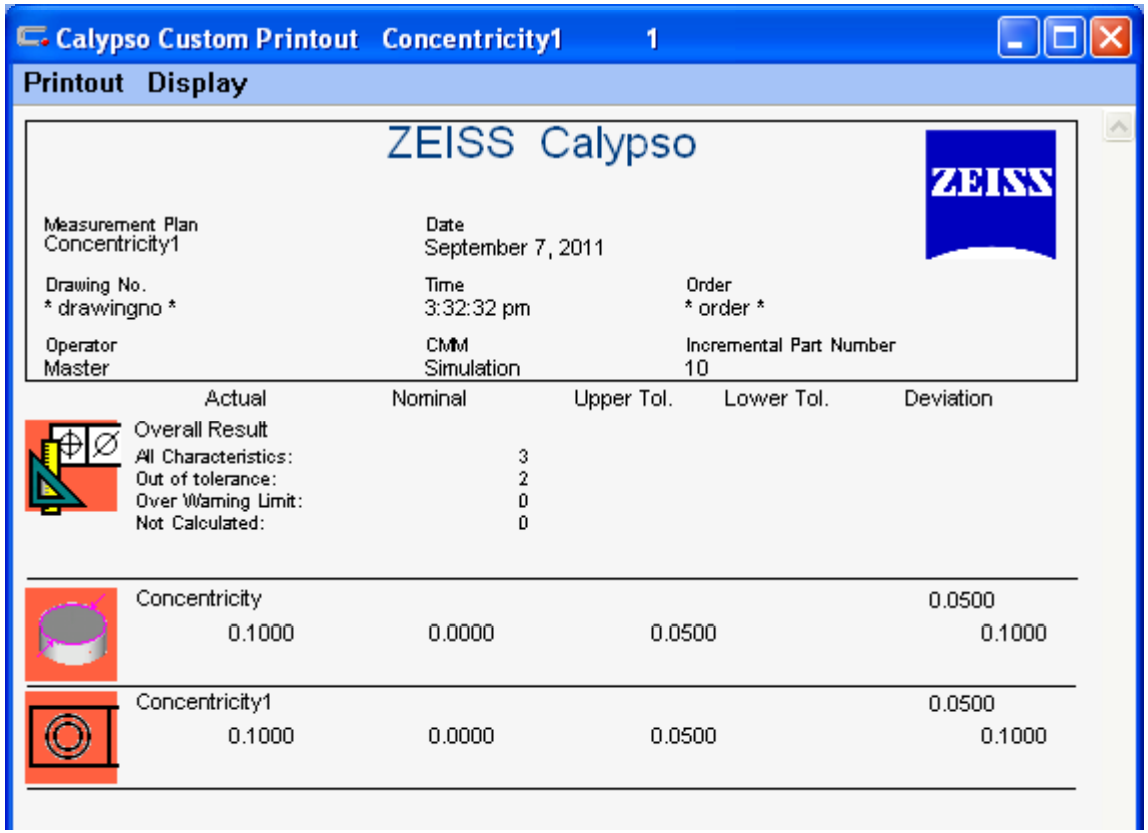
Let's change the FEATURE circle to X=0, Y=0.05 and run it in simulation.

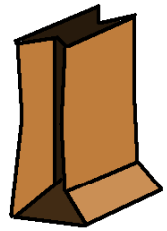
LUNCHEON LEARN

YAY!

Same Result!

The results make sense!





One more try…

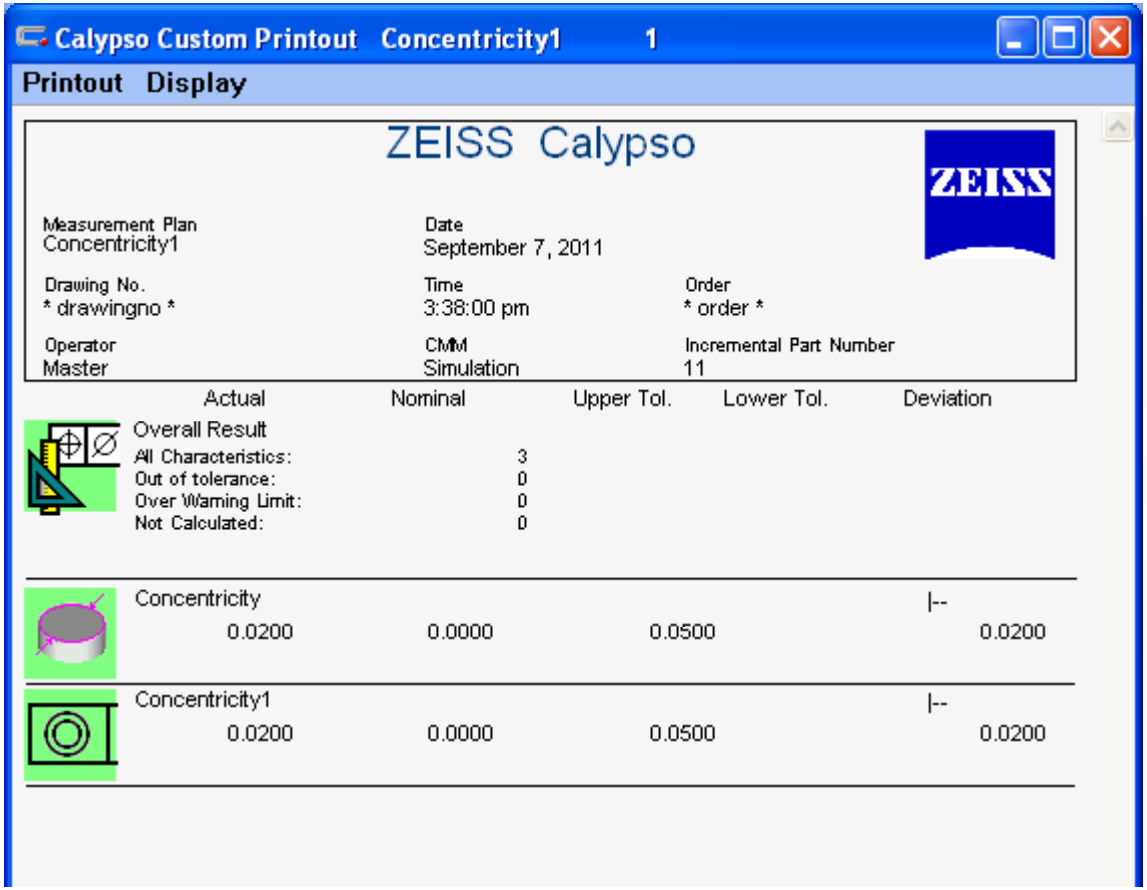
Another theoretical example to see if it makes sense.

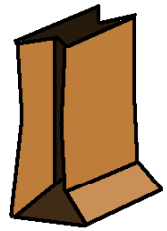
Let's change the FEATURE circle to X=0.00707, Y=0.00707 and run it in simulation.

LUNCHEON LEARN

YAY again!

The results make sense!





Now a REAL program with REAL data…

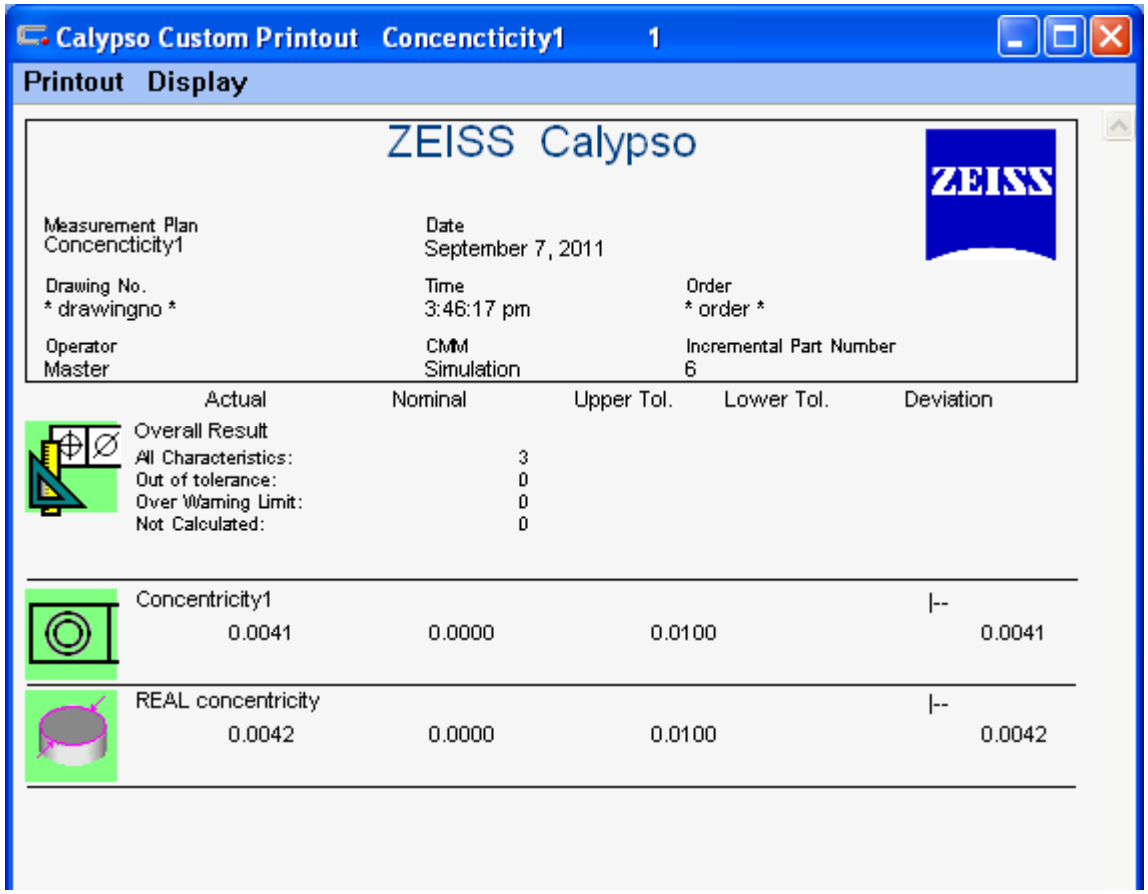
ELLISON TECHNOLOGIES

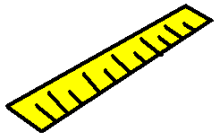
LUNCHEON LEARN

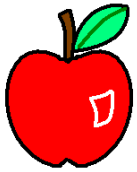
ZEISS

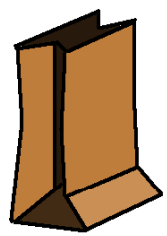
YAY again!

The results STILL make sense!





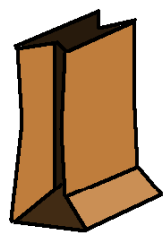




LUNCHEON LEARN

Well, now you know how to check "REAL" concentricity…

LUNCHEON LEARN



Why in the world would you ever want to do that considering the "REAL" answer is a whole 0.0001mm different than the way Calypso does it?!?!?

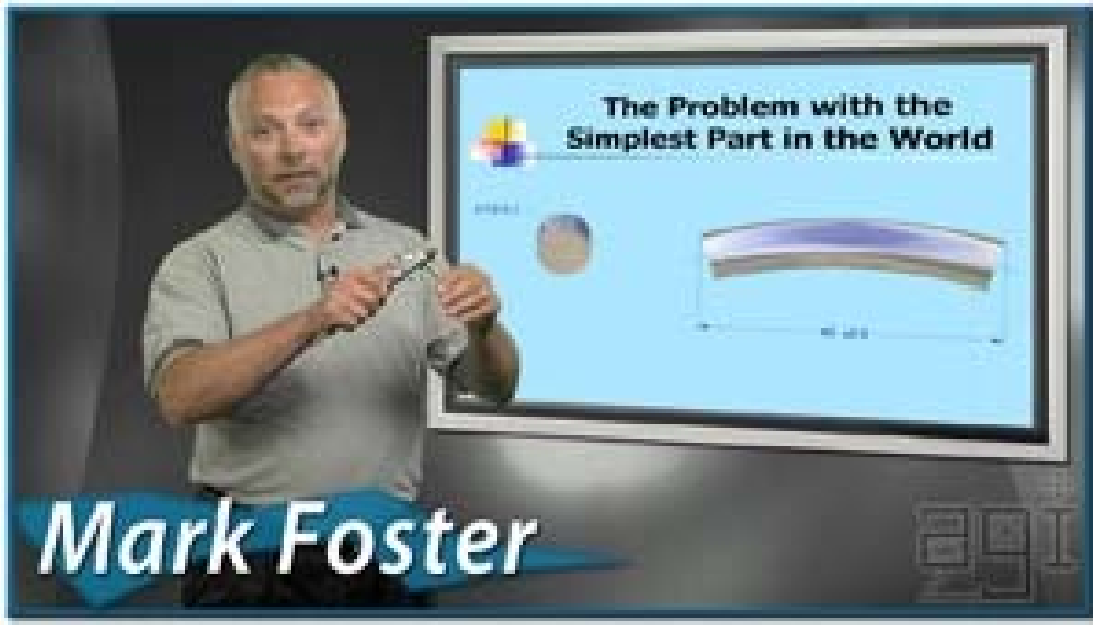
ELLISON TECHNOLOGIES

LUNCHEON LEARN

ZEISS

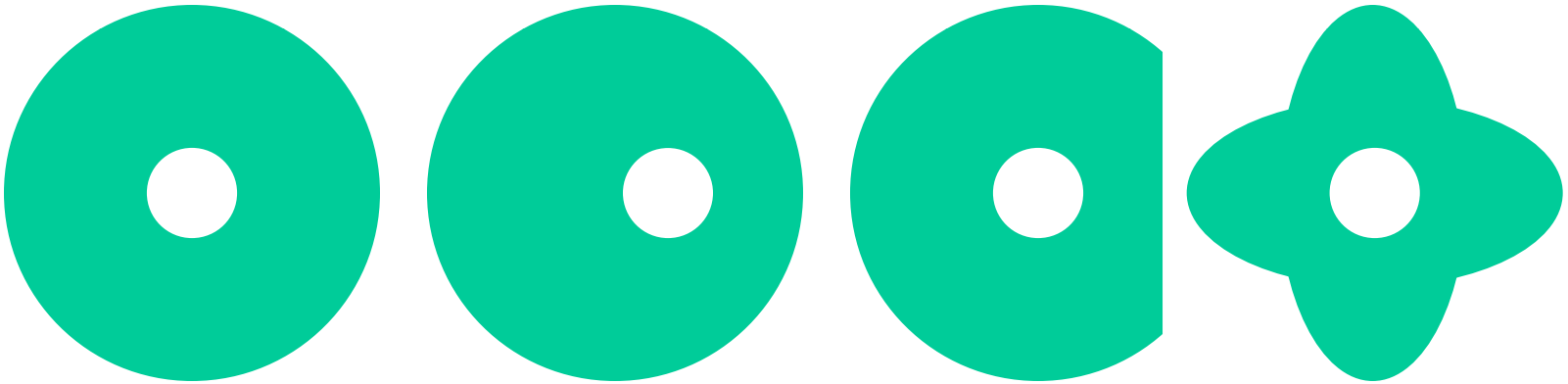
I honestly don't know considering we can use position, roundness, and runout…

is what I said before talking to Mark Foster at Applied Geometrics, Inc. (www.gdandt.com)

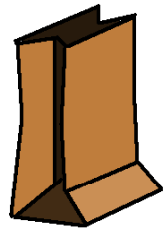


LUNCHEON LEARN

Here's what's going on and WHY "REAL" concentricity is used…

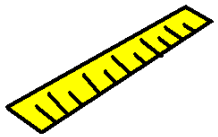


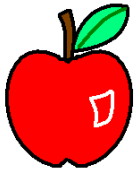
Roundness:	**GOOD**	**GOOD**	**BAD**	**BAD**
Position:	**GOOD**	**BAD**	**GOOD**	**GOOD**
Runout:	**GOOD**	**BAD**	**BAD**	**BAD**
Concentricity:	**GOOD**	**BAD**	**BAD**	**GOOD**

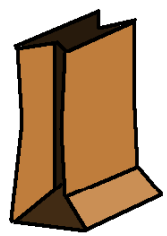


With all that understood, "REAL" concentricity does not apply in MOST applications.

The Y14.5 standard says it best…







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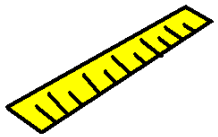
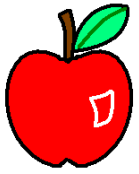
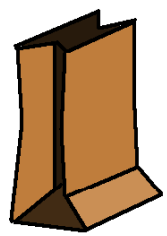
…Therefore, unless there is a definite need for the control of a feature's median points, it is recommended that a control be specified in terms of a runout tolerance or a positional tolerance.



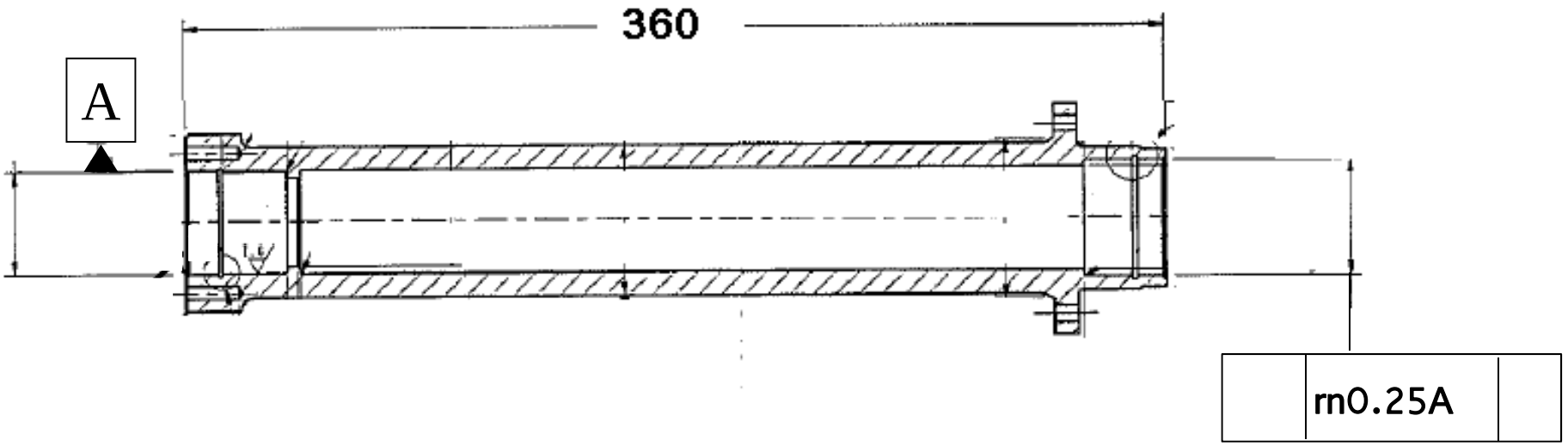




LUNCHEON LEARN

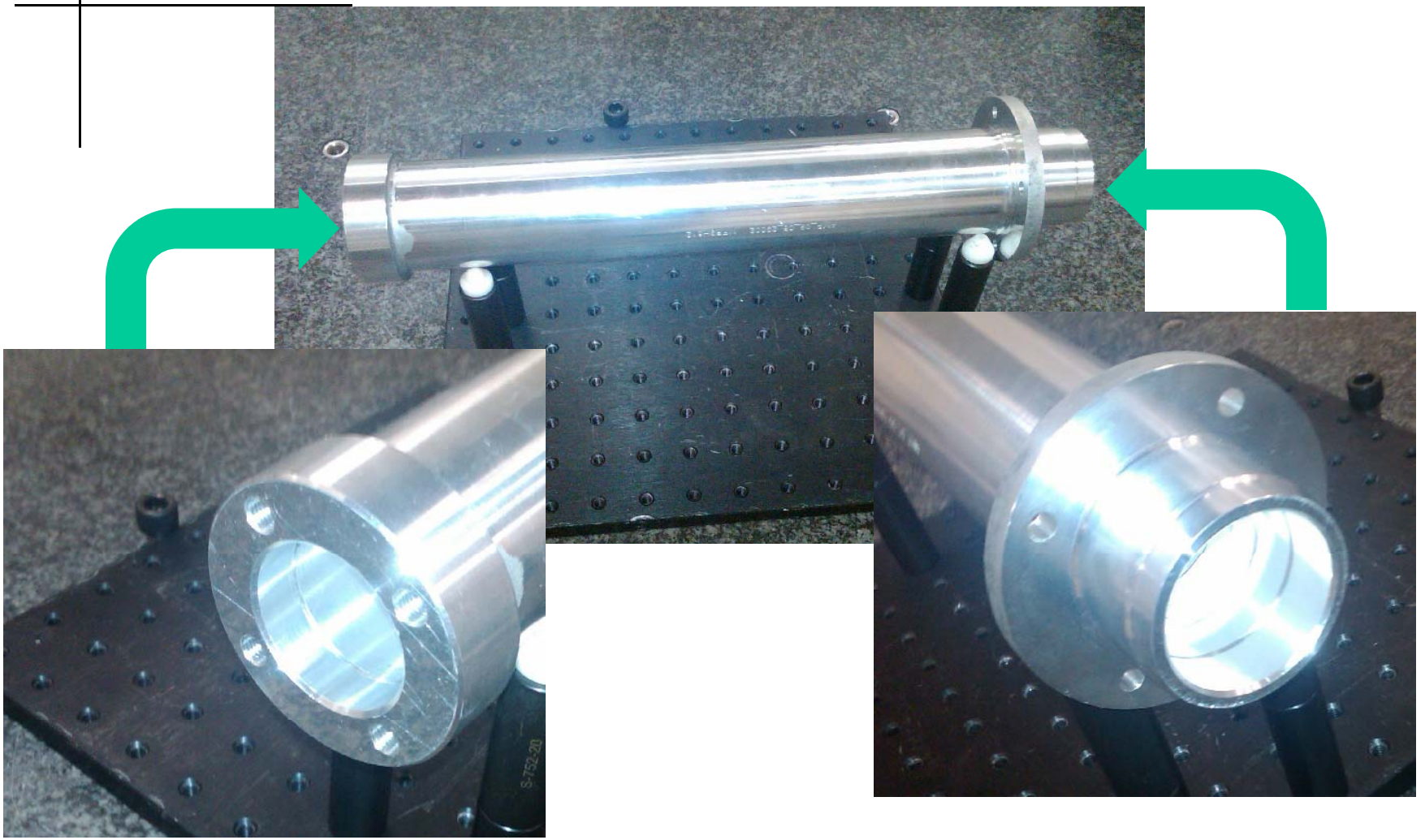
Let's take a look at a REAL part and a REAL print with a REAL bad dimension we have to check.

LUNCHEON LEARN



I'm going to assume the designer meant "Calypso Concentricity" ("Position") and not "REAL Concentricity".

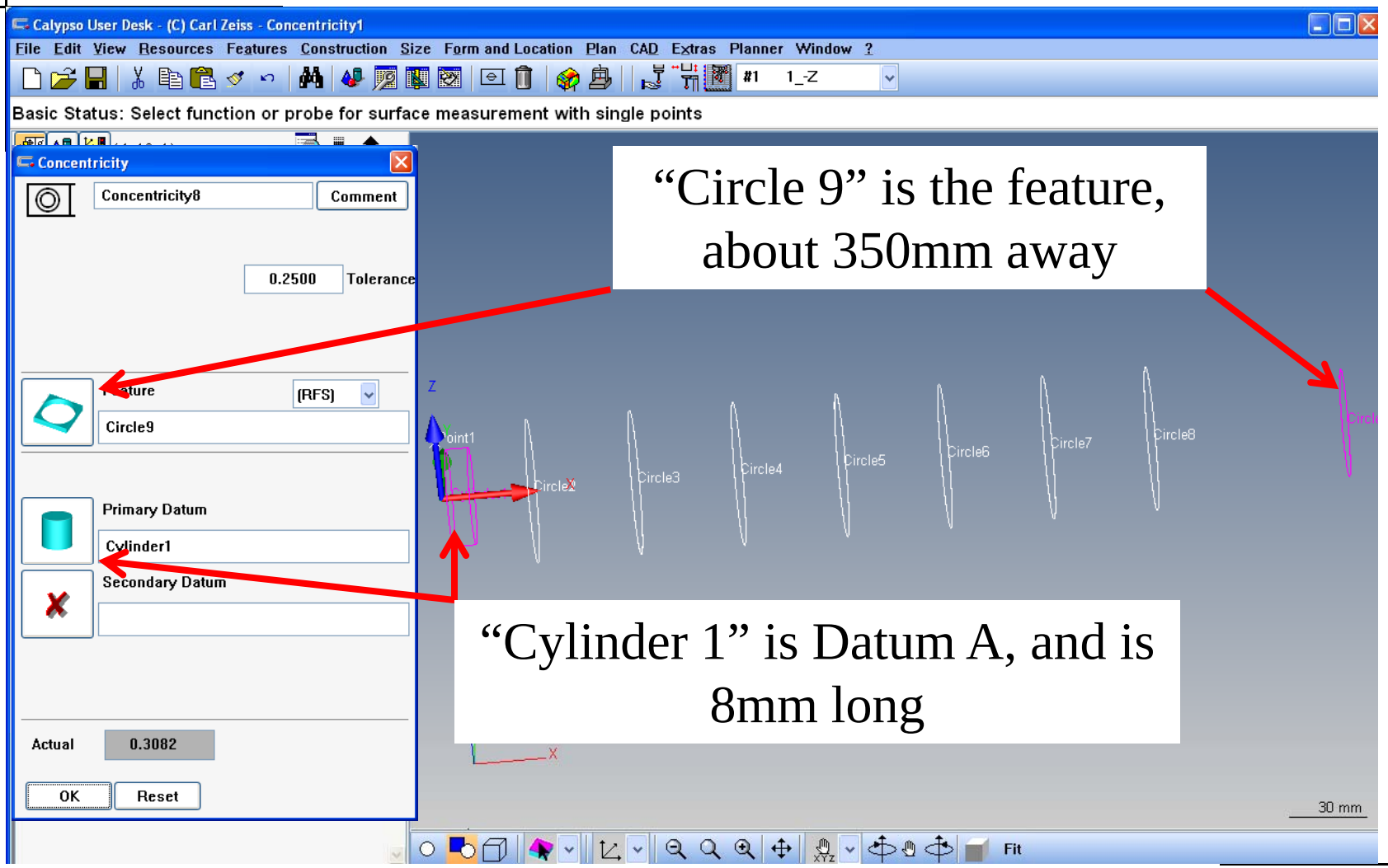
LUNCHEON LEARN

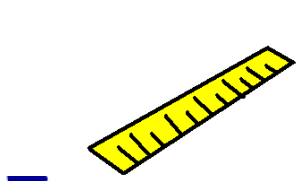


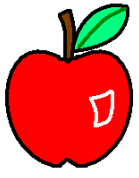
ELLISON TECHNOLOGIES

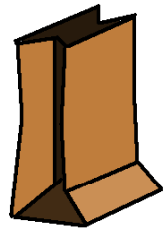
LUNCHEON LEARN

ZEISS









LUNCHEON LEARN

The tolerance is 250 microns for goodness sake.

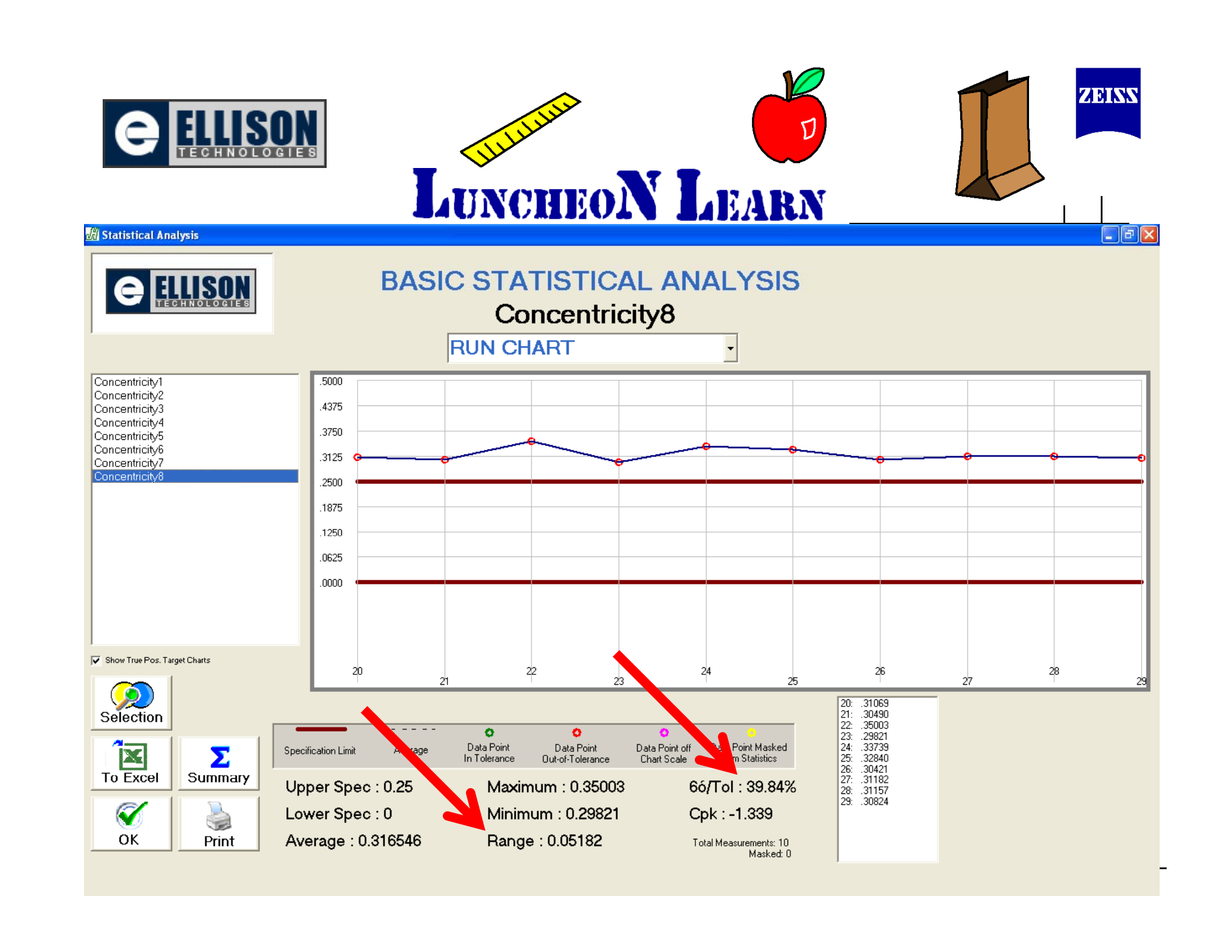
I'm using a ZEISS afterall. The machine has an accuracy of 1.7 microns. PIECE OF CAKE!

What could go wrong?

Run the part 10 times in a Loop.

Don’t Touch the part.

Let’s check repeatability…


ELLISON TECHNOLOGIES
LUNCHEON LEARN
ZEISS
Statistical Analysis
ELLISON TECHNOLOGIES
BASIC STATISTICAL ANALYSIS
Concentricity8
RUN CHART
Concentricity1
Concentricity2
Concentricity3
Concentricity4
Concentricity5
Concentricity6
Concentricity7
Concentricity8
.5000
.4375
.3750
.3125
.2500
.1875
.1250
.0625
.0000
20
21
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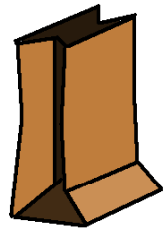
24
25
26
27
28
29
Show True Pos. Target Charts
Selection
To Excel
Summary
OK
Print
Specification Limit
Data Point In Tolerance
Data Point Out-of-Tolerance
Data Point off Chart Scale
Upper Spec : 0.25
Lower Spec : 0
Average : 0.316546
Maximum : 0.35003
Minimum : 0.29821
Range : 0.05182
66/Tol : 39.84%
Cpk : -1.339
Total Measurements: 10
Masked: 0
20: .31069
21: .30490
22: .35003
23: .29821
24: .33739
25: .32840
26: .30421
27: .31182
28: .31157
29: .30824

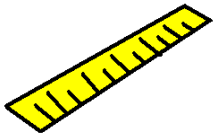


Range of 52 microns?

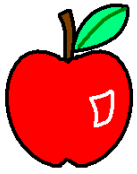
An estimated GR&R of 40%?

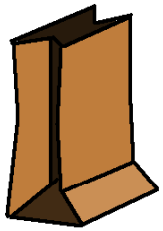
I think I need to call service…

ELLISON TECHNOLOGIES



LUNCHEON LEARN





ZEISS

…before I do, I wonder if the distance from the Datum has anything to do with it.

Check this out:

LUNCHEON LEARN

Statistical Analysis

ELLISON TECHNOLOGIES

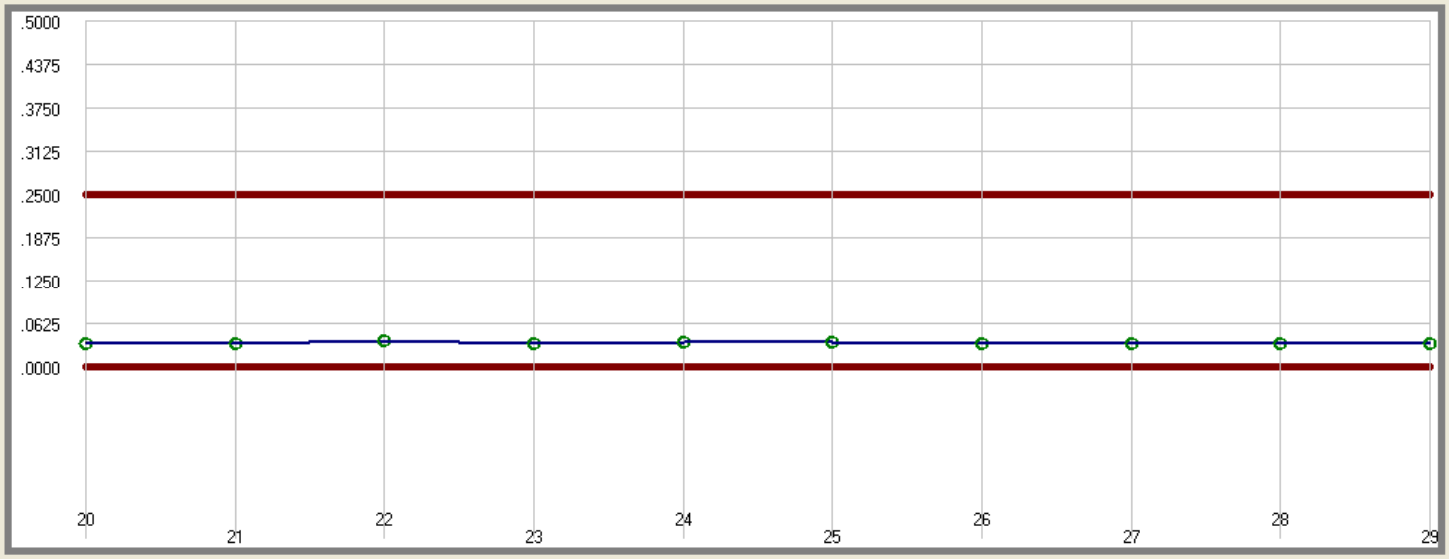
BASIC STATISTICAL ANALYSIS

Concentricity1

RUN CHART

30mm from Datum A

- Concentricity1
- Concentricity2
- Concentricity3
- Concentricity4
- Concentricity5
- Concentricity6
- Concentricity7
- Concentricity8



Show True Pos. Target Charts

Selection

To Excel

Summary

OK

Print

Specification Limit | Average | Data Point In Tolerance | Data Point Out-of-Tolerance | Data Point off Chart Scale | Data Point Masked from Statistics

Upper Spec : 0.25
Lower Spec : 0
Average : 0.034459

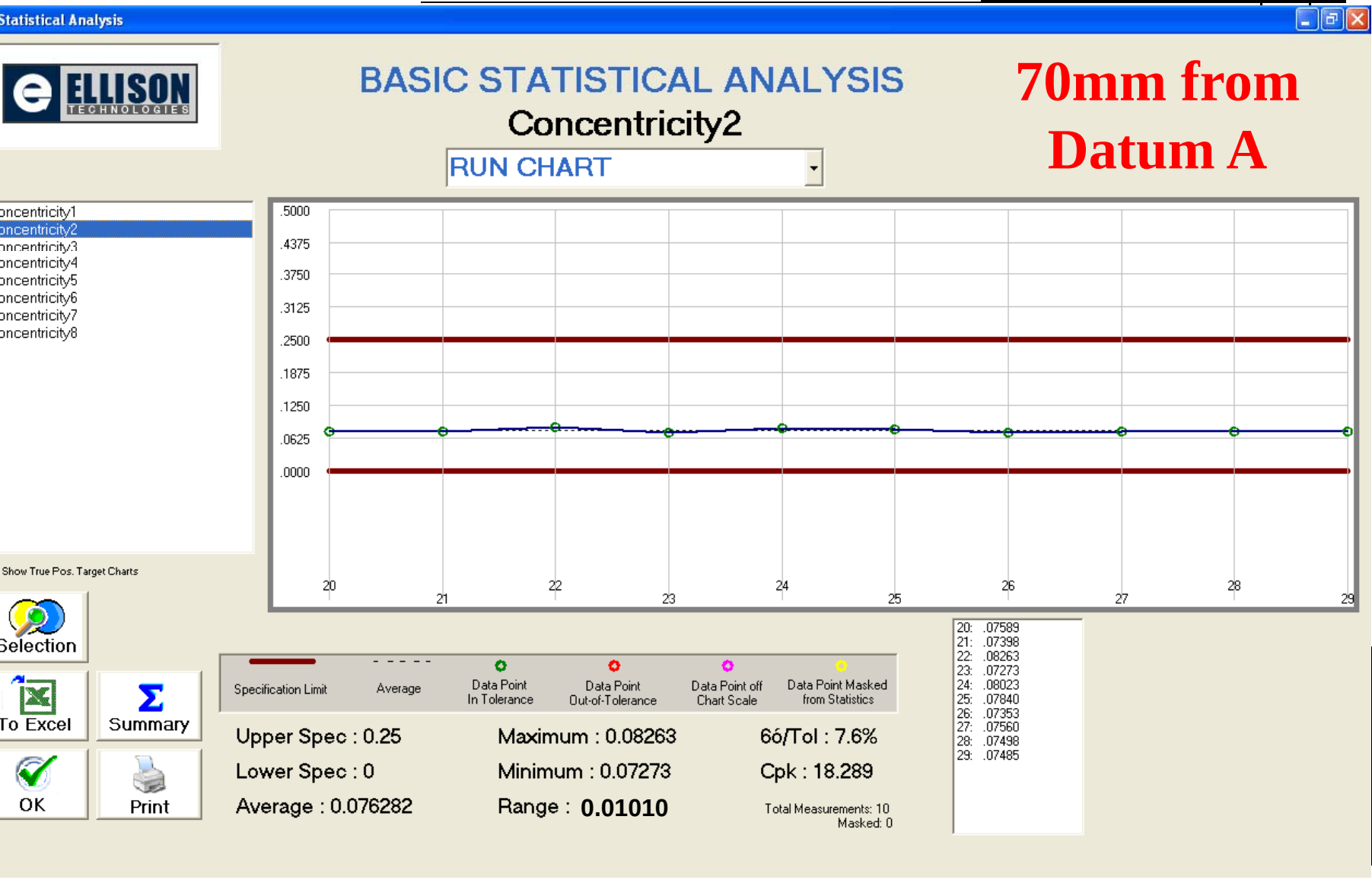
Maximum : 0.0366
Minimum : 0.03338
Range : 0.00322

6ó/Tol : 2.5%
Cpk : 68.890

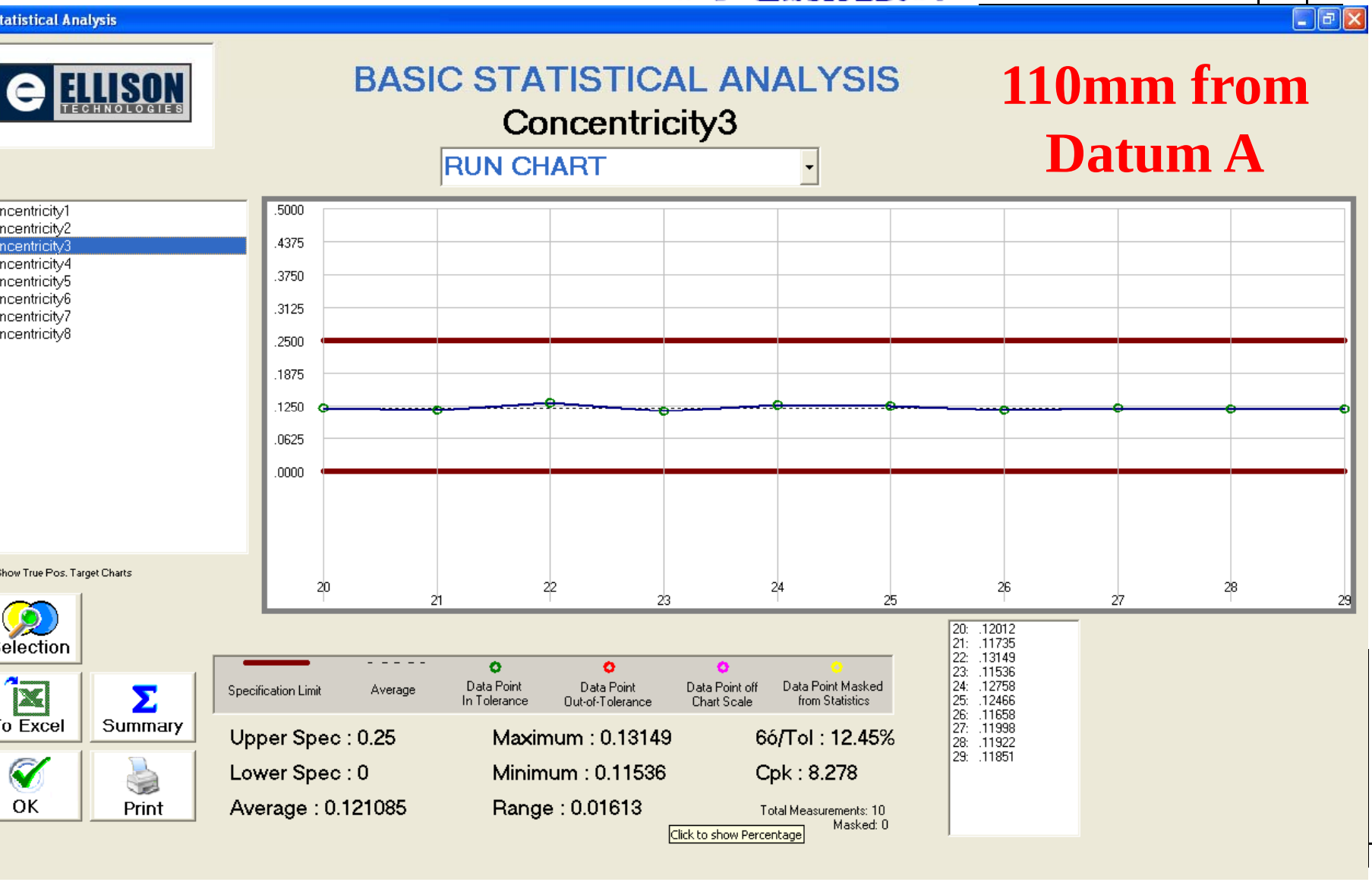
Total Measurements: 10
Masked: 0

20: .03426
21: .03366
22: .03660
23: .03338
24: .03572
25: .03511
26: .03353
27: .03432
28: .03384
29: .03417

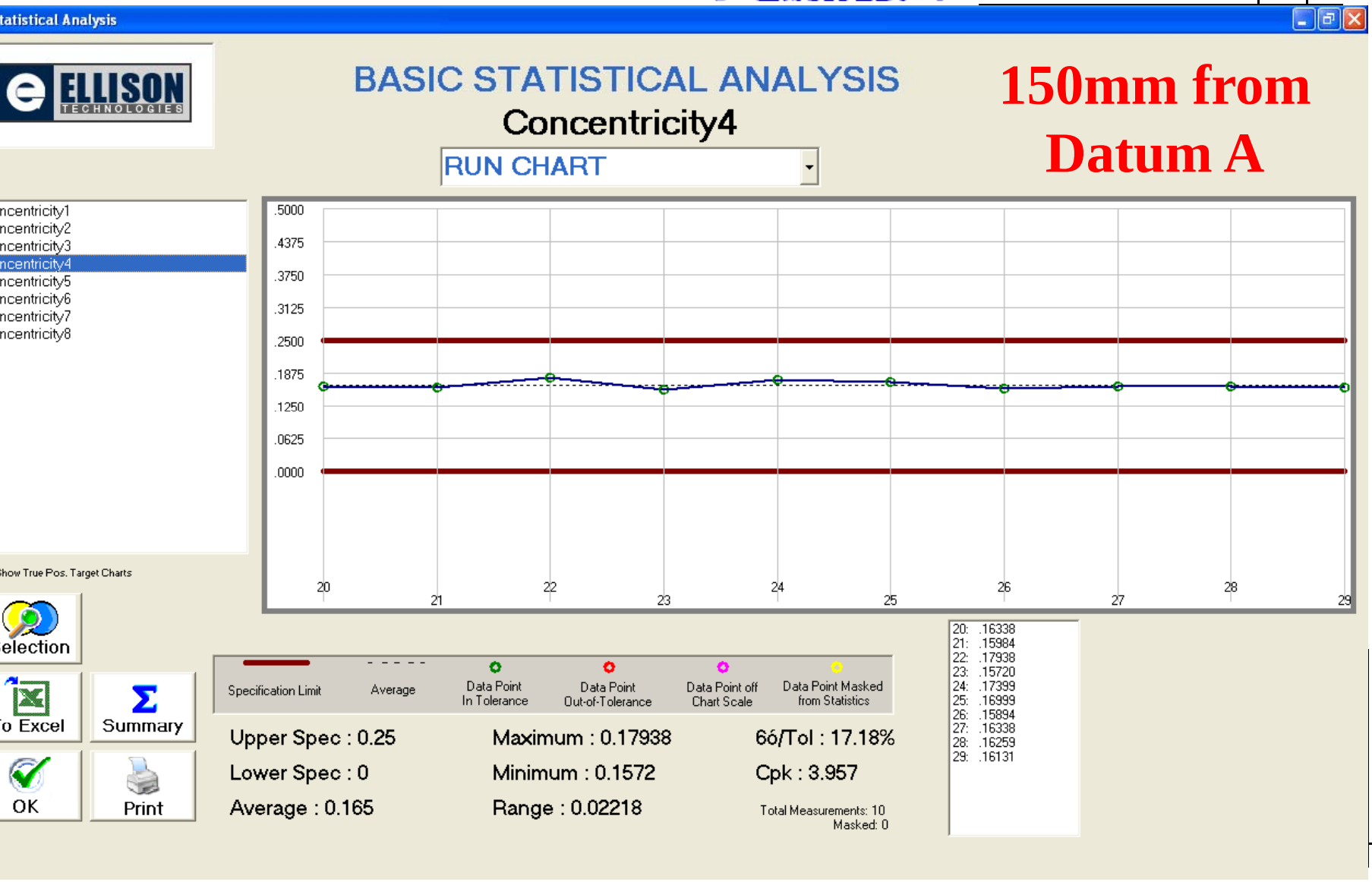
LUNCHEON LEARN



LUNCHEON LEARN



LUNCHEON LEARN



LUNCHEON LEARN

Statistical Analysis

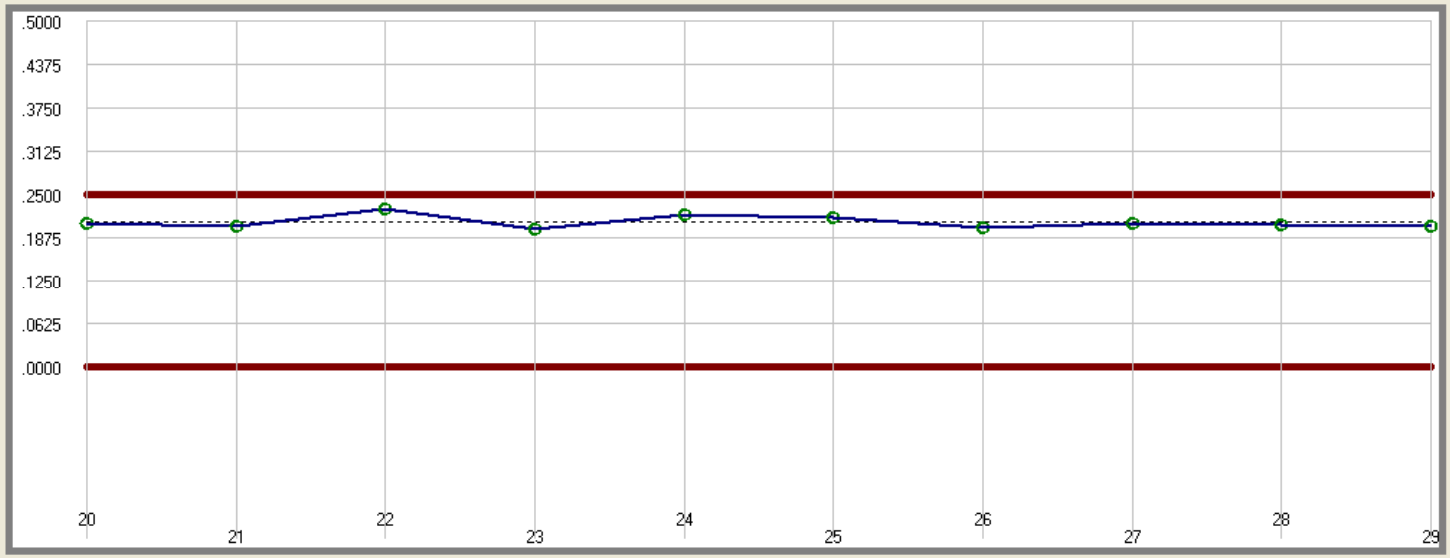
BASIC STATISTICAL ANALYSIS

Concentricity5

190mm from Datum A

RUN CHART

- Concentricity1
- Concentricity2
- Concentricity3
- Concentricity4
- Concentricity5
- Concentricity6
- Concentricity7
- Concentricity8



Show True Pos. Target Charts

Selection

To Excel

Summary

OK

Print

Specification Limit | Average | Data Point In Tolerance | Data Point Out-of-Tolerance | Data Point off Chart Scale | Data Point Masked from Statistics

Upper Spec : 0.25
Lower Spec : 0
Average : 0.209944

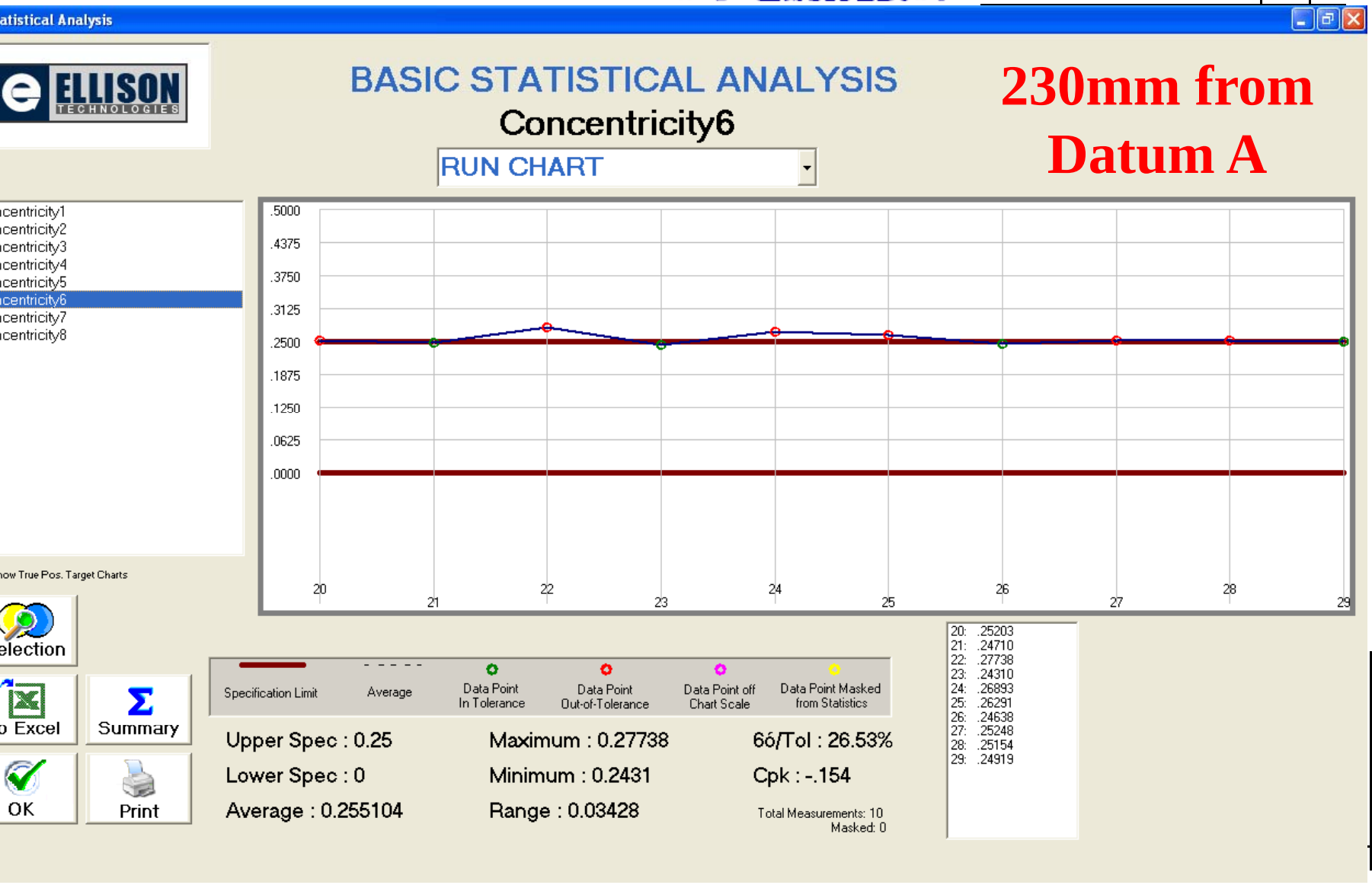
Maximum : 0.22827
Minimum : 0.20008
Range : 0.02819

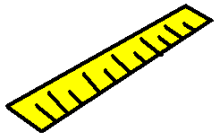
6ó/Tol : 21.88%
Cpk : 1.466

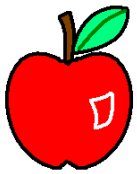
Total Measurements: 10
Masked: 0

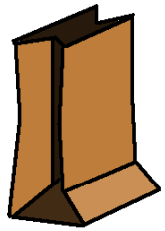
20: .20766
21: .20336
22: .22827
23: .20008
24: .22138
25: .21636
26: .20246
27: .20783
28: .20694
29: .20510

LUNCHEON LEARN









LUNCHEON LEARN

Statistical Analysis

ELLISON TECHNOLOGIES

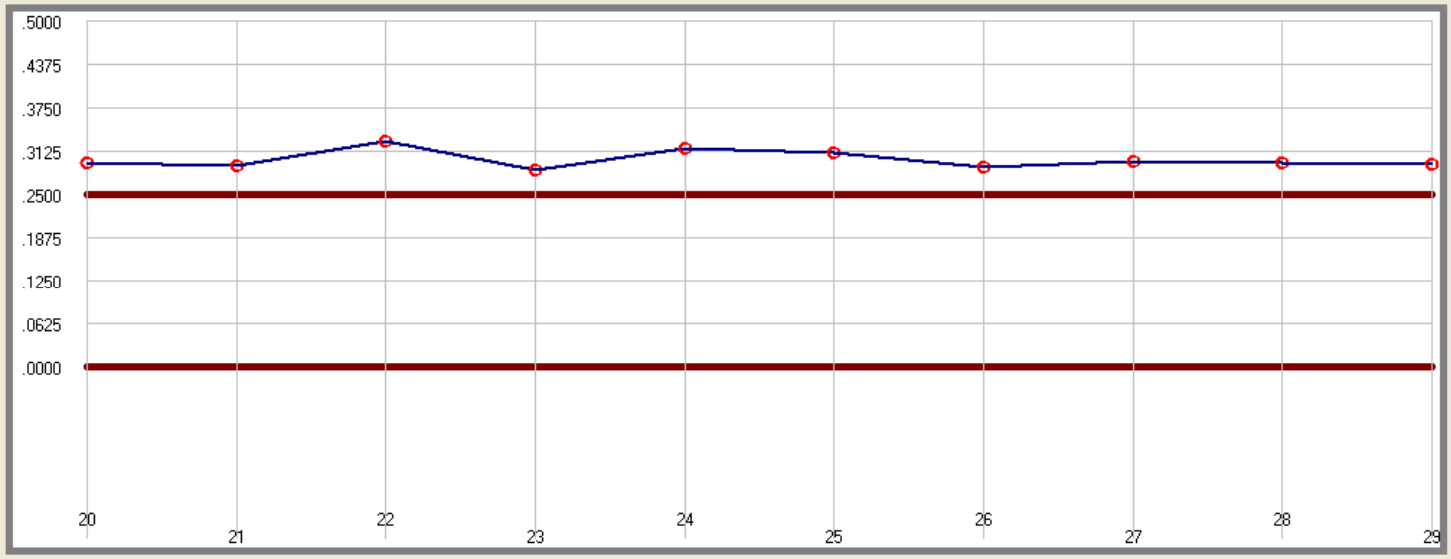
BASIC STATISTICAL ANALYSIS

Concentricity7

RUN CHART

270mm from Datum A

- Concentricity1
- Concentricity2
- Concentricity3
- Concentricity4
- Concentricity5
- Concentricity6
- Concentricity7
- Concentricity8



Show True Pos. Target Charts

Selection

To Excel

Summary

OK

Print

Specification Limit | Average | Data Point In Tolerance | Data Point Out-of-Tolerance | Data Point off Chart Scale | Data Point Masked from Statistics

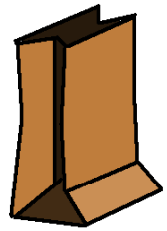
Upper Spec : 0.25
Lower Spec : 0
Average : 0.300479

Maximum : 0.32674
Minimum : 0.28604
Range : 0.0407

6ó/Tol : 31.25%
Cpk : -1.293

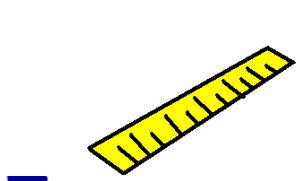
Total Measurements: 10
Masked: 0

20: .29673
21: .29107
22: .32674
23: .28604
24: .31674
25: .30969
26: .29049
27: .29734
28: .29638
29: .29357

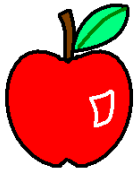


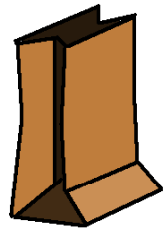
I think I'm seeing a trend here.

Distance from the Datum has a serious effect on the Concentricity (Position) result.



LUNCHEON LEARN





I wonder if the length of the Datum has anything to do with the results as well?

Let's shorten a Datum a bit, from 8mm down to 5mm and see the effect.

LUNCHEON LEARN

Statistical Analysis

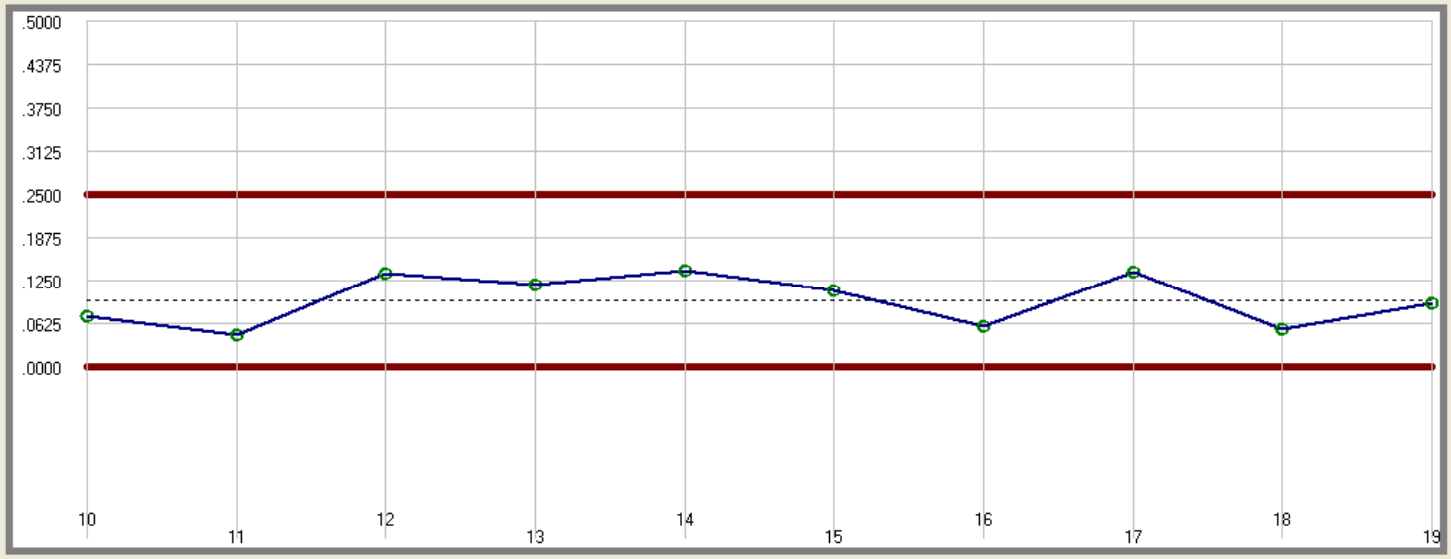
BASIC STATISTICAL ANALYSIS

Concentricity1

RUN CHART

30mm from Datum A

- Concentricity1
- Concentricity2
- Concentricity3
- Concentricity4
- Concentricity5
- Concentricity6
- Concentricity7
- Concentricity8



Show True Pos. Target Charts

Selection

To Excel

Summary

OK

Print

Specification Limit | Average | Data Point In Tolerance | Data Point Out-of-Tolerance | Data Point off Chart Scale | Data Point Masked from Statistics

Upper Spec : 0.25
Lower Spec : 0
Average : 0.096347

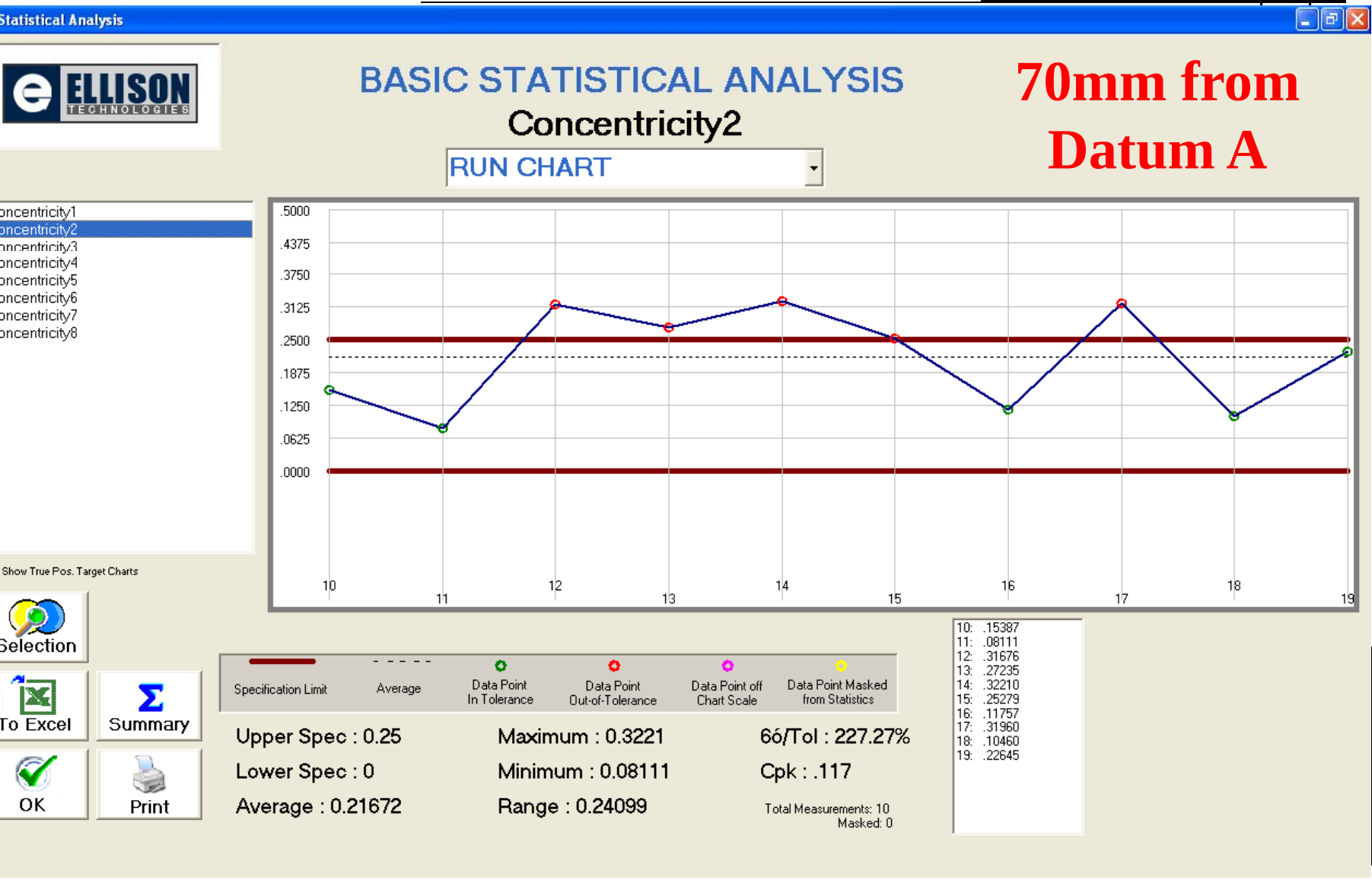
Maximum : 0.13858
Minimum : 0.04498
Range : 0.0936

6ó/Tol : 88.5%
Cpk : 1.393

Total Measurements: 10
Masked: 0

10: .07282
11: .04498
12: .13586
13: .11873
14: .13858
15: .11098
16: .05901
17: .13734
18: .05382
19: .09135

LUNCHEON LEARN



LUNCHEON LEARN

Statistical Analysis

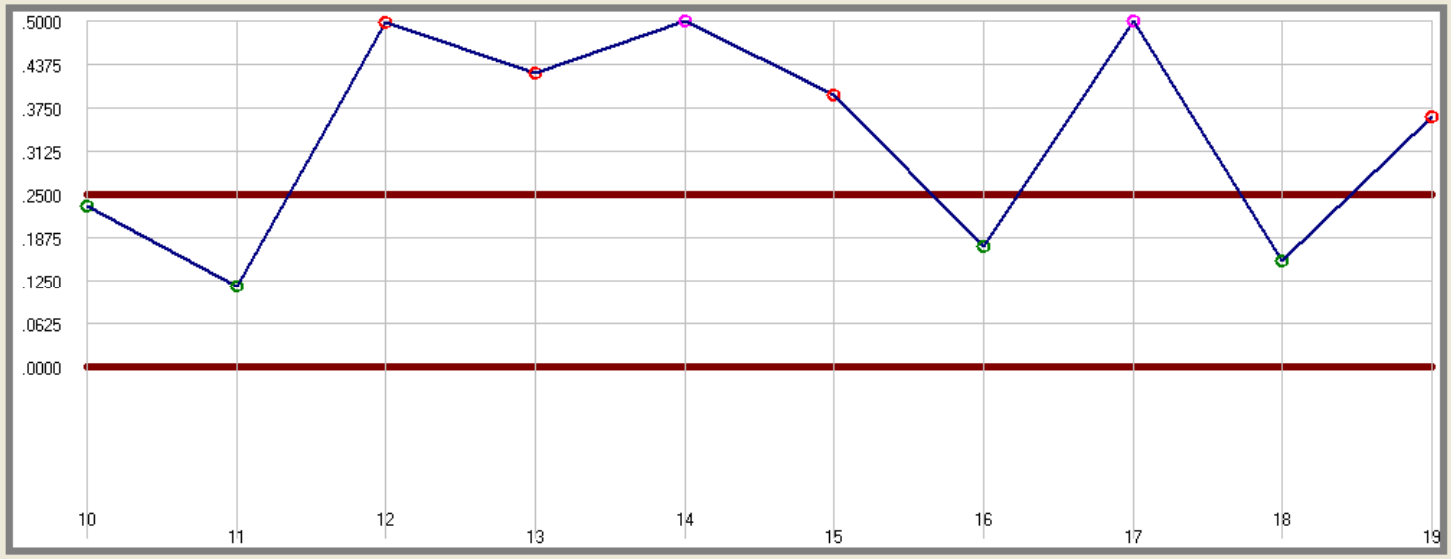
BASIC STATISTICAL ANALYSIS

Concentricity3

110mm from Datum A

RUN CHART

- Concentricity1
- Concentricity2
- Concentricity3
- Concentricity4
- Concentricity5
- Concentricity6
- Concentricity7
- Concentricity8



Show True Pos. Target Charts

Selection

To Excel

Summary

OK

Print

Specification Limit | Average | Data Point In Tolerance | Data Point Out-of-Tolerance | Data Point off Chart Scale | Data Point Masked from Statistics

Upper Spec : 0.25
Lower Spec : 0
Average : 0.33643

Maximum : 0.50503
Minimum : 0.11584
Range : 0.38919

6ó/Tol : 370.37%
Cpk : -.188

Total Measurements: 10
Masked: 0

Click to show Percentage

10: .23421
11: .11584
12: .49705
13: .42548
14: .50503
15: .39388
16: .17520
17: .50118
18: .15424
19: .36219

LUNCHEON LEARN

Statistical Analysis

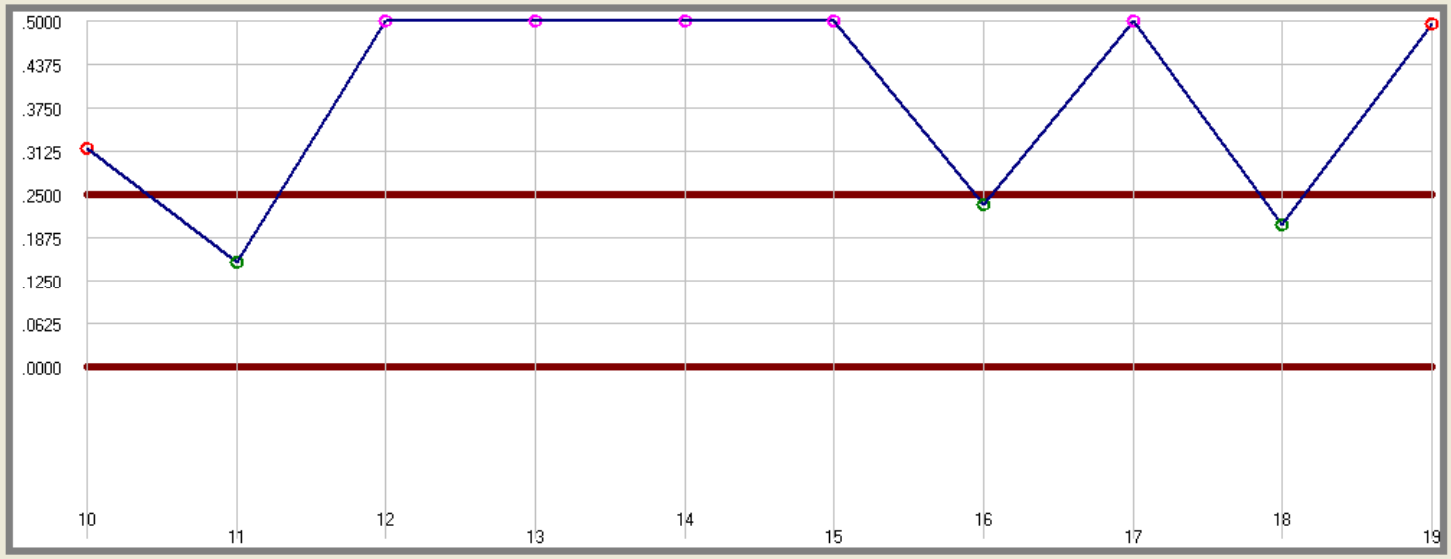
BASIC STATISTICAL ANALYSIS

Concentricity4

150mm from Datum A

RUN CHART

- Concentricity1
- Concentricity2
- Concentricity3
- Concentricity4
- Concentricity5
- Concentricity6
- Concentricity7
- Concentricity8



Show True Pos. Target Charts

Selection

To Excel

Summary

OK

Print

Specification Limit | Average | Data Point In Tolerance | Data Point Out-of-Tolerance | Data Point off Chart Scale | Data Point Masked from Statistics

Upper Spec : 0.25
Lower Spec : 0
Average : 0.458054

Maximum : 0.6901
Minimum : 0.15309
Range : 0.53701

Cp : .197
Cpk : -.328

Total Measurements: 10
Masked: 0

10: .31695
11: .15309
12: .67938
13: .58082
14: .69010
15: .53705
16: .23538
17: .68495
18: .20628
19: .49654

LUNCHEON LEARN

Statistical Analysis

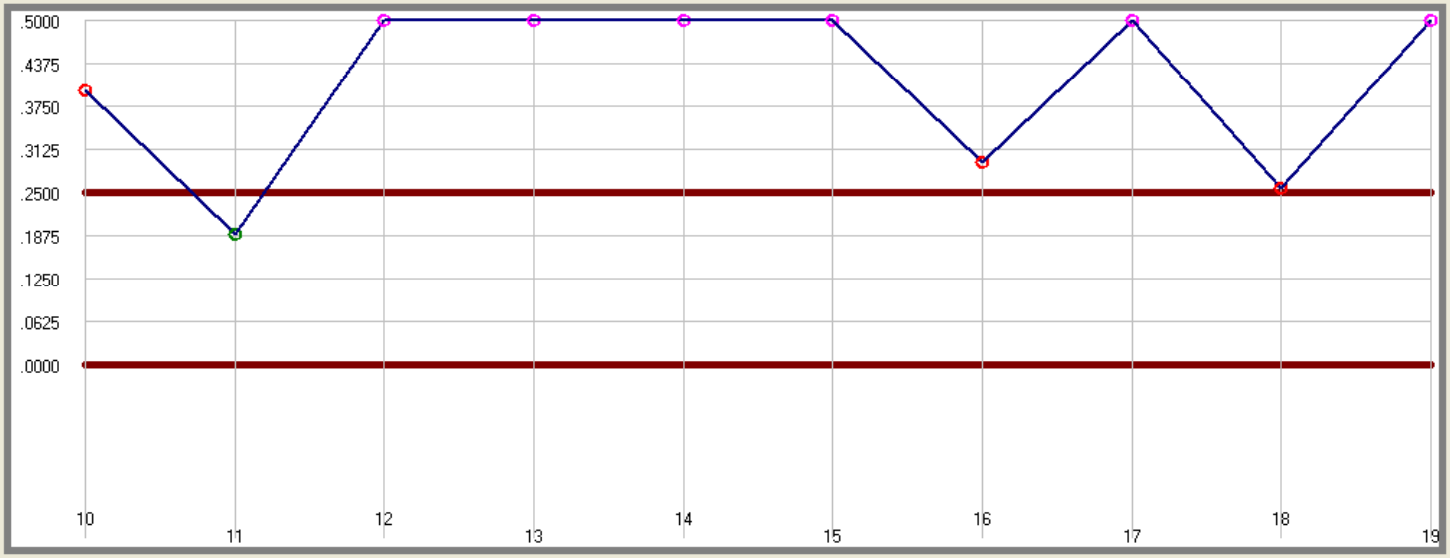
BASIC STATISTICAL ANALYSIS

Concentricity5

190mm from Datum A

RUN CHART

- Concentricity1
- Concentricity2
- Concentricity3
- Concentricity4
- Concentricity5
- Concentricity6
- Concentricity7
- Concentricity8



Show True Pos. Target Charts

Selection

To Excel

Summary

OK

Print

Specification Limit | Average | Data Point In Tolerance | Data Point Out-of-Tolerance | Data Point off Chart Scale | Data Point Masked from Statistics

Upper Spec : 0.25
Lower Spec : 0
Average : 0.578671

Maximum : 0.87406
Minimum : 0.18899
Range : 0.68507

Cp : .154
Cpk : -.406

Total Measurements: 10
Masked: 0

10: .39852
11: .18899
12: .86088
13: .73502
14: .87406
15: .67905
16: .29427
17: .86764
18: .25704
19: .63124

LUNCHEON LEARN

Statistical Analysis

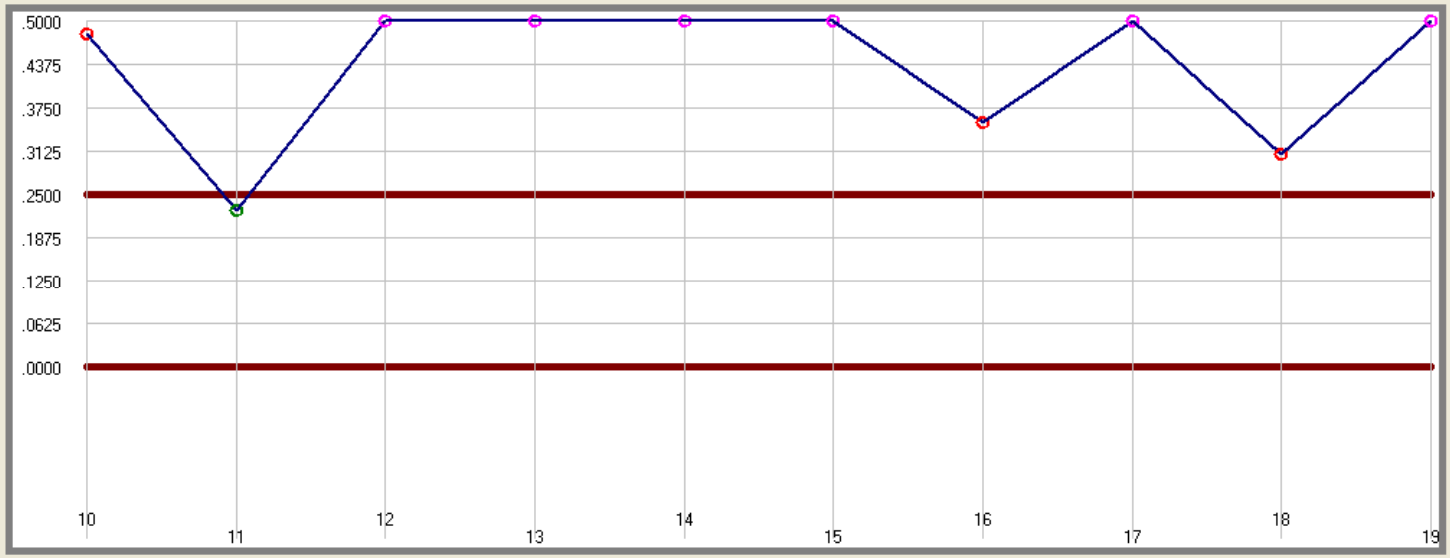
BASIC STATISTICAL ANALYSIS

Concentricity6

230mm from Datum A

RUN CHART

- Concentricity1
- Concentricity2
- Concentricity3
- Concentricity4
- Concentricity5
- Concentricity6
- Concentricity7
- Concentricity8



Show True Pos. Target Charts

Selection

To Excel

Summary

OK

Print

Specification Limit | Average | Data Point In Tolerance | Data Point Out-of-Tolerance | Data Point off Chart Scale | Data Point Masked from Statistics

Upper Spec : 0.25
Lower Spec : 0
Average : 0.699846

Maximum : 1.05835
Minimum : 0.22615
Range : 0.8322

6ó/Tol : 769.23%
Cpk : -.457

Total Measurements: 10
Masked: 0

10: .48072
11: .22615
12: 1.04281
13: .88963
14: 1.05835
15: .82150
16: .35404
17: 1.05060
18: .30858
19: .76608

LUNCHEON LEARN

Statistical Analysis

ELLISON TECHNOLOGIES

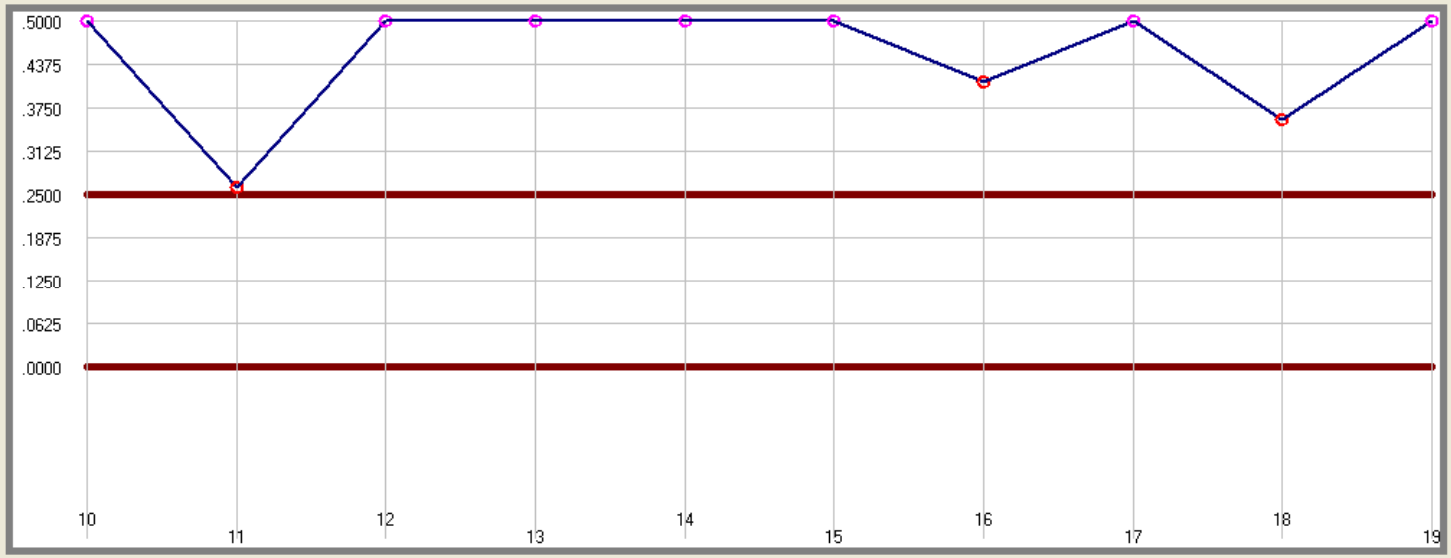
BASIC STATISTICAL ANALYSIS

Concentricity7

270mm from Datum A

RUN CHART

- Concentricity1
- Concentricity2
- Concentricity3
- Concentricity4
- Concentricity5
- Concentricity6
- Concentricity7
- Concentricity8



Show True Pos. Target Charts

Selection

To Excel

Summary

OK

Print

Specification Limit | Average | Data Point In Tolerance | Data Point Out-of-Tolerance | Data Point off Chart Scale | Data Point Masked from Statistics

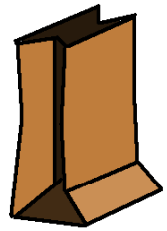
Upper Spec : 0.25
Lower Spec : 0
Average : 0.820086

Maximum : 1.24187
Minimum : 0.26137
Range : 0.9805

6ó/Tol : 909.09%
Cpk : -.491

Total Measurements: 10
Masked: 0

10: .56170
11: .26137
12: 1.22407
13: 1.04340
14: 1.24187
15: .96314
16: .41227
17: 1.23285
18: .35845
19: .90174



WOW!

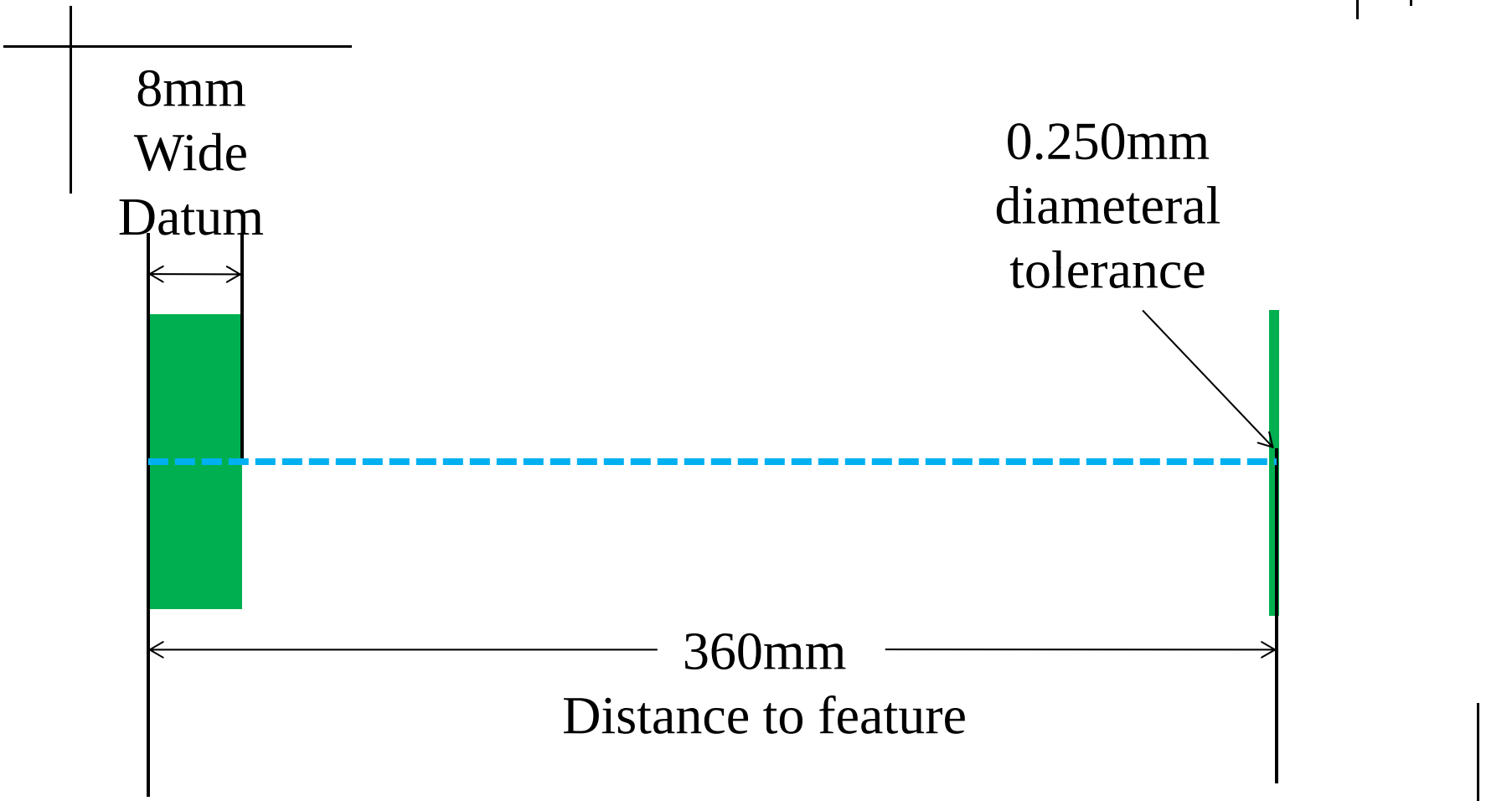
A 3mm difference in Datum Length had a HUUUGE difference in results.

So, we have two problems here:

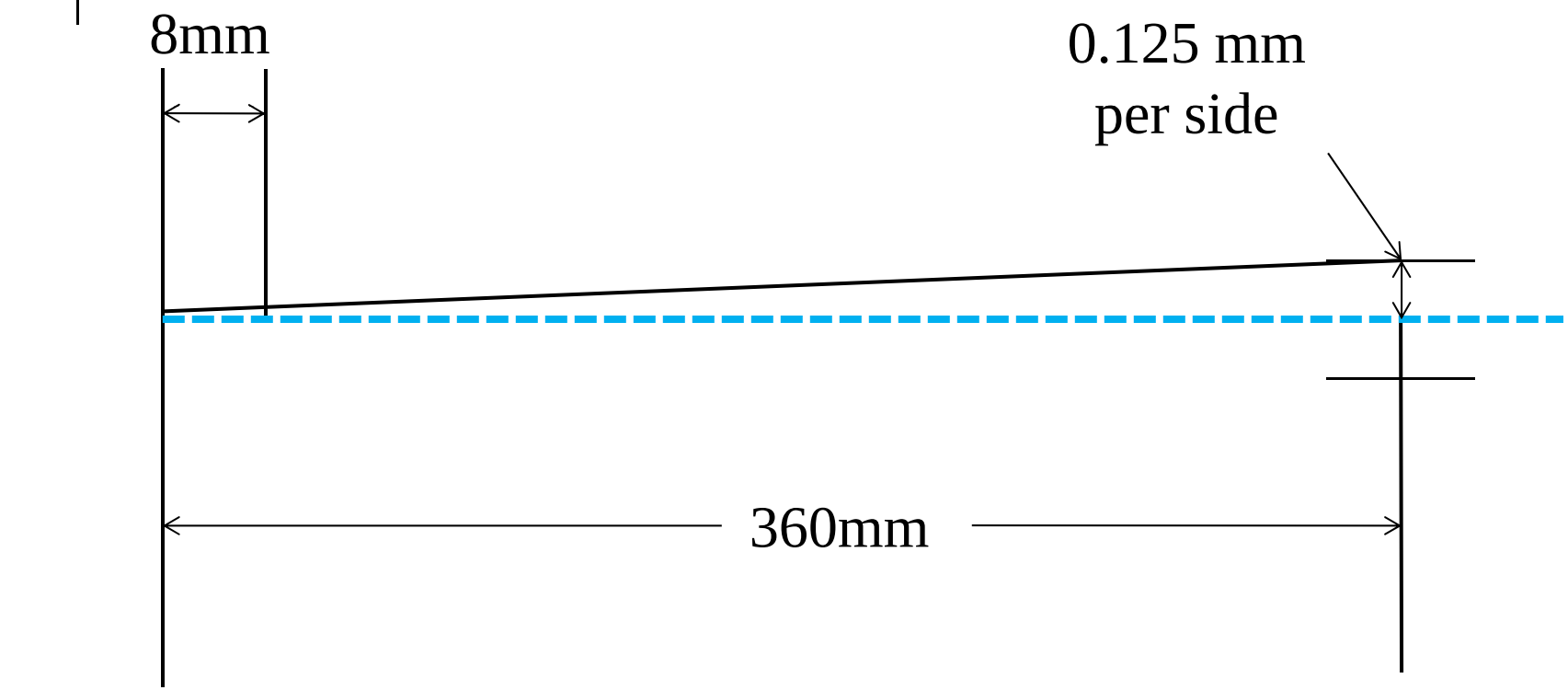
- **Feature located a long way from Datum**
- **Short, Unstable Datum**

Let's think about what we are trying to do…

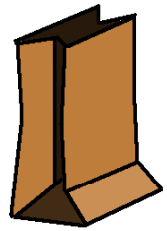
LUNCHEON LEARN



LUNCHEON LEARN

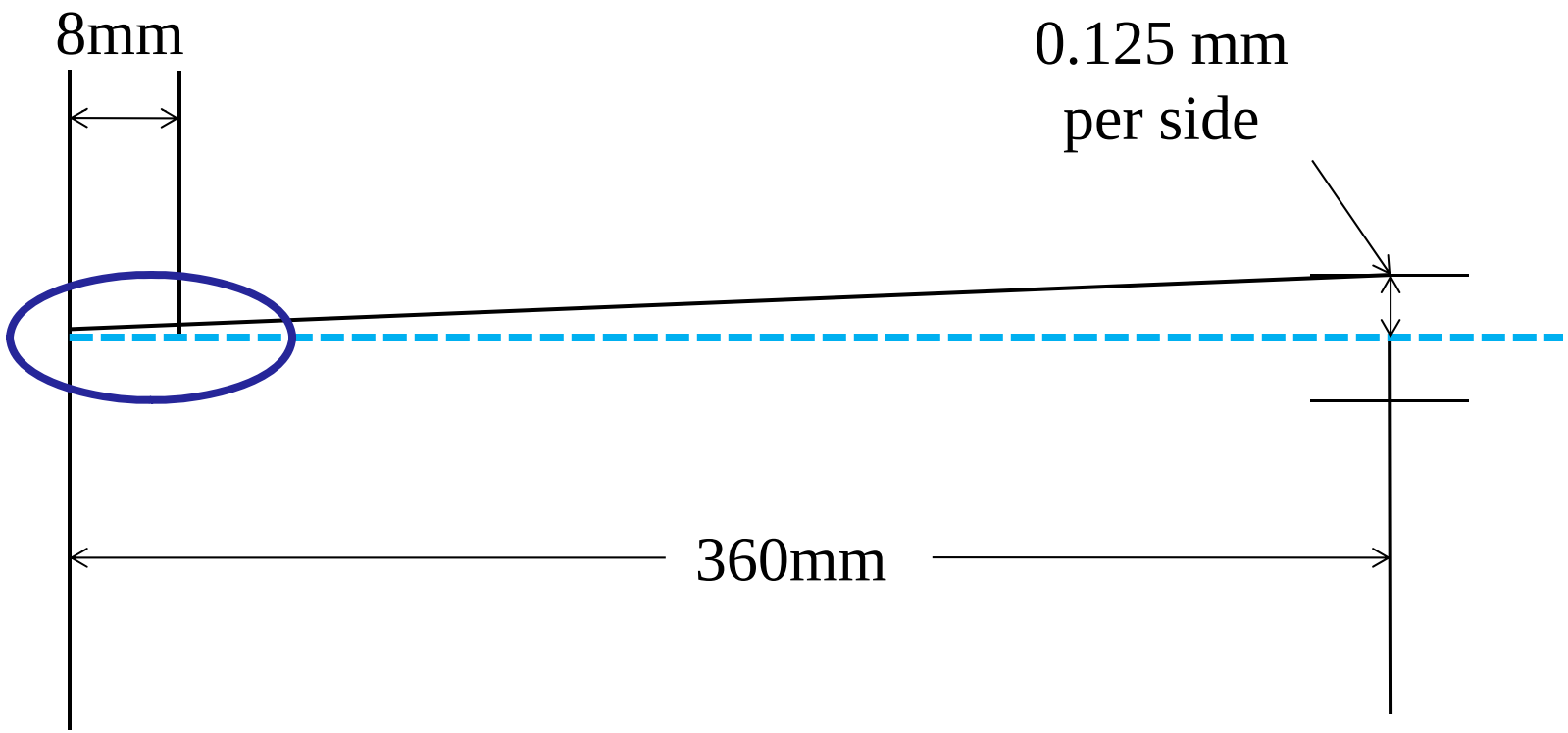


LUNCHEON LEARN

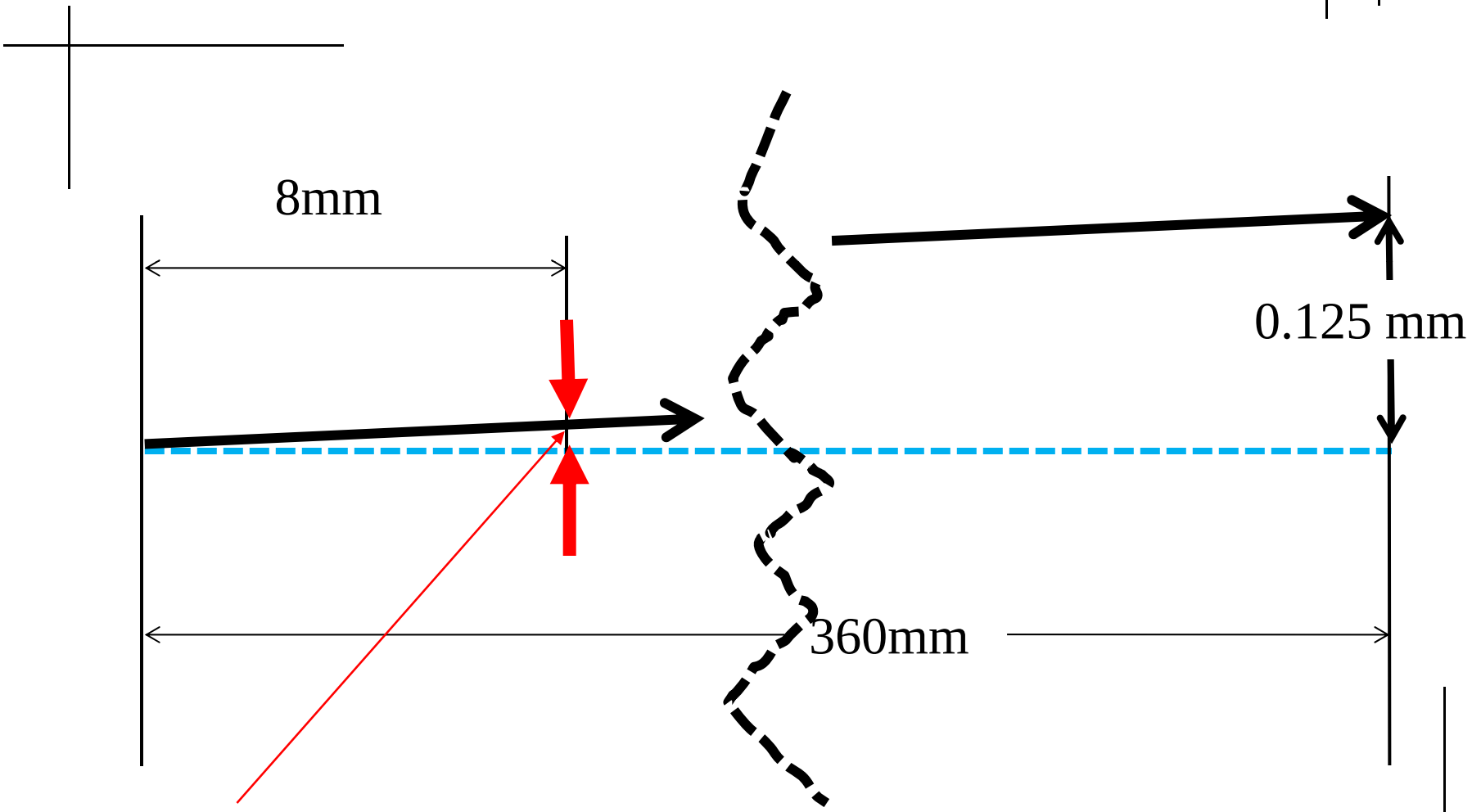


Assuming we hold the feature left side of the datum and the feature still, what tolerance is on the right side of the datum?

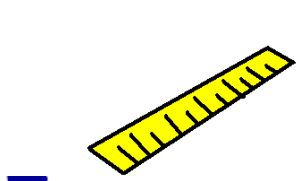
LUNCHEON LEARN

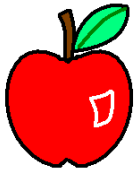


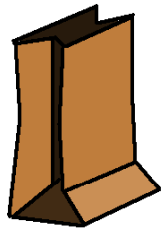
LUNCHEON LEARN



0.125/360*8=0.0028mm!







LUNCHEON LEARN

So, in this case, a tolerance of 250 microns is REALLY a tolerance of 2.8 microns.

YIKES! No wonder we are having problems!

ELLISON TECHNOLOGIES

LUNCHEON LEARN

ZEISS

Time to go buy a UPMC ultra with an accuracy spec of 0.4 microns!

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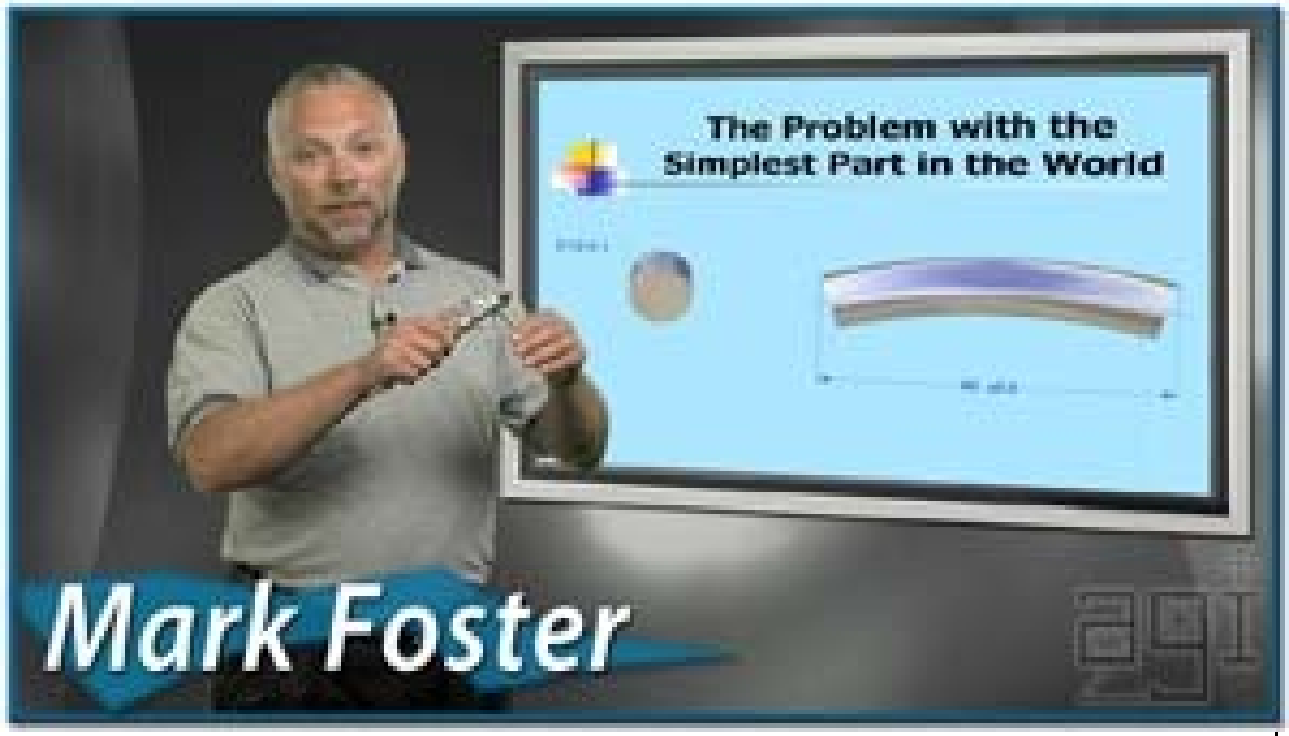
I can't buy a UPMC ultra right now…

So I ask myself "WWMFD"?

What Would Mark Foster Do?



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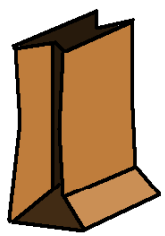
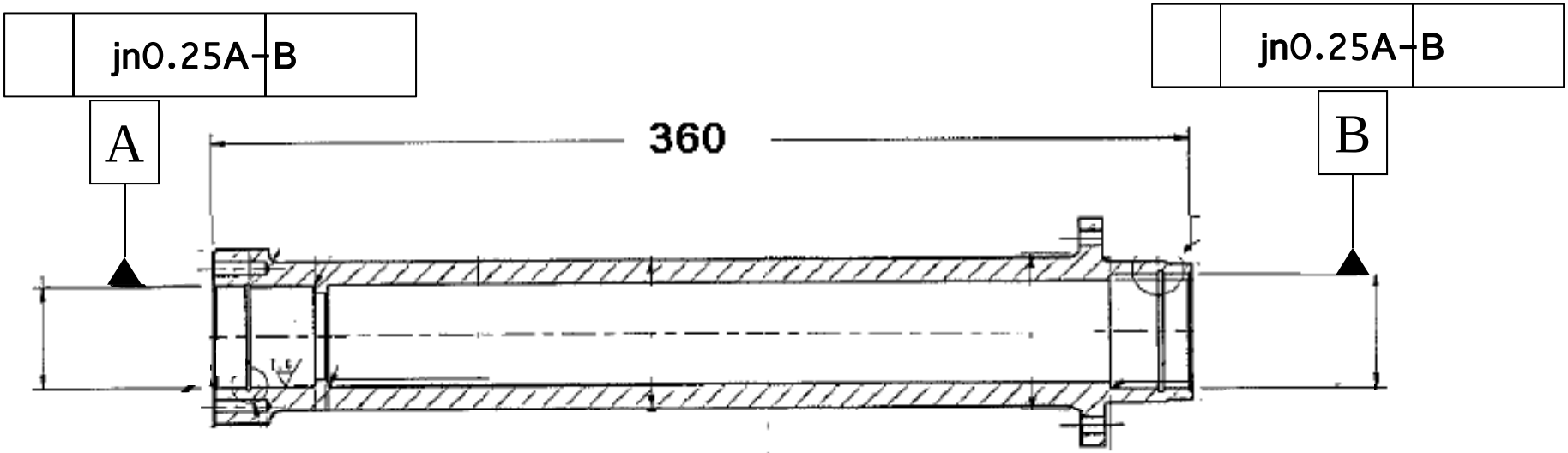


ZEISS



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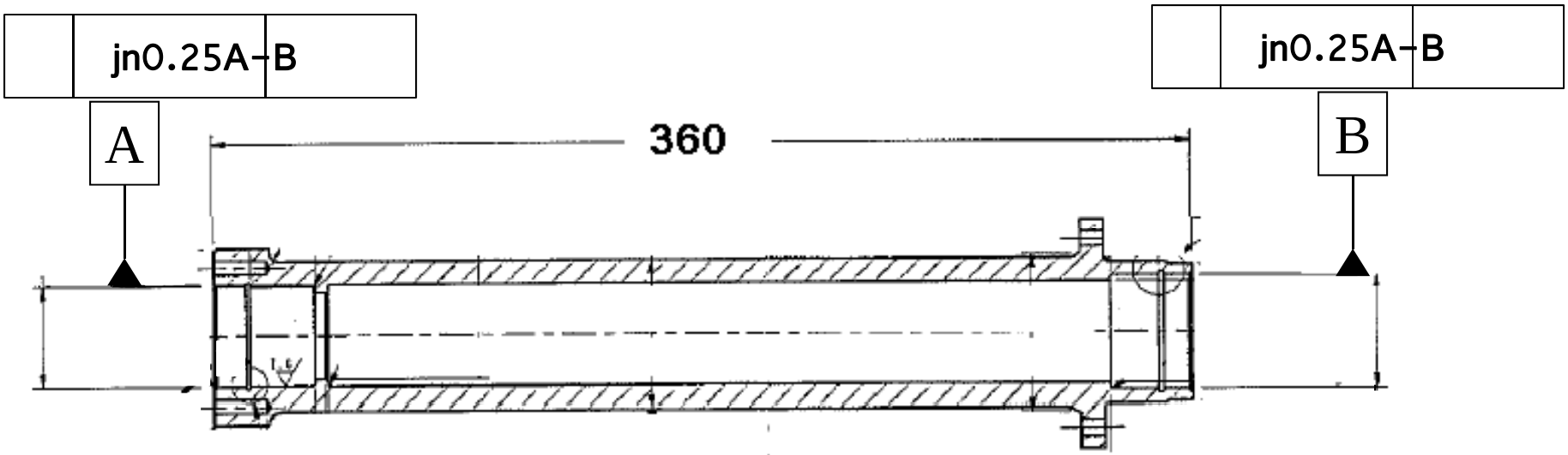
That makes sense! Functionally, -A- does not 100% control how a shaft fits through there!



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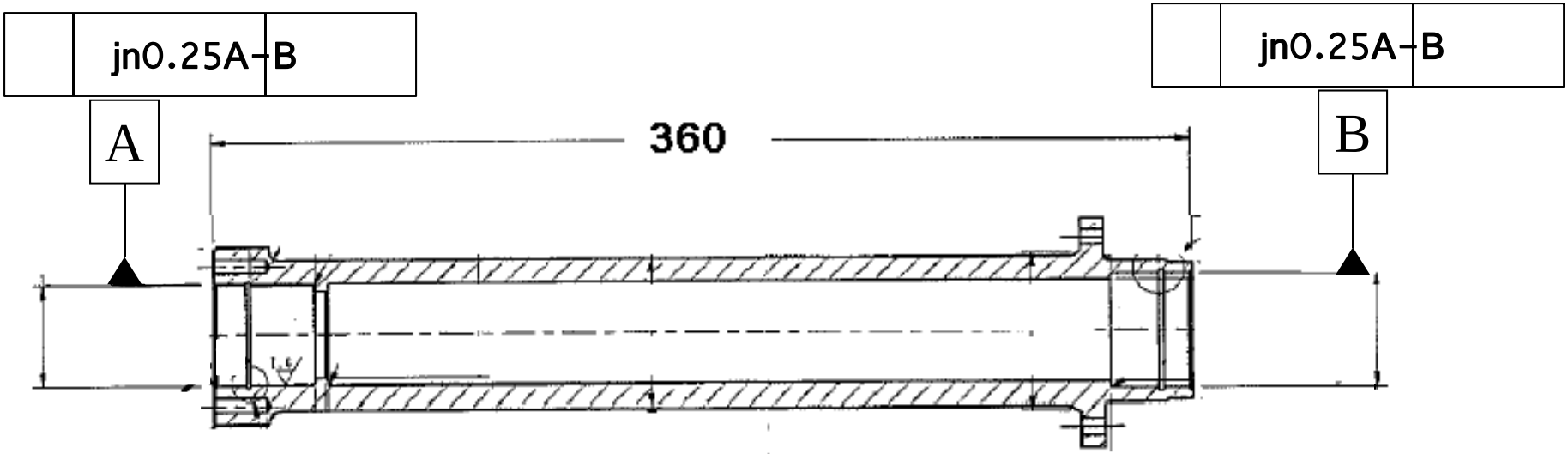
-A- and –B- equally control things.

An axis created through –A- and –B- is now Datum A-B.



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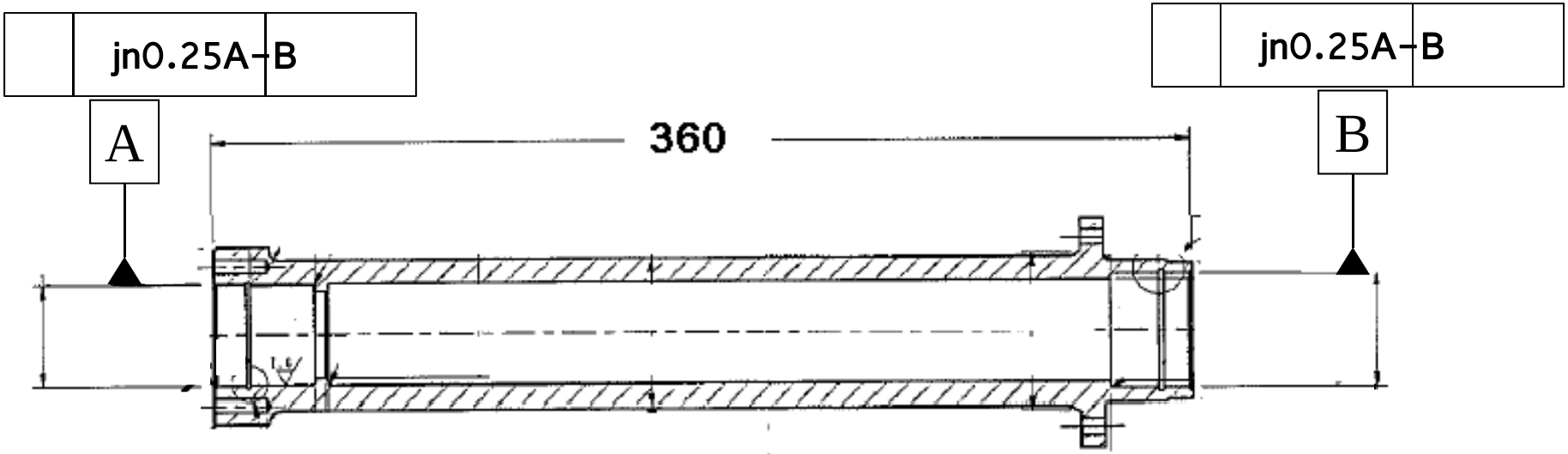
We are trying to make sure –A- and –B- are positioned the same way on the same axis so nothing gets bound up.



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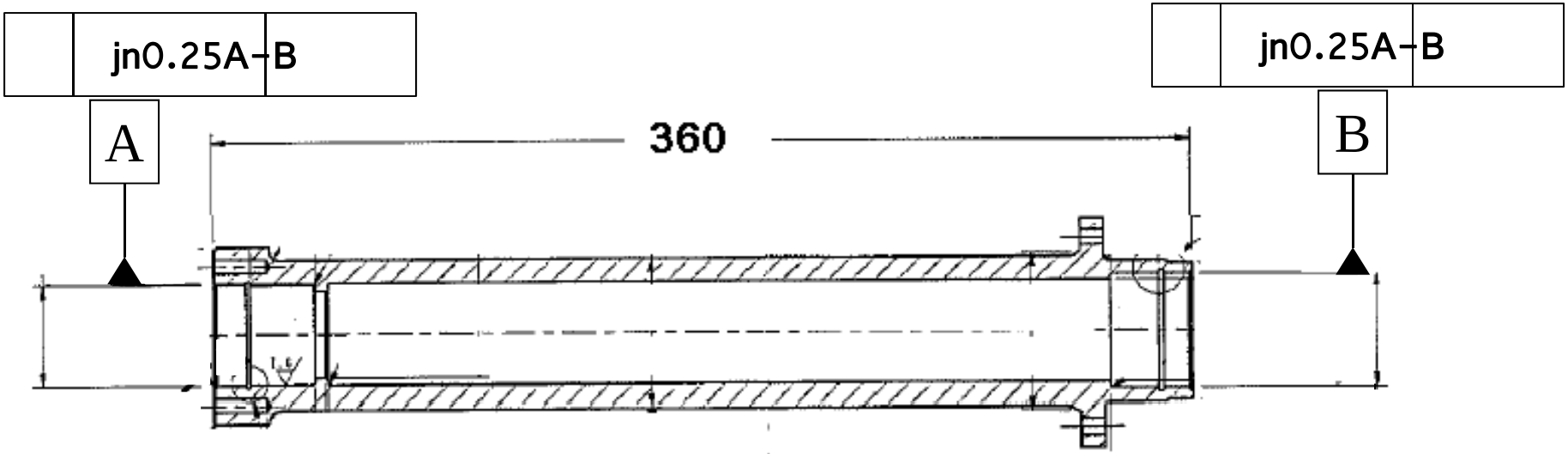
The individual axes of the cylinders of A and B need to be within a cylindrical zone centered on A-B.



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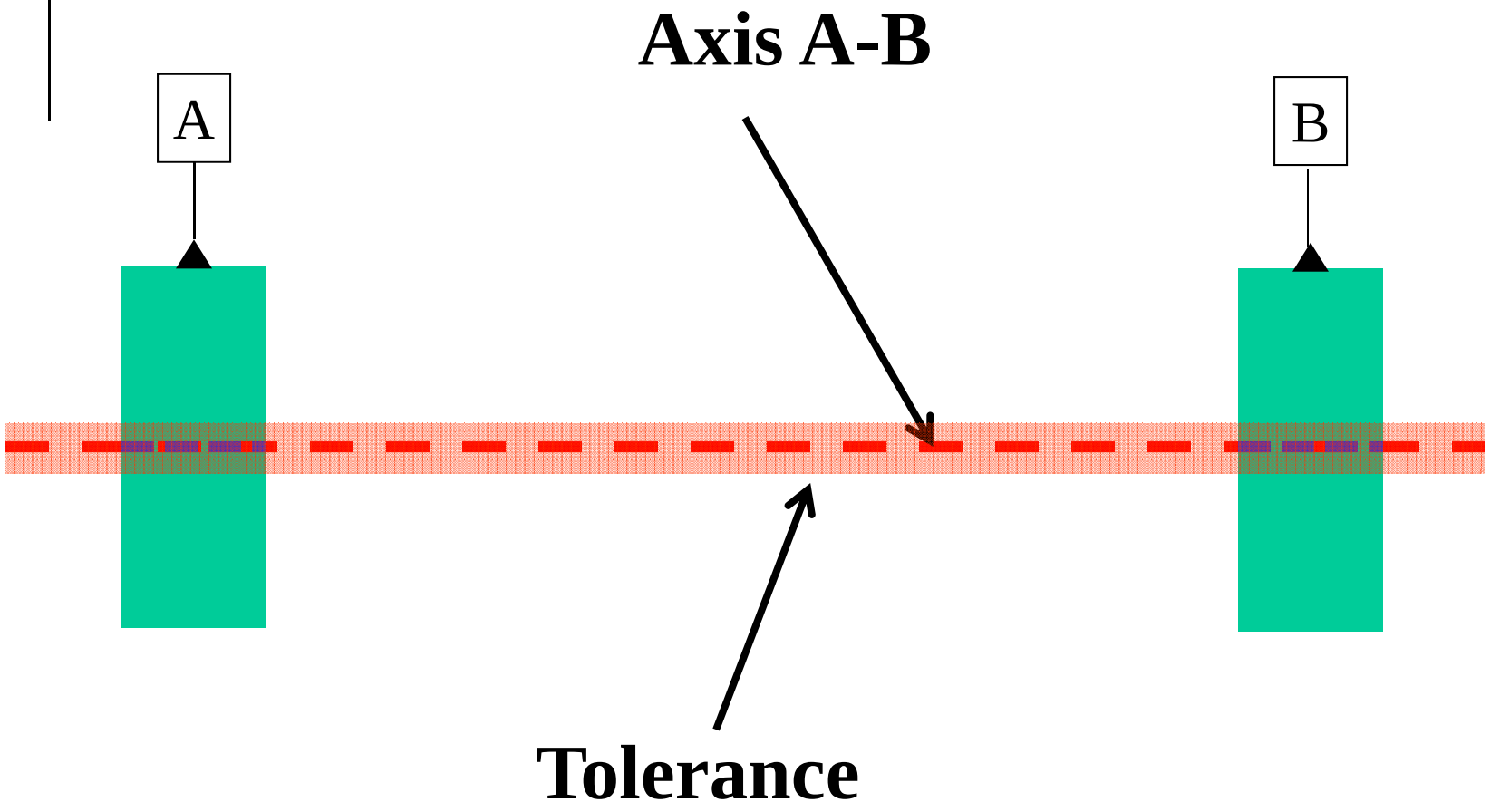
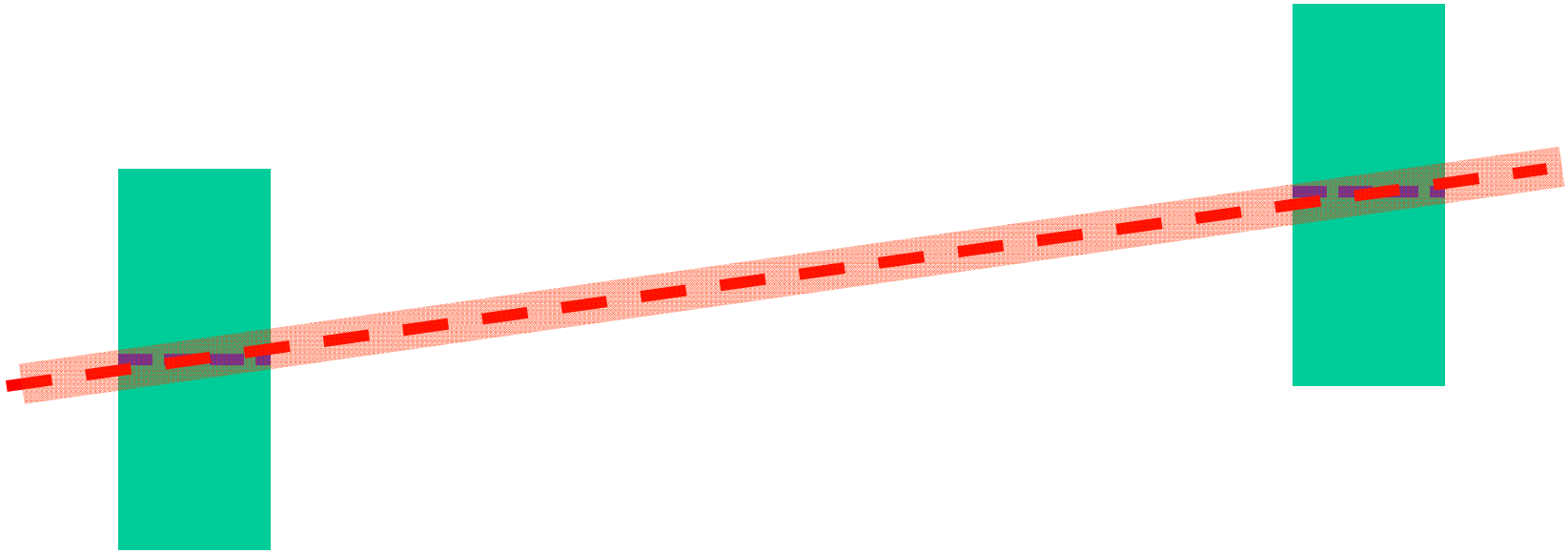
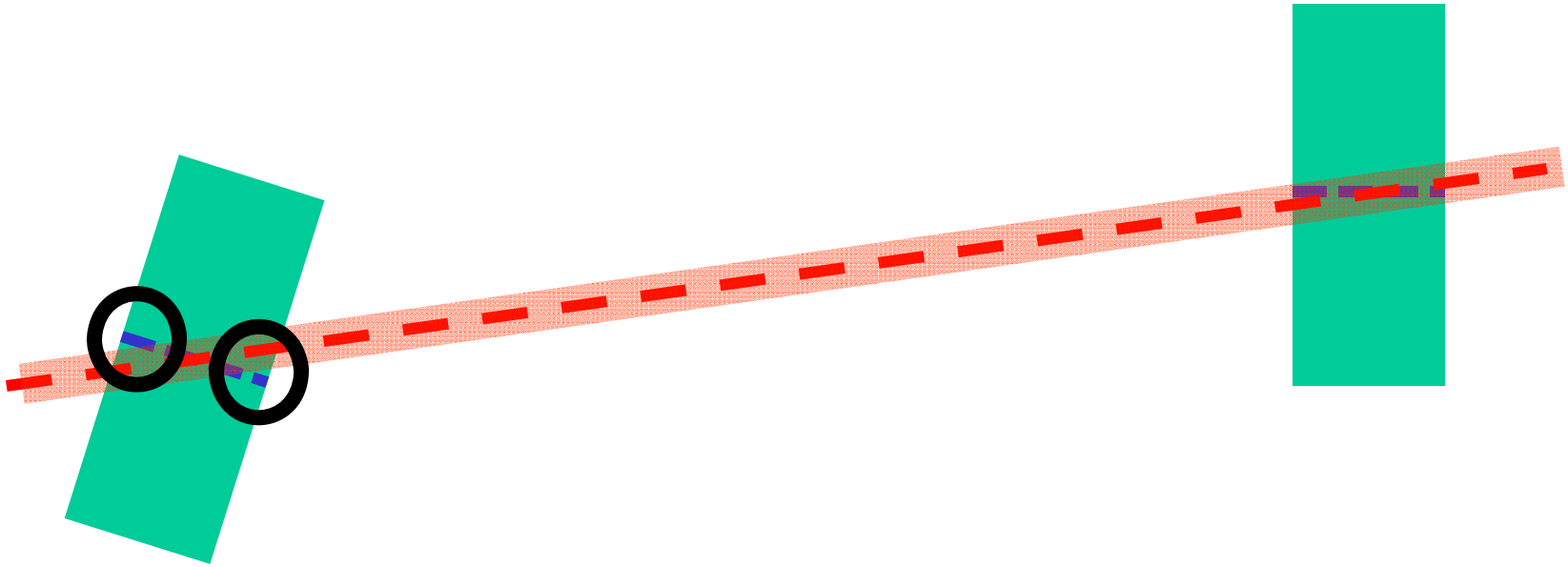


OK



NOT OK



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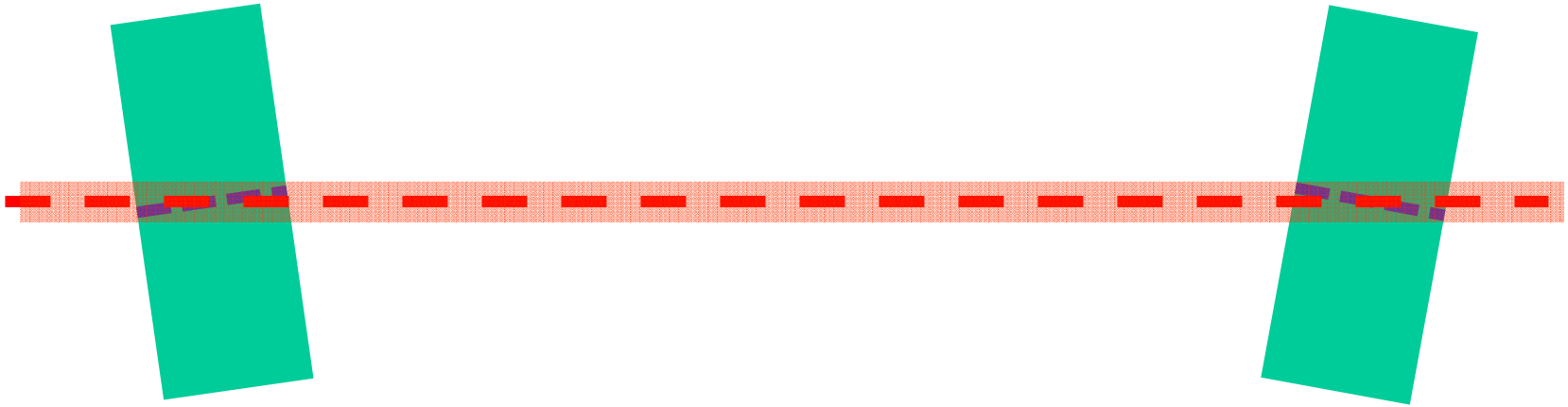

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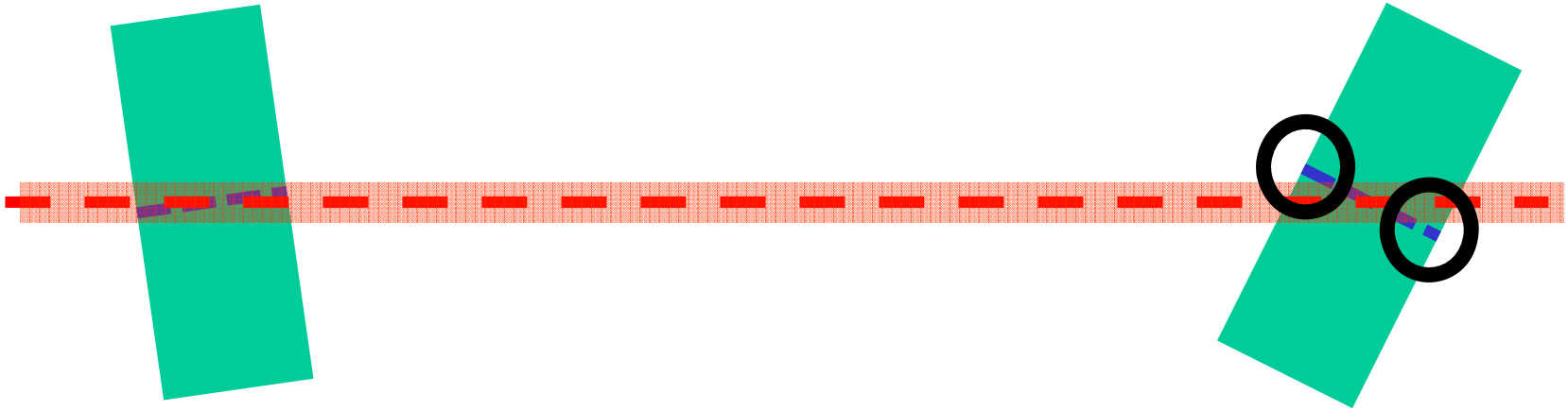

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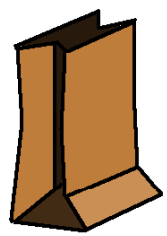

Let's do this in Calypso.

Fortunately, this is MUCH easier than trying to figure out "REAL" Concentricity!!!!

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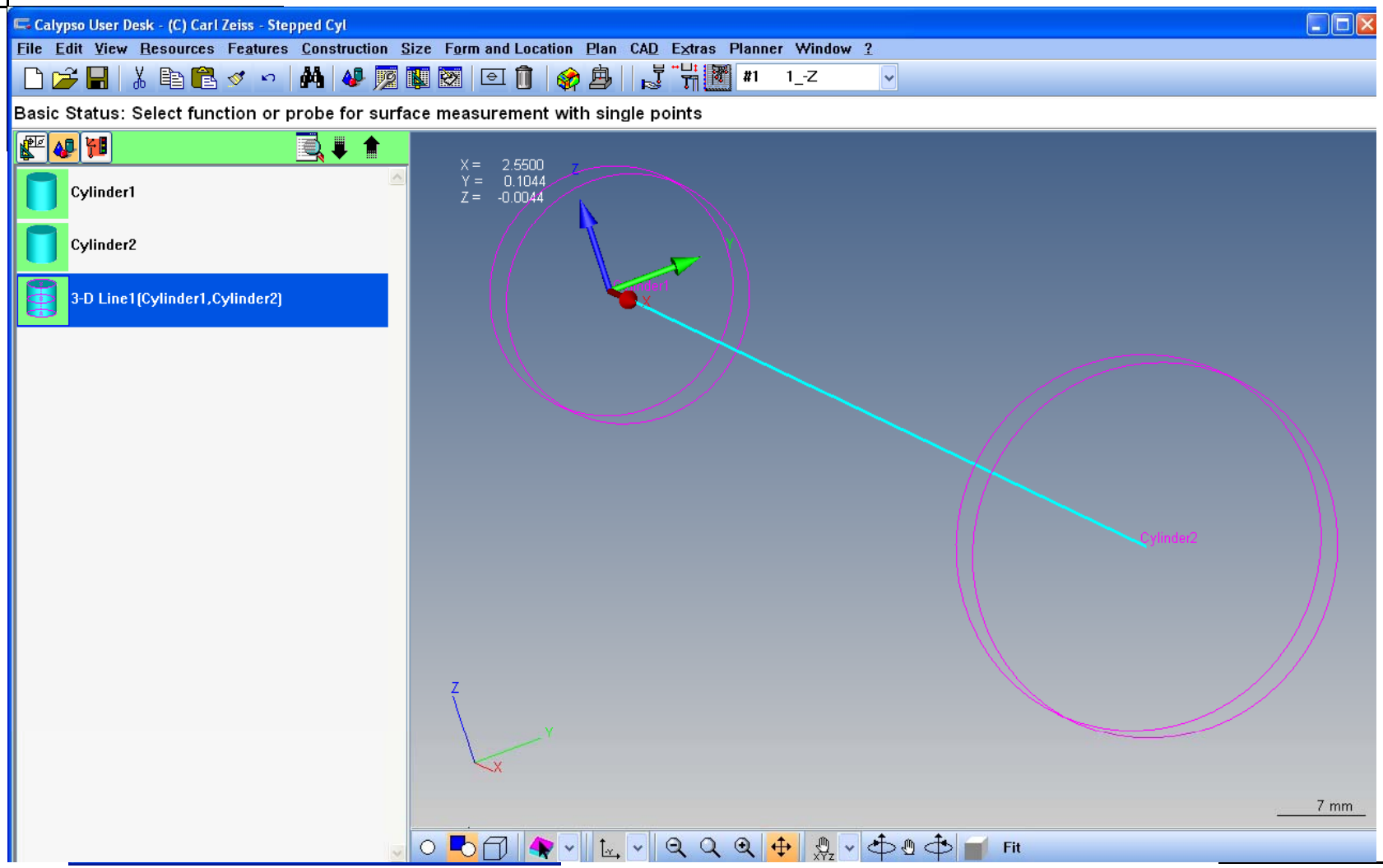

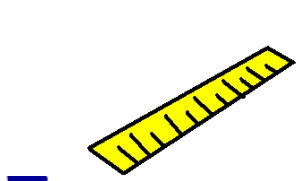

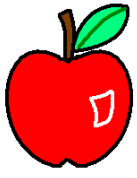

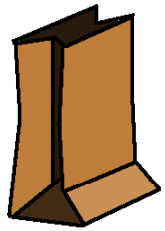

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NOTE:

Using a 3-D line with RECALL creates a line between the CENTERS of the two cylinders selected.

Make sure LSQ is selected in the feature window for each cylinder.

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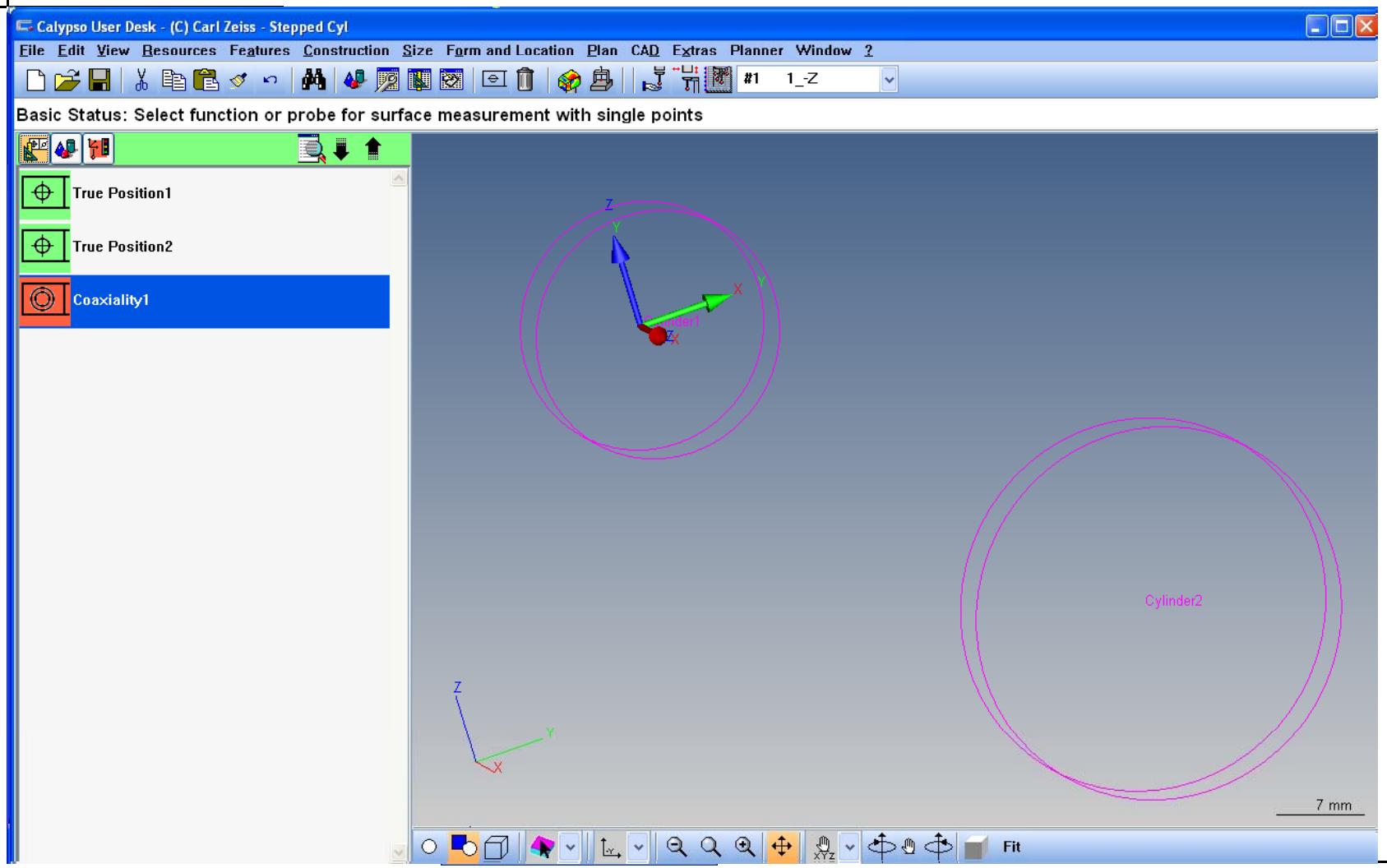

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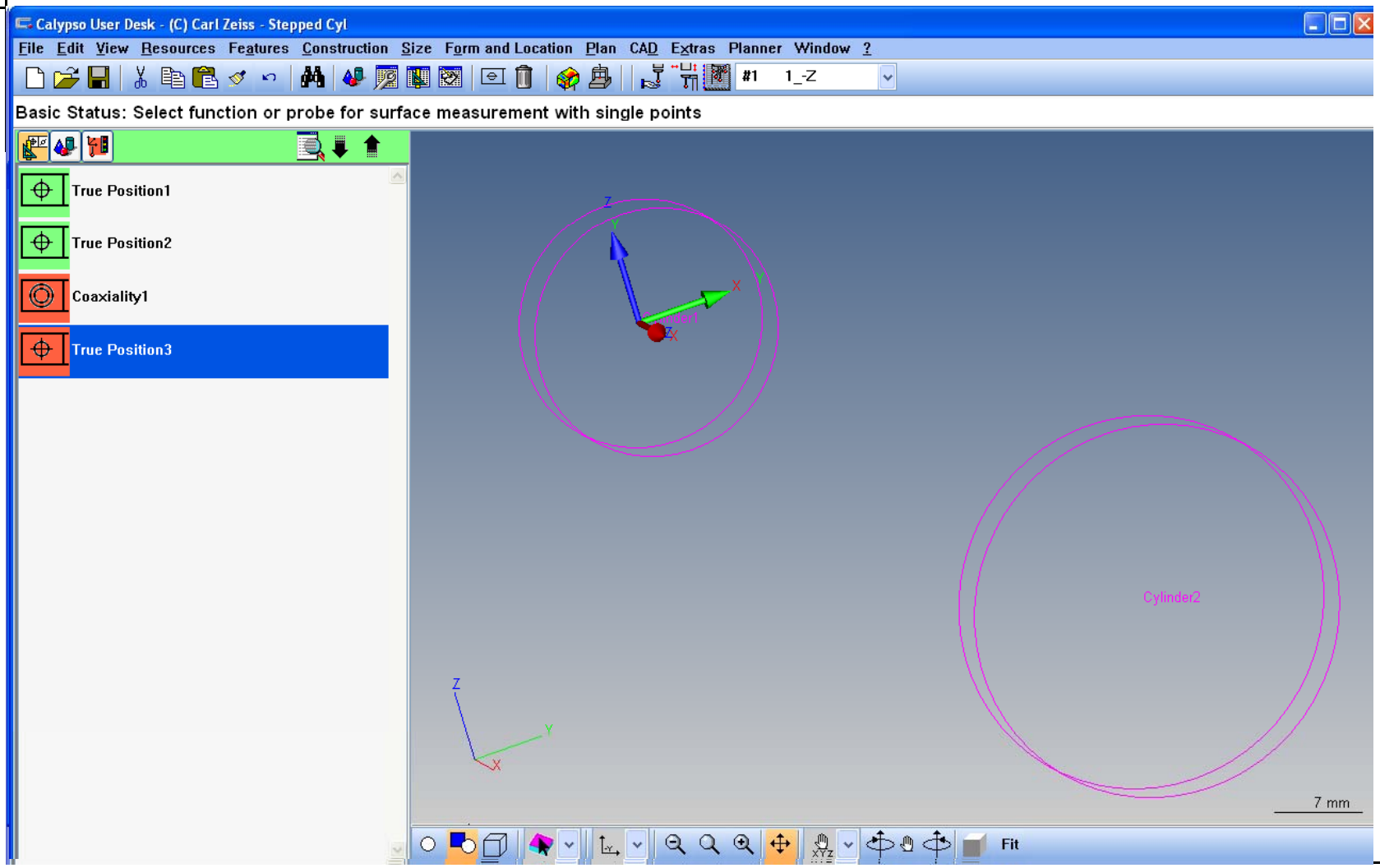

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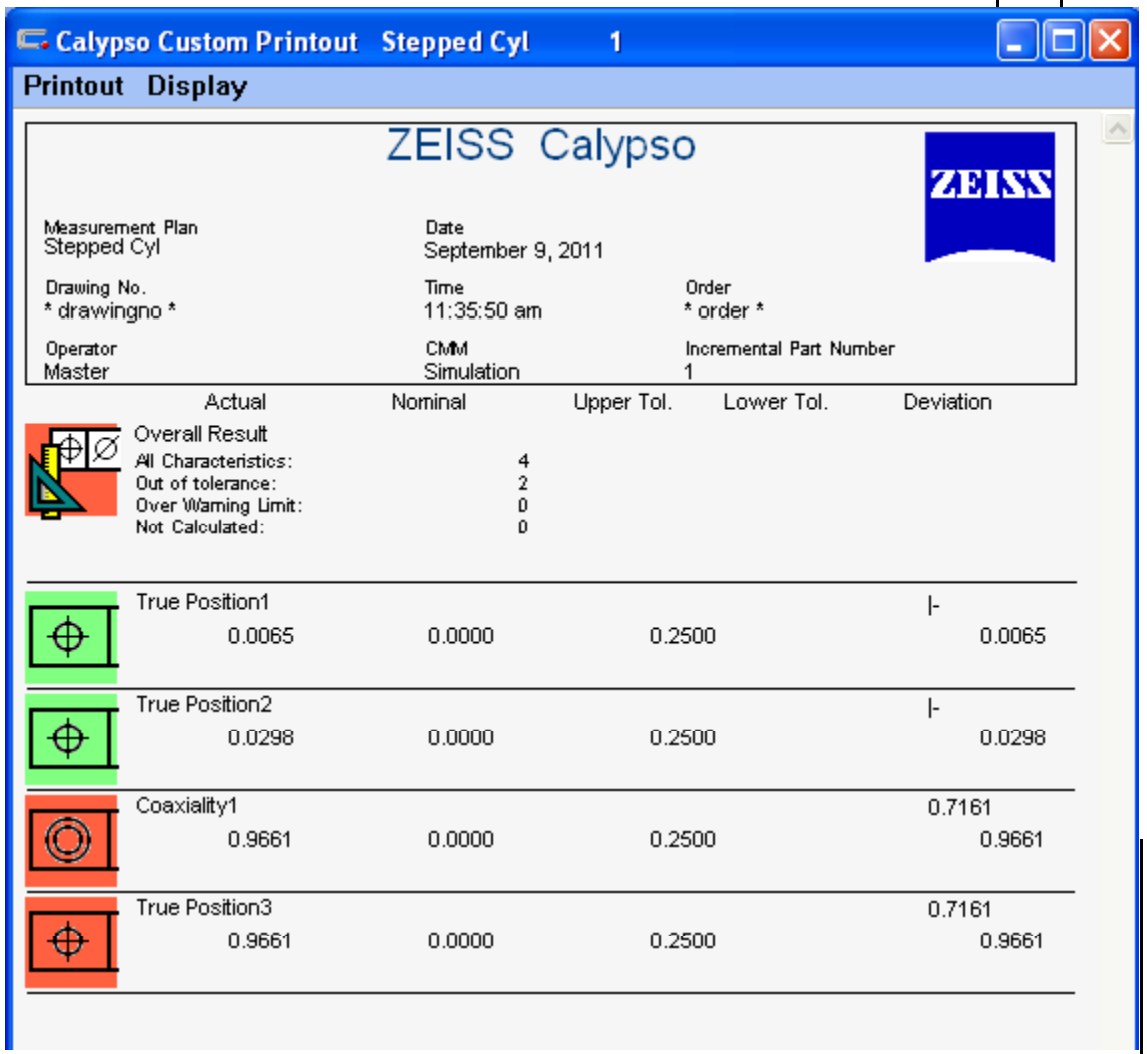
WOW!

That's a big difference.

Maybe our part isn't as bad as I thought after all!



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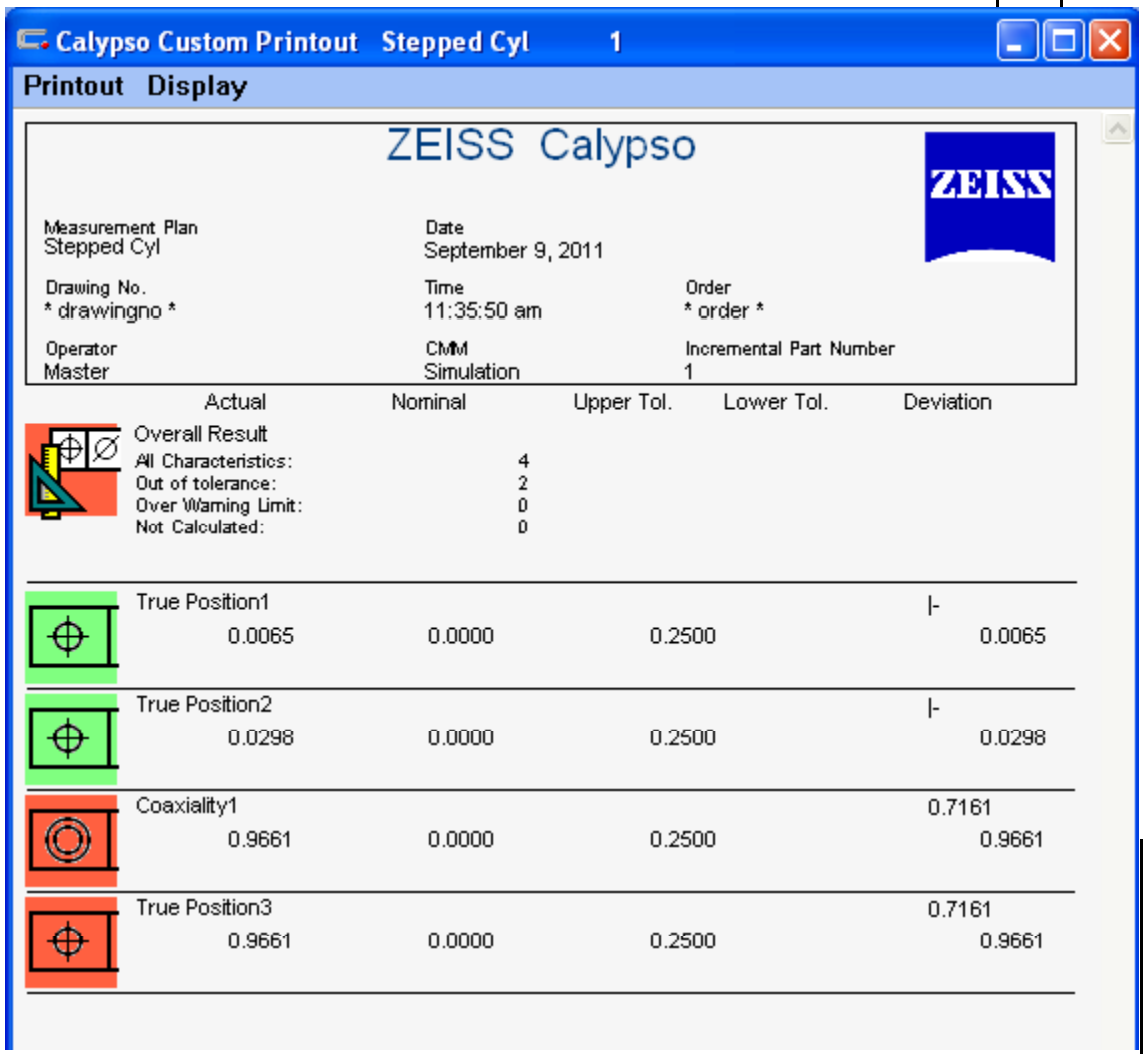
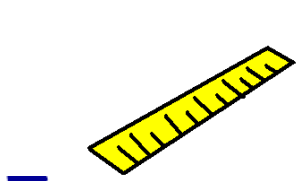
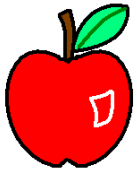
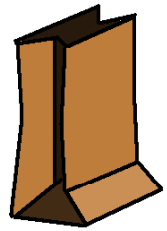
Coaxiality is the same as True Position of a Cylinder when the Feature Nominals are zeroed on the datum.









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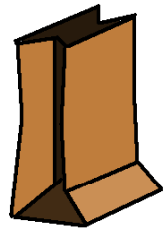
We suggest reporting both results and document WHY you did what you did:

1) You reported “concentricity/coaxiality” as the print states, however that was probably not the design intent.

2) You reported Position to A to A-B and B to A-B because functionally, that is what the part really “sees” and you presume that was the design intent.



Concentricity

More than you ever wanted to know

Questions?