EN1740 Computer Aided Visualization and Design

Spring 2012

4/12/2012

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Last Time:

- Design Analysis
  - Clearance/Interference Checking
  - Sensitivity/Feasibility/Optimization
- Intro to GD&T

Tonight:

- Group Project Overview
- Tolerance Analysis
  - CETOL
- Intro to GD&T

Supporting Reading:

- Second half of Chapt. 4 (pg 96-112)
- Chapt. 6
- Chapt. 8

Group Project Subjects

Need one group for each

- Blades
- Hub
- Gear train
- Base
- Collapsible stand
- Tail (Horizontal Furling)
    - Fluids
    - Structures
- Structure for Batteries, Inverter and Controls
- BBS

Manufacturing Tolerances

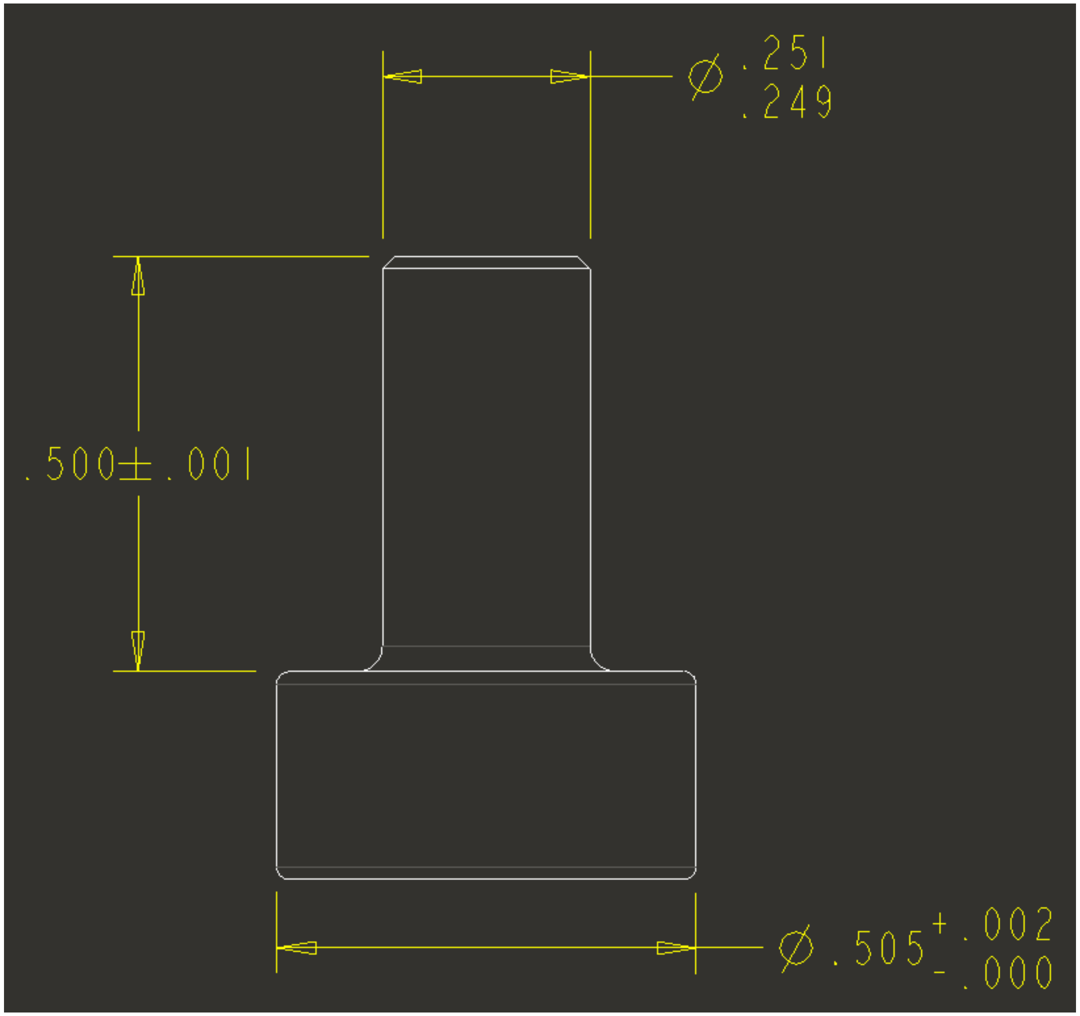
Nothing's perfect

Fig. 4-50, B. A. Wilson, GD&T App. And Intr., 2010

Manufacturing Tolerance

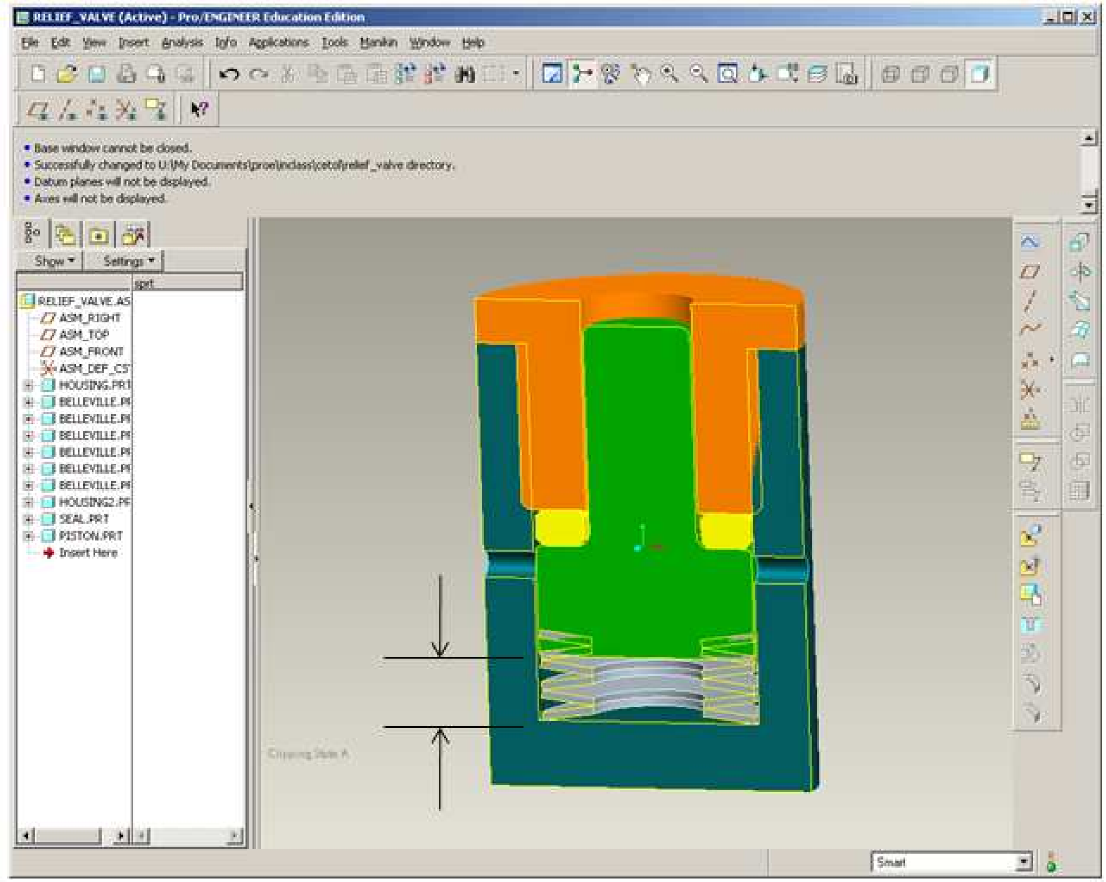
Components must specify allowable tolerances

- Tolerances can be specified in a number of ways
  - **Dimensional**
    - Limits
    - Unilateral
    - Bilateral
  - Geometric
    - Form
    - Orientation
    - Position



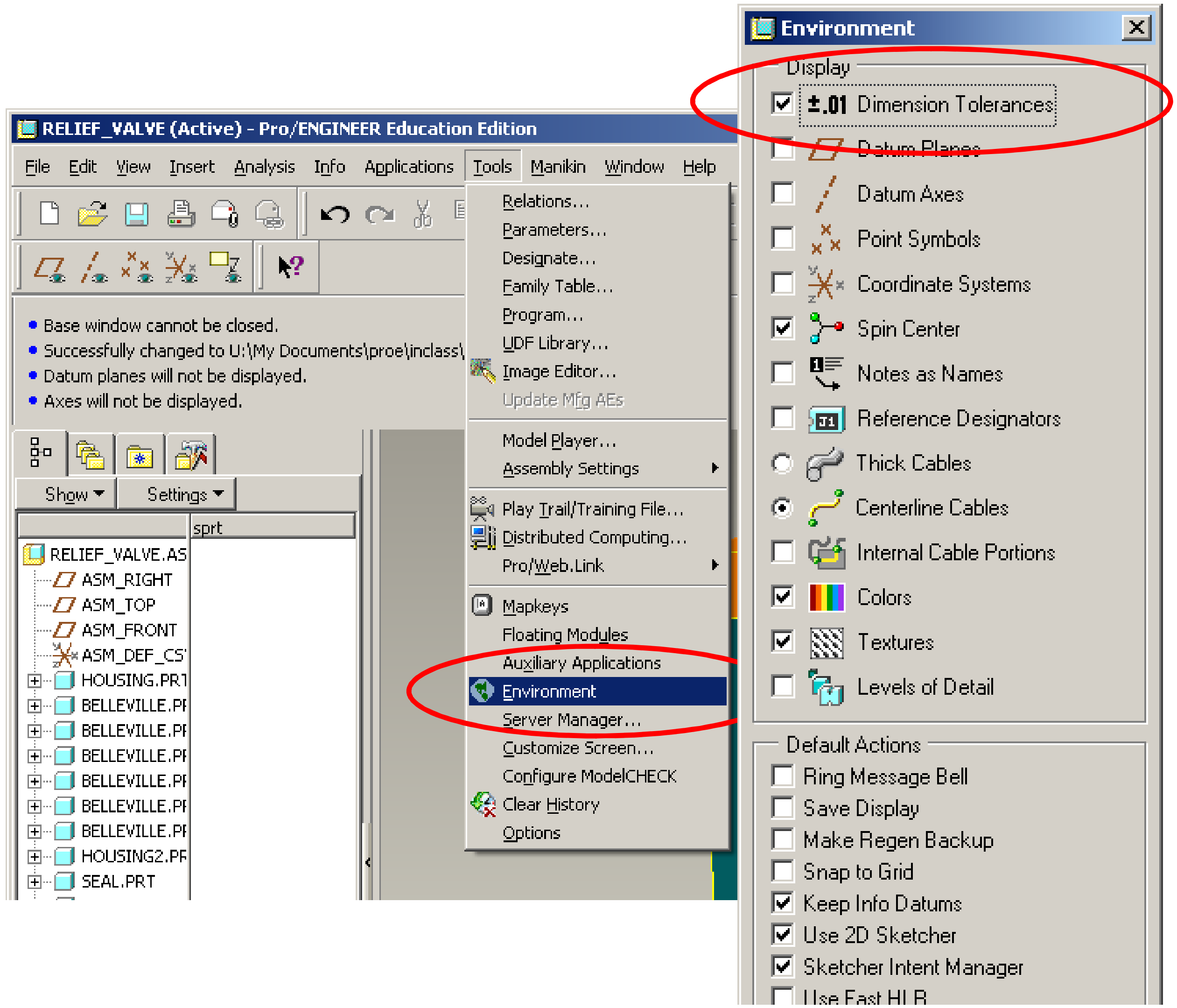
Design Tolerance Analysis

- How dimensional variation affects component/product performance
    - Critical to everything manufactured
    - Example – Change in part dimensions affect spring pocket height which effects output pressure
- Use CETOL to calculate the variation in spring pocket size
    - As design evolves stackup is updated
    - Easily accounts for advanced dimensioning



EXERCISE - Design Tolerance Analysis

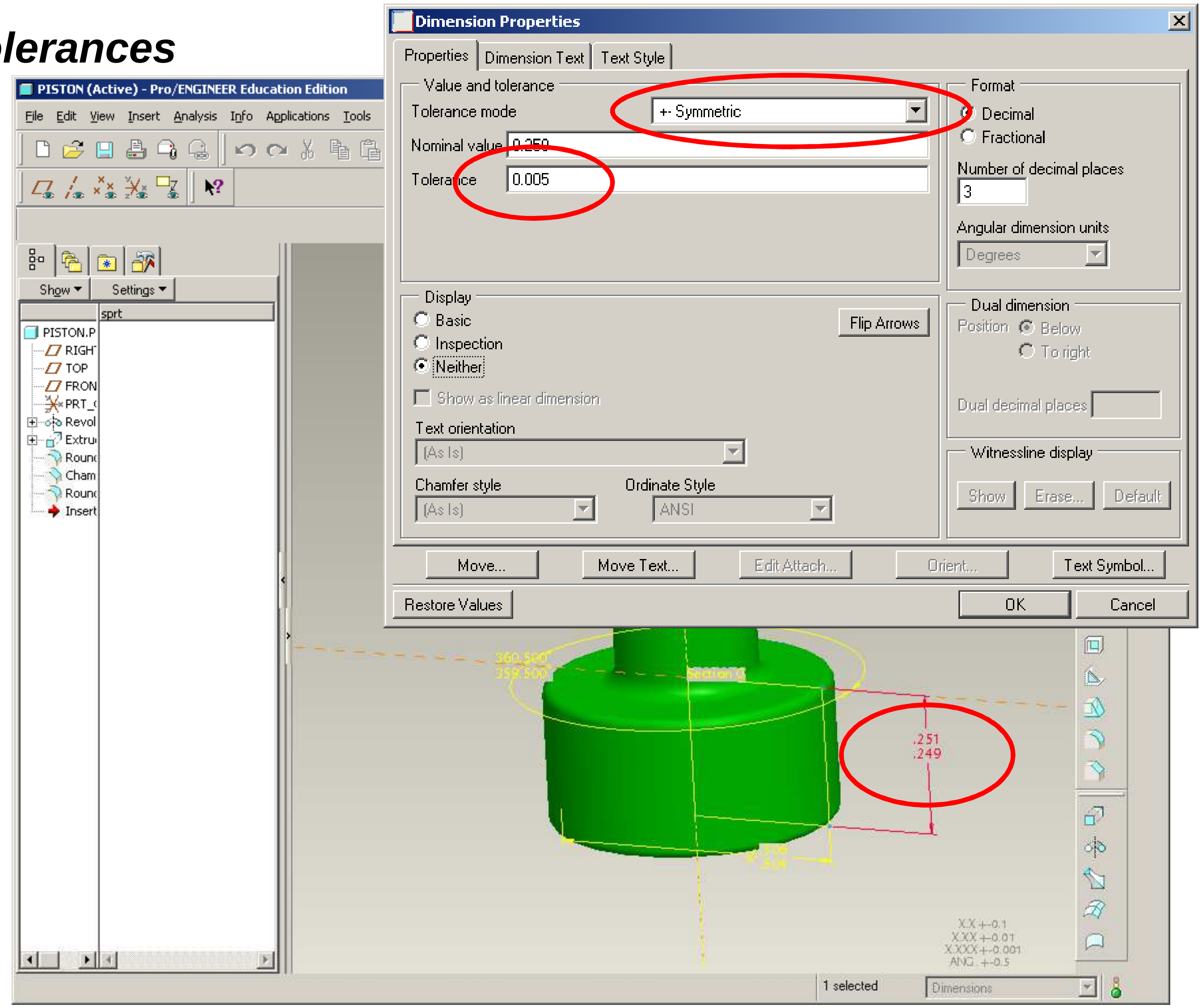
- Open relief valve assembly
- Turn on Dimension Tolerances
    - Tools > Environment
    - Check Dimension Tolerances



EXERCISE - Design Tolerance Analysis

Define part feature tolerances

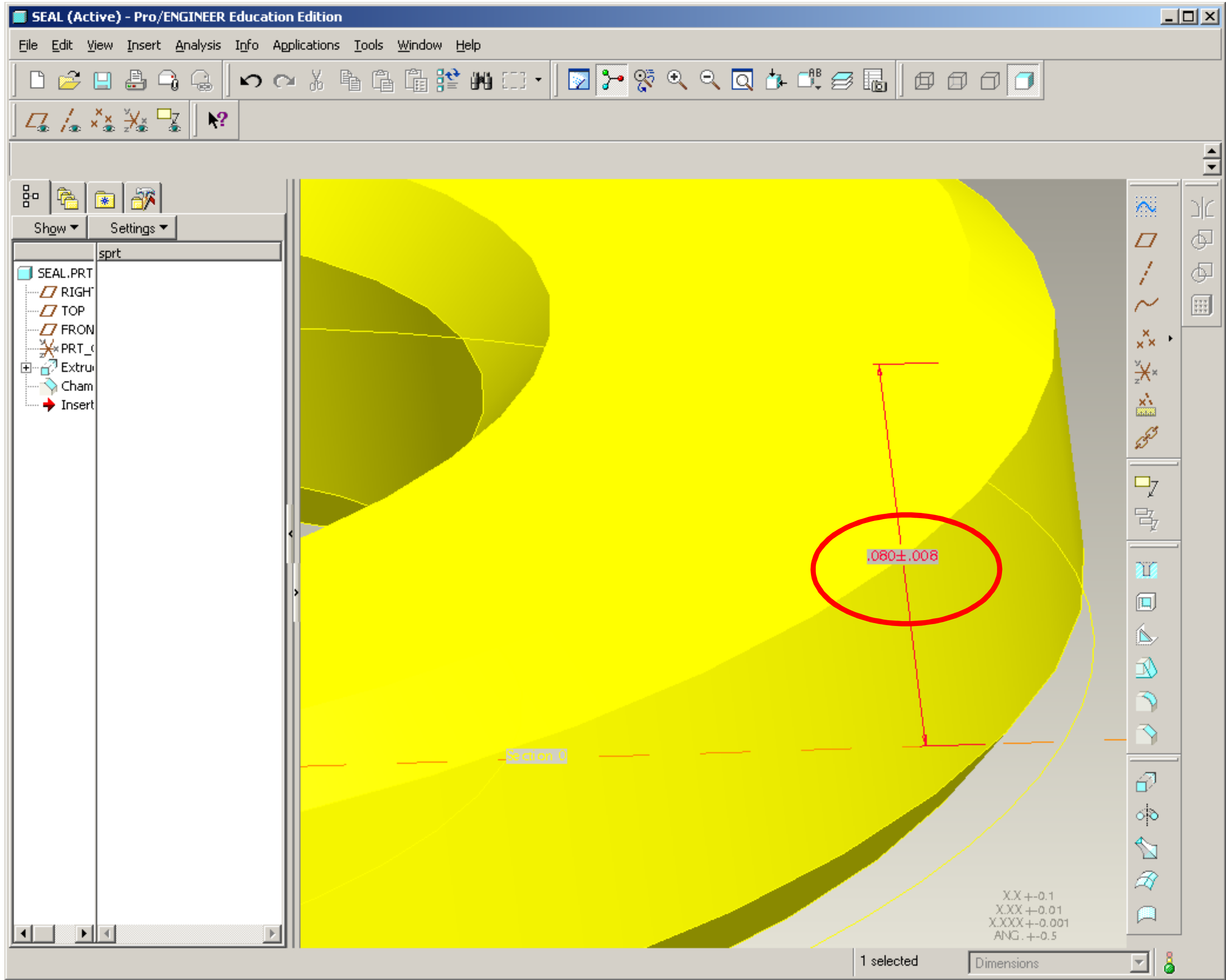
- Open piston.prt
- Create a symmetric tolerance of .005 on .250 height
    - Edit feature
    - Select dimension
    - RMB > Properties
    - Set Tolerance Mode to Symmetric
    - Set Tolerance to .005



EXERCISE - Design Tolerance Analysis

Define part feature tolerances

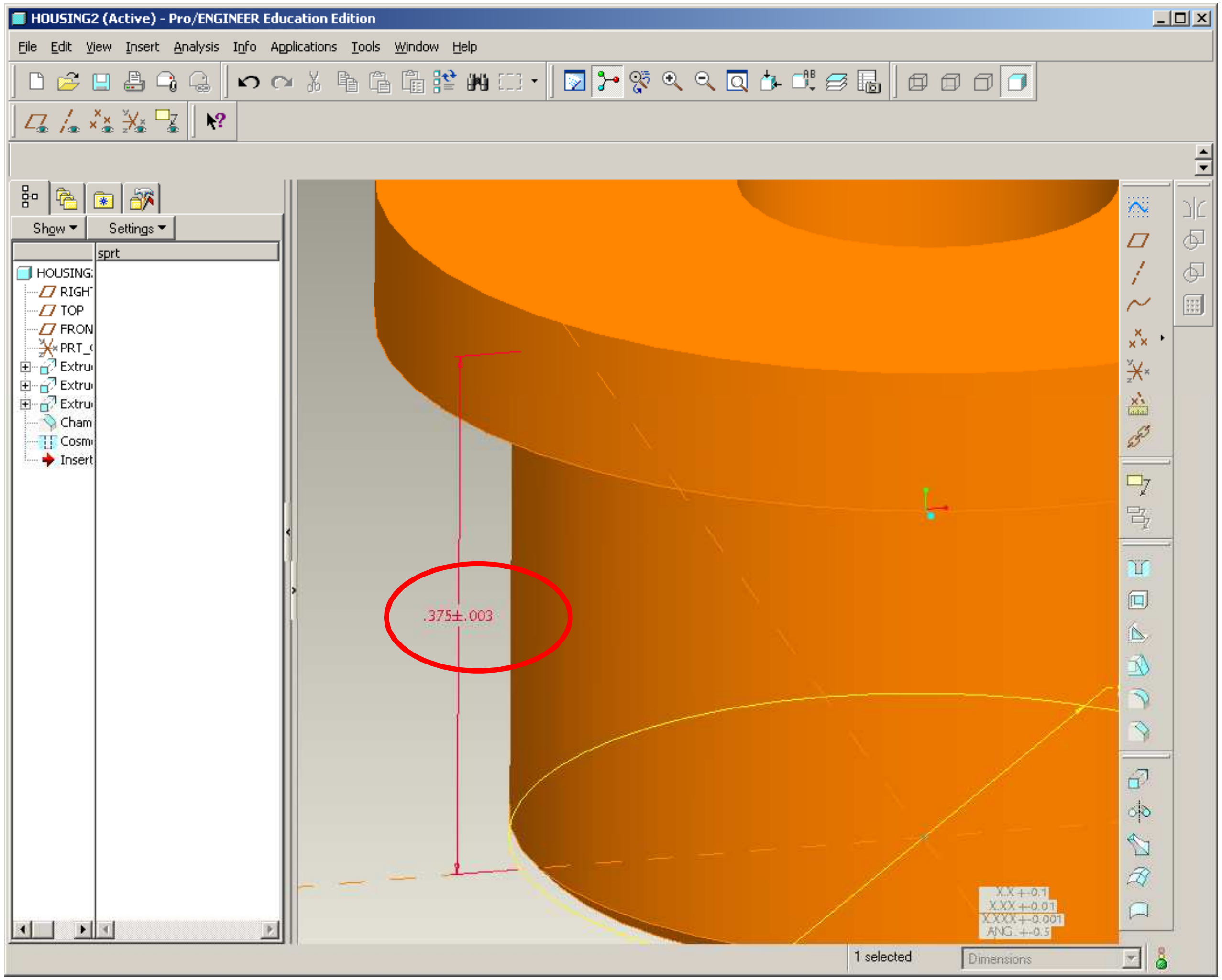
- Using the steps shown previously, apply a symmetric tolerance of .008 to the thickness of the seal .080



EXERCISE - Design Tolerance Analysis

Define part feature tolerances

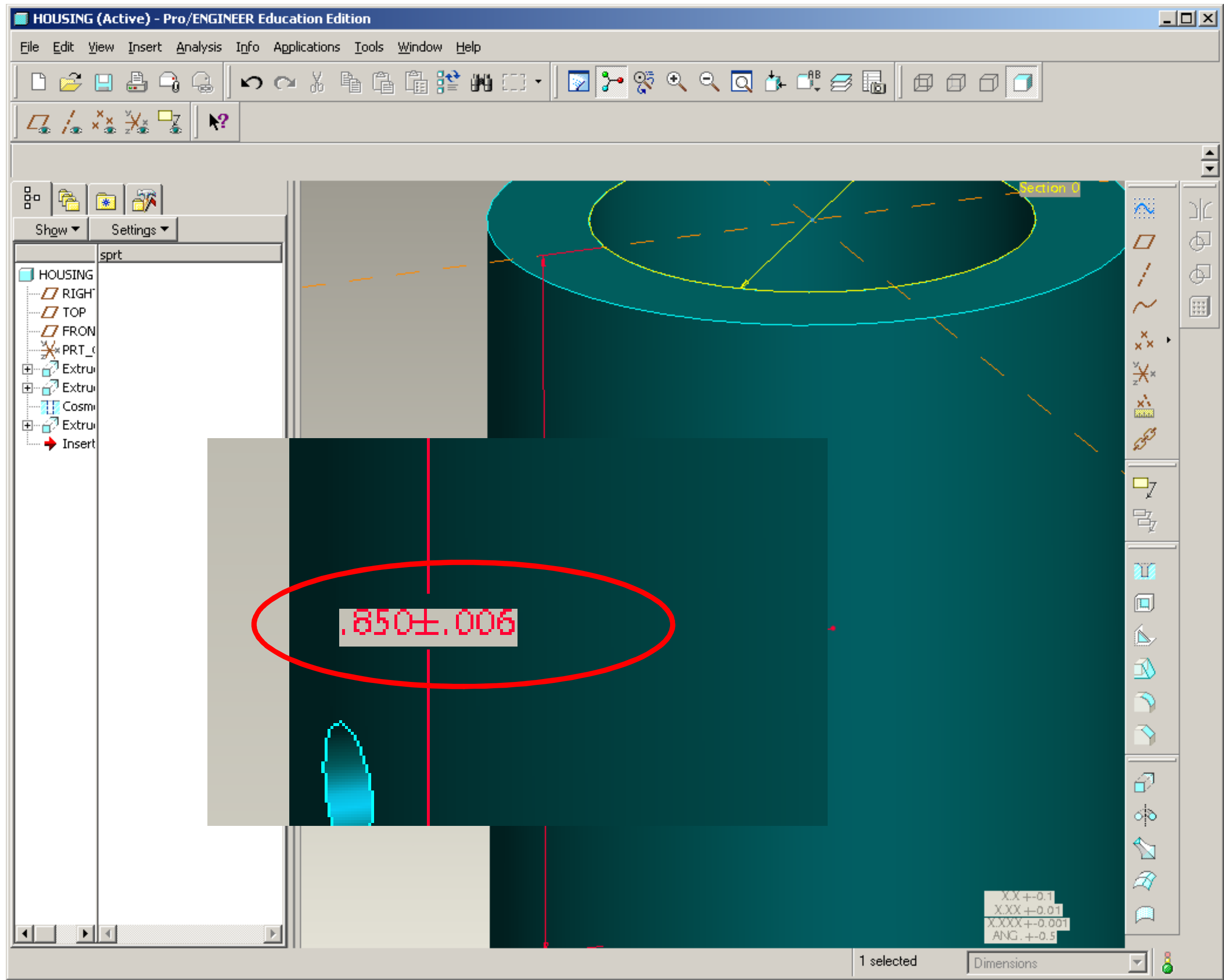
• Using the steps shown previously, apply a symmetric tolerance of .003 to the height of the seal .375



EXERCISE - Design Tolerance Analysis

Define part feature tolerances

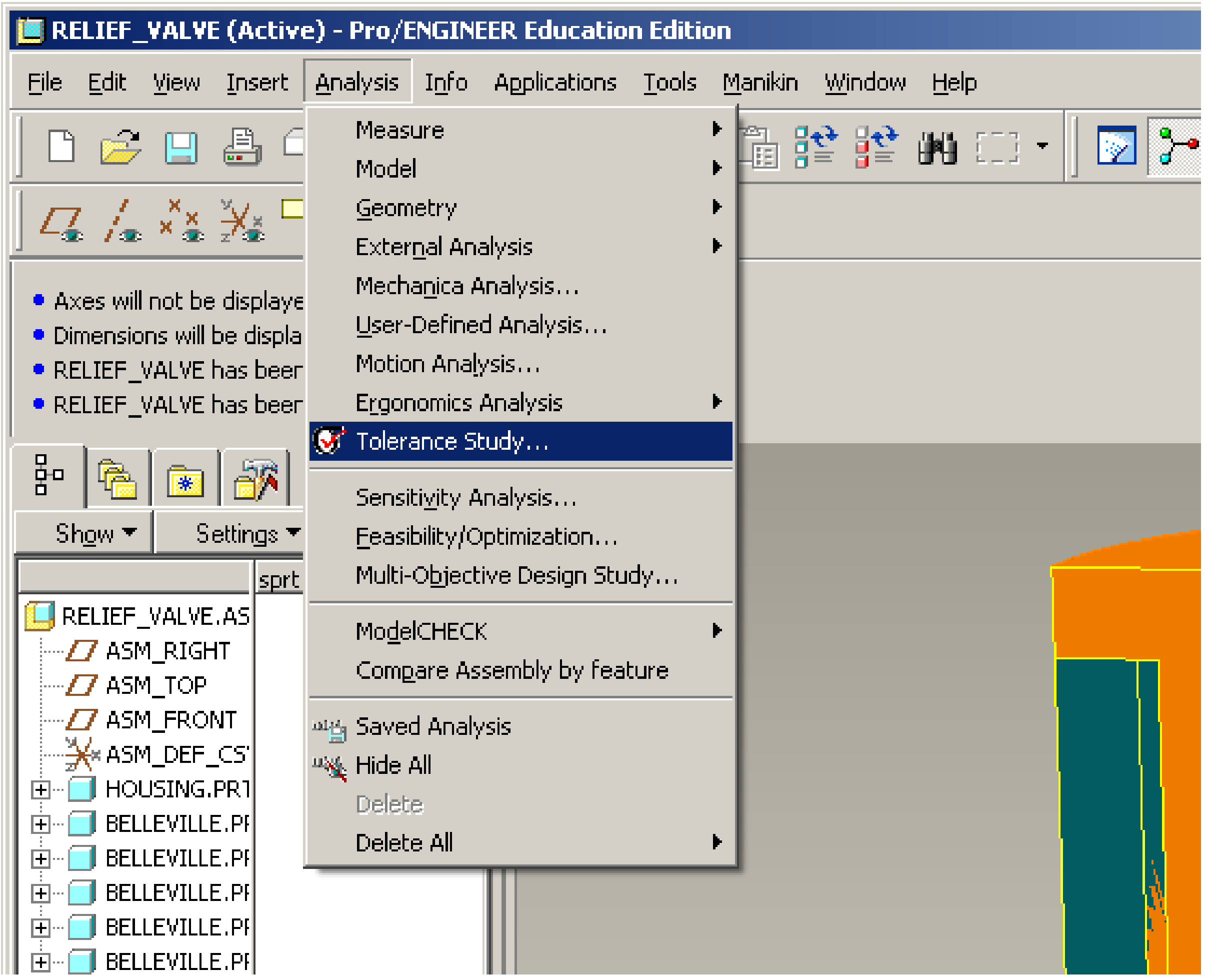
- Using the steps shown previously, apply a symmetric tolerance of .006 to the height of the seal .850



EXERCISE - Design Tolerance Analysis

Define tolerance study

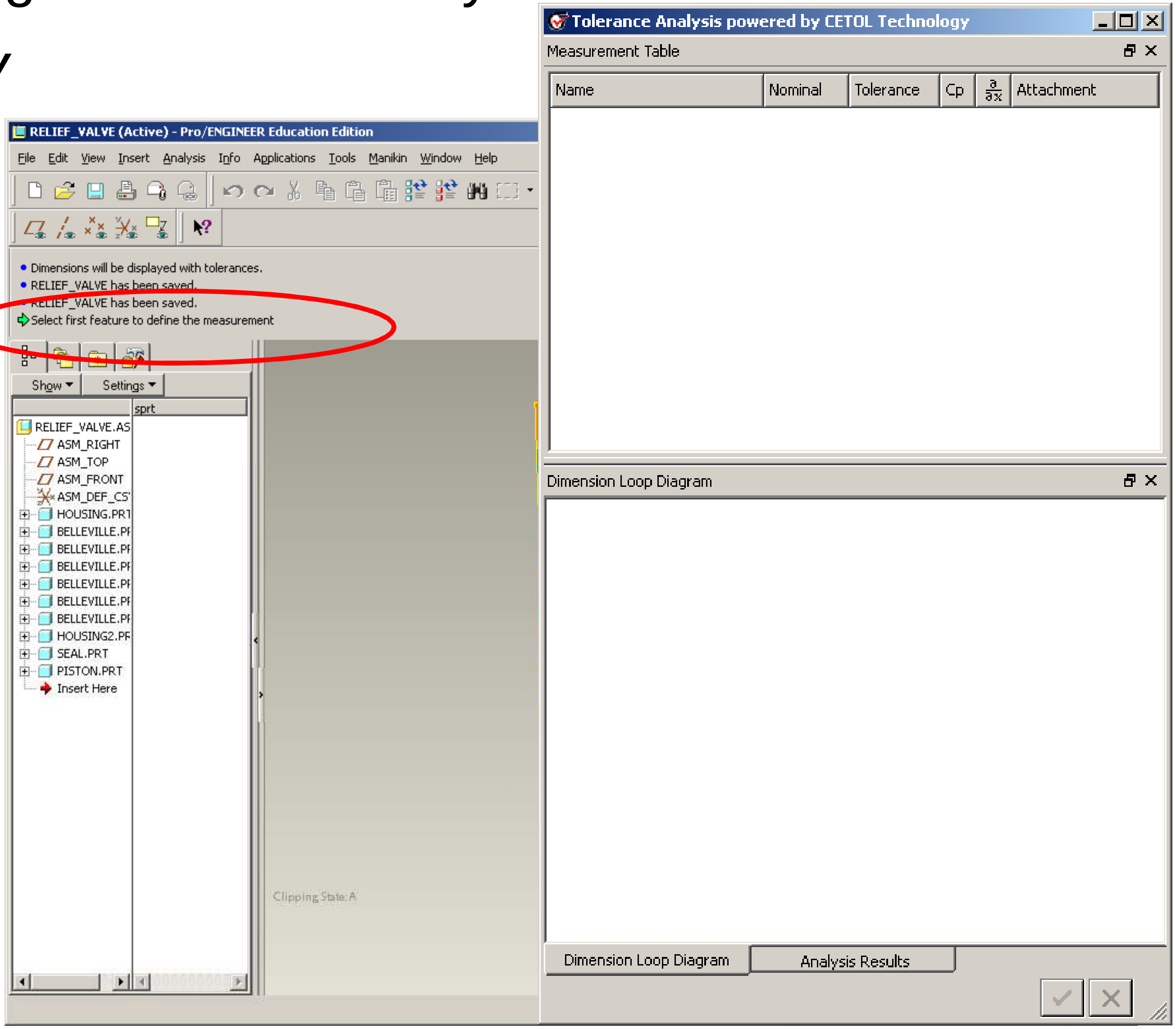
- Back to the top level assembly
- Analysis > Tolerance Study…



EXERCISE - Design Tolerance Analysis

Define tolerance study

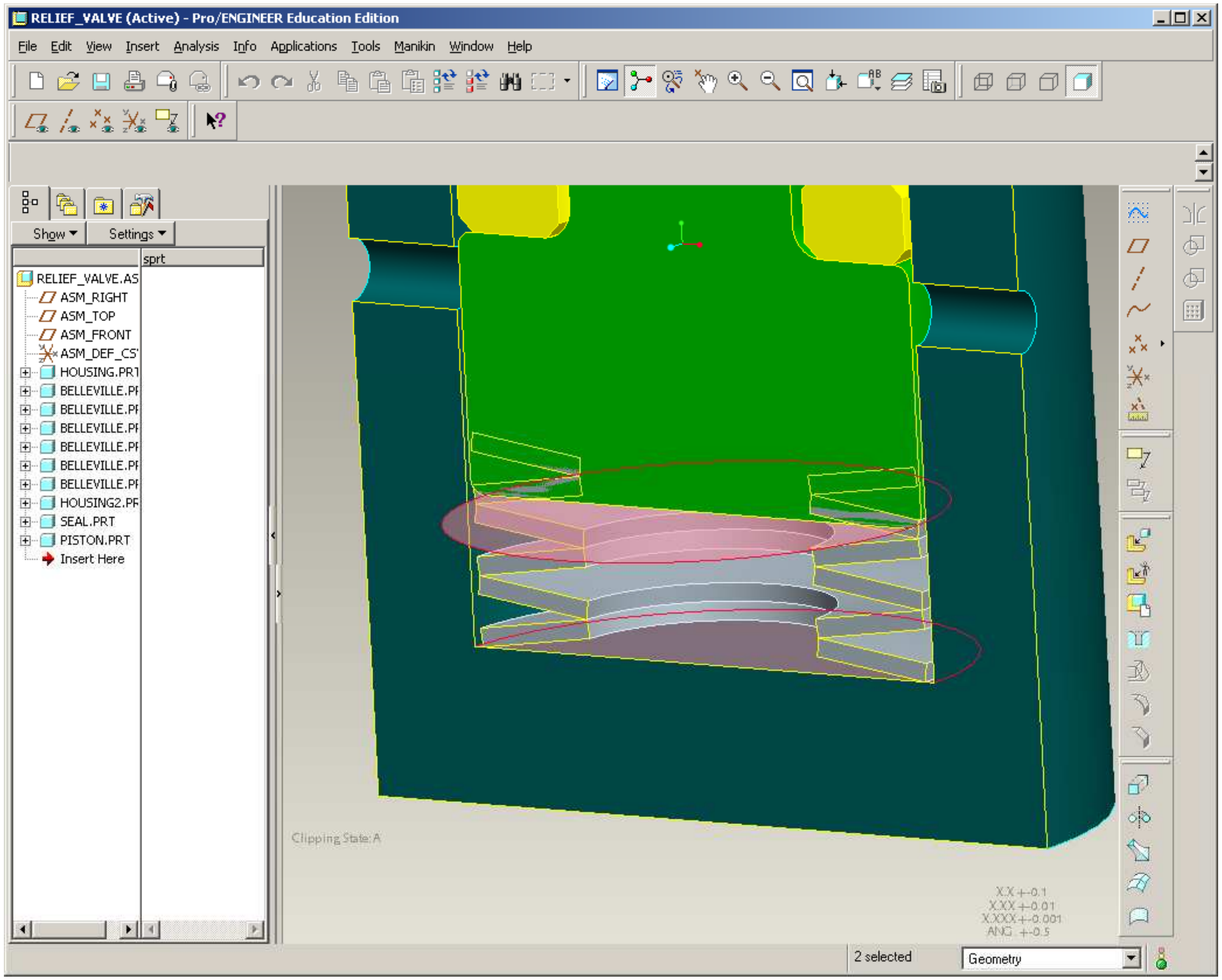
- The CETOL dialog will launch
- The tol analysis software will prompt you with instructions



EXERCISE - Design Tolerance Analysis

Define tolerance study

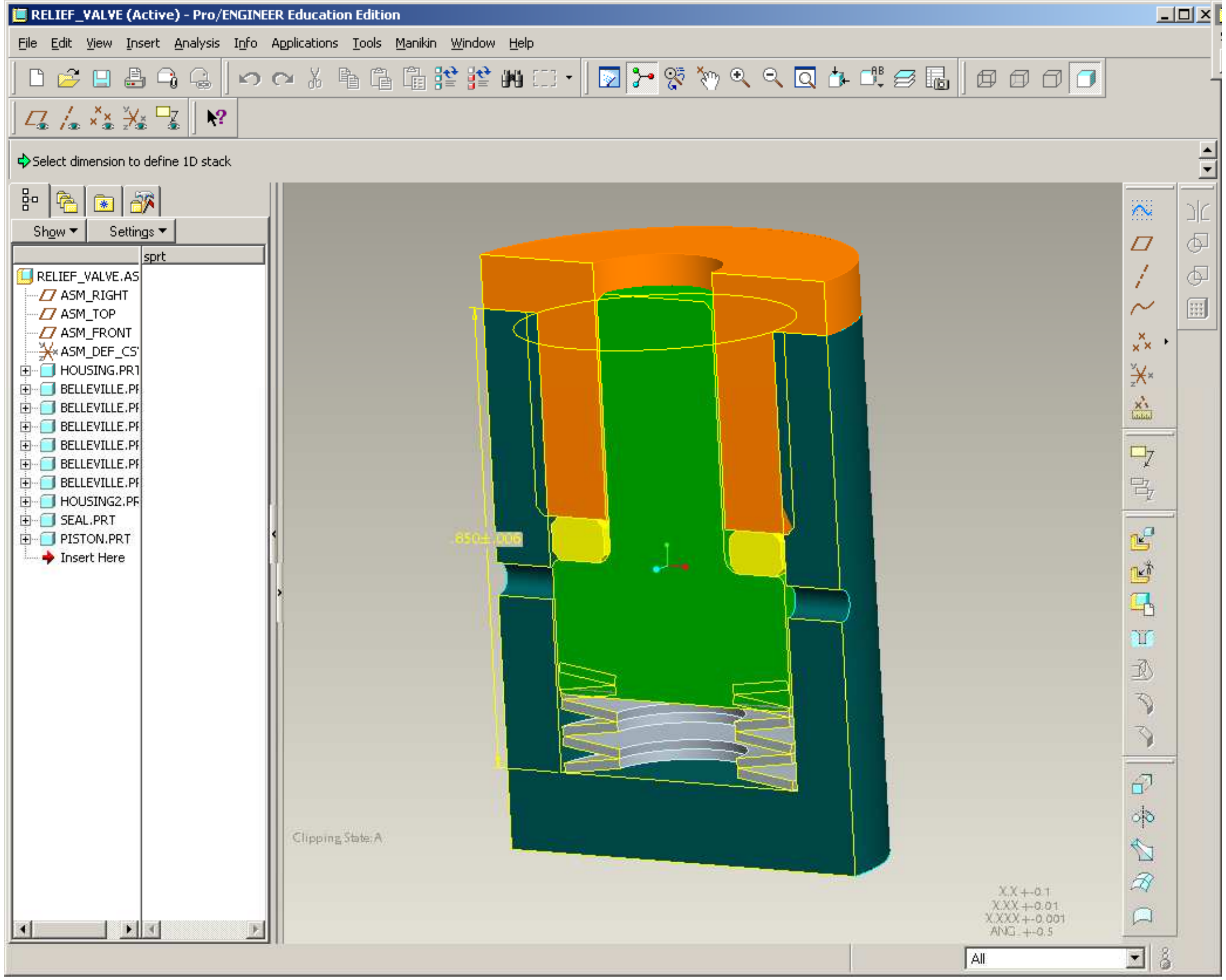
- *STEP 1:* Define the dimension to analyze
  - Select the bottom of the housing
  - Select the bottom of the piston



EXERCISE - Design Tolerance Analysis

Define tolerance study

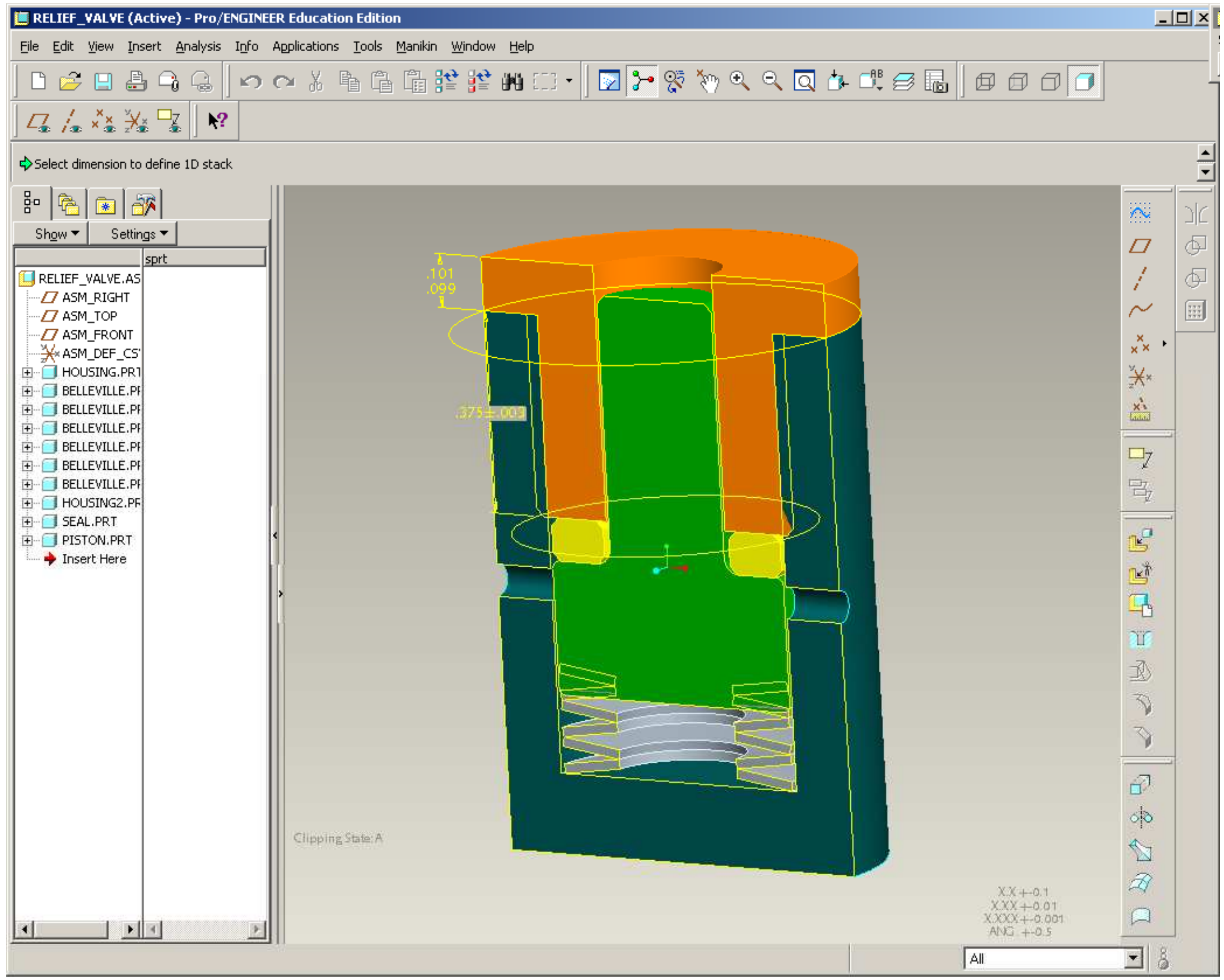
- *STEP 2:* Specify dimensions that contribute to tolerance
    - As soon as the subject of the analysis is defined the system begins prompting for candidate dimensions
    - Alternate selecting parts and dimensions > Use LMB for both



EXERCISE - Design Tolerance Analysis

Define tolerance study

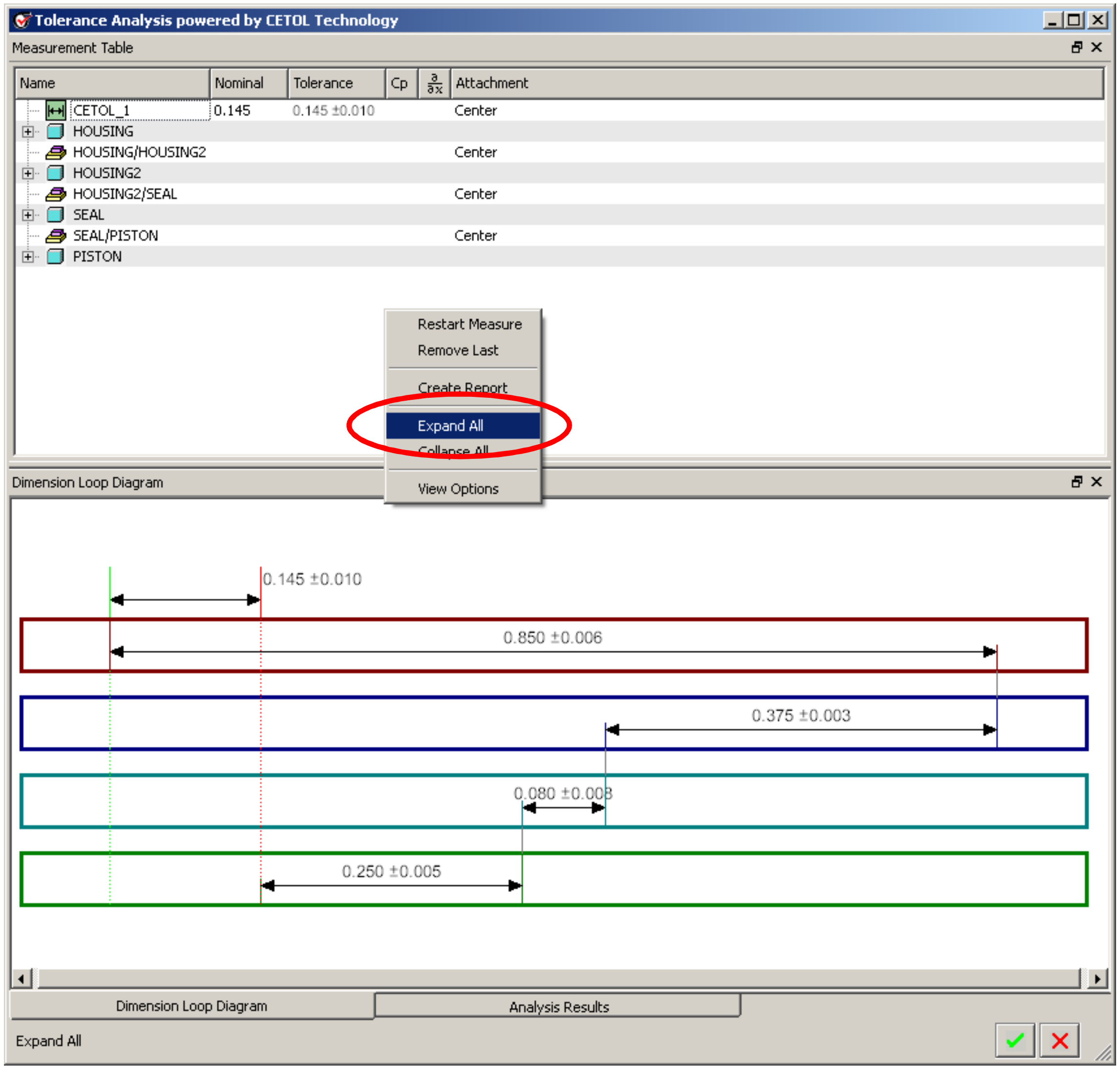
- *STEP 2 (cont.):* Specify dimensions that contribute to tolerance
    - Continue selecting until all the dimension we specified tolerances for have been selected
    - .850±.006
    - .375±.003
    - .080±.008
    - .250±.005
- **MMB done**



EXERCISE - Design Tolerance Analysis

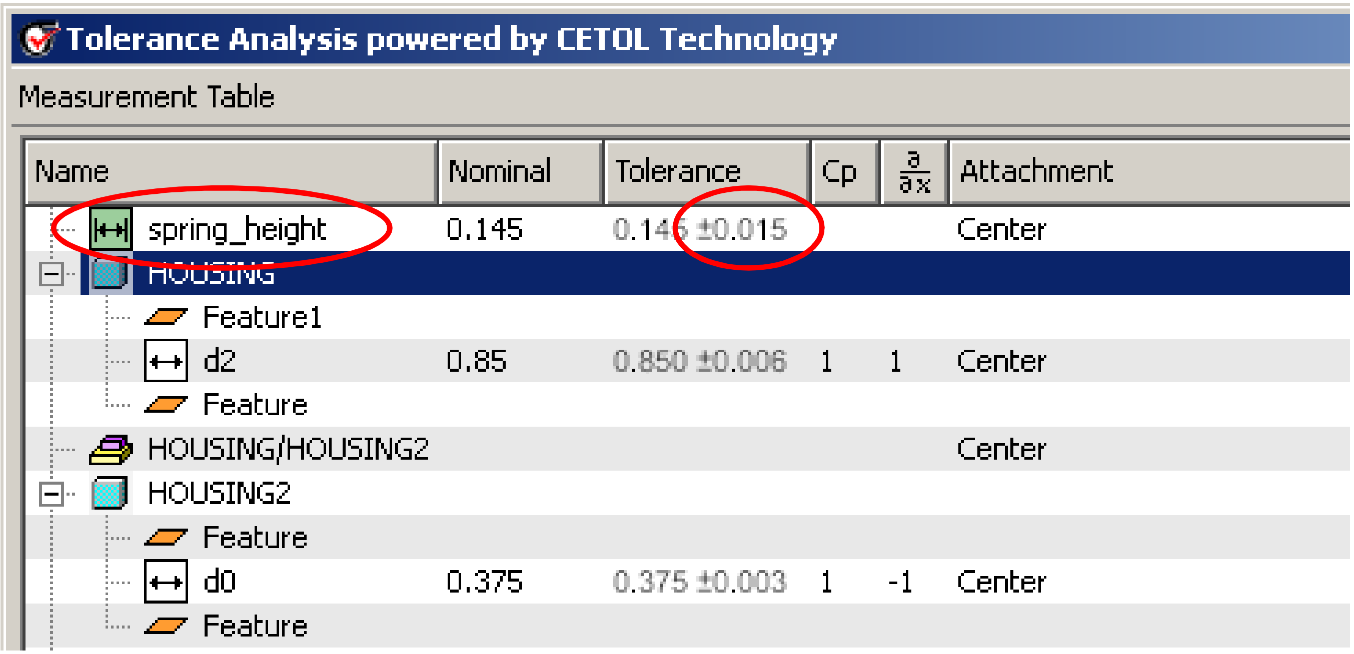
Go back to CETOL window

- **RMB in Measurement Table > Expand All**
- **This will show the dimensions included in the stack**



EXERCISE - Design Tolerance Analysis

Rename analysis and enter design objective


Tolerance Analysis powered by CETOL Technology

Measurement Table

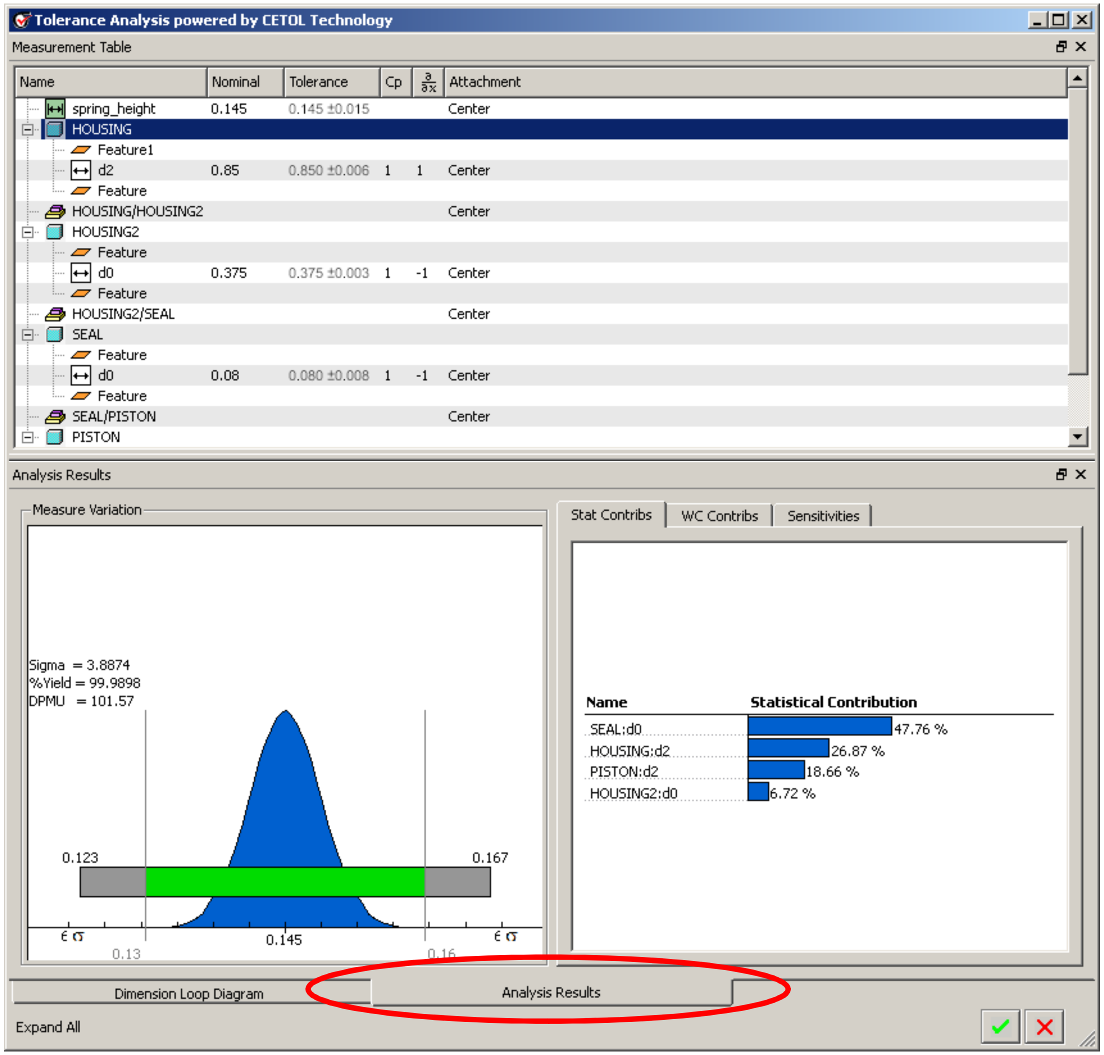
Name	Nominal	Tolerance	Cp	$\frac{\partial}{\partial x}$	Attachment
spring_height	0.145	0.145 ±0.015			Center
HOUSING					
Feature1					
d2	0.85	0.850 ±0.006	1	1	Center
Feature					
HOUSING/HOUSING2					Center
HOUSING2					
Feature					
d0	0.375	0.375 ±0.003	1	-1	Center
Feature					

- Name the analysis something descriptive
- Note nominal dimension and tolerance set by *DESIGN REQUIREMENTS*
  - **This is not the result of the analysis; this is where the goal is set**
  - **Set design tolerance to .015**

EXERCISE - Design Tolerance Analysis

Define tolerance study

- Click on the Analysis Results tab
- Left pane shows graphically the results
- Right pane shows contributions from individual tolerances

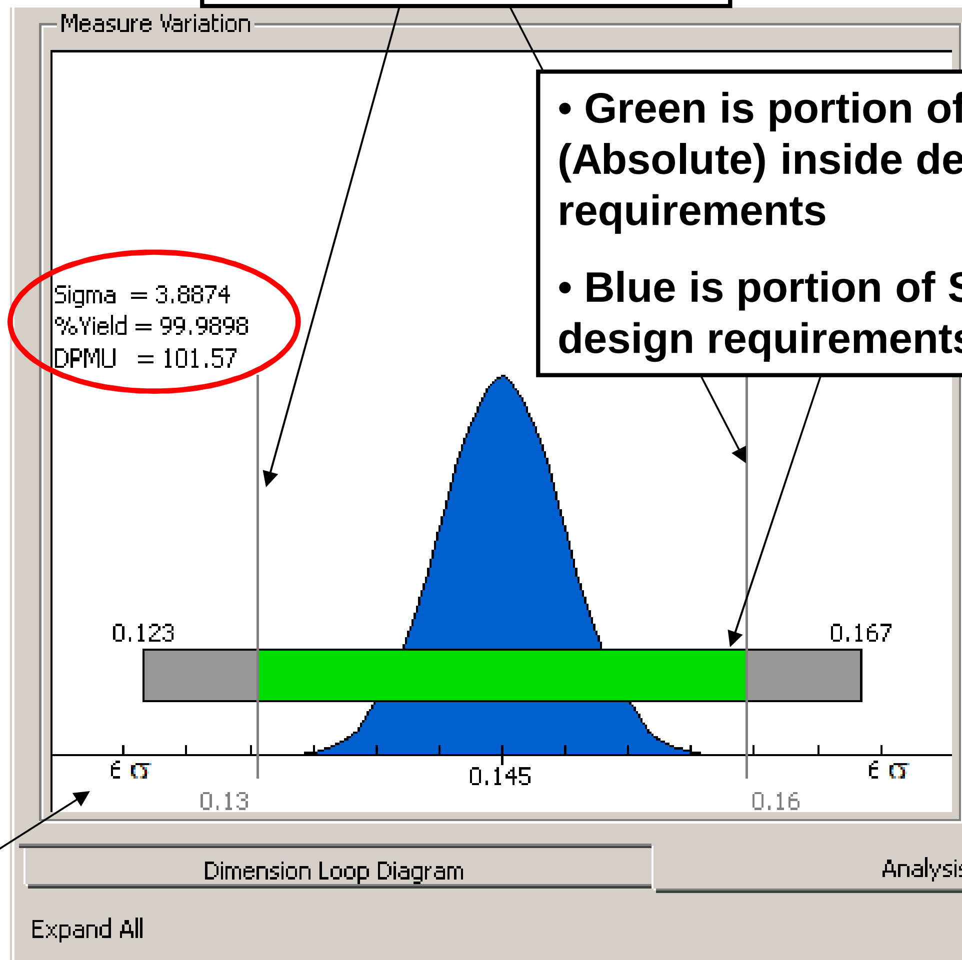


EXERCISE - Design Tolerance Analysis

Define tolerance study

Design requirement

- **Standard deviation**
- **Percent Yield from process**
- **Defects per Million Units**



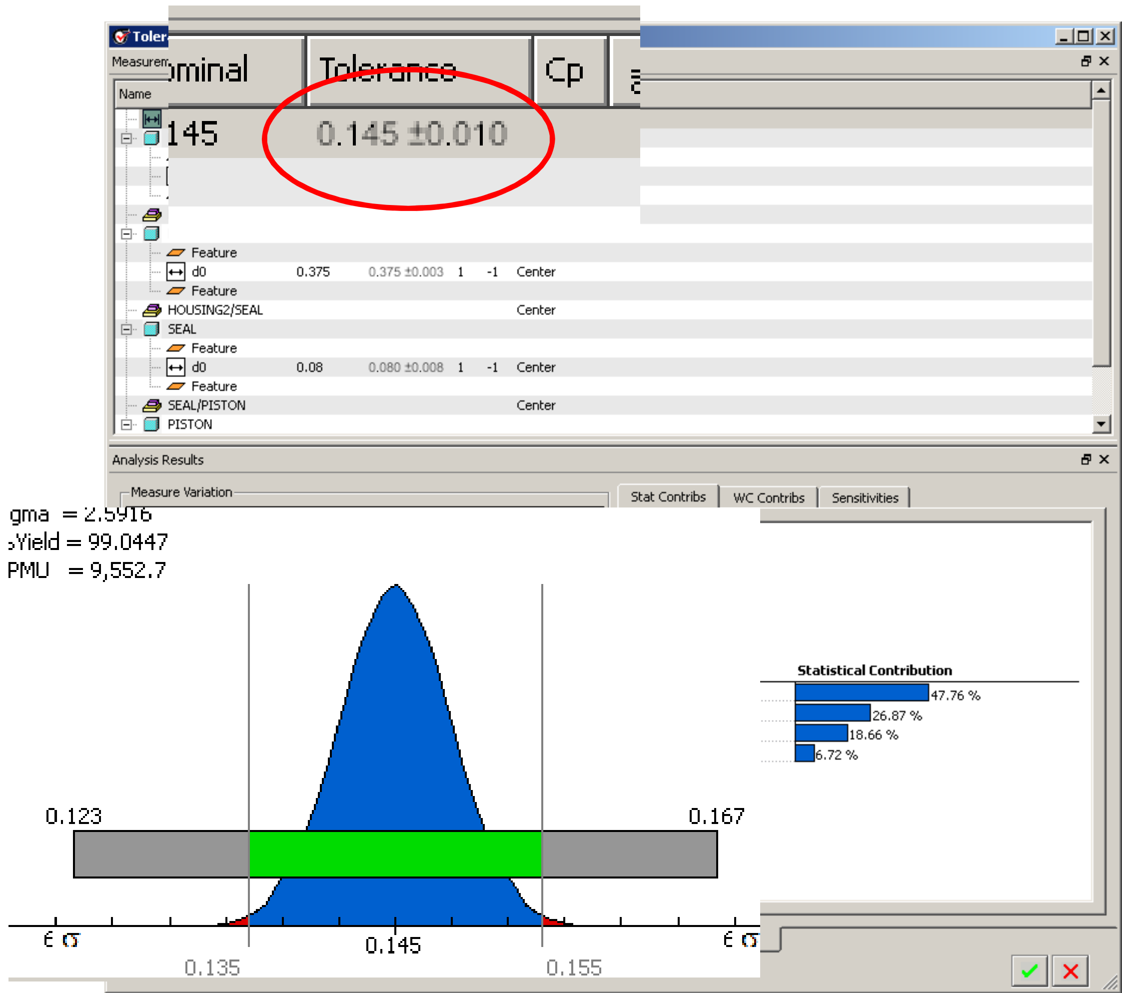
- **Green is portion of Worst Case (Absolute) inside design requirements**
- **Blue is portion of STAT inside design requirements**

Actual tolerance band

EXERCISE - Design Tolerance Analysis

Adjust tolerance objective and update

- Change the tolerance objective to .010
- Observe the change in the output (what happened to DPMU?)



Manufacturing Tolerance

Components must specify allowable tolerances

- Tolerances can be specified in a number of ways
  - Dimensional
    - Limits
    - Unilateral
    - Bilateral
  - **Geometric**
    - Form
    - Orientation
    - Position

Fig. 8-1, B. A. Wilson, GD&T App. And Intr., 2010

Geometric Dimensioning and Tolerancing (GD&T)

Introduction

- GD&T Includes 3 types of tolerances: Form, Orientation and Position

Fig. 5-1, B. A. Wilson, GD&T App. And Intr., 2010

Fig. 7-1, B. A. Wilson, GD&T App. And Intr., 2010

Fig. 8-2, B. A. Wilson, GD&T App. And Intr., 2010

Geometric Dimensioning and Tolerancing (GD&T)

Form Tolerances – Straightness and Flatness

Fig. 5-11, B. A. Wilson, GD&T App. And Intr., 2010

Fig. 5-27, B. A. Wilson, GD&T App. And Intr., 2010

Geometric Dimensioning and Tolerancing (GD&T)

Form Tolerances – Circularity and Cylindricity

Fig. 5-33, B. A. Wilson, GD&T App. And Intr., 2010

Fig. 5-34, B. A. Wilson, GD&T App. And Intr., 2010

Geometric Dimensioning and Tolerancing (GD&T)

Datums

- Datum feature references
    - Labels (Letters)
- Datum features
    - Part features
- Datum
    - Theoretical (perfect) reference geometry
- ***Datums are required for orientation and position tol's***

Fig. 6-3 & 6-4, B. A. Wilson, GD&T App. And Intr., 2010

Geometric Dimensioning and Tolerancing (GD&T)

Types of datums

- There are various types of physical features that can be used as a datum

Fig. 6-7, B. A. Wilson, GD&T App. And Intr., 2010

Fig. 6-6, B. A. Wilson, GD&T App. And Intr., 2010

Geometric Dimensioning and Tolerancing (GD&T)

Orientation Tolerances – Angularity, Perpendicularity and Parallelism

Fig. 7-30, B. A. Wilson, GD&T App. And Intr., 2010

Fig. 7-13, B. A. Wilson, GD&T App. And Intr., 2010

Fig. 7-7, B. A. Wilson, GD&T App. And Intr., 2010

Geometric Dimensioning and Tolerancing (GD&T)

Position tolerance requires Datums, Basic Dim's and Tolerance

Fig. 8-7 & 8-8, B. A. Wilson, GD&T App. And Intr., 2010

Datums establish how to measure the part, ***Basic dimensions*** state theoretical location & ***Position Tolerances*** state allowances