<<*DyRoBeS - RotorBal*>> Help Index

Influence coefficient method is used in the balancing calculation. The theory is documented in the following references:

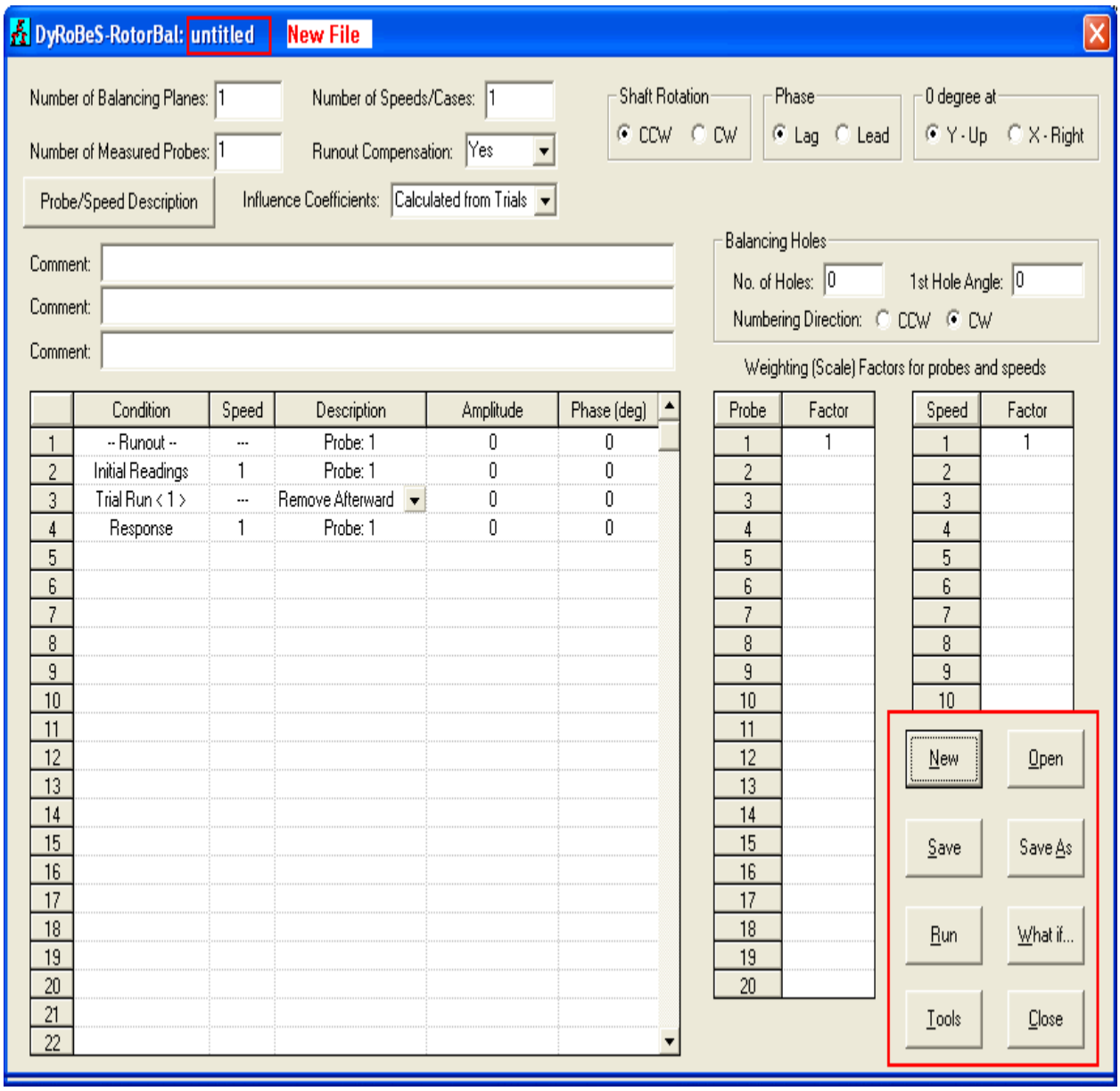
1. Tessarzik, J. M., Badgley, R. H., and Anderson, W. J., 1972, Flexible Rotor Balancing by the Exact Point-Speed Influence Coefficient Method, ASME Journal of Engineering for Industry, Feb., 1972, pp 148-158.
2. Lund, J. W. and Tonnesen, J., 1972, Analysis and Experiments on Multi-Plane Balancing of a Flexible Rotor, ASME Journal of Engineering for Industry, Feb., 1972, pp 233-242.
3. Chen, W.J. and Gunter, E.J., 2005, Introduction to Dynamics of Rotor-Bearing Systems, Trafford Publishing.

Since the least square method is used to solve the simultaneous equations, the Number of Measured Probes (Nm) times the Number of Speed/Case Points (Ns) must be greater than or equal to the Number of Balancing Planes (Nb). That is: (NmXNs >= Nb).

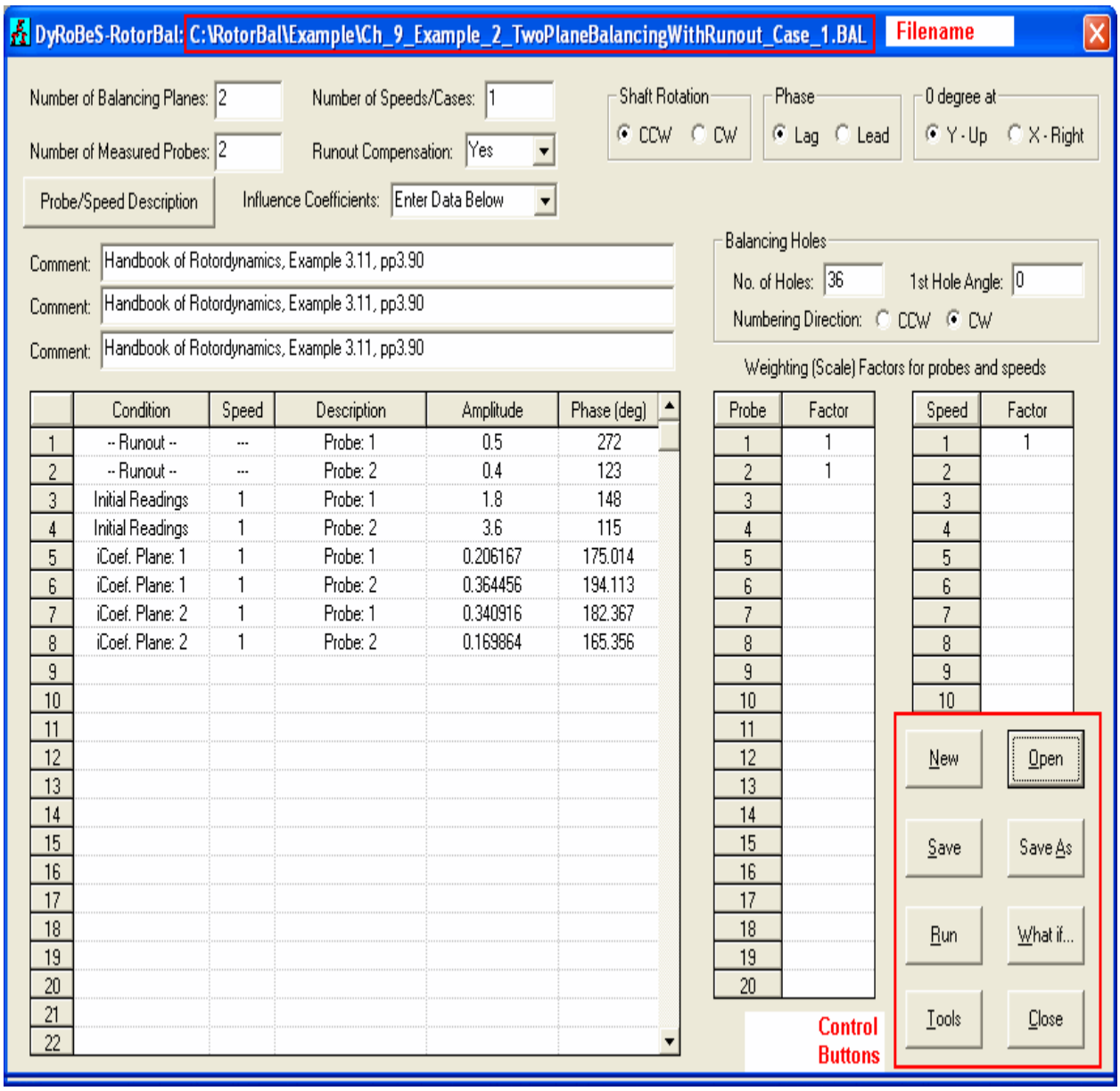
To use the influence coefficient method, no prior knowledge in rotor mode is required. However, the influence coefficients (transfer function), which relate the force (input) and response (output), must be known. The influence coefficients can be calculated by using the trial weights and corresponding responses, can be obtained from the previous trials, or can be obtained from a similar machine. There are three methods to input the influence coefficients in this current version (Ver 2.0).

1. The influence coefficients can be calculated by using the trial weights and corresponding responses. When this option is selected, the influence coefficients will be calculated and outputted in a file with an extension INF. That is: filename.INF will be saved for future use.
2. The influence coefficients can be entered into the table from previous calculation.
3. The influence coefficients can be imported from an external file.

When the program is activated. The following initial screen will be shown:



when an existing file is opened, the data fields will be filled:

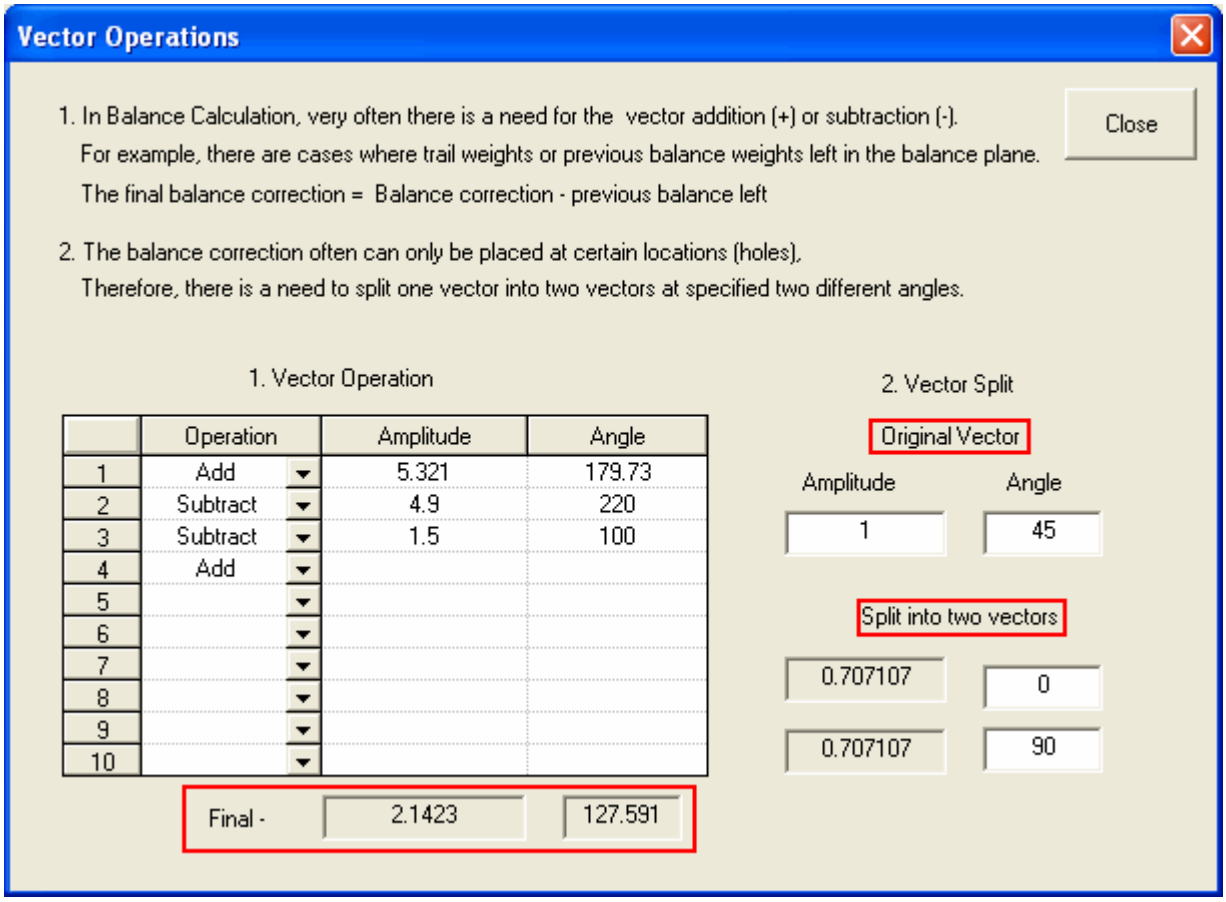


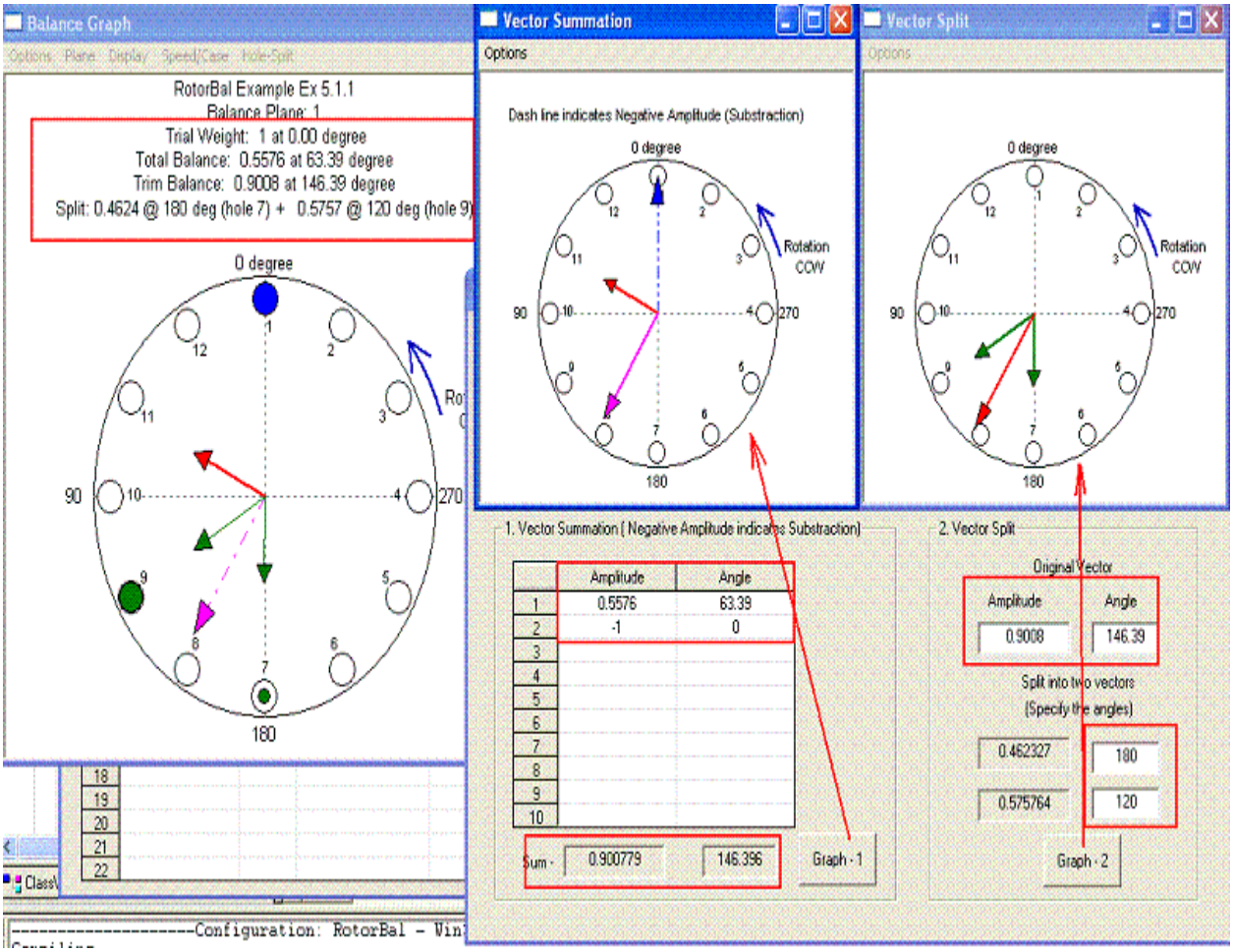
Note that the top of screen (headline) will display the active filename. If the data file is not specified or saved, untitled will be shown in the filename field. All the control buttons and inputs are self-explanatory. They are briefly described below:

<Control Buttons>

1. New: create a new file.
2. Open: open an existing file.
3. Save: save the data into file.
4. SaveAs: save the data into another file.
5. Run: run the analysis
6. What If: Very often the calculated optimal balance correction is not feasible and cannot be applied due to constraints. The balance correction can be specified in this option to see the response.
7. Tools: In the balancing calculation, very often there are needs for the vector addition (plus) and subtraction (minus), and vector split. For examples, there are cases that the trial weights or previous

balance weights are left in the machine, then the final balance correction will be the calculated balance correction minus the previously left corrections. Also, since the balance correction is usually not located at the balance hole, a split may be needed. That is a vector split into two vectors with specified angles.





8. Close: close the program.

<Data Inputs>

1. Number of Balancing Planes: Nb
The balancing planes are the planes along the rotor where the trial weights and balancing corrections are applied. Note that the trial weight can be **left-in** or **removed** after the trial run.

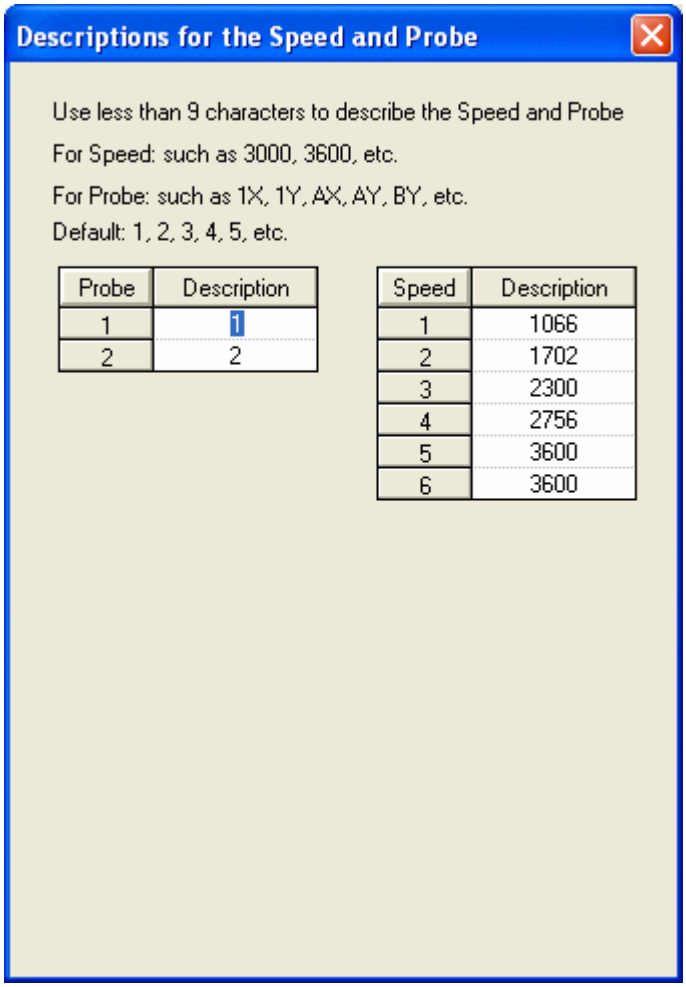
2. Number of Measured Probes: Nm
The measurement probes are where the vibrations are taken and recorded. The purpose of the balancing is to find the optimal balancing corrections at the balancing planes such that the vibrations at the measurement probes are minimized.

3. Number of Speeds/Cases: Ns
The number of speeds or cases allows for different speeds or cases, such as idle speed, full speed, full load, unloads, etc…

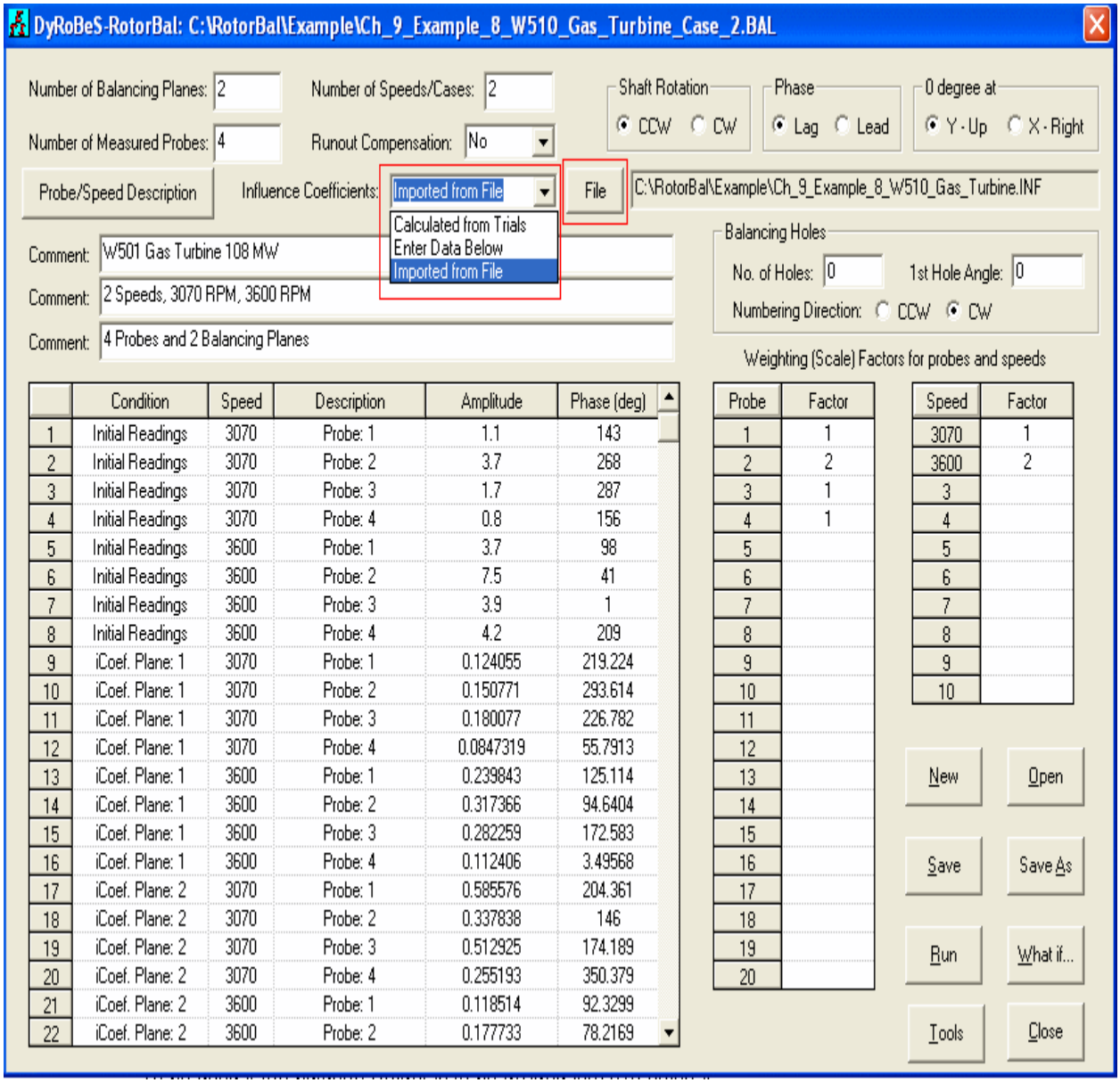
4. Runout Compensation
Runout can be included or excluded in this balancing calculation.

5. Probe/Speed Description:
By default, the probe and speed are numbered numerically as 1, 2, 3, .etc. However, one can enter the descriptions for the probe and speed. Say, probe can be described as 1X, 1Y, 2X, 2Y, CX, TY, etc. The

speed can be entered as the measurement speed, such as 2500 rpm, 2750 rpm, 3000 rpm, etc.

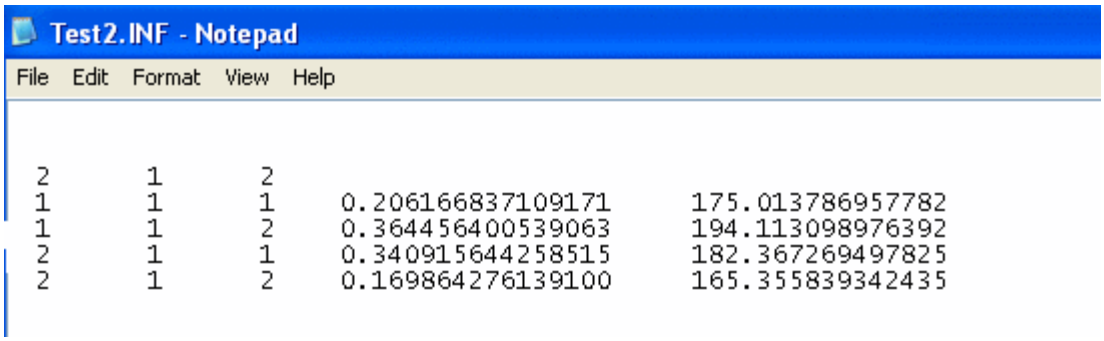


6. Influence Coefficients
Influence Coefficients can be entered in three methods:
6.1 Calculated from trial weights and corresponding responses. The influence coefficients will be calculated and saved in a file with extension INF (filename.INF).
6.2 Enter the influence coefficients into the table
6.3 Import the influence coefficients from an existing file. If this option is selected, a **File** button will be shown next to the selection. Click this button to select the influence coefficients file.



The influence coefficients file is in ASCII text format. The format is shown below:

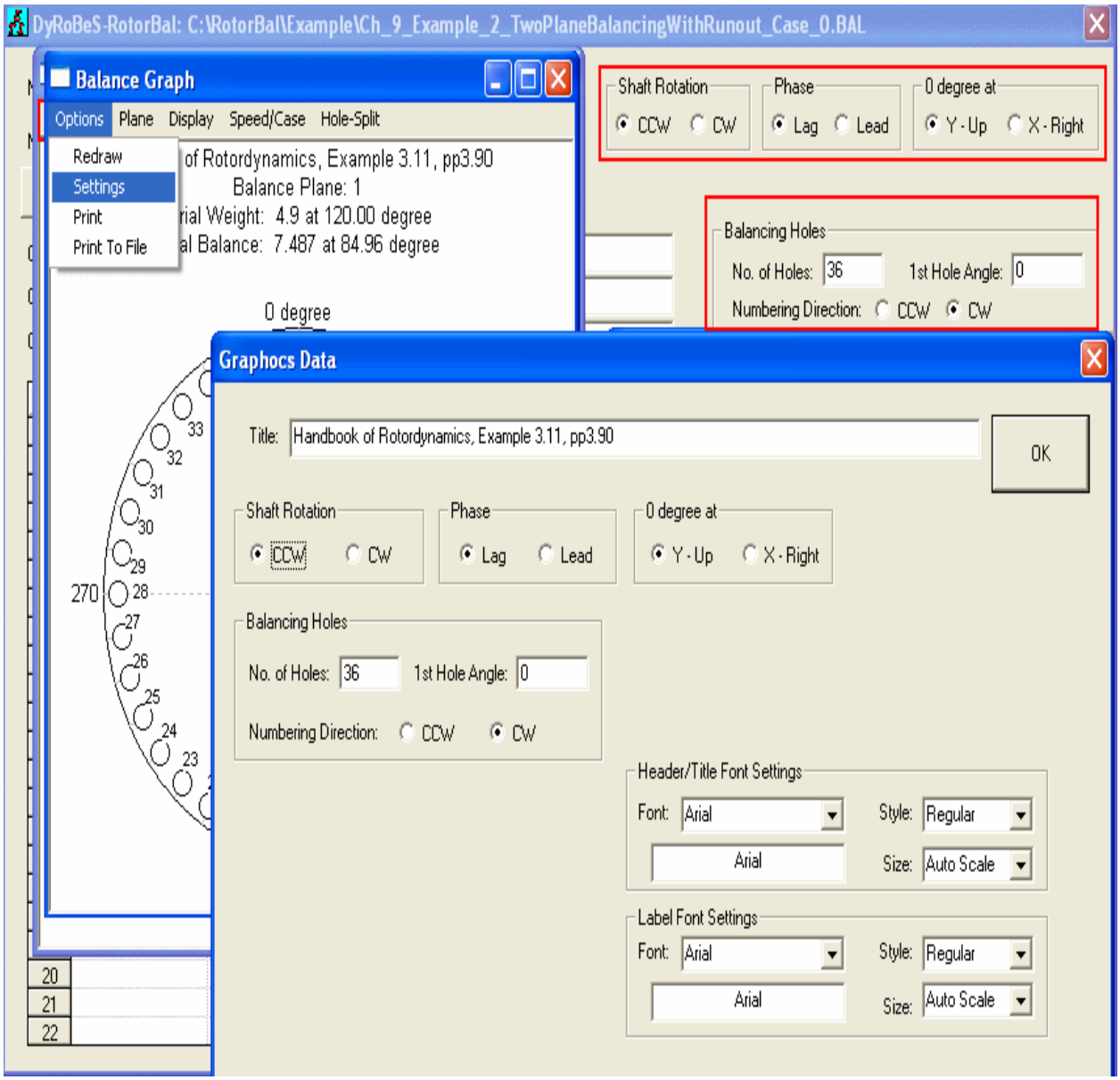
Nb, Ns, Nm (# of balance planes, # of speeds, # of measurements)
Balance plane, speed, measurement, influence coefficient amplitude, angle
Report the above line until all the data are entered.



7. Comments
Up to 3 comment lines can be used to describe the system under study.

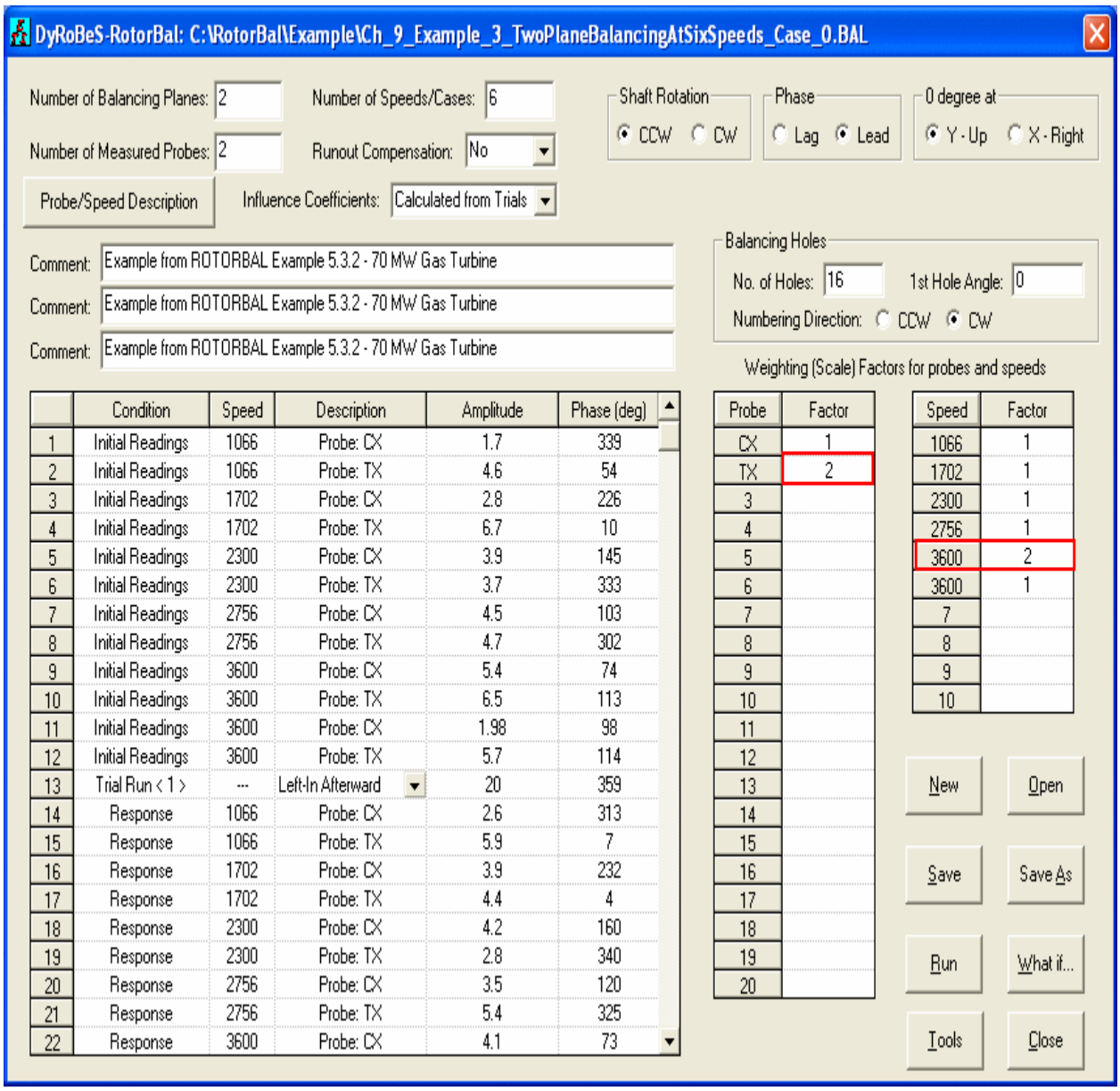
8. Graphic Data
The following graphic data are used for the graphic purposes which do not affect the calculation results. These data can be changed in the postprocessor if necessary.
8.1. Shaft Rotation: CCW or CW
8.2. Phase: Lag or Lead
Phase Lag indicates that the phase angle increases against the shaft rotation direction, and Phase Lead indicates that the phase angle increases with the shaft rotation direction.
8.3. 0 degree: Up or Right.
0 degree position defines the reference mark where all the angles (phases) are measured from.
8.4. Number of Balancing Holes
To be used if the balance weight is to be divided into two holes.
8.5 1st Hole Angle
Phase angle of the first hole from the zero degree position. Measured according to Phase Lag or Phase Lead in 6.2.
8.6 Numbering Direction
The hole numbering direction can be either CCW or CW.

Again, these graphic settings can be changed in the PostPerocessor – Options – Settings. This setting also allows you to modify the font size and style.



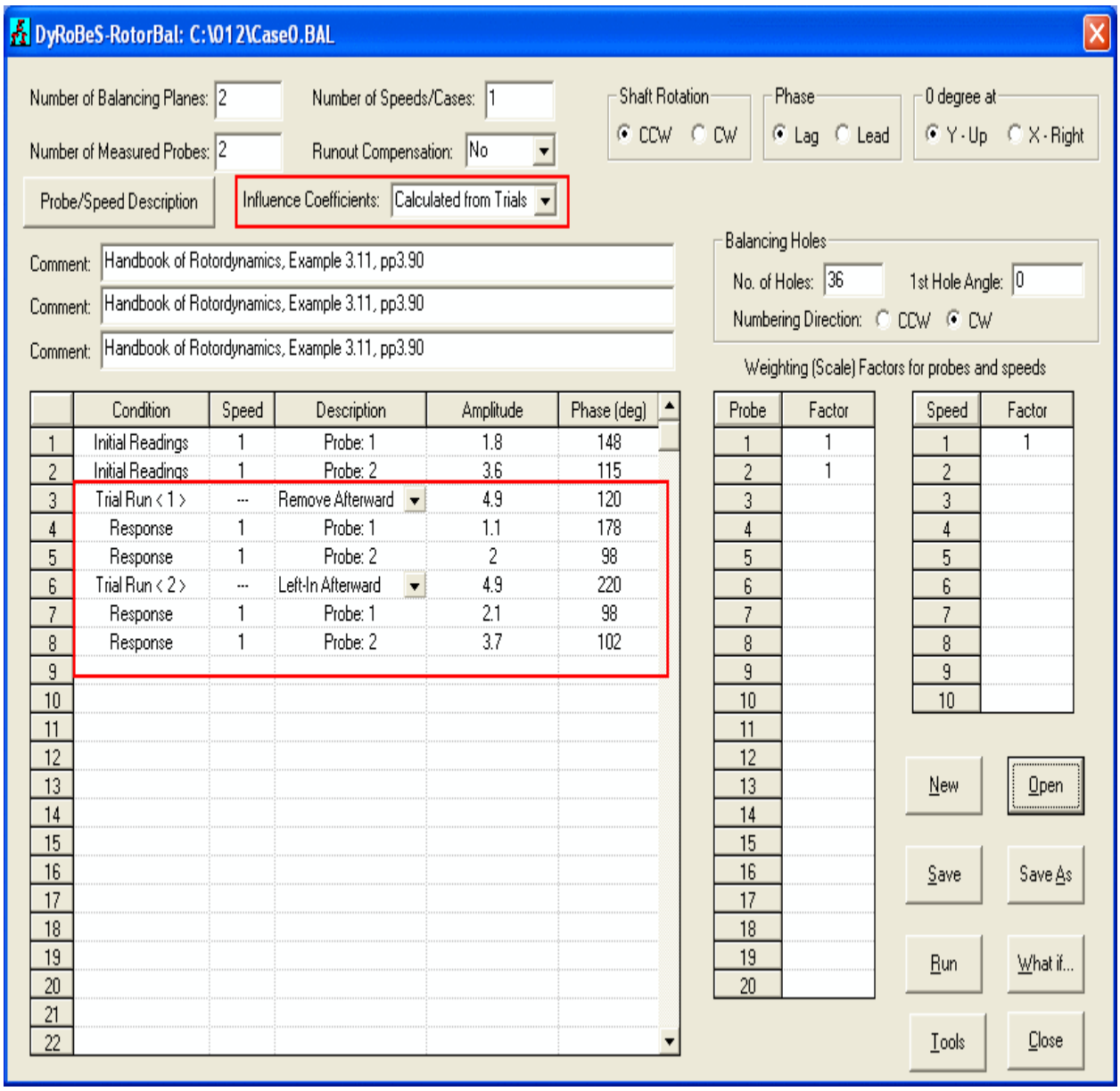
9. Weighting Factors

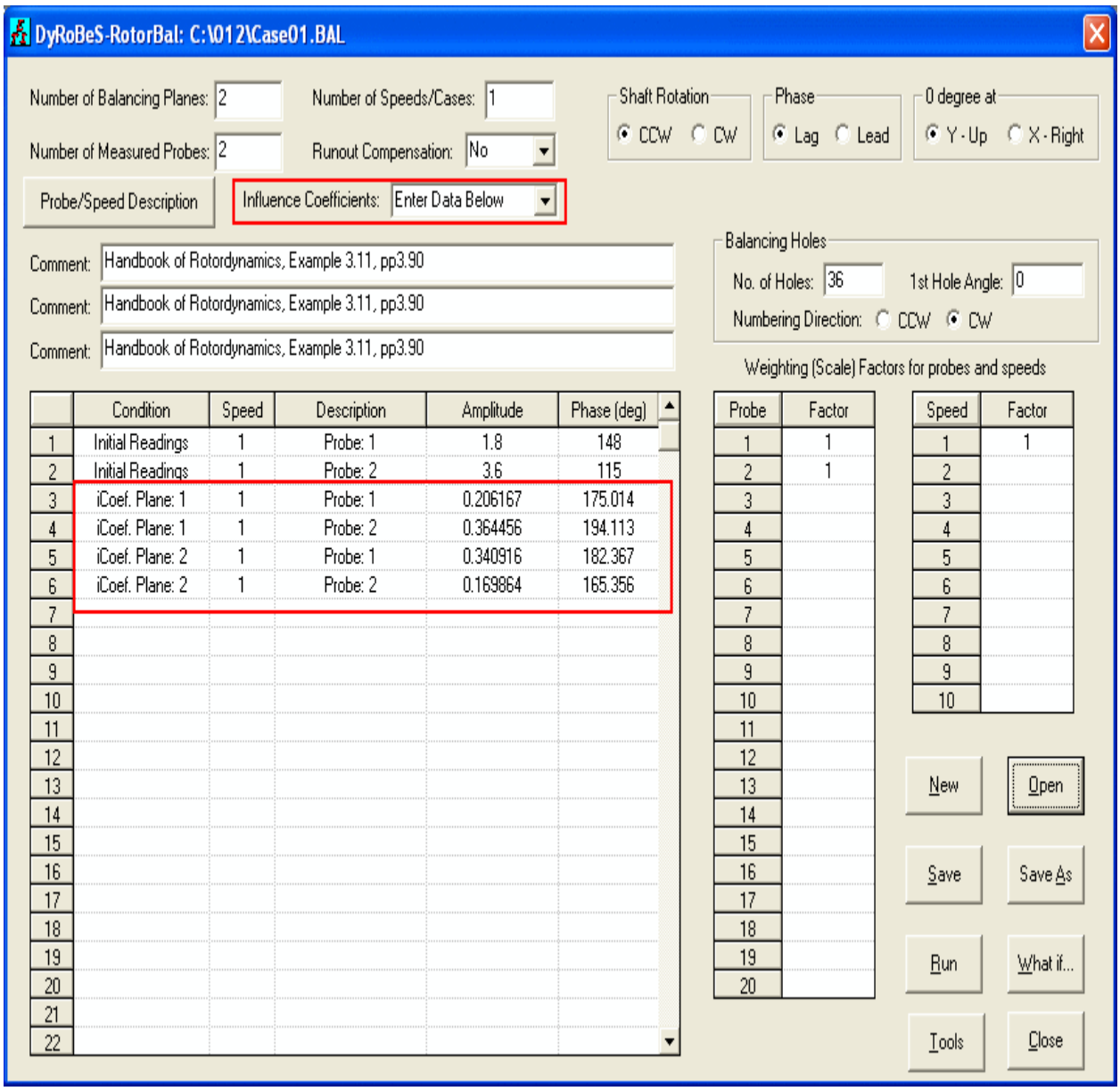
Weighting factor allows one to strengthen or weaken the data for the measurement probes or speeds. For example, one may use higher weighting factors for the probes where the critical components are located and/or speeds where the rotor will be operated most of the time. Weighting factor zero indicates that the specific probe data will NOT be included in the calculation.

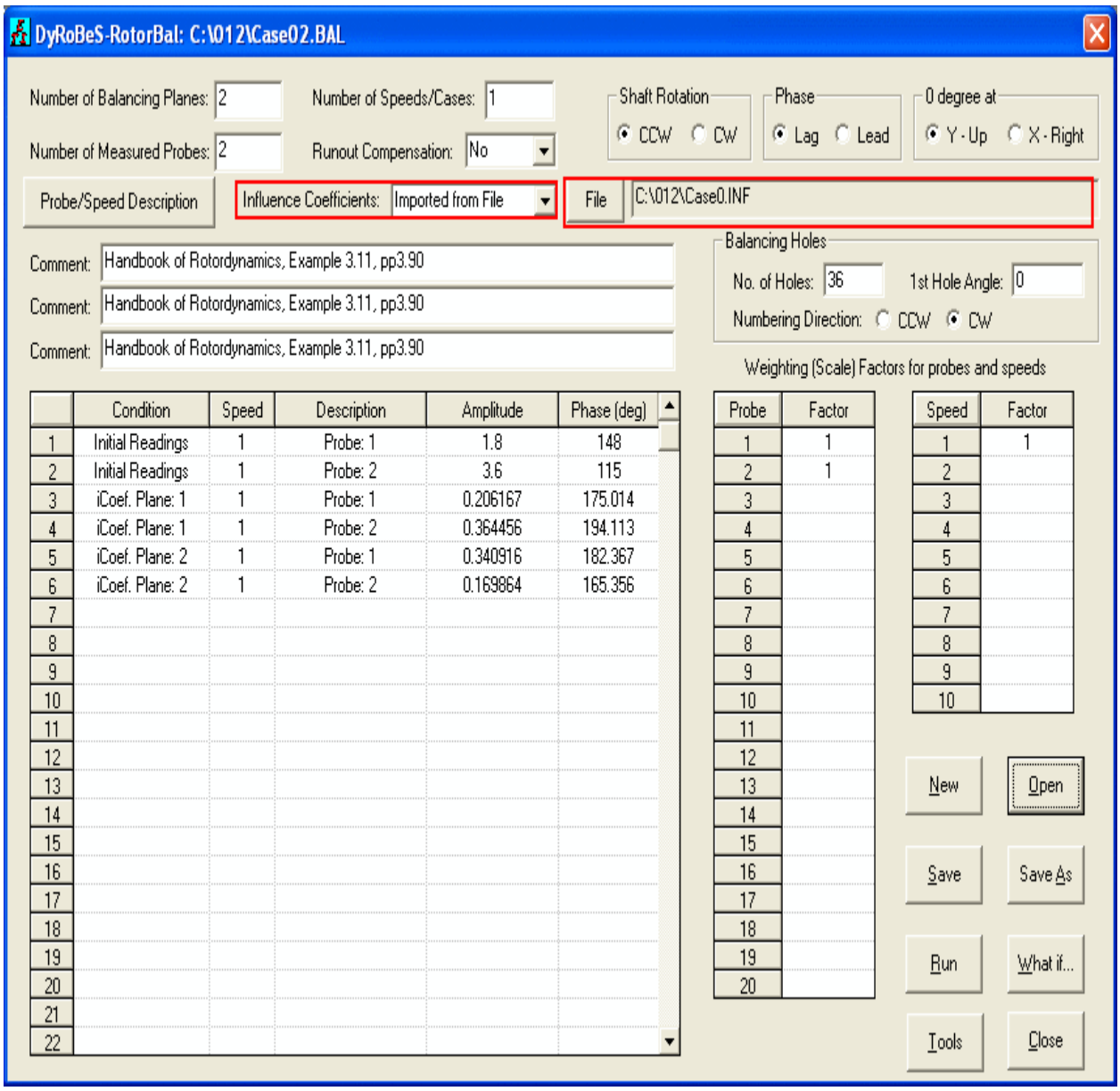


10. Data Table

All the data are entered in this table according the input method for the influence coefficients and runout option.

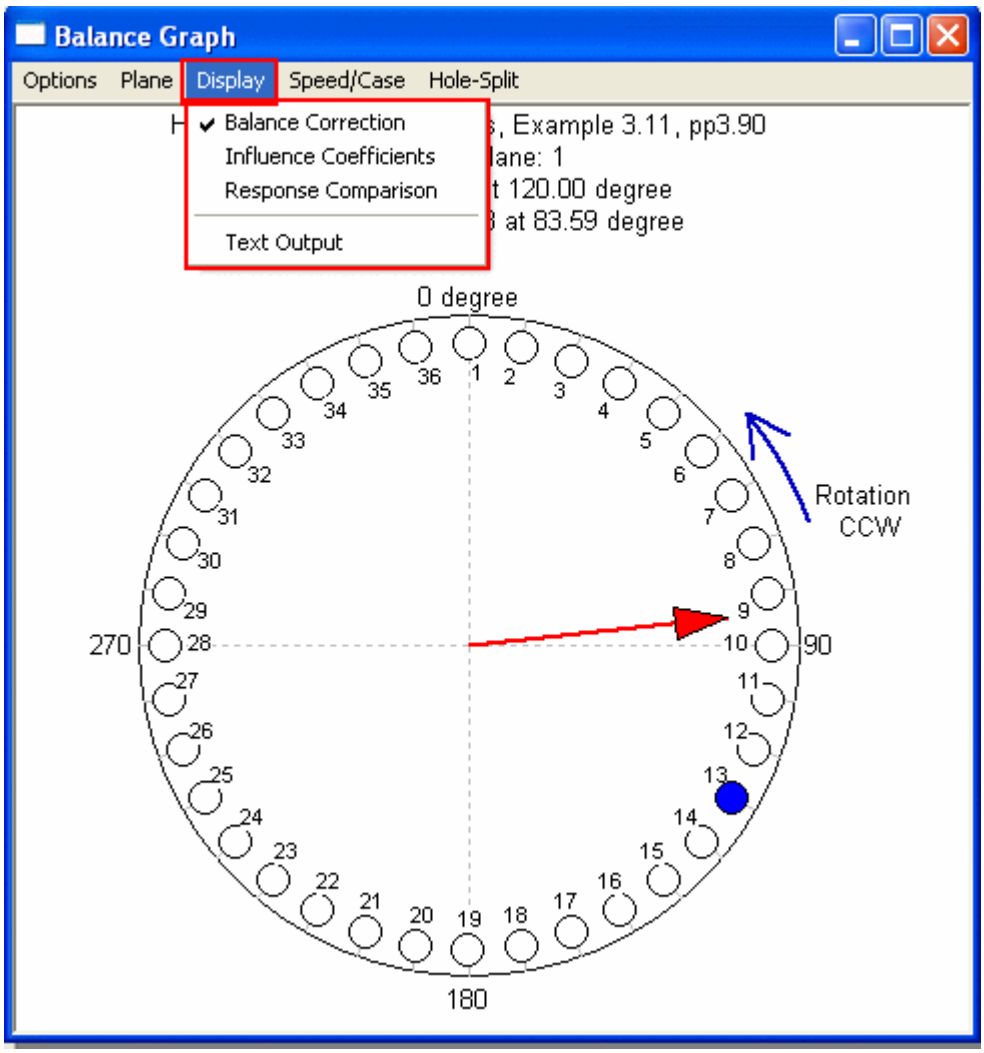

DyRoBeS-RotorBal: C:\012\Case0.BAL
Number of Balancing Planes: 2
Number of Speeds/Cases: 1
Number of Measured Probes: 2
Runout Compensation: No
Shaft Rotation
CCW
CW
Phase
Lag
Lead
0 degree at
Y - Up
X - Right
Probe/Speed Description
Influence Coefficients: Calculated from Trials
Comment: Handbook of Rotordynamics, Example 3.11, pp3.90
Comment: Handbook of Rotordynamics, Example 3.11, pp3.90
Comment: Handbook of Rotordynamics, Example 3.11, pp3.90
Balancing Holes
No. of Holes: 36
1st Hole Angle: 0
Numbering Direction: CCW CW
Weighting (Scale) Factors for probes and speeds
Condition
Speed
Description
Amplitude
Phase (deg)
1 Initial Readings 1 Probe: 1 1.8 148
2 Initial Readings 1 Probe: 2 3.6 115
3 Trial Run < 1 > --- Remove Afterward 4.9 120
4 Response 1 Probe: 1 1.1 178
5 Response 1 Probe: 2 2 98
6 Trial Run < 2 > --- Left-In Afterward 4.9 220
7 Response 1 Probe: 1 2.1 98
8 Response 1 Probe: 2 3.7 102
Probe
Factor
Speed
Factor
New
Open
Save
Save As
Run
What if...
Tools
Close

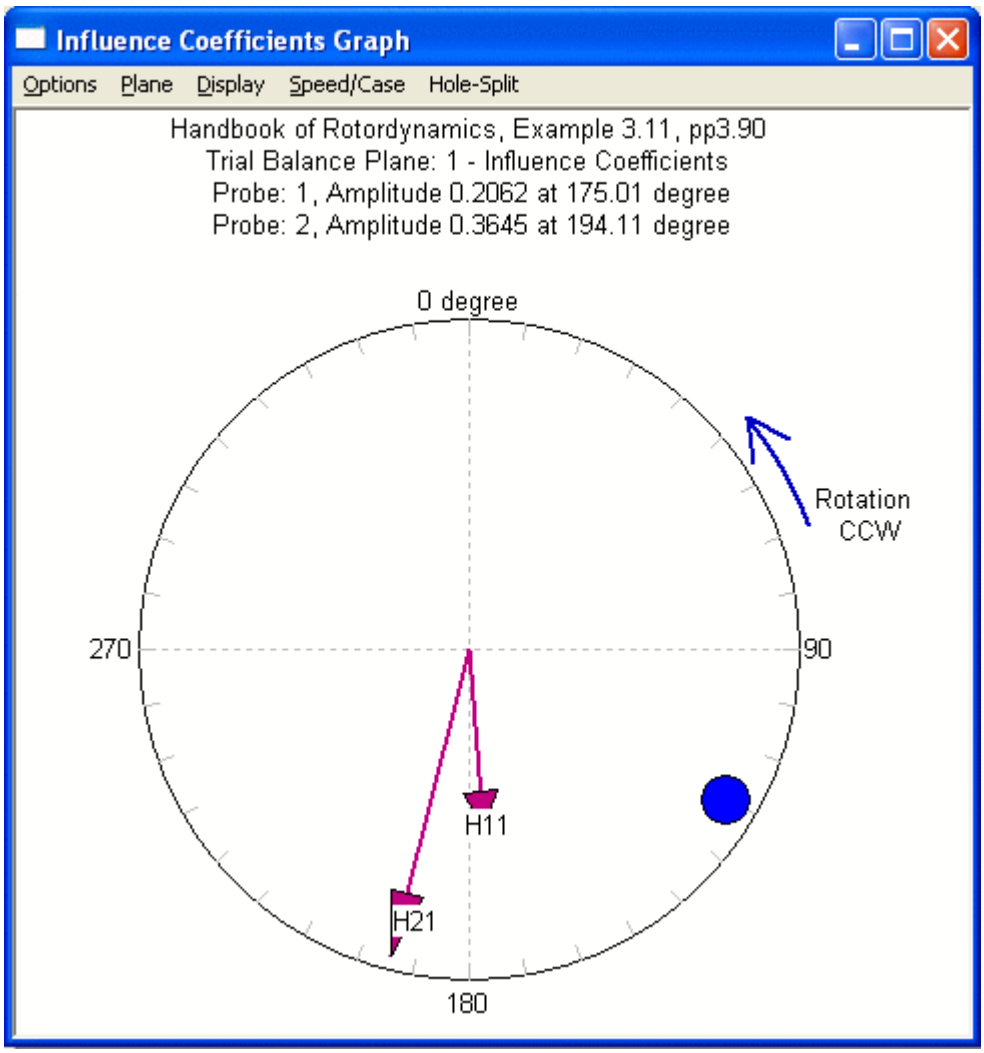

DyRoBeS-RotorBal: C:\012\Case01.BAL
Number of Balancing Planes: 2
Number of Speeds/Cases: 1
Number of Measured Probes: 2
Runout Compensation: No
Shaft Rotation
CCW
CW
Phase
Lag
Lead
0 degree at
Y - Up
X - Right
Probe/Speed Description
Influence Coefficients: Enter Data Below
Comment: Handbook of Rotordynamics, Example 3.11, pp3.90
Comment: Handbook of Rotordynamics, Example 3.11, pp3.90
Comment: Handbook of Rotordynamics, Example 3.11, pp3.90
Balancing Holes
No. of Holes: 36
1st Hole Angle: 0
Numbering Direction: CCW CW
Weighting (Scale) Factors for probes and speeds
Condition Speed Description Amplitude Phase (deg)
1 Initial Readings 1 Probe: 1 1.8 148
2 Initial Readings 1 Probe: 2 3.6 115
3 iCoef. Plane: 1 1 Probe: 1 0.206167 175.014
4 iCoef. Plane: 1 1 Probe: 2 0.364456 194.113
5 iCoef. Plane: 2 1 Probe: 1 0.340916 182.367
6 iCoef. Plane: 2 1 Probe: 2 0.169864 165.356
Probe Factor
1 1
2 1
Speed Factor
1 1
New
Open
Save
Save As
Run
What if...
Tools
Close

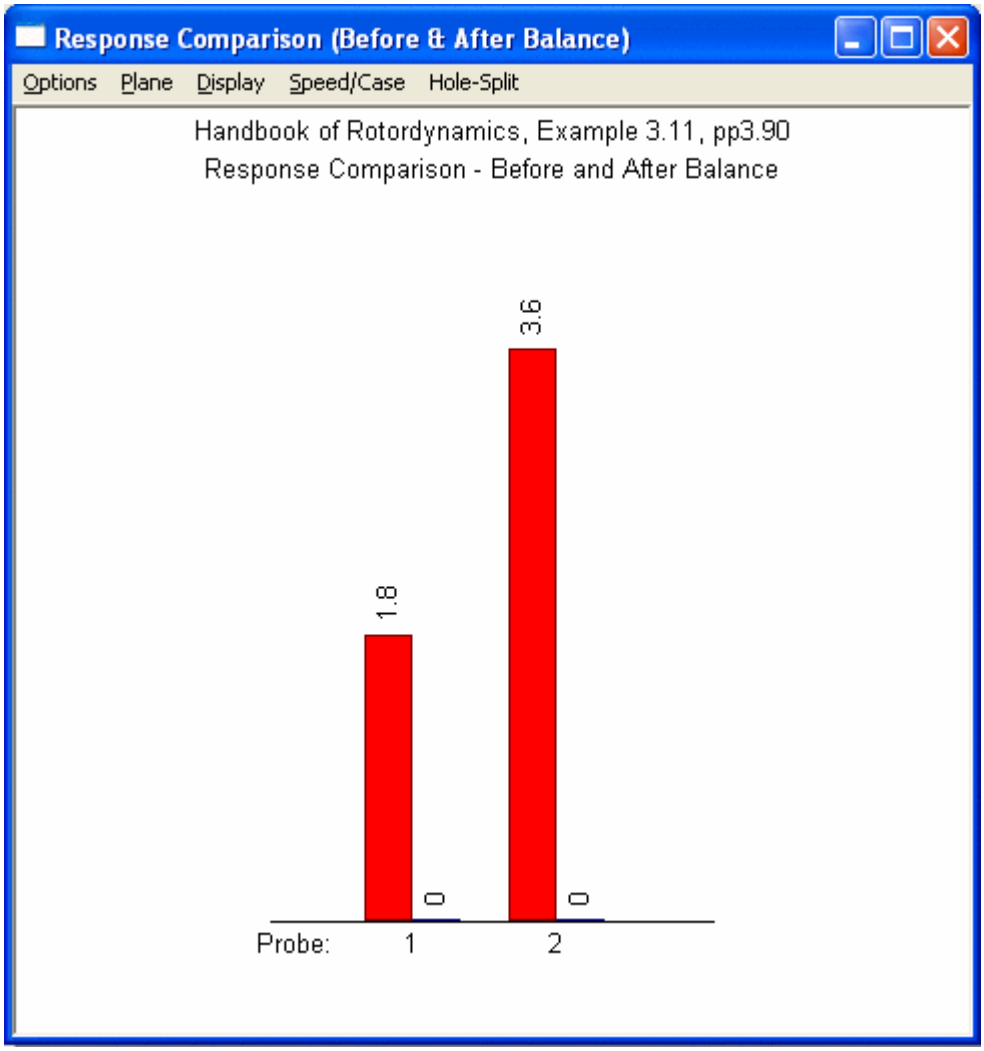


<Outputs>

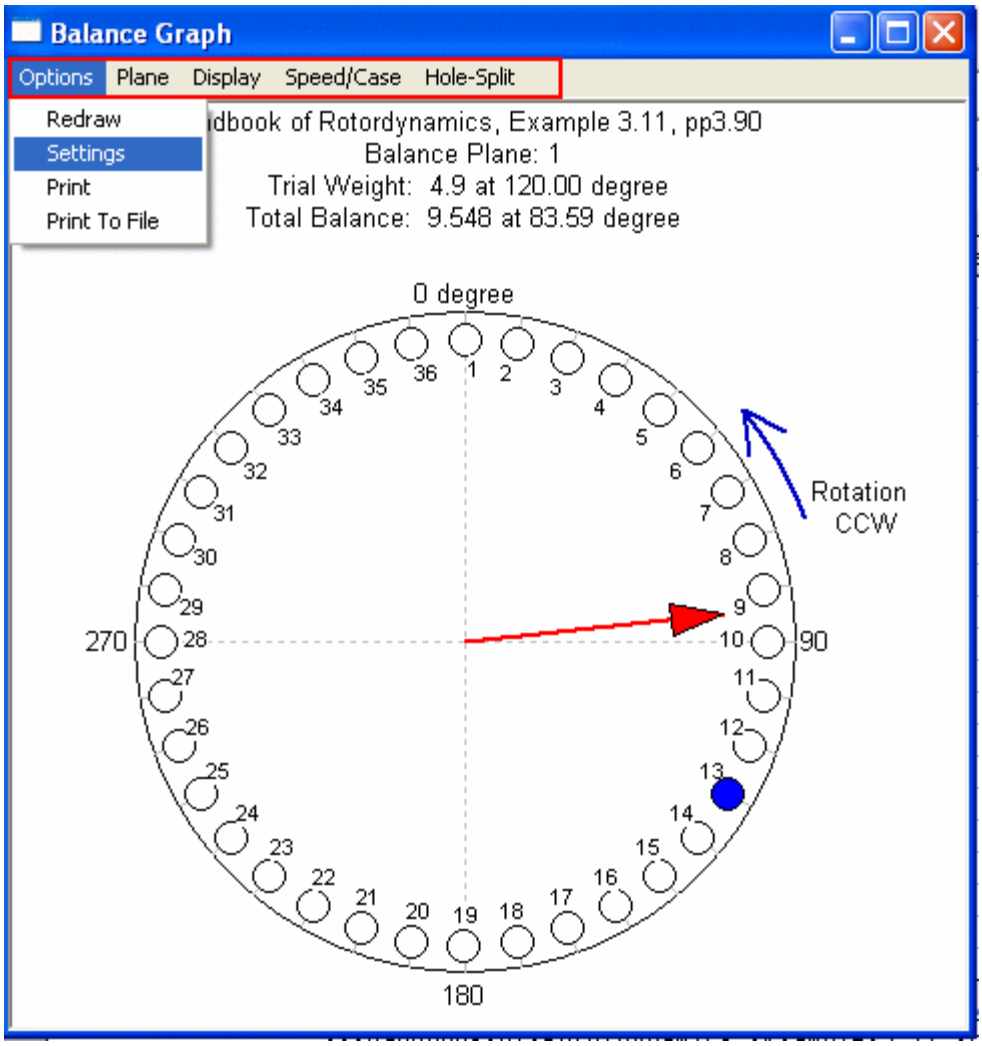
When click Run and What If button, the analysis will be performed. There are 4 outputs available: 1 – Balance Correction, 2 – Influence Coefficients, 3 – Response Comparison, and 4 – Text output. The initial default output is the Balance Correction plot as shown below:


Balance Graph
Options
Plane
Display
Speed/Case
Hole-Split
Balance Correction
Influence Coefficients
Response Comparison
Text Output
, Example 3.11, pp3.90
lane: 1
t 120.00 degree
at 83.59 degree
0 degree
90
180
270
Rotation
CCW


Influence Coefficients Graph
Options
Plane
Display
Speed/Case
Hole-Split
Handbook of Rotordynamics, Example 3.11, pp3.90
Trial Balance Plane: 1 - Influence Coefficients
Probe: 1, Amplitude 0.2062 at 175.01 degree
Probe: 2, Amplitude 0.3645 at 194.11 degree
0 degree
Rotation
CCW
270
90
H11
H21
180



In the graphic window, one can use the menu to make proper selection for the desired output.




```
FileName: C:\012\Case0.BAL

Handbook of Rotordynamics, Example 3.11, pp3.90
Handbook of Rotordynamics, Example 3.11, pp3.90
Handbook of Rotordynamics, Example 3.11, pp3.90

*****  Number of Speeds or Cases   :   1
*****  Number of Balancing Planes  :   2
*****  Number of Measurement Probes:   2

*****  Influence Coefficients: Calculated by Trials

*****  NO Runout Compensation

======  Initial Response (Without Trails)  ======
   Speed    Probe      Amplitude     Phase Angle
     1        1          1.8000         148.00
     1        2          3.6000         115.00

**************  Trial Unbalance Run: 1  **************
   Plane       Amplitude     Phase Angle    Afterward
     1           4.9000         120.00       Remove

---------  Response to Trial Unbalance  ---------
   Speed    Probe      Amplitude     Phase Angle
     1        1          1.1000         178.00
     1        2          2.0000         98.000
```

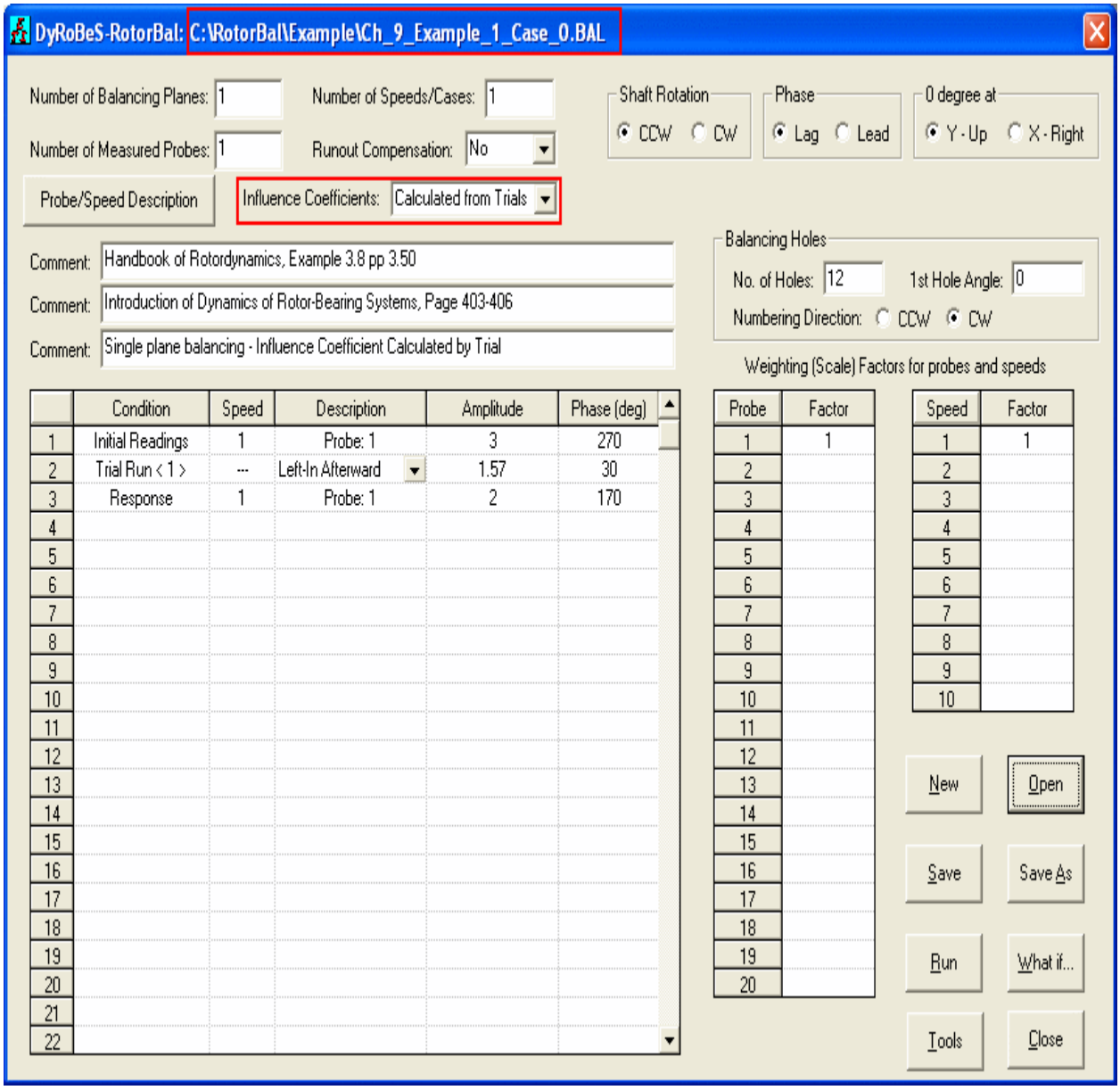
```
**************  Trial Unbalance Run: 2  **************
   Plane      Amplitude     Phase Angle   Afterward
     2          4.9000         220.00      Left-In

---------  Response to Trial Unbalance  ---------
   Speed   Probe      Amplitude     Phase Angle
     1       1          2.1000         98.000
     1       2          3.7000         102.00

***  Weighting Factors for probes and speeds ***
     Probe  Description  Weighting Factor
       1       1              1.0000
       2       2              1.0000

     Speed  Description  Weighting Factor
       1       1              1.0000

================================================
<<<<<<<<  Total Balance Correction  >>>>>>>>
  Correction Required to Balance the Rotor
   Plane No.    Amplitude     Phase Angle
      1          9.5481         83.592
      2          6.3055         204.63


<<<<<<<<<  Trim Balance Correction  >>>>>>>>>>
  Correction Required if Trial Weight Left-in
  Trim Balance = Total Balance - Trial Weight
   Plane No.    Amplitude     Phase Angle
      2          2.0458         165.23
================================================
________________________________________________

**********  The Influence Coefficients  ***********
                              Influence Coef.
  Trial-Run  Speed  Probe   Amplitude     Phase
      1        1      1     0.20617      175.01
      1        1      2     0.36446      194.11
      2        1      1     0.34092      182.37
      2        1      2     0.16986      165.36
________________________________________________

================  Predicted Residual Response (Without Runout) =================
                     ----- Before (Initial) -----  ----- After Balancing -----
   Speed   Probe      Amplitude      Phase Angle    Amplitude     Phase Angle
     1       1          1.8000         148.00         0.0000        0.0000
     1       2          3.6000         115.00         0.0000        0.0000
================================================================================
================================================================================
```

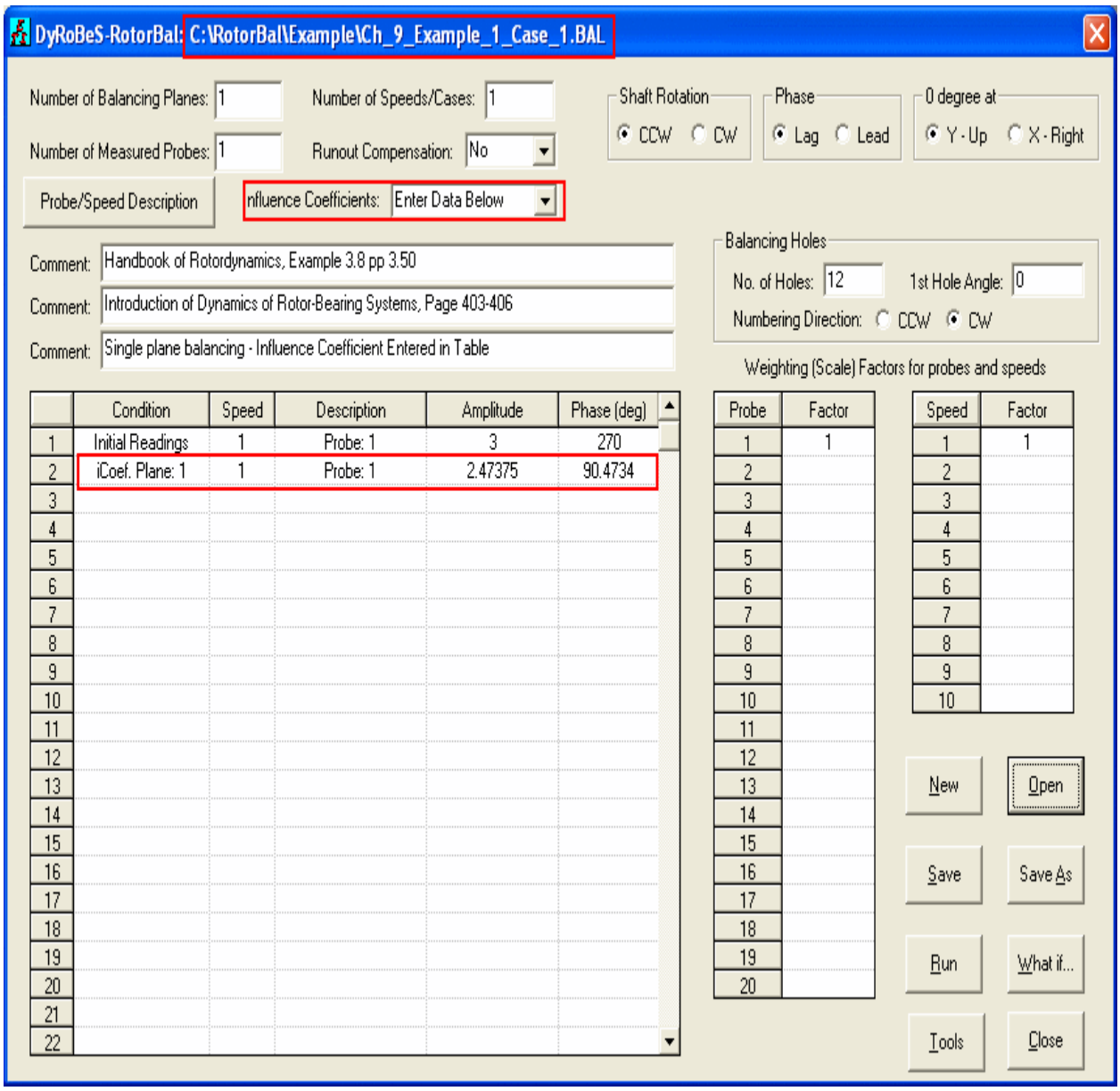
<Examples>

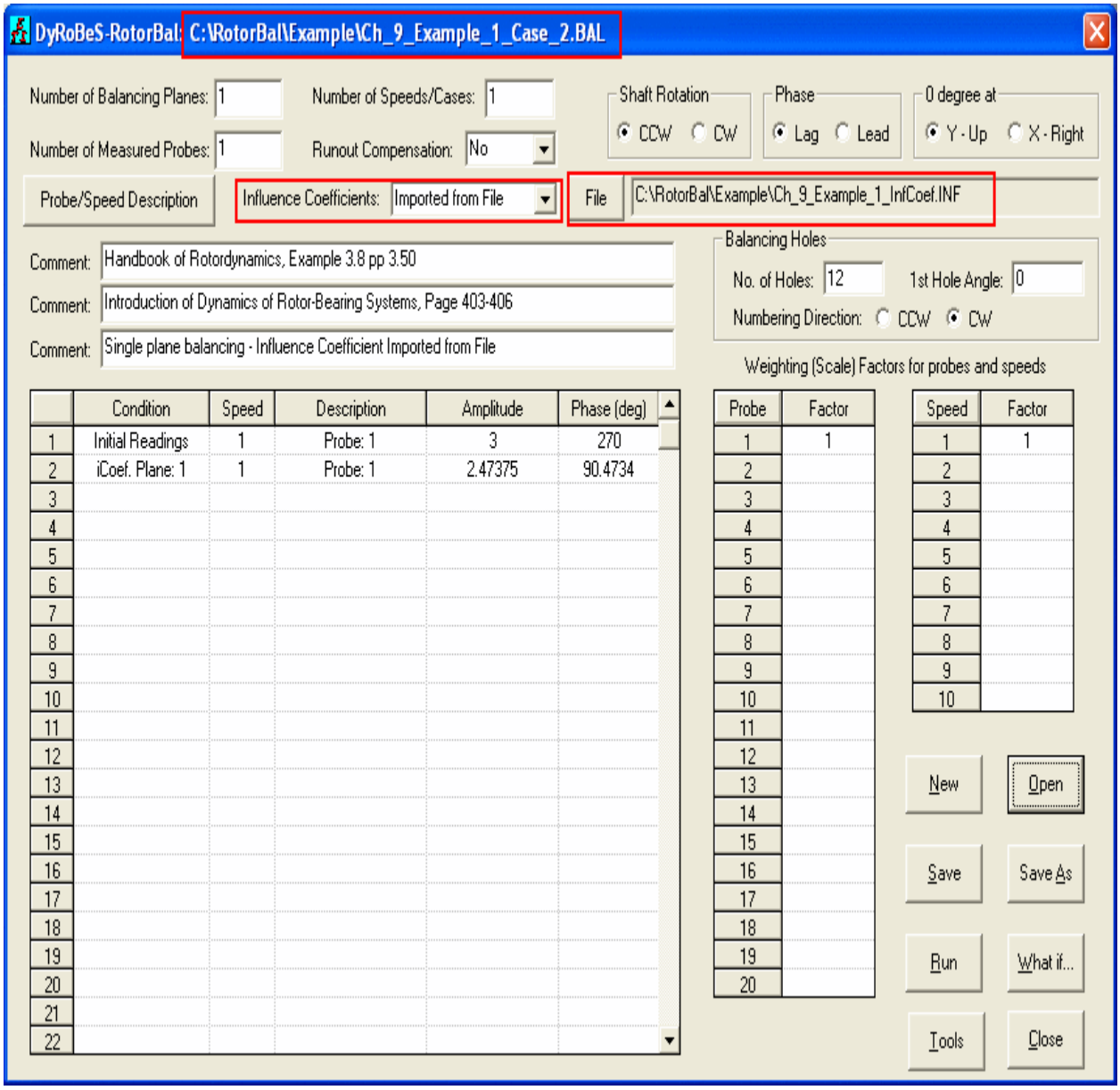
Several examples are presented here.

Example 1 – Single Plane Balance

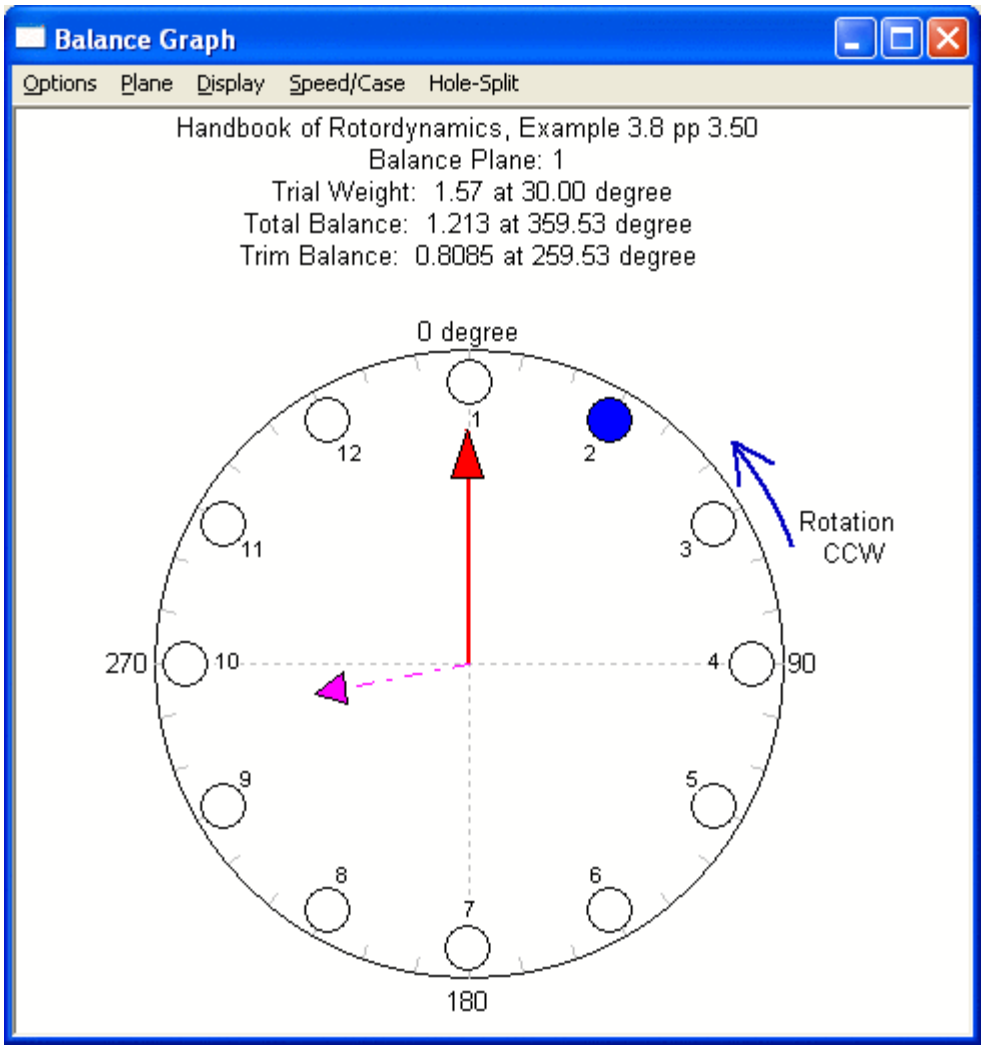
The influence coefficient is entered in all three methods and the results are identical. Case_0 – Influence coefficient is calculated by trial weight, Case_1 – influence coefficient is entered in the table. Note that the influence coefficient is from the Case_0 output. Case 2 – Influence coefficient is imported from a file.


DyRoBeS-RotorBal: C:\RotorBal\Example\Ch_9_Example_1_Case_0.BAL
Number of Balancing Planes: 1
Number of Speeds/Cases: 1
Number of Measured Probes: 1
Runout Compensation: No
Shaft Rotation
CCW
CW
Phase
Lag
Lead
0 degree at
Y - Up
X - Right
Probe/Speed Description
Influence Coefficients: Calculated from Trials
Comment: Handbook of Rotordynamics, Example 3.8 pp 3.50
Comment: Introduction of Dynamics of Rotor-Bearing Systems, Page 403-406
Comment: Single plane balancing - Influence Coefficient Calculated by Trial
Balancing Holes
No. of Holes: 12
1st Hole Angle: 0
Numbering Direction: CCW CW
Weighting (Scale) Factors for probes and speeds
Condition
Speed
Description
Amplitude
Phase (deg)
1 Initial Readings 1 Probe: 1 3 270
2 Trial Run < 1 > --- Left-In Afterward 1.57 30
3 Response 1 Probe: 1 2 170
Probe
Factor
Speed
Factor
New
Open
Save
Save As
Run
What if...
Tools
Close

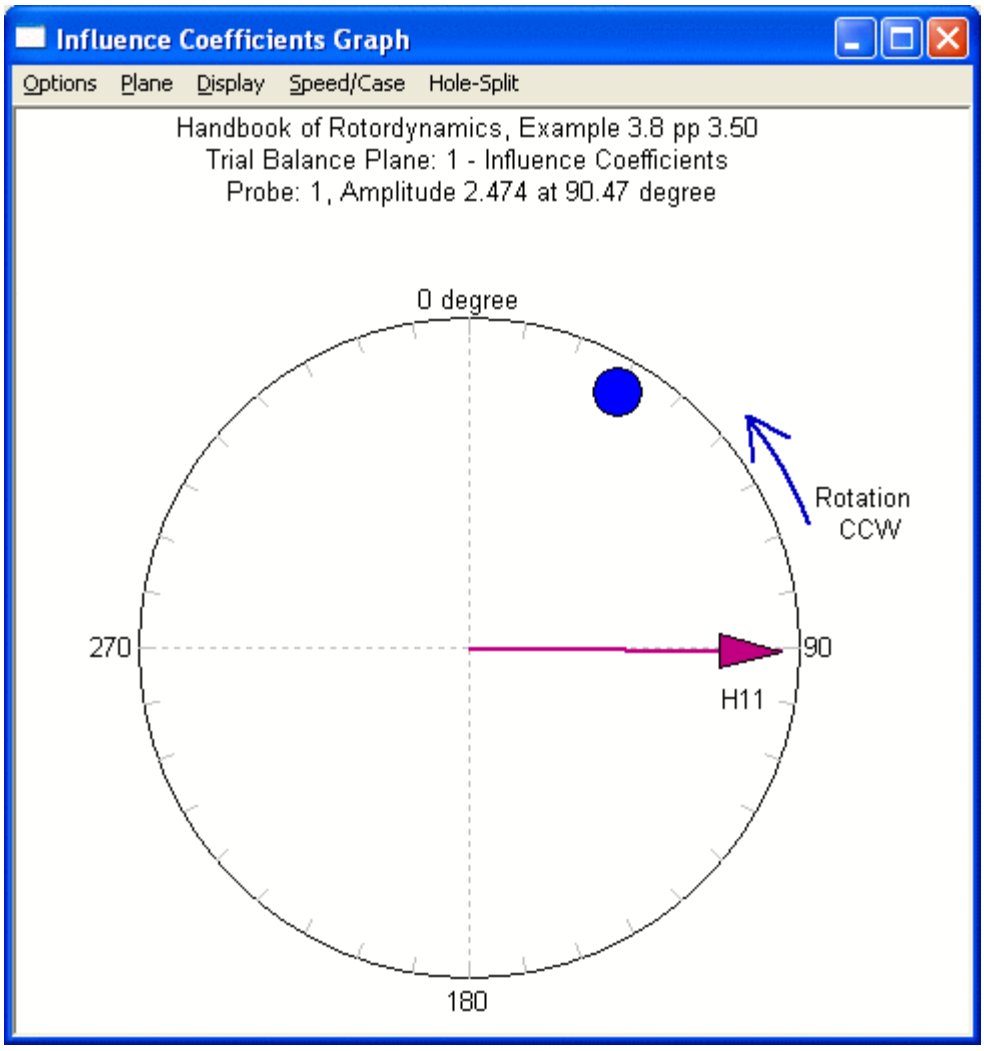

DyRoBeS-RotorBal: C:\RotorBal\Example\Ch_9_Example_1_Case_1.BAL
Number of Balancing Planes: 1
Number of Speeds/Cases: 1
Number of Measured Probes: 1
Runout Compensation: No
Shaft Rotation
CCW
CW
Phase
Lag
Lead
0 degree at
Y - Up
X - Right
Probe/Speed Description
nfluence Coefficients: Enter Data Below
Comment: Handbook of Rotordynamics, Example 3.8 pp 3.50
Comment: Introduction of Dynamics of Rotor-Bearing Systems, Page 403-406
Comment: Single plane balancing - Influence Coefficient Entered in Table
Balancing Holes
No. of Holes: 12
1st Hole Angle: 0
Numbering Direction: CCW CW
Weighting (Scale) Factors for probes and speeds
Condition
Speed
Description
Amplitude
Phase (deg)
1 Initial Readings 1 Probe: 1 3 270
2 iCoef. Plane: 1 1 Probe: 1 2.47375 90.4734
Probe
Factor
Speed
Factor
New
Open
Save
Save As
Run
What if...
Tools
Close

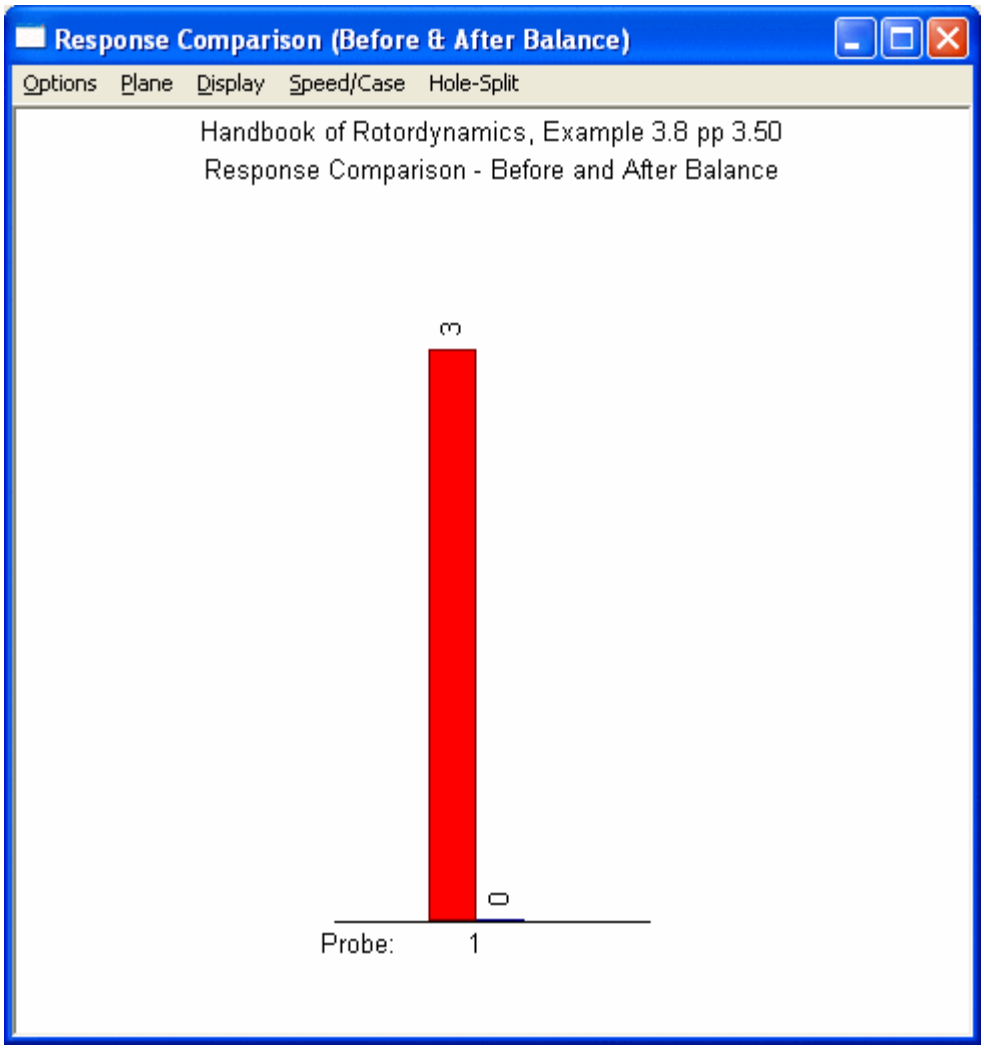


The calculated Balance Correction is shown below:

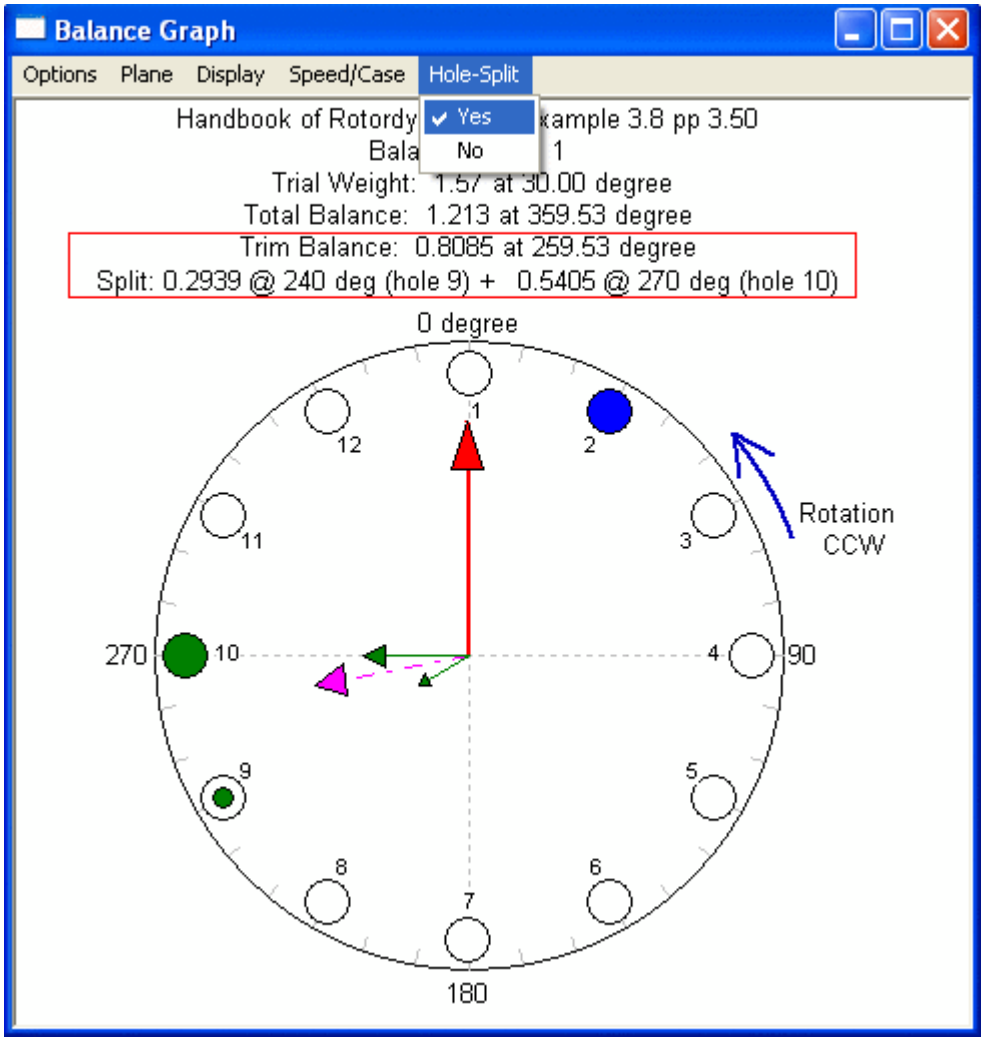


For this system, a Balance Correction 1.213 @ 359.53 degree will balance the rotor such that the response becomes zero. If the trial weight is left in the rotor after the trial run, a trim balance 0.8085 @ 259.53 degree will balance the rotor. The calculated influence coefficient and response before and after this balance are shown below:

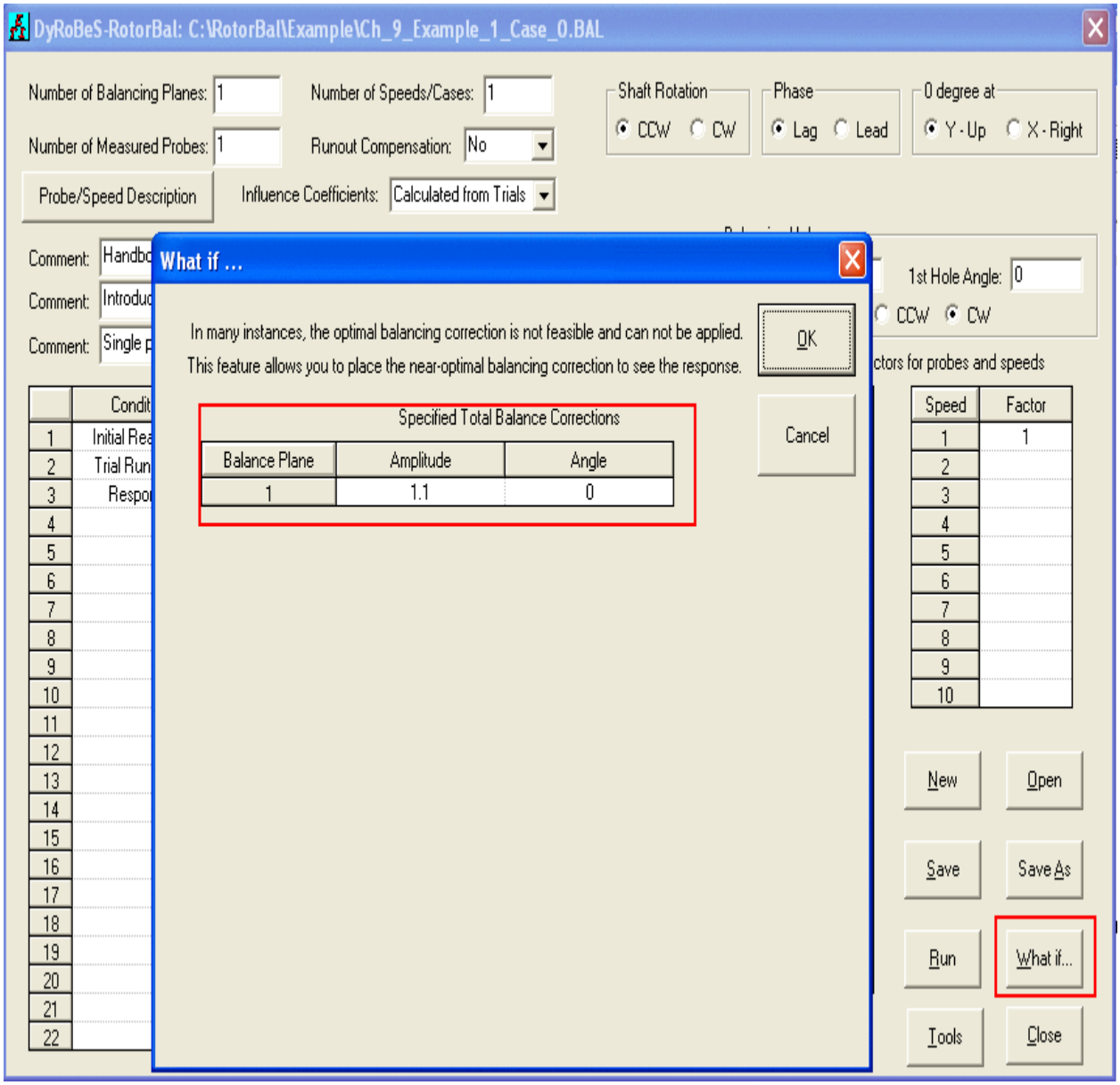

Influence Coefficients Graph
Options
Plane
Display
Speed/Case
Hole-Split
Handbook of Rotordynamics, Example 3.8 pp 3.50
Trial Balance Plane: 1 - Influence Coefficients
Probe: 1, Amplitude 2.474 at 90.47 degree
0 degree
Rotation
CCW
270
90
H11
180

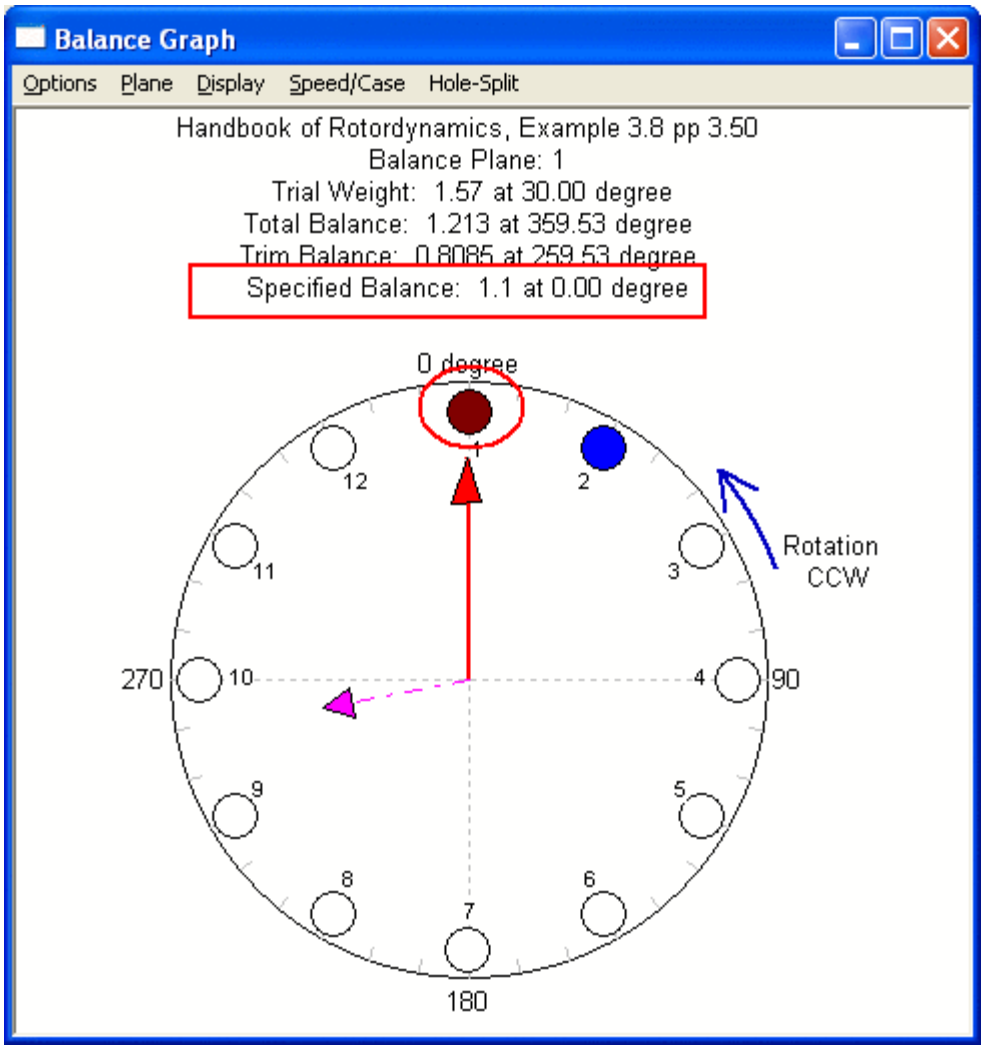


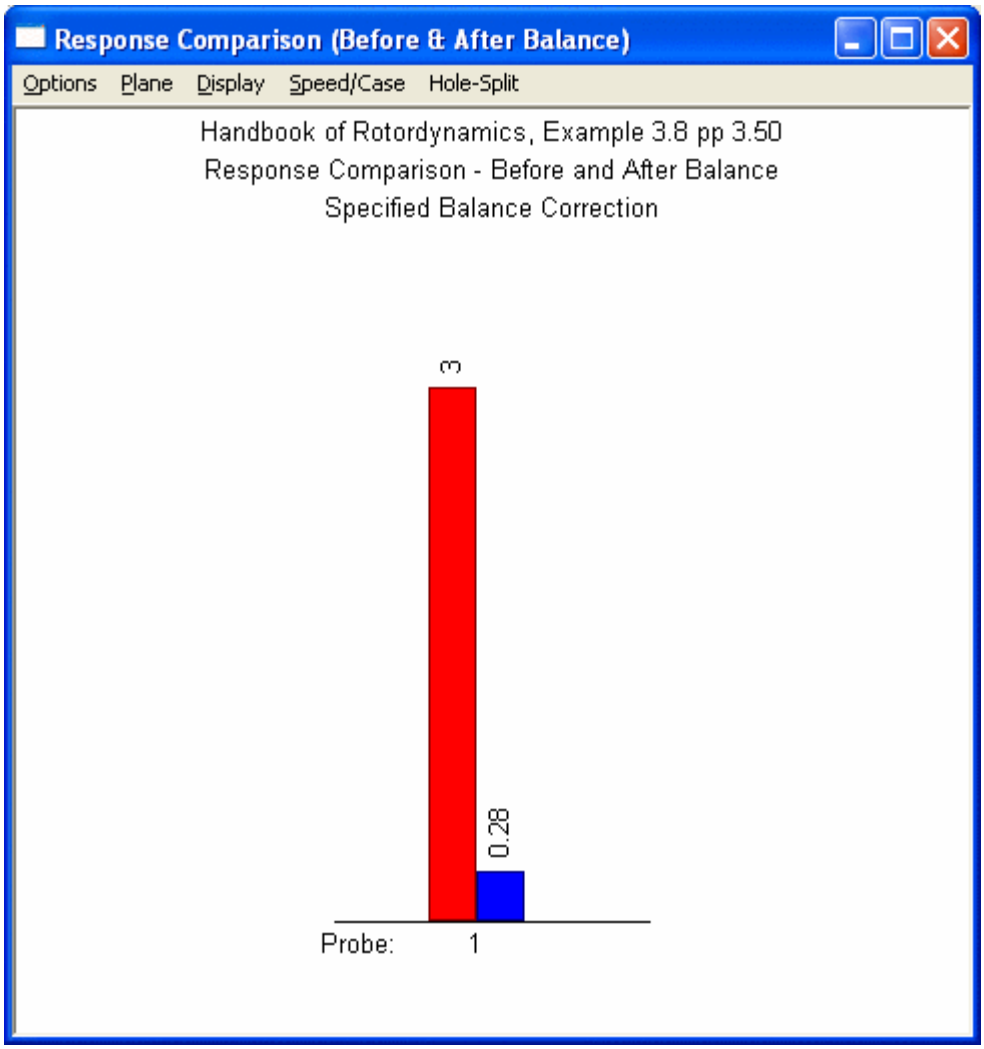
Since the balance hole is not located @ 259.53 degree, the trim balance can be split into two neighboring holes (holes #9 and 10). Two trim balances are calculated using the Hole-Split menu from the window menu.



What if the Total Balance Correction can only be 1.1 @ 0 degree instead of the required 1.213 @ 359.53 degree. The What If button serves this purpose. The response after balance is not zero anymore, it has a small value of 0.28 reduced from the initial response value of 3.


DyRoBeS-RotorBal: C:\RotorBal\Example\Ch_9_Example_1_Case_0.BAL
Number of Balancing Planes: 1
Number of Speeds/Cases: 1
Number of Measured Probes: 1
Runout Compensation: No
Probe/Speed Description
Influence Coefficients: Calculated from Trials
Shaft Rotation
CCW CW
Phase
Lag Lead
0 degree at
Y - Up X - Right
Comment: Handbo
Comment: Introduc
Comment: Single p
1st Hole Angle: 0
CCW CW
ctors for probes and speeds
Speed Factor
1 1
2
3
4
5
6
7
8
9
10
What if ...
In many instances, the optimal balancing correction is not feasible and can not be applied.
This feature allows you to place the near-optimal balancing correction to see the response.
OK
Cancel
Specified Total Balance Corrections
Balance Plane Amplitude Angle
1 1.1 0
New
Open
Save
Save As
Run
What if...
Tools
Close

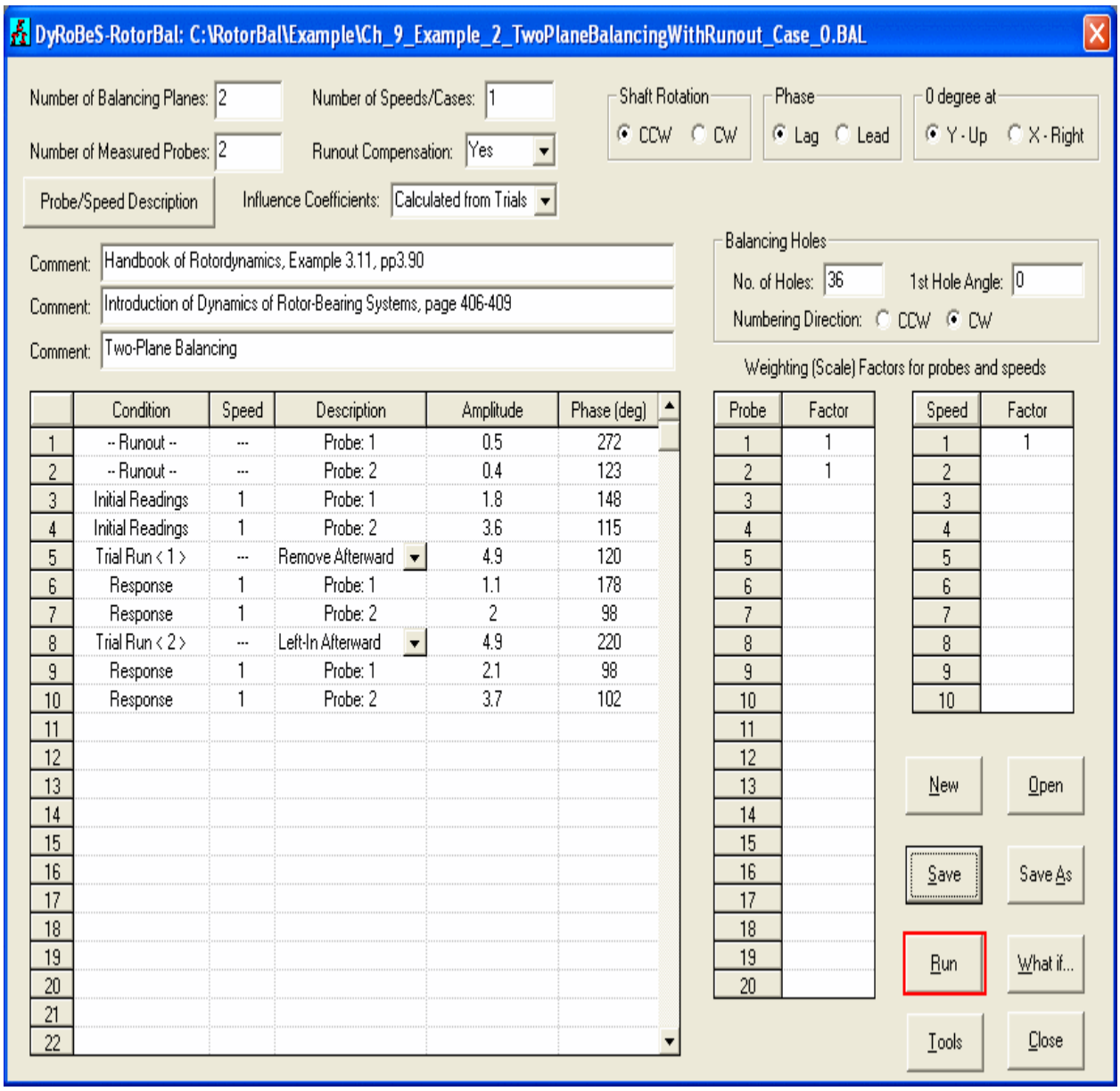

Balance Graph
Options
Plane
Display
Speed/Case
Hole-Split
Handbook of Rotordynamics, Example 3.8 pp 3.50
Balance Plane: 1
Trial Weight: 1.57 at 30.00 degree
Total Balance: 1.213 at 359.53 degree
Trim Balance: 0.8085 at 259.53 degree
Specified Balance: 1.1 at 0.00 degree
0 degree
1
2
3
4
5
6
7
8
9
10
11
12
90
180
270
Rotation
CCW



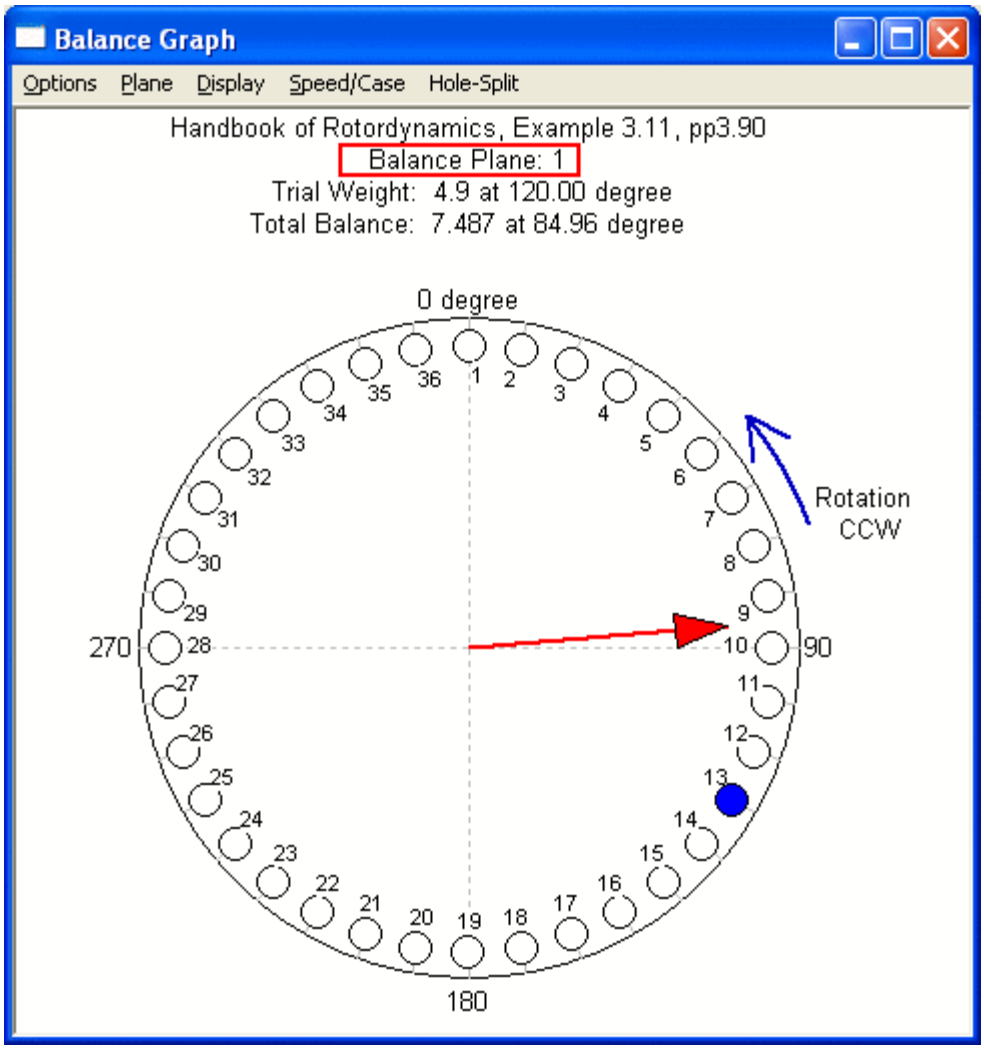

```
FileName: C:\RotorBal\Example\Ch_9_Example_1_Case_0.BAL

Handbook of Rotordynamics, Example 3.8 pp 3.50
Introduction of Dynamics of Rotor-Bearing Systems, Page 403-406
Single plane balancing - Influence Coefficient Calculated by Trial

*****  Number of Speeds or Cases   :   1
*****  Number of Balancing Planes  :   1
*****  Number of Measurement Probes:   1

*****  Influence Coefficients: Calculated by Trials

*****  NO Runout Compensation

======  Initial Response (Without Trails)  ======
   Speed    Probe      Amplitude     Phase Angle
     1        1          3.0000         270.00

**************  Trial Unbalance Run: 1  **************
   Plane      Amplitude     Phase Angle   Afterward
     1          1.5700         30.000      Left-In

---------  Response to Trial Unbalance  ---------
   Speed    Probe      Amplitude     Phase Angle
     1        1          2.0000         170.00

***  Weighting Factors for probes and speeds ***
     Probe  Description  Weighting Factor
```

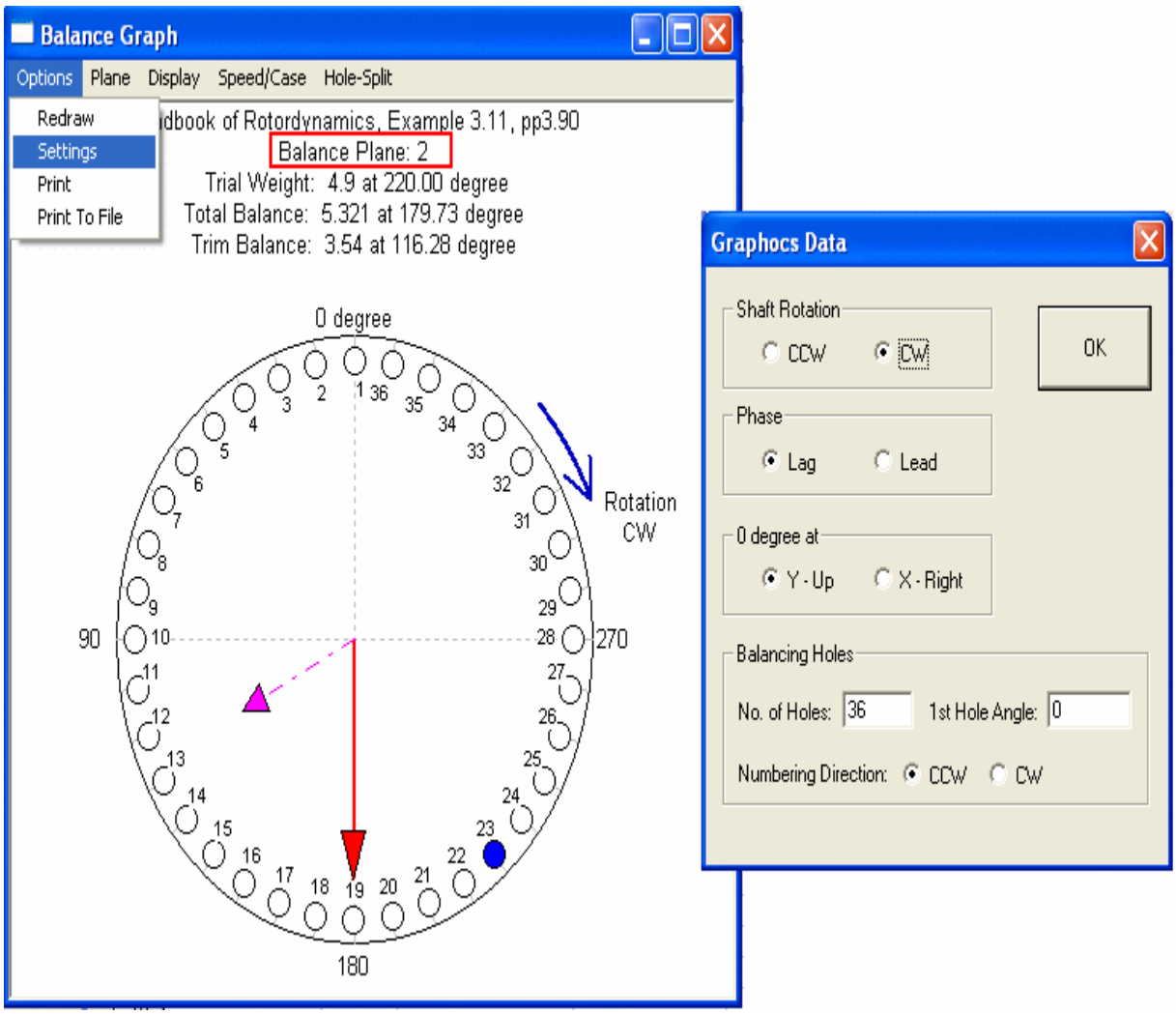
```
       1       1              1.0000

     Speed  Description  Weighting Factor
       1       1              1.0000

================================================
<<<<<<<<  Total Balance Correction  >>>>>>>>
  Correction Required to Balance the Rotor
   Plane No.    Amplitude     Phase Angle
      1          1.2127         359.53

<<<<<<<<<  Trim Balance Correction  >>>>>>>>>>
  Correction Required if Trial Weight Left-in
  Trim Balance = Total Balance - Trial Weight
   Plane No.    Amplitude     Phase Angle
      1         0.80849         259.53

------------------------------------------------
<<<<<<<  Specified Balance Correction  >>>>>>>
 Correction Specified to Balance the Rotor
   Plane No.    Amplitude     Phase Angle
      1          1.1000         0.0000
================================================
________________________________________________

**********  The Influence Coefficients  **********
                              Influence Coef.
  Trial-Run  Speed  Probe   Amplitude     Phase
      1        1      1      2.4737       90.47
________________________________________________

================  Predicted Residual Response (Without Runout) =================
                     ----- Before (Initial) -----  ----- After Balancing -----
   Speed   Probe      Amplitude      Phase Angle    Amplitude     Phase Angle
     1       1          3.0000         270.00        0.27987       265.39
=============================================================================
=============================================================================
```

Example 2 – Two-Plane Balance with Runout

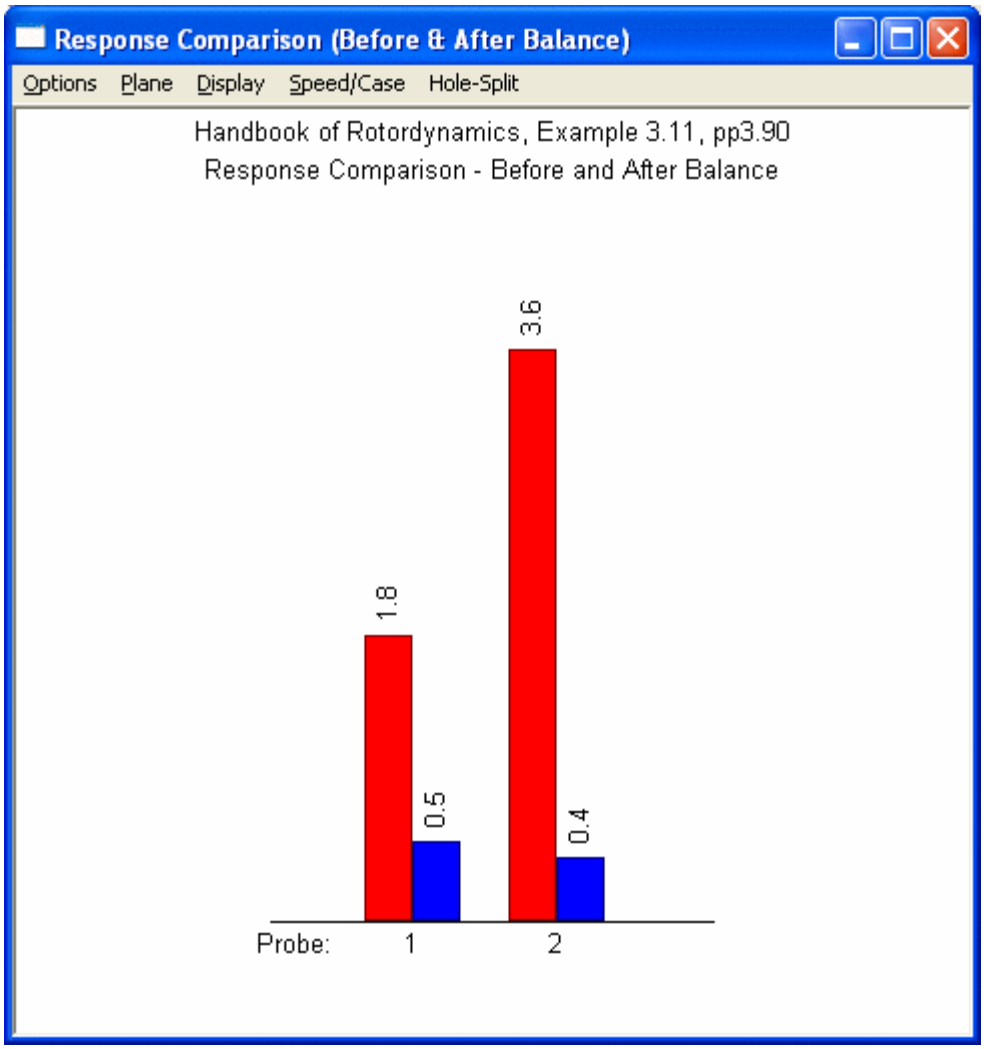


Note that the calculated balance corrections for both planes are shown below. Since the balance plane 2 is accessed from other side of the machine. Therefore, the rotation for the graphic presentation is CCW for plane 1 and CW for plane 2.


Balance Graph
Options
Plane
Display
Speed/Case
Hole-Split
Handbook of Rotordynamics, Example 3.11, pp3.90
Balance Plane: 1
Trial Weight: 4.9 at 120.00 degree
Total Balance: 7.487 at 84.96 degree
0 degree
90
180
270
Rotation
CCW
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36



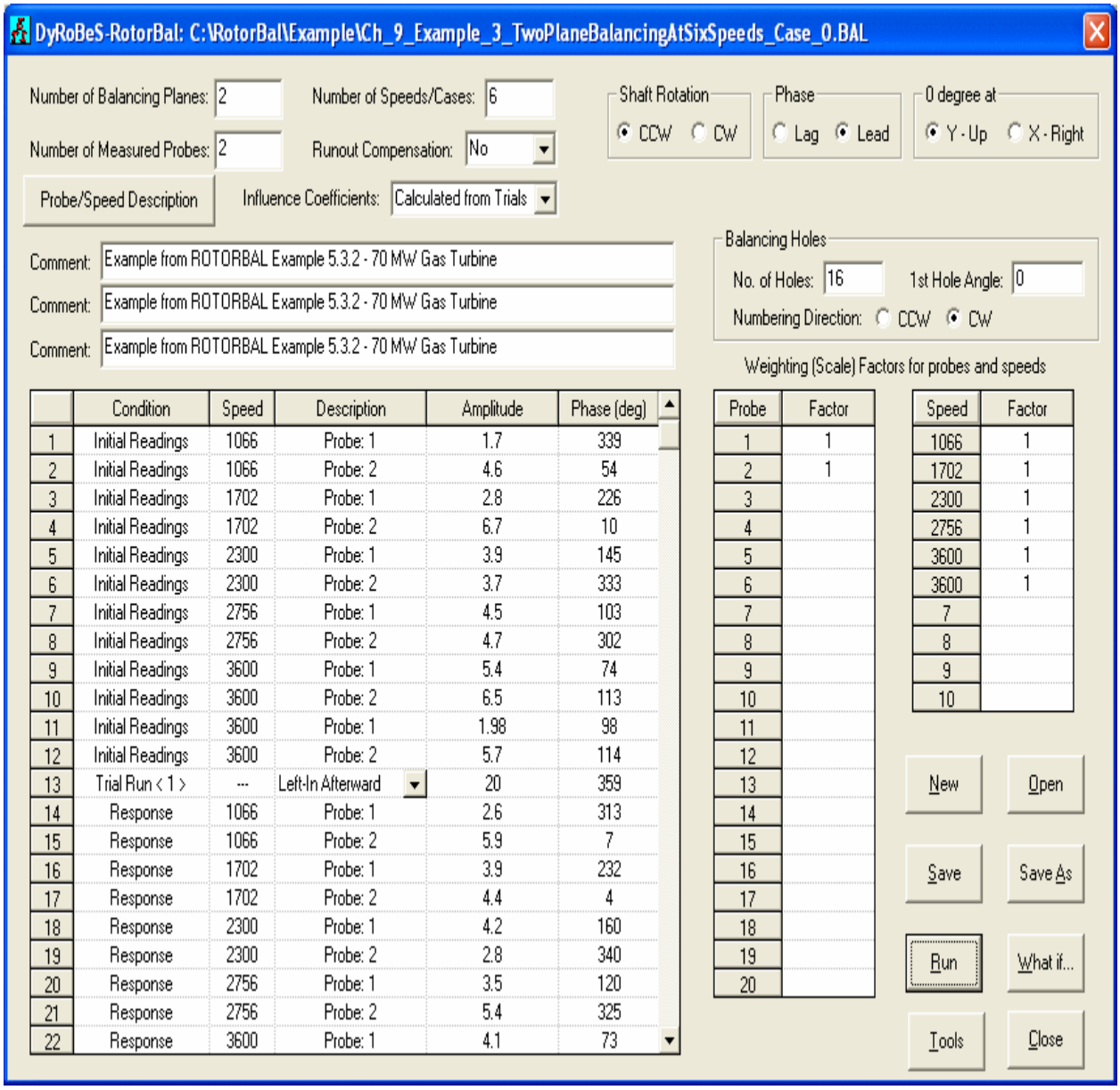
The response before and after balance is shown below. Note that the balance will only eliminate the response caused by the unbalance, not the runout. Therefore, after balance, the residual response will be the runout specified in the input.




```
FileName: C:\RotorBal\Example\Ch_9_Example_2_TwoPlaneBalancingWithRunout_Case_0.BAL

Handbook of Rotordynamics, Example 3.11, pp3.90
Introduction of Dynamics of Rotor-Bearing Systems, page 406-409
Two-Plane Balancing

*****  Number of Speeds or Cases   :   1
*****  Number of Balancing Planes  :   2
*****  Number of Measurement Probes:   2

*****  Influence Coefficients: Calculated by Trials

*****  Runout (slow-roll vectors)  *****
   Probe      Amplitude     Phase Angle
     1         0.50000         272.00
     2         0.40000         123.00

======  Initial Response (Without Trails)  ======
   Speed   Probe      Amplitude     Phase Angle
     1       1          1.8000         148.00
     1       2          3.6000         115.00

**************  Trial Unbalance Run: 1  **************
   Plane      Amplitude     Phase Angle   Afterward
     1          4.9000         120.00      Remove

---------  Response to Trial Unbalance  ---------
   Speed   Probe      Amplitude     Phase Angle
```

```
     1       1          1.1000         178.00
     1       2          2.0000         98.000

**************  Trial Unbalance Run: 2  **************
   Plane      Amplitude     Phase Angle   Afterward
     2          4.9000         220.00      Left-In

---------  Response to Trial Unbalance  ---------
   Speed   Probe      Amplitude     Phase Angle
     1       1          2.1000         98.000
     1       2          3.7000         102.00

***  Weighting Factors for probes and speeds ***
     Probe  Description  Weighting Factor
       1       1              1.0000
       2       2              1.0000

     Speed  Description  Weighting Factor
       1       1              1.0000

================================================
<<<<<<<<  Total Balance Correction  >>>>>>>>
  Correction Required to Balance the Rotor
   Plane No.    Amplitude     Phase Angle
      1          7.4873         84.957
      2          5.3209         179.73


<<<<<<<<<  Trim Balance Correction  >>>>>>>>>>
  Correction Required if Trial Weight Left-in
  Trim Balance = Total Balance - Trial Weight
   Plane No.    Amplitude     Phase Angle
      2          3.5402         116.28
================================================
________________________________________________

**********  The Influence Coefficients  ***********
                              Influence Coef.
  Trial-Run  Speed  Probe   Amplitude     Phase
      1        1      1     0.20617      175.01
      1        1      2     0.36446      194.11
      2        1      1     0.34092      182.37
      2        1      2     0.16986      165.36
________________________________________________

================  Predicted Residual Response (Without Runout) =================
                     ----- Before (Initial) -----  ----- After Balancing -----
   Speed   Probe      Amplitude      Phase Angle    Amplitude     Phase Angle
     1       1          2.1205         136.73         0.0000        0.0000
     1       2          3.2044         114.00         0.0000        0.0000
================================================================================
================================================================================

================  Predicted Residual Response (Include Runout) =================
                     ----- Before (Initial) -----  ----- After Balancing -----
   Speed   Probe      Amplitude      Phase Angle    Amplitude     Phase Angle
     1       1          1.8000         148.00         0.50000       272.00
     1       2          3.6000         115.00         0.40000       123.00
================================================================================
================================================================================
```

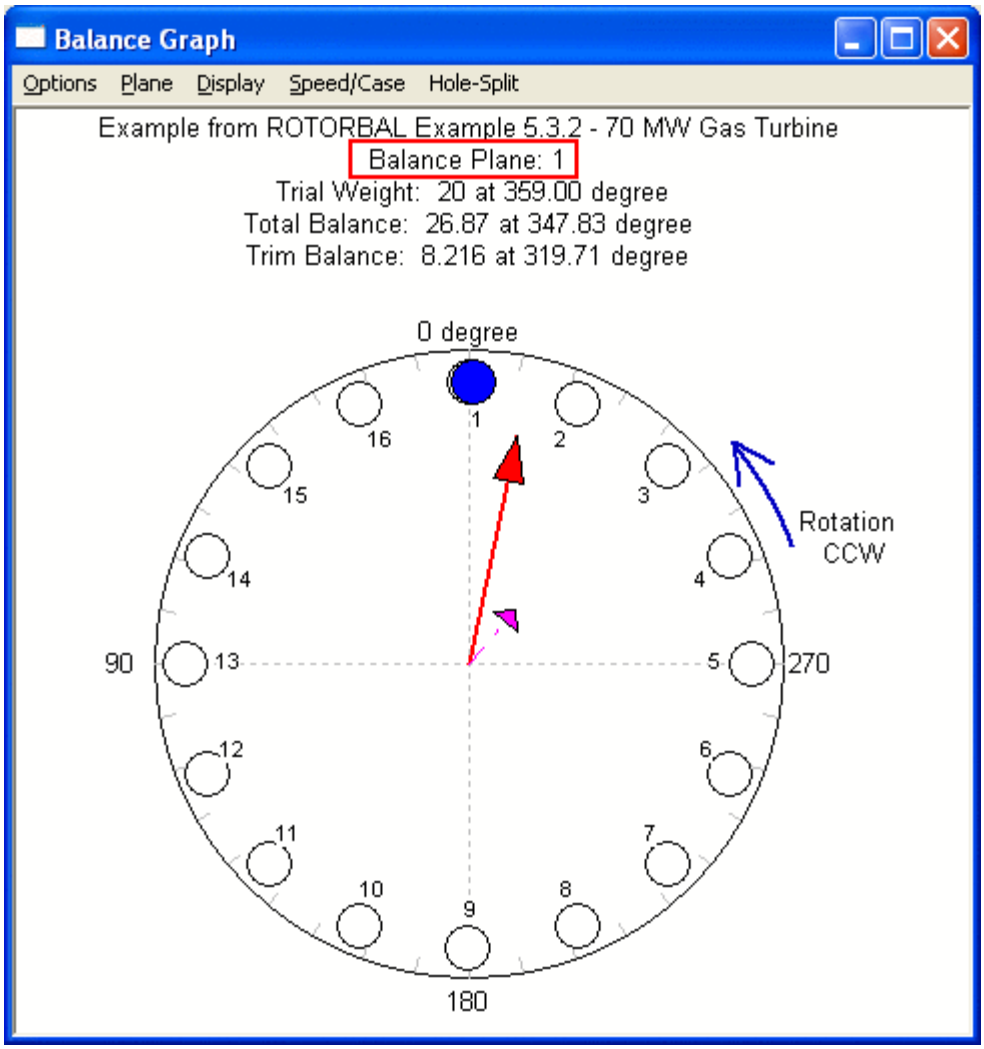
Example 3 – Two-Plane Balance at Six Speeds

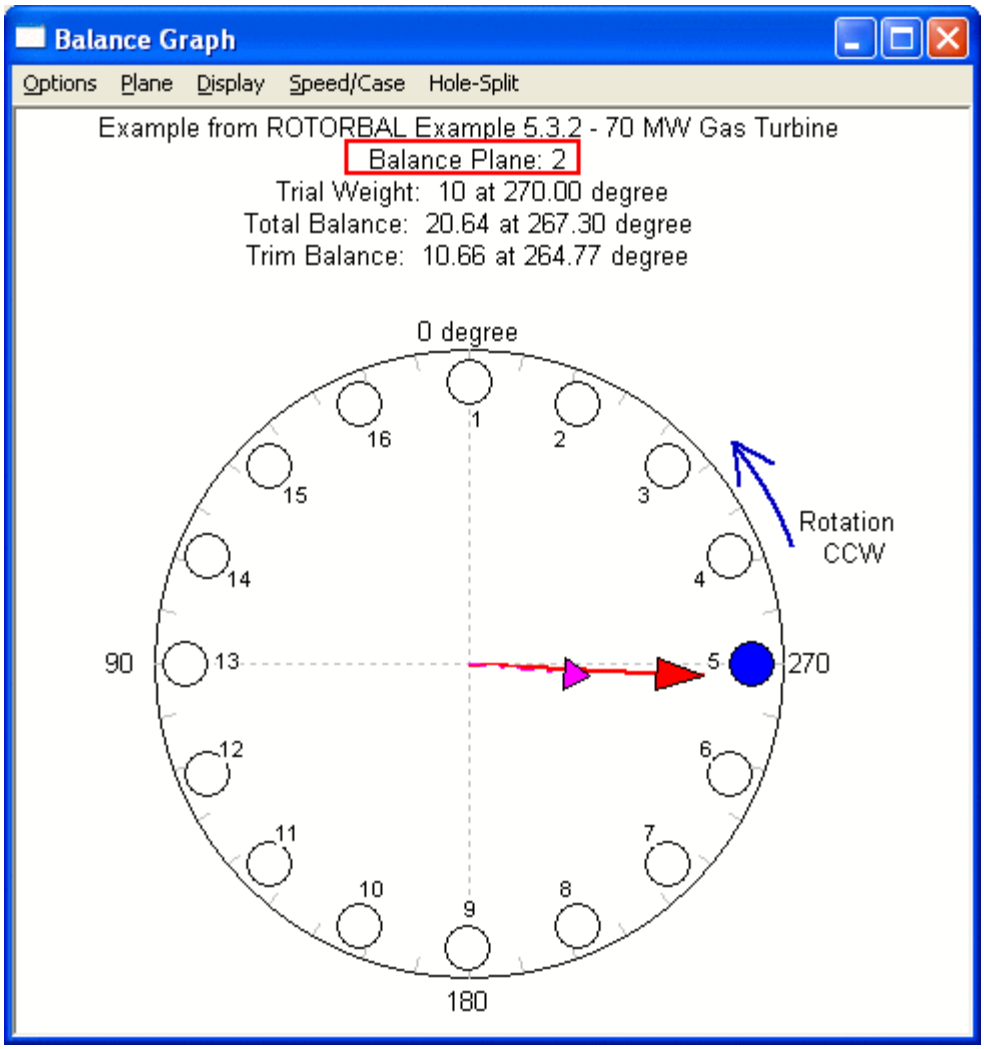


	Condition	Speed	Description	Amplitude	Phase (deg)
1	Initial Readings	1066	Probe: 1	1.7	339
2	Initial Readings	1066	Probe: 2	4.6	54
3	Initial Readings	1702	Probe: 1	2.8	226
4	Initial Readings	1702	Probe: 2	6.7	10
5	Initial Readings	2300	Probe: 1	3.9	145
6	Initial Readings	2300	Probe: 2	3.7	333
7	Initial Readings	2756	Probe: 1	4.5	103
8	Initial Readings	2756	Probe: 2	4.7	302
9	Initial Readings	3600	Probe: 1	5.4	74
10	Initial Readings	3600	Probe: 2	6.5	113
11	Initial Readings	3600	Probe: 1	1.98	98
12	Initial Readings	3600	Probe: 2	5.7	114
13	Trial Run < 1 >	---	Left-In Afterward	20	359
14	Response	1066	Probe: 1	2.6	313
15	Response	1066	Probe: 2	5.9	7
16	Response	1702	Probe: 1	3.9	232
17	Response	1702	Probe: 2	4.4	4
18	Response	2300	Probe: 1	4.2	160
19	Response	2300	Probe: 2	2.8	340
20	Response	2756	Probe: 1	3.5	120
21	Response	2756	Probe: 2	5.4	325
22	Response	3600	Probe: 1	4.1	73

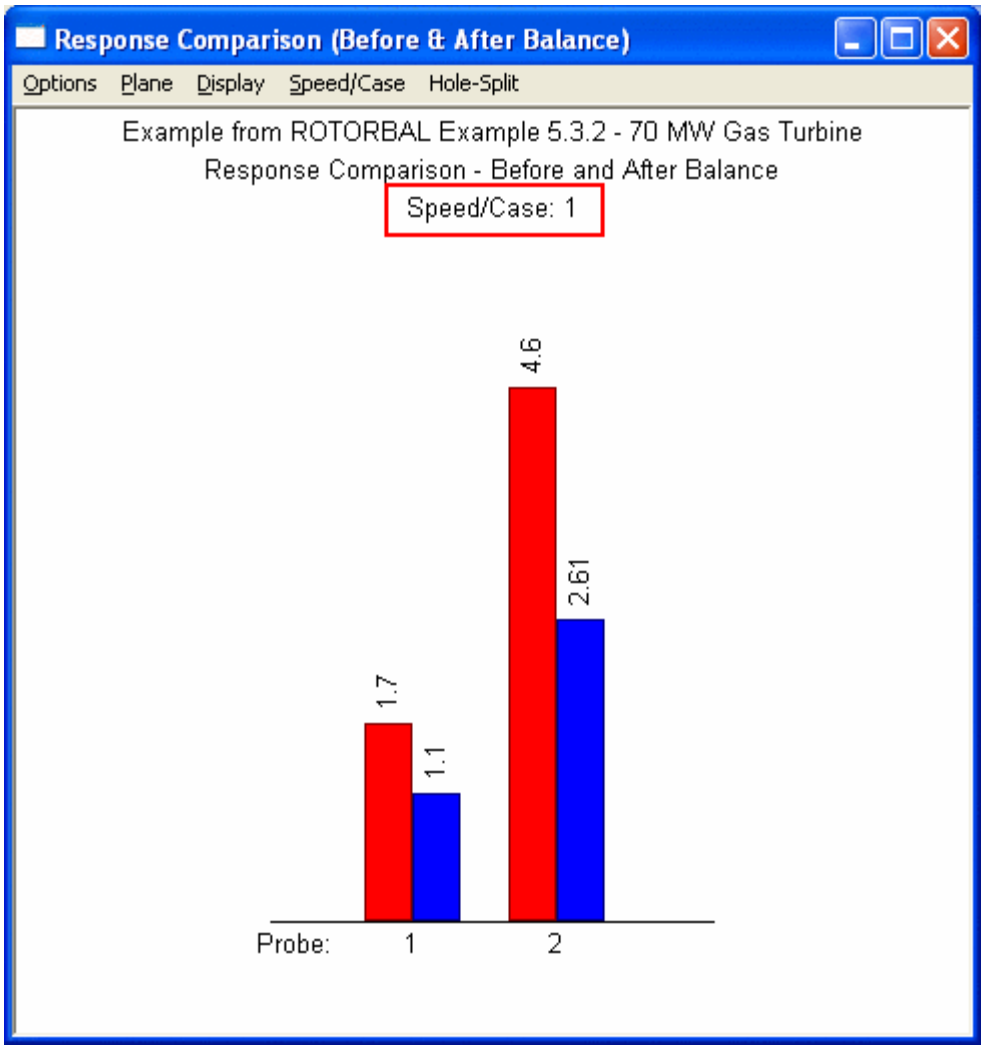
Probe	Factor
1	1
2	1
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
20	

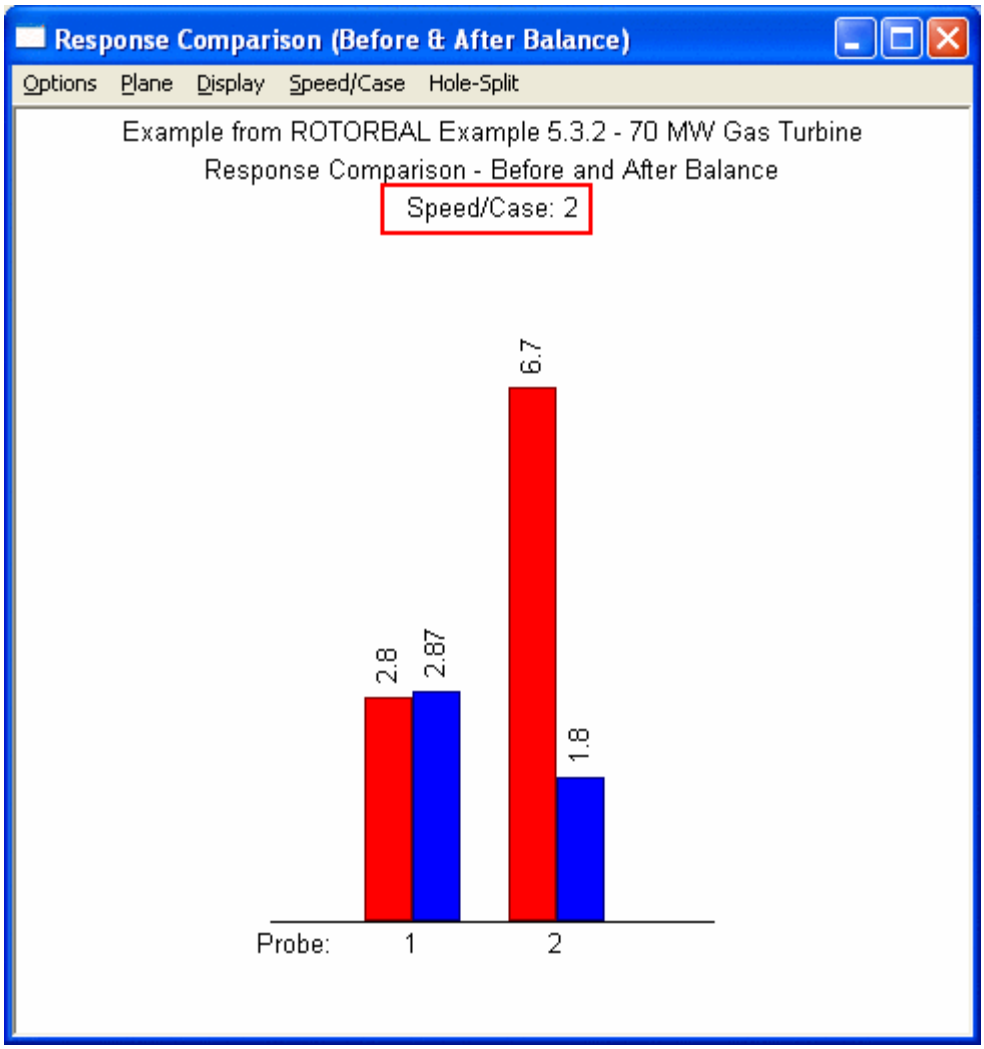
Speed	Factor
1066	1
1702	1
2300	1
2756	1
3600	1
3600	1
7	
8	
9	
10	

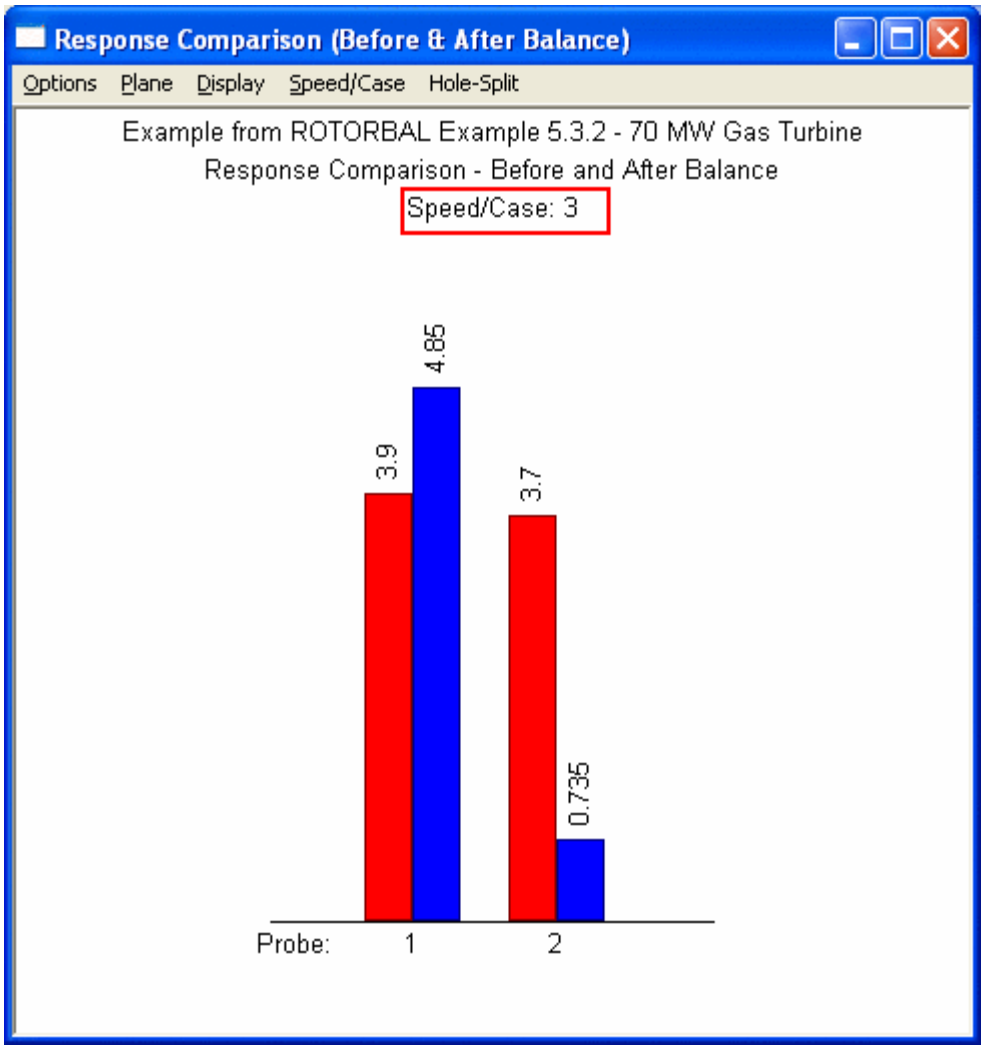

Balance Graph
Options
Plane
Display
Speed/Case
Hole-Split
Example from ROTORBAL Example 5.3.2 - 70 MW Gas Turbine
Balance Plane: 1
Trial Weight: 20 at 359.00 degree
Total Balance: 26.87 at 347.83 degree
Trim Balance: 8.216 at 319.71 degree
0 degree
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
90
180
270
Rotation
CCW

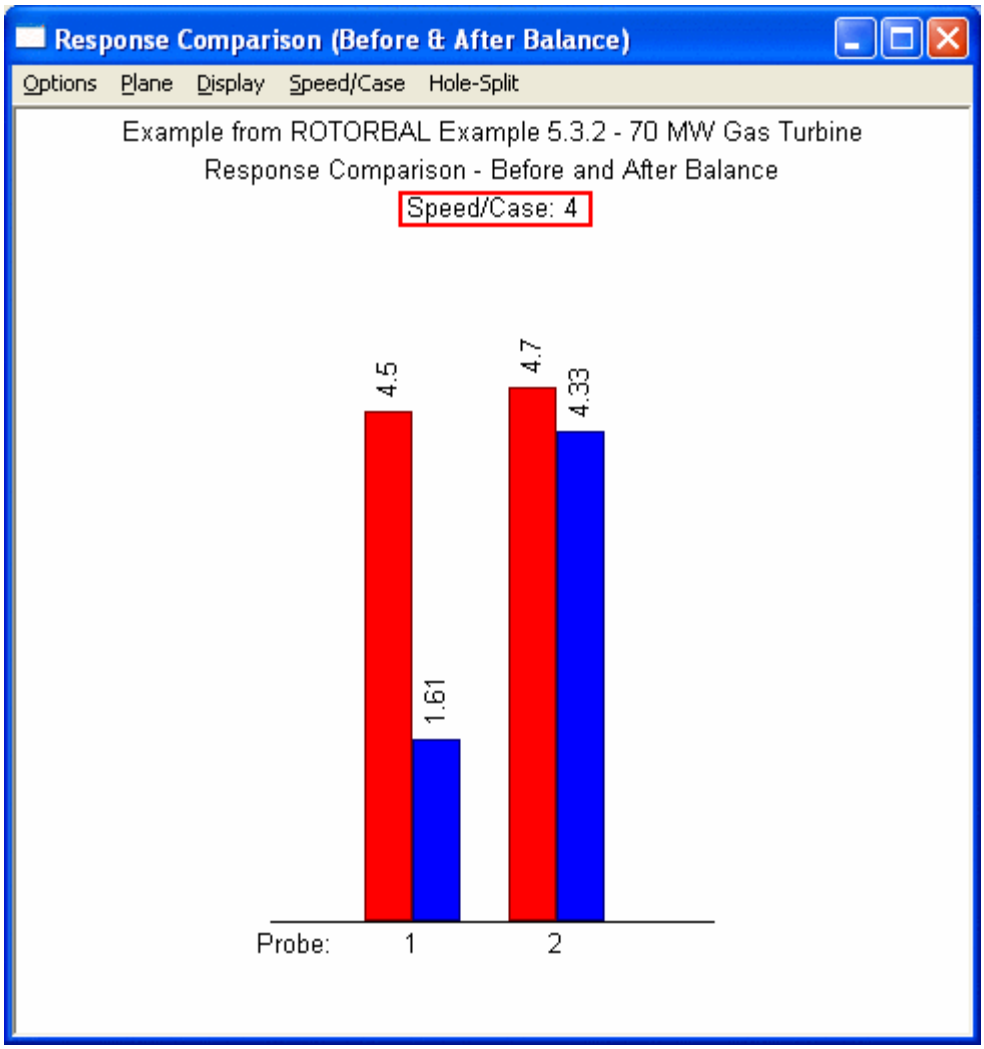


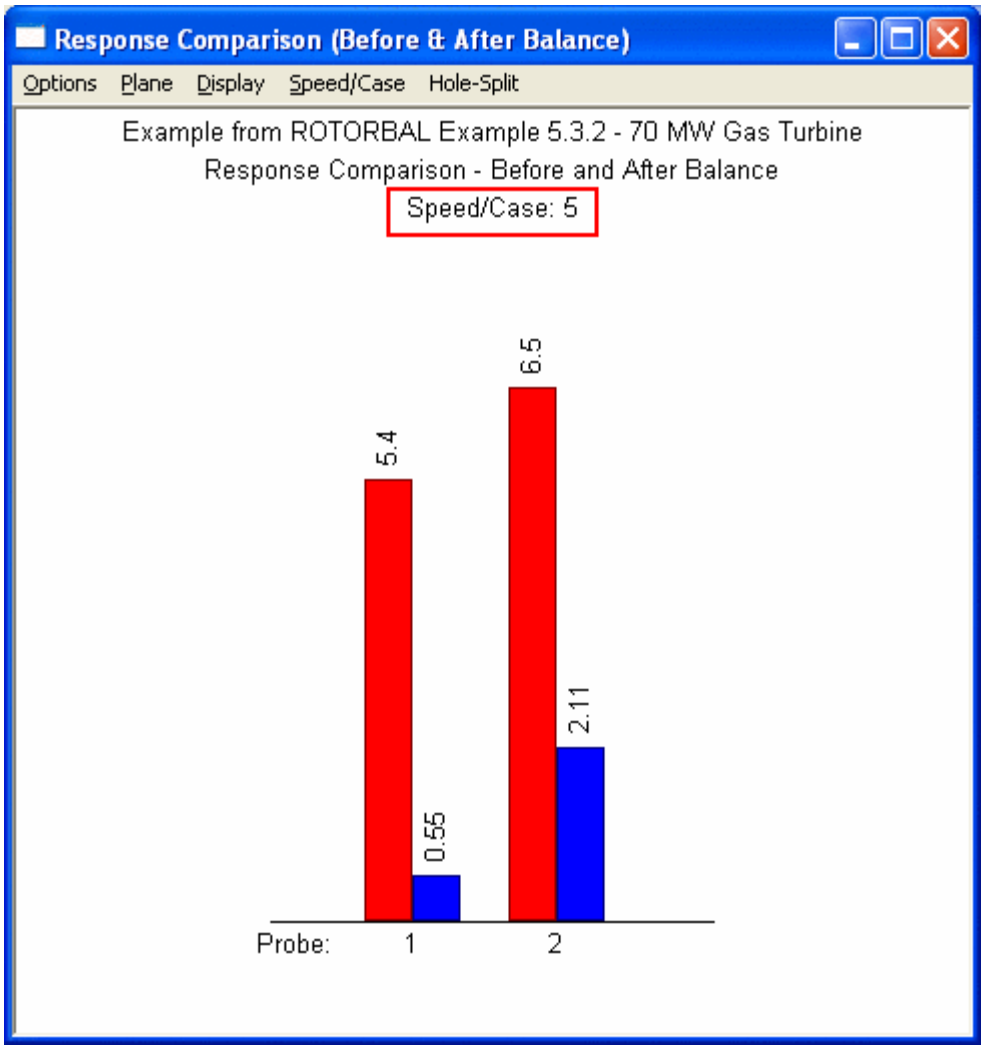
The response comparison (before and after balance) at all 6 speeds/cases are shown below:

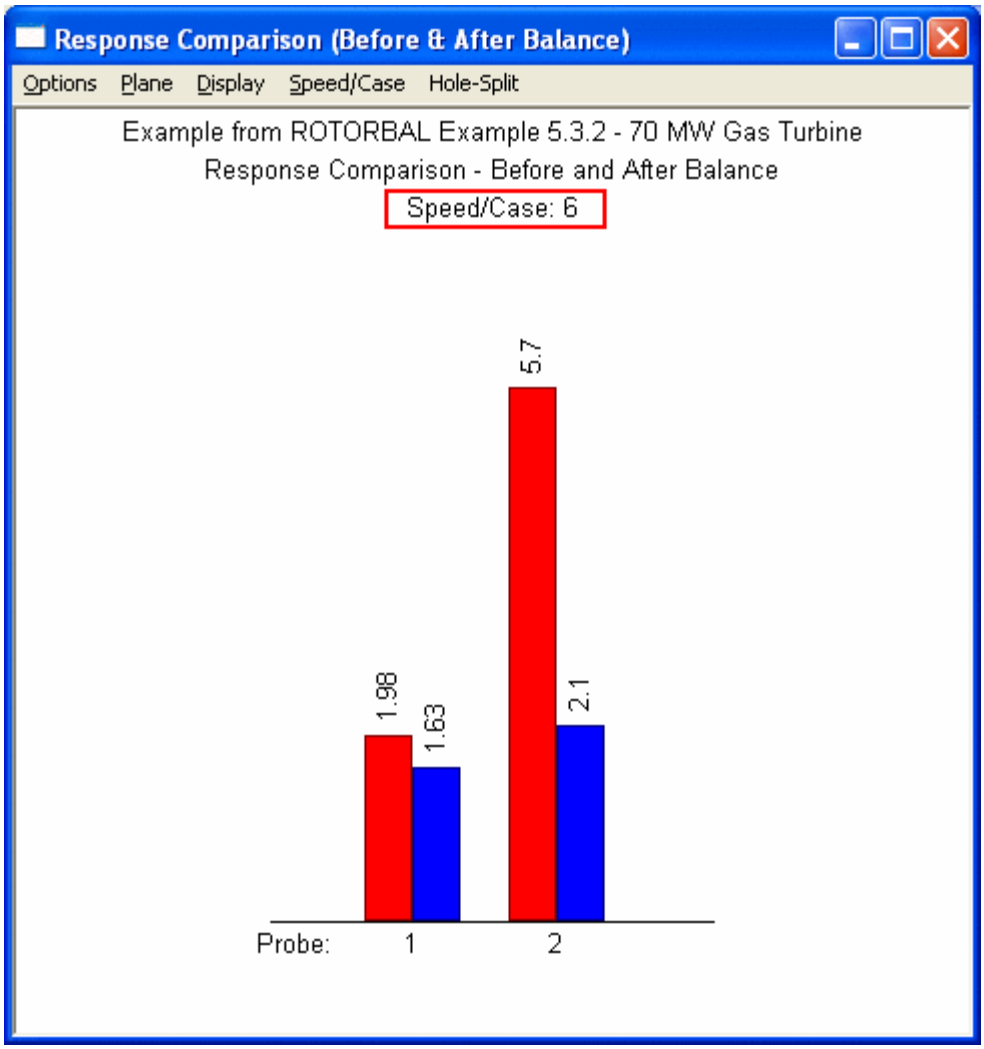

Response Comparison (Before & After Balance)
Options
Plane
Display
Speed/Case
Hole-Split
Example from ROTORBAL Example 5.3.2 - 70 MW Gas Turbine
Response Comparison - Before and After Balance
Speed/Case: 1
1.7
1.1
4.6
2.61
Probe:
1
2


Response Comparison (Before & After Balance)
Options
Plane
Display
Speed/Case
Hole-Split
Example from ROTORBAL Example 5.3.2 - 70 MW Gas Turbine
Response Comparison - Before and After Balance
Speed/Case: 2
6.7
2.8
2.87
1.8
Probe:
1
2


Response Comparison (Before & After Balance)
Options
Plane
Display
Speed/Case
Hole-Split
Example from ROTORBAL Example 5.3.2 - 70 MW Gas Turbine
Response Comparison - Before and After Balance
Speed/Case: 3
3.9
4.85
3.7
0.735
Probe:
1
2


Response Comparison (Before & After Balance)
Options
Plane
Display
Speed/Case
Hole-Split
Example from ROTORBAL Example 5.3.2 - 70 MW Gas Turbine
Response Comparison - Before and After Balance
Speed/Case: 4
4.5
1.61
4.7
4.33
Probe:
1
2


Response Comparison (Before & After Balance)
Options
Plane
Display
Speed/Case
Hole-Split
Example from ROTORBAL Example 5.3.2 - 70 MW Gas Turbine
Response Comparison - Before and After Balance
Speed/Case: 5
5.4
0.55
6.5
2.11
Probe:
1
2



Note that although the overall response is decreased. But at speed point #2 (1702 rpm) and speed point #3 (2300 rpm), the response at the measurement probe 1 is slightly higher than the initial response. If this response increase is not acceptable, then weighting factors at speed 2 and 3 can be increased. However, by doing so, the response at other speeds can be reverse. Caution must be taken when balance the rotor with multiple planes and multiple speeds.

```
FileName: C:\RotorBal\Example\Ch_9_Example_3_TwoPlaneBalancingAtSixSpeeds_Case_0.BAL

Example from ROTORBAL Example 5.3.2 - 70 MW Gas Turbine
Example from ROTORBAL Example 5.3.2 - 70 MW Gas Turbine
Example from ROTORBAL Example 5.3.2 - 70 MW Gas Turbine

*****  Number of Speeds or Cases   :   6
*****  Number of Balancing Planes  :   2
*****  Number of Measurement Probes:   2

*****  Influence Coefficients: Calculated by Trials

*****  NO Runout Compensation

======  Initial Response (Without Trails)  ======
   Speed    Probe      Amplitude     Phase Angle
     1        1          1.7000         339.00
     1        2          4.6000         54.000
     2        1          2.8000         226.00
     2        2          6.7000         10.000
```

```
     3       1          3.9000         145.00
     3       2          3.7000         333.00
     4       1          4.5000         103.00
     4       2          4.7000         302.00
     5       1          5.4000         74.000
     5       2          6.5000         113.00
     6       1          1.9800         98.000
     6       2          5.7000         114.00

**************  Trial Unbalance Run: 1  **************
   Plane      Amplitude     Phase Angle   Afterward
     1          20.000         359.00      Left-In

---------  Response to Trial Unbalance  ---------
   Speed   Probe      Amplitude     Phase Angle
     1       1          2.6000         313.00
     1       2          5.9000         7.0000
     2       1          3.9000         232.00
     2       2          4.4000         4.0000
     3       1          4.2000         160.00
     3       2          2.8000         340.00
     4       1          3.5000         120.00
     4       2          5.4000         325.00
     5       1          4.1000         73.000
     5       2          3.7000         97.000
     6       1          1.5000         141.00
     6       2          3.1000         99.000

**************  Trial Unbalance Run: 2  **************
   Plane      Amplitude     Phase Angle   Afterward
     2          10.000         270.00      Left-In

---------  Response to Trial Unbalance  ---------
   Speed   Probe      Amplitude     Phase Angle
     1       1          1.8000         319.00
     1       2          4.3000         15.000
     2       1          3.1000         244.00
     2       2          3.4000         9.0000
     3       1          3.2000         107.00
     3       2          1.9000         329.00
     4       1          2.4000         122.00
     4       2          4.4000         330.00
     5       1          2.4000         61.000
     5       2          3.5000         101.00
     6       1          1.0200         170.00
     6       2          3.1100         104.00

***  Weighting Factors for probes and speeds ***
     Probe  Description  Weighting Factor
       1       1              1.0000
       2       2              1.0000

     Speed  Description  Weighting Factor
       1       1066           1.0000
       2       1702           1.0000
       3       2300           1.0000
       4       2756           1.0000
       5       3600           1.0000
       6       3600           1.0000

==================================================
<<<<<<<<  Total Balance Correction  >>>>>>>>
  Correction Required to Balance the Rotor
   Plane No.    Amplitude     Phase Angle
      1          26.867         347.83
      2          20.639         267.30


<<<<<<<<<  Trim Balance Correction  >>>>>>>>>>
  Correction Required if Trial Weight Left-in
  Trim Balance = Total Balance - Trial Weight
   Plane No.    Amplitude     Phase Angle
      1          8.2159         319.71
      2          10.660         264.77
==================================================
```

********** The Influence Coefficients **********

Trial-Run	Speed	Probe	Influence Coef. Amplitude	Phase
1	1	1	0.65281E-01	279.20
1	1	2	0.21766	317.39
1	2	1	0.57655E-01	247.70
1	2	2	0.11846	202.19
1	3	1	0.54915E-01	227.79
1	3	2	0.49103E-01	133.67
1	4	1	0.77078E-01	242.41
1	4	2	0.10636	25.69
1	5	1	0.65130E-01	258.15
1	5	2	0.15575	313.11
1	6	1	0.67568E-01	229.80
1	6	2	0.14110	311.52
2	1	1	0.83143E-01	209.92
2	1	2	0.17475	256.97
2	2	1	0.10809	105.40
2	2	2	0.10554	257.69
2	3	1	0.34210	118.33
2	3	2	0.10027	271.20
2	4	1	0.11046	25.65
2	4	2	0.10867	214.34
2	5	1	0.18221	358.89
2	5	2	0.32108E-01	317.50
2	6	1	0.78362E-01	11.87
2	6	2	0.27106E-01	279.39

========== Predicted Residual Response (Without Runout) ==========

Speed	Probe	Before (Initial) Amplitude	Before (Initial) Phase Angle	After Balancing Amplitude	After Balancing Phase Angle
1	1	1.7000	339.00	1.0968	310.43
1	2	4.6000	54.000	2.6067	358.29
2	1	2.8000	226.00	2.8744	257.03
2	2	6.7000	10.000	1.7963	40.778
3	1	3.9000	145.00	4.8509	66.019
3	2	3.7000	333.00	0.73525	317.09
4	1	4.5000	103.00	1.6051	154.41
4	2	4.7000	302.00	4.3282	341.01
5	1	5.4000	74.000	0.55031	343.11
5	2	6.5000	113.00	2.1098	114.00
6	1	1.9800	98.000	1.6347	207.09
6	2	5.7000	114.00	2.0997	118.93