FOCUS6

Integrated Modular Wind Turbine Design Tool

R.R.H. Brood

R. Numan

M.J. De Ruiter

G.D. De Winkel

Knowledge Centre WMC

Wind turbine Materials and Constructions

© Knowledge Center WMC, 2010

What is FOCUS6

- FOCUS6 is an advanced ‘suite’ to design wind turbines and blades
- A set of application modules integrated via a graphical user interface
- Each module has specific functionality eg. ‘Parse blade model’, ‘Generate Load Sets’
- Modules ‘optionally’ purchaseable

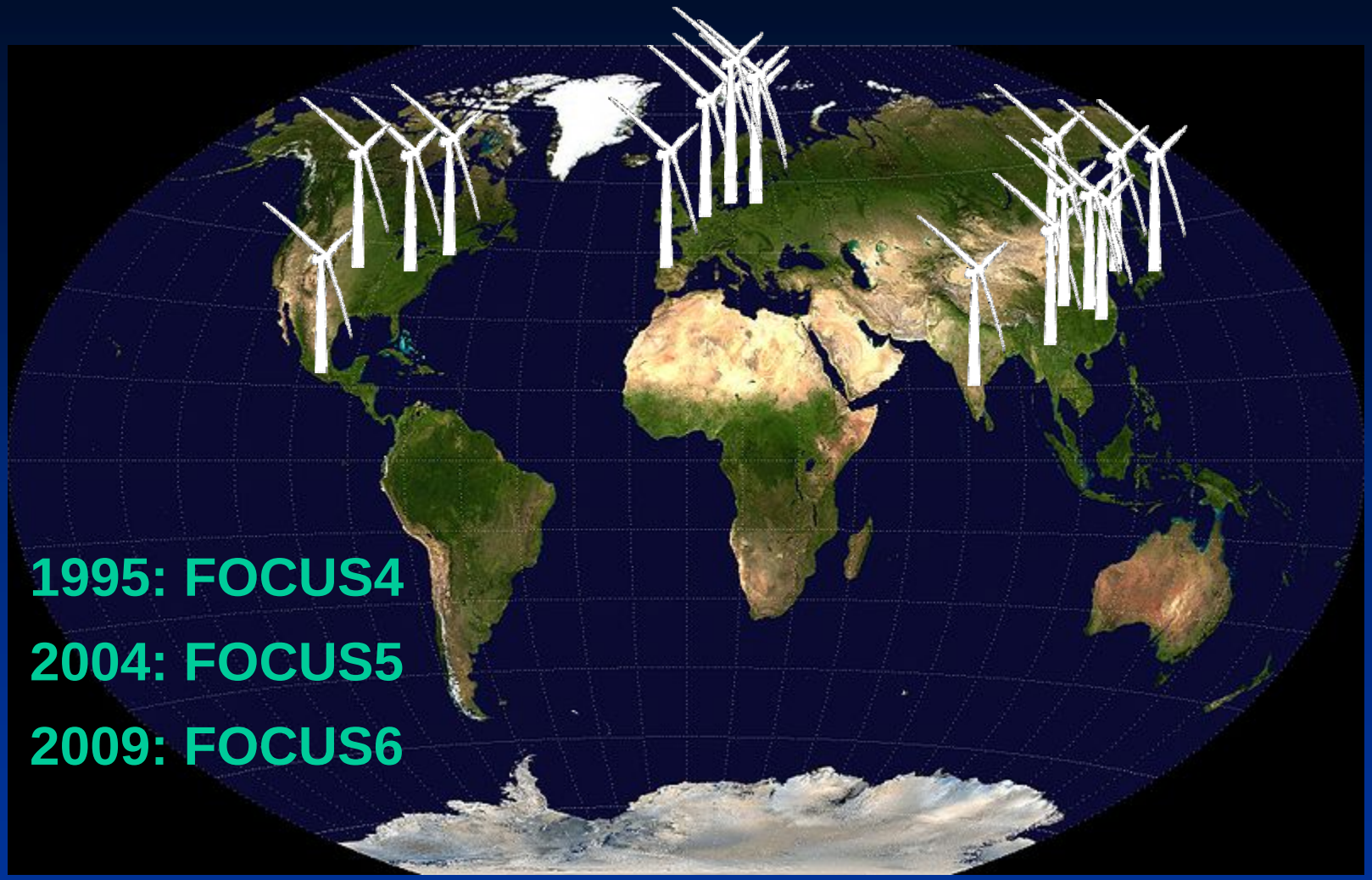
FOCUS6 Modules

- Rotor Pre-Design
- Wind Turbine Design
- Structural Blade Modeller (3d)
- Design Optimization
- Wave Loads (Offshore)
- 3e Party Module Integration Tool
- Blade Design FEM (Q3 2010)
- Report Generator

FOCUS6 Upcoming Modules

- CAD/CAx Blade Export & Import (2010)
- Enterprise Cluster Computing (2010)
- Noise Emission (2010)
- Cost (2010)
- Earthquake loads (2010)
- Offshore Additions (2011)

FOCUS6 WORLDWIDE

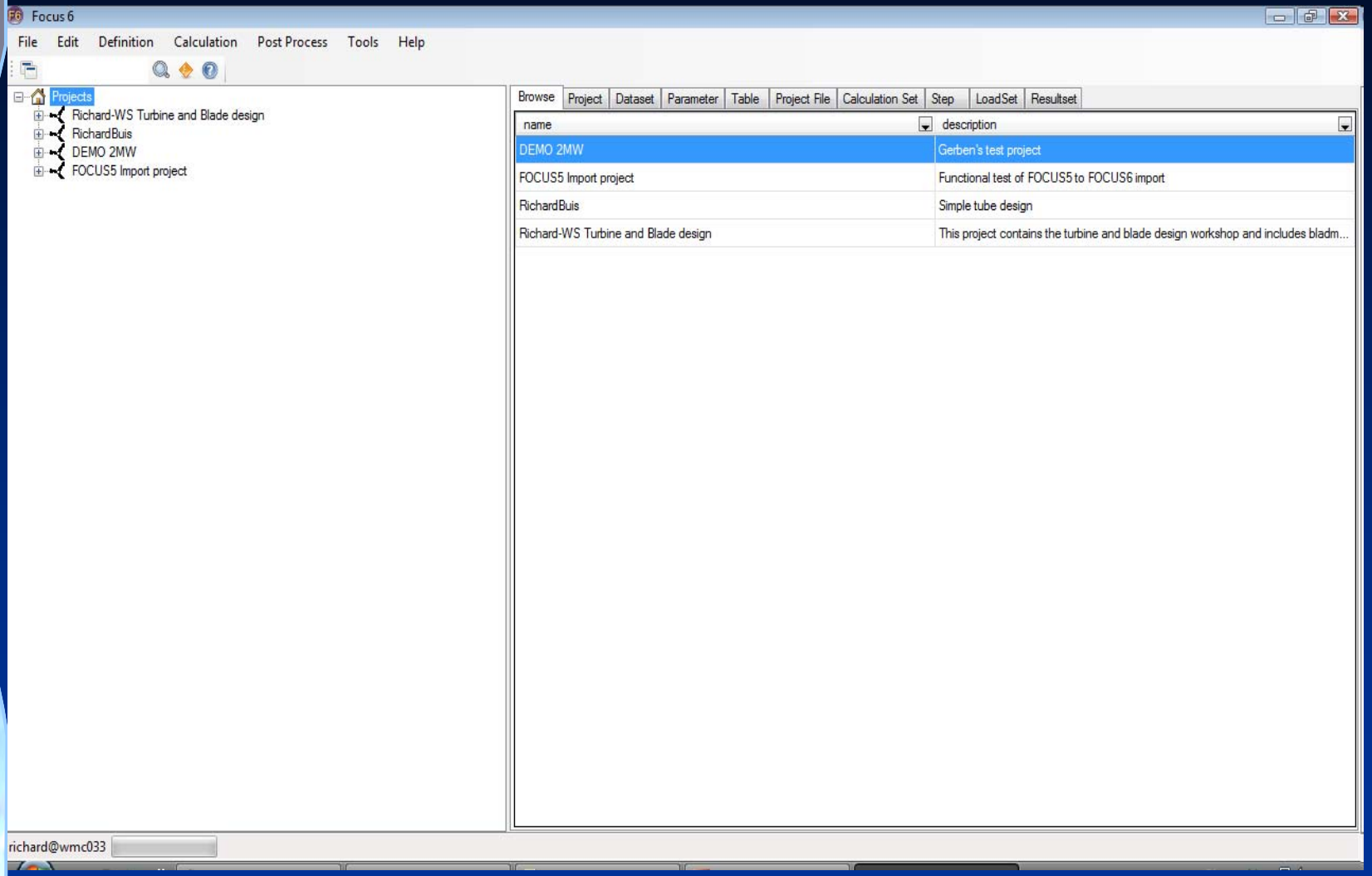


FOCUS6 Improvements from FOCUS5

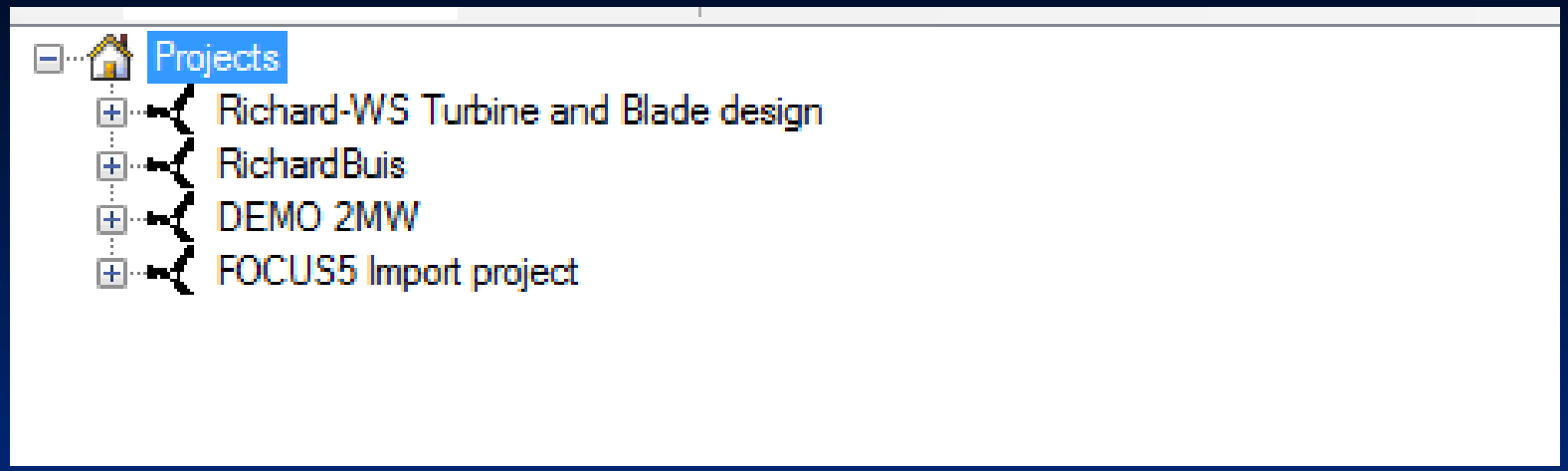
- FOCUS6 user interface experience
- Multi-user environment
- 3D graphical blade modeller
- Results visualization 2D/3D

FOCUS6 User Interface Experience

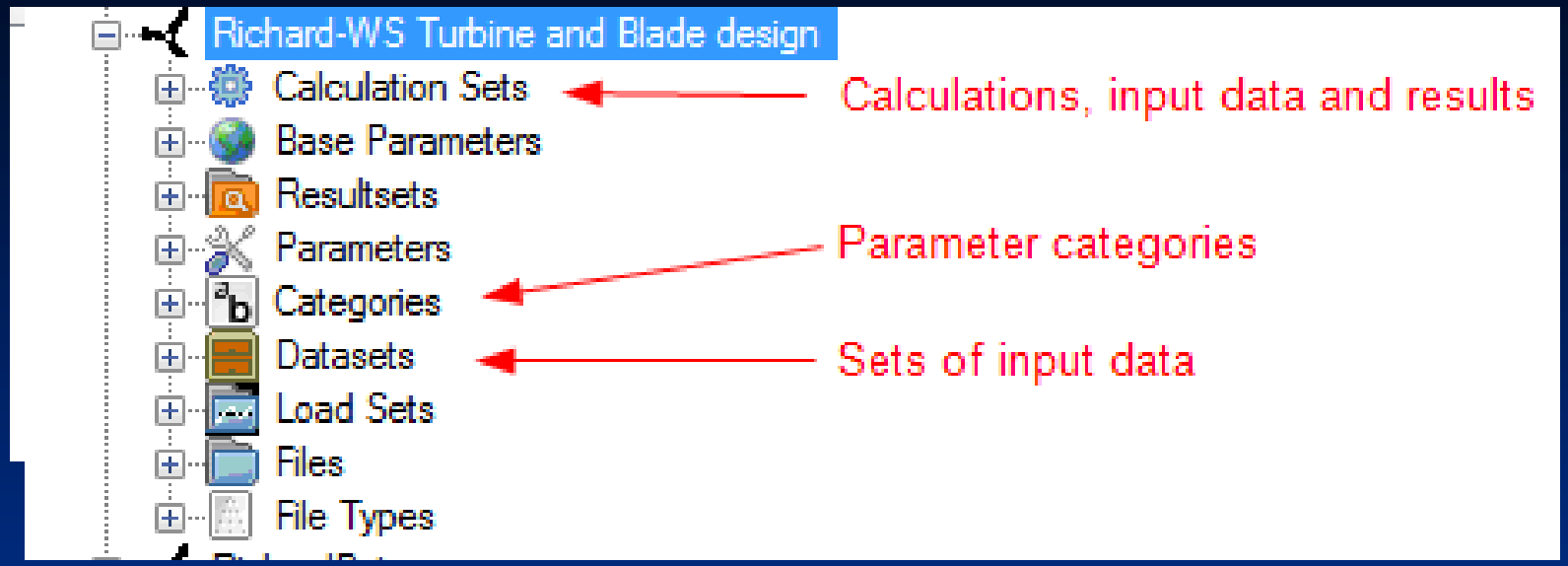
Control Design Projects



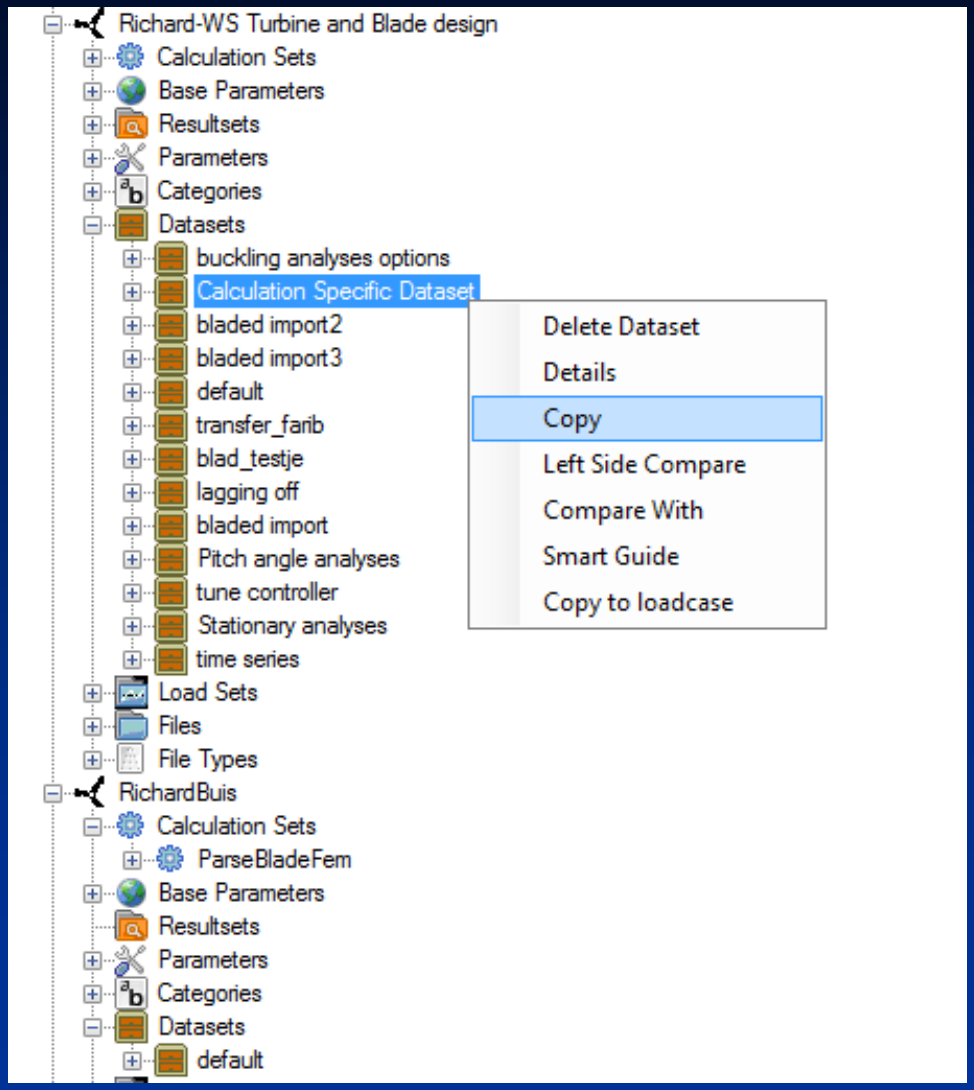
Control Design Projects



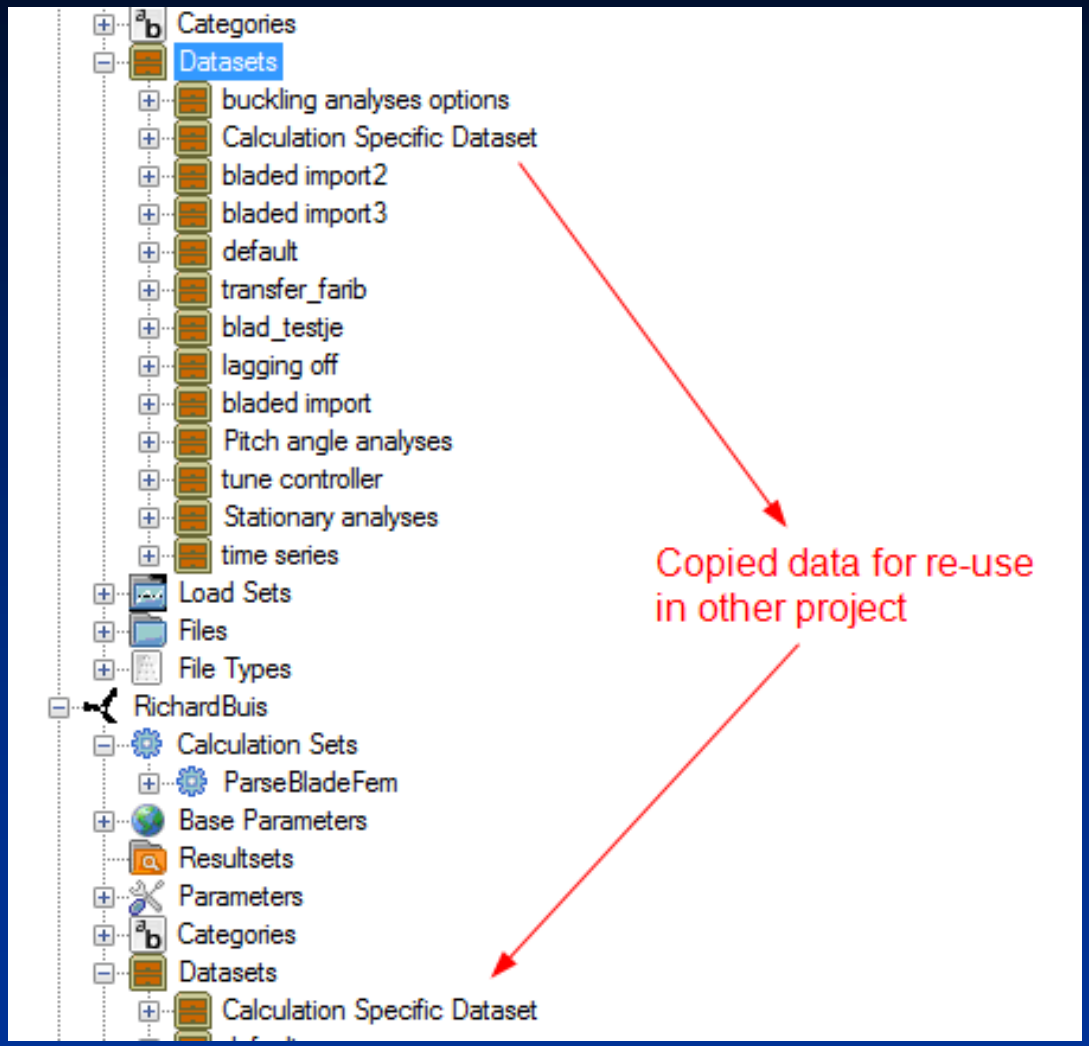
Control Design Projects



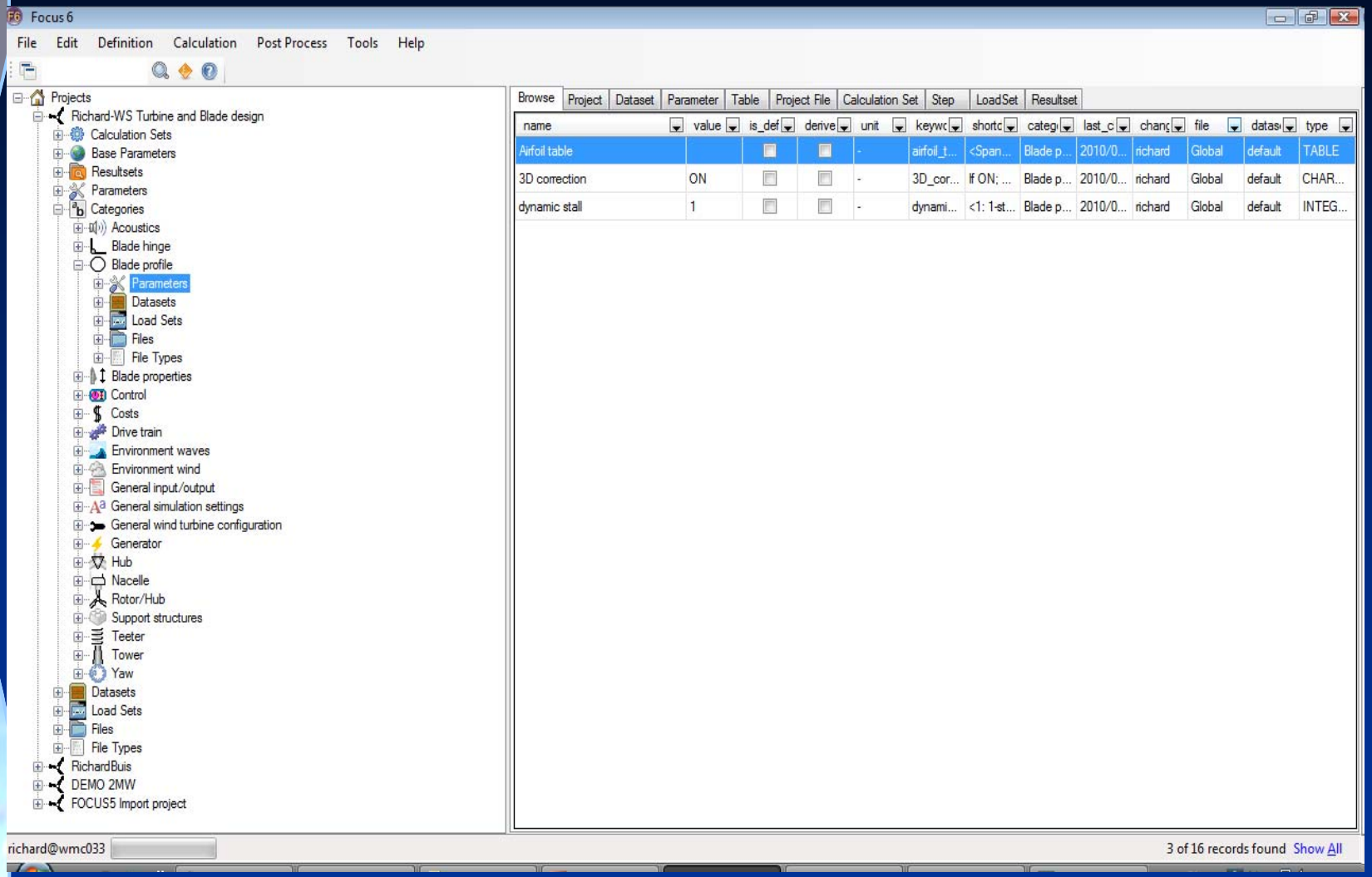
Control Design Projects



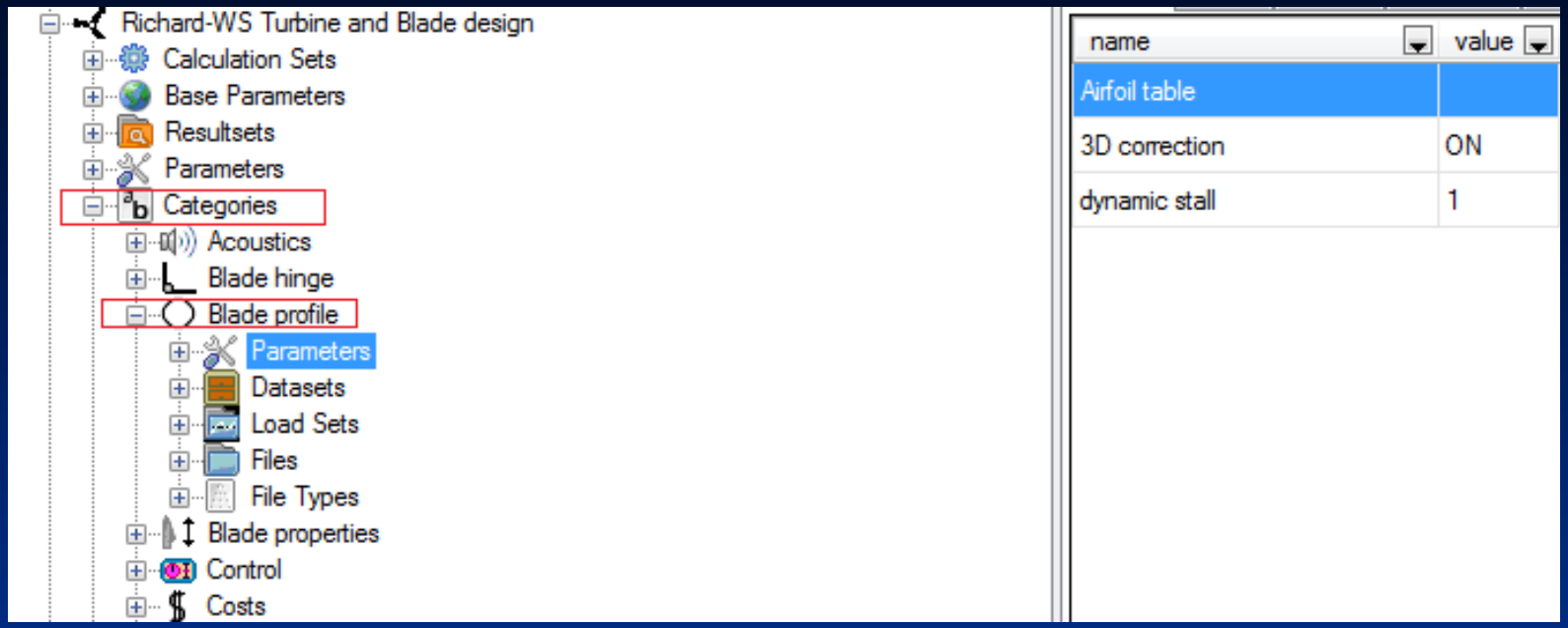
Control Design Projects



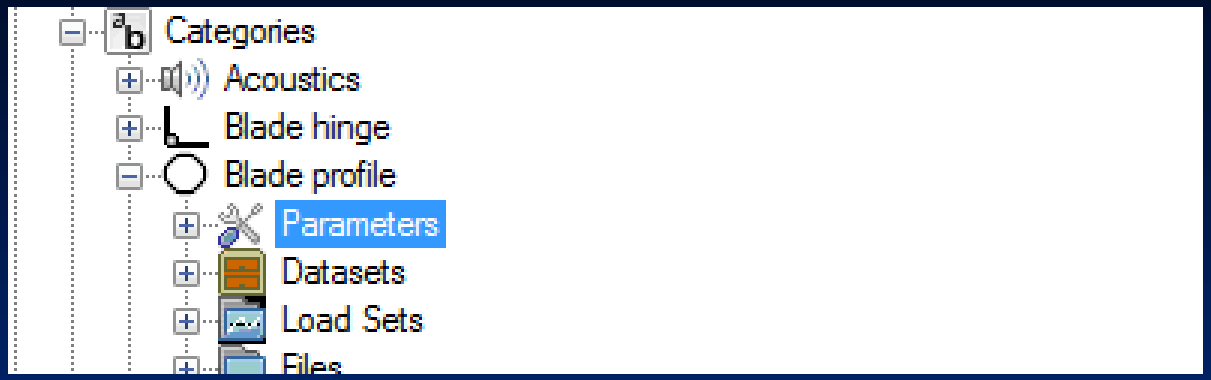
Parameters Organized In Categories



Parameters Organized In Categories

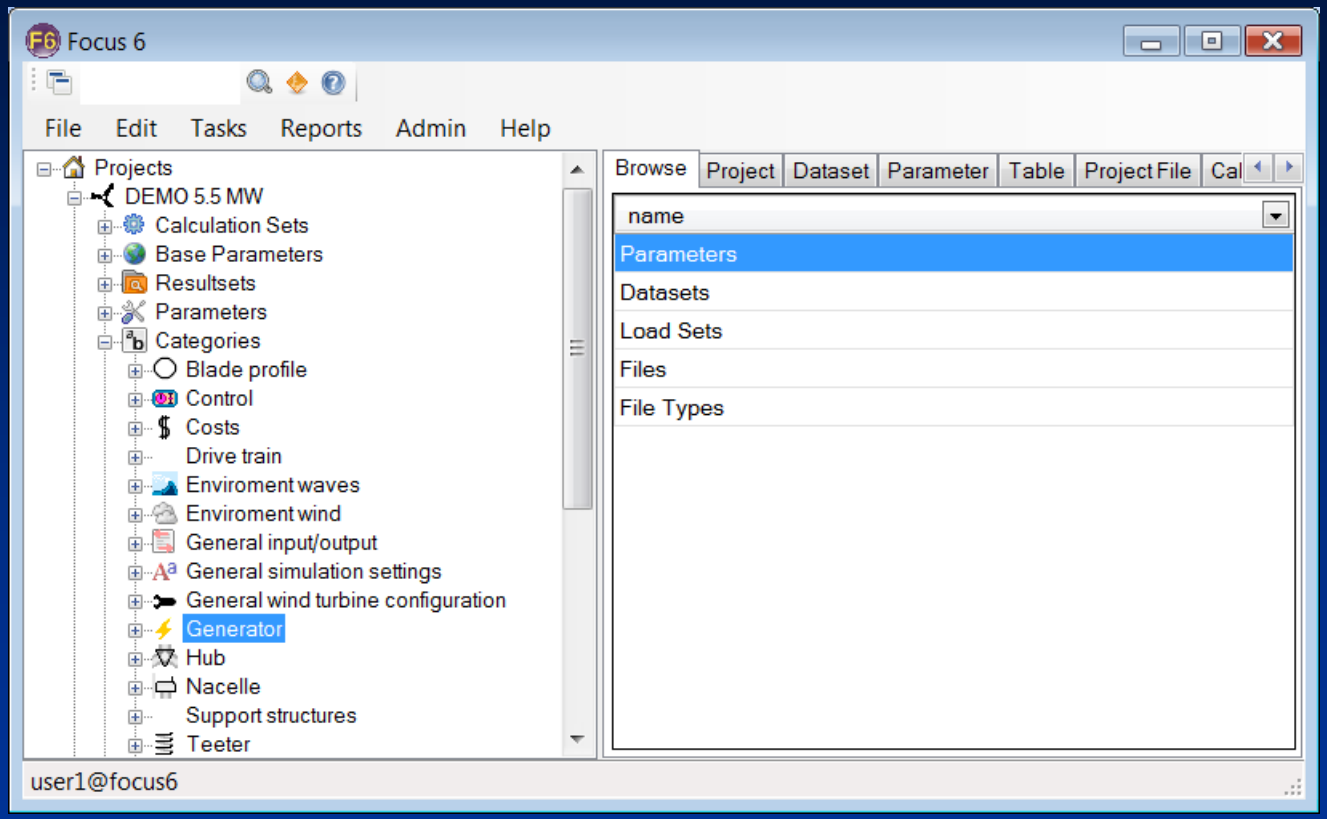


Parameters Organized In Categories

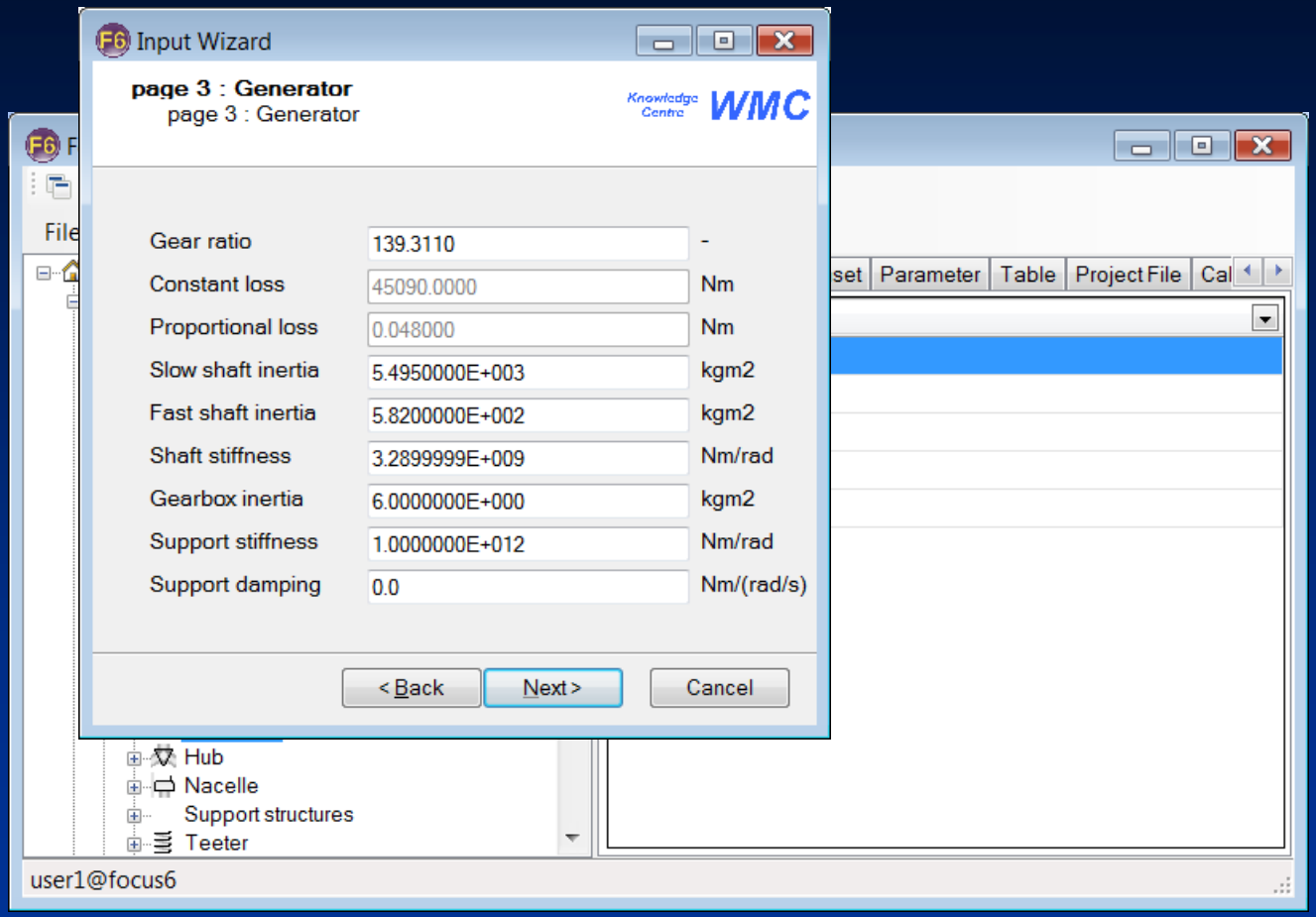


name	value	is
Airfoil table		
3D correction	ON	
dynamic stall	1	

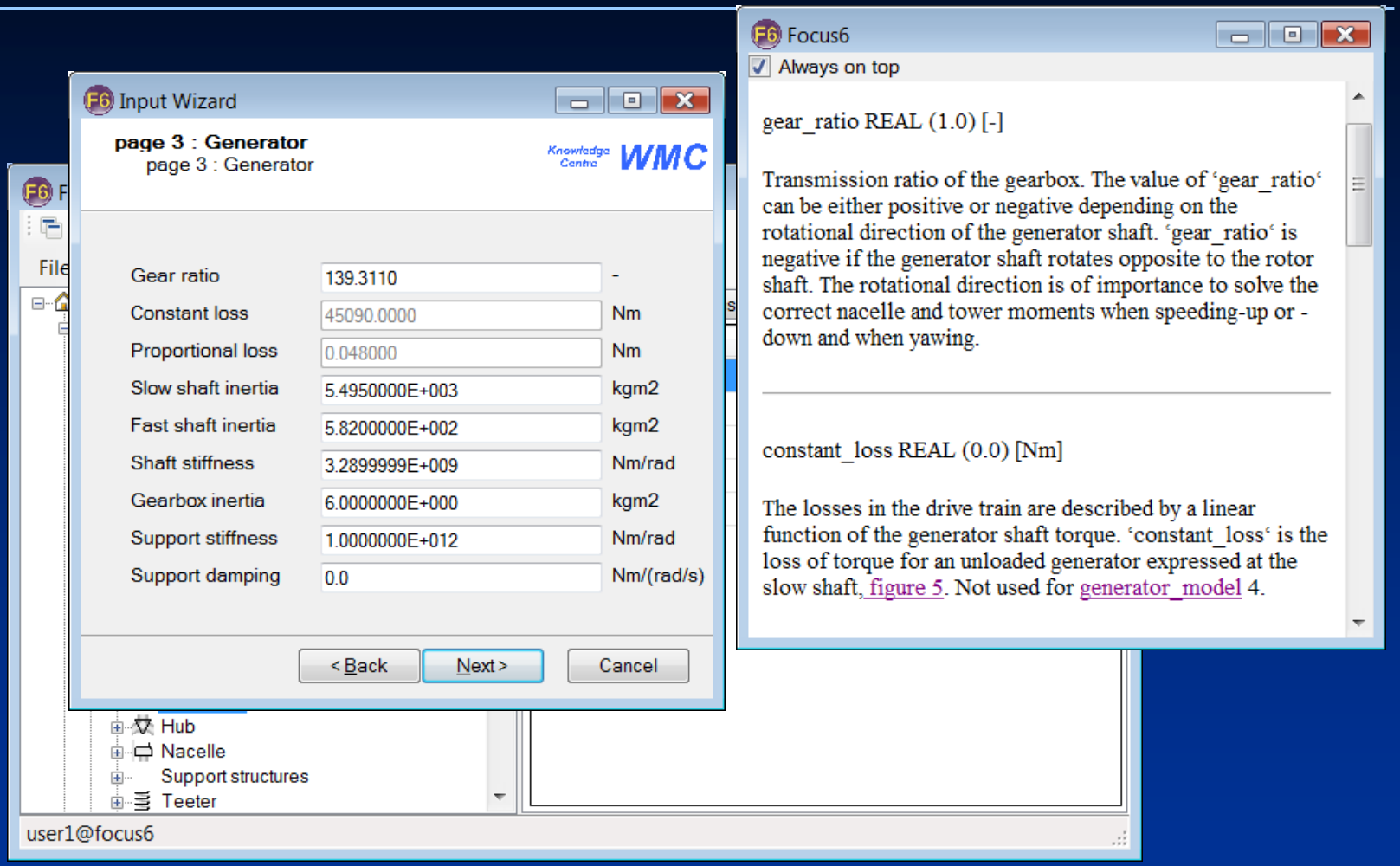
Parameter Input Wizards



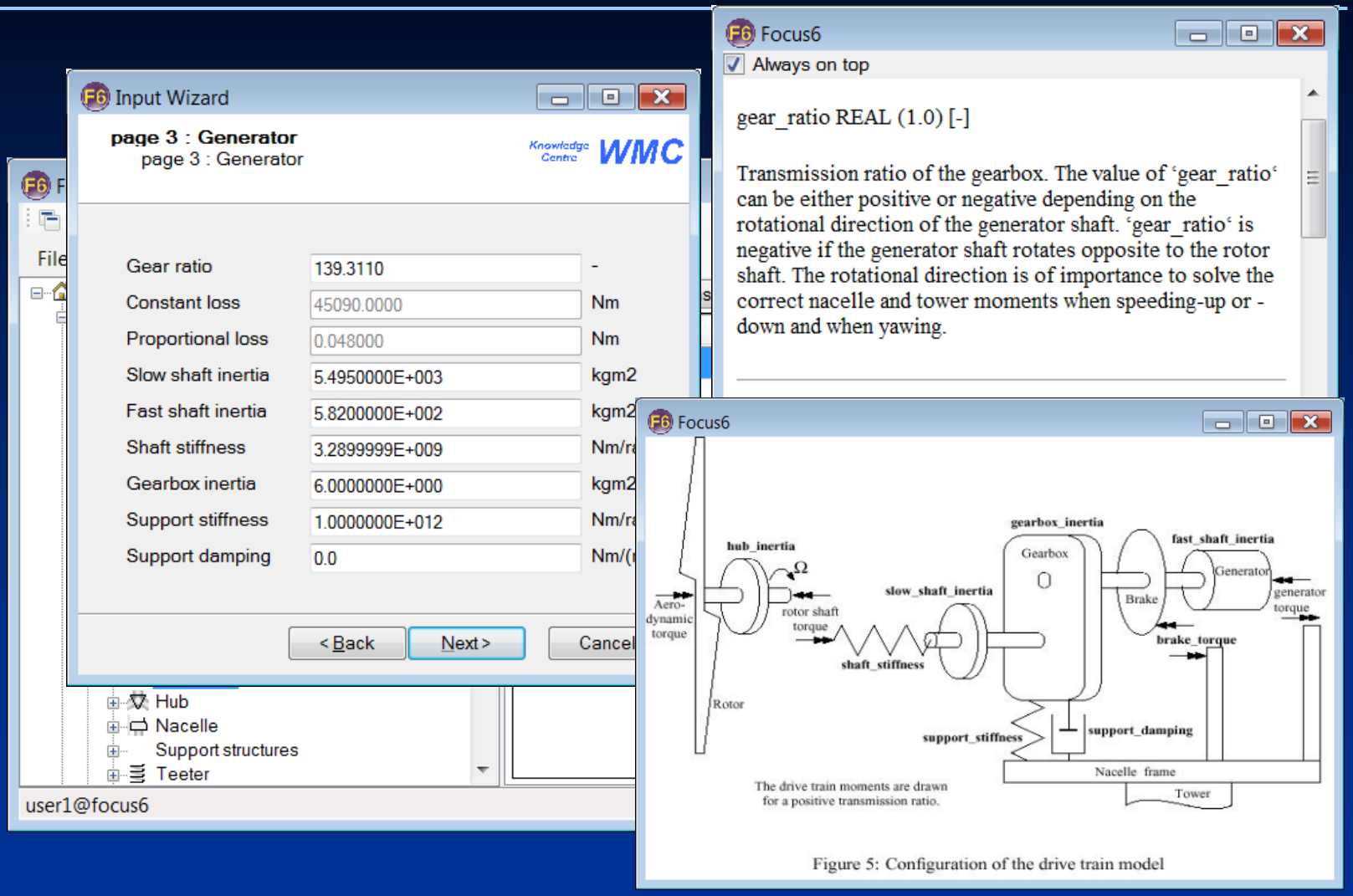
Parameter Input Wizards



Parameter Input Wizards



Parameter Input Wizards



Knowledge Centre WMC

Wind turbine Materials and Constructions

Calculation Sets

Focus 6

File Edit Definition Calculation Post Process Tools Help

- Projects
  - Richard-WS Turbine and Blade design
    - Calculation Sets
      - alt_fem
      - Cross section based buckling
      - deflection line
      - Fatigue analysees
        - Steps
          - 1 FAROB_structural_analysis
        - Runs
        - Datasets
          - default
        - loadcases
      - FE mesh
      - fins
      - Get load
      - Loadcase Preprocessor
      - Load file conversion
      - Panel based buckling
      - parse blade model
      - phatas
      - phatas_E
      - Power Curve
      - rotor blade analyses with Bladmode
      - Rotor characteristics
      - Static strength analyses
      - time series
      - time series 6108
      - Tip deflections
      - Tune Controller
    - Base Parameters
    - Resultsets
    - Parameters
    - Categories
    - Datasets
    - Load Sets
    - Files
    - File Types
  - RichardBuis
  - DEMO 2MW

Browse | Project | Dataset | Parameter | Table | Project File | Calculation Set | Step | LoadSet | Resultset

Project: Richard-WS Turbine and Blade design

Name: Fatigue analysees

☑ Post Process ☐ Optimize

Description

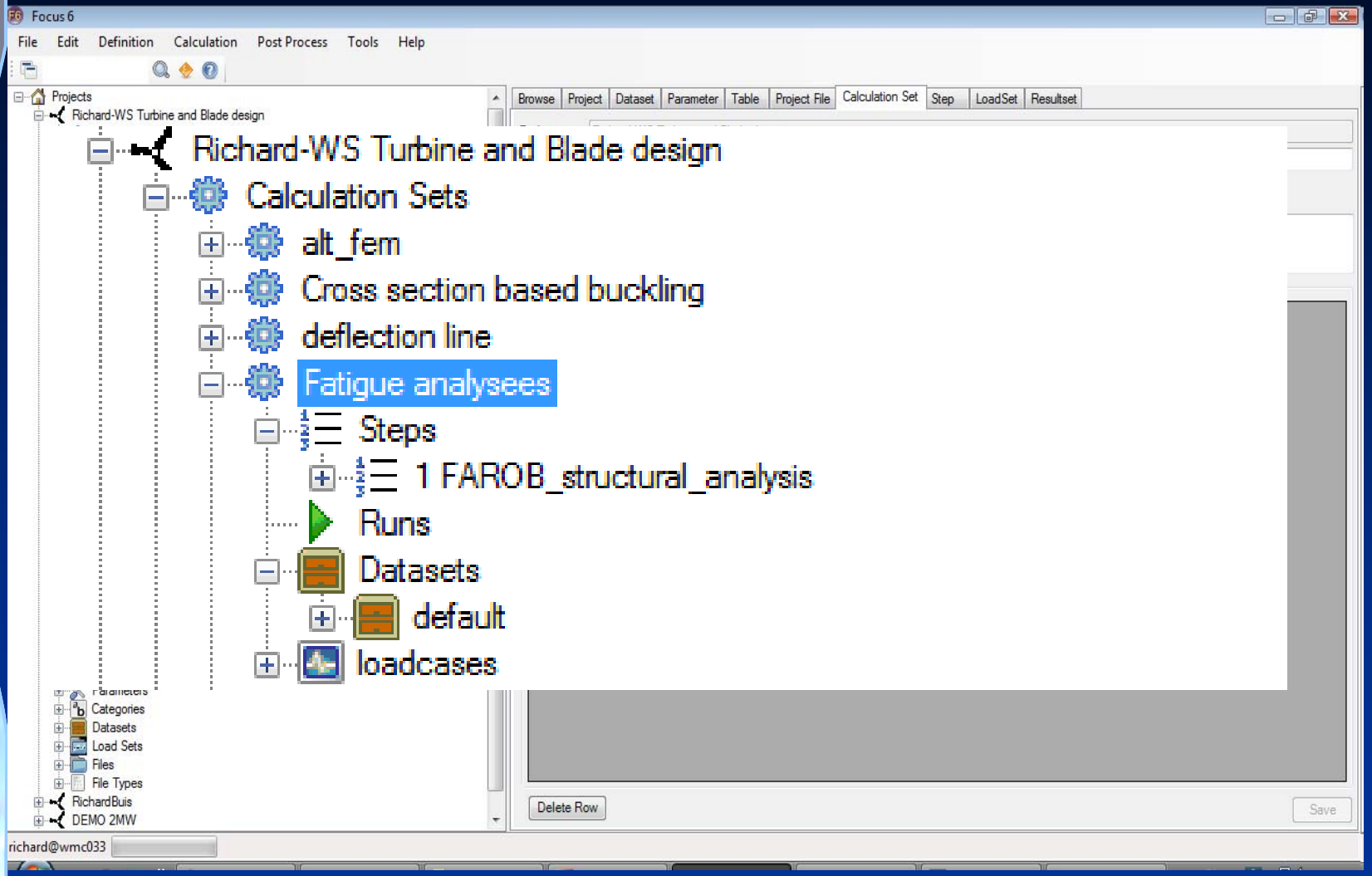
Parameter Variation

	parameter	start_value	stop_value	steps
*				

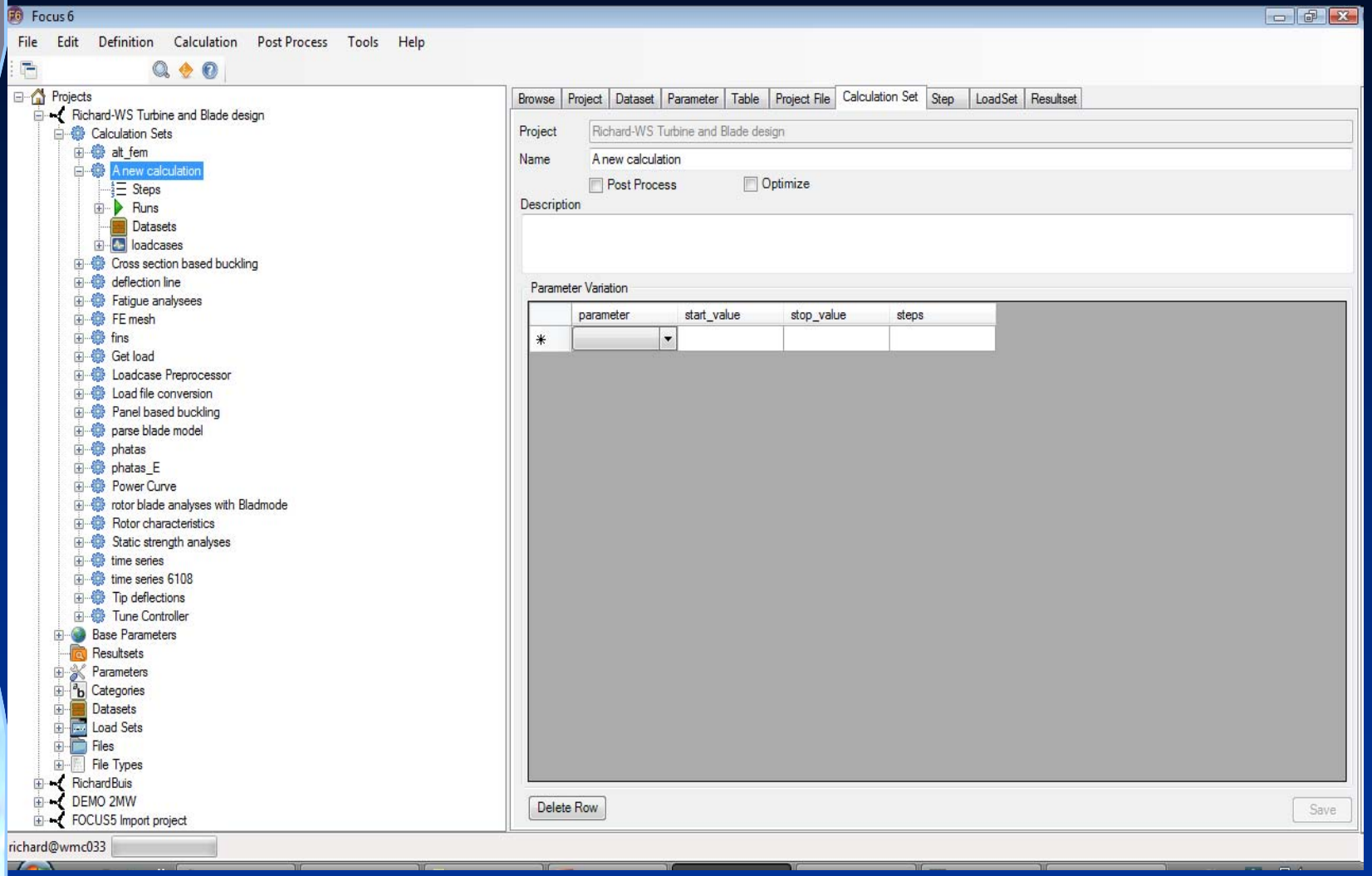
Delete Row Save

richard@wmc033

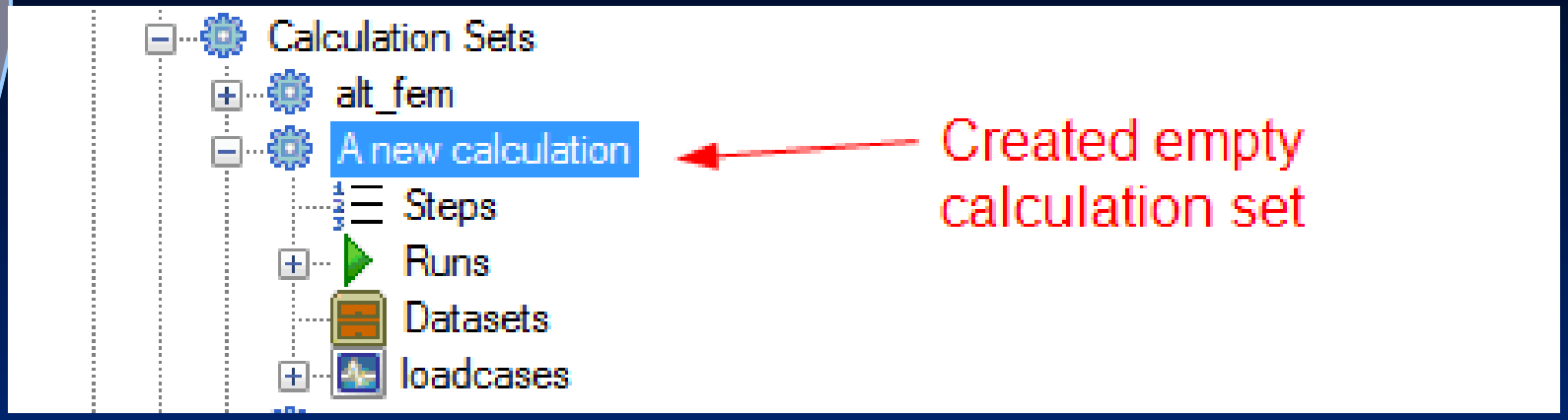
Calculation Sets



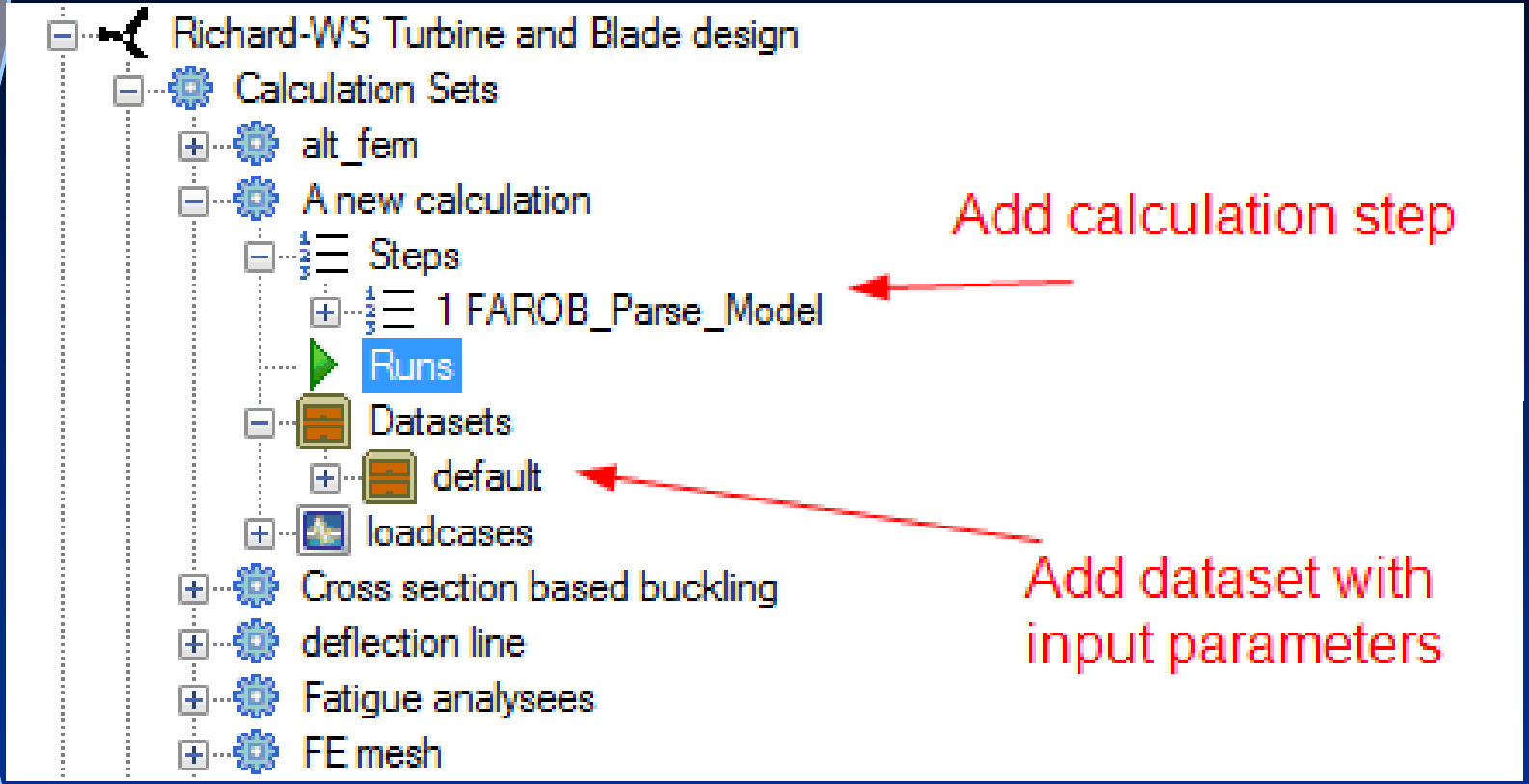
Running Calculations



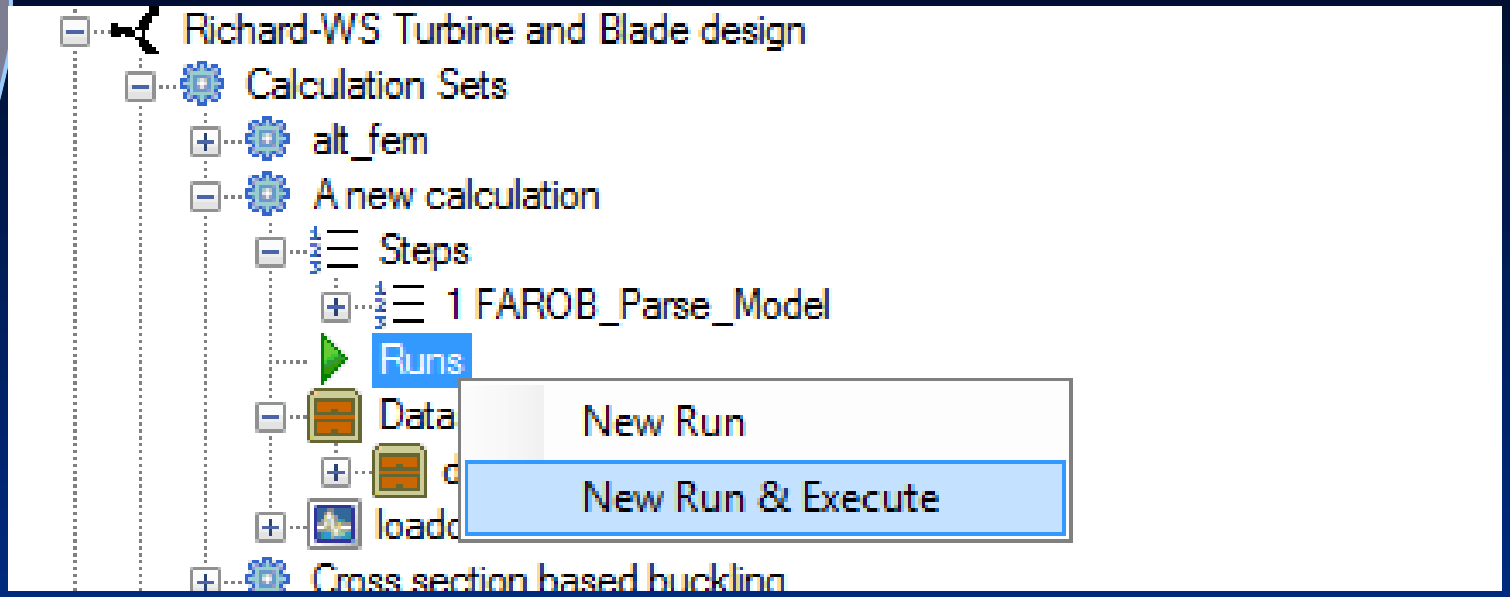
Running Calculations



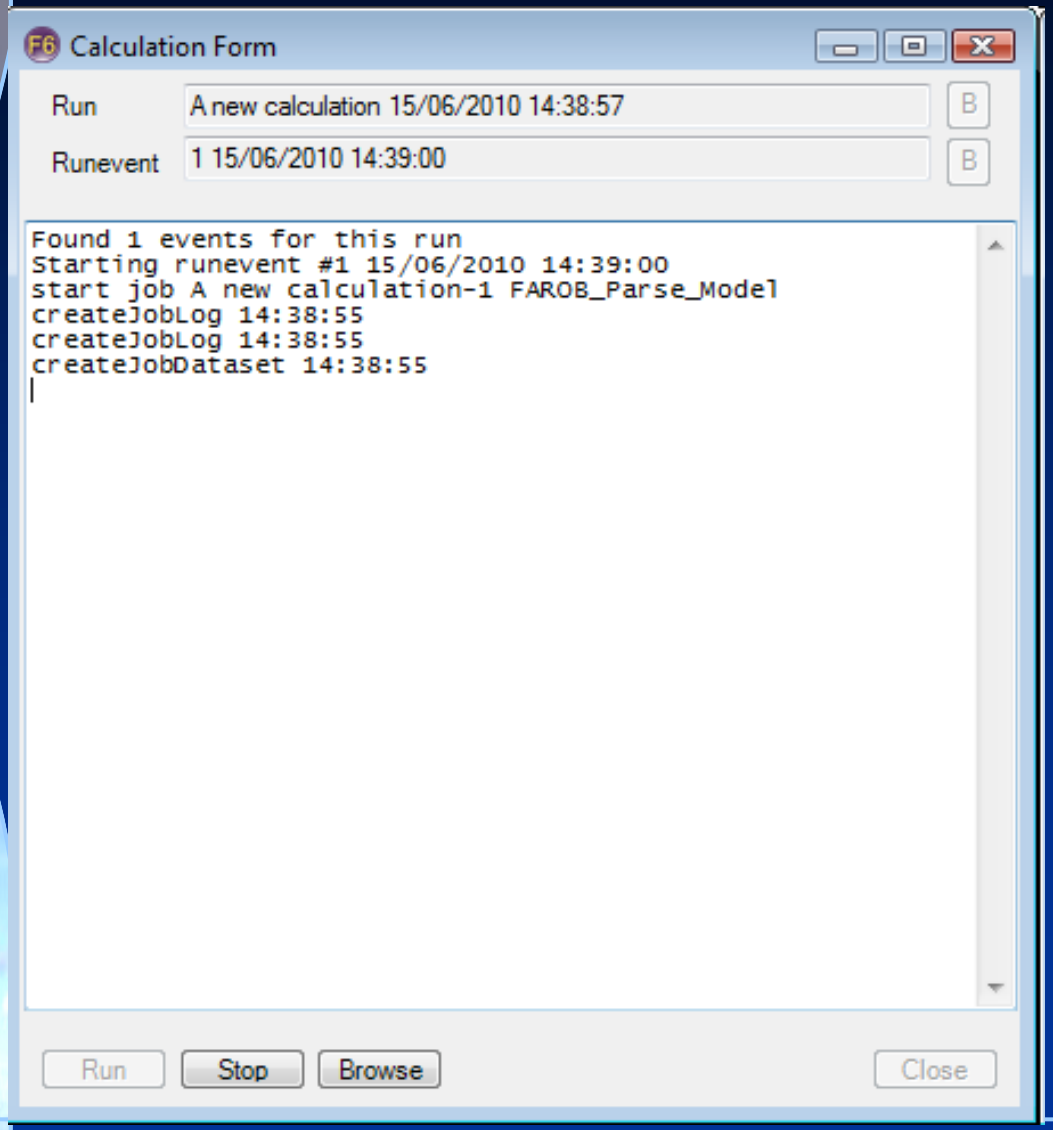
Running Calculations



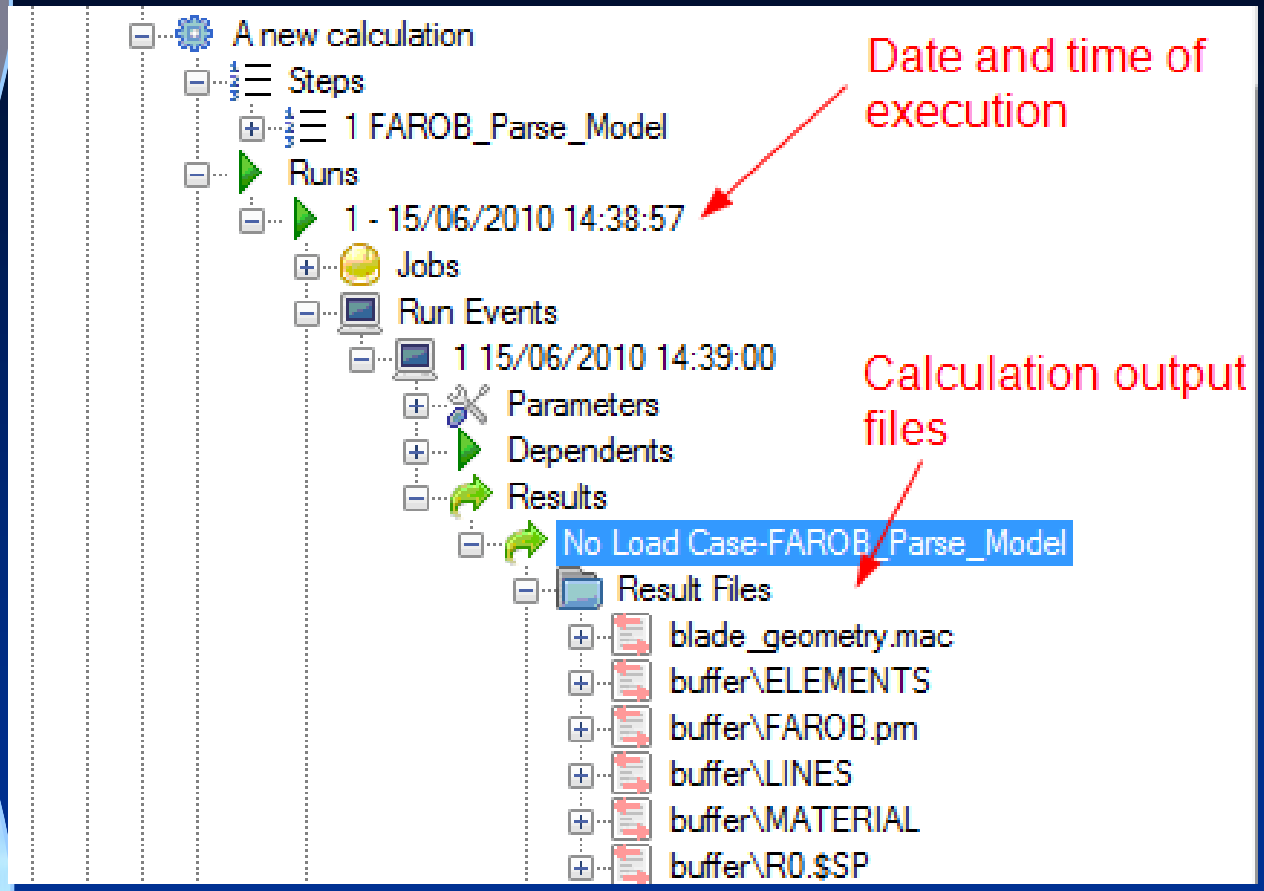
Running Calculations



Running Calculations



Running Calculations



Parametric Models

- A set of global parameters defines the turbine model
- Calculation modules (programs) under FOCUS6 can use these parameters
- For "What-If" studies sets of parameters can be defined to override the global parameters without changing the actual model

‘What-If’ Calculation Parameters

Focus 6

File Edit Definition Calculation Post Process Tools Help

- Projects
  - Richard-WS Turbine and Blade design
    - Calculation Sets
      - alt_fem
      - A new calculation
        - Steps
          - 1 FAROB_Parse_Model
        - Runs
          - 1 - 15/06/2010 14:38:57
        - Datasets
          - default
          - Calculation Specific Dataset
            - Parameters
              - Blade identifier
            - Categories
            - Files
            - File Types
        - loadcases
      - Cross section based buckling
      - deflection line
      - Fatigue analysees
      - FE mesh
      - fins
      - Get load
      - Loadcase Preprocessor
      - Load file conversion
      - Panel based buckling
      - parse blade model
      - phatas
      - phatas_E
      - Power Curve
      - rotor blade analyses with Bladmode
      - Rotor characteristics
      - Static strength analyses
      - time series
      - time series 6108
      - Tip deflections
      - Tune Controller
    - Base Parameters
    - Resultsets

Browse | Project | Dataset | Parameter | Table | Project File | Calculation Set | Step | LoadSet | Resultset

Name	Blade identifier
Value	blade2mw2
Change Message	
Validate	Save
Project	Richard-WS Turbine and Blade design
Dataset	Calculation Specific Dataset
File	Global
Unit	-
Type	STRING
Value formula	
Global formula	
Filetype	Global
Keyword	blade_identifier
Category	Blade properties
Order no	0
Default	blade
Desc.	Blade identifier

blade_identifier CHARACTER (blade) [-]

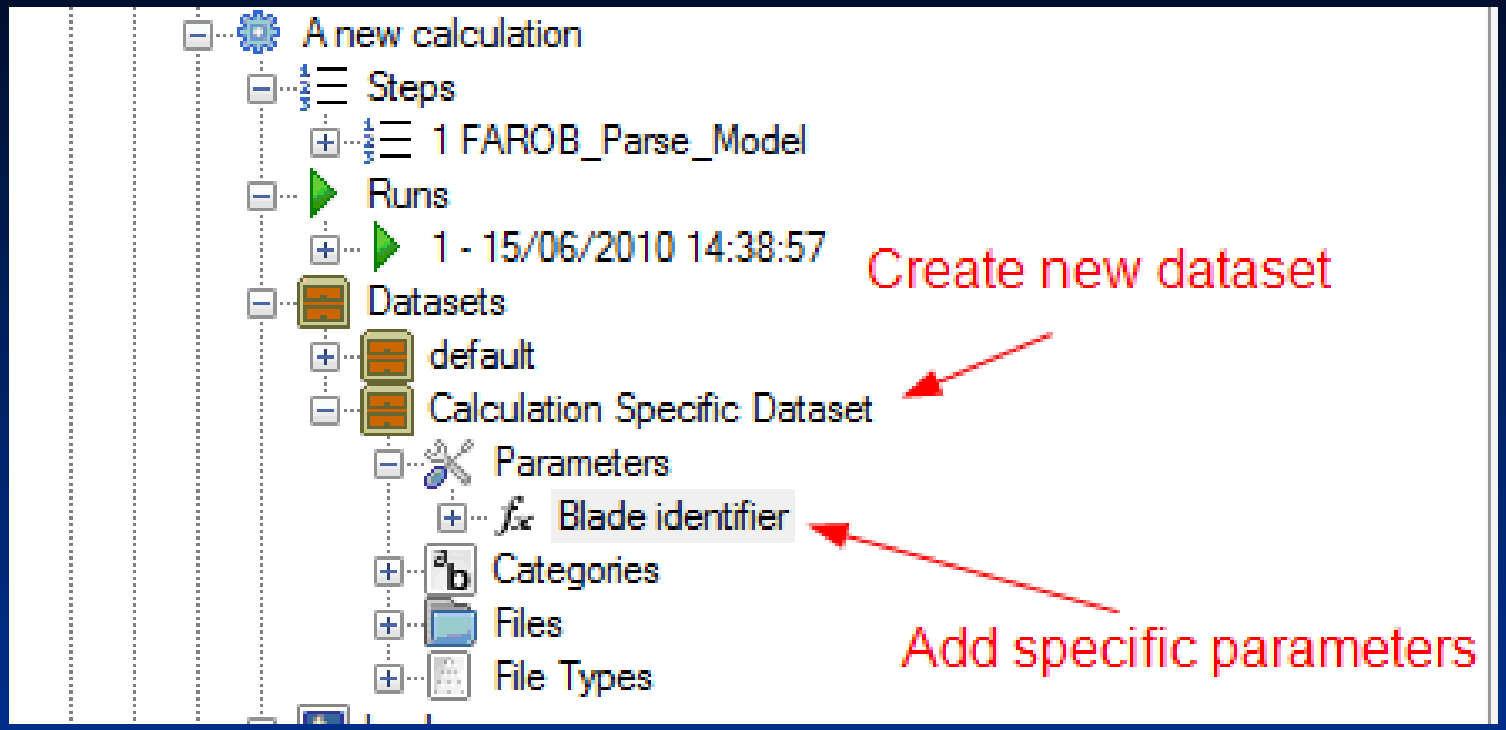
Blade identifier

Change Log

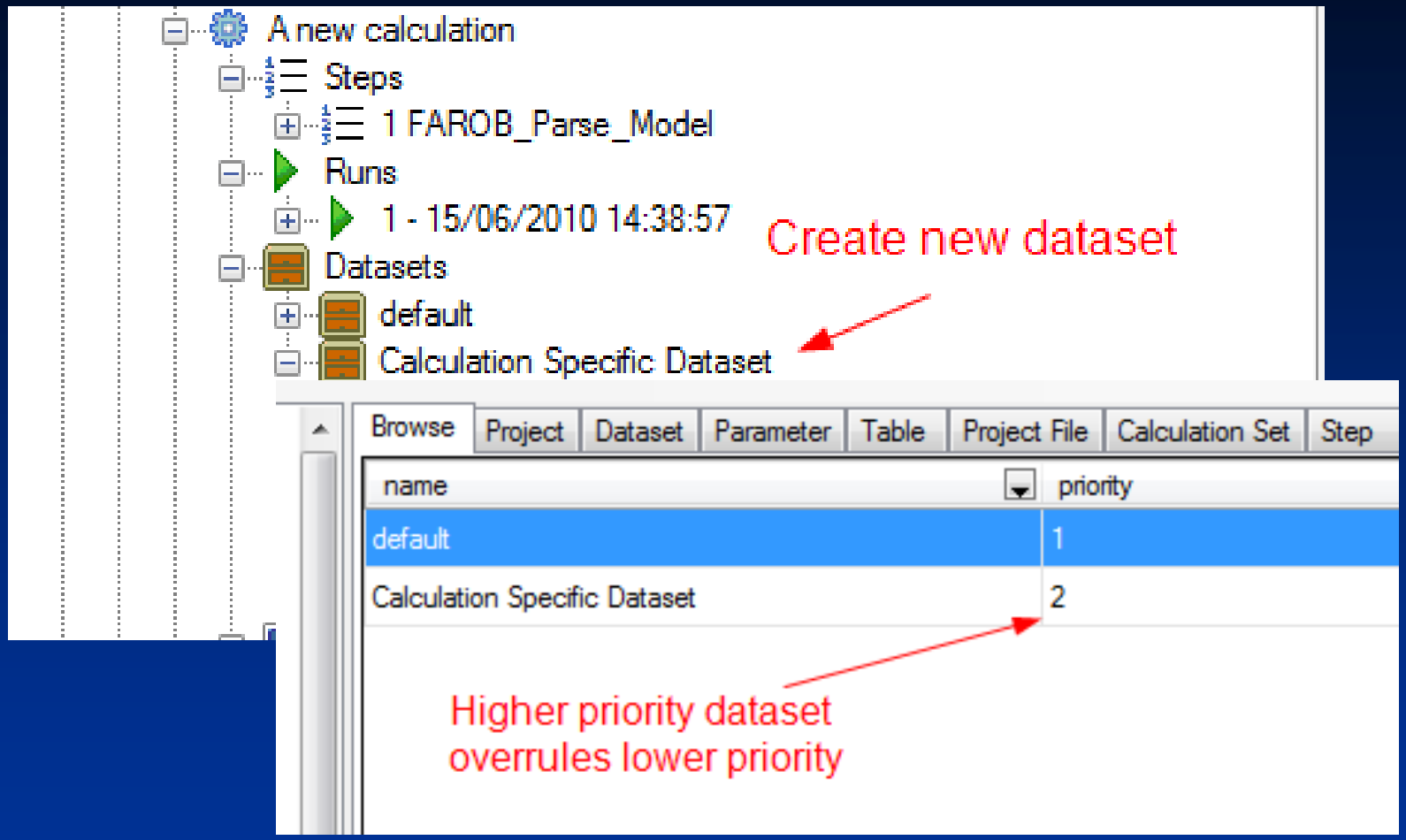
15/06/2010 14:55:58 richard blade_identifier=blade2mw2

richard@wmc033

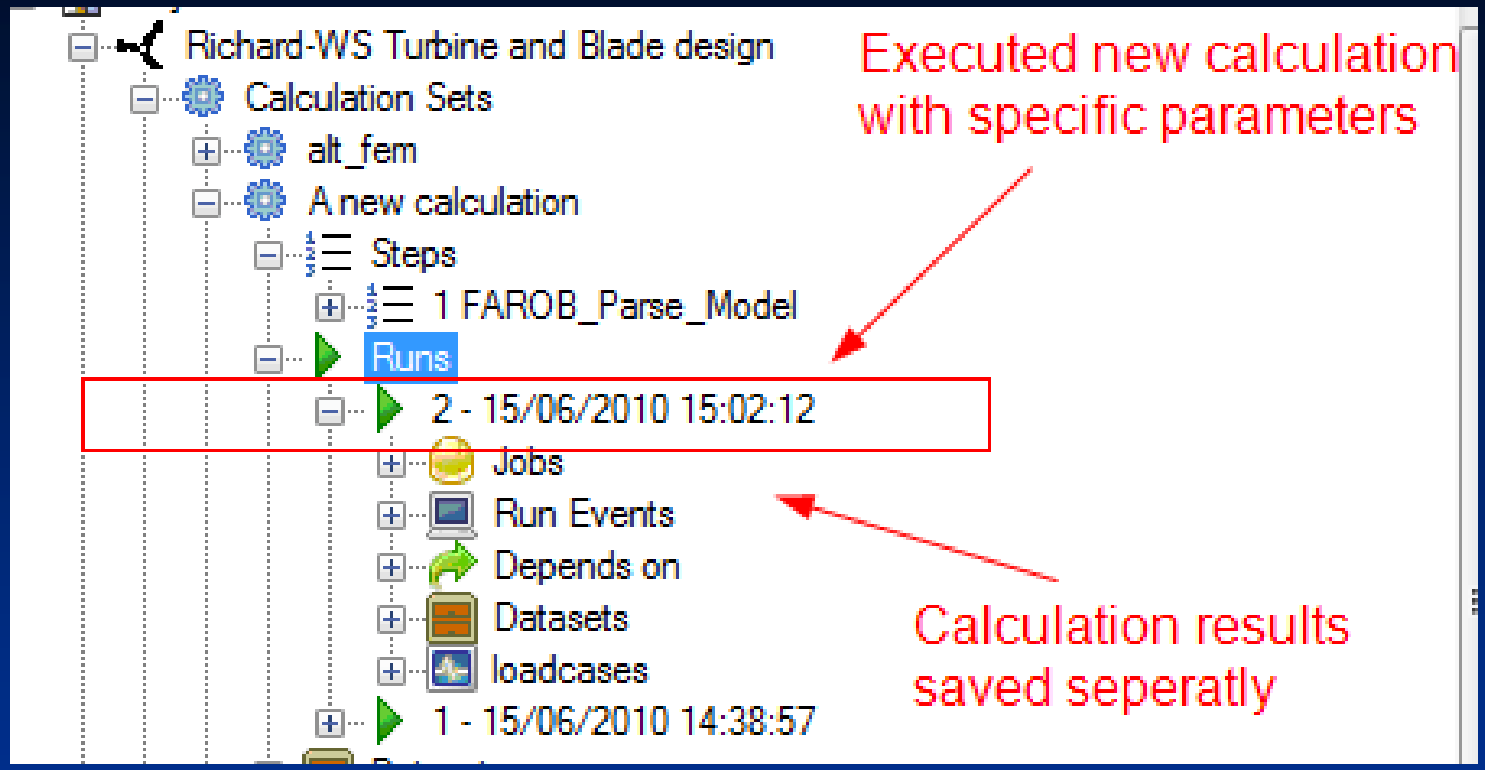
‘What-If’ Calculation Parameters



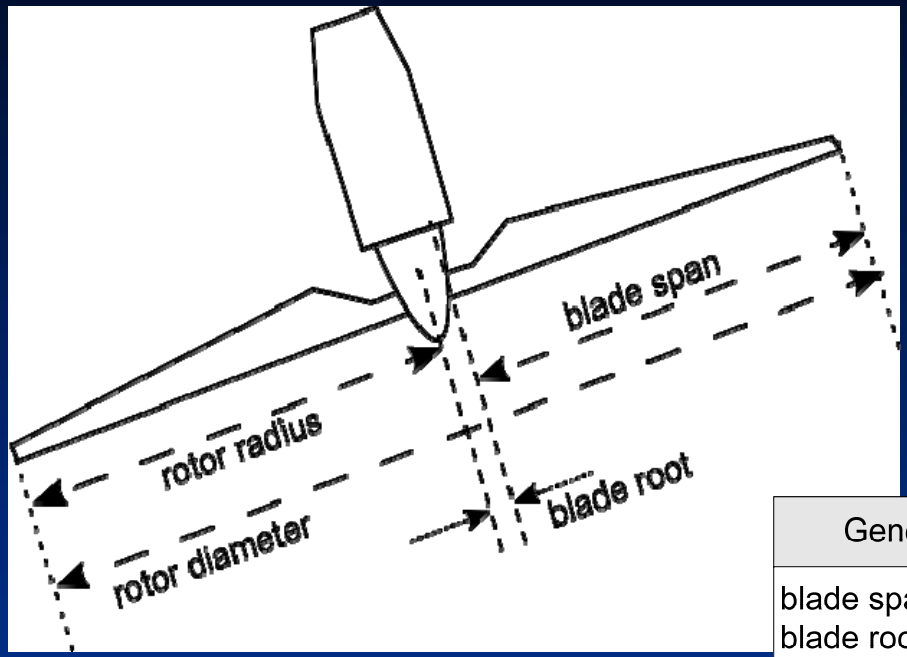
‘What-If’ Calculation Parameters



‘What-If’ Calculation Parameters



Normal Model Parameters



Generic Turbine

blade span = 60 m
blade root = 2 m

Module 1

rotor radius = 62 m

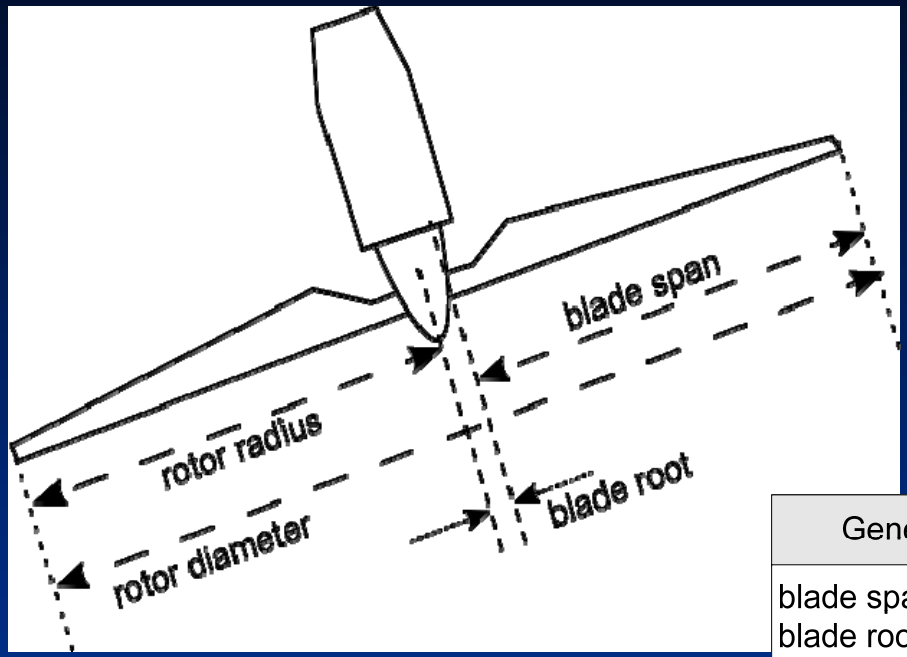
Module 2

rotor diameter = 124 m

Module 3

blade length = 60000 mm

Variable Model Parameters



Generic Turbine

blade span = **X**
blade root = 2 m

Module 1

rotor radius = **X + 2** m

Module 2

rotor diameter = 2·(**X + 2**) m

Module 3

blade length= 1000· **X** mm

Variable Expansion

- FOCUS6 handles ('expands') variables
- Variables are replaced with actual values by FOCUS6
- Calculations modules (programs) do not know about these variables!
- Any custom program can be used!

Multi-User Design Projects

- **FOCUS6 organizes projects and data into a shared location**
- **Multiple users may work on the same project simultaneously!**
- **All changes by users are tracked**
  - *("Who? – When? – What?")*
- **Calculations can run in parallel on PCs with multi-core processors**
  - Other computers in the network can join in for even shorter turnaround times e.g. for load set calculations

3D Graphical Blade Modeller

3D Graphical Blade Modeller

- 3D graphical viewer and editor
- Easily create or edit blade properties
- Representation using 1st degree lines, surfaces, etc
- Direct 3D/2D feedback of changes

Define Shapes

Workshop Turbine and Blade design - Focus 6 Blade Modeler

File View Options Help

Overview

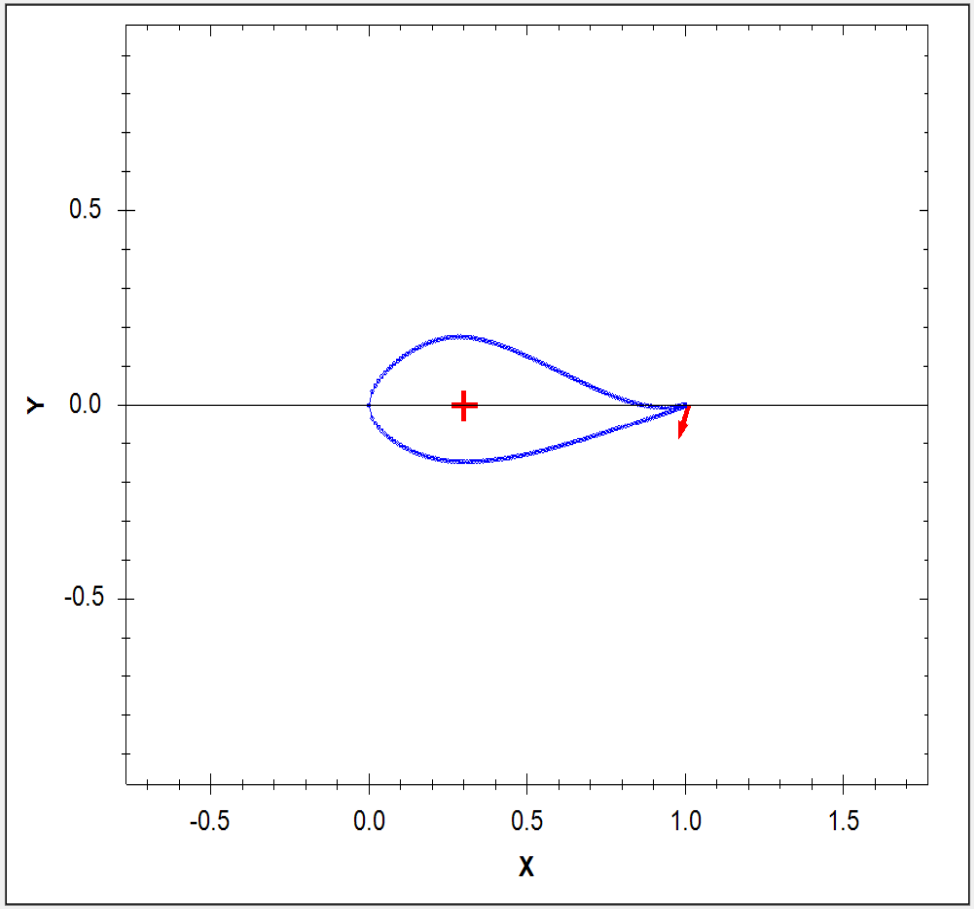
- Workshop Turbine and Blade design
  - Parameters
  - Strings
  - Shapes
    - R0
    - R3
    - R7
    - R9
    - R11
    - R13
    - R15
    - R17
    - R25
    - R29
    - R33
    - R36
    - R37
  - Shape Locations
  - Materials
  - S-N Lines
  - Lines
  - Sections
  - Templates

Properties

Mirrored	False
Reversed	False
Points	
[0]	(1,0)
[1]	(0.999,-0.00279)
[2]	(0.99,-0.00544)
[3]	(0.98,-0.0084)
[4]	(0.97,-0.0113)
[5]	(0.96,-0.01415)
[6]	(0.95,-0.01696)
[7]	(0.94,-0.01973)
[8]	(0.93,-0.02248)
[9]	(0.92,-0.02522)
[10]	(0.91,-0.02797)
[11]	(0.9,-0.03071)
[12]	(0.89,-0.03345)
[13]	(0.88,-0.03618)
[14]	(0.87,-0.03892)
[15]	(0.86,-0.04165)
[16]	(0.85,-0.04438)
[17]	(0.84,-0.04711)
[18]	(0.83,-0.04983)
[19]	(0.82,-0.05254)
[20]	(0.81,-0.05525)
[21]	(0.8,-0.05795)
[22]	(0.79,-0.06063)
[23]	(0.78,-0.0633)
[24]	(0.77,-0.06596)
[25]	(0.76,-0.06861)
[26]	(0.75,-0.07124)
[27]	(0.74,-0.07386)
[28]	(0.73,-0.07646)
[29]	(0.72,-0.07904)
[30]	(0.71,-0.08161)
[31]	(0.7,-0.08415)
[32]	(0.69,-0.08667)
[33]	(0.68,-0.08917)
[34]	(0.67,-0.09164)
[35]	(0.66,-0.09409)
[36]	(0.65,-0.09651)
[37]	(0.64,-0.0989)
[38]	(0.63,-0.10125)
[39]	(0.62,-0.10358)
[40]	(0.61,-0.10587)

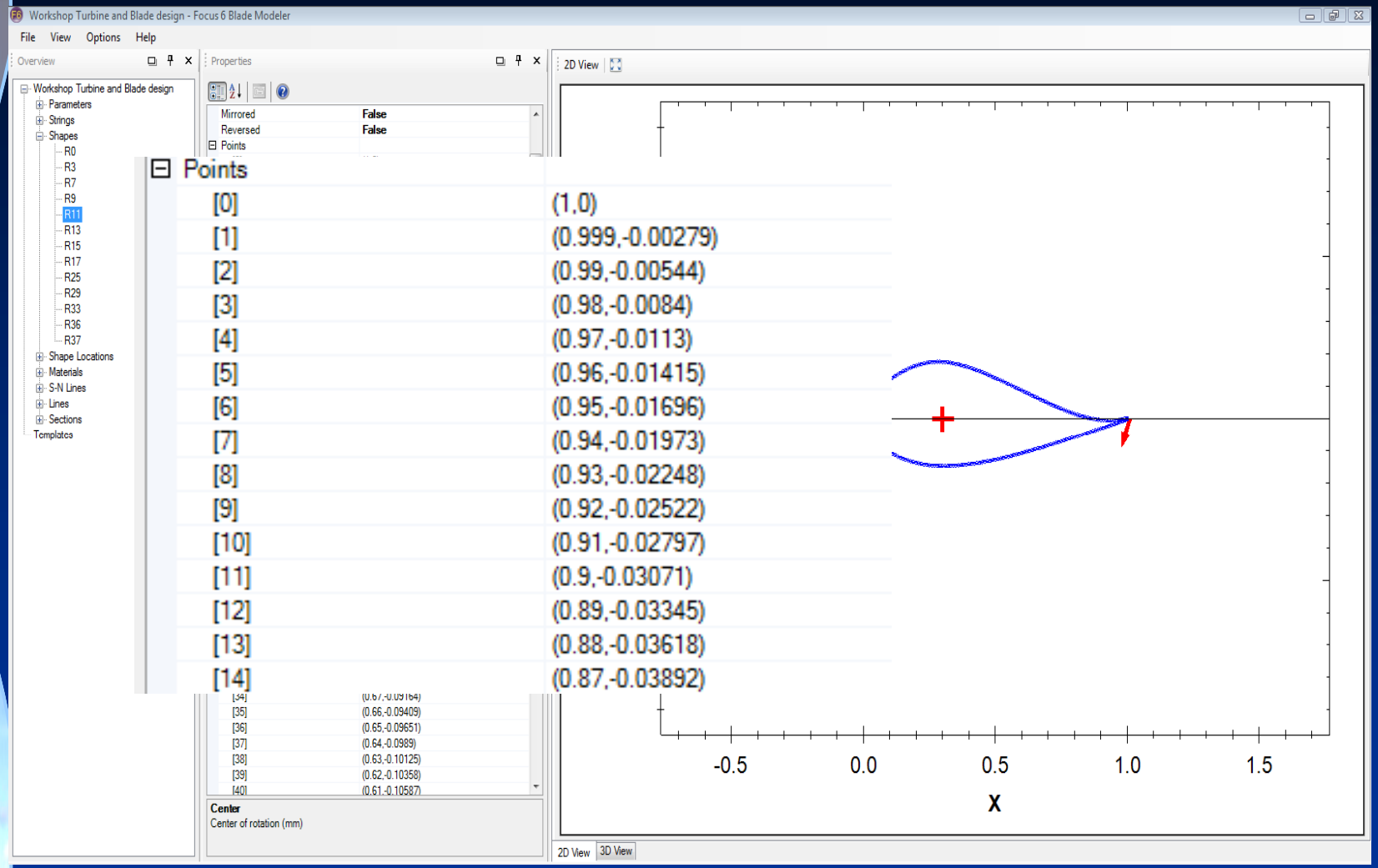
Center
Center of rotation (mm)

2D View

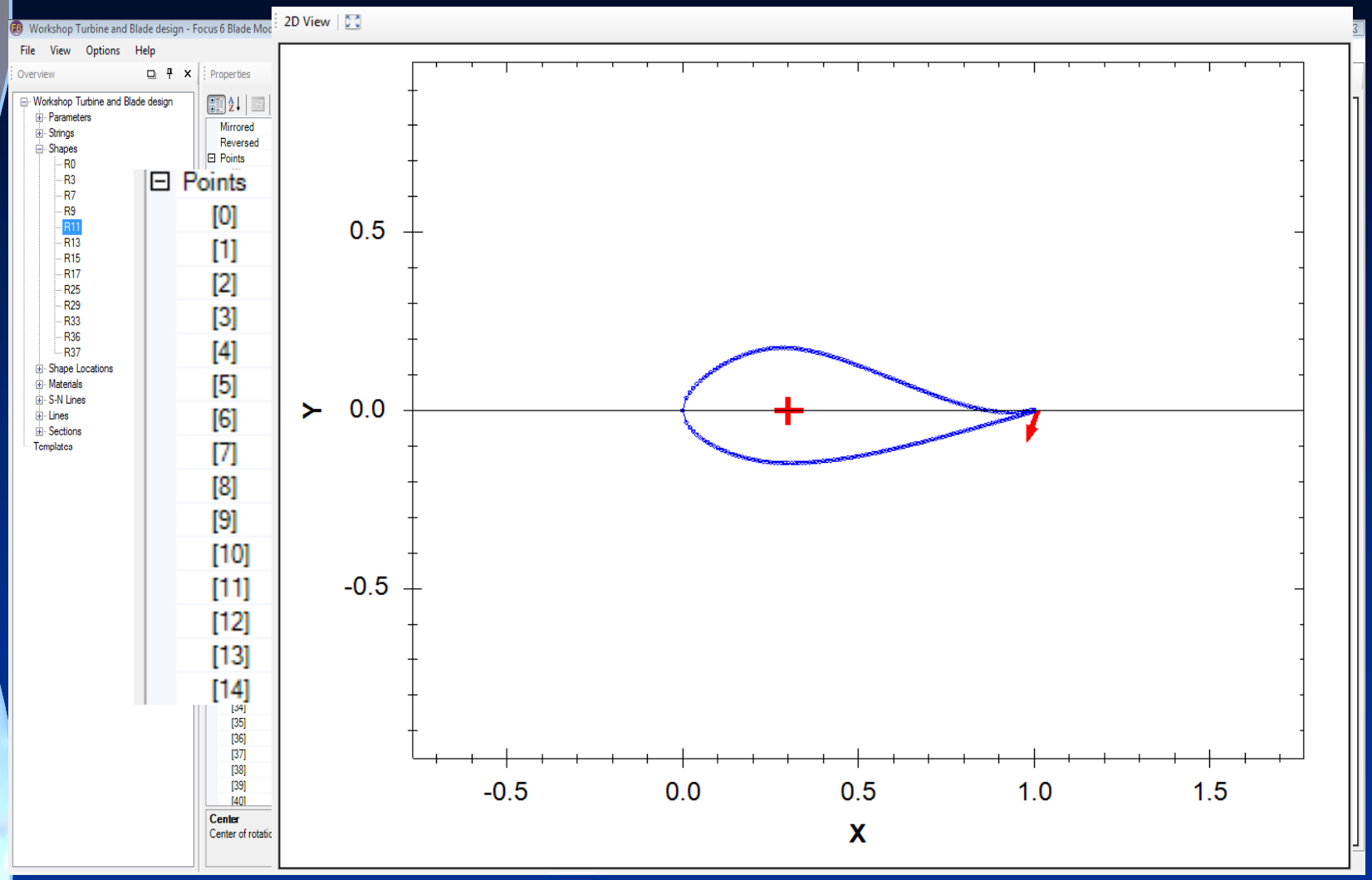


2D View 3D View

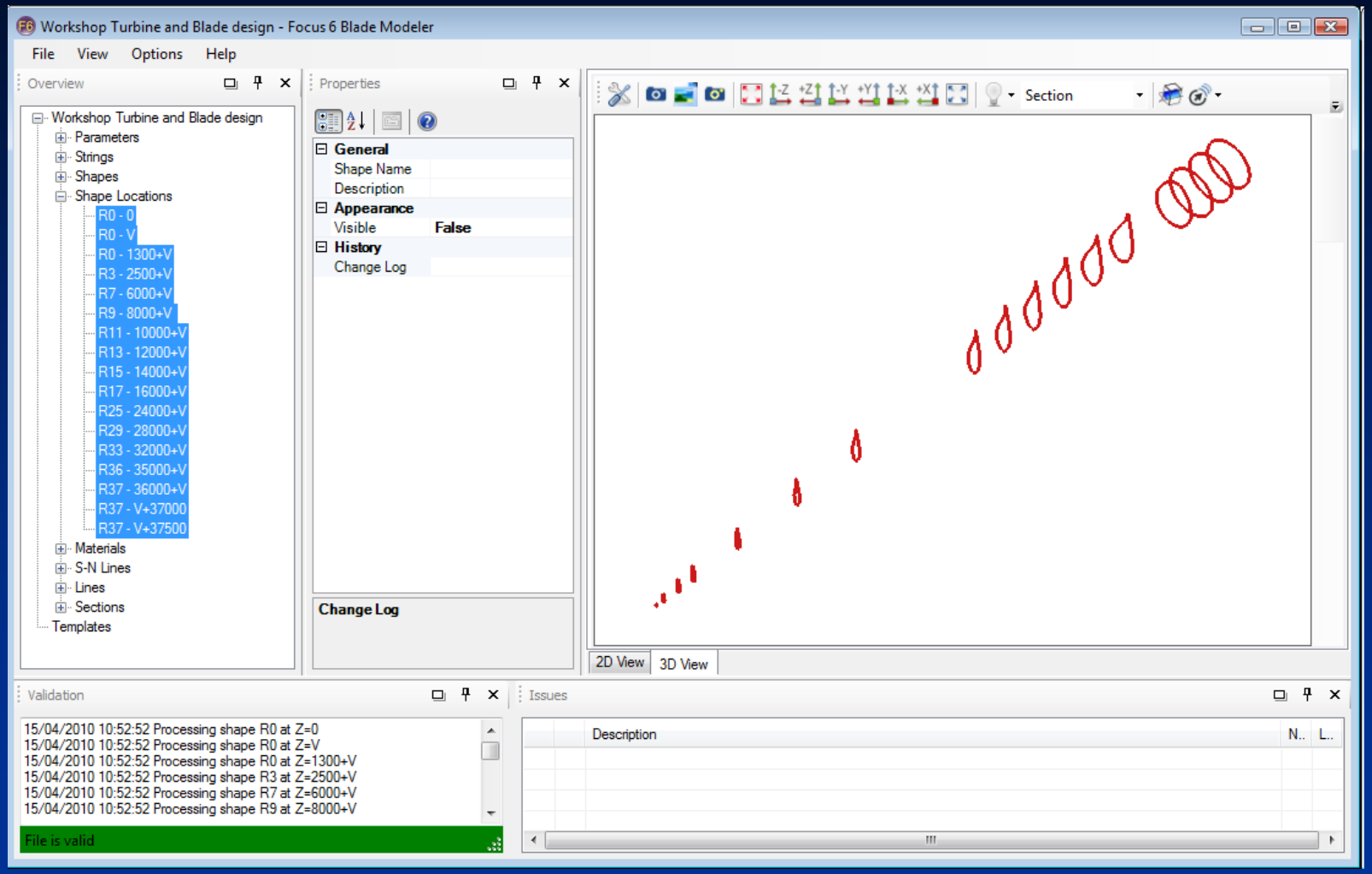
Define Shapes



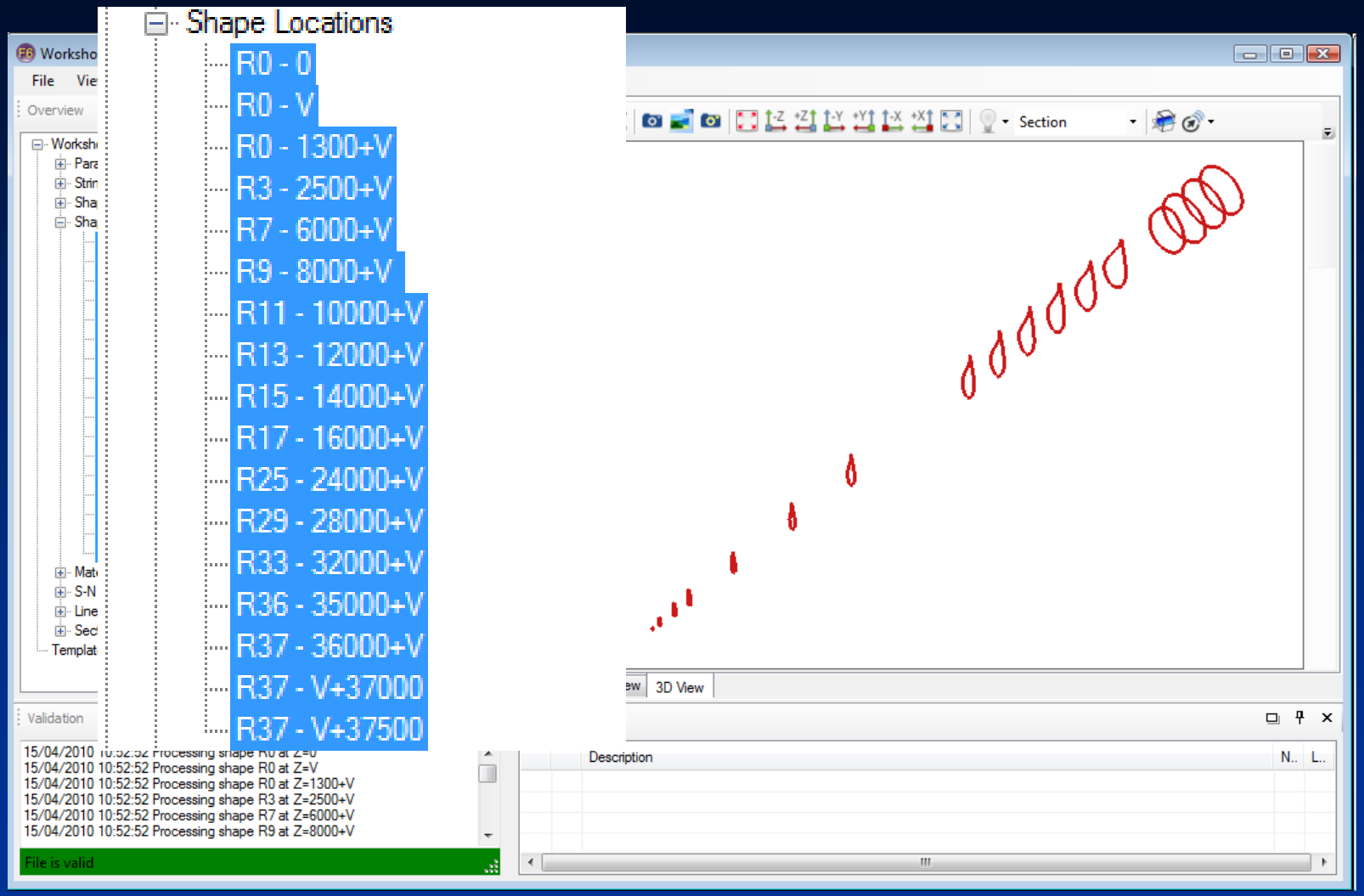
Define Shapes



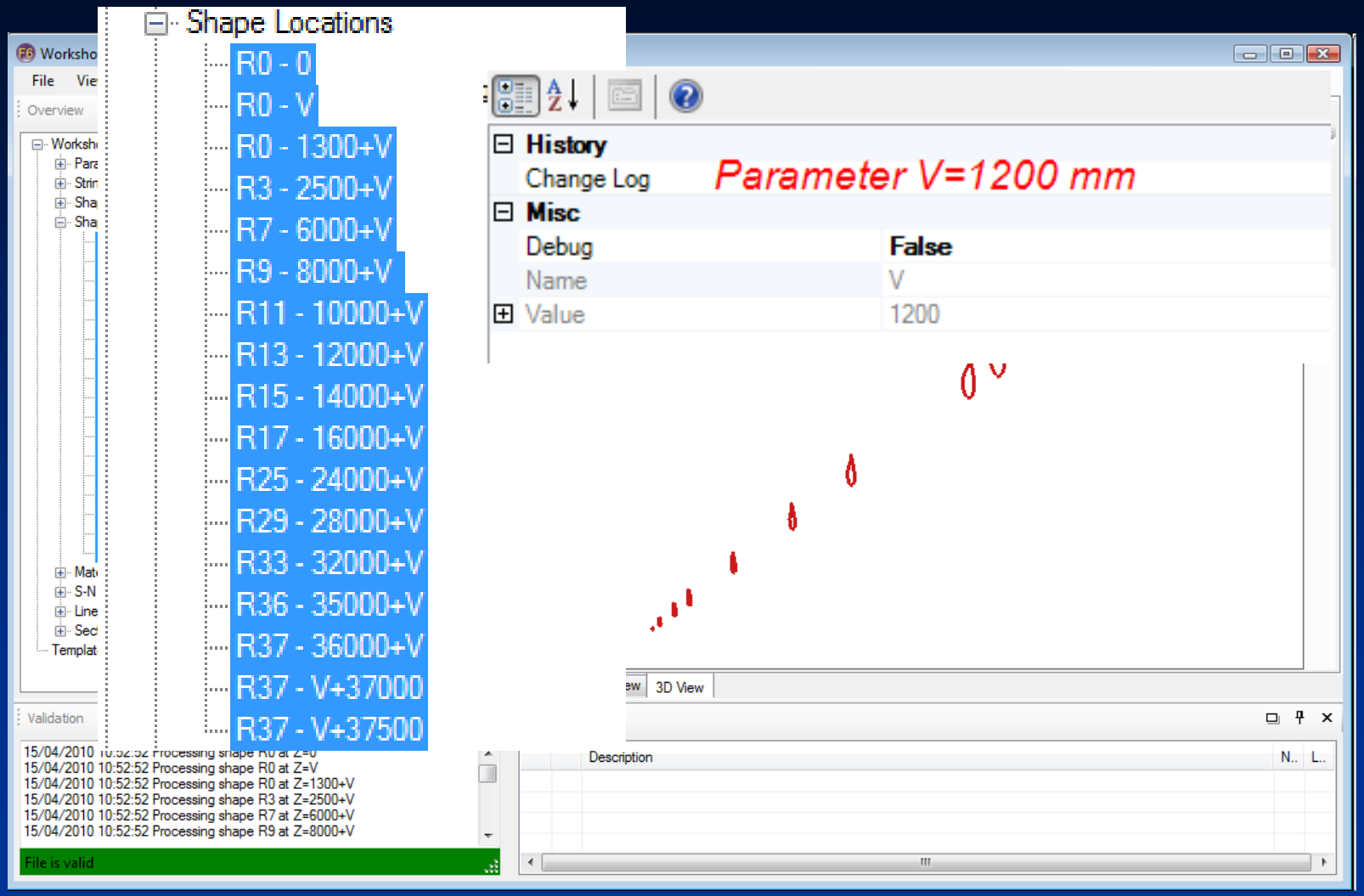
Define Blade: Place Shapes



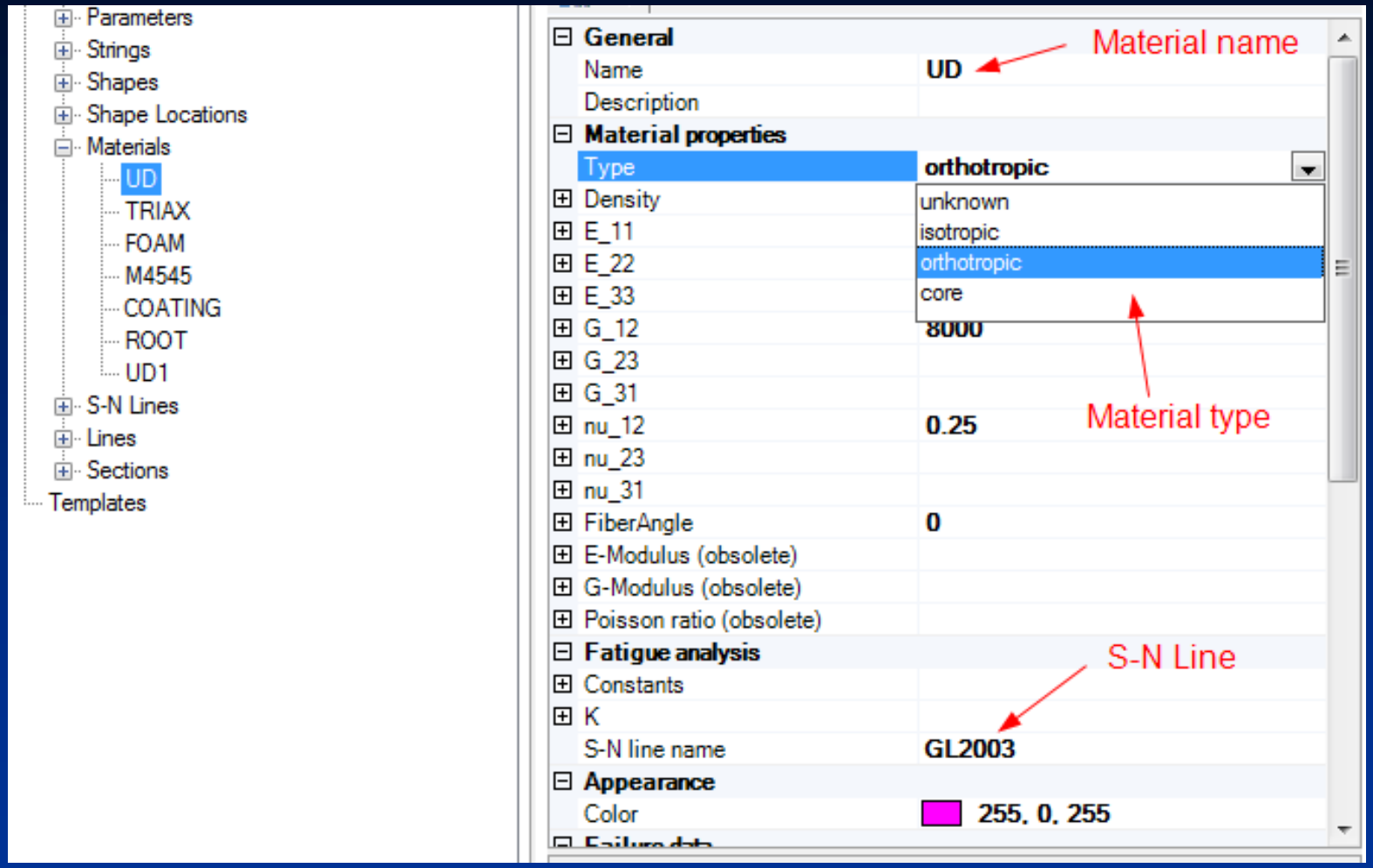
Define Blade: Place Shapes



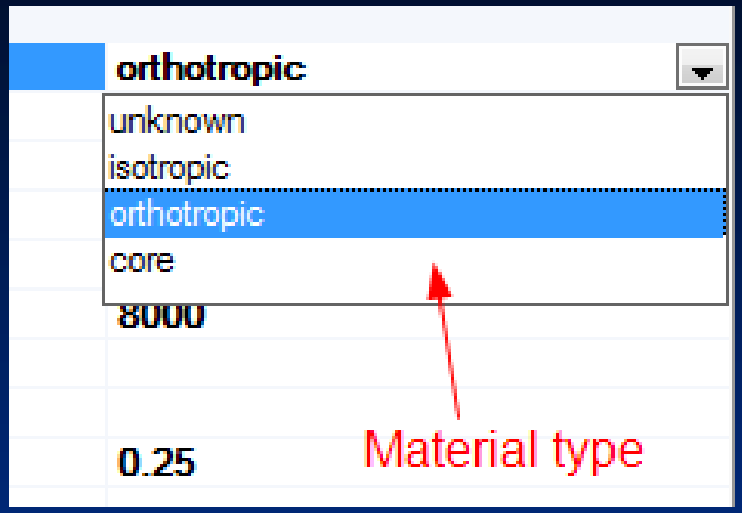
Define Blade: Place Shapes



Define Materials



Define Materials



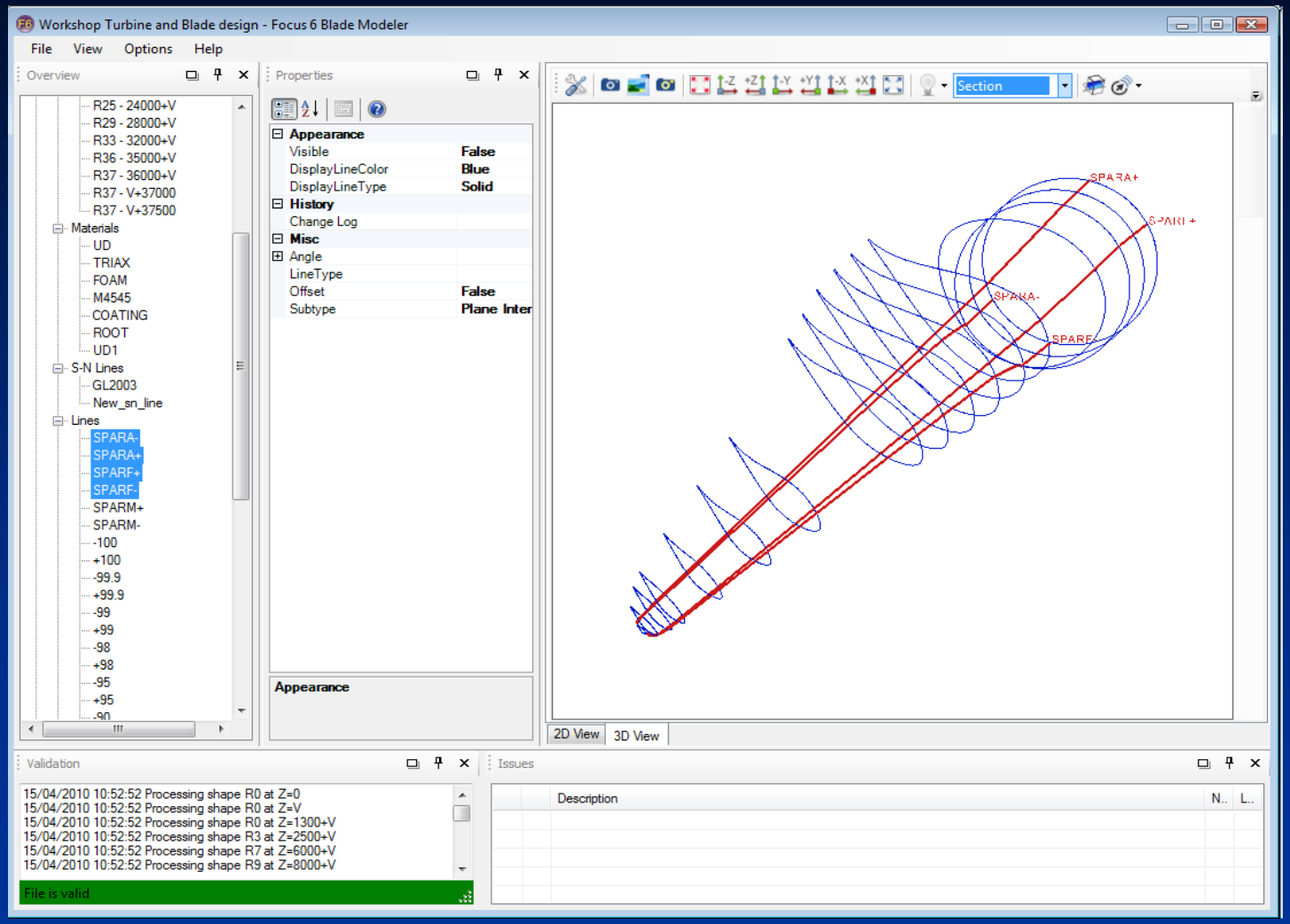
Define Materials

General	
Name	**GL2003**
Description	**test**
S-N line branches	
Branch	((UTS+ABS(UCS)-ABS(2*GMa*Smean-UTS+ABS(UCS)))/(2*GMb*Samp))^SLOPE
History	
Change Log	**08/06/2010 14:55:57 richard row(4) SNLine_lines=**
Misc	
Constants	
Debug	**False**
REDUCTION NEN2063	**False**

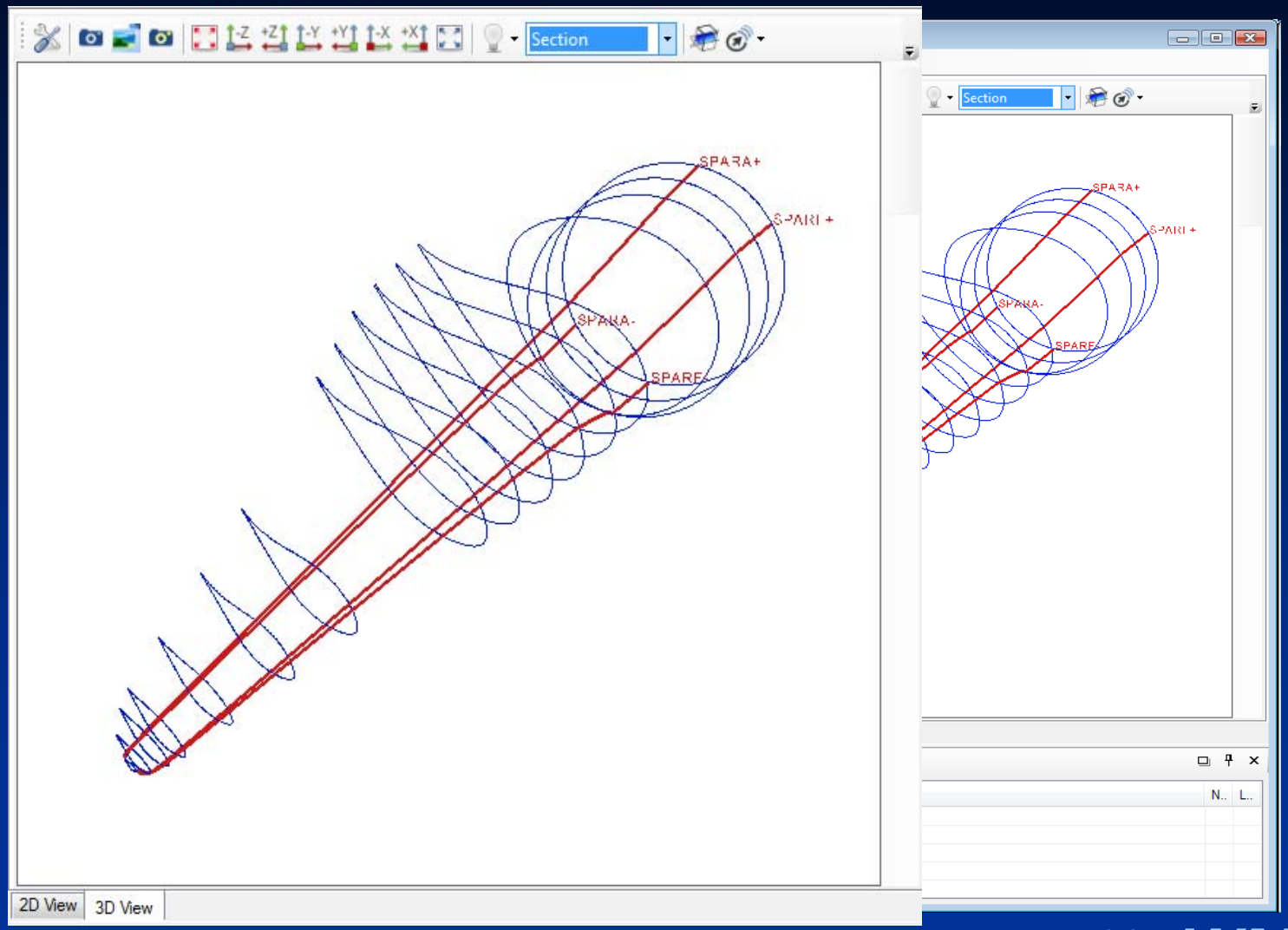
S-N Line name

Goodman diagram fatique formulation

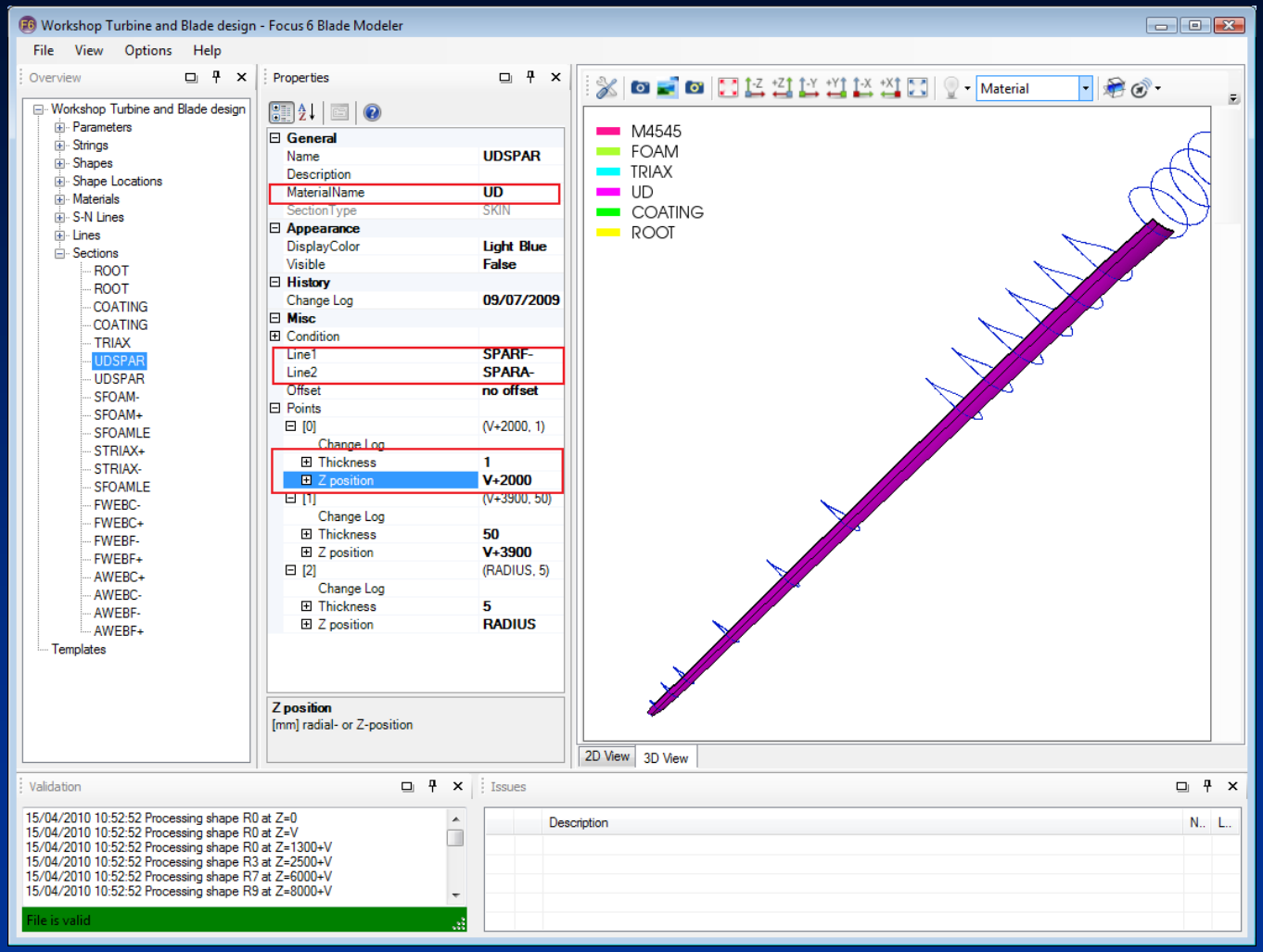
Define Material Boundary Lines



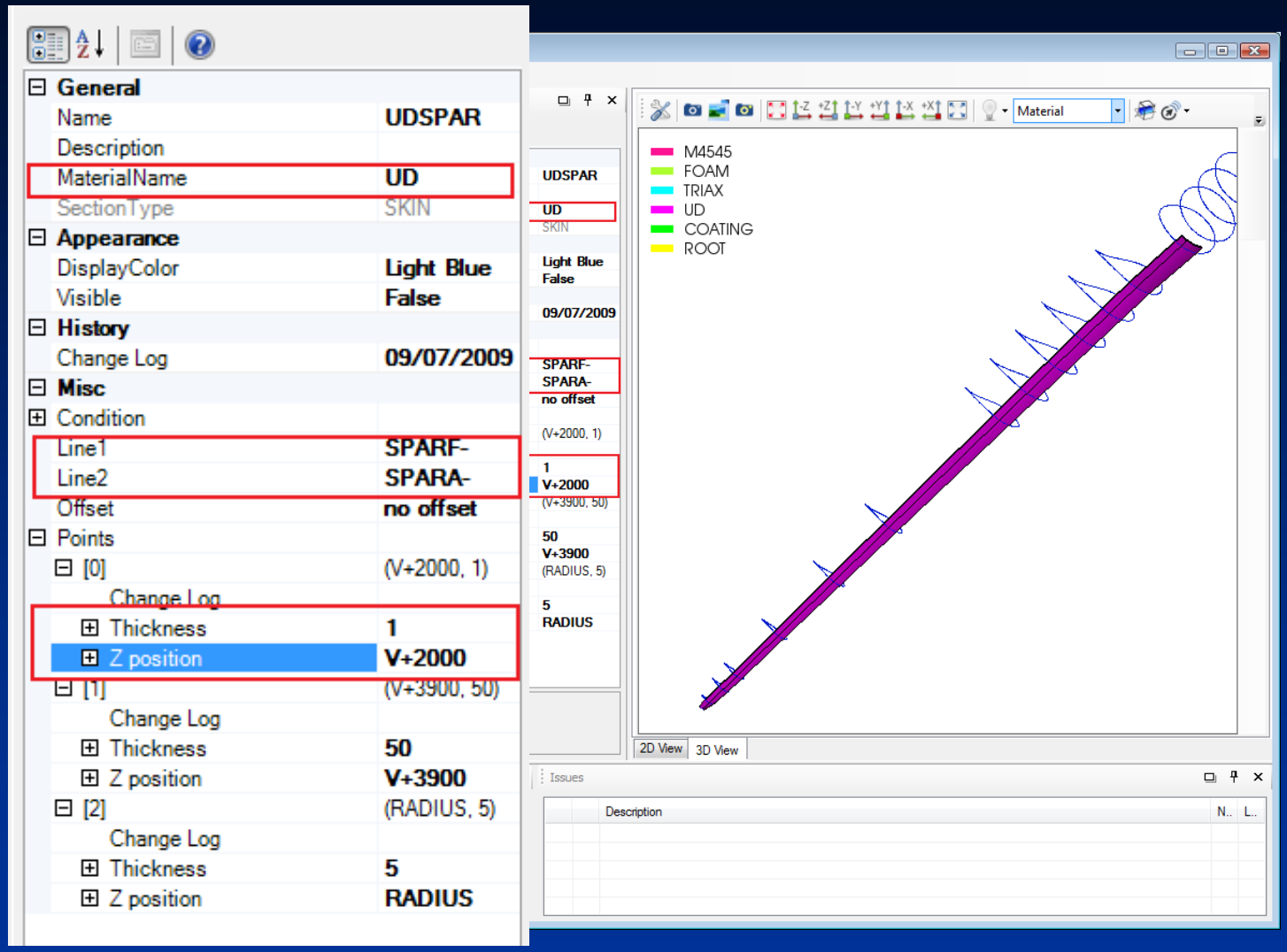
Define Material Boundary Lines



Place ‘Sections’ of Material

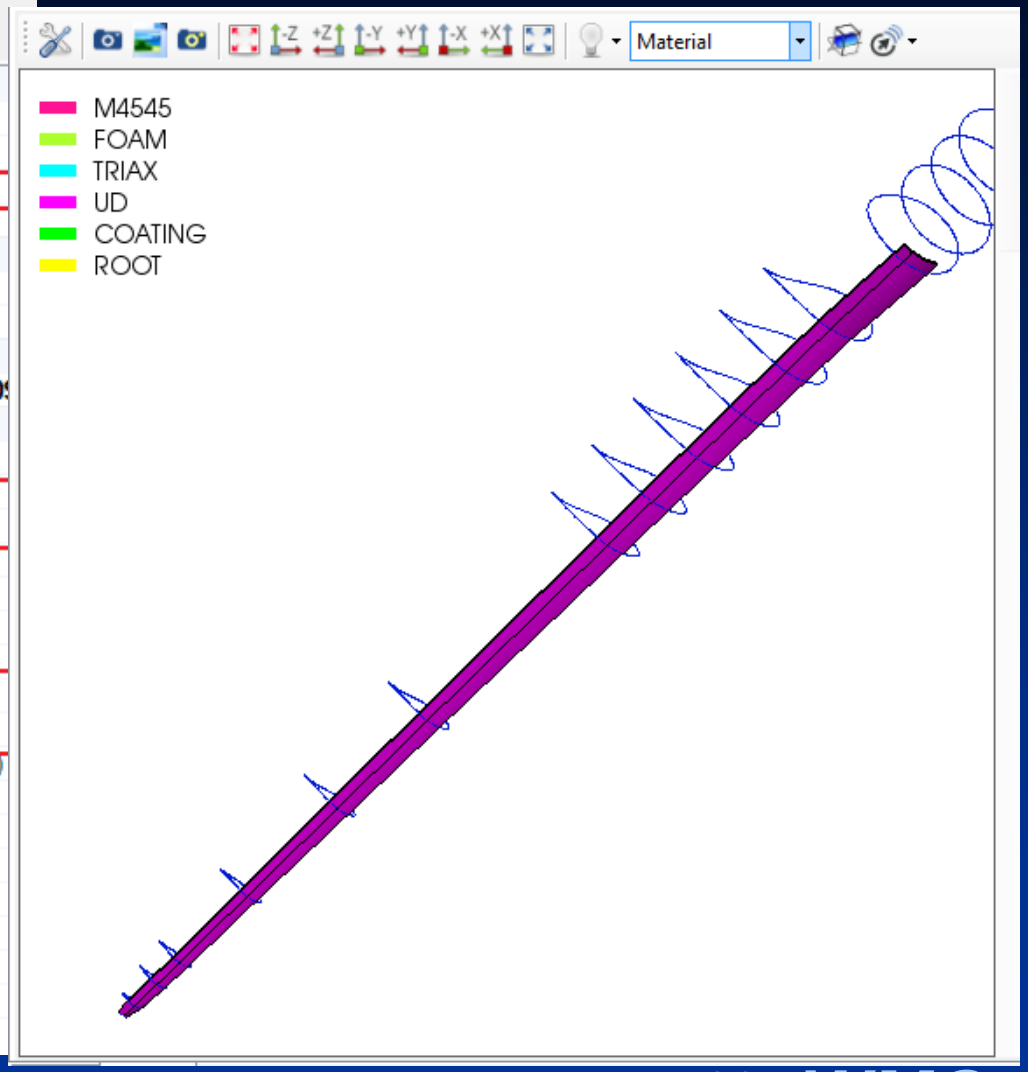


Place ‘Sections’ of Material

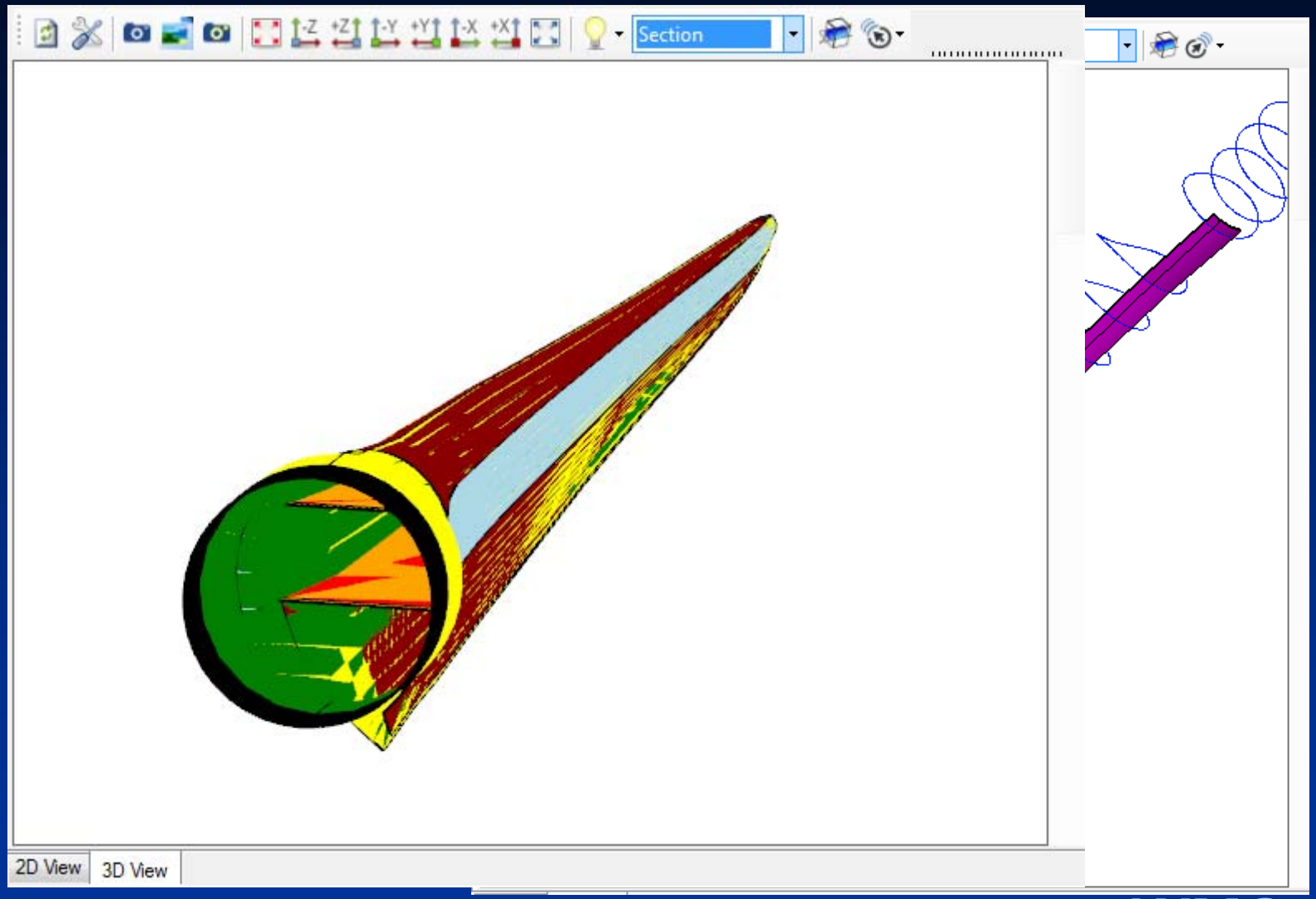


Place ‘Sections’ of Material

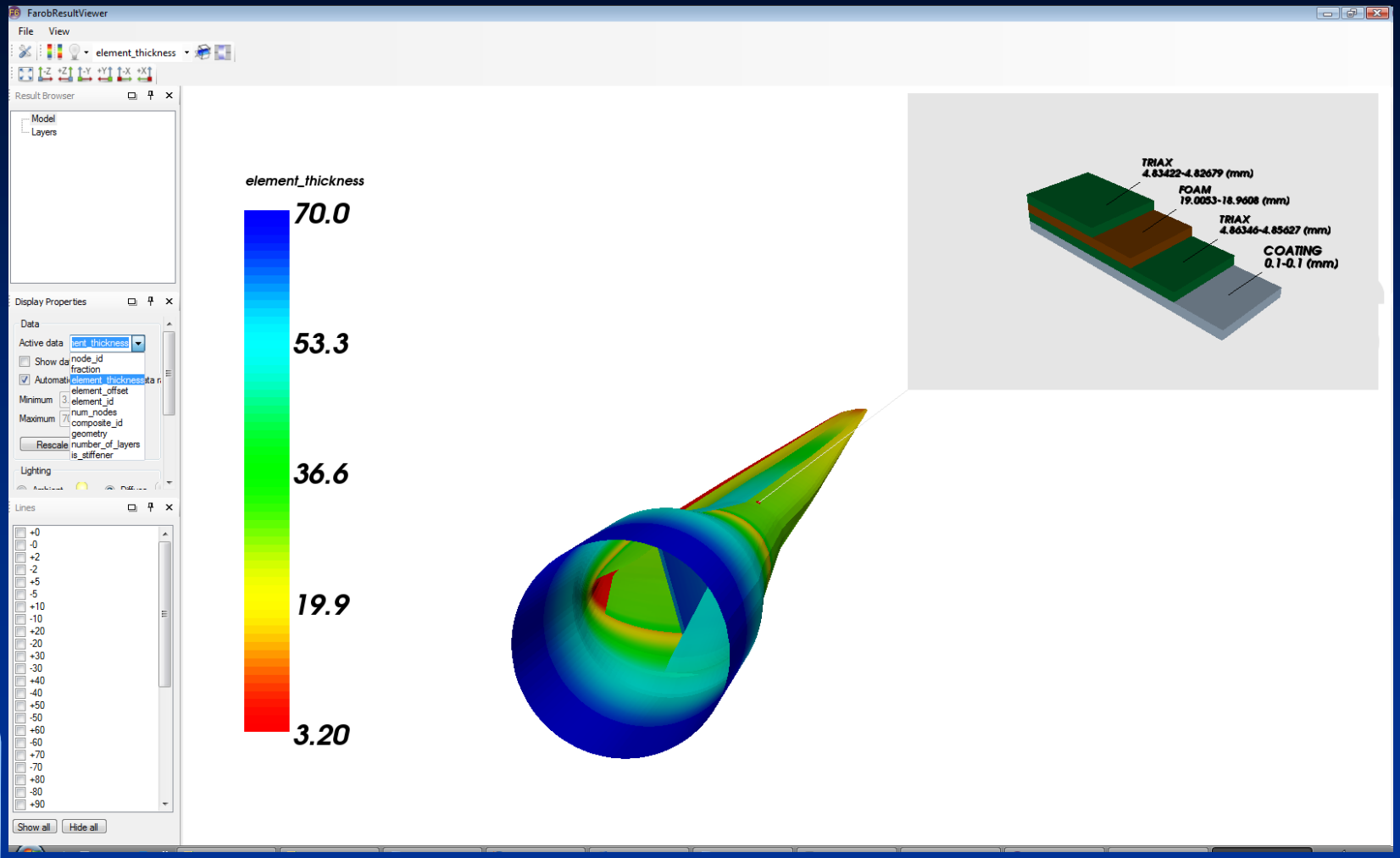
General	
Name	**UDSPAR**
Description	
MaterialName	**UD**
SectionType	SKIN
Appearance	
DisplayColor	**Light Blue**
Visible	**False**
History	
Change Log	**09/07/200**
Misc	
Condition	
Line1	**SPARF-**
Line2	**SPARA-**
Offset	**no offset**
Points	
[0]	(V+2000, 1)
Change Log	
Thickness	**1**
Z position	**V+2000**
[1]	(V+3900, 50)
Change Log	
Thickness	**50**
Z position	**V+3900**
[2]	(RADIUS, 5)
Change Log	
Thickness	**5**
Z position	**RADIUS**



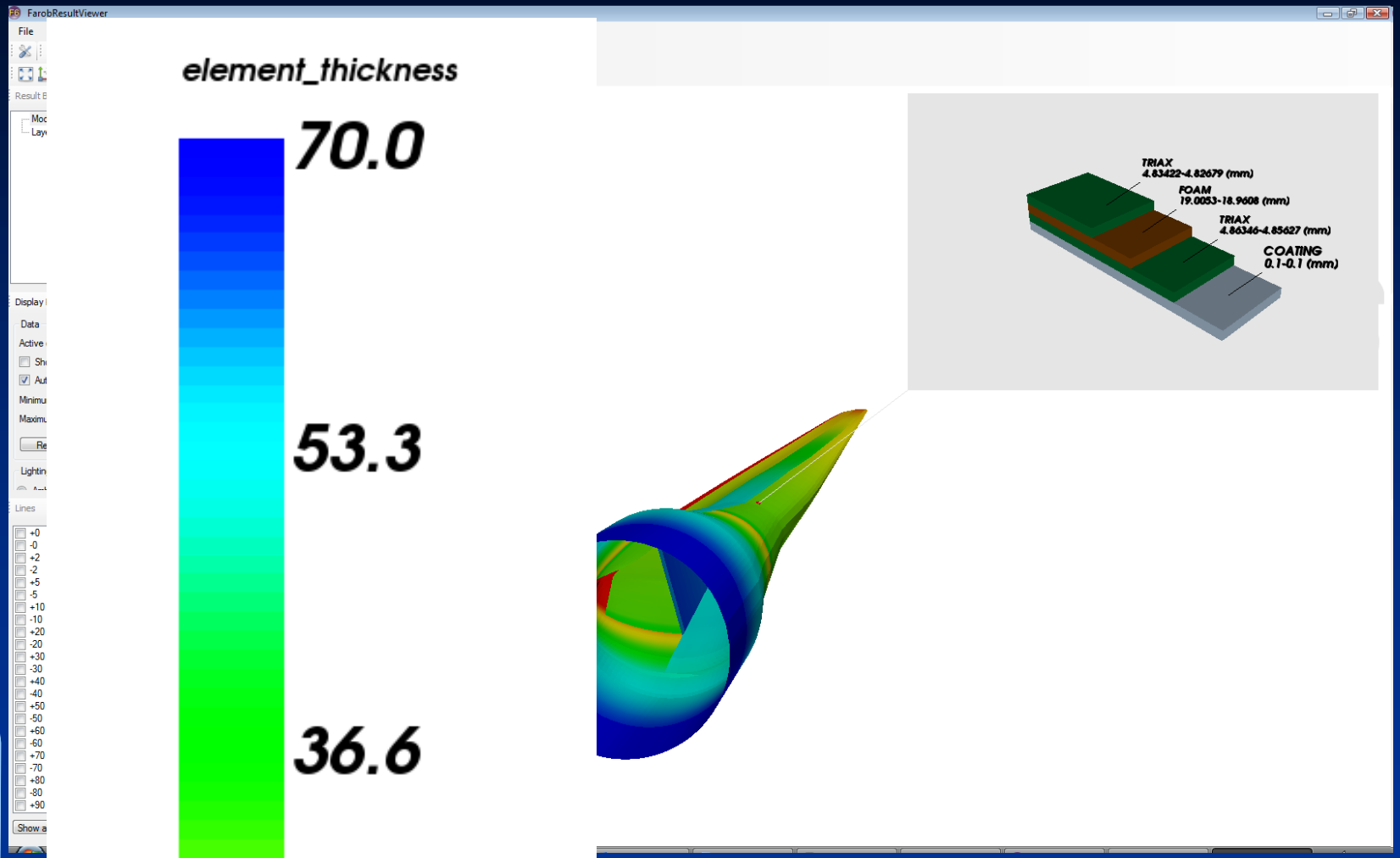
Place ‘Sections’ of Material



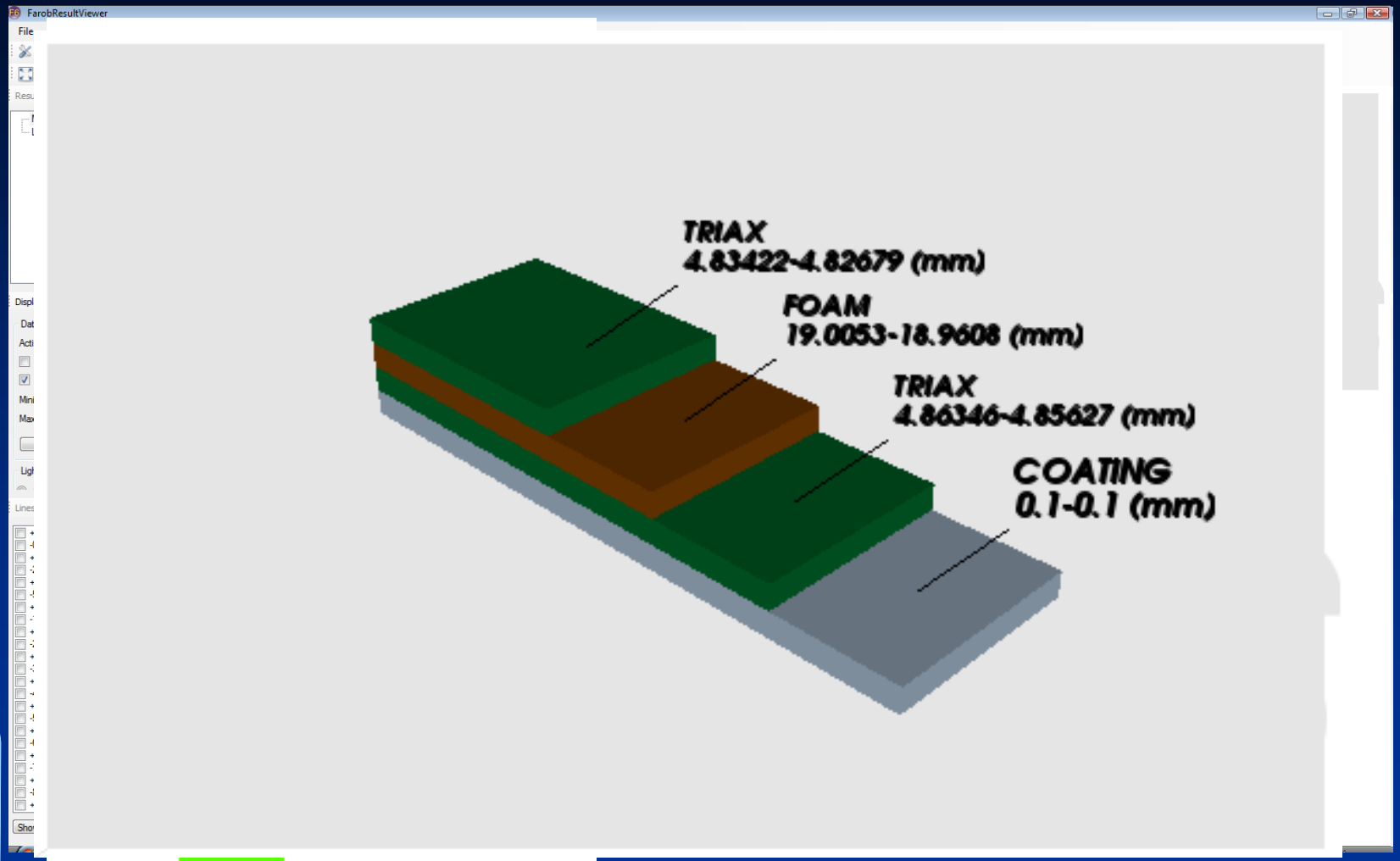
Verify Parsed Blade Model



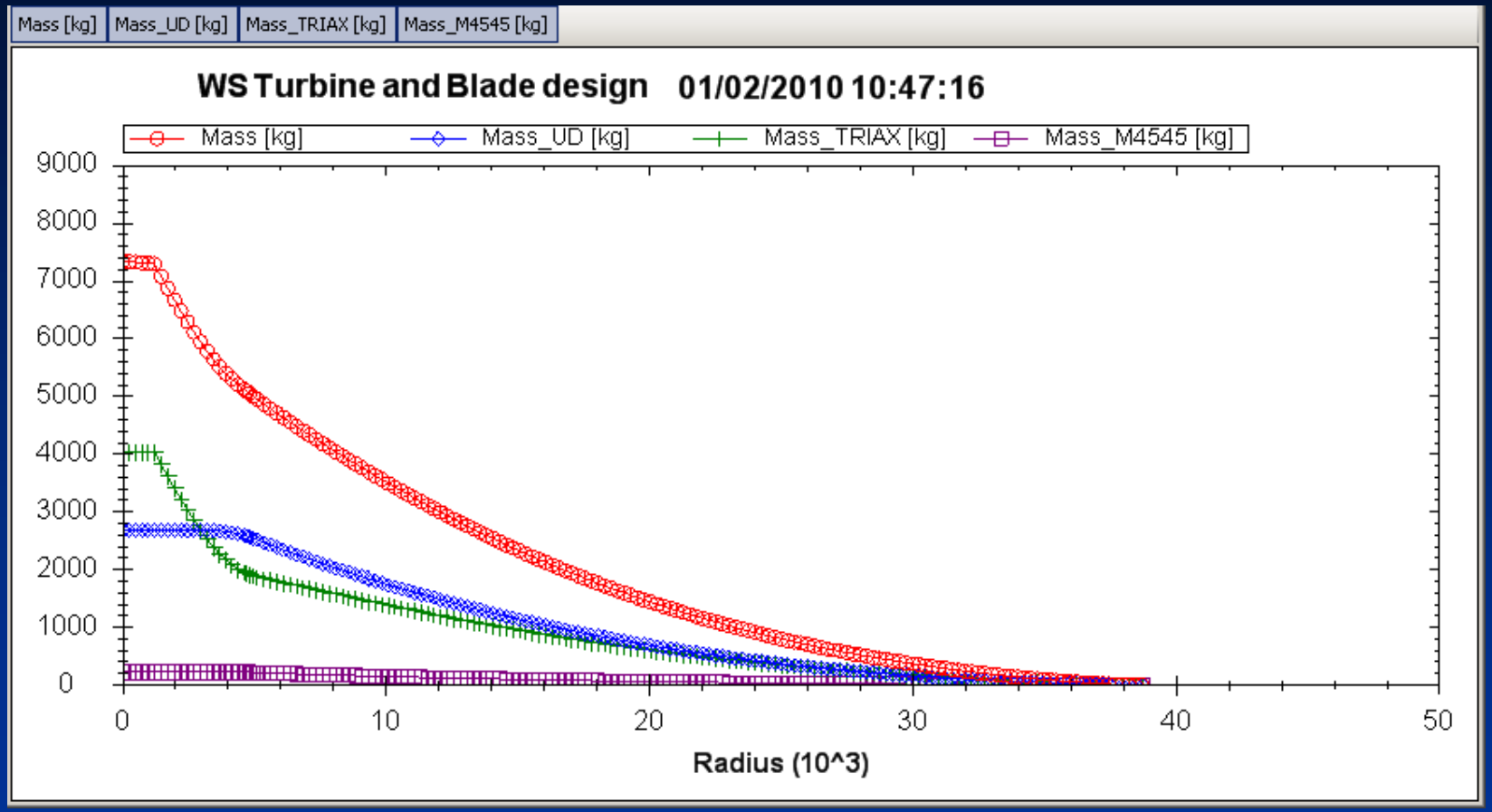
Verify Parsed Blade Model



Verify Parsed Blade Model



Verify Parsed Blade Model

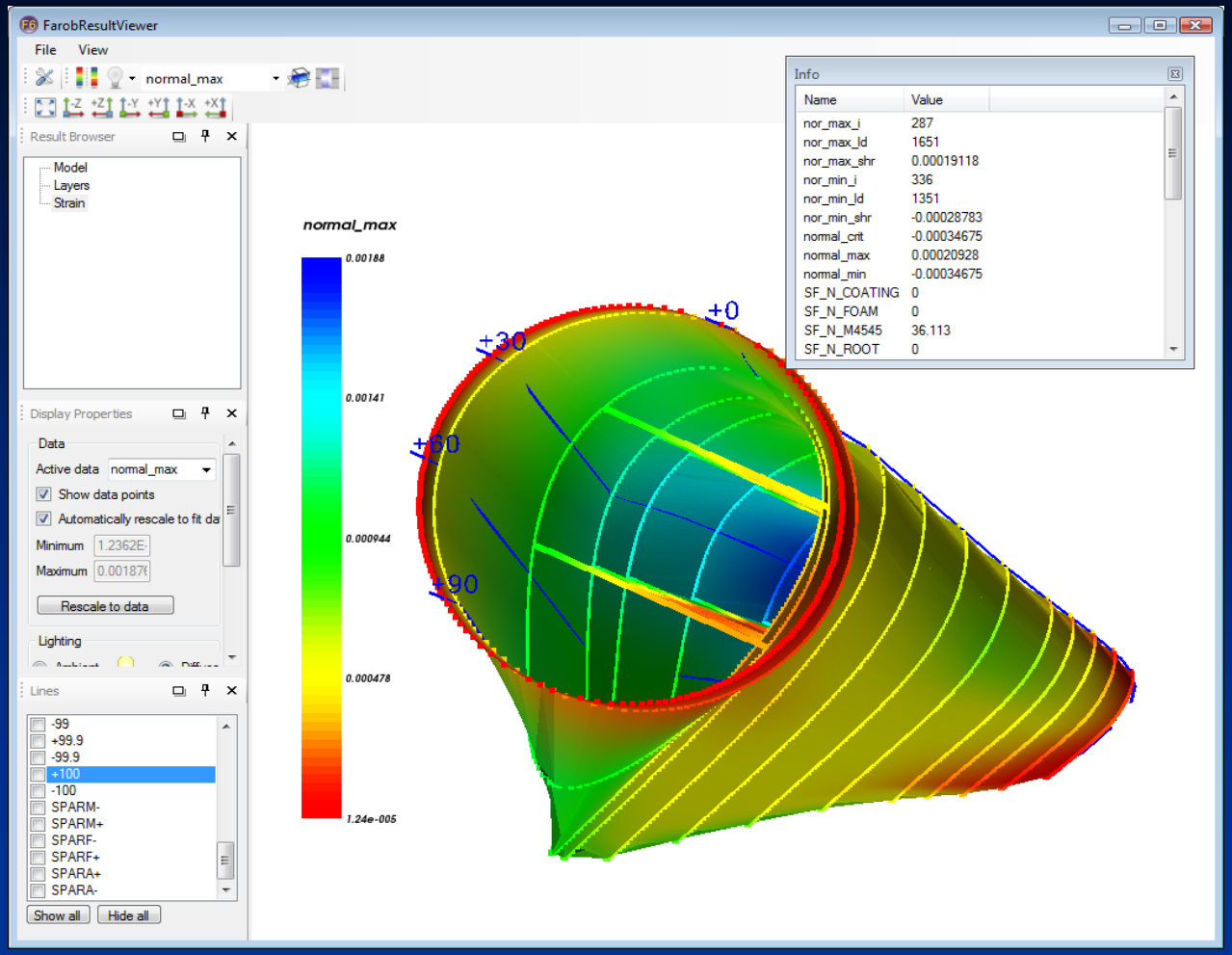


Blade mass distribution per material

3D visualization of analysis results

- **Strain based analysis results**
  - Overall minimum / maximum normal and shear strains for a full load set
  - Static reserve factors per material
    - Compression
    - Tension
    - Shear
- **Fatigue analysis results (fatigue reserve factors)**

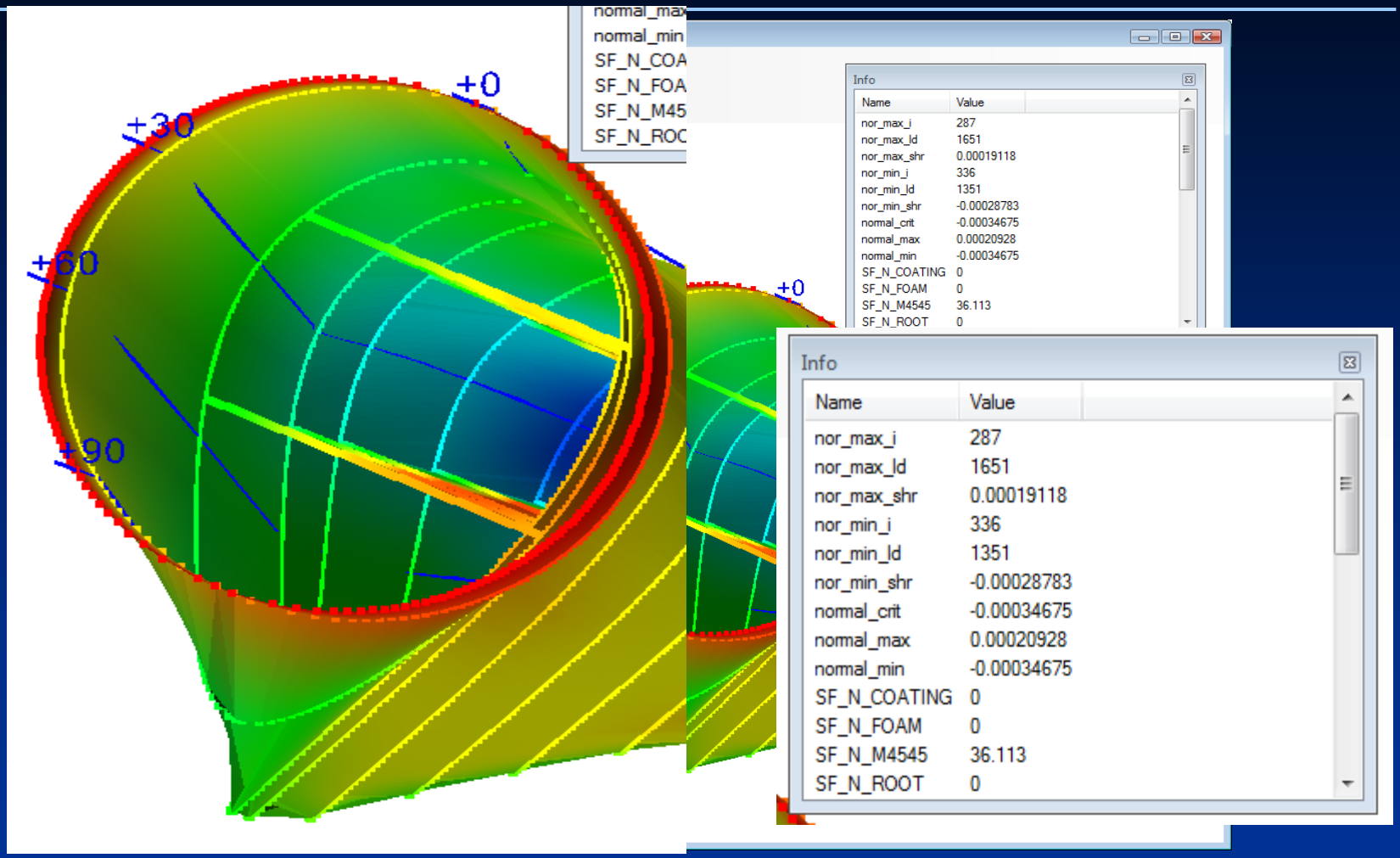
3D interactive view



Maximum normal strain plot

Similar plot to show fatigue reserve factors

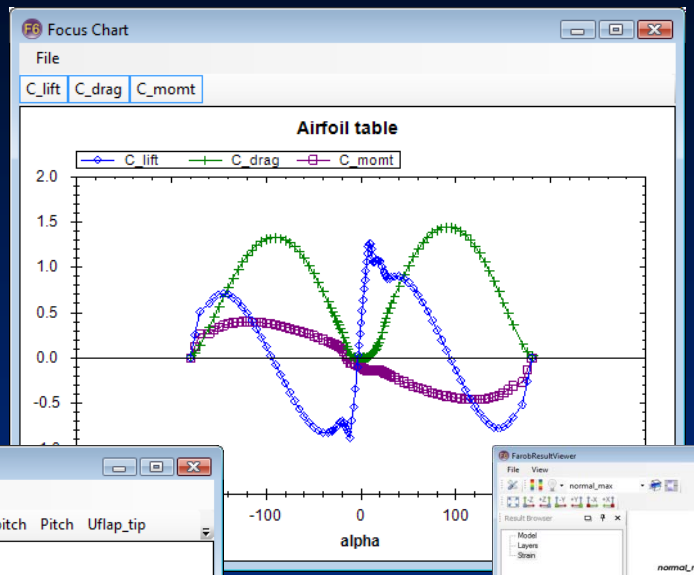
3D interactive view



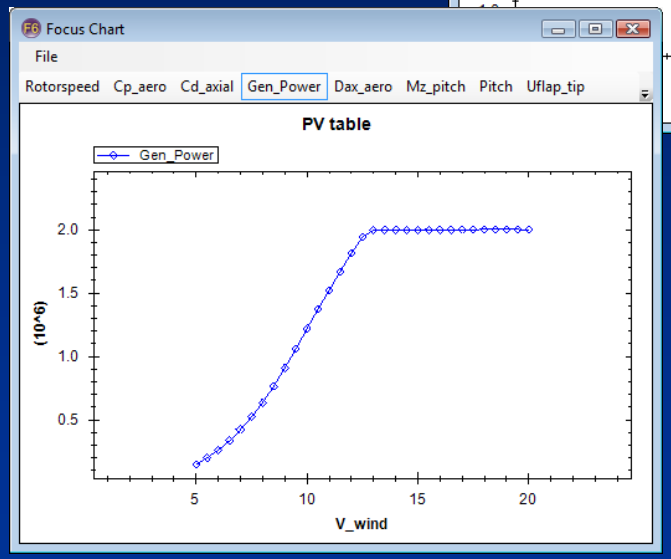
Maximum normal strain plot

Similar plot to show fatigue reserve factors

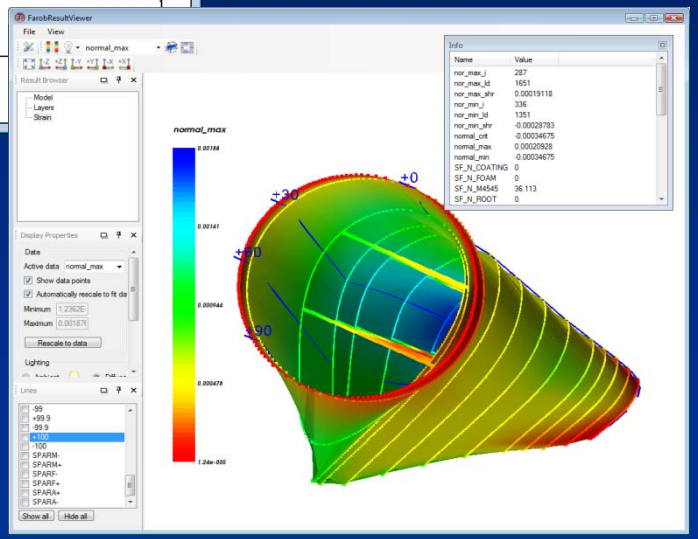
Visualization of data and results



Airfoil data

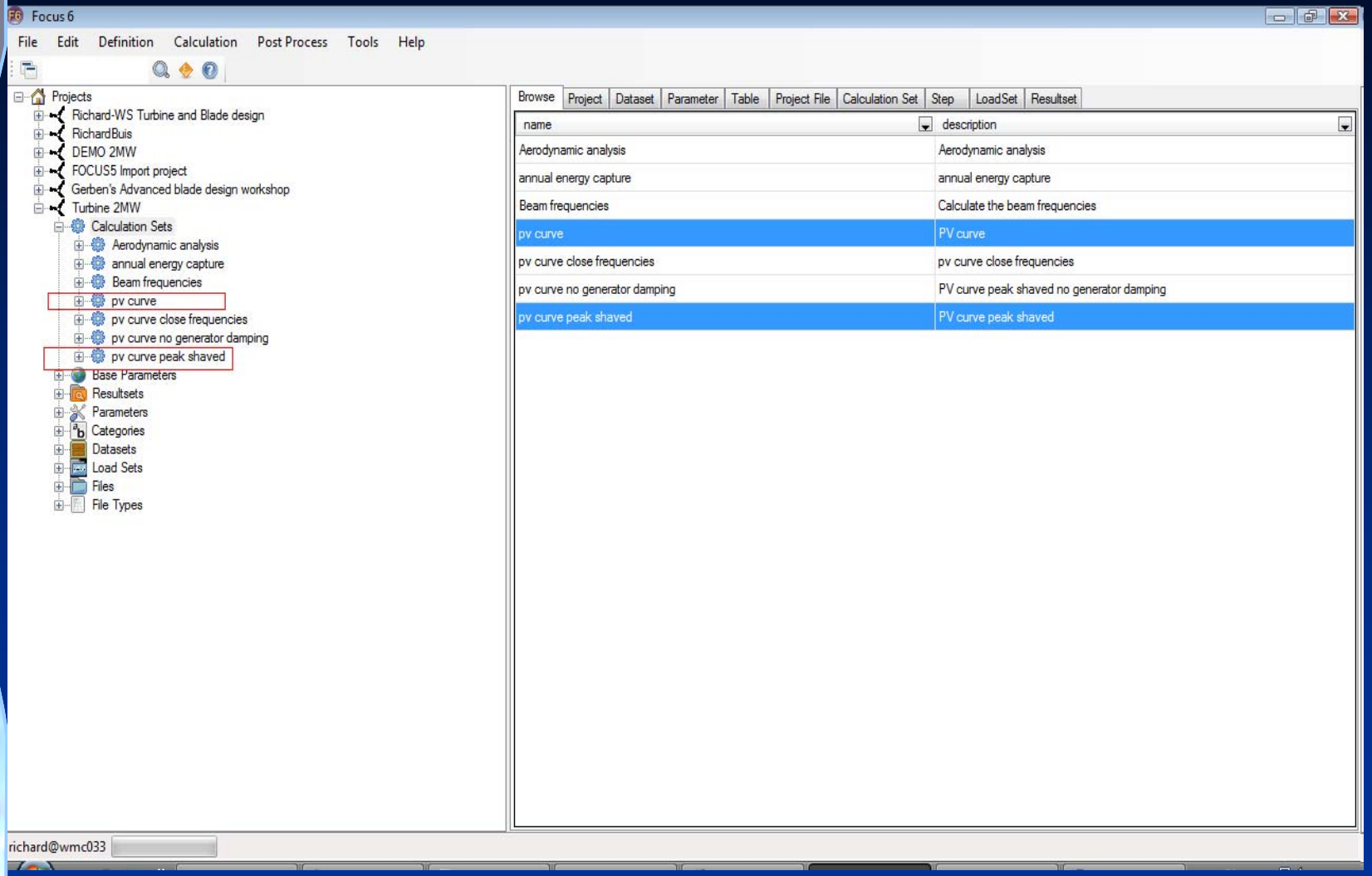


PV curve

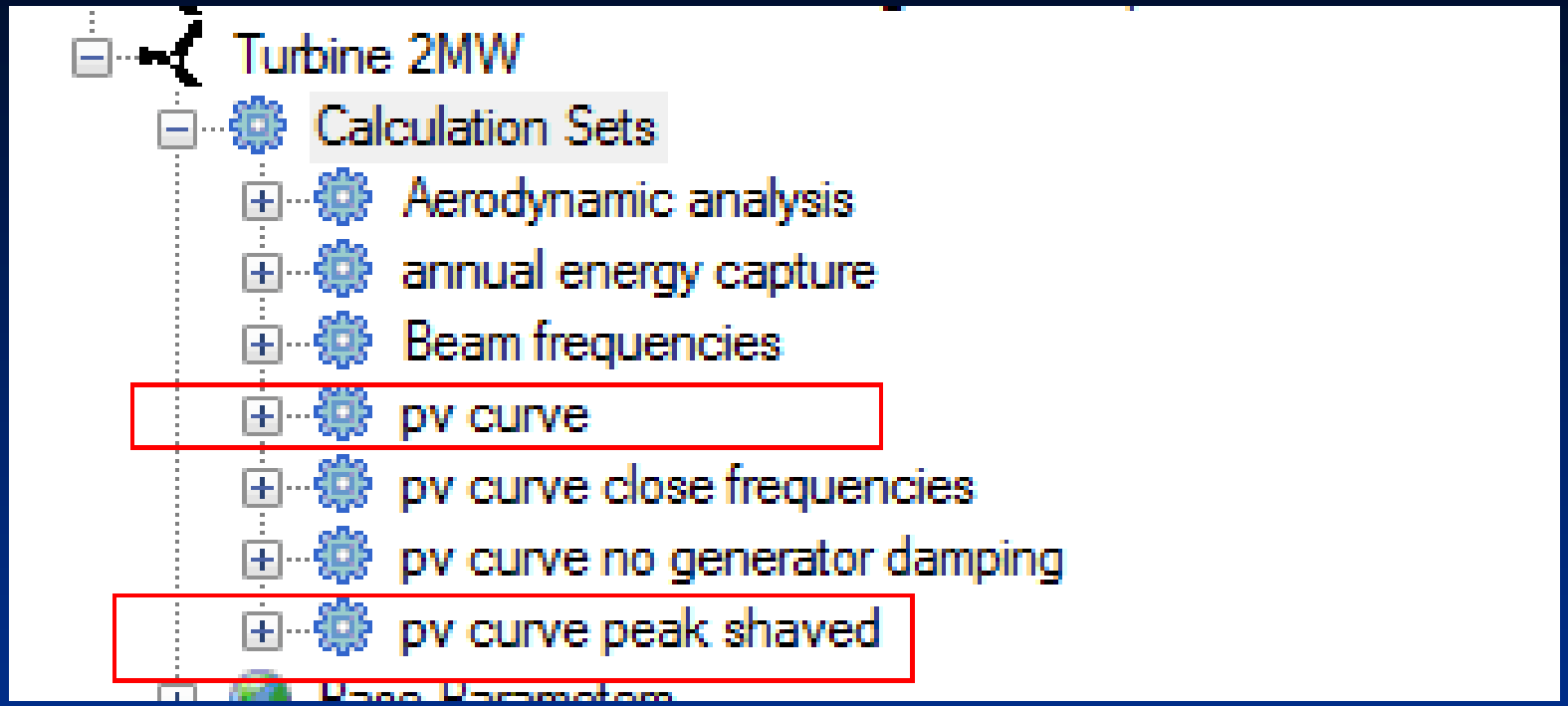


Max normal strain

Comparing Calculation Results



Comparing Calculation Results



Comparing Calculation Results

Chart Wizard

Chart Wizard

Select Loadcases JOBOUT

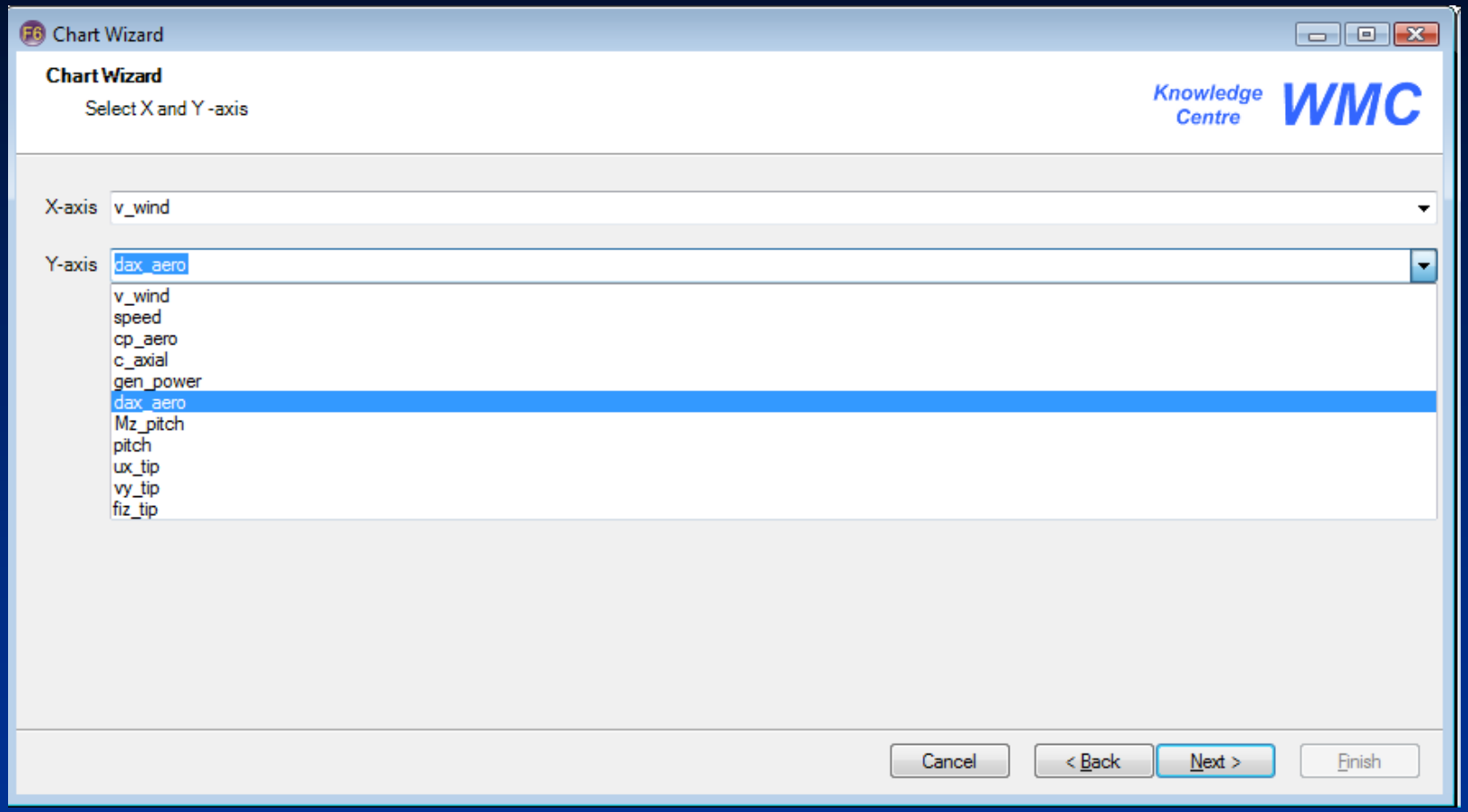
Knowledge Centre WMC

In the table below, please select the loadcases

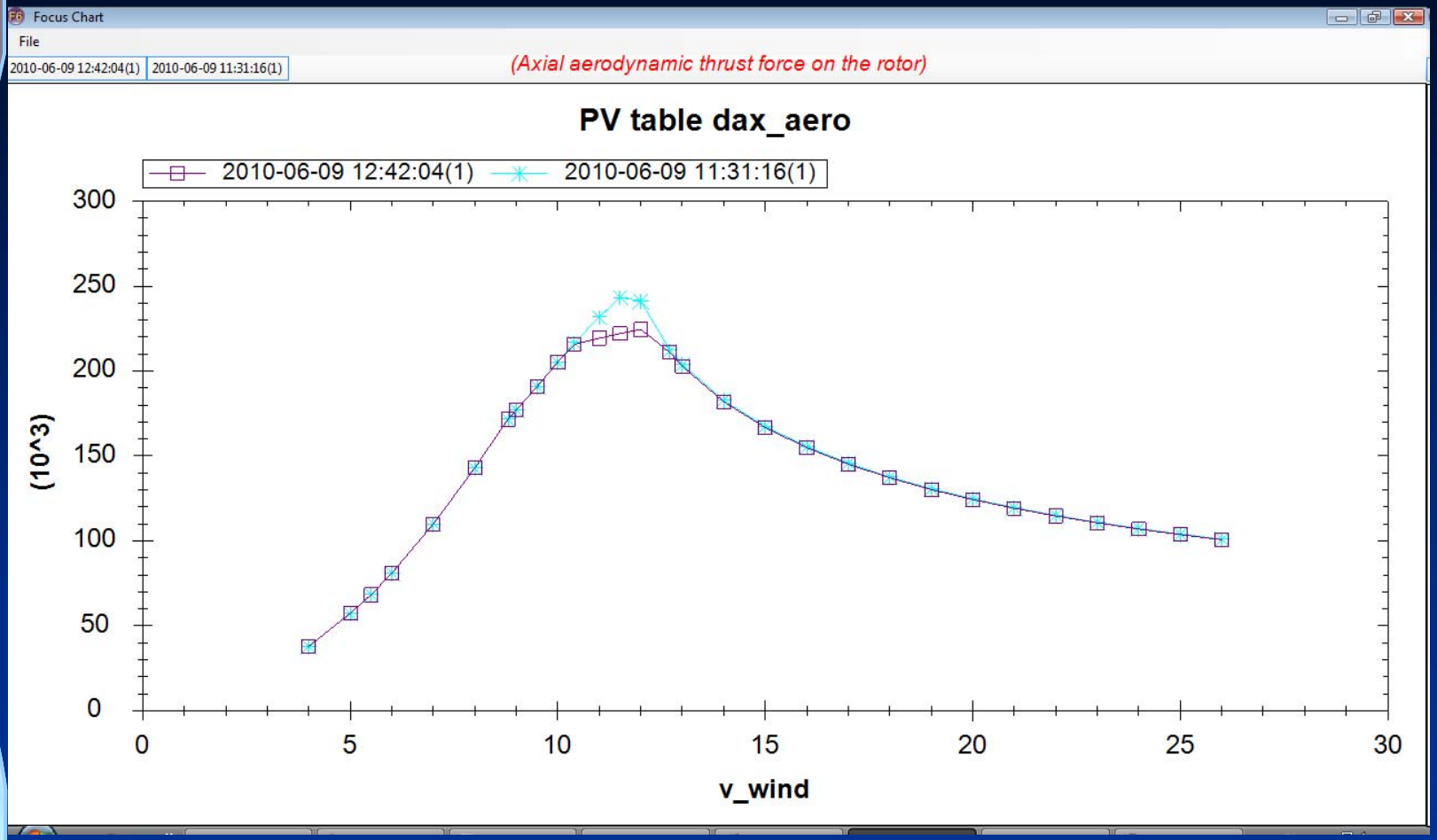
loadcase	program	calculation	run_date	order_no	event_date	description
None	BLADMODE	Aerodynamic analysis	2010/06/08 11:30:12	1	2010/06/08 11:30:13	No loadcase
None	BLADMODE	Aerodynamic analysis	2010/06/08 10:25:27	1	2010/06/08 10:25:28	No loadcase
None	Bladmode Annual energy capture	annual energy capture	2010/06/09 11:57:04	1	2010/06/09 11:59:47	No loadcase
None	BLADMODE	Beam frequencies	2010/06/07 15:05:07	1	2010/06/07 15:05:08	No loadcase
None	BLADMODE	Beam frequencies	2010/06/07 15:03:40	1	2010/06/07 15:03:41	No loadcase
None	BLADMODE	Beam frequencies	2010/06/07 14:51:22	1	2010/06/07 14:51:23	No loadcase
None	BLADMODE	pv curve	2010/06/09 11:31:16	1	2010/06/09 11:31:17	No loadcase
None	BLADMODE	pv curve close frequencies	2010/06/09 14:16:05	1	2010/06/09 14:16:06	No loadcase
None	BLADMODE	pv curve no generator damping	2010/06/09 14:02:13	1	2010/06/09 14:02:14	No loadcase
None	BLADMODE	pv curve peak shaved	2010/06/09 12:42:04	1	2010/06/09 12:42:05	No loadcase

Cancel | < Back | Next > | Finish

Comparing Calculation Results

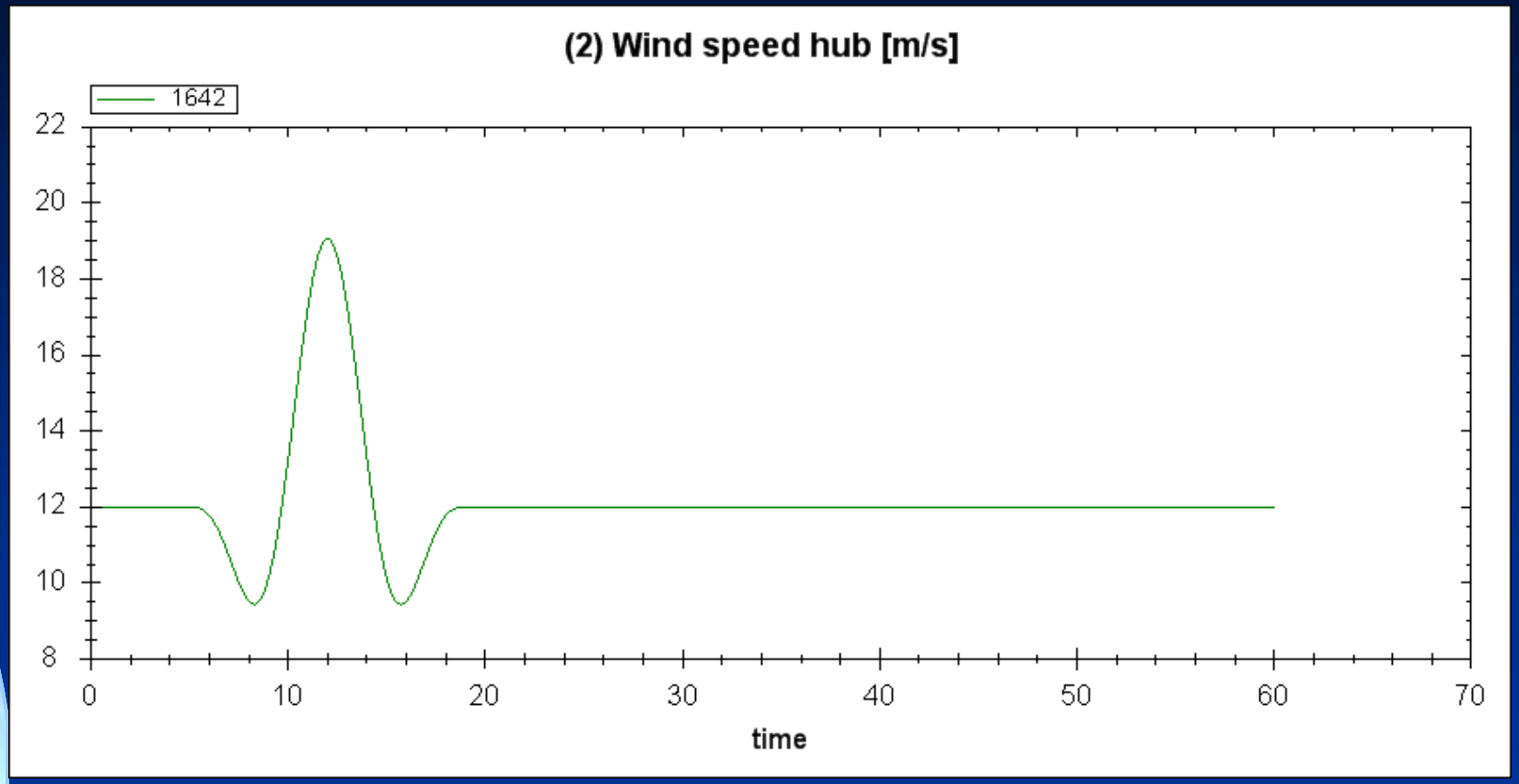


Comparing Calculation Results



Plotting (GL) Loadcase Results

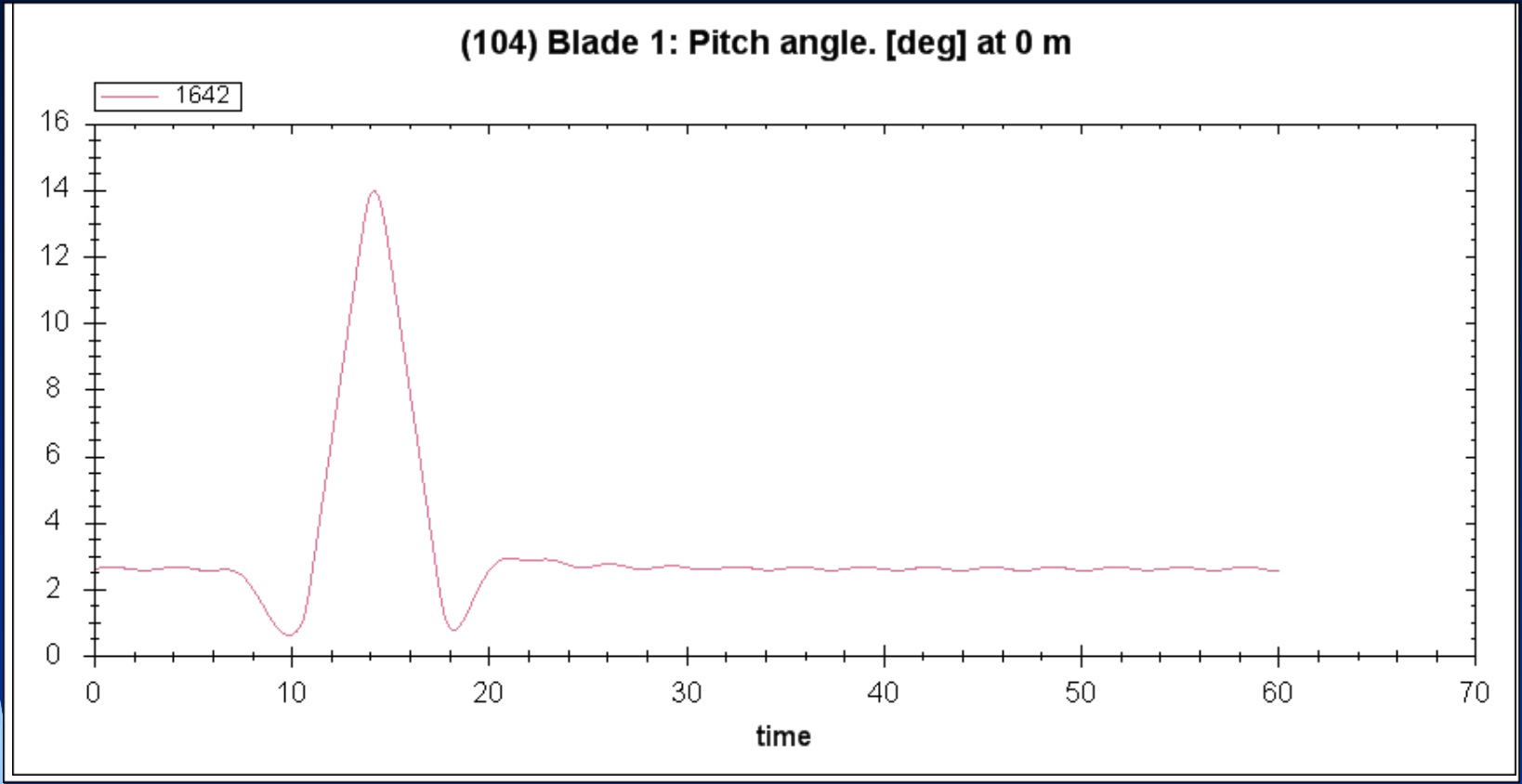
Extreme operating gust (50 years at rated wind)



Knowledge Centre WMC
Wind turbine Materials and Constructions

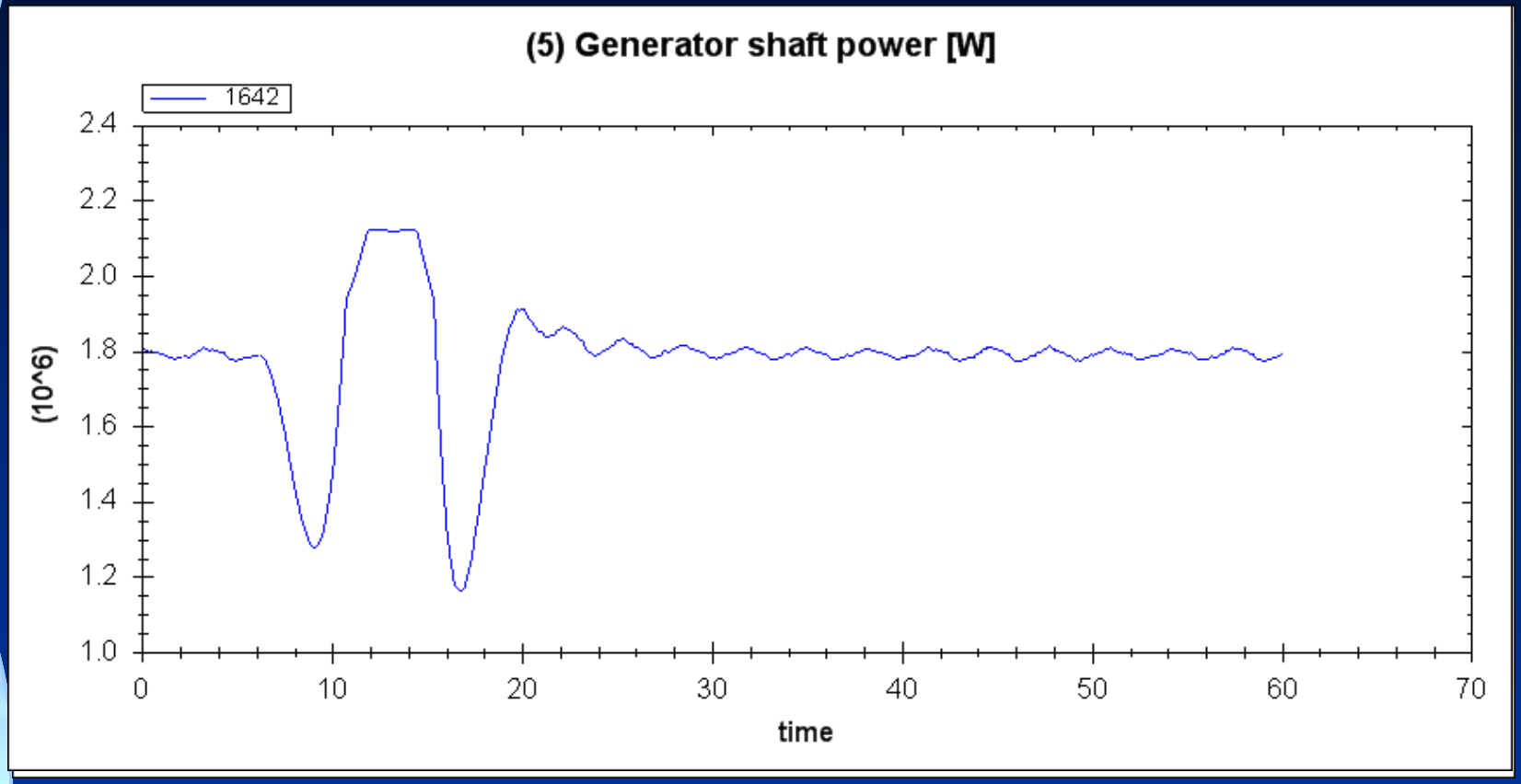
Plotting (GL) Loadcase Results

Extreme operating gust (50 years at rated wind)



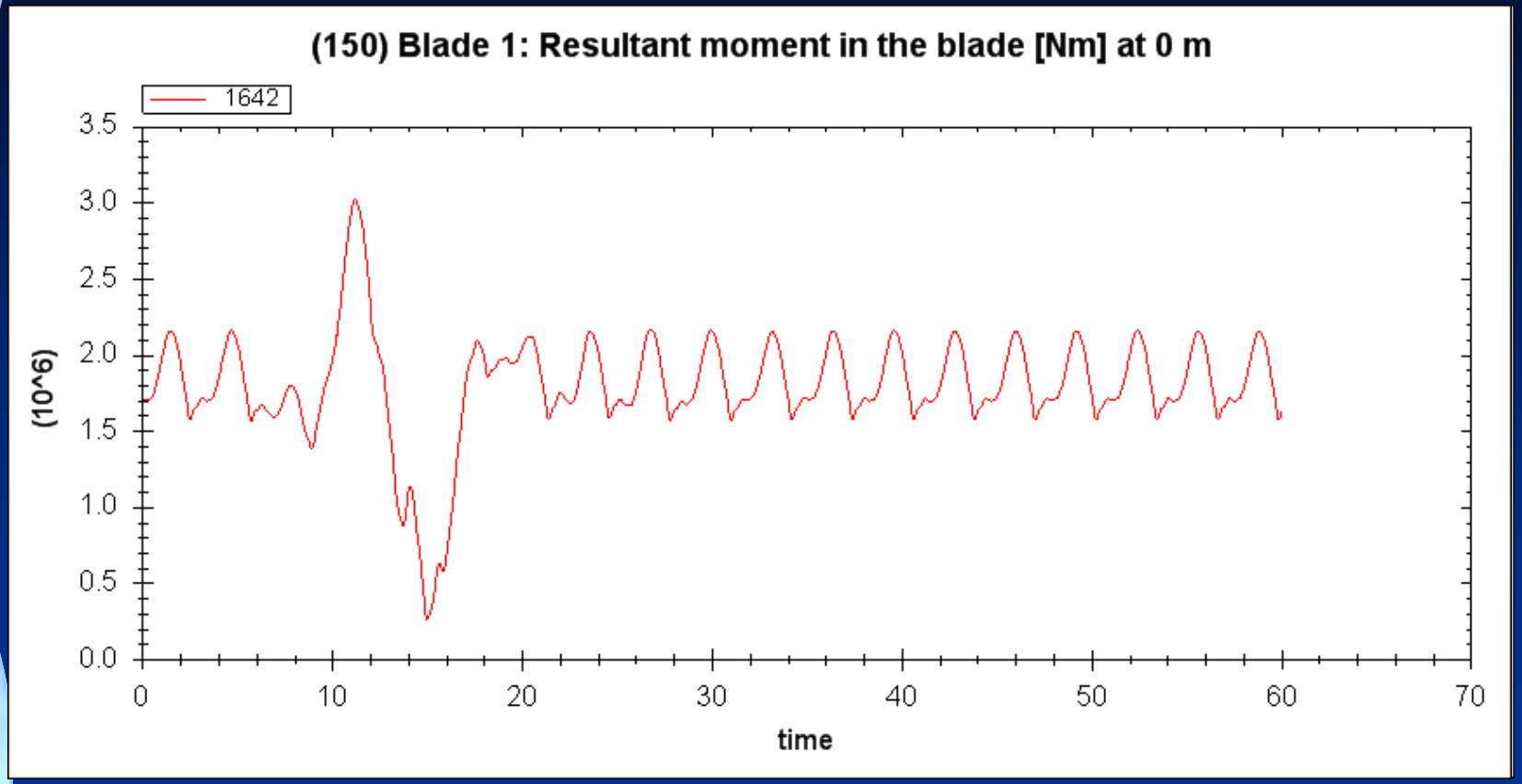
Plotting (GL) Loadcase Results

Extreme operating gust (50 years at rated wind)



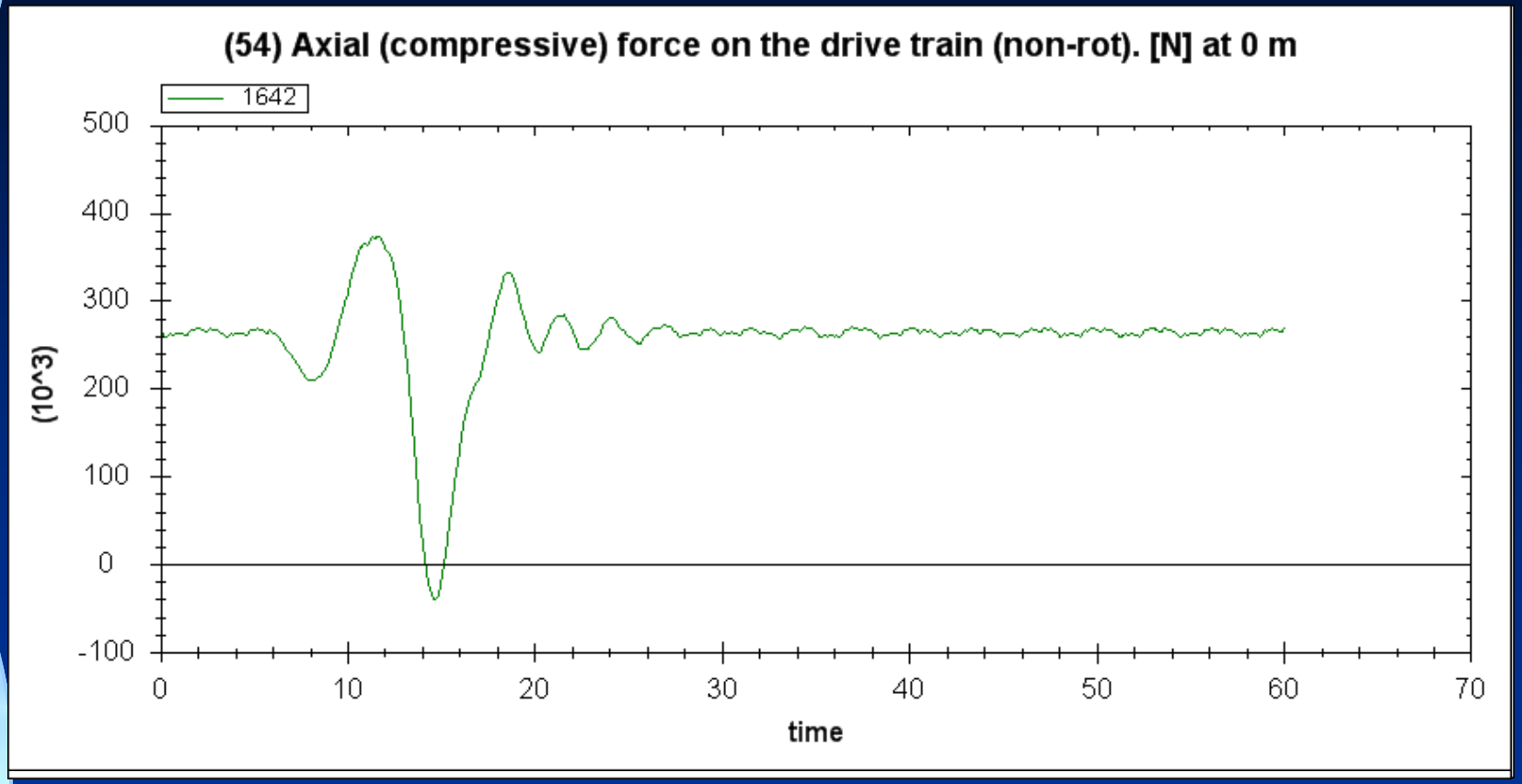
Plotting (GL) Loadcase Results

Extreme operating gust (50 years at rated wind)



Plotting (GL) Loadcase Results

Extreme operating gust (50 years at rated wind)



Knowledge Centre WMC
Wind turbine Materials and Constructions

GET FOCUSSED

WWW.WMC.EU / FOCUS6

Or mail

info@wmc.eu