DNV·GL

Bladed User Conference 2015

30 September 2015

Ungraded

 DNV GL © 2014

SAFER, SMARTER, GREENER

- Introduction
- User interface developments

Aims of the conference

- An opportunity for users and developers of Bladed to meet and interact
- To hear from your peers about interesting work going on in the industry
- More details about recently released features in Bladed
- A preview of upcoming features in Bladed
- **A chance for you to contribute to the future direction of Bladed**

The team

Patrick Rainey

William Sardar

Oliver Maunder

Menno Kloosterman

William Collier

Ricard Buils Urbano

Agenda

09:15	Bladed 5 update	Patrick Rainey
09:35	Multi-part (non-linear) blade feature in Bladed	William Collier
10:05	Non-linear blade comparison to measurements from Alstom turbines	Alstom Wind
10:30	Coffee Break	
10:50	Alpha Ventus M5000 load measurements and model validation	8.2 Consulting
11:15	Fixed Offshore modelling in Bladed	William Collier
11:40	Bladed scripting API	William Sardar
12:20	Lunch	
13:40	New BEM Aerodynamics and Vortex Line model	Menno Kloosterman
14:15	Wind turbine active power regulation and its behavior facing grid frequency events	Acciona Windpower
14:40	Running Bladed in the Cloud	Oliver Maunder
15:10	Coffee Break	
15:40	Integrating Bladed with Reliability based design methods	Ricard Buils Urbano
16:10	Other recent and future Bladed developments	Patrick Rainey
16:30	Q&A	All
17:00	Drinks reception	

Ungraded

The Bladed Vision

The vision for Bladed

To deliver wind turbine simulation software for the calculation of loading and performance, serving the needs of turbine design, turbine certification and operational assessment and optimisation.

- The needs of the turbine designer can be summarised as:
  - To model turbine dynamics in sufficient accuracy for design purposes
  - To run simulations as quickly as possible to facilitate design iterations
  - To specify and review the calculation inputs in such a way as to minimise errors
  - To view, report and analyse the results
  - To integrate their turbine simulations into the wider design activity

Five themes of Bladed development

- Modelling accuracy
- Simulation speed
- Input specification and review
- Results analysis
- Integration of design activity

Ungraded

Five themes of Bladed development

- Modelling accuracy
  - Multi-part blade 4.8 (Beta in 4.7)
  - New Aerodynamics 4.8 (Beta in 4.7)
- Simulation speed
- Input specification and review
- Results analysis
- Integration of design activity

Ungraded

Five themes of Bladed development

- Modelling accuracy
- Simulation speed
  - Bladed Cloud 4.8
  - Maintaining performance for multi-part blade and new aerodynamics 4.7
- Input specification and review
- Results analysis
- Integration of design activity

Ungraded

Five themes of Bladed development

- Modelling accuracy
- Simulation speed
- Input specification and review
  - MultiSetup 4.7
  - New Electrical Screen 4.7
  - New Tower Screen 4.9
  - Scripting API 4.8
- Results analysis
- Integration of design activity

Ungraded

Five themes of Bladed development

- Modelling accuracy
- Simulation speed
- Input specification and review
- Results analysis
  - Animation of results 4.8
  - Scripting API 4.8
- Integration of design activity

Ungraded

Five themes of Bladed development

- Modelling accuracy
- Simulation speed
- Input specification and review
- Results analysis
- Integration of design activity
  - Scripting API 4.8

Ungraded

Bladed User Interface Developments

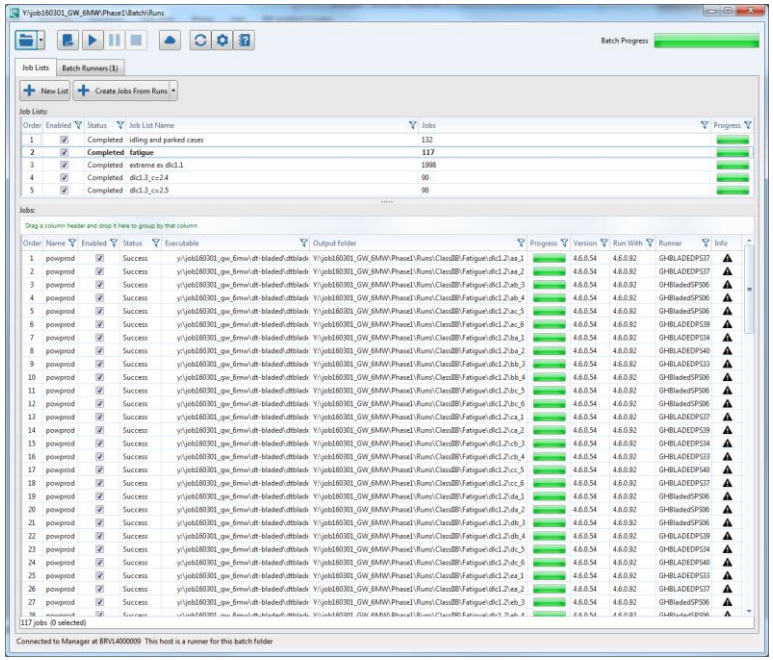
MultiSetup

Design load case (DLC):	1.1

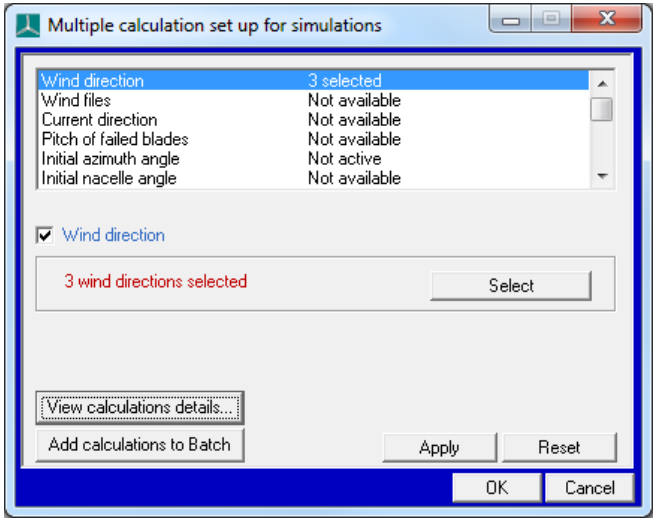
Design load case (DLC):	1.3
Operating condition:	Power production for extrapolation of extreme events
Wind conditions:	Normal turbulence model, $V_{in} < V_{hub} < V_{out}$

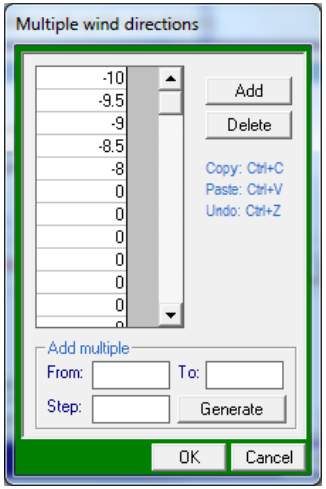
Description of simulations:

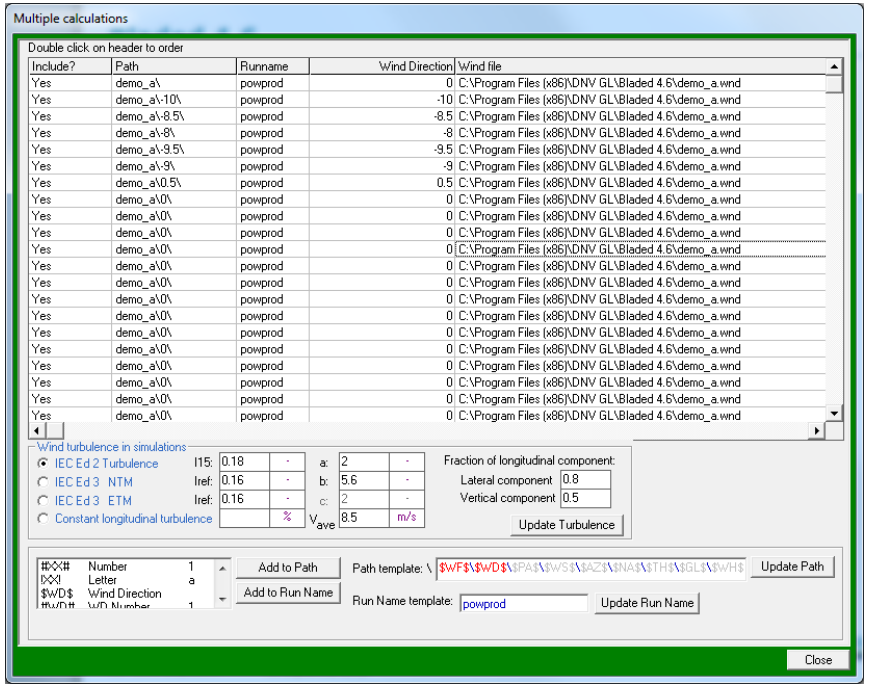
	Mean wind speed (m/s) (mid bin)	Longitudinal turbulence intensity (%)	Wind direction (deg)
aa	4	30.10	-8
ac			8
ba	6	26.93	-8
bc			8
ca	8	23.20	-8
cc			8



Bladed 4.6

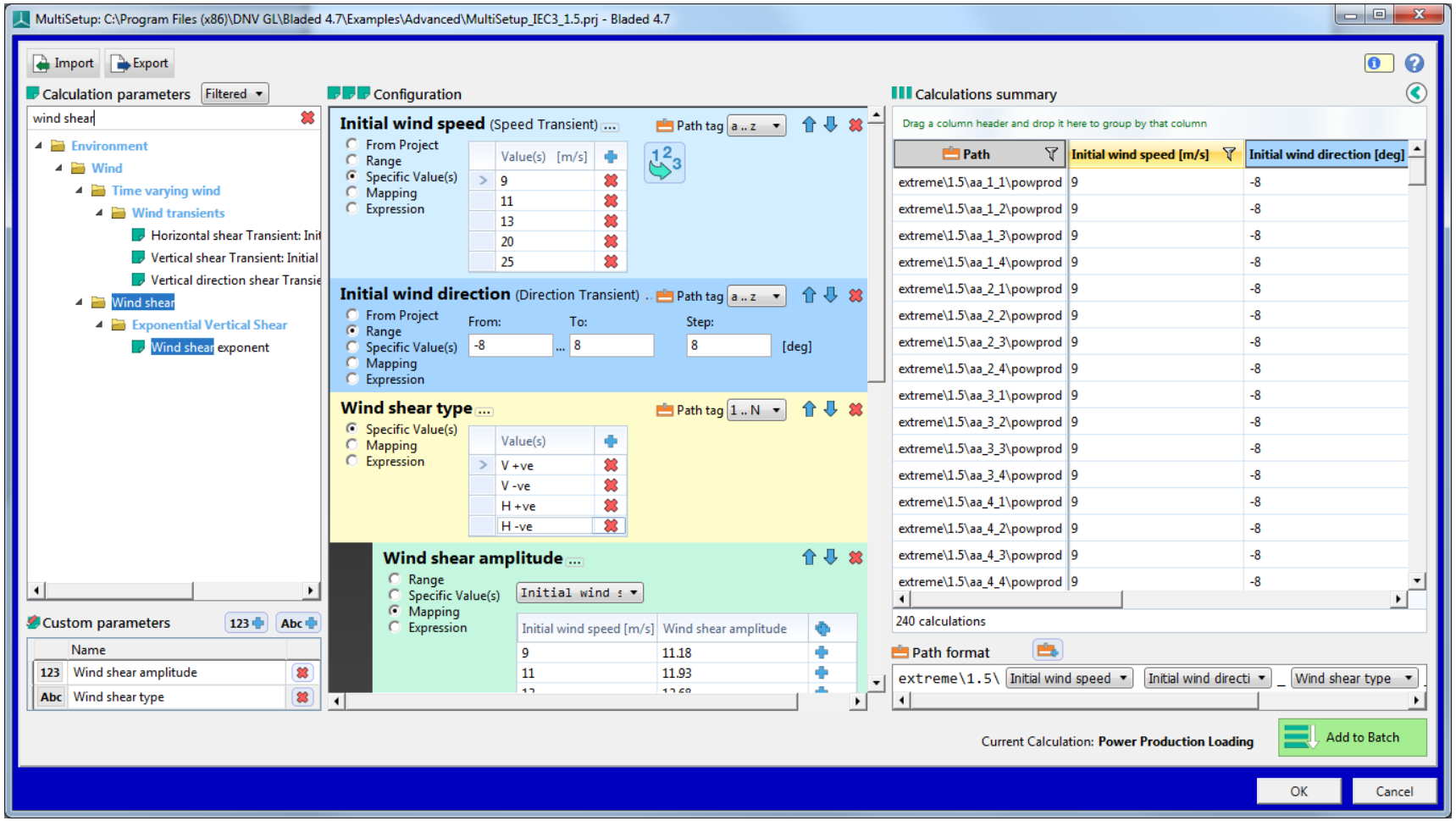






Ungraded

Bladed 4.7



Ungraded

MultiSetup Demo

- Electrical Fault with Extreme Operating Gust

Design load case (DLC):	1.3
Operating condition:	Power production with electrical fault
Wind conditions:	Extreme operating gust, V_{hub} +/- 2m/s, V_{out}

Description of simulations:

	Initial wind speed (m/s)	Gust amplitude (m/s)	Fault time relative to start of gust(s)
a	10	5.810112	0, 2.45, 4, 5.25
b	12	6.475392	0, 2.45, 4, 5.25
c	14	7.140672	0, 2.45, 4, 5.25
d	25	10.79971	0, 2.45, 4, 5.25

Animation of Results

- Demo

Ungraded

That’s all from me.

Let the User Conference begin….

Other recent and future Bladed developments

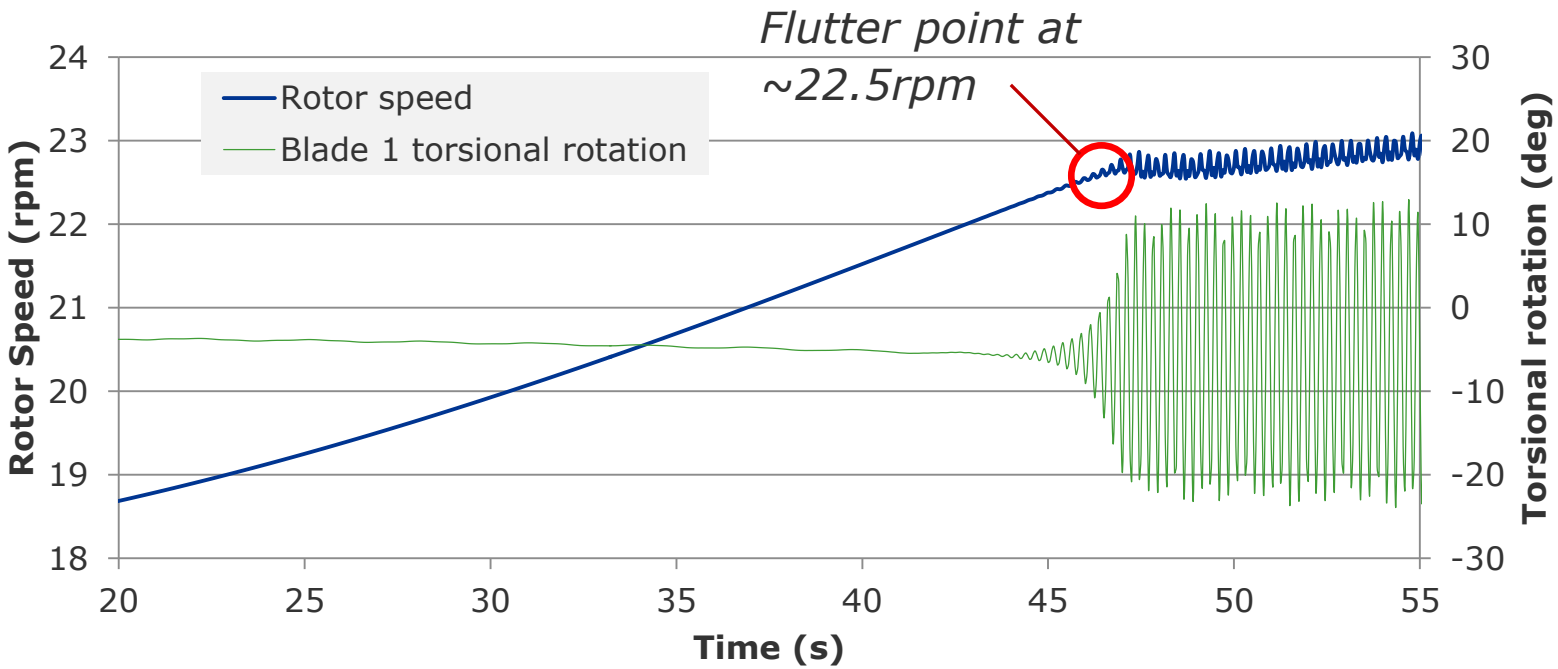
What can we expect in Bladed 4.9?

- Blade stability tool
- Dynamic moorings
- Post processing
- New Tower Screen

Ungraded

Blade Stability Analysis (time domain)

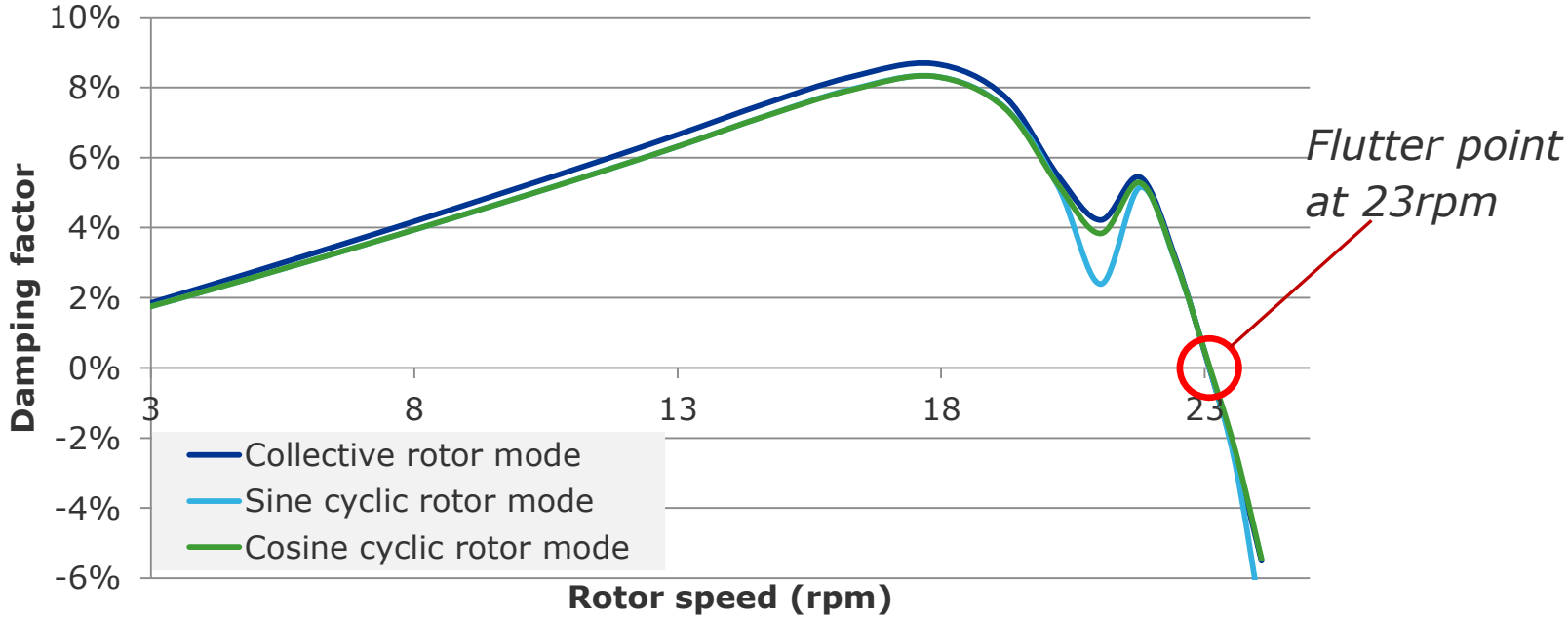
- Idling rotor, no generator torque
- Steady, horizontal uniform wind
- Wind speed ramped from zero to high values
- Instability (**flutter**) observed through large oscillations in blade deflections above certain rotor speeds



Ungraded

Blade Stability Analysis (frequency domain)

- New blade stability tool in using Bladed aeroelastic model
- Steady-state rotor speed and blade deflections determined at each wind speed.
- Aero-elastic model is linearised by perturbing all structural states (blade modes) and aerodynamic states.
- Frequency, damping and mode shape calculated for all coupled modes.
- Instability occurs when the **damping** of any coupled mode becomes **negative**.

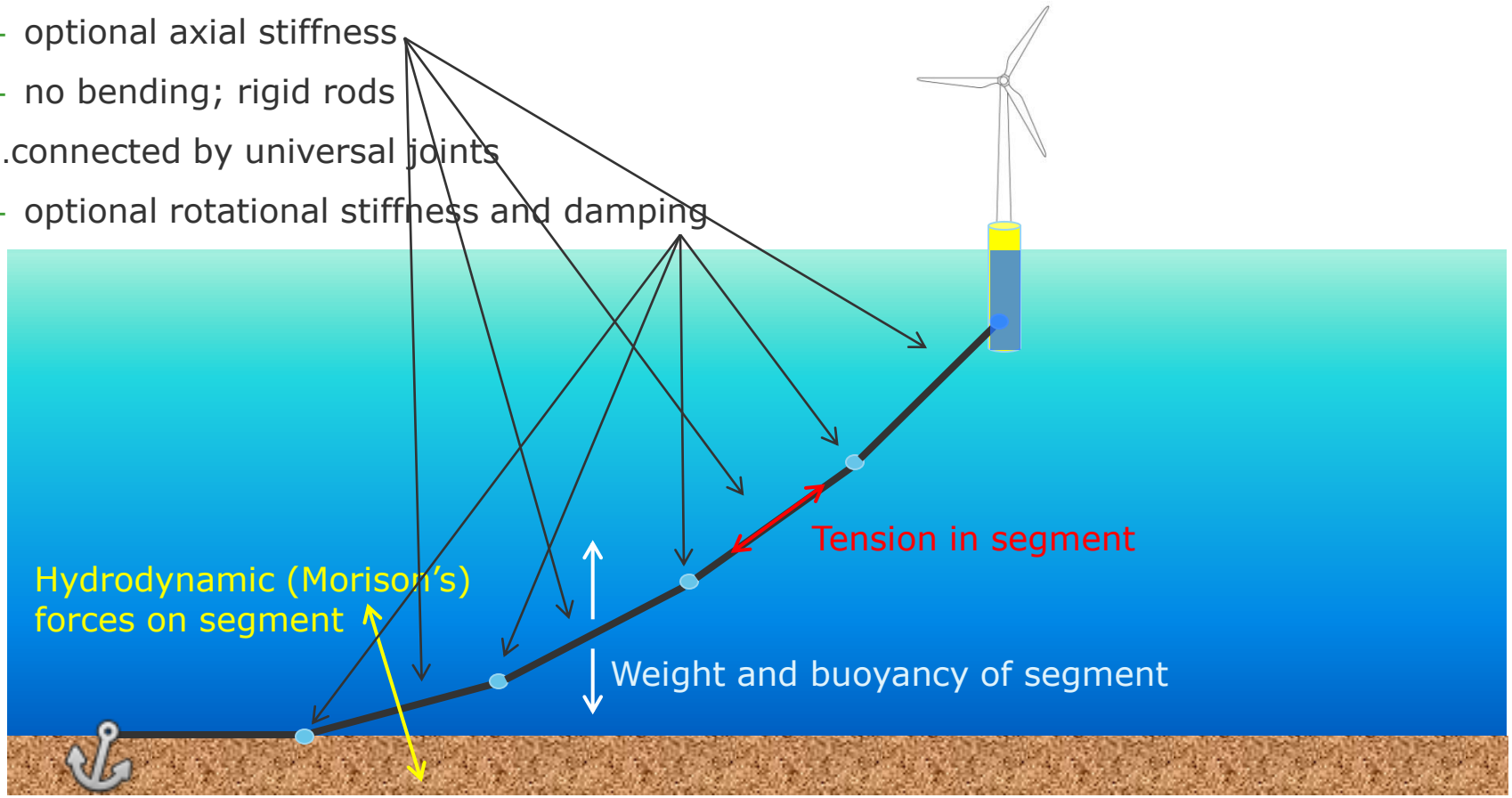


Ungraded

Dynamic Moorings

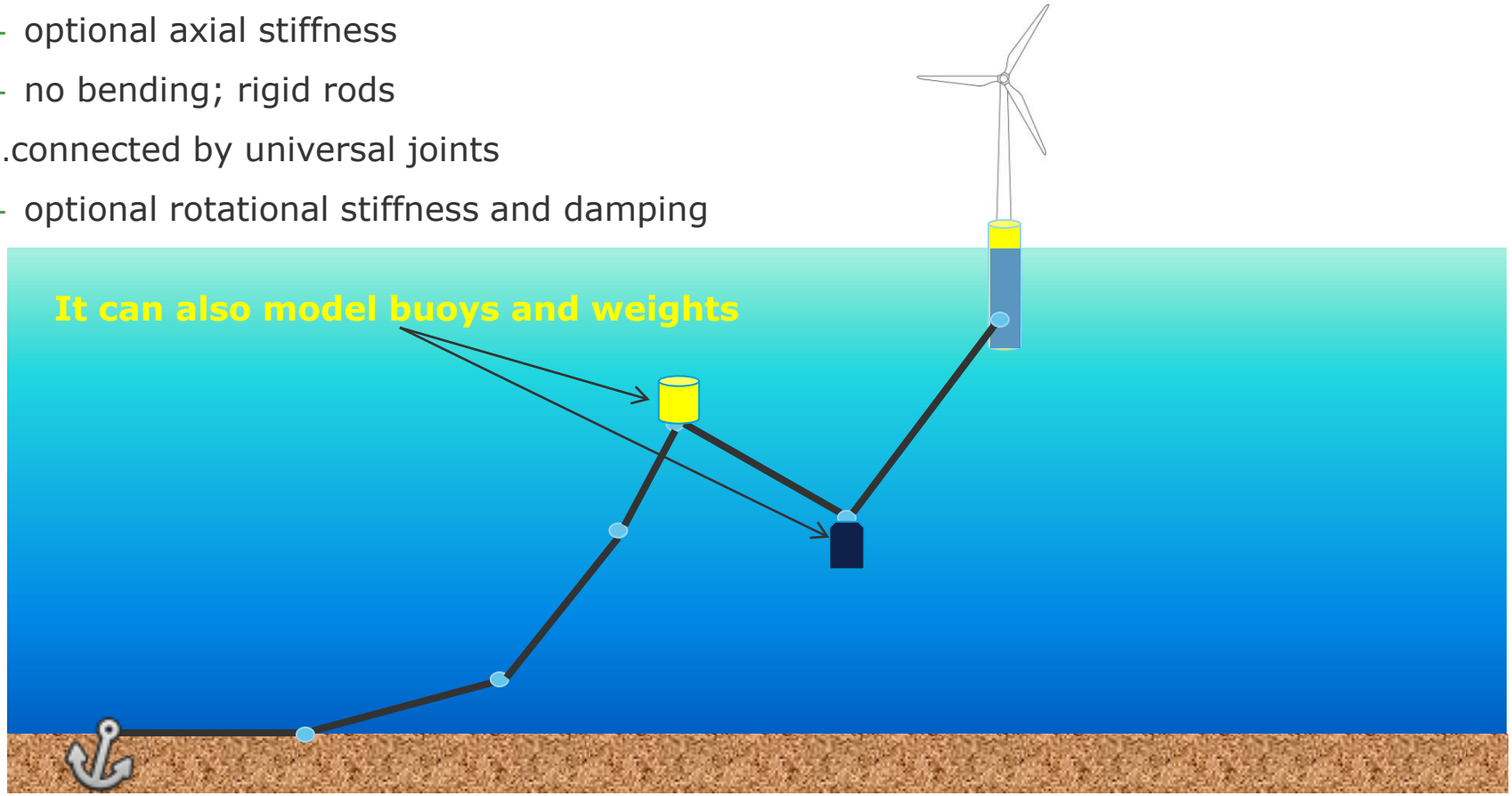
Full dynamic model of mooring lines

- Utilise the Multibody engine to model mooring lines as a series of bodies
- Line modelled as a chain of stretchable rods (segments)…
  - optional axial stiffness
  - no bending; rigid rods
- …connected by universal joints
  - optional rotational stiffness and damping



Full dynamic model of mooring lines

- Utilise the Multibody engine to model mooring lines as a series of bodies
- Line modelled as a chain of stretchable rods (segments)…
  - optional axial stiffness
  - no bending; rigid rods
- …connected by universal joints
  - optional rotational stiffness and damping



OC5 Involvement

- DNV GL involved in Bladed validation and verification as part of OC5 project

- Comparison of Bladed with:
  - Other codes
  - Measured data

- 4 year project following on from OC3 and OC4 projects

- 3 phases of comparison with measured data
  - **Phase 1 - Monopile tank testing**
  - Phase 2 - Semi Submersible tank testing
  - Phase 3 - Jacket/tripod open ocean

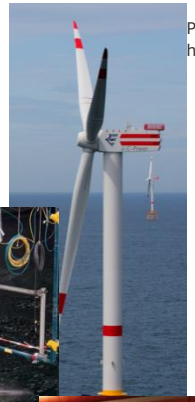


Photo provided by http://www.offshorewindindustry.com

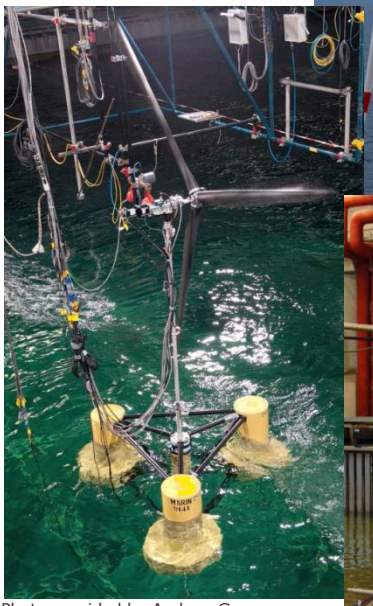


Photo provided by Andrew Goupee, University of Maine

Photo provided by DTU, DHI

Ungraded

Post-processing

- Pressure distribution calculation
- Uses completely new user interface

Ungraded

Ongoing/future developments

- Currently investigating second order wave forcing
- Wave-current interaction for BEM (Morison only at present)
- 3D Visualisation
- NewWave type constrained waves for SEA files

- **Anything else you may like to see available for modelling in Bladed?**

New Tower Screen

New Tower Screen

- Demo

Thanks you for attending

Keep in touch!

www.dnvgl.com

SAFER, SMARTER, GREENER

Ungraded