

# **OrcaFlex interface to VIVA**

**Effect of VIV on wave induced fatigue of  
suspended mid-water flowlines**

**VIVARRAY JIP Meeting**

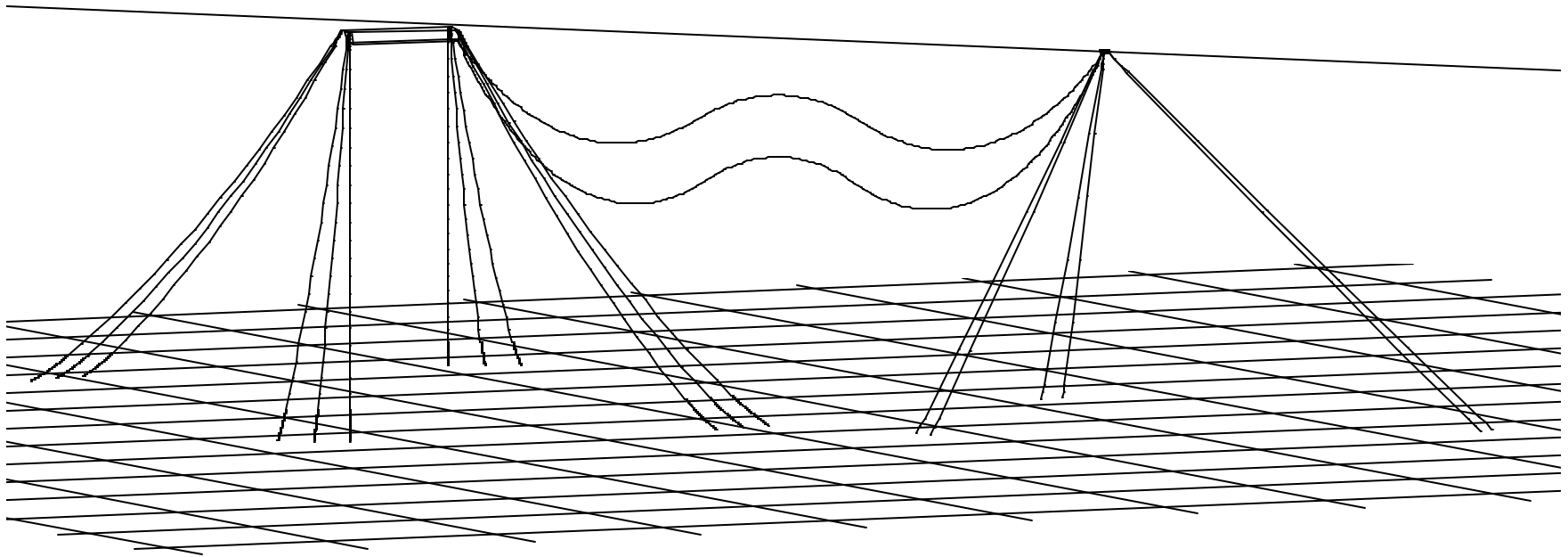
**January 31, 2002**

**Caspar Heyl**

# Purpose of the work

- **Test OrcaFlex interface to VIVA and provide feedback**
- **Study effect of VIV on wave induced fatigue**
- **Sensitivity analysis:**
  - **Update Interval**
  - **Single Mode vs Multi Mode response**

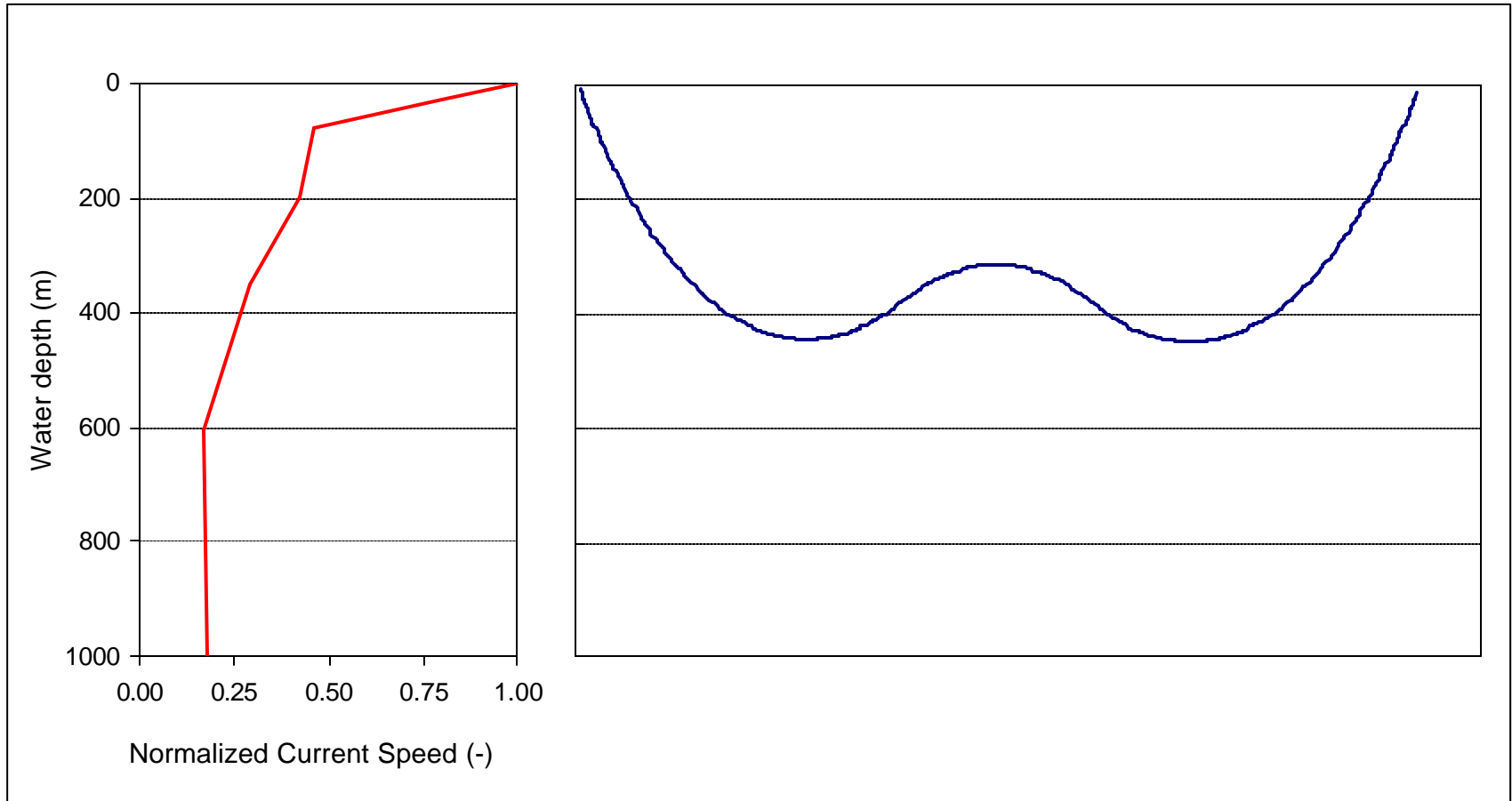
# Deepwater Offloading System



# Environment

- **Water Depth**
  - 1000 m
- **Waves**
  - $H_s = 1.125\text{m}$ ,  $T_p = 5.8\text{ s}$
  - Direction 23 degrees from flowline plane
- **Current**
  - 0.5 m/s (95% non-exceedence level)
  - Direction normal to flowline plane

# Current Profile



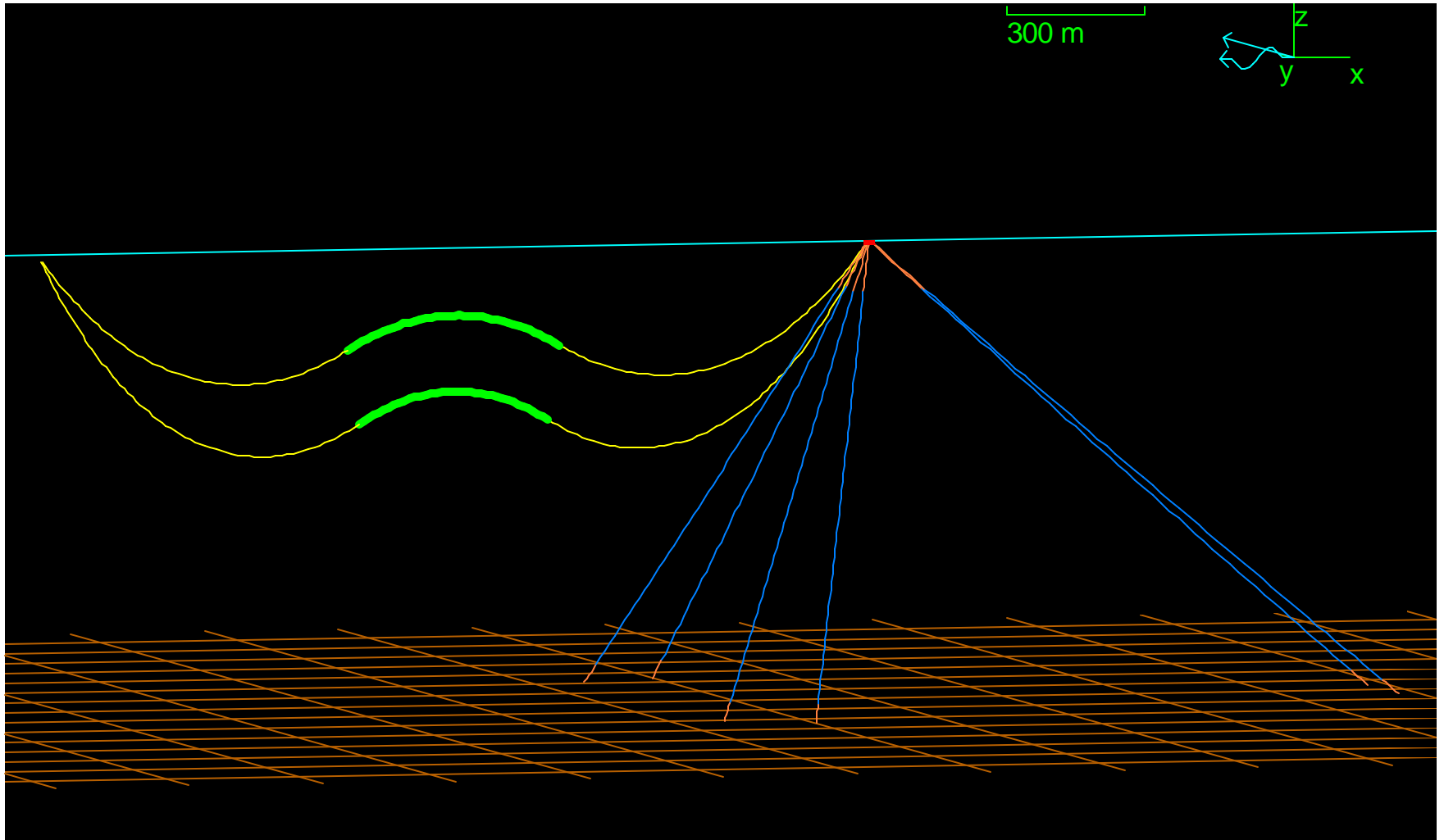
# Flowline Physical Properties

	Upper	Lower	
<b>Horizontal Span</b>	<b>1850</b>	<b>1850</b>	<b>m</b>
<b>Flowline Length</b>	<b>2100</b>	<b>2300</b>	<b>m</b>
<b>Outer Diameter</b>	<b>0.559</b>	<b>0.559</b>	<b>m</b>
<b>Wall Thickness</b>	<b>25.4</b>	<b>25.4</b>	<b>mm</b>
<b>Buoyancy Length</b>	<b>500</b>	<b>450</b>	<b>m</b>
<b>Total Buoyancy</b>	<b>2592</b>	<b>2333</b>	<b>kN</b>
<b>Total End Tension</b>	<b>1750</b>	<b>2010</b>	<b>kN</b>
<b>Horizontal End Tension</b>	<b>1031</b>	<b>887</b>	<b>kN</b>
<b>Vertical End Tension</b>	<b>1414</b>	<b>1803</b>	<b>kN</b>
<b>End Angle From Vertical</b>	<b>36</b>	<b>26</b>	<b>deg</b>

# Flowline Fatigue Evaluation

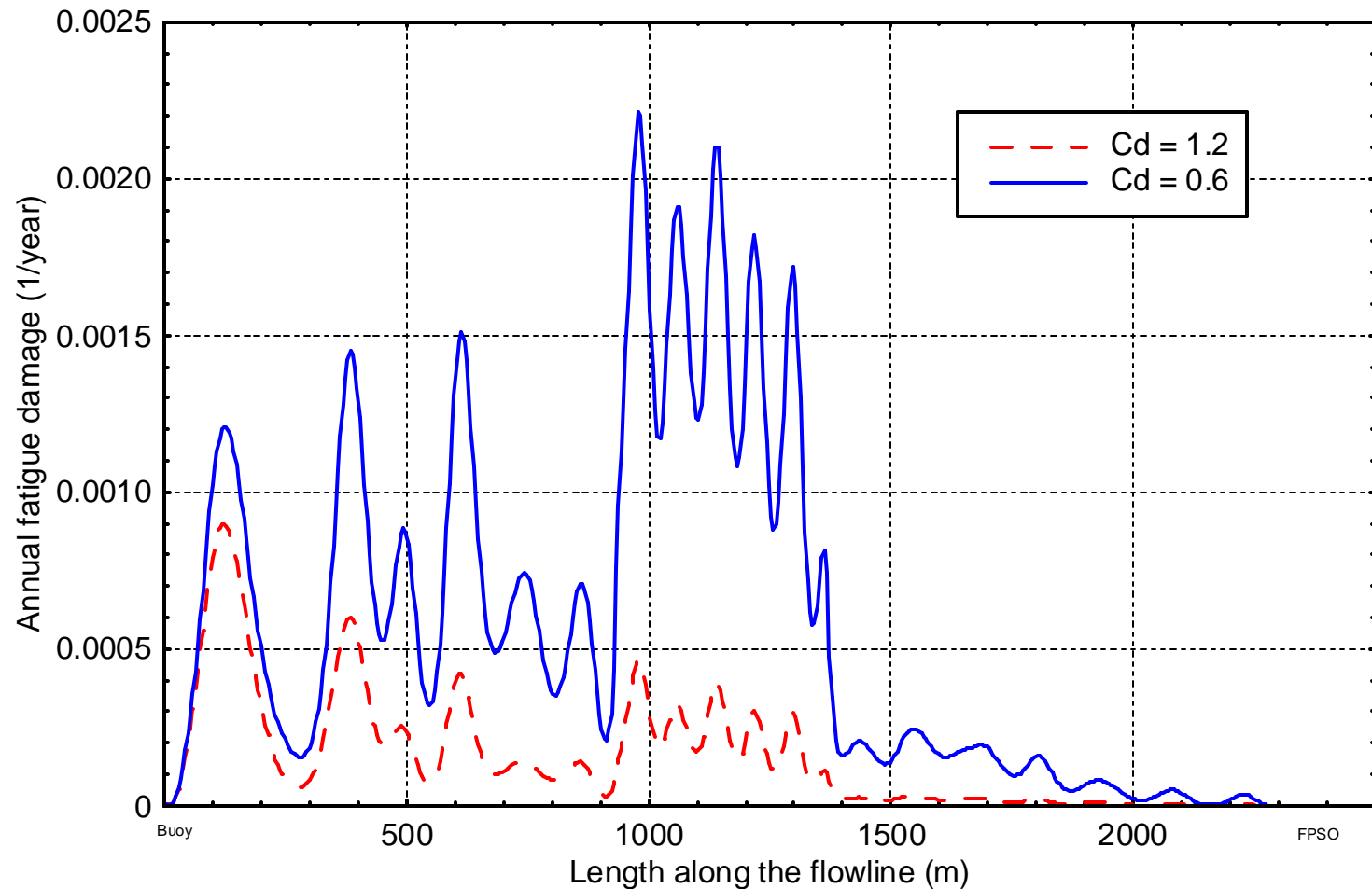
- **Sources of flowline fatigue damage**
  - Wave induced fatigue (vessel/buoy motions)
  - Low Frequency fatigue (LF vessel/buoy motions)
  - VIV induced fatigue (current & vessel/buoy motions)
  - Installation induced fatigue
- **Time domain analysis with coupled buoy model**
- **Rayleigh damage formulation**

# Deepwater Offloading System

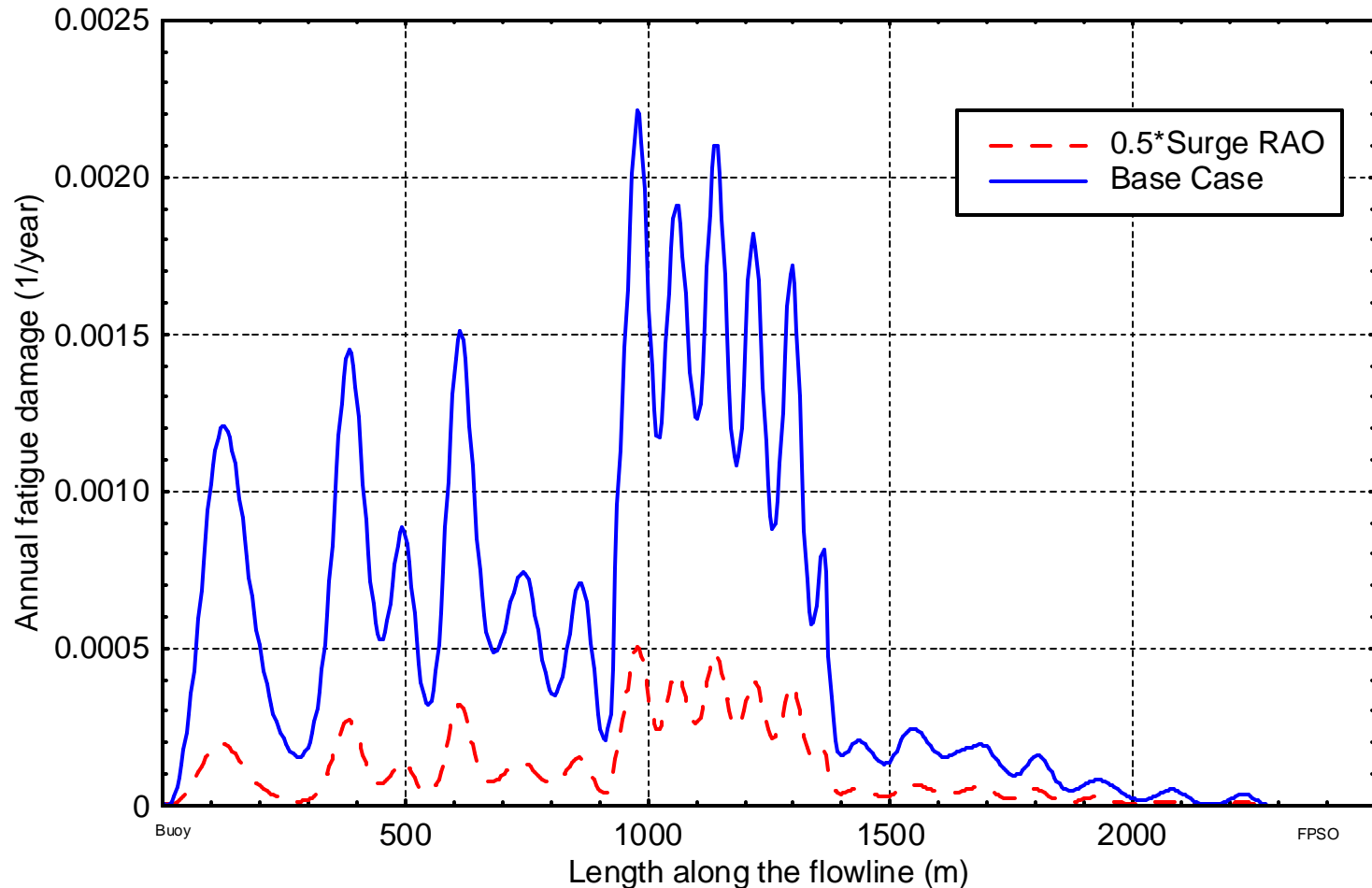




# Sensitivity to Drag Coefficient



# Sensitivity to Surge Motions



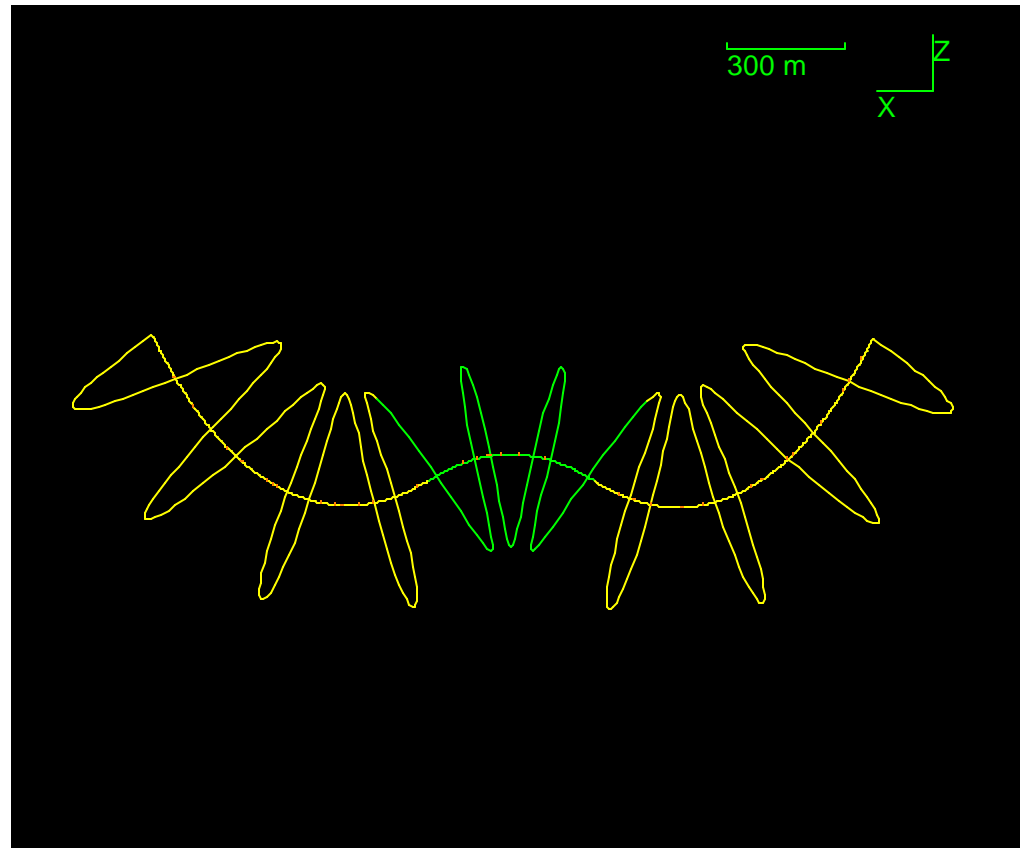
# Subsea Processing

- **Current perpendicular to plane of flowlines**
- **Time domain analysis with coupled buoy model**
- **Rayleigh damage formulation**
- **Fatigue damage from local waves and swell independent**

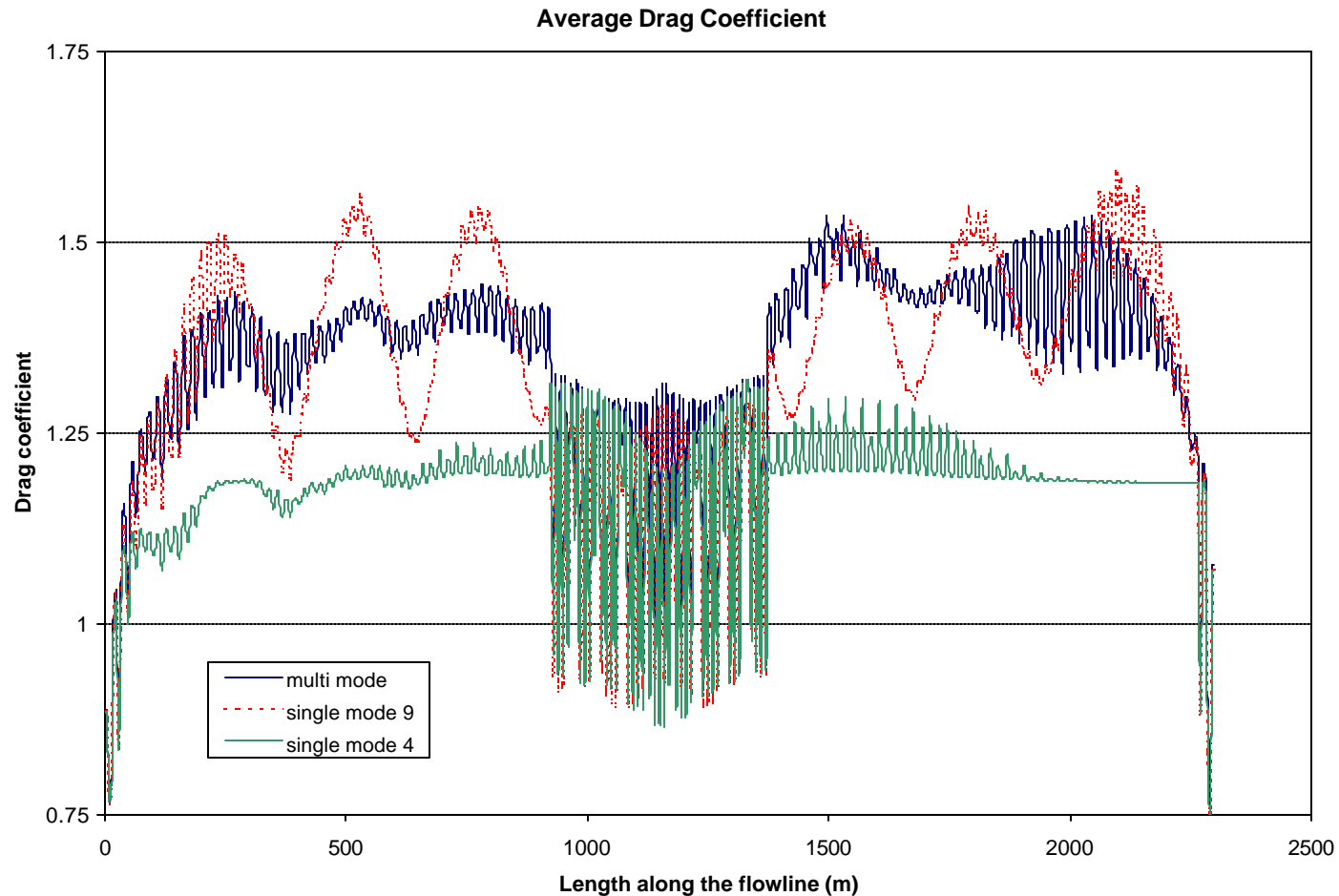
# Natural Modes

Mode (#)	VIVA Period (s)	OrcaFlex	
		Period (s)	Direction (-)
1	147.1	147.2	out
2	60.9	107.4	in
3	44.2	75.1	in
4	34.6	60.9	out
5	26.0	44.3	out
6	22.5	39.9	in
7	19.2	34.7	out
8	16.3	31.5	in
9	14.8	26.0	out
10	13.1	25.5	in
11	11.7	22.5	out
12	10.9	20.4	in
13	9.8	19.2	out
14	9.1	17.2	in
15	8.5	16.3	out
16	7.8	15.8	in
17	7.3	14.8	out
18	6.9	13.5	in
19	6.4	13.1	out
20	6.1	12.1	in

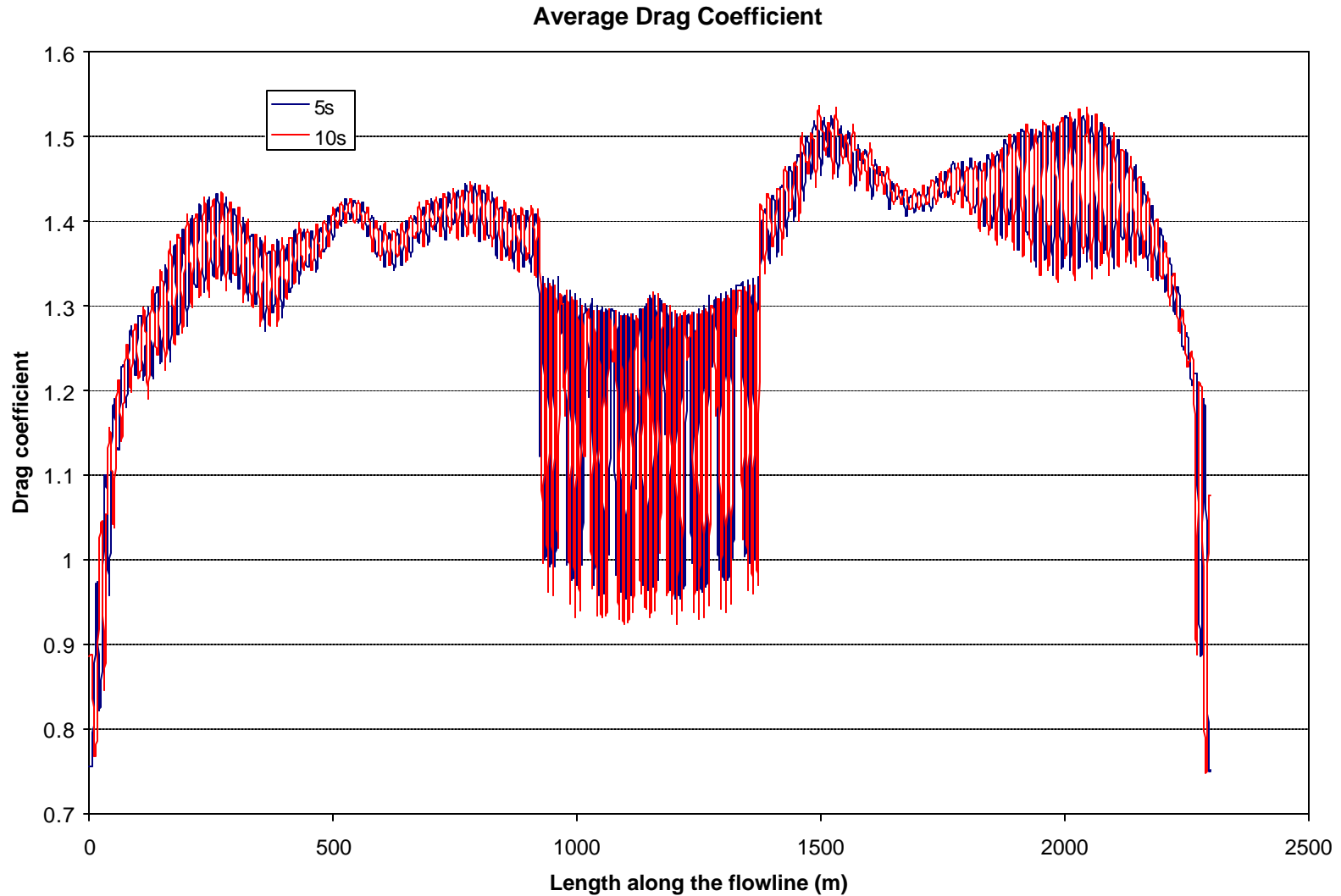
# Mode 40; Period 5.7s



# Multi vs single mode response



# Effect of update interval



# Conclusions

- **Applicability of OrcaFlex-VIVA to mid-water suspended flowline configuration limited**
- **Possible interface improvements:**
  - Feedback of VIVA displacements into OrcaFlex
  - Allow user more control of VIVA module