

Analysis of TLP VIV Responses to Eddy Currents



Presented by:
Steve Leverette
Atlantia Offshore Limited

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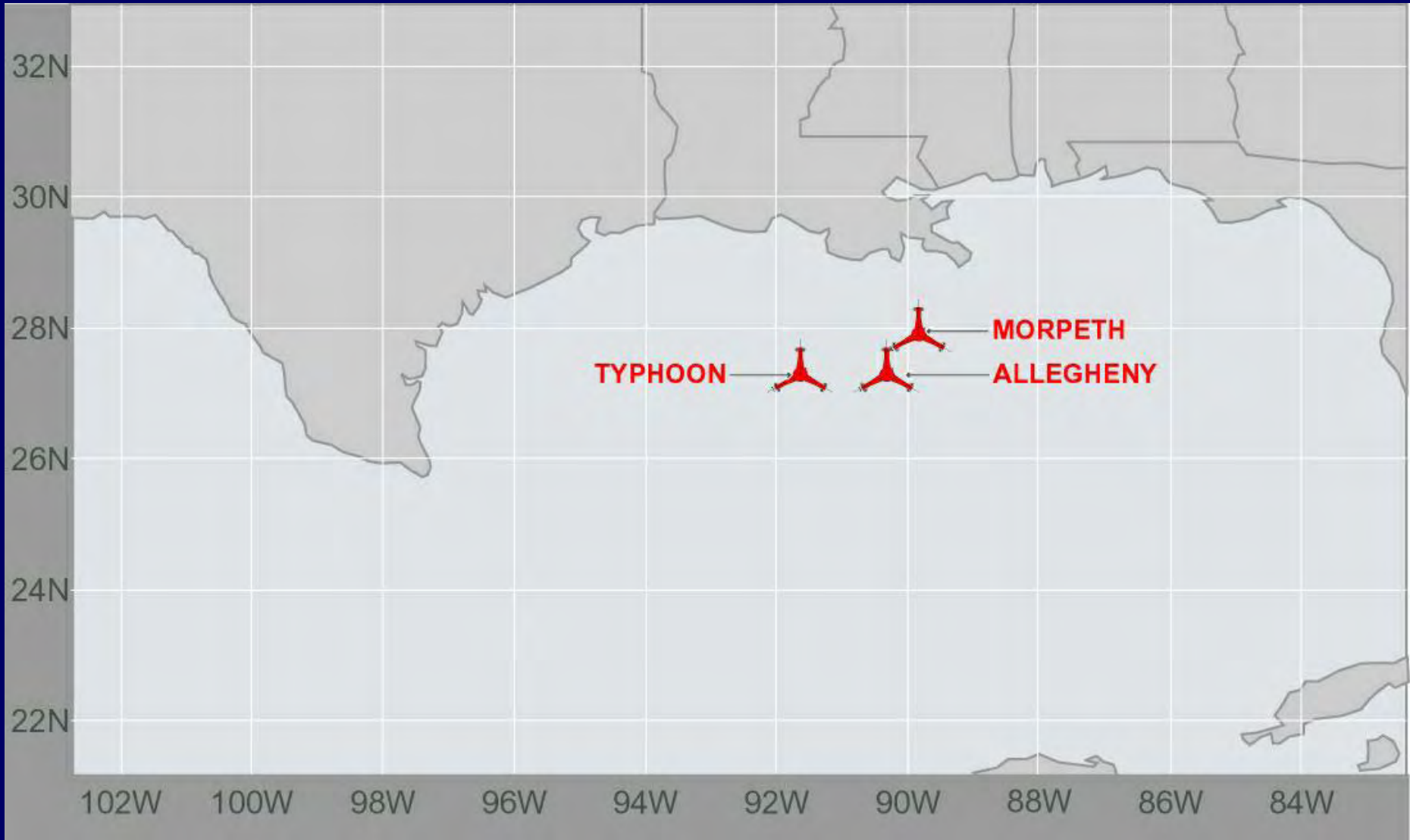
Analysis of TLP VIV Responses to Eddy Currents

- **SeaStar TLP**
- **Currents**
- **Millennium Field Data**
- **Simulation Procedure**
- **Results**



Allegheny and Typhoon SeaStars

Gulf of Mexico



World's Installed and Planned TLPs

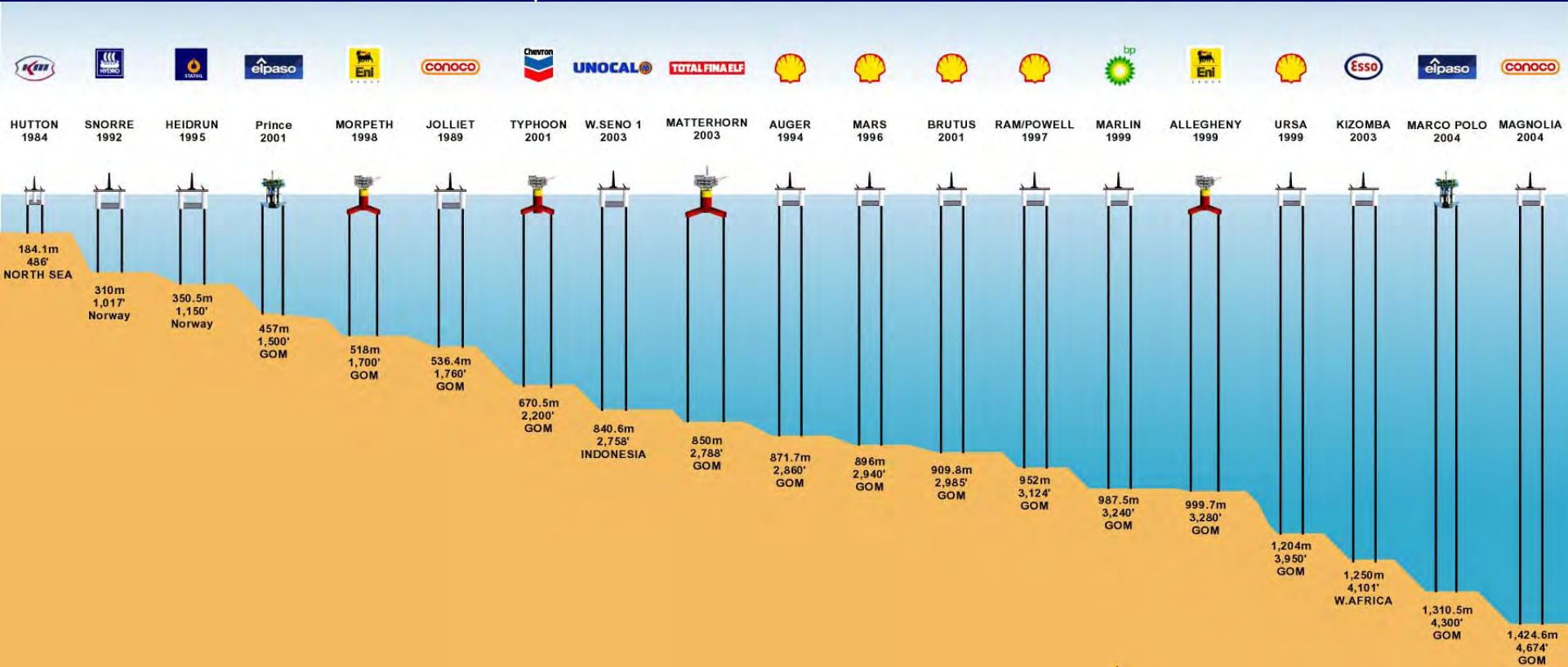
Typhoon

2000 ft



Allegheny

3200 ft



NOTES:

1. Year indicates year of first production
2. Logos represent current operator of the TLP

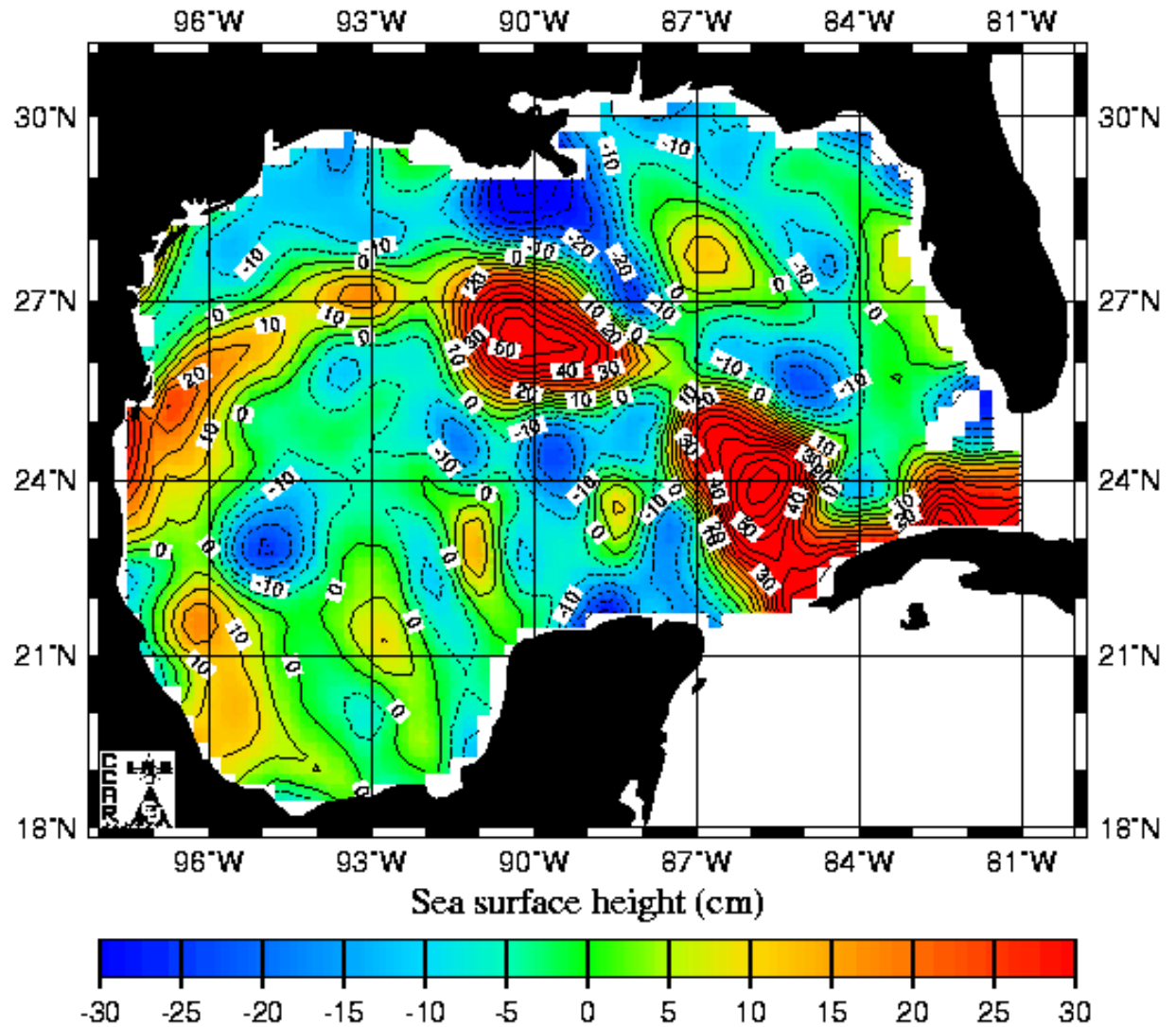


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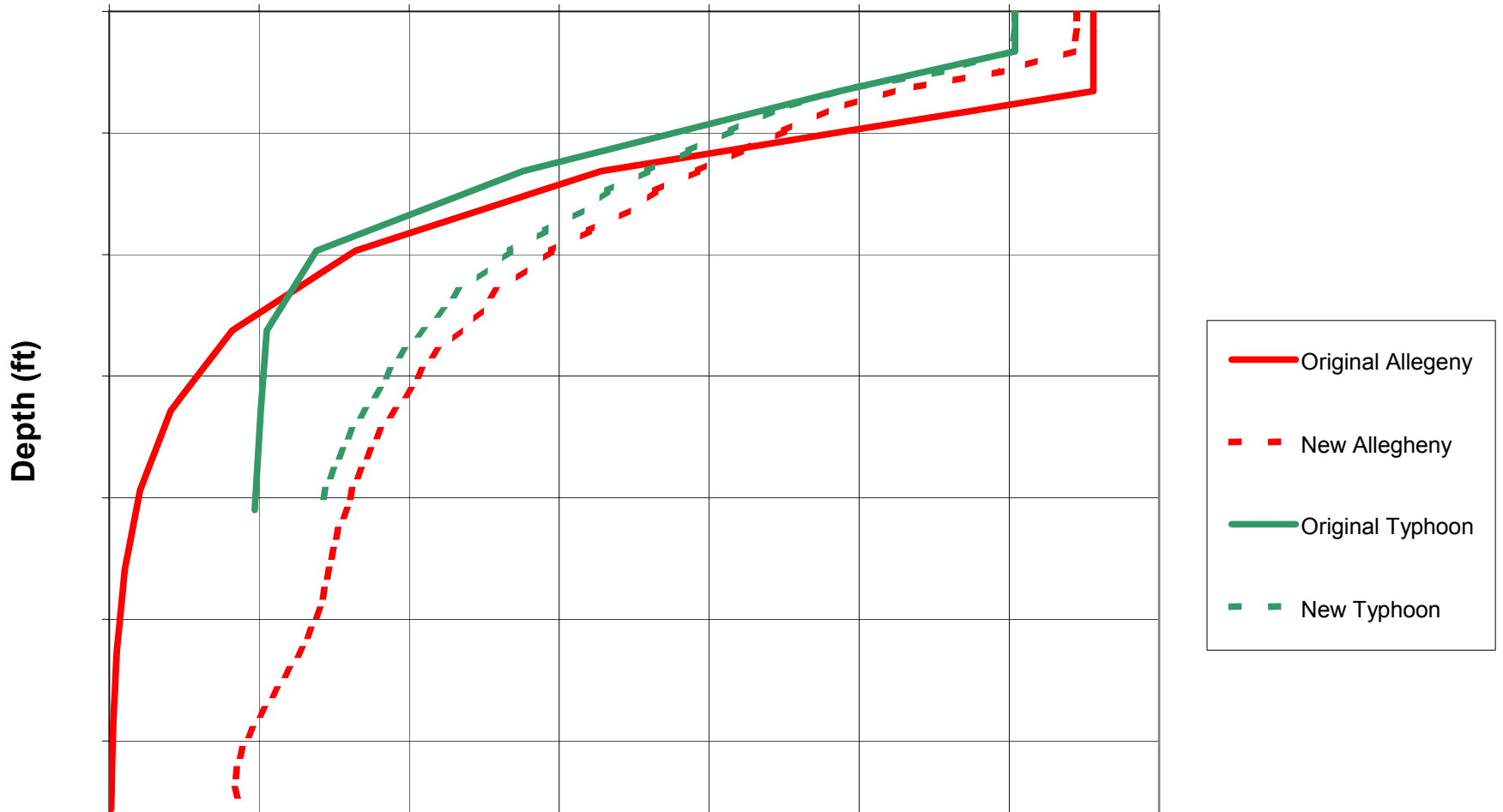
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Millennium Eddy

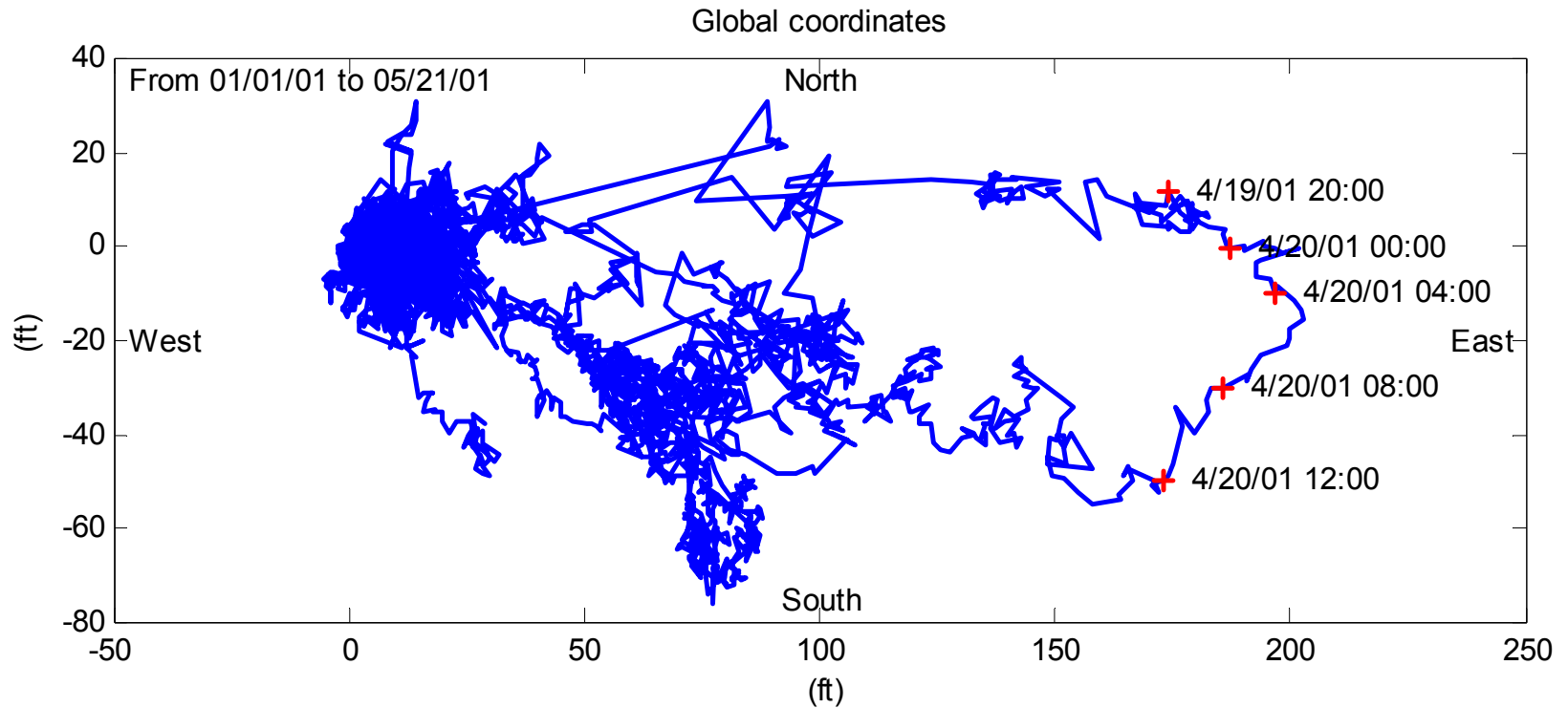


Warm Core Profiles

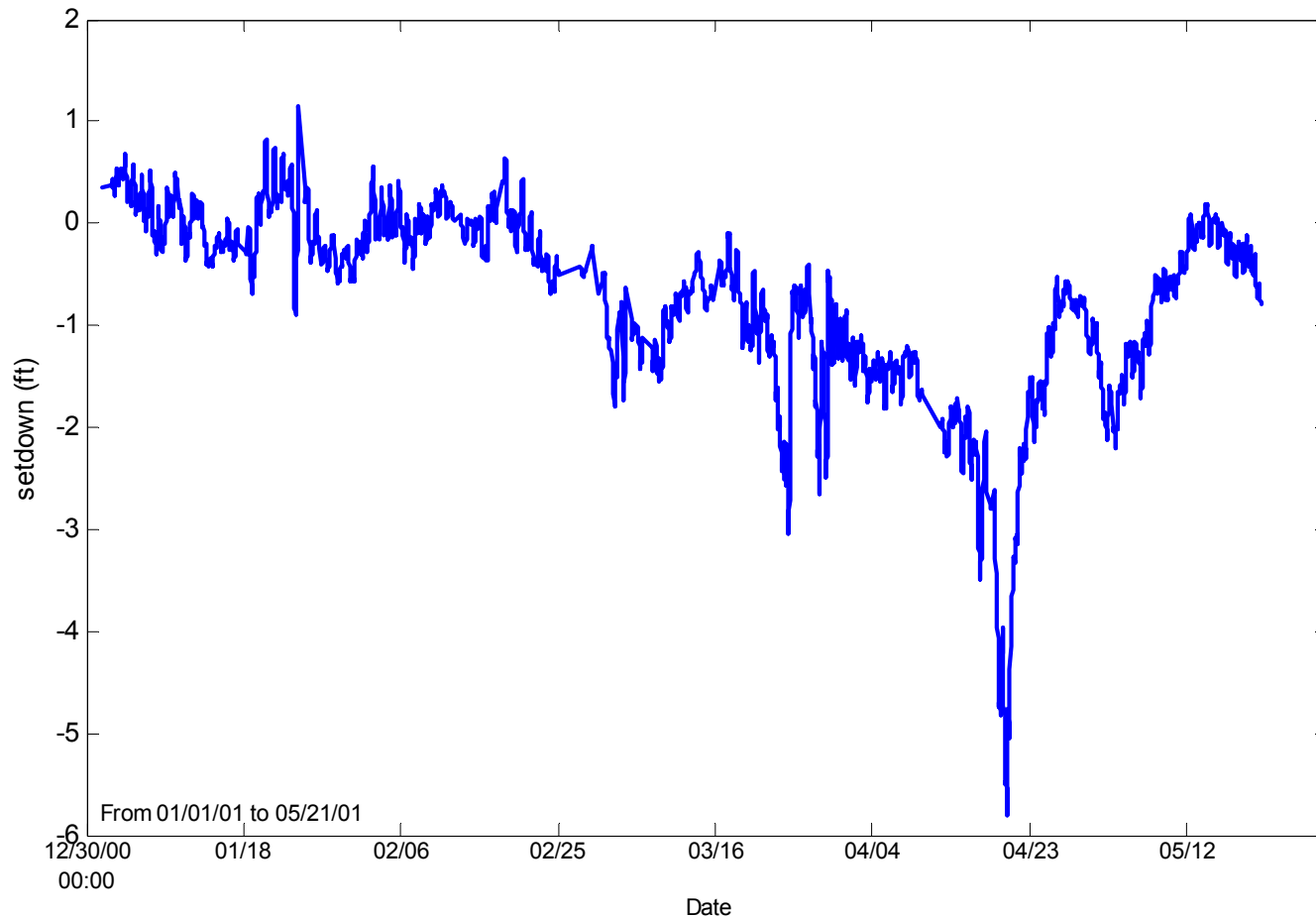
Speed (ft/sec)



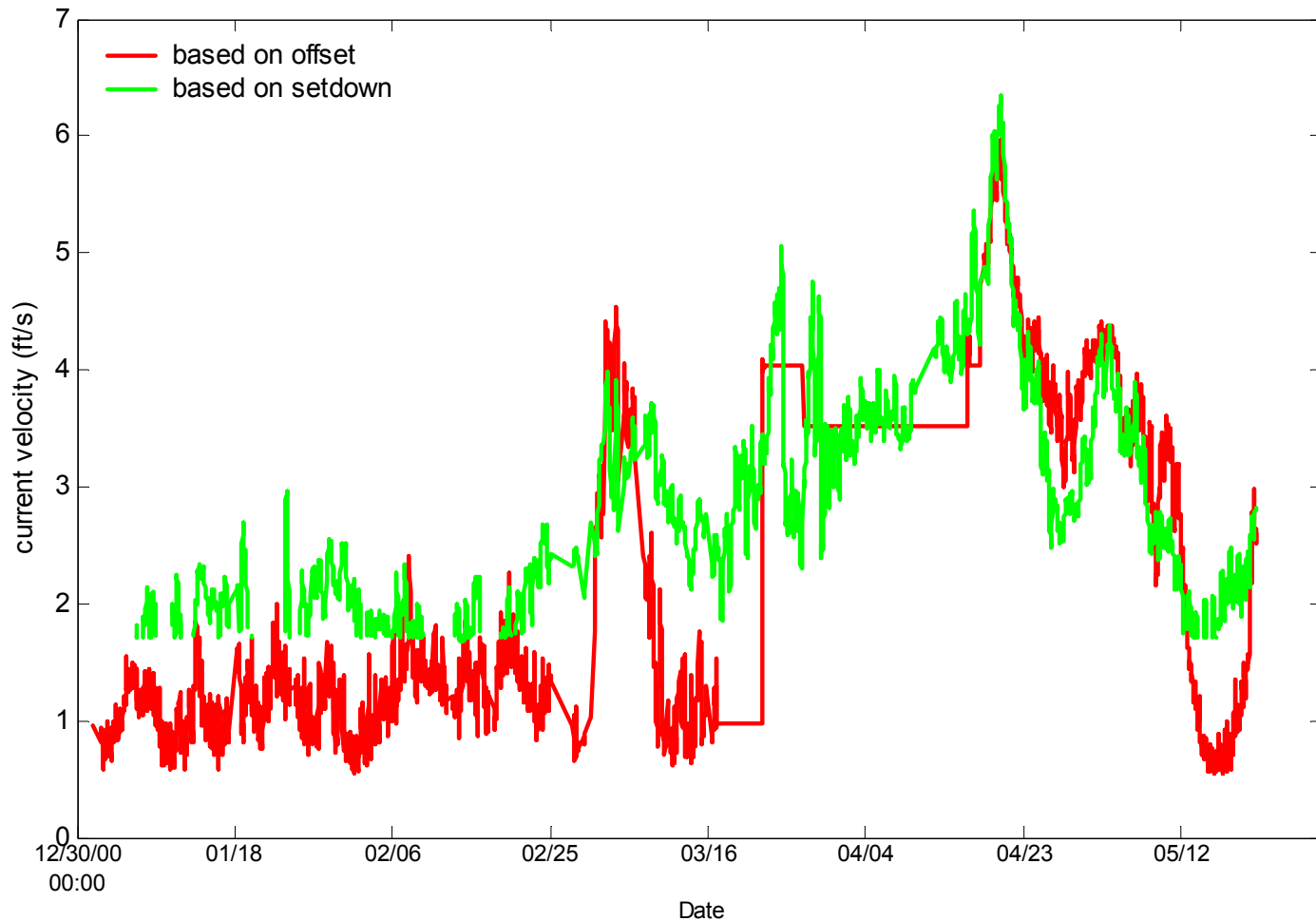
Allegheny GPS data,



Allegheny "Setdown" data tidal effects removed

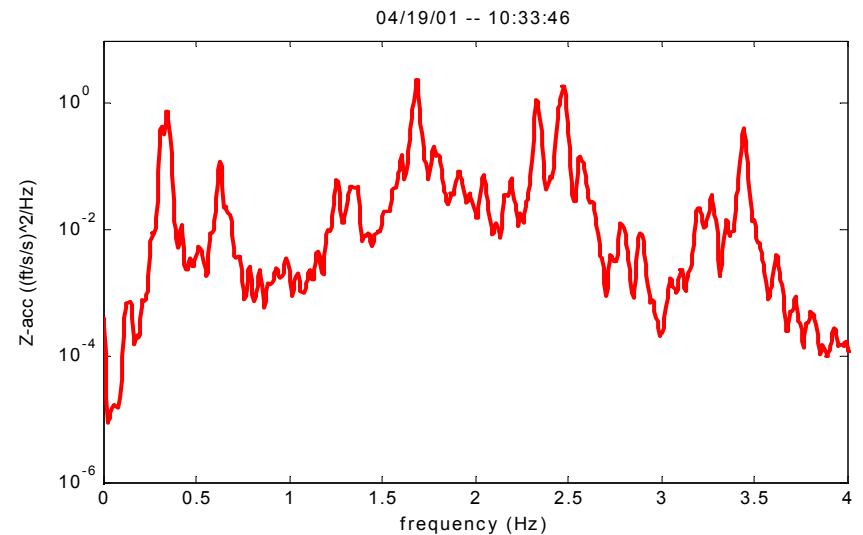
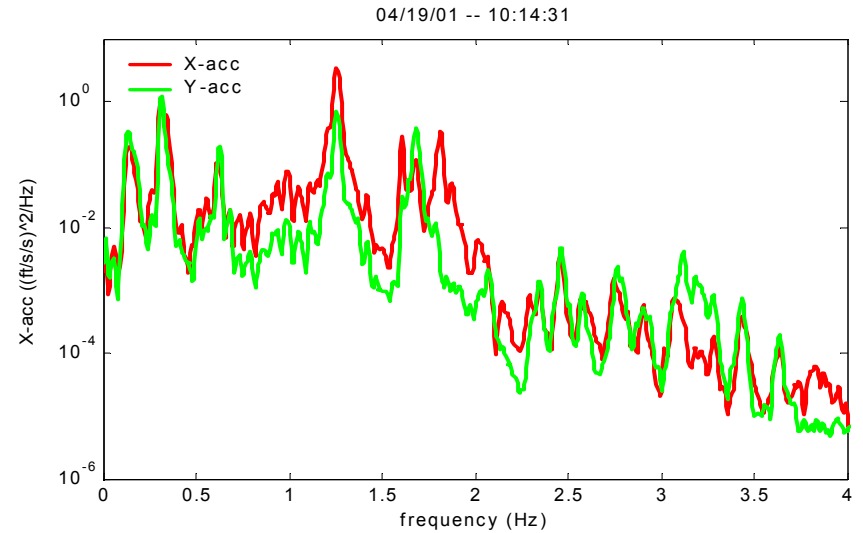


Estimates of current velocity

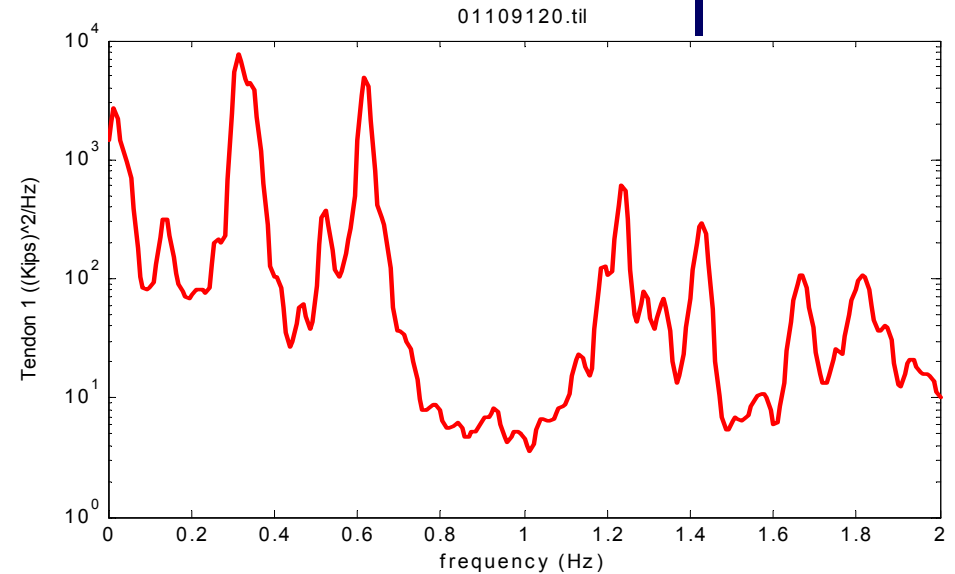
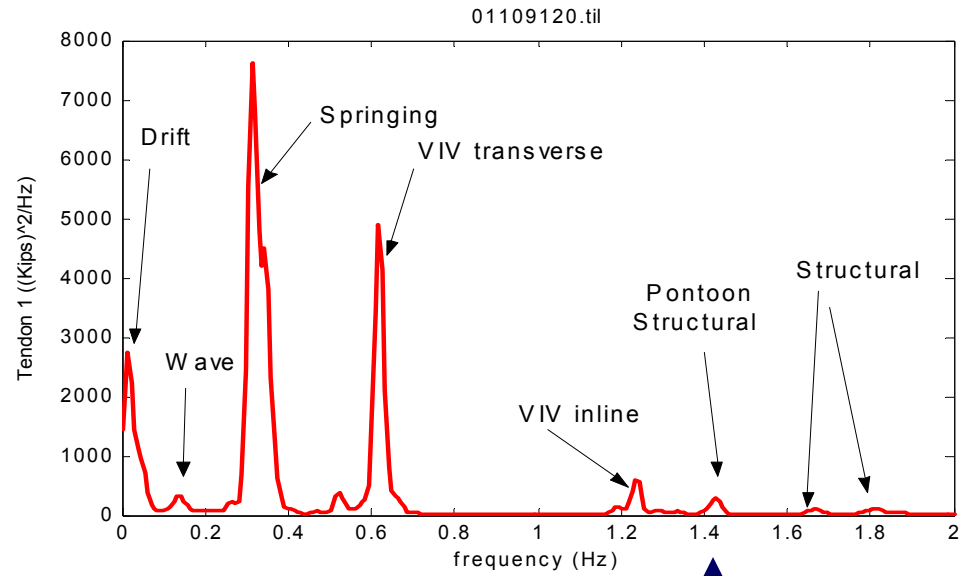




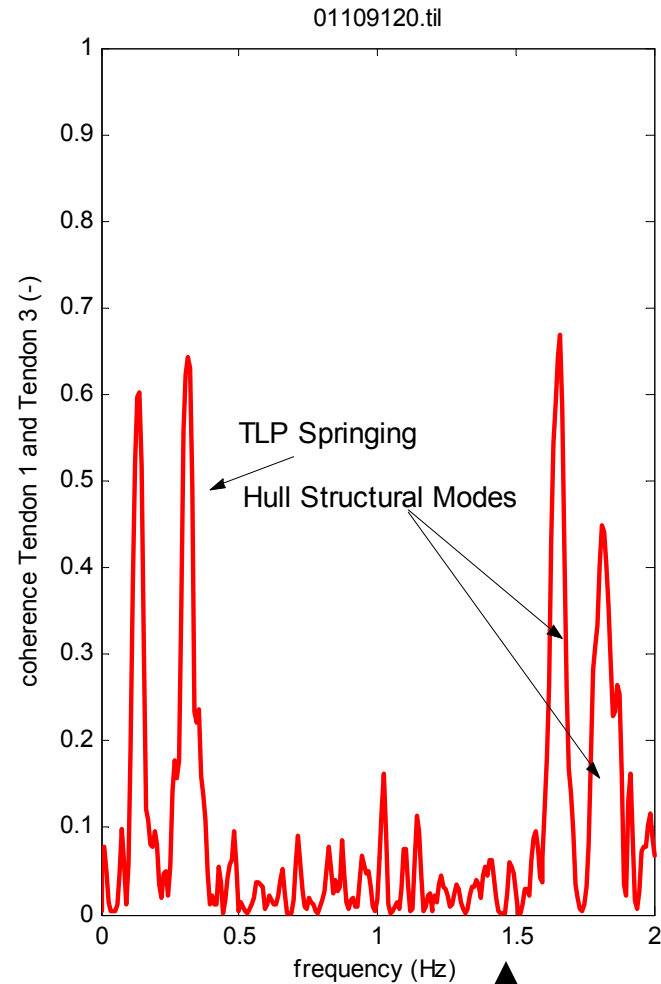
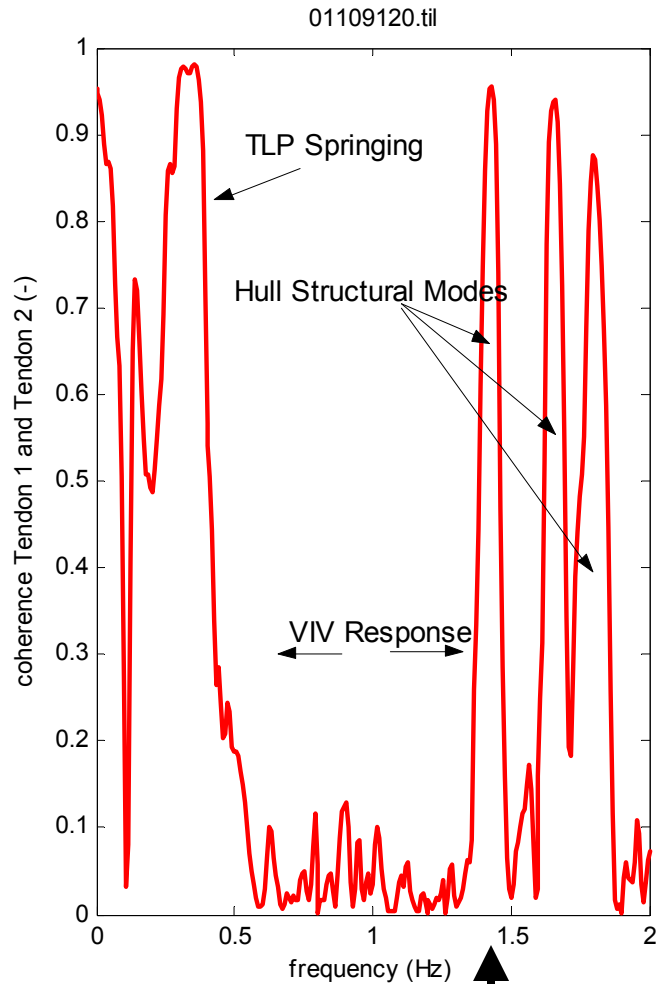
Acceleration Spectra (x, y, z)



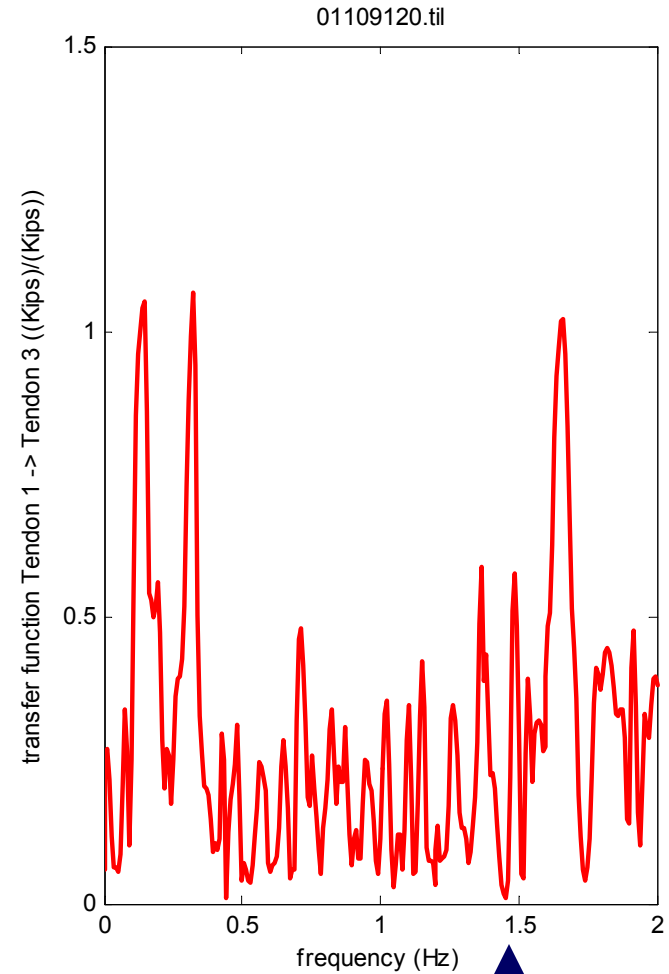
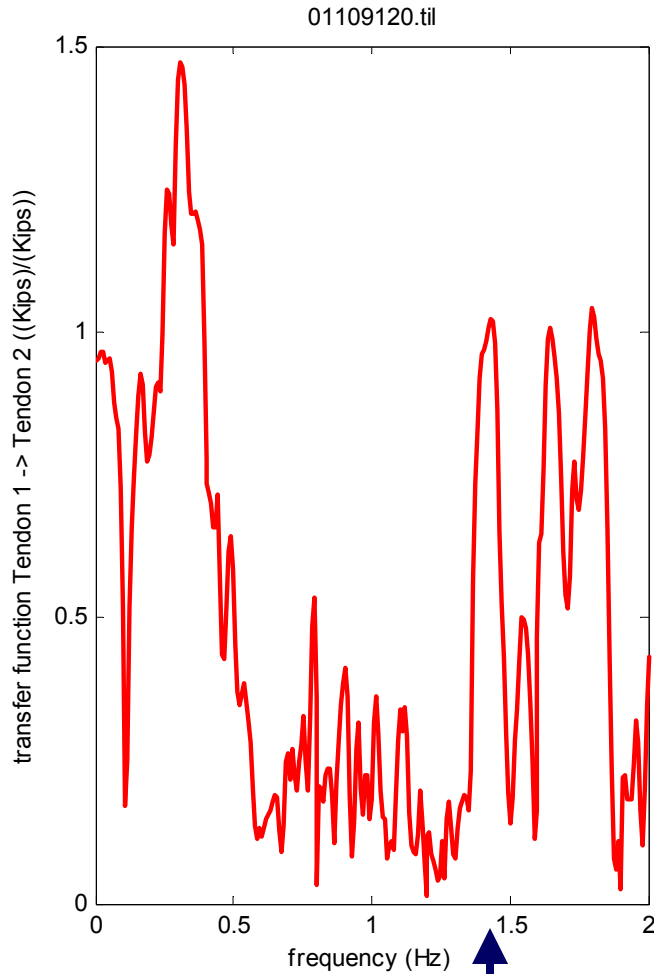
Linear and Log plots of Tension Spectrum – with identified tension modes



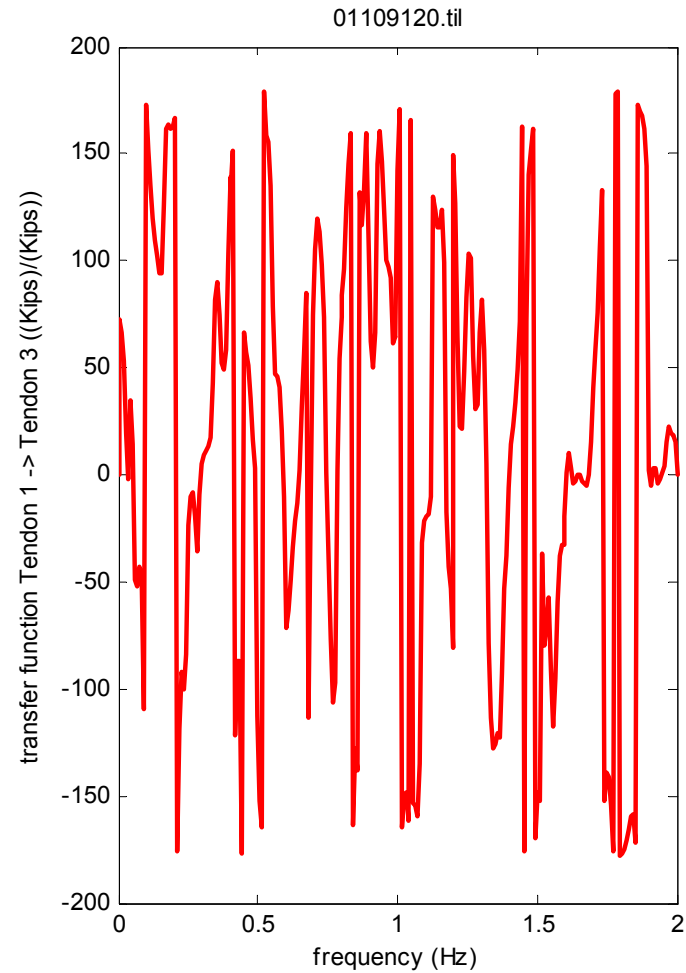
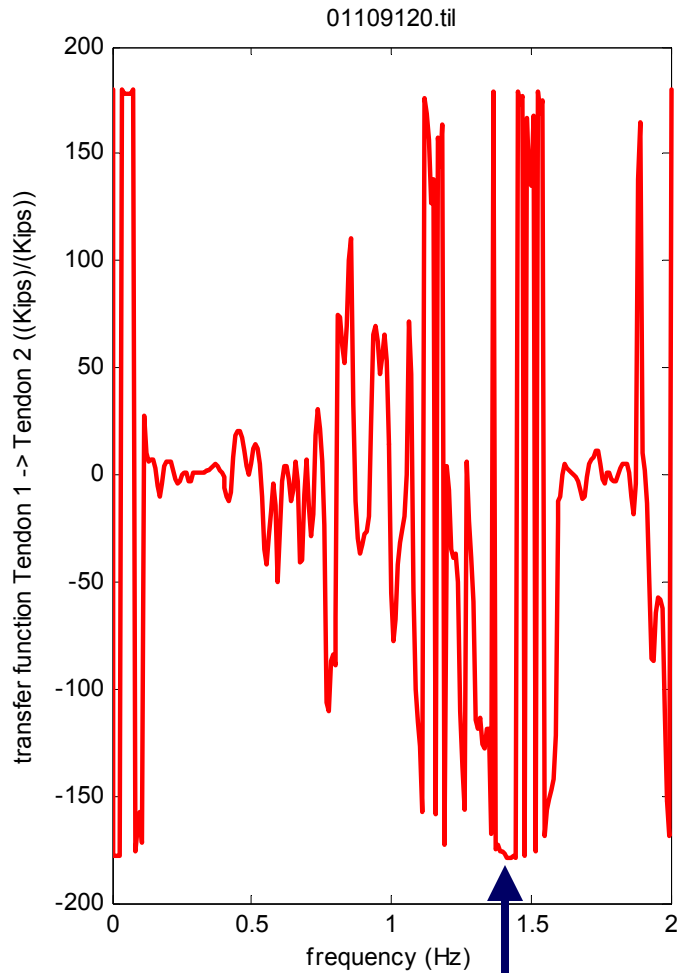
Transfer Function Coherence between two tendons on same pontoon (left) and on separate pontoons(right) Data recorded at Allegheny on April 19, 2001



Transfer Function Amplitude between two tendons on same pontoon (left) and on separate pontoons (right) Data recorded at Allegheny on April 19, 2001



Transfer Function Phase between two tendons on same pontoon (left) and on separate pontoons (right) Data recorded at Allegheny on April 19, 2001



Allegheny Tension Spectrum for 6 weeks

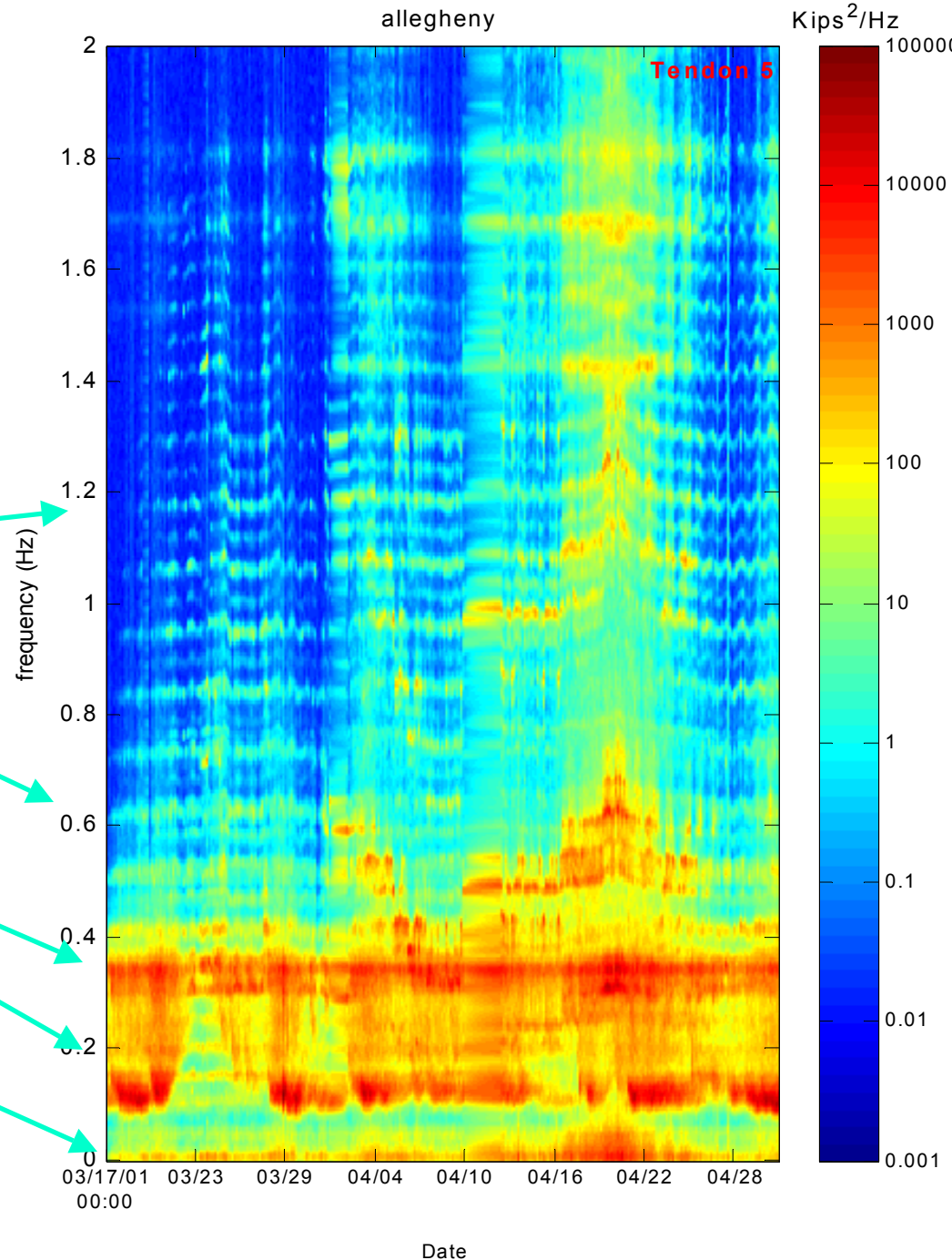
In-line VIV

Transverse VIV

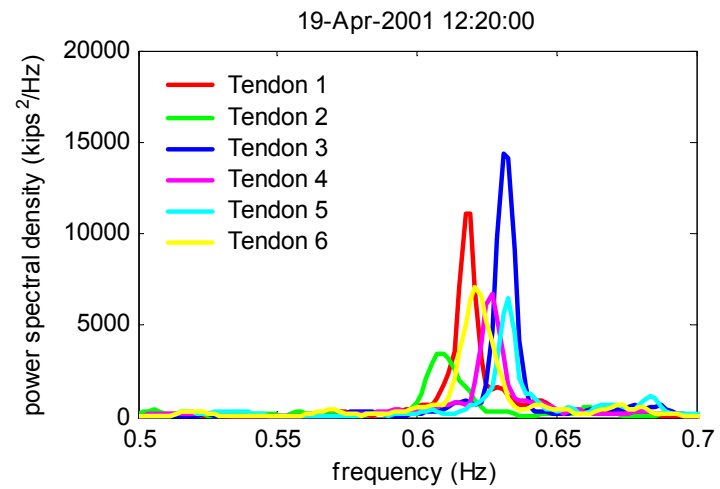
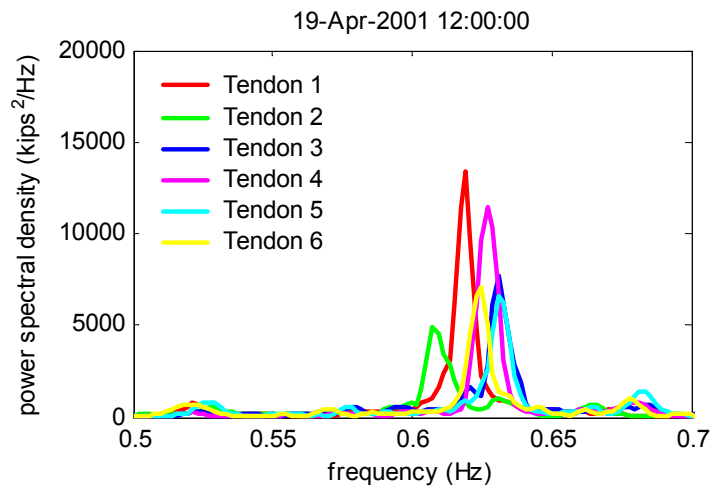
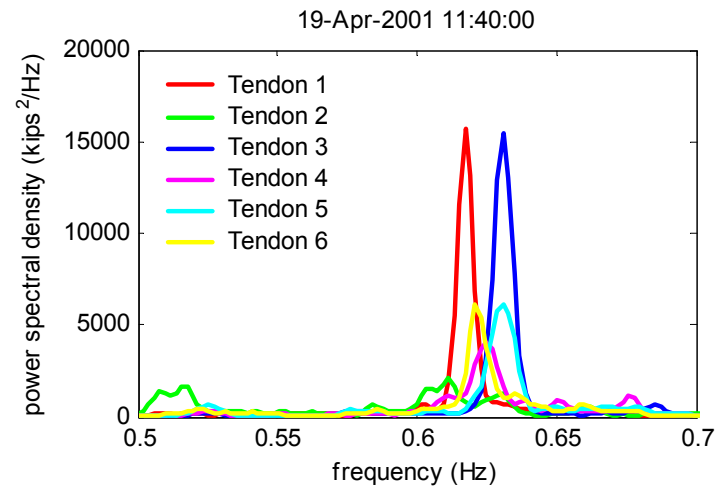
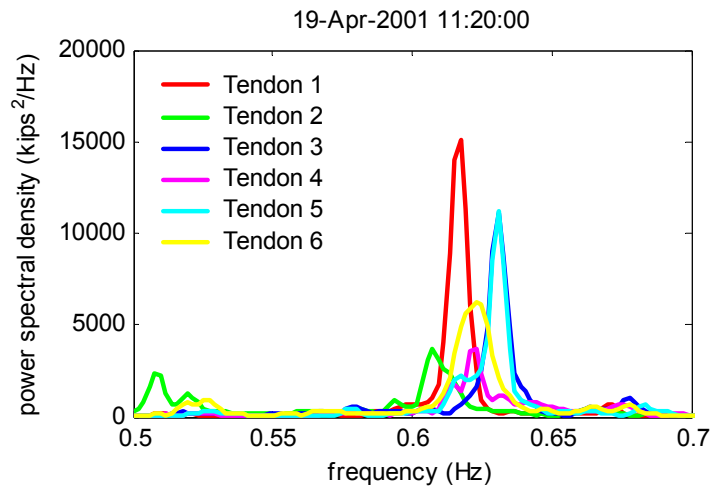
Springing

Wave Response

Slow Drift



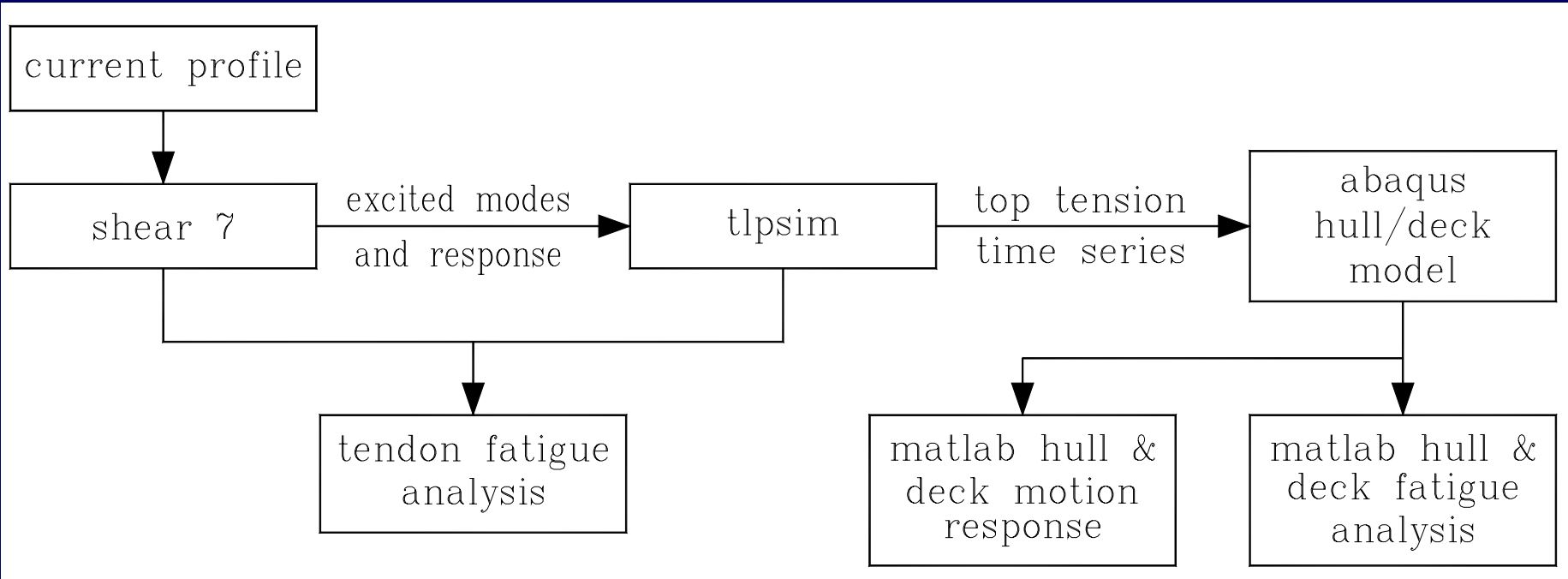
Variation in VIV peak with time and location



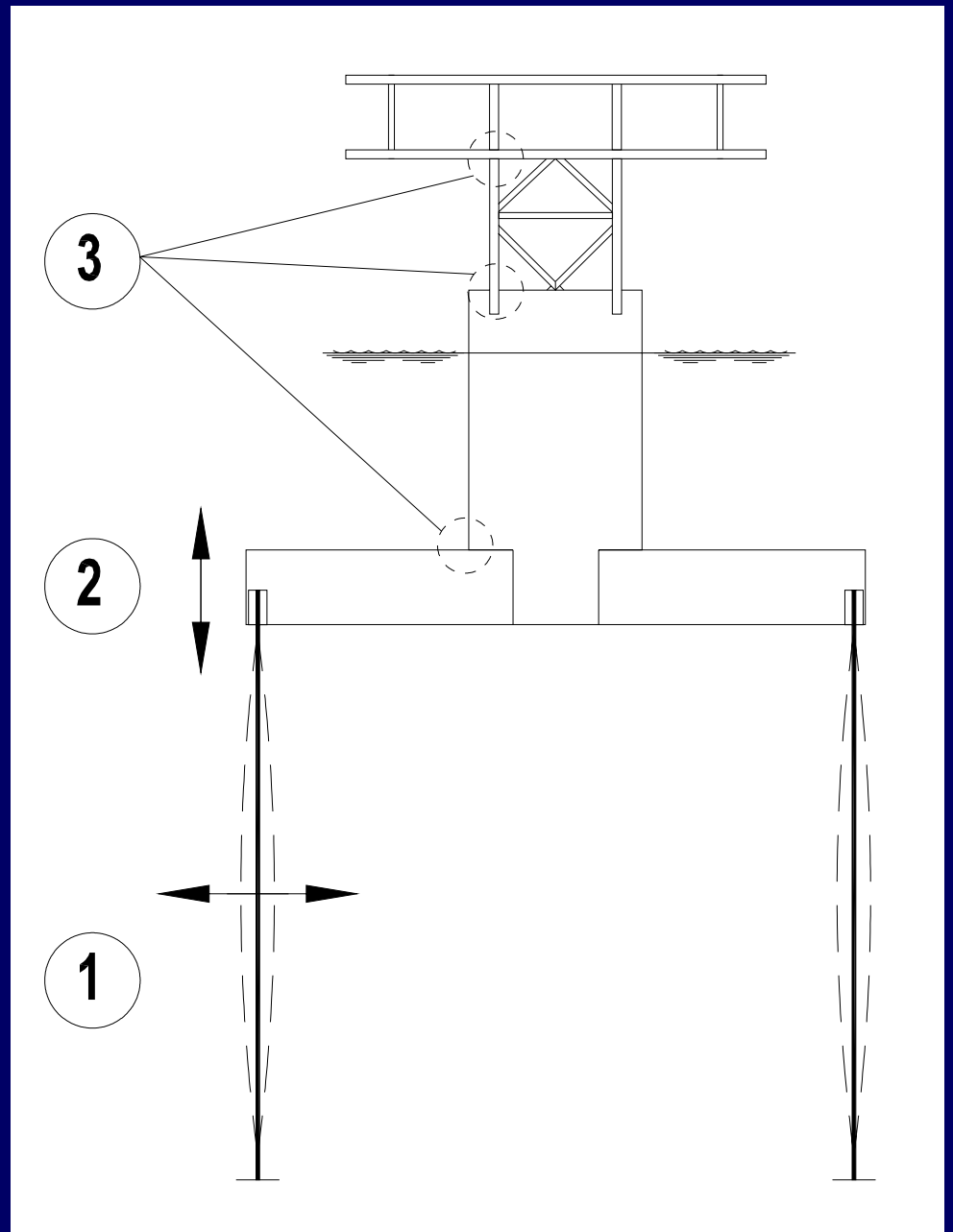
Analysis Procedures

- **Tendon**
 - VIV : SHEAR7
- **Global**
 - Time domain :
 - Large deflection - Non-linear geometry
 - Random excitation model
- **Structural**
 - Time domain – 6 tendon forces input
 - Full structural dynamics model (modal)
 - Rainflow fatigue

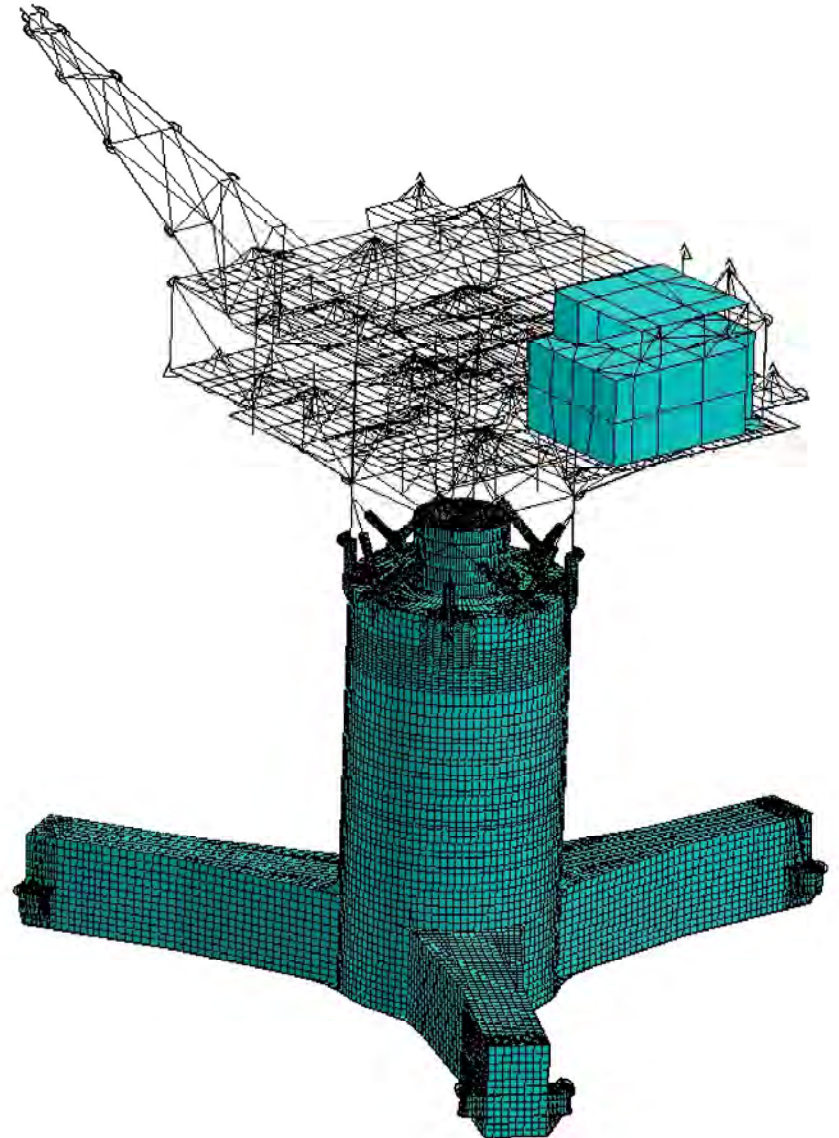
Flowchart of simulation procedure



Summary of VIV Analysis

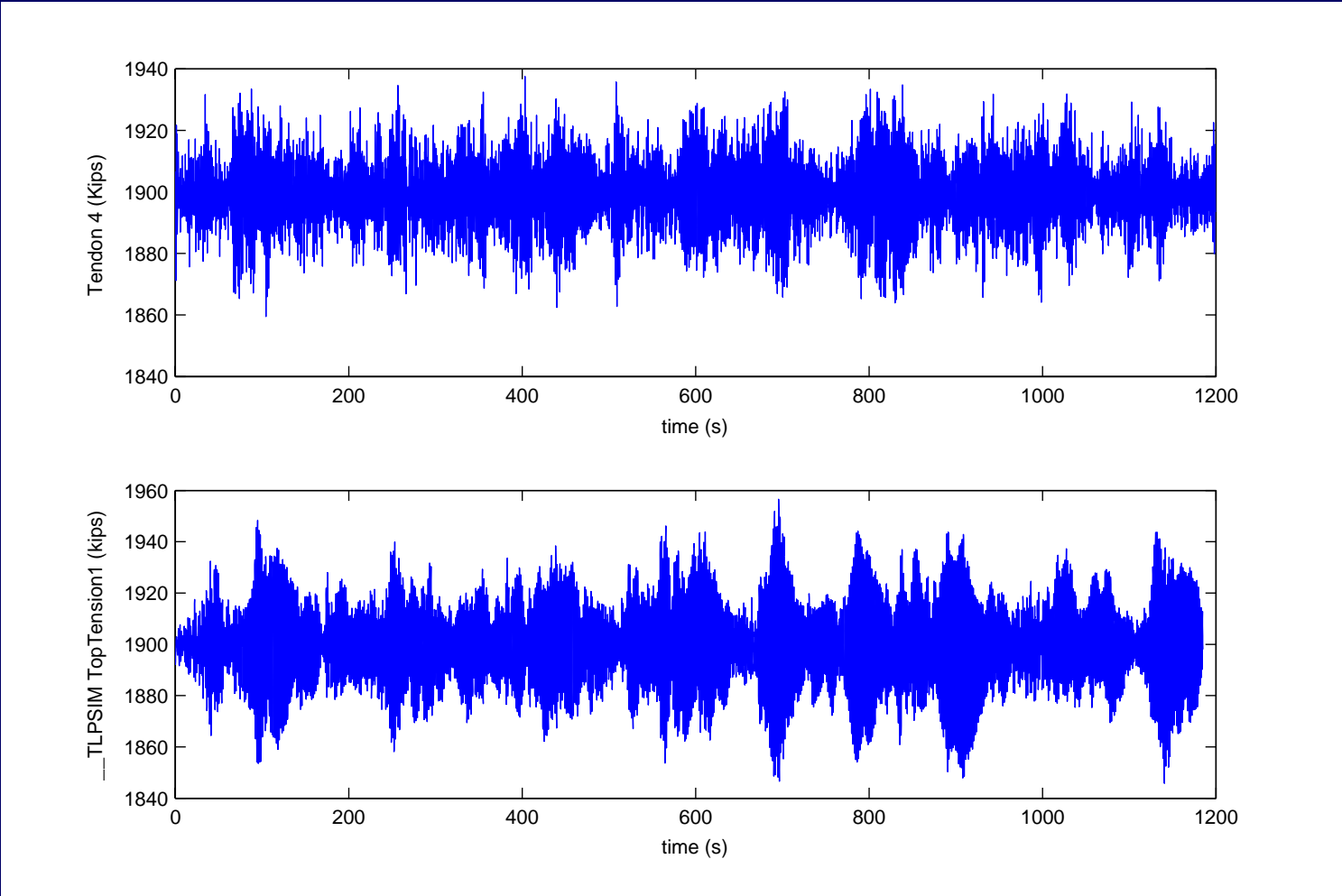


Abaqus global model

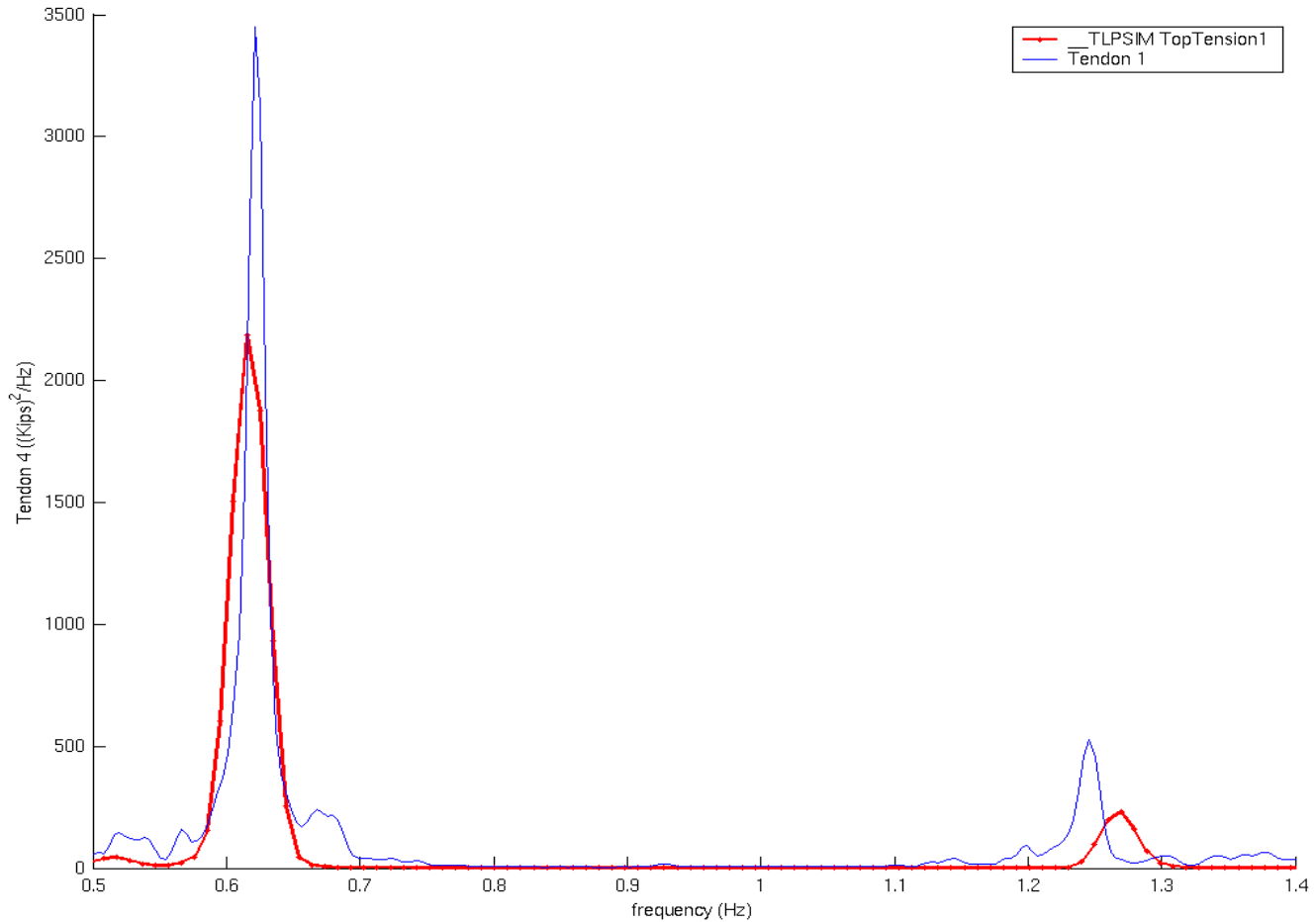


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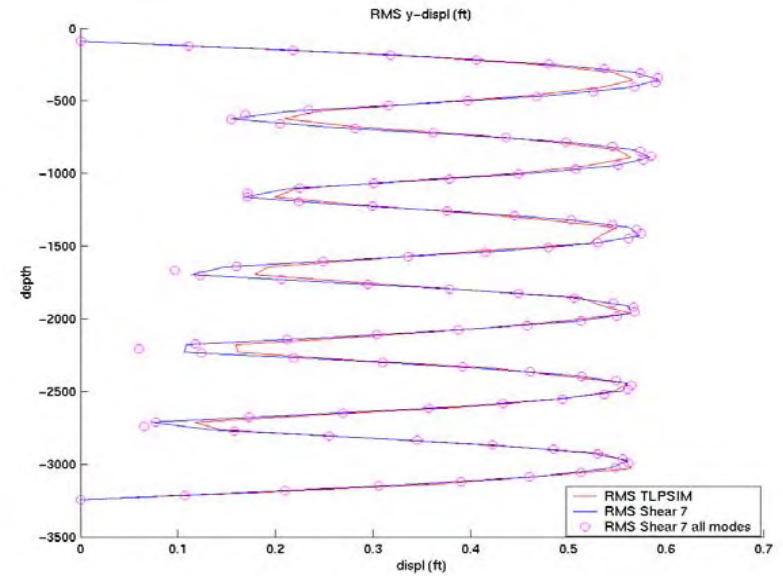
Random Excitation of Tendon



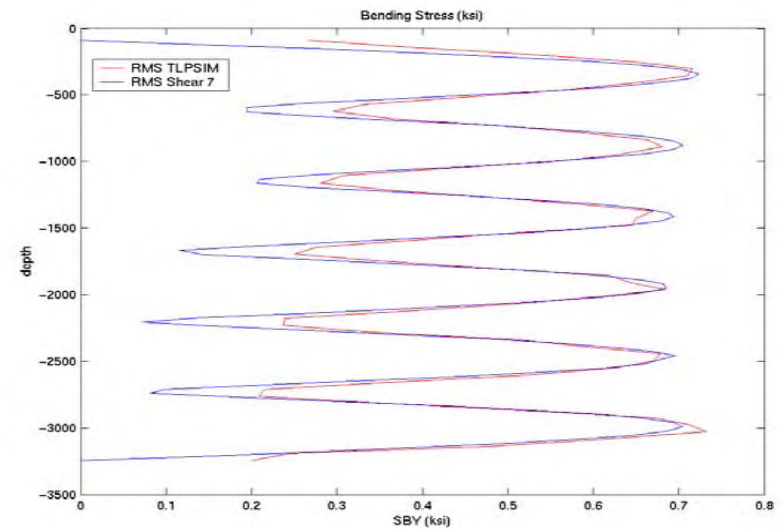
Random Excitation of Tendon



Comparison of transverse displacement between TLPSIM and SHEAR 7



Comparison RMS bending stress between TLPSIM and SHEAR 7



Comparison of fatigue lives based on Transverse VIV only (Shear7); and Transverse and Inline (incl. tension) (TLPSIM)

Speed (%)	TLPSIM		SHEAR 7	
	life (years)	max rms stress (ksi)	life (years)	max rms stress (ksi)
100	1	2.45	3	2.16
95	3	2.01	15	1.74
90	2	2.13	5	1.92
85	4	1.89	10	1.66
80	12	1.49	49	1.35
75	10	1.61	27	1.36
70	26	1.30	70	1.19
60	73	1.07	207	0.95
50	471	0.72	1919	0.62
40	6187	0.42	32468	0.36

Conclusions

- **VIV is important to Tendons, Hull and Deck**
- **VIV is important to Operability**
- **Monitoring is Important**
- **Current criteria subject to change**
- **Design calculations require sequence of analyses**
- **Inline VIV component is significant**



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