Review of Soft Torque
Songa Venus RIG
Preliminary results

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Contents

- **Situation Summary**

- **Soft Torque Installation**

- **Soft Torque Tuning**

- **Soft Torque Performance**

- **Observations**

- **Conclusions**

- **Appendix A: Tomax Tool Performance**

- **Appendix B: IDM Torvibsim scouting simulations**

RESTRICTED

Situation summary

- Semi Sub Songa Venus

    - Tesco 1350ECI TD; MD5000 VFD

    - Top drive inertia: 720 kgm^2.

    - Passive heave compensator (Rucker model 187·

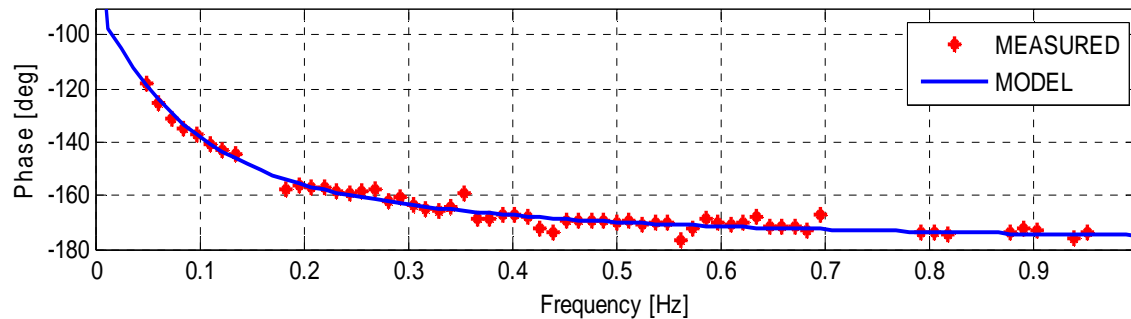   - Water depth~260m
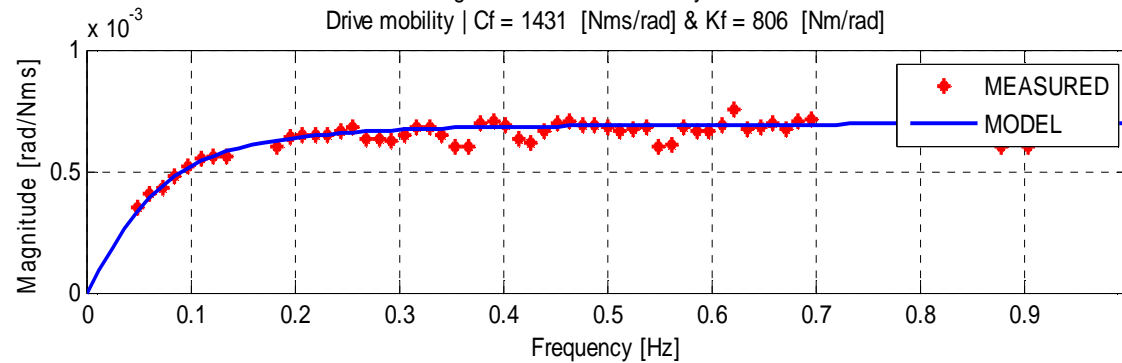
- 8 ½" hole;

- 8 ½" PDC bit
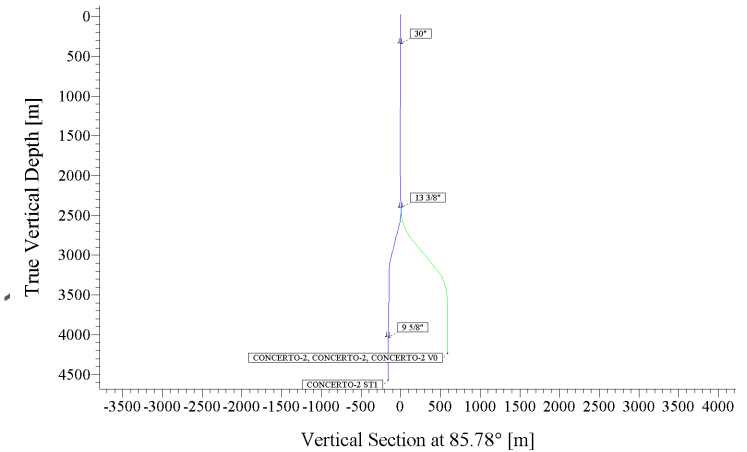
Situation summary (2)

- STRS was installed on Friday 23/7. Several ON/OFF tests and has been working since.

- On Sunday 25/7 BHA #15 was pulled
  - RIH with BHA #5, drilling 8 ½" hole.
- From there on two coring runs:
  - BHA#6 (RIH on Wednesday 28/7)
  - BHA 7 (RIH on Friday 30/7)

- Several hours of EP's high frequency data (200Hz- STQ and SRPM). Available between Friday 23/7 to Friday 30/7. That data is most important input to this presentation.

STRS installation

Kf [Nm/rad]
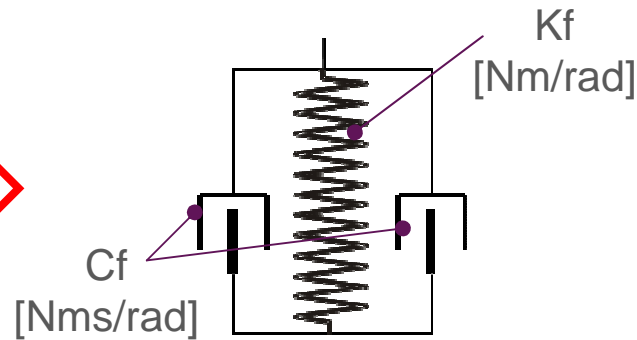
Cf [Nms/rad]

Songa Venus EP STRS - July 23 18:12
Drive mobility | Cf = 1431 [Nms/rad] & Kf = 806 [Nm/rad]

- STRS was installed and tested on 23/7

- STRS makes the TD behave like a tuned spring-damper.

- This means there now should be a known relation between TQ load on SRPM

- The **measured** drive mobility is an exact match with **model**.

- **This proves STRS is successfully**

STRS tuning by RTOC

Bit Depth [m]	Stiffness (kf) [N-m/rad]	Damping (cf) [N-m-s/rad]
4100.0	789.7	1549.5
4128.5	780.6	1545.4
4157.0	771.7	1541.3
4185.5	763.0	1537.3
4214.0	754.4	1533.3
4242.5	745.9	1529.3
4271.0	737.6	1525.4
4299.5	729.4	1521.5

- RTOC is providing Cf and Kf tuning tables using IDM 3.17

- Tuning and usage is being checked by RTOC via WITS

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Up to two lines if required

STRS performance (1)

Songa Venus EP STRS ON/OFF- July 23 19:34
Time Signals

- First ON / OFF plot

- Showing STRS eliminating stick-slip but not eradicating

- Stick-slip starts up again after switching STRS OFF @ ~75sec.

STRS performance (3) – Severe stick-slip

Songa Venus STRS OFF - July 23 18:12
Frequency spectrum - Torque

X: 0.1548
Y: 6175

Songa Venus STRS ON - July 23 18:12
Frequency spectrum - Torque

X: 0.174
Y: 1782

Top Drive: No

Concerto-1ST1 - 8.5" PowerV BHA
Natural Mode Shapes at selected Eigen Frequencies

Eigen Frequencies
— 0.17 Hz
— 0.52 Hz
— 0.89 Hz
— 1.29 Hz
— 1.69 Hz
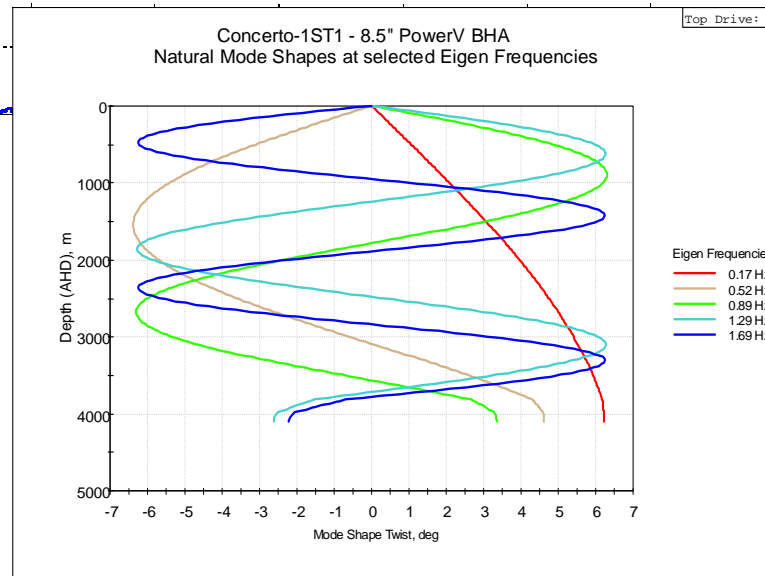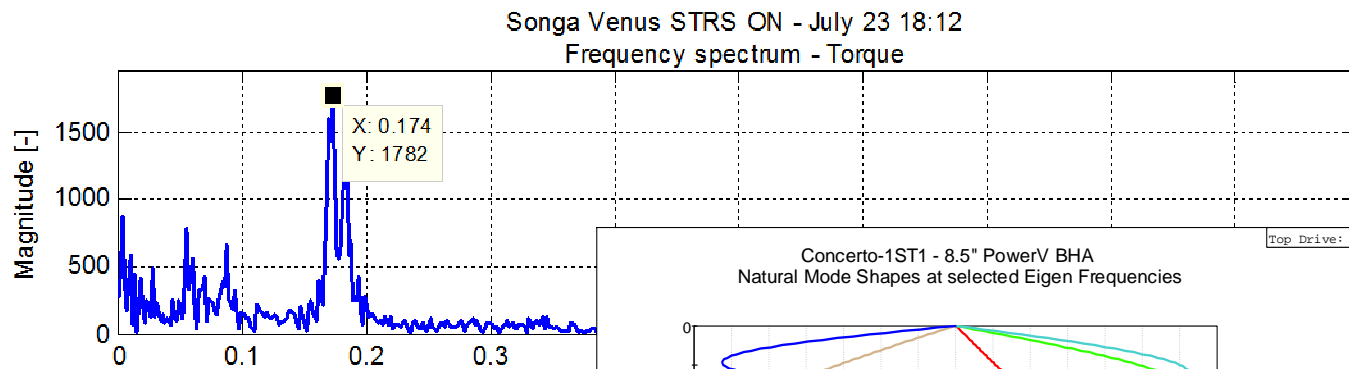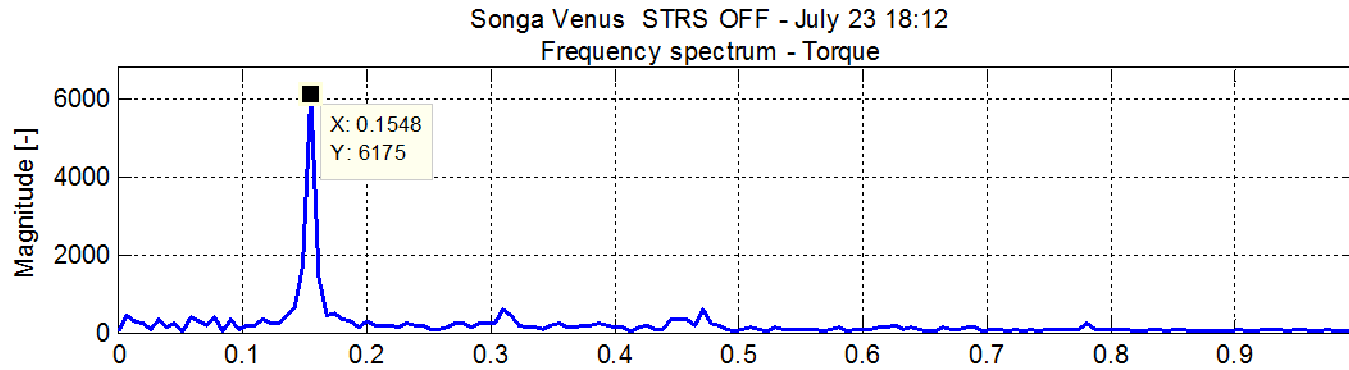
- Frequency content of surface torque for time signals on previous slide

- STRS ON and OFF

- For ON, low amplitude; matching 1st torsional mode

- For OFF, high amplitude; frequency below 1st torsional mode == stick-slip

STRS Performance (4)

Songa Venus - DDSr run 1100 - 14:00 22/7 to 04:00 25/7

- •STRS reducing stick-slip
- • No full eradication though
- •Clear difference between ON & OFF
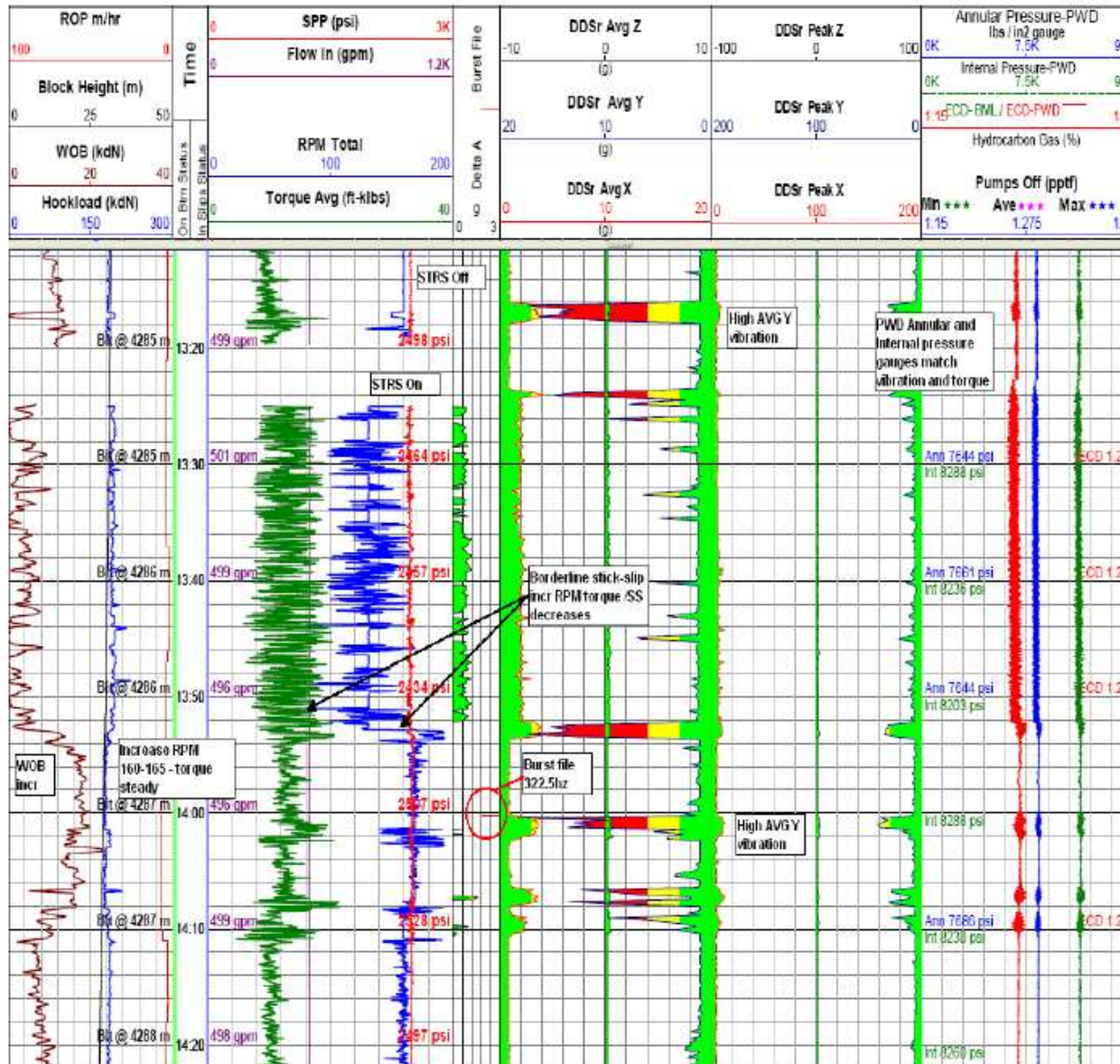
The plot opposite displays when the STRS was again switched on towards the end of the run. Initially with the RPM at 135 RPM the torque signal is very cyclic and the DDSr is recording low/moderate stick slip. The variations seen in the RPM indicate that the STRS is attempting to reduce the amount of cyclic torque but the conditions for stick slip are borderline.
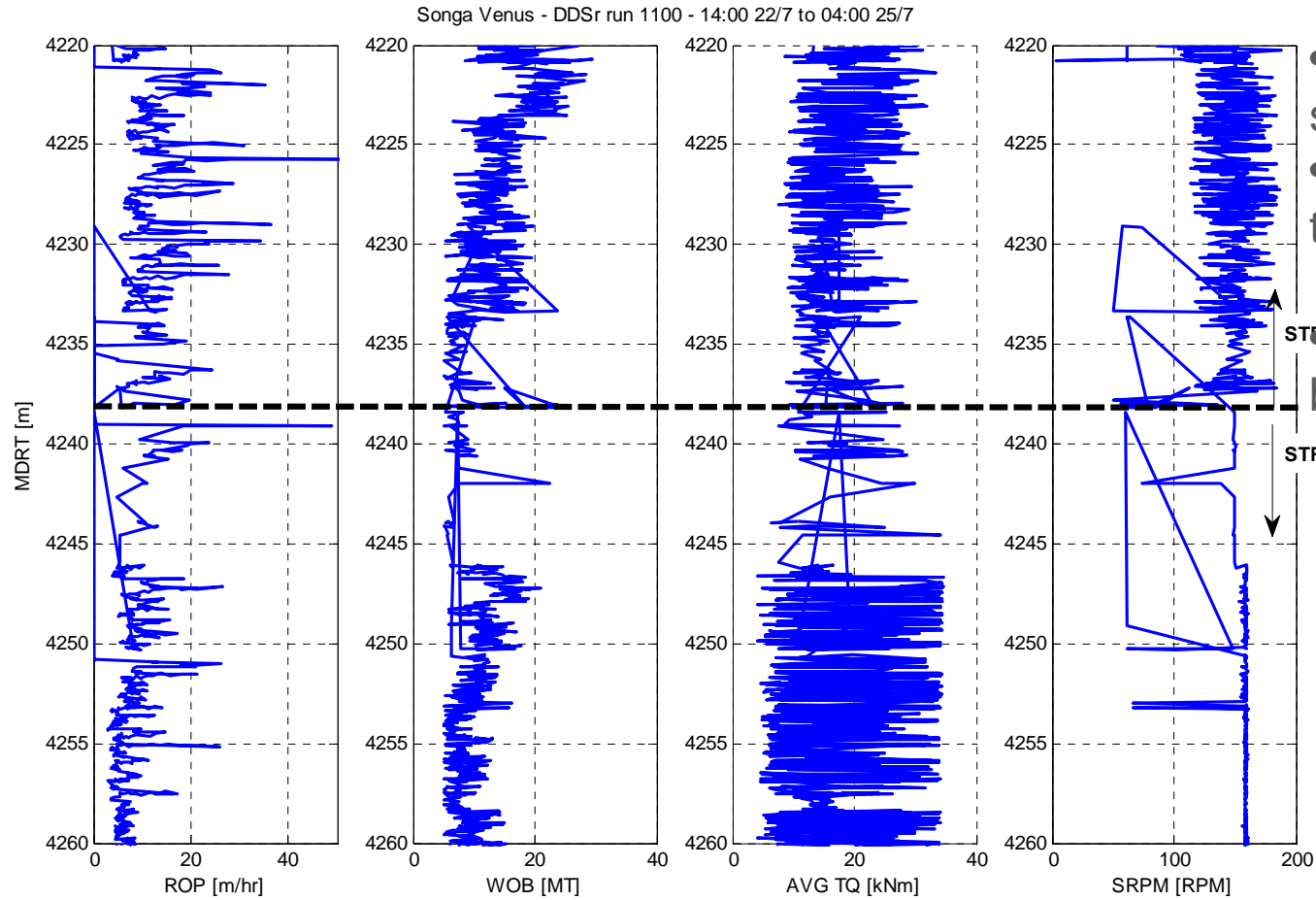
Increasing the RPM to 160-165 RPM results in the STRS being able to effectively reduce the cyclic nature of the torque. The downhole PWD pressure gauges are also smoother as the STRS reduces the downhole torsional vibration. The DDSr Delta Avg reduces to zero in response to the increase in RPM.

There are several short incidents of high Avg Y vibration and the STRS appears to respond to this.

(24-07-10 at 13:20 Hrs – 4285m)

Observations (2) Stick slip and weight-on bit
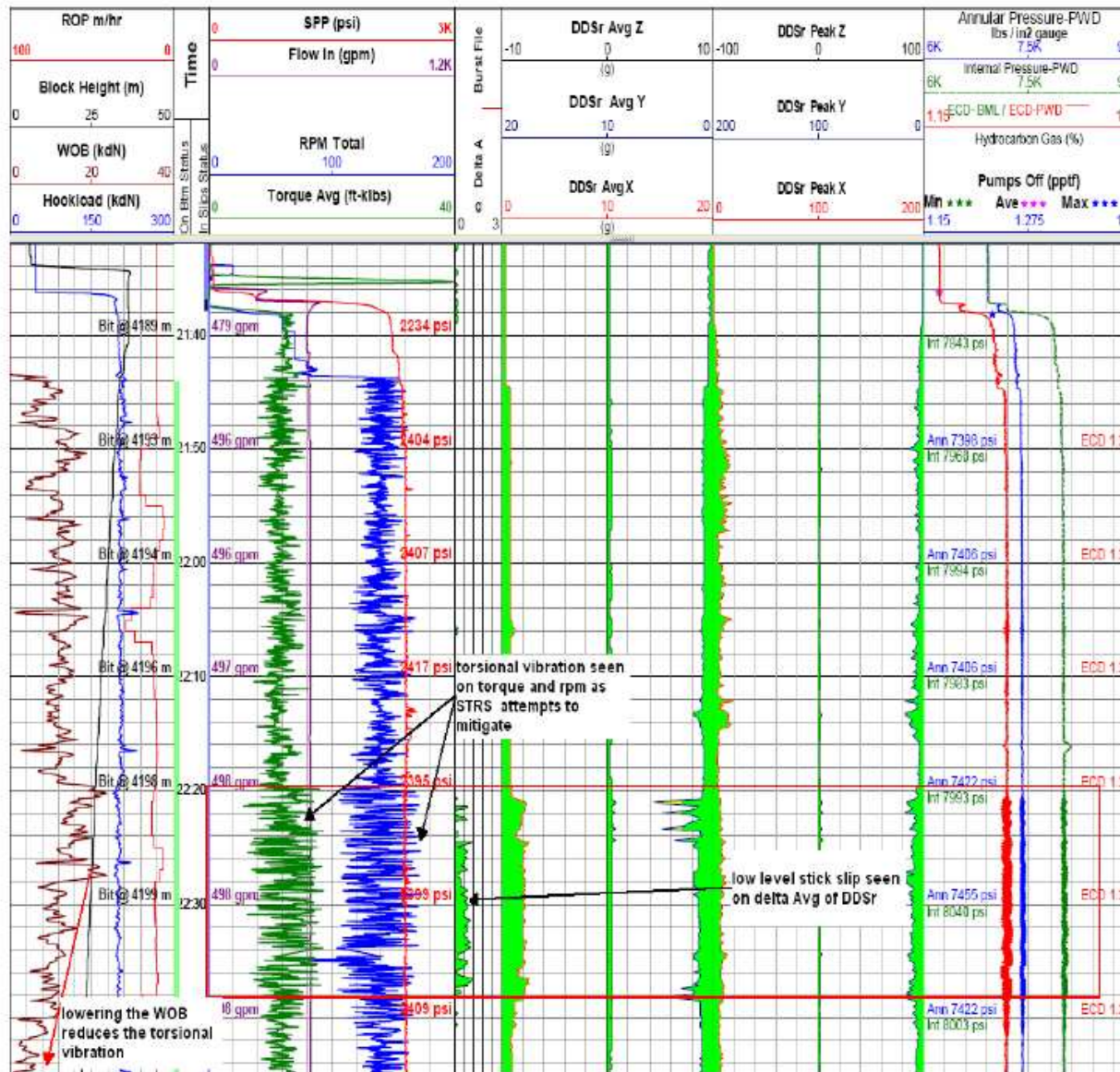
- Soft Torque suppresses but not fully eliminates the stick-slip
- Increasing the WOB increases the stick slip level
- Suggests bit generated stick slip
- Confirms earlier studies that linked stick slip to the bit drilling the harder formations (sands, volcanics)
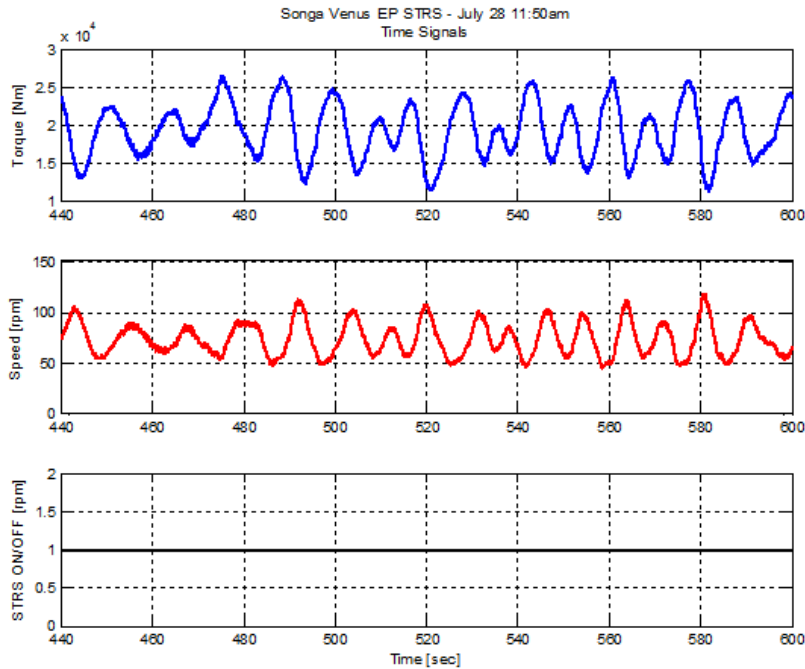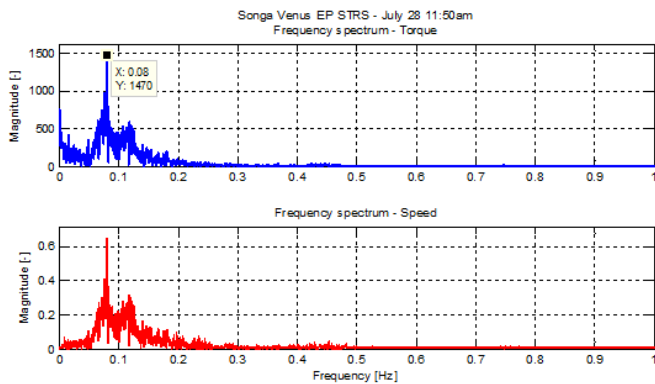
(22:20, 23rd of July)

Observations (3) "Heave induced stick-slip"

Songa Venus EP STRS - July 28 11:50am
Time Signals

Songa Venus EP STRS - July 28 11:50am
Frequency spectrum - Torque

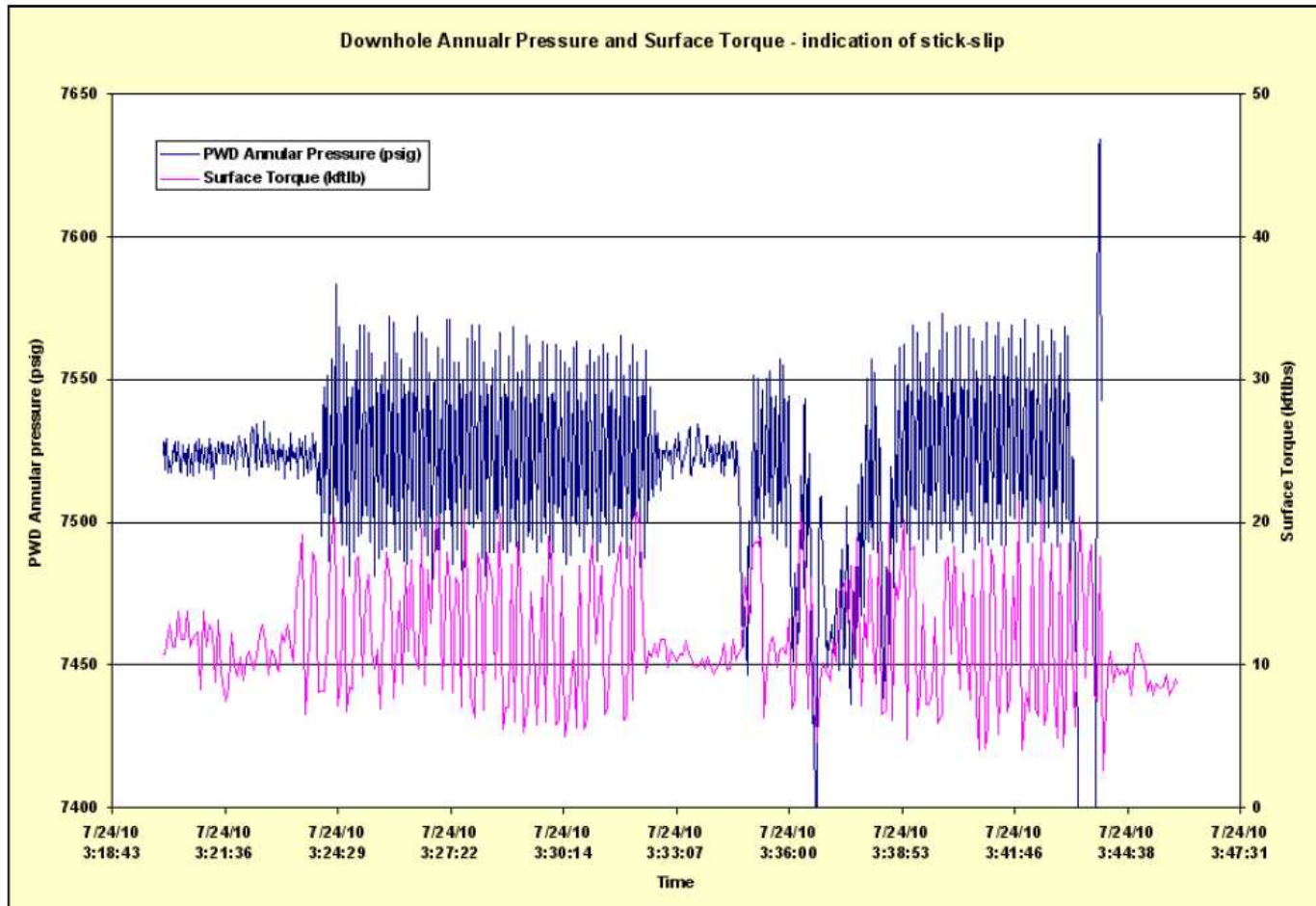X: 0.08
Y: 1470

Frequency spectrum - Speed

- On several occasions STRS eliminates stick-slip, but heave-induced vib's remain

- Amplitude TQ variation >10kNm (!)

- Frequency of this oscillation is ~0.08Hz. (as compared with ~ 0.17 Hz from stick slip)

- Confirmed to match ocean swell from that day.

- STRS cannot cure this!

Date:	28-Jul-10		Location:		Concerto 2 ST1	
			Rig Heading :		110°	
			Latitude:		13°40.9' S	
			Longitude:		123°21.5' E	
			Water Depth:		879'	

Bulk Data

	Rig Fuel	Drill Water	Pot Water	Brine	Base Oil	SBM	WBM	Cmt Neat G	Cmt Blend HTB	Barite	Bento	Heli fuel	Avail Deck Load
	M3	M3	M3	M3	M3	M3	M3	MT	MT	MT	MT	LTS	LT
Yesterday	582	1438	103	143	95	228	0	16	71	78	36	12112	691
Rec	0	0	89	0	0	46	0	0	0	0	0	0	N/A
Used	20	14	34	0	0	38	0	0	0	0	0	865	N/A
Today	562	1424	158	143	95	236	0	16	71	78	36	11247	674

Weather

Wind			Wave		
Wind speed (kts)		10	Period (sec)		3
Wind direction		SE	Direction		ESE
10		15	Height		
			Swell		
Current speed (kts)		N/A	Period (sec)		13
Current direction (deg)		N/A			SW
Temperature (deg C) H/L	34	24	Height (ft)		2
Visibility (naut miles)		9	Heave (m)		0.5
Cloud cover		3/8	Pitch (deg)		0.3
Barometric pressure (m/bar)		1016	Roll (deg)		0.5

Downhole Annualr Pressure and Surface Torque - indication of stick-slip

- Stick slip couples with <u>internal</u> and <u>external</u> PWD sensor

- Seen this before in the NAM 15 years ago

- Suspect that varying rotational speeds causes varying pressure drops

- Not fully understood

Note: Small shift in time data

Conclusions

- Severe stick slip observed during 8.5" run

  - With no STRS upto 15kNm amplitude!

- Soft Torque

  - STRS successfully installed

  - STRS effective most of time in surpressing stick-slip

  - For severe stick-slip STRS sometimes not able to fully eradicate

  - **Using low WOBs and High RPMs will give the best results**

  - Tuning via Miri RTOC works