


# Troubleshooting Operational Aspects of Well Drilling and Completion Using the PI System

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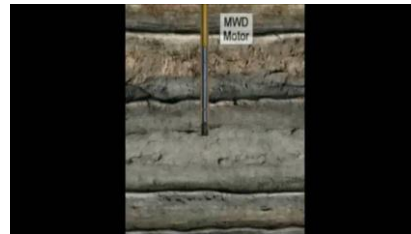
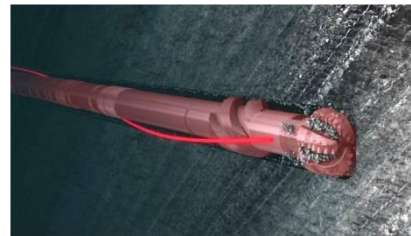
# Business Challenge

- High Cost - \$80,000/d to \$1,000,000/d
- Reduce Drilling/Completion Days
  - Drilling – 20 to 25 days
  - Completion – 50 to 70 days
- Current focus – Depth Based Analysis
- Compare Shifts, Crews, Drilling Outfits
- Noise in the Data



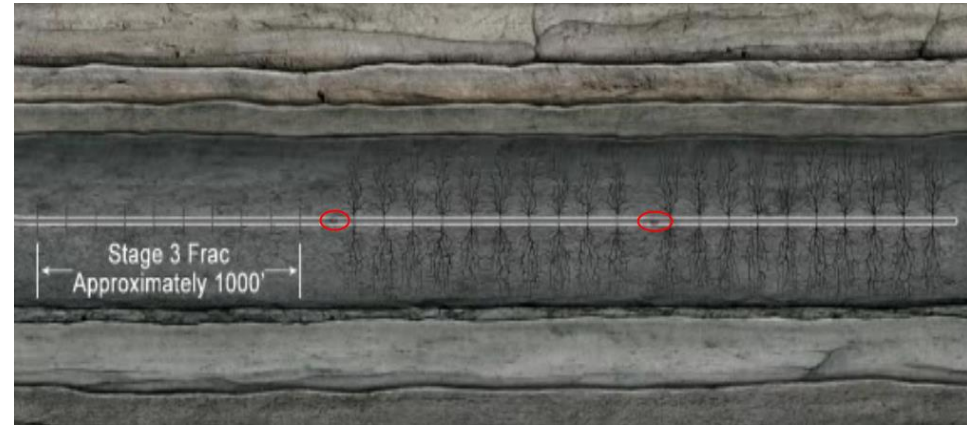
# Background and Terminology

- Stick-Slip →
- Rotating Drilling ↘
- Sliding ↘
- Tripping In/Out
- On/Off Bottom
- Other Types of Events ...



# Completion - Fracking

- Process
  - Blast
  - High Pressure Fluid
  - Plug
- Stages
  - Typically 1000 ft

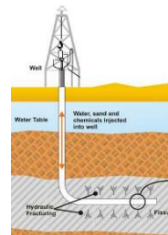


# The Approach

- PI AF Elements
  - Rigs
- PI Event Frames
  - Wells
- PI Asset Based Analytics
  - Triggers for Well Events



Name	Description	Default Value
Rig_InstName	Rig Name	
Rig_MakeModel	Make/Model	
Rig_Make	Make	
Rig_Model	Model	
Rig_Location	Location	
Rig_Status	Status	
Rig_Depth	Depth	0 ft
Rig_Pressure	Pressure	0 psi
Rig_Temperature	Temperature	0 °F
Rig_Vibration	Vibration	0 mm/s
Rig_Speed	Speed	0 rpm
Rig_Power	Power	0 kW
Rig_Fuel	Fuel	0 gal
Rig_Emissions	Emissions	0 tons
Rig_Weight	Weight	0 lbs
Rig_Height	Height	0 ft
Rig_Diameter	Diameter	0 ft
Rig_WeightPerFoot	Weight Per Foot	0 lb/ft
Rig_Material	Material	
Rig_Color	Color	
Rig_Year	Year	
Rig_MakeModel	Make/Model	
Rig_Make	Make	
Rig_Model	Model	
Rig_Location	Location	
Rig_Status	Status	



Name	Description	Start Time	End Time
Well 1		24:11:41:12	4/1/2014 2:00:00 AM
Sliding		0:19:00	4/1/2014 2:40:00 PM
Rotary ...		4:40:38	4/1/2014 3:33:45 PM
Sliding		0:28:30	4/1/2014 5:23:04 PM
Stick-Slip		0:03:30	4/2/2014 6:02:30 AM
Sliding		0:20:33	4/3/2014 3:42:00 AM
Rotary ...		8:10:26	4/4/2014 1:33:23 AM
Stick-Slip		0:00:51	4/5/2014 3:33:45 PM
Sliding		0:22:01	4/12/2014 10:41:10 AM
Cl-Down		4/14/2014 8:41:10 AM	4/14/2014 8:41:10 AM

Name	Expression	Value
DepthChange	(Abs(TagVal("Mole Depth","")) - Abs(PrevVal("Mole Depth","-20s")))	
StartTrigger	DepthChange > 0.1 AND "ROP" > 0.1 AND "Top Drive RPM" > 15 AND Left("Well Name",4) = "Well1"	
EndTrigger	"ROP" > 0.1 AND "Top Drive RPM" < 15 AND Left("Well Name",4) = "Well1"	

# Step 1: *Model the Drilling Rigs*











Rig

General | Attribute Templates | Ports | Analysis Templates

Filter

	Name	Description	Default Value
Template: Rig			
	Bit Position		0 ft
	Bit Weight		0 klb
	Block Height		0 ft
	Diff Press		0 psi
	Flow In Rate		0 gpm
	Hole Depth		0 ft
	Hook Load		0 klb
	Midas Number		
	Mud Weight In		0 lb/US gal
	Pump Pressure		0 psi
	ROP		60 ft/h
	Top Drive RPM		0 rpm
	Top Drive Torque		1 lbf-ft
	Well Name		0
	Well Name State		

## Step 2: *Define Critical Well Events*

☐	Well 1		24:11:41:12	4/1/2014 2:00:00 AM	4/25/2014 1:41:12 PM
	Sliding		0:19:00	4/1/2014 2:40:00 PM	4/1/2014 2:59:00 PM
	Rotary ...		4:40:38	4/1/2014 3:33:45 PM	4/1/2014 8:14:23 PM
	Sliding		0:28:30	4/1/2014 5:23:04 PM	4/1/2014 5:51:34 PM
	Stick-Slip		0:03:30	4/2/2014 5:59:00 AM	4/2/2014 6:02:30 AM
	Sliding		0:20:33	4/3/2014 3:42:00 AM	4/3/2014 4:02:33 AM
	Rotary ...		8:10:26	4/4/2014 1:33:23 AM	4/4/2014 9:43:49 AM
	Stick-Slip		0:00:51	4/5/2014 3:33:45 PM	4/5/2014 3:34:36 PM
	Sliding		0:22:01	4/12/2014 10:41:10 AM	4/12/2014 11:03:11 AM
	Sliding		0:18:09	4/14/2014 8:41:25 AM	4/14/2014 8:59:34 AM



# Step 3: *Discover Performance Problems*

Rig

General | Attribute Templates | Ports | Analysis Templates

Name: Rotary Drilling Trigger

Description:

Categories:

Analysis Type: ☐ Expression ☐ Rollup ☒ Event Frame G

Example Element: [Drill1](#)

Event Frame Template: Rotary Drilling

[New](#) [Edit](#) [Evaluate](#)

Name	Expression	Value
DepthChange	<code>(Abs(TagVal('Hole Depth','*')) - Abs(PrevVal('Hole Depth','*-20s')))</code>	<input type="text"/>
StartTrigger	<code>DepthChange &gt; 0.1 AND 'ROP' &gt; 0.1 AND 'Top Drive RPM' &gt; 15 AND Left('Well Name',4) = "Well"</code>	<input type="text"/>
EndTrigger	<code>'ROP' &gt; 0.1 AND 'Top Drive RPM' &lt; 15 AND Left('Well Name',4) = "Well"</code>	<input type="text"/>

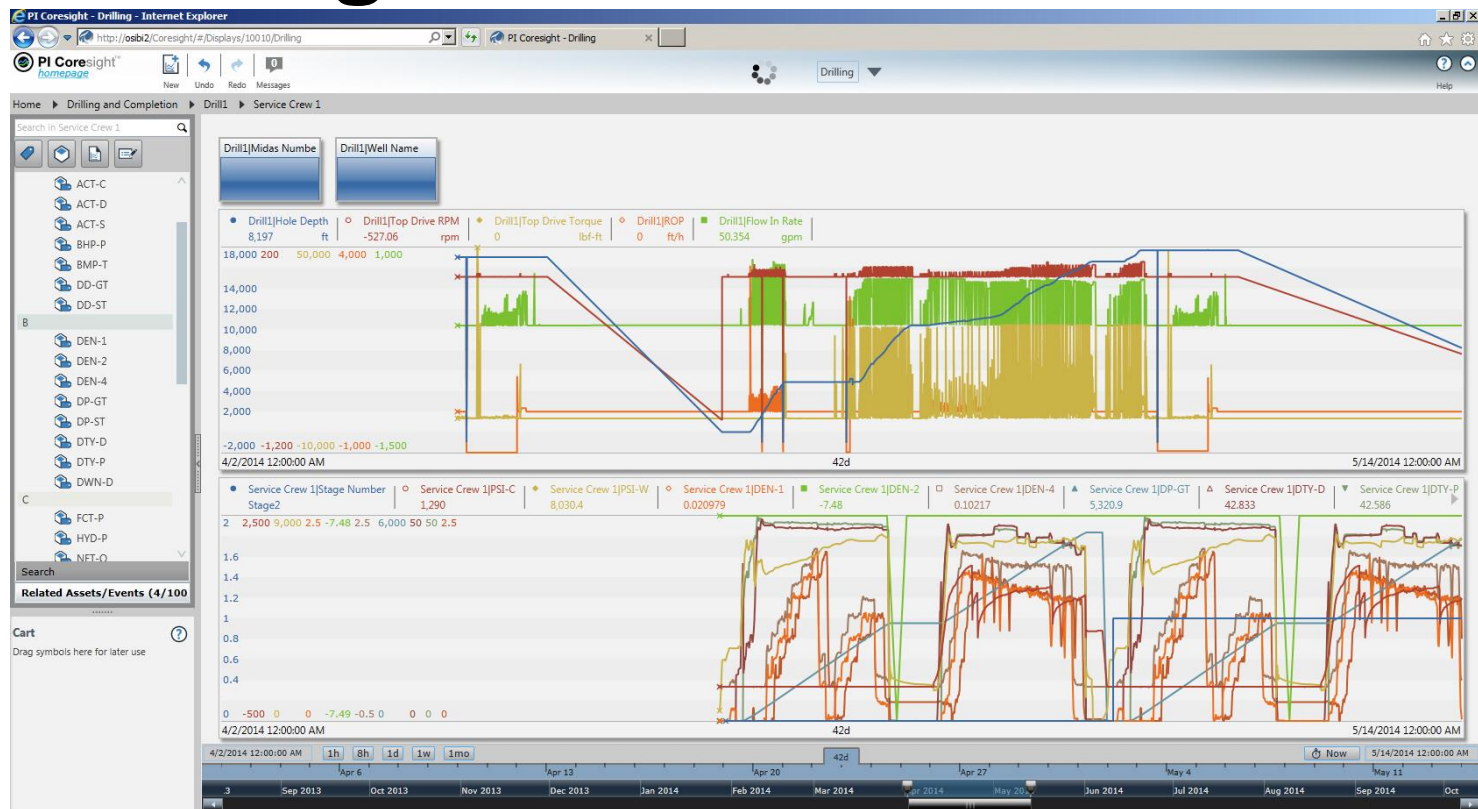
# OSIsoft Products Used

- PI AF (2014)
- PI Asset Based Analytics
- PI Event Frames
- PI OLEDB Enterprise
- PI Coresight
- PI DataLink

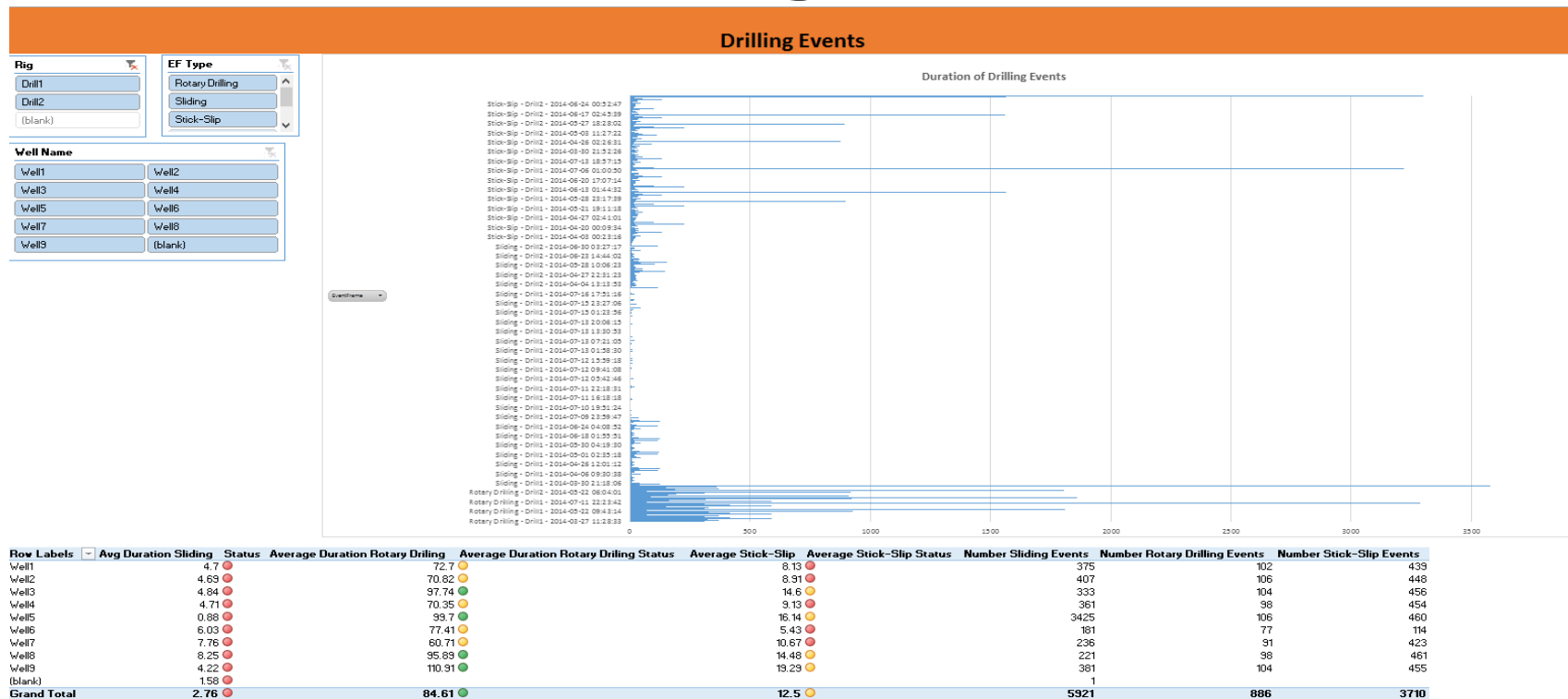
# Results

- Analyzing Results
  - PI Coresight
  - Microsoft PowerView
  - PI DataLink

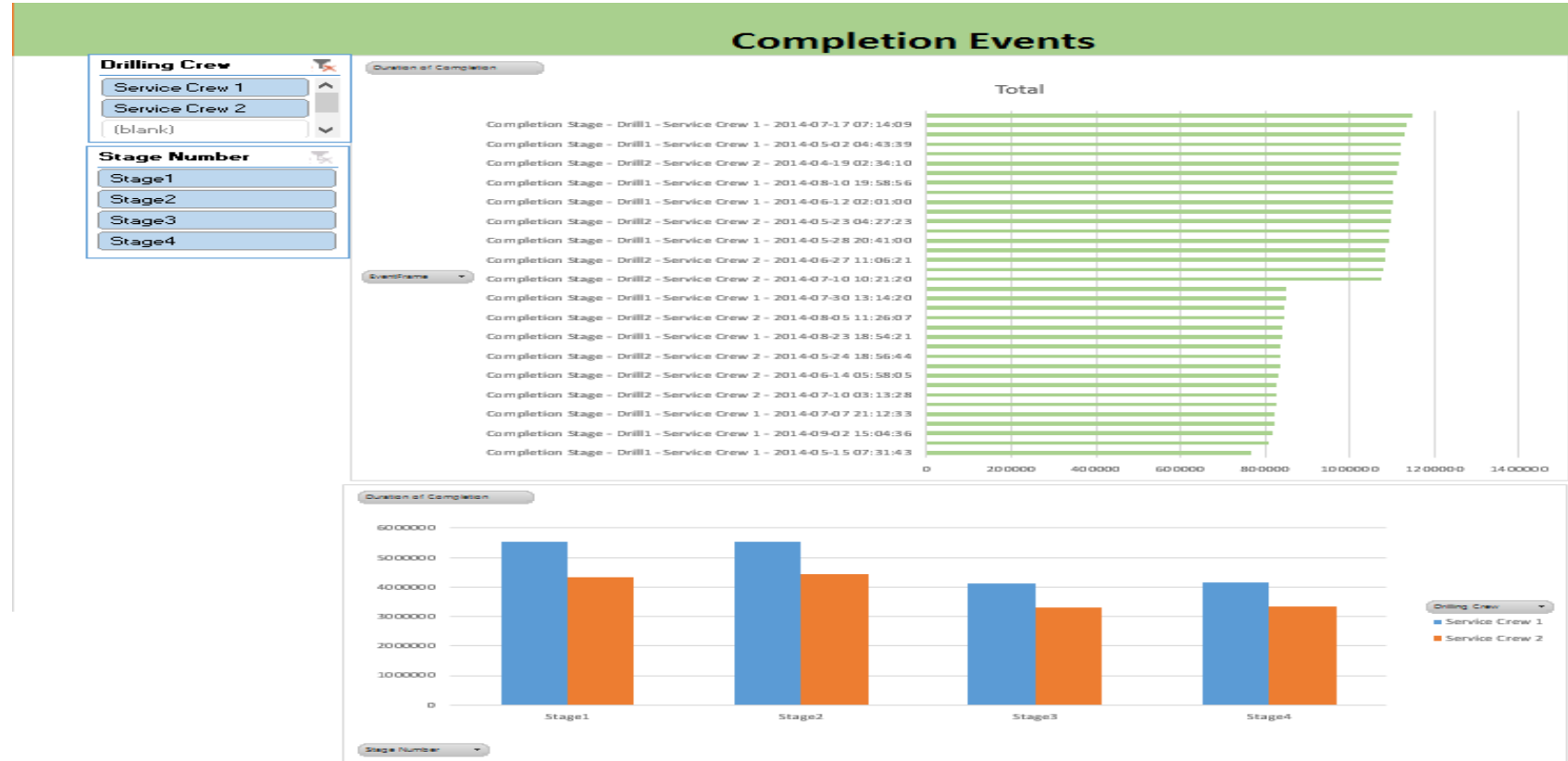
# PI Coresight



# Overview of Drilling Events



# Overview of Completion Events

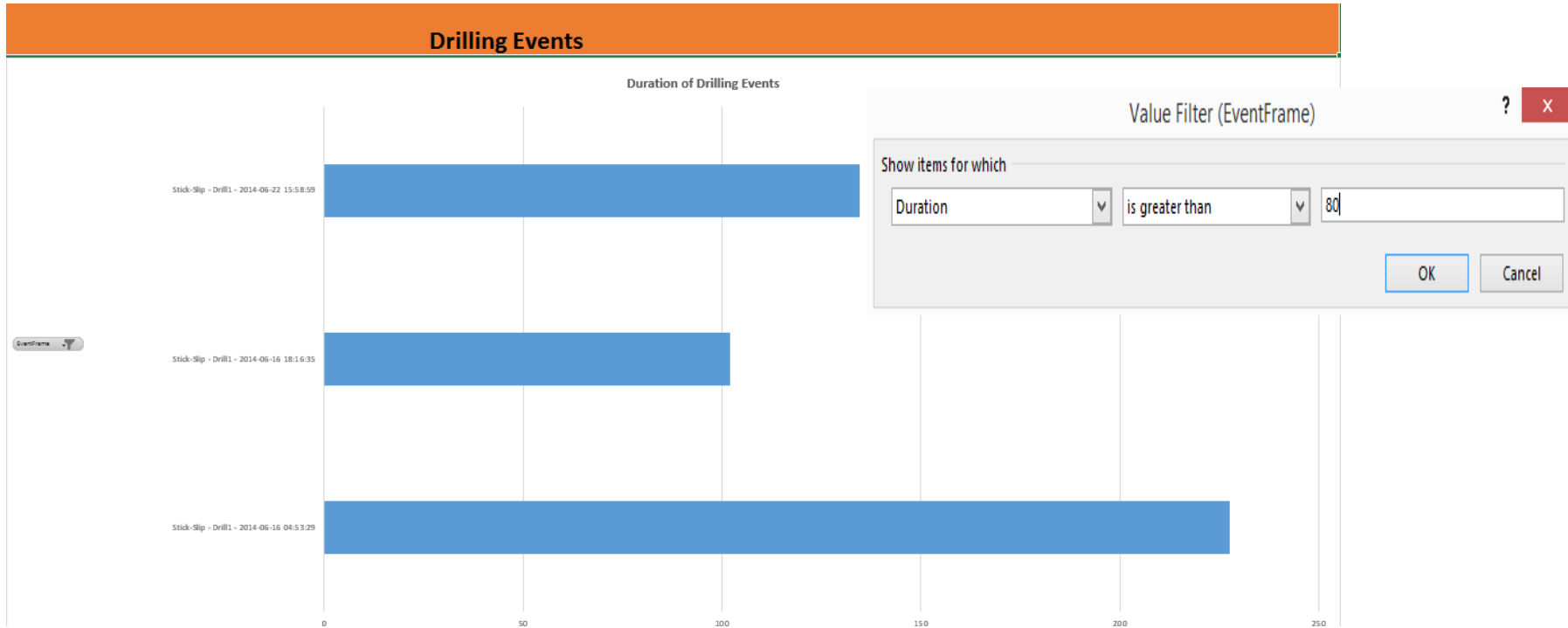


# Drilling Event – Ad hoc Analysis

## Drilling Events



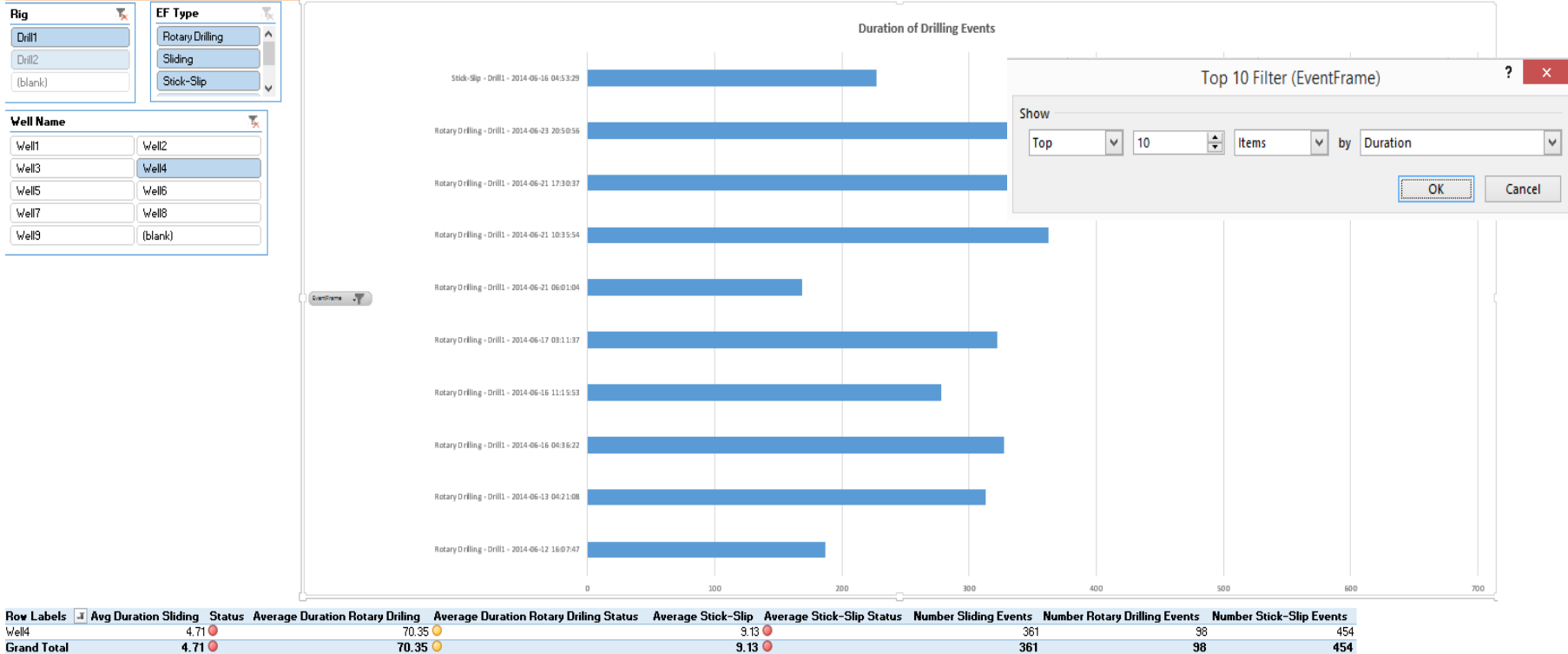
# Drilling Event – Search based on Duration



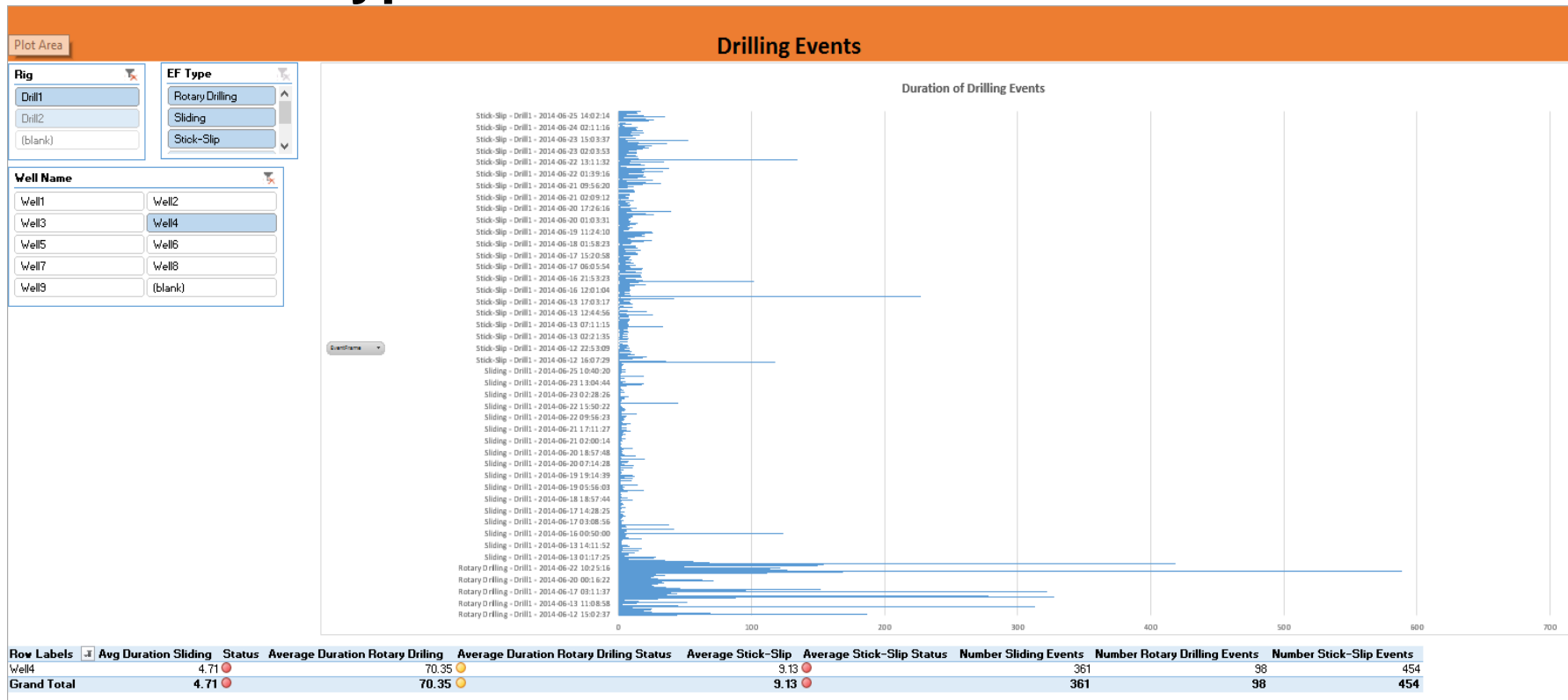


# Drilling Event – Search based on top 10 events

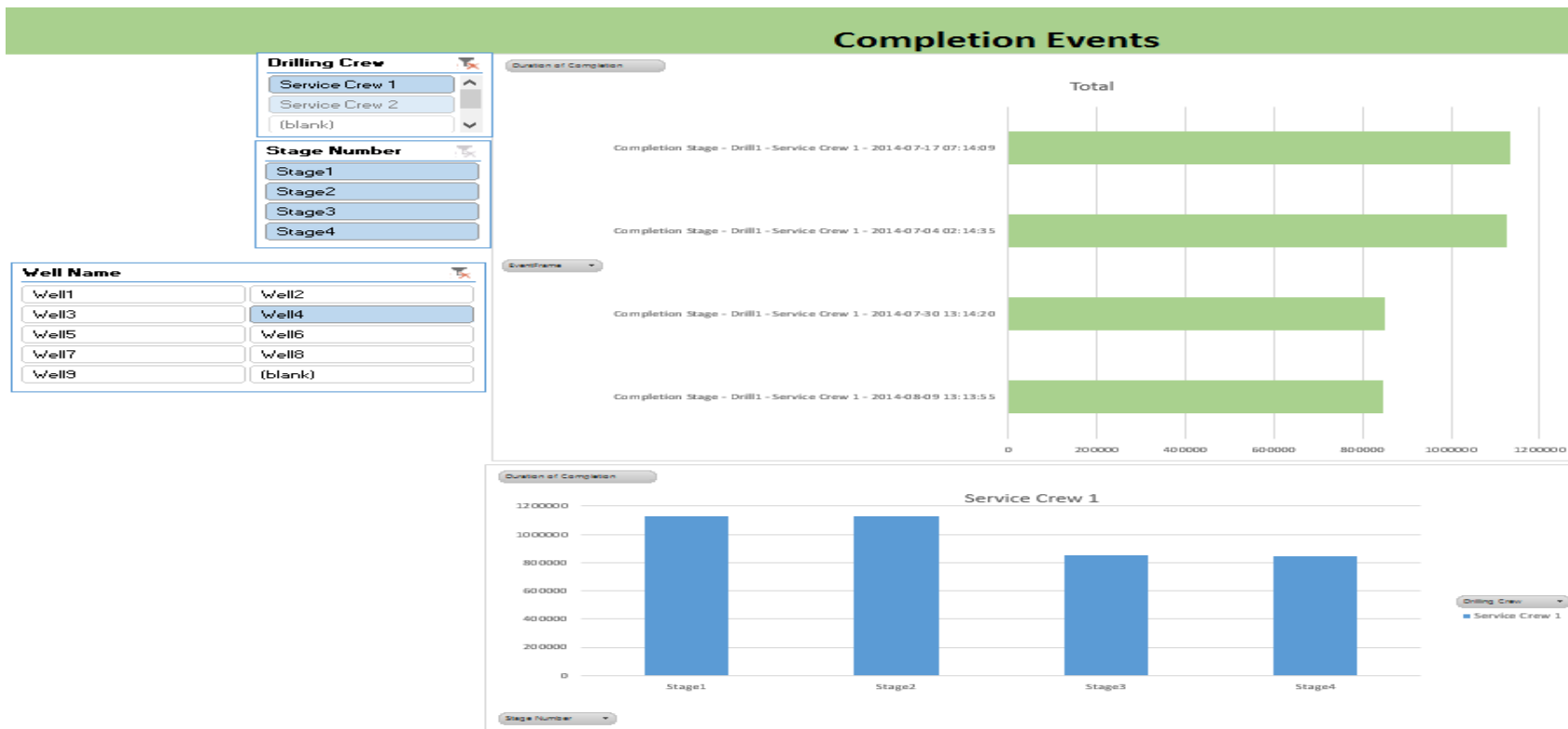
## Drilling Events



# Drilling Event – Calculate the average duration for each event type



# Completion Event – Search for completion events on a Well



# PI DataLink

## Sample Drilling Report

	A	B	C	D	E	F	G	H	I
1									
2									
3	Start Time	*-500d							
4	End Time	*							
5	EF Type	Stick-Slip							
6	Well Name	Well3							
7	Duration		5						
8									
9									
10									
11	Event name	Start time	End time	Duration	Event template	Primary element	EF Type	Drilling	
12	Stick-Slip - Drill1 - 2014-06-03 16:01:	03-Jun-14 16:01:15	05-Jun-14 23:02:27	2 7:01:12	Stick-Slip	Drill1	Stick-Slip	Service Crev Sti	
13	Stick-Slip - Drill1 - 2014-06-02 00:48:	02-Jun-14 00:48:27	03-Jun-14 02:55:19	1 2:06:52	Stick-Slip	Drill1	Stick-Slip	Service Crev Sti	
14	Stick-Slip - Drill1 - 2014-05-26 21:39:	26-May-14 21:39:18	27-May-14 12:35:38	0 14:56:20	Stick-Slip	Drill1	Stick-Slip	Service Crev Sti	
15	Stick-Slip - Drill1 - 2014-05-22 14:31:	22-May-14 14:31:13	24-May-14 20:07:28	2 5:36:15	Stick-Slip	Drill1	Stick-Slip	Service Crev Sti	
16									
17									

### Explore Events

Database

\NOSIB\3\Calgary Seminar 2014

Search start

'Raws'\SB\$3

Search end

'Raws'\SB\$4

☐ Limit to database level

More search options

Event category

\*

Minimum duration

'Raws'\SB\$7

Maximum duration

Event name

\*

Event template

Stick-Slip

Element name

\*

Element template

\*

Search mode

active in range

Sort order

start time ascending

Attribute value filters

Attribute	Operator	Value
EF Type	=	'Raws'\SB\$5
Well Name	=	'Raws'\SB\$6

# Future Plans

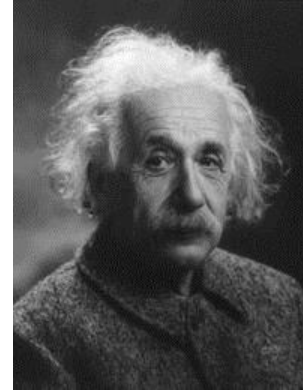
- Expand PI Event Frames Template
- Expand Analyses
- Create Performance KPIs

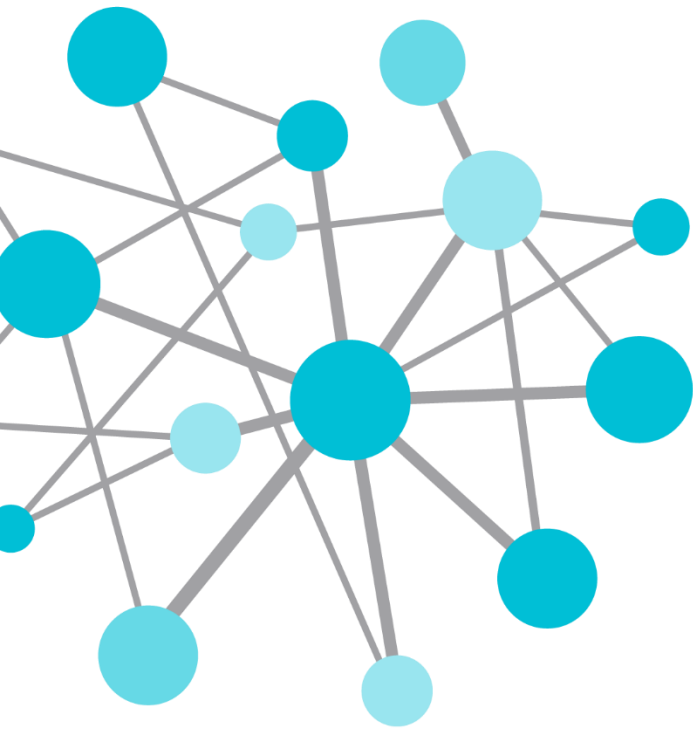
# Conclusion

- Ability to Analyze Operations
  - Event Frames
  - Analytics
  - BI Tools
- Shorten time for Drilling and Completions

# Word to the Wise

"Everything should be made as simple as possible,  
but not simpler."





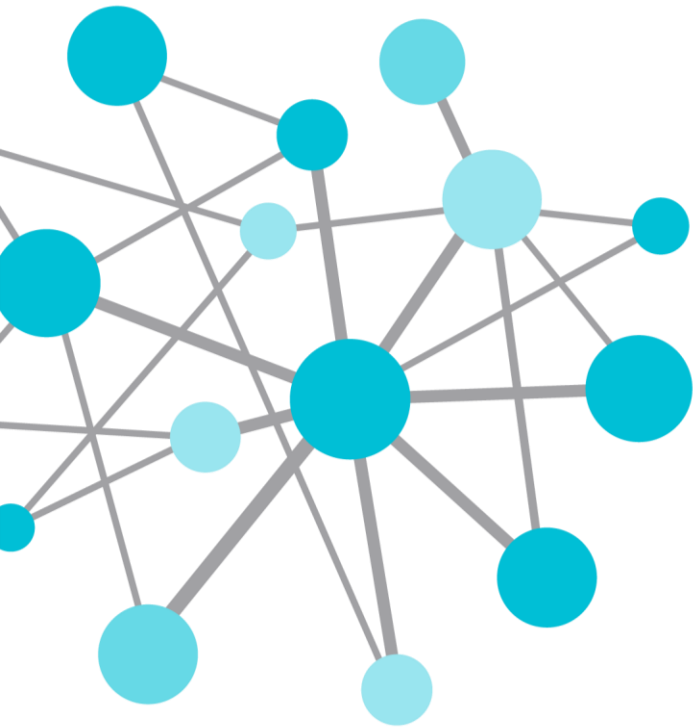
# Questions

**Please wait for the  
microphone** before  
asking your question



**Please state your name  
and your company**





THANK  
YOU

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