

# Use of MATLAB in post-processing of offshore measurements



Statoil. The Power of Possible

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# Presentation outline

- Who we are – Statoil and Wellhead Fatigue Group
- Wellhead fatigue – why is it an issue?
- Offshore measurements
- Our process – from raw data to a report
- Why MATLAB?
- Questions

# Who are we?

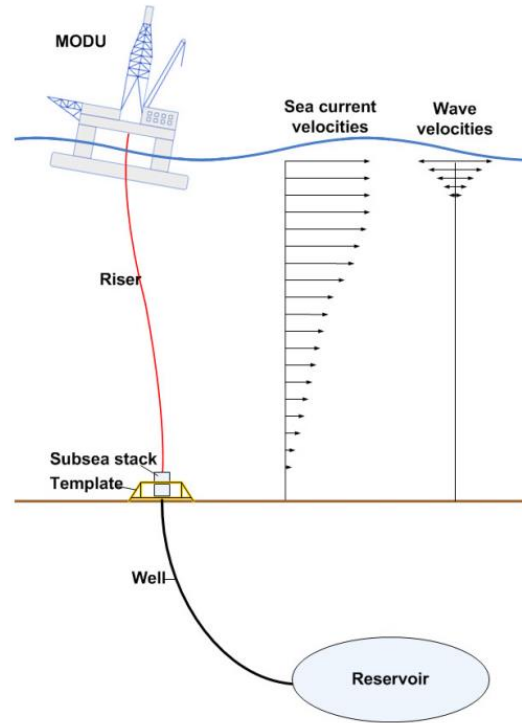
# Statoil



# Wellhead Fatigue Group

- Part of the Research and Technology department
- Established in 2008
- Wellhead fatigue analysis is performed to assess the capacity of subsea wellheads prior to drilling operations
- Wellhead fatigue analysis based on DNV method statement
- <https://rules.dnvgl.com/docs/pdf/DNVGL/RP/2015-04/DNVGL-RP-0142.pdf>

# Why is wellhead fatigue an issue?



Source: DNV Method Statement

# Drilling operation



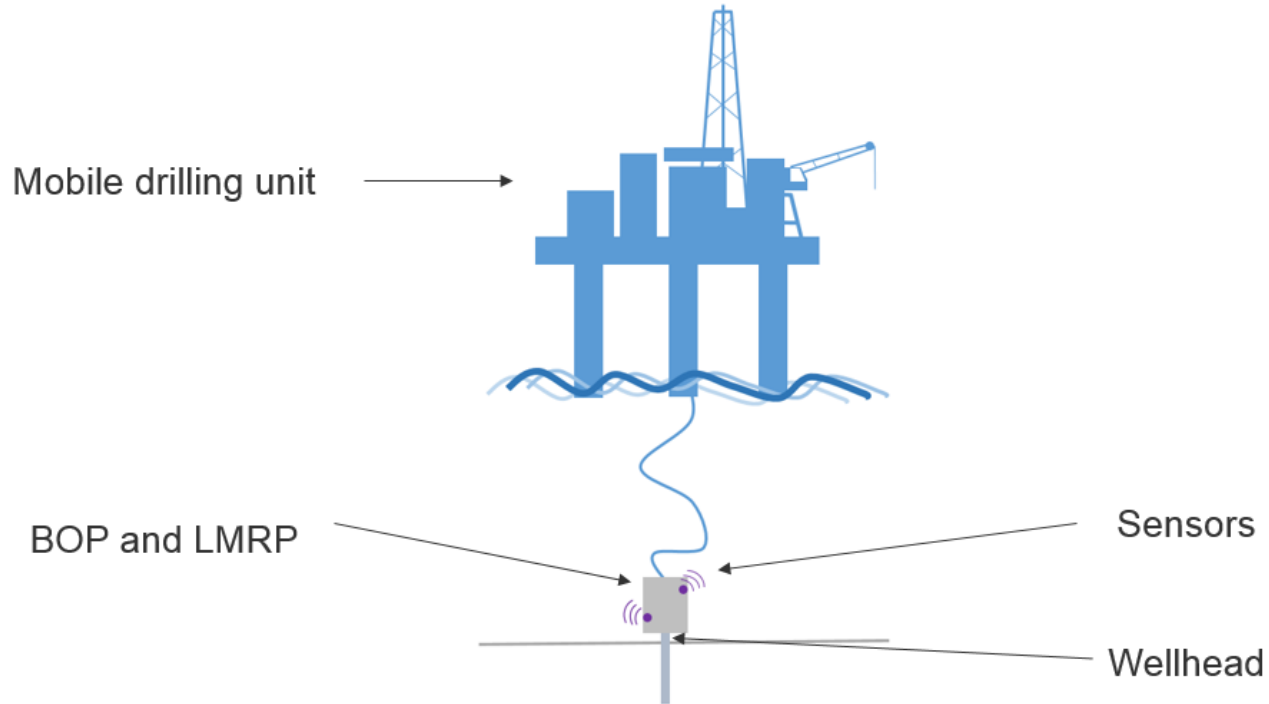
# What do we do?



# Measurement systems

- Online systems
  - Continuously measure data at different locations on the BOP
  - Data is automatically processed, stored and transported to shore
  - Used when fatigue accumulation needs to be monitored throughout the campaign
- Autonomous systems
  - Consist of battery powered sensor packages
  - Data is retrieved at regular intervals and post processed at the end of campaign

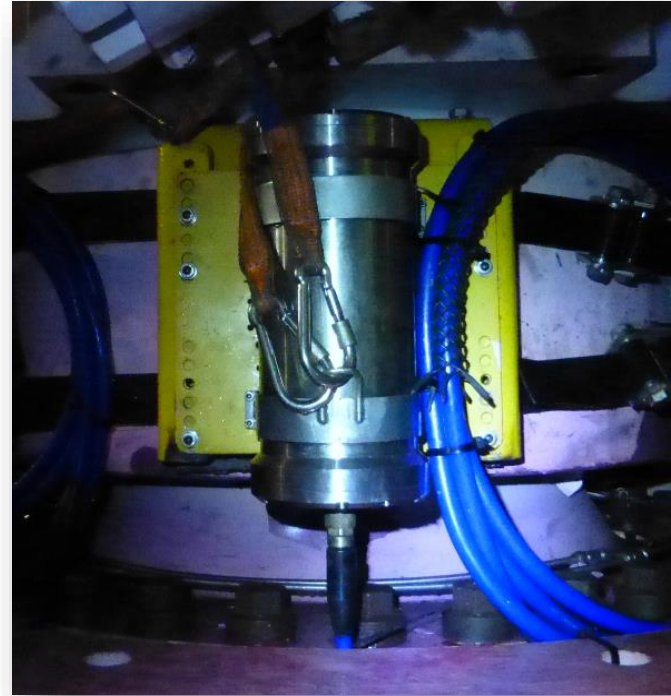
# Online measurement systems



# Sensors: MRU – motion reference unit



MRU on LMRP



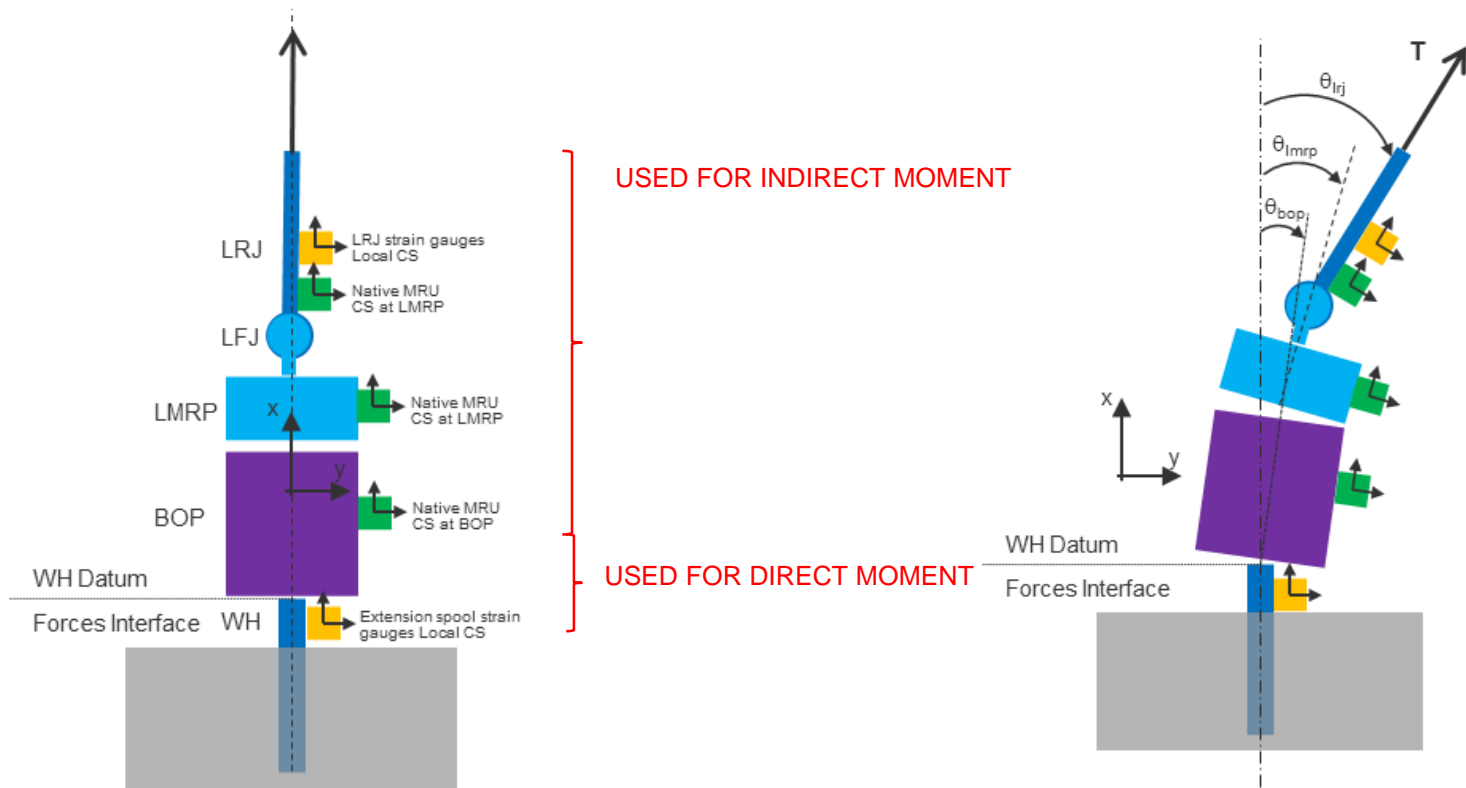
MRU on BOP

# Sensors: LVDT



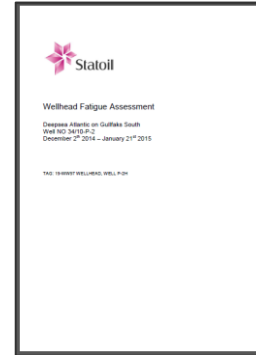
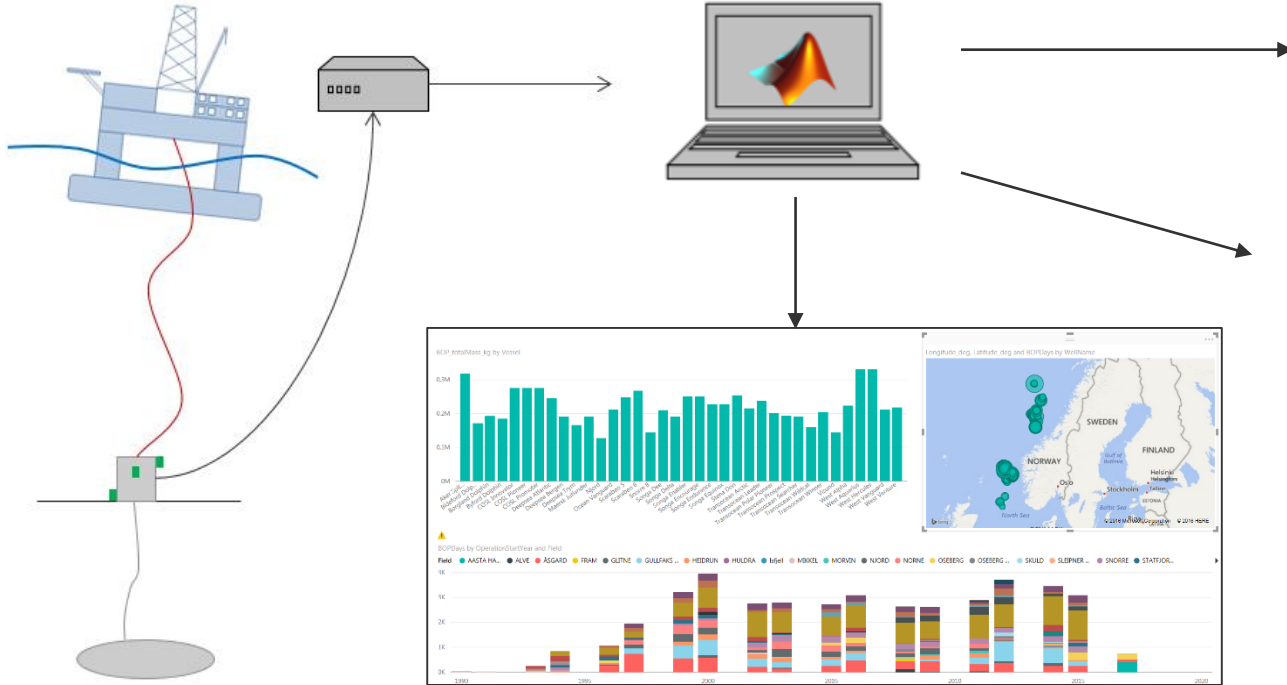
LVDT on BOP connector

# WHF calculation methods



# Our process

# Measurements



WELL ANALYSIS

## Manage WH Fatigue Analyses

New Analyses | Ongoing Analyses | Completed Analyses

New Analysis

Open personal list settings

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Ref #	Priority	Field	Well	Title	Need Date	Type	Template
0047	1	TORDIS	NO 347-1-5	NO 347-1-5	Not set	Normal	No
0008	2	ÅSGARD	NO 6507/11-Y-1	NO 6507/11-Y-1	Not set	Normal	Yes
0031	3	ÅSGARD	NO 6506/11-F-3	NO 6506/11-F-3	Not set	Normal	Yes
0007	4	ÅSGARD	NO 6506/12-P-2	NO 6506/12-P-2	Not set	Normal	Yes
0011	5	ÅSGARD	NO 6506/12-N-1	NO 6506/12-N-1	Not set	Normal	Yes
0032	6	ÅSGARD	NO 6506/12-K-4	NO 6506/12-K-4	Not set	Normal	Yes
0030	7	ÅSGARD	NO 6506/12-NB-1	NO 6506/12-NB-1	Not set	Normal	Yes
0029	8	ÅSGARD	NO 6506/12-P-4	NO 6506/12-P-4	Not set	Normal	Yes
0012	11	ÅSGARD	NO 6506/12-N-3	NO 6506/12-N-3	Not set	Normal	Yes
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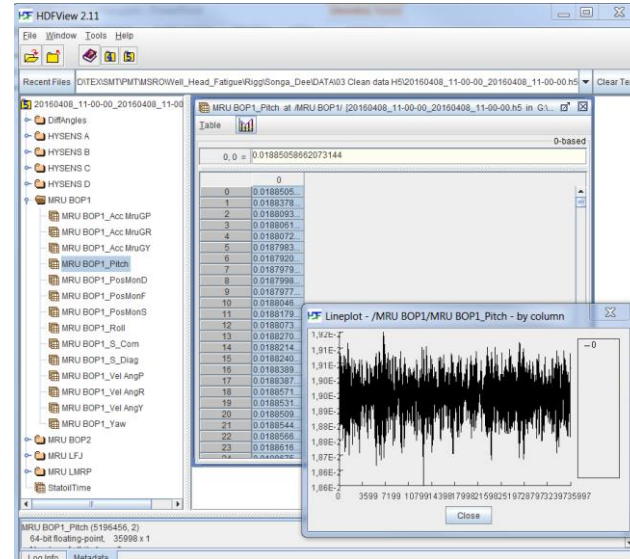
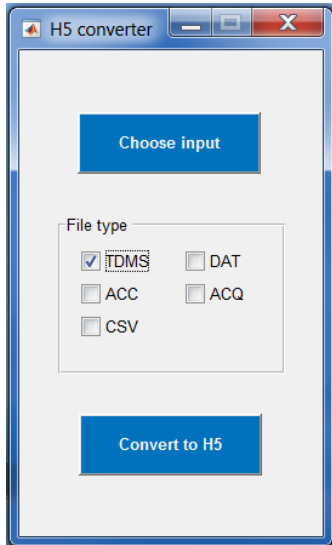
# Handling raw data

- There are several suppliers of measurement systems, each offering a different sensor set-up and providing the data in a predefined format
- Measurement data provided in several formats including:
  - TDMS files
  - ACQ files
  - PI data base
  - CSV files
  - ACC files
  - DAT files



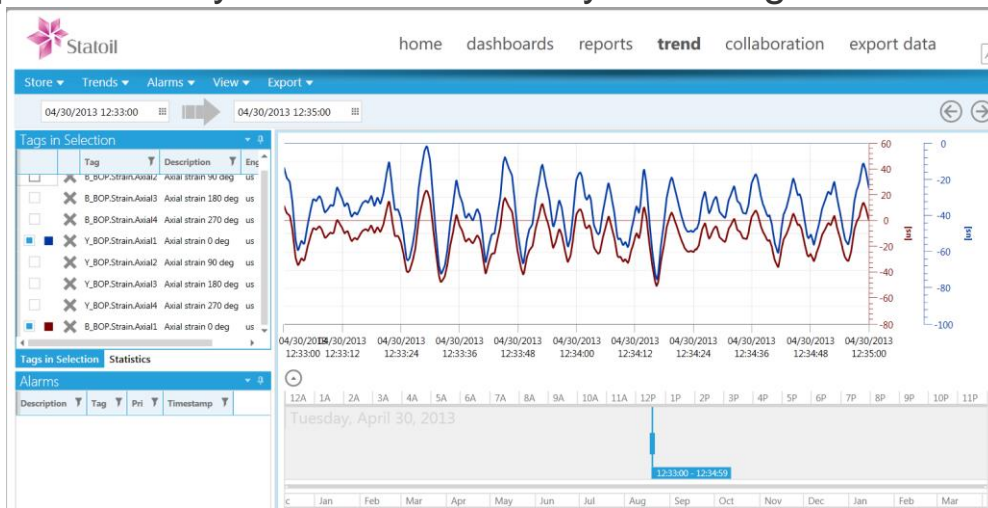
# Handling raw data – H5

- Using MATLAB's HDF5 support we developed a set of converters allowing us to get the data we receive from vendors to the predefined structure in a H5 file



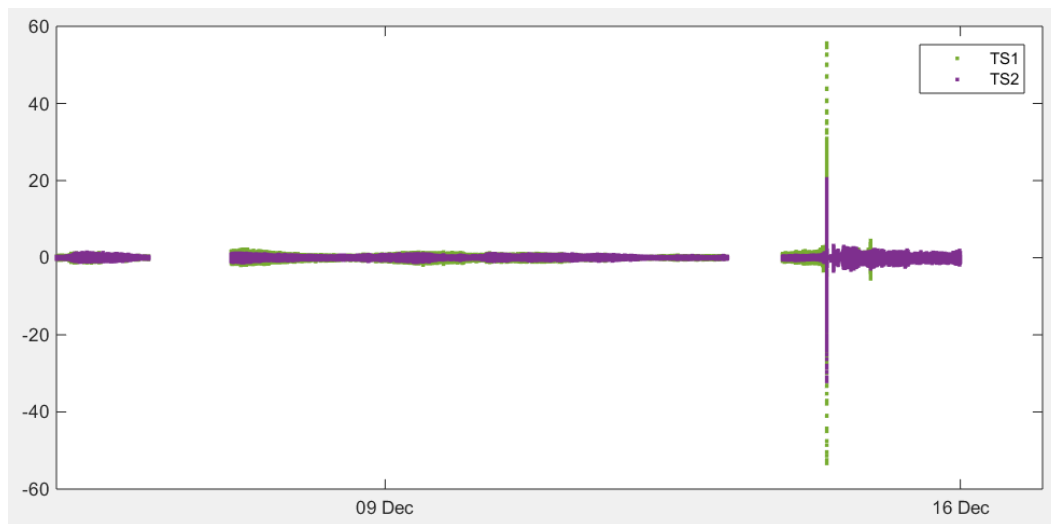
# PI database

- In case of one project, the data is provided not as files but in a database
- White papers: <https://pisquare.osisoft.com/docs/DOC-1305>
- The white paper published by OSIsoft lists 8 ways of using PI Data with MATLAB

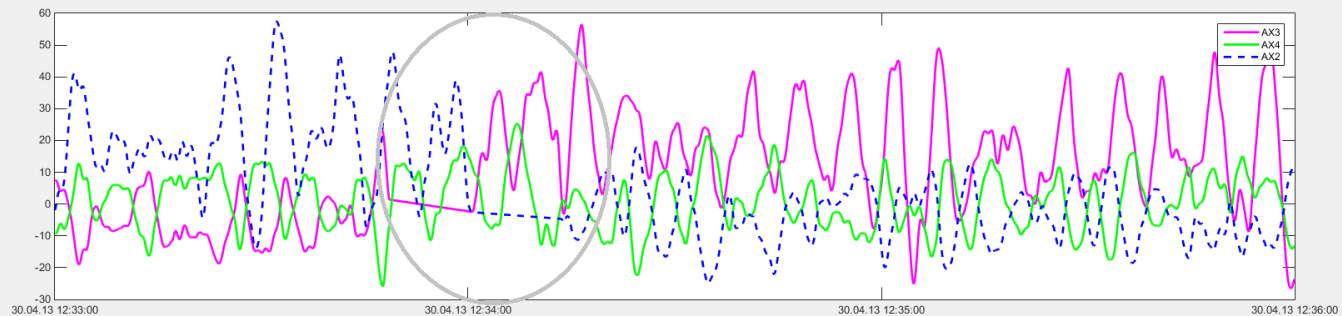
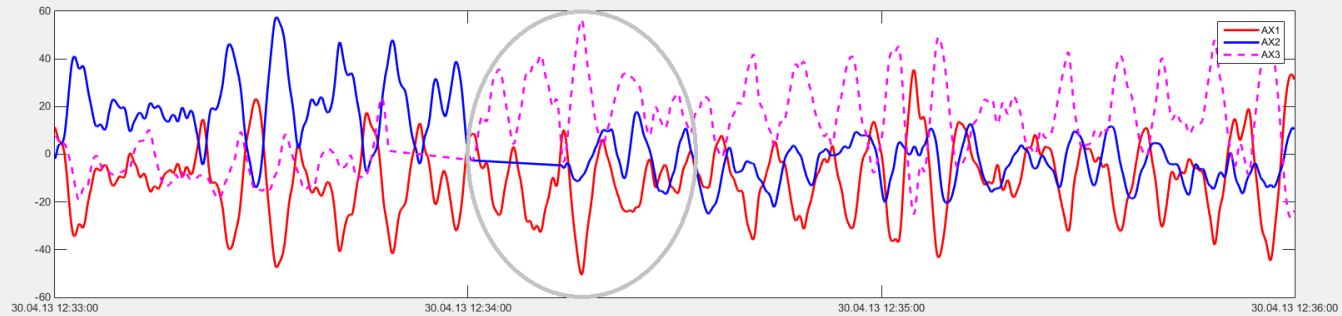


# Challenge – data quality

- The quality of provided data differs between sensors and vendors
- We encounter missing values, spikes, asynchronous timeseries

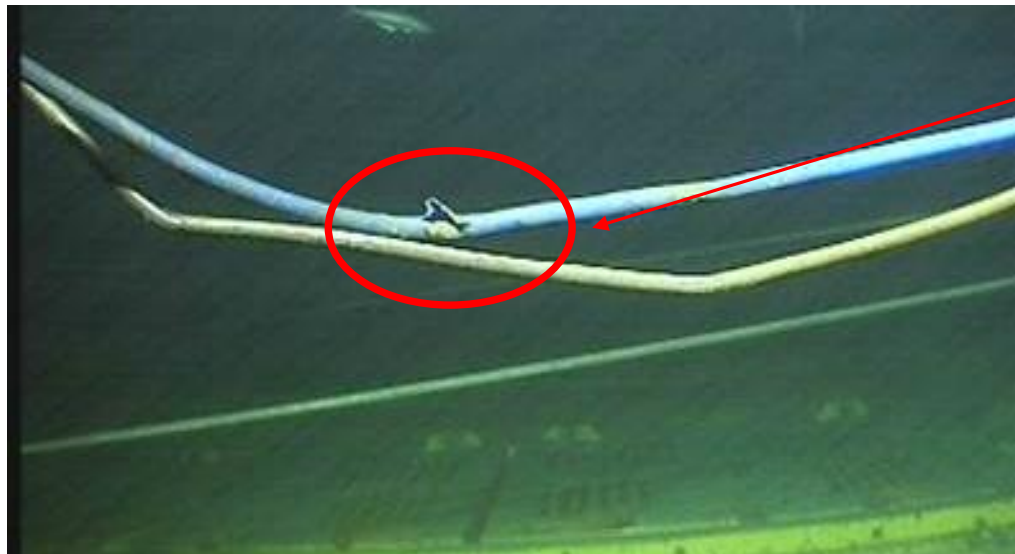


# Challenge – data quality



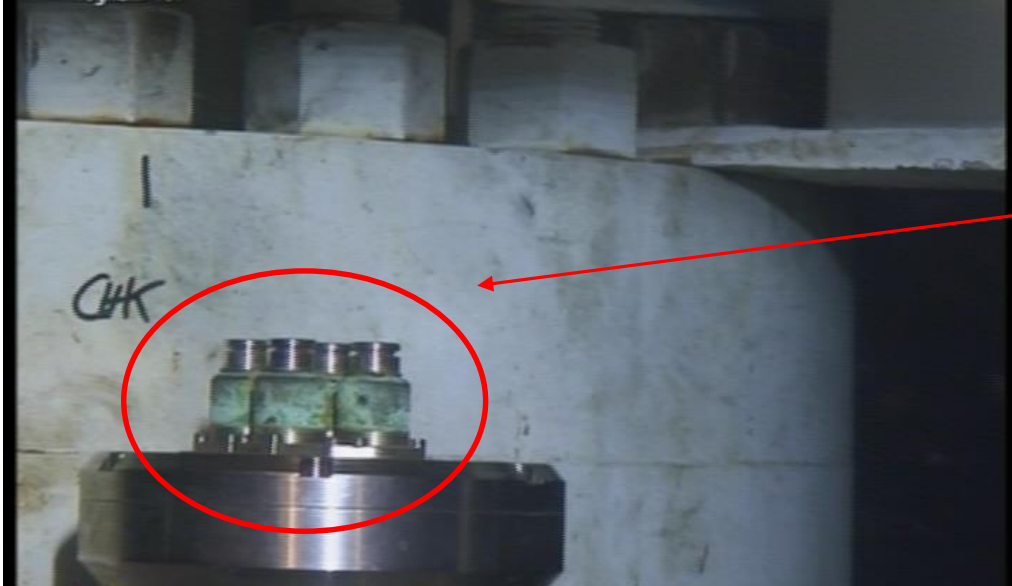
# Challenge – missing data

- Due to the harsh environment offshore we encounter hardware malfunctions that lead to loss of data



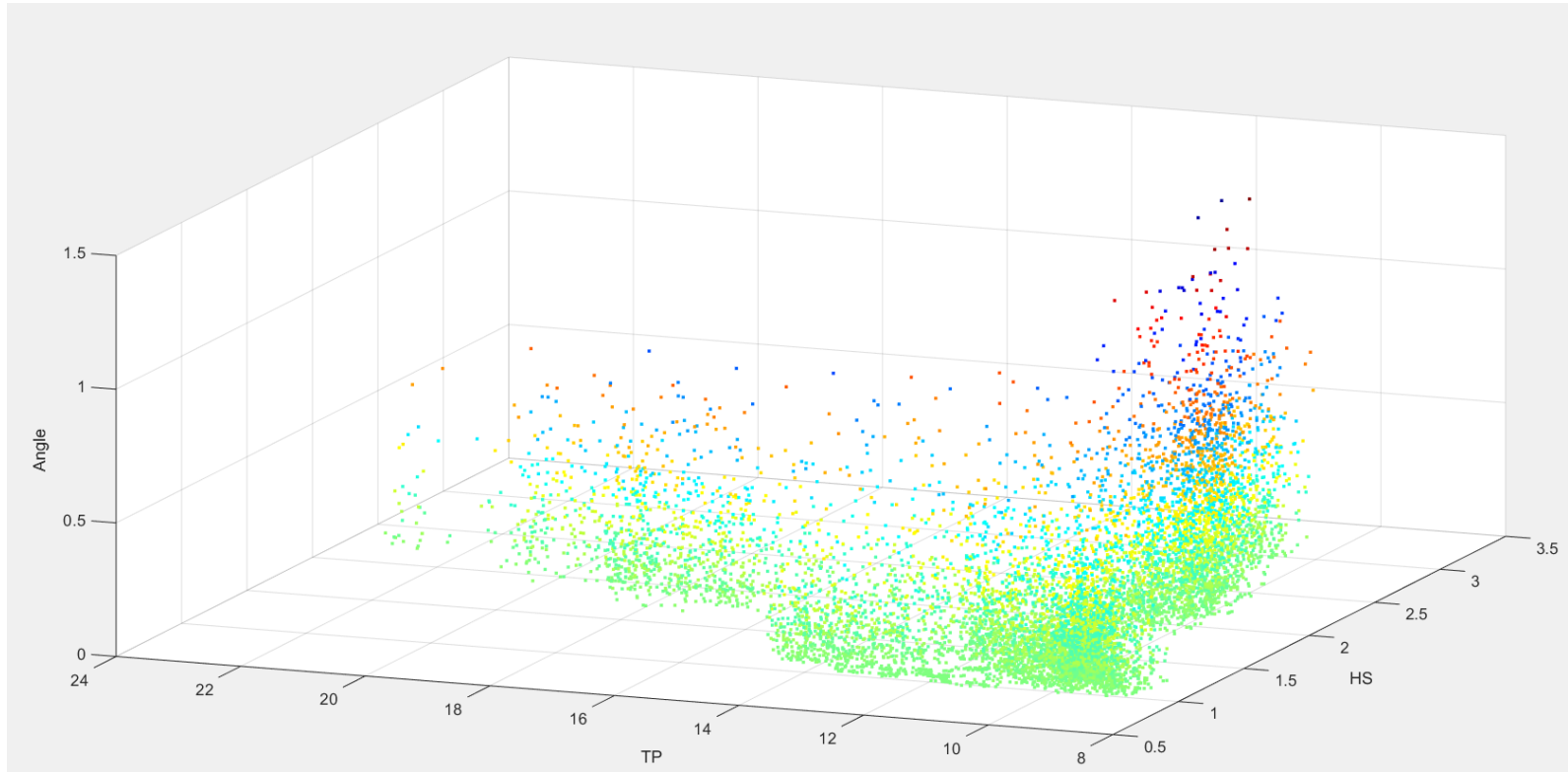
The cable got tangled during the storm, the coating was damaged

# Challenge – missing data



The connector was submerged unblinded

# Missing data



# Calculating the fatigue damage

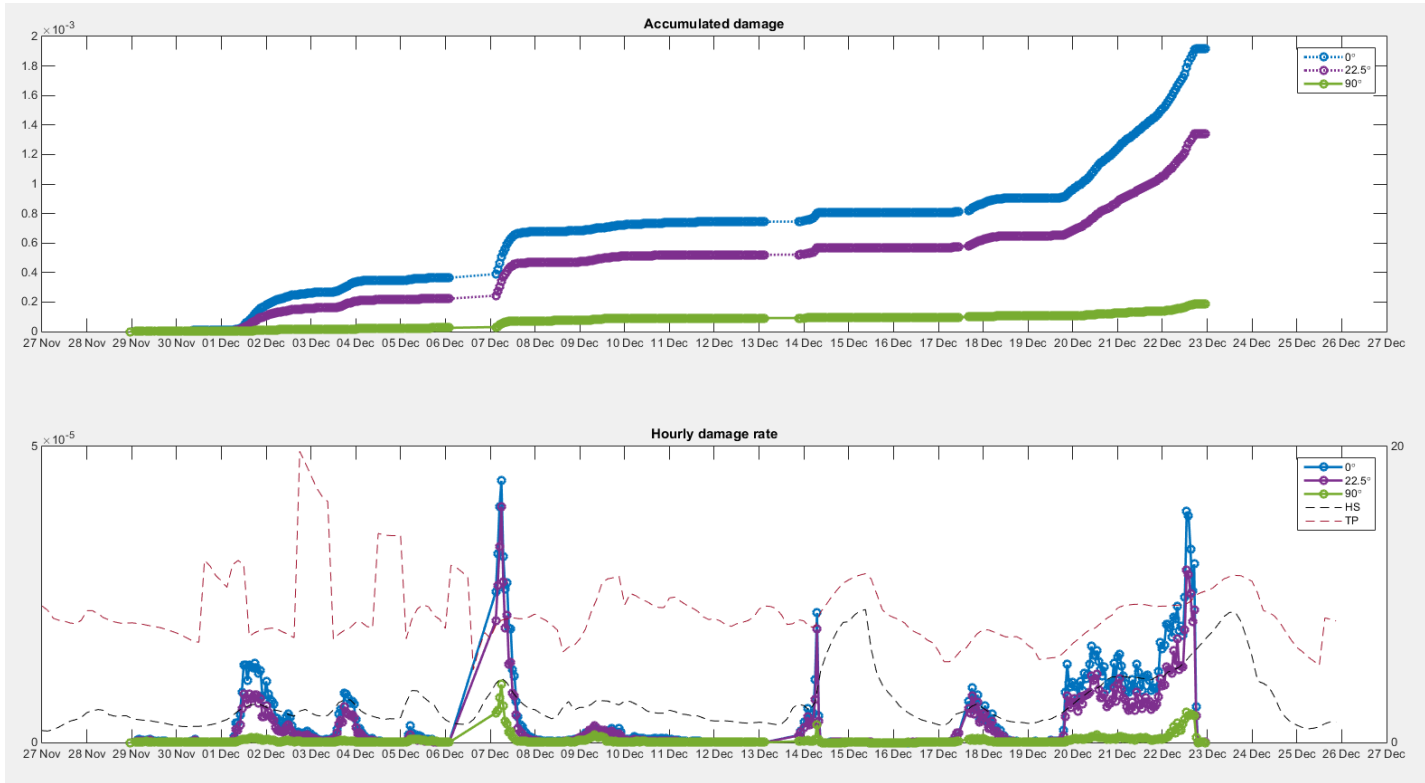
In the process of calculating fatigue damage we use following data:

- Data recorded using subsea sensors (H5 files)
- Well specific data – results from the local FE analysis (XML file)
- Weather data for the particular rig location (csv file)
- Rig specific data, size of the BOP, LMRP, XT etc





# Results – accumulated damage



# Main reasons for using MATLAB

- Popular across the company
- Built-in support for source control systems
- Easy to share code/tools with other
- Support for the technologies and concepts we use
- Worldwide user community
- Support for cloud solutions

# References

- DNV Method Statement <https://rules.dnvgl.com/docs/pdf/DNVGL/RP/2015-04/DNVGL-RP-0142.pdf>
- Russo M., Myhre E., Wolak U., Grytøyr G., "Measured wellhead loads during drilling operations – Paper 1 – data processing and preliminary results“, 2015
- Russo M., Reinås L., Sæther M., and Holden H., “Fatigue assessment of subsea wells for future and historical operations based on measured riser loads”, 2012
- Grytøyr G., Lindstad H., and Russo M., “Direct And Indirect Measurement Of Well Head Bending Moments”, 2015

# Statoil. The Power of Possible



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