Use of MATLAB in post-processing of offshore measurements

Statoil. The Power of Possible

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

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Who are we?

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Wellhead Fatigue Group

- Part of the Reaseach 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

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Why is wellhead fatigue an issue?
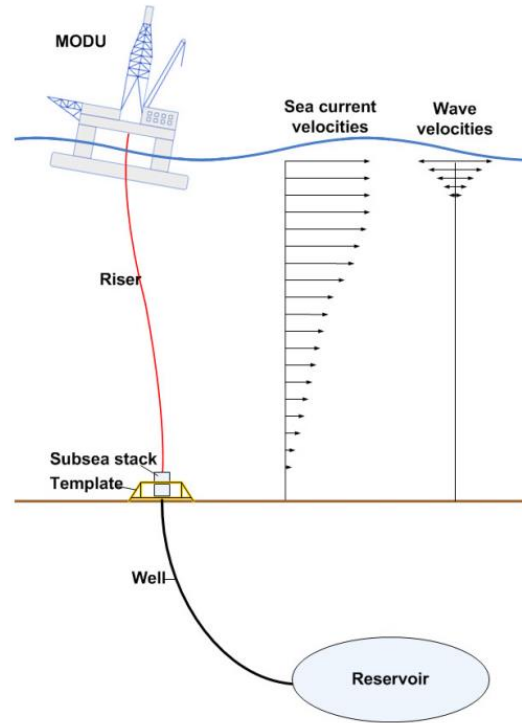
Source: DNV Method Statement

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Drilling operation

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What do we do?

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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

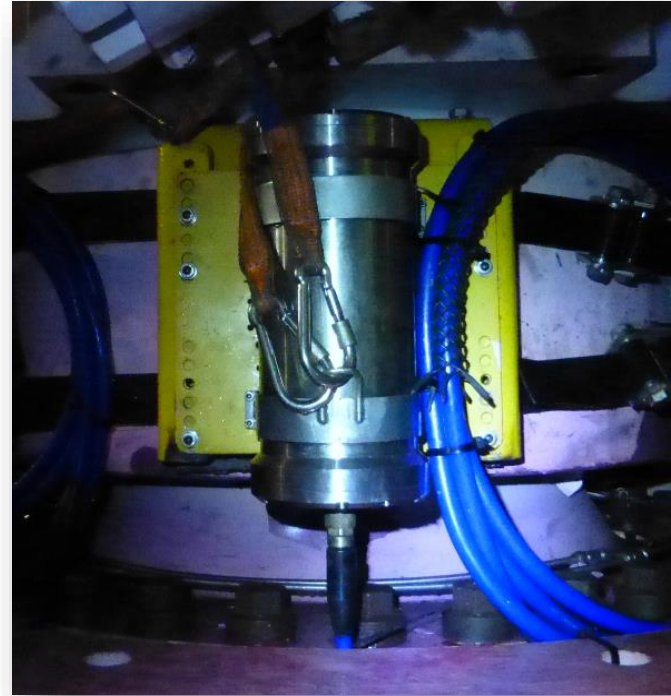 - Data is retrieved at regular intervals and post processed at the end of campaign

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Online measurement systems

Mobile drilling unit →

BOP and LMRP

Sensors

Wellhead

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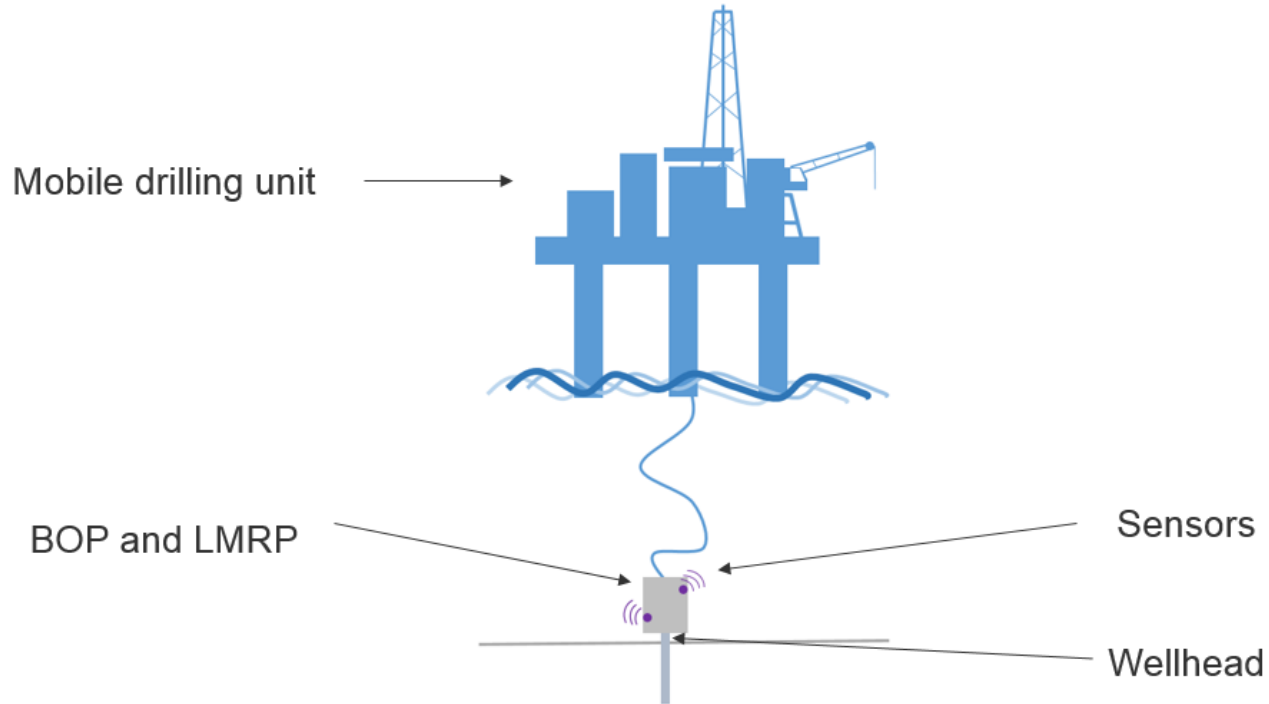
Sensors: MRU – motion reference unit

MRU on LMRP

MRU on BOP

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Sensors: LVDT

LVDT on BOP connector

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WHF calculation methods

USED FOR INDIRECT MOMENT

USED FOR DIRECT MOMENT

Our process

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Measurements

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

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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

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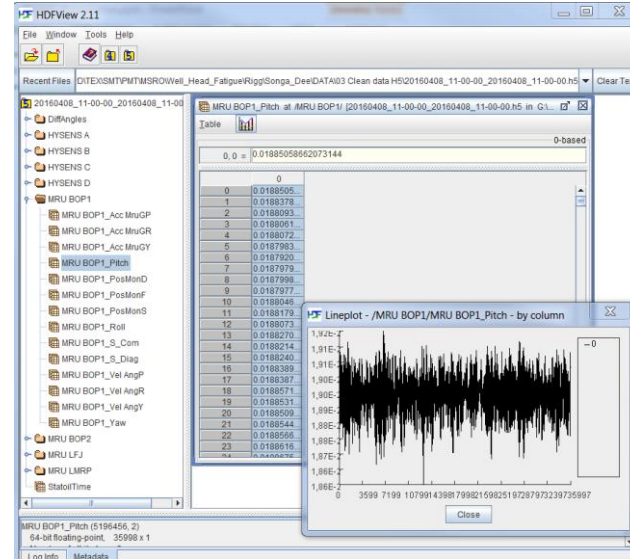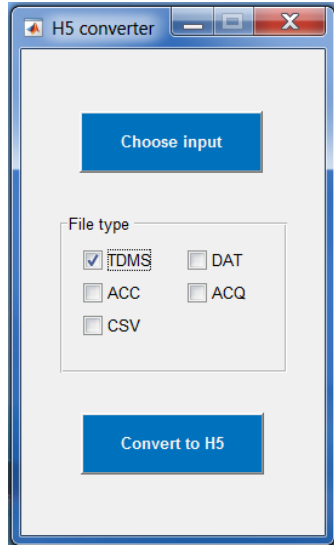
PI database

- 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

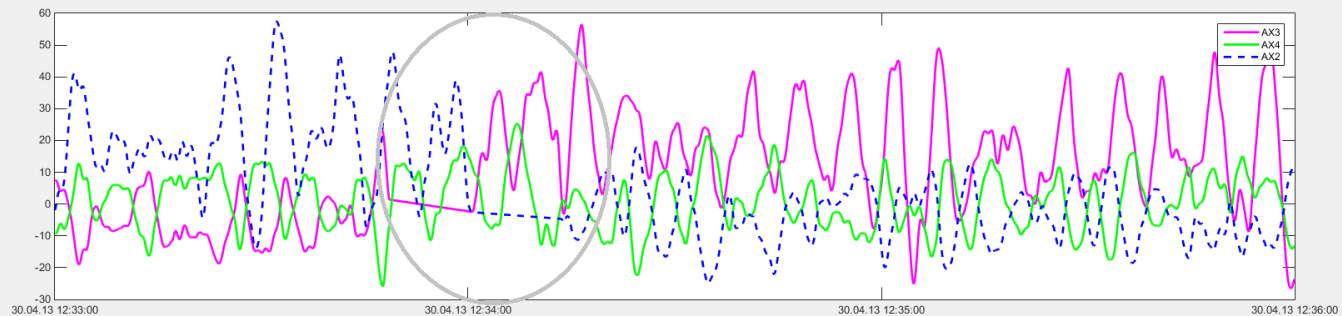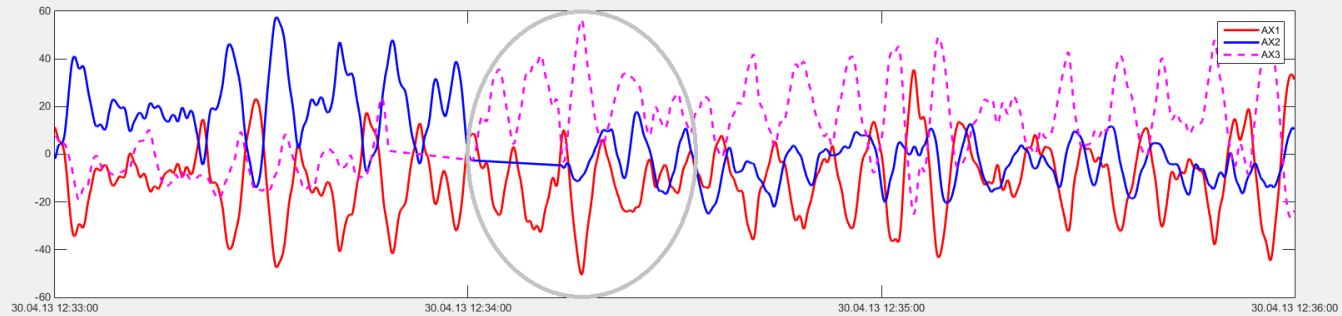- The white paper published by OSISoft lists 8 ways of using PI Data with MATLAB
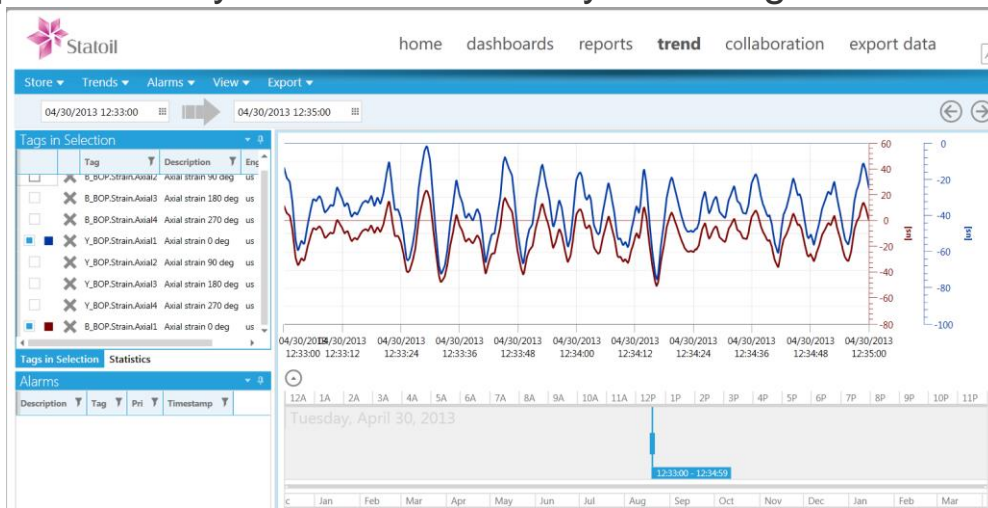
Challenge – data quality

- The quality of provided data differs between sensors and vendors

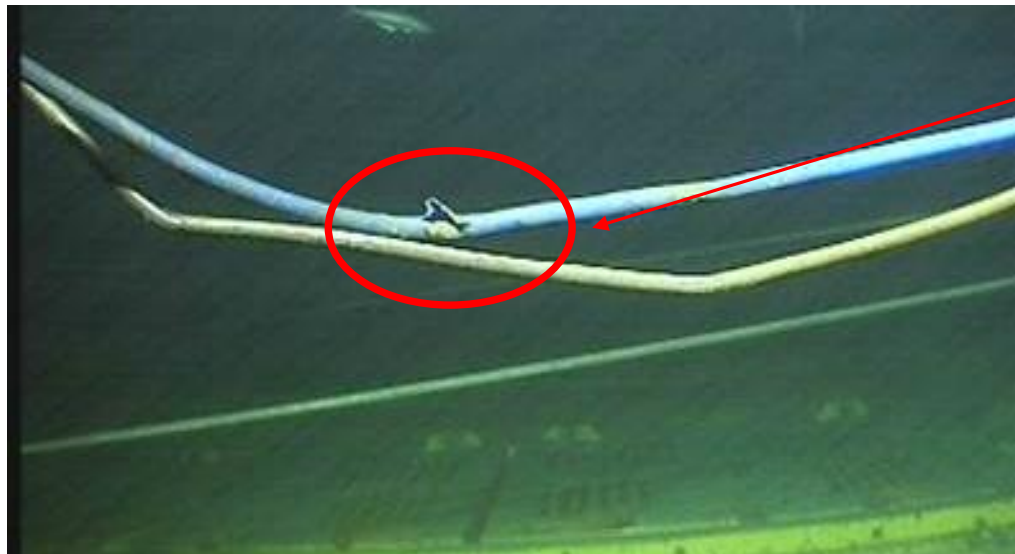- We encouter missing values, spikes, asynchronous timeseries
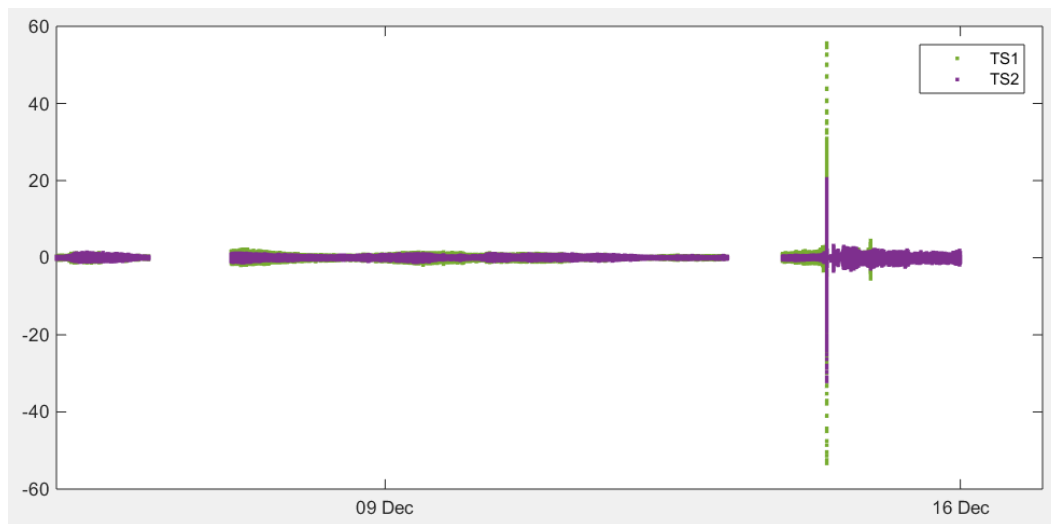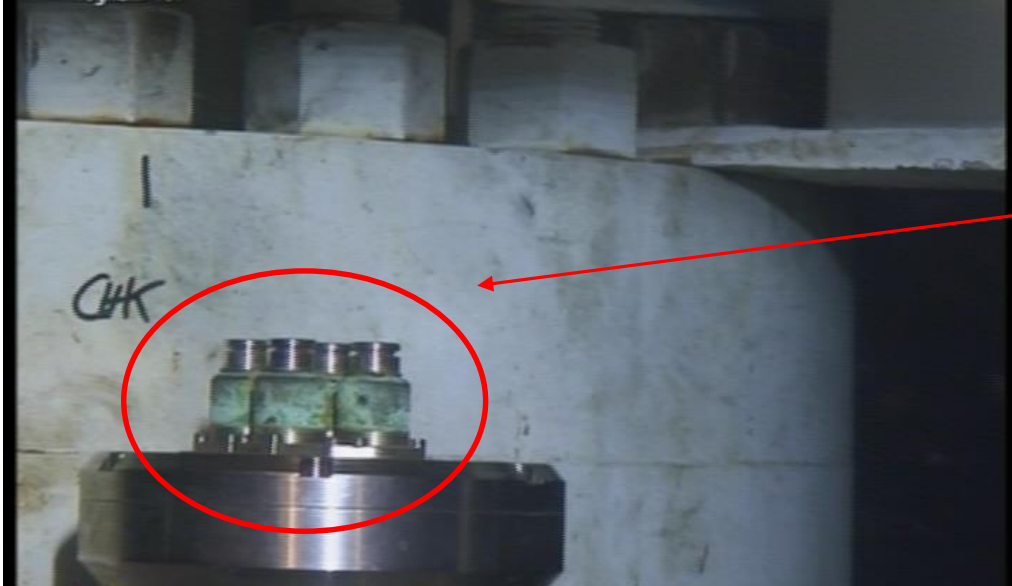
Challenge – data quality

Challenge – missing data

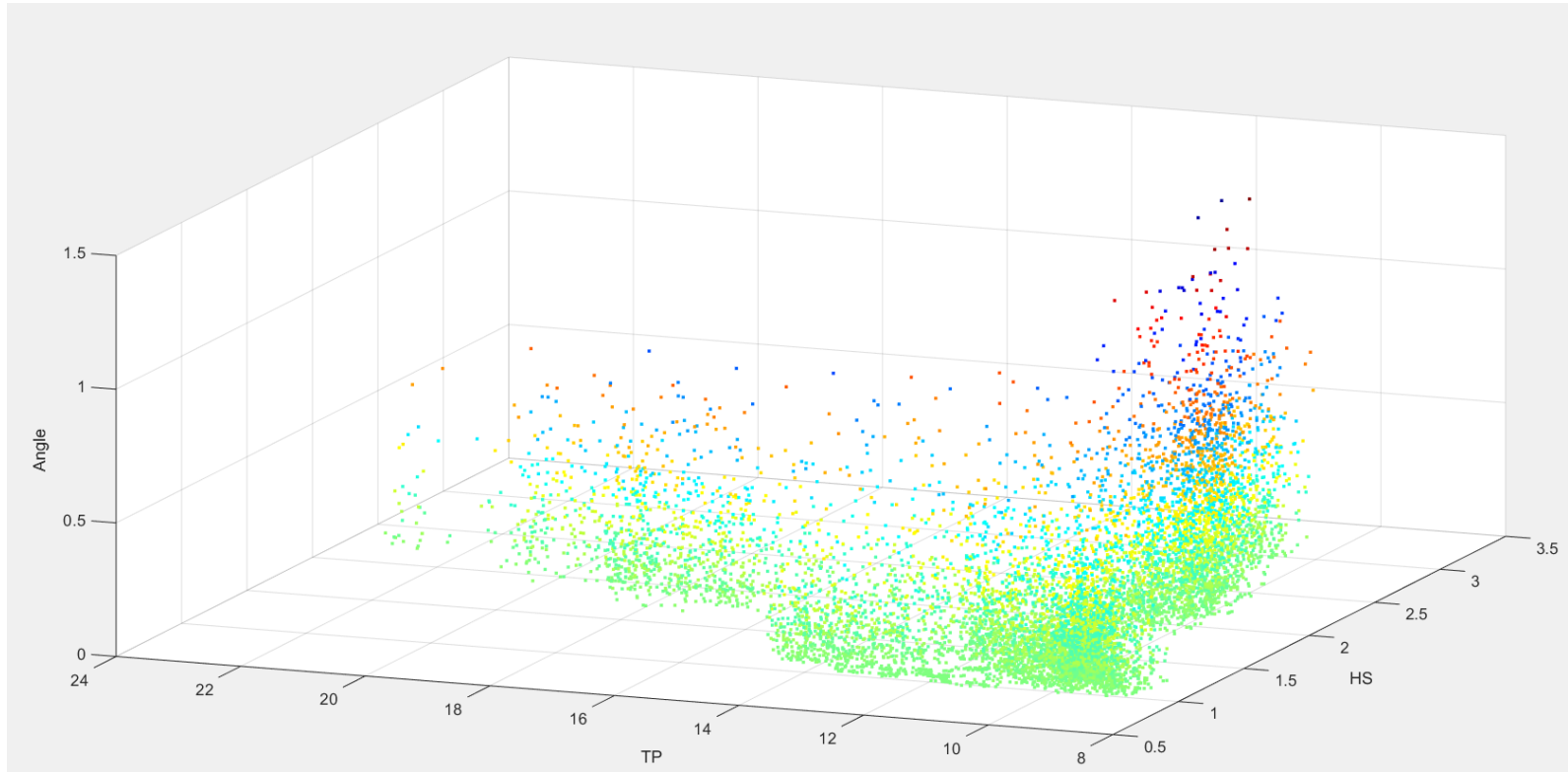- Due to the harsh environment offshore we encounter hardware malfunctions that lead to loss of data

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

Challenge – missing data

The connector was submerged unblinded

Missing data

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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

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Load-to-stress

Results – accumulated damage
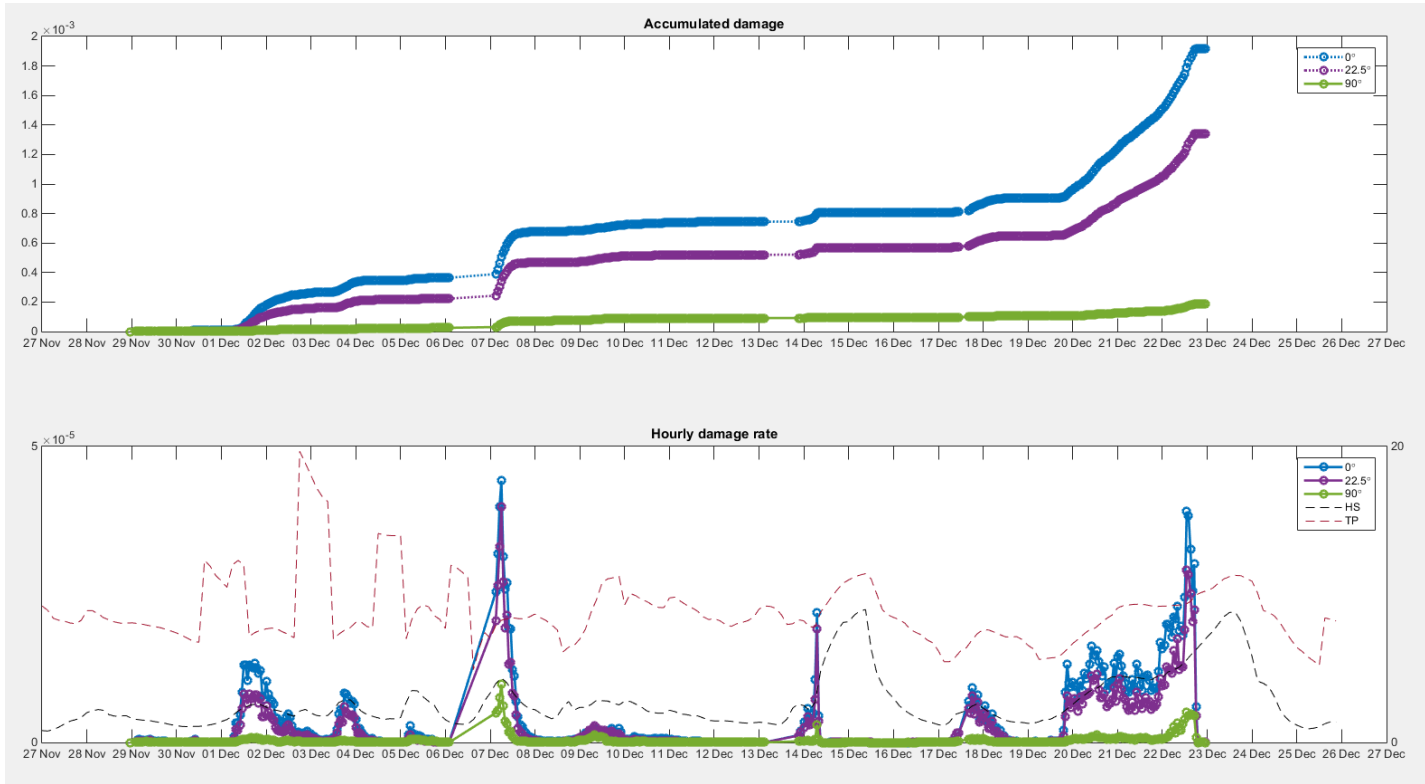
Main reasons for using MATLAB

- 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

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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

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