Combining information from pigging with data logger with operational and pipeline data for wax zone estimation

Content

Status cleaning pigging in Equinor

Running of pipeline data loggers

- Low cost and low effort operation - returning valuable data
    - Maintenance pigging follow up
    - Pre inspection cleaning verification

Monitoring of process data maintenance pigging

- Pressure drop in pipelines
- Ruff estimation of bypass

Challenges

- Time based data from datalogger
- Process data, system data and data logger data all in different software systems
- Difficult to compare multiple pig runs in the same pipeline system.

Determining the pig speed

- First approach we assumed a constant speed from launch to receive. This was to inaccurate to have any value in the data interpretation
- Second approach we calculated the pig speed from actual DP measured by the data logger by the following formula:

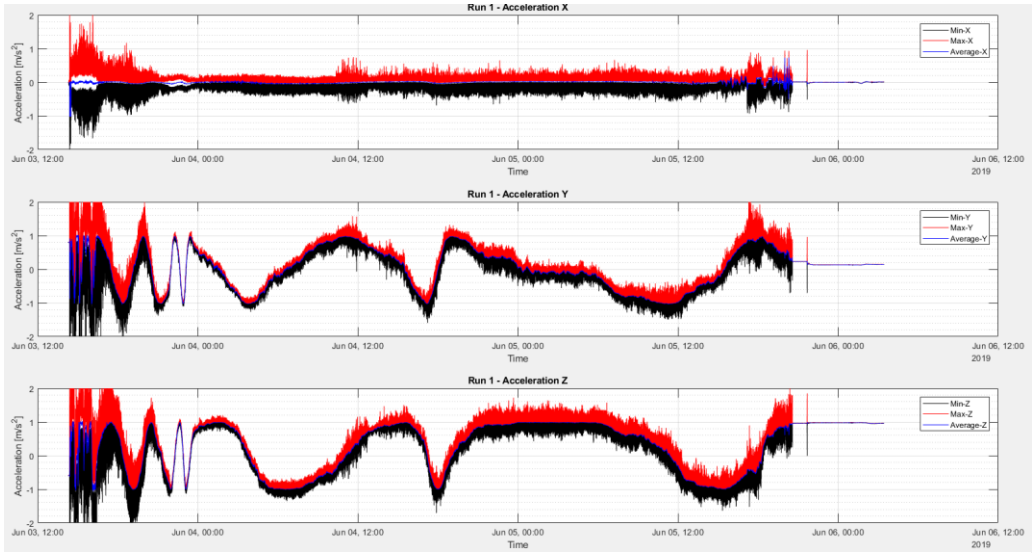
$$Q_{bypass} = C_d \sqrt{\frac{2\Delta P}{\rho}} A_{bypass}$$

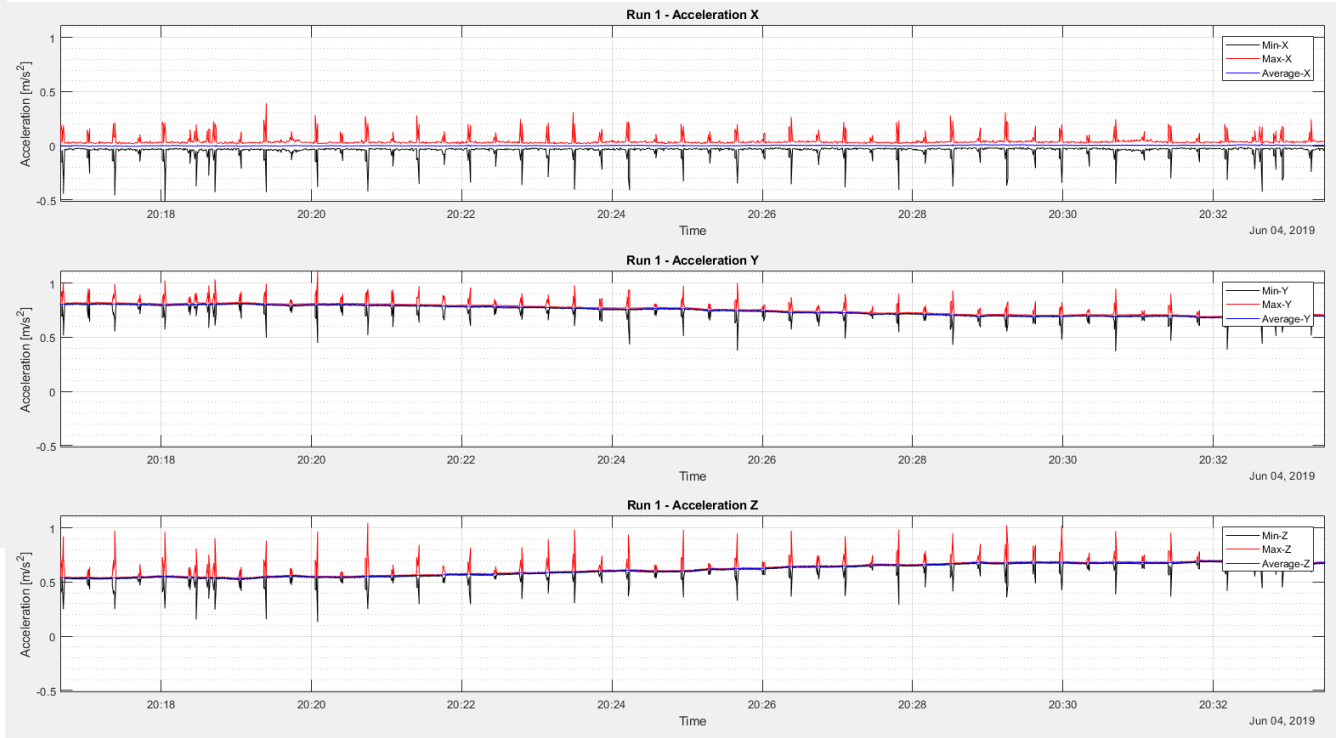
Where C_d is the flow coefficient which is the only unknown parameter in the formula

  - This approach requires a constant bypass area in the pig, no blocking of bypass ports. This method also proved to be inaccurate. We saw that for different runs in the same system we had to use different values for the flow coefficient to get the total travelled distance to add up. – We suspected that this was caused by blocking of bypass ports.

Determining the pig speed

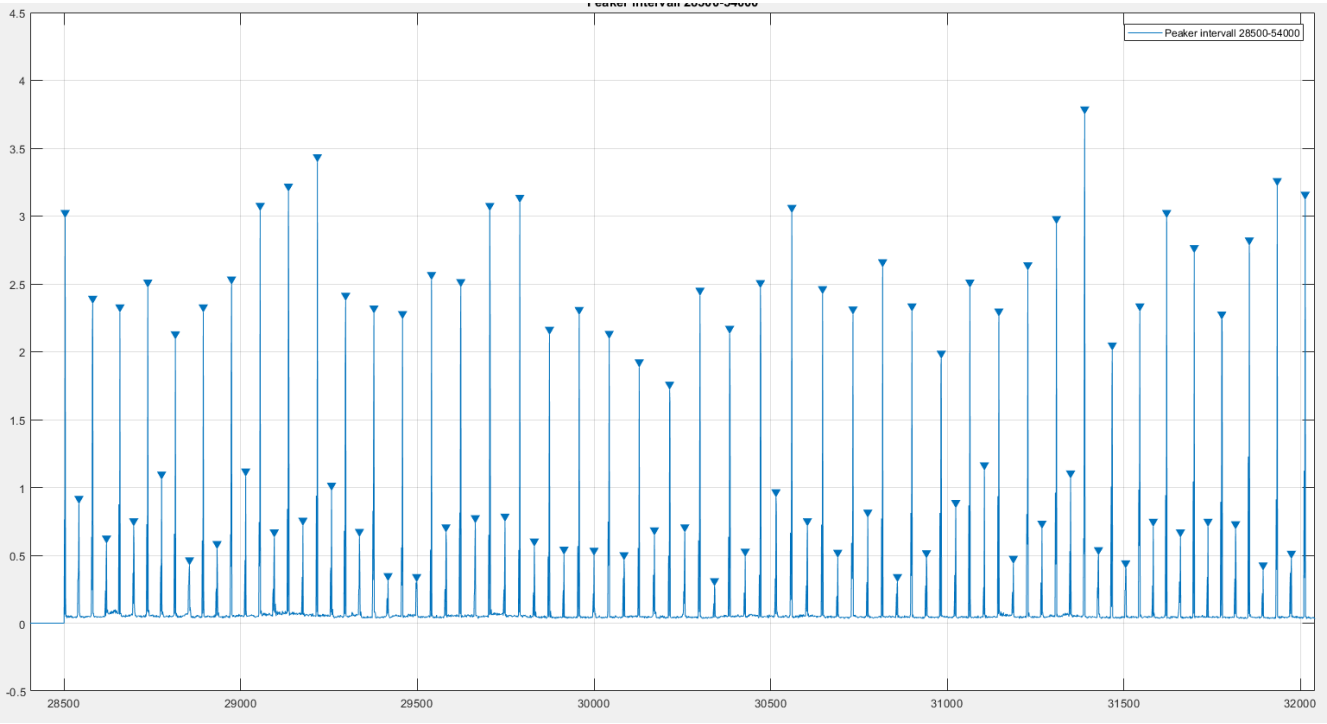
- Final approach we looked at the vibration data from the PDL. It looked like the majority of the girth welds was picked up by acceleration in one or more directions.





Determining the pig speed

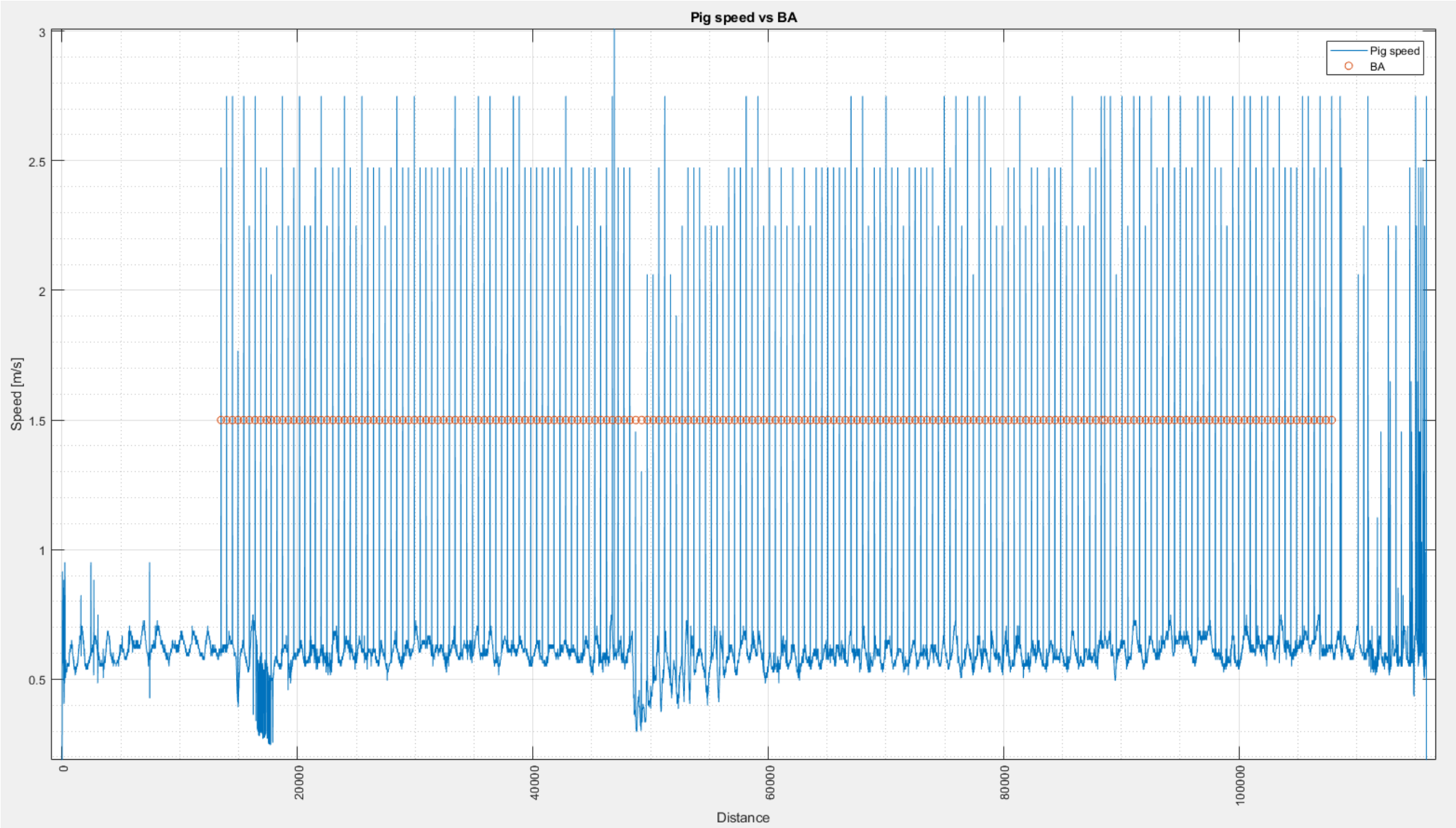
- We then used Matlab built in algorithm to pick all acceleration peaks. From that we calculate the pig speed by the time between passing girth welds and the average joint length from the pipe tally.

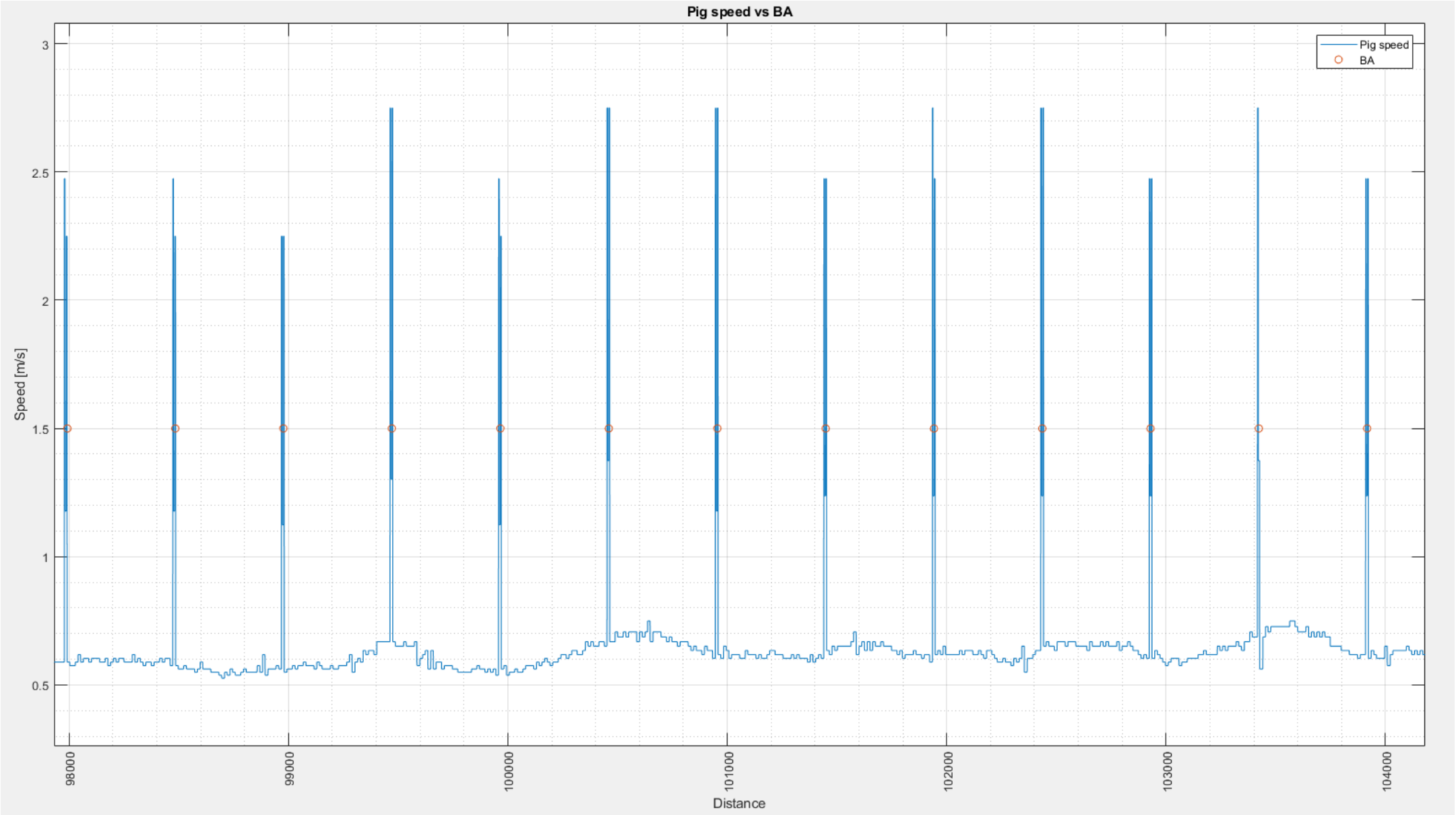


- There is calculated a pig speed all joints. This speed is calculated independent of the flow speed.
- A distance file is generated for the whole pig run and all the measurements from the data logger can then be pinned to a KP in the pipeline.
- How can we confirm that the calculated pig speed and pig position is correct trough out the pipeline?

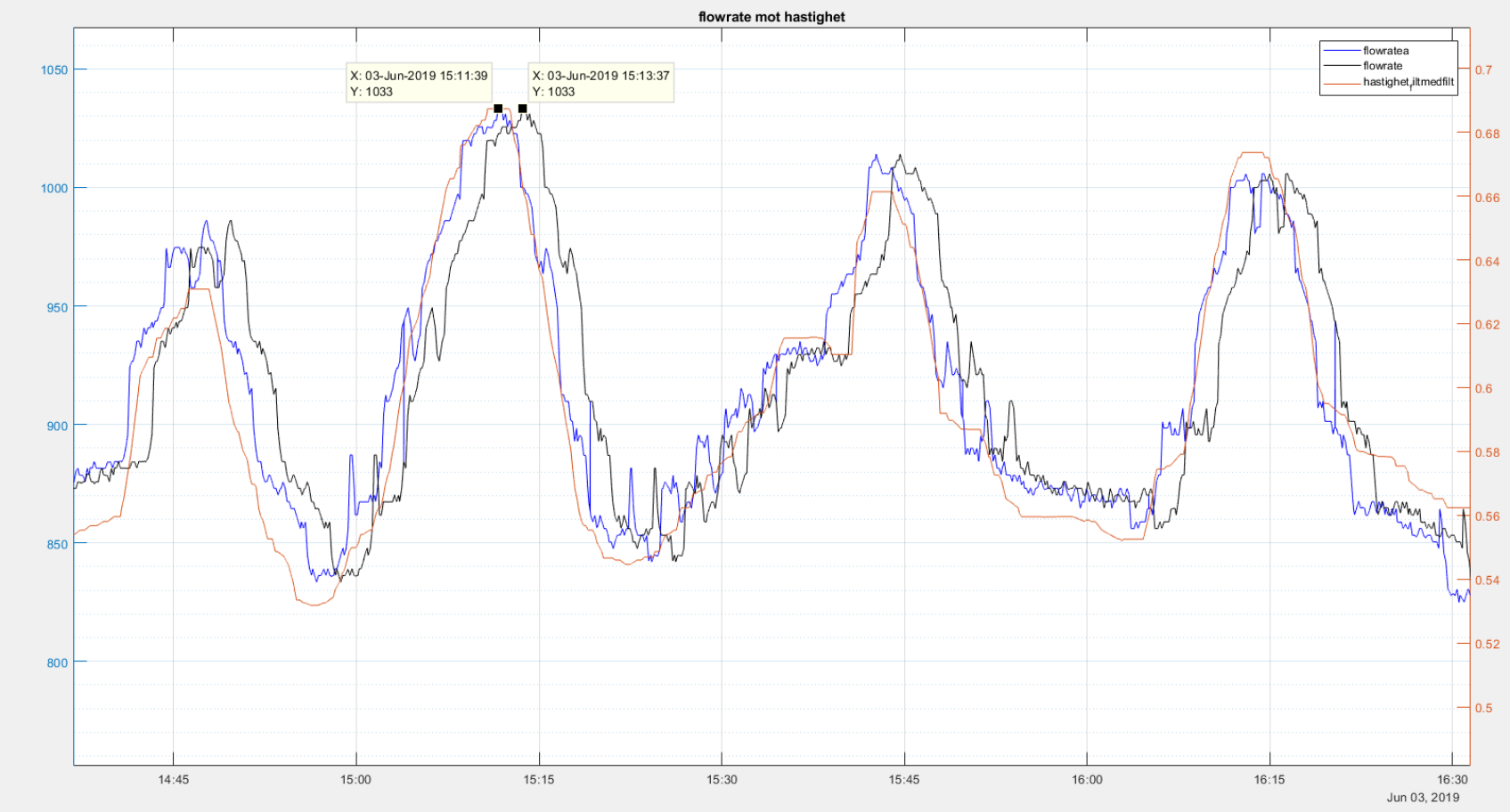
Confirming the speed and position calculations

- A few of our pipelines have buckle arrestors, BA, where 3 shorter joints are premade to a 12 m joint.
- When the pig speed calculations assume a joint length of approximately 12 m, passing the 4 m joints will generate a false peak in the calculated pig speed.
- Knowing the KP of the BA we can confirm our calculations by plotting the BA together with an unfiltered pig speed against KP.


Pig speed vs BA
Pig speed
BA
Speed [m/s]
3
2.5
2
1.5
1
0.5
0
20000
40000
60000
80000
100000
Distance


Pig speed vs BA
Pig speed
BA
Speed [m/s]
3
2.5
2
1.5
1
0.5
98000
99000
100000
101000
102000
103000
104000
Distance

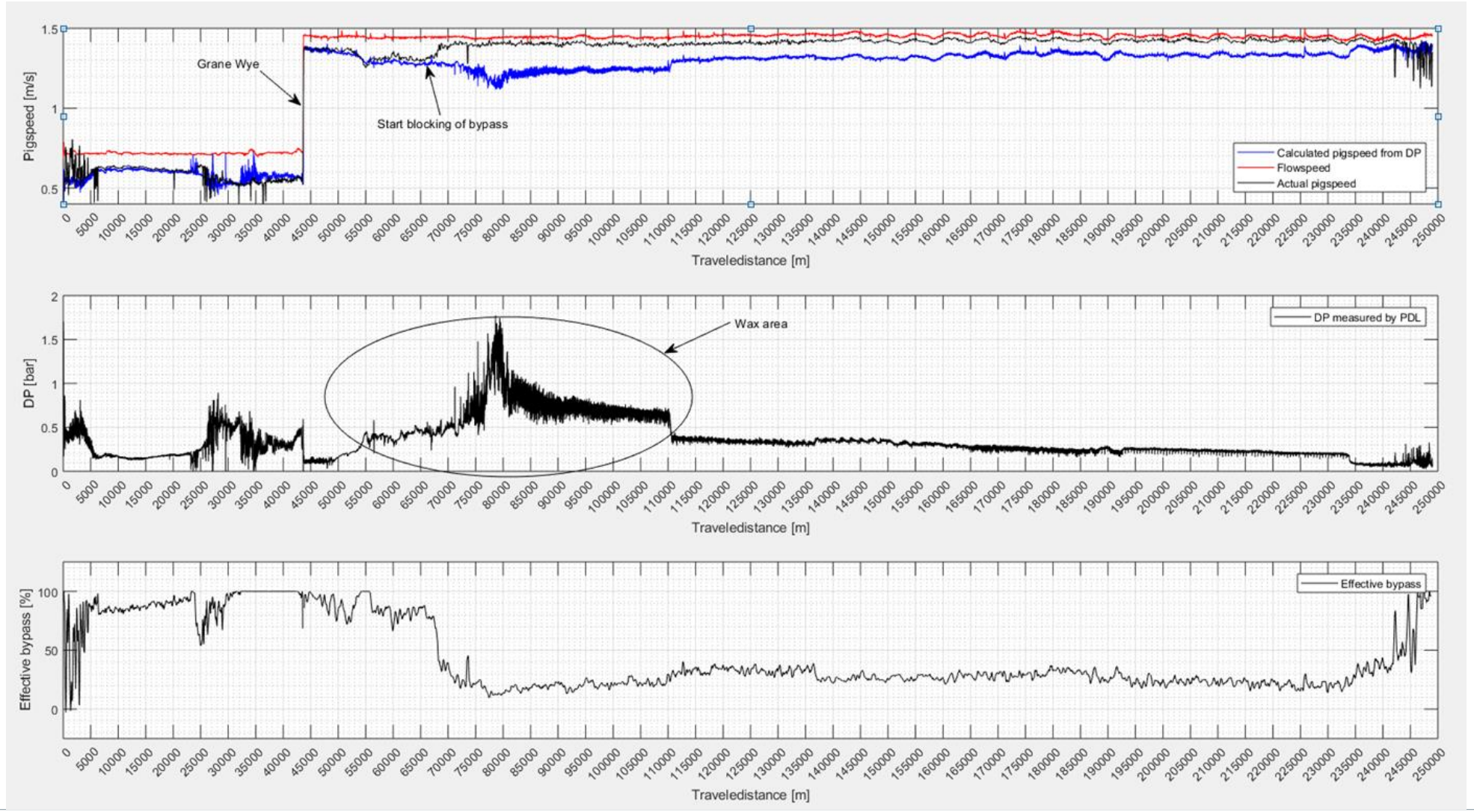
Flow speed correction



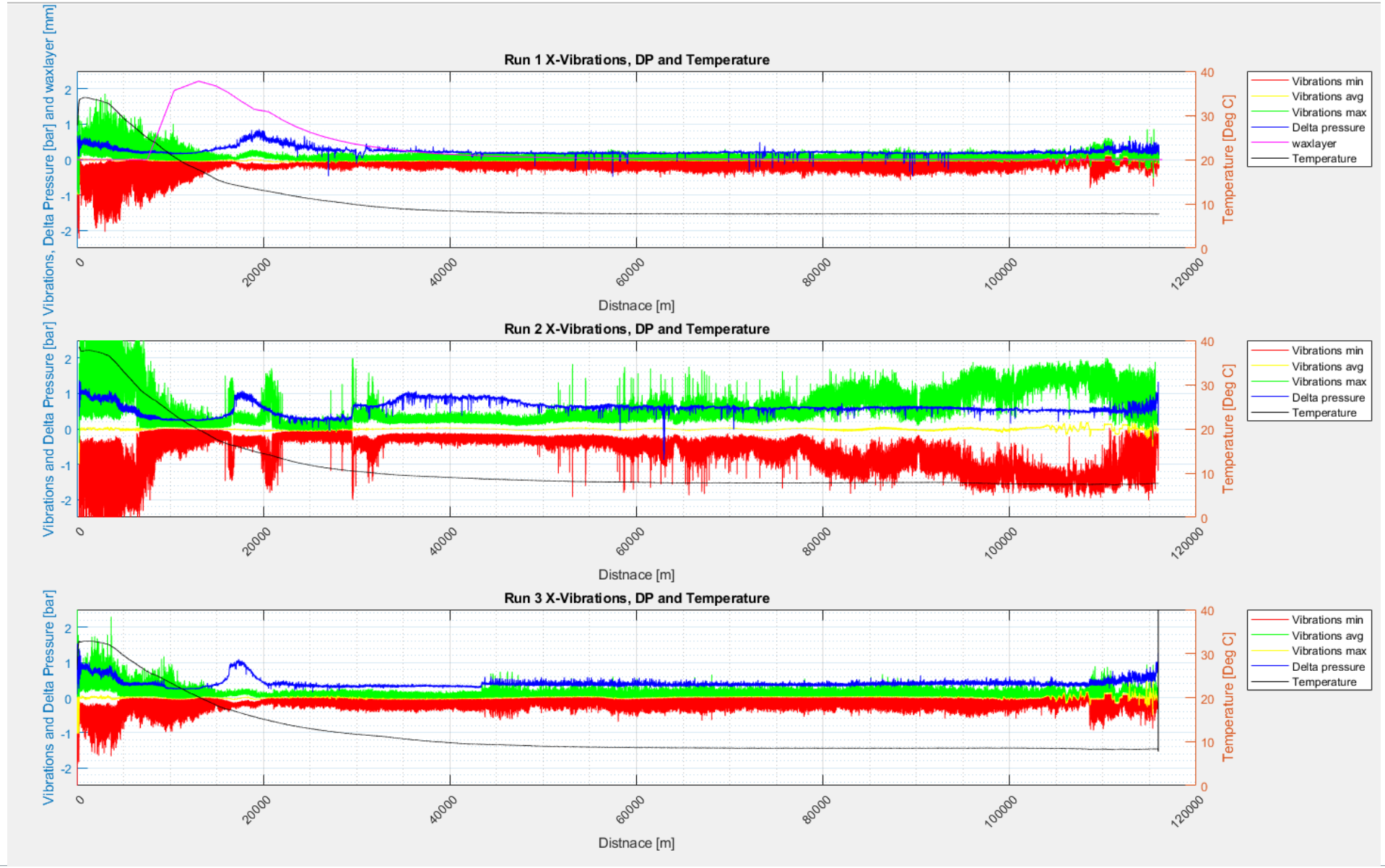
- When calculationg the actual bypass we observed a mismatch between calculated pig speed and flow speed.
- This is solved by linearly stretching or compressing the flow speed to match it's variations to the variations in the calculated pig speed.

Actual bypass

- Now we can estimate the effective bypass by comparing the different speeds previously calculated

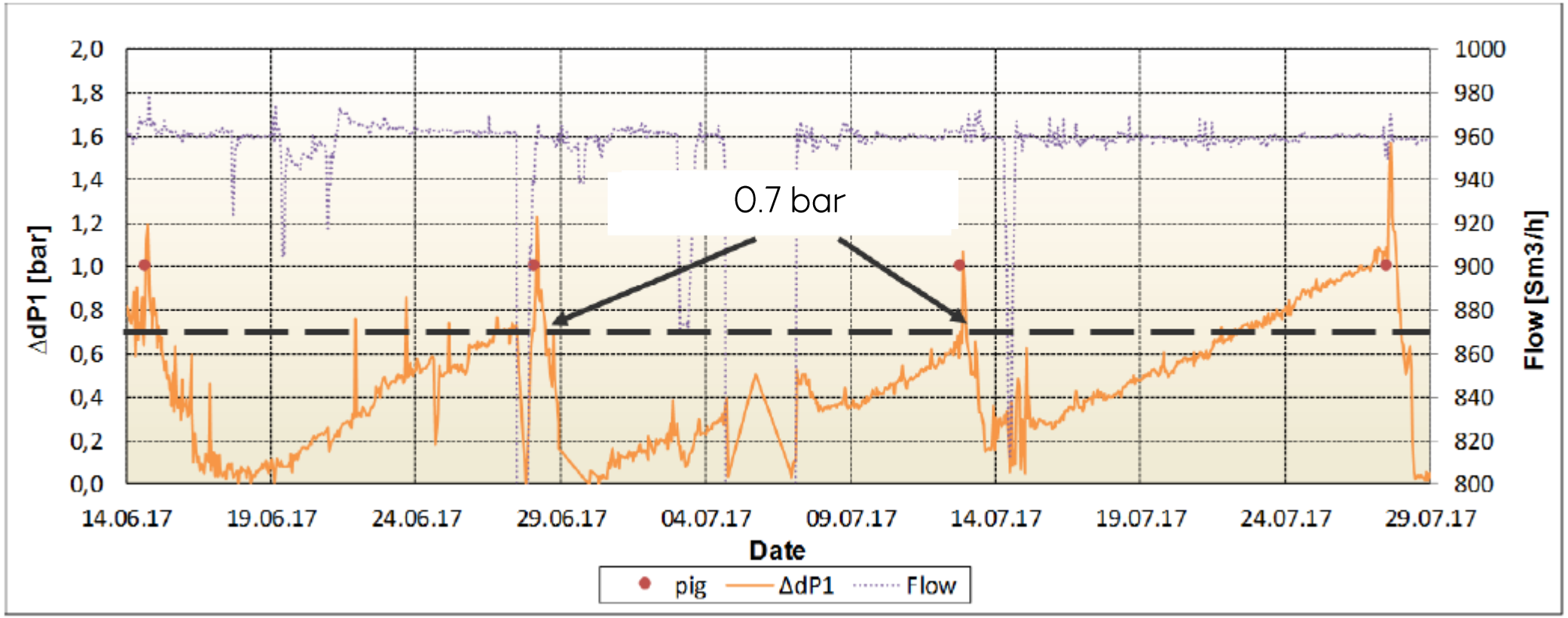


Comparing pig runs



Pressure drop in pipeline

- Differential pressure increase in pipeline between pigsending



Summary

- Datalogger data, system data and process data can be combined and used in calculation to derive new valuable data e.g.
  - Actual pig speed – Derived from vibrations and buckle arrestors
  - Actual bypass – Derived from flow speed, actual pig speed and differential pressure
  - All data pinned to a distance – Derived from actual pig speed

- We now have better understanding of wax deposition and pig behaviour.