SOLVING COMPLICATED CASES WITH SIMPLE ANALYTICS

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Europe’s largest producer of renewable energy

OWN CAPACITY

19 300 MW

PRODUCTION

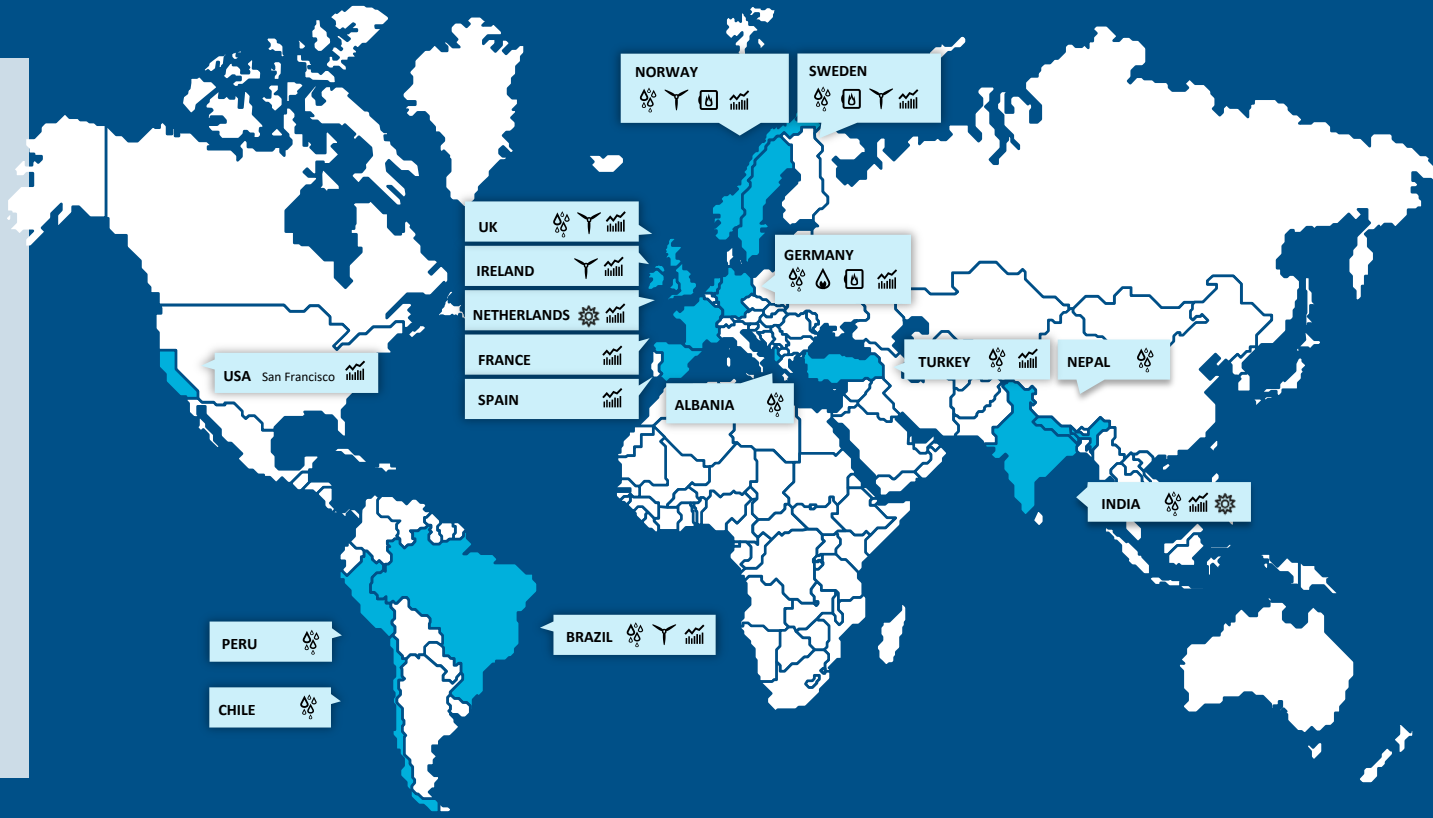
62 TWh

EMPLOYEES

3 600

NET PROFIT

13.4 NOK billion



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Taskforce Advanced Analytics

- Wind cases
- Hydro cases
- Backend


Stamåsen wind farm


Blåsjø


Kvilldal power station, interior

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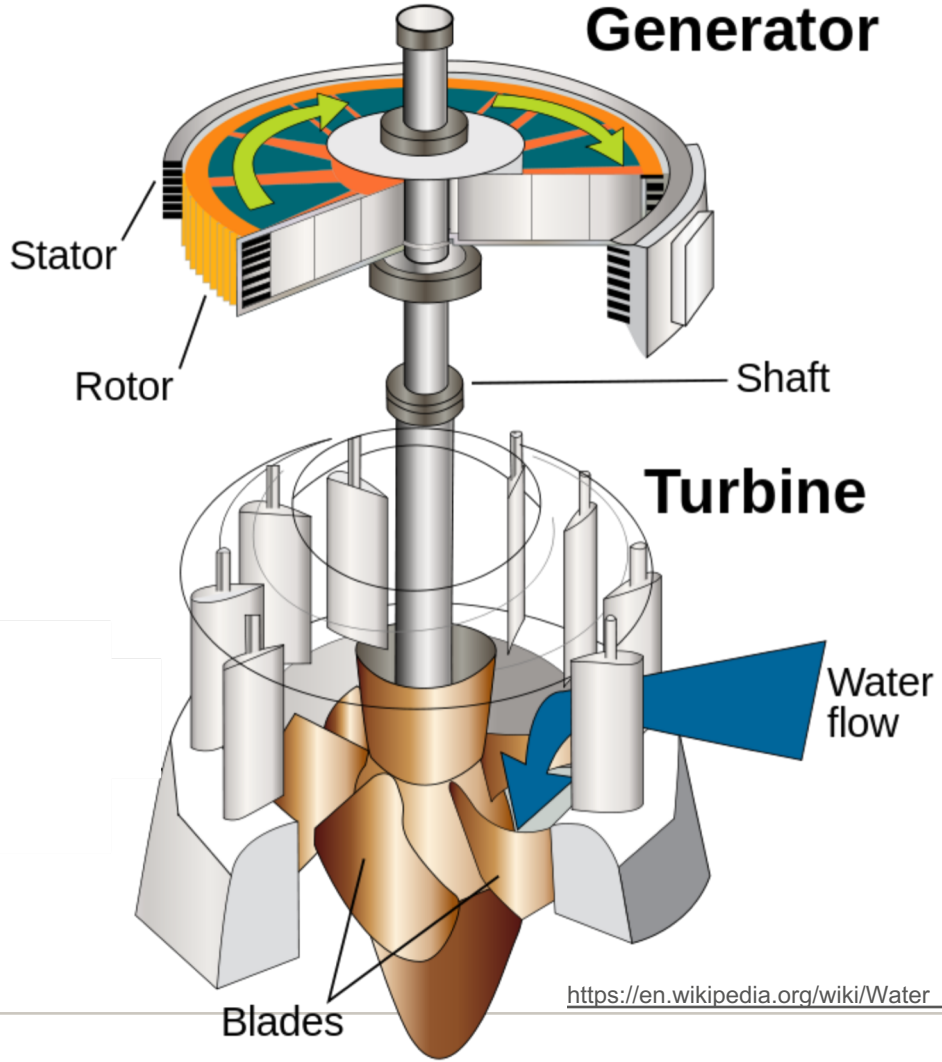
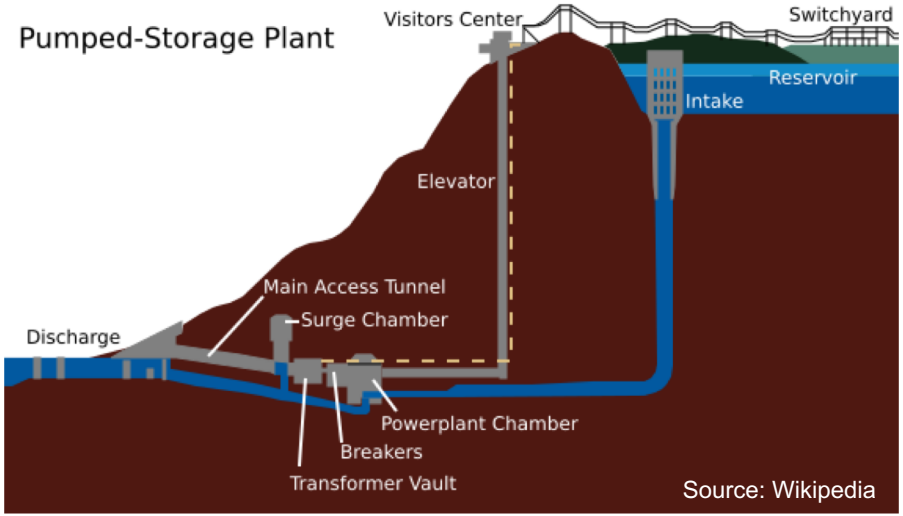
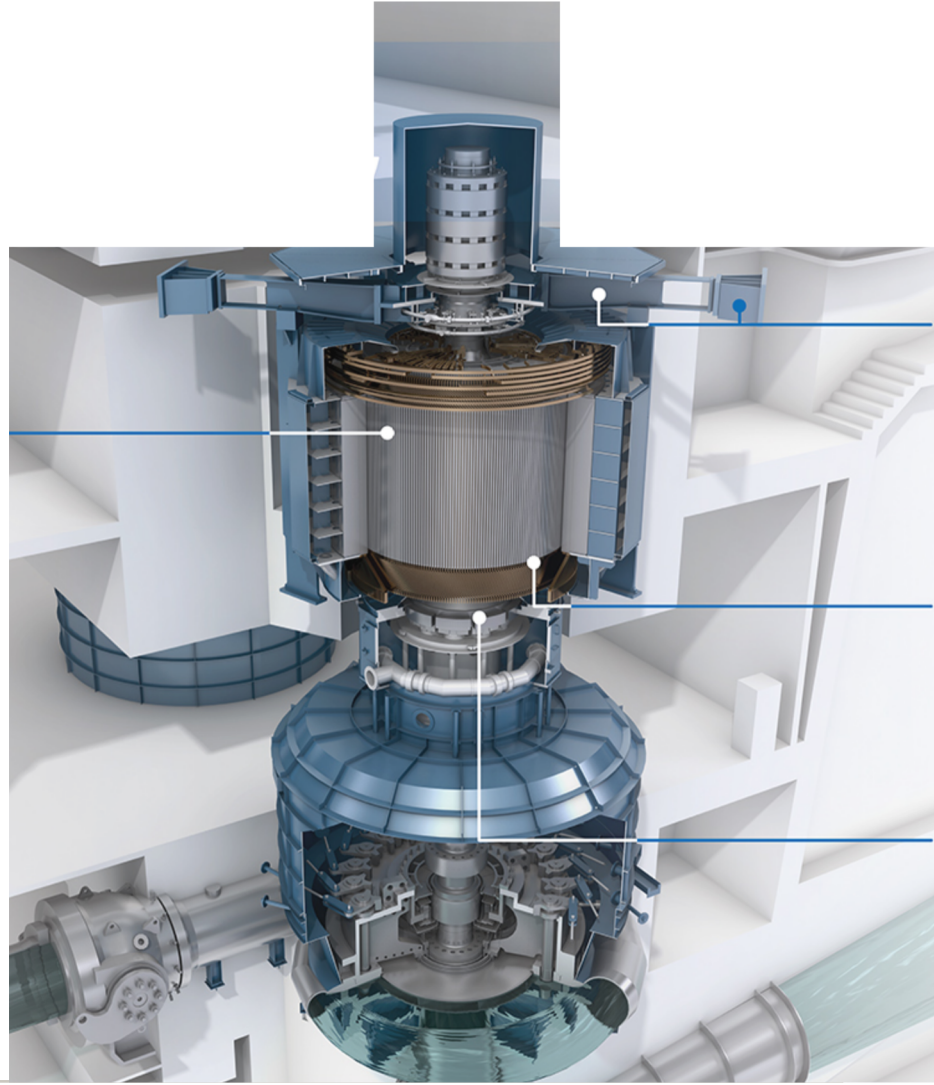
But today:

Hydropower plants



https://en.wikipedia.org/wiki/Water_turbine





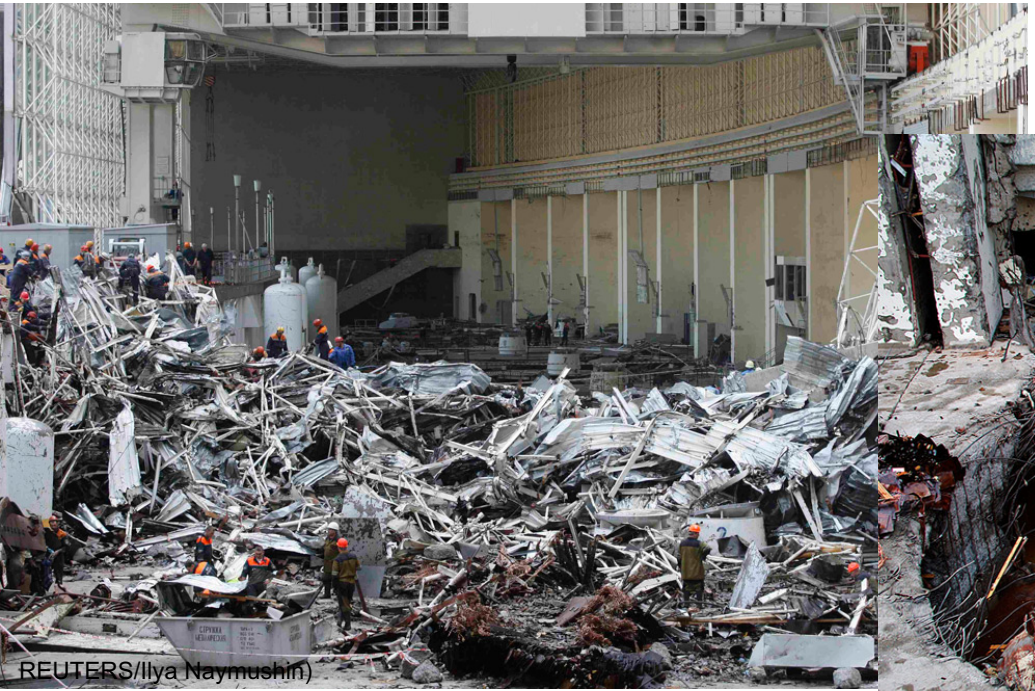
https://www.ge.com/renewableenergy/hydro-power/large-hydropower-solutions/generators/variable-speed

2009-Sayano-Shushenskaya power station accident

ALEXANDER NEMENOV/AFP/Getty Images

https://commons.wikimedia.org/w/index.php?curid=7709947

2009-Sayano-Shushenskaya power station accident



REUTERS/Ilya Naymushin)

AP Photo/ Rossiiskaya Gazeta Newspaper

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Leirdøla hydropower plant

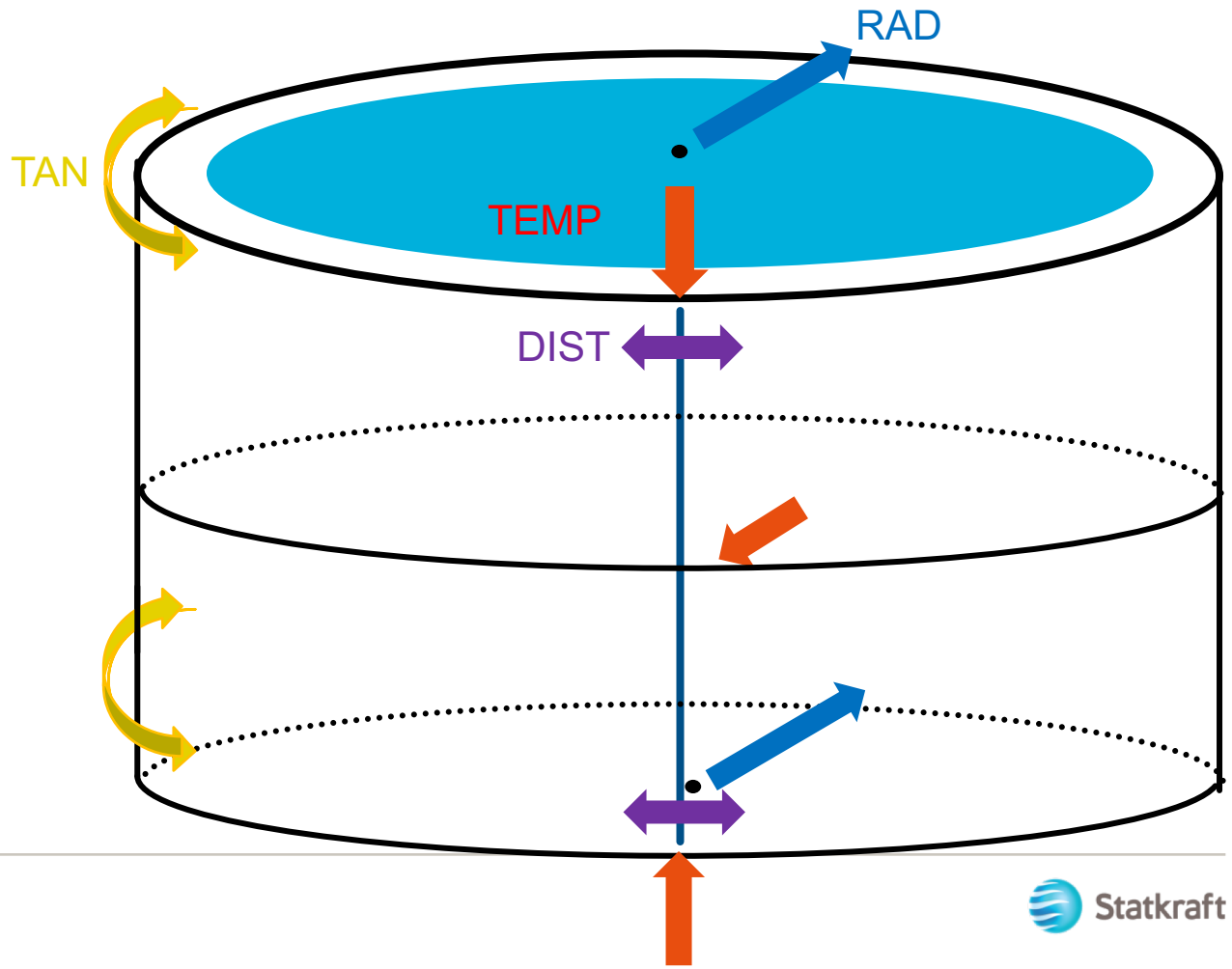

UT


LAV OPEDAL A.S
185/20 ton

Leirdøla hydropower plant – problems

- Root cause problem – poor cooling of the stator (2012 – 2018)
  - *Changes in raw water, cooling air cold and warm*
- Fire in stator bar – summer 2017
  - *Changes in vibration of upper guide bearing*
- Current situation – 2018
  - *Changes in gap distances, temperatures (across generator) and vibrations stator back*

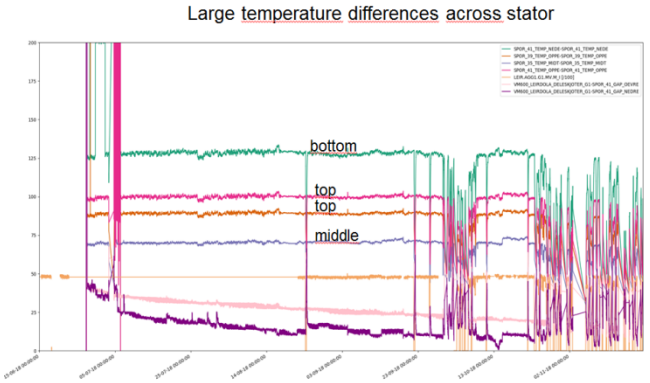
New Sensors!

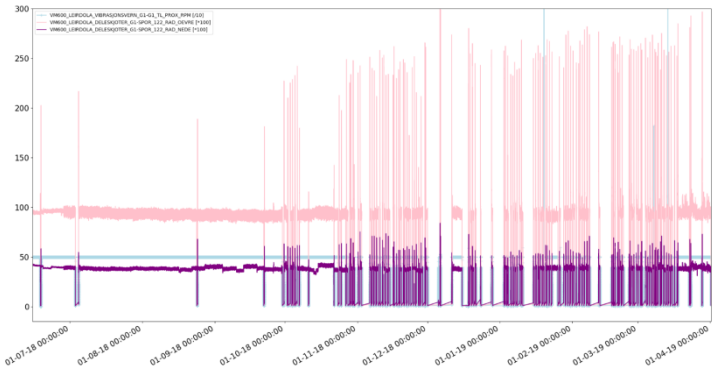


Symptoms & Root Cause

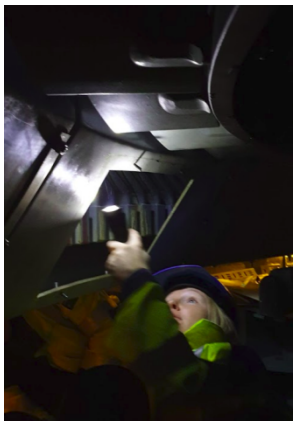
Analysing trends

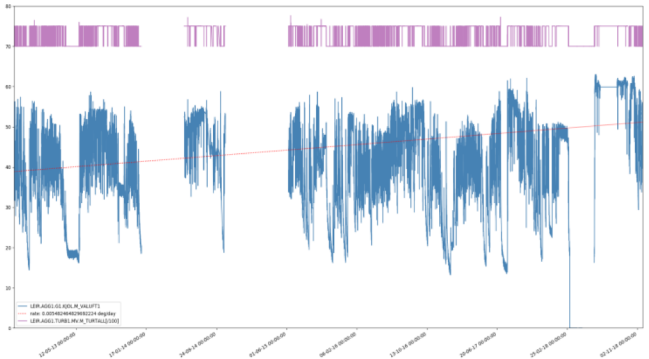
- Sympthoms
- Root cause..?





https://www.pixelsquid.com/png/metal-can





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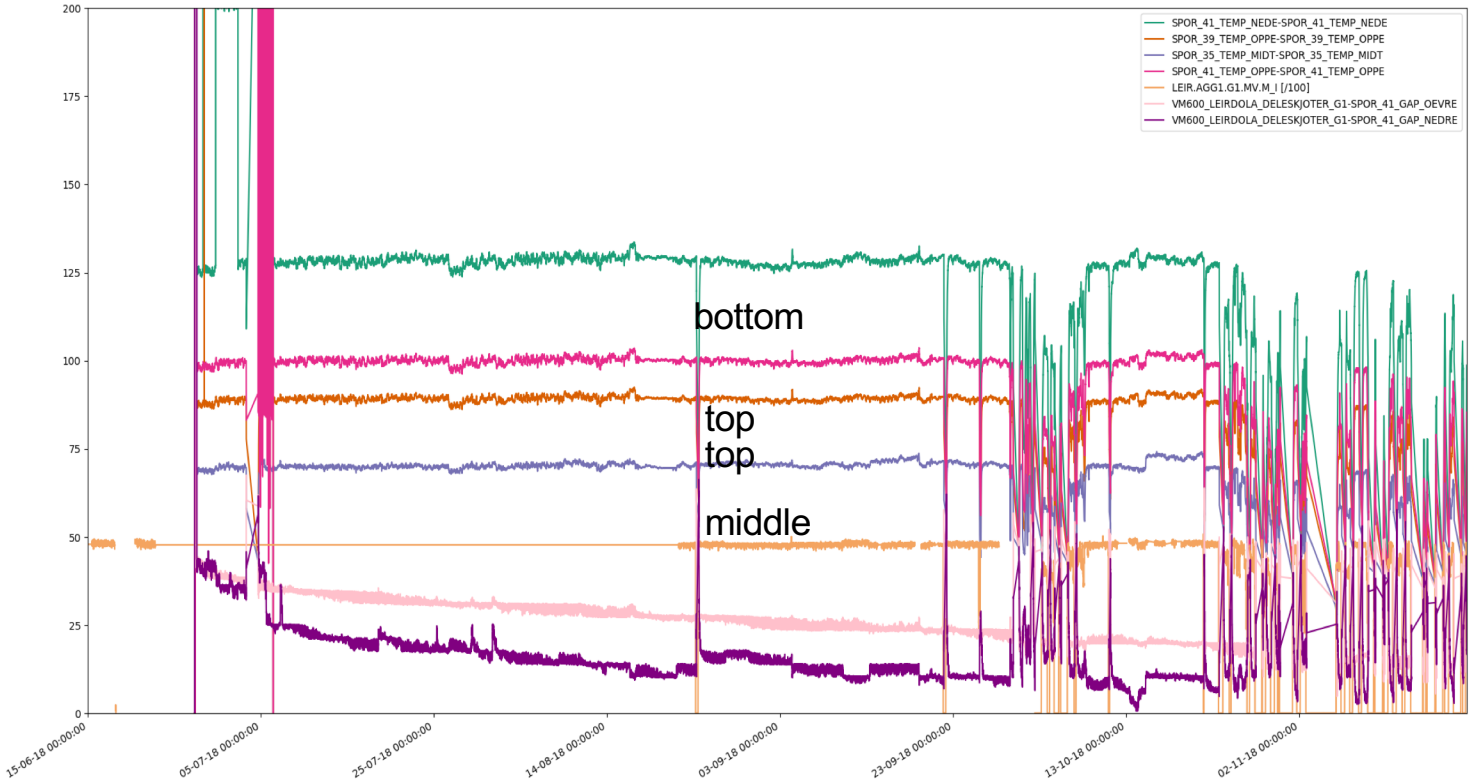
Cooling system

https://www.youtube.com/watch?v=VydPQuLyEns

Large temperature differences across stator



but, only one temperature available in PI, the rest only available locally…

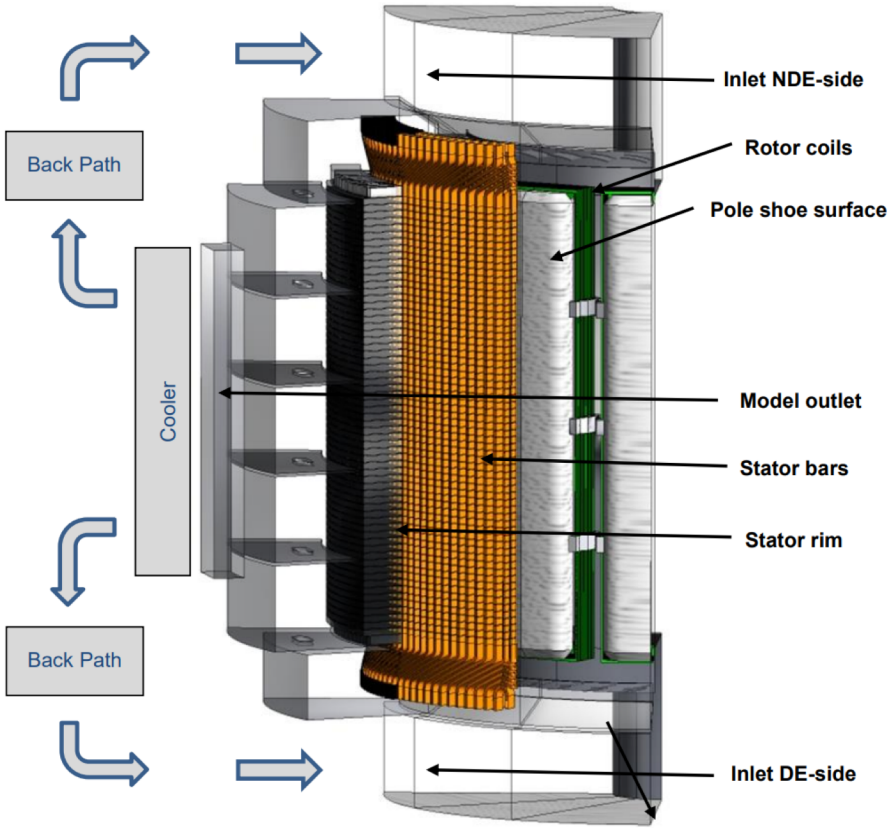


Figure 4: Boundaries applied to the model

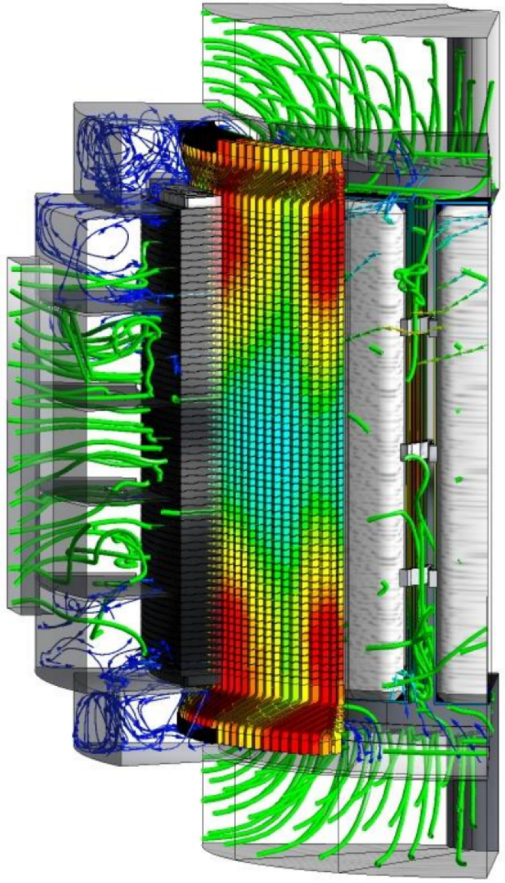
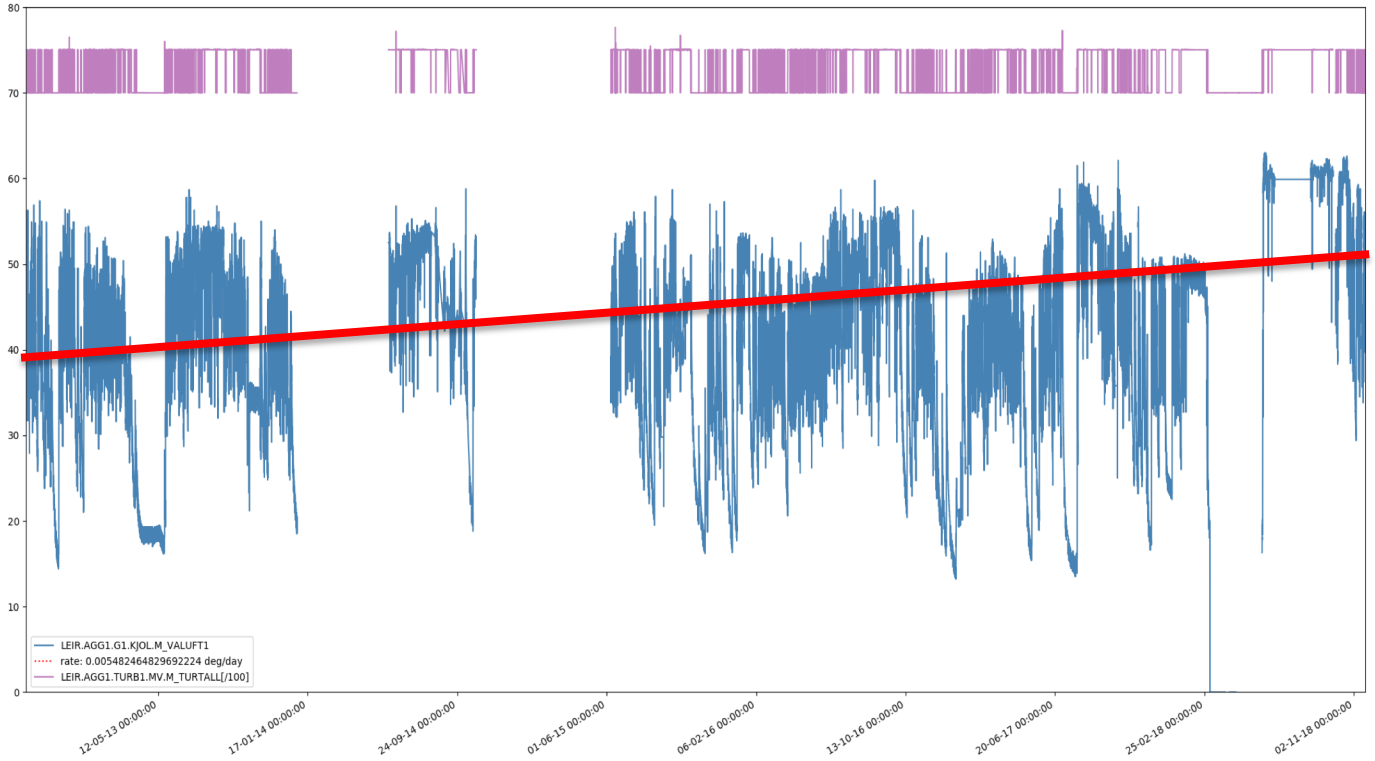


Figure 5: Potential results from the CFD investigation

Source: GE Leirdola CFD Inverstigation

Warm air cooler 1 increases over time…

~2.0 deg/yr



2012 2018

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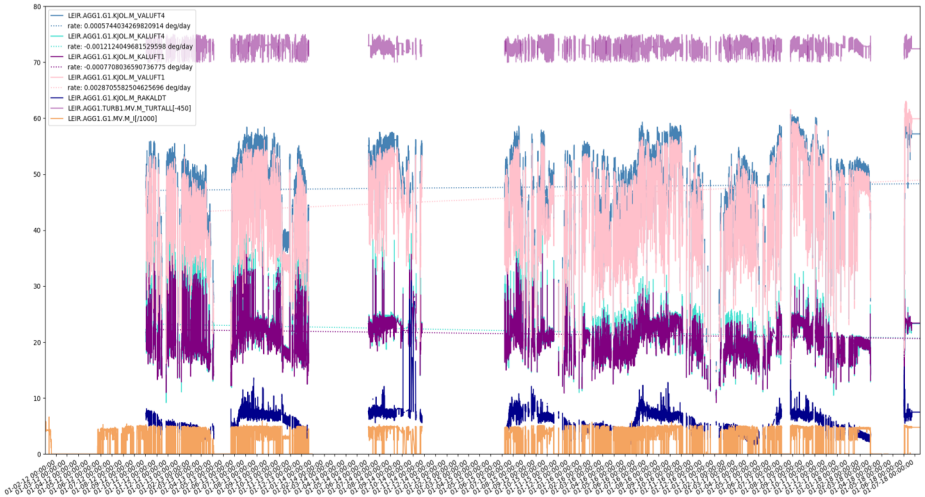

… but further investigation requires even more sensors!

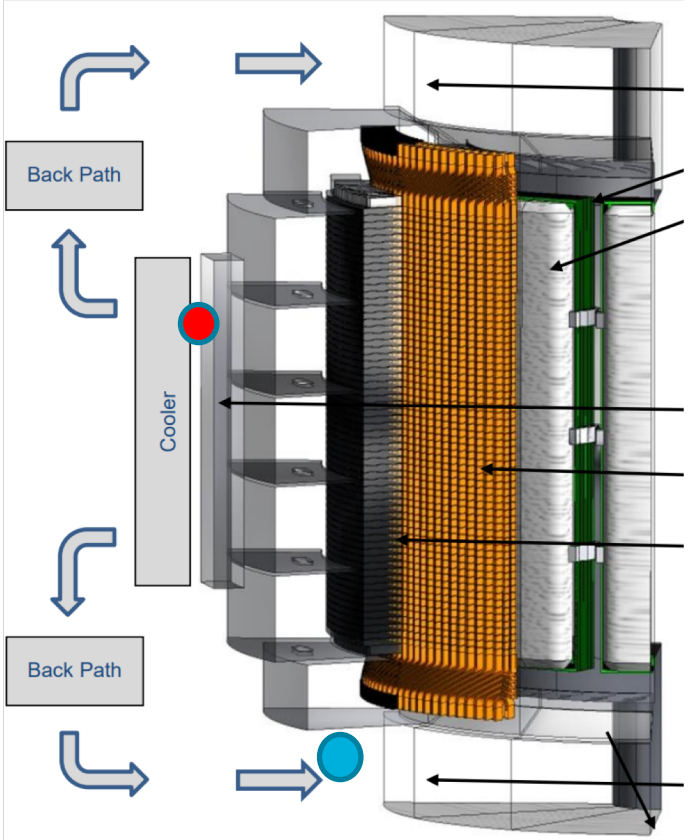

Figure 4: Boundaries applied to the model

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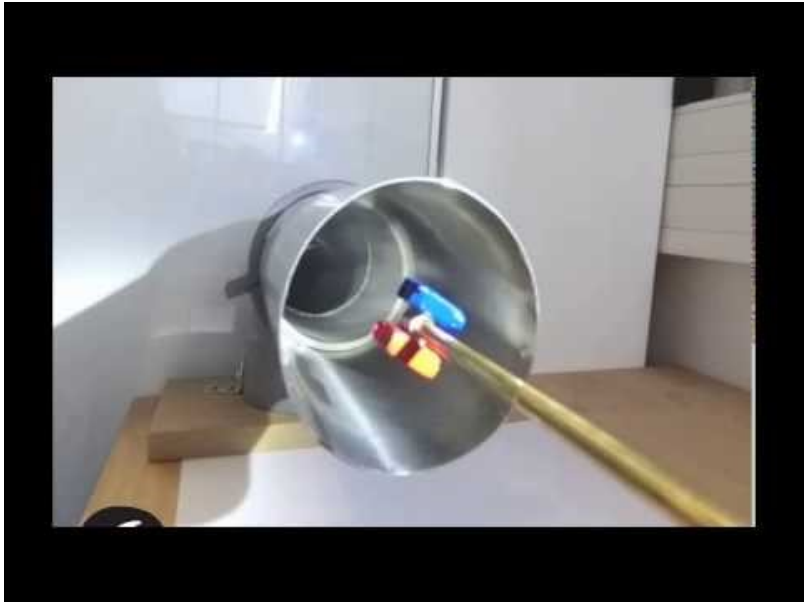
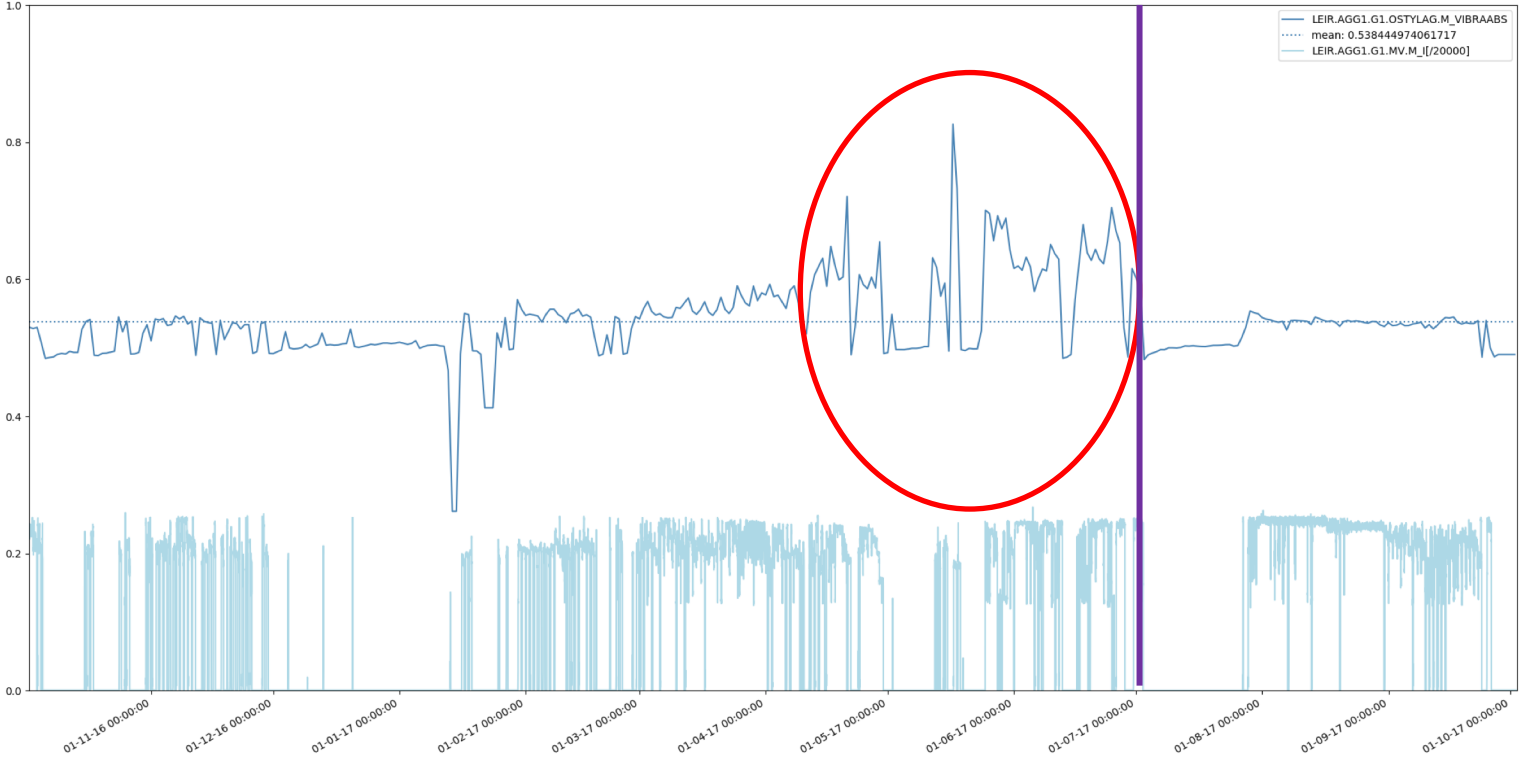
Vibrations



https://www.youtube.com/watch?v=5489-rzCaMQ

Unusual bearing vibrations shortly before stator bar fire



Oct 2016

Oct 2017

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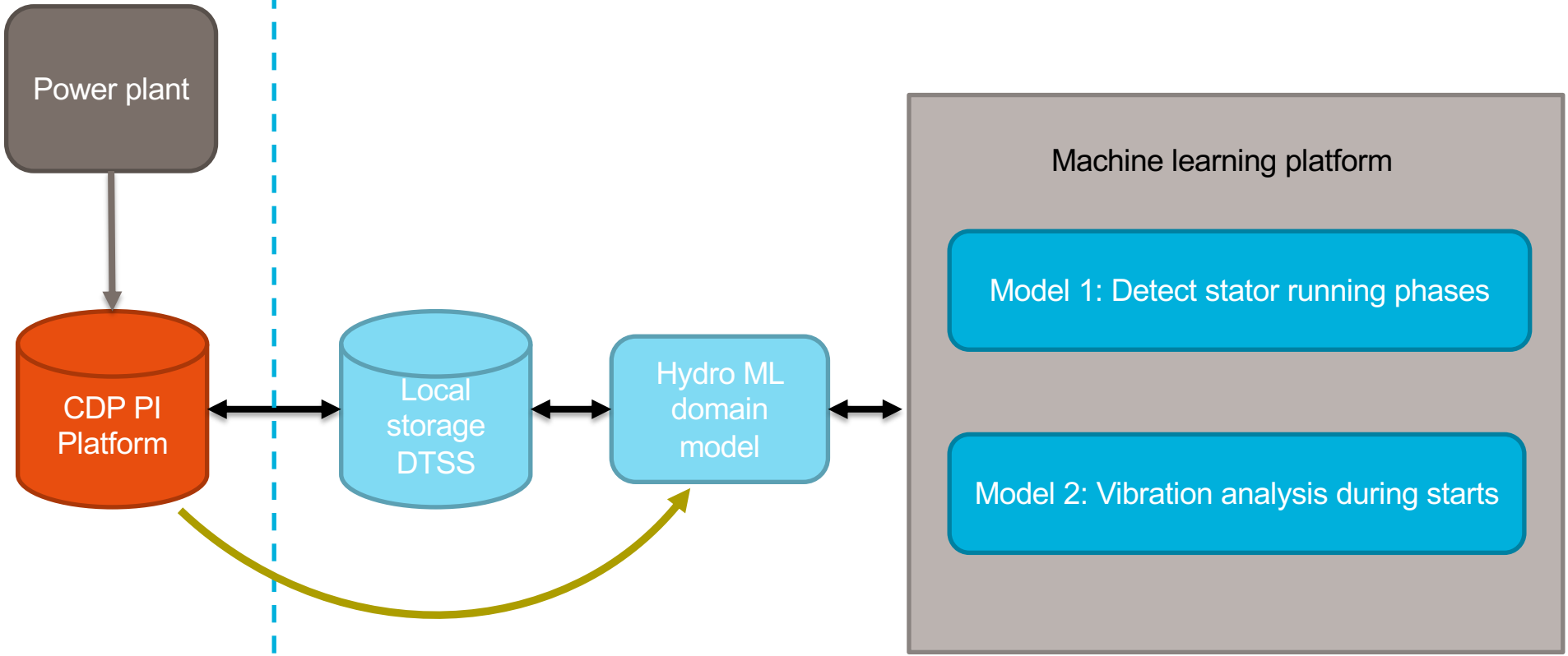
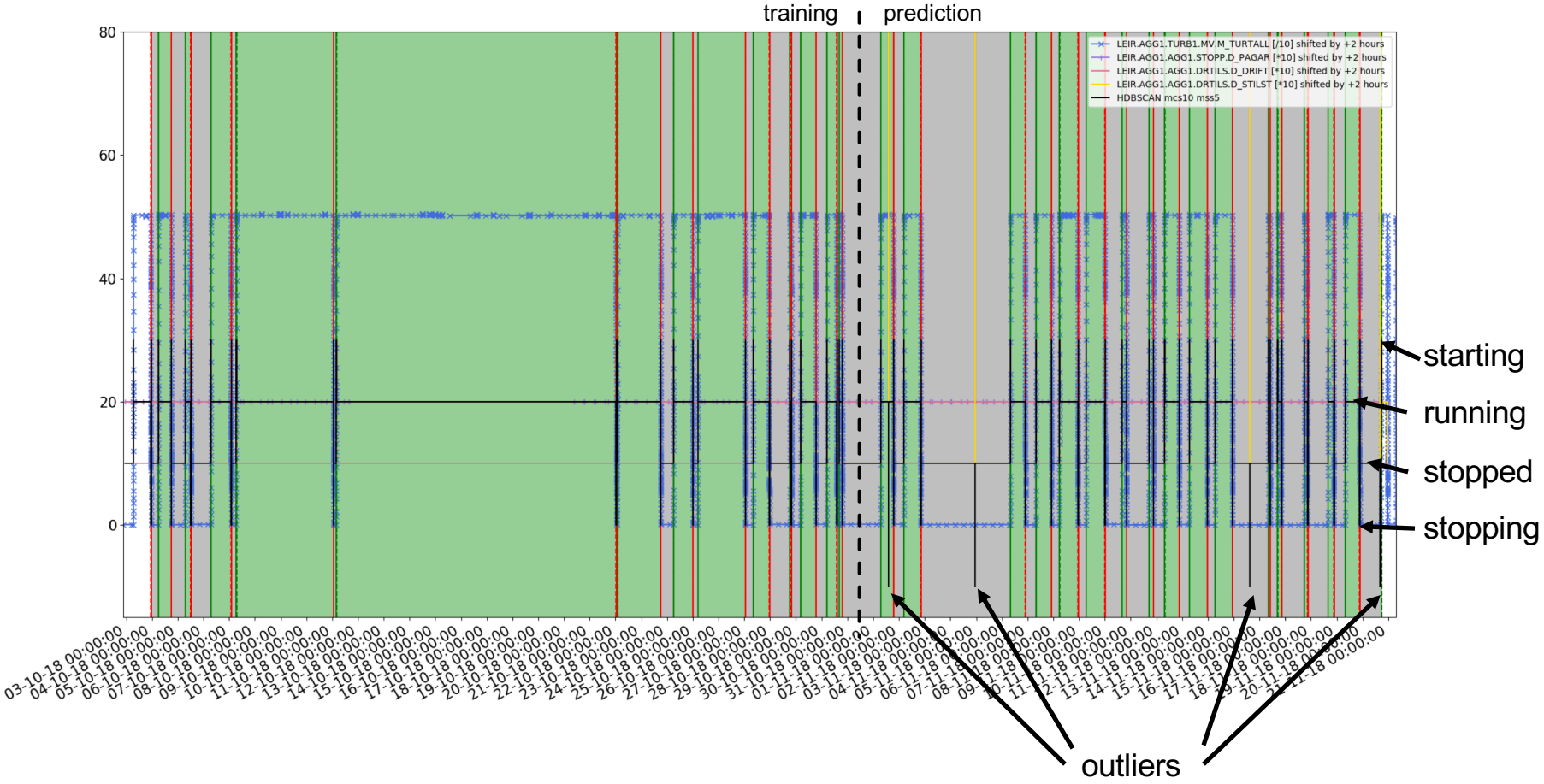
The first ML models:



Apply ML to identify start stop sequences



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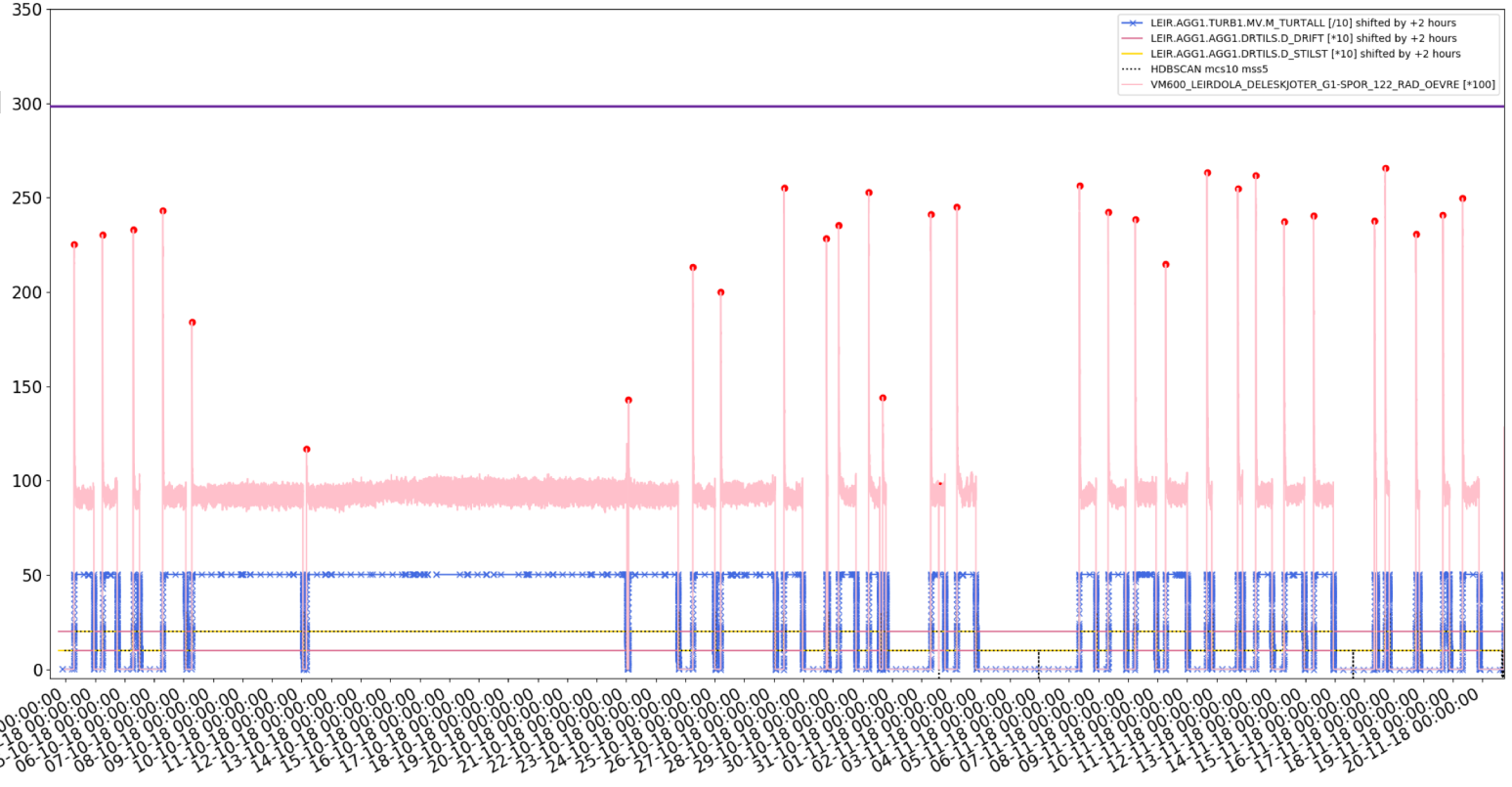
Anomaly detection model: Vibration peaks during starts

critical level



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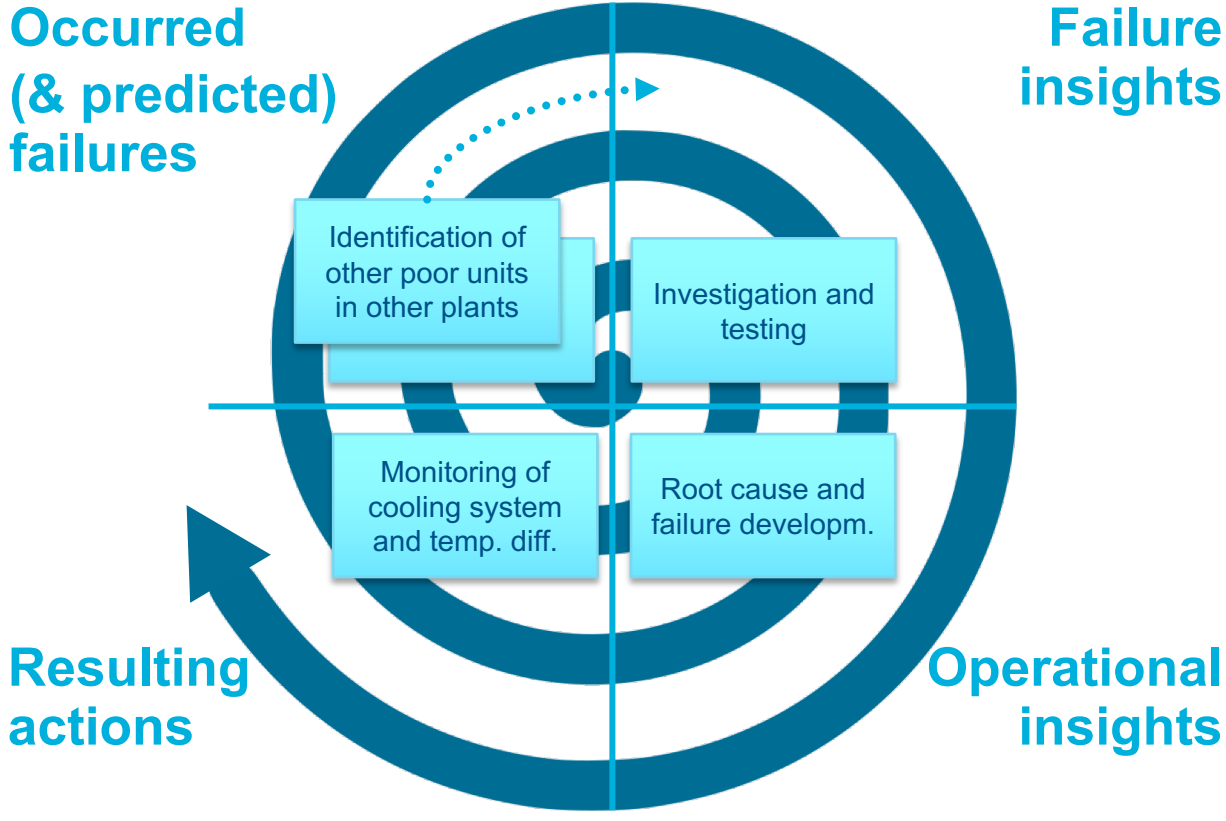
From one insight to many



https://www.geckoandfly.com/24794/calvin-hobbes-words-wisdom-quotes//

Thank you!