TATA STEEL

TATA

Advanced Analytics at Tata Steel in IJmuiden

Warbout Tesselaar

April 2022

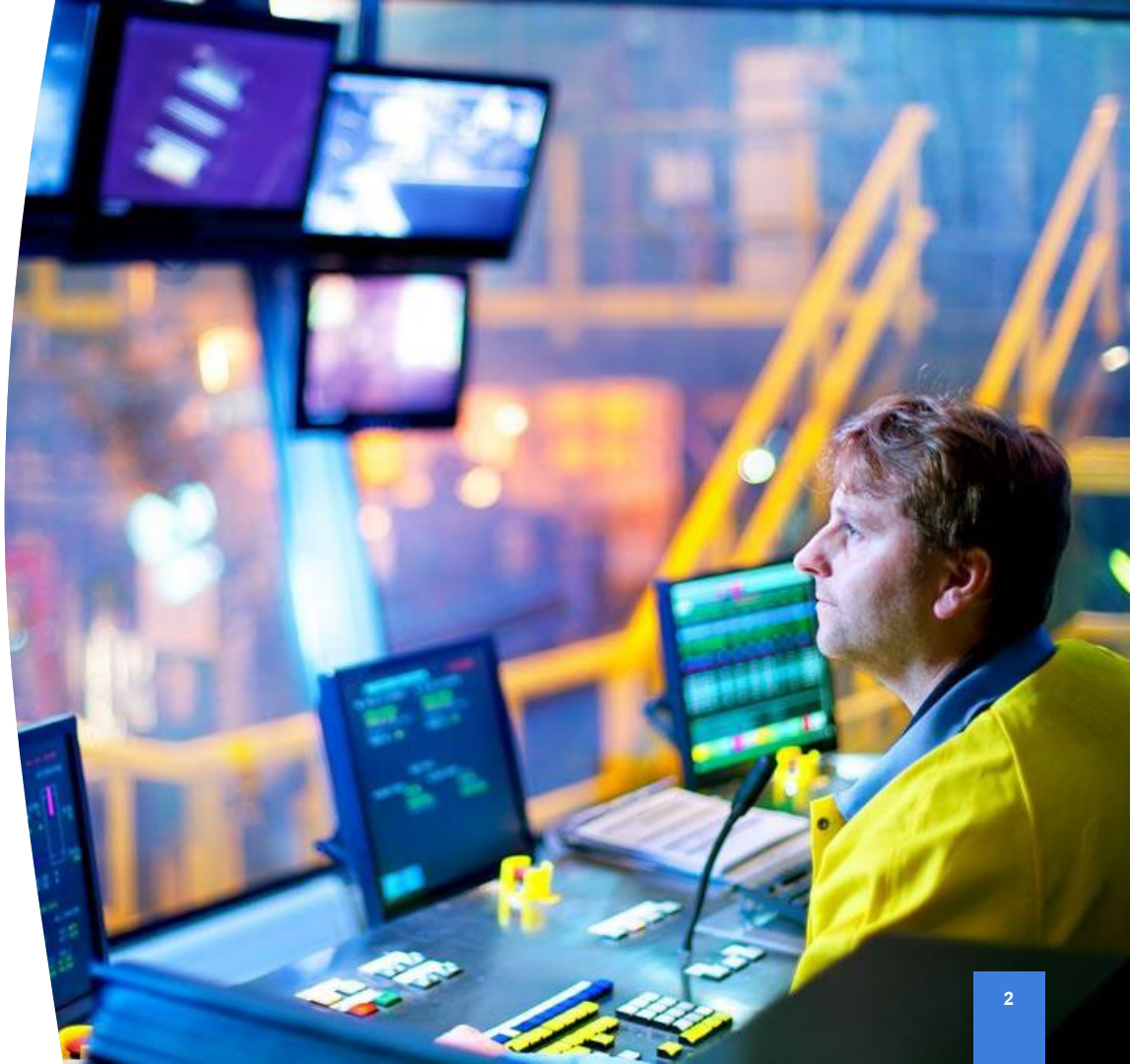
Together we make the difference

Agenda

The Tata Steel Advanced Analytics program

Use case: steel ladle impact pad wear

- Background
- Approach
- Outcomes



We started our AA program in 2017, got recognized for at scale implementation in 2019 and continue rolling out the Digital Roadmap in 2022

Vision


worldsteel ASSOCIATION

FOR DISCUSSION

WHAT'S NEW

Press release 1 April 2019

Tata Steel IJmuiden awarded leading advanced analytics steel plant in the world

Today, Tata Steel IJmuiden received the WSA award for the leading advanced analytics enabled steel plant in the world. Hub director Hans vd Berg comments: "as leadership team we embraced the opportunities of advanced analytics and digital early on. Over the past years we build a local Tech community, update our IT architecture and drove an holistic program deploying AA on topics like process and quality control, predictive maintenance, procurement of raw materials and planning optimization

CLICK HERE FOR MORE INFO

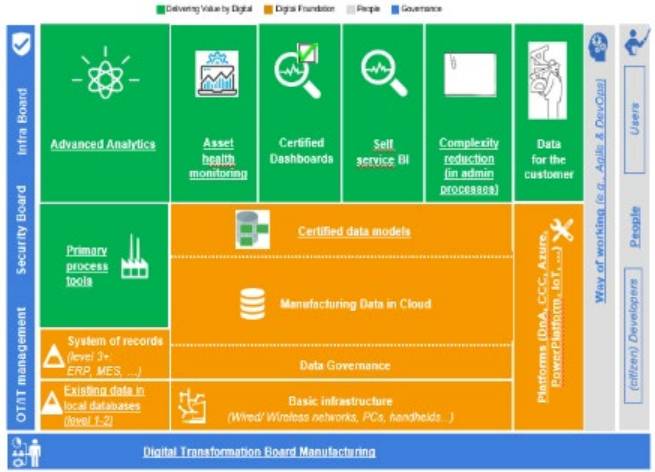
WEF recognition

10 JANUARY 2019 | CORPORATE NEWS

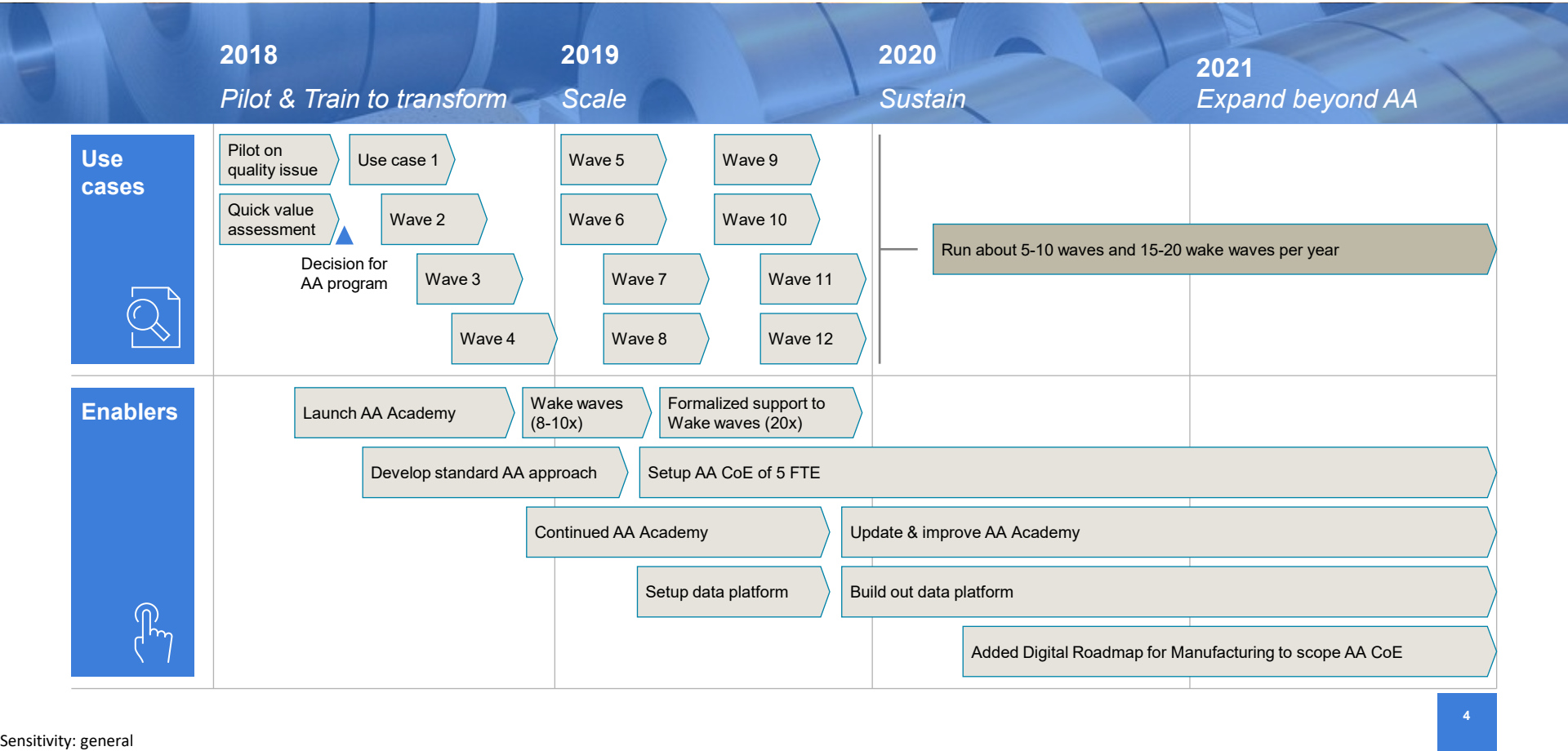
The World Economic Forum recognises Tata Steel steelmaking plant as a 'factory of the future'

Today, the World Economic Forum (WEF) announced Tata Steel Europe's steelmaking plant at IJmuiden in the Netherlands has been inducted into its prestigious community of 'Lighthouses', a distinction awarded to manufacturing facilities which are seen as leaders in the technologies of the Fourth Industrial Revolution.

Digital roadmap

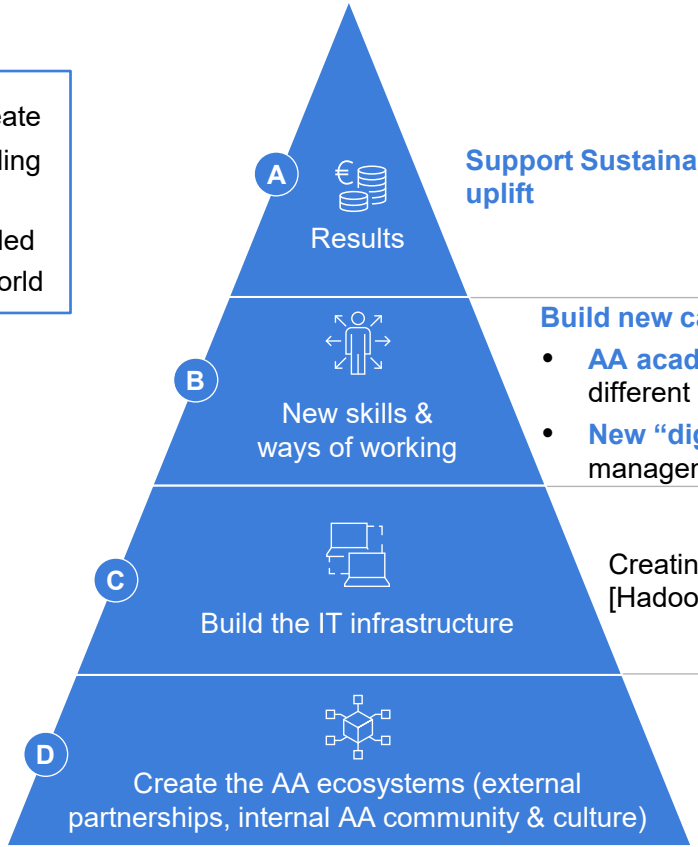


We started with an Advanced Analytics pilot and quick value assessment before onboarding on a full AA transformation



The Tata Steel AA program consists of 4 elements

Vision : Create one of the leading manufacturing analytics enabled plants in the world



Support Sustainable Profit objective with delivery of annual EBITDA run-rate uplift

Build new capabilities through

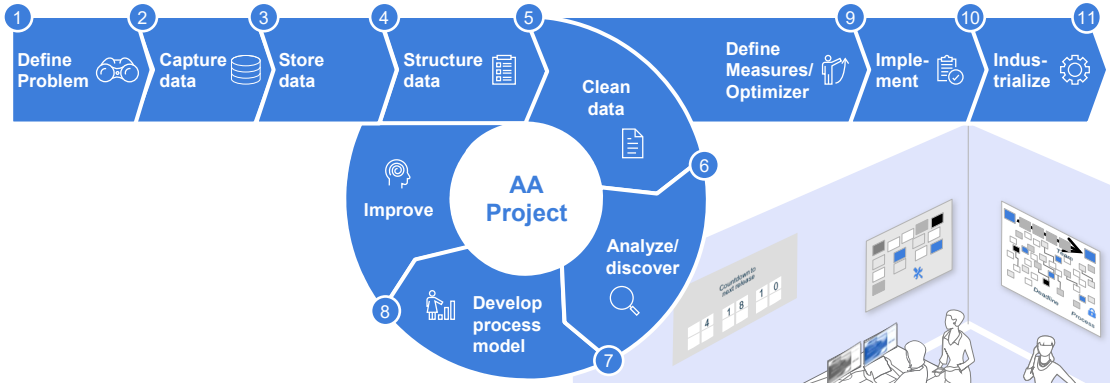
- **AA academy** to train & certify >400 Advanced Analytics professionals in different rolls and skill levels (at least 20 experts)
- **New "digital" ways of working** (Digital Apps & Dashboards, "Agile" project management)

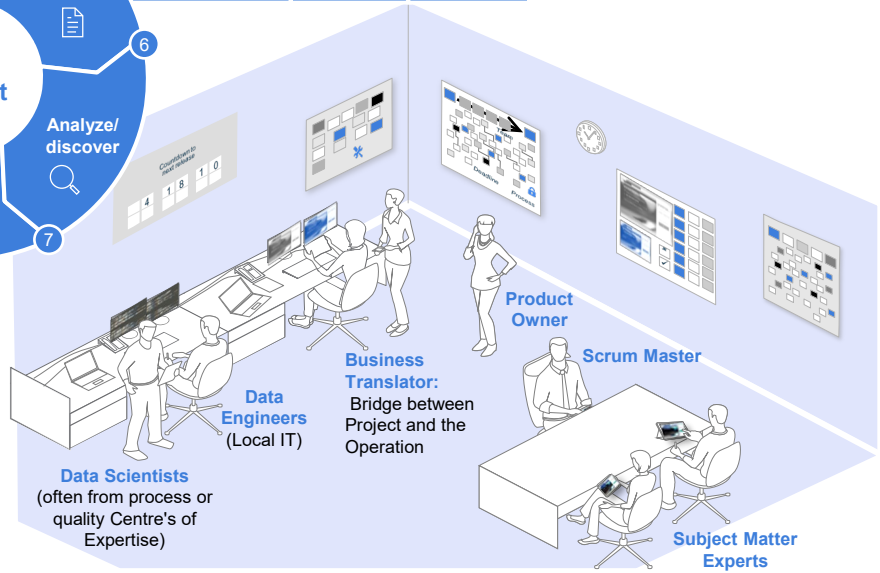
Creating a state of the art **cloud based IT & Data infrastructure** [Hadoop / Azure] for data storage, processing and analysis

Ensure an active cross fertilisation within the **AA community inside Tata Steel and with the outside world**

Standard, structured AA use case approach to run cross-functional teams uniformly

Tata Steel Ijmuiden AA use case approach





Agile way of working

- 4-7 (FT) team members
- PO and MSE's part time involvement
- Synchronised in time
- Ideally co-located, however very positive experiences with virtual co-location

Cross-functional team with domain-expertise at the core

A standard, structured AA use case approach helps to

- Deploy use cases uniformly across teams and plants
- Create one language about stage of AA use case
- Clarify non-debatable intermediate products
- Make it easy for AA CoE to jump in and support use case teams

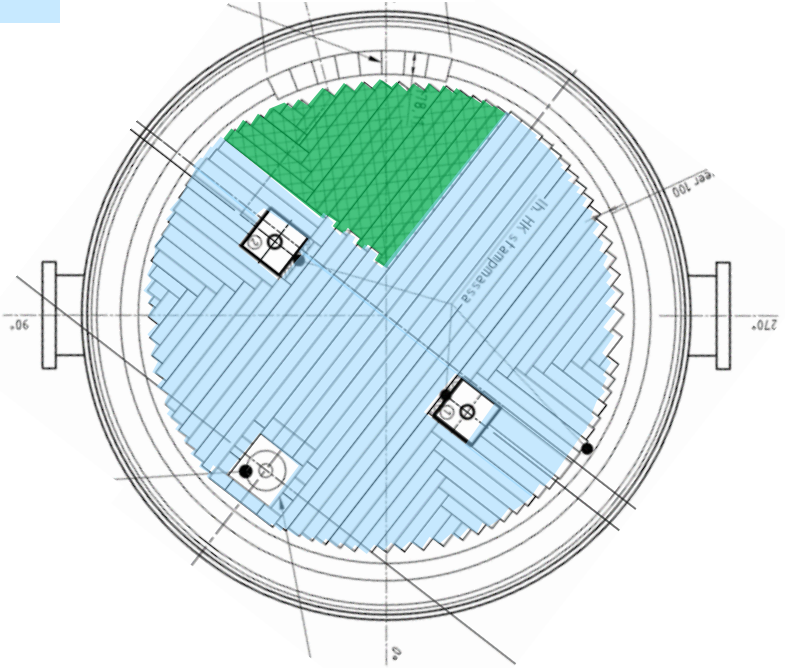
Example of AA wake wave

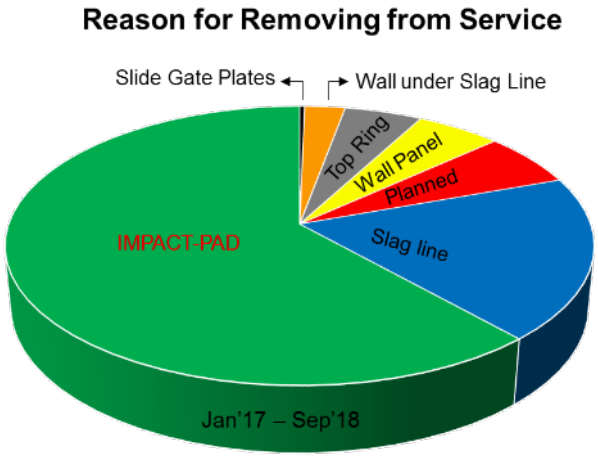
Steel ladle impact pad wear

Situation: impact pad wear is limiting ladle life

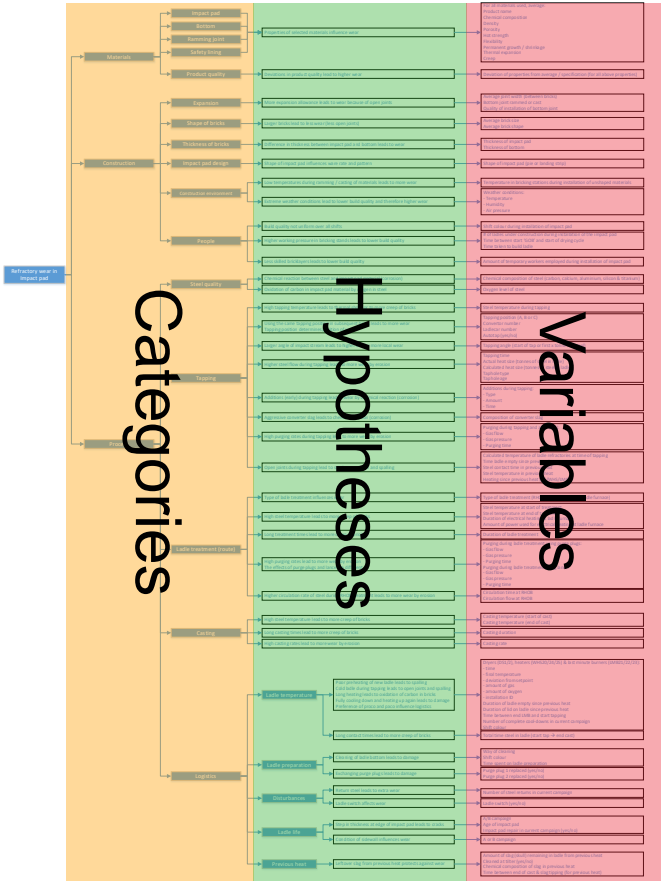
Impact pad

Bottom





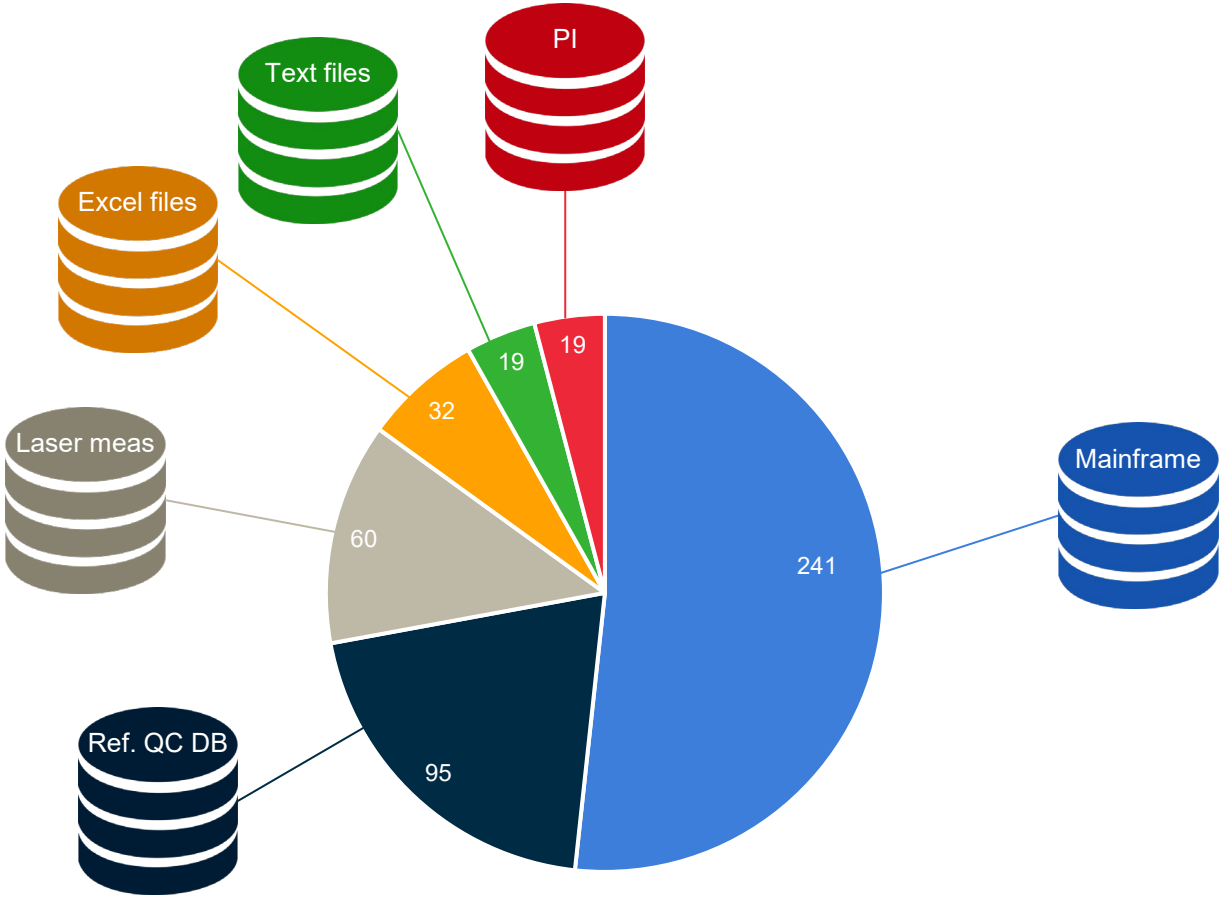
Hypothesis tree is used as basis for data gathering



Priorities are ranked by experts

Priority	ID	Hypothesis	Total score (from 6)
1	1	Properties of selected materials in impact pad influence wear	5
2	2	Properties of selected materials in bottom influence wear	5
3	39	Cold ladle during tapping leads to open joints and spalling	5
4	38	Poor preheating of new ladle leads to spalling	4
5	50	Leftover slag from previous heat protects against wear	4
6	3	Properties of selected materials in ramming joint influence wear	3
7	11	Difference in thickness between impact pad and bottom leads to wear	3
8	18	Chemical reaction between steel and impact pad material (corrosion)	3
9	21	Using the same tapping position in subsequent heats leads to more wear	3
10	24	Higher steel flow during tapping leads to more wear by erosion	3
11	40	Long heating leads to oxidation of carbon in bricks	3
12	41	Fully cooling down and heating up again leads to damage	3
13	25	Additions (early) during tapping lead to wear by chemical reaction (corrosion)	2
14	28	Open joints during tapping lead to steel penetration and spalling	2
15	29	Type of ladle treatment influences wear	2
16	43	Long contact times lead to more creep of bricks	2
17	5	Deviations in product quality in impact pad lead to higher wear	1

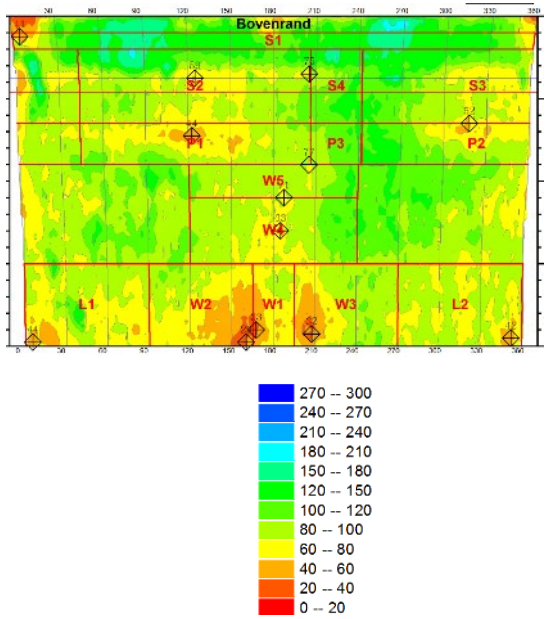
Data is imported from a range of databases and files



Laser scanner can be used to quantify wear

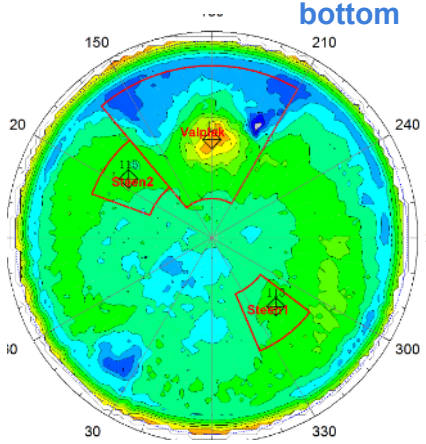
- Thickness of refractory lining in service is measured frequently using a laser scanner.
- Results presented graphically and used by operators to help decide on taking ladles out of service.
- Results also stored → can be used for analysis of wear and wear mechanisms.

laser



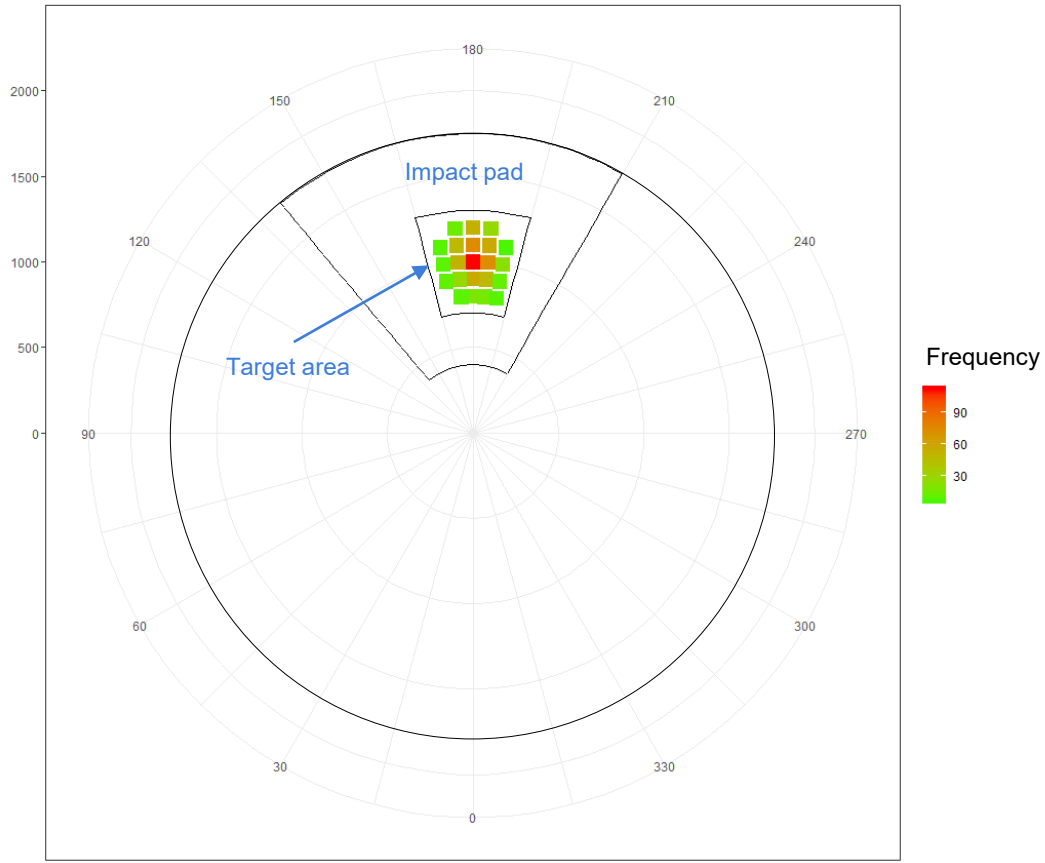
wall

bottom



Target function: average thickness change in target area per heat

Location of thinnest spot in last 3 heats



98% of ladles out of service on impact pad has thinnest point in **target area**

Model performance improving but not to desired level

Main refinements

1 Data cleaning and features
- 801 variables from 6 data sources
- Reduced to 82, based on expert session
- Addition of synthetic variables (features)

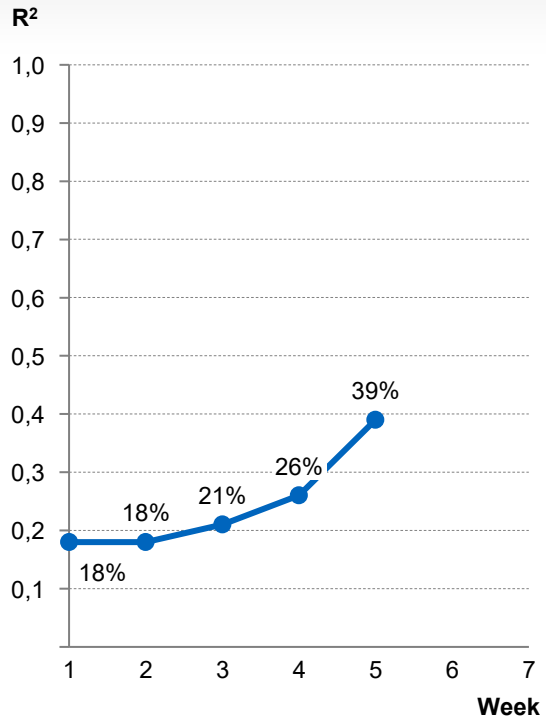
2 Target function
- Different target functions did not result in increase in R^2

3 Data selection & quality
- Anomaly detection to remove faulty data

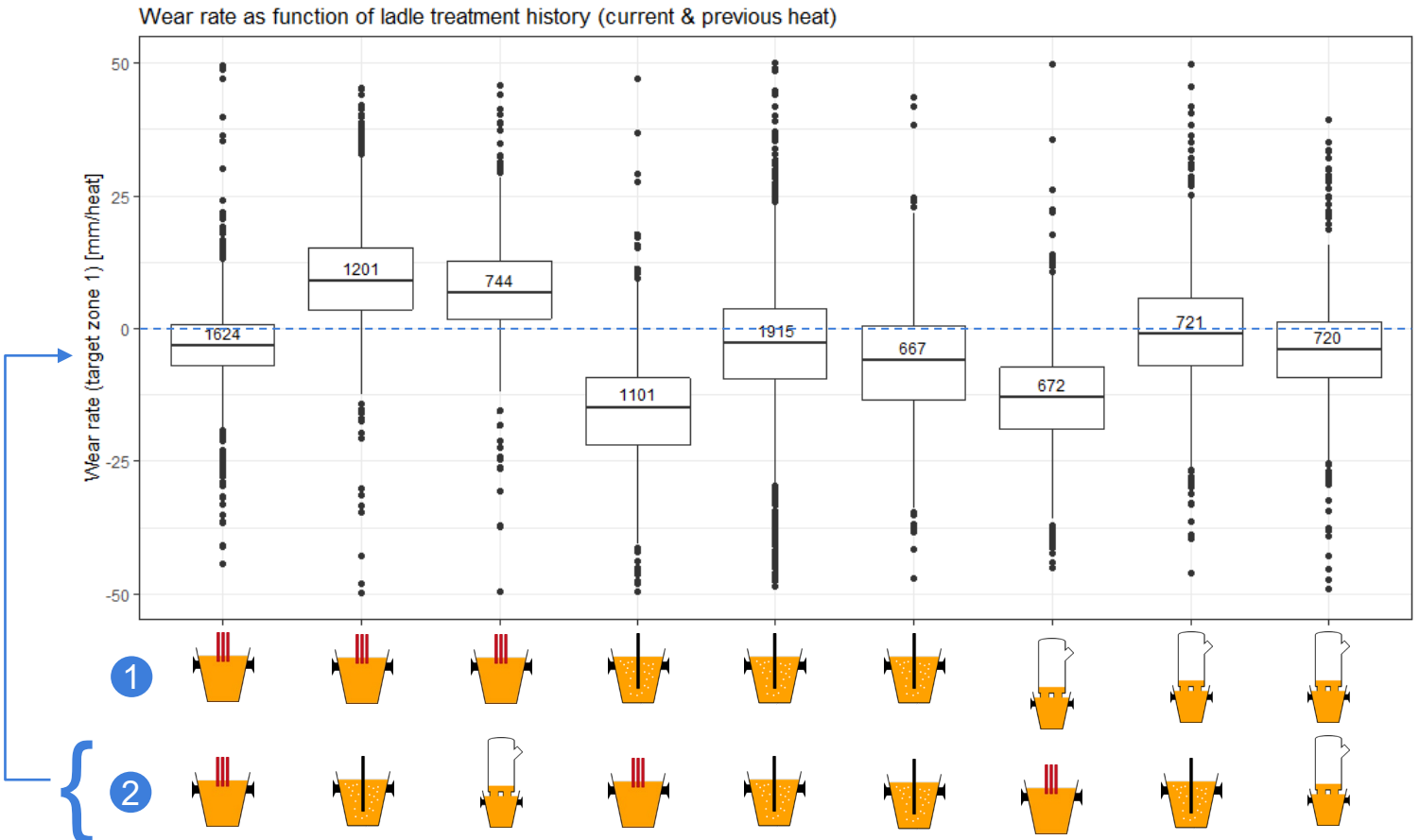
4 Data selection & quality
- NA fixing on certain variables

5 Model Type
- MARS performing best

Resulting model performance



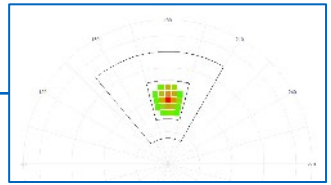
Sequence of ladle treatment has biggest influence on wear



No predictive model, but very important insights

1 | **Location of thinnest point** in the impact pad is dependent on ladle life

2 | **Current spread in tap position** does not lead to spread in wear over the impact pad

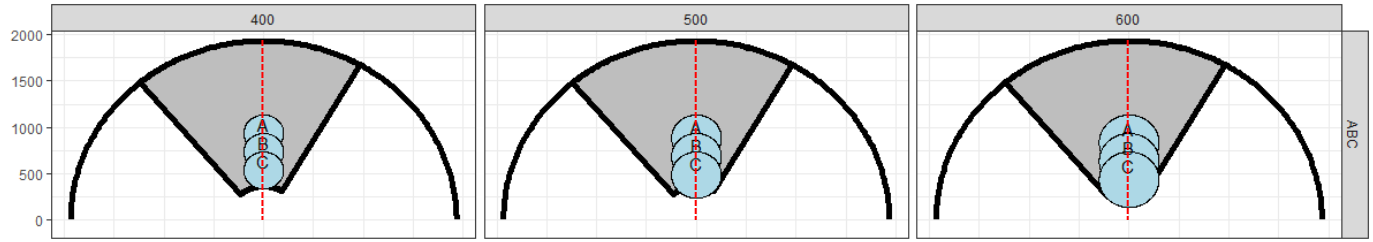


3 | **Ladle treatment type** has a large impact on build-up and removal of slag

4 | **Ladle furnace** treatments result in almost no slag/skull build-up on the impact pad

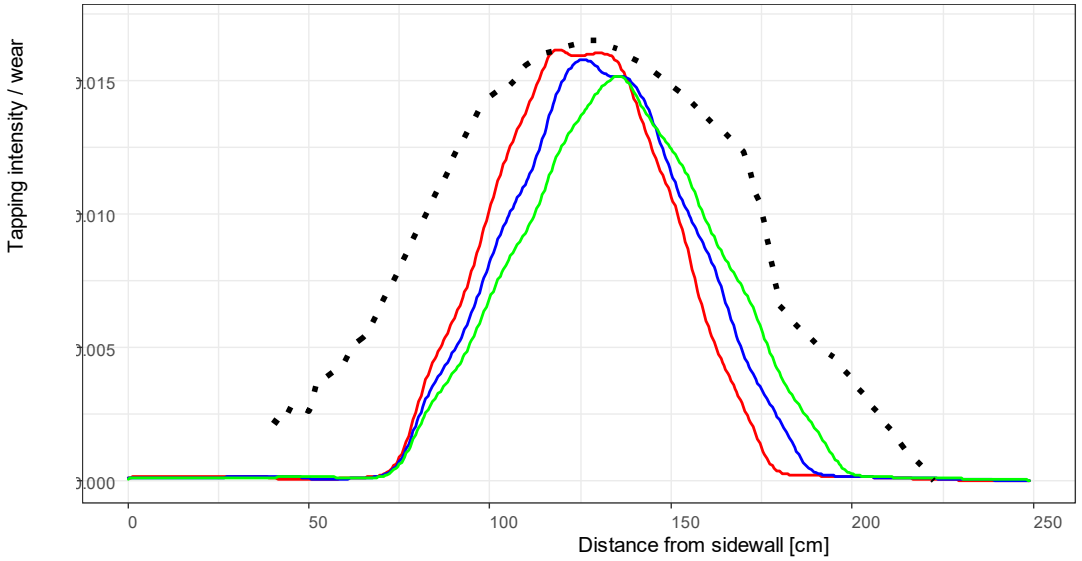
Local wear is a result of overlapping positions

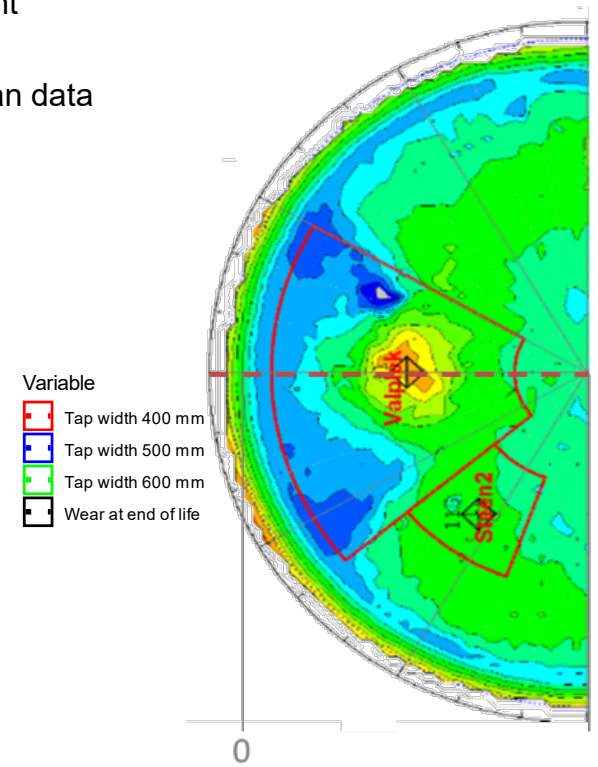
- Number above plot is estimated tap stream diameter in mm. Positions A, B and C **always overlap**, regardless of tap stream diameter. Position of highest intensity depends on tap stream diameter.



Tapping intensity calculated from cumulative tapping position

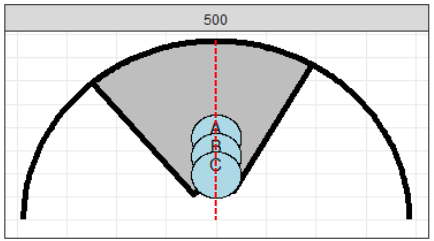
- **Tapping intensity** calculated based on actual tapping positions from plant database and assuming different values for tap stream diameter.
- **Average wear profile** (dotted line) at end of life calculated from laser scan data
- Best correlation found for tap stream **diameter of 500 mm**





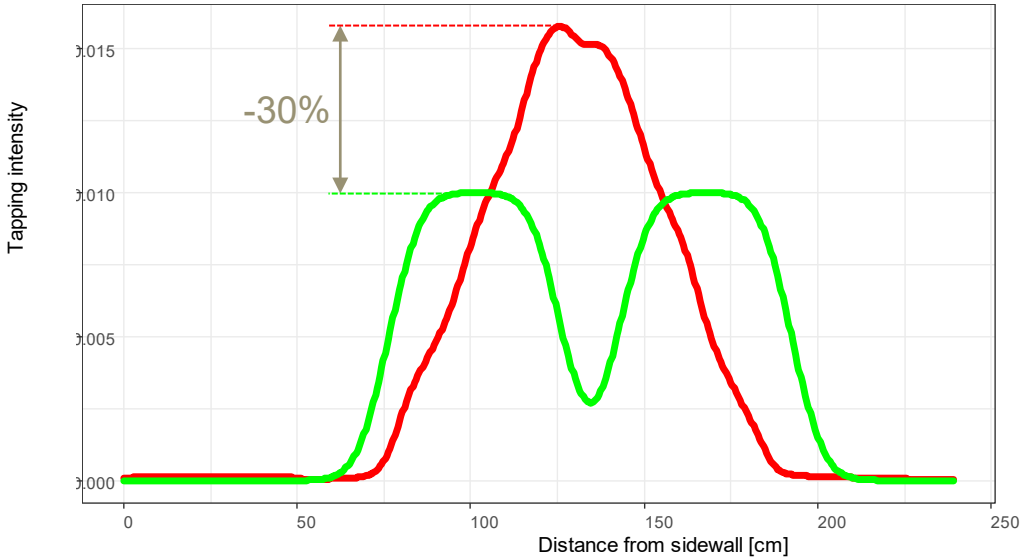
Introduction of alternative tapping patterns

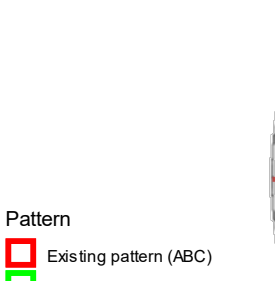
- At 500 mm tap width, there is strong overlap for ABC, less for DEF and none for DF (assuming zero deviation).

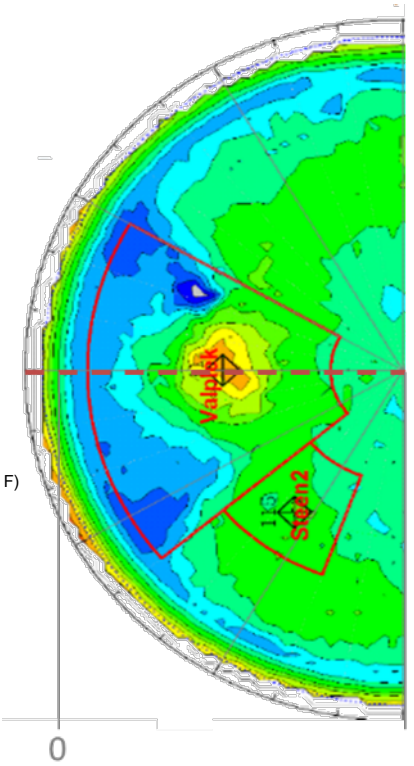


Advise: increase tapping spread to improve ladle life

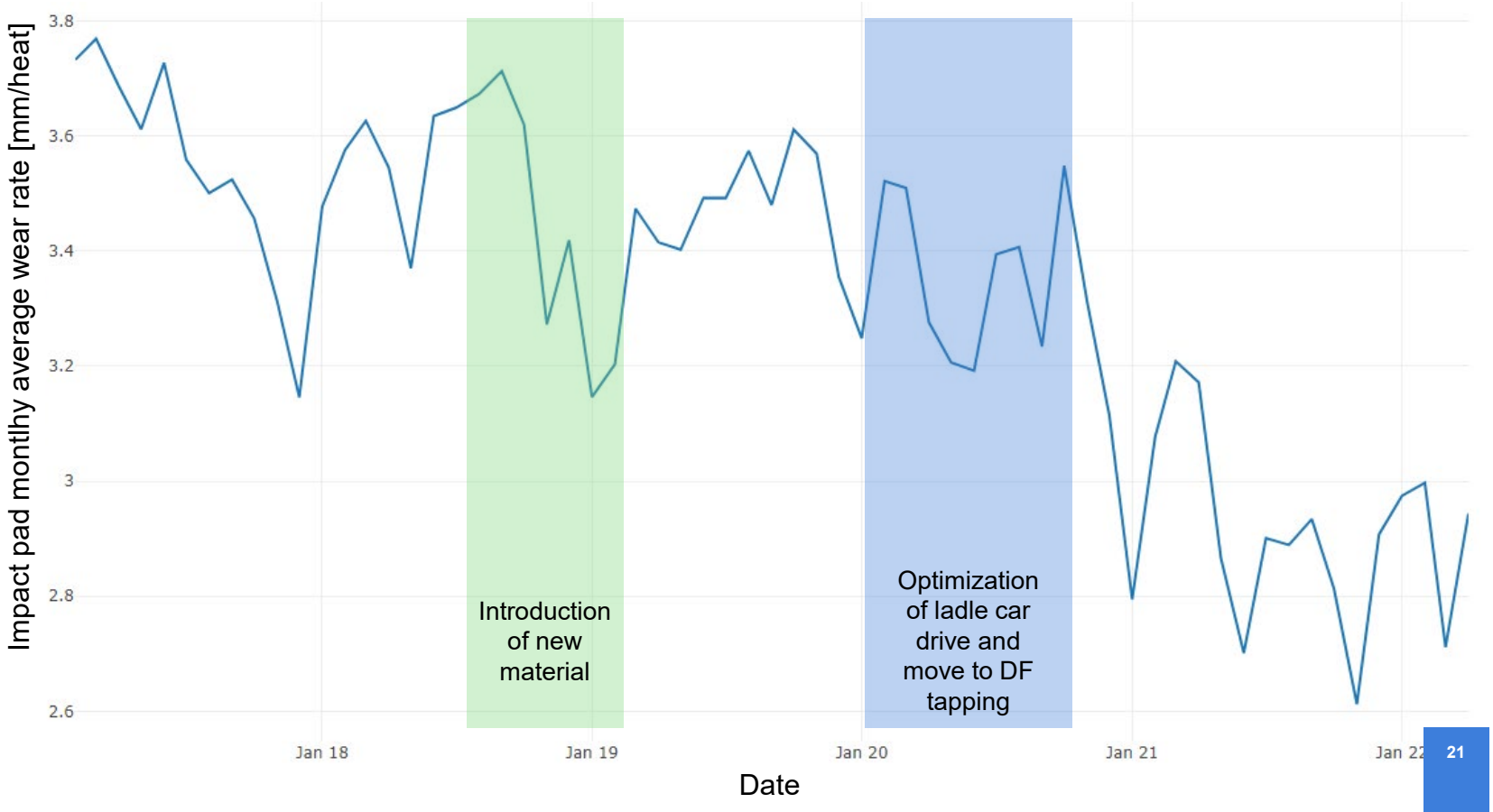
- Tapping **intensity reduced by ~30%** by new pattern
- 2/3 of wear in impact pad is caused by tapping → **~20% reduction in total wear**
- ViU model shows 20% lower wear could result in up to **13 heats higher ladle life**







Reduced wear is result of improved materials and tapping



Conclusions

- Roll-out of Advanced Analytics at Tata Steel has been very successful and resulted in major EBITDA uplift
- This success has been enabled by investing in people, IT infrastructure and the creation of an AA ecosystem.
- AA projects follow a standard, structured approach.
- Personal experience:
  - Even if your (AA) project does not go as planned, it can still deliver great results.
  - Using agile approach (limited time, small team, focused on result) for AA projects works well.
  - Developing general data science skills helps me most in my daily work. Advanced techniques are also important but have a smaller area of use.
  - Applying AA is fun!

Do you have any questions?

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