Increased steam temperature in grate fired boilers – Steamboost
(KME 709)

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Overall Goal of KME709

- Research strategy and correlation to KME goals

Increase energy production in grate fired boilers

Laboratory studies – FeCrAl alloys + Generating new knowledge in boiler

- CFD modeling
- Boiler installations
- Deposit tests
- Corrosion tests

KME goals:

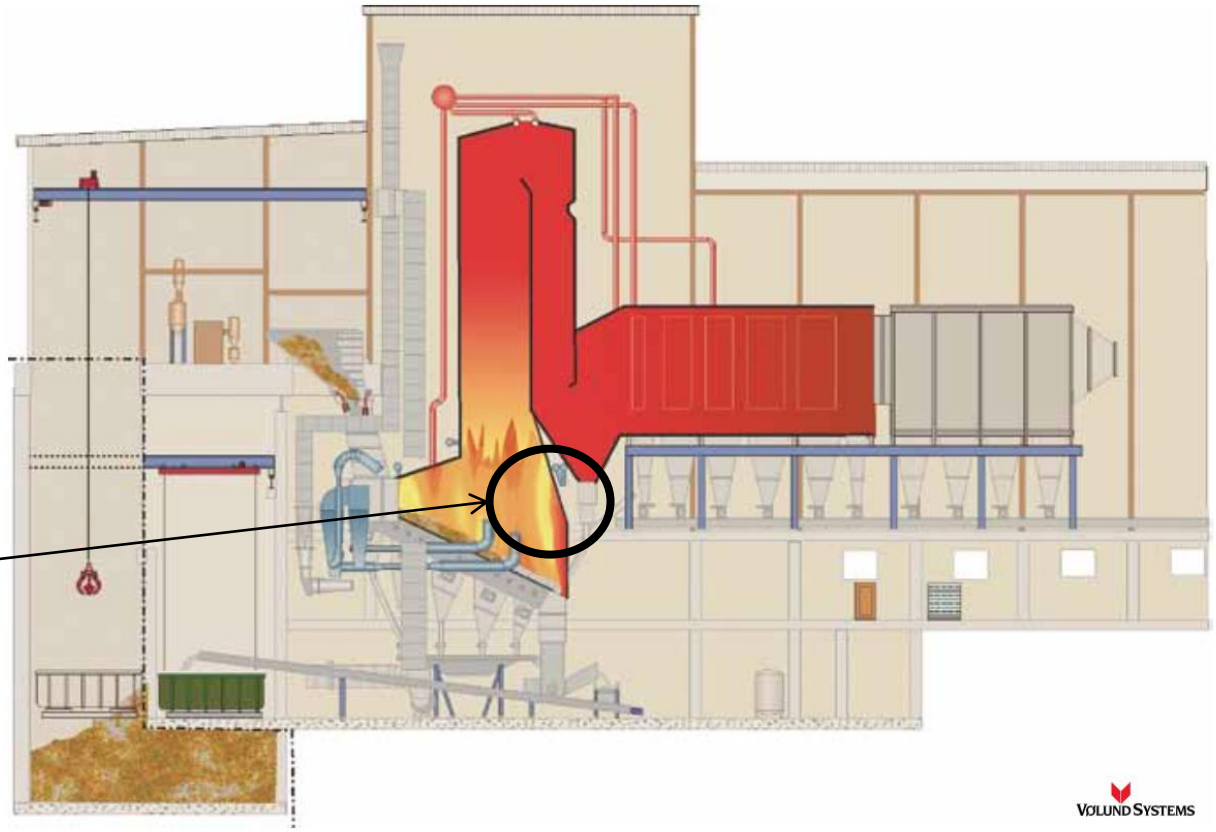
- Higher steam parameters & high electrical efficiency
- Development of novel solutions where steam is superheated in the furnace
- Develop improved material solutions – including alumina formers

Grate fired boiler

- What´s the idea behind Steamboost?

- Waste fired boiler.
- Different processes over the grid.
- **CFD calculations indicates a position over the grid with less corrosive species.**
- **New position of superheaters!**

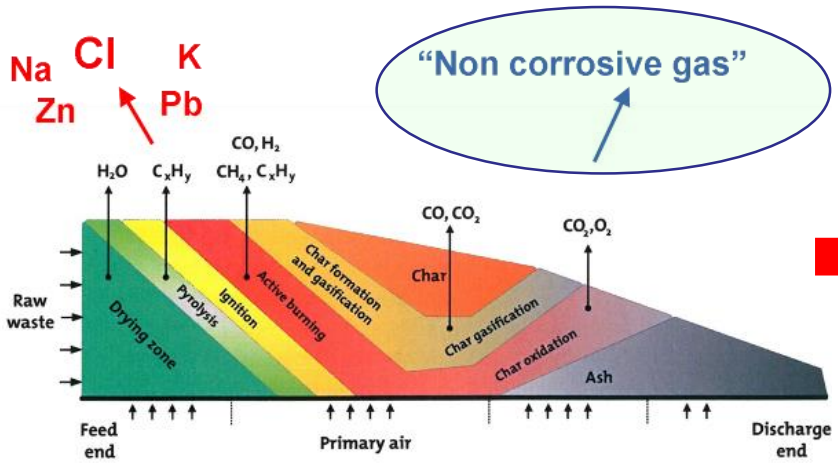
Combined heat and power plant
AffaldPlus, Denmark



What´s the idea behind Steamboost?

Waste incineration is a complex combustion process

Several processes over the grate



B&W vølund

KME709 strategy field exposures

CFD calculations ⟶ Gas composition

✚

Deposit probes ⟶ Deposit composition

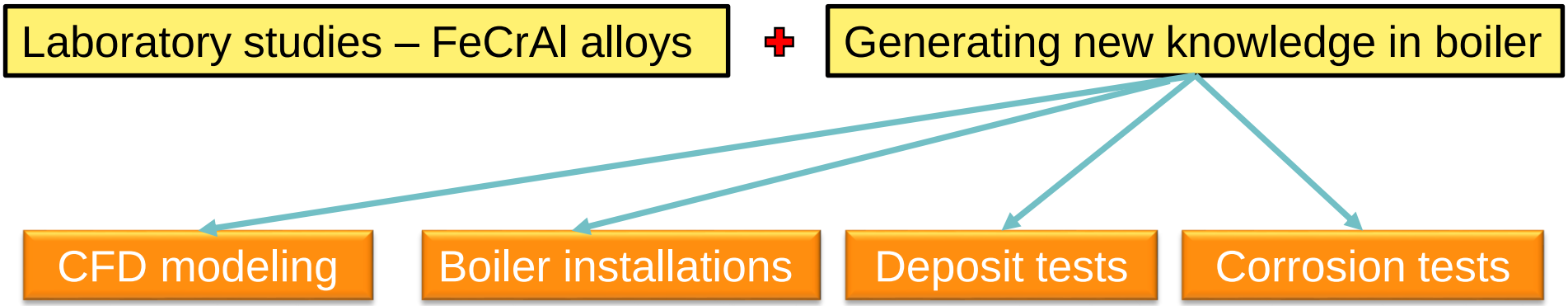
✚

Deposit composition ⟶ Corrosion attack

Overall Goal of KME709

- Research strategy and correlation to KME goals

Increase energy production in grate fired boilers



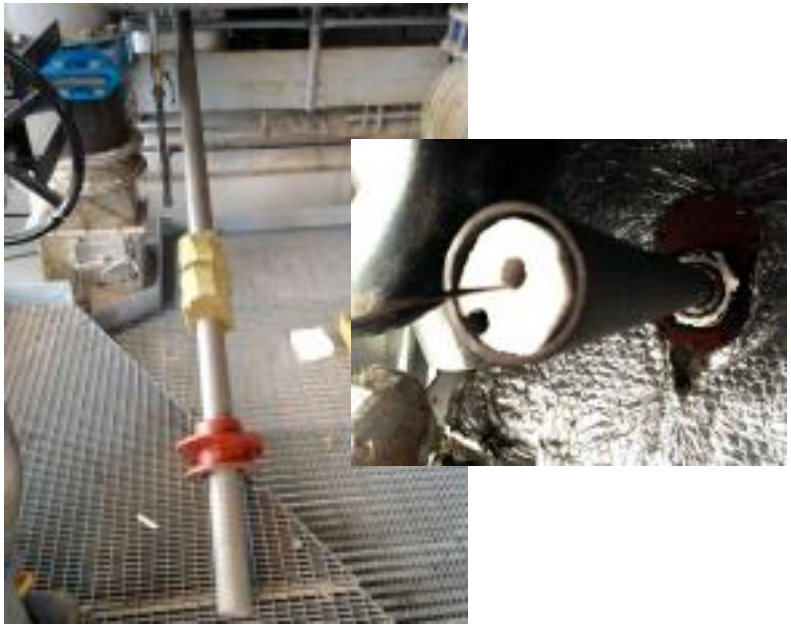
Boiler exposures (installations)

Sept 2014

- Steamboost tubes installed (several materials)

Feb 2015

- FeCrAl tubes installed inside boiler



Boiler exposures - installations

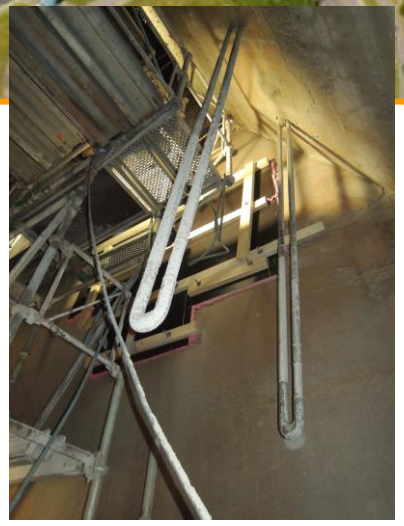
Steamboost

- Installed tubes with several different materials (1 year)
- Investigate the long time corrosion attack – on different materials.

FeCrAl

- Installed uncooled tube
- Investigate the long time corrosion attack on FeCrAl at higher temperatures

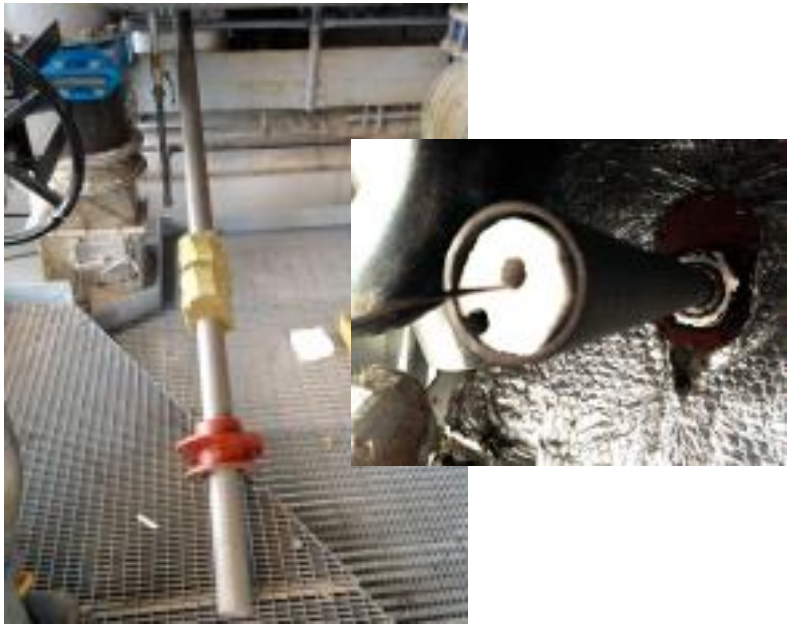
Naestved- Steamboost



Boiler exposures (installations-FeCrAl tube)

Feb 2015

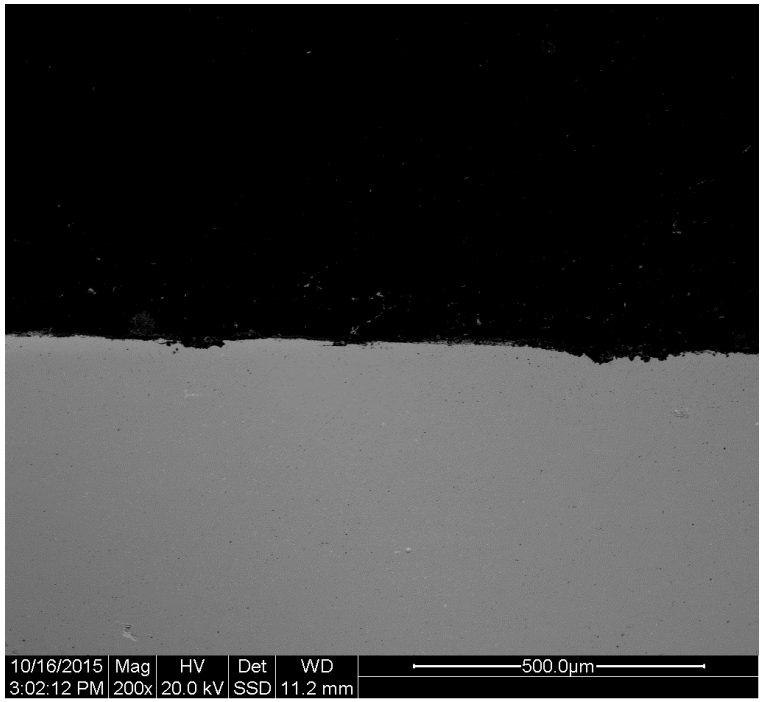
- FeCrAl tubes installed inside boiler

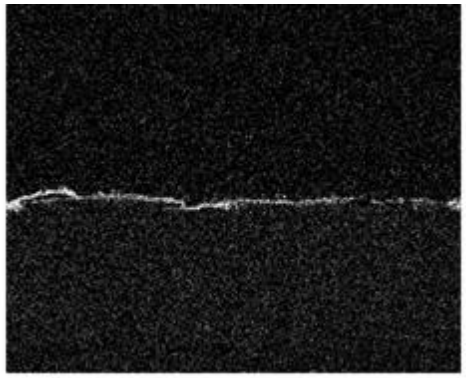


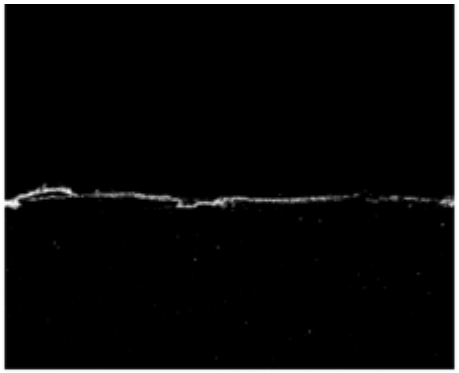
FeCrAl tube

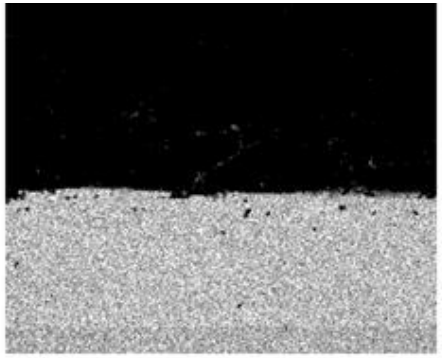
SEM

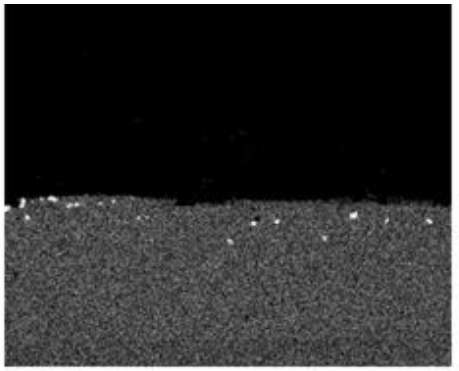
Area 1 (50%)




O Ka1


Al Ka1


Fe Ka1

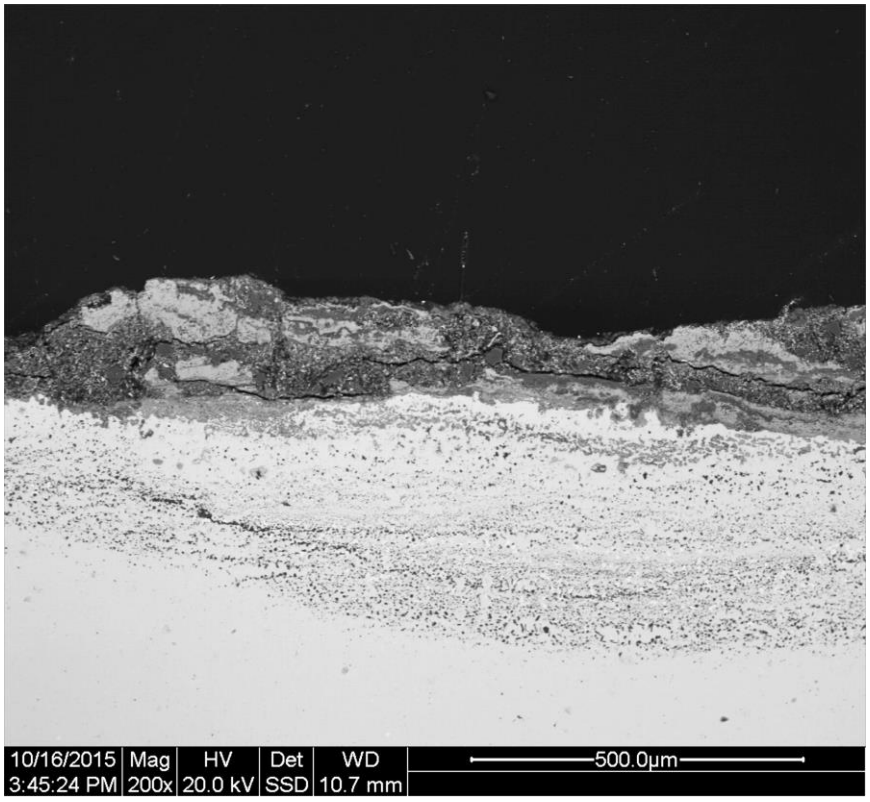

Cr Ka1

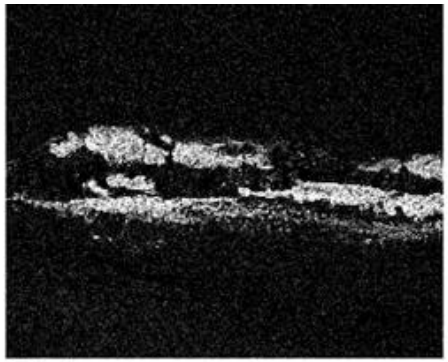
Temperature ≈ 900°C Time ≈ 4500 h

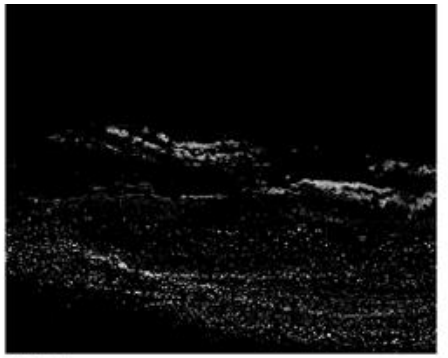
FeCrAl tube

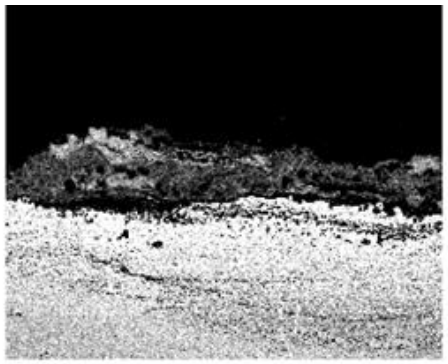
SEM

Area 2 (50%)




O Ka1


Al Ka1


Fe Ka1

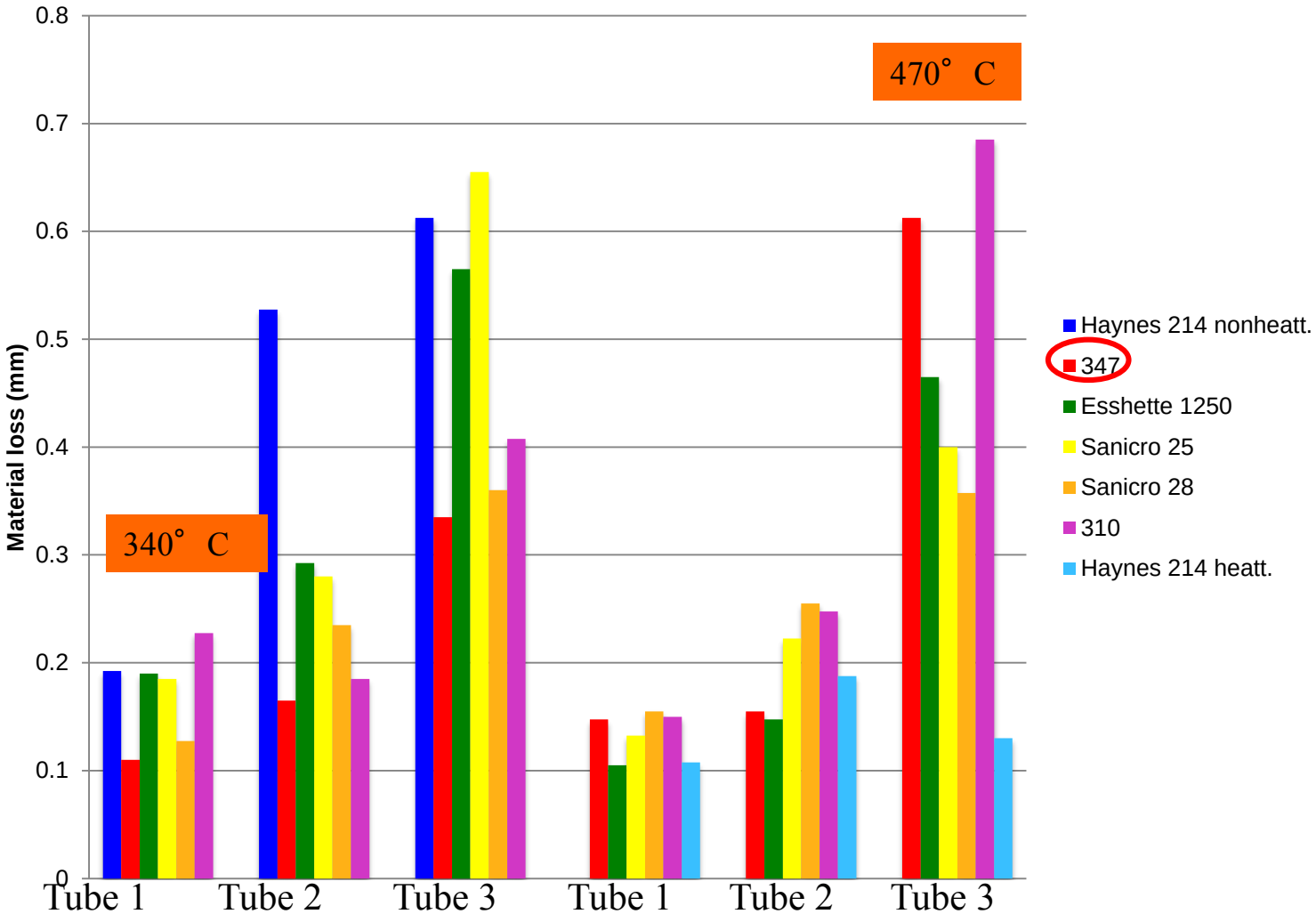

Cr Ka1

Temperature ≈ 900°C Time ≈ 4500 h

Boiler exposures (installations-Steamboost)

Samples cut after boiler cleaning

Material loss (8000 h)

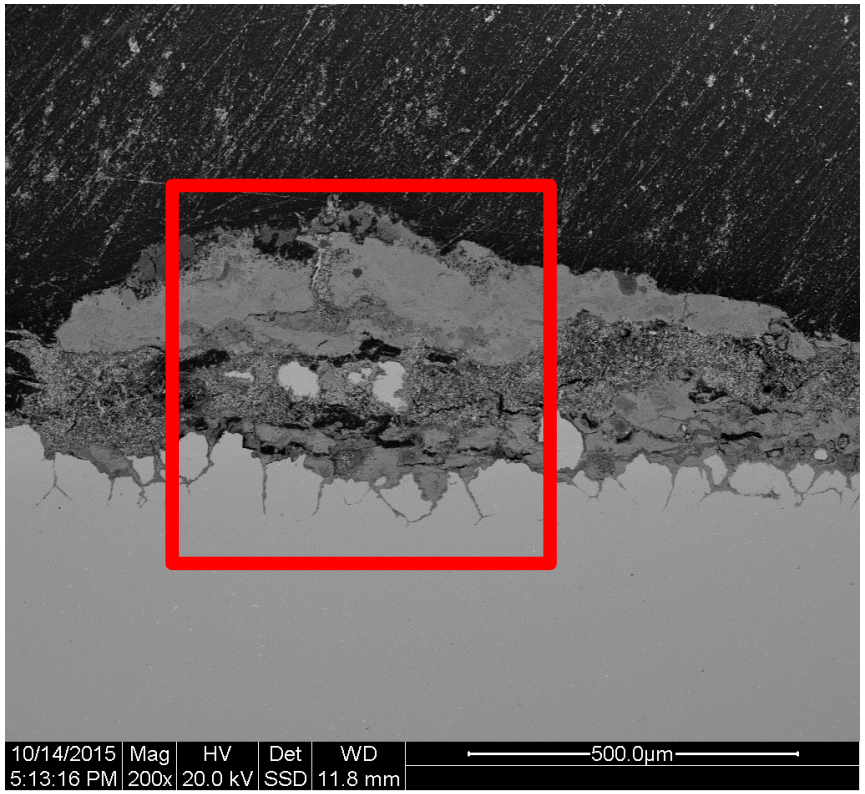


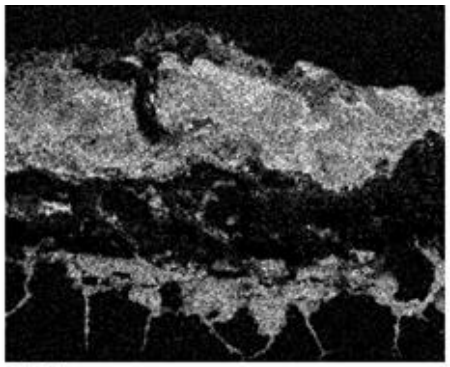
INLET

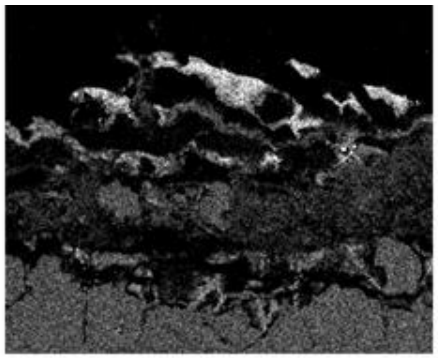
OUTLET

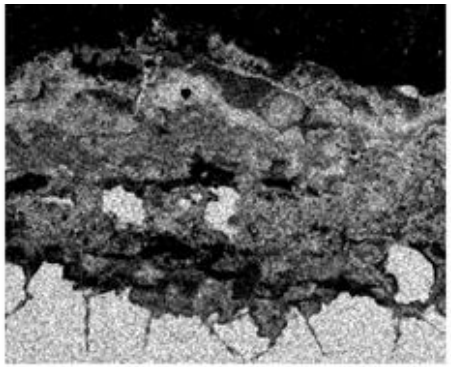
SEM

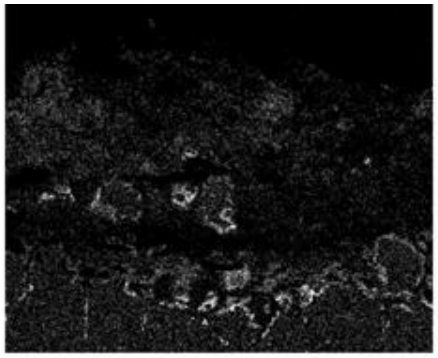
347

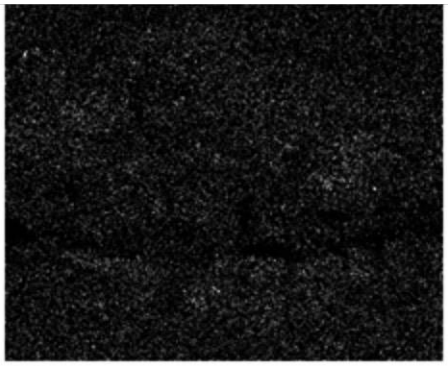



O Ka1


Cr Ka1


Fe Ka1


Ni Ka1

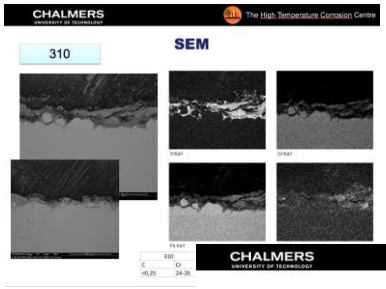

Cl Ka1

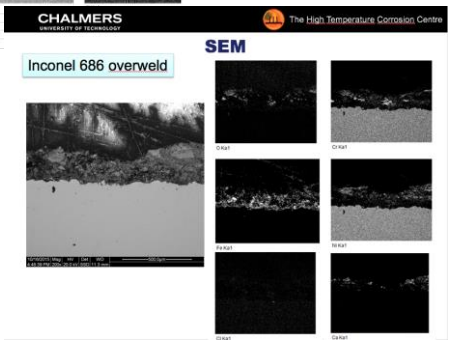
Chemical composition (weight%)

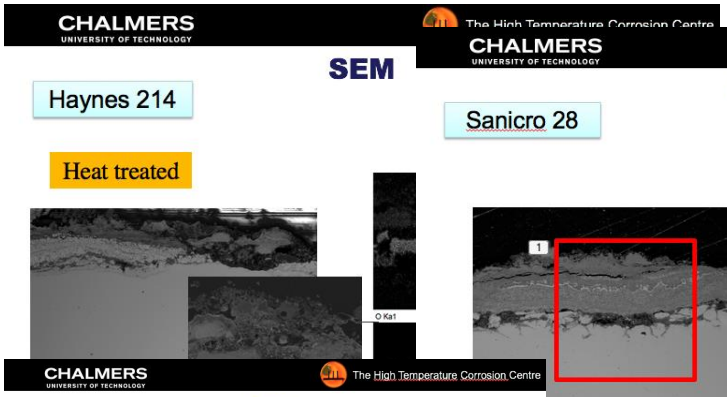
Heat	C	Si	Mn	P	S	Cr	Ni	Nb
533026	0.050	0.57	1.61	0.027	0.0016	17.66	10.13	0.64

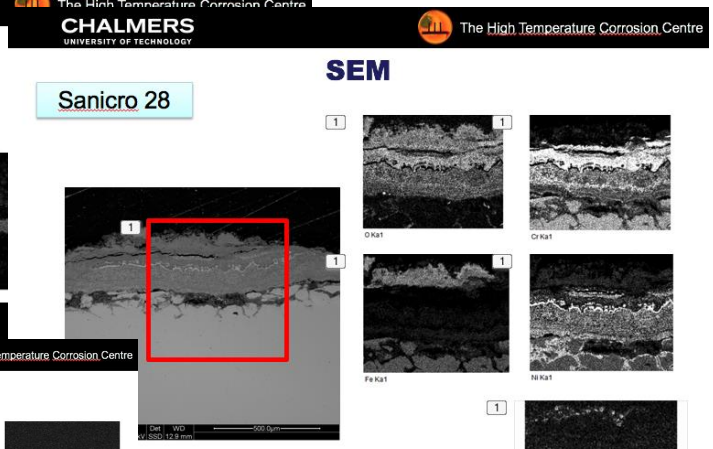
Temperature ≈ 470°C Time ≈ 8000 h

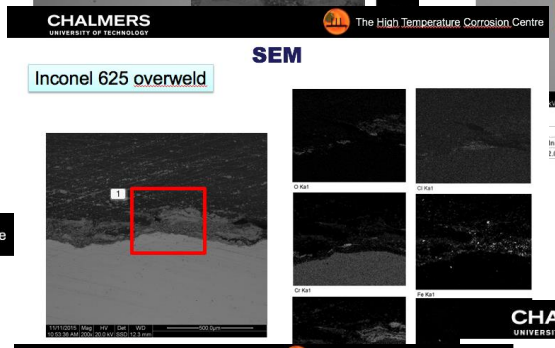
SEM/EDX analyses

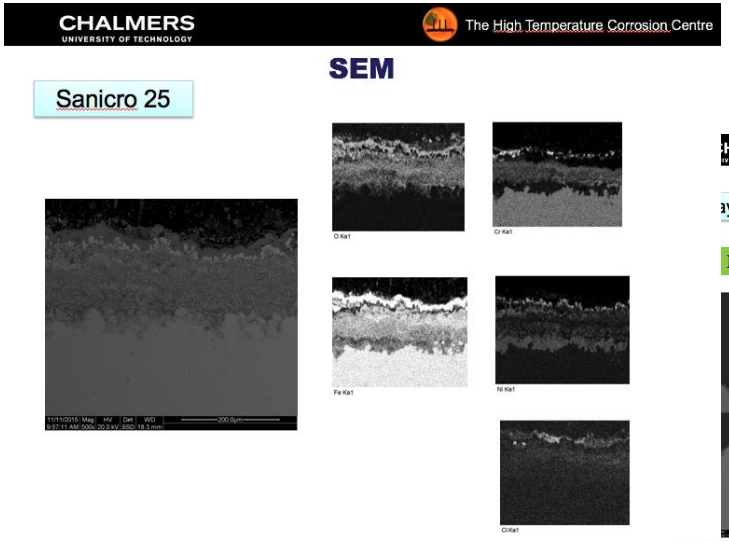


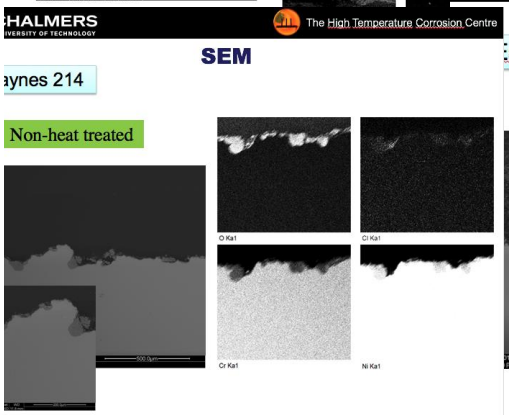


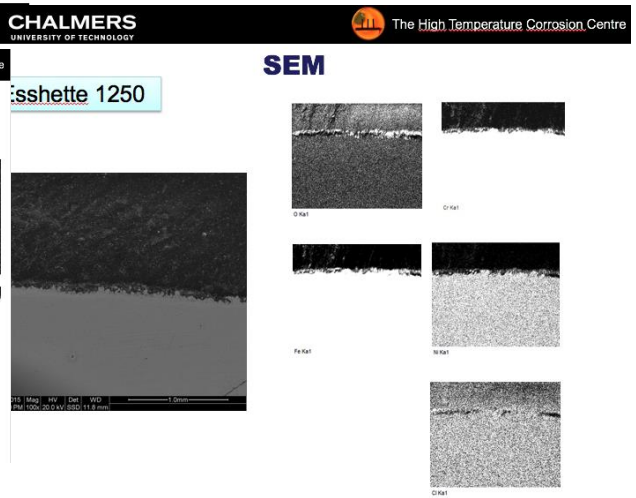








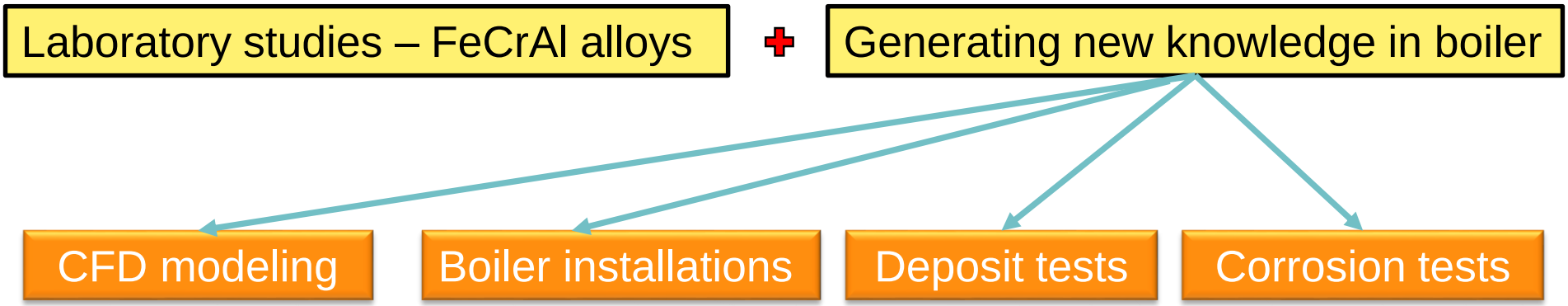




Overall Goal of KME709

- Research strategy and correlation to KME goals

Increase energy production in grate fired boilers



Probe exposures

Deposit test

October 2015

Deposit test

October 2015

Corrosion test

February 2016

Research plan KME709

Aim deposit test:

Understand the link between settings of the boiler and deposit composition

Aim short/long time corrosion test:

Link the deposit to the corrosion mechanisms for different types of materials

Material suggestion for Steamboost

Aim laboratory work:

Generate knowledge about the corrosion mechanisms of FeCrAl materials

Boiler exposures – probe test

Deposit test

- Run the boiler to get the least corrosive deposit in the region of the Steamboost
- Aid in the process of selecting materials and understanding the corrosion mechanisms.

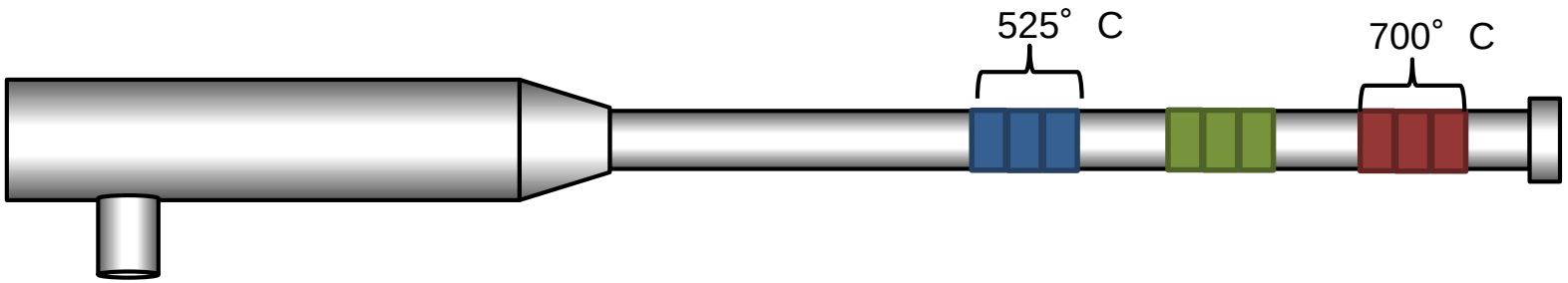
Boiler exposures (deposit test)

October 2015

- **Deposit/corrosion test**
- Temperatures 525 and 700° C

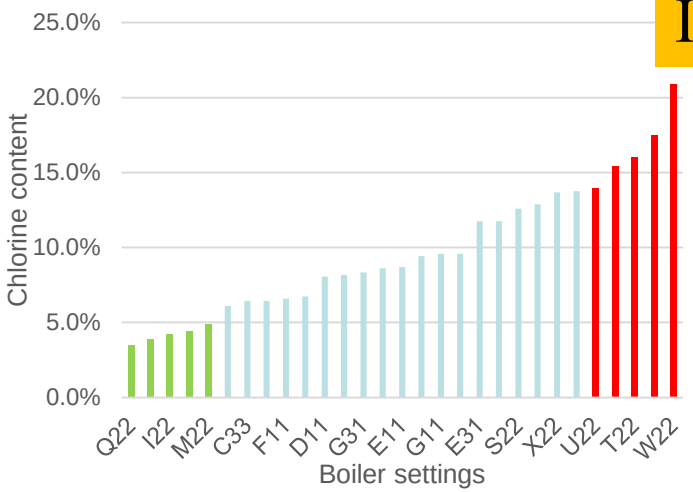
Sample material

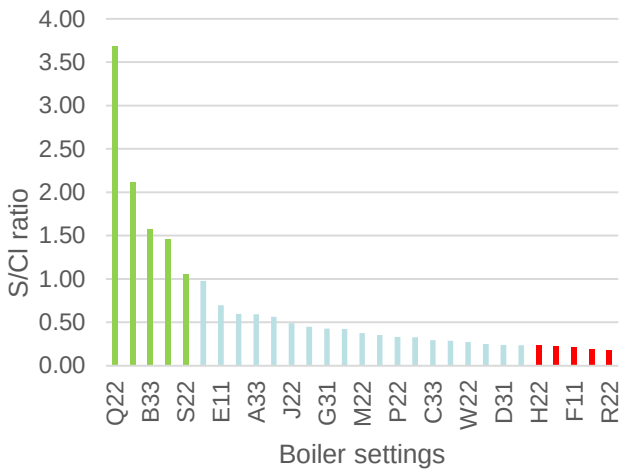
- Sanicro28 (40 samples)
- 7RE10 (310) (5 samples)



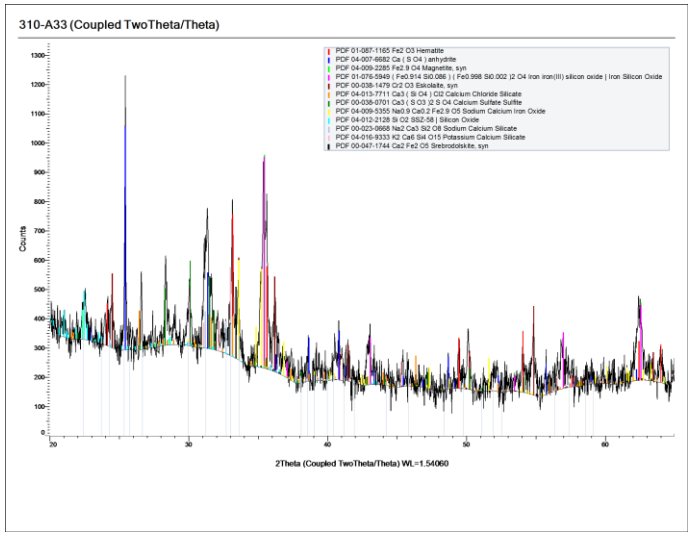
Deposit test – analyses

IC analyses

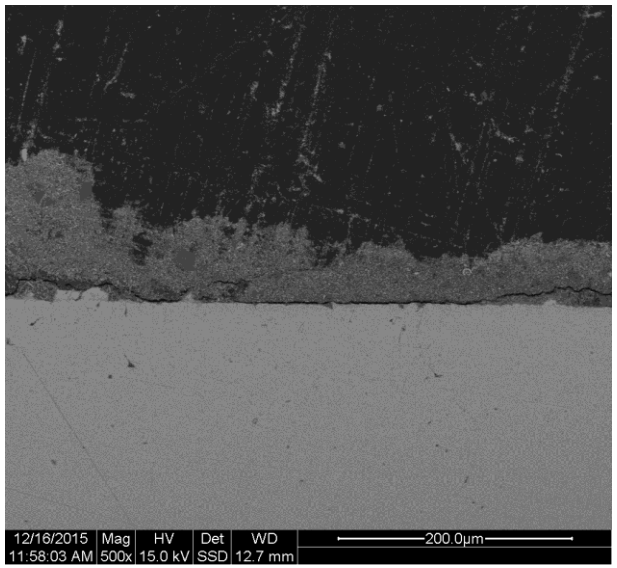




XRD analyses

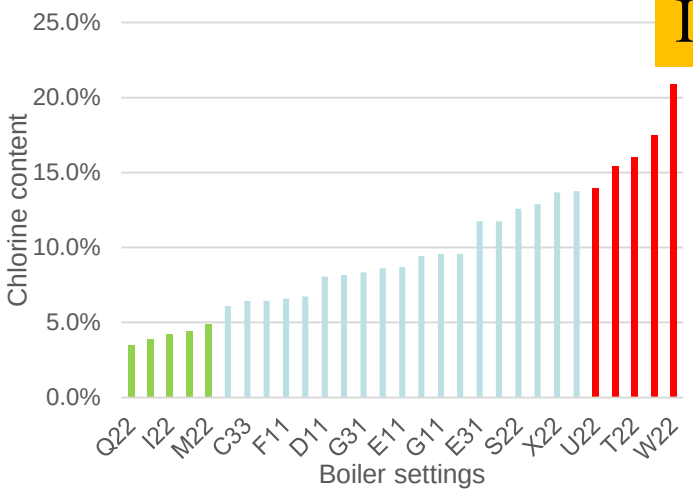


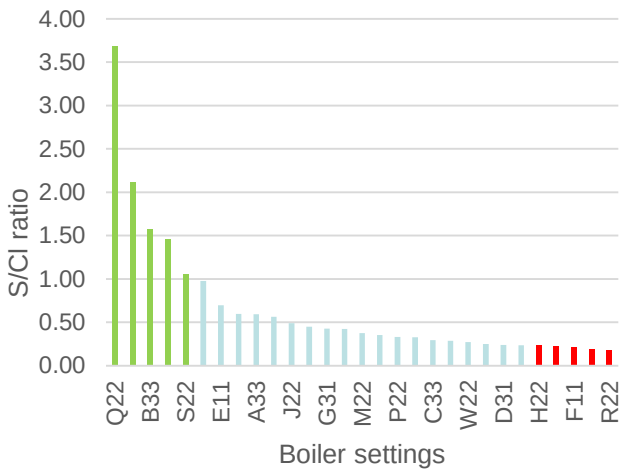
SEM/EDX analyses



Deposit test – analyses

IC analyses





Boiler settings suggestion

Heat data calculations

Corrosion test

B&W vølund

Research plan KME709

Aim deposit test:

Understand the link between settings of the boiler and deposit composition

Aim short/long time corrosion test:

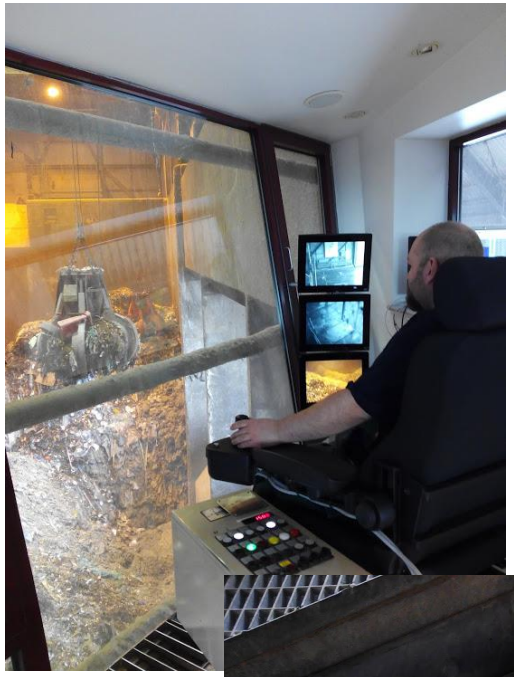
Link the deposit to the corrosion mechanisms for different types of materials

Material suggestion for Steamboost

Aim laboratory work:

Generate knowledge about the corrosion mechanisms of FeCrAl materials

Boiler exposures – probe test



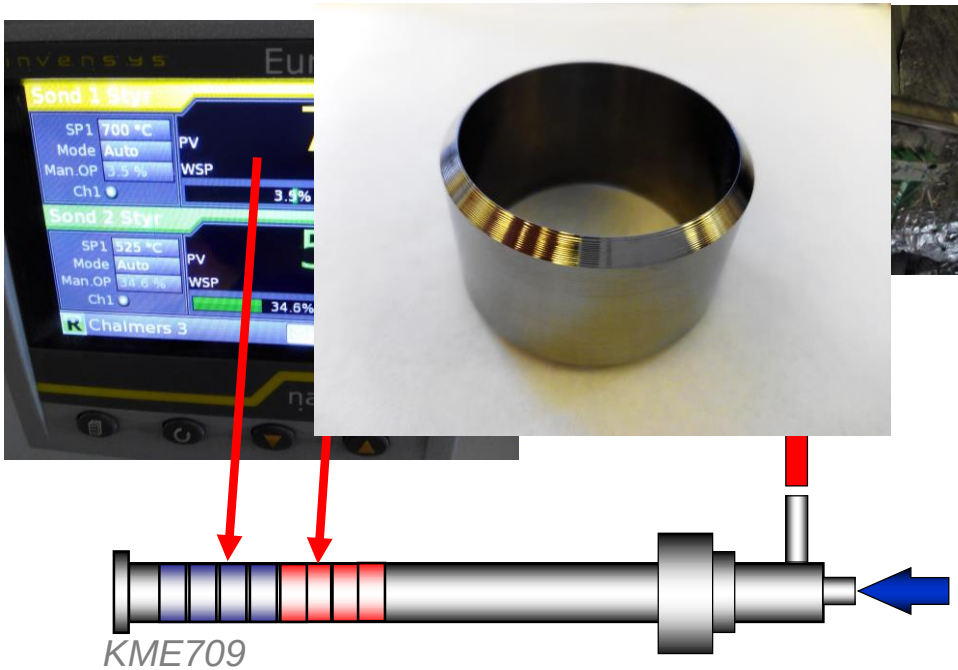
Corrosion test

- Get an initial corrosion rate of different materials in the region of the Steamboost
- Aid in the process of selecting materials and understanding the corrosion mechanisms.

Boiler exposures (corrosion probe)

Winter 2015/16

- Short time exposures (**24h**)
- Long time **corrosion test – 1000h**
- Different materials
- New probe design and temperature controller



Sample material

SANDVIK

- 7RE10 (310)
- TP347H (6R44)
- Sanicro 33

B&W vølund

- 625 over weld

SANDVIK

- APMT
- Nikrothal PM58
- Model alloy

Research plan KME709

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Corrosion mechanisms of FeCrAl materials

CHALMERS UNIVERSITY OF TECHNOLOGY — The High Temperature Corrosion Centre

The effect of corrosive deposit and gases – KCl continuously deposited in laboratory exposures

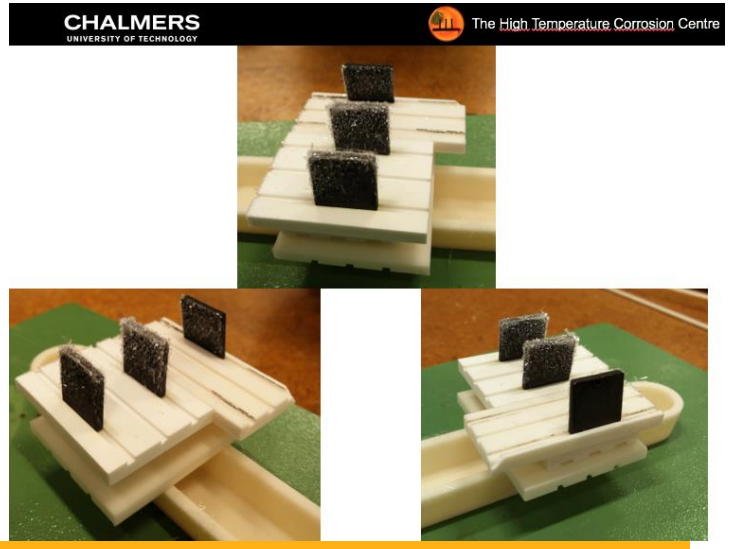
SANDVIK

Bo Jönsson (SHT)
Johanna Nockert Olovsjö (SHT)
Mats Lundberg

Torbjörn Jonsson
Jesper Liske
Loli Paz
Julien Phother

Kristina Hellström
NI

CHALMERS UNIVERSITY OF TECHNOLOGY — The High Temperature Corrosion Centre



Model alloys as rings

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KCl added continuously
Short and long time

Collaboration with the project critical corrosion phenomenon

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- Develop improved material solutions – including alumina formers