2019 FORUM TERATEC

MACHINE LEARNING FOR COAL BOILER PRESSURE PARTS INTEGRITY MANAGEMENT

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SUMMARY

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BUREAU VERITAS INTRODUCTION

02
DIGITAL STRATEGY & AI EFFORTS

03
BOILER PRESSURE PARTS RESULTS

A GLOBAL LEADER
OF THE TEST, INSPECTION AND CERTIFICATION MARKET

COST
control

BRAND
reputation

SAFETY
and reliability

TRADE
facilitation

RKET
ccess

LICENS
to oper

BUREAU VERITAS
IN KEY FIGURES

€4.8 billion

Revenue in 2018

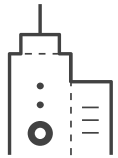
More than

75,000

employees

400,000

clients



More than

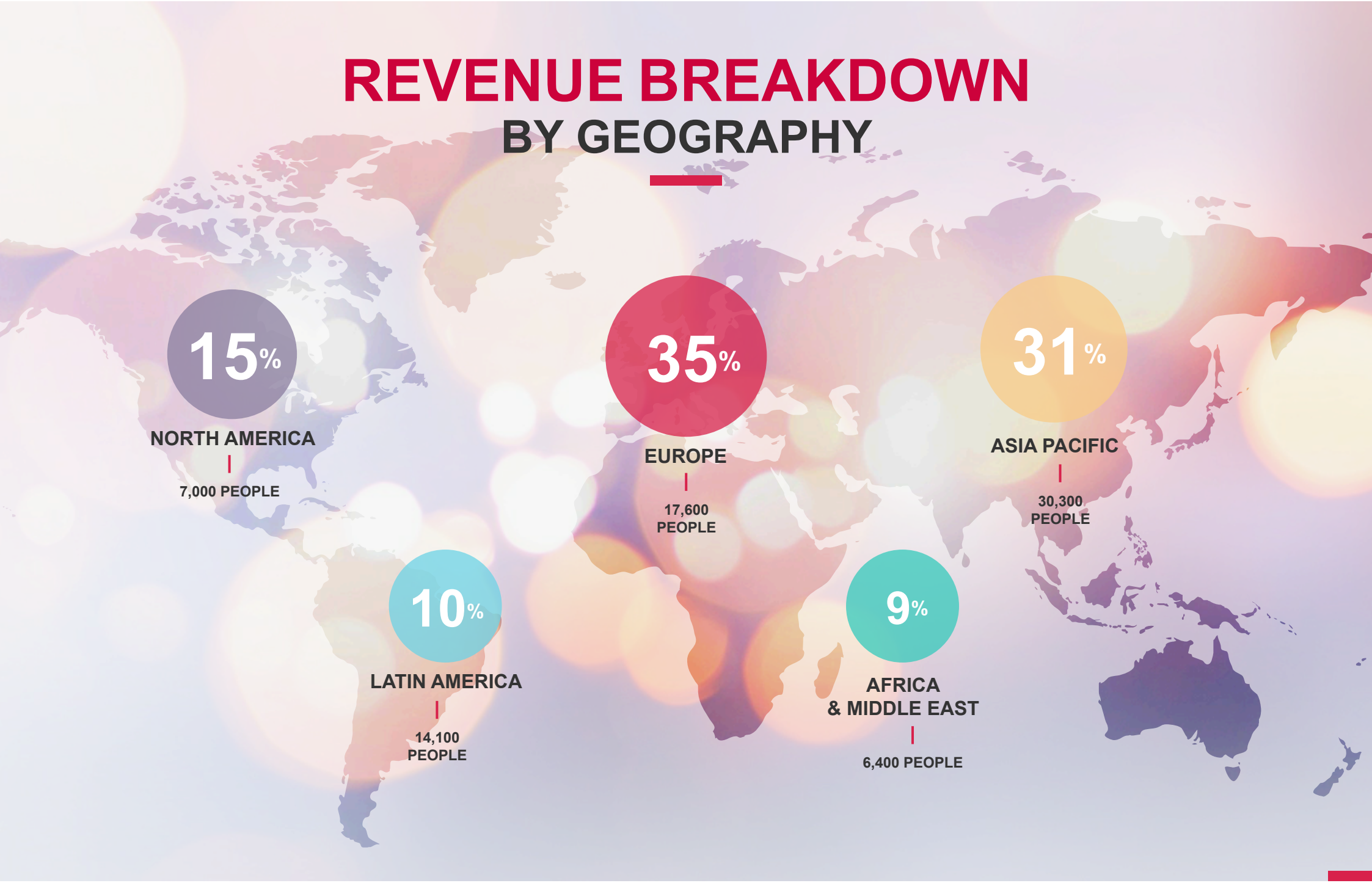
1,500

offices
& laboratories in
140 countries

3,500

accreditations
& agreements

REVENUE BREAKDOWN
BY GEOGRAPHY



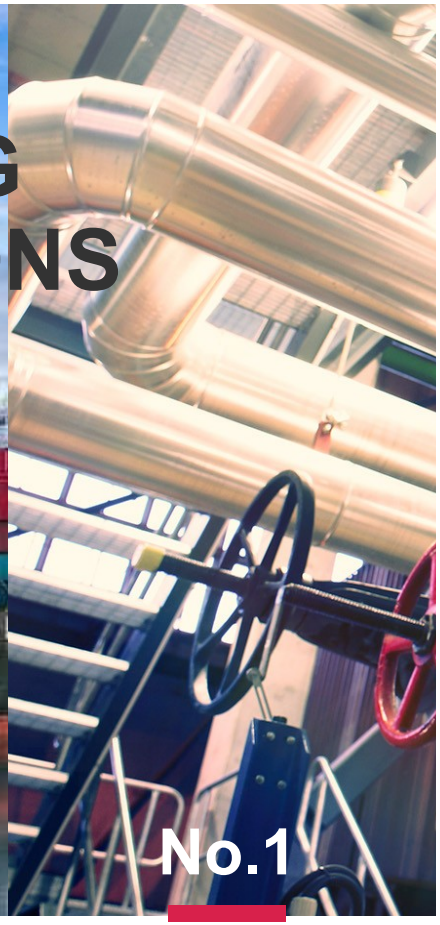
TRONG
OSITIONS

No.2

MARINE
OFFSHORE

7%*

ety at sea through
ffshore platform
n services. Provide
xpertise to assess
e risks and improve
e



No.1

INDUSTRY

22%*

Ensure the safety, security, reliability and integrity of industrial assets throughout their life cycle, and assess their compliance with national, international and voluntary QHSE standards. Control quality and provide supply chain optimization assistance in the automotive industry

No.1

BUILDINGS & INFRASTRUCTURE

27%*

Provide assurance that property assets and infrastructure in service or under construction are safe, energy efficient and comply with applicable regulations. Ensure business continuity and environmental protection by assessing the safety and efficiency of in-service installations and by analyzing air and water quality

No.1

CERTIFICATION

8%*

Certify that quality, health, safety and environmental management systems comply with applicable international, national or industry standards, or standards specific to large companies, in order to improve risk management and performance

No. 3

AGRI-FOOD & COMMODITIES

22%*

Improve transparency, inspect the composition, quality and quantity of commodities throughout the value chain, from extraction to sale, and farm to fork. Facilitate international trade and protect citizens from poor quality products by verifying import conformity

No. 3

CONSUM
PRODUCT

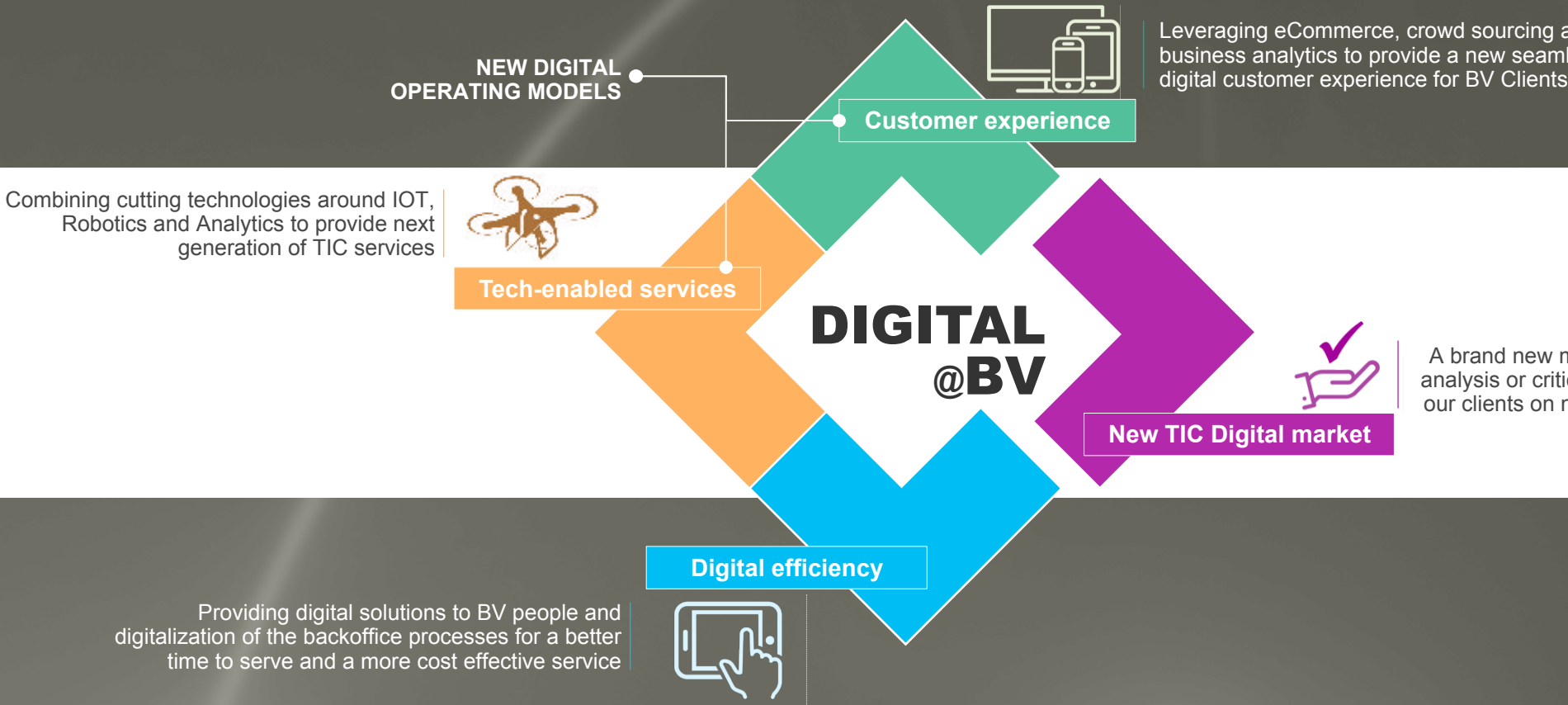
14%*

Test and verify consu
product conformity, c
safety and performan
improve supply chain

* Percentage of 2018 revenue

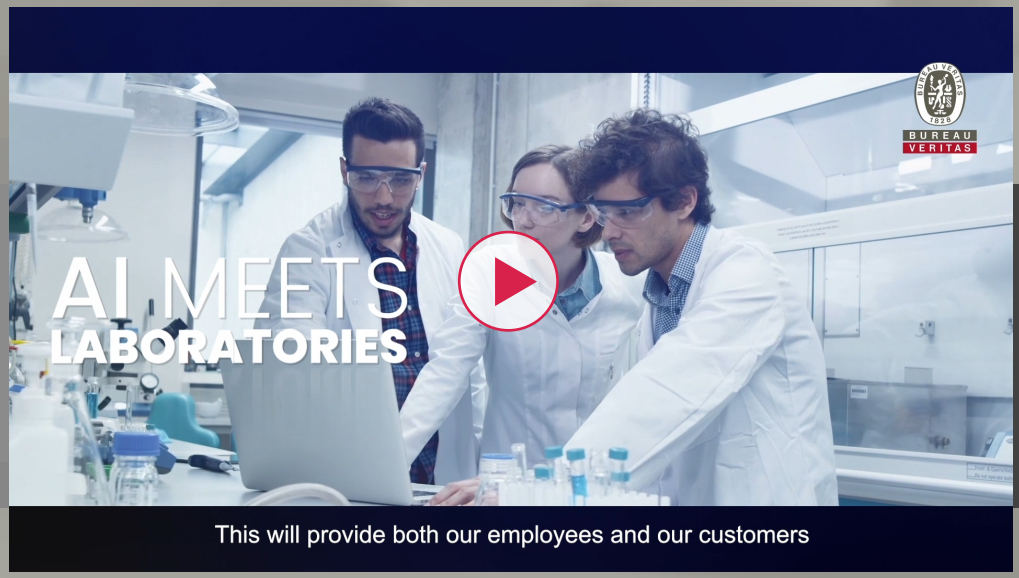
DIGITAL STRATEGY &
AI EFFORTS

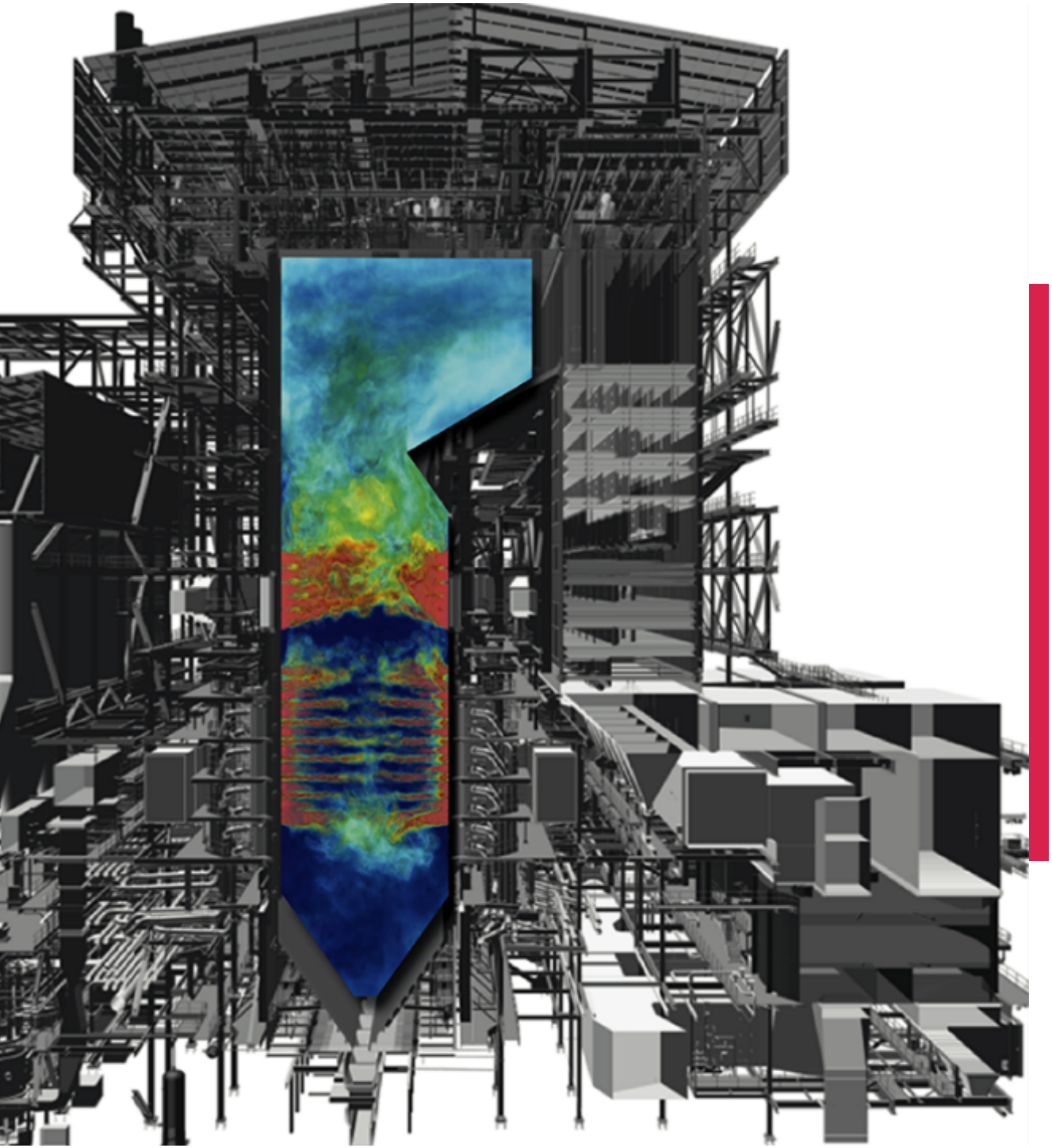
UREAU VERITAS DIGITAL STRATEGY
DIGITAL FRAMEWORK ON FOUR AXIS



GITAL EFFICIENCY FOR LABORATORIES
AB AUTOMATION

BV AUGMENTED LABS VIDEO





COAL BOILER PRESSURE PARTS

Experimentation, results & methodology

ONTEXT: PLANT CARE SOLUTION

er Pressure Parts includes all thin walled components ted to the boiler pressure envelope (e.g. superheaters, eaters, economizers and evaporators).

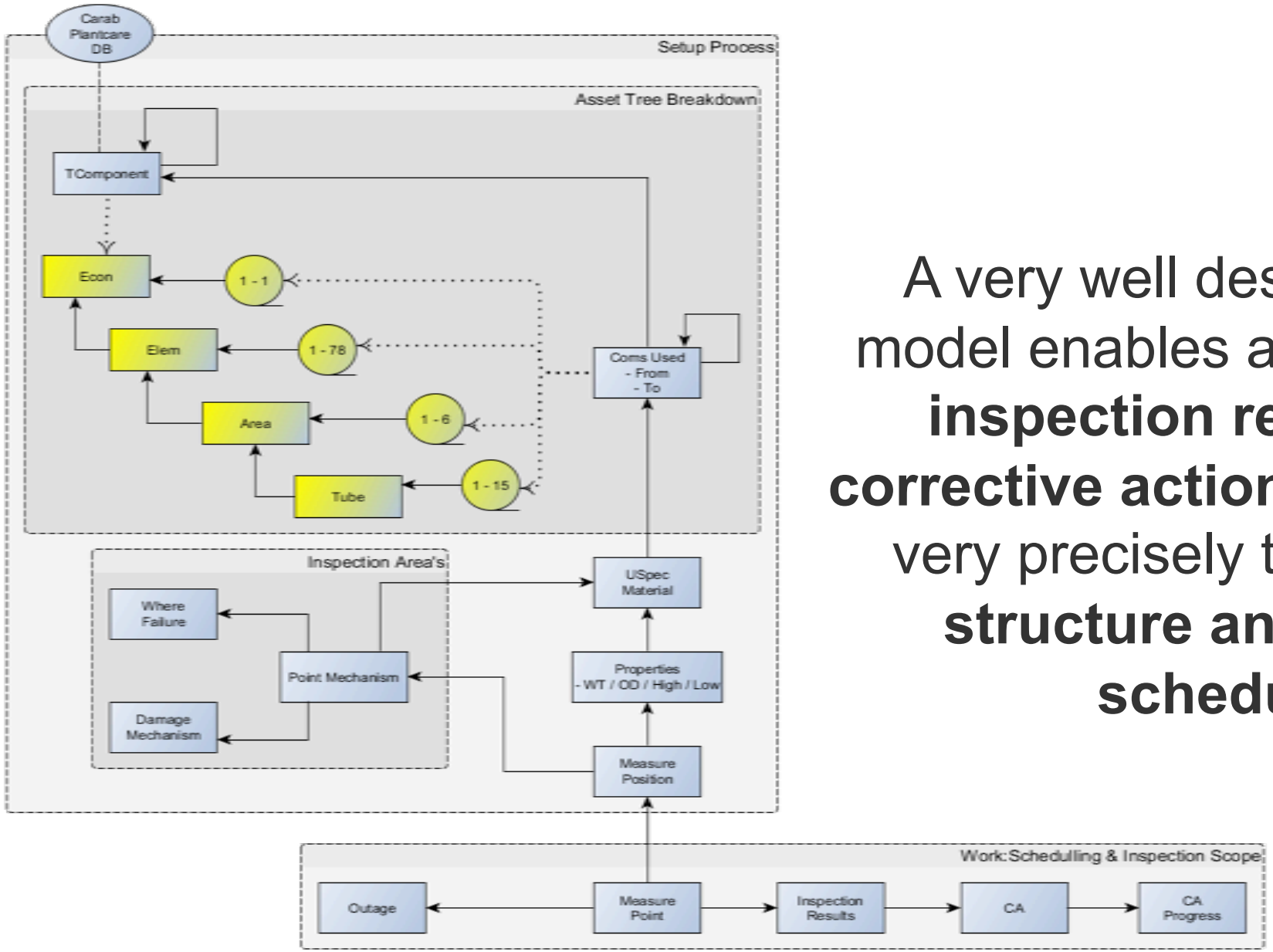
cal damage mechanisms : fretting, tube misalignment, ning from erosion, corrosion and visual inspection results.

essure parts failure have a big impact on plant availability and it is not always possible to do maintenance predefined scheduled times.

e Pressure Parts module manages the inspection and repair process and provides the following features:

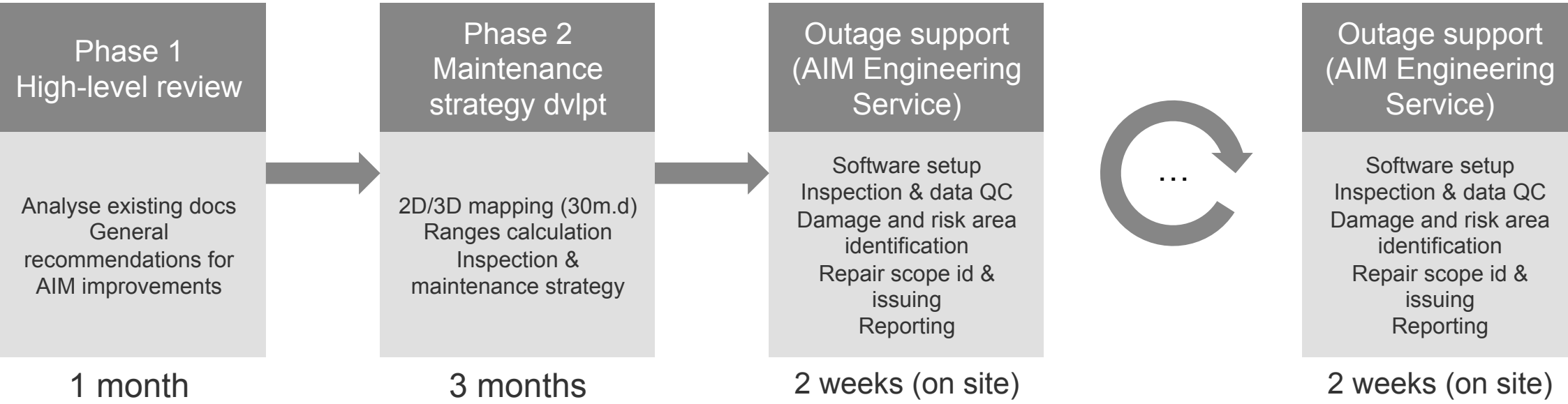
- Data is QA checked with expected values & recaptured when needed to ensure quality
- Wear Rates are calculated and the data is trended to asset the risk of cut lines
- Budget scope is available before start of outage
- The flow of data is bi-directional and the original templates can be generated for final QA procedures.
- **The Boiler Pressure Parts module is used at 15 coal power stations.**

LANTCARE DATA STRUCTURE

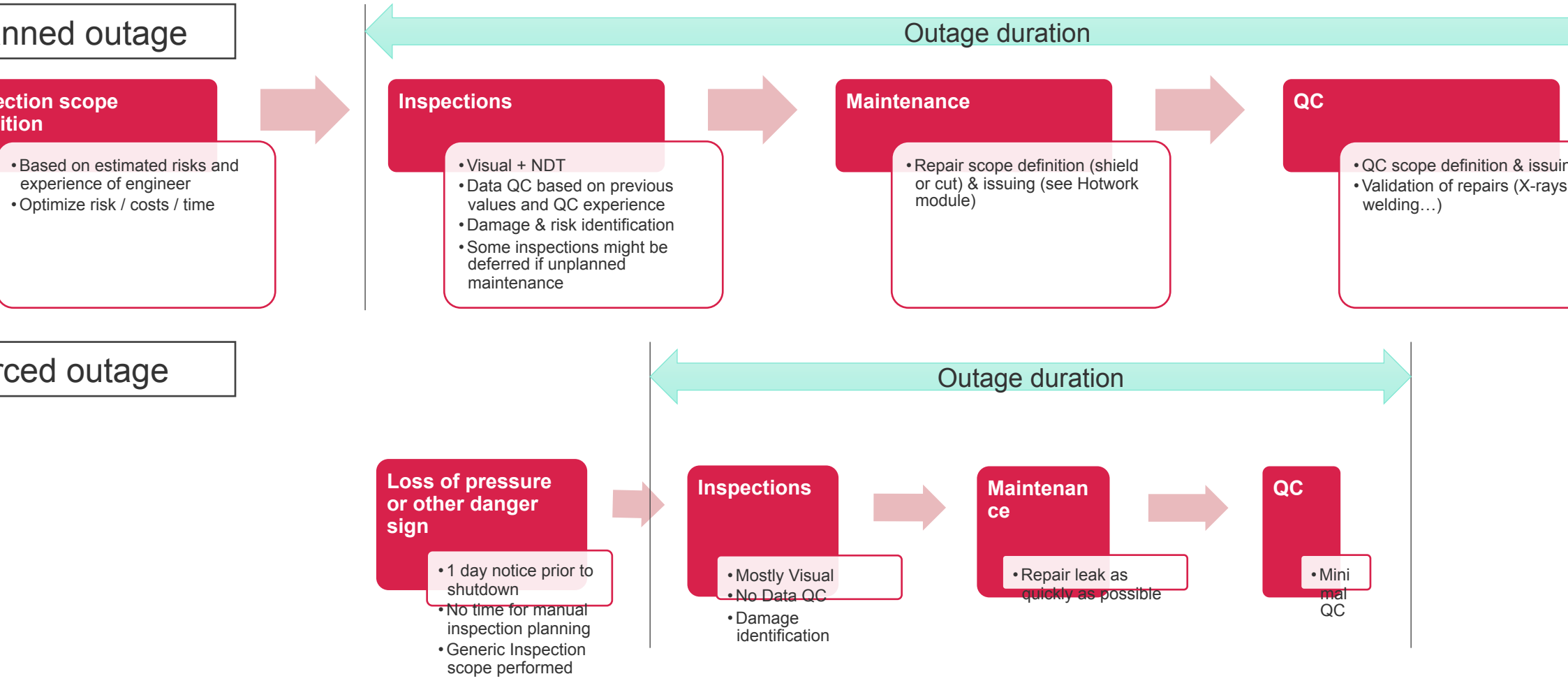


A very well designed data model enables all **measures**, **inspection results** and **corrective actions** to be linked very precisely to the **asset structure and outage schedule.**

VERVIEW OF THE CURRENT PLANTCARE AIM APPROACH



UTAGE SUPPORT PROCESS



REDICTIVE RBI / AIM

OAL BOILERS PRESSURE PARTS POC

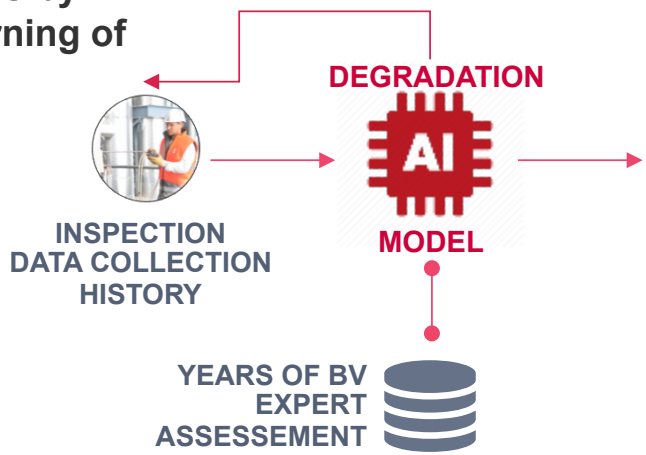
Current situation

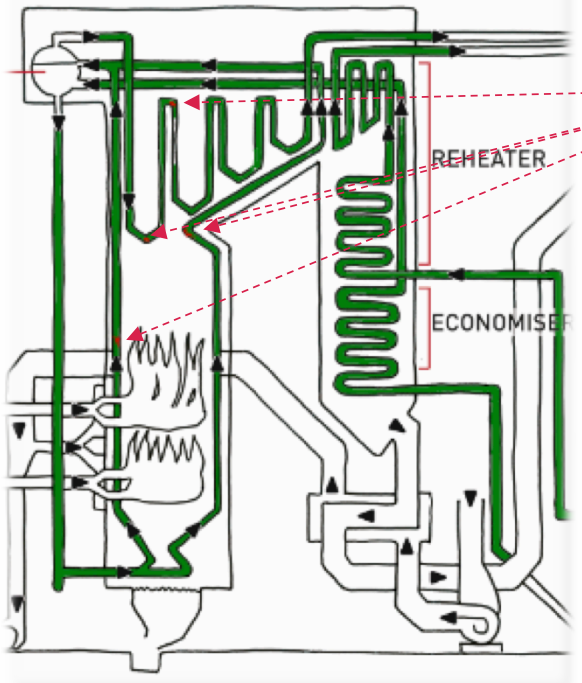
Despite a solid engineering-based AIM approach, **some leaks still occur**

Due to limits of current prediction methods, **less than 20% of risk areas are actually inspected during an outage**

Quality check of NDT measures is a **lengthy and uncertain** process

C proposal :
ate a predictive
radation model of
e thickness by
chine Learning of
et history





PREDICT VALUE FOR EACH MEASURE POINT AND IDENTIFY LEVEL OF RISK FOR EACH AREA

DETECT WRONG READINGS

IMPROVE MODEL WITH FINDINGS

OC BUSINESS OBJECTIVES & KPIS

build a generic predictive model on the data for Site A Power station for the 6 Boiler units installed on the site and for 2 or components per unit viz. Economizer and Reheater.

e model should predict the tube thickness at any particular point in time. The model should also be able to identify risky as and also predict potential leaks.

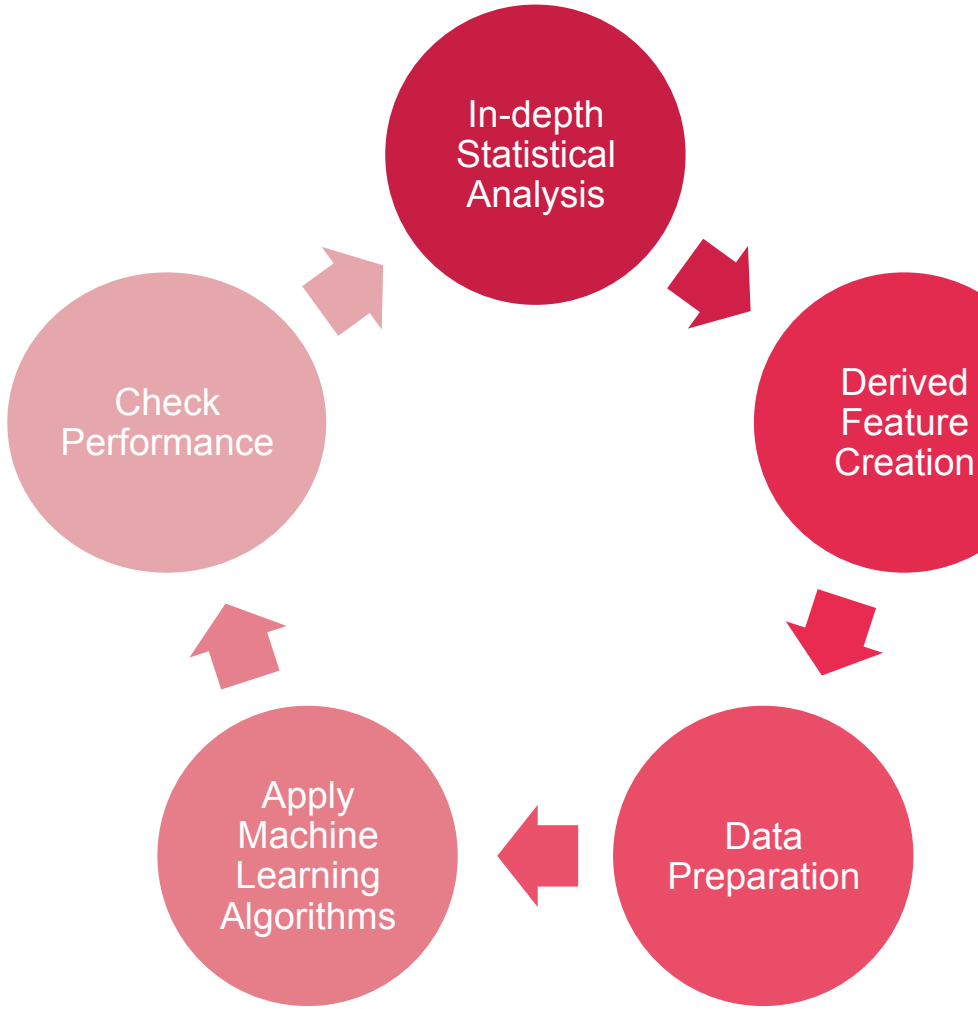
jectives	KI
uce effort and risk for asset outage & inspection planning	Identify >70% of risky areas in validation set
ess thickness prediction performance	Determination coefficient (R^2) >90%
ess capability of model to support inspection data quality check	>90% measures should be in a >90% confidence interval from prediction
ance asset reliability with improved leak prediction and anticipated repair	At least one additional leak avoided as result of predictive model

REDICTIVE MODEL DEVELOPMENT CYCLE

Data are split in separate learning & validation datasets so that predictive (future) performance of the model can be assessed

8-9 years

1.5 years



ALIDATION RESULTS REHEATER – FOR SITE A

Iteration 1 : *better thickness prediction*

KPI 1 :

	Predicted(1)	Predicted(0)
Actual(1)	444	181
Actual(0)	590	40378

71% Risks predicted

KPI 2 : R2=**0,74**

KPI 3 : **92%** actual values lie in 90CL

KPI 4 : **Predicted 1 out of 2 leakages**

Iteration 2 : *better risk prediction*

KPI 1 :

	Predicted(1)	Predicted(0)
Actual(1)	461	164
Actual(0)	1047	39921

74% Risks predicted

KPI 2 : **R2=0,67**

KPI 3 : **86%** actual values lie in 85%CL

KPI 4 : **Predicted 2 out of 2 leakages**

Risk areas and leak prediction match success criteria.

Counter-intuitively, optimizing for risks detection decreases thickness prediction performance and vice-versa.

ALIDATION RESULTS ECONOMIZER – FOR SITE A

Iteration 1 : *better risk prediction*

KPI 1 :

	Predicted(1)	Predicted(0)
Actual(1)	283	83
Actual(0)	1088	45474

77% Risks predicted

KPI 2 : R2 = 31%

KPI 3 : 85% values lie in 80%CL

Iteration 2 : *better thickness prediction*

KPI 1 :

	Predicted(1)	Predicted(0)
Actual(1)	242	124
Actual(0)	720	45842

66% Risks predicted

KPI 2 : R2 = 37%

KPI 3 : 86% values lie in 80%CL

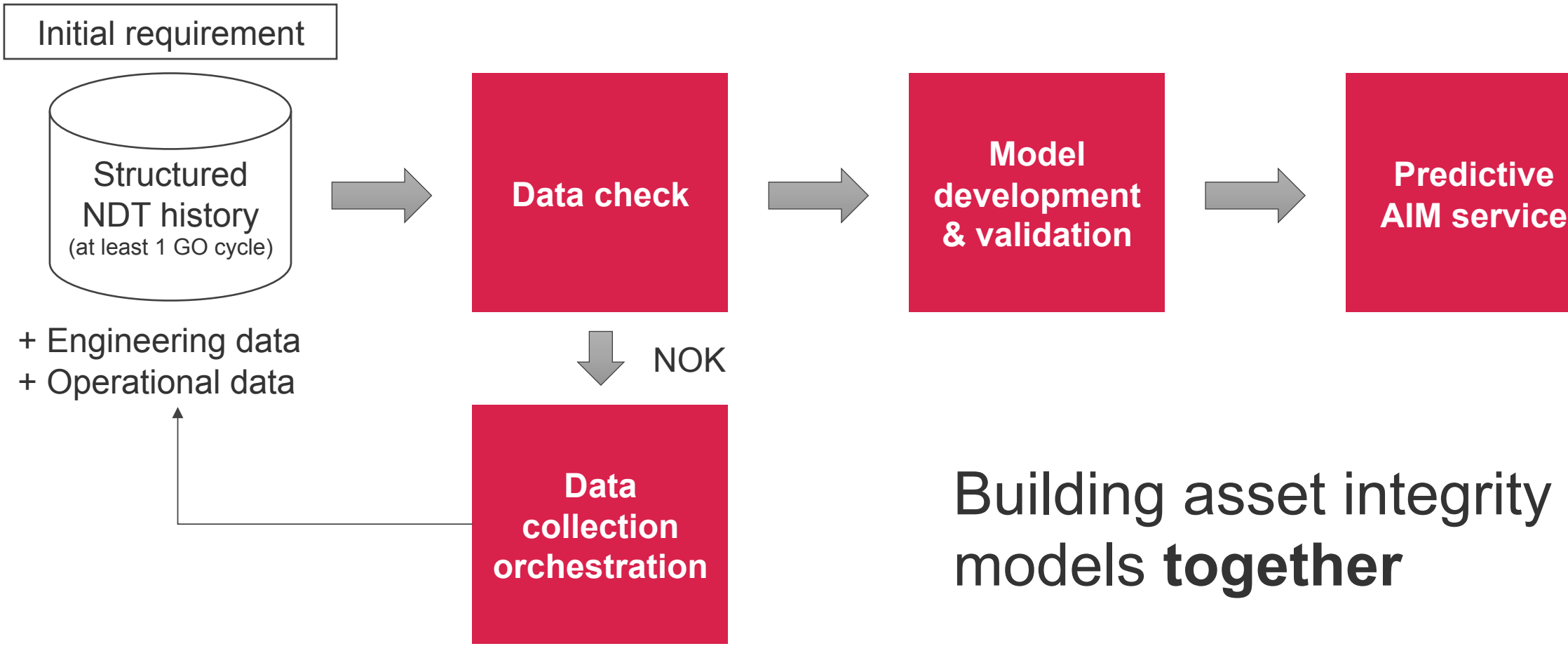
No leaks were present in the validation dataset

Due to less data than Reheater (and possibly worse data quality),
thickness prediction performance is bad,
but risk area prediction still works

USINESS BENEFITS FOR CUSTOMER

	Current	New with model	Gain
ne to plan a normal outage	5-10 days	1-2 days	**4-8 m.days / outage** (internal)
al-time NDT ta Quality check	Limited, based on engineer experience	Systematic and automated	Better prediction (see below)
k areas inspected in an age	<20%	>70%	Leak avoidance → reduced maintenance costs + forced outage avoidance → **421 k€ / leak avoided** (est. medium size uni + possible reduction o number of inspection
pacity to define a specific k-based plan for opportunity xt day) outage	NO	YES	
ak prediction	Yes, but with very significant human effort, and big probability of miss	Yes, result of the computation, with a good chance of finding	

ENERIC METHODOLOGY FOR OTHER ASSETS



Building asset integrity models **together**

THANK YOU

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