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Building a future we can all trust

Digitalisierung und KI in der Produktion: vom Engineering Projekt mit KI-System Analyser® zur Pilot-Linie

Thales Deutschland
Microwave & Imaging Subsystems

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Thales is a global technology leader with more than 81,000 employees on five continents. The Group is investing in digital and "deep tech" innovations – Big Data, artificial intelligence, connectivity, cybersecurity and quantum technology – to build a future we can all trust.
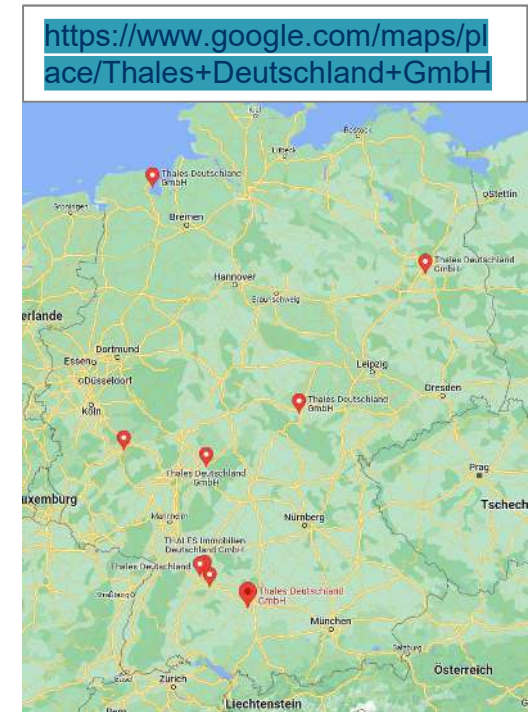
Thales Deutschland with 9 sites across Germany offers highly sophisticated solutions in the area of

Transportation
Defence & Security
Digital Identity & Security
Space & Aerospace

Electron Devices Ulm

Together with the sister factory in France, the location in Ulm is the global market leader in **travelling wave tube amplifiers** for **space travel applications**. Today, travelling wave tubes from Thales are utilized on board most satellites used for messages, television, terrestrial surveillance, navigation and scientific purposes.

Here we will look closer on the aspect of digitalization and usage of sophisticated modelling with usage of Data Analyser ® in industrial environment

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General discussion on *problem solving*

- Standard Analysis is working **very effective** for *most* cases (Failure Tree, A3, PDCA, Kaizen….)

    → Complex issue at the beginning doesn't mean automatically complex tool needed….

- Some special cases *cant' be* solved for *long-time period* and they will come back in new form

    → here more complex tools might help (cross-talking tolerances, drifts over time,….)
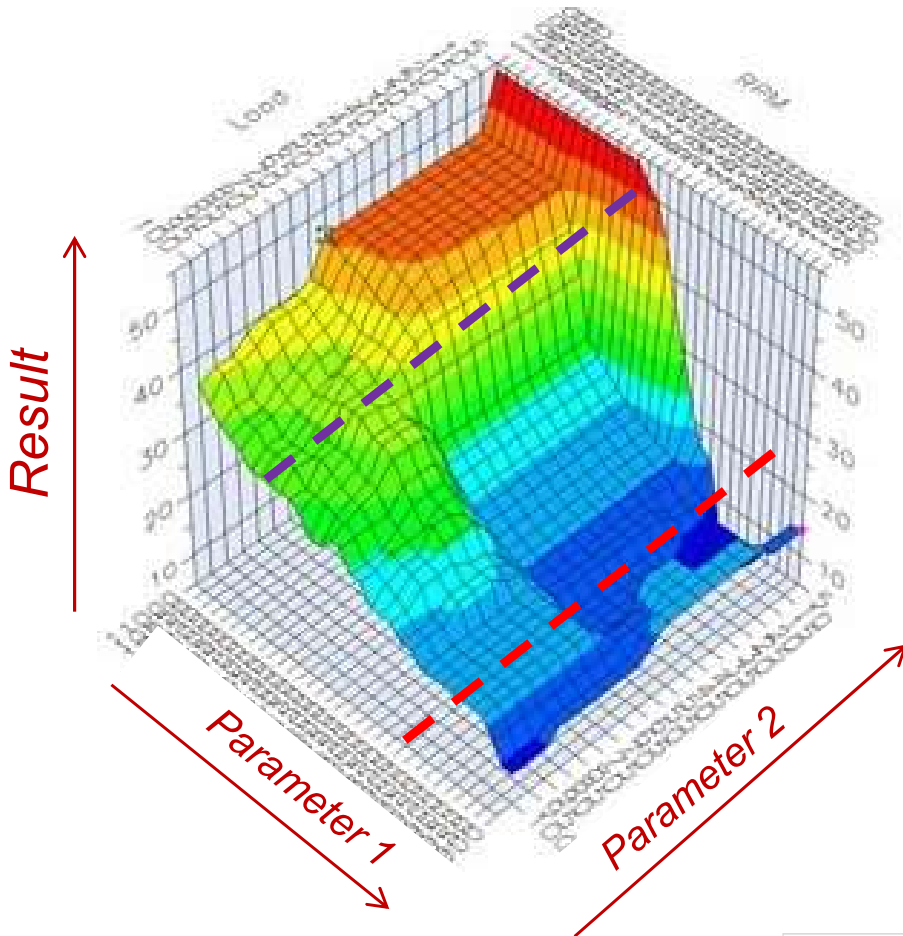
Consider two cases:

1. Red one for certain value of *Parameter 1*
→ conclusion is that the other *Parameter 2* is very flat, so basically **no dependence** for the result

2. Violet case for another value of *Parameter 1*
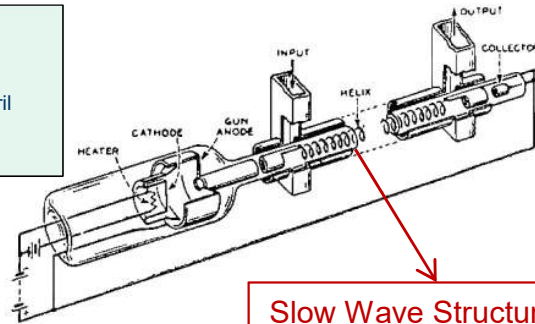→ Results **depends strongly** on the *Parameter 2*

The issue is.. that nor answer is right here

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1. Proof of Concept for very complex mechanical part with > 1000 mechanical parameters

Slow Wave Structure being critical here

>**1000 mechanical inputs** at part level
Relevant electrical output measured ***much, much later***…

→ Huge impact on ***schedule*** and ***NQC***

→ Possible ***impact on customer satisfaction***

→ Need for robust prognosis for mechanic dimensions today vs. electrical performance tomorrow

Goal here is:

- **Real life application** of professional tool for Big Data Analytics (with Artificial Intelligence Module)

Objective / choice:

- ***Data Analyser*®** elaborates statistical link between defined input parameters Xi (i=1,2,…..n) and the output parameters Yi (i=1,2,…..n)

- Parameters in form of ***single data point*** / ***functions*** can be used

- Data Analyser® capable of ***detecting cross-talk*** and their own functions

2. Ultimately the goal is

- Identify and remove **hidden risk** (bad cantered tolerance, interaction between tolerances,….)

- Define and roll out the real and reasonable SPC with right limits

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Approach

→ Definition of all Parameters *Xi* and *Yi* with SIPOC approach (Supplier, Input, Process, Output, Customer)

→ **Critical** to **Quality Analysis** for all *Xi*

→ Pairwise comparison of *Xn* and *Xm* / *Yi* and *Yj*

→ Finally impact analysis with risk of occurrence is derived

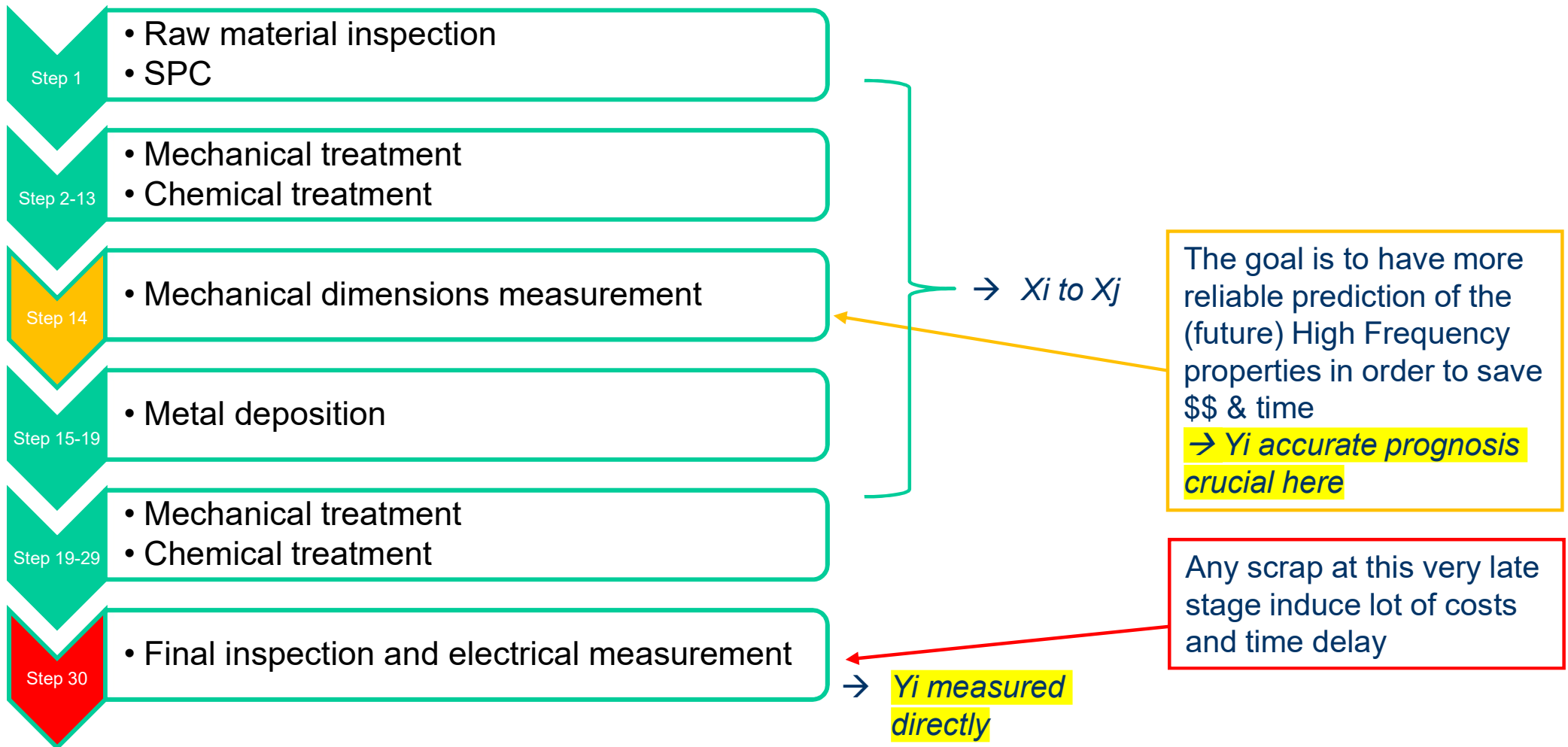→ Hottest 10 (to 20) *Xi* defined and analysed

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Key message

→ Powerful tools *will not* replace product understanding & systematic work

→ Putting all possible parameter *Xi* into complex model will make it very slow and very likely *induce apparent correlation*

→ *Correlation ≠ Causality*

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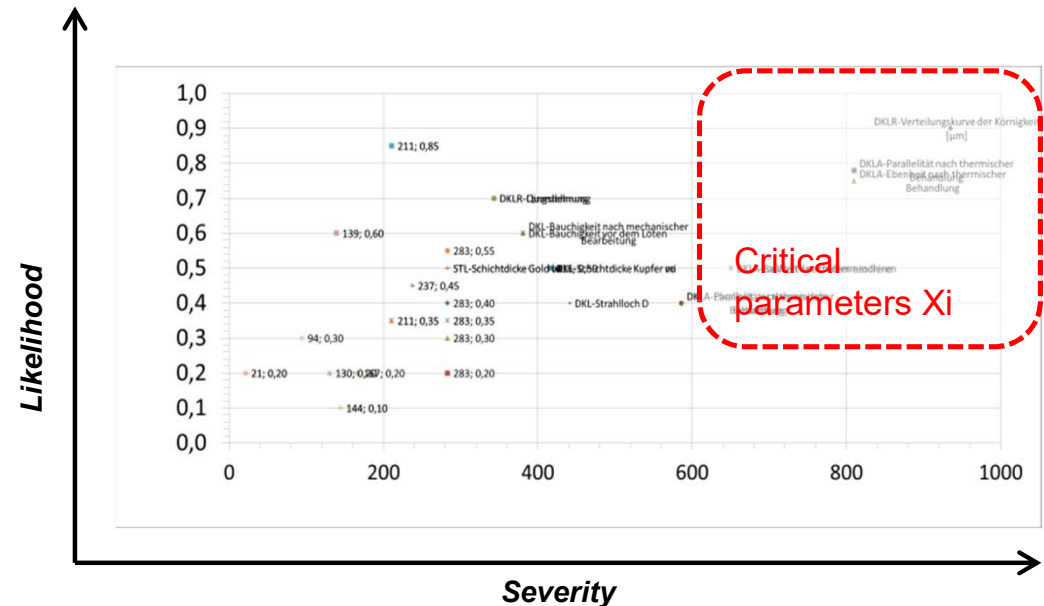
Process chain of the product / assembly considered time & $$ consuming

→ Very tight tolerances on the parts (<< 0.05mm)

→ Difficult materials and very specific process (some of them developed on site)

Step	Process
Step 1	• Raw material inspection • SPC
Step 2-13	• Mechanical treatment • Chemical treatment
Step 14	• Mechanical dimensions measurement
Step 15-19	• Metal deposition
Step 19-29	• Mechanical treatment • Chemical treatment
Step 30	• Final inspection and electrical measurement

→ *Xi to Xj*

The goal is to have more reliable prediction of the (future) High Frequency properties in order to save $$ & time
→ *Yi accurate prognosis crucial here*

Any scrap at this very late stage induce lot of costs and time delay

→ *Yi measured directly*

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Some obstacles to overcome in real life….

→ Many data existing but on local machines only
→ Some data tricky to store (very specific machines with limited storable data content)
→ **Some machines in internal network.. However very specific and not adjustable data format**
→ **Many interfaces to be created….. and enrolled**

Step 1
- Raw material inspection
- SPC

Step 2-13
- Mechanical treatment
- Chemical treatment

Step 14
- Mechanical dimensions measurement

Step 15-19
- Metal deposition

Step 19-29
- Mechanical treatment
- Chemical treatment

Step 30
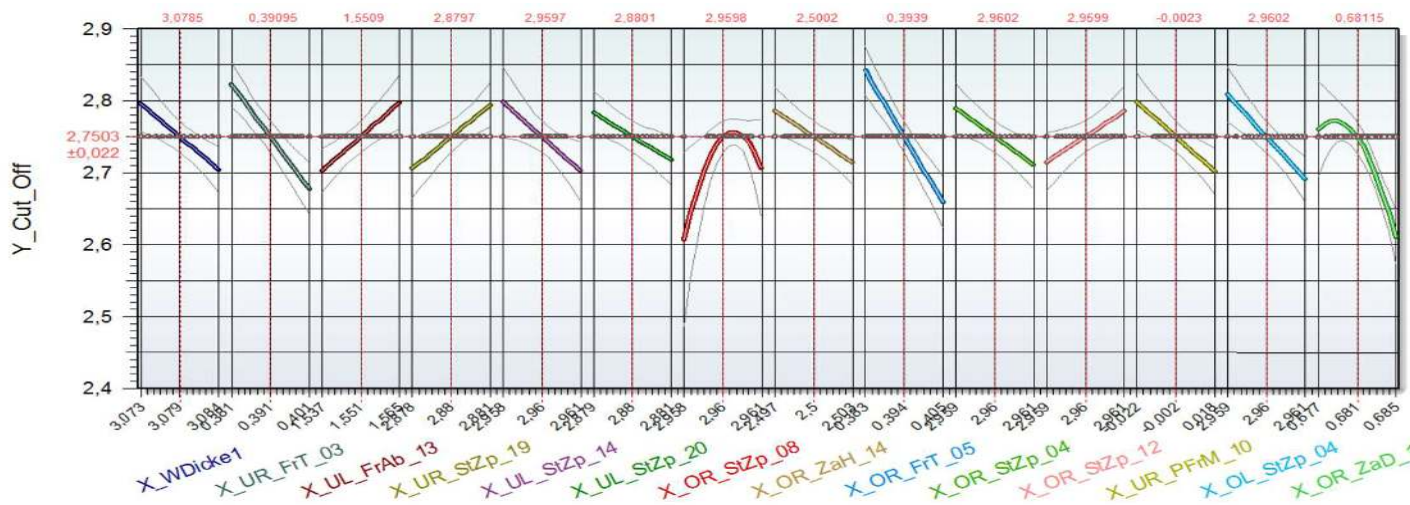- Final inspection and electrical measurement
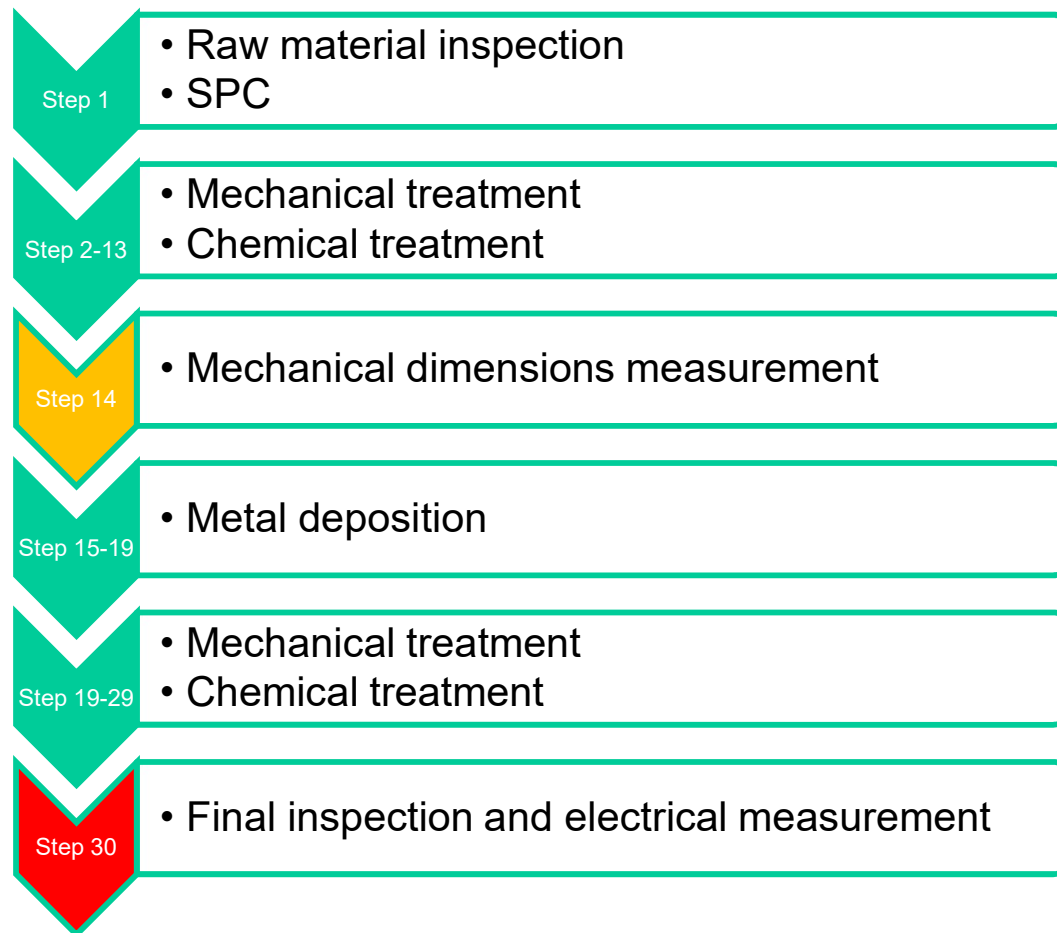
Example of high-temperature furnace:

→ *stand-alone machine*
→ *No network connection (security issue)*
→ *Data output controllable only to very tight extend*
→ *No simple way to include ID*
→ *And so on….*

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1. First results

→ *14 Parameters* being significant here (Sampling > 1000)
→ Some of them *quadratic functions* (be **careful!**)
→ *However R2 / regression of about 57% only (**target > 80%**)*

→ *Need for further improvement*
  → *Some hidden parameters missing*
  → ***And/or** available parameters not accurate enough*

2. Some parameter are showing surprisingly **no correlation**….

→ Investigation and *inclusion* of additional **hidden parameter** (unexpected drift of mechanical dimension)

→ Creation of new model
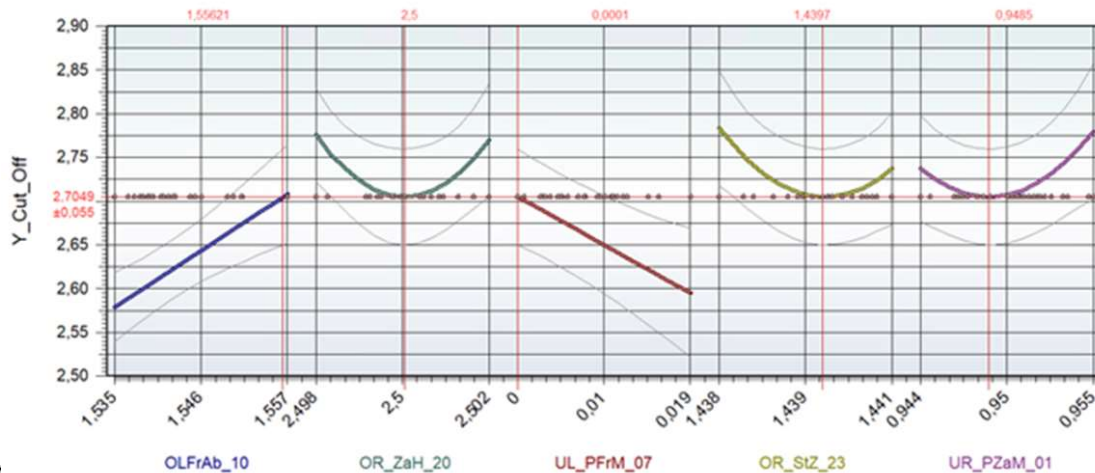
→ *Model with 5 Parameters only**
→ *Regression **> 90%** ***

* Some old parameters now included in the "big 5"
** Sampling < 100 Pcs, so we need to add further samples

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Results:

→ Detection of hidden parameter via Data Analyser ®

→ New model Level 1 with acceptable R2 available
  → Adapted model with very good R2 now available
  → Thales started to implement new tolerances

→ Cost savings and reliable schedule and improved On Time Delivery

Outlook:

→ Increased sampling for new model
→ SPC on hidden parameter Xi
→ New interfaces now being enrolled for other sub-processes

Long term:

→ Usage of Data Analyser® for other products / sub-components

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