

PlateMod – Software tools for premium quality heavy plate production built with Wolfram Technologies

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Heavy Plate Production

slab

reheating

rolling

cooling

levelling



chem. comp.

reheating temp.

finishing temp.

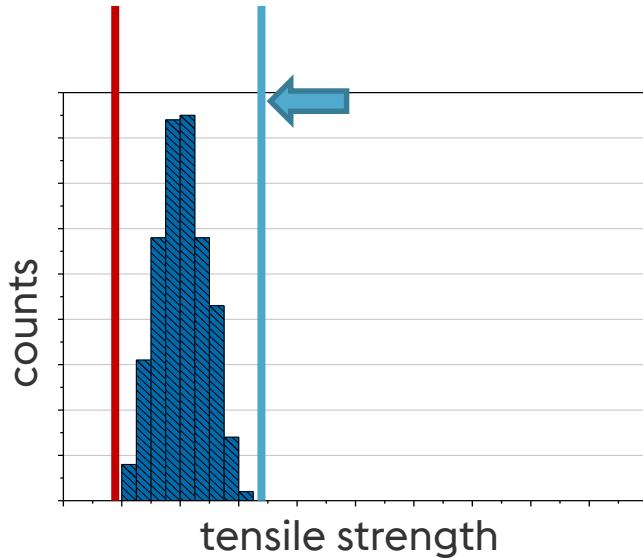
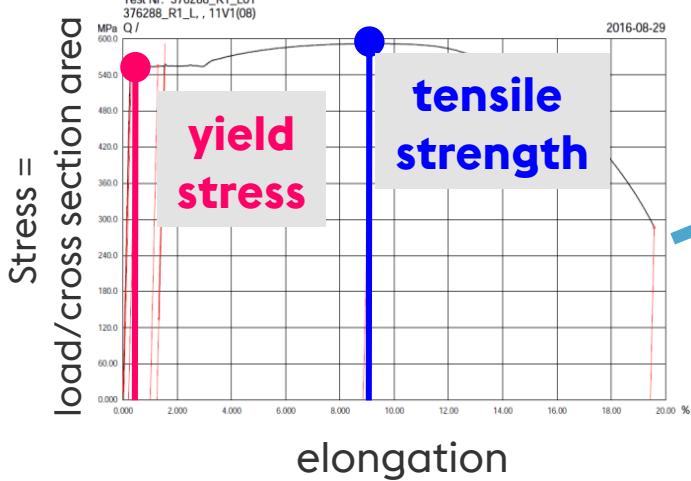
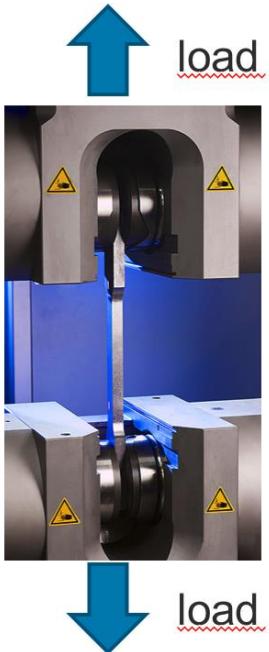
cooling stop temp.

plastification

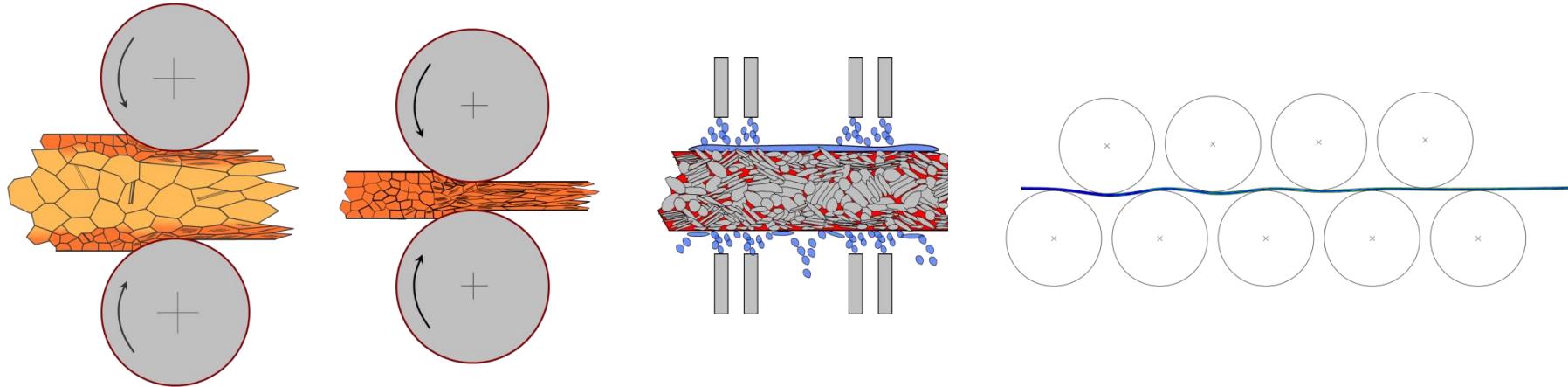
classical automation strategy: keep target values as constant as possible within plate series

One main goal of the PlateMod Project

» Minimize the variance of mechanical properties

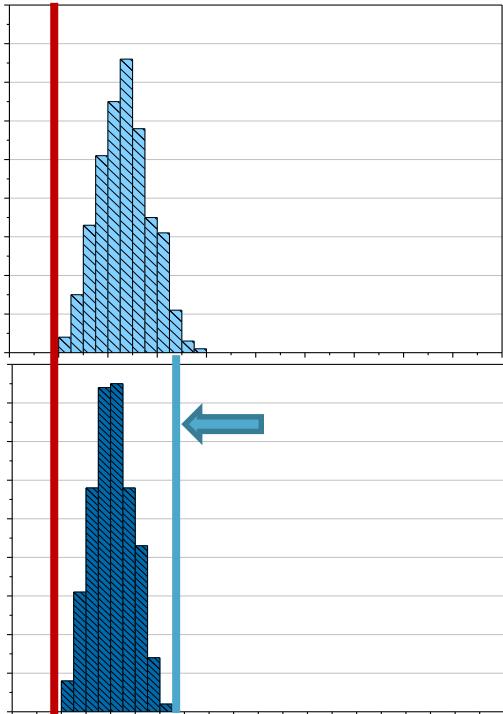


Needs for the PlateMod Project



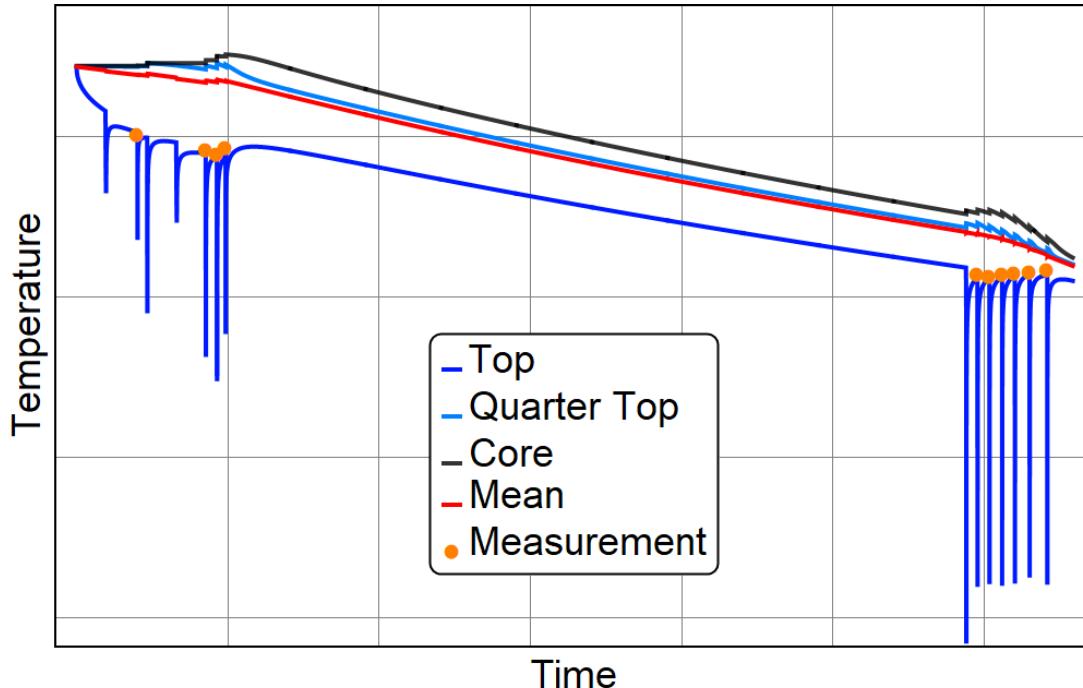
- » Fast, physical based simulation of the thermomechanical state dependent on thickness coordinate of the plate throughout the whole process chain
- » Prediction of the mechanical properties – yield and tensile strength and toughness (future) – based on progression of thermomechanical state

PlateMod Control is the solution



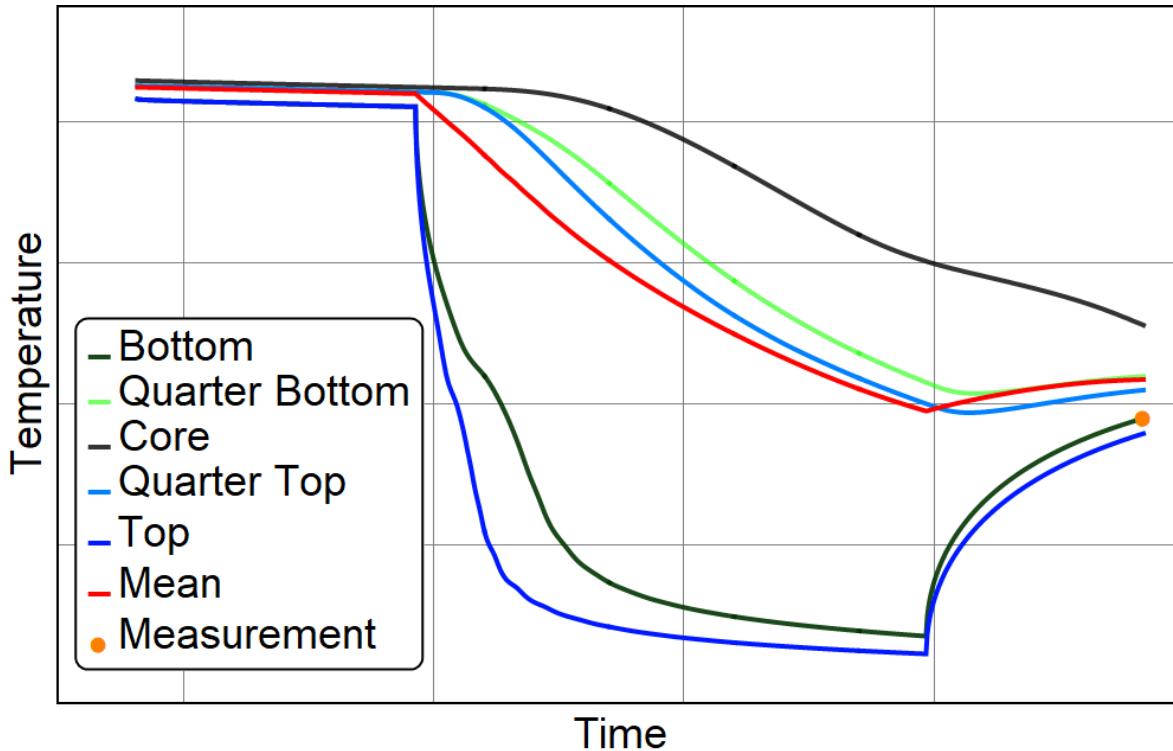
- » ... offers the ability to dynamically adapt target values
- » Measuring of actual process parameters (e.g. rolling temperatures)
- » Calculation of the expected progression of the thermomechanical state during the remaining process steps
- » Prediction of mechanical properties and adaption of the target values of the remaining process steps

Hot Rolling process



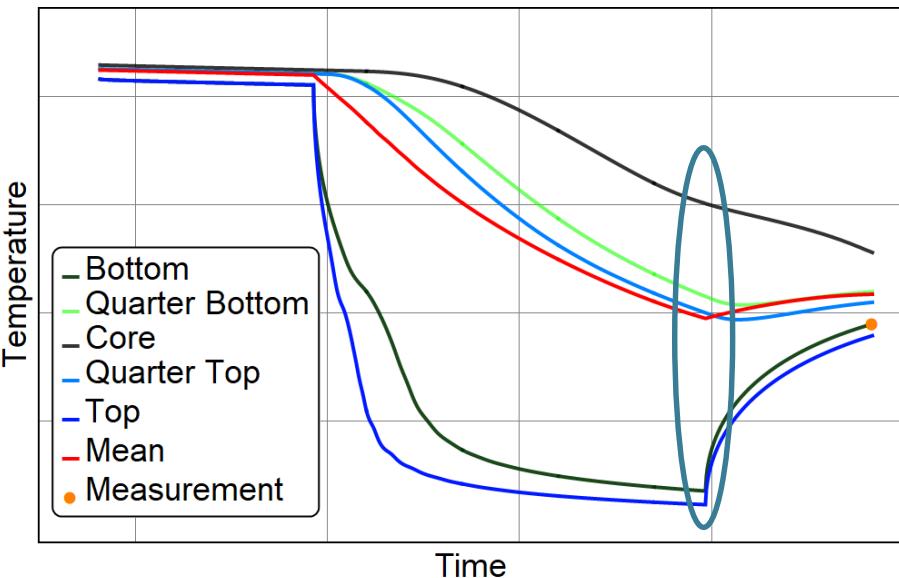
- » heat loss due to contact with work rolls
- » air cooling between roll passes
- » deformation heat

Accelerated Cooling process



- » water is used to cool down plate to specific cooling stop temperature
- » phase transformation controls the mechanical properties

Derived Quantities



- » temperature measurements only at specific times at the surface
- » access to calculated values on every point of the plate at any time
- » access to other quantities that are not (or can not be) measured directly

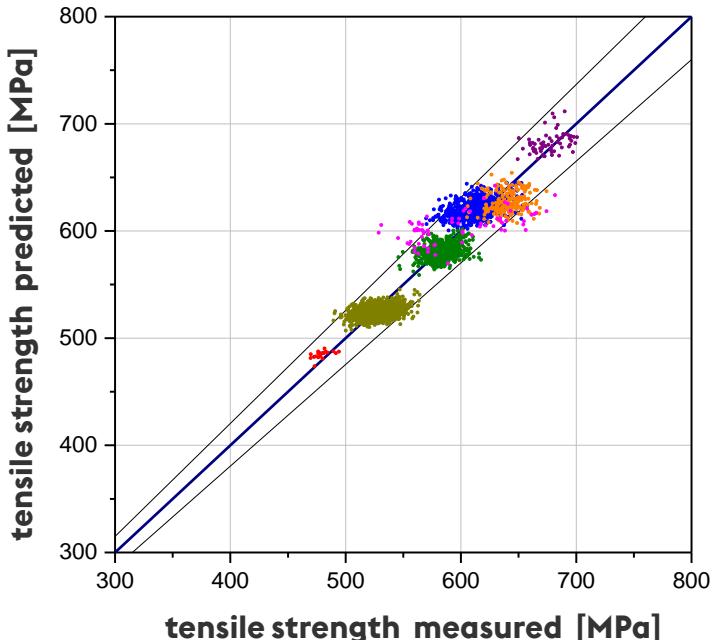
Only viable if agreement between simulations and measurements is high!

Prediction of mechanical properties

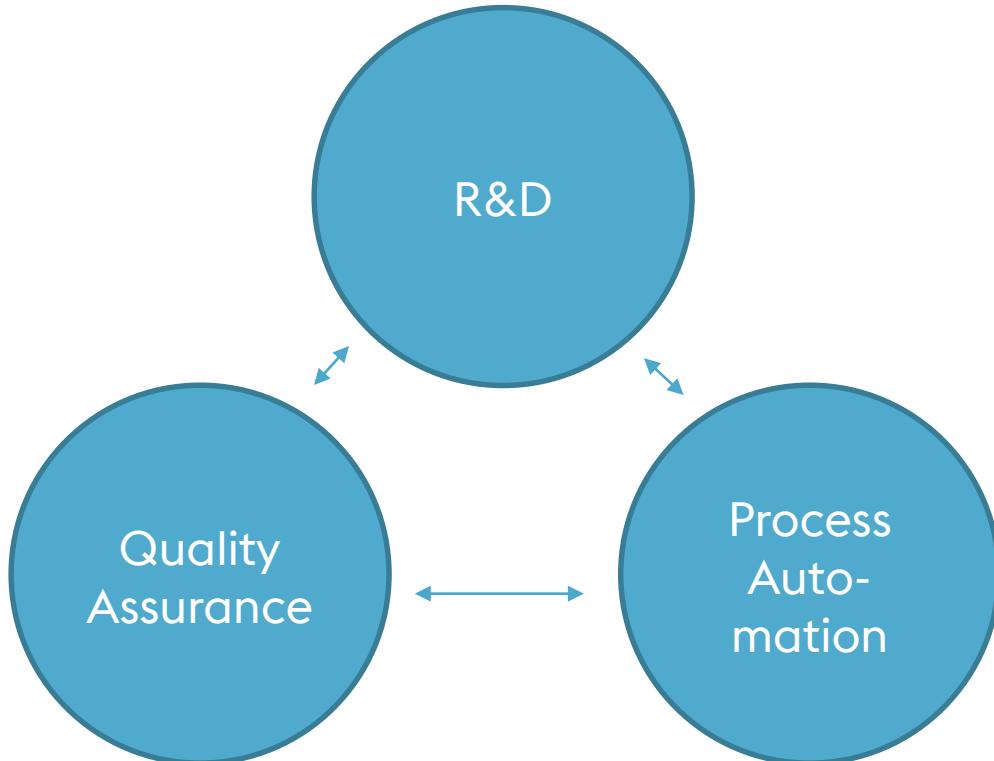
- » chemical composition c
- » process parameters p
- » derived quantities d

- » mechanical property = $f(p,c,d)$

- » good prediction enables dynamic adaption



Enterprise – wide usage of Wolfram Technologies



- » Research & Development:
 - » development of process- and prognosis models
 - » model reduction
 - » surrogate modelling
 - » advanced data analytics
- » Quality Assurance:
 - » simulation of production processes to help determine target parameters
 - » evaluation and visualization of product properties
- » Process Automation:
 - » application of process models
 - » application of prognosis models
 - » feedback loops
 - » data collection

Across the domain - a specific language

Load Mathematica PlateModeling Package

Load PlateModeling Package. Then connect to the PlateMod Database

```
In[1]:= Needs["PlateModeling`"];
In[2]:= ConnectToDatabase[];
In[3]:= BaseDataFiles = PlateModCurrentBaseDataFileNames[];
```

Choose plate MatID and check if it exists in Database

```
In[4]:= MatIDWant = 333100;
In[5]:= If[MatIDQ[MatIDWant] == False, {Print["MatID ", MatIDWant, " nicht gefunden"]; Interrupt[]}];
```

Load the chosen plate from the PlateMod Database into Mathematica

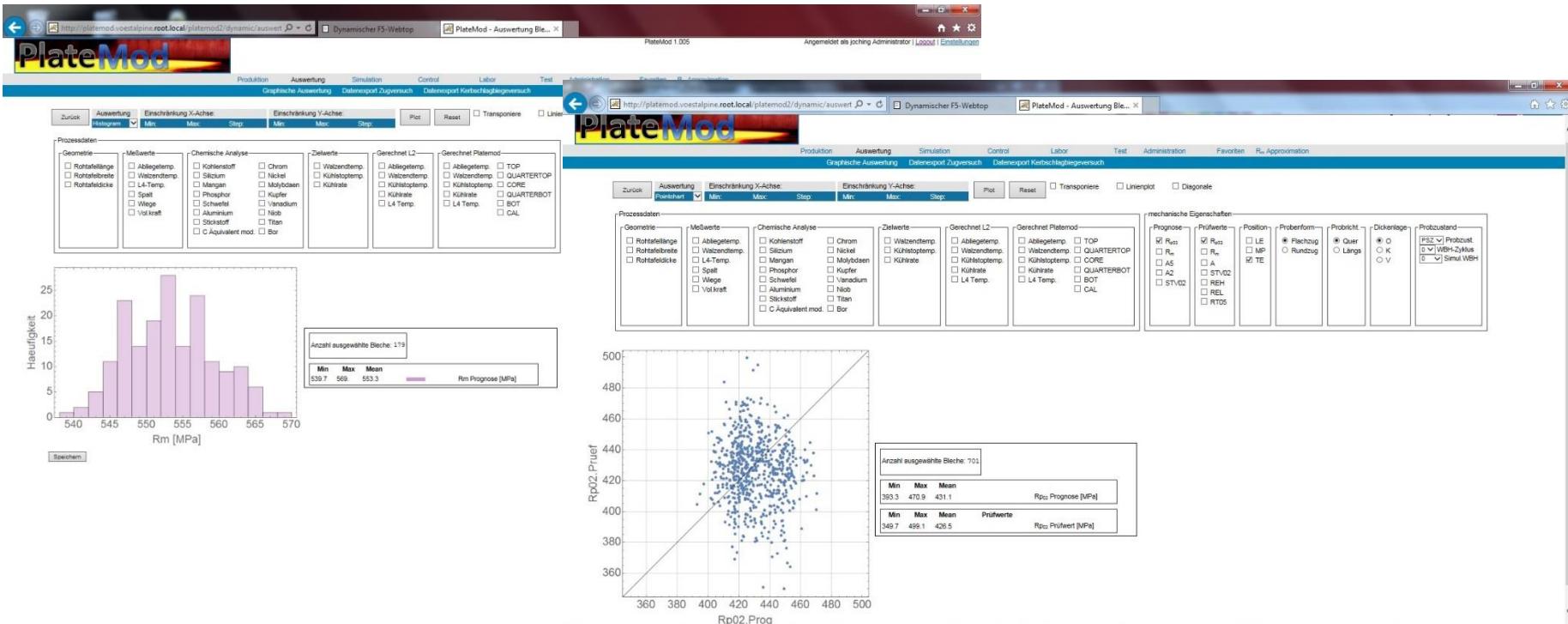
```
In[6]:= OnePlate = LoadPlateData[MatIDToIntMENrCurrent[MatIDWant]];
Loading plate INTMENR 745334254
LoadP51Setup plate INTMENR 745334254
LoadP51SegData plate INTMENR 745334254
SK setup Mode 1 found
SK setup Mode 4 not found
In[7]:= MatIDQ[MatIDWant]
Out[7]= True
```

Compute plate

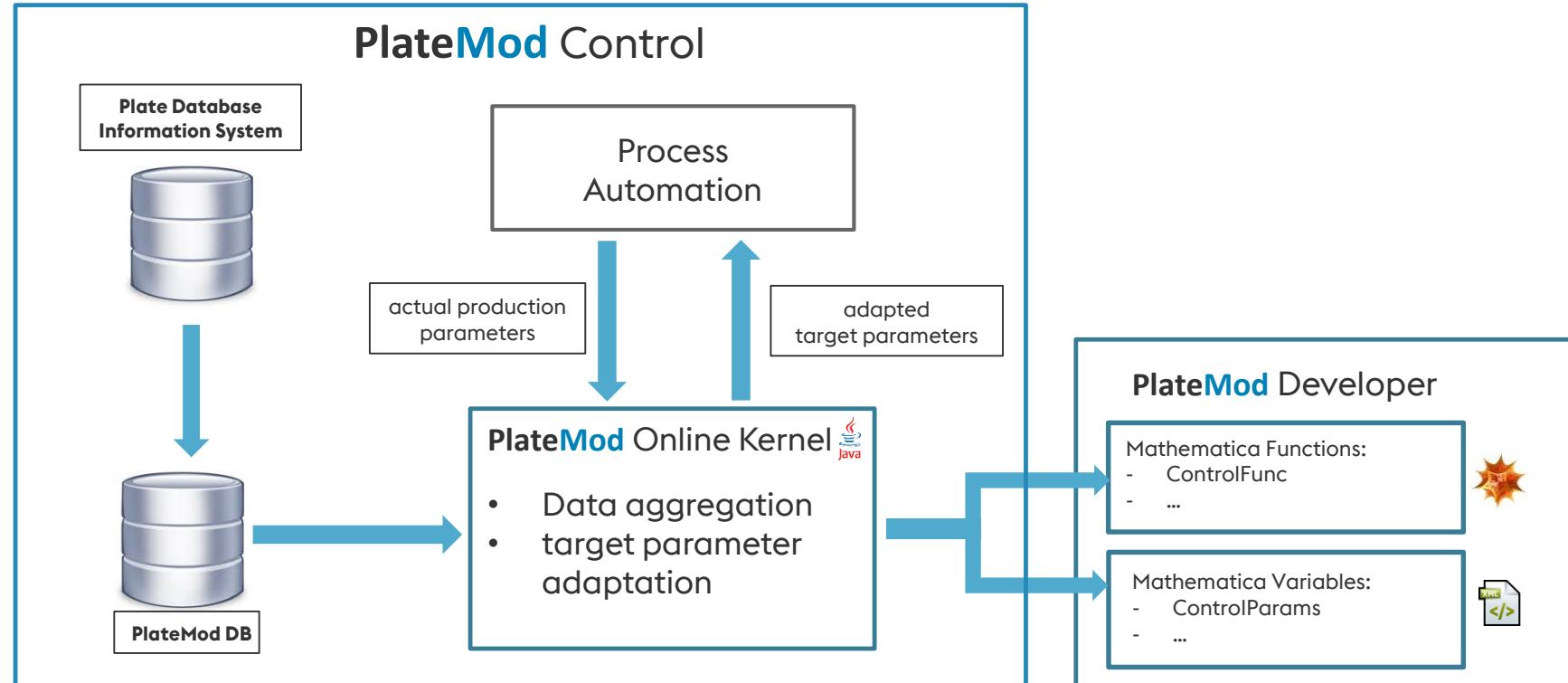
```
In[9]:= OnePlate = PreprocessPlate[BaseDataFiles, OnePlate];
--- Plate MAID 333100 (TM3130) --- preprocessed.
In[10]:= OnePlate = ComputePlateHDF5dev[OnePlate, {"MethodWalzen0" → "1.0D", "MethodSK0" → "1.5D", "CoolDown" → 0, "TmpDir" → False}];
```

- » Functions bundled in Mathematica Package
- » Access to plate data
- » Access to production line parameters

Quality Assurance with Wolfram Technologies



Wolfram Technologies in Process Automation



Conclusion

- » PlateMod Control enables dynamic adaption of the process parameters during production and is successfully applied by VAGB
- » Wolfram Technologies are not only valid for rapid prototyping but using the large stack of technologies available, enterprise systems can be built
- » The combination of webMathematica, Mathematica and Grid Extensions allows to build SaaS systems that scale extremely well with the needs of the customers
- » The variety of linking technologies allows to make Mathematica a central tool within such a system.