

The Ansys logo, featuring the word "Ansys" in a white sans-serif font with a yellow diagonal bar above the 'A'.

Ansys

INNOVATION
CONFERENCE

2020

仿真流程集成与多学科优化设计

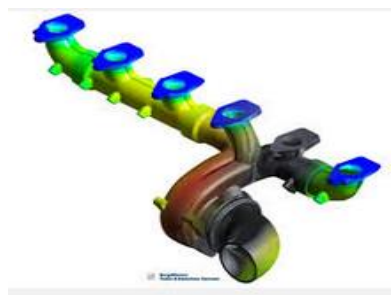
姓名：刘丙权

职务：Senior Application Engineer

公司：ANSYS

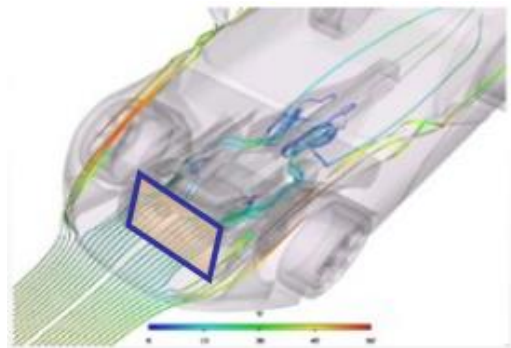
法拉利汽车过去20年的仿真应用经验

工程价值



单个部件的失效分析

- 理解工作原理/为什么失效

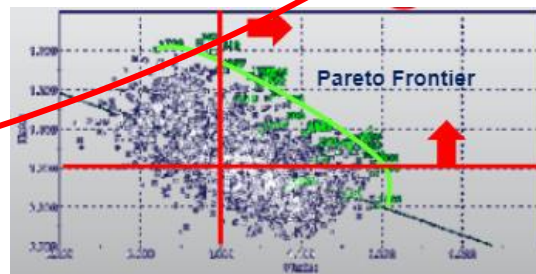


产品部件的设计验证

- 满足设计要求
- 虚拟验证

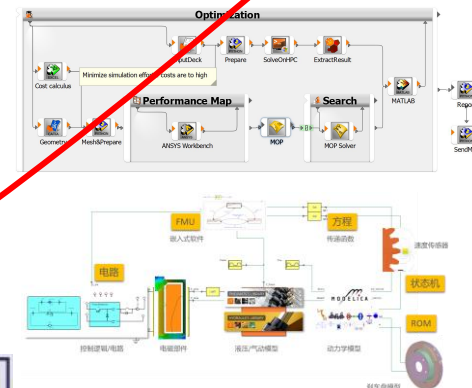
设计探索

- 支持定义设计准则
- 对设计全局的敏感性分析
- 单目标/多目标优化设计



系统工程

- PIDO—工具集成
- 复杂系统和多物理域耦合分析



应用程度和应用领域

关于仿真设计问题的思考

- 仿真驱动研发-优化设计
 - 结构强度、热性能、电磁性能、成本等是否达到最优
 - 多个相关性能的综合考虑
- 缺失材料数据？
- 仿真结果与试验有偏差？
- 加工的公差、材料属性的随机性对设计的影响？
- 仿真流程自动化—重复性仿真工作能否减少？
- 仿真流程标准化—不同Level工程师仿真结果的保证？

内容提要

1 PIDO仿真流程集成与多学科协同优化

2 optiSLang与产品设计的紧密结合

PIDO是什么?

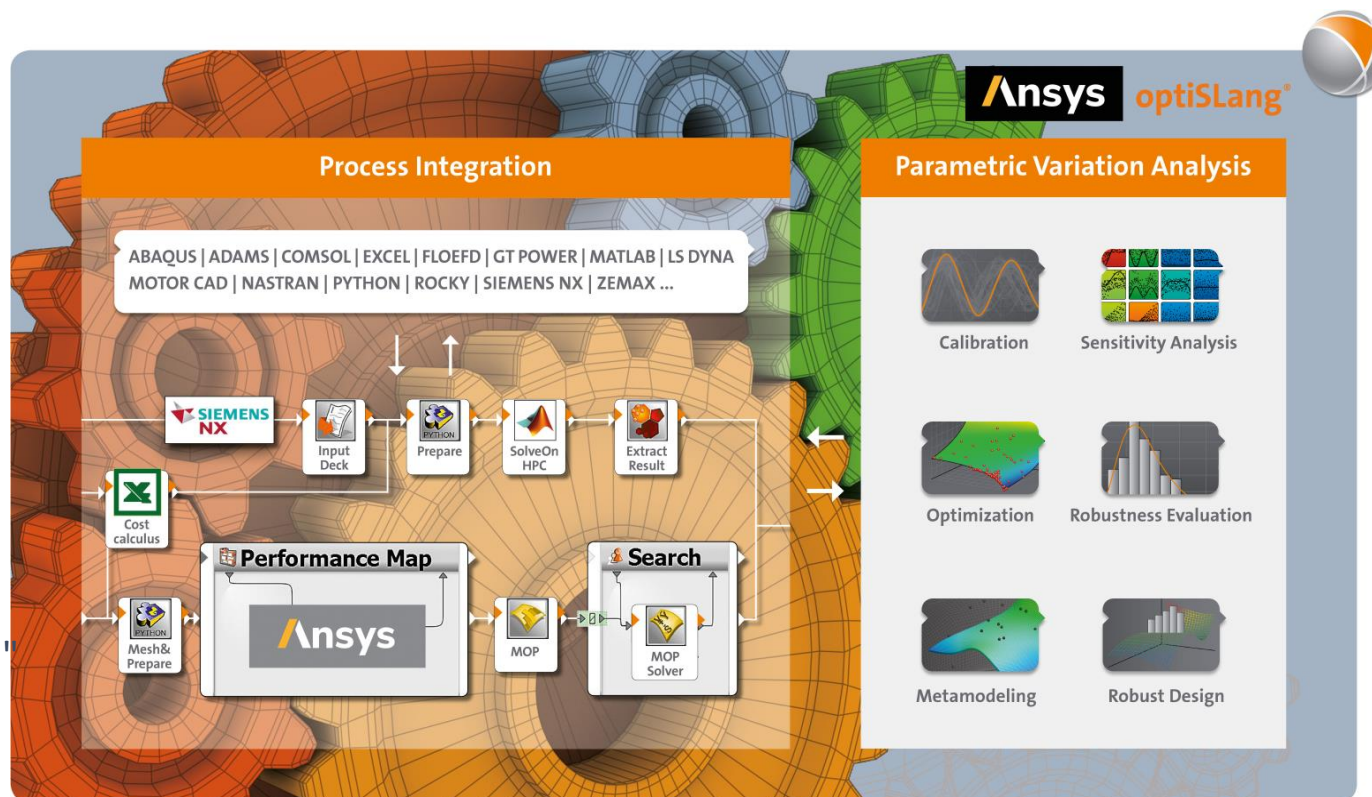
PI (Process integration)

流程整合与自动化

DO (Design Optimization)

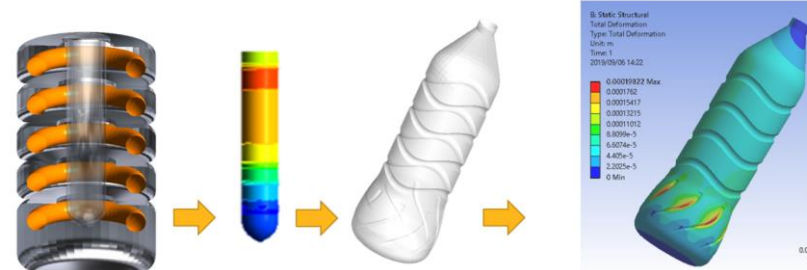
基于鲁棒性的优化设计

- 流程自动化
- 集成CAE&CAD工具
- 开放且灵活
- 构建可复用APP
- 可集成于Minerva
- “非仿真专家的仿真应用”



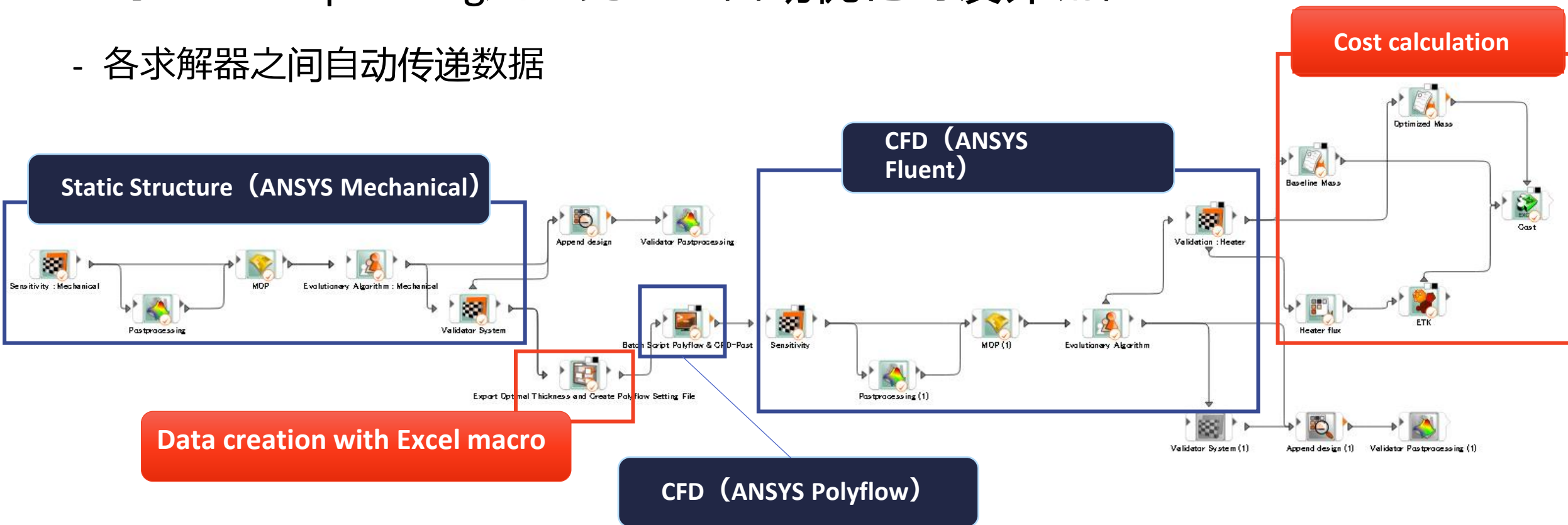
- 确定参数相关性
- 降低复杂性
- 了解您的设计
- 以最少的工作量优化您的产品
- 验证鲁棒性和可靠性
- 为数字孪生创建高保真度的ROM模型

PET瓶制造工艺案例—分析流程



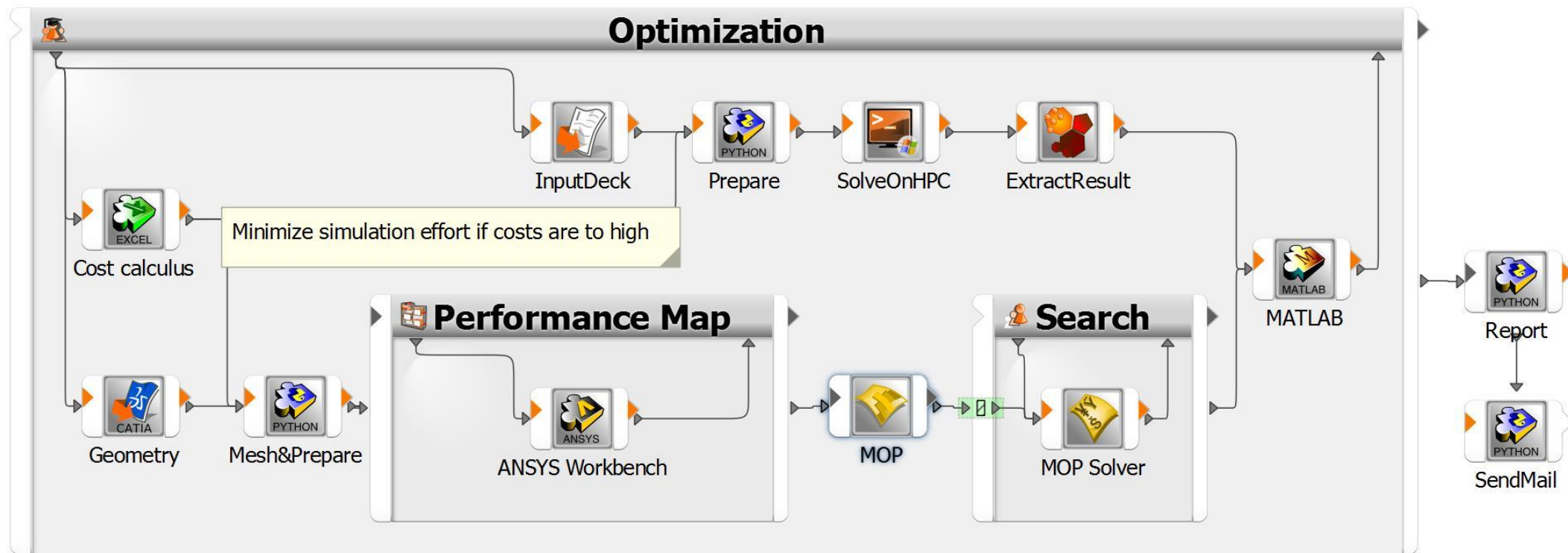
- 基于ANSYS optiSLang建立完整且自动优化的设计流程

- 各求解器之间自动传递数据



optiSlang提供多学科协同优化平台

- 灵活地构建（参数化） workflow; 集成任意 CAX 工具



博世案例-ECU仿真APP搭建



Wizard page

admin
Logout

Example 1

RC-Network (Cauer Regression)

Provides Cauer-based RC-chain elements based on thermal behaviour

Go!

Example 2

Component Model Updating

Performs Model Updating of electrical components

Go!

Example 3

EBS Thermal Assessment

Performs standardized Thermal Assessment for ESP Gen9.x & ESP Gen10

Go!

EBS Thermal Assessment (python)

Performs standardized Thermal Assessment for ESP Gen9.x in python

Go!

Project Queue

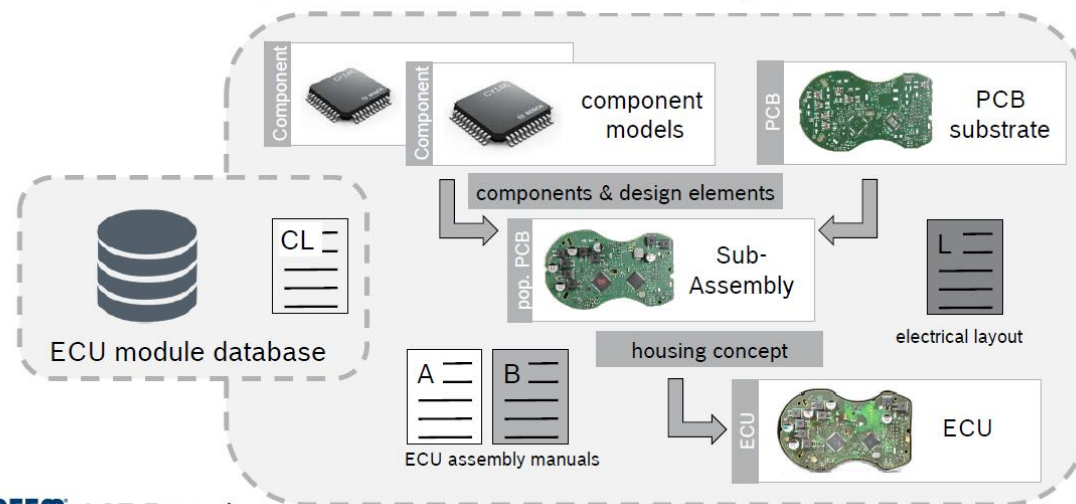
Execute optiSLang projects successively as defined in a configuration file.

Go!



针对ECU关键部件搭建自动化仿真流程

- 模块装配APP
- 电子部件热仿真APP
- EBS热评估仿真APP
-

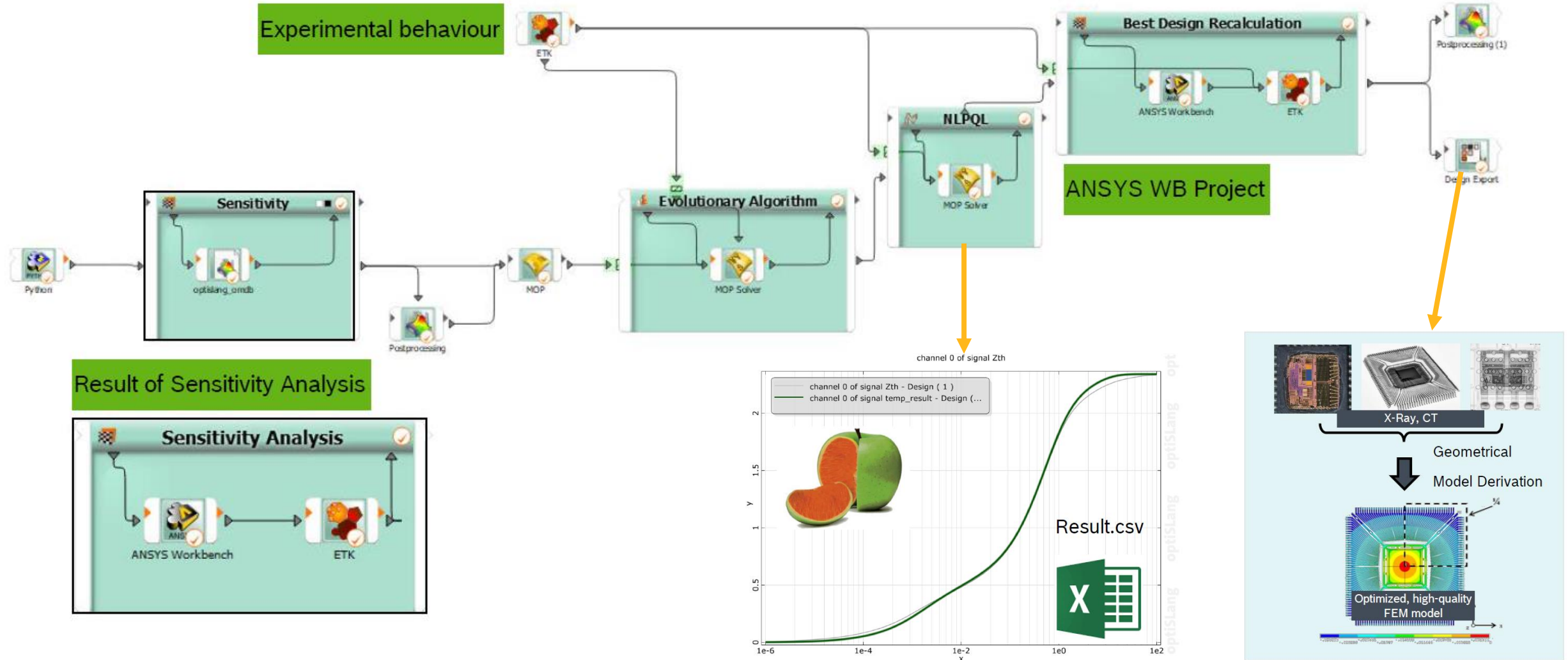


CADFE[®] ACT Extension

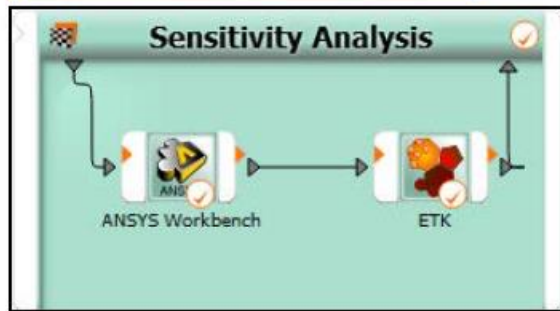
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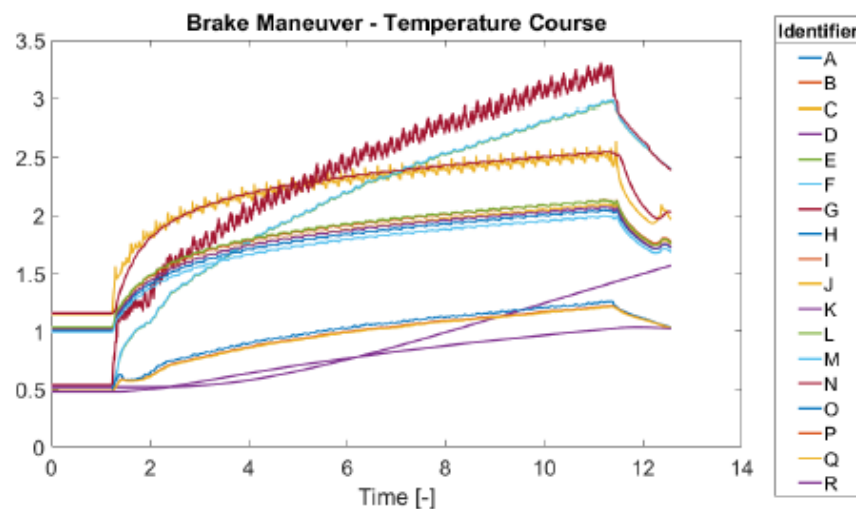
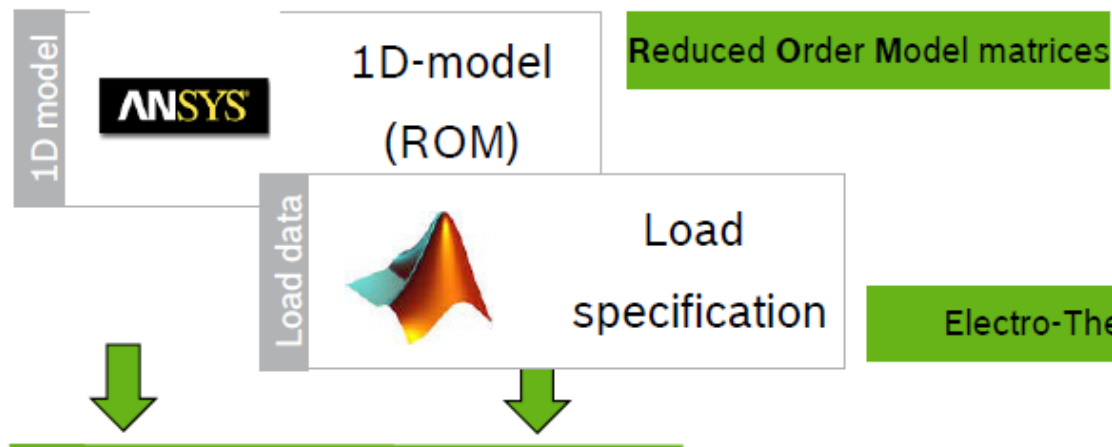
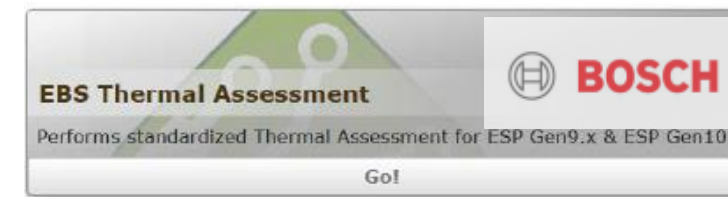
博世案例-电子部件热仿真APP



Result of Sensitivity Analysis



博世案例-EBS热评估APP



Setup of optiSLang project

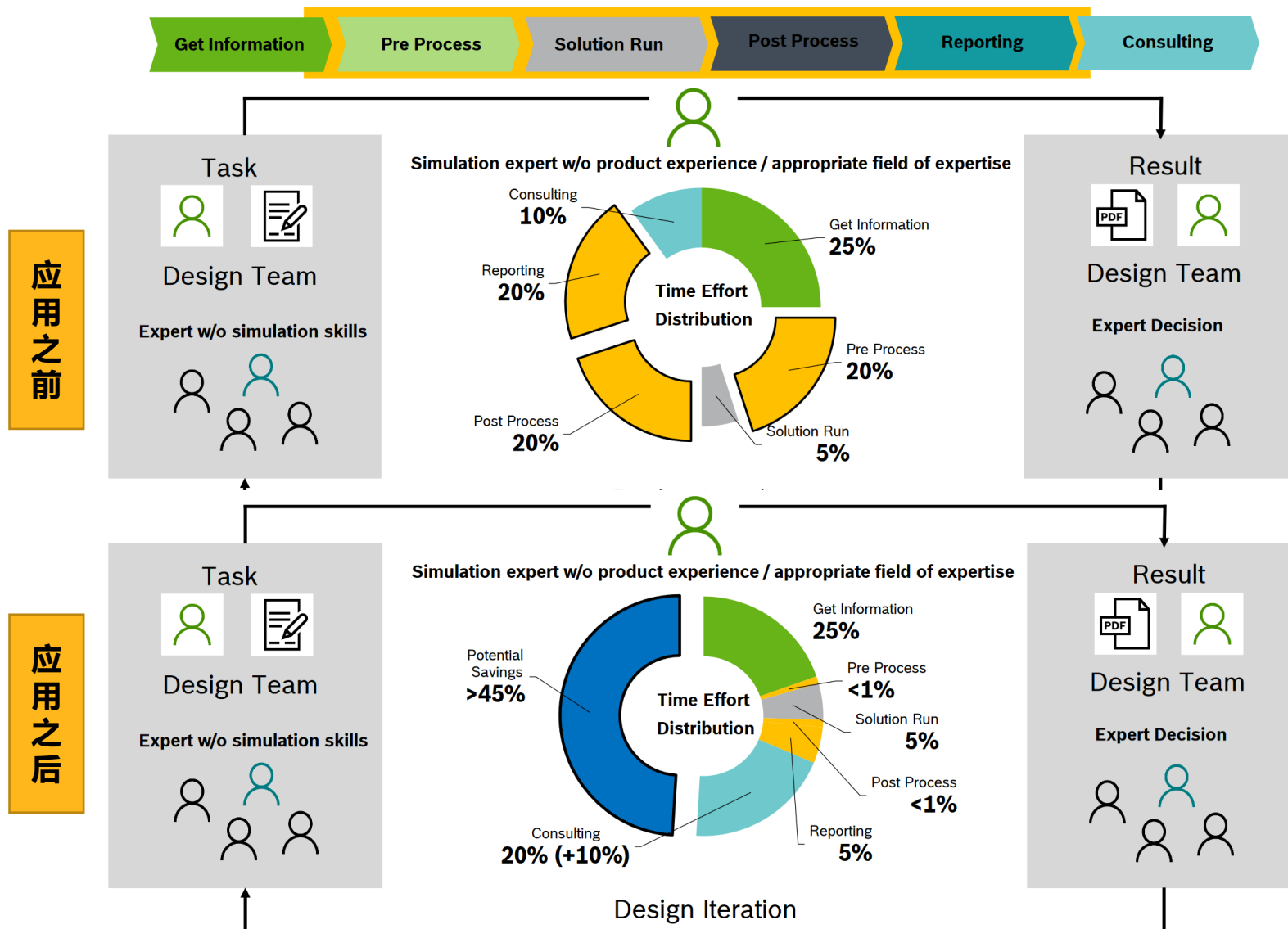
- ▶ Simple optiSLang setup for the MATLAB-based calculation of temperature courses (and assessments) based on ANSYS-provided Reduced Order Model (ROM) matrices (MORinsideANSYS)
- ▶ Python-node to auto-generate Microsoft PowerPoint report
- ▶ Data Send node to send PowerPoint results + result zip-files by Email

Placeholders and Registered files

- ▶ Definition of placeholders to be provided by user interface

博世案例-工程师仿真时间大幅缩减

- 总体时间节省**45%以上**
- 前处理、后处理、报告的时间大幅缩短
- 设计讨论的时间增加**10%**

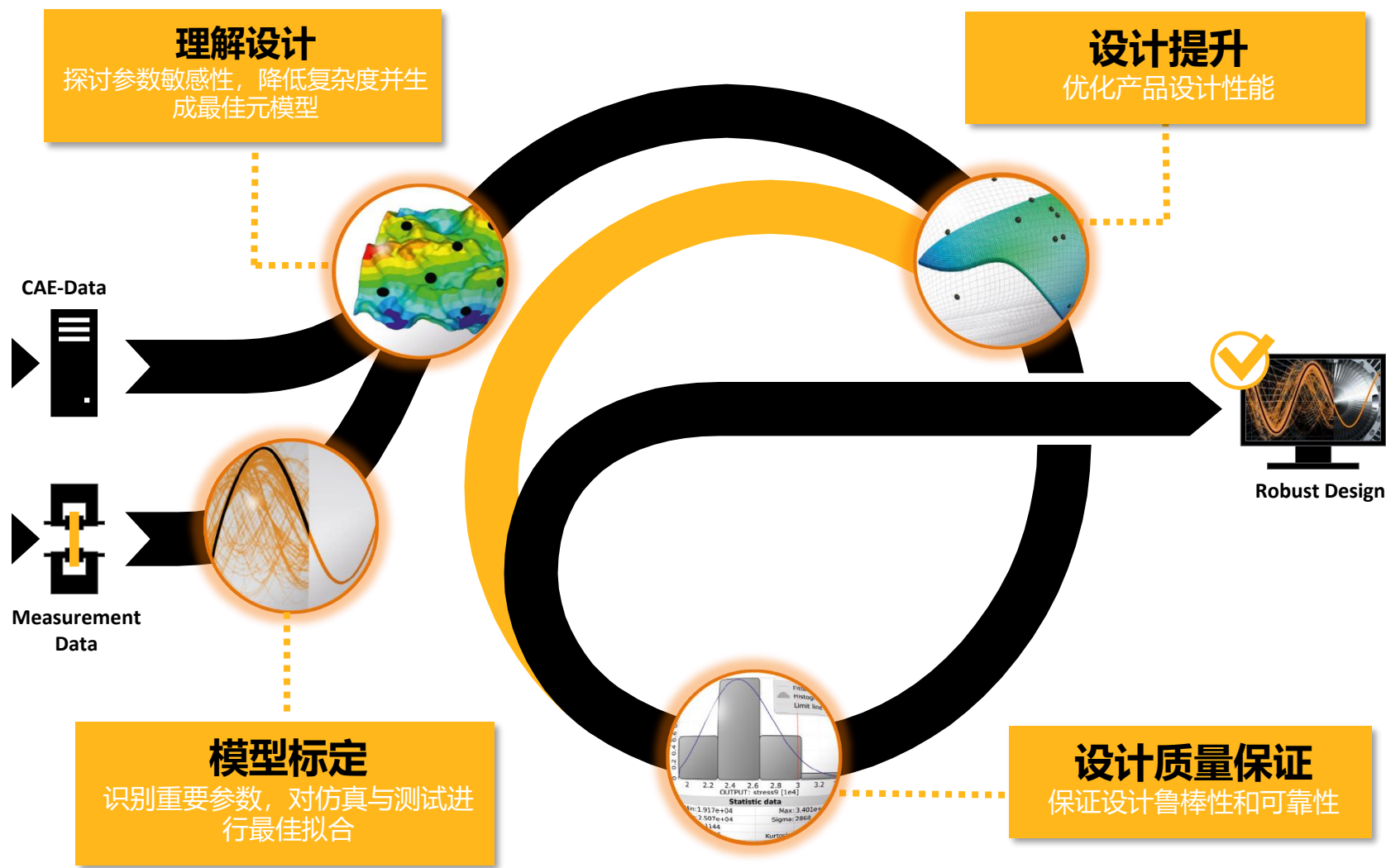


optiSLang与产品设计的 紧密结合

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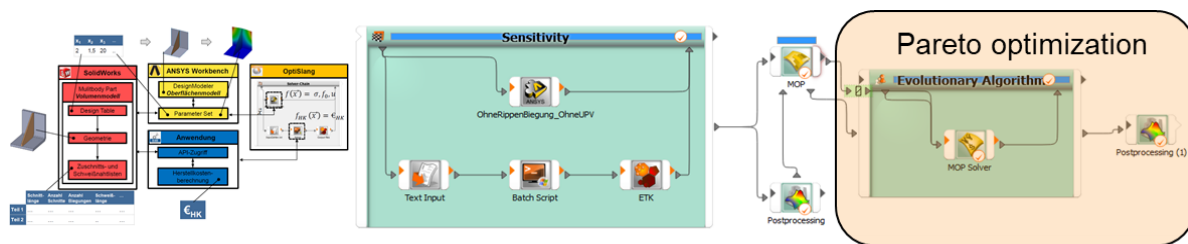
Optislang与产品设计周期的紧密结合



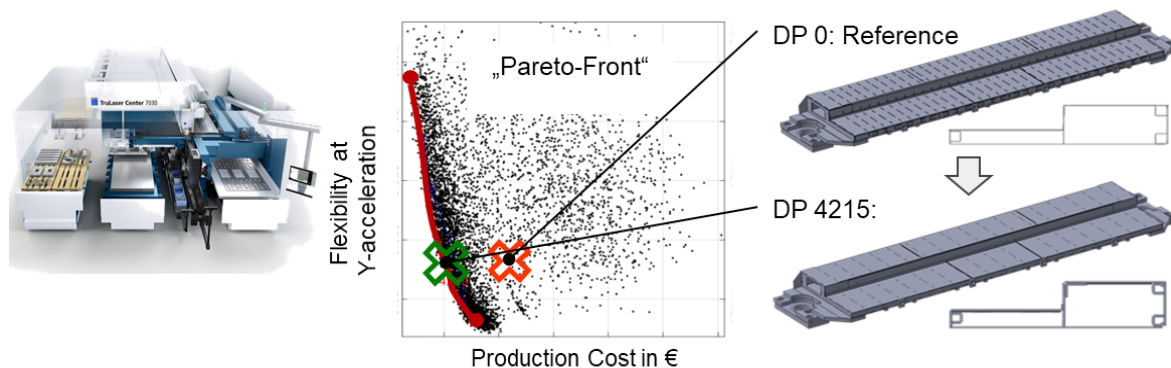
多学科优化设计—设计空间探索

3D打印机优化设计案例—TruLaser Center 7030

- 降低成本和刚度增加
- 帕雷托边界显示巨大的优化潜力。
- 选择与初始设计相同刚度的方案，总成本可以降低27%



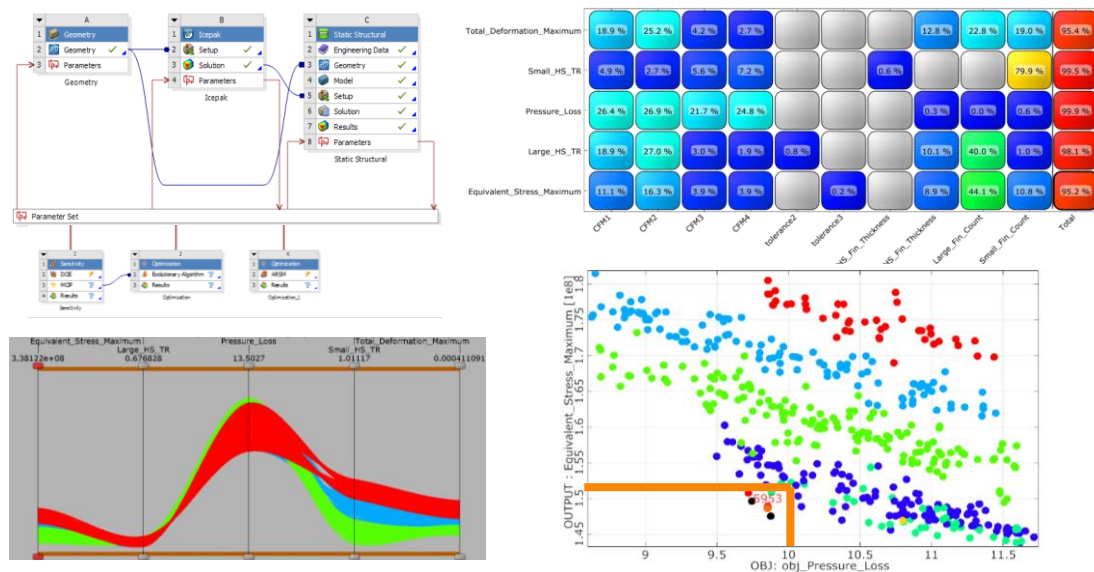
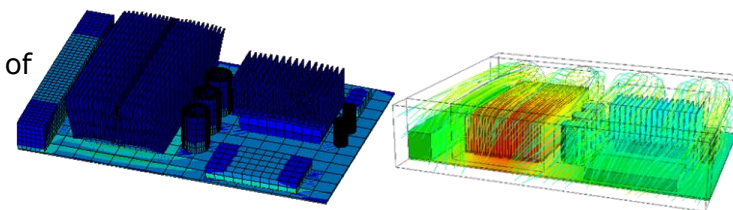
Pareto optimization at MOP
(10,000 design evaluations in 5 minutes run time)



PCB多学科优化设计案例

- 包含结构形变和散热性能仿真
- 目标：结构应力和变形最小，流体压损和散热器热阻最小
- 获得最优解区域，各目标之间的相关性

12 parameters: number of fins, fin thickness, fan flow rates and positions



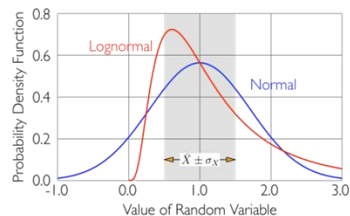
identify negative correlated objectives

鲁棒性和可靠性分析—考虑加工等随机变量的影响

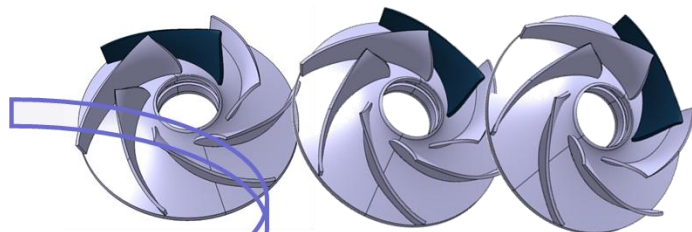
离心泵鲁棒性分析案例—Grundfos

- 基于加工公差分散性进行鲁棒性分析；
- 交通灯的形式对各输出参数的分析性进行评估；
- 确定影响性能的关键区域，重新规划加工要求。

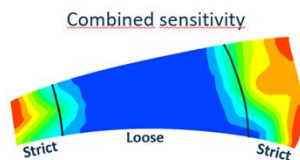
1) Define the robustness space using scatter range, distribution and correlation



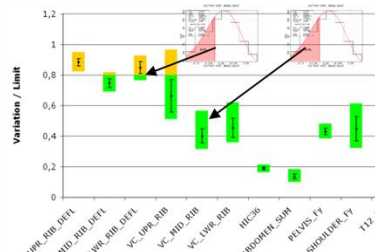
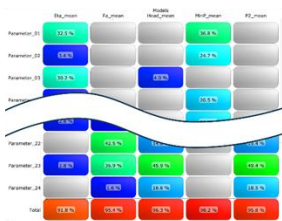
2) Scan the robustness space by producing and evaluating n designs



4) Narrow and wide production tolerances

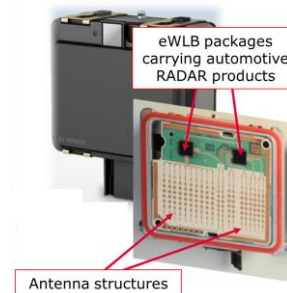


3) Check the output variation



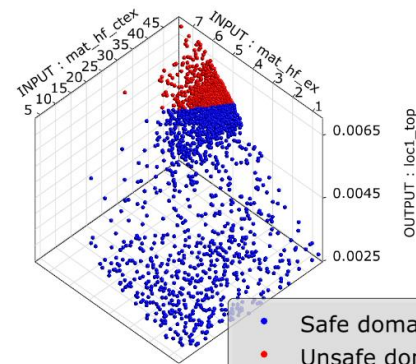
汽车雷达可靠性设计案例—Infineon

- 针对三种不同的设计方案进行可靠性分析，得到方案3的可靠性最高；
- 利用MOP完成几千个设计点计算，大大提升计算速度



Case	#1	#2	#3
Situation	Tier1 type reliability test	Tier2 type module loading	Tier2 type module loading + improvement
Cyclic loading condition	Temperature	Temperature + bending	Temperature + bending
View of deformation during loading			
Top view (half model)			

hf_ctex vs. INPUT : mat_hf_ex vs. OUTPUT : loc1_top



Method : Adaptive Sampling (AS)

Complete iterations : 3 / 3
Selected data : All designs

Probability of Failure : 1.65916e-12
Standard deviation error : 1.56916e-15
Reliability Index : 6.96354

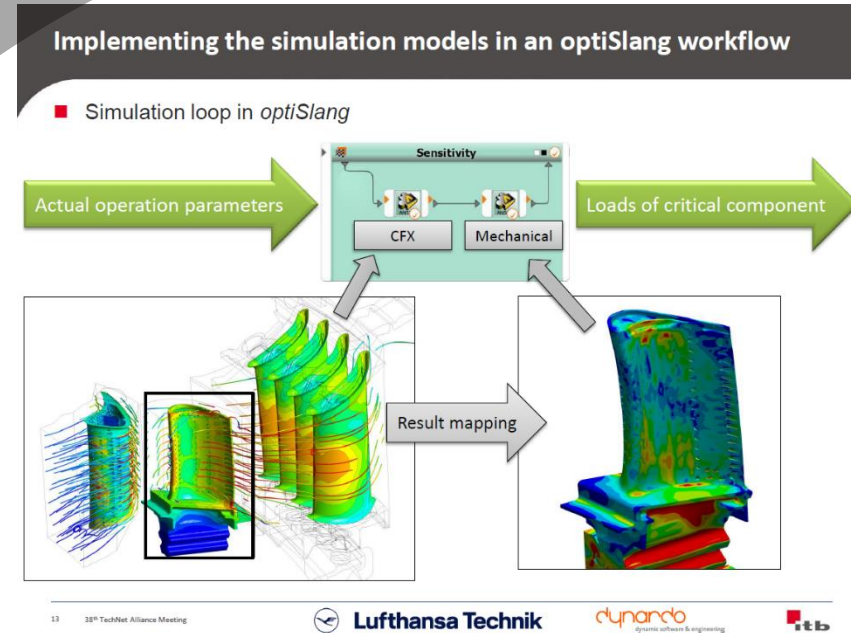
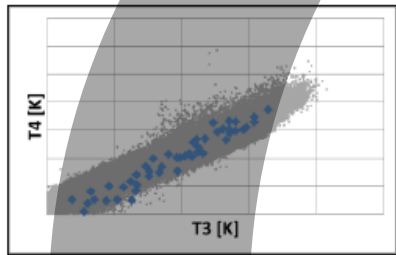
Number of designs
Total : 3000
Safe domain : 1443
Unsafe domain : 644
Failure strings : 0
Failed : 913

客户案例：为数字孪生技术提供高保真度的ROM模型

The sample set is calculated with high fidelity ANSYS CAE for temperature, stress and life effects on blades.

1 selected DOE sample runs 15 hours at HPC cluster.

DOE Generation: Based on available flight schedules a representative set of flight is selected



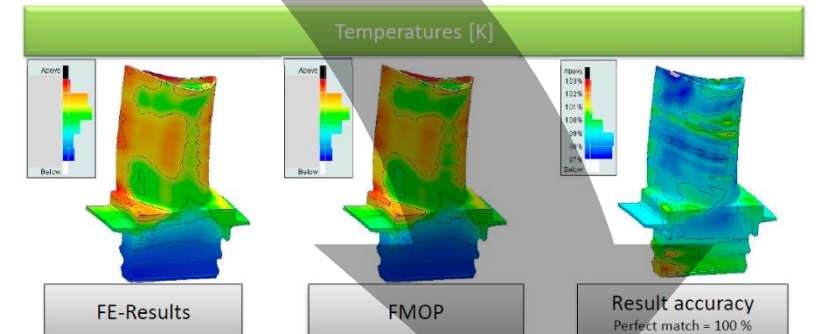
The forecast quality is quantified to be very good!

FMOP in Statistics on Structures

List of available individual objects/samples:	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	TEMP
F-CoP[Total]	95.37 %	91.52 %	91.96 %	96.49 %	92.38 %	93.27 %	92.00 %	92.08 %	95.01 %	99.21 %	99.21 %



File includes the FE-results of the validation points for direct comparison

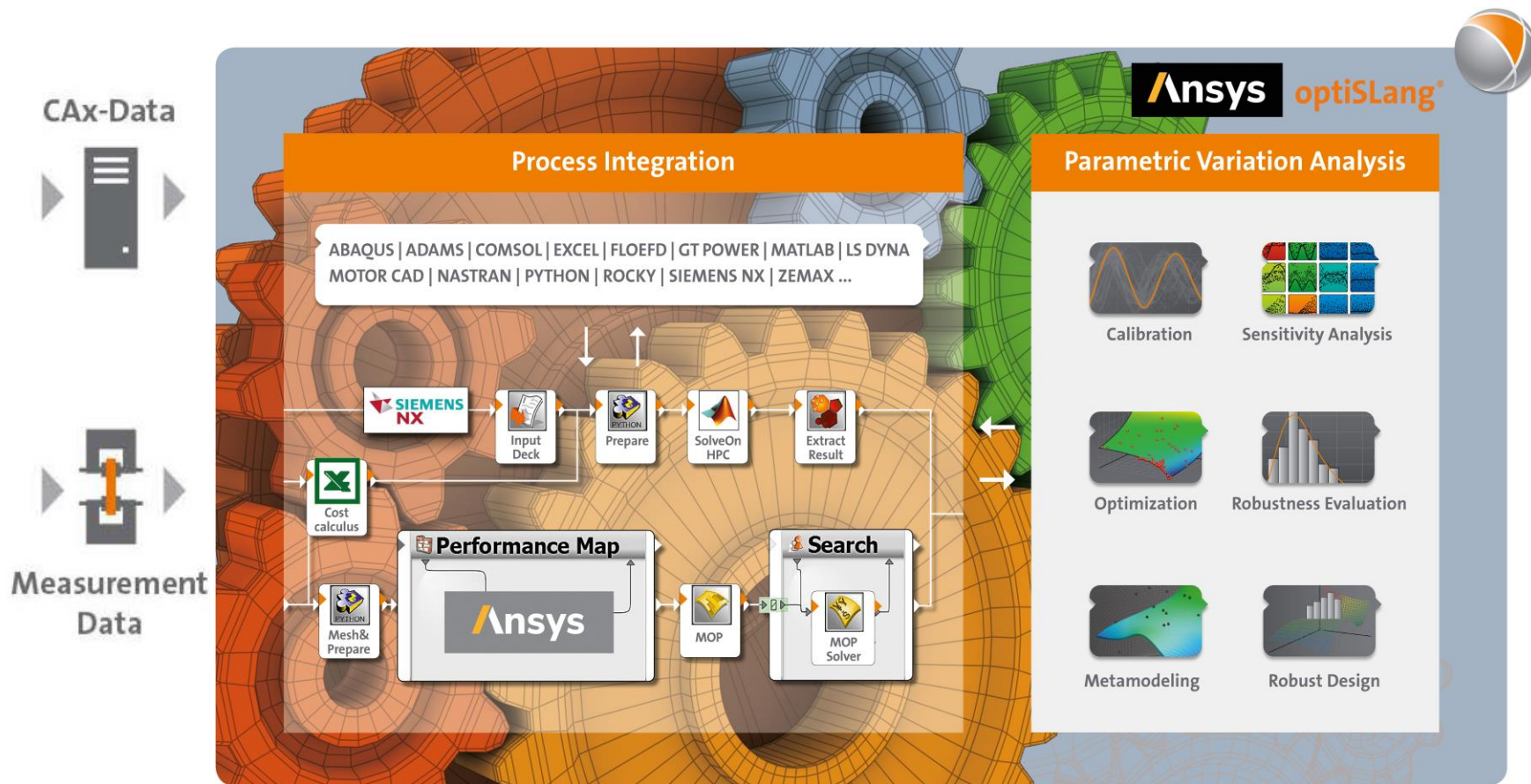


Field ROM ready for system simulation and predictive maintenance using digital twins

One flight forecast evaluation runs in seconds

完整且开放的PIDO平台

仿真流程和数据管理 (SPDM)



仿真流程和数据管理 (SPDM)

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