



Component Management and Postprocessing in KULI

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In many situations it is important to get a ***quick overview*** regarding...
在很多情况下，我们需要对结果有一个快速的浏览，关于

- What components are ***available***?
哪些零部件可以使用？
- Which component is the ***best for my application***?
哪些零部件最适合？
- How does a component ***perform at a certain operating point***?
某个零部件在特定工况下的表现？

Clear ***diagrams and tables*** then help to ***interpret the results*** intuitively.
清楚的图片和表格能够直观的解释结果

KULI can help you with this...
KULI可以帮助你实现这些.....



Introduction

An Example...

Problems and Solutions

Finding Possible Components

Comparison with KULI Components

Finetuning

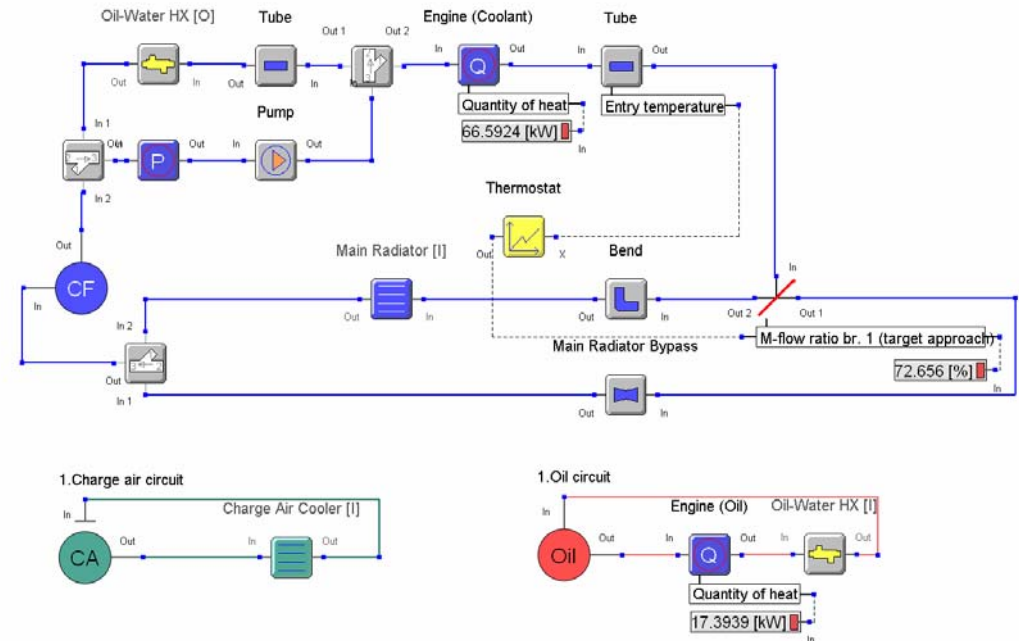
Statistics and Postprocessing

Conclusions and Outlook



An Example

Working cooling system: 冷却系统模型



	Heat Coolant 冷却液热量	Heat Oil 机油热量	Therm. Open 节温器开度	T Coolant 冷却液温度	T Oil 机油温度
V max 最大车速	66.59kW	17.39kW	27.34%	90.68°C	123.52°C
Load 负载条件	23.87kW	6.66kW	86.02%	98.81°C	125.88°C

Inserting a stronger engine

**Power increase
by 20% ?
功率增加20%?**



	Heat Coolant 冷 却液热量	Heat Oil 机油热量	Therm. Open 节温器开度	T Coolant 冷却液温度	T Oil 机油温度
V max 最大车速	79.91kW	20.87kW	69.51%	95.25°C	129.93°C
Load 负载条件	28.64kW	7.99kW	max	109.6°C	140.01°C



Target 目标:
Coolant temperature 冷却液温度 < 100°C
Oil temperature 机油温度 < 140°C

**Coolant and oil too hot!
冷却液和机油温度过高!**

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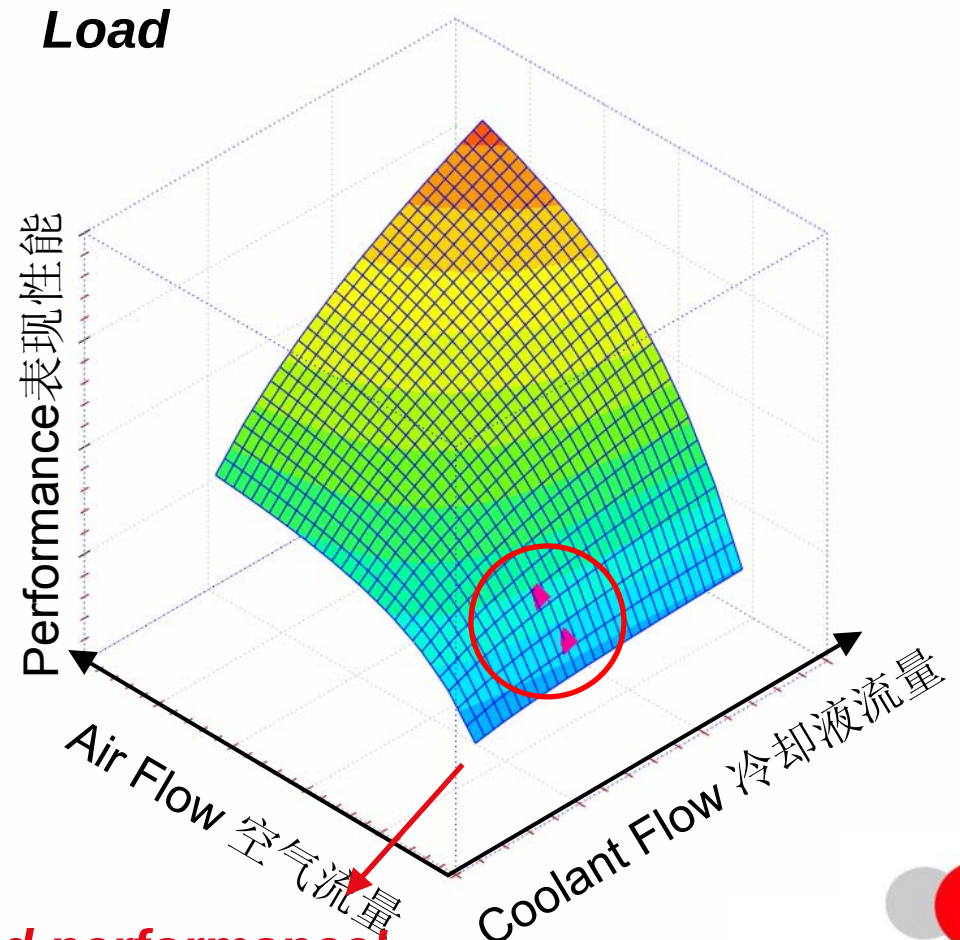
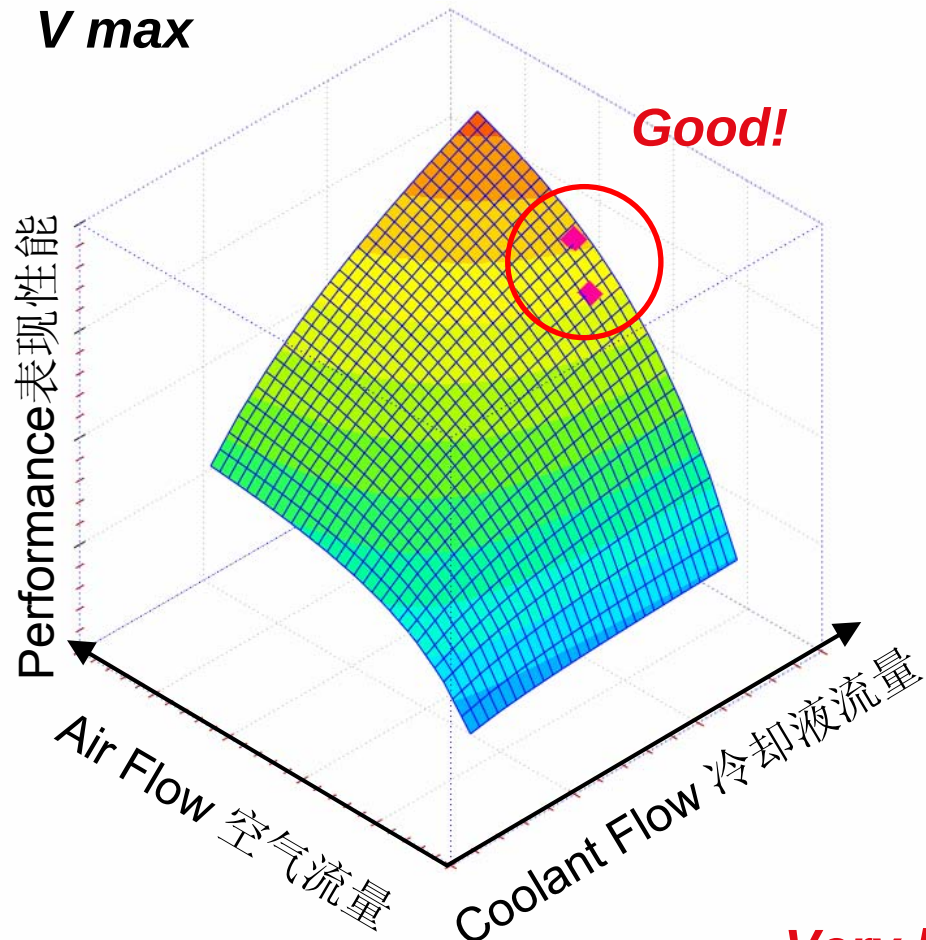
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Problems with the Main Radiator



Possible Solutions

Shape of characteristic

determined by

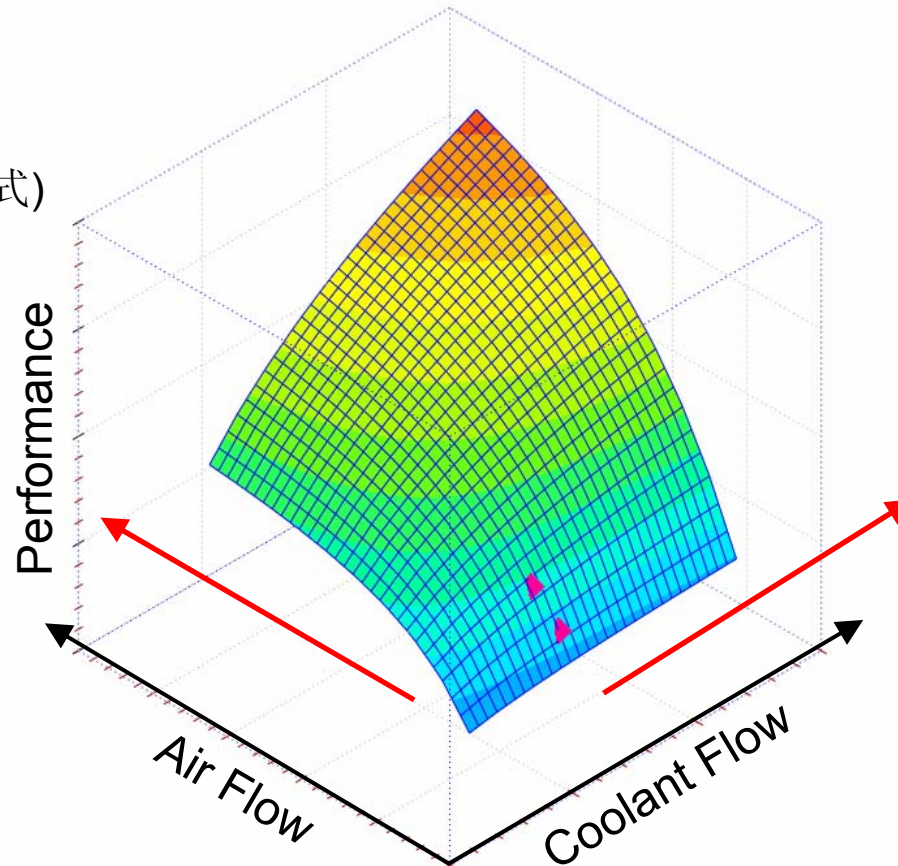
radiator type (eg.fins)

特性曲面的形状由散热器的类型所决定(例如:翅片形式)

- Stronger fan
更换更强的风扇
- Electrical fan
改用电风扇
- Larger air inlet
增加空气入口面积

High gain!

较大的改进效果!

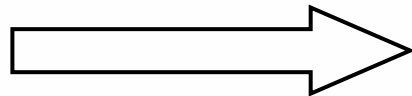


- Stronger coolant pump
更换更强的水泵
- Reduced system pressure loss
减少系统压力损失

Little gain!

较小的改进效果!

- What are the problematic **operating points**?
哪些是有问题的工况点？
- Find **best radiator for these points**
寻找适合这些工况点的散热器
- **Improve airflow**
改进空气流通
- **Improve coolant flow**
改进冷却液流量
- **Verify results**
验证结果



Operating point at:
工况点处于：

Coolant Flow 冷却液流量	: 1 kg/s
Air Flow 空气侧流量	: 0.68 kg/s

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Finding possible components

KULI Components 零部件:

Component Type 类型

Components Library 数据库

Size restrictions 尺寸限制

400mm < width 宽度 < 800mm

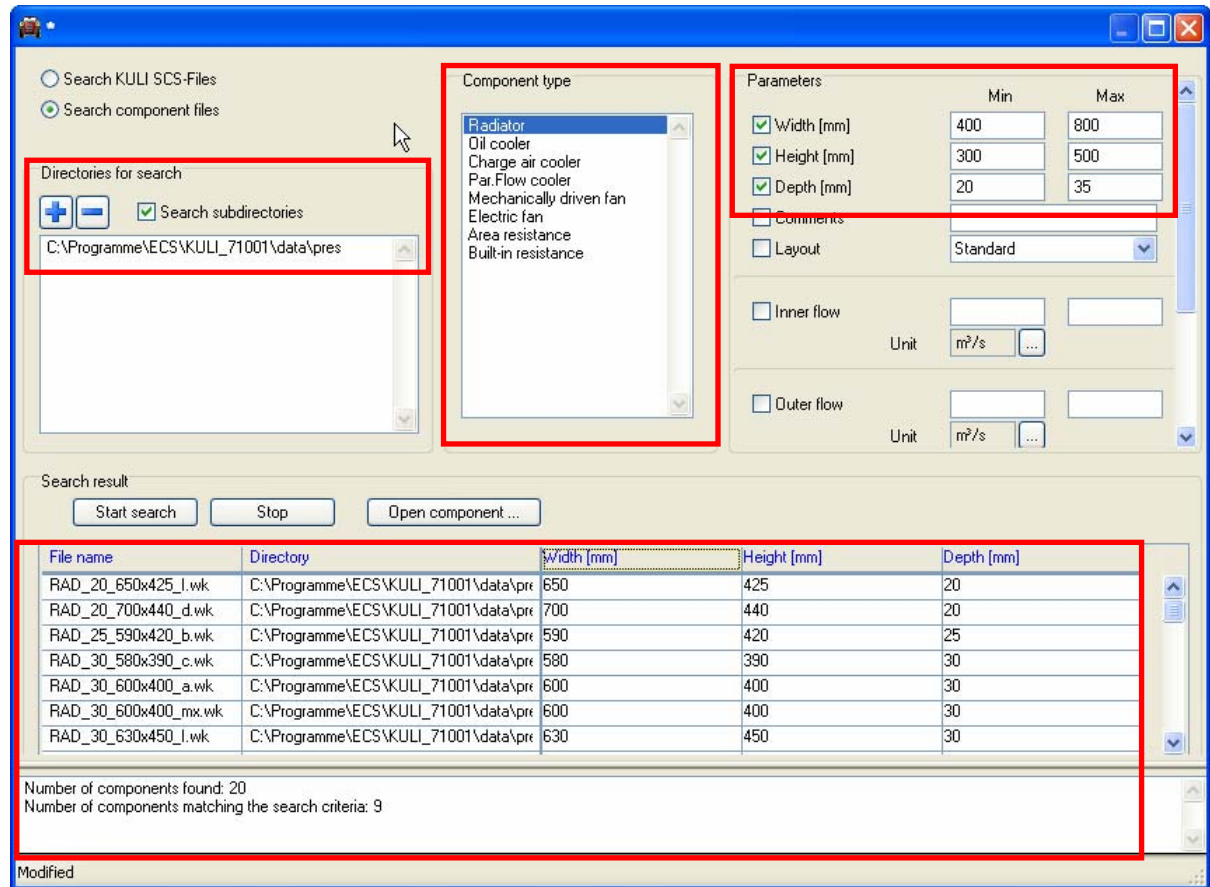
300mm < height 高度 < 500mm

20mm < depth 厚度 < 35mm

Result 结果

**9 of 20 components
fulfill all criteria!**

总共20个零部件, 9个满足要求



Search KULI SCS-Files
Search component files

Directories for search
+ - Search subdirectories
C:\Programme\ECS\KULI_71001\data\pres

Component type
Radiator
Oil cooler
Charge air cooler
Par.Flow cooler
Mechanically driven fan
Electric fan
Area resistance
Built-in resistance

Parameters

	Min	Max
☒ Width [mm]	400	800
☒ Height [mm]	300	500
☒ Depth [mm]	20	35
☐ Comments		
☐ Layout	Standard	
☐ Inner flow		
Unit	m³/s	
☐ Outer flow		
Unit	m³/s	

Search result

Start search Stop Open component ...

File name	Directory	width [mm]	Height [mm]	Depth [mm]
RAD_20_650x425_l.wk	C:\Programme\ECS\KULI_71001\data\pres	650	425	20
RAD_20_700x440_d.wk	C:\Programme\ECS\KULI_71001\data\pres	700	440	20
RAD_25_590x420_b.wk	C:\Programme\ECS\KULI_71001\data\pres	590	420	25
RAD_30_580x390_c.wk	C:\Programme\ECS\KULI_71001\data\pres	580	390	30
RAD_30_600x400_a.wk	C:\Programme\ECS\KULI_71001\data\pres	600	400	30
RAD_30_600x400_mx.wk	C:\Programme\ECS\KULI_71001\data\pres	600	400	30
RAD_30_630x450_l.wk	C:\Programme\ECS\KULI_71001\data\pres	630	450	30

Number of components found: 20
Number of components matching the search criteria: 9

Modified

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Comparison with KULI Components

Select radiators...

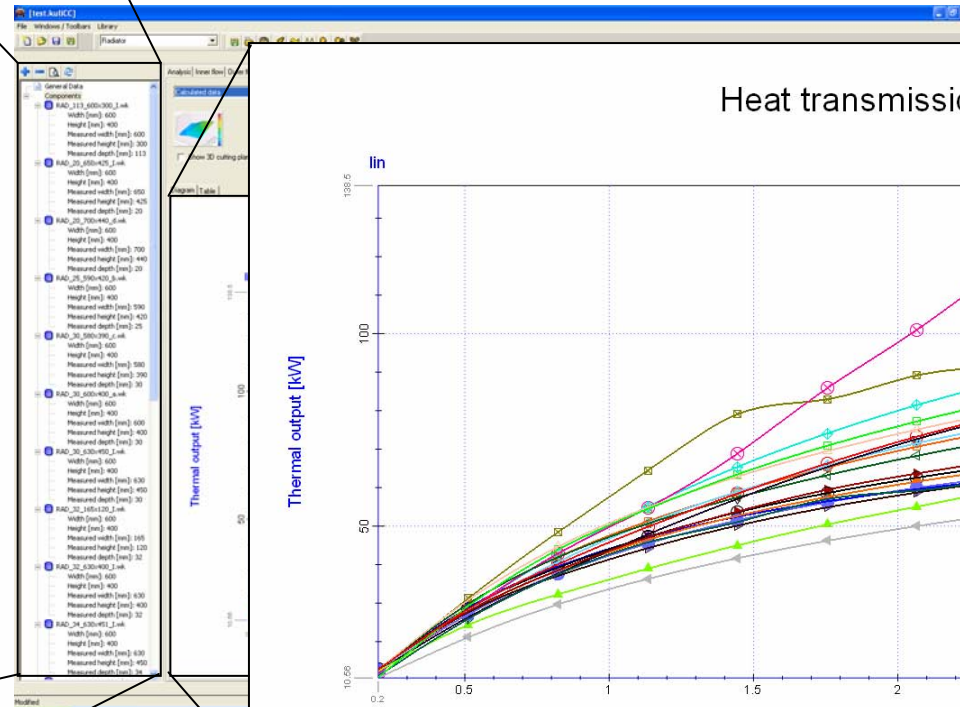
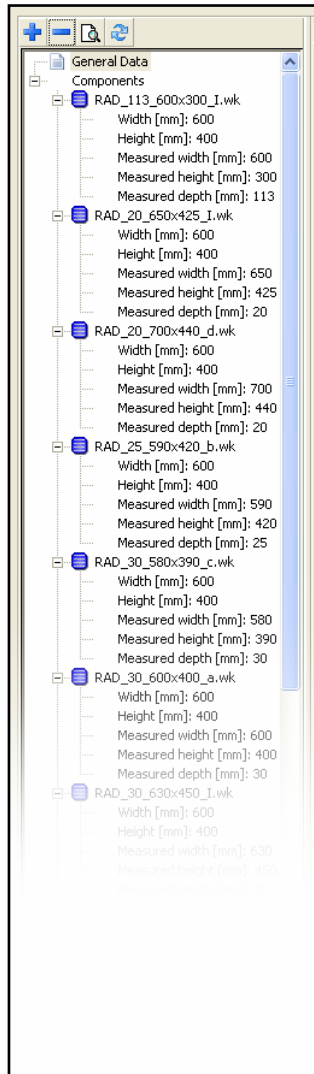
选择散热器

Scale to common size (600mm x 400mm)...

改变尺寸至 (600mm x 400mm)...

Compare performance!

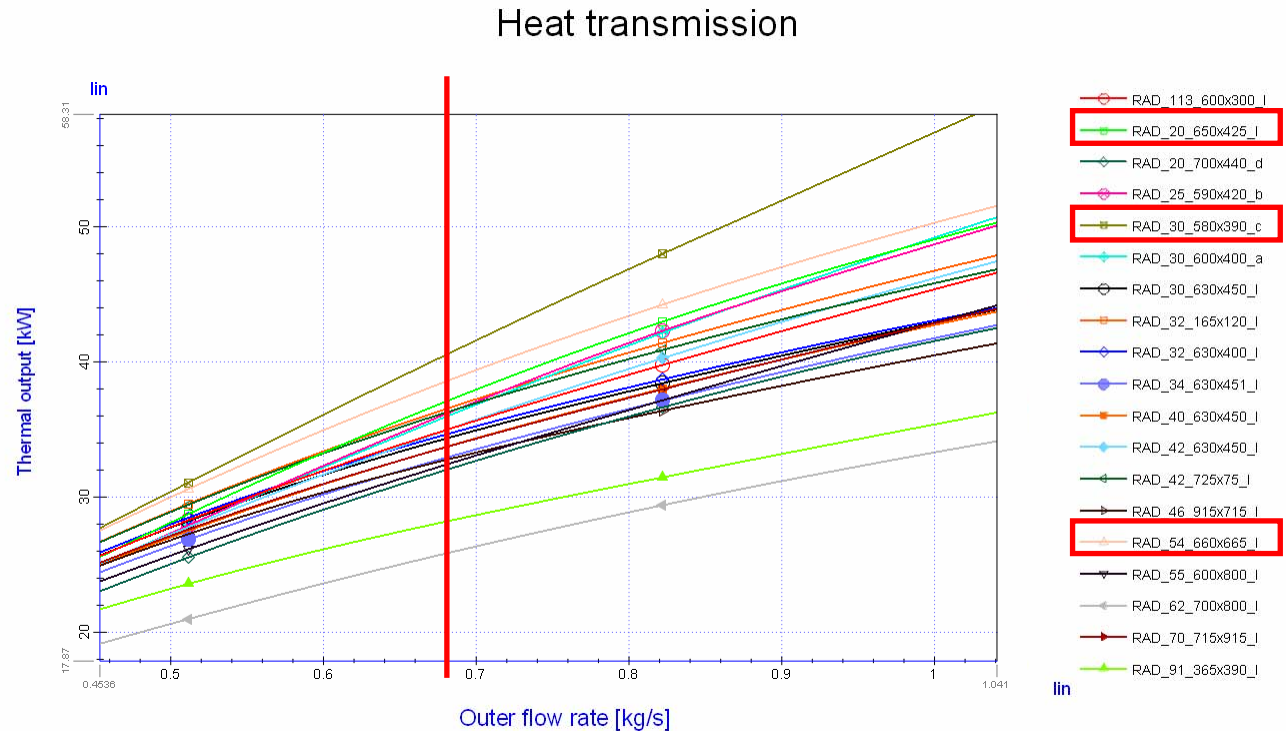
比较性能差异!



Comparison of performance

Performance at...
性能表现.....

Coolant 冷却液 : 1 kg/s
Air 空气流量 : 0.68 kg/s

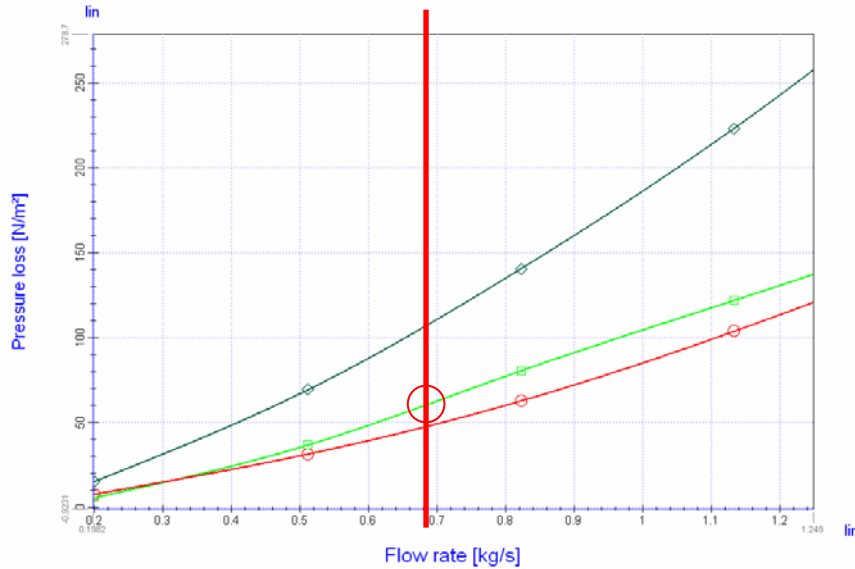


3 possible candidates...
3个可行的候选散热器

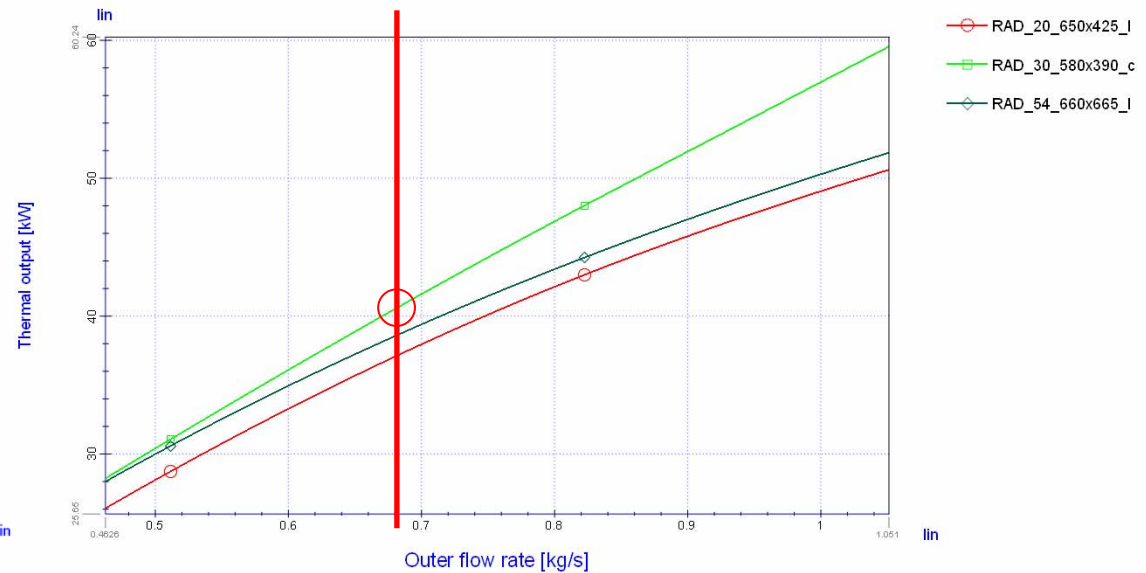
Evaluation of pressure loss!
评估其压力损失!

The Decision

External pressure loss



Heat transmission



The **Green** radiator has **best performance** and **very low pressure loss**!
绿色的散热器有较佳的性能表现，并有较低的压力损失！

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Using the improved radiator

The ***new radiator improves*** the situation a lot!
新的散热器改进了存在的问题！

	Therm. open	T Coolant	T Oil
V max	30.41%	90.38°C	127.72°C
Load	max	101.4°C	133.18°C

109.6°C

140.01°C

But we still need to ***cool down the coolant a little bit more...***
但是我们仍旧需要降低一些冷却液温度.....

Additional steps

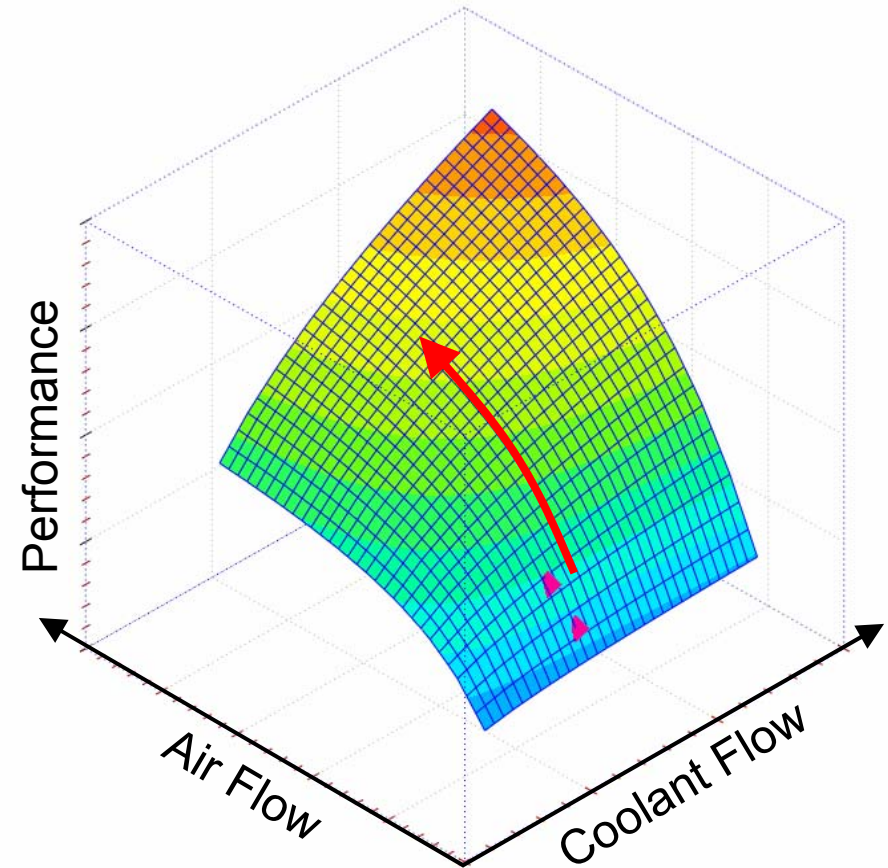
We can also try to *improve the air flow*
我们尝试改进空气流动

Transmission ratio of mechanical fan
将机械风扇的传动比调整为1.5

~~1.1~~ → 1.5

	Therm. open	T Coolant	T Oil
V max	28.8%	90.30°C	127.89°C
Load	88.6%	99.08°C	130.24°C

Everything OK!



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How stable is this cooling system, if we apply an error to...

冷却系统的稳定性如何

... ***oil pump*** volume flow,

油泵的体积流量,

... ***water pump*** volume flow and

水泵的体积流量 以及

... ***turbo charger air temperature?***

涡轮增压器的空气温度

We will use ***Monte Carlo Simulation*** to find out!

我们将使用***Monte Carlo***分析方法来求解！

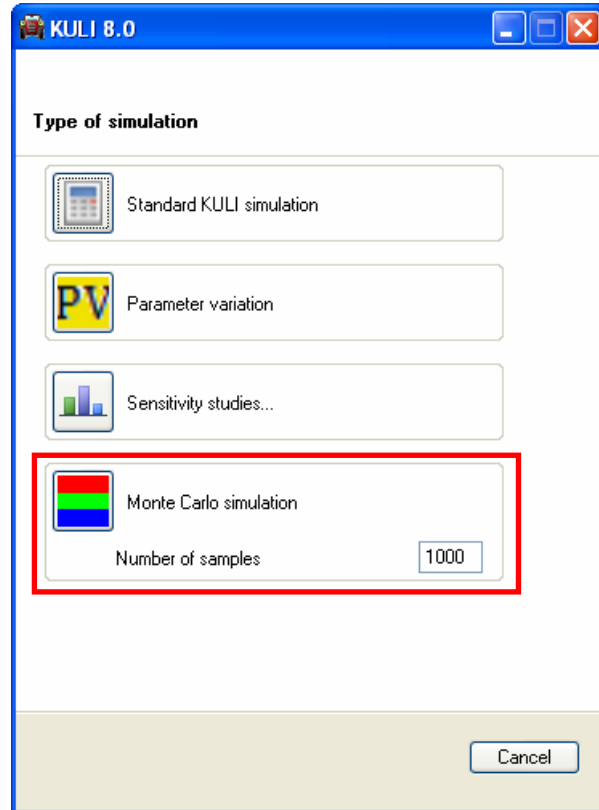
- **Oil** pump
油泵
- **Water** pump
水泵
- **Charge air**
涡轮增压

by adding ***normally distributed errors***
with
添加正态分布的偏差值

- **mean values** μ
平均值
- **standard deviation** σ
标准差



Starting the Monte Carlo Simulation



Then we start a
Monte Carlo Simulation
with a **sample size of 1000...**
然后我们开始**Monte Carlo**计算
采样尺寸为1000

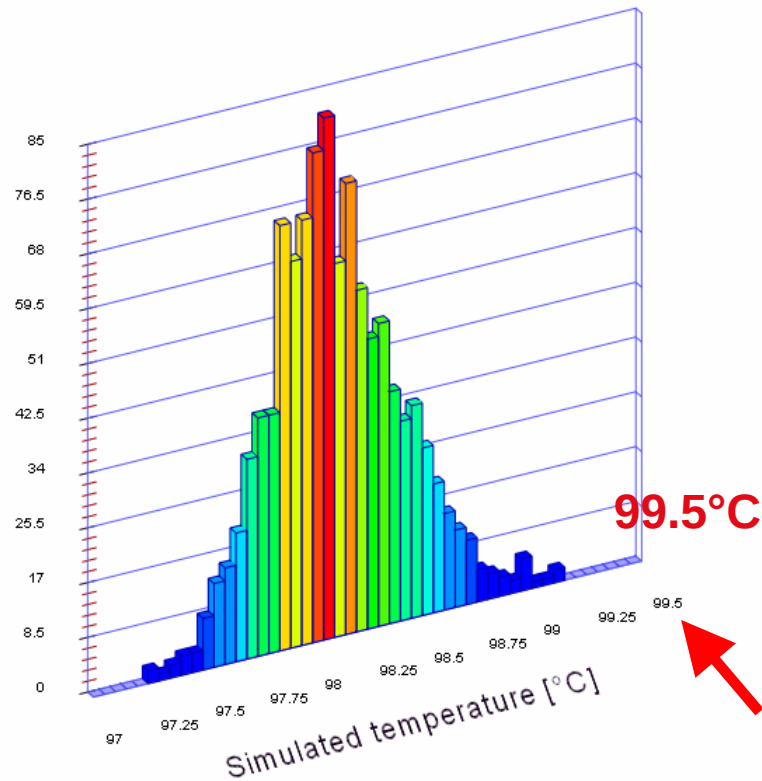
... to investigate the ***influence of the errors on oil and water temperature!***
用于分析偏差值对水、油的影响

Statistical Results in the Postprocessor

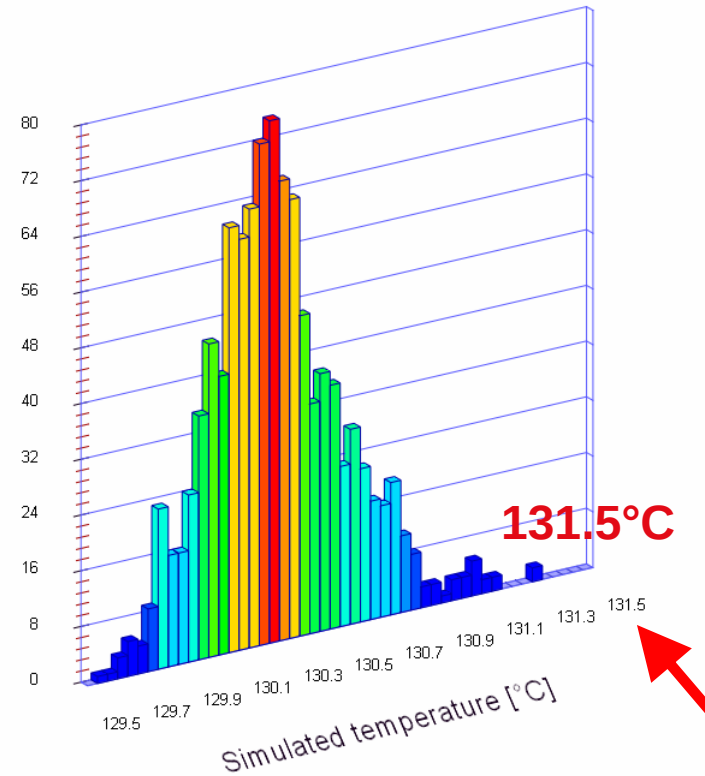
Number: Simulated temperature, 1.Water circuit

Number: Simulated temperature, 1.Oil circuit

Simulated temperature, 1.Water circuit



Simulated temperature, 1.Oil circuit



We see that
oil and water
**do not reach
critical levels!**
我们发现不管是
水温还是油温都
处于安全水平!

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So finally we have
最后我们拥有了

- Scaled an engine to **120% performance**
能力提高至120%的引擎
- **Identified problems** in the cooling system
明确的冷却系统问题
- Set up a **solution strategy**
解决方案的策略
- Found a new **optimal radiator**
最理想的散热器
- **Optimized** the cooling system
最优化的冷却系统
- Verified the **stability** with **statistical methods**
使用统计方法判定了的系统稳定性

Extended Statistics will be available in KULI 8!
拓展的统计分析能力将在KULI 8中实现！





Thank you for your attention!

