Technology that makes its mark

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Pumps ▪ Valves ▪ Service

KSB

Optimization of new centrifugal pump with space guide vane

Shanghai KSB Pump Co., LTD.

Li Haifeng
2017-10-27

强大的生产基地

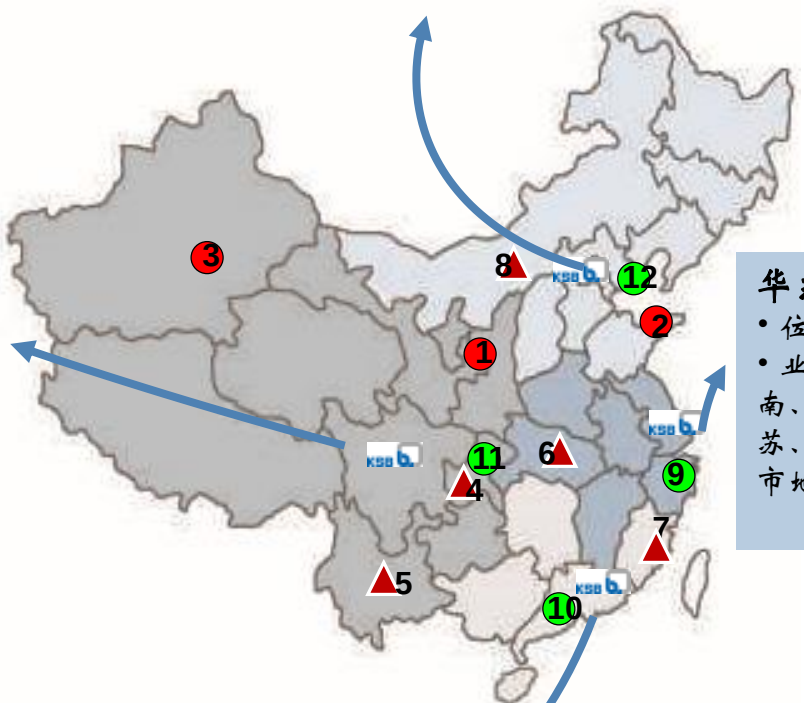
上海凯士比泵有限公司

- 坐落于上海闵行工业园区
- 占地137,000平方米
- 上海凯士比有限公司是上海电气与KSB集团的
  合资公司
- 注册资金2700万美金
- 总投资2980万美金
- 约900 员工

国内现有销售网络

北方销售分公司
- 位于北京市
- 业务覆盖北京、天津、黑龙江、吉林、辽宁、内蒙古、河北、山西、山东各省市地区。

西部销售分公司
- 位于成都市
- 业务覆盖四川、重庆、贵州、陕西、甘肃、云南、宁夏、青海、新疆、西藏各省市地区。



华东销售分公司
- 位于上海市
- 业务覆盖上海、河南、湖北、安徽、江苏、浙江、江西各省市地区。

南方销售分公司
- 位于广州市
- 业务覆盖福建、广东、广西、海南、湖南各省市地区。

KSB 分公司

● 办事处
1. 西安
2. 青岛
3. 乌鲁木齐

▲ 办公室（常驻工程师）
4. 重庆
5. 昆明
6. 武汉
7. 厦门
7. 呼和浩特

● 售后服务中心
9. 上海
10. 广州
11. 重庆
12. 天津（在建中）

凯士比中国 – 泵：上海凯士比泵提供一流产品

KSB 已成为中国提供先进泵类产品之最重要供应商

产品链

Movitec

Amacan

Amarex KRT

SEZ

Omega

RDL/O

HG

CHTC

Magnochem

Etanorm

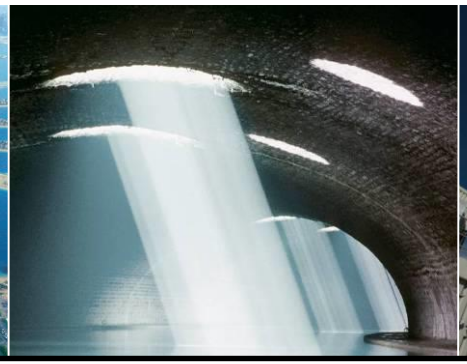
CPK/N

HPKL

KSB

KSB 中国 – 泵: 适用行业

清水 | 污水 | 工业 | 能源 | 楼宇


应用领域

- 取水
- 脱盐
- 水处理
- 水运输
- 灌溉

- 废水处理
- 污水泵站
- 雨水泵站

- 基础工业
- 流程工艺
- 热水运送
- 化工/石化
- 航运

- 燃料电站
- 联合循环电站
- 核电站
- 可再生能源

- 楼宇供水/排水
- 卫生设备
- 供暖
- 通风空调系统

Contents

- Introduction
- Impeller & guide vane design
- Optimization in CAESES
- Conclusion

Impeller and guide vane design

设计参数

	单位	参数值	备注
流量Qopt	m^3/h	550	
扬程	m	40~45	
效率	%	84.7%	达到GB 19762-2007 单级单吸清水离心泵节能要求值
转速	rpm	1480	
介质		常温清水	

结构设计要求

参数	单位	叶轮	导叶
结构形式		闭式离心式叶轮	空间导叶形式
轴孔直径dk	mm	≥80	≥115
轮毂直径	mm	≥95	≥130
叶片数		5或7	7~9

Impeller and guide vane design

设计参数

	单位	参数值	备注
流量Qopt	m^3/h	550/500	
扬程	m	40~45/33~35	
效率	%	84.7%	达到GB 19762-2007 单级单吸清水离心泵节能要求值
转速	rpm	1480	
介质		常温清水	

结构设计要求

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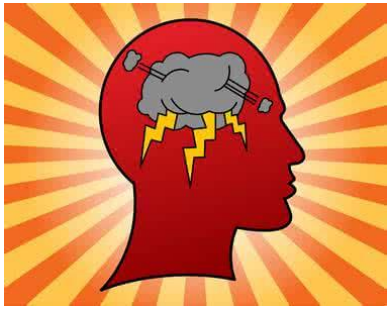
Impeller and guide vane design

- 参考模型：公司原有的水力模型
- 设计软件：内部软件
- 建模软件：UG
- 优化软件：CAESES
- 模拟软件：CFX18.0

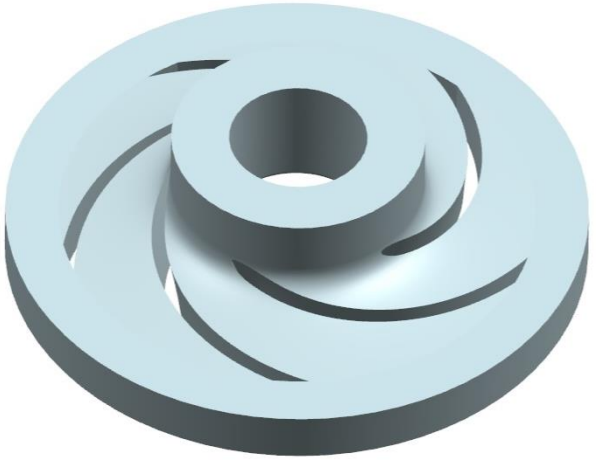


开发流程

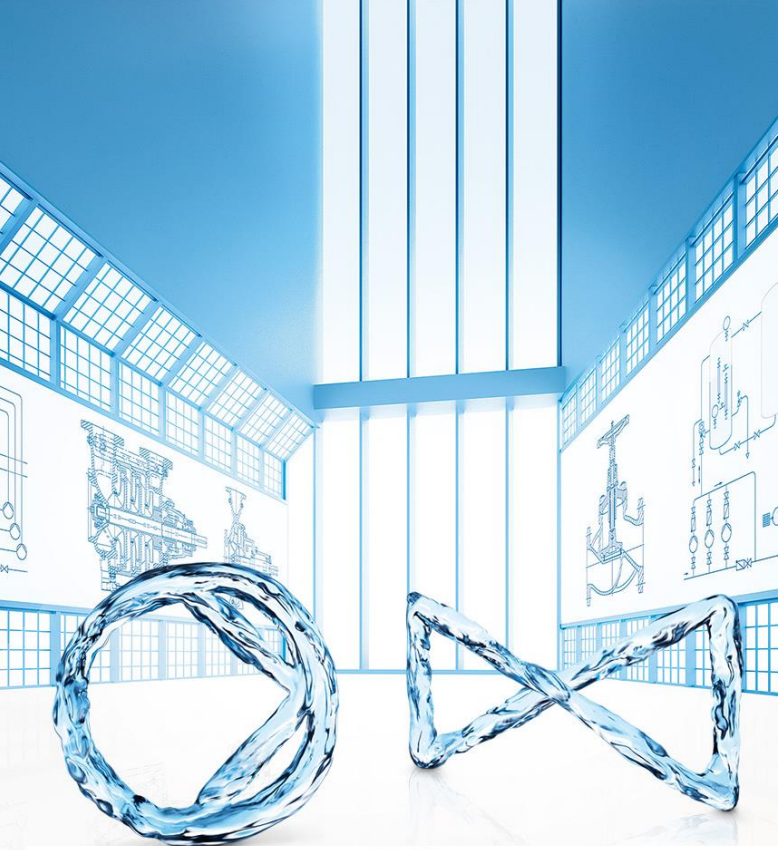
1. 参考已有的水力模型设计叶轮
2. 凡方软件设计空间导叶
3. UG软件将叶轮和导叶装配为级泵
4. CFX数值模拟，预测水泵性能，分析流场结构
5. 根据分析结果重复上述4步，直到满足设计要求。

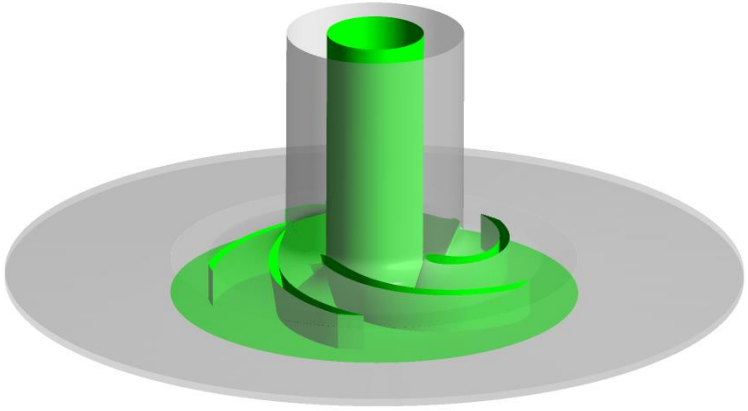
Impeller design and simulation

水泵扬程要在40-45m之间，因此初步设计叶轮扬程为45m



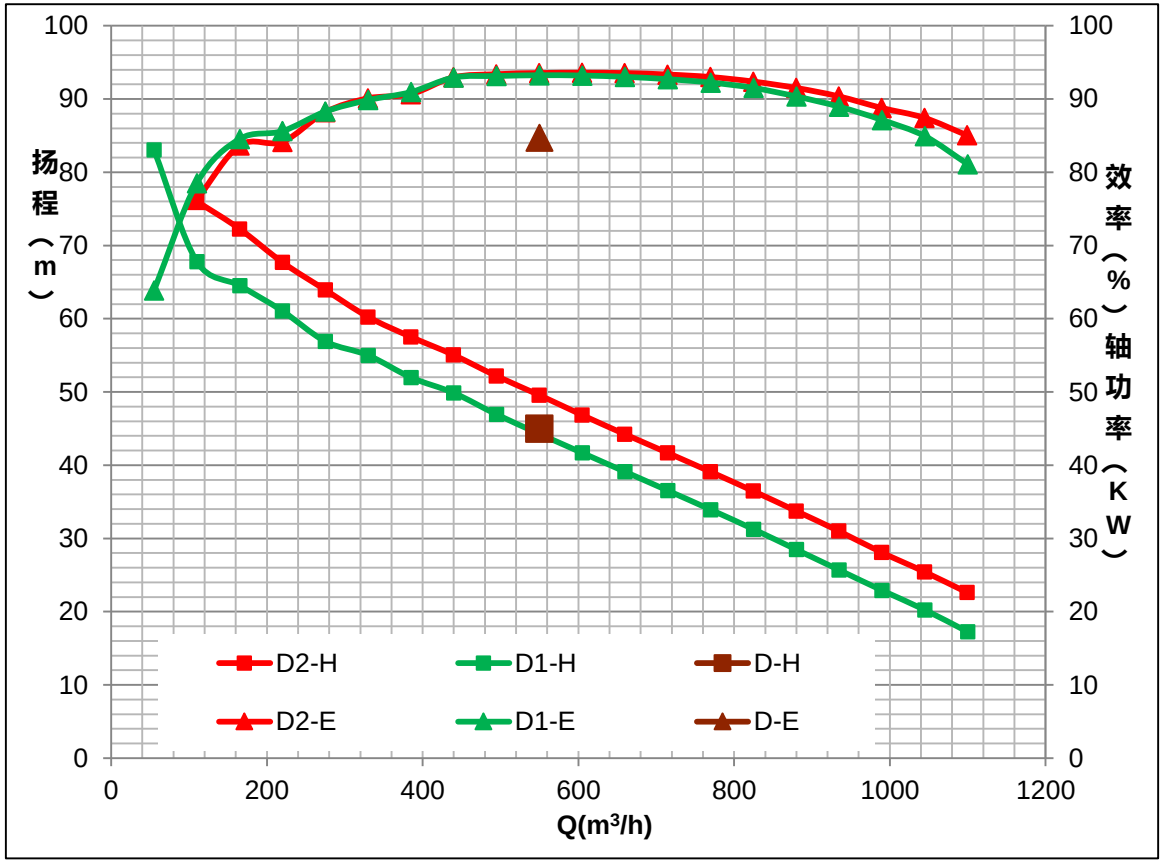
	比转速 Ns	叶轮外径 D_2(mm)	进口直径 D_j (mm)	轮毂直径 D_h(mm)	叶片数 z	叶片包角 ϕ（°）	出口宽度 b（mm）	出口角 β_2（°）
D1	121.5	402.7	214.4	116.8	5	93	42	22.5
D2	121.5	389	212.1	113	5	93	44.5	22.5





Impeller and guide vane design

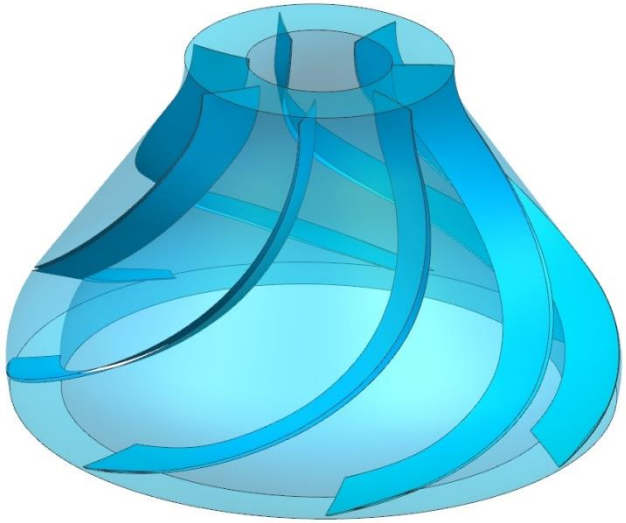
水泵扬程要在40-45m之间，因此初步设计叶轮扬程为45m

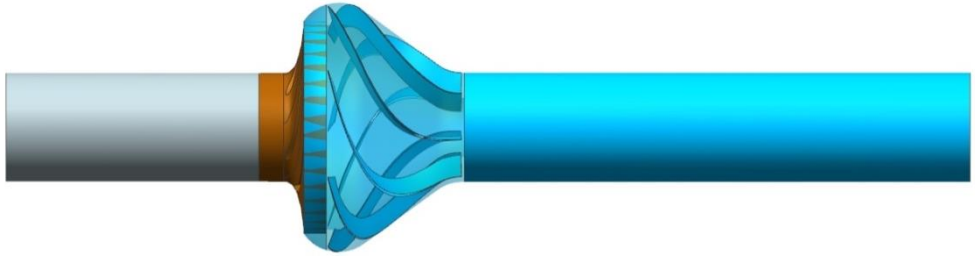


Impeller and guide vane design

IMP2+Diff1

	叶轮外径 D_2 (mm)	进口直径 D_j (mm)	出口轮毂直径 D_h	叶片数 z
Diff1	214.4	489	116.8	7





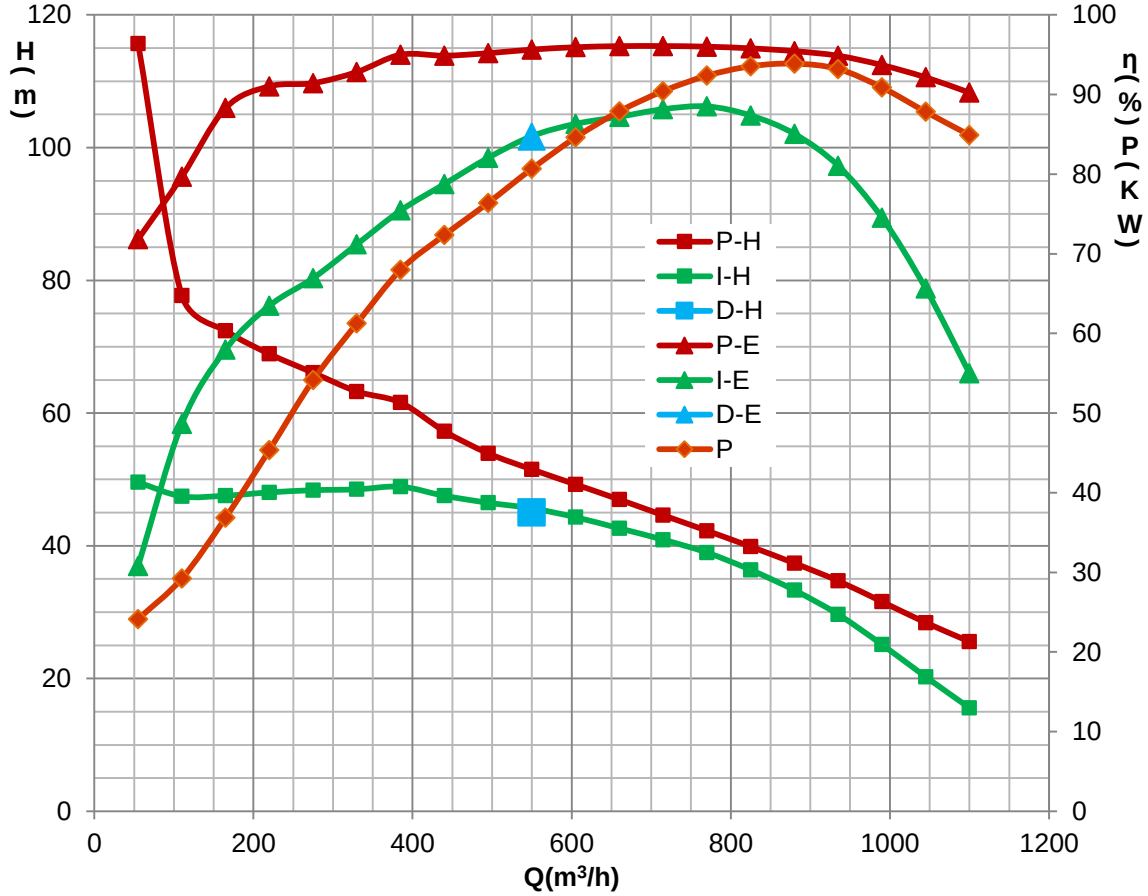
Impeller and guide vane design

IMP2+Diff1

出口流量 (m^3/h)	水泵扬程 (m)	水泵效率 (%)	轴功率 (KW)	叶轮扬程 (m)	叶轮效率 (%)
55	49.57	30.78	24	115.70	71.84
110	47.45	48.65	29	77.72	79.68
165	47.56	57.98	37	72.43	88.31
220	48.05	63.48	45	68.92	91.03
275	48.38	66.94	54	66.08	91.43
330	48.51	71.19	61	63.26	92.83
385	48.91	75.44	68	61.58	95.00
440	47.54	78.76	72	57.27	94.88
495	46.49	82.05	76	53.94	95.19
550	45.65	84.78	81	51.51	95.65
605	44.31	86.32	85	49.25	95.94
660	42.63	87.21	88	46.97	96.08
715	40.93	88.16	90	44.61	96.09
770	38.98	88.51	92	42.28	96.01
825	36.37	87.37	94	39.88	95.80
880	33.31	85.06	94	37.38	95.45
935	29.66	81.05	93	34.71	94.87
990	25.12	74.54	91	31.58	93.70
1045	20.26	65.65	88	28.43	92.16
1100	15.58	54.99	85	25.57	90.24

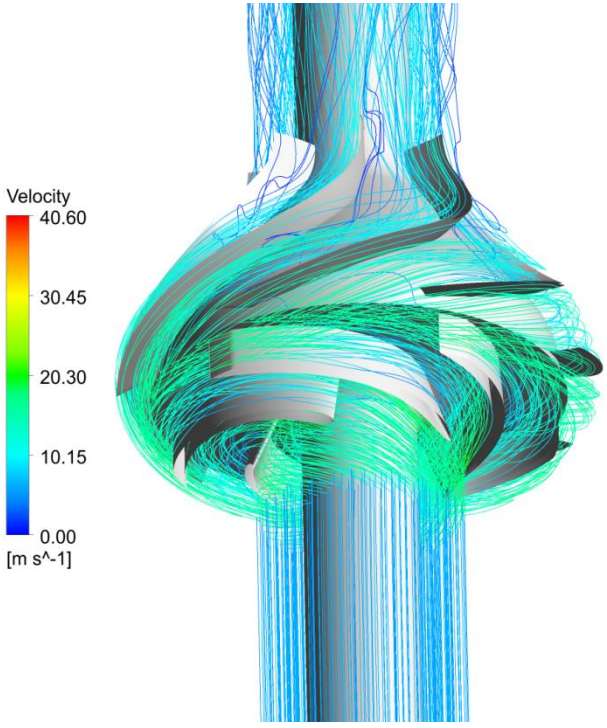
Impeller and guide vane design

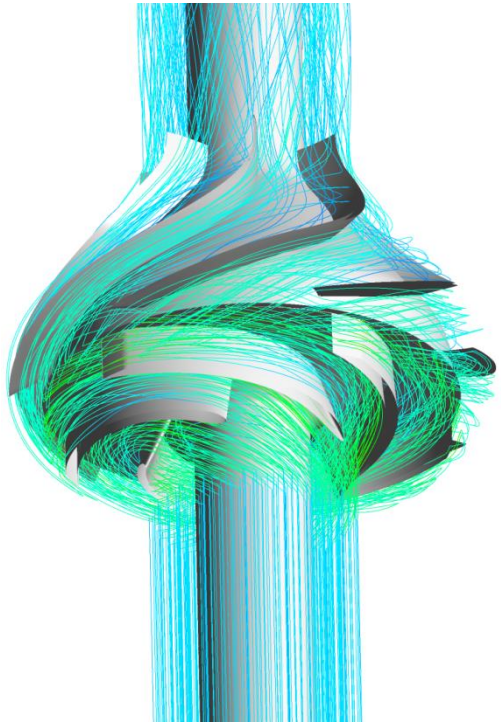
IMP2+Diff1



Impeller and guide vane design

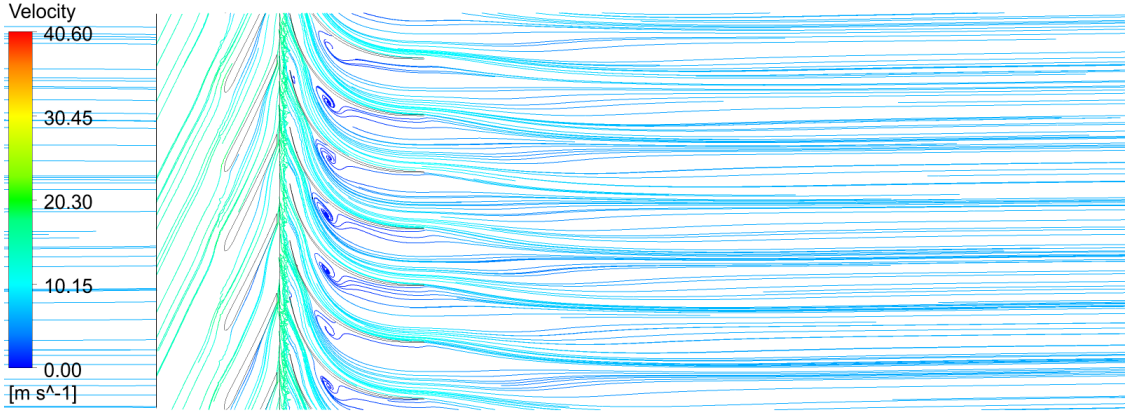
IMP2+Diff1

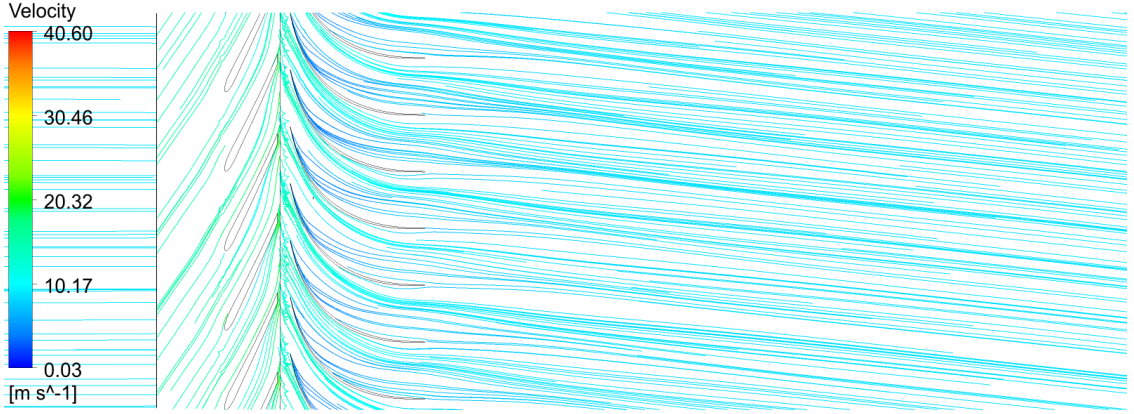




Impeller and guide vane design

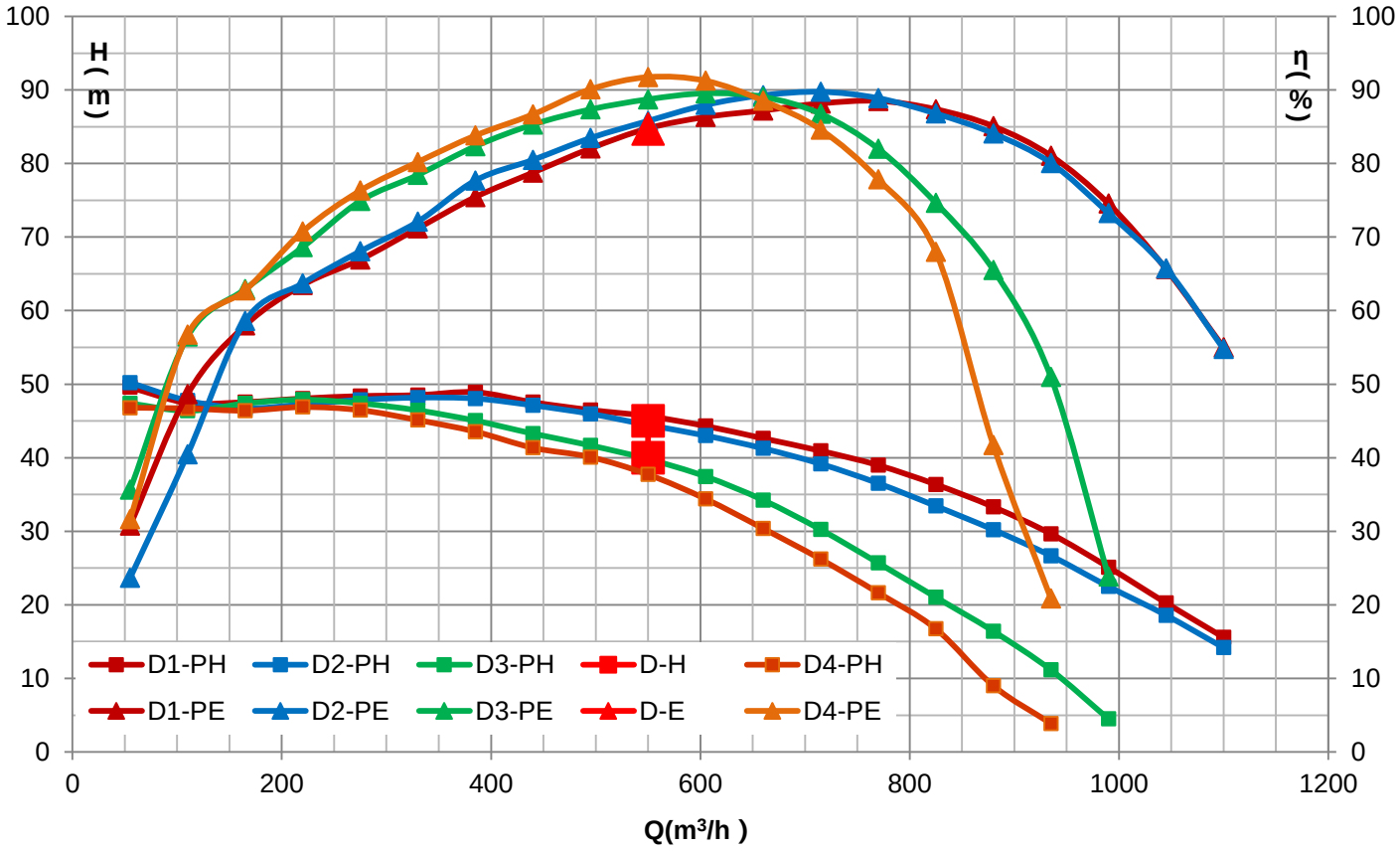
IMP2+Diff1





Impeller and guide vane design

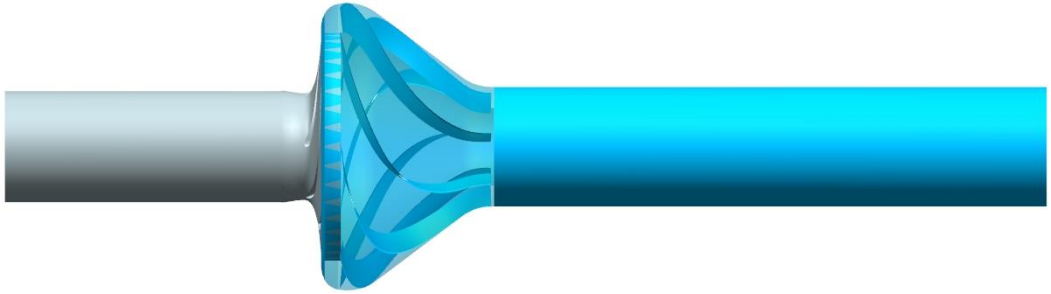
IMP3+Diff3



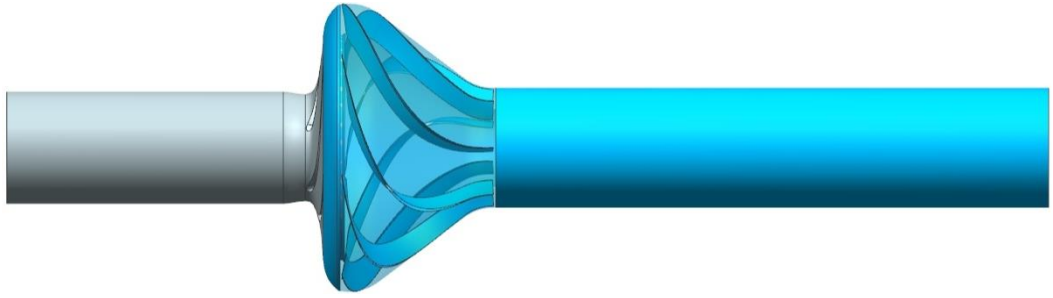
Impeller and guide vane design

新开发的空间导叶式离心泵满足设计要求，即性能满足设计要求，结构满足设计要求。其中第三种模型满足设计要求，第四种模型高效，扬程还需进一步提高。

IMP3+Diff2



IMP3+Diff3

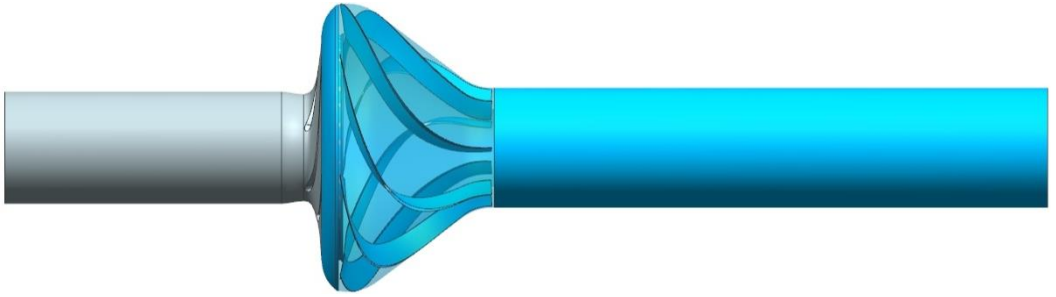


Impeller and guide vane design

1. 利用软件可以快速得到性能优异的水力模型
2. 关老师软件存在诸多经验参数，需要慎重选择
3. 设计-模拟-分析-再设计的开发流程繁复
4. 泵结构参数多，参数对性能的影响程度
5. 水泵参数化建模，计算机硬件水平

Optimization in CAESES

IMP3+Diff3



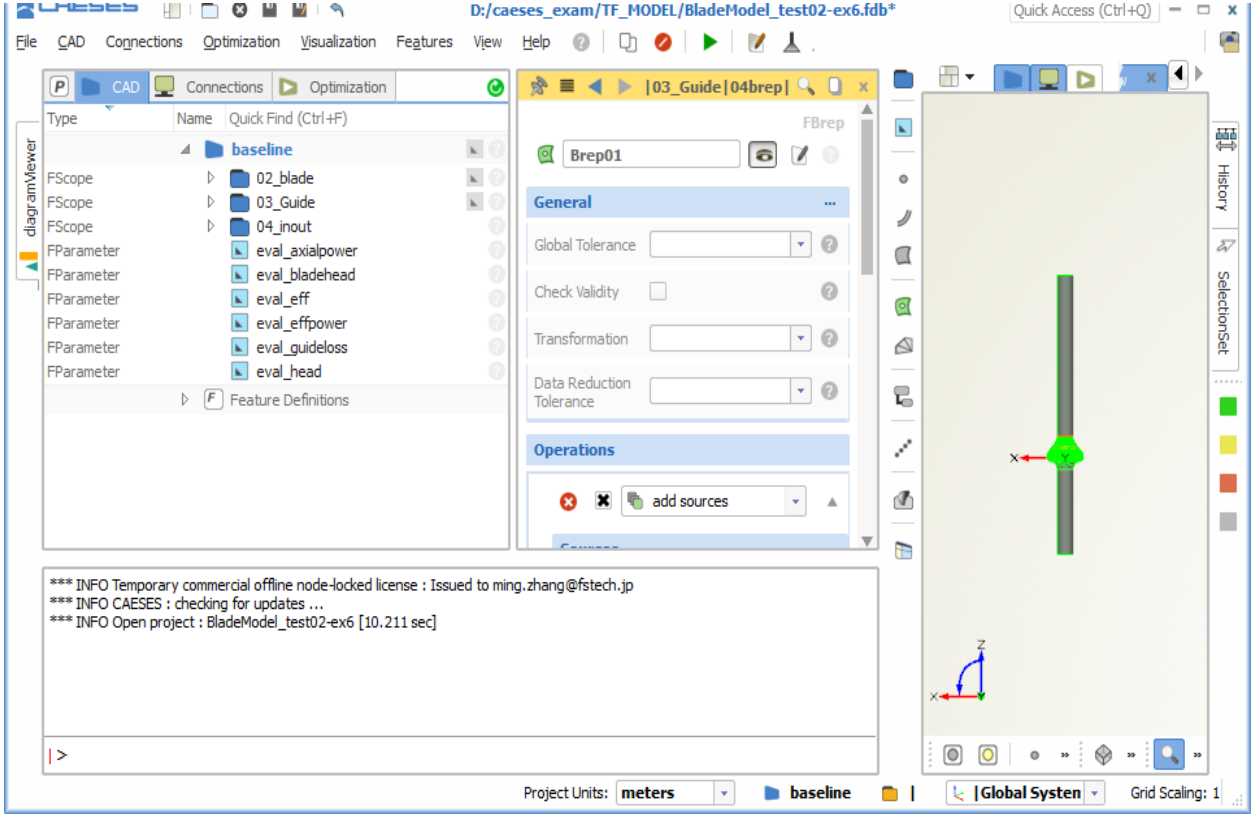
How to optimize?

Manual & software

Parametric modeling for the blades & vanes

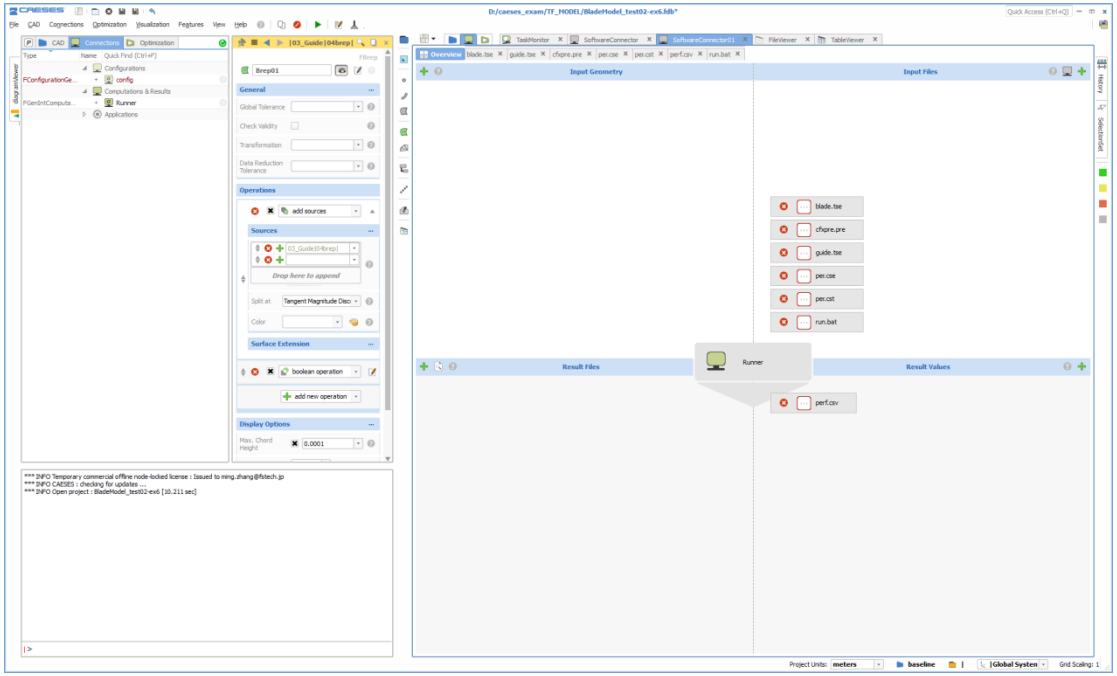
Optimization in CAESES

CAESES



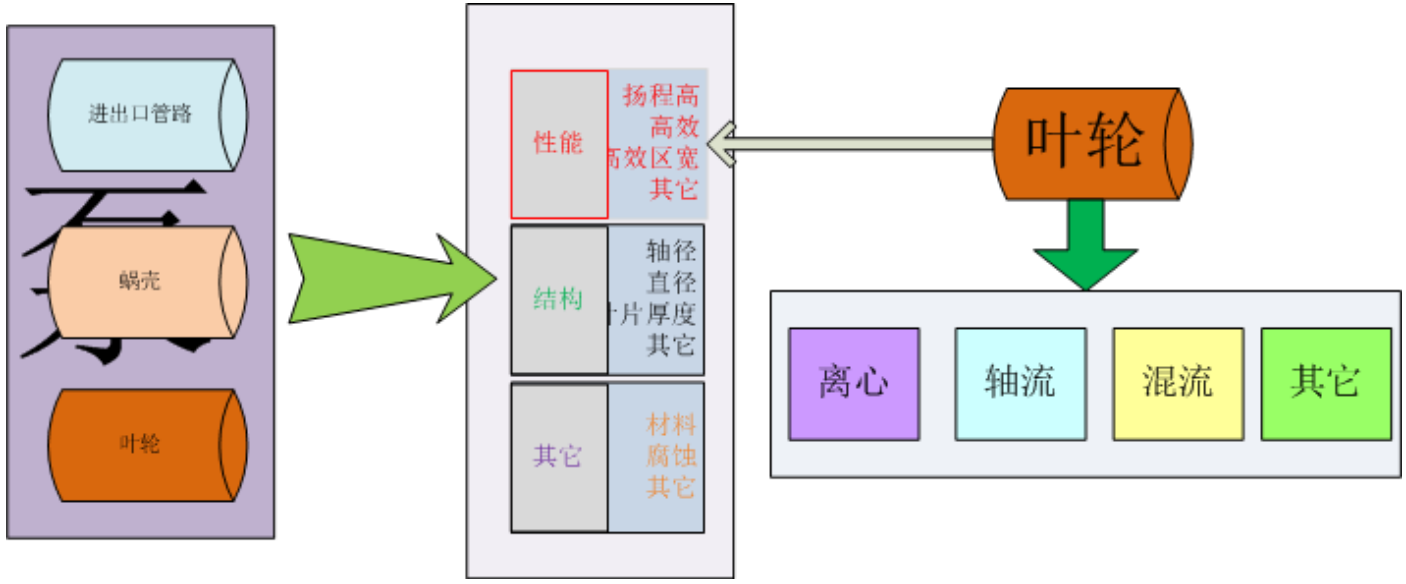
Optimization in CAESES

CAESES



Optimization in CAESES

Parametric modeling for the blades & vanes

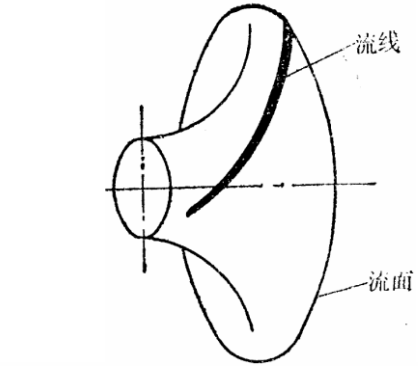


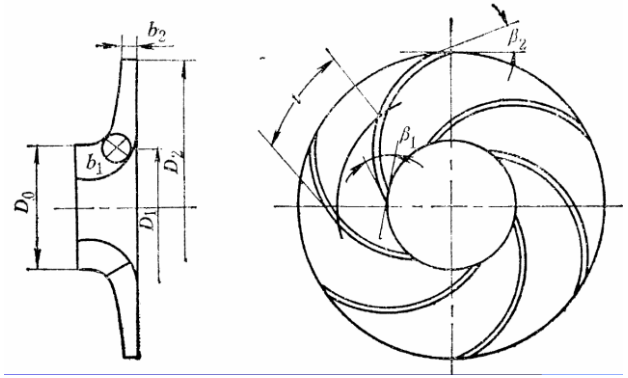
Parametric modeling for the blades & vanes

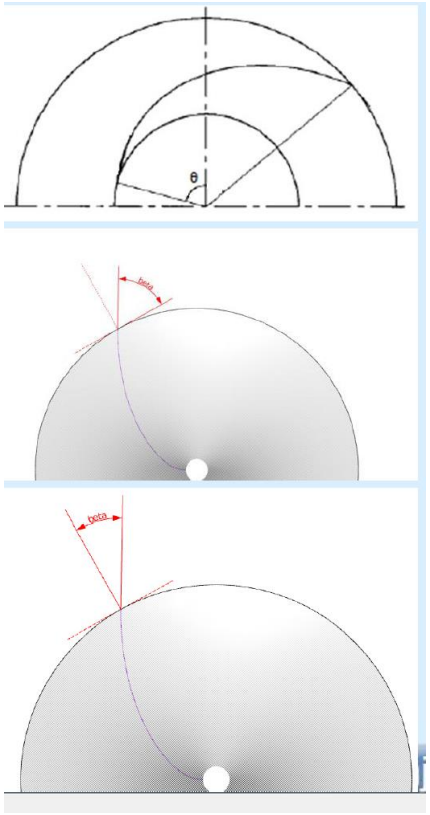
叶轮主要几何参数

汽蚀性能	叶轮进口直径Dj	效率
	叶片进口直径D1	
	叶轮轮毂直径dh	
	叶片进口宽度b1	
	叶片进口角β1	
性能	叶轮出口直径D2	
	叶轮出口宽度b2	
	叶片出口角度β2	
	叶片数z	
	叶片包角φ	

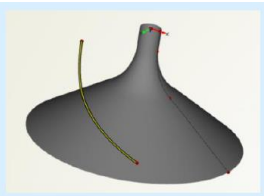
现代泵技术手册，P187

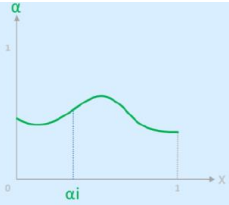


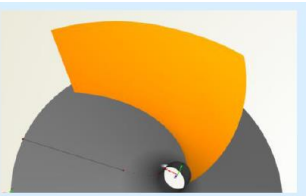




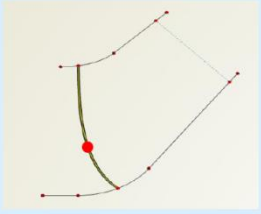
Optimization in CAESES

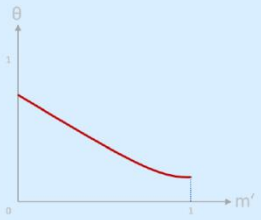


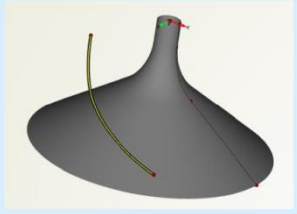




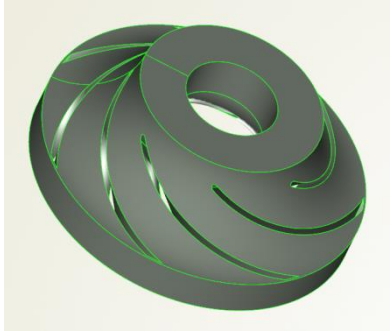
Stream Section + Distributions = Camber Surface

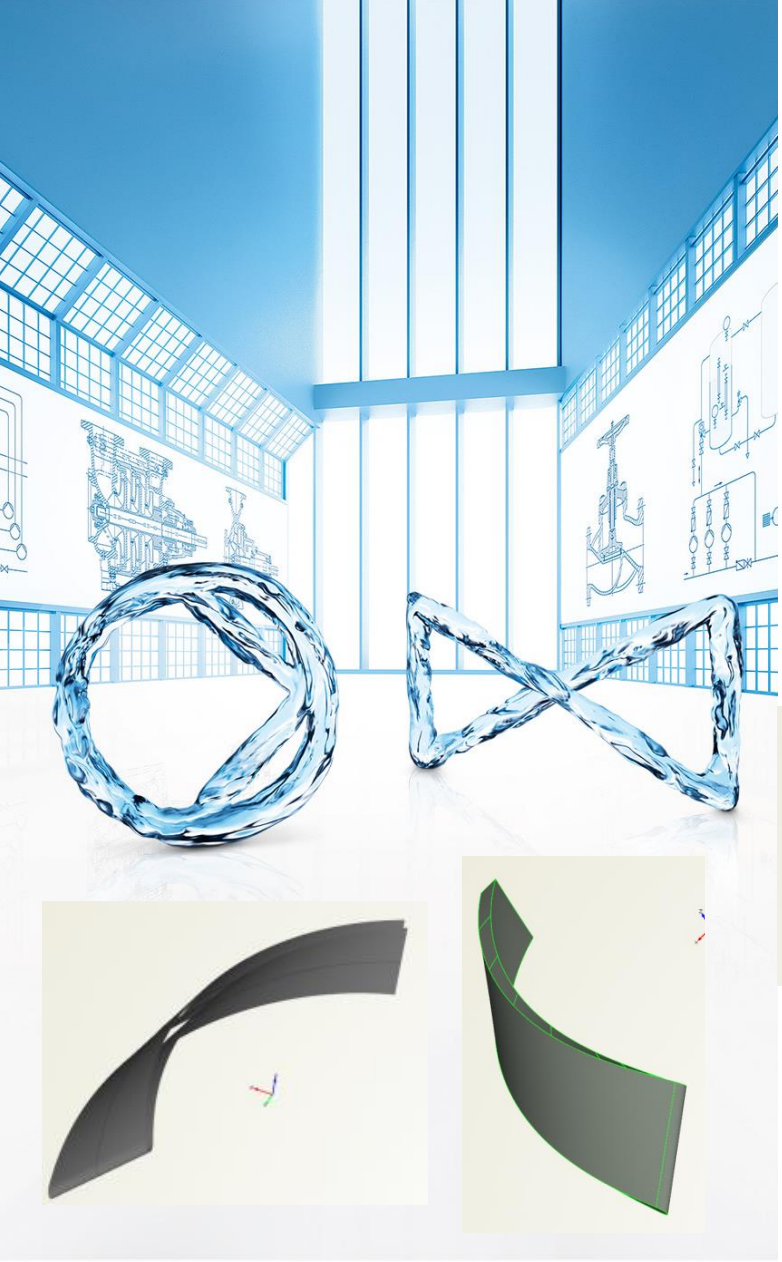






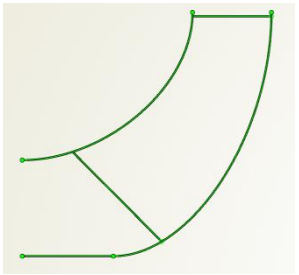
Hub and Shroud Stacking Axis Radius + Mean Camber Definition = 3D Stream Section

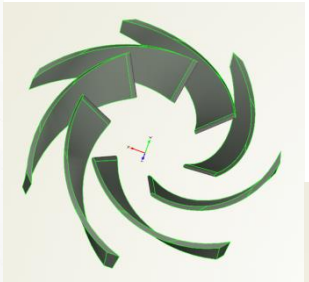


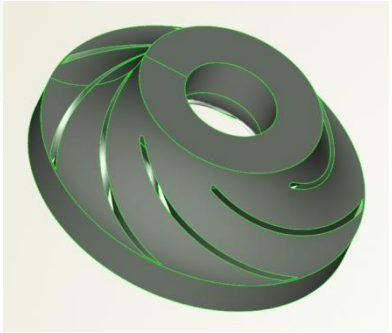


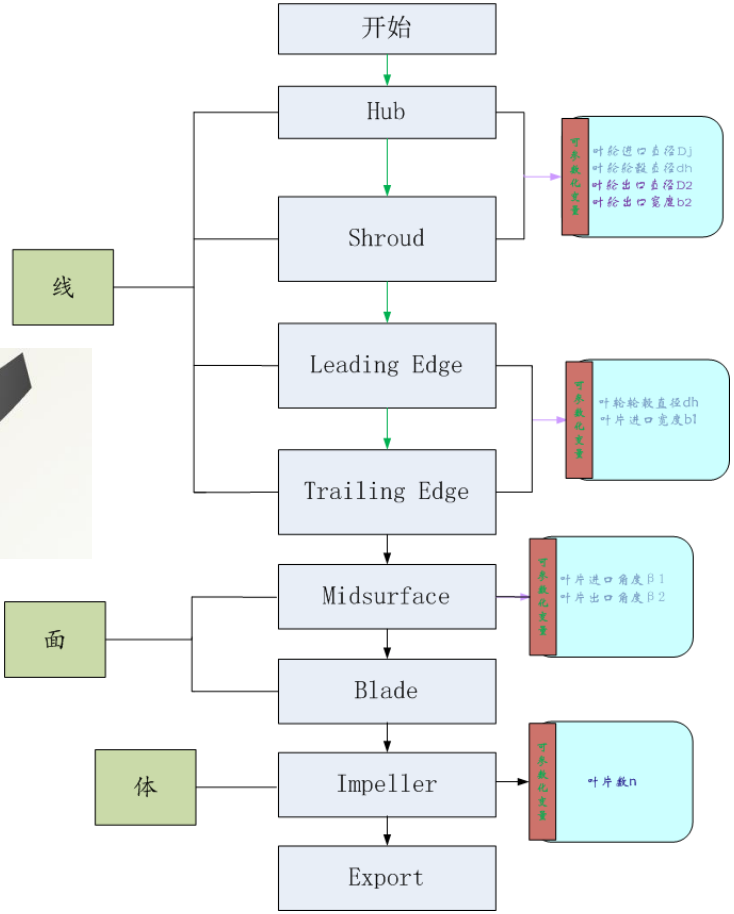
Optimization in CAESES

Parametric modeling of the blades & vanes

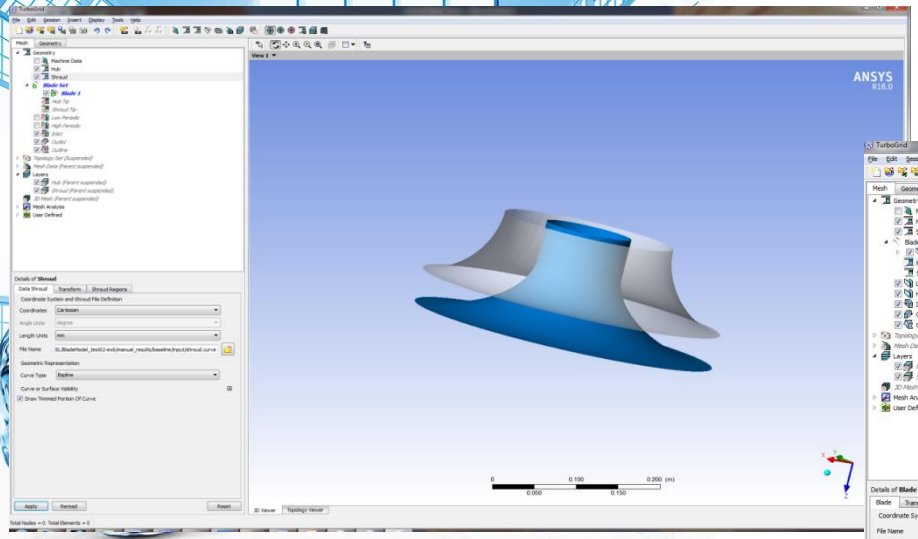


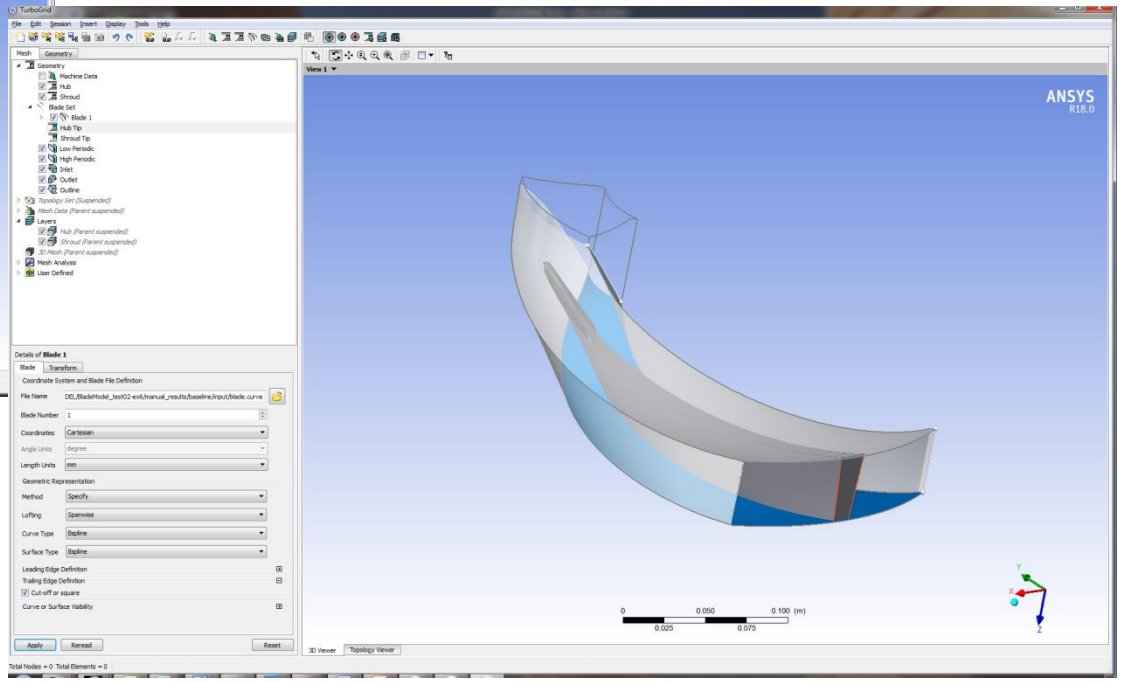






Optimization in CAESES





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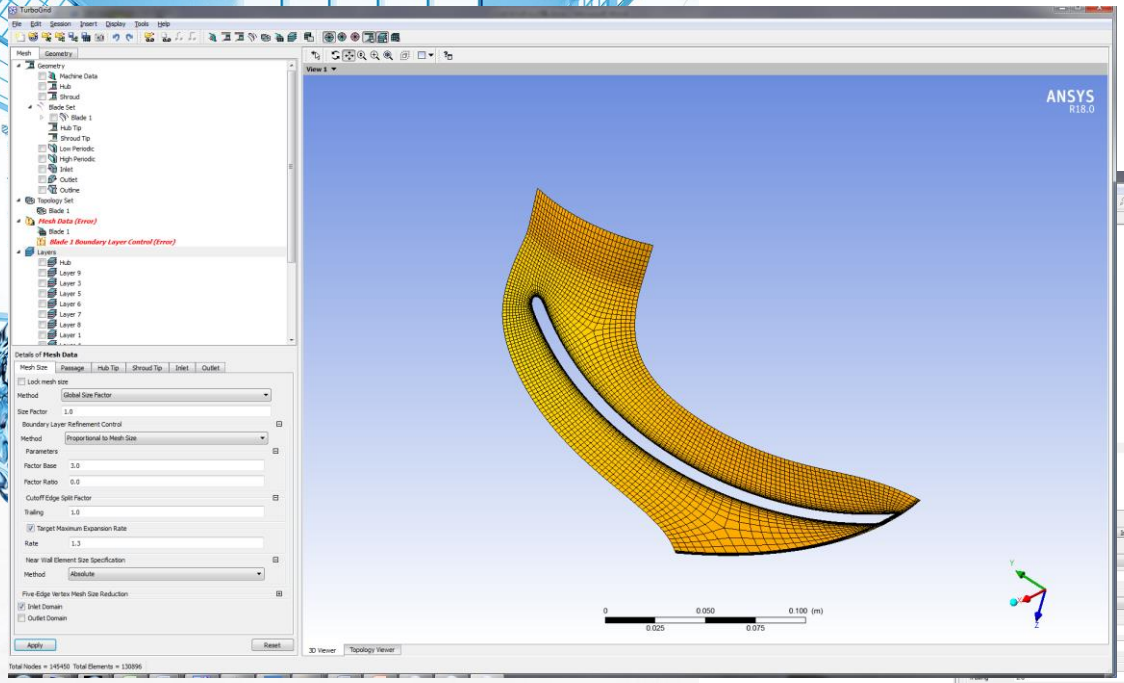

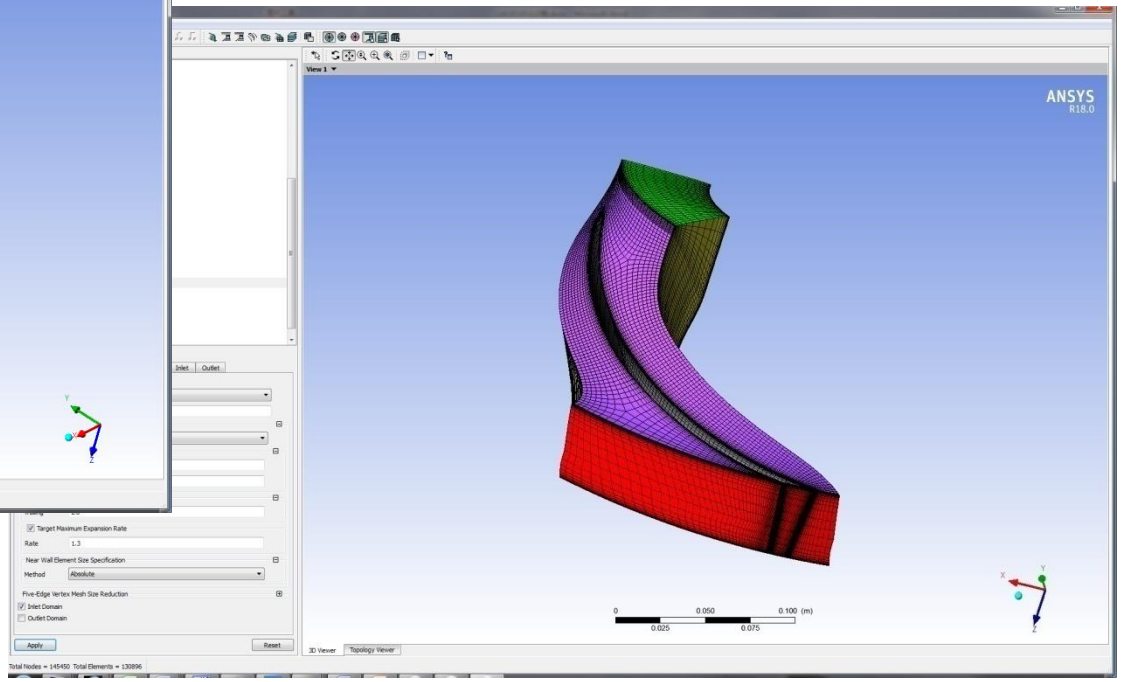

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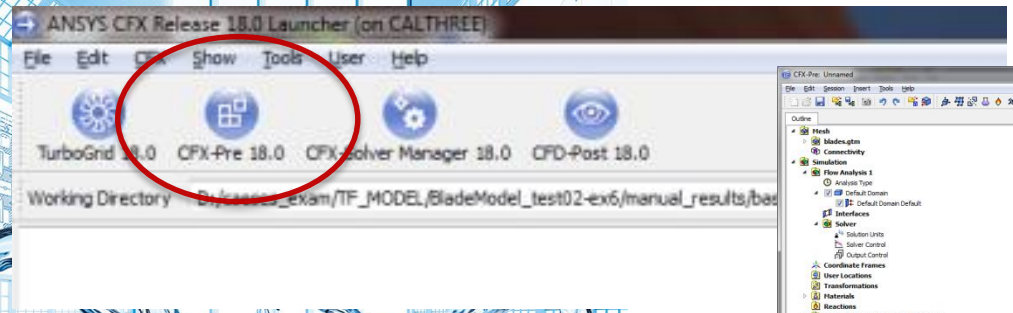

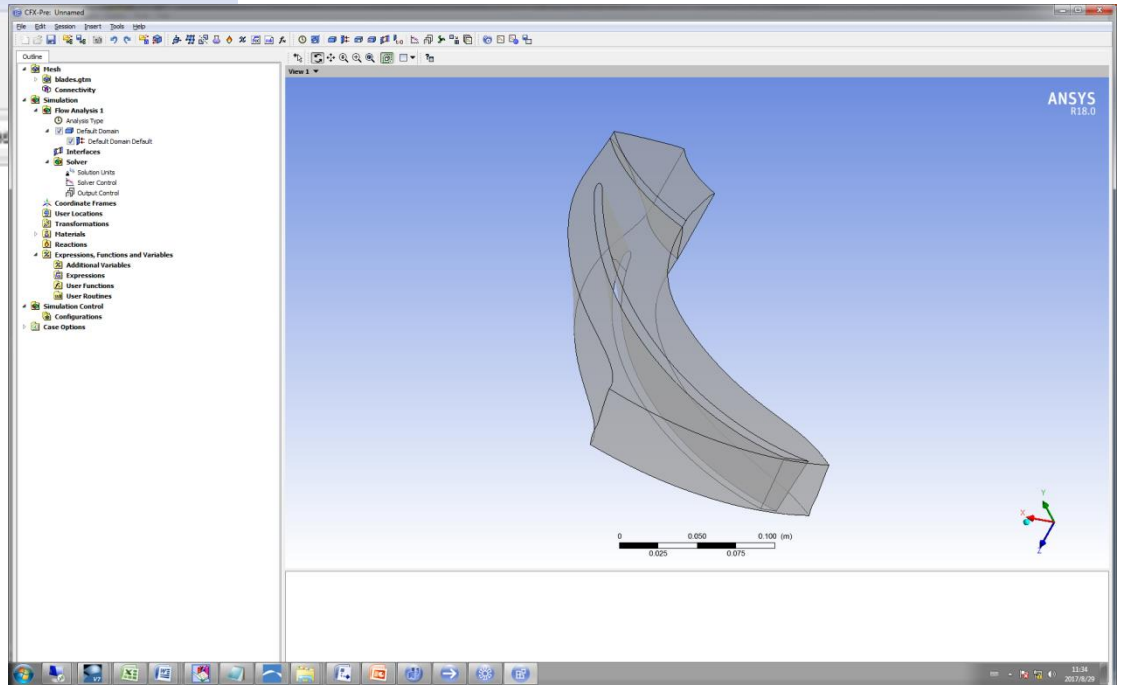

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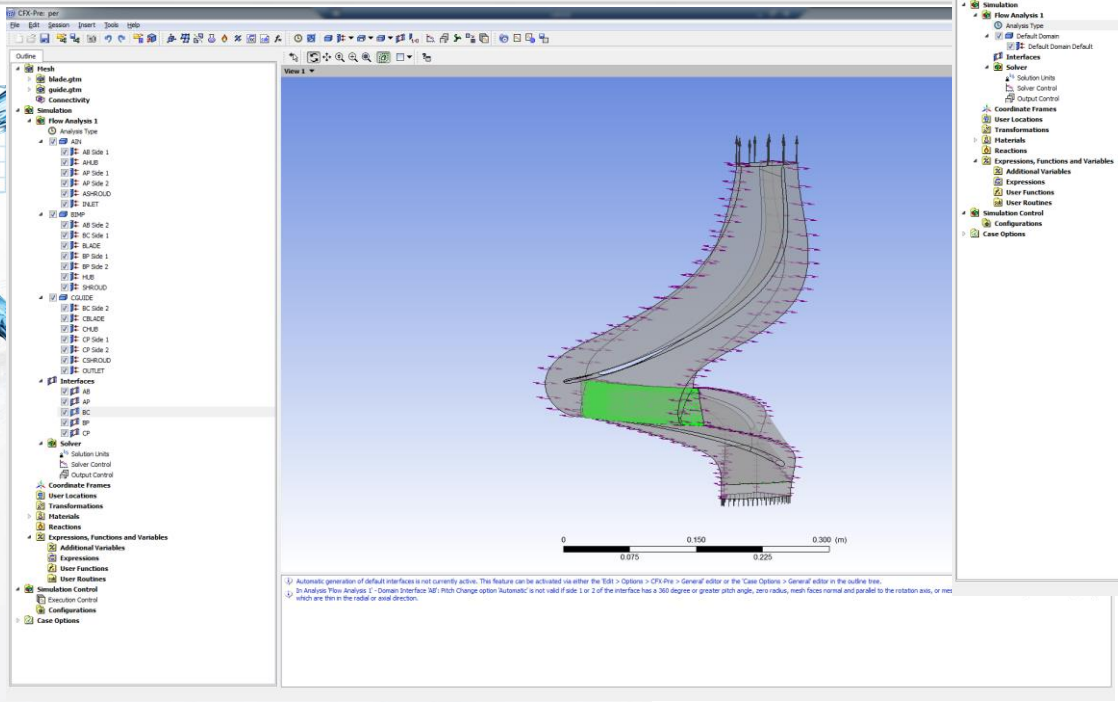

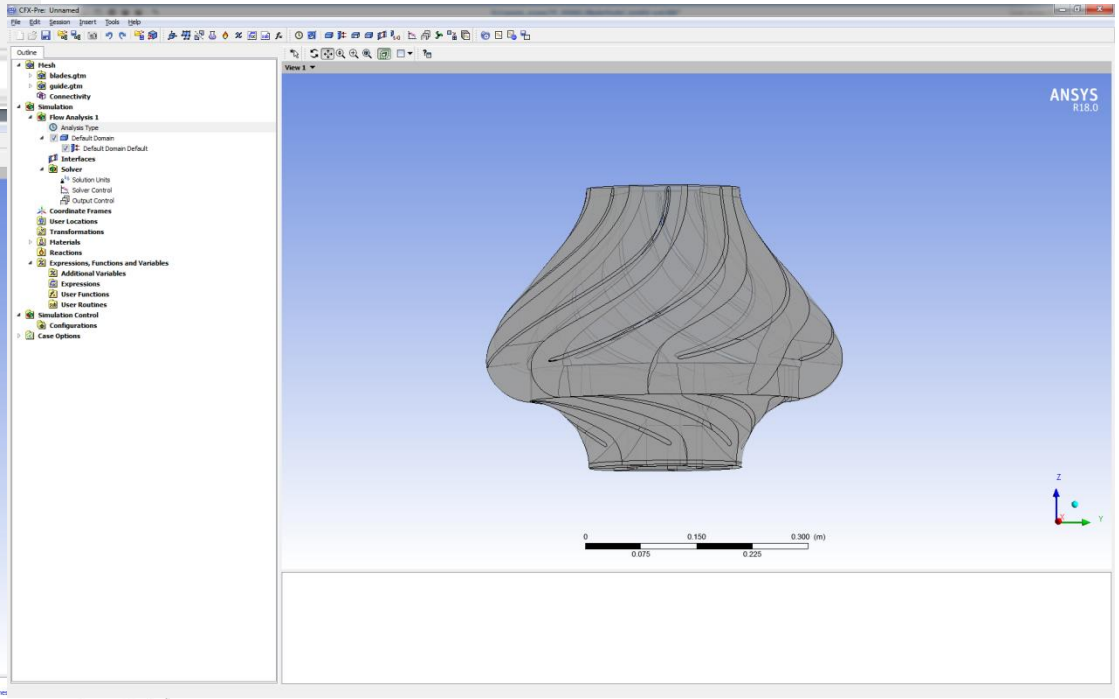

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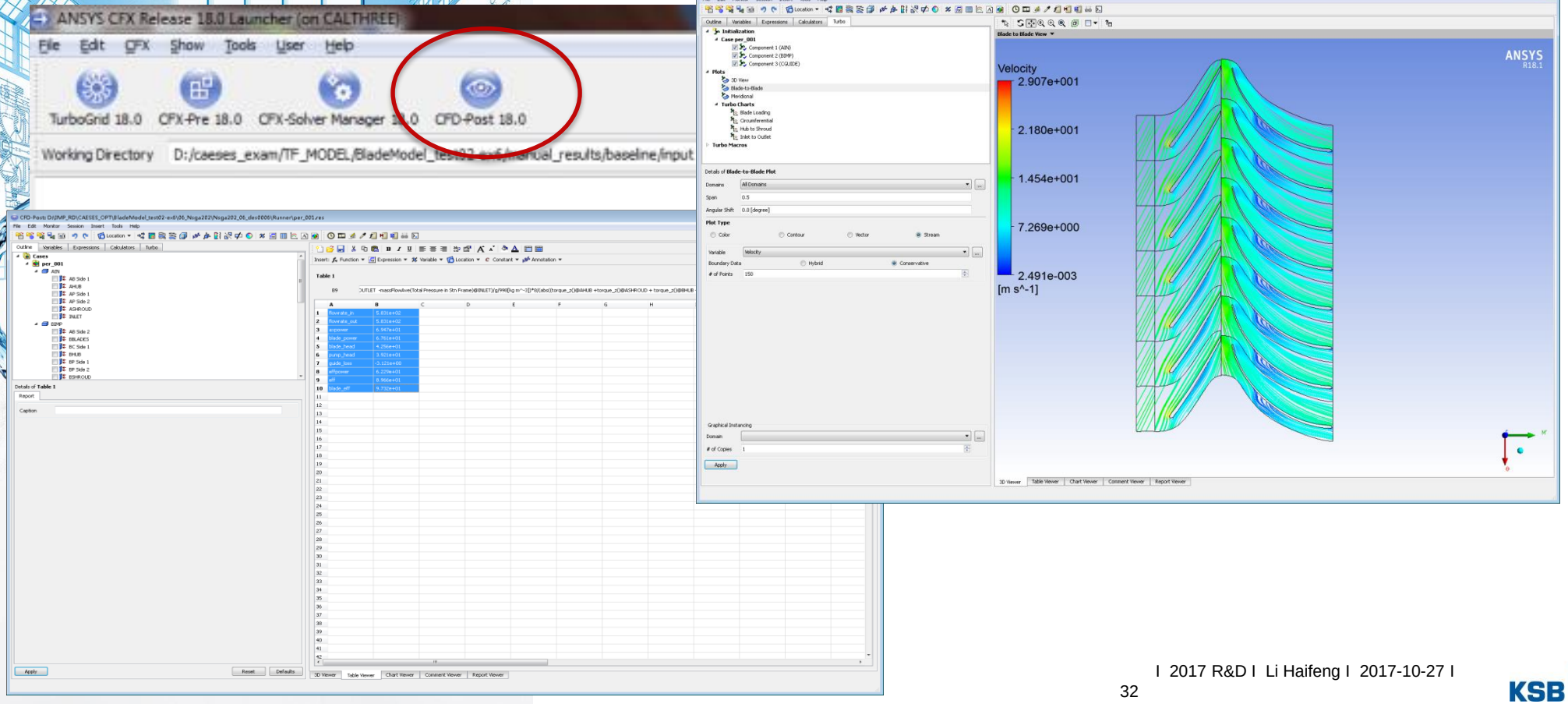

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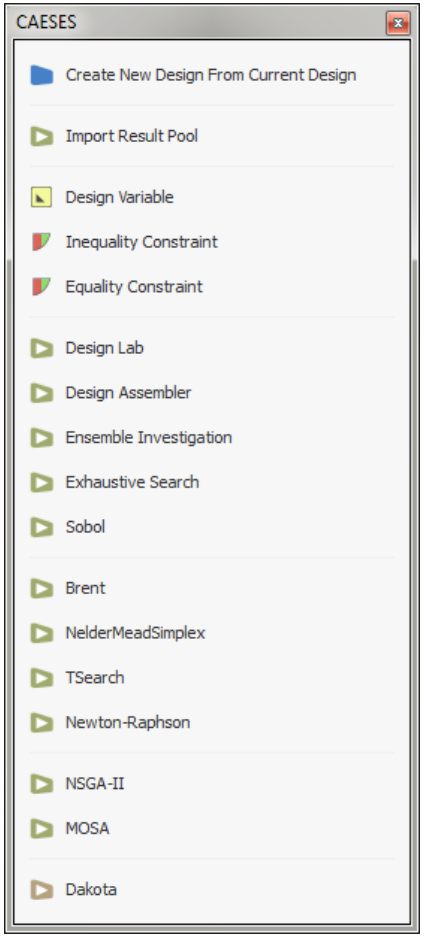

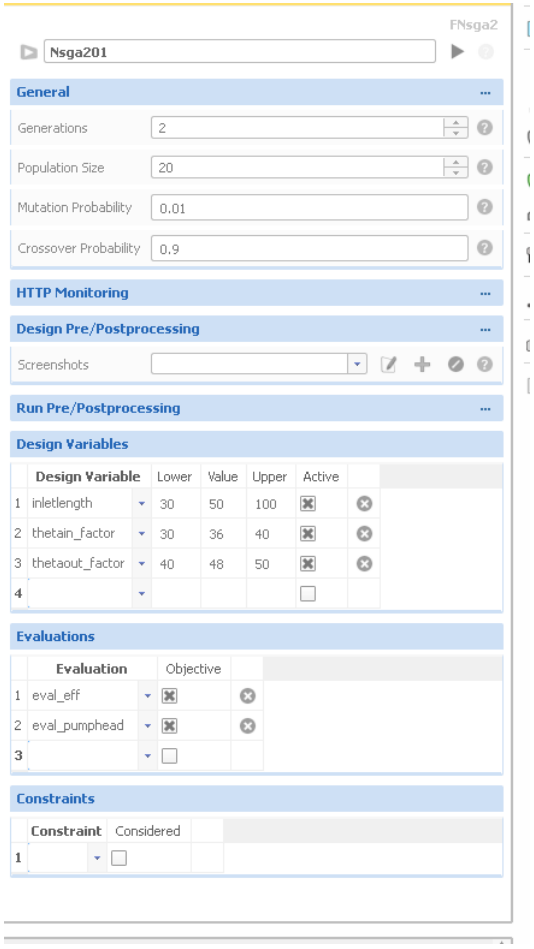

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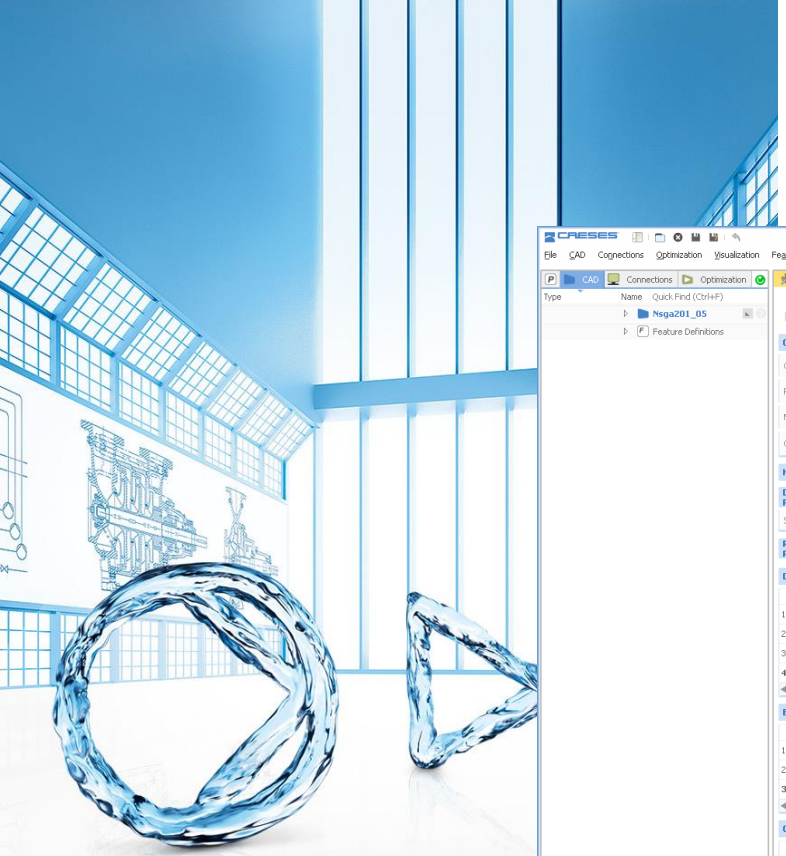

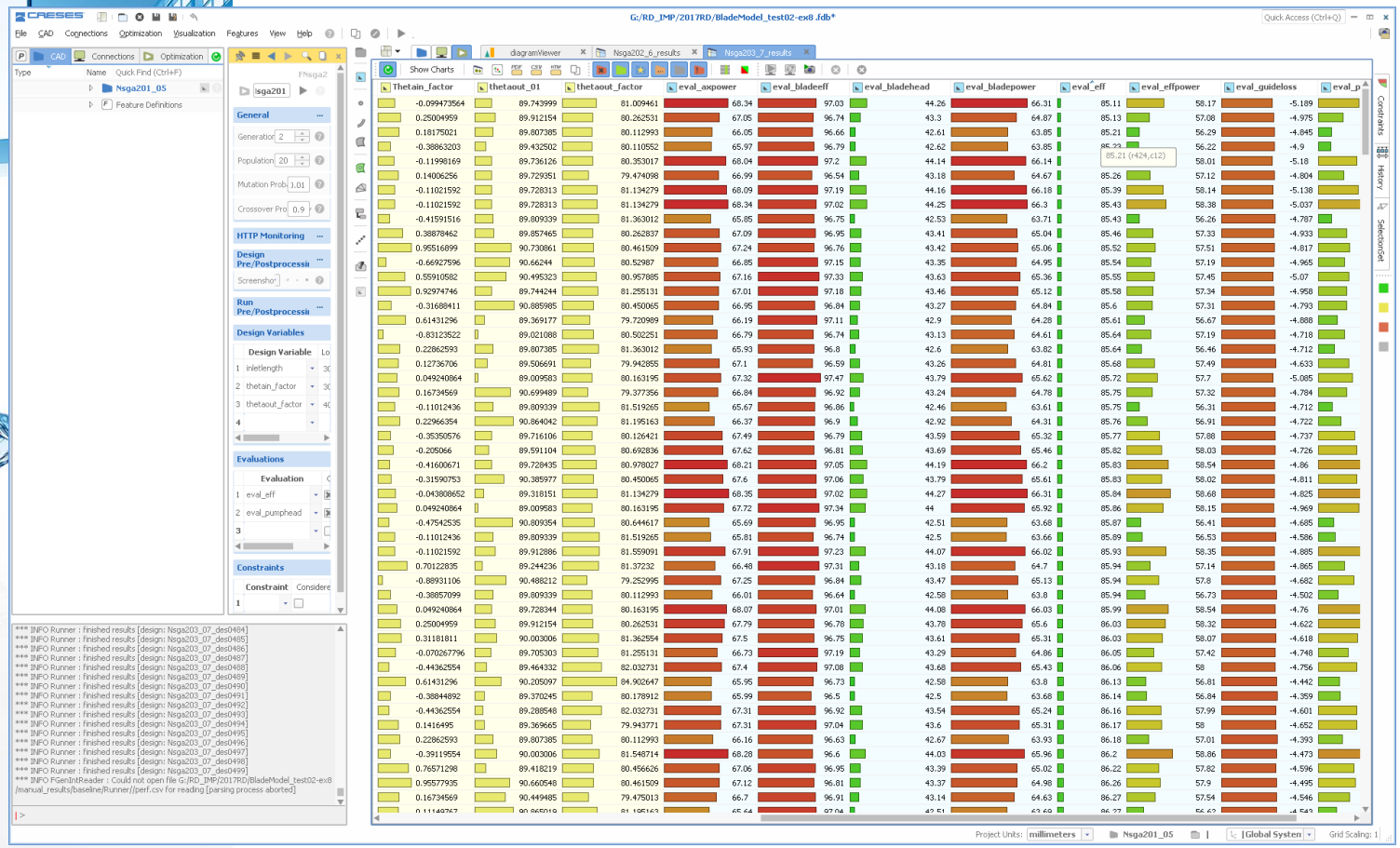

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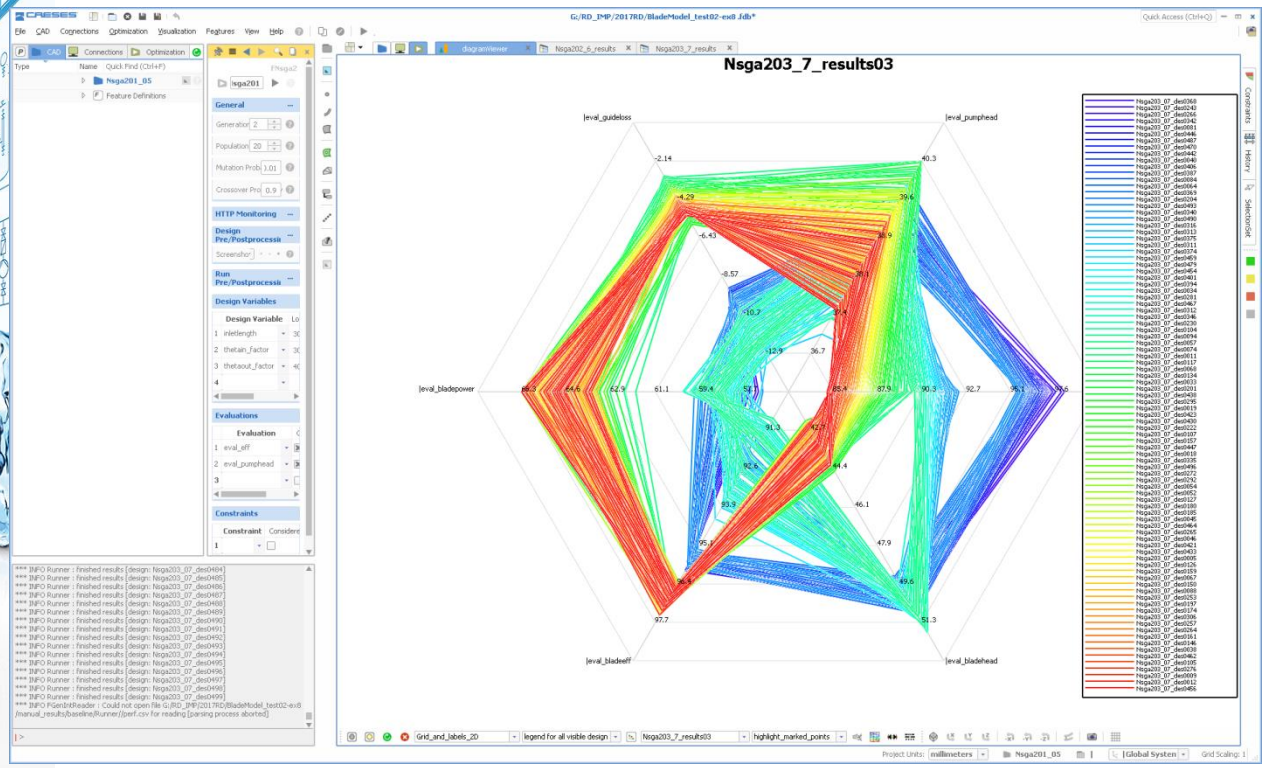

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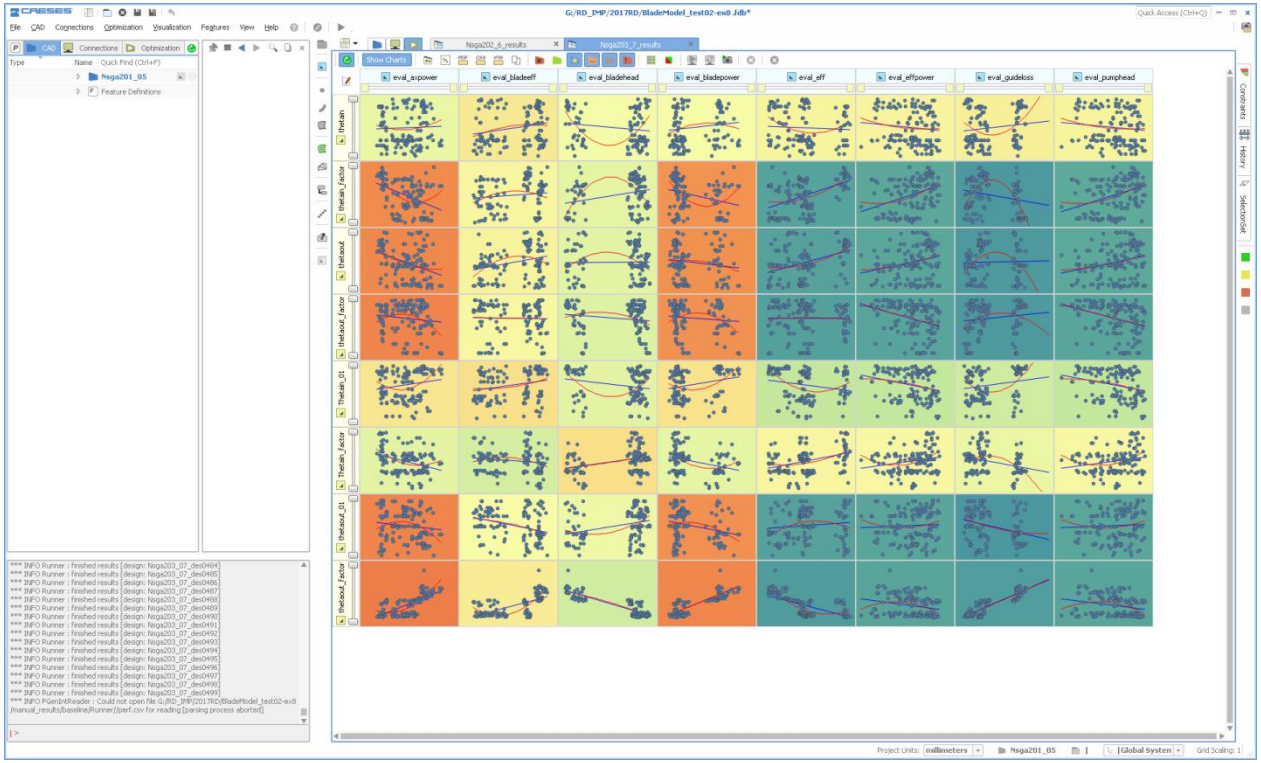

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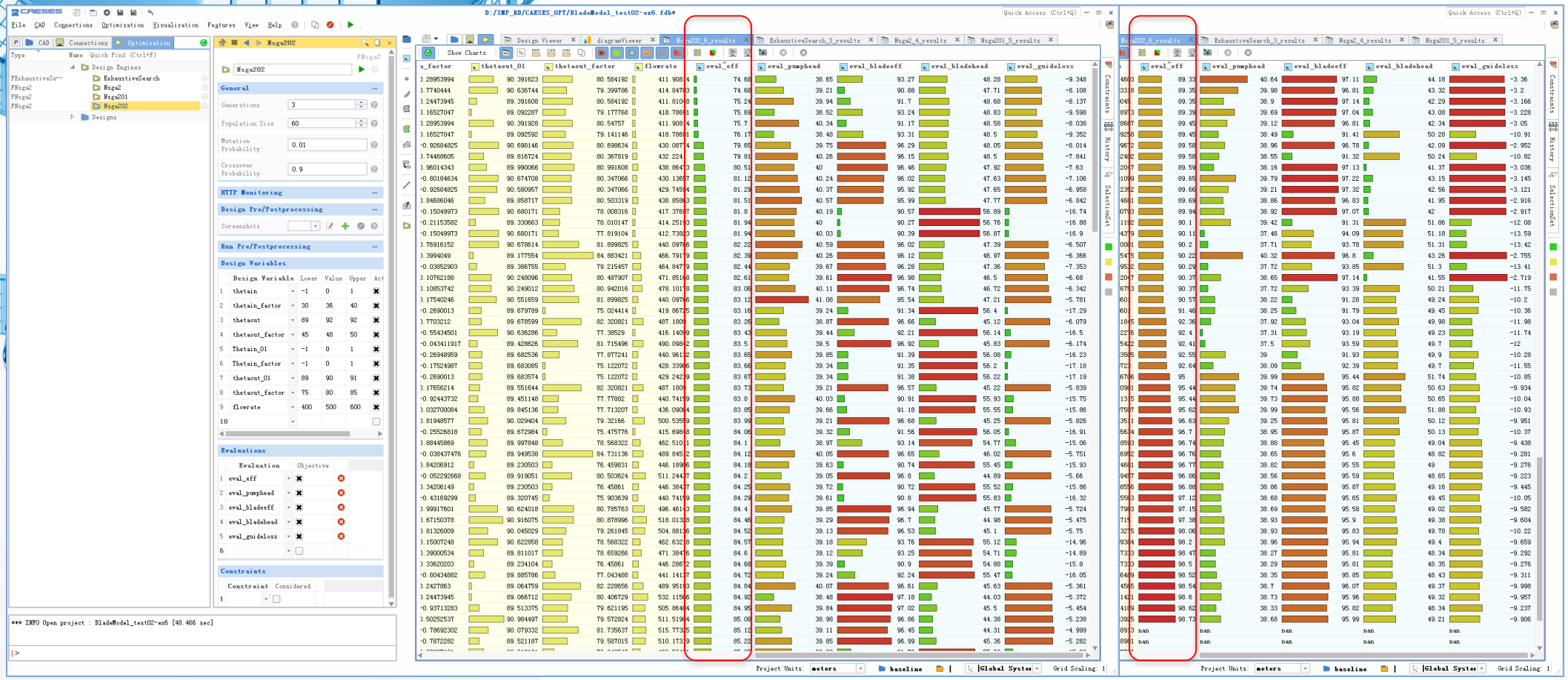

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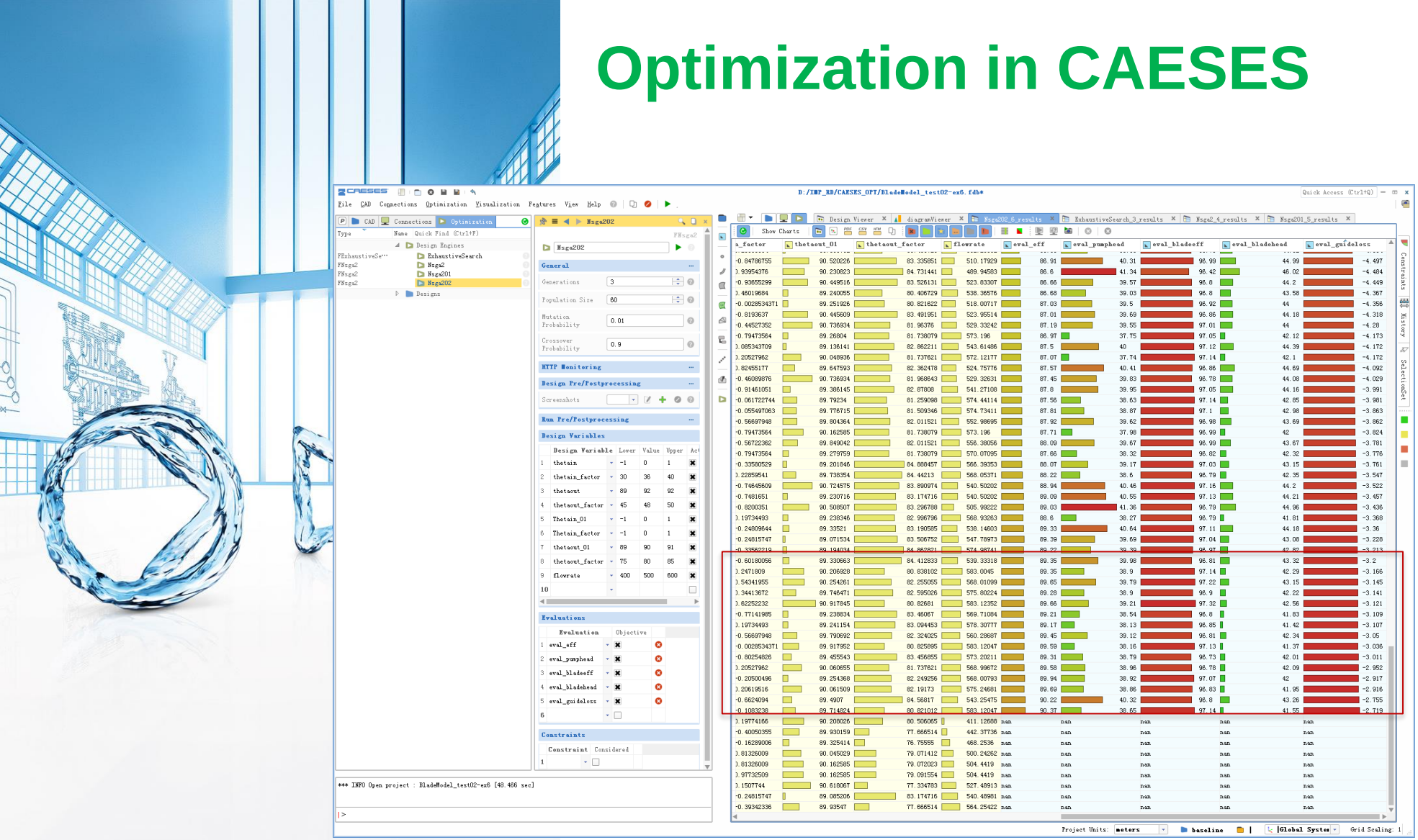


Optimization in CAESES

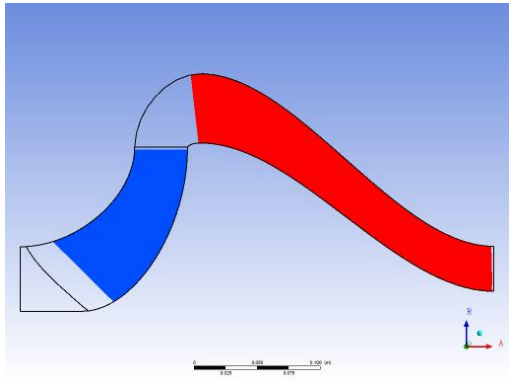
atures View Help

Nsga202_06_des0112

flowrate

Evaluations

Name	Value	Is Objective
eval_eff	90.22	Yes
eval_pumphead	40.32	Yes
eval_bladeeff	96.8	Yes
eval_bladehead	43.26	Yes
eval_guideloss	-2.755	Yes



flowrate	543.255
02_blade|01_hub	
inletlength	50
02_blade|03_LETE	
t3	0.35
t4	0.2
02_blade|04_midsur|section	
thetain	0.256123
thetain_factor	33.6526
thetaout	91.6389
thetaout_factor	47.1211
03_Guide|02midface|variable	
Thetain_01	0.828183
Thetain_02	0
Thetain_factor	-0.662409
thetaout_01	89.4907
thetaout_02	90
thetaout_factor	84.5682

Conclusions

- 水泵的参数化建模
- 采用Nsga算法对叶轮和导叶体进行了优化
- 不同参数对水泵性能的影响
- 优异的水力模型

Questions & Comments

Thank you for your attention!