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# 先进中、高频振动及噪声分析软件 ALTAIR SEAM 全面解析

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# 先进中高频振动及噪声分析软件 Altair SEAM 全面解析

1 Altair NVH仿真技术和理念

2 中、高频NVH仿真工具Altair SEAM 全面解析

3 应用及合作案例分享



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# 1. ALTAIR NVH仿真技术和理念

# Altair NVH仿真技术和理念

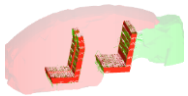
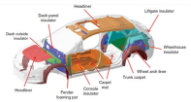
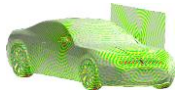
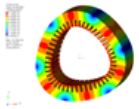
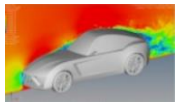
## 先进的车辆NVH仿真建模、分析工作框架

- 整车NVH仿真技术
- 标准分析工况管理
- 完备的后处理、诊断及优化
- 多样本分析及基于稳健性优化设计（MSA&RBDO）
- 整车级分析推动试验与仿真相结合的全球NVH最佳实践

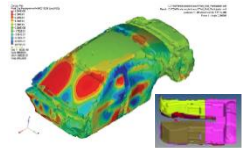
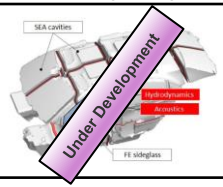
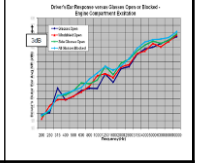
# Altair NVH仿真技术和理念

完备的求解器序列

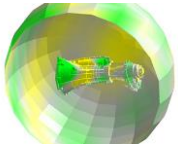
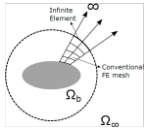
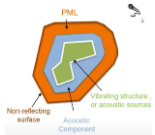
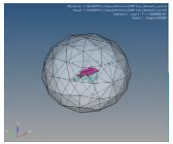
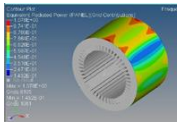
## Acoustics Solvers

| FEM | SEA/EFEA/EBEM | BEM | EM | CFD |
|---|---|---|---|---|
|  OptiStruct |  Altair Seam |  Coustyx |  Flux |  uFx |

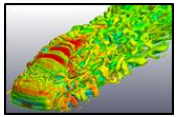
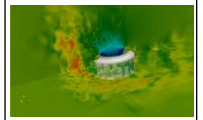
## Interior Acoustics Applications

| Low Freq FEM-PEM | Hybrid FEM/SEA/BEM | High Freq SEA |
|---|---|---|
|  |   |  |

## Exterior Acoustics Applications

| BEM/EBEM | FEM-Inf. Element | FEM-APML | FEM-Rayleigh Integ. | FEM-ERP |
|---|---|---|---|---|
|  |   |   |  |  |

## Flow Induced Acoustics

| Wind Noise | Fan Noise |
|---|---|
|  |  |



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# 2.中、高频NVH仿真工具ALTAIR SEAM全面解析

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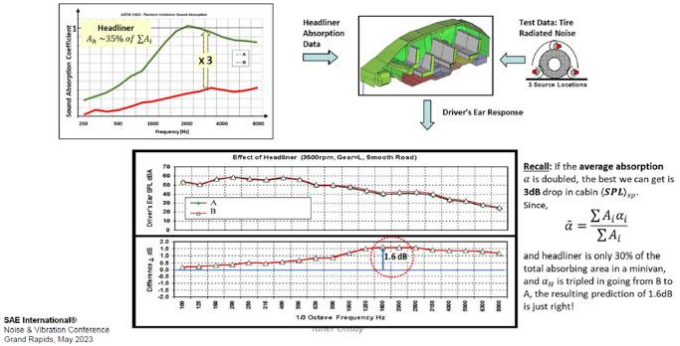
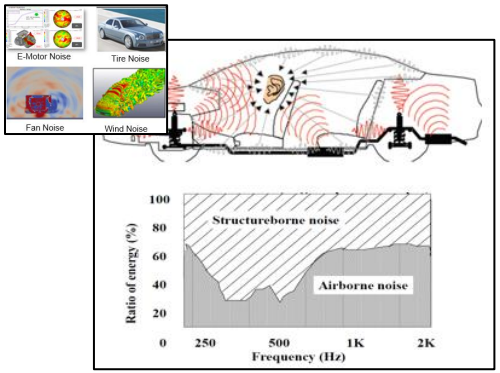
# 中、高频NVH仿真工具Altair SEAM全面解析

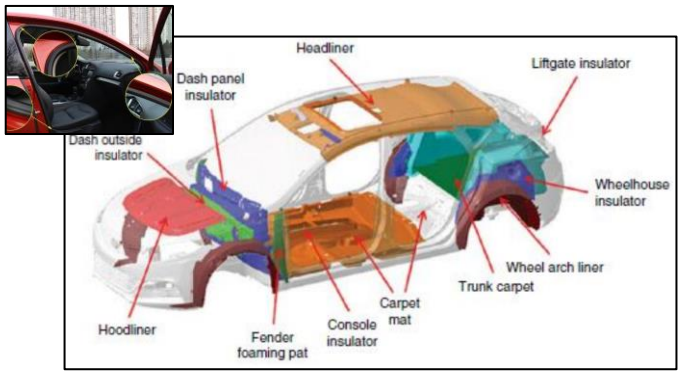
## 车辆声学包设计

- 车辆运行中的各种振动、噪声源和宽频噪声
- 源头控制、车身密封性、声学包设计
- 声学包需要平衡：性能、布置空间、重量
- 短板识别、材料选型、方案验证
- 以测试为主的开发流程短板

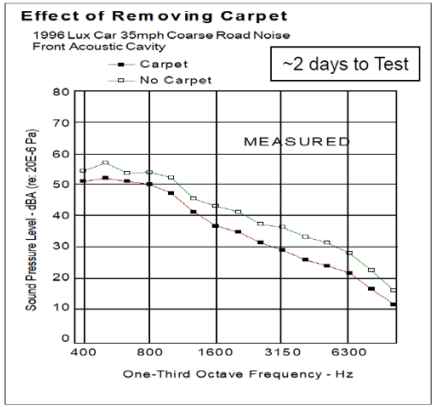



各种源和传递路径




车身密封性和声学包




声学包方案验证



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# 中、高频NVH仿真工具Altair SEAM全面解析

## 声学包分析流程

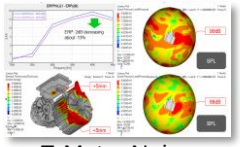
输入准备：
载荷、材料、
CAD/FEA模型

子系统建模及连接:
Plate\Cavity\Junction\
NCT

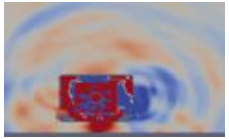
模型生成
和求解

后处理

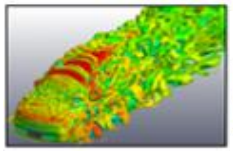
诊断分析\DSA\
Optimization



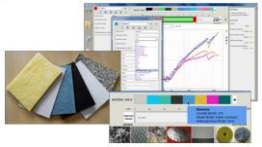
E-Motor Noise



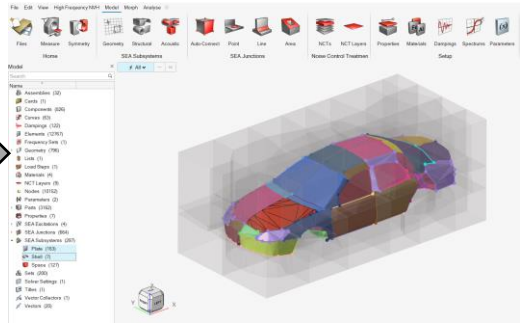
Fan Noise

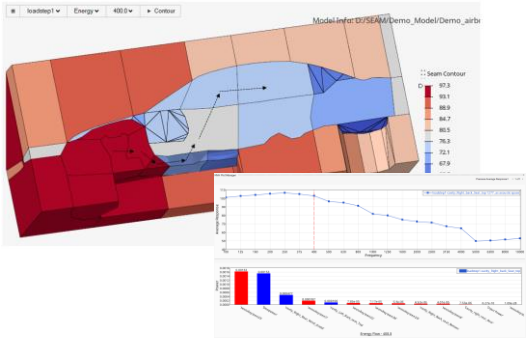


Wind Noise



Materal data





载荷定义

SEA建模及模型验证

后处理、诊断、优化

Systematic and Efficient Approach / Technology to perform SEA Analysis



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# 中、高频NVH仿真工具Altair SEAM全面解析

## SEAM的行业应用历史

**Aerospace – since 1970's**
- Airplanes
- Rotary wing aircraft (helicopters)
- Launch vehicles

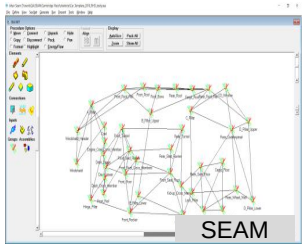
**Ground vehicles – since 1990's**
- Passenger vehicle manufacturers (OEMs)
- Construction equipment and heavy truck manufacturers
- Automotive and truck material and component suppliers

1980's

1970's

1990's

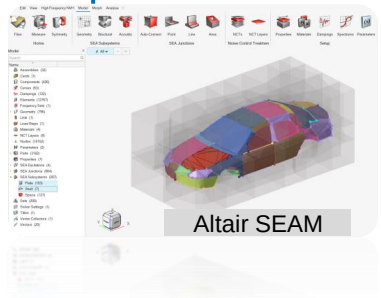
2023




**1983 commercialized**

**Ships and heavy machinery – since 1980's**
- Ship companies
- Ship machinery and other ship suppliers

**Other – since 1990's**
- Oil platforms
- Consumer products



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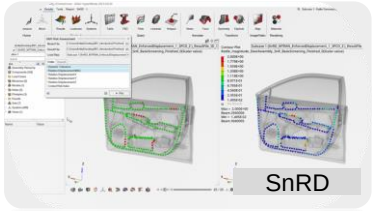
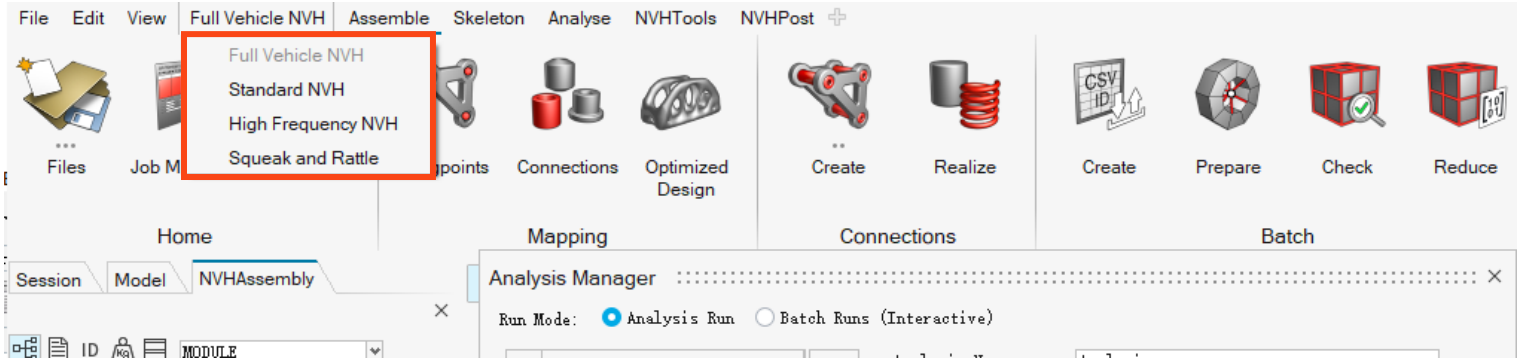
# 中、高频NVH仿真工具Altair SEAM全面解析

## 全新NVH仿真分析环境——HyperMesh NVH（since 2023）

- NVH 功能模块
- NVHD：整车NVH仿真
- Altair SEAM：中、高频NVH
- SnRD：异响仿真（V2024 new）





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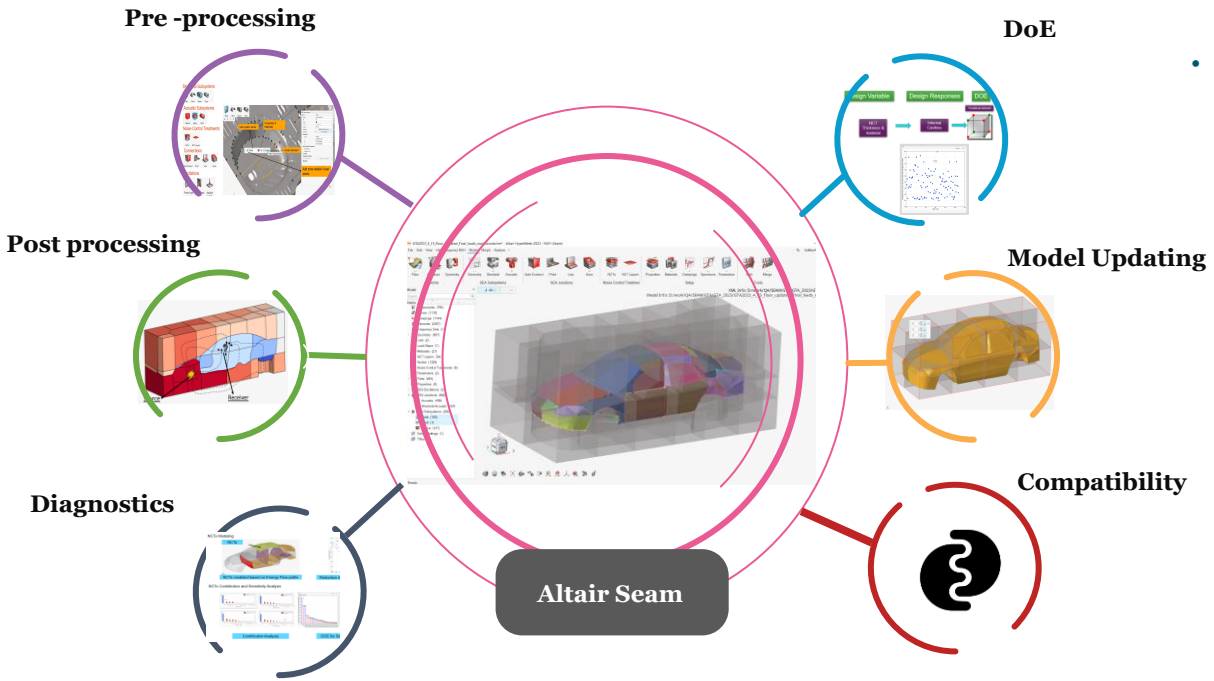
# 中、高频NVH仿真工具Altair SEAM全面解析

## Altair SEAM模块概述




- 集成、高效的3D建模，分析GUI
- 基于几何和FEA模型建立SEA子系统
- SEA子系统属性自动创建
- 丰富的声学材料类型
- 多种声腔建模方式
- 半无限声场
- 结构模态修正
- 对称建模
- 模型变形
- NCT定义及可视化
- 结果云图显示
- 能量流分析
- 载荷贡献量分析
- NCT贡献量分析
- 参数设计灵敏度分析
- 第三方XML模型读取



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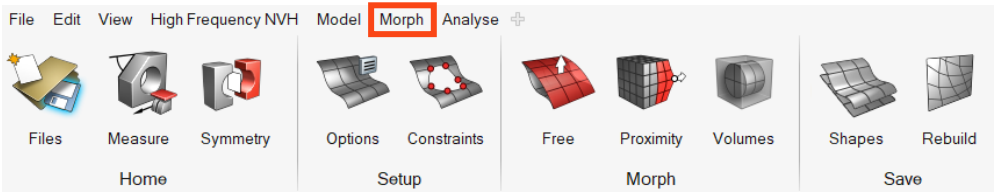
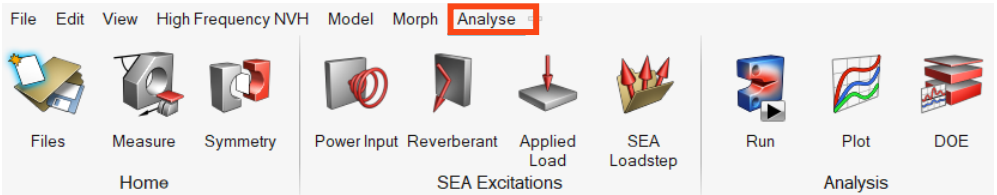
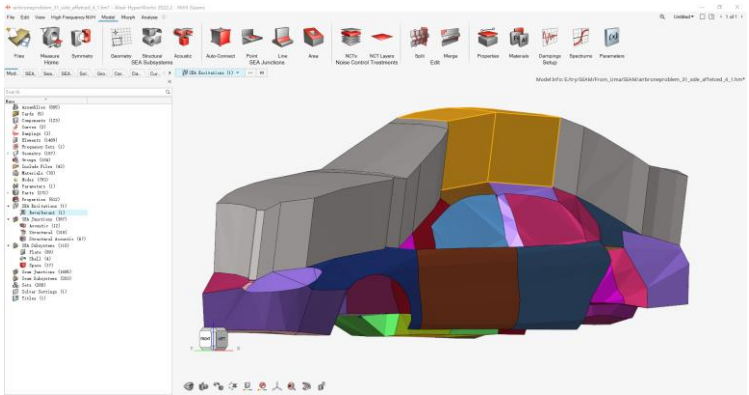
# 中、高频NVH仿真工具Altair SEAM全面解析

## Altair SEAM界面介绍

- 简洁的界面和功能罗列：Model（子系统搭建及连接）、Morph（变形操作）、Analysis（载荷、计算、后处理）



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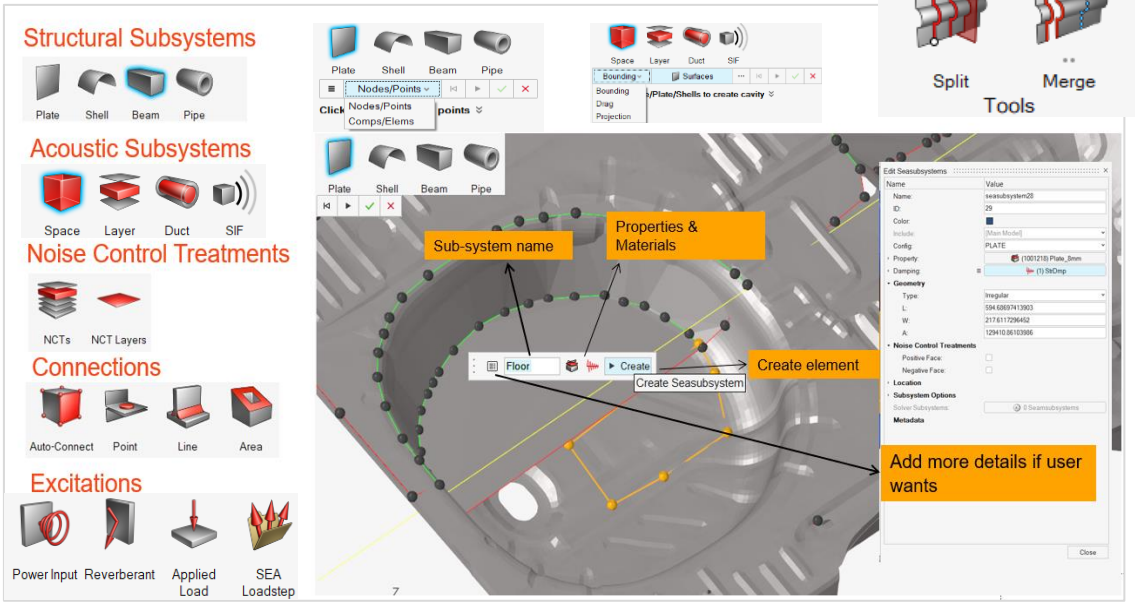
# 中、高频NVH仿真工具Altair SEAM全面解析

## 高效便捷的前处理功能

- 3D图形操作界面
- 支持基于CAD及FEA建模
- 支持结构自系统属性自动创建（FEA）
- 支持结构子系统拆分与合并


SEAM老界面




Altair SEAM 基础建模功能



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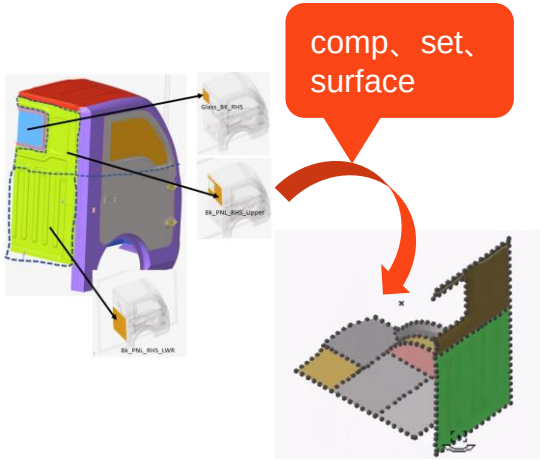
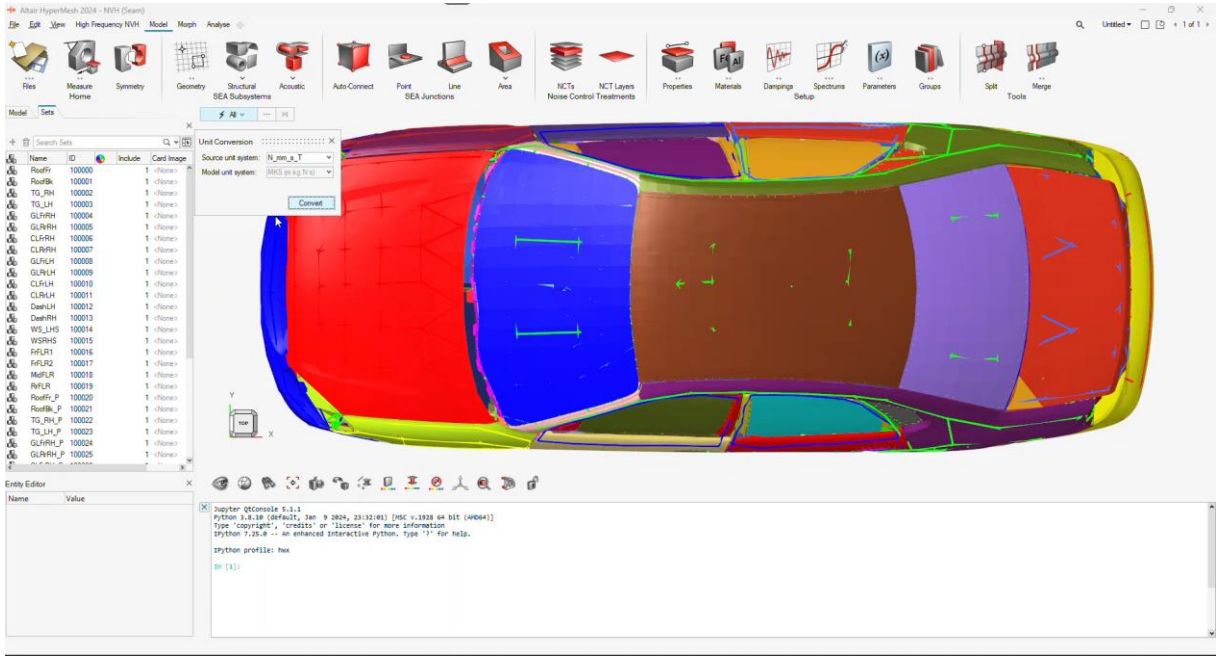
# 中、高频NVH仿真工具Altair SEAM全面解析

## 高效便捷的前处理功能

- 模型单位识别和转换
- 结构子系统自动建模





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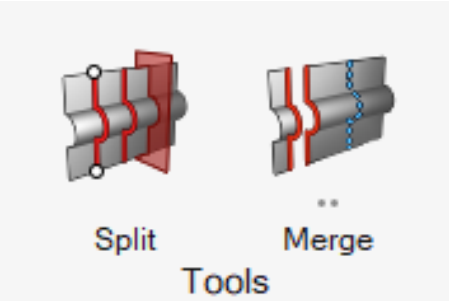
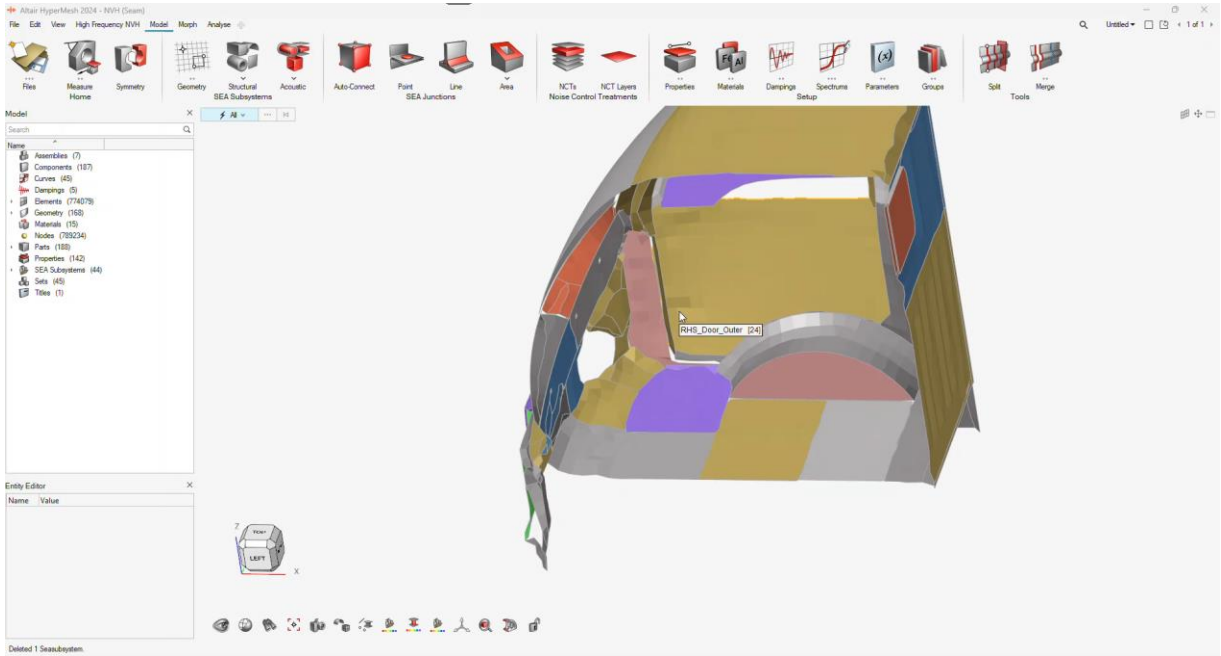
# 中、高频NVH仿真工具Altair SEAM全面解析

## 高效便捷的前处理功能

- 边界容差搜索合并



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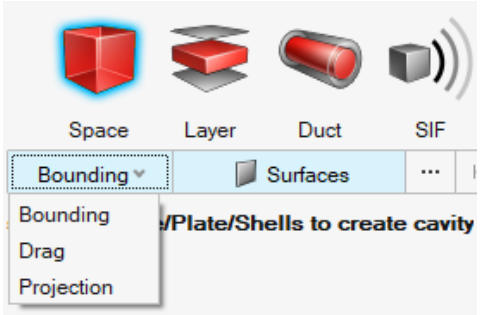
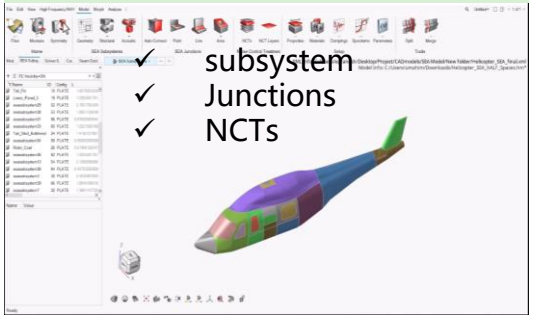
# 中、高频NVH仿真工具Altair SEAM全面解析

## 高效便捷的前处理功能

- 支持对称建模，包括：结构和声腔、连接、NCT
- 支持多种声腔建模方式：Bounding、Drag、Projection
- 支持结构模态密度修正

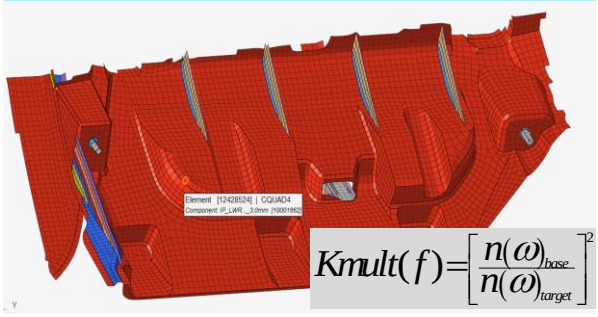



### Symmetry




### Cavity building


### Stiffness Multipler



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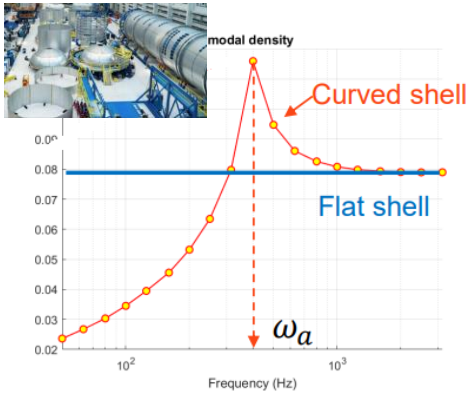
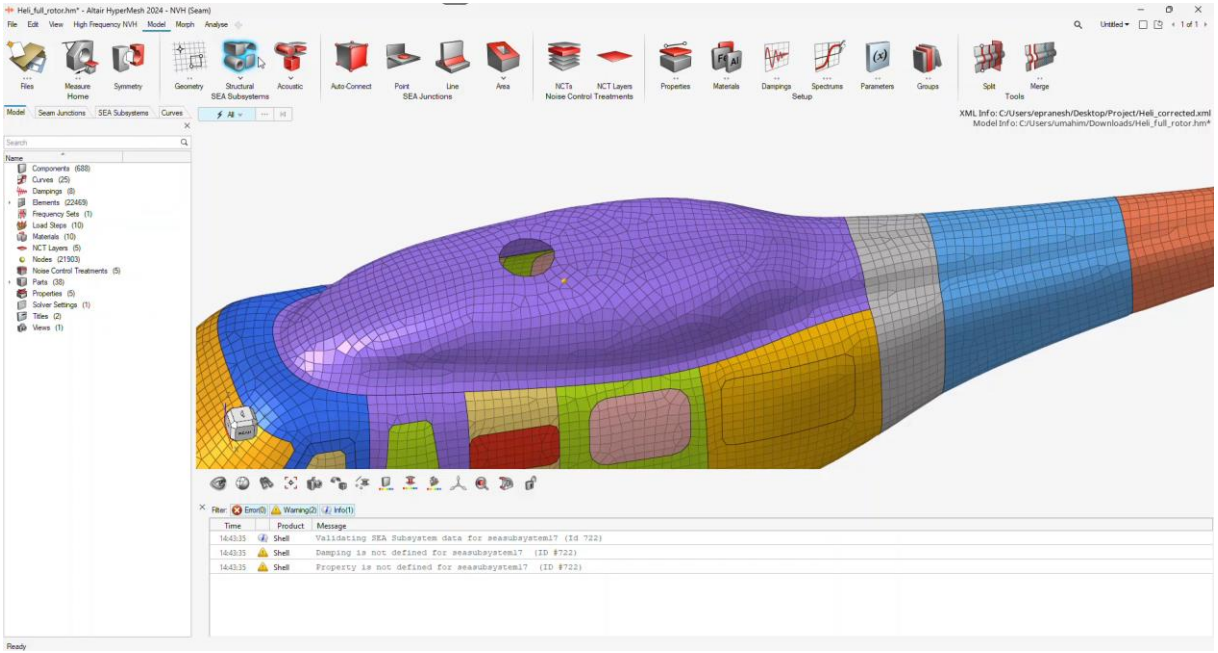
# 中、高频NVH仿真工具Altair SEAM全面解析

## 高效便捷的前处理功能

- 双曲率壳建模
- 几何参数自动识别



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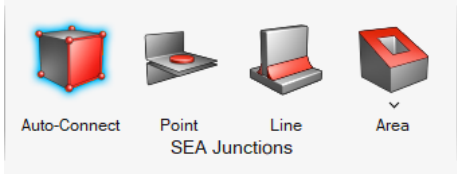
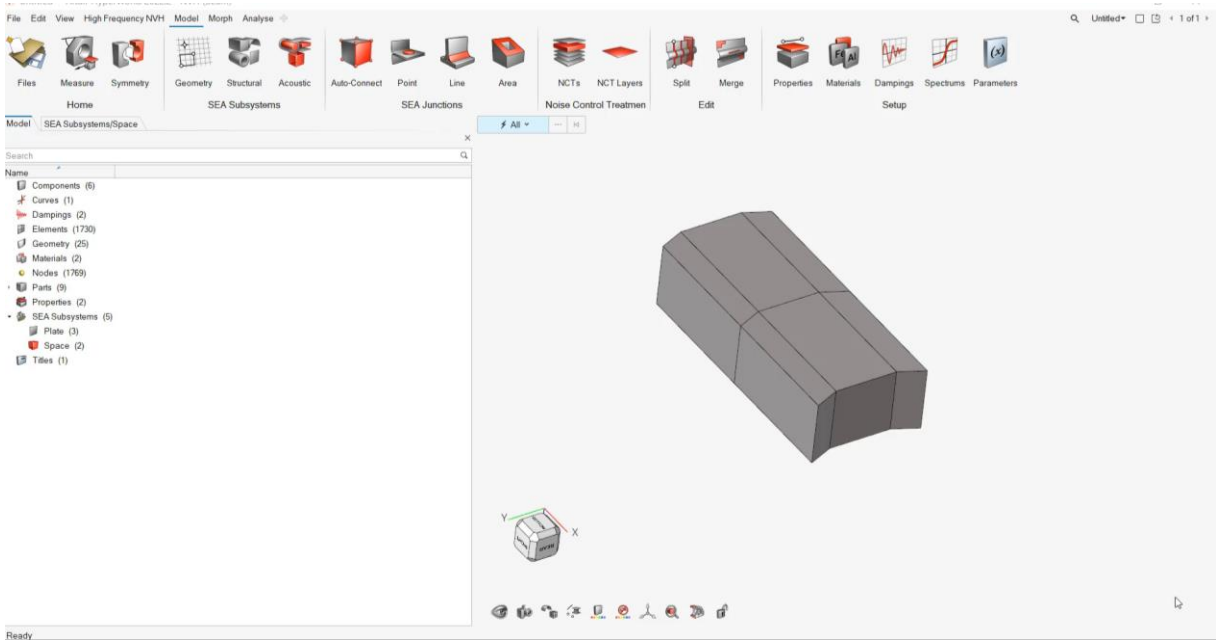
# 中、高频NVH仿真工具Altair SEAM全面解析

## 高效便捷的前处理功能

- Auto connection 自动连接
- 点、线、面
- 连接显示
- 手动方式连接



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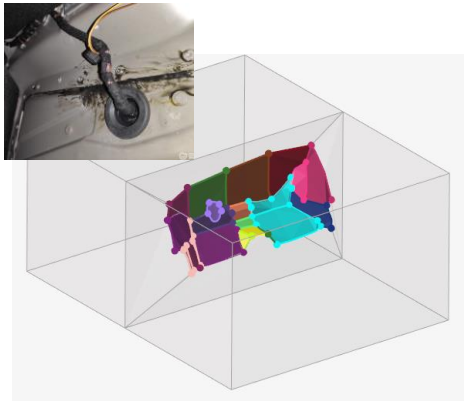
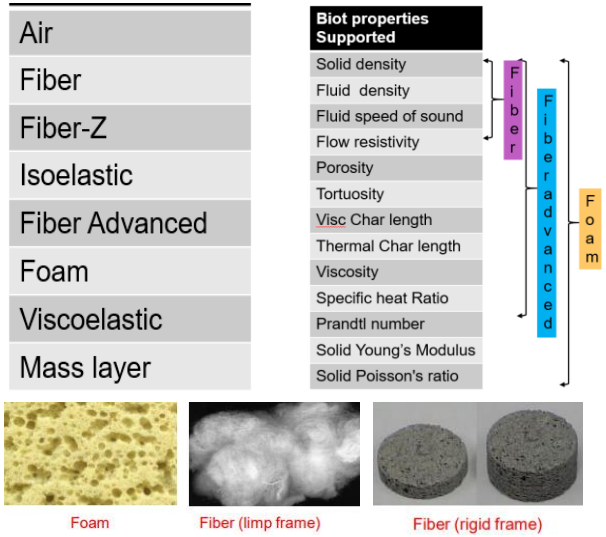
# 中、高频NVH仿真工具Altair SEAM全面解析

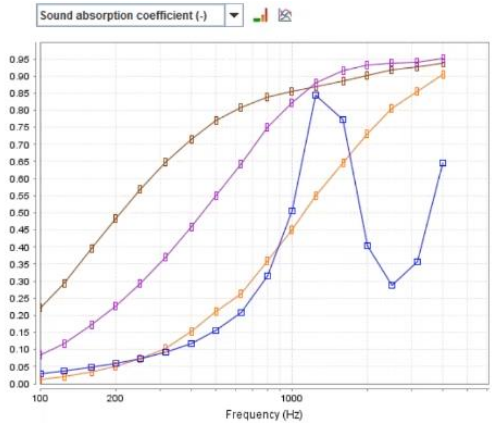
## 高效便捷的前处理功能

- leak定义：前围、电池包
- 丰富的材料类型：Fiber、Fiber advanced、Foam
- 支持损耗因子、吸声系数、传递损失、插入损失、混响时间定义



Leak定义




声学材料吸声系数示例



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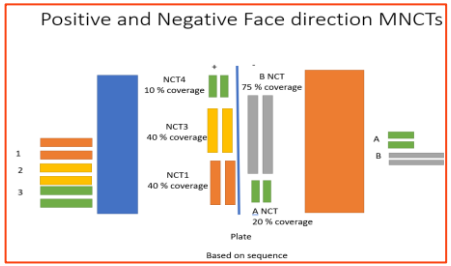
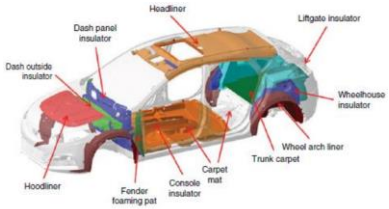
# 中、高频NVH仿真工具Altair SEAM全面解析

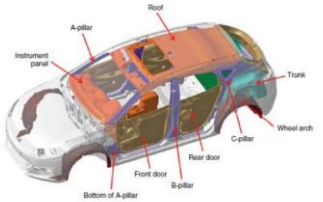
## 高效便捷的前处理功能

- 支持双向、多层NCT定义
- 支持声腔表面NCT赋予
- NCT可视化

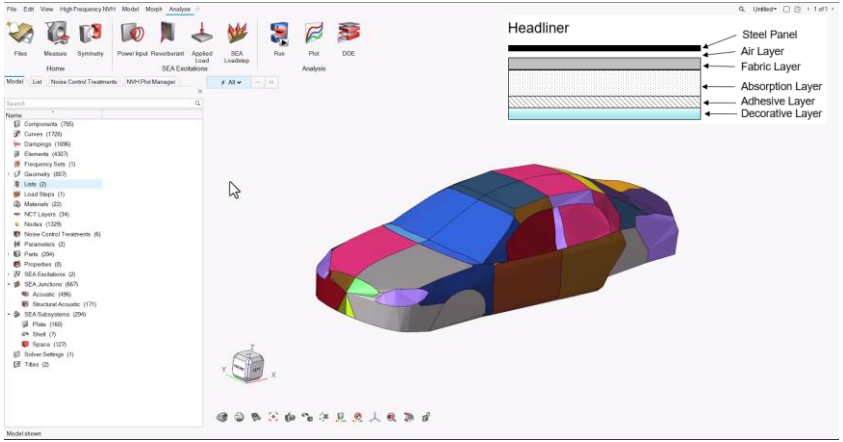


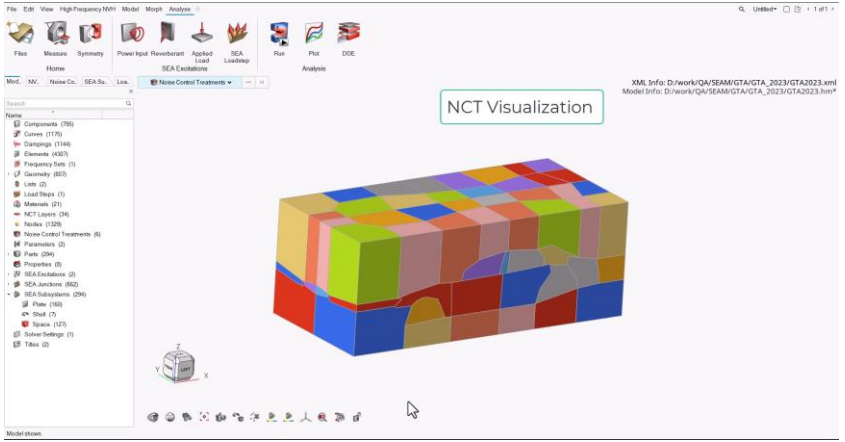




Sound Package intended components




Additional Absorption providing component



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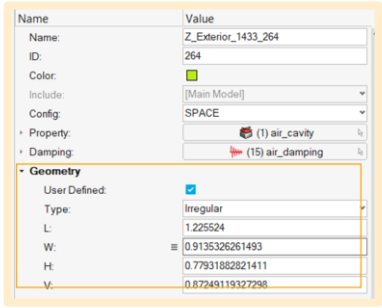
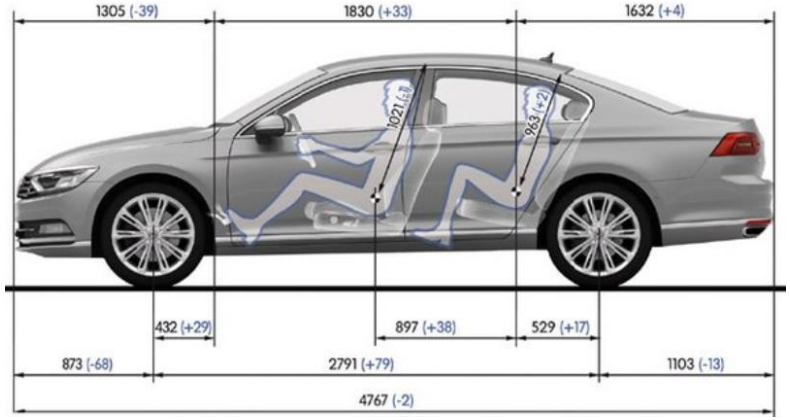
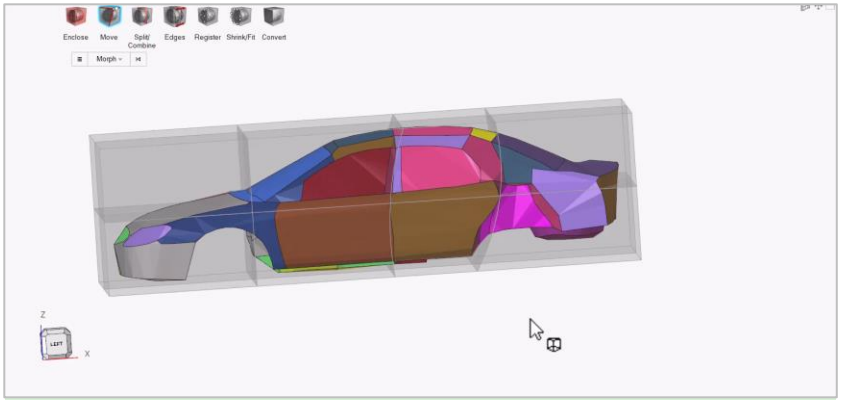
# 中、高频NVH仿真工具Altair SEAM全面解析

## 高效便捷的前处理功能

- SEA子系统尺寸缩放
- 尺寸相近车型模型快速建模




Volume Morphing



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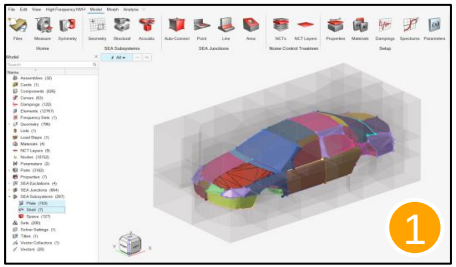
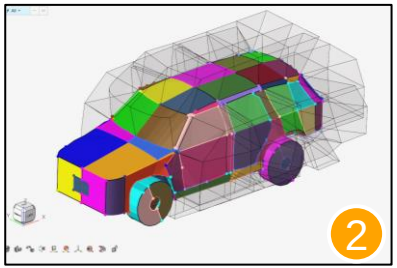
# 中、高频NVH仿真工具Altair SEAM全面解析

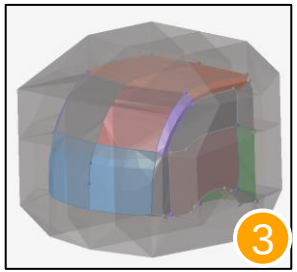
## 高效便捷的前处理功能

- SEA建模效率对比：业内平均水平 vs Altair SEAM

| Sr. No. | | Existing Efforts | | Target | Current Status |
|---|---|---|---|---|---|
| 1 | NVHD Demo Model | 30 working days | Altair Seam | < 15 days | ~ 22 days |
| 2 | Major OEMs | 40 working days | Competition /Altair Seam | <25 | 40/30 days |
| 3 | LCV Model | 7 working days | Altair Seam | < 4 days | 4 days |

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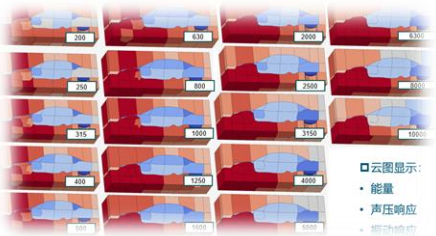
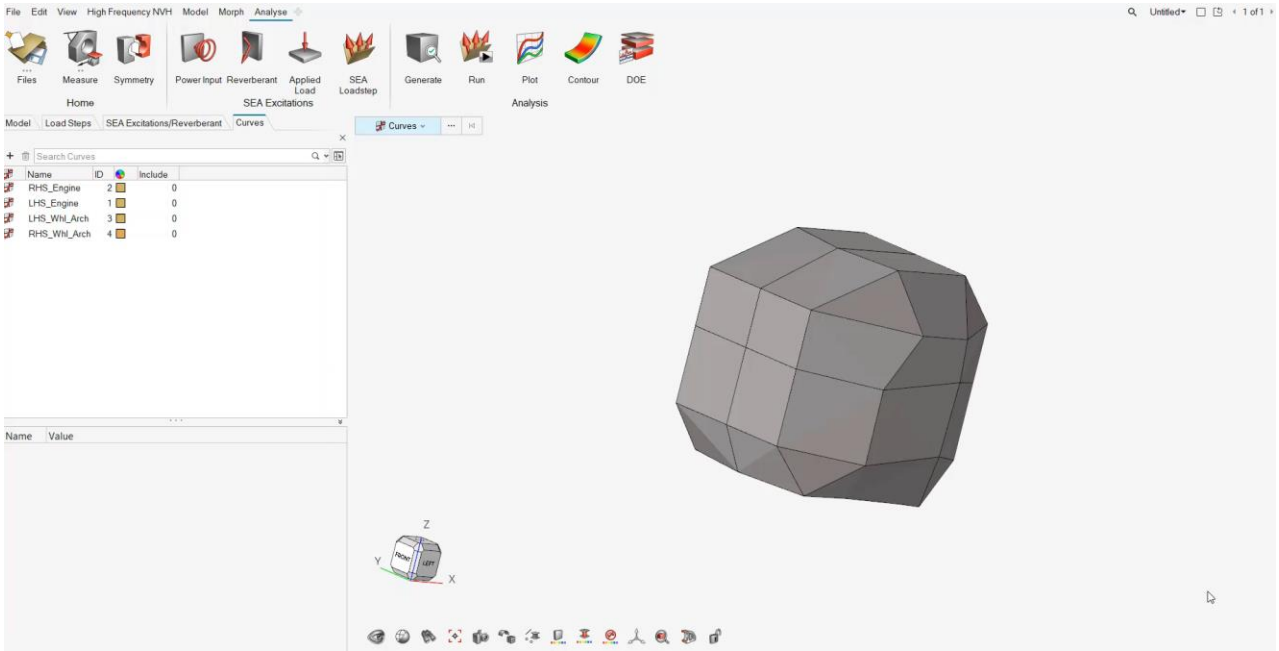
# 中、高频NVH仿真工具Altair SEAM全面解析

## 先进的后处理、诊断功能

- 多窗口操作
- 右键结果显示
- 结果保留及对比
- 结果数据导出
- 结果云图显示



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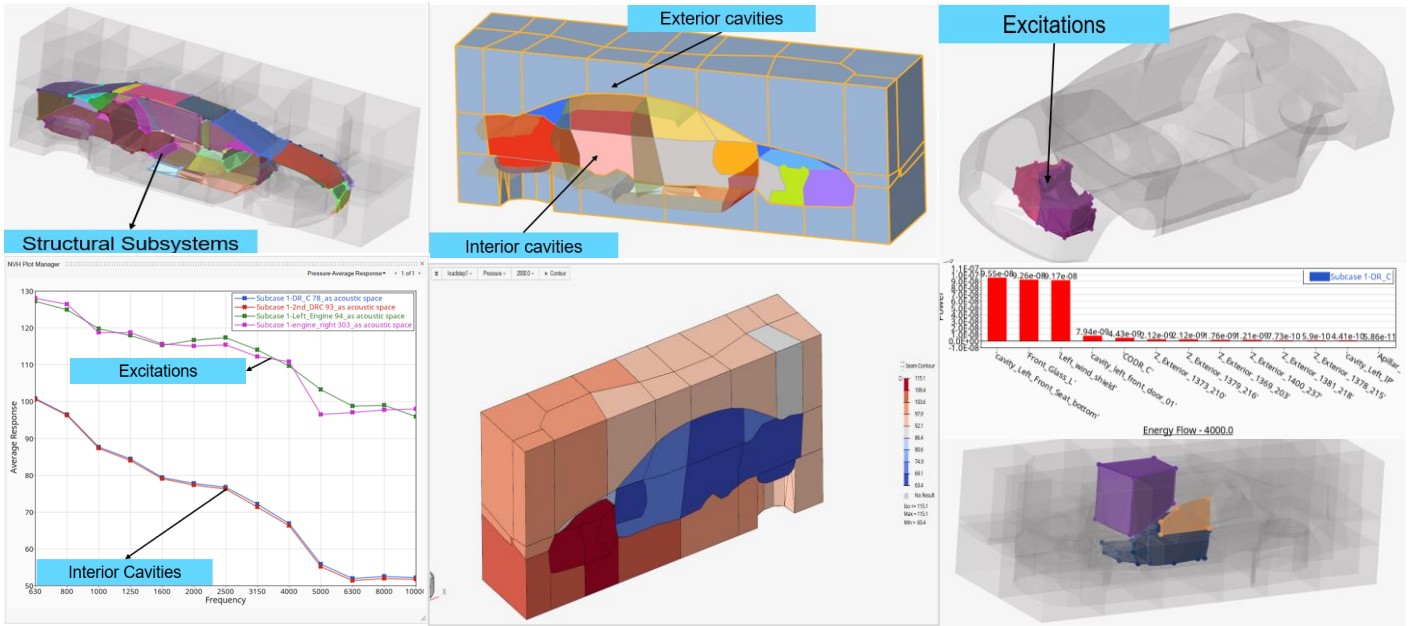
# 中、高频NVH仿真工具Altair SEAM全面解析

## 先进的后处理、诊断功能




| 激励贡献量分析 | 能量流分析 | Window effect分析 | NCT贡献量分析 | NCT参数DOE分析 |
|---|---|---|---|---|



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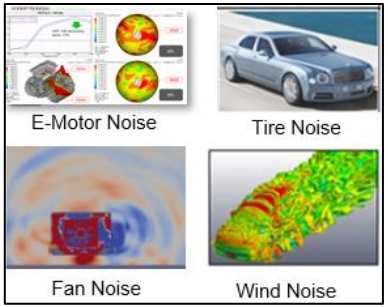
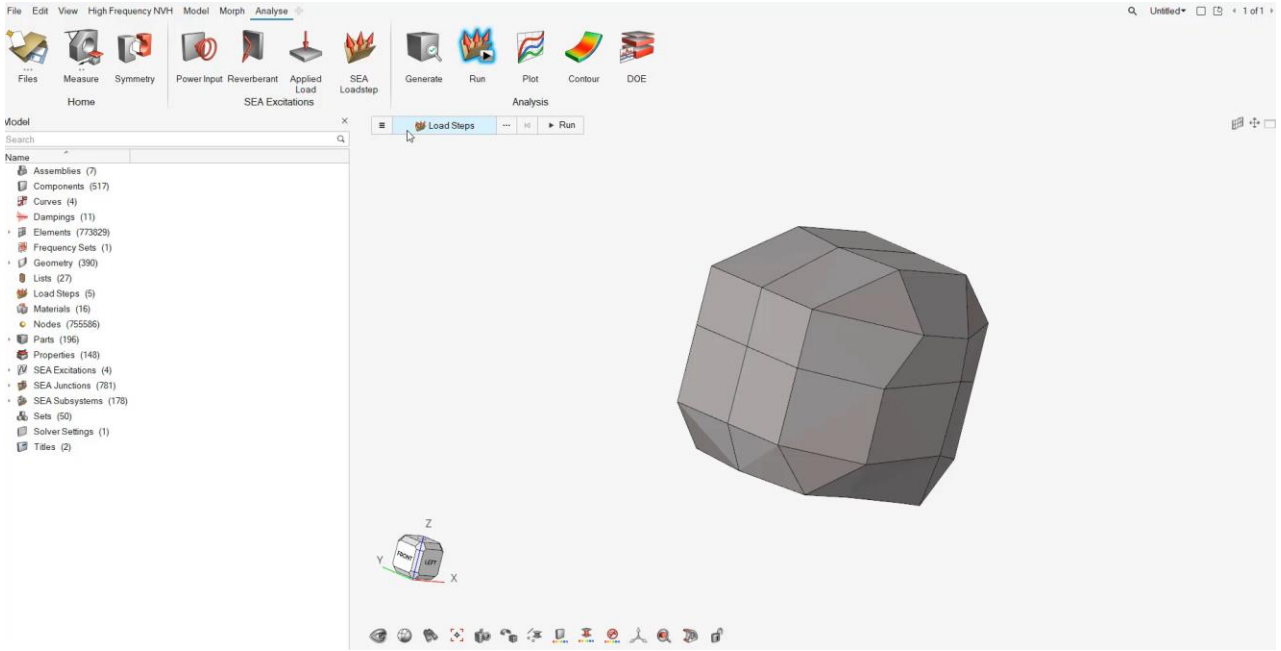
# 中、高频NVH仿真工具Altair SEAM全面解析

## 先进的后处理、诊断功能

- 整车目标分解
- 多个载荷同时加载
- 源的贡献




| 激励贡献量分析 | 能量流分析 | Window effect分析 | NCT贡献量分析 | NCT参数DOE分析 |
|---|---|---|---|---|



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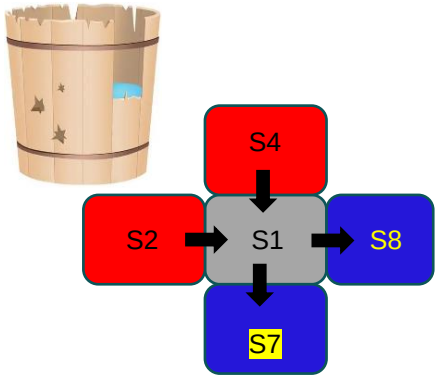
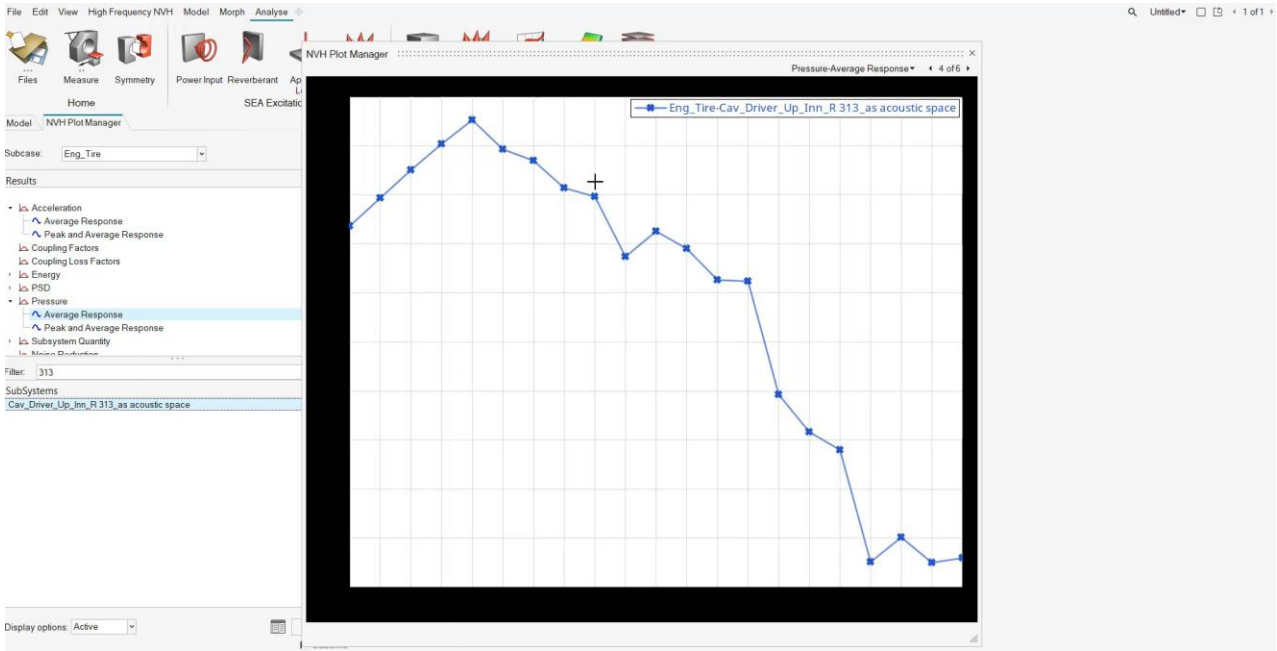
# 中、高频NVH仿真工具Altair SEAM全面解析

## 先进的后处理、诊断功能

- 能量传递路径
- 声学包设计短板
- 设计平衡




| 激励贡献量分析 | 能量流分析 | Window effect分析 | NCT贡献量分析 | NCT参数DOE分析 |
|---|---|---|---|---|



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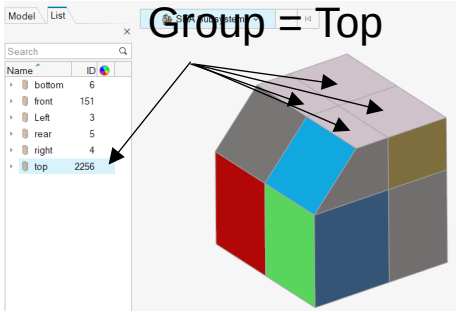
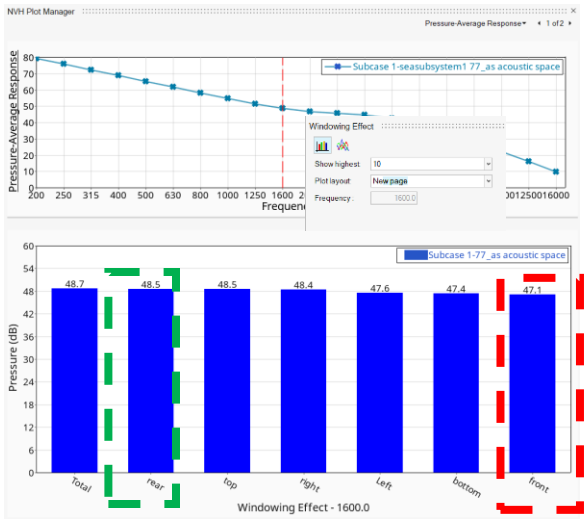
# 中、高频NVH仿真工具Altair SEAM全面解析

## 先进的后处理、诊断功能

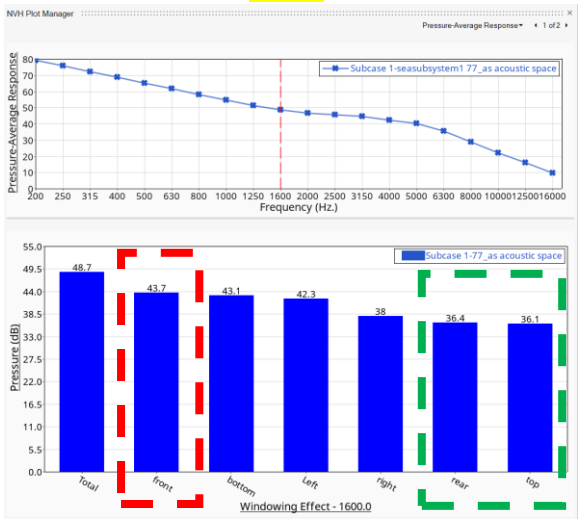
- 子系统到零部件
- Block
- Unblock
- 能量传递路径




Block：单独断开某个window




Block：单独激活某个window




| 激励贡献量分析 | 能量流分析 | Window effect分析 | NCT贡献量分析 | NCT参数DOE分析 |
|---|---|---|---|---|



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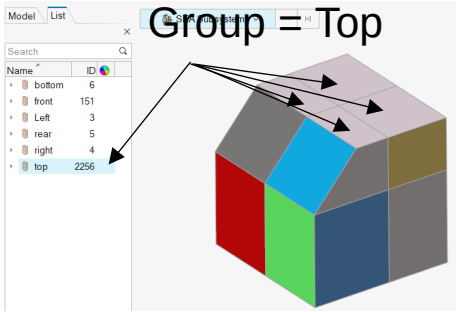
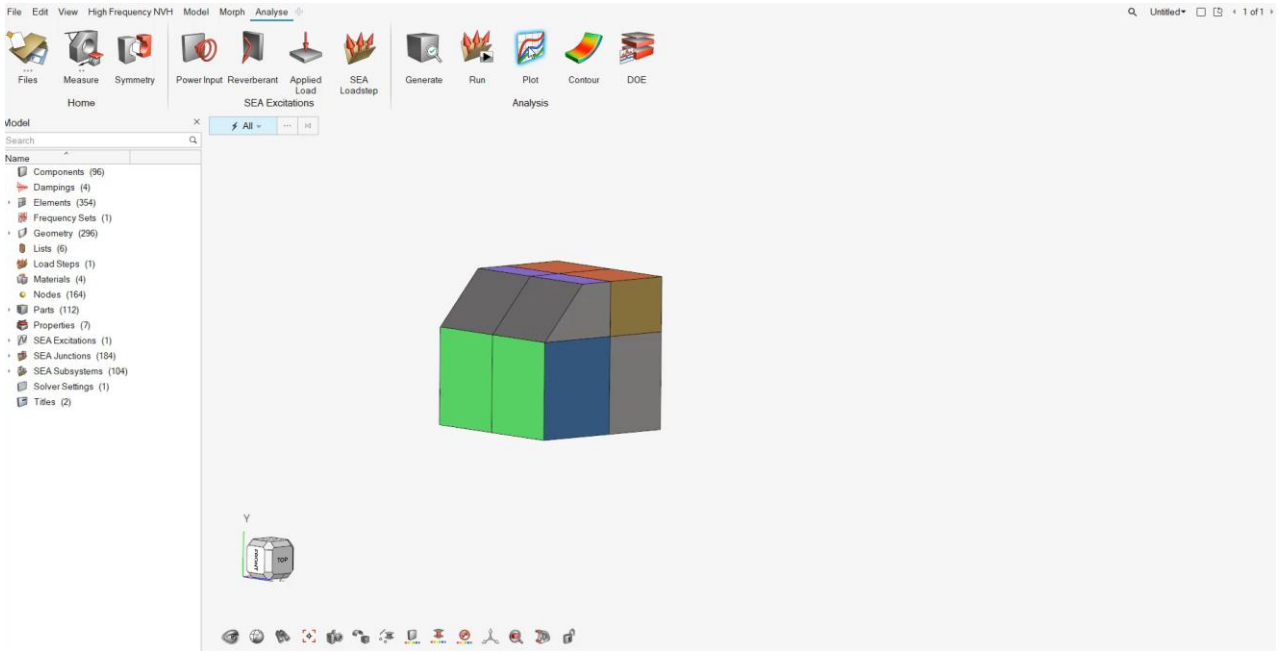
# 中、高频NVH仿真工具Altair SEAM全面解析

## 先进的后处理、诊断功能

- 子系统到零部件
- Block
- Unblock
- 能量传递路径




| 激励贡献量分析 | 能量流分析 | Window effect分析 | NCT贡献量分析 | NCT参数DOE分析 |
|---|---|---|---|---|



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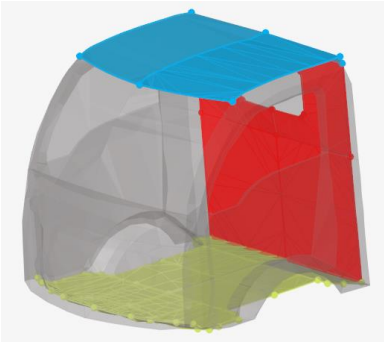
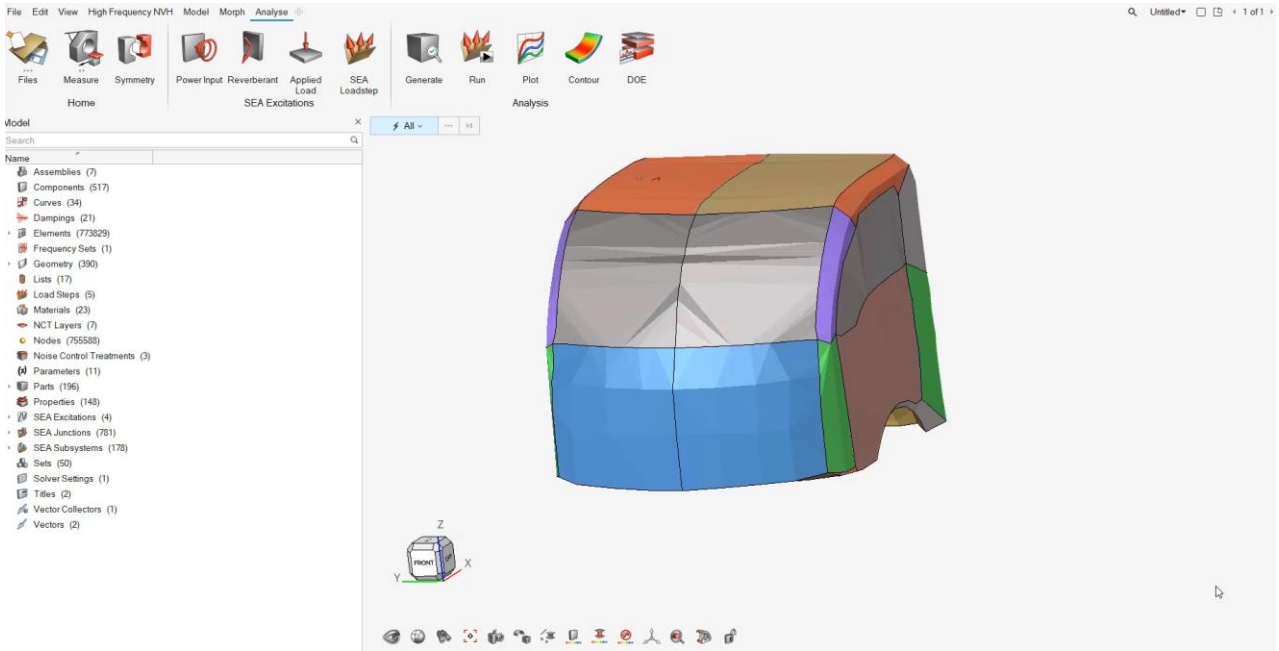
# 中、高频NVH仿真工具Altair SEAM全面解析

## 先进的后处理、诊断功能

- NCT隔吸声特性
- 乘员舱外
- 乘员舱内






| 激励贡献量分析 | 能量流分析 | Window effect分析 | NCT贡献量分析 | NCT参数DOE分析 |
|---|---|---|---|---|



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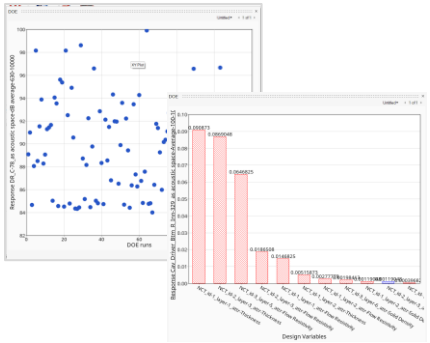
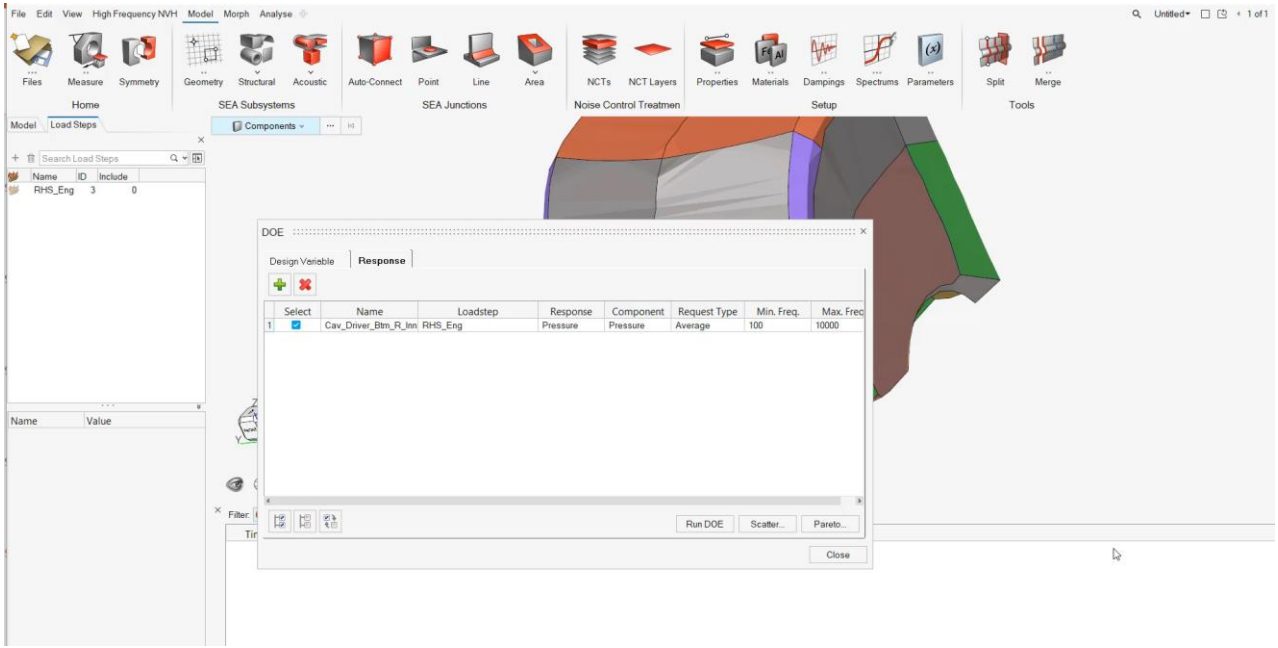
# 中、高频NVH仿真工具Altair SEAM全面解析

## 先进的后处理、诊断功能

- NCT选型
- NCT参数设计
- 支持变量自动识别






| 激励贡献量分析 | 能量流分析 | Window effect分析 | NCT贡献量分析 | NCT参数DOE分析 |
|---|---|---|---|---|



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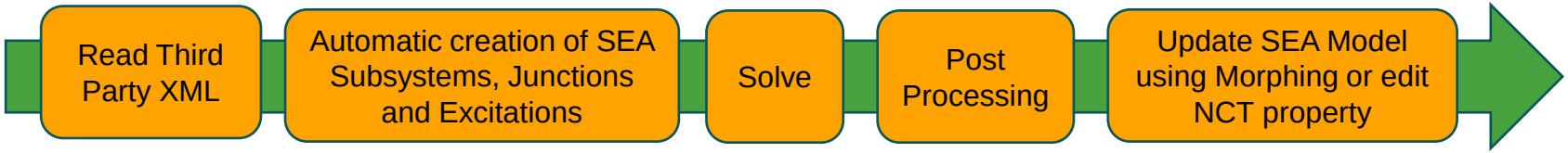
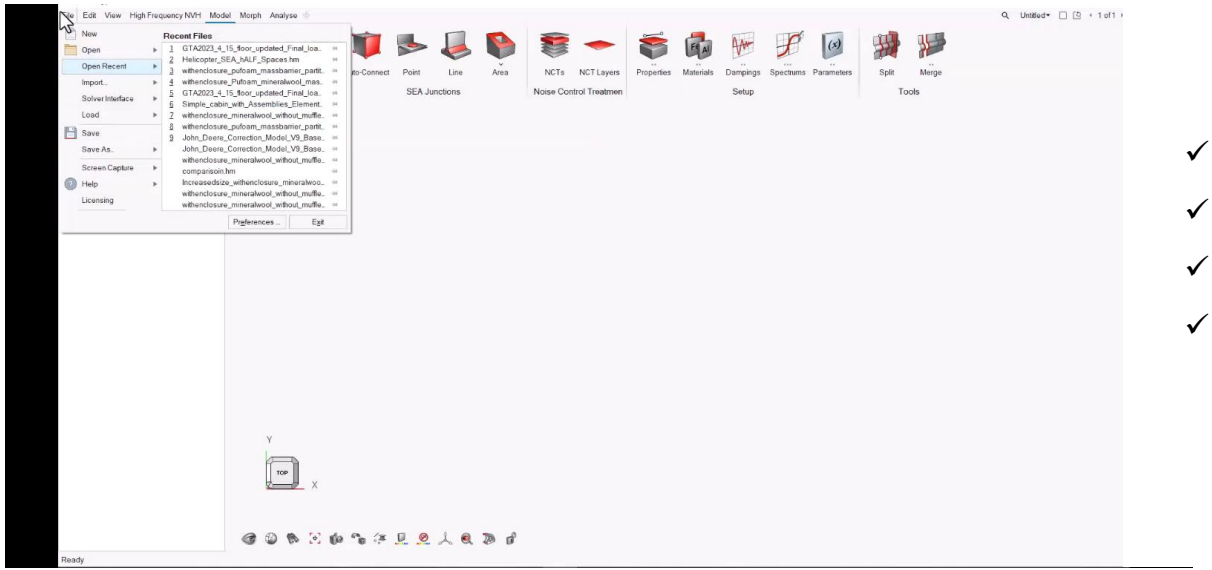
# 中、高频NVH仿真工具Altair SEAM全面解析

## Altair SEAM：第三方 XML 模型读取




- ✓ 读取第三方XML模型
- ✓ 参数自动转换，SEAM求解
- ✓ 支持模型参数编辑
- ✓ 支持模型几何变形



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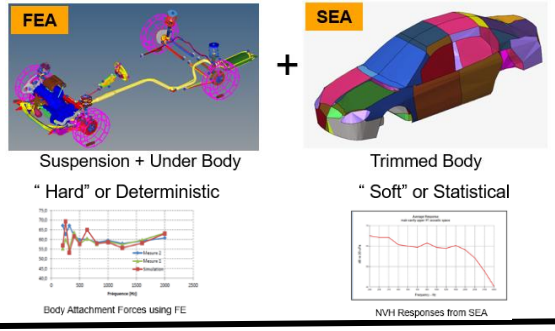
# 中、高频NVH仿真工具Altair SEAM全面解析

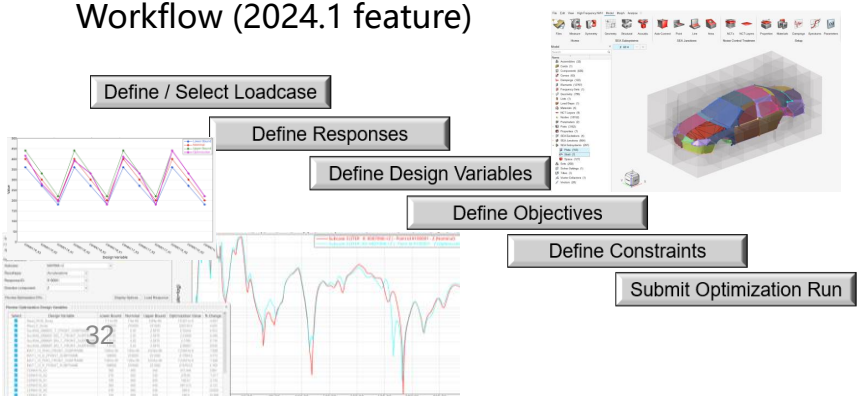
## 未来版本技术路线

New solver： SEA + FEM, for Mid-Frequency NVH

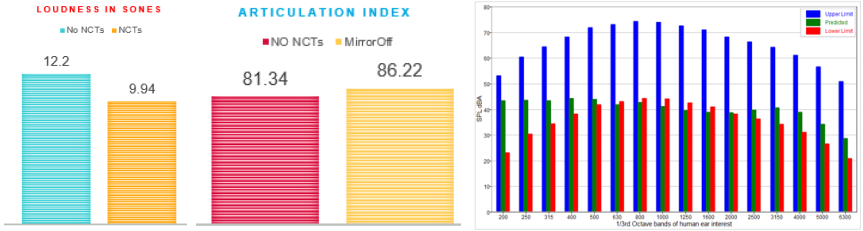



Integrated Environment： for Low + High Freq NVH


Optimization: Seamless and Integrated Workflow (2024.1 feature)




Sound Quality Analysis and Subjective Evaluation




No NCTs　　With NCTs



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# 中、高频NVH仿真工具Altair SEAM全面解析

## APA——声学材料数据库及拟合工具Alphacell

- **AlphaCell** 集合了常用的声学材料参数，可为声学包分析提供材料的BIOT参数及传递损失、吸声系数、混响时间特征曲线，并且可对多层材料及复杂几何特征声学零部件进行声学性能预测，实现声学零部件设计。


- 材料类型: 各向同性，各向异性, 粘弹性；
- 多孔模型: 泡沫, 纤维, 颗粒, 压缩纤维；
- 支持多种载荷，垂直入射、扩散场；
- 声学响应可听；
- 输出参数支持多种分析类型：FEA，EFEA，SEA

# 3.应用及合作案例分享

# CUSTOMER STORIES

## SEAM Software in the Aerospace Industry

Since the 1970's SEAM software has been used for high frequency noise and vibration analysis in countless successful projects. Starting as far back as NASA's hugely successful Cassini Spacecraft, to the 1980's Boeing 737, 767 and 777 designs, and finally on to the modern Gulfstream and Sikorsky aircraft, SEAM has lead the way in vibro-acoustic design.

***"Here at NASA we often have to deal with high levels of noise and aircrafts leading to problematic structural vibration and sonic fatigue issues.***
***Cambridge Collaborative's high frequency noise and vibration modeling software SEAM was compared directly with the competition in a recent analysis. The SEAM results won hands-down. Its predictions were remarkably close when compared to measured acoustic data of a complex command module.***
***I consider SEAM to be an invaluable component of NASA's Loads."***

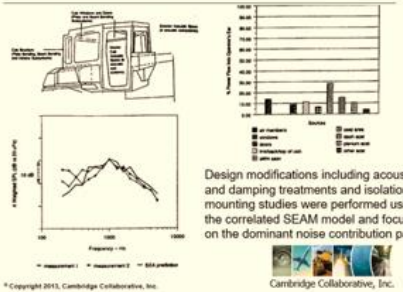
***-Sasan Armand, Ph.D., NASA Langley Research Center***

***BMW has successfully integrated SEAM as their tool to support concept studies at the very earliest stages oft he design cycle.***

The flexibility of SEAM to quickly generate answers to planned or proposed changes of materials, properties, sound package, damping treatments, and construction details is a powerful and useful CAE tool at a stage of the vehicle development process where FEA and CAE models are not finalized enough to be useful, and where prototype hardware is not yet available to measure. The software is not used to replace measurement, but serves a very useful role in the early design phase and reduces the need for testing later in the cycle.

SEAM is used effectively in the preliminary design phase at an assembly level, where a more detailed model is used and component-level responses are predicted and used to compare to or to set component level targets for the vehicle. The overall effect of this component-level change can also be seen in the full-vehicle model, where the sensitivity of the passenger ear locations to the proposed changes can be determined to show the relevance of the changes being considered on overall vehicle NVH (Noise, Vibration, and Harshness).

## Trucks Get Overhauled Using SEAM.

Design modifications including acoustic and damping treatments and isolation mounting studies were performed using the correlated SEAM model and focusing on the dominant noise contribution paths.

Cambridge Collaborative, Inc.



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# THANK YOU

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#ONLYFORWARD

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