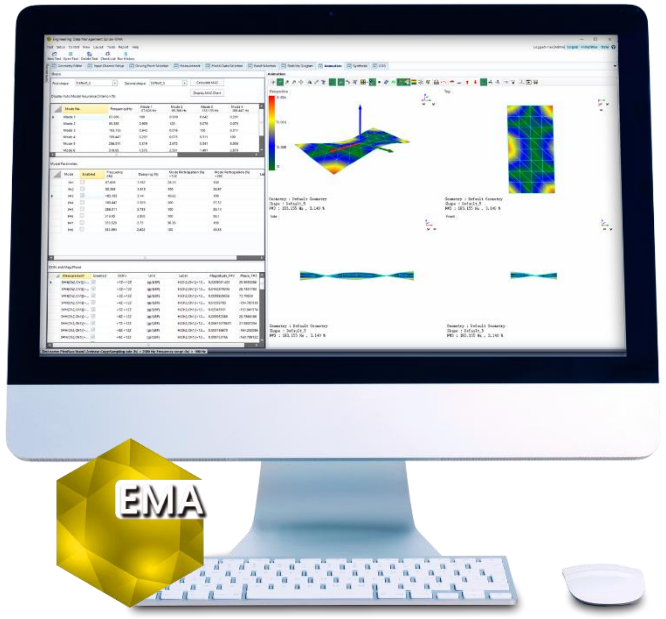
CRYSTAL INSTRUMENTS

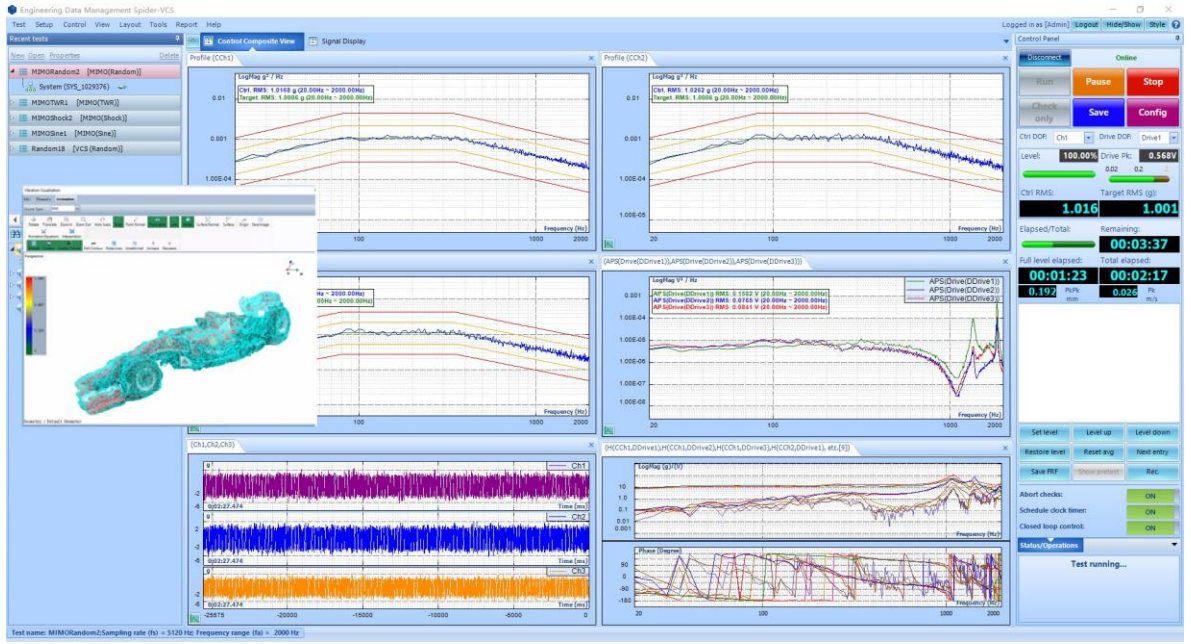


Vibration Visualization

An Innovative & Efficient Method for the Modern User

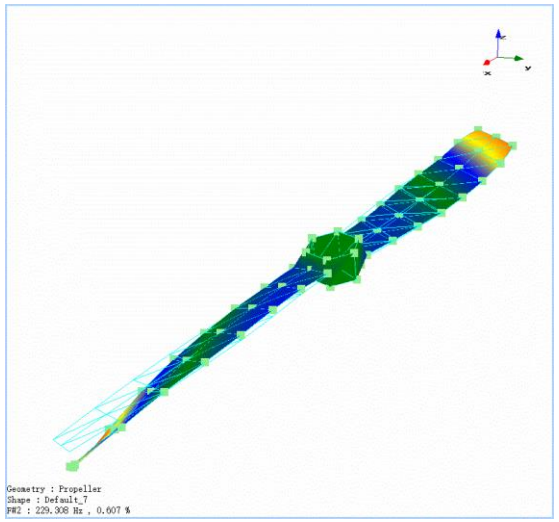
Why we need Vibration Visualization

- **Difficult to interpret or understand the intensity/amplitude of vibration that the structure under test is experiencing**
- **Visualization/animation of the test article's deformation makes it easier to understand the vibration experienced by the test structure**

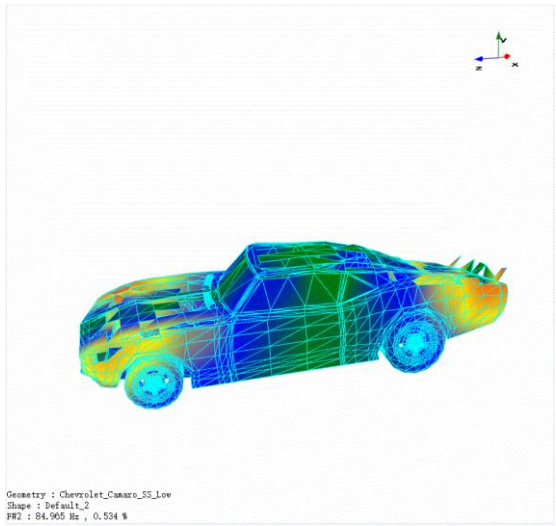


Vibration Visualization

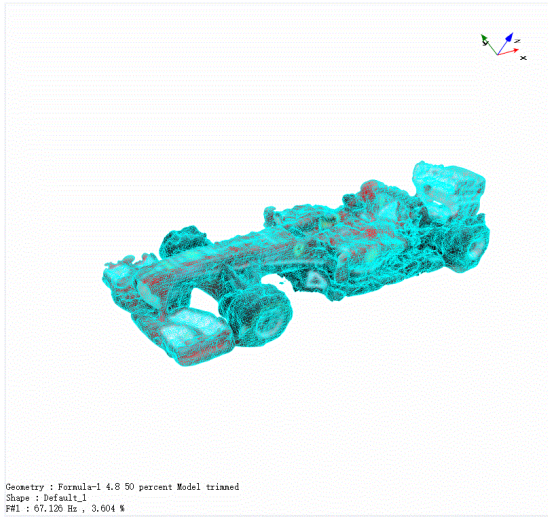
Vibration Visualization will create a visual effect to represent the intensity and distribution of vibration on a real testing article. It involves the following technical elements in our products:



VV of Geometry Model



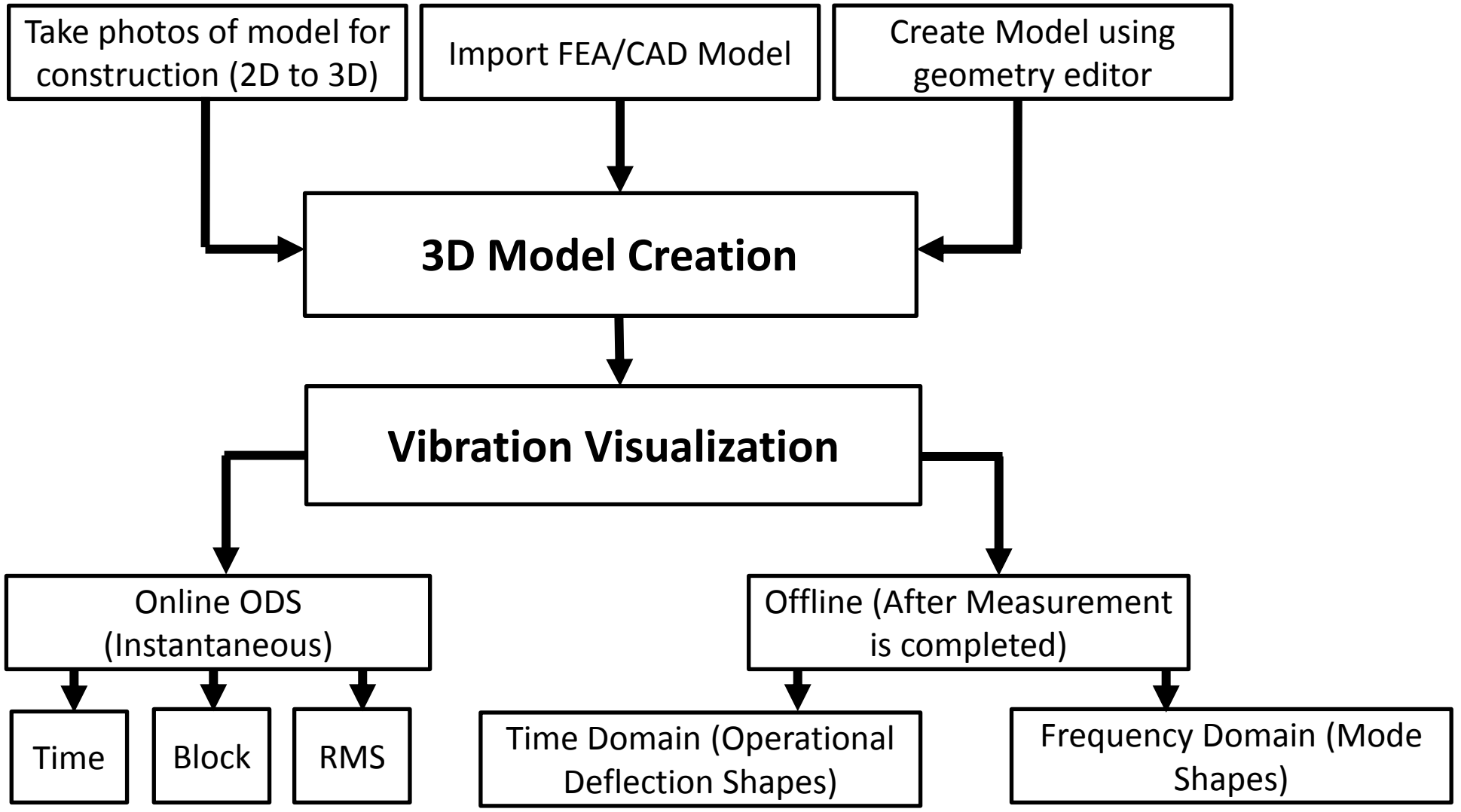
VV of FEA/CAD Model



VV of 3D Model reconstructed from 2D photos

CRYSTAL INSTRUMENTS

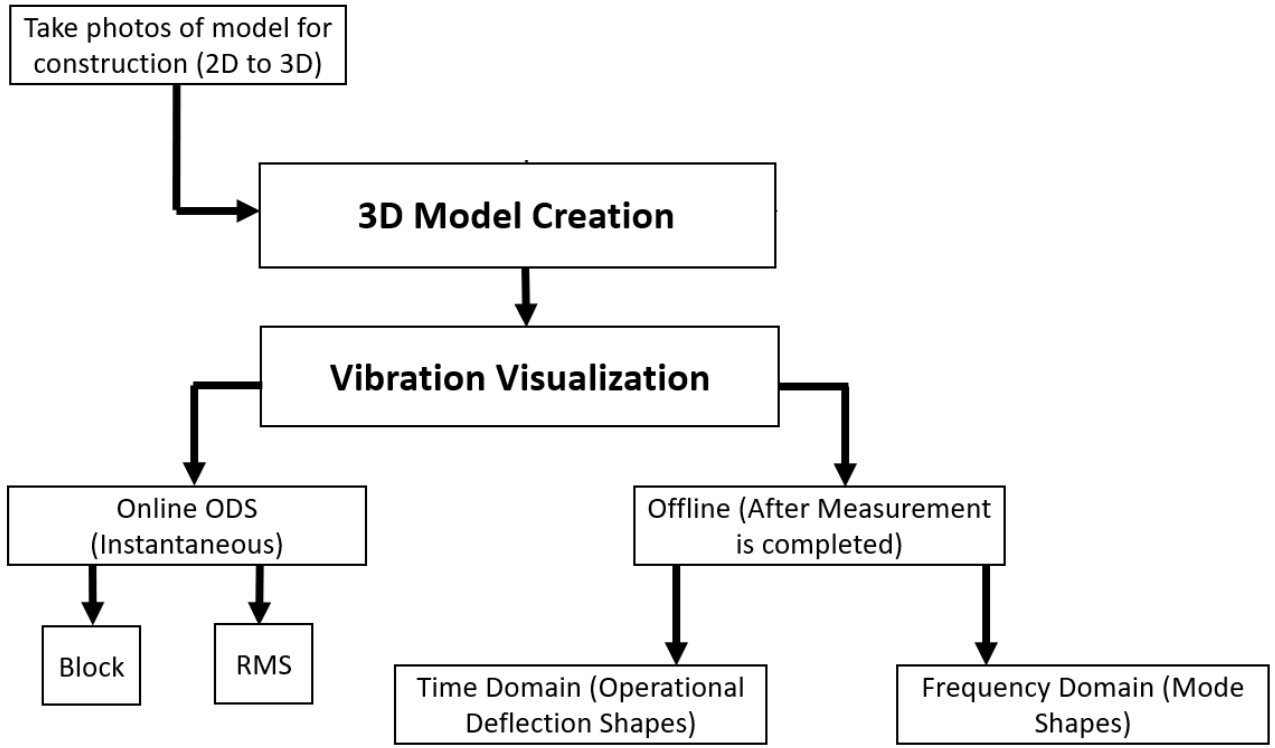
Vibration Visualization Flow Chart



CRYSTAL INSTRUMENTS

Method 1 – 2D to 3D Reconstruction

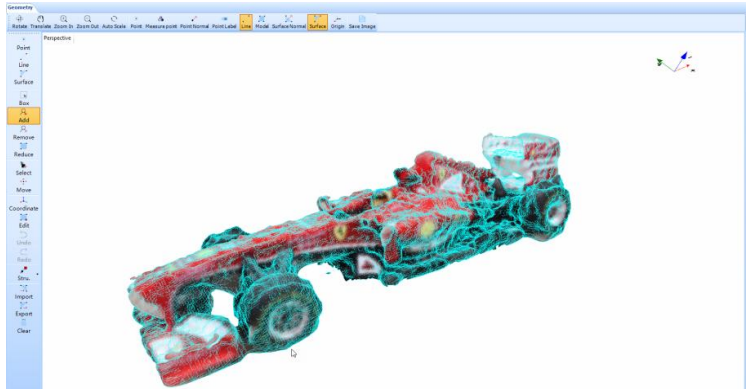
- **Take photos of the model**
- **Import the reconstructed 3D model into geometry editor.**



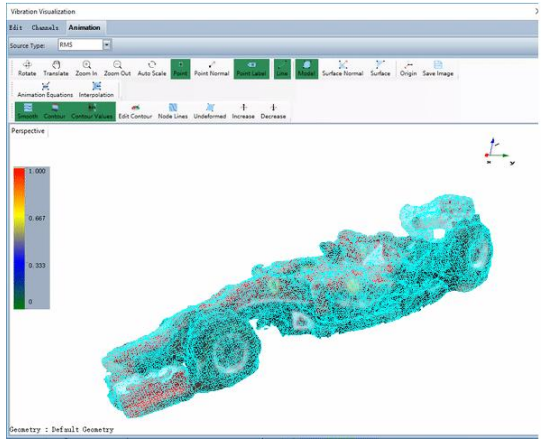
Advantages:

1. No skill required
2. No manual labor required
3. Very accurate to the real model (with colors)
4. Much lesser time and efforts than other 2 methods

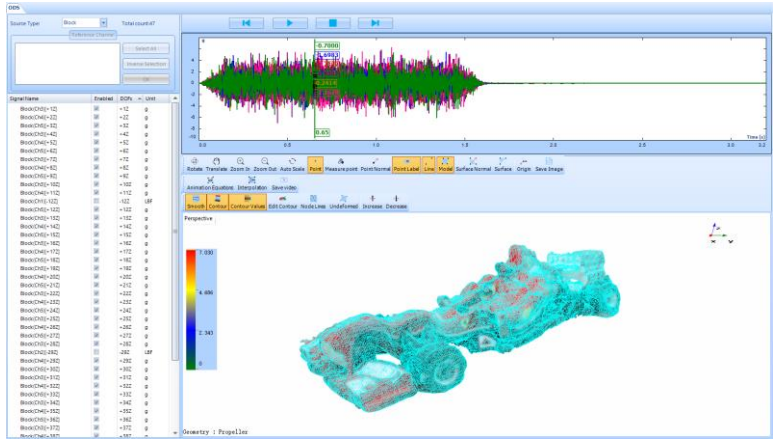
Test Structure



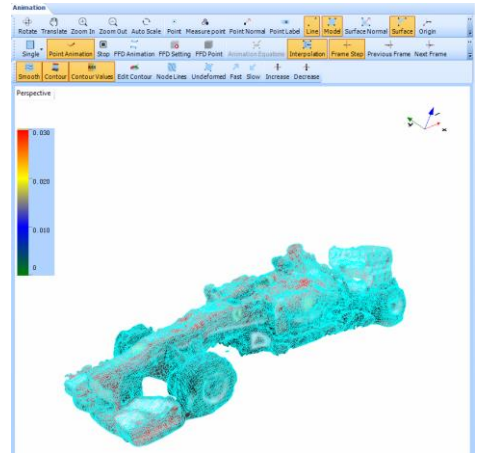
3D Model created using geometry editor



Online ODS



Offline ODS (Time Domain)



Offline ODS (Freq Domain)

CRYSTAL INSTRUMENTS

Measurement Approach

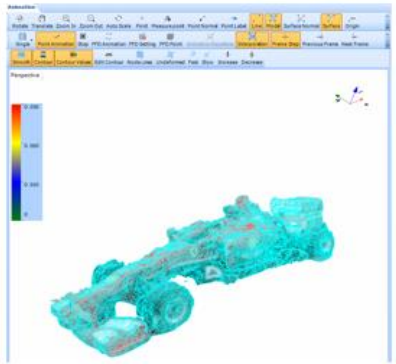
Vibration Visualization

2D photos

3D model

DUT under test

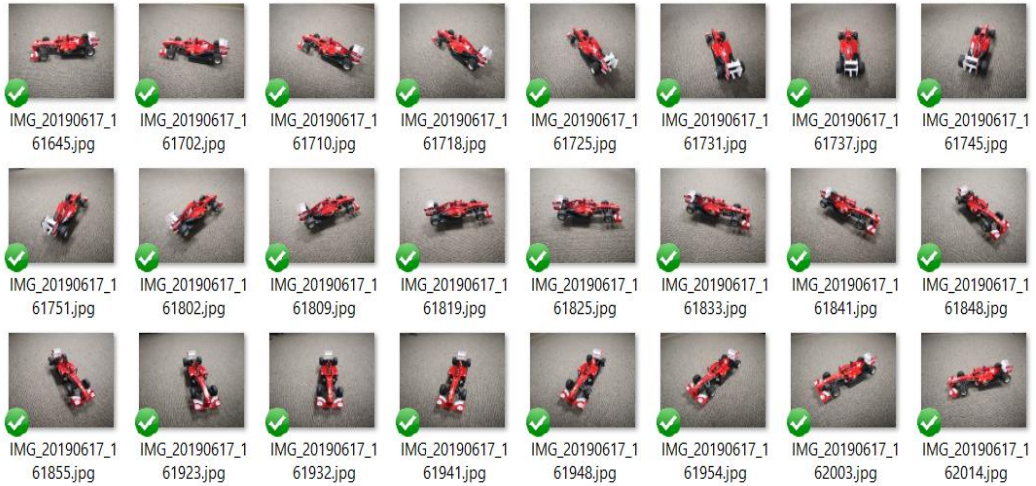
Spider Measurement Platforms



Vibration Visualization

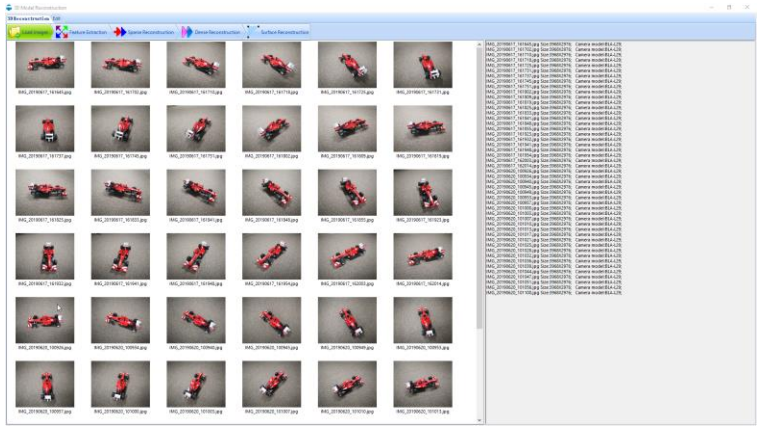
VV of reconstructed 3D models

- **Capture photos of the test article**

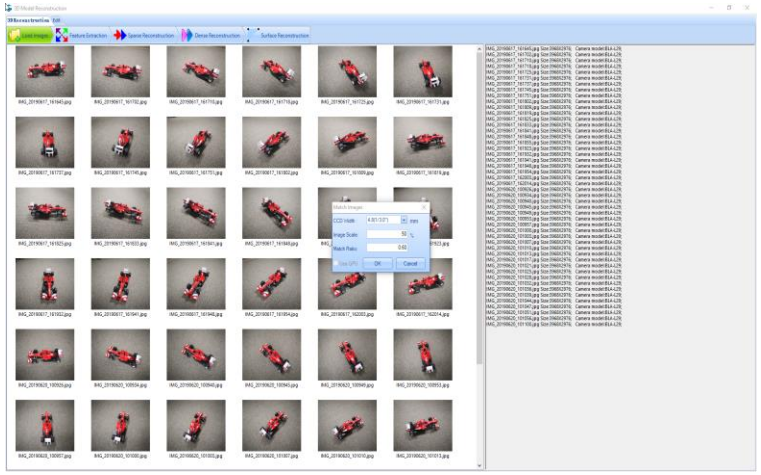


- **2D to 3D reconstruction (Load Images, Feature Extraction, Point Reconstruction (Sparse and Dense), Surface Reconstruction)**

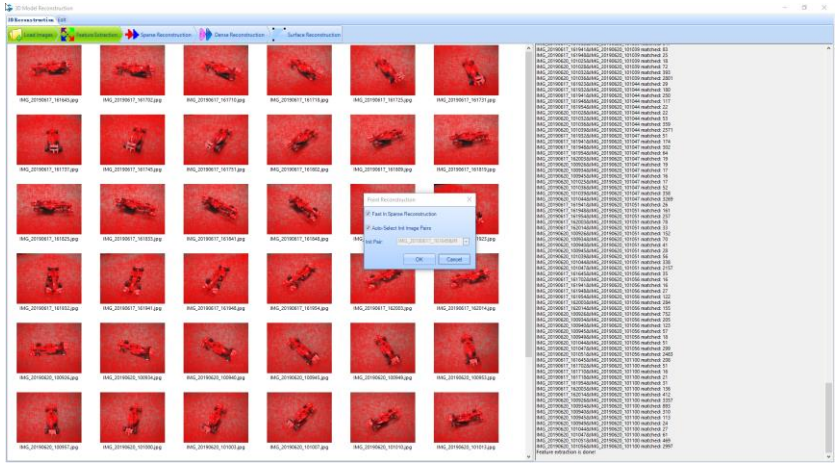
- **Load Images**

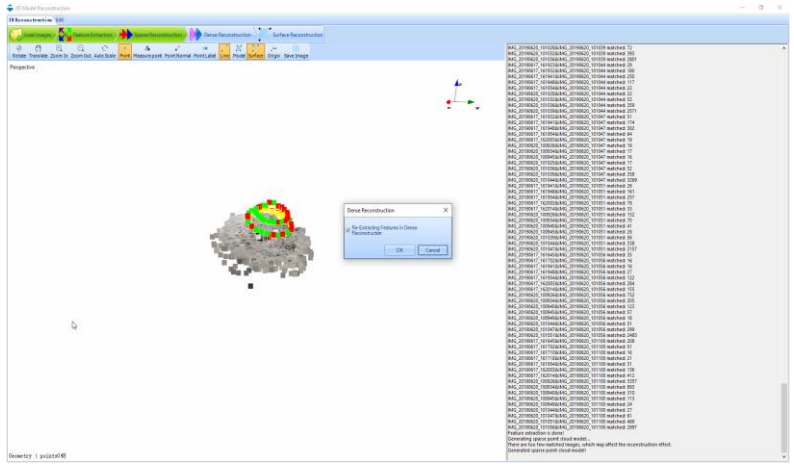


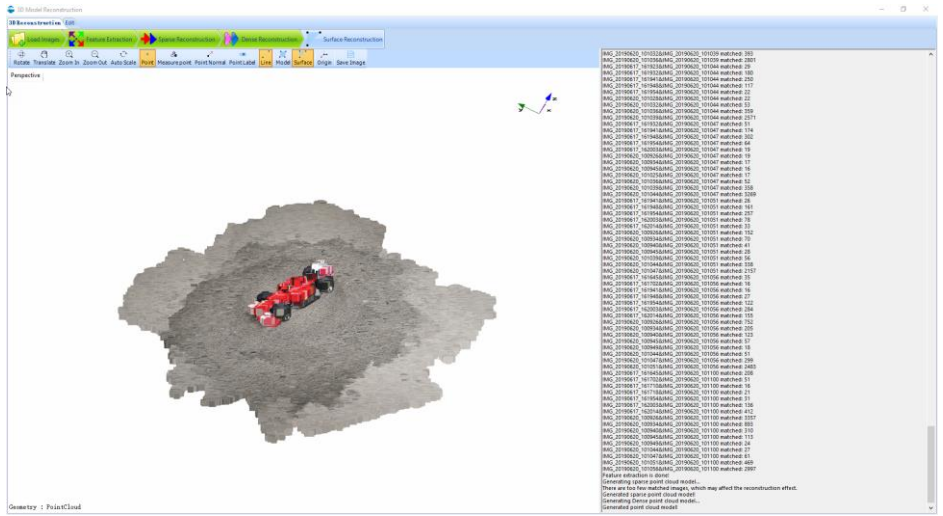
- **Feature Extraction**



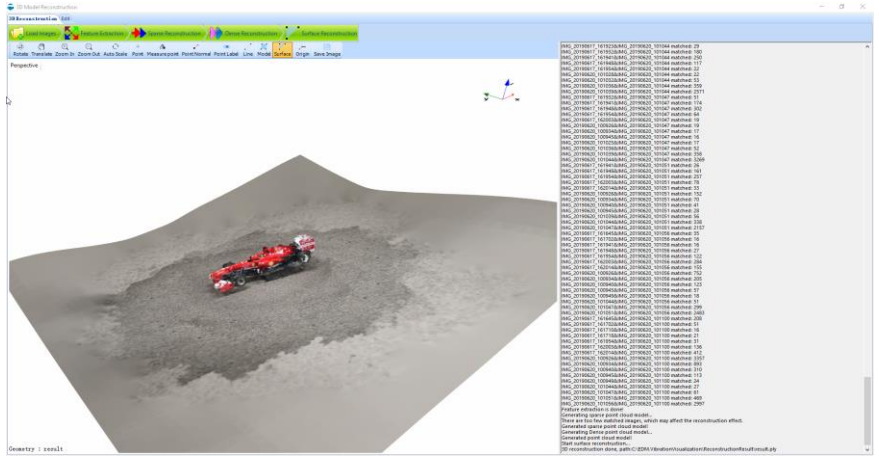
- **Sparse and Dense Reconstruction**



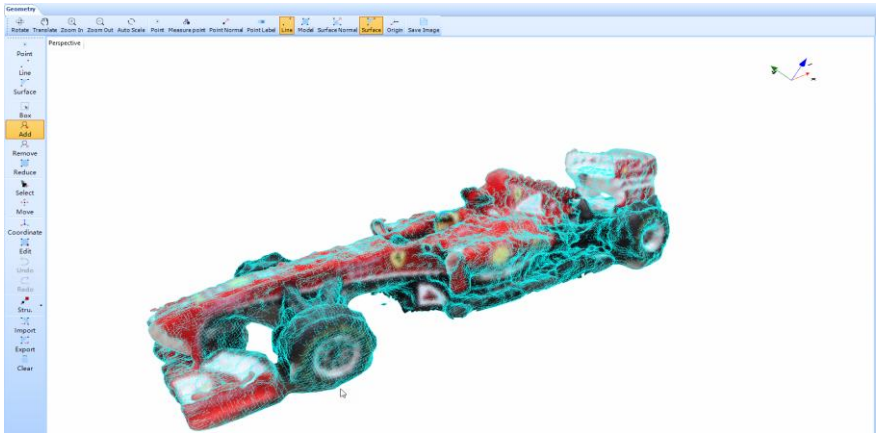




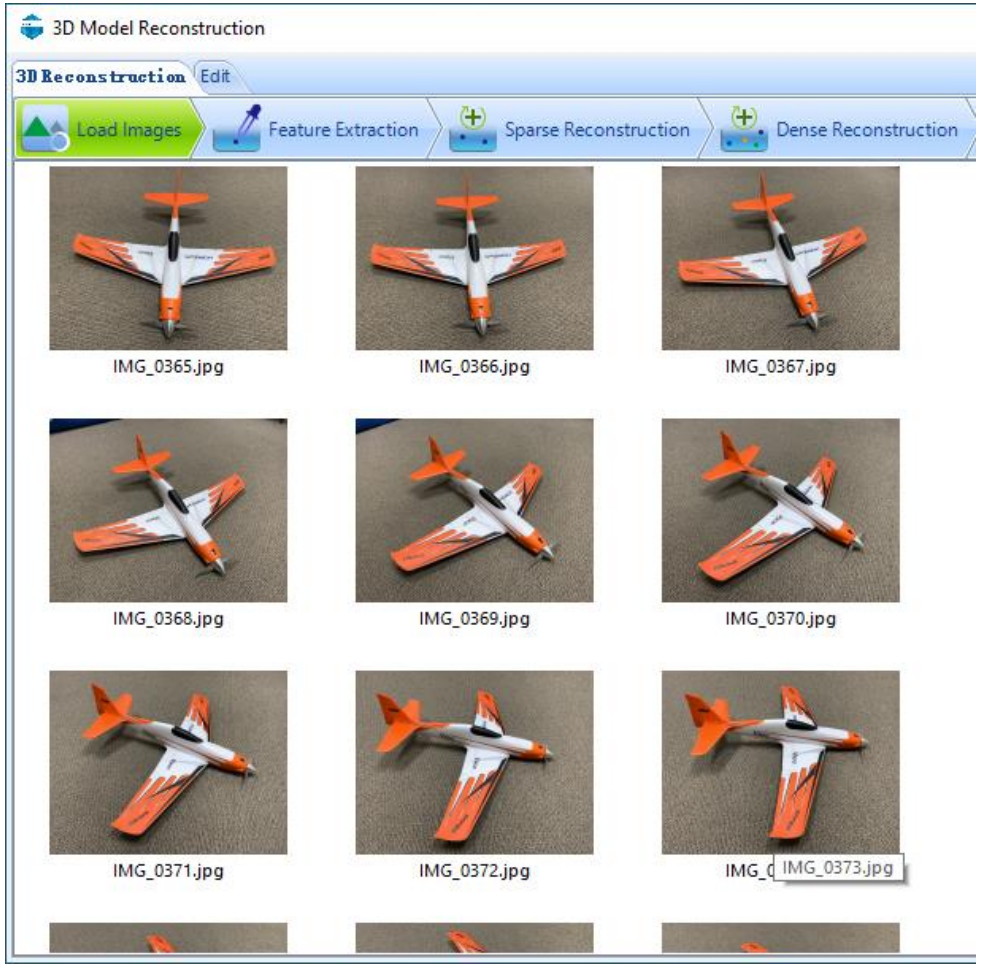
- **Surface Reconstruction**

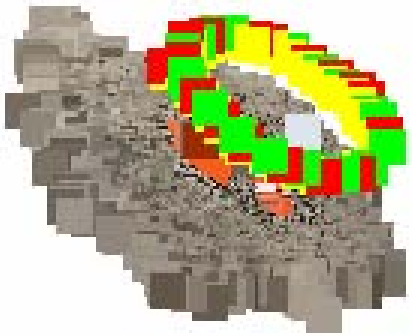


- **Geometry Editor**

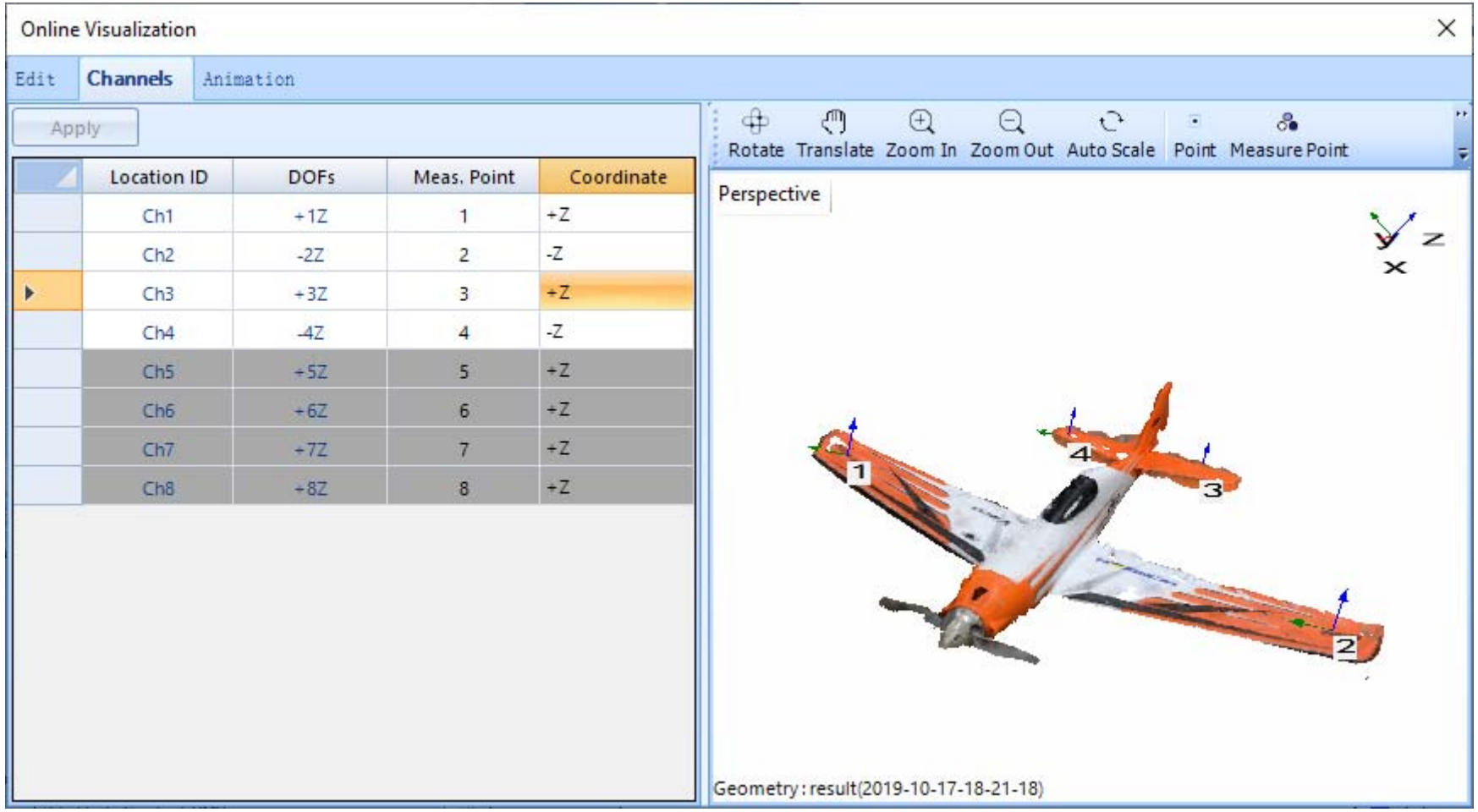


Airplane example: Load Images and Construct Model

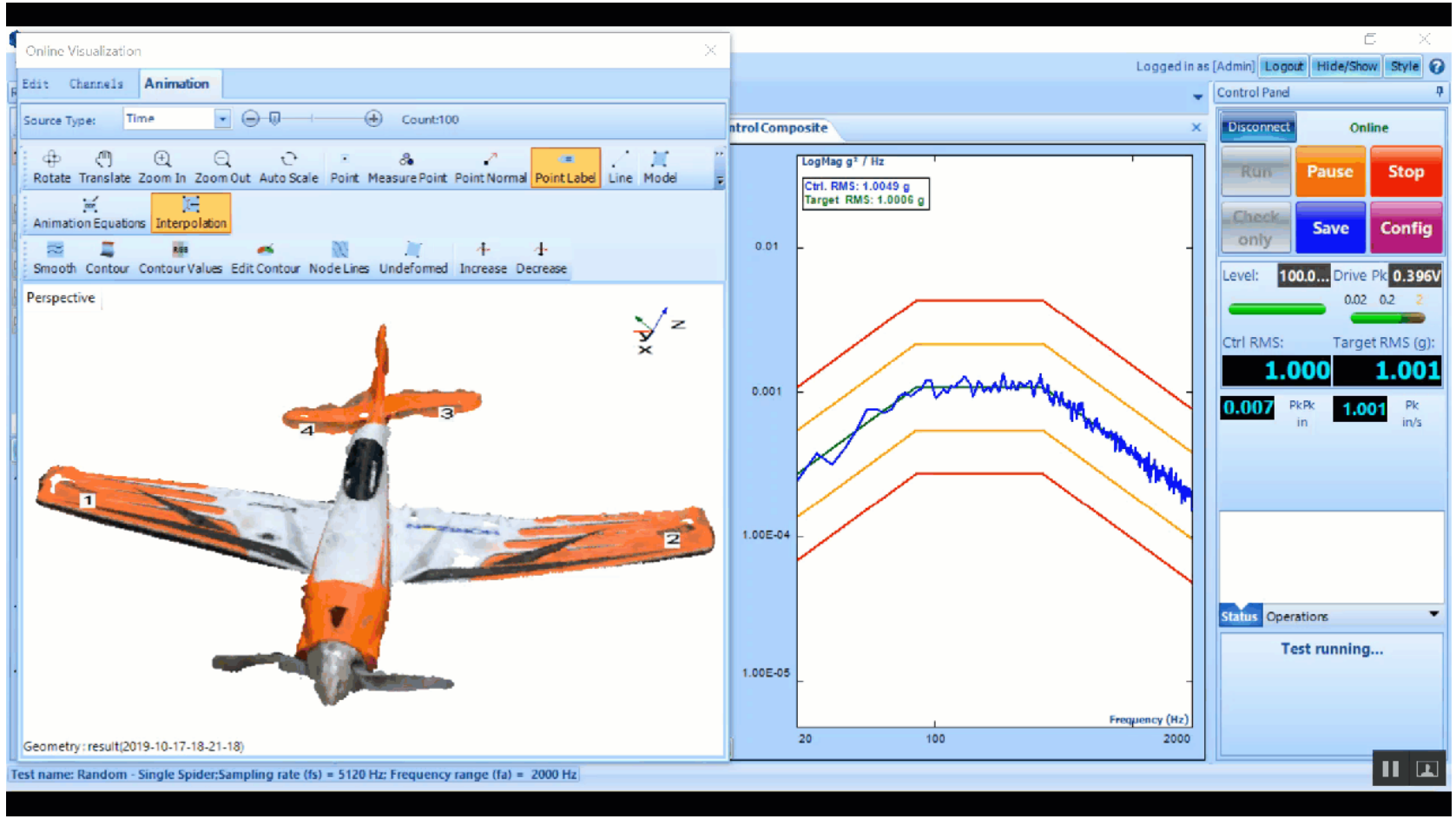




Airplane example: Import Model to EDM

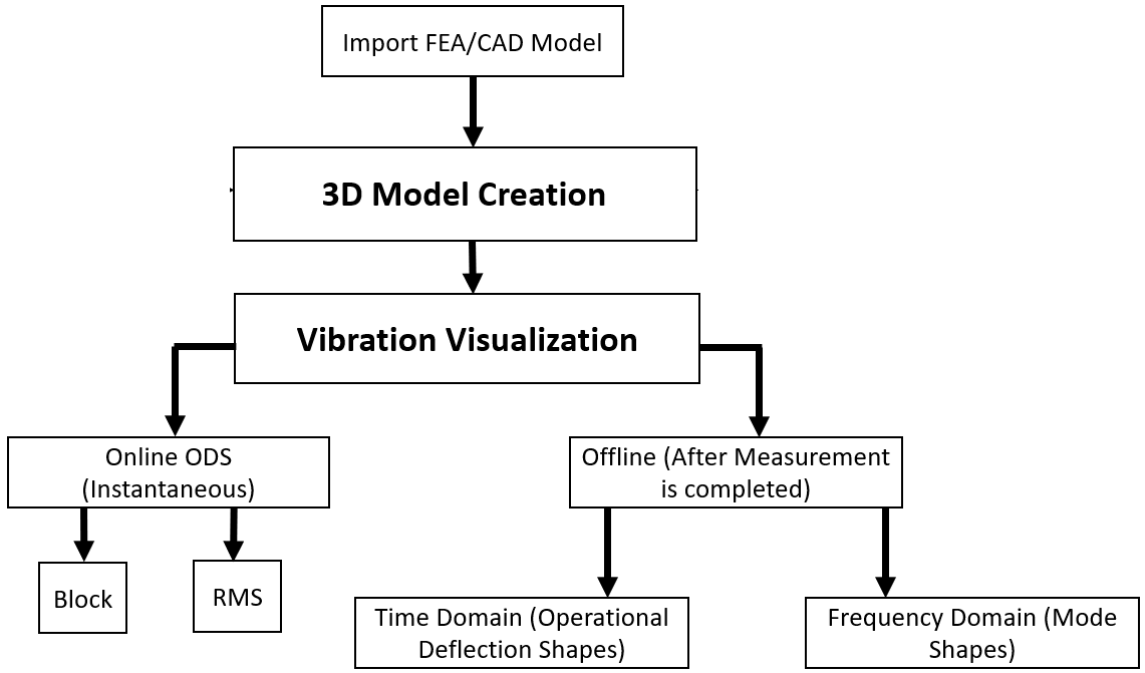


Airplane example: Vibration Visualization



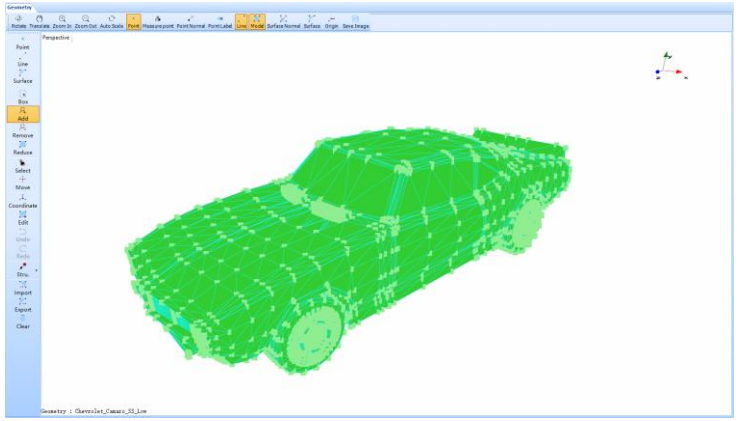
Method 2 - FEA/CAD Model

“Mapping EDM Geometry to the FEA model”

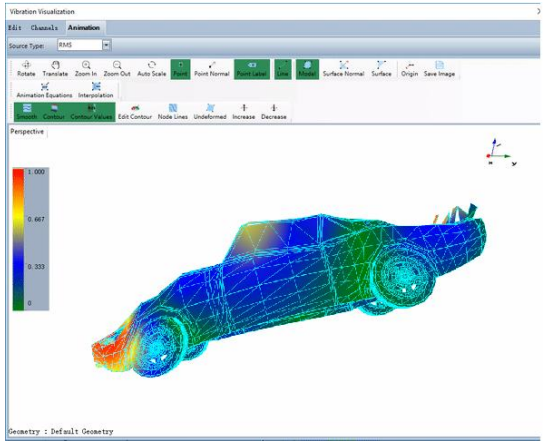


Drawbacks:

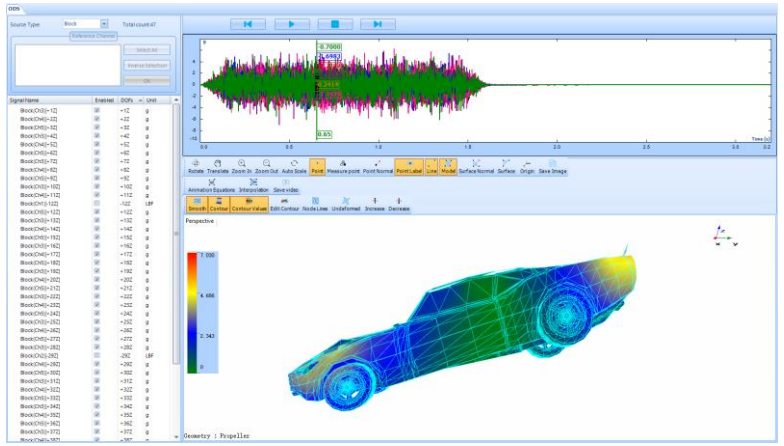
1. It is difficult to create the FEA/CAD model as high number of points are required for complex features
2. Expensive, long time and requires expertise



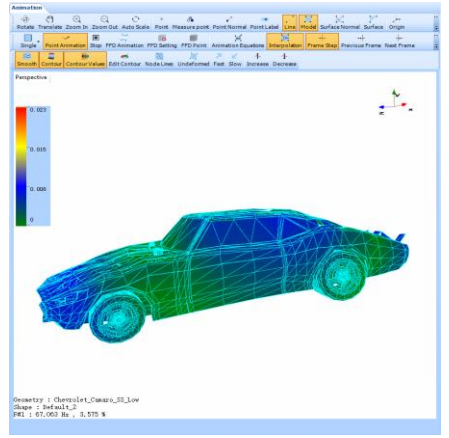
CAD Model imported into geometry editor



Online ODS



Offline ODS (Time Domain)

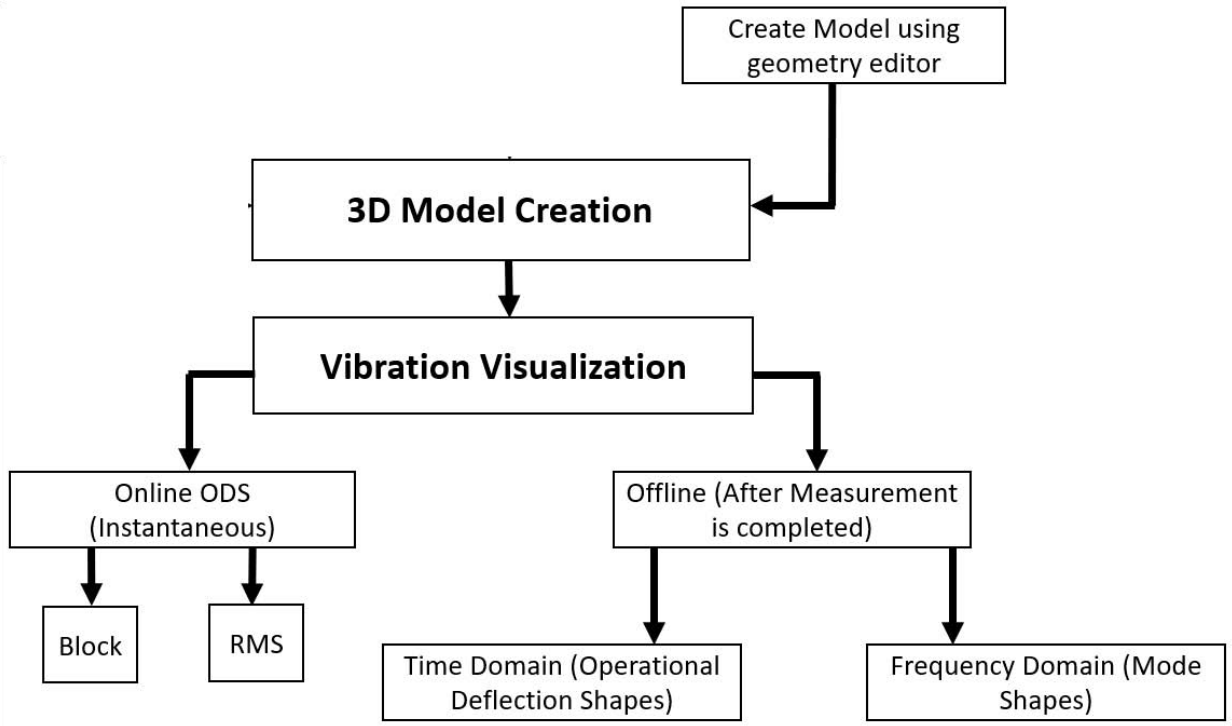


Offline ODS (Freq Domain)

CRYSTAL INSTRUMENTS

Method 3 – Geometry Editor

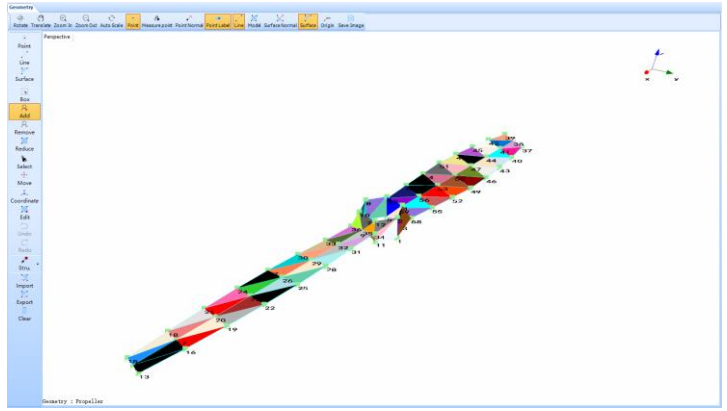
The Geometry Editor in EDM Modal/VCS/DSA uses coordinate values to define the locations and directions of points that represent the shape of the UUT.



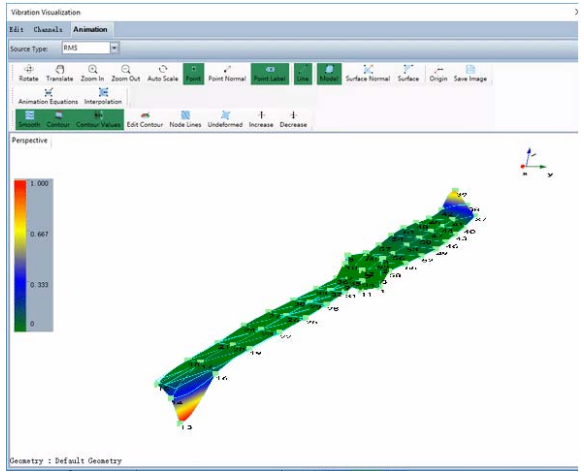
Drawbacks:

1. **Difficult to measure coordinates for complex models**
2. **Lot of manual work and time involved in creating model of complex structures**

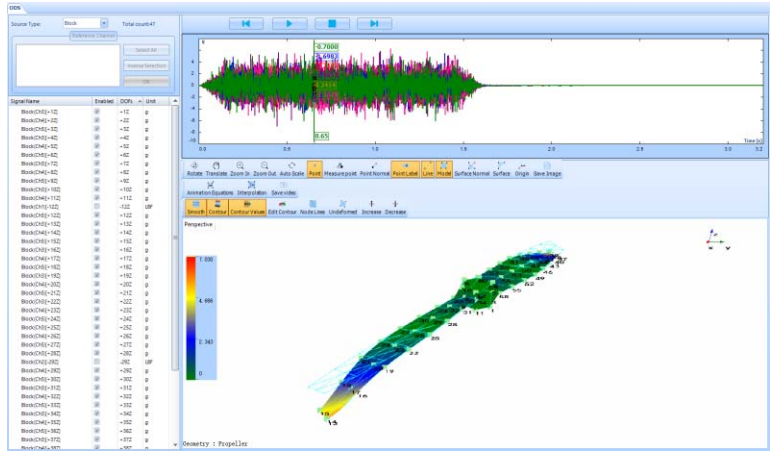
Test Structure



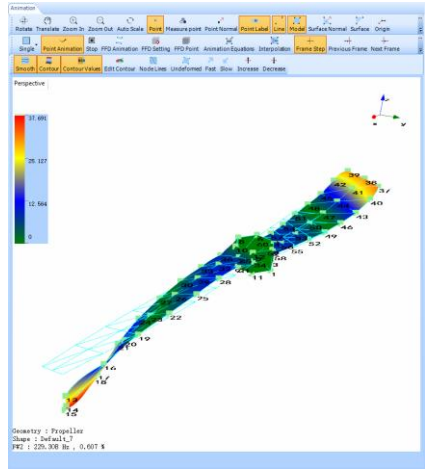
3D Model created using geometry editor



Online ODS



Offline ODS (Time Domain)

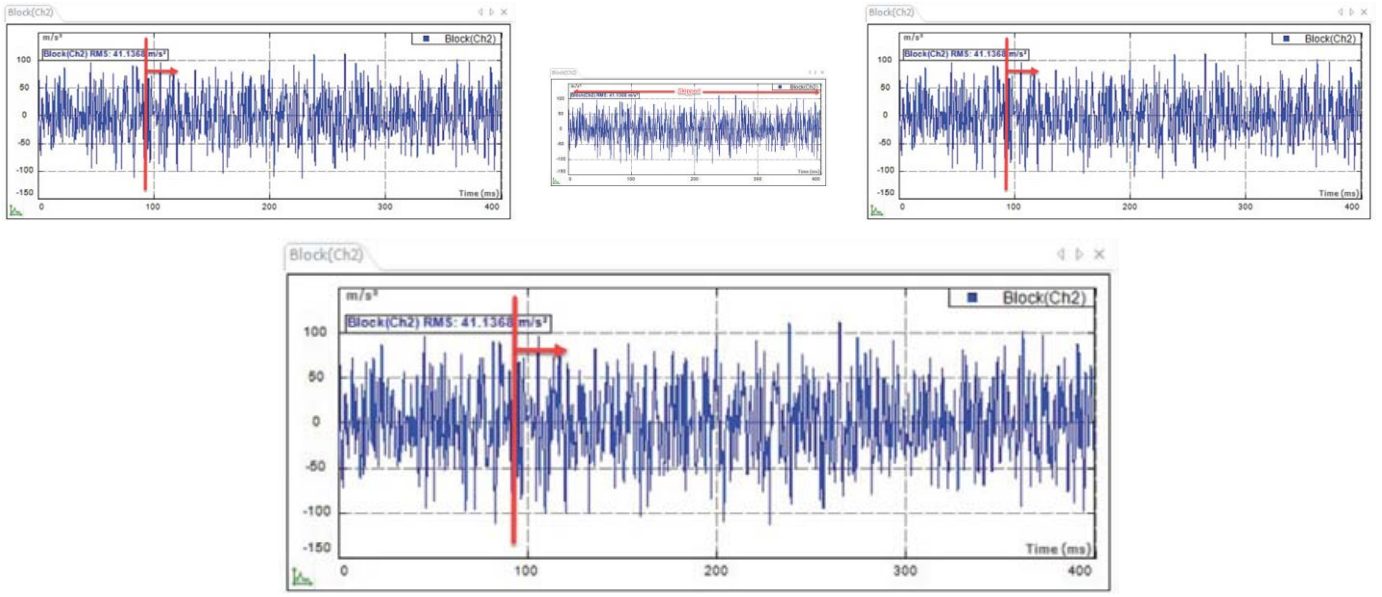


Offline ODS (Freq Domain)

CRYSTAL INSTRUMENTS

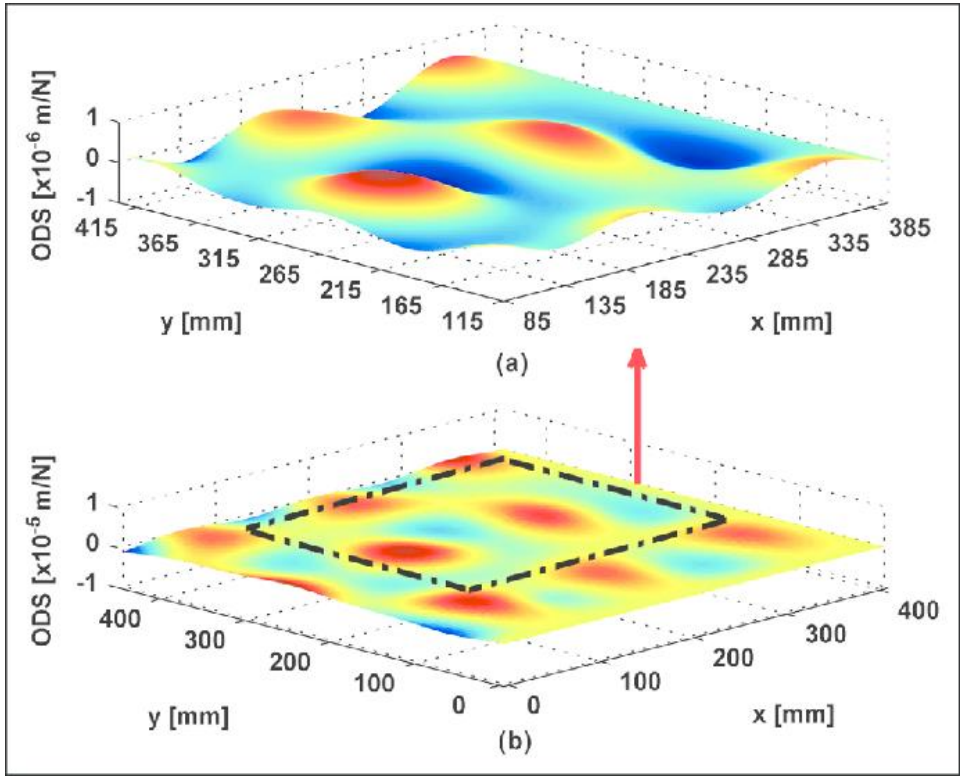
ODS Processing | At Different Thread

- DSP Processing is highly real-time (with overlapping).
- EDM Math calculation can skip some data.
- ODS processing is at a much slower speed than Math operation.



ODS Processing | Display in Intensity Mode

Use RMS of time signal to display the intensity and shape of vibration at different locations.

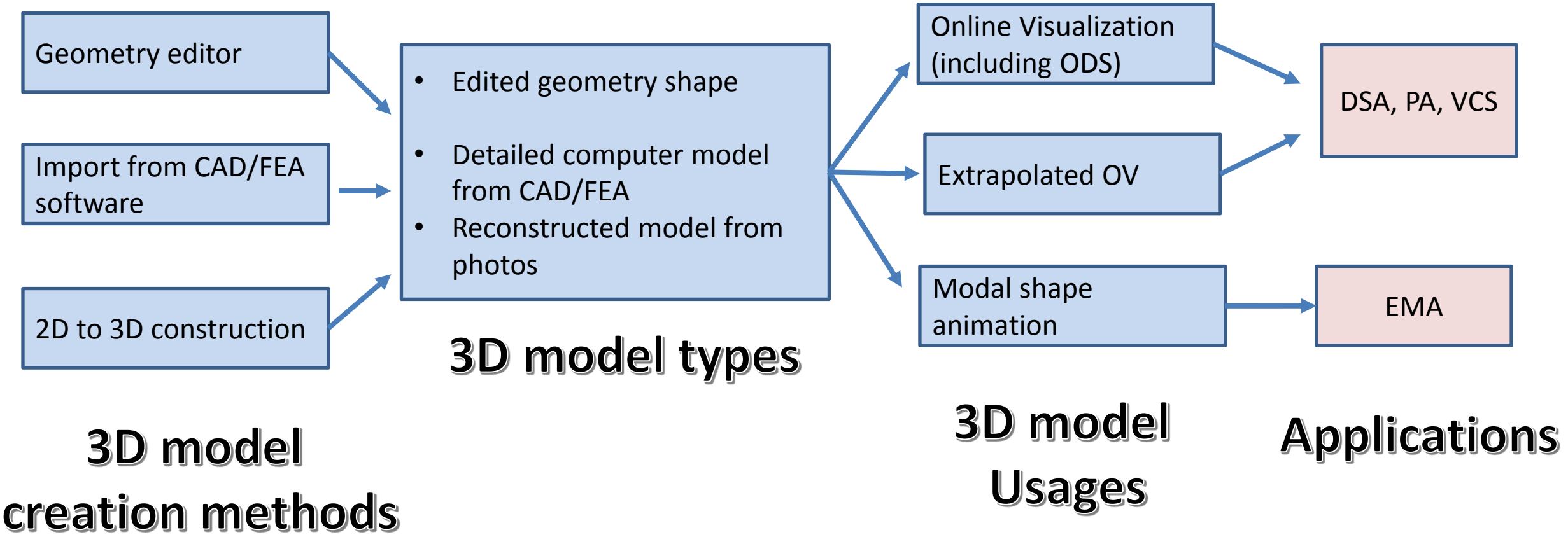


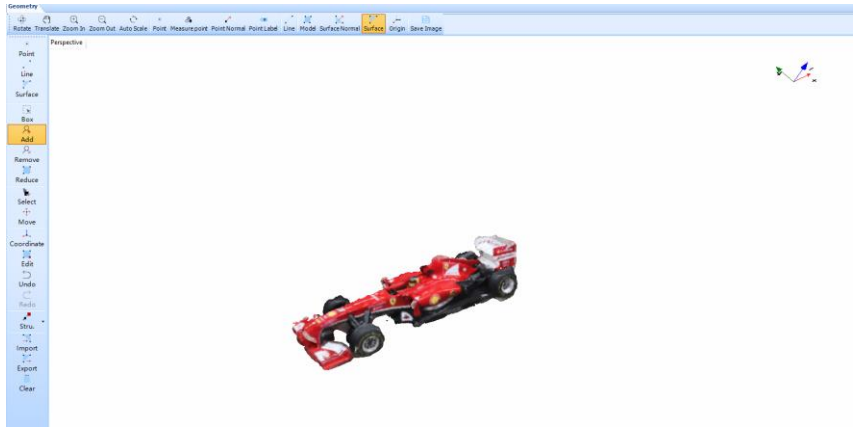
Vibration Visualization | Competitive Edge

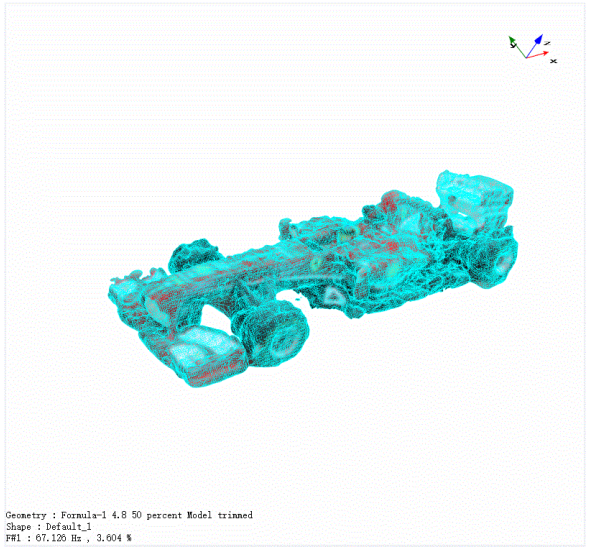
Crystal Instruments is able to develop the vibration visualization function thanks to our technological resources:

- **Data acquisition hardware (large channel count)**
- **Vibration control and data acquisition software**
- **Modal analysis and geometry functions**
- **Animation functions**
- **Positive research results of 2D to 3D transform**
- **Committed engineering resource**

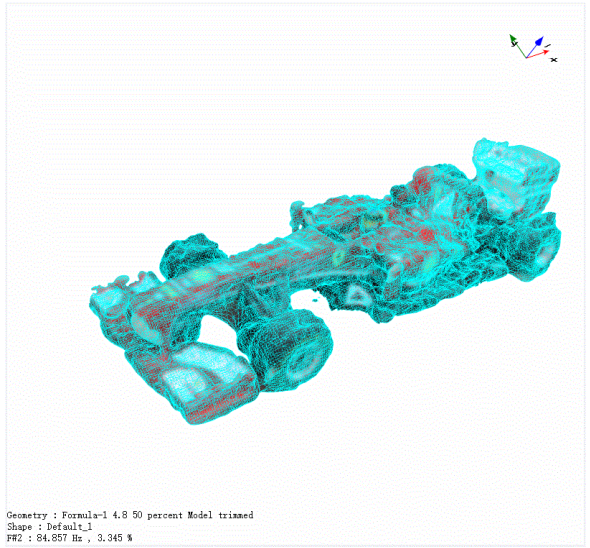
Vibration Visualization | Software Component Functions




Geometry
Rotate
Translate
Zoom In
Zoom Out
Auto Scale
Point
Measure point
Point Normal
Point Label
Line
Model
Surface Normal
Surface
Origin
Save Image
Perspective
Point
Line
Surface
Box
Add
Remove
Reduce
Select
Move
Coordinate
Edit
Undo
Redo
Stru.
Import
Export
Clear



Geometry : Formula-1 4.8 50 percent Model trimmed
Shape : Default_1
FM1 : 67.126 Hz , 3.604 %



Geometry : Formula-1 4.8 50 percent Model trimmed
Shape : Default_1
FM2 : 84.857 Hz , 3.345 %