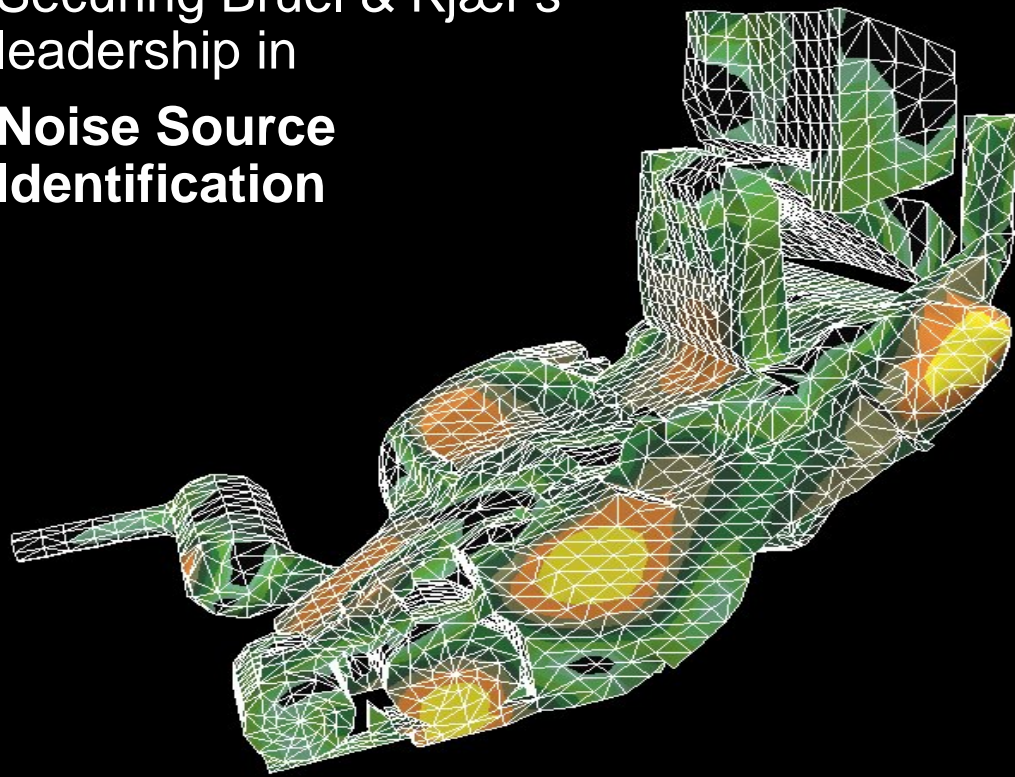
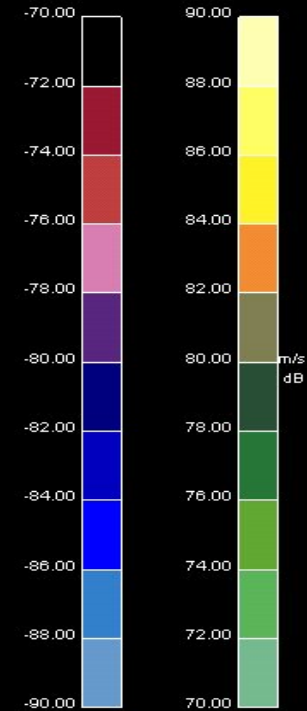


Conformal mapping

Securing Brüel & Kjær's leadership in
Noise Source Identification



12th order 828 Hz, Velocity, Frequency: 828.0 Hz



- Type 8602 Conformal Mapping Using SONAH
- Type BZ-5611 Position Detection Option for ATC

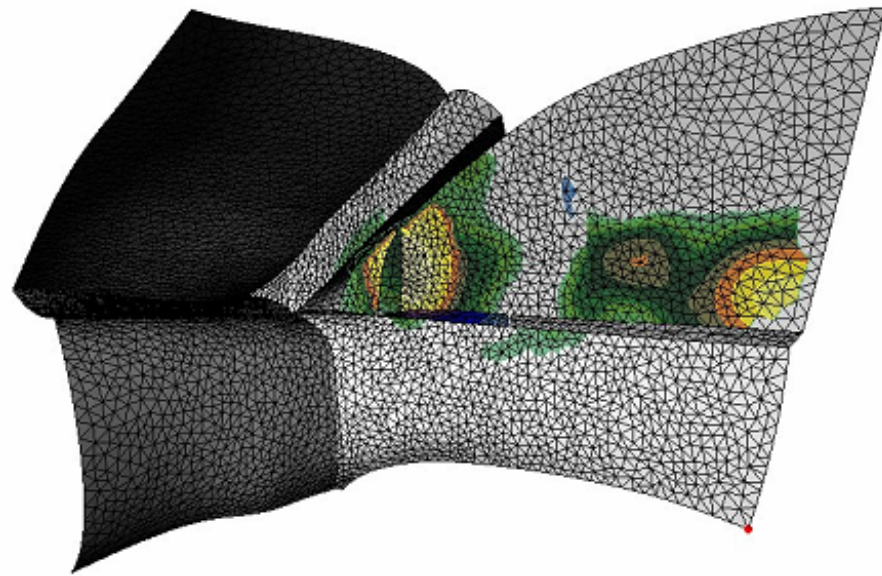
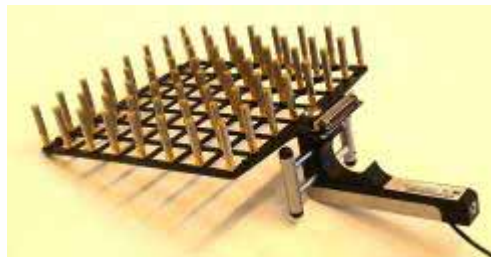


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Conformal Mapping using SONAH

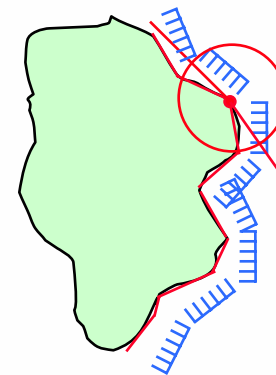
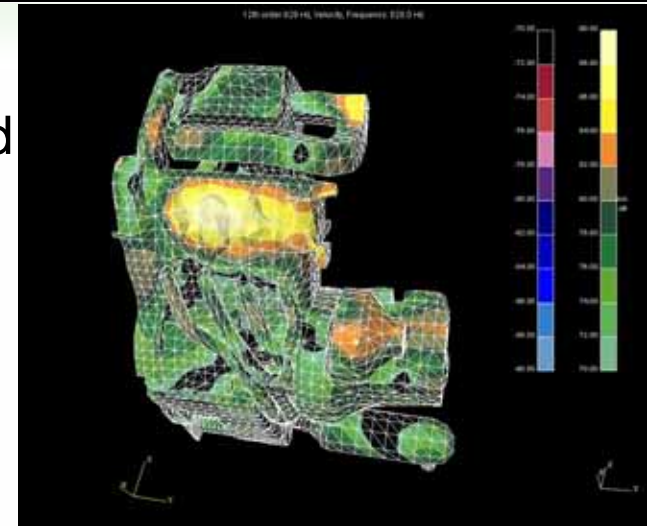
Easy and flexible high-resolution source location on curved surfaces



The extremely difficult made easy!

Conformal Mapping

- **Conformal mapping** provides a map directly on the actual surface geometry of an arbitrary shaped object
 - Maps are more informative and easier to interpret by non-acousticians and give an indication of surface vibration levels
- Easily performed using hand-held array measurements at random, accessible positions around the source
 - Positions are automatically detected with the position detection system in the handle
 - No need for a conformal array
 - Fast calculation time



How does it work?

Local SONAH calculation based on the array position closest to the target point on the geometry

Object geometry can be created using the position detection system in the handle of the array followed by meshing

Geometry models not a prerequisite

Existing object geometry models can be imported but access to geometry data reduces work

Based on SONAH (Statistical Optimal NAH)

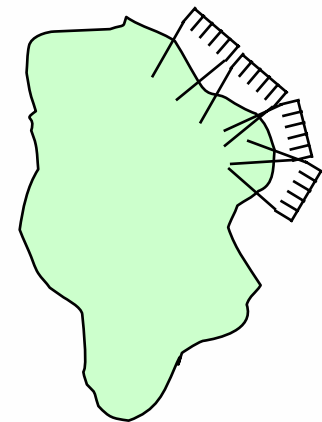
Low frequencies can be calculated even from small patches

Main specifications:

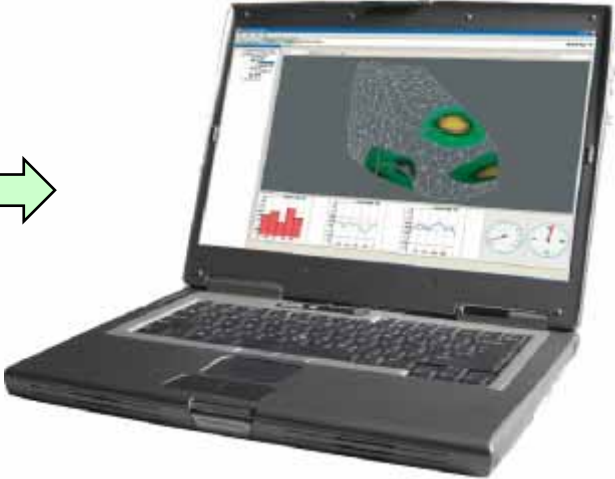
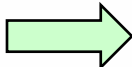
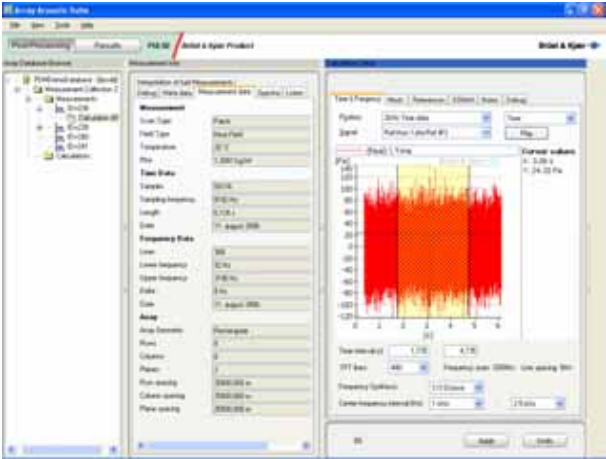
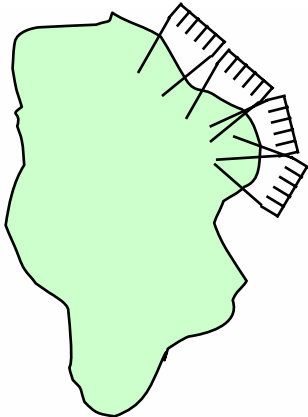
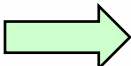
Typical f_{min} : 100 Hz Array size

Typical f_{max} : 5 kHz Meas. Point Density

Resolution: 3 – 5 cm Meas. Point Density



Conformal Mapping



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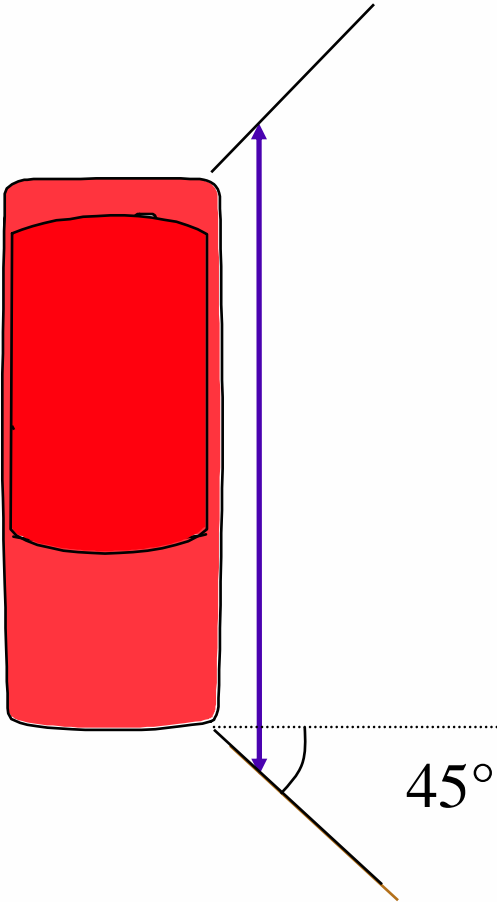
PNAH: *Patch Holography mapping in car*



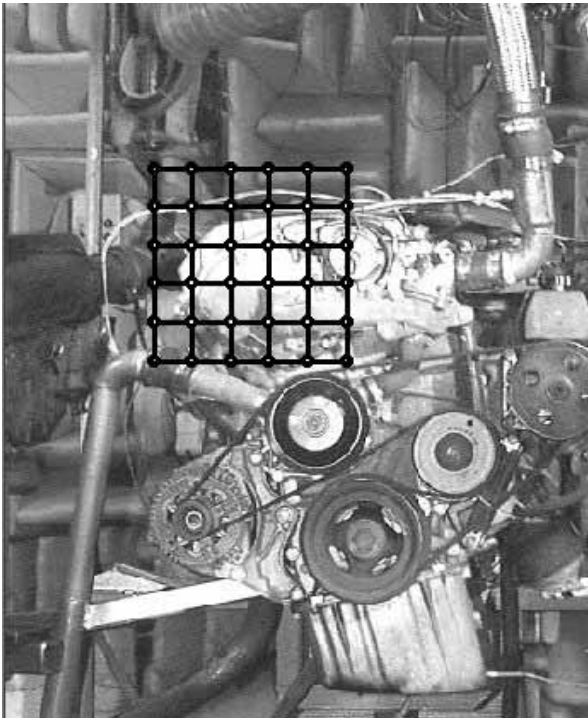
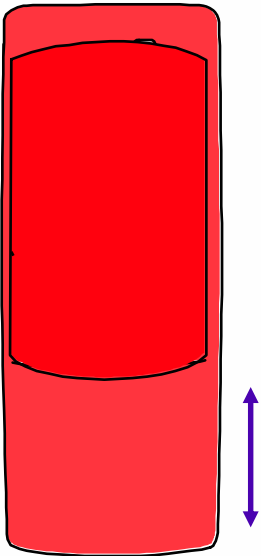
- Noise from aircondition system at 500 Hz

Statistically Optimal NAH (SONAH)

NAH

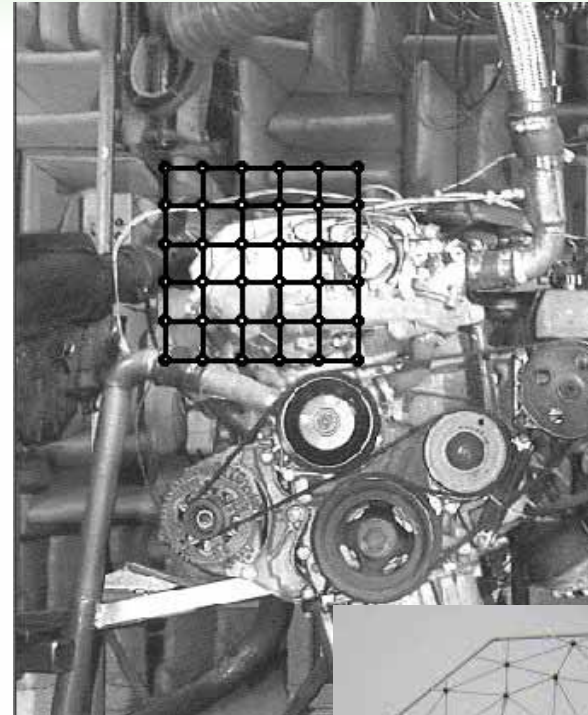


SONAH



SONAH - Statistically Optimal NAH

- Avoids **typical artefacts** of the **FFT based NAH**
 - Windowing effects
 - Wrap-around errors
- **Lower sensitivity** to **sources outside** of the **measurement plane**
 - No requirement to cover the full source
 - Less sensitivity to background noise
- **Improved performance** at **low frequencies**
 - Measurement area can be less than one wavelength
 - Increased resolution & accuracy
- **Free array geometry**
 - For example “Pizza Array”



Measuring Patches: *Single & Double Layer Handheld Array*



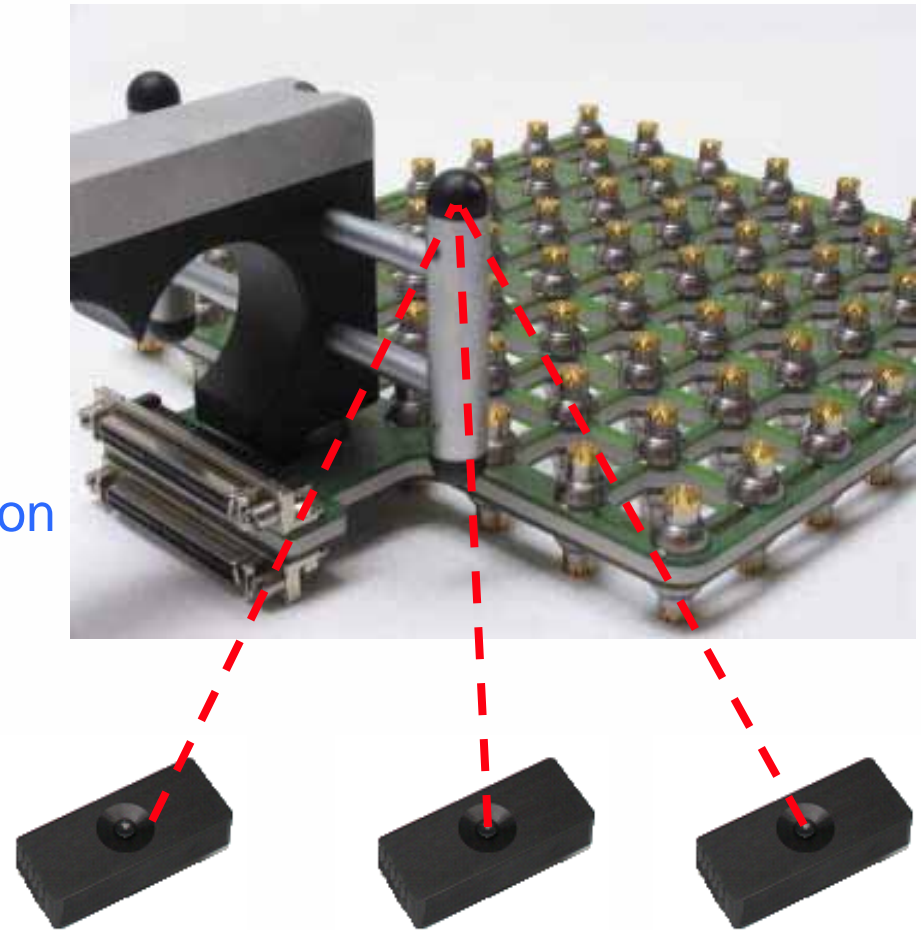
- Ultra slim design to enable access to difficult places



- **Single or Double Layer:**
 - **Single Layer** for “free field”
 - » e.g. outside vehicles
 - **Double Layer** for “diffuse field”
 - » e.g. inside vehicles

Handheld Array Positioning: *Positioning system*

- Determines the **array position** (x,y,z) and **angles** in real time
 - **Position** determined by **inertia** using a combination of **gyros** and **DC accelerometers**
 - Absolute **offset compensation** using either **ultrasonic triangulation** or **local magnetic field**
 - **Absolute accuracy** 2-3 mm
 - No need for continuous line of sight



Handheld Array Option: *PDA Display*

- **Integrated PDA Display** for:
 - Real-time troubleshooting
 - Pre test investigation
- **Wireless** communication
- **Replicates** map from PC
- **Remote control** for data acquisition
- **Attached** to array or **separate**



Outline

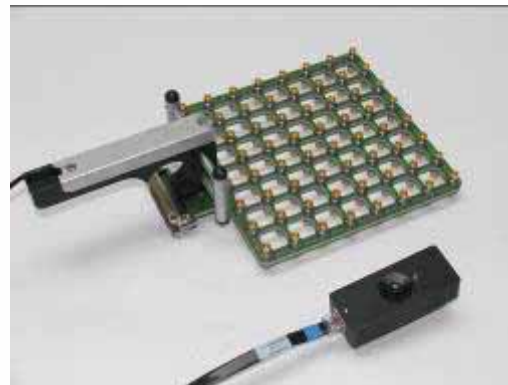
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Surface Digitizing

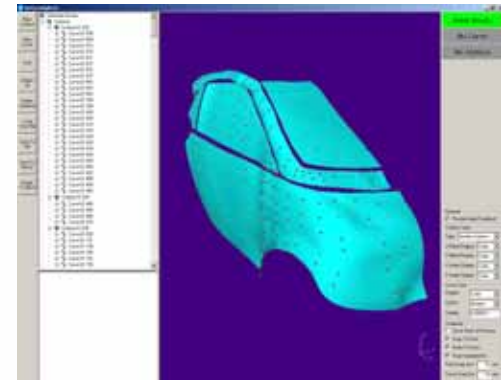
- In many situations a CAD surface model is not available
- Need for estimating a surface geometry from measurements
- NURBS Surfaces enable interfacing with Open Inventor, Mesher etc.
- Surface models may be exported to CAD for other purposes



Digitize Points



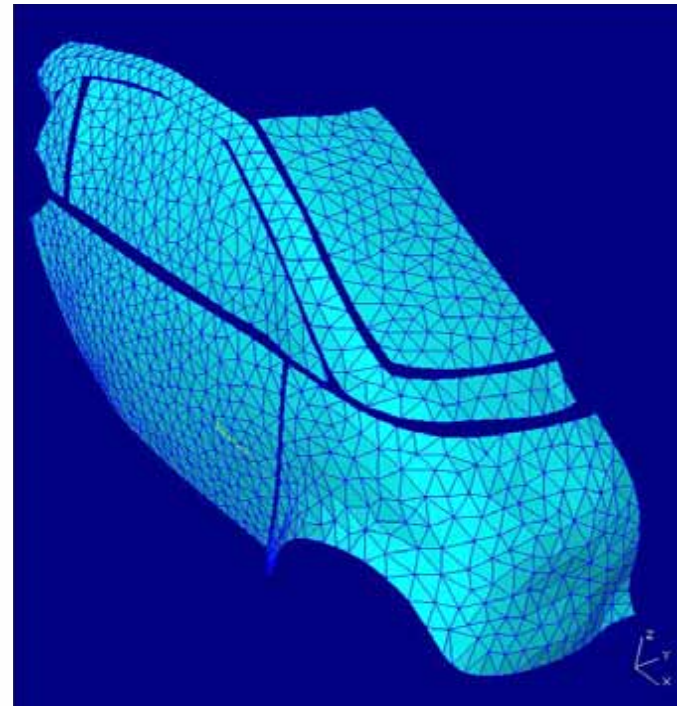
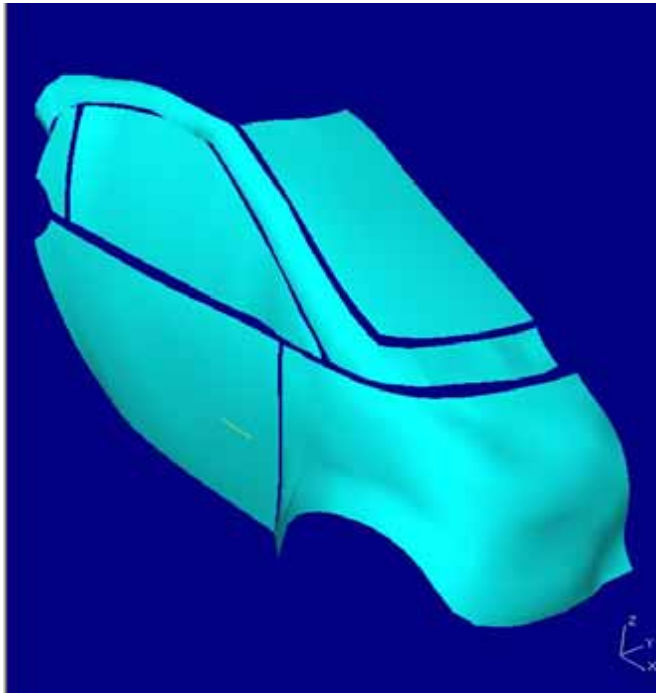
Use Handheld Array
Positioning System



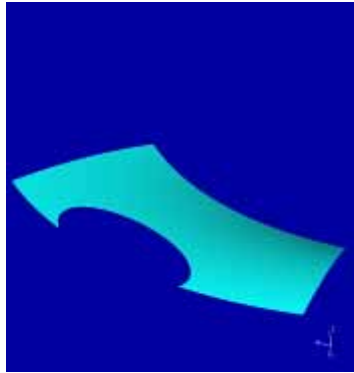
Surface Creation Software

Meshing

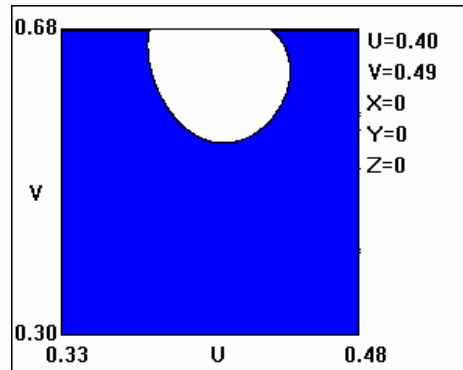
- Calculation and mapping of results requires a *mesh* (discretized surface)
- Required mesh density depends on frequency and required level of detail and resolution



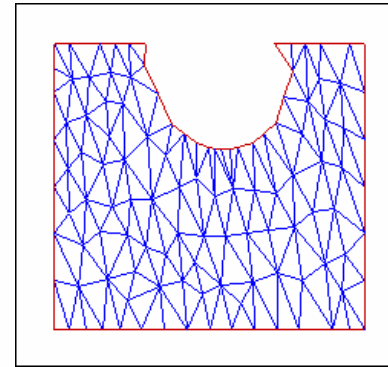
Meshing



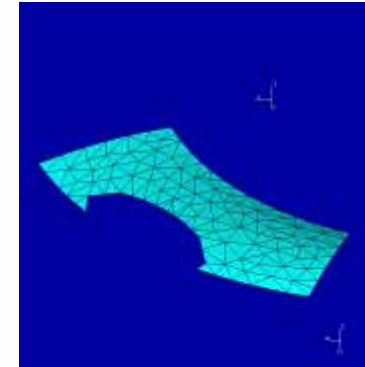
3D Surface



2D Parametric Space



2D Mesh



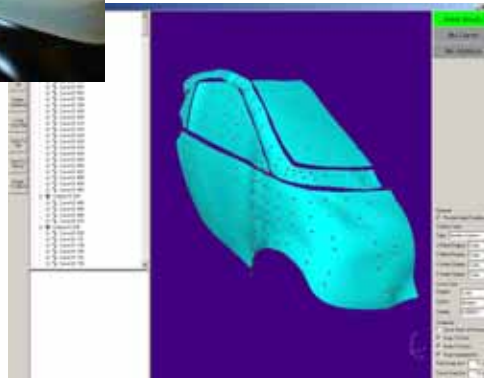
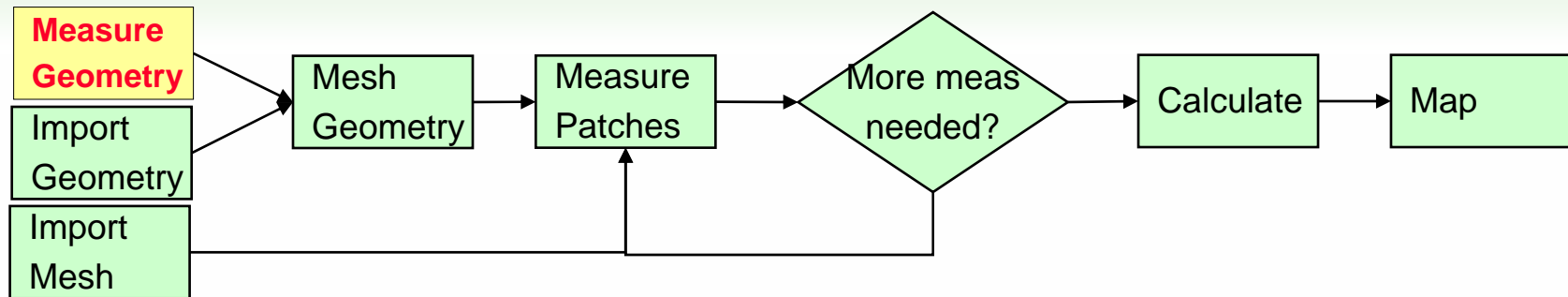
3D Mesh

- Actual meshing is performed in 2D parametric space
- Parametric surface description is used to transform 2D points to 3D
- Mesh connectivity is maintained

Outline

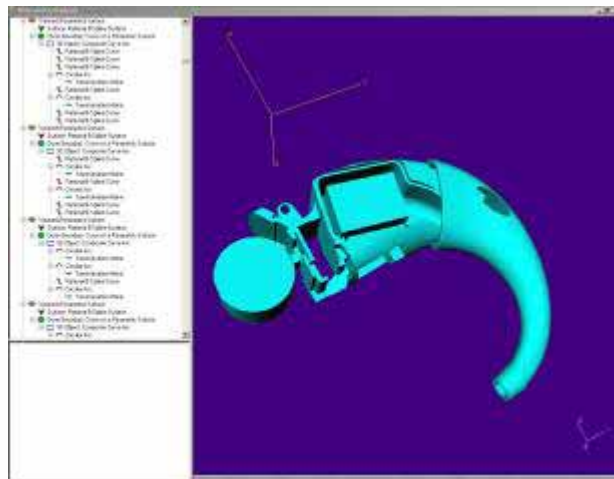
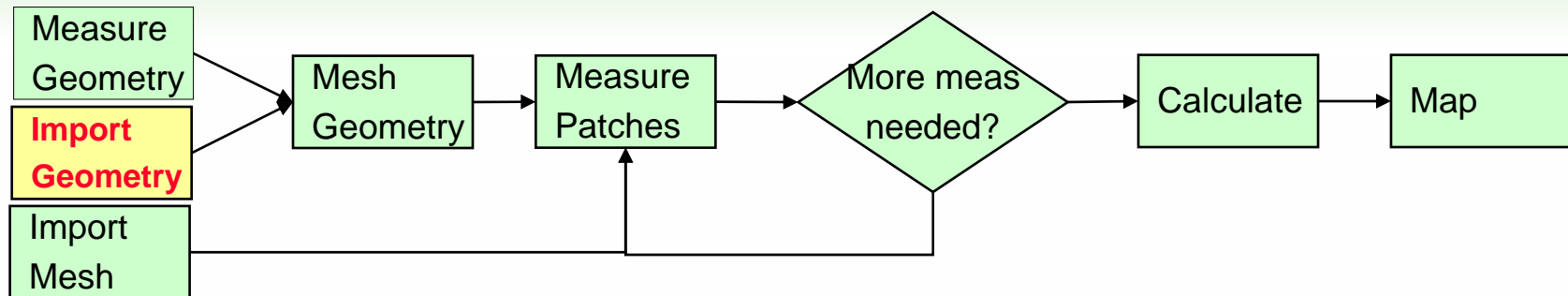
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Simple Workflow: *Measure Geometry*



- The **source geometry** is measured using the position detection system integrated in the array handle plus the built-in modeling software
- **Profile curves** are identified by "shooting points" on the surface
- Curves are used to extrude surfaces
- NOTE: The geometry may be detailed, outline or even just a plane

Simple Workflow: *Import Geometry*

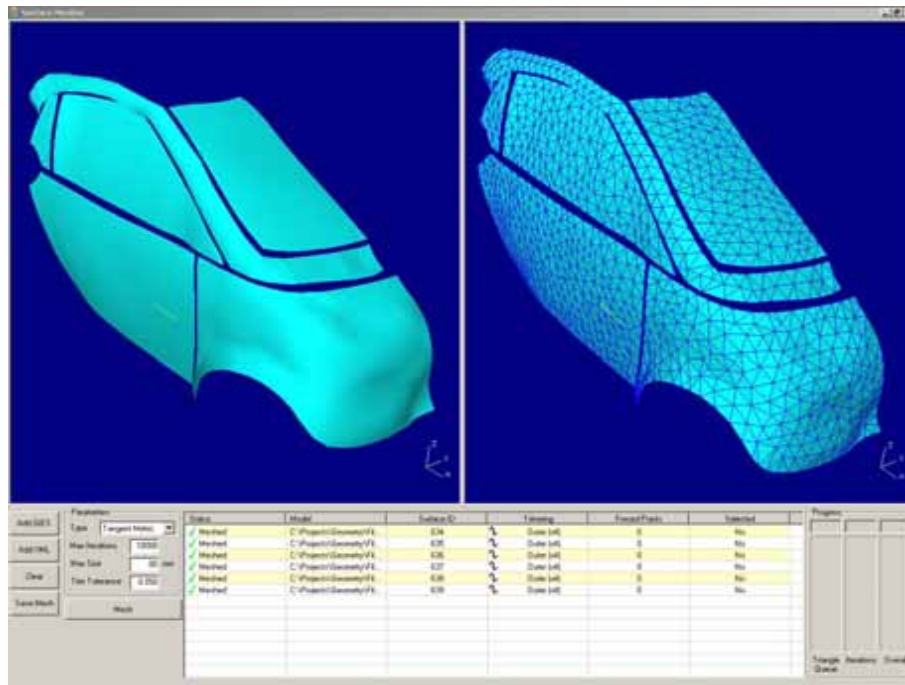
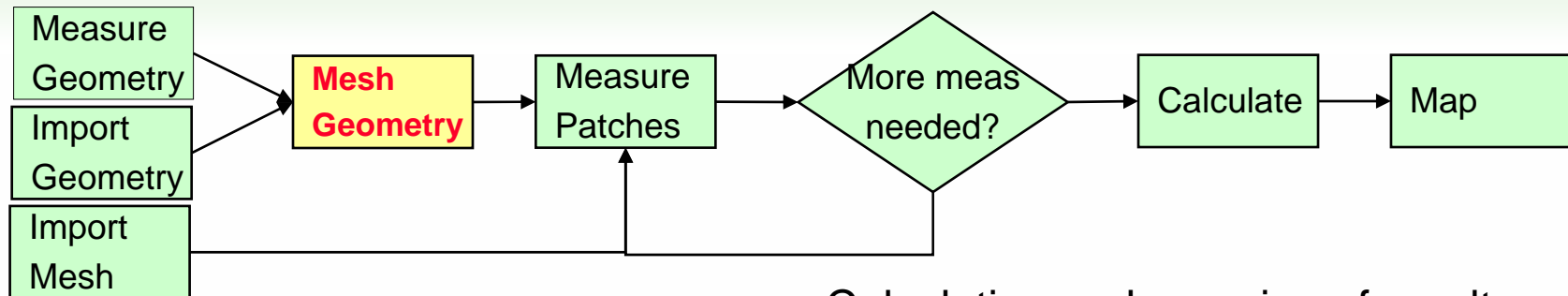


- **CAD surface geometry** may be imported from the IGES* file format
- IGES* is one of the most widespread general CAD file formats in the industry
- Import via IGES* from CATIA, Solid Edge, Pro-Engineer, NX, Rhino,...
- Detailed specification of currently supported "dialects" available

*Initial Graphics Exchange Specification (IGES)

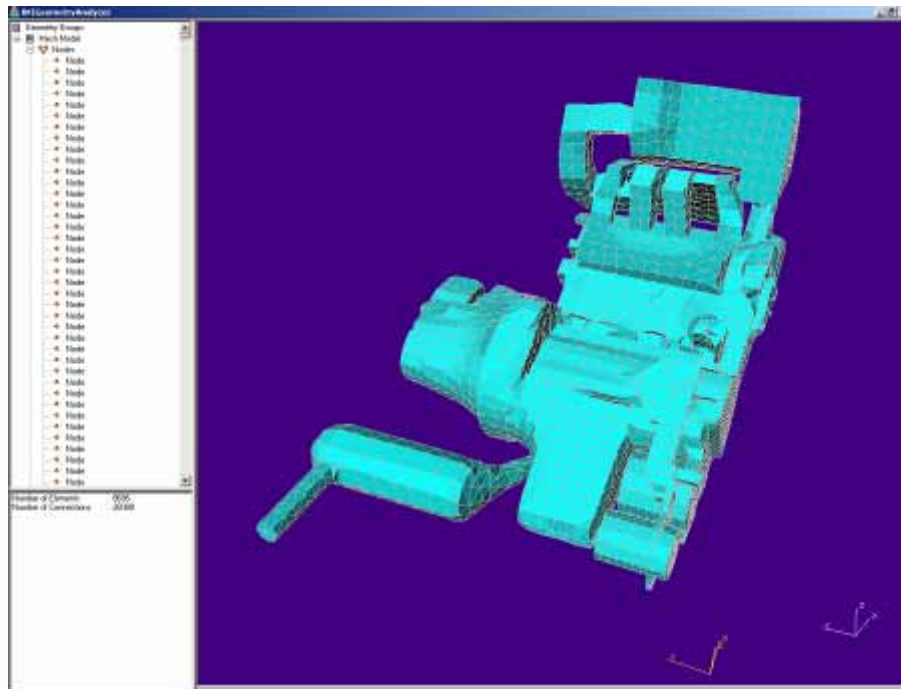
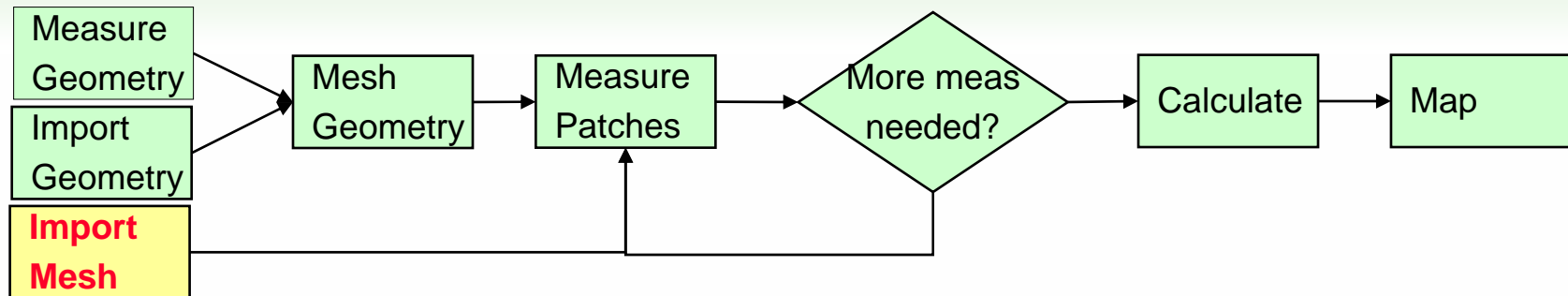


Simple Workflow: *Mesh Geometry*



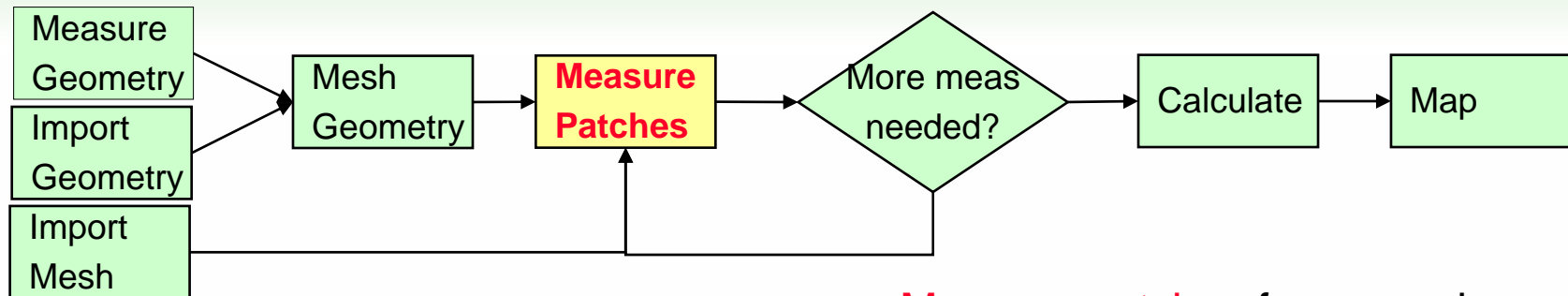
- Calculation and mapping of results requires a **mesh** (discretized surface)
- Required **mesh density** depends on **frequency range** and required **level of detail** and **resolution**
- Selected parts of the geometry may be meshed to any desired mesh density, using **built-in mesher**
- **Selected surface points** may be tagged and **enforced in the final mesh** to ensure easy identification of surface features

Simple Workflow: *Import Mesh*



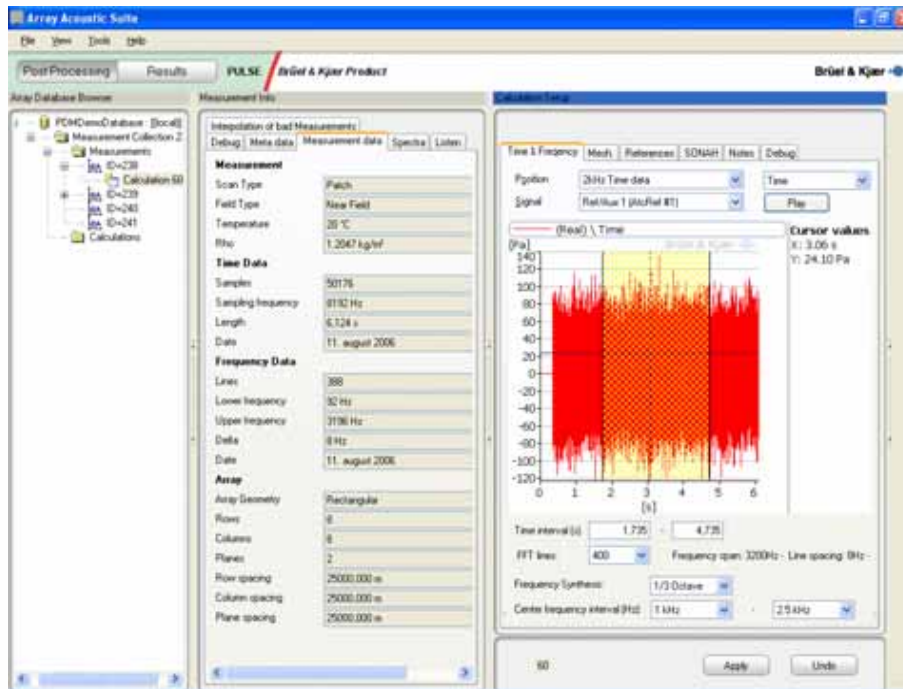
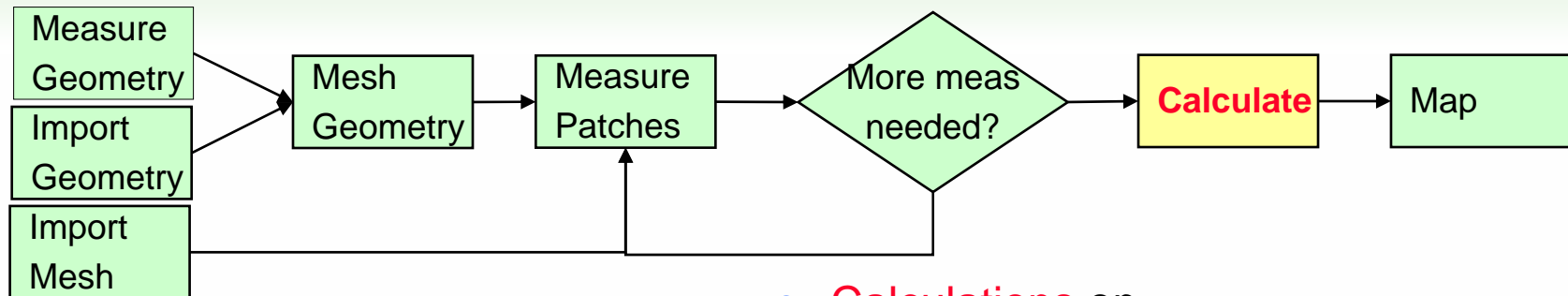
- Useful if a **mesh** is **already generated** in **CAE software** (like UGS FEMAP, Altair HyperMesh, MSC.Patran, ANSYS)
- Supported formats:
 - I-DEAS Universal File Format
 - » #2411 (nodes)
 - » #2412 (elements)
- Easily extensible (PSE) to read other native mesh export formats

Simple Workflow: *Measure Patches*



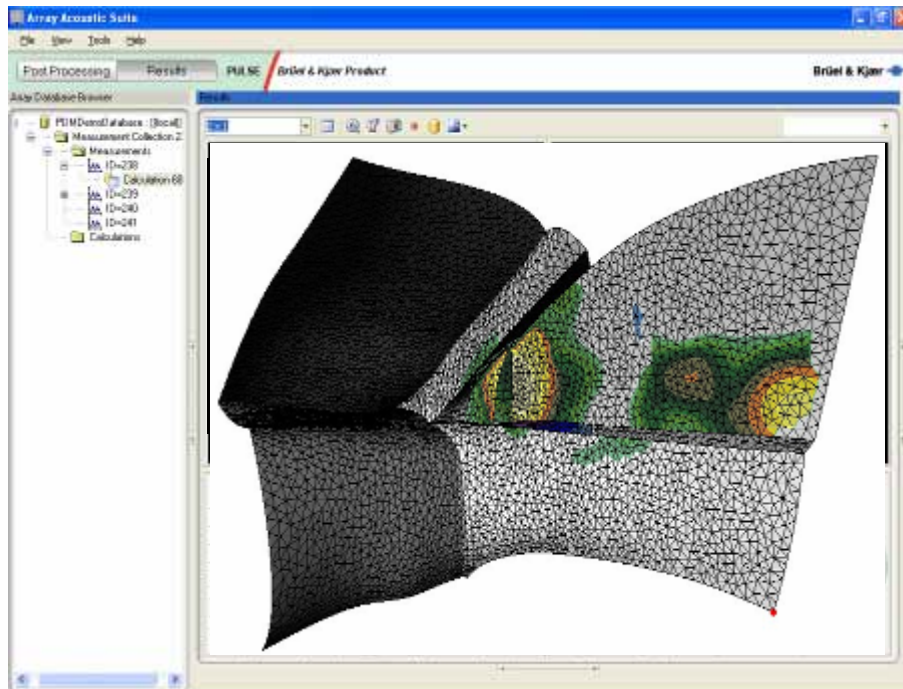
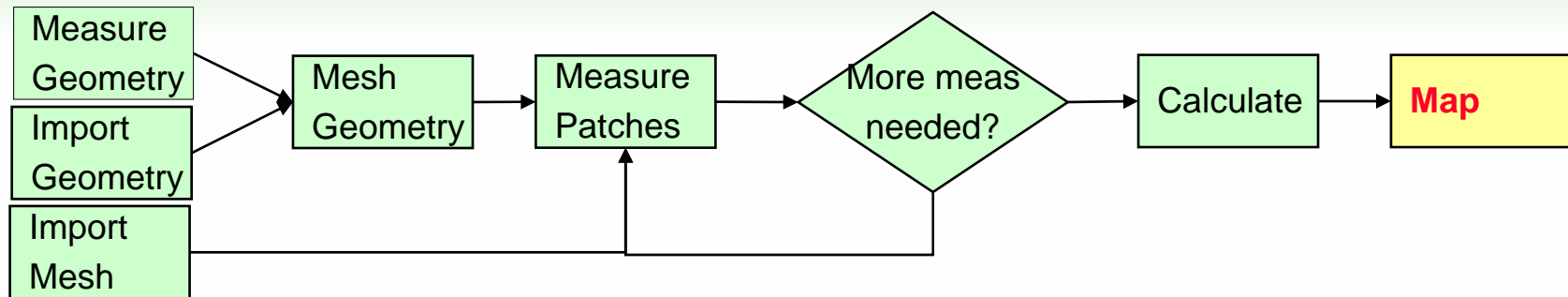
- **Measure patches** for example using a handheld array:
 - Close to the source
 - At accessible places
 - Sufficient to cover to area to be mapped
- **Patches** may **overlap**, be at **different angles**, **depths** etc.
- During measurement the **3D position** of each patch is **automatically recorded** from the position detection system

Simple Workflow: *Calculate*



- **Calculations** on measurement collections
- Inside PULSE for joint measurement and processing
- Stand alone for separate post processing
- GUI Improvements:
 - » More efficient use of screen space
 - » Undo of setup changes
 - » Increased set of annotations
 - » Multiple named default setups

Simple Workflow: *Process & Map*



- 3D conformal map
- 3D sound power area selection
- Fixed map layout (1x1, 1x2, 1x2, 2x2 ...) independant of screen resolution
- Alignment in:
 - Selected point
 - Frequency
 - Index (RPM, Angle etc)
 - View angle
 - Data set

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Conclusions

- Complete system for creating a geometry based conformal maps of a noise emitting test object
- Uses fast SONAH based calculation algorithm
- Data acquisition via simple hand held array based measurements
- Fast measurement and creation of object geometry using surface digitisation, intelligent surface generation and automatic meshing