

**MAUL-THEET**

*Vibration & Test Solutions*

# ScanSet

from  
**MAUL-THEET**



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*Vibration & Test Solutions*



- **Basic idea of the ScanSet**
- **Hardware**
  - System components
    - Mirrors & control
    - CCD Camera
    - DAQ
  - Laser Doppler Vibrometer
- **Software**
  - Wallpaper (mirror synchronization)
  - Geometry- and Mesh Editor
  - Measurement Analyzer (DAQ)
  - ODS calculation
  - Result viewer (animation of ODS)
  - Data Export (UFF, ASCII)
  - Modal Analysis Option



- Complete SLDV (Scanning Laser Doppler Vibrometer) are expensive!
- In principle the Laser Vibrometer (LDV) of the SLDV is the most expensive part!
- At lot of customer already have a LDV but want to do scanning!

**Solution:**

$$\left[ \begin{array}{l} \text{VibroLaser ScanSet} \\ + \text{SinglePoint Laser} \\ \hline = \text{ScanningLaser} \end{array} \right]$$

- **ScanSet + LDV has the same possibility and features as a complete SLDV!**
- **Even when a customer buys a new LDV and the ScanSet it is cheaper than buying a complete SLDV**

# Hardware: Delivery



Controller with DAQ, mirror steering  
And power supplies

Aluminium base

Scan Head with mirror drives and  
HD CCD Camera



Interface cable between Controller  
and Scan Head

USB and power  
cable

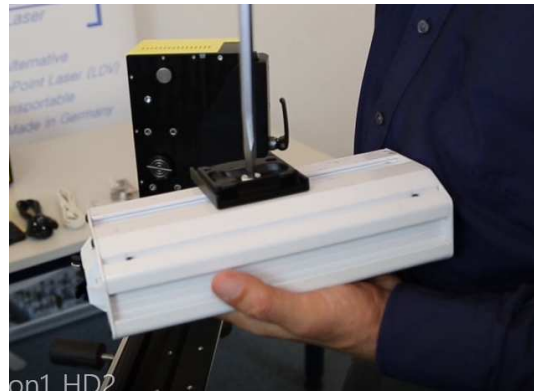
Adapter to setup all  
LDV

Scanning software  
**VLScanner**

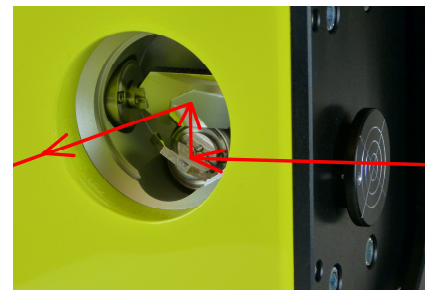
# Hardware: Setup of ScanSet and LDV



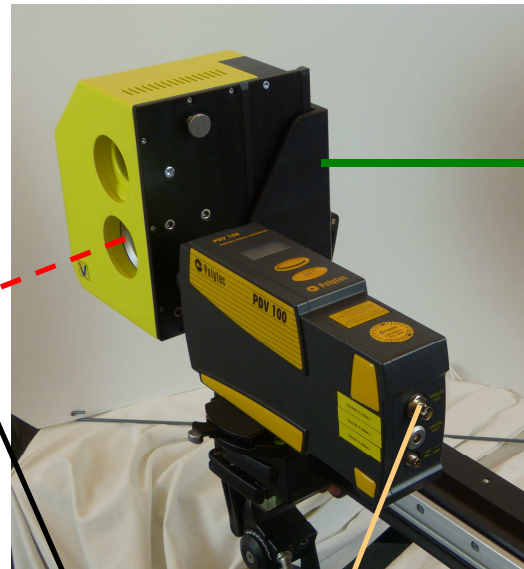
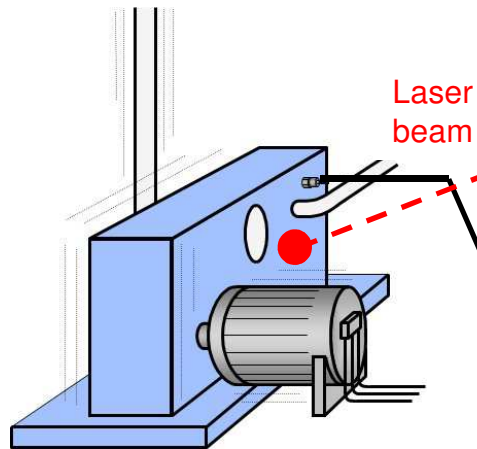
- The aluminum base of the ScanSet can be fixed to a standard photo tripod with large photo thread (3/8" inch - 16 UNC)
  - Rigid tripod recommended
  - Adapters to small photo thread (1/4" inch - 20 UNC) available



- The LDV is fixed on the aluminium base of the ScanSet by a "Manfrotto quick release plate"
- LDV is adjusted to hit the mirrors in their middle axis



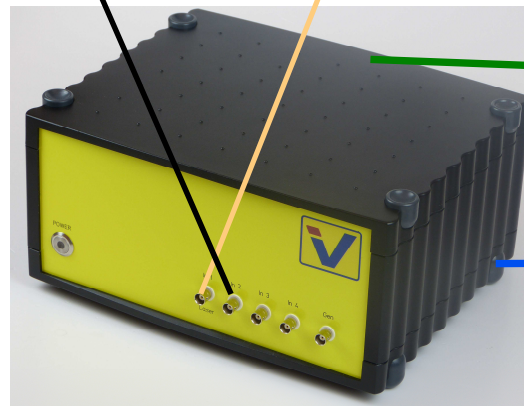
# Hardware: Wiring for a ODS measurement with ACC



Interface cable

Reference signal

Velocity Signal LDV



USB 2.0 cable



Windows PC with only one USB slot!

Vibrating object

ScanSet + Laservibrometer

# Hardware: System components – Scan head



## Camera:

- Full HD Color Camera
- 1920 x 1080 resolution
- 30 x optical zoom
- Auto focus
- Adjustable inclination for measurement distance

## Mirrors:

- Galvo technology
- $\pm 20^\circ$  beam range
- Nonlinearity  $< 3.5$  mrad
- Repeatability  $< 22$   $\mu$ rad
- Mirror reflectivity for normal laser light 97%

# Hardware: System components – Controller



## DAQ:

- 4 Channel 20 kHz
- 3 Channel 80 kHz
- 2 Channel 2.5 MHz (16 bit)
- 24-bit resolution
- Max input range  $\pm 10V$
- Anti-aliasing filter
- Synchronous sampling
- IEPE (ICP) supply
- Generator output for sine, noise, chirp and step sine

## Mirrors control:

- 16 bit resolution at  $\pm 10V$

Framegrabber, power supplies, USB hub



# Hardware: Laser Doppler Vibrometer (LDV)



ScanSet was successfully used with:

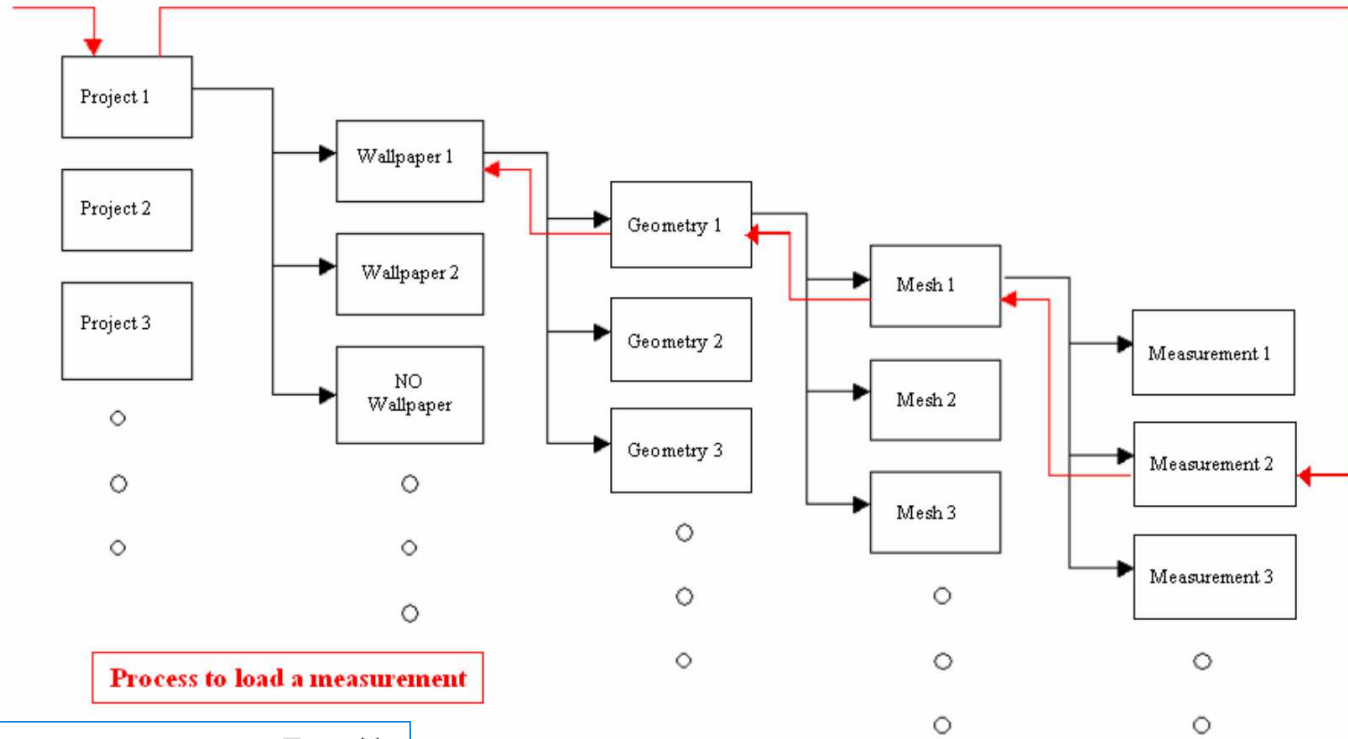
- Polytec
  - IVS 400
  - PDV 100
  - OFV 302+OFV3000 series
  - OFV 505+OFV5000 series
  - CLV series
  - OFV 552 faser optic
  - RSV at short distance
- OptoMet
  - Nova series
  - Vector series
- OMS
  - LP01 (former VibroMet 500V)
- Ometron (old systems)
  - VH 300, VH300+
  - VS1000

So far no type of LDV known which will not work with the **ScanSet !!!**

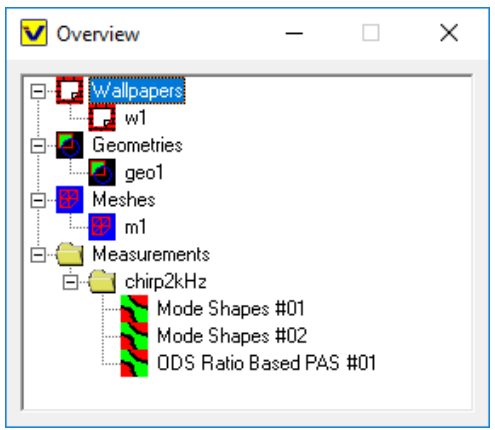


- Hardware control
  - Imaging control for live picture from CCD Camera
  - Mirror control to drive the mirrors (laser beam)
  - DAQ control to process the vibration signals
  - Interface for CCD focus, CCD zoom and CCD Settings by RS232
- Scanning software
  - Project data handling
  - Wallpaper: Synchronization of CCD, Laser and object
  - Geometry and Mesh: Setup of Scan Points on CCD pic.
  - Scanning: Vibration measurement with FFT Analyzer
  - Data processing: ODS calculation
  - Result viewing: Animation of mode shapes and ODS
  - Data Export: UFF, ASCII of geometry and measurement data
- Optional: Modal Analysis with direct interface to **VLScanner**

# Software: Project data handling

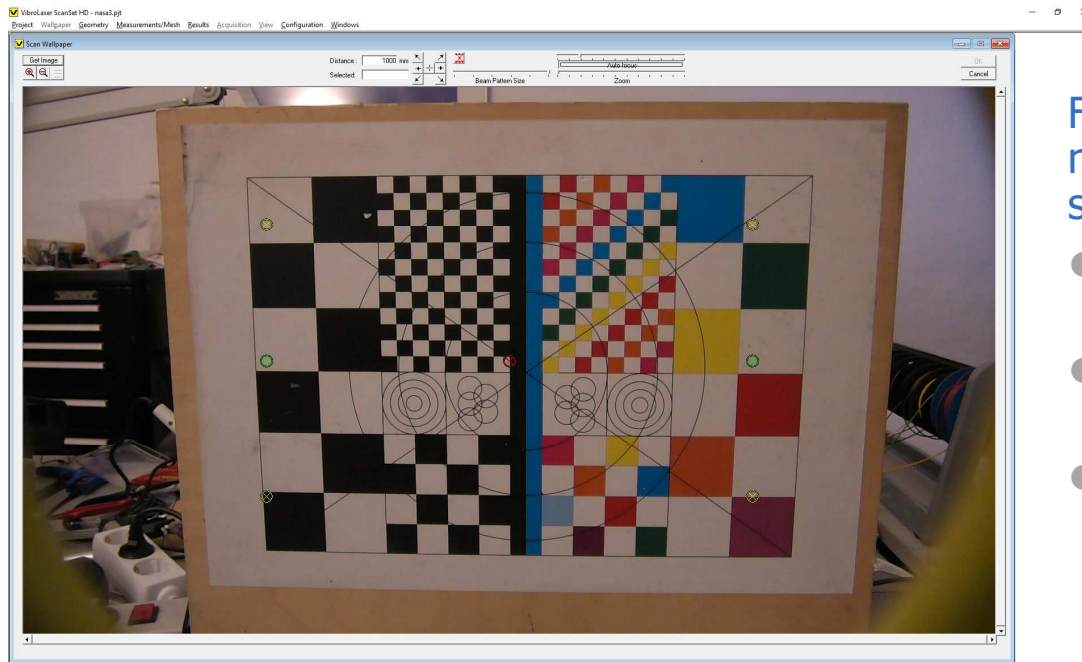


**Process to load a measurement**



- VLScanner handles all occurring data: Pictures, Geometries, measurement data results
- Data is stored in automatically generated subdirectories
- If a measurement is loaded for analysis, all corresponding data (geometry, meshes, measurement data and results) are loaded
- Content of a scan project can easily be shown with the „Overview“-Project browser

# Wallpaper: Synchronization of CCD, Laser and object



For Scanning it is necessary to synchronize 3 plane:

- CCD Picture plane, Pixel position
- Mirror plan, 2 mirror angles
- Object plane, x,y-values on the object

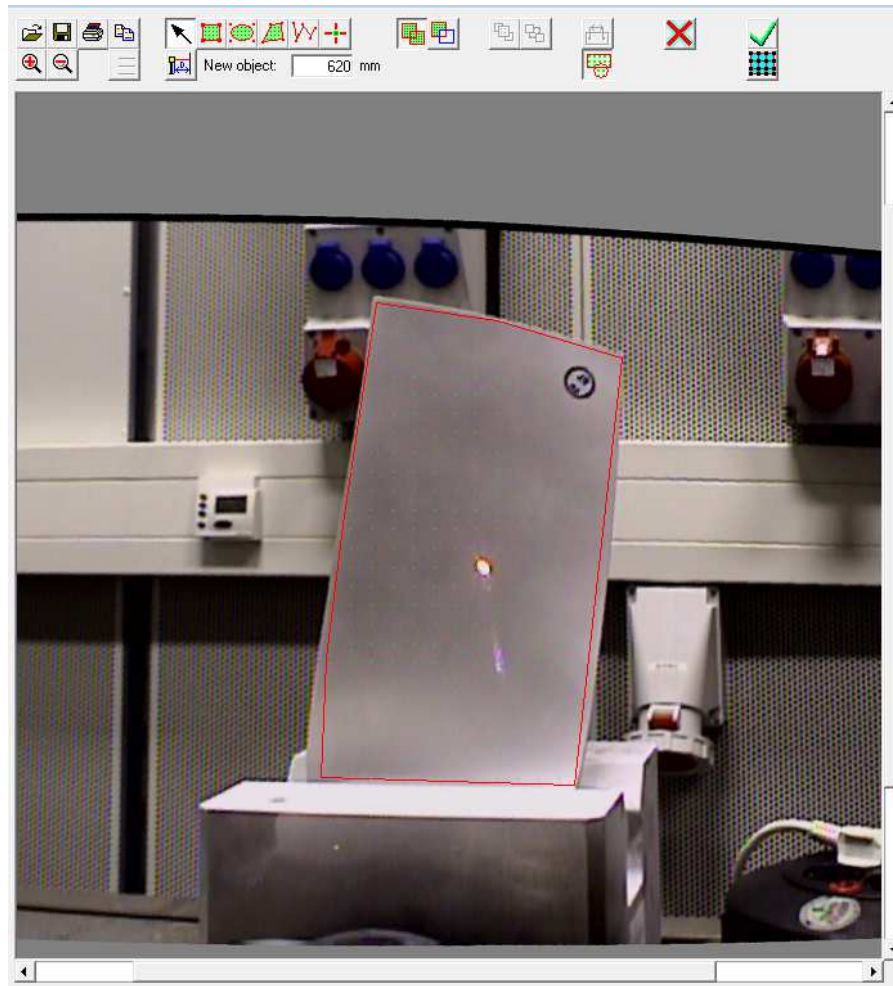
Synchronization procedure:

- Move the laser to certain positions by moving the mirrors
- Drag and drop the according handles to the laser spots in the live display by mouse move
- Process synchronization: Picture will be frozen and adjusted

Result:

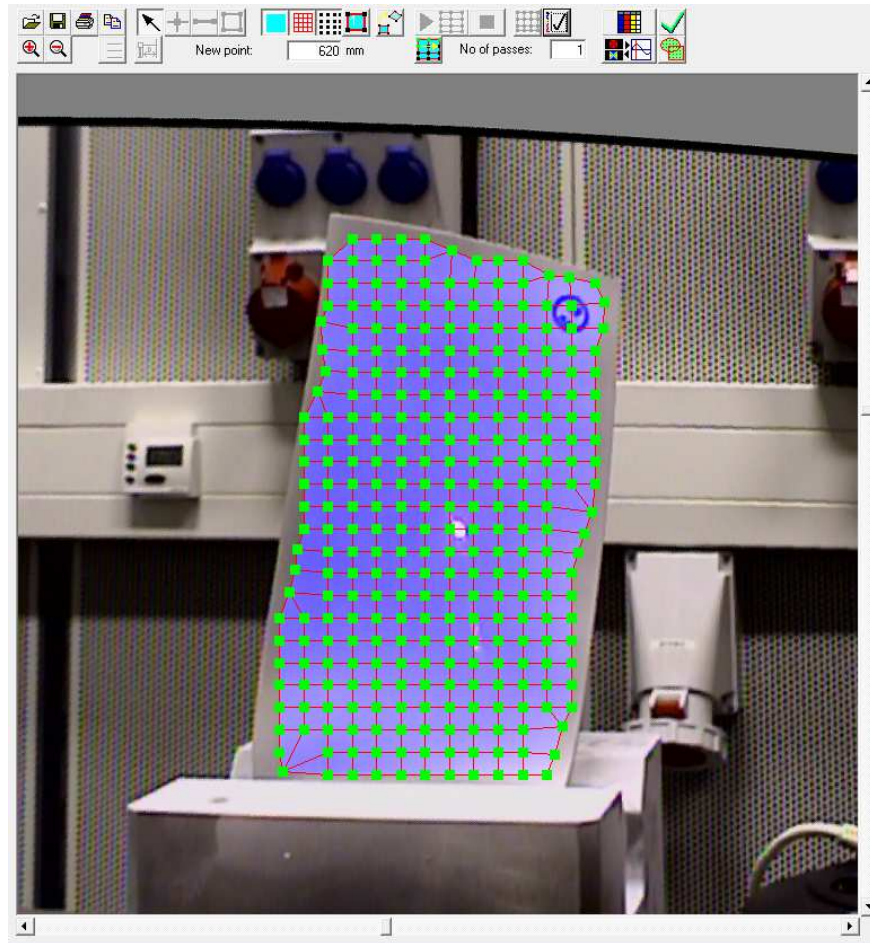
- Clicking in the picture moves the laser to the correct position on the object.

# Software: Geometry Editor



The Geometry editor allows you to define flexible area which a filled with scan points

- Geometry objects:
  - Rectangles
  - Circles and ellipses
  - Polygons
  - Polylines
  - Single points
- Objects can be drawn on the picture including laser beam movement.
- Selectable point density for each object
- Object can have different distance to the scan head
- Objects can also be exclude area for no scan points
- Back- and forward for objects with intersection

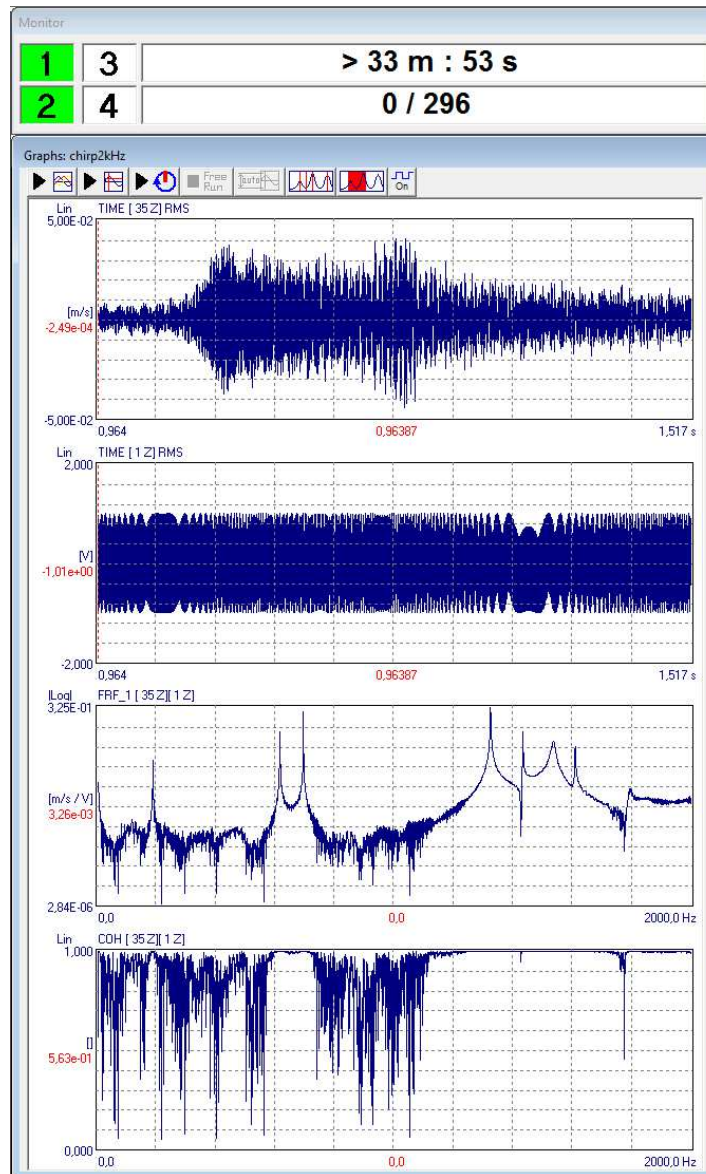


The Mesh Editor generates the final position of the scan points and a wire frame model with

- Points (x,y,Z)
- Lines
- Surfaces

for modal analysis and ODS

- Points can be moved by mouse drag&drop
- Points, Lines and surfaces can be added or deleted manually
- Display of point state by color (unmeasured, OK, Overload etc.)
- Tool to move, stretch and rotate mesh on picture
- Back- and forward for objects with intersection
- Display of scan progress (white point)



## Internal multi channel built in FFT Analyzer with:

- Frequency ranges 1 to 20 or 80kHz
- High Frequency option up to 2.5 MHz
- FFT windowing (Hanning, Force, Exp)
- Up to 25600 FFT-Lines
- Extended Trigger functionality for impact testing
- Time Recording for each point
- Multiple References
- Signal generator (sine, chirp, noise, step sine)
- Extended view of function in up to 64 displays
  - Time, time after FFT window
  - FFT, Auto and Cross spectra
  - FRF1, FRF2 and FRF3
  - Coherence
  - Integrated and Differentiated FRF
  - Octave and 3rd Octave (by FFT Calculation)
  - Cepstrum
  - Sum and Difference between channels (Time and FFT)
- Monitor window for Overload, scan progress and remaining scan time

# Software: Scanning: Operation mode



**Analyser** [X]

Frequency Range	20 kHz
Lines	25600
Trigger type	Free
Trigger source	Channel 1
Trigger level [%]	10
Trigger delay [%]	0
Overlap [%]	50
No. of Averages	2
Average control	Off

Blocklength = 1,28 s    Delta F = 0,7813  
Point Sampling Time = 3,2 s

Averaging type

Sum      Delay between averages [sec]

Peak line     

Operating mode

Block mode (FFT)

Lockin

RMS time domain

RMS frequency domain

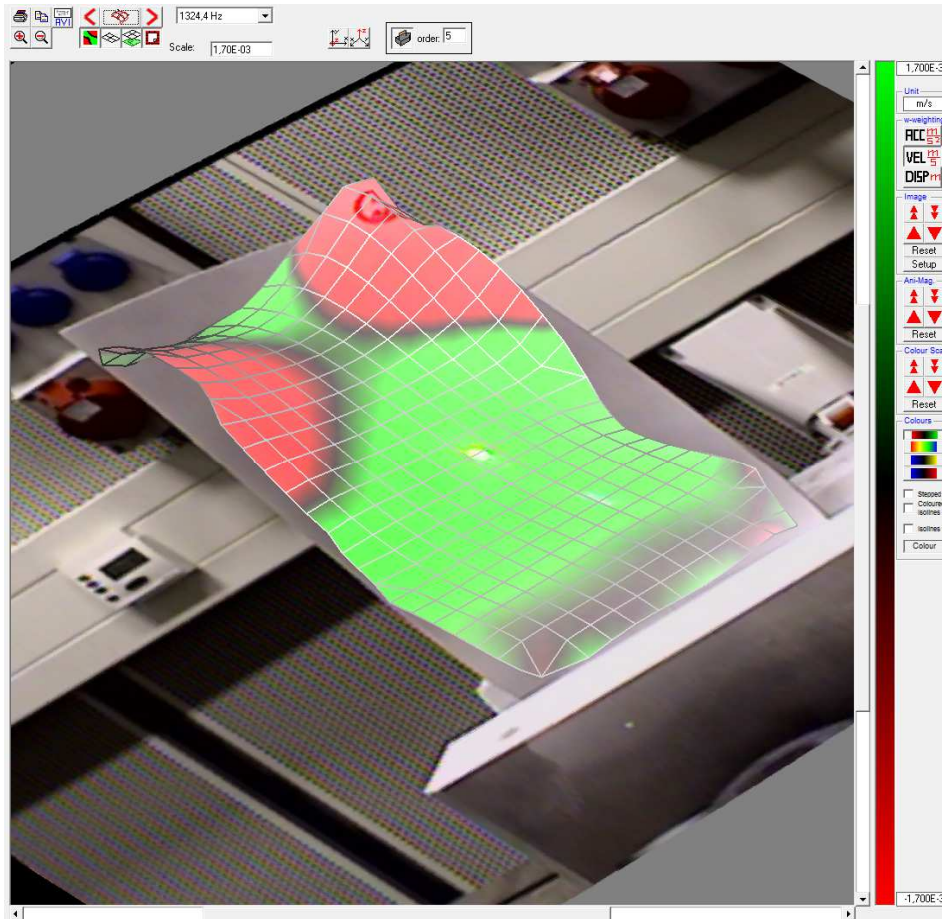
Centre frequency  Hz

Bandwidth  Hz

- **Block mode (FFT)**
  - Most used mode
  - Calculates and save all time and Spectral data (FFT, Auto, Cross, FRF, Coherence) for each scan point for modal analysis and ODS
  - Requires reference signal
- **Lockin**
  - Only for periodic signals with one major frequency
  - Very fast scanning as only a few periods of vibration are needed
  - Fast scanning mode
  - No spectral data
  - Requires reference signal
- **RMS time domain**
  - RMS values for each point
  - No reference required, no phase information
  - No spectral data
- **RMS frequency domain**
  - RMS values in frequency band for each point
  - No reference required, no phase information



# Software: Result Viewer, ODS and mode shape animation



Animation of ODS and mode shapes:

- 3D wire model
- Color map overlay
- Texturing by wallpaper pic.
- Background pic.
- Different color scales
- Stepped and continuous color scale
- ISO-lines
- Polynomial shape smoothing
- AVI-File of animation
- Point Marker for view of
  - Displacement
  - Velocity
  - Acceleration
- Free model rotation view by mouse move
- Print and Clipboard functionality

# Software: Export data in UFF



Export UFF

Data

UFF- Filename  
C:\Temp\TestUFF.UFF File

Geometry  
 UFF 15 / UFF 82

Auto Spectrum Coherence  
Auto Spectra  No  Yes

Frequency Response  
 UFF 58

ODS as Complex Vector  
 UFF 55 Result No

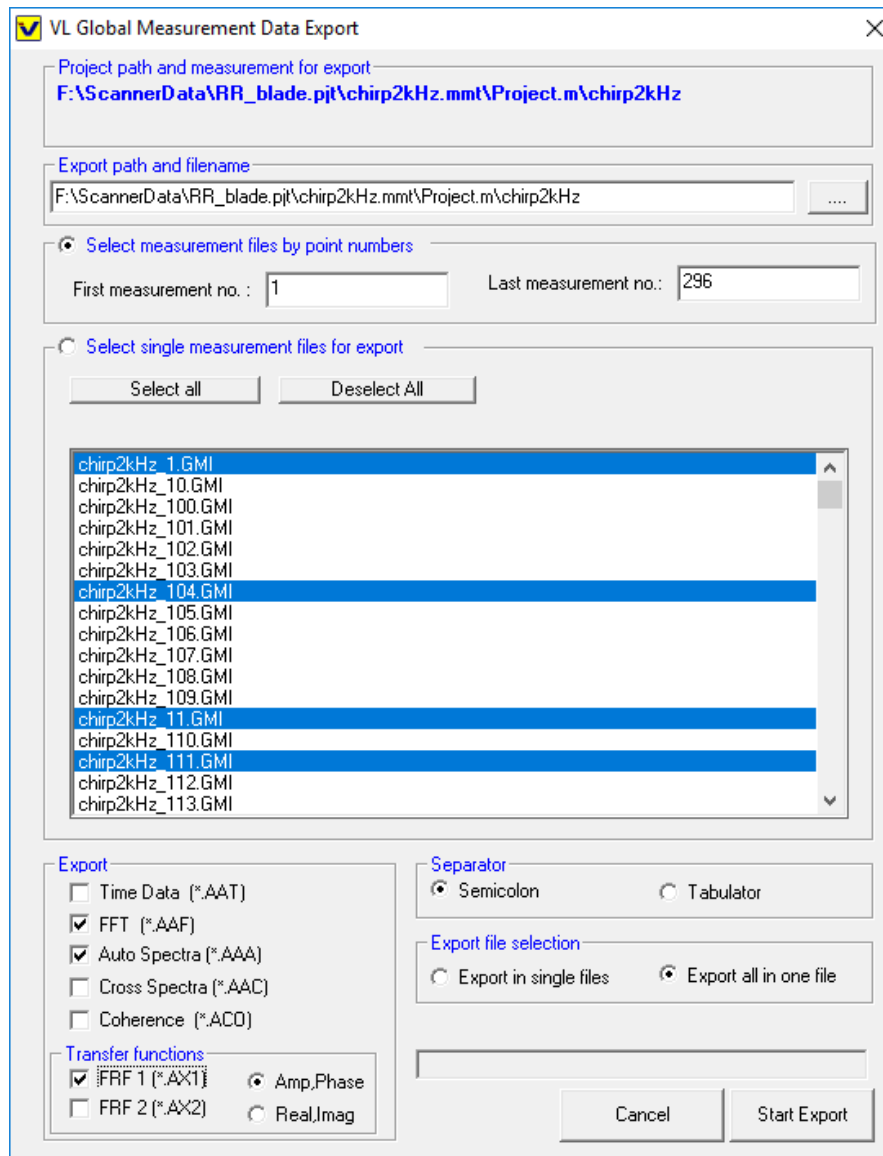
Recording format  
 CR + LF  LF  No separators

Cancel Export

## Export UFF:

- UFF 15/82 Geometry
- UFF 58 FRF data
- UFF 55 Shapes and ODS
  
- Different separators

# Software: Export data in ASCII



## Export ASCII:

- Export of Measurement data selectable for each point:
  - Time
  - FFT
  - Auto
  - Cross complex
  - FRF1 & FRF2 complex
  - Coherence
- Export to one file for all selected point or one file for each point labeled with point number
- Different separators
- For applications like
  - MS Excel (\*.CSV)
  - MatLab
- ASCII- Export is very popular at universities and research departments

# Software: Dithering of poor points



Relative Coordinates for Dithering

Line #	X offset	Y offset
1	0	3
2	4	4
3	9	0
4	8	-8
5	0	-15
6	-13	-13
7	-21	0
8	-17	17
9	0	27
10	21	21
11	32	0
12	25	-25
13	0	-38
14	-29	-29
15	-44	0
16	-33	33
17	0	50
18	38	38
19	56	0
20	42	-42

Shape preview:

Generate

Dither points:

Max. Mirror steps:   
~ 1,06669 mm

Angle between points:

Use Overload for Dithering

Use Coherence for Dithering

Lower Frequency:

Upper Frequency:

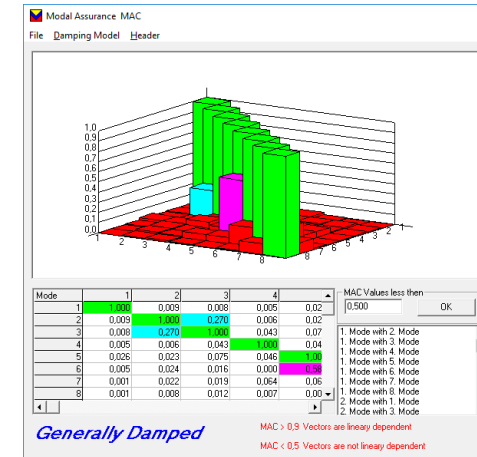
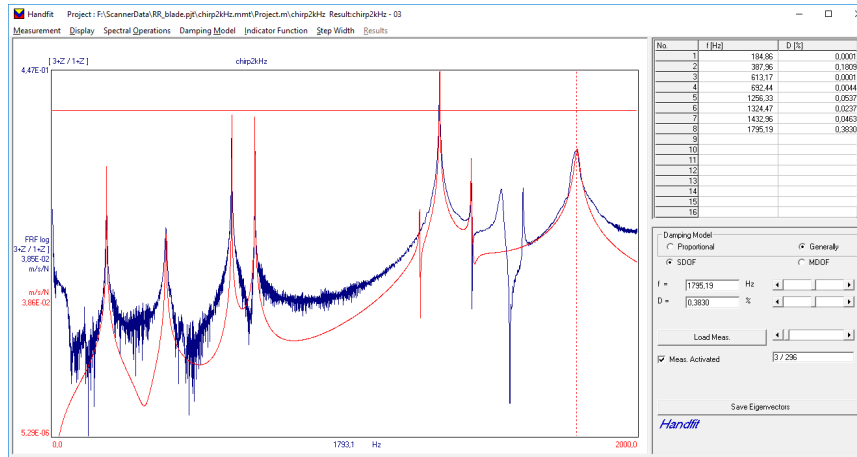
Coherence Value for dither:

Averaged  
 Minimum

## Improving bad measurement points: Dithering

- All Laser Doppler Vibrometer are optical instruments and have „drop outs“ at points with bad reflection
- Drop outs give bad signals -> bad FRF -> bad shapes
- Points with overload or bad coherence will be move in the hope of better reflectivity -> better signals -> better shapes
- Procedure will be repeated until the signal is good and the coherence is satisfying
- The movement for dithering follows mostly a spiral around the original scan point
- The spiral (dither points) can be user defined.

# Software: Modal option



## Optional: Software module **vModal** to perform modal analysis calculations

- Direct interface between **VLScanner** (scanning software) and **vModal** (modal analysis software)
- Identification of modal values (eigen frequencies, damping and mode shapes) with different identification methods (curve fitting):
  - SDOF complex amplitude fit
  - MDOF complex exponential fit
  - MDOF global fit
  - Handfit (adjustment of frequency and damping with sliders)
- Tools in structural dynamics: MAC, CoMAC, fit quality, resonance indicator
- Tools for forced response calculations, structure modification, sensitivity analysis
- Direct animation of calculated mode shapes in VLScanner



- VLScanner can run as “office”- version without hardware on any Windows PC
- Analysis, Calculation, Reporting, Printing and AVI-Files can be done on any PC where VLScanner is installed
- Software-Licensing by serial number of hardware components
- ScanSet is CE-tested and patented
- ScanSets are running worldwide
- ScanSet is built with reliable standard products
- Signal quality is not related to the ScanSet. This depends on the quality of the used laser (LDV)



**Thanks!**