SIO X-Ray: View inside your material with contact experiments

Nick Bierwisch, Norbert Schwarzer

Sächsisches Institut für Oberflächenmechanik – SIO

Tankow 2
18569 Ummanz / Rügen

Am Lauchberg 2
04838 Eilenburg

Germany

SIO AntMan technology

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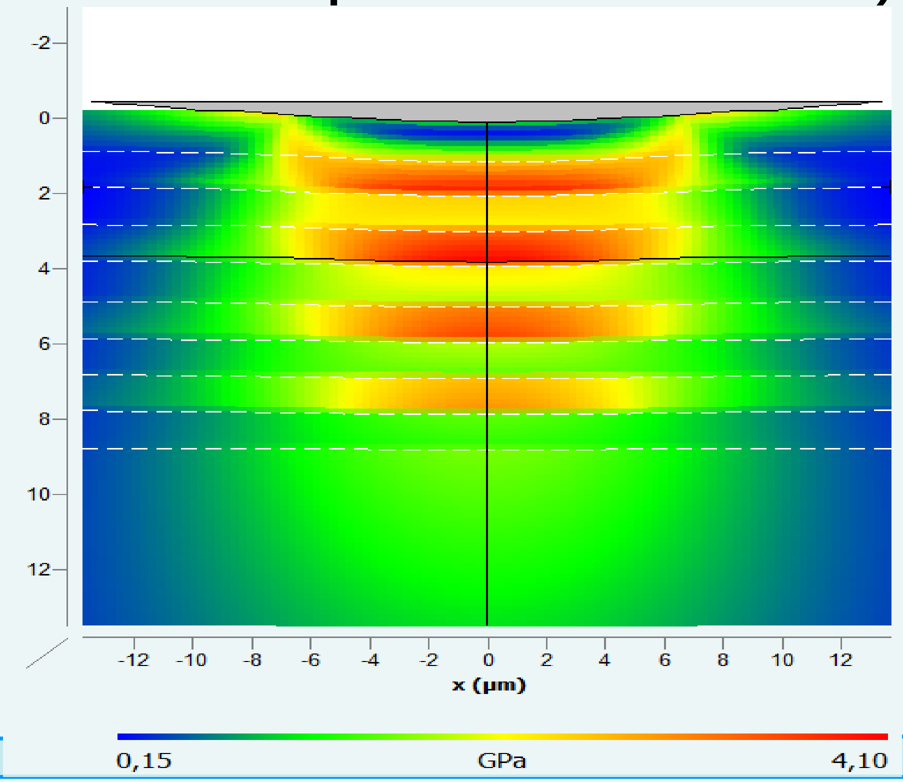
Goal

Optimize the materials and material combinations to increase application performance to reach certain goals (e.g. longer application life time of our composite structures)

but structures are more and more complex nowadays

need computers and models, personal experience and rules of thumb are no longer enough

generic material parameters needed



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No FEM system – closed formula calculations

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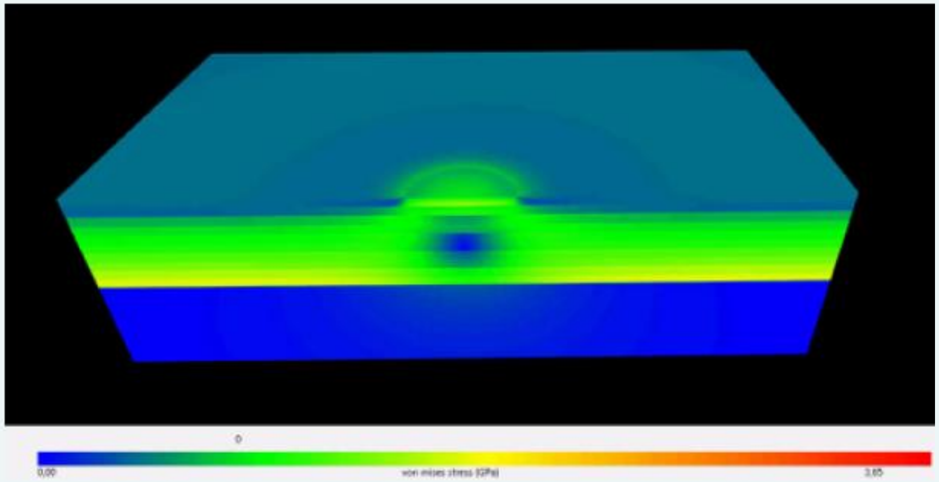


generic material parameters needed

Analytical models

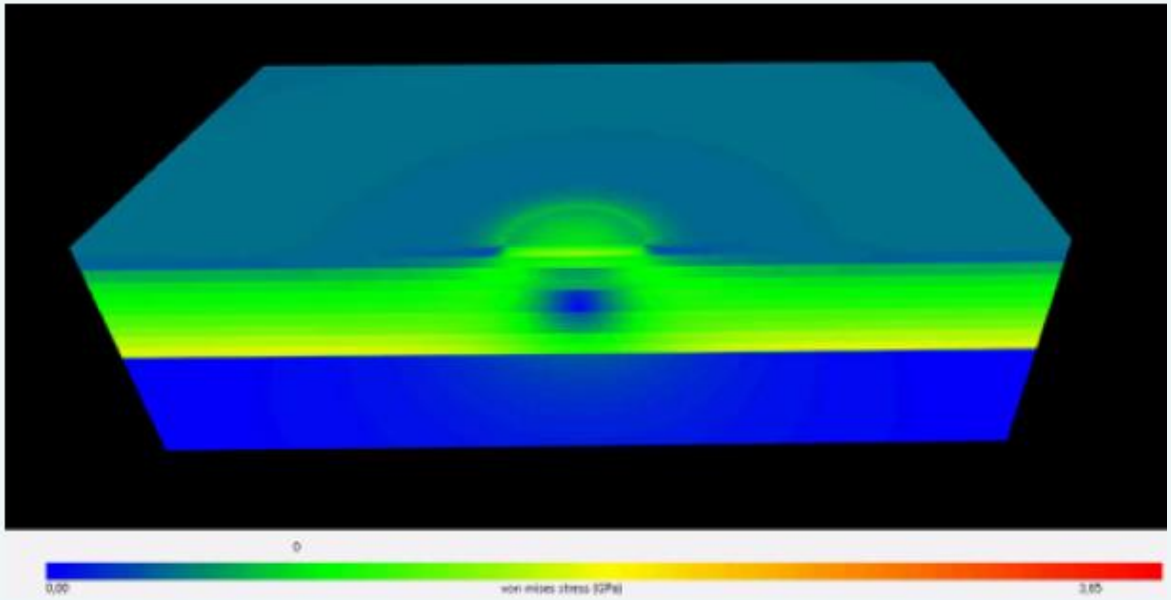
Much faster calculations possible

→ thus allows software for

experimental analyzis

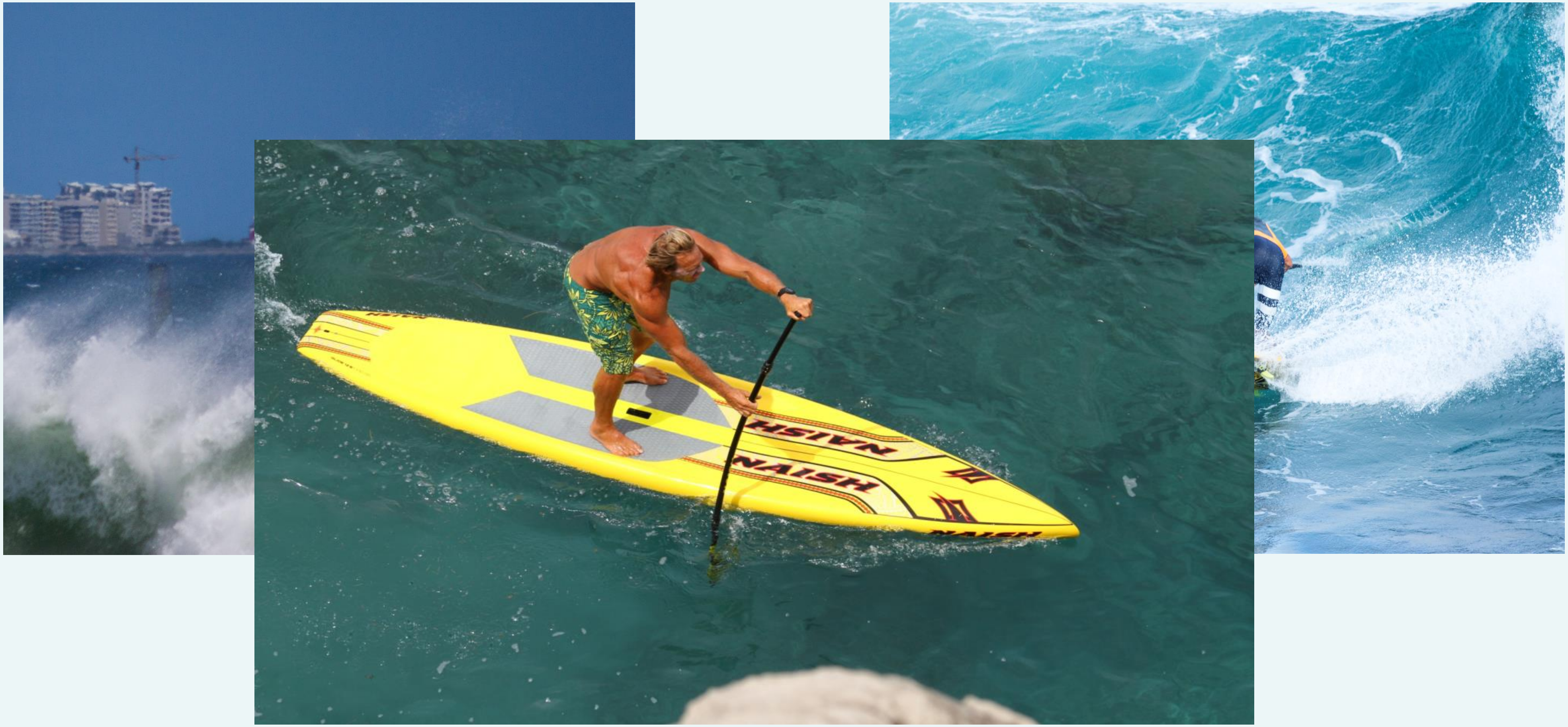
simulation

optimization



Complex structures

Complex structures



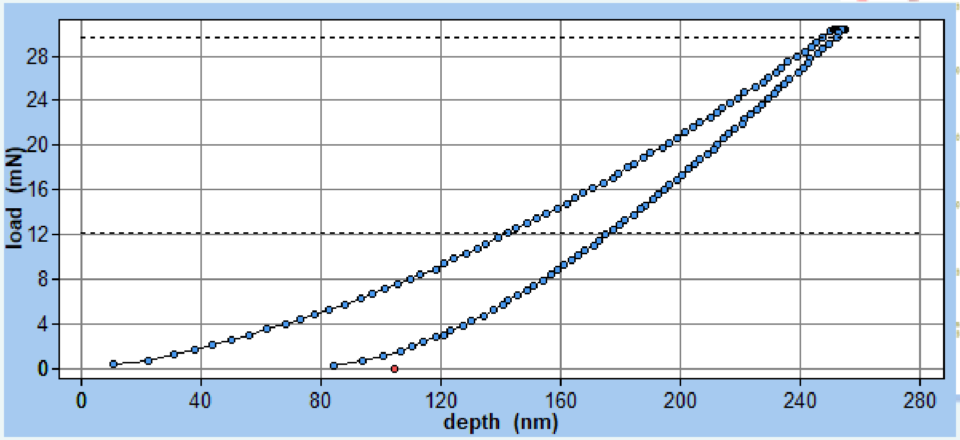
Local project with Naish International (http://www.naish.com) from 11/21/15 to 2/18/16

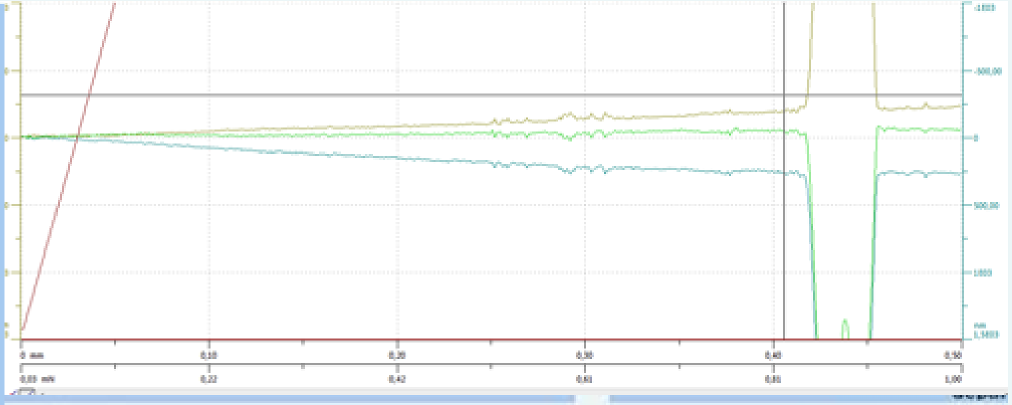
Complex structures

Complex structures

- use nanoindentation to get generic material parameters

- analyze more complex experiments with these parameters



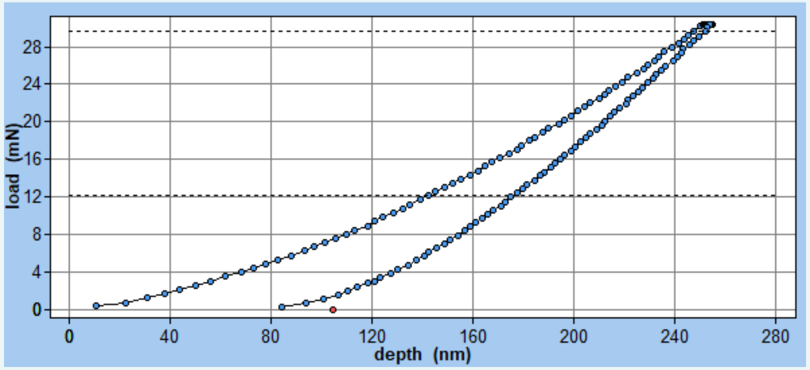


Determination of physical parameters by nanoindentation

Standard analyzis method (Oliver & Pharr) gives you only effective values for Young's modulus and Hardness

For measurement analyzis needed:

- physical parameters like e.g. Yield Strength
- true material parameters for inhomogeneous materials



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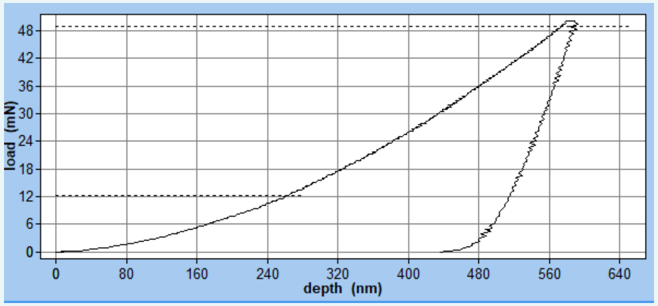

For measurement analyzis needed:

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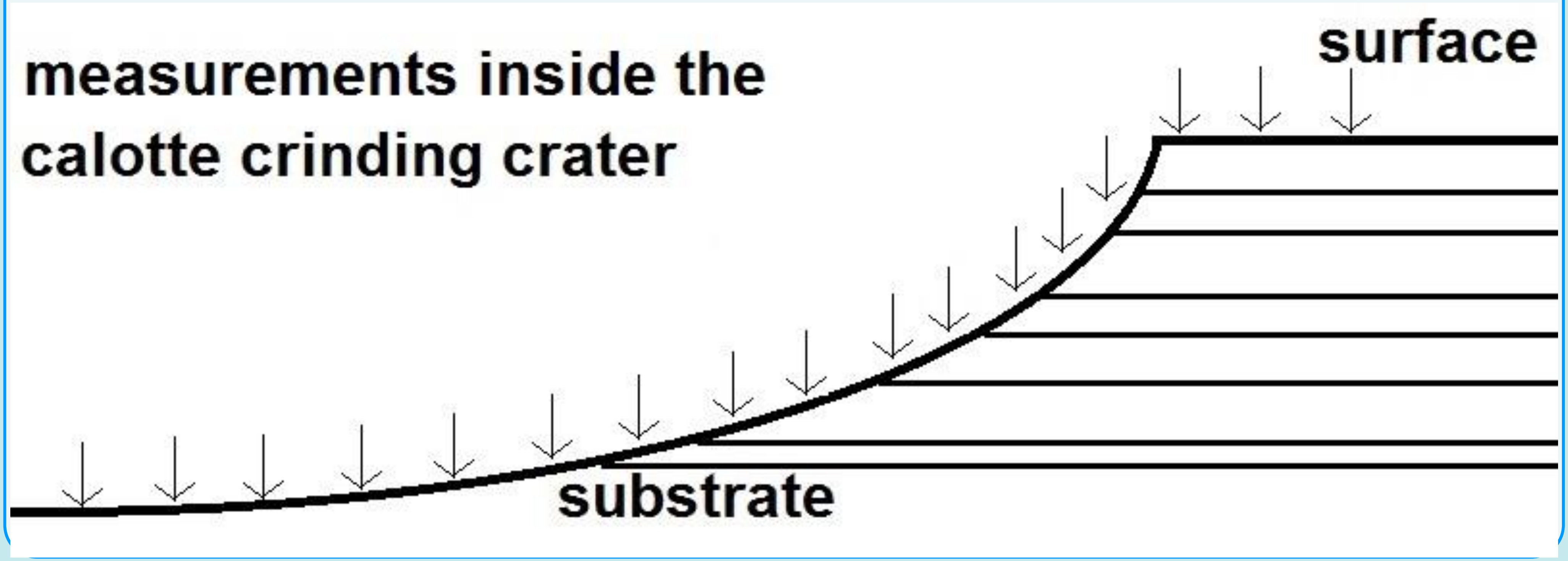
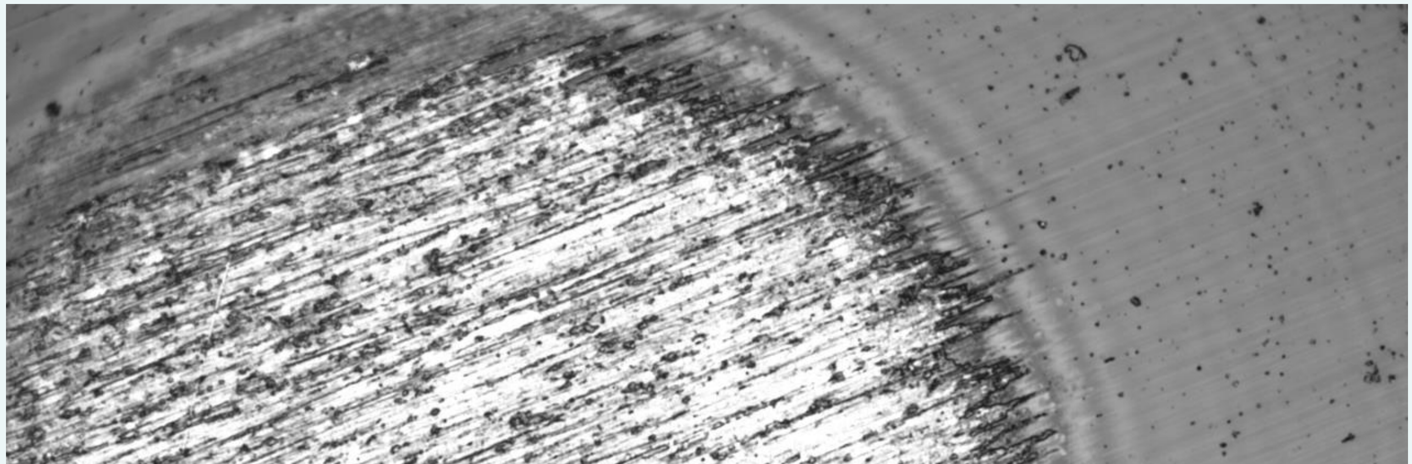
Therefore SIO has extended the standard method → Oliver & Pharr for Coatings

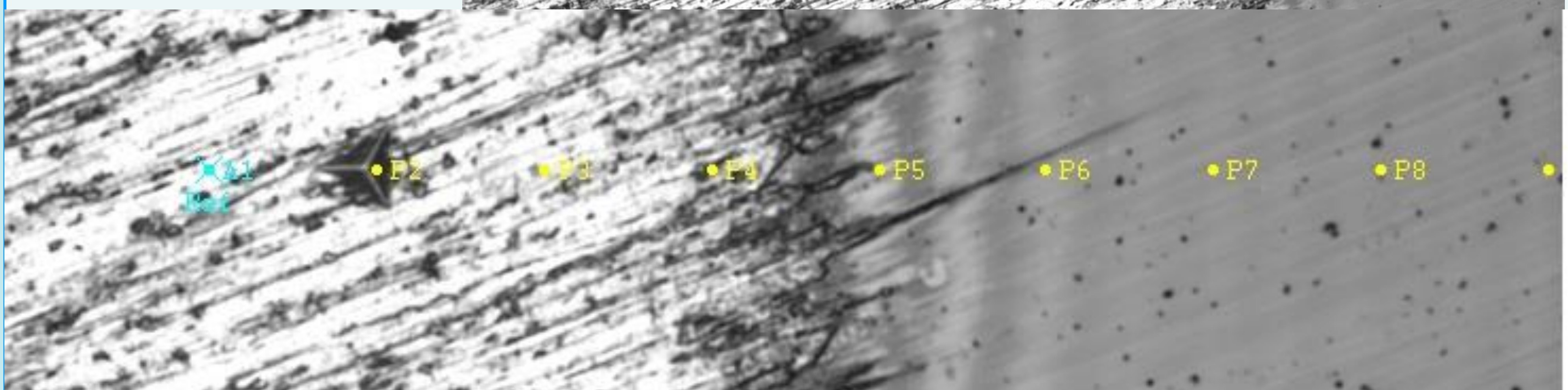
- for inhomogeneous materials (layered, gradients, …)
- for time depending material behaviour (viscose, creep (HT))

Now perform a series of indentation measurements inside and outside of the crater



Can be easily programmed in modern indentation devices

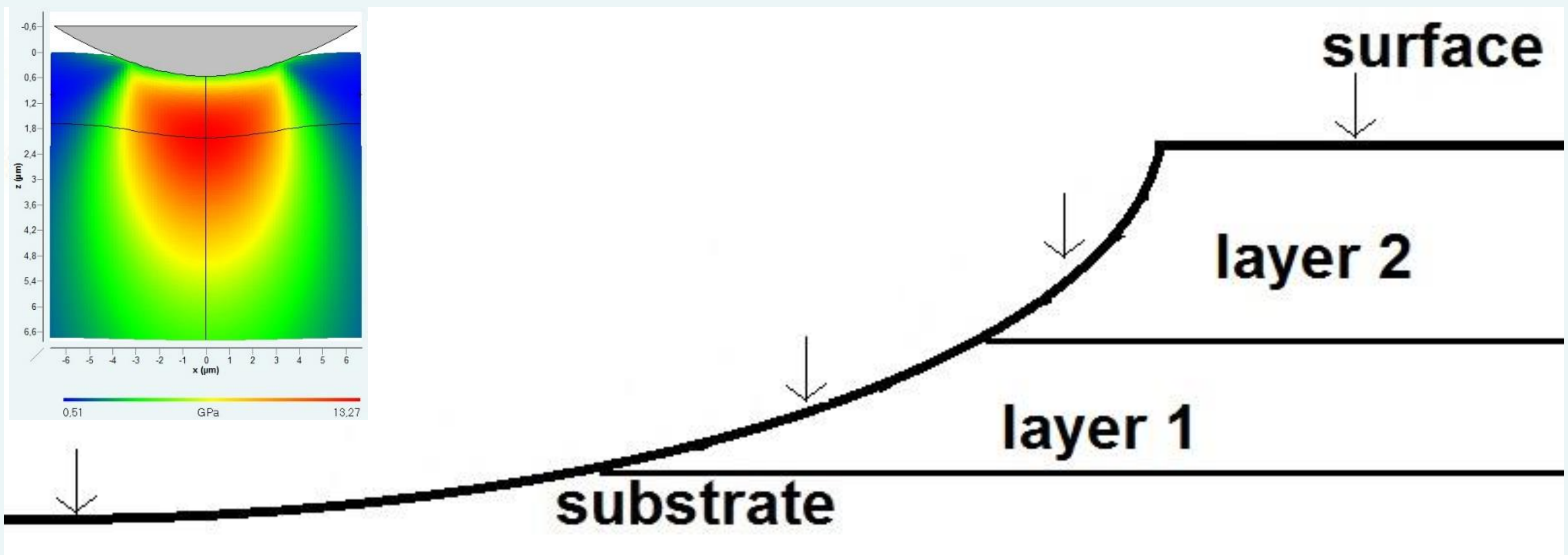




SIO Calotte Module

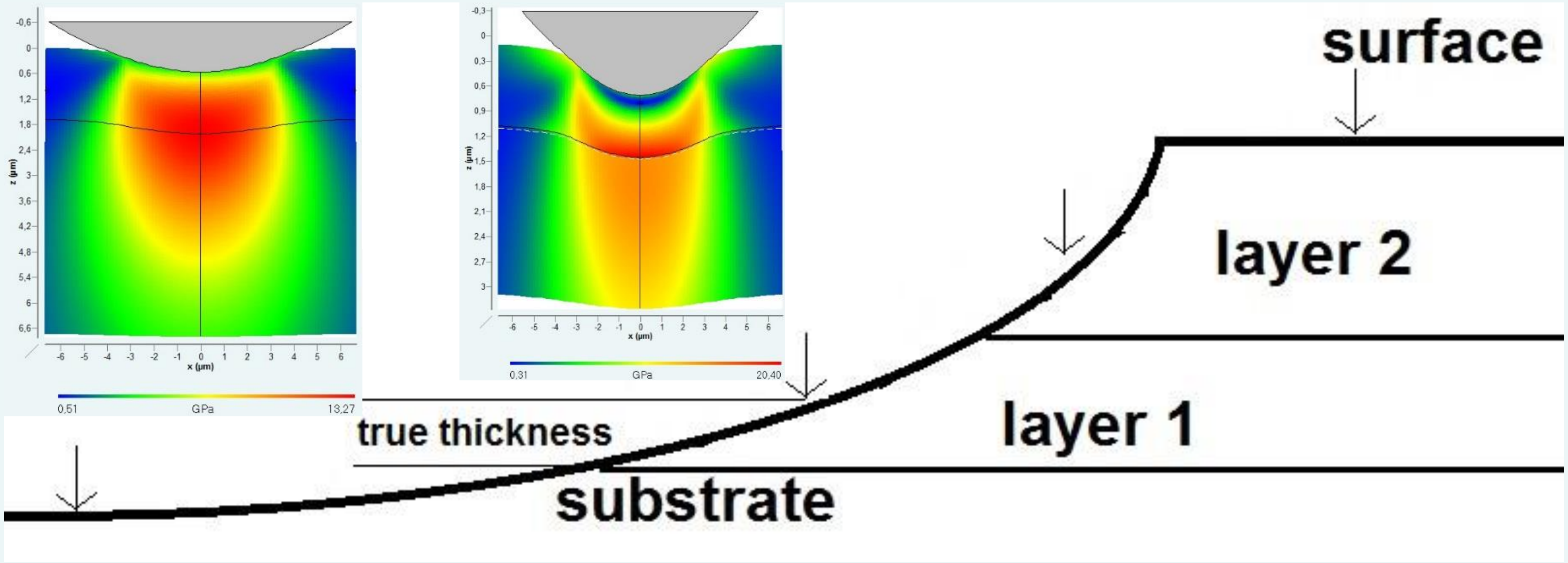
How it works in detail

- Analyzis I: substrate measurement → E_s



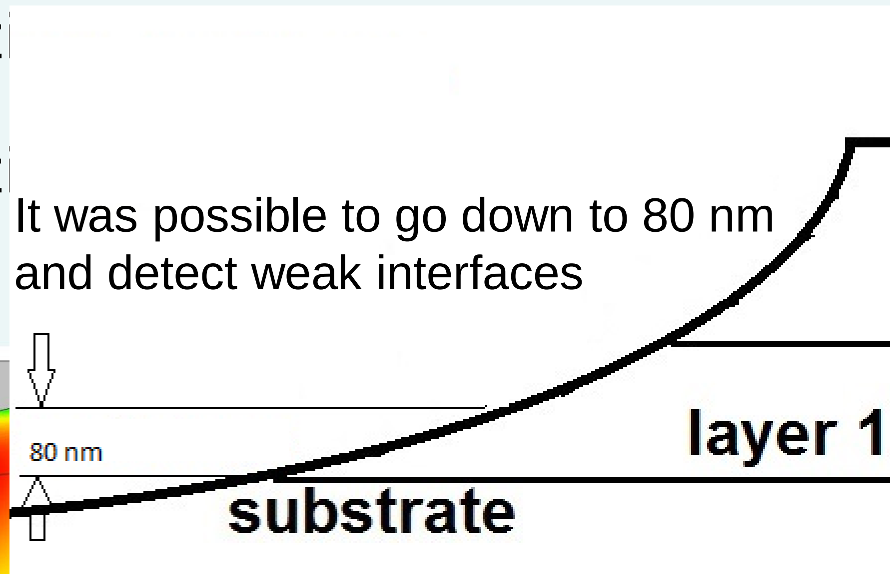
How it works in detail

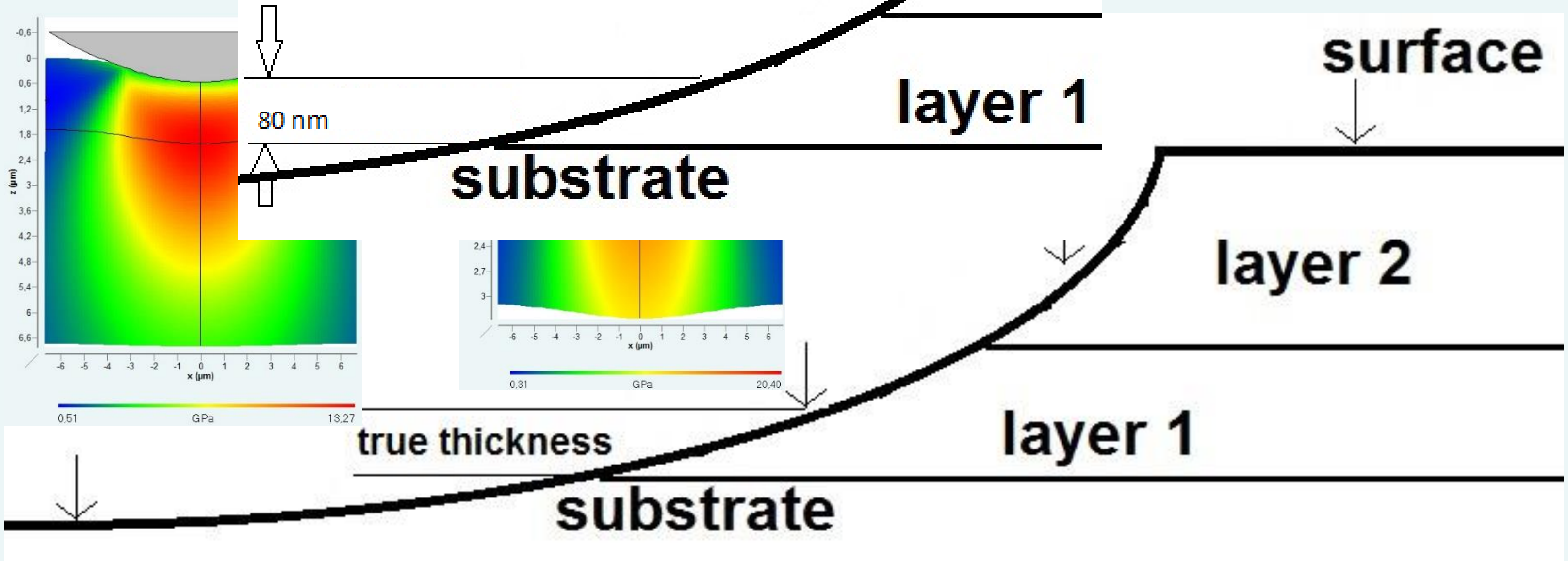
- Analyzis I: substrate measurement → E_s
- Analyzis II: 1 µm thick layer 1 → E_1



How it works in detail

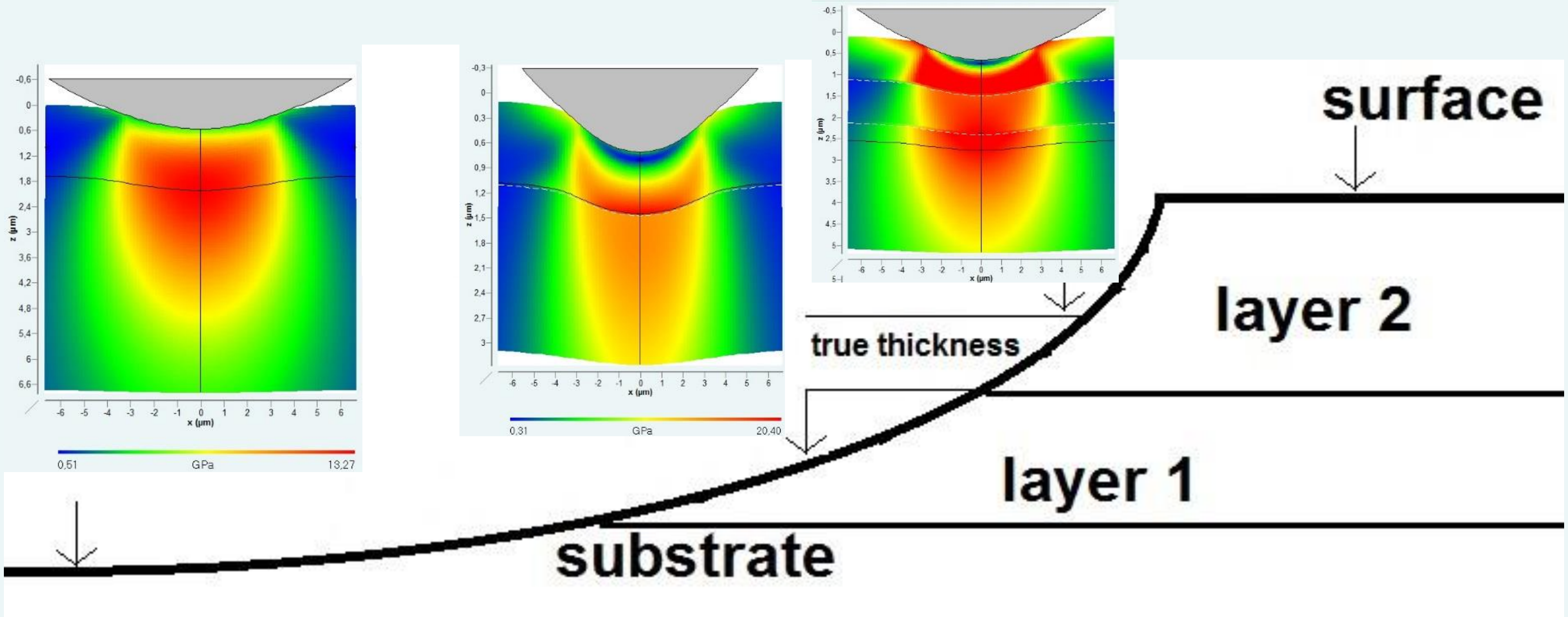
- Analyzi E_s
- Analyzi





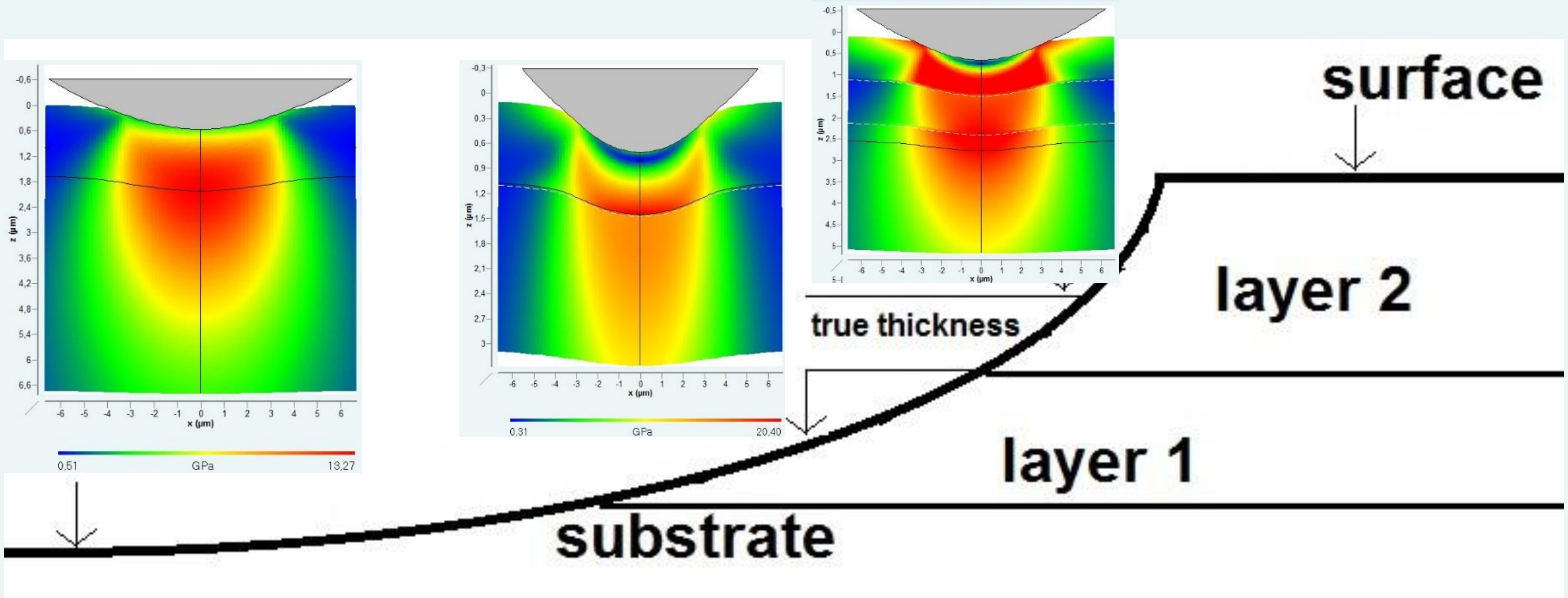
How it works in detail

- Analyzis III: 1 µm thick layer 2 → E_{21}
-

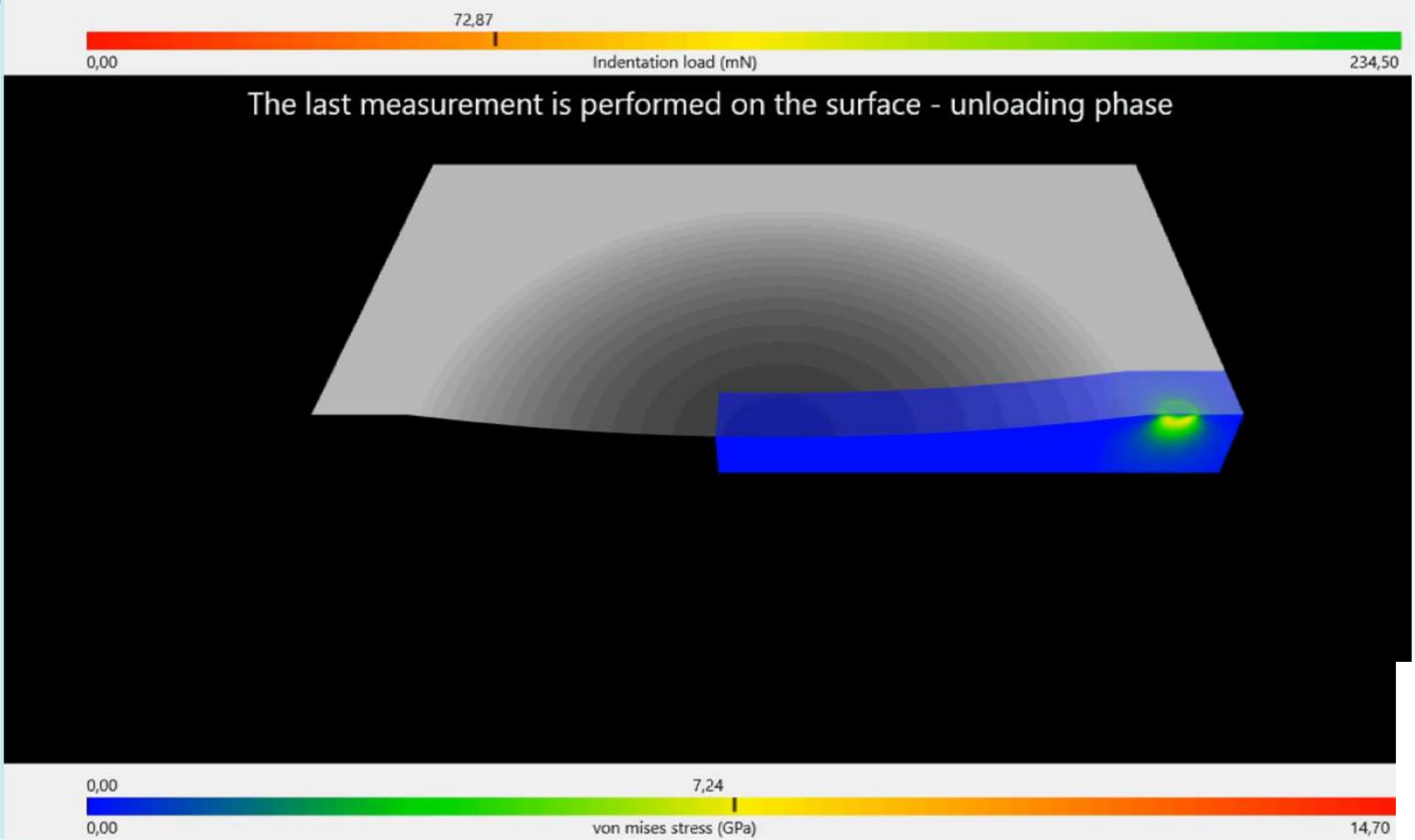


How it works in detail

- Analyzis III: 1 µm thick layer 2 → E_{21}
- Analyzis IV: 3 µm thick layer 2 → E_{22}
- If E_{21} and E_{22} differs significantly check homogeneity!



SIO Calotte Module

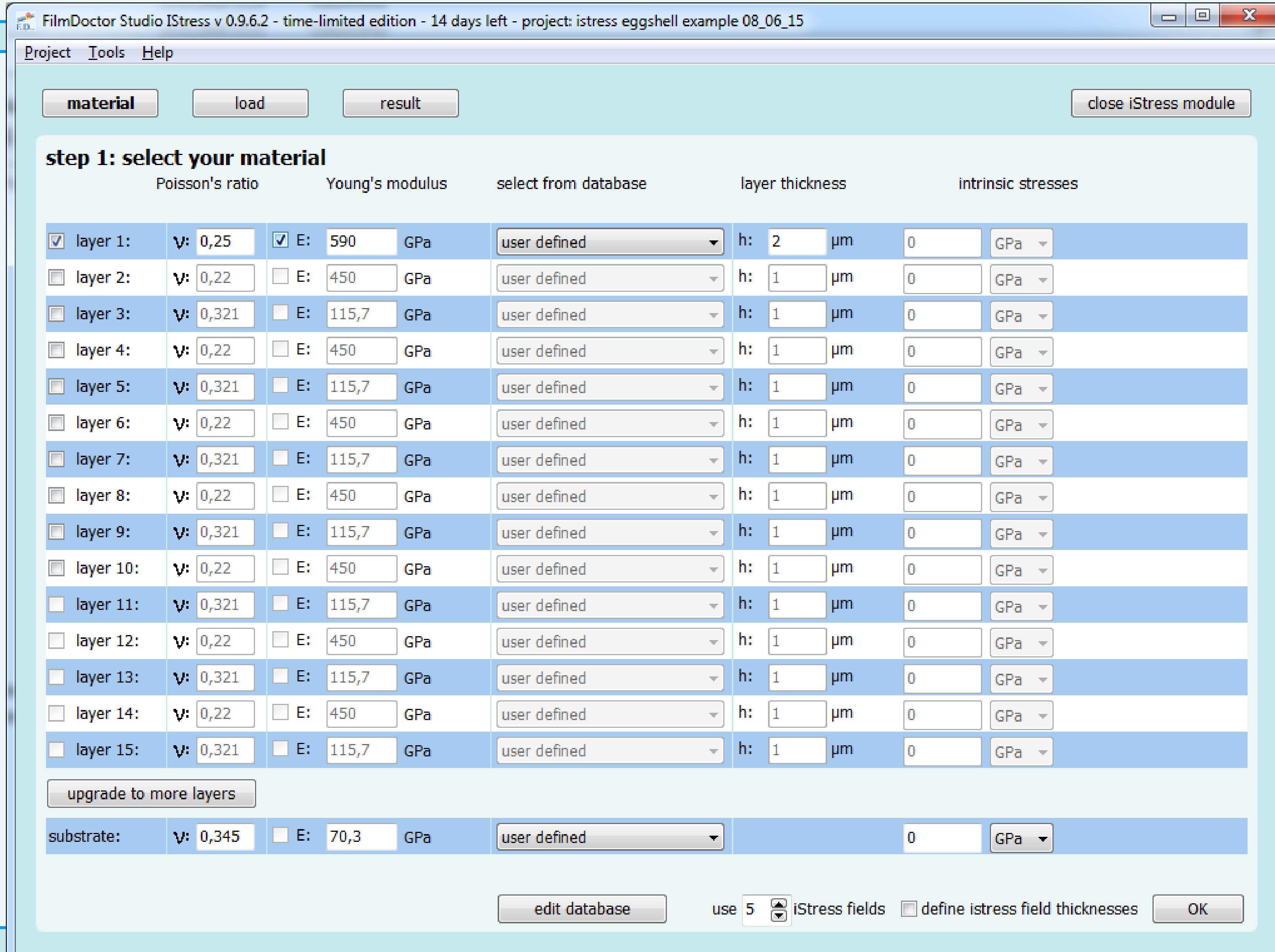


http://worldformulaapps.com/videos/calotteindentationanalyzis

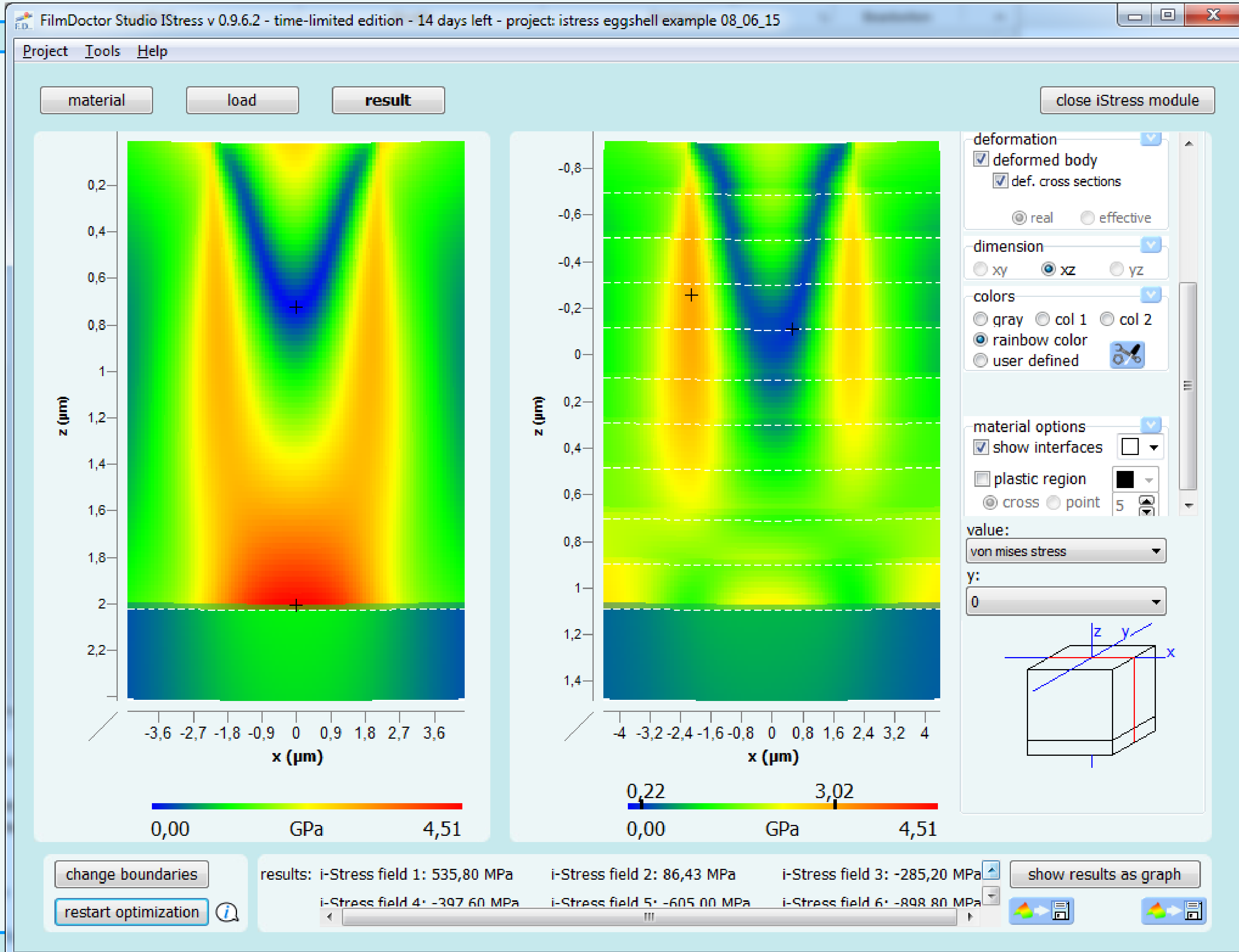
IStress module

www.stm.uniroma3.it/iSTRESS

IStress module



IStress module



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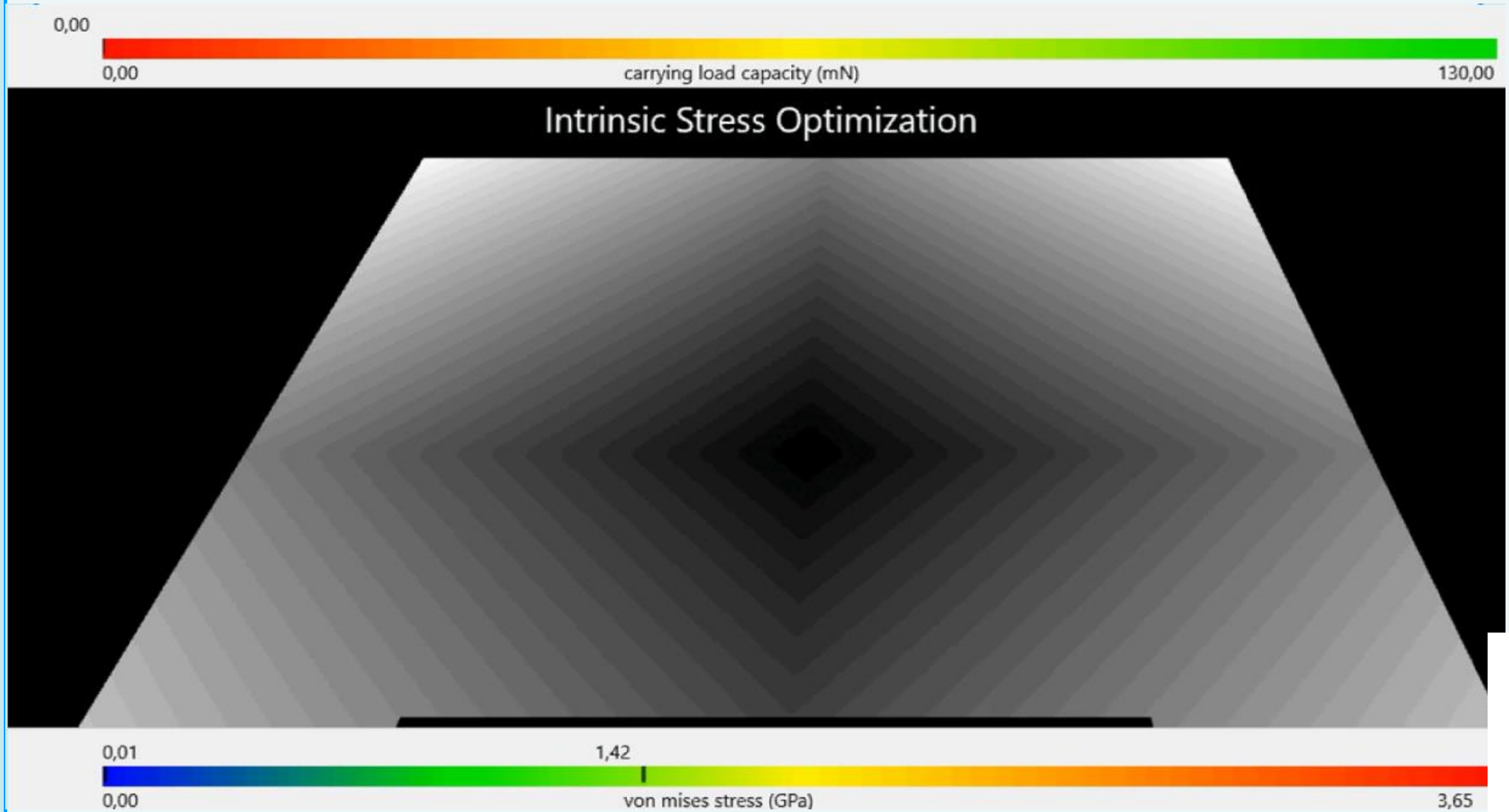
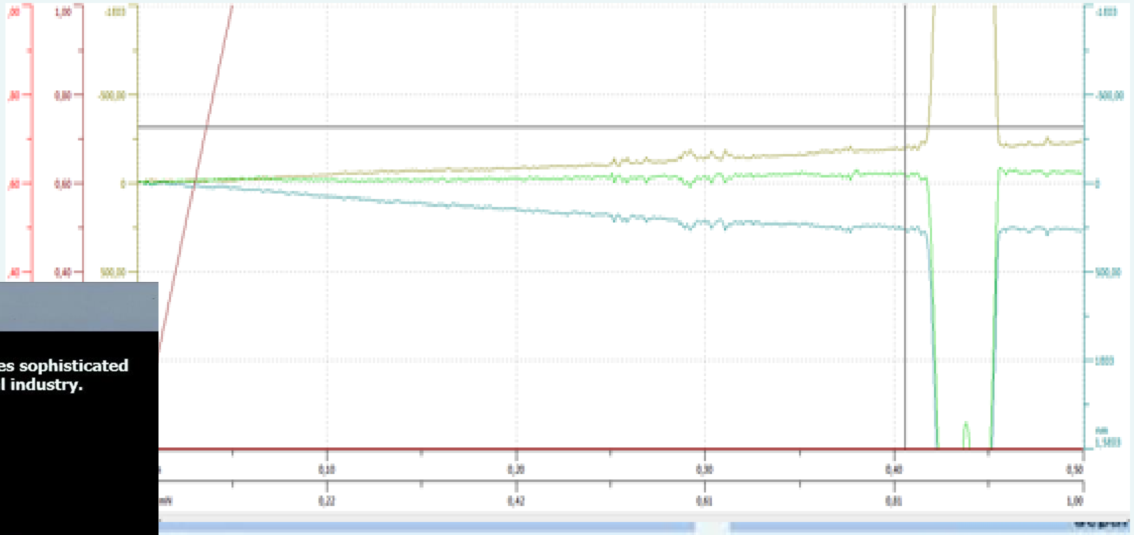
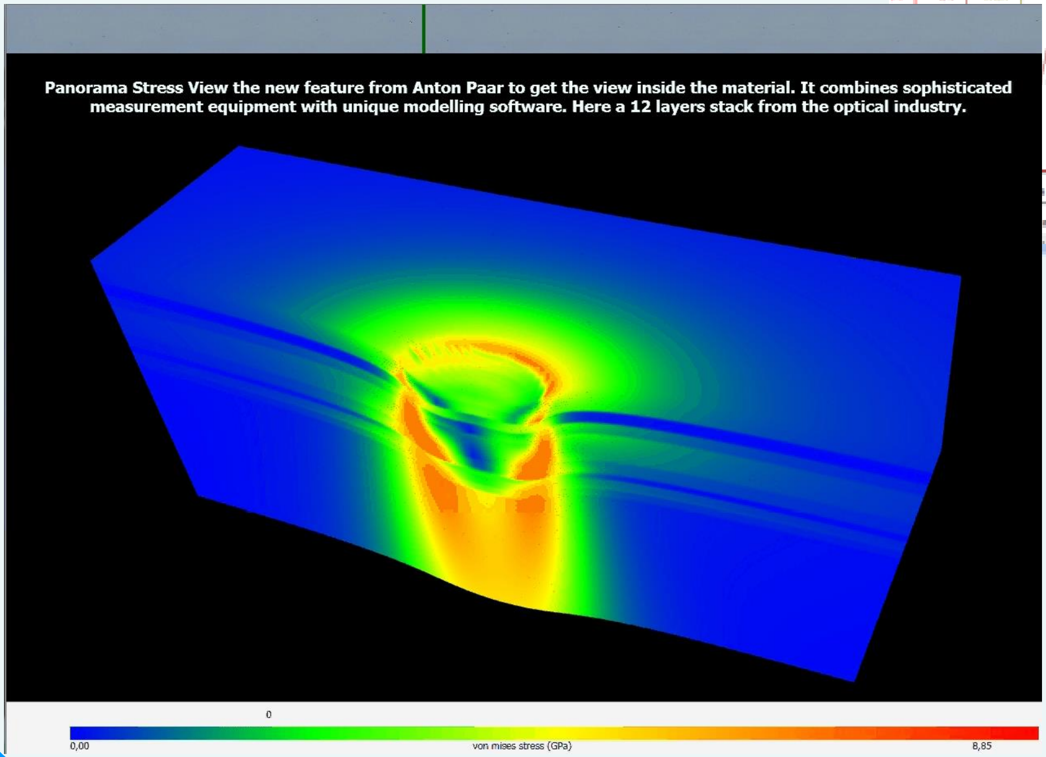


http://worldformulaapps.com/videos/intrinsicstressoptimization

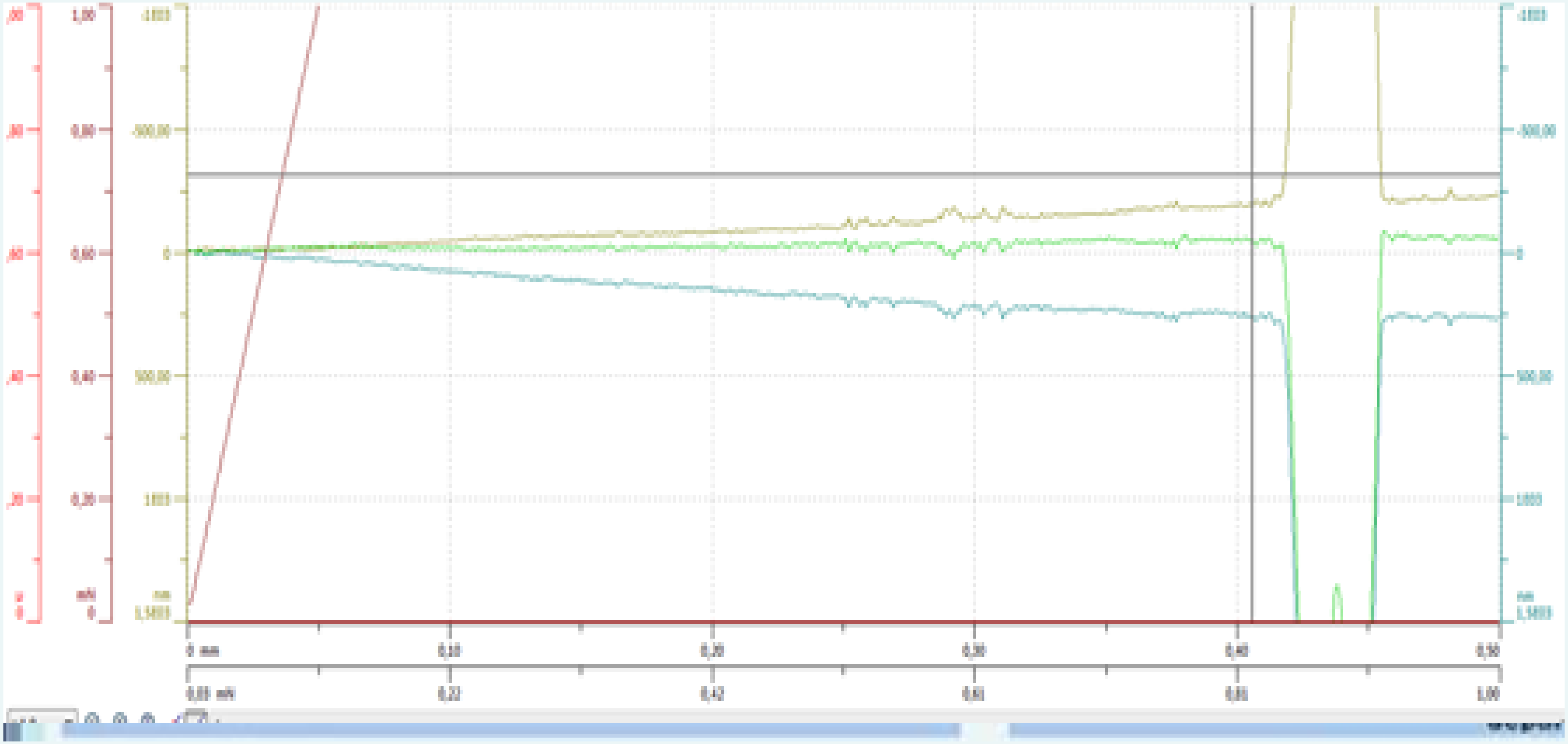
Combining measurements with modelling made easy.

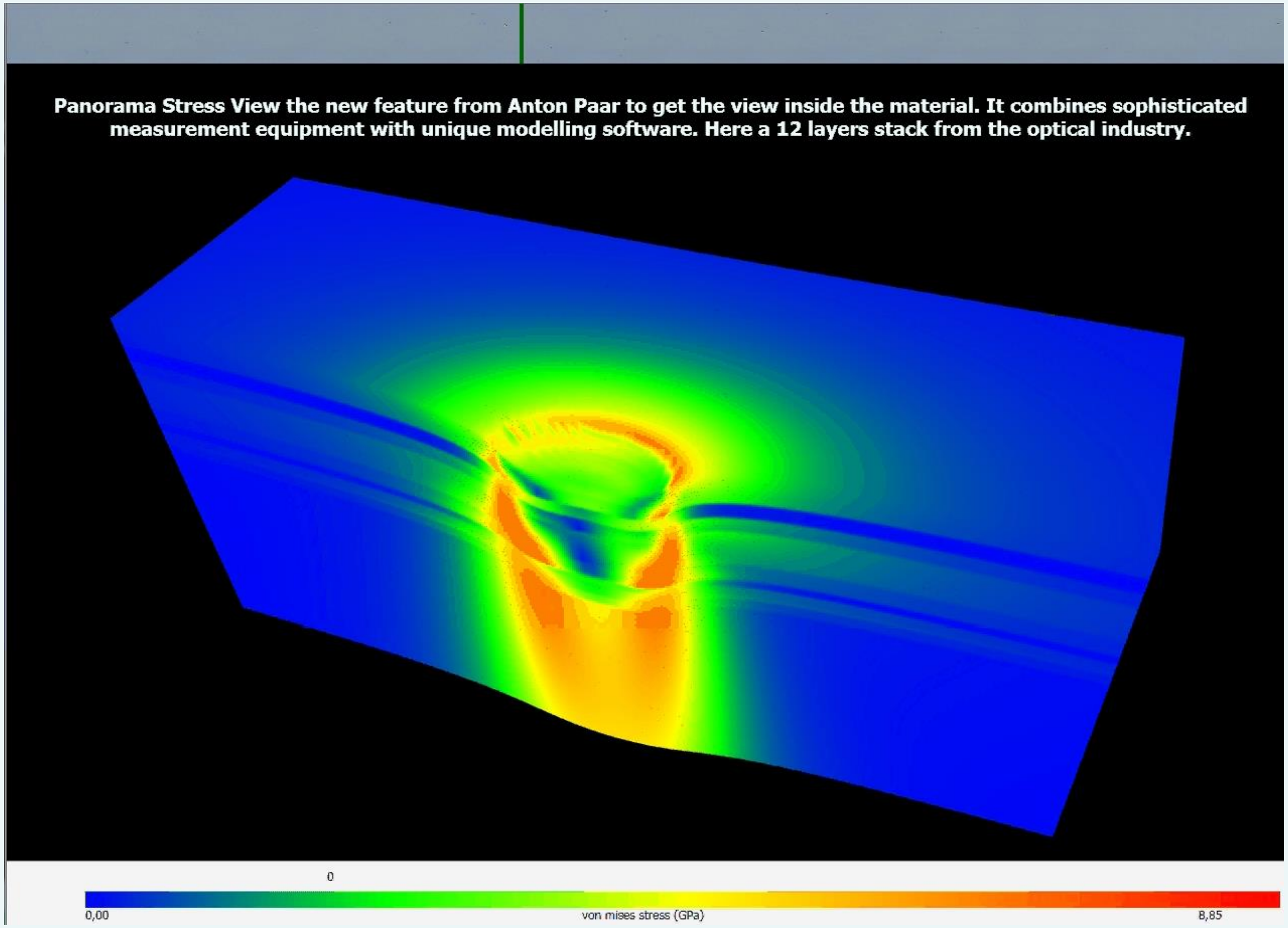




Example today: 12 layers stack with total thickness below 400 nm.

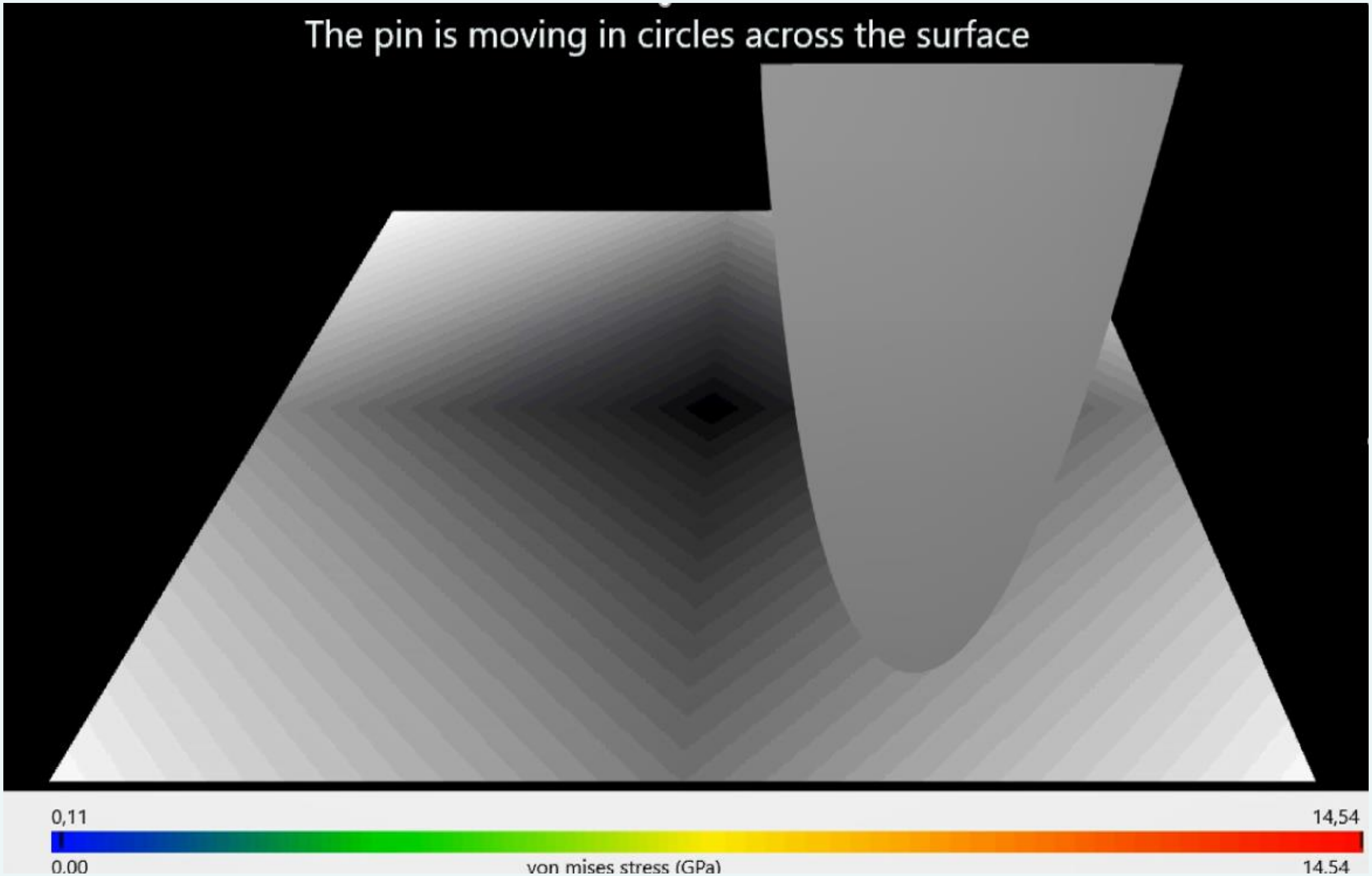
Analyzing a scratch test from 1 to 8 mN on a multi layer stack.





No FEM system – closed formula calculations

SIO AntMan



http://worldformulaapps.com/videos/wearanalyzis

Summary

Analytical models allow to analyze contact experiments very easily and quickly.

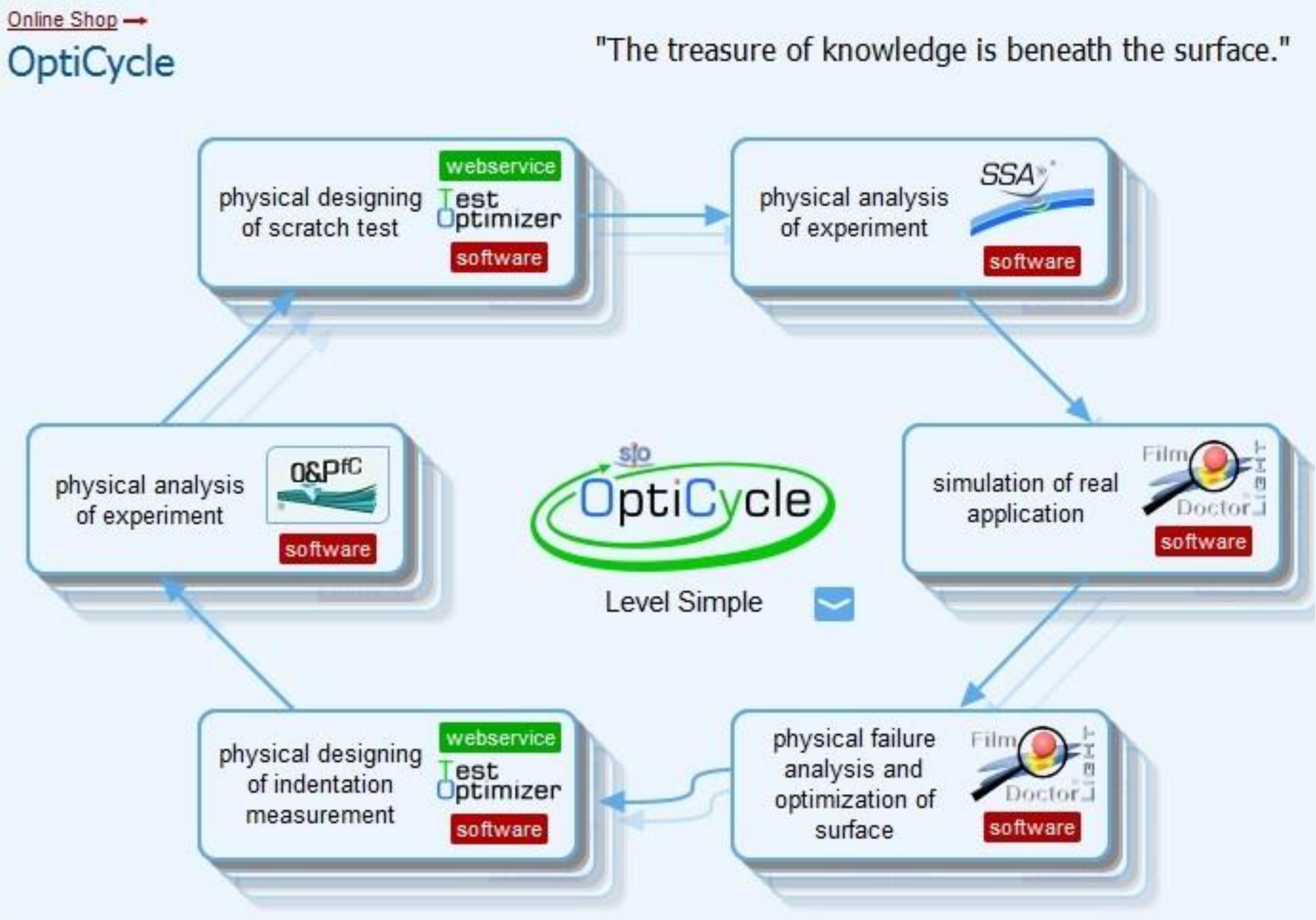
With specialized software packages simulations and optimizations are possible.

Residual stresses can be determined and optimized very easy and fast with the new modules developed within the EU and german research projects.

Indentation, Scratch AND Tribo-Tests

No FEM system – closed formula calculations

The flow chart of the Plan



http://siomec.de/en/119/OptiCycle

Reference module

Actual project with technical university of munich

SPP 2013

www.spp2013.tum.de