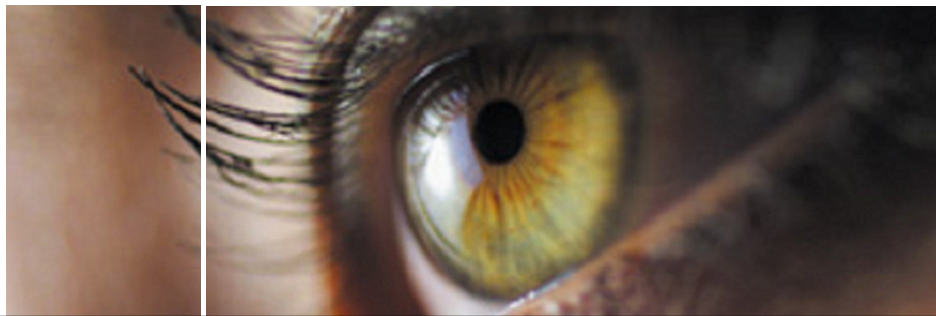


Unternehmer? Warum nicht!

Joachim Koenen
WITec GmbH, Ulm Germany
www.WITec.de



Über mich

12.07.1960 in Sigmaringen geboren
1981-1987 Physikstudium, Universität Ulm
14.02.1991 Promotion zum Dr. rer. nat.
01.04.1991 Postdoc
20.06.1997 Geschäftsführer der WITec
Wissenschaftliche Instrumente und
Technologie GmbH

WITec wurde im Juni 1997 als klassisches Start-Up aus der Universität Ulm heraus gegründet

Joachim Koenen

Olaf Hollricher

Klaus Weishaupt



- 30 Mitarbeiter in Ulm
- 4 Mitarbeiter in USA
- 2 Mitarbeiter in Asien
- 8.5 Mio € Umsatz 2009

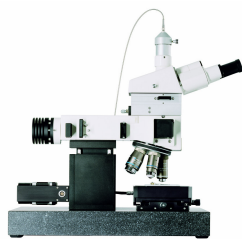
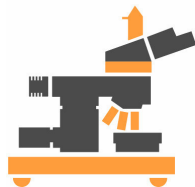
Neues Gebäude seit Mai 2009



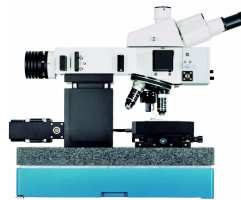
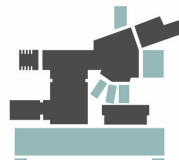
- Scanning Near-Field Optical Microscope alpha300 S
- Atomic Force Microscope alpha300 A
- Confocal Raman Imaging Microscope alpha300 R, alpha500 R, alpha700 R
- Digital Pulsed Force Mode
- Auswertesoftware WITecProject

alpha300 Microscope Series

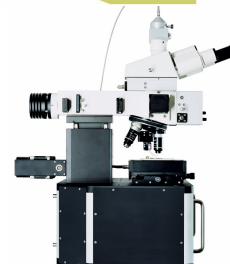
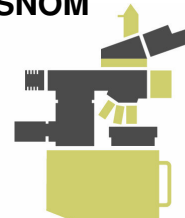
CRM



AFM



SNOM



Copyright WITec GmbH

Wie wird man Unternehmer?

- Vorbilder
- Man hat gerade nichts besseres vor
- Es gibt eine Chance
- Man erkennt die Chance
- Man nutzt die Chance

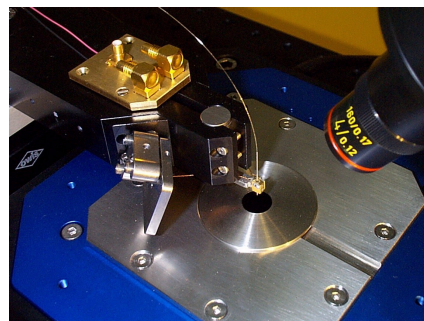
- Technische Kompetenzen:
 - Konstruktion
 - Mechatronik
 - Meßtechnik
 - Optik
 - Software
 - Chemische Erzeugnisse
 - Halbleiter
 - Verfahren, Methoden

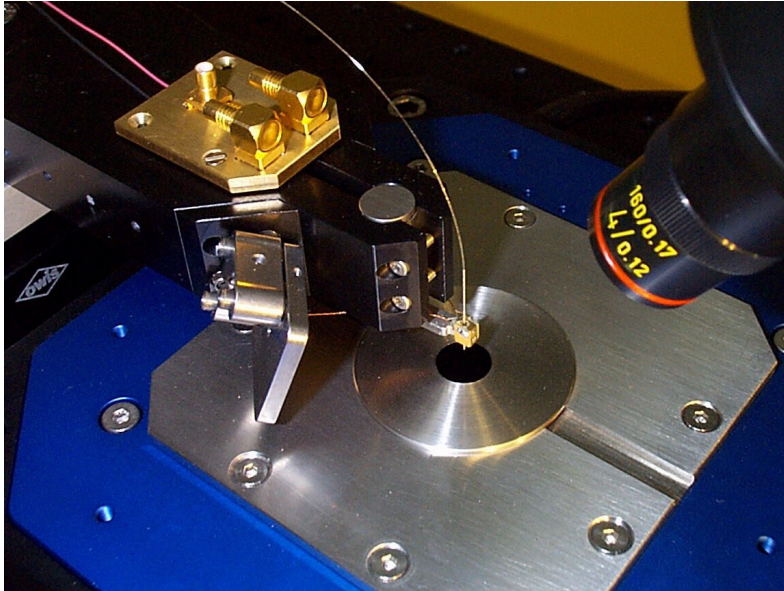
- Kaufmännische Kompetenzen
- Riecher
- Mut
- Sozialkompetenz im Umgang mit
 - Kunden
 - Lieferanten
 - Personal
- Recht
- Patente
- Steuer
- Verhandlungsgeschick

- Technisch-wissenschaftliche Ideen
- Bei WITec waren das:
 - Neues feedback für shear-force bei Faser-SNOM
 - XYZ sample scanning
 - Parfokale Detektionsoptik

First Product, First Generation:

SNOM (NSOM) Scanning Near Field Optical Microscope



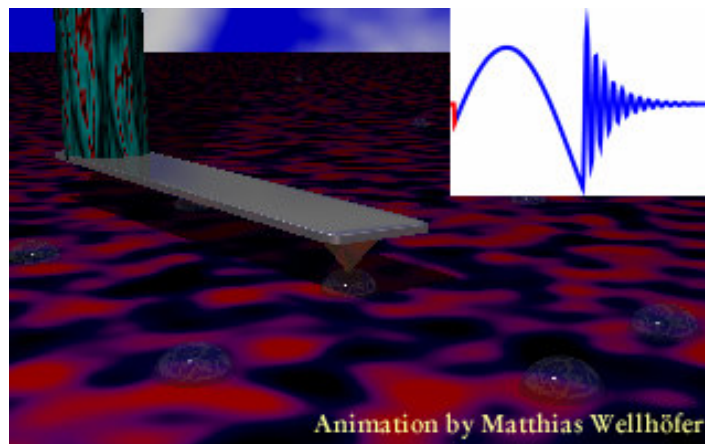


- Technisch-wissenschaftliche Ideen
- Bei WITec waren das:
 - Neues feedback für shear-force bei Faser-SNOM
 - XYZ sample scanning
 - Parfokale Detektionsoptik
 - Pulsed Force Mode Zusatzelektronik für AFM

Second Product:
PFM Pulsed Force Mode



Second Product:
PFM Pulsed Force Mode



- Technisch-wissenschaftliche Ideen
- Bei WITec waren das
 - Neues feedback für shear-force bei Faser-SNOM
 - XYZ sample scanning
 - Parfokale Detektionsoptik
 - Pulsed Force Mode Zusatzelektronik für AFM
- Umsetzung
- Patente
 - WITec hat 19 Patente (6 Familien)
 - Defensiv
 - Tauschware

- Kundennutzen
- Kommunikation, Marketing
 - WEB
 - Messen
 - Kongresse, Tagungen
 - Anzeigen
 - Workshops
 - Kundenbesuche
 - Gerätevorführungen
 - Testmessungen
 - Projekte

A customer is the most important
Visitor on our premises
He is not dependent on us,
We are dependent on him,
He is not an interruption of our work,
He is the purpose of it.
He is not an outsider to our business
He is a part of it
We are not doing him a favour by
Serving him.
He is doing us a favour by giving us
An opportunity to do so

Mahatma Gandhi

- **Businessplan**
 - Wichtig: Selber machen!
 - Verstehen
 - Kalkulation
 - Vollkostenkalkulation
 - Teilkostenkalkulation
 - Deckungsbeiträge 1,2,3

Plan G&V

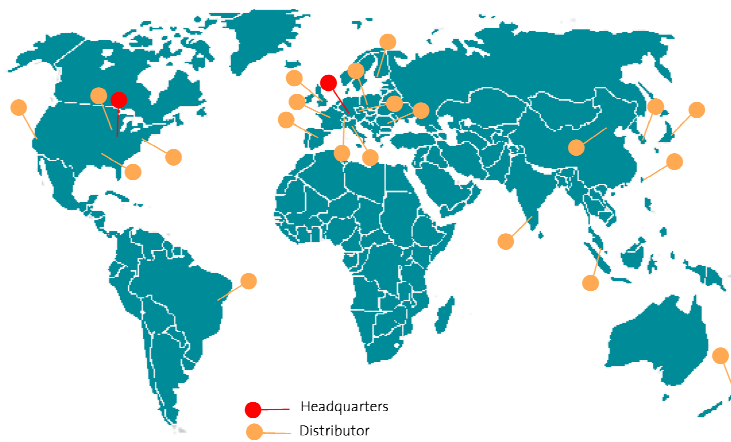
Position	1997 soll	1997 ist	1998 soll	1998 ist bis 5/98	1999	2000	2001	2002
Umsatz	190.000	50.695	1.008.200	383.297	1.549.829	2.146.137	2.208.544	3.284.879
+ Bestandsveränderungen	0	67.600	-67.600	-67.600	0	0	0	0
+ aktivierte Eigenleistungen	0	71.337	0	0	0	0	0	0
- Roh-, Hilfs- u. Betriebsstoffe	78.600	162.326	375.140	111.073	581.819	869.789	901.961	1.408.573
= Rohergebnis	111.400	27.306	565.460	204.624	968.010	1.276.348	1.306.583	1.876.305
- Löhne und Gehälter	26.500	15.749	130.000	37.831	300.600	398.012	423.172	428.436
- Abschreibungen	1.809	4.585	34.510	1.500	133.094	133.094	7.363	831
- Betriebsmittel	45.500	7.816	90.500	20.163	116.645	122.904	126.261	134.719
- Sonstige Aufwendungen	0	0	0	0	0	0	0	0
= Betriebsergebnis	37.591	-844	310.450	145.131	417.671	622.338	749.786	1.312.320
+ Zinserträge	0	221	0	9	0	0	0	0
- Zinsaufwendungen	4.500	1.305	9.750	599	13.000	13.000	13.000	13.000
= Geschäftsergebnis	33.091	-1.928	300.700	144.541	404.671	609.338	736.786	1.299.320
- Verlustvortrag	0	0	1.928	1.928	0	0	0	0
= Jahresüberschuß v. Steuer	33.091	-1.928	298.771	142.612	404.671	609.338	736.786	1.299.320
- Ertragsteuer 45%	0	0	134.447	64.176	182.102	274.202	331.554	584.694
= Bilanzgewinn/verlust	33.091	-1.928	166.252	80.365	222.569	335.136	405.232	714.626

Businessplan

- **Businessplan**
 - Selber machen!
 - Verstehen
 - Kalkulation
 - Vollkostenkalkulation
 - Teilkostenkalkulation
 - Deckungsbeiträge 1,2,3
- **Vorschlag: Bei Wettbewerben mitmachen**
 - Startup 97
 - Gründerchampion
 - Gründerpreis
 - Gründer des Jahres
 - VR Innovationspreis

- Vertriebspartner

WITec's World-wide distribution network



- Vertriebspartner
- Steuerberater
- Universität
 - Junge Innovatoren
 - Gründerverbund
 - Kooperations- und Nutzungsvereinbarung
- Business Angels
- Bank(en)

- Idee Firmengründung war latent vorhanden
 - Innovationstag Stuttgart 1995
 - Internetfirma
- Erste Kunden waren vorhanden
 - University of Illinois (SNOM)
 - Topometrix (PFM)
- Businessplan
 - Banken
 - Steuerberater
 - Antrag Junge Innovatoren
 - Business Angels
- GmbH Gründung
 - Eigenes Geld, Privatdarlehen, Kontokorrent
 - Startup Wettbewerb

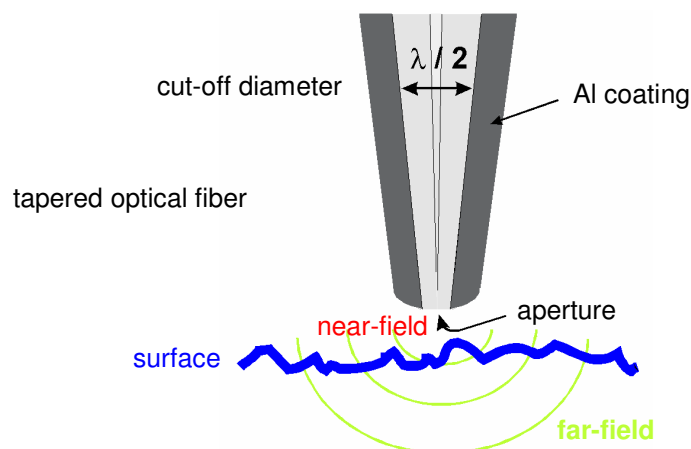
- Firmensitz bei mir Zuhause
- Finanzwesen ebenso
- Telefon- und Faxweiterleitung an Uni
- Gerätebau an der Uni
 - Mechanische Werkstatt
 - Elektronikwerkstatt
 - Abteilung Experimentelle Physik
- Training on the Job
 - Finanzwesen
 - Löhne
 - Arbeitsrecht
 - Vertragsrecht
 - Patente
 - Zoll, Import, Export
 - Organisation
 - Einkauf

- Vertrieb weltweit ausbauen
 - Niederlassung USA
 - Representatives
 - Vertriebspartner
 - Wissenschaftlicher Berater Indien
 - Niederlassung Singapur
- Kunden, Kunden, Kunden
- Umzüge
 - Albert-Einstein-Allee
 - Hörvelsinger Weg
 - Lise-Meitner-Straße

- Die richtigen Mitarbeiter finden
 - Dreamteam
- Geräte weiterentwickeln
 - SNOM Spitzen

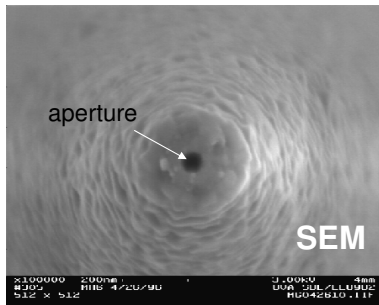
SNOM - History

Optical near-field experiments: Pohl (1982), fiber optical probes: Betzig (1986)



SNOM - History

Pulled fiber optical probes



Problems

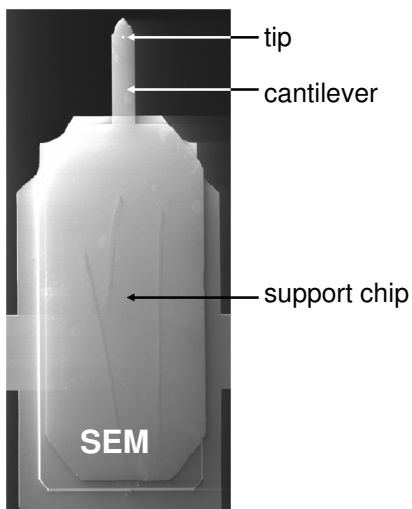
- not reproducible manufacturing process
- low optical throughput
- shear-force distance control
- very fragile

other approaches:

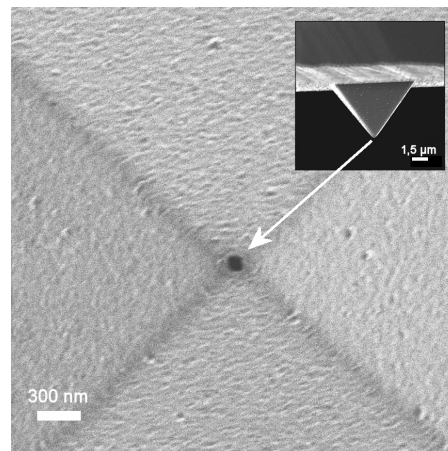
- etched fiber probes
- bent fiber probes
-

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SNOM - Cantilever SNOM Sensors

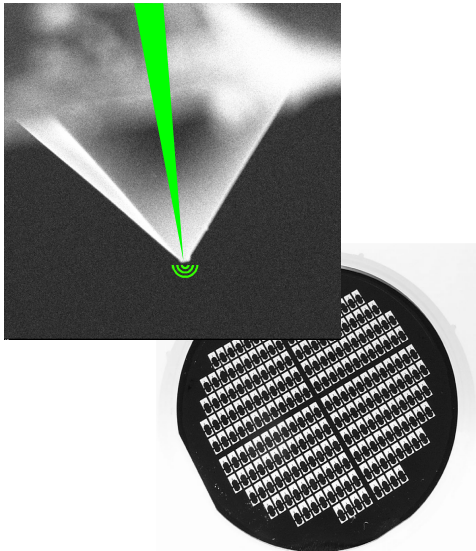


hollow SiO₂ tip with aluminium coating



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SNOM - Cantilever SNOM Sensors

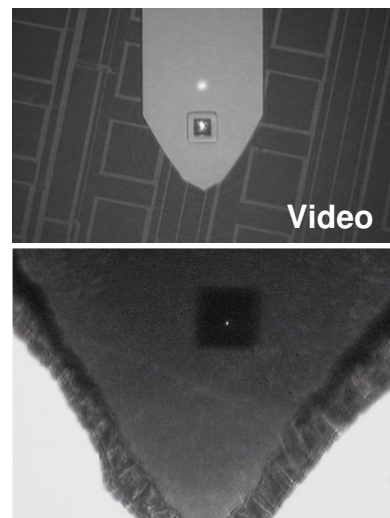
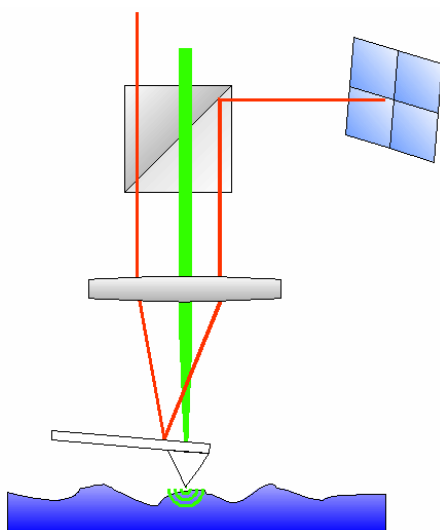


Advantages

- batch process
- reproducible
- different aperture sizes possible
- beam deflection feedback
- easy to use
- very reliable (soft in z-direction)
- high transmission coefficient

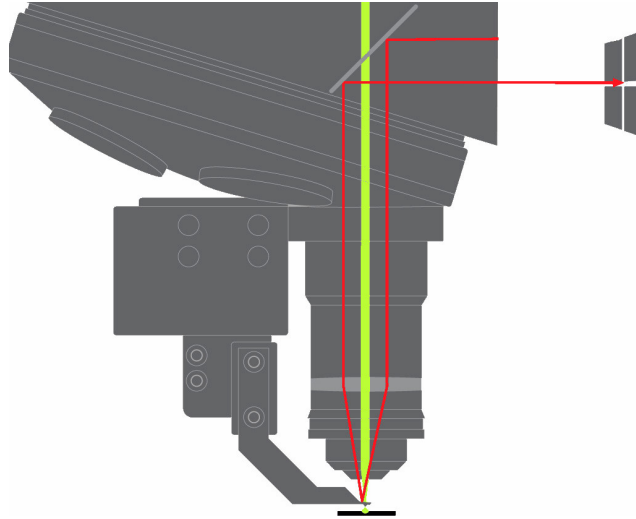
Copyright WITec GmbH

SNOM - Cantilever SNOM Sensors



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SNOM - SPM Objective



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SNOM - SPM Objective

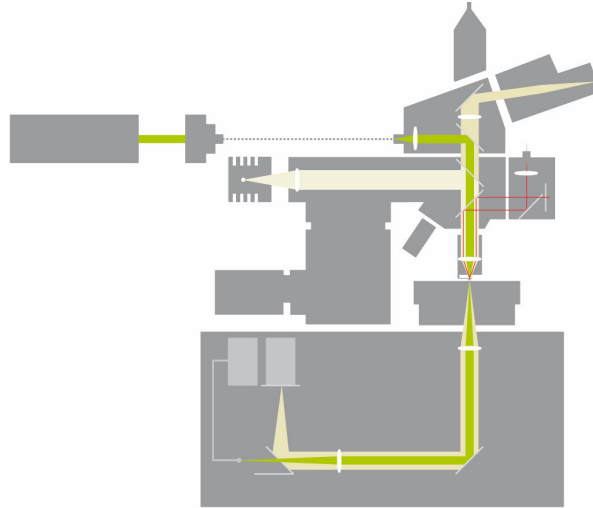


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SNOM Optischer Aufbau

WITec
focus innovations

alpha300 S Scanning Near-field Optical Microscope

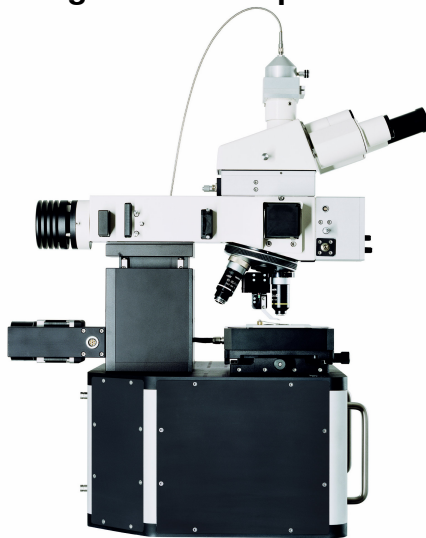


Copyright WITec GmbH

SNOM Apertur

WITec
focus innovations

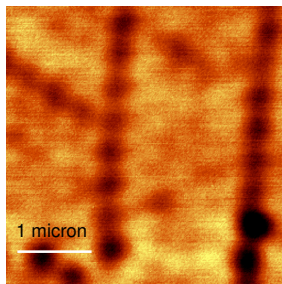
alpha300 S Scanning Near-field Optical Microscope



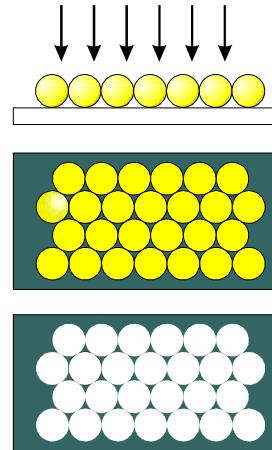
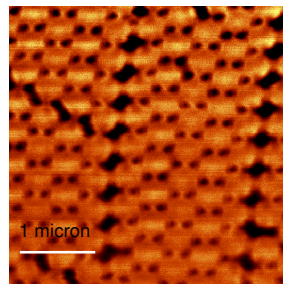
Copyright WITec GmbH

alpha300 S Scanning Near-field Optical Microscope

Confocal



SNOM



Al test sample, 450 nm latex spheres

Copyright WITec GmbH

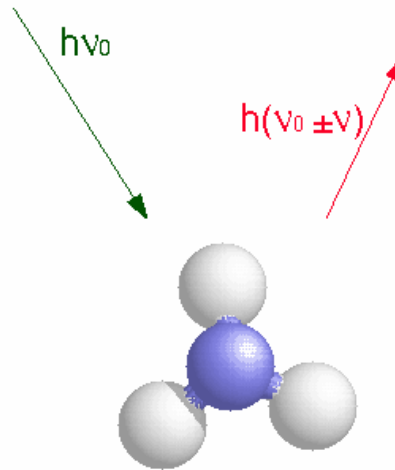
Wie geht es weiter?

- Die richtigen Mitarbeiter finden
 - Dreamteam
- Geräte weiterentwickeln
 - SNOM Spitzen
- Neue Geräte
 - Raman Mikroskop

alpha300 R Confocal Raman Microscope

Raman effect:

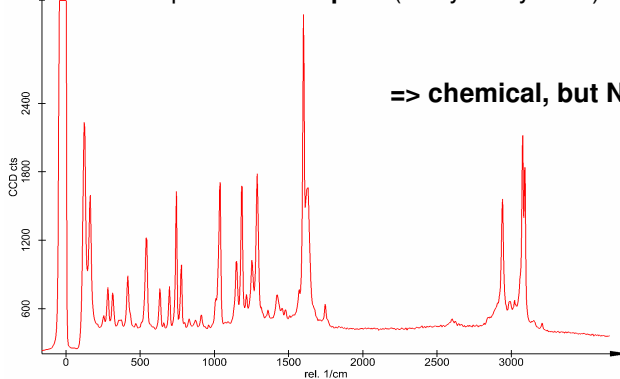
- non-resonant excitation (Stokes) or annihilation (Anti-Stokes) of a vibrational quantum states
- energy shift between the exciting and scattered photon is characteristic for the molecules involved in the scattering process



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alpha300 R Confocal Raman Microscope

Raman spectrum of **Aspirin** (acetylsalicyl-acid)



=> chemical, but NO spatial resolution



- theoretical prediction 1923 by A. Smekal
- experimentally discovered 1928 by Sir Chandrasekhara Raman, Nobel Prize 1930

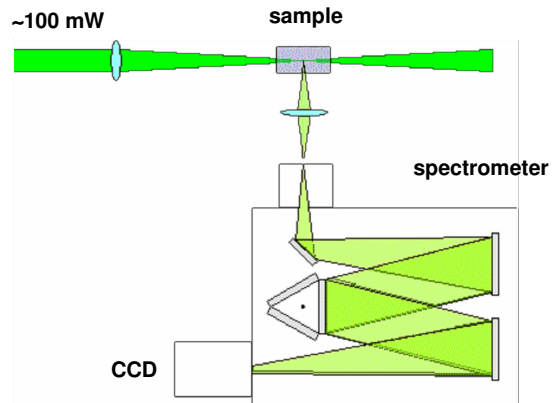
Copyright WITec GmbH

Raman Spectroscopy

typical Raman experiment:

$$I_{\text{Rayleigh}} \sim 10^6 \times I_{\text{Raman}}$$

=> Notch filter necessary



- typical integration times: 10s - several minutes

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alpha300 R Confocal Raman Microscope

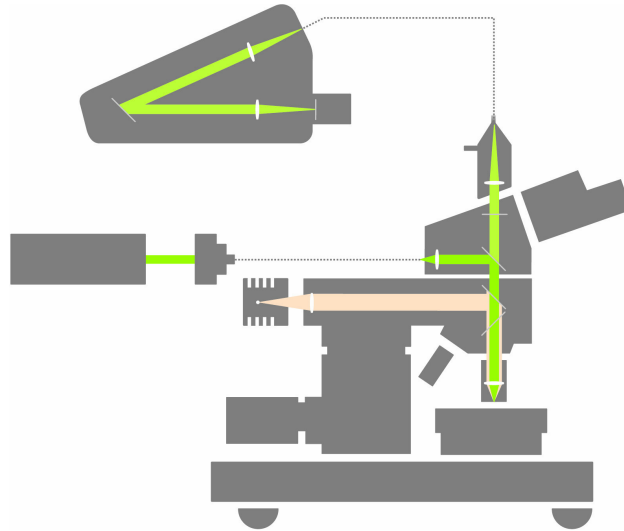
Confocal Microscopy + Raman spectroscopy

=

3-D Imaging with chemical sensitivity

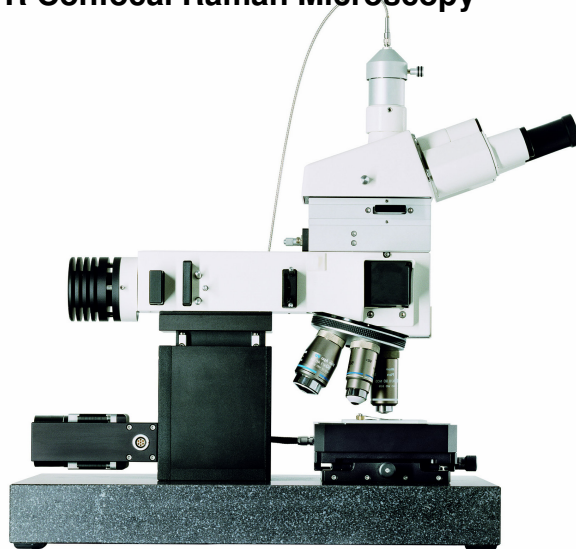
Copyright WITec GmbH

alpha300 R Confocal Raman Microscope



Copyright WITec GmbH

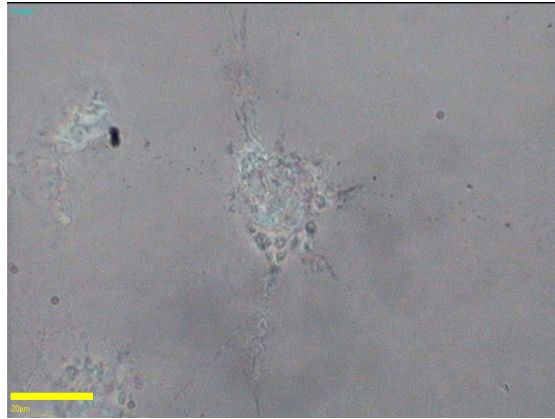
alpha300 R Confocal Raman Microscopy



Copyright WITec GmbH

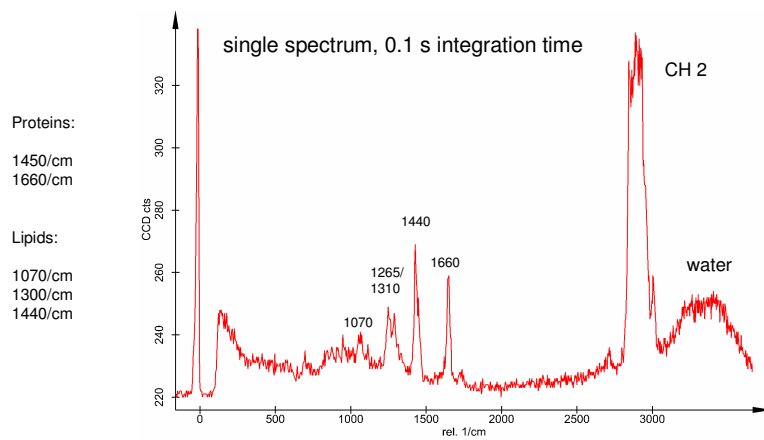
alpha300 R Confocal Raman Microscope

(living) epithelium cells of rat in physiological buffer
(RR1022 virus transfected)



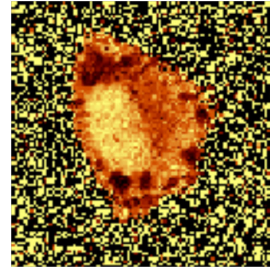
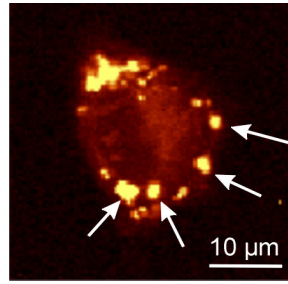
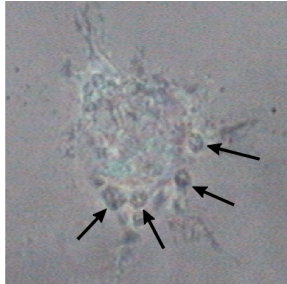
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alpha300 R Confocal Raman Microscope



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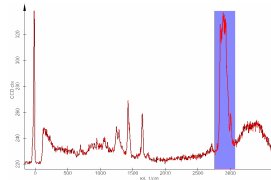
alpha300 R Confocal Raman Microscope



Intensity in the CH 2 stretching band
(2800 - 3000 / cm)

Peak position of the CH 2 stretching band
(2885 - 2935 / cm)

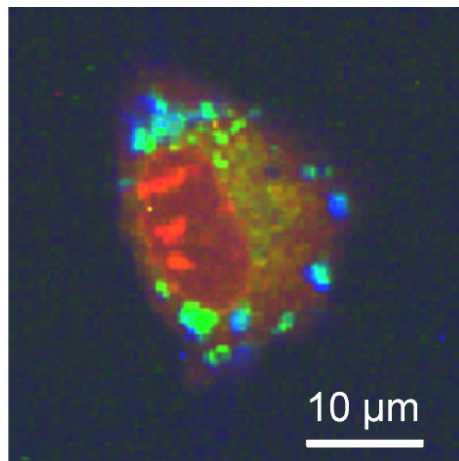
100 x 100 pixel = 10000 spectra
objective: 60x, NA = 1.0 water
532 nm excitation, 5 mW
100 ms / spectrum => 17 min.



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alpha300 R Confocal Raman Microscope

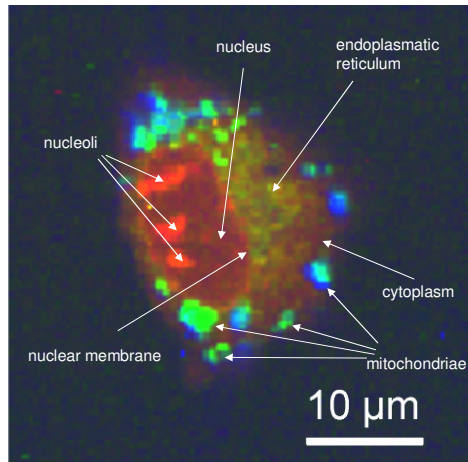
(living) epithelium cells
of rat in physiological buffer
(RR1022 virus transfected)



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alpha300 R Confocal Raman Microscope

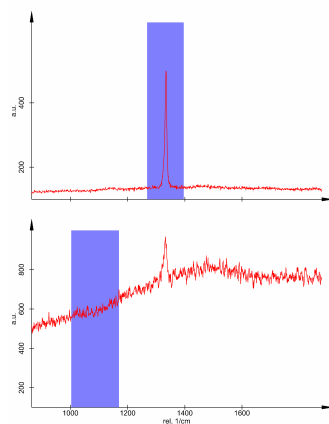
(living) epithelium cells
of rat in physiological buffer
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Copyright WITec GmbH

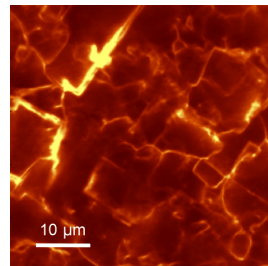
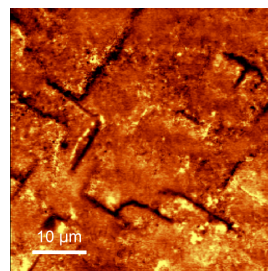
alpha300 R Confocal Raman Microscopy

CVD diamond on silicon



=>
diamond signal

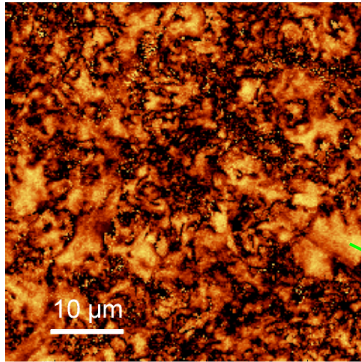
=>
fluorescence



50 x 50 μm, 256 x 256 = 65536 spectra @ 50ms
4 mW @ 532nm, 100x, NA=0.9,

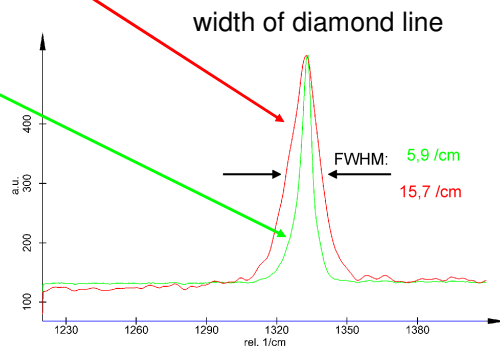
Copyright WITec GmbH

alpha300 R Confocal Raman Microscopy



CVD diamond on silicon

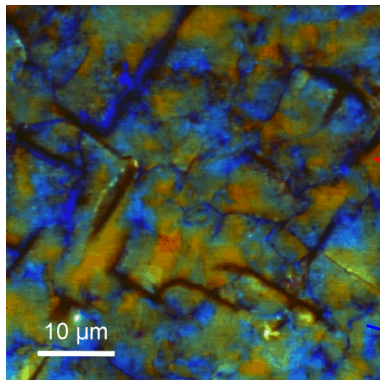
Scale:
5/cm (white) => 15/cm (black)



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alpha300 R Confocal Raman Microscopy

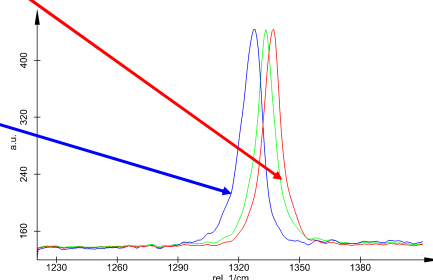
CVD diamond on silicon



stress colour coded:

red: shift to higher wavenumbers
=> compressive strain

blue: shift to lower wavenumbers
=> tensile strain



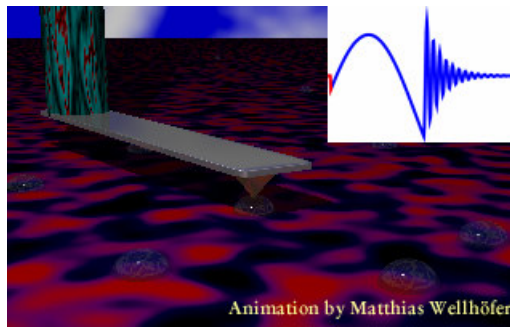
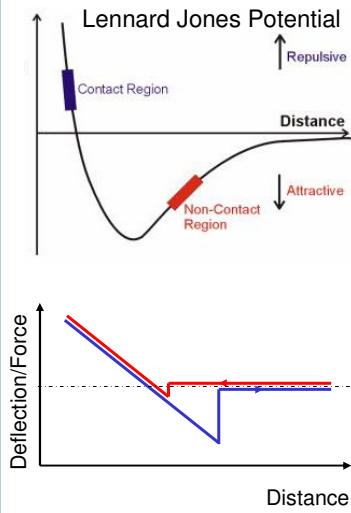
Wie geht es weiter?

- Die richtigen Mitarbeiter finden
 - Dreamteam
- Geräte weiterentwickeln
 - SNOM Spitzen
- Neue Geräte
 - Raman Mikroskop
 - Digital Pulsed Force Mode

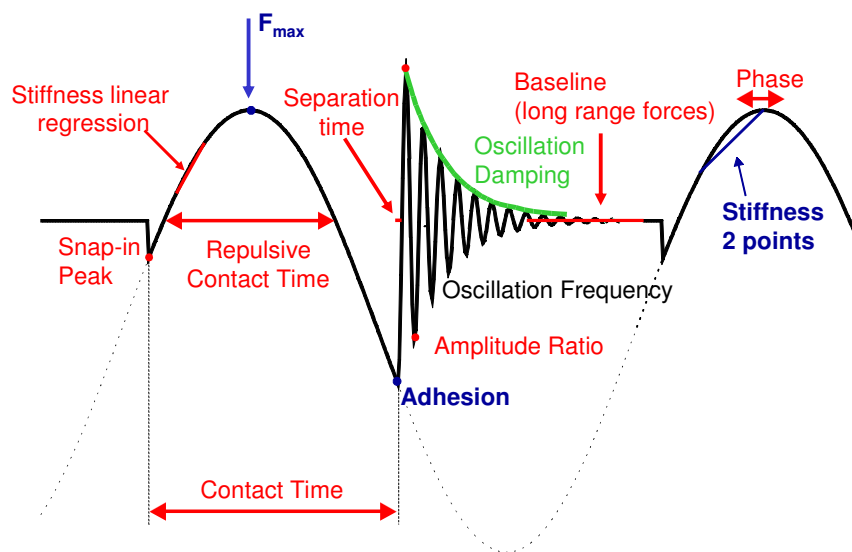
DPFM

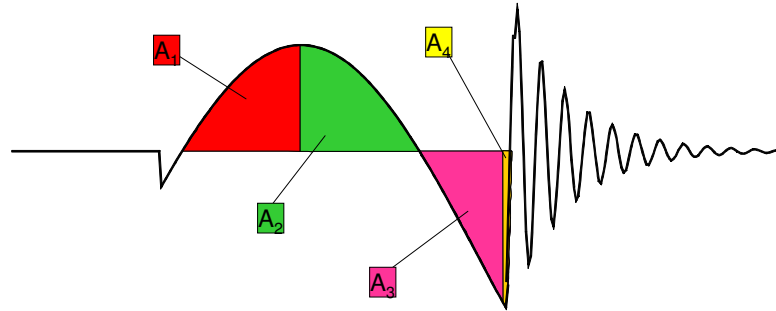


- free programmable digital function generator for cantilever excitation
- high resolution, high speed data acquisition module (5 MHz, 16 bit)
- computer controlled electronics with online data evaluation capabilities
- PC can store the complete data stream for offline data evaluation

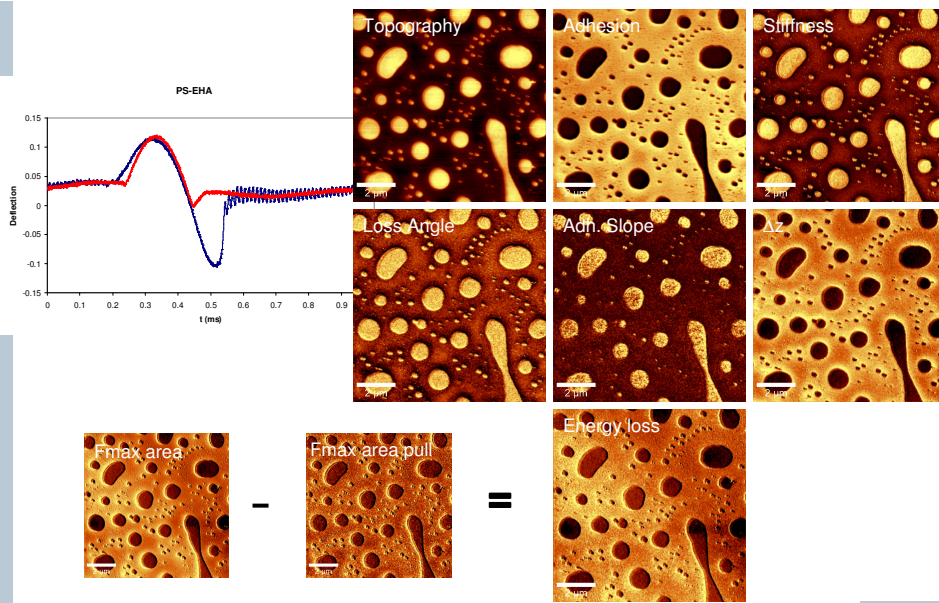


Pulsed Force Mode





$A_2 - A_1 \sim$ Energy loss in sample
 $A_3 + A_4 \sim$ Adhesion Energy



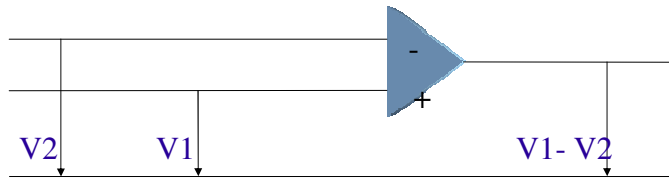
- Die richtigen Mitarbeiter finden
 - Dreamteam
- Geräte weiterentwickeln
 - SNOM Spitzen
- Neue Geräte
 - Raman Mikroskop
 - Digital Pulsed Force Mode
 - alphaControl Mikroskop Steuerung

Basic Principles

To illustrate the new basic idea behind the controller, we will demonstrate different solutions for a simple problem:

- Input 1: Voltage V_1
- Input 2: Voltage V_2
- Output: Voltage $V_1 - V_2$

A: Analog Solution



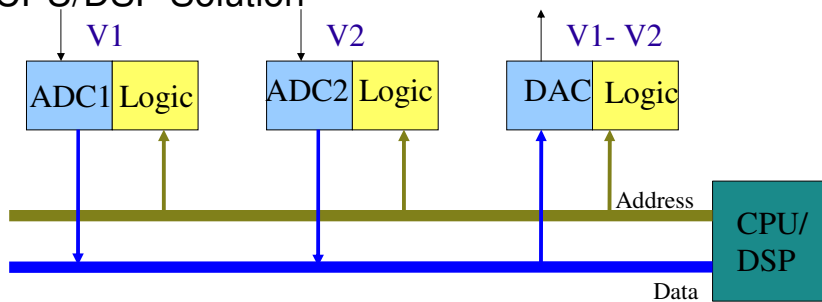
Advantages:

- . Fast
- . Simple
- . Cheap
- . Accurate
- . Low noise

Disadvantages:

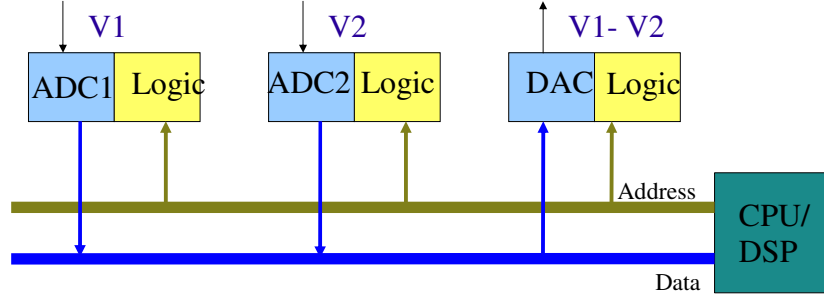
- . Inflexible
- . No gains
- . No other operations
- . No easy computer control
- . No digital access to data

B: CPU/DSP Solution



1. Put Address for ADC1 on Address bus
2. Read Data from ADC1 in CPU
3. Put Address for ADC2 on Address bus
4. Read Data from ADC2 in CPU
5. Subtract ADC1 - ADC2 in CPU
6. Put Address for DAC on Address bus
7. Write Result to Data bus for DAC

B: CPU/DSP Solution



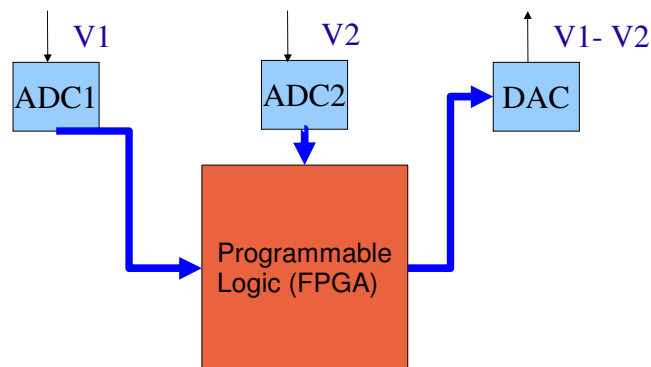
Advantages:

- Very Flexible
- Gain, Factors possible
- Complex Operations Possible
- Digital Data
- Computer Control

Disadvantages:

- Slow
- ADC, DAC need logic
- Buses are bottlenecks
- Collisions on bus
- Step by step processing

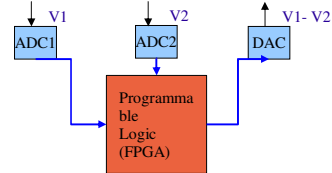
C: Programmed Logic Solution (FPGA)



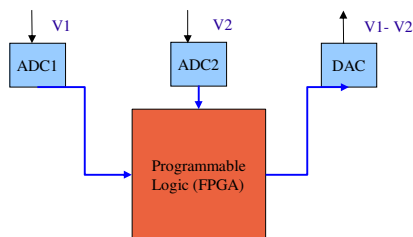
Both ADCs and the DAC are permanently connected with the FPGA
Part of the FPGA's logic calculates the difference permanently within a few cycles

Advantages:

- .Very flexible
- .Very Fast
- .Everything runs parallel
- .Gains, factors, complex operations possible
- .Data are digital
- .Computer control
- .No logic needed at the ADC/DAC
- .No bottleneck
- .Fixed timing, determined behavior

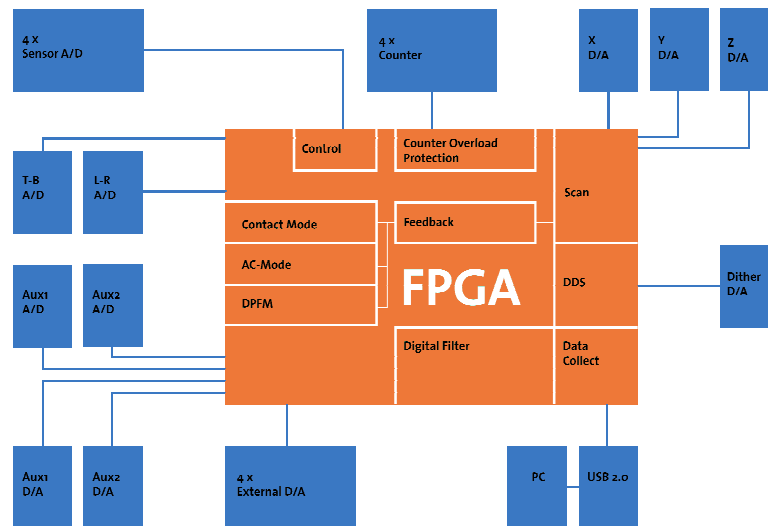
**Disadvantages:**

- . Programmable logic (FPGA) setup (VHDL) is very complex compared to C++
- . Slow floating point operations

C: Programmed Logic Solution (FPGA)

Now, let use this idea to build up a digital controller for SPM

System-on-a-programmable-Chip



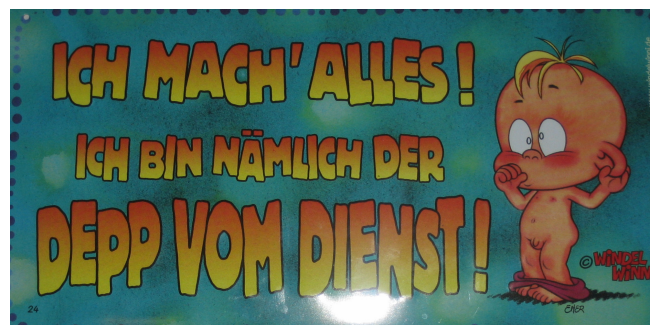
Wie geht es weiter?

- Die richtigen Mitarbeiter finden
 - Dreamteam
- Geräte weiterentwickeln
 - SNOM Spitzen
- Neue Geräte
 - Raman Mikroskop
 - Digital Pulsed Force Mode
 - alphaControl Mikroskop Steuerung
 - WITecProject, WITecControl Software

- Raman TV (Spectrum to Image)
- Cluster Analysis by K-Means
- Principle Component Analysis
- Advanced Fitting
- Weighted Spectrum Subtraction
- Data Binning and Reduction
- Graphical Demixer
- Image Correlation
- 2D FFT Filter
- Advanced Image Filters
- Remove Bad Image Data

Nicht nur Geräte machen eine Entwicklung durch, auch Mitarbeiter und Führungskräfte entwickeln sich

Früher: Geschäftsführer war Mädchen für alles



Nicht nur Geräte machen eine Entwicklung durch, auch Mitarbeiter und Führungskräfte entwickeln sich

Früher: Geschäftsführer war Mädchen für alles
Jetzt: Mehr Führung

- Ziele
- Strategien
- Firmenzukäufe

Positiv

- Freiheit
- Kreativität
- Prestige
- Geld
- Selbstbewusstsein
- Ziele
- Vielseitigkeit
- Verantwortung
- Entscheidungen
- Macht

Negativ

- Belastung
- Freizeit
- Familie
- Risiko
- Haftung
- Verantwortung
- Taskswitching
- Druck
- Vorschriften
- Finanzamt

Vielen Dank für Ihre Aufmerksamkeit

