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# VG Scienta PES solutions

By Henrik Bergersen

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[www.vgscienta.com](http://www.vgscienta.com)



VG SCIENTA

# Company Overview



Vacuum Generators  
(UK, 1962)



Scienta  
(Sweden, 1983)

Vacuum  
Technology

Scientific  
Instruments



**VG Scienta inc**  
Denver, CO  
Tel: 720 350 5000



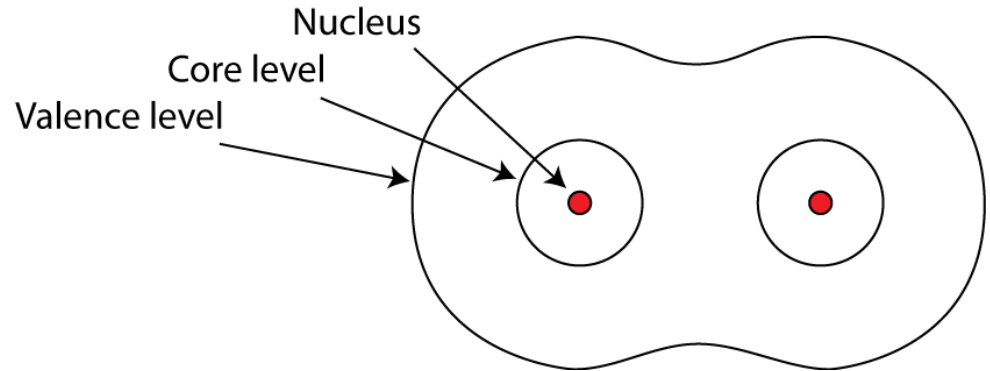
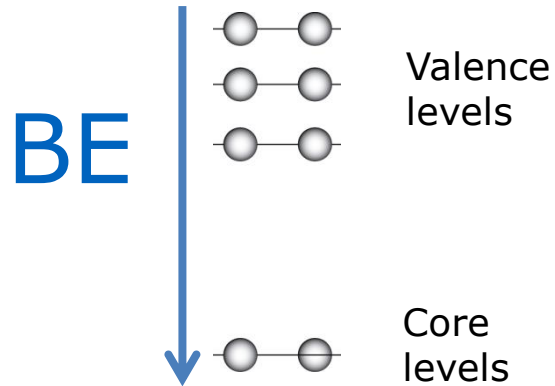
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# Scientific Instruments

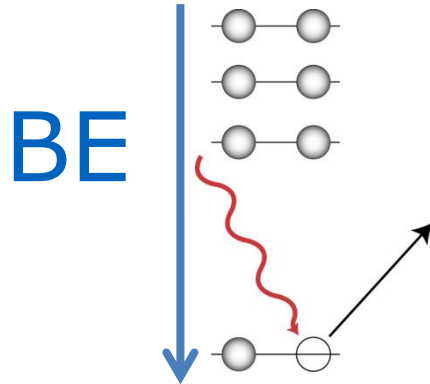


- 1981: Nobel Prize to Prof Siegbahn
- 1983: Prof Siegbahn co-founder of Scienta
- 1994: Parallel ARPES
- Today:
  - Global leader ARPES, HAXPES and APPES
  - Very active R&D
    - **Latest release: R4000 HiPP-3**

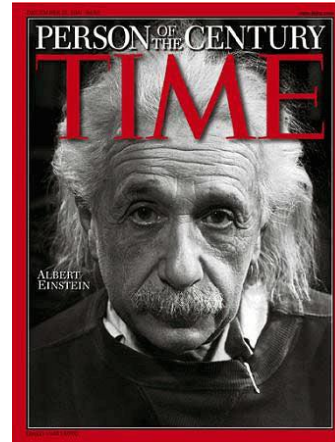
# Energy levels in the atom



# Phototelectron spectroscopy



$$BE = h\nu - E_k$$



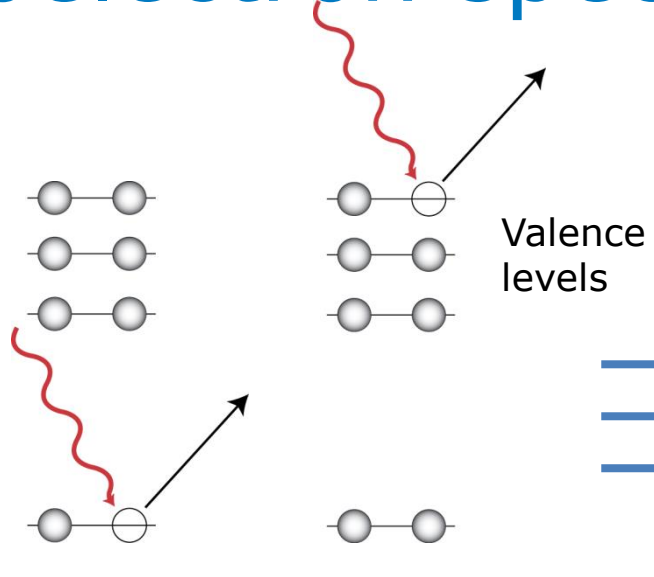
1921 Nobel Prize in Physics

# Photoelectron spectroscopy

HAXPES

APPES

XPS



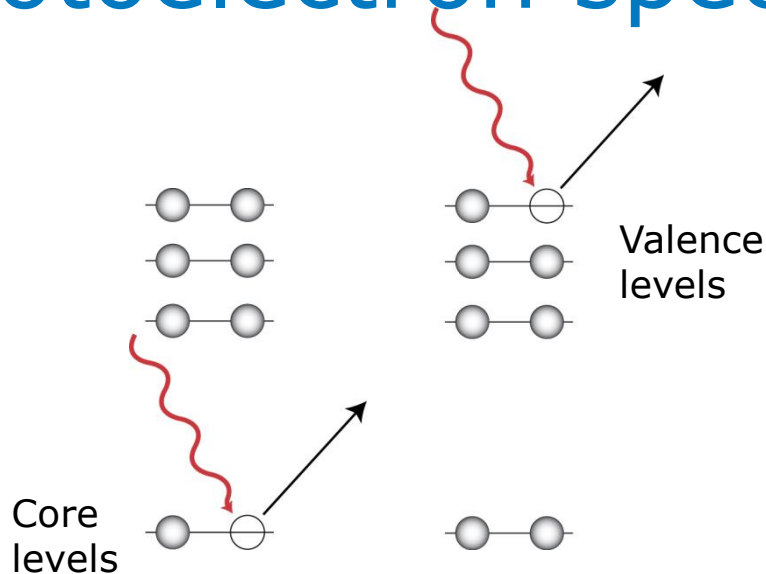
SARPES

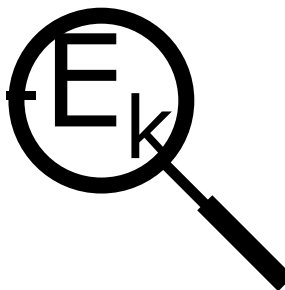
ARPES

UPS

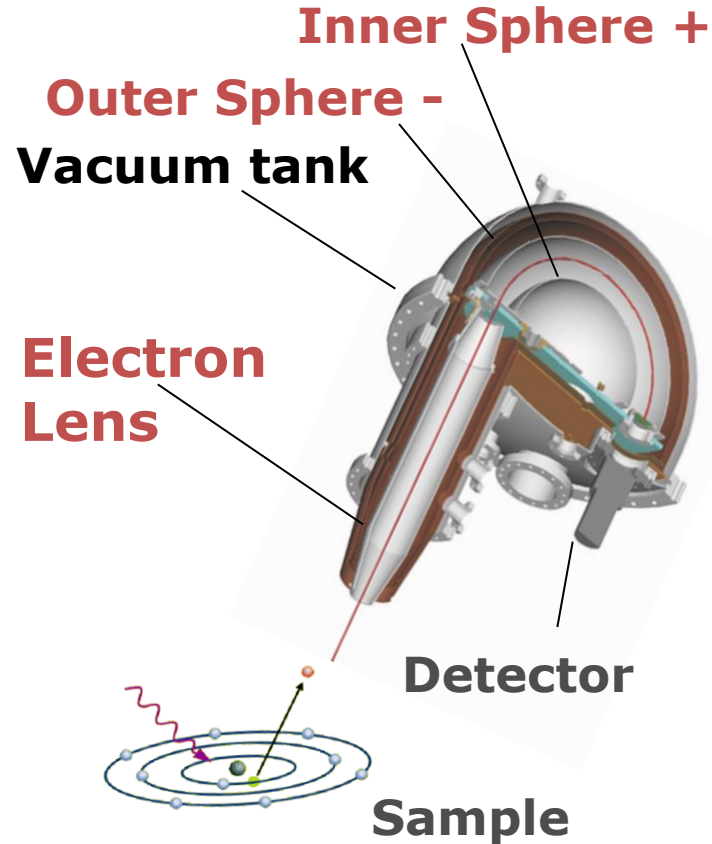
$$BE = h\nu - E_k$$

# Photoelectron spectroscopy



$$BE = h\nu - E_k$$


# Photoelectron spectroscopy



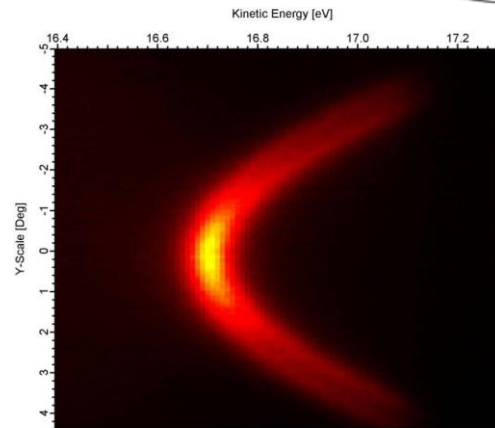
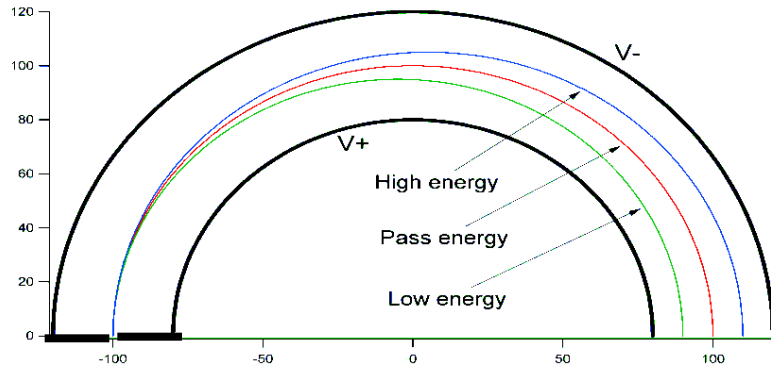
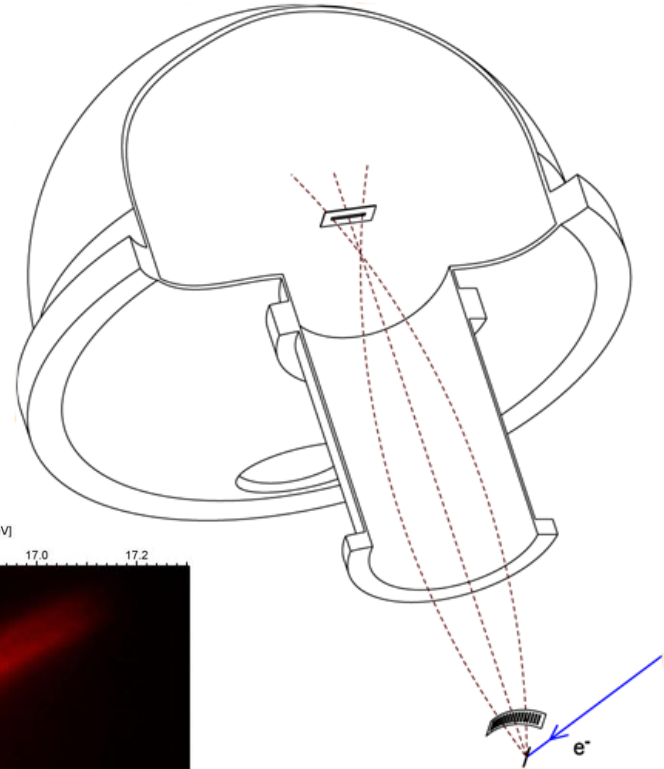




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# 2-D detection

- 2-D detector: 2 properties may be probed
- Energy perpendicular to slit
- Angle/Position along slit





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# Angular mode

- Angular mode enables parallel measurement of different emission angles
- This enables a number of powerful techniques without sample rotation:
  - Band structure measurements (bandmapping)
  - Depth profiling
  - X-ray photoelectron diffraction (XPD)
- Technique pioneered by VG Scienta in 1994
- VG Scienta still world leading in energy and angular resolution



**VG Scienta's Dr. Björn Wannberg** was the recipient of the American Physical Society Keithley award 2008: "*For advances in the development of angle-resolved electron analyzers for photoelectron spectroscopy.*"

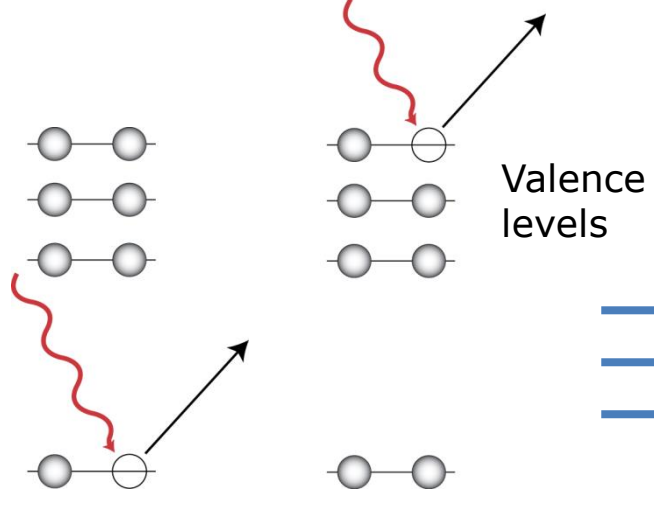


# Application areas

HAXPES

APPES

XPS



SARPES

ARPES

UPS

$$BE = h\nu - E_k$$

# Application areas

HAXPES

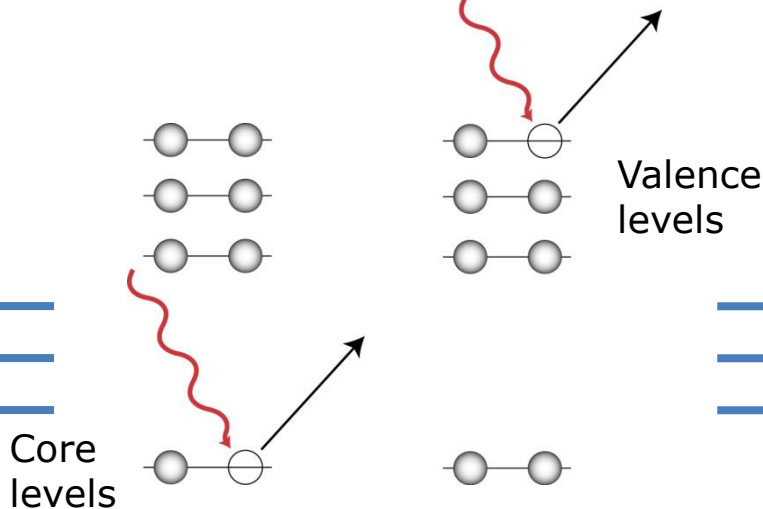
APPES

XPS

SARPES

ARPES

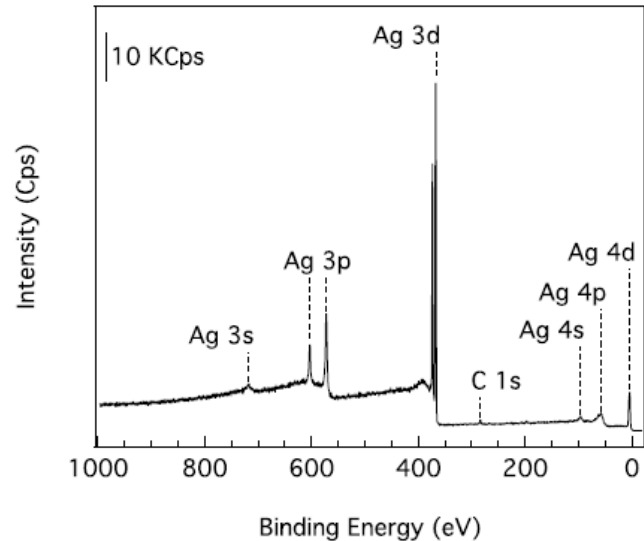
UPS



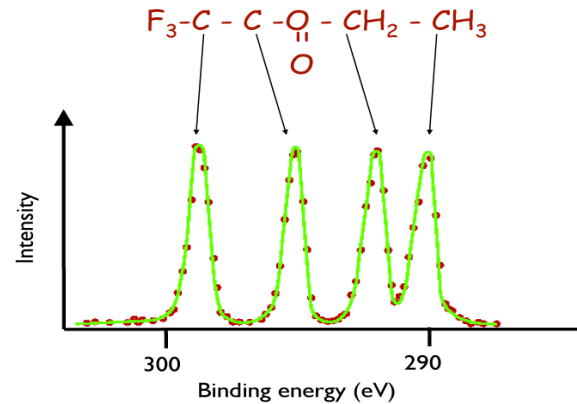
$$BE = h\nu - E_k$$

# XPS – X-ray Photoelectron Spectroscopy

Element and chemical state specific information



Data courtesy: F. Mangolini



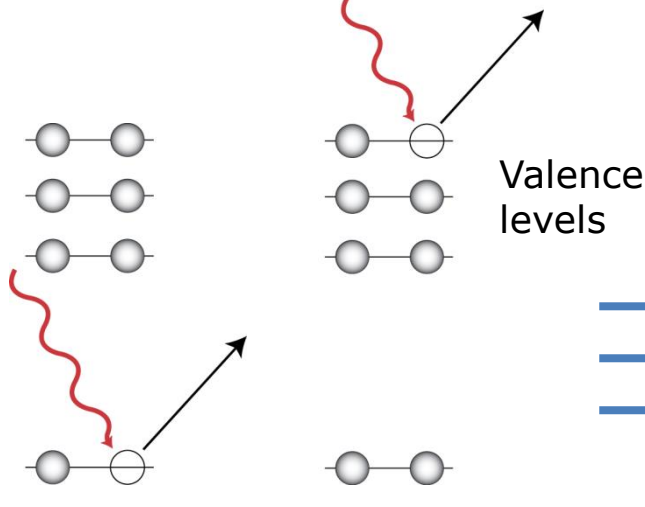
Siegbahn: "The ESCA molecule"

# Application areas

HAXPES

APPES

XPS



SARPES

ARPES

UPS

$$BE = h\nu - E_k$$



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# Ambient Pressure

- Traditional PES require UHV
- Some systems/processes can not be studied under UHV
  - Volatile samples prohibits UHV (gaseous samples, liquids)
  - Some processes are fundamentally different in higher pressures

Problems:

- Some components sensitive to high pressures (e.g. MCP)
- Electrons are scattered before reaching the detector
  - Differential pumping



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$10^{-13}$  mbar



$10^{-11}$  -  $10^{-1}$  mbar



1 - 5 mbar



$\sim 25$  mbar

$P_{\text{Water vapor}}$



1 bar

$P_{\text{Atmosphere}}$



Pressure

Catalysis



Water chemistry



Atmospheric chemistry



Liquid jet



Ionic liquids

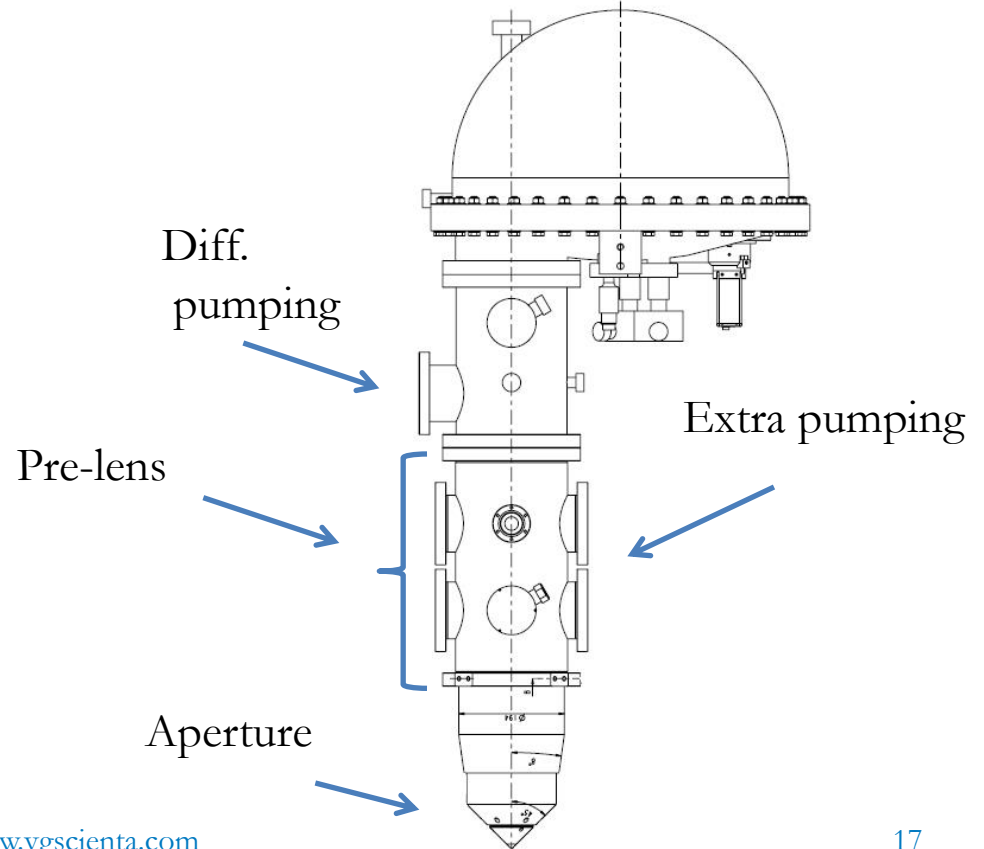
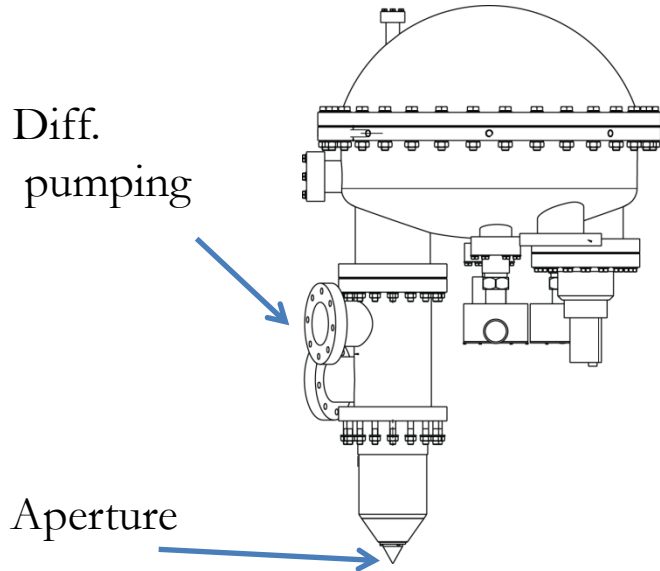




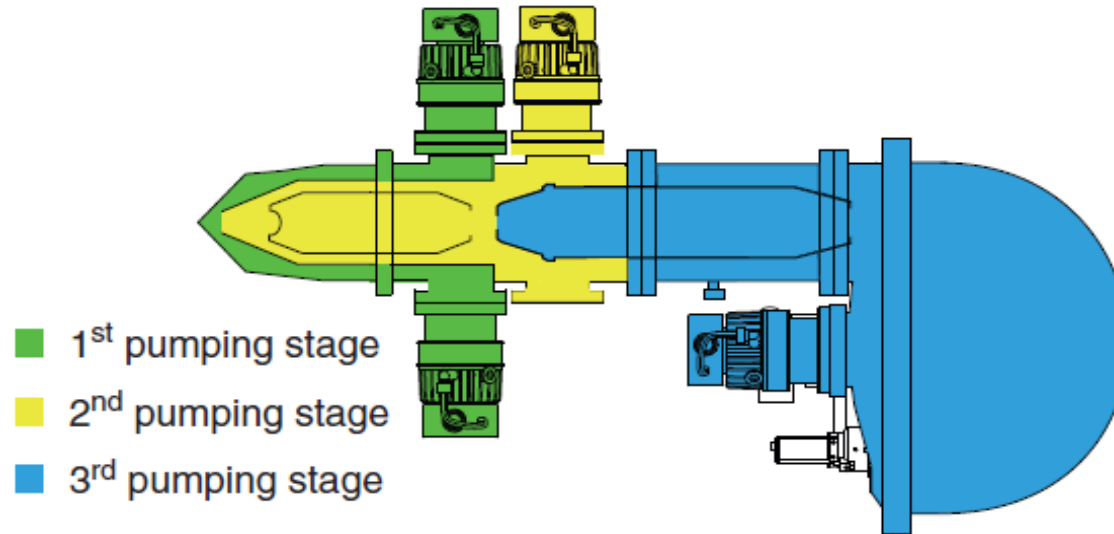
# Ambient Pressure Analysers

## R4000 HiPP-3

## R3000 HP



# Differential pumping stages

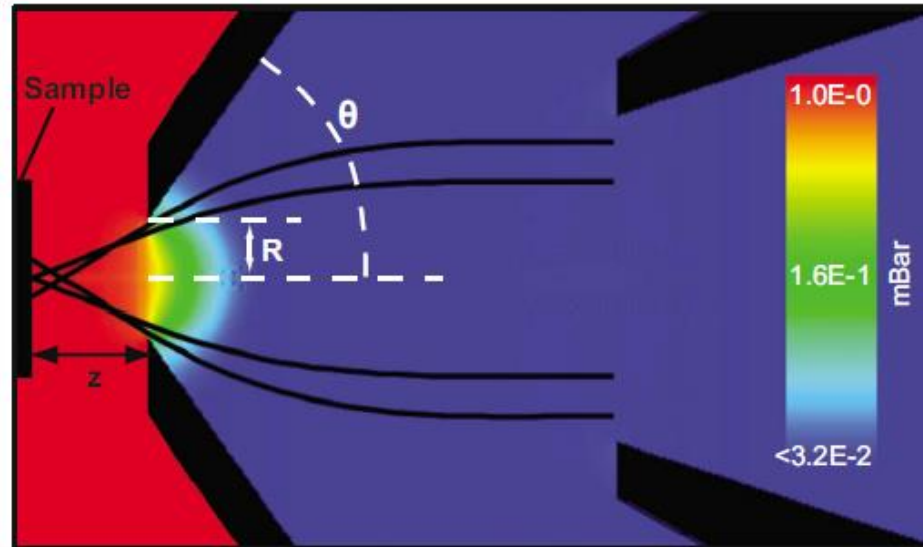




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# Differential pumping design

- The Scienta design provides very rapid pressure decrease
- Nodeless design
  - High transmission
  - Angular mode in full kinetic energy range





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$10^{-13}$  mbar



# Install Base

$10^{-11}$  -  $10^{-1}$  mbar



1 - 5 mbar



$\sim 25$  mbar

$P_{\text{Water vapor}}$



1 bar

$P_{\text{Atmosphere}}$



Suzuki SES-100

ALS HiPP

Nilsson SES-100

Pressure 

de Brito R4000 Spec.

**U Penn R3000 HP**

**Pune R3000 HP**

PSI HiPP-2

ALS HiPP-2

**Tokyo HiPP-2**

Spring-8 HiPP-2

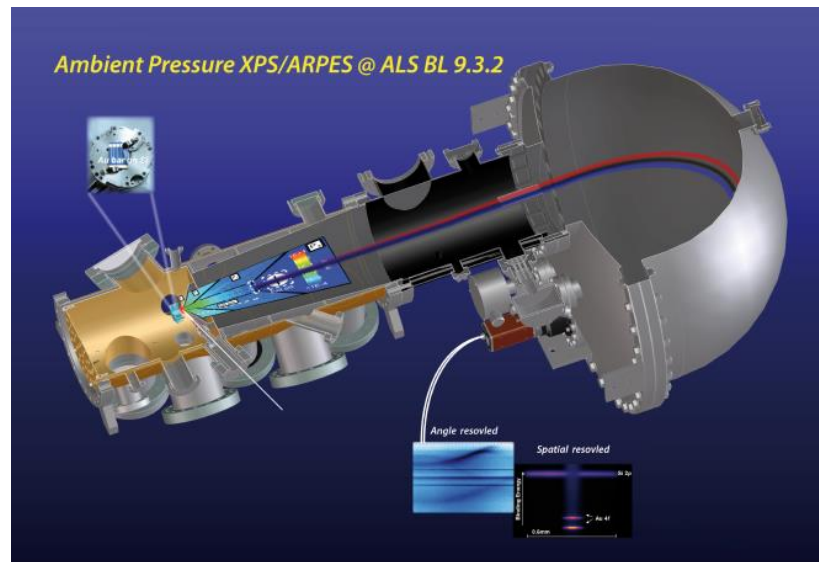
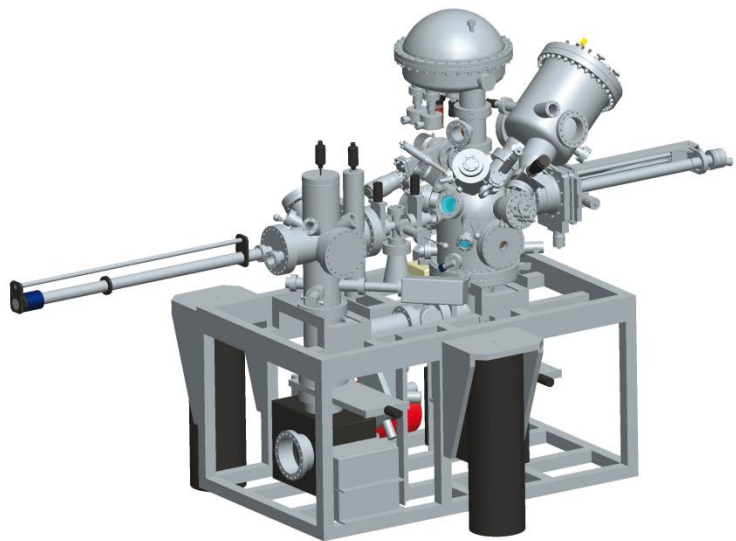
**Imp. Collage**

**HiPPlab**

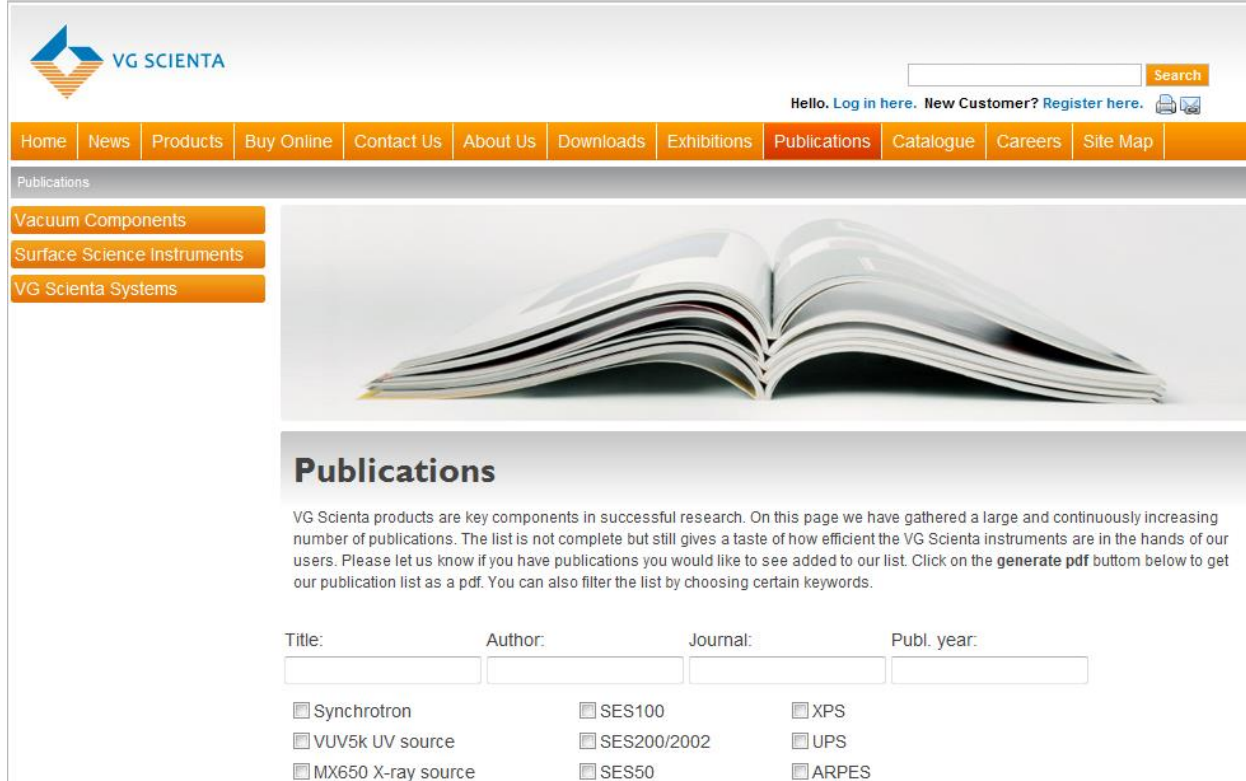
**FZ Jülich**

**HiPPlab**

# Install Base - examples





# Customer proven performance



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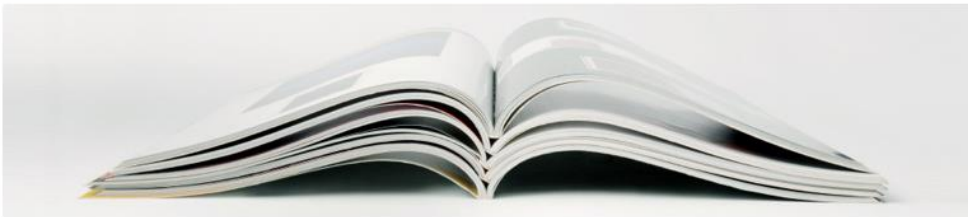
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Publications

Vacuum Components

Surface Science Instruments

VG Scienta Systems



## Publications

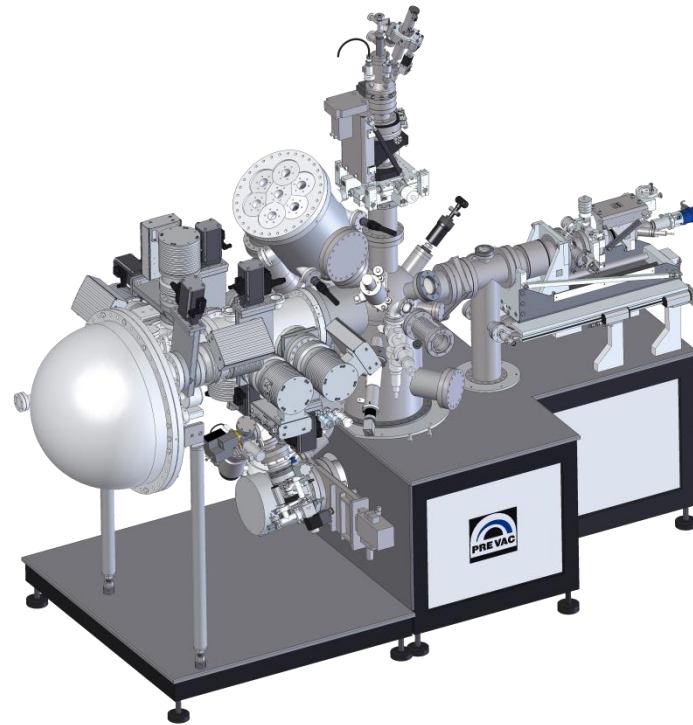
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 MX650 X-ray source       SES50       ARPES

<http://www.vgscienta.com/publicationlist.aspx>

# HiPP-3 System Solution





# Scienta R4000 HiPP-3

## New analyser for APPES+Imaging

- Based on Scienta R4000 HiPP-2
- Optimized for XPS energies ( $E_k < 1500$  eV) but available up to 6 keV
- Improved Swift Acceleration Mode
- Imaging XPS  $< 20$   $\mu\text{m}$

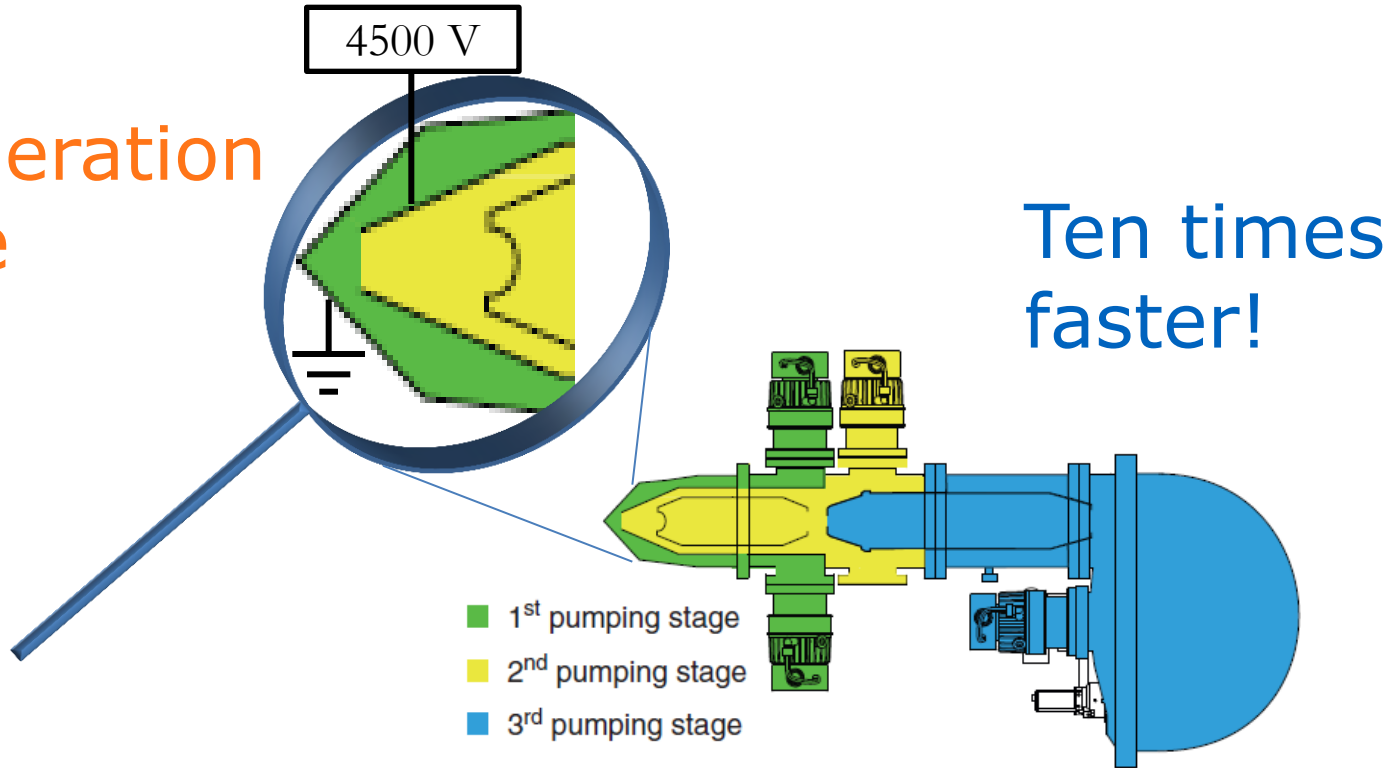




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# Scienta R4000 HiPP-3

Swift  
Acceleration  
Mode



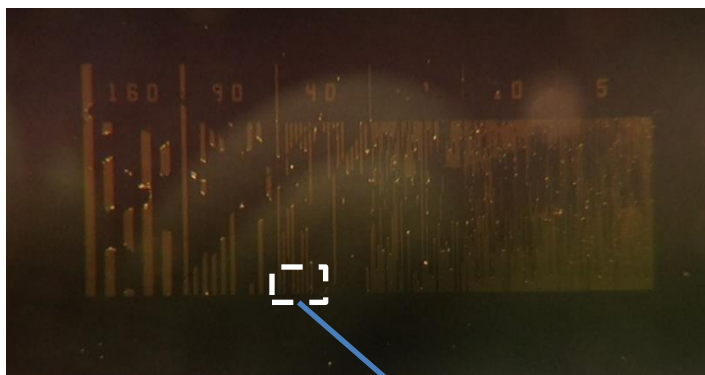


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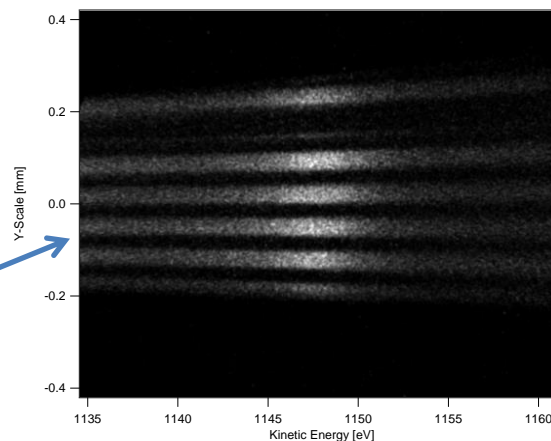
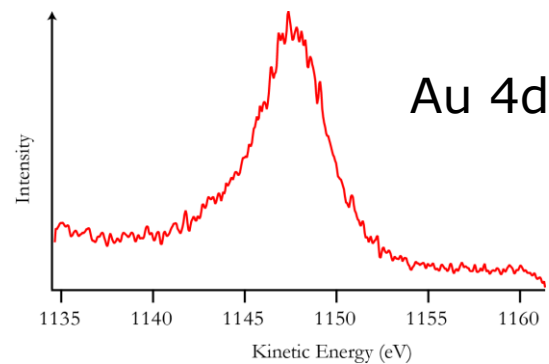
# Imaging XPS

- Spatial Resolution 20  $\mu\text{m}$
- Field of view 0.8 mm
- Step size 2.5  $\mu\text{m}$
  
- Parallel imaging in one direction

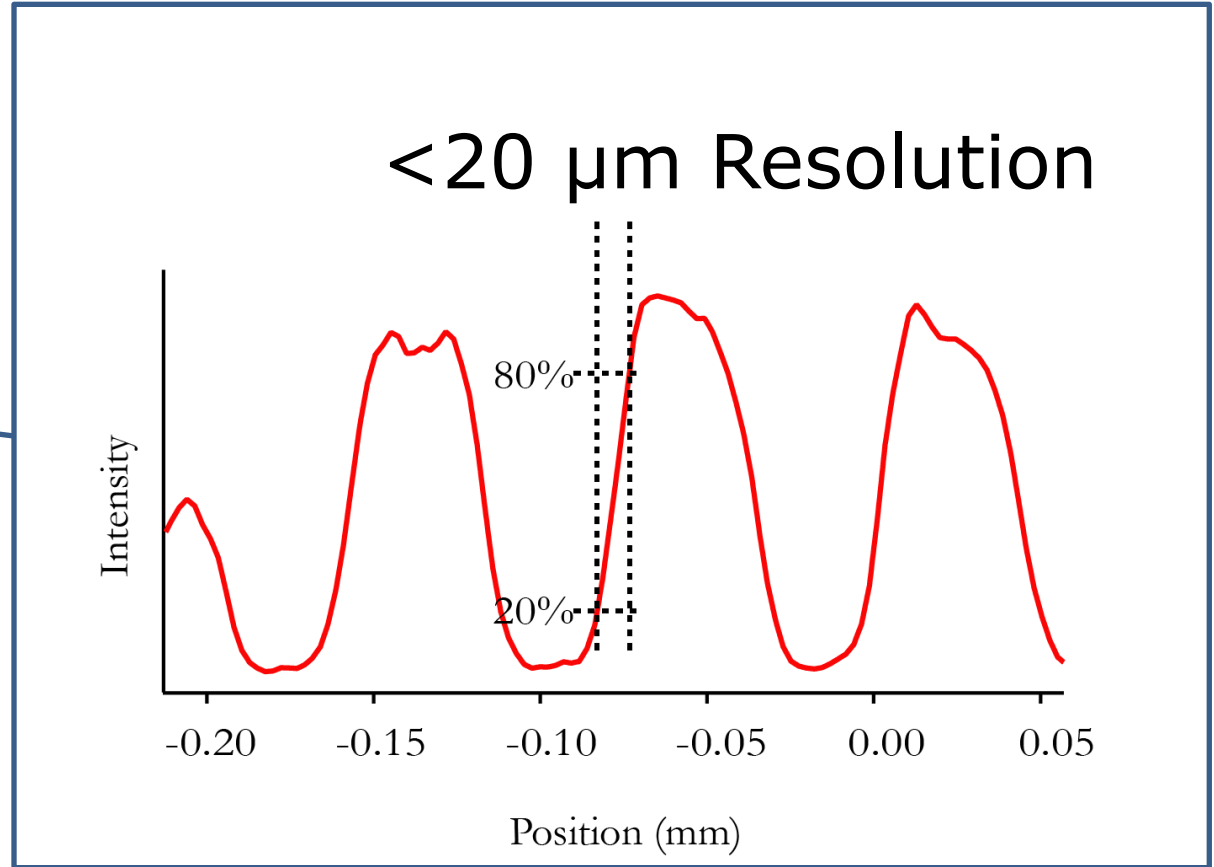
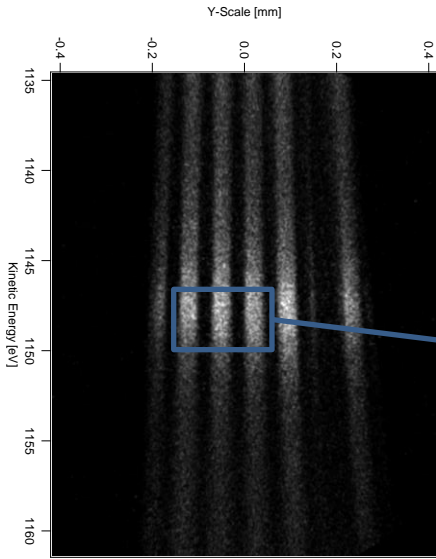
# Imaging XPS – first results



**Sample:**  
Si substrate with Au  
lines



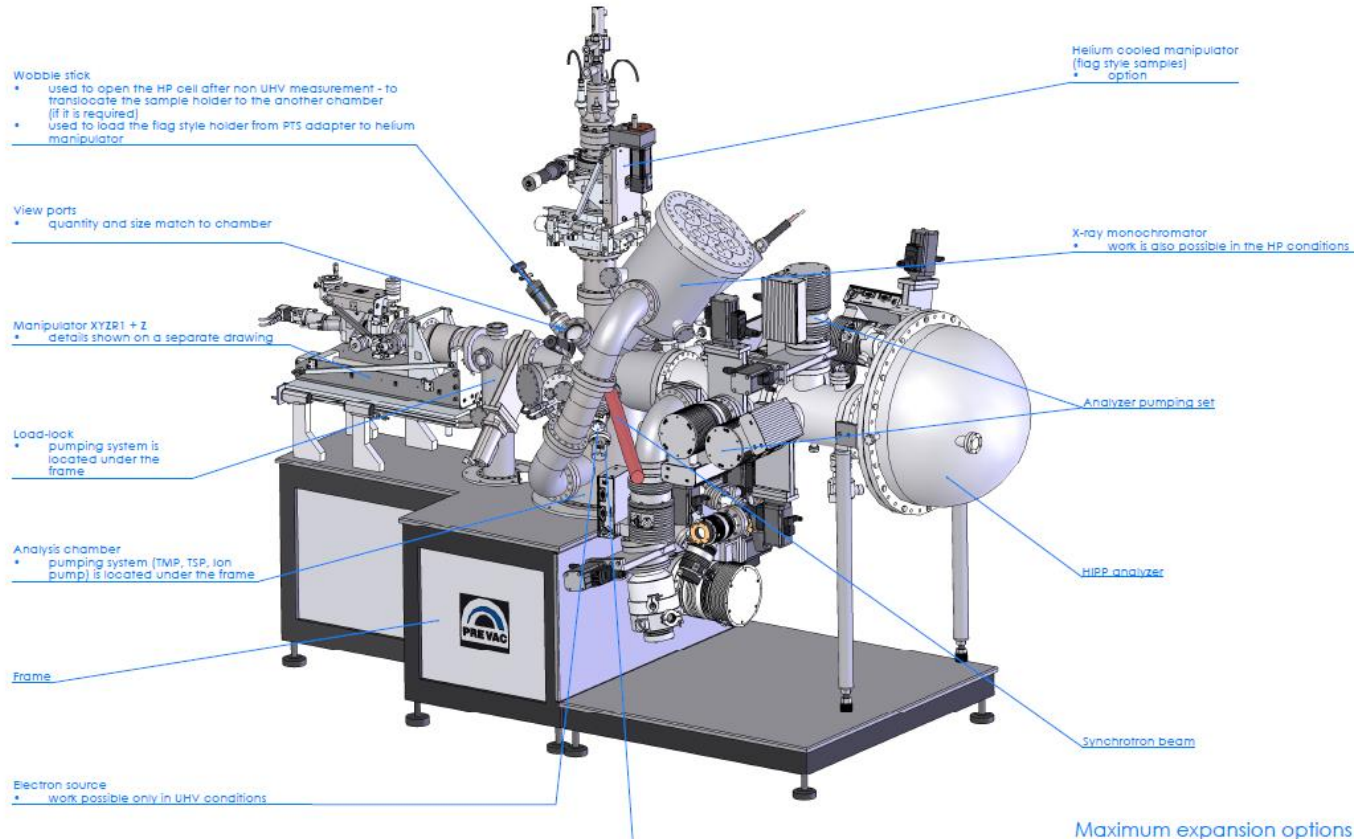
# Spatial Resolution





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# HiPP-3 System Solution





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# HiPP-3 HPGC

