

Experimental Equipment

1. Accelerators, Ion Implanters and Ion-Assisted-Deposition

⇒ Van de Graaff Accelerator	(VdG)	1.8 MV	TuR Dresden, DE
⇒ Tandem Accelerator	(Td)	5 MV	NIIEFA, RU
⇒ Tandetron Accelerator	(Tdt)	3 MV	HVEE, NL
⇒ Tandetron Accelerator (commissioning)		6 MV	HVEE, NL
⇒ Low-Energy Ion Implanter		0.5 - 50 kV	Danfysik, DK
⇒ High-Current Ion Implanter		20 - 200 kV	Danfysik, DK
⇒ High-Energy Ion Implanter		40 - 500 kV	HVEE, NL
⇒ Plasma Immersion Ion Implantation		5 - 60 keV	GBR, DE/Home-built
⇒ Focused Ion Beam (15 nm, variable ions)		30 keV, 10 A/cm ²	Orsay Physics, FR
⇒ Highly-Charged Ion Facility		25 eV - 25 keV × Q	Home-built
		Q = 1...40 (Xe)	
⇒ Dual-Beam Magnetron Sputter Deposition			Roth & Rau, DE
⇒ Ion-Beam-Assisted Deposition			Danfysik, DK
⇒ Ion-Beam Sputtering		200 - 2000 V	Home-built
⇒ UHV Ion Irradiation (Ar, He, etc.)		0 - 5 keV	VG, USA
		Scan 10×10 mm ²	

2. Ion Beam Analysis (IBA)

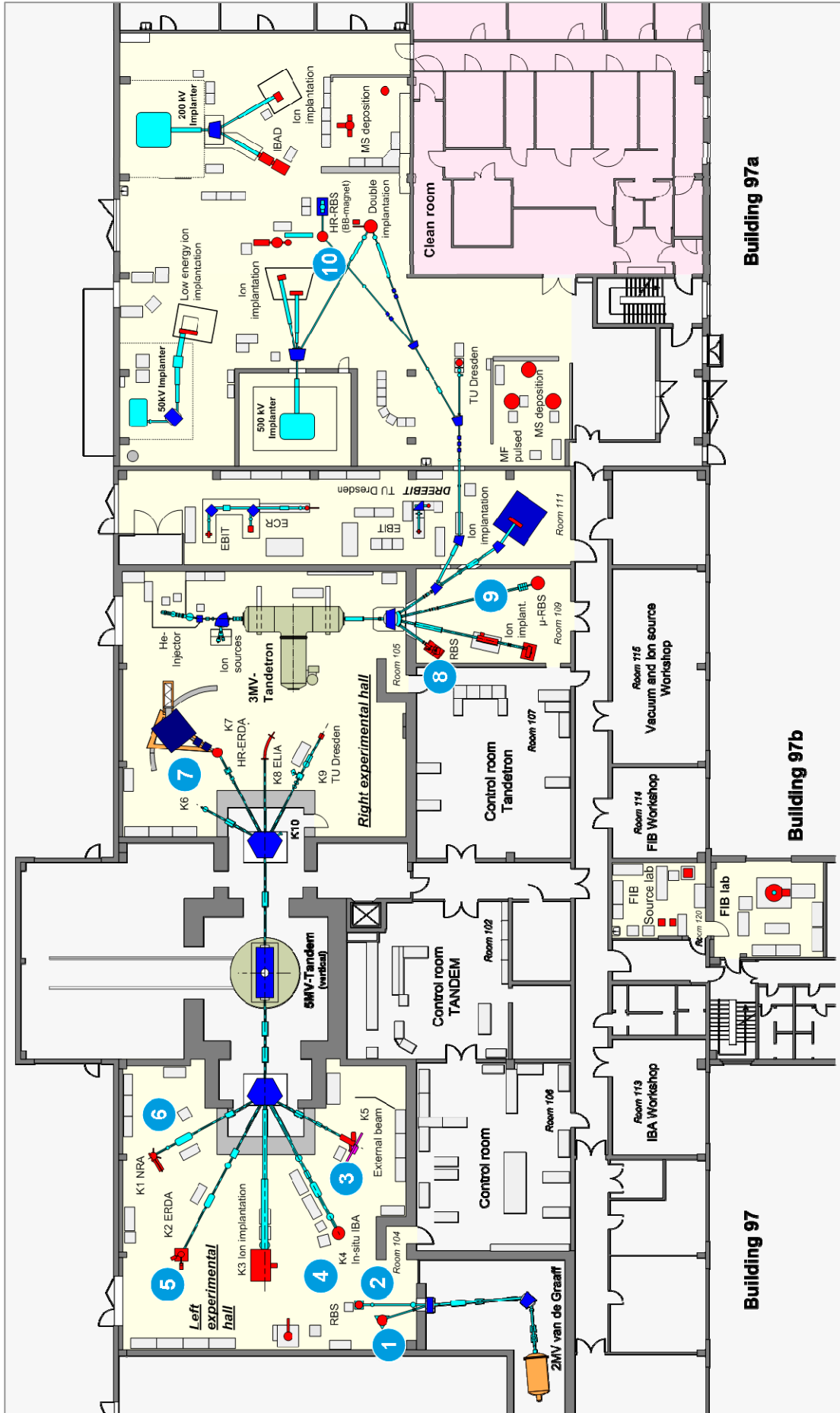
A wide variety of advanced IBA techniques are available at the MeV accelerators (see figure).

⇒ RBS	Rutherford Backscattering	(1), (2), (3), (8)	VdG, Td, Tdtr
⇒ RBS/C	RBS + Channelling	(1), (2), (3), (8)	VdG, Td, Tdtr
	High-Resolution RBS/C	(7), (10)	Tdtr
⇒ ERDA	Elastic Recoil Detection Analysis	(2), (4), (5)	VdG, Td
	High-resolution ERDA	(7)	Td
⇒ PIXE	Proton-Induced x-ray Emission	(3)	Td
⇒ PIGE	Proton-Induced γ Emission	(3)	Td
⇒ NRA	Nuclear Reaction Analysis	(4)	Td
⇒ NRRA	Nuclear Resonance Reaction Analysis	(6)	Td
⇒ N μ P	Nuclear Microprobe	(9)	Tdtr
⇒ AMS	Accelerator Mass Spectrometry	(commissioning)	
	(focused to cosmogenic radionuclides: ¹⁰ Be, ²⁶ Al, ³⁶ Cl, ⁴¹ Ca, ¹²⁹ I)		

Some stations are equipped with additional process facilities which enable *in-situ* IBA investigations during ion irradiation, sputtering, deposition, annealing etc.

3. Other Particle Based Analytical Techniques

⇒ SEM	Scanning Electron Microscope	1 - 30 keV + EDX	Hitachi, JP
⇒ TEM	Transmission Electron Microscope (Titan 80-300 with Image Corrector)	80 - 300 keV + EDX, +GIF	FEI, NL
⇒ FIB/SEM	Focused Ion / Electron Cross Beam (NVision 40 with Elphy Plus Litho)	0.5 - 30 keV + IL, + EDX	Zeiss-NTS, DE Raith, Bruker, DE
⇒ AES	Auger Electron Spectroscopy	+ XPS	Fisions, UK
⇒ CEMS	Mössbauer Spectroscopy	⁵⁷ Fe source	Home-built
⇒ PAS	Positron Annihilation Spectroscopy	²² Na source 30 V - 36 kV	Home-built



Ion Beam Centre: Schematic Overview of Installations.

4. Photon Based Analytical Techniques

⇒	XRD/XRR	X-Ray Diffraction and Reflection	Cu-K α	Bruker axs, DE
	HR-XRD	High-Resolution XRD	Cu-K α	GE Inspection, DE
⇒	XRD/XRR	with Synchrotron Radiation	5 - 35 keV	ROBL at ESRF, FR
⇒	SE	Spectroscopic Ellipsometry	250 - 1700 nm	Woolam, US
⇒	FTIR	Fourier-Transform Infrared Spectr.	600 - 7000 cm $^{-1}$	Nicolet, US
⇒	FTIR	Fourier-Transform Infrared Spectr.	50 - 15000 cm $^{-1}$	Bruker, DE
⇒		Ti:Sapphire Femtosecond Laser		Spectra Physics, US
⇒		Femtosecond Optical Parametric Osci.		APE, DE
⇒		Ti:Sapphire Femtosecond Amplifier		Femtolasers, AT
⇒		Femtosecond Optical Parametric Amplifier		Light Conversion, LI
⇒	THz-TDS	Terahertz Time-Domain Spectroscopy	0.1 - 4 THz	Home-built
⇒	Raman	Raman Spectroscopy	45 cm $^{-1}$ shift	Jobin-Yvon-Horiba, FR
⇒	PL	Photoluminescence	300 - 1500 nm	Jobin-Yvon-Horiba, FR
⇒	TRPL	Time-Resolved PL	$\tau = 3$ ps - 2 ns $\tau > 5$ ns	Hamamatsu Phot., JP Stanford Research, US
⇒	EL	Electroluminescence (10-300 K)	300 - 1500 nm	Jobin-Yvon-Horiba, FR
		Optical Split-Coil Supercond. Magnet	7 T	Oxford Instrum., UK
⇒	PR	Photomodulated Reflectivity	300 - 1500 nm	Jobin-Yvon-Horiba, FR
⇒	PLE	Photoluminescence Excitation	300 - 1500 nm	Jobin-Yvon-Horiba, FR

5. Magnetic Thin Film Deposition and Analysis

⇒	MBE	Molecular Beam Epitaxy with in-situ FIB		CreaTec, DE
⇒	MBE	Molecular Beam Epitaxy		Home-built
⇒	PLD	Pulsed Laser Deposition		SURFACE, DE
⇒	MFM	Magnetic Force Microscope	~ 50 nm resol.	VEECO / DI, US
⇒	SQUID	Supercond. Quantum Interf. Device	± 7 T	Quantum Design, US
⇒	MOKE	Magneto-Optic Kerr Effect (in-plane)	± 0.35 T	Home-built
⇒	MOKE	Magneto-Optic Kerr Effect (perpend.)	± 2 T	Home-built
⇒	SKM	Scanning Kerr Microscope		Home-built
⇒		Kerr Microscope		Evico Magnetics, DE
⇒	TR-MOKE	Time-Resolved MOKE (Pump-Probe)		Home-built
⇒	VNA-FMR	Vector Network Analyzer Ferromagnetic Resonance		Agilent / Home-built
⇒	ME	Magnetoellipsometer		LOT, DE; AMAC, US

6. Other Analytical and Measuring Techniques

⇒	STM	Scanning Tunneling Microscope (with AFM-Option)		DME, DK
⇒	STM	<i>In-situ</i> Scanning Tunneling Microscope (T variable)		Omicron, DE
⇒	AFM	Atomic Force Microscope (Tapping Mode)		SIS, DE
⇒	AFM	Atomic Force Microscope (with c-AFM, SCM-Module)		Veeco Instruments, UK
⇒	KFM	Kelvin Probe Force Microscopy		Anfatec, DE
⇒		Dektak Surface Profilometer		Veeco, US
⇒		Micro Indenter / Scratch Tester		Shimatsu, JP
⇒		Wear Tester (pin-on disc)		Home-built
⇒	HE	Hall Effect Equipment	(2 - 400 K, ≤ 9 T)	LakeShore, US
⇒	RS	Sheet-Rho-Scanner		AIT, South Korea
⇒	DLTS	Deep Level Transient Spectroscopy	(+ I-U / C-V) (10 - 300 K, 1 MHz)	PhysTech, DE
⇒		Photocapacitance (+I-U/G-V)	(250 - 2500 nm)	Home-built
⇒		I-V and C-V Analyzer		Keithley, US

⇒	I-V and C-V Semi-Automatic Prober	(-60 – 300°C)	<i>Süss, DE; Keithley, US</i>
⇒	I-V Prober	(4.2 – 600 K)	<i>LakeShore, Agilent, US</i>

7. Processing and Preparation Techniques

⇒	Physical Deposition	Sputtering DC / RF, Evaporation Electron Beam Evaporation System Thermal Evaporation	<i>Nordiko, UK</i> <i>Leybold Optics, DE</i> <i>Bal-Tec, LI</i>
⇒	Chemical Deposition	Plasma Enhanced CVD (for a-Si, SiO ₂ , SiON, Si ₃ N ₄)	<i>Oxford Instruments, UK</i>
⇒	Dry Etching	Plasma and RIE Mode	<i>Sentech, DE</i>
⇒	Reactive Ion Beam Etching	Ø 6", Ar, CF ₄	<i>Roth & Rau, DE</i>
⇒	Etching / Cleaning	incl. Anisotropic Selective KOH Etching	
⇒	Photolithography	Mask-Aligner, 2 µm-level	<i>Süss, DE</i>
⇒	Electron Beam Lithography	Raith 150-TWO: Ø 6", 10 nm res.	<i>Raith, DE</i>
⇒	Thermal Treatment	Room Temperature - 2000°C	
	• Furnace		<i>InnoTherm, DE</i>
	• Rapid Thermal Annealing		<i>ADDAX, FR</i>
	• Flash-Lamp Units (0.5 – 20 ms)		<i>Home-built; FHR, DE</i>
	• RF Heating (Vacuum)		<i>JIP.ELEC, FR</i>
⇒	Bonding Techniques	Ultrasonic Wire Bonding	<i>Kulicke & Soffa, US</i>
⇒	Cutting, Grinding, Polishing		<i>Bühler, DE</i>
⇒	TEM Sample Preparation	Plan View and Cross Section incl. Ion Milling Equipment	<i>Gatan, US</i>