Microscopia elettronica oltre la nanoscala
come vedere gli atomi (e cosa c'è oltre)

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Lo sviluppo delle nanoscienze e la didattica universitaria di base

S
Mo
1Å

Outline

- Strumenti (TEM convenzionale, probe-corrected)
- Spettroscopia EDS
- Spettroscopia EELS

Conventional TEMs

JEOL JEM 2010F
Ultra High Resolution microscope

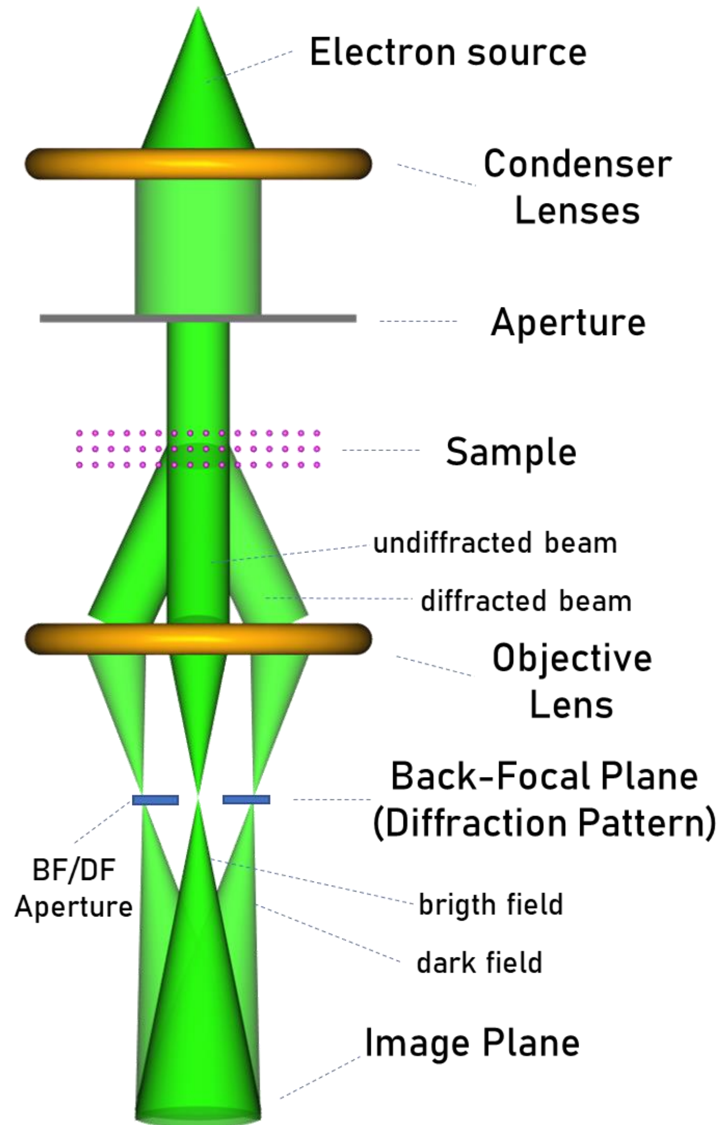
- 200 KeV FEG emitter
- GIF 2001 with advanced STEM EFTEM/ EELS spectrum-imaging package
- BF/HAADF STEM detectors

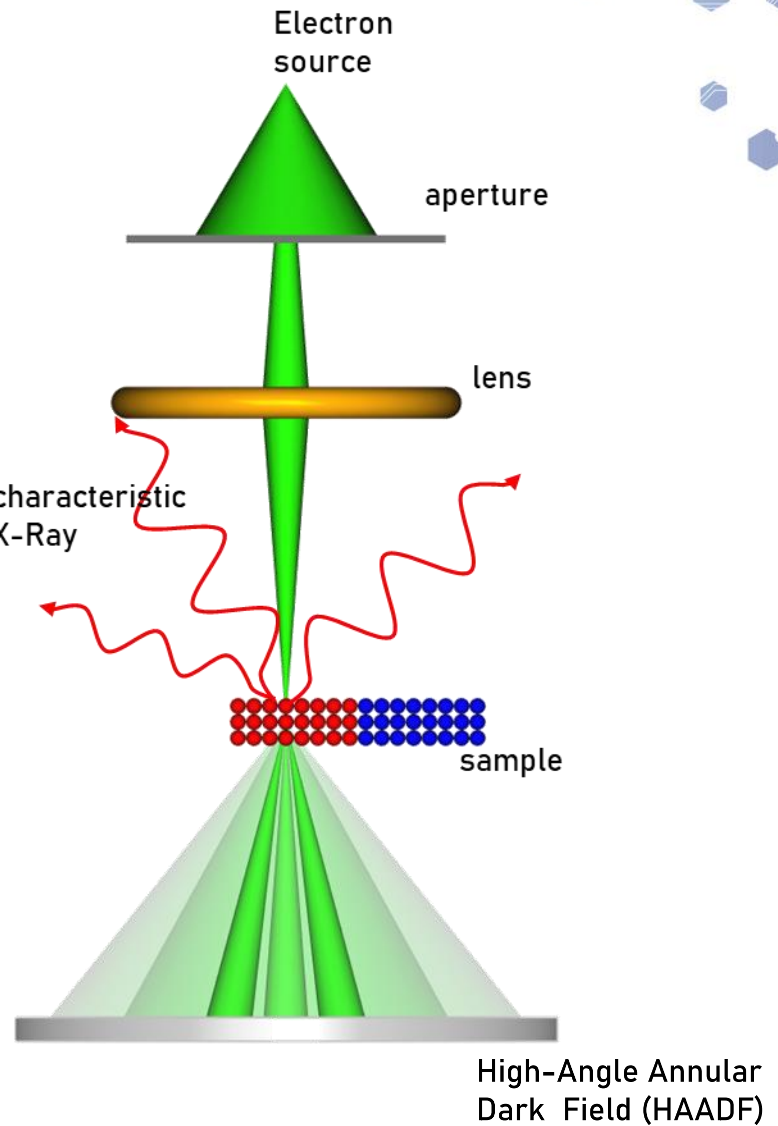
JEOL JEM 2010
High Resolution Microscope

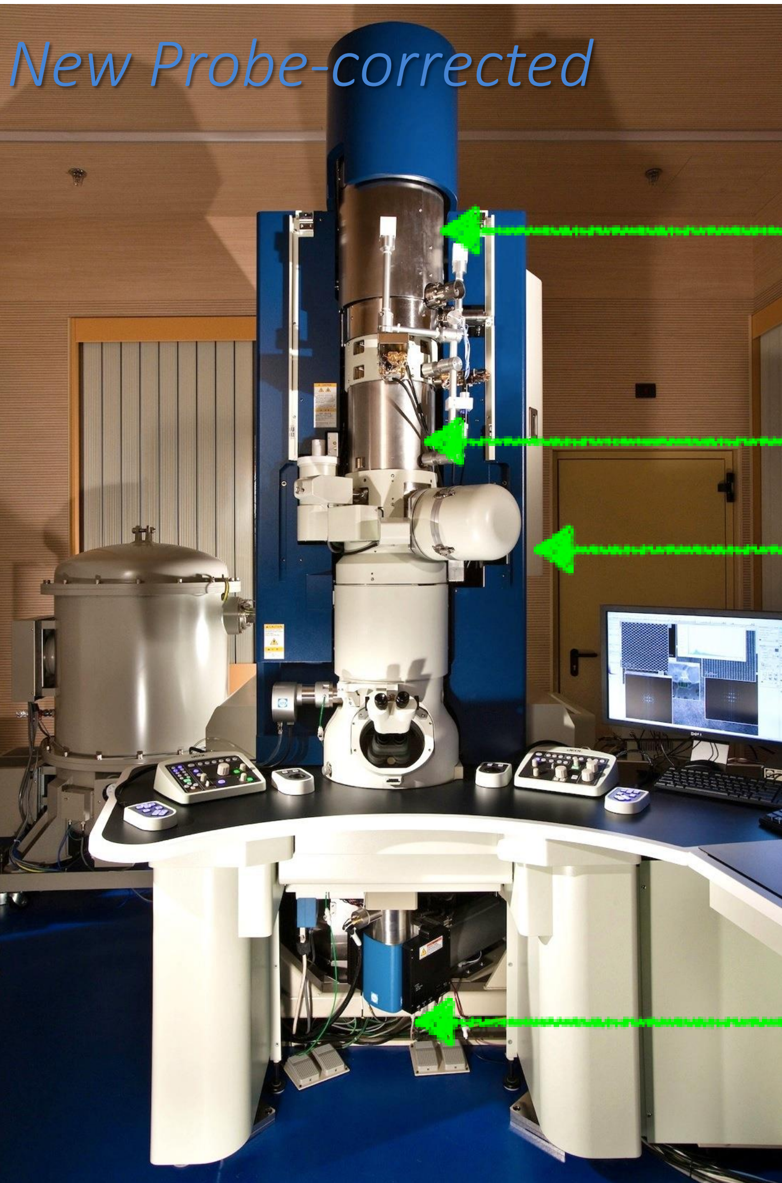
- 200 KeV LaB6 emitter
- LN_2 EDS Oxford x-sight 6498 res 136eV

TEM

STEM







JEOL ARM 200F Specification

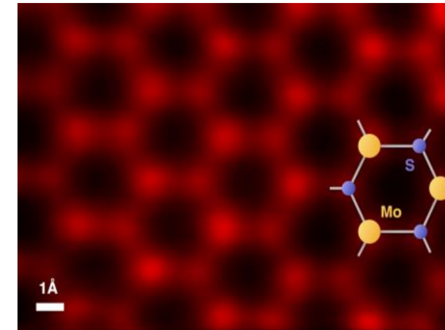
Cold-FEG
energy spread 0.3 eV FWHM at 200 kV

electron acceleration voltage range between 40 and 200 KeV

Cs corrector on the probe

CEOS CESCOR hexapole, resolution of 68 picometers

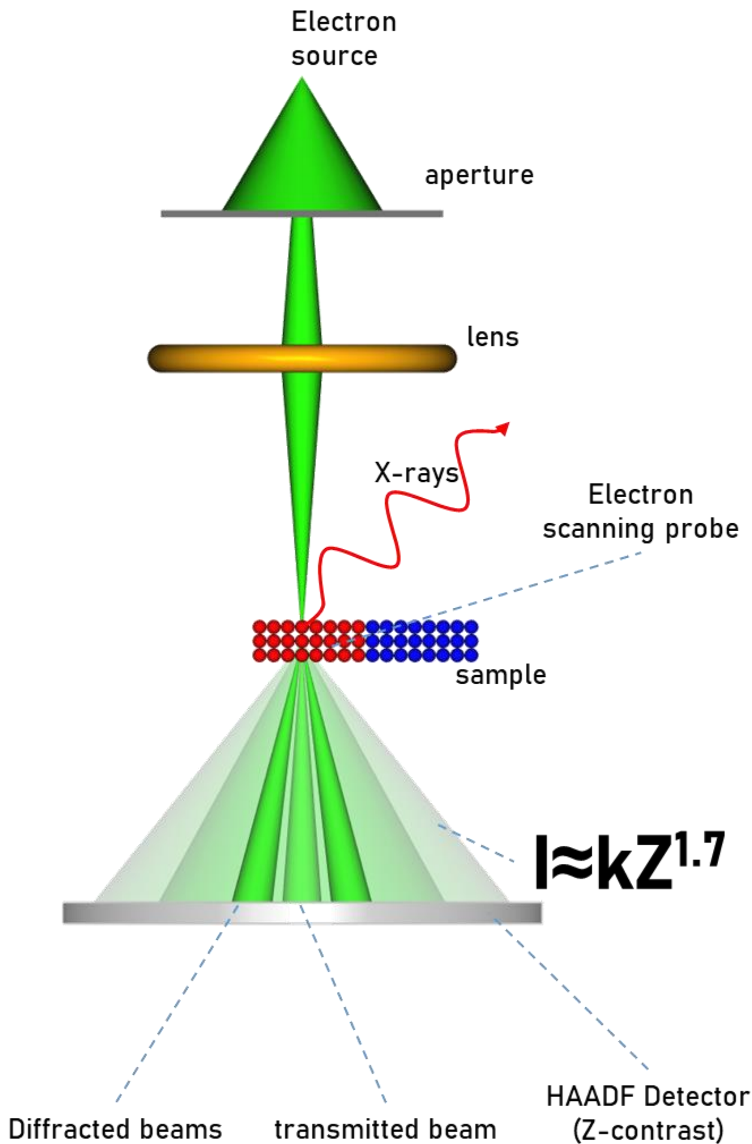
EDX detector 100mm^2, 0.98sr

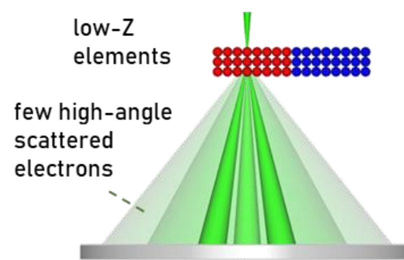


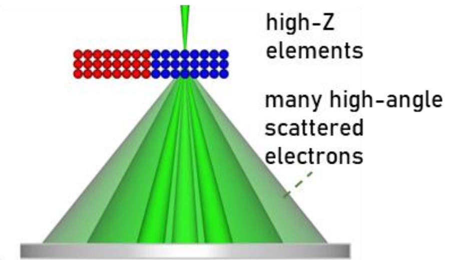
Gatan GIF Quantum ER fully loaded for EFTEM and Fast EELS and Fast EDX able to acquire up to 1500 /s

Beyond
NANO
Catania
EM Italian Facility

STEM: Working principle





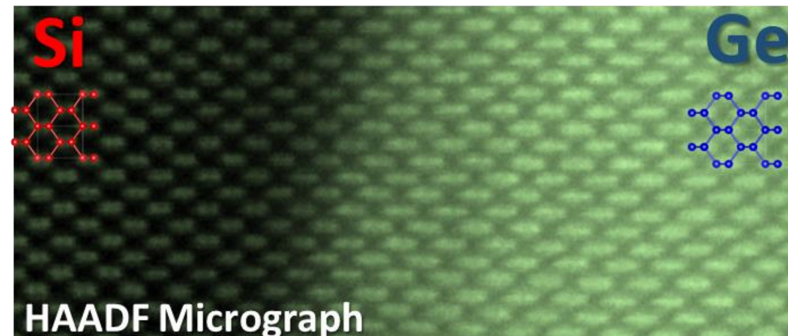


$Z^{1.7}{}_{Si}=89$

$Z^{1.7}{}_{Ge}=362$

Low HAADF Signal

High HAADF Signal

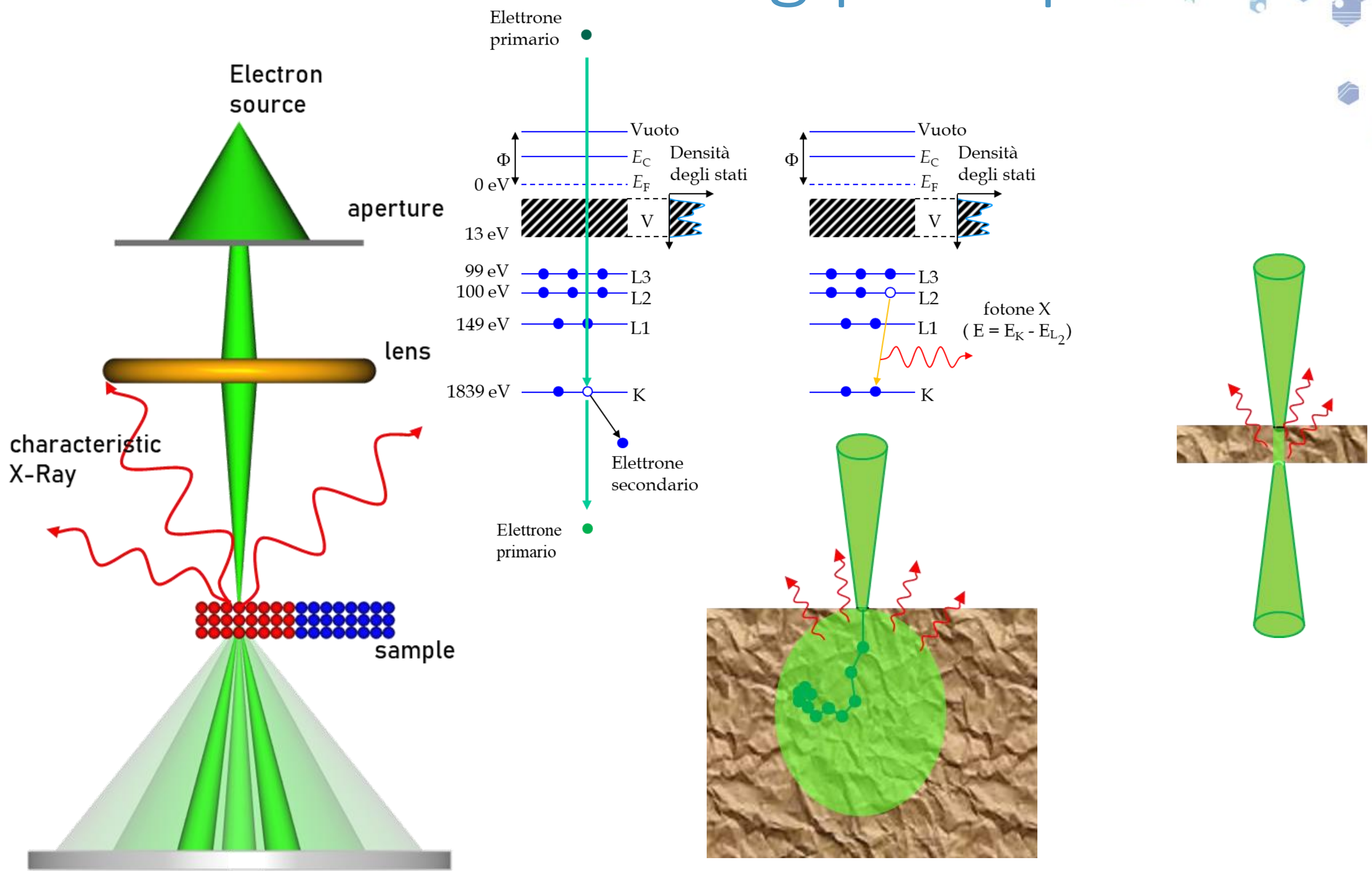


Tecniche spettroscopiche

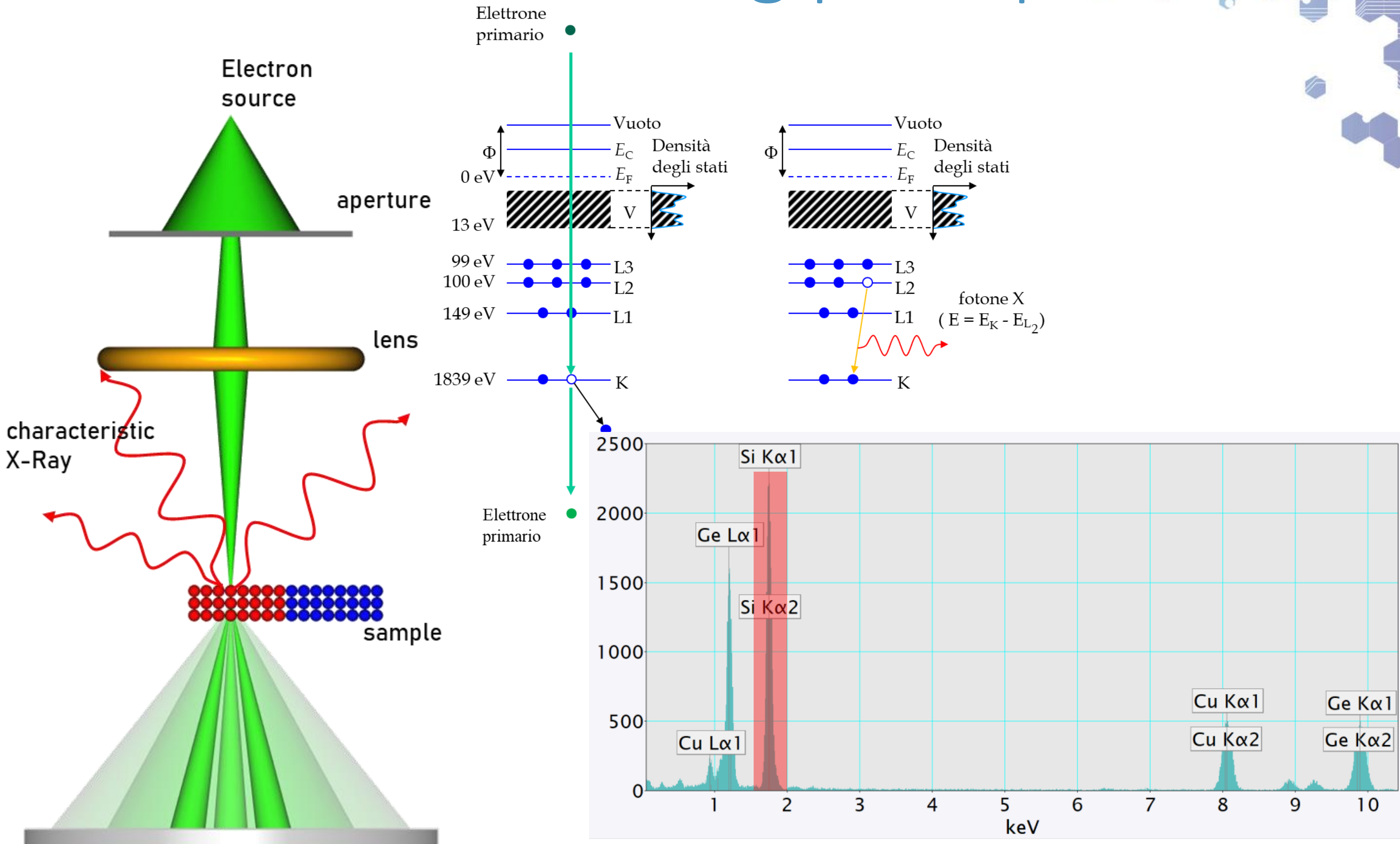
Energy Dispersive X-ray Analysis (EDS o EDX)

IMM Institute for Microelectronics and Microsystems
Consiglio Nazionale delle Ricerche

STEM-EDS: Working principle



STEM-EDS: Working principle



Multishell GaAs/AlGaAs NWs: polarity driven nanofacets evolution

Scuderi, M et al. (2016). III-V core-multishell nanowire heterostructures: nanofacets evolution, shell thickness change and compositional segregation. In *NanoSEA 2016*

Al segregation dependence from nanofaceting

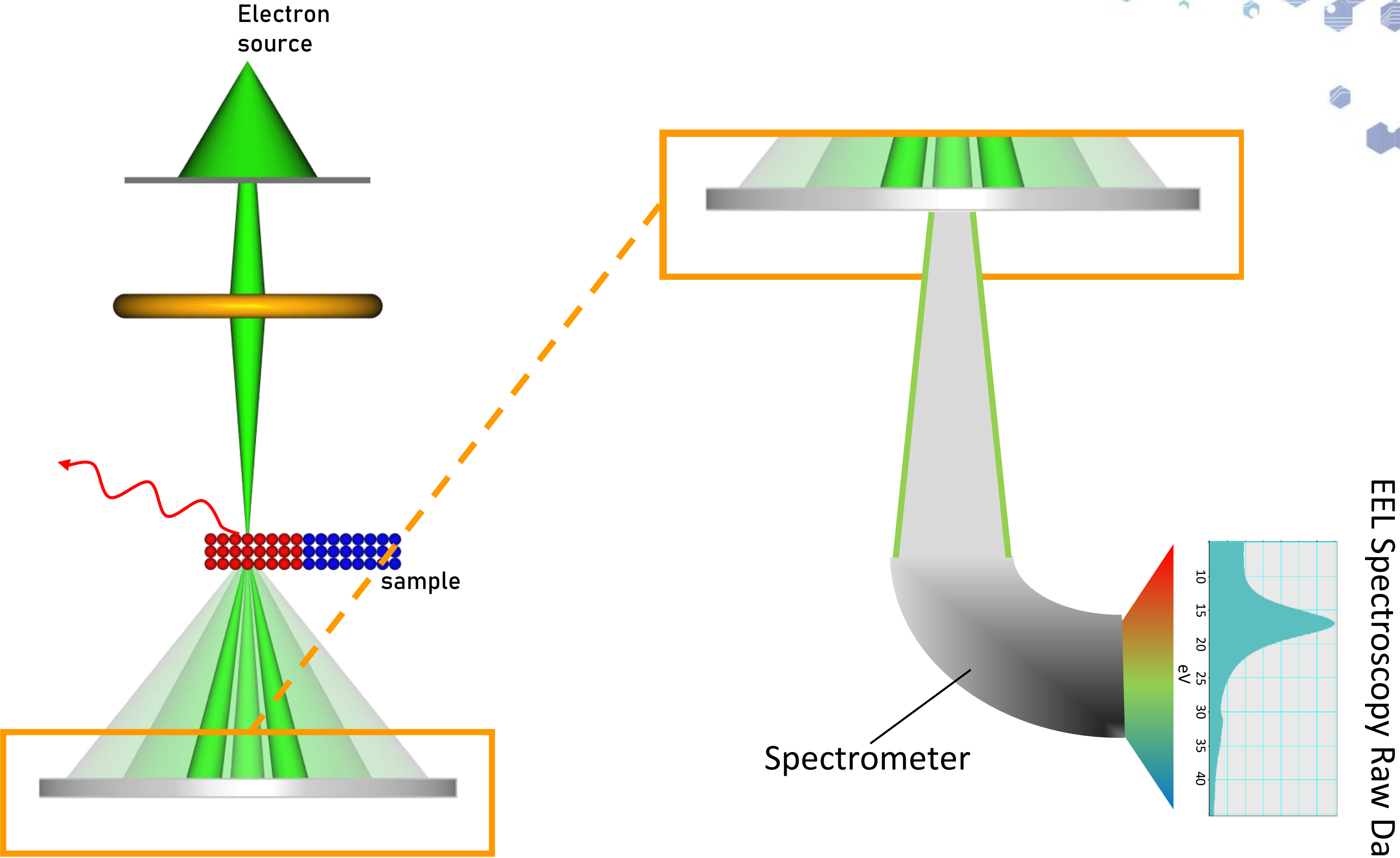
Courtesy of Mario Scuderi and Giuseppe Nicotra

Tecniche spettroscopiche

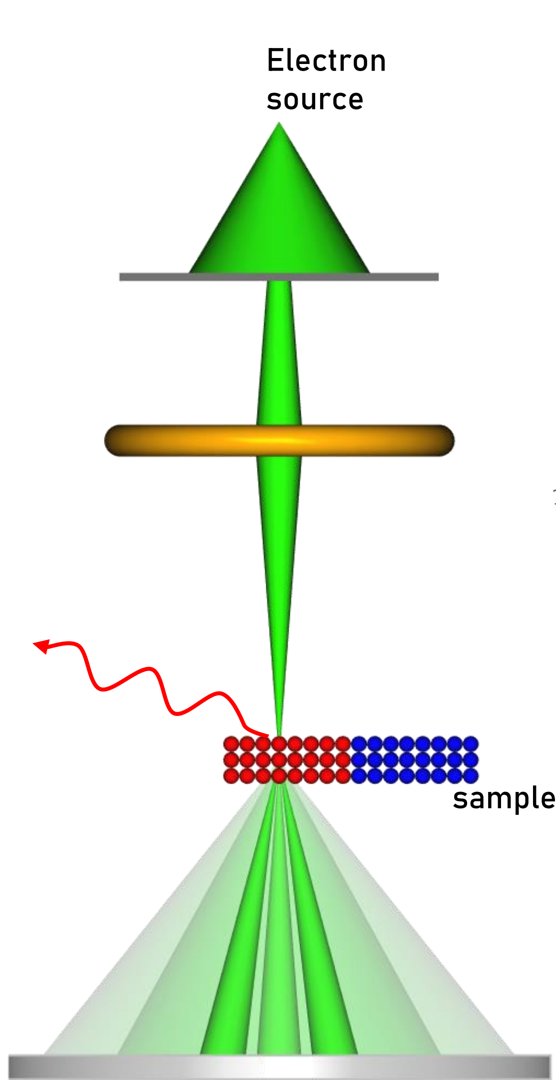
Electron Energy Loss Spectroscopy (EELS)

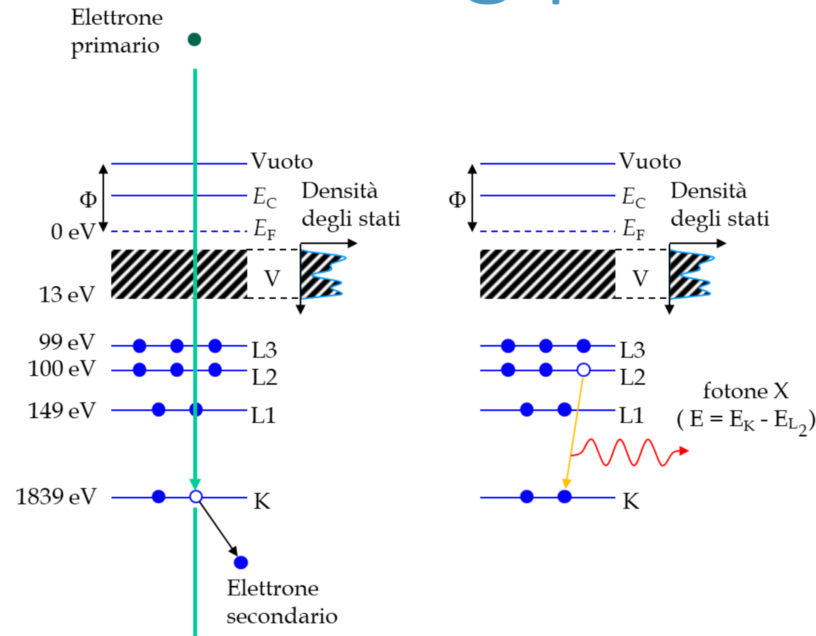
IMM Institute for Microelectronics and Microsystems
Consiglio Nazionale delle Ricerche

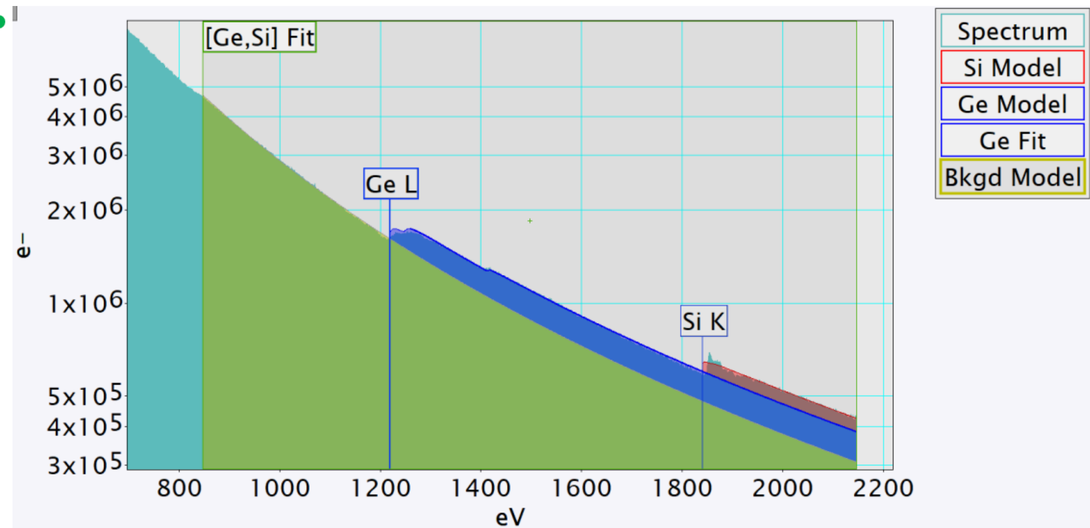
STEM-EELS: Working principle



STEM-EELS: Working principle







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- Vanni et al., Chem. Mater. 2019, 31, 5075−5080
- Nicotra et al., ACS Nano 2013, 7, 4, 3045–3052

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