Topic Outline

IVE. Analysis Modes

Position Sensitive Analysis

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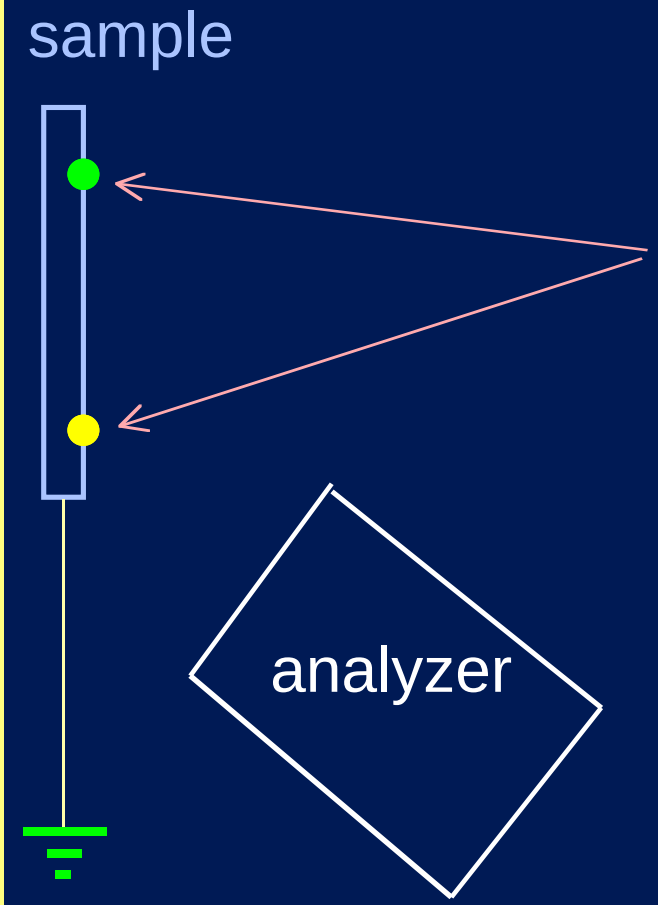
Goal

The goal of position sensitive detection (PSD) is to be able to distinguish between electrons arriving from the same type of event but occuring at two different locations on the sample.

The electrons will have the same energy but be observed at different spatial locations.

Position sensitive detection is used to “map” elemental concentrations in both AES and XPS.

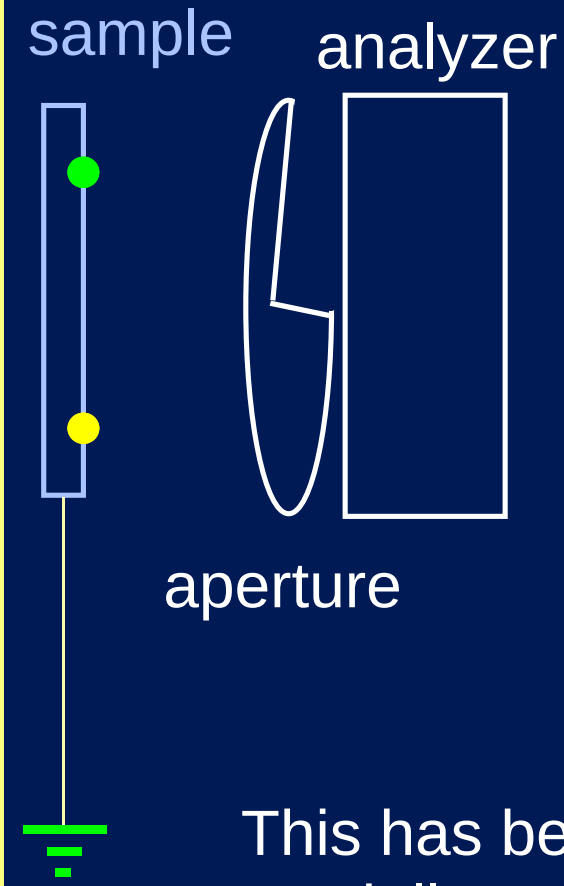
Spatially Resolved Sources



Electron beams can be rastered across a given area, and we can map the signal from the sample as a function of where the source beam is positioned.

This is commonly used with HSA's to do scanning AES.

Mechanical Apertures

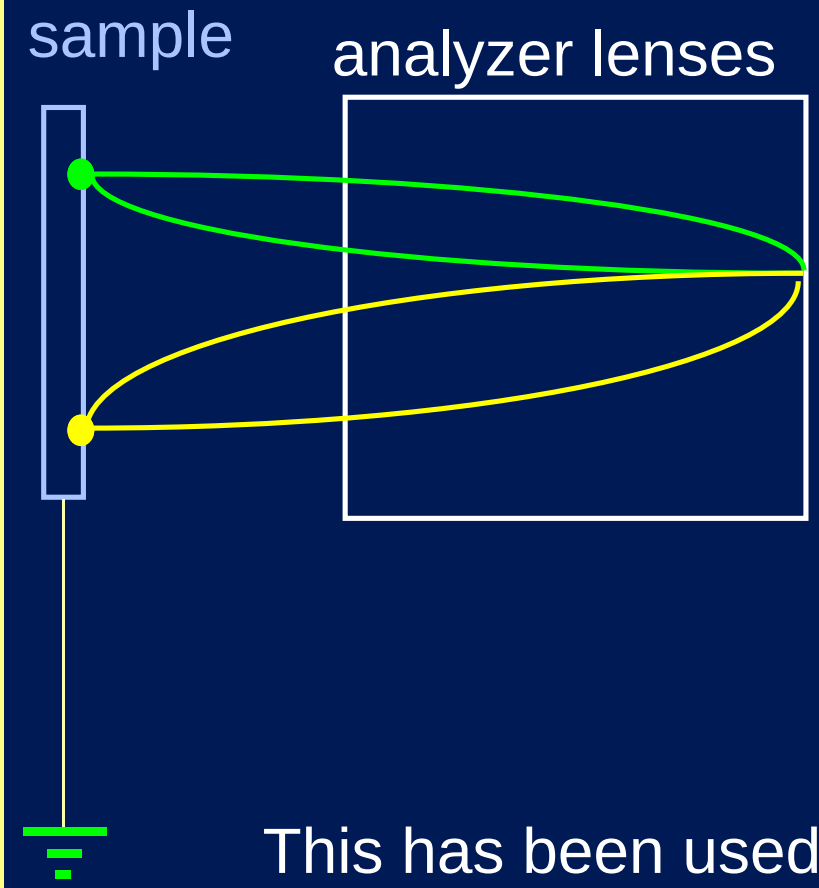


One method used is to place a mechanical aperture between the sample and the analyzer. The aperture allows only certain regions of the sample to pass electrons through it.

The aperture typically sits immediately in front of the analyzer.

This has been used with RFA's and CMA's for spatially resolved (and angle resolved) AES.

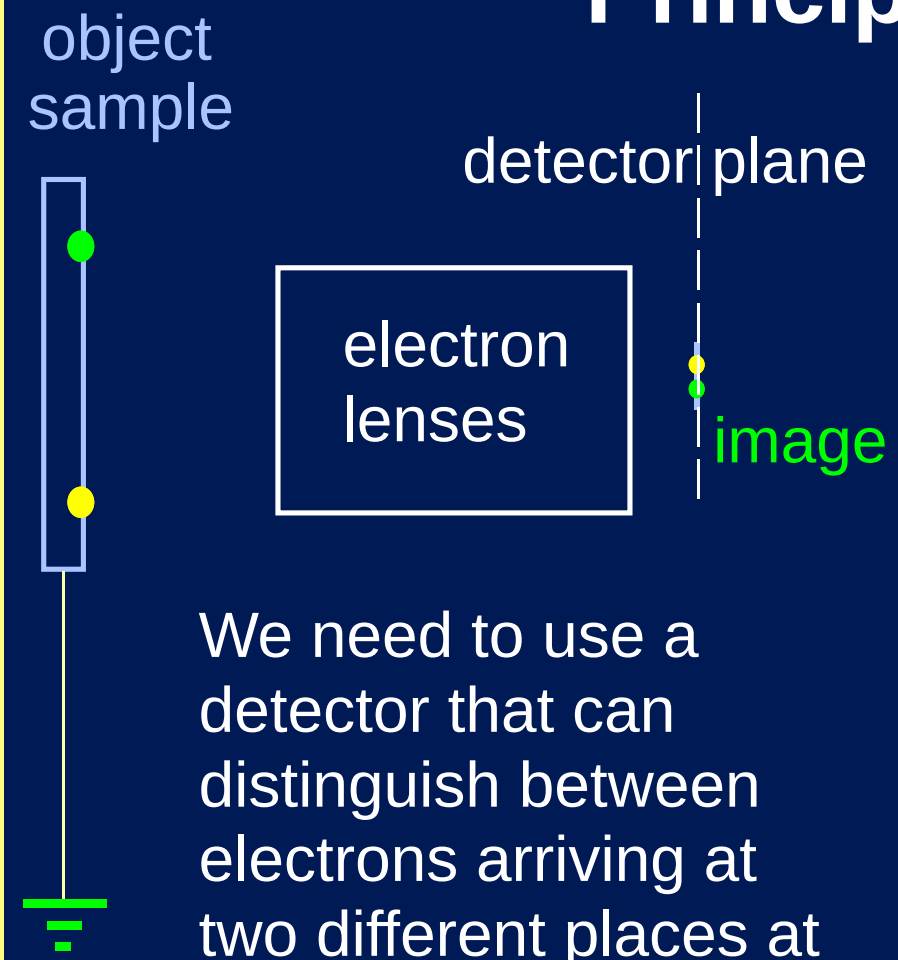
Spatially Mapping Analyzers



Lenses can be placed in front of the analyzer. The lenses can be designed to “sweep” their focal point across the sample surface and thereby selectively collect electrons only from certain regions.

This has been used with HSA’s for spatially resolved mapping in XPS.

Principles



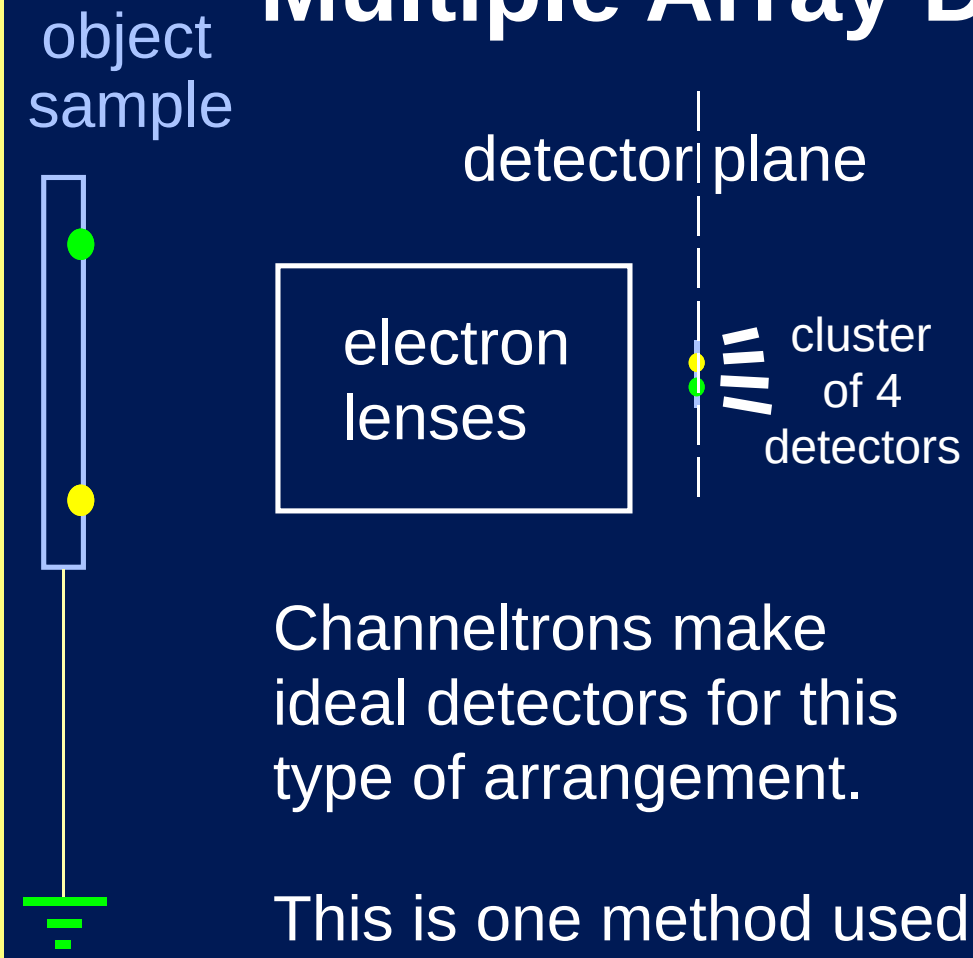
We need to use a detector that can distinguish between electrons arriving at two different places at its entrance plane.

Following the principles of electron optics, we allow the analyzer to form an image of the surface at the detector.

As in light optics, this image is often inverted.

It will usually have to be smaller than object being imaged (the sample surface).

Multiple Array Detectors



We can position an array of detectors around the focal plane. Each detector images a different portion of the sample.

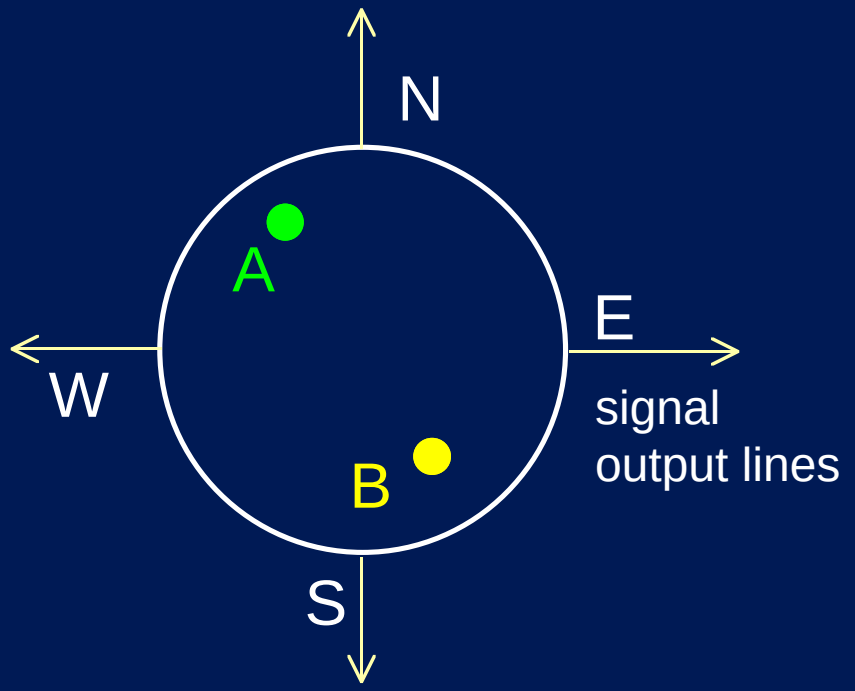
Channeltrons make ideal detectors for this type of arrangement.

This is one method used with spatially focussing HSA's to perform XPS mapping.

Channelplate PSD

Signal output lines run from each quadrant of the channel plate (north, south, east, or west). Each line sends a signal that is proportional to its distance from where the signal strikes the detector.

This is also used with HSA's for spatial mapping in XPS.



Where Outputs are Found

Signal A -> primarily in NW quadrant
Signal B -> primarily in SE quadrant

Comparisons

scanning beams
only possible with electrons
used frequently in scanning AES (with HSA's only)

mechanical apertures
cumbersome, used occasionally with CMA's

scanning analyzers
only with HSA's (need lenses to scan sample surface)
common for scanning and "small spot" XPS

position sensitive detectors
only with HSA's (need lenses to focus object to image)
common for scanning and "small spot" XPS

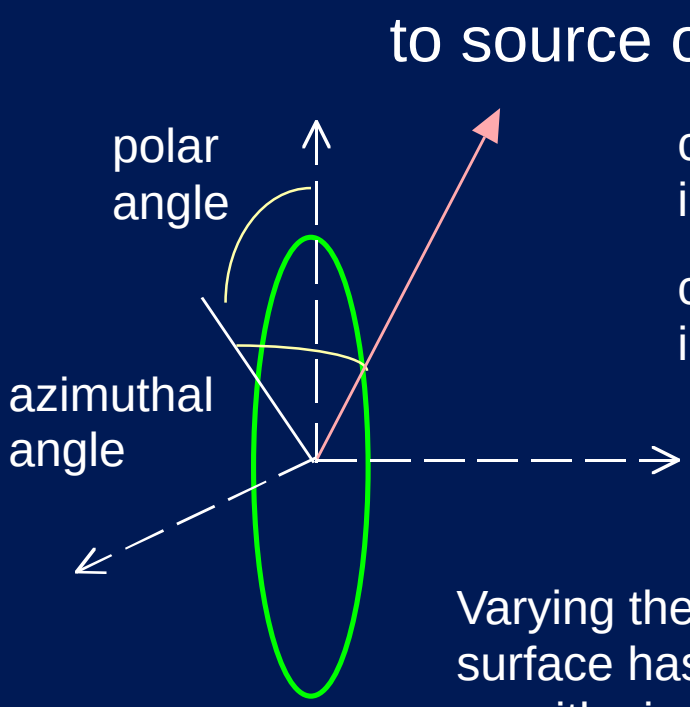
Small Spot Analysis

Small spot analysis is a term used to denote that XPS systems have spatially resolved (position sensitive) analysis capabilities.

	spatial resolution possible
AES	sub-micron
XPS	current value is typically 25 microns

Principles

In angle resolved analysis, we vary an angle of the sample relative to the source and/or detector to determine how this effects the signal.



changing the polar angle involves rotating the sample

changing the azimuthal angle involves tilting the sample

Varying the polar angle only makes sense if the surface has in plane symmetry operations (such as with single crystal surfaces).

Terminology

glancing incidence
the source beam (typically electrons) arrive nearly in plane with the sample surface

normal incidence
the source beam arrives perpendicular to the sample surface

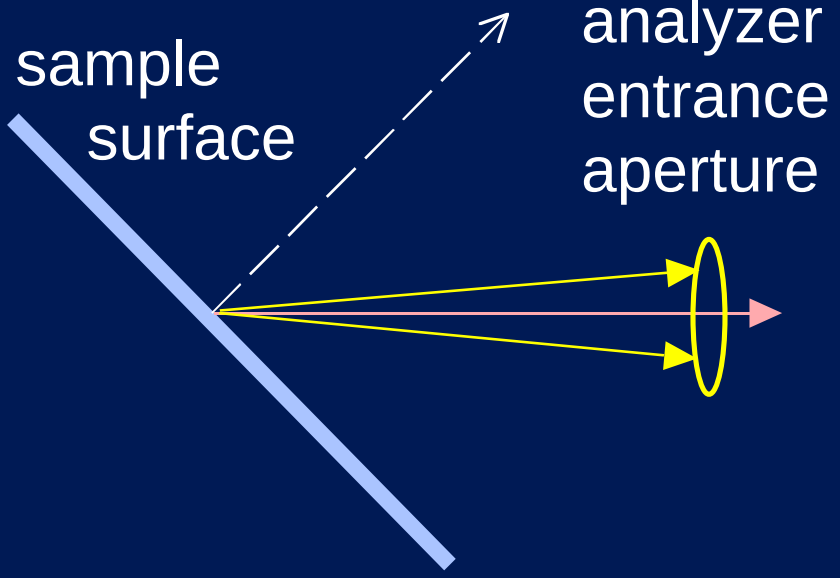
take-off angle
the polar angle at which the electrons are leaving the sample surface (with regard to the sample normal or the sample plane - be careful!)

Cautions

Analyzers have acceptance angles.

Polar angle can be defined versus the surface plane or versus the surface normal (both conventions are typical - be careful).

Often, we both source and analyzer angles change when the sample is tilted (because of the design of the chamber).



typical acceptance angles on conventional analyzers are about 10^{o} - 20^{o}