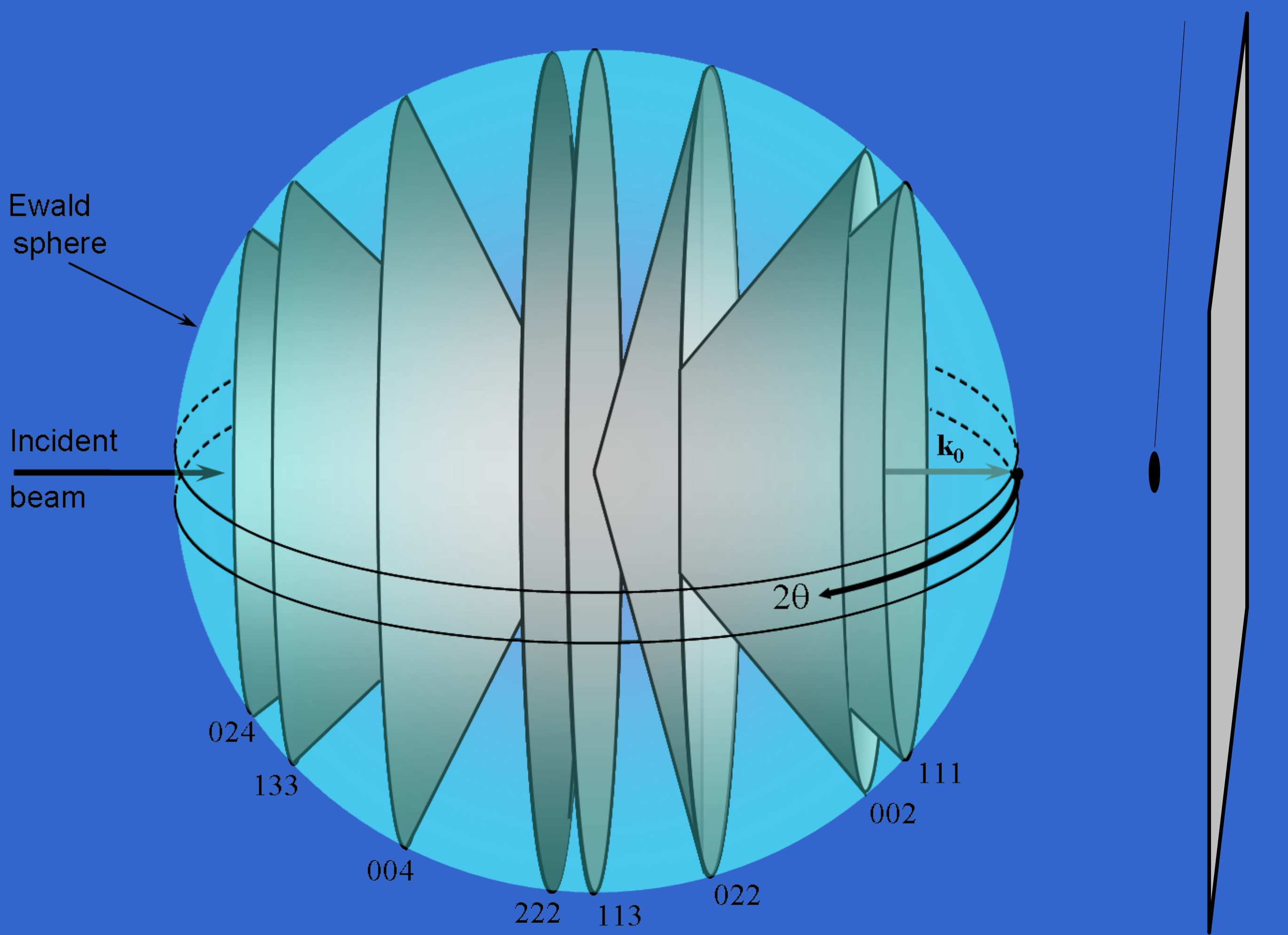
X-ray powder
diffractometer

X-ray powder diffractometer



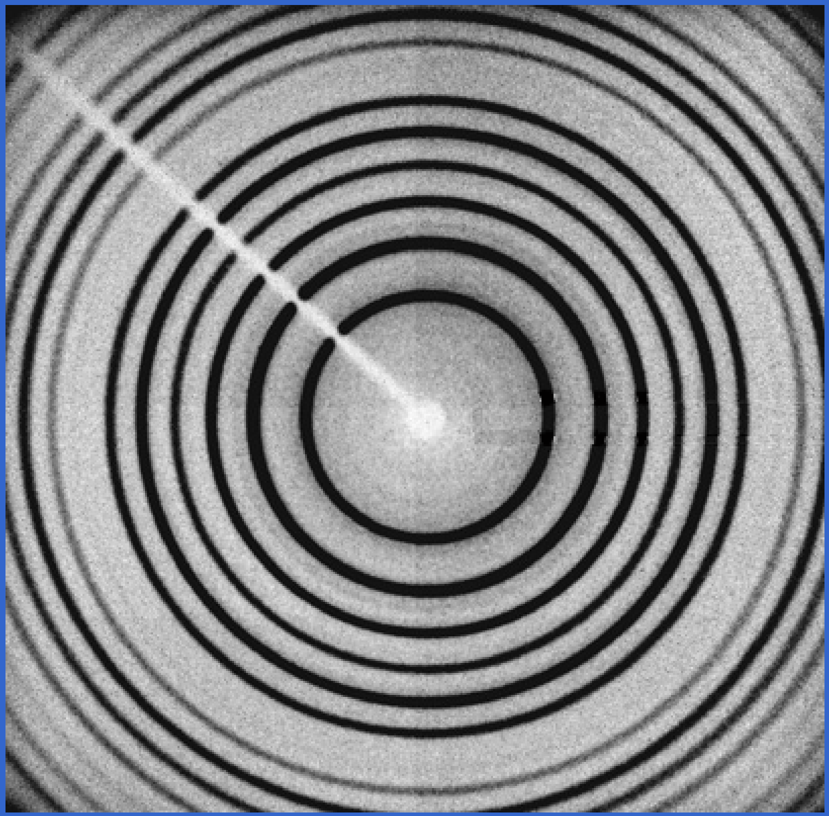
film, image plate,
or area detector

X-ray diffraction

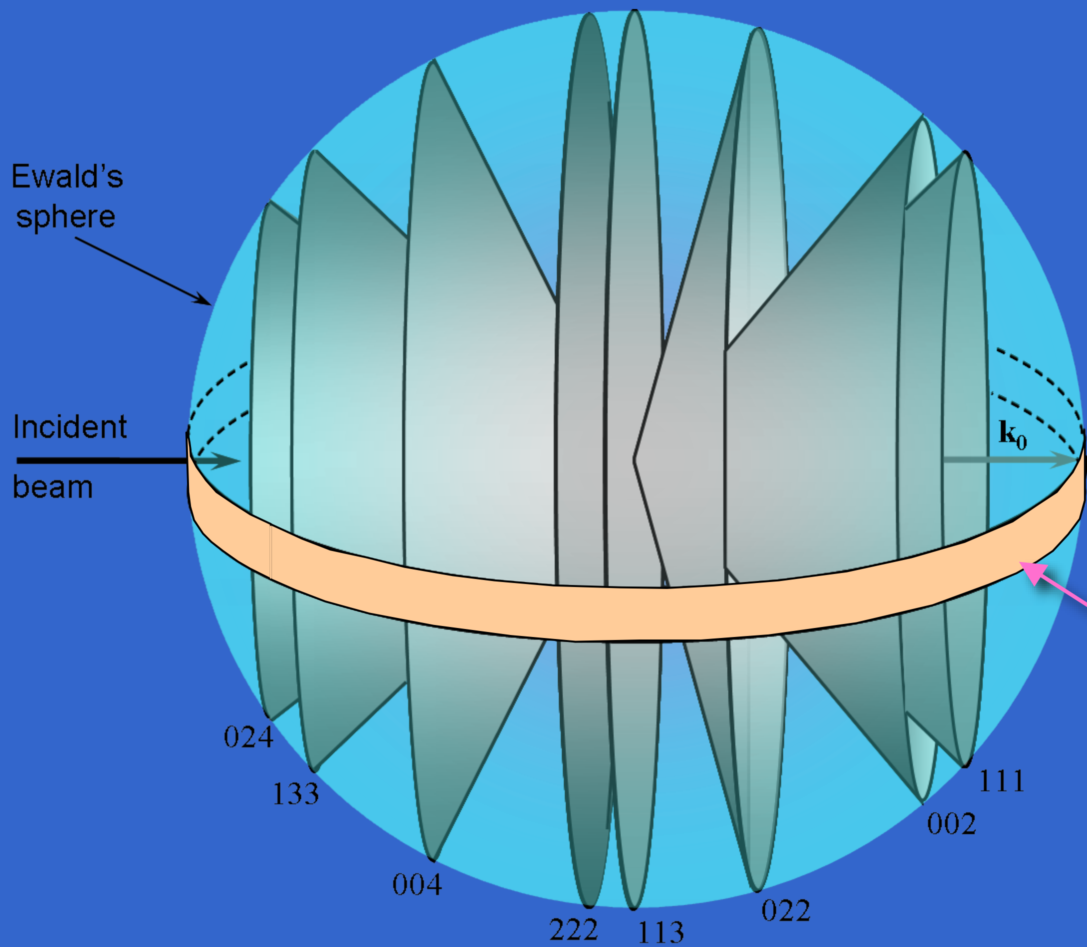
Braggs' law $\boxed{\lambda = 2d_{hkl} \sin \theta_{hkl}}$

Debye rings

Diameters give θs



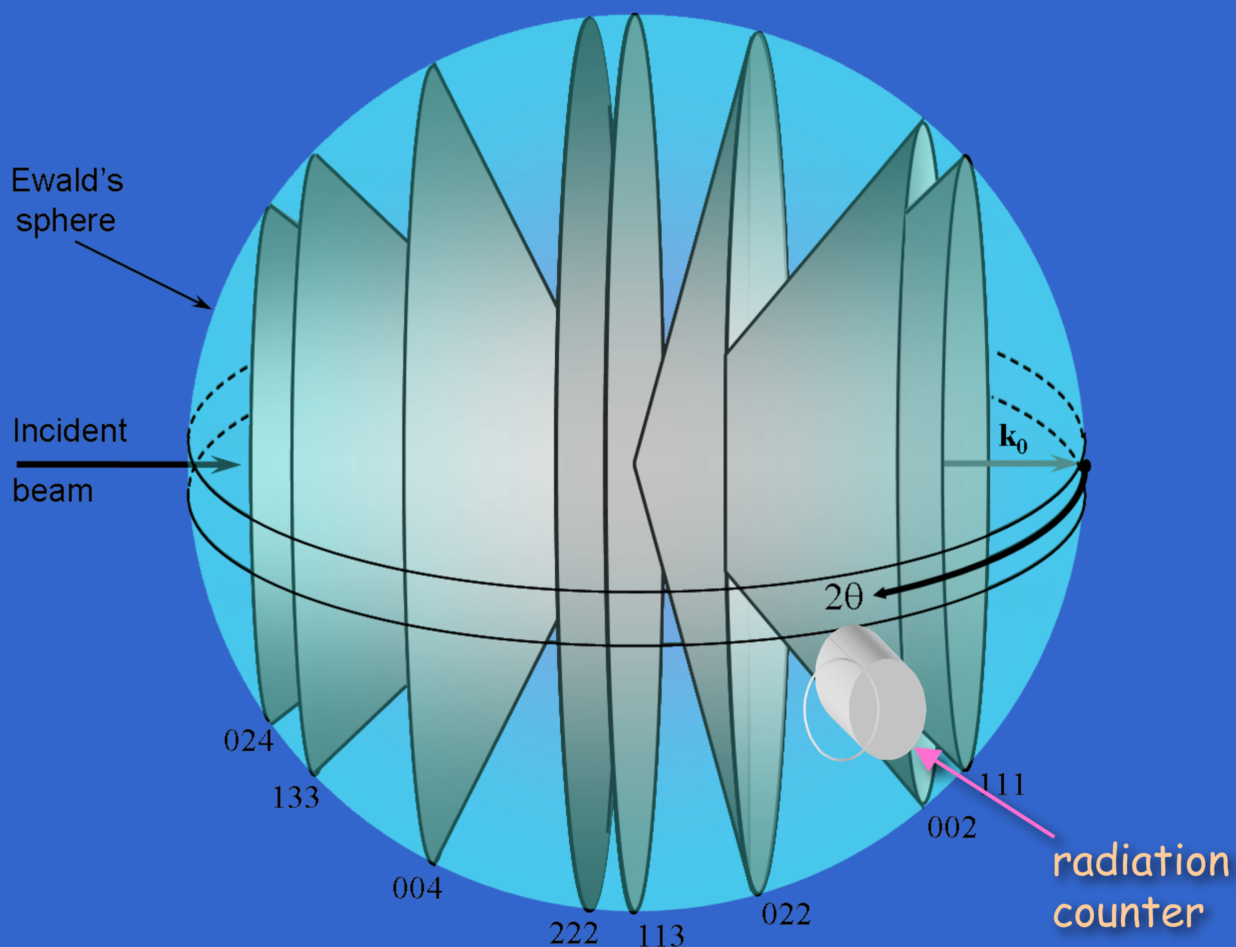
X-ray powder diffractometer



rarely used now

film or image paper

X-ray powder diffractometer



X-ray powder diffractometer

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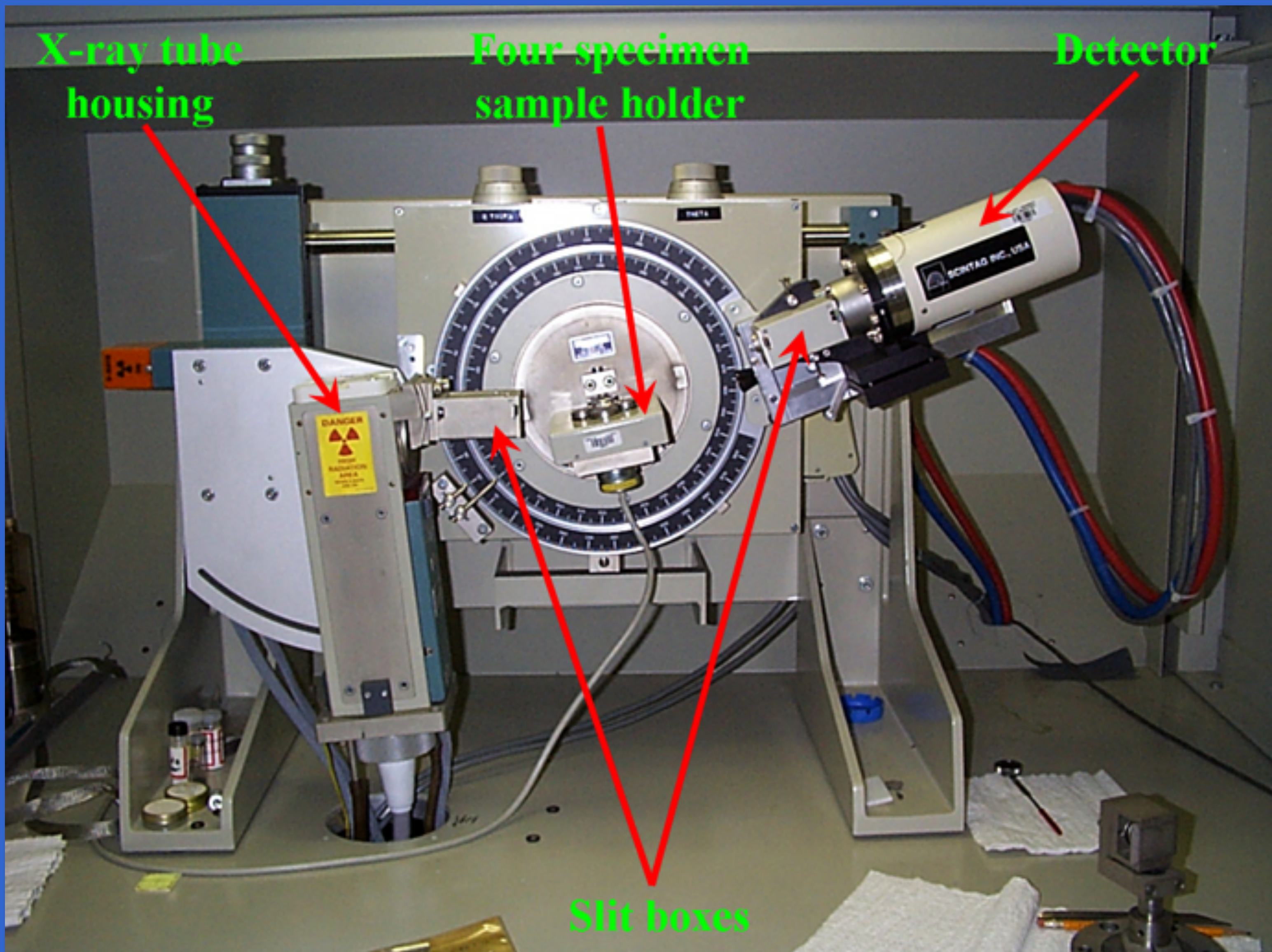
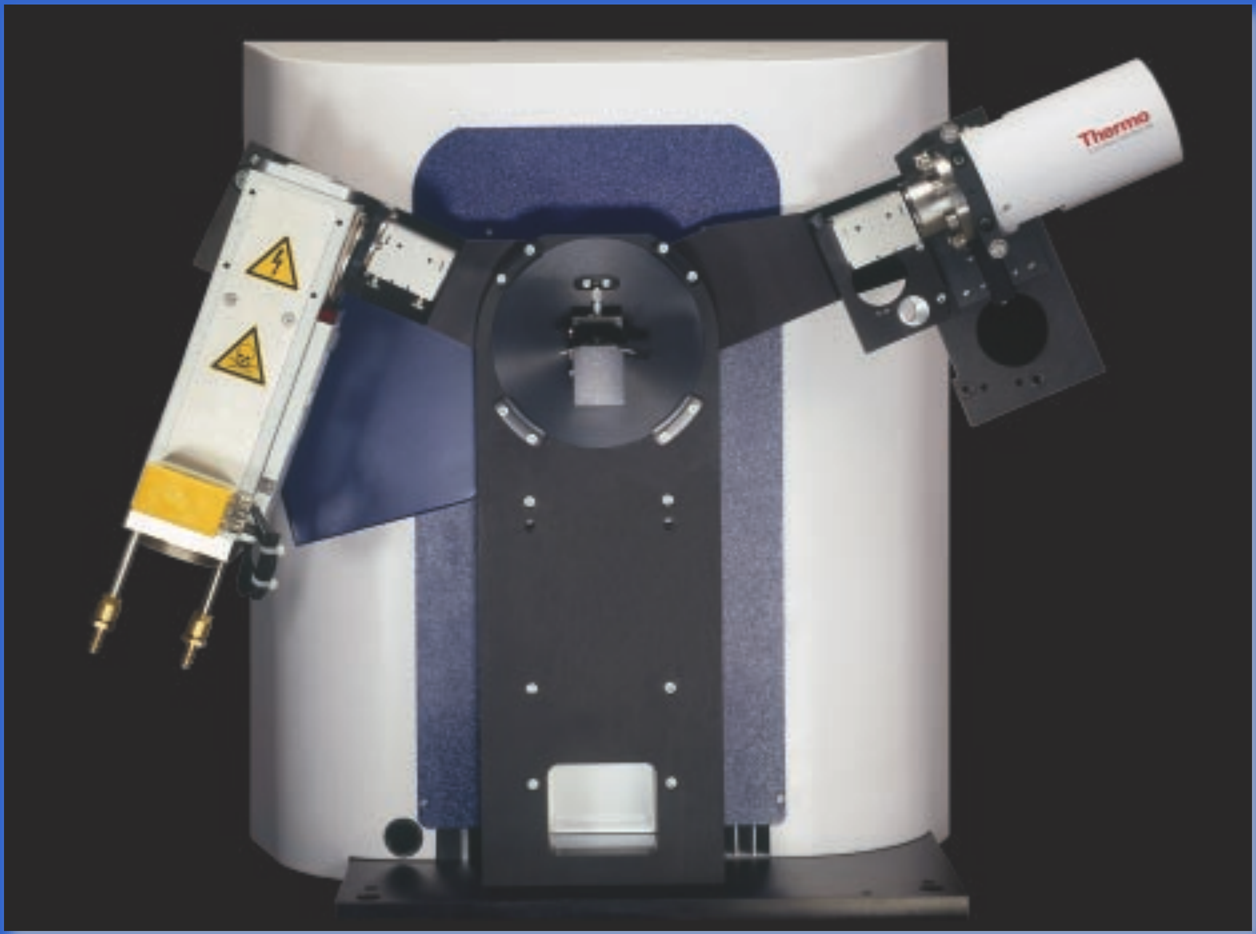
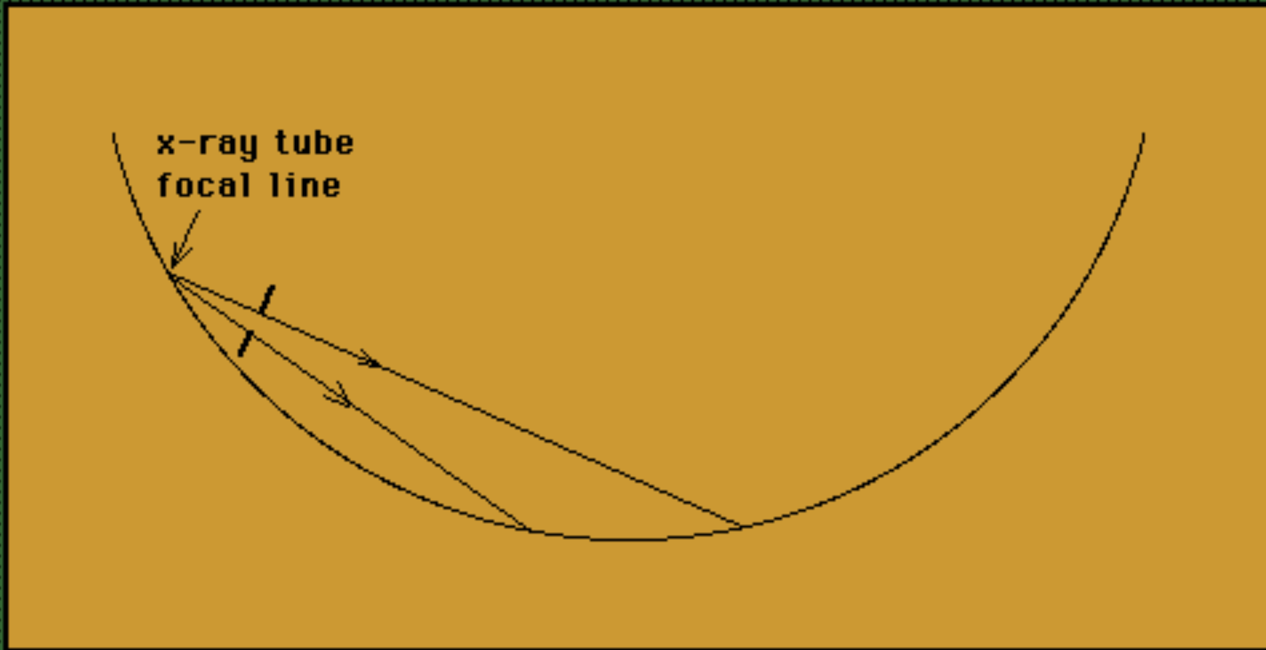


X-ray powder diffractometer



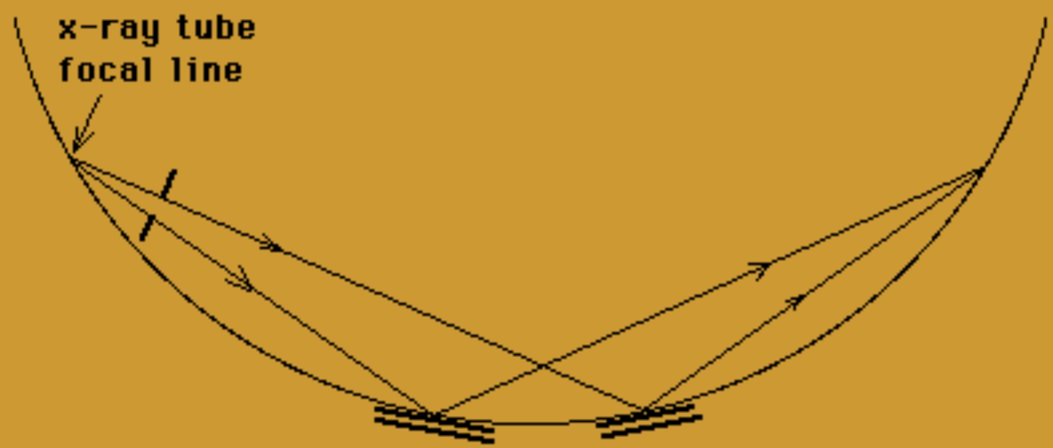
X-ray powder diffractometer

In the powder diffractometer, a slit defines a diverging beam



X-ray powder diffractometer

The x-rays are reflected by sets of planes in the sample at the Bragg angle for those planes.



X-ray powder diffractometer

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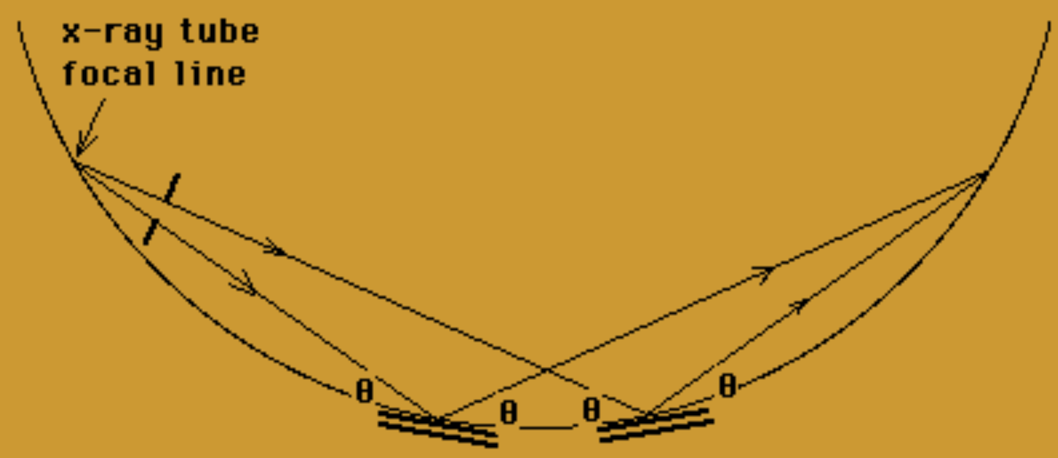
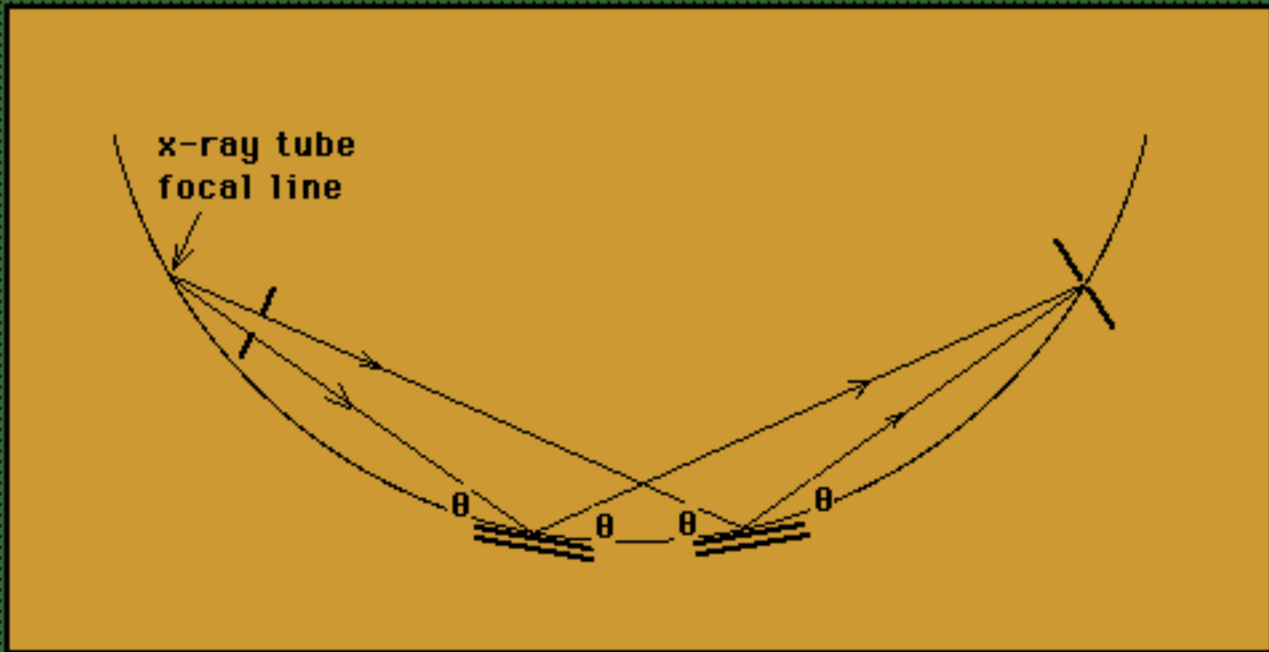


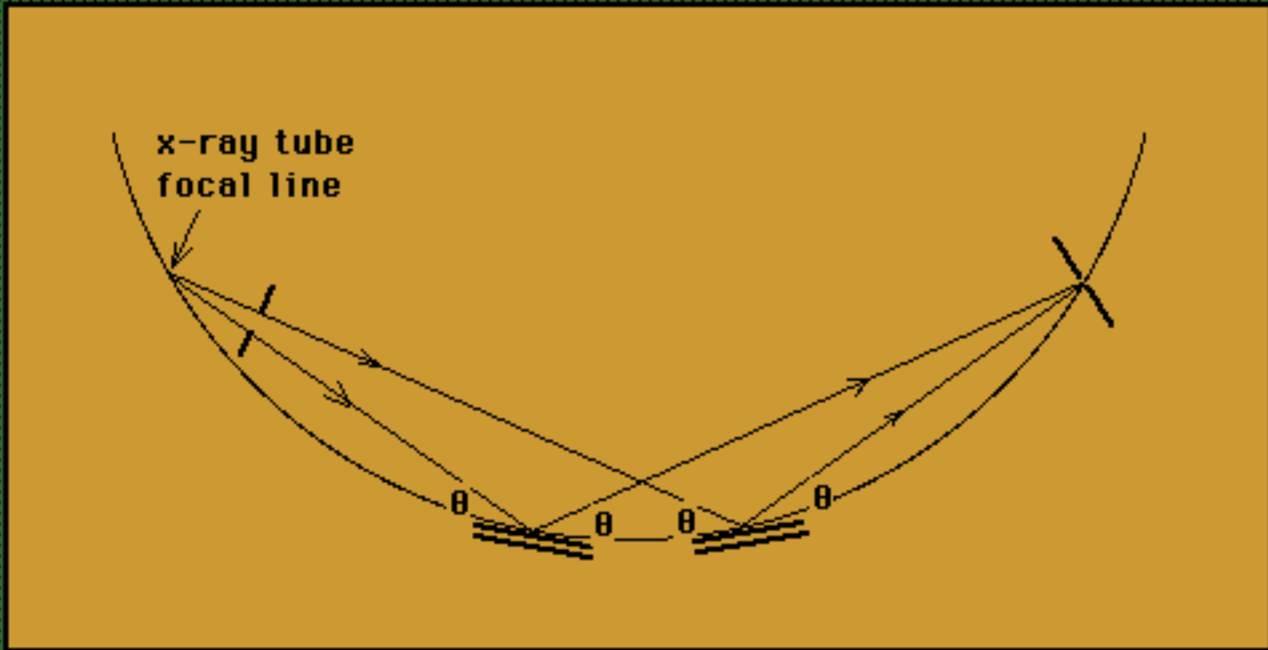
X-ray powder diffractometer

The reflected x-rays are focused at the receiving slit.



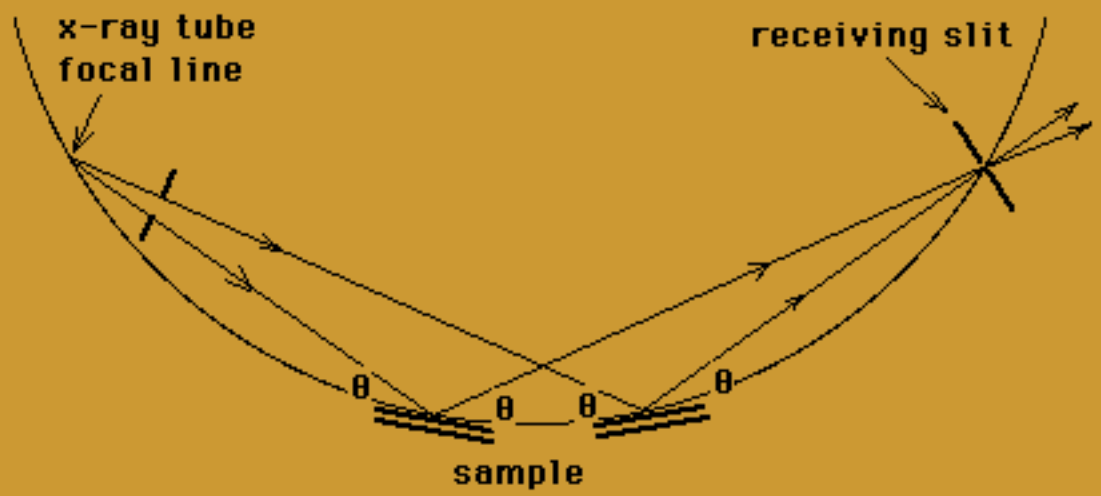
X-ray powder diffractometer

Angles which subtend the same arc of a circle are equal.



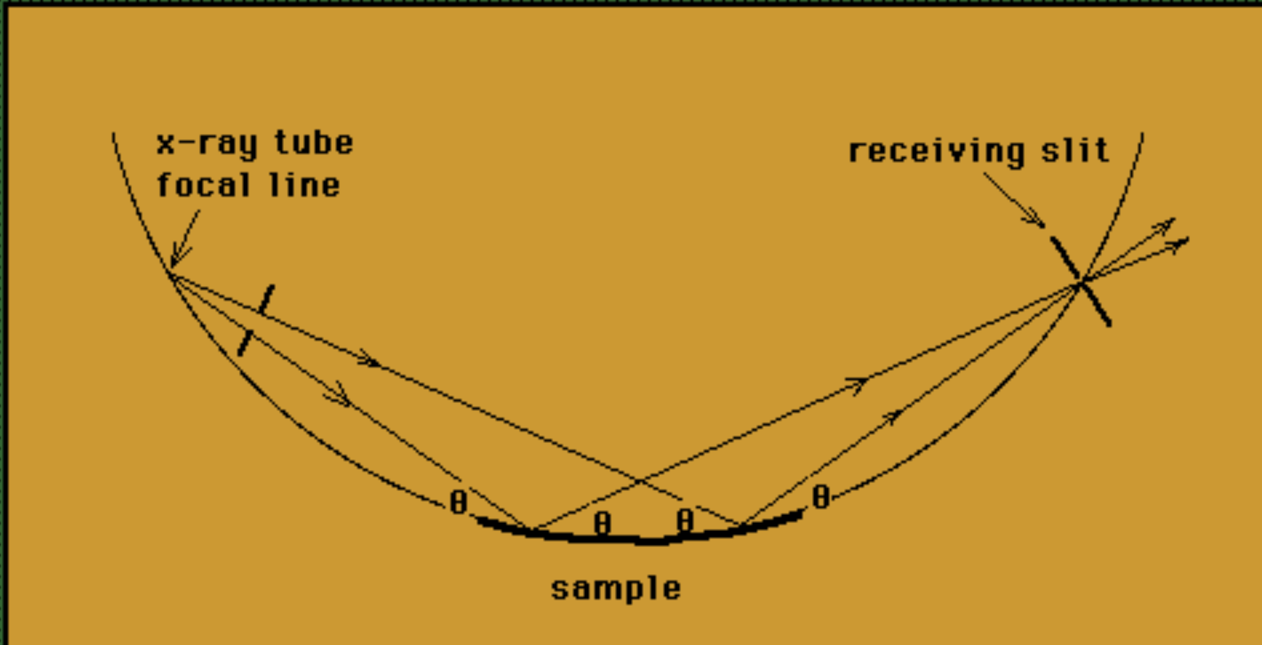
X-ray powder diffractometer

The focal line, the sample surface, and the receiving slit define the "focusing circle".



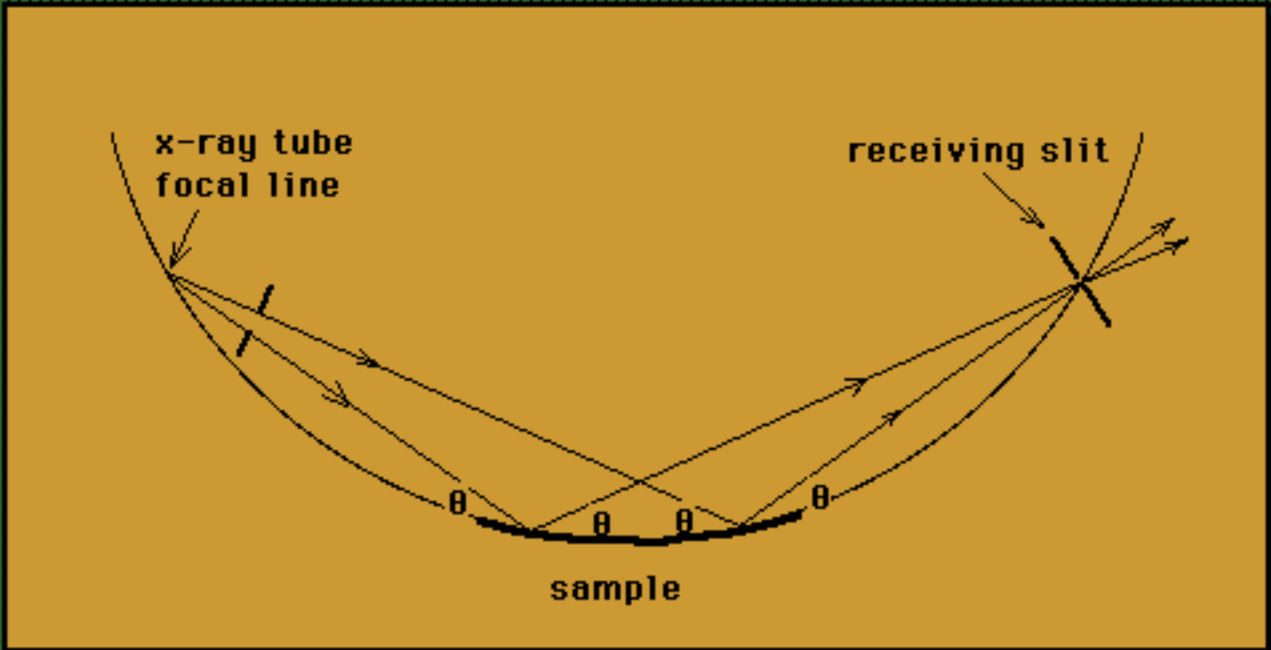
X-ray powder diffractometer

Sample should be curved.



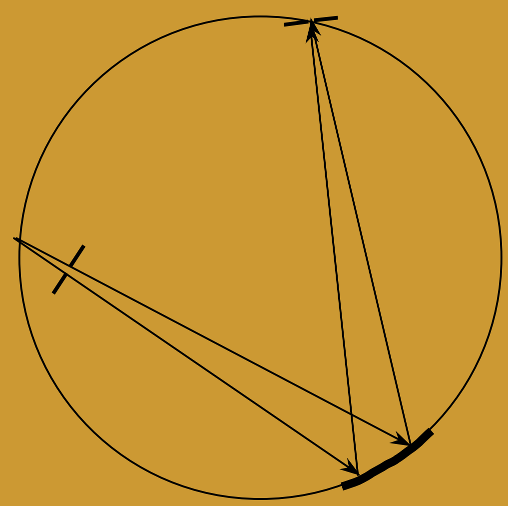
X-ray powder diffractometer

Sample should be curved. Impractical since radius of curvature changes with 2θ.



X-ray powder diffractometer

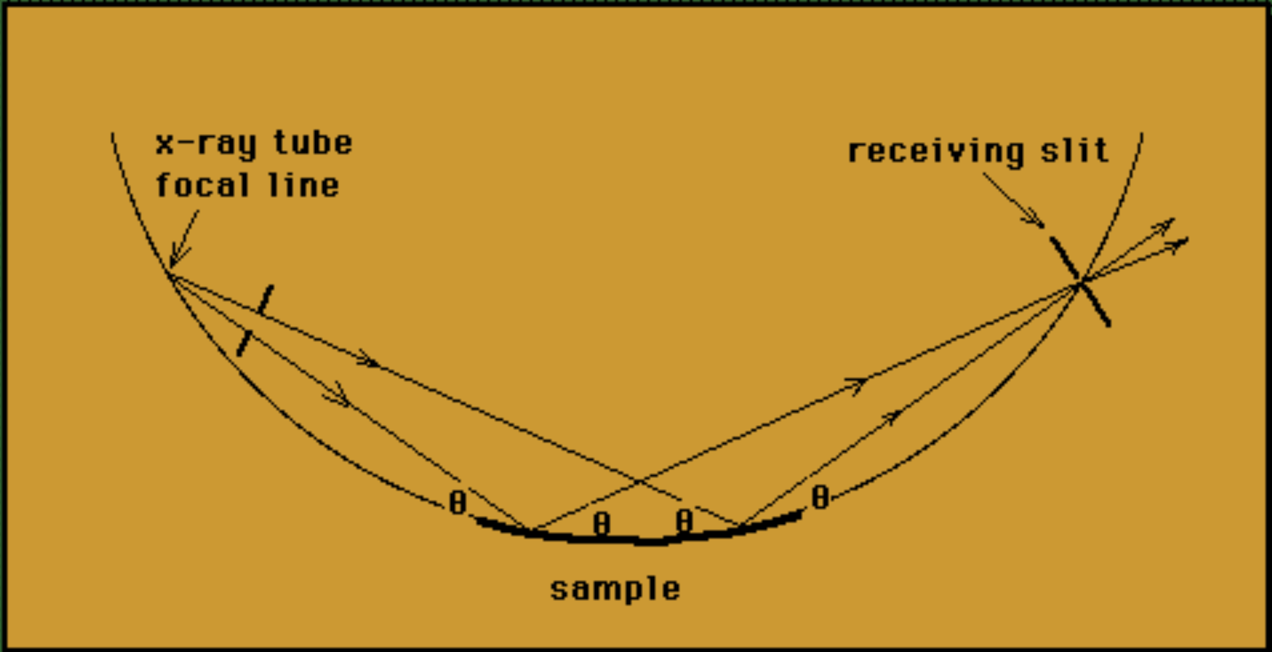
Sample should be curved. Impractical since radius of curvature changes with 2θ.



X-ray powder diffractometer

Sample should be curved. Impractical since radius of curvature changes with 2θ.

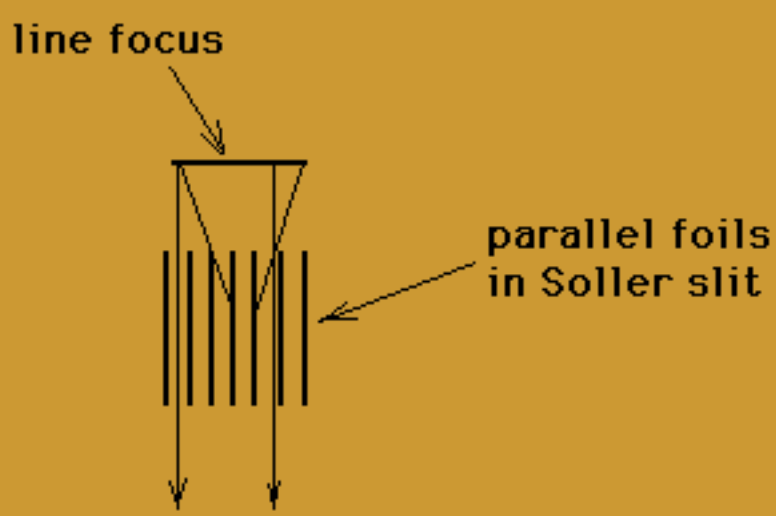
Compromise: flat sample. Some defocusing



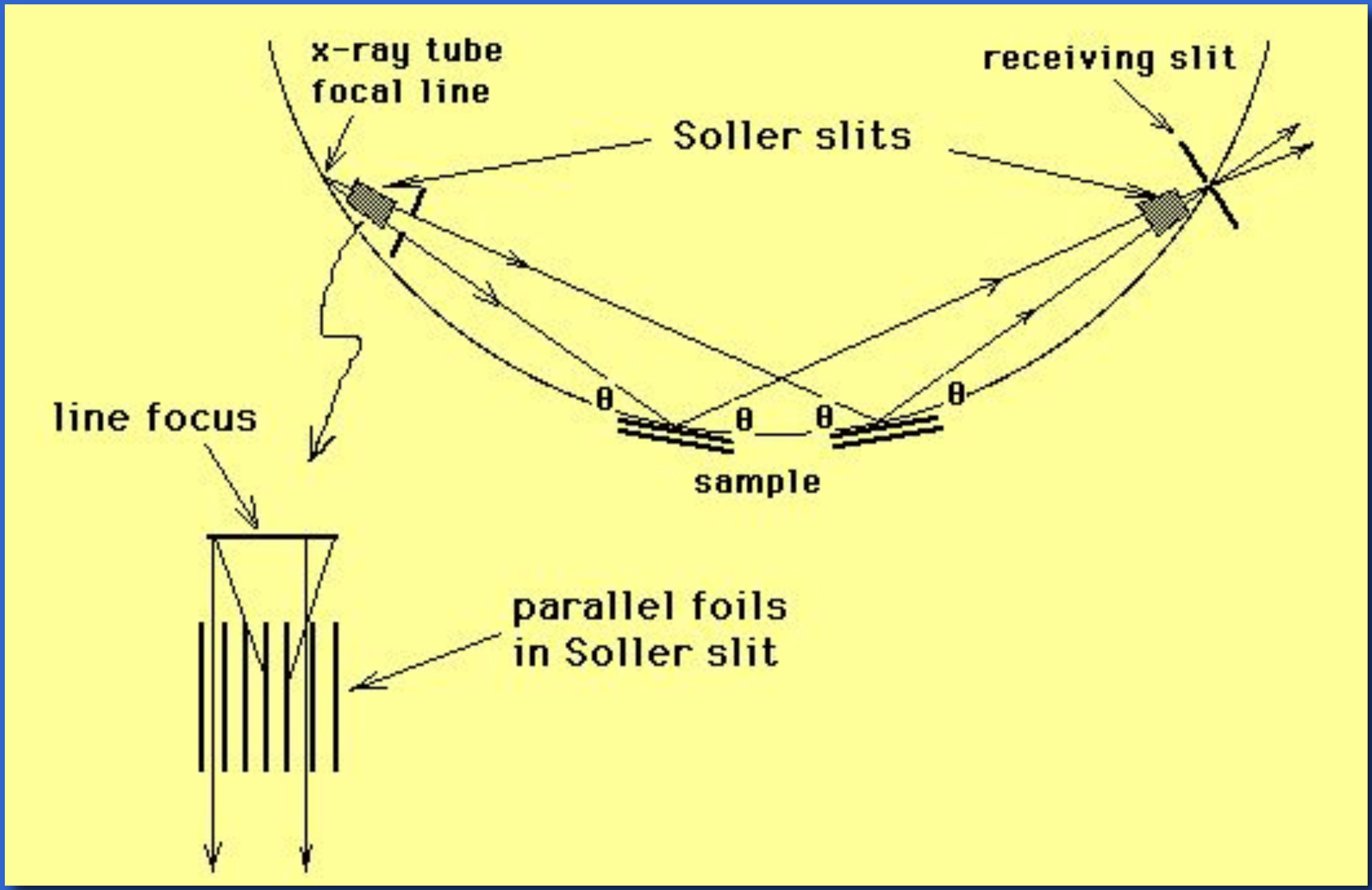
X-ray powder diffractometer

Sample should be curved. Impractical since radius of curvature changes with 2θ.

Use Soller slit

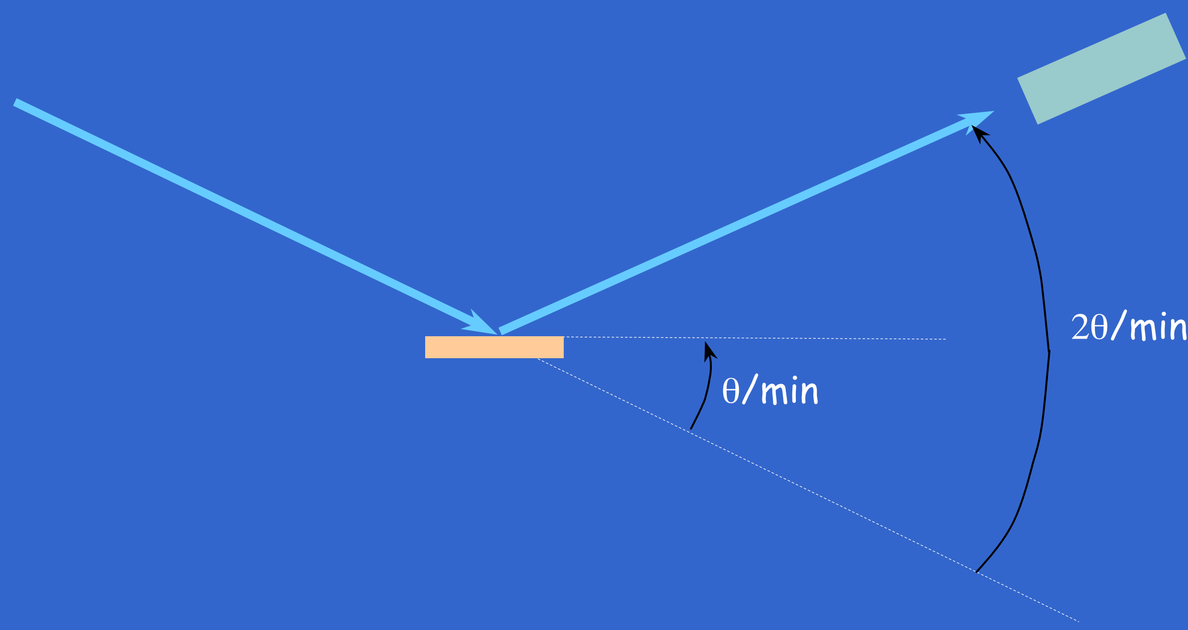


X-ray powder diffractometer



X-ray powder diffractometer

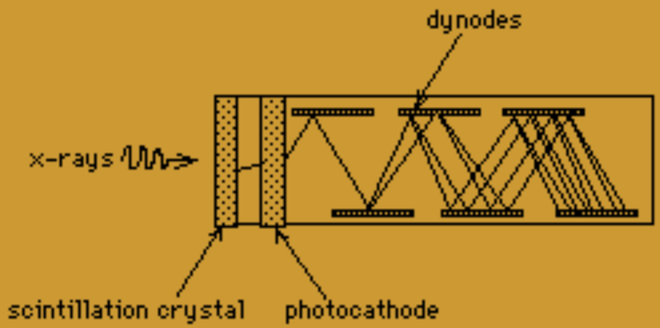
To maintain the focusing geometry, when counter is rotated at rate of 2θ/min, specimen is also rotated at rate of θ/min



X-ray powder diffractometer

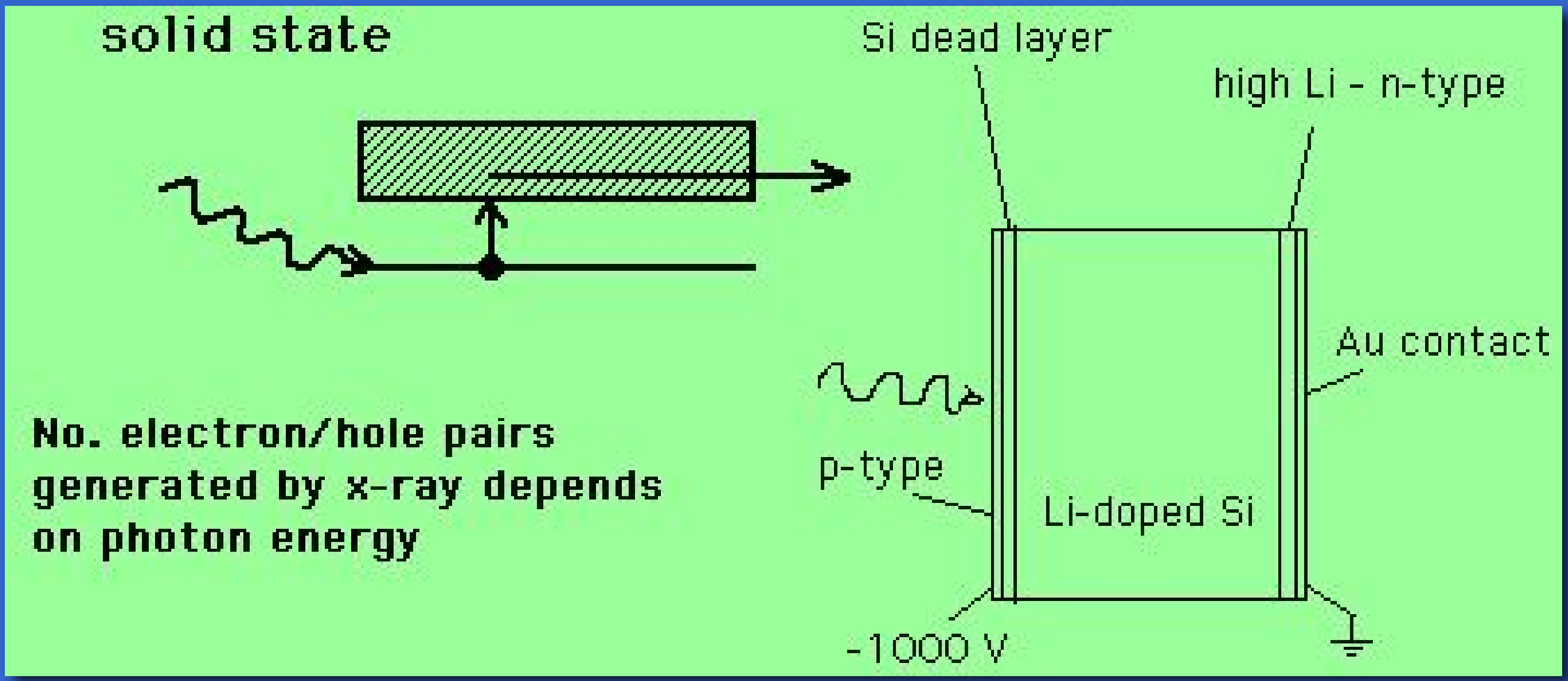
Counters

Scintillation counter - can do PHD



X-ray powder diffractometer

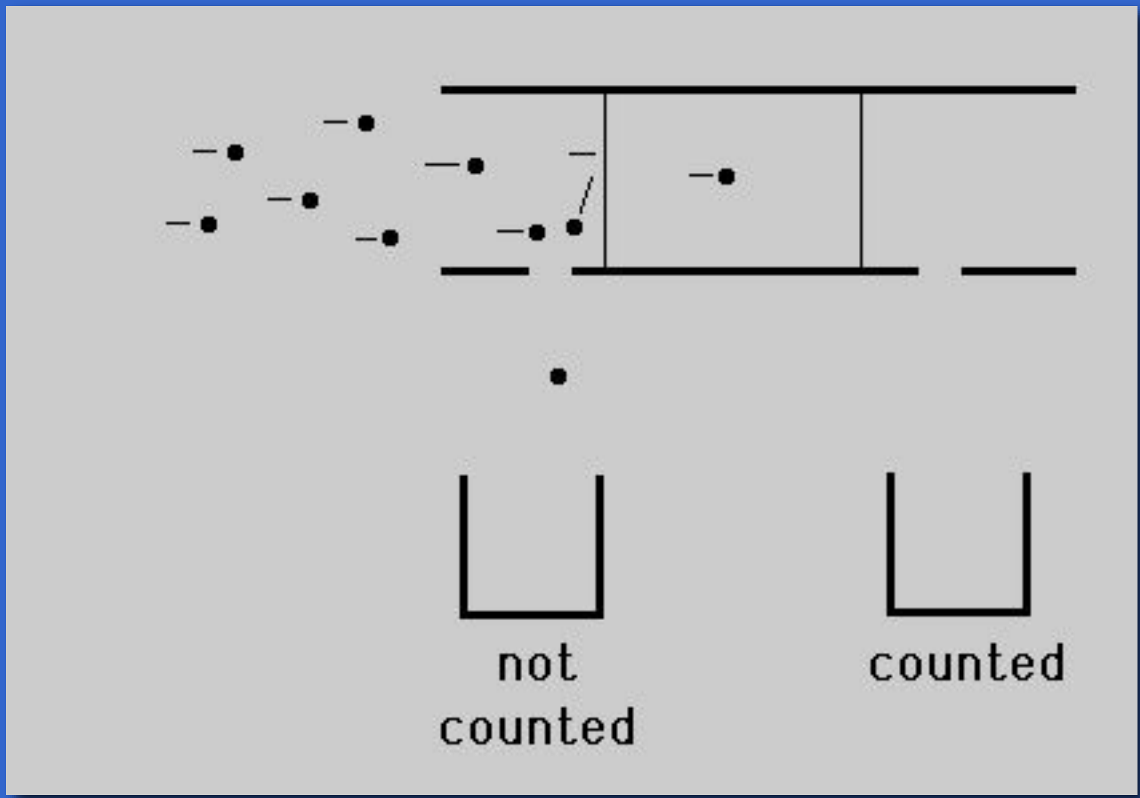
Solid state detectors



High energy (wavelength) resolution - no filter or monochromator needed
Gives high intensities, very low backgrounds
Problem with "deadtime"

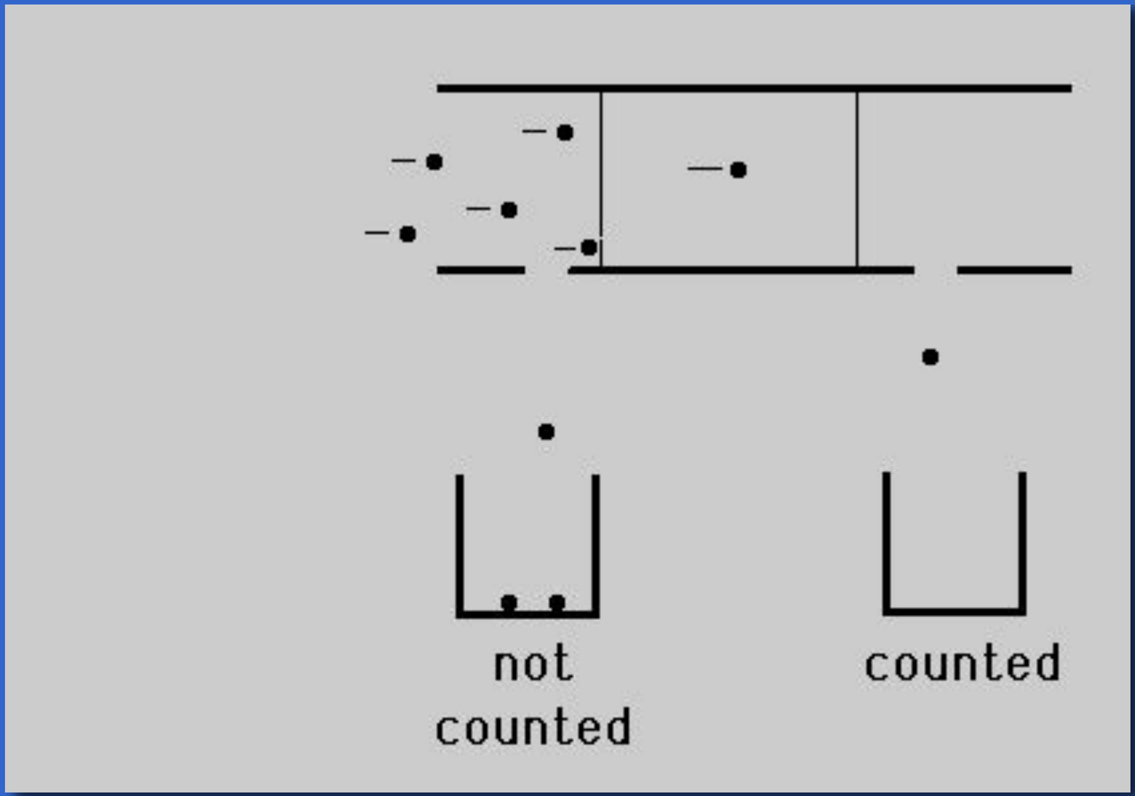
X-ray powder diffractometer

Deadtime



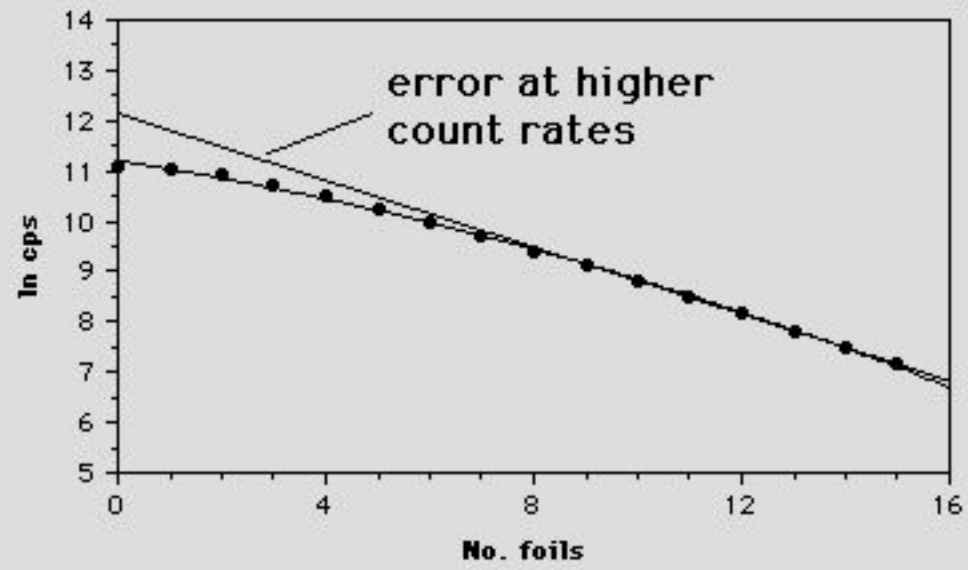
X-ray powder diffractometer

Deadtime



X-ray powder diffractometer

Deadtime



$I/Io = \exp(-\mu^{*}x)$

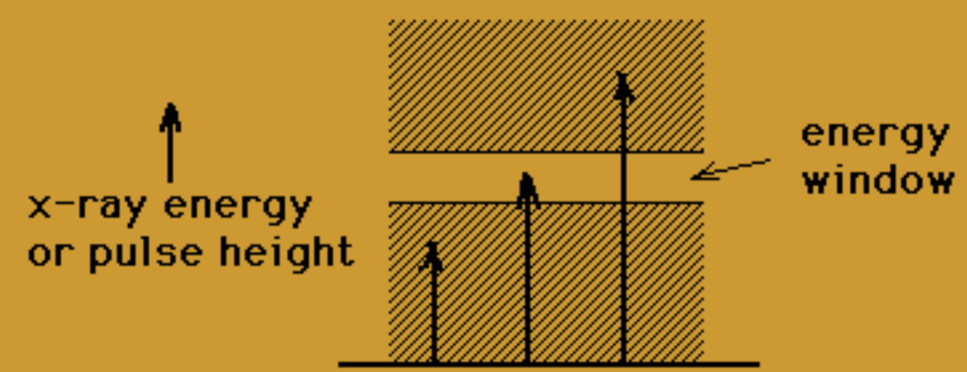
$\ln I = \ln I_o - \mu^{*}x$

straight line

X-ray powder diffractometer

Counters

Pulse height discrimination

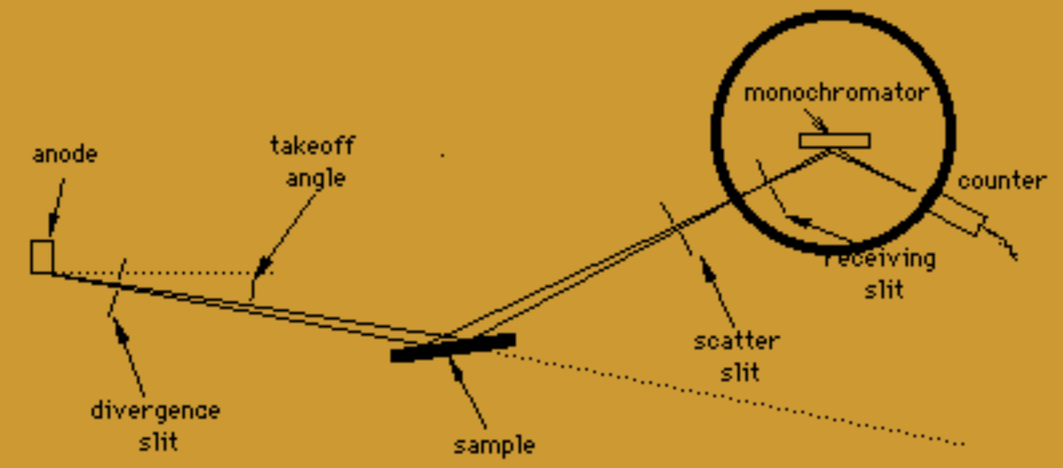


X-ray powder diffractometer

<u>Monochromator</u>

Pyrolytic graphite single crystal

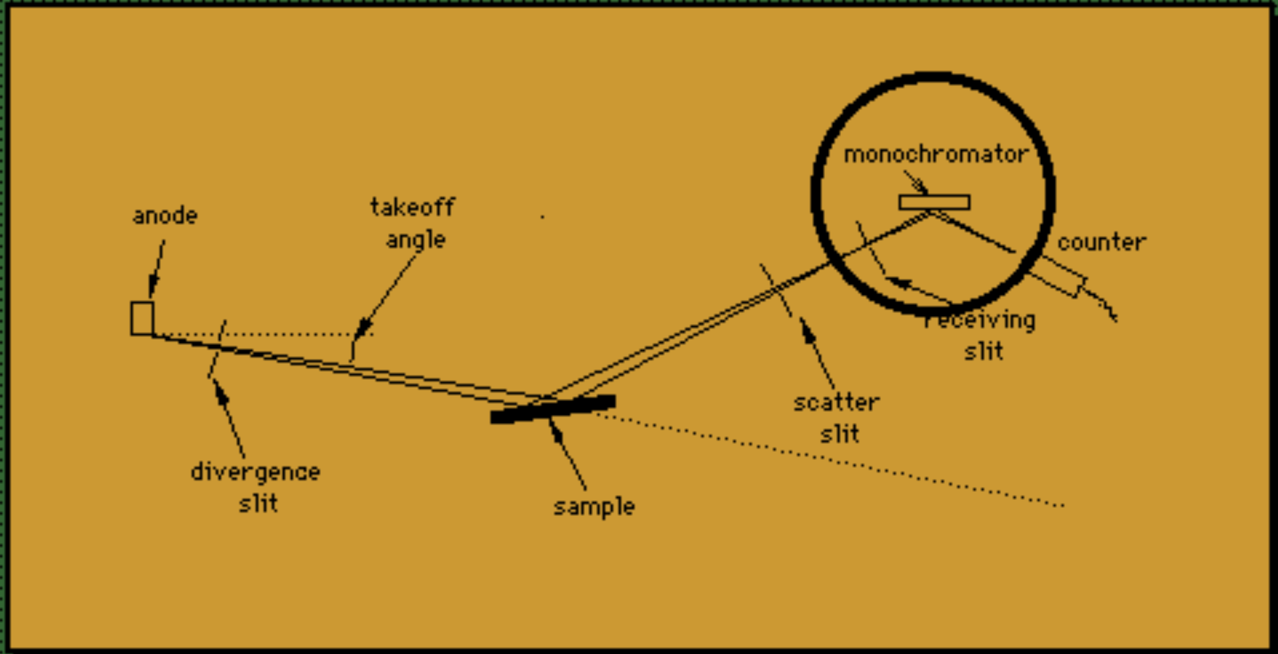
Oriented w/ (00l) planes II surface



X-ray powder diffractometer

Monochromator

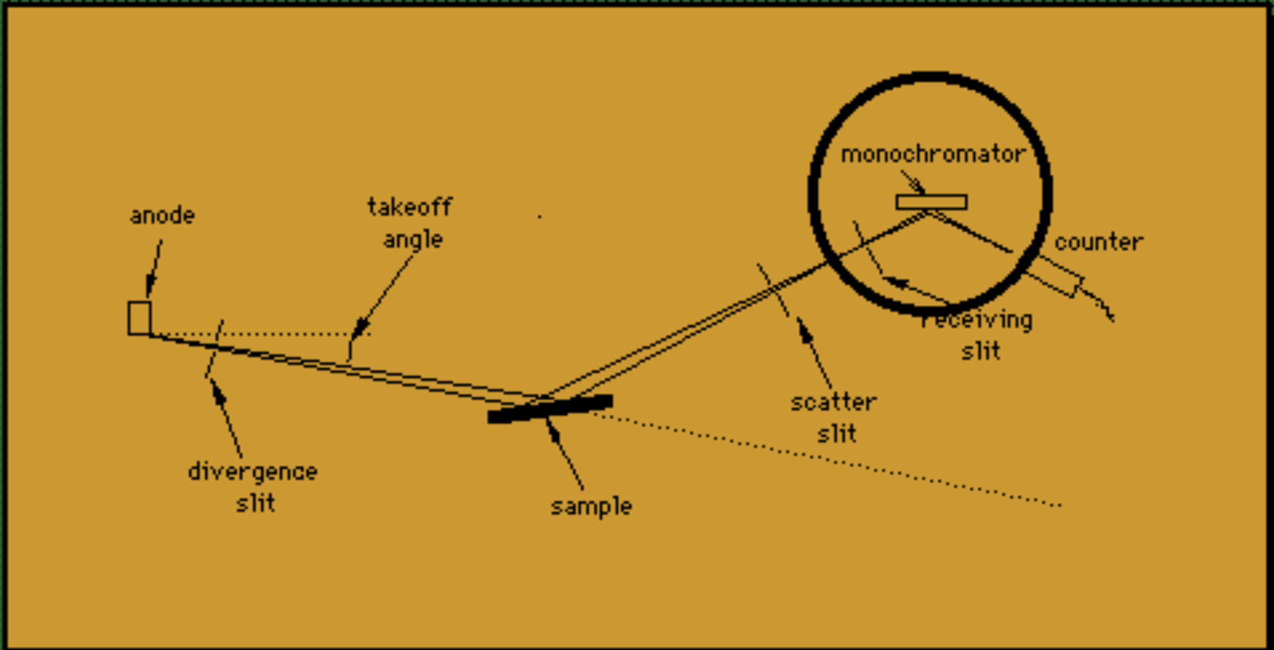
Crystal is fixed, doesn't rotate wrt diffracted beam from sample



X-ray powder diffractometer

Monochromator

Set crystal, counter angles from Bragg's law, using (002) planes. c = 6.708 Å

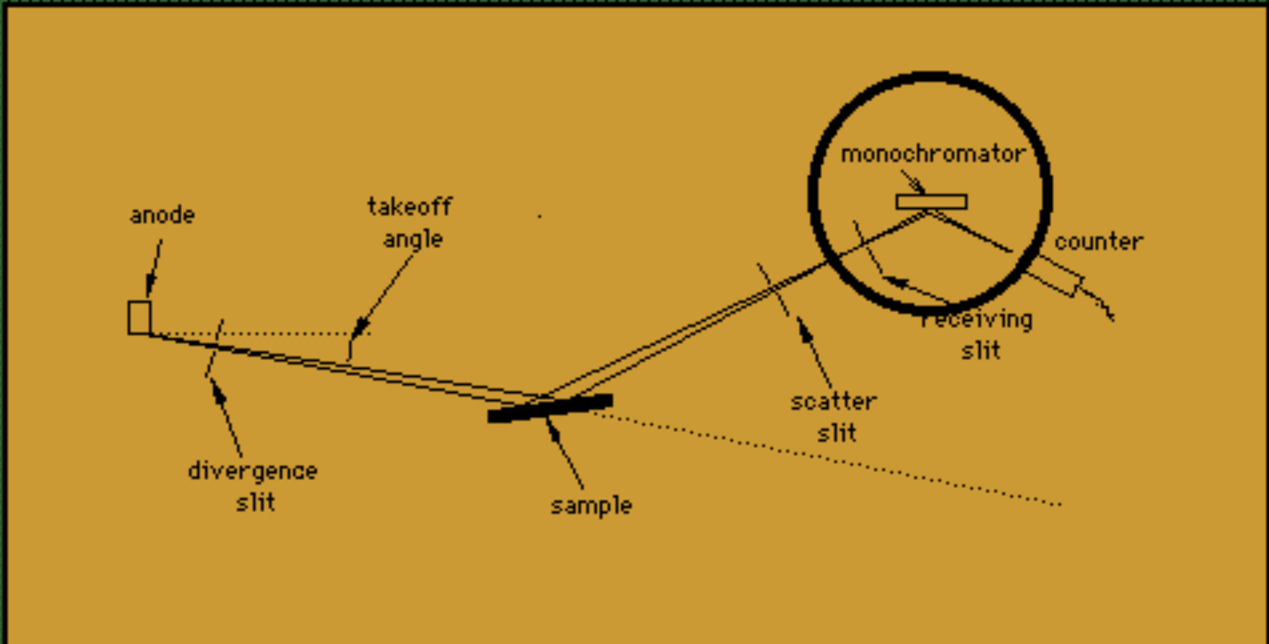


X-ray powder diffractometer

Monochromator

Set crystal, counter angles from Bragg's law, using (002) planes. c = 6.708 Å

$\theta = \arcsin(\lambda/2 \times 3.354)$



X-ray powder diffractometer

Monochromator

White, β, and fluorescence radiation essentially gone

$\theta = \text{arc sin } (\lambda / 2 \times 3.354)$