Detector Zoology

8th X-ray Scattering School

Apurva Mehta
Scattering Measurement

Intensity as a function of scattering angle

\[ Q = \frac{4\pi \sin(\theta)}{\lambda} \]
Traditionally

\[ Q = \frac{4\pi \sin(\theta)}{\lambda} \]

Sample Space → Angular Space
Traditionally

\[ Q = \frac{4\pi \sin(\theta)}{\lambda} \]

Sample Space → Angular Space
Traditionally

\[ Q = \frac{4\pi \sin(\theta)}{\lambda} \]
Traditionally

\[ Q = \frac{4\pi \sin(\theta)}{\lambda} \]

Sample Space \rightarrow Angular Space
Traditionally

\[ Q = \frac{4\pi \sin(\theta)}{\lambda} \]
Area Detector

Light → Sample → Scattering Pattern

\[ Q = \frac{4\pi \sin(\theta)}{\lambda} \]

Sample Space → Angular Space
Area Detector

light

sample

Sample Space

Scattering Pattern
Detector Zoology

• Point Detectors
  - Photomultiplier, Solid State detector, ion chamber

• Area Detectors
  - MAR345, MARCCD, Pilatus
Advantages of Area Detectors

- parallel data collection.
  - Fast
    - In-situ
- 2D
  - Azimuthal coverage
    - Texture
    - Strain

![Graphs](Q-chi polarization corrected.tif)
Why not always use a 2D detector?

• Energy Discrimination:

• Collimation (separation of different sources of scatter)

• Need for Parallel Beam Geometry
Why not always use a 2D detector?

- **Energy Discrimination:** 2D detectors have poor E resolution
Why not always use a 2D detector?

- **Energy Discrimination:**

- **Collimation (separation of different sources of scatter):**

- **Need for Parallel Beam Geometry**
Why not always use a 2D detector?

- **Collimation** (separation of different sources of scatter)
• **Collimation** (separation of different sources of scatter)
Why not always use a 2D detector?

- Energy Discrimination:
- Collimation (separation of different sources of scatter)
- Need for Parallel Beam Geometry
Why not always use a 2D detector?

- Need for Parallel Beam Geometry
Parallel Beam Geometry

Detect the angle of the diffracted beam not the position
Advantage of Parallel Beam Geometry

Sample Moves → Diffracted Beam Moves → Diffraction Angle Doesn’t
In Grazing Incidence Geometry higher angle peaks are broaden due to asymmetric geometry.
Grazing Incidence in Parallel Beam Geometry
Parallel beam detection

• Crystal Analyzer
  – Perfect crystal (Si or Ge)

• Soller Slits
Parallel Beam Geometry with an analyzer

Gives the highest angular resolution
But Still the use of area detectors is on the rise

Question?