

Optimization of X-Ray Scattering for Characterization of Materials

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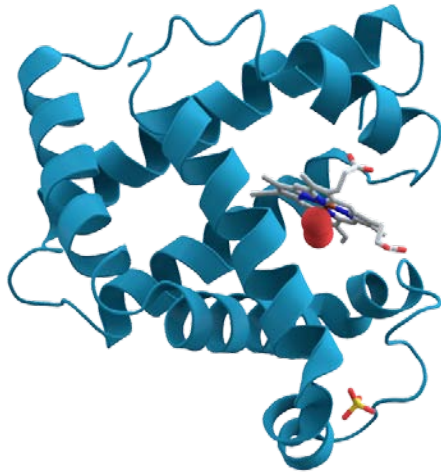
Faculty Advisor: Cyrus Safinya

Materials Research Laboratory

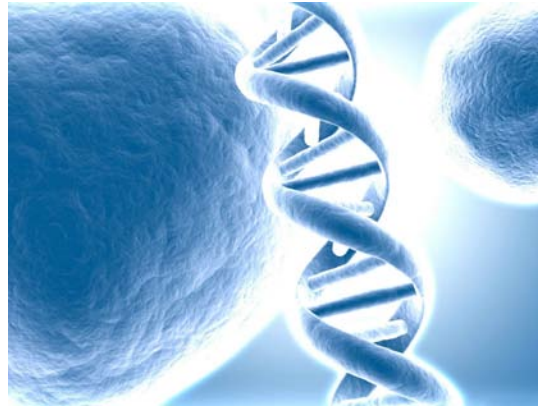
EUREKA, UC Santa Barbara

Thursday, August 11, 2012

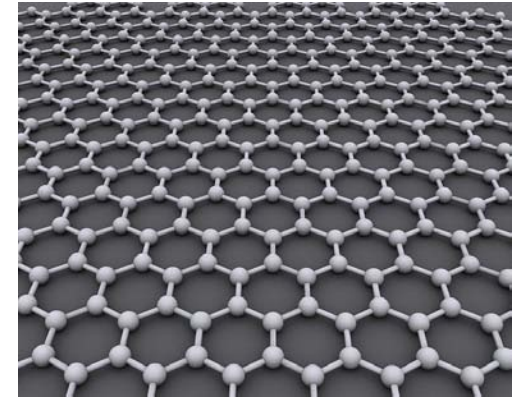
Small Angle X-ray Scattering (SAXS) is important and has a variety of real world applications



Protein



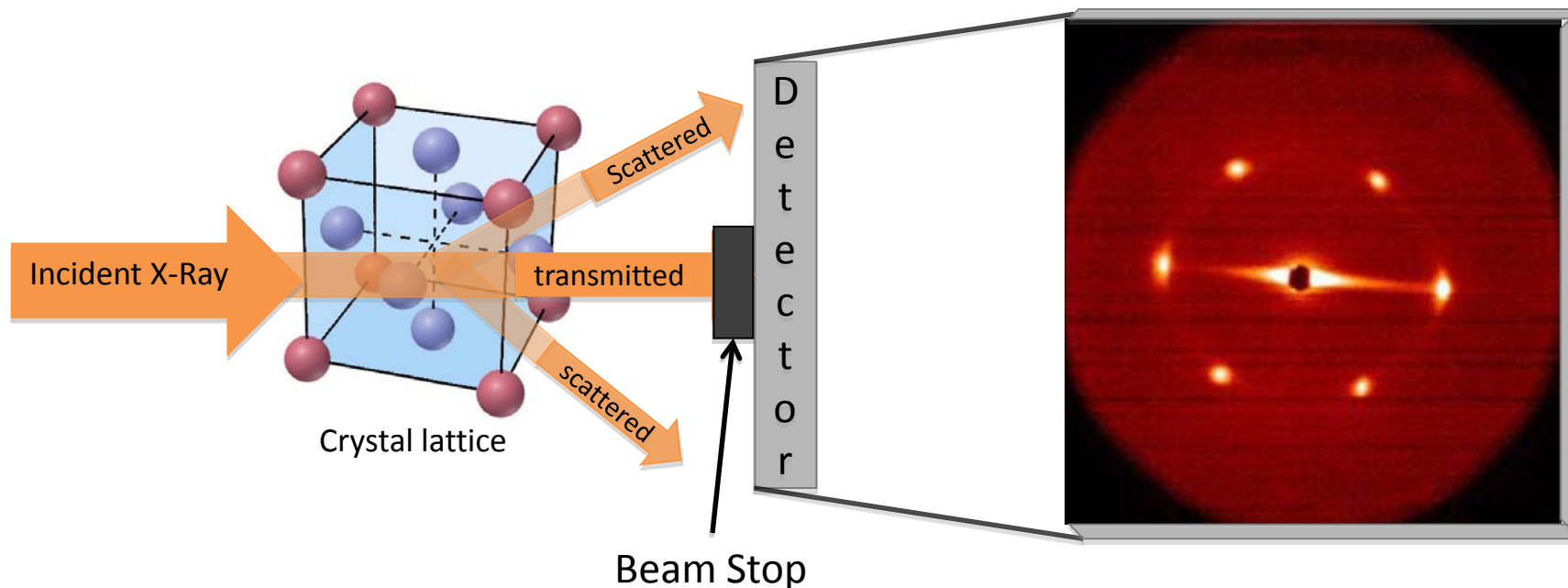
DNA



Graphene

- Allows scientist and engineers to manipulate materials to our benefit
- Biological materials as a vehicle for drug delivery.

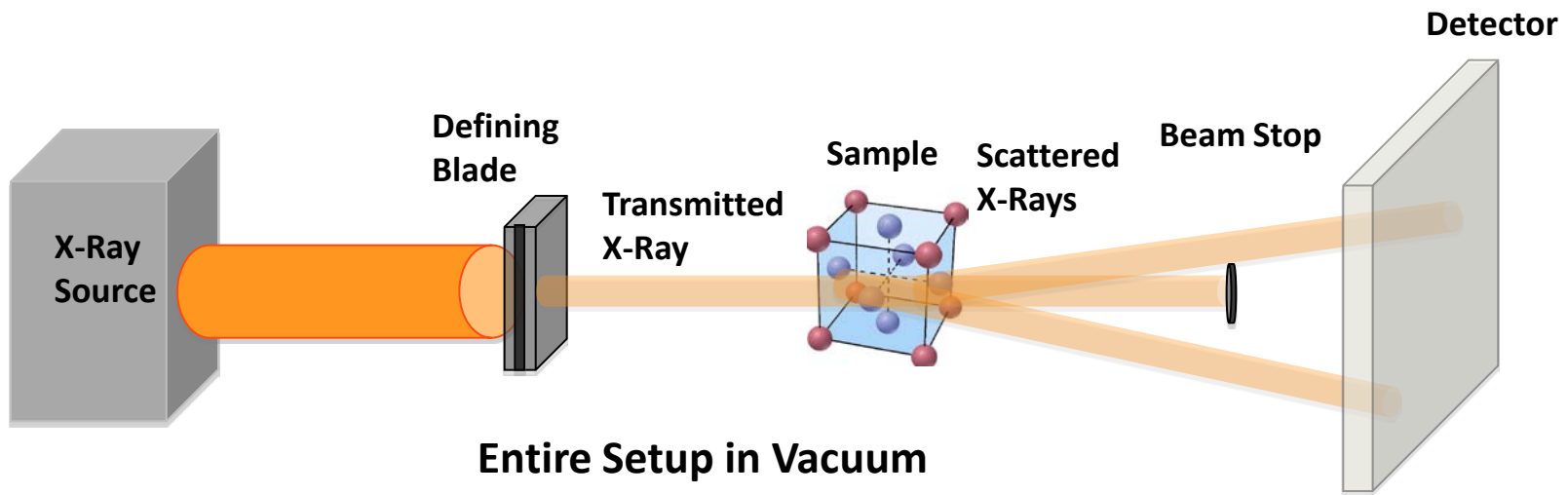
Interaction of X-Rays with matter provides useful information about the material



- Bragg Peak = Scattering
- X-Rays scatter off all materials, due to electron interaction.
 - undergo constructive interference in accordance to Bragg's law
- Precisely define incident X-Ray beam by controlling beam size and divergence

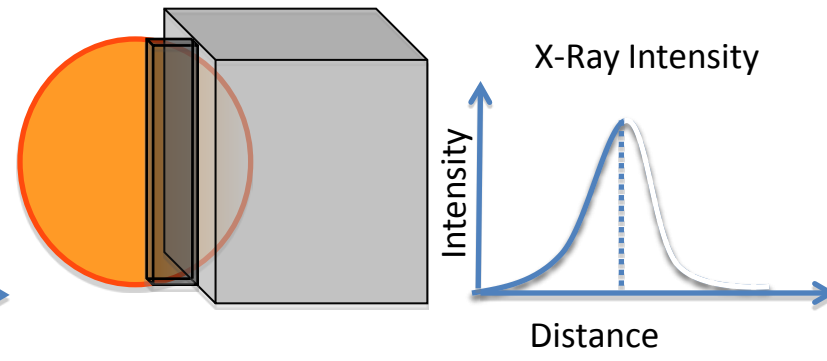
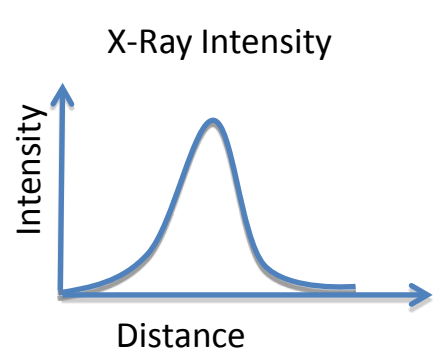
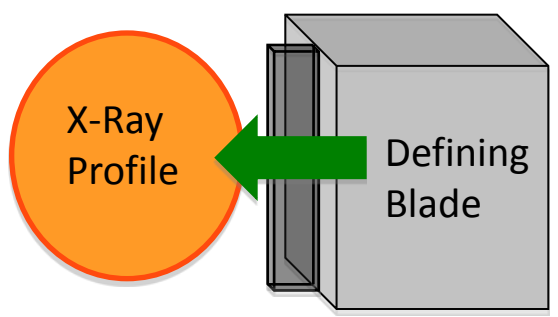
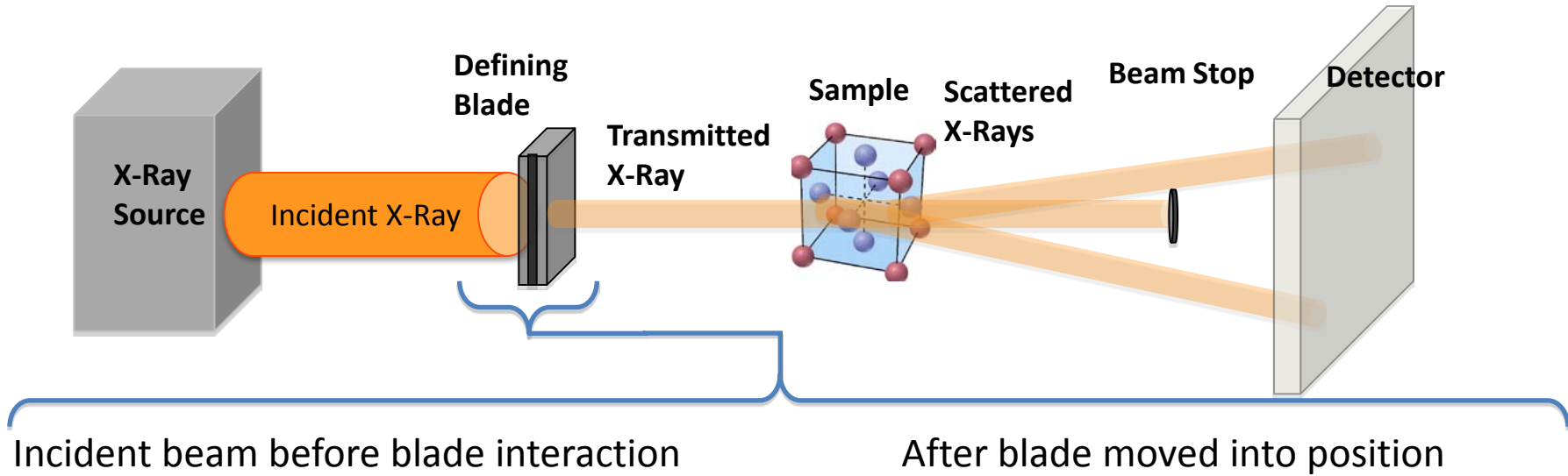
SAXS is a very powerful method in determining the **nanostructure** of materials

SAXS Setup



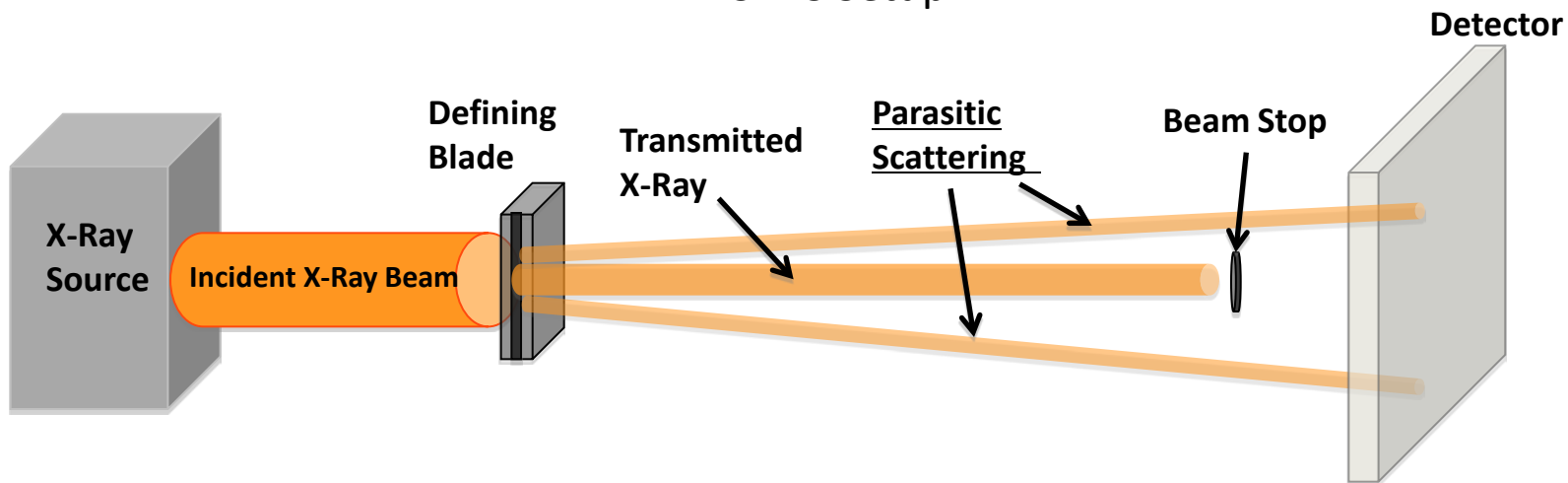
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SAXS Diffractometer Setup



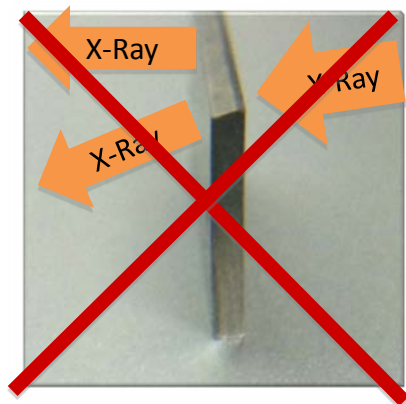
To optimize SAXS performance a better understanding of blade and beam interaction is necessary

SAXS Setup



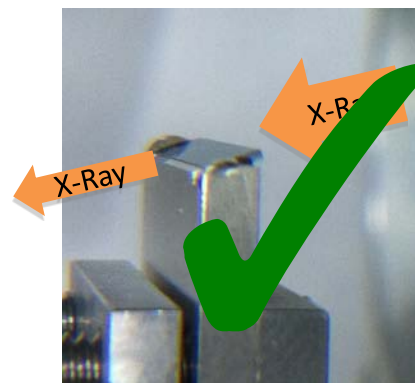
Bad

Aluminum Blade

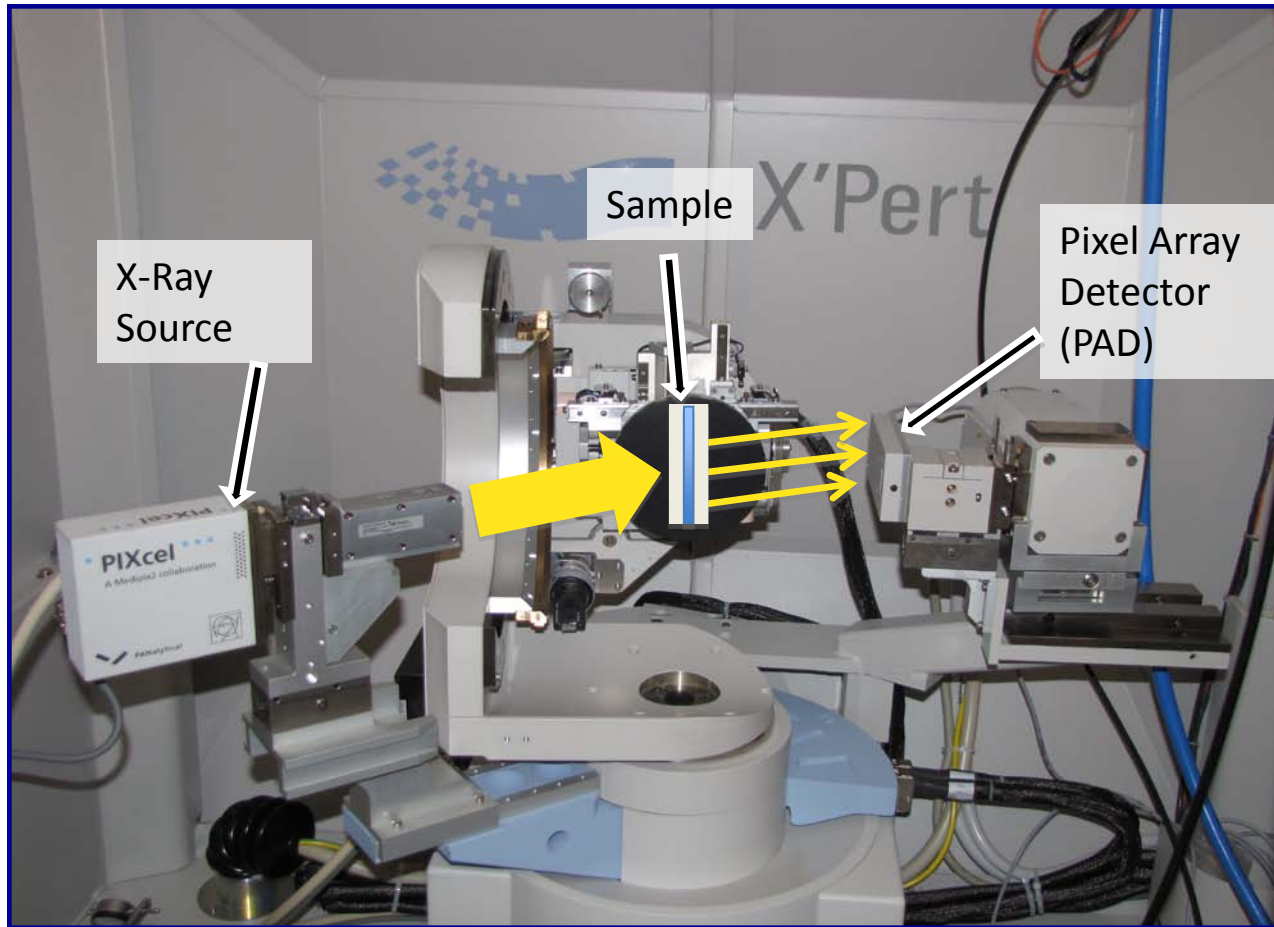


Good

Hybrid Single Crystal Blade



MRD PRO X'Pert Pro has no beam stop, thus allows for better view of defined X-Ray beam



X'Pert Pro not in vacuum!

Candidate material for hybrid scatterless slit

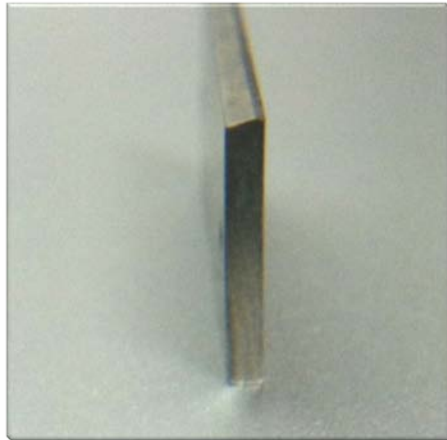
- Significant factors:
 - **X-Ray Attenuation for slit and base**
 - Ability to stop X-Rays
 - Correlated to density
 - **Strongest reflection angles (pitch angles)**
 - Angle on base tapered edge

Candidate Materials Properties:

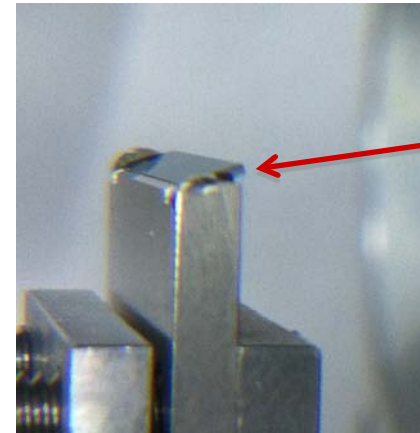
Material:	Tungsten	Silver	Germanium	Aluminum
Density [g/cm ³]	19.3	10.49	5.32	2.70
X-Ray Attenuation Length [μm]	3.13	4.57	28.12	78.26
Crystal Structure	BCC	FCC	FCC	FCC

Newly designed scatterless slits have proven to **drastically reduce** slit scattering...

Aluminum Blade (no crystal)

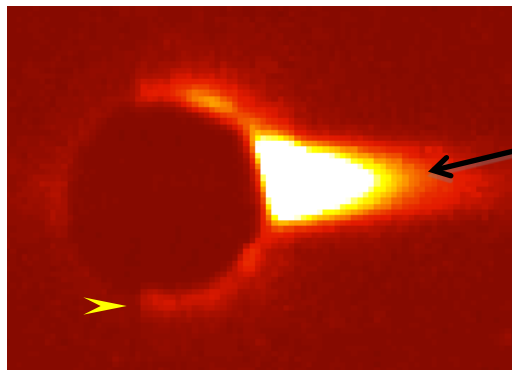


Hybrid Blade



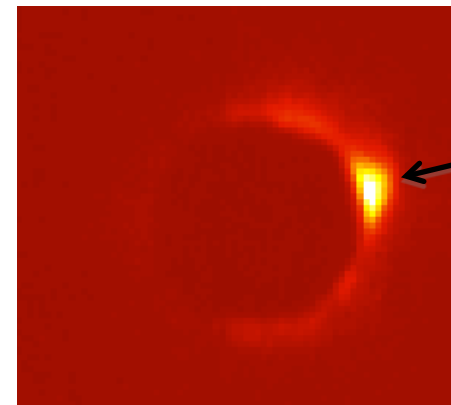
Single Ge Crystal

Aluminum Blade Scattering



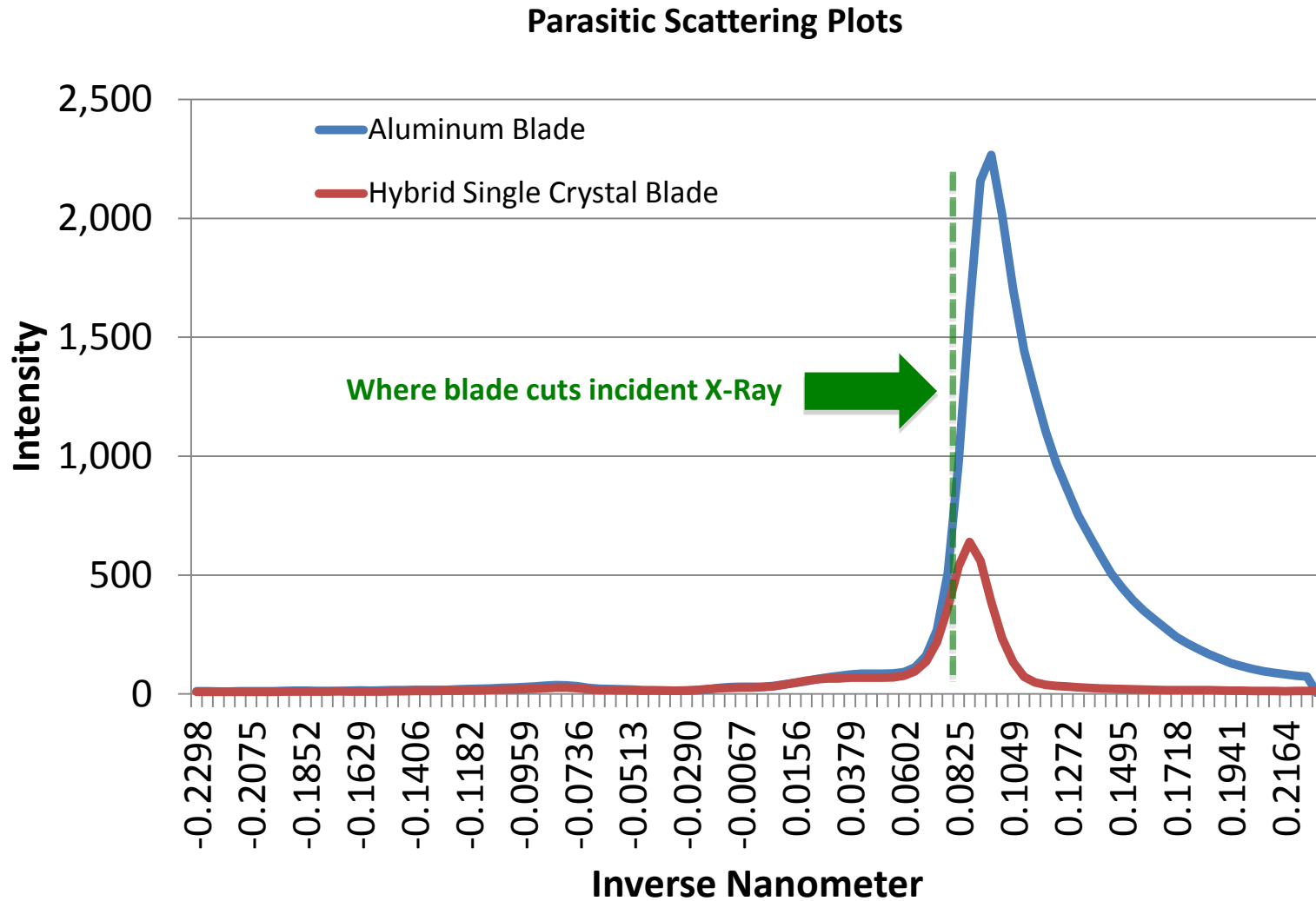
Scattering

Hybrid Blade Scattering



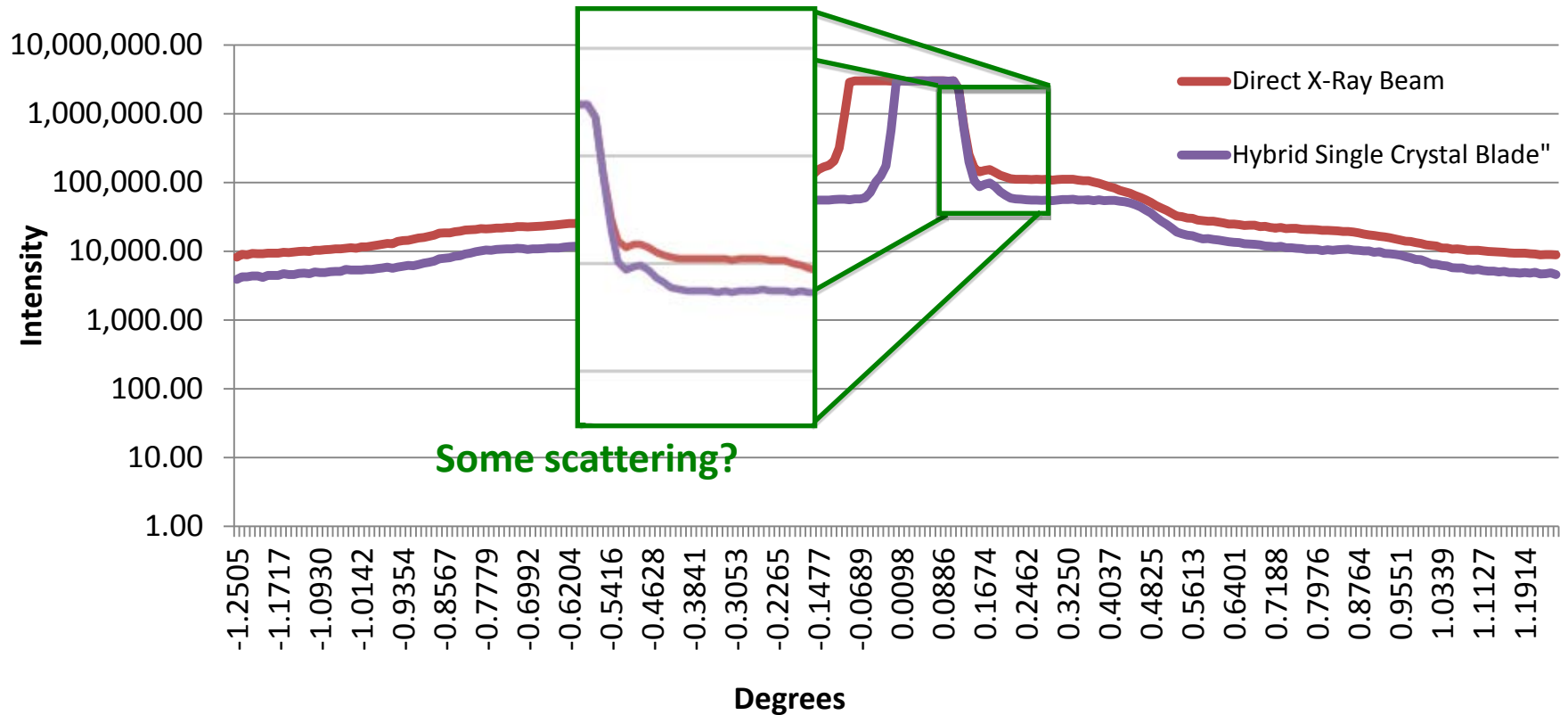
Scattering

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MRD X'Pert Pro allows us to characterize the X-ray beam profile for optimal use

Full X-Ray Beam Profiles



- Scattering slightly detected
- Incident X-ray beam too intense to analyze any scattering
- Air scattering another issue
- Further data is being processed to bring about better results

Summer research has lend to much insight

- The MRD Pro setup is providing insight into X-ray beam profile
 - Further investigation into experimental setup necessary.
- Many candidate materials to analyze
 - X-Ray attenuation, crystal smoothness, pitch angle etc
- Plan on continuing my research in the Fall in hopes of achieving optimal beam definition.

Acknowledgements

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- MRL Facilities

