

# **Large Area CCD Detector Systems**

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# What is a “Large Area” Detector ?

**Area**

**Bigger than 200 mm by 200 mm**

**Divided into**

**More than 3000 by 3000 pixels**

# Basic Detector Types

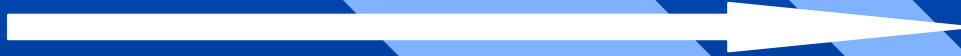
Film and “Film-like” Detectors

Lens-based CCD Detectors

Fiberoptic-based CCD Detectors

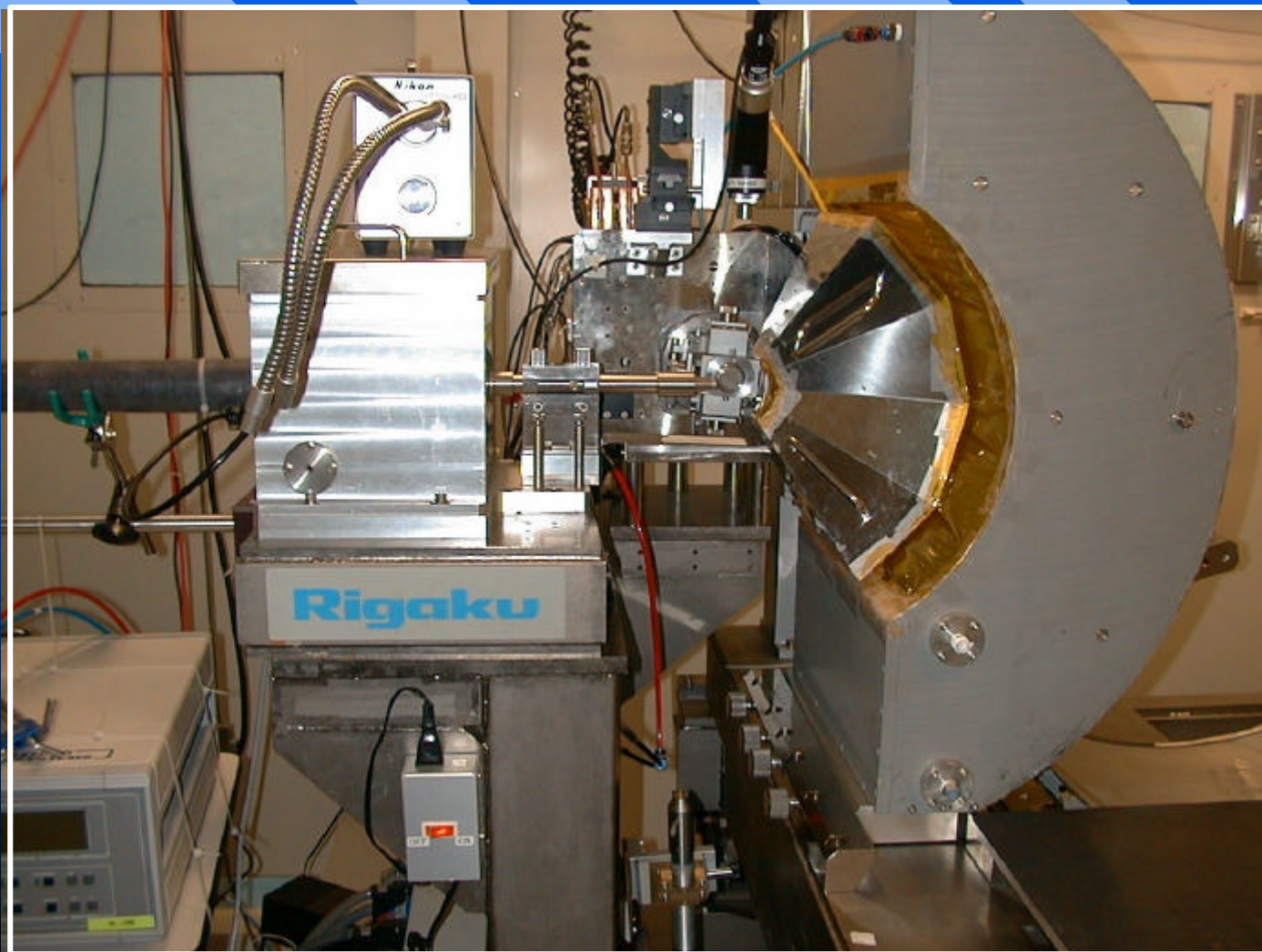
# Film and “Film-like” Detectors

*X-rays*



**Detector**

# Weissenberg Image Plate Detector at Photon Factory



# Generic Flat Panel Detector for Medical Xrays

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 **DirectRay**  
TECHNOLOGY



**DirectRay**

Technology

The DirectRay direct-to-digital image capture detector introduces a step-change in productivity, enabling conventional radiographic imaging to go from a film-based system to a quick, easy and effective digital system. Clinical tests have found that DirectRay images are equal to the best screen-film and computed radiography systems over the full range of general radiography exams.

DirectRay detector uses a direct conversion process that is simple, yet elegant. Simplicity stems from its direct capture and conversion of x-ray energy into electrical signals. No light-emitting materials, intermediate steps or additional processes are required to capture and convert the incident x-ray energy. Elegance is shown by the consistent high quality of the image data it captures.



Digital Radiography Systems

DirectRay Technology

Direct vs. Indirect Image Capture

Image Quality

Productivity

Evolution of Digital Imaging

Published Research

White Paper

35cm by 43cm

2560 by 3072  
pixels

“Sharpness of  
[ASA] 100 speed  
film When exposed  
at 400 speed”

# Special Requirements for Protein Crystallography at Synchrotrons

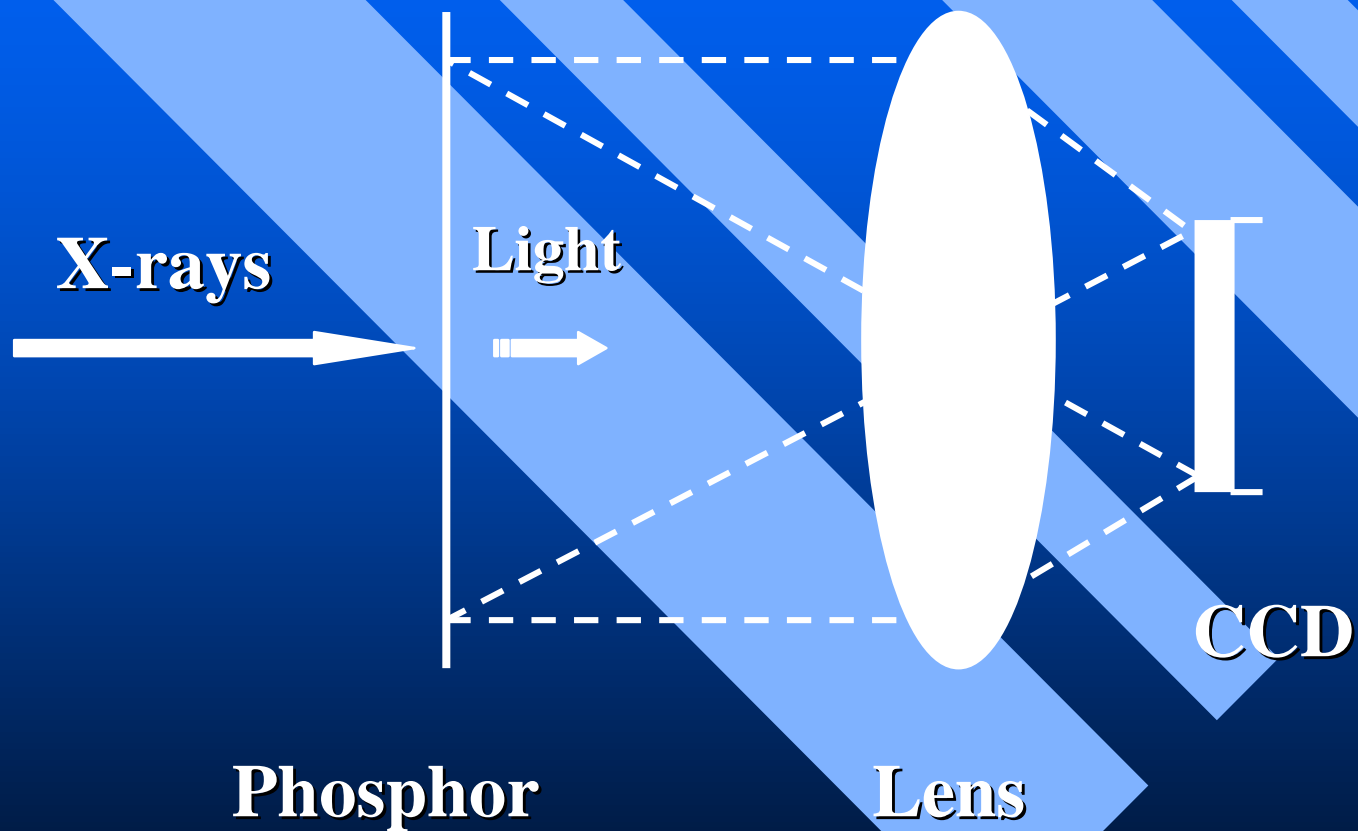
- ✍ **1 second** readout time
- ✍ Sensitivity at least **10X** film
- ✍ Resolution of at least **400** Diffraction orders
- ✍ Full capability to do **MAD** data collection

# Film and “Film-like” detectors

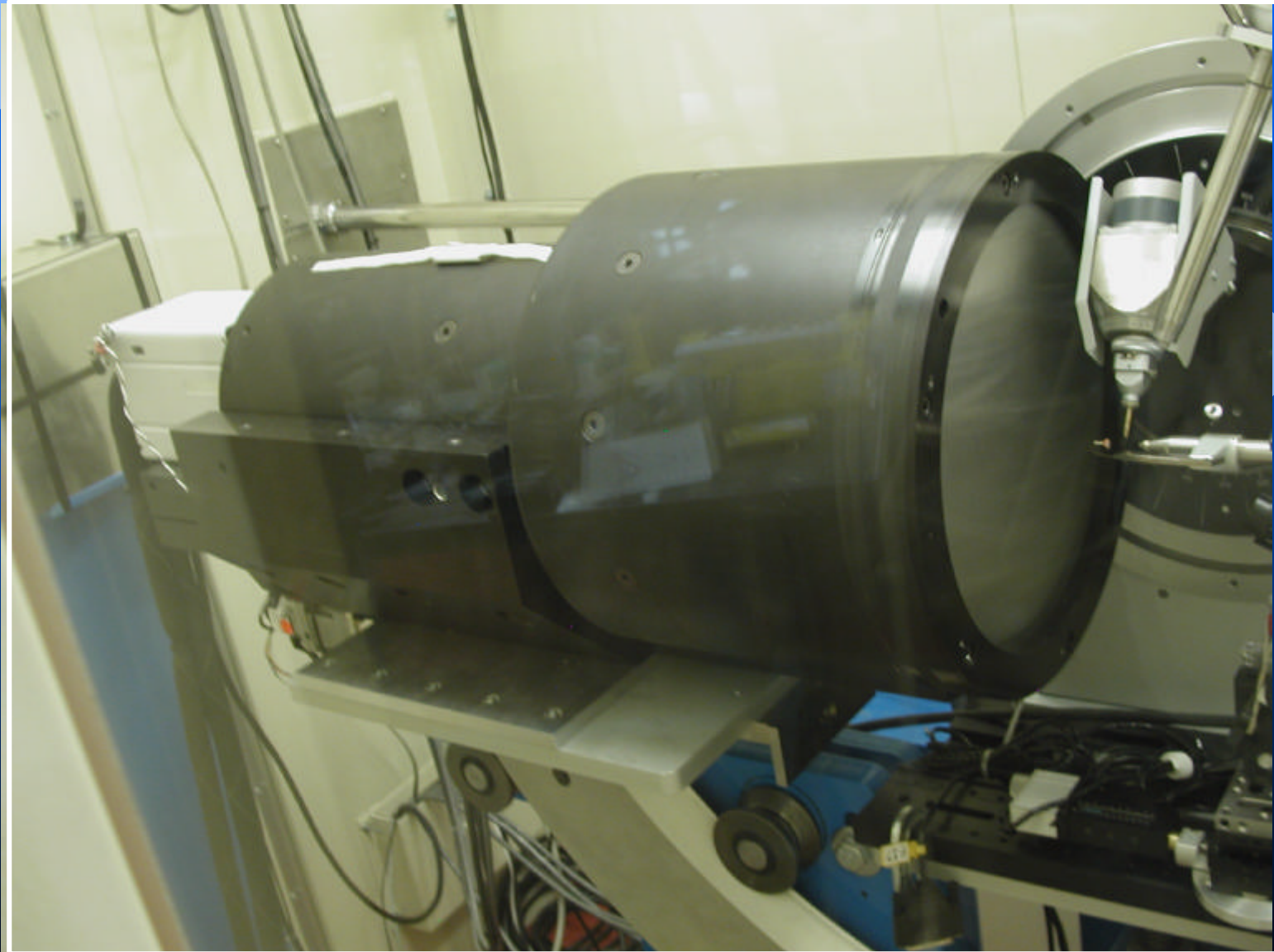
	1 sec readout	10X film	400 orders	for OK MAD
Film	<b>NO</b>	-----	<b>YES</b>	<b>?</b>
I.P.	<b>NO</b>	<b>YES</b>	<b>YES</b>	<b>YES</b>
Panel	<b>(?)</b>	<b>(?)</b>	<b>(YES)</b>	<b>NO</b>
P.A.D.	<b>(YES)</b>	<b>(YES)</b>	<b>(YES)</b>	<b>(YES)</b>



# Lens-based CCD Detectors



# Brucker Proteum



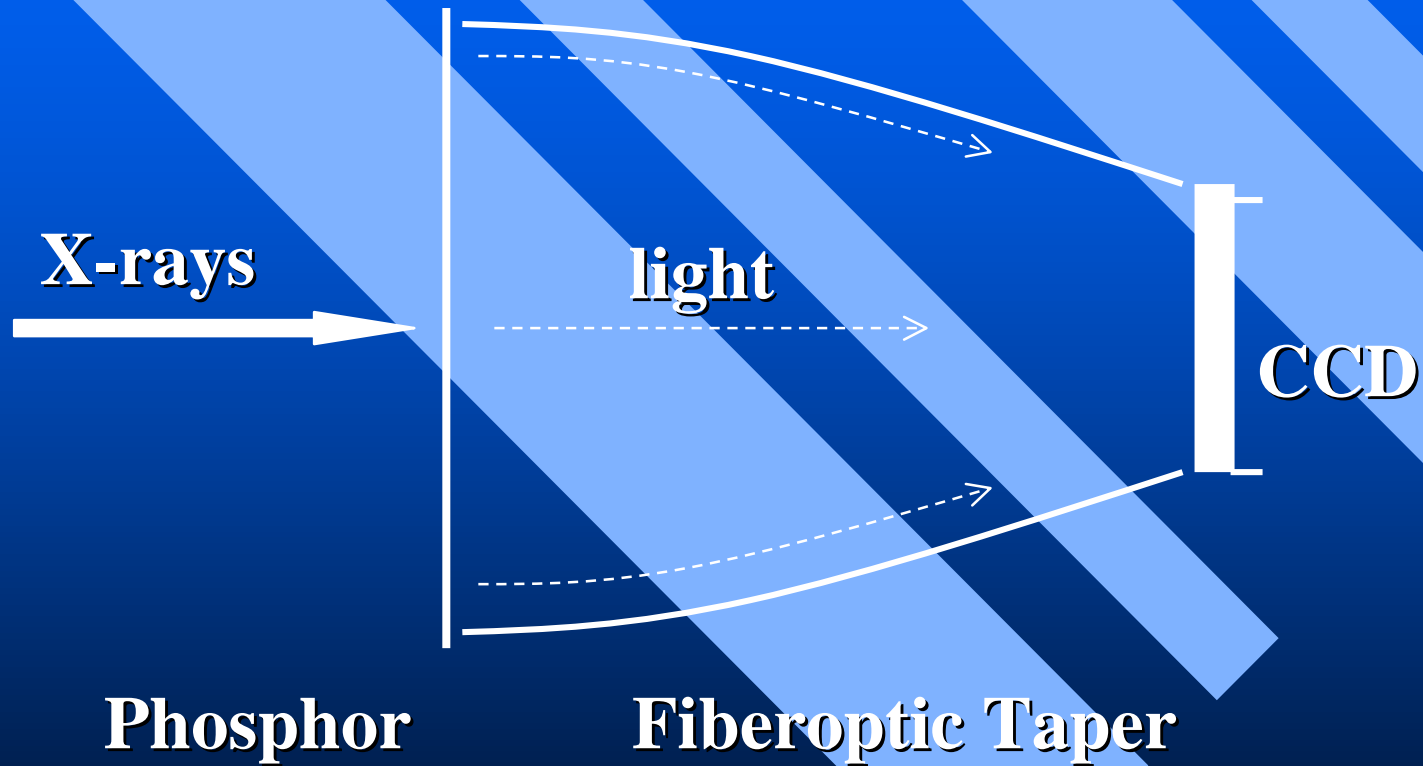
# Large Lens-based CCD detector

	1 sec readout	10X film	400 orders	OK for MAD
Proteum	NO	Yes	NO	?

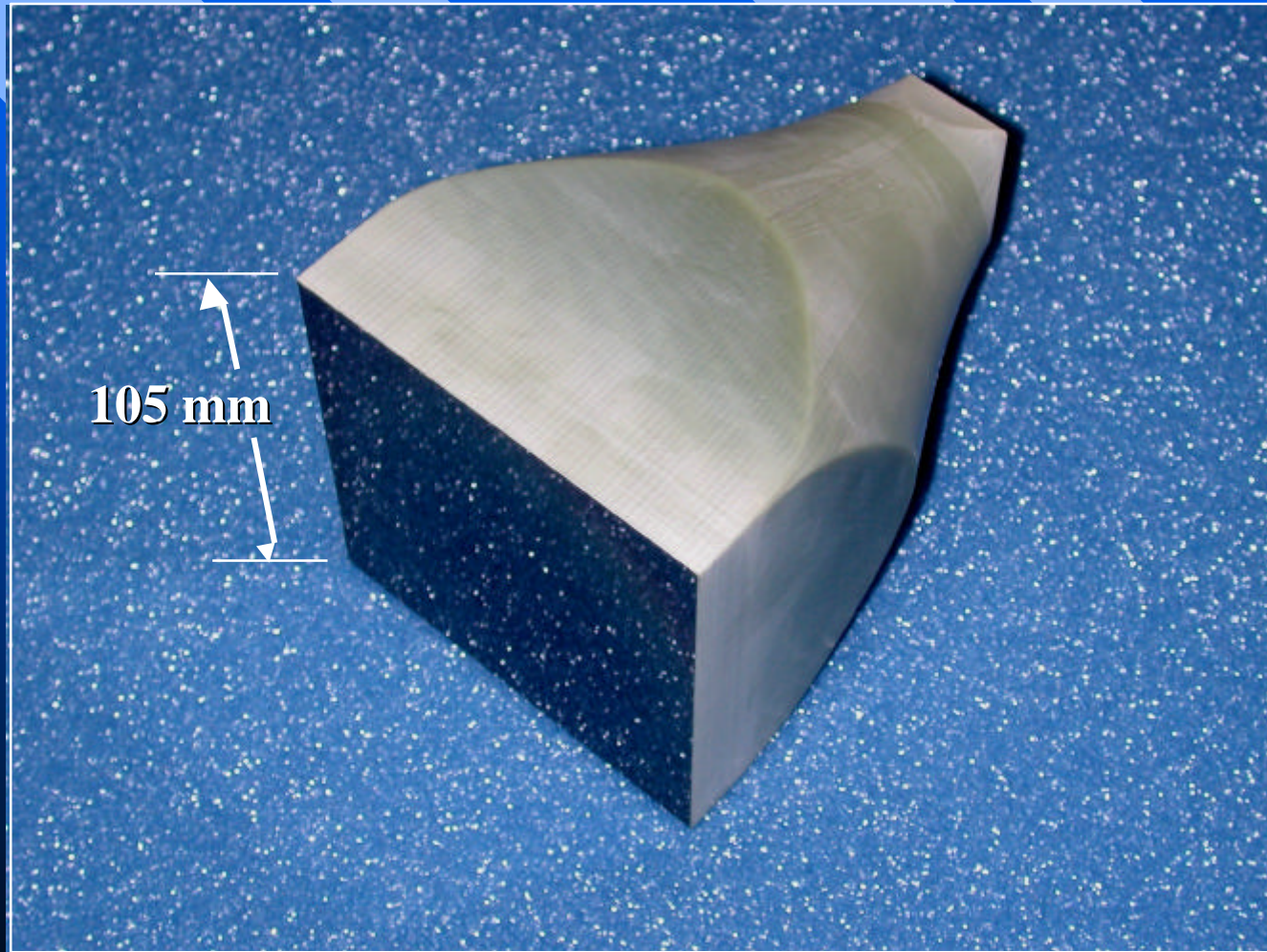
# Fiberoptic Tapers



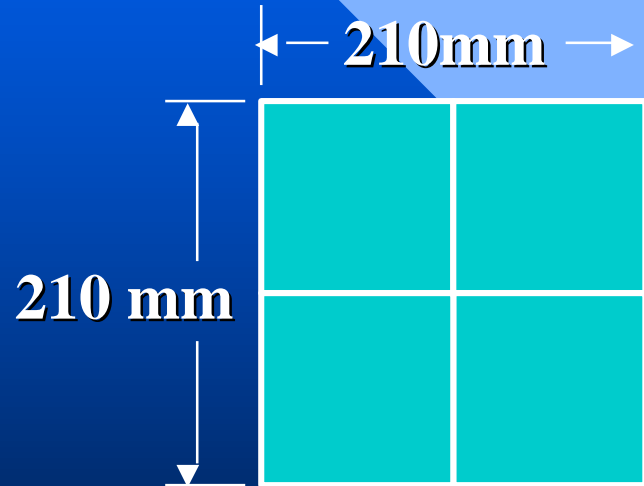
# Fiberoptic-based CCD Detectors



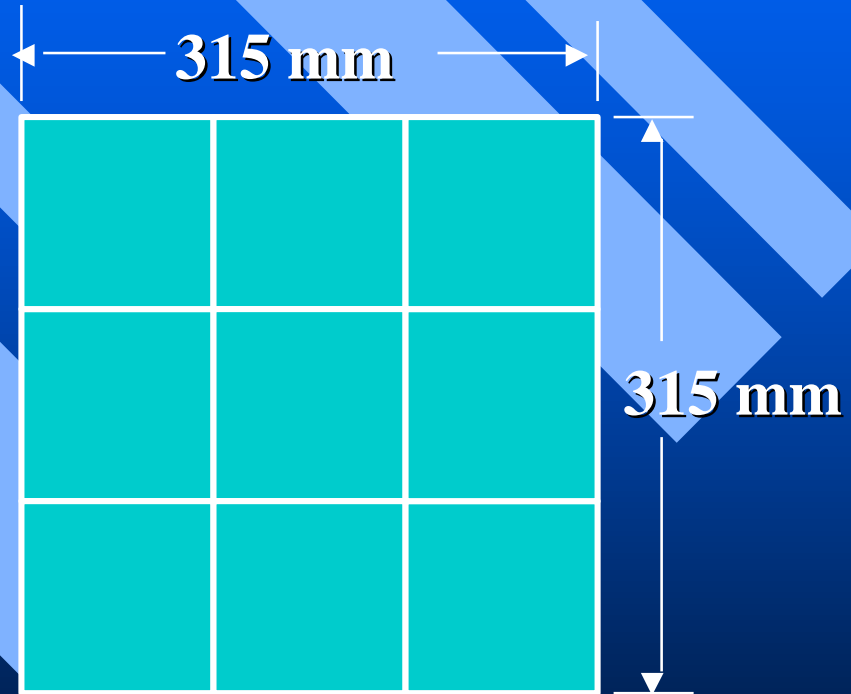
# Single Fiberoptic taper cut square for use in an array



# Arrays of fiberoptic tapers required to achieve large area

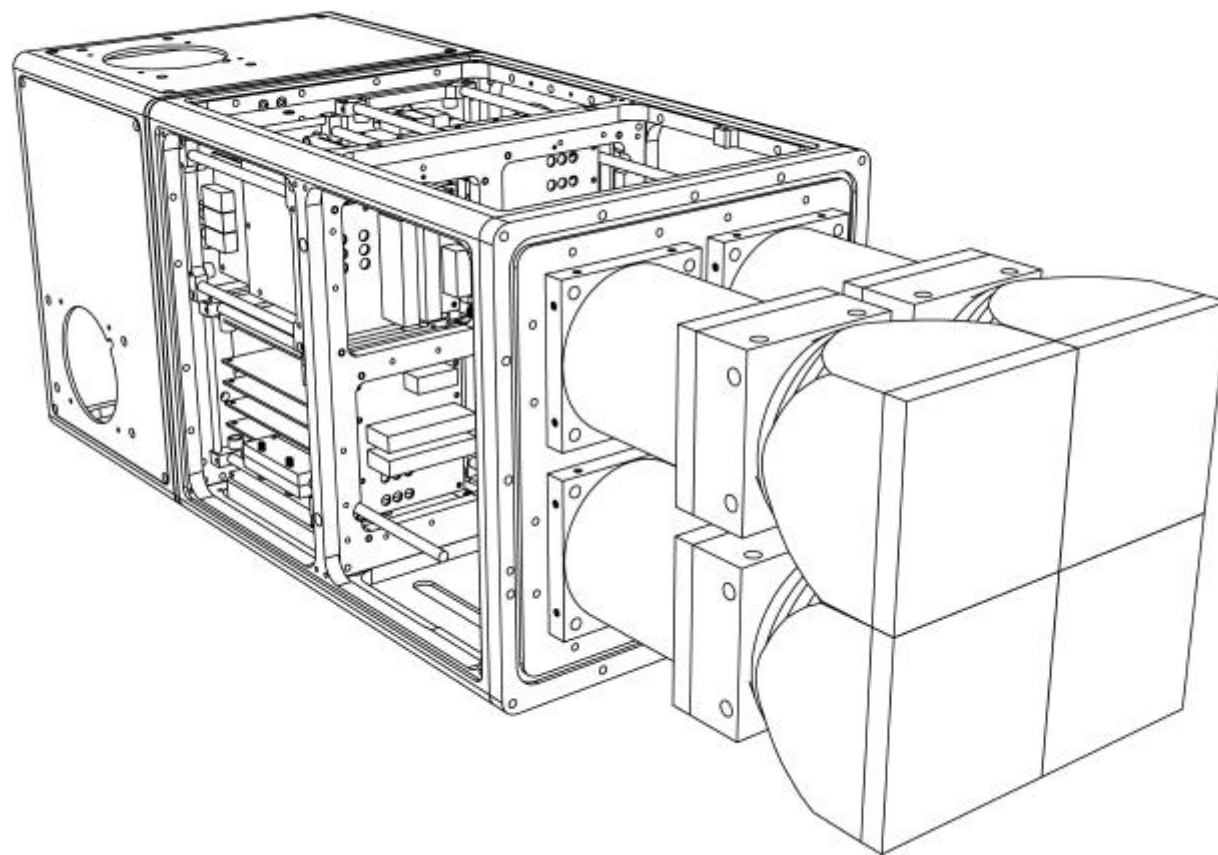


**Quantum 210**  
**4K by 4K**



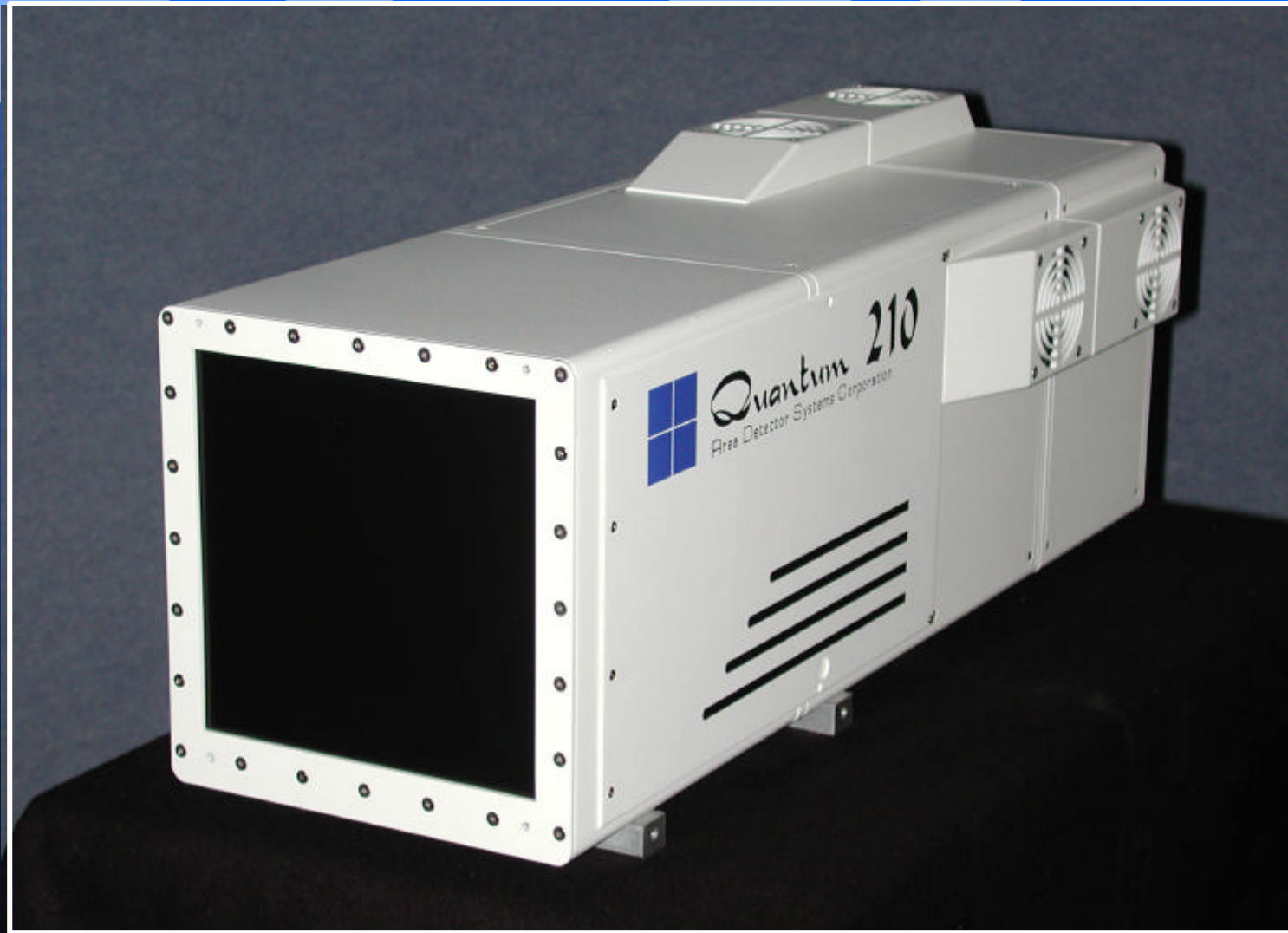
**Quantum 315**  
**6K by 6K**

# Quantum 210

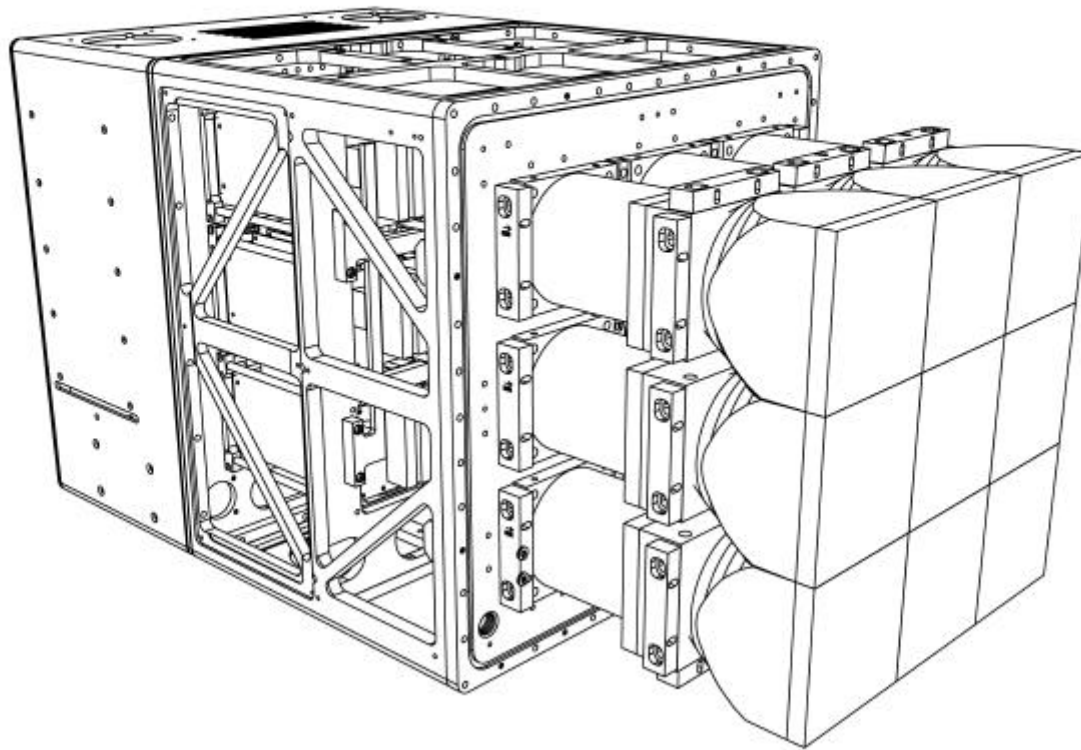




# Quantum 210



# CAD drawing of Quantum 315



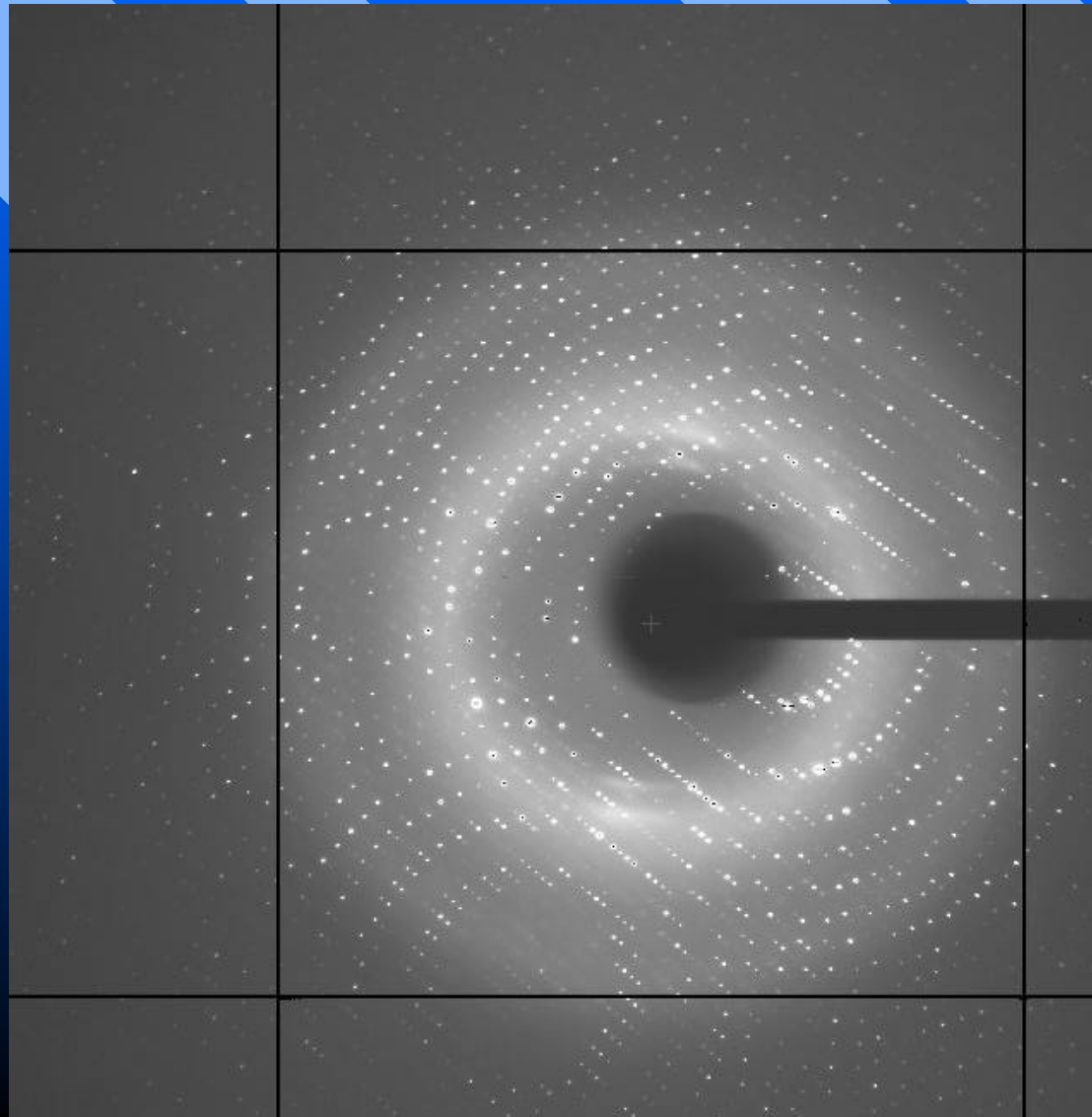
# Quantum 315 at SSRL



# Specifications

	Quantum 210	Quantum 315
<b>Array Size</b>	<b>2 by 2</b>	<b>3 by 3</b>
<b>dimensions</b>	<b>210 by 210 mm</b>	<b>315 by 315 mm</b>
<b>pixels</b>	<b>4K by 4K</b>	<b>6K by 6K</b>
<b>Full Resolution Readout time</b>	<b>1 second</b>	<b>1 second</b>
<b>Raw image size</b>	<b>36 MB</b>	<b>80 MB</b>
<b>D.R. full res.</b>	<b>16,000 : 1</b>	<b>16,000 : 1</b>
<b>D.R. 2x2 sw bin</b>	<b>30,000 : 1</b>	<b>30,000 : 1</b>

# Part of an image from a Quantum 315



# Are large fiberoptic-based CCD detectors suitable for SR protein crystallography ?

	1 sec readout	10X film	400 orders	OK for MAD
Quantum 210	YES	YES	YES	YES
Quantum 315	YES	YES	600	YES

# Current Installations as of 15 Feb. 03

	Quantum 210	Quantum 315
ALS Berkeley	3	2
APS Chicago	1	1
Brookhaven	1	2
CHESS	2	
ESRF	1	
PhotonFactory	1	
SSRL		3
<b>Totals</b>	<b>9</b>	<b>8</b>

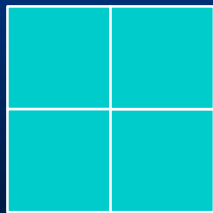
*de novo* Protein Structures solved  
using Q210 and Q315 data  
from 2 of the 17 installed detectors

	MAD	Other	Contact
<b>APS</b> 1 Q315	10	14	<b>Malcolm Capel</b> (630) 252-0638 Capel@slate.imm.aps.anl.gov
<b>ALS</b> 1 Q210	30	100	<b>James Holton</b> (510) 468-4587 (510) 928 5556

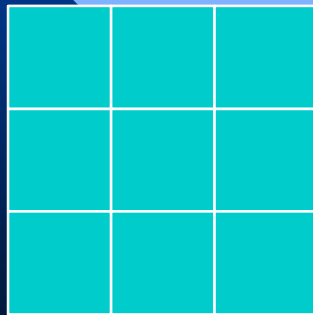


# Possible further improvements in CCD detector systems

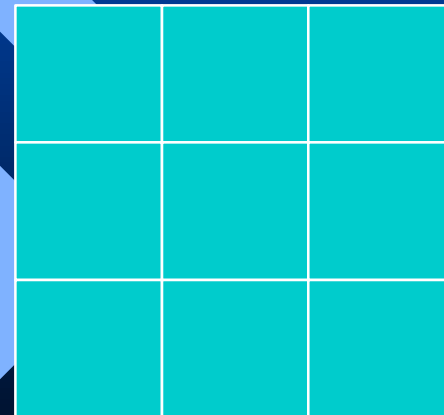
- ✍ Even bigger area
- ✍ Even faster readout
- ✍ Even better sensitivity



Quantum 210



Quantum 315



Quantum 420

# Cost of Detector Size and Speed



# Summary

Given today that we can build CCD-based detector systems with active area of  $(315 \text{ mm})^2$  by and 1.0 sec readout time, would there be a technical need to increase the area and speed up to  $(420 \text{ mm})^2$  and 0.4 sec? Even if this requires a price increase of 50% ?

