Detector needs and requirements for Protein Crystallography

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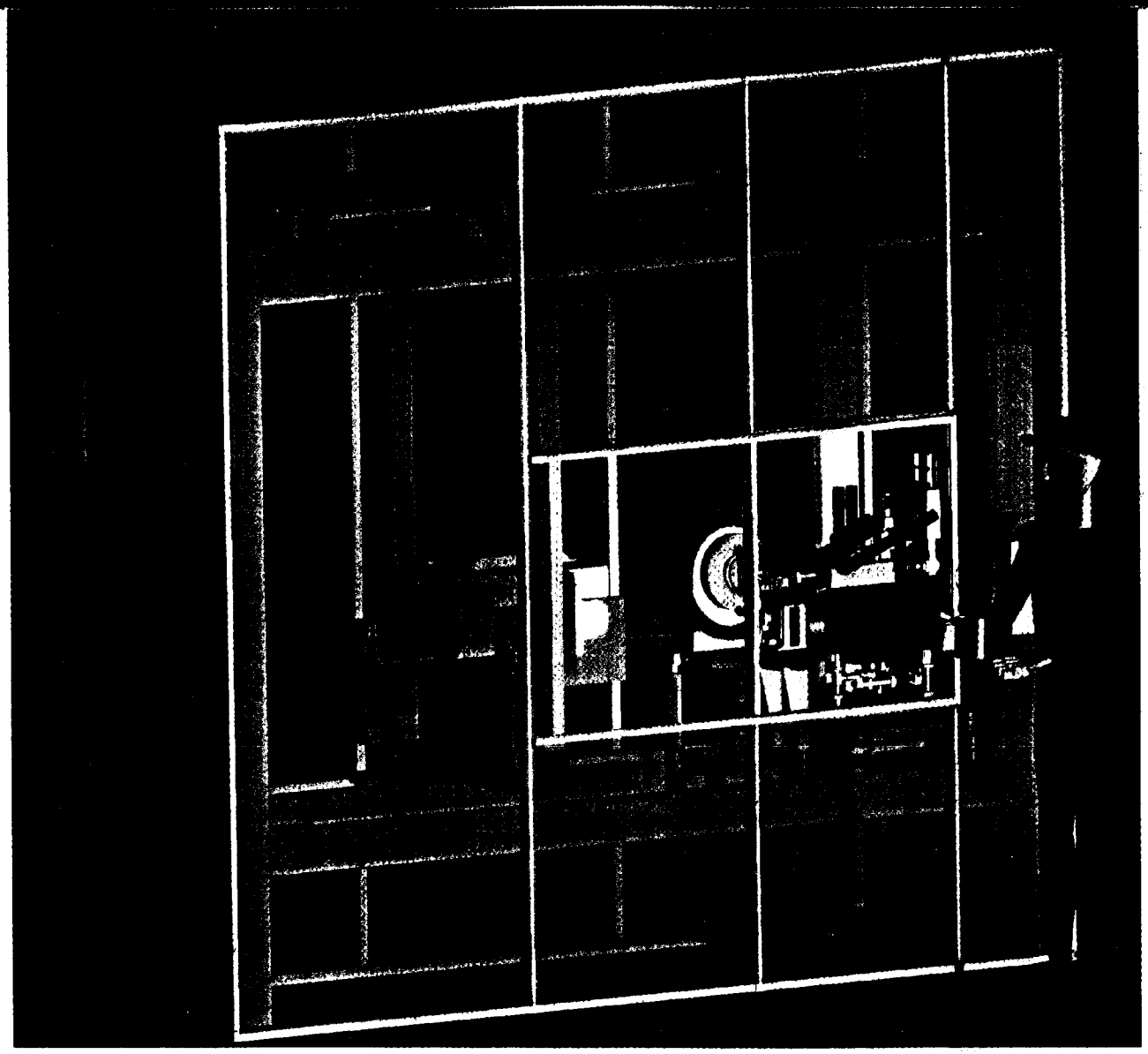
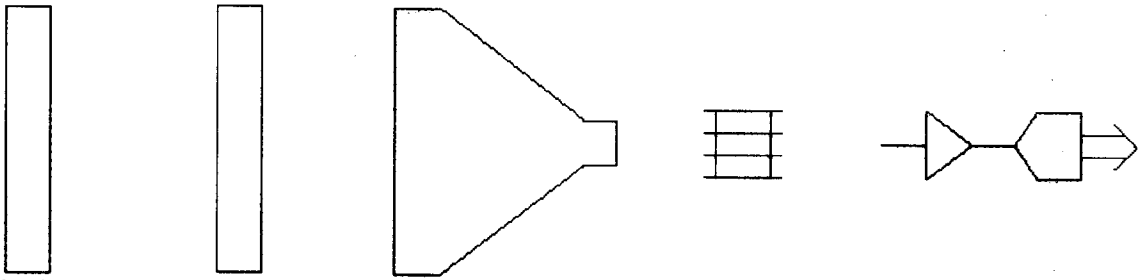
Film
Multiwire
Imaging plates
CCDs
Pixel array detectors

Minihutches for Superbend PX beamlines



CCD vs. Pixel detectors

CCD Detector



16 bits

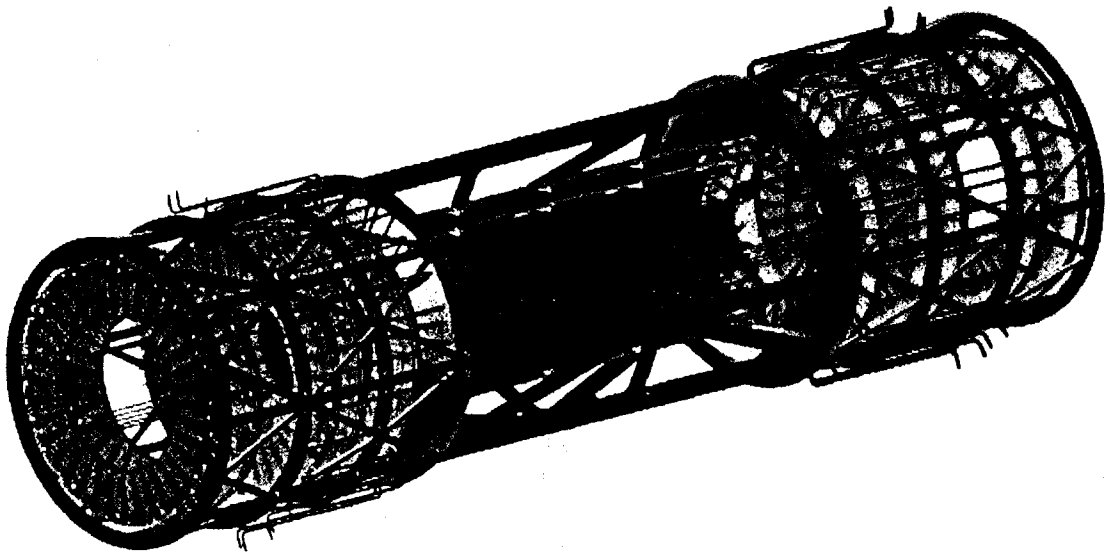
	Window	Phosphor	Taper	CCD	Preamp + Digitizer	Histogram Memory
Gain:	T_W	$Q_S M_S$	T_T	$Q_{CCD} M_{CCD}$	M_{DIG}	
Variance:	N_S^2			N_{CCD}^2	N_{DIG}^2	

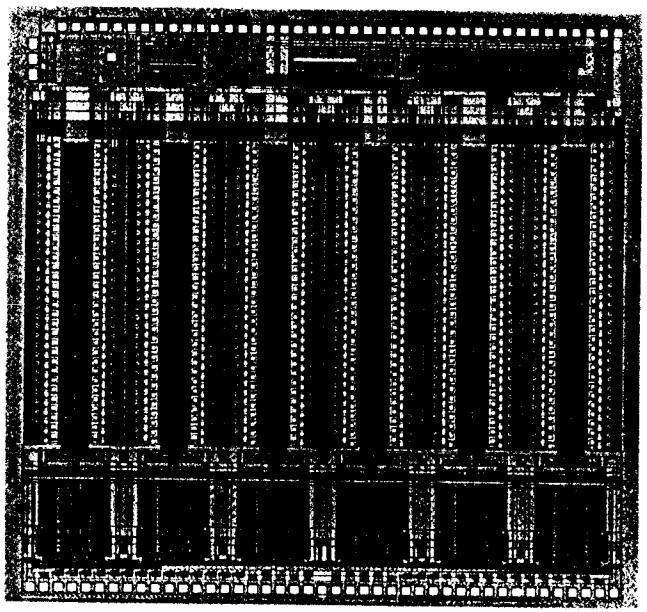
Pixel Detector

16, 32, 64 bits

	Photodiode	Preamp + Discriminator	Histogram Memory
Gain:	$Q_{PD} M_{PD}$	M_e	
Variance:	N_{PD}^2	N_e^2	

Atlas pixel detector

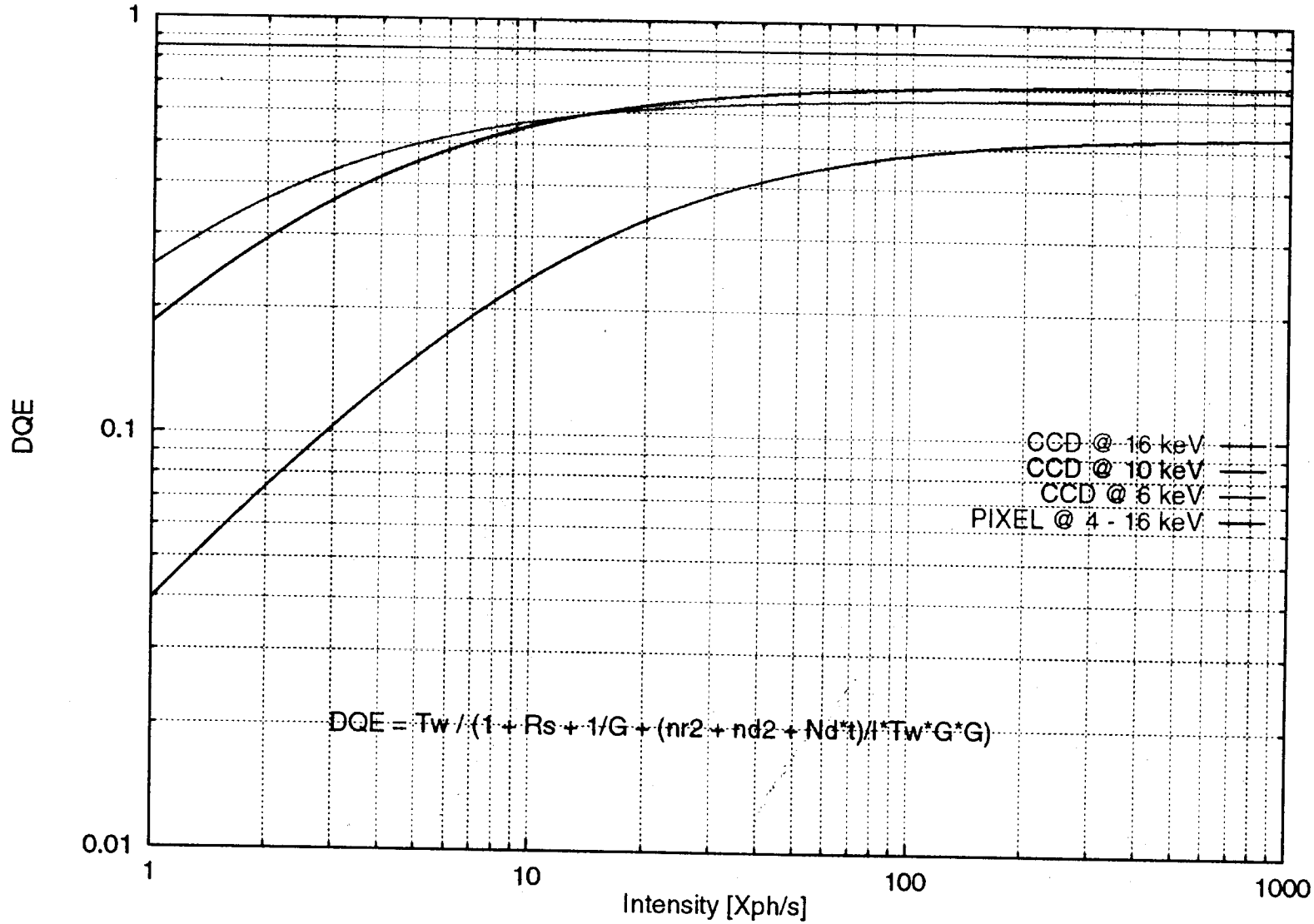




Signal and Noise

Description	Parameter	Digital Pixel Detector	APS CCD Detector
Total Noise, (N_T), (10 second exposure):	6 keV	0 XPh/pixel	3.5 XPh/pixel
	12 keV	0 XPh/pixel	1.7 XPh/pixel
	18 keV	0 XPh/pixel	1.2 XPh/pixel
Minimum detectability, (10 second exposure):	6 keV	1 XPh/pixel 0.1 XPh/s	18 XPh/pixel, (=5N_T) 1.8 XPh/s (CALCULATED)
	12 keV	1 XPh/pixel 0.1 XPh/s	9 XPh/Pixel, (=5N_T) 0.9 XPh/s
	18 keV	1 XPh/pixel 0.1 XPh/s	6 XPh/Pixel, (=5N_T) 0.6 XPh/s
Maximum signal, (S_M), (10 second exposure):	6 keV	2^{32} XPh/pixel, 6,554 XPh/s	78,000 XPh/pixel, 7,800 XPh/s
	12 keV	2^{32} XPh/pixel, 6,554 XPh/s	39,000 XPh/pixel, 3,900 XPh/s
	18 keV	2^{32} XPh/pixel, 6,554 XPh/s	26,000 XPh/pixel, 2,600 XPh/s
Detective quantum efficiency, (DQE), (@12 keV)	@ 0.1% max. signal	95%, 6.6 XPh/s	42%, 3.9 XPh/s
	@ 1% max. signal	95%, 65.5 XPh/s	65%, 39 XPh/s
	@ 10% max. signal	95%, 655.4 XPh/s	70%, 390 XPh/s
	@ 100% max. signal	95%, 6,554 XPh/s	70%, 3,990 Xph/s

Data Acquisition Throughput

Description	Parameter	Digital Pixel Detector	APS CCD Detector
Readout time	1 x 1 unbinned:	1.0×10^{-5} s	1.7 s (3.2 μs/pixel)
	2 x 2 binned	N/A	0.4 s
Duty cycle, 10 second exposure	1 x 1 unbinned:	99%	85%
	2 x 2 binned	N/A	96%
Duty cycle, 1 second exposure	1 x 1 unbinned:	99%	37%
	2 x 2 binned	N/A	71%
Frame size	1 x 1 unbinned:	4 Megabytes	18 Megabytes
	2 x 2 binned	N/A	4.5 Megabytes

DQE as a Function of Intensity, 10 second exposure