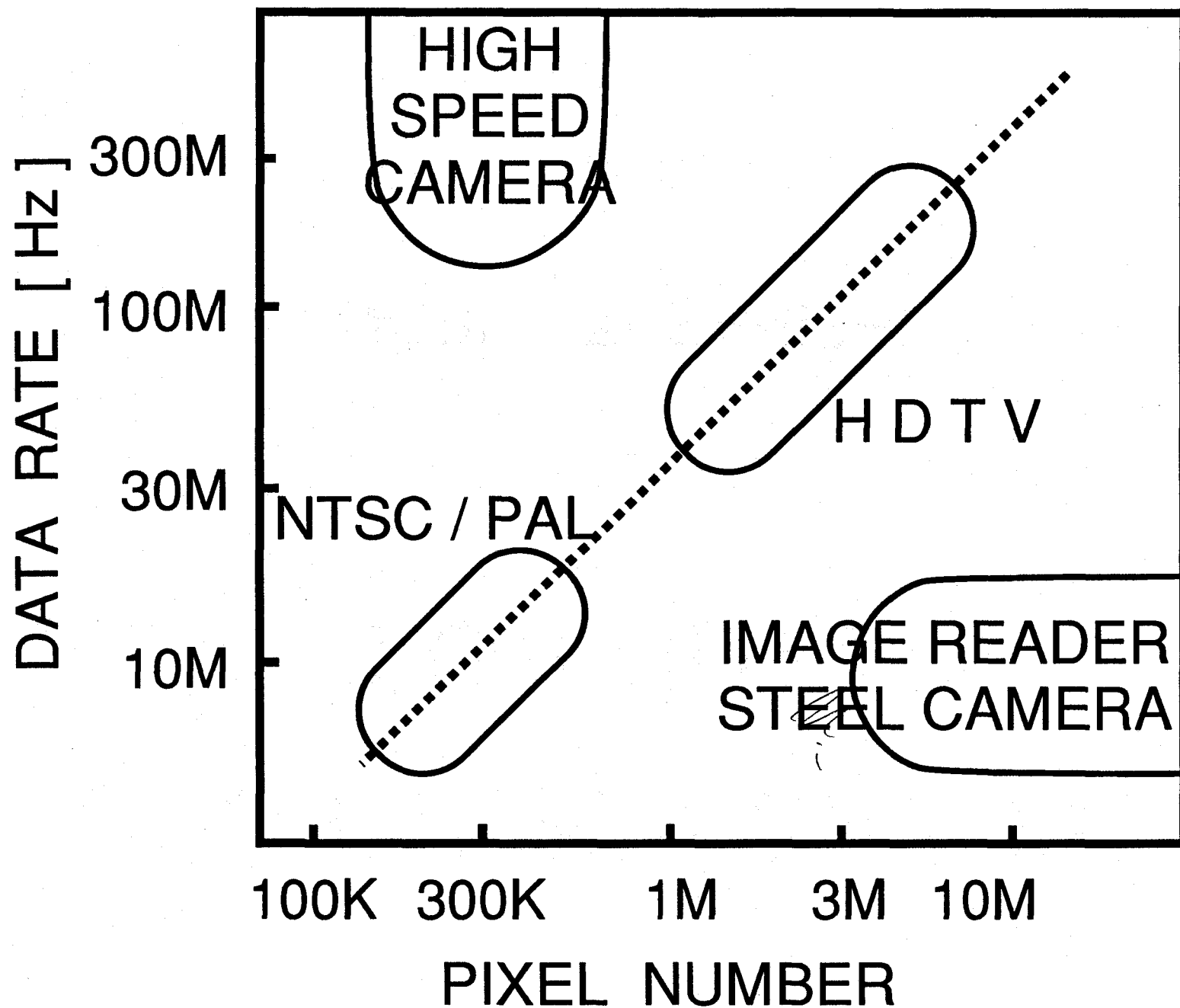


CCD IMAGE SENSORS FOR HDTV

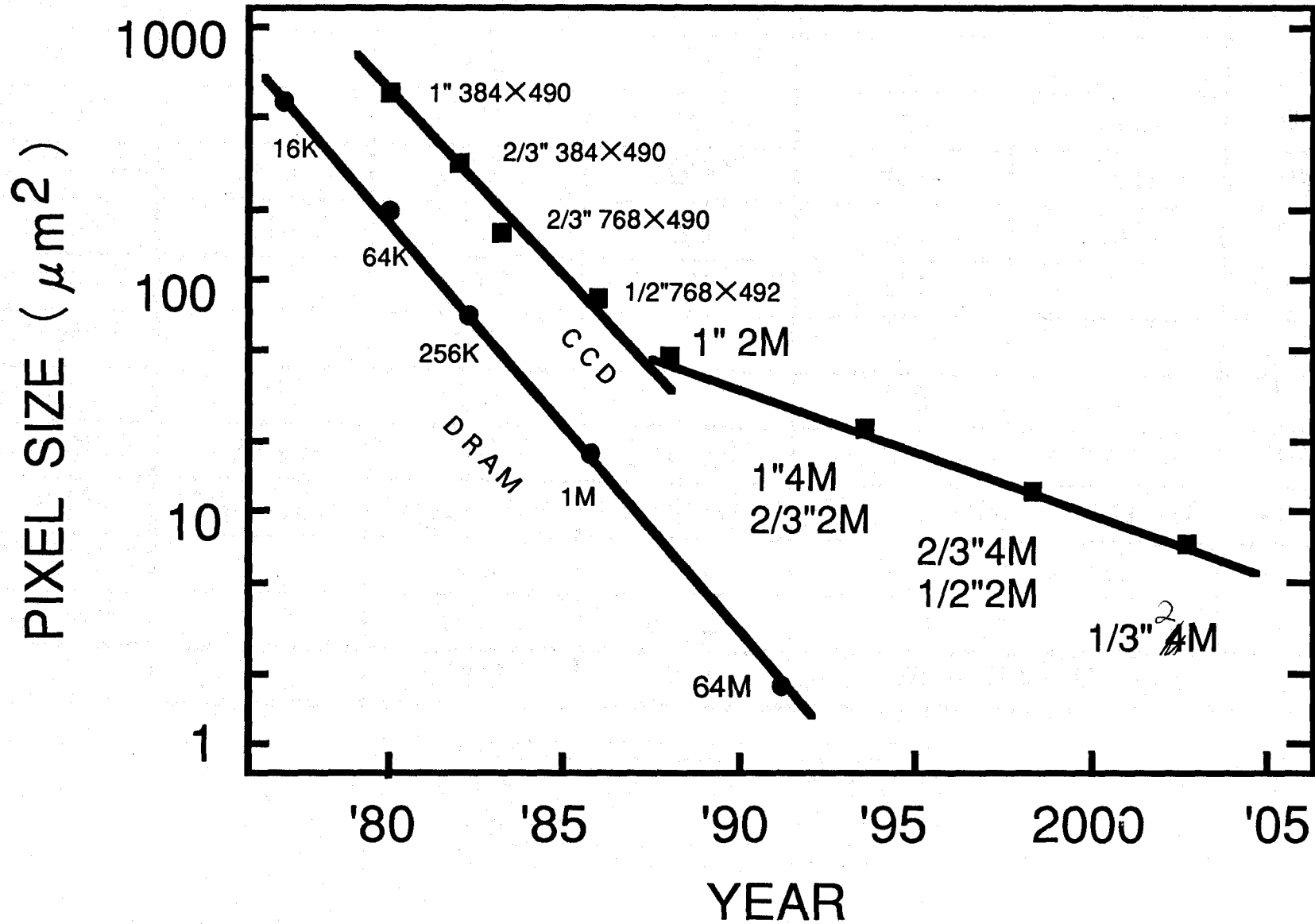
NOBU. TERANISHI

NEC Corporation

NEC

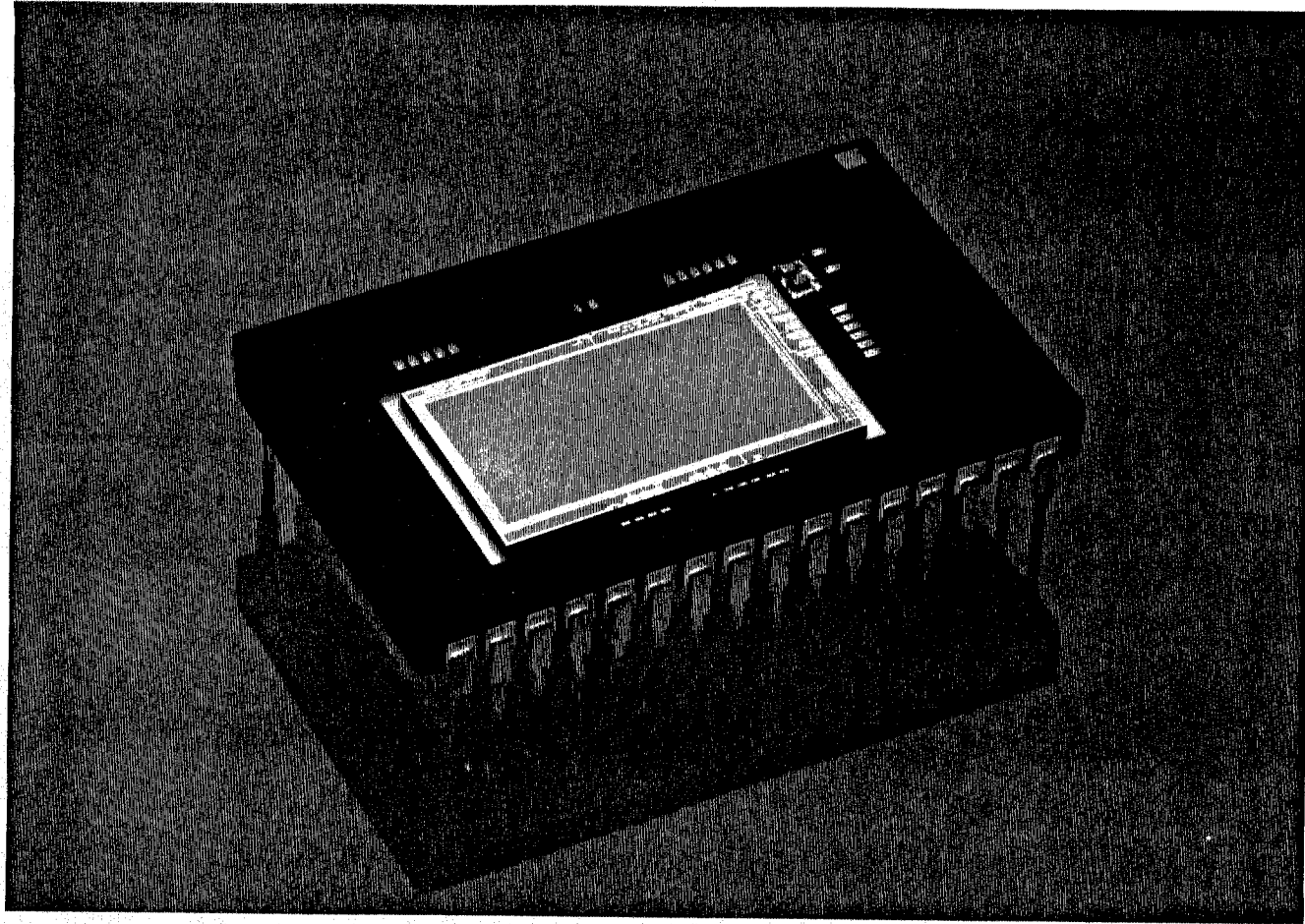


CCD TREND



HDTV CCD

	NEC	Toshiba	Sony	Matsushita	Matsushita	
Scheme	IL	a-Si/IL	FIT	FIT	FIT	
Image Size	1"	1"	1"	1"	2/3"	
Pixel No.	1920×1035	1920×1035	1920×1036	1258×1035	1258×1035	H×V
Pixel Size	7.3×7.6	7.3×7.6	7.3×7.6	10.8×7.4	7.6×5.2	μm ²
Rule	1.4	1.0		1.2	0.8	μm
Aperture		100				%
Sensitivity		210	75	50	24	nA / lx
D. Range	71	72	72	72	70	dB
Sat. Current	760	2000	1000	900	300	nA
Smear		-110	-100	-100	-100	dB
Lag		1.3	≤1		<1	%
Die Size	16.5×10.0	16.2×10.5	17.4×16.8	15.6×14.4	11.6×12.2	mm ²
Date	'88.2.	'88.2.	'90.2	'89.2.	'91.2.	
Camera	3CCD,1CCD	3CCD	3CCD	3CCD	3CCD	



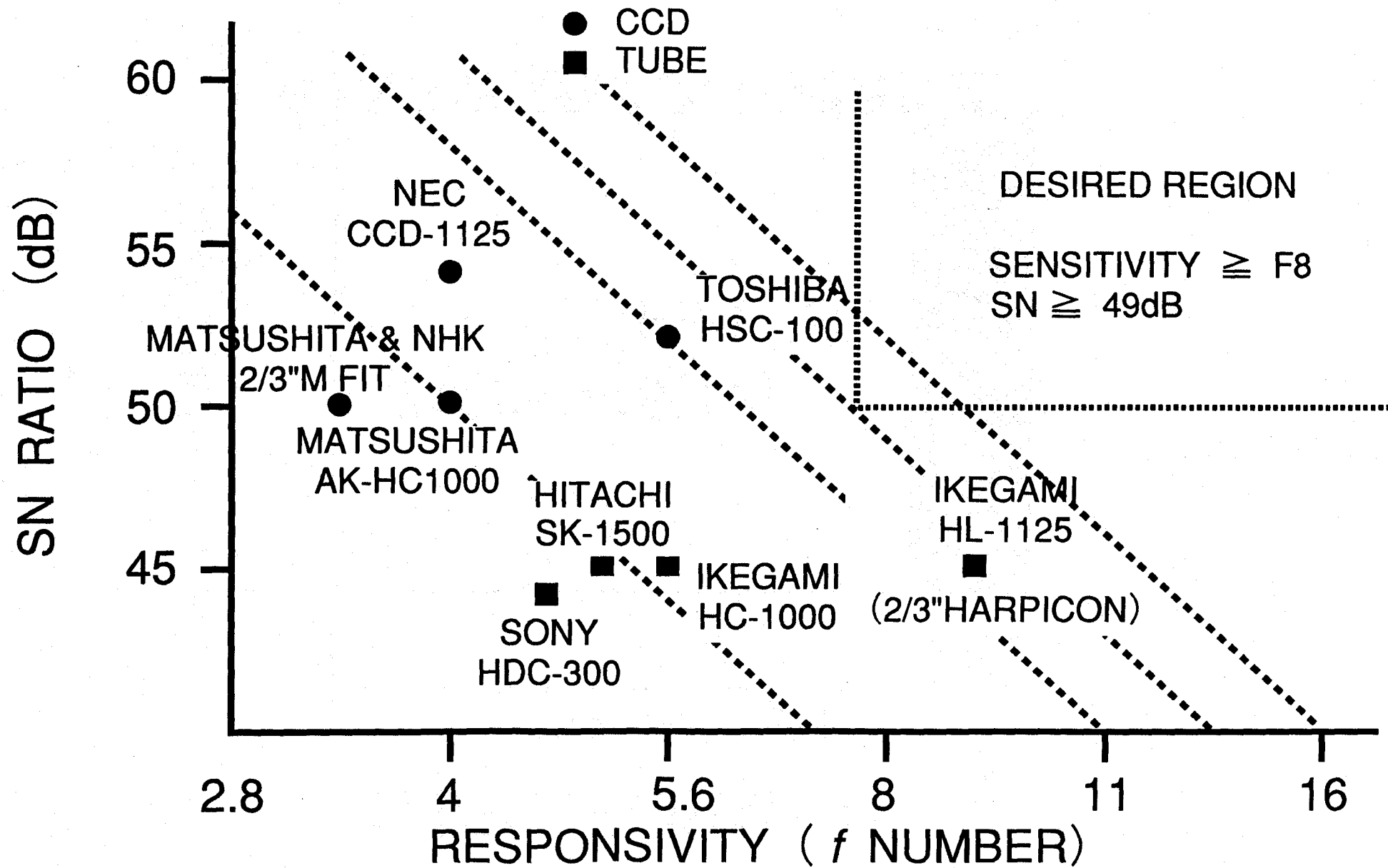
2M PIXEL IL CCD

NEC

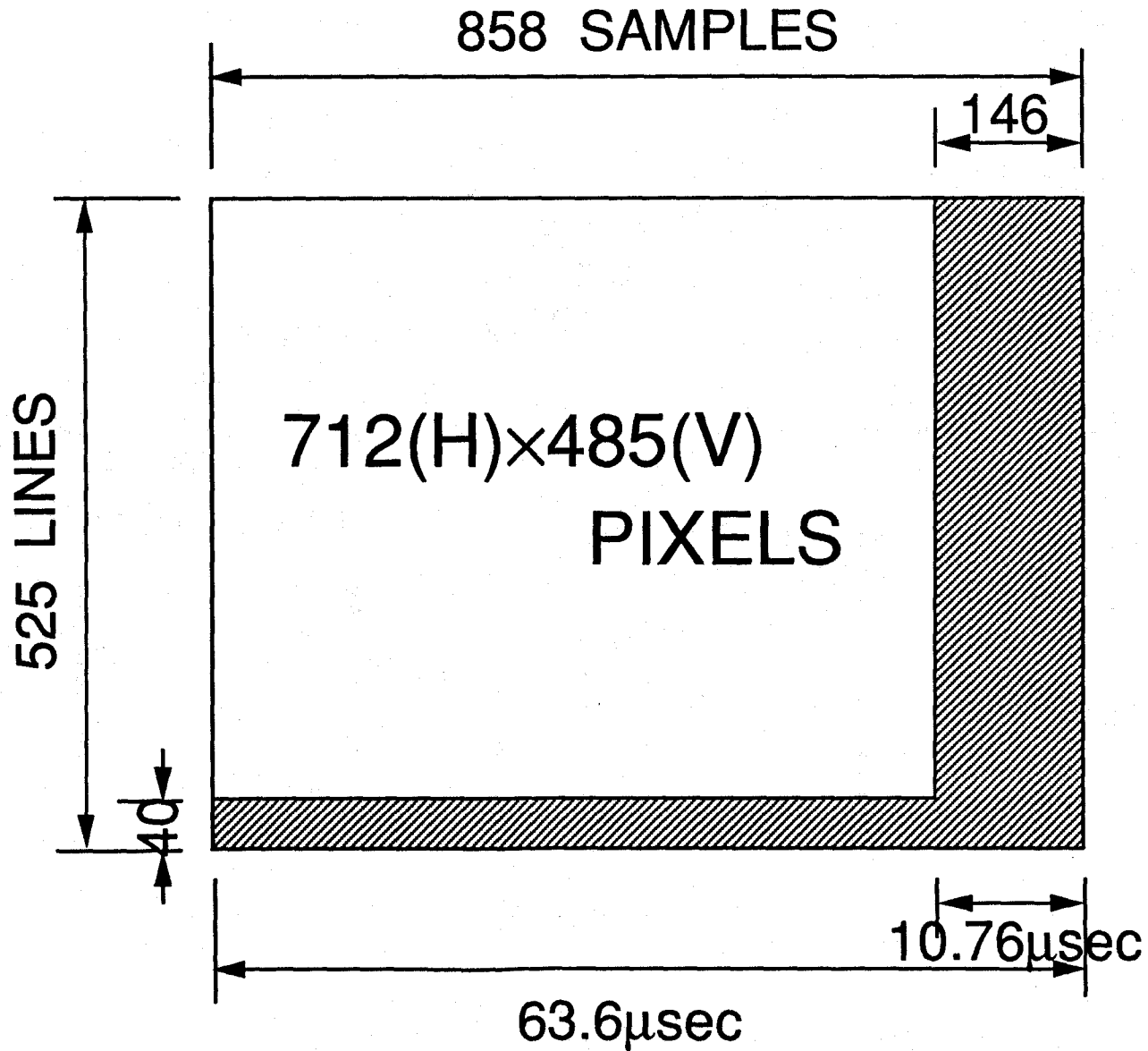


REPRODUCED PICTURE BY 2M PIXEL IL CCD

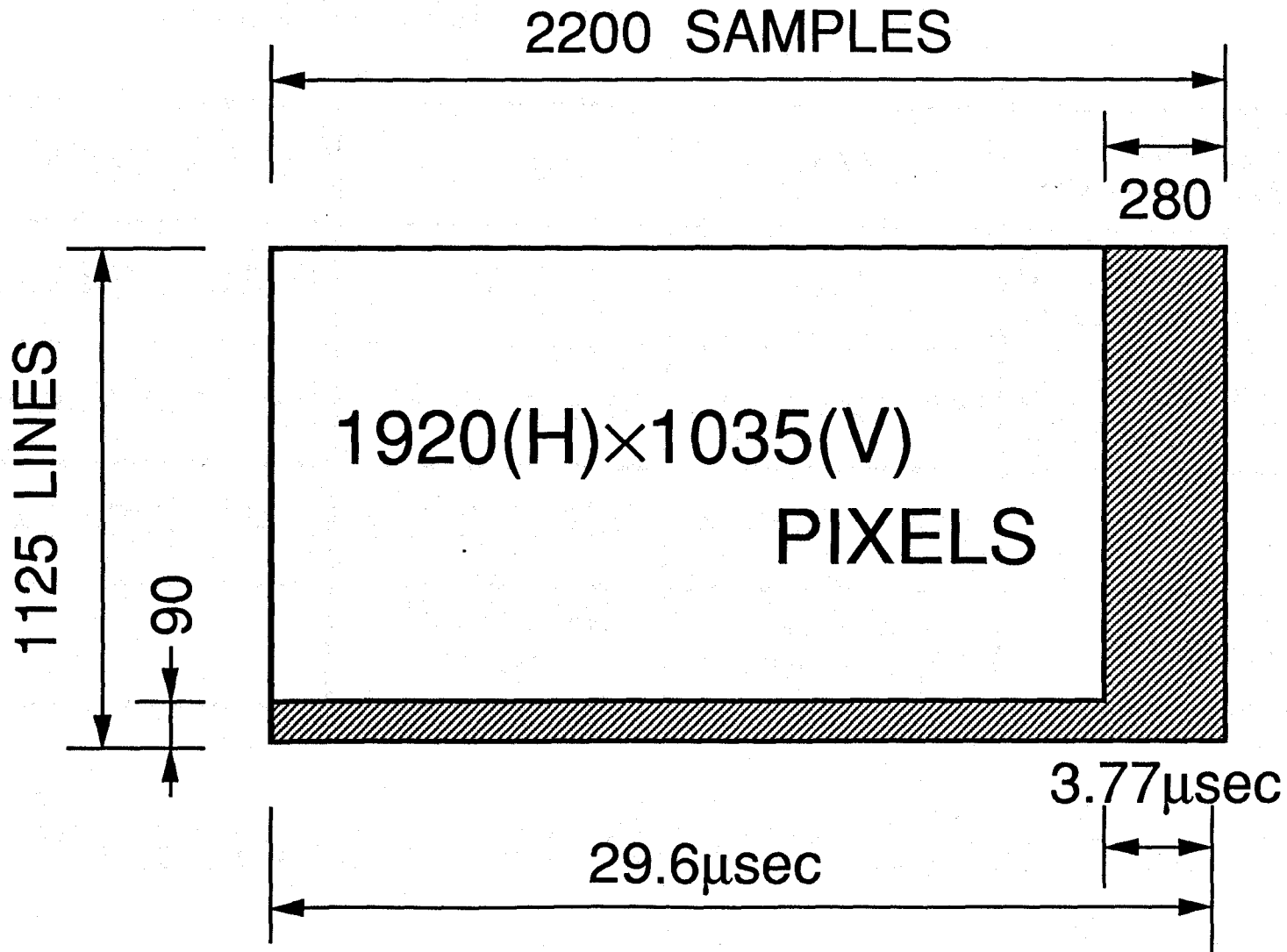
HDTV CAMERA COMPARISON



NTSC FORMAT



HIVISION FORMAT



*~ 7.2 mm
pixel*

COMPARISON BETWEEN NTSC AND HVISION

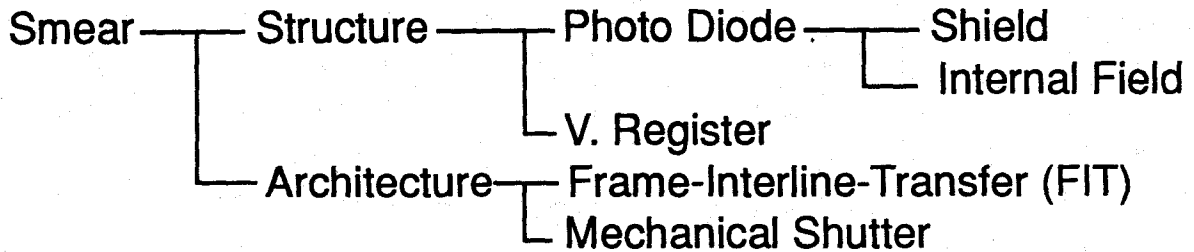
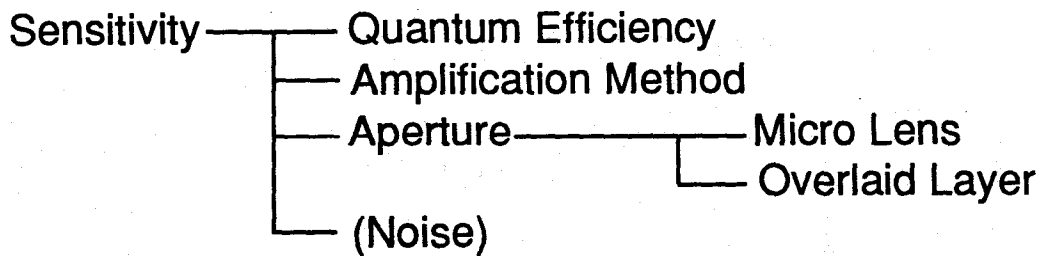
	NTSC (1/3",0.36M)	HVISION (1",2M)	PROBLEM
PIXEL SIZE (μm)	6.8(H) \times 7.5(V)	7.3(H) \times 7.6(V)	
IMAGE AREA (mm)	4.8(H) \times 3.6(V)	14.0(H) \times 7.8(V)	SHADING BY MICROLENS PULSE DECAY
DATA RATE (MHz)	13.5	74.5	TRANSFER EFFICIENCY BANDWIDTH OF AMP.
H-BLANKING (μsec)	10.76	3.77	2CH-HCCD TRANSFER VOD SHUTTER

COMMON PROBLEM

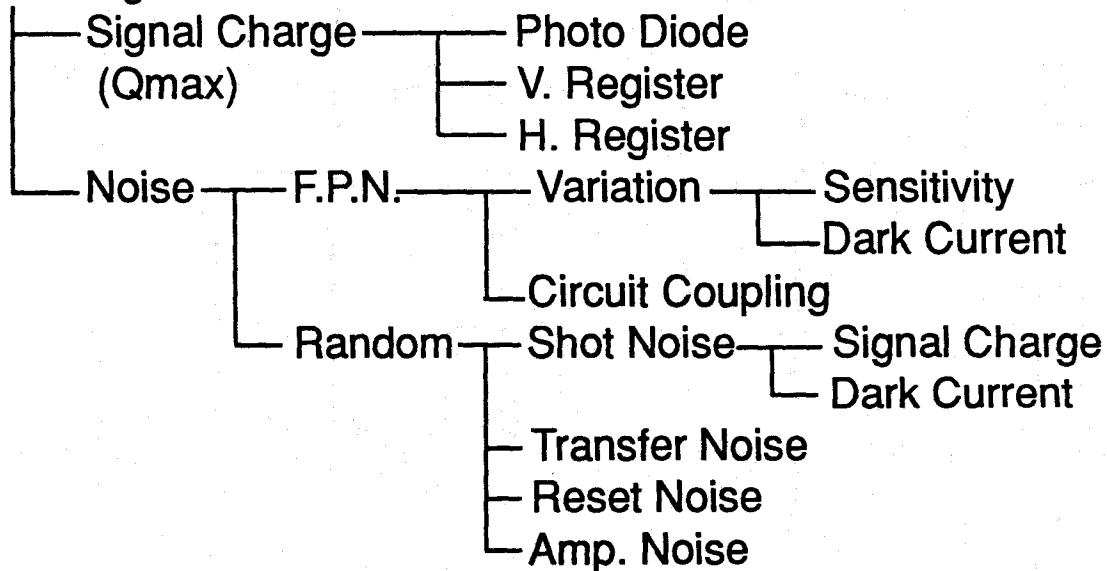
- HANDLING CAPABILITY OF VCCD
- SENSITIVITY
- SMEAR

IMAGER SCHEME COMPARISON

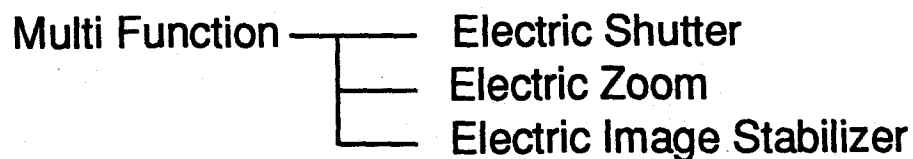
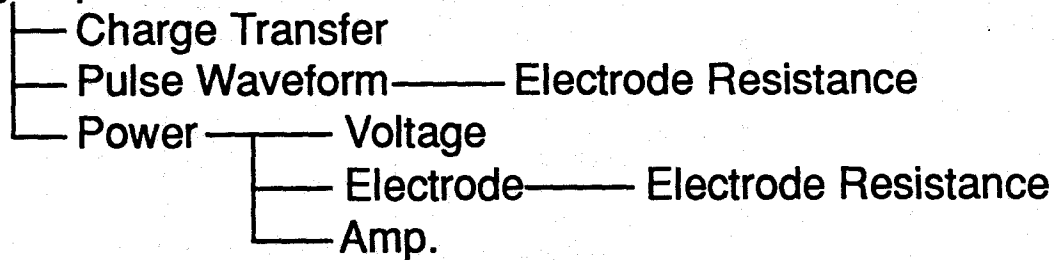
	Sensitivity	S / N	D / R	Smear	L a g
I L	△	○	○	X	○
FT (Rear Illumination)	○	○	○	△	○
FIT+Lens	○	○	○	○	○
C S D	△	○	◎	X	○
Overlaid	○	○	○	○	X
Amplified	◎	?	?	○	○
M O S	△	△	○	○	○
H A R P	◎	○	◎	◎	X

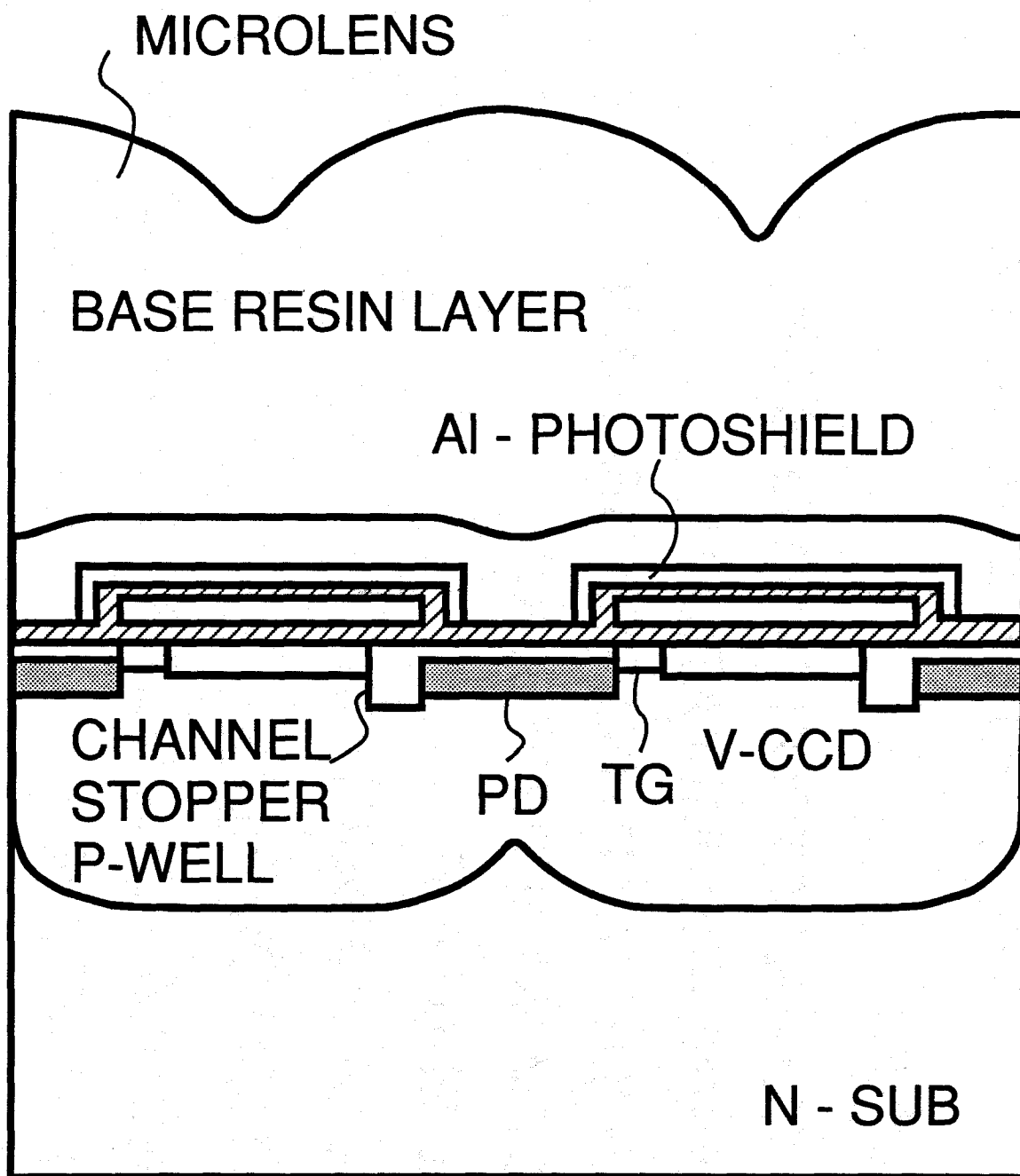


D. Range & S/N



High Speed / Wide Bandwidth





CROSS - SECTIONAL VIEW OF PIXEL

PHOTODIODE DESIGN

FUNCTIONS

- PHOTO - ELECTRON CONVERSION
- CHARGE ACCUMULATION
- COMPLETELY DEPLETED READOUT
- BLOOMING SUPPRESSION
- VOD SHUTTER
- SMEAR REDUCTION

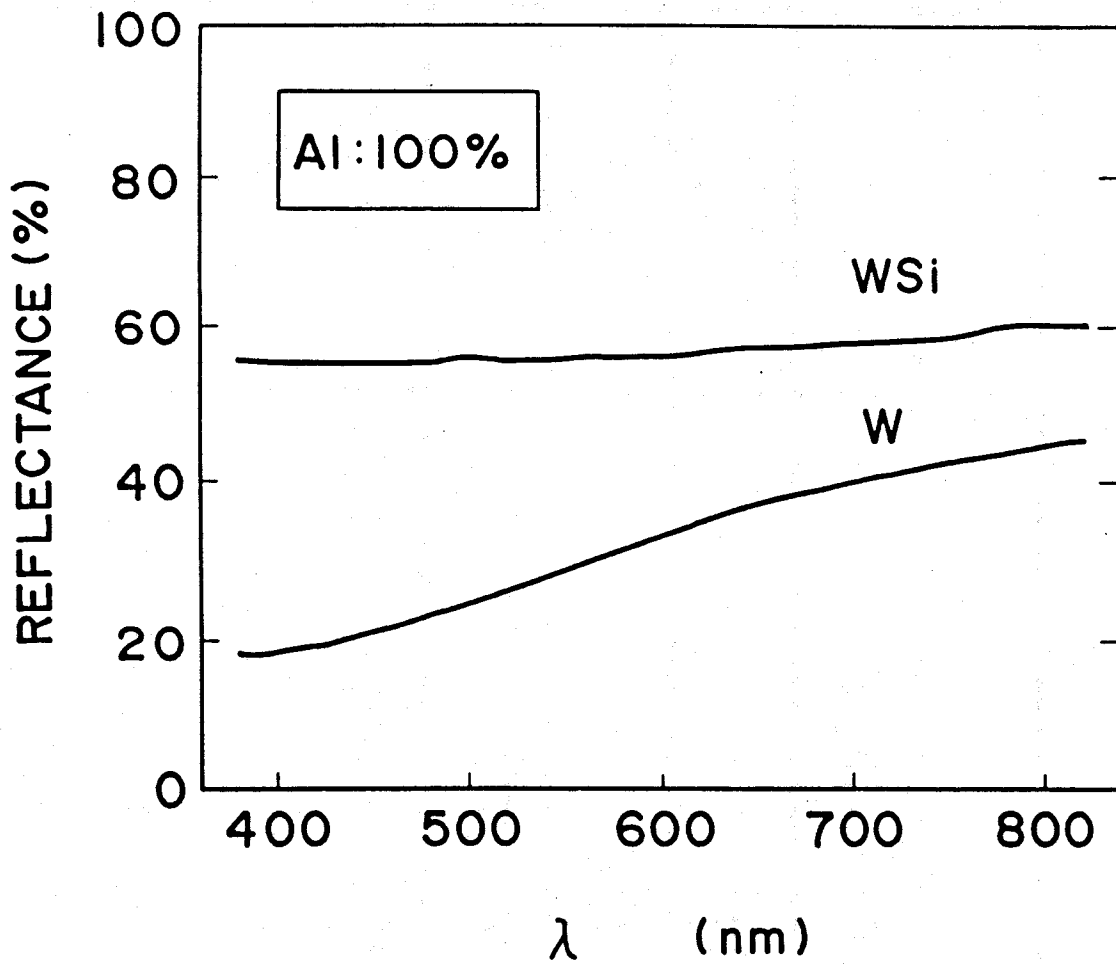
SIMULATION DIFFICULTY

- FUNCTIONS CAN NOT BE SEPARATELY SIMULATED.
- 3 - DIMENSION
- LARGE MESH NUMBER

PHOTO SHIELD MATERIAL

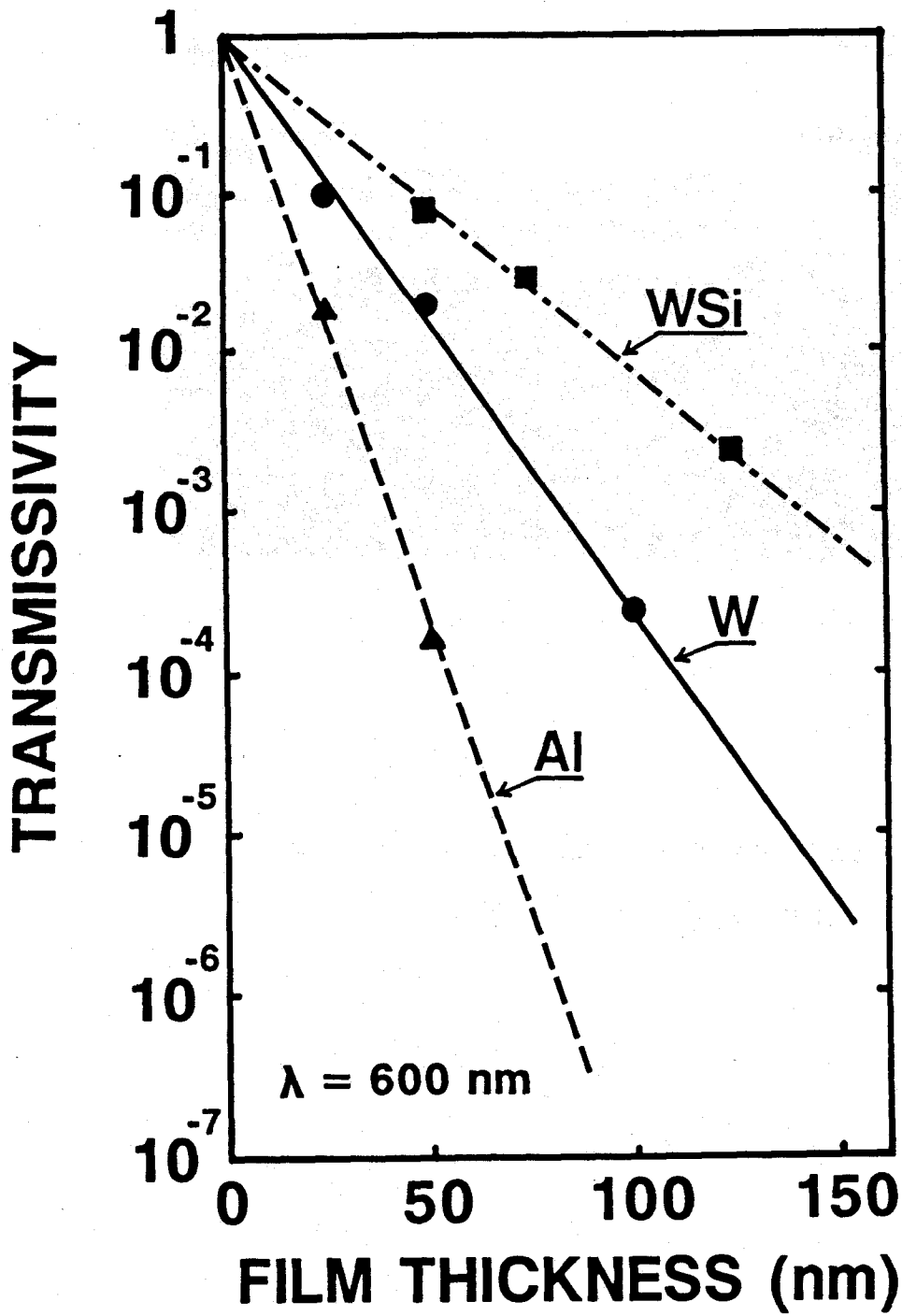
	W	Al
TRANSMITTANCE		○
PIN HOLE	○	
COVERAGE	○	
REFLECTIVITY	○	
APERTURE UNIFORMITY		
GRAIN GROWTH	○	
STRESS MIGRATION	○	

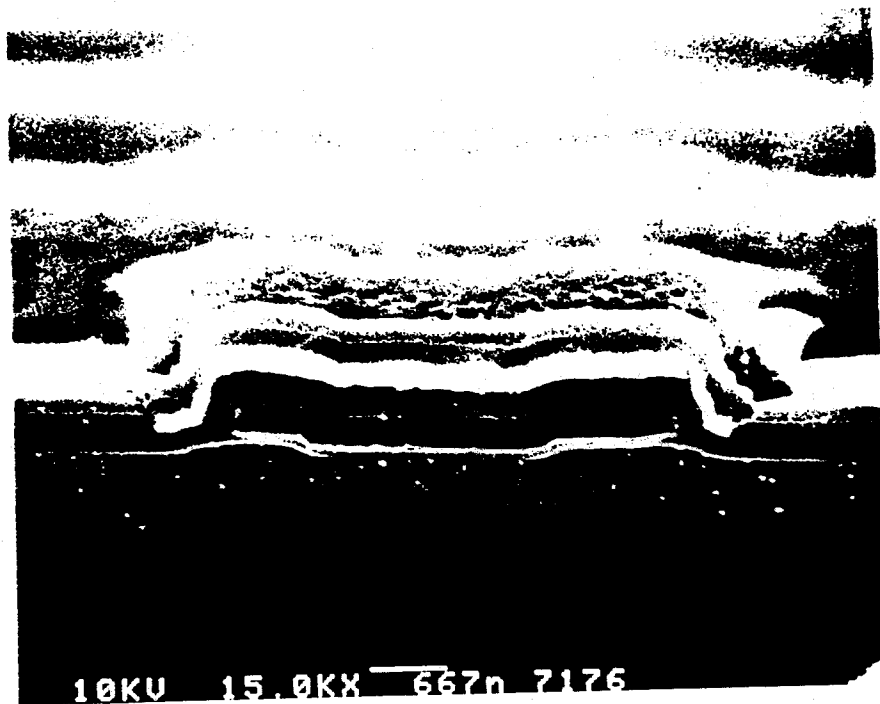
REFLECTANCE OF W AND WSi



by A. TOYODA et al (1990)

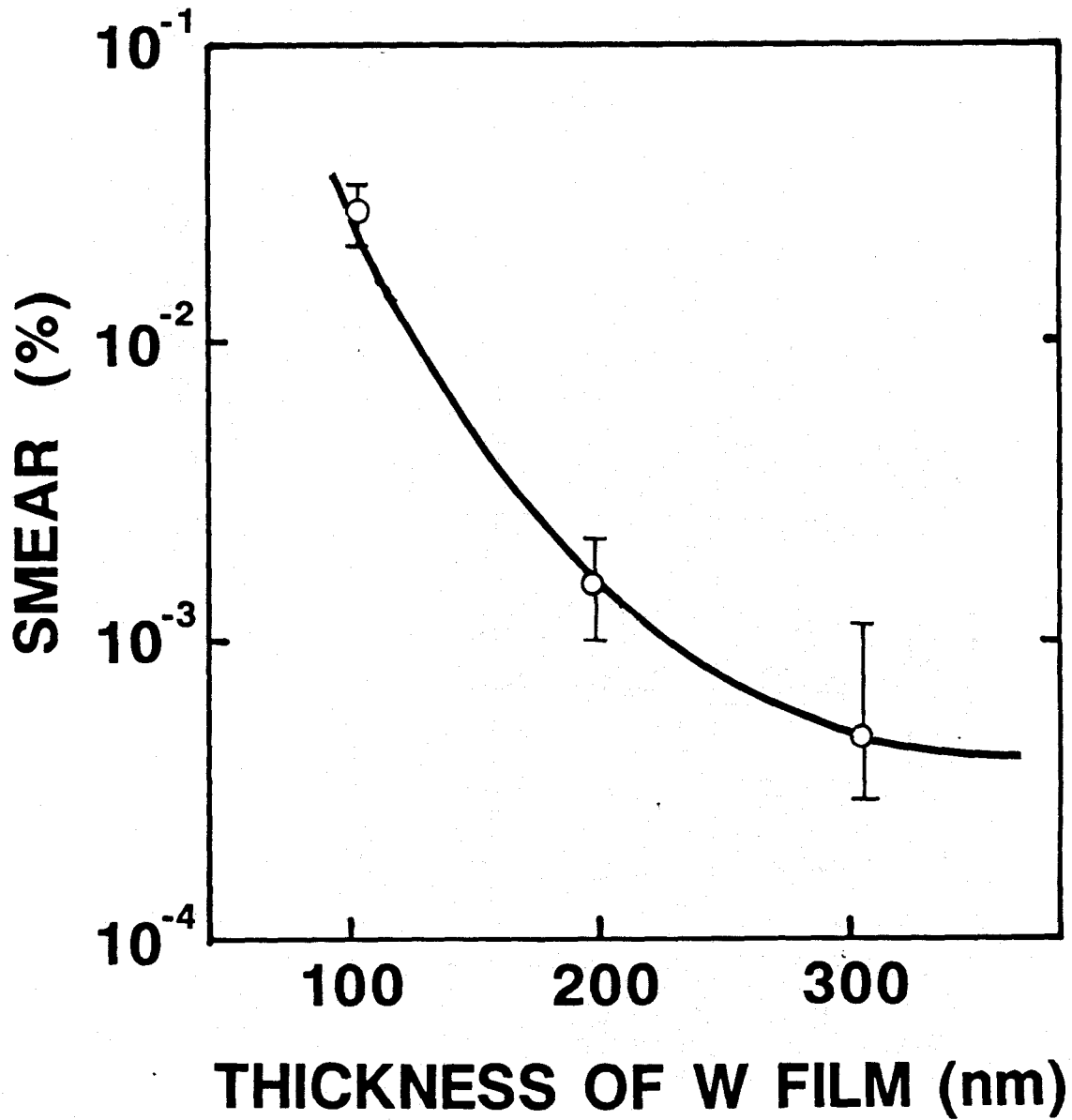
TRANSMISSIVITY OF PHOTOSMIELD MATERIAL





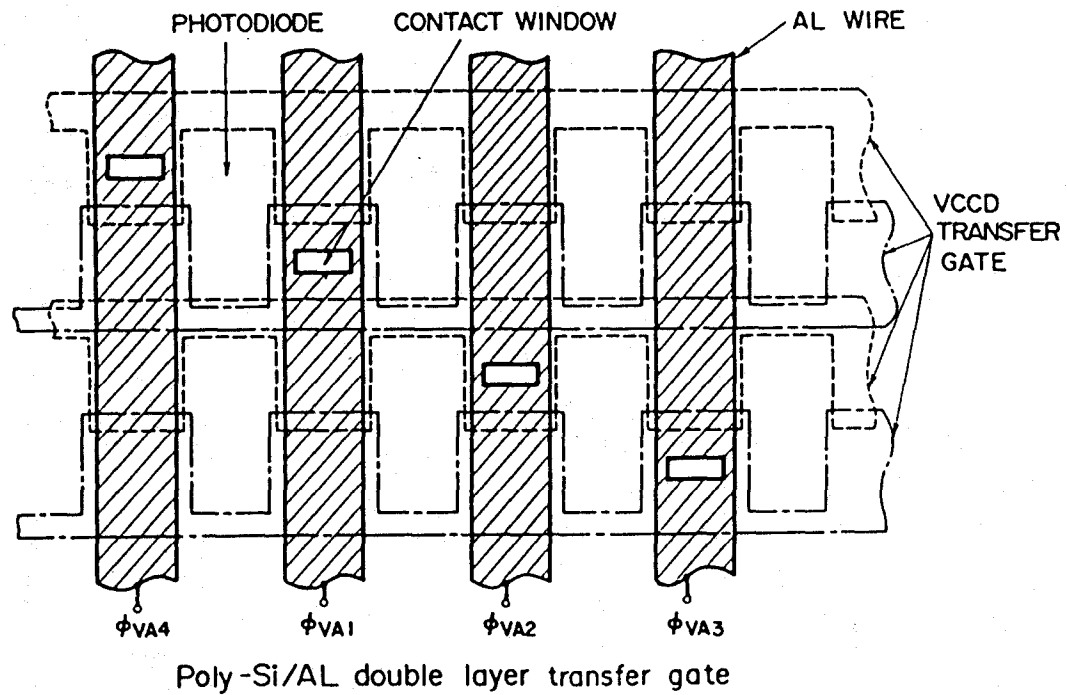
An SEM photograph of a CCD pixel cross-section.

SMEAR vs. W THICKNESS



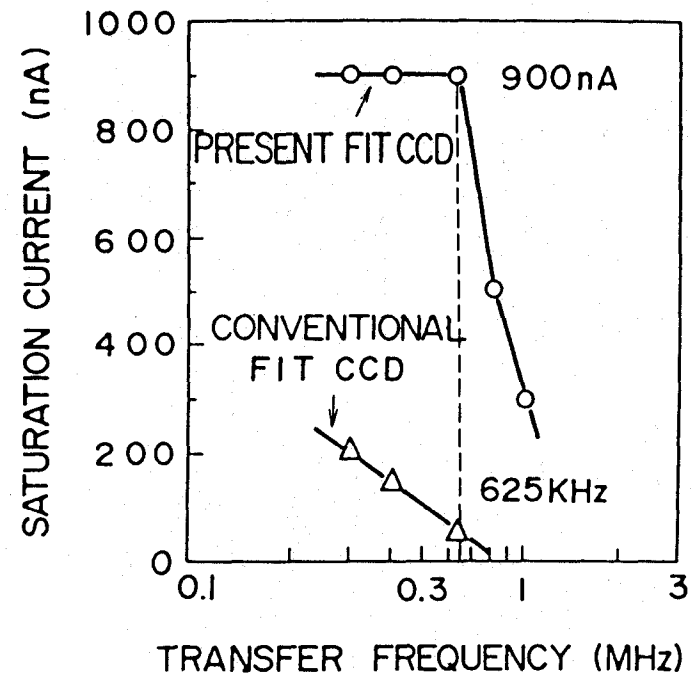
by A. TOYODA et al (1990)

AI SHUNT STRUCTURE



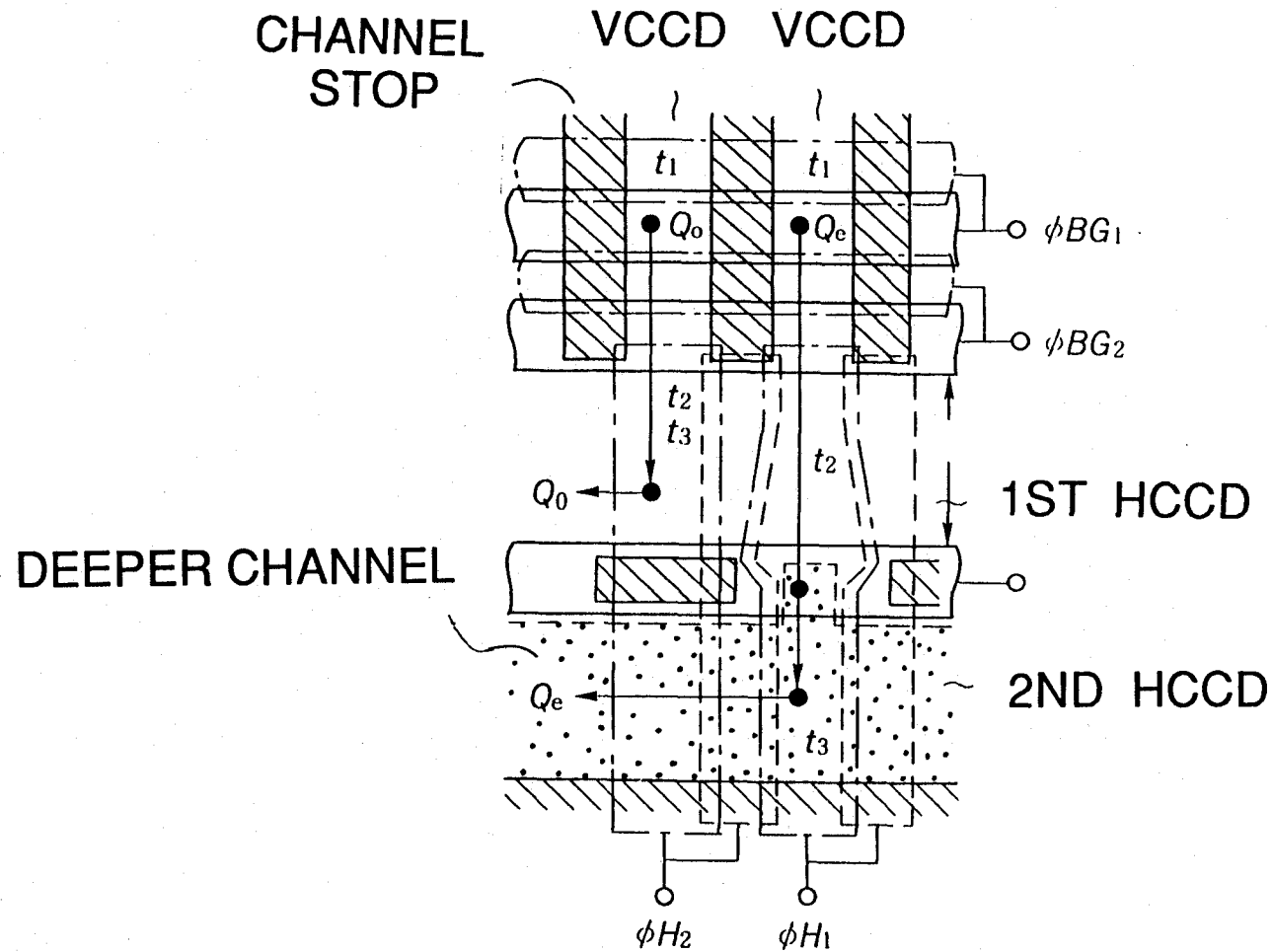
by T.Nobusada et al (1989)

EFFECT BY Al SHUNT STRUCTURE



by T.Nobusada et al (1989)

2CH - HCCD STRUCTURE



by S. MANABE (1990)

OUTPUT NOISE REDUCTION

COMPONENT

RESET NOISE

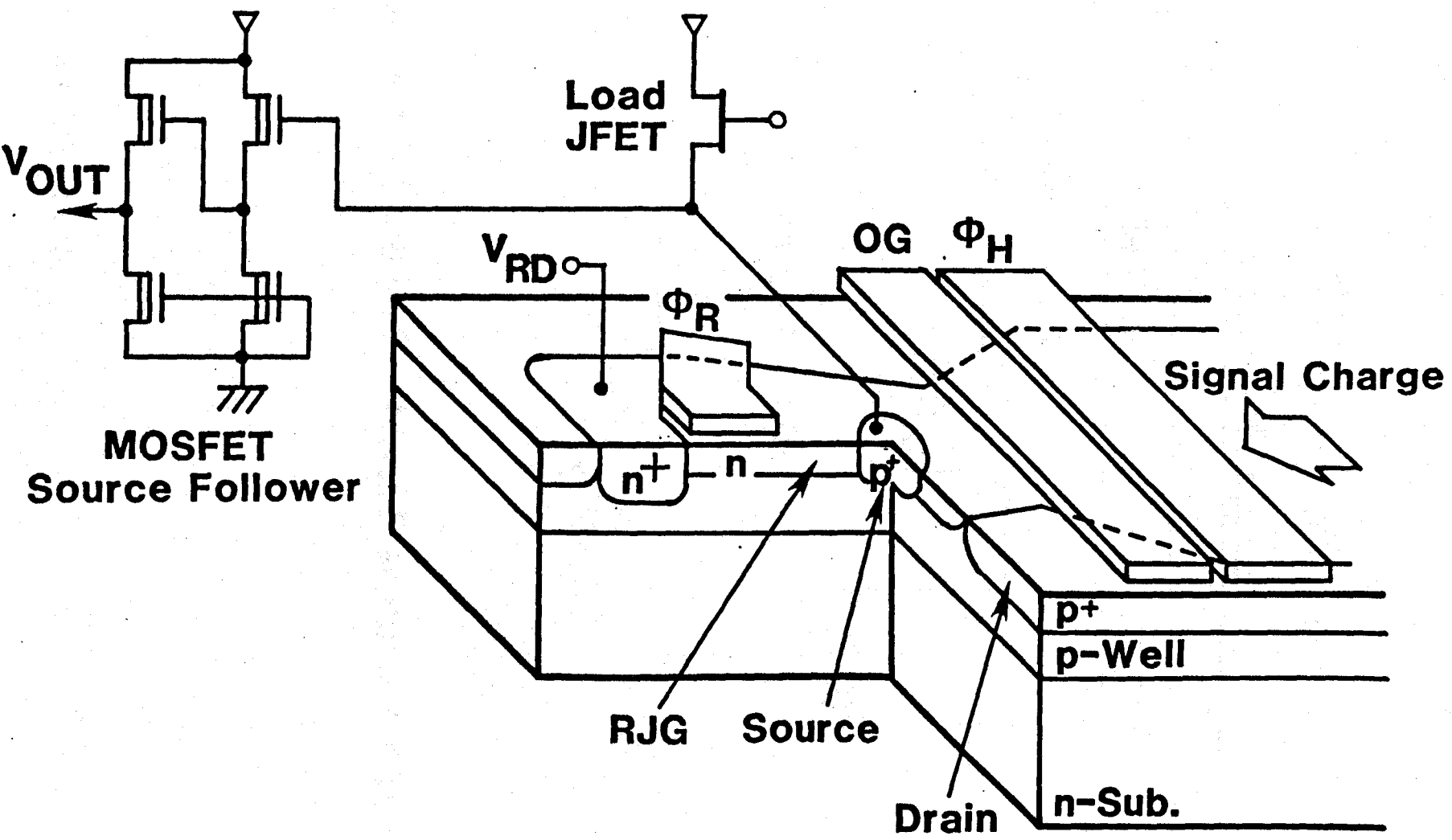
AMP. NOISE

METHOD

- SMALL CFJ
- NOISE REDUCTION CIRCUIT
- NEW OUTPUT ARCHITECTURE

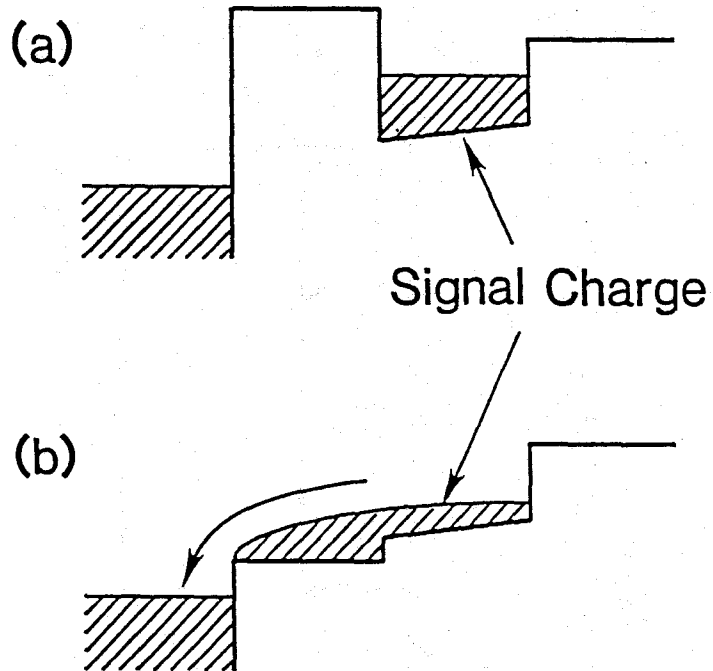
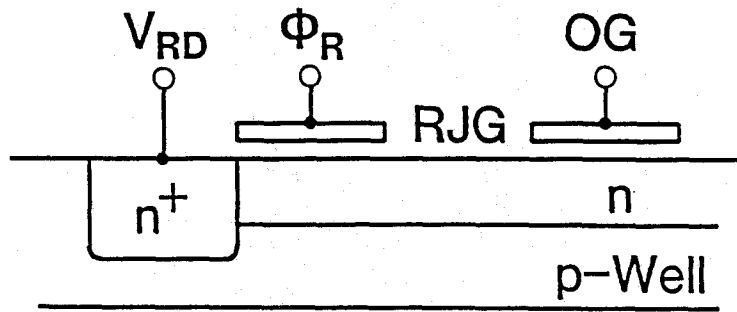
NOISE REDUCTION CIRCUIT

1. CORRELATED DOUBLE SAMPLING (CDS)
M.H.WHITE et al (1974).
2. DIFFERENTIATION WITH SAMPLING
P.A.LEVINE (1985).
3. INVERSE ADDITION METHOD
Y.ENDO et al (1985).
4. DELAYED AND DIFFERENTIAL NOISE SUPPRESSION (DDS)
Y.NISHIDA et al (1985).
5. INTEGRAL DELAYED AND DIFFERENTIAL NOISE SUPPRESSION (IDDS)
M.OHBO et al (1988).
6. REFLECTION DELAYING NOISE SUPPRESSION (RDS)
M.OHBO et al (1989).

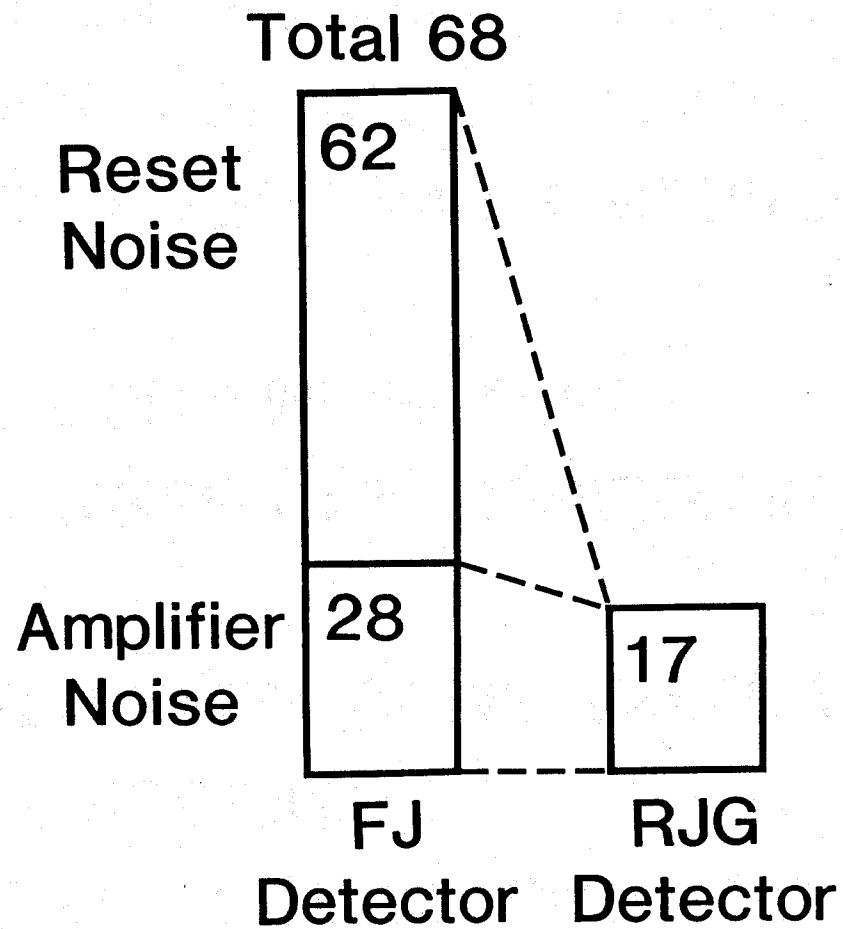


Ring-Junction-Gate Detector

by N. MUTOH et al (1989)



Complete Charge Transfer in Reset Operation



Noise Equivalent Electrons

by N. MUTOH et al (1989)

CONCLUSIONS

1. DEVELOPMENT OF CCD FOR HDTV :
JUST BEGINNING.
USEFUL FOR SOME APPLICATIONS.
2. 1" 2M PIXEL (1ST GENERATION) :
 - FIT CCD + MICROLENS
3. 2/3" 2M PIXEL (2ND GENERATION) :
 - NOISE REDUCTION AT OUTPUT
 - SOMETHING NEW ON VCCD
 - ?