

IMAGE **one**

RADIATION TOLERANT VIDEO CAMERA
WITH A PROPRIETARY CMOS IMAGE SENSOR

APPLICATIONS:
NUCLEAR DOMAIN OUTER SPACE

Applications for the Radiation Tolerant Video Camera

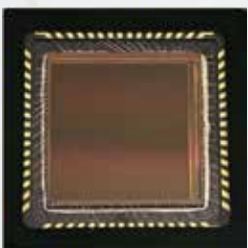


Nuclear fuel element inspections / services
Hot cell surveillance
Reactor and pipe inspections
Offload and refueling of fuel assemblies
Surveillance for fuel debris retrieval



Radiation Tolerant Video Camera Specifications

Total Dose Radiation Tolerance	Tolerant >2mGy (@3kGy/h)	Focal Length	13.6 mm
Pixel Size	12μm (V) × 12μm (H)	F-Stop Number	3.9
Number of Effective Pixels	720 (H) × 720 (V)	Output Signal	Analog Video Signal
Effective Pixel Area	8.64mm x 8.64mm	Cable Length (Between Camera & Control Unit)	50m maximum
Field of View	48°	Operating Temperature	0 ~ +40°C
Frame Rate	20fps	Power Consumption	>0.2W
Horizontal Resolution	35 deg / 720 pix	Dimensions	50mm x 50mm x 120 mm
Horizontal Resolution	>1.7m	Weight	200g
Filter Diameter	14mm	Supply Voltage	VDD: +3.3 V
Frame Rate	200 fps	Package	Ceramic/LCC/64 pin
Sensing Method	Global / Rolling Selectable	Image Output	Monochrome, color is in development now
Lens	Non-browning lens coating	Dimensions	



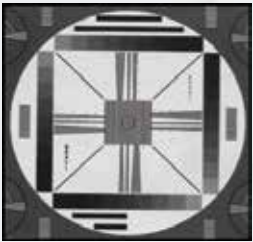
Production Model of the monochrome CMOS image sensor that was jointly developed by Mach Corporation and JAXA/ISAS
 Japan Aerospace Exploration Agency (JAXA)
 Institute of Space and Astronautical Science (ISAS)

Currently, the color CMOS image sensor is designed and will be available shortly

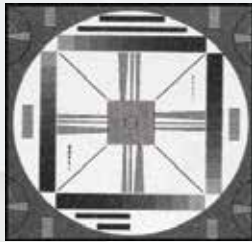
MACH CAMERA VERSUS COMPETITORS

	MACH CAMERA	COMPETITOR
Radiation Hardness	Radiation tolerance: 2MGy Radiation dose rate: 3kGy	1MGy (2kGy/hr)
Dimensions	50mm x 50mm x 120mm	30 x 95m
Weight	200g	500g
Cables	7mm diameter / 50 m	100mm / 50 m
Image Quality	500k pix (1M pix being developed)	300k pix

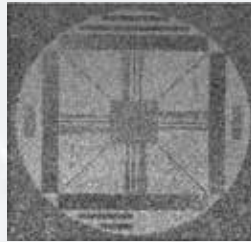
The Complementary-Metal-Oxide-Semiconductor (CMOS) Image Sensors (CIS) was tested by a third party. The sensor was irradiated with gamma radiation. The camera took pictures at different intervals to show the impact of gamma radiation on the sensor's ability to take a clear picture. This test shows that the sensor can withstand large amounts of radiation up to 2MGy. Gamma irradiation results:



[Cumulative dose: 0 kGy]
Non-irradiation
TID:E0



[Cumulative dose: 0 kGy]
100 Gy/h irradiation
TID:E0



[Cumulative dose: 100 kGy]
1,200 Gy/h irradiation
TID:80



[Cumulative dose: 300 kGy]
3,300 Gy/h irradiation
TID:AF

Irradiated sensor test

Cumulative irradiation time (h)

Samples(N=5)	17	34.5	75	139	296	447	510
Dose rate (kGy/h)	2.5	5.0	5.0	5.0	5.0	5.0	5.0
Cumulative dose (kGY)	42.5	130	333	653	1438	2194	2509

Irradiation test results

Images after gamma irradiation

Upper side - no compensation control voltage added

Lower side - compensation control voltage added



The camera was used over 7-years on a space exploration mission and the sensor remained fully operational on the Hyabusa 1 space craft.

