ULTRA-CLEAN CCD CRYOSTATS

CCD CONTAMINATION CAN BE KEPT UNDER CONTROL

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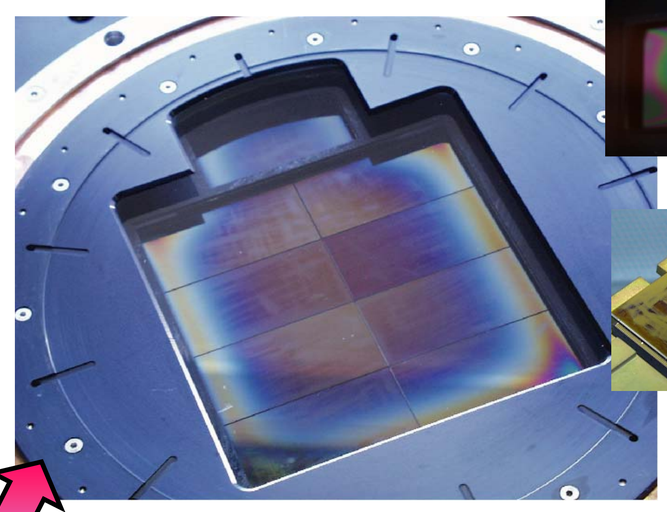
Summary:

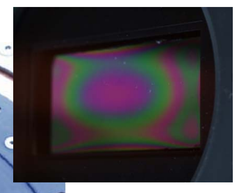
During the last years ESO's Optical Detector Team (ODT) developed a comprehensive methodology to achieve ultra-clean CCD cryostats. Like other observatories ESO struggled in the past with contamination problems which cause significant and unforeseeable QE decreases of scientific CCD detectors. Therefore scientific results obtained with such systems can be insecure. A reproducible method to avoid this hazard is available. The procedure to measure the degree of contamination on detectors, in order to be able to recognize and quantify that critical problem, was also developed.

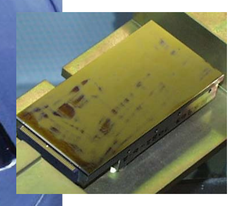
Contamination happens under vacuum conditions because of outgassing of unsuitable materials. If this occurs near the CCD detector, having the lowest surface temperature, unwanted condensations form at its surface and change its QE as a function of time.
The procedure used to achieve ultraclean cryostats and the suitable materials in CCD cryostats are given below in diagrams. Now ESO only uses these selected materials. All components are cleaned and the whole CCD cryostat is assembled with gloves under clean-room conditions.
Lists of suitable and bad materials have been obtained as a result of ESO's program of categorizing materials with a mass-spectrometer. Investigations of a comparison between Zeolith and charcoal, the ingredient of the cryostat's molecular sieve are currently done. Cocoonut charcoal seems to be the best material to prevent contamination. Zeolith is the best material to avoid water ice inside the cryostat. Finally we built up a clean-room for the proper handling and assembly of the cleaned parts to a very clean CCD cryostat. With all these measures we could avoid any contamination since several years.

Assembly of clean cryostats in the special designed clean-room

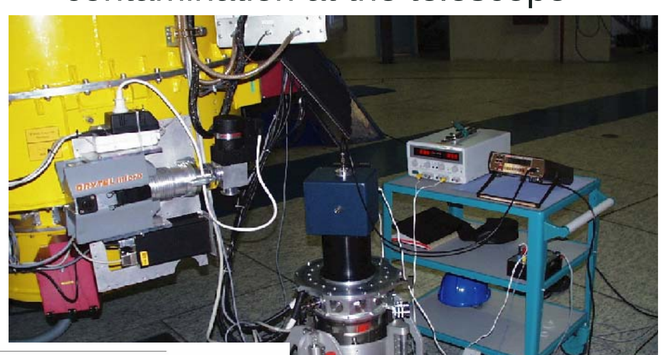
Contamination on CCDs



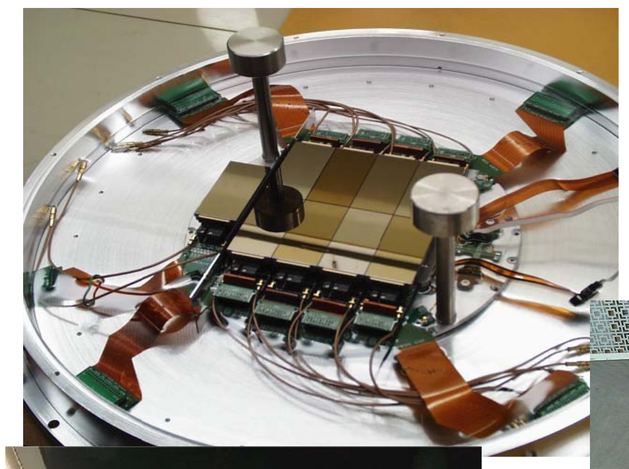


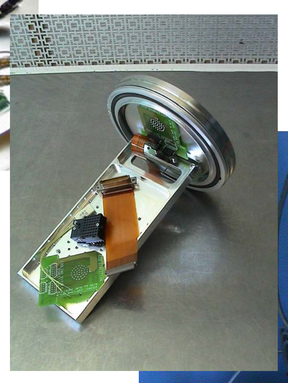


Portable test-bench for testing of contamination at the telescope



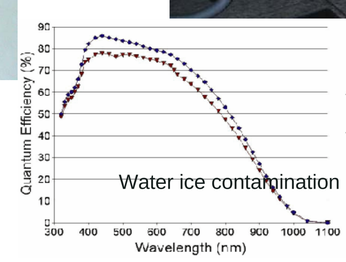
Washing of assembled CCD mosaic in alcohol bath

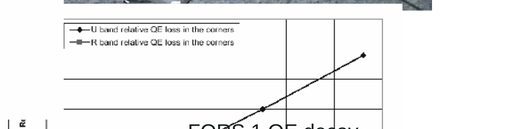




Coconut charcoal for molecular sieves supresses effectively contamination.

Mass spectrometer tests



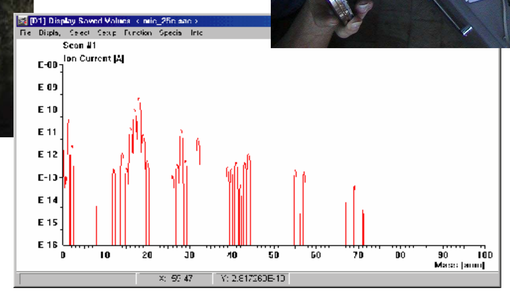


Variation of relative QE loss over time (U band and R band).

Baking in vacuum ovens

List of main contaminants

Material	Causes contamination on CCD
Water, water vapour	Temperature dependent
Finger grease	Very low
Silicon vacuum grease	Fairly
Softener from plastic gloves	
Unbaked paint	Strong
Backstreaming pump oil from vacuum pump	
Lubricating oil (from manufacturing)	Very strong



Material		Washing: Possible solvent	Washing: Hand cleaning	Washing: 1. Ultrasonic water bath with Tickopur detergent at 80°C	Washing: 2. Ultrasonic bath with water (80°C) or non ultrasonic bath with solvent	Vacuum baking (10^{-2} mBar): Maximum temperature	Vacuum baking (10^{-2} mBar): Minimum duration
Modified epoxy material		Acetone	no	30 min.	30 min.	120 °C	16 h
Metals parts (Al and steel)		Acetone	yes	30 min.	30 min.	180 °C	16 h
Electronic boards	ZIF sockets	Alcohol	no	30 min.	30 min.	150 °C	72 h
	Raw boards	Alcohol	no	30 min.	30 min.	120 °C	72 h
	Soldered PCB	Alcohol	yes	no	no	85 °C	72 h
CCDs	EEV	no	yes	no	no	80 °C	72 h
	Tektronix	no	no	no	no	55 °C	72 h
	MIT/LL	no	yes	no	no	60 °C	72 h
Vacuum connectors		Alcohol	no	30 min.	30 min.	85 °C	16 h
Welded inner tank		Acetone	yes	30 min.	30 min.	85 °C	72 h
CFC inner tank structure		Alcohol	yes	30 min.	30 min.	85 °C	72 h
Painted shields		no	no	no	no	120 °C	72 h
Glued components		Alcohol	yes	no	no	120 °C	72 h
VITON O rings		Alcohol	yes	30 min.	30 min.	120 °C	16 h
Zeolith (sorption pump)		-	no	-	-	>180°C	16 h
Active charcoal		Alcohol	no	-	-	100 °C	16 h
Vacuum pipes		Acetone	yes	30 min.	30 min.	180 °C	16 h
Fittings	Vacuum valve	Alcohol	yes	-	-	120 °C	16 h
	Vacuum gauge	Alcohol	yes	-	-	85 °C	16 h

Cleaning in ultrasonic bath

Inflammable chemicals are not suitable in ultrasonic baths: A special detergent is recommended.

	Material, manufacturer	Curing in vacuum	Maximum service temperature
Alcohol	Ethanol	-	-
	Isopropylalcohol	-	-
Coax video cables	(Have to be replaced in the future)	-	-
Fiberglass	HGW 2372, Ferrozell	-	130 °C
Glue	Master Bond EP21TCHT 1	1 – 2 h / 93 °C	- 269 °C to + 204 °C
	Supreme 10 HT (not yet used)	1 h / 121 °C	- 269 °C to + 204 °C
Heating resistors	Caddock, MP821, TO 220 power package, 20 W	-	175 °C
Internal connectors	Harwin connectors, Glass filled polyester UL94V 0	-	85 °C
O-ring	Busak Shamban material: Viton 70A/80A ("Flow kautschuk")	-	200 °C
PCBs	Printed circuit boards material: Polyimide resin with copper	4 h / 120 °C	130 °C (250 °C)
Ultra high vacuum grease	Fluorinated Fomblin grease, FM 090, Balzers	-	100 °C
Vacuum connectors	High density hermetic connectors, Filcon	-	95 °C
Sorption pumps	Zeolite	18 h / 200 °C	350 °C
	Active charcoal	18 h / 20 °C	100 °C (?)

A special cleaning mixture…

List of used and tested materials (in addition of stainless steel and aluminium)

See for more details about ESOs ultra clean cryostats: http://www.eso.org/projects/odt/contamination/clean.html