RAMS
Reliability Availability Maintainability and Safety

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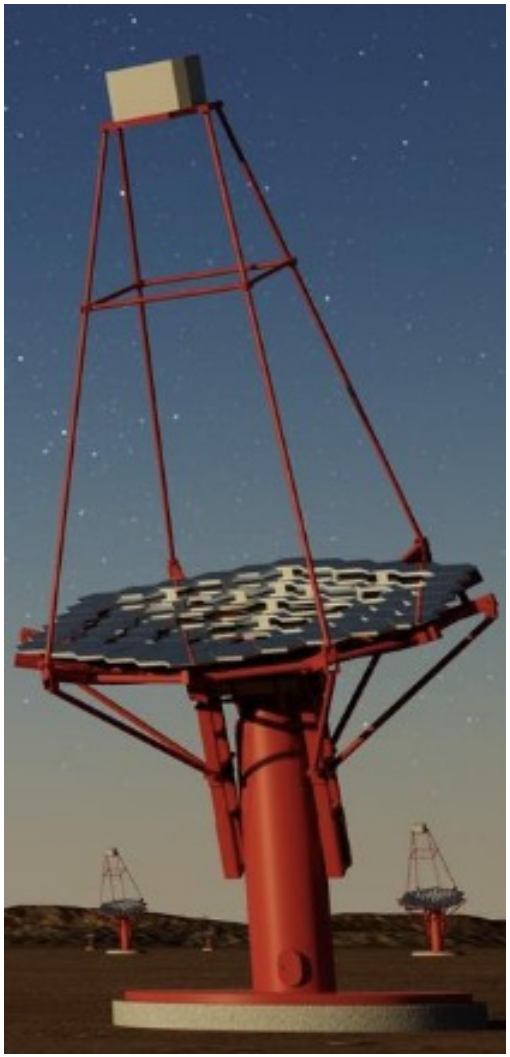


RAMS analysis

- **Standard used : FIDES 2009**
  - *Updates using new ceramic capacitors models to be published in FIDES 2022*
  - *Reliability data are calculated for the camera using FIDES Expertool*

Produced tools and documents:

- *Excel tool to aggregate failures data: MST-CAM-AN-0161-APC*
- ***NectarCAM RAMS report :*** *MST-CAM-RP-0088-APC*
- ***Maintenance plan*** *(policy and frequency): MST-CAM-RP-0235-APC*
- ***Maintenance procedures*** *to be written for the camera and components*

Availability

Camera availability (%)	**99,4**
Number of corrective actions per year:	0,75/year
Total down time / year (hours)	1 day (estimates)

-Firmware / software : *failures modes need to be assessed*

-Maintenance and test tools spare policy not already defined

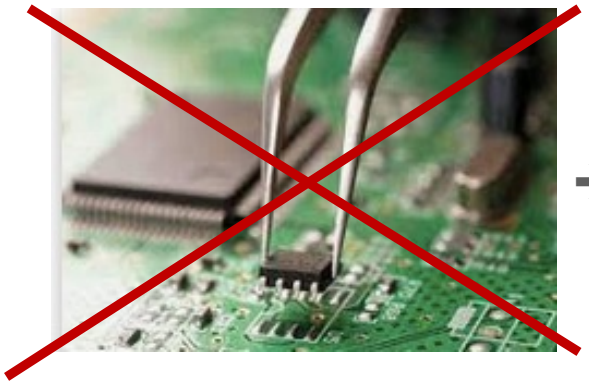
Custom electronic spare quantity needed first maintenance level

Component	Recommended Spares for 2 years			Recommended Spares for 15 years		
	1 camera	9 cameras	15 cameras	1 camera	9 cameras	15 cameras
1 - Module	6	54	90	6	54*	90*
2 - DTB	1	5	8	4	31	52
15 - SPE system	1					
16 - UCTS	1					2
17 - TIB	1					2
18 - Internal cabling	1					2
23 – DTS crate	1 (full rack)					
30 – FF Calibration box	1					
36 – External cabling	1					

***2 years Time to repair considered (for warranty or time to repair by the institute)**

Spare quantity needed for modules Second level corrective maintenance

Component	Recommended Spares for 2 years			Recommended Spares for 15 years		
	1 camera	9 cameras	15 cameras	1 camera	9 cameras	15 cameras
1.1.1 - DU	3	26	42	21	189	314
1.1.2 - IB	1	7	12	6	53	87
1.2 - FEB	2	17	27	14	122	203
23.2 - CTDB	1				4	7
23.2 – L2CB	1					



➔ Third maintenance level not considered (no repairing actions on boards)

Spare quantity for commercial components

- Only 1 spare recommended for commercial and easy replaceable components (COTS) ➔ buy new spare after each failure
- COTS obsolescence (End Of Life) to be checked

List of COTS:

7 - Ethernet switch /8 - PSB Power Supply Box /9 - Cooling system (embedded) /10 – Sensors / 11 – ECC Embedded Camera Controller / 19 – PSB Power distribution box / 20 - Optical I/F / 21 - Power I/F /22 - Cooling I/F / 24 - SFP transceivers / 25 - Dryer system I/F connector / 32 - Dry air generator / 33 - Camera server

==> *Maintenance strategy TBC*

➔ No more action *26-28/01/2022 maintenance workshop : Obsolescence management plan? Technical support (workshop and human resources)?*

➔ *I strongly recommend an « onsite » maintenance*

Additional slide From Paola G.Calisse CTA-N site manager 26-28/01/2022 Maintenance worskhop

Personnel requirement "reality check"

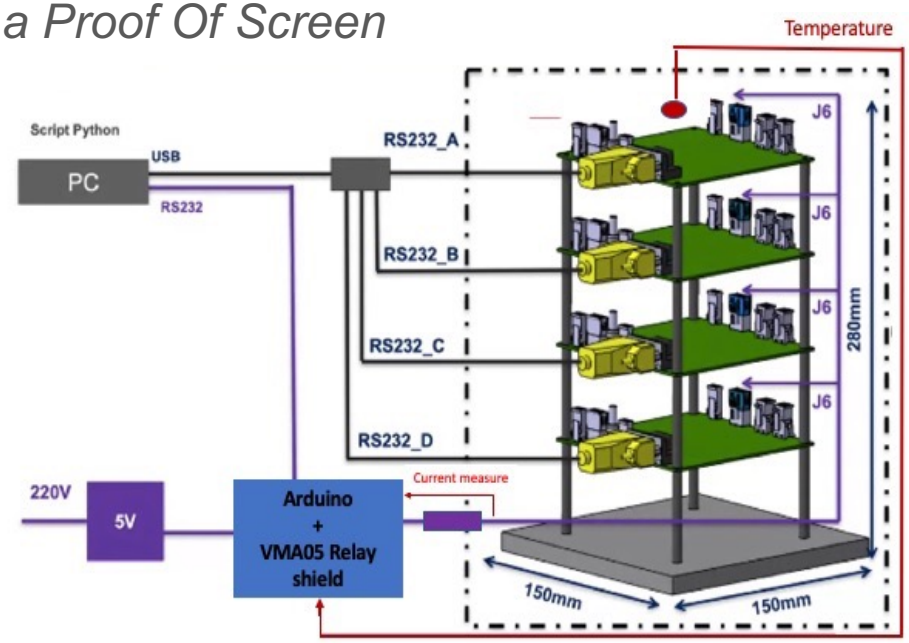
Observatory	Sites	Construction budget (M€)	Total staff	Technical Staff
Gemini	2	150	171	123
Keck	1	200	150	100
ALMA	1	1,300	150?	100?
GranTeCan	1	130	45	~35
TNG	1	~70	45	~35
NOT	1	40	12	6
CTAO	2	400	?	?

Technical staff does not include operators and astronomrs
Some figures are estimated (~)
Open facilities only – current high-energy observatories do not fit the requirement

- And also…Storage and workshop needs underestimated

Stress screening – HASS recommendations

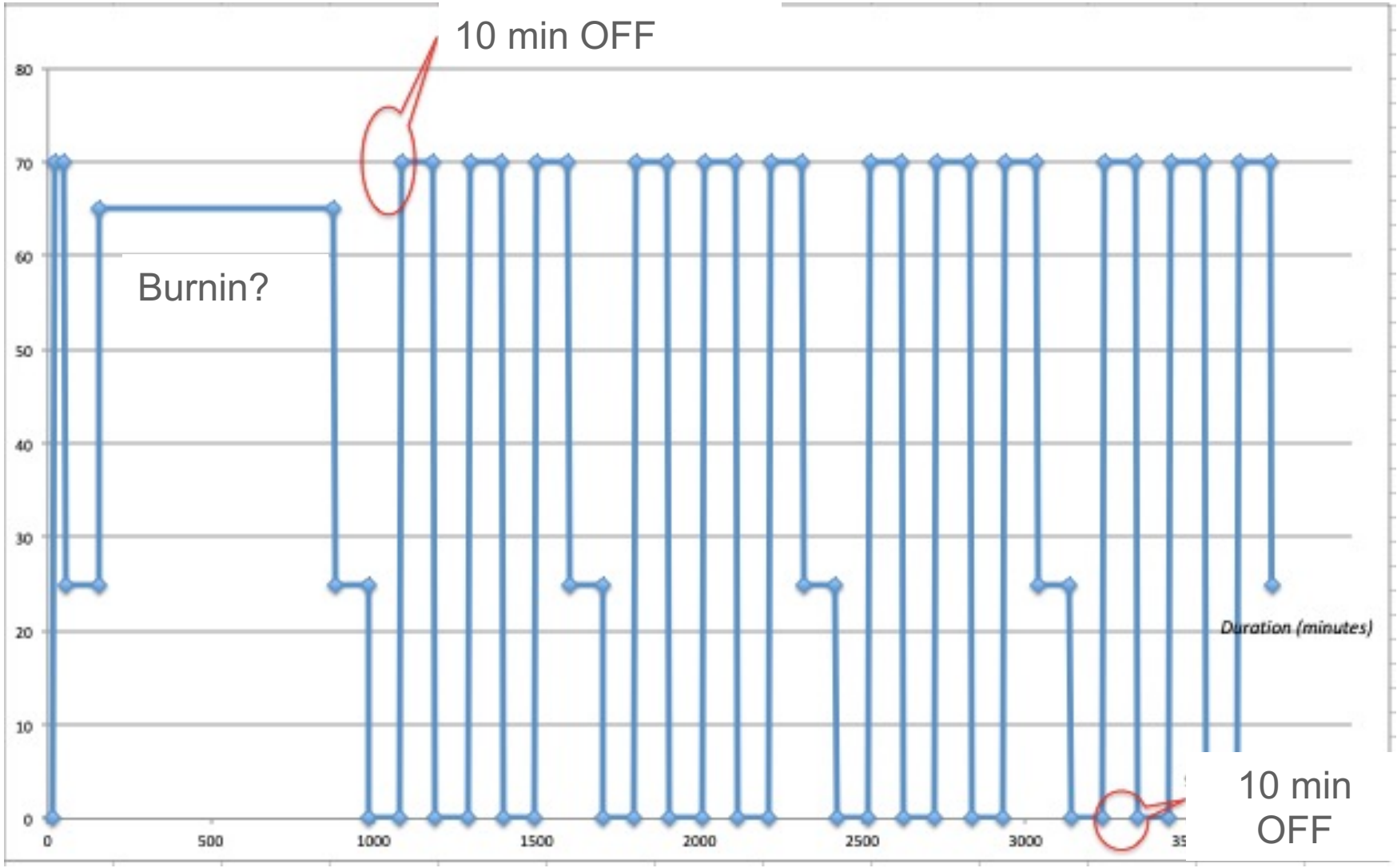
- *First heat cycle to remove humidity (board powered off) – 3 to 6 hours at 55° C*
- *3h30 / cycle with board powered ON*
- *Current consumption monitoring + eventual light functional test (to detect failures)*
- *Slope : at least 10° C*
- *At least 12 cycles without failures (less if slope >10° C)*
- *10 minutes Power OFF during upper and lower temperature dwell time*
- *Apply 80% of the limit found by the HALT. If not -20° C to +70° C*
- *If possible confirm HASS profile with a Proof Of Screen*



** Mandatory for large quantities batch (>100)*

** PMT should not be stressed above 50° C*

Stress screening – HASS recommendations

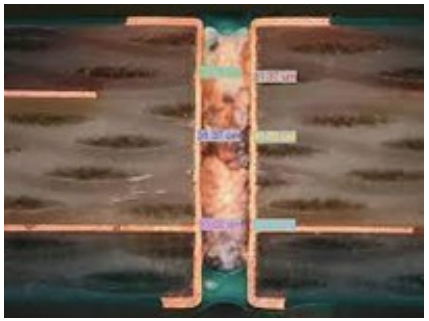


Manufacturing and procurement

Manufacturing :

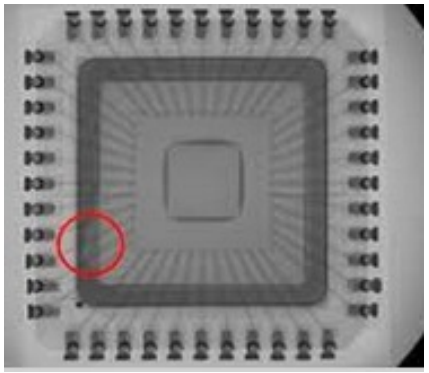
- MIP/KIP and audits
  - ➔ Product Assurance Plan MST-CAM-PL-0166 chap 3.8.4
- Acceptance review (chap 3.8.5)

➢ **Please include RAMS manager**



Procurements:

- Obsolescence / long delivery time (track in the DCL)
- Date code tracking
- Incoming inspection and conformance reports
- **Additional incoming tests :**



Procurements – Components from brokers - Counterfeiting

Test step	applicable standard	Non-BGA active	Active BGA	passive, discrets
Level 1 / standard tests: counterfeit detection		*Number of components to be checked*		
External visual inspection, marking	MIL-STD-883 Test Method 2009 + SCC 24800	20 ou +	20 ou +	20 ou +
X-ray RX2D	MIL-STD-883 Test Method 2012	20 ou +	20 ou +	20 ou +
Opening + optical inspection	MIL-STD-883 Test Method 2010 Cond. B	2	2	2
Price level 1			**835 €**	
Level 2 / batch homogeneity, stored components				
Weldability test **	IEC-68-2-20 Test Ta Method 1	2		2
X-ray fluorescence (XRF)			2	
Acoustic microscopy CSAM *	IPC/JEDEC J-STD-035 ; MIL-883 Method 2030.2	3	3	3
Electrical measurements +25°C				5
Price level 1 + level 2		**1 355 €**	**1 355 €**	**1 615 €**

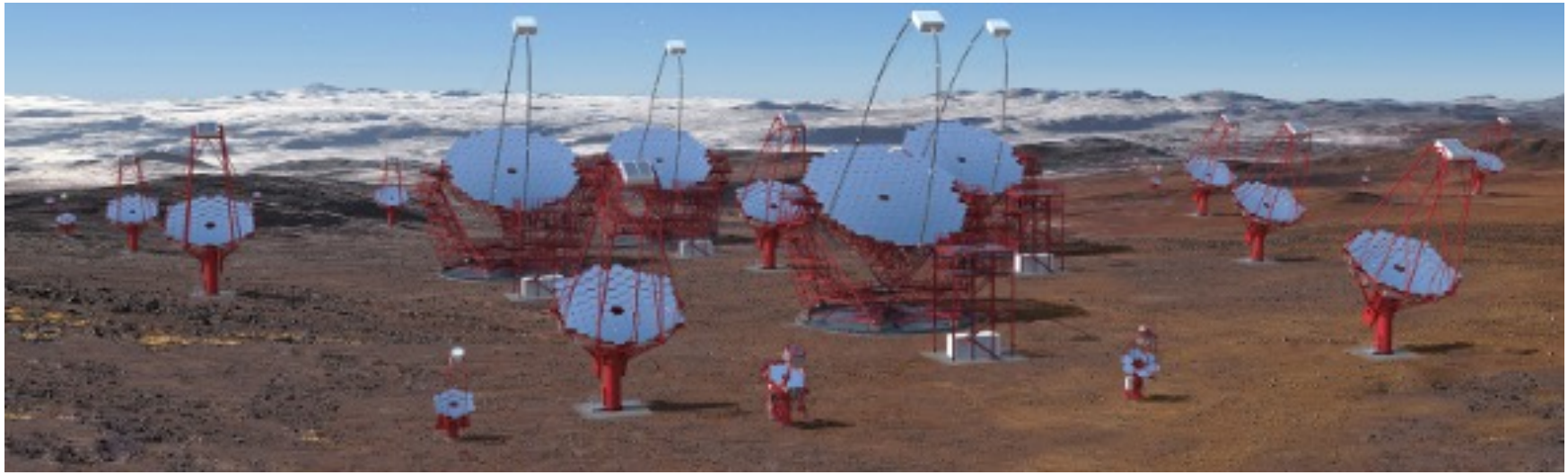
PCB Procurements

- Risk on Chinese PCB conformance to IPC rule
- ELEMCA offer :

PCB Validation	Price
Surface control of a PCB panel according tol IPC-A-600	105€/PCB
Microsections at T0 on coupons (provide 4 coupons 20x20mm with aligned vias)	4X315€
Thermal stress on coupon (provide 4 coupons 20x20mm with aligned vias) • One PCB bake-out for 8 hours at +125°C +/- 5°C • 4 thermal shocks performed according to IPC-TM-650 2.6.8 test condition A (simulation of a wave soldering process, one manual soldering and 2 repairs) with Sn63Pb37	500 €
4 microsections after thermal stress on vias with control according to IPC-A-600 (class to be determined by the customer) and IPC-6012 and IPC-4552	4X315€
Report	360 €

Conclusion / Roadmap

- Number of spare reviewed with (future) FIDES 2022 standard
- LST Camera use NectarCAM values (EDMS 2754819)
- Software/Firmware RAMS…
- Maintenance strategy and procedures **TBC**
- Stress Screening Procedures to be reviewed
- Additional controls for broker supplying and PCB when needed
- KIP/MIP and DRB : Status? At least inform RAMS manager
- NCR management @NectarCAM level? + Change request



Questions ?