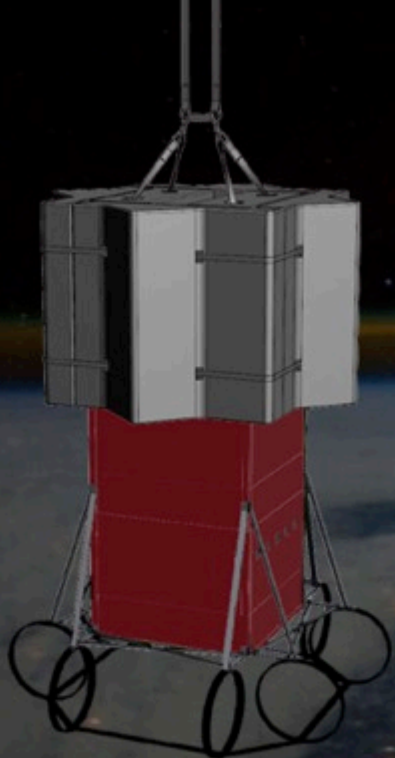


EUSO-BALLON

Un détecteur de rayons cosmiques embarqué dans un ballon stratosphérique

Guillaume Prévôt
APC Paris

Les enjeux de la mission EUSO-Ballon, précurseur de JEM-EUSO sur l'ISS

Le projet international EUSO-Ballon 1er vol : l'histoire de trois ans d'aventures

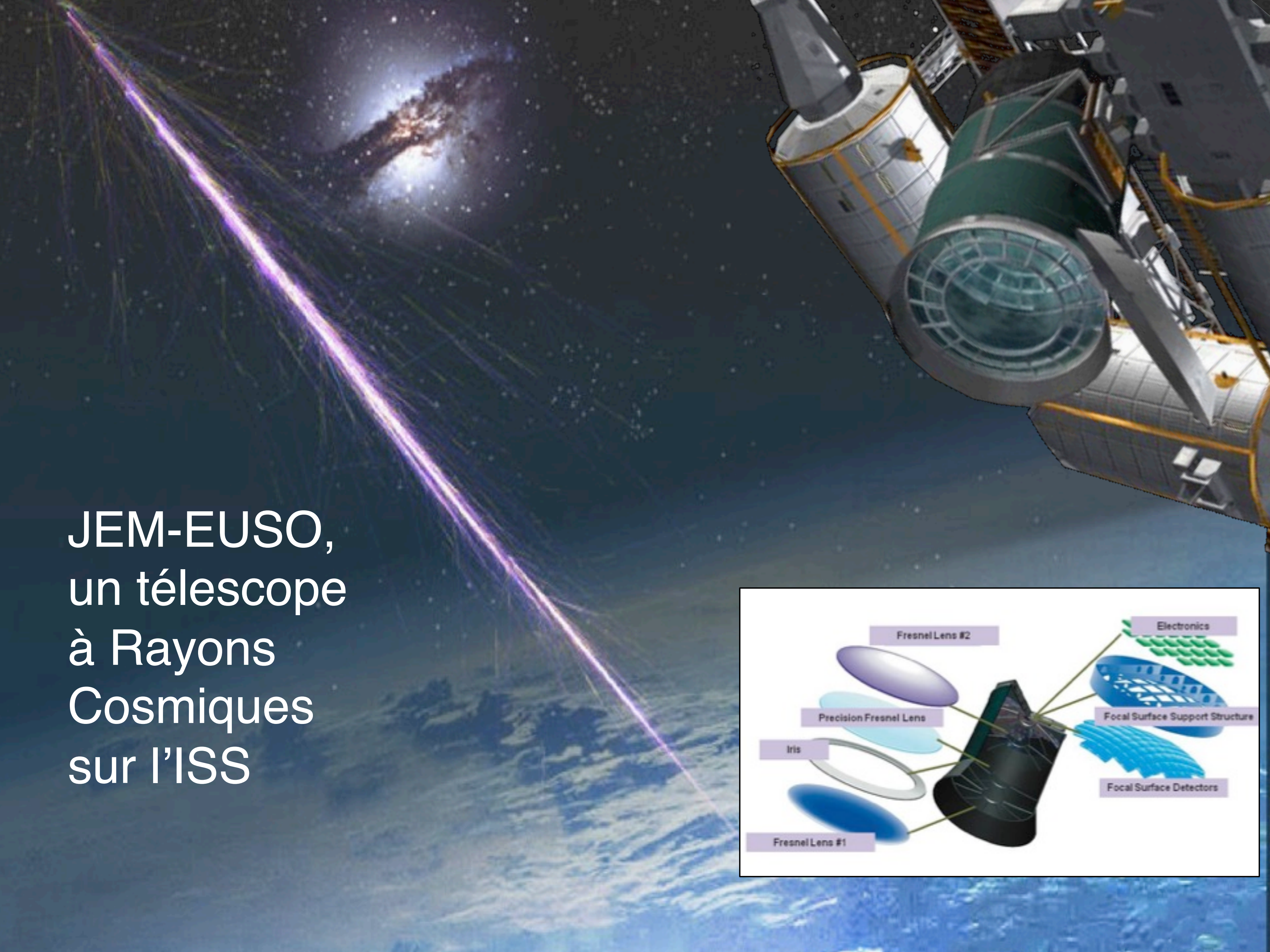
La campagne de vol EUSO-Ballon à Timmins (Ontario, Canada) en août 2014

Résultats et publications

Les perspectives (second vol en Nouvelle-Zélande, Mini-EUSO dans l'ISS)

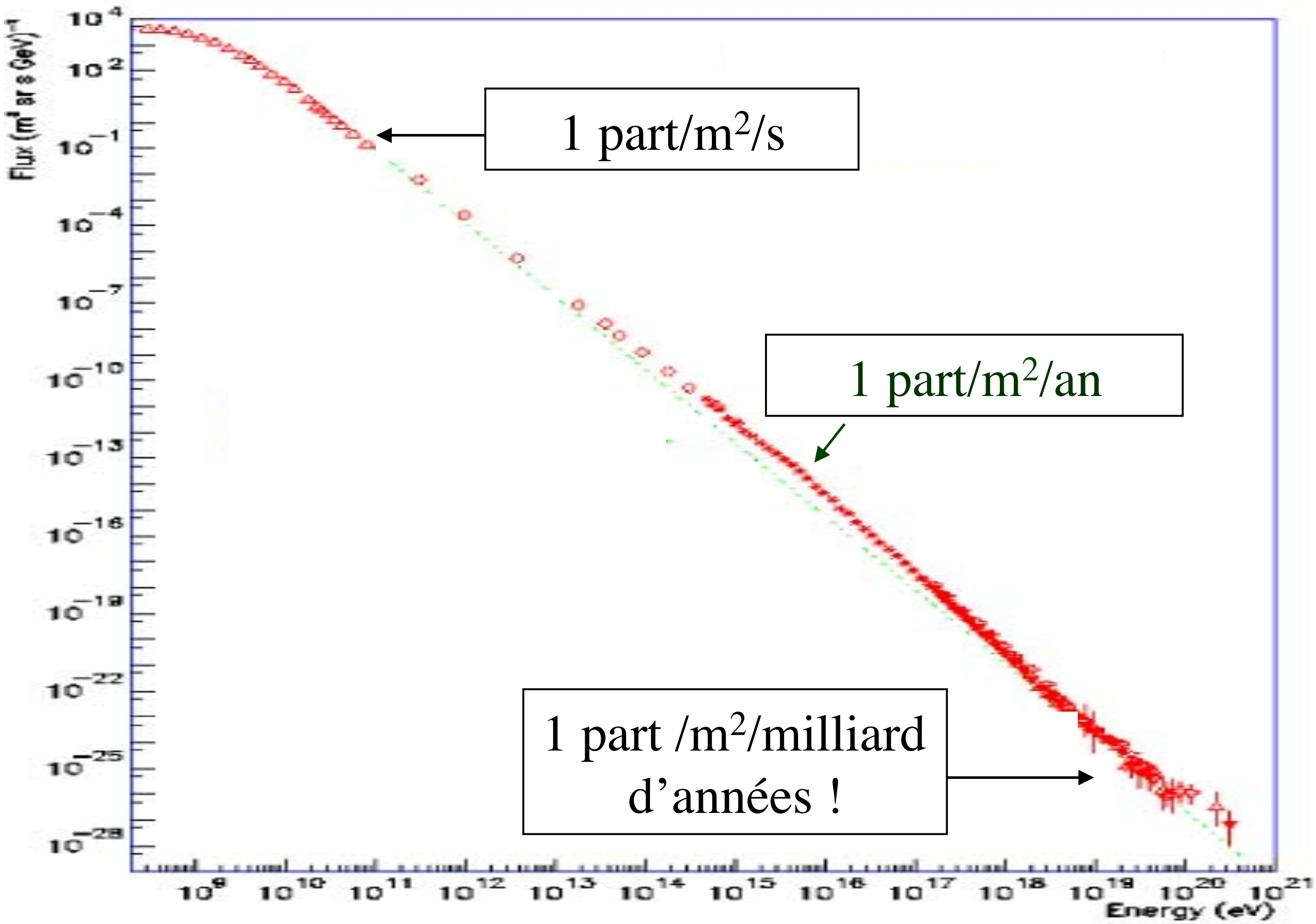

JEM-EUSO,
étude des
rayons
cosmiques
d'ultra-haute
énergie

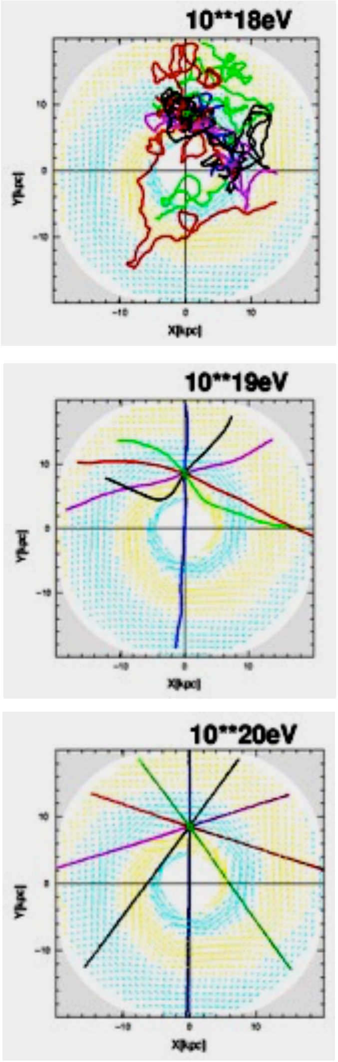
JEM-EUSO, un télescope à Rayons Cosmiques sur l'ISS



But de la future mission JEM-EUSO

JEM-EUSO: détecter depuis l'espace les rayons cosmiques d'ultra-haute énergie (les moins déviés)

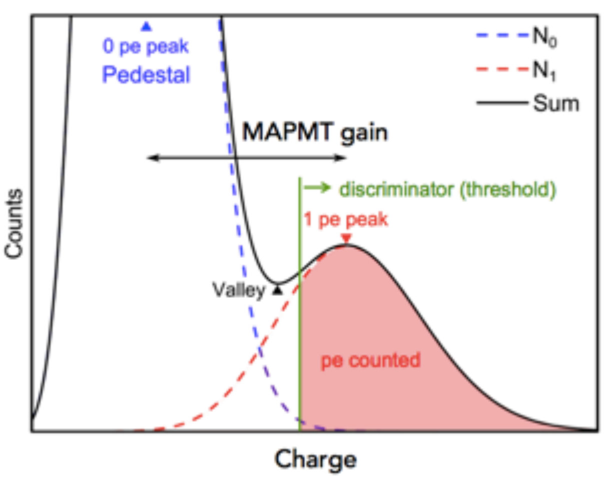


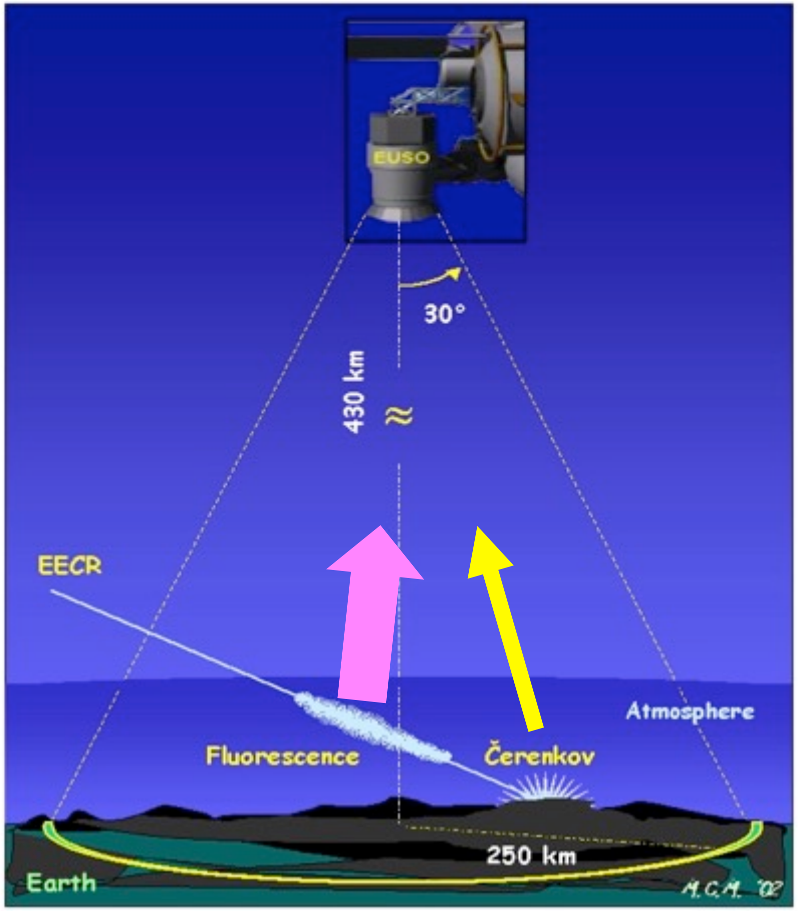


Détecter les rayons cosmiques d'ultra-haute énergie par la lumière de fluorescence émise dans l'UV, suite au développement dans l'atmosphère d'une gerbe de particules secondaires (GTU = 2,5 μs)

Volume de détection considérable !
Surface au sol :
190 000 km^2

Comptage de photon





Ne fonctionne que les nuits sans Lune…

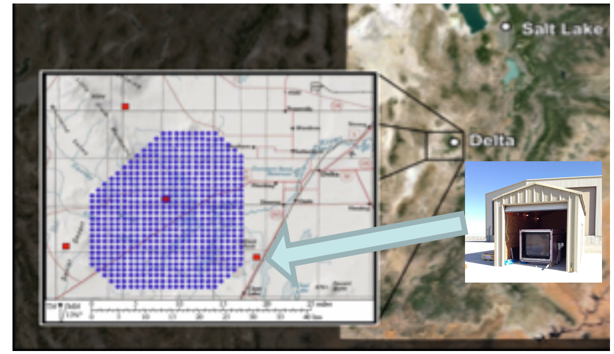
Présentation globale : les précurseurs

EUSO-Ballon (France)

Un pathfinder dans un ballon stratosphérique 2014

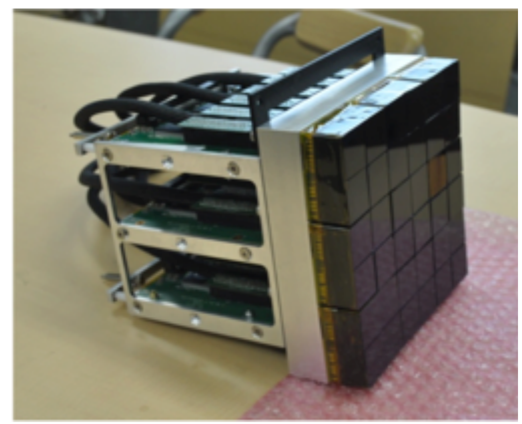
EUSO-TA (Japon)

Un pathfinder au sol (Utah) 2015



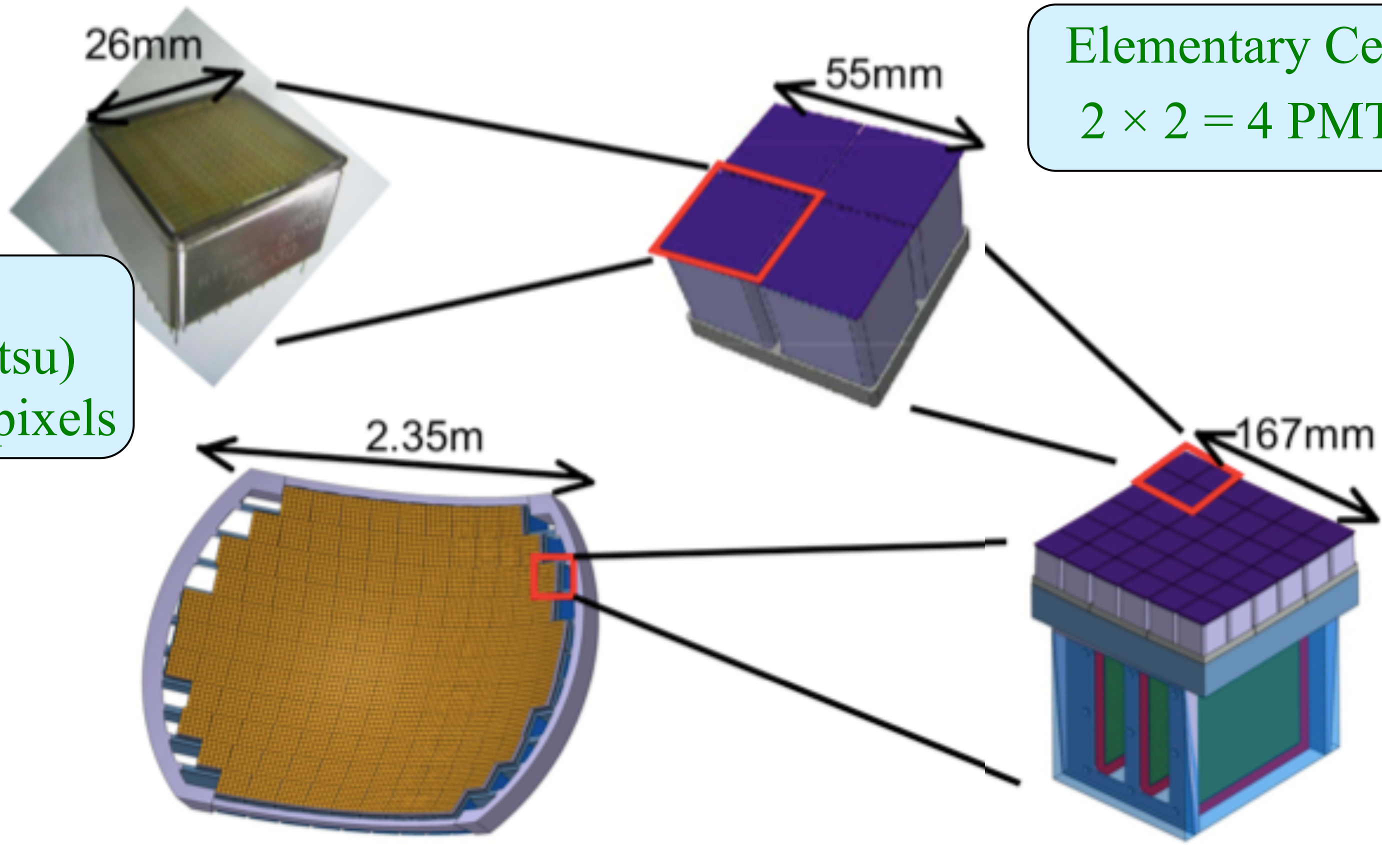
Mini-EUSO (Italie+Russie)

Un pathfinder dans l'ISS 2017



La surface focale de JEM-EUSO

Surface de détection: tubes photo-multiplicateurs



Elementary Cell (EC)
2 × 2 = 4 PMTs (flat)

MAPMT
(Hamamatsu)
8×8 = 64 pixels

Focal surface (FS)
137 PDM = 4932 PMT = 315 648 pixels

Photo-Detection Module (PDM)
3 × 3 = 9 EC (curved)

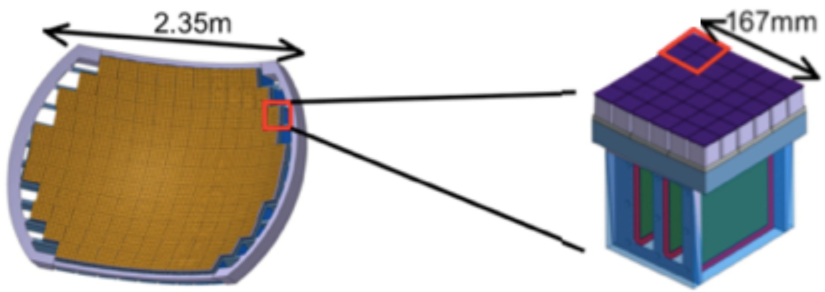
JEM-EUSO et EUSO-Ballon : propale CNES 2011

Idée d'un projet éclaireur pour la mission JEM-EUSO en mai 2011

JEM-EUSO

137 PDM

1 PDM



EUSO-Balloon,
a.k.a. α-EUSO

… avec trois objectifs hiérarchisés (pour plusieurs vols)

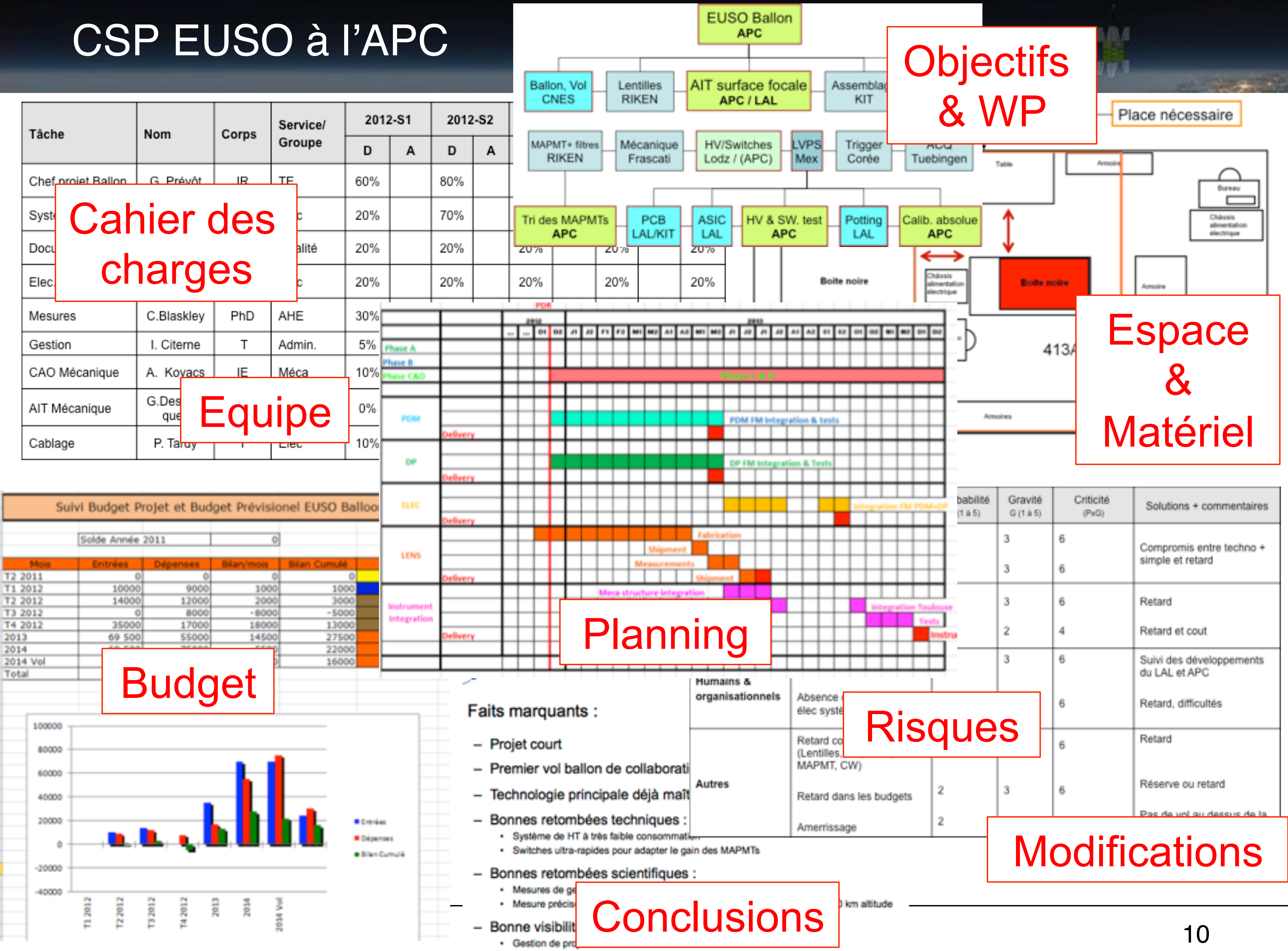
- **Objectif n°1 : prouver la validité du concept, et valider la technologie (en augmentant le degré de maturité TRL des sous-systèmes)**
- **Objectif n°2 : mesurer le bruit de fond UV (pour différents albédos)**
- **Objectif n°3 : détecter des évènements physiques (réels et/ou simulés)**

Les points clés EUSO-Ballon :

14 Sept. 2011 : kick-off meeting pour le démarrage de la Phase A

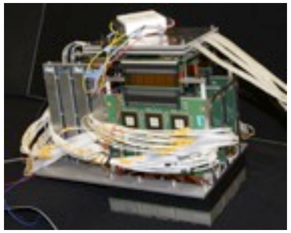
- Phase A d'octobre 2011 à mars 2012.
- En avril 2012, le CNES accorde le démarrage de la phase B à la condition d'un renforcement de la gestion de projet avec l'arrivée d'un chef de projet global dédié.
- En mai 2012, la gestion de projet est confiée à l'APC (après discussions CNES/APC).
- En septembre 2012, Cellule Suivi de Projet (CSP) EUSO à l'APC.
- **Projet ballon très court (proche R&D) ≠ projet satellite : intention commune de trouver un compromis dans le management par la qualité.**

CSP EUSO à l'APC



Les objectifs des vols EUSO-Ballon formalisés

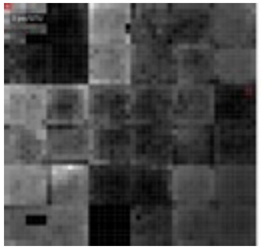
Objectifs des vols (définis durant le kick-Off meeting et accompagnés d'un document de définition instrument et d'un document de spécifications techniques):



Niveau A : Test à l'échelle 1 de l'ensemble de la technologie JEM-EUSO = OBJECTIF PREMIER VOL

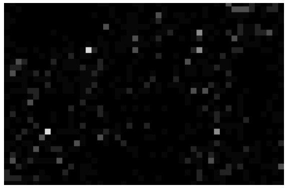
Alimentation haute-tension, commande des switches HT pour la réduction ultra-rapide du gain des PMTs, électronique de front-end (ASICs, FPGA…)

Hardware et software pour les triggers et la reconnaissance des gerbes



Niveau B : Recueil de données et étude du bruit de fond dans des conditions similaires à JEM-EUSO

Avec une résolution suffisante → taille du pixel au sol < celle de JEM-EUSO, acquisition de données type JEM-EUSO depuis une plateforme de type spatial, test et optimisation des algorithmes de trigger en conditions réelles et variables

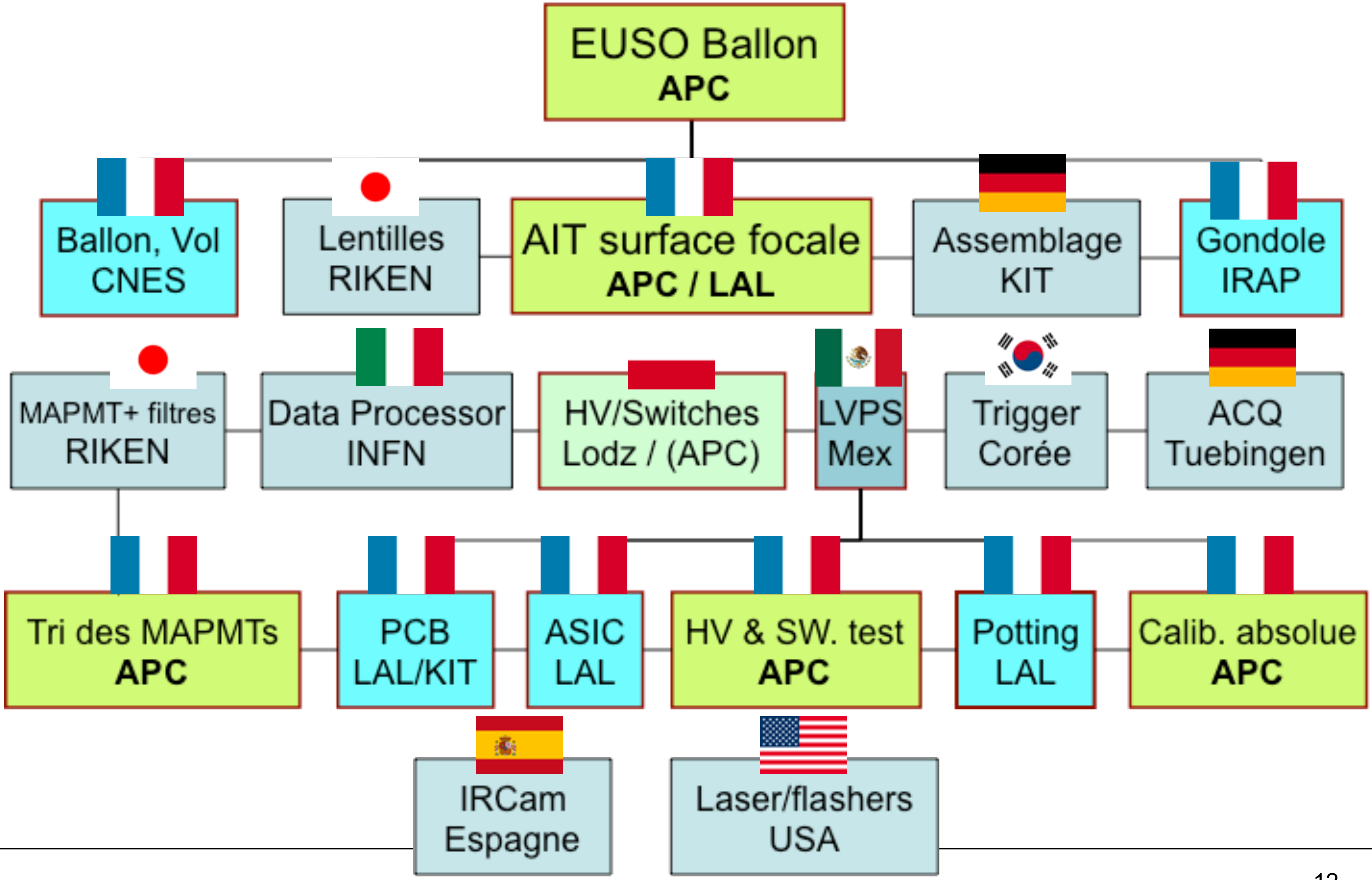


Niveau C : Mission précurseur

Première détection d'une gerbe de rayon cosmique par le dessus ?

Détection d'événements induits par laser ou flashs ?

Organigramme (formalisé dans la note d'organisation) avec WBS



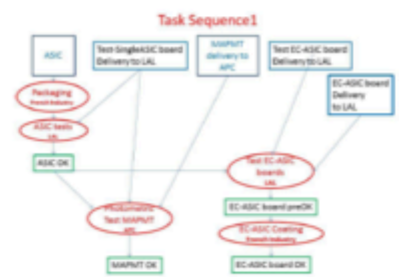
PBS (formalisé dans le plan de développement) -> fiches de tâches

Sub-System	Component	Maturity, Development Status	Direct use for EUSO-B or adaptation required	Need for an Engineering Model (Y/N)	FM availability and place for production
TLS	Lenses	Industrial production Under control	The produced circular lenses need to be cut in a square	No	To be produced by RIKEN
Photo Detector	UV-Filter	Industrial production Under control	Direct use	No	Under production
	MAPMT	Industrial production Under control	Direct use	No	Already produced
EC Unit	ASIC	Produced for JEM EUSO Project and used on UFFO	Direct use	No	ASIC is produced. Packaging to be done. => LAL
	EC-Dynode board	New design for EUSO. Done.		Mechanical mock up to check holes fitting. Then, flight production	To be produced by LAL
	EC-Anode board	New design for EUSO. Done.			To be produced by LAL
	EC-ASIC board	New design for EUSO. Done.		Mechanical mock up + proto PCB, then flight production.	To be produced by LAL
	EC-HV board	New design for EUSO. Done.		Proto model TBD. Depend on the design choice.	To be produced by KIT/Germany
	HV-Cockoft Walton and Switches	Design done for JEM EUSO. Tests done.	Direct use TBC The size has to match the one available for EUSO	Eng models developed in Poland laboratory	To be produced by NCBJ/Poland
	Assembled and potted EC Unit	New design Proto EC on going to be potted		Yes => A mechanical mock up and a proto EC	To be produced under LAL responsibility
PDM Board	Configured FPGA	Version done for UFFO. VHDL to be slightly modified for EUSO	VHDL to be modified. Minor changes.	Will be tested on the PDM board proto model.	To be produced by EWHA/Korea
	PDM Board	A design has been done for UFFO. Adaptation to do for EUSO	Minor changes (modification to be done to fit with EUSO connectors	Proto model and then flight production.	To be produced by EWHA/Korea
PDM-LVPS	PSB board	Design done for JEM-EUSO.	Possibly minor adaptation for EUSO: input voltage from 24	Proto model and then FM	To be produced by UNAM/Mexico
CPU	Processor	Off the Shelf	Direct Use	No	To be produced by INFN/Naples
CCB	Configured FPGA	Dose (Virtex-4-FX140)	Direct use	Proto model and then FM prod	To be produced by IAAT/Germany
	CCB Board	Design on going	Direct use	Proto model and then FM prod	To be produced by IAAT/Germany
	Mass Storage	Off the shelf	Direct use	No	To be produced by IAAT/Germany
DP-LVPS	PSB board	Design done for JEM-EUSO and for EUSO B	Modifications to be done to adapt to increase power	Proto model and then FM	To be produced by UNAM/Mexico
HK	HK board	Brand new design Done		Proto model and then FM	To be produced by UNAM/Mexico
Clocks CPU	CPU	Off the Shelf Done		No	To be produced by Naples/INFN
	Clock board	Done		Proto Model and FM prod	To be produced by Naples/INFN
	GPS	Off the shelf	Direct use	No	CNES
PWP	Batteries	Off the Shelf	Direct use	No	CNES

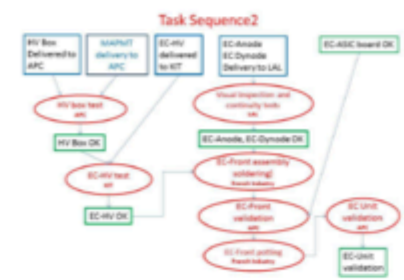
EC UNIT TASKS SEQUENCES AND VALIDATION PLAN

MAPMT Procurement

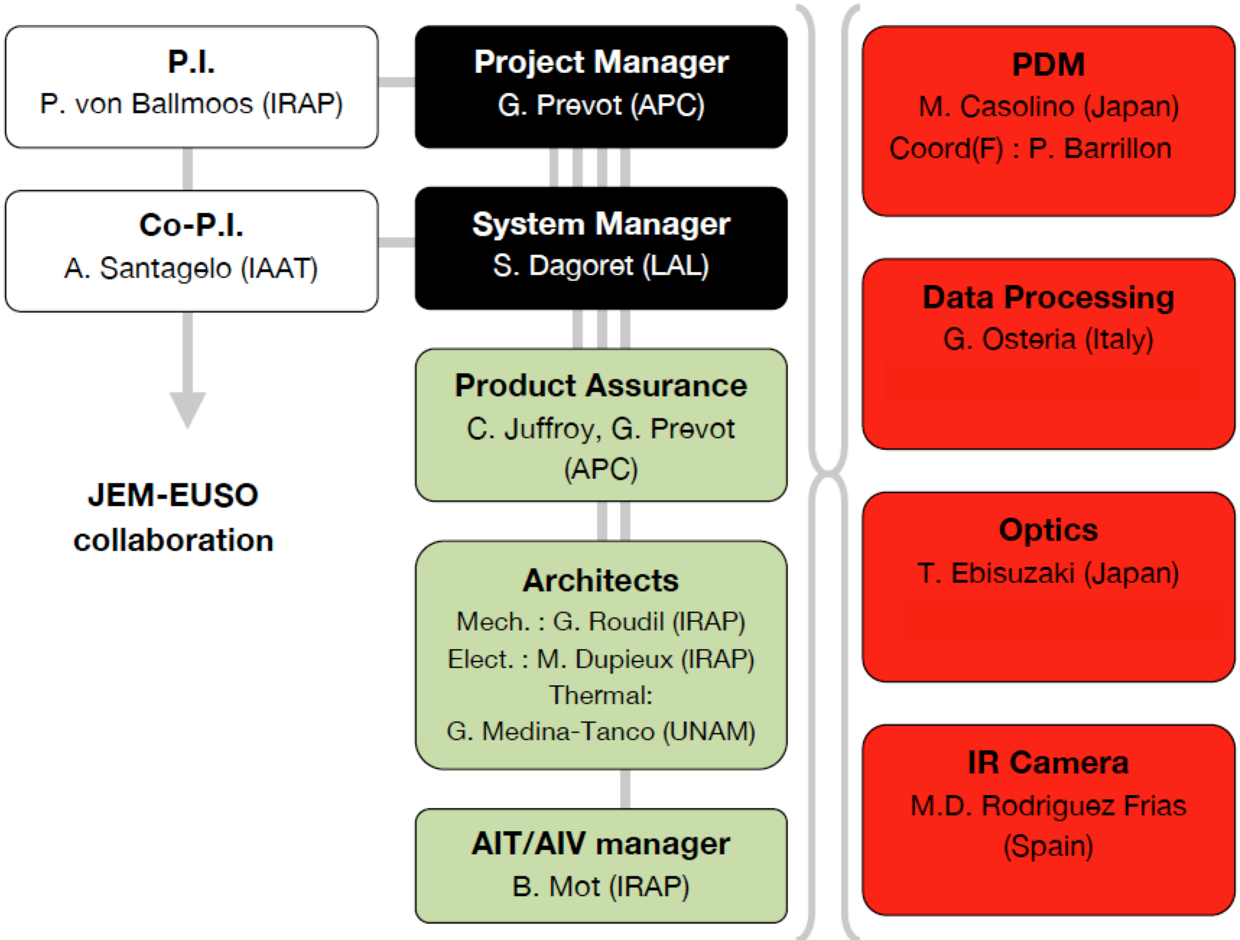
EUSO-BALLOON DEVELOPMENT PLAN



EUSO-BALLOON DEVELOPMENT PLAN



Etablissement de la note d'organisation



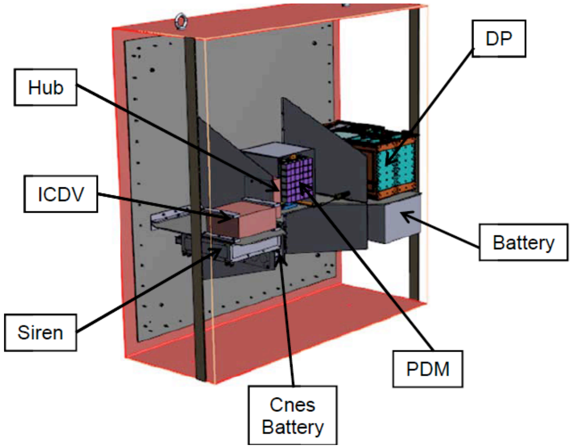
Difficultés projet :

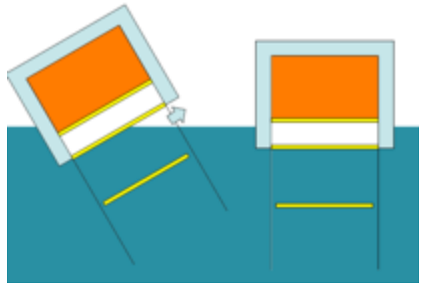
Nombreuses équipes sur le projet -> nombreuses I/F

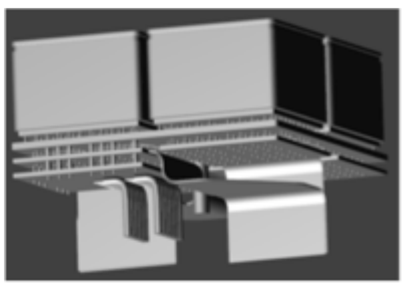
- découpe par tâches PBS
- téléconfs spécifiques courtes (hebd.) & réunions physiques collaboration (bimestrielles)
- Comptes rendus, documentation, revues

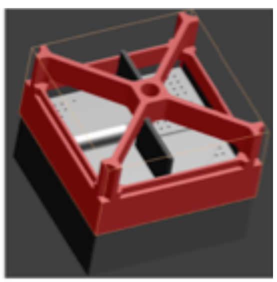
nous ont aidé à nous structurer.

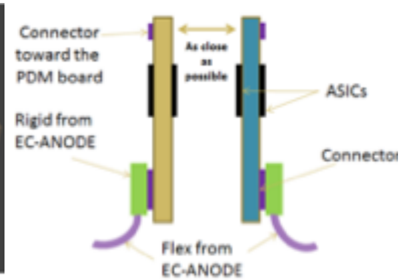
EUSO-Balloon: finalisation du design (documenté dans docs architectures)

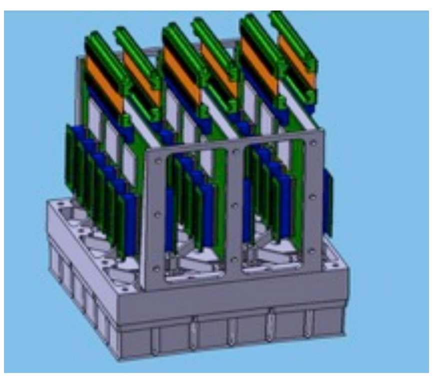


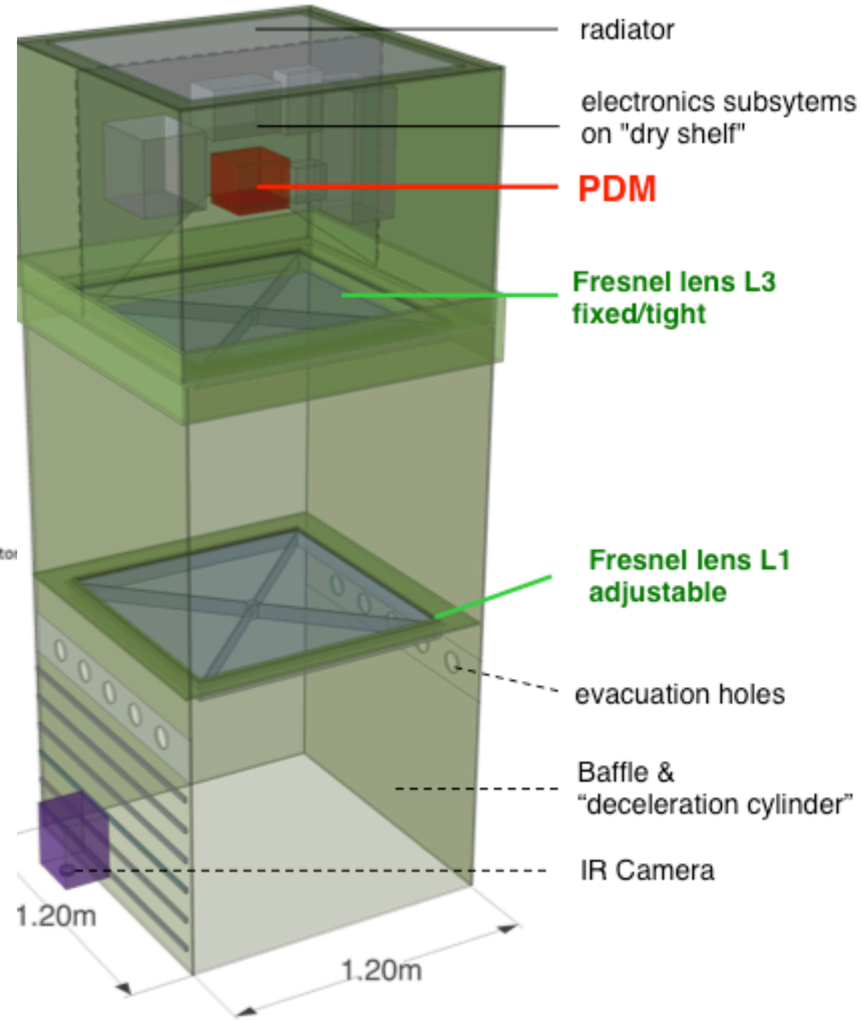




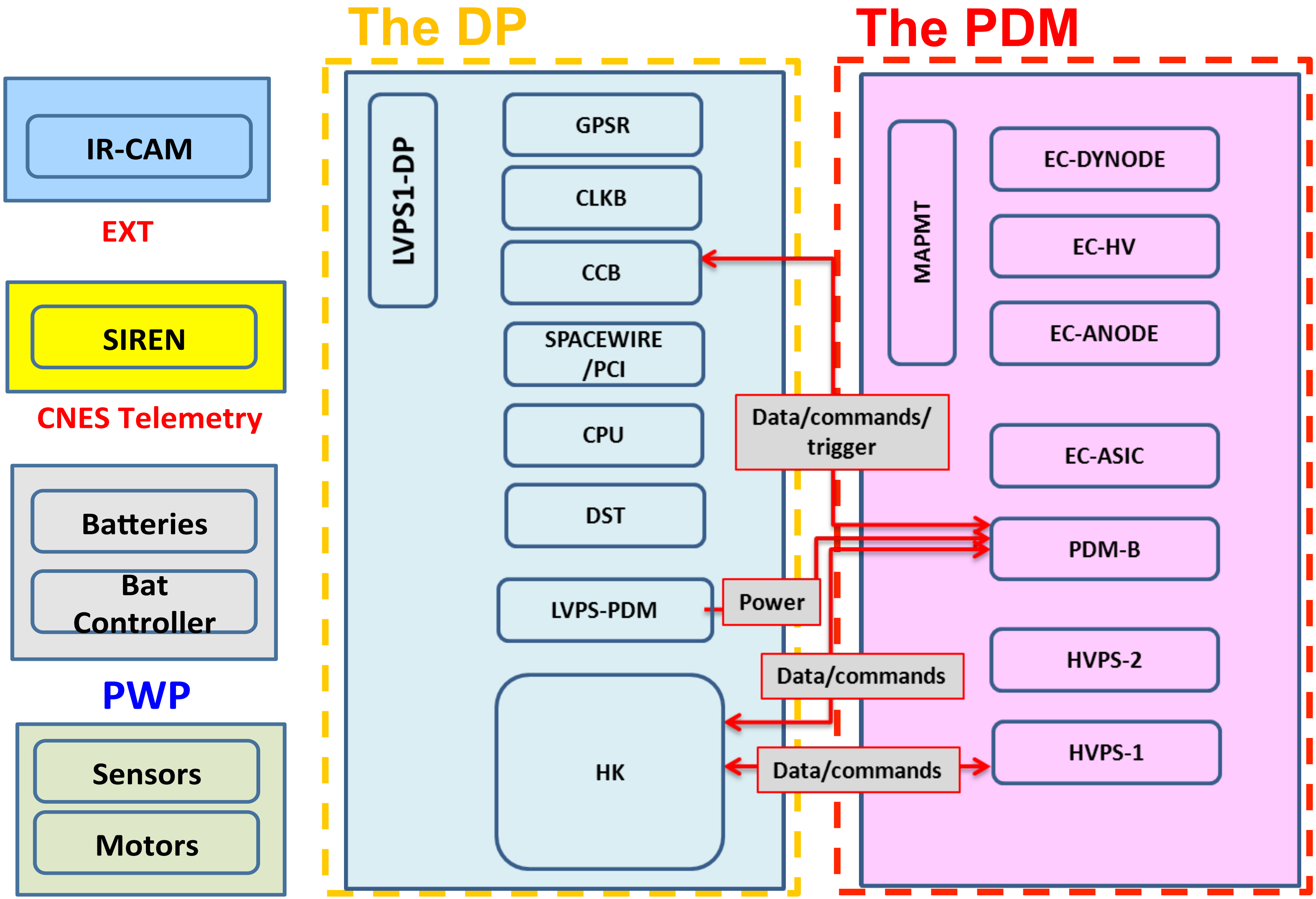








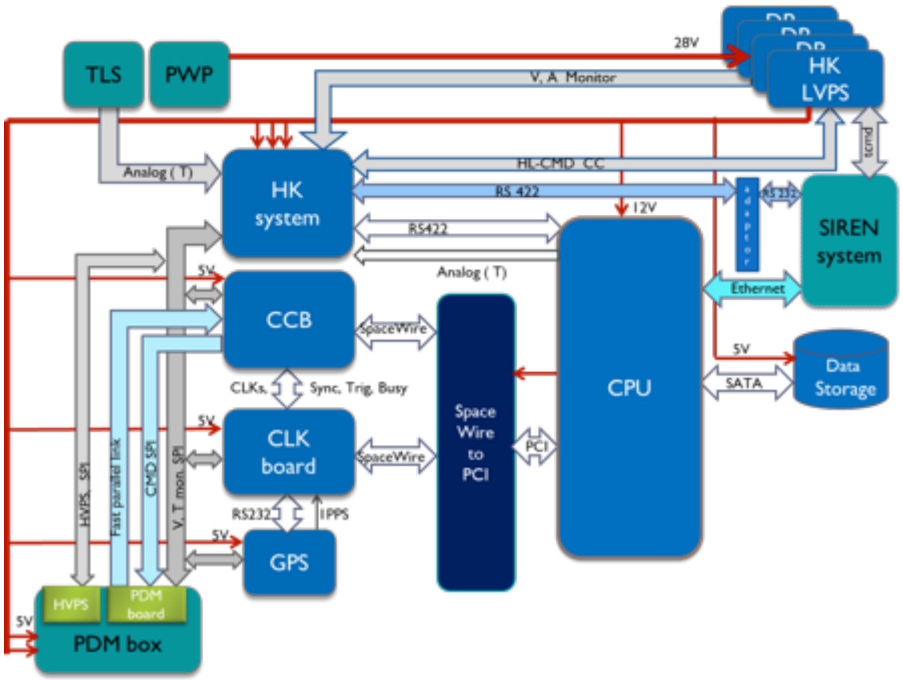
Formalisation de la structure détecteur



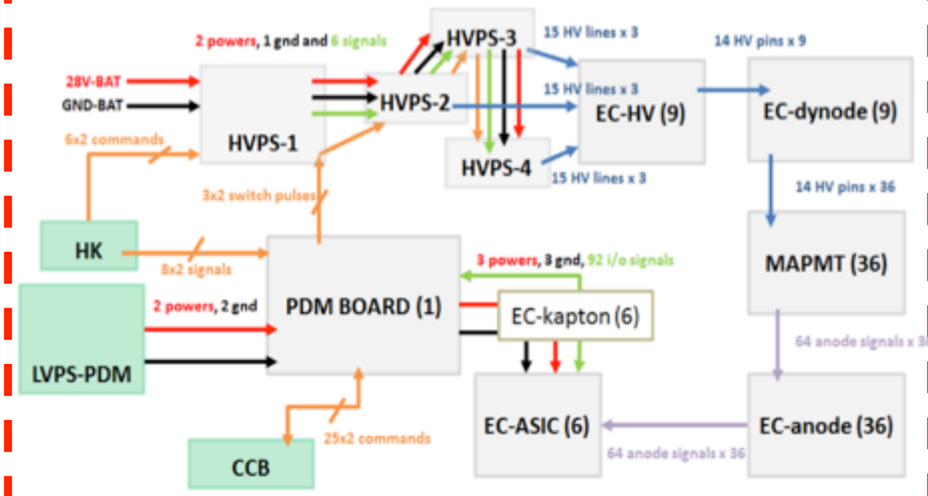
Le PDM détecte les photons UV issus des lentilles, digitalise les données et réalise le premier niveau de trigger. La chaine électronique est constituée du DP qui réalise le second niveau de trigger, la synchronisation, l'acquisition et le stockage des données ainsi que la télémétrie.

Formalisation de la structure détecteur

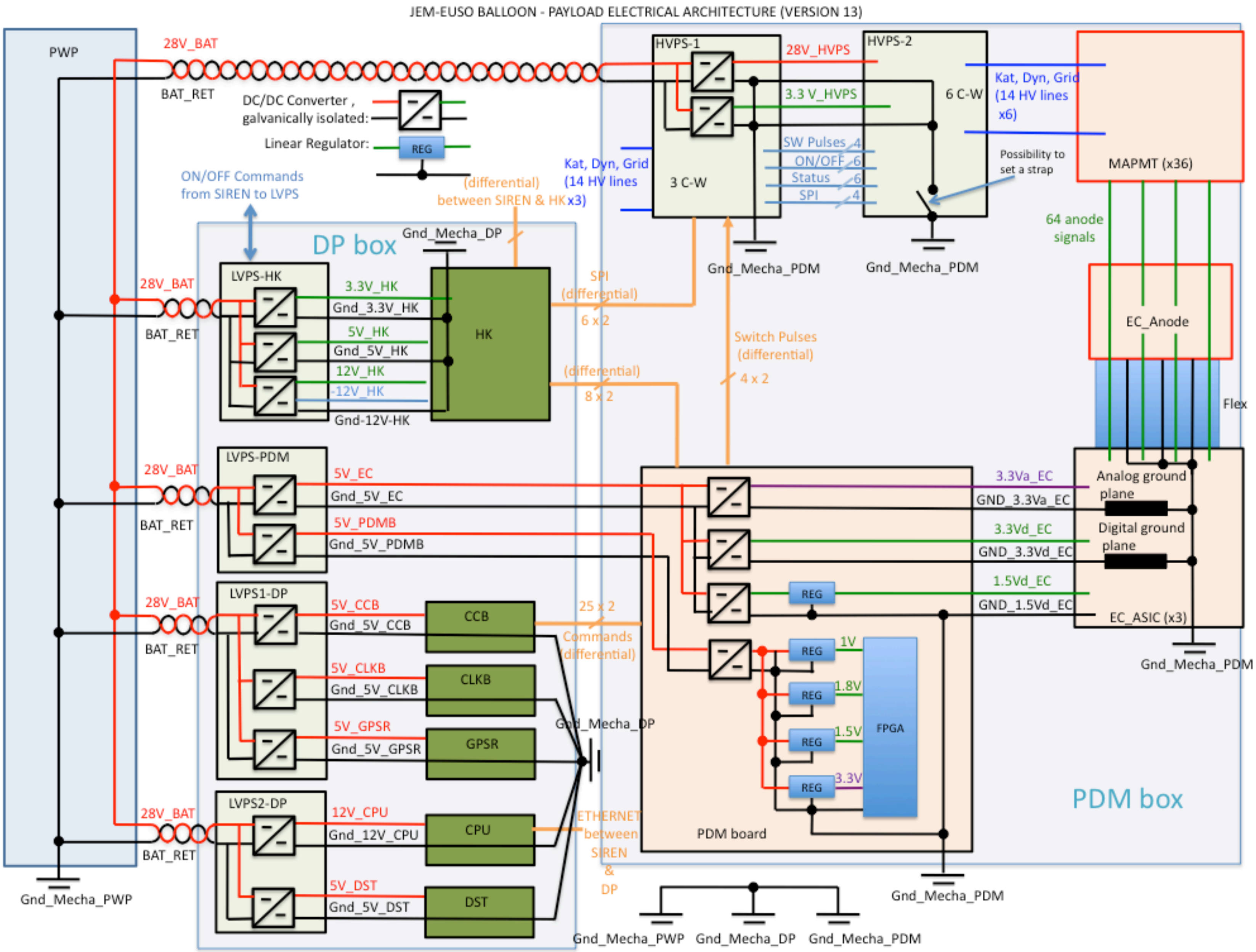
The DP



The PDM



Définition d'une architecture électrique (après revues internes et externes)



Liste des câbles I/F : spécifications et responsables

N°	Connection A/B	Shielding	Equipment	Connector Marking	Connector Reference	Shielding Connection to Cover	Shielding Connection to Cover	Connector Reference	Connector Marking	Equipment	Function	Remark	Who provide	Status	length
				A					B						
1	INSTRUMENT-PWP/LVPS1-DP	NO	PWP	PW-01M	DB 9M			DB 9M	LVDP1-01M	LVPS1-DP	PRIMARY POWER	TWISTED PAIRS	UNAM	OK	50 cm
2	INSTRUMENT-PWP/LVPS2-DP	NO	PWP	PW-02M	DB 9M			DB 9M	LVPD2-01M	LVPS2-DP	PRIMARY POWER	TWISTED PAIRS	UNAM	OK	50 cm
3	INSTRUMENT-PWP/LVPS-PDM	NO	PWP	PW-03M	DB 9M			DB 9M	LVPD-01M	LVPS-PDM	PRIMARY POWER	TWISTED PAIRS	UNAM	OK	50 cm
4	INSTRUMENT-PWP/LVPS-HK	NO	PWP	PW-04M	DB 9M			DB 9M	LVHK-01M	LVPS-HK	PRIMARY POWER	TWISTED PAIRS	UNAM	OK	50 cm
5	INSTRUMENT-PWP/HVPS-1	NO	0	PW-05M	DB 9M			DB 9M	HV1-03M	HVPS-1	PRIMARY POWER	TWISTED PAIRS	IRAP	OK	50 cm
6	LVPS1-DP/HK	NO	LVPS1-DP	LVDP1-02M	DB 37M			DB 37M	HK-05M	HK	SUPPLIES MONITORING		UNAM	OK	50 cm
7	LVPS1-DP/GPSR	NO	LVPS1-DP	LVDP1-03M	DB 9M			DB 9M	GPS-02M	GPSR	SECONDARY POWER	TWISTED PAIRS	INFN	OK	50 cm
8	LVPS1-DP/CLKB	NO	LVPS1-DP	LVDP1-04M	DB 9M			DB 9F	CLK-01F	CLKB	SECONDARY POWER		INFN	OK	50 cm
9	LVPS1-DP/CCB	NO	LVPS1-DP	LVDP1-05M	DB 9M			µD 9F	CCB-01F	CCB	SECONDARY POWER	TWISTED PAIRS	IAAT	OK	50 cm
10	LVPS2-DP/HK	NO	LVPS2-DP	LVDP2-02M	DB 25M			DB 25M	HK-04M	HK	SUPPLIES MONITORING		UNAM	OK	50 cm
11	LVPS2-DP/CPU	NO	LVPS2-DP	LVDP2-03M	DB 15M			DB 15F	CPU-05F	CPU	SECONDARY POWER	TWISTED PAIRS	INFN	OK	50 cm
12	LVPS-PDM/HK	NO	LVPS-PDM	LVPD-02M	DB 25M			DB 25M	HK-01M	HK	SUPPLIES MONITORING		UNAM	OK	
13	LVPS-PDM/PDMB	YES	LVPS-PDM	LVPD-03M	DB 9M	YES @ 90°	YES @ 90°	µD 9M	PDM-01M	PDMB	SECONDARY POWER	TWISTED PAIRS	UNAM	OK	
14	LVPS-HK/HK	NO	LVPS-HK	LVHK-02M	DB 9M			DB 9M	HK-02M	HK	SUPPLIES MONITORING		UNAM	OK	
15	LVPS-HK/HK	NO	LVPS-HK	LVHK-03M	DB 9M			DB 9M	HK-11M	HK	SECONDARY POWER	TWISTED PAIRS	UNAM	OK	
16	LVPS-HK/SIREN	NO	LVPS-HK	LVHK-04M	DB 15M			DB 44M	SIR_TOR	SIREN	ON/OFF COMMMANDS		UNAM	OK	
17	HK/LENSES	YES	HK	HK-03M	DB 25M	YES @ 90°	NO		CAPTEURS T	LENSES	TM		UNAM	OK	
18	HK/PDMB	YES	HK	HK-06M	DB 25M	YES @ 90°	YES @ 90°	µD 25M	PDM-02M	PDMB	LVDS	TWISTED PAIRS	UNAM	OK	
19	HK/RS232-RS422 ADAPTOR	YES	HK	HK-07M	DB 9M	YES @ 90°	YES @ 90°	DB 9F	ADAP-02F	RS232/RS422 ADAPTO	RS422	TWISTED PAIRS	UNAM	OK	
20	HK/CPU	YES	HK	HK-08M	DB 9M	YES @ 90°	YES @ 90°	DB 9F	CPU-04F	CPU	RS422	TWISTED PAIRS	INFN	OK	50 cm
21	HK/CCB	YES	HK	HK-09M	DB 25M	YES @ 90°	YES @ 90°	µD 25M	CCB-02M	CCB	LVDS	TWISTED PAIRS	IAAT	OK	45 cm (max)
22	HK/CLKB	YES	HK	HK-10M	DB 25M	YES @ 90°	YES @ 90°	DB 25F	CLK-02F	CLKB	LVDS	TWISTED PAIRS	INFN	OK	45 cm (max)
23	HK/HVPS-1	YES	HK	HK-12M	DB 15M	YES @ 90°	YES @ 90°	DB 15M	HV1-01M	HVPS-1	LVDS	TWISTED PAIRS	UNAM	OK	45 cm (max)
24	HK/GPSR	YES	HK	HK-13M	DB 15M	YES @ 90°	YES @ 90°	DB 15M	GPS-01M	GPSR	LVDS	TWISTED PAIRS	INFN	OK	45 cm (max)
25	SIREN/RS232-RS422 ADAPTOR	YES	SIREN	SIR_SY/AS	µD 62M	YES @ 90°	YES @ 90°	DB9 F	ADAP-01F	RS232/RS422 ADAPTO	RS232		UNAM	OK	
26	SIREN/CPU	YES	SIREN	SIR-Ethernet	RJ45_M	YES @ 90°	YES @ 90°	RJ45 M	CPU-06M	CPU	ETHERNET		INFN	OK	
27	HVPS-1/PDMB	YES	HVPS-1	HV1-02M	µD 9M	YES @ 90°	YES @ 90°	µD 9M	PDM-03M	PDMB	HV GAIN PULSES - LVDS	TWISTED PAIRS	APC	OK	
28	HVPS-1/HVPS-2	YES	HVPS-1	HV1-04F	DB 25F	YES @ 90°	YES @ 90°	DB 25M	HV2-01M	HVPS-2	HVPS-1 HVPS-2		APC	OK	
29	PDMB/CCB	YES	PDMB	PDM-04M	µD 51M	YES @ 90°	YES @ 90°	µD 51M	CCB-05M	CCB	LVDS	TWISTED PAIRS	IAAT	OK	
30	CCB/CPU	YES	CCB	CCB-03M	µD 9M	YES @ 90°	YES @ 90°	µD 9M	CPU-02M	CPU	Space-Wire2		IAAT	OK	
31	CCB/CLKB	YES	CCB	CCB-04M	µD 15M	YES @ 90°	YES @ 90°	µD 15M	CLK-06M	CLKB	DIFFERENTIAL CLOCKS	TWISTED PAIRS	IAAT	OK	
32	CLKB/CPU	YES	CLKB	CLK-03F	µD 9M	YES @ 90°	YES @ 90°	µD 9M	CPU-01M	CPU	Space-Wire1		INFN	OK	50 cm
33	CLKB/GPSR	YES	CLKB	CLK-05M	µD 15M	YES @ 90°	YES @ 90°	µD 15M	GPS-03M	GPSR	DIFFERENTIAL SERIAL I/F	TWISTED PAIRS	INFN	OK	45 cm (max)
34	GPSR/GPS-ANTENNA	COAX	GPRS	GPS-04M	SMA M			SMA M	Antenna-GPS-M	GPS2-ANTENNA	GPS RF SIGNAL		INFN	OK	5 m

Rédaction d’une documentation partagée pour revue phase C/D

Rédaction commune de 35 documents pour les revues CNES CDR (revue de design) et RAV (revue de vol) **:**

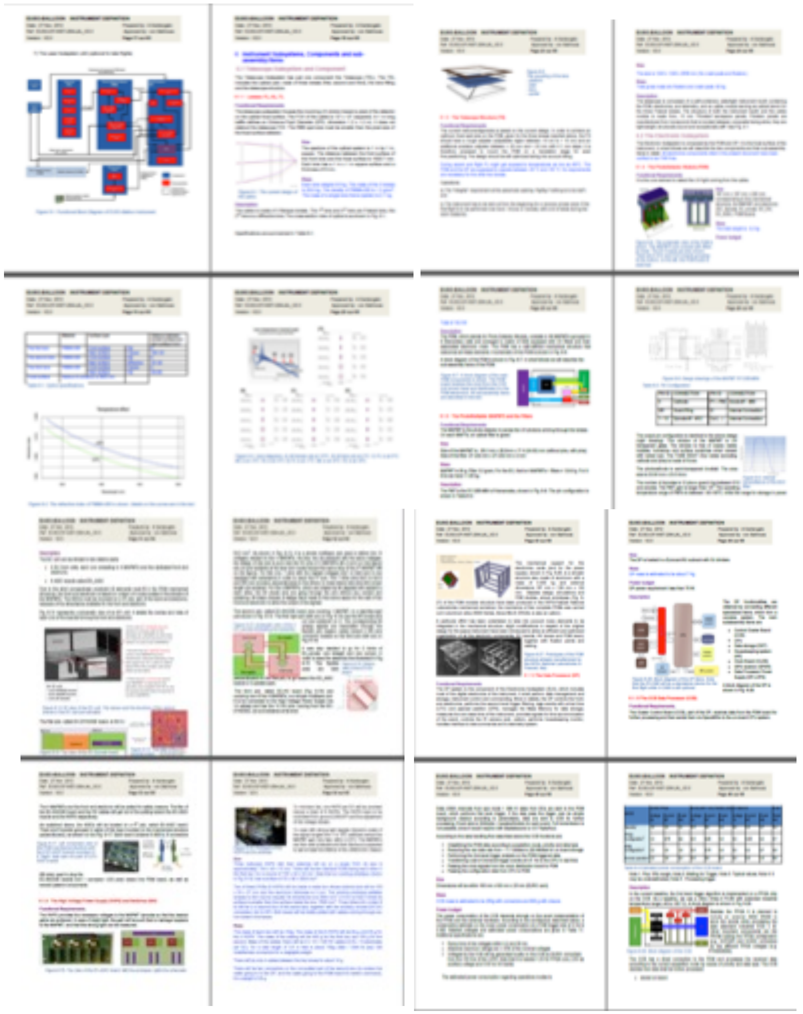
- Documents de spécifications (instrument et mission) et de définition (instrument et logiciel de vol)
- Docs d’architectures (électrique, mécanique, thermique)
- Documents d’interfaces (électrique, mécanique)
- Plan de développement
- Plan d’assemblage, d’intégration et de tests PAIE
- Rapports de tests
- Matrices de conformités (à l’assurance produit CNES et aux spécifications)
- Document d’analyse de risques
- Planning MS Project (250 lignes, MAJ à chaque revue)

avec l’aide de la cellule qualité APC et du CNES

Documents de définitions instrument et de spécifications tech.

Spécifications techniques

Document de définition



Documents d'analyse des risques

approvisionnements

EVENT ID	EVENT	Risk Factor	Risk Scenario ID	Risk Scenario Name	Risk ID	cause	mitigation
RD	Unsuccessful development		RD	Unable to reach program objectives			
		PROCUREMENT	RD1	Key elements not available	RD1.1	FRESNEL lenses not available at due time	plenty of contingency time is already budgeted by TOSHIBA
					RD1.2	[illegible]	[illegible] exist for TA.
					RD1.3	[illegible]	[illegible] are needed. ASIC yield is around 70%. Packaging of new ASICs can be done if the yield is found too low.
		DEVELOPMENT	RD2	Development of key system elements not successful	RD2.1	Delay in the EC integration	Mockup + prototype (PFM) produc[illegible] company in charge of it. The subc[illegible] CNES expert is following the deve[illegible]
					RD2.2	Delay of HV design (occurs after EC and PDM electronics)	Mitigation by use of a commercial[illegible] this is TBC, since it would imply [illegible] Trade off with other technical risks[illegible]
					RD2.3	Phone Booth / Instrument design not adequate	sufficient time (factor 4) for redesi[illegible] review to freeze the design taking [illegible] instrument.
		SCHEDULE	RD3	program exceeds schedule	RD3.1	NOSYCA not qualified in due time	Is now sufficiently close to the de[illegible]
					RD3.2	Launch site logistics not ready in due time	Kiruna is already perfectly establi[illegible]
		MANAGMENT	RD4	program exceeds schedule	RD4.1	Very large collaboration with many actors involved in various subsystems, risk of inadequate management	mitigated with efficient organizati[illegible] B

Table 2-1: Risk factors, scenarios and mitigations for the development phase

intégration

ID	Risk Cause – Cause	Likelihood 1 (<0.01%) to 5 (=1)	Severity 1 (negligible) to 4 (critical) – Science performance	Severity – Instrument Performance	Severity – Safety	Severity – Schedule / Cost	Risk Index – Science performance	Risk Index – Instrument Performance	Risk Index – Safety	Risk Index – Schedule / Cost
RD1.1	FRESNEL lenses not available at due time	2				4				8
RD1.2	PMT's not available at due time *	1				4				4
RD1.3	ASIC delivery (ASIC production has unknown yield)	1				2				2
RD2.1	Delay in the EC integration	2				4				8
RD2.2	Delay of HV design (occurs after EC and PDM electronics):	0				0				0
RD2.3	Phone Booth / Instrument design not adequate	1				4				4
RD3.1	NOSYCA not qualified in due time yield)	1				4				4
RD3.2	Launch site logistics not ready in due time	1				4				4
RD4.1	Very large collaboration, many actors and subsytems, inadequate management	2				4				8

Risk scenarios: Implementation phase

développements

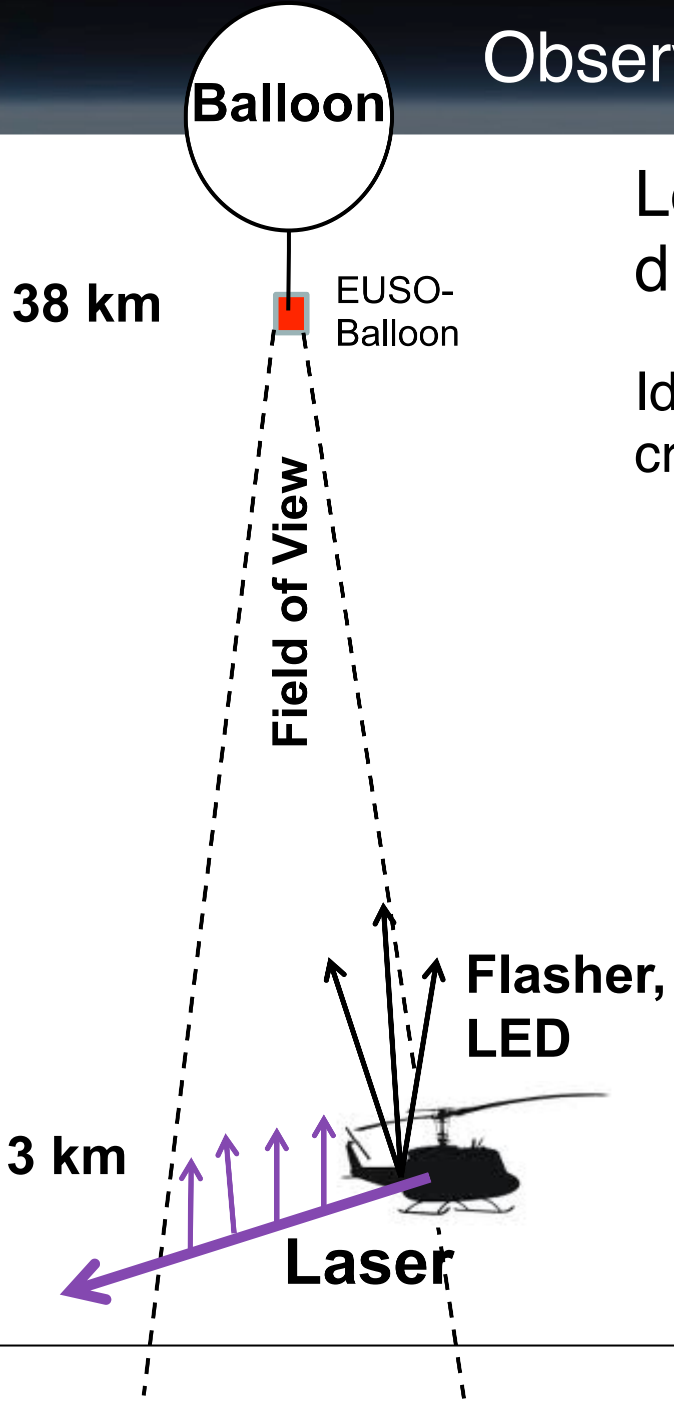
EVENT ID	EVENT	Risk Factor	Risk Scenario ID	Risk Scenario Name	Risk ID	cause	mitigation
RI	Unsuccessful implem-entation		RI	Unable to implement payload.			
		ELECTRONICS	RI1	Failure to implement subsystem	RI1.1	Failure in complex MAPMT pins soldering	Mockup and EC proto to train, mature subcontractor & help from CNES
					RI1.2	EC board and integration design not satisfying the requirements	EC proto will verify that the design meets the requirements. Phase B review will evaluate this point.
					RI1.3	EC insulation insufficient on dense printed circuit board (failure due to short circuit betwen ground/ and h[illegible]	a) we have made the choise of an apropriate CAD design; b) all the HV [illegible]
					RI1.4	Failure of HV Crockoft-Walton: no m[illegible]	[illegible]
					RI1.5	Failure of HV Switches: cannot swit[illegible]	[illegible] off manually in case of intense light.
					RI1.6	Failure of HV Switches: cannot protect MAPMT	a) this will be simulated with the prototype b) stay at high gain & switch-off manually in case of intense light.
					RI1.7	Interface Inconsistency between components.	System manager for both PDM and DP in the organization whos role is to managing interfaces. Design review foreseen to verify this issue.
		MECHANICS	RI2	Failure of mechanical subsystem	RI2.1	Fresnel lenses not matched by platform mechanics	Spider or Lenses can be re-machined easily
					RI2.2	Fresnel lens(es) broken during integration	Lenses will be protected at any time, Protection removed for launch
					RI2.3	Fresnel lens(es) broken during flight	
		SYSTEM	RI3	program exceeds schedule	RI3.1	Instrument exceeds available mass envelop	
					RI3.2	Project exceeds available M/power resource envelop	Phase A to define tasks, organization and necessary manpower. Phase A review to assess this point.

Table 2-2: Risk factors, scenarios and mitigations for the implementation phase

Lancement / vol

ID	Risk Cause – Cause	Likelihood 1 (<0.01%) to 5 (=1)	Severity 1 (negligible) to 4 (critical) – Science performance	Severity – Instrument Performance	Severity – Safety	Severity – Schedule / Cost	Risk Index – Science performance	Risk Index – Instrument Performance	Risk Index – Safety	Risk Index – Schedule / Cost
	LAUNCH / BALLOON FAILURE									
RP4.1	Failure of balloon to reach float altitude	2	2	2		3	4	4		6
RP4.2	Failure of to remain at float for the minimum required time	2	4	2		3	8	4		6
	FIRE									
RP5.1	Over heat after landing	1	1	1		2	1	1		2
RP5.2	Over heat of damaged battery	1	1	2		2	1	2		2
RP5.3	Over heat of the instrument	1	2	3		2	2	3		2
RP5.4	Spark or Discharge	1	1	1		1	1	1		1
	EXPLOSION									
RP6.1	Explosion of the explosive device due to improper design and/or operation.	1	3	3		3	3	3		3
RP6.2	Improper design of Pressure Vessel may explode.	1	3	3		3	3	3		3
RP6.3	Internal short circuit may cause explode of the battery.	1	4	4	2	4	4	4	2	2
	FALLING PARTS									
RP7.1	Loose fasteners may be falling out from instruments.	1	1	1		3	1	1		3
RP7.2	Falling Component	1	1	3		3	1	3		3
RP7.3	Falling of Tentative subassemblies or units.	1	1	2		3	1	2		3

Observations d'évènements simulés



Les chances de détecter des RC au court d'un vol d'une nuit sont trop faibles…

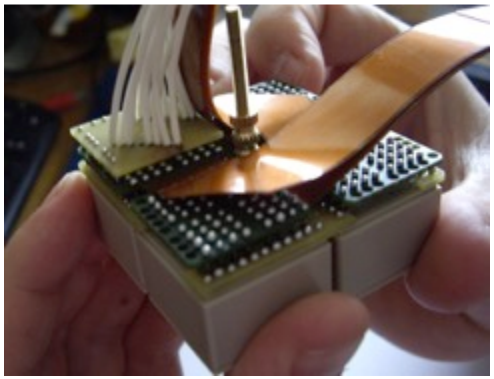
Idée de nos collègues américains : pourquoi ne pas créer nos propres évènements ?

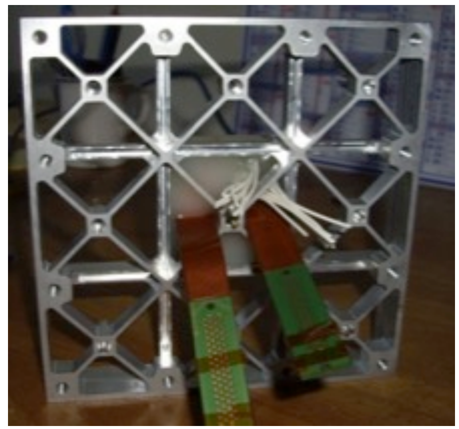
- En utilisant un hélicoptère
- Equipé d'un Laser et de LED pulsés
- Volant sous le ballon au plafond
- Les tirs laser et LED synchronisés avec l'acquisition de données (2 GPS)

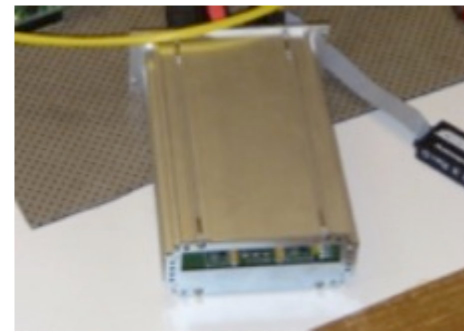
Démarrage de la Phase B: réalisation des prototypes

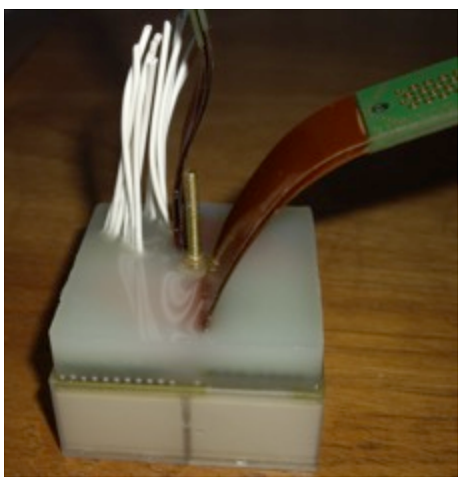
De Juillet à Déc. 2012 : développement et tests des prototypes

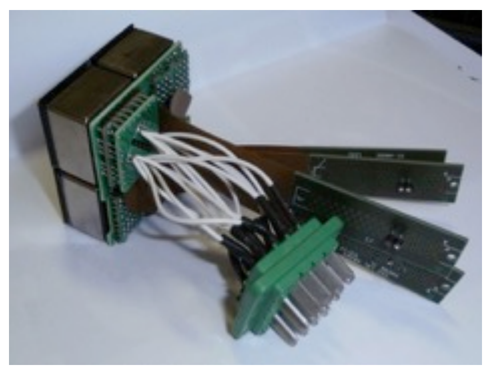
Philo. PFM pr certains modèles // EM -> FM pour les + critiques











Les points clés EUSO-Ballon :

14 Sept. 2011 : *Phase A kick-off*

18 Dec. 2012 : *Critical Design Review* (pour passage en phase raccourcie C/D)

- CDR suivie d'une réunion de réponses aux 30 RID (*Review Item Discrepancy* = FEPS en français) + rédaction d'un document dédié de réponses aux RID.
- CDR suivie de MRR (MANUFACTURING READINESS REVIEW) pour tous les sous-systèmes début 2013.
- Feu vert pour le démarrage de la phase finale C/D en février 2013

Exemples de MRR (par téléconférences + CR référencé)

	EUSO-BALLOON	Réf. : EUSO-MRRHK-INST-011-APC Date : 13/02/2013 Page : 1/3
		Lieu : CNES / APC / UNAM Teleconf

COMPTE RENDU DE REUNION

OBJET : HK MANUFACTURING READINESS REVIEW

ORDRE DU JOUR PREVU
- Design
- Tests
- Schedule

PARTICIPANTS

NOM	SIGLE	DPI	NOM	SIGLE	DPI
P.DANTO (resp CNES)	CNES		G. MEDINA TANCO (resp HK) G.PREVOT (resp Euso Balloon)	UNAM APC	

PRINCIPALES CONCLUSIONS

Design is frozen and successful tests have been made on prototype, allowing the Flight Model fabrication of the HK module.

DESTINATAIRES : Les participants +

NOM	SIGLE	DPI	NOM	SIGLE	DPI

Actions à gérer : voir tableau des actions en fin de compte-rendu

Niveau de protection : Diffusion limitée (par défaut) / Public

Document officiel

	Compte-rendu de réunion	Réf. : EUSO-MRRHK-INST-011-APC Date : 13/02/2013 Page : 2/

Texte | Action

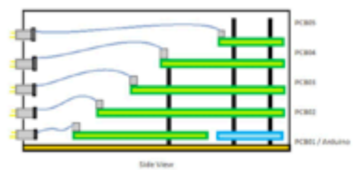
1. PURPOSE OF THE DOCUMENT

As an action asked by the steering committee, this document presents the minutes of the Key Point Meeting before the start of the production of the HK boards flight models, called Manufacturing Readiness review, or BT (Bilan Technique) in French.

Were involved in the teleconf:

P.DANTO (resp CNES)

Description



For which the individual boards' functionalities are:

PCB 05: LENSES, LVPS-PDM, LVPS-HK: (DC25-DB25).
PCB 04: LVPS1-DP, LVPS2-DP: (DC37-DB25).
PCB 03: SIREN-HK, CPU-HK, PDM-HK (DE9-DE9-DA15).
PCB 02: CCB-HK, CLKB-HK: (DB25-DB25).
PCB 01: POWER-HK, GPS-HK, HVPS-HK: (DE9-DA15-DA15)

And an off-the-shelf microprocessor board Arduino Mega 2560

	Compte-rendu de réunion	Réf. : EUSO-MRRHK-INST-011-APC Date : 13/02/2013 Page : 3/

Texte | Action

Design

It has been underlined that the designs and the interfaces of the different boards are frozen without any open point.

Some missing information only concerns the software, and discussions are on going.

Concerning the tests performed for the different boards, we can summarize as followed:

PCB05:
LVPS-HK PDM has been successfully tested with the LVPS board in Mexico
LVPS-HK has been successfully tested with the LVPS board in Mexico

PCB04:
LVPS1-DP, LVPS2-DP has been successfully tested in Naples

PCB 03:
CPU has been successfully tested in Naples
HK with PDM board has not been tested. No test is foreseen and can be organized before may. It is agreed that the risk to produce the flight model without these tests can be taken since the interfaces are clear and frozen on both sides.
SIREN ... discussed with CNES and are clear. OK also ...

Tests

PCB ...
CLK ... Naples

PCB 01:
POWER-HK has been tested successfully in Mexico
GPS I/F has been successfully tested in Naples
HVPS-HK has not been tested. No test is foreseen and can be organized before may. It is agreed that the risk to produce the flight model without these tests can be taken since the interfaces are clear and frozen on both sides.

In order to summarize, we can conclude that the HK module was tested (successfully) with everything but the HVPS module and the PDM board. However, the I/F are well defined.

The remaining tests are supposed to be done in Utah by two HK team engineers by the beginning of April.

The different tests have brought some minor design modifications concerning a few connectors and components positions, made directly on the prototypes and validated. All the PCBs designs are now validated and frozen.

	Compte-rendu de réunion	Réf. : EUSO-MRRHK-INST-011-APC Date : 13/02/2013 Page : 4/

Texte | Action

Last but not least, thermal tests into a vacuum chamber have been performed for the complete HK (at 3mbar, from -30°C to +50°C, 2.5 cycles of 13hours), with the HK in operation, and the boards survived. The ... and all of them were well inside their data sheet thermal range.

It has been underlined by Pascale Danto that some attention needs to be given to the welding process, though no requirement is given for balloon payloads (shape of the tin drop, temperature of the brazure, materials, appearance, see ECSS Q-ST-70-08 and Q-ST-70-38). The recommendation is taken into account. CNES will provide to the HK team a note about soldering.

PLANNING

2 Flight Model HK modules will be produced for EUSO BALLOON, in order to get one spare.

Planning, prod, nombres de spares, sous-traitants

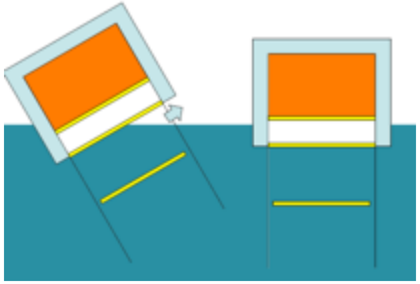
	Compte-rendu de réunion	Réf. : EUSO-MRRHK-INST-011-APC Date : 13/02/2013 Page : 5/

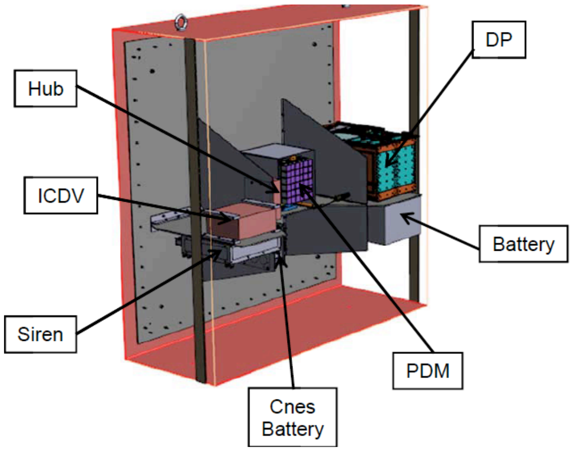
Tableau des actions

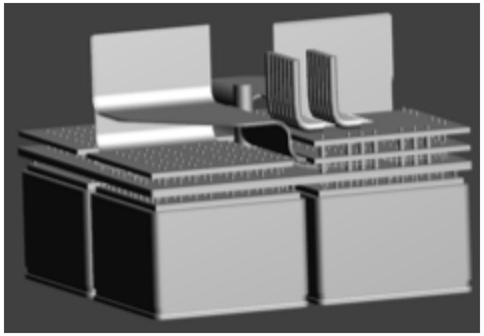
N°	Libellé	Date	Resp. Action	Resp. Clôture

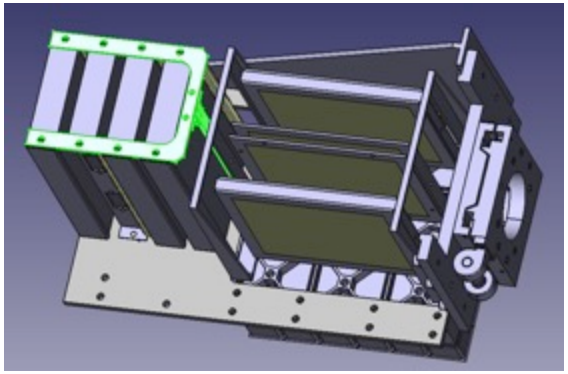
Liste d'actions

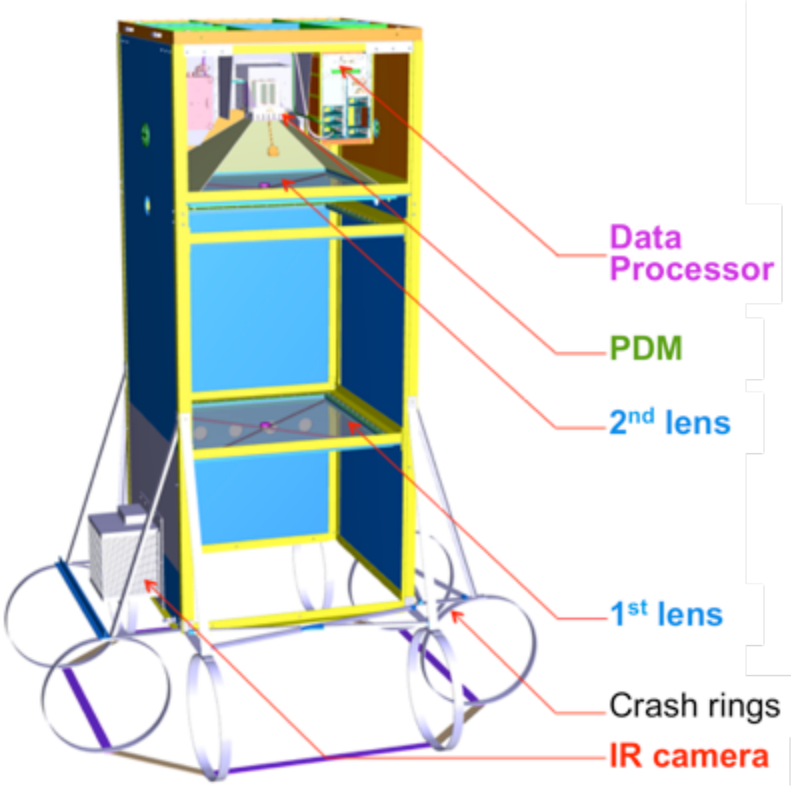
EUSO-Balloon: du design (phase A)…



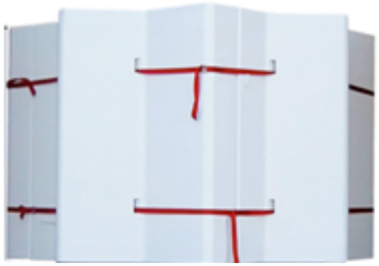


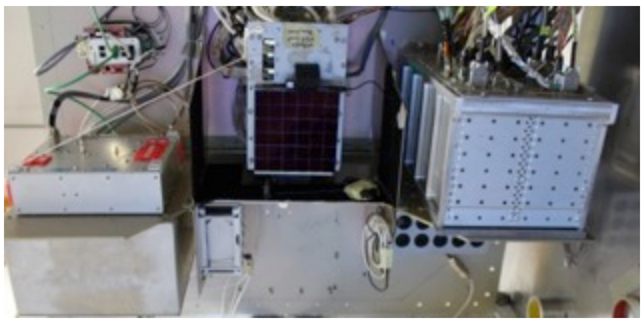


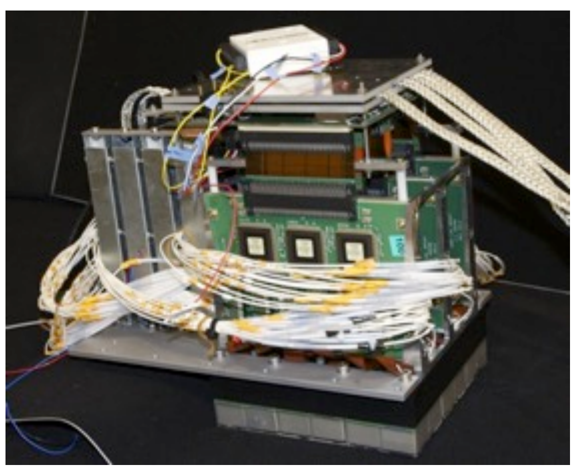




… à la réalisation des FM (durant la phase raccourcie C/D)



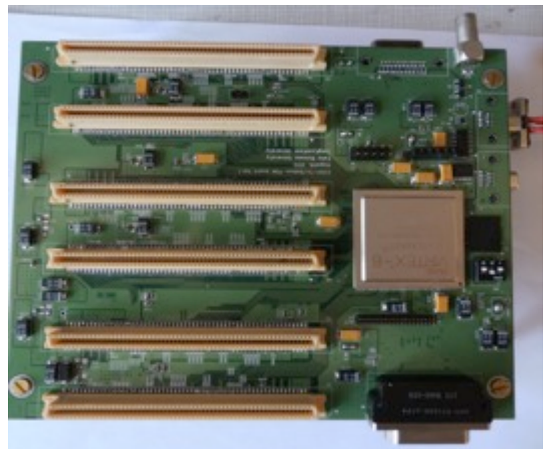




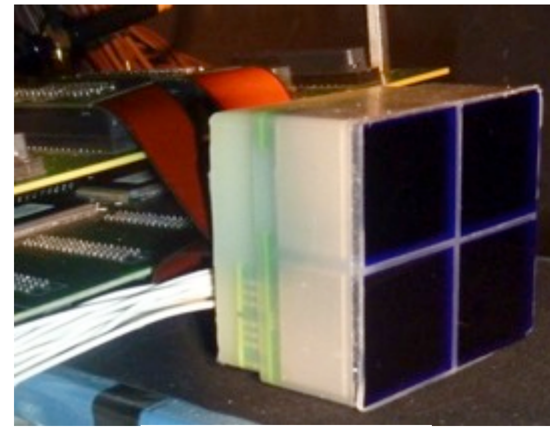
Phase C&D: production of the Flight Models

De février à octobre 2013 : Production des modèles FM (pour les non PFM) et des spares

6 FM EC-ASIC in mechanical structure



FM PDM board



FM EC unit

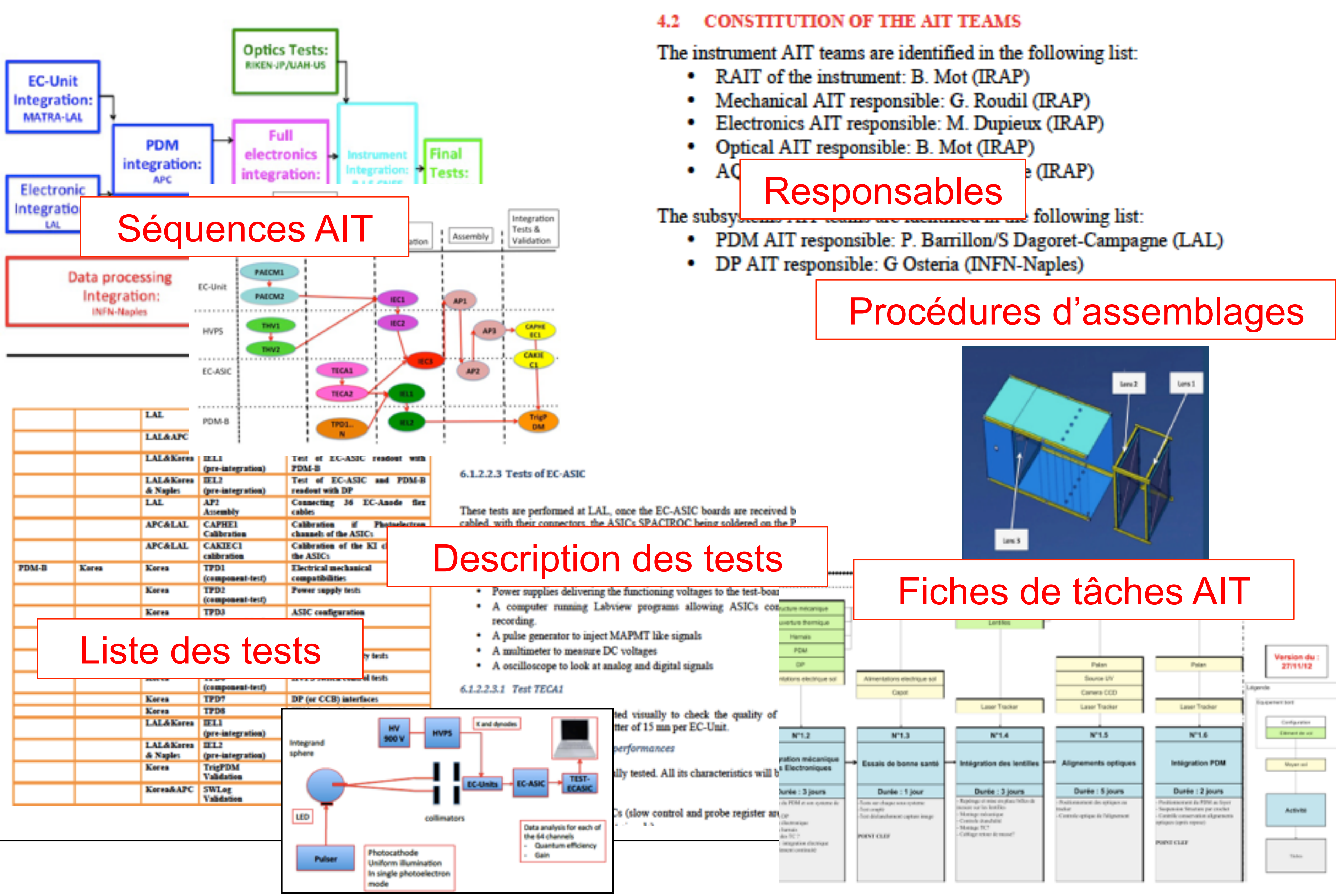
CPU, GPS, CLKb

CCB

HK

LVPS's

Le PAIE (Plan d'Assemblage, d'Intégration et d'Essai) = 70 pages



PDM tests (d’octobre 2013 à janvier 2014)

Test individuels:

- Tri et sélection des MAPMTs et des ASICs
- EC units (mesures gain & efficacité)
- Performances cartes EC-ASICs
- Communication carte FPGA
- Tests HVPS (alimentation MAPMT, switches, protections)

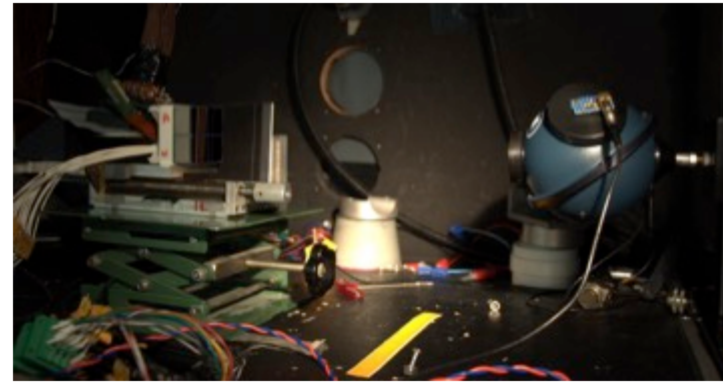
Tests Basse Pression

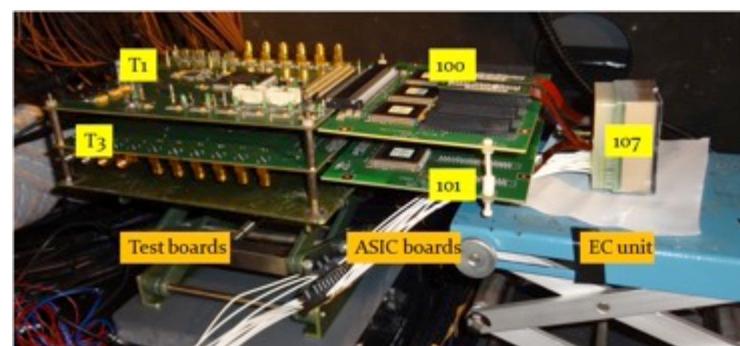
Tests Température

Test Interface :

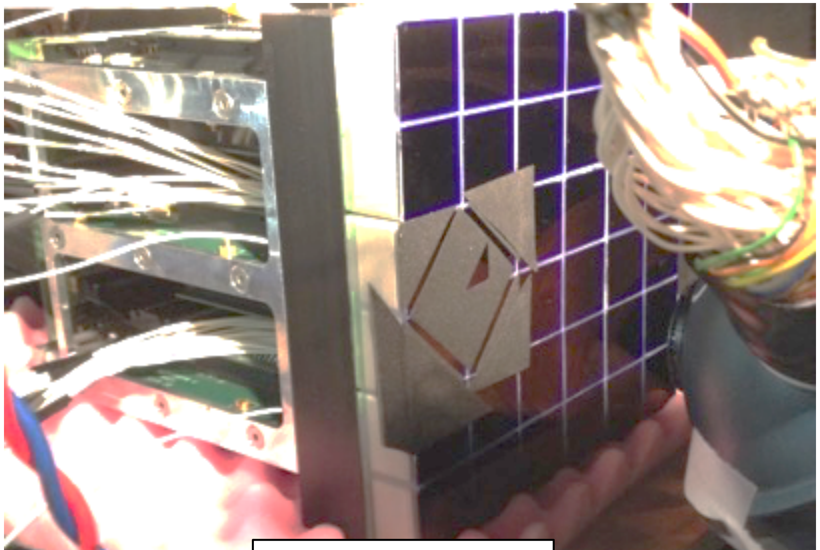
- EC units + EC-ASICs (performances)
- EC-ASICs + PDM board (consommation, controles/commandes)
- PDM board + HVPS (controles/ commandes)

Calibration détecteur, mapping, etc.

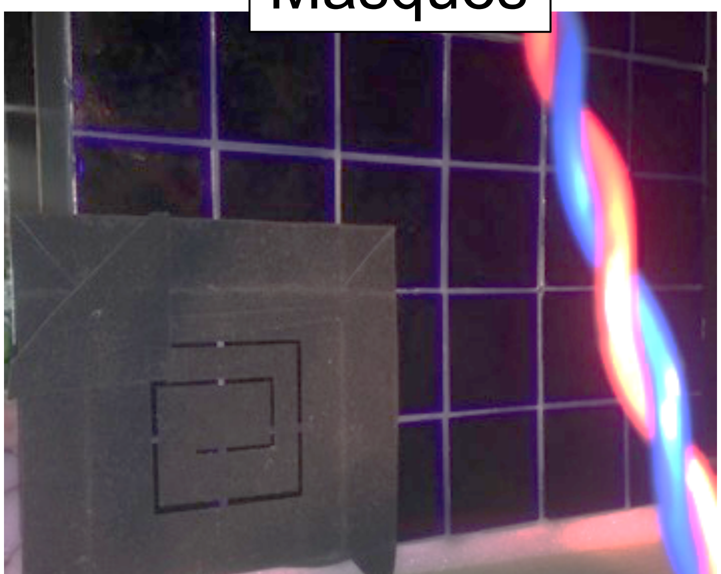


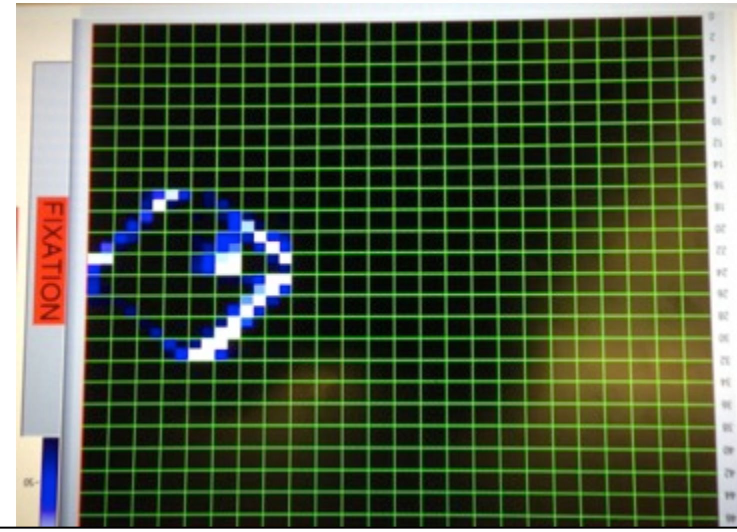


Exemple de test : le mapping

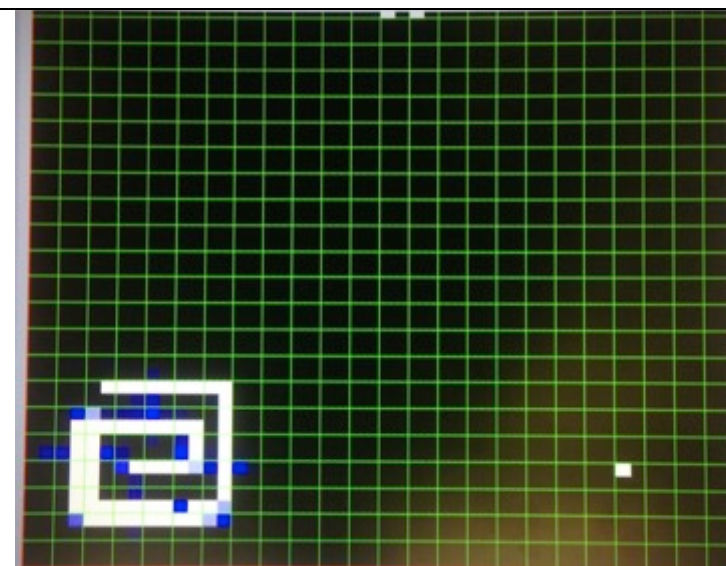


Masques





Reconstruction (p-c data)

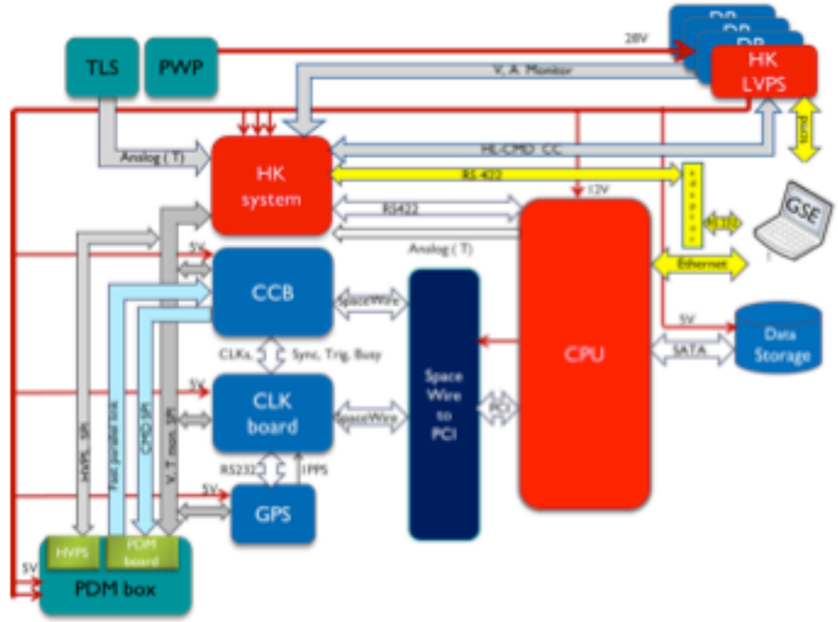


Tests fonctionnels DP (extrait PAIE)

The instrument, on ground, can be completely controlled by the GSE (Ground Support Equipment).
2 Interfaces:

- GSE-HK   Telemetry-Telecommand
- GSE-CPU   Data-TM/TC

They simulate the control of the instrument as it should be performed by Siren system (CNES in flight communication). HK (RS 232 port) and CPU (TCP-IP)



Switching ON sequence

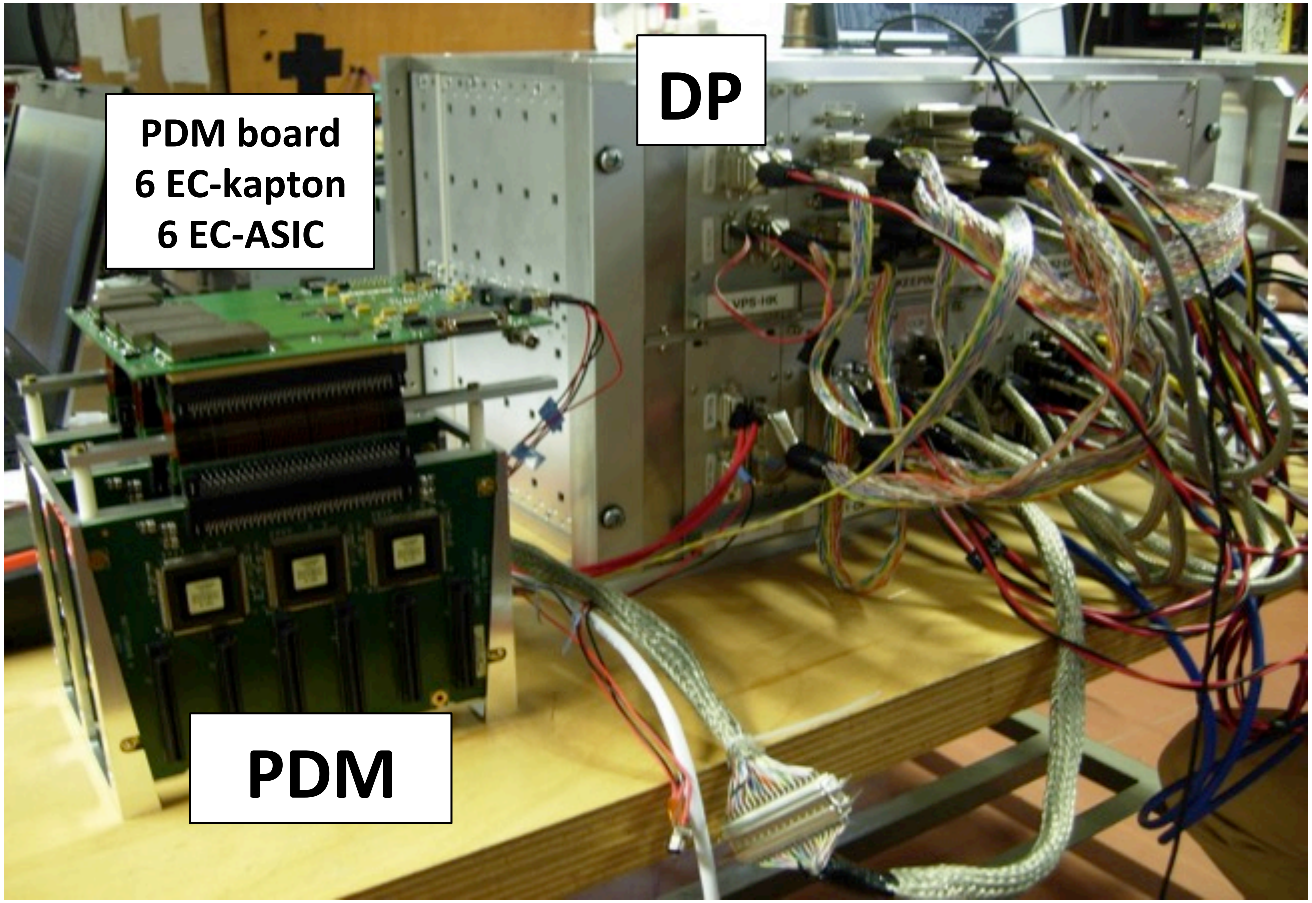
The sequence of operation successfully performed by sending command from the GSE console was:

- Switch ON the HK system (open drain switches simulated by a 2 jumpers DB9 connectors)
- Receiving of telemetry data (it starts automatically when HK is ON)
- Switch ON LVPS2 (CPU's disks) and CPU
- Read the status of the Contact Closure to verity that the operation has been properly execute
- Verify on the telemetry data the voltages and the absorbed currents for LVPS2
- Switch ON LVPS1 (GPS) (then verify the CC status and Voltages and currents on LVPS1)
- Switch ON LVPS1 (CLKB) (then verify the CC status and Voltages and currents on LVPS1)
- Switch ON LVPS1 (CCB) (then verify the CC status and Voltages and currents on LVPS1)
- Switch ON LVPS-PDM (PDM board) (then verify the CC status and Voltages and currents on LVPS-PDM)

Tests thermiques Data processor

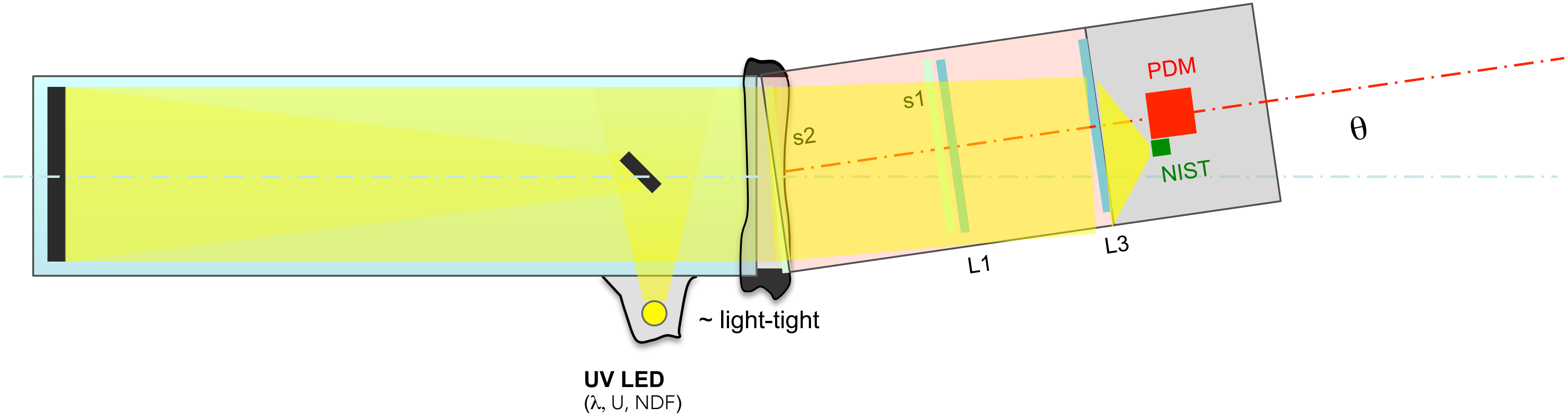
	production			test			
Sub-assembly	FM module	FM spare	FM cables	Functonality Conf. to spec.	Vacuum (3 mbar)	Thermal (-20 + 50)°C	Termo-vacuum
CPU	■	■	■	■	■	■	■
CCB	■	■	■	■	■	■	■
CLKb	■	■	■	■	■	■	■
GPS	■	■	■	■	■	■	■
HK	■	■	■	■	■	■	■
LVPS-HK	■	■	■	■	■	■	■
LVPS-DP1	■	■	■	■	■	■	■
LVPS-DP2	■	■	■	■	■	■	■
LVPS-PDM	■	■	■	■	■	■	■

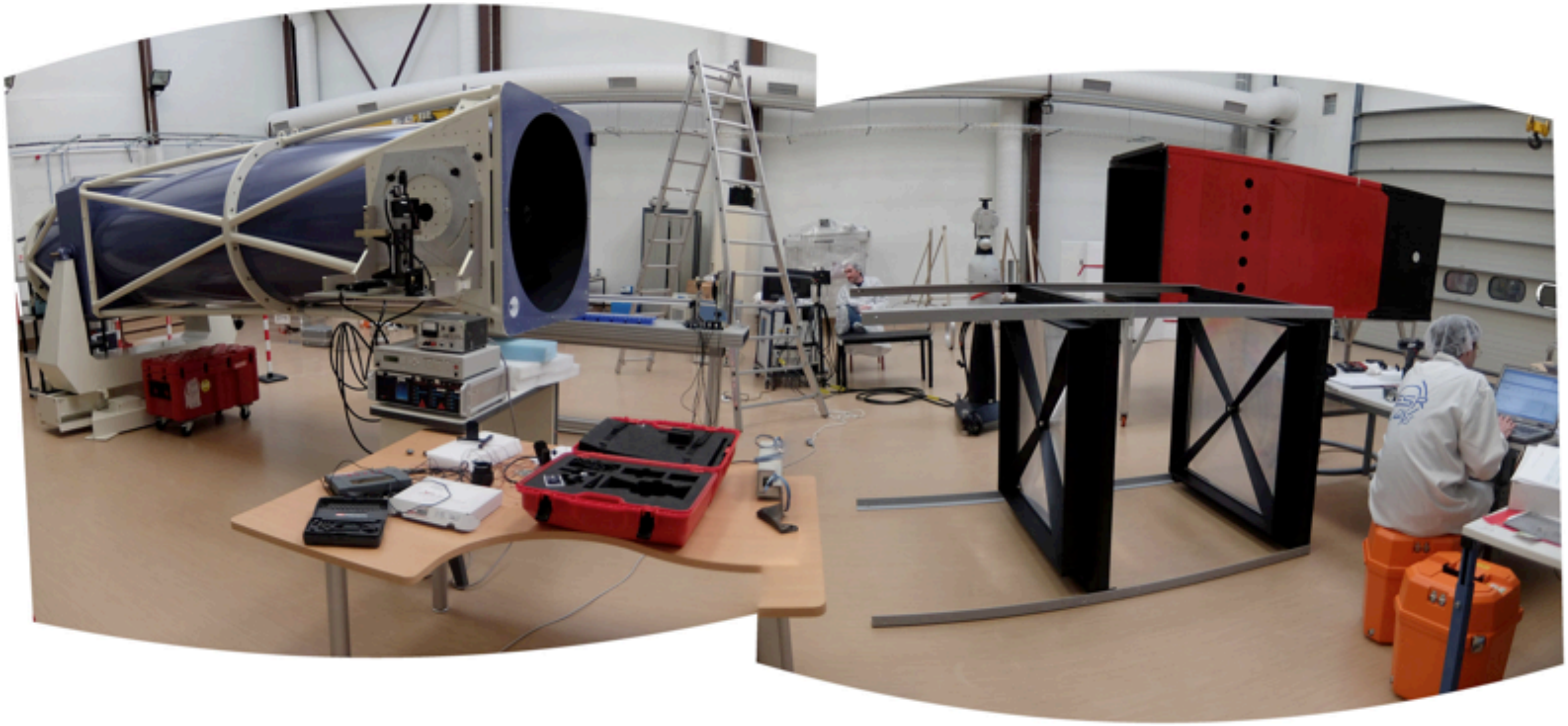
De début février à début mars 2014 : démarrage de l'intégration de la chaine électrique (câbles d'intégration non FM)



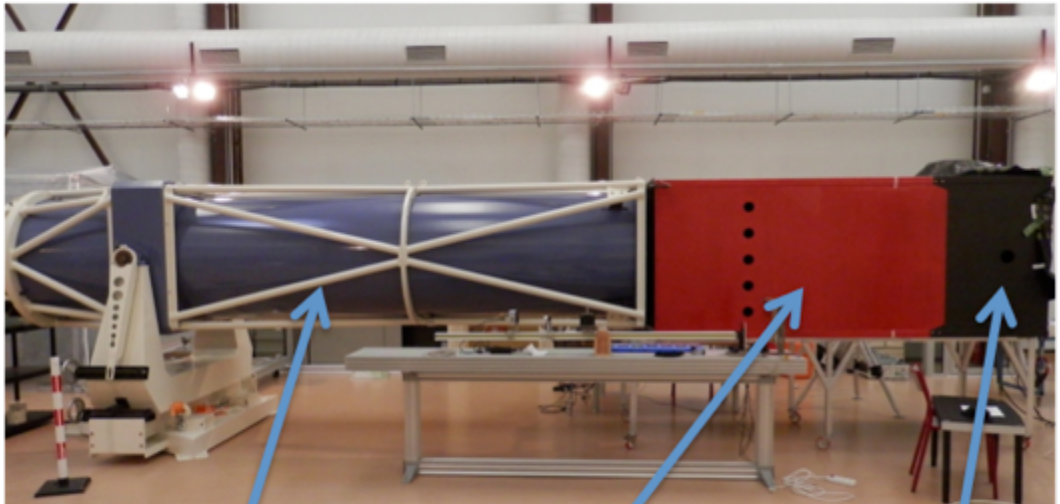
Tests thermiques (du 5 au 7 mars 2014, réservée des mois à l’avance)

Tests PDM+DP + optiques (@IRAP, Toulouse) mai 2014





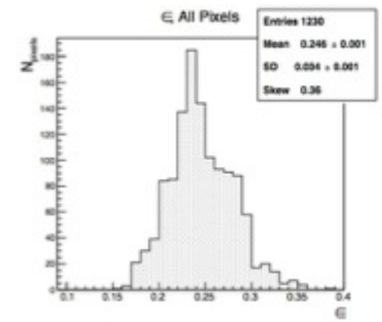
Tests PDM+DP + optiques (@IRAP, Toulouse) mai 2014

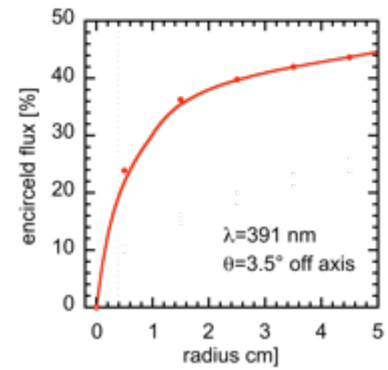


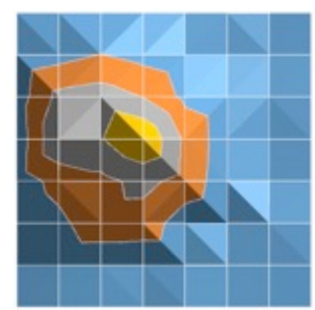
Collimator

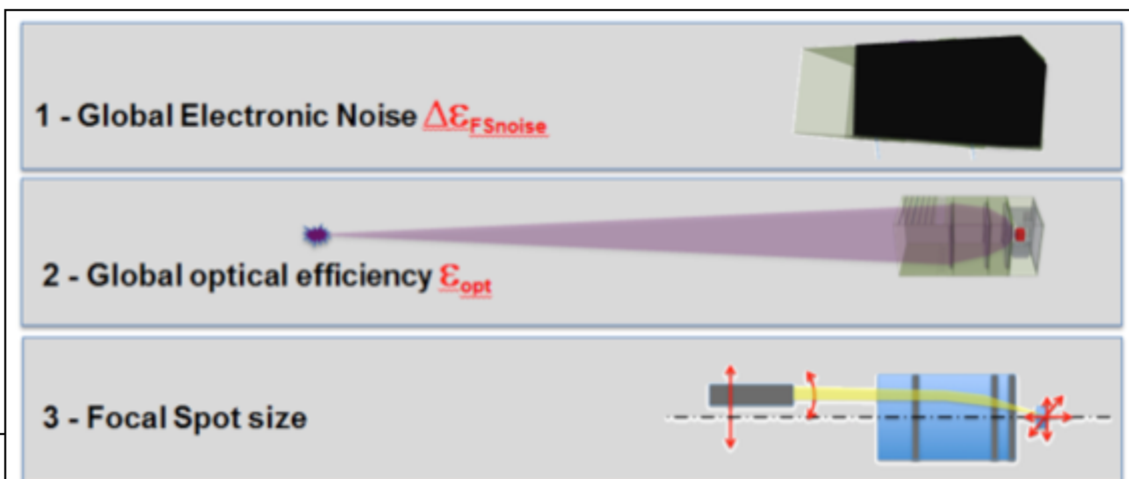
Optical system

CCD+NIST puis PDM



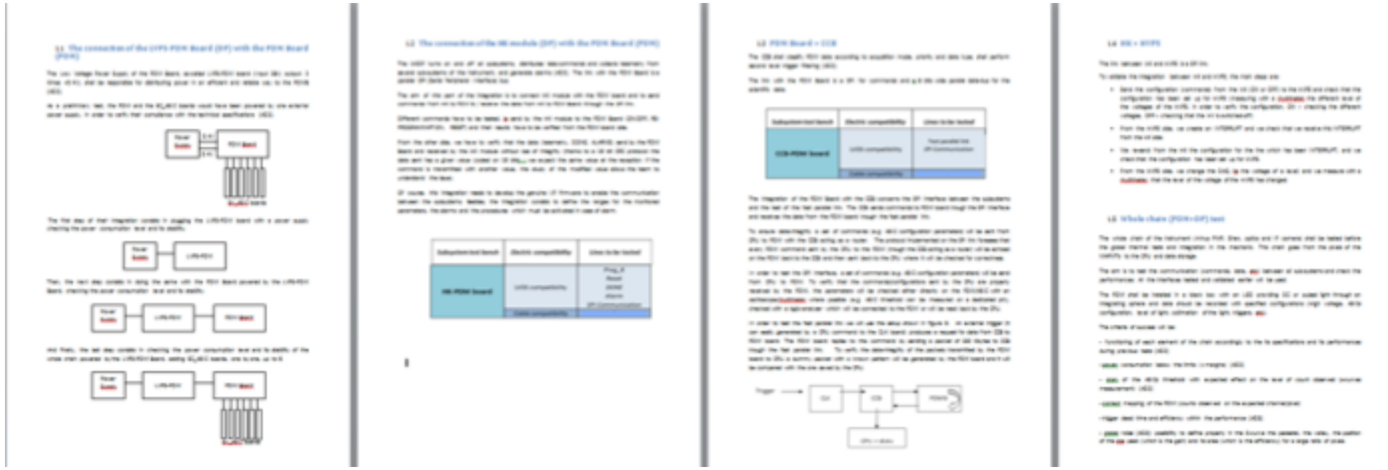




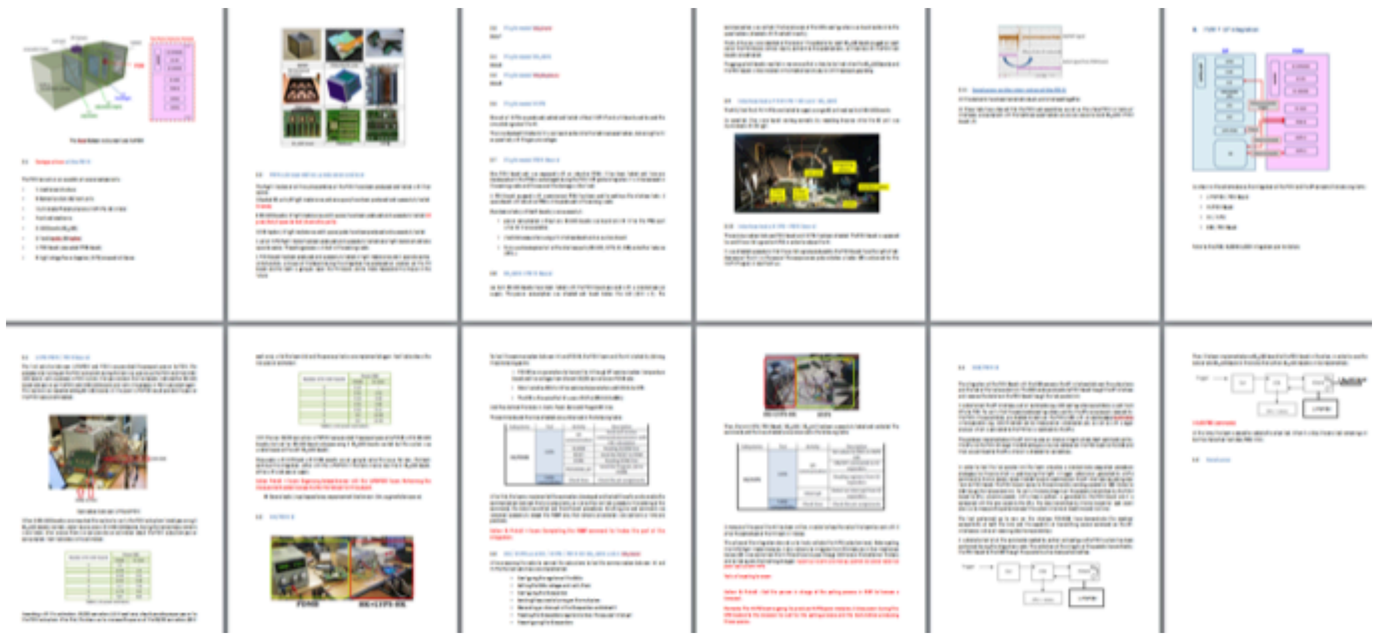


Rapports de tests

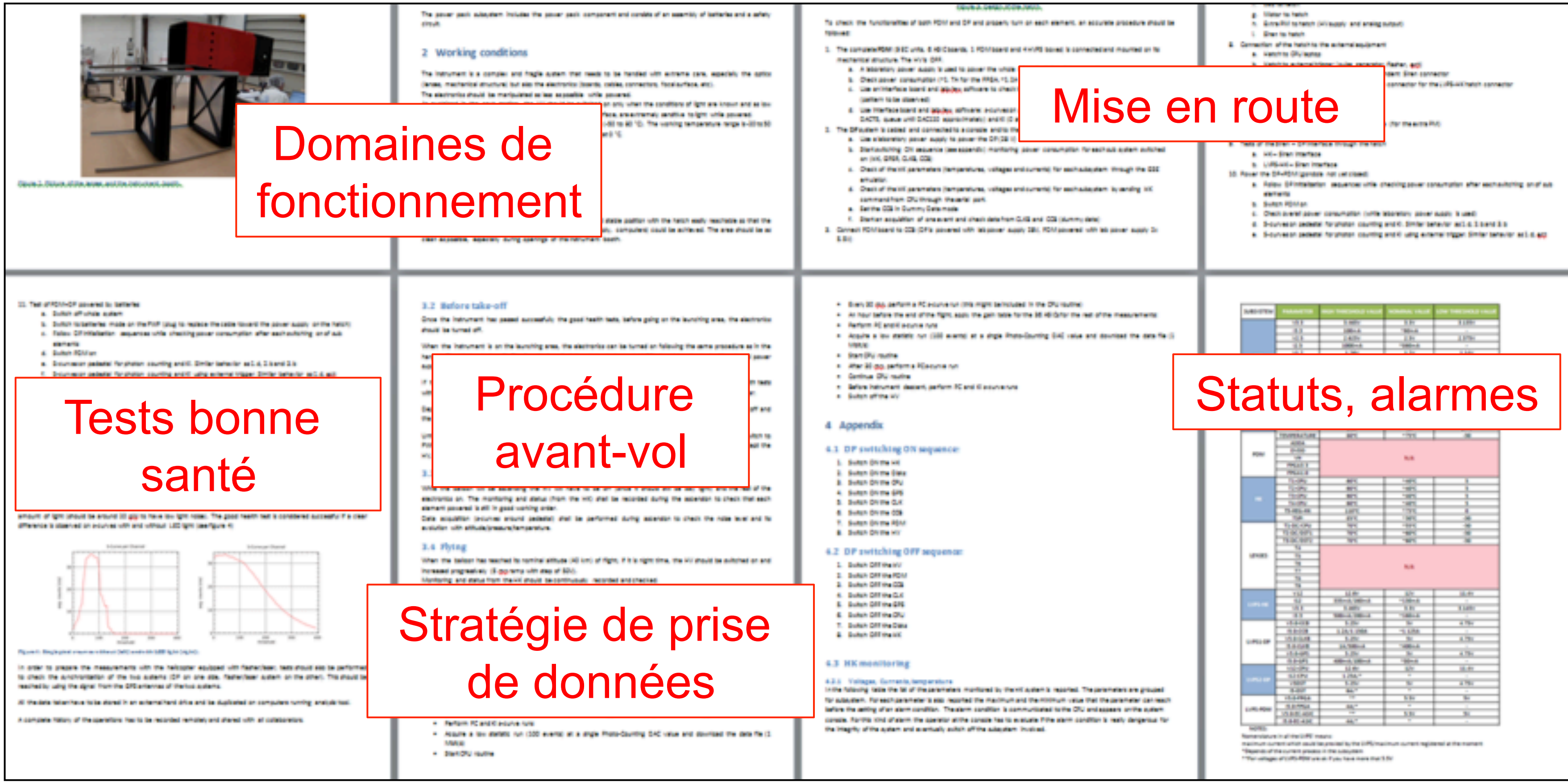
Bilan Technique (BT) avant intégration finale



Compte-Rendu d'Essai (CRE) après intégration finale



Manuel utilisateur EUSO-Ballon (hardware et software)

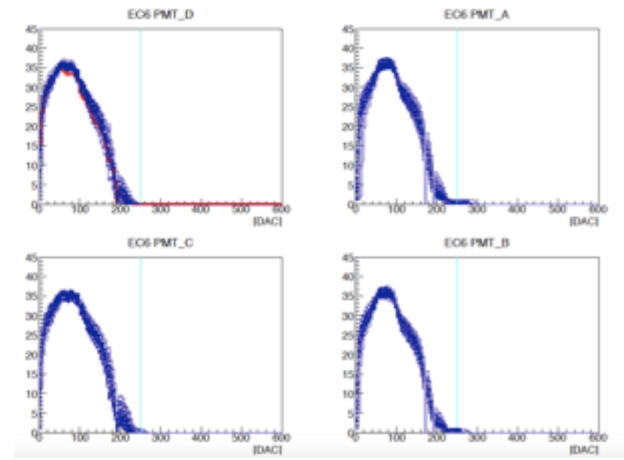


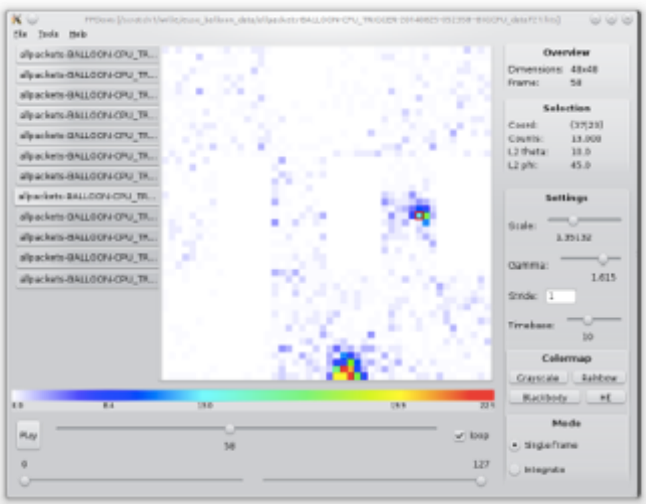
+ manuel logiciel instrument

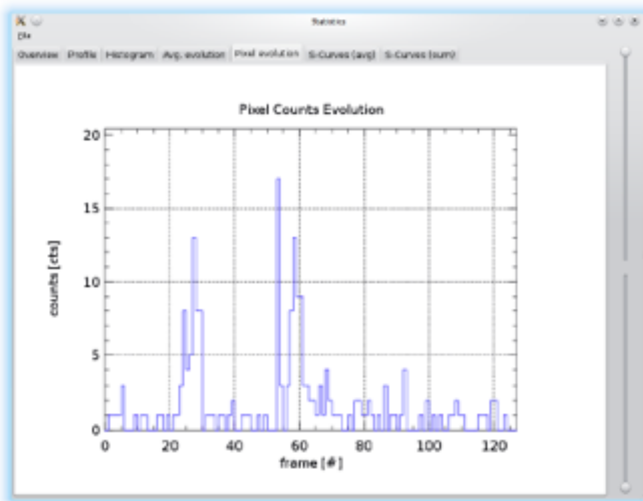
Logiciel d'analyse et de visualisation rapide des acquisitions

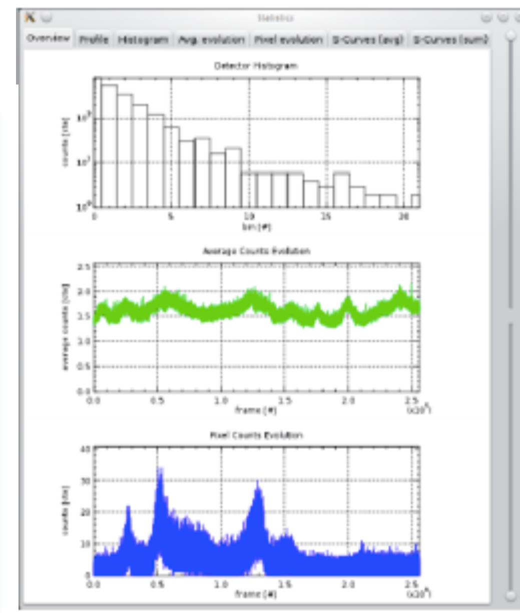
Développement d'un logiciel et de sa documentation

Utilisé pendant l'intégration et le vol









Les points clés EUSO-Ballon :

14 Sept. 2011 : Phase A kick-off

18 Dec. 2012 : Critical Design Review

4 June 2014 : Flight Acceptance Review

Les anomalies…

ASIC Spaciroc 1 (Juillet 2012) :

- L'intégrateur de l'ASIC n'a pas une dynamique suffisante pour piloter les swiches et protéger les MAPMT

<u>Solutions</u> :

- Ne pas utiliser les SW, HK coupe les HV qd surcharge (plan B anticipé dans le doc. Risques)

Tests thermiques (mars 2014) :

- Impossible d'alimenter les <u>9</u> EC à 3mbar pour HV max (dû à une erreur de design PCB non détectée pdt le test du prototype seul)

<u>Solutions</u> :

- HV optimale (1100V) -> nominale (950V)

Réalisation des optiques (novembre 2013) :

- Anomalie réalisation L2 (erreur usine Japonaise)

<u>Solutions</u> :

- Config. à 2 Lentilles (plan B anticipé dans le doc. risques)

Anomalie fournisseur 'spider' (janvier 2014) :

- Les croisillons des lentilles déforment les lentilles, non-conformes aux specs (erreur fournisseur)

<u>Solutions</u> :

- Reprise des spiders et intégration des lentilles par l'IRAP (plan B anticipé dans le doc. risques)

Les accidents…

Tests AIT (octobre 2013) :

- Carte Coréenne FPGA contraire aux specs (connecteurs signal et power identiques, même genre et sans détrompeur)

  => erreur de branchement

Conséquences : o Changement du FPGA et changement du genre du connecteur

Tests hors PAIE (document de tests) non spécifié (avril 2014) :

- Un test non spécifié des HV => Mesure destructive

  (pas de spare à ce moment-là)

Conséquences : o 1 mois de délai (en travaillant les WE). Durant la réalisation du second FM, travail pour rendre les I/F plus fiables, modif du design mécanique, AIT + simple

Les problèmes…

Workpackage/organisation :

- L'équipe HVPS sous-dimensionnée

Solutions :
- Aide de l'APC (accord après réunions projets)

Workpackage/organisation :

- La Corée ne travaille pas sur son workpackage (la carte FPGA étant la pierre angulaire de la chaine électronique)

Solutions :
- Reprise du WP par APC, embauche de la PhD Coréenne (retards & difficultés => pas de trigger on-line pour 1er vol)

Suivi du CNES : problème potentiel de souplesse, en période critique

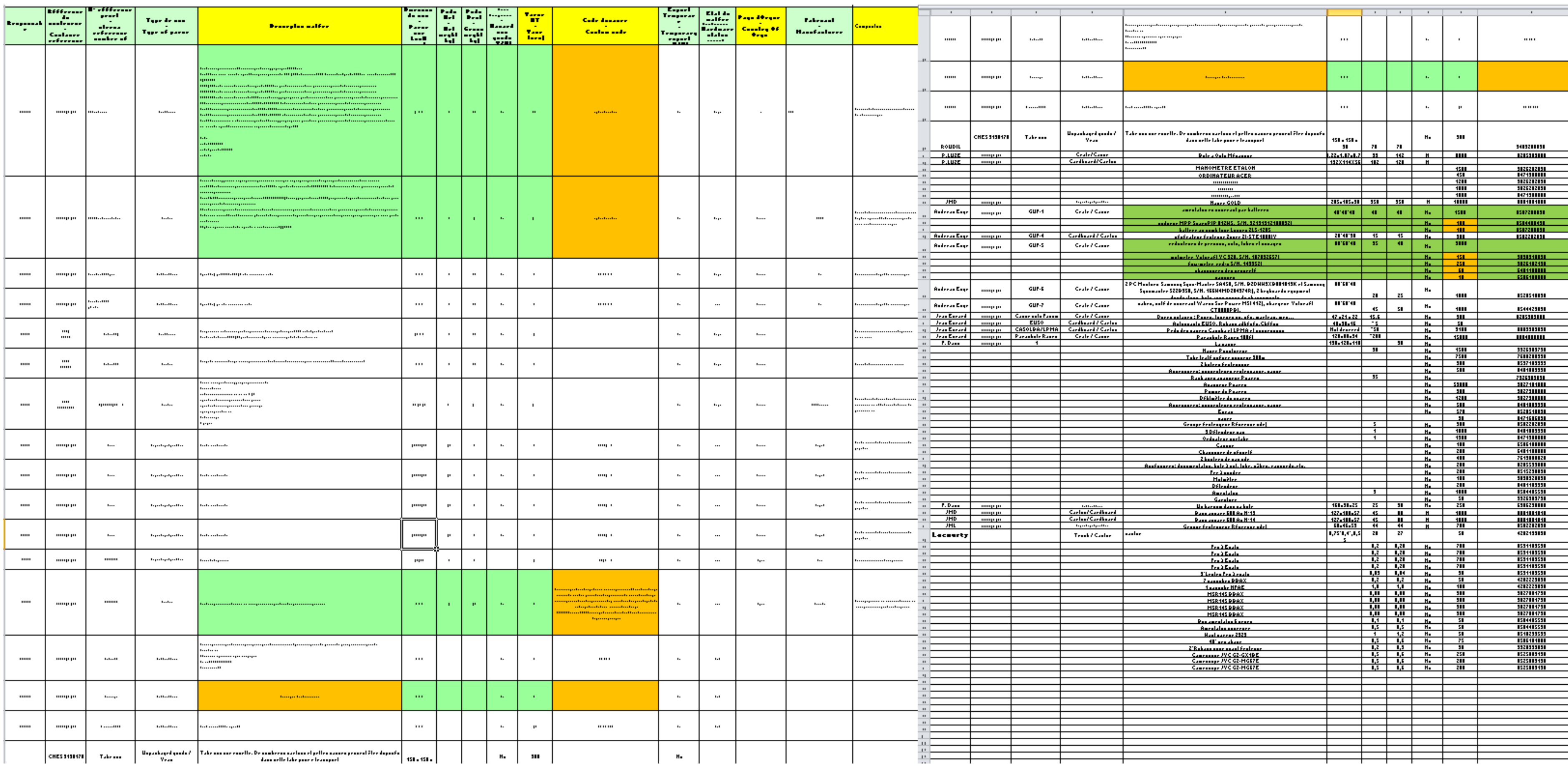
- Revue performances pendant l'intégration détecteur
- Exigence de fiches anomalie sous 48h et de documentation AIT pendant l'intégration

Solutions :
- Task force pour absorber le choc, transparent pour les équipes AIT

La campagne de vol : Welcome to Timmins !

Liste de colisage Timmins

Ne rien oublier !



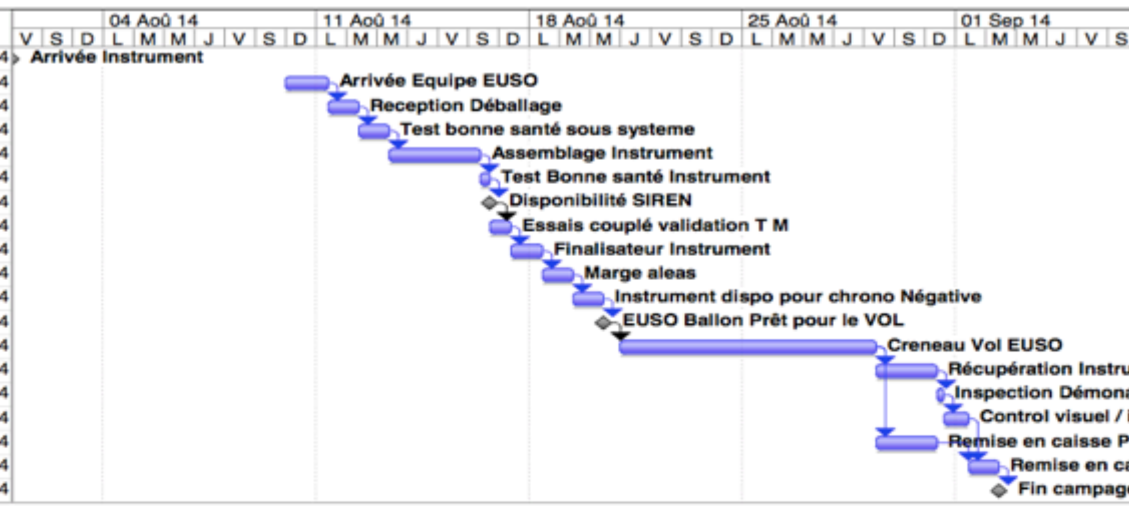
Liste de présence et planning de la campagne de vol

Du 10 aout au 4 septembre 2014

Equipe AIT

Date	10/08/2014	11/08/2014	12/08/2014	13/08/2014	14/08/2014	15/08/2014	16/08/2014	17/08/2014	18/08/2014	19/08/2014	20/08/2014	21/08/2014	22/08/2014	23/08/2014	24/08/2014	25/08/2014	26/08/2014	27/08/2014	28/08/2014	29/08/2014	30/08/2014	31/08/2014	01/09/2014	02/09/2014	03/09/2014	
Peter V	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	21
Cami	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	19
Mich	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8
Bap	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8
Gill	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	24
Guilla	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	25
Ae	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	17
Simo	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	15
Philipp	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	11
Pi	0	0	0	0	0	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	7
Etien	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	0	0	0	0	0	0	7
Sylv	0	0	0	0	0	0	0	0	0	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	5
Juli	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	23
Pierr	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	13
Cami	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	11
Hirok	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	12
Giuse	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	18
Valer	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	18
Clau	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	16
Hec	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	20
Mic	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	1	1	1	1	0	0	0	0	0	7
Matth	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	18
Jir	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	18
Lawre	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	15
Jo	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	17
D	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	17
Somme	2	6	10	13	14	18	19	20	20	19	20	20	21	21	20	18	18	18	18	15	9	5	4	4	4	356

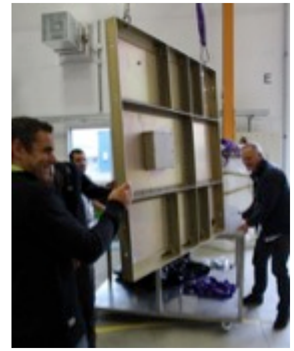
N°	Nom de la tâche	Durée	Début	Fin
1	Arrivée Instrument	0 j	01/08/14	01/08/14
2	Arrivée Equipe EUSO	1 j	10/08/14	11/08/14
3	Reception Déballage	1 j	11/08/14	12/08/14
4	Test bonne santé sous systeme	1 j	12/08/14	13/08/14
5	Assemblage Instrument	3 j	13/08/14	16/08/14
6	Test Bonne santé Instrument	0,75 j	16/08/14	16/08/14
7	Disponibilité SIREN	0 j	16/08/14	16/08/14
8	Essais couplé validation T M	0,25 j	16/08/14	17/08/14
9	Finalisateur Instrument	1 j	17/08/14	18/08/14
10	Marge aleas	1 j	18/08/14	19/08/14
11	Instrument dispo pour chrono Négative	1 j	19/08/14	20/08/14
12	EUSO Ballon Prêt pour le VOL	0 j	20/08/14	20/08/14
13	Creneau Vol EUSO	8 j	21/08/14	29/08/14
14	Récupération Instrument	2 j	29/08/14	31/08/14
15	Inspection Démonatge	0,5 j	31/08/14	31/08/14
16	Control visuel / intégrite Sous Systeme	0,5 j	31/08/14	01/09/14
17	Remise en caisse Part I	2 j	29/08/14	31/08/14
18	Remise en caisse Part II	1 j	01/09/14	02/09/14
19	Fin campagen EUSO	0 j	02/09/14	02/09/14

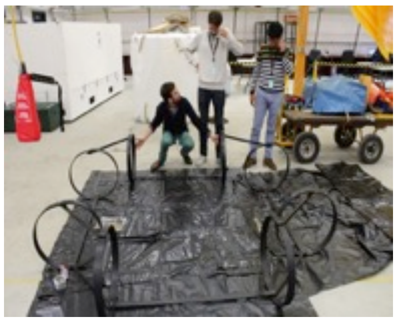


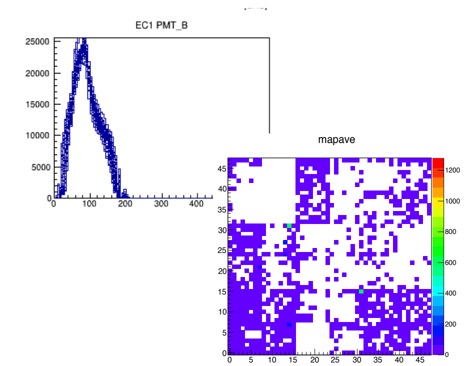
Le site : l’aéroport civil de Timmins

Campagne de vol : l'intégration avant-vol

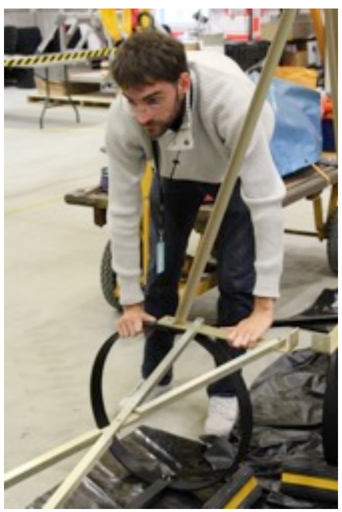











Partage des tâches sur dans le hall d'intégration

Time	Chrono action	Coordinator	DP acquisition and monitoring	Secretary	Flasher/ Laser	Data analysis	Additional people (role)
8:30 - 10:00 am	Good health tests with laboratory power	Guillaume/Peter	Giuseppe, Claudio and Valentina	Camille M.	-	Simon/Hiroko	-
10:00 - 10:30 am	Good health test on battery	Guillaume/Peter	Giuseppe, Claudio and Valentina	Camille M.	Lawrence & Jim	Simon/Hiroko	Hector & Jörg (IR CAM status)
10:30 am - X pm	Recharge the SIREN and PASTIS batteries	Guillaume/Peter	-	Camille M.	-	-	-
12:00 am - 2:30 pm	Lunch buffet	Julio	-		-	-	Entire EUSO team
3:00 - 3:15 pm	ICDV initialisation	Guillaume/Peter	-	Sylvie D.	-	-	Xavier (CNES)
3:15 - 3:30 pm	SIREN - NSO initialisation	Guillaume/Peter	Giuseppe, Claudio and Valentina	Sylvie D.	-	-	-
3:30 - 4:00 pm	End to end good health test	Guillaume/Peter	Giuseppe, Claudio and Valentina	Sylvie D.	-	Simon/Hiroko	-
4:00 - 4:15 pm	Check structure ready for roll - out	Guillaume/Peter	-	Julio	-	-	Gilles
4:15 - 4:30 pm	Instrument put at its loading location	Guillaume/Peter	-	Julio	-	-	EUSO team to help
4:30 - 4:45 pm	Check GPS signal (US)	Guillaume/Peter	-	Julio	Lawrence & Jim	-	-
4:45 - 5:15 pm	Roll - out to tarmak	Guillaume/Peter	-	Julio	-	-	Local team + Gilles
5:15 - 5:45 pm	Preparation on tarmak	Guillaume	-	Camille C.	Lawrence & Jim	-	Local team + Gilles + Peter
5:45 - 6:00 pm	Good health tests with generator	Guillaume	Giuseppe, Claudio and Valentina	Camille C.	Lawrence & Jim	Simon/Hiroko	Local team + Gilles + Peter
6:00 - 6:15 pm	Good health tests on battery	Guillaume	Giuseppe, Claudio and Valentina	Camille C.	Lawrence & Jim	Simon/Hiroko	Local team + Gilles + Peter
6:15 - 7:00 pm	Finalisation of the instrument: ICDV calib, hatch joint, hatch fixation, IR CAM cover to remove, LEDs flasher, additional box finalised and fixed	Guillaume	Giuseppe, Claudio and Valentina	Camille C.	Lawrence & Jim	Simon/Hiroko	Local team + Gilles + Peter
7:00 - 7:15 pm	Short run (100 packets) at DAC 250	Guillaume	Giuseppe, Claudio and Valentina	Camille C.	Lawrence & Jim	Simon/Hiroko	Local team + Gilles + Peter
7:15 - 8:00 pm	Remove before flight (skier, covers), heating the lens	Guillaume	Giuseppe, Claudio and Valentina	Camille C.	Lawrence & Jim	Simon/Hiroko	Local team (Inflation of the balloon) + Gilles + Peter
8:00 - 8:15 pm	LAUNCH						Team near tarmak
8:00 - 10:30 pm	Ascending (s-curves every 10mn)	Guillaume/Peter	Giuseppe, Claudio and Valentina	Julio	Lawrence & Jim	Simon/Hiroko	CNES
10:30 - 11:00 pm	Assess location and darkness	Guillaume/Peter	Giuseppe, Claudio and Valentina	Julio/Jörg	Lawrence & Jim	Simon/Hiroko	CNES
11:00 - 1:00 am	Standard acquisition procedure	Guillaume/Peter	Giuseppe, Claudio and Valentina	Jörg	Lawrence & Jim	Simon/Hiroko	CNES
1:00 - 2:00 am	Standard acquisition procedure	Guillaume/Peter	Giuseppe, Claudio and Valentina	Sylvie D.	Lawrence & Jim	Simon/Hiroko	CNES
2:00 - 3:00 am	Standard acquisition procedure	Guillaume/Peter	Giuseppe, Claudio and Valentina	Camille M.	Lawrence & Jim	Simon/Hiroko	CNES
3:00 - 4:00 am	Alternative configuration run	Guillaume/Peter	Giuseppe, Claudio and Valentina	Aera	Lawrence & Jim	Simon/Hiroko	CNES

Chronologie négative pour le jour du vol

Tests to be done before launch (around 8:30 am)

They have to be performed 1h30 – 2h before the flying decision.
The instrument has

- Instrument i
- Visual detail
- Light tight in
- PASTIS and S
- SIREN powe
- SIREN in wir
- GSE through
- IR CAM filled

Only thing different

Test sequence:
- DP switch-on
- switch-on PD
- *good-health t*
  - Stand
  - HVPS
  - LED O
  - ramp
  - increa
  - Stand
  - HV OF
  - LED ON (3.2 V) – check NIST (~40 pW)
  - HV ON (950 V)
  - Standard s-curves -> analysis
- Switch OFF DP and PDM (2')
- End-to-end test on FM batteries (20'):
  - Remove power supply cable from the hatch and start to be used)
  - DP switch ON sequence
  - Switch ON PDM
  - HVPS ON (50V), LED OFF, check HVPS status
  - 100 events run at fixed threshold (DAC 250) -> analysis
  - Switch OFF PDM and DP
  - Remove Power Plug from hatch
- IR CAM (20'):
  - Switch ON -> status
  - Fix the connectors cover (16 screws with 3/32 allen key)
  - Fix styrofoam protection (4 screws with 5/32 allen key)
  - Stays ON -> status
- Flashers: OK (phone call to the helicopter base)

=> Decision GO/NO-GO EUSO project

➔ Around **10:30 am**: Recharge SIREN/PASTIS batteries (≤ 6h)
➔ NO INTERVENTION on the instrument allowed after that point

Meteo briefing at 11:30 am

Around 3:00 pm:
➔ Put ICDV plug on the hatch (CNES team: Xavier): 15'

cable plugged on the

ain)

main gate) using

the skate boards.

7:00 pm (TBC) OK => unpacking of the balloon

- Electronics still ON -> short (100 packets) run at DAC 250
- Electronics status (HK/CPU)

7:15 pm (TBC): OK => Start filling of the balloon: 45' before launch

- Remove "before flight" items
  - Unfix skier
  - Pull the tarp on the vents
- Skier on the ground below the instrument
- Heater (110 V) on the skier (to heat the first lens)
- Switch on GO-PRO with a stick (2 sec push) – check LED (red flash every ~2 sec)

OK for launch ?

- Auxiliary balloon test (lift the instrument)
- Configure everything for the tests (ladder, power supply, etc)
- Generator + 28V lab power supply
- Connect external cable from power supply to the hatch
- Test GO/NO-GO:
  - DP switch ON sequence (checking power consumption)
  - Switch ON PDM
  - HVPS ON (50V), LED OFF, check HVPS and NIST status
  - Standard s-curves -> analysis
  - Switch OFF PDM and DP

At 6:30 pm:
- Unplugged the power cable from the hatch
- Power plug on the hatch to replace the power cable and use the batteries
- Test GO/NO-GO:
  - DP switch ON sequence (checking power consumption)
  - Switch ON PDM
  - HVPS ON (50V), LED OFF, check HVPS and NIST status
  - Standard s-curves -> analysis
- IR CAM status - remove red cover (REMOVE BEFORE FLIGHT LABEL) : need 3/32 allen key
- Flasher status (LEDs on the roof)
- ICDV initial calibration (gondola aligned to the landing track of the airport, use of google map)
- Prepare the silicon joint of the cap of the hatch
- Close hatch (tight screwing)
- Close the additional box (with geiger, iphone and NIST monitor) after FM batteries installed
- Remove securities and ladders

Fichier log + télémétrie

Durant le vol, on note toutes les actions (acquisitions, changements de configurations, reboot, reset, etc)

La télémétrie enregistre elle aussi son propre fichier log (Températures, statuts des sous-systèmes, noms des fichiers de données, etc)

Log Projet

18:43 (UTC) short run CPU trigger, 5 packets, HV OFF, DAC = adjusted, Gain table = equalized => filename "20140824-184133"

18:53 (UTC) Checking low light level (NIST = 1 pW)
18:53 (UTC) Ramping up HV up to 900V
18:59 (UTC) HV On at 950V

18:59 (UTC) temperatures (Disc1, CPU, Disc2, SP2 // FPGA plate, FPGA braid, DP side, PDM cavity, ICDV Cavity):
37, 59, 37, 51 // 41, 27, 29, 26, 25

19:02 (UTC) 3 runs CPU trigger HV ON, LED OFF:
- run 1: Gain = equalized, DAC = 250 => filename "20140824-190218"
- run 2: Gain = equalized, DAC = adjusted => filename "20140824-190245"
- run 3: Gain = 64, DAC = adjusted => filename "20140824-190343"

19:06 (UTC) starting s-curve with Gain = equalized, DAC = 0 to 300, step 5, 5 packets (HV ON, LED OFF) => filename "20140824-19??"

19:09 (UTC) temperatures (Disc1, CPU, Disc2, SP2 // FPGA plate, FPGA braid, DP side, PDM cavity, ICDV Cavity):
37, 59, 37, 51 // 41, 27, 30, 26, 25

19:11 (UTC) Turning LED ON (3.0 V, NIST = 21 pW)

19:11 (UTC) CPU trigger, 200 packets, GAIN = 64, DAC = adjusted => filename "20140824-191158"

19:12 (UTC) CPU trigger, 200 packets, GAIN = equalized, DAC = adjusted => filename "20140824-191236"

19:13 (UTC) CPU trigger, 200 packets, GAIN = 64, DAC = 250 => filename "20140824-191317"

19:14 (UTC) taking s-curve, from 0 to 500, step 5, 20 packets, GAIN = equalized => filename "20140824-191429"

19:03 (UTC) temperatures (Disc1, CPU, Disc2, SP2 // FPGA plate, FPGA braid, DP side, PDM cavity, ICDV Cavity):
38, 60, 38, 51 // 41, 27, 30, 26, 25

19:34 (UTC) switching LED OFF (from [3.0 V, NIST = 21 pW] to 3 pW)

19:35 (UTC) switching HV OFF (?)

Log HK

NB: CCB currents are in A
The others are in mA

```
GSE SC 2014-Aug-25 00:30:44 -->>DONE Signal detected from CLKB
GSE SC 2014-Aug-25 00:30:44 -->>No ALARM from CLKB
GSE SC 2014-Aug-25 00:30:44 -->>
GSE SC 2014-Aug-25 00:30:44 -->>DONE Signal detected from CCB
GSE SC 2014-Aug-25 00:30:44 -->>No ALARM from CCB
GSE SC 2014-Aug-25 00:30:44 -->>
GSE SC 2014-Aug-25 00:30:44 -->>
GSE SC 2014-Aug-25 00:30:44 -->>***HouseKeeping***   Firmware 6.0.6
GSE SC 2014-Aug-25 00:30:44 -->>
GSE SC 2014-Aug-25 00:30:44 -->>TempHK, 35.81, 85.70,
GSE SC 2014-Aug-25 00:30:44 -->>
GSE SC 2014-Aug-25 00:30:44 -->>CPUThermistor, 37.06, 58.59, 37.29, 50.34
GSE SC 2014-Aug-25 00:30:44 -->>
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GSE SC 2014-Aug-25 00:30:44 -->>TherLVPS2-DP, 47.61, 52.90, 58.97,
GSE SC 2014-Aug-25 00:30:44 -->>
GSE SC 2014-Aug-25 00:30:44 -->>TherLenses, 39.54, 27.61, 30.43, 25.03, 26.87, 61.22,
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GSE SC 2014-Aug-25 00:30:44 -->>LVPS-DP1, 5.037, 1119, 4.961, 386, 4.947, 117,
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GSE SC 2014-Aug-25 00:30:44 -->>CLKB, 44.779,  0.989,  2.471,
GSE SC 2014-Aug-25 00:30:44 -->>CLKB-date, 1, 1, 2004
GSE SC 2014-Aug-25 00:30:44 -->>CLKB-time, 12, 43, 15, c, ccfe
GSE SC 2014-Aug-25 00:30:44 -->>CLKB-position, 0, 0, 0, 0, 0, 0
GSE SC 2014-Aug-25 00:30:44 -->>
GSE SC 2014-Aug-25 00:30:44 -->>CCB,  5a,  a5,  3.296,  0.046,  2.470,  0.830,  1.197,  0.194,  4.860,  1.799,  37.369,  40.369,
GSE SC 2014-Aug-25 00:30:44 -->>
GSE SC 2014-Aug-25 00:30:44 -->>HVPS, 0, 0, 0
GSE SC 2014-Aug-25 00:30:44 -->>
GSE SC 2014-Aug-25 00:30:44 -->>PDM, -323.150, ffff, ab0f, ffff, ffb, 606
GSE SC 2014-Aug-25 00:30:44 -->>
GSE SC 2014-Aug-25 00:30:44 -->>GPS,  27.05,  3.14,
```
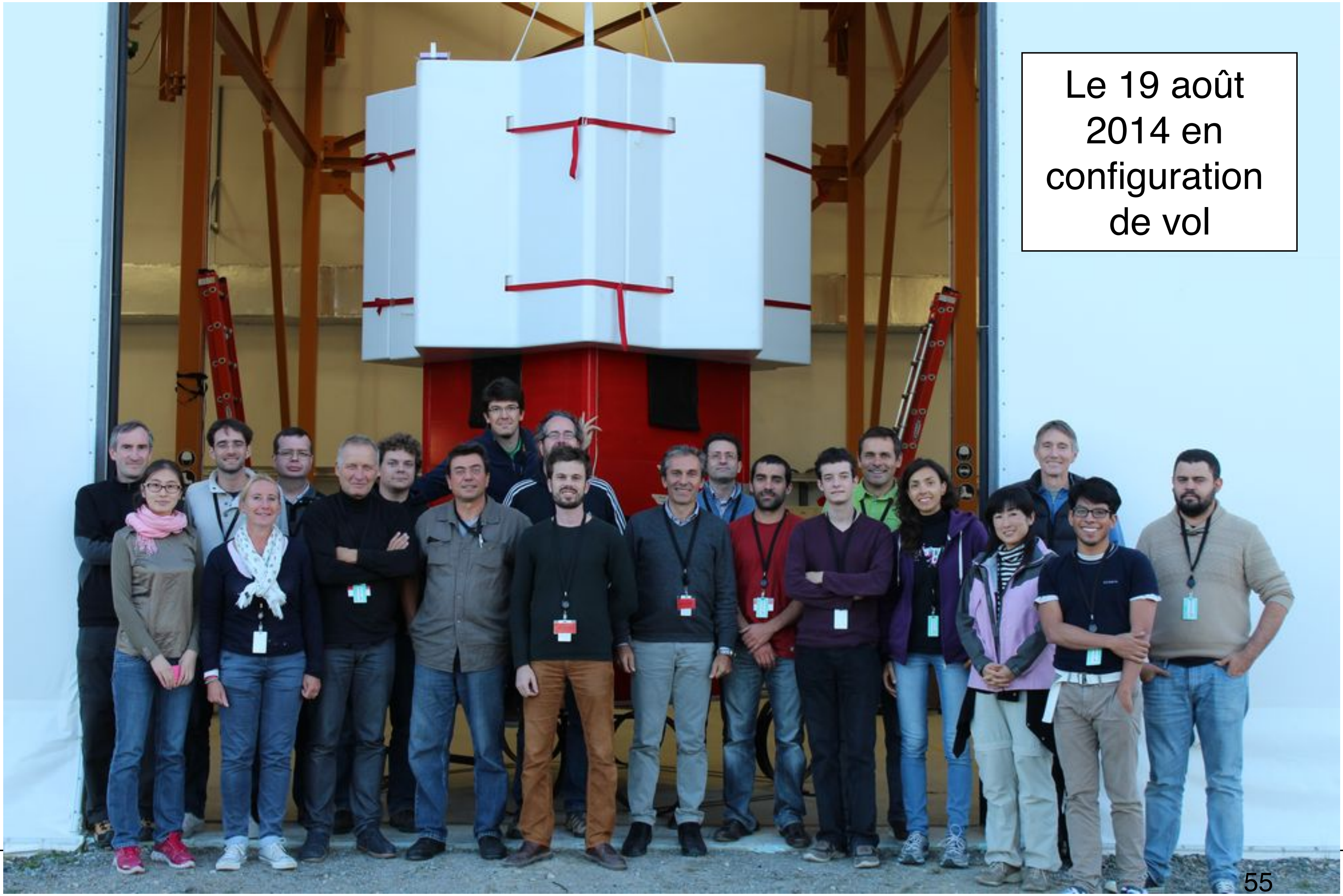

- TempHK: **Temperatures: PCB01-HK, Reg5V-HK**
- CPUThermistor: **Temperatures: DISC1, CPU, DISC2, SP2**
- LVPS-HK: **V12V-HK, I12V-HK , V3.3V-HK, I3.3V-HK**
- TherLVPS2-DP: **Temperatures: LVPS-DP2/ DC1, DC2, DC3**
- TherLenses: **Temperatures: PDM plate, PDM thermal braid, DP, PDM cavity, ICDV cavity, last to be discarded**
- LVPS-DP1: **V5V-CCB, I5V-CCB, V5V-CLKB, I5V-CLKB, V5V-GPS, I5V-GPS**
- LVPS-DP2: **V12V-CPU, I12V-CPU, V5V-DST, I5V-DST**
- LVPS-PDM: **V5.5V-PDMB, I5.5V-PDMB, V5.5V-EC, I5.5V-EC**
- CLKB: **From CLKB: Temperature, Vcint, Vcaux**
- CLKB-date: **Month, date, year**
- CLKB-time: **Hours, Minutes, seconds, fractional second**
- CLKB-position: **Latitude, longitude, height**
- CCB: **From CCB: test values(5a,a5) V3.3V, I3.3V, V2.5V, I2.5V, V1.2V, I1.2V, V5V, V1.8V, T-BOARD, T-FPGA**
- HVPS: **Status for the 3 HVPS**
- PDM: **From PDM board: Temperature,VEC2, VEC2, VEC3, VFPGA1, VFPGA2**
- GPS: **GPS information: Temperature, Voltage**

Configuration de vol (après 9 jours)



Le 19 août 2014 en configuration de vol

Sequence of operations

Phase	Operation	Follow-up
ascension	Take S-curves every 10 minutes with HV OFF (→ check the behavior of the electronics)	→ send by telemetry → check (noise)
at maximum altitude and astronomical night	Ramp up the HV up to 900V, then 950V	
	Take S-curves with HV ON Short run (100 packets)	→ send by telemetry → check (DAC=250 is OK)
regular flight	Start default data taking procedure	→ telemetry → checking
helicopter operation	Keep doing the same!	
regular flight	Continue default data taking procedure	
[extra time]	Apply modified configuration(s)	
descent	Turn OFF everything (DP and PDM) Don't do anything, not even sending data!	

Default data taking procedure

Standard run of 2000 packets at fixed DAC (adjusted)
Standard run of 2000 packets at fixed DAC (DAC=250)

→ If fully confirmed

[~ 2 min each]

(reminder: 1 packet = 128 GTU)

Every 10 minutes:

Short run of 100 packets at fixed DAC (adjusted) → send by telemetry [~ 2 min]

→ check (light level)

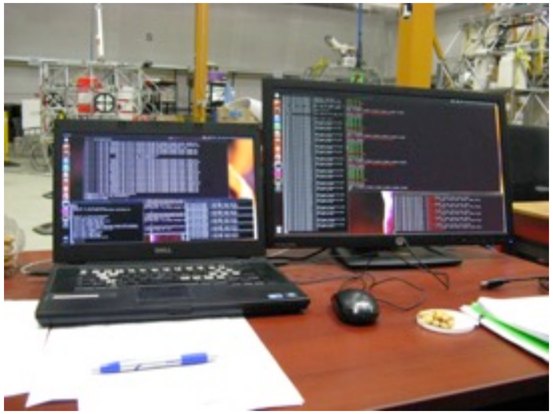
Every 30 minutes:

Take S-curves (0 to 500, step=5, 5 packets, KI=0) → send by telemetry [~ 4 min]

→ check

(DAC position OK, degradation…)

La veille du vol…



En route pour le tarmac

Le 24 août 2014 le jour du vol

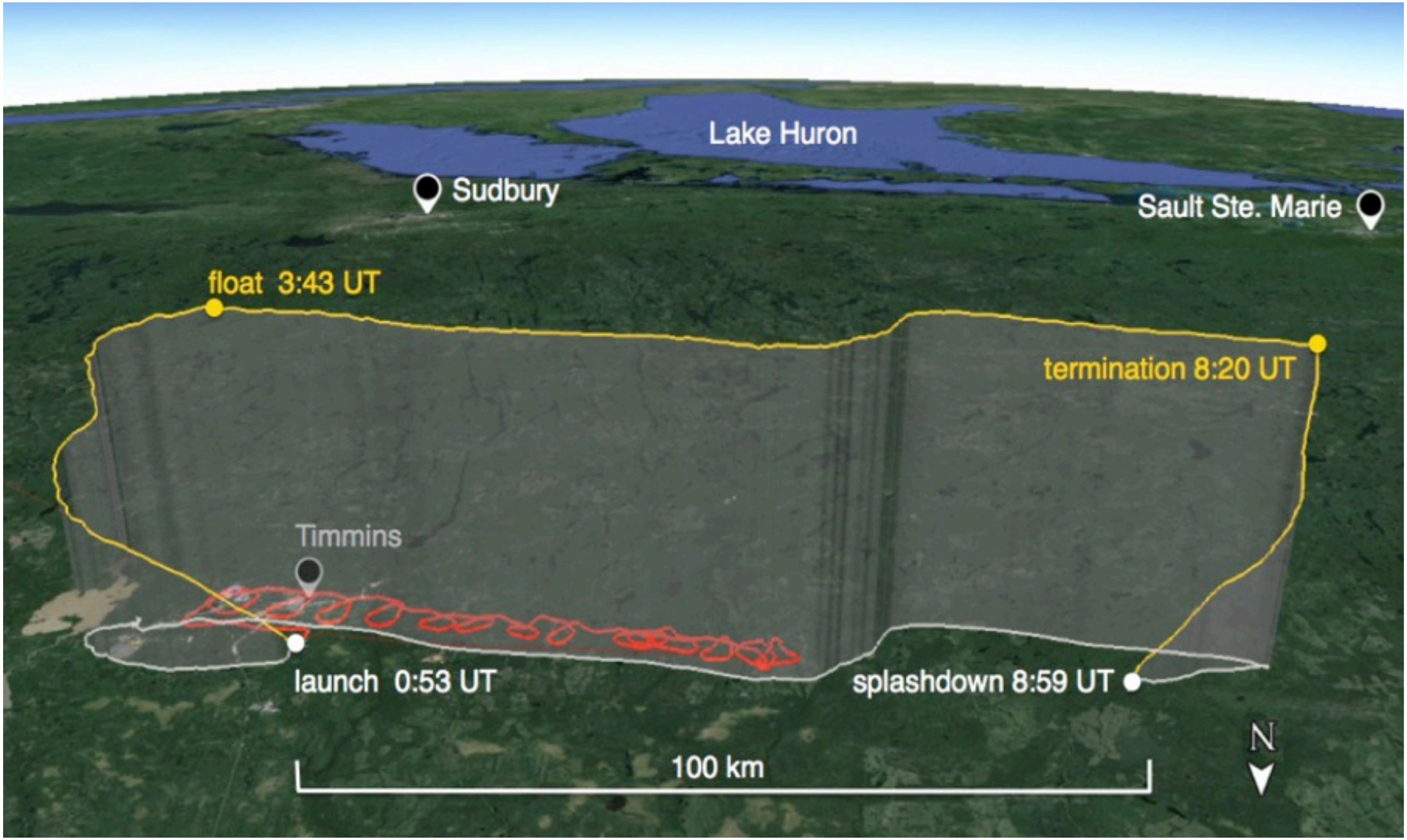
Quelques photos du vol (avant les vidéos)





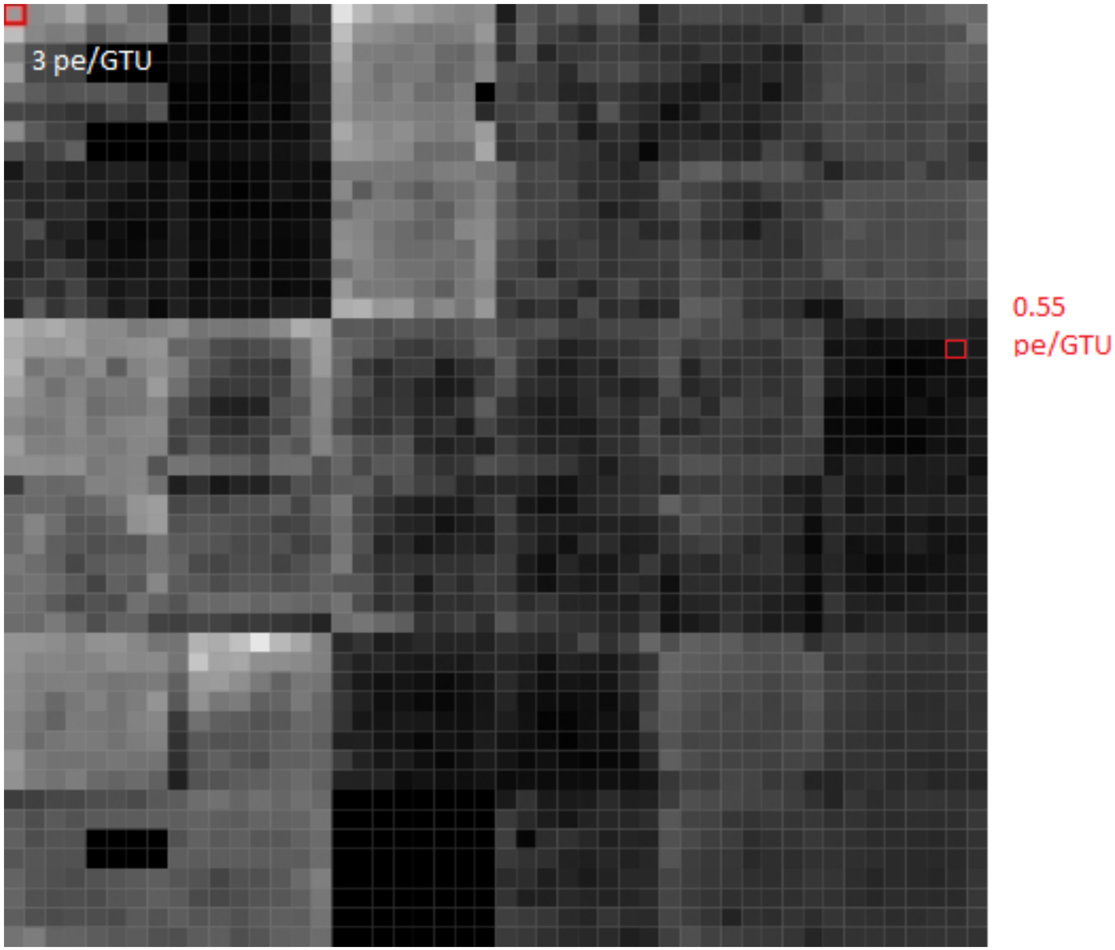


Trajectoire du vol ballon (jaune) et hélico (rouge) 3D

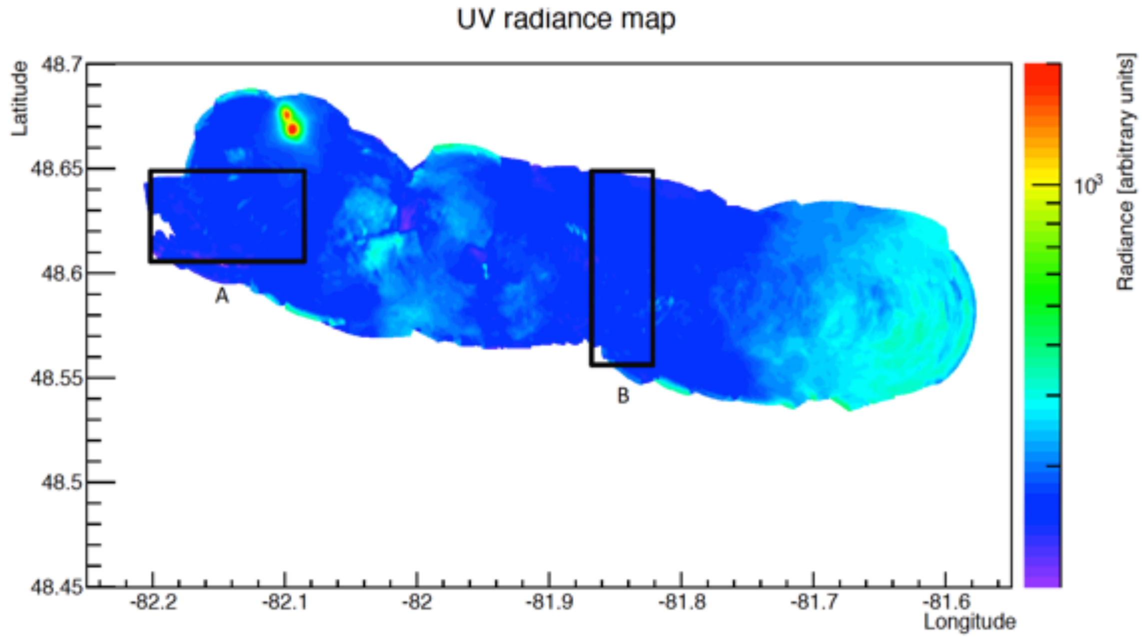


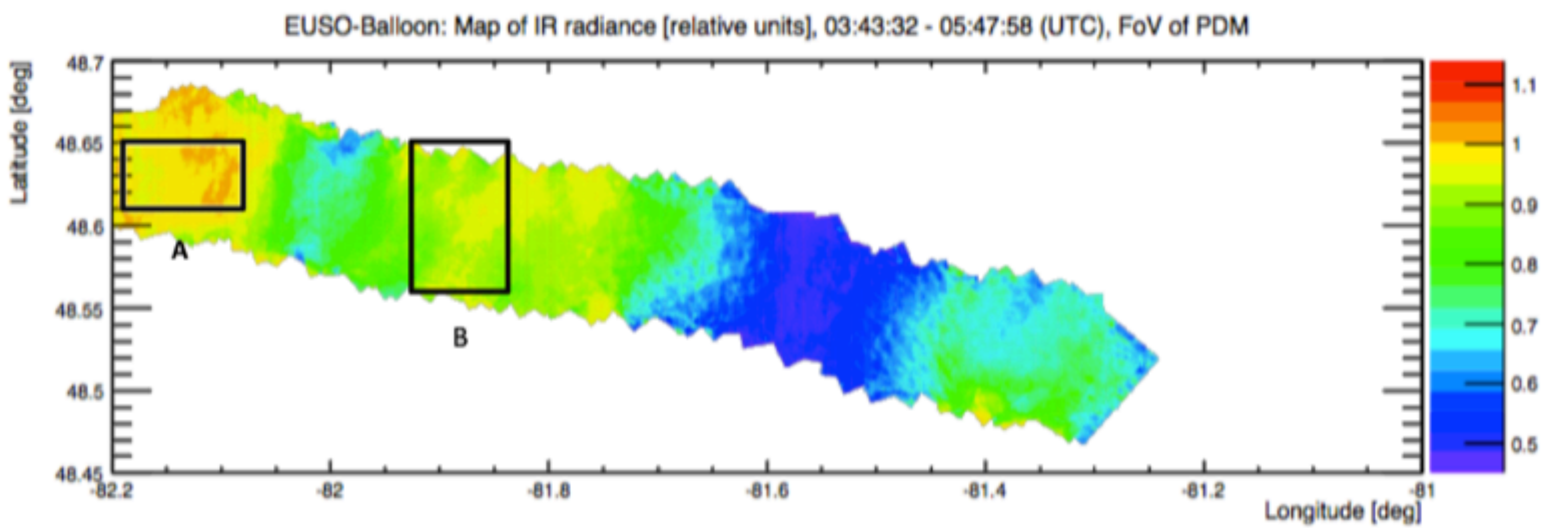
La première matrice de données (sur la base du 1% de TM)

EUSO-Ballon : première lumière du détecteur !

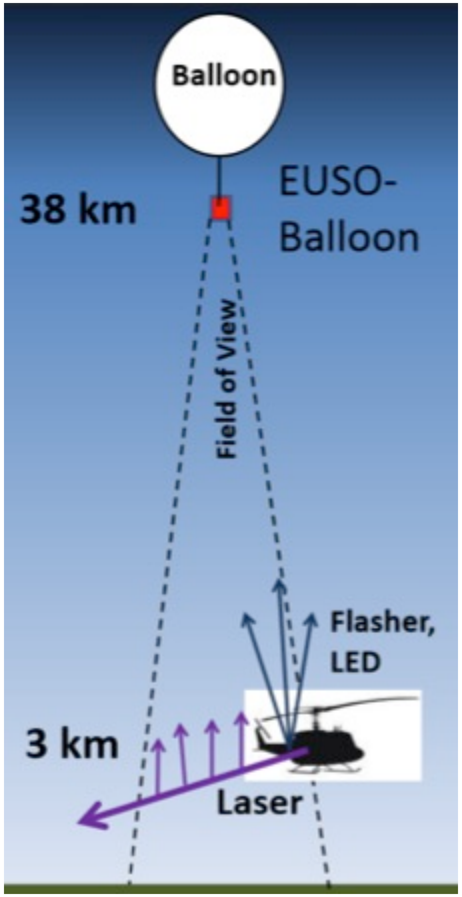


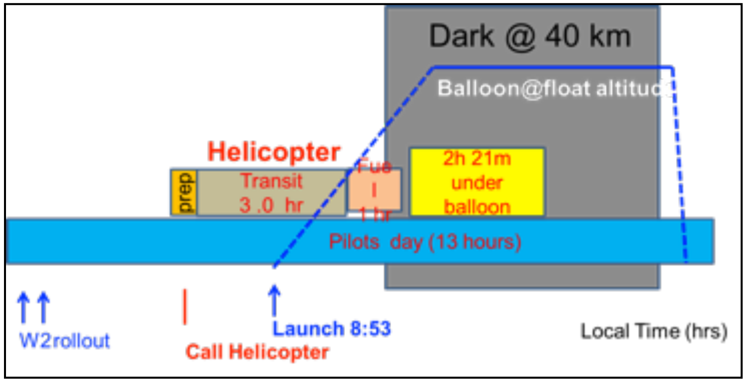
EUSO-Ballon : premières cartes UV et IR

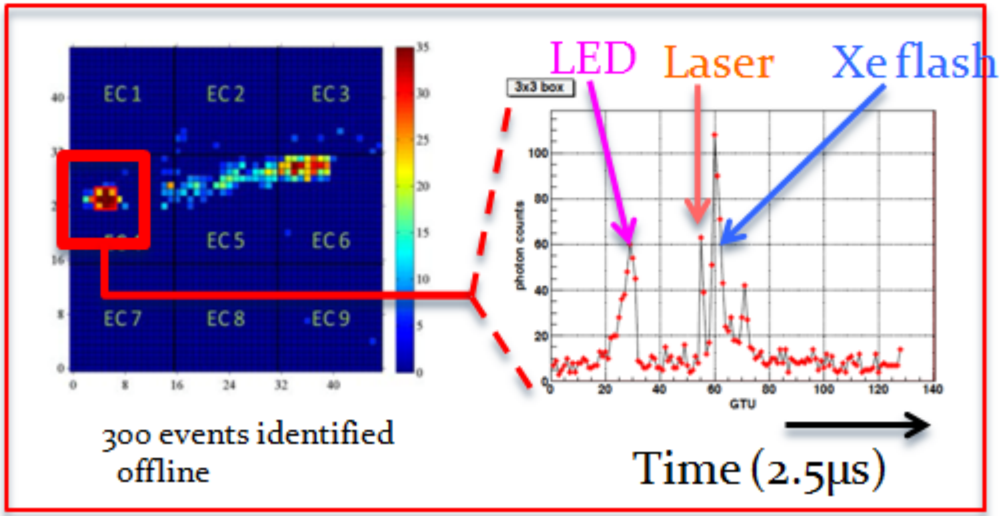




Générations d'évènements simulés à bord d'un hélico

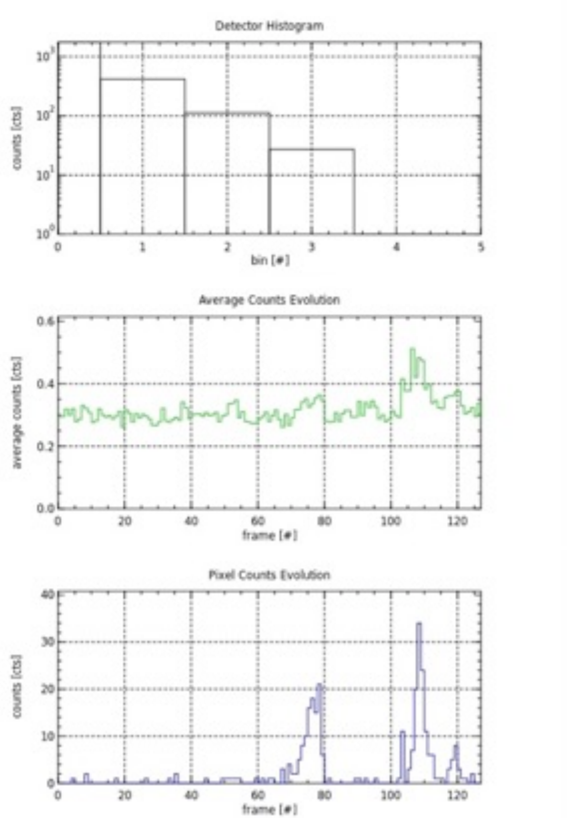


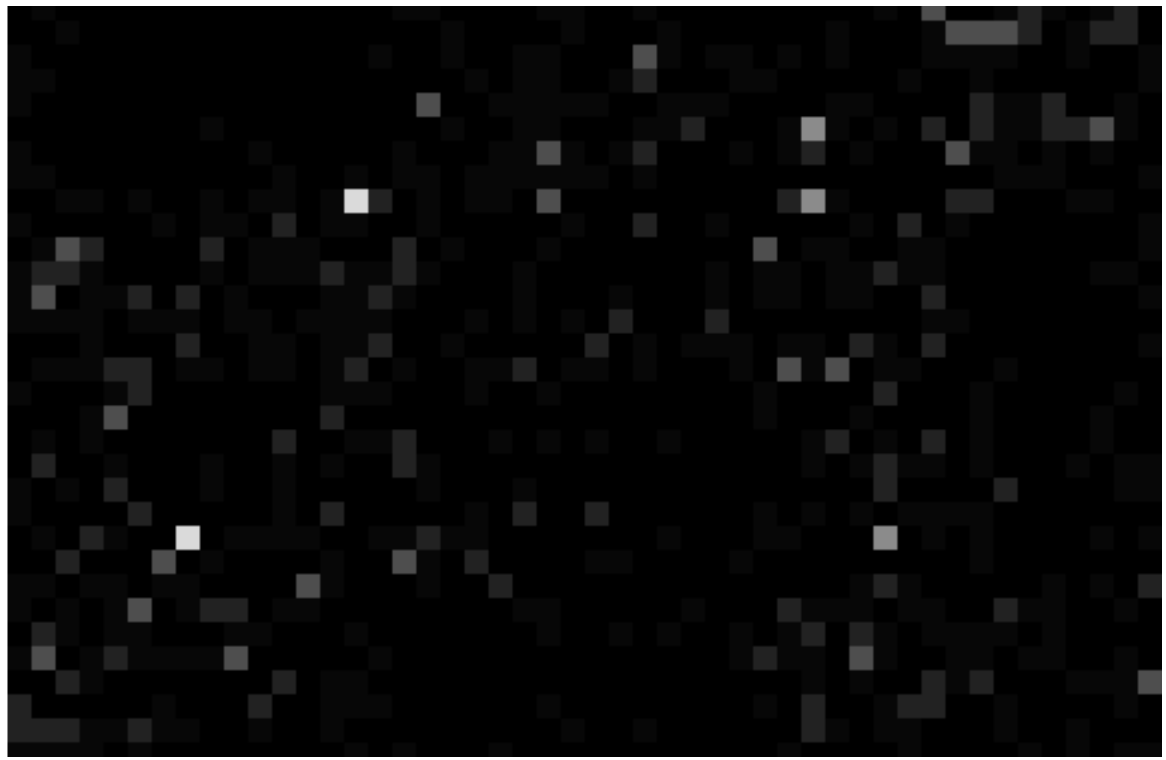




Quelques résultats préliminaires (sur la base du 1% de TM)

EUSO-Ballon : première détection d'événement simulé !





Spot laser (hélicopter)

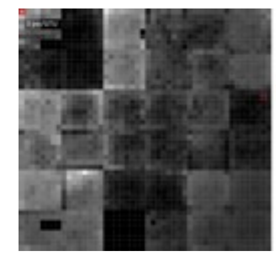
Nombreux articles publiés / en cours de publication

- Calibration absolue PDM
- Efficacité du système optique (throughput, PSF, champ: comparaison avec les simulations)
- ⇨ Détection et reconstruction des événements lasers et flashers
- Altitude des nuages: application des algorithmes aux données de vol (+ comparaison avec les données météo locales)
- ⇨ Bruit de fond UV et variabilité
- Evénements atmosphériques, météores, avions… rayons cosmiques ! (→ limites?)
- Étude comparative de différents (compte tenu du bruit de fond mesuré et des simulations de gerbes)
- ⇨ Acceptance en fonction de E (déduite des mesures de bkgd UV)
- ⇨ Prédiction de taux de comptage pour un vol long

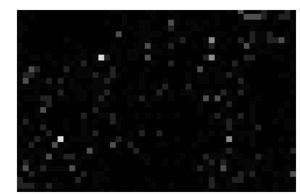
Présentation globale : objectifs

Chaque niveau d'objectif a été partiellement atteint dès le premier vol :

Niveau A : Test à l'échelle 1 de la technologie JEM-EUSO
Alimentation haute-tension, commande des **switches** HT pour la réduction ultra-rapide du gain des PMTs, électronique de front-end (ASICs, FPGA…)
Hardware et **software pour les triggers** et la reconnaissance des gerbes



Niveau B : Etude du bruit de fond JEM-EUSO
Avec une résolution suffisante → taille du pixel au sol < celle de JEM-EUSO, acquisition de données type JEM-EUSO depuis une plateforme de type spatial, test et optimisation des algorithmes de trigger en conditions réelles et variables



Niveau C : Mission précurseur
Première détection d'une gerbe de **rayon cosmique** par le dessus ?
Détection d'événements induits par laser ou flashs ?

Le second vol devra valider les switches et surtout la détection par le trigger de rayons cosmiques (validé au sol en 2015 par l'équipe dans le cadre de TA-EUSO)

EUSO-Ballon : de l'intérêt des crashpads et des flotteurs

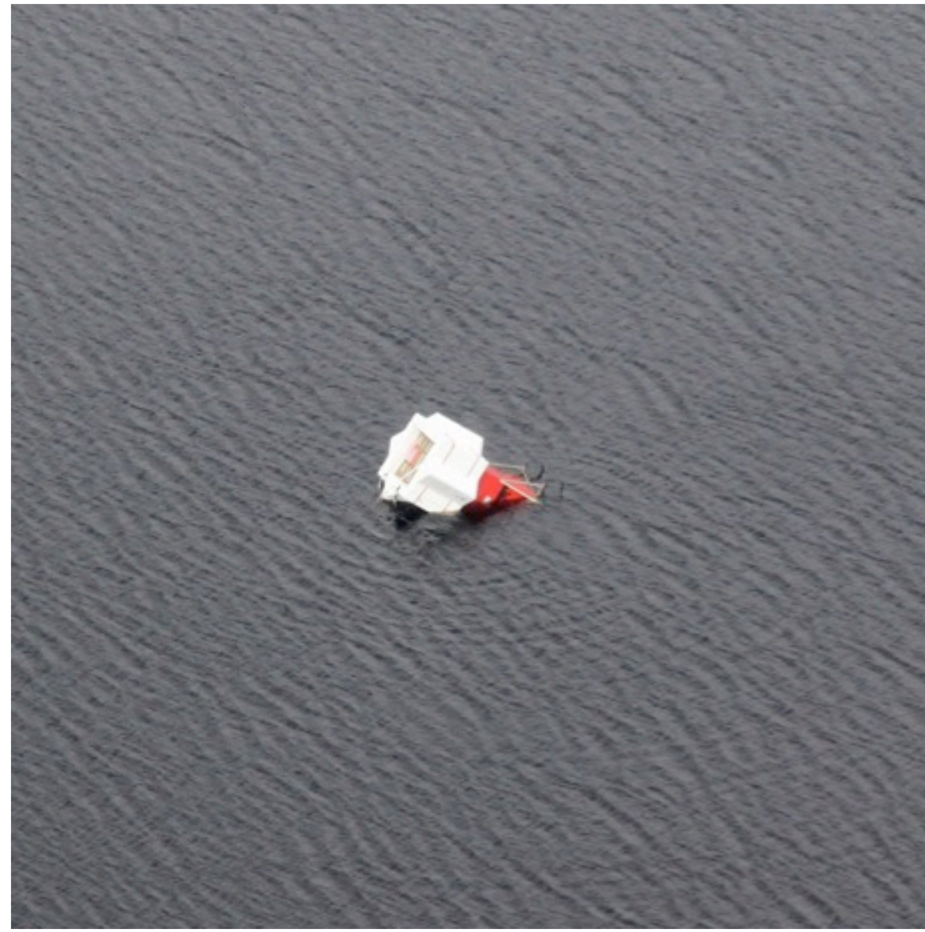
Nacelle étanche (design)

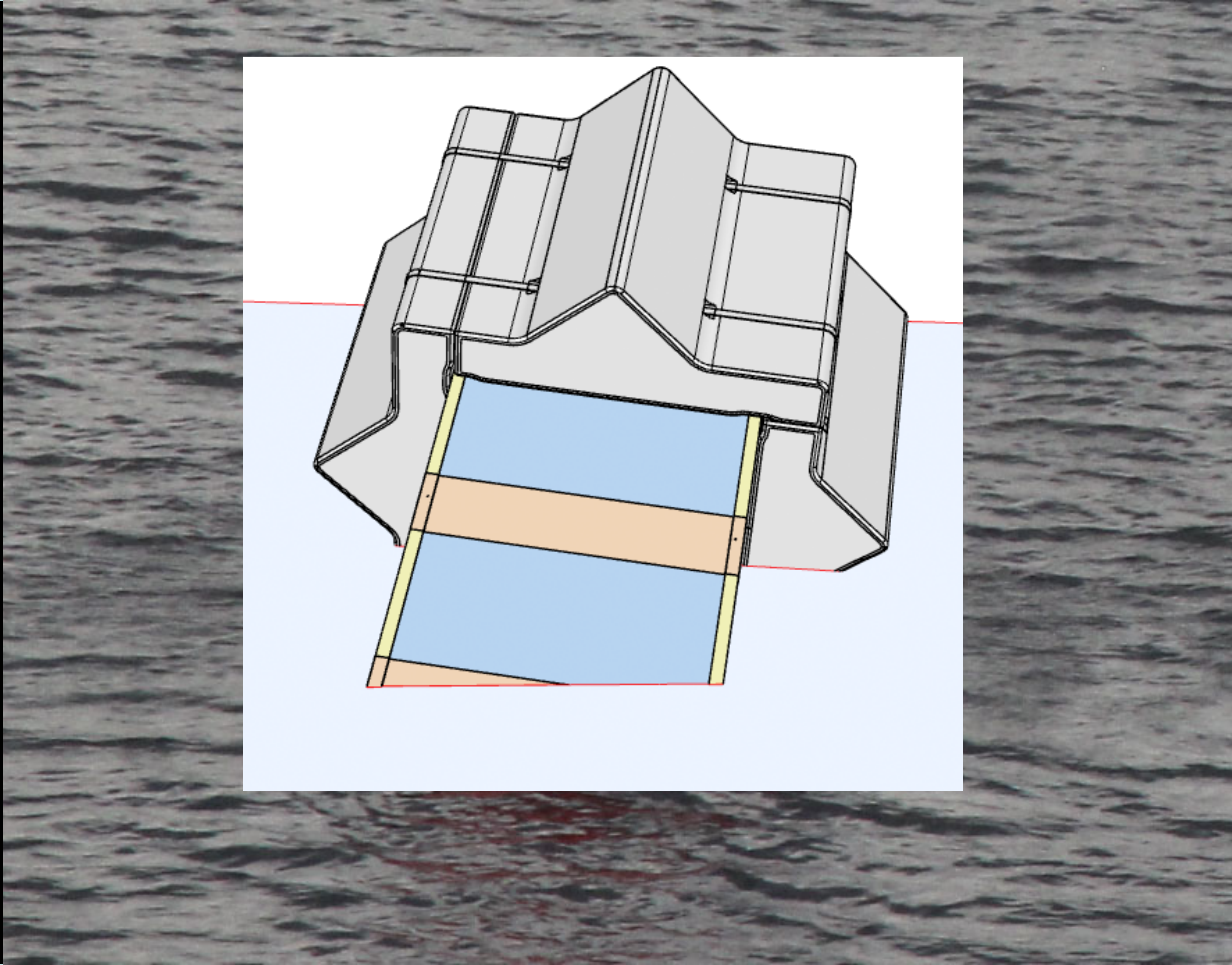
<u>Pas de sous-système contre les parois</u>

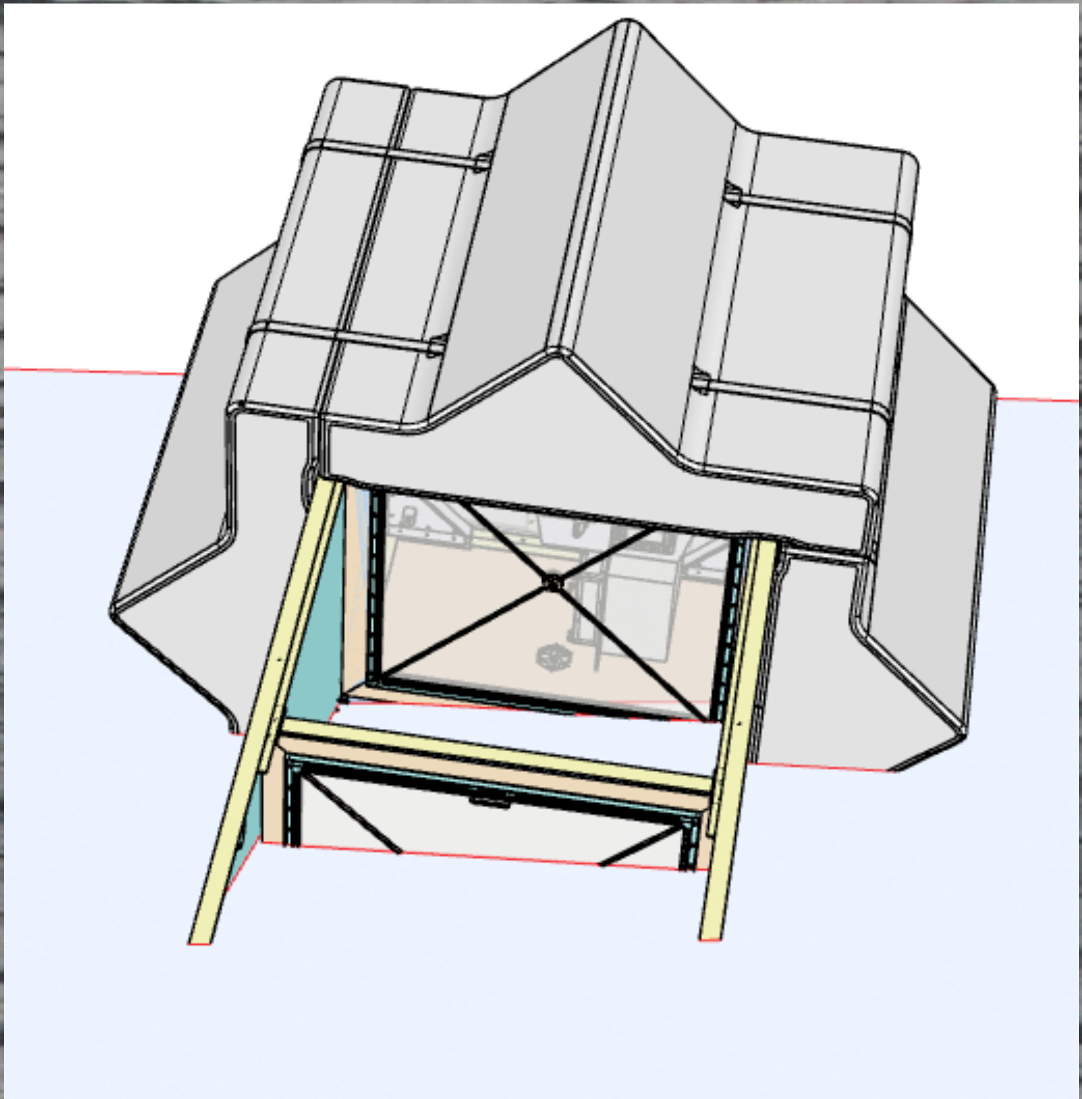
Atterrissage : zone la plus sèche possible (Canada: 3 millions de lacs)

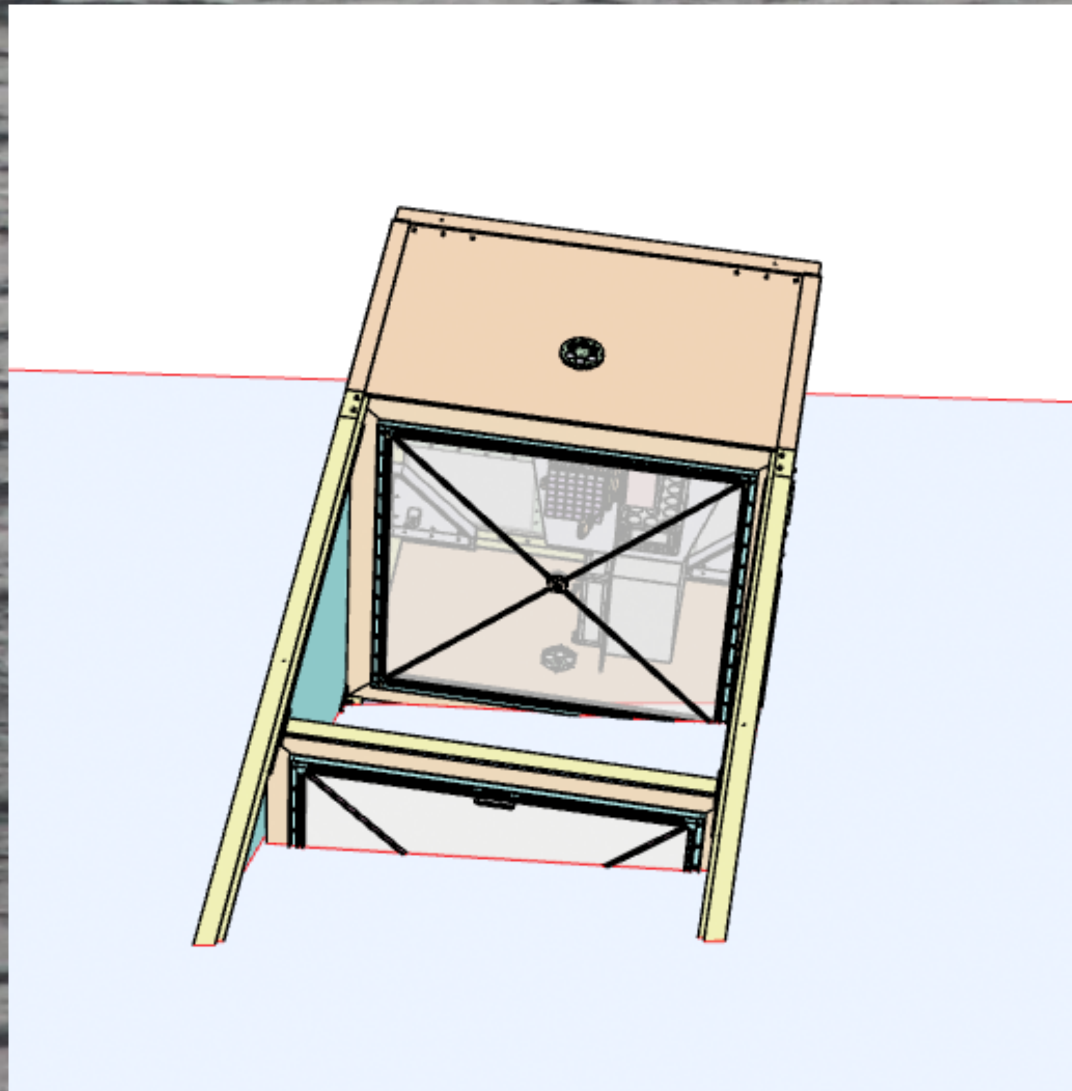
Att/merrissage

Atter/merrissage : 1% de TM au sol, 99% dans la nacelle









Les données sont dans la boite !

Développement d'une nouvelle version du détecteur PDM

(ASIC v3, FPGA v2, HVPS intégrées)

Mars 2017

Vol 20-30 nuits à bord d'un ballon SPB (NASA), depuis la Nouvelle-Zélande jusqu'en Amérique du Sud, puis Afrique du Sud (Détection de Rayons Cosmiques)

Mai 2017

mini-EUSO, prototype spatialisé à bord de l'ISS (airglow, météores, débris).

REX (qui n'engage que moi ☺)

L'expérience ne sert-elle qu'à avoir des remords ?

Gérer un projet : utiliser les **soutiens labos** (Cellule de Suivi de Projet, structure matricielle, cellule qualité), les **outils institut** (EDMS/Atrium, Forge, etherpad, Renater (EVO), tableaux de bord, indico, meeting Core, etc.), les **supports de gestion** CNES & CNRS (docs types d'I/F, docs architecture, CR type, liste suivi d'actions), les **applications/logiciels** (redmine, freemind), les **méthodes** de gestion, les **formations**.

Quelques règles générales de bon sens, d'expériences apprises au cours de ce projet :

- **Cahiers des charges** : vision et objectifs clairs = clarifier les besoins.
- Définir **organisation** & rôles (MoU), hiérarchies, objectifs, livraisons (avec interfaces -> ex: Harnais et câbles ☺ !)
- **Phase initiale**: design concourrant, revues de design internes et externes, etc.
- **Prendre les bonnes décisions** (virage difficile), le plus **tôt** possible (on a plus de temps pour rebondir après un problème), avec un **plan B** en tête.
- **Ne pas essayer de tout faire** (vous êtes moins expert, moins endurant, moins résilient qu'une équipe. Exemple de Kobe Briant et des Lakers : chaque fois que Kobe marque plus de 30 points par match, son équipe perd).
- **Attention** : on a tendance à commencer / à faire ce qui est simple, pour ne pas faire ce qui demande une **organisation**, ce pour quoi on n'a pas toujours d'une vision simple et claire de la finalité.


eusoballoon - a wonderful adventure