XEUS DSC PLM accommodation study
Executive summary

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1. STUDY OVERVIEW

The XEUS payload module accommodation study is the basis for the forthcoming XEUS mission system study. The main objectives of the accommodation study are

- to define the preliminary Detector SpaceCraft PayLoad Module (DSC PL design
- to identify the resources drivers
- to define the interfaces
- to assess the feasibility with core and extended instruments configuration
- to identify the potential solutions for cryogenic chain
- to identify the technology development and the critical issues

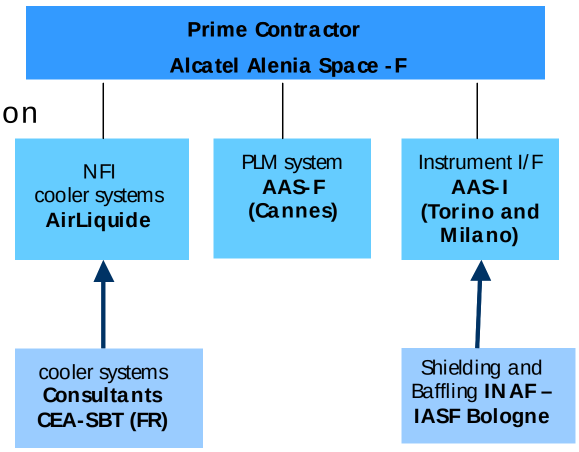
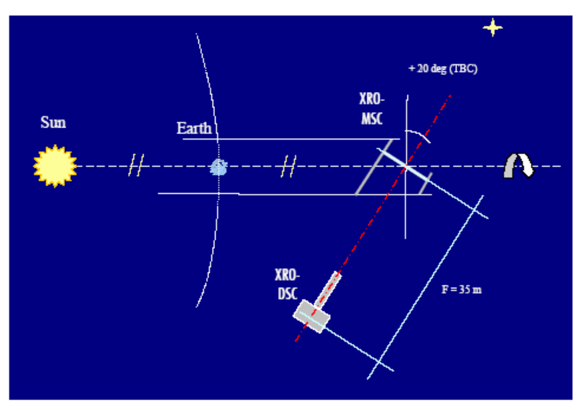


Figure 1-1 : study team organisation with consultants for coolers and baffle shielding

> ➢ The XEUS mission aims to detect and perform spectroscopy of faint astrophysical sources located at high redshift. The scientific topics addressed are: the evolution of large scale structure and nucleosynthesis, the coeval growth of galaxies and supermassive black holes and matter under extreme conditions
>
> ➢ This new generation of X ray observatory is designed to have a large X-ray collecting area, follow on to the XMM-Newton X-ray spectroscopy but with enhance science performance

The Xeus mission goals are not achievable by means of a monolithic X-ray telescope but requires two satellites in a formation flying configuration at L2:



- ➢ The Mirror SpaceCraft (MSC) hosting the Telescope Module, a circular X-ray composite optics with a diameter of 4.25 meters
- ➢ The Detector SpaceCraft (DSC) hosting the Payload Module with core instruments of Wide Field Imager (WFI) and Narrow Filed Imager (NFI)

MSC + DSC formation flying configuration

In the L2 Halo orbit, the MSC and DSC in formation flying, will operate like a large X-ray observatory with a focal length of 35 meters.

2. STUDY FLOW

- The first steps of the study focused on the instrument analysis, on the identification of the resource and accommodation demands and the identification of potential cryogenic chains

- The cryogenic trade-off leads to consider two configurations (with and without V-grooves, cold 20K cryostat or warm 300K cryostat, continuous cooling or recycled coolers) which widens the range of candidates for the cooling chains

- The DSC PLM design was studied on the basis of two pre-selected cryogenic chains and accommodation constraints

- The trade-off analysis concluded, that the final selection of cryogenic chain for XEUS NFI has to remain open with the present knowledge of the instrument. Nevertheless the most promising cryogenic chain was chosen for the study considering commonality between the two possible NFI instruments and large flexibility with regard to heat loads. This preliminary analysis work will prove as very useful for further mission level studies

- Recommendations for ESA & PLWG and a technology development plan were formulated

3. INSTRUMENTS

- The nominal instruments are the WFI (Wide Field Imager) and one NFI (Narrow Field Imager, NFI 1 or NFI 2)

- In addition to this core payload, ancillary instruments considered, resources permitting are:
  - High Time Resolution Spectrometer (HTRS)
  - Hard X-ray Camera (HXC)
  - X-ray Polarimeter (XPOL)
  - Narrow Field Imager (2nd unit)

- The recommendation for potential accommodation of HXC is to group it with WFI

The instruments analysis addressed:

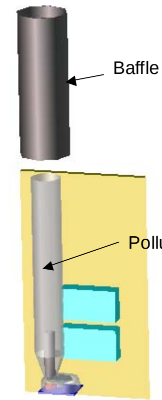
- Critical review of payload definition document provided by ESA
- Identification of instrument resources requirements
- Identification of mechanical, electrical and thermal interfaces between each instrument and the PLM
- Contamination control needs, identifying possible drawbacks and requirements
- Instrument grouping possibilities
- Evaluation of shielding needs (baffle dimension and estimation of shielding mass) and straylight.
- Evaluation of particle diverter at DSC level

The main instrument characteristics that impact the accommodation design, in particular for baffle length and focal plane temperature are presented below:

Baffle characteristics

Instrument	WFI	NFI 1	NFI 2	HXC	HTRS	XPOL
Length (m) calculated from focal plane	8.15	1.09	1.1	8.2	2.4	2.95
Diameter at the top (m)	1.05	0.14	0.14	1.05	0.31	0.38

Considering the present PLM accommodation, the selected baffle configuration, except for NFI (baffle made of one cylinder), is based on one short cylinder internal baffle and one long external baffle



For the low energy instruments the more suitable material seems to be Al. This Al can be solid Al or (if necessary for mechanical reasons) a part of it can be "expanded" in honeycomb shape to provide the necessary rigidity. It is convenient to foresee a thin C layer on Al for grading reasons (to absorb the possible K alpha secondary radiation coming from Al).

For WFI a solution is Al honeycomb with C skins and a suitable high atomic number absorber like e.g. Pb, Ta or W.

For the high energy HXC it is necessary to use denser materials which also require a complex set of grading materials to absorb secondary emission.

Instrument characteristics

Instrument	WFI	NFI 1	NFI 2	HXC	HTRS	XPOL
Energy range (keV)	0.1 - 15	0.2 - 6	0.2 - 6	15 - 40	0.5 - 20	2 - 10
FOV (arcmin)	Φ 7	Φ 0.74	Φ 0.75	5 x 5 square	1.2 x1.2 square	1.5 x 1.5 square
Focal plane temp.	210 K	300 mK	50 mK	220 K	250 K	290 K

- The instrument analysis provides the following recommendations for each instrument

WFI recommendations
Field of view dimension has a critical impact the baffle dimension. FoV reduction will allow minimizing the baffle length criticality
Focal plane dissipation has to be treated with care. It has a direct impact on the passive thermal control (strap definition and weight)
Low energy boundary (0.1keV) increase will permit relaxing the cleanliness requirements
NFI 1 recommendations
Requirements/constraints (such as operating temperature & stability, wiring, focal plane design, micro-vibrations susceptibility, cleanliness) have to be confirmed as soon as possible in order to secure the PLM and cryogenic chain design
Instrument design should be defined with a particular attention to thermal optimisation (wiring, focal plane mass)
The present design of the focal plane is the driver of the cryostat envelope. It is recommended to consolidate the focal plane envelope, and if possible, to optimize accommodation of its elements.

Wiring is a major contributor to heat load. The wire definition has to be further studied in order to minimize this heat load.
Harness length requirement between focal plane and proximity electronic (< 300mm) should be relaxed since it is an important accommodation constraint
Due to the harness length requirement, the FEE is located as close as possible to the cryogenic envelope. The FEE dissipation, and if possible investigate solutions to limit this dissipation should be investigated
NFI 2 recommendations
Requirements/constraints (such as operating temperature & stability, wiring, focal plane design, micro-vibrations susceptibility, cleanliness) have to be confirmed as soon as possible in order to secure the PLM and cryogenic chain design
Instrument design should be defined with a particular attention to thermal optimisation (wiring, focal plane mass)
The focal plane design need to be refined. The following topics have a major impact on the concept and need further investigations: • support structure of the 50mK area with respect to the 2,5K envelope. Since it has an impact on the 50mK heat load. • distance 50mK area with respect to CADR cold finger. The focal plane design needs to allow the shortest distance. • Dissipation of the focal plane and SQUID need to be consolidated
Harness length requirement between focal plane and proximity electronic (< 300mm) should be relaxed since it is an important accommodation constraint
Due to the harness length requirement, the SEB is located as close as possible to the cryogenic envelope. The SEB dissipation, and possible solutions to limit this dissipation should be investigated
SEB fixation on the cryostat should not be required. If the cryostat is 300K, it is not suitable to have dissipative electronic boxes fixed on it. If cryostat envelope temperature is lower than 300K (in the case of the V-grooves), it is not possible to fix the SEB on it.
HTRS recommendations
HTRS grouping with WFI/HXC is not recommended since the detector dimensions have a large impact on the baffle dimension
The collimator baffle option has to be evaluated since this baffle will lead to a very compact instrument
The upper energy boundary goal of 50 keV implies reconsideration of the baffle and might be not compatible with collimator baffle concept
Data rate in photon-photon mode is too high. Binned spectral mode should be used for bright sources
HTRS observes powerful sources, thus when HTRS is observing all the other instruments must be protected by the filter wheel in closed position
XPOL recommendations
Xpol design has to be clarified in particular for the function of the grid on the top baffle,

high voltage electrodes, presence of getter
1.5 arcmin diameter Field of view (instead of 1.5 square) will allow to reduce the baffle dimensions
HXC recommendations
HXC should be grouped with WFI for better mission efficiency and mass reduction (only one large baffle). WFI + HXC instrument has to be managed as one instrument under one PI responsibility
Reduce slightly the HXC field of view, so that baffle is defined only by WFI
High energy boundary (0.1keV) decrease will allow to reduce baffle mass

Particle diverter

Cosmic charged particles can be funnelled down to the focal plane by X-ray optics under certain circumstances, resulting in a sudden increase of the background level and causing in some cases a decrease of instruments performance. The classical solution is a magnetic diverter, made of a high magnetic field placed behind the rear mirror aperture. Possible proton diverter positions have been evaluated on the basis of the identified DSC baseline. The best potential solution for mass and accommodation is to place the proton diverter at a distance of 1.3m from the detectors. the required magnets have dimensions of 240 mm x 20 mm x 80 mm and a mass of about 3kg each, thus a total mass of 6 kg without considering the structure to maintain the devices in the correct position. This structure has to be quite robust (considering the intensity of forces acting between the magnets) and made of non-magnetic material, to avoid perturbing the magnetic field.

Straylight

All the Xeus DSC instruments on the focal plane need to receive the scientific information only from objects present in the X-ray Mirror FOV and not from other directions/other wavelength bands. The straylight sources are summarized in the following table, identifying the potential solutions for reducing the straylight depending on the source. As optical filtering of instruments is not presently defined, this evaluations are based on the assumption that the optical filters have a transmission of about 10^{-7}.

Straylight sources	Impact reduction – potential solutions
Non-X radiation coming from observed objects	Instruments optical filtering
Stars, planets (out of FOV)	Instruments optical filtering + baffling system
Direct Sun on baffle internal part	To be avoided - baffle upper profile shape suitable to all foreseen sun angles
Sun reflection on	Avoidance angles free + precautions for S/C

S/C features	features visible by detectors + instruments optical filtering
Moon - Earth	Less critical than sun but difficult to predict (depends on how much sunlight is sent to L2 by these objects)
Metrology beams	Precautions at S/C level to avoid metrology beams reflections

4. SELECTED DESIGN

- The selected DSC PLM design is defined as follows:
- Common SVM/PLM structure with 'pentagon' shape
- Cryogenic chain composed of 3 V-grooves/pulse tube/3He JT/3 HE Sorption cooler (and cADR for NFI 2)
- Two main instruments configuration:
  - core configuration: WFI and NFI (NFI 1 or 2)
  - extended configuration: WFI grouped with HXC, one NFI (NFI 1 or 2), XPOL and HTRS

Note: accommodation of two separated NFI is not compliant with mass limit and accommodation of the two NFIs in one cryostat appears to be a complicated solution

- The DSC shape offers a large radiative surface, while having a large volume for all equipment. The PLANCK SVM heritage has been considered to offer large accessibility and possibility of integrating instrument component on removable panels

- PLM/SVM common structure is the optimized choice for XEUS. SVM can be on dedicated DSC panel or even inside central tube (as for MSC)

- The MSC/DSC stacked configuration for launch is compatible with Ariane 5 long fairing

The DSC PLM design overview is presented in the following figures

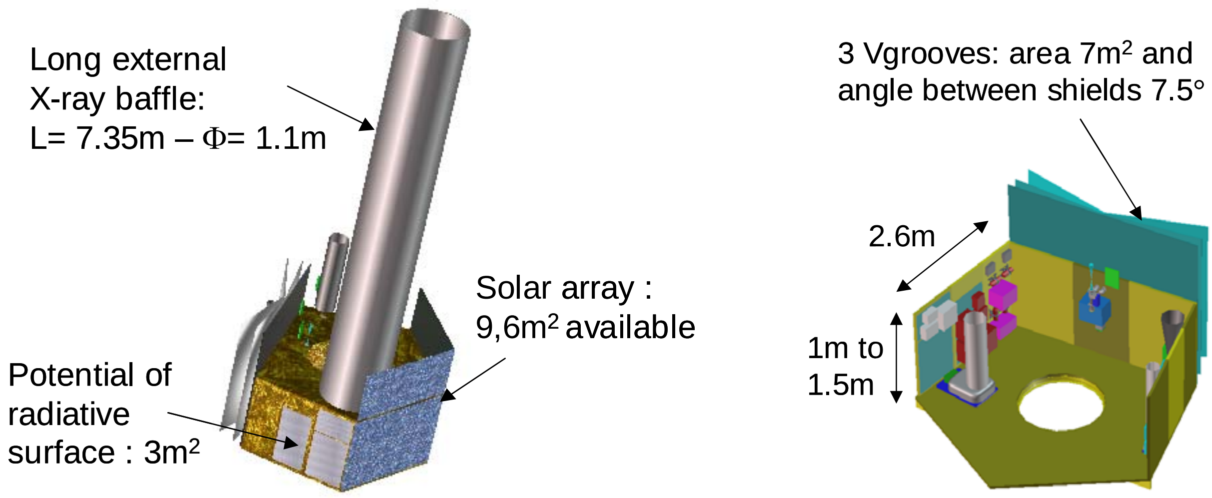


Figure 4-1 Overview of the XEUS DSC PLM selected design: cryogenic with V-grooves, large sun shield and radiative areas

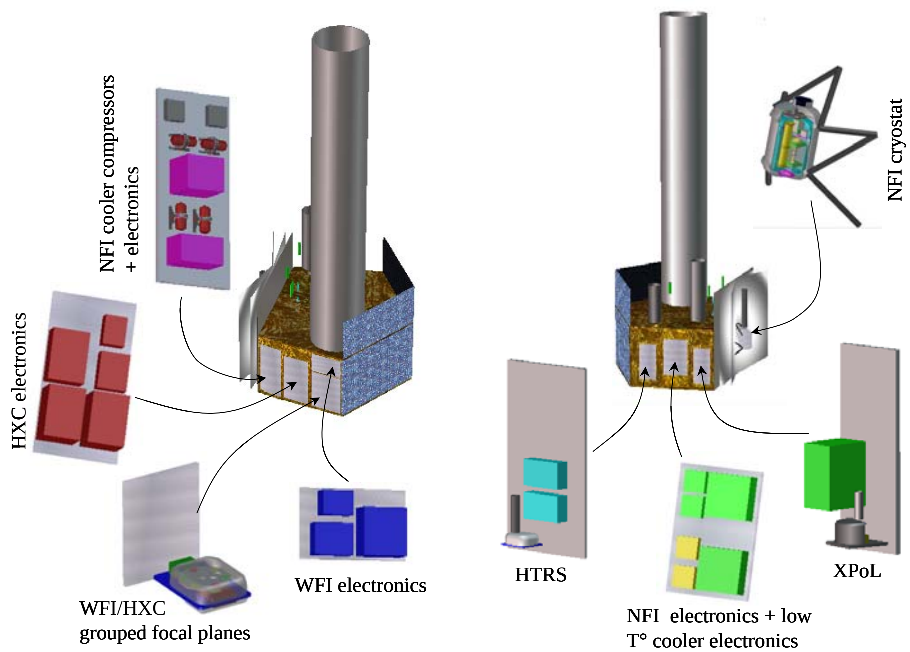


Figure 4-2 XEUS DSC PLM extended configuration: one instrument per panel, the accommodation is similar for NFI 1 or NFI 2. Only one large external baffle thanks to grouping HXC with WFI

PLM constraints on DSC satellite

item	PLM constraints

Mass	The allowed mass for SVM equipment + common SVM/PLM structure is about 1000 kg with the extended configuration.
Power	The maximum required power is 1050 W when WFI is operating.
Thermal control	The required radiator surface area is about 4.5m^2 with the extended configuration
Sunshield	The sunshield area required to protect V-grooves and platform from sun is 9.6 m^2
Data handling	PLM would communicate with SVM through a 1553 bus for command/control and a Spacewire bus for science data.
Science data download	Preliminary estimate for needed data rate is about 18Mbits/s without compression
Stacked configuration	Some heating power will be needed to warm-up the cryostat and V-groove during initial decontamination phase and to avoid cooling of platform and electronics.

Formation flying

Analysis of pointing and formation keeping requirements for XEUS spacecrafts during the observation phase was performed based on experience developed through studies for Darwin and Symbol X programs. One main conclusion of this analysis is a requirement for absolute attitude measurement error below one arcsec in order to fulfil the formation flying requirement.
This analysis leads to recommend RF sensors and Ullis optical sensor for metrology. These sensors have been considered for the PLM accommodation.

4.1 Cryogenic chain

- The two selected cryogenic chains are:
- For NFI-1: 3He sorption + 3He JT + PT + V-Grooves
- For NFI-2: cADR + 3He sorption + 3He JT + PT + V-Grooves

- The main reasons for this choice are
- V-Grooves associated to PT cooler offer a flexible first cooling stage (with respect to Stirling cooler without V-grooves)

- The 3He JT cooler is light and compact. It is well adapted to high cooling power requirements at 300mK and allows 10-year mission duration (as opposed to LHe dewar and dilution cooler with their present characteristics)
- The cADR is a continuous and compact system requiring low magnetic fields (as compared to dADR)
- The 2 cooling chains feature similar coolers except at minimum temperature

➢ The correlation level between coolers is a critical issue and heat load budget shows coolers development is necessary

➢ Further inputs on system priorities as recycling time, lifetime, mass and power constraints and refined instrument characteristics as focal plane design, wiring, micro vibrations susceptibility are required to conclude on the cryogenic trade-off

Methodology for cryogenic chain trade-off

The following approach, based on the requirements for each instrument and the characteristics of individual coolers, builds up cryogenic systems for NFI-1 and NFI-2:

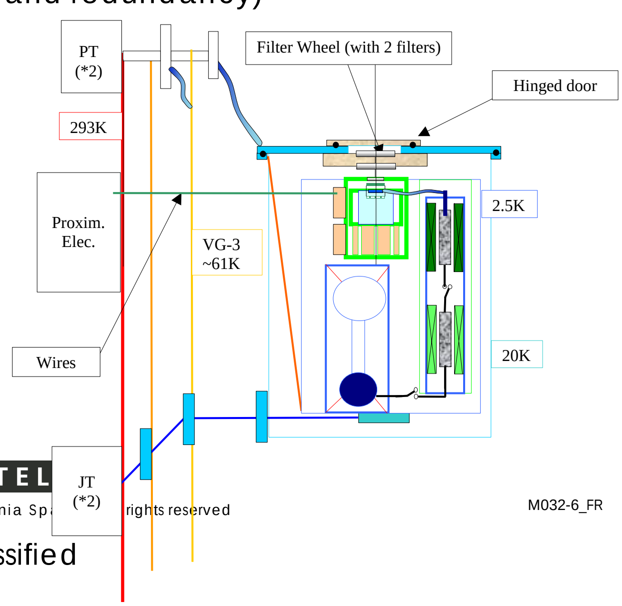
- The starting points are the low temperature requirements: Tmin and cooling power
- The requirements of lowest temperature coolers identifies the possible pre-cooling sources
- Eliminate the less adapted coolers (with justification)
- Duplicate this approach towards top level coolers

7 cooling chains are thus identified for NFI-1 and 6 cooling chains for NFI-2.

The different identified cooling chains are compared as function of the following cryogenic system issues:

- Performance (including 10-year option and redundancy)
- Accommodation constraints
- Technology readiness level
- Assembly integration and test / Validation
- Cost drivers

Note: the trade-off conclusions are largely affected by the weighting factor associated to the different mission requirements.



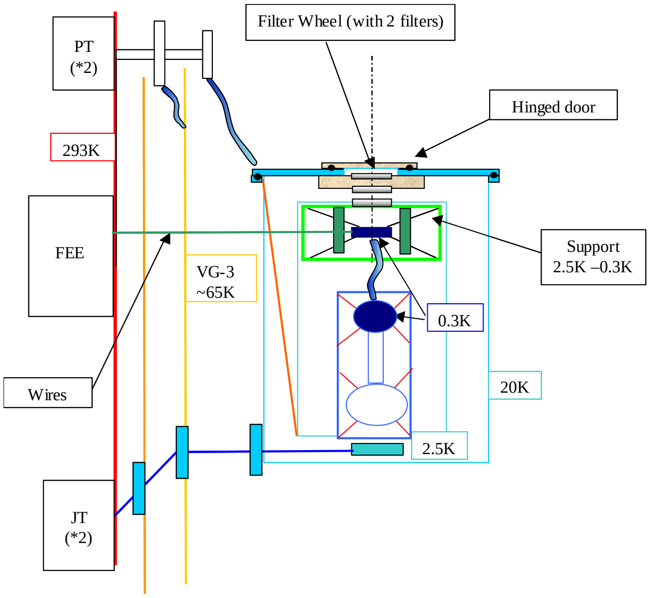
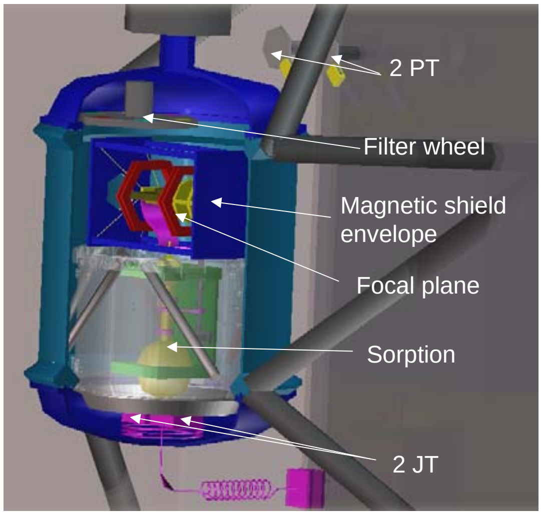


Figure 4-3 Schematic of selected cryogenic chain for NFI 1 and NFI 2 composed of V-grooves + pulse tube + 3He Joule thompson + 3He sorption +cADR for NFI 2

The 2 cooling chains feature a 3 V-Groove system providing about 60K at 3rd V-Groove level. The V-Groove is used as a pre-cooling stage for the pulse tube cooler providing 20K.
This 20K stage provides the envelope for the vacuum cryostat containing the instrument (NFI-1 or NFI-2).
The Pulse Tube cooler is also used as a pre-cooling source for the 2.5K 3He Joule-Thomson cooler. This 2.5K stage is used to anchor thermal elements of the instruments (shielding, SQUID boxes in the case of NFI-2, etc) and also to pre-cool the 3He sorption cooler.
The 3He sorption cooler provides about 300mK cold stage for NFI-1 and is used as a pre-cooling source for the cADR in the case of NFI-2.
The cADR (NFI-2 only) provides a 50mK continuous stage for NFI-2 instrument.



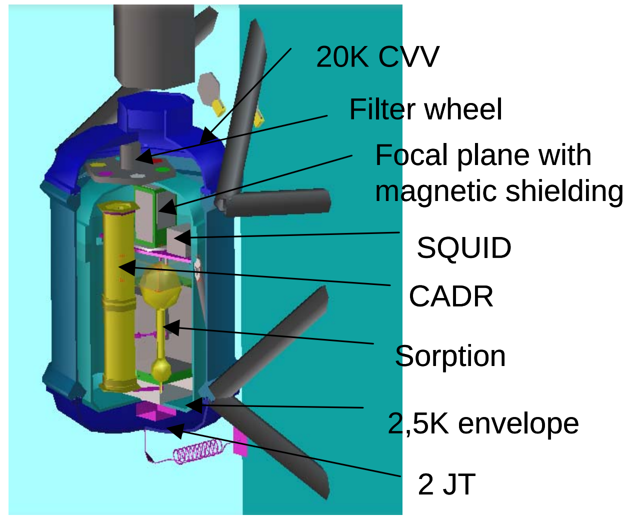
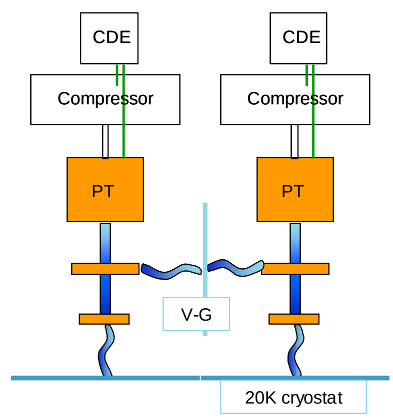


Figure 4-4 : 3D views of NFI 1 and NFI 2 with their 20K cryostat



For the 2 cooling chains, the trade-off on redundancy lead to a “hot” redundancy approach for pulse tube and Joule-Thomson coolers: 2 systems in parallel running at 50% input power.

The main advantages for such a configuration are:

- No single point failure
- Cooling power of 2 systems running at 50% input power equals the cooling power of 1 system at 100% input power
- Increased reliability (each coolers runs at 50% of full capacity only)
- Potential cooling power increase (to compensate for degraded mode)

For the low–end coolers, the trade-off concluded on a limited redundancy approach due to parasitic loads. As a consequence, only heaters and temperature sensors would be duplicated.

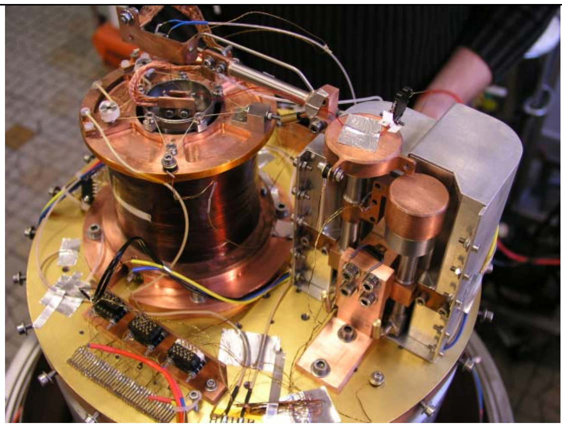
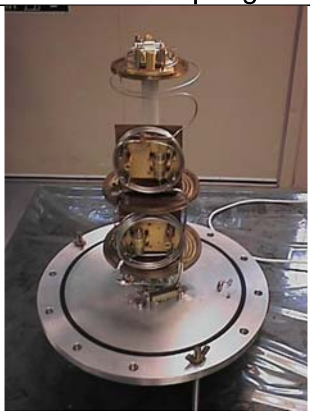
 3He Sorption cooler developed for Herschel program	 Prototype of the cADR
 4He Joule Thompson sorption cooler developed for Planck program	 Large pulse tube cooler developed under ESA GSTP contract

Figure 4-5 : Coolers under development or developed in the frame of Herschel/Planck programs

Conclusion on the cryogenic chain

The cooling chains proposed for NFI-1 and NFI-2 are good candidates. They are compact and light and are adapted to 10-year lifetime.

Based on present requirements, the selected cooling chains are marginal with respect to heat load budgets. The main drivers for the heat loads are:

- The severe requirements of instruments at base temperature: recycling time for NFI-1 and dissipated power for NFI-2
- Dissipation of wires at all stages for NFI-1

- The limited performance of the 3He Joule-Thomson cooler (minimum temperature, cooling power) and its heavy load on the 20K pre-cooling stage
- The limited performance of the 20K cooler for the present loads from lower end coolers and instrument

Nevertheless there are ways to recover margin with the present coolers. Evolution of requirements/coolers could relax some of the constraints on the cold stages. Alternative cooling coolers might also be considered. For example, a pulse tube cooler might be replaced by H2 JT sorption cooler or Stirling cooler. As far as low-end coolers are concerned, alternative solutions might be considered in future:

- Replacing 3He sorption cooler with a dilution cooler for NFI-1
- Replacing cADR with dADR for NFI-2

As a result, we recommend to consider development of other coolers in order to consolidate the overall program.

4.2 Passive thermal control

- The passive thermal control for NFI is based on three V-grooves with an area of 7m^2. This concept is inherited from Planck experience
- The thermal control of non-cryogenic instrument is achieved with radiator linked to the focal plane through a thermal strap
- Considering the present design a tilt of Xeus DSC satellite up to 30 degrees is easily achievable

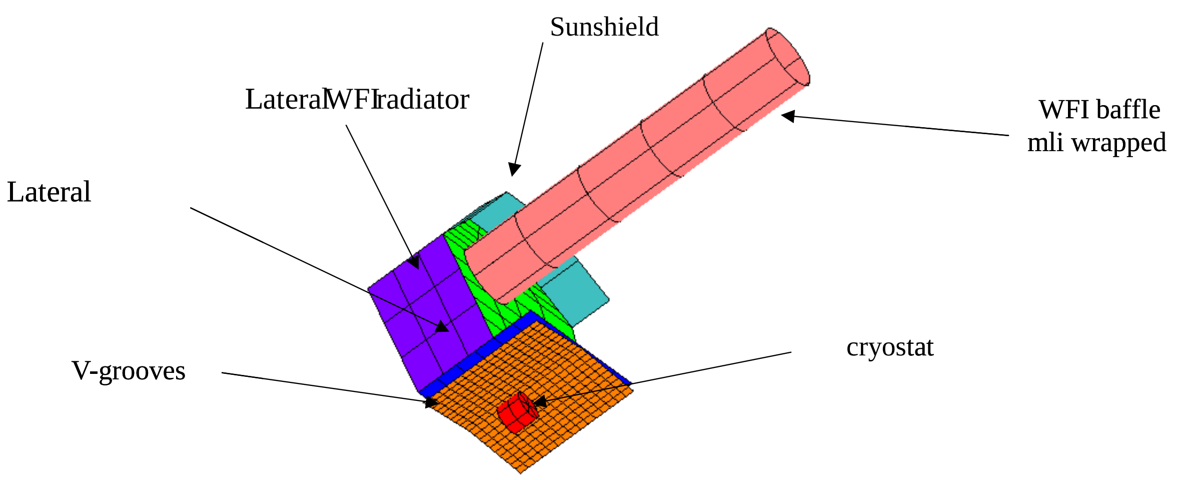


Figure 4-6 : Thermal analysis and optimisation of V-grooves was performed thanks to DSC thermal model

A compact, robust and adaptative thermal control architecture is proposed, coping with any kind of retained cryogenic solutions

- Global architecture is driven by sun constraints and flexibility, i.e.:

- Adjustable Sunshield/Solar Array on front side insulated on rear side with MLI to protect platform and instruments from sun impact
- Adjustable radiative area located lateral and rear sides with adjustable height and rejection capability
- Lateral panel slightly tilted at 10 degrees to avoid solar flux during manoeuvres
- Thermal decoupling from MSC allows future evolution without an impact on technical choices

- Optimal localization of radiators on lateral and rear sides:

- Thermal decoupling of DSC from MSC during all phases
- No radiator on permanently solar exposed sides

5. PROGRAMMATIC ASPECTS & DEVELOPMENT PLAN

➢ The project organisation integrates lessons learned from programs as Herschel / Planck:

- Clear interface between Prime and PI is proposed
- The cryogenic chain has to be managed as a sub-system

➢ The main identified risks are:

- Instrument development and requirements consolidation
- The cryogenic sub-system performance consolidation
- Metrology development and potential impact on PLM design
- Validation of system (MSC + DSC) performances

➢ A PFM development approach is selected, the associated CQM and STM qualification models allow early verification in an effective way in terms of cost and schedule

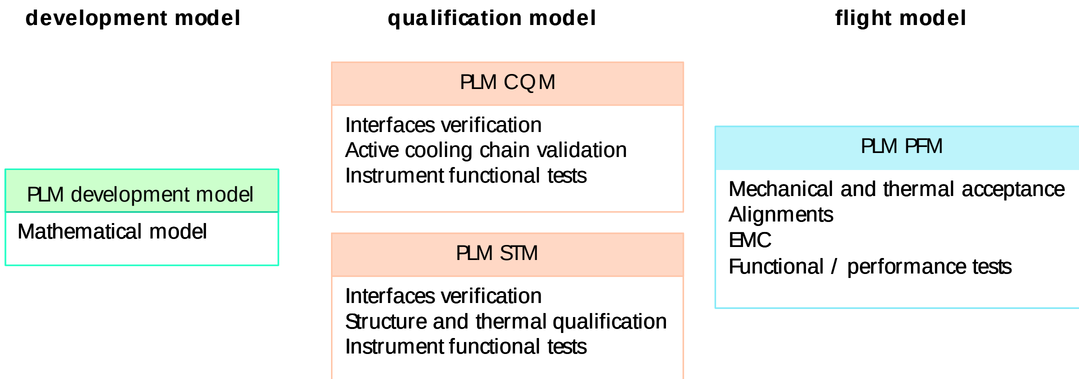
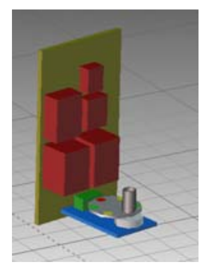


Figure 5-1 PLM development philosophy based on three models CQM, STM & PFM

Interfaces between PIs and Prime

The proposed DSC modular design concept allows to allocate a panels for each instrument



This modular concept lead to propose the following instrument PI/prime interface:

- The prime is responsible for the panel design and the interface specification, The panel with its instrument is integrated on the satellite by the Prime in addition to the long external baffle
- The PI is responsible for the design of instrument (electronics and the cryostat including focal plane, filter wheel). The PI integrates the instrument on its panel and performs functional and performance tests before delivery to the Prime
- For the cryogenic instrument, the cryogenic sub-system manager is responsible for the design, the interface between last stage cooler and focal plane and the qualification of cryogenic sub-system

6. TECHNOLOGY DEVELOPMENT PLAN

> ➢ the identified critical technologies concern the cryogenic system and baffling/shielding

Baffle technology development

In order to demonstrate the suitability of the baffle design regarding X-ray shielding for the current Xeus DSC baseline, three prototypes are envisaged:

- A prototype for the WFI baffle based on Al honeycomb + C skins and Pb absorber

- A prototype for the WFI + HXC baffle based on Ta/Sn/Cu/Al/C multilayer
- A prototype for the baffles based on solid Al + 0.1mm C grading

Those prototypes have to pass the standard qualification tests and additionally they have to be tested by the means of:
- An X-ray facility reproducing the CXB spectra
- X-ray detectors with spectral and signal sensitivity similar to WFI/HXC (in principle the baffle prototypes could be tested using the instrument prototypes)

Coolers technology development

The development approach can be summarised:
- Mature individual blocks not limited to selected cooling chains
- Demonstrators of the selected chains should be initiated in parallel because correlation levels between blocks is of outmost importance

The three main phases are:
- Preliminary phase dedicated to the establishment of specifications.
- Breadboard phase, the main activities are:
  - Development of the most critical coolers of the selected chains with the aim of rapidly manufacturing and testing breadboards
  - Development of a breadboard demonstrator including the above breadboards + breadboards or dummies of the other coolers (V-Groove, 3He sorption cooler).
- Engineering model phase that would consist in manufacturing and testing engineering models of the selected coolers.

Coolers	TRL	Objectives	Activities
cADR	2	Demonstrate performance	- Optimisation of pills assembly - Optimisation of coils - Optimisation of recycling cycle
3He sorption cooler	8	Demonstrate performance with mechanical coolers	Coupling to mechanical coolers
3He Joule-Thomson cooler	5	- Lower min. temperature - Increase cooling power - Decrease load onto upper stages	- Develop Vacuum pump - Develop maxi-compressor - Optimise heat exchangers
Pulse Tube	3	- Increase cooling	- Investigate alternative

cooler		power - Decrease minimum temperature	configurations (e.g. 2-stage) - Optimise regenerators - Optimise cold buffer - Optimise heat intercept assembly - Maxi-compressor

Table 6-1 : Development and optimisation required for the proposed coolers

Other coolers can be graded with high development priority as being part of promising alternative cooling chains:

- Open cycle dilution cooler
- Double stage ADR
- Stirling cooler optimised for high cooling power at 15K
- He or H2 Joule-Thomson sorption cooler

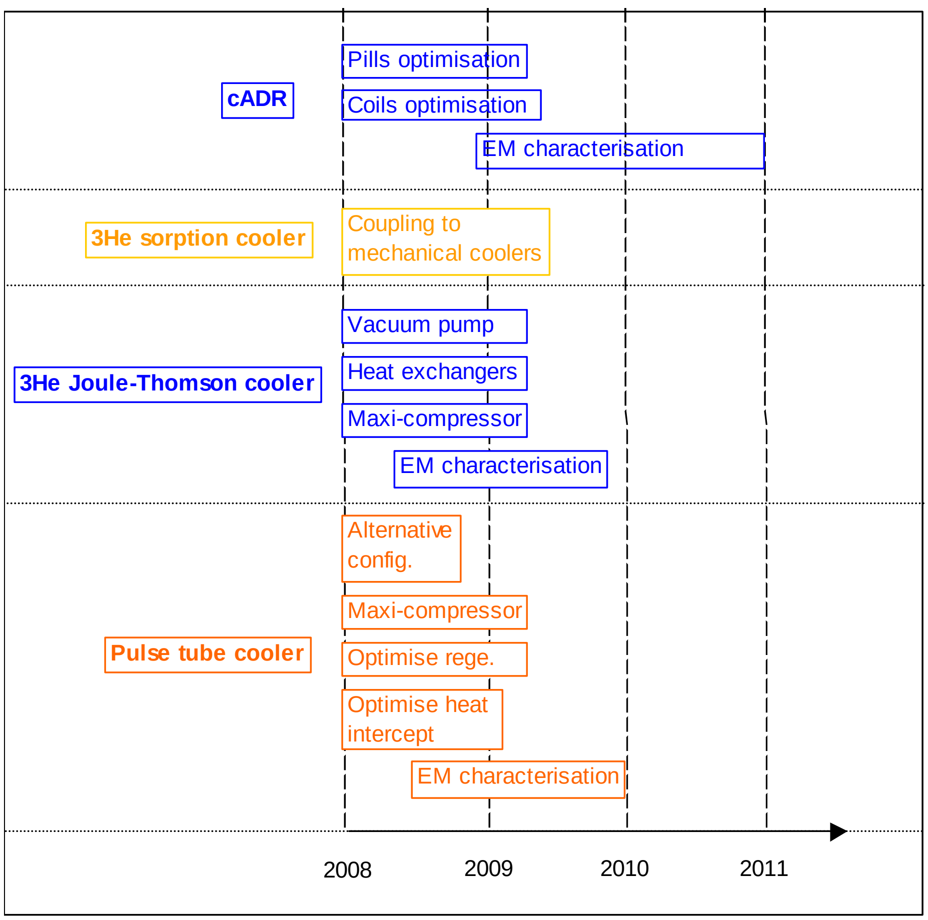


Figure 6-1 : Coolers technology development activities required before DSC B2/C/D phase

7. MAIN CRITICAL ISSUES AND RECOMMENDATIONS

Main critical issues

- Cryogenic chain heat load budget margin
  - Improvement of cooler performances might be needed
  - Interface between the last stage cooler and the NFI focal plane to be studied at an early stage

- Large WFI and HXC external baffle design & accommodation (length about 7.4m)

- MSC / DSC Formation flying
  - need for metrology system that complies with multi instruments management (Ullis sensor is a potential candidate)
  - need for high accurate star tracker (AAME < +/- 1 arc sec)
  - need for thermal and mechanical stability between STR, optical sensor and focal planes in order to comply with pointing requirements => potential problem for accommodation

- DSC mass budget with instruments extended configuration (requirement is < 2 tons)

The preliminary mass budget for core and extended configuration with NFI 1 are given here-below. The data are similar with NFI 2. These budgets illustrate that the extended configuration is critical with regard to mass.

	mass (kg)		center of mass (mm)		
element	nominal	maximal	X	Y	Z
SVM / PLM struct.	770	924	0	50	538
WFI	242	290	462	1455	3216
NFI 1	259	310	-911	-171	919
system margin		*305*			*150*
TOTAL	**1270**	**1829**	-67	242	1275
requirement	< 2000				< 1800

Figure 7-1 : Mass budget for core configuration with NFI1, the total mass is well within the 2 tons limit.

element	mass (kg)		center of mass (mm)		
	nominal	maximal	X	Y	Z
SVM / PLM struct.	970	1164	0	39	775
NFI 1	259	310	-911	-171	919
WFI / HXC	323	388	385	-1228	2901
Xpol	30	36	-870	1257	1569
HTRS	35	42	380	1500	859
system margin		*388*			*150*
TOTAL	**1617**	**2328**	-53	-217	1389
requirement	< 2000				< 1800

Figure 7-2 : Mass budget for extended configuration with NFI1, the total mass exceed the 2 tons limit.

Main recommendations for cryogenic sub-system

- The H/P experience leads to consider the cryogenic chain as a sub-system with a dedicated manager
- Cryogenic coolers pre-development are necessary to confirm the performances and required margins at the different stages of cryogenic chain.
- Due to the strong correlation level between all coolers, coupled tests are necessary, at least from 20K down to the minimum temperature

Main general recommendations

- The metrology will have to be defined early in the program because of its potential impact on PLM design. Pointing budget has to be consolidated
- Data rates and measurement scenario have to be defined in order to consolidate mass memory and data transmission need
- The thermal performances of PLM passive stage have major impacts on the cryogenic system. These performances have to be verified at an early stage of the program. Fourth V-groove efficiency might be considered
- Straylight analysis with a complete model of DSC + MSC has to be achieved early in the program to issue recommendations with regard to surface properties selection and geometry
- Structural analysis is necessary to consolidate the design and to analyze the large external baffles constraints

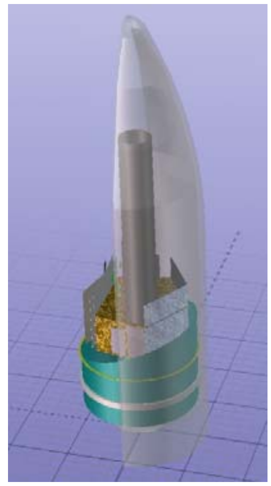


Figure 7-3 : XEUS stacked configuration in Ariane 5 long fairing: DSC is fixed on MSC central tube through a release mechanism

8. CONCLUSIONS

- The XEUS DSC PLM accommodation study took advantage of cryogenic Herschel/Planck programs experience and formation flying development studies to demonstrate the DSC feasibility with core payload (WFI + NFI)

- DSC extended configuration might be considered: HXC grouped with WFI, one NFI, XPOL and HTRS

- The main critical items are:
  - The NFI constraints: focal plane and wiring
  - The cryogenic chain
  - The large size of X-ray baffles