A European consortium for a LUVOIR UV instrument

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12 Jan. 2017

Agenda

- Context
- Phase 0 Study Goals
- LUVOIR NASA short term planning
- Concept Maturity Level Metric
- CNES participation
- Organigram
- Work Breakdown Structure
- Retro planning
- Consortium
- Work organisation
- LUMOS
- Open points (for discussion)

Context

- CNES is willing to support the participation of French space laboratories to LUVOIR study, scientifically and technically,
- The UV instrument could be an opportunity for European Scientists/Labs to be part of US LUVOIR mission, build on previous studies and to provide specific expertise (i.e. spectro-polarimetry)
- CNES, via PASO department, is willing to lead/manage a "Phase 0" technical study, with a consortium of French and European laboratories.
- The conceptual study conducted by CNES could serve as a support for a future ESA contribution.

Phase 0 Study Goals

- Take the opportunity to be part of the US LUVOIR mission,
- Define the scientific goals and interests for a European UV spectro-polarimeter,
- For each telescope size (9 and 16m), study different instrument architectures consistent with the scientific requirements range (CML3 at the end of 2017),
- Identify needed technologies and criticities
- For each telescope size,
  - select the design reference mission,
  - assess the feasibility and the risks drivers, the needed technologies maturity and their development plan, and provide an estimate of the costs of each chosen design reference mission
    - (CML4 August 2018)

LUVOIR NASA short term planning

- **M3 Complete Concept Maturity Level 2 Audit** **February 2017**
  –Identify, quantify and prioritize technology gaps for 2017 technology cycle

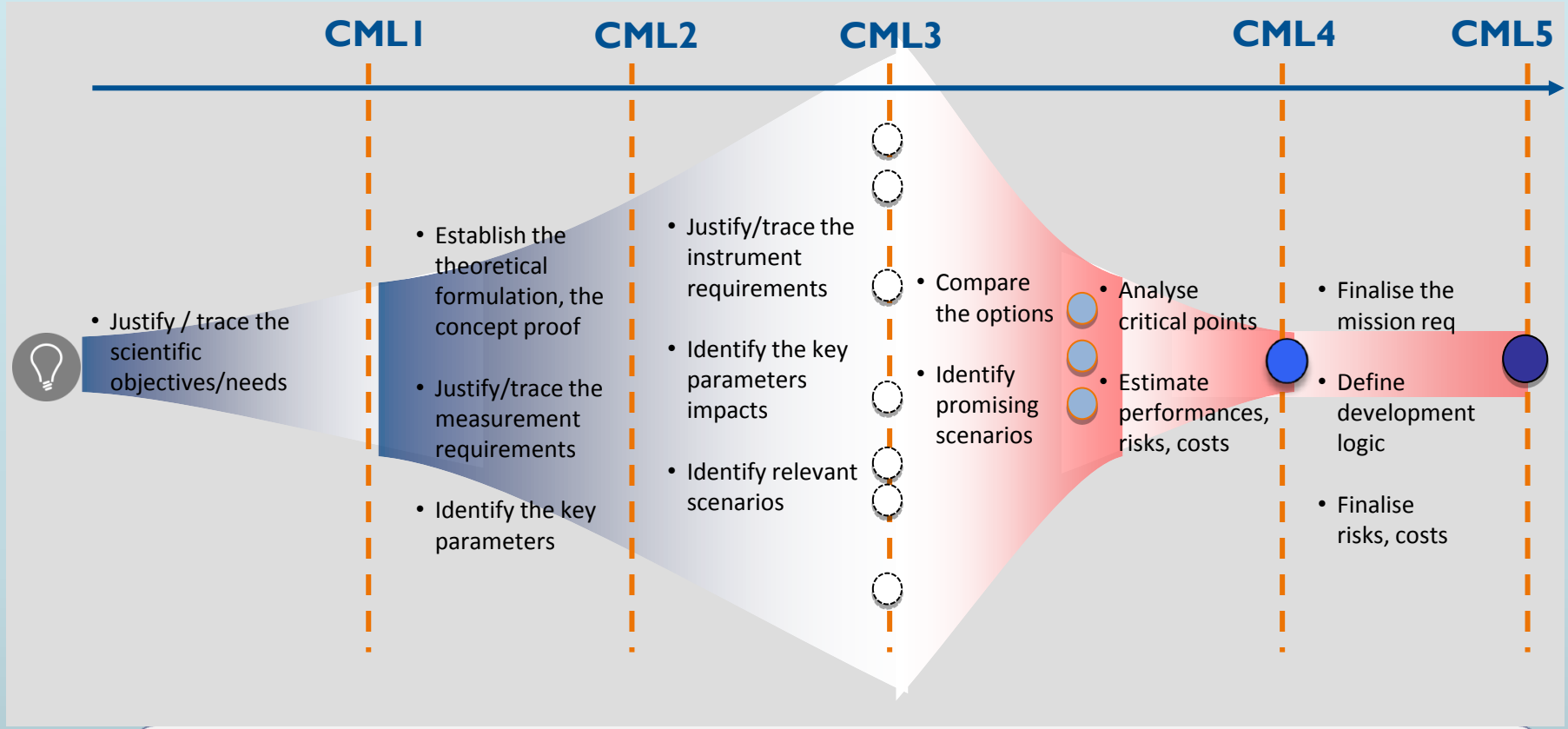
- **M4 Interim Report - Concept Maturity Level 3** **December 2017**
  –Deliver initial technology roadmaps; estimate technology development cost/schedule

- **M5 Update Technology Gap Assessments** **June 2018**
  –In support of 2018 technology cycle

- **M6 Complete Decadal Concept Maturity Level 4 Audit and Freeze Point Design** **August 2018**
  –Support independent cost estimation/validation process

- **M7 Final Report** **January 2019**
  –Finalize technology roadmaps, tech plan and cost estimates for technology maturity

Concept Maturity Level (CML) metric



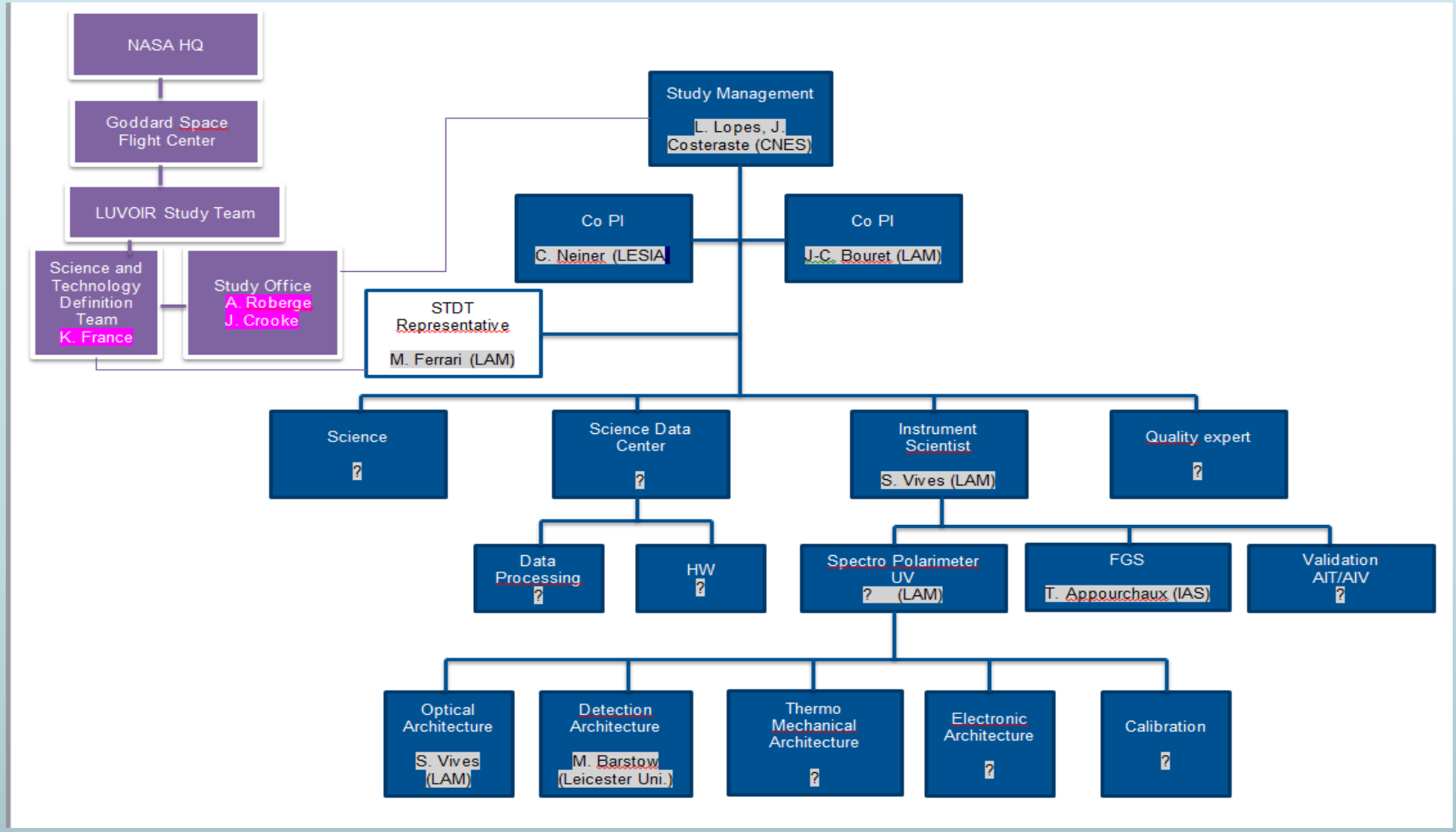
Concept Maturity Level (CML) metric

Attribute	CML 2	CML 3	CML 4
Instrument System Design	One sentence description of potential measurement technique(s) Perform high-level comparison to similar measurement technique(s)	Key instrument performance requirements, measurement techniques and instruments selected against science / mission objectives, cost & risk Sensitivity studies to bound performance within trade space performed	Instrument system architecture for design reference mission defined with mechanical configuration drawings and block diagrams to support instrument flowdown requirements and performance simulations Instrument performance requirements traced to scientific requirements

CNES participation

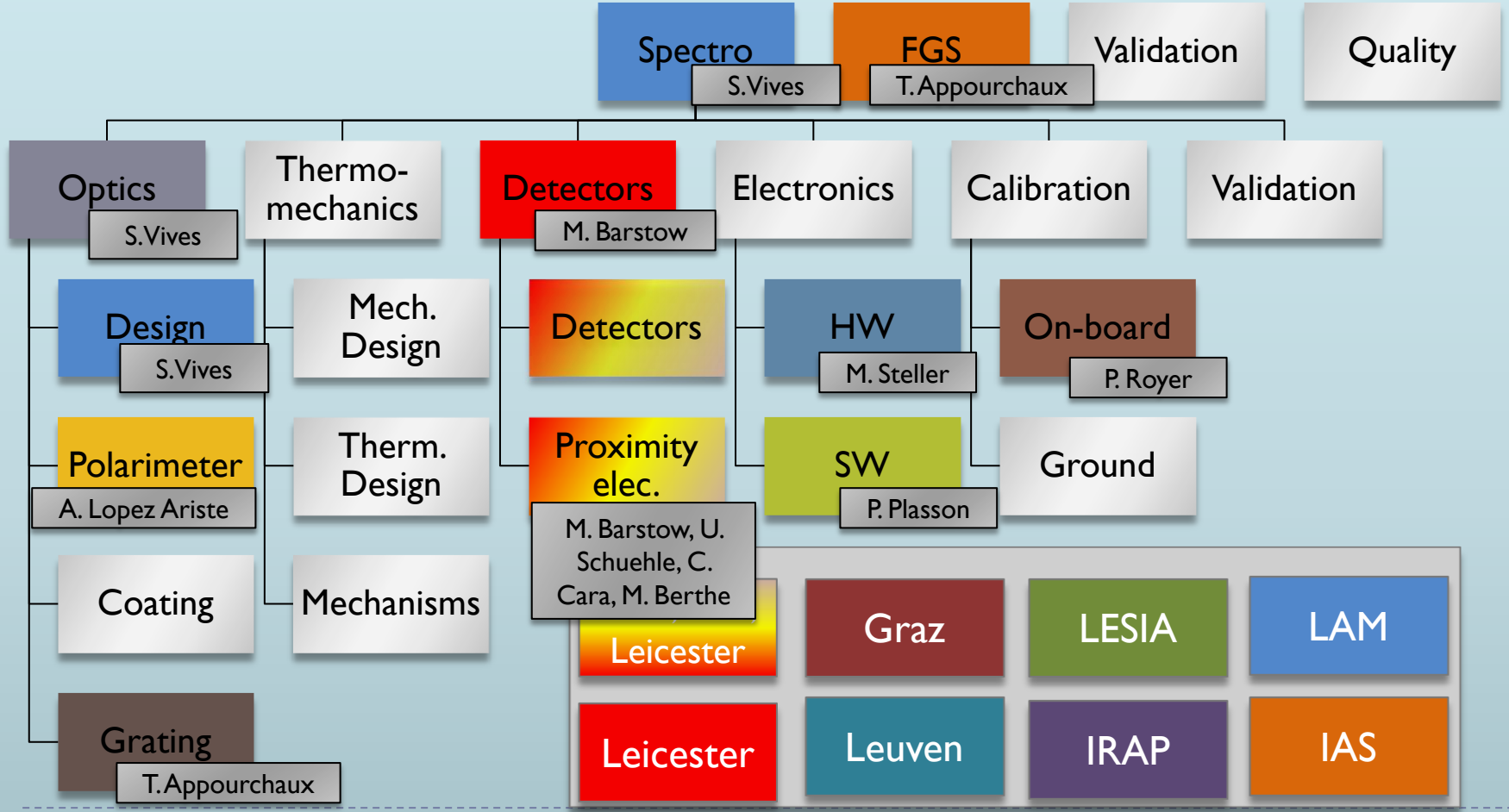
- CNES is willing to act as a facilitator
- CNES potential fields of interventions :
  - Study coordination, management
  - Mission / system support
  - Technical experts for advice
  - Interface link with US team

Organigram


NASA HQ
Goddard Space Flight Center
LUVOIR Study Team
Science and Technology Definition Team
K. France
Study Office
A. Roberge
J. Crooke
Study Management
L. Lopes, J. Costeraste (CNES)
Co PI
C. Neiner (LESIA)
Co PI
J-C. Bouret (LAM)
STDT Representative
M. Ferrari (LAM)
Science
?
Science Data Center
?
Instrument Scientist
S. Vives (LAM)
Quality expert
?
Data Processing
?
HW
?
Spectro Polarimeter UV
? (LAM)
FGS
T. Appourchaux (IAS)
Validation AIT/AIV
?
Optical Architecture
S. Vives (LAM)
Detection Architecture
M. Barstow (Leicester Uni.)
Thermo Mechanical Architecture
?
Electronic Architecture
?
Calibration
?

Preliminary WBS

WP to be defined with architects

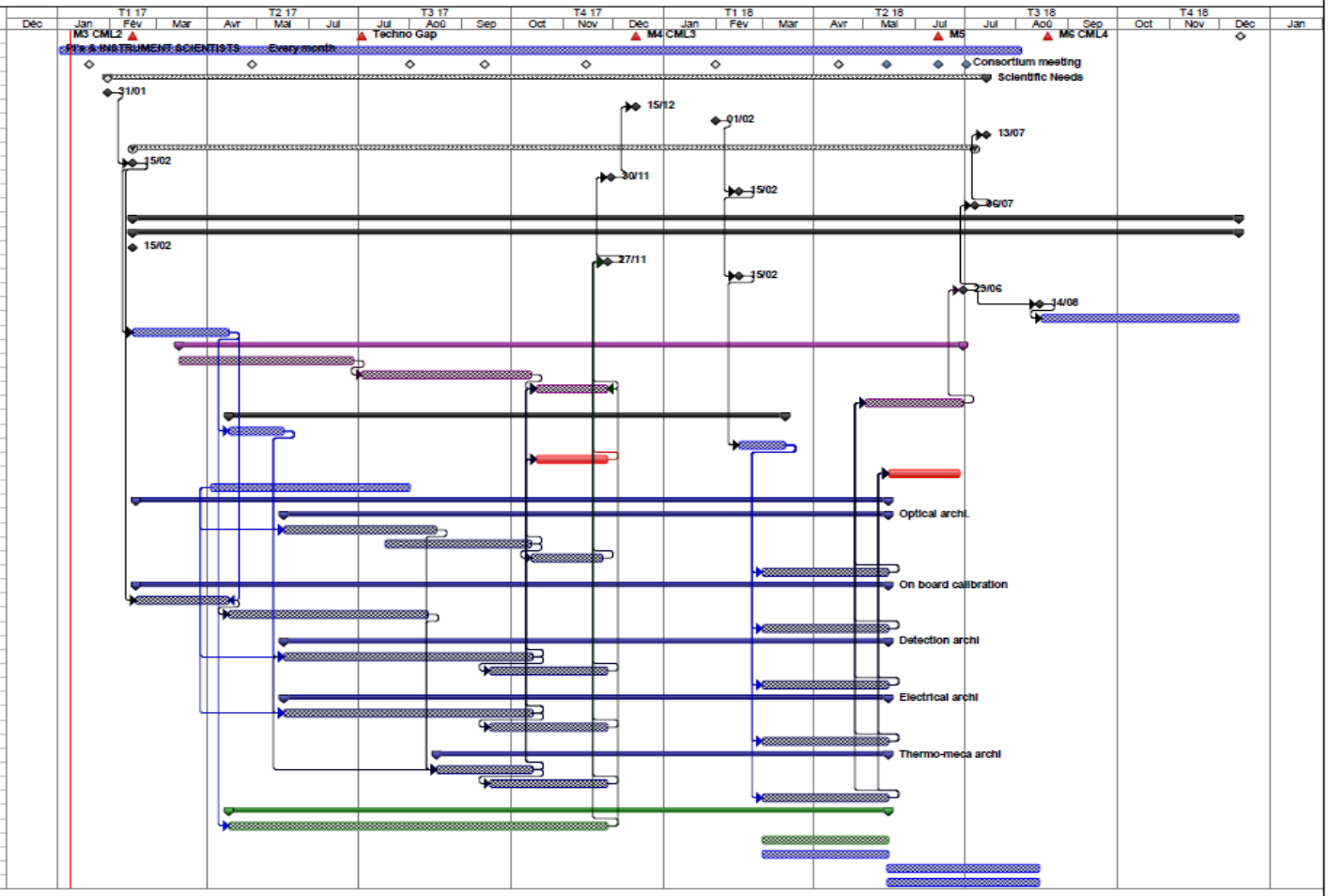


Retro planning

09/01/17

LUVOIR Spectrometer Schedule

N°	Nom de la tâche	
1	NASA	
8	PI's & INSTRUMENT SCIENTISTS	Every month
9	Consortium meeting	
20	Scientific Needs	
21	S1	
22	S2	
23	S3	
24	S4	
25	Measurement Needs	
26	N1	
27	N2	
28	N3	
29	N4	
30	Instrument	
31	Instruments Points & report	
32	I1	
33	I2	
34	I3	
35	I4	
36	I5	
37	Report	
38	First sizing	
39	Performances	
40	Tools	
41	Budget 1	
42	Budget 2	
43	Budget 3	
44	Sizing elements	
45	Sizing elements part 1	
46	Sizing elements part 2	
47	Architectures	
48	CIC	
49	Interfaces	
50	Architectures	
51	Optical archi.	
52	Sizing	
53	Tolerances	
54	Critical points	
55	Optical archi. Part 2	
56	On board calibration	
57	Needs	
58	Design	
59	On board calibration part 2	
60	Detection archi	
61	Detection archi sizing	
62	Critical points	
63	Detection archi part 2	
64	Electrical archi	
65	Electrical archi sizing	
66	Critical points	
67	Electrical archi part 2	
68	Thermo-meca archi	
69	Thermo-meca archi sizing	
70	Critical points	
71	Thermo-meca archi part 2	
72	Verification-validation	
73	Verification-validation v1	
74	Verification-validation v2	
75	Ground segment	
76	Cost	
77	Risk	



Document élaboré par MI-GSO

Consortium

- How will the different laboratories contribute to the study ?

To be discussed

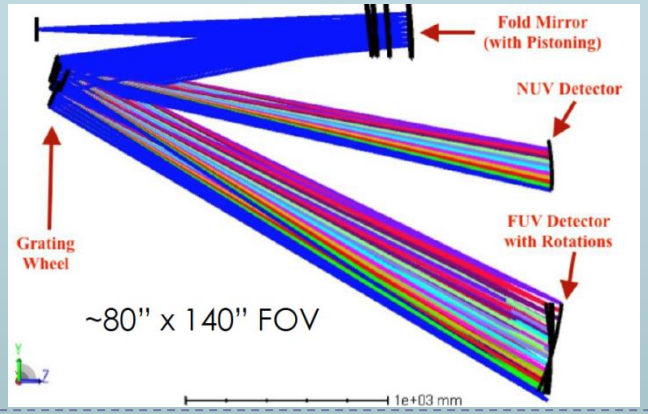
  - Types of interventions
  - Human ressources
  - Financial ressources
  - Directorate approval / national agency support

Work Organisation

- Regular meetings
  - Monthly meetings :
    - Participants : Study Management, Co PIs, Instrument Scientist, STDT representative, CNES Responsible for Astrophysics
  - Every 3 months (TBC) workshops :
    - Participants : all the consortium team
  - On-request meeting :
    - Anybody, anytime, in case of need : contact study manager
- Common website to exchange information
- Any suggestion ?

LUMOS /1

- LUMOS is one of the 3 instruments of the strawman payload
- Complementarity explicitely requested
- LUMOS = LUVOIR Ultraviolet Multi-Objects Spectrograph
- Lead: Kevin France (Colorado)
- Multi-channel instrument:
  - HR point source spectrograph
  - MO imaging spectro MR and LR
  - Under discussion: Near UV IFU + Near-UV & Far-UV imaging mode



LUMOS /2

- Spectral band: 100(90)-400nm
- Spectral resolution:
  - ~~HR: 120 000~~
  - MR: 15 000 – 50 000
  - LR: 5 000 – 15 000
- FoV (multi-object): 2'x2' (3'x3')
- Resolution: 50mas (30mas)

Open points (for discussion)

- Our planning : best effort based on NASA one.
  - Should we do differently ?
  - Do we have to stick with the NASA milestones?
  - shall we propose our own schedule ?
- What are the US specs regarding our instrument ?
  - At least size and mass as this seems already estimated.
- WRT LUMOS (US UV instrument) : how shall we work ?
  - Two independents paralell studies ?
  - Depth of interaction ?
  - Meaning of the complementarity with LUMOS?

Open points (for discussion)

- Simulation tools : UVMAG Arago simulation tool possible adaptation ?
- Instrument costs boundaries (ESA ?) : which cap do we have to consider ?

Back up Slides

CML / 1

Attribute	CML 2	CML 3	CML 4
Scientific Objectives and System Requirements	Objectives described to levels that allow comparison with previous investigations and NASA science community documents	Objective linked to investigation and measurements Scientific return as a function of cost, risk, and programmatics quantified	Working top-level scientific requirements drafted, linkages to scientific objectives identified and described Design reference scientific investigation defined with viable reduction options identified
Science Data System	Identify science data drivers	Science data rates and volume included in trade space analysis	Design reference science data system sized to support data system flowdown requirements
Mission Development	Key mission concept parameters and performance requirements quantified Rudimentary calculations & comparisons to mission analogues performance Gross characterization of space environment quantified	Alternative set of mission architectures evaluated against science objectives, cost & risk Quantitatively bounded hazards of space environment	Design reference mission defined, including driving requirements, initial high-level scenarios, timelines and operational modes; mass, delta-V, and power estimates; telecom, and data processing approach defined to mission flowdown requirements
Spacecraft System Design	Key flight elements, design parameters & performance requirements listed High-level comparison to similar flight systems documented	Unique features that distinguish one flight system architecture from another evaluated Perform sensitivity studies to bound performance within trade space performed	Spacecraft system architecture for design reference mission defined with mechanical configuration drawings and block diagrams to support spacecraft flowdown requirements

CML / 2

Attribute	CML 2	CML 3	CML 4
Instrument System Design	One sentence description of potential measurement technique(s) Perform high-level comparison to similar measurement technique(s)	Key instrument performance requirements, measurement techniques and instruments selected against science / mission objectives, cost & risk Sensitivity studies to bound performance within trade space performed	Instrument system architecture for design reference mission defined with mechanical configuration drawings and block diagrams to support instrument flowdown requirements and performance simulations Instrument performance requirements traced to scientific requirements
Ground System / Mission Operations System Design	Mission ops approaches defined	Mission ops drivers and sensitivities assessed Major flight / ground trades identified New ground system capabilities identified	Mission Operations System / Ground Data System architecture for design reference mission to support the ops scenarios described
Technical Risk Assessment & Management	Identify risks Identify areas of major concerns	Compare risks across the various architectures Identify mitigation strategies for key risks	Risk drivers listed 5x5 matrix provided with relevant risk drivers (include selected mitigation / development options)
Technology	Identify enabling technologies and / or significant engineering developments required to get to TRL 6 by PDR	Compare technologies and major developments required for design options across the trade space	Technology options described Baseline options selected and justified (technology roadmap) Rationale for TRL(s) explained Risk mitigations (including fallback options, if any) for all new technologies identified

CML / 3

Attribute	CML 2	CML 3	CML 4*
Inheritance	Identify source of assumed inheritance	Early evaluation of inheritance options, benefits, and risks across trade space	Discuss all significant heritage assets used by the design reference mission
Master Equipment Lists	N/A	Mass of major elements quantified based on subsystem estimates	MEL documented for design reference mission to assembly level (e.g., antenna, propellant tank, star tracker, etc.)
Technical Margins	Identify high risk areas that need significant margin Assess uncertainty	Use institutional margins where applicable Analyze best and worst case scenarios	Critical performance margins estimated, resource margin estimated for design reference mission (AIAA S-120 margin policies followed)
System Engineering	Initial generation of trade space options	Capture the relative merits of performance, cost and technical risk over a broad range of architectures Subsystem dependencies identified	Selective, high-leverage science, spacecraft, and ground system trades completed
Launch Services	Launch approach and performance identified	Perform trades for candidate launch vehicles demonstrating compatibility with performance and fairing size	Preliminary launch vehicle(s) selection documented (NASA Launch Services used)

CML / 4

Attribute	CML 2	CML 3	CML 4*
Verification & Validation	N/A	Identify any major or unique V&V activities	Approach for verifying new and enabling functions of the design reference mission defined to support an acceptable risk assessment by independent reviewers System testbeds and prototype models identified where applicable
Acquisition & Surveillance	N/A	N/A	N/A
Project Organization, Implementation Mode & Partnering	N/A	N/A	N/A
Schedules	Potential launch opportunities identified Use Schedule & Cost Rules-of-Thumb to estimate lifecycle duration	Assess variations and risks to science, development schedule and impacts to mission duration	Top-level schedule (one page) developed for design reference mission to support (coarse) independent cost estimates

CML / 5

Attribute	CML 2	CML 3	CML 4*
Work Breakdown Structure	N/A	NASA Standard WBS & Dictionary (down to level 2 and level 3 for spacecraft and payload) used	N/A
Cost Estimation and Cost Risk	Cost estimate range provided based on analogous missions Cost uncertainty quantified	Cost sensitivities explored across trade space as a function of major drivers Initial estimate down to level 2 and level 3 for spacecraft and payload Cost uncertainty quantified System cost risks identified	Cost estimate and basis of estimate provided for design reference mission Cost uncertainty quantified Cost risks identified at subsystem level, with emphasis on enabling technologies
NEPA Compliance	Identify any nuclear material or public safety issues	Explore options (e.g., non-nuclear options for nuclear power missions)	N/A
Export Compliance	N/A	N/A	N/A

* Tailored CML4 = Decadal CML

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