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LETTERSS

# Lead-free Transition for the European Space Sector (LETTERSS): a new EU-funded R&D project

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Content:

1. Background
2. LETTERSS Project
3. Main results expected

# LETTERSS BACKGROUND

- **2003**: The RoHS directive was approved and took effect on 1 July 2006. The Space Industry was 'Out of Scope'
- **2006-2018**:
  - The European Space Sector (TESS) understood there could be an obsolescence risk for leaded solder paste.
  - In addition the strong and growing interest in COTS, where the finishes are Pb-free, added urgency for TESS to act.
  - But the actions were uncoordinated and the budgets wholly insufficient, many were waiting for others to solve the problem and then use the results
- **2018**: Inclusion of **Pb-metal** in the **REACH Candidate List** of SVHCs for Authorisation and here the Space Industry has to comply


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# LETTERSS BACKGROUND

- **2018: :** TESS finally addressed the issue at the SCSB, and agreed that a coordinated approach was needed. It launched a Task Force with the mission of delivering a consensual Roadmap for the Lead Free Transition for TESS. All TESS stakeholders were represented including an EDA observer.
- **2018-2020**: The Task Force delivered the Roadmap which was widely distributed to all funding bodies, including the EC.
- **2020-2023**:
  - ESA, CNES, and perhaps others, funded some activities with small budgets vs. the estimated cost for the transition.
  - The EC retained the subject in the 2022 Horizon call, but no projects retained, and then again in 2023 when LETTERS was retained and funded.


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# LETTERSS BACKGROUND: UPDATE

- **2018: :** Inclusion in REACH Candidate List ➔REACH Art. 33 and WFD/SCIP reporting above 0.1% w/w in articles
- **2022**: ECHA recommended lead for inclusion in REACH Annex XIV (Authorisation List) ➔ **If confirmed by the EC**, lead will be ultimately banned for everybody ➔ Lead-free transition for the European Space Industry is mandatory from a regulatory standpoint
- **2024**: The European Commission has clarified in June 2024 that it "is not obliged to follow this recommendation and does not intend to include lead in the authorisation list" .
- **2025**: For electronics the main relevant restriction for lead remains RoHS (Directive 2011/65/EU) which is under review. But we still have : Exclusion for "equipment designed to be sent into space" (Art. 2(4)(b))


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# LETTERSS BACKGROUND: UPDATE

- **Lead is still allowed to be used in the production of space hardware today and in the foreseeable future**
- **However, lead is targeted by various other regulatory measures (e.g. RoHS, Batteries, update of REACH Annex XVII Entry 63) which may create indirect risks for the space sector**

- The regulatory pressure to go lead-free for the European Space Sector has all but vanished
- It remains the obsolescence pressure: Will SnPb solder paste become unavailable ?


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# LETTERSS BACKGROUND: UPDATE

**In view of this situation, space manufacturers should conduct a comprehensive risk-benefit analysis addressing these critical factors before transitioning from SnPb to lead-free assembly lines**



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# LETTERSS PROJECT
## ID Card

| ACRONYM | LETTERSS |
|---|---|
| HORIZON EUROPE CALL | HORIZON-CL4-2023-SPACE601 |
| IMPLEMENTING AGENCY | Health and Digital Executive Agency |
| FUNDING INSTITUTION | European Commission, EU Space R&D Programme |
| HORIZON EUROPE SPACE TOPIC | Critical Space Technologies for EU non-dependence |
| TYPE OF ACTION | RIA |
| START DATE | 01 January 2024 |
| DURATION | 36 months |
| FUNDING | 2.7 million € |
| COORDINATOR | SCALIAN OP |
| CONSORTIUM | 11 Partners |


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# LETTERSS PROJECT

## Consortium

The Consortium is built around **11 partners from 4 different countries** selected for their high quality and expertise in the field of space-based systems, components procurement and testing and materials research with:

- **Two major industrials end-users**: ADS-FR and TAS-FR
- **Three equipment manufacturers**: TESAT, TAS-ES, SODERN
- **One service provider in engineering**: ALTER
- **One electronic test house** : HTV
- **One research institute** : IRT
- **One university**: TU-DA
- **One expert in EU regulations** : REACH
- **One expert in Project Management** : SCALIAN OP

| # | Short Name | Participant Organization Name | Coun |
|---|---|---|---|
| 1 (COO) | SCALIAN | **SCALIAN OP** | FR |
| 2 | ADS-FR | **AIRBUS DEFENCE AND SPACE SAS** | FR |
| 3 | ALTER | **ALTER TECHNOLOGY TUV NORD SAU** | ES |
| 4 | IRT | **IRT ANTOINE DE SAINT EXUPERY** | FR |
| 5 | SODERN | **SODERN SA** | FR |
| 6 | TAS-FR | **THALES ALENIA SPACE FRANCE SAS** | FR |
| 7 | TAS-ES | **THALES ALENIA SPACE ESPANA SA** | ES |
| 8 | TESAT | **TESAT SPACECOM GMBH & CO.KG** | DE |
| 9 | TU-DA | **TECHNISCHE UNIVERSITAT DARMSTADT** | DE |
| 10 | HTV | **HTV CONSERVATION GMBH** | DE |
| 11 | REACH | **REACHLaw** | FI |



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# LETTERSS PROJECT
## Advisory Board

- The project also established an Advisory Board.
- The Board is composed by other Space stakeholders, mainly Space Agencies, which complete the overall project vision and aims, providing guidance as needed.
- Their support will be instrumental for a wide acceptability of the results of the Project.

| EEAB | Advisory Expert |
|---|---|
| ESA | Gianni COROCHER |
| CNES | Pierre ROUMANILLE |
| DLR | Hans-Dieter HERRMANN |
| EDA | Benoit MICHEL |
| JAXA | Suzuki KOICHI |

Discussion ongoing


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# LETTERSS PROJECT
## Objectives

### Objectives:

- Find solutions to the issues that slow down using COTS with existing SnPb Assembly Technology (WP2)
- Finding and validating suitable replacement(s) for the SnPb solder, workhorse of the Space Electrical Assembly for 60 years (WPs 3 and 4)
- Reducing the risks of the Pb-free transition by advancing the state-of-the- art in our understanding of Tin-whisker formation and growth. (WP5)


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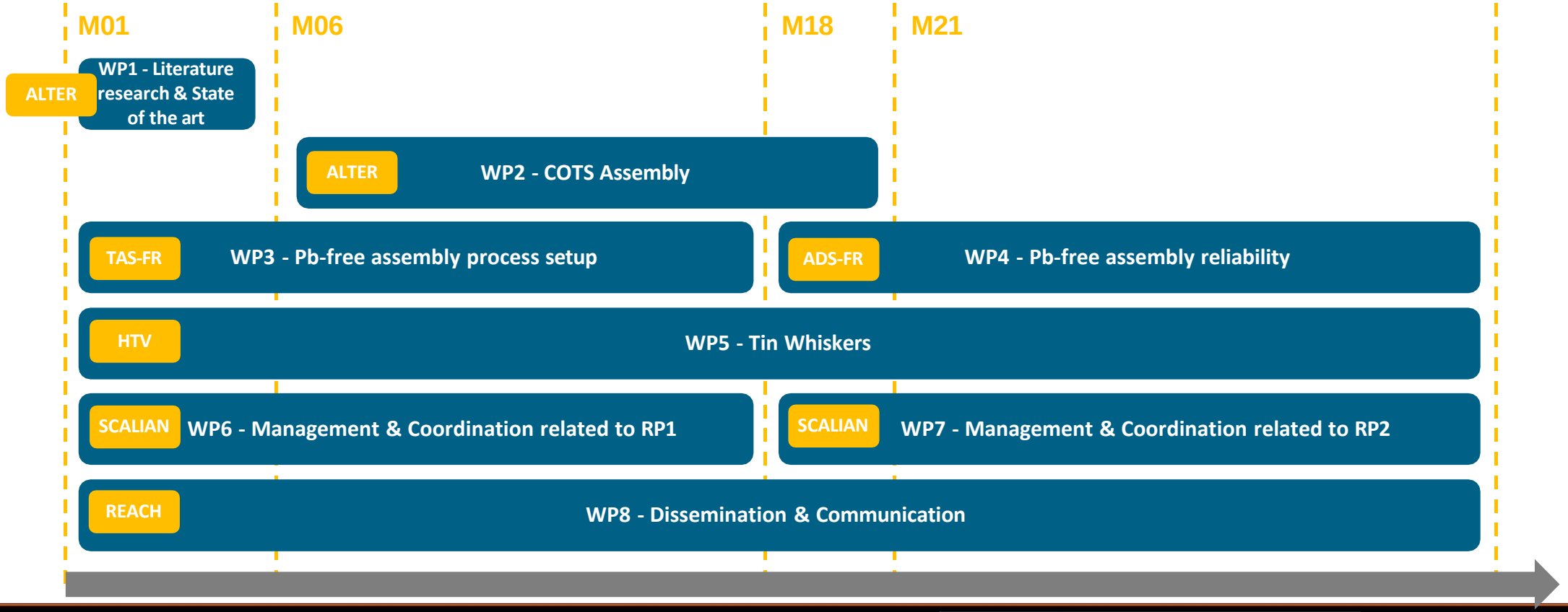
# LETTERSS PROJECT
## Project Organization



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# LETTERSS PROJECT
## Work Package 2, COTS Assembly

- The WP2 objective is to identify the bases to reliable assemble and use COTs, with the standard Pb-free finishes, on standard leaded PCBs and using tin lead solder pastes. Moreover, the bibliography review and the gathered knowledge will support the tailoring proposal on related requirements in ESCC specification and ECSS standards. Include actions needed to use COTs with the standard SnPb Assembly Process on standard leaded PCBs
- The results of WP2 will have immediate impact on the relevant standards as explained in section 2.2. The recommended standards or specification tailoring will be presented to the proper ECSS and ESCC bodies, following their applicable rules, for its consideration and implementation. The results of WP3 and WP4 will be presented at the end of the project when they will be available
- A key consideration is that the main and only purpose of WP2 is to generate the additional reliability data **necessary** to update the standards that block the use of COTS with existing SnPb Assembly Lines


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# LETTERSS PROJECT
## Work Packages 3 & 4, Pb-free assembly

- These WPs represent the core of the Project and its results will have the most impact in the European Space Sector
- Key challenges will include test vehicle and test plan designs.
- The most important result will include the understanding of the behaviour, degradation and failure mechanisms of the solder alloys in the operative environment for space applications. This has not been published yet.


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# LETTERSS PROJECT
## Work Packages 3 & 4, Pb-free assembly

- The project contemplates the full evaluation of two lead-free solders.
- One, SAC305, was already chosen at the proposal level. This choice is well-founded, given its established performance in aeronautic and space products.
- The choice of the second solder paste took longer than expected, two main sets of requirements emerged during the selection process:
  - **High-Performance Backup to SAC305**: Some end-users advocated for a solder paste like Innolot, which is designed to be a high-reliability alternative to SAC305.


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# LETTERSS PROJECT
## Work Packages 3 & 4, Pb-free assembly

- **High-Performance Backup to SAC305**: Some end-users advocated for a solder paste like Innolot, which is designed to be a high-reliability alternative to SAC305.
- **Lower Melting Temperature and Improved Reparability**: Other end-users preferred a solder paste with:
  - Lower melting point (below approximately 210°C)
  - Improved repair capabilities
  - Reduced thermal stress on components and PCBs during assembly and rework


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# LETTERSS PROJECT
## Work Packages 3 & 4, Pb-free assembly

**After careful consideration and debate, the end-users collectively chose the second set of requirements. This decision was influenced by several factors**

- **Thermal Management**: Lower melting point solders can significantly reduce thermal stress on sensitive electronic components and PCBs during assembly and repair processes.
- **Minimise the extent of warpage for ADD (Advanced Digital Devices) plastic packages**: Thermal stress reduction, minimized package warpage, improved joint reliability, preservation of package integrity
- **Rework Considerations**: Improved repair capabilities are crucial for space hardware, where post-assembly modifications or repairs might be necessary.
- **Versatility**: A lower melting point solder offers more flexibility in assembly processes, especially for temperature-sensitive components.
- **Energy Efficiency**: Lower reflow temperatures can lead to reduced energy consumption in manufacturing processes.


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# LETTERSS PROJECT

## Work Packages 3 & 4, Pb-free assembly

**Once the choice of a lower temperature paste was made, we had to choose the composition and we chose a bismuth  based composition . The advantages are:**

- **Bismuth alloys like Sn42Bi57Ag1** melt between 138–140°C, significantly lower than SAC305 (217–220°C).
- **Fatigue resistance:** Sn42Bi57Ag1 matches or exceeds SnPb alloys in shear strength and creep resistance
- **Thermal cycling reliability**: Bismuth alloys perform well in tests
- **Reduced copper dissolution**: Minimal copper leaching compared to SAC alloys
- **Compatible with existing SnPb assembly lines**, avoiding costly infrastructure changes

**However Bismuth forms a low-melting eutectic (96°C) with lead, risking joint failure if Pb residues exist**



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# LETTERSS PROJECT
## Work Package 5, Whisker formation and growth

- There is no consensus within the Space Sector on the risk due to whiskers. Some people think that today the risk is low/acceptable while others don't agree. It also depends on the type of program.
- The debate is not settled since we do not know the activation energies in order to design accelerated tests that will help to close the debate.
- There was a lot of research in 2000-2010 when most industrial sectors transitioned to Pb-free. Today only Space and other HiRel sectors are interested.
- LETTERS aims to advance our understanding on the whisker formation and growth in order to establish an accelerated test approach for whiskers formation in space application.


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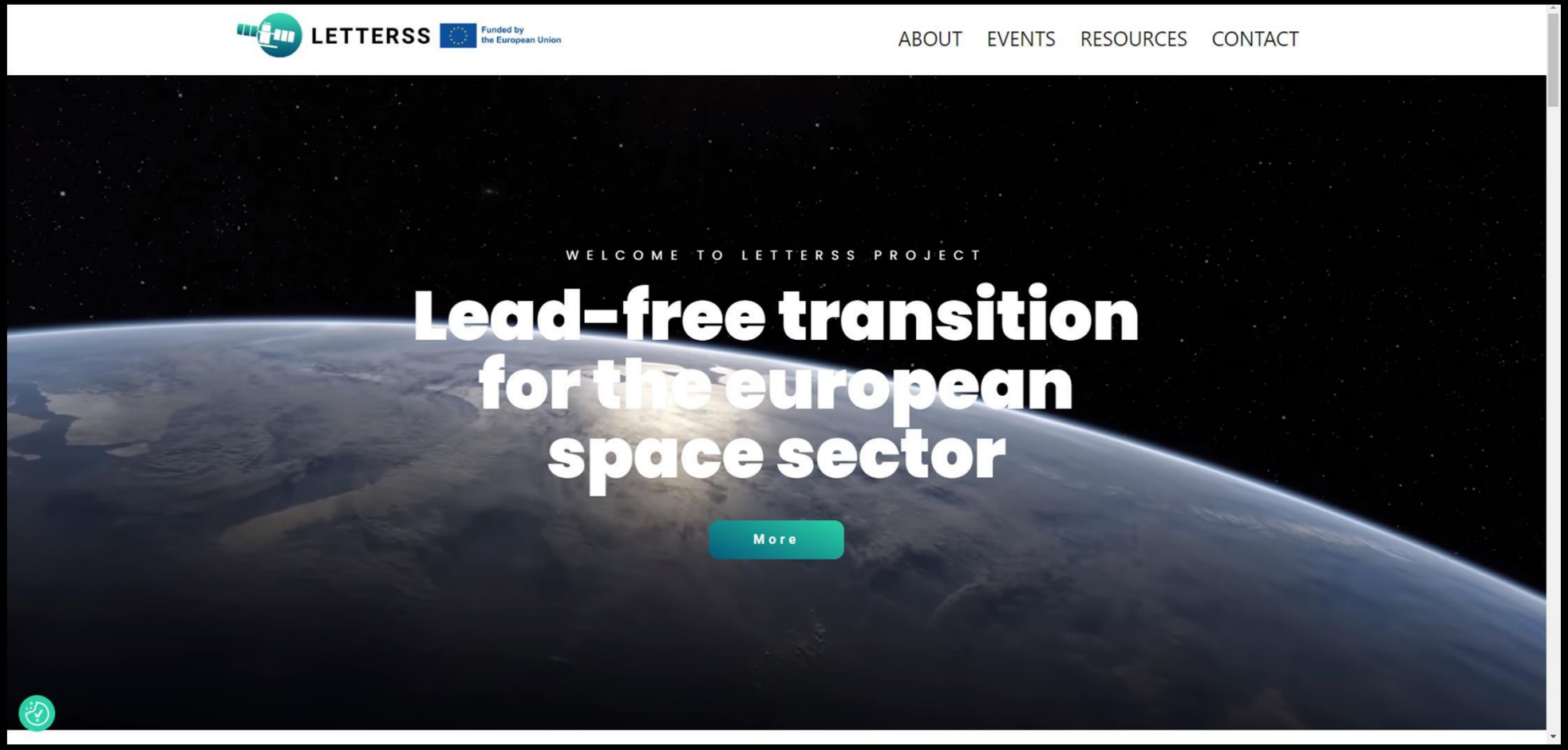
https://letterssproject.eu/



# LETTERSS PROJECT

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- HORIZON EUROPA CALL: HORIZON-CL4-2023-SPACE-01
- CONTRACT NUMBER: 101135428


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