**Grant Agreement no. 640174**

# PHySIS

## Sparse Signal Processing Technologies for HyperSpectral Imaging Systems

**INSTRUMENT: Bottom-up space technologies at low TRL**
**OBJECTIVE: COMPET-06-2014**

## *D1.2 Risk Assessment Procedure*

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| **Dissemination Level** | | |
| **PU** | Public | ✓ |
| **PP** | Restricted to other programme participants (including the Commission Services) | |
| **RE** | Restricted to a group specified by the consortium (including Commission Services) | |
| **CO** | Confidential, only for members of the consortium (including Commission Services) | |

## Document History

| Issue Date | Version | Changes Made / Reason for this Issue |
|---|---|---|
| 20 June 2015 | V0.1 | Initial draft |
| 30 June 2015 | V02 | Final version with all partner input included |
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## Contents

# 1. Introduction

## 1.1. Scope

In deliverable D1.2 of WP1, we provide an outline of the key risks associated with each WP, the importance, and the impact of these risks on the success of PHySIS. Furthermore, we provide actions that should/will be taken in order to avoid these risks, as well as actions that will be taken in order to mitigate the impact of failures.

## 1.2. Purpose

The purpose of this deliverable is to act as a living document that will specify both known as well as unexpected risks that could endanger the success of PHySIS.

## 1.3. Applicable documents

[AD 01] PHySIS_Proposal-SEP-210155336

## 1.4. Referenced documents

[RD 01] Rose, Kenneth H. "A Guide to the Project Management Body of Knowledge (PMBOK® Guide)—Fifth Edition." Project Management Journal 44, no. 3 (2013): e1-e1.

## 1.5. Definitions, acronyms and abbreviations

ESA: European Space Agency

HSI: Hyperspectral Imaging

HYP: Hyperspectral

PHySIS: Sparse Signal Processing Technologies for HyperSpectral Imaging Systems

SW: Software

# 2. Risk management protocol

The risk management protocol that we will follow in PHySIS is composed of the following stages:

- Risk Planning where the risk management procedures and responsibilities are identified. The Risk Management Planning continues throughout the lifetime of the project to ensure potential impacts on project risks related to changes in the project scope or focused as analyzed.

- Risk Identification Process is a proactive and iterative process where risks are resolved before they become problems. Risks will be assigned to the following cases i) internal risk contained within a single WP, ii) research where the risk and its impact on other WPs need to be further investigated, and iii) external referring to risks introduced from outside the project. This deliverable is part of the risk identification procedure.

- The Risk Response Process refers to the process of deciding on what should be done with a risk, if anything at all. The Risk Response Process must answer i) who is responsible for this risk and ii) what are the necessary actions that should be taken. The responsible partner will outline the course of actions that can include i) accept the risk as part of the solution, ii) mitigate by reducing the impact of the risk and iii) watch, in which case the consortium will closely monitor the risk and its impact.

Risk management will follow the flow of the consortium structure shown in Figure 1.

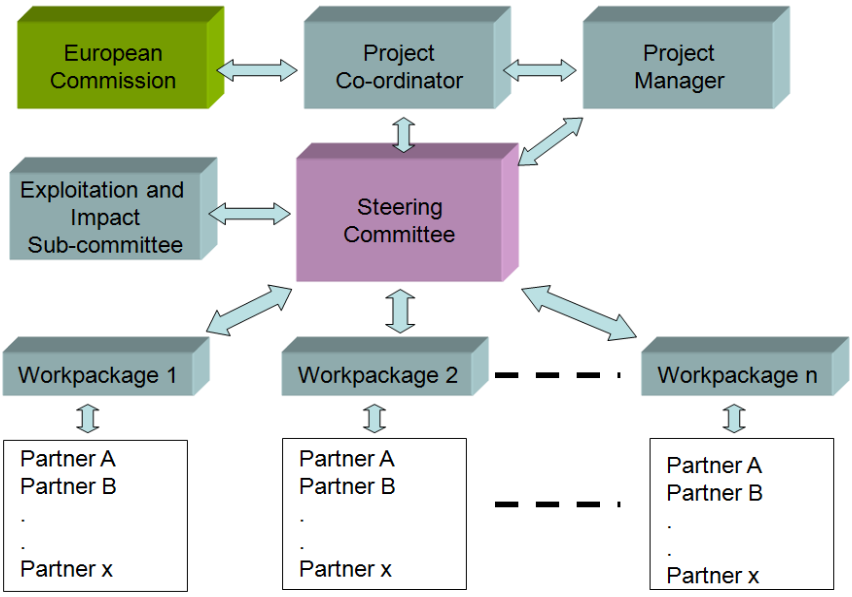


*Figure 1: The overall management structure of the PHySIS project.*

# 3. Risk management for PHySIS

## 3.1. WP2: Application scenarios and system requirements

The primary objectives of WP2 include the development of a detailed application scenario description that will include the corresponding system requirements and the evaluation of this scenario, with respect to technical and economic benefits, as well as the definition of a hyperspectral imaging system that will support the identified operational tasks. The critical risks associated with this WP include the failure to provide the required specifications for spaceborne applications, failure to evaluate the performance of the developed technologies with real data, and the failure to identify a terrestrial application of the developed technologies. We explore these issues in the following tables.

| Risk | Partner | Importance | Prob. of failure | Impact |
|---|---|---|---|---|
| **R2.1** | *FORTH* | High | Medium | High |
| Failure to define on-board capabilities of remote sensing devices with respect to complexity, memory, and bandwidth. | | | | |
| **Avoidance actions** | We will collect and consider all available information regarding the hardware specifications of remote sensing devices. | | | |
| **Mitigation actions** | We will consider scalable approaches with respect to the system's capabilities. We will also explore publicly available specifications of remote sensing systems. | | | |

| Risk | Partner | Importance | Prob. of failure | Impact |
|---|---|---|---|---|
| **R2.2** | *FORTH/IMEC/PLANETEK* | High | Medium | High |

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| Failure to provide real data for simulation and evaluation of the developed models. | |
| **Avoidance actions** | We will collect and consider all available information regarding the hardware specifications of remote sensing devices. |
| **Mitigation actions** | We will evaluate the proposed technologies on publicly available data and in-house data from PLANETEK and IMEC. |

| Risk | Partner | Importance | Prob. of failure | Impact |
|---|---|---|---|---|
| **R2.3** | *FORTH* | Low | Medium | Low |
| Failure to identify appropriate terrestrial applications. | | | | |
| **Avoidance actions** | Various terrestrial applications will be simultaneously considered in order to identify the best fitting one. The list of possible applications includes applications in recycling, biology, agriculture, and food quality. | | | |
| **Mitigation actions** | A small scale demonstration will be considered aiming at a rudimentary presentation of the capabilities of the developed technologies. The small scale demonstration will consider a limited dataset that will be generated by the project and will aim at providing a baseline for future developments. | | | |

## 3.2. WP3: Hyperspectral image acquisition

The key objectives of WP3 are the design and evaluation of novel SSI architectures. To that end, information from WP2 will be considered as a baseline for traditional spectral imaging architectures and we will explore novel designs that leverage the capabilities of CS to achieve novel trade-off points.

| Risk | Partner | Importance | Prob. of failure | Impact |
|---|---|---|---|---|
| **R3.1** | *IMEC* | High | Low | Medium |
| Failure to physically acquire the necessary data. | | | | |
| **Avoidance actions** | IMEC will provide at least one prototypical design of a hyperspectral camera that will be utilized for collecting real data that will be considered as a scaled version of the ideal real data. | | | |
| **Mitigation actions** | Failure to collect real data can be mitigated by exploring simulated data and evaluating the developed technologies on realistic datasets and conditions. | | | |

| Risk | Partner | Importance | Prob. of failure | Impact |
|---|---|---|---|---|
| **R3.2** | *IMEC* | High | Medium | Medium |
| Physical realization of CS based sampling scheme not possible using current fabrication technologies. | | | | |
| **Avoidance actions** | We will consider the introduction of either owned or easily purchasable items that will be used for introducing the incoherent sampling that is required by CS. Furthermore, we will restrict our attention to sensors already developed and prototyped by IMEC. | | | |
| **Mitigation actions** | The architecture will be evaluated on a theoretical basis where the impact and effects of the required components will be realistically simulated. | | | |

## 3.3. WP4: Sparse representation and compression of hyperspectral data

WP4 is responsible for the investigation and design of novel representation and compression schemes based on the concepts of Sparse Representations for application in HSI data.

| Risk | Partner | Importance | Prob. of failure | Impact |
|---|---|---|---|---|
| **R4.1** | *FORTH* | Medium | Medium | Low |
| Failure to generate compression schemes that outperform state-of-the-art compression algorithms. | | | | |
| **Avoidance actions** | We will consider incremental enhancements of image compression standards like the CCSDS 122. | | | |
| **Mitigation actions** | We will investigate standardized compression algorithms with respect to the rest of the WPs. | | | |

## 3.4. WP5: Sparsity-enforcing restoration and robust recovery

WP5 will explore the potential of sparsity-enforcing models for the enhancement of low quality HYP imagery, as well as the introduction of sparsity models and dictionary learning for the recovery of CS-based sampling data in the presence of noise.

| Risk | Partner | Importance | Prob. of failure | Impact |
|---|---|---|---|---|
| **R5.1** | *CEA* | Low | Low | Medium |
| Failure to develop appropriate hyperspectral representations. | | | | |
| **Avoidance actions** | We will introduce new sparse representations for multispectral data based on learning techniques. These models will be deployed for solving robust signal recovery | | | |

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|---|---|
| | problems. |
| **Mitigation actions** | We will consider existing techniques for modelling high dimensional image data. |

## 3.5. WP6: Hyperspectral image understanding

WP6 will explore the application of spectral unmixing and spectral clustering, as well as joint models for unmixing and clustering, of HYP data.

| Risk | Partner | Importance | Prob. of failure | Impact |
|---|---|---|---|---|
| **R6.1** | *NOA* | Low | Medium | Low |
| Failure to accurately model endmembers for specific scenarios. | | | | |
| **Avoidance actions** | We will use state-of-the-art endmember extraction algorithms and/or reference material spectra from publicly available spectral libraries. | | | |
| **Mitigation actions** | We will evaluate the capabilities of the developed unmixing and clustering algorithms on publicly available hyperspectral data. | | | |

| Risk | Partner | Importance | Prob. of failure | Impact |
|---|---|---|---|---|
| **R6.2** | *NOA* | Low | Medium | Low |
| Hyperspectral images may not form dense in data regions which can be handled by possibilistic clustering algorithms. | | | | |

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| **Avoidance actions** | We will develop appropriate feature generation/selection schemes to represent data in dense in data regions. |
| **Mitigation actions** | We will evaluate the capabilities of the developed clustering algorithms on publicly available hyperspectral data. |

| **Risk** | **Partner** | **Importance** | **Prob. of failure** | **Impact** |
|---|---|---|---|---|
| **R6.3** | *NOA* | Low | Medium | Low |
| Failure to cluster data resulting from the unmixing stage in a joint unmixing/clustering scheme. | | | | |
| **Avoidance actions** | We will explore various clustering methods on the data provided by the unmixing process. | | | |
| **Mitigation actions** | We will treat unmixing and clustering separately and combine their results. | | | |

## 3.6. WP7: Integration, demonstration and validation

WP7 will consider the integration of the individual modules developed in WP2-WP6 into a unified framework. This framework will be considered as a baseline for trade-off analysis compared to state-of-the-art architectures. The effort of this WP will be primarily focused on developing a SW suite that will provide a demonstration platform for the various functionality of individual modules.

| **Risk** | **Partner** | **Importance** | **Prob. of failure** | **Impact** |
|---|---|---|---|---|
| **R7.1** | *PLANETEK* | High | Low | Medium |
| Failure to integrate the individual modules to an end-to-end system. | | | | |

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| **Avoidance actions** | The consortium will strive to develop clear interfaces between individual modules that will support their integration. |
| **Mitigation actions** | We will evaluate the components individually and replace problematic components with similar state-of-the-art technologies. |

| **Risk** | **Partner** | **Importance** | **Prob. of failure** | **Impact** |
|---|---|---|---|---|
| **R7.2** | *PLANETEK* | Medium | Low | Low |
| Failure to demonstrate a system that will meet the specified capabilities | | | | |
| **Avoidance actions** | We will prepare and map the demonstration plan to the system design and then maintain the plan updated according to the intermediate results as soon as they are achieved. | | | |
| **Mitigation actions** | System will be designed in order to support the possibility to independently demonstrate different sub-sets of capabilities (where a full system end-to-end demonstration would be un-feasible/ un-practical). | | | |

# 4. Discussion

This living document encodes the current list of possible risks associated with the WPs and Tasks of PHySIS. The document will be constantly updated in order to support the timely monitoring of the developments and the work plan of the project.