1 INTRODUCTION

1.1 Background

European involvement in low gravity research began approximately 30 years ago, with nationally funded programmes (in particular those of France and Germany) and US collaborations. Later, in January 1982, a European Space Agency (ESA) funded programme was initiated by the ESA Member States, who agreed to a small programme to which governments could contribute according to their interests and budgets. The first phase of this new ESA programme (Microgravity Programme: Phase-1) was established for the period 1982-1985. This allowed ESA to participate in the German Texus Sounding Rocket programme (later extended to include Swedish Maser Sounding Rockets) to perform short duration microgravity experiments. The Phase-1 programme also covered the development of a first set of multi-user experiment facilities to be flown on the Space Shuttle Spacelab and SpaceHab missions.

Since then, ESA has sponsored more than 1500 experiments, payloads and facilities, which have been integrated and operated on various types of low gravity platforms, including:

- Drop Towers;
- Parabolic Flights;
- Sounding Rockets;
- Retrievable Capsules;
- Space Shuttle;
- MIR Space Station;
- International Space Station.

1.2 Relation to Ground Based Facilities

Besides the five major low-gravity platforms presented in this User Guide, ESA also supports access to specific facilities and environments on Earth that simulate the space environment. Extensive and timely use of the research capabilities offered by these facilities, will not only improve the preparation of spaceflight experiments, but will also increase the level of scientific knowledge of the influence of gravity and/or extraterrestrial environments on life, physical and interdisciplinary processes. A separate “User Guide to Ground Based Facilities” is in development that in conjunction with this current guide, will form a comprehensive review of the continuum of research facilities supported by ESA.

Specific ground facilities that simulate space and planetary conditions like climate, physical and psychological isolation, low gravity, extreme environments, high velocity impacts, etc., are available in a wide range of scientific disciplines. More information on these facilities and how to access them can be found at the following web site: http://www.spaceflight.esa.int/users/file.cfm?filename=facgrbased

In addition to providing support to users in accessing these facilities, ESA also regularly announces calls for proposals to participate in large coordinated scientific investigations, which are of strategic importance to the long-term preparation of long duration human space missions. Recent examples of these are Long Term Bed Rest Studies (refer to the following web site http://www.spaceflight.esa.int/users/file.cfm?filename=miss-gbfac) and Antarctic Isolation Studies (see http://www.esa.int/esaCP/SEMOS4T1VED_index_0.html). Both types of studies are aimed at investigating the physiological and psychological problems that may arise in conditions of isolation and confinement, such as those that will be experienced during a long duration space mission.

1.3 Structure of the Guide

This guide has been developed to provide potential and existing users, as well as the general public, with the basic information relative to the access and utilisation of the 5 major low gravity platforms currently supported and sponsored by ESA.

Each of these platforms is covered separately in 5 dedicated sections together with an initial section describing the process by which users can access the various platforms:

- Section 2 describes the access processes applicable to utilisation of the various platforms (and also ground based facilities);
- Section 3 provides an overview of drop towers and contains more specific access and utilisation information relative to the ZARM drop tower based in Bremen, Germany, which was officially declared an ESA external facility in October 2003;
- Section 4 covers the general aspects of parabolic flights as a means of obtaining low gravity, and concentrates on the Novespace Airbus A-300 "Zero-g" aircraft based at the Bordeaux-Mérignac airport, which has been used by ESA since 1997;
- Section 5 highlights the most important aspects involved in utilising the four ESA supported sounding rockets (miniTexus, Texus, Maser and Maxus), which are launched from the Esrange base near Kiruna, Sweden;
- Section 6 presents users with information regarding the utilisation aspects of the Russian Foton retrievable capsule, an unmanned Earth-orbiting spacecraft offering microgravity and space exposure, that ESA has used since the early 1990's;
- Section 7 is the more detailed of the five sections, covering the most complex low gravity platform currently accessible through ESA, the International Space Station (ISS).

A common contents structure has been applied to all five platforms, containing the same level of information. The two main driving factors for this approach are that this makes it easier to compare 2 or more platforms (especially for potential users), as well as making it easier to use when transitioning from one platform to another.

Changes to various aspects of the platforms will be commonplace in the future, in particular for the ISS, which is such a dynamic programme. For this reason the Guide is treated as a living document, presented in a loose-leaf binder format that allows for the periodic update of sections, by inserting them into the Guide, thus ensuring that it contains the latest validated reference data. A dedicated web page for the User Guide will be set-up, which will allow Users to monitor the various sections making up the Guide and to download any updated revisions for insertion into their binder. In most cases, Users will also be able to download high resolution versions of the images contained in the Guide. This web page will be accessible from the main Users web site, which has the following URL: http://spaceflight.esa.int/users/

The Guide represents the first step in discovering the capabilities of the suite of low gravity mission platforms offered for utilisation by ESA, and is a synthesis of a large number of reference documents and various other sources. It is intended for the guide to contain sufficient utilisation information, but where necessary however, and at appropriate points in the text, references to more detailed documentation and other information sources is made. The fundamental aim being to provide a clear, complete and easily understandable utilisation path for users to follow.

1.4 Overview

As stepping stones for the consultation of this guide, users can refer to the following figures (Figure 1-1, Figure 1-2, and Figure 1-3), to provide them with a global overview of some of the major utilisation aspects that need to be taken into account when deciding which platform is more suitable to their needs.

Figure 1-1 shows the average ranges of low gravity (with respect to Earth's 'g') experienced on each of the 5 ESA-sponsored platforms, and the average range of time to which experiments are exposed to these values. Users must bear in mind that these are average values, and may differ from mission to mission.

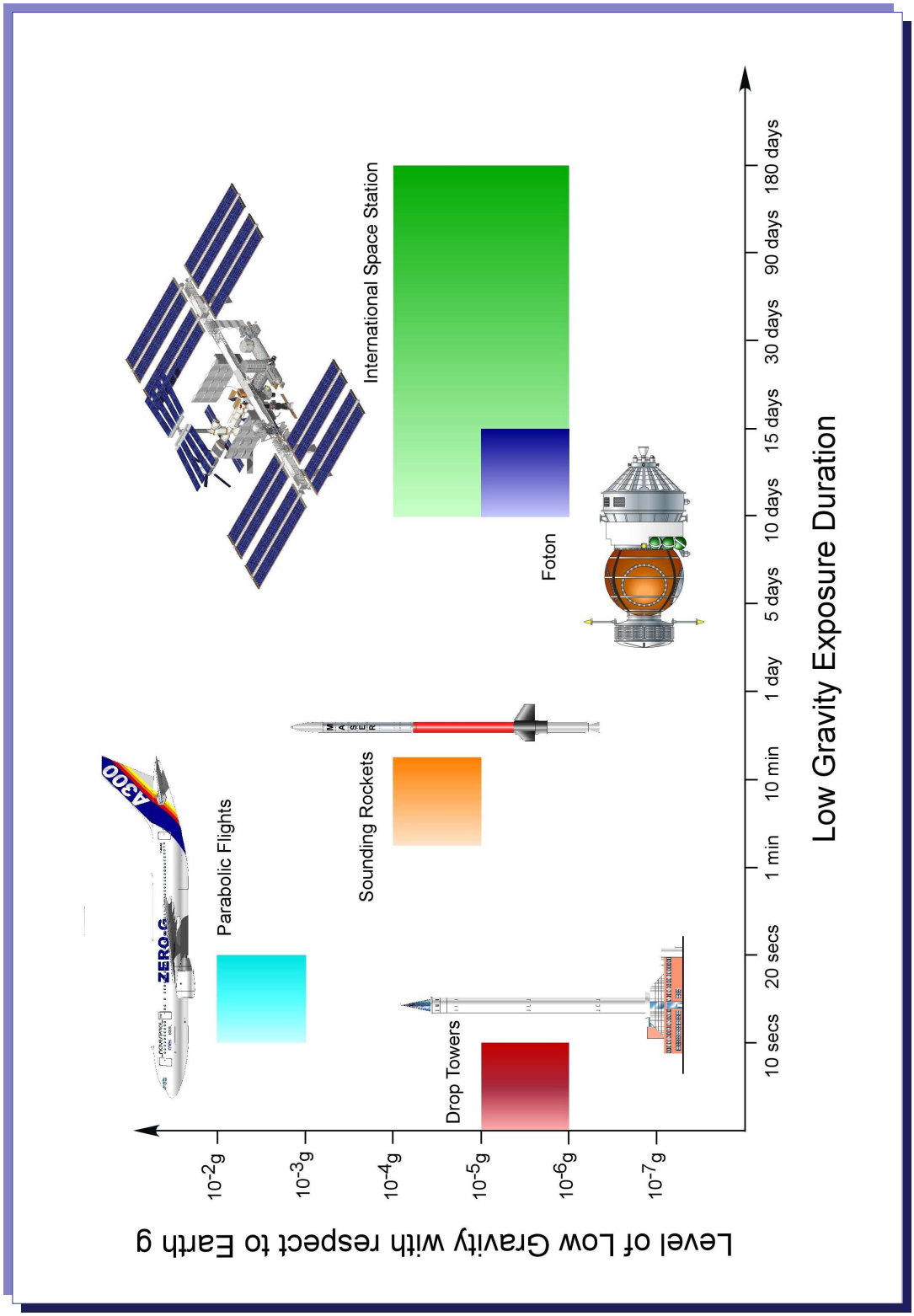

Figure 1-1: Low gravity magnitude and duration for the 5 ESA-sponsored platforms

The following figure, Figure 1-2, provides users with an indication of which platforms are more suitable to what type of scientific field of research, based on the 14 ESA Research Cornerstones established for the period 2002-2006 (see **7.4.1.1** for a definition of these Cornerstones). The green tick marks refer to cases where experiments belonging to a cornerstone have been carried out on a particular platform in the past. The red question marks indicate that experiments have not been executed in the past on a specific platform, but this does not exclude the possibility of future experiments. Cases in which experiments belonging to a particular cornerstone are generally not suitable to a platform due to limitations and restrictions, are identified by red 'X' symbols. Users should keep in mind though, that the objective of the table is only to provide an overview of what is generally possible on each platform.

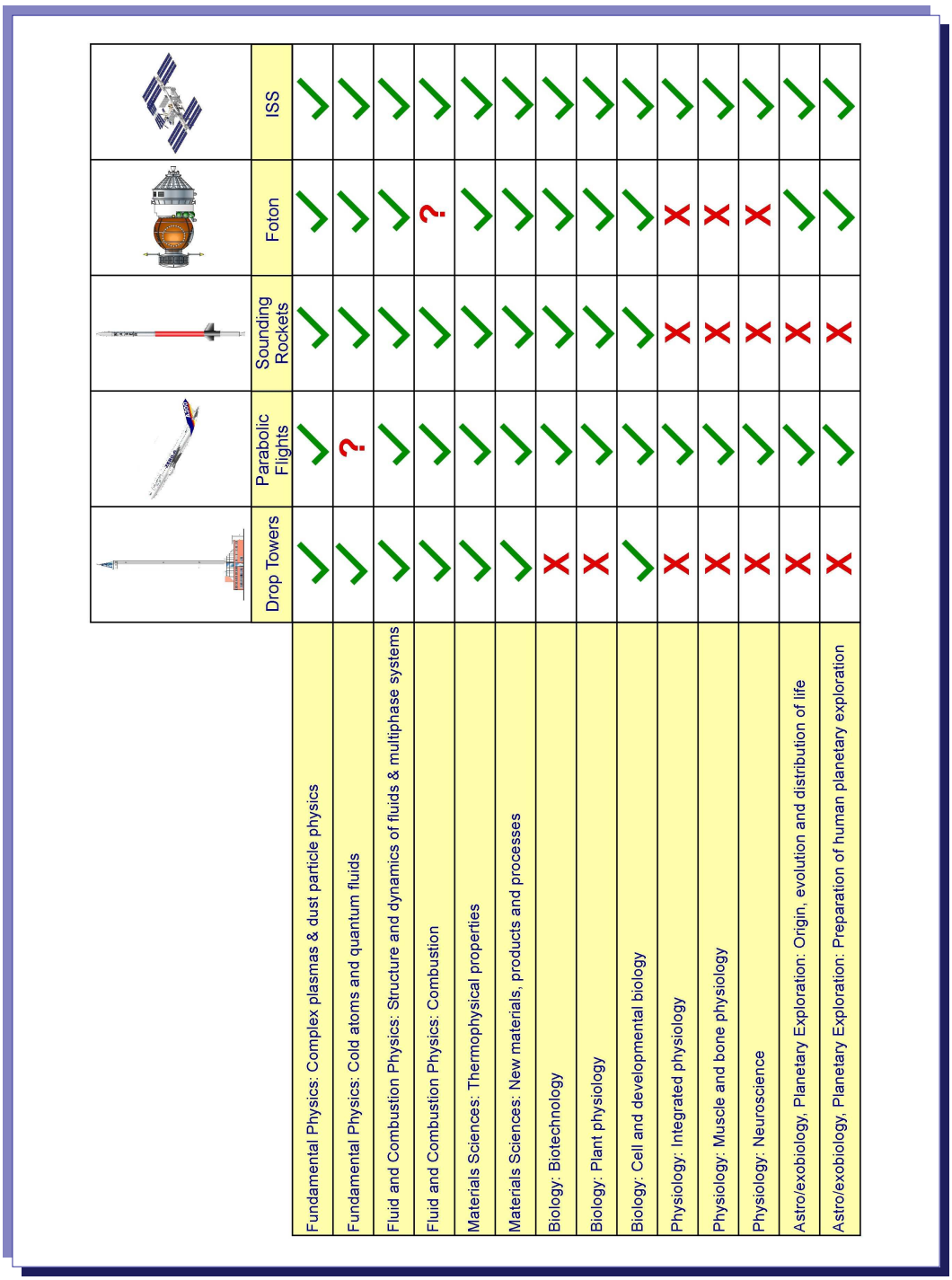

Figure 1-2: Fields of research applicable to the 5 ESA-sponsored platforms

Figure 1-3 is aimed at giving users an idea of the development and integration times usually required before launching experiments, payloads or facilities on-board each of the 5 ESA-sponsored low gravity platforms. The coloured bars in the figure are average ranges of time in terms of months, but users must remember that these will depend highly on the mission and on the complexity of the hardware being flown.

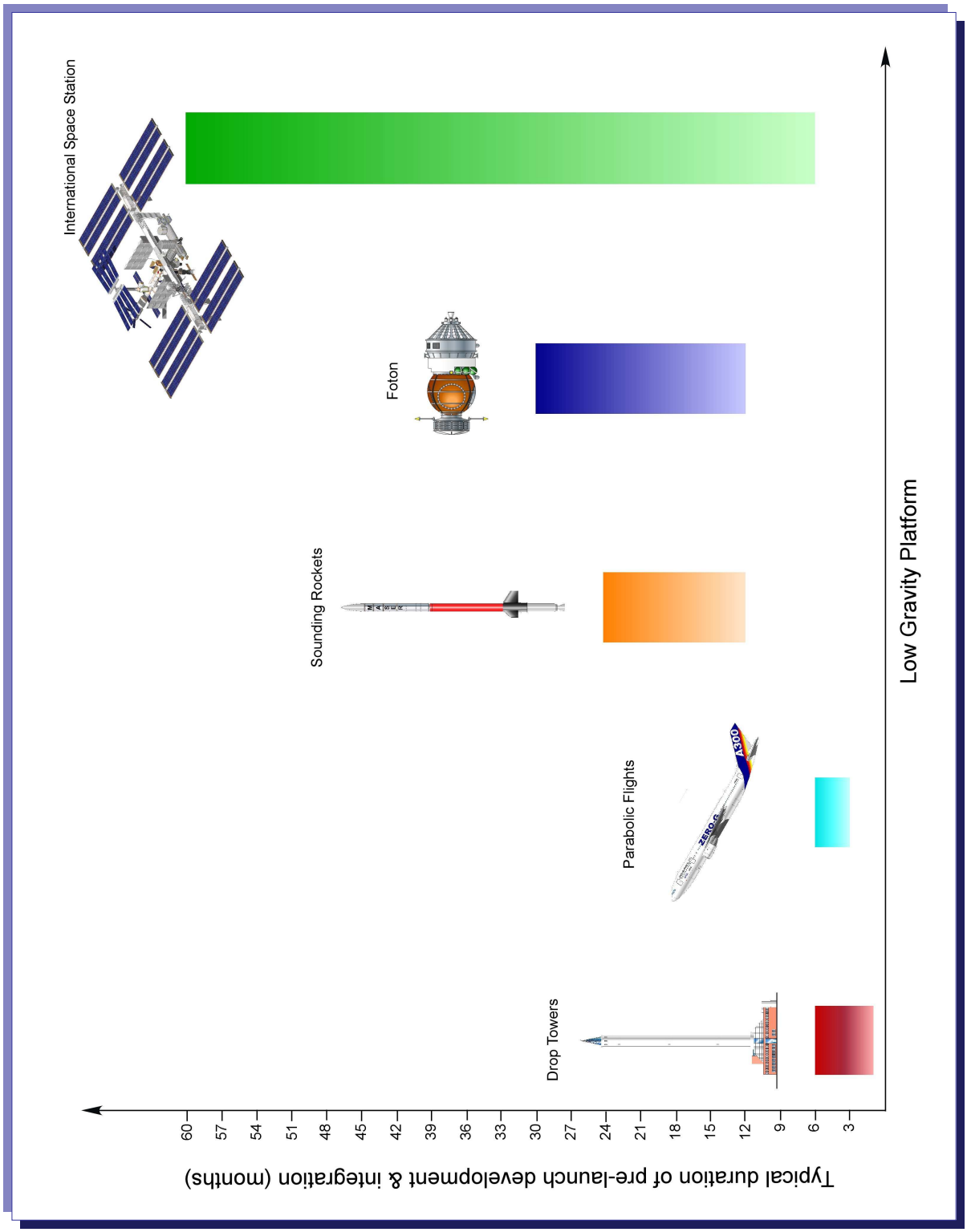

Figure 1-3: Payload development & integration times for the five ESA-sponsored low gravity platforms

1.5 General Information and Advice

The scientific entry and selection of experiments that users wish to accommodate on/in the five low gravity platforms discussed in this guide, is carried out via the ESA Announcement of Opportunity process, described in detail in section 2. However, as a first step, potential users who would like additional information or advice on the ESA low gravity platforms can contact the Erasmus User Centre (EUC). The Centre is located at ESA's Science and Technology Centre in Noordwijk, the Netherlands. The EUC forms part of the Directorate of Human Spaceflight, Microgravity and Exploration Programmes and has the mandate to inform and advise institutional and commercial users interested in making use of space platforms and ground based facilities. The Centre can provide the following:

- Support to access of user facilities;
- Familiarisation to the requirements and procedures related to the use of these facilities;
- Access to data of past experiments;
- Access to payload integration reference and applicable documentation.

1.5.1 Erasmus Experiment Archive (EEA)

An important resource of the EUC is the Erasmus Experiment Archive (EEA). The EEA is a database of ESA funded or co-funded experiments covering a wide range of scientific areas, which were performed during missions and campaigns on/in various space platforms and microgravity ground-based facilities over the past 30 years. The archive is continuously being updated and as of June 2005, contained more than 1300 experiment records. The major items of information covered in the EEA include:

- Research cornerstone;
- Date of experiment;
- Mission name;
- Team members and institutes;
- List of publications/references;
- Experiment objectives;
- Experiment procedures;
- Experiment results;
- Attachments (figures, graphs, videos, etc.).

The EEA depends highly on the support provided by users; therefore users are encouraged to send inputs to the above contact coordinates, once they have executed an experiment. In fact, users who perform ESA funded experiments have the obligation to provide an abstract to the EEA. Failure to meet this obligation will be taken into account when deciding on new experiment opportunities/proposals from the user team in question.
Users are invited to visit the database, from which they can, among other things, obtain further information regarding experiments of their field of research already carried out in the past. The EEA web address is the following: http://www.spaceflight.esa.int/eea
(See section 1.5.4 for contact details)

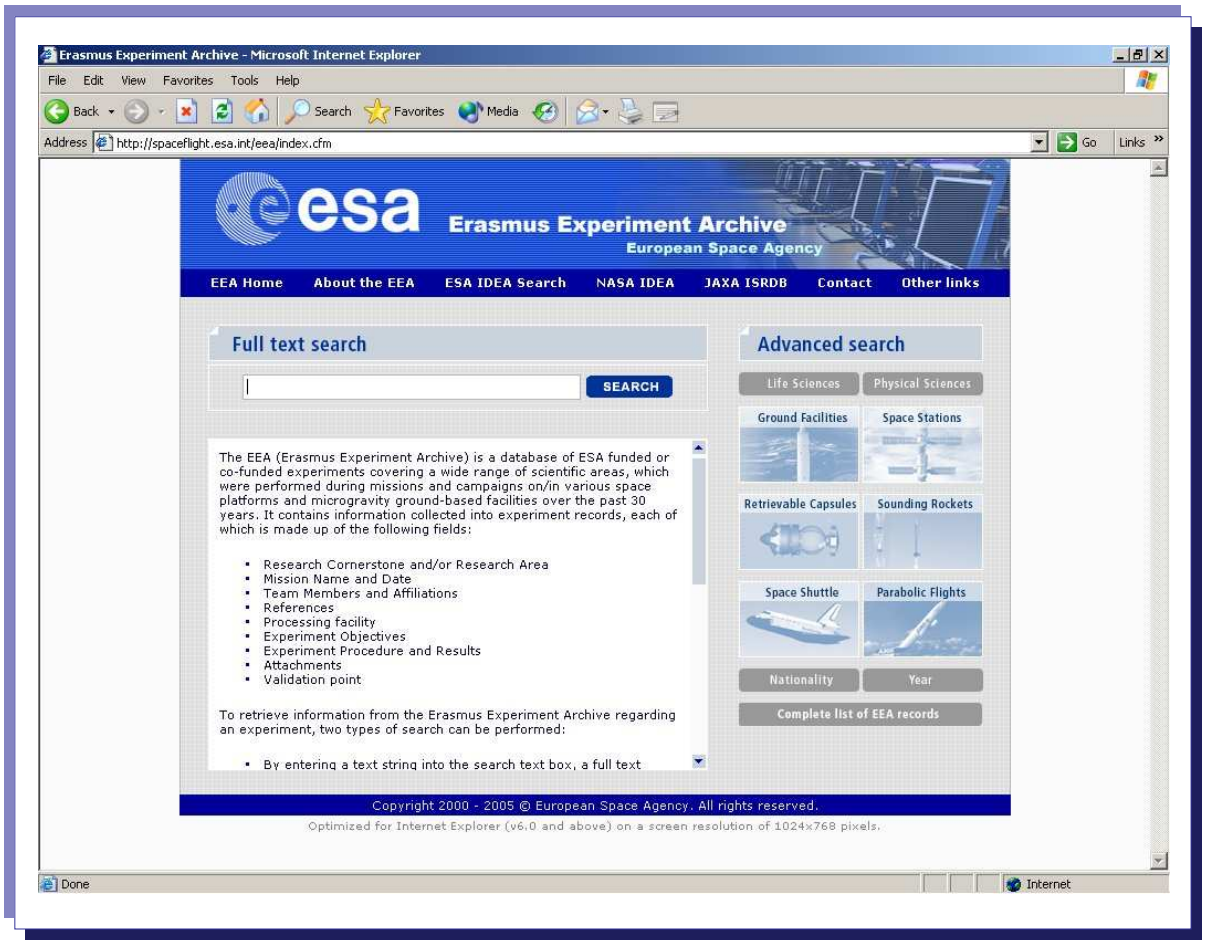

Figure 1-4: Erasmus Experiment Archive (EEA) home page

1.5.2 User Documentation Access System (UDAS)

The User Documentation Access System (UDAS) is a repository of documents developed by the EUC to support potential and experienced users, in particular with regards to the International Space Station. The documents contained in this archive range from simple familiarisation material to more complex design, development and integration applicable and requirement documents. Many of the reference documents cited in this User Guide are contained within UDAS. Note that UDAS is currently only accessible with a username and password (see section 1.5.4 for contact details).

1.5.3 Erasmus User Centre High Bay

The Erasmus User Centre High Bay hosts various mock-ups (e.g. A300 Zero-G cross-section, Columbus Laboratory module) and flown hardware (e.g. Foton re-entry capsule), which are at the disposal of visitors and potential users. Furthermore, in November 2004, the Erasmus User Centre inaugurated a Drop Tower demonstrator, erected in its high-bay area, built with the objective of familiarising visitors and potential users with the drop tower concept (see chapter **3**), as well as to provide a tool for demonstrating a weightless environment. The tower is a 14 metre woven metal structure, providing 1.5 seconds of microgravity. Drop tests can be carried out in the inner payload bay of the cylindrical capsule, surrounded by an aerodynamic protective outer shield. At the base of the tower, a 1.75 metre deep pit filled with PVC lentil-shaped objects breaks the fall of the experiment capsule.

Figure 1-5: Erasmus User Centre Drop Tower demonstrator

1.5.4 Contacts

As this Guide has been written for the user, any updates or modifications to any of its content will depend significantly on the feedback received. Comments, suggestions or requests for further information on any of the low gravity platforms or the Erasmus Experiment Archive, should be sent to either of the following by phone, fax, mail or e-mail:

Dr. William Carey or Enrico Ceglia
Erasmus User Centre
HME-HE
Directorate of Human Spaceflight, Microgravity and Exploration Programmes
European Space Agency
Keplerlaan 1
2201 AZ Noordwijk
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For more information regarding the use of UDAS or the EUC drop tower demonstrator, users should contact:

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