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THE HEMERA INFRASTRUCTURAL E.U. PROGRAMME: EPO ACTIVITIES

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ABSTRACT

HEMERA is a new Research Infrastructure funded by the Horizon 2020 Research and Innovation Programme of the European Union (grant number 730970). It integrates a large starting community in the field of tropospheric and stratospheric balloon-borne research, to make existing balloon facilities available to all scientific teams in the European Union, Canada and associated countries. The complementary of the HEMERA members capabilities in the field of balloon systems and operations will offer an easy and enhanced service to the scientific community. A wide range of scientific and technical themes are addressed, such as astronomy, atmospheric physics and chemistry, climate research, fundamental physics, biology, space research and technology.

This program aims at provide a transnational access to balloon flights for all the users; enlarge and strengthen the network of the community working in balloon science; join the research to improve balloon technology and scientific instrumentation. Finally, HEMERA aims at develop strong synergies with the European Union programs.

Keywords: Infrastructure, balloon Science, stratospheric balloon, astrophysics

1 INTRODUCTION

HEMERA is a new Research Infrastructure funded by the Horizon 2020 Research and Innovation Programme of the European Union (grant number 730970). It integrates a large starting community in the field of tropospheric and stratospheric balloon-borne research, to make existing balloon facilities available to all scientific teams in the European Union, Canada and associated countries. The complementary of the HEMERA members capabilities in the field of balloon systems and operations will offer an easy and enhanced service to the scientific community. A wide range of scientific and technical themes are addressed (Masi S. et al., (2008)), such as astronomy, atmospheric physics and chemistry, climate research, fundamental physics, biology, space research and technology. This programme aims at provide a transnational access to balloon flights for all the users; enlarge and strengthen the network of

the community working in balloon science; join the research to improve balloon technology and scientific instrumentation. Finally, HEMERA aims at develop strong synergies with the European Union programme COPERNICUS, be complementary to the European Space Agency programmes and establish links with other European Commission (EC) infrastructures (e.g. ACTRIS, IAGOS). To do so, HEMERA provides the possibility to fly small to medium payloads at no cost on Centre National d'Etudes Spatiales (CNES) or Swedish Space Corporation (SSC) gondolas under Zero Pressure Balloons (ZPB) and Sounding Balloons (SB) (see Section 3). The cost for the development and construction of the payloads is not included. Moreover, it will provide a virtual access to the data: those data acquired during those flights will be collected and mad publicly accessible on a dedicated we portal on www.hemera-h2020.eu.

2 BALLOON SCIENCE IN THE LAST CENTURY

The era of modern stratospheric ballooning, from the beginning of the last century have provided unique flight opportunities for aerospace experiments. In particular, the Italian scientific community have played a crucial role, with stratospheric balloons flight since the '50s carrying cosmic rays and high energy astrophysical experiments. Launches have been performed from the Cagliari Elmas Airport in Sardinia, Italy. One of those have been designed and exploited under the lead of Prof. Edoardo Amaldi, together with the 'Ragazzi di Via Panisperna': Oscar D'Agostino, Emilio Segre, Edoardo Amaldi, Franco Rasetti ed Enrico Fermi (see Figure 1). The scientific objective was to study the production of "starge" particles in the atmosphere, by means the use of emulsions. The flight was successfully exploited in 1953 (Ubertini, P., 2008).

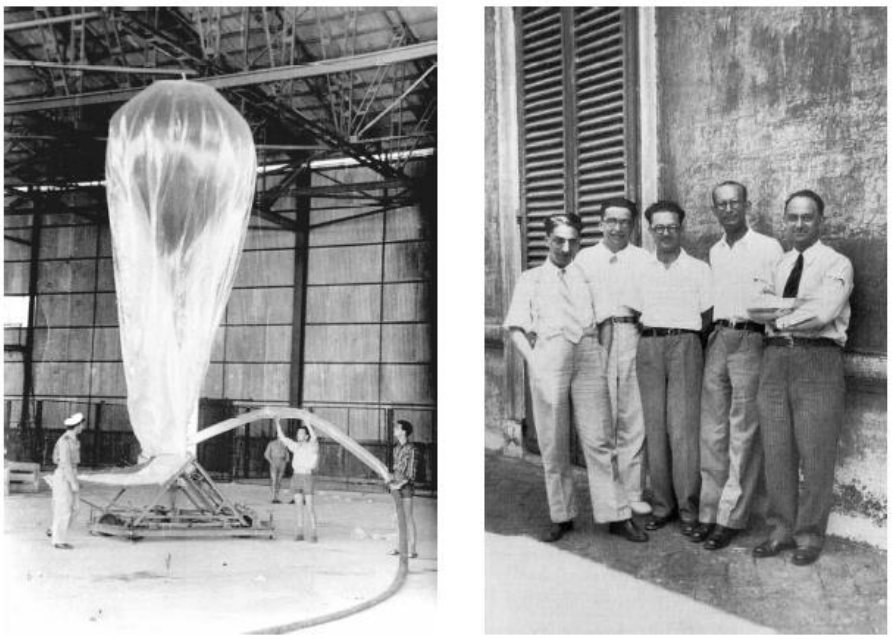

Figure 1: Left: one of the first experiment carried out with stratospheric balloon in Italy is shown. The balloon, with a volume of about 9,000 cubic meters, was launched from the Cagliari Elmas Airport (Sardinia, Italy).The experiment was designed and exploited under the lead of Prof. Edoardo Amaldi. Right: The group of the "Ragazzi di Via Panisperna": starting from the left: Oscar D'Agostino, Emilio Segre, Edoardo Amaldi, Franco Rasetti ed Enrico Fermi.

In Italy, after the World Warr II, the military airport in the area of Trapani-Milo in Italy was revived as a facility to perform scientific experiment at the beginning of the '70s. This facility

was at first managed by the 'Piano Spaziale Nazionale-CNR' and later by ASI. The italian scientific community have always been interested in all the science fields that balloon flights allows to exploit, and in particular high energy astrophysics. Table 1 shows the high energy astrophysics balloon experiments conducted with the 'Istituto di Astrofisica Spaziale e Fisica Cosmica' (IASF) involved between 1975 and 1991.

Name	Energy Range	Main aim	Range	Launch	Note
HXR-76	Hard-X-Ray	AGN, Cosmic BGD	Trapani-Milo Italy/USA	1976	Transatlantic
HXR-79	Hard-X-Ray	Crab Nebula	Trapani-Milo, Italy	1979	TransMed.
TXT	Hard-X-Ray	Gamma ray bursts	Trapani-Milo, Italy	1978	TransMed.
HXR-80	Hard-X-Ray	Galactic Binaries	Trapani-Milo, Italy	1980	TransMed.
HXR 80-I	Hard-X-Ray	Her X-1	Hyderabad, India	1980	Turn around
TXT	Hard-X-Ray	Gamma ray bursts	Trapani-Milo, Italy	1981	TransMed.
HXR-81	Hard-X-Ray	Galactic Binaries	Trapani-Milo, Italy	1981	TransMed.
Minizebra	Soft Gamma Ray	Test Flight	Trapani-Milo, Italy	1981	TransMed.
FIGARO	Soft Gamma-Ray	Pulsar	Trapani-Milo,Italy	1982	TransMed.
Phoswich	Hard X-Ray	Binaries	Trapani-Milo,Italy	1982	TransMed.
FIGARO	Soft Gamma-Ray	Pulsar	Sao Manuel, Brasil	1983	Turn around, Free Fall
POKER83B	Hard X-Ray	Galactic Centre	Sao Manuel, Brasil	1983	Turn around, Ball. Fault
X-PALLAS 83	Hard X-Gamma	Cygnus X-1	Palestine Texas (USA)	1983	Turn around, Ball. Fault
POKER 84	Hard X-Ray	All Sky Survey	Trapani-Milo, Italy	1984	TransMed., Fault
GAMTEL	Soft Gamma-Ray	All Sky	Palestine Texas (USA)	1984	Turn around, Ball. Fault
X-PALLAS 84	Hard X-Gamma	Binaries	Palestine Texas (USA)	1984	Turn around, Ball. Fault
POKER 85	Hard X-Ray	All Sky Survey	Trapani-Milo, Italy	1985	TransMed.
X-PALLAS 85	Hard X-Gamma	Binaries	Palestine Texas (USA)	1985	Turn around, Ball. Fault
X-PALLAS 86	Hard X-Gamma	Cygnus X-1	Trapani-Milo, Italy	1986	TransMed., Ball. Fault
HIBAL 86	Hard X-Ray	Galactic Centre	Alice Spring, Australia	1986	Turn around, Free Fall
FIGARO	Soft Gamma-Ray	Pulsar	Trapani-Milo,Italy	1986	TransMed.
X-PALLAS 87	Hard X-Gamma	Extragalactic sources	Trapani-Milo, Italy	1987	TransMed.
Sugar	X-Gamma Ray	SN87a	Pocos de Caldos, Brasil	1987	Turn around
SN87a - I	HE X-Ray	Supernova 1987a	Alice Spring, Australia	1987	Turn around
SN87a -II	HE X-Ray	Supernova 1987a	Alice Spring, Australia	1988	Turn around
POKER 89	Hard X-Ray	Galactic Plane	Alice Spring, Australia	1989	Turn around
Lapex	Hard X-Ray	SN87a	Alice Spring, Australia	1989	Turn around
FIGARO	Soft Gamma-Ray	Pulsar	Trapani-Milo,Italy	1990	TransMed.
Blimp	Technological	INTEGRAL CsI test	Fort Sumner, New Mex. USA	1991	Turn around

Table 1: High Energy Astrophysics Balloon Experiments with IASF participation in the time frame of 1975-1991.

3 PARTNERS

The HEMERA project sets up a large consortium dealing with balloon-borne research, that encompasses 13 Partners from seven countries:

- Space agencies: Centre National d'Etudes Spatiales (CNES) in France; Swedish National Space Board (SNSB) in Sweden; Agenzia Spaziale Italiana (ASI) in Italy; Deutsches Zentrum fur Luft- und Raumfahrt e.V. (DLR) in Germany; Canadian Space Agency (CSA) in Canada.
- Companies operating these balloons and providing the hardware: Swedish Space Corporation (SSC) in Sweden; Andoya Space Center (ASC) in Norway; Airstar in France, which provides balloon envelopes.
- Scientists fromthe atmospheric sciences, astronomy and astrophysics communities: Centre National de la Recherche Scientifique (CNRS) in France; Karlsruhe Institut fur Technologie (KIT) in Germany; Istituto Nazionale di Astrofisica (INAF) in Italy; Heidelberg University in Germany (UHEI); Cranfield University (CU) in the UK.

These partners are mostly European and from Canada. Figure 2 shows the location of the institutes, companies and space agencies.

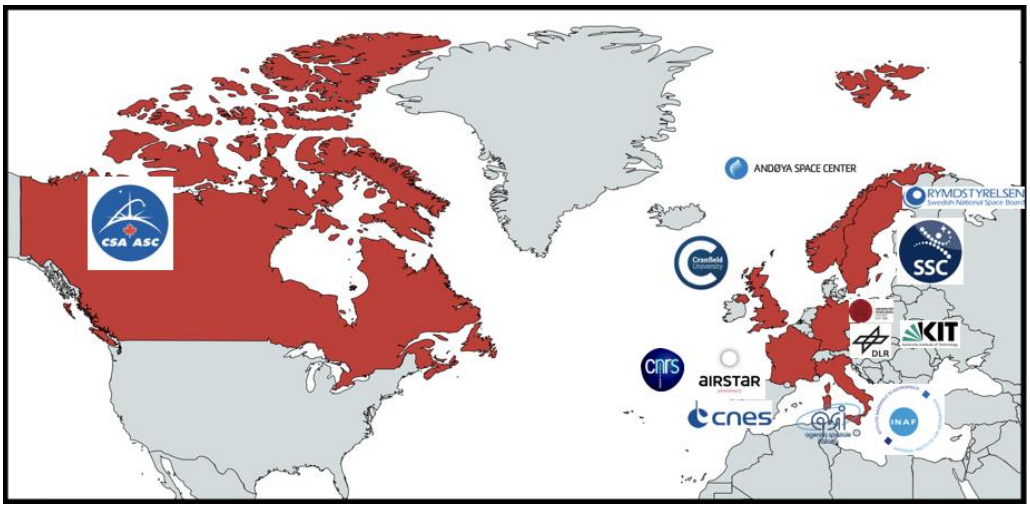

Figure 2: Locations of the HEMERA partners, encompassing space agencies, companies providing the facilities and balloons and scientific bodies, such as research centres and universities.

4 HEMERA BALLOONS

Within the HEMERA programme, two different types of balloons will be accessible by the users who wants to fly their payloads: Sounding Balloon (SB) and Zero Pressure Balloon (ZPB). Those tropospheric and stratospheric balloon types allows users to collect data related to several science fields, starting from Earth observations. In fact, atmospheric science can be achieved regarding stratospheric chemistry and dynamics. Moreover, astronomy and astrophysics contributes can be achieved in different fields, such as solar physics and cosmic ray physics, infrared and microwave measurements and gamma ray astronomy. Hereafter a brief description of the SB and ZPB balloons characteristics.

4.1 Sounding Balloons

Sounding Balloons are the smallest type of balloon users can access within the HEMERA programme. They allow small payloads with weights up to 3 kg. The maximum altitude these balloons can reach is 30 km in the atmosphere with flight durations up to ~ 2 hours. Balloons ascents are slower compared to the ZPB ones and the payloads are not always recovered. Figure 3 shows a picture of the SB as example, while Figure 4 shows the altitude in km of the SB as a function of the time flight in hours.

Figure 3: Photo of a Sounding Balloon as an example of the one used within the HEMERA programme.

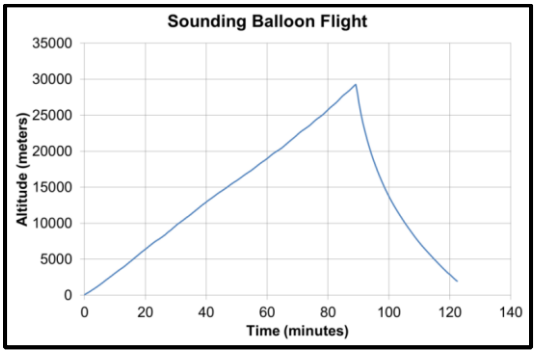

Figure 4: The plot shows the altitude in km of the Sounding Balloon used within the HEMERA programme as a function of the flight time in hours.

4.2 Zero Pressure Balloons

Zero Pressure Balloons are bigger balloon which allow payloads with a weight up to 150 kg. The maximum altitude these balloons can reach is 40 km with a flight time of ~ 24 hours. The ascent of ZPB is quite rapid and in this case the payload can be always recovered thanks to the presence of a parachute between the balloon and the gondola. Figure 5 shows the scheme of the ZPB used within the HEMERA programme, while Figure 6 presents the altitude as a function of the flight time for ZPB.

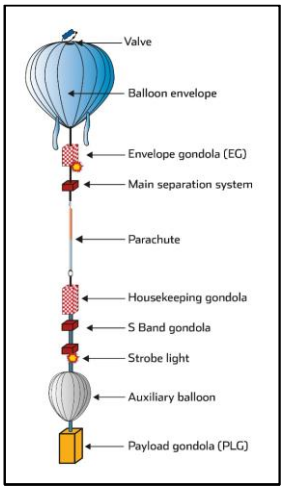

Figure 5: Scheme of a Zero Pressure Balloon used within the HEMERA programme.

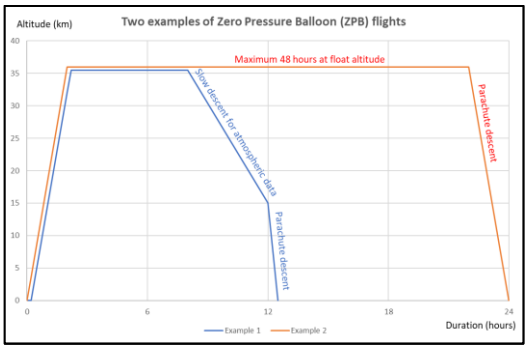

Figure 6: The plot shows the altitude in km of the Zero Pressure Balloon used within the HEMERA programme as a function of the flight time in hours.

5 HEMERA LAUNCHING SITES

HEMERA allows users to launch their instruments on the balloons from three different sites: Esrange (Sweden), Timmins (Ontario,Canada) and Aire Sur l'Adour (France). Figure 7 presents the locations of these launch sites. HEMERA partners are considering a new launch sites in different latitude, including from Sicily, in order to perform medium latitude flights. The duration of those flights will be of ~ 24 hours and the direction will be toward Spain during summer and toward Turkey in winter.

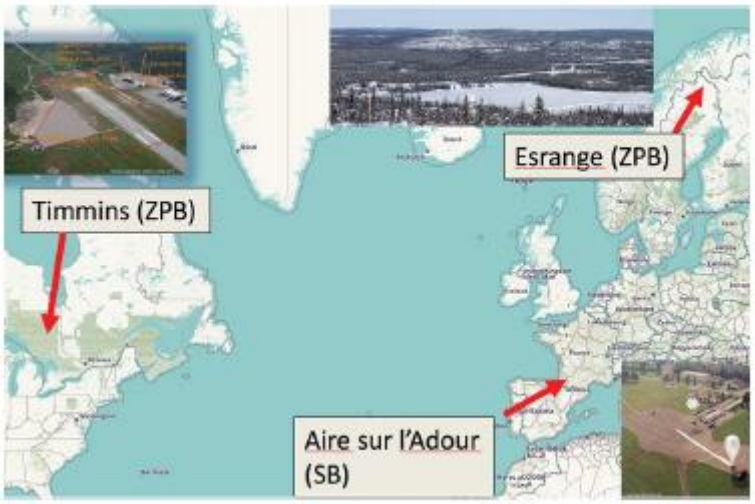

Figure 7: Locations of the launch sites used within the HEMERA programme.

- **Esrange**: this is the space operations center for SSC and it has been conducting balloon flights since 1974. The launch facility offers flights in air space with low air traffic density and over sparsely populated areas.
- **Timmins**: it was selected in March 2012 as the Canadian ZPB launch site because of its favourable latitude, wind and weather conditions, low population density in areas surrounding the city and optimal on-site infrastructure.
- **Aire sur l'Adour**: Flights from Aire sur l'Adour have been conducted since early 1960s. This site, located in southwestern France, is the main launch base of CNES and is also the home base for the CNES balloon operations team.

6 HEMERA EVENTS

Within the HEMERA programme two events planned, the HEMERA Summer School and the HEMERA Workshop. The Summer School is organized in Heidelberg from 9th to 13th of September 2019. It is open to advanced master students, PhD students and young scientists interested/involved in balloon research, technicians and engineers from the participating agencies and industries. Major themes of the summer school will cover the following:

- The history, early and modern balloon science and industrial opportunities, recent advances and discoveries.
- The atmospheric environment.
- The general logistics of balloon types, flight control, limitations of the ballooning environment, launching techniques, regulations.
- Specific scientific and industrial ballooning operations of the agencies.

- More detail on modern scientific results from ballooning and the instruments involved.
- Future work, opportunities and measurements.

A dedicated HEMERA workshop will be organized in Rome in autumn 2020. The programme together with the first balloon flights results will be presented. Further information about the workshop will be included the HEMERA website www.hemera-h2020.eu.

7 CONCLUDING REMARKS

HEMERA is a new Research Infrastructure funded within the Horizon 2020 programme by the European Union. It aims at integrate a large starting community in the field of tropospheric and stratospheric balloon-borne research, in order to make existing balloon facilities available to all scientific teams in the European Union, Canada and associated countries. It offers tropospheric and stratospheric balloon flights at no cost for small to medium payloads. To apply for those flights Call For Proposals are issued every year.

8 ACKNOWLEDGEMENTS AND REFERENCES

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♦ P. Ubertini ASI associate.

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