FP7-SPACE-2013-1

ANNEX 1 – Part B

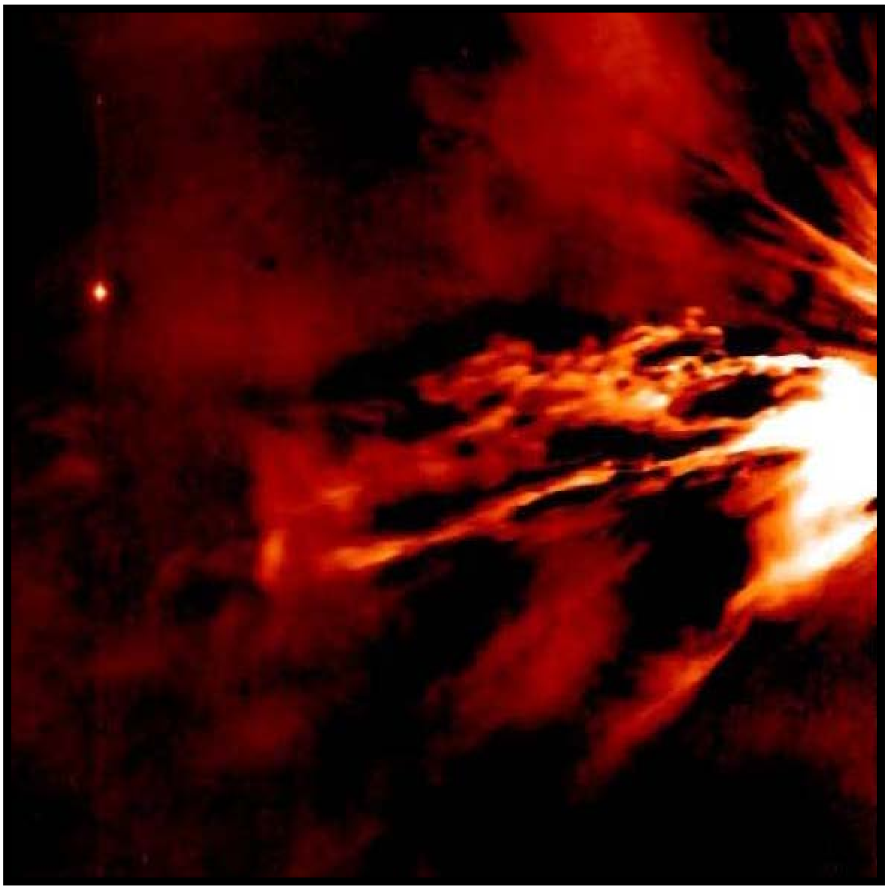
Collaborative Projects

Project full title:

Heliospheric Cataloguing, Analysis and Techniques Service

Project acronym:

HELCATS



Project full title: **Heliospheric Cataloguing, Analysis and Techniques Service**
Project acronym: **HELCATS**
Type of funding scheme: ***Collaborative Project - Small or medium-scale focused research project***

Work programme topics addressed: **HELCATS** addresses the call **SPA.2013.2.1-01 Exploitation of space science & exploration data**. It is well suited to the expected impacts of the call.

- The advent of wide-angle imaging of the inner heliosphere has revolutionised the study of the solar wind and, in particular, transient solar wind structures such as Coronal Mass Ejections (CMEs) and Co-rotating Interaction Regions (CIRs). CMEs comprise enormous plasma and magnetic field structures that are ejected from the Sun and propagate at what can be immense speeds through interplanetary space, while CIRs are characterised by extensive swathes of compressed plasma/magnetic field that form along flow discontinuities of solar origin that permeate the inner heliosphere. With Heliospheric Imaging came the unique ability to track the evolution of these features as they propagate through the inner heliosphere. Prior to the development of wide-angle imaging of the inner heliosphere, signatures of such solar wind transients could only be observed within a few solar radii of the Sun, and in the vicinity of a few near-Earth and interplanetary probes making in-situ measurements of the solar wind. Heliospheric Imaging has, for the first time, filled that vast and crucial observational gap.
- HELCATS provides an unprecedented focus for world-leading European expertise in the novel and revolutionary, European-led field of Heliospheric Imaging, in terms of instrumentation, data analysis, modelling and science. HELCATS is a strategic programme that aims to empower the wider scientific community, in Europe and beyond, by providing access to advanced catalogues - validated and augmented through the use of techniques and models - for the analysis of solar wind transients, based on observations from European-led space instrumentation. All beneficiaries are at the forefront of heliospheric research and bring distinct, yet highly complementary, skills to the project. HELCATS will add significant value to the exploitation of existing European space instrumentation, providing a strong foundation for enhanced exploitation and advancement of the heliospheric research in Europe.
- HELCATS recognises the synergy between solar and heliospheric physics research (both of which are European strengths) and their applied space weather aspect, currently a topic of vigorous debate in many political and scientific arenas. With the impending development of a European space weather capability, HELCATS has real relevance.

Name of the coordinating person: Richard Harrison (STFC, UK)

List of beneficiaries:

Beneficiary no.	**Beneficiary organisation name**	**Country**
1 (Coordinator)	Science and Technology Facilities Council (STFC)	UK
2	Universitaet Graz (UNIGRAZ)	Austria
3	Universite Paul Sabatier Toulouse III (UPS)	France
4	Georg-August-Universitaet Goettingen Stiftung Oeffentlichen Rechts (UGOE)	Germany
5	Koninklijke Sterrenwacht van Belgie (ROB)	Belgium
6	Imperial College of Science, Technology & Medicine (IMPERIAL)	UK
7	Helsingin Yliopisto (UH)	Finland
8	The Provost, Fellows, Foundation Scholars & the other members of Board of the College of the Holy and Undivided Trinity of Queen Elizabeth near Dublin (TCD)	Ireland
(Third party)	Centre National de la Recherche Scientifique (CNRS)	France
(Third party)	George Mason University (GMU)	USA

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B1.1. Concept and objectives

During recent times, the field of Heliospheric Imaging (HI), a unique capability for wide-angle, white-light imaging of the heliosphere, has developed rapidly. Through such imaging, we can identify and track the passage of solar wind transients such as Coronal Mass Ejections (CME), and study the underlying structure of the heliosphere itself through so-called Co-rotating Interaction Regions (CIRs); CIRs delineate the boundaries of flow discontinuities in the solar wind outflow. The emphasis of many of the ensuing studies has been on (1) tracking CMEs and, in particular Earth-directed CMEs, and (2) studying the solar sources of CMEs and CIRs and investigating their impacts on near-Earth space. The impacts of these transient solar wind phenomena at other solar system locations (including Venus, Mars, and Mercury) as well as their effect on comets, has been the subject of parallel study. The focus for the revolutionary scientific and technological developments in HI has been in Europe. Exploitation of the UK-led Heliospheric Imagers aboard the STEREO spacecraft (STEREO/HI: Harrison *et al.* 2008; Eyles *et al.* 2009) has led to ground-breaking work in the study of solar mass ejection and space environment research, including space weather.

The concept for this project comes out of the recognition that there is potential for adding considerable value - for scientific exploitation and space weather studies alike - by pooling the considerable and world-leading European expertise in this field (in terms of science, instrumentation, modelling, etc). A programme of cataloguing, modelling validation and information provision would clearly bolster community-wide research into the physics of the heliosphere – the volume of space in which we live. Our aim is to enhance considerably the European lead in this key area of science research by applying a coordinated approach to the provision of techniques, tools, and data access. This goes beyond providing post-launch support for the STEREO instruments alone and beyond the individual research interests of groups around Europe.

The following headline activities form the basic set of objectives for the HELCATS project. The relevant Work Packages (WPs), tasks and deliverables are listed (with timings) in Annex 1 – Part A. We note the relevant WPs here:

- Production of the first comprehensive catalogue of CMEs ***in the heliosphere*** for the period from 2007, using manual recognition of CMEs in STEREO/HI data but also assessing the potential for automatic CME recognition. (WP2).
- The generation (and inclusion in the catalogue), for those CMEs, of parameters such as radial speed, 3-dimensional (3-D) trajectory, orientation, projected launch time, and projected arrival times at various locations in the heliosphere, in particular Earth and other planets. This would be achieved through the application of a range of models (geometric and forward). The net result of these activities would be the provision of a unique and comprehensive facility for characterising transient activity in the heliosphere and, in particular, Earth-impacting CMEs. (WP3).
- Production of the first comprehensive catalogue of CIRs, including their modelled kinematic and spatial properties, from STEREO/HI data using manual recognition (over the same period). (WP5).
- Comparison with solar 'source' and in-situ data in order to correlate the white-light imagery with activity on the Sun and at various locations in the heliosphere (such as Earth and other planets), thereby providing validation of the models. (WP4, WP5).
- The application of global numerical modelling, that also allows an assessment of the potential for driving such models (widely used for space weather applications) based on HI data. (WP6).

- The assessment of the potential for combining white-light imaging of the inner heliosphere with ground- and space-based radio data, in particular Interplanetary Scintillation (IPS) and Type II radio bursts; catalogues of such radio events will be produced as required. (WP7).
- The dissemination of the aforementioned results, not only through publications emanating from the consortium but also from members of the broader scientific community through providing them with easy access to the catalogues/methodologies; the latter will enable a much wider exploitation and understanding of the HELCATS results. (WP8).

Assembling the aforementioned activities into a co-ordinated project, supported by the key European players, will provide Europe and the world with an unprecedented facility to enhance the exploitation of heliospheric observations, feeding into key scientific programmes for research into solar, heliospheric and space environment physics, as well as space weather.

Moreover, we note explicitly that the catalogues produced under the auspices of the HELCAT project will also be invaluable to planetary scientists. Solar wind transients, such as CMEs and CIRs, play a vital role in structuring magnetospheres and induced magnetospheres at Mercury, Venus, Mars, Jupiter and Saturn. Our catalogues will enhance exploitation of the data taken by European-funded space missions around these planets (e.g. Mars Express, Venus Express, Rosetta and Cassini). The studies will also be critical for understanding the environments to be encountered by inner Solar System missions such as Solar Orbiter and Solar Probe

Cross-referencing this work with the individual bullets stated in the SPA.2013.2.1-01 element of the FP7 call:

- This project mobilises the finest expertise in this thematic area, bringing together the HI hardware team with European groups that are world-leading in the fields of coronal and heliospheric physics. The co-ordinator of this proposal is the Principal Investigator (PI) of STEREO/HI while all beneficiaries are established experts in key areas of heliospheric science, such as white-light imaging, heliospheric modelling, in-situ data analysis, etc.
- The project is designed to encourage the use of existing (past and current) heliospheric data through the provision of extensive catalogues, assessments of techniques and models, along with investigations into additional ways of adding value to existing observations.
- We recognise that the HI methodology is being held-up as a benchmark for detection/tracking of solar transients for space weather applications and, thus, the project also anticipates the need to establish, consolidate and validate methods for future missions. An HI-based mission is extremely likely to be a major element of our future space weather capability.

Rationale

Although our planet lies within the heliosphere, it is an area of space that is not well understood. The fundamental structure of the heliosphere is governed by the Sun's magnetic structure and solar wind outflows, and is peppered with discrete ejecta known as CMEs. Understanding the heliosphere, and the transient events such as the CMEs that propagate through it, is central to understanding our space environment, and is key to the applied branch known as space weather. Major outstanding scientific questions relate to how the Sun's atmosphere expels matter into space, how the resulting ejecta propagate through the heliosphere and interact with the planets, and how the structure of the heliosphere is formed and evolves with time.

The launch of the NASA STEREO spacecraft in October 2006 marked the coming of age of a new field that we call Heliospheric Imaging (HI), which was pioneered by the SMEI instrument (Eyles *et al.* 2003) that operated onboard the USAF Coriolis spacecraft from 2003 to 2011. Although STEREO and Coriolis are both US spacecraft, it is important to note that the clear technical lead for the HI instruments on both missions was European, involving the Rutherford Appleton Laboratory and the University of Birmingham (both UK). This evolved into a scientific lead.

The STEREO spacecraft occupy near-1 AU heliocentric orbits, with STEREO-A (Ahead) leading the Earth and STEREO-B (Behind) lagging the Earth in its orbit. The two spacecraft drift away from Earth at a rate of 22.5^{o} per year and are each currently (December 2013) ~ 150^{o} from the Sun-Earth line. For a detailed description of the mission see Kaiser *et al.* (2008). The two spacecraft carry near-identical instrumentation, imaging the Sun itself, sampling the solar wind in-situ and, of relevance to this project, imaging the heliosphere. The UK-led Heliospheric Imaging (HI) instrument on each spacecraft consists of two wide-angle cameras that, between them, view from 4 to 88^{o} elongation from Sun-centre (the inner HI-1 camera observes from 4 to 24^{o}, while the outer HI-2 camera observes from 18 to 88^{o} elongation). The off the Sun-Earth line vantage point of the STEREO spacecraft – together with novel baffle and detector designs of the HI instruments (Eyles *et al.* 2009) – allow wide-angle imaging of the heliosphere that can detect brightness down to the equivalent of 12th to 13th magnitude stellar sources, with the minimum of scattered light from the occulted Sun. The Earth has been within the HI field of view since early in the mission. HI is part of the SECCHI package, along with an EUV imager and two coronagraphs (COR1 and COR2).

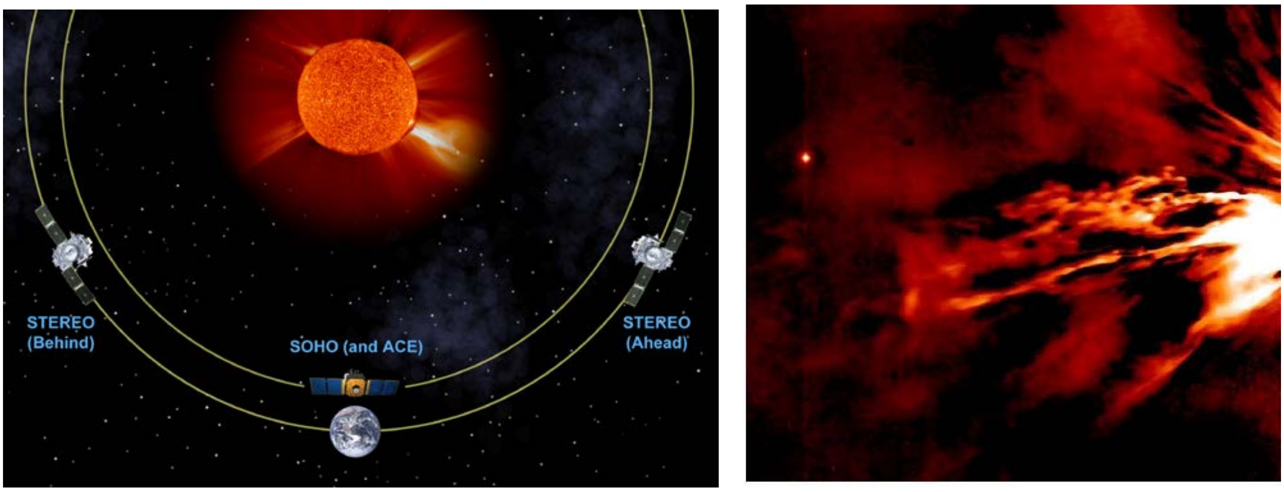

Fig. 1: (left) A schematic of the STEREO orbital configuration. (right) An image of a CME in the STEREO-A/HI-1 field of view. The Sun is only 4^{o} off the right hand side of the frame. Venus can be seen on the left hand side of the image.

The left-hand frame of Figure 1 shows a schematic of the orbital configuration of the STEREO spacecraft, relative to the Sun and the Earth, and also indicates the location of other relevant near-Earth spacecraft. The HI cameras on both STEREO spacecraft are mounted such that their fields-of-view look towards the Sun-Earth line. The right-hand frame of Figure 1 presents an image from the near-Sun (inner) HI-1 camera on STEREO-A, taken on 8 June 2012 at 04:49 UT. The HI-1 cameras have a 20^{o}x20^{o} wide field-of-view, centred on the ecliptic plane, with a bore-site that is aligned at an angle 14^{o} from Sun-centre (the Sun is 4^{o} off the right-hand side of the image). A complex CME can be seen propagating into the heliosphere.

The original rationale behind the STEREO mission was the study of CMEs in the heliosphere, with particular emphasis on those CMEs directed towards Earth. However, various lines of research have evolved, that focus not only on the study of CMEs, for example:

- the identification and tracking of CMEs (e.g. Harrison *et al.* 2008; 2009),
- the prediction of CME arrival at Earth (e.g. Davis *et al.* 2009),
- the comparison of CME imaging with in-situ observations (e.g. Möstl *et al.* 2009),
- the identification and tracking of CIRs-associated features (e.g. Rouillard *et al.* 2008; 2009)

Following this, a number of key techniques have emerged, including the application to heliospheric imaging of the so-called J-map method (e.g. Davies *et al.* 2009; see Figure 2 below). J-maps (a common name for time-elongation maps) comprise stack-plots of white-light intensity (Y-axis) along a defined solar position angle – usually the ecliptic – as a function of time (X-axis). Any outward-moving solar wind transient feature appears as a diagonal line with a positive slope. The shape of that line carries crucial information about the radial speed and the 3-dimensional trajectory of the solar wind transient, purely from geometrical considerations. Thus the time-elongation profiles of solar wind transients observed by a single-spacecraft, and extracted from such J-maps, can be used to retrieve the kinematic properties of CMEs and CIRs. Retrieving the speed and 3-D trajectory of solar transients from their time-elongation profiles in this way is a powerful tool for identifying potential planetary impact. The analysis relies on the need to assume a geometrical model for the form of the solar transient. Three basic geometrical models are used, namely (1) the Fixed Phi (or FP) model (see e.g. Rouillard *et al.* 2008) in which the solar wind transient (be it a CME or a CIR-associate plasma blob) is assumed to be a point-source, (2) the Harmonic Mean (HM) model (see e.g. Lugaz *et al.* 2010) in which the solar wind transient is assumed to take the form of a circle anchored to Sun-centre by a point on its circumference, and (3) the Self-Similar Expansion (SSE) model (Davies *et al.* 2012) in which the transient is assumed to be circle that is not necessarily anchored to the Sun but defined in terms of the half angle that it subtends at Sun-centre) These three geometrical models are becoming the standards by which we retrieve basic CME propagation characteristics from HI observations (though, in reality, the FP and HM methods are limiting cases of the SSE model). These three models are shown schematically in Figure 3. It is important to note that these models can also be applied stereoscopically, where twin-spacecraft observations of a solar wind transient are available.

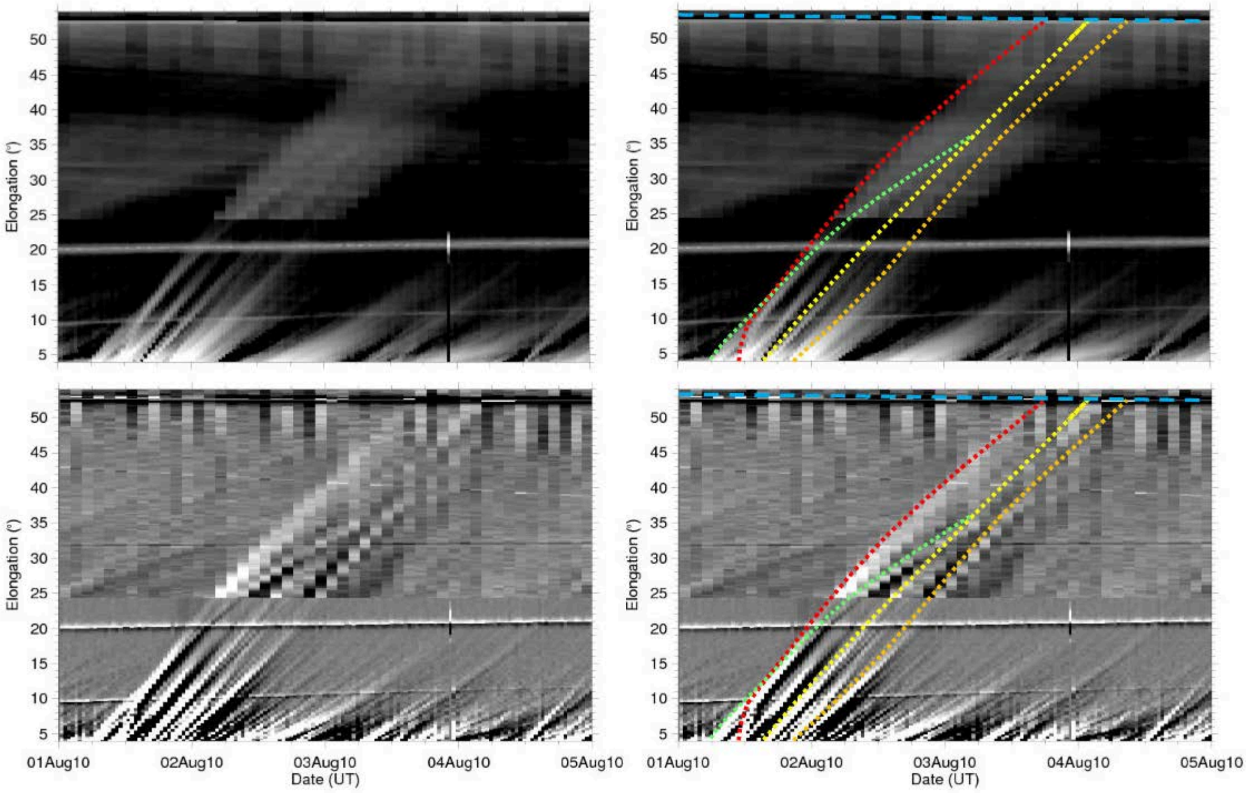

Fig. 2: Time-elongation maps (J-maps; e.g. Davies et al. 2009) showing a sequence of CMEs launched on 1st August 2010. Observations taken in the ecliptic plane are presented. Upper frames show background-subtracted data; lower frames use an image differencing technique. Right-hand frames are overlaid with the tracks that were used to extract the kinematic properties of these CMEs using FP and HM models (from Harrison et al. 2012).

The analysis of CMEs using these simple geometrical models is being complimented by the development of forward modelling, in which images of CMEs in the corona are 're-created' through mass-loading a 3-D model structure (usually a flux rope) to mimic the image (e.g. Thernisien *et al.* 2006). This technique is now being applied to CMEs in the heliosphere (e.g. Bosman *et al.* 2012;

Cremades and Bothmer 2004). Such modelling can provide more realistic topologies, but with greater computational needs, in particular for studies of CME propagation. Moreover, numerical models, such as the ENLIL model (Odstrcil and Pizzo 2009), are being applied. ENLIL is an MHD model of the inner heliosphere that uses a projection of photospheric magnetic mapping to define a background heliosphere into which CMEs are injected, based on CME speed, direction and size, determined from coronagraph data. The model is an effective method for exploring the development of CIRs and CMEs in the heliosphere and is geared in particular to space weather applications. Figure 4 shows an image from an ENLIL run for the CME launched on 7th March 2012.

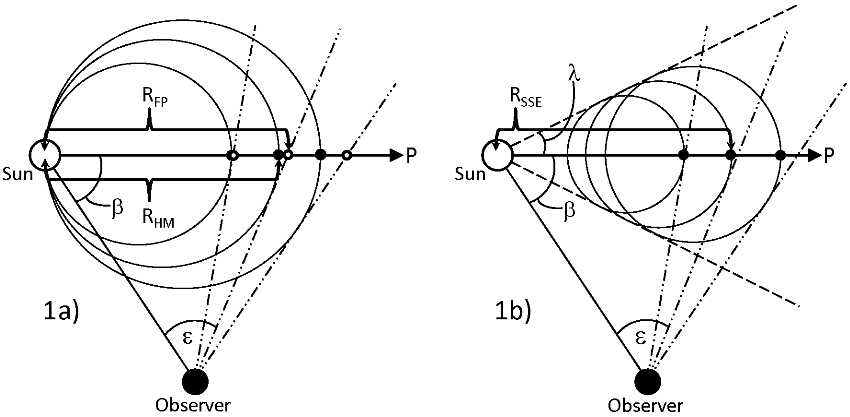

Fig 3: The geometry of the FP, HM and SSE models (taken from Davies et al. 2012). The FP (HM) model is indicated by the black dots (large circles) in (a). (b) shows the SSE model. ε denotes elongation, β is the propagation angle relative to the Sun-observer line.

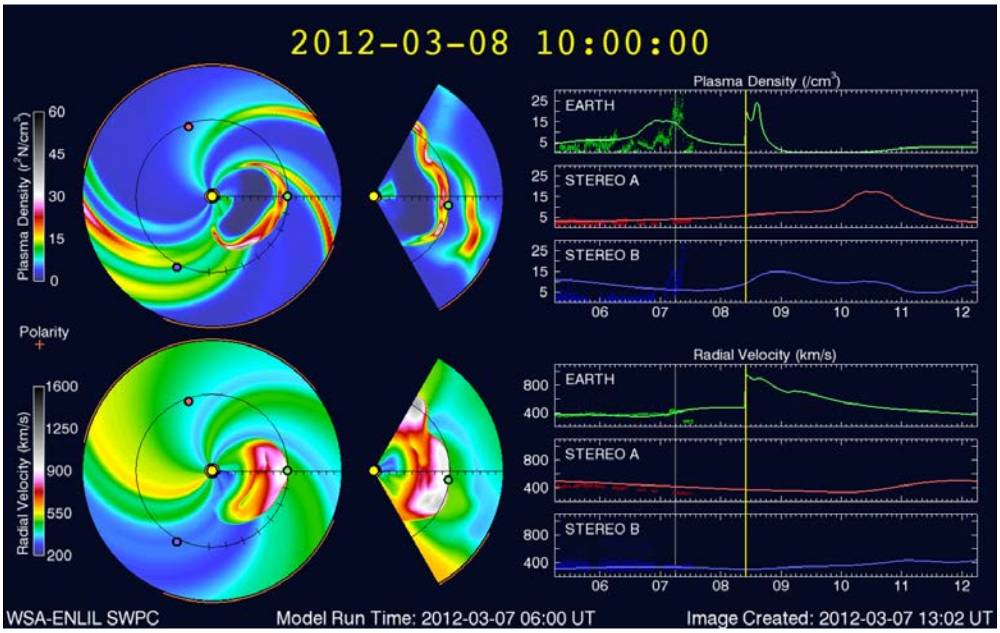

Fig.4: A snapshot from an ENLIL run (7th March 2012 CME) showing the distribution of plasma density (top left) and radial velocity (bottom left). The background solar wind structure was determined using the photospheric magnetic structure and the CME was defined using coronagraph data. The Sun, Earth and STEREO-A and B are denoted by yellow, green, red and blue dots. Density and velocity time-profiles are also shown for the locations of Earth, and the two STEREO spacecraft.

One of the outstanding observational breakthroughs of STEREO/HI has been the identification of signatures of CIR structures, through the detection of density 'blobs' entrained at the stream interface (Rouillard *et al*., 2008; Sheeley *et al*., 2008a,b; Harrison *et al*., 2009; Rouillard *et al.,* 2009). These blobs, which act as tracers for the CIR itself, allow detailed analysis of CIR structure and evolution as never before, in particular using the geometrical modelling of time-elongation profiles extracted from the J-maps. The HELCATS work is intended to extend this innovative capability to catalogue CIRs, and investigate their impact at various points in the heliosphere, including Earth (in an analogous manner to with CME investigations); this providing a level of completeness that is rarely possible.

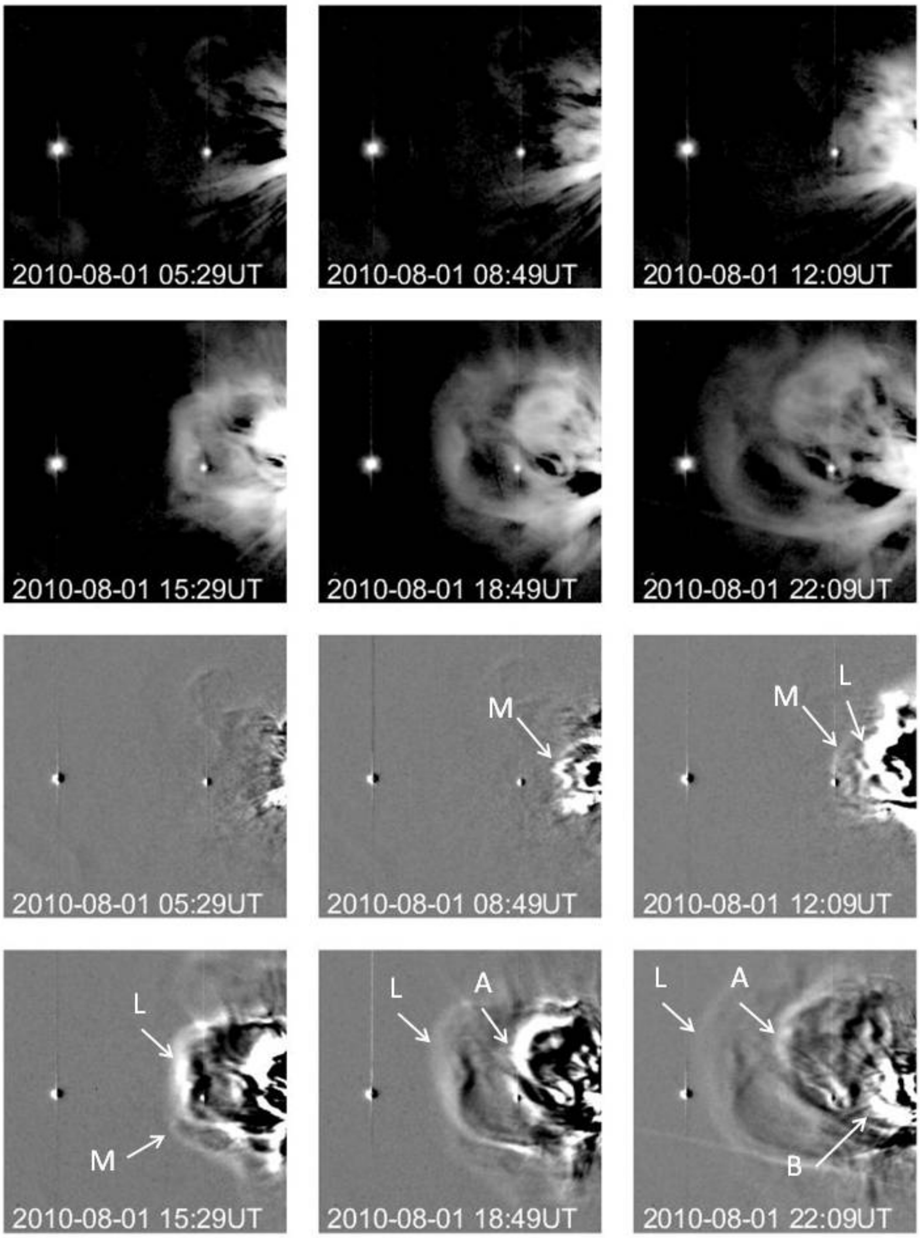

Fig.5: HI-1 data from STEREO-A showing the CMEs of 1st August 2010. The upper images are background subtracted; the lower images use a differencing technique. Four CMEs are labelled (lower panels only), three of which impacted the Earth. The CMEs were detected by a variety of imaging instruments, on various spacecraft, and by in-situ devices on spacecraft near the Earth and other planets. Mercury and Venus are visible in the images. These multi-spacecraft observations spawned multiple papers, including those by Harrison et al. (2012), Möstl et al. (2012) and Temmer et al. (2012). The modelling techniques discussed in this project were used extensively in these publications.

HI analyses have often incorporated in-situ observations, with the aim of correlating plasma and magnetic field measurements with white-light imagery. Such analyses, usually performed on a case-by-case basis, have included in-situ data from Cluster, ACE, Wind, Mars Express, Venus Express, MESSENGER and SOHO, as well as in-situ measurements from the STEREO spacecraft themselves. Comparing the results of modelling of HI data with associated in-situ measurements can provide the validation for particular analysis strategies, and can provide valuable insights into solar transient impact at specified heliospheric locations. In parallel, coronal, chromospheric and photospheric observations (from missions such as SOHO, Hinode, SDO and, again, STEREO) have been used, again on a case-by-case basis, to investigate the solar sources of heliospheric phenomena, by back-projecting to the Sun. Several of the studies referenced above incorporate data from multiple spacecraft. For example, multi-spacecraft analysis of the series of CMEs launched on 1st August 2010 yielded a large number of papers including those by Harrison *et al.* (2012; see Figure 5), Möstl *et al.* (2012) and Temmer *et al.* (2012). The STEREO/HI CME observations from this interval are illustrated in Figure 5.

In a number of HI-based studies, ground-based and space-based radio observations have also been included. Interplanetary Scintillation (IPS) of radio signals from point-like radio sources (quasars) can be used to retrieve solar wind parameters - including those of CMEs - using, for example, the ground-based EISCAT and LOFAR radio receivers (e.g. Dorrian *et al.* 2010; Bisi *et al*. 2010a, 2010b). Variations in the level of scintillation relate to solar wind density; solar wind speed can be retrieved if signals from the same radio source are received at spatially-separated receiver sites.

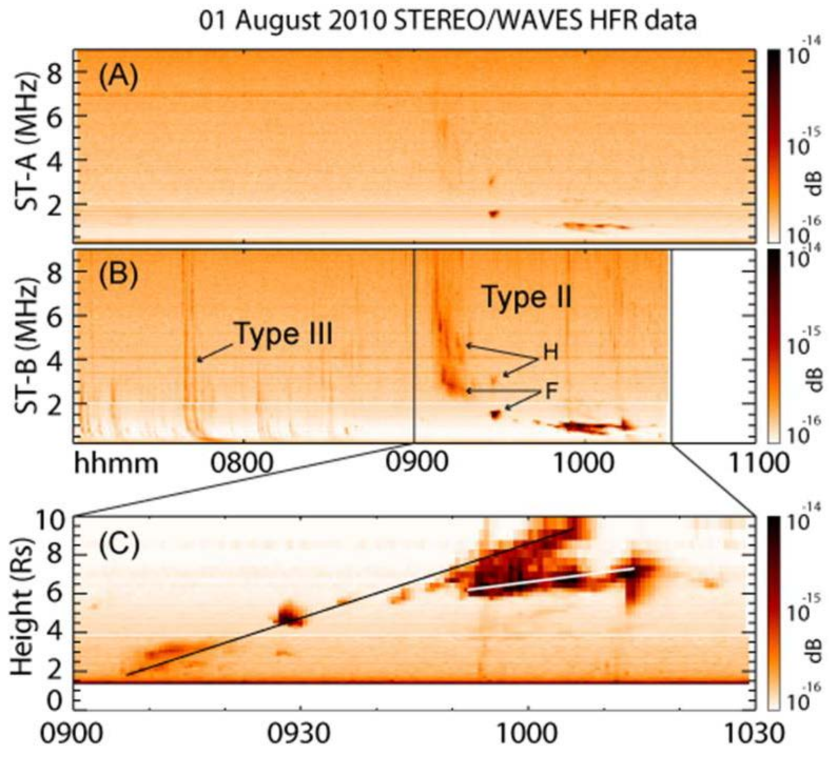

Fig. 6: Metric radio Type II observations relating to the 1st August 2010 CMEs, recorded by the S/WAVES instruments on STEREO. These observations were used in the multi-wavelength, multi-instrument analysis presented by Harrison et al. (2012).

We have long known that so-called Type II metric radio bursts, which decrease in frequency with time, are generated as shocks propagate out from the Sun, and that such shocks are associated with CMEs. Such radio observations can be made by spacecraft, or by the ground using facilities such as the Nançay radioheliograph in France (Pick 1999; Bastian *et al*. 2001). The inclusion of Type II radio measurements in HI-based analyses has provided useful additional information in a number of specific studies (see Figure 6). Again such coordinated analysis of white-light imagery and radio burst observations has been performed only on a case-by-case basis.

The inclusion of IPS and Type II radio observations in heliospheric imaging studies of CMEs and CIRs, can greatly enhance these studies through the provision of additional information on such properties as solar transient speed and structure.

The HI-oriented HELCATS project is focused on the propagation of plasma density structures through the inner heliosphere. We know that shocks, that can travel ahead of CMEs, can accelerate so-called Solar Energetic Particles (SEPs). Thus, although HI does not directly detect such accelerated particles, assimilating the HI data into numerical simulations can provide valuable information on such acceleration processes. This was demonstrated by Rouillard *et al.* (2011) who used HI data to specify the boundary conditions of the 3rd April 2010 CME, and then simulated the CME propagation using ENLIL. This allowed the authors to determine the time that near-Earth spacecraft were magnetically connected to the CME shock, and hence explain the apparently delayed-onset of such SEPs. As well as being a pointer to fundamental shock process, SEPs can have serious space weather implications.

What we have described is a vibrant field of research, building on the revolutionary development of Heliospheric Imaging. HI has considerable importance for our understanding of basic heliophysical (and indeed fundamental plasma) processes and is also of great relevance for the planet on which we live through its implications for space weather science and applications. However, it is clear that the relevant communities (solar, space environment, near-Earth space, space weather) would benefit enormously from a consolidation exercise. This is the purpose of the HELCATS project. There is a need for information and tools that enable the combined data-sets to be exploited to their fullest, and there is also a need for inter-comparison and validation of the variety of relevant models. Given the European lead in this field, it is natural that this should be done through an FP7 project.

Thus, our basic premise is the following:

The concept for the HELCATS proposal comes out of the recognition that there is potential for adding considerable value, for scientific exploitation and space weather studies alike, that can be gained by pooling the considerable and world-leading European expertise in this field (in terms of science, instrumentation, modelling, etc). A programme of cataloguing, modelling validation and information provision would clearly bolster community-wide research into the physics of the heliosphere – the volume of space in which we live.

and we can state our overall objective as the following:

Our aim is to enhance considerably the European lead in this key area of science research by applying a coordinated approach to provision of techniques, tools, and data access. This goes beyond providing post-launch support for the STEREO instruments alone and beyond the individual research interests of groups around Europe.

The specific objectives that outline the work plan of the project are bulleted items on pages 4 and 5; how this fits with the requirements of the call is discussed on page 5.

B1.2. Progress beyond the state-of-the-art

In outlining the concept of the HELCATS project, Section B1.1 has provided a basic review of the state of the art with regard to the HI-related research. However, due to the volume of such research, it was necessarily selective. The relevant STEREO websites, both in the UK and in the USA (namely http://www.stereo.rl.ac.uk/Documents/STEREO_publications.pdf and http://stereo-ssc.nascom.nasa.gov/publications.shtml) list around 180 publications that exploit the HI observations from the STEREO mission to date (as of December 2013). This illustrates the extent of active research in this field. Active research topics include: identifying and tracking CMEs and CIRs as they propagate through the heliosphere; studying impacts of CMEs and CIRs at Earth and other solar system locations; identifying the solar sources of CIMEs and CIRs. There has also been research into the effect of the solar wind on comets. Much of what is listed would not have been possible prior to the maturing of Heliospheric Imaging. However, there has been little coordination between cataloguing and modelling activities, or between the different communities involved (e.g. white-light imaging and in-situ groups, or solar and magnetospheric groups) and much can be gained through such a coordination exercise. ***Therefore, this defines the current 'baseline' upon which the project builds; the following paragraphs outline how the project progresses beyond that baseline, and how the success of that work would be measured.***

The core of the project is the production of a comprehensive catalogue of CMEs ***in the heliosphere***. This is the foundation on which the project is built. HELCATS would yield the first comprehensive catalogue of interplanetary CMEs for the STEREO-era (from 2007 to date). By systematically applying geometrical and forward models (see B1.1) we will augment the basic observational catalogue parameters such as trajectory, speed, and projected CME launch and arrival times (at Earth and elsewhere). Such a complete catalogue of CMEs in the heliosphere would be a valuable facility for a large number of researchers in Europe and world-wide, particularly in areas such as solar, heliospheric, magnetospheric and planetary physics. The fact that the UK PI team of the STEREO heliospheric imagers is leading the proposed project will ensure that the catalogue is fully endorsed by those who have a thorough understanding of the instrumentation involved. While the data analysis that generates the event listing is best done through that UK PI team, the key European expertise in developing and applying geometrical and forward models also resides in Austria and Germany. Other issues related to the catalogue production also demand particular expertise, found across Europe (such as Belgium's expertise in automated techniques for CME detection). ***The catalogue is the prime deliverable of the first phase of the HELCATS project; it will be freely available, enabling a wide range of research activities. Thus, the report and research papers that emerge in the later phases of the HELCATS project, as well as research publications from the wider community, are a direct measure of the success of this facility.***

The production of the STEREO/HI CME catalogue, including the systematic application of the aforementioned models to generate CME kinematic properties, allows us to embark on a comparison with in-situ measurements taken near Earth and elsewhere. This enables us to address the question of what plasma and magnetic field signatures are associated with the CMEs that have been imaged remotely. This involves correlating the STEREO/HI CME catalogue with catalogues of in-situ CME signatures from a range of spacecraft near Earth (ACE, Wind, SOHO, Cluster) and elsewhere (Venus Express, Mars Express, MESSENGER). In HELCATS, this will be done systematically for the first time. As well as providing a useful facility for correlating remote-sensing and in-situ measurements of CMEs, this activity enables validation of the geometrical and forward modelling. We can compare the projected arrival times/speeds with the in-situ data and provide a robust assessment of the success of the different models. Again, no such validation exercise has been performed to date. This work will be published in the open literature and will provide valuable information for those wishing to apply models of CMEs in the heliosphere for future research and space weather applications. The combination of in-situ expertise and modelling experience demands involvement from teams from Austria, Finland and the UK. ***The exploitation of the initial CME catalogues, bringing in comparisons to in-situ observations and the modelling activities feed into both research projects and to a wide range of space weather applications. This work should act as a benchmark that will pave the way to future strategies in modelling and research. Thus, its success will be measured through the reports and publications from the HELCATS projects and the wider research publications and space weather applications in the coming years.***

In parallel with the comparisons of white-light imaging and in-situ observations, back-projections provided by the HI cataloguing/modelling activities will be used to examine the solar 'surface' activity associated with CME launch (active regions, prominence eruptions, flares, etc), systematically over large numbers of events. Use of spacecraft observations from SDO, SOHO, Hinode and STEREO, as well as ground-based observations in, for example, H-alpha, will enable scientists to systematically investigate the CME onset process, while also enabling the assessment of the assumptions that feed the models. These aspects will, again, be subject to publication in the open literature and will, again, be valuable information for the application of models for CME onsets in future years. In this case, the combination of expertise in solar phenomena and modelling experience required resides in Germany, Belgium, Ireland and the UK. ***Success in identifying CME onset phenomena using this uniquely large and comprehensive dataset can also be exploited for space weather applications; this work will also be the subject of a number of research publications.***

Much of the logic regarding CME cataloguing, modelling, and model validation through comparisons to signatures observed at the Sun and in-situ, applies equally to CIRs. CIRs represent the major, non-CME, solar wind phenomena encountered by Earth. The world-leading expertise for this resides squarely in France. Never before has a catalogue of CIRs observed by white-light imaging – including information on their spatial extent and temporal variations – been produced. Like the CME catalogue, the CIR catalogue will be openly-available. Exercises in validation will be published in the open literature, as for the CME work above. ***The unique capability of the HI instruments to image CIRs allows us to produce a parallel CIR catalogue, including modelling results of their kinematic and spatial properties; this will the same benefits for wider research and space weather applications as the CME work.***

The thorough and systematic activities in CME and CIR cataloguing and modelling, and model validation essentially consolidate the plethora of activities that have, up to now, been performed in an ad-hoc manner. Undertaking such activities in a coordinated way will ensure the most effective exploitation of the data and techniques in the future. There can be no doubt that this is both timely and an extremely valuable exercise for the future direction of research in this field. To round off the project, there are two additional areas that we include (discussed in the following paragraphs).

Firstly, we note that the aforementioned models of solar wind transients are basic by design. However, they are tools that are commonly applied, and although they show good potential for the parameterisation of events, they contain no physics. So we need to consider more advanced numerical codes. Our aim is to assess the potential of using HI observations to drive such codes. The ENLIL MHD code of the inner heliosphere (see section B1.1) allows the global modelling of density and velocity in the inner heliosphere. In its standard implementation, the background solar wind is characterised using observations of photospheric magnetic fields, and the CMEs launched into it are characterised using coronagraph data. The aim here is to assess the added value of assimilating HI data into ENLIL, both in terms of characterising background conditions and the CMEs. Assessing the added value of using HI data, involves the comparison with 'traditional' ENLIL runs. 'Success' will be assessed through comparison with in-situ data. This will be performed for a range of mainly Earth-directed CMEs. The use of complex numerical modelling will also be compared with the more basic approaches of geometric and forward modelling. A comprehensive report on all of this work will be published. The work naturally harnesses expertise from France, but with an expert group in the US as a third party. A validation exercise of the kind proposed in this work package has never been done before. ***Thus, the outcome of HELCATS for the modelling of solar wind transients is an advancement in terms of current techniques applied to space weather forecasting, signifying a clear benefit.***

The second additional area to consider is the complementarity of additional datasets. Two in particular have been singled out due to their potential: IPS and Type II radio burst data (see previous section). The advent of LOFAR has seen a recent increase in Europe's ability to make IPS observations of the solar wind. In conjunction with observations from the European EISCAT system, we will systematically catalogue IPS features that are associated with events in the STEREO/HI CME and CIR catalogues. We will assess how IPS can contribute to the cataloguing activities - the potential for adding of IPS-derived speeds, for example. IPS can provide ground-truth information at specified locations for particular events, and the use of this information needs to be investigated as part of a coordinated campaign. Thus, we plan to incorporate this as part of the current project, noting that the relevant expertise resides in the UK. The inclusion of Type II radio burst observations, from the ground or space, is also recognised as being a key feature in solar wind physics. Type II radio bursts are a recognised tool for analysing the passage of shocks, making them highly complementary to the HI observations of CMEs. Type II radio burst catalogues will be compared with the STEREO/HI CME catalogue. Not all CMEs have Type II signatures and there is a clear need to investigate why this is. If we can such see evidence for a shock, how does that relate to the characteristics of the CME observed in white-light imagery? The results of this work will be published; the HELCATS expertise on Type II radio burst resides in the UK. ***Therefore, the HELCATS project also explores aspects of radio science that can enhance future observational programmes, resulting in the first instance in publications and reports that define such an observational strategy.***

We note here that the value of ground-based observations in the study of CMEs in the heliosphere has been somewhat limited. Whilst ground-based radio observations in particular have been used in a number of studies involving CMEs observed using STEREO data, it is clear that much more can be done. Thus, our activities in WP7 to investigate IPS and Type II associations are, in part, an attempt to assess the impact that such data can play in the development of this field, potentially consolidating a ground-based effort in the world-wide studies of solar wind transients. On the other hand, as noted above, ground-based solar 'surface' observations are critical for the study of associations with CME onsets, and this forms part of WP4. This can include synoptic observations made in H-alpha, in particular, for the associations of flare and prominence activity, in parallel with spacecraft observations in wavelengths that cannot be seen from the ground.

We have described above a consolidation exercise that will provide the wider research community with unprecedented access to catalogues, and assessments of models and methods. **These activities *are easily quantifiable in terms of progress achieved and deliverables for the wider community to exploit.*** HELCATS will be highly influential on the future strategy for heliospheric science and space weather. ***The performance of the project is measurable by the productivity, in terms of publications and reports, of the consortium members, but also by the publications that will result from the wider community due to their uptake of the unique catalogues. Given the uniqueness of the observations, the strength of the team, and the potential for wide exploitation in the growing space weather arena, the products of this project are extremely likely to have a major impact on the field.*** Thus, we feel that this work is both timely and valuable, providing tools to enhance European leadership and investments.

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B1.3. Science and technology methodology and associated work plan

Overall Strategy: The fundamental aim of the HELCATS project is to start with heliospheric imaging observations and, from that, build up facilities, methods and assessment studies in a logical programme of activities. The work will be managed by STFC, involving a total of eight European research groups. The details of the Work Packages (WPs) are given in Annex 1 – Part A, as are the tasks, deliverables and milestones. The schedule for meetings and reviews is defined in the management section of the current document. The activities of the groups are tailored to their scientific and technical strengths, maximizing the potential scientific return for the project. However, to mitigate any unforeseen events, we include a risk plan in this section.

Here, we describe the WP structure and refer the reader to the workflow diagram, and to the detailed WP descriptions, including tasks and deliverables, in Annex 1A:

<u>WP1: Management</u> The consortium includes 8 European groups from 7 EU countries and two third parties. The project coordinates work involving observations, cataloguing, modelling, and studies in validation and assessment. WP covers the formal management roles of the HELCATS project. This includes administrative tasks, maintaining project infrastructure, coordinating inputs and reporting as required and handling a range of project issues. WP1 will oversee the website production and management.

<u>WP2: Producing a definitive catalogue of CMEs imaged by STEREO/HI</u> This WP provides the foundation for this project (including scientific coordination), namely the production of a catalogue of CMEs in the heliosphere. The catalogue will be produced from manual inspection of STEREO/HI data but use of automated techniques will be investigated. Comparisons with coronal CME catalogues will be made.

<u>WP3: Deriving/cataloguing the kinematic properties of STEREO/HI CMEs based on geometrical and forward modelling</u> Here we apply recently established geometrical, forward and (prototype) inverse modelling methods to derive CME parameters, which will be added to the catalogue (including back- and forward-projections to ‘predict’ CME launch and arrivals at various solar system locations). Comparisons will be made between the parameters yielded by the different models.

<u>WP4: Verifying the kinematic properties of STEREO/HI CMEs against in-situ CME observations and coronal sources</u> This WP catalogues in-situ CME information (at Earth and elsewhere) for comparison to the projected data from WP3 in order to assess the performance of the aforementioned models. Similarly, comparisons are made with solar ‘surface’ phenomena. These allow a thorough validation of the models.

<u>WP5: Producing a definitive catalogue of CIRs imaged by STEREO/HI that includes verified model-derived kinematic properties</u> In parallel with the CME cataloguing, modelling and model assessment in WP2-4, this WP performs an analogous activity for CIRs, again with cataloguing, geometrical modelling and the validation of results through comparisons to in-situ/solar data.

<u>WP6: Initialising advanced numerical models based on the kinematic properties of STEREO/HI CMEs and CIRs</u> This WP recognises the potential for using HI data as input to numerical MHD models of the heliosphere (in terms of both CME and CIR phenomena) by considering the use of HI images for initialisation/driving of the ENLIL model. The results will be compared to traditional methods for running such models, based on coronal and photospheric inputs, to assess their potential.

<u>WP7: Assessing the complementary nature of radio measurements of solar wind transients</u> WP7 explores the value of incorporating radio observations, to augment the HI data. It assesses the value of using interplanetary scintillation (IPS) observations and Type II radio burst data in conjunction with HI data, both of which can provide additional information.

<u>WP8: Dissemination</u> WP8 brings the results to the community through (1) the publication of results in the open, refereed literature, (2) the running of annual open meetings, (3) the installation of all relevant documentation, catalogues and reports on the website and (4) the dissemination of information to the public and policy makers. This includes ingestion of the products into the AMDA data-mining tool the IRAP propagation tool, and integration with projects such as HELIO. This WP coordinates the exploitation of the project outputs, such that they feed into numerous research activities and future space weather applications.

Overall, the HELCATS strategy is to coordinate a range of observational and modelling studies of heliospheric phenomena to provide a foundation for enhancing the scientific discipline and the exploitation of European investment in the hardware involved.

Table 1.3 shows an overview of the WP listing, including WP managers and schedule. Again, for the detailed WP descriptions, tasks, deliverables and milestones, refer to Annex 1 – Part A.

HELCATS workflow diagram

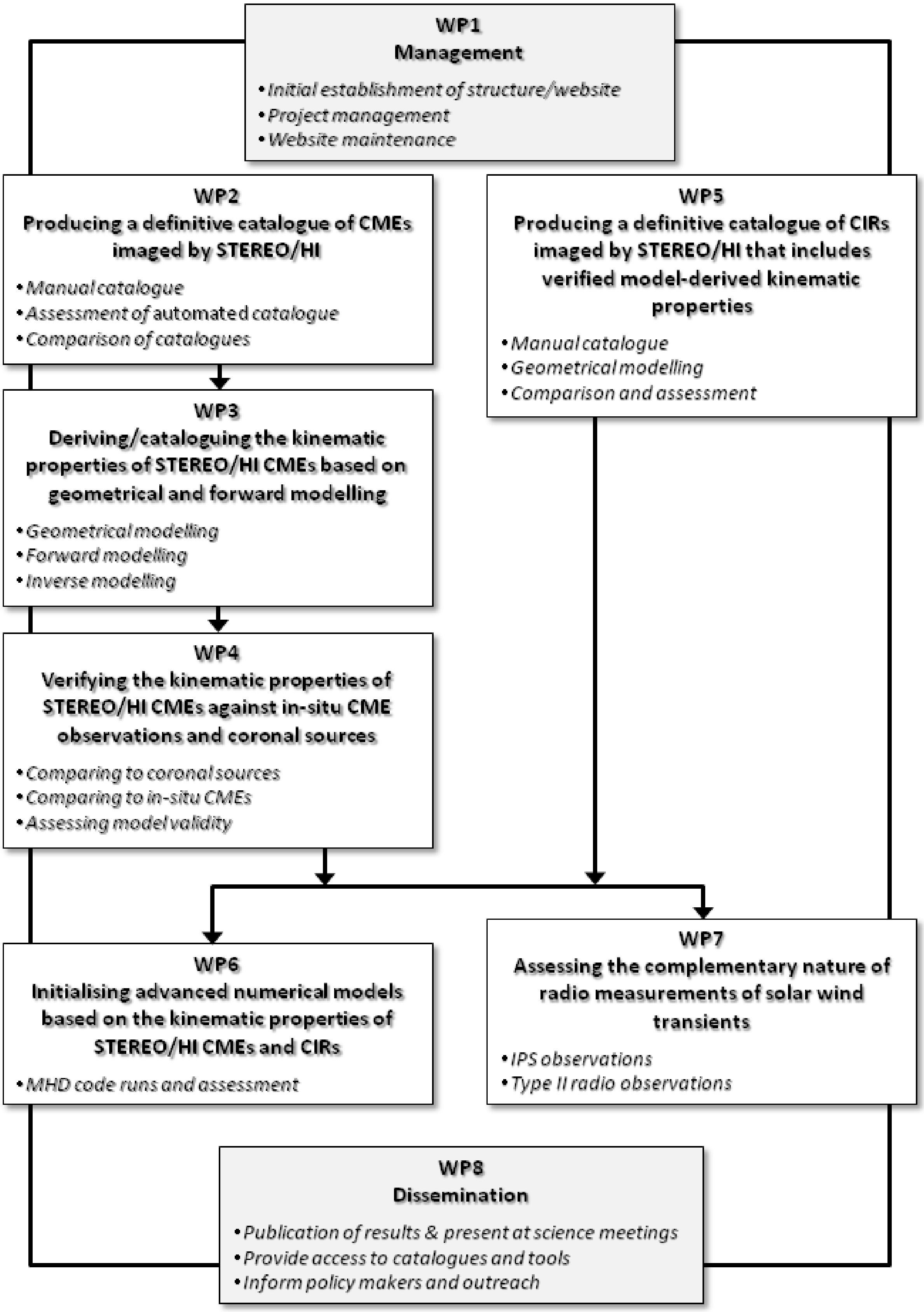

Table 1.3: Work package list

Work package No.	Work package title	Type of activity	Lead beneficiary No.	Lead beneficiary short name	Person months	Start month	End month
WP1	Management	MGT	1	STFC	8.5	1	36
WP2	Producing a definitive catalogue of CMEs imaged by STEREO/HI	RTD	1	STFC	51.5	1	36
WP3	Deriving/cataloguing the kinematic properties of STEREO/HI CMEs based on geometrical and forward modelling	RTD	4	UGOE	51	7	36
WP4	Verifying the kinematic properties of STEREO/HI CMEs against in-situ CME observations and coronal sources	RTD	2	UNIGRAZ	68	10	36
WP5	Producing a definitive catalogue of CIRs imaged by STEREO/HI that includes verified model-derived kinematic properties	RTD	3	UPS	42	1	36
WP6	Initialising advanced numerical models based on the kinematic properties of STEREO/HI CMEs and CIRs	RTD	3	UPS	27	7	36
WP7	Assessing the complementary nature of radio measurements of solar wind transients	RTD	6	IMPERIAL	39.5	10	36
WP8	Dissemination	OTHER	1	STFC	21.5	1	36
				TOTAL	308		

Risk Plan

The risk plan philosophy is underpinned by the following: This is a low-risk project making use of existing instrumentation and data products, and using software that are already under development. It is based on collaboration between world-leading teams from Europe, with the required skill base to undertake the proposed work. Thus, in terms of technical readiness level, the project is at the maximum. It is the coordination of all of that expertise that yields something truly unique (as described in the work package descriptions and in Sections 1.1 and 1.2).

There are three general risks associated with the project, the first two of which are associated with any collaboration of this kind.

Risk	**Comment**	**Potential Impact**	**Mitigation Strategy**
Unforeseen loss of capability to perform the work at any of the collaborating institutes	Example: due to unexpected circumstances relating to loss of staff or closure.	The risk is that the project would be unable to complete the defined work.	Executive Board will take advice from the Steering Committee and the affected work will be reassigned within the remaining consortium; given the skill-base of the groups involved, this is a feasible option. Appropriate redirection of funds would be arranged.
Risks associated with the technical activities, such as the inability to complete a specific task could compromise an aspect of the project.	The project is set up as a coordination of well-tested and developing skills and activities with a very high 'technical readiness', making such a risk negligible.	However, the risk would be that a technical task could not be completed.	The Executive Board will take advice from the Steering Committee and the affected area of work would be reassigned to another group, that we believe could deliver the appropriate work, or the project would be reassessed to develop a work-around or alternative method as appropriate, with full discussion with the FP7 administrators.
Loss of the STEREO spacecraft and/or the STEREO/HI instruments	As long as one HI instrument is operational, the HELCATS project is not affected.	If both HI instrument operations are terminated the data-sets would be curtailed.	The project states that CME and CIR data form the core of the work, with the analysis of data from 2007 (start of operations), to date. In the event of HI-loss, new data would cease to be collected, but the study could be completed using the extant dataset. There is no impact on the results or the value of the project outcome.

The risk plan involves the assessment of all risks throughout the project. At the regular meetings, the Executive Board will review all activities to ensure that there are no signs of risks materializing. Risk will, therefore, always be included on meeting agendas.

B2. Implementation

B2.1. Management structure and procedures

The HELCATS consortium involves 8 administrative institutes, and two third-party institutes. The work involved in the HELCATS project includes scientific, instrumental, data and modelling aspects, brought together in a set of well-defined work packages that require the carefully managed transfer of products between the partners; this which requires an efficient level of communication and oversight. In addition, the management of financial issues and reporting requires careful attention. Thus, the following management plan is proposed to cater for these issues.

Organisational structure and decision-making mechanisms

The following organisational structure has been chosen to enable effective management and integration of the diverse elements of the HELCATS project, linking processes on a work package level to those that involve reporting to the FP7 programme.

The HELCATS project would be overseen by a **Project Coordinator** who is the formal point of contact to the FP7 programme and who takes formal responsibility for the project. The Project Coordinator is responsible for all major project decisions, both political and strategic, whilst taking advice from the Executive Board and the Steering Committee.

The detailed direction of scientific and technical issues (and also some of the day-to-day running of the project) are managed by the **Scientific and Technical Manager**. Both the Project Coordinator and the Scientific and Technical Manager reside at the lead institute. The **Executive Board**, which is comprised of the Project Coordinator and the Scientific and Technical Manager, will act as the project management team, with responsibility for monitoring the progress of the project and ensuring that decisions taken at all levels are implemented. Such a small team is necessary to deliver clear and decisive management on short time-scales.

The Executive Board interfaces directly with the other 7 institute leads who make up the **Steering Committee** (including the Project Coordinator and the Scientific and Technical Manager). **We include all institute leads in the Steering Committee, not just WP leads, to ensure that all institutes are fully represented in the decision making and reporting processes.** The Chair of the Steering Committee will be nominated during the kick-off meeting. The Steering Committee is at the core of the management structure from the technical perspective, making sure that the work packages have a common outlook and that the planned work is well coordinated. It is planned that the Steering Committee will have monthly meetings by teleconference (and more if necessary) as well as bi-annual face-to-face meetings. The Steering Committee will have formal responsibility to approve the quality of deliverables, before submission to the Executive Board. In case of disagreements, the Executive Board will make the final decision.

Each work package has a defined leader and, in most cases, involves several institutes (as defined in Annex 1 – Part A). Each institute has a named principal contact and key staff, listed in section B2.2.

We summarise the meeting schedule here:

- Kick-off meeting: Month 1 (involving all institutes)
- Monthly Steering Committee teleconferences (Steering Committee and Executive Board)
- Bi-annual face to face project meetings: Months 6, 12, 18, 24, 30, 36 (all institutes)
- Annual open workshops: Months 12, 24, 36 (open to the science community)

The annual open workshops are open to the wider scientific community, with the aim of disseminating the HELCATS outputs. In fact, in all meetings, we will not just monitor progress and oversee forthcoming activities and reports, but we will also adhere to the dissemination plan (see later) by ensuring that dissemination is always an agenda item. This will ensure that we manage appropriate interaction not just with the science community but also with the public, the media and policy makers (see section B3.2). As part of this we will also ensure that the project remains in close contact with the relevant programmes within ESA (the Space Situational Awareness space weather activity) and with the US Space Weather Prediction Center and the UK Met Office. Relaying our results and recommendations to these bodies is key to exploiting the activities of HELCATS and our relationship with them will be closely fostered throughout the project.

The key roles within the HELCATS management structure are:

The Project Coordinator: The Project Coordinator, Professor Richard Harrison (STFC), will have overall executive responsibility for the project and will provide leadership. The Coordinator will have prime responsibility for representing the project externally, including liaison with REA. He is formally the leader of work package 1.

The Scientific and Technical Manager: The Scientific and Technical Manager, Dr. Jackie Davies (STFC), has prime responsibility for ensuring the scientific coherence of the project and the quality of its outputs, and is in charge of the overall coordination of the various technical activities. She reports to the Project Coordinator. She is formally the leader of WP2. Thus, the majority of her activities are RTD effort, though she will participate in WP1 (MGT).

Work packages leaders: Work packages leaders will have day-to-day responsibility for achieving the milestones and deliverables of their work packages, within agreed timescales and budgets. They will monitor and report progress through the Executive Board and identify issues that may impact the project as a whole. With the Scientific and Technical Manager, work-package leaders will assure the quality of deliverables. The nominated WP leaders are as follows:

WP1: Professor Richard Harrison (STFC)
WP2: Dr. Jackie Davies (STFC)
WP3: Dr. Volker Bothmer (UGOE)
WP4: Dr. Christian Möstl (UNIGRAZ)
WP5: Dr. Alexis Rouillard (UPS)
WP6: Dr. Alexis Rouillard (UPS)
WP7: Dr. Jonathan Eastwood (IMPERIAL)
WP8: Dr. Chris Perry (STFC)

Principal values of the HELCATS management approach

The key values of the management approach that we have adopted are: excellence, responsiveness, timeliness, transparency and accountability. Scientific excellence is our main driver at every level of the project and in everything we do. All project activities will be monitored and benchmarked against international standards of scientific excellence, under the supervision of the Steering Committee and, ultimately, the Executive Board. Through bi-annual project meetings, where all technical teams of HELCATS will be expected to actively participate, all beneficiaries will feel a sense of shared ownership and responsibility for the project, not just the part with which they may be directly involved. This will help to maintain the engagement and commitment of all beneficiaries. In addition, the agenda and minutes of all project meetings (including the Steering Committee meetings) will be available in a private area of the project website. All beneficiaries will be encouraged to contribute ideas and opinions on issues under discussion in the Steering Committee.

Another major issue is to target the resources such that they will have the greatest impact, ensuring the most effective use of resources to achieve the project’s goals. The proposed management structure will ensure close oversight of the individual elements of the project and will ensure the ability to redirect resources as may be required by changing circumstances. This will be the responsibility of the Executive Board, acting on advice from the Steering Committee.

Transparency on decisions taken in each level is a vital element of the management. Decisions must be made, and must be seen to be made, against clear and relevant criteria for the benefit of the project, and in a timely manner. The Steering Committee and the Executive Board will ensure the availability of up-to-date consistent information to inform the team at all levels.

Finally, after the kick-off meeting, clear assignments and roles will be given to all the beneficiaries of HELCATS, with their responsibilities and lines of reporting well defined, to ensure the effective delivery of the project to time and budget.

Modification of responsibilities

It is possible that circumstances dictate a change in the project structure, for example, in response to a key individual moving institutes. Given the scientific and technical strengths of the consortium partners we are well able to redirect tasks to different groups or to recommend the inclusion of a new partner, or/and the removal of an existing partner. Such matters will be discussed by the Steering Committee, as required, either at the nominal telecons or meetings, or through an extraordinary telecon or meeting. The recommendations of the Steering Committee would then be discussed with REA and the conclusion implemented.

Dispute resolution

The consortium will try to ensure that issues are thoroughly discussed and resolved during the frequent conference calls and meetings. This will create a co-operative environment and reinforce the trust among the consortium members. In case any conflicts do arise from project activities, the Project Coordinator will support the parties in finding an amicable solution. Cases where the parties can not to reach an agreement will be referred to the Executive Board and Steering Committee for advice. If an agreement is not possible then the Project Coordinator will discuss the problem with the REA Project Officer in charge of the HELCATS project.

Monitoring progress

Progress will be monitored through regular meetings and reports:

- Progress will be monitored at the regular teleconferences, as well as at the bi-annual project meetings. The website will be used to record progress.

- Formal finance reports will be provided to REA in months 18 and 36. Technical reviews will be made at the same time. Intermediate technical reviews will be made at the six monthly project meetings, some of which will be attended by the Project Officer.

It is the responsibility of the work package leaders to ensure that the activities within their work packages progress as planned, and the responsibility of the Executive Board to ensure that the overall progress of the HELCATS project is maintained.

Table 2.1: Reporting and Review Schedule (formal submissions to REA in italics)

	Month	Comment
Kick-off meeting	1	2 day meeting of all institutes
Monthly teleconferences	Regular	Executive Board and Steering Committee
Bi-annual project meetings/workshops	6, 12, 18, 24, 30, 36	2 day meetings of Executive Board and Steering Committee
Technical reviews to REA	*18, 36*	*Formal technical reports to be submitted to REA*
Intermediate technical reviews	6, 12, 24, 30	Intermediate technical reviews, associated with the bi-annual project meetings, some of which will be attended by the REA Project Officer
Finance reports to REA	*18,36*	*Formal reports to be submitted to REA*
Annual open workshops with the science community	12, 24, 36	2 day meetings open to all
Science workshops	TBD	Attendance at regular science meetings (see table 2.4a)

Management tools

The programme will be monitored scientifically, technically, schedule-wise and financially. To facilitate this, the following tools will be put in place:

- A consortium website that will contain information about the project, including formal documentation about the work package structure, tasks, schedule and the management plan, as well as the project products.

- A teleconference schedule (as defined in the management plan) will be established as the principal, regular communication facility for all beneficiaries.

- Standard management tools, e.g. Open Office, will be adopted throughout the project to simplify the exchange of information.

- All of the formal documentation as well as code produced by the consortium, when appropriate, will be stored in a central "Documentation Repository" accessible through the consortium website. Advanced technology for archiving, monitoring and distributing information will be used to guarantee simple and efficient information distribution and update, including version control.

Consortium agreement and IPR

The Project Coordinator will design and implement a Consortium Agreement to set out in detail the rights, roles and responsibilities of beneficiaries, both to each other and towards REA.

The Consortium Agreement will address issues such as governing bodies and decision making; roles and responsibilities; intellectual property rights and access rights; liability and indemnification. The Consortium Agreement will regulate the organisation of work between the beneficiaries and organise the management of the project, in order to define the rights and obligations of the parties, including (but not limited to) their liability and indemnification, and to supplement the provisions of the Grant Agreement.

An advanced draft of the Consortium Agreement will be made available to the beneficiaries for discussion at the negotiations phase; once agreed by all concerned, the final version will be signed by all beneficiaries prior to signature of the Grant Agreement.

In addition to covering the responsibilities of the partners to the project, the Consortium Agreement will also set out the agreed position on intellectual property rights (IPR). It will include any declarations of pre-existing knowledge within the project (background IP) and define how the rights related to knowledge generated by the project (foreground IP) will be handled. However, we do note that this project makes extensive use of public domain scientific data produced using instrumentation led by members of the consortium, will produce catalogues open to the wider community, and will publish results in the open literature.

Risk management

The risk management plan is detailed in section B1.3.

B2.2. Individual beneficiaries

1 – Science and Technology Facilities Council (STFC)

Formed by Royal Charter in 2007 (as a merger of CCLRC and PPARC), STFC is one of Europe's largest multidisciplinary research organisations supporting scientists and engineers world-wide. STFC operates world-class, large-scale research facilities and provides strategic advice to the UK government on their development. It also manages international research projects in support of a broad cross-section of the UK research community. STFC also directs coordinates and funds research, education and training. STFC has a budget of around £530M per annum and employs more than 2200 staff. STFC's space department, *RAL Space*, located at the Rutherford Appleton Laboratory, has been at the forefront of UK space research for over 50 years, with a heritage illustrated by involvement in the development of over 200 instruments launched into space.

RAL Space has expertise in astrophysics, space environment physics and space weather, solar physics, Earth observation and atmospheric physics, with parallel associated activities in space instrument engineering and technology ranging from optics and detector technology to thermal engineering and assembly, integration and verification testing of space hardware. Activities include instrument operations (currently including instruments aboard the SOHO, Cluster, Herschel, Hinode and STEREO spacecraft) and leading roles in ground-based facilities (such as EISCAT and LOFAR UK) and archives (UK Solar System Data Centre; UKSSDC). HELCATS is focused on the *RAL Space* Solar Physics and Space Environment Groups whose leadership and expertise in the conception, development and operation of key instruments (e.g. aboard missions such as SOHO, STEREO and Cluster) and whose established scientific expertise in solar mass ejection and heliospheric physics, are central to the work described in this project. *RAL Space* has experience in FP7-funded activities, for example, ESPAS and HELIO.

Since the proposal of HELCATS, in November 2012, the key beneficiary at Aberystwyth University (Dr Mario Bisi) has moved to STFC. The work under WP7 that involved Aberystwyth University will now be performed by the same individual at STFC. Thus, we now incorporate this activity (Interplanetary Scintillation, IPS) within the STFC effort and Aberystwyth University is removed from the project.

Professor Richard Harrison (principal contact) is an internationally recognised expert in solar physics, with a 30 year heritage in solar mass ejection physics and studies of the corona and heliosphere, principally using extreme-UV spectroscopy and coronal/heliospheric imaging. He is Head of the Space Physics Division within *RAL Space,* is Principal Investigator (PI) for the HI instruments aboard the two NASA STEREO spacecraft and was PI for the ESA/NASA SOHO/CDS instrument from 1992 to 2004. He has been a Co-Investigator (Co-I) on numerous space missions and was one of the proposers of the ESA Solar Orbiter mission being developed for launch in 2017. He has over 200 research papers to his name, has honorary professorships at St Andrews University, Aberystwyth University and Imperial College, and was awarded the MBE in the Queen's honours list in 2004, for services to solar physics. In the same year he was awarded the Royal Astronomical Society Chapman medal. He will act as Project Coordinator for HELCATS, overseeing the management of the project and leading WP1.

Dr. Jackie Davies is an established space physicist, with experience in ionospheric, magnetospheric, and heliospheric physics through extensive involvement in a range of major ground- and space-based projects including EISCAT, SuperDARN, Cluster and STEREO. Her expertise is demonstrated by a publication list comprising almost 150 peer-reviewed papers, over a diverse range of topics including: natural and artificial heating processes in the ionosphere; signatures of magnetic reconnection on the magnetopause and in the magnetotail; tracking and geometric modelling of the white-light signatures of CMEs and CIR-associated transients using STEREO/HI. She is Project Scientist for STEREO/HI, has Co-I status on the RAPID instrument on Cluster, has been a member of several research networks under the auspices of the International

Space Science Institute (ISSI), and has been an external collaborator on a number of NASA proposals. She will act as Scientific and Technical Manager for the project, and lead WP2.

Dr Chris Perry is the leader of the Space Data Processing and Archiving group within RAL Space. He has more than two decades experience working with space science data processing, analysis, standards and dissemination in solar, heliospheric, magnetospheric and planetary domains. Roles have included technical manager of the ESA Cluster Active Archive, member of the SPASE space physics access standards consortium and manager for various instrumentation, software, study and post-launch support activities. He has been involved in, or interacted with, other FP7 projects including HELIO, ESPAS, ECLAT and MAARBLE. Dr Perry will lead the dissemination work package (WP8).

Dr. Mario Bisi was, until recently, a Post-Doctoral Research Associate at Aberystwyth University, where he was leader of the IPS and solar wind observation sub-group, with over 10-years' experience in IPS studies. He was a key player in the development of the ELB IPS experiment using EISCAT, ESR, and MERLIN. ELB IPS allows a far greater resolving capability of multiple solar wind velocity streams crossing the line of sight and for detailed determination of properties of each stream. He also co-led the recent ELB IPS observing campaign with a combination of EISCAT, ESR, LOFAR, and the present EISCAT_3D test bed, the Kilpisjärvi Atmospheric Imaging Receiver Array (KAIRA), across various frequencies. He is experienced in analysing various spacecraft data in order to support the IPS remote-sensing observations and 3-D reconstructions of the solar wind. Dr. Bisi's inclusion in HELCATS (WP7) is based on him being arguably Europe's foremost IPS researcher. He has now taken a post within *RAL Space* (STFC) as a research scientist and will perform the work through STFC.

2 – Universitaet Graz (UNIGRAZ) [University of Graz]

In Austria, research in the field of solar flares and CMEs, and their interplanetary consequences and space weather impact is mainly performed at the Institute of Physics of the Universitaet Graz (UNIGRAZ). UNIGRAZ is the second largest university in Austria, and its community is comprised of about 3,500 staff and 25,000 students.

The Institute of Physics has a solar and astrophysics research group that runs its own observatory, the Kanzelhöhe Observatory for Solar and Environmental Research, located 200 km from Graz. Kanzelhöhe Observatory is one of the main stations world-wide providing regular, high-cadence, full-disc observations of solar phenomena such as sunspots, flares and prominence eruptions. The Observatory provides ground-based support for space missions (e.g. SOHO, TRACE, RHESSI) and sends regular sunspot and solar flare reports to SIDC (ROB) and NGDC (US).

The solar and astrophysics research group at UNIGRAZ, including its Kanzelhöhe Observatory, currently consists of five scientific staff members: Manuela Temmer, Astrid Veronig, Arnold Hanslmeier, Ute Möstl and Werner Pötzi, who are engaged in many national and international collaborations. In addition, there are currently about ten PhD students involved in solar physics research, all third-party funded through national and international research projects. The research group has a strong focus on the physics of space-weather related events on the Sun, i.e. solar flares and CMEs, as well as their interplanetary propagation and Earth impact. The group has extensive experience in data analysis and interpretation from all recent solar and solar-wind dedicated space missions (STEREO, SDO, Hinode, TRACE, SOHO, RHESSI, GOES, ACE, Wind etc) as well as ground-based solar observations. The group is in close contact with the magnetospheric research group (led by R. Nakamura) and the Venus Express magnetometer PI (T. Zhang) at the Space Research Institute of the Austrian Academy of Sciences, also in Graz.

Dr. Christian Möstl (principal contact) will be team leader in charge of HELCATS at UNIGRAZ. He is an established post-doc researcher in the field of space weather, with more than 30 papers in international refereed journals, and is experienced in working in EU projects (COMESEP, Marie Curie International Outgoing Fellowship). He has organised a small STEREO workshop in Graz, 4 sessions at AGU and SHINE meetings, and has been awarded several young researcher prizes at a national level. His expertise concerns in particular the initiation, propagation, 3-D structure, and forecasting of CMEs and their sub-structures (such as magnetic clouds), and he has long experience with handling in-situ data from different sources. He pursues many international collaborations (e.g. NASA/JPL (USA), University of New Hampshire (USA), State Key Laboratory of Space Weather (China), University of Zagreb (Croatia) etc.). He recently joined the group of Janet Luhmann at the University of California, Berkeley, for one year, with an EU FP7 funded Marie Curie International Outgoing fellowship. Other UNIGRAZ staff involved will be Dr. Astrid Veronig and Dr. Manuela Temmer, who are experienced with many collaborative EU projects (eHEROES, COMESEP, HESPE) and many other third-party projects on a national level as PIs.

The main contributions of UNIGRAZ to the proposed HELCATS project will be to provide methods to extract CME properties from HI time-elongation data in collaboration with RAL (WP3), and to statistically analyse these results to compare with interplanetary CMEs detected in-situ (in collaboration with UH), in order to establish a catalogue useful for testing all kinds of space weather prediction models. Further, UNIGRAZ will coordinate WP4 to enhance the same catalogue to cover CMEs observed in-situ (together with others). The group has expertise in handling coronal and HI data and in-situ data of all kinds, from different spacecraft, including the modelling of flux ropes (Minimum Variance and Grad-Shafranov analysis), and also in using HI observations (WP3) to predict CME arrivals.

3 – Universite Paul Sabatier Toulouse III (UPS) [Paul Sabatier University, Toulouse]

The Institut de Recherche en Astrophysique et Planétologie (IRAP former CESR) is a joint research unit of the Universite Paul Sabatier Toulouse III (UPS) and the Centre National de la Recherche Scientifique (CNRS). IRAP is active in three main areas: solar system sciences, high energy astrophysics, and the cold universe, each covering theory, instrumentation, data interpretation, teaching and dissemination of knowledge. Research in the solar system group covers two main fields: (1) natural plasmas; the ionised surroundings of the Earth and planets, the Sun and the interplanetary space; (2) planetology; the surfaces and the atmospheres of planets and moons. The Solar System group of IRAP is renowned for its high level of expertise in data analysis software development (CLWeb, http://clweb.cesr.fr/). The Centre de Données de la Physique des Plasma (CDPP, Plasma Physics Data Centre, http://cdpp.cesr.fr/) is a data centre for space plasma data that is operated jointly by CNRS and Centre National d'Etude Spatiale (CNES). CDPP maintains a large and steadily growing database and provides access to some external databases through interoperable services. It has been instrumental in many European projects: HELIO, IMPex and EUROPLANET. The CDPP created the Automated Mutli-Dataset Analysis (AMDA) data-mining tool (reachable on the CDPP web server at http://cdpp-amda.cesr.fr/) that will be exploited in HELCATS. Additionally CDPP is currently creating a propagation tool that will facilitate comparison of solar and in-situ data. The tool, accessible to users in March 2013, will offer a web-based interface for users to visualise J-maps created from heliospheric images. The involvement of UPS/IRAP in the HELCATS project is therefore three-fold. It will provide (1) the science expertise necessary to analyse/catalogue CMEs, CIRs and blobs in imaging and in-situ data, (2) provide the scientific/technical expertise to assimilate HI data into numerical simulations, and (3) provide the technical expertise to integrate the HELCATS CME and CIR catalogues in the propagation tool in order to facilitate their visualisation and distribution. The in-situ CME and CIR lists will easily integrate into AMDA, also promoting distribution of the data.

Dr. Alexis Rouillard* (principal contact; permanent staff) will lead WP5 and WP6, and contribute to WP8. He has extensive experience in analysing HI images with 12 first-author papers exploiting HI images and over 50 refereed science articles on solar and heliospheric physics. He led the first studies on (1) the white-light detection of CIRs, (2) the simultaneous comparisons of CMEs in HI and in-situ data, (3) the assimilation of heliospheric images into solar wind numerical simulations. He is a CDPP scientific advisor and is supervising the creation of the propagation tool to be used in HELCATS. In 2013 he will receive the EGU outstanding young scientist award for his contribution to geophysics. ***see page 37 re CNRS association**

Dr. Benoit Lavraud* (permanent staff) will contribute mainly to WP4. He is an expert in solar wind and magnetospheric physics. He has worked on understanding plasma physics processes near CMEs and their geo-impact. He has published over 100 papers in the peer-reviewed literature and is the Editor of AGU's Geophysical Research Letters since 2010. He is science advisor for CDPP working on AMDA and has worked on the European HELIO project.

Dr. Vincent Génot (permanent staff) will help with WP8. He is the scientific director of CDPP. He is an expert on preparing and integrating catalogues within web-based tools (e.g. AMDA), connections and interfaces between databases and tools. He is the project scientist for the FP7 IMPEx project, project scientist for the (ESA) project Vispanet; support scientist for the FP7 EUROPLANET and HELIO projects. He is significantly involved in teaching at UPS, as a lecturer for Master level courses, supervisor for PhD students and advisor for post-docs.

Dr. Myriam Bouchemit* (permanent staff) will assist with WP6, and WP8 by helping with the creation of web services necessary to disseminate the HELCATS catalogues. She is currently responsible for the maintenance of the CDPP server. She is the AMDA technical manager, the flagship tool of CDPP for multi-missions multi-databases data analysis. She works on value-added services (webservices, catalogues, graphic display of data) for AMDA and EU projects (HELIO, EUROPLANET, IMPEX).

4 – Georg-August-Universitaet Goettingen Stiftung Oeffentlichen Rechts (UGOE) [University of Göttingen]

Space and ground-based solar physics and the origins of solar and stellar activity are key research areas of the Institute for Astrophysics at the Georg-August-Universitaet Goettingen Stiftung Oeffentlichen Rechts (UGOE), Germany. The institute's long tradition in ground-based observations, based on leading involvement in the Gregory, THEMIS and VTT telescope projects on Tenerife, has now been extended to space activities through Co-I and G-I involvement in the SOHO and STEREO missions, and the forthcoming Solar Orbiter and Solar Probe Plus missions. The institute's participation will be led by Dr. Volker Bothmer as head of the institute's research group on "Physics of the Sun and Heliosphere, solar activity and space weather, and space mission and instrument development" based on his leading role in international projects and his dedicated space physics expertise. The Institute offers a unique research environment, through state-of-the-art software and hardware and an excellent administrative infrastructure.

Dr. Volker Bothmer uses state-of-the-art spacecraft observations for research in solar and heliospheric physics. He was involved in planning and payload design of missions like STEREO, Solar Probe Plus where he also was a member of NASA's Science Definition Teams. He currently leads the German projects CGAUSS for Solar Probe Plus and Stereo/Corona. In recognition of his contribution (science and hardware) to the STEREO, Solar Probe Plus (planned launch 2018) and Solar Orbiter missions (planned launch 2017), he is Co-I of the SECCHI, WISPR and SOLO-HI cameras). Dr. Bothmer is co-ordinator of the EU FP7 project AFFECTS and leader of the UGOE contribution to the FP7 eHEROES project. He has successfully led WP3 "chromosphere and corona" for the FP7 SOTERIA project and has been involved in EU COST actions. His research focuses on the physics of CMES and their effects on geospace. Dr. Bothmer's university lectures include solar physics, ground- and space- instrumentation and data analysis techniques. Amongst the more than 100 publications as author/co-author there are science firsts, invited reviews, public outreach articles, and instrumentation and mission proposals. He has published as lead editor the books "Space Weather – Physics and Effects" (2006, Springer/Praxis) and the IAUS233 Proceeding's Volume "Solar Activity and its Magnetic Origin" (2006, CUP). He has organized international symposia and workshops and convened and chaired various conference sessions at major international meetings. He currently serves as secretary of the EGU, Co-chair of COSPAR sub-commission D2/E3 as member of ESA's SWWT and of the IAU. He is member of the editorial boards of AGU's Space Weather journal, and Springer/Praxis scientific book series.

Dr. Volker Bothmer (principal contact) will lead the UGOE HELCATS contribution. He will use his vast expertise to study the solar and heliospheric physics of CMEs and their interplanetary manifestations.

PhD student Eckard Bosman has gained EU-project experience from work within the SOTERIA and AFFECTS projects. His expertise is in 3-D modelling of CMEs.

PhD student Malte Venzmer has played a leading role in the FP7 AFFECTS project in work on the correlation of remote sensing and in-situ measurements (using STEREO, SDO, ACE data).

PhD student Adam Pluta has played a key role in AFFECTS, in the analysis of CMEs detected by STEREO and SOHO and in their heliospheric evolution.

Dr. Laura Volpes will provide expertise in HI modelling and J-map techniques.

UGOE are involved in WPs 2, 3 (lead) and 4. It is expected that undergraduate and graduate students will help actively fulfil the project goals. It is encouraged that the project enables suitable undergraduate and graduate students to actively gain first-hand research experience.

5 – Koninklijke Sterrenwacht van Belgie (ROB) [Royal Observatory of Belgium]

ROB is a Belgian government research institute organised into four operational directorates: Reference Systems and Planetology, Seismology and Gravimetry, Astronomy and Astrophysics, and finally Solar Physics and Space Weather. In total, ROB employs about 180 people. The operational directorate dedicated to solar physics (SIDC) has 42 members, including scientists, engineers and support staff. The research includes the study of magnetic reconnection, CMEs, solar wind, plasma flows in solar features, line-profile analysis, studies of the corona based on disc image or time series, and coronographic investigations in the heliosphere. The SIDC infrastructure includes a dedicated building for ground-based solar observing in which the Uccle Solar Equatorial Table (USET) is mounted with 4 operational telescopes. These telescopes (white light and H-alpha) operate on a daily basis and support the World Data Centre activities. In space, SIDC is PI of two instruments on board the PROBA2 mission: SWAP, a full-Sun EUV imager, and LYRA, a high-cadence radiometer. It is also co-PI institute of EUI, the EUV imager aboard Solar Orbiter. SIDC is also co-I on SOHO/EIT. SIDC scientists are also co-Is on STEREO, SDO and PICARD. ROB hosts a SDO data centre, the European root for distribution of SDO/AIA data, and whenever necessary, SDO/HMI data. Recently it became a Virtual Solar Observatory server in order to alleviate the load on the US server. ROB is also in charge of the Humain Radioastronomy Station.

Dr. Luciano Rodriguez (principal contact) will lead the ROB contribution to HELCATS. He is a post-doc with extensive experience in solar and heliospheric studies. His interests range from low coronal studies (e.g. 3-D reconstruction of loops and prominences) to in-situ analysis of solar wind and CMEs, also in connection with space weather. He works with data from different space missions (Ulysses, ACE, WIND, SOHO, STEREO) in particular relating solar to interplanetary phenomena. He is a Co-I of the EUI instrument on Solar Orbiter and on SWAP and Lyra on Proba2.

Dr. David Berghmans is Operational Director SIDC. His research interests cover all aspects of coronal physics and related fields. He has specific interest in image processing, and is the original developer of the CACTus automated tool for CME detections in coronagraph data, viz. http://sidc.be/cactus. He leads the PROBA2 science center that coordinates the operations of the SWAP and LYRA space weather instruments. He is co-PI in the EUI consortium that is preparing for the EUV imagers onboard Solar Orbiter.

Dr. Jasmina Magdalenic is a post-doc at ROB, with experience in multiwavelength analysis of coronal and interplanetary shock waves. She is an expert in radio signatures of shock waves, i.e. Type II bursts, in association with coronagraph and flare observations. Her scientific interests include dynamical processes in the solar atmosphere, flares, CMEs, and their relationship, flare-related radio signatures, CME dynamics, and coronal shock waves.

Dr. Marilena Mierla is a post-doc at ROB. She has experience in coronal observations and is an expert on the determination of 3-D CME parameters from SOHO and STEREO data. Her interests focus on white-light SOHO and STEREO data analysis, in particular the determination of coronal densities, CME kinematic properties near the Sun and in interplanetary space.

Sarah Willems (Master mathematics) manages the operational IT systems at ROB/SIDC. She has extensive experience with large scale automated data synchronisation, including e.g. the STEREO/SECCHI data, and with handling the operational aspects of the SIDC automated detection tools such as CACTus. She developed the core workflow handling of the PROBA2 Science Center

ROB's contribution to HELCATS will focus on (1) WP2, with the assessment of the possibility of detecting CMEs automatically in HI data, and, if feasible, creating an event catalogue, (2) WP4, with the analysis of CME arrival predictions at selected spacecraft, and (3) WP7 with the identification and analysis of solar wind transients observed by both HI and in Type II radio bursts.

6 – Imperial College of Science, Technology & Medicine (IMPERIAL)

Consistently rated amongst the world's best universities, Imperial College of Science, Technology & Medicine, London (IMPERIAL) is a science-based institution with a reputation for excellence in teaching and research. In *The Times* Higher Education World University Rankings 2011-12, it was rated the 3rd best in Europe and 8th in the World. Founded in 1907, it hosts nearly 14,000 full-time students from 126 countries and conducts 242 taught courses. Space physics research at IMPERIAL is of the highest international standing as evidenced from leadership roles in international space projects, high-profile publications, invited talks, awards and prizes. Over the past 5 years the research group has collectively published over 100 first author publications including several in high-profile publications such as Nature and Science. Recent awards and prizes to the applicants have included the 2007 Institute of Physics Chree medal and 2008 Royal Society Hughes medal to Prof. Michele Dougherty, the 2008 Royal Astronomical Society Chapman medal to Prof. André Balogh, the 2006 Chapman medal to Prof. Steve Schwartz, the 2004 Fowler award to Prof. Tim Horbury and the 2006 and 2012 COSPAR Zeldovich medals to Dr. Marina Galand and Dr. Jonathan Eastwood.

IMPERIAL's current research programme is built on the success of the Cluster and Cassini missions, for which the Group is PI on the magnetometer instruments, and Rosetta (PI institute for the Rosetta Plasma Consortium). It leads the Cluster Science Centre activities. Members of the group are Co-Investigators on STEREO, Hinode, Themis, and Venus Express. IMPERIAL is playing a leading role in the development of new missions, including Solar Orbiter (PI institute), CINEMA (PI institute), Sunjammer (PI institute), Magnetospheric Multi-Scale (Co-I institute), and Venus Climate Orbiter (Co-I institute). IMPERIAL is world leading in the advanced analysis of space mission plasma data. IMPERIAL has previously participated in Marie Curie research networks, and currently participates in a Marie-Curie IRSES programme.

Dr Jonathan Eastwood (principal contact) is a Lecturer in the Space & Atmospheric Physics Group at IMPERIAL. He is the recipient of a prestigious 5 year STFC advanced fellowship. His expertise is in the physics of collisionless space plasmas and the analysis of multi-point in-situ space plasma data. He has performed postdoctoral work at NASA's Goddard Space Flight Center USA (2004-05) and was an assistant research physicist at the University of California, Berkeley USA (2006-09), with which he continues a fruitful cooperation. He is involved in several missions including Cluster (ESA), STEREO (NASA), THEMIS (NASA), the future MMS (NASA) and Solar Orbiter (ESA) missions, and CINEMA (UK/NSF) projects. He is a Co-I on Solar Orbiter and a member of the STEREO/WAVES science team. He has led, participated in and managed several successful research proposals/projects, sponsored by NASA, the NSF, the UK Space Agency and STFC (UK). He has also participated in several international research networks organised by ISSI, leading to the publication of Cluster results (2005) and multi-spacecraft analysis methods (2008).

Dr Robert (Bob) Forsyth is a Reader in Space Physics in the Space & Atmospheric Physics Group at IMPERIAL. He has over 20 years experience in solar wind and heliospheric physics, built on his original co-investigator role on the magnetic field investigation on the ESA/NASA Ulysses mission, authoring over 100 papers in peer reviewed journals. His interests have been in the formation, structure and evolution of CIRs and in transient disturbances caused by CMEs. On these topics he has contributed to ISSI workshops and books published in 1999 and 2006, and led a 60 page chapter in "The Heliosphere at Solar Minimum" (published 2001), intended to be the definitive reference book on the solar minimum phase of the Ulysses mission. More recently, he has worked on exploiting multi-point observation opportunities provided by the fleet of spacecraft now operating in the inner heliosphere in combination with remote sensing of the corona and inner heliosphere from STEREO. He has a co-investigator role on the forthcoming Solar Orbiter mission.

Jonathan Eastwood and Bob Forsyth will oversee work performed by a post-doc in WP4 and WP7.

7 – Helsingin Yliopisto (UH) [Helsinki University]

The Finnish component of this project will be conducted at the Division of Geophysics and Astronomy (established on 1st January 2010) of the Department of Physics at the University of Helsinki (UH-Phys). UH-Phys is a large physics department with 30 professors and a total annual staff effort of about 330 person-years (http://www.physics.helsinki.fi/), of which about 50 person-years are within space research and astronomy.

The space scientists at UH-Phys are part of the Kumpula Space Centre (KSC), which also includes space researchers at the Aalto University, and the Finnish Meteorological Institute. KSC is the largest space research environment in Finland (taken together, the three research groups have 2 professors, over 20 PhD scientists, and several graduate students) and conducts basic space research in a variety of fields, including solar-terrestrial and solar-planetary physics, cosmology related to the Planck satellite project, studies of the Martian meteorology and studies of meteorite impacts. KSC has a world leading role in developing global magnetospheric computer simulations and is well-known for solar energetic particle modelling and analysing solar eruptions in the interplanetary medium and their consequences in the near-Earth space. Researchers at KSC have active roles in ESA space weather activities and lead several FP7 projects both in the areas of space science and space weather.

The studies of solar eruptions and solar wind within KCS are primarily conducted at UH-Phys. The UH-Phys team consist of six scientific researchers: Hannu Koskinen, Rami Vainio, Emilia Kilpua, Kateriina Andreeova, Kristian Snekvik and Jens Pomodell as well as several PhD and graduate students that are trained together with the other KSC institutes. The team focuses on analysing and modelling coronal mass ejections (CMEs) and their shocks close to the Sun and in the interplanetary medium, as well as particles accelerated at the CME shocks and their geomagnetic consequences. Through these studies the team has gained extensive experience in using a large variety of spacecraft measurements, including data from STEREO, SOHO, Wind and ACE.

Dr. Emilia Kilpua (née Huttunen; principal contact) will be the HELCATS team leader at UH-Phys. After receiving her PhD from UH-Phys in 2005 she spent three years as a post-doctoral researcher at the Space Sciences Laboratory of the University of California, Berkeley (UCB). She has received two highly-competitive research grants in Finland, a UH post-doc grant in 2008 and a five-year Academy Research Fellow position in 2009. She has a strong background in studying CMEs from the Sun to their geomagnetic consequences, focused primarily in the analysis of their in-situ signatures. She has maintained close collaborations with researches at UCB, the most important being Janet Luhmann who is the PI of the STEREO/IMPACT instrument. With her diverse research activities, Dr. Kilpua has established herself in the space science community with a wide network of international collaborations, including UCB, Naval Research Laboratory (USA), University of New Hampshire (USA), University of California, Los Angeles (USA), Ecole Polytechnique (France), and Armagh Observatory (UK). The other UH-Phys team member involved will be PhD student Alexey Isavnin currently models the global structure of CMEs using in-situ and white-light observations.

UH-Phys will contribute to HELCATS (WP4; led by UNIGRAZ) by conducting a detailed analysis and categorisation of the in-situ counterparts of CMEs that were observed by HI. The UH-Phys' particular expertise in this task will be the identification of CMEs and their substructures from in-situ data (STEREO, Wind, ACE) and connecting them to the large-scale solar wind structure. In addition, UH-Phys will also participate in WP5 by analysing small plasma blobs entrained in CIRs.

8 – The Provost, Fellows, Foundation Scholars & the other members of Board of the College of the Holy and Undivided Trinity of Queen Elizabeth near Dublin (TCD) [Trinity College Dublin]

The Provost, Fellows, Foundation Scholars & the other members of Board, of the College of the Holy and Undivided Trinity of Queen Elizabeth near Dublin (generally called Trinity College Dublin; TCD) is a university in the liberal arts tradition, established in 1592 by Queen Elizabeth I, and is the leading university on the island of Ireland. It is highly successful in securing research funding, and has been an active beneficiary in the Framework Programmes dating back to the very first.

The School of Physics is in the top 5 schools at TCD in terms of research income and has a well-established international stature in innovative research in materials, photonics, nanoscience, computational physics and astrophysics. Indeed, members of the school have included five Fellows of the Royal Society and a Nobel Prize winner in physics. Members of the School publish 100 to 150 peer-reviewed articles in international journals annually. The School of Physics has an annual research budget of close to €10M – by far the largest and most internationally reputable physics department in Ireland.

The Astrophysics Research Group (ARG) carries out world-leading research in solar physics, stellar astronomy, active galactic nuclei and emission line diagnostics. It enjoys close research links with researchers at the European Space Agency, NASA, University of Cambridge, Queen's University Belfast, University of St. Andrews, ROB, University College London and STFC. ARG has published extensively in highly ranked international journals.

Professor Peter Gallagher (principal contact) leads research in solar physics at TCD. His team has 6 PhD students and 2 post-docs, in the areas of sunspot evolution, solar flare physics, CMEs, and solar radio astronomy. TCD have recently installed a number of sensitive solar radio spectrometers at the Rosse Solar-Terrestrial Observatory in the midlands of Ireland (www.rosseobservatory.ie). These enable the group to monitor the Sun for Type II and Type III radio bursts at ~10-400 MHz. The TCD group also run the www.SolarMonitor.org website, which gives near-real-time information on sunspot groups and solar activity.

The TCD contribution to the HELCATs project involves their expertise in the inverse modelling of CMEs to enable the study of their solar sources, and associated activity, as part of WP3.

B2.3. Consortium as a whole

The core of the HELCATS project is the identification and cataloguing of CMEs in the heliosphere, specifically through the analysis of HI data from the STEREO spacecraft. The initial image inspection and related analysis leading to the generation of the CME catalogue is to be done by the STEREO/HI Principal Investigator (PI) team at STFC's Rutherford Appleton Laboratory, who have the relevant skill-base to perform this task (Harrison *et al.* 2008; Eyles *et al.* 2009) Members of the PI team have intimate knowledge of the instrumentation, a world-leading heritage in studies of the physics of solar ejecta, and well-established software tools, and skills, for image processing. However, an additional element proposed for the cataloguing of CMEs in the STEREO/HI data is through automated detection procedures akin to those developed to identify CMEs in the solar corona from coronagraph images. The expertise for this lies with the Koninklijke Sterrenwacht van Belgie (ROB), with their CACTuS method (Robbrecht *et al.,* 2009). Thus, the initial cataloguing activities of this project are being performed by the two world-leading groups in this field, both with long and auspicious heritage in aspects absolutely central to this project.

Assessment of the CME cataloguing activities would naturally include inter-comparison of the results of manual and automated detection techniques, but would also include comparisons with CME catalogues generated using traditional coronagraph methods. This naturally brings the STEREO coronagraph experience of the Georg-August-Universitaet Goettingen Stiftung Oeffentlichen Rechts (UGOE), Germany, into the collaboration with STFC and ROB at this stage.

The geometrical modelling of CMEs has been developed by a handful of groups in Europe and the USA. Two of the leading groups in this work are Universitaet Graz (UNIGRAZ), Austria (see Möstl *et al.* 2009) and STFC (see Davies *et al.* 2012). These two groups will apply the models being developed to the catalogued CMEs, in particular deriving forward-projected arrival times at various heliospheric locations, including Earth and other planets, and back-projected launch times at the Sun. However, in parallel, forward-modelling techniques for CMEs have been developed over recent years, with one of the leading groups involved in this area of work being at UGOE (Bosman *et al.* 2012; Cremades and Bothmer 2004). The forward-modelling work will also involve forward- and back-projections, to assess the CME onset times and in-situ associations. Additionally, there is also a related inverse-modelling component to the work, and this also involves established expertise from The Provost, Fellows, Foundation Scholars & the other members of Board of the College of the Holy and Undivided Trinity of Queen Elizabeth near Dublin (TCD), working with UGOE. All of these models will provide parameters that will augment the catalogues, and the results and performance of the modelling work will be assessed in a number of ways (as discussed below). It is thus a logical and, indeed, a powerful combination to bring the strengths of STFC, UNIGRAZ, UGOE and TCD to bear in the application of these models to the catalogued CMEs.

Having established catalogues, and applied geometrical and forward models to augment the information that they contain, it is natural to assess the performance of the modelling through the comparison of arrivals of CMEs with in-situ data taken at various heliospheric locations (including Earth and other planets). We call upon leading expertise in the identification and analysis of in-situ solar wind transient data to perform such comparisons, namely UNIGRAZ (see Möstl *et al.* 2009) and Helsingin Yliopisto (UH; see Kilpua *et al.* 2009). These groups are exceedingly well qualified in understanding in-situ datasets, such that the results from the geometrical and forward-modelling techniques can be validated against the in-situ data. However, there is additional specific expertise in the interpretation of in-situ observations that resides at Imperial College of Science, Technology & Medicine (IMPERIAL), ROB and Universite Paul Sabatier Toulouse III (UPS), that means that they are also extremely well placed to contribute this work.

In parallel with the aforementioned comparison with in-situ data, we must also compare the results of back-projecting the model data in order to investigate what phenomena on the Sun are associated with CME launch. This is a particular expertise of UGOE.

A natural extension to the analysis of CMEs, is to perform an analogous study of CIRs. This is built on the tremendous expertise of UPS (Rouillard *et al.* 2008, 2009). The study of CIRs observed by

STEREO/HI includes (as with the CME work) their cataloguing, and derivation of their 3-D kinematic properties through the applications of models. Contributing to this work, through established skills in terms of the in-situ signatures of CIRs, is UH.

The proposed work package that involves the initialisation of advanced (numerical) models using HI observations calls for expertise centred on the work of UPS in collaboration with the originator of the inner heliosphere MHD ENLIL code who resides at George Mason University (GMU; Odstrcil *et al.,* 2009). ENLIL is the code of choice, both for scientific and space weather applications. This is an unsurpassable combination for the study of solar wind transient propagation, in terms of expertise in HI data and MHD heliospheric coding. The results of initialising the numerical code based on the HI data, will be compared to the more simplistic geometrical modelling and to more conventional ways of running ENLIL.

The final step of the project assesses the potential of using radio measurements in conjunction with HI observations to study solar wind transients - CMEs and CIRs. This homes in on (1) interplanetary scintillation expertise developed at Aberystwyth University (AU; Bisi *et al.* 2010a; 2012b) using the EISCAT and LOFAR systems, now located at STFC (see B2.2) and (2) exploitation of Type II radio data based on expertise of IMPERIAL. These two groups are extremely well qualified to assess the potential for using such observations in applications relevant to this project.

HELCATS brings together the leading players in the required topical areas, as outlined above. This unique combination of people and skill-sets provides the unrivalled potential for generating a powerful set of tools, facilities and studies to enable significant advances to the field. The heritage of the beneficiaries can also be gauged through the text and references in Section B1.

The project is led by the STEREO/HI PI team at STFC. The instrumental, observational and scientific expertise of this team, combined with its long history and standing in the field of solar mass ejection processes, makes it ideal to lead such a project. It is also important to note that the participating teams have well-established inter-connections – well illustrated by the reference list. Thus, this is not only a well chosen team to cover the topical and skill-base requirements, it is a team that has a proven track record in working successfully together.

B.2.3.1 Subcontracting

There are no subcontracted activities within the HELCATS project.

B.2.3.2 Third Parties

Third Party Carrying out Work

The *Centre National de la Recherche Scientifique* (CNRS) is a third party, via UPS. CNRS is the largest governmental research organisation in France and the largest fundamental science agency in Europe. It employs 26,000 permanent employees (researchers, engineers, and administrative staff) and is included here because it is the employer of the UPS staff working on HELCATS. Thus, Dr Alexis Rouillard, Dr Benoit Lavraud and Ms Myriam Bouchemit are three CNRS permanent staff working to supervise/help in three work packages (WP4, 5, 6 and 8) of HELCATS. Alexis Rouillard will work 9 months over the entire project period to lead WP5 and 6. Dr Benoit Lavraud will work for 4 months on WP4. Mme Myriam Bouchemit will work for 2 months on WP8, and 2 months on WP6 to integrate simulation results to the analysis of HI images. Team sheets to reflect the exact time spent on the project by CNRS employees will be submitted at the end of each reporting periods.

Third Party Making Available Resources

George Mason University (GMU) is a public university based in Fairfax County (Virginia) in the United States of America. The university has strength in the basic sciences with critical mass in computational sciences. Dr Dusan Odsctril is a research professor at GMU, he will work with Dr Alexis Rouillard (UPS) on WP6. Dr Rouillard and Odsctril have already collaborated in a number of studies together being for two years work colleagues at GMU. Dusan Odstrcil (GMU) will run 3-D MHD simulations of the solar wind and transients for UPS as part of the deliverables of WP6. GMU will provide this service to UPS for free and is an unfunded collaborator on this project. UPS will invite Dusan to join the first HELCATS science meeting to prepare WP6. Dr Odstrcil will be reimbursed for this particular collaborative visit using HELCATS funding. It should be noted that the ENLIL code is available for research use in this way and there is no IPR issue**. There is no cost to the HELCATS project for the use of the ENLIL code in this way.**

Interested Third Parties

We note three interested parties that have been consulted during the development of this project. They do not have formal involvement as beneficiaries but will be kept informed of progress as the project proceeds. These interested parties are the following:

- The Space Weather Prediction Center (SWPC, USA), is funded by NOAA, and is the principal space weather prediction centre world-wide. Many HELCATS beneficiaries have well established collaborations with SWPC. SWPC are clearly interested in the development and assessments of techniques relevant to space weather applications. It is anticipated that they will be active participants in the open meetings.
- The UK Met Office is developing a space weather capability as a mirror to the SWPC facility, based mainly on the use of the ENLIL code. As with SWPC, the Met Office have a clear interest in the results of HELCATS, and has been involved in discussions as they developed. Again, it is anticipated that they will be active participants in the open meetings.
- The University of Reading (UK) has an established project of work with the Met Office in the use of ENLIL, and, as such, has a keen interest in this project. They have close links with STFC and will collaborate with the HELCATS team.

B2.4. Resources to be committed

Annex 1 – Part A and Table 1.3 summarises the allocation and schedule of WPs and staff-month allocations for the HELCATS project as a function of WP and beneficiary. The figures allocated for each task have been assessed to be appropriate for the task in terms of complexity and duration. The Gantt chart of section B1.3 shows the period over which the tasks would be performed for each WP. Consistent with these is the strategy that drives the financial profile (as defined below):

- A three-month (one quarter) initiation phase (under WP1) starts the project, with a kick-off meeting in month 1. During this time, the website is installed and administrative issues associated with the start up are dealt with.

- After the initiation phase, WP1 activities enter a phase of regular reporting, meetings and coordination as described in the WP1 description.

- Simultaneously, the cataloguing activities of WP2 and WP5 begin; these are required to provide initial results before the subsequent activities (in WP3, WP5 and WP6) can proceed.

- We initiate the modelling activities of WP3, WP5 and WP6 one quarter after the onset of the cataloguing activities; this provides time for sufficient catalogue information to be available as input to the modelling activities.

- Once the cataloguing and modelling activities are well underway, we can embark on the comparison of CME and CIR events to solar source and in-situ observations; so we start WP4 and the relevant element of WP5 one quarter after the onset of the modelling.

- At the same time, we have sufficient catalogue/modelling information to embark on WP7.
- The activities all continue, as a continual stream of catalogue/modelling information feeds into the solar source and in-situ comparisons. Near the end of the first year, comparison activities in relevant WPs can begin (comparing catalogues, model results, performance, etc). This runs to the end of the project.
- As we come to the last quarter of the project, only these comparison activities (in addition to the management line and WP8) remain active, as the cataloguing tasks are completed. The results all feed into WP8.
- WP8 starts up half way through the project, and is charged with dissemination activities.

The detailed activities of the WPs are given in the WP descriptions of Annex 1 – Part A. However, the funding models and staff allocations vary between institutes, so below we include a statement from each beneficiary regarding the funding for their activity. Before that, we outline the structure of the meetings and travel needs, which are consistent with the management model given in the WP1 and 2 descriptions and in Section B2.1, and shown as Table 2.4a. Costs for travel to these meetings are included in the statements from the individual beneficiaries below. All staff and travel costs are consistent with the inputs to Annex 1 – Part A.

Given the meeting details and schedule, we estimate as a baseline a cost of order €6k per person per year, calculated for travel to a European city, with two days subsistence and associated costs. Some estimates will vary due to additional needs specified below.

Finally, we note that the WP8 costs, related to the dissemination of results and information, which includes publication and outreach costs, and meeting arrangement costs, will be held centrally by the lead institute and appear in their figures.

The Science workshop costs (bottom row of Table 2.4a) target attendance at international science meetings, e.g. at the EGU, European Space Weather Week and similar international meetings, where HELCATS results will be advertised by the team. For efficient dissemination to the community, we plan on one such attendance per year per team. Given the size of the community and frequency of international community science meetings, we believe this approach is efficient.

Table 2.4a: Travel requirements

Required Travel	Project month	Meeting Duration	Location of meeting	Attendees
Kick-off meeting	1	2 days	Oxford, UK	All beneficiaries
Bi-annual project meetings/workshops	6, 12, 18, 24, 30, 36	2 days	Rotate around beneficiaries	Executive Board and Steering Committee (all Institute Leads)
Annual open workshops with the science community	12, 24, 36	2 days	Held in association with the above (an extension to every other bi-annual mtg)	All
Science workshops (attending established science meetings e.g. EGU, European Space Weather Week)	TBD (assume 1 per year per team)	3 days	European city (e.g. EGU in Vienna, SWW in Brussels)	All

Cost statements from each beneficiary

The costs for each beneficiary are now described in detail, with identical tables (tables 2.4b-i). A complete table of travel needs and costs, consistent with table 2.4, is given at the end (table 2.4j). **Note that there are no plans for subcontracting in this project.**

1. STFC

Table 2.4b: STFC Direct Costs

Cost category	Activity	Direct Cost	Description/WP
Personnel	MGT	58,203.1	WP1
Personnel	RTD	282,379	WP2, WP3, WP7
Personnel	OTH	72,957	WP8
Total		**€413,539.1**	
Cost category	Activity	Direct Cost	Description/WP
Travel	RTD	21,600	See table 2.4j
Travel	OTH	9,562.5	See table 2.4j
Publication/dissemination	OTH	51,000	See text below.
Audit Cost	MGT	1,920	See below.
Total		**€84,082.5**	

The lead STFC team has an allocation of 8.5 staff months for WP1 (MGT) and 11.5 for WP8 (OTH), both supported at 100%. The WP2, WP3 and WP7 allocations (all RTD) are 25.0, 9.0 and 19.5 staff months. STFC has an agreed exchange rate of €1.28 per £. Direct travel costs are €21,600 (RTD) and €9,562.5 (OTH) and. The WP8 costs for publication charges and consumables (e.g. for outreach costs) for the entire project are included (OTH). We include €1,920 for two finance audits as required by the EU (MGT). The total other direct costs are €84,082.5. The agreed overhead is 105% (indirect cost) on personnel with 0% overhead on other direct costs. The total requested EU contribution is €781,718.35.

2. UNIGRAZ

Table 2.4c: UNIGRAZ Direct Costs

Cost category	Activity	Direct Cost	Description/WP
Personnel	RTD	201,000	WP3, WP4
Total		**€201,000**	
Cost category	Activity	Direct Cost	Description/WP
Travel	RTD	17,500	See table 2.4j
Travel	OTH	4,875	See table 2.4j
Total		**€22,375**	

At UNIGRAZ, one post-doc will be working on the project for 36 months (30 months in WP4 and 6 months in WP3). Currently, the WP4 leader Christian Möstl is planned for this position. If he were to accept a different role for the duration of the project, the work could be carried out, under his supervision, by a different post-doc from the UNIGRAZ Solar Physics group to achieve the WP objectives. A well-qualified candidate would be current PhD student Tanja Rollett, whose activities involve comparing in-situ and HI data, and who is likely to finish her PhD by 2014. The full budget for UNIGRAZ is equivalent to 36 post-doc months (12 post-doc months cost €67,000). Travel costs for project team meetings, and presentation of results at international conferences, are requested at €7,458 per year. Including the flat rate of 60% for overheads, amounts to a total over the project of €357,400. The requested EC contribution (RTD at 75% and OTH at 100%) is €270,000.

3. **UPS**

Table 2.4d: UPS Direct Costs

Cost category	Activity	Direct Cost	Description/WP
Personnel	RTD	228,000	WP5, WP6
Personnel	OTH	67,342	WP8
Total		**€295,342**	
Cost category	Activity	Direct Cost	Description/WP
Travel	RTD	31,000	See table 2.4j
Travel	OTH	5,625	See table 2.4j
Total		**€36,625**	

Beneficiary no. 3: CNRS (Third Party)

Cost category	Activity	Direct Cost	Description/WP
Personnel	RTD	56,000	WP4, WP5, WP6, WP8
Total		**€56,000**	

UPS is involved in WPs 4, 5, 6 and 8 (leading WPs 5 and 6). The four UPS-affiliated permanent staff members are CNRS employees (CNRS will be declared a third party institution). Funding is requested for Alexis Rouillard (9 months) to supervise/undertake work in WPs 5 and 6, for Benoit Lavraud (4 months) to work on WP4, for Myriam Bouchemit to work on WP6 (2 months). and for both Vincent Génot and Myriam Bouchemit (2 months each) to work on catalogue dissemination in WP8. UPS is also requesting funding for a post-doc working on WP5 (9 months) and WP6 (2 months) and a PhD student working on WP5 (17 months) and WP6 (19 months). A computer engineer (10 months) will be hired to standardise data formats across WPs, help create the web-services between the UKSSDC (catalogue archive) and the CDPP data center, and work on integrating the catalogues via web-services into the IRAP propagation tool and AMDA to ensure widespread data distribution. The total requested travel budget (see table 2.4j) includes annual visits from the United States to Europe of Dusan Odstrcil (to collaborate on WP6). For UPS, RTD staff effort is €364,800 (including 60% overhead) and OTH staff effort is €107,747 (including overheads). UPS, ODC are €36,625 (€58,600 with overheads). CNRS staff effort (RTD) is €89,600 including the 60% overhead. Note there is no charge for the two required finance audits.

4. UGOE

Table 2.4e: UGOE Direct Costs

Cost category	Activity	Direct Cost	Description/WP
Personnel	RTD	195,000	WP2, WP3, W4
Total		**€195,000**	
Cost category	Activity	Direct Cost	Description/WP
Equipment/computing	RTD	12,000	Software/Hardware, see text
Travel	RTD	16,800	See table 2.4j
Travel	OTH	5,400	See table 2.4j
Total		**€34,200**	

At UGOE, the HELCATS contribution will be supported in terms of administrative tasks by the UGOE's EU-Office that consists of a personnel team of four full-time and seven part-time positions, who take care of all the University's EU project activities. The HELCATS contribution will be led by the beneficiary lead, Volker Bothmer, including members of his Solar, Heliospheric and Space Weather Research Group (Eckhard Bosman, Malte Venzmer, Adam Pluta, Laura Volpes). The HELCATS scientific tasks within WPs 2, 3 and 4 will be specifically carried out by two PhD. students at TV-L 1-3 salary levels. At 39 staff months, this amounts to €195,000. A major meeting of 4 days duration in Europe is estimated based on normal travel cost regulations at UGOE (daily allowance, travel and hotel costs) to be at €2,400 costs for 2 persons, amounting to a total sum of €16,800. For project presentations at major conferences, one yearly travel is estimated to €1,800 for a European conference (e.g., EGU, European Space Weather Week or equivalent), amounting for three years to €5,400. The travel budget is €22,200 in total.

The modelling of CMEs for WP3 based on data from the SOHO and STEREO missions requires the dedicated software environment SolarSoft and the programming language IDL on a Linux/Mac platforms in order to facilitate calibration of the measurements and use of the existing mission software infrastructure and the special CAT and GCS CME modelling tools, with a data volume of around 100 GB. Through this dedicated server system the results will also be provided to the consortium and scientific community. For collaboration purposes a mobile platform of this system is needed to demonstrate CAT and GCS modelling which cannot be done remotely because of the large amount of coronagraph and EUV data files required locally for the specific event analysis. The overall costs for software and hardware are estimated to be €12,000 in total, including system backup software and storage media.

The travel, equipment and consumables resources are calculated to €34,200, yielding total direct cost of €229,200. With the 60% flat rate overhead the total costs are €366,720. Activities are of RTD and OTH type, supported at 75% and 100% respectively, so the total requested EU contribution is €277,200.

The FP7 rule of depreciation related to the purchase cost of durable equipment applies.

5. ROB

Table 2.4f: ROB Direct Costs

Cost category	Activity	Direct Cost	Description/WP
Personnel	RTD	147,500	WP2, WP4, WP7
Total		**€147,500**	
Cost category	Activity	Direct Cost	Description/WP
Equipment/computing	RTD	3,000	
Travel	RTD	13,500	See Table 2.4j
Travel	OTH	3,375	See Table 2.4j
Total		**€19,875**	

At ROB, the contribution is led by Luciano Rodriguez, with an allocation of 29.5 staff months (20.5 in WP2, 6 in WP4, and 3 in WP7). All work is classified under RTD activities. The cost to ROB for a Phd/IT engineer is €5,000 per staff month, which equates to a total of €147,500 over the 30 month allocation. With travel and subsistence costs of €5,625 per year, and equipment costs of €1k per year, we have other direct costs of €19,875 over the length of the project. The equipment costs are for acquiring a data processing work station dedicated to the project activities. The total direct costs requested by ROB are €167,375. ROB costs overheads at "specific flat rate 60%", giving indirect costs of €100,425 (60% of the total personnel costs plus other direct costs). The total cost is thus €267,800. The requested EC contribution (mostly RTD but some OTH) comes to €202,200.

The FP7 rule of depreciation related to the purchase cost of durable equipment applies.

6. IMPERIAL

Table 2.4g: IMPERIAL Direct Costs

Cost category	Activity	Direct Cost	Description/WP
Personnel	RTD	129,196	WP4, WP7
Total		**€129,196**	
Cost category	Activity	Direct Cost	Description/WP
Travel	RTD	7,100	See table 2.4j
Travel	OTH	6,300	See table 2.4j
Consumables	RTD	2,689	
Total		**€16,089**	

IMPERIAL's personnel costs cover a post-doc, and fractional time of Jonathan Eastwood and Bob Forsyth (20 months total on WP4 and WP7, which are both RTD activities). Also requested are associated travel (as specified) and provision for consumables (in particular funds for a high performance desktop PC are requested since university-provided machines are insufficient for the data intensive nature of the work involved). The personnel costs total €129,196 with other direct costs totalling €16,089. Indirect costs of €87,171 are calculated using a specific flat rate of 60% as allowed for higher education establishments. This brings the total cost to €235,816. The requested EU contribution (mainly RTD at 75% but some OTH at 100%) equates to €176,862.

7. **UH**

Table 2.4h: UH Direct Costs

Cost category	Activity	Direct Cost	Description/WP
Personnel	RTD	127,234	WP4, WP5
Total		**€127,234**	
Cost category	Activity	Direct Cost	Description/WP
Travel	RTD	15,500	See table 2.4j
Travel	OTH	3,375	See table 2.4j
Total		**€18,875**	

The UH work amounts to 22 months of RTD effort assigned for a post-doc, giving total calculated personnel costs of €127,234. UH is involved in WPs 4 and 5, which are both classified as RTD activities. With travel and subsistence costs of €18,875 for the three years and the specific flat rate of 60% for overhead costs, this comes to a total of €233,774.40. At a combination of 75% and 100% funding, the requested EU contribution is €176,681.80.

8. TCD

Table 2.4i: TCD Direct Costs

Cost category	Activity	Direct Cost	Description/WP
Personnel	RTD	80,354	WP3
Total		**€80,354**	
Cost category	Activity	Direct Cost	Description/WP
Equipment/computing	RTD	3,000	
Travel	RTD	9,000	See table 2.4j
Travel	OTH	4,500	See table 2.4j
Consumables	RTD	2,000	
Total		**€18,500**	

The TCD allocation is 15 staff months (all assigned to WP3, which is classified as an RTD activity). This equates to €80,354 in direct costs. Travel and subsistence costs totalling €13,500 are requested over the course of the activities, with equipment, computing and consumable costs of €5,000. With the flat rate overhead of 60%, the total cost is €158,166.40, and the requested EU contribution (a combination of 75% and 100% funding) comes to €120,425.80.

The FP7 rule of depreciation related to the purchase cost of durable equipment applies.

Table 2.4j: Travel Details and Costs

Beneficiary no. and short name	Activity	Total Direct Cost per meeting (€)	Meeting	Meeting length (days)	No. of persons per meeting
1. STFC	RTD	0 (local)	Kick-off meeting	2	3
1. STFC	RTD	3,700	Project (M6)	2	2
1. STFC	RTD	5,250	Merged project/annual (M12)	4	3
1. STFC	OTH	3,187.5	Science (Y1)	3	2
1. STFC	RTD	3,700	Project (M18)	2	2
1. STFC	RTD	5,250	Merged project/annual (M24)	4	3
1. STFC	OTH	3,187.5	Science (Y2)	3	2
1. STFC	RTD	3,700	Project (M30)	2	2
1. STFC	RTD	0 (local)	Merged project/annual/wrap-up (M36)	4	3
1. STFC	OTH	3,187.5	Science (Y3)	3	2
Total travel		**31,162.5**			
2. UNIGRAZ	RTD	1,500	Kick-off meeting	2	1
2. UNIGRAZ	RTD	3,000	Project (M6)	2	2
2. UNIGRAZ	RTD	3,500	Merged project/annual (M12)	4	2
2. UNIGRAZ	OTH	2,625	Science (Y1)	3	2
2. UNIGRAZ	RTD	1,500	Project (M18)	2	1
2. UNIGRAZ	RTD	2,000	Merged project/annual (M24)	4	1
2. UNIGRAZ	OTH	1,125	Science (Y2)	3	1
2. UNIGRAZ	RTD	1,500	Project (M30)	2	1
2. UNIGRAZ	RTD	2,500	Present WP4 results at other scientific meeting	4	1
2. UNIGRAZ	RTD	2,000	Merged project/annual/wrap-up (M36)	4	1
2. UNIGRAZ	OTH	1,125	Science (Y3)	3	1
Total Travel		**22,375**			
3. UPS	RTD	5,000	Kick-off meeting (STFC)	2	3
3. UPS	RTD	5,000	Project (M6)	2	3
3. UPS	RTD	2,000 (local)	Merged project/annual (M12) (+Odstrcil)	4	6
3. UPS	OTH	3,000	Science (Y1)	3	2
3. UPS	RTD	4,000	Project (M18)	2	3
3. UPS	RTD	5,000	Merged project/annual (M24)	4	2

3. UPS	OTH	(local)	Science (Y2)	3	6
3. UPS	RTD	4,000	Project (M30) (Helsinki)	2	2
3. UPS	RTD	6,000	Merged project/annual/wrap-up (M36) (STFC)	4	3
3. UPS	OTH	2,625	Science (Y3)	3	2
Total travel		**36,625**			
4. UGOE	RTD	3,600	Kick-off meeting	2	3
4. UGOE	RTD	2,400	Project (M4), Start WP2	2	2
4. UGOE	RTD	0 (local)	Project (M7), Start WP3	2	3
4. UGOE	RTD	2,400	Project (M10), Start WP4	2	2
4. UGOE	RTD	4,200	Merged project/annual (M12)	4	3
4. UGOE	OTH	1,800	Science (Y1)	4	2
4. UGOE	RTD	0 (local)	Merged project/annual (M24)	4	3
4. UGOE	OTH	1,800	Science (Y2)	4	2
4. UGOE	RTD	0 (local)	Project (M30), Wrap-up WP3	2	3
4. UGOE	OTH	1,800	Science (Y3)	4	2
4. UGOE	RTD	4,200	Merged project/annual/wrap-up (M36)	4	3
Total travel		**22,200**			
5.ROB	RTD	1,500	Kick-off meeting	2	2
5.ROB	RTD	1,500	Project (M6)	2	2
5.ROB	RTD	2,500	Merged project/annual (M12)	4	2
5.ROB	OTH	1,125	Science (Y1)	3	1
5.ROB	RTD	1,500	Project (M18)	2	2
5.ROB	RTD	2,500	Merged project/annual (M24)	4	2
5.ROB	OTH	1,125	Science (Y2)	3	1
5.ROB	RTD	1,500	Project (M30)	2	2
5.ROB	RTD	2,500	Merged project/annual/wrap-up (M36)	4	2
5.ROB	OTH	1,125	Science (Y3)	3	1
Total travel		**16,875**			
6. IMPERIAL	RTD	600	Kick-off meeting	2	2
6. IMPERIAL	RTD	1,000	Project (M6)	2	1
6. IMPERIAL	RTD	1,250	Merged project/annual (M12)	4	1
6. IMPERIAL	OTH	1,800	Science (Y1)	3	2
6. IMPERIAL	RTD	1,000	Project (M18)	2	1
6. IMPERIAL	RTD	1,250	Merged project/annual (M24)	4	1
6. IMPERIAL	OTH	2,250	Science (Y2)	3	3

6. IMPERIAL	RTD	800	Project (M30)	2	1
6. IMPERIAL	RTD	1,200	Merged project/annual/wrap-up (M36)	4	1
6. IMPERIAL	OTH	2,250	Science (Y3)	3	3
Total travel		**13,400**			
7. UH	RTD	2,600	Kick-off meeting	2	2
7. UH	RTD	2,600	Project (M6)	2	2
7. UH	RTD	1,600	Merged project/annual (M12)	4	1
7. UH	OTH	1,125	Science (Y1)	3	1
7. UH	RTD	2,600	Project (M18)	2	2
7. UH	RTD	1,600	Merged project/annual (M24)	4	1
7. UH	OTH	1,125	Science (Y2)	3	1
7. UH	RTD	1,300	Project (M30)	2	1
7. UH	RTD	3,200	Merged project/annual/wrap-up (M36)	4	2
7. UH	OTH	1,125	Science (Y3)	3	1
Total travel		**18,875**			
8. TCD	RTD	1,500	Kick-off meeting	2	2
8. TCD	RTD	1,000	Project (M6)	2	2
8. TCD	RTD	1,500	Merged project/annual (M12)	2	3
8. TCD	OTH	1,500	Science (Y1)	2	3
8. TCD	RTD	1,000	Project (M18)	2	2
8. TCD	RTD	1,500	Merged project/annual (M24)	2	3
8. TCD	OTH	1,500	Science (Y2)	2	3
8. TCD	RTD	1,000	Project (M30)	2	2
8. TCD	RTD	1,500	Merged project/annual/wrap-up (M36)	2	3
8. TCD	OTH	1,500	Science (Y3)	2	3
Total travel		**13,500**			

B3. Impact

B3.1. Expected impacts listed in the work programme

The HELCATS project is aimed at the call SPA.2013.2.1-01 “Exploitation of space science and exploration data”. This call provides specific statements about expected impact and we comment on these here.

First, the call stated that “*Projects are expected to add value to space missions and earth based observations by significantly contributing to the effective scientific exploitation of collected data. They are expected to enable space researchers to take full advantage of the potential value of data sets. Projects are expected to expand the use of data, and/or contribute to dissemination of space mission data on a global scale, and/or enhance the relations with established international space powers”.*

The HELCATS project caters for this statement directly by enhancing spacecraft observations of CMEs and CIRs in the heliosphere, by producing the first complete catalogues of these heliospheric phenomena and using them to provide a thorough assessment of the performance of a variety of appropriate models. This involves the coordination of data from remote sensing and in-situ instrumentation and the application of a range of models. The basic products are the comprehensive catalogue, which will be made available as a facility for general use, and reports on the validations of models. Whilst the former will enable a better targeted scientific exploitation of the HI instruments and associated datasets, the latter will enable a more efficient and better targeted use of heliospheric models.

Furthermore, the project will also advance the exploitation of numerical models by exploring the use of heliospheric MHD codes for CME and CIR modelling, including their initialisation based on the use of HI data. This work not only provides a platform for model comparisons and assessments, but also undertakes the vital task of validating the use of HI data in setting up such models. The product of this assessment will, therefore, provide pointers for the wider community in the future development and use of codes of this type.

Finally, the project also explores the use of other datasets, to enhance the capability of the HI observations of heliospheric transients, through the use of specific radio observations, namely interplanetary scintillation (IPS), and Type II radio bursts. The aim is to study the added value of using such observations in interpreting the HI observations. A thorough assessment of this aspect will be pivotal in the development of future studies, including the development of new observing strategies for space weather applications.

Considered in parallel with spacecraft operational and research activities, which are both outside the remit of this project, HELCATS will provide tools and assessments that will enable a better and more complete exploitation of HI data in the future. Given the value of HI to understanding the nature of the heliosphere, the solar corona and likely impacts at Earth - including the applications of such understanding to space weather programmes - this activity has far-reaching consequences for future research.

The second statement on expected impacts given in the call was “*Projects are expected to contribute to the much needed coordination and exploitation of existing and future data collections from space missions, and coordination with ground based observatories, and thereby enhancing the possibility to base research on datasets providing comprehensive or full coverage, while at the same time addressing the potential need for further analysis of existing datasets. It is also expected that the projects will facilitate access to, and appropriate use of data for those scientists who were/are not part of the team having obtained the space mission data (e.g. principal investigators).”*

Much of the discussion immediately above is highly relevant to this. However, we point out that there is currently a major international programme of study aimed at understanding the Sun and its influences on Earth. This is well illustrated by the fleet of relevant spacecraft operated by the international space agencies, including SOHO (ESA/NASA, launched 1995), ACE (NASA, 1997), Cluster (ESA, 2000), Hinode (JAXA, 2006), STEREO (NASA, 2006) and SDO (NASA, 2010). The HELCATS project coordinates a key area of this work, building in particular on the unique heliospheric observations from STEREO and bringing in other observations and appropriate models. The products, namely the catalogues and reports (validations, assessments etc), will feed directly into the efficient exploitation of past data from these missions (in particular to the start of the science phase of the STEREO mission in 2007). The information and access to techniques will provide an effective method for selecting data and methods/models for scientific analyses.

The HELCATS products will be available to the wider community as information on a widely publicised website, and as material published in the professional literature. This open access policy is in keeping with the open data policy for missions such as STEREO. Thus, the outcome of this project should be enhanced exploitation of space assets in which Europe has invested. The project and its results and products will also be widely publicised at major scientific meetings and dedicated open workshops.

The final statement on expected impacts in the call was "*Furthermore, projects are expected to add value to existing activities on European and national levels, and to raise the awareness of coordination and synergy efforts among stakeholders.*"

As mentioned in Section B2.3, critical expertise in the topical areas covered by this project resides at a number of leading institutes around Europe - specifically in the UK, Austria, France, Germany, Finland, Belgium and Ireland. The project aims to consolidate the European lead in this area as well as to enhance the European investment in space projects, by coordinating a focused activity across these groups. Each has a world-leading capability, be it in hardware development and operation, software and modelling, or aspects of space physics. We note that although STEREO is a NASA mission, the HI instruments are UK-led, another instrument is French-led and there are major additional hardware contributions from Germany and the UK; it is said that, in all, 60% of the STEREO payload comes from Europe. European specialities in heliospheric imaging, in space environment physics, as well as CME and CIR research, in appropriate areas of modelling ensure that a coordination of the kind provided by HELCATS enables a strong European foundation to develop on the understanding of solar ejecta and our space environment.

By integrating the resultant catalogues in CDPP/AMDA, the users of the European Research infrastructure (EUROPLANET) node who are currently automatically directed to AMDA when requesting planetary data, will have direct access to the predicted arrival times of CMEs and CIRs at any planet of the solar system. This source of information is often lacking in planetary research, which currently has to rely on less accurate estimates of the arrival of times of CMEs extrapolated from coronagraphs or sometimes poorly constrained numerical simulations. We will also permit access to the catalogues through other European projects via the European Space Weather portal, including the space-weather catalogue, the Coronal Mass Ejections and Solar Energetic Particles (COMESEP) and the Data Services and Analysis Tools for Solar Energetic Particle Events and Related Electromagnetic Emissions (SEPSERVER) that are used by scientists who will be typically very interested in using the HELCATS catalogues.

Whereas the principal stakeholders are research scientists, we are well aware of the potential for space weather applications and that means that the results would be of interest to European activities such as the ESA Space Situational Awareness (SSA) programme. Indeed, it is projects such as this, taking place at the same time as the ESA SSA programme develops and evolves, that will feed into a better focused European space weather activity.

The strong relevance to space weather means that there is a clear socio-economic impact of this project. The potential for disruption due to space weather is well documented and it is fully understood that the most damaging element of space weather, to human systems, is the CME. With space weather impacts appearing, for example, on the UK National Risk Register, and with a number of European companies considering the potential disruption to their activities, it is clear that this is a topic that is becoming more important with time; we are becoming more susceptible to space weather impacts as we make more use of high-tech systems and space assets, such as GPS. A European-wide activity that illustrates this, as mentioned above, is the development of ESA's SSA programme. The HELCATS team intends to maintain communication with the ESA SSA programme to ensure that future applications are fully understood, and that the project is well able to provide pointers to future, practical space weather applications tools and models. Indeed, we note that members of the HELCATS team have, in fact, already been active in communicating with the ESA SSA team throughout the development of this project.

Absolutely central to any practical application of space observations to mitigate the effects of space weather is the observation of CMEs and the development of tools to understand their propagation, such that their arrival at salient locations can be predicted accurately. Thus, the development of catalogues and the validation of models that consider the propagation of these events are of prime interest and will provide a valuable stepping-stone in Europe to better predictions. In terms of impact, this is less to do with 'wealth creation' and more to do with 'wealth protection'.

B3.2. Dissemination and/or exploitation of project results, and management of intellectual property

The HELCATS project has well defined products that will be disseminated via the project and other website, and through workshops and publications. These dissemination activities are catered for by WP8 and are described through the following objectives:

- To publish the results of the studies in the professional literature, and present them at major international science meetings.
- To arrange annual, open meetings for the scientific community during the lifetime of the project.
- To install all relevant documents, catalogues, publications on the project website (with open access areas).
- To integrate with relevant, established community facilities and websites, including the IRAP propagation tool, the AMDA data-mining tool, HELIO and the UKSSDC.
- To disseminate information and results to the public and policy makers.

The CME and CIR catalogues will be made available on the website to the global research community, both in their initial phase (WP2 and WP5) and with the additional parameters determined through the geometrical and forward modelling (WP3 and WP5). The resulting facility will provide a unique directory of such events that will enhance a wide range of research activities relevant to heliospheric physics and space weather. The comparisons of the CME catalogues with coronagraph catalogues and the assessment of automated techniques for CME detection (WPs 2, 3 and 5) will generate conclusions, and hence recommendations; products of these comparisons will be in the form of detailed reports posted on the website and subsequently published in the professional literature.

The use of in-situ data to validate the model results (WP4), and the investigation of numerical MHD modelling based on the use of HI data (WP6), will both be the subject of reports posted on the website, and will also be published in the professional literature. Similarly, the study into the added value of radio observations (WP7), namely the IPS observations and Type II observations, will be the subject of reports and of publications in the professional literature.

The project website is the principal repository for all information, for the project team and the wider community. Its development ensures that all information is available for that community as different aspects of the study are completed. The lead beneficiary, STFC, will be responsible for the website (WP1) and will oversee the posting of information by all beneficiaries as the tasks progress. Whereas the website should maintain a restricted working area, open only to the HELCATS team and holding documents internal to the project (e.g. working documents, finance information), the section of the website holding the final reports and the catalogues will be open access. The open area will also provide basic information on the project, its structure and activities.

Throughout the life of the project, regular meetings/workshops of the HELCATS team will ensure that all of those involved are kept informed of progress in all aspects of the work. However, the principal tool for the wider dissemination of results and information will be a series of annual meetings/workshops, open to the global scientific community. These will be held in association with every other bi-annual project meeting; nominally, we anticipate one in Oxfordshire (UK), Toulouse (France) and Gottingen (Germany) to maximise the potential involvement of the community across Europe. The meetings will focus on the dissemination of project outcomes, and their exploitation in future research. We anticipate that these meetings will be in a workshop-style (akin to the US CDAW-style meetings - see http://spdf.gsfc.nasa.gov/cdaw.html) involving between 30 and 50 attendees. The coordination for these meetings will be done through the lead beneficiary.

In addition, the HELCATS team will give dedicated presentations at major international meetings, describing the project and results/facilities/methods. In order to serve the largest and most relevant community meetings, we anticipate a HELCATS presence at EGU and AGU meetings.

As a logical extension of the dissemination work of WP8, we will work at integrating the advanced catalogues into pre-existing databases, web-based interfaces, and data-mining tools. The targeted databases are the UKSSDC, HELIO and CDPP/IRAP. The catalogues of CIRs and CME time-elongation profiles and fitted parameters can be directly assimilated to the IRAP propagation tool. This tool, which will become fully operational in March 2013, will provide web-based access and manipulation of HI J-maps, including tools to plot and fit pre-existing time-elongation profiles or enabling the user to carry out their own fits by clicking on the J-map. Scientists will have direct access to the CIR and CME time-elongation profiles derived in WP3 and WP5, which they will be able to plot on the J-maps. The solar features associated with each CME and each CIR (determined as part of WP4 and WP5) will be included in the IRAP propagation tool and HELIO. Similarly the in-situ list of CME, CIR and small-scale transient impacts will also be integrated into AMDA and the IRAP propagation Tool.

The comments, above, are all concerned with the dissemination of information/results/facilities to the whole scientific community. However, whilst the professional scientific community is a key stakeholder group, it is not the only stakeholder group. We also consider the public (including the media) and policy makers and, for completeness, stress the relative engagements of all three groups in the dissemination phase in the following bulleted paragraphs:

- **The professional scientific community** requires access to the catalogues and will expect the results of studies to be endorsed through publication in the relevant professional refereed literature. The community will also require basic information on the project, online. These requirements and expectations shall be satisfied through the actions detailed above. However, there is a need, also, to advertise the activities and products of the project and this will be done through presentations from members of the HELCATS team at established international scientific meetings, as mentioned previously, such as the EGU and AGU assemblies. These activities are the logical interface to the scientific community and the strong scientific background of the team members ensures that they can be readily achieved.

- **The public** (including the media) are interested in matters relating to space and to solar events potentially impacting the Earth. As a result, our objective is to engage the public at large, and the media, in the project. We anticipate the production of press releases and associated television and radio interviews when appropriate, including at the start and end of the project. We will ensure that the website includes basic information aimed at the general, non-scientific reader, including all releases, project information, appropriate galleries and links to related websites. The key groups involved in the HELCATS project all run websites that include public/media targeted information, using facilities such as Facebook and Twitter (see STFC examples at http://www.stfc.ac.uk/ralspace/default.aspx and http://www.facebook.com/pages/RAL-Space/260441520640228) and they produce press releases and provide regular interviews; thus the team are extremely well prepared to satisfy these requirements. The individual teams also have active programmes of public engagement with their local communities involving presentations at schools, local astronomy societies and local media. The HELCATS project would certainly be included in this, as a major international activity of great interest. Outreach will be discussed on the agenda of all regular meetings, from the start of the project, and all opportunities will be taken to advertise this important work to the public/media. Some key activities and events that will generate potential public and press events would be the following:

- **Project Launch:** Press release/interviews as required, coordinated by STFC but including events local to all team members, targeting organisations such as the BBC and the press.
- **Solar Events:** In the case that major solar events occur that are noted by the media, such as aurora, CME impacts, flares, the HELCATS team will take the opportunity to advertise the work being done to understand these phenomena.
- **Catalogue Release:** Key phases in the project may be considered to be appropriate for press releases, for example when the first release of the catalogues occurs. This will be assessed at the time.
- **Local Events/Opportunities:** Different beneficiaries will take advantage of different opportunities e.g. UGOE exploiting their local planetarium facility (as the group has done successfully on several occasions), STFC proposing stands at events such as the Royal Society Soirees. Talks at schools, astronomy societies, the public at large and the media will be done frequently; we note that this is something that the HELCATS teams are particularly active in already.

- **Policy makers** at Government level, space agencies and research councils, will be targeted to ensure (1) that the project outcomes are fed effectively into strategy for space weather applications and (2) that the scientific impacts of the work are seen to enable future productive research programmes that should be supported. Again, this requires relevant information to be posted on the website, but it also demands a close engagement with activities such as ESA's Space Situational Awareness programme. The HELCATS team will ensure that progress reports, press releases and reports are received by such groups regularly during the lifetime of the project. Indeed, during the conception phase and proposal writing, the STFC team has discussed the impending HELCATS proposal in the context of high-level US-UK Space Weather meetings held in 2011/12 that were instigated by the UK Foreign and Commonwealth Office in response to statements on US-UK space weather collaboration by US President Obama and UK Prime Minister Cameron. STFC was a core player together with the US Space Weather Prediction Center in the arrangement and running of these international, policy-directed meetings. In addition, the HELCATS team have discussed plans with the management of the ESA Space Situational Awareness (SSA) space weather programme, in particular with a view to future space weather instrumentation developed in Europe benefiting from the HELCATS study results. Thus, we have maintained a high profile in targeted policy areas at international and national levels to date and would continue to do so with established contacts.

It is essential that after the completion of the project, information is not lost. Results and recommendations published in the open, professional literature will clearly be available beyond the lifetime of the project. However, it is proposed that the website be adopted by the lead institute, STFC, after the end of the project to ensure that all catalogue and report information, as well as project information remains available. The STFC site, located at RAL Space, already maintains websites for past space projects and would keep the HELCATS facility open in the same way.

Finally, we comment on intellectual property rights. For most of the work being done within HELCATS, the IP issues are the same as for any research activity, as opposed to an industrial development activity. All data are in the public domain and the final products, such as the catalogues, web facilities and publications are all open to the global community. The aim of the project is enhanced knowledge rather than financial benefit. If, during the project there are any issues which may demand some kind of IP consideration, the issue will be taken up with REA and steps taken to protect the particular aspect that requires IP protection. The HELCATS team will take steps to ensure that no IP issues impact the final outcome of the project in terms of public and scientific access to data, catalogues and other products.

B4. Ethics issues

The HELCATS project will not carry out any experiments that directly affect human beings, animals or biological materials or use information derived from such experiments. So no ethical issues arise in respect of such experiments or the protection of personal data arising from those experiments.

The project will encourage ethical behaviour by beneficiaries in the conduct of the proposed research. In the context of this project, the key ethical issues are:

- proper and open acknowledgement of the sources of data and other information used by the project,
- proper recognition of the efforts of individuals working for the project
- the importance of listening to, and responding professionally, to ideas put forward by all participants

The Executive Board and the Project Coordinator will work to ensure that these principles are upheld across the HELCATS project.

ETHICS ISSUES TABLE

	Research on Human Embryo/ Foetus	YES	Page
	Does the proposed research involve human Embryos?		
	Does the proposed research involve human Foetal Tissues/ Cells?		
	Does the proposed research involve human Embryonic Stem Cells (hESCs)?		
	Does the proposed research on human Embryonic Stem Cells involve cells in culture?		
	Does the proposed research on Human Embryonic Stem Cells involve the derivation of cells from Embryos?		
	I CONFIRM THAT NONE OF THE ABOVE ISSUES APPLY TO MY PROPOSAL	YES	

	Research on Humans	YES	Page
	Does the proposed research involve children?		

	Does the proposed research involve patients?		
	Does the proposed research involve persons not able to give consent?		
	Does the proposed research involve adult healthy volunteers?		
	Does the proposed research involve Human genetic material?		
	Does the proposed research involve Human biological samples?		
	Does the proposed research involve Human data collection?		
	I CONFIRM THAT NONE OF THE ABOVE ISSUES APPLY TO MY PROPOSAL	YES	

	Privacy	**YES**	**Page**
	Does the proposed research involve processing of genetic information or personal data (e.g. health, sexual lifestyle, ethnicity, political opinion, religious or philosophical conviction)?		
	Does the proposed research involve tracking the location or observation of people?		
	I CONFIRM THAT NONE OF THE ABOVE ISSUES APPLY TO MY PROPOSAL	YES	

	Research on Animals	**YES**	**Page**
	Does the proposed research involve research on animals?		
	Are those animals transgenic small laboratory animals?		
	Are those animals transgenic farm animals?		
	Are those animals non-human primates?		
	Are those animals cloned farm animals?		
	I CONFIRM THAT NONE OF THE ABOVE ISSUES APPLY TO MY PROPOSAL	YES	

	Research Involving non-EU Countries (ICPC Countries)	**YES**	**Page**
	Is the proposed research (or parts of it) going to take place in one or more of the ICPC Countries?		
	Is any material used in the research (e.g. personal data, animal and/or human tissue samples, genetic material, live animals, etc) : a) Collected and processed in any of the ICPC countries?		
	b) Exported to any other country (including ICPC and EU Member States)?		
	I CONFIRM THAT NONE OF THE ABOVE ISSUES APPLY TO MY PROPOSAL	YES	

	Dual Use	**YES**	**Page**
	Research having direct military use		
	Research having the potential for terrorist abuse		
	I CONFIRM THAT NONE OF THE ABOVE ISSUES APPLY TO MY PROPOSAL	YES	

B5. Consideration of gender aspects

In terms of its personnel, the objective of the HELCATS project has been to form the best scientific and technical team available to perform the specified task. It is pleasing that at no time did any decision making in the formation of the collaboration involve any gender bias in either way.

Of the institute leads and Executive Board, we note that two highly-capable and well-qualified female scientists are involved, though we are aware that this is a minority of the lead players (ratio 2:8). The project will not tolerate gender bias in the selection of specific post-doctoral or student posts in the application of HELCATS and will monitor the hiring of staff to ensure that the best candidates are employed with no gender bias. In addition, every attempt will be made to ensure that the balance of work and private life for any individual, male or female, is appropriate for their needs; the nature of the project allows for some flexibility. This approach is well illustrated by other projects at the institutes involved.

In addition, talks and presentations to the public, schools, and the media will be presented with no gender bias and will encompass both genders and all backgrounds.

Annex: ACRONYM LIST

AGU	American Geophysical Unioon
AMDA	Automated Multi-Dataset Analysis (software tool)
EGU	European Geosciences Union
CIR	Co-rotating Interaction Region
CME	Coronal Mass Ejection
CNRS	Centre National de la Recherche Scientifique
GMU	George Mason University
HELCATS	Heliospheric Cataloguing, Analysis and Techniques Service
HI	Heliospheric Imager/Imaging
IMPERIAL	Imperial College of Science, Technology and Medicine, London
IPR	Intellectual property rights
IPS	Interplanetary Scintillation
MGT	Management
MHD	Magnetohydrodynamics
ROB	Koninklijke Sterrenwacht van Belgie
RTD	Research and Technology Development
RAL	Rutherford Appleton Laboratory
OTH	Other
SECCHI	Sun Earth Connection Coronal and Heliospheric Investigation (instrument package)
SDO	Solar Dynamic Observer (mission)
SOHO	Solar and Heliospheric Observatory
STEREO	Solar Terrestrial Relations Observatory (mission)
STFC	Science and Technology Facilities Council
TCD	The Provost, Fellows, Foundation Scholars & the other members of Board of the College of the Holy and Undivided Trinity of Queen Elizabeth near Dublin
UKSSDC	UK Solar System Data Centre
UGOE	Georg-August-Universitaet Goettingen Stiftung Oeffentlichen Rechts
UH	Helsingin Yliopisto
UNIGRAZ	Universitaet Graz
UPS	Universite Paul Sabatier Toulouse III
WP	Work Package

ANNEX: Letters of Support

Met Office

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RE: Heliospheric Cataloguing, Analysis and Techniques (HELCATS) FP7 Project

Dear Richard,

Thank you for sharing with the Met Office your plans for the proposed HELCATS FP7 project.

Within the Met Office, as we develop CME modelling techniques and space weather forecasting services, the outputs of your project will be of great benefit to us.

Once we have completed the implementation of the WSA ENLIL model, both the data catalogue and the new analysis techniques you are developing will be beneficial to the ongoing model development and testing we undertake. It will also allow us to better understand the behaviour of CMEs and CIRs.

The catalogue will also be useful to allow us to train forecasters in the analysis of CMEs and undertake assessments of the skill of our analysis and forecasting process.

We hope your proposal will be successful and we look forward to being able to use the outputs of your project.

Kind regards,

M A Gibbs
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15 November, 2012

MEMORANDUM FOR: Richard Harrison, Science and Technology Facilities Council, Rutherford Appleton Laboratory, RALSP

FROM: Rodney Viereck, Director, Space Weather Prediction Testbed, Space Weather Prediction Center

SUBJECT: Support for the Heliospheric Cataloguing, Analysis and Techniques (HELCATS) Proposal to the EU FP7 Program

With this letter, I would like to indicate our organization's strong interest in the research you have proposed in the HELCATS project. We see this effort as contributing importantly to NOAA's future ability to provide accurate forecasts of geomagnetic storms.

We recognize that your proposed effort takes a broad approach to incorporating space-based observations, ground-based observations, and numerical prediction models. Your deliverables involve a comprehensive characterization of space weather events caused by coronal mass ejections and include a validation of the ability to predict these events using existing numerical models and data analysis tools. Of particular interest to us is the assessment you have proposed of the relative value of different data sets to the quality of predictions made with numerical models. This kind of assessment is essential for decisions that will need to be made in the future on the priorities of critical observing assets.

Thank you for the opportunity to discuss your proposed effort and to offer our comments. We consider this work to be highly valuable, and we look forward to your progress.

Rodney Viereck

15 November 2012
Date

Signature

CC
Terry Onsager