CLOSE-UP

Campfires, Loops, and Oscillations in the Solar EUV atmosphere at Unprecedented Precision

DURATION
1/09/2022 – 1/12/2026

BUDGET
489 199 €

PROJECT DESCRIPTION

The heating of the solar corona by small-scale energy release events requires an increasing number of such events at progressively smaller scales, with the bulk of the heating occurring at currently unresolved scales. The goal of the project is to study the smallest coronal brightening events observed to date in the Extreme Ultraviolet quiet Sun, in the unparallelled high-resolution images taken by the High Resolution EUV imager (HRI EUV; Rochus et al. 2020), which is a part of the Extreme Ultraviolet Imager (EUI) onboard the Solar Orbiter mission of ESA launched in 2020 (Müller et al. 2020).

The discovery of small energy release events was reported by Berghmans et al. (2021), where localised brightenings, also known as 'campfires', were observed in the high resolution images of the quiet Sun taken by EUI on May 30, 2020. The smallest and weakest of these HRI EUV brightenings had not been observed by the previous generation of instruments. From 2022 onwards, EUI will further improve its record resolution by a factor 2, which means we will be able to observe campfires in even more detail as well as detect even fainter events on its semi-annual close approaches to the Sun. This will allow us to perform dedicated campfire studies in different phases of the solar cycle and in different types of coronal regions (quiet Sun, active regions, coronal holes). In this project, we will investigate campfires in the cutting edge data sets that EUI and other instruments onboard Solar Orbiter (PHI and SPICE) will produce in the next few years.

The project is driven by three overarching science questions:

1. What is the physical nature of campfires?
2. To which extent do campfires contribute to coronal heating?
3. Can coronal wave seismology reveal the internal physics of campfires?

These questions were translated into four science objectives:

1. To study EUV brightenings systematically via a thorough analysis of the Solar Orbiter data, exploiting their full potential for discovery
2. To diagnose the local plasma properties of EUV brightenings via coronal seismology
3. To study the EUV brightening energy distribution so as to estimate the contribution of EUV brightenings to coronal heating
4. To build a catalogue of EUV brightenings and to derive a comprehensive understanding of their properties

CLOSE-UP is a collaboration between the Royal Observatory of Belgium (ROB, coordinator) and KU Leuven. As Principal Investigator institute for EUI and through its world class experience in the study of small scale heating events, ROB is uniquely placed to ensure the implementation of dedicated campfire observing campaigns and the optimal exploitation of the corresponding data sets. With its leading role in modelling solar observations, KU Leuven is an ideal partner to complement the observations.

The figure below illustrates the methodological approach adopted in CLOSE-UP to attain the science goals.

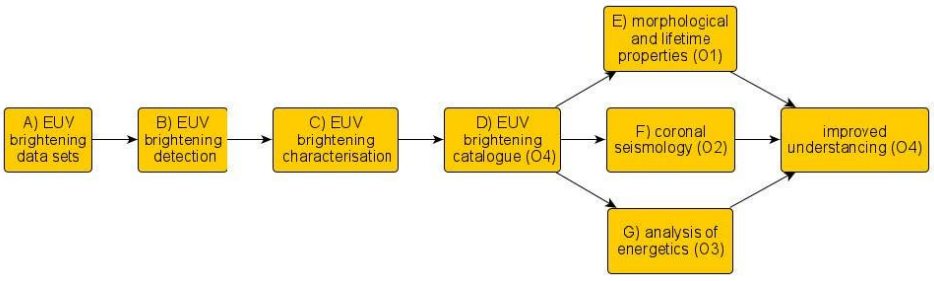

Figure 1. Overarching methodological approach. It is indicated which actions correspond to scientific objectives 1 to 4.

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The first step is to work out the best orbital opportunities for Solar Orbiter EUV brightening observing campaigns in the next years, to gather the corresponding data and to build comprehensive data sets as input for EUV brightening studies (A). Automatic EUV brightening detection (B) and characterisation (C) will allow us to build a FAIR EUV brightening catalogue (D). This catalogue will be an invaluable source for various studies on campfires, both by the CLOSE-UP team and external researchers. We will employ it to study morphological and lifetime properties (E) and energetics (G) of EUV brightenings and to identify proper data sets for coronal seismology on EUV brightenings (F). All previous steps contribute to an improved understanding of EUV brightenings.

CLOSE-UP's main impact is on science: the project aims at a breakthrough impact on our fundamental understanding of a key astrophysical object, the high-temperature solar corona, and the long-standing mystery of how it is heated.

Impact on civil society is mainly through solar EUV images, which are welcomed by the general public as both beautiful and spectacular. Planetarium exhibits (including a 3D mock-up of Solar Orbiter/EUI), open doors, participation to science fairs, press releases and regular updates on the project on ROB and STCE website will promote increased awareness of the beauty, complexity and wonder of the Sun and of the significant Belgian contributions in this field. This engagement will also foster young people's interest to study STEM.

CLOSE-UP has only minor direct impact on contemporary economy but a potential giant indirect impact, as it studies the same plasma physical processes relevant for nuclear fusion and space weather.

We will inform the scientific community through high-impact peer-reviewed publications, sessions and talks at conferences, conference proceedings, seminars and science nuggets. Active discussions with the solar physics community will be held during weekly EUI science teleconferences. The EUV brightening catalogue is one of the main valorisations of the project to the scientific community.

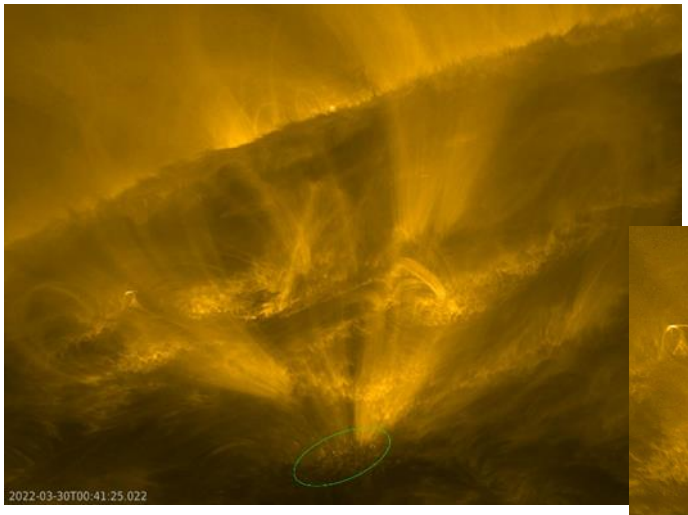
CONTACT INFORMATION

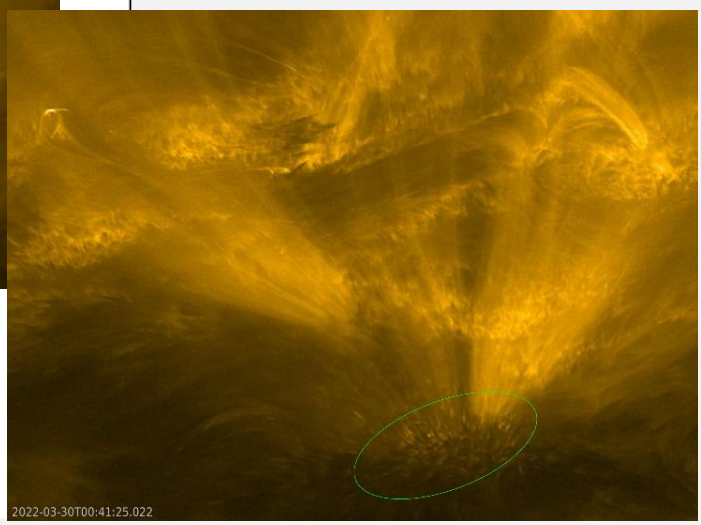
Coordinator

Francis Verbeeck
Royal Observatory of Belgium (ROB)
Department of Solar Physics and Space Weather
francis.verbeeck@oma.be

Partner

Tom Van Doorsselaere
Katholieke Universiteit Leuven (KU Leuven)
Departement wiskunde
tom.vandoorsselaere@kuleuven.be





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WTC III - Simon Bolivarlaan 30 bus 7 - Boulevard Simon Bolivar 30 bte 7
1000 Brussels - Tel. +32 (0)2 238 34 11
http://www.belspo.be/brain-be/ • Email: BRAIN-be@belspo.be