

**SHIPS (Solar Hidden Photon Search)**  
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## 1 Goal of experiment

The goal of SHIPS is to search for solar hidden sector photons (HPs). In particular, it aims to hunt for solar HPs in a previously unexplored parameter range in mass and coupling which has been suggested in the context of an embedding of the standard model in string theory and of a possible explanation of the extra dark radiation during decoupling of the cosmic microwave background photons and of non-thermally produced cold dark matter. At low masses, the parameter range to be explored with SHIPS compares to the one probed by ALPS II.

## 2 Experimental setup

SHIPS is an astronomical search for astroparticles (HPs) in the optical and near-infrared. The experimental facility is a fully steerable 'solar' telescope (helioscope) enabling continuous tracking of the Sun's HP-'image'. The optical tube assembly is enclosed in a light-tight shroud to eliminate contamination by ordinary solar and ambient photons. Evacuating the chamber to  $< 10^{-4}$  mbar avoids the suppression of HP-photon conversion by gaseous matter. SHIPS uses antipodal optical assemblies to facilitate 24h tracking and simultaneous background monitoring. Simple lightweight optics with sufficient image quality are provided by large Fresnel lenses. Initially available detectors are 2 photomultiplier tubes and a low-noise CCD camera, all cooled to minimize dark current noise. SHIPS is an offspring of the ongoing ALPS projects at DESY. Unlike the laboratory experiments ALPS and ALPS II, SHIPS does not involve magnetic fields.

### 2.1 Development items:

The major development items involve detectors, optics and software.

- The focus lays on ultra-low-noise imaging detectors for the optical and infrared spectral region.

- Large lightweight optics (Fresnel lenses) are being engineered and evaluated for TSHIPS 1 and the larger TSHIPS 3 (see Sec. 6).
- Dedicated data reduction and analysis software needs to be developed.

### 3 Accelerator or Lab Facility

SHIPS is a standalone experiment currently set up with limited resources at the Hamburg Observatory (Hamburger Sternwarte). Infrastructure procurement for upgrades is under way.

### 4 Physics Reach

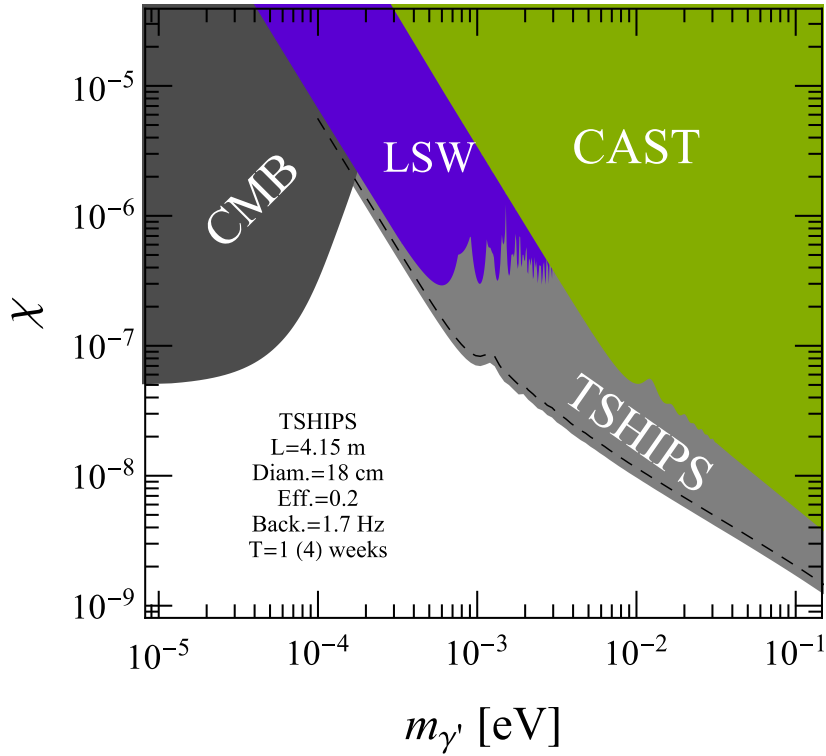


Figure 1: Current bounds on HPs (kinetic mixing  $\chi$  between HPs and photons vs. HP mass  $m_{\gamma'}$ ) and projected range to be explored by TSHIPS 1 (gray).

## 5 Status and Schedule

The experiment was initiated in the fall of 2010. TSHIPS 1 (Telescope for Solar HIdden Photon Search 1) has been attached to the large equatorial mount of the HS Oskar-Lühning telescope on October 27th 2011 (Fig. 2). This TSHIPS prototype employs two coupled 26 cm diameter vacuum tubes with integrated optics to form a 4 m long helioscope. The upper tube is a lightweight vault structure developed for this project. Integration, verification and performance tests are under way. The start of science operations is expected within the next weeks.

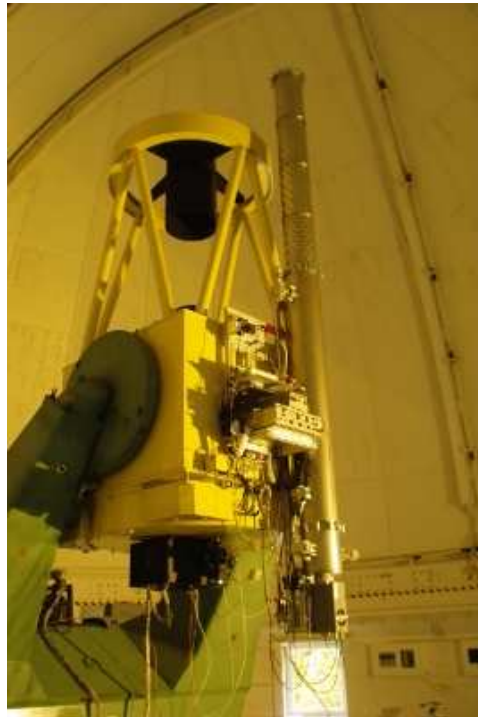


Figure 2: TSHIPS 1 (Telescope for Solar HIdden Photon Search 1) attached to the equatorial mount of the HS Oskar-Lühning Telescope (OLT) at the Hamburger Sternwarte.

## 6 Future Plans

Phase 2 planning has started with TSHIPS 3 as the next much wider (2 m diameter) and longer (16 m) helioscope. This massive tube will be put on a separate large alt-az mount for long-term operation and will presumably be installed on the DESY premises. Detector development is ongoing in conjunction with other astronomical programs. There is no secured future funding yet for the complete experiment.

## 7 Collaborating Institutions and Collaborators

The following institutes and persons are members of the SHIPS collaboration:

- Deutsches Elektronen-Synchrotron DESY, Hamburg, Germany:  
Paola Arias (now at University of Santiago, Chile), Ernst-Axel Knabbe, Axel Lindner, Cornelius Martens, Carsten Niebuhr, Javier Redondo (now at MPP, Munich, Germany), Andreas Ringwald, Ernst-Otto Saemann.
- Hamburger Sternwarte, Hamburg, Germany:  
Christopher Blohm, Magnus Schneide, Matthias Schwarz, Günter Wiedemann.

## 8 Written Materials (e.g. references)

To obtain more information on the project and the physical background, please visit the webpage of the SHIPS experiment under:

<http://www.ships.uni-hamburg.de>.

Here also links to the Sonderforschungsbereich 676 and the State Excellence Cluster, 'Connecting Particles to the Cosmos' are given, where SHIPS is part of.

A clear summary of the SHIPS physics is to find in:

D. Cadamuro and J. Redondo, arXiv:1010.4689 [hep-ph].

An extensive collection of papers giving a deeper impression of the HPs physics can be found on the web presentation of SHIPS under:

<http://www.hs.uni-hamburg.de/DE/Ins/Ships/theory.html>

## 9 Any other info?