New Generation Axion Helioscope (NGAH)
Igor G Irastorza

1 Goal of experiment

The main goal is the search for solar axions (and axion-like particles, ALPs) in a broad axion mass range with sensitivity down to a few $\times 10^{-12}$ GeV^{-1}, improving up to 1.5 orders of magnitude in $g_{a\gamma}$ that of the CERN Axion Solar Telescope (CAST), currently the most powerful implementation of the axion helioscope concept. The probed region of the parameter space would include a large fraction of realistic, previously unexplored, QCD axion models at the meV mass scale and above, complementary to the region to be explored by axion dark matter haloscope searches.

2 Experimental setup

The NGAH experimental setup follows Sikivie's helioscope concept [**?**], extended with the use of x-ray optics and low background detectors [**?**], as was pioneered by CAST[**?**]. The NGAH will require a new toroidal magnet with substantially increased magnetic volume with respect that of CAST. Photons out of axion conversion in the magnet will be focused by large aperture x-ray optics, built using cost-effective techniques based on thermally formed glass substrates, already successfully used in x-ray astronomy missions like NuSTAR [**?**]. Finally, the focused x-rays are detected by several systems, using state-of-the-art low background techniques like the ones offered by the high granularity gaseous Micromegas detectors developed in CAST, making also use of radiopure components, shielding and powerful offline discrimination based on the topology of the events in gas. Beyond this backbone setup, further specific instrumentation may be used for additional physics byproducts of the experiment.

All needed technologies are proven in essence and no R&D is needed. However, a phase of prototyping and of design study is ongoing to define final specifications of each subsystem and assure all technical solutions.

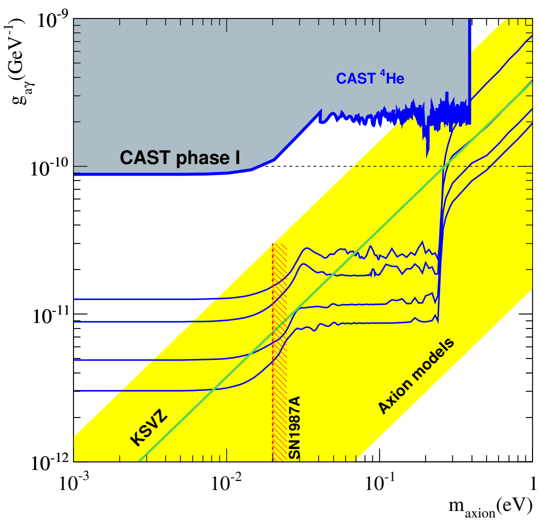

Figure 1: The parameter space for hadronic axions and ALPs. The CAST limit, some other limits, and the range of PQ models (yellow band) are also shown. The blue lines indicate the sensitivity of the four scenarios for the NGAH ranging from more conservative to more optimistic prospects. See [?] for more details.

3 Accelerator or Lab Facility

CERN is the preferred site due to the experience developed with CAST, but there is no formal decision yet. The experiment does not make use of accelerator.

4 Physics Reach

NGAH will achieve sensitivity to solar axions (and axion-like particles, ALPs) in a broad axion mass range and down to a few $\times 10^{-12}$ GeV^{-1}, in particular, including realistic, previously unexplored, QCD axion models at the meV mass scale and above. This sensitivity improves up to 1.5 orders of magnitude in $g_{a\gamma}$ that of the CERN Axion Solar Telescope, currently the most powerful implementation of the axion helioscope concept. See left of figure 1. In addition, sensitivity to other more specific models of hidden scalars is expected. Generic models of very light ALPs invoked in a number of astrophysical unexplained observations will be directly tested. More-

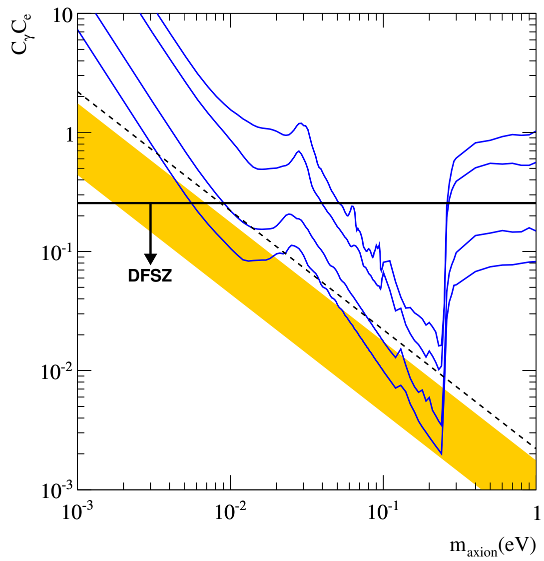

Figure 2: The expected sensitivity regions of the four same scenarios in the parameter space of non-hadronic axions with both electron and photon coupling. In GUT models C_γ is fixed to 0.75 and we show the bound on the electron coupling (C_e) from red giants (dashed line along the diagonal) and the region motivated by WD cooling (orange band). DFSZ models lie below the horizontal line $C_\gamma C_e < 0.25$. From [?]

over the specific electron-coupled QCD axion models invoked to explain the White Dwarfs (WD) cooling anomaly could also be partially probed through the direct detection of the same axion bremsstrahlung emission in our Sun, as shown on the right of figure 2. Finally, the possibility to search for dark matter axions with this setup is under study.

We refer to [?] for more details.

5 Status and Schedule

The experiment has published a first paper with the physics case, expected sensitivity and first feasibility results. The collaboration is at the moment working to produce a Conceptual Design Report, and a formal proposal in the coming months.

6 Future Plans

7 Collaborating Institutions and Collaborators

The collaboration is in the process of growing and getting formalized. Active groups or groups having shown interest include CERN, CEA/Saclay, LLNL, U. Trieste, RBI Zagreb, U. Zaragoza, U. Patras, Demokritos, DESY, INR Moscow, Yale University, U. Columbia, DTU Denmark and others.

8 Written Materials (e.g. references)

JCAP 1106 (2011) 013

9 Any other info?