



2023 Helmholtz – OCPC – Programme for the involvement of postdocs in bilateral collaboration projects

PART A

Title of the project:

Enlightening the Dark Sector at Future Higgs Factories

Helmholtz Centre, division:

DESY-FH

Project leader:

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Description of the project (max. 1 page):

DESY is one of the world's leading research centers in high energy physics and in photon science. In addition to strong participations in ongoing experiments, DESY is a leading player in planning the next generation of collider experiments, in particular for future electron-positron colliders operating as so-called Higgs factories. Currently, several proposals for future e⁺e⁻ colliders operating at energies from the Z pole to a few TeV are being discussed, including both Linear and Circular Colliders.

While the Higgs precision program at such machines is quite well understood, the capabilities of such electron-positron colliders for discoveries in the Dark Sector and the related detector requirements are just beginning to be explored. New particles from a Dark Sector could lead to a large variety of signatures, including very exotic ones, including for instance late decays deep inside the detectors and decays into complicated decay chains. These pose special challenges to detector technologies as well as reconstruction software. Detector concepts need to be well-adapted to identify and reconstruct such signatures, under the constraints from the accelerator environment, which differs significantly between linear and circular colliders and their respective energy stages.



The aim of this project is to study typical dark sector signatures in detailed, Geant4-based simulation of typical detector concepts adapted to circular (FCCee / CEPC) or linear (ILC/ CLIC) colliders. This requires the development of suitable reconstruction algorithms in the joined future collider software framework Key4HEP. Based on these, the impact of the forward region design and the choice of the main tracking detector on the discovery potential will be evaluated taking into account realistic assumptions on beam conditions and backgrounds. Depending on the interest of the successful candidate, the work on the signatures and detector performance can be complemented by more phenomenological aspects, like mapping the signature-based performance study onto the parameter space of various dark sector models.

Description of existing or sought Chinese collaboration partner institute (max. half page):

Collaboration exists with IHEP, recently strengthened by a previous round of the DESY-ONAPCR program. The project is open to any partner institute which is interested in the physics program of a future e⁺e⁻ Higgs factory, be it in China or elsewhere in the world.

Required qualification of the postdoc:

- PhD in experimental particle physics or particle phenomenology
- Experience in programming and large-scale data analysis
- Ability to collaborate in an international team
- Very good knowledge of the English language