Expression of Interest for participating in the H2020 Innovation Pilot on detector technologies at accelerators

Title: *Turnkey software stack for detector studies*

Participants (max. 6): *list the participating institutes, laboratories and industrial partners*

Name of the legal entity	Type (university, institute, laboratory, company)	Country
CERN	Laboratory	Switzerland
DESY	Laboratory	Germany
IHEP	Laboratory	China
INFN	Institute	Italy

Contacts: *One name + e-mail per participant*

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Description: *(max. 1 page)*

Detector studies for future colliders critically rely on well-maintained software stacks to model detector concepts and to understand a detector's limitations and physics reach. These software stacks resemble the offline software of a running experiment, including event generation, detector response simulation, reconstruction algorithms, analysis tools, and distributed computing resource management. In contrast to the software suite of running experiments, detector studies tools must be lightweight and be able to rapidly adapt to detector design changes and varying collider conditions. Moreover, the software must handle a wide range of detail during the detector development lifecycle, from first estimates based on a coarse-grained geometry during the inception phase to detailed physics studies using sophisticated reconstruction algorithms on simulated event data.

Existing experiment software stacks, such as the LHC experiment frameworks, are highly customized to a specific experiment, which makes them complex to operate and maintain and too difficult to reuse with the much more limited computing effort available to the study groups for future detectors. Individual HEP libraries, some of which were developed in the previous AIDA projects, solve particular problems, such as geometry description, track reconstruction, or data serialisation and plotting, but still require significant effort to integrate into a stack that can be used with minimal effort by an experiment or detector study group. This led in the past to the creation of multiple independent solutions, which are quite pragmatic, but non-optimal and incomplete and result in a significant duplication of effort.

The goal of this task is the development of a common turnkey software stack that can be used for detector studies at future accelerator-based experiments. A turnkey stack is the natural continuation of the previous AIDA projects, in which a number of independent components were developed, that need to be put together in a coherent manner to ease their use. The main challenge is in identifying a maximum subset of detector-independent data structures and algorithms, in particular in identifying common parts of the event data model, which is a precondition for applying common reconstruction algorithms. Most of the development work will be adding the necessary glue logic between the various existing software components to make them interoperate and provide a consistent and fully functional solution that can be customised by the different detector study groups. The scope will cover simulation, reconstruction and data analysis of Monte Carlo data and test beam. A practical approach is required towards documentation, physical structure of the code, software dependencies and detector-specific plugin interfaces such that a low maintenance stable software core is readily usable for established and new detector study groups, as well as to make use of the best practices for building, testing and deploying the software.

Deliverables (max. 3): list the expected deliverable(s) of the proposed activities

- Requirements and design document. It should include:
  - input from the collider communities
  - adoption of software best practices
  - development of project templates
  - testing and evaluation of alternative solutions
  - planning for the components to be incorporated into the turnkey stack
- First version of the turnkey stack. It should include at least:
  - Definition and adoption of the common event data model (EDM4HEP)
  - Adaptation of geometry package (DD4HEP)
  - Selection of the data processing framework with upgraded set of features
  - Packaging, building, deploying, CI system
  - Complete documentation with description of all included components and examples in various domains
- Production-ready version of turnkey system
  - Compete the integration of all the components identified in first deliverable
  - Automation of the procedures to ease maintenance and the evolution of the software stack.

Budget estimate

- *Man-power (total number of person-months which are needed to achieve the objectives)*
- *Full cost including personnel and other direct costs (typically 1/3 EC contribution, 2/3 matching resources)*
- *DO NOT include overheads, which will be added to the EC contribution at the proposal preparation phase*

Total number of PMs	EC contribution (in kEUR) (a)	Matching funds (in kEUR) (b)	Full costs (in kEUR) (a) + (b)
72	214	428	642