TauFV: a fixed-target experiment to search for flavour violation in tau decays

Addendum to EPPSU submission

As requested, in this addendum we address several questions posed in the guidelines for submitting EPPSU input. It should be noted, however, that TauFV is a very recent proposal and so most of these questions cannot yet be answered with the same level of precision as is possible for a mature project. We expect to be able to provide more detailed information on the timescale of half a year.

Interested community

The proponents are experienced and well respected physicists, beam experts and engineers drawn from CERN and major European institutes. This already provides firm foundations for the project, but over the coming year we will seek to attract other groups and hence form a proto-collaboration. Many of these groups will come from the world-wide flavour community in both collider and dedicated muon Lepton Flavour Violation experiments. The timeline of the project is ideal for physicists currently involved in Belle II, who will be looking for new experimental opportunities towards the middle of the coming decade. We will also seek to establish a working partnership with LHCb to enable scientists and engineers to participate in both experiments, an arrangement that is well motivated by the complementary physics goals of TauFV and the LHCb Upgrades, and the commonality in much of the detector technology. Finally, we remark that the exciting detector challenges of TauFV will make the experiment attractive to many hardware-oriented groups currently focused on the ATLAS and CMS Phase-II Upgrades.

Timeline

The two principal factors that will determine the start date of TauFV are the schedule for the BDF construction, and the time required to develop the sub-detector technology, in particular the front-end ASICs. The current BDF planning would allow for the TauFV experimental hall to be prepared in 2026-27, which would also represent the earliest opportunity to install the experiment. As this would be a few years before Upgrade II of LHCb, with which a significant part of the detector R&D is coupled, it might be that LS4 in 2030 is a more realistic goal. In this case it would still be possible to install a demonstrator experiment at the earlier date, either at the BDF or in another beam line, to establish proof-of-principle for many of the key aspects of the project, and to perform first physics measurements.

Over the coming half a year we intend both to attract more collaborators and refine our simulation studies, with the intention of submitting an Expression of Interest to the SPCC before the end of 2019. By then a clearer picture will have

emerged of the realistic timeline, which in turn will dictate a suitable schedule for the writing of a Technical Design Report. Design studies and test-beam evaluation on the critical detector elements (in particular the VELO, TORCH and ECAL) are already ongoing, and are following a well defined programme, which will allow for baseline technology choices to be already made within two or three years.

Construction and other costs

No detailed cost estimate has yet been attempted for TauFV, but guidance comes from the observation that the experiment is similar in layout to LHCb, but significantly smaller and without a RICH system or hadron calorimeter. The ECAL has a surface area around four times smaller than that of LHCb, although we are seeking to equip this more compact device with highly performant technology. In some aspects the sub-detectors will be more straightforward in design (for example the VELO has no need of retraction outside stable data-taking conditions, and does not require an RF box nor secondary vacuum), although the high radiation environment and possible need for remove handling will introduce new challenges. In our baseline design the experiment will operate a conventional trigger system, and hence have significantly lower computer and DAQ costs than the LHCb Upgrades. In summary, we would expect the total construction cost of the experiment to be below 30 MCHF.

In the R&D phase, many of the costs can be shared with those of LHCb Upgrade II, given the high degree of commonality between the two experiments.

The electricity costs will be dominated by those required for a warm-core dipole magnet and the High Level Trigger computing farm.

Computing requirements

Given the trigger choice outline above, and the rather focused physics goals of the experiment, we would anticipate both online and offline processing requirements that are relatively modest, and certainly smaller than those of LHCb in Runs I and II. We will also prioritise data-driven analysis techniques that will obviate the need for very large simulation samples.