***How to read this document****: This lays out a set of points that could be made in the UK submission to the European strategy process on future colliders. The points are for discussion in B’ham. Some of these are non-controversial but some are deliberately so to prompt discussion. Some points are mutually incompatible and there for discussion. Statements in italics are there for further explanation and not part of a point to potentially be made.*

**Colliders**

**Introduction**

1. Completion of the LHC and HL-LHC programme is the UK’s highest priority.
2. UK supports a collider approach to HEP.
3. CERN should conduct R&D to enable it to follow the HL-LHC programme with a next collider programme.
4. In order to follow the HL-LHC with a next collider in a timely fashion the UK believes that relevant R&D at CERN should focus on one objective and by 2020 this objective should be identified.

**Scenarios**

5) ILC given go ahead by end of year.

1. UK community would engage in experiment and accelerator work on an ILC.
2. UK would recommend that CERN focus on accelerator R&D for the next hadron collider (i.e. high field magnets) and that R&D on CLIC be reduced or cease altogether to enable this.
   * *Implication of above is that if ILC goes ahead there will not be a CLIC*

6) ILC not given go ahead by end of year. Decision not made.

1. UK does not believe that further physics information from the LHC could strengthen a case for an ILC in Japan. The UK recommends that a decision on whether or not to go ahead with an ILC be made in the near future.
2. UK recommends that CERN focus R&D on one of high field magnets or CLIC to ensure that CERN is ready to follow on from the HL-LHC programme with the next energy frontier accelerator.

*Following is a set of options on more specific UK positions that could be taken. These possible positions are NOT all mutually compatible. The points are for discussion.*

* 1. An e+e- collider is essential and should be built at CERN if the ILC is not built. *Not specifying CLIC or FCC-ee*
  2. An HE-LHC would be the highest return next collider after LHC and is achievable. This should be CERN’s highest priority.
  3. The physics case for an HE-LHC is not strong enough and it would be a distraction and merely delay the start of an FCC-hh.
  4. An FCC-ee followed by an FCC-hh is the highest return physics combination of colliders and should be CERN’s primary focus.

7) Chinese options

1. UK believes a CepC e+e- collider would provide valuable physics. Operation from 2030, should an ILC not be built, would be timely. *Is 2030 at all technically realistic?*
2. *Should make some comment on CERN options should CepC be built.*

8) Should an ILC or a CepC be built the UK recommends that CERN focus on the next generation of pp collider.

9) Reuse of LHC tunnel.

1. An HE-LHC programme following on quickly in time from the HL-LHC could provide an intermediate step to a 100 TeV machine. *Points for discussion. Is there any point doing this? Do physics prospects justify only factor 2 in energy? Maybe best we can get and CERN can afford to do it.*
2. LHeC adding an electron beam to the LHC. A low cost option. *Are the returns worth the disruption? Would this delay a future FCC? Is this incompatible with an HE-LHC option?*

10) Muon collider option. Should such an option become available the UK would be interested in considering it.

* *Should CERN do anything on this?*

**Neutrino physics**

**Long-baseline Neutrino Physics**

The 2013 update to The European Strategy for Particle Physics noted that there was a ``strong scientific case for a long-baseline neutrino programme exploring CP violation and the mass hierarchy in the neutrino sector.'' There have been significant developments since this time with the establishment of the DUNE and HK collaborations. The neutrino platform established at CERN following the recommendations that emerged from the 2012 process, has been very useful to the UK community. It has provided a central focus for the European neutrino community, enabled strong European involvement in DUNE, and facilitated the protoDUNE experiment.

*Points to potentially make*

1. The UK is committed to DUNE and HK.
2. We recommend that CERN to continue to support the engagement of European physicists in the worldwide neutrino programme.
3. We recommend that CERN continue to support the neutrino platform
4. We recommend that the neutrino platform continue as a facility in and of itself, such that is conducts experiments that are self-contained

**Neutrinoless double beta decay**

1. Probe of a fundamental property of neutrinos. Important to conduct experiments on this area.
2. UK has long history of involvement in such experiments and is looking to the next generation of experiments.
3. Experiments are conducted at underground laboratories such as Gran Sasso. Next-generation ton-scale experiments are major projects requiring engagement of the whole European 0νββ community
4. Facilities such as Boulby low background important for this work
5. *Is there any unique technical expertise that CERN can provide that will be useful to next-generation experiments? Discussion point*
6. *Can we tap into CERN funds in any way to support such work? Discussion point.*
7. Neutrino astronomy is an important part of the future European programme, with a strong European involvement in the running experiments IceCube and ANTARES and their proposed upgrades, IceCube-Gen2 and KM3NeT. There is UK involvement in IceCube-Gen2.

* *nuSTORM at CERN. What do we say about this?*

**Flavour Physics**

1. Complimentary to energy frontier collider physics. Provides an indirect probe higher mass scales. Should be pursued.
   1. May provide insights and guidance for decision on future energy and intensity frontier machines.
2. Large UK involvement in LHCb and its upgrades. Support for LHCb upgrade(s) to exploit the full flavour potential of LHC.

1. UK involvement in NA62, should we make a statement?
   1. Support an extension of the operation and data taking of NA62 to reduce the statistical uncertainty to X% in its flagship measurement.
   2. Support an upgrade of Kaon physics programme at CERN?
2. UK involvement in SHiP, should we make a statement about SHiP?
   1. Support continued R&D towards a general-purpose beam dump facility at CERN?
   2. Support of the construction of the SHiP experiment?
3. Lepton flavour experiments potential for interesting measurements. UK involved in several. UK will continue with involvement in current and future LFV experiments.
4. UK involvement in g-2. Should we make a statement about support for MuonE?
5. Limited UK involvement in hadron eEDM measurements at CERN
   1. Do we want to make a statement about these?
6. Other activities that would support a rich flavour physics programme?

**Dark Matter**

1. UK has strong DM community.
2. Experiments are now growing to a scale that is starting to require major lab infrastructure
3. Likely to be one LXe G3 ‘rare-event search observatory’ somewhere in the world. The UK aims to be prominent in this.
   1. Will require large international collaboration. An evolution from current situation
4. UK primary interest for near future DM experiments is in using liquid Xenon
5. CERN could provide support for R&D into Cryogenics and purification for LXe and LAr
6. It may be possible to capitalise on the neutrino platform to study LAr veto systems.

**R&D for Detectors**

1. Detector R&D should be supported.
2. *Some comment about CERN role within member state community. For discussion.*