The scientific potential of muon beams

- Discovery programmes are underway:
  - At the energy frontier; LHC and its upgrades;
  - In neutrinos:
    - NOvA, T2K, reactor astroparticle,…
    - DUNE/LBNF, Hyper-K and the SBN programme
- Therefore timely to consider opportunities to:
  - Go beyond the present/planned programme;
  - Change the paradigm for:
    - "Low-energy", cLFV
    - The production of neutrino beams;
    - l^+/l^- collisions at high energy
  - Alone *and in combination*

- Hoping for consensual conclusions of the meeting:

Recommendations

Over the next two years, through an appropriate series of international plenary and working-group meetings, determine the scope of the physics programme that can be addressed through the incremental development of current facilities and the staged implementation of specific capabilities. Further, determine the technology R&D programme that must be carried out in parallel to the physics programme to allow the subsequent increments in capability to be delivered.

When determining the incremental development of the programme consider:

1. Low-energy muon beams:
   (a) Improved and higher sensitivity experiments on cLFV through the golden channels $\mu \to e\gamma$, $\mu \to eee$ and $\mu N \to eN$;
   (b) Measurements of muon properties such as the anomalous magnetic moment a_μ or the electric dipole moment d_μ;
   (c) Muon cooling and phase rotation to achieve muon beams of unprecedented brightness for low energy muon physics;
   (d) High-intensity, high-brightness sources of muonium, revisiting of muonic atom spectroscopy and a measurement of atomic parity violation in muonic atoms;
2. Neutrinos from stored muon beams:
   (a) The precision with which $\overset{(-)}{\nu}_e N$ and $\overset{(-)}{\nu}_\mu$ scattering processes can be measured and the potential for these measurements to enhance the reach of present and future accelerator-based neutrino experiments and experiments that exploit atmospheric or astrophysical sources of neutrinos;
   (b) The technology development and prototyping programme necessary to achieve the neutrino-scattering programme; and
   (c) If appropriate, the construction of system-demonstration experiments beyond MICE;
3. Energy frontier $\mu^+\mu^-$ collider:
   (a) The physics potential and conceptual design of a Higgs Factory and the investigation of a possible demonstrator facility;
   (b) The physics potential, conceptual design and incremental development of a multi-TeV muon collider;
   (c) The specification and conceptual design of a 6D cooling demonstration to follow on from the MICE 4D ionization cooling proof of principle; and
   (d) If appropriate, the construction of system-demonstration experiments beyond MICE, MERIT, MuCool and the component development carried out by the US Muon Accelerator Programme;
4. Sources of resource to execute the development programme including Horizon 2020, national funding agencies and national laboratories.

The programme must be capable of incremental development and exploit the synergies that exist between its various aspects as is the case, for example, for the ionization-cooling and demonstrator programmes (1c, 2c, 3d and 3c).

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