IAC Summary

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Joint future charm-tau factories International Advisory Committee

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Introduction

- we thank for organizers for having organized a pleasant and interesting joint workshop
- both the Russian SCTF and the Chinese HIEPA projects are approaching important funding decisions in 2019
- for the Russian project, a concrete international participation is an essential element to trigger a positive decision
- both project will greatly profit from international participation on the detector project, realization and operation and on the full physics exploitation of the collected data
- although to a lesser degree, also international collaboration on accelerator the design, simulation and realization is becoming more frequent and desirable
- we consider as duty of the IAC to provide advises on
  - investigating and documenting the physics cases of the proposed facilities
  - promoting international participation and support
  - making progress in the design of the accelerator, the detector and the physics tools
  - attracting and organizing all interested parties to facilitate the approval and, after that, to collaborate in the realization and the exploitation of the proposed facilities

Introduction (2)

- several on-going HEP projects compete for funding and attention in flavour physics
- LHCb has an ambitious multi-year upgrade plan, has already recorded and will record the largest samples of heavy flavours, but:
  - will be limited in many measurements by the hadronic interaction environment
  - is not a competitor for tau physics
- BelleII appears to be superior for most physics cases
- high-luminosity e^+e^- colliders at the Z^0 peak are dream machines for about all sectors of flavour physics. However, their realization at CERN and in China is not approved and will anyway only happen in the relatively far future and are going to be remarkably expensive
- however,
  - there are some clear physics cases in charm physics were the charm-tau factories offer unique advantages at entirely reasonable costs
  - some other physics cases in tau physics may be studied to be presented as additional unique features

Notes on this workshop

- we all appreciated the very interesting set of presentations on physics, physics studies, accelerator and detector designs
- this joint workshop has shown that an international collaboration has already started between the Russian and Chinese core SCTF & HIEPA groups
  - we noted that common working groups and regular meetings have been started, we encourage to proceed
  - this event will hopefully also mark the beginning of a collaboration with LAL, specifically on the production of conceptual design reports
- the beginning of Russian-Chinese collaboration is also instrumental in facilitating further international aggregations because it naturally promotes sharing of tools, techniques, knowledge, and naturally leads to a more rational, structured and transparent governance of all involved activities

Accelerators

- symmetric accelerators at the charm-tau energies with $\mathcal{L} \sim 10^{35}\,\mathrm{cm}^2\mathrm{s}^{-1}$, based on nanobeams and crab-waist design appear to be feasible. Similar design choices have been adopted for BelleII, which is being commissioned, and for future high-energy high-luminosity e^+e^- colliders. However, the design, construction and commissioning of the proposed machines remains challenging and complex
- in particular, many tradeoffs exist, and many choices influence the final cost
- the very large increase of the luminosity w.r.t. BESIII is the largest asset of a super charm-tau factory
- in preliminary estimates, the accelerator cost is 3/4 of the total

Accelerators

recommendations

- the goals of the machine should be defined taking into account physics goals, realistic accelerator performances and cost considerations
  - what energy range?
  - how much integrated luminosity for each energy interval?
  - should there be longitudinal polarization?
  - how does physics reach and performance depend on the polarization value?
  - what magnetic field in the detector will need compensation? (larger fields require larger and more problematic compensation)
- a possible sensible strategy could be
  - set goal $\mathcal{L} \sim 10^{35}\,\mathrm{cm}^2\mathrm{s}^{-1}$ for $E = 3.7-4.1\,\mathrm{GeV}$ (highest charm-tau tau cross-section)
  - consider impact on physics of scaling down $\mathcal{L} \sim 0.5 \cdot 10^{35}\,\mathrm{cm}^2\mathrm{s}^{-1}$: may be less expensive and more reliably assured with no significant loss of physics reach
  - accept lower luminosities at lower and higher energies
  - limit and better define energy range, e.g. $E \sim 2-5.5\,\mathrm{GeV}$
  - first stage with no polarization but prepared for polarization at a second stage
  - consider adopting a detector design with the 1 T rather than 1.5 T magnetic field

Detectors

- physics reach progress will be set mostly by the accelerator performance w.r.t. the existing and former facilities
- however, to exploit the much larger luminosities and to maintain for instance the BES III detector performance, the detectors
  - must be faster, more radiation hard
  - must accept higher levels of machine background
- furthermore, many useful detector improvements may improve today's detector performances to an significant extent

recommendations

- initiate design of a complete detector
  - based on agreed physics goals, to be better defined
  - relying on fast simulation studies of physics reach of some "golden channels"
- consider using 1 T rather than 1.5 T magnetic field, to benefit the accelerator design
- use the BESIII detector performance as a baseline for physics studies, and evaluate the physics reach impact of adopting proposed improvements with parameterized fast simulation

Physics

- the proposed facilities have clearly unique advantages for
  - studying exotic charm states
  - studying coherent D meson pairs
- furthermore, they appear to be the best facilities for studying low energy QCD
- however, their potential for tau physics has not yet been clearly shown
  - the tau mass measurement precision does not depend critically on the luminosity
  - performances for searching for tau LFV decays have not been reliably evaluated yet
  - achievable precision on tau BRs and spectral functions have not been evaluated
  - need to understand how to best balance luminosity (E_{CM} for maximum $\tau^+\tau^-$ cross-section) with monochromaticity of two body tau decays (at threshold)

Physics

recommendations

- identify a small number of "golden channels" to study, for the purpose of
  - evaluating and documenting the physics reach of the future charm-tau factories
    - for the international community
    - also for the funding agencies (although this information is not decisive)
  - guiding the design of the detectors
  - attract international collaboration and support
- potential "golden channels" may be
  - studies on exotic charm states
  - studies on coherent D meson pairs
  - search for $\tau \to \mu\gamma$
  - measurement of one or few tau BRs and spectral functions
  - search for tau CPV (using polarized beams)
- for the above studies, but also to attract collaborators and international contributions
  - a fast simulation facility is required
  - a comprehensive computing framework would have significant benefits
  - developments of common physics tools would be helpful

Computing tools

- common tools and a common fast simulation framework are very useful to implement our recommendations and to facilitate international involvement
- I appreciated the presentations
- I have a couple of personal notes
  - while using now Scientific Linux 6 is acceptable, a plan to evolve to SL 7 must be at least stated as a part of the project
  - collaborative versioning system: subversion has been mostly abandoned and the HEP community primarily already now uses git. CERN discourages subversion since several years, most modern experiments use git. CMS is known for having all its SW in a single github repository, with remarkable users' and developers' satisfaction
  - to attract international young physicists that frequently also are computing "wizards" it is good to offer either the usage or at least the perspective of promoting and using the most modern and performing tools

General recommendations

- prepare cost estimates for accelerator and detector
  - carefully enough to be able to stick to them when dealing with funding agencies
- appoint a steering committee in order to
  - understand physics reach and set meaningful physics goals
  - insure coordination and consistency of activities
  - make choices and tradeoffs on accelerator and detector requirements and design
- prepare conceptual design reports on accelerator, detector, physics
  - for this activity, an editorial board is required
  - this is also useful to involve theorists and to promote international collaboration

Conclusions

- it would be ideal to get both projects approved
  - there is no direct competition for funds
  - benefits of a healthy competition and consistency checks
- before funding decisions, improve the definition of unique physics goals, maximize efficiency, promote international involvement, build a community ready for full exploitation of funding after approval
- it may happen that a one of the two facilities will be approved, or a common facility will be build: in this case all collaborative efforts now will directly facilitate the full exploitation of the common facility