Report on
INFN Super Flavour Factory Project as an input for forming ECFA position

Plenary ECFA meeting
Geneva, 28.11. 2008

On behalf of the RECFA Internal Working Group

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History I

- RECFA meeting in Lisbon 29.3 2008, NFN requested ECFA evaluation on the INFN Super Flavour Factory Project. RECFA agreed the proposal by the chairman to form an internal working group for preparation of a recommendation, which should be endorsed by the Plenary ECFA, and TN was nominated to form this group and to chair.

  In agreement with the ECFA chairman, TN formed the working group with the following RECFA members. Y. Karyotakis (Annecy), F. Linde (NIKHEF), B. Spaan (Dortmund) and T. Nakada (EPFL); Chair

History II

- Working practice and time scale of the work presented to RECFA during the Uppsala meeting on 10.5 and approved
- Intermediate presentation to RECFA during the DESY meeting on 17.7.
- Draft final report distributed to RECFA for comments and necessary consolidations during the Athens meeting on 11.10 and a presentation being made. The content and conclusions of the draft report were approved.

History III

- Final report distributed to all the ECFA members on 21 November. Presentation at the Plenary ECFA on 28.11 at CERN for an approval.

Important issues and working practice

Important issues
- physics concerned in conjunction with statistics and timing
- feasibility of the machine design
- environment
    e.g. available expert manpower, infrastructure etc.
- community support
- in view of the European strategy
- relation to similar projects
    e.g. SuperKEKB

Working practice
- use existing material rather than organizing a workshop or review
- make direct discussion with concerned communities
- survey the worldwide situation
  we also consulted third party machine experts

Summary of the WG activities I

- TN participated in the final meeting of the International Review Committee for the INFN SuperB Factory chaired by J. Dainton, Rome, 29-30.4.
- YK, FL, TN and BS attended the first two days of the INFN SuperB Factory Workshop in Elba, 31.5-1.6. Met with the interested funding agencies and institute leaders and held a dedicated discussion meeting with the representatives of the proponents and the INFN management

Summary of the WG activities

- FL and TN visited KEK and had a dedicated meeting with the representatives of the KEKB Upgrade proponents and the KEK management, Tsukuba, 29.6.
- Working group phone meetings: 23.04, 06.05, 20.06, 07.07. 15.08, 03.10, plus many many e-mail exchanges.
- Final meeting with the INFN management and proponent in Frascati, 07.10, before the submission of the draft report to the RECFA meeting in Athens.

Physics I

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  ⇒ will play an important role in the study of physics beyond the Standard Model:
  - Potentially higher energy sensitivity than the direct search at LHC
  - If New Physics found by the direct search, it provides complementary information

Physics II

- b→d in ΔB=2 reasonably well tested
  in ΔB=1 not too well tested

  – SM works reasonably well for b→d in ΔB = 2
  (New Physics effect must be small, if exists):
  CP asymmetry($B_d \to J/\psi K_S$) and Δm_d, agree with $|V_{ub}/V_{cb}|$
  Analysis is theory (soft QCD) limited

Physics II

- $b \to d$ in $\Delta B=2$ reasonably well tested
  in $\Delta B=1$ not too well tested
- $b \to s$ in $\Delta B=2$ somewhat tested
  in $\Delta B=1$ somewhat tested
  - SM works reasonably well for $b \to d$ in $\Delta B = 2$
    (New Physics effect must be small, if exists):
    CP asymmetry($B_d \to J/\psi K_S$) and Δm_d, agree with $|V_{ub}/V_{cb}|$
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  - Interesting, but statistically insignificant sign of New Physics in $b \to s$: e.g. $B_s \to J/\psi\phi$ by CDF and D0
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    $\Rightarrow$ will be tested by the coming experiment, LHCb,
    as well as not yet well explored area ($B_s \to \mu\mu, \phi\gamma$. $B \to K^*\mu\mu$, etc.)
    another interesting signals: ~~CP~~ in $b \to s$ penguin, $Br(B \to \tau\nu)$, …

Physics III

- By 2015, LHCb will explore 10 fb^{-1} of data. A step beyond the "LHCb" era for an e^+e^- machine requires >50 time more statistics than now to unambiguously establish any effects of beyond the Standard Model for those, which exhibit no sign now, or which may appear in a couple of years at LHCb (more "inclusive" $\Delta B=1$ $b\rightarrow s$ and $b\rightarrow d$ studies may become important?).
- LFV, e.g. $\tau\rightarrow e\gamma$ would be a big issue. (interesting to see what $\mu\rightarrow e\gamma$ will say in coming years)

Physics III

- The main goal of PEB-II and KEKB was a quantitative test of the KM mechanism of CP violation from the $B_d \rightarrow J/\psi K_S$ decays.
  $\Rightarrow$ CKM parameters were known enough to make a good prediction for the required luminosity at the time of their construction.

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- The main goal of PEB-II and KEKB was a quantitative test of the KM mechanism of CP violation from the $B_d \rightarrow J/\psi K_S$ decays.
  $\Rightarrow$ CKM parameters were known enough to make a good prediction for the required luminosity at the time of their construction.
- For a SuperB project, there is no "success guaranteed" minimum luminosity, since we don't know the New Physics parameters.
  $\Rightarrow$But this is the case for the most of the high energy frontier accelerators too.

INFN Super Flavour Factory I

- Very high luminosity $>10^{36}cm^2s^{-1}$ obtained by colliding very tiny beams. (similar to an LC final focus)
  ⇒ needs small emittance (similar to an LC damping ring), large crossing angle and crab waist

  But must work as a circular collider (Novel idea developed by INFN)

  ☺☺ Its required current not higher than the present machines (RF power 17 MW)
  - affordable operation cost
  - easier operation for issues related to high currents
  - small background

INFN Super Flavour Factory II

- Test being done with DAFNE very successful, but still at lower total currents (NB: among others KEK is participating in the test)
- More simulation work needed to fully understand the result
- Machine parameters need some robustness.
- No real design for the complete system.

⇒ to be addressed by the TDR within 1 to 2 years in collaboration with the interested Asian, European and US laboratories: MoU among the laboratory directors.

INFN Super Flavour Factory III

- Project costs: ~500 M€*)
  SLAC for a large fraction of the PEP-II components
  Regional government for the infrastructure
  ⇒ remaining cost ~200 M€*)
  Forming an international consortium for the construction and operation

  *) indicative number quoted by INFN

- SLAC is expected to play an important role also in expert manpower needed for the accelerator R&D, design and construction.

Global situation I

- ATLAS/CMS results on New Physics in 2010~2015
  LHCb results based on ~10 fb^{-1} data by 2015
  ⇒ impact on LC, LHC upgrade, etc
- KEKB Upgrade goal is to achieve $L>5\times10^{35}cm^{-2}s^{-1}$
  10 ab^{-1} data by 2015~2017
  50 ab^{-1} data by ~2020
  KEKB running till the end of FY2009
  Shutdown and upgrade FY2010-1012
  Start running in FY1013
  Earmarked R&D fund requested for 2009
  Less ambitious, but good people with well proven record.

Global situation II

- Possible LHCb upgrade after 10 fb^{-1} data:
  Working with 10 times higher luminosity (few times 10^{33} $cm^{-2}s^{-1}$ to obtain 100 fb^{-1} data.
  Trigger-less DAQ, 40 MHz readout to the processor farm. Statistical increase for the muon channels ≈10, and hadronic channels >10.
  -actual realisation depends on how the experiment will work and on the outcome of the very early result-
- Search for LFV and CP violation in the lepton sector, μ, τ, and ν will continue. Possible τ-charm factory in Novosibirsk.

Conclusions I

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- Flavour physics is an important part of the European particle physics programme. Rich physics programme.
  -European Strategy Document already recognises a flavour physics facility as a national or regional activity-
- An e^+e^- collider at Y(4S) energy region would be a significant milestone if
  - much more than 50 ab^{-1} data by the end of ~2020
  - moderate cost

Conclusions II

- INFN Project addresses these points by
  - Very high luminosity $>10^{36}$ with a unique machine concept
  - Reutilizing PEP-II and BaBar parts

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- Machine R&D for the TDR should be strongly supported to show that the concept can be realised.
  (R&D is also useful for the future machines)

Conclusions II

- INFN Project addresses these points by
  - Very high luminosity $>10^{36}$ with a unique machine concept
  - Reutilizing PEP-II and BaBar parts
- Machine R&D for the TDR should be strongly supported to show that the concept can be realised. (R&D is also useful for the future machines. Continue collaboration with KEK?)
- Still large amount of work needed for the TDR and a strong team of machine physicists and engineers centrally located should be formed very soon.

Conclusions III

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- For considering an approval, there should be
  - a clear plan containing realistic technical milestones
  - a description of required resources and concrete strategy how to obtain them

  with a goal to achieve much more than 50 ab^{-1} data by ~2020 to make a meaningful impact. If much later than this, physics landscape could be drastically different.

Conclusions IV

- A very ambitious plan and a clear decision procedure should be defined soon.