Plans for International Scoping Study: Machine Working Group

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Introduction

• Phase 1 of ISS: study alternative configurations to arrive at baseline specifications for a system to pursue further
  — Proton Driver, Target, Capture Section, Decay Section
  — Bunching, Phase Rotation, Cooling
    ◦ no-cooling option will also be examined
  — Acceleration
  — Storage Ring

• Goal is to complete this work within 6 months
  — then reach consensus on which option(s) to pursue further

• Remaining ISS work will focus on selected option
  — as prelude to subsequent World Design Study
  — develop R&D list as we proceed
Proton Driver/Target /Capture/Decay (1)

• Optimum beam energy
  — depends on choice of target
    ○ consider C, Ni, Ta, Hg

• Optimum repetition rate
  — depends on target and downstream RF systems

• Bunch length trade-offs (1 vs. 3 ns)
  — need (and approaches) for bunch compression
  — performance implications for downstream systems

• Hardware options
  — FFAG, linac, synchrotron
    ○ compare performance, cost
Proton Driver/Target/Capture/Decay (2)

• Optimum target material
  – solid or liquid
    - low, medium, or high Z

• Intensity limitations
  – from target
  – from accelerator issues
    - e.g., due to 1 ns bunches, injection limits, or activation limits

• Superbeam vs. Neutrino Factory trade-offs
  – required emittance and focusing
  – horn vs. solenoid capture
    - energy range of interest
  – choice of target material
Bunching/Phase Rotation /Cooling (1)

• Practical accelerating gradient and cost per GeV at several frequencies (5, 88, 201 MHz)
  — include power sources as well as cavities

• Compare performance of existing schemes (KEK, CERN, U.S.-FS 2b)
  — use common proton driver and target configuration(s)
  — evaluate costs (top-down)
  — consider possibility of both signs simultaneously
Bunching/Phase Rotation /Cooling (2)

• Evaluate trade-offs between cooling efficacy and downstream acceptance
  – consider several values of downstream acceptance (longitudinal and transverse)
  – develop agreed-upon figure-of-merit (e.g., $\mu/P_{prot}$)
  – consider need/merits of longitudinal cooling
  – identify cost-effective schemes (top-down)

• Evaluate performance issues and limitations
  – absorbers ($\text{LH}_2$, LiH, Be or plastic)
    o consider implications of both sign muons
  – RF gradient
  – magnetic field requirements
Acceleration

• Compare different schemes
  – RLA, scaling FFAG, non-scaling FFAG
    o consider implications of keeping both sign muons

• Define realistic spacing between cavities and adjacent magnets

• Evaluate acceleration system cost vs. acceptance
  – transverse and longitudinal
  – identify main cost drivers

• Consider matching from upstream system and into downstream ring
Storage Ring

• Implications of final energy (20 vs. 50 GeV)

• Optics requirements vs. beam emittance
  — injection and decay straight section
  — arcs

• Implications of two simultaneous baselines

• Implications of keeping both sign muons

• Radiation issues at $10^{21}$ useful neutrinos per year
  — liner vs. open-midplane magnets

• Cost implications of design
Detector

• Not our responsibility… but
  – need to understand cost trade-offs of higher neutrino intensity vs. bigger detector
  – need to understand issues related to simultaneous use of both sign muons
Organization

• Selected lieutenants to serve as “Machine Council”
  — Fernow (BNL), Garoby (CERN), Mori (Kyoto), Palmer (BNL), Prior (RAL)

• Picking topic leaders in consultation with Council
  — need lists of all potential “workers” too
  — would like help from NFMCC

• Strawman organizer names
  — Driver: Garoby, TBD, Mori, Prior
  — Target: TBD, TBD
  — Phase rotation/Bunching/Cooling: Fernow, TBD
  — Acceleration: TBD, Mori, Prior
  — Storage Ring: TBD, TBD, TBD
Proposed Meeting Schedule

• Three plenary meetings before NuFact06
    - CERN, Japan (KEK, Kyoto, or Osaka), RAL (in conjunction with BENE meeting)

• Final meeting a day or two before NuFact06
  — August 21-22, '06

• Goal is to complete Phase 1 of Machine study by January '06 meeting
Summary

• Challenge is to try to reach consensus on a single optimized Neutrino Factory scheme
  — if we can do this ourselves, without requiring an uninvolved panel of “wise persons” to do it for us, we have truly accomplished a lot as an international community

• Even if we don’t quite succeed in selecting a single design, whatever convergence we attain will improve the probability of having a future international facility

• Developing optimal design requires an adequately-funded accelerator R&D program
  — we need to articulate this need and define the ingredients of the program