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., μ/P_{prot})
  - consider need/merits of longitudinal cooling
  - identify cost-effective schemes (top-down)

- **Evaluate performance issues and limitations**
  - absorbers (LH_2, LiH, Be or plastic)
    - consider implications of both sign muons
  - RF gradient
  - magnetic field requirements

Acceleration

- Compare different schemes
  - RLA, scaling FFAG, non-scaling FFAG
    - 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

- **Identify lieutenants to serve as "Machine Council"**
  - Fernow (BNL), Garoby (CERN), Mori (Kyoto), Prior (RAL)
    - plus Palmer (BNL) hopefully
- **Pick topic leaders in consultation with Council**
  - need lists of all potential "workers" too
- **Strawman names**
  - Driver: Garoby, Kirk, Mori, Prior
  - Target: Bennett, Lettry, McDonald, Sievers
  - Phase rotation/Bunching/Cooling: Fernow, Lombardi or Hanke, Neuffer, Palmer, ? from Japan
  - Acceleration: Berg, Garoby, Mori, Prior
  - Storage Ring: Garren, Mokhov, Rees

Strawman Meeting Schedule

- Three plenary meetings before NuFact06
  - October '05, January '06, April '06
    - Europe (CERN), U.S. (LBNL, Fermilab, or BNL), Japan (KEK or Osaka)
- Final meeting at NuFact06, or perhaps a day or two before
  - late August '06
- Goal is to complete Phase 1 of Machine study by January '06

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