MAP Design & Simulation Overview

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MAJOR D&S GOALS

- provide sufficient design & simulation effort to demonstrate
  - feasibility of a 25 GeV NF in FY14
  - feasibility of a 1.5 TeV MC in FY16
- provide complete description of all major facility subsystems
- optimize performance of all subsystems
- do end-to-end simulations of beam behavior
- provide best estimate of expected machine performance
- estimate uncertainties in performance & tolerances in machine parameters
- provide required part counts for preliminary costing
- identify items that need additional R&D

MAP D&S INTERIM ORGANIZATION

Design & Simulations (Rick Fernow, BNL)

1. Proton Driver (Keith Gollwitzer, FNAL)
2. Front End (Harold Kirk, BNL)
3. Cooling (Tom Roberts, Muons Inc.)
4. Acceleration (J.Scott Berg, BNL)
5. Collider Ring (Yuri Alexahin, FNAL)
6. Machine-Detector Interface (Nikolai Mokhov, FNAL)

MACHINE CONFIGURATIONS

- proposal identifies "Initial Design Configurations"
  - provide a concrete example of what the facilities might look like
  - try not to confuse outsiders by showing all possible options
- milestones aim to define "Interim Design Configurations"
  - result of optimization studies, engineering considerations, and experimental measurements
  - design will be used for the Interim Design Reports
- results of interim studies will lead to more-detailed "Final Design Configuration"
  - design will be used for Final Design Reports
  - use for costing

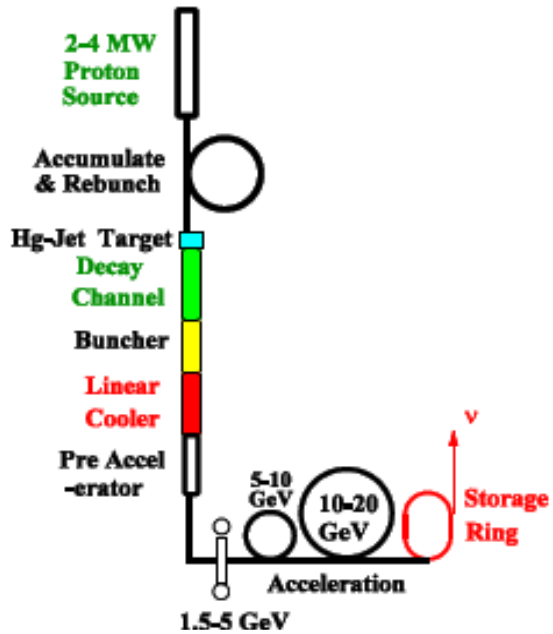
NF INITIAL CONFIGURATION

- proton driver — 4 MW + structure rings
- target — liquid Hg jet
- decay - precooling — enhanced Study 2a
- acceleration — linac + 2 RLAs + FFAG
- storage rings — 2 racetracks with long straight sections

Design performance

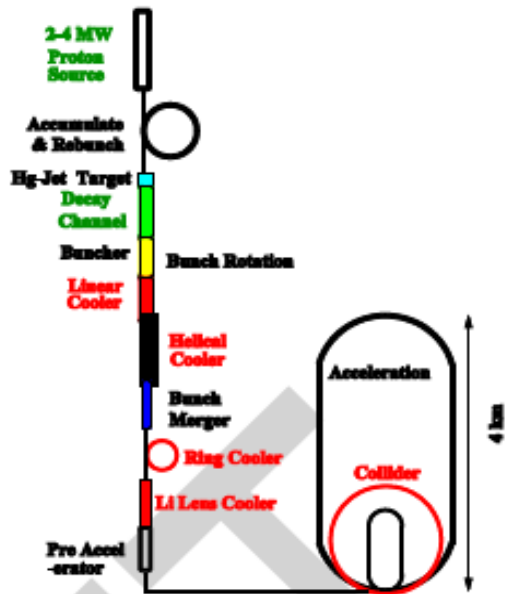
5 10^{20} muon decays per year per baseline

two detector baselines



MC INITIAL CONFIGURATION

- proton driver — enhanced Project X
- target — same as NF
- decay thru precooling — same as NF
- 6D cooling — tbd
- final 4D cooling — 50 T solenoid channel
- LE μ acceleration — same as NF
- HE μ acceleration — fast-cycling synchrotrons
- collider ring — large-acceptance HEMC lattice



CURRENT 1.5 TeV MC SCENARIOS

	LEMC	HEMC
Avg Luminosity ($10^{34}/cm^2/s$)	2.7	1
Avg bending field (T)	10	8
Proton driver rep rate (Hz)	65	15
β^* (cm)	0.5	1
Muons per bunch (10^{11})	1	20
Muon bunch train in collider	10	1
Norm. Transv. Emittance (μm)	2.1	25
Norm. Long. Emitiance (m)	0.35	0.07
Energy spread (%)	1	0.1
Muon survival (%)	31	7

PROTON DRIVER TASKS

- assume independent baseline Project X study
- our effort addresses upgrades to meet NF and MC specs
  - acceleration to ~8 GeV ?
  - power upgrade to ~4 MW
  - proton bunch structure rings
  - trombone & funnel optics at target
- develop conceptual designs
- evaluate potential instabilities
- do tracking studies with realistic errors

FRONT END TASKS

- front end ≡ target + decay channel + buncher + phase rotation + precooling
- assume these system are the same for NF and MC
- study & optimize the major FE subsystems
- target
  - benchmark MERIT results
  - refine MHD modeling of beam/jet/field interactions
  - refine nozzle simulations
  - study Hg jet splash issues for Hg collection pool
- decay channel
  - studying decay in higher field channel
- bunching & phase rotation
  - optimizing new shorter channels from D. Neuffer
- precooling
  - studying using gas to increase available RF gradient

COOLING TASKS

- study & optimize the major subsystems
  - 6D cooling
    - Guggenheim, HCC, Helical FOFO-snake
  - final 4D cooling
    - 50 T channel, Li lenses, PIC, low-β bucked coil
- design other needed auxiliary subsystems
  - charge separation & recombination
  - bunch merging
- do end-to-end tracking simulations
- try to understand breakdown in normal conducting RF cavities in B fields
  - design suitable methods for mitigation

MUON ACCELERATOR TASKS

- need complete design for low energy acceleration (120 MeV to 25 GeV)
  - study suitability of NF accelerator design for MC
- need complete designs for high energy acceleration (25 to 750 GeV)
  - recirculating linear accelerator (RLA)
  - fast-ramping synchrotron
  - other alternatives? (FFAGs, reinject in PD linac)
- do single particle tracking simulations thru entire chain
- study collective effects

COLLIDER RING TASKS

- need basic lattice designs
  - IR design with appropriate constraints on quad gradients & radii
  - chromatic correction schemes
  - arc cells
- need complete design of matching regions
- design chromaticity & nonlinear detuning correction circuits
- design RF and diagnostic systems
- simulate dynamic aperture
- detailed studies of coherent effects

Machine-Detector Interface Tasks

- simulate secondary particle fluxes
  - detector backgrounds
  - radiation environment in machine
- study techniques to mitigate backgrounds
  - shielding in machine near detector
- iterate IR designs with Physics & Detector Groups

MILESTONES & DELIVERABLES

Date	Milestone	Deliverable
FY10	specify target interim design configuration finish D&S for Interim IDS-NF RDR report	MAP Rev, Des Report Formal Report
FY11	specify front end interim design configuration	MAP Rev, Des Report
FY12	specify collider ring interim design configuration specify cooling interim design configuration	Ext Rev, Des Report MAP Rev, Des Report
FY13	specify proton driver interim design configuration specify NF acceleration interim design configuration specify MC acceleration interim design configuration	Ext Rev, Des Report MAP Rev, Des Report MAP Rev, Des Report
FY14	finish D&S for Interim MC DFS report finish D&S for Final IDS-NF RDR report	Formal Report Formal Report
FY15	provide specifications & parts count for MC costing	Design Report
FY16	provide description of remaining MC R&D items finish D&S for Final MC DFS report	Design Report Formal Report

LEVEL 2 FTE PLAN

	FY10	FY11	FY12	FY13	FY14	FY15	FY16	Total
Proton Driver	0.7							
Front End	2.2							
Cooling	4.7							
Acceleration	0.8							
Collider Ring	0.9							
MDI	0.6							
Total	9.9	11.3	14.3	16.3	16.3	16.5	12.2	97

STATUS QUO

1. Proton Driver
   minimal resources available
2. Front End
   significant effort from MERIT group and IDS-NF
3. Cooling
   significant effort, but many topics under consideration
   → effort is spread thin
4. Muon acceleration
   minimal resources available
5. Collider Ring
   good progress in past year
   minimal resources available
6. Machine-Detector Interface
   good progress in past year
   minimal resources available

SUMMARY OF PLAN

Successful completion of this plan will allow:

- completion of a more-detailed reference design for a 25 GeV neutrino factory in FY14
- completion of a feasibility study for 1.5 TeV muon collider in FY16
- a best estimate of the facilities performance
- a rough cost estimate of both facilities
- a description of additional required R&D
- documentation of the results in a series of formal reports