Muon Collider Research and Development Plan

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Ongoing R&D

- Feasibility study presented at Snowmass96
  - Catalyst for present collaboration (formalized in June)
  - Identified critical research topics
- FY97 series of topical workshops on these areas, International Workshop in May
- Initial experimental work:
  - Proton driver (E932 at AGS, PSR Experiment)
  - Capture and target (E910 at AGS)
  - Cooling experiment planning (Geer Talk)
- Theoretical work now concentrated on low energy machine

R & D Needs

- Next five years: Identify and test critical components for collider complex.
  - Proton driver experiments
  - Target and capture experiments
  - Cooling experiments (Geer Talk)
  - Pulsed and superconducting magnet development
  - Theoretical studies

Theoretical Research

- Present level of effort: 21 FTEs (but 100 researchers!)
- Expanded level of effort: 48 FTEs
- Critical immediate need is dedicated personnel
- Goals:
  - Theoretical studies of muon collider complex
  - Develop simulations of muons in systems of the collider
  - Identify and prioritize areas that require experimental research.
  - Determine a single self-consistent set of parameters for the lower and higher energy colliders

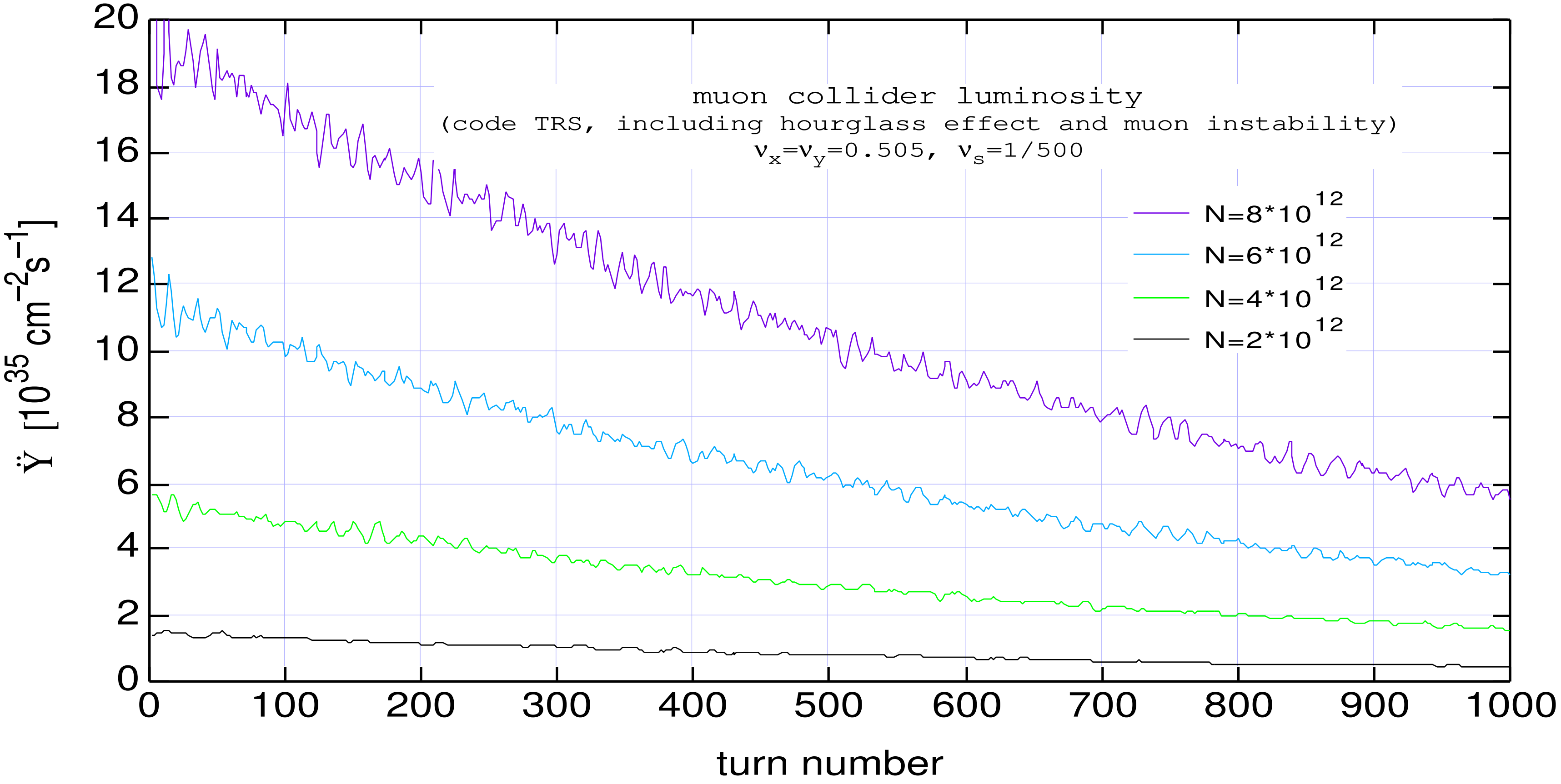
Theoretical Research: Critical Problem Areas (I)

- Proton Driver:
  - » Define parameters for the proton source,
  - » Investigate beam stability and short bunch production
- Target:
  - » Study target options
  - » Benchmark codes --yield is (historically) difficult to predict.
- Capture and phase rotation systems:
  - » develop particle transport code
- Cooling: Define and simulate a complete cooling scenario.

Theoretical Research: Critical Problem Areas (II)

- Acceleration:
  - Define a preferred acceleration scenario
  - Perform complete simulations including wakefields.
  - Design cavity for pulsed operation, high gradient, minimized HOM loads
  - Pulsed lattice studies
- Collider ring:
  - continue lattice design including lattice errors, higher order multipole correctors
  - stability and impedance budgets
  - rf system for BNS damping of transverse instabilities
  - beam-beam integration with nonlinear tracking and wake codes
  - design a halo scraping system

Luminosity in a high-energy muon collider



Theoretical Research: Critical Problem Areas (III)

- Detector and background:
  - » optimization of the shielding
  - » straw man detector with all components capable
  - » of withstanding the backgrounds,
  - » simulate some representative physics observations.
- General:
  - » Investigate the operation with polarized and/or very low energy spread bunches.
  - » Investigate muon-electron collider
  - » Begin design work towards integrated front end of complex.
  - » Study safety and radiation exposures both on and off site, including the hazards from neutrino fluxes.
  - » Site power budget

Proton Driver Experiment: Short bunch production at the AGS

The proton driver technology is an extrapolation of that needed for spallation neutron sources. Major difference: muon collider requires a short bunch (~1-2ns). This leads to stability concerns.

- Initial experiment at E932 at AGS has demonstrated a reduction of bunch length (10ns-->3ns) by operating near transition. Future plan calls for systematic studies at higher currents and shorter bunch length.
- Experiment operated with a longitudinal phase space volume of 1.5V-s, comparable to proton driver requirements; the total charge was lower than needed by a factor of 10.

Proton Driver Experiment: Test of inductive inserts at the PSR

- Results from PSR at LANL show that longitudinal space charge was modified and RF thresholds were lowered.
- With 3×10^{13} ppp rf required to suppress instability was reduced by 40%.
- Similar results have been obtained at KEK

Target and Pion Capture

- Monte-Carlo model of pion production to be based on data from ongoing E910 at AGS on pion production
- Experimental plan:
  - » Design and construct (or obtain) high field, large bore solenoid
  - » Study target integrity with high-power beam. Thermal cooling may require liquid (jet) target.
  - » Optimize target for π production
  - » Measure π/p capture ratio in 20T field
  - » Test rf cavity in high-radiation environment.

Target experiment: pion production at AGS E910

- data from experiment--Harolds color vg of log(dE/dx)
- data from experiment--Harold’s 18GeV dsigma/dp cross section vg

Target Experiment Schematic

- Harold Kirk's new schematic

Superconducting Magnet Development

Design dominated by

- High radiation environment
- high fields
- low costs

- *SC Dipole development--higher field increases luminosity*
- *SC IR quadrupoles are critical magnets at 4 TeV*--Beam is large after IP & shielding increases distance to magnet

Acceleration R&D

- Neuffers vg of rapid cycling synchrotron and recirculating linac options.

Acceleration R&D

- Rapid Cycling R&D
  - » pulsed magnets prototypes --high field and eddy currents require innovative designs
  - » pulsed lattice studies
- SRF R&D
  - » Pulsed SRF operation tests (350MHz, 1300MHz)
  - » HOM load--design to minimize loads and test HOM configurations and materials for pulsed SRF

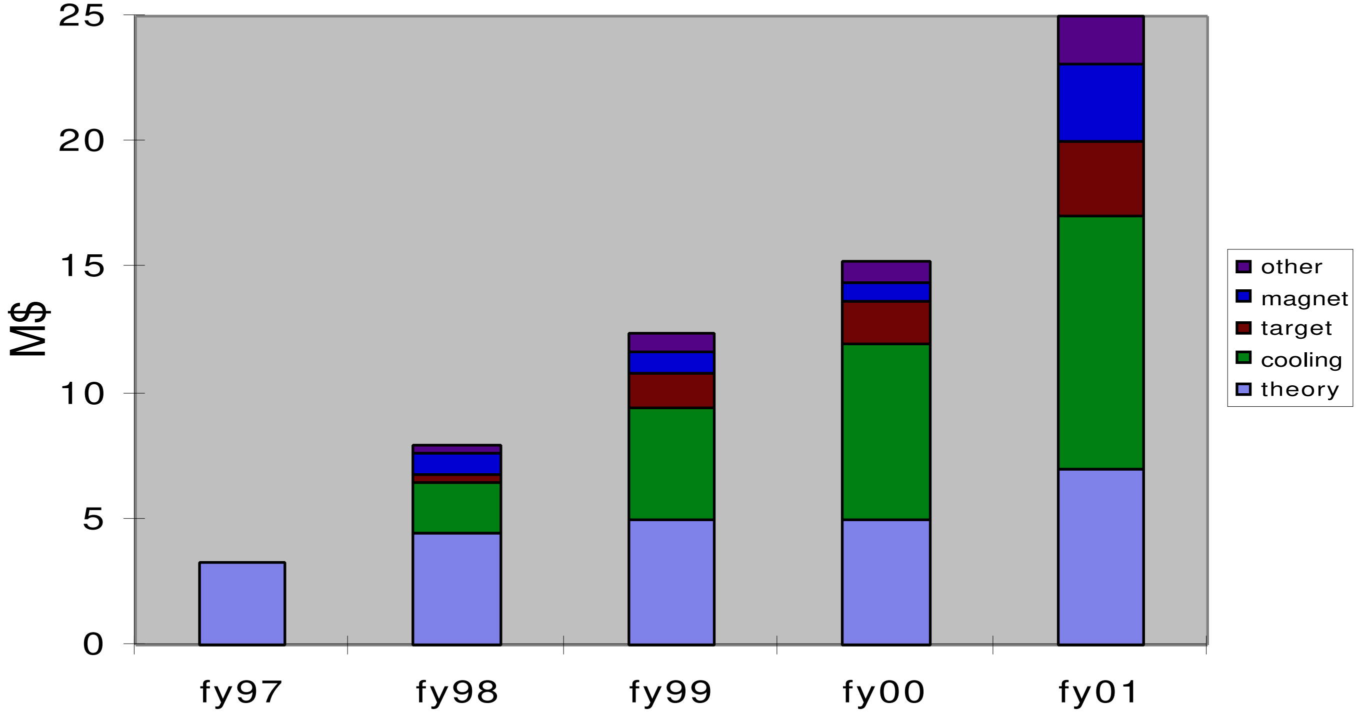
Present Status

- Increased community interest in muon colliders
- Multilab and university collaboration has prioritized research plan
- Further progress needs
  - » more dedicated personnel for expanded theoretical studies
  - » experimental research funds

Short term funding needs

» These numbers are a first estimate. They do not include contingencies or EDIA.

» Fiscal year 01 is very approximate, but indicates that increased funding will be needed.



Status after 5 years of R & D

- Goal: Decision on feasibility of muon collider
  - » Demonstration of critical collider components:
    - – driver
    - – target
    - – capture
    - – cooling
  - » Numerical and theoretical models of the full collider complex
  - » Designs for further R & D needed prior to an actual proposal