# Neutrino Factory and Muon Collider Collaboration Meeting

## NFMCC Status and Update

January, 2009

Alan Bross

# Welcome

**Collaboration Meeting XIII**

*Well, unfortunately we are still getting older*
*But we also still manage to get Better*

- **It has been another productive year**
  - MuCool is entering a new phase with beam experiments
  - MERIT continues analysis of its data
  - MICE: a good deal of beam data has now been accumulated
  - A 5 Year Plan for Neutrino Factory and Muon Collider R&D has been submitted to DOE
- **We hope for the coming year**
  - First beam experiment in the MTA
  - MICE makes first cooling measurement
  - Neutrino Factory International Design Study
  - Muon Collider Design Effort
  - Action on 5 Year Plan?

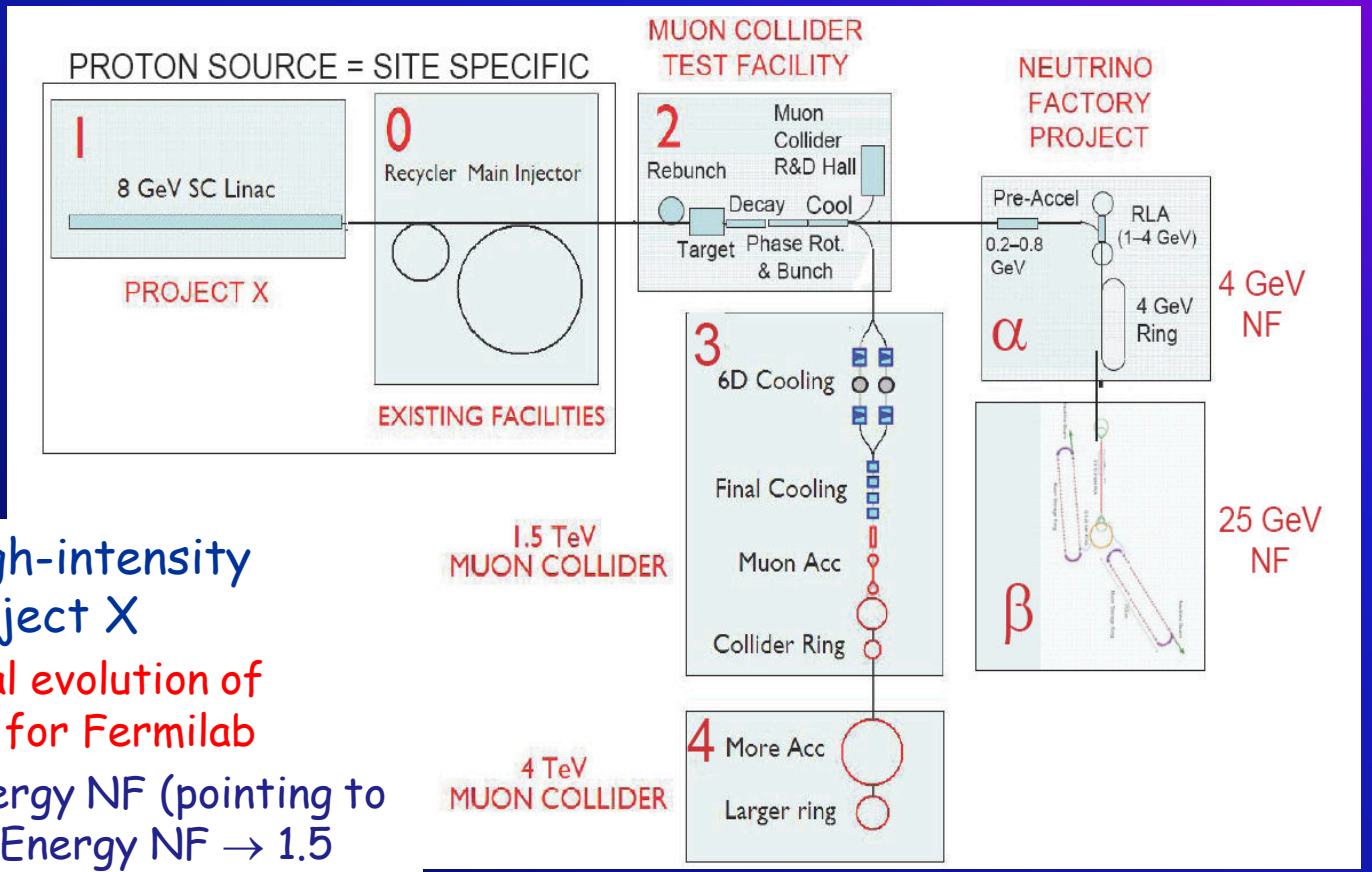
# NFMCC Mission

*To study and develop the theoretical tools, the software simulation tools, and to carry out R&D on the hardware that is unique to the design of Neutrino Factories and Muon Colliders*

- **Extensive experimental program to verify the theoretical and simulation predictions**

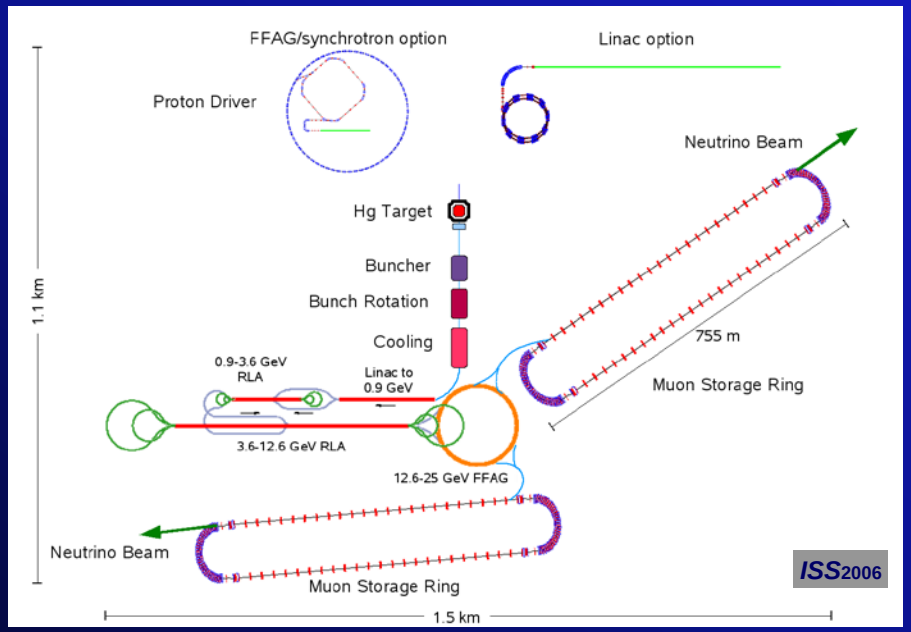

# Mission → Vision

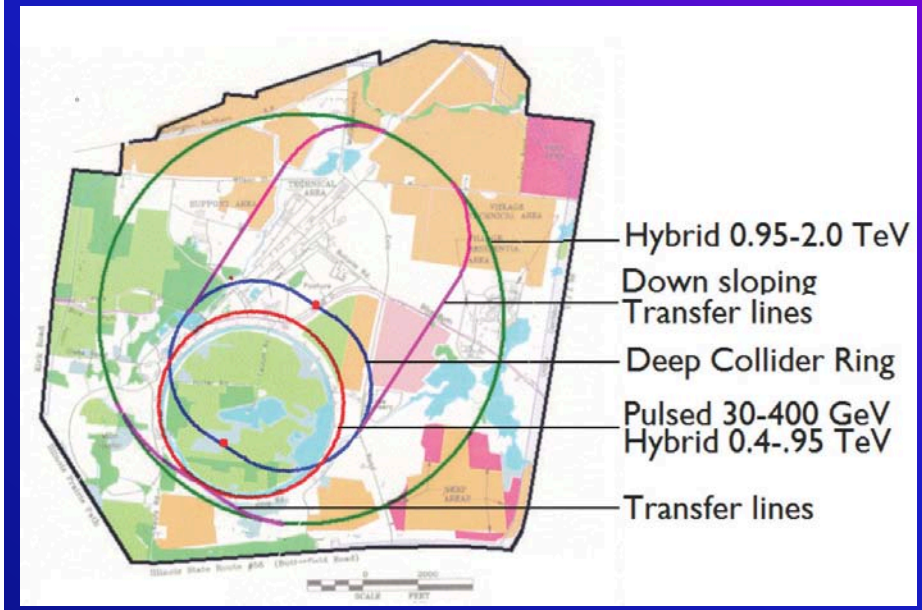
# Muon "Complex" Evolution At Fermilab




- Starting with a high-intensity proton source: Project X
  - We see a natural evolution of "muon" program for Fermilab
- Project X → Low-Energy NF (pointing to Homestake) → High-Energy NF → 1.5 TeV MC → 4 TeV MC

# Muon Acceleration and Future HEP Facilities
## *Neutrino Factory & Muon Collider*



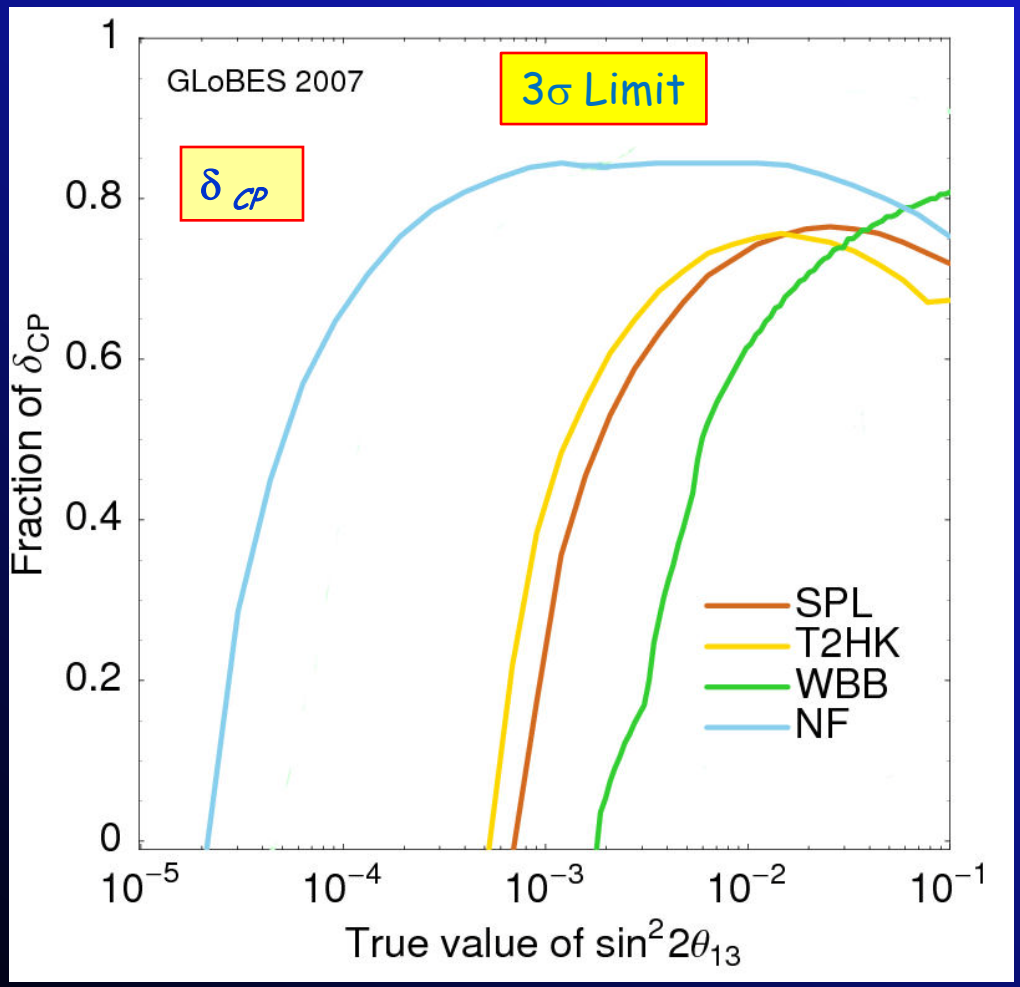

- **Neutrino Factory**
  - **IDS Baseline (FS1, FS2(a)(b), ISS)**
    - **25 GeV μ storage ring**
    - **4 GeV Option under study**
- **MC: One Concept**
  - **4 TeV Center-of-Mass**
    - Rapid-Cycling Synchrotron Acceleration

***Common Front-End, SMALL FOOTPRINT***


# Physics Motivation

*We believe a excellent case has been made*

# NF Motivation - Physics Reach (ISS)




- The NF gives the best Physics Reach
  - NF ≡ Precision
- Even with $\sin^2 2\theta_{13}$ in the range of 5 X $10^{-4}$ to $10^{-3}$, these very aggressive "conventional" experiments – Run Out of Steam
- Similar arguments can be made for $\sin^2 2\theta_{13}$ discovery reach and determination of the neutrino-mixing mass Hierarchy

SPL: 4MW, 1MT $H_2OC$, 130 km BL
T2HK: 4 MW, 1MT $H_2OC$, 295 km BL
ProjX: 2MW, 1MT $H_2OC$, 1300 km BL

NF: 4MW, 100KT MIND, 4000 & 7500 BL

# Muon Collider - Motivation

Reach Multi-TeV Lepton-Lepton Collisions
at High Luminosity

Muon Colliders may have
special role for precision measurements.
Small $\Delta E$ beam spread –
Precise energy scans

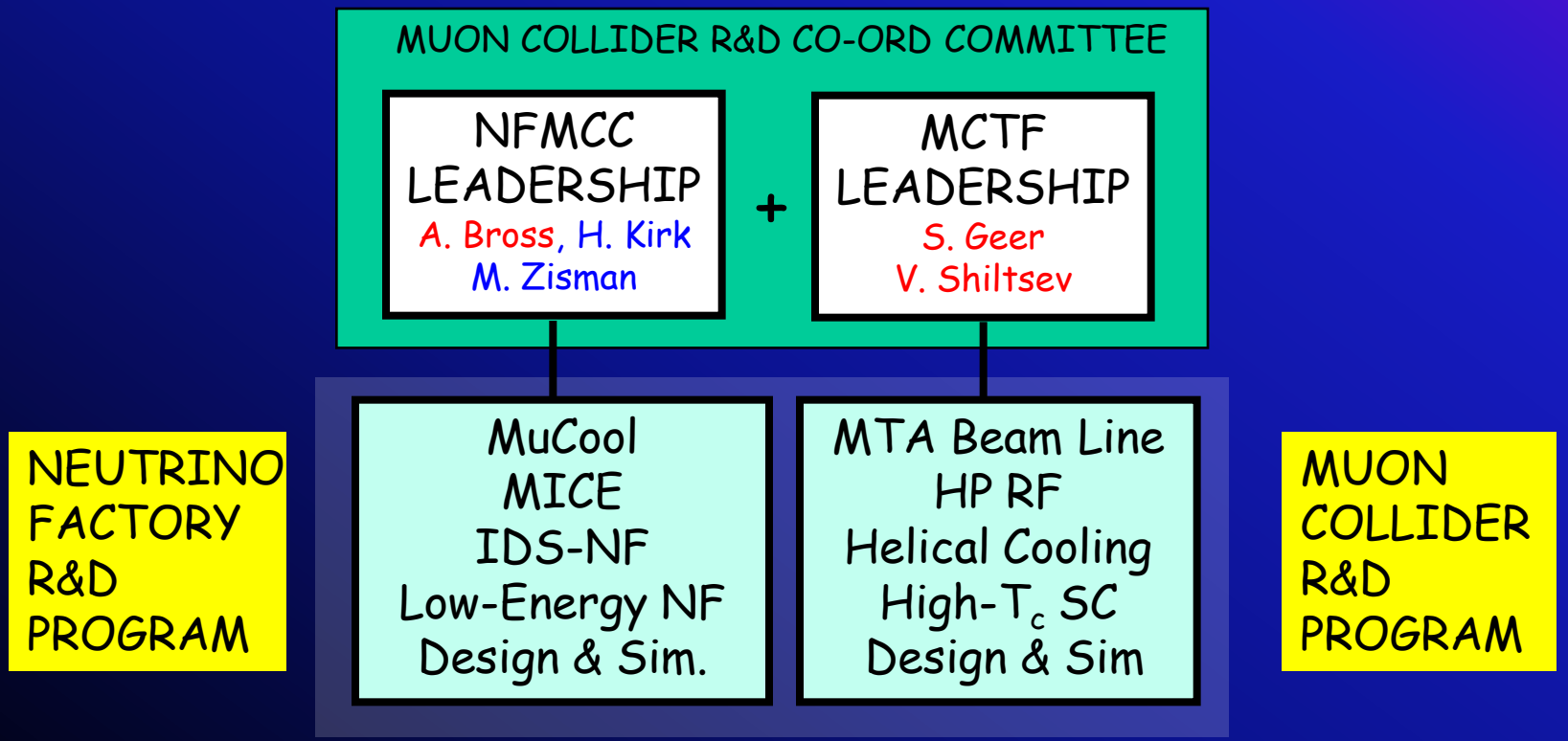
Small Footprint -
Could Fit on Existing Laboratory Site

# Organization

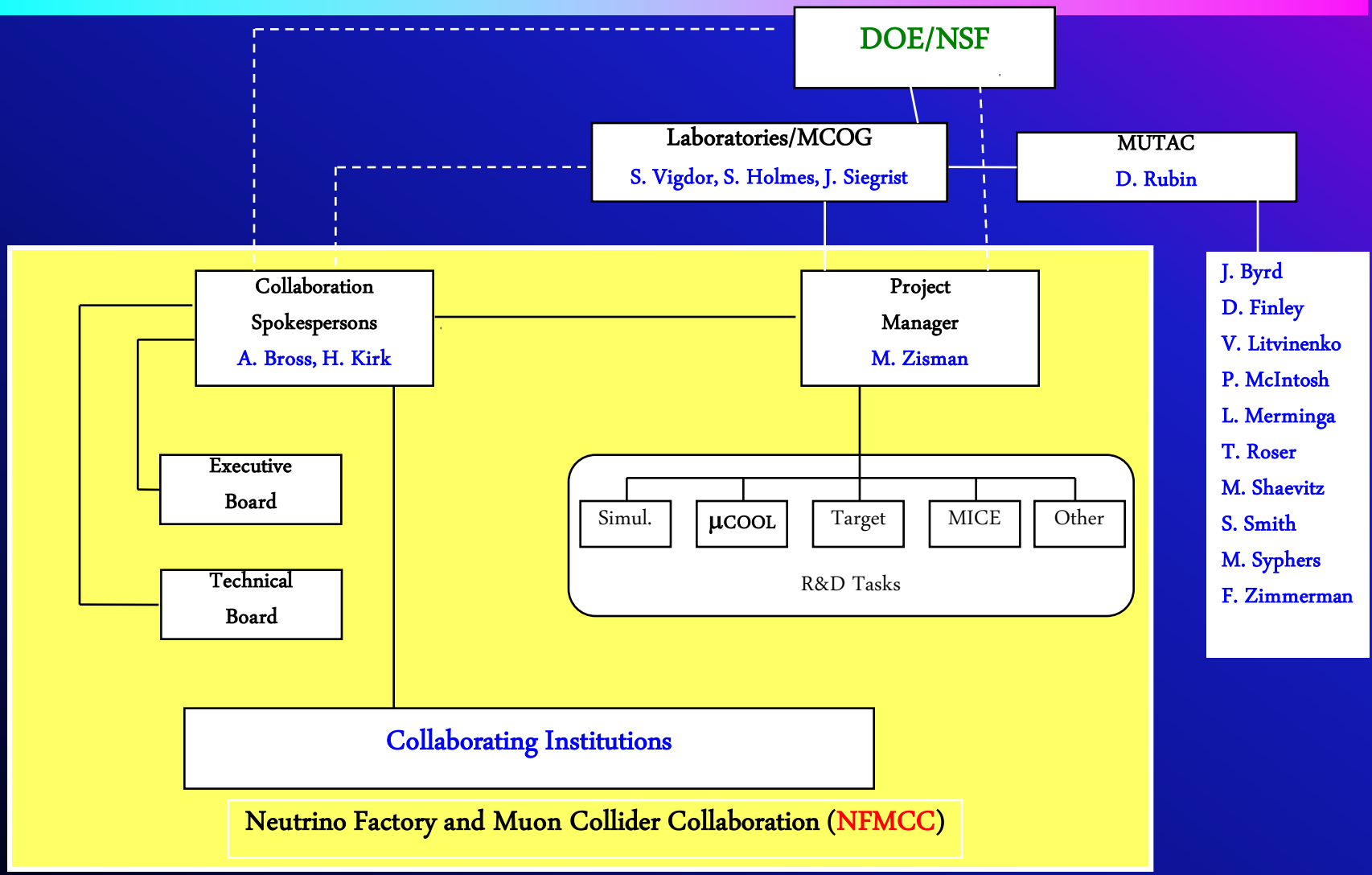
*Some Changes This Year*

# Muon Acceleration R&D Organization

- R&D Program carried out by two groups
  - Neutrino Factory and Muon Collider Collaboration
  - Fermilab Muon Collider Task Force



# NFMCC Organization



# Collaborating Institutions

## US

### National Labs
ANL
BNL
FNAL
LBNL
ORNL
TJNAF

### Universities
Chicago
Cornell
Illinois
IIT
Indiana
Iowa
Michigan State
Mississippi
Northern Illinois
Princeton
UC-Berkeley
UC-Davis
UC-Los Angeles
UC-Riverside
Wisconsin

## International

### National Labs
Budker
CERN
DESY
INFN
JINR, Dubna
KEK
RAL
TRIUMF

### Universities
Karlsruhe
Imperial College
Lancaster
Max Planck
Osaka
Oxford
Pohang
Tel Aviv

### Corporate Partners
Muons Inc.
Tech-X Corporation

# Executive Board

| | | | |
|---|---|---|---|
| **A. Bross** | **FNAL** | **Co-Spokesperson** | bross@fnal.gov |
| **H. Kirk** | **BNL** | **Co-Spokesperson** | kirk@bnl.gov |
| **A. Sessler** | **LBNL** | **Associate Spokesperson** | amsessler@lbl.gov |
| **I. Ben-Zvi** | **BNL** | | benzvi@bnl.gov |
| **D. Cline** | **UCLA** | | dcline@physics.ucla.edu |
| **S. Geer** | **FNAL** | | sgeer@fnal.gov |
| **G. Hanson** | **UC Riverside** | | Gail.Hanson@ucr.edu |
| **D. Kaplan** | **IIT** | | kaplan@fnal.gov |
| **K. McDonald** | **Princeton University** | | kirkmcd@Princeton.edu |
| **R. Palmer** | **BNL** | | palmer@bnl.gov |
| **D. Summers** | **U. Mississippi** | | summers@phy.olemiss.edu |
| **A. Tollestrup** | **FNAL** | | alvin@fnal.gov |
| **J. Wurtele** | **LBNL/UC Berkeley** | | wurtele@physics.berkeley.edu |
| **M. Zisman** | **LBNL** | **Project Manager** | mszisman@lbl.gov |
| **J. Gallardo** | **BNL** | **Scientific Secretary** | gallardo@bnl.gov |

# Technical Board

| | | |
|---|---|---|
| **Alan Bross** | **Co-Spokesperson** | bross@fnal.gov |
| **Rick Fernow** | | fernow@bnl.gov |
| **Michael Green** | | magreen@lbl.gov |
| **Don Hartill** | | dlh@lns.cornell.edu |
| **Dan Kaplan** | | kaplan@fnal.gov |
| **Harold Kirk** | **Co-Spokesperson** | kirk@bnl.gov |
| **Kirk McDonald** | | kirkmcd@Princeton.edu |
| **Jim Norem** | | norem@anl.gov |
| **Bob Rimmer** | | rarimmer@jlab.org |
| **Mike Zisman** | **Project Manager** | MSZisman@lbl.gov |

# Theory & Simulation Board

| | | |
|---|---|---|
| **R. Fernow (BNL)** | **Chair** | fernow@bnl.gov |
| **H. Kirk (BNL)** | **Targetry Simulation Co-ordinator** | kirk@bnl.gov |
| **D. Neuffer (FNAL)** | **Front-End Systems Co-ordinator** | neuffer@fnal.gov |
| **R. Fernow (BNL)** | **Emittance Exchange/Ring Cooler Coordinator** | fernow@bnl.gov |
| **S. Berg/ C. Johnstone (BNL)/(FNAL)** | **Acceleration Simulation Coordinators** | jsberg@bnl.gov<br>cjj@fnal.gov |
| **A. Sessler (LBNL)** | **Theory Co-ordinator** | amsessler@lbl.gov |
| **M. Berz (MSU)** | | berz@msu.edu |
| **G. Hanson (UCR)** | | Gail.Hanson@ucr.edu |
| **E. Keil (FNAL)** | | Eberhard.Keil@t-online.net |
| **S. Koscielniak (Triumf)** | | shane@triumf.ca |
| **R. Palmer (BNL)** | | palmer@bnl.gov |

# Core Program

Targetry R&D: Mercury Intense Target Experiment
MERIT
Co-Spokespersons: Kirk McDonald
Harold Kirk

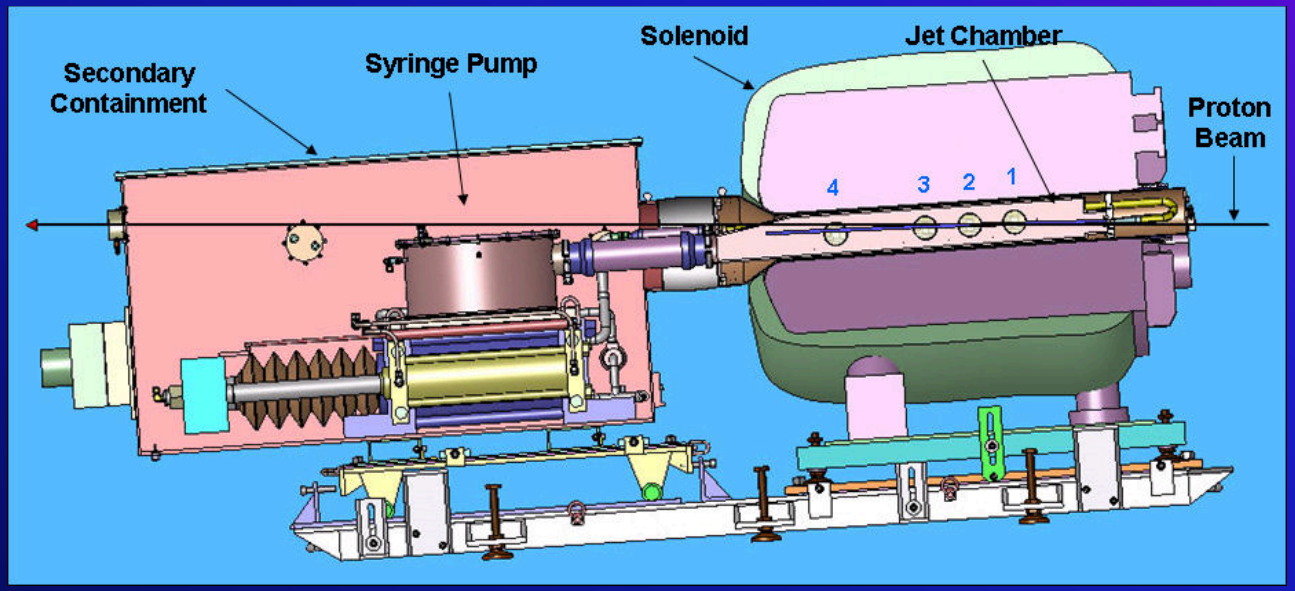
Ionization Cooling R&D: MuCool and MICE
MuCool Spokesperson: Alan Bross
US MICE Leader: Dan Kaplan

Simulations & Theory
Coordinator: Rick Fernow

Fermilab Muon Collider Task Force

# Highlights Reel

# MERIT




- We actually Finished Something!
  - & With Great Success!
- You will hear about the latest data analysis results and status of the continuing targetry program

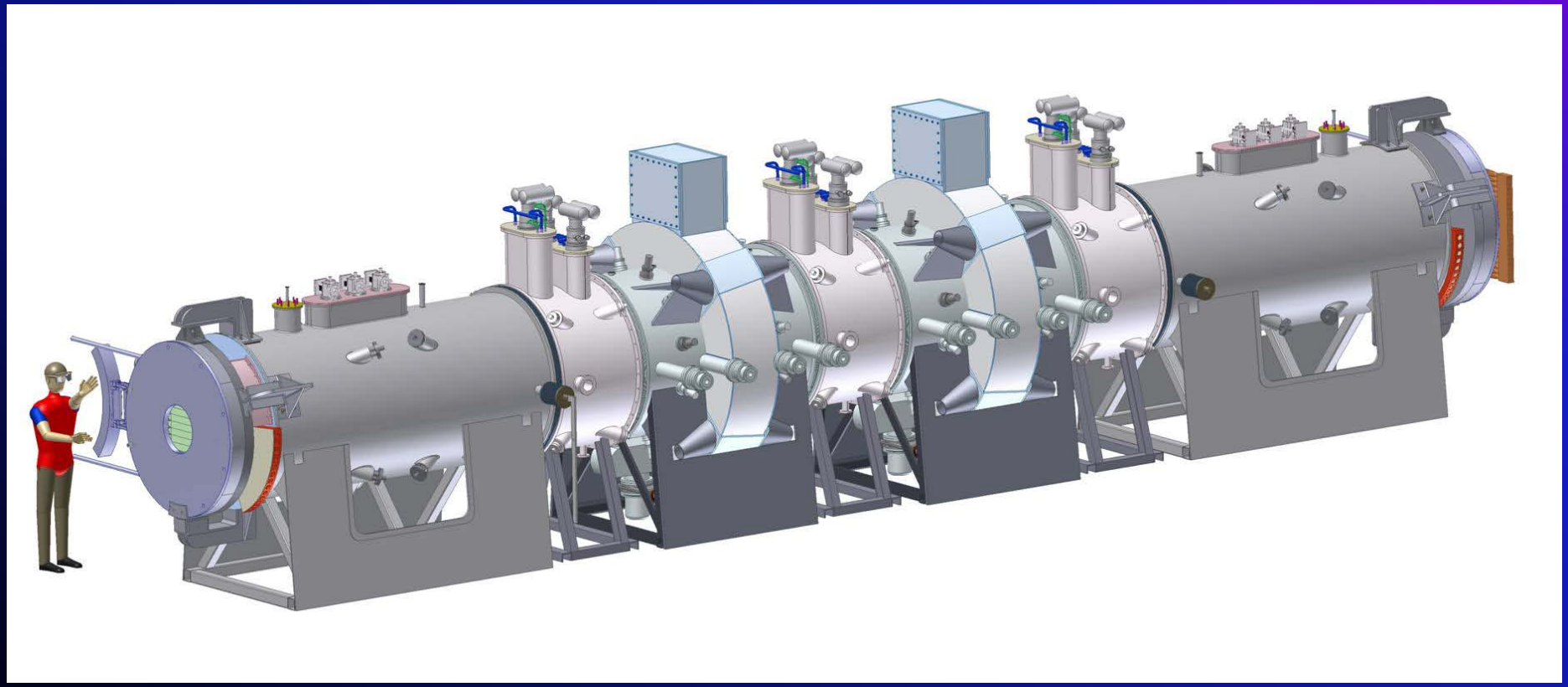
# RF Test Program

- Study the limits on Accelerating Gradient in NCRF cavities in magnetic field
- It has been proposed that the behavior of RF systems in general can be accurately described (predicted) by universal curves
  - Electric Tensile Stresses are important in RF Breakdown events
- This applies to all accelerating structures
- Fundamental Importance to both NF and MC
  - Muon capture, bunching, phase rotation
  - Muon Cooling
  - Acceleration

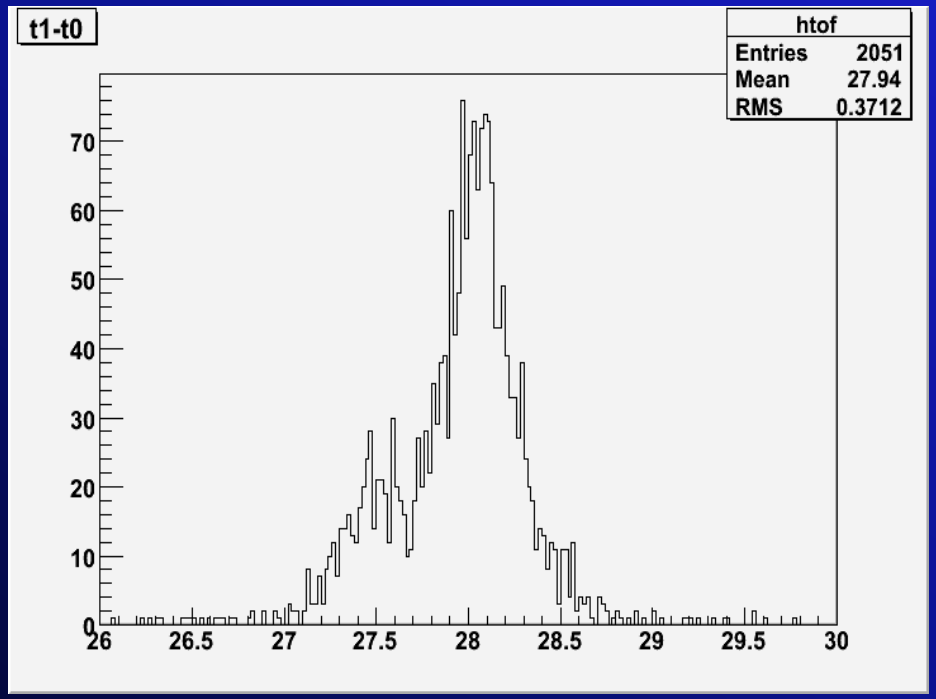
*Arguably the single most critical Technical challenge for the NF & MC*

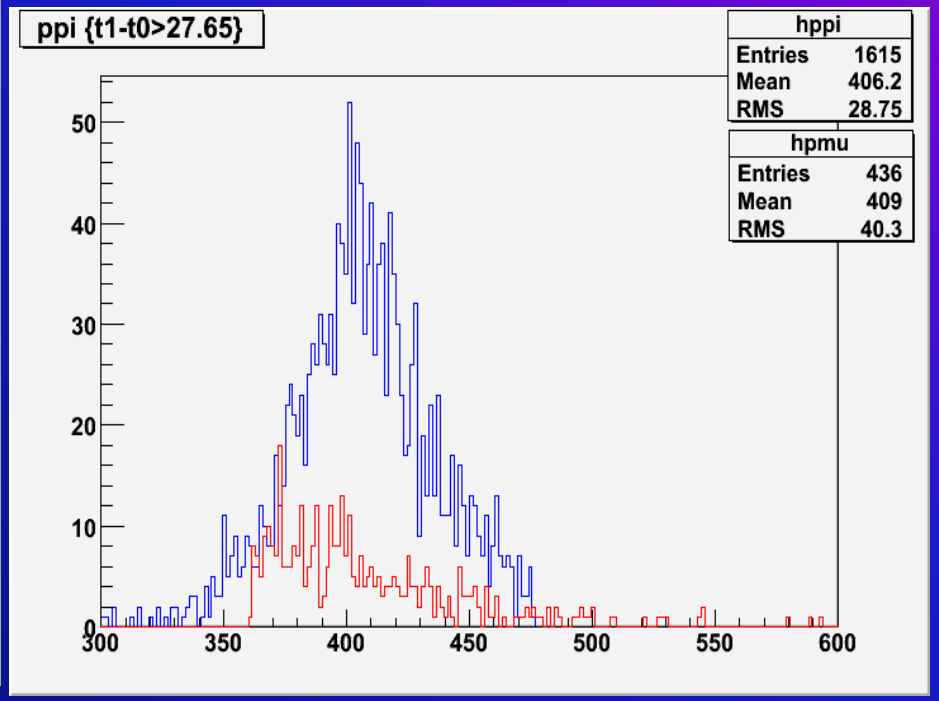
- You will hear about our 3-Pronged Attack
  - Reduce (eliminate) field emission in Vacuum RF, HP gas-filled cavities, Magnetic Insulation for vacuum RF

# Muon Ionization Cooling Experiment (MICE)



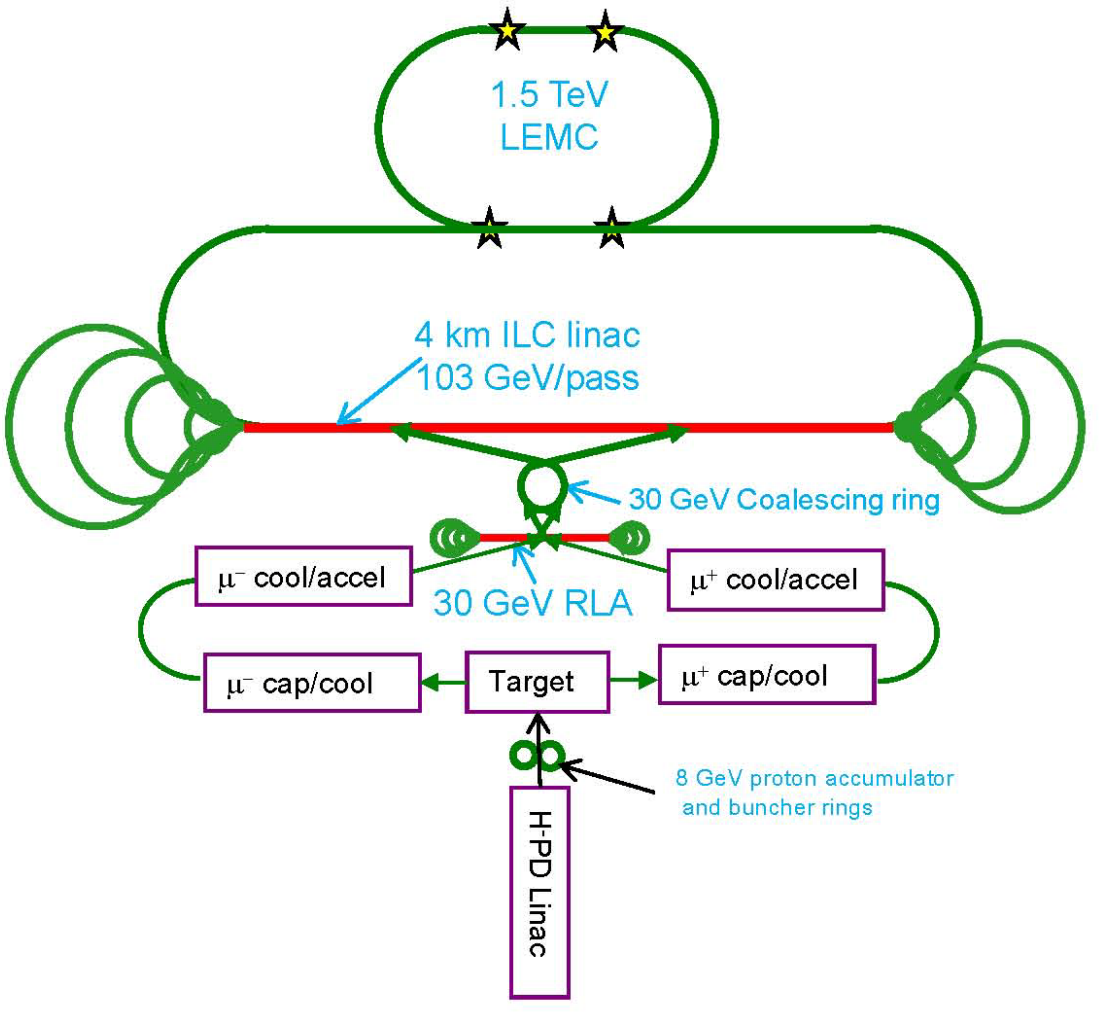
# MICE




- First muons observed
- You will get an update on the status of the experiment

# Design Studies



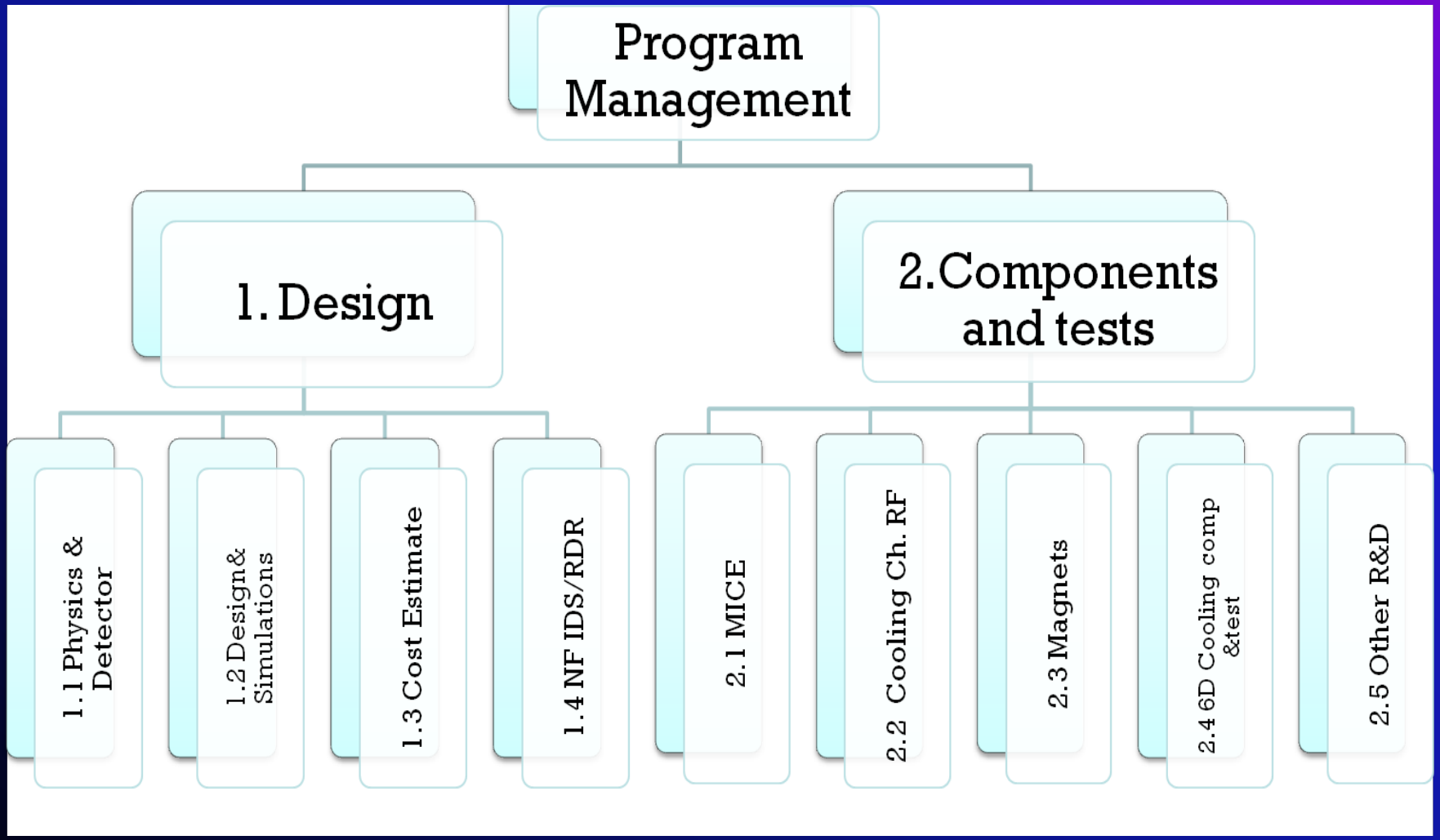

- A great deal of work has been done on the High, Medium and Low Emmittance Options for the MC
- You will get summary of the recent MCD WS and learn about
  - Cooling
  - Acceleration
  - Ring and IR
  - Detector design considerations

# The 5 Year Plan

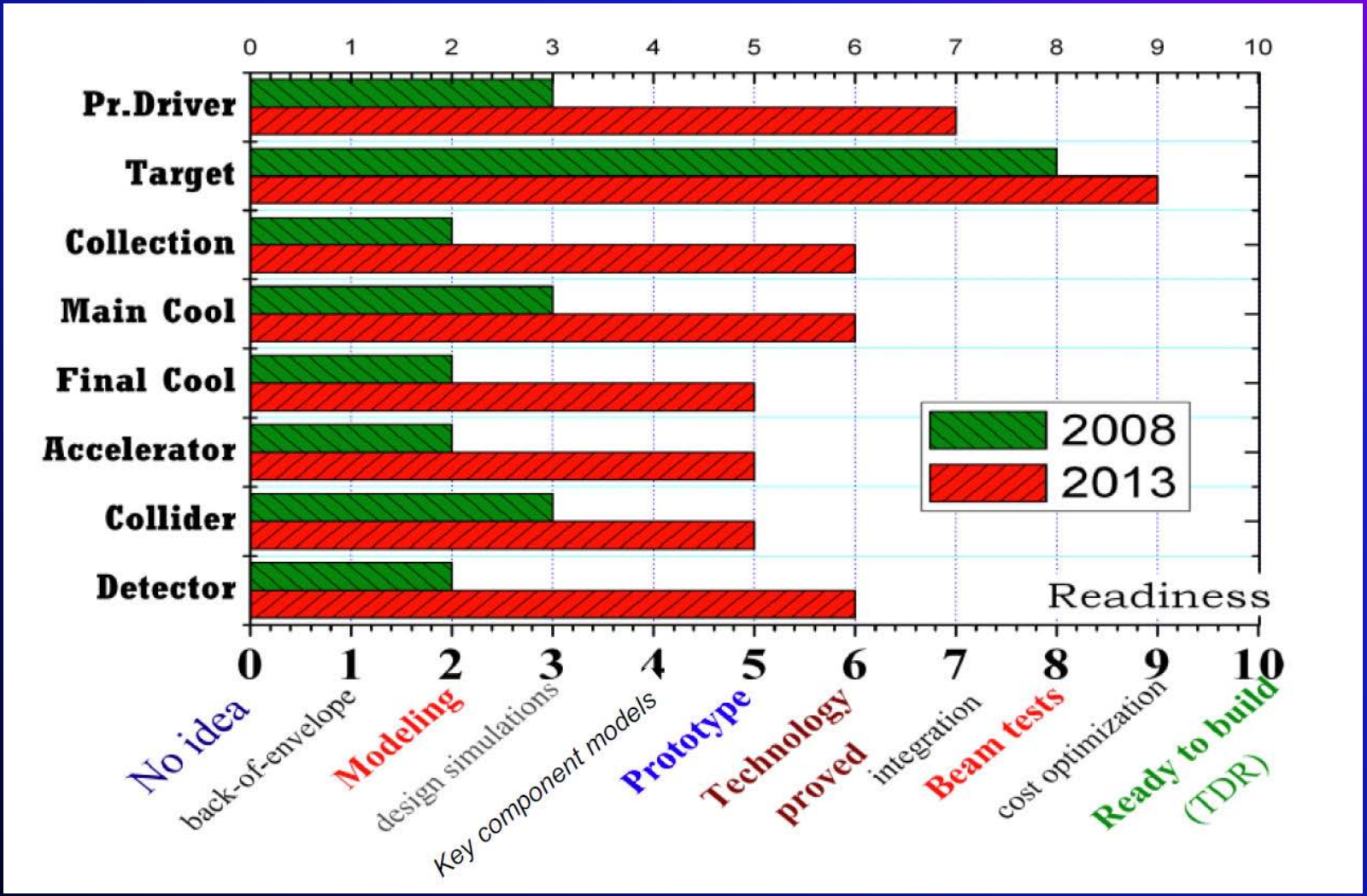
*The Proposal Has now been submitted to DOE*

- **A joint US: NFMCC-MCTF Plan**
  - A measured program based on the solid muon accelerator R&D achievements of the last decade
  - Sufficiently ambitious to make substantial progress before the next round of long-term decisions by the particle physics community
  - Includes accelerator, physics & detector studies (only accelerator part in this talk – we also have plans & estimates for physics & detector studies)
- **Meets our existing commitments (NF-RDR, MICE) and in addition will deliver:**
  - MC performance requirements based on physics
  - A first end-to-end MC simulation
  - Critical component development & proof-of-principle experiments
  - A first MC cost estimate

# Elements of the MC R&D Plan



# From Here to There



# Outlook

- With the Continuing Resolution, it has, so far, been a tight year, but there is reason for some optimism
  - End to CR
  - Supplemental funding
- The submission of our 5 Year Plan Proposal to the DOE is the first step towards an expanded and much broader US effort on NF and MC R&D
- The Muon Acceleration Program will be represented at the DOE budget retreat in March
- Hope for a formal review of the 5 Year Plan proposal this FY