# Initial Baseline Selection Process

in view of recent P5 recommendations regarding MAP

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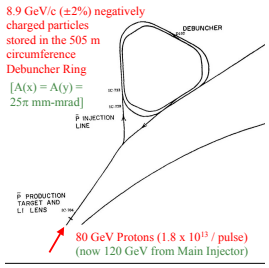
# Historical context: After ~30 years we are on the verge of having initial designs of all key accelerator systems for muon-based neutrino factories and colliders @ Fermilab




**1980: A muon storage ring for neutrino oscillation experiments (Cline & Neuffer)**

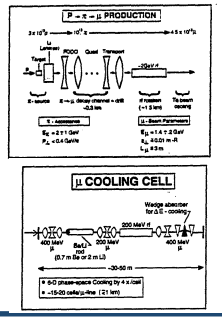
**1979: Colliding muon beams at 90 GeV (Neuffer)**

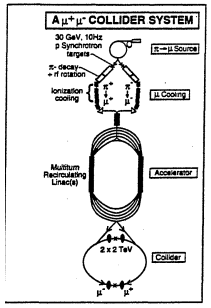
**1982: Skrinsky & Parkhomchuk: Ionization cooling**

**1986 (Madison WI): AAC Symposium: Multi-TeV Muon Colliders (Neuffer)**

**1991 (Napa,CA): First workshop on muon colliders**

**1994 (Sausalito,CA): 2nd workshop on muon colliders: A Practical HE-HL mu-mu collider (Palmer/Neuffer/Gallardo)**

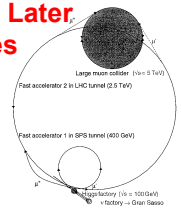


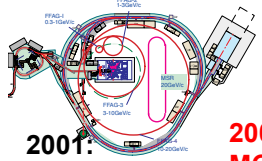

**1997: Muon Collider Collab formed. Later becomes NFMCC**

**Snowmass'96**

**1997: Workshop on physics at 1st muon collider and FE of a muon collider**




**CERN studies 1999**



**2001: Japanese NuFac Design Study 1**

**2001: US NuFac Design Study 1**

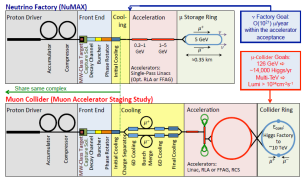
**2002: US NuFac Design Study 2**

**Snowmass 2001: The Program in Muon and Neutrino Physics: Super Beams, Cold Muon Beams, Neutrino Factory and the Muon Collider**

**2005-2006: ISS**

**2006: MCTF @ FNAL**

**2007: IDS-NF initiated**




**2011 IDS-NF Interim Design Report**

**MASS, IBS, R&D demonstrations**

**2011: US muon R&D consolidated into a single entity, MAP**

**P5 recommends MAP reassessment**

**Snowmass 2013: Enabling Intensity & Energy Frontier Science w/ a Muon Acc. Facility in the U.S.**

1980 — 1990 — 2000 — 2010

# What does the P5 report mean for MAP and for the IBS?

*"... reassess the Muon Accelerator Program (MAP), incorporating into the general accelerator R&D program those activities that are of broad importance to accelerator R&D, and consult with international partners on the early termination of MICE. In addition, in the general accelerator R&D program, focus on outcomes and capabilities that will dramatically improve cost effectiveness for mid- and far-term accelerators."*

- As has already been mentioned this morning, MAP as we know it will change at the close of 2014
- Some activities will continue under GARD
- Exact details remain to be worked out
  - we anticipate that design activities related to Neutrino Factories will be incorporated into an "Accelerator Concepts" GARD program
  - we anticipate that design activities for a collider will receive reduced priority

- These changes have nothing to do with MAP technical progress, which is viewed as highly successful
- The changes reflect the near- and mid-term priorities set forth by P5 and accepted by HEPAP.
  - These priorities push the need for muon-based accelerators further into the future

# Muon accelerators in the broader context

- As is clear from the P5 report and the Q&A following the P5 presentation, muon accelerators are viewed alongside ILC and future circular colliders as facilities of the late- mid-term and the far-term
- Each of these has pros & cons
- The sheer size of ILC and FCC makes them very expensive
  - recall the P5 recommendation to focus on R&D that will "*dramatically improve cost effectiveness for mid- and far-term accelerators*"
- ILC is not favorable power-wise for scaling much beyond 1 TeV
- Muon accelerators have major technological challenges, particularly with regard to cooling, hence feasibility as a collider is an open question

# Muons in context, cont.

- Summary:
  - ILC: big, O( $10 billion), limited energy-frontier capability, no impact to US domestic facilities
  - FCC: big, $30-40 billion, energy frontier, no impact to US domestic facilities
  - muon: small, potentially least expensive due to reduced size, impacts domestic intensity- and energy-frontier facilities, big technology challenges, feasibility not demonstrated

Our policy makers have strong incentive to continue muon R&D due to potential impact to domestic HEP research and potential cost reduction of future facilities

# DOE/OHEP is not giving up on muon accelerators

- P5 recommended continuing some muon R&D under GARD
- Ending all muon R&D is counter to the P5 report
  - *"maintain a stream of science results while investing in future capabilities, which implies a balance of project sizes; maintain and develop critical technical and scientific expertise and infrastructure to enable future discoveries."*
  - *"in the general accelerator R&D program, focus on outcomes and capabilities that will dramatically improve cost effectiveness for mid- and far-term accelerators."*
  - *"Our society's capacity to grow is limited only by our collective imagination and resolve to make long-term investments that can lead to fundamental, game-changing discoveries, even in the context of constrained budgets."*

Muon accelerators, if feasible, would be a game-changing technology

- OHEP is directing us to reduce and refocus our muon activities to the medium-term

# Initial Baseline Selection (IBS) Prior to P5

- A site-specific set of designs for staged facilities at Fermilab
  - nuSTORM, NUMAX, Higgs Factory, Multi-TeV colliders
- Designs based on available knowledge *at the time*
  - Choose our initial baselines, then study in more detail and optimize in MAP FP-II
- Designs have evolved due to opportunities identified by MASS
  - better staging, reduced cost

# Initial Baseline Selection (IBS) Post-P5

**Key differences compared with present IBS:**

- Target is medium-term neutrino facilities
  - long-term (collider) design will be phased out
- More focused
- Still includes muon cooling
  - but since muon collider design will have reduced priority, some cooling subsystems will not be considered

# The IBS process has had a huge impact on moving us from "exploring concepts" to "selecting initial baselines"

- We will retain the key elements:
  - Concept specification
  - Lattice files & performance evaluation
  - Lattice file sign-off
  - Global optimization (where appropriate)
  - Interface parameters
  - Technology specification
  - Technology sign-off
  - Final review (+ initial review in some cases)

# Refocused effort under GARD will have reduced scope and budget

- Proton Driver: No requirement for multiple beams on target
- Front End: No requirement for 4 MW upgrade
- Cooling: Focus on Initial Cooling and (what was formerly called pre-merge) 6D cooling
- Acceleration: only up to NuMAX energy
- NF Decay Rings: intact
- Collider Ring: reduce design activity and document
- Collider MDI: reduce design activity and document
  - but some energy deposition studies will remain
    - Front End; Muon acceleration for NuMAX

# Summary

- As Mark has stated earlier this morning:
  - prepare for DOE review of MAP in early July
  - prepare a transition plan under which certain MAP activities will be carried out under GARD
- IBS process will transition into an "Accelerator Concepts" GARD effort starting in FY15
  - this MAP meeting is an opportunity to begin planning this transition, identify & prioritize design activities to be transferred to GARD