Muon Accelerator Front-End Status

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Acknowledgement

• Front-End is a core building block of a Neutrino Factory and a Muon Collider
Front-End (FE) channel

• Major components include:
  • Target & capture
  • Chicane
  • Decay channel
  • Buncher
  • Phase-Rotator
Outline

• Front-end major sub-systems
  • Target & Capture Solenoid
  • Chicane
  • Drift Channel
  • Buncher
  • Phase-Rotator
• Future work & challenges
• Summary
Accomplishments after DOE Review

- Conceptual design of a carbon target, optimized for 1 MW 6.75 GeV proton beam.
- Feasibility study of a magnet design to capture the produced muon beam.
- Following the findings from numerical simulations, the field drops from 20 T to 2 T within a short 6 m taper length.
- Previous discrepancies in modeling the chicane/absorber system are now understood.
- Chicane is now optimized and integrated into the FE
- Reduced substantially the number of Buncher & Phase Rotator rf frequencies.
Target & Capture system

• Proton Driver:
  • 6.75 GeV (kinetic energy) proton with 3 ns pulse
  • 1 MW initial beam power
  • NF: 50 Hz rep rate, MC: 15 Hz rep rate

• Target Concept:
  • Graphite target
  • Inside 20 T magnet
  • Tilted in magnetic axis
  • Proton beam dump via graphite rod downstream of the target

• Details: K.T. McDonald Talk on May 30th, 8:30 am
Target System Optimizations

- Optimum C target: len. = 80 cm, rad = 8 mm, tilt = 65 mrad
- Optimum Graphite beam dump: len. = 120 cm, rad = 24 cm to intercept most of the proton beam
- Details: X. Ding, Talk on May 29th, 1:55 pm
Optimizations of Muon Capture

- Global optimization for:
  - Peak target field, end field, length of field taper

- Results showed:
  - Shorter taper leads to higher muon yield (~6 m)
  - Favorable to increase the baseline end field (2.0 T)
  - Higher target peak field improves performance (20 T)

- Details: H. Sayed Talk on May 29th, 11:10 am
Magnet design for short taper

- Magnet design for 5-7 m short taper delivered
- Tapers from 15T – 20 T to 1.5-3 T magnetic field
- Implemented to the new Front-End
Front-End Chicane

- High energy particles could activate the entire FE channel
- Bent solenoid chicane induces vertical dispersion in beam
  - High-Momentum particles scrape
  - Single chicane for both muon signs
- Proton absorber to remove low momentum protons
Earlier simulations showed 15% discrepancy between ICOOL & G4BL.
It was thought that this was due to the different field model.
Later simulations showed that this was due to the Be model in ICOOL.
Chicane Optimization I (Berg)

• Details: J.S. Berg Talk on May 30th, 8:55 am
• Significant tradeoff between muon transmission and downstream proton power
Buncher & Rotator parameters

• Re-designed to match to a 325 MHz cooler

• Buncher (21 m long)
  • 490 to 365.0 MHz (56 freq.)
  • RF voltage: 0.3 to 15.0 MV/m
  • 2.0 T magnetic field

• Rotator (24 m long)
  • 364.0 to 326.0 MV/m (64 freq.)
  • RF voltage: 20 MV/m
  • 2.0 T magnetic field

• Details: D. Neuffer, Talk on Th. May 29th, 2:20 pm

Baseline has 120 different frequencies!
Discretization of rf frequencies

- Our goal is to reduce the number of frequencies.
- Going from 120 to 30 frequencies -> 8% loss

### Buncher rf parameters

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<th>Gradient (MV/m)</th>
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### Rotator rf parameters

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Graph showing the comparison of different rf-pair configurations.
Six Contributions to IPAC

- Target Concept:
  - Poster: TUPRI008

- Muon Capture Magnet Concept:
  - Poster: THPRI087

- Target Optimizations:
  - Poster: THPRI089

- Muon Capture Optimizations:
  - Poster: MOPRI007

- Chicane Integration in the FE:
  - Poster: TUPME022

- Buncher & Phase-Rotator Discretization:
  - Poster: TUPME023
• We are on good standing based on the IBS schedule:
  • A conceptual design for target, capture solenoid and beam dump has been delivered.
  • On our way to deliver a concept for chicane, buncher & rotator
  • Still a lot of work to do (next slide).

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Future Steps

• Specify buncher and phase-rotator parameters for the new chicane & absorber settings [Person A, Person B]
  • Evaluate performance
  • Energy deposition downstream of the chicane
  • Detailed MARS simulation for specific areas
• Repeat the process for different B-fields [Person A, Person B]
• Energy deposition chicane/ target [Person C, Person D]:
  • Detailed studies in the chicane & target for different target configurations
• Finalize buncher & phase-rotator [Either A, B, C. D]
  • Windows and realistic coils