GLOBAL OPTIMIZATION FOR THE NEW MUON COLLIDER FRONT END

HISHAM SAYED
BROOKHAVEN NATIONAL LABORATORY

FRONT END MEETING
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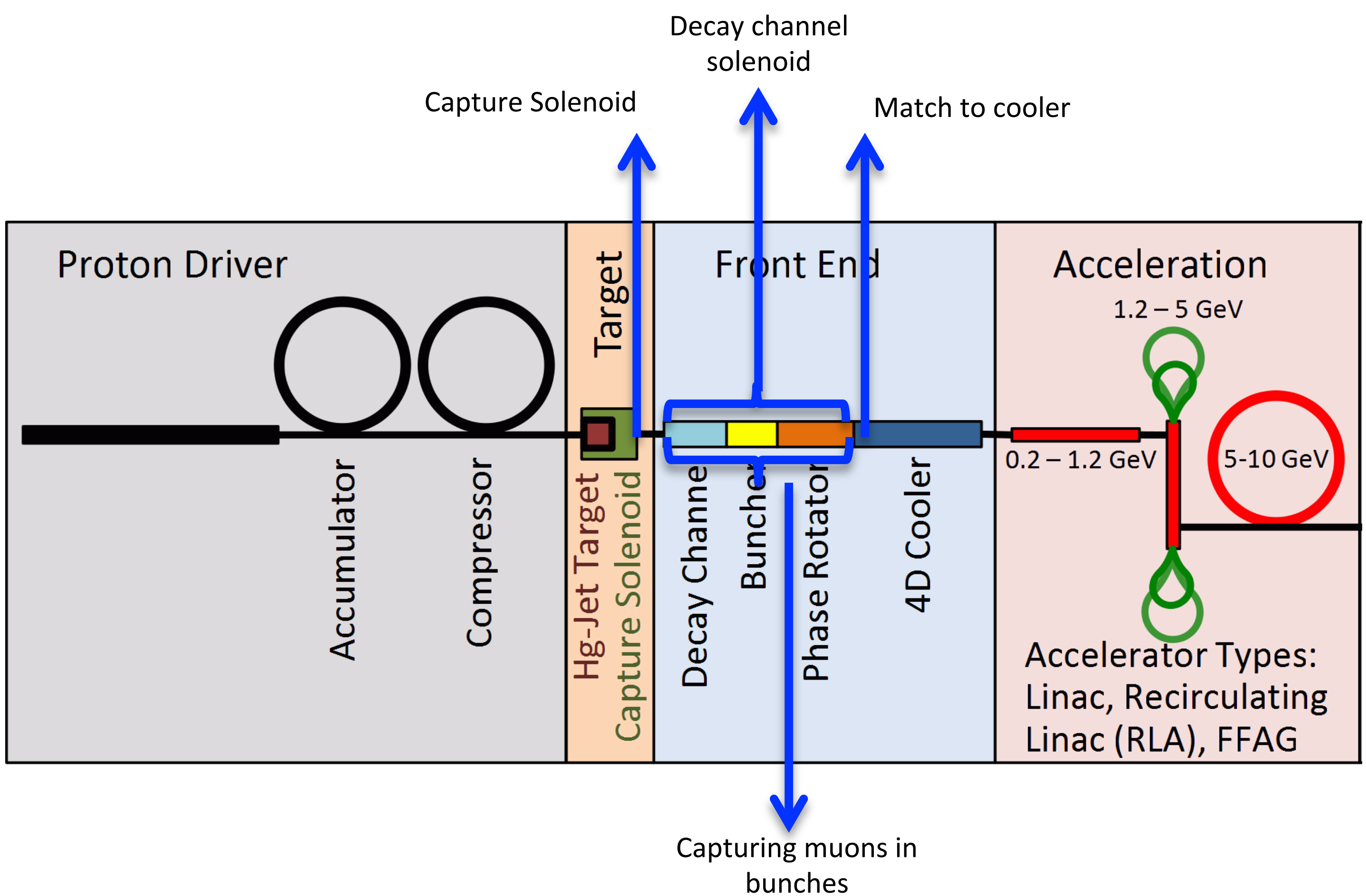
Muon Accelerator Program

BROOKHAVEN NATIONAL LABORATORY

GLOBALLY OPTIMIZING MUON TARGET & FRONT END 325 MHZ LATTICE

1- Target solenoid
2- Decay channel
3- Buncher – Phase rotator
4- Broadband Matching to the cooling channel



INTRODUCTION & LAYOUT

- High performance Optimization Tools on NERSC
- Target:
  - Capture Field → Optimize capture
    → Optimize longitudinal & transverse phase space
  - Target – Proton Beam geometry (size – incident angle) pion count
- Decay Channel: → Control stop band losses (optimize realistic coil design)
- Decay Channel - Buncher – Phase rotator → Length- RF (voltage- frequency – phase)
- Transverse focusing field in decay channel-buncher-rotator
- Broadband match to ionization cooling channel for every end field case 1.5 T → 3.5 T
- Realistic Coil Design & performance optimization

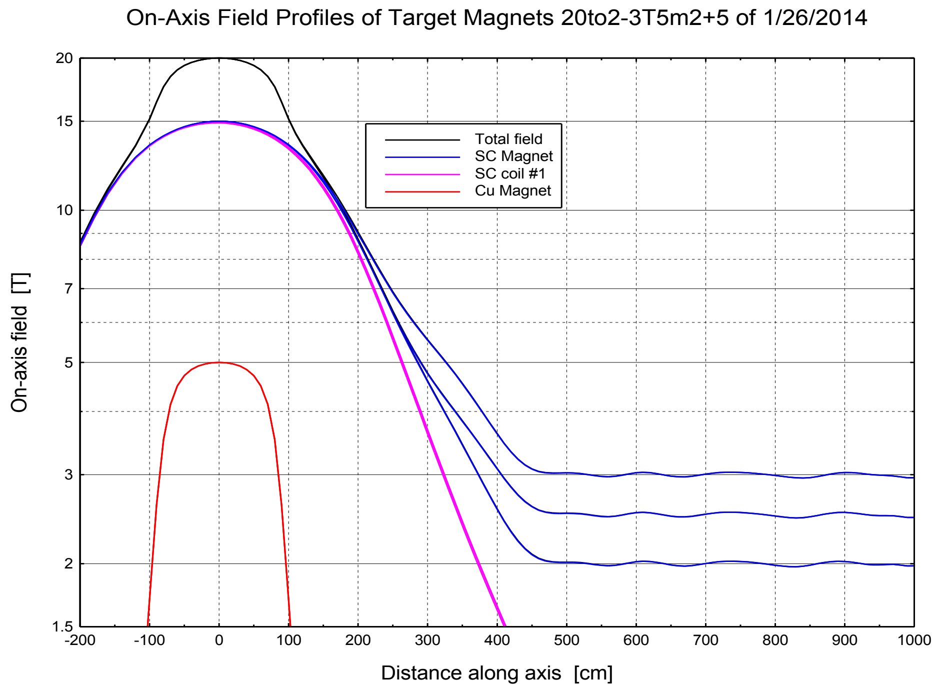
OPTIMIZATION PLAN

Parameters which effects the performance of the overall front end in every system

- Capture Solenoid Field Study: Use the short taper
- Transverse focusing field in decay-channel-buncher-rotator
- Realistic Coil Design (Target taper solenoid – constant focusing)& performance optimization
- Match to ionization cooling channel for every end field case 2.0 T → 3.0 T
- Buncher & rotator phases – frequencies and gradients
- Impact of the proton bunch length on the performance of front end

NEW SHORT TARGET CAPTURE MAGNET (WEGGEL)

Muon Target Short Taper Magnet taper length =5 m- B=20- 2.0, 2.5. & 3.0 T

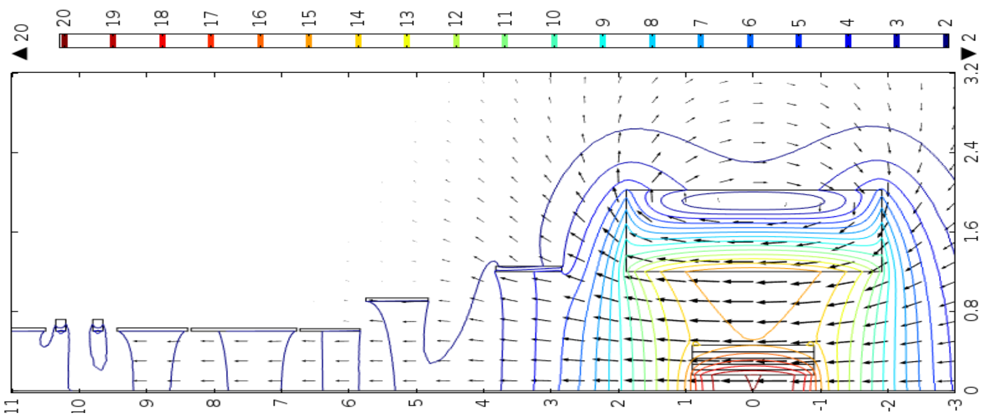


On-axis field profiles of 20-T magnets of 16-cm I.R

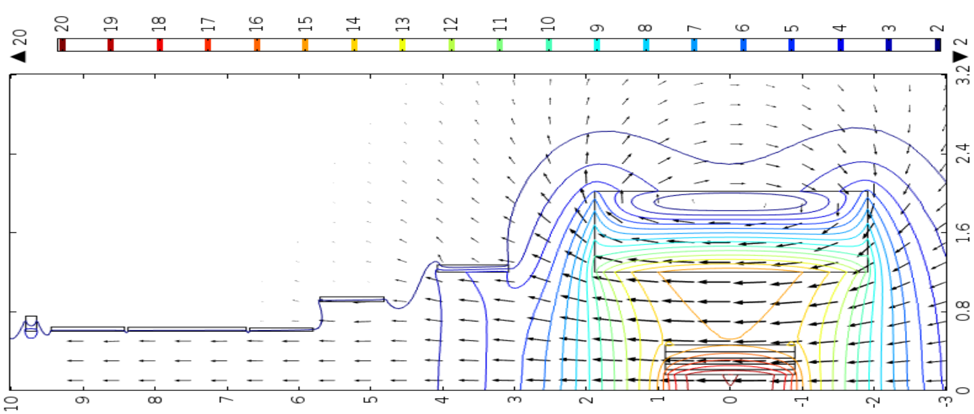
The copper magnet generates 5 T at 8.6 MW with five tightly-nested two-layer coils of mineral-insulated hollow conductor.

The conductor is rectangular, with aspect ratio Δz/Δr = 2, optimized in size and cooling-hole diameter to maximize the incremental efficiency dB/dP [T/MW]. The peak hot-spot temperature is 90 ºC with inlet water at 10 ºC, a water-pressure drop of 40 atm, and three hydraulic passages per coil.

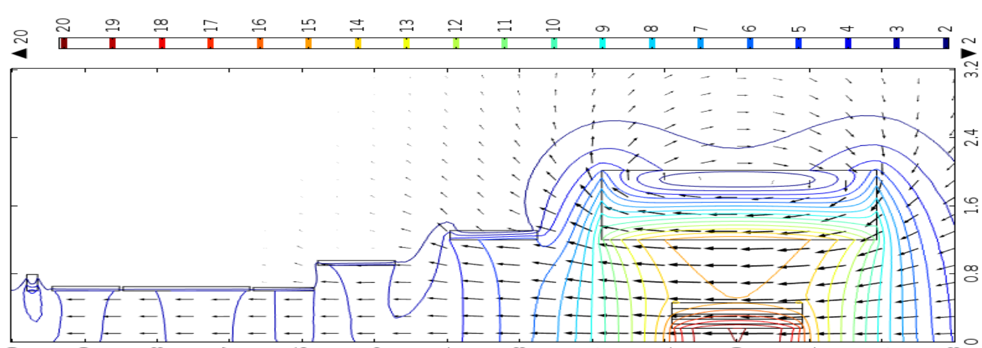
Realistic Short Target capture magnet (Weggel)



Coil cross sections and field direction (arrows) & magnitude (color & contours) of Target Magnet 20to2T5m2+5, whose field tapers to 2 T at z = 5 m.



Field tapers to 2.5 T at z = 5 m.



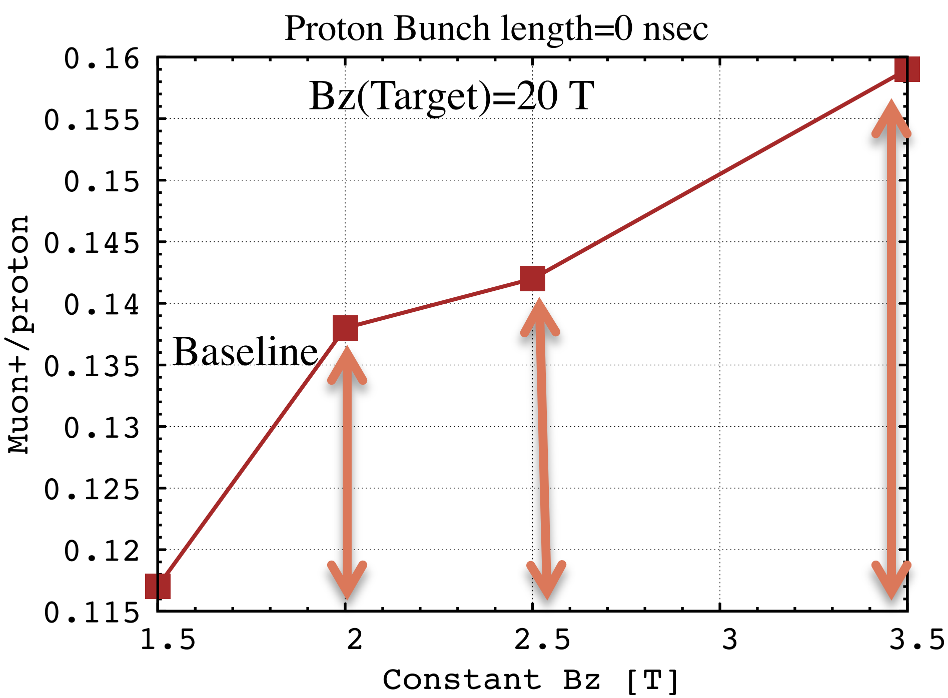
Field tapers to 3 T at z = 5 m.

CONCLUSION & SUMMARY

1- New realistic coild design for the short taper and constant focusing magnets
2- Perform optimizations based on realistic coils
3- Global optimization of the new integrated system
4- Impact of the chicane on the performance of the Front End.

MUON YIELD VERSUS END FIELD 201 MHZ

Performance of FE as function of Constant solenoid filed in Decay Channel – Buncher – Rotator (matched to +/- 2.8 T ionization cooling channel)



20% for every 1 T increase in constant field

μ+ only

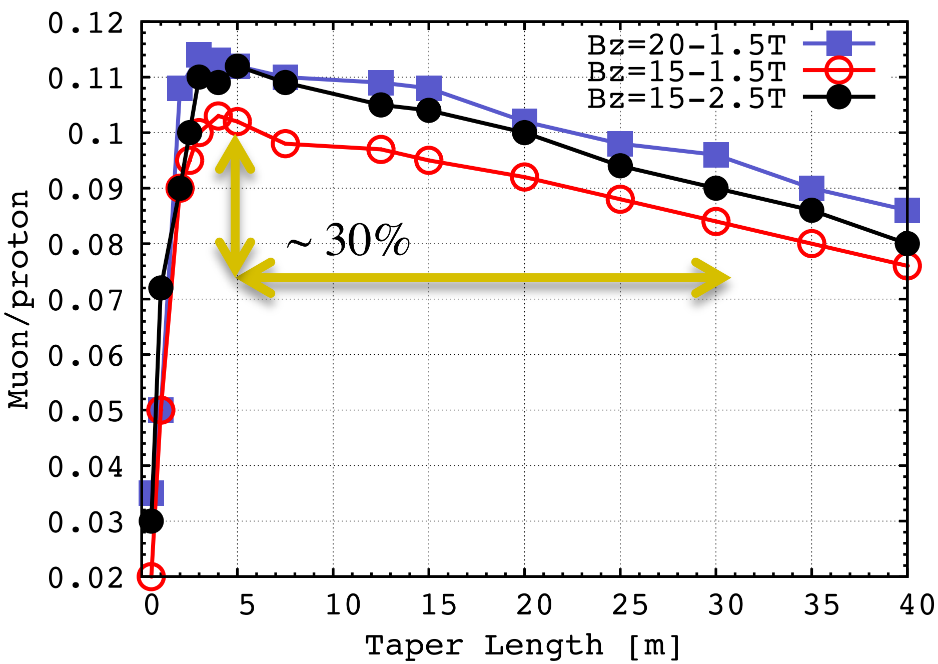
Muon yield versus end field

Front End Performance 201 MHz

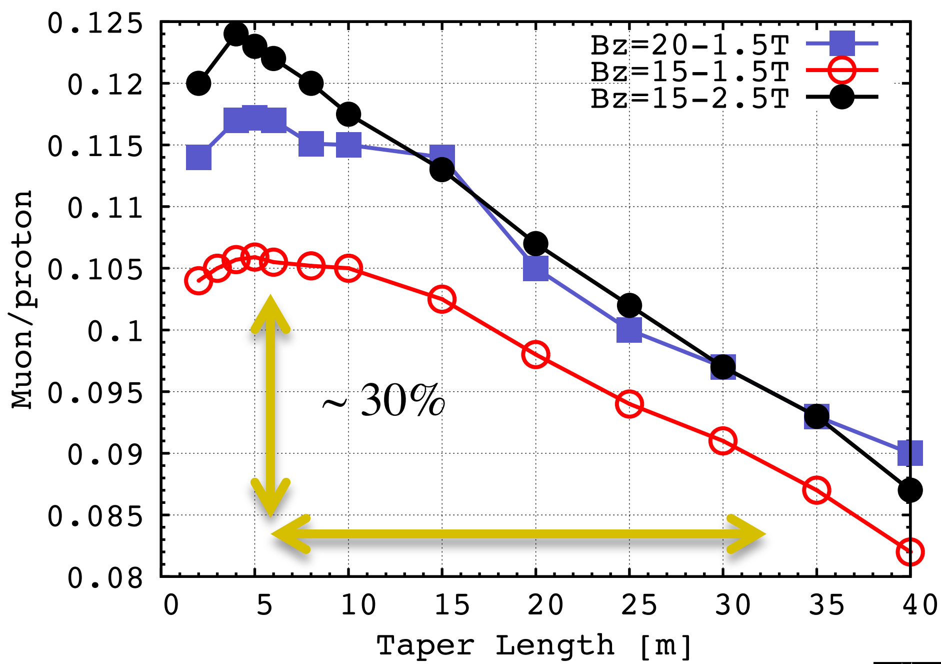
Muon count within acceleration acceptance cuts at end of ionization cooling channel

μ+ only

Before optimizing ionization cooling channel



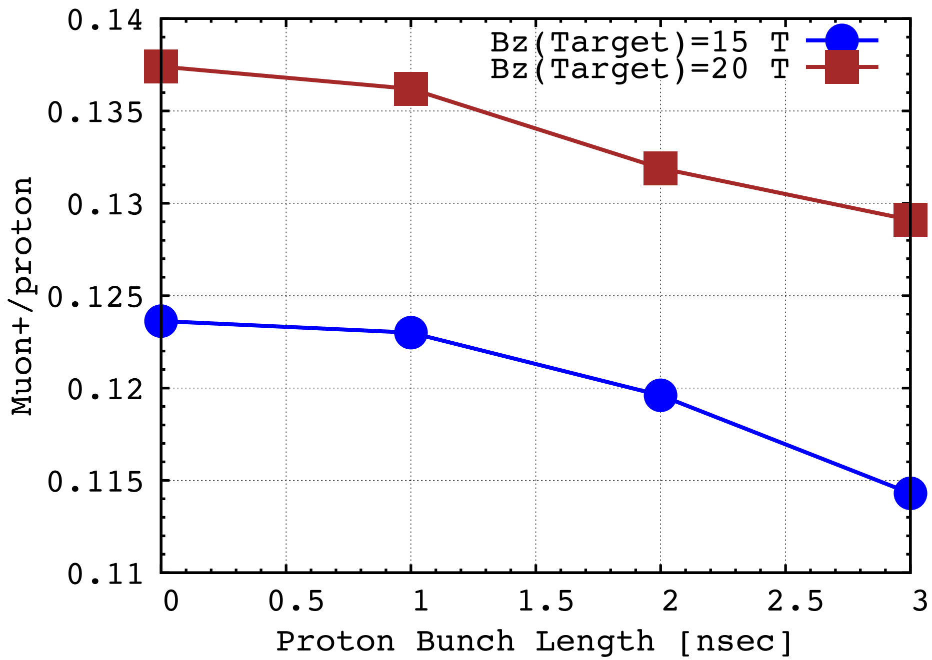
After optimizing ionization cooling channel



Shorter taper provide better quality muons → More muons at end of ionization cooling channel

PROTON BUNCH LENGTH FOR THE 201 MHz

Muon yield versus Proton Bunch Length



~ 3% loss per 1 nsec increase in bunch length