# Alternative options for beam cooling for a muon accelerator front-end

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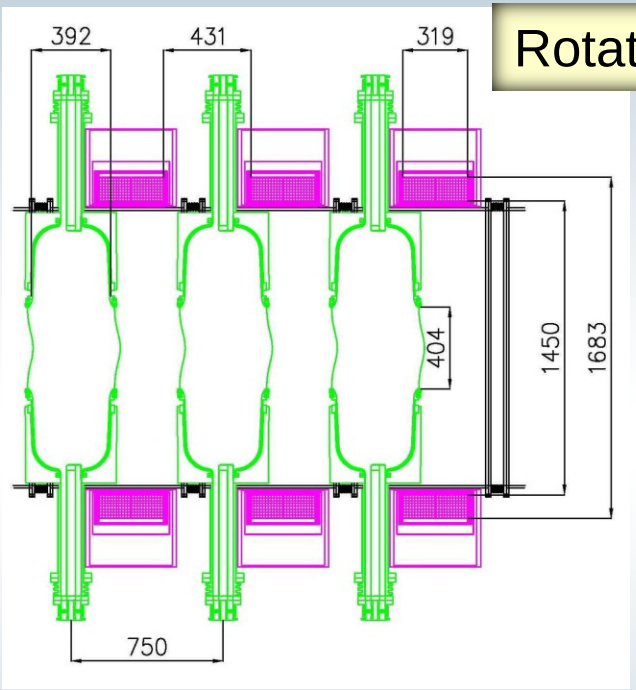
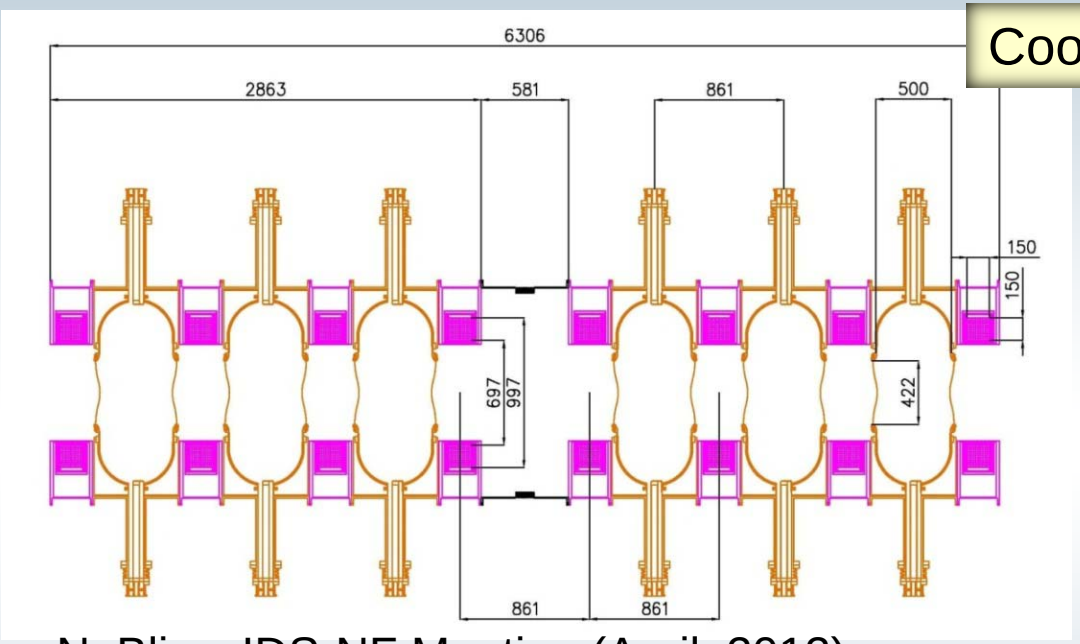
# What's new

- Designed a new front-end lattice by taking into account recent engineering studies (next slide)
- Added bucked coils on rotator
- Examined two bucked-coils schemes for cooler:
  - Radial bucked coils (A. Alekou)
  - Longitudinal bucked coils
- Compared performance of those schemes with ICOOL

# Engineering challenges for a Muon Accelerator

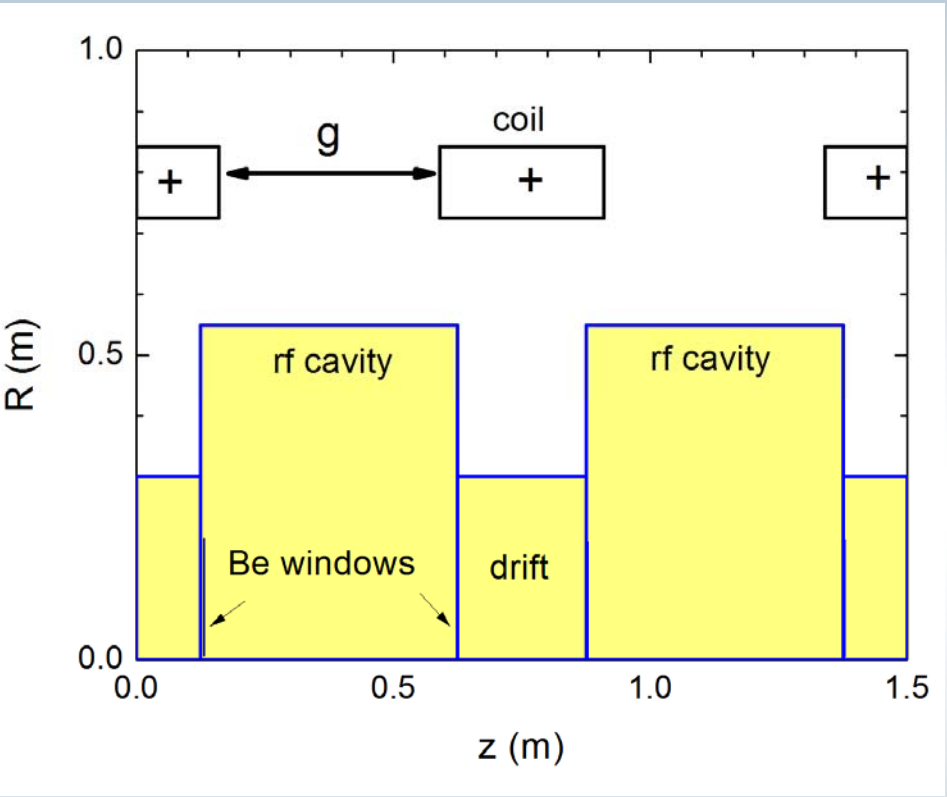


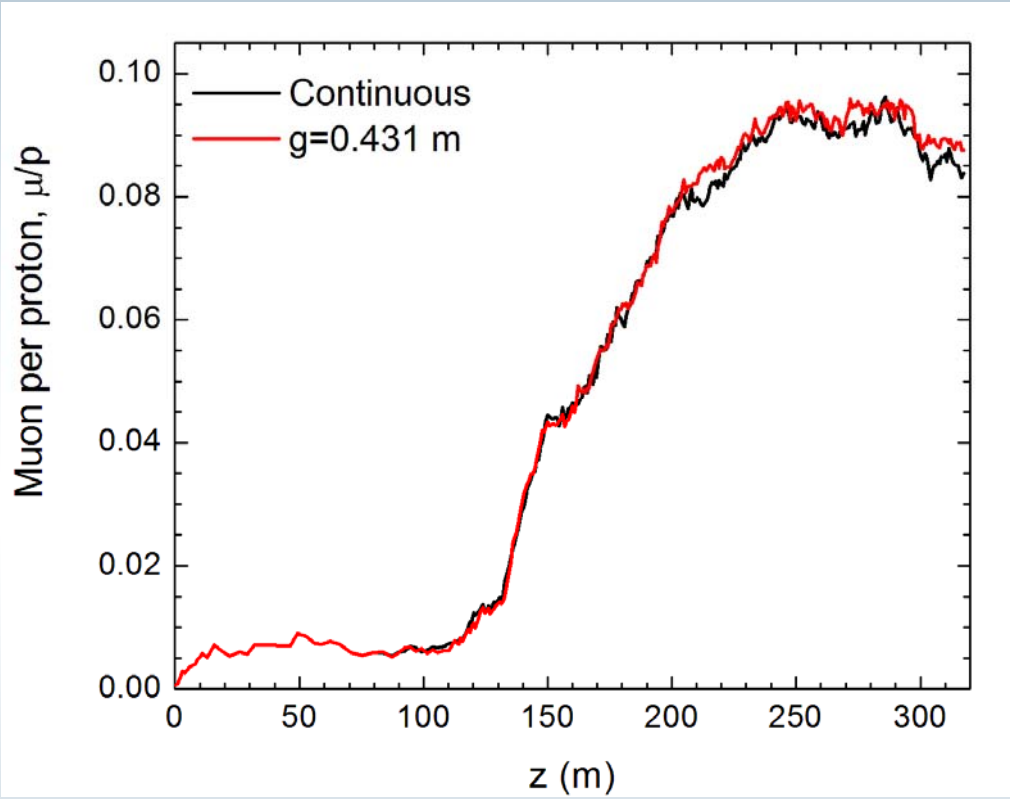




N. Bliss, IDS-NF Meeting (April, 2012)

- Recent engineering studies suggest to:
  - Increase the gap between coils in buncher & rotator
  - Increase cooler cell length from 0.75 m to 0.86 m
  - Have one “empty” cell after a series of cavities

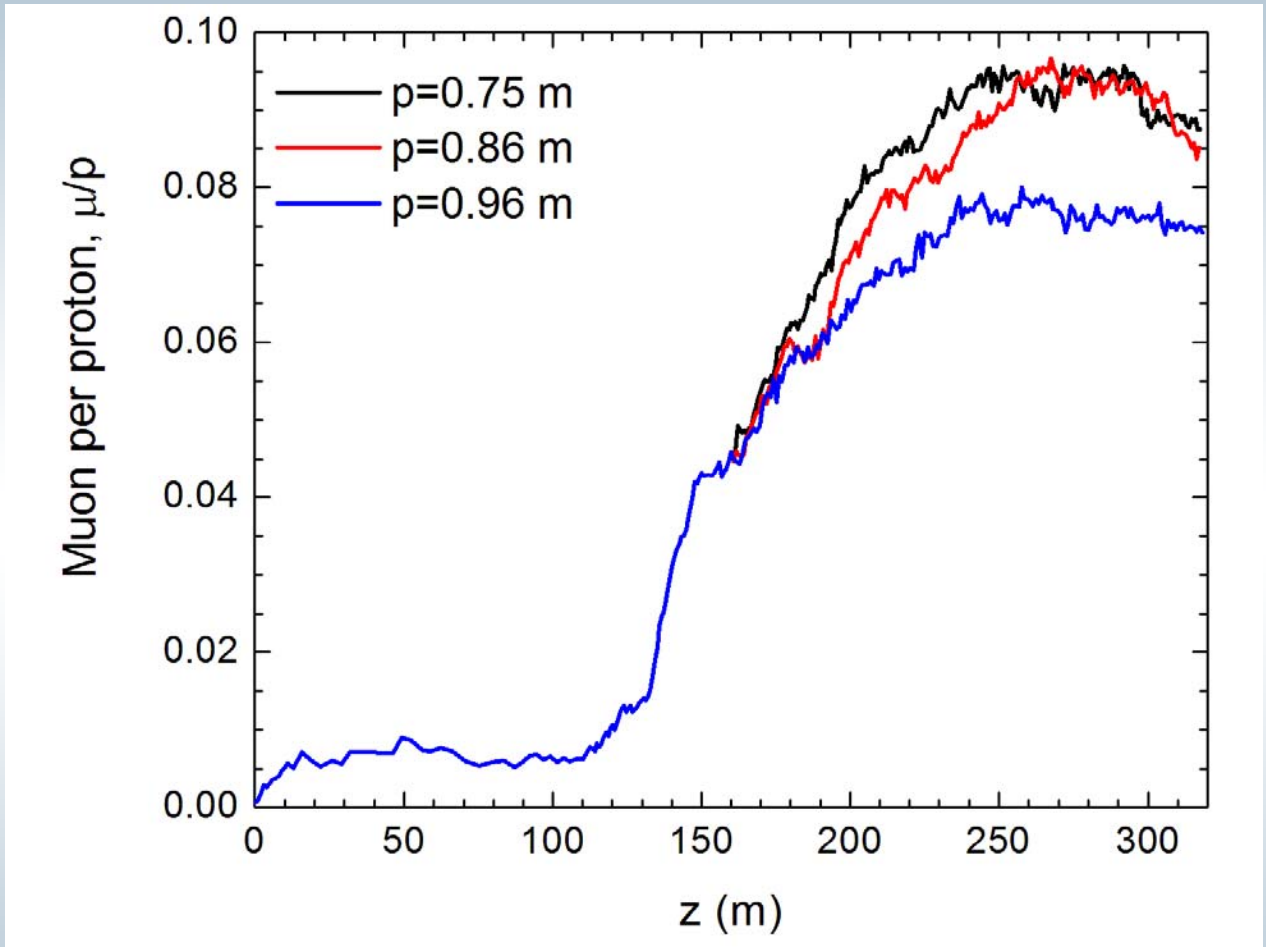
# Buncher/ Rotator: Discretize B-field



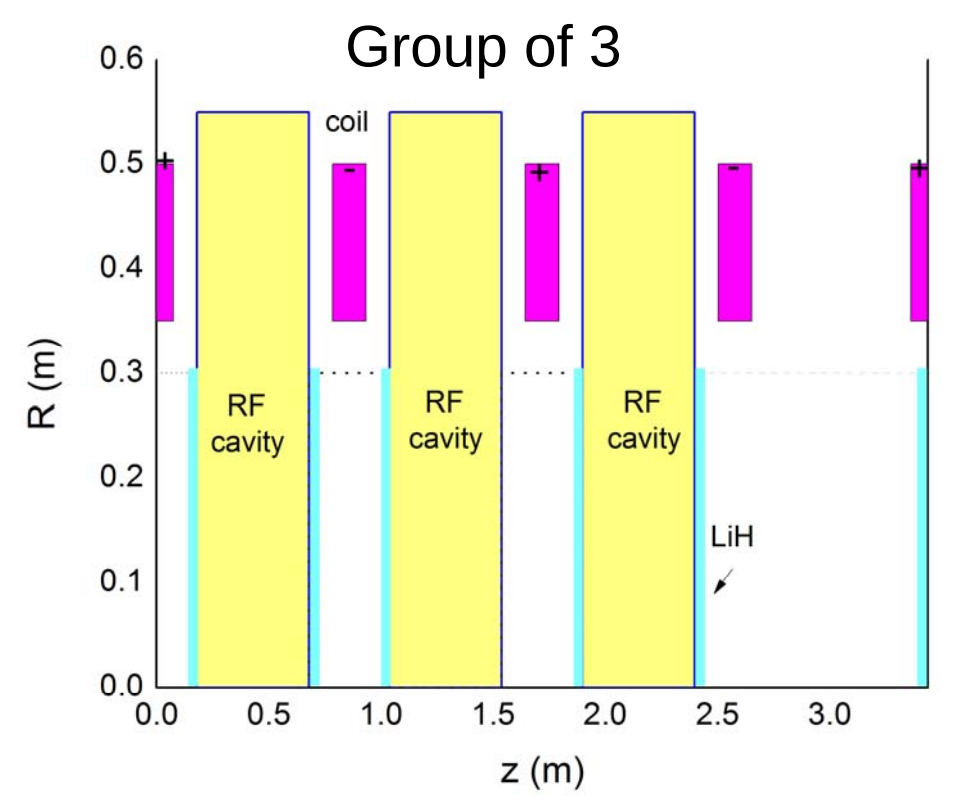

- Simulations suggest that it is safe to increase the gap up to g=0.50 m without loss of performance or presence of stop bands

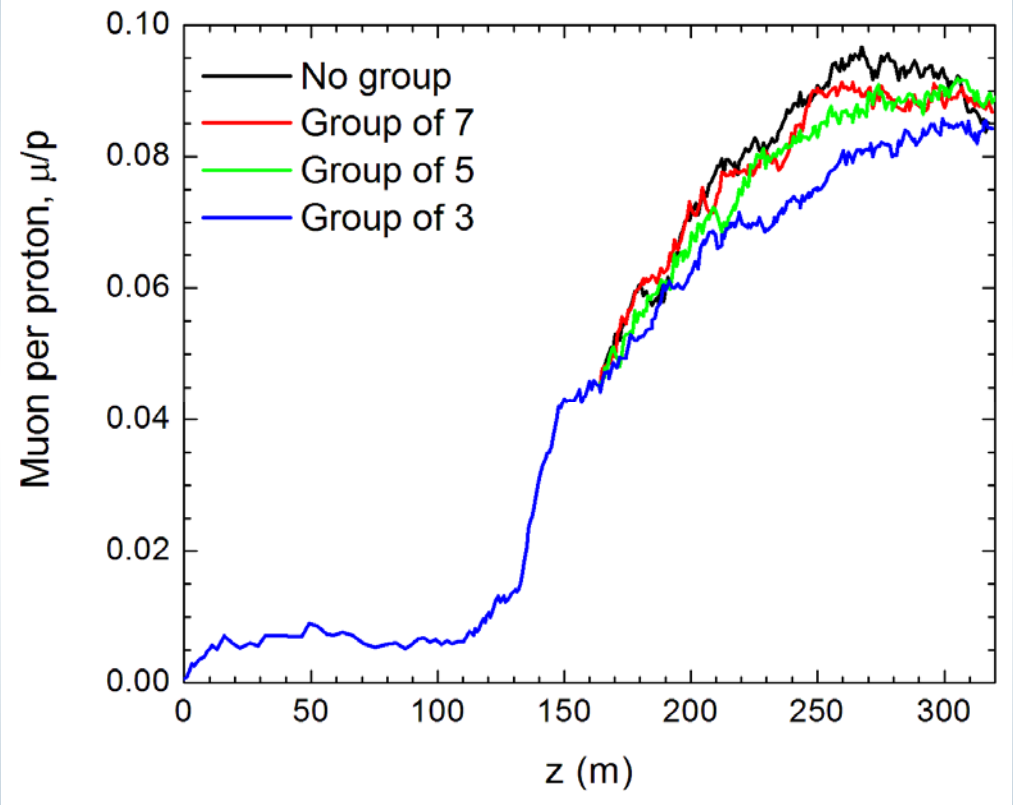
# Cooler: Increasing the lattice cell




- Simulations suggest that it is safe to increase the cooler cell to 0.86 m without loss of performance.
- However beyond that point performance drops dramatically

# Adding a gap between cavities

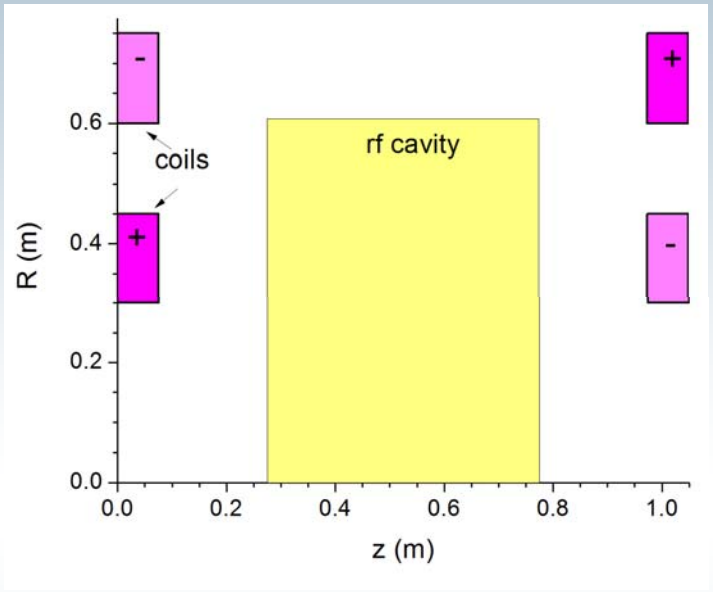


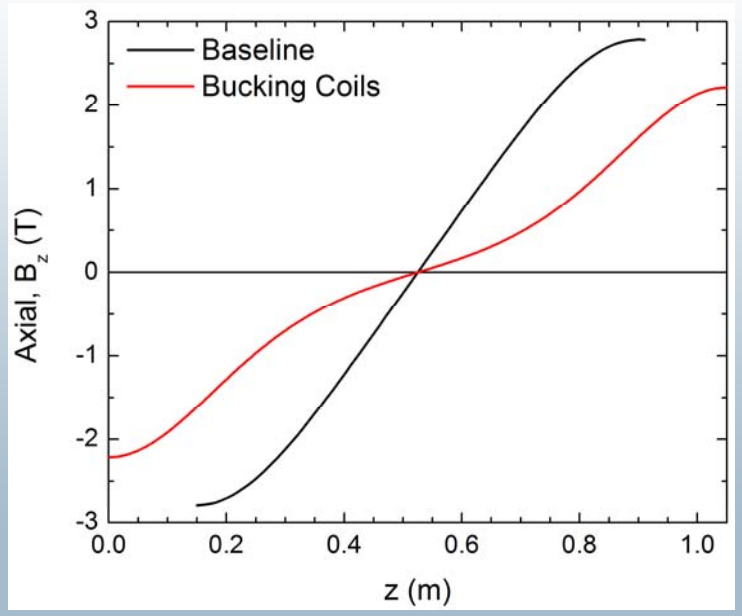




- There is a loss of ~5% if empty cell is after 5 cavities
- Results do not seem sensitive to rf gradient, phase and absorber length variations. Optimum values are 16 MV/m

# Bucked Coils (BC) scheme

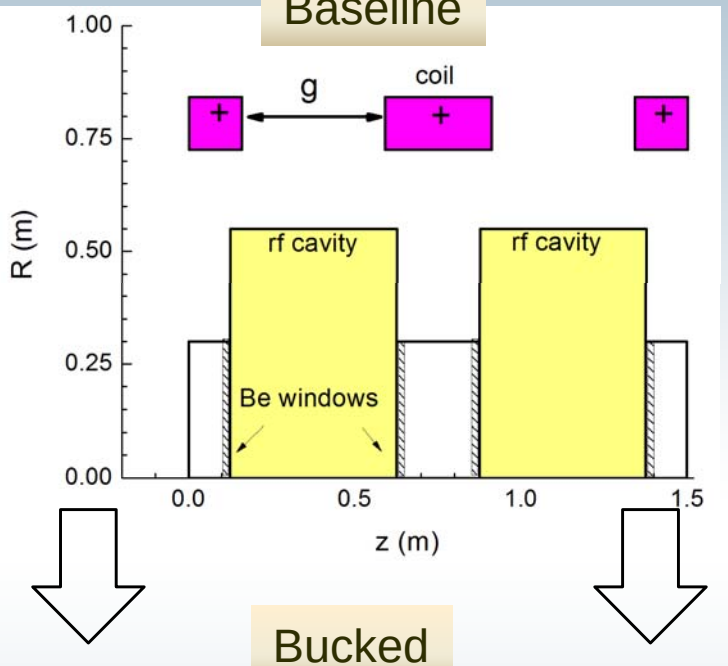
- Idea discussed by R. Fernow in IDS-NF (2008) and A. Alekou at the IDS-NF 2012
- With bucked coils, the magnetic field drops within the cavity area.
- The concept shows promising cooling results (details later)



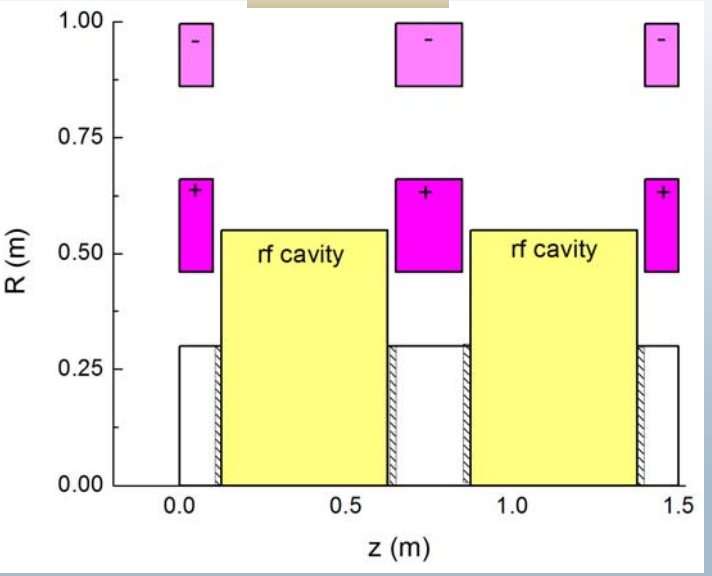



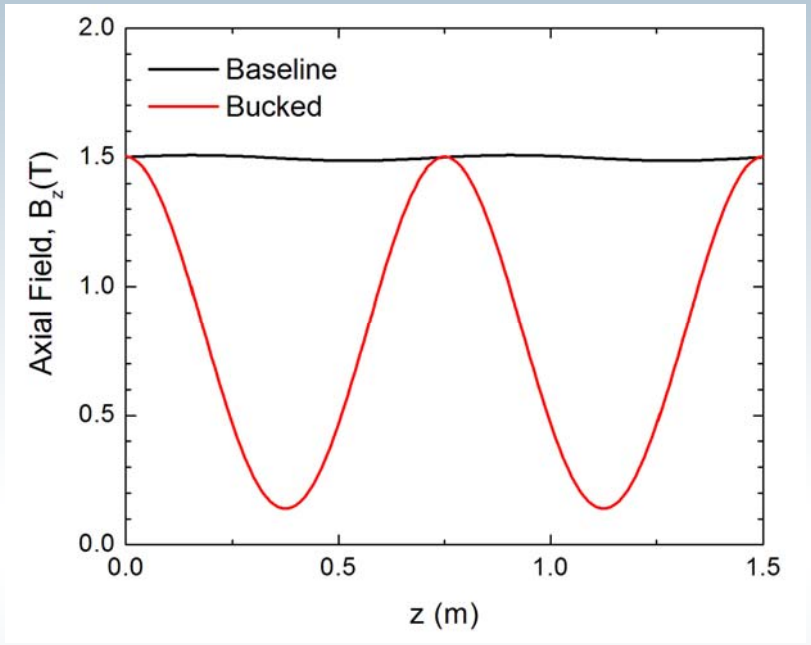
# Bucked Coils for Phase-Rotator

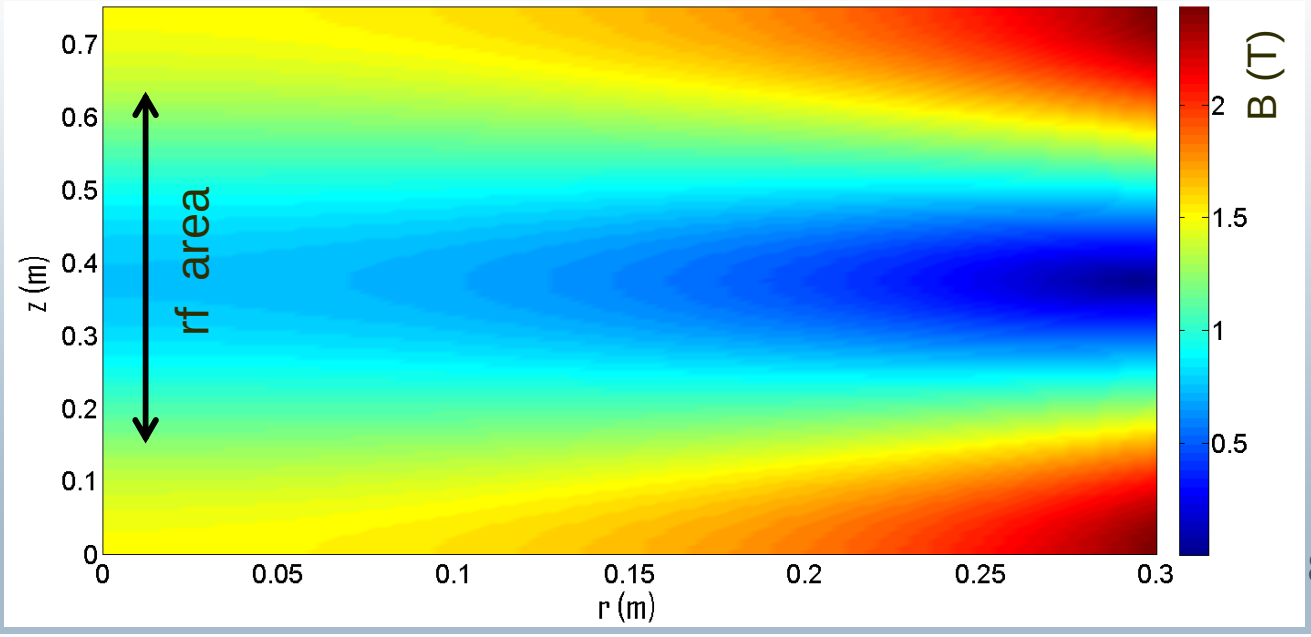
Baseline



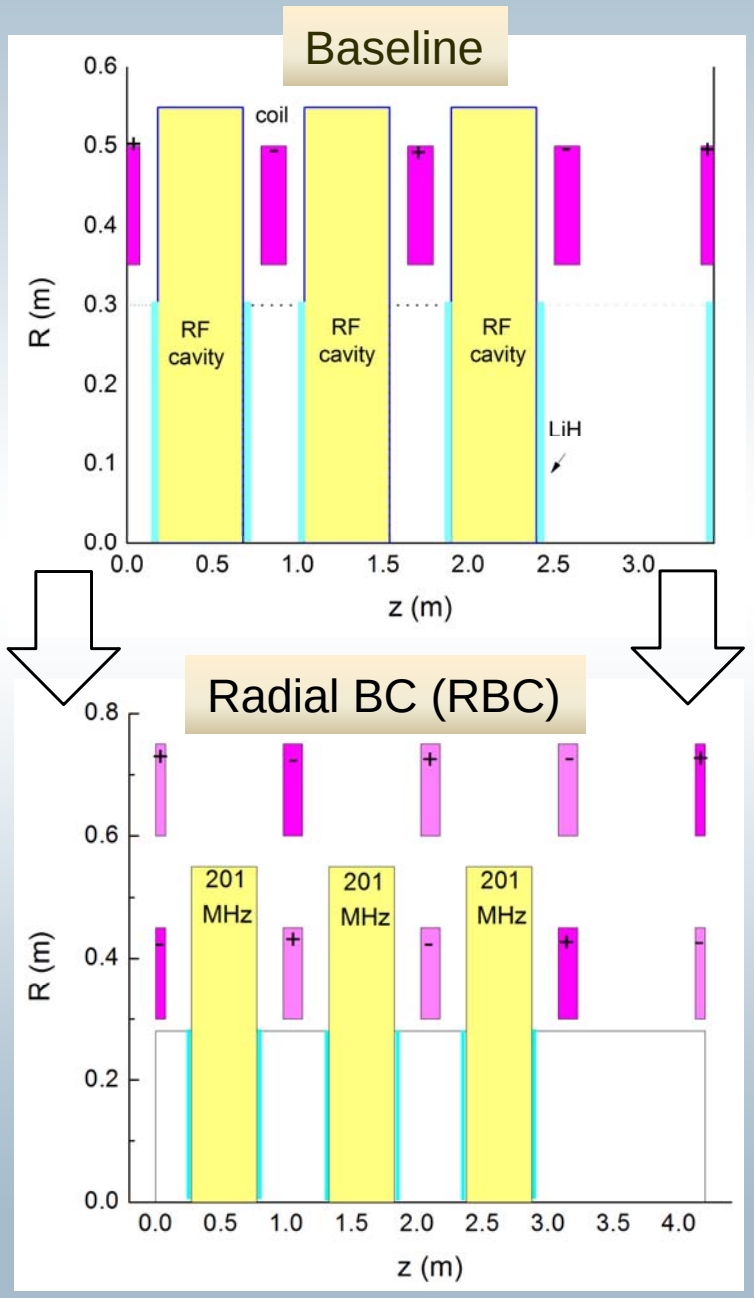

Bucked



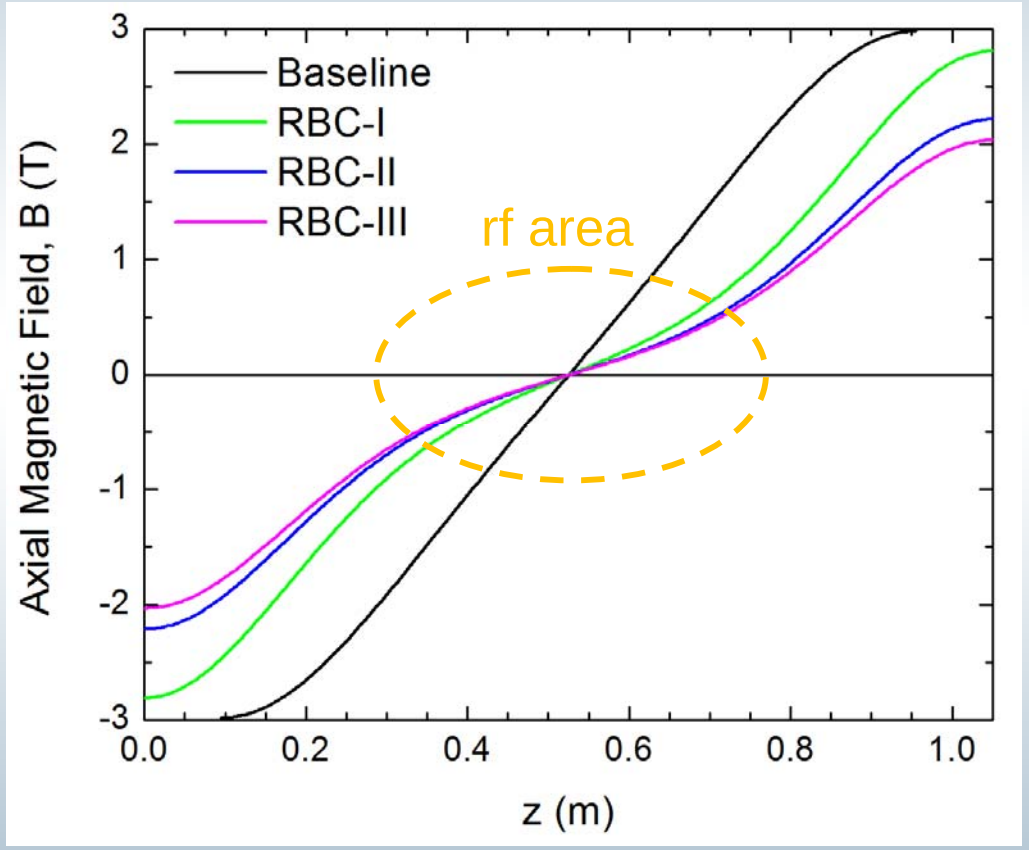



# Bucked Coils for cooler: Scheme I (Alekou)

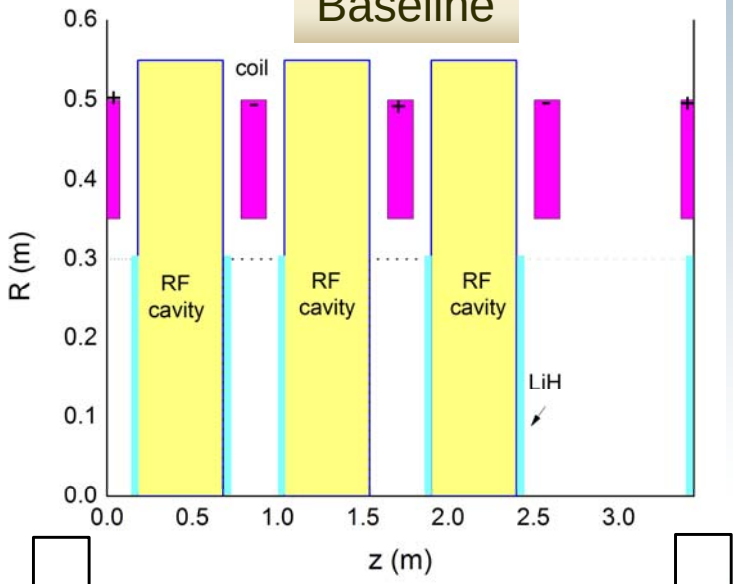



- Bucked coils are placed radial

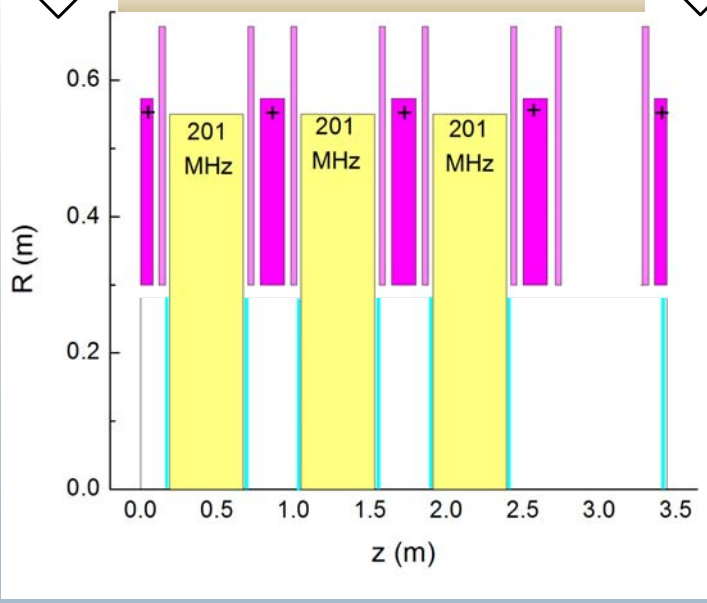


# Bucked Coils for cooler: Scheme II

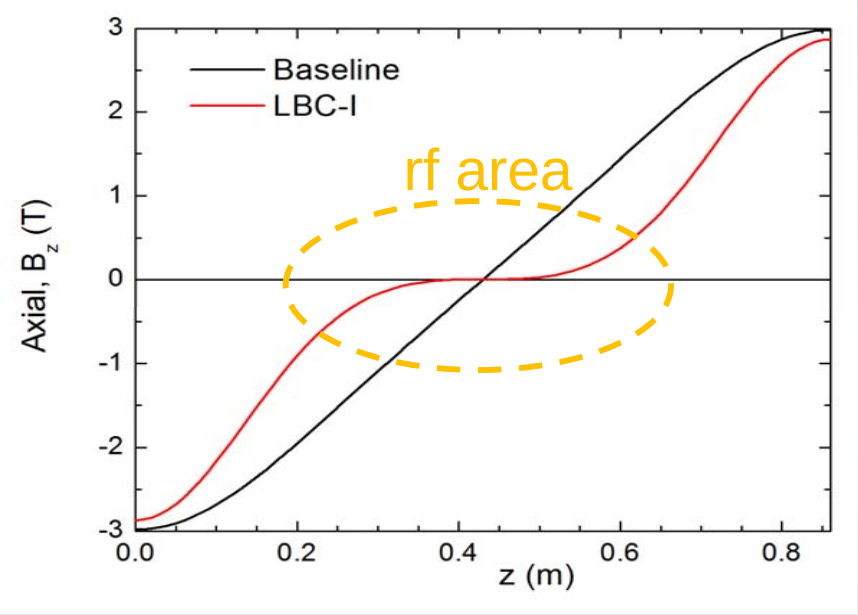
Baseline

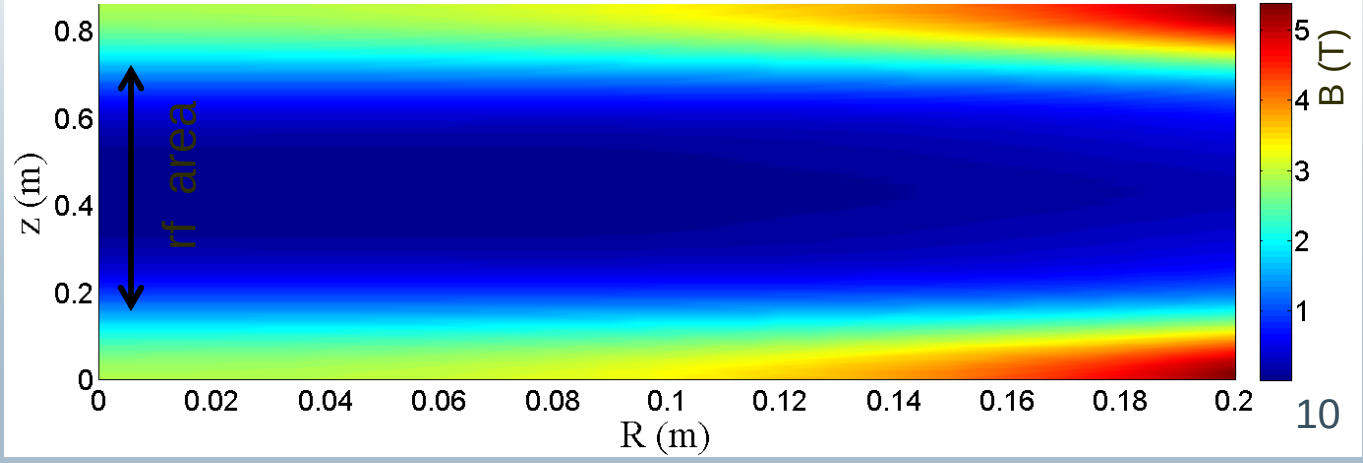



Longitudinal BC (LBC)



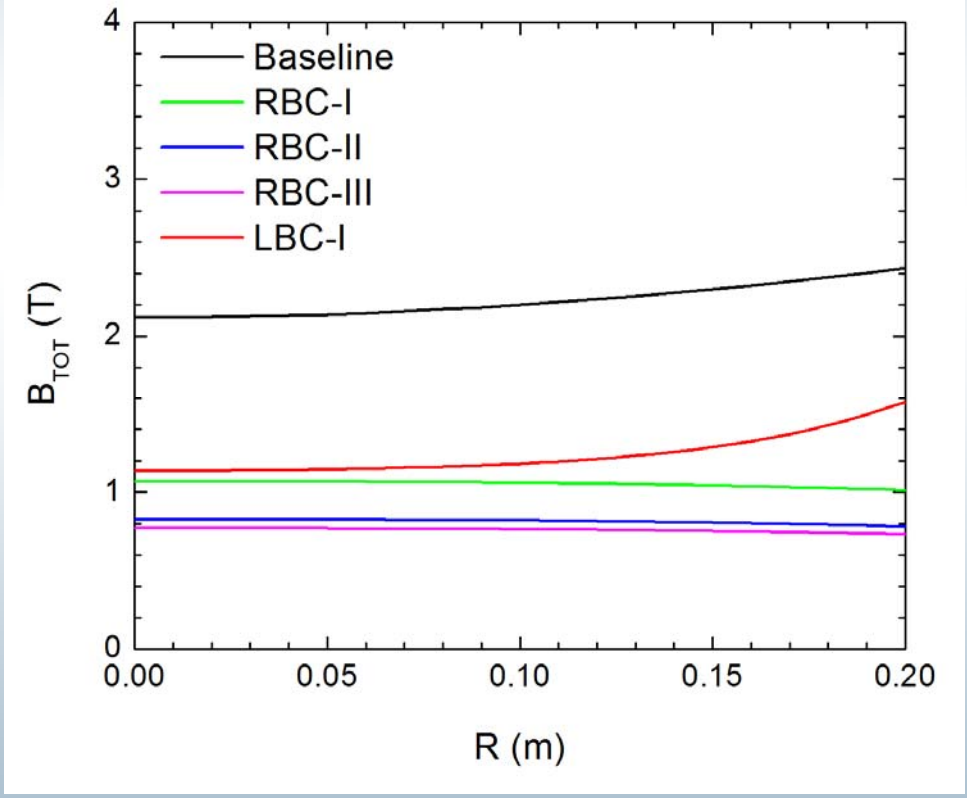

- Bucked coils are placed longitudinally



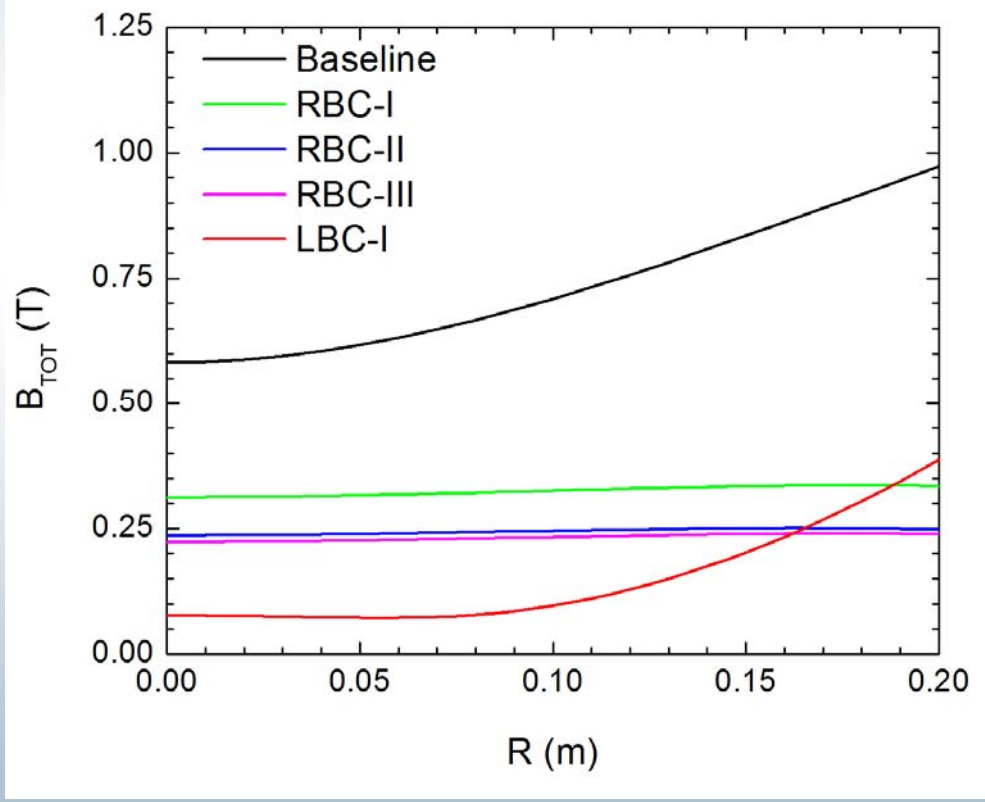



# Off-axis B-Fields

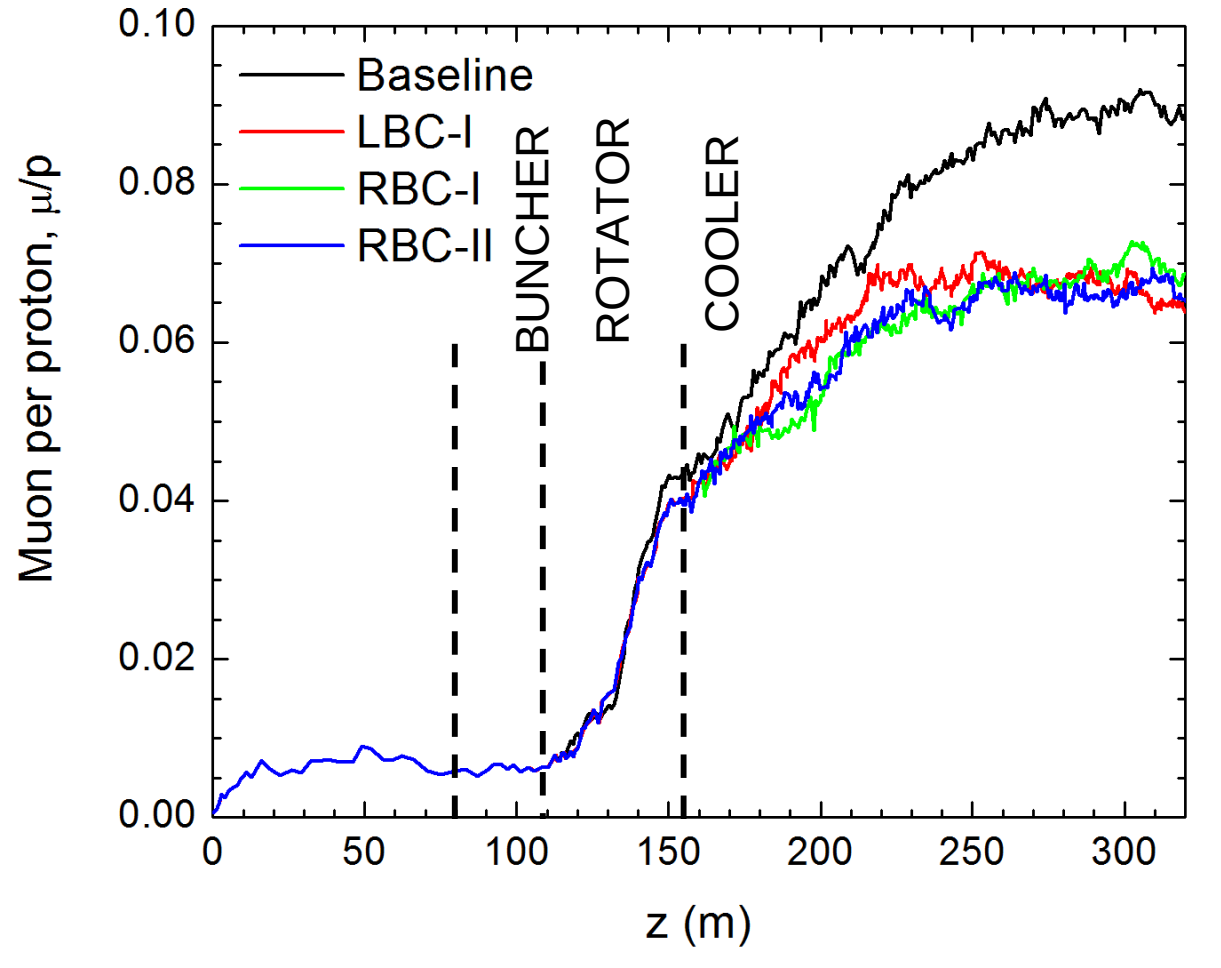
- End of rf (near rf iris)




- 10 cm from rf center

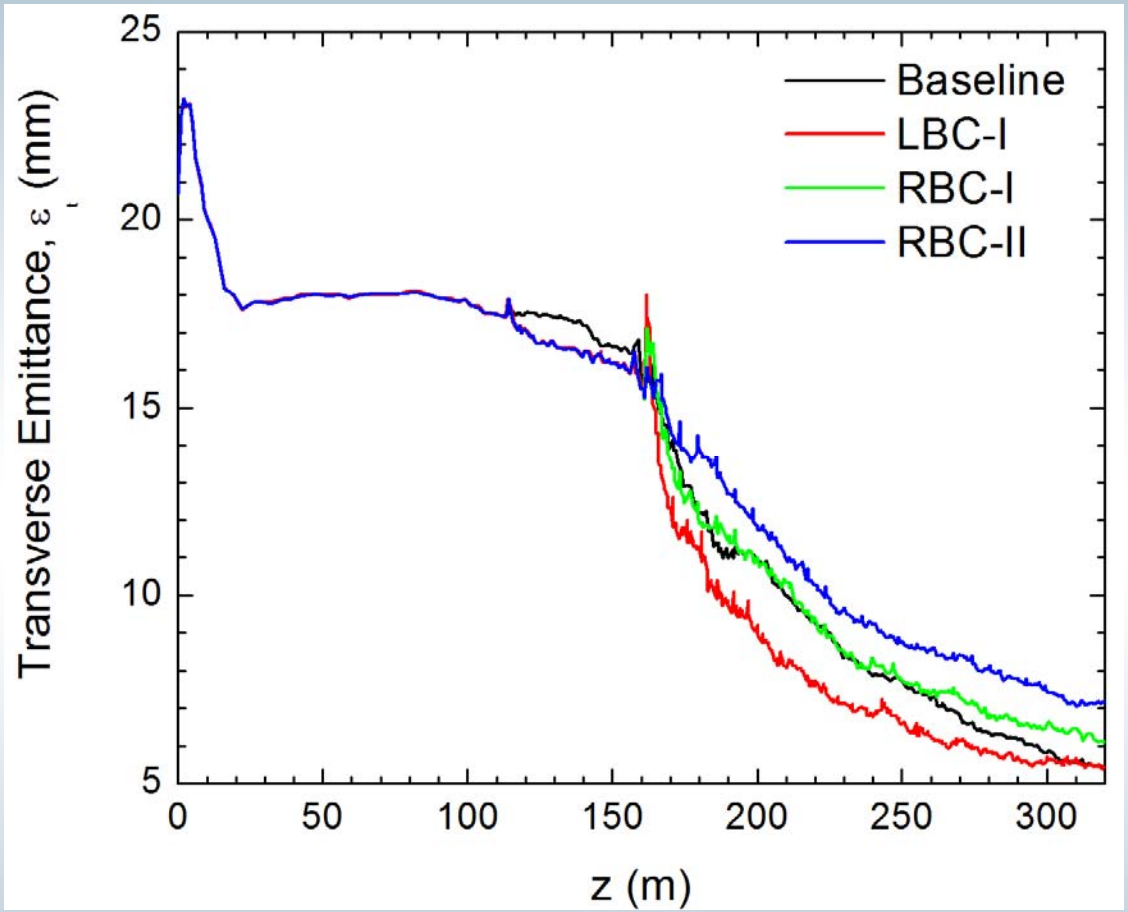


# ICOOL simulation (1)




- Common behavior between LBC and RBC schemes
- 20% less muon per protons compared to baseline

# ICOOL simulation (2)




- Cooling performance of BC schemes is comparable to baseline (especially LBC)

# Summary

- For the baseline:
  - It safe to increase the gap between the coils in the buncher & rotator as desired by the engineering studies. ‘Safe’ means same good cooling and a high muon/p rate.
  - It is also safe to increase the cooler cell length up to 0.86 m
  - It is better if the gap is placed every 5 or 7 cavities instead of 3
  - Performance goes down by 5-7%
- Bucked Coils (BC) were applied in both rotator and cooler.
- Two schemes tested on cooler, but RBC looks better so far
- With bucked coils:
  - Lost about 5% on rotator
  - Lost an additional 15% on cooler