Front End – present status

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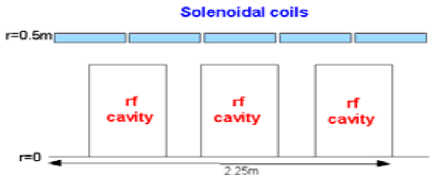
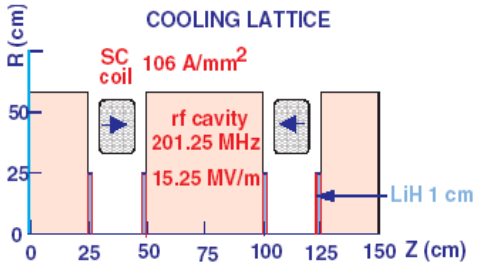
Outline

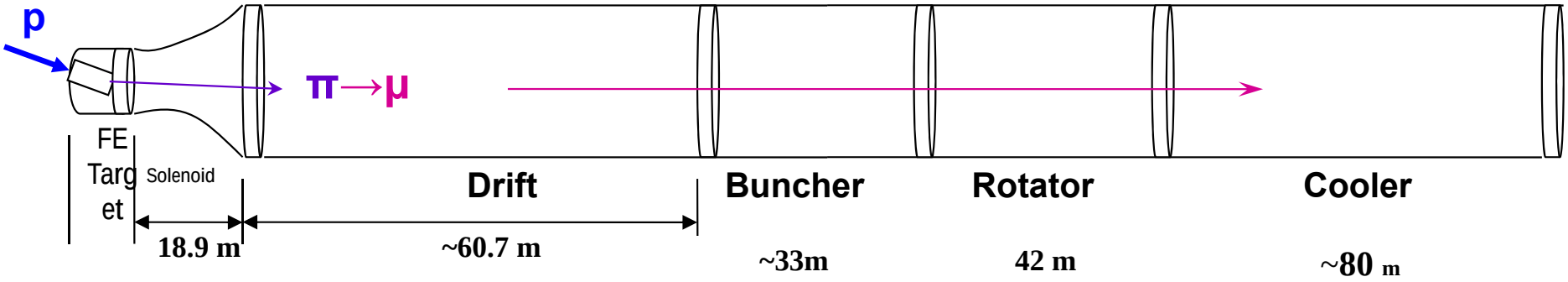
- **Previous Versions**
  - 201.25 MHz baseline examples
    - 24/8GeV initial beam
- **Front End for Muon Collider/ Neutrino Factory**
  - Baseline for MAP
    - 8 GeV proton beam on Hg target
  - 325 MHz
  - With Chicane/Absorber
- **Current status**
  - New targetry
    - 6.75 GeV on C target
  - Possible changes

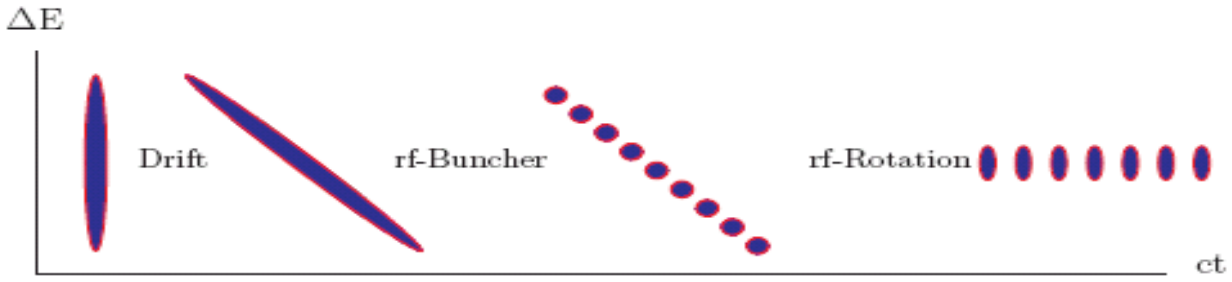
IDS Baseline Buncher and φ-E Rotator

- Drift ($\pi \rightarrow \mu$)
- "Adiabatically" bunch beam first (weak 320 to 232 MHz rf)
- Φ-E rotate bunches – align bunches to ~equal energies
  - 232 to 202 MHz, 12MV/m
- Cool beam 201.25MHz
- Captures and Cools both μ^+ and μ^-

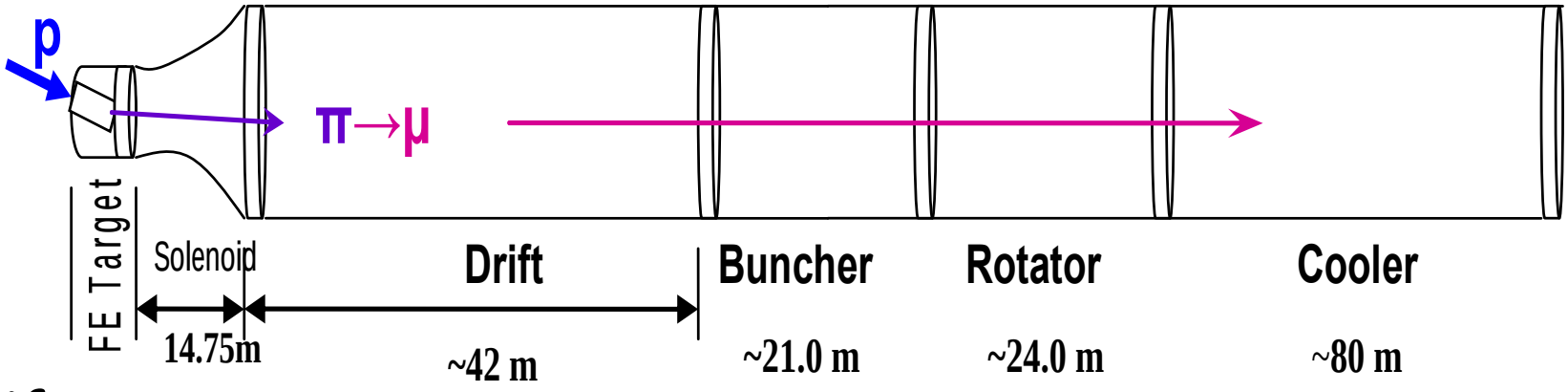




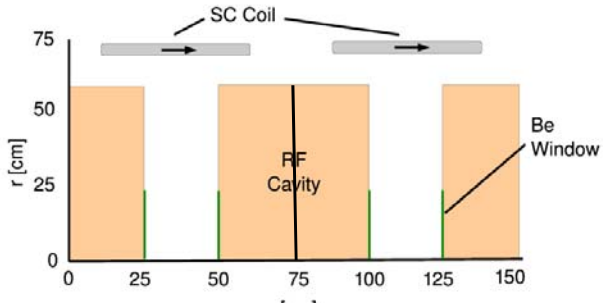




325MHz System "Collider"



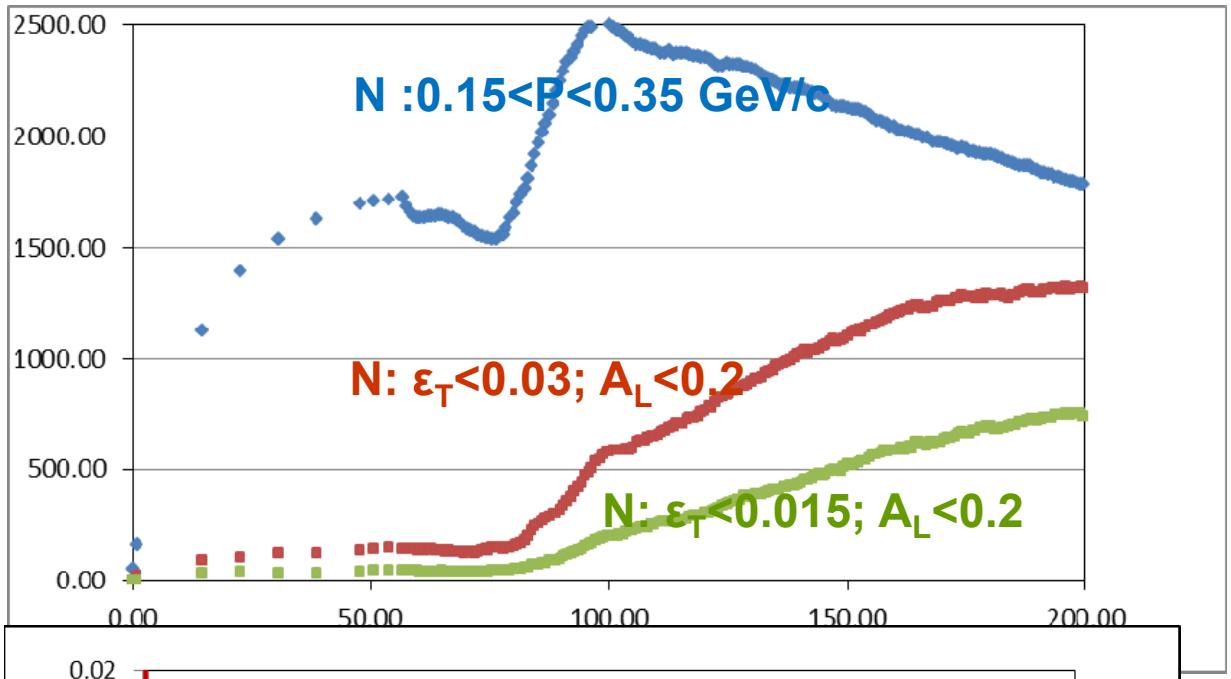
- **Drift**
  - 20T→ 2T
- **Buncher**
  - P_o=250MeV/c
  - P_N=154 MeV/c; N=10
  - V_{rf} : 0→ 15 MV/m
    - (2/3 occupied)
  - f_{RF} : 490→ 365MHz

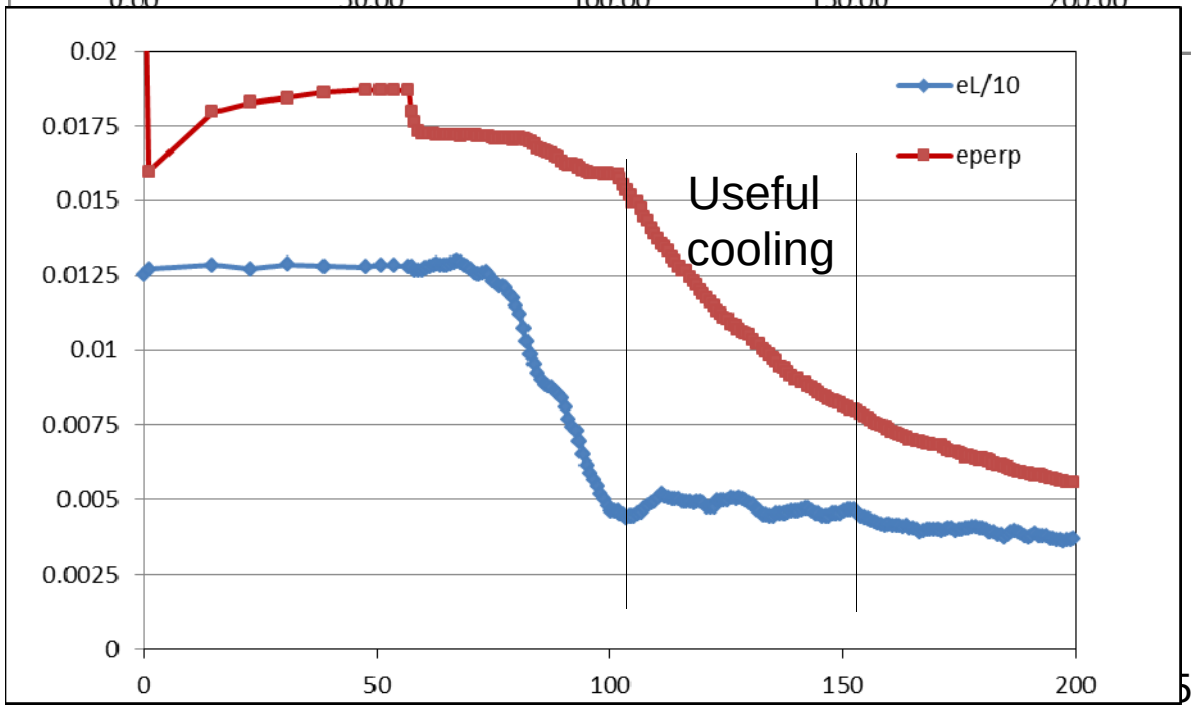


- **Rotator**
  - V_{rf} : 20MV/m
    - (2/3 occupied)
  - f_{RF} : 364→ 326MHz
  - N=12.045
  - P_0, P_N→245 MeV/c
- **Cooler**
  - 245 MeV/c
  - 325 MHz
  - 25 MV/m
  - 2 1.5 cm LiH absorbers /0.75m

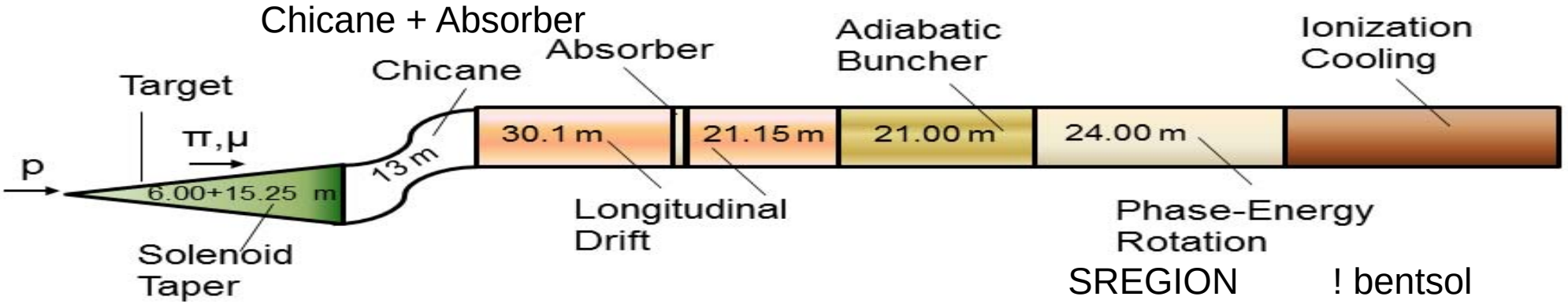
Simulation Results

- **Simulation obtains**
  - ~0.125 μ/p within acceptances
  - with ~60m Cooler
  - 325 MHz – less power
  - shorter than baseline NF
- **But**
  - uses higher gradient
  - higher frequency rf → smaller cavities
  - shorter than baseline NF
  - more bunches in bunch train



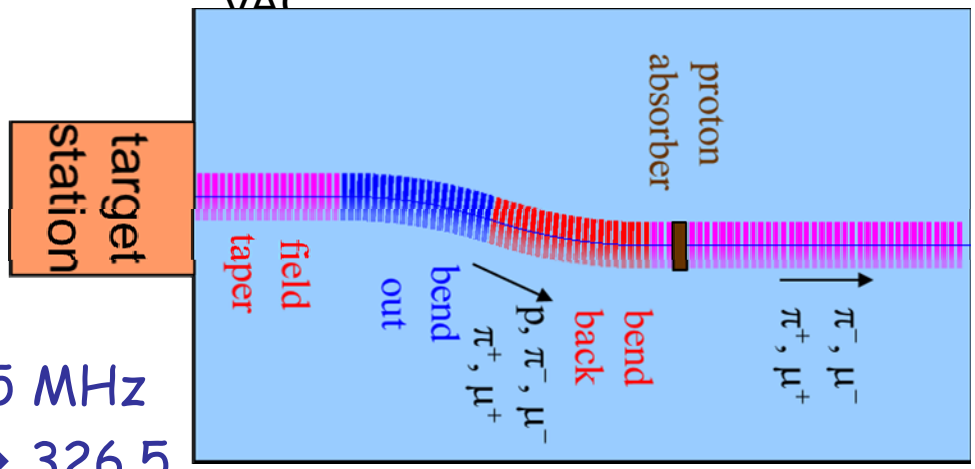


325 "Collider " w Chicane/Absorber

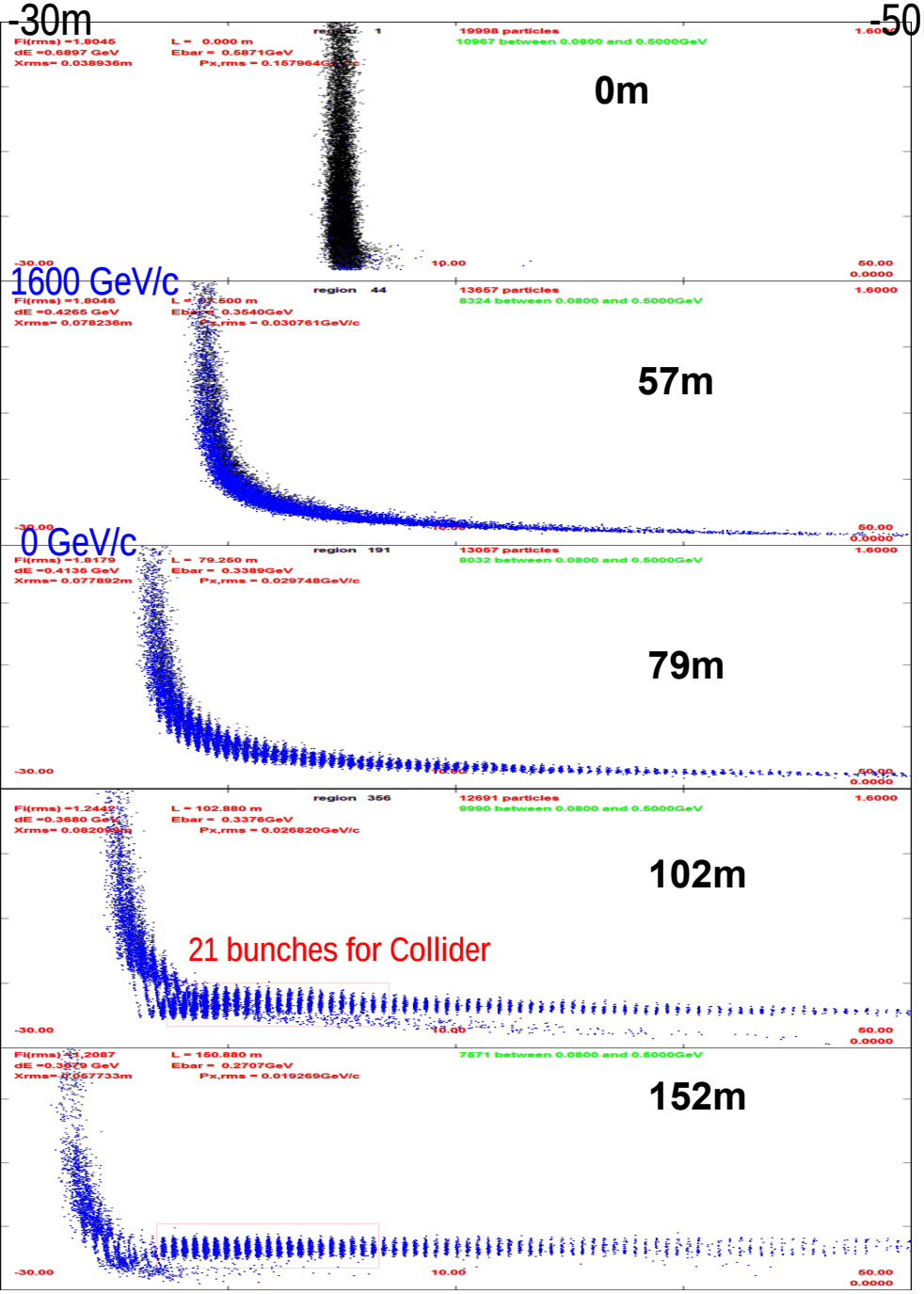


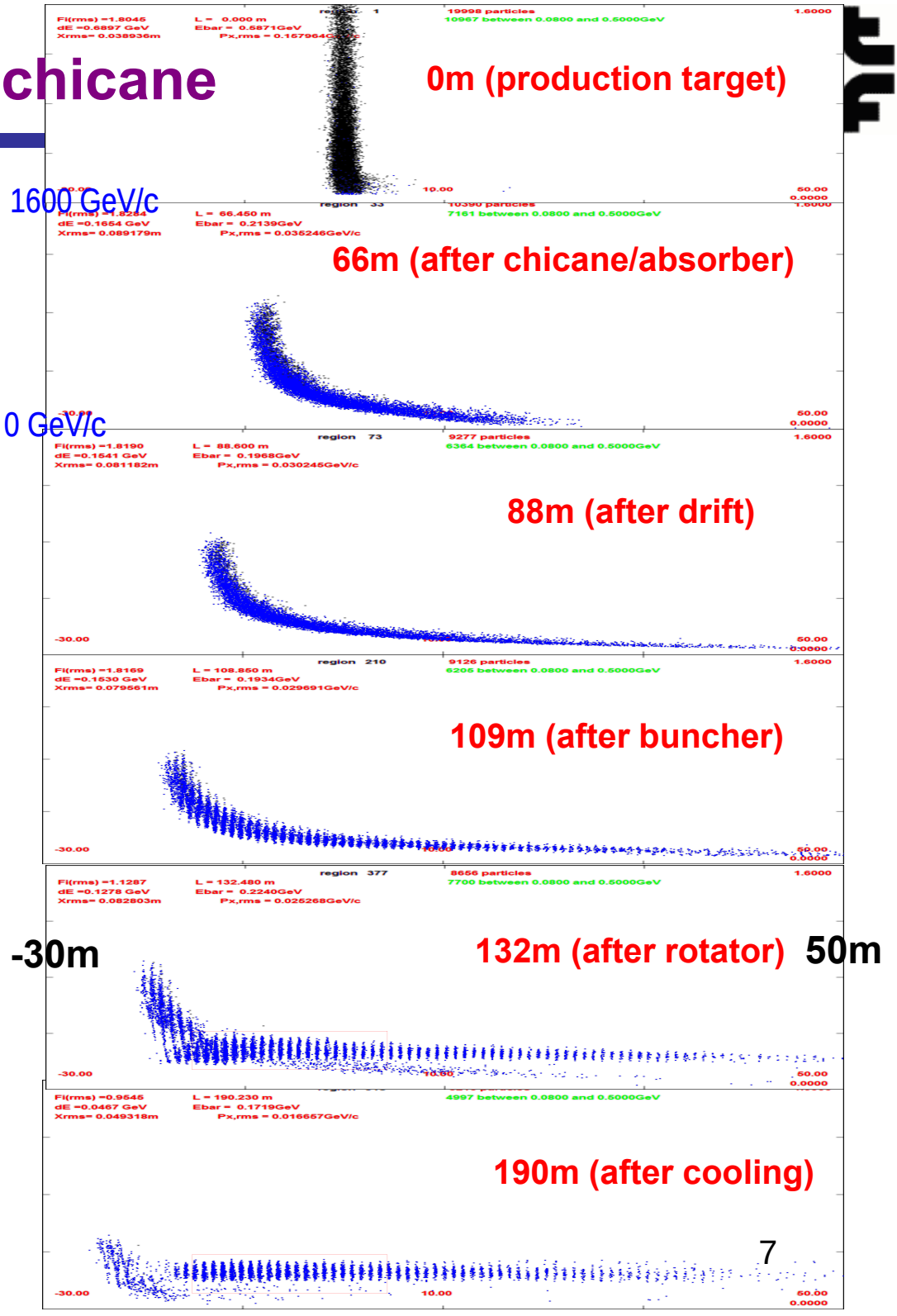
- **Add 30 m drift after chicane**
  - 6.5m → +21.67°,-21.67°
- **Add chicane + absorber**
  - particle 1-283 MeV/c
  - particle 2-194 MeV/c
  - absorber at 54m
    - 10cm Be
    - particle 1-250 MeV/c
    - particle 2-154 MeV/c
  - Bunch (N=12) 0→15 MV/m :496→ 365 MHz
  - Rotate (N=12.045)- 20MV/m : 365 → 326.5 MHz
  - Cool -325MHz -25 MV/m
    - p_{ref}=245 MeV/c

```
SREGION        ! bentsol
6.5  1   1e-2
1  0.   1.0
BSOL
1 2.0 0.0 1 0.283 0.0  0.058181
0.0 0.0 0.0  0. 0. 0. 0. 0.
VAC
```



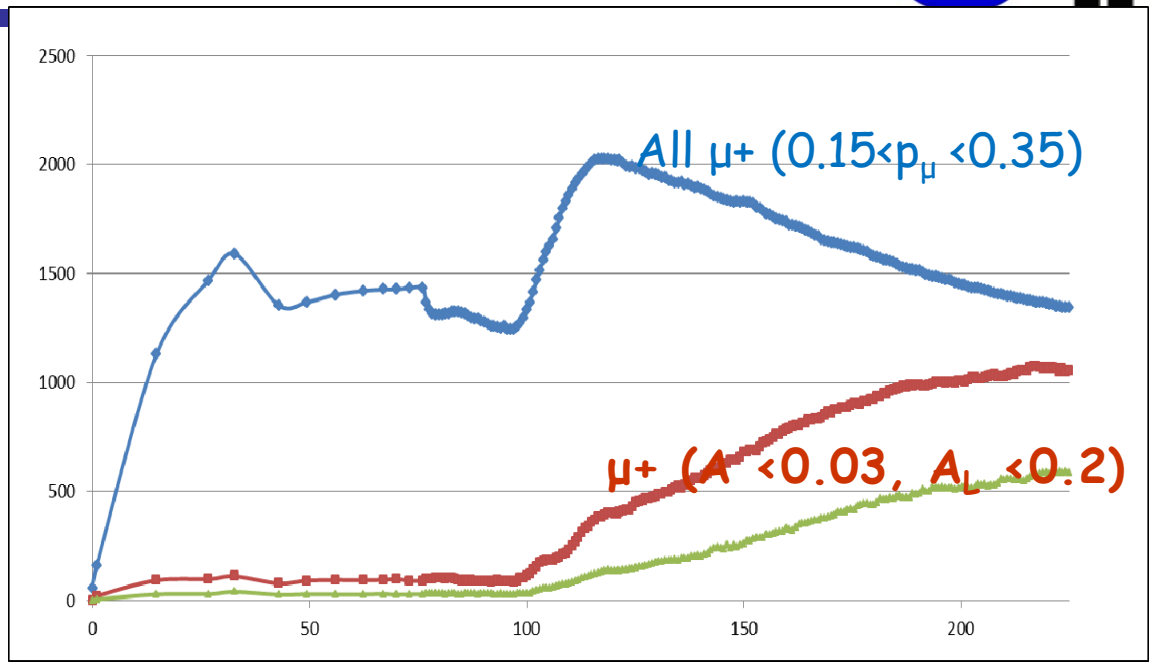
Compare without/with chicane



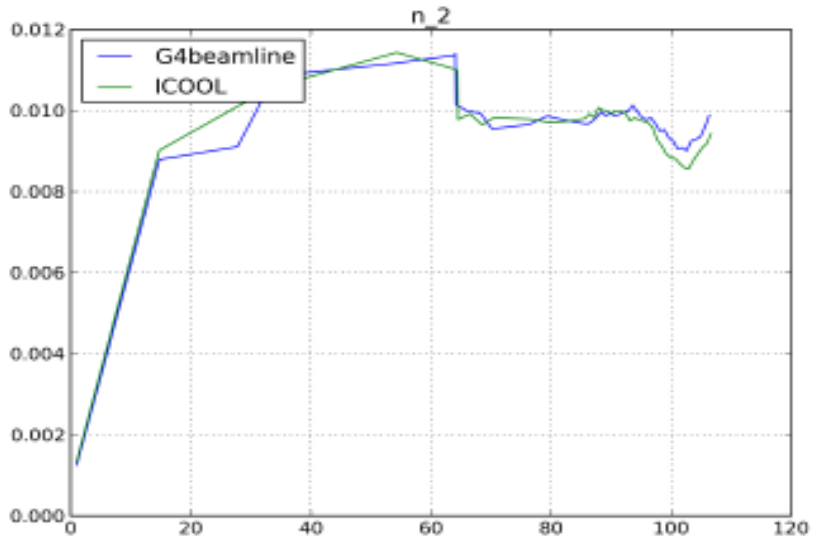


ICOOL results

- **325 "muon collider" with chicane absorber**
  - with added drift between chicane and absorber
    - ~30m
  - ~0.12 μ/p → ~0.105 μ/p
  - smaller emittance beams
    - scraped to better fit

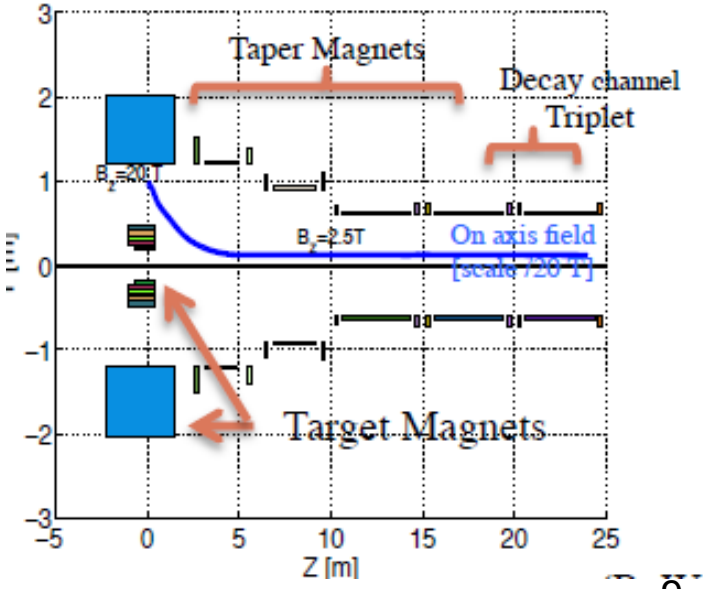


Useful muons (n_2, typical cuts)



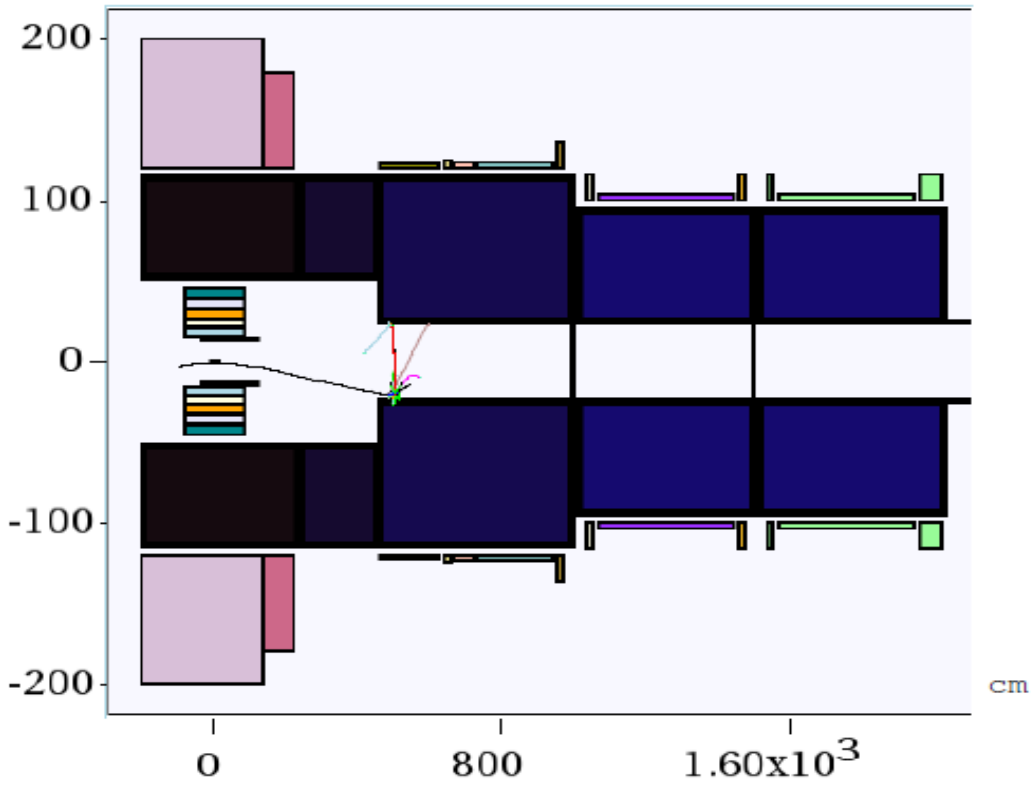
ICOOL results

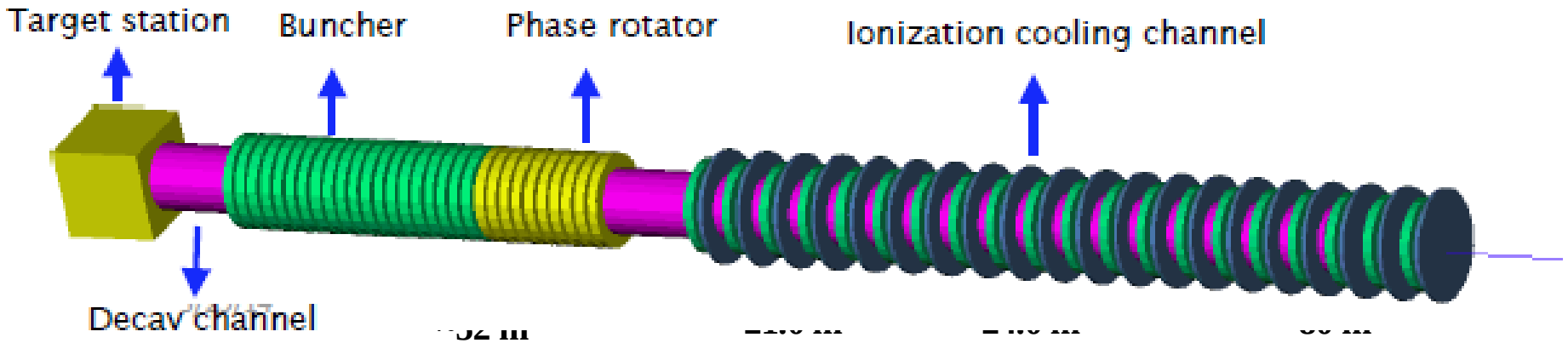
- **Change to shorter taper**
  - 15m → 6m
  - (Hisham) slight improvement in throughput (~5%)
  - We were using Hishams more recent distributions
    - (May 2014)
    - Gains ~5—10%
    - Total is now ~0.115 μ/p (in baseline ICOOL simulation units)



New Proton Driver parameters

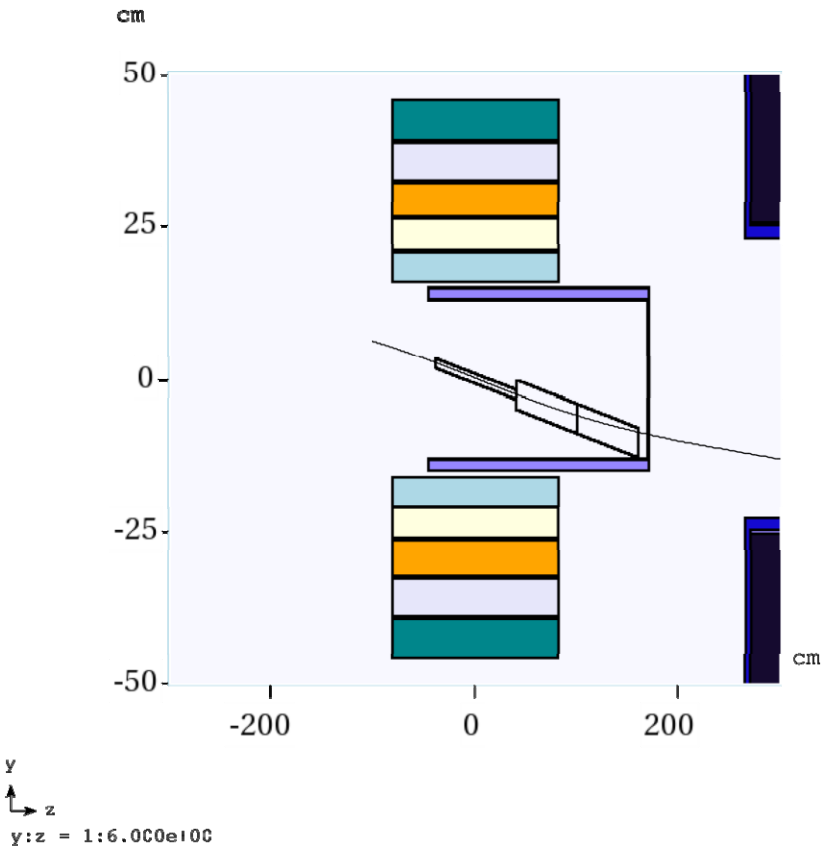
- **6.75 GeV p, C target**
  - 20→2T short taper
    - ~5m (previously 15)
  - X. Ding produced particles at z=2m using Mars
  - short initial beam
- **Redo ICOOL data sets to match initial beam**
  - ref particles redefined
    - in for003.dat
    - and for001.dat

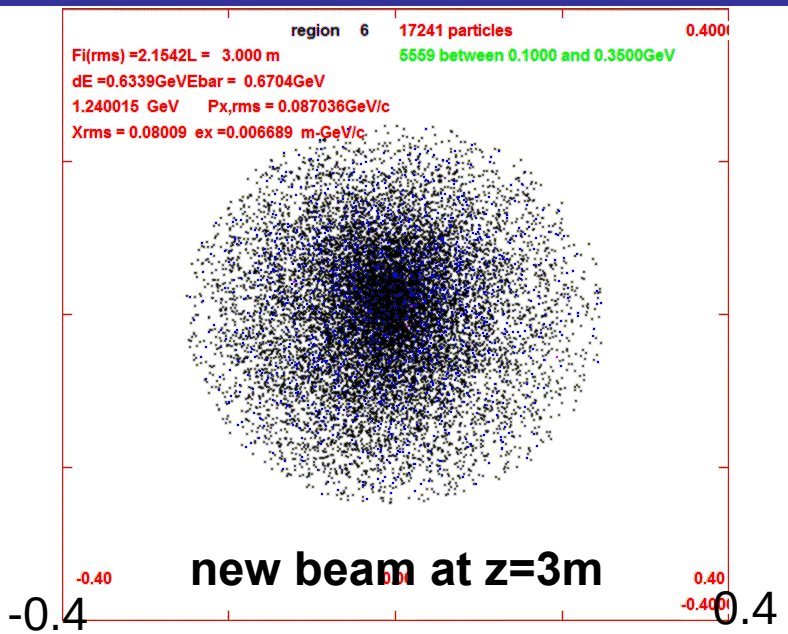


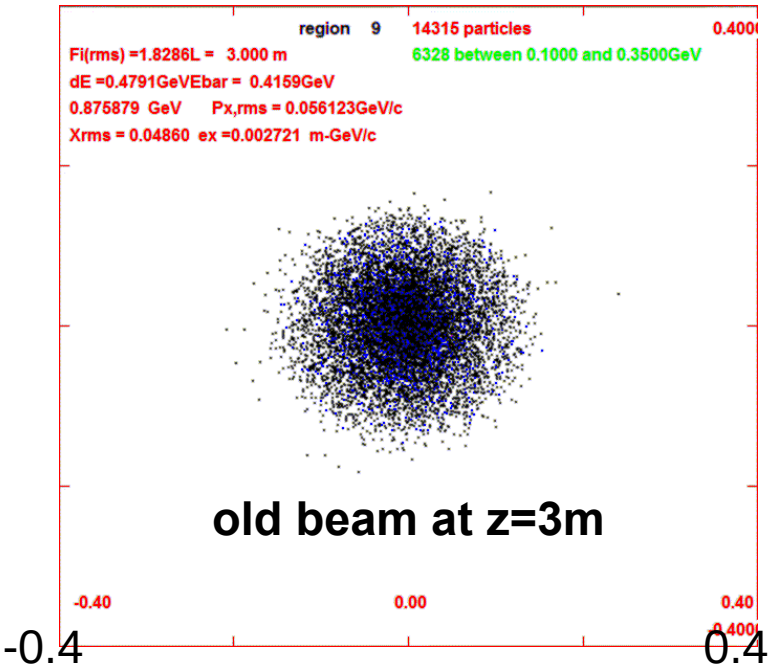


Use old FE with new initial beam

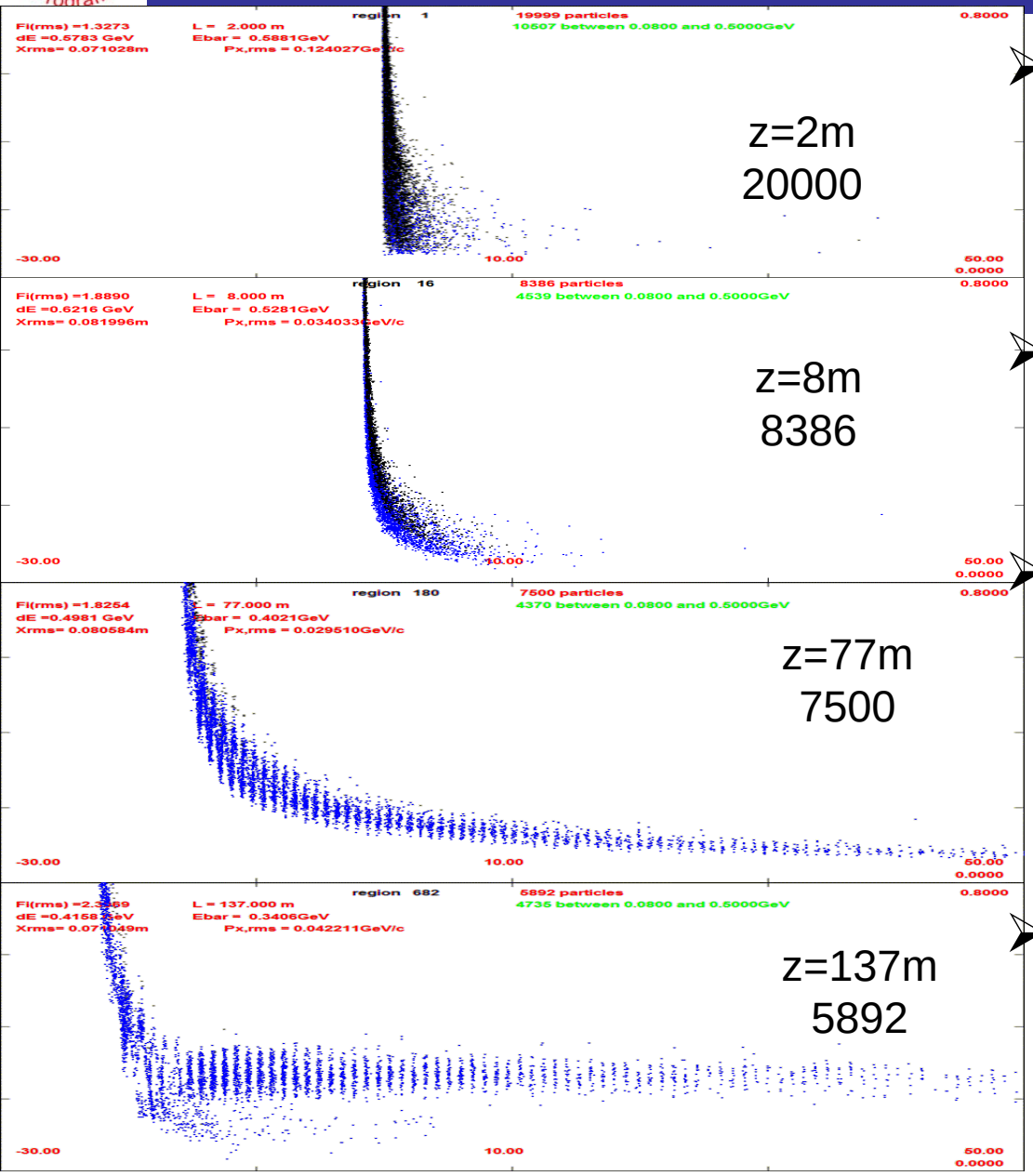
- **New beam has too large initial size and divergence**
  - initial transverse emittance >2X larger
    - 0.0027 → 0.0067 m-GeV/c
  - ~half of initial beam lost in <6m







First simulations results



- ~60% of initial particles are lost in first 6m
  - previous front end lost ~20%
- Beam starts out very large
  - previous much smaller in
  - front end simulations
- μ/p reduced by factor ~ 2
  - → ~0.0545 μ^+/p
  - ~0.042 μ^-/p
    - μ^- less than μ^+
- Not fully reoptimized for new initial beam

6.75 GeV p/ C target – First Look

- Much worse than previous 8 GeV p / Hg target
- 6.75 (~25% less), Hg → C …
  - but initial beam has very large phase space
- Causes for early losses ???
  - Long C target not a good match to short taper ?
    - target should be within lens center …
  - "Beam dump" after target blows up π beam ??
- Bugs, errors?
  - Changes in Mars production code ??
  - normalization error ??
  - initialization errors
    - starts from z=2m rather than z=0
- After initial factor of 2 loss, very similar to old front end case
  - not yet reoptimized
- To investigate/debug/reoptimize ..

Other topics to explore

- **Replace vacuum rf with gas-filled rf**
  - Do Buncher / phase rotation function as well ?
- **Replace initial 4-D Cooler with 6-D cooler**
  - Has been initiated by Yuri
  - Would like a reference version to use as acceptance baseline
- **Integrate Buncher / Phase-rotation / Cooling**
  - more compact system
  - adiabatic → snap rotation
- **Transform to general R&D**
  - initial beam →???
    - lower B-field, lower energy
  - other uses (mu2e … LFV expts.

Any comments?