Bunched beam Phase Rotation Optimization

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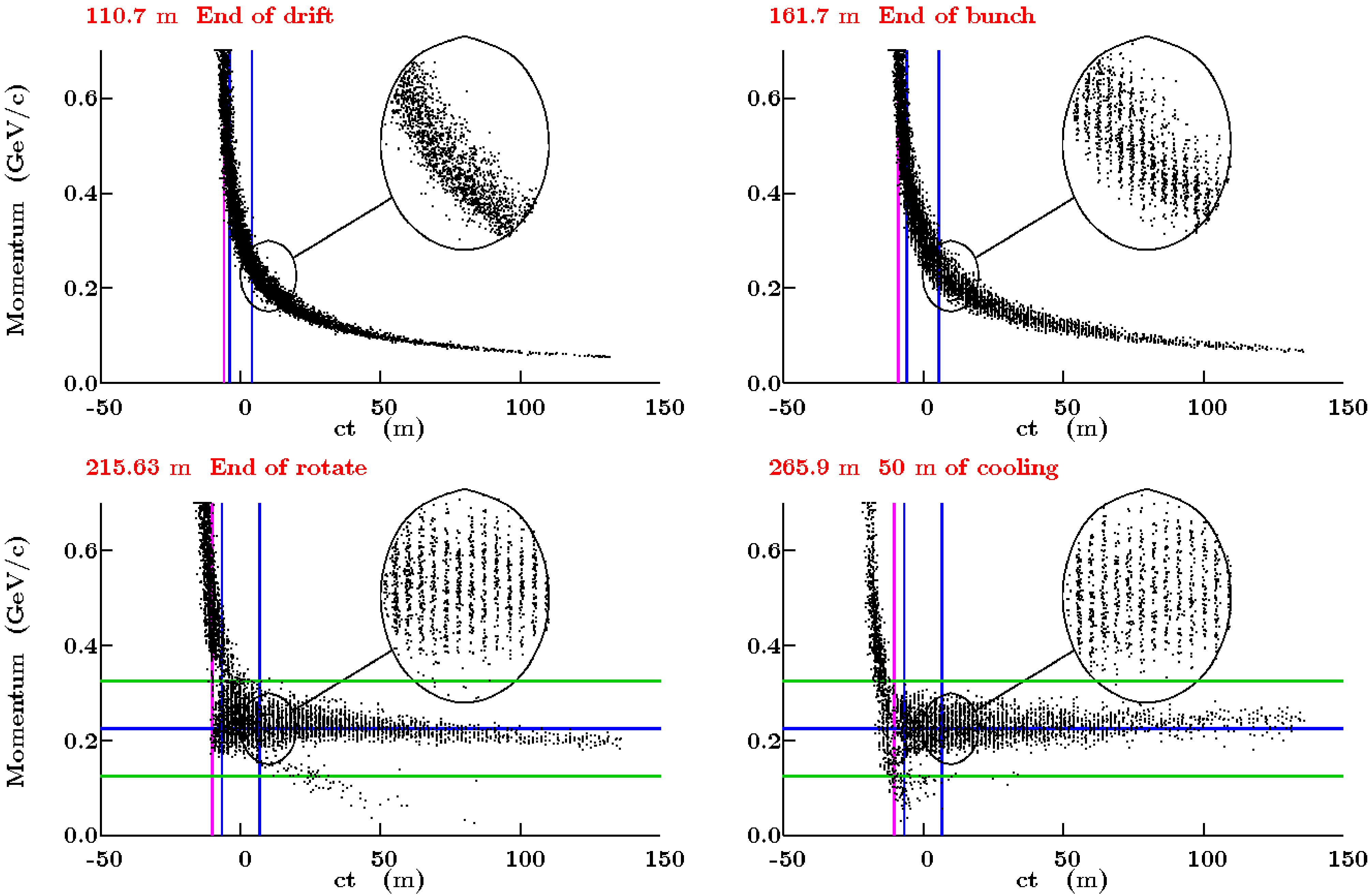
ISS KEK Workshop

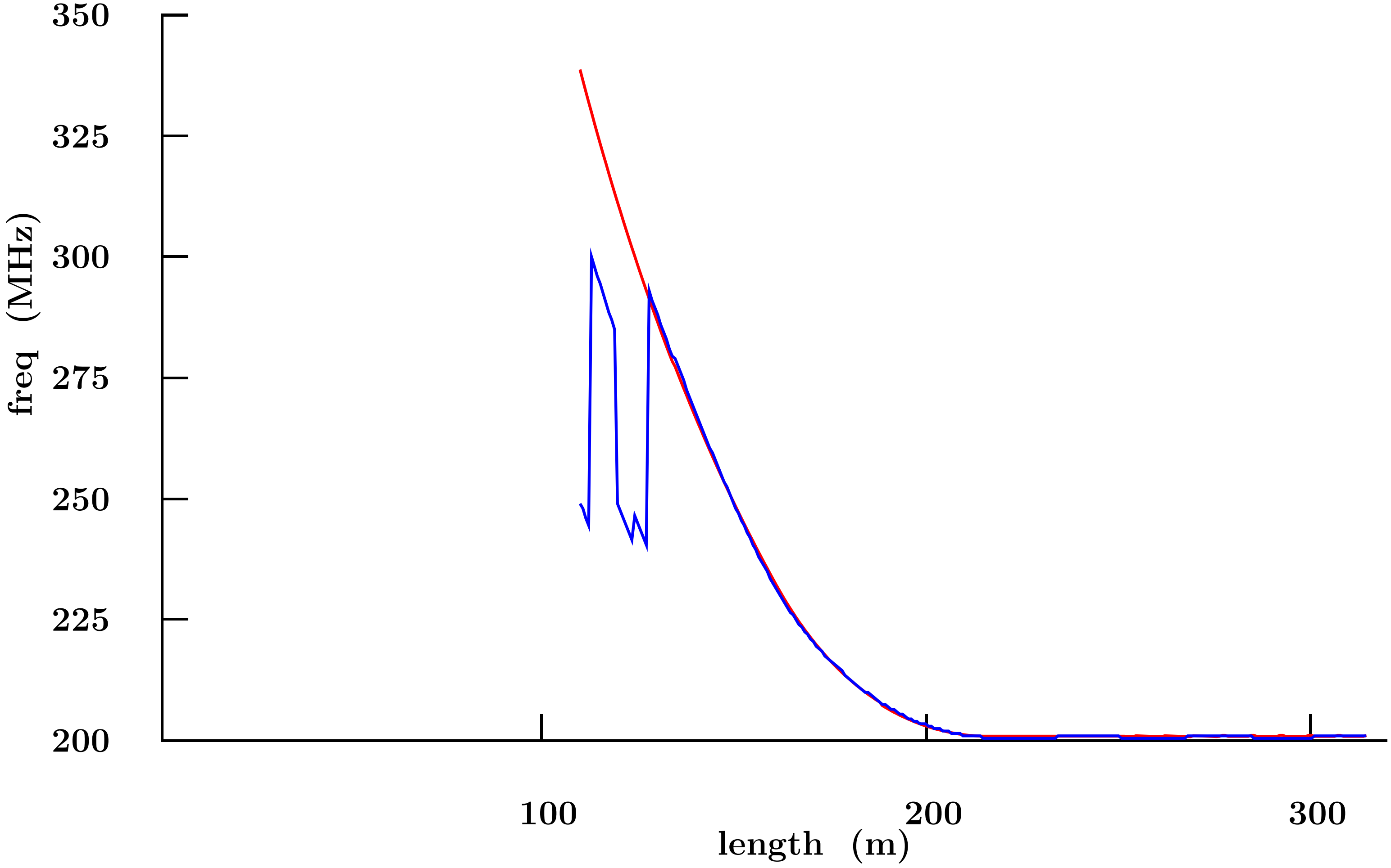
1/23/06

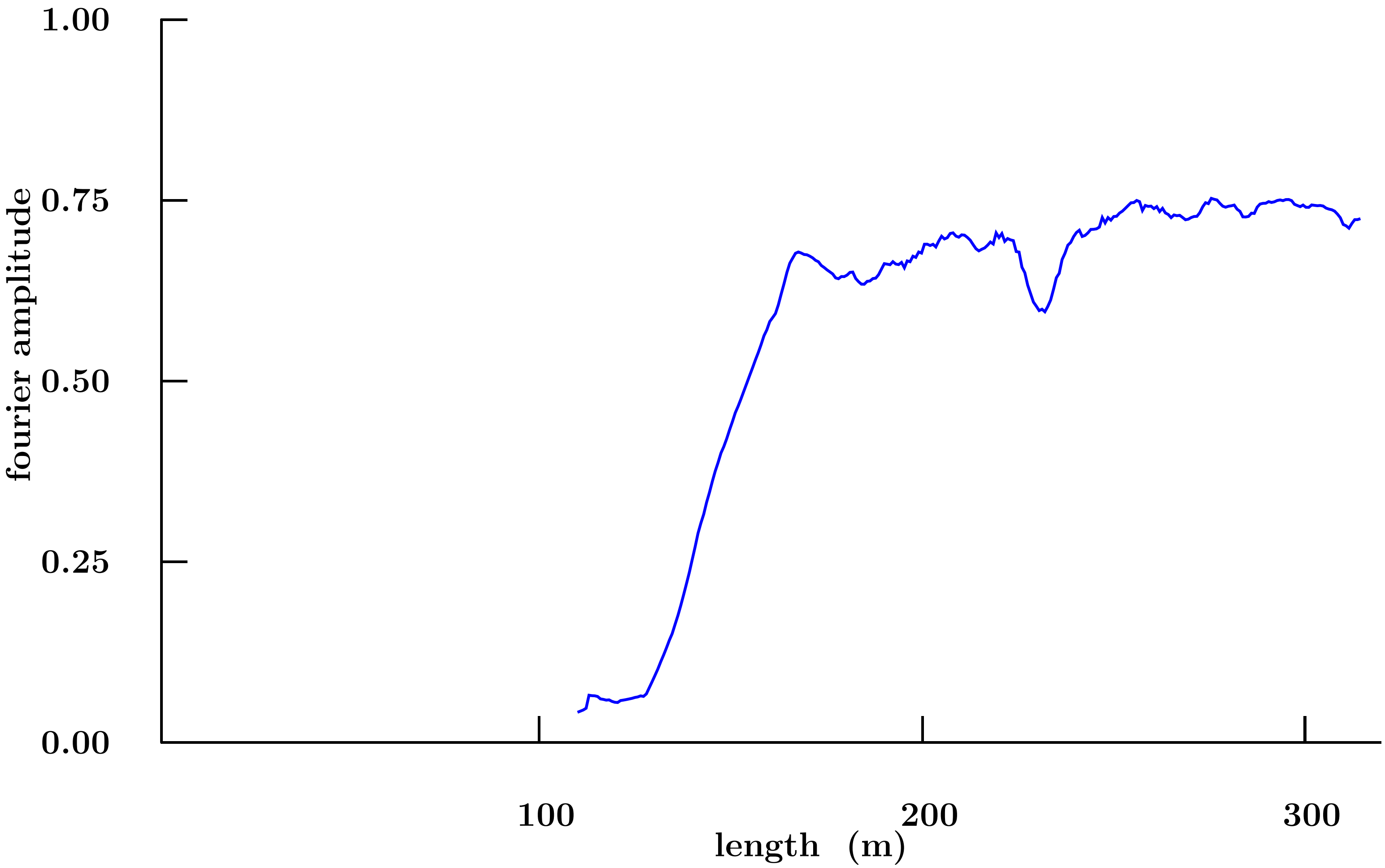
- Study 2a
- Initial Concept
- 1D optimizing Model
- Problem with delta
- eg 1 unoptimized
- eg 2 optimized
- eg 3 Short
- probelem with delta
- eg 4 Adiabatic
- Conclusion

Study 2a Rotation with ICOOL

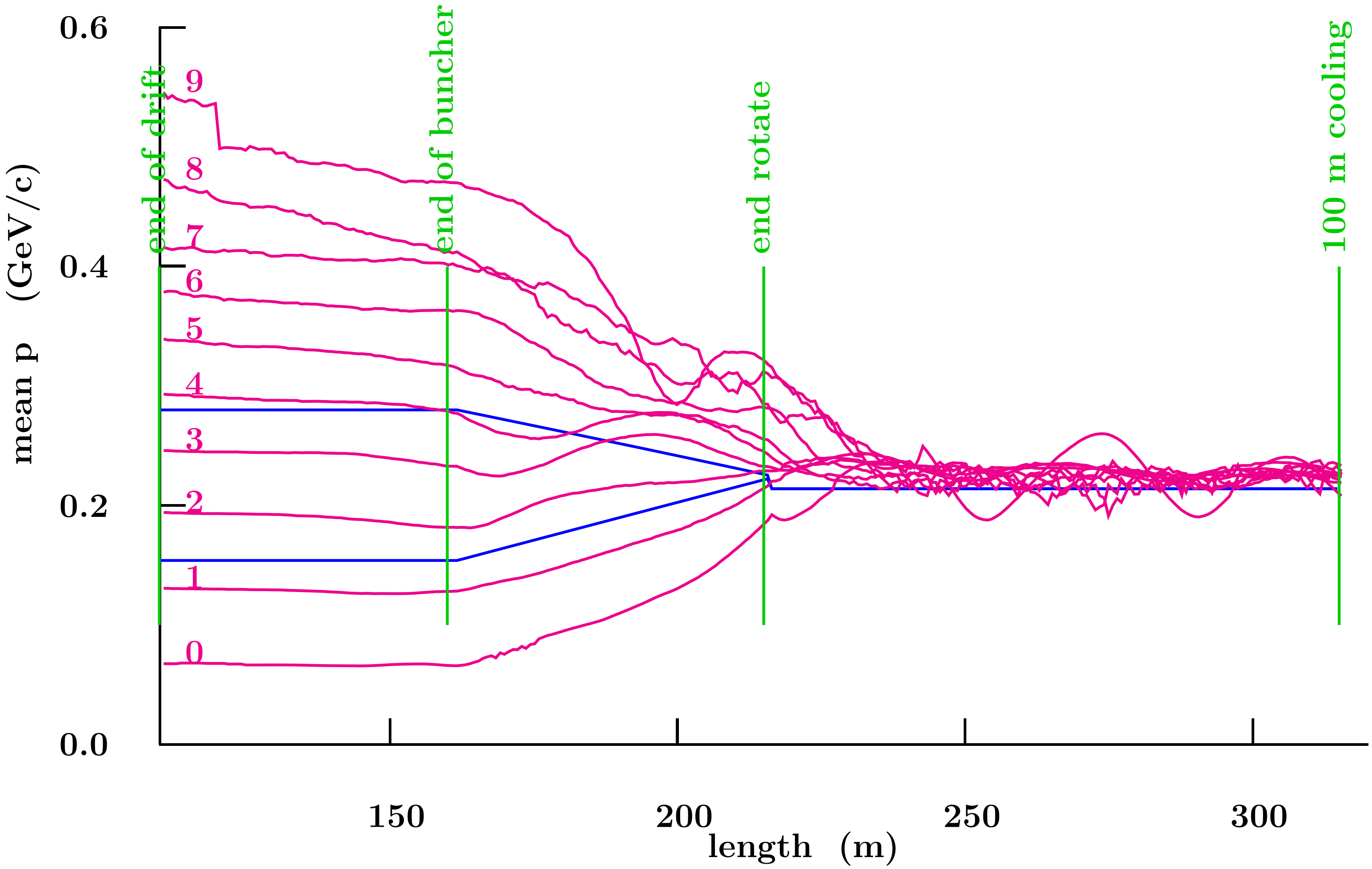


Study 2a diagnostics

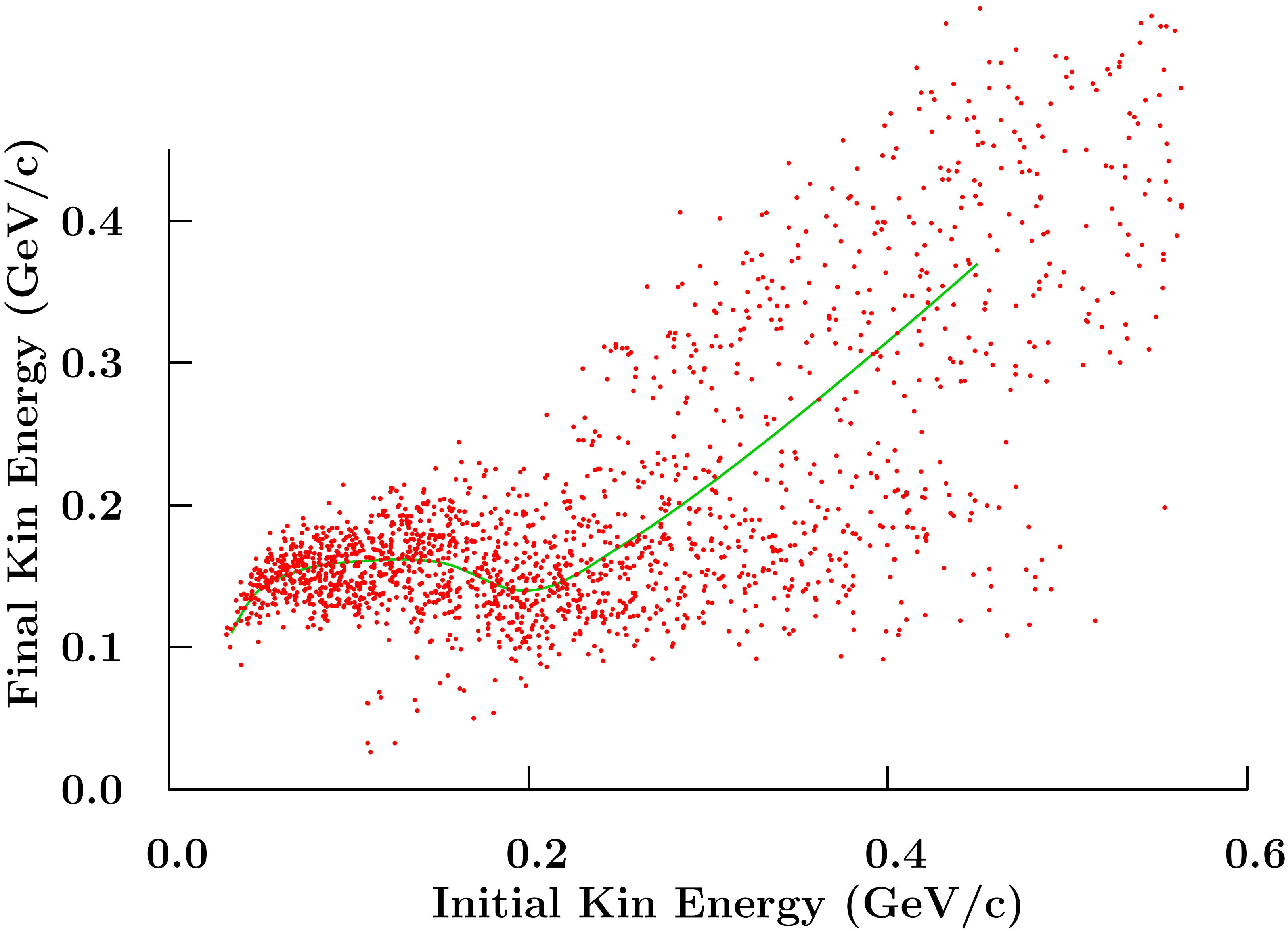




1.00
0.75
0.50
0.25
0.00
fourier amplitude
100
200
300
length (m)

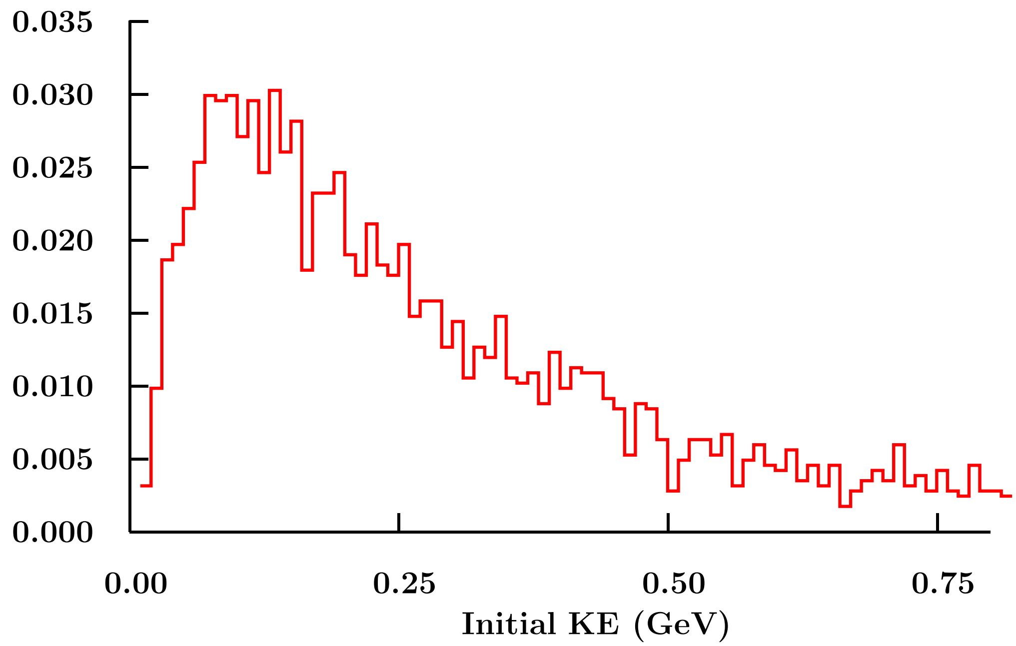


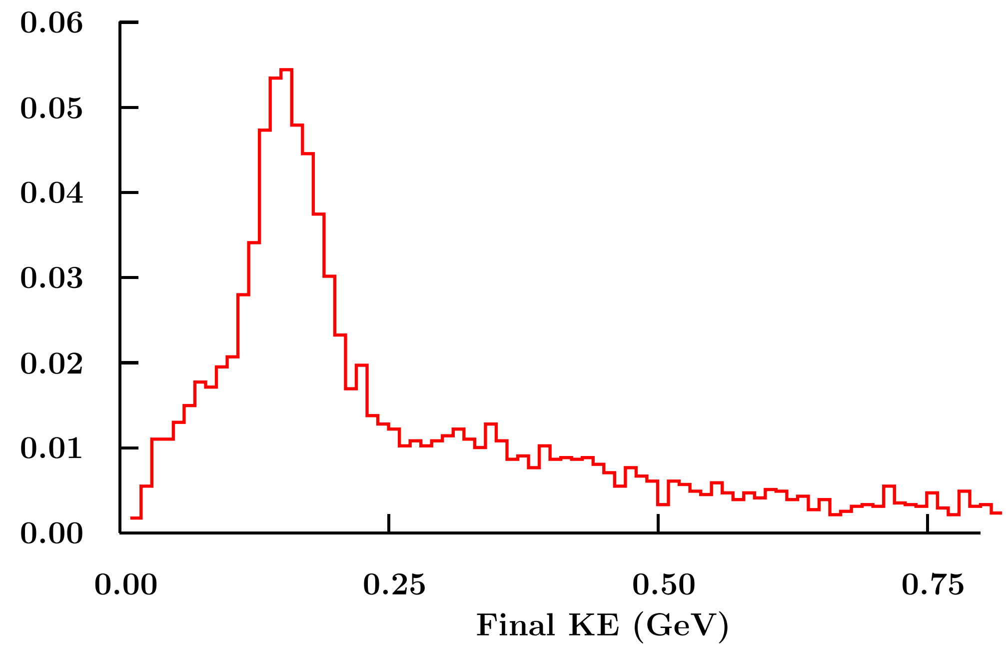
- Lines are mean energies of time slices
- Note delta was not set as theory suggested



- **Green line joins bunch centers**
- **It is not constant**
- **though deviations less than spread**

Projections of previous plot

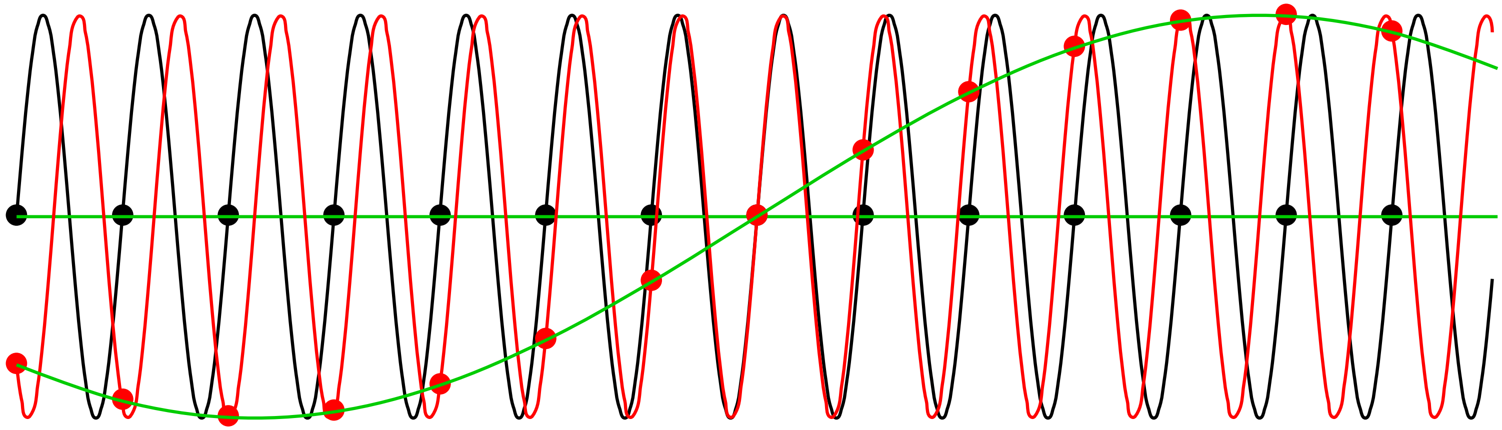




Method as Conceived

- Two reference particles, that see no RF, with p1 and p2,
- Drift 100 m
- Start RF with $\lambda = c(t_1 - t_2)/n$ with n=18
  where t_1 and t_2 (of reference particles)
- Increase the average RF gradient over next 50 m to bunch
- Lower the upper reference energy dE/dz=slope 1
- Increase the lower reference energy dE/dz=slope 2
- RF wavelength $\lambda = c(t_1 - t_2 + \delta)/n$ with n=18 and δ=.03
- When reference 1 = reference 2 (56 m)
  go to the fixed wavelength $\lambda = c(t_1 - t_2)/n$

Effect of Delta

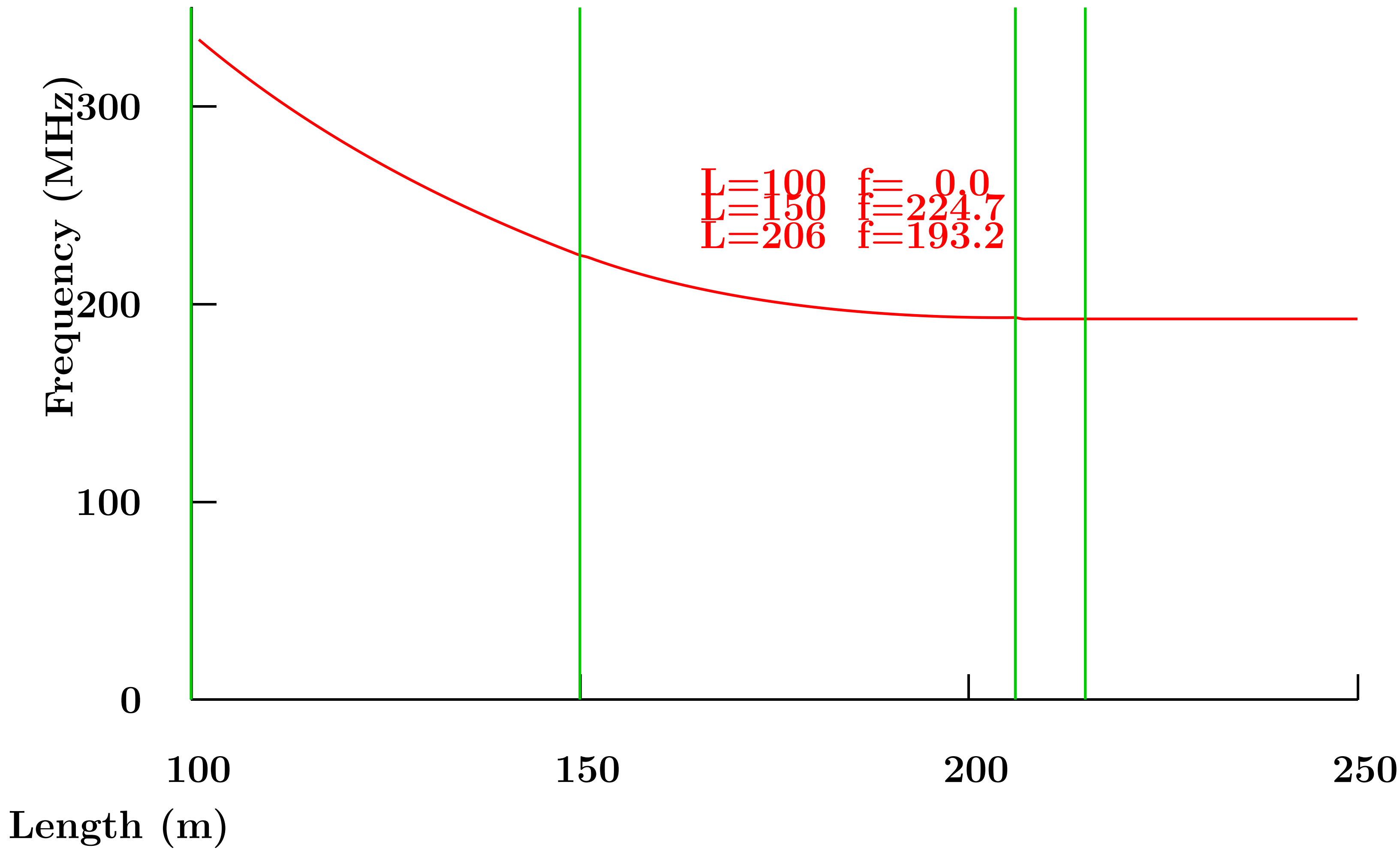


- Black line is before rotation
- Black dot are bunch centers
- Red line is after delta lambda
- Red dots are delta E at centers
- The effect is sinusoidal

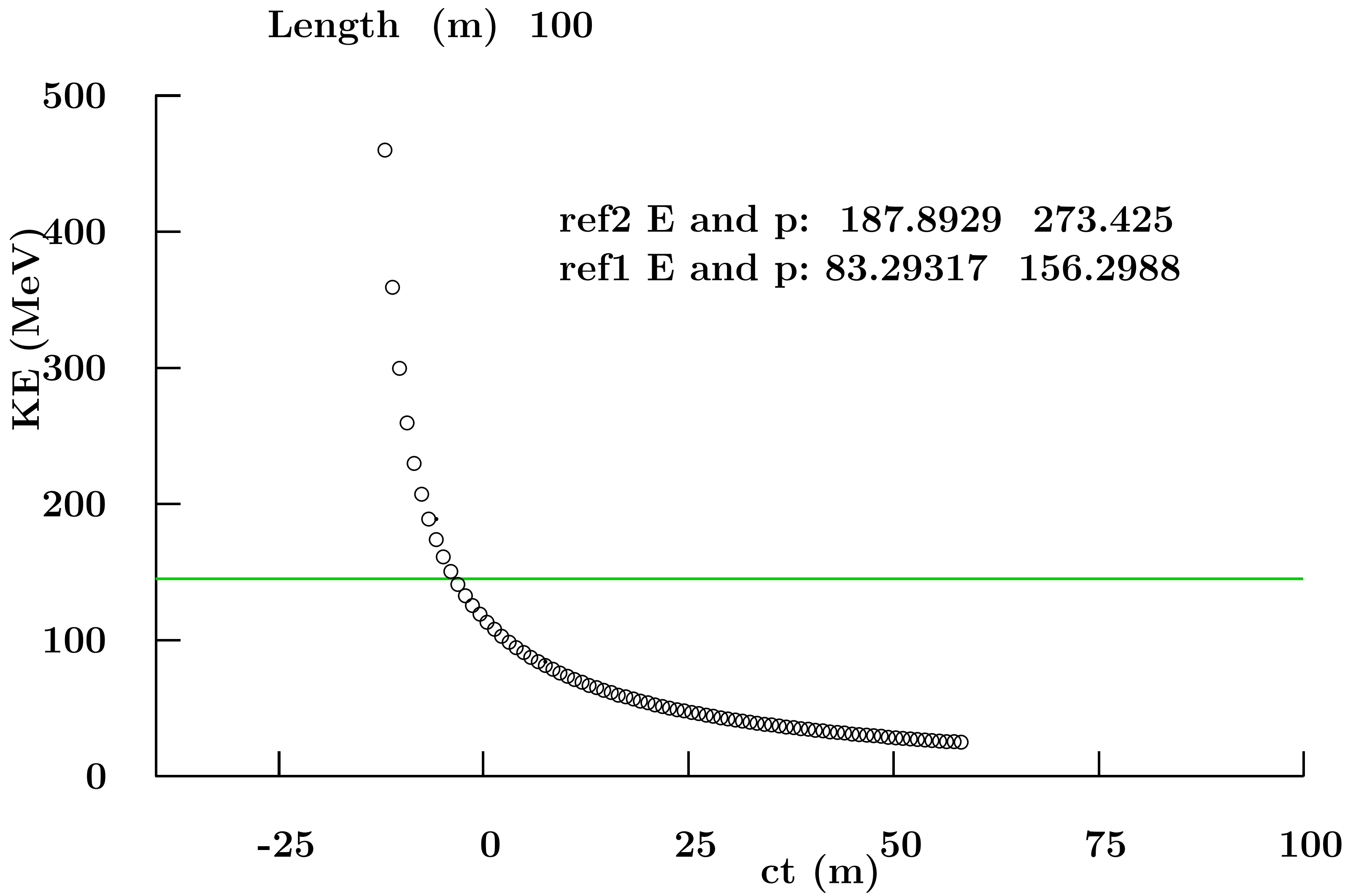
Computer Optimized Design

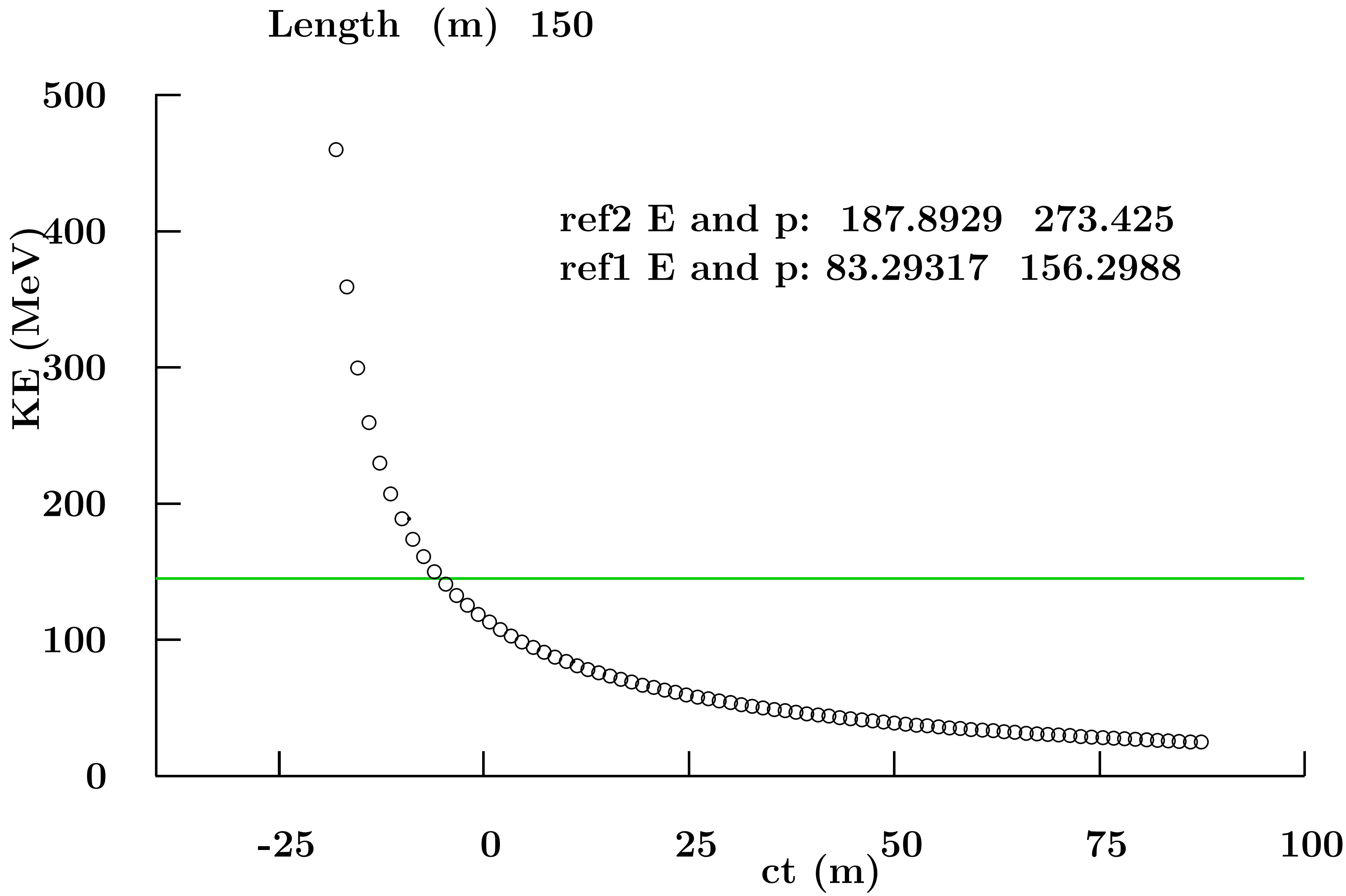
- 1D Model (but with some stansverse effect)
- start with generated tracks
  or tracks from ICOOL at end of drift
- Propagation can include an amplitude dependent effect
- Pure sin RF acceleration (no amplitude effect)
- Energy Loss in windows ($t \propto \mathcal{E}^2$)
- Embedded in optimizer

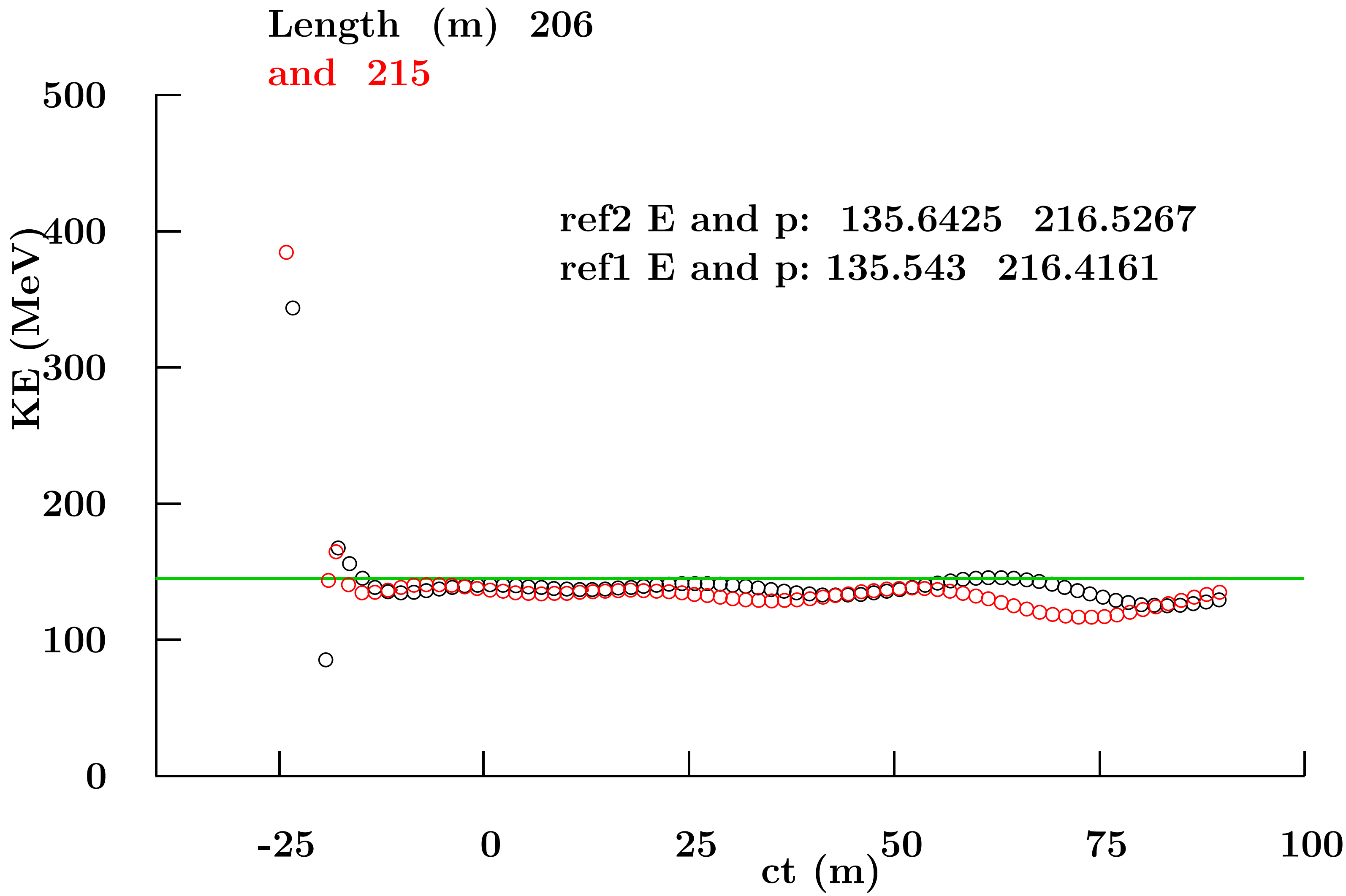
Try original concept
(without window E loss, or amplitudes)



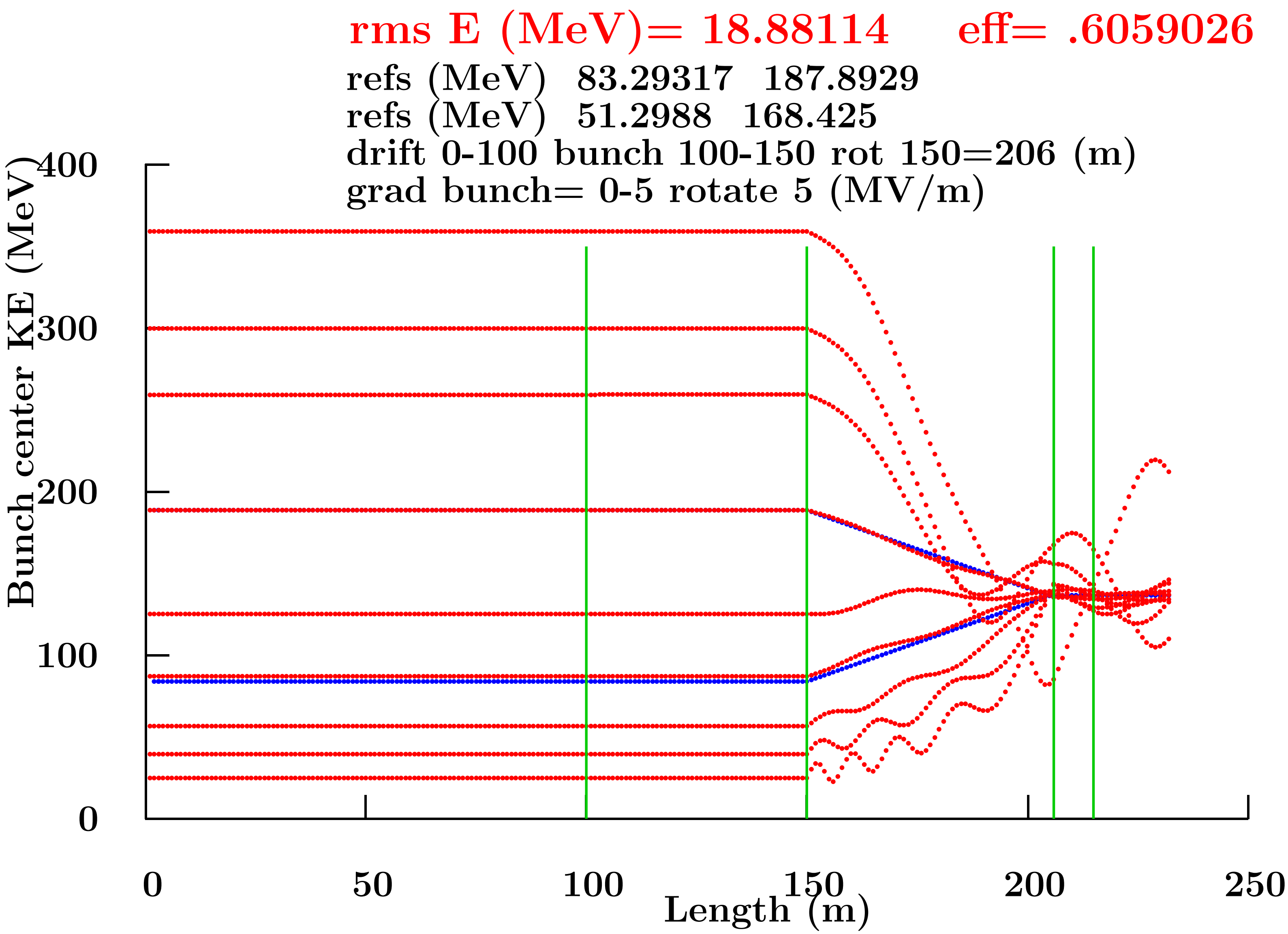
Parameters bucket centers



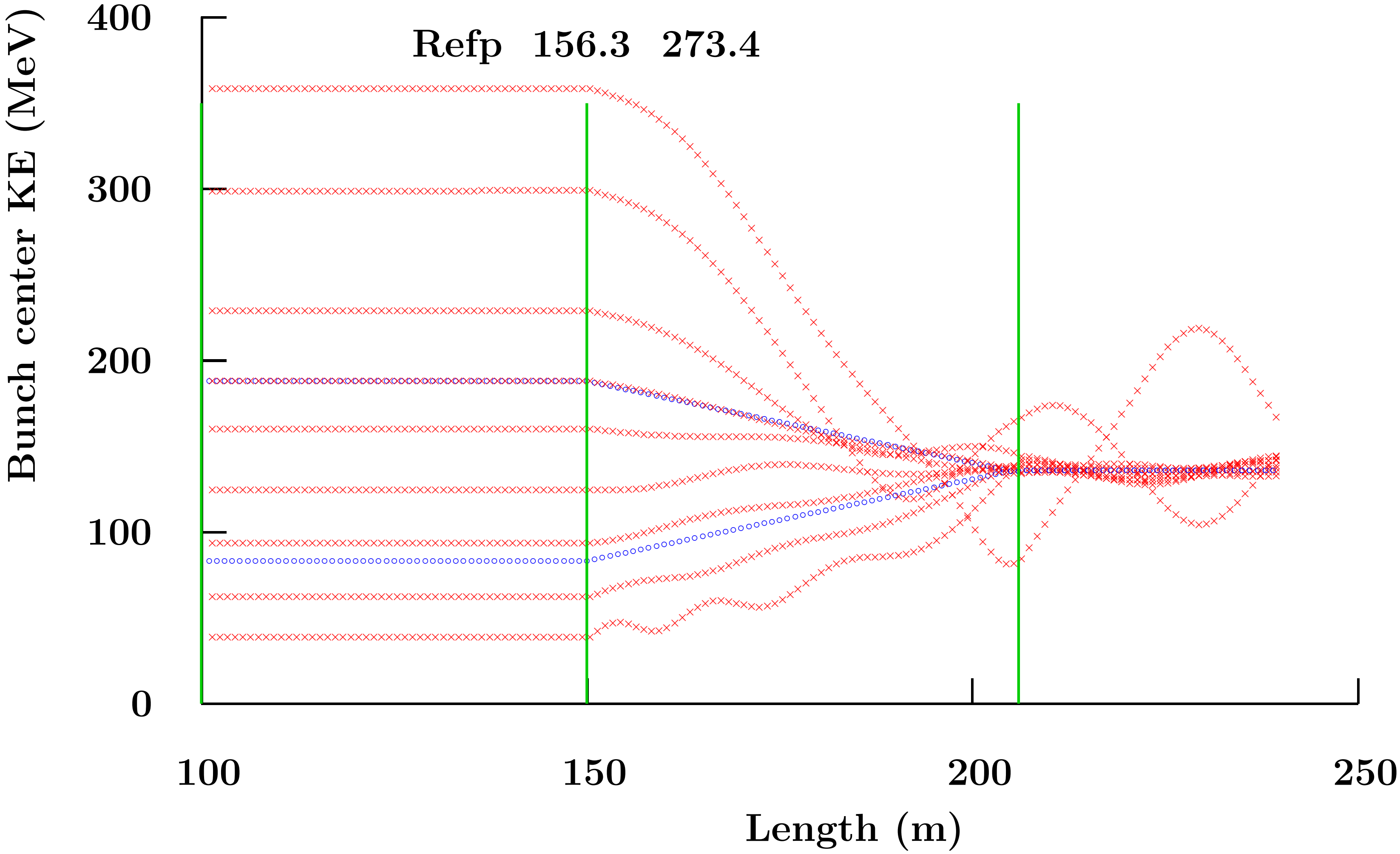

Length (m) 150
ref2 E and p: 187.8929 273.425
ref1 E and p: 83.29317 156.2988
KE (MeV)
500
400
300
200
100
0
-25
0
25
50
75
100
ct (m)


Length (m) 206
and 215
500
400
300
200
100
0
KE (MeV)
ref2 E and p: 135.6425 216.5267
ref1 E and p: 135.543 216.4161
-25
0
25
50
75
100
ct (m)

Centers of selected energies vs x

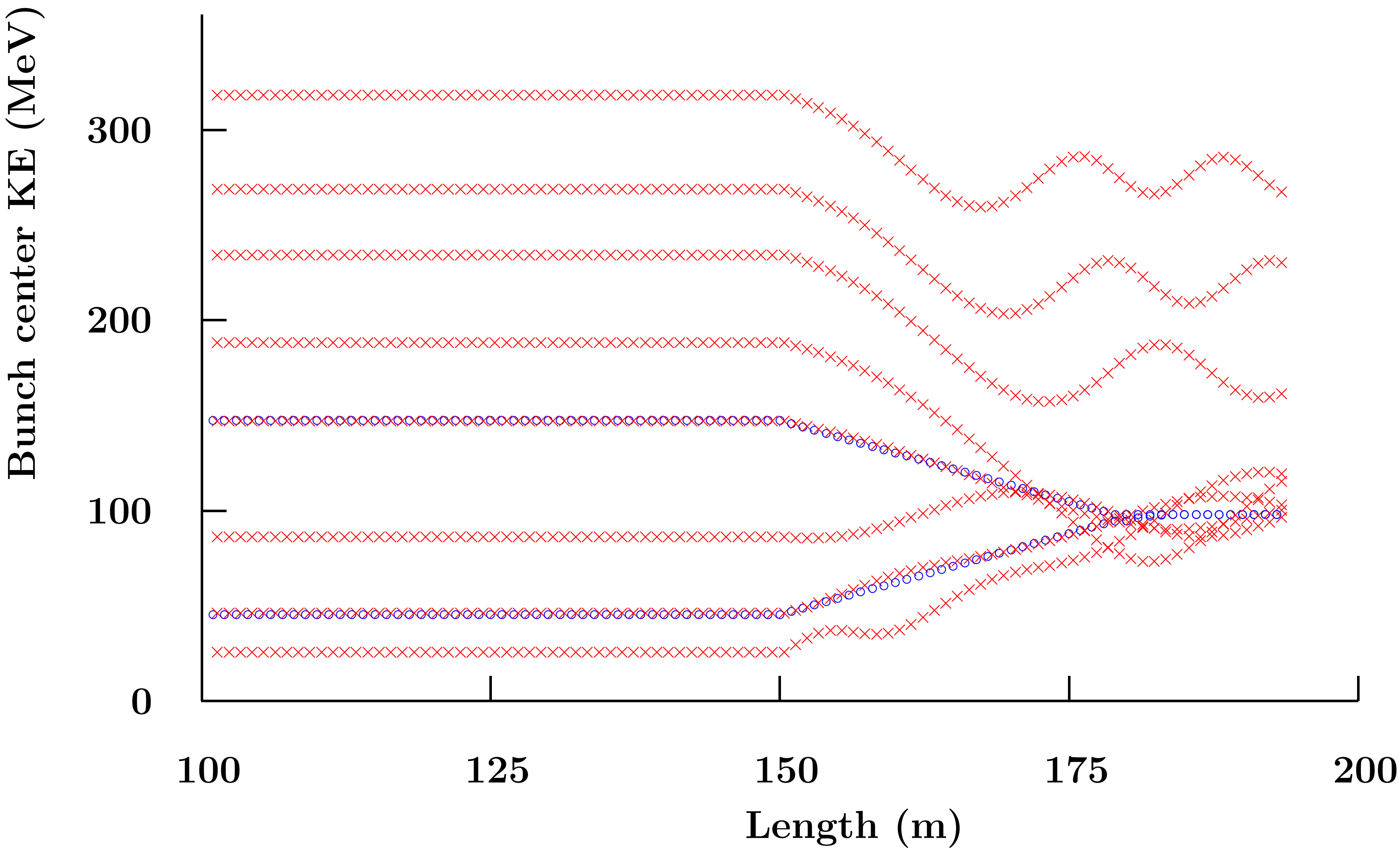


56 m Rotate Optimized



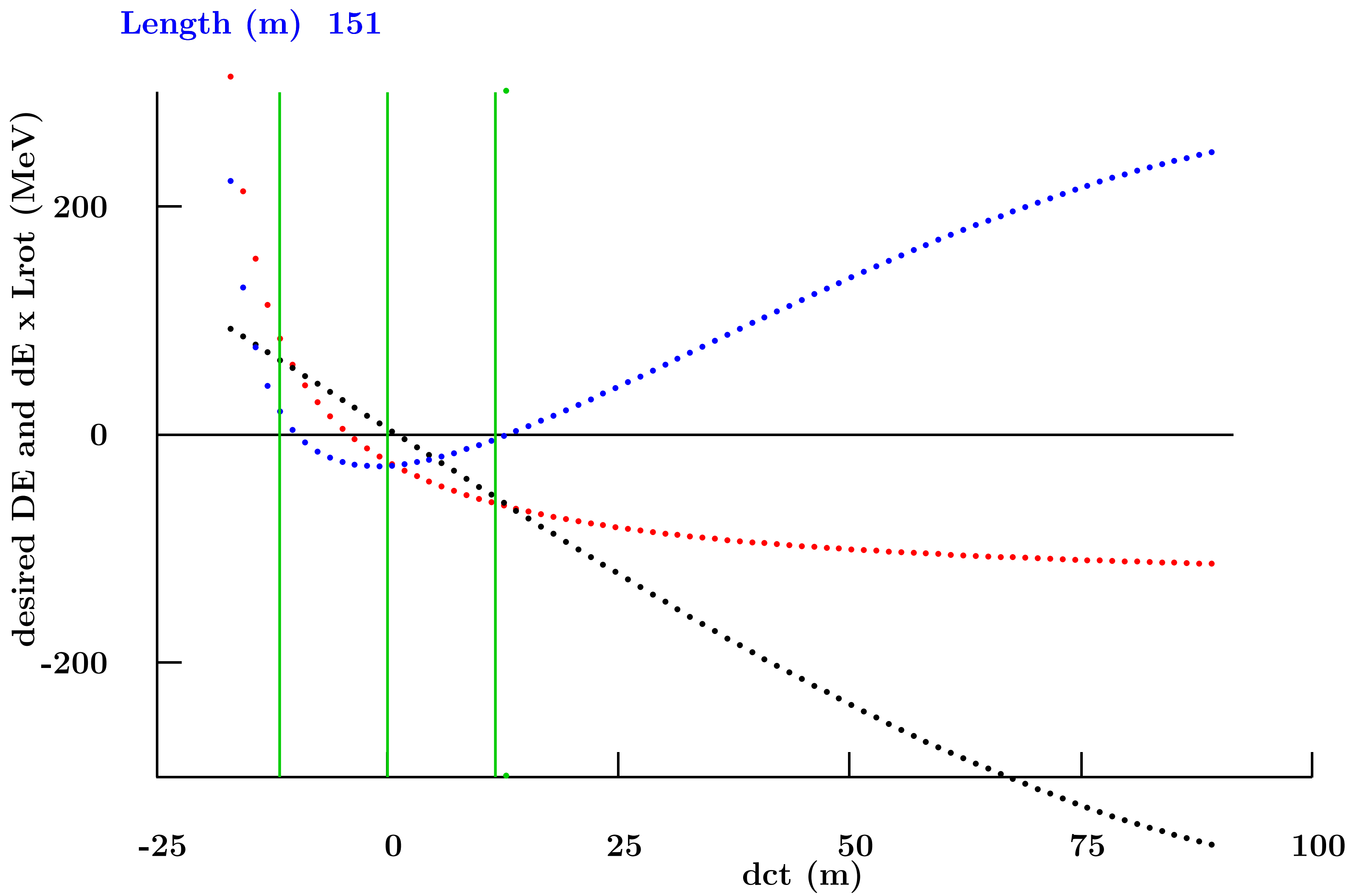
- similar to S2a
- Some gain from optimizing
- But no better for high E

Try shorter Rotation: 30 m (vs 56 m)

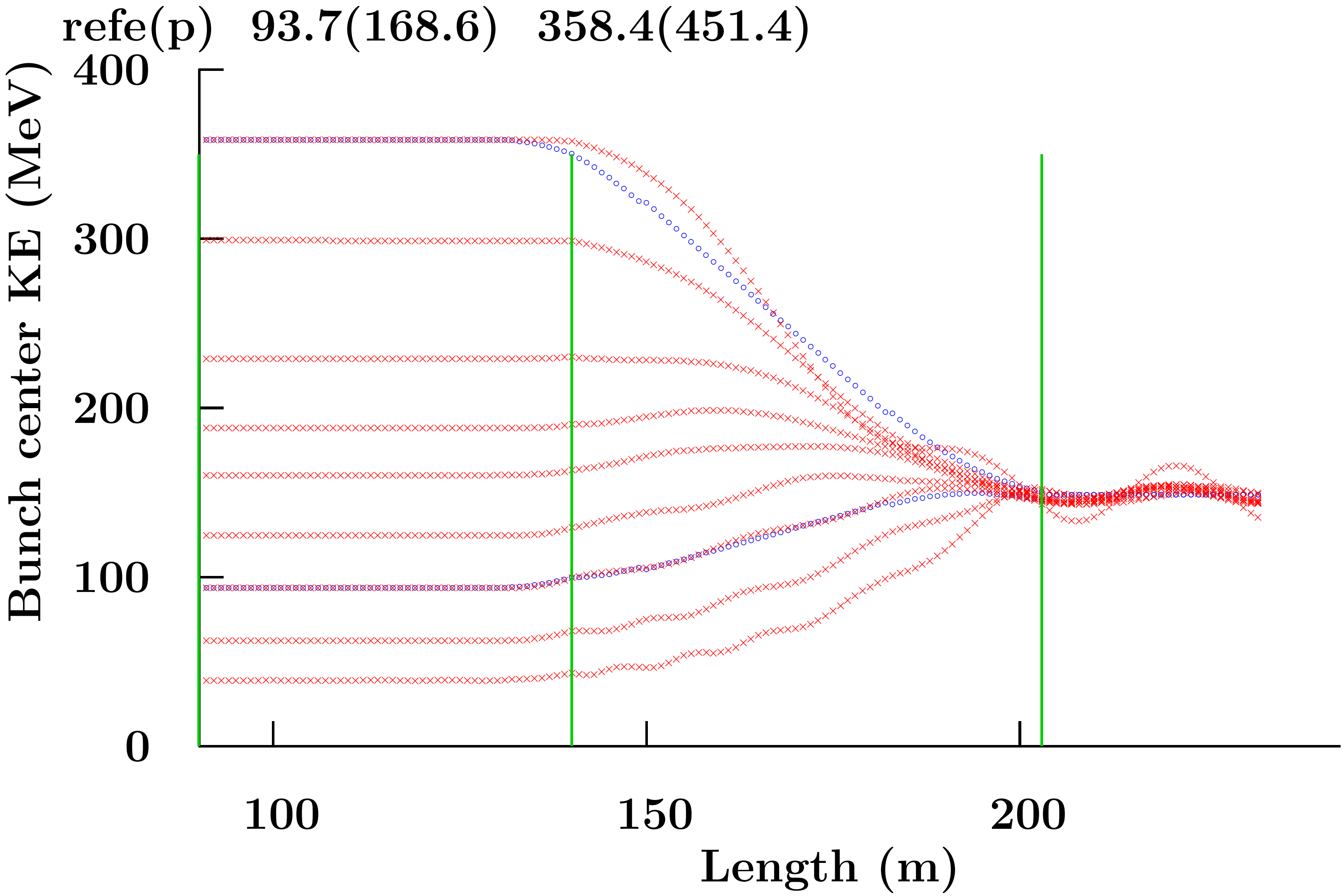


Loses higher energy tracks

Problem with use of delta

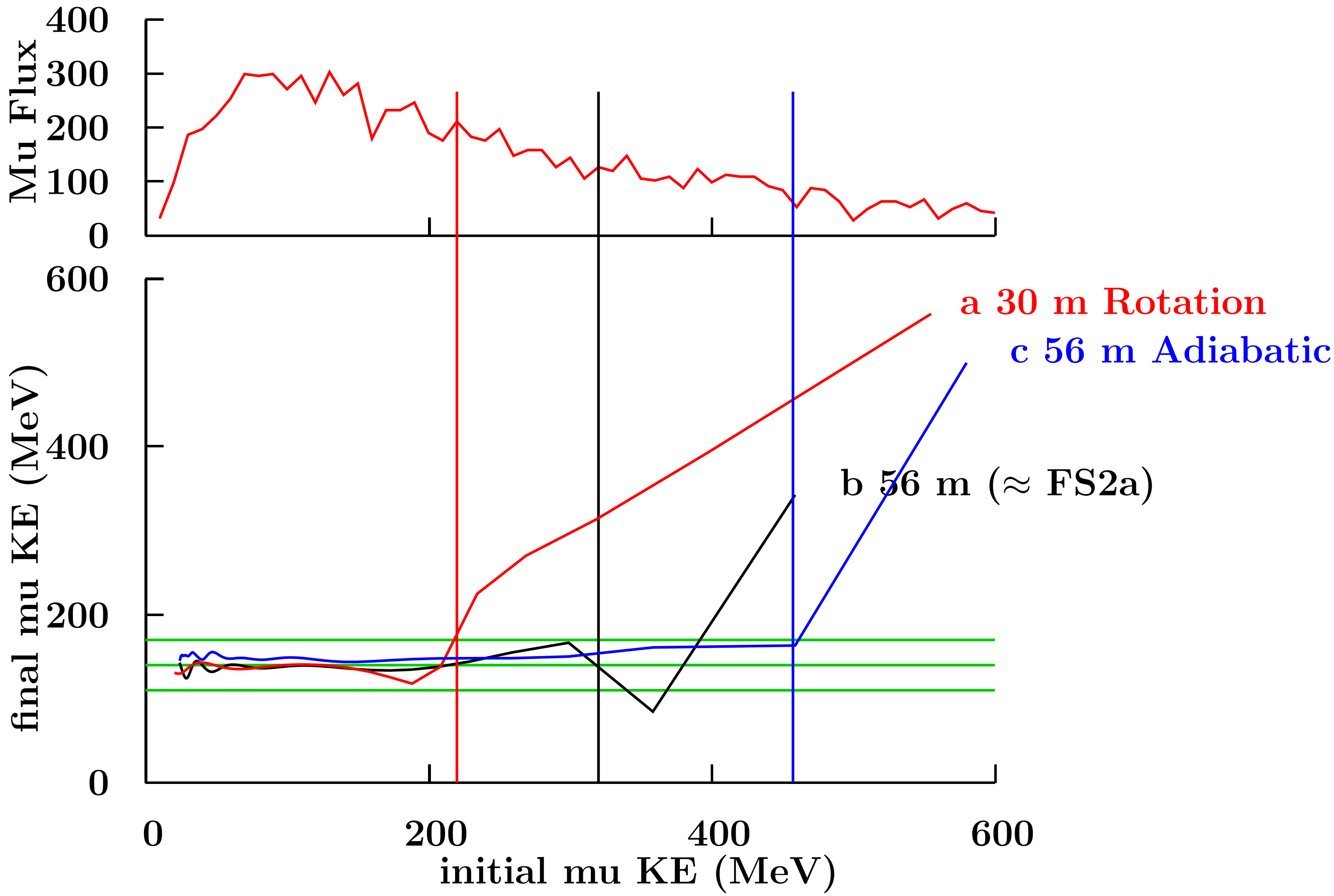


56 m Rotate delta=0, more adiabatic



- Slow onset and removal of ref dE/dz
- No delta
- Significant apparent improvement

Compare Bunch Center E2's vs E1's



Gain may not be large because fewer high energy tracks

Conclusion

- Neuffer scheme does not work as I imagined
  - Use of "delta f" does not work well
  - Adiabatic bunch dragging seems better

- Reducing Rotation length looses higher energy tracks
- Have not tried increasing it

- Overall performance not clearly better (not shown)

  - Need Ecalc9 like criterion
  - Bunching not yet optimized

- Must transfer design to ICOOL
- Try optimizing in ICOOL (Marco)