Step limit optimization inside the final focus

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SuperB

Outline

- **Step limit optimization**
  - Step limit vs Beam optics
  - Step limit vs Rad-Bhabha losses at beam pipes
  - Step limit vs Rad-Bhabha rates on final focus boundary

- **Summary**

Step limit optimization strategy

- **Current default value of step limit (SL) parameter is 8mm**
- **Current final focus model: ±16m from IP**

  ⇒ execution time high (~25 mins/bunch-crossing)

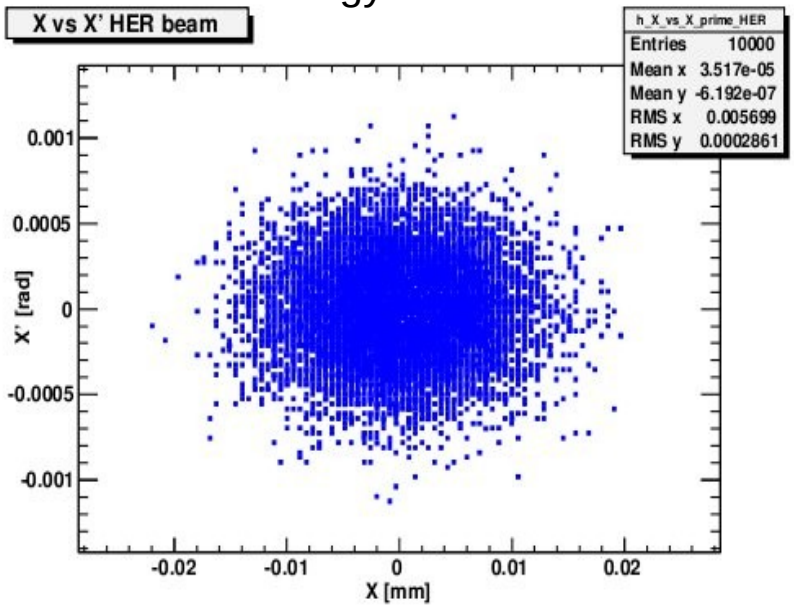
- **Want to optimize SL parameter, a trade-off between**
  - Reasonable simulation results ⇒ SL as small as possible
  - Smallest execution time ⇒ SL as big as possible

- **Strategy:**
  - SL scan: 8, 16, 32 and 64 mm
  - Check if simulation performances are similar for different SL values
    - Beam optics sampling
    - Losses rate (at beam pipes) of Rad-Bhabha
    - Rad-Bhabha rates at final focus boundaries
  - Choose the highest SL value which gives reasonable results

SL vs Beam optics: Strategy

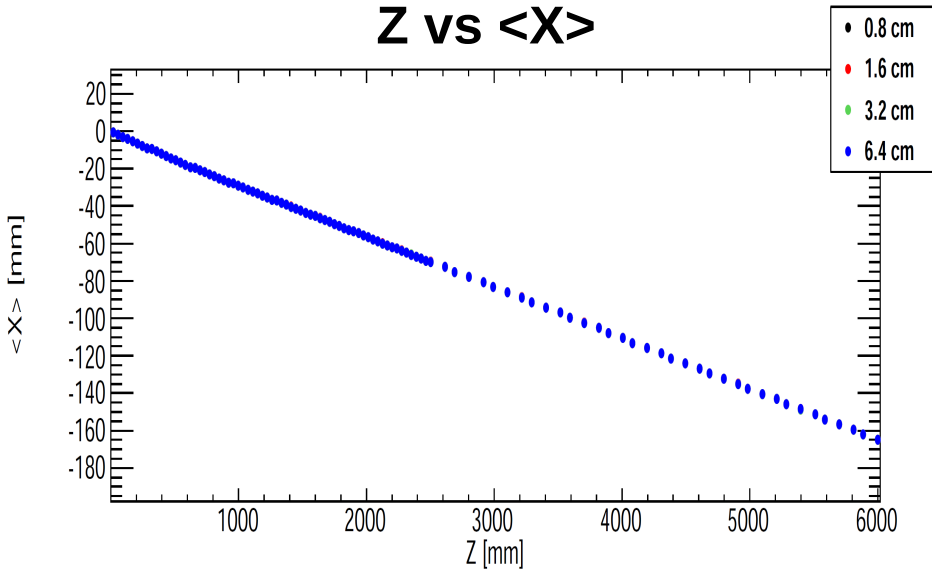
- **Use final focus v12 sf11 layout**
- **Generate particles (20k) with HER beam parameters at the IP:**
  - All particles are generated at Z = 0 and at the nominal beam energy

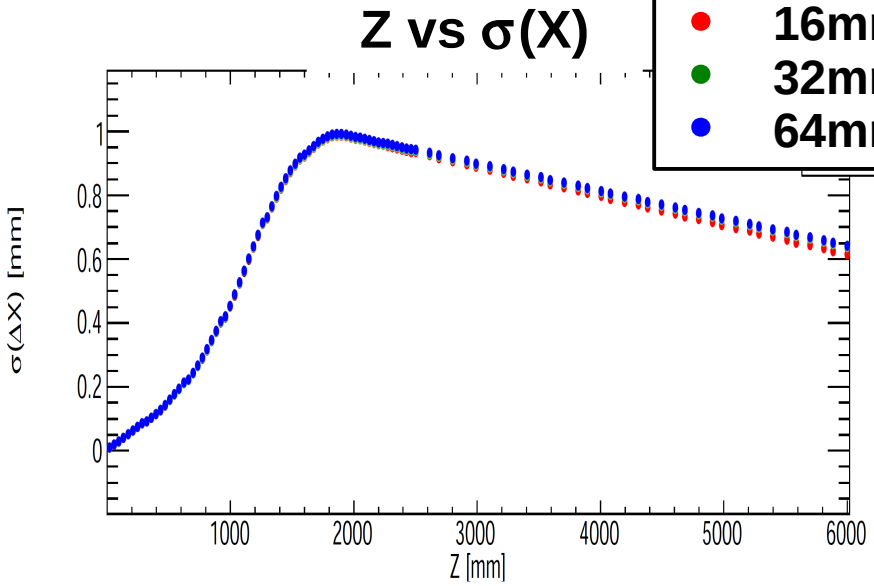
parameter	HER (e^+)	LER (e^-)
Energy	6.69 GeV	4.18 GeV
σ_X	7.3×10^{-3} mm	8.7×10^{-3} mm
β_X	26.0 mm	32.0 mm
σ_Y	36.0×10^{-6} mm	35.0×10^{-6} mm
β_Y	253.0×10^{-3} mm	205.0×10^{-3} mm
α_Z	-30mrad	π+30mrad

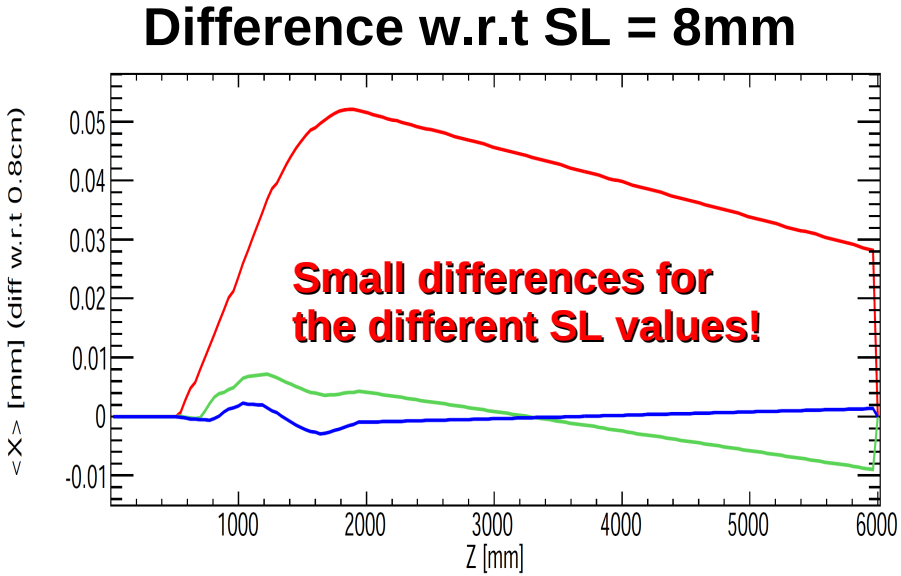


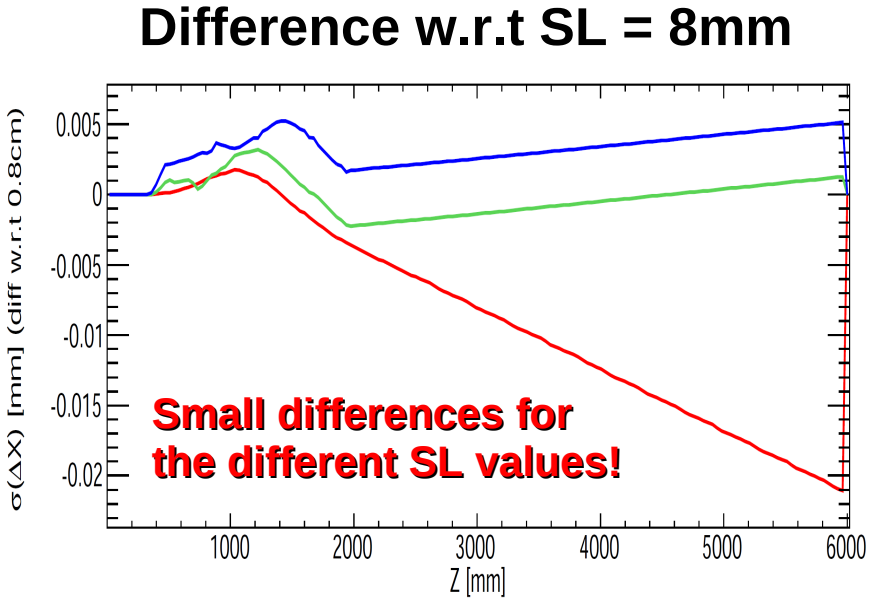
- **Feed this particles into Bruno which transport them through the FF B-field**
- **Scoring cylinders to study beam optics as a function of Z-coordinate**
- **Simulate for different SL values: 8, 16, 32 and 64 mm**
- **Check if different step limit values give similar beam parameters vs Z: <X>, <Y>, σ(X), σ(Y), …**
- **Estimate execution time vs SL**

SL vs Beam optics: Results (I)

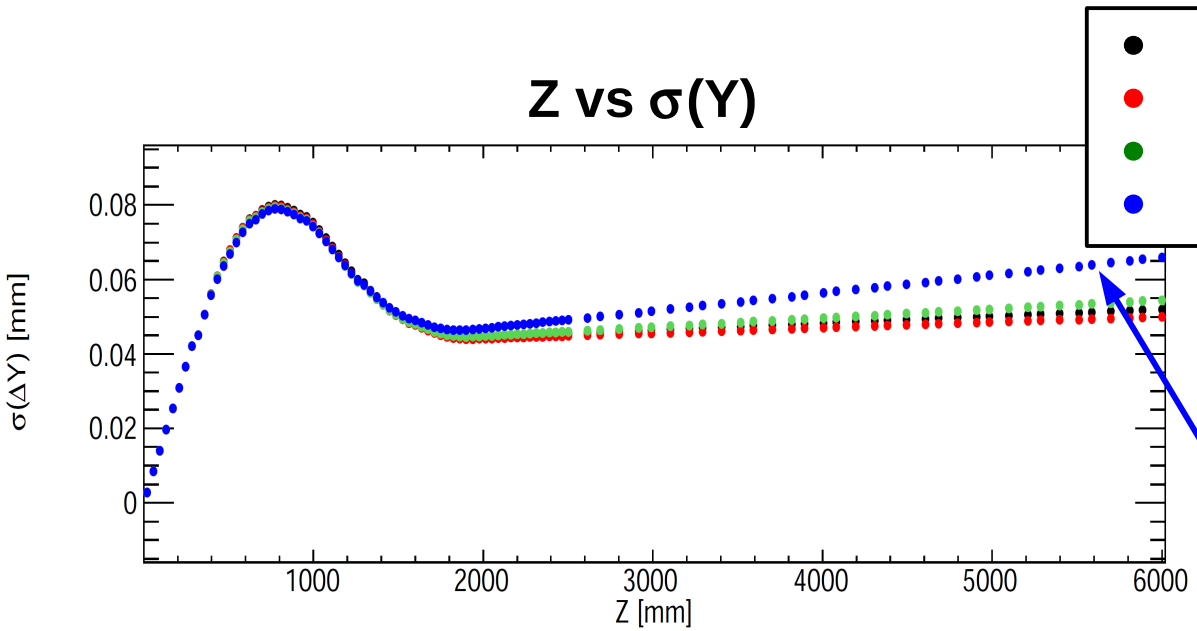


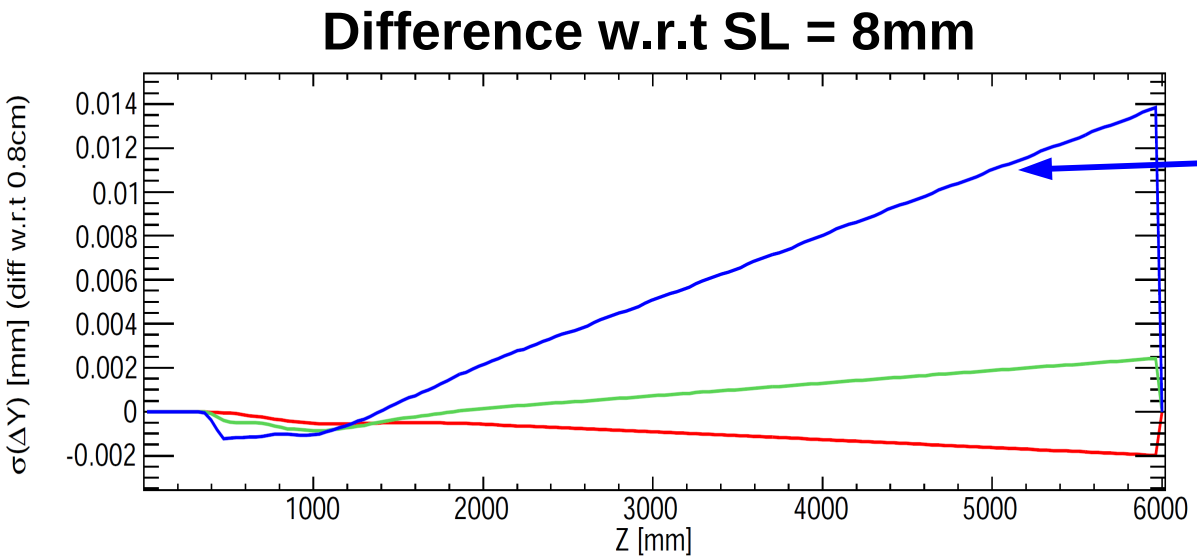






SL vs Beam optics: Results (II)

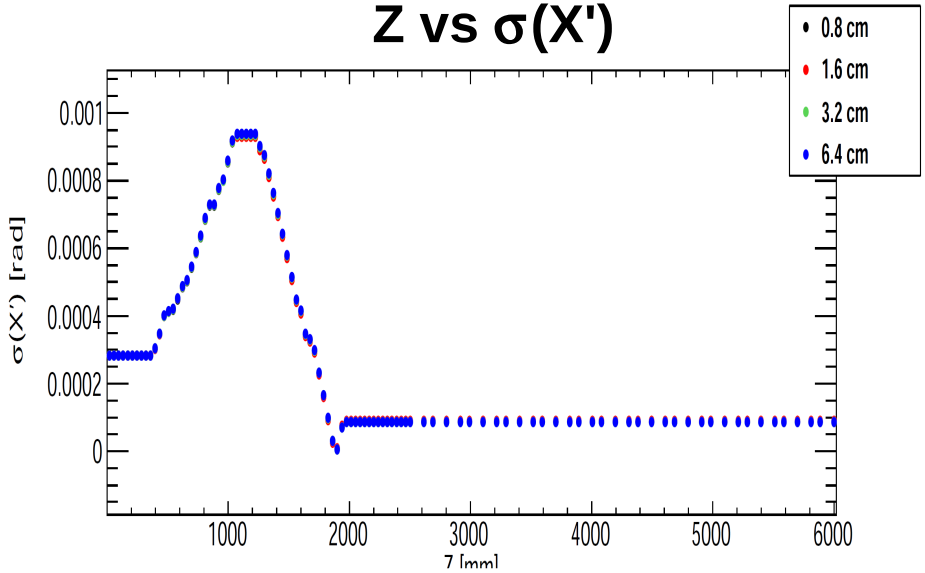


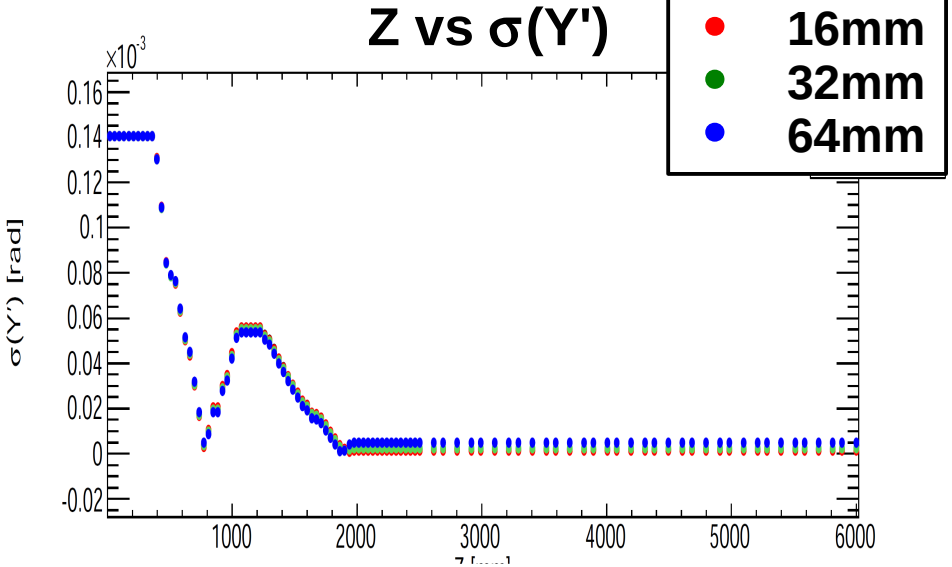


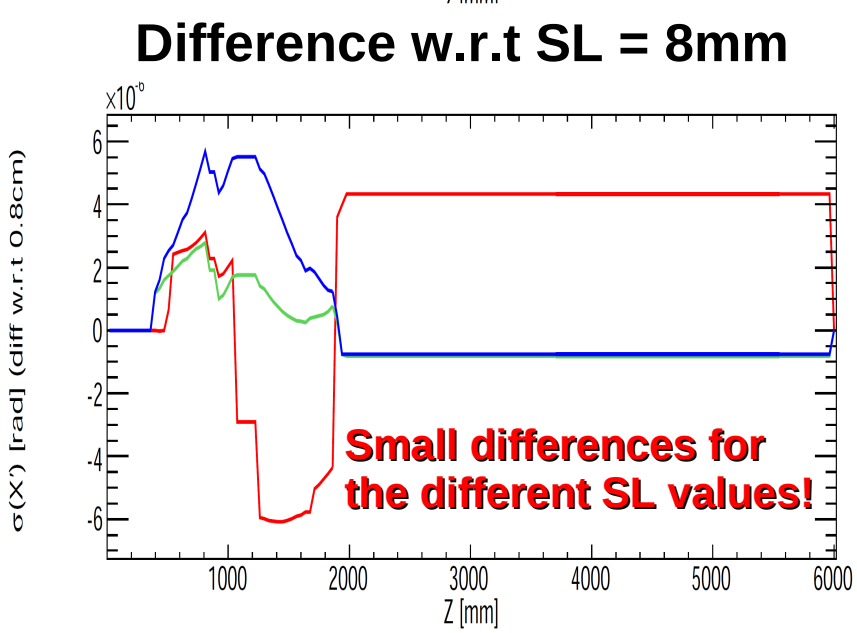
Small differences between SL 8, 16 and 32 mm

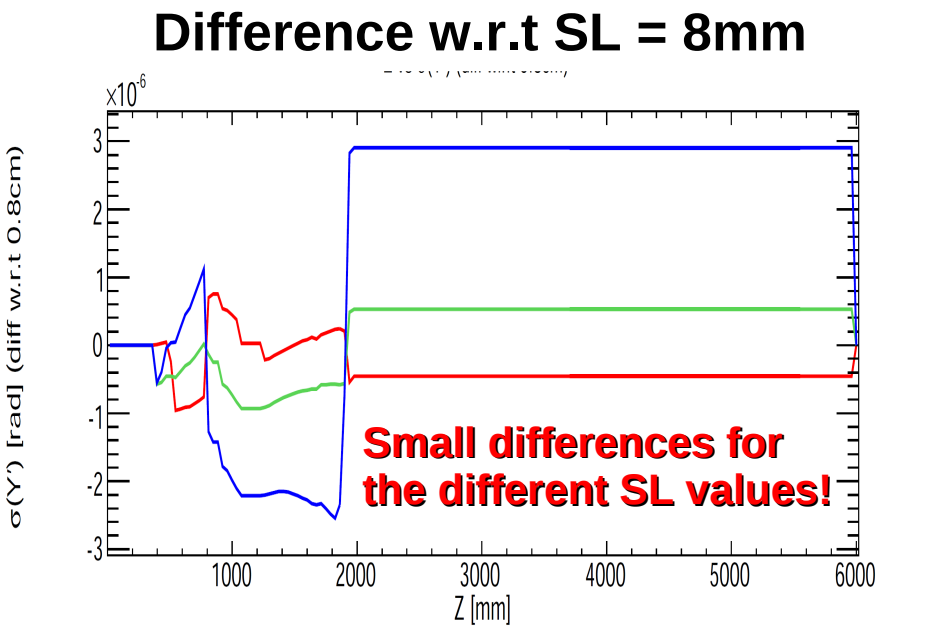
Significant difference for SL = 64mm!

SL vs Beam optics: Results (III)



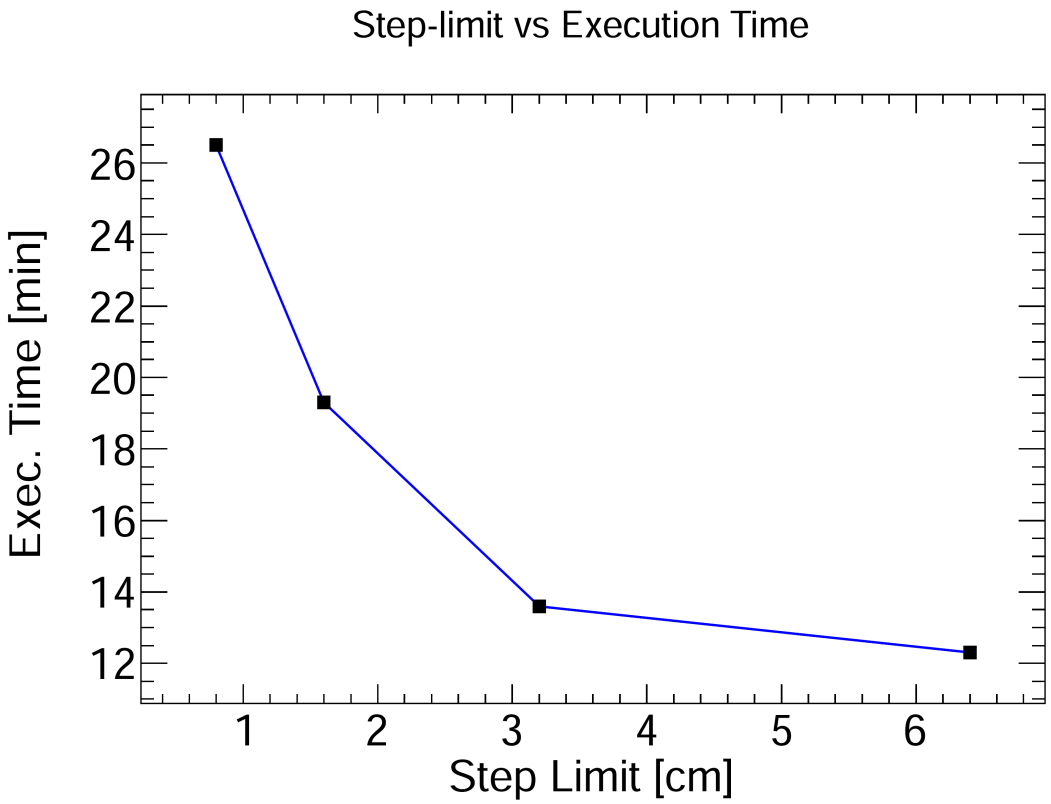






SL vs Beam optics: Summary

- **Very similar results for SL values 8, 16 and 32 mm (differences below 1%)**
- **SL = 64 mm seems to be too high value ⇒ discarded**



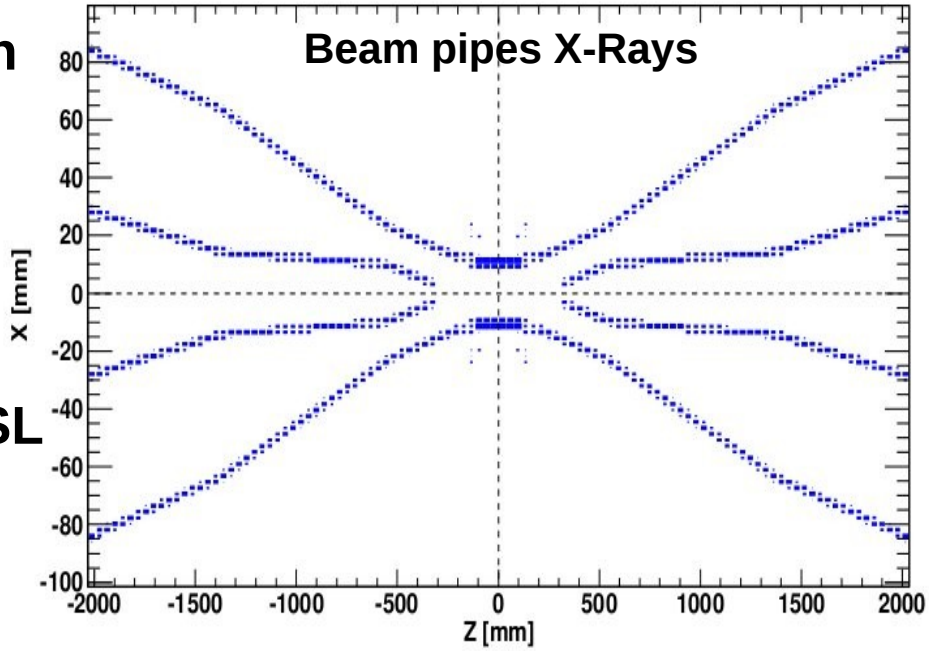
- **Execution time reduces faster than linear with SL**
- **Can reduce execution time by a factor of 2 by choosing SL = 32mm**

SL vs Rad-BhaBha Losses: Strategy

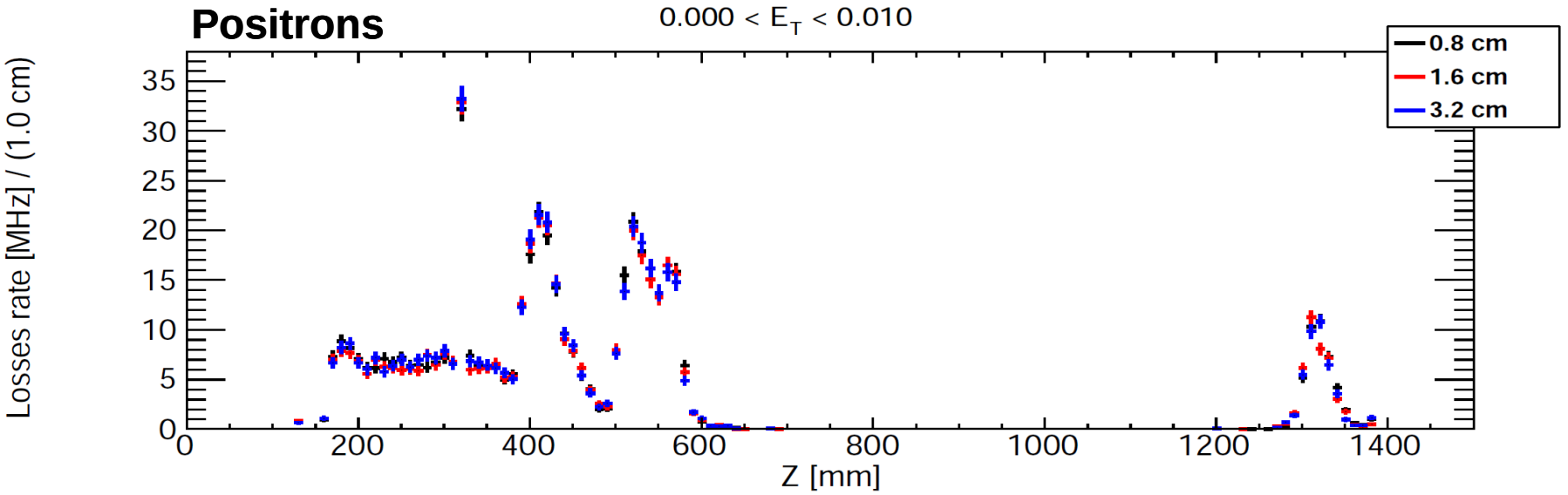
- **Run Bruno with the final focus only (Rad-BhaBha generator)**
- **Remove everything (magnets, flanges, Plug …) but beam pipes**
- **Replace beam pipes material with vacuum**

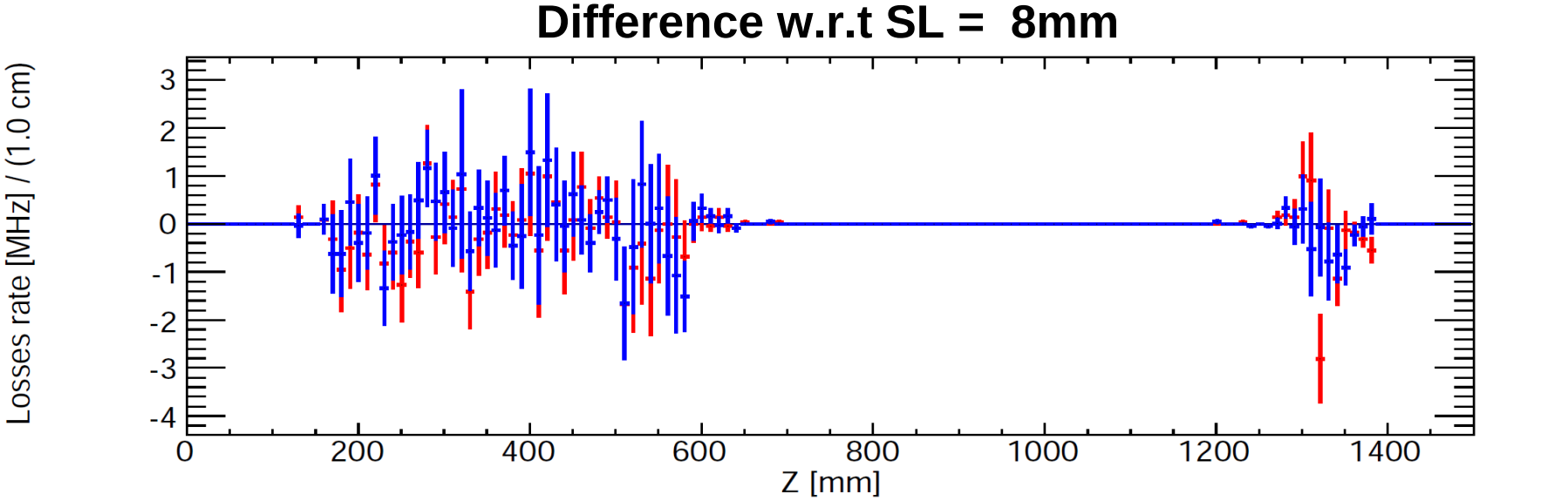
- **Simulate for different SL values: 8, 16 and 32 mm**
- **Evaluate losses rates as a function of Z-coordinate for different:**
  - Particle type: e^-, e^+ and γ
  - Energy bins
  - Transversal energy bins
- **Compare results for the different SL values**

V12-sf11 layout

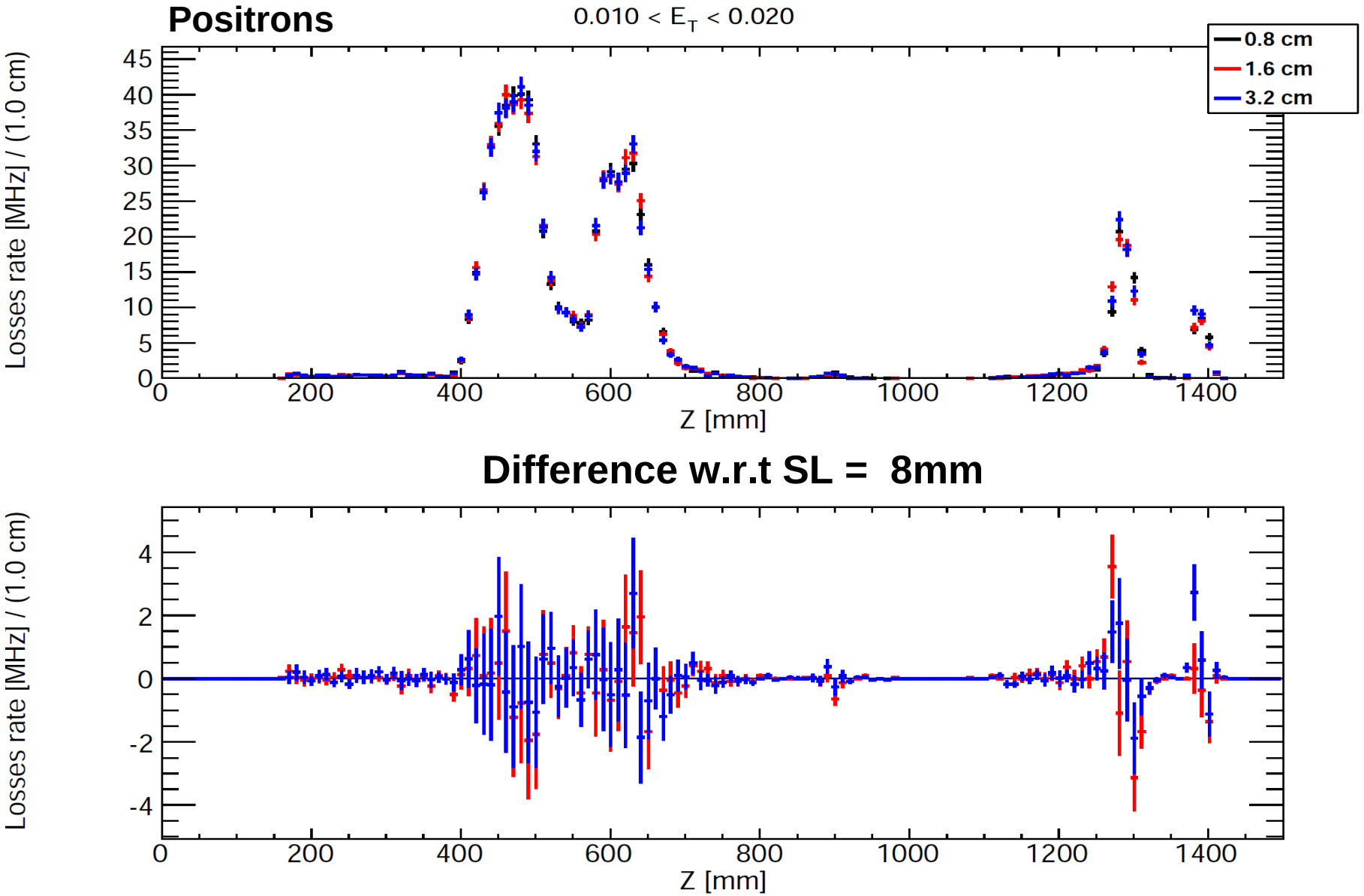


SL vs Rad-BhaBha Losses: Results (I)

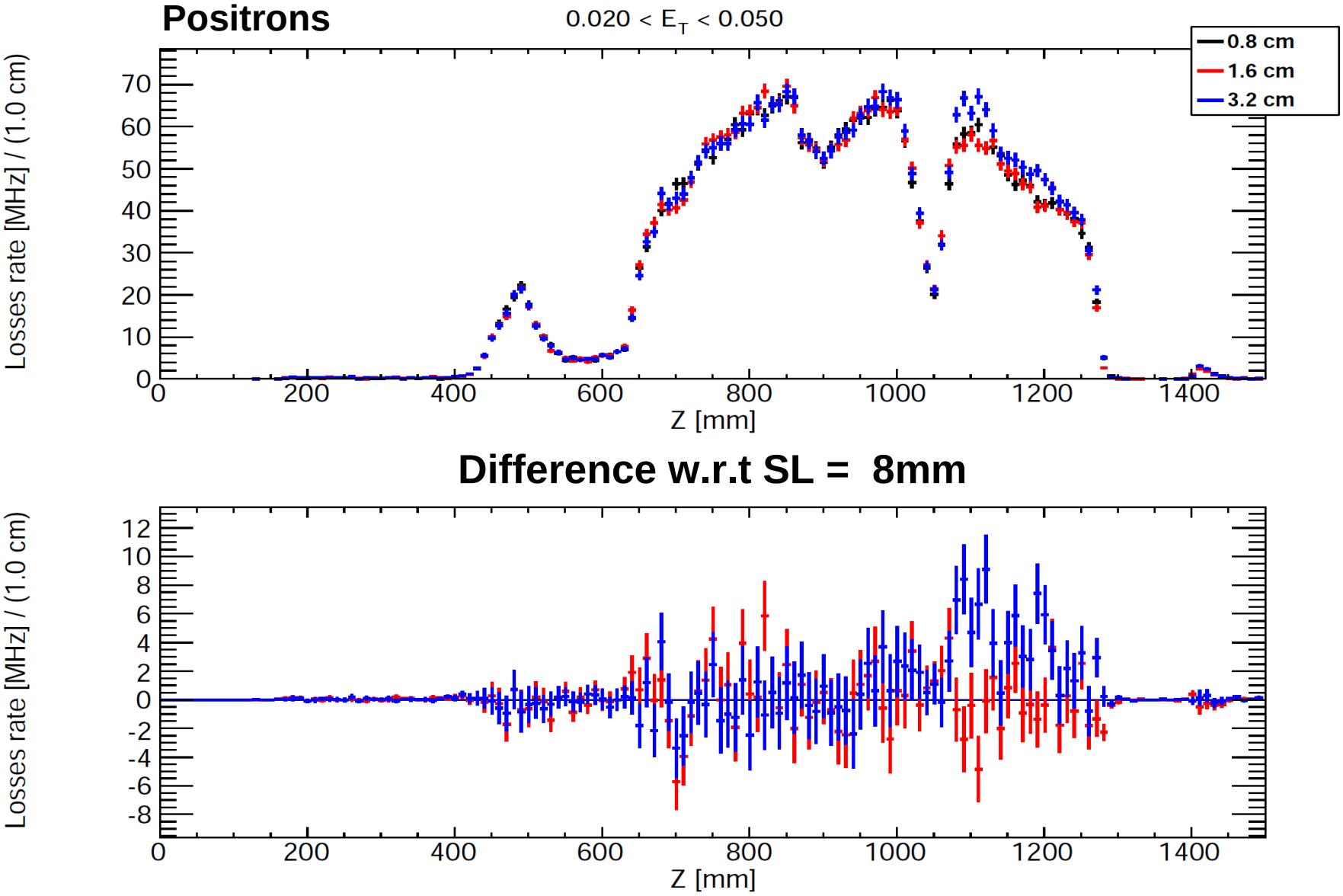




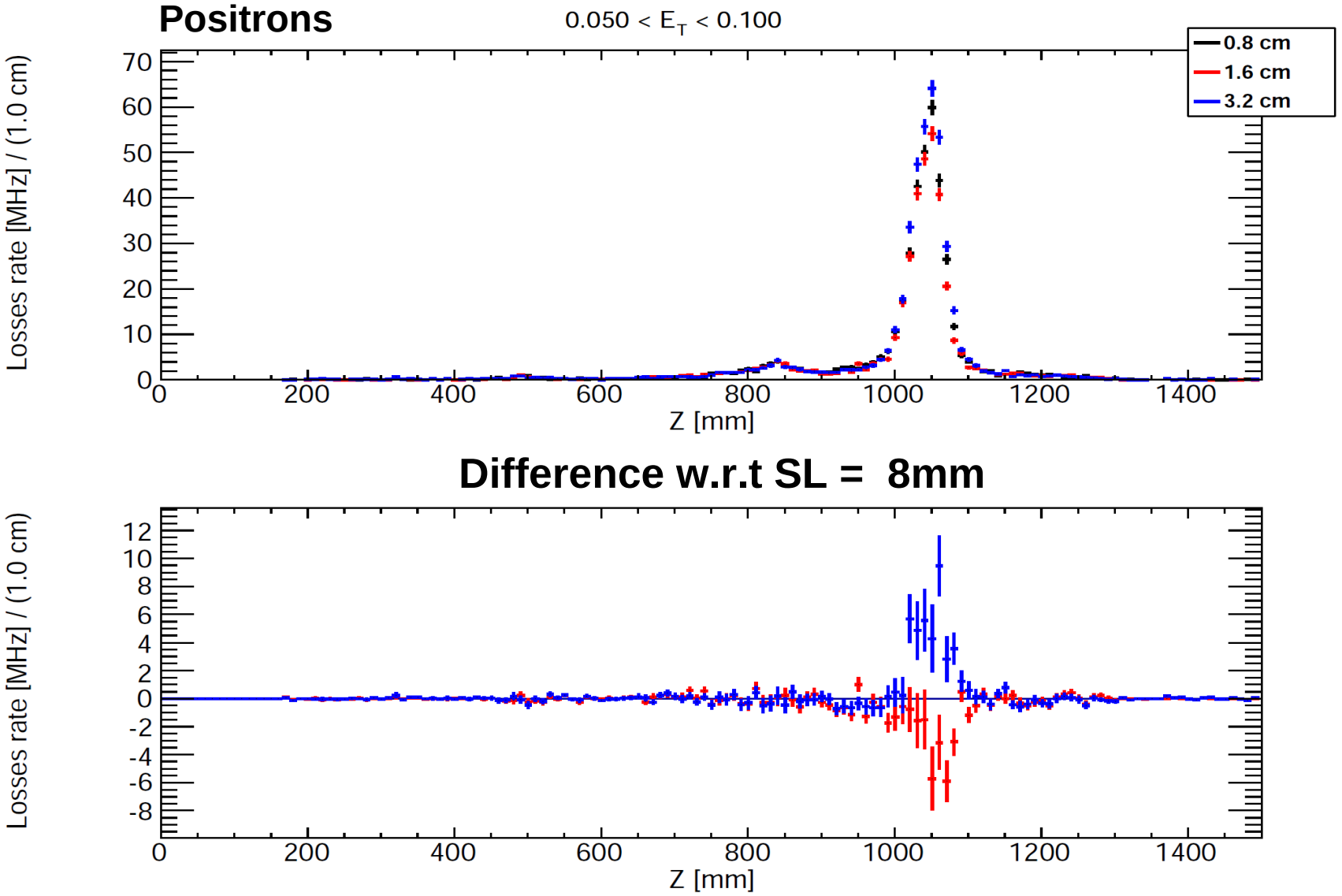
SL vs Rad-BhaBha Losses: Results (II)



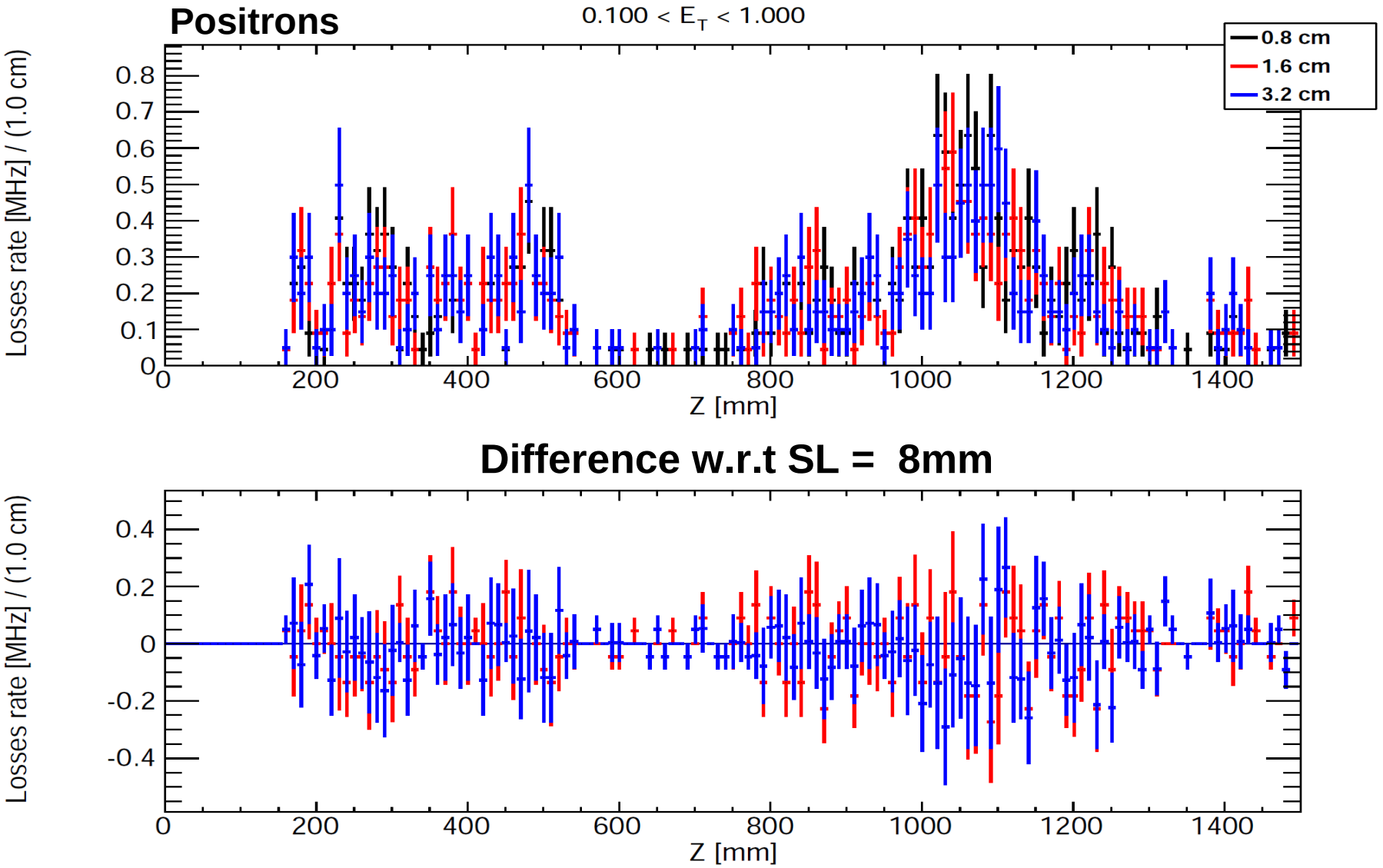
SL vs Rad-BhaBha Losses: Results (III)



SL vs Rad-BhaBha Losses: Results (IV)



SL vs Rad-BhaBha Losses: Results (V)



SL vs Rad-BhaBha Losses: Summary

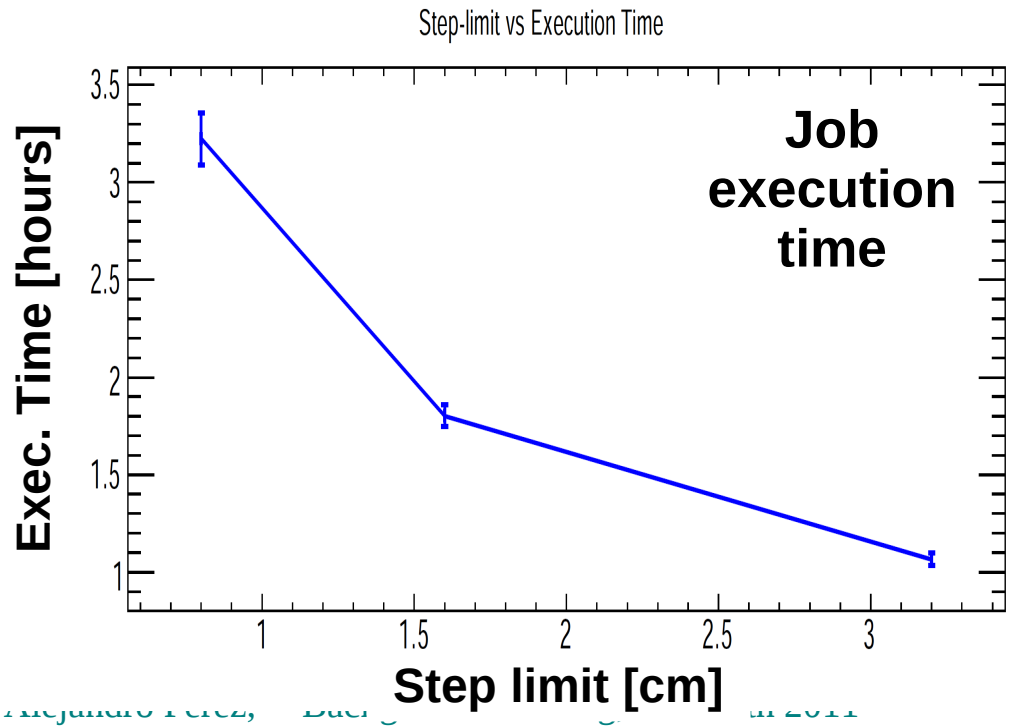
- **Similar results for other Z-ranges and for the other particles types (electrons and gammas). See links,**

Positrons:http://www.slac.stanford.edu/~aperez/SuperB/SuperB_Pisa/StepLimit_Studies/RadBhaBhaLosses/Comparing_Losses_HER_Different_StepLimits.eps

Electrons:http://www.slac.stanford.edu/~aperez/SuperB/SuperB_Pisa/StepLimit_Studies/RadBhaBhaLosses/Comparing_Losses_LER_Different_StepLimits.eps

Photons:http://www.slac.stanford.edu/~aperez/SuperB/SuperB_Pisa/StepLimit_Studies/RadBhaBhaLosses/Comparing_Losses_Gamma_Different_StepLimits.eps

- **Results for SL = 8, 16 and 32 mm in agreement within 10%**

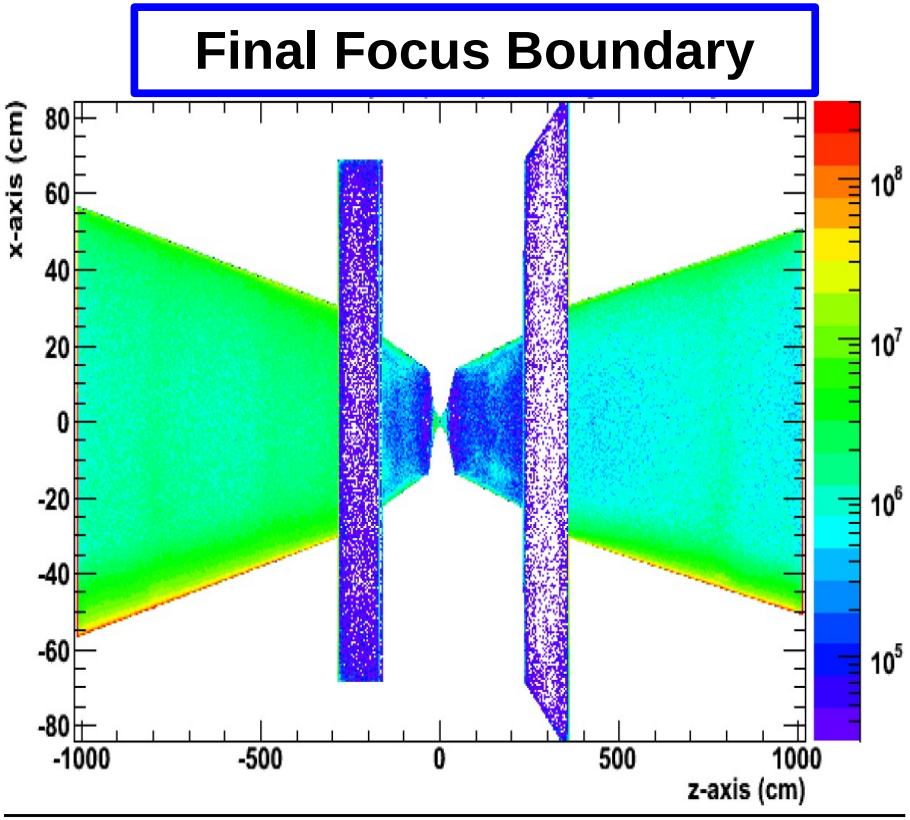


- **Execution time reduces faster than linear with SL**
- **Can reduce execution time by a factor of 3 by choosing SL = 32mm**

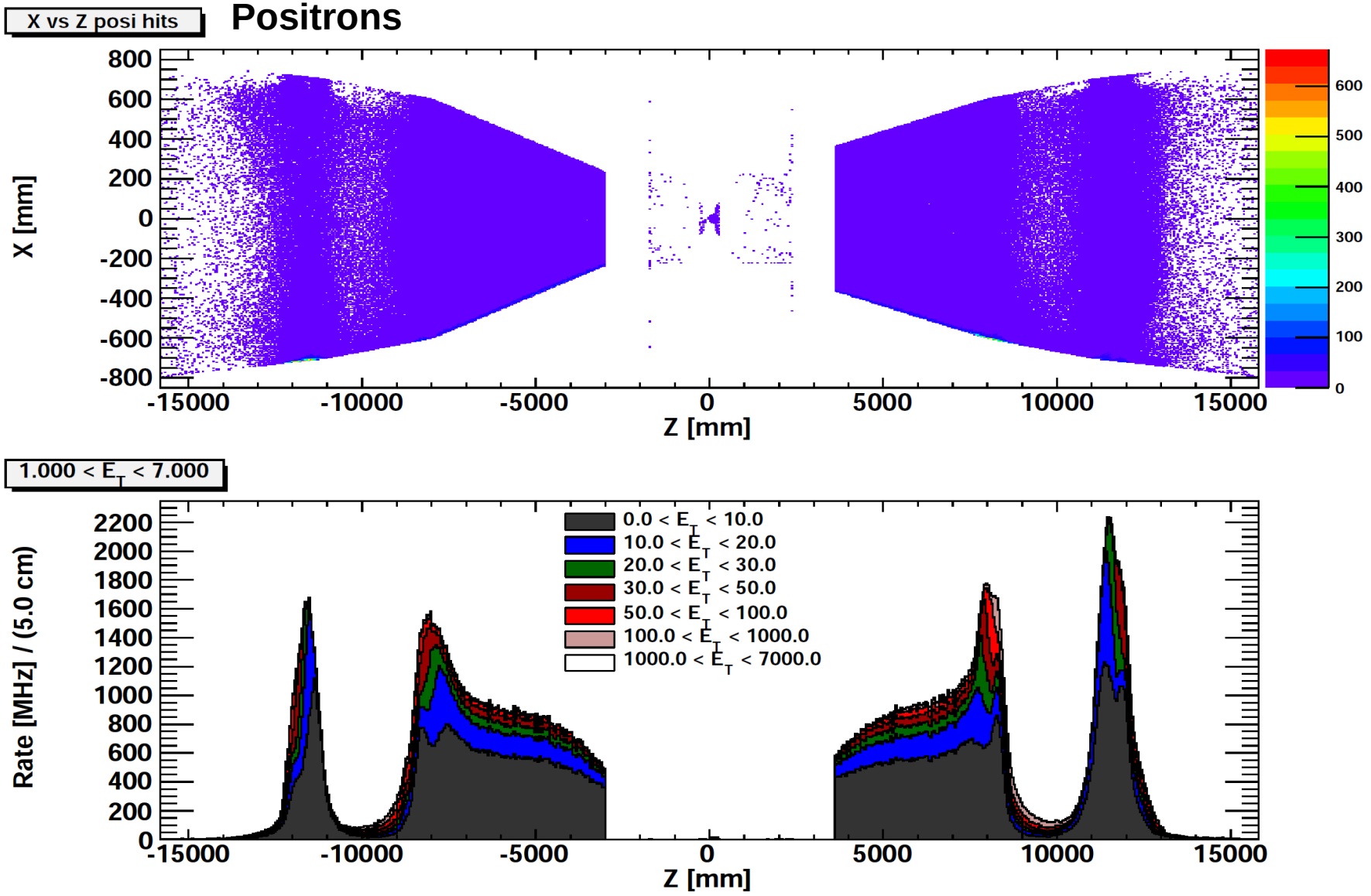
SL vs Rad-BhaBha rates at FF: Strategy

- **Run Bruno with the final focus only (Rad-BhaBha generator)**
- **Use nominal final focus geometry**

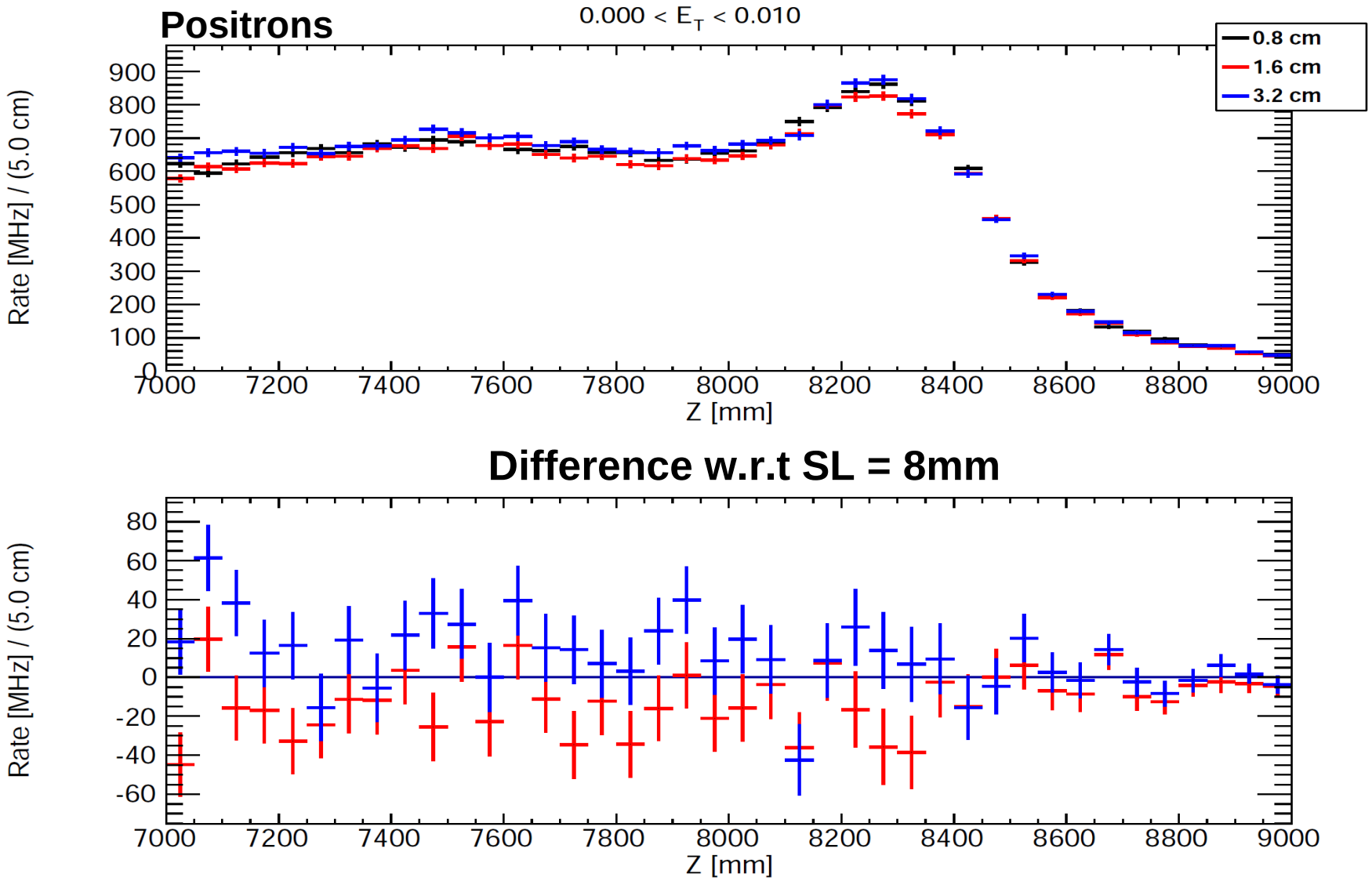
- **Simulate for different SL values: 8, 16 and 32 mm**
- **Evaluate rates at final focus Boundary as a function of Z-coordinate for different:**
  - Particle types: e^-, e^+, γ and n^0
  - Energy bins
  - Transversal energy bins
- **Compare results for different SL values**



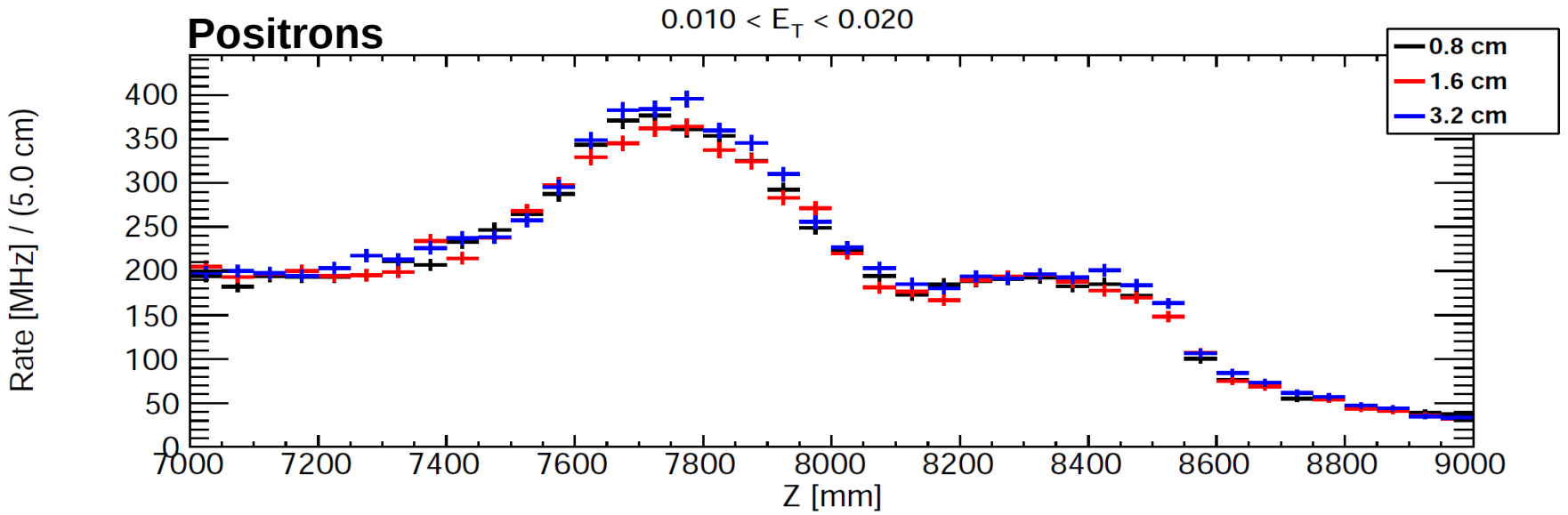
SL vs Rad-BhaBha rates at FF: Results (I)

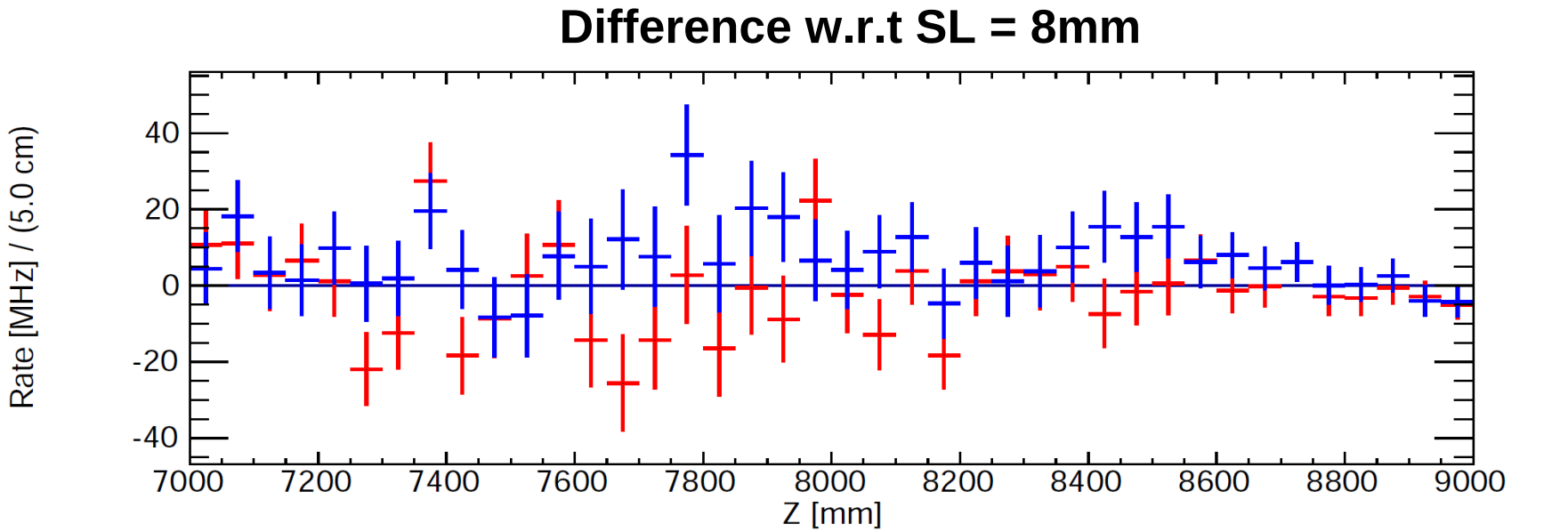


SL vs Rad-BhaBha rates at FF: Results (II)

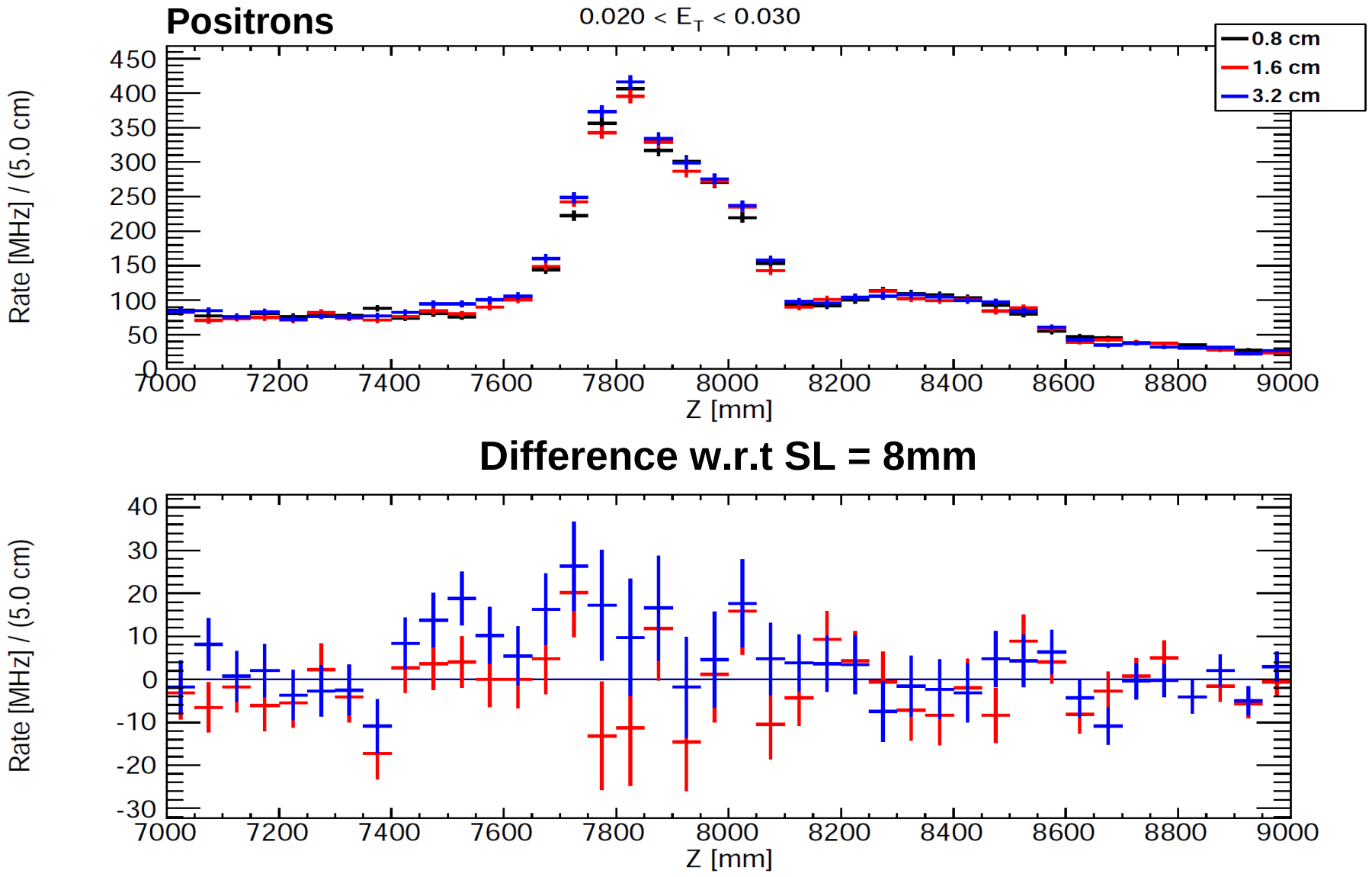


SL vs Rad-BhaBha rates at FF: Results (III)

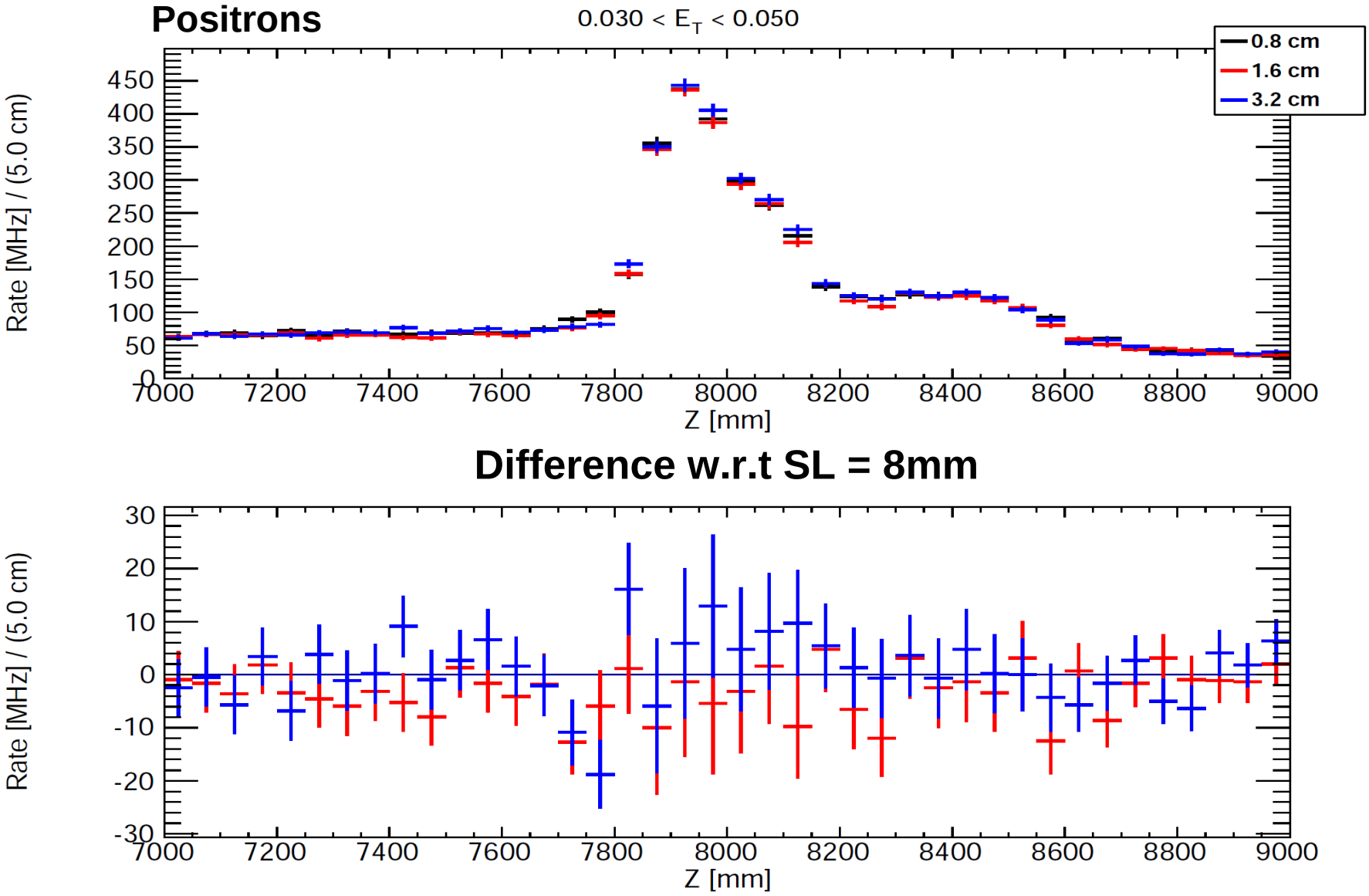




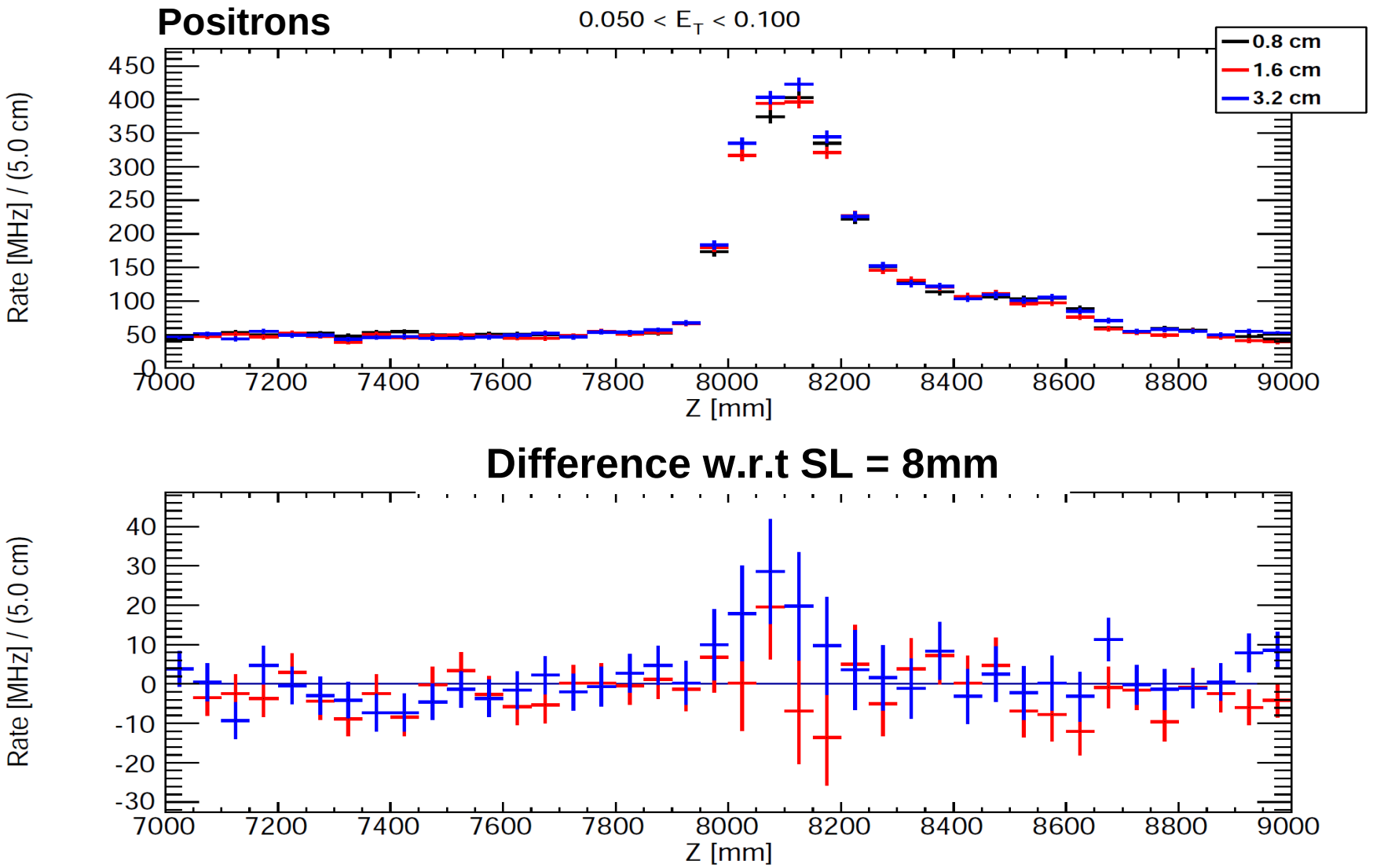
SL vs Rad-BhaBha rates at FF: Results (IV)



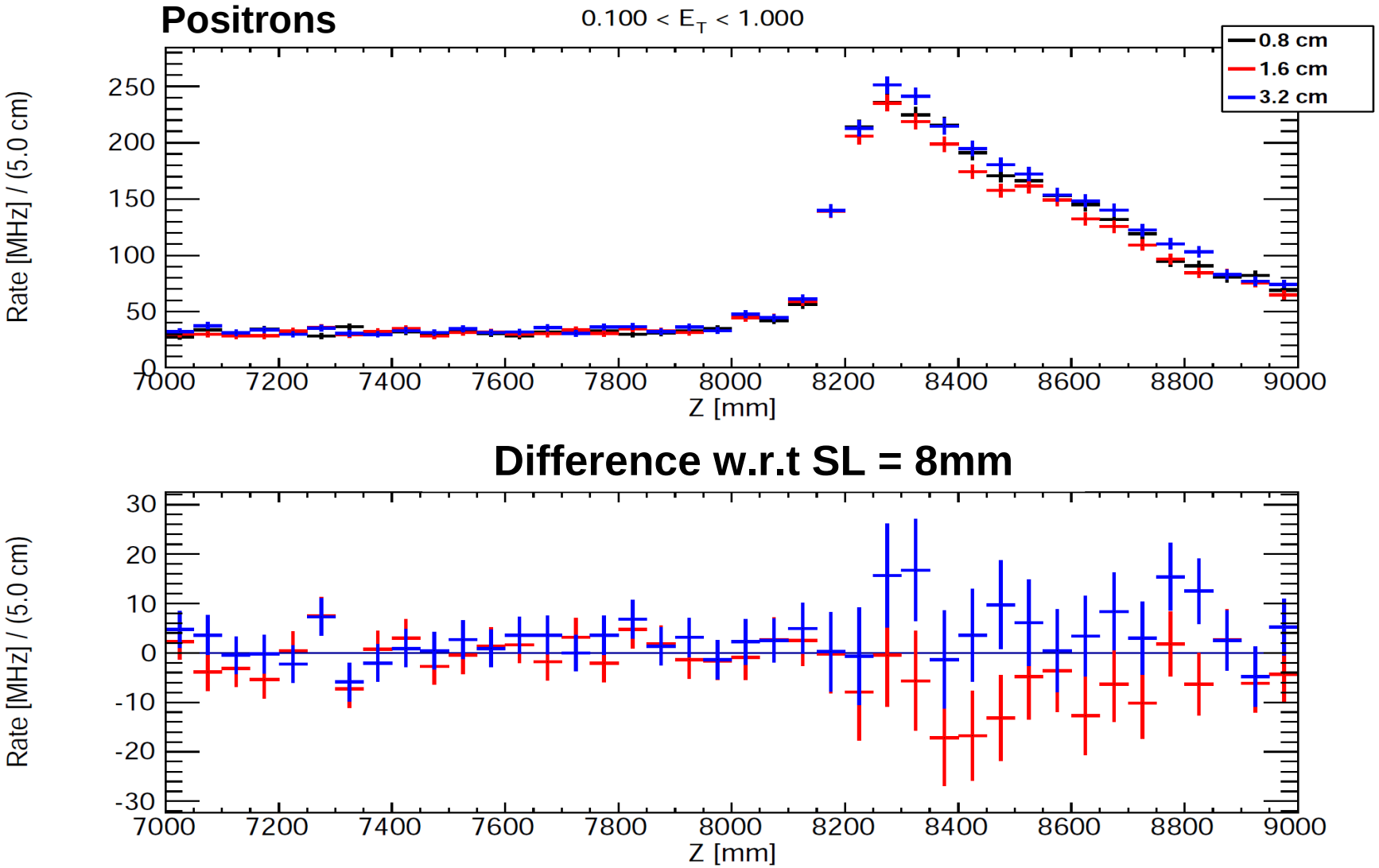
SL vs Rad-BhaBha rates at FF: Results (V)



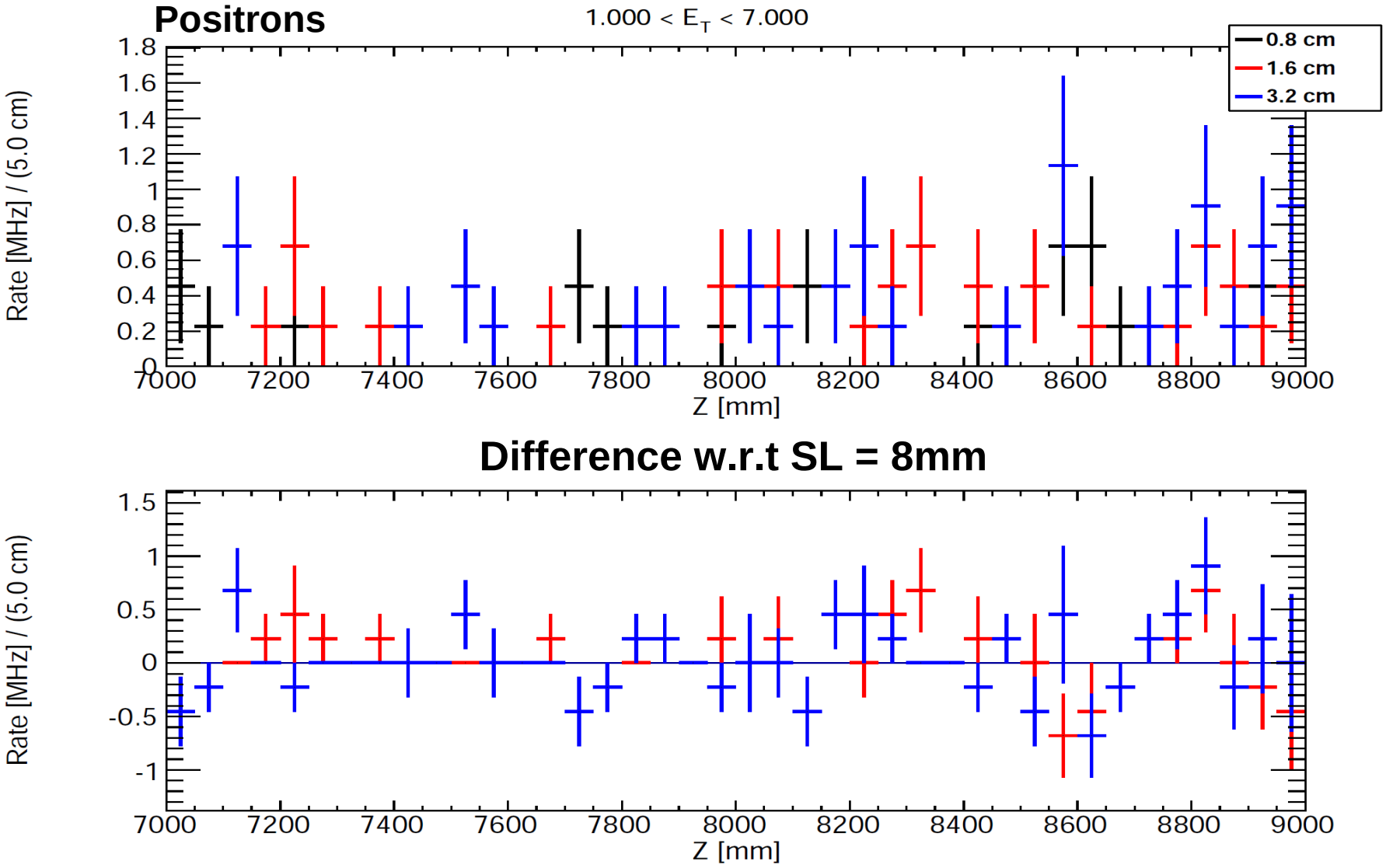
SL vs Rad-BhaBha rates at FF: Results (VI)



SL vs Rad-BhaBha rates at FF: Results (VII)



SL vs Rad-BhaBha rates at FF: Results (VIII)



Step limit vs Rad-BhaBha rates at FF Summary

- **Similar results for other Z-ranges and for the other particles types (electrons and gammas). See links,**

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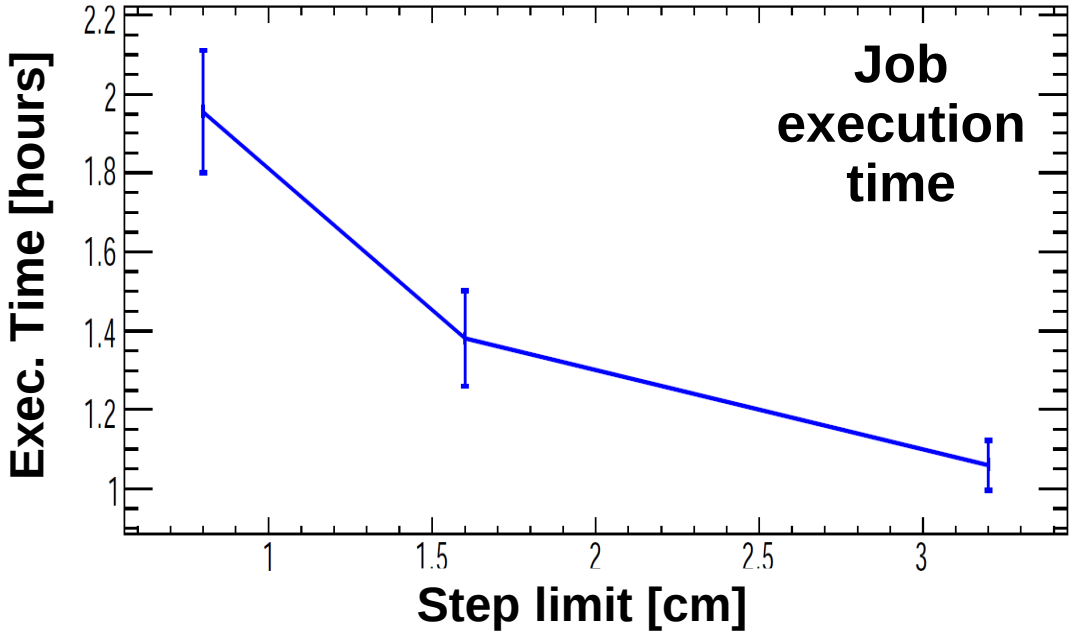
Electrons:http://www.slac.stanford.edu/~aperez/SuperB/SuperB_Pisa/StepLimit_Studies/RadBhaBhaFFBoundary/Comparing_FF_boundary_elec_Different_StepLimits.eps

Photons:http://www.slac.stanford.edu/~aperez/SuperB/SuperB_Pisa/StepLimit_Studies/RadBhaBhaFFBoundary/Comparing_FF_boundary_Gamma_Different_StepLimits.eps

Neutrons:http://www.slac.stanford.edu/~aperez/SuperB/SuperB_Pisa/StepLimit_Studies/RadBhaBhaFFBoundary/Comparing_FF_boundary_Neutron_Different_StepLimits.eps

- **Results for SL = 8, 16 and 32 mm in agreement within 10%**



- **Execution time reduces faster than linear with SL**
- **Can reduce execution time by a factor of 2 by choosing SL = 32mm**

Summary

- **Step limit optimization studies performed**

- **Studies point to use SL = 32mm**
  - Negligible effect on beam parameters
  - Small effect (less than 10%) on Rad-bhabha losses and rates at FF boundary
  - Can reduce execution time by a factor of 2 w.r.t SL = 8mm

- **Will set-up the nominal value of SL inside the final focus to 32mm**


Backup