



# Ionization cooling studies with ICOOOL and G4BL

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# The Big Picture...

- Benchmark ionization cooling codes
  - Run G4BL and ICOOL
  - Compare front-end for BL and BC lattices (present at the IDS meeting, PRST-AB level paper)
  - Examine flip and no flip lattices for muon collider (linear, with matrix)
  - Proceed to 3D (with Rick)
- Space-charge studies
  - Add a model in G4BL
  - Compare with WARP and COSY (Pavel) for above lattices
  - SC vs No-SC?



# Outline

- ICOOL 3.28 vs G4BL 2.12 comparison
  - Zero emittance beam through absorber
  - Varying scattering models
- Add to G4BL a matrix for emittance exchange
  - Case with absorber only
  - Case with absorber and magnetic field
- Next steps

# Lattice Parameters

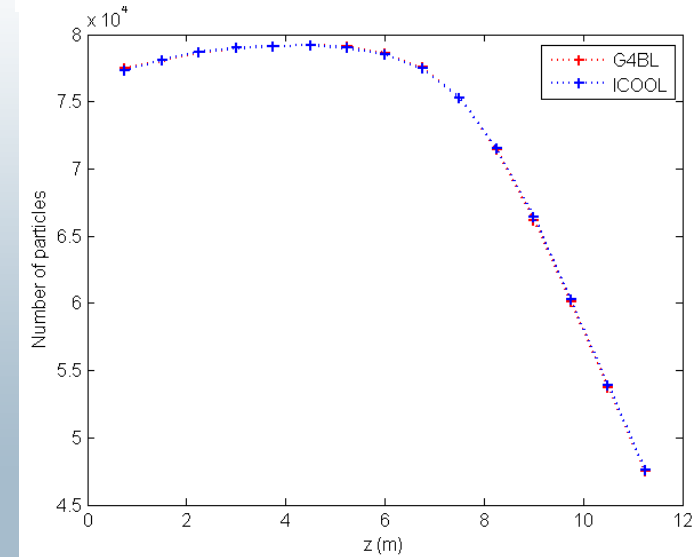
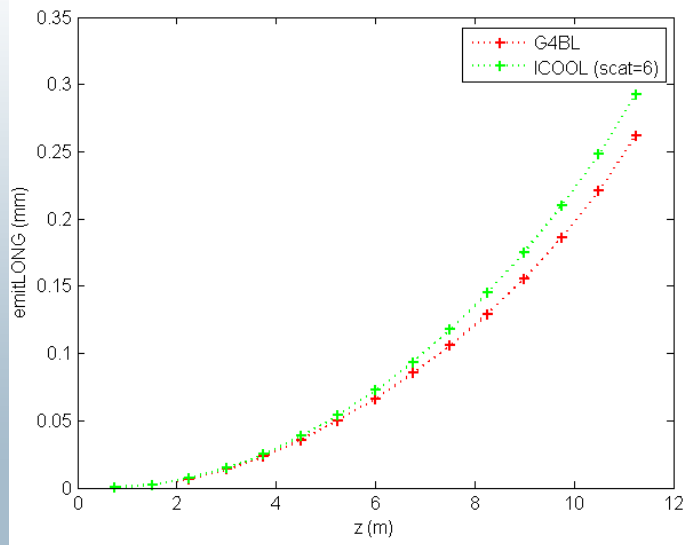
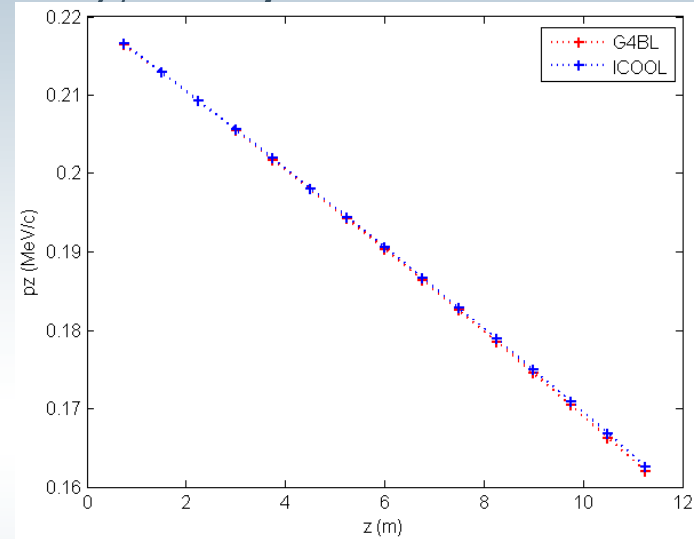
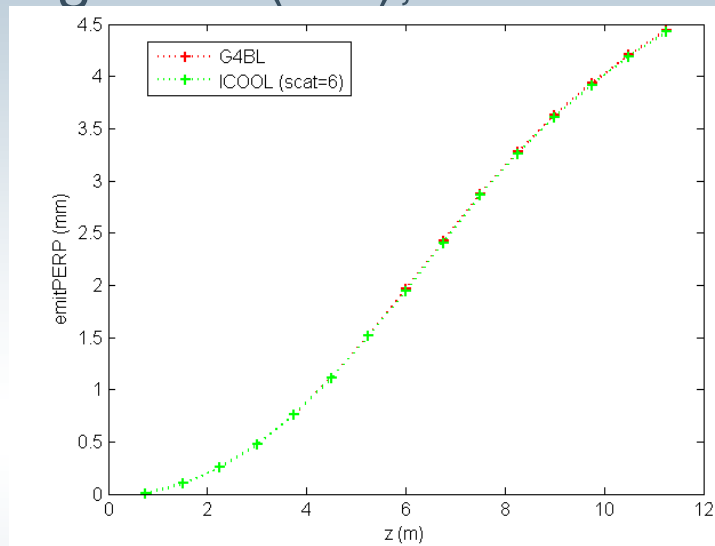
- Cell length 75 cm
- A 2cm absorber at the center of the cell
- Absorber material is Lithium Hydride
- Run for 15 cells

# Beam Parameters

- Zero emittance beam
- Center momentum at 220 MeV/c
- Positive muons
- Start with 80,000 particles
- Muon decay OFF

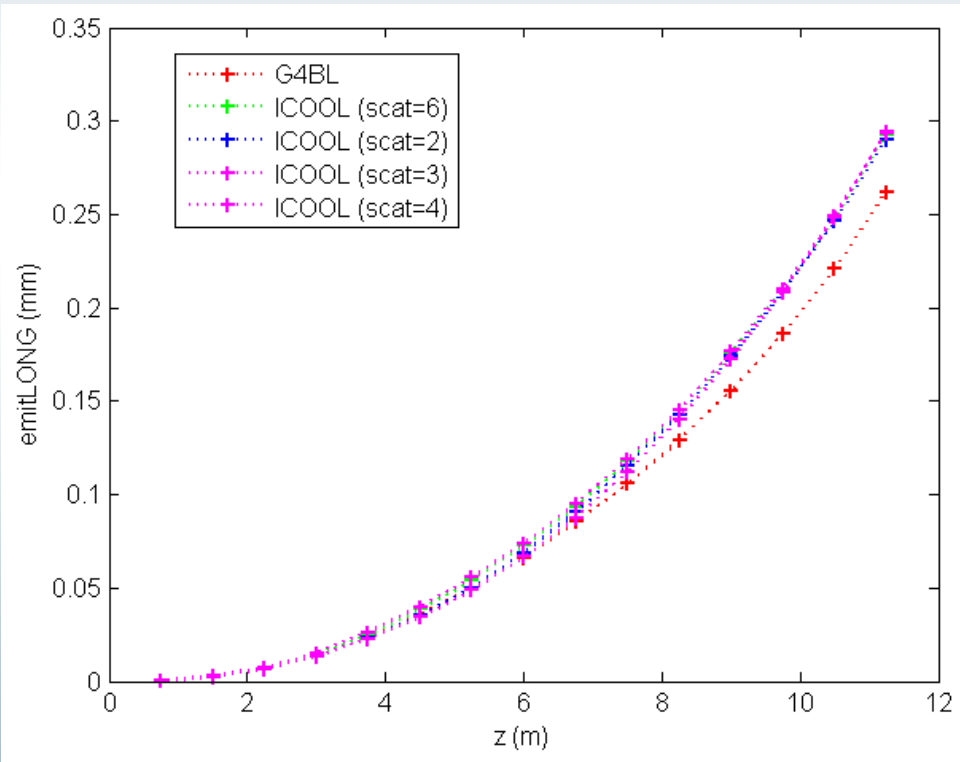
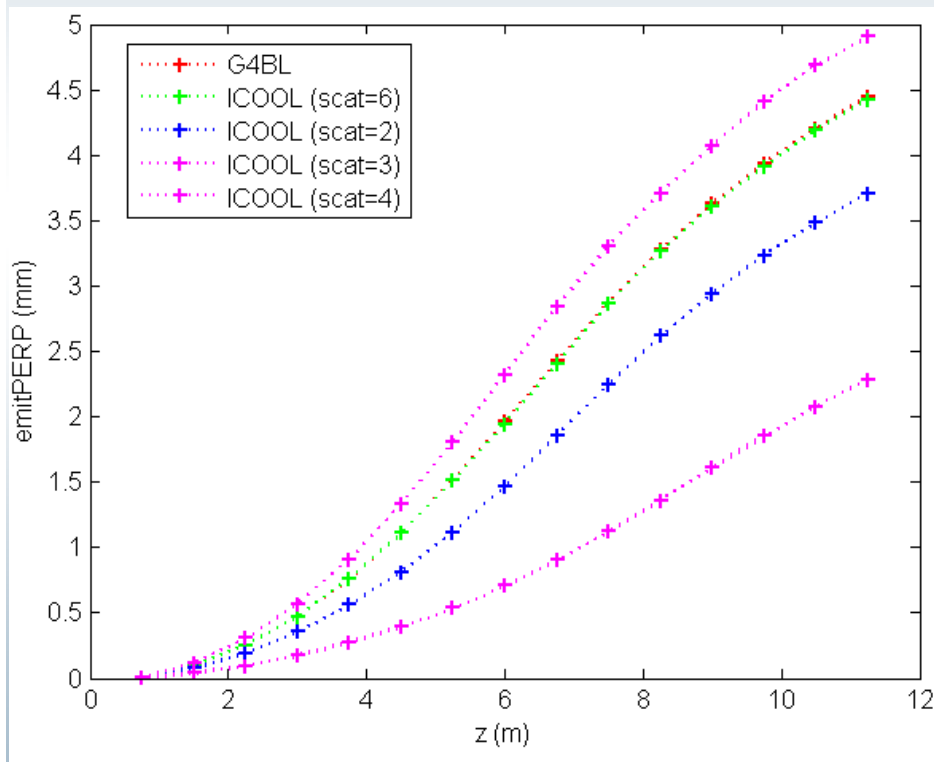
# ICOOL versus G4BL

- straglev=5 (def), scatlev=6 (def), ldray ON



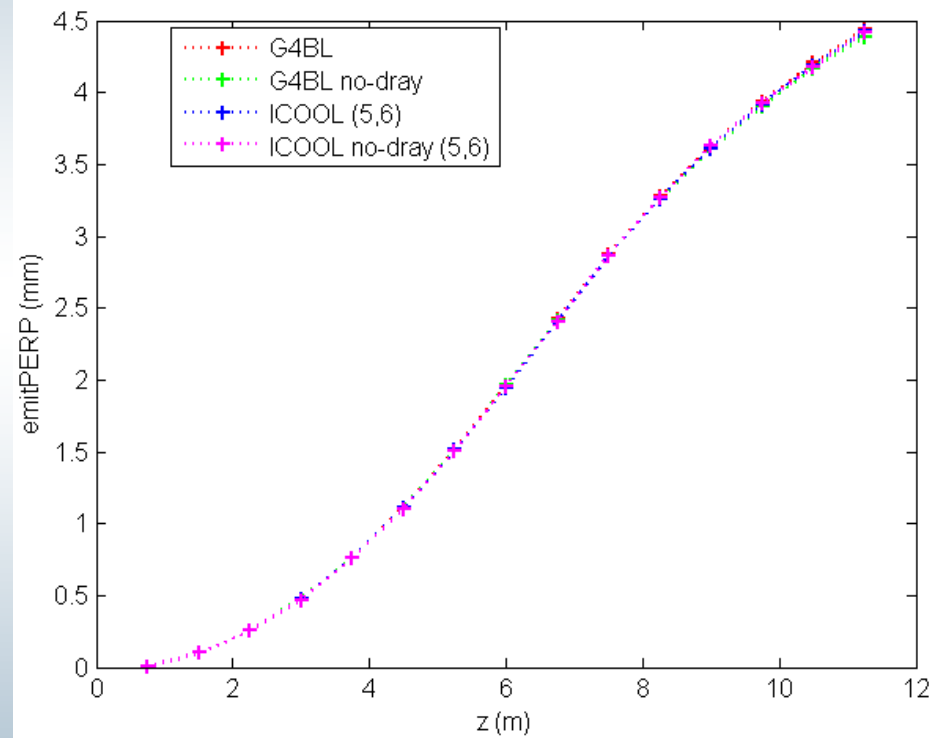
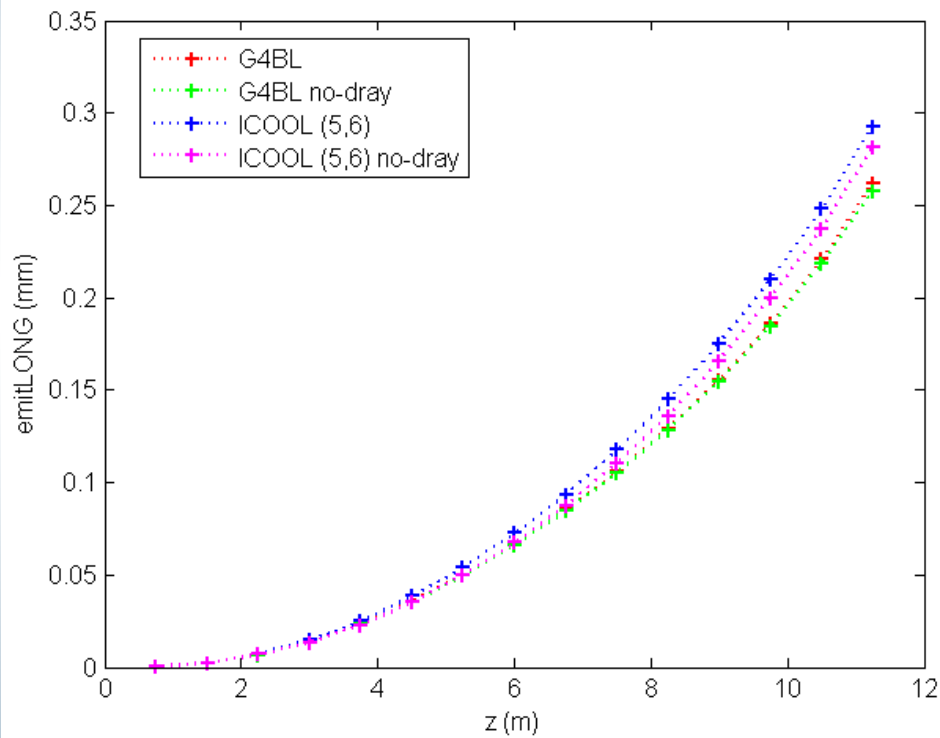
# Varying scattering models in ICOOL

- straglev=5 (def), scatlev=**VARY**, ldray **ON**



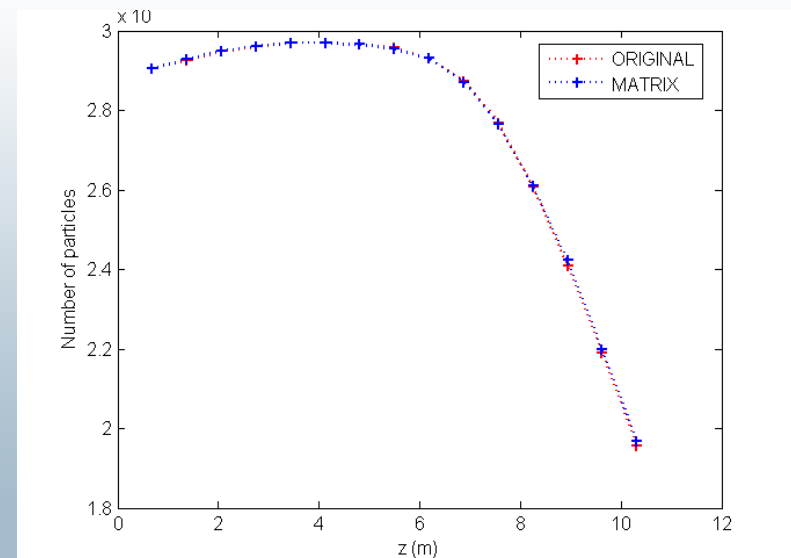
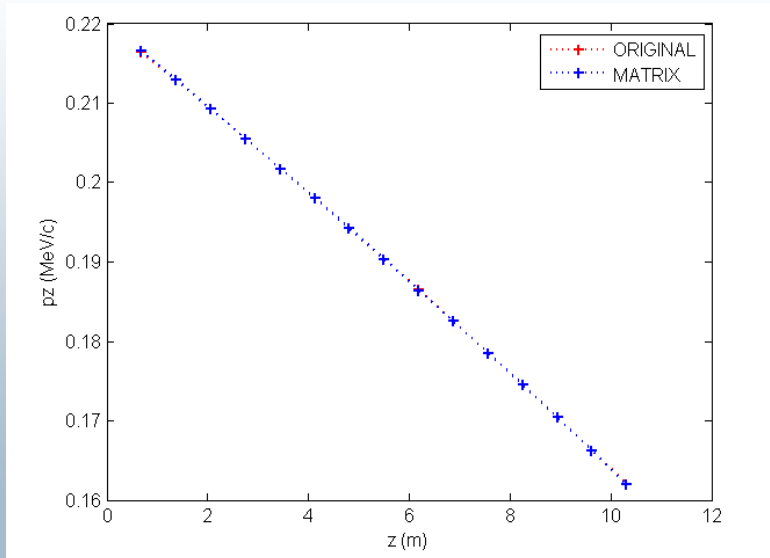
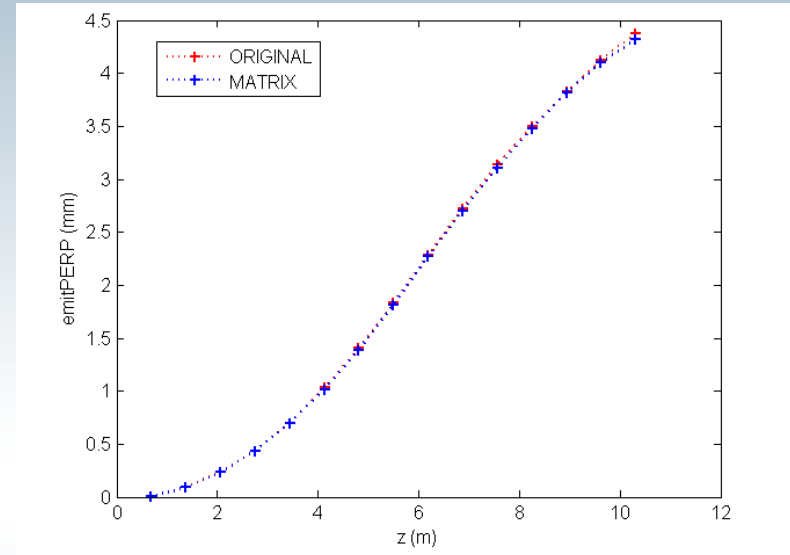
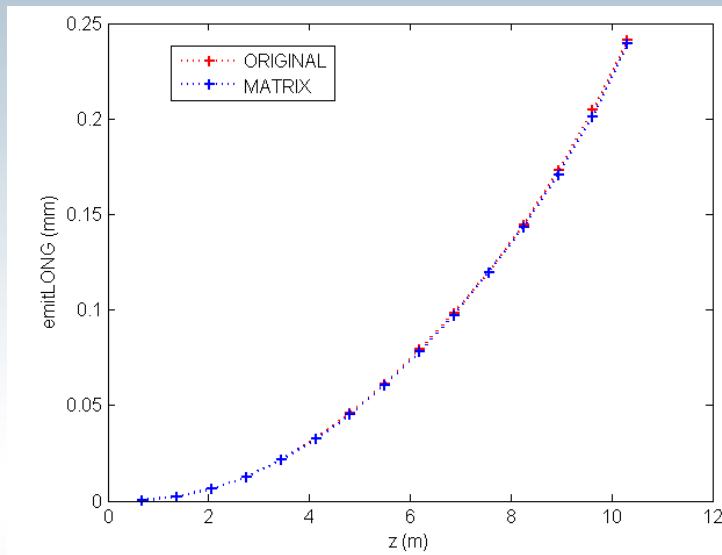
# Without delta rays

- straglev=5, scatlev=6, ldray **OFF**

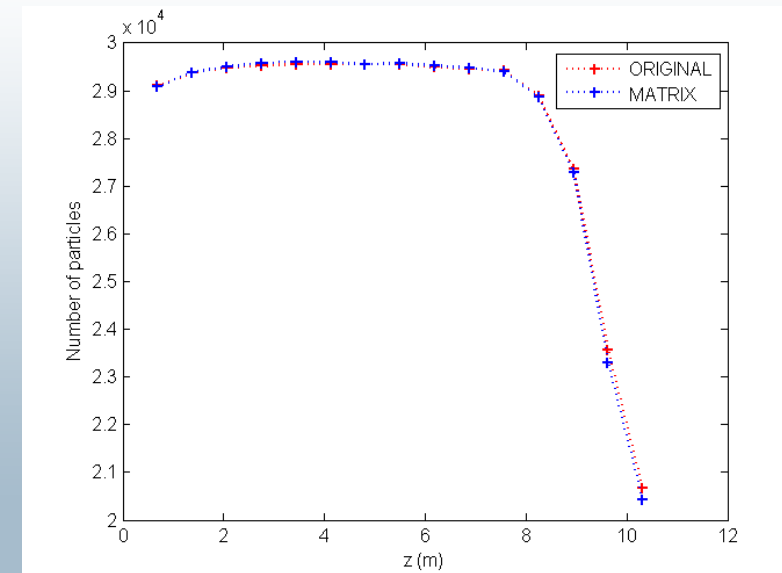
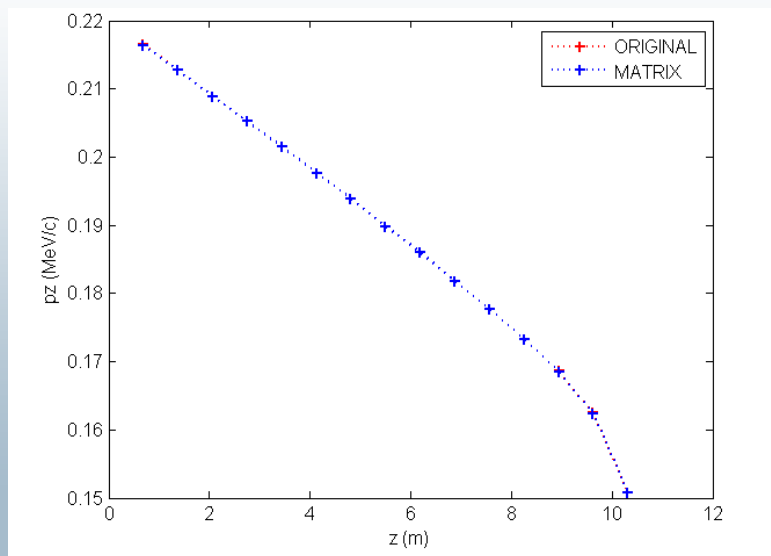
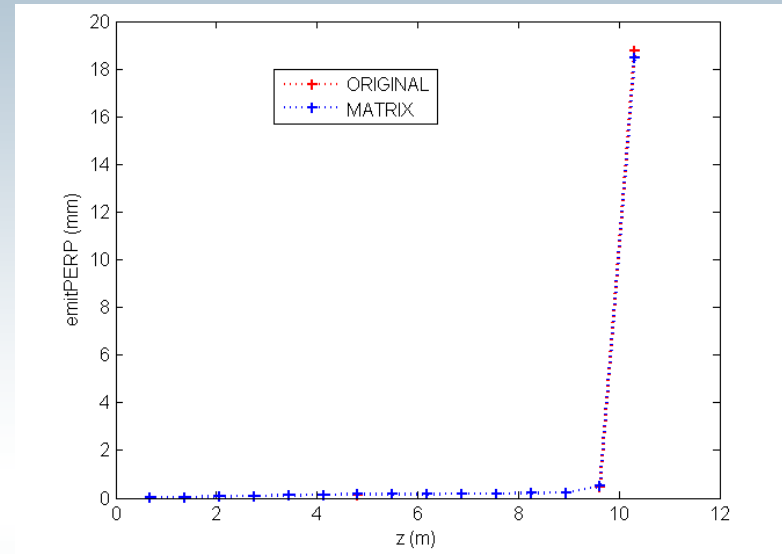
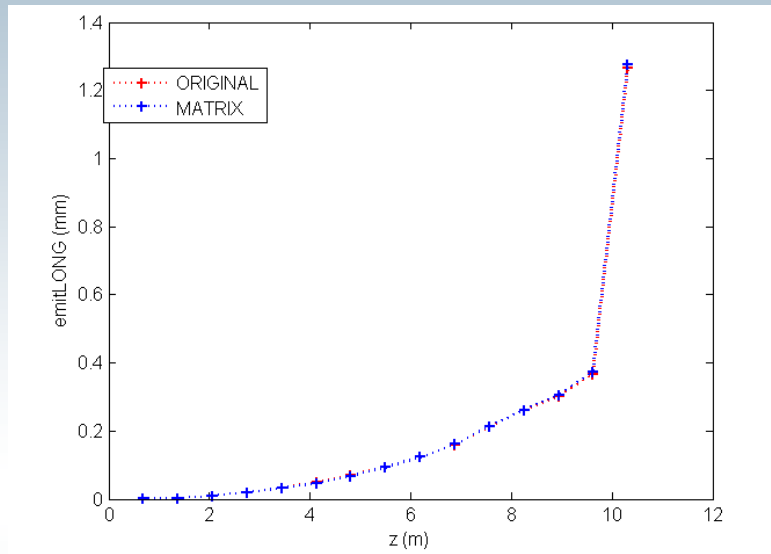




# Matrix manipulation (without B)



# Matrix manipulation (with B)



# Summary & Outlook

- G4BL and ICOOL codes were compared
- Satisfactory agreement on rms transverse emittance and  $P_z$  with  $\text{scatlev}=6$
- 10% off in longitudinal emittance not sensitive to different scattering models
- Next step vary straggling levels
- After 3 weeks of trying a (identity) matrix was added to G4BL and works well with absorbers and B-fields
- Next I will test this concept with rf cavities
- Simulate with G4BL last 6D cooling stage and compare with ICOOL