Ionization cooling studies with ICOOL and G4BL

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D&S Phone Meeting
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Outline

- Particle-Matter interaction with ICOOL & G4BL
  - Zero emittance beam through absorber
  - Varying scattering models
  - Varying straggling models
- Cooling with ICOOL & G4BL for a realistic lattices
  - Last 6D cooling stage of a muon collider
  - Muon accelerator front-end
- Conclusions and 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

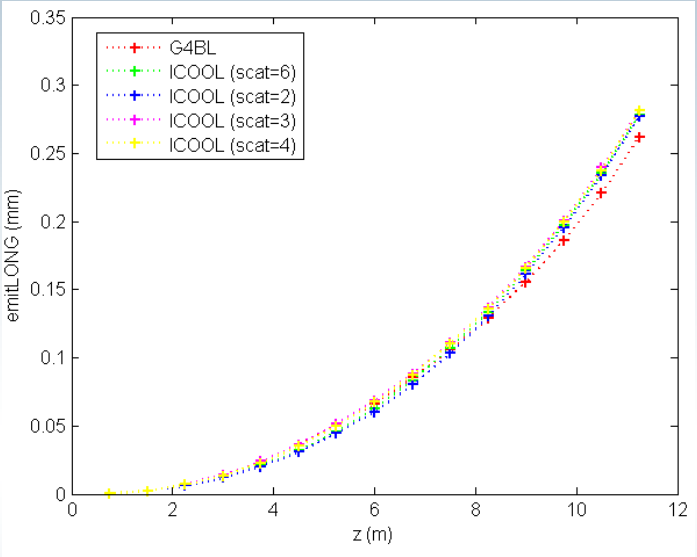
- Zero emittance beam
- Center momentum at 220 MeV/c
- Positive muons
- Start with 80,000 particles

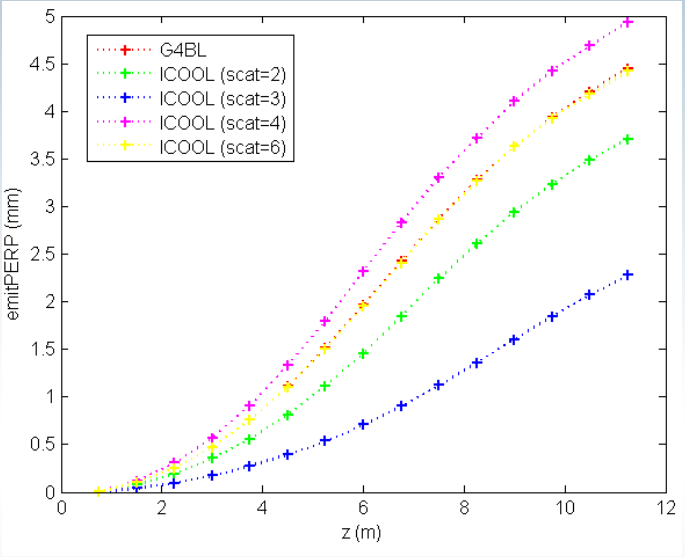
Simulation Parameters

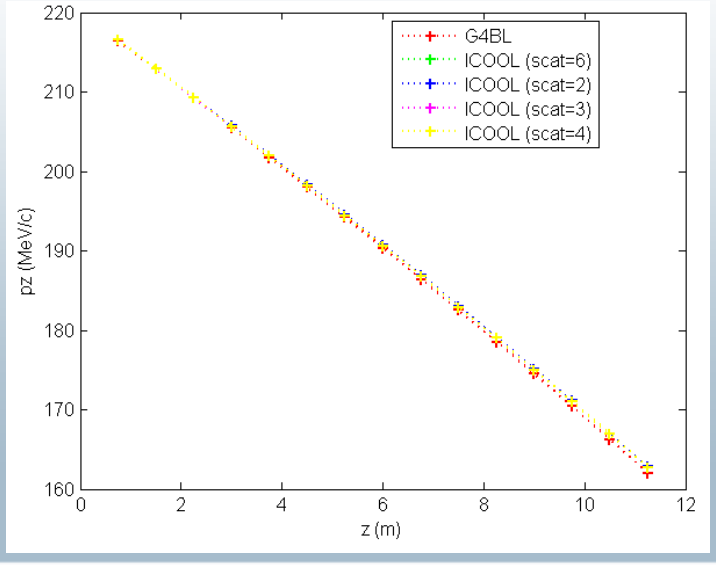
- ICOOL 3.28 and G4BL 2.12
- “Force” ICOOL and G4BL to use the same density for Lithium Hydride (0.78 g/cm^3)
- Include stochastics but:
  - Muon decay is OFF
  - deltaray is OFF

Scattering Models

- straglev=5, ldray **OFF**



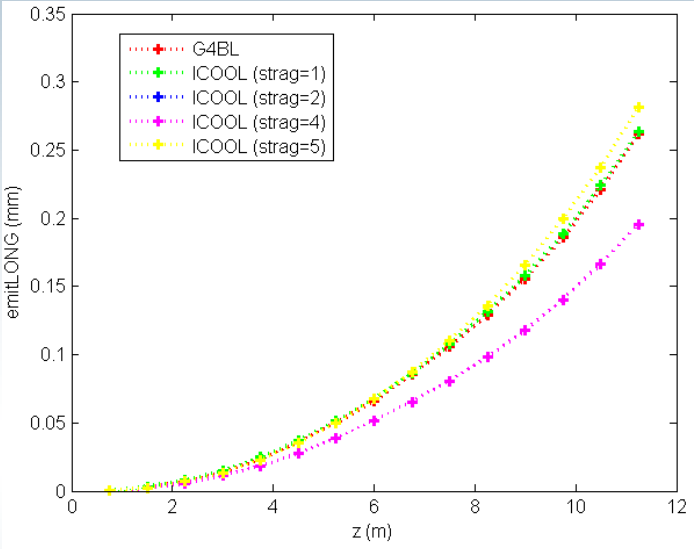


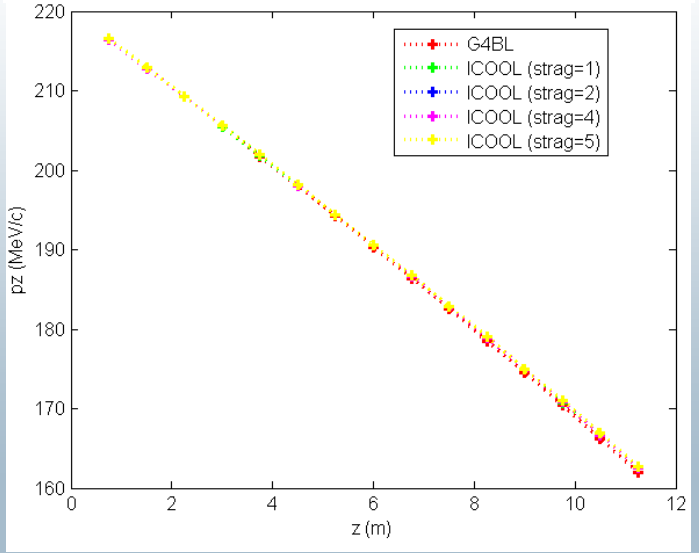


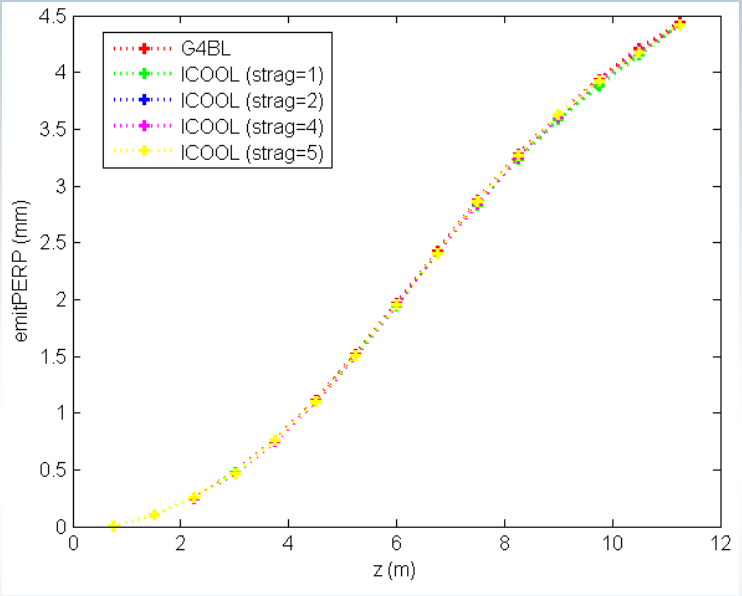
scatlev=2, Gaussian (0, Highland)
scatlev=3, Gaussian (0, Lynch-Dahl)
scatlev=4, Bethe version of Moliere distribution
scatlev=6 Fano (with Rutherford limit)

Straggling Models

- scatlev=6, ldray **OFF**

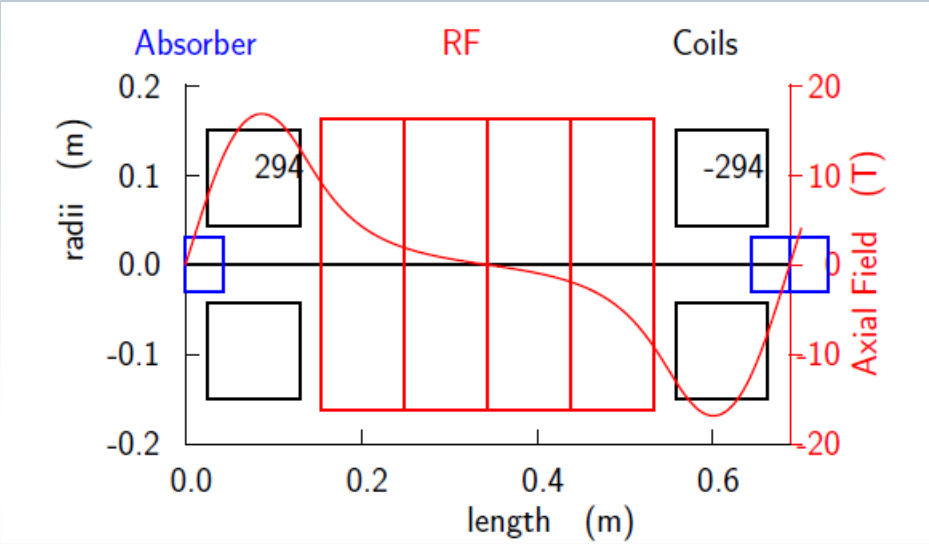






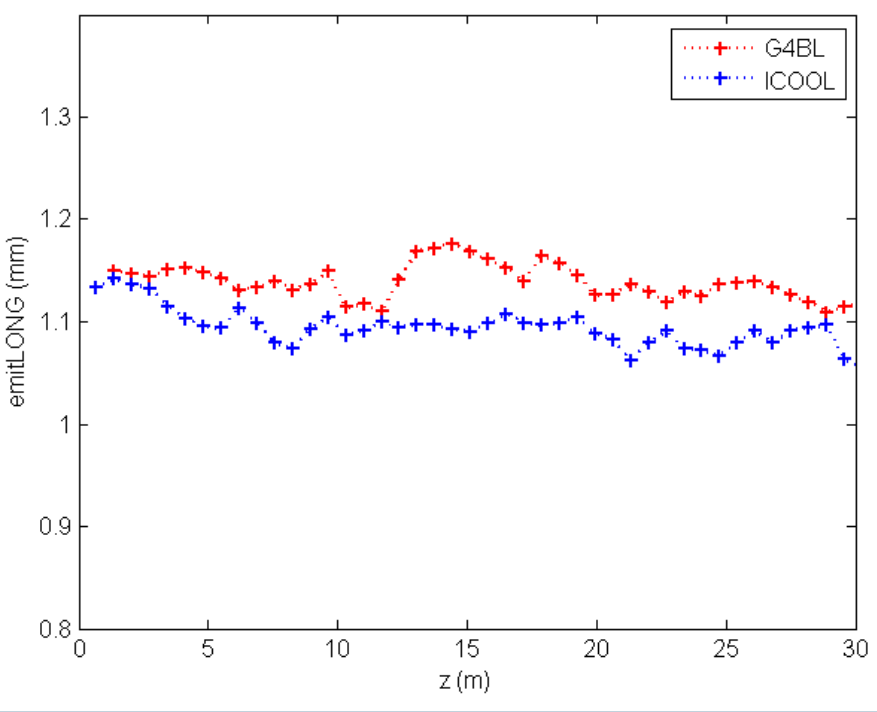
straglev=1, Gaussian(Bohr)
straglev=2, Landau distribution
straglev=4, Vavilov
straglev=5, restricted energy fluctuations from continuous processes with energy below 3 MeV

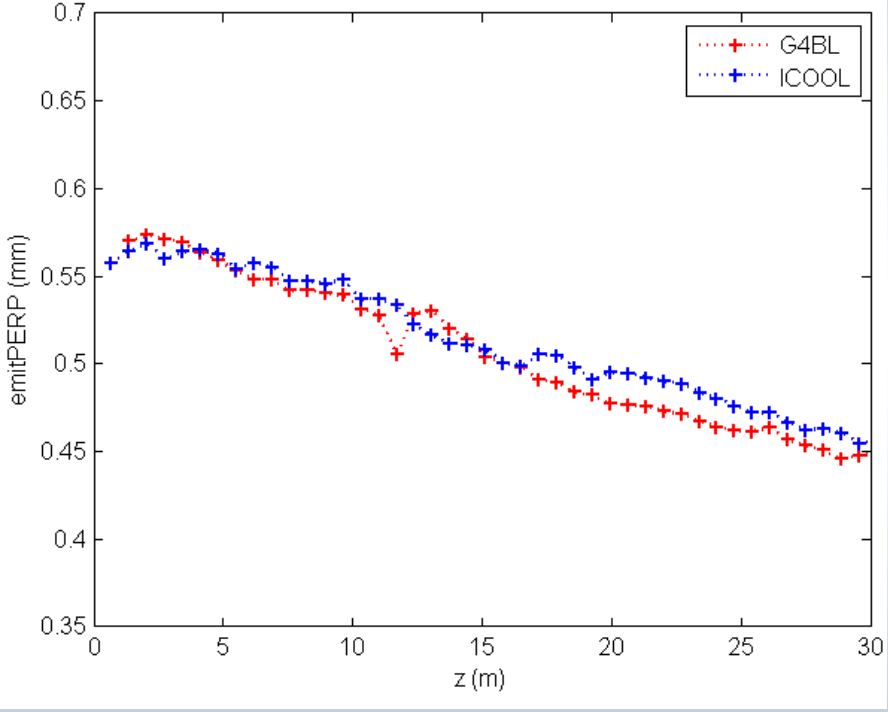
Final 6D Cooling



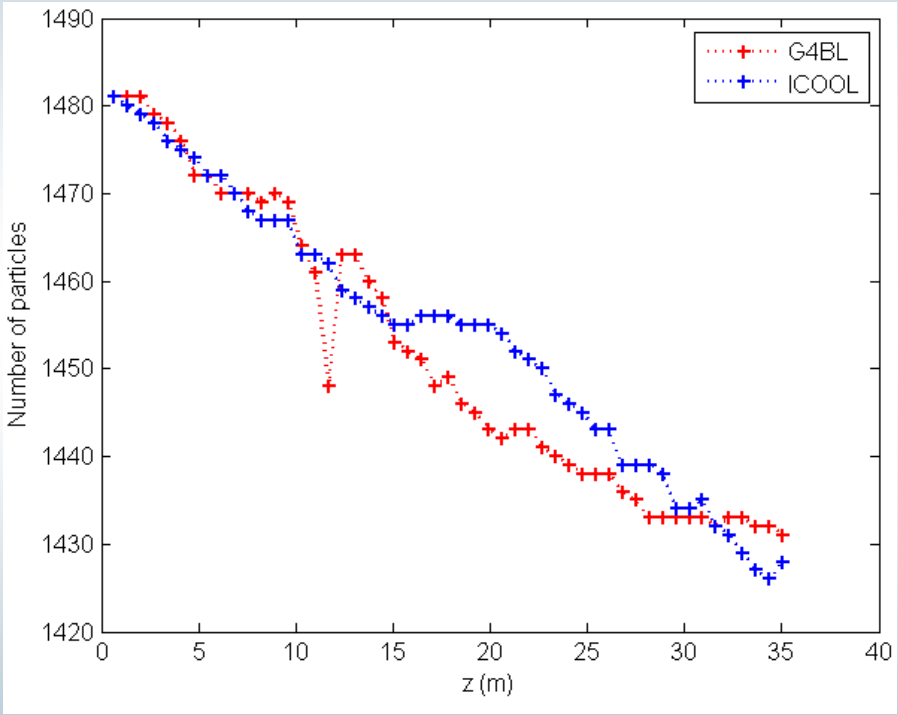
- Cell length 68.75 cm (51 cells)
- Absorber material is Lithium Hydride
- It is the regime where space-charge can “kick-in” but for the moment we ignore
- NEW: Cooling with a emittance-exchange matrix – a new tool I implemented to G4BL

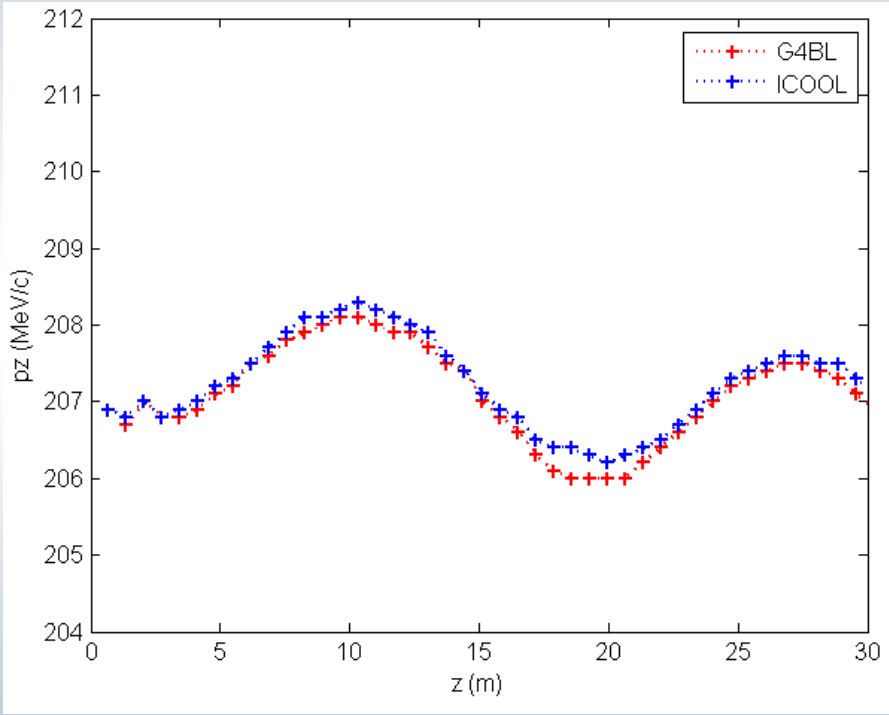
ICOOL & G4BL in Final 6D Cooling (1)





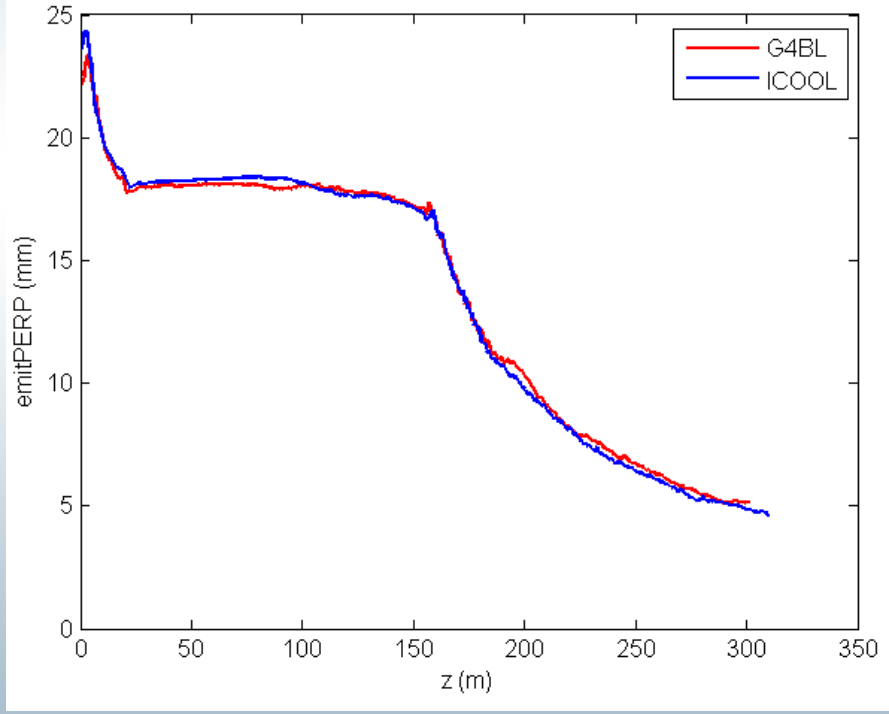
ICOOL & G4BL in Final 6D Cooling (2)

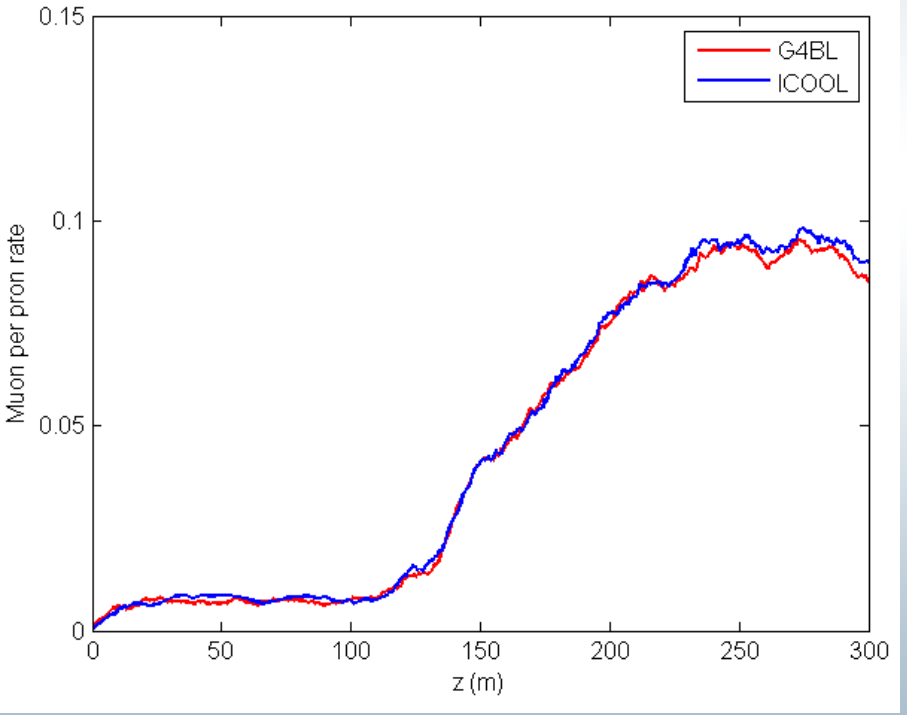




Muon Accelerator Capture Front-End

- This work will be discussed in more detail at the IDS-Meeting in October





Summary & Outlook

- G4BL and ICOOL were compared and they do show similar results in the way the model particle-matter interaction.
- Best agreement when: scatlev=6 (Fano) and strag=1 (Bohr)
- The codes show also reasonable agreement for “realistic” cooling lattices:
  - Muon accelerator front-end
  - 6D Final cooling after merging
- Next step is to compare with WARP for the 6D cooling lattice
- Study space-charge effects WARP/ G4BL