An Update on BDSIMxG4BL Solenoid Validations

Muon Collider Cooling Meeting

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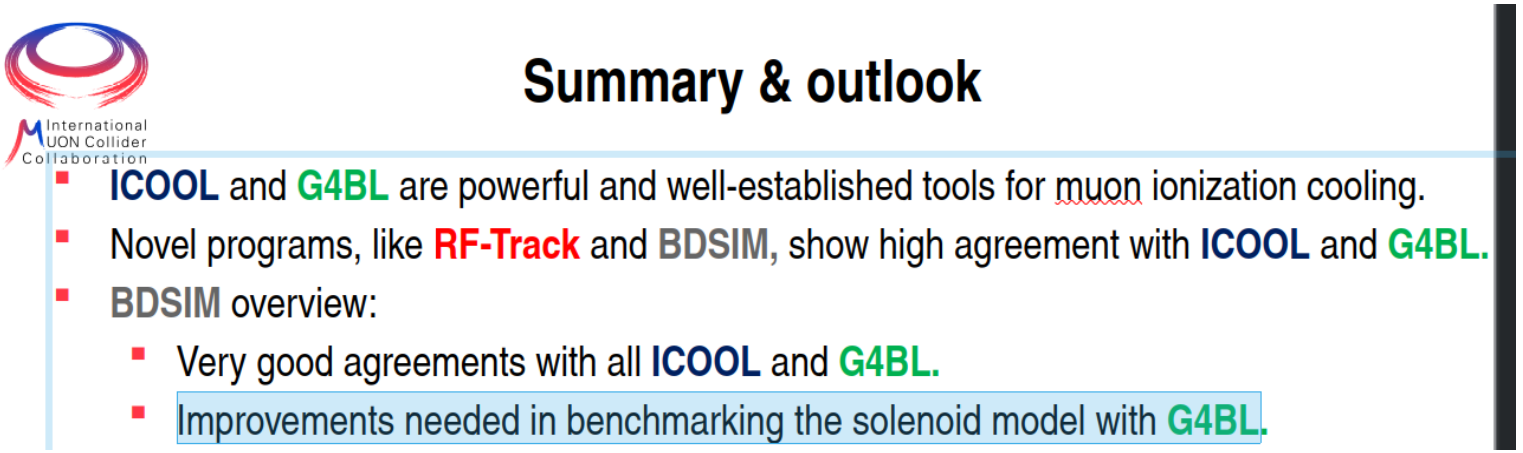
Context

- A software mini-workshop (https://indico.cern.ch/event/1446644/)before the demonstrator workshop looked to do a like-for-like validation of different tracking codes and softwares for muon cooling.
- This has been summarized by Bernd Stechauner in the Fermilab workshop here. https://indico.fnal.gov/event/64984/timetable/#20241030.detailed

Context

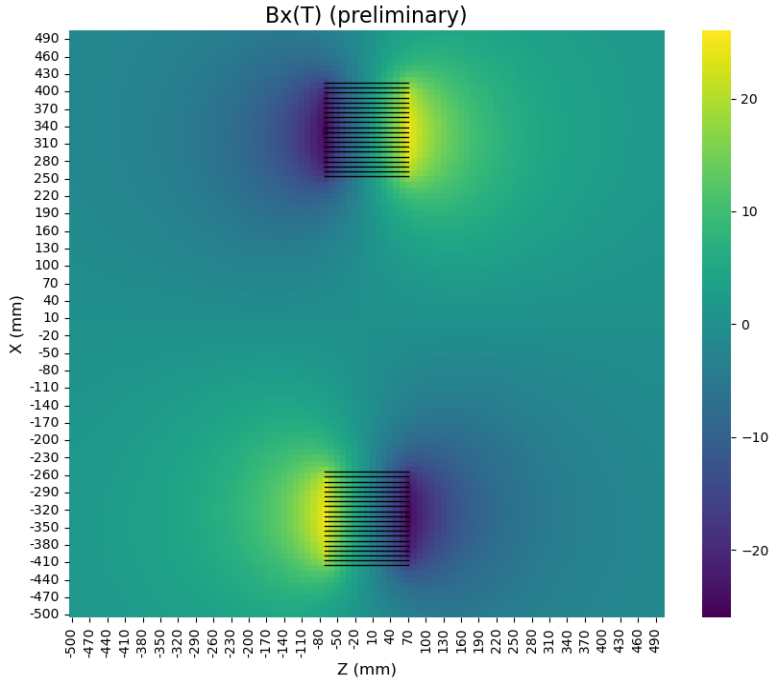
- Particularly, one of the outcomes of the workshop was the shortfall in the solenoid implementation in BDSIM.

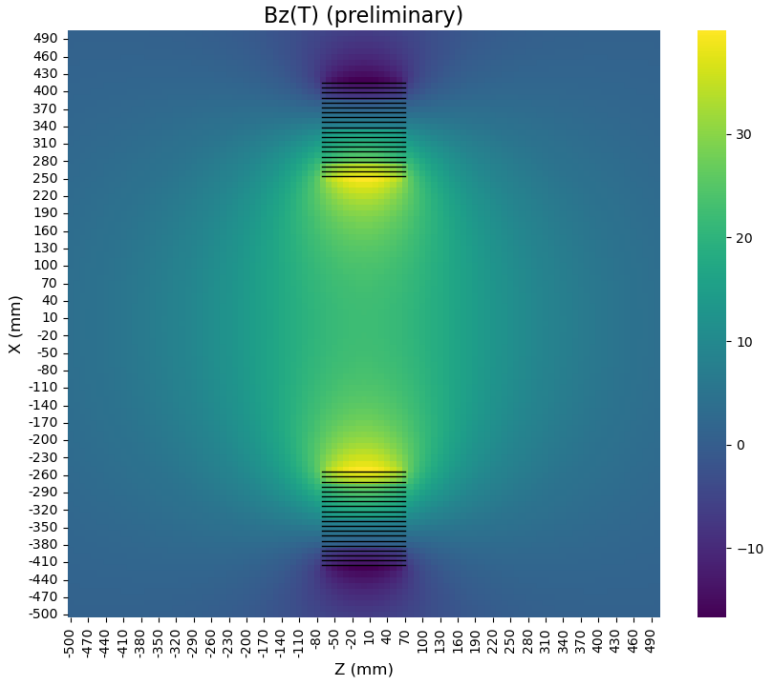


Since then...

- Bugs in the analytic calculation of the solenoid field off axis have been fixed.
- BDSIM only did a solenoid sheet model natively.
- G4BL does solenoid blocks by modelling a block as multiple sheets. This has been now implemented, and BDSIM does solenoid block models out of the box as well.
- Bounding boxes have been added to solenoid (calculated based on a user supplied tolerance) to save flops on calculating complex elliptic integrals off axis for far away solenoids.
- The cooling branch has been merged* with the develop branch of BDSIM and can compile/run after the latest updates in the wider BDSIM framework.

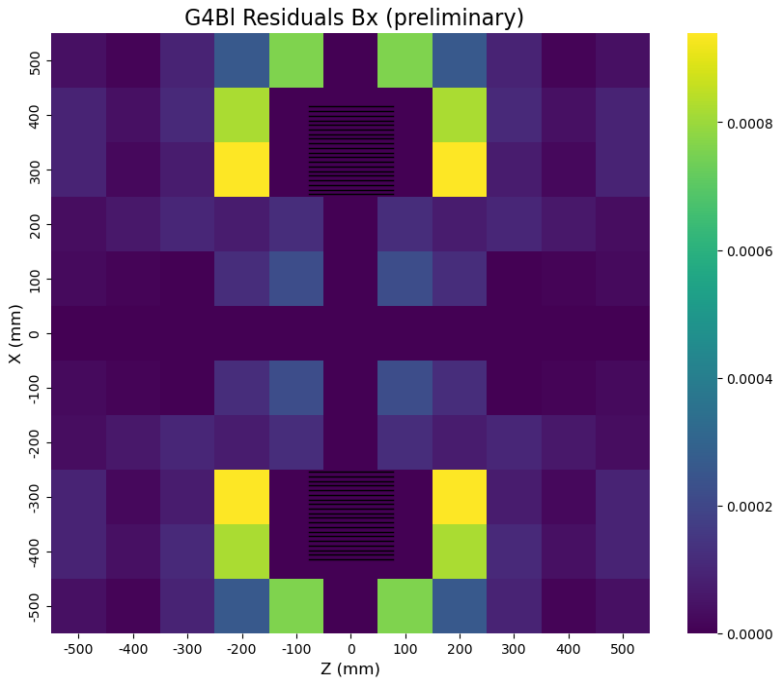
B Field Maps

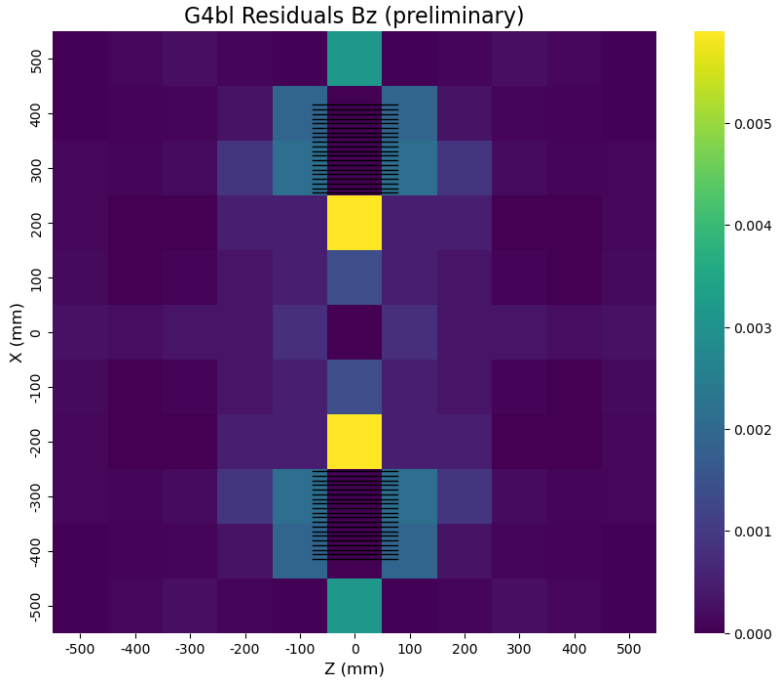




B Field blows up near the actual coils of the solenoid - currently BDSIM returns 0 very close to the sheet so the integral isn't calculated inside a spatial limit.

G4BL Residuals

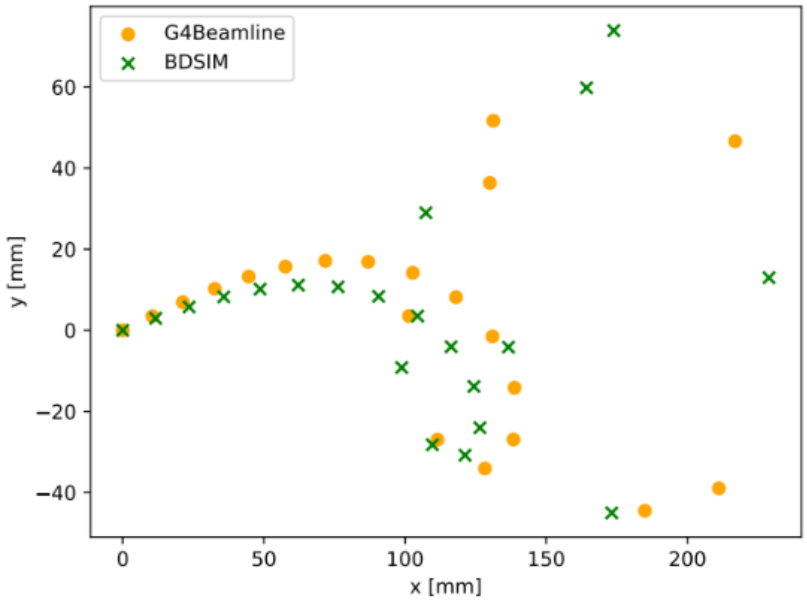




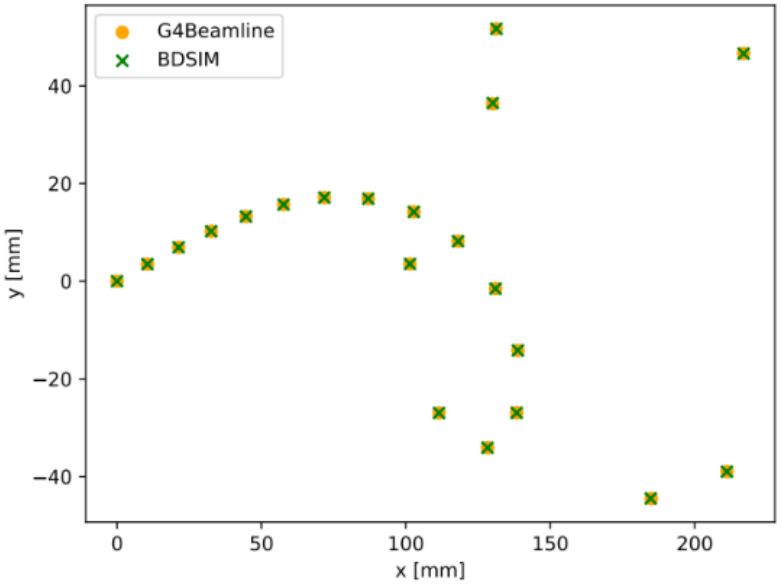
NB: Masked 6x points in the Bx plot and 2x points in the Bz plot *inside* the solenoid coil due to aforementioned reasons

Tracking

Before



After



Next Steps

- Get the PR accepted into the main BDSIM repo.
- Rerun the residuals with a more granular G4BL field map.
- Model currently returns 0 close to the sheet, this can be improved/replaced with something more physical.
- Extend validations to include RFs, absorbers towards a tracking validation of the entire cooling channel.
- Add and validate dipoles (WIP)

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