Geant 4 status in ATLAS
Physics, plans, and technicalities

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ATLAS simulation status

- Full sim currently using G4 9.2.patch02.atlas04 – $\sim$12 patches incorporated for issues reported by/affecting ATLAS, incl. Bertini CPU. Some use of 9.3 in heavy ion run.
- Currently validating G4 9.4.0, intended for MC11 production. 4.9.1 patch build underway, will be in technical testing soon.
- Some uncertainty about G4 9.4 effects and physics list performance from ATLAS MC/data comparison workshops. Awaiting full validation: possibility of regressing to 9.2...not a happy prospect for sim maintenance: patches have made upstream version migration troublesome and I think support is coming to an end (?)
- G4 internal physics validation plots for releases would be useful for understanding any physics changes before / in the context of our own validation.
- Special cases: cosmics, forward detectors, beam halo and cavern background (require extra particle transport); *R*-hadrons, stopped gluinos, Q-balls, monopoles...awkward!

G4 sim physics issues

- Neutral hadron response: neutrons, K^0_S, etc. – how to estimate uncertainty? FTFP_BERT with CHIPS is being studied, but we are now awaiting G4 9.4.1 to take that seriously.
- Some unexpected shower behaviours in QGSP_FTFP_BERT, e.g. pion response more like CHIPS (and further from data) than either QGSP or FTFP in ATLAS tilecal test beam. So despite continued interest (no unphysical energy dip in pion response – *yes!*), ATLAS is very unlikely to change to that for this round.
- Other physics lists: Moving to QGSP_BERT_CHIPS is a possibility for MC11. Interest in QGSP_BIC due to good performance against test beam data: being run in validation now. Best observables for validation?
- Examining use of G4 for cavern background simulation. Scoring and parallel navigation $\Rightarrow$ $\sim$100% CPU overhead. Plus need for HP physics list $\Rightarrow$ factor of 5 in CPU.

G4 sim technical issues

- Stuck tracks are a long-standing problem: 10k–10M steps taken by a single, barely-moving track. Kill heuristics difficult: ATLAS production uses a "looper killer" to detect tracks with > 10M steps and abort the event. Small (?) bias? Small CPU hit $\sim 1\%$. Any progress?
- Fast sim integration: new interest in integration of det region-specific fast sim strategies (i.e. fast tracking, fast calo sim) with G4 full sim: some mechanisms exist in G4 exist, but are they used? Work needed on ATLAS side, also to integrate fast sim approaches which also bypass digi/reco for some regions.
- Interface stability and large-scale substitutability: uncertainty over which G4 to use i production can only be resolved by running large-scale validation samples. Chicken/egg: need G4 in an ATLAS sw Grid release to run enough events to determine if G4 should be in a release! Any suggestions of how to plug 'n' play G4?

G4 sim technical issues (contd.)

- OO-ness in interface designs: e.g. G4NystromRK4 field stepper has field caching length methods which need to be set by the stepper dispatcher according to the particle category currently being long-stepped. But stepper interface doesn't provide such an interface: do we really have to dynamic_cast for each of trillions of steps to determine if our long stepper is a G4NystromRK4?!
- Platforms: Scaling of G4 VMEM and RSS from 32 to 64 bit? Important for upgrade. Current production on i686-slc5-gcc43-opt – GCC 4.5 etc. requirement anticipated: status in G4?
- For app developers! Please Doxygen comment the G4 source so that the G4 Doxygen pages are actually useful! Currently just a huge, pretty HTML collection of undocumented classes and methods :-(

Summary

- ATLAS simulation has served us well. On our side, there has been large-scale rewriting of the ATLAS sim framework: most dev work has gone into ATLAS code. Next steps will be refactoring in the ATLAS C++ that touches G4: need G4 interfaces to be stable and functional for substitutibility, and for integrating selective fast simulation.
- Migration to G4 9.4 underway: desparately hoping that there is not an executive decision to return to 9.2.x: what would the support implications be?
- "Stuck tracks" still an issue for ATLAS production.
- Interest in physics improvements, of course! Assessing systematics and constant data/MC review in development.