Accelerating the World's Largest Accelerators

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CERN

At CERN – European Organization for Nuclear Research – scientists are probing the fundamental structure of the universe. Using the world's largest and most powerful particle accelerators as well the most complex and precise detectors, physicists study the fundamental particle and their interactions.

Accelerators

The accelerator complex at CERN is a succession of machines that accelerate beams of particles (mainly protons) to increasingly higher energies, before injecting them into the next machine.
The Large Hadron Collider (LHC) is the last machine in this chain and can accelerate particle beams up to a record energy of 6.5 TeV. The beams are then transferred to two oppositely circulating beam pipes and finally collide inside four detectors – ALICE, ATLAS, CMS and LHCb.

The <u>B</u>eam <u>Lon</u>gitudinal <u>D</u>ynamics simulator [1] is a unique code developed at CERN to model beam motion in synchrotrons. Important upgrades of beam parameters are based on BLonD simulations. The code is modular and each simulation is composed via pipelining of multiple physics modules. The code is written in Python with C/C++ extensions for the computational kernels.

BLonD is an open-source project [2] with more than 10 contributors and numerous users. Some of the most important conclusions that have been made using BLonD can be found in the literature[3][4][5].

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[1]http://blond.web.cerh.ch

[2]https://github.com/blond-admin/BLonD

[3]Helga Timko et al. "Studies on Controlled RF Noise for the LHC". In: *54th ICFA Advanced Beam Dynamics Workshop on High-Intensity, High Brightness and High Power Hadron beams, East-Lansing, USA* (2015).

[4]Helga Timko et al. "Benchmarking the Beam Longitudinal Dynamics Code BLonD". In: *7th International Particle Accelerator Conference, Busan, Korea* (2016).

[5]Alexandre Lasheen et al. "Synchrotron frequency shift as a probe of the CERN SPS reactive impedance". In: *54th ICFA Advanced Beam Dynamics Workshop on High-Intensity, High Brightness and High Power Hadron beams, East-Lansing, USA* (2015).
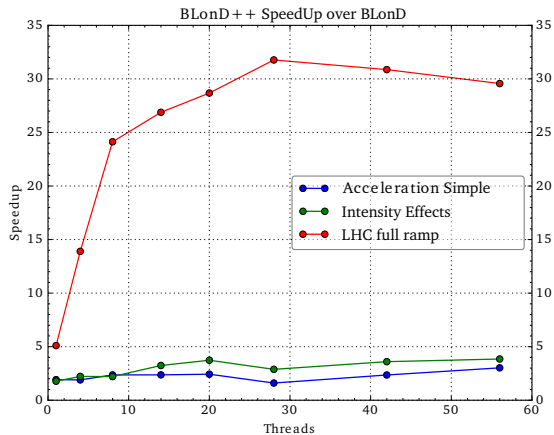
LHC Blow-up

PS-SPS Transfer

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BLonD++

- BLonD++ is the C++ version of BLonD
- Native support for multi-threading, auto-vectorization, compiler optimizations etc
- Proved to perform better in complex simulations

BLonD++ SpeedUp over BLonD

Future Studies

Thank you all for your attention!