Update on the Status of BDSIM

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Recent updates to the status of the BDSIM particle tracking code are presented. In particular, we describe efforts to combine the secondary particle generation of BDSIM with the wakefield calculations of Placet in order to quantify backgrounds from collimating elements in the beam delivery system of the International Linear Collider. Further recent updates to BDSIM are also introduced.

1 Introduction

BDSIM [1] is an extension to the Geant4 [2] toolkit. It combines accelerator style particle tracking with Geant4 Runge-Kutta based tracking. Beamline elements are implemented through C++ classes, each with an associated stepper function which implements the particle transportation inside this element. The full Geant4 physics processes are available, and non-Geant processes can be added as separate C++ classes. The motivation is to permit fast tracking within the beampipe, while being able to generate backgrounds from beam/material interactions.

2 Wakefields

As a single-particle tracking code, BDSIM does not take account of intra-particle effects such as wakefield generation in collimating elements. In order to correctly model the backgrounds induced by wakefield kicks, some method is required to interface BDSIM with another code that is capable of performing the necessary calculations.

Placet [3] is a multi-particle tracking code which simulates the dynamics of the beam in the presence of wakefields. Particle bunches are divided into slices longitudinally and the induced wakefield of each slice is applied to all those which follow. In cases where particles are near to the beampipe aperture, the wakefield kick may be sufficient to cause these particles to interact with the beampipe material. BDSIM is capable of generating the secondary particles in this situation, while Placet is not.

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2.1 BDSIM

BDSIM is a single-particle tracking code; wakefields are a multi-particle effect. Calculation of the wakefield kicks requires a description of the full bunch at the appropriate location. In order to generate this, a sensitive volume is introduced prior to the element, which transfers particles from the urgent stack to the postpone stack. This pauses the tracking of each particle in turn at this location. When the requested number of particles has been tracked up to this point, the clean up routine passes the bunch description to PLACET through a temporary fifo. BDSIM then listens on the same fifo, waiting for PLACET to return the distribution of particles from after the collimator. Tracking continues in BDSIM from the end of the previous run.

2.2 PLACET

As a multi-particle code, PLACET has a full description of the bunch at each point of tracking. Routines were added to insert a new bunch description at a given location, in this case at the entrance to a collimating element, and also to output the bunch description.

2.3 Tracking

The implementation described above simply calls PLACET to perform tracking in wakefield regions. However the purpose of this interface is to quantify the backgrounds caused by near-wall particles which are kicked into the beampipe by wakefield effects. This requires that the tracking be done by BDSIM. Ideally, BDSIM will use the bunch description returned by PLACET to calculate the wakefield kicks $\Delta x' = x'_{\text{after collimator}} - x'_{\text{before collimator}}$ (and similarly for $\Delta y'$) and apply these at the centre of the collimator logical volume.

The process currently requires that equivalent decks are available in both PLACET and gmad. The CLIC deck (dated 28/11/05) has been used so far as a test system. However, as tracking in PLACET is only relevant in the collimating elements, it should be possible to generate the same results with *only* the collimating elements in the PLACET input file.

3 Further Developments

Arbitrary materials definitions can now be placed in the gmad file to generate materials that are not already included in BDSIM using the `material` command like this:

```
CarbonDioxide :  material, density=1e-14, components={"C","O"},
componentsWeights{1,2}
```

Chemical elements which have not been previously defined may also be included using the `atom` keyword:

```
ytterbium :  atom, Z=70, A=174, symbol="Yb"
```

Currently this allows for the inclusion of materials in which every molecule is identical. Further refinements will allow the user to specify a mixture of materials by fractional weight. This will generate a more accurate description of common accelerator (tunnel) materials such as soil and concrete.

The BDSIM installation has now been updated to make use of gcc4.0, CLHEP2.0.x.x and Geant4.9.0. Numerous bugfixes have also been included.

4 Future updates

BDSIM is continually evolving. A short list of the updates intended for inclusion in future releases includes:

- The integration of the OpenScientist framework [4] to allow interactive pan and zoom functionality in the visualisation.
- Design of realistic magnet element geometries to be built by default. This would replace the current default cylindrical elements.
- Support for a GDML/XML input format, such as LCDD [5] complementary to the gmad and Mokka/SQL formats.
- Polarisation tracking is supported in later versions of Geant4. This facility should be utilised by BDSIM.
- Further output data options, such as energy deposition by element. This would include dosimetry/activation.

5 Conclusions

The implementation of data transfer between the single- and multi-particle codes has been completed. This in effect calls PLACET to track through wakefield regions during BDSIM tracking; further refinements will use the bunch description from PLACET to calculate the wakefield kicks so that they can be applied in BDSIM and near-wall particles will interact with the beampipe material. Updated Materials input from gmad file. The current development version can be obtained from CVS at `http://cvs.pp.rhul.ac.uk/cvsweb.cgi/BDSIM`. The next major release, version 0.4, is expected by the end of October.

References

[1] I. Agapov *et al.*, *BDSIM - Beamline Simulation Toolkit Based on Geant4*, EuroTev-Report-2006-035 (2006).

[2] Geant4 Users' Guide,
`http://geant4.web.cern.ch/geant4/`

[3] Daniel Schulte, *The Tracking Code* PLACET, Users' Manual, (2000)

[4] G. Barrand, *OpenScientist. Status of the Project*, Proceedings of CHEP04, Interlaken, Switzerland (2004)

[5] LCDD Homepage
`http://lcsim.org/software/lcdd/`

[6] Slides:
`http://ilcagenda.linearcollider.org/contributionDisplay.py?contribId=221&sessionId=67&confId=1296`