

Recent improvements in SixTrack for collimation

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Outline

- 1 Building SixTrack
 - CMAKE
 - GIT
 - Build manual
- 2 Recent COLLIMATION changes
 - Emittance
 - Other changes
- 3 New features
 - HUGENPART
 - Other
- 4 Conclusions

New build system: CMAKE

- Replaces the old `make_six`
 - More maintainable
 - More flexible
 - A *lot* faster
 - Supports 64-bit, Mac OS X etc.
- Options etc. can be configured using menu-based system `ccmake`
- ...or using wrapper `cmake_six`
- Options can be combined; they are checked for compatibility by `cmake`

Standard version:

```
cmake_six
```

Collimation version:

```
cmake_six COLLIMAT  
-CRLIBM
```

Compile with debug options:

```
cmake_six COLLIMAT  
-CRLIBM debug
```

Compile with ifort:

```
cmake_six ifort
```

See all available options:

```
cmake_six help
```

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Downloading the sources using GIT

- Development moved from CERN SVN to GitHub in 2015
 - Provides issue tracking, pull requests, code branches, etc.
 - Does not require a CERN account
 - Very good user interface, very widely used
 - <https://github.com/SixTrack/SixTrack>
- To download the code:

```
git clone https://github.com/SixTrack/SixTrack.git
```
- See any changes *you* made to the sources:

```
git diff
```
- Update downloaded source:

```
git pull
```
- For checking out a specific branch or version, clone the right repository fork, then `git checkout VERSION` where `VERSION` is a branch name, tag name, or commit ID.
- Slightly different procedure if contributing changes; please see the build manual!

Build manual

- Explains the build procedures
- How to contribute (setting up git etc.)
- Newest version in \LaTeX form in the repository at
Doc/building_sixtrack/building_sixtrack.tex
- New-ish version in PDF form at
[http://sixtrack.web.cern.ch/SixTrack/doc/
building_sixtrack/building_sixtrack.pdf](http://sixtrack.web.cern.ch/SixTrack/doc/building_sixtrack/building_sixtrack.pdf)

Emittance specification for collimation

- Used for collimator openings and initial distributions
- Before v4.5.41¹, emittance taken from BEAM block
 - Emittance in COLL block was ignored
- Changes:
 - Do NOT use BEAM block emittance for collimation
 - Separate emittance used for collimator positioning etc. and particle distribution
 - Read emittances from COLL block
- Results are not changed!

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Emittance specification for collimation

- New format – Line 9 of COLL block:

$\epsilon_{norm,dist,x}$ $\epsilon_{norm,dist,y}$ $\epsilon_{norm,pos,x}$ $\epsilon_{norm,pos,y}$

- Normalized emittances in mm*mrad
- Separate for x / y and distribution / positioning
- Typical example (HL-LHC):
2.5 2.5 3.5 3.5
- Typical example (LHC):
3.5 3.5 3.5 3.5
- General conversion strategy:
Copy emittances from BEAM block into COLL, twice

- If running old input with new SixTrack:

```
ERR> EMITTANCES NOT DEFINED! CHECK COLLIMAT BLOCK!
ERR> EXPECTED FORMAT OF LINE 9 IN COLLIMAT BLOCK:
emitnx0_dist emitny0_dist emitnx0_collgap emitny0_collgap
ERR> ALL EMITTANCES SHOULD BE NORMALIZED.FIRST PUT EMITTANCE FOR DISTRIBUTION GENERATION, THEN FOR
COLLIMATOR POSITION ETC. UNITS IN [MM*MRAD].
ERR> EXAMPLE:
2.5 2.5 3.5 3.5
```

- Not done: Update collimation block documentation at

<http://lhc-collimation-project.web.cern.ch/lhc-collimation-project/code-tracking-2012.php>

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Other collimation changes

- Updated cross-sections for single diffraction – v4.5.33:
<https://github.com/SixTrack/SixTrack/pull/56>
- More collimator materials – v4.5.35:
<https://github.com/SixTrack/SixTrack/pull/83>
- Radial amplitude efficiency analysis – v4.5.35:
<https://github.com/SixTrack/SixTrack/pull/84>
- Non-collimation: STOP if collimation block present&active – v4.5.42:
<https://github.com/SixTrack/SixTrack/pull/193>
- Collimation version: STOP if collimation block not present – v4.6.2:
<https://github.com/SixTrack/SixTrack/pull/141>
- Tagging of “other” halo, array sizes, output during tracking – v4.6.9:
<https://github.com/SixTrack/SixTrack/pull/226>
- Possibility to use Merlin scattering routines – v4.6.10:
<https://github.com/SixTrack/SixTrack/pull/105>

HUGENPART

- Possible to track 65'536 particles at once (collimation still limited to 20k)
- Compilation:
`./cmake_six COLLIMAT -CRLIBM HUGENPART DATAMODS STF`
- Changes in fort.3 file:

TRACK

TRACKING

```
20 0 9984 0 17 0 1
1 1 0 0 0
0 0 100 100 42000 20000 2
```

NEXT

- Set wanted *number of pairs*
- May want to increase *nwr(3)*

COLL

COLLIMATION

```
.TRUE.
1 7000000
...
```

- Set *number of packs* = 1

Performance with HUGENPART

■ Test case 1:

- Crab cavity failure scenario
- Beam core (small losses)
- 20 turns
- 19968 (64*312) particles
- HLLHCv1.2

■ Test case 2:

- Extreme crab failure scenario
- Beam core
- 200 turns (150 pre-fail)
- 19968 (64*312) particles
- HLLHCv1.2

| | Case 1, time [s] | Case 2, time [s] |
|------------------------------|------------------|------------------|
| Standard | 877 | 8906 |
| Hugenpart | 261 | 2810 |
| Hugenpart, noFirstImp | 135 | |
| Hugenpart, nwr4 | 251 | |
| Standard, noFirstImp, merlin | 770 | |

■ Test conditions:

- Tests ran sequentially, STDOUT redirected to file
- Dell XPS 13, i7-7500U, SSD

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| | Case 1, turns/s | Case 2, turns/s |
|------------------------------|-----------------|-----------------|
| Standard | 455 | 448 |
| Hugenpart | 1530 | 1421 |
| Hugenpart, noFirstImp | 2958 | |
| Hugenpart, nwr4 | 1591 | |
| Standard, noFirstImp, merlin | 518 | |

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- Factor 3 speedup when using hugenpart
- Further factor 2 speedup possible by removing `FirstImpacts_AcceleratorFrame.dat`

Other new features

- ZIPF – output file compression
 - New block in fort.3
 - List files to compress
 - Needs LIBARCHIVE
- HDF5
 - Binary version of tracks2.dat
 - Faster, requires less space
 - Needs special version of BeamLossPattern
- CTEST
 - General framework for automated tests
 - Currently no collimation support

Future possibilities

- New scattering block – talk tomorrow
- Improved initialization of scattering routines
- Online aperture check

Summary and conclusions

- New CMAKE-based build system implemented & documented
- Lots of general code improvements
- Factor 3 speedup possible by using hugenpart
- Remove `FirstImpacts_AcceleratorFrame.dat`?