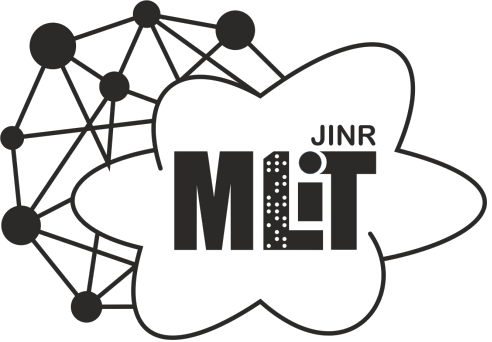

On SpdRoot profiling

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Relevance

SpdRoot is a software package that is capable of performing Monte Carlo simulation of events, reconstruction, analysis and visualization of events.

It is argued that the reconstruction runs slower than expected event processing speeds.
The current issue of this project is to find bottlenecks in the source code of the program and further improve the processing speed and efficiency of computing resources.

Aim of the work

Aim of the work: to find bottlenecks of the event reconstruction process in the SpdRoot source code.

Tasks:

For reconstruction functions measure:

- % resources used;
- execution time.

To study the influence of field type on reconstruction speed.

Technology stack

```
[alxdid@ncx104 ~]$ perf

 usage: perf [--version] [--help] [OPTIONS] COMMAND [ARGS]

 The most commonly used perf commands are:
   annotate        Read perf.data (created by perf record) and display annotated code
   archive         Create archive with object files with build-ids found in perf.data file
   bench           General framework for benchmark suites
   buildid-cache   Manage build-id cache.
   buildid-list    List the buildids in a perf.data file
   c2c             Shared Data C2C/HITM Analyzer.
   config          Get and set variables in a configuration file.
   data            Data file related processing
   diff            Read perf.data files and display the differential profile
   evlist          List the event names in a perf.data file
   ftrace          simple wrapper for kernel's ftrace functionality
   inject          Filter to augment the events stream with additional information
   kallsyms        Searches running kernel for symbols
   kmem            Tool to trace/measure kernel memory properties
   kvm             Tool to trace/measure kvm guest os
   list            List all symbolic event types
   lock            Analyze lock events
   mem             Profile memory accesses
   record          Run a command and record its profile into perf.data
   report          Read perf.data (created by perf record) and display the profile
   sched           Tool to trace/measure scheduler properties (latencies)
   script          Read perf.data (created by perf record) and display trace output
   stat            Run a command and gather performance counter statistics
   test            Runs sanity tests.
   timechart       Tool to visualize total system behavior during a workload
   top             System profiling tool.
   version         display the version of perf binary
   probe           Define new dynamic tracepoints
   trace           strace inspired tool

 See 'perf help COMMAND' for more information on a specific command.
```

python™

pandas

matplotlib

Profiling as a method for finding bottlenecks

Profiling is used to monitor the execution of a program to collect data on various aspects such as:

- execution time;
- resources used.

The purpose of profiling is to find bottlenecks or areas where the program can be optimized to improve its efficiency and performance.

perf as a tool for analyzing software performance

perf is a profiling tool that is designed for Linux-based systems. Advantages:

- simple command line interface
- rich functionality.

To analyze the performance of SpdRoot we used such perf commands as:

- perf record
- perf report
- perf probe

```
[alxdid@ncx104 ~]$ perf

 usage: perf [--version] [--help] [OPTIONS] COMMAND [ARGS]

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 See 'perf help COMMAND' for more information on a specific command.
```
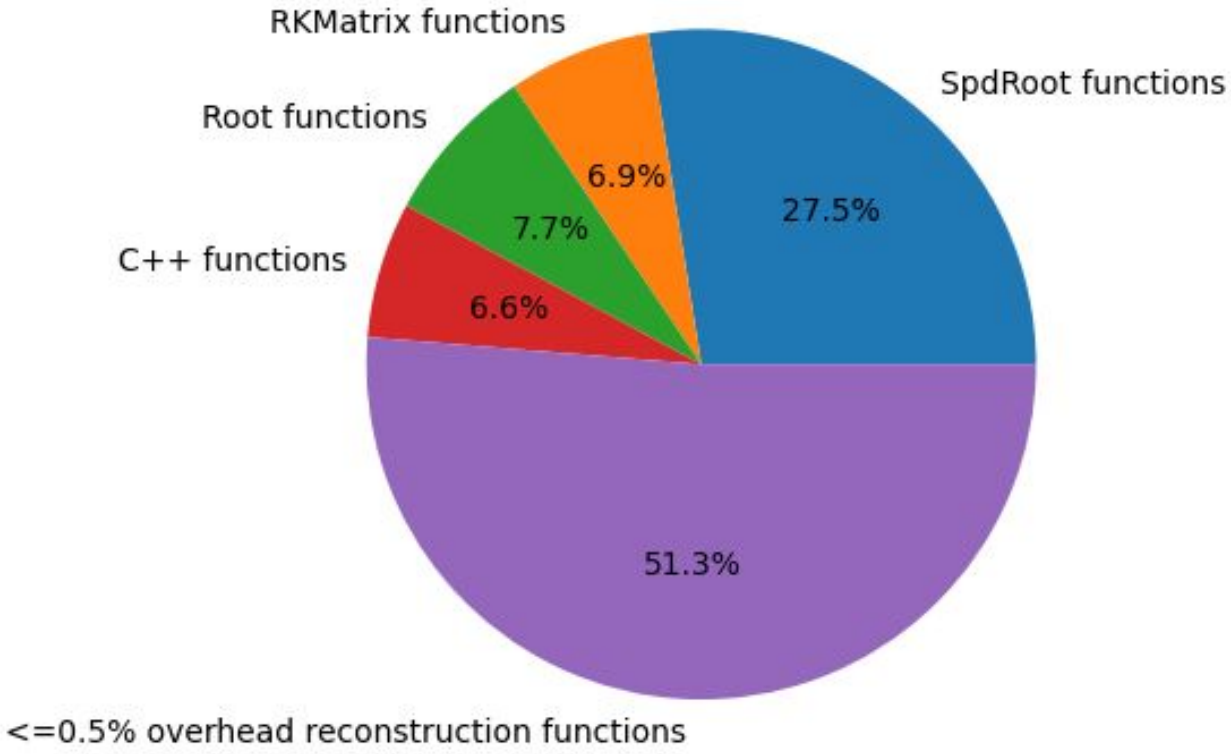

Characteristics in the case of a field of 1/8 of the total size

```
SpdFieldMap1_8 *MagField = new SpdFieldMap1_8("full_map");
MagField->InitData("field_full1_8.bin");
SpdRegion *reg = MagField->CreateFieldRegion("box");
reg->SetBoxRegion(-330, 330, -330, 330, -386, 386); //
(X,Y,Z)_(min,max), cm
run->SetField(MagField);
```

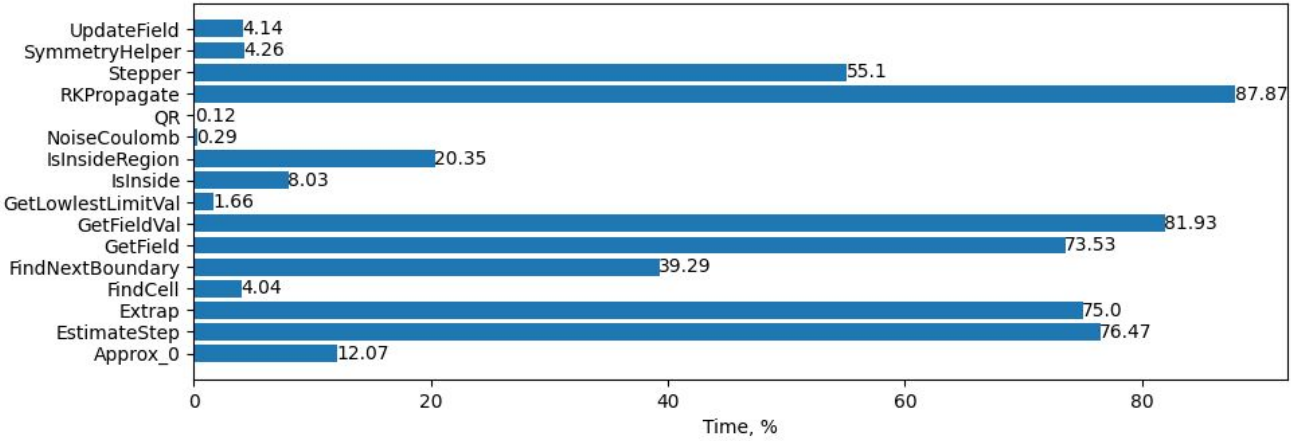
Characteristics in the case of a field of 1/8 of the total size. Resources used

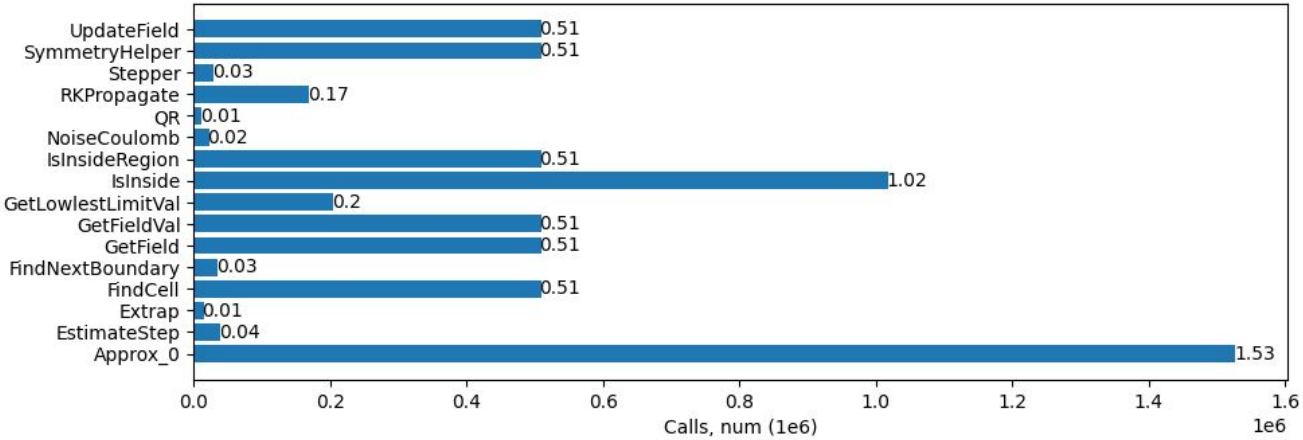


SpdRoot functions (27.5%) top CPU users

6.97% **genfit::RKTrackRep::RKPropagate** - old algorithm (2013) part of GENFIT. Extrapolation by Runge-Kutta method, many matrix operations.
5.60% **SpdFieldMap1_8::Approx_0** - function consists of multiplication and addition of vectors and matrices.
2.14% **SpdFieldMap1_8::FindCell** - search for the cell in the field to which the point belongs.
1.61% **SpdFieldMap1_8::GetField** - returns value of the field at the point.
1.52% **SpdBoxRegion::IsInside** - check if the point is inside the area around the point (r,z).

Characteristics in the case of a field of 1/8 of the total size. Execution time



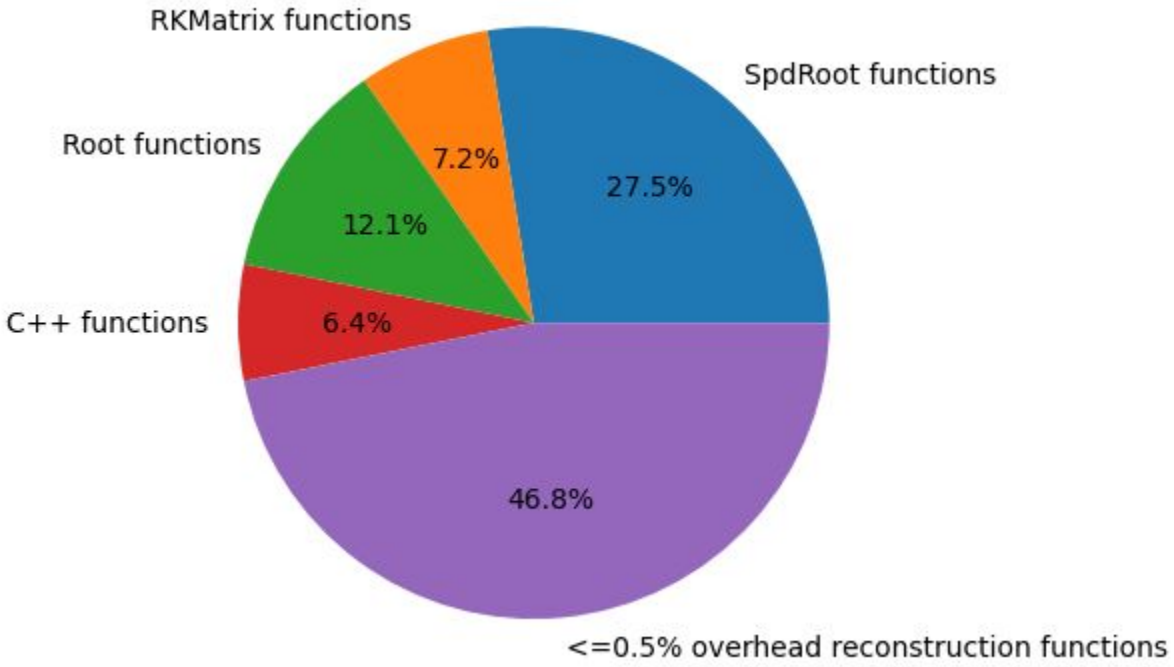


Total time = 124,0379 sec per event (including perf)

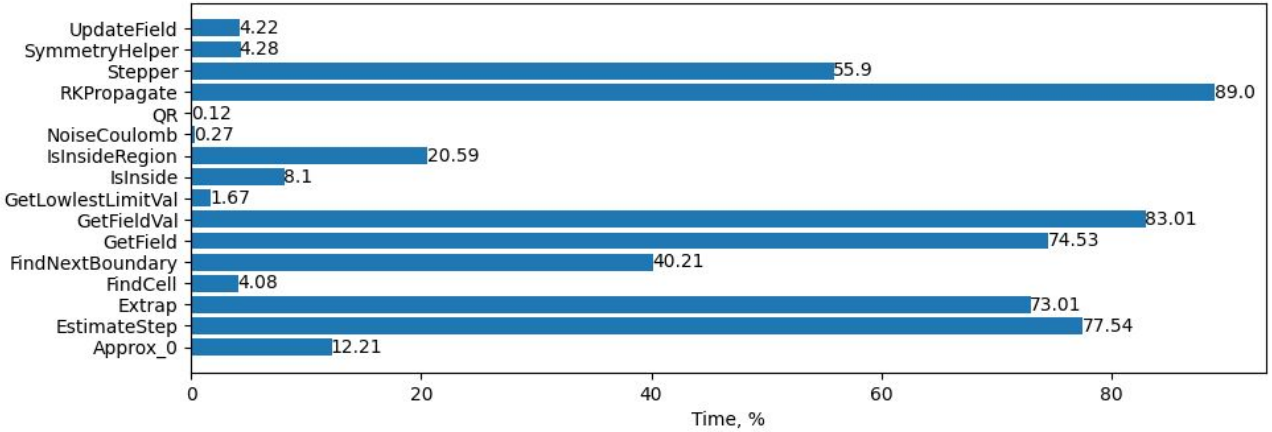
Characteristics in case of constant field

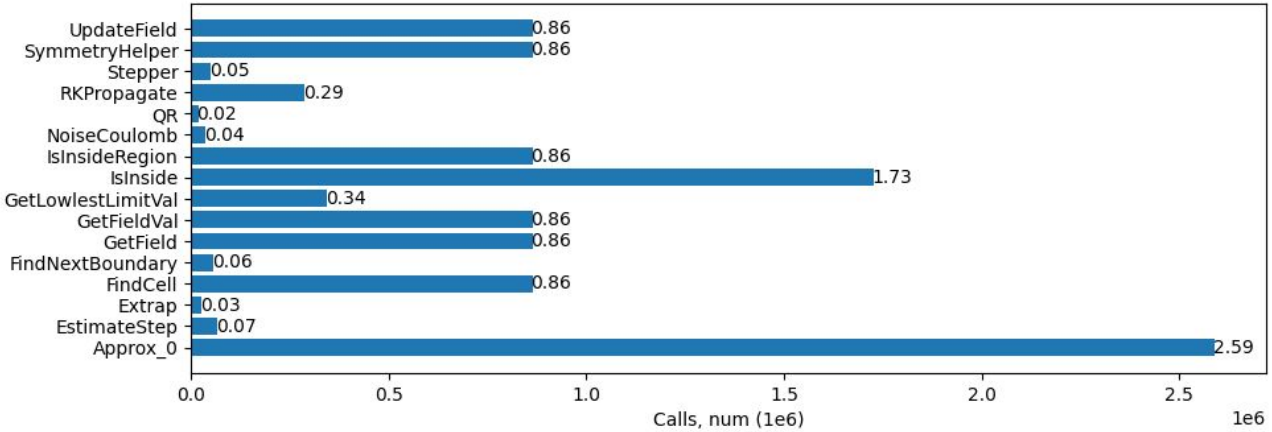
```
SpdConstField* MagField = new SpdConstField();
MagField->SetField(0., 0., 10.0); //  kG
SpdRegion* reg = 0;
reg = MagField->CreateFieldRegion("tube");
reg->SetTubeRegion(0, 174, -246, 246); // (R,Z)_(min,max),
cm
run->SetField(MagField);
```

Characteristics in case of constant field. Resources used



Characteristics in case of constant field. Execution time





Total time = 205,3638 sec per event (including perf)

Conclusion

- Different types of fields affect the reconstruction speed, but the percentages of function running time are quite close in different cases.
- There are differences in the number of function calls.
- Root - functions take more resources in the case of constant field.

Plans:

- Get more statistics on more events and on other types of magnetic fields.
- Make sure that field parameters affect the reconstruction speed.

Thank you for your attention!