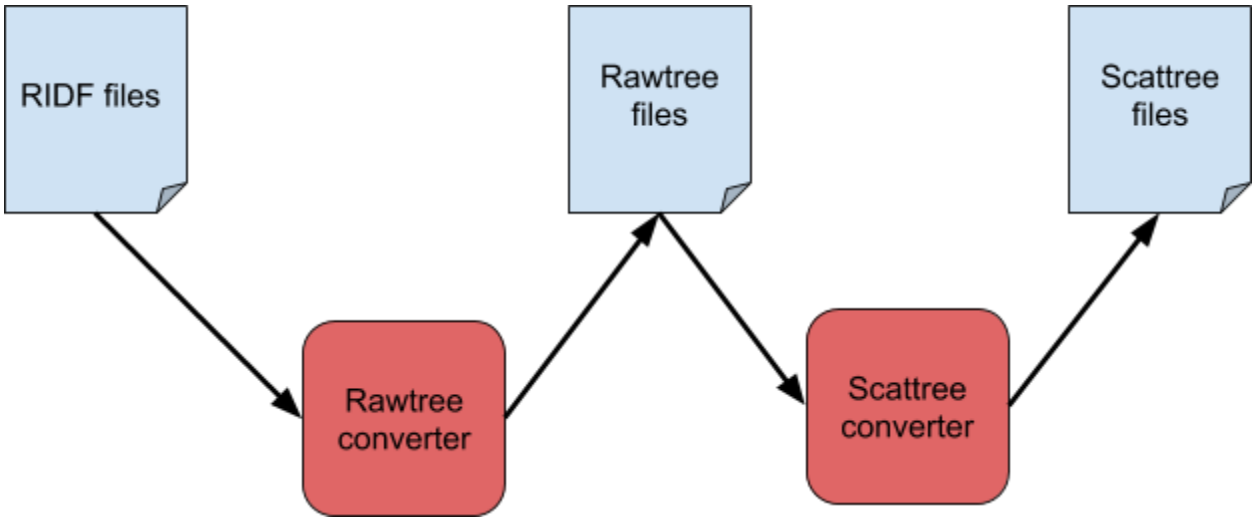
Table of contents

Scheme of data flow

Tree conversion

- **Tree converter** - an executable which job is to transform trees from one format into other, or the same format but by adding some information
- **Rawtree** - contains direct (not transformed in any way) observables from detectors (just converted from RIDF into ROOT tree format)
- **Scattree** - contains derived values like theta and phi angles for protons and scattered He, theoretical kinematics of elastic scattering reaction, calibrated energy values, etc…

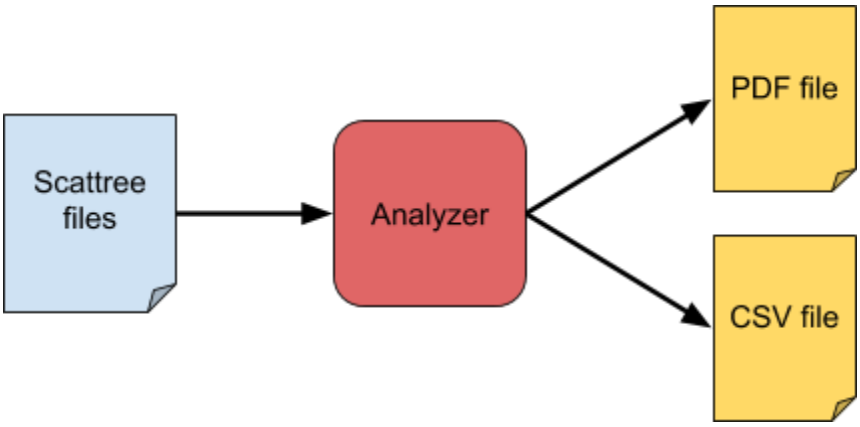


RIDF files which were created by BigRIPS DAQ system are converted by rawtree converter. Second stage - scattree converter converts rawtrees into scattrees.

Analyzers

- **Analyzer** - an executable which job is to walk **scattrees** and do computation of interest, for example: elastic events selection, capturing correlations or some observables, etc…

Analyzers' sources are in `src_ana` directory.



Typical input & outputs of analyzer.
The analyser "walks" through a set of scattree files, selects events according to some criteria, and creates its output, usually a PDF file with histograms of selected events or CSV files for further plotting/analysis.

Environment setup for S13 data analysis

System requirements

- System with C++11 support
- ~50 Gb of free space on local drive or some external USB storage for scattree files
    - Optionally +56 Gb more for rawtrees (if you plan to regenerate scattrees)

Download scattree and/or rawtree files

Prepare local directory (or directory on some external USB storage):

```
mkdir ~/s13_data
mkdir ~/s13_data/rawtrees
mkdir ~/s13_data/scattrees
```

Then download rawtrees & scattrees (you will need rawtrees only in case you will regenerate scattrees by yourself):

```
cp/scp rawtrees_location/* ~/s13_data/rawtrees/

cp/scp scattrees_location/scattrees/* ~/s13_data/scattrees/
```

Obtain sources

Below is assumed that you setup environment under ~/ana directory. To clone Git repo:

https://github.com/serjinio/thesis_ana.git

```
mkdir ~/ana
cd ana
git clone https://github.com/serjinio/thesis_ana.git
```

How to setup sources

On Mac

1. Install homebrew: http://brew.sh/
2. Install boost libs from command line: `brew install boost`
3. Install scons build system from command line: `pip install scons`
    a. If there is no pip then install it with these commands.
    b. check installation with "`scons --version`" - should report installed version
4. Unpack `ana1.zip` into some directory on your filesystem, say under user home dir: `~/s13_ana`
5. In `~/ana` create a symlink to scattree files:
    `ln -s ~/s13_data/scattrees scattree_rootfiles`
6. Optionally also create a link to rawtrees (if you have rawtrees):
    `ln -s ~/s13_data/rawtrees rootfiles`
7. In `~/ana/Sconstruct` file change (if necessary) directory where boost was installed:
    `boost_install_dir = '/usr/local/boost_1_59_0'`

Build

After setup try to build existing sources with command:

```
$ scons
scons: Reading SConscript files ...
scons: done reading SConscript files.
scons: Building targets ...
g++ -o src_lib/bgsubtract.o -c -std=c++14 -Wall -std=c++11 -pthread
-m64 -stdlib=libc++ -I/Applications/root_v6.06.02/include
-I/usr/local/boost_1_59_0 -Iinclude src_lib/bgsubtract.cpp
g++ -o src_lib/common.o -c -std=c++14 -Wall -std=c++11 -pthread -m64
-stdlib=libc++ -I/Applications/root_v6.06.02/include
-I/usr/local/boost_1_59_0 -Iinclude src_lib/common.cpp
g++ -o src_lib/csalg.o -c -std=c++14 -Wall -std=c++11 -pthread -m64
-stdlib=libc++ -I/Applications/root_v6.06.02/include
-I/usr/local/boost_1_59_0 -Iinclude src_lib/csalg.cpp
...
```

```
g++ -o src_ana/yields.o -c -std=c++14 -Wall -std=c++11 -pthread -m64
-stdlib=libc++ -I/Applications/root_v6.06.02/include
-I/usr/local/boost_1_59_0 -Iinclude src_ana/yields.cpp
Install file: "src_ana/yields" as "bin/yields"
scons: done building targets.
```

If the build was successful then in `~/s13_ana/bin` directory will be located built binaries.

Folder structure

ana
├── bin - binaries built from sources
├── data - data files
├── include - library code includes
├── macros - various macros for interactive ROOT sessions
(were used in the beginning, not used currently, done by analyzers)
├── out - directory to store output PDFs
├── scattree_rootfiles - a symlink to scattrees
├── src - sources for scattree converter
├── src_ana - sources for analyzers
├── src_lib - sources for library code
├── rootfiles - a symlink to rawtrees
├── Sconstruct - build script
├── he4_cs_cuts.conf - cuts configuration file for he4 cross-section
├── he6_cs_cuts.conf - cuts configuration file for he6 cross-section

Example usage of a binary

All binaries have similar command line options (provided by class from `cli.hpp`) which can be seen by supplying --help option, for example:

```
$ bin/fdc2_events_dist --help --cuts-conf sample_cuts.conf
List of allowed options:
  --help                produce help message
  --ds arg              type of dataset [he4|he6]
  --ds-size arg         number of runs to use from the dataset
  --espri arg           which ESPRI to use [both|left|right]
  --mt                  indicates to use multi-threading, number of
threads to use will be determined basing on hardware
  -j [ --threads ] arg  number of threads to use, use if you want to
force usage of a certain number of threads
  --cuts-conf arg       filename for cuts configuration
```

To run an analyzer:

```
$ bin/fdc2_events_dist --ds he6 --ds-size 5 --cuts-conf ela_cuts.conf
[parse_cuts_config] DEBUG:  parsed AST of cuts config file:
trigger_cut : true
vertexXY_cut : true
vertexXY_radius : 6
phi_cut : true
phi_width : 6
theta_cut : true
theta_width : 3.2
espri_aang_cut : false
espri_aang_width : 180
espri_min_e_de_cut : false
espri_e_cut : false
espri_y_cut : true
espri_y_width : 132
hodf_he6_cut : false
espri_selector : both

[compute_events_dist()] DEBUG:  Computing events distribution...
[Fdc2EventsDistributionAlg] DEBUG:  init of hist: FDC2 Y vs. S1DC
bang (6.0<He(aang)<9.0))
[Fdc2EventsDistributionAlg] DEBUG:  init of hist: FDC2 Y vs. S1DC
bang (3.0<He(aang)<6.0))
[Fdc2EventsDistributionAlg] DEBUG:  init of hist: FDC2 Y vs. S1DC
bang (0.0<He(aang)<3.0))
[Fdc2EventsDistributionAlg] DEBUG:  init of hist: FDC2 Y vs. S1DC
bang (-3.0<He(aang)<0.0))
[Fdc2EventsDistributionAlg] DEBUG:  init of hist: FDC2 Y vs. S1DC
bang (-6.0<He(aang)<-3.0))
[Fdc2EventsDistributionAlg] DEBUG:  init of hist: FDC2 Y vs. S1DC
bang (-9.0<He(aang)<-6.0))
[make_segmented_dataset()] DEBUG:  Will make 1 segments with 5 runs
in each one...
Adding file to chain: scattree_rootfiles/scattree_run133.root
Adding file to chain: scattree_rootfiles/scattree_run134.root
Adding file to chain: scattree_rootfiles/scattree_run135.root
Adding file to chain: scattree_rootfiles/scattree_run136.root
Adding file to chain: scattree_rootfiles/scattree_run137.root
Adding file to chain: scattree_rootfiles/scattree_run138.root
[make_segmented_dataset()] DEBUG:  Made segment #1
```

```
[make_segmented_dataset()] DEBUG:  1 segments were made
[Fdc2EventsDistributionAlg] DEBUG:  Total amount of elastic events:
581
Total elastic events: 581
Info in <TCanvas::Print>: pdf file out/fdc2_events_dist.pdf has been
created
Info in <TCanvas::Print>: Current canvas added to pdf file
out/fdc2_events_dist.pdf
stuff
Info in <TCanvas::Print>: Current canvas added to pdf file
out/fdc2_events_dist.pdf
Info in <TCanvas::Print>: Current canvas added to pdf file
out/fdc2_events_dist.pdf
Info in <TCanvas::Print>: Current canvas added to pdf file
out/fdc2_events_dist.pdf
Info in <TCanvas::Print>: Current canvas added to pdf file
out/fdc2_events_dist.pdf
Info in <TCanvas::Print>: Current canvas added to pdf file
out/fdc2_events_dist.pdf
```

For details on how command line options are handled refer to sources in `src_ana` directory.