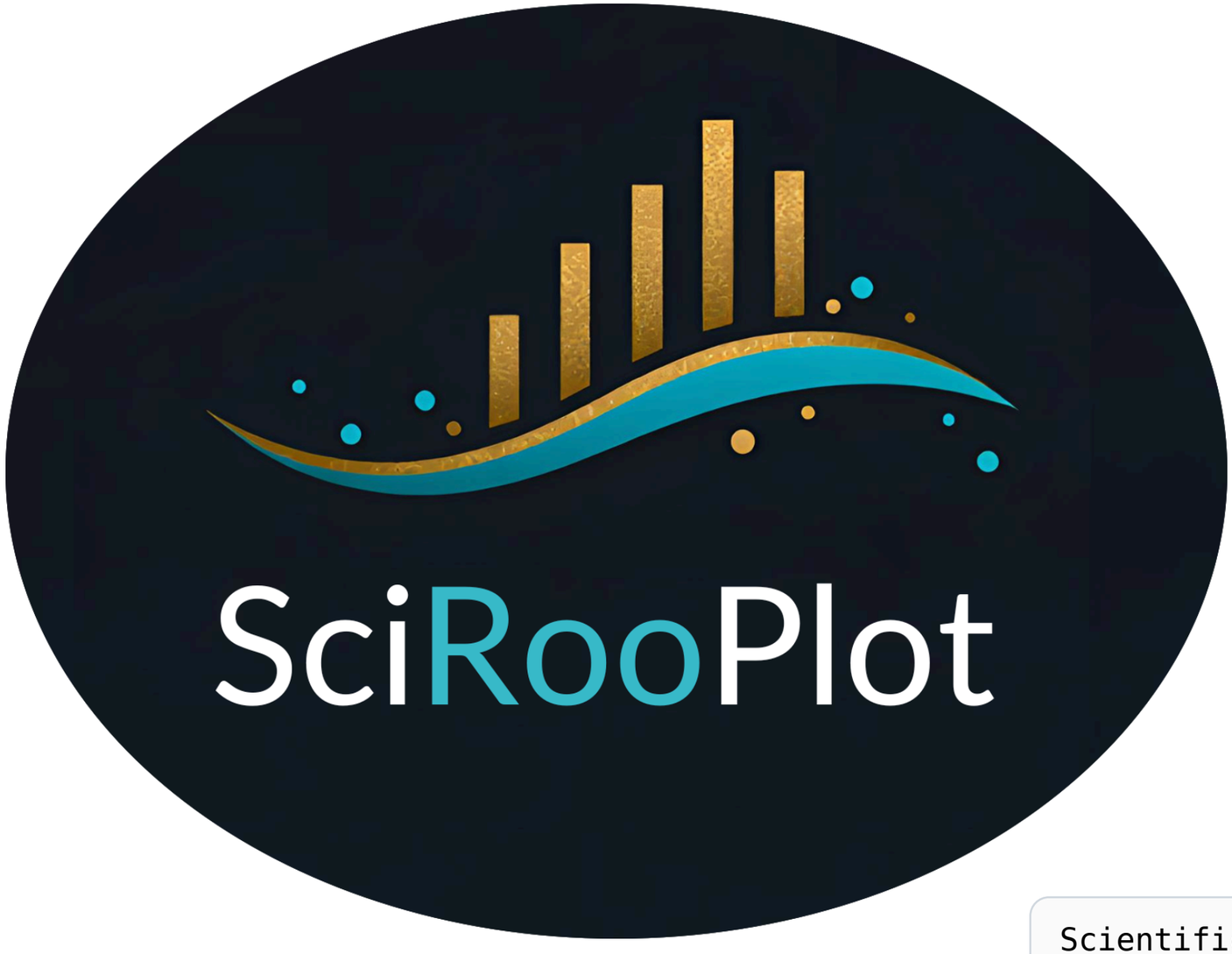
SciRooPlot User Manual

Python Version



Scientific Plotting Made Simple

A ROOT-based Plot Organizer

The ROOT plotting challenge

- ROOT is powerful, but everyday plotting often requires substantial boilerplate code.
- Similar I/O and styling tasks are repeatedly implemented in different macros.
- Often plotting logic becomes intertwined with analysis code, making iteration slow.
- Producing figures requires handling files, data types, styling, and other ROOT details.

The SciRooPlot approach

- Introduces an abstraction layer on top of ROOT.
- Provides a common plotting infrastructure and organization.
- Lets users describe the desired figure rather than its implementation.
- Preserves the familiar ROOT ecosystem and styling conventions.
- Enables interactive, project-based plotting workflows.

ROOT

✓ Histograms
✓ Graphs
✓ Functions
✓ Files

+

SciRooPlot

✓ Abstract plot specifications
✓ Plot grouping & organization
✓ Interactive plotting
✓ Project-based workflows

SciRooPlot Workflow

- Store analysis results in ROOT or CSV files.
- Define plot specifications using C++ or Python interface and save them as a SciRooPlot project.
- Generate and explore plots interactively via the `plot` command-line tool.
- Create and manage projects with the `srp` command-line tool.

Installation

```
$ git clone https://github.com/SciRooPlot/SciRooPlot.git
$ cd SciRooPlot
$ ./scripts/install.sh
```

- The installer prints a command that enables the SciRooPlot environment.
- Add it to the shell startup script (e.g. `~/.bashrc` or `~/.zshrc`) to load SciRooPlot automatically in new terminals.
- After setup, the `srp` and `plot` command-line tools are available system-wide.
- Future updates can be installed with: `$ srp update`

Your First Project

- Initialize a new SciRooPlot project:

```
$ srp init-py <project> [<dir>]
```

- Creates a project directory (`./<project>` or `./<dir>`).
- Contains `DefinePlots.py`, where plot specifications are defined.

```
myProject/
├── DefinePlots.py
└── output/
```

- Project automatically registered with SciRooPlot.
- Includes working examples using dummy data.
- Generate your first plot immediately:

```
$ plot examples ptSpec
```

- Plots always stay in sync with `DefinePlots.py`.

Project Management

Select another project

```
$ srp select <project>
```

List all projects

```
$ srp projects
```

Change output directory (default is `./output`)

```
$ srp set <project> outdir <path>
```

Additional commands:

$ srp help	List available options.
$ srp show <project>	Show project settings.
$ srp remove <project>	Unregister project.
$ srp print <file>	List root file contents.
$ srp open <file>	Open root file.

Using the App

- Plots specified in `DefinePlots.py` have a unique **name** within a **group**.
- These identifiers are used to select plots from the command line.

```
$ plot <group> <name> [<mode>]
```

- Tab completion simplifies browsing through available names.
- Both `<group>` and `<name>` support regular expressions.
- Multiple plots can be generated with a single command.

Mode	Description
`show`	Open plots interactively (default mode).
`list, print`	List plots matching the request or print their settings.
`pdf, eps, svg, png`	Export plots as graphics files.
`macro`	Generate ROOT `.C` macros that reproduce the plots.
`gif`	Combine matching plots into an animated GIF (`gif+N` sets the frame delay in units of 10 ms).
`file`	Save all requested plots into a single ROOT file.
`data`	Save input data for requested plots into a ROOT file.

Regular Expressions

Select plot names matching pattern

```
$ plot paperPlots 'moneyPlot[1,2]'
```

NB.: Quotes are only required if regex contains special shell characters like `[]`, `()` and `|`.

Select all plots in a figure group

```
$ plot paperPlots .+
```

Select plots in groups starting with pattern

```
$ plot pp_.+ myPlot
```

General Code Structure

- Plots are handled and exported by `PlotManager`.
- Input files are registered under user-defined aliases.
- Data objects within input files are identified by name.
- Each Plot has a unique name within a figure group
- It consists of one or more Pads (`plot[1]`, `plot[2]`, ..)
- Pads contain settings of Axis, Data, Text and Legend.

```
PlotManager
│
├── Plot
│      ├── Pad
│      │      ├── Axis
│      │      ├── Data
│      │      ├── Legend
│      │      └── Text
│      ├── Pad
│      │
│      └── ...
├── Plot
│
└── ...
```

DefinePlots.py

```python
def main():
  pm = PlotManager("myProject")
  pm.AddDataSource("dataSource", "/path/to/file.root")
  # ------------------------------------------------------------
  plot = Plot("plotName", "groupName")
  plot[1].AddData("dataObjectName", "dataSource", "my label")
  plot[1].AddLegend()
  plot[1].AddText("some text")
  plot[1]['X'].SetTitle("x axis title")
  pm.AddPlot(plot)
  # ------------------------------------------------------------
  pm.SaveProject()

if __name__ == "__main__":
  main()
```

Language Note

This documentation uses the Python interface.
Find the C++ version here.

Adding Data Sources

- A data source is a collection of input files with a unique identifier that is later used for the plot definitions.
- Entire ROOT files or individual subdirectories/lists therein can be registered as input sources.
- Multiple inputs can be added either via successive `AddDataSource()` calls or by passing them as a list.
- Adding a directory to a data source registers all ROOT files it contains, including the ones in subdirectories.
- File paths are always absolute, but the `SRC_DIR` helper enables paths relative to `DefinePlots.py`.
- Shell environment variables (including user-defined ones) are supported and expanded automatically.
- Registered files are searched in alphabetical order. Within each file, the directory hierarchy is traversed until the first matching data object is found.
- Local ROOT objects can also be directly added.

```
pm.AddDataSource("sourceA", "/path/to/file1.root")

pm.AddDataSource("sourceB", SRC_DIR + "../path/file2.root")

pm.AddDataSource("sourceC", "${HOME}/path/to/file/file3.root")

pm.AddDataSource("sourceD", ["/path/to/file4.root",
                             "/path/to/file5.root"])

pm.AddDataSource("sourceE", "/path/to/directory/")

pm.AddDataSource("sourceF", "/path/to/file6.root:dir/or/list")
```

```
myHist = ROOT.TH1D("myHist", "", 100, -5, 5)
pm.AddDataSource("sourceG", myHist)

myGraph = ROOT.TGraph()
myGraph.SetName("myGraph")  # graph needs a name!
myFunc = ROOT.TF1("myFunc", "gaus", -5, 5)
pm.AddDataSource("sourceG", [myGraph, myFunc])
```

Plot Appearance

- Defining base plots avoids repeating common layout settings across many plots.
- Base plots are ordinary `Plot` objects registered with the `PlotManager` via `AddBasePlot()`.
- Default settings applied to `plot[0]` automatically affect all pads unless overridden.
- Several ready-to-use base plots (e.g. `1d`, `2d`, `1d_ratio`) are provided with SciRooPlot.
- Existing base plots can be used directly or modified to create custom layouts.
- Axis ranges, titles, scales, and other axis properties are configured intuitively through plot[pad][‘X’], [‘Y’], and [‘Z’].
- List of accessors of Plot, Pad and Axis in appendix.

```
plot = Plot("myBasePlot")
plot.SetDimensions(710, 710)
plot.SetTransparent()

plot[0].SetMargins(0.07, 0.14, 0.12, 0.07)
plot[0].SetDefaultMarkerSize(1.2).SetDefaultLineWidth(2.)
plot[0].SetDefaultTextFont(43).SetDefaultTextSize(24)
plot[0].SetDefaultColors([kBlack, kBlue, kRed])
plot[0].SetDefaultMarkerStyles([kFullCircle])
plot[0].SetDefaultLineStyles([kSolid, kDashed])

plot[0]['X'].SetTitleSize(28).SetTitleOffset(1.1)
plot[0]['Y'].SetTitleSize(28).SetTitleOffset(1.5)

plot[1].SetPosition(0., 0., 1., 1.)

pm.AddBasePlot(plot)
```

```
pm.AddBasePlot(PlotManager.MakeBasePlot("1d"))
# create a new plot based on the "1d" base plot
plot = Plot("myPlot", "myGroup", "1d")
plot[1]['X'].SetRange(0., 10.).SetTitle("x title")
```

Adding Data

- The data-type agnostic `AddData()` function accepts virtually all ROOT histograms, graphs, profiles, functions and trees.
- Data is identified by name and automatically searched for in the corresponding data source across all associated files.
- Directory or list paths within ROOT files can be prepended to object names to disambiguate identical names.
- Data from multiple input aliases can be combined seamlessly within the same plot.
- By default, the first added object defines the plot frame. This can be overridden via `SetDefinesFrame()`.
- Ratios are added analogously via `AddRatio()` and support divisions between different data types. If the abscissae or binning differ, the denominator is interpolated.

Supported types

- Histograms (`TH1`, `TH2`, `TH3`, `THn`, `THnSparse`)
- Profiles (`TProfile`, `TProfile2D`)
- Graphs (`TGraph`, `TGraph2D`)
- Functions (`TF1`, `TF2`, `TF3`)
- Efficiencies (`TEfficiency`)
- Trees (`TTree`)
- Tables (`.csv`, `.dat`, `.txt`, `.tsv`, `.tab`)

Data Appearance

- Data appearance is configured by chaining setters directly to `AddData()` or afterwards by accessing previously added data via `plot[1](n)` (equivalent to `plot[1].GetData(n)`).
- Drawing styles are configured via `SetOptions()`, accepting both native ROOT drawing option strings and predefined aliases (e.g. `points`, `line`, `curve`, `band`, `boxes`, `hist`, `colz`).
- Complete `Data` layouts can be defined once and reused across many plots, ensuring a consistent appearance.
- See the appendix for the complete list of available `Data` and `Ratio` setters.

Default Styles and Color Palettes

- Default colors, marker styles, line styles and other properties can be defined once per pad.
- Style lists are applied cyclically to newly added data.
- Continuous color gradients can be generated from arbitrary color endpoints.
- The same gradients can be used both for automatic styling of many data objects and as palettes for 2D histograms.

Legends and Text

- Legend entries are generated automatically and inherit the appearance of the corresponding data by default.
- Labels support placeholders such as `<mean>`, `<integral>`, `<entries>`, `<maximum>`, which are expanded automatically.
- Multiple legends can coexist and data can be assigned to specific legends via `SetLegend(n)`.
- Legend entries can be customized individually.
- custom legends and legend entries can be made
- Text can be added also with multiple lines

Projecting and Profiling Multidimensional Data

- Existing multidimensional histograms can be projected directly when adding them to a plot.
- Standard projections (`ProjectX()`, `ProjectY()`, ...) are available for 2D and 3D histograms.
- Projections can be restricted to selected ranges of the remaining axes using either bin numbers or user coordinates.
- The generic Project() function supports arbitrary-dimensional histograms and arbitrary projection axes.
- One- and two-dimensional profiles can be created analogously from multidimensional histograms.
- The same functionality is available for numerator and denominator of ratios.

Processing Tree and Table Data

- Tree leaves and table columns of csv files are accessed through the same interface.
- Create histogram projections, profiles and scatter plots directly from tabular data.
- Binning can be inferred automatically or specified explicitly with uniform or custom bin edges.
- Data can be filtered, derived quantities defined and arbitrary C++ expressions used for projections and selections.
- Entry ranges can be selected to process only subsets of the input.
- The same functionality is available for both ROOT trees and CSV tables.

Work in Progress...