H5PartROOT

a visualization and post-processing tool for accelerator simulations

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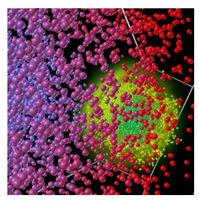
Abstract

Modern particle tracking codes with their parallel processing capabilities generate data files of the order of 100 Gigabytes. Thus they make very high demands on file formats and post-processing software. H5PartROOT is a versatile and powerful tool addressing this issue. Based on ROOT, CERN's object-oriented data analysis framework developed for the requirements of the LHC era, and the HDF5 hierarchical data format, supplemented by an accelerator-specific interface called H5Part, H5PartROOT combines the statistical and graphical capabilities of ROOT with the versatility and performance of the HDF5 technology suite to meet the needs of the accelerator community. Providing the user with both a graphical user interface (data browser) and a shared library to be used in an interactive or batch ROOT session, H5PartROOT passes on the full power of ROOT without presupposing any knowledge about the intricacies of either ROOT or C++.

Building Blocks

- **HDF5:**
  - Highly sophisticated, "self-describing" data format
  - Completely portable
  - No limits on data size



- **H5Part:**
  - Portable, high-performance parallel data interface to HDF5
  - Optimized for particle accelerator simulations (time steps, phase space, etc.)

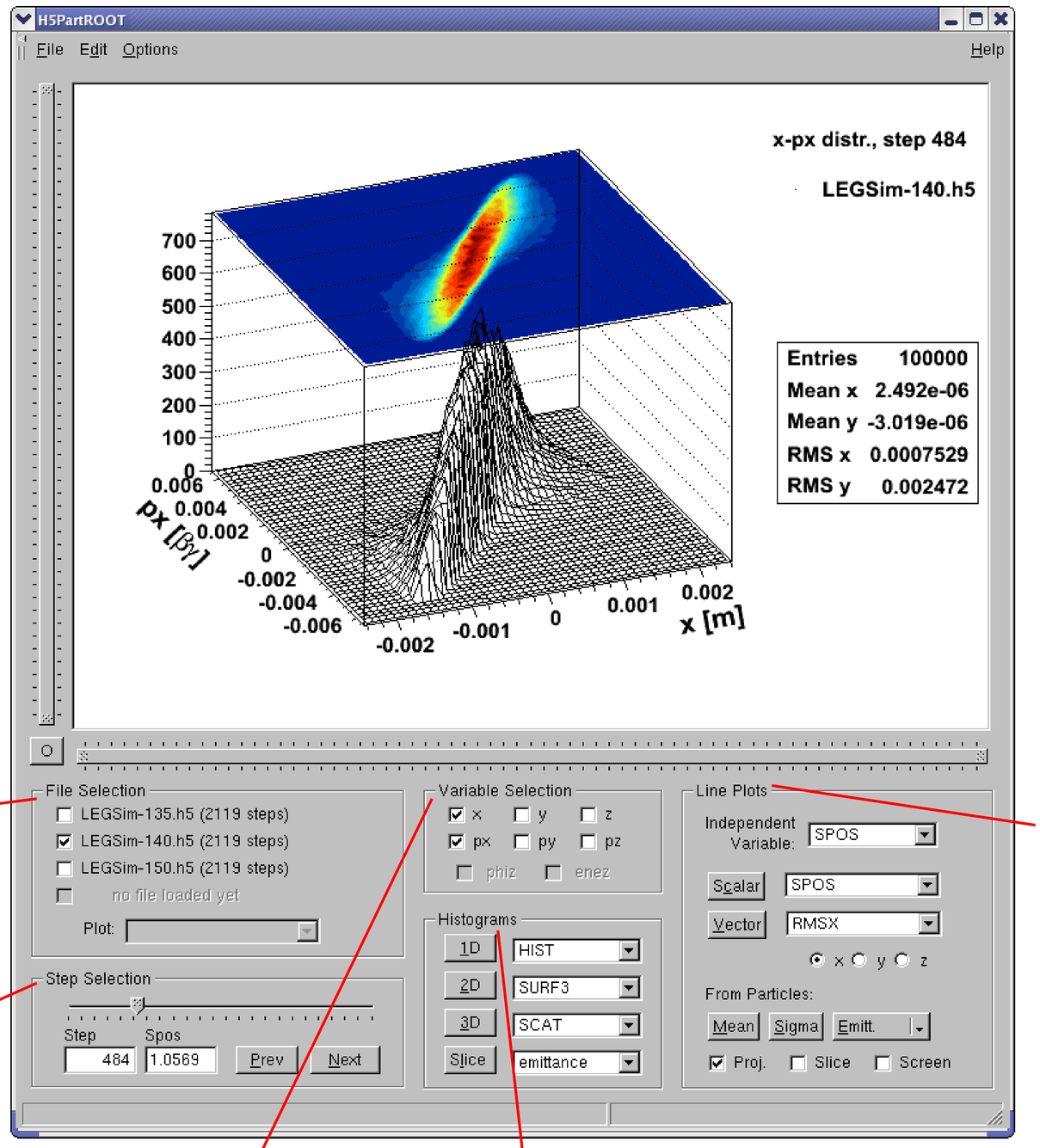
- **ROOT:**
  - Object-oriented data analysis framework developed at CERN to process high-energy physics data (LHC)
  - With plotting, statistics, GUI functionality

The Shared Library

A GUI is great, but sometimes you need more control over what and how to plot.

H5PartROOT as a shared library gives access to all plotting/analysis routines from...

- **...an interactive ROOT session;**
- **...a ROOT macro;**
- **...a compiled ROOT application**



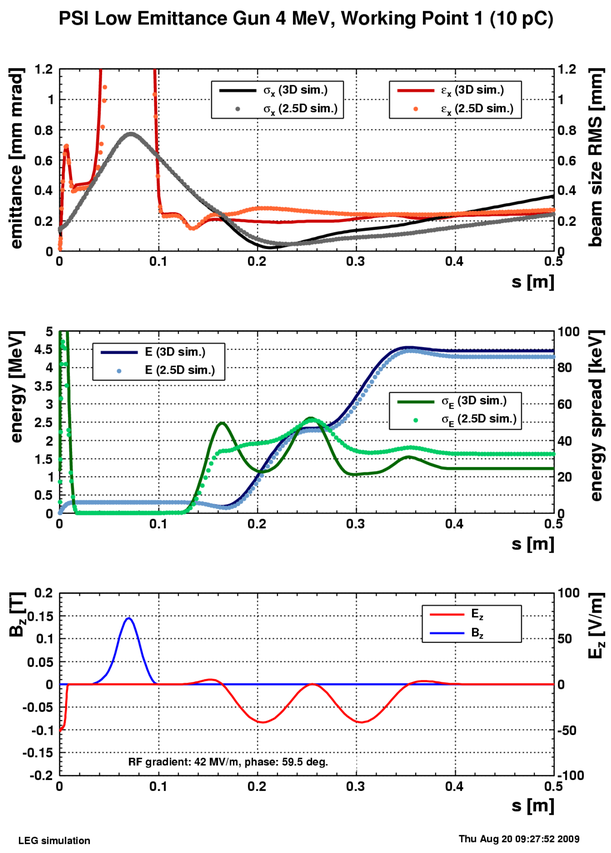
File Selection:
- load up to 4 files into the browser
- select between comparison, difference, sum, average for plotting

Step Selection:
- Select time step with slider or numerical input of step or position in accelerator
- Buttons to jump forward and backward

Variable Selection:
- Select variables to be plotted in histograms
- Also for line plots (e.g. for x-emittance, select x and px)

Histograms:
- 1D, 2D, 3D, and slice histogram (slice emittance along z-axis)
- Choose drawing style with selection box

Line Plots:
- Plot a quantity as a function of the time step.
- The quantity may be stored during the simulation or computed on-the-fly from the particle distributions.

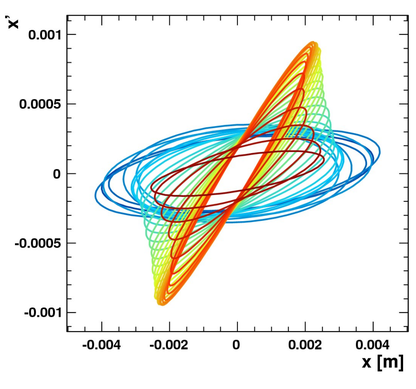


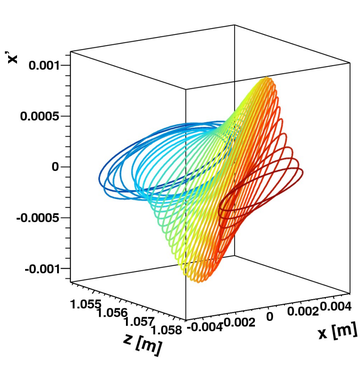
Code comparison plot produced by a ROOT macro after loading the H5PartROOT shared library.

Accelerator-Physics Features

- **RMS emittance**
- **Twiss parameters** **for**
- **Phase space ellipses**

- **fully projected**
- **screen projected**
- **sliced** **bunch**
- **clipped**

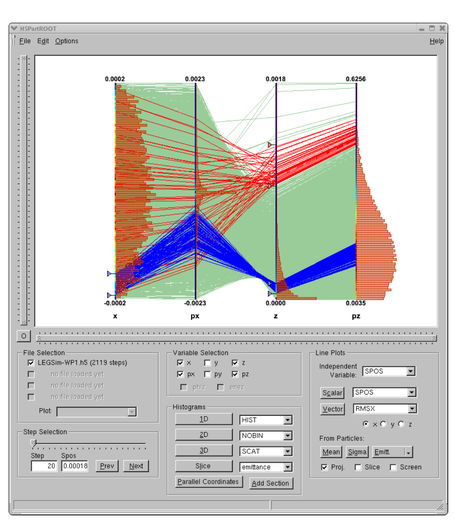




Twiss phase space ellipses for bunch slices in 2D (left) and 3D (right) representation.

Future Plans

- More particle selection features
- Better 3D plotting capability (with **OpenGL**)
- New visualization concepts
  - e.g., **Parallel Coordinates**
- Visualization of slice-based simulations (e.g., Homdyn)
- Parallelization?



Prototype version of H5PartROOT featuring parallel coordinates. The plot shows a phase space distribution (x,px,z,pz) with one selection in z (red) and another one in x and z (blue).

Acknowledgements

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