

# Belle-II Event Display

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für Bildung  
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# Whats an Event Display

- tool to display events
- takes as input root files in the Belle-II data format (real or simulated data)
- uses the Belle-II geometry to translate these data into a graphical representation of what is going on in one event (collision)
- comes (for free) with installation of the Belle-II software (basf2)
- shown is a much simplified representation of the Belle-II detector (full geometry is possible but currently bugged)

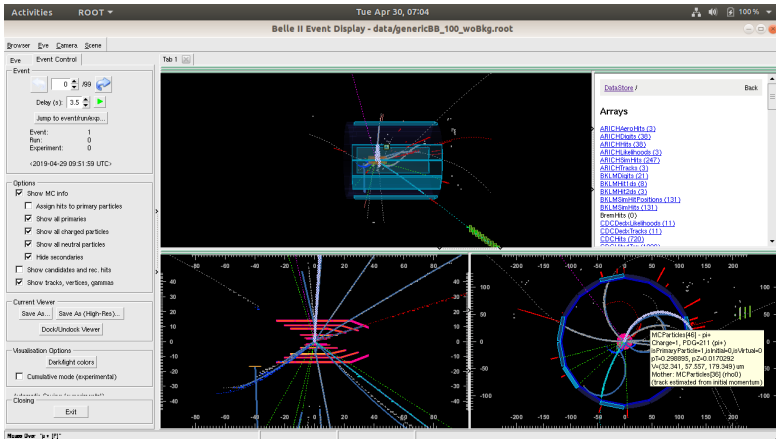
We need working Belle-II software, so log into working node with pre-installed software

- open a command shell (Ctrl+Alt+T)
- type: `ssh bachelorIntro2019@kuhrios.universe-cluster.de -X`
- password:

Setup the software and find some data, and start

- type: `source setup_belle2.sh`
- start the event display: `b2display data/SomeRootFile.root`

# How does (should) it look



# What can be seen

## Monte Carlo Information (only for MC data)

- true information on all particles created by the generator
- true trajectory through detector
- true identity (particle type) and true mother

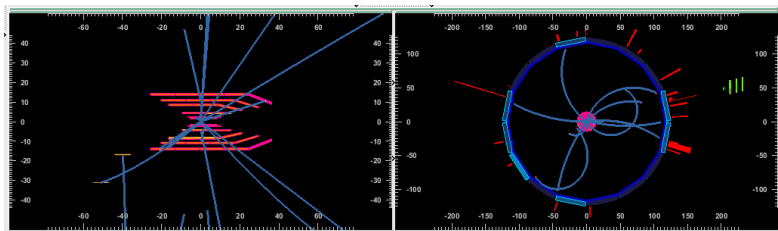
## Detector level information (if written out)

- hits for most of the sub-detectors
- hit positions

## Reconstructed quantities

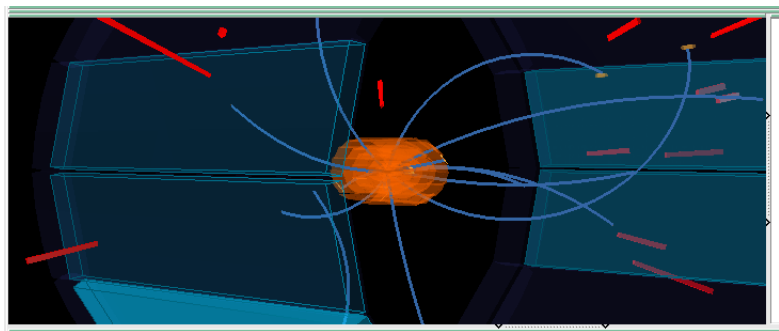
- reconstructed tracks (combination of hits in the tracking detectors)
- reconstructed clusters (combination of ECL crystals)
- KLM clusters
- ...

# Different views: projections in x-y- and y-z-plane



- zoom: mouse scroll; or hold right mouse button + move mouse
- moving image: arrow keys

## Different views: full 3D view



- zoom: mouse scroll; or hold right mouse button + move mouse
- moving image: arrow keys
- rotate image: hold left mouse button + move mouse

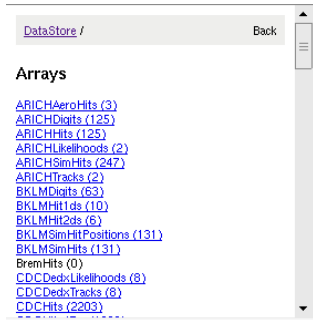
# Event steering

The screenshot shows the 'Event Control' window with the following sections:

- Event:** Navigation buttons, a counter showing '0 / 99', a 'Delay (s): 3.5' field with a play button, and a 'Jump to event/run/exp...' button.
- Statistics:** A table showing 'Event: 1', 'Run: 0', and 'Experiment: 0'. Below it is a timestamp: '<2019-04-29 09:51:59 UTC>'. A vertical scrollbar is visible to the right of this section.
- Options:** A list of checkboxes: 'Show MC info' (unchecked), 'Assign hits to primary particles' (unchecked), 'Show all primaries' (checked), 'Show all charged particles' (checked), 'Show all neutral particles' (checked), 'Hide secondaries' (checked), 'Show candidates and rec. hits' (unchecked), and 'Show tracks, vertices, gammas' (checked).
- Current Viewer:** Buttons for 'Save As...', 'Save As (High-Res)...', and 'Dock/Undock Viewer'.
- Visualisation Options:** A 'Dark/light colors' button and a 'Cumulative mode (experimental)' checkbox (unchecked).
- Closing:** An 'Exit' button.

- go one event back / forward
- play all events as a movie (can adjust time between events)
- activate or deactivate certain kinds of information
- save screen shots for events

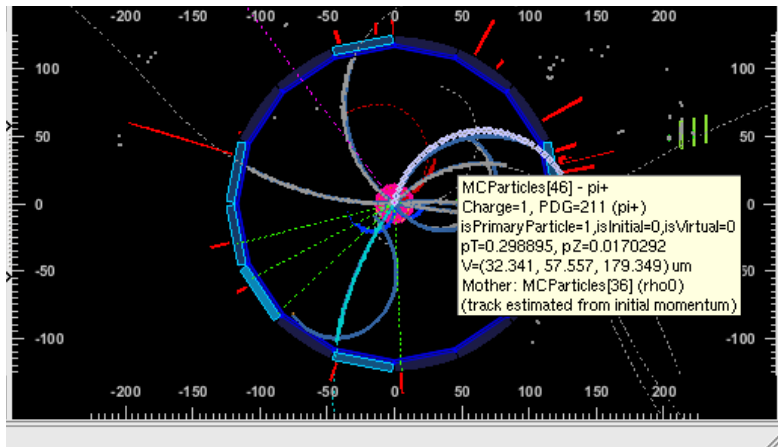




- complete list of all objects or arrays of objects in the event (reconstructed and generated)
- click on specific objects to get more information

## Final tip:

- hover mouse over certain objects to get more information on said object
- object will be highlighted in all views



# Generated different types of events (100 per file)

- $e^+e^- \rightarrow B\bar{B}$ 
  - $B$  mesons decay generically: into all allowed/known final states
  - two versions: one with (w), one without (wo) beam induced background
  - activate "Show candidates and rec. hits" (if you dare) and see if you can spot the difference
  - files: genericBB\_100\_woBkg.root; genericBB\_100\_wBkg.root
- $e^+e^- \rightarrow c\bar{c}$ 
  - pair of c-quarks produced which hadronize into the final state
  - more boosted compared to  $B\bar{B}$  events
  - similar for lighter quarks:  $e^+e^- \rightarrow s\bar{s}$ ;  $e^+e^- \rightarrow u\bar{u}$ ;  
 $e^+e^- \rightarrow d\bar{d}$
  - file: cccbar.root
- radiative Bhabha events:  $e^+e^- \rightarrow e^+e^-\gamma$ 
  - very large cross section compared to  $B\bar{B}$  events
  - easy to reject due to event topology (2 charged tracks)
  - mainly at low scattering angles
  - file: rad\_bhabha.root

# Generated different types of events (100 per file)

- $e^+e^- \rightarrow \mu^+\mu^-$ 
  - 2 charged tracks (back to back in CMS)
  - file: mumu.root
- $e^+e^- \rightarrow \tau^+\tau^-$ 
  - also quite boosted event topology
  - more particles in the final state compared to  $e^+e^- \rightarrow \mu^+\mu^-$   
 $e^+e^- \rightarrow e^+e^-$
  - file: tautau.root

- you cannot break anything, so toy around
- If you have any question: Ask!
- Have fun!