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Belle2 Masterclass

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- › Design
- › Implementation
- › Status
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Introduction

Belle II Masterclass – our effort to disseminate our knowledge to the general public as a part of the Masterclasses organized all over the world <http://physicsmasterclasses.org/>

Target audience:

- › students of physics
- › high school students
- › primary school students
- › general public

Explain and show:

- › What are we doing ?
- › How does the Belle II detector look like?
- › What are our research methods?
- › What do we expect to see?
- › What are our results?

Target date: March 2018

Hands on science with our data

The complete solution will consist of:

- Introduction to the tools used
- Detector simulation
- Event display of several events
- Exercise with the data

› Existing solutions:

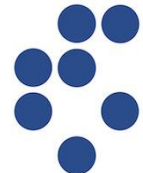
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- CMS offers only event display,
- LHCb offers also basic analysis of data based running the python scripts,
- Belle Blab is more complex and requires the modification of the code.



Unique user friendly insight in our data

- › Prepare exercises at different level of complexity
- › Make data sample available to the general public
 - Graphical user interface which generates pseudocode which runs the analysis in the backend
 - › user friendly
 - › expose physics of particles
 - › minimize the starting errors made during coding
 - Web version enables access to everyone and runs on a single web server
 - Virtual appliance with data and software pre-installed – allow download to user computer and parallel execution, targeted mainly to the schools & workshops



Design

- › Belle II analysis and software framework used for the event display and the analysis
 - data sample: Belle at the beginning, when available, switch to Belle II
- › Web interface
 - The graphical user interface based on Blockly - google graphical library
- › Several exercises:
 - spectroscopy examples will be used.
 - Based on the feedback and our experiences we will extend it later (next year) with more complex examples.
- › Design the exercises to be used by larger groups of people - In Italy 270 students take part in the masterclasses in parallel

Status

Task force for the implementation of the Masterclass formed

First step: Exercise based on Belle B-Lab:

<http://belle2.ijs.si/blab/blab.html>

- › exercise instructions, two datasets and supporting scripts available for download

Test installation at the web server hosted at our institute

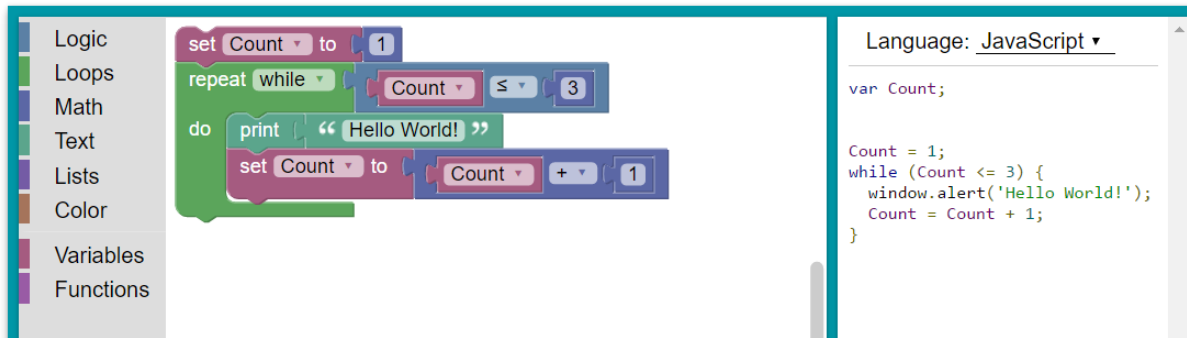
- › Virtual machine CentOS +root 6.08 + php + mysql at JSI
- › <http://belle2.ijs.si/masterclass>

Virtual appliance:

- › VirtualBox + Ubuntu16.04 + root 6.08 + php + data + scripts)
- › <http://belle2.ijs.si/bellellubuntu16.04.3.7z>
- › Run the appliance, log in and start the browser

Visual programming environment to interface the Belle II data

<http://developers.google.com/blockly/>



Inspired by MIT Scratch <https://scratch.mit.edu>

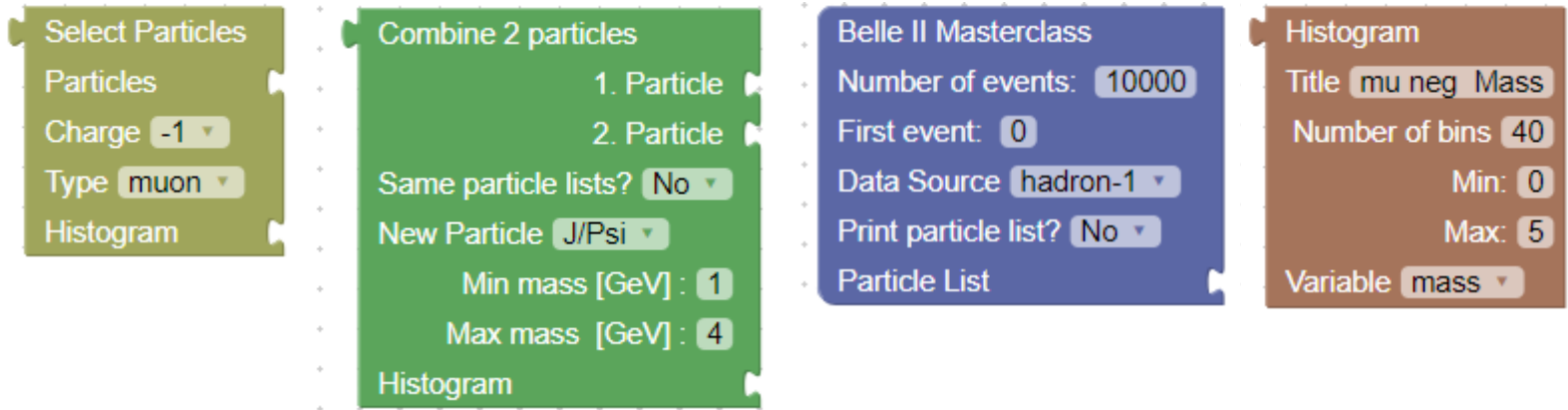
Example implementation based on Blab data:

<http://belle2.ijs.si/masterclass>

1. Blockly JavaScript generates JSON text strings
2. they are sent to the server
3. converted into the computer code (python steering file)
4. The code is executed on the server
5. histograms are sent back to the client
6. displayed using JSROOT JavaScript.



Basic blocks



Limited number of blocks:

Select particles ... to select particle type for analysis

Combine two particles ... combination of particles from two lists

Belle II Masterclass ... analysis condition:

data source

Number of events

Histogram ... plotting of the variable

Define range and variable to plot

Basic quantities of the particles

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Belle II Masterclass

Number of events: 10000

First event: 0

Data Source hadron-1

Print particle list? No

Particle List

Select Particles

Particles

Charge Any

Type all particles

Histogram

Histogram

Title All particles;cos(polar angle);N

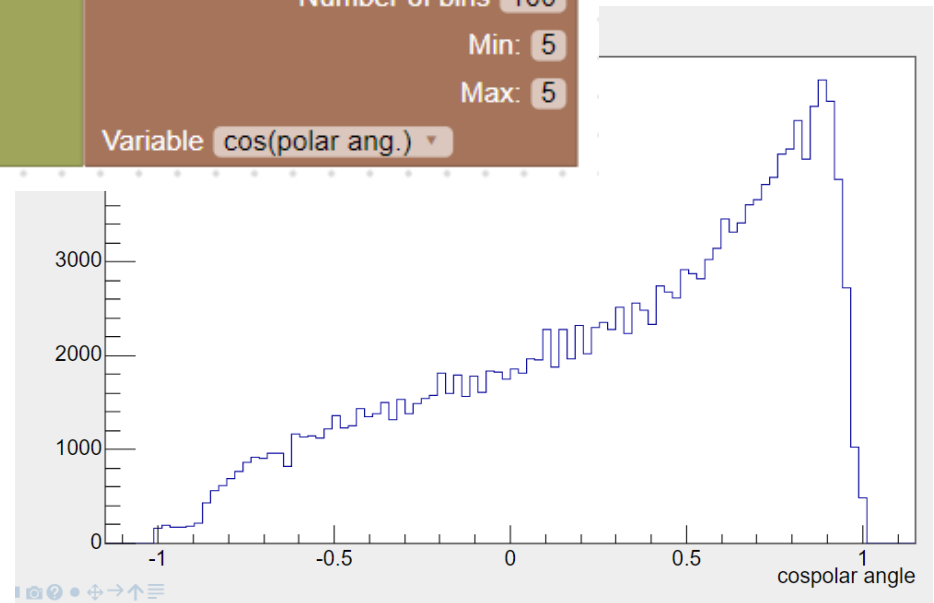
Number of bins 100

Min: 5

Max: 5

Variable cos(polar ang.)

Current variables:
mass, momentum, energy,
charge, identity, px,py,pz,
cos(theta), theta,pT



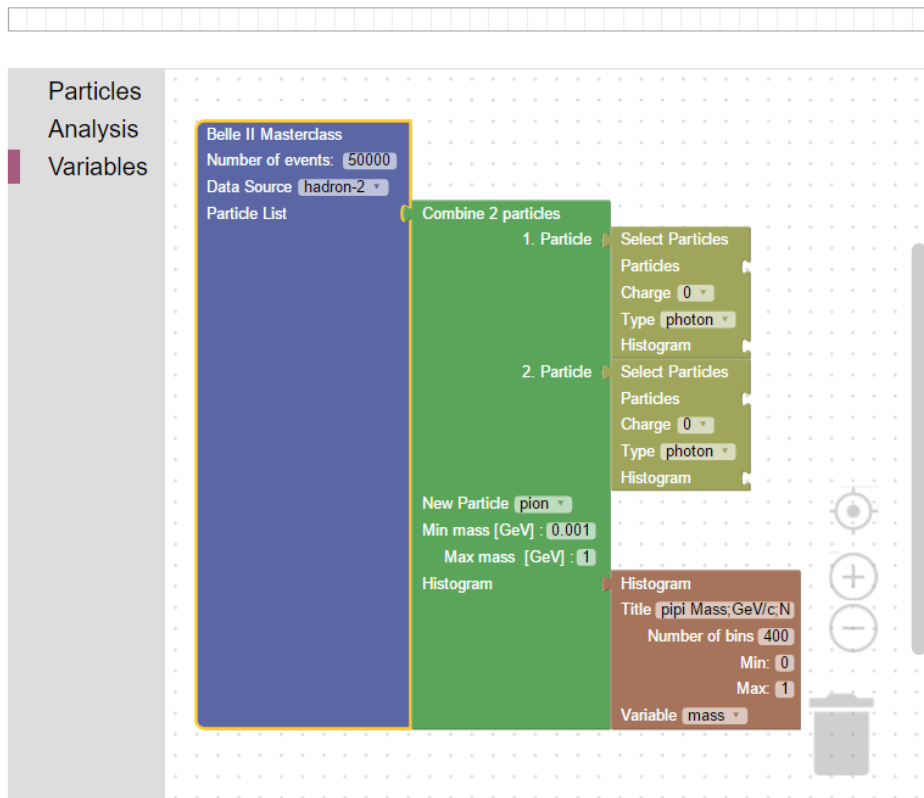
Basic Usage



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Belle II Masterclass: Define process → Analyse data → Visualise results → Save/load process locally

Run Analysis Interrupt Switch between Diagram and Results Save Diagram Load Diagram



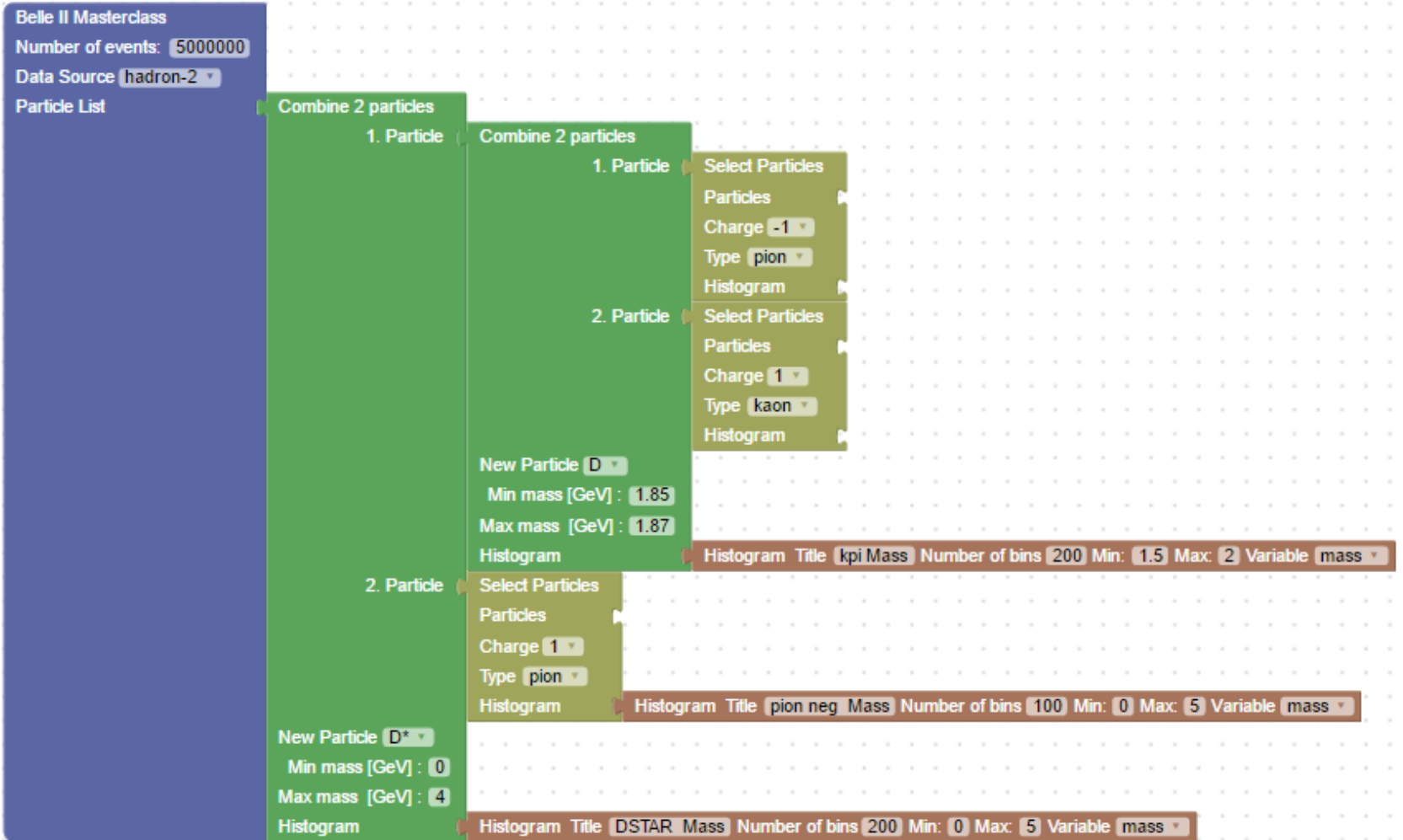
User describes a decay by blocks:

- › Fixed block connections – minimize errors



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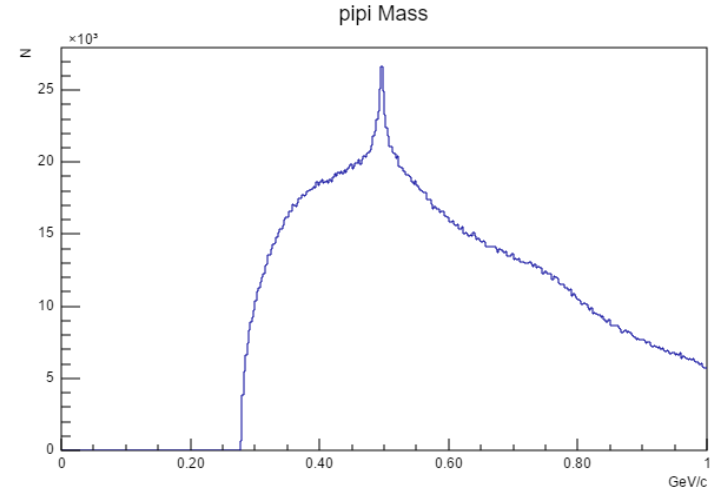
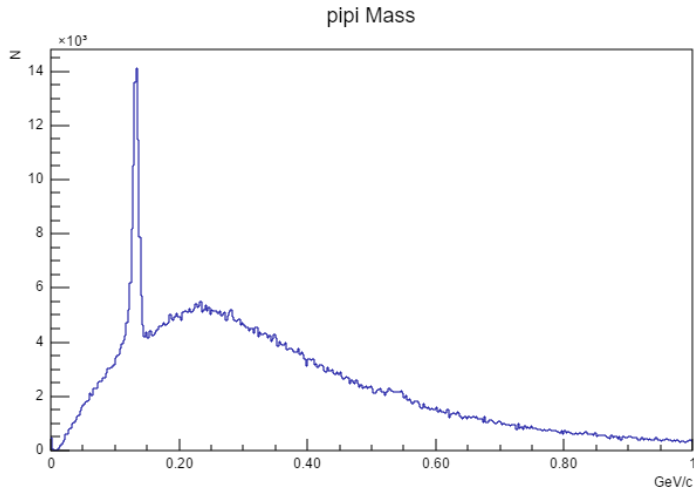
Combination of three particles



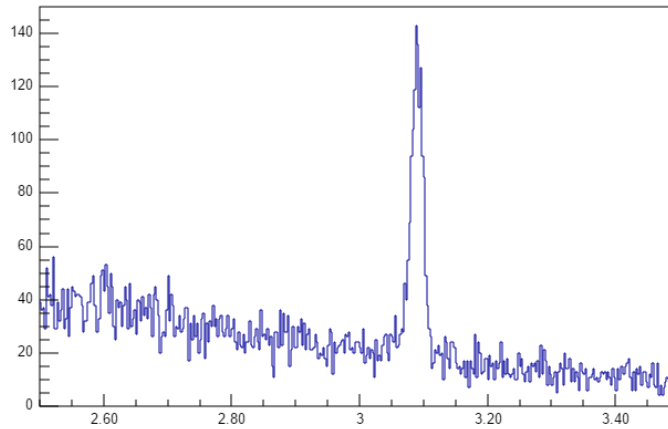


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Different decays

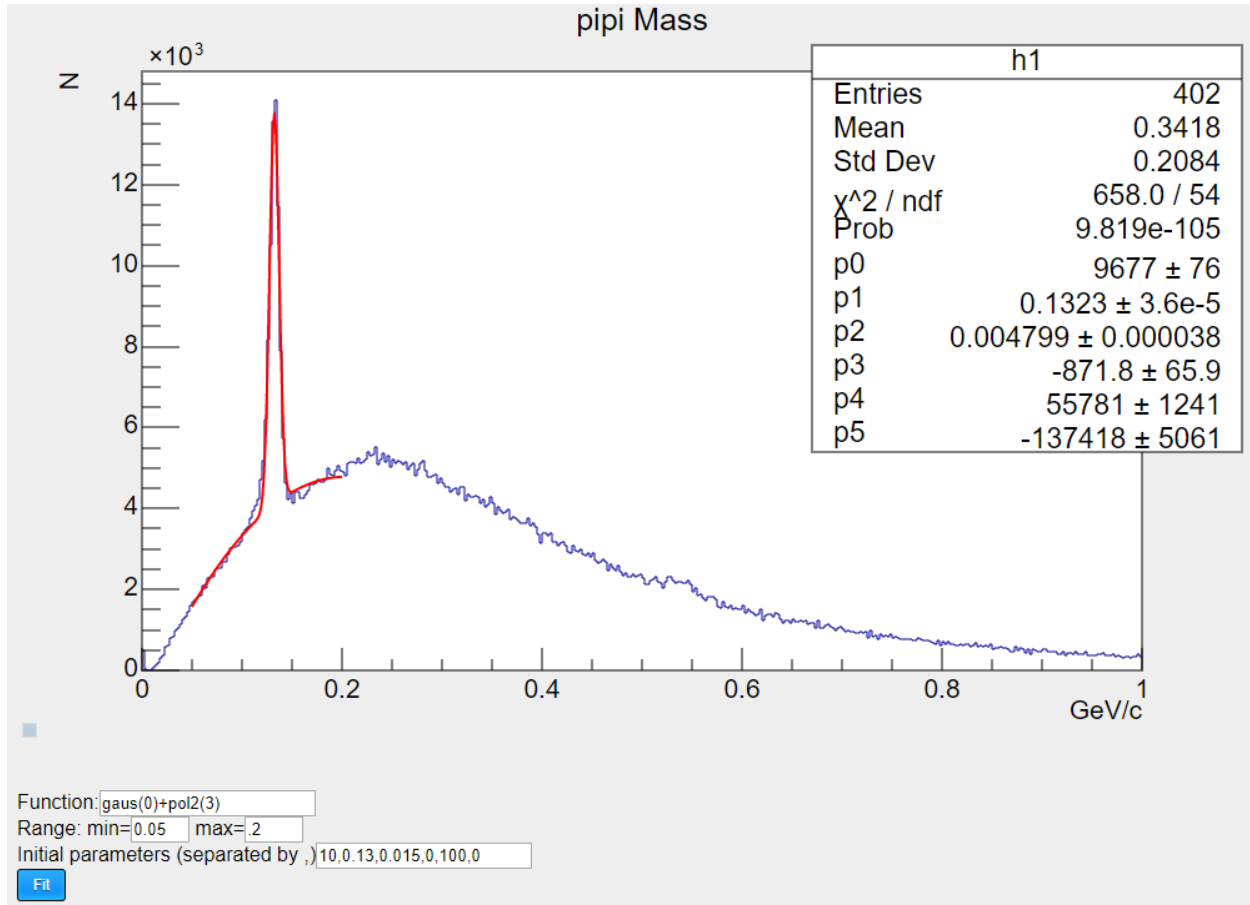


mumu Mass





Fit the resulting histogram



The interface has a possibility to fit the resulting histograms to compare the results between students

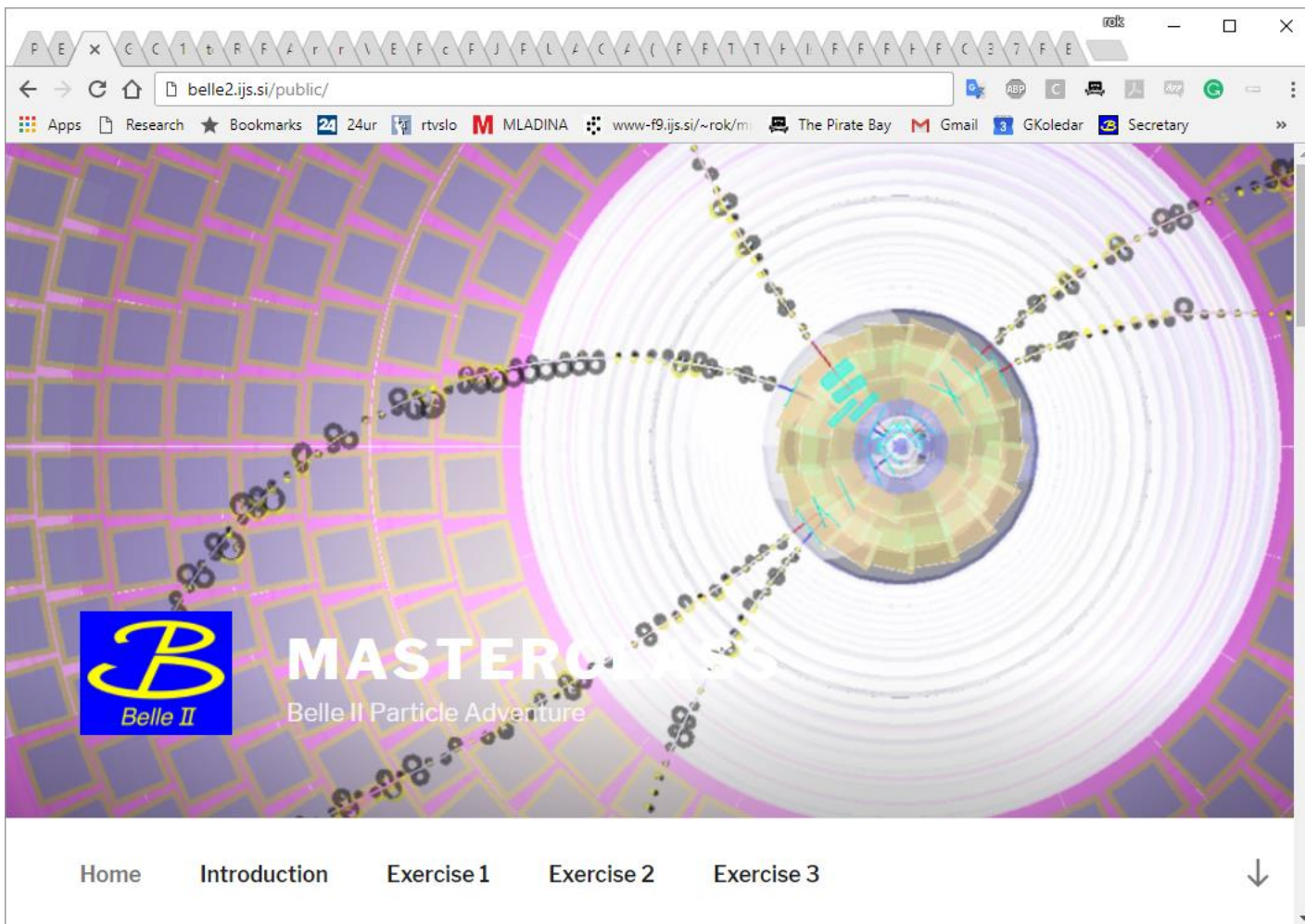


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Example table to be filled by students

Particle		Proces	Mass (GeV/c ²)	Number of entries	Number of detected particles	Probability	Decay width (GeV)
π^0	$\frac{1}{\sqrt{2}}(u\bar{u} - d\bar{d})$	$\pi^0 \rightarrow \gamma \gamma$					
Ks	$\frac{1}{\sqrt{2}}(ds\bar{s} + \bar{d}s)$	$K_s \rightarrow \pi^+ \pi^-$					
ϕ	$s\bar{s}$	$\phi \rightarrow K^+ K^-$					
J/ψ	$c\bar{c}$	$J/\psi \rightarrow e^+ e^-$					
		$J/\psi \rightarrow \mu^+ \mu^-$					
D ⁰	$c\bar{u}$	$D^0 \rightarrow K^+ \pi^-$					
		$D^0 \rightarrow K^- \pi^+$					
D ^{*+}		$D^{*+} \rightarrow D^0 \pi^+$					
D ^{*-}	$d\bar{c}$	$D^{*-} \rightarrow D^0 \pi^-$					
B ⁺	$u\bar{b}$	$B^+ \rightarrow J/\psi K^+$					
B ⁻	$\bar{u}b$	$B^- \rightarrow J/\psi K^-$					

Web page with an introductory material





Usage statistics

<http://belle2.ijs.si/masterclass/visitormap.php>

User IP address, the execution scripts and time are recorded in the database and can be displayed

Belle II Masterclass visitor map





First experience

- › Web page for self training is available:
 - <http://belle2.ijs.si/masterclass/>

- › Training of the high school students:
 - Virtual appliances installed to 45 computers
 - 25 participants of the Summer school of Faculty of Mathematics and Physics, University of Ljubljana, Aug. 2017
 - Students had a lot of fun



Next steps

- › Change the existing interface to use the Belle II Analysis Software Framework
 - Light weight binary distribution of BASF2
- › Define data format
- › Prepare the examples and sample data sets
- › Prepare the License to use the Belle II software and data (part of the software taskforce)
- › Create supporting introduction and documentation and virtual appliances
- › Localization: translate the documentation to different languages
- › First full size Masterclasses expected in March 2018