



Belle II Masterclasses

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The screenshot shows several control panels for the Belle II Masterclass software. On the left, a 'Select Particles' panel includes 'Particles', 'Charge' (set to -1), 'Type' (set to muon), and 'Histogram'. Next to it is a 'Histogram' panel with 'Title' (mu neg Mass), 'Number of bins' (40), 'Min' (0), 'Max' (5), and 'Variable' (mass). The central 'Belle II Masterclass' panel displays 'Number of events: 10000', 'First event: 0', 'Data Source' (hadron-1), 'Print particle list?' (No), and 'Particle List'. On the right, a 'Combine 2 particles' panel lists '1. Particle' and '2. Particle', with 'Same particle lists?' (No), 'New Particle' (J/psi), 'Min mass [GeV]' (1), and 'Max mass [GeV]' (4). A 'Histogram' button is also visible at the bottom of this panel.

One day outreach event:
Disseminate our goals, methods and results to the public



MASTERCLASS
Belle II Particle Adventure

Pilot Run

March 22, 2019 from 9h-17h CET

- Invitations: 3 months before
- Technical meeting: 2 weeks before
- Event
- Evaluation

Resources

Introduction to HEP: <http://indico.ijs.si/conferenceTimeTable.py?confId=1034#20190322>

Belle II Virtual Reality: <http://www1.phys.vt.edu/~piilonen/VR/>
https://store.steampowered.com/app/810020/Belle_II_in_Virtual_Reality/

Exercises with data: <http://belle2.ijs.si/masterclass>

You Tube Introduction:

- Start: https://youtu.be/q6M2_dnp3pl
- Particle distribution: https://youtu.be/q6M2_dnp3pl
- J/psi to mumu: <https://youtu.be/xUYmXoPfZOU>
- J/psi to ee: <https://youtu.be/3TGsHJ8j8pE>
- Fit: <https://youtu.be/wWbjWYHVLU>
- B to J/psi K <http://youtube.com/watch?v=e-GErqzY3HM>

INTERNATIONAL
MASTERCLASSES
ON PARTICLE
PHYSICS

Vabilo

»International Masterclasses« iz fizike osnovnih delcev nudijo gimnazijem enkratno priložnost, da se sami spoznajo s svetom kvarkov in leptonov, tako da izvedejo meritve na resničnih podatkih, zajetih v CERNu in v drugih raziskovalnih centrih po svetu, da se srečajo s pravimi raziskovalci in se povežejo s svojimi vrstniki – dijaki iz drugih držav in z njimi pregledajo rezultate in izmenjajo mnenja.

Ljubljana, 30.1.2019

Dijaki bodo na enodnevnem dogovoru s predavanji in delavnico, kjer bodo uporabljali podatke iz poskusa Belle z Japonske (<http://belle2.jp>), spoznavali osnovne delce in sile, ki delujejo med njimi.

Dopolnje bomo raziskovalci z Inštituta Jožef Stefan v Ljubljani, Fakultete za matematiko in fiziko Univerze v Ljubljani in Fakultete za kemijo in kemijsko tehnologijo Univerze v Mariboru predstavili fiziko osnovnih delcev in detektorje, ki jih uporabljamo pri naših raziskavah. Pred skupnim kosilom bo obilo priložnosti za pogovor z sprehodom ogledali notranjost detektorja Belle II. Med skupnim kosilom bo obilo priložnosti za pogovor z raziskovalci. Na popoldanski delavnici pa se bodo dijaki sami lotili analize podatkov, ki so bili zajeti s poskusom Belle na trkalniku KEKB, v inštitutu KEK v Cukubi na Japonskem. Po končanem delu se bomo povežali z drugimi šolami in inštituti, ki se pogovarili o delu na poskusu Belle II.

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Dogodek h

Mrg Miloša Zidanska 1
prijava



Participants

6 participating sites from Europe and ~200 high school students

Site	Contact person	Number of students
Padua	Ezio Torrassa	100
Ljubljana	Rok Pestotnik	26
Strasbourg	Isabelle Ripp-Baudot	10
Prague	Zdenek Dolezal	10
Krakow	Andrzej Bozek	20
Roma Tre * April 3	Antonio Passeri	40



Event Program

- ❑ Introductory lectures to Particle Physics and Belle II
- ❑ Immerse in the Belle II detector: **Belle II Virtual Reality presentations**
- ❑ **Exercises** with a live introduction and instructions + worksheet to fill the results
- ❑ Video conference

8:45	Registration
9:00 - 9:15	Introduction
9:15 - 10:00	Physics of elementary particles
10:15 - 11:00	Experimental methods in high energy physics
11:00 - 11:30	Belle II Virtual reality
11:30 - 12:15	Data Analysis
12:15 - 13:00	Lunch – meet the HEP researchers
13:00 - 16:00	Belle Data Analysis
16:00 - 17:00	Video conference



Run in parallel at different sites

Several live entries from KEK: canteen, accelerator & Belle II control room



Multisite international video conference to discuss the results and to conclude the event

Belle II Virtual Reality



Immerse in the Belle II detector and observe particle collisions

<http://www1.phys.vt.edu/~pilonen/VR/>

[https://store.steampowered.com/app/810020/Belle II in Virtual Reality/](https://store.steampowered.com/app/810020/Belle_II_in_Virtual_Reality/)



Hands on workshop

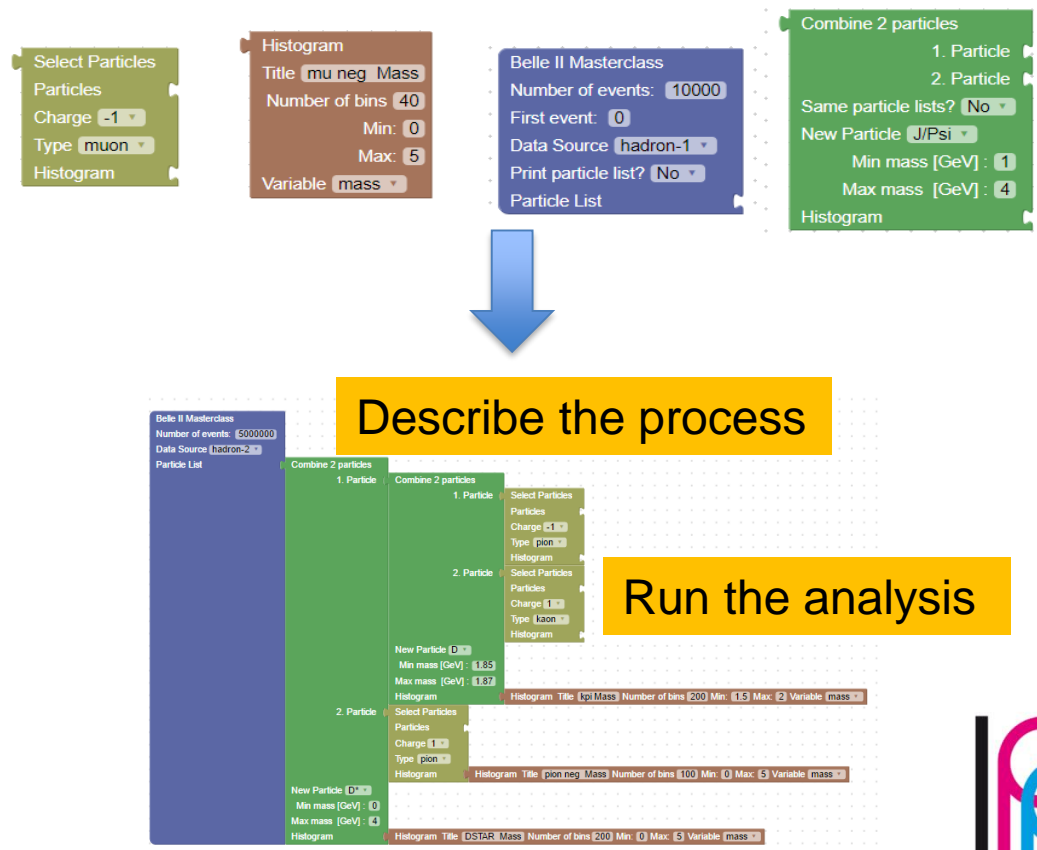
Exercises with a Belle public data sample spectroscopy examples

- ❑ Data Root file with reconstructed particles
- ❑ Web interface: four types of blocks connected to each other



- ❑ Momentum: p_x, p_y, p_z
- ❑ Energy
- ❑ Charge
- ❑ Identity

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



Summary table filled by students

Particle	Quark structure	Channel	Invariant mass		
			PDG	Center (p_1)	Width (p_2)
π^0	$u\bar{u} + d\bar{d}$	$\gamma^0 \gamma^0$	0.134	0.132	0.005
π^0	$u\bar{u} + d\bar{d}$	$\gamma^0 e^+ e^-$	0.134	0.133	0.005
η^0					
K^0					
K^{*0}					
ϕ^0					
D^0					
D^0					
D_s^+					
D_s^0					
J/Ψ					
J/Ψ					
B^+					
B^-					
B^0	$b\bar{d} / d\bar{b}$	$\mu^+ \mu^- K^0$	5.279	5.285	0.05

Invariant mass distribution

Summary statistics for the peak:

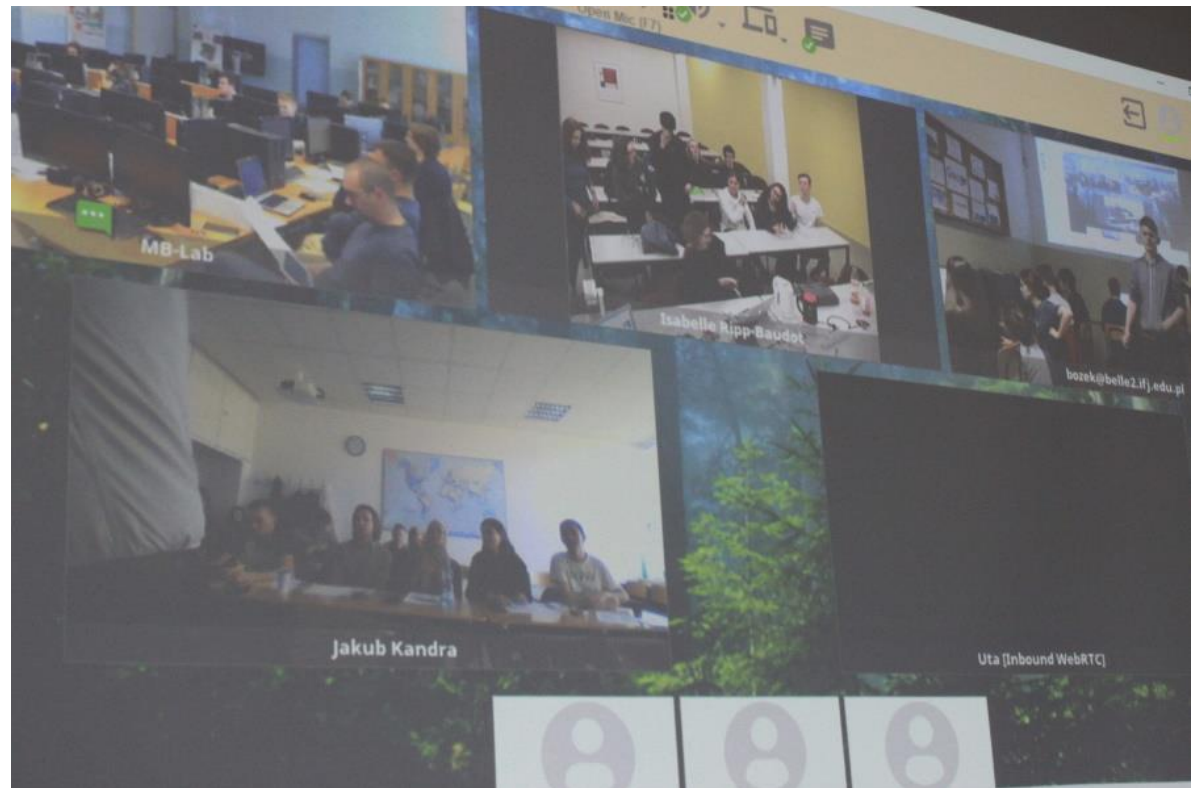
h1	Entries	Mean	Std Dev
h1	32296	1.071	0.04813

Video conference

5 sites connected together in a video conference

Moderated by one of the participating lecturers

- 2min : Opening
- 5x5min: Presentation of the results
- 5 min: Connection to the Belle II control room
- 10 min : Particle quiz
- 5 min: Closing



Quiz

15 not too serious questions:
10 Particles Physics + 5 Japan

Competition between sites

A lot of fun - students liked the format and questions

Prizes for the best students:
distributed by site moderators

T-shirts, cups, badges from KEK, Japan
purchased with JENNIFER money.

Which one of the following is not a name of a quark?

1

A. Charm
B. Beauty
C. Elegance
D. Top

To strongly increase the energy of a charged particle you can use which one of the following?

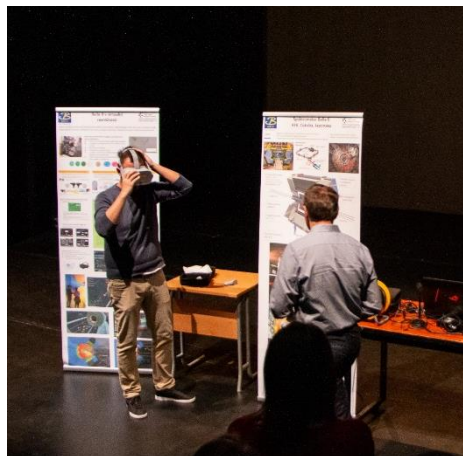
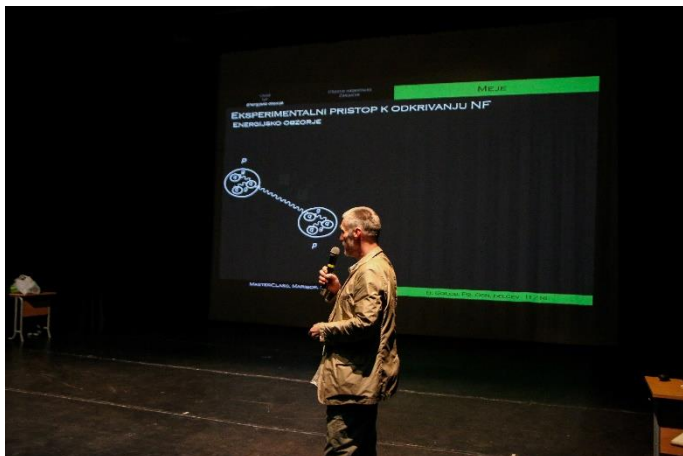
4

A. A magnetic field
B. An electric field
C. A gravitational field
D. A strong wind



Photos

The Event was really a success:
TEDx like atmosphere – very inspiring



INTERNATIONAL
MASTERCLASSES

hands on particle physics 9

Plans

Run Belle II masterclasses once or twice per year

- Gain from IPPOG to attract broader audience
 - Include Belle II MC in the list of events
- Belle II Internal call for participation
- Limit: up to 5 participating sites/ video call
- Include Japan and none European institutions

To do:

- Improve Audio during video connection
- Prepare & translate common materials to enable non-Belle II institutions to participate
- Employ Belle II event display
- Exercises: Prepare Belle II data & Improve the app for easier data fitting
- Collect GDPR permissions to take pictures



Conclusions

- 6 sites and 200 high school students participated in the Belle II Masterclass pilot run on March 22nd, 2019
- Very good performance – a lot of enthusiastic students
- We are ready to participate in the regular IPPOG IMC program

