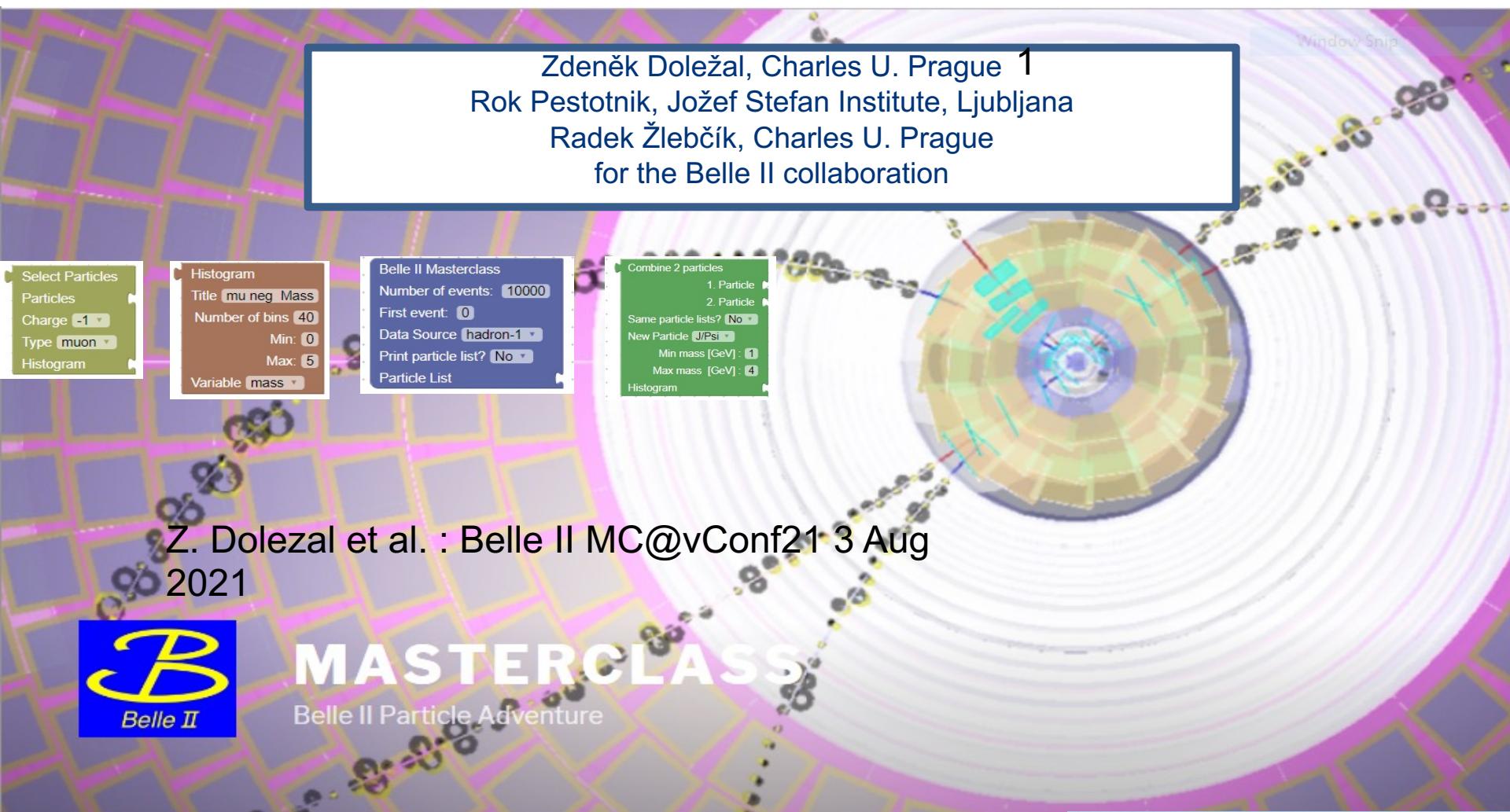


Belle II Masterclasses

Zdeněk Doležal, Charles U. Prague 1
Rok Pestotnik, Jožef Stefan Institute, Ljubljana
Radek Žlebcík, Charles U. Prague
for the Belle II collaboration



MASTERCLASS
Belle II Particle Adventure

Home

Intro

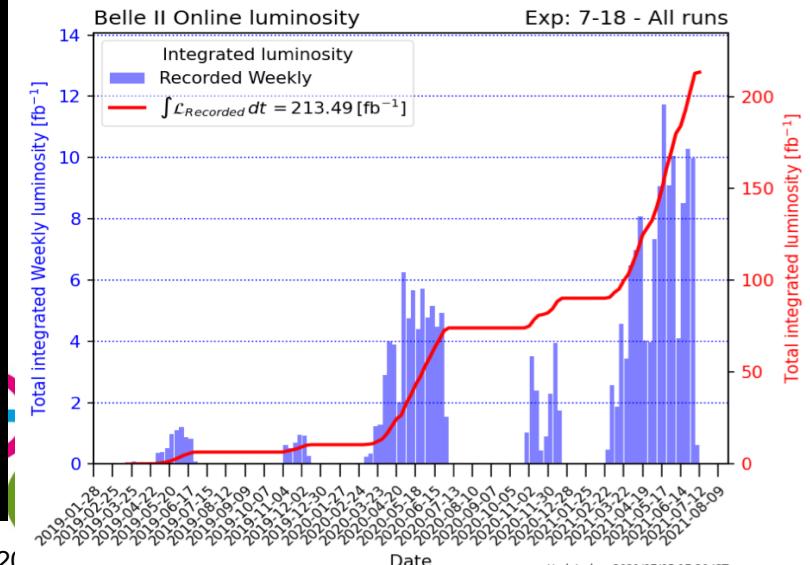
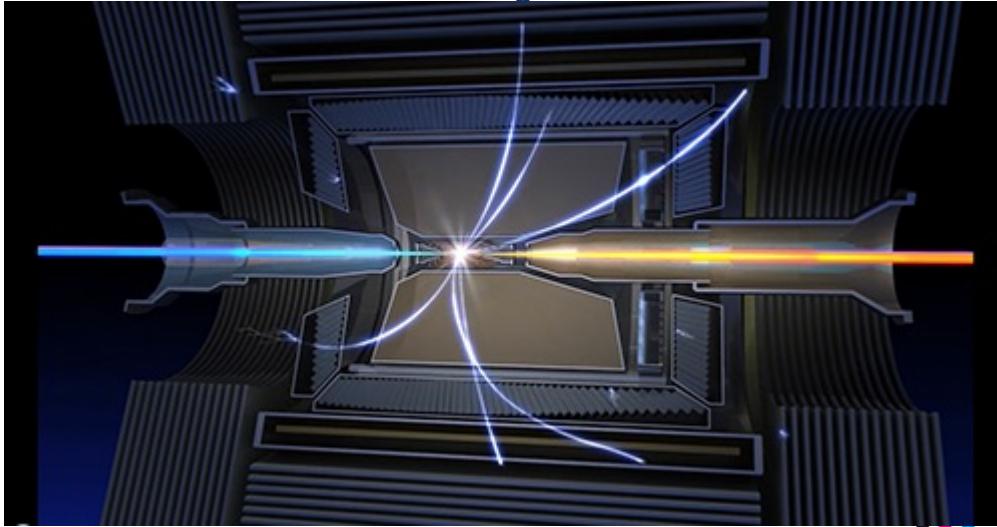
Belle II

Exercise ▾



Belle II

- Belle II <http://belle2.jp>
 - study of rare decays of B and D mesons and tau leptons
- @ SuperKEKB Tsukuba, Japan
 - e+e- collider at Y(4S) resonance
- Experiment outreach
 - What are we doing ?
 - How do our detectors look like?
 - What are our research methods?
 - What do we see?
 - Masterclasses running since 2019



Event Program

- ❑ Introductory lectures to HEP and Belle
- ❑ 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 to discuss the results with other groups

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

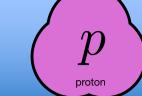
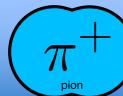
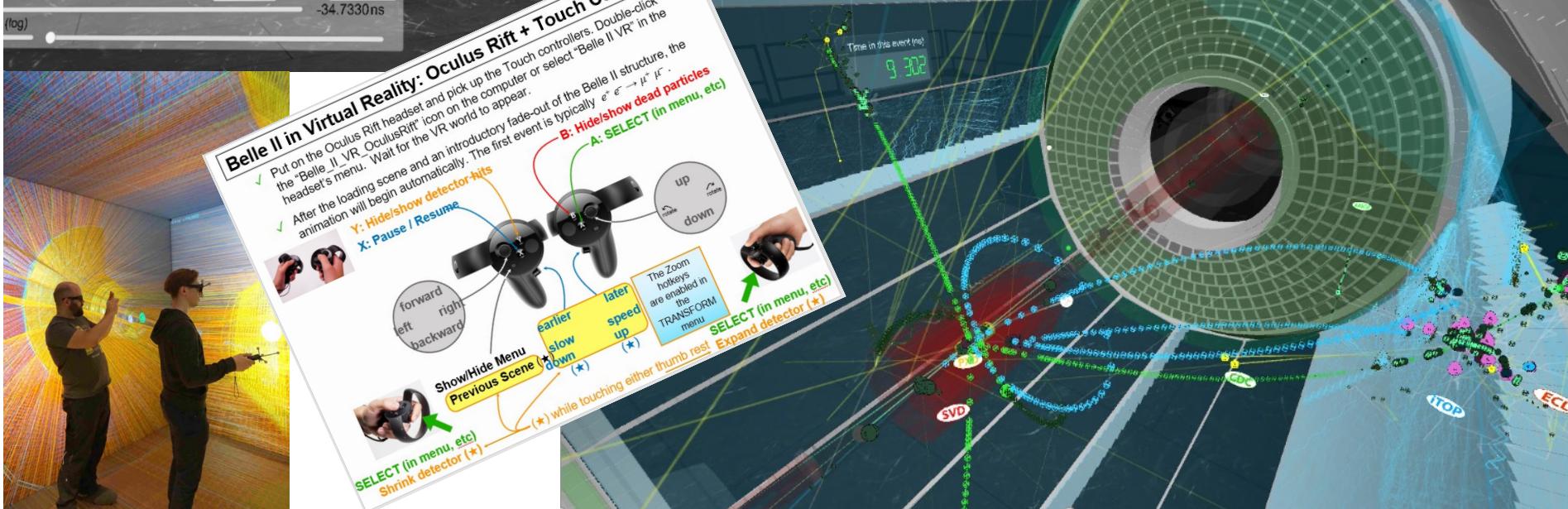
- an introduction to HEP, Belle II – designed individually by each site
- hands on exercises:
 - Belle II VR
 - Public analysis – common exercises

Run in parallel at different sites

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



Virtual reality - Immersion in the Belle II detector



Public analysis of 6M events from Belle/Belle II

Interactive web application

Run Analysis Interrupt Save Diagram Load Diagram

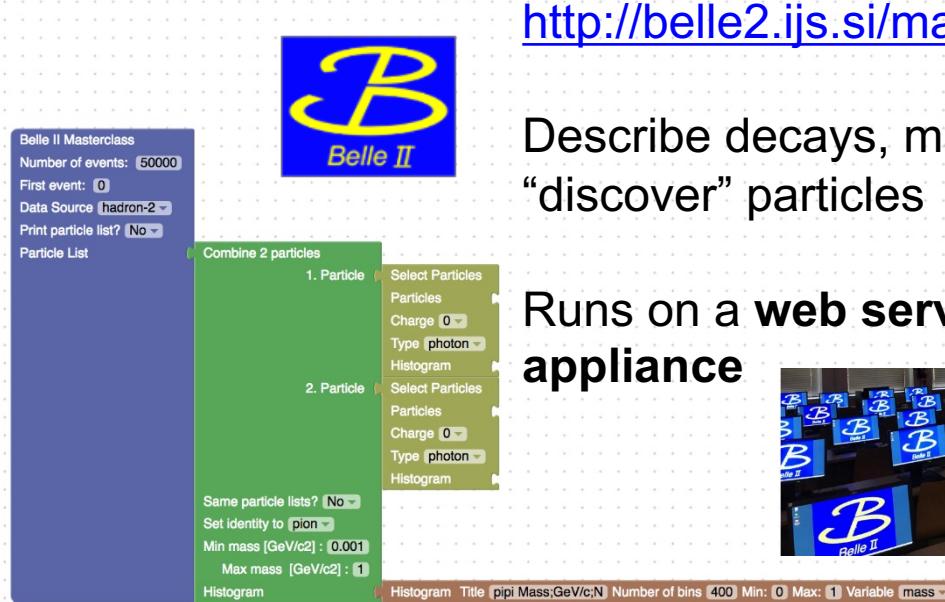
Particles Analysis Variables

Belle II Masterclass
Number of events: 50000
First event: 0
Data Source hadron-2
Print particle list? No
Particle List

Combine 2 particles
1. Particle Select Particles
Particles Charge 0 Type photon Histogram
2. Particle Select Particles
Particles Charge 0 Type photon Histogram

Same particle lists? No Set identity to pion Min mass [GeV/c²] : 0.001 Max mass [GeV/c²] : 1 Histogram

Histogram Title pipi Mass;GeV/c²;N Number of bins 400 Min: 0 Max: 1 Variable mass

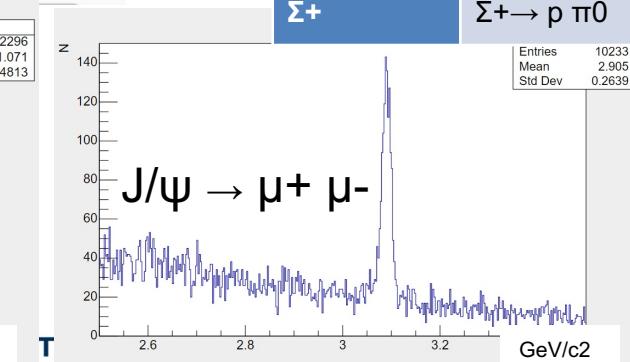
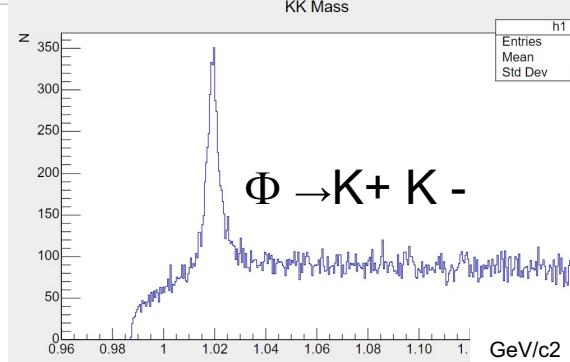
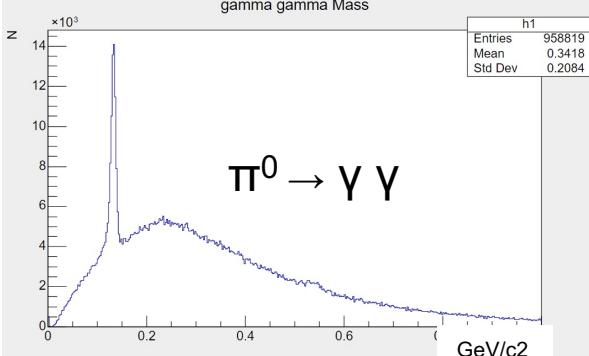


<http://belle2.ijs.si/masterclass>

Describe decays, make simple cuts,
“discover” particles



Runs on a **web server** or in a **virtual appliance**

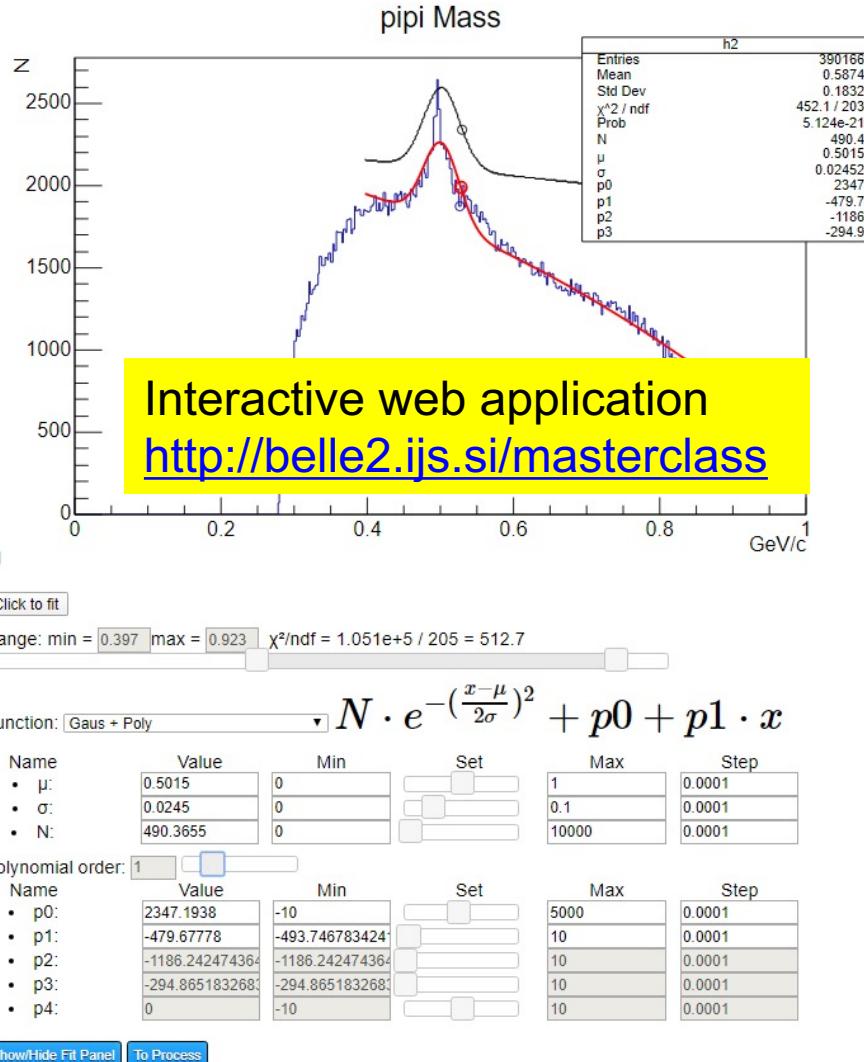


MASTERCLASSES

hands on particle physics 5

New features since 2020 exercise: Public analysis of 6M events from Belle II

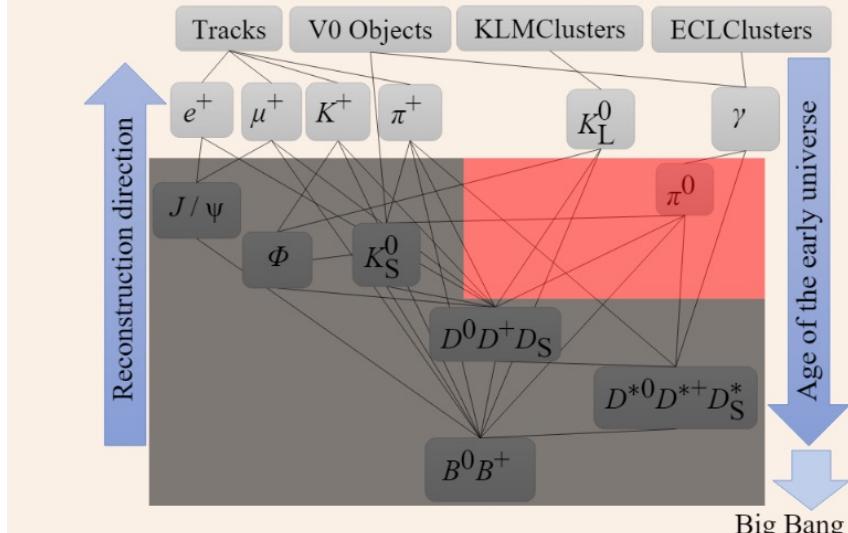
Fitting tools for interactive fitting



New page to check the results

On the way to a B meson

1. $\pi^0 \rightarrow ???$ π^0 mass GeV/c² Sadly not correct. Did you find the right peak?
2. $K_S \rightarrow ???$ K_S mass GeV/c² Please start to enter a number!
3. $\Phi \rightarrow ???$ Φ mass GeV/c² Please start to enter a number!
4. $J/\Psi \rightarrow \mu^+ \mu^-$ J/Ψ mass GeV/c² Please start to enter a number!
5. $J/\Psi \rightarrow e^+ e^-$ J/Ψ mass GeV/c² Please start to enter a number!
6. $D^0 \rightarrow K^+ \pi^-$ avg. D^0 mass GeV/c² $D^0 \rightarrow K^- \pi^+$ GeV/c² Please start to enter a number!
7. $D^{*+} \rightarrow D^0 \pi^+$ D^{*+} mass GeV/c² $D^{*+} \rightarrow D^+ \pi^0$ GeV/c² Please start to enter a number!
8. $B^+ \rightarrow J/\Psi K^+$ avg. B^+ mass GeV/c² $B^- \rightarrow J/\Psi K^-$ GeV/c² Please start to enter a number!



Video conference

- ❑ 2min : Opening
- ❑ 5x5min: Presentation of the results from the
 - ❑ collection of the results in a google form
- ❑ 5 min: Connection to the Belle II control room
- ❑ 10 min : Particle quiz
- ❑ 5 min: Closing

- ❑ several live entries from KEK (canteen, accelerator control room), during the morning – very interesting for students
- ❑ time zone issues (EU videoconference = JP midnight)



Quiz

15 not too serious questions:
10 HEP + 5 Japan

Students answered on their answer sheets

Competition between sites:
the site to answer the next question has been
randomly selected by the computer

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.



Belle II Masterclass resources

Introduction to HEP:

<http://indico.ijs.si/conferenceTimeTable.py?confId=1034#20190322> - documents in Slovene

Belle II Virtual Reality

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

Exercises with data:

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

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

You Tube:

- Start: https://youtu.be/q6M2_dnp3pl
- Particle distribution: https://youtu.be/q6M2_dnp3pl
- J/psi to mu mu: <https://youtu.be/xUYmXoPfZOU>
- J/psi to ee: <https://youtu.be/3TGsHJ8j8pE>
- Fit: <https://youtu.be/wWbjWYHVaLU>
- B to J/psi K <http://youtube.com/watch?v=e-GERqzY3HM>



Conclusions

- Belle II Masterclass exercise available for public
- International Masterclass campaign:
 - Dates and booking coordinated by IPPOG
 - Run by Belle II, videoconferences moderated by KEK
- Can be run in person or online only
- Details will be shown in the exercise
- In case of interest, contact us, we are happy to assist

