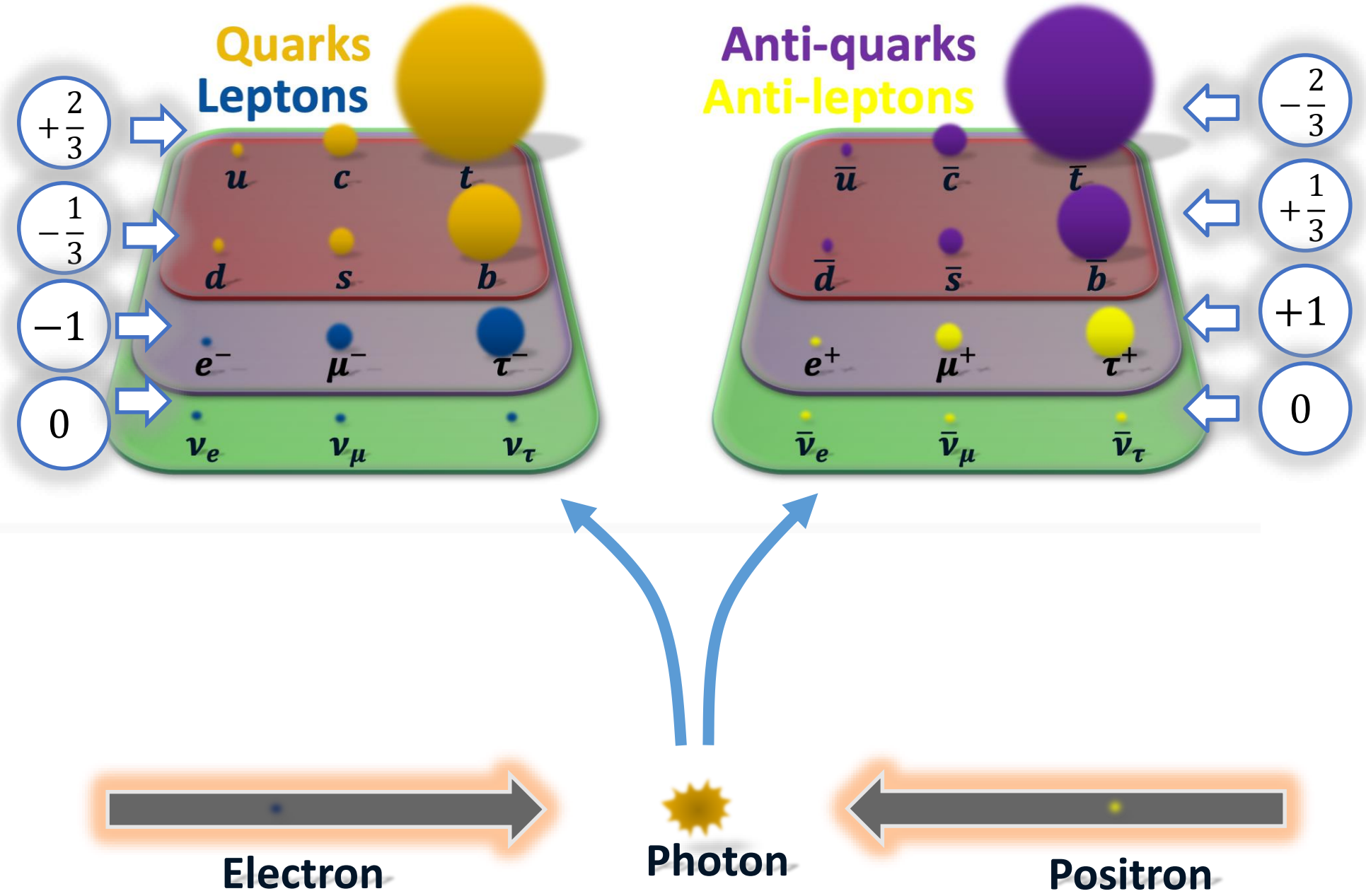
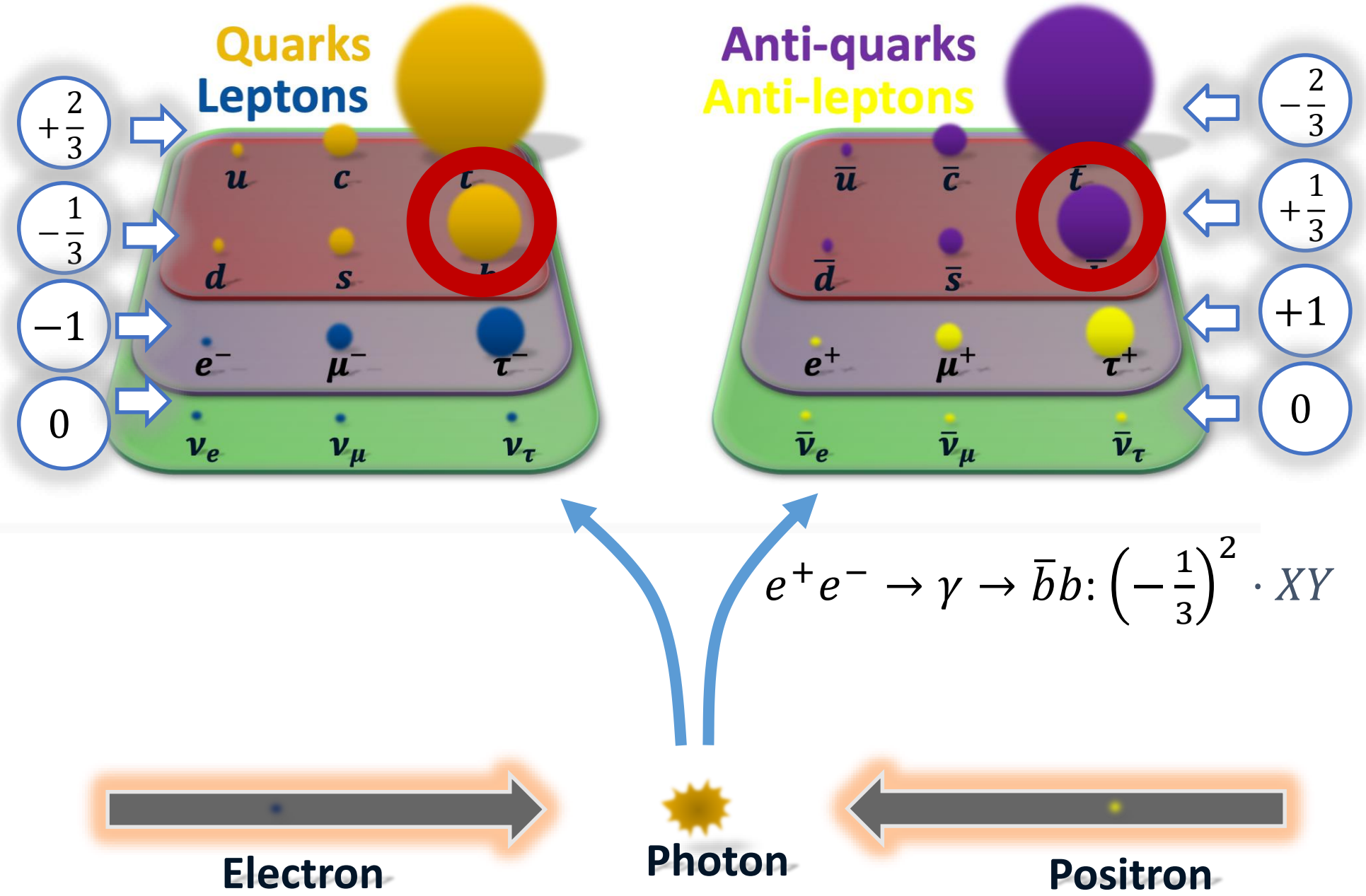
Masterclass Belle II 2024
CPPM

https://belle2.ijs.si/public/home/quark-colors/

Combien existe-t-il de couleurs de quark ?


Quarks
Leptons
Anti-quarks
Anti-leptons
$+\frac{2}{3}$
$-\frac{1}{3}$
-1
0
u c t
d s b
e^- μ^- τ^-
ν_e ν_μ ν_τ
$\bar{u}$ $\bar{c}$ $\bar{t}$
$\bar{d}$ $\bar{s}$ $\bar{b}$
e^+ μ^+ τ^+
$\bar{\nu}_e$ $\bar{\nu}_\mu$ $\bar{\nu}_\tau$
$-\frac{2}{3}$
$+\frac{1}{3}$
$+1$
0
Electron
Photon
Positron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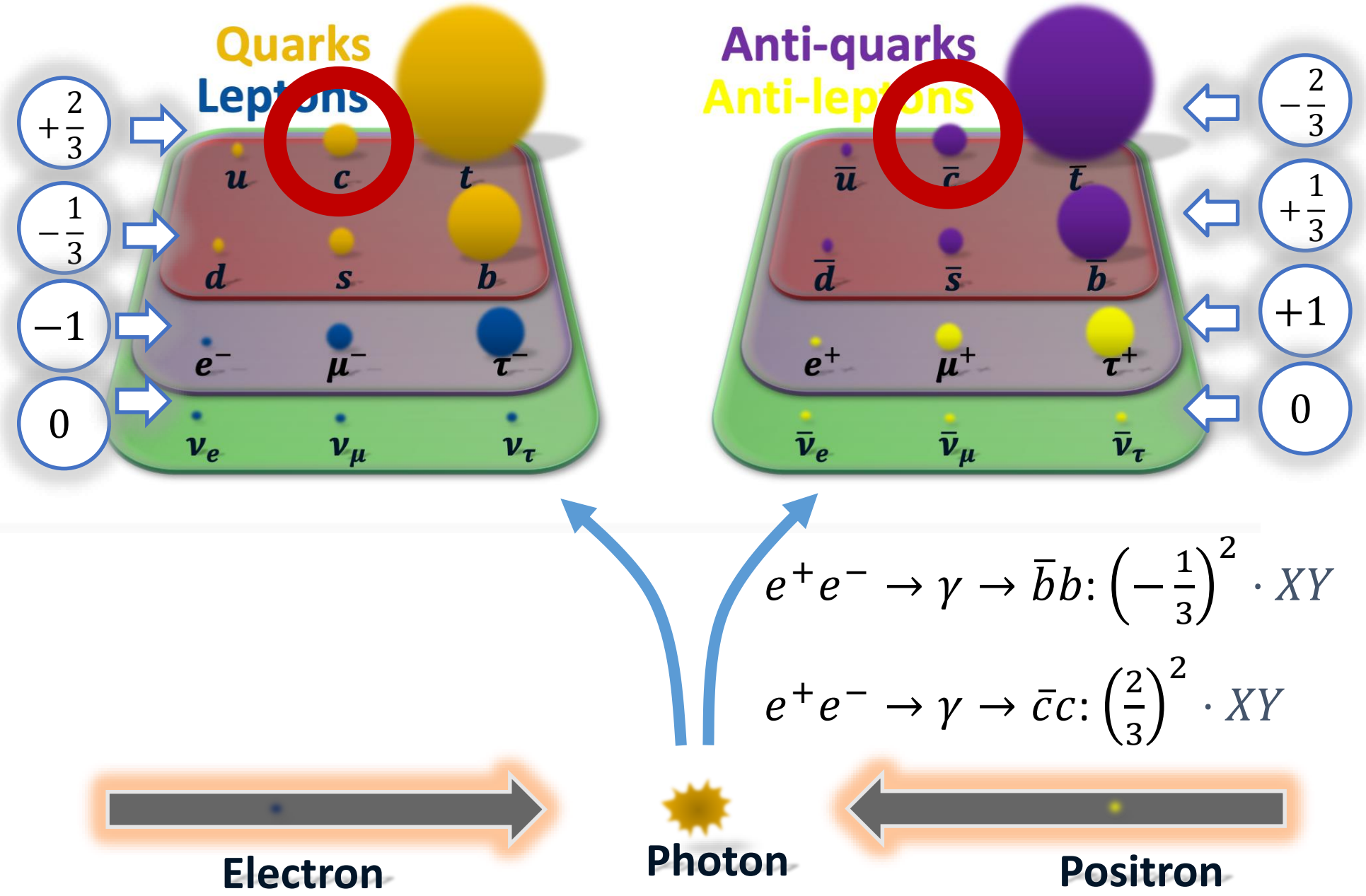
$+1$
0
$e^+e^- \to \gamma \to \bar{b}b: \left(-\frac{1}{3}\right)^2 \cdot XY$
Electron
Photon
Positron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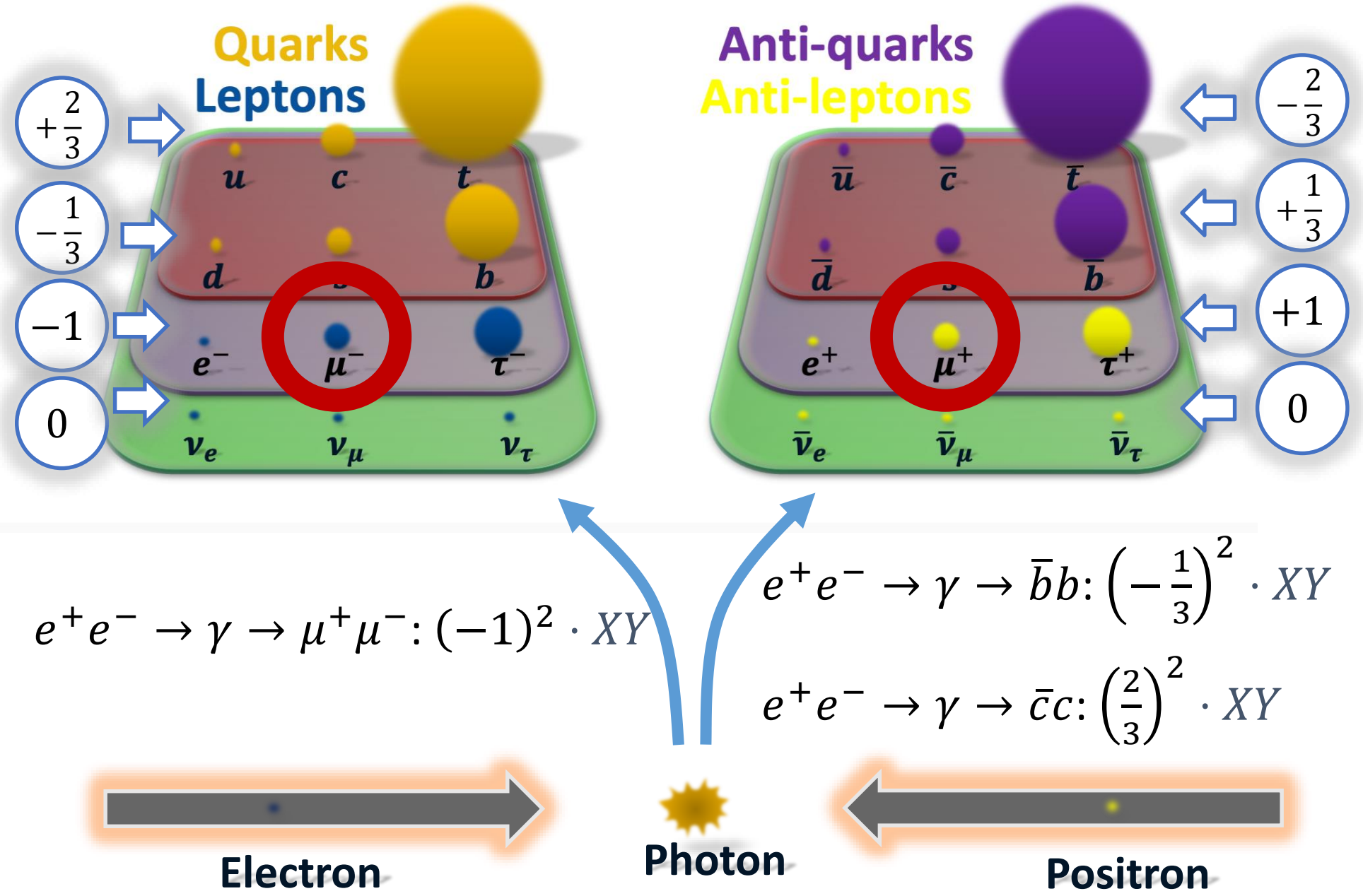
$e^+e^- \to \gamma \to \bar{b}b: \left(-\frac{1}{3}\right)^2 \cdot XY$
$e^+e^- \to \gamma \to \bar{c}c: \left(\frac{2}{3}\right)^2 \cdot XY$
Electron
Photon
Positron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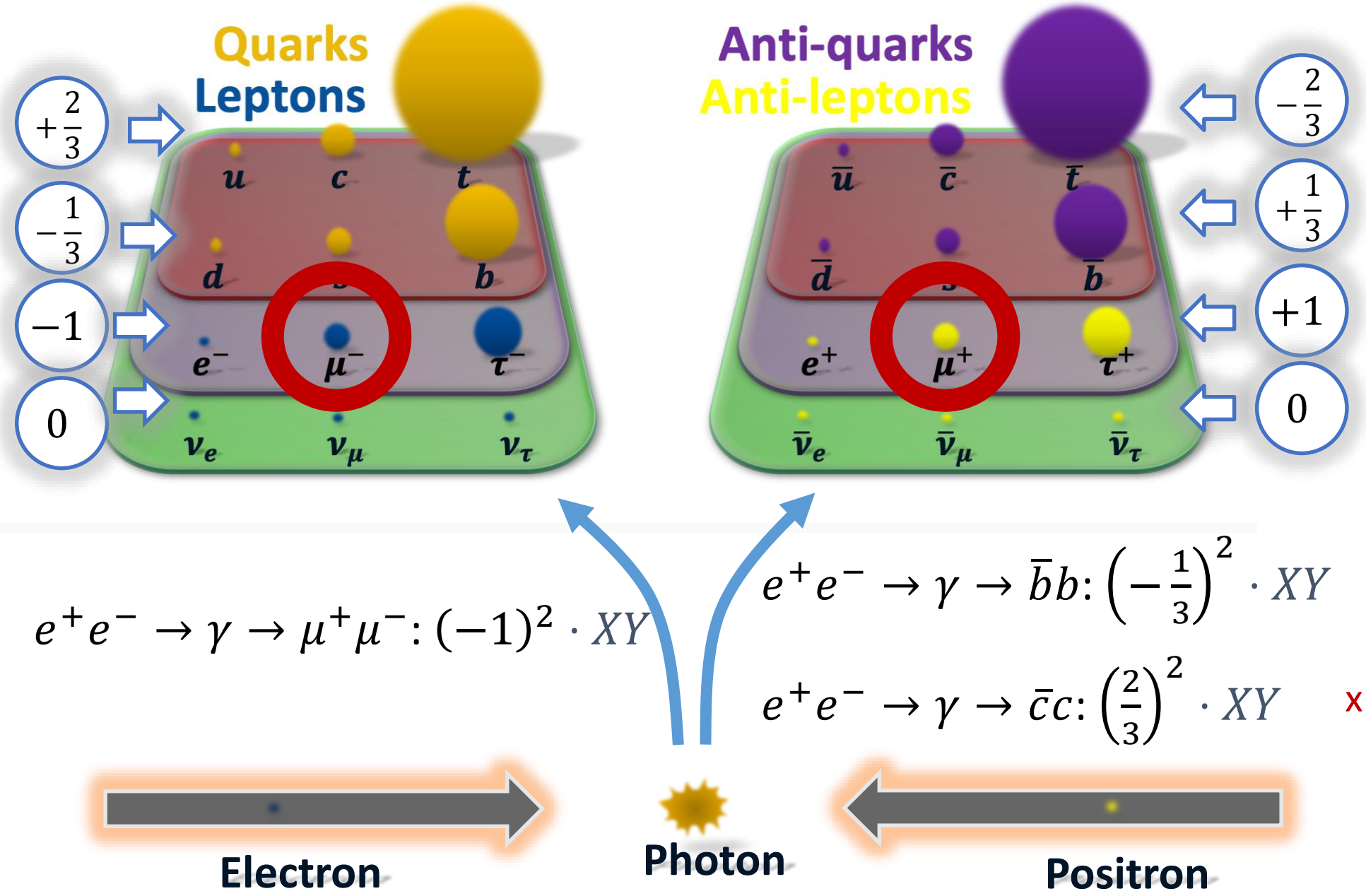


$$e^+e^- \to \gamma \to \mu^+\mu^-: (-1)^2 \cdot XY$$

$$e^+e^- \to \gamma \to \bar{b}b: \left(-\frac{1}{3}\right)^2 \cdot XY \quad \text{x } N_c$$

$$e^+e^- \to \gamma \to \bar{c}c: \left(\frac{2}{3}\right)^2 \cdot XY \quad \text{x } N_c$$

Electron

Photon

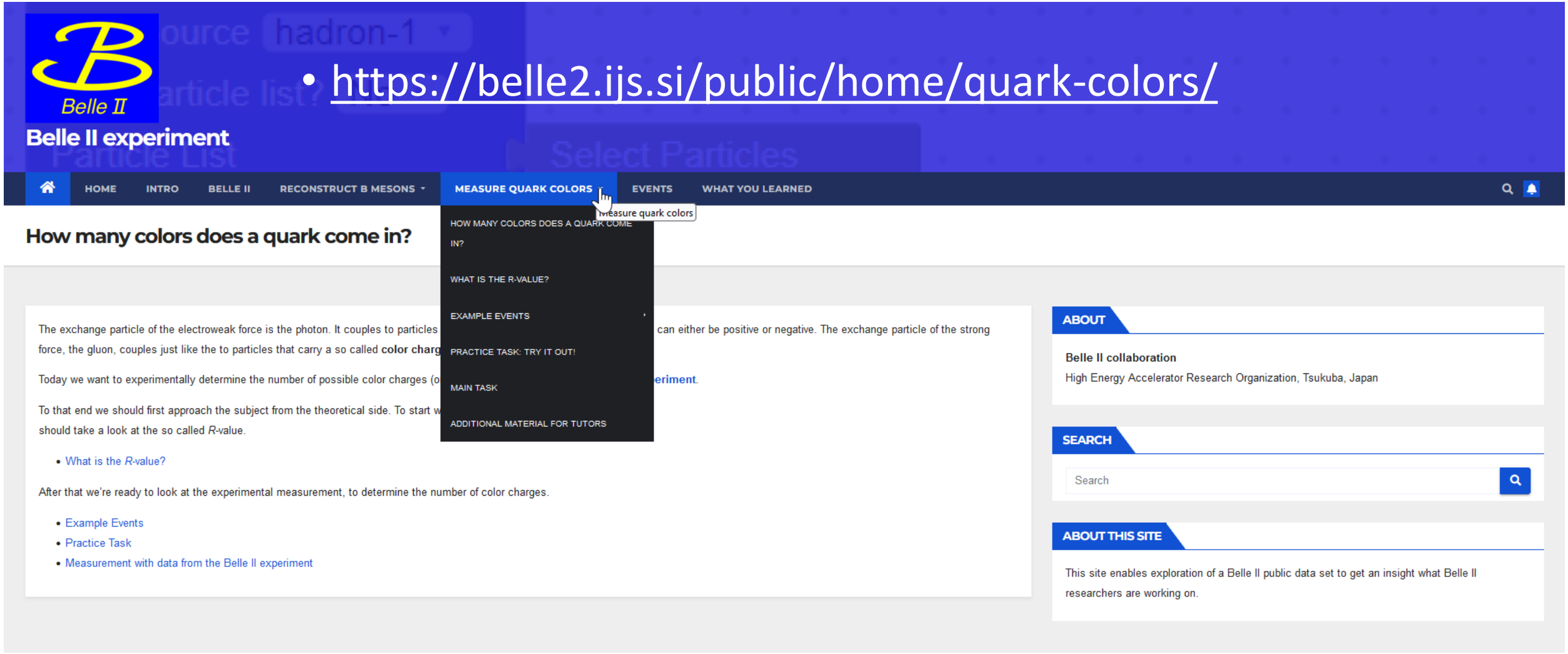
Positron

Rapport R

$$R = \frac{N(e^+e^- \to \gamma \to \bar{u}u, \bar{d}d, \bar{s}s, \bar{c}c)}{\frac{1}{2}[N(e^+e^- \to \gamma \to \mu^+\mu^-) + N(e^+e^- \to \gamma \to \tau^+\tau^-)]} = \mathbf{N_C \cdot 1.111 \ldots}$$

Pourquoi on n'utilise pas les évenements e+e- → bb ?
Pourquoi on n'utilise pas les e+e- → e+e- ?

- https://belle2.ijs.si/public/home/quark-colors/



But: trouver combien de couleurs un quark peut avoir
Comment : en comptant les évènements qui se produisent dans chaque catégorie : e+e-, μ+μ-, τ+τ-, uu, dd, ss, cc, bb
Pour cela, il faut regarder leurs propriétés : nombre de particules, energie manquante, rectitude, impact dans le detecteur à muon

The exchange particle of the electroweak force is the photon. It couples to particles with an electromagnetic charge. This charge can either be positive or negative. The exchange particle of the strong force, the gluon, couples just like the to particles that carry a so called **color charge**.

Today we want to experimentally determine the number of possible color charges (or simply colors) with data of the **Belle II experiment**.

To that end we should first approach the subject from the theoretical side. To start with we should take a look at the so called *R*-value.

- What is the *R*-value?

After that we're ready to look at the experimental measurement, to determine the number of color charges.

- Example Events
- Practice Task
- Measurement with data from the Belle II experiment

Example Events

How do the different particle-antiparticle pairs look in the detector?

Here you can look at the different processes in form of example videos and pictures.

1. electron/positron events
2. muon/antimuon events
3. tauon/antitauon events
4. light quark events
5. *b*-quark/antiquark events

After you've done that you can test your new knowledge by clicking here and trying to sort the example events yourself.

ABOUT

Belle II collaboration
High Energy Accelerator Research Organization, Tsukuba, Japan

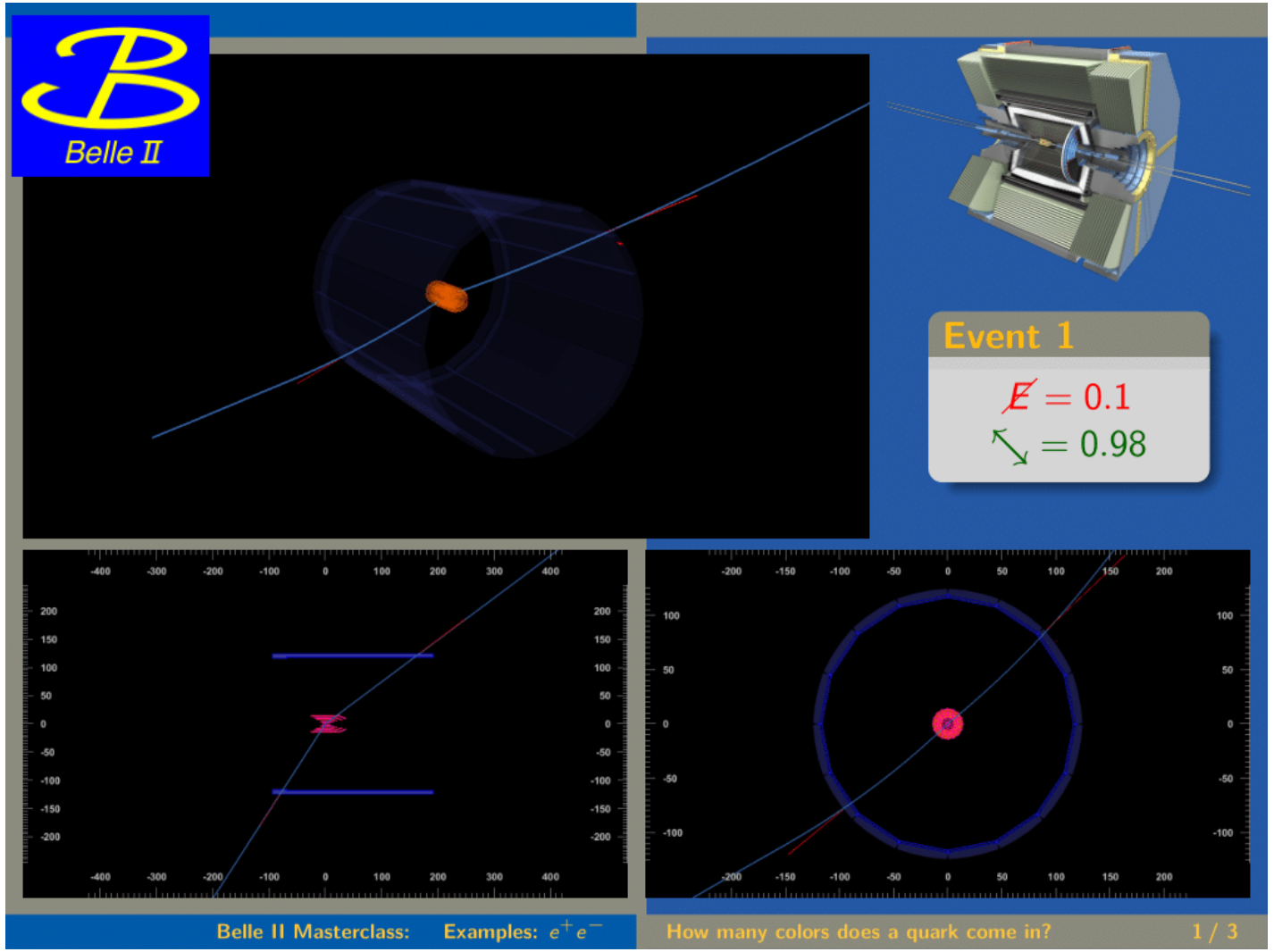
SEARCH

Search

ABOUT THIS SITE

This site enables exploration of a Belle II public data set to get an insight what Belle II researchers are working on.

e+e-

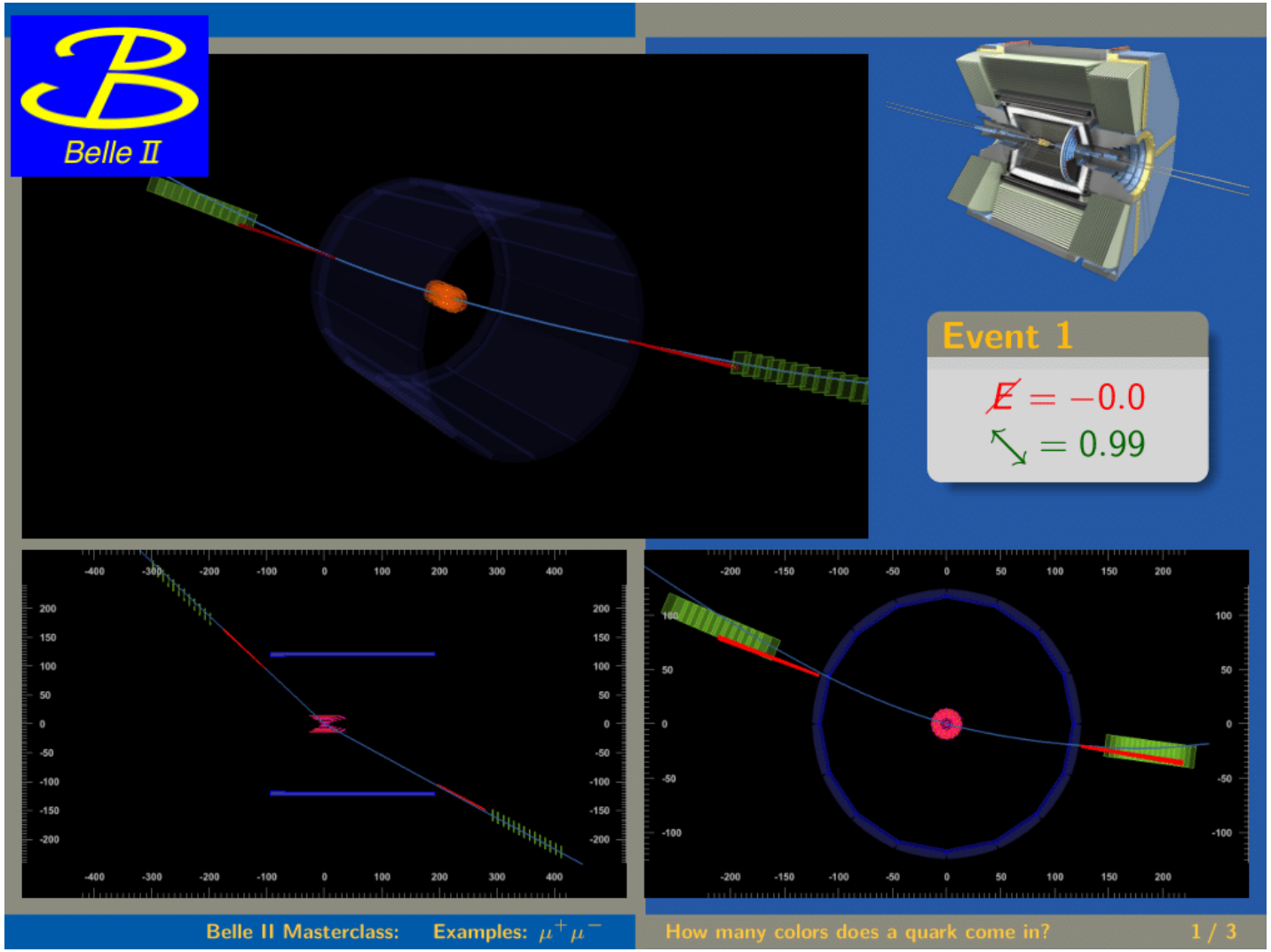


2 particules

Faible énergie manquante

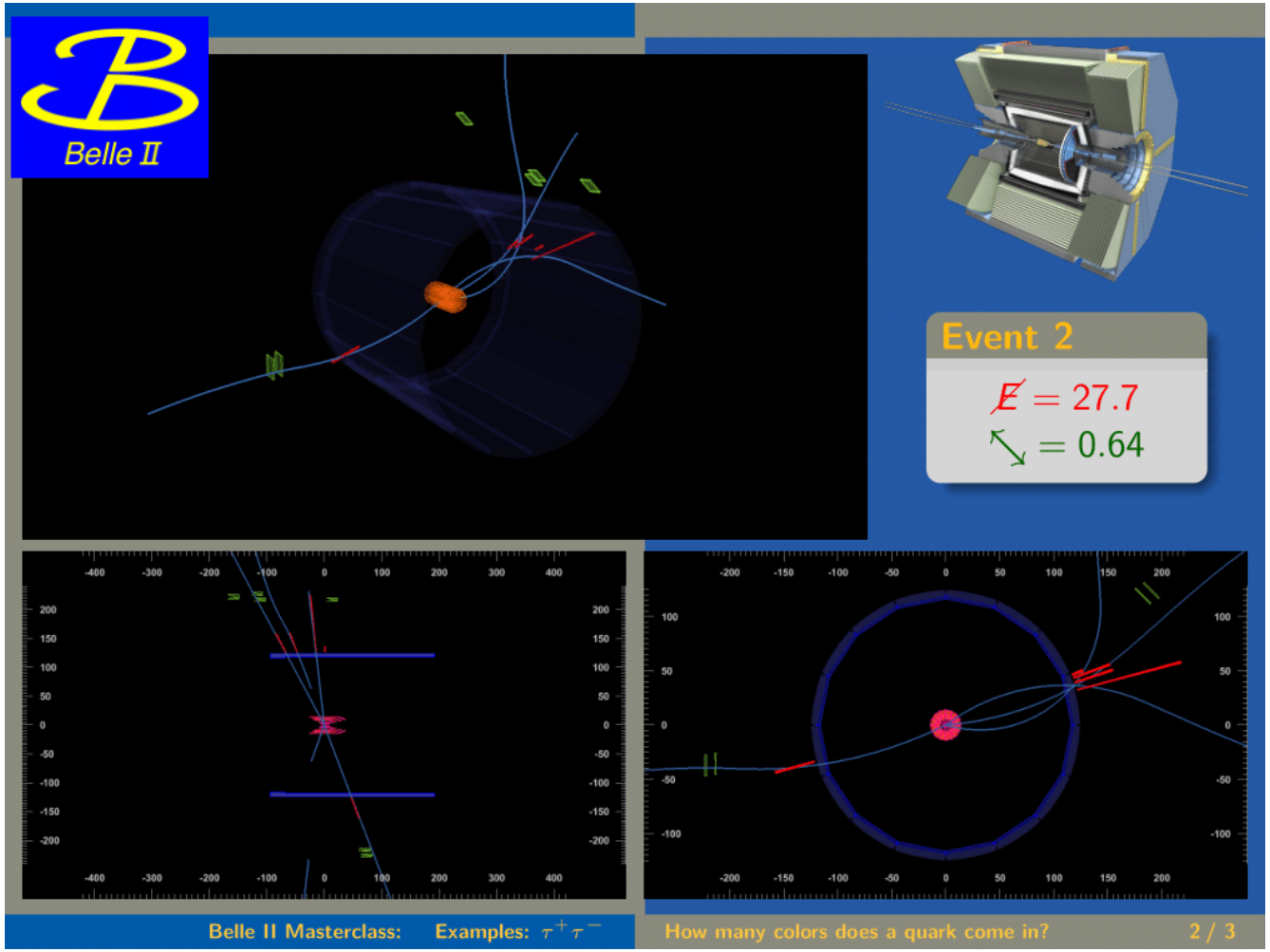
Tres grande rectitude

μ+μ-



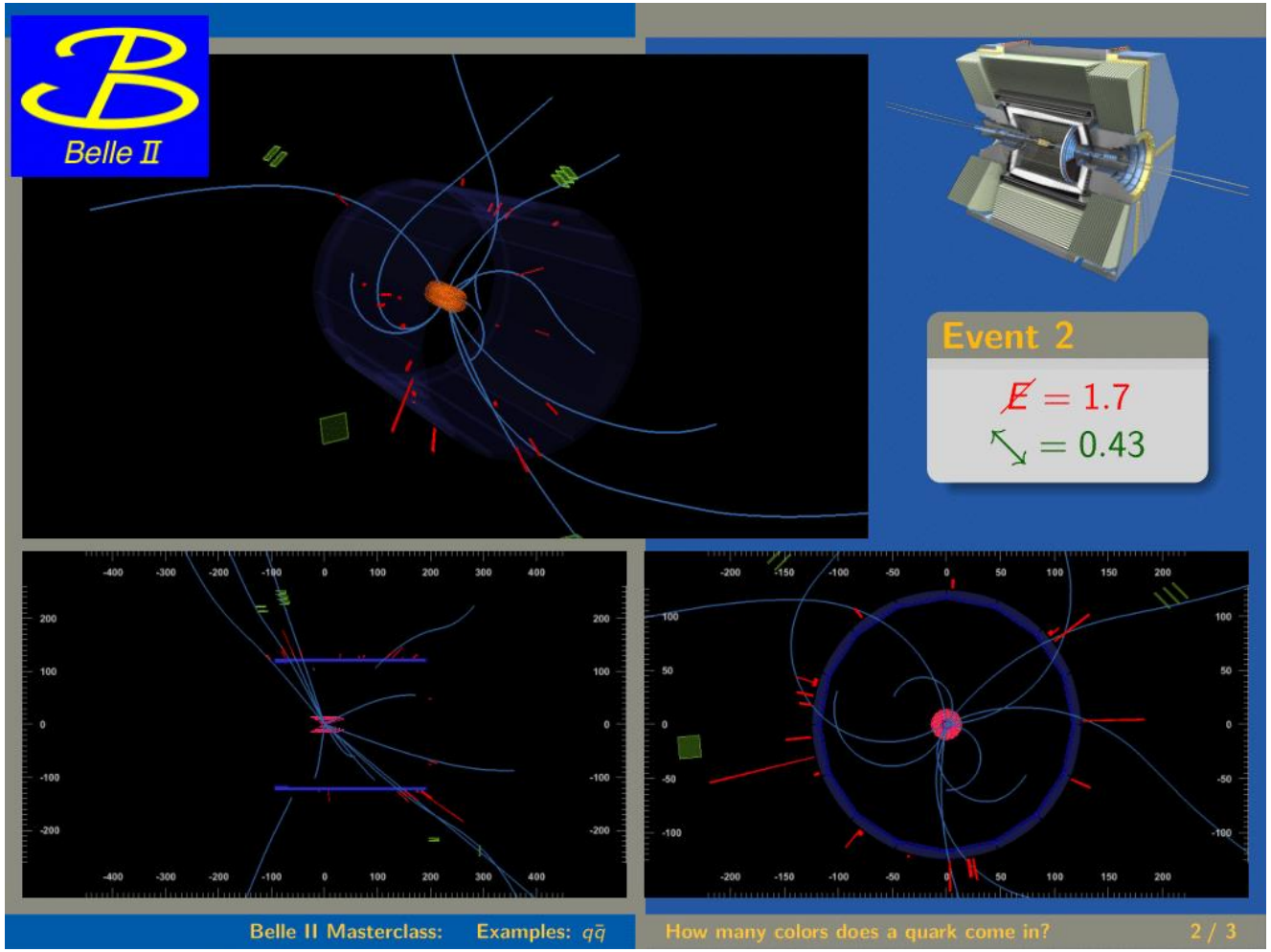
2 particules
Faible energie manquante
Tres grande rectitude
Trace dans le détecteur à muons

τ+τ-



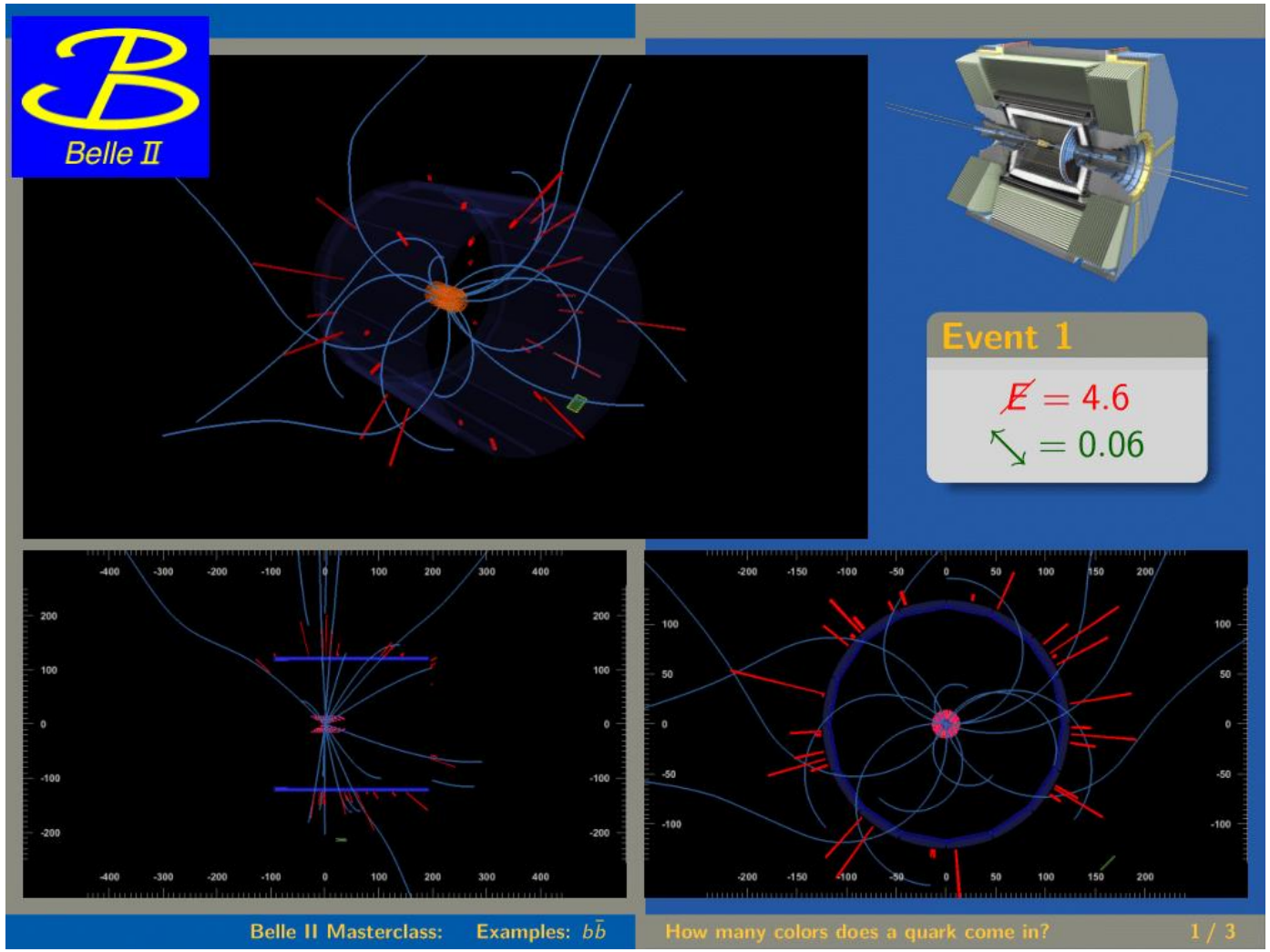
Entre 2 et 6 particules
énergie manquante (neutrinos!)
Rectitude moyenne
Trace dans le détecteur à muons, parfois

quark-anti-quark légers

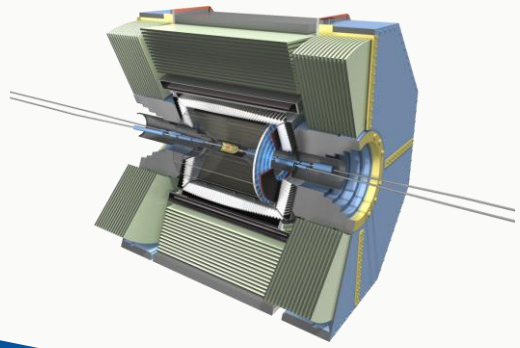


Entre 3 et 11 particules
peu d'énergie manquante
Rectitude faible
Trace dans le détecteur à muons, parfois

B- anti-b



Plus de 5 particules
énergie manquante
Rectitude très faible
Trace dans le détecteur à muons, parfois


depart
Combien de particules ?
≤ 1
2
3
4
5 – 11
≥ 12
Other
Quelle est $\not{E}$?
Est ce que l'evenement ressemble à ψ
unsure/no
Quelle est la ↘ ?
≤ 5.9
≥ 6
yes
Quelle est $\not{E}$?
≥ 0
≤ −0.1
Combien de traces laisse un impact vert (muon)?
Quelle est la ↘ ?
≥ 0.16
≤ 0.15
0
2
1
≥ 0.6
≤ 0.59
e^+e^-
$\mu^+\mu^-$
$\tau^+\tau^-$
$\bar{q}q$
$\bar{b}b$

- Exemples events
- Practices task
- Measurement with data from Belle II
  - 50 évènements à classer bar binôme (pas obliger de finir mais plus vous en faites, plus le resultat sera précis!)
  - Remplir les resultats ici: https://docs.google.com/spreadsheets/d/1B-AieGyXsVmosiMU86E__cGQuVMCoIlo0prU2AcVz1M/edit?usp=sharing