Belle II in Virtual Reality: Rift/Go/Vive + Gamepad
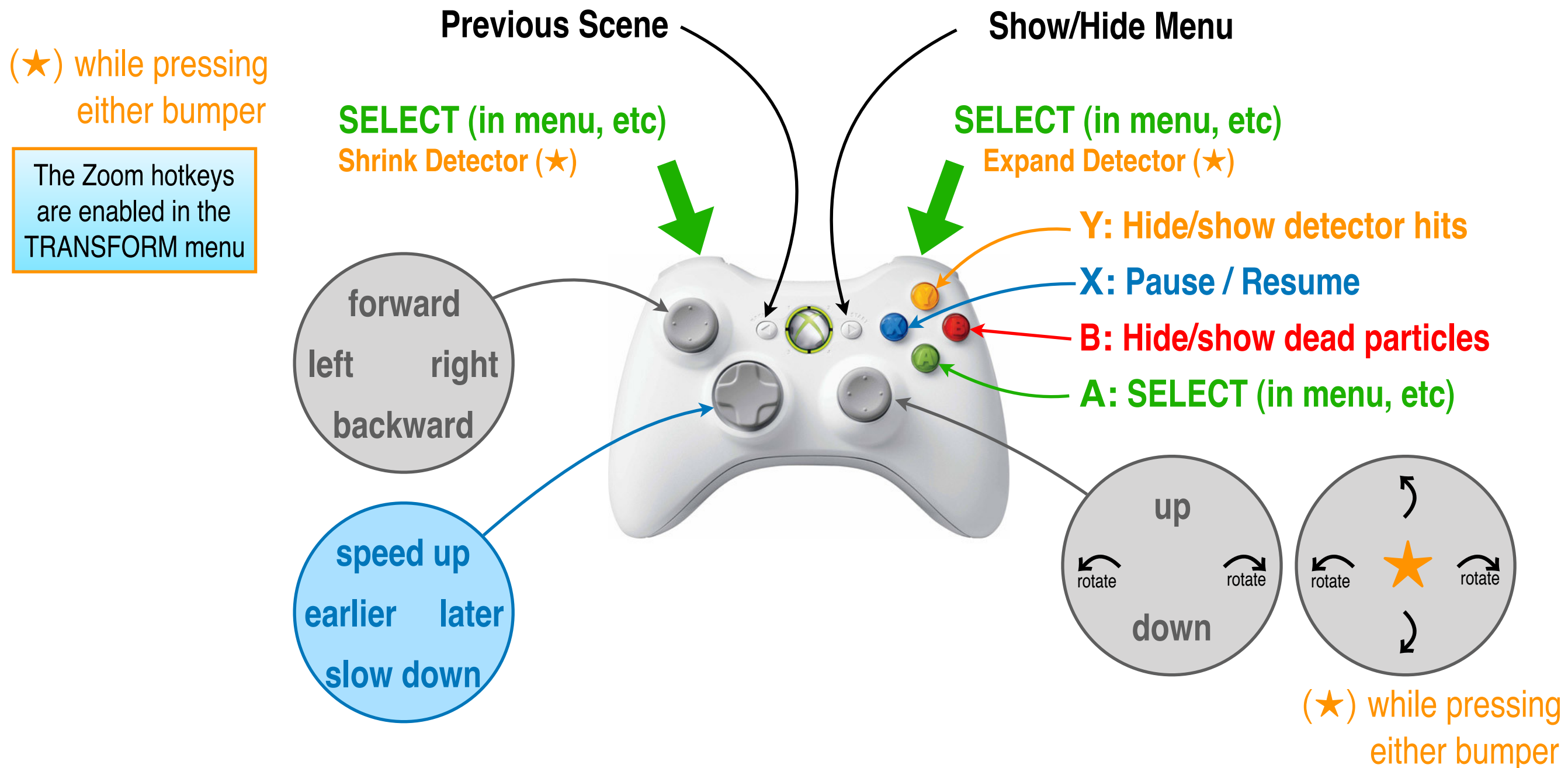
✓ Put on the Oculus Rift, Oculus Go or HTC Vive headset and pick up the gamepad. Double-click the "Belle_II_VR" icon on the computer or select "Belle II VR" in the headset's menu. Wait for the VR world to appear.

✓ After the loading scene and an introductory fade-out of the Belle II structure, the animation will begin automatically. The first event is typically $e^+ e^- \rightarrow \mu^+ \mu^-$.

Previous Scene

Show/Hide Menu

(★) while pressing either bumper

The Zoom hotkeys are enabled in the TRANSFORM menu

SELECT (in menu, etc)
Shrink Detector (★)

SELECT (in menu, etc)
Expand Detector (★)

Y: Hide/show detector hits

X: Pause / Resume

B: Hide/show dead particles

A: SELECT (in menu, etc)

forward

left   right

backward

speed up

earlier   later

slow down

up

rotate   rotate

down

rotate   rotate

(★) while pressing either bumper

Belle II in Virtual Reality: Oculus Rift + Touch Controllers

✓ Put on the Oculus Rift headset and pick up the Touch controllers. Double-click the "Belle_II_VR_OculusRift" icon on the computer or select "Belle II VR" in the headset's menu. Wait for the VR world to appear.

✓ After the loading scene and an introductory fade-out of the Belle II structure, the animation will begin automatically. The first event is typically $e^+ e^- \rightarrow \mu^+ \mu^-$.
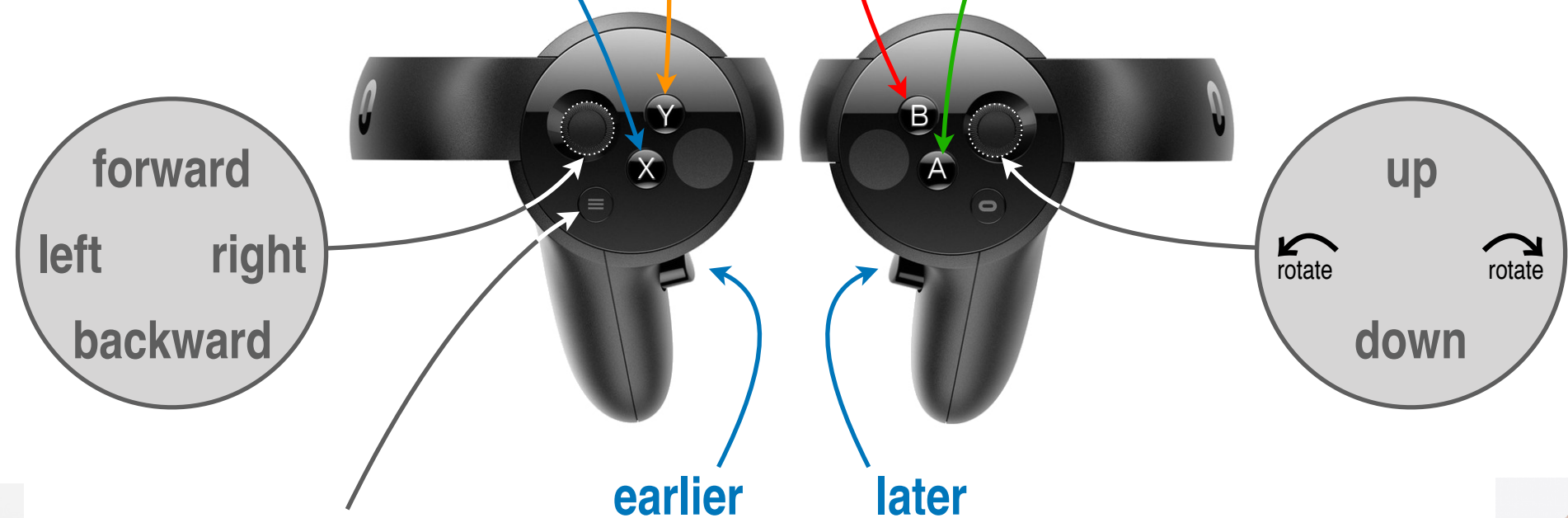
Y: Hide/show detector hits

X: Pause / Resume

B: Hide/show dead particles

A: SELECT (in menu, etc)

forward

left   right

backward

up

rotate   rotate

down

earlier   later

Show/Hide Menu

Previous Scene (★)

slow   speed
down   up

(★)   (★)

The Zoom hotkeys are enabled in the TRANSFORM menu

SELECT (in menu, etc)

Shrink detector (★)

(★) while touching either thumbrest

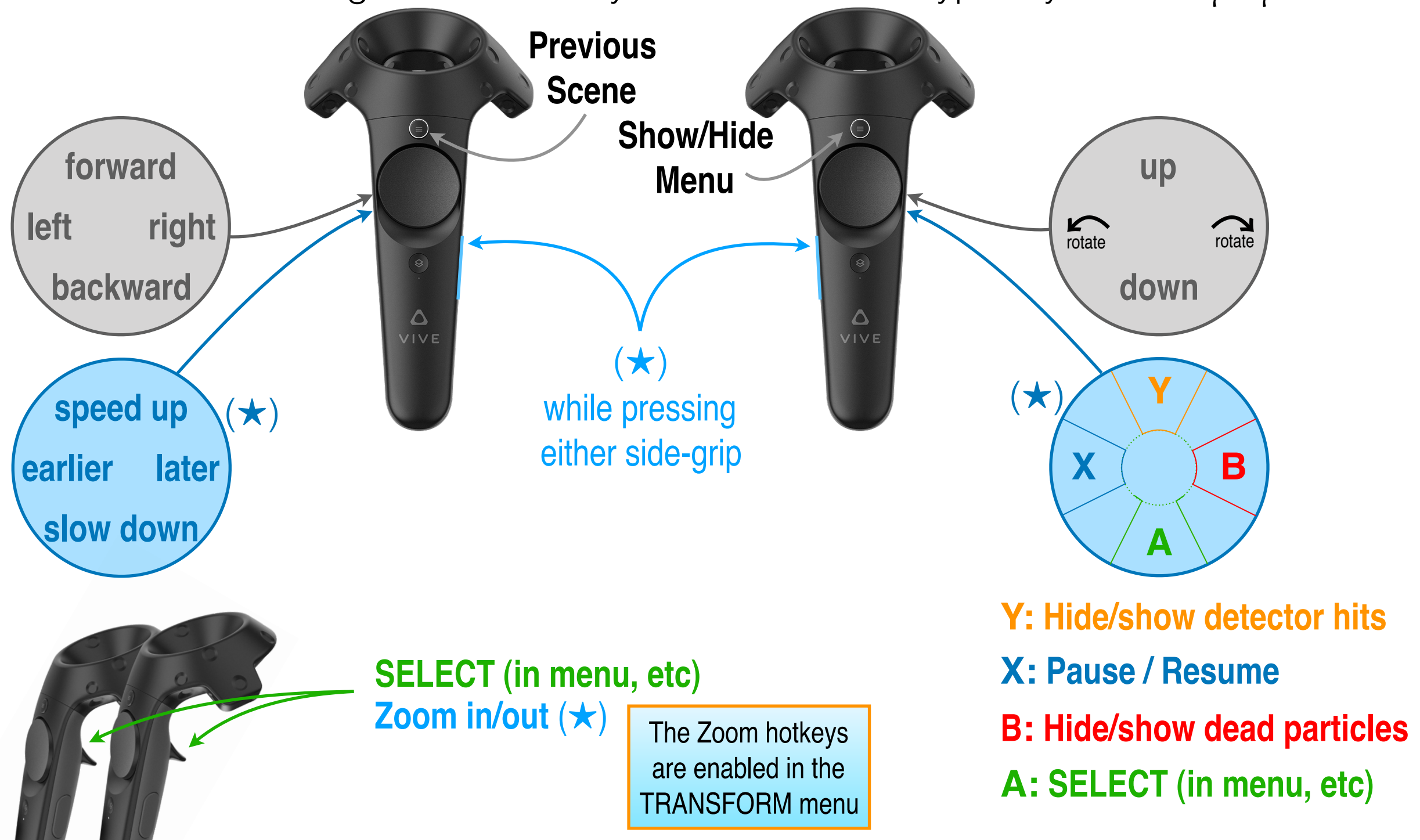**SELECT (in menu, etc)**

Expand detector (★)

Belle II in Virtual Reality: Oculus Go + Remote

✓ Put on the Oculus Go headset and pick up the remote. Select "**Belle II VR**" in the headset's menu, and wait for the VR world to appear.

✓ After the loading scene and an introductory fade-out of the Belle II structure, the animation will begin automatically. The first event is typically $e^+ e^- \to \mu^+ \mu^-$.

Click to SELECT (in menu, etc)
Double-click to show/hide menu
Hold to modify trackpad action

Previous scene

OCULUS Dash menu

	not holding the trigger	while holding the trigger
pointing horizontally	forward / left / right / backward	Y / X / B
pointing vertically	up / rotate / rotate / down	speed up / earlier / later / slow down

Y: Hide/show detector hits

X: Pause / Resume

B: Hide/show dead particles
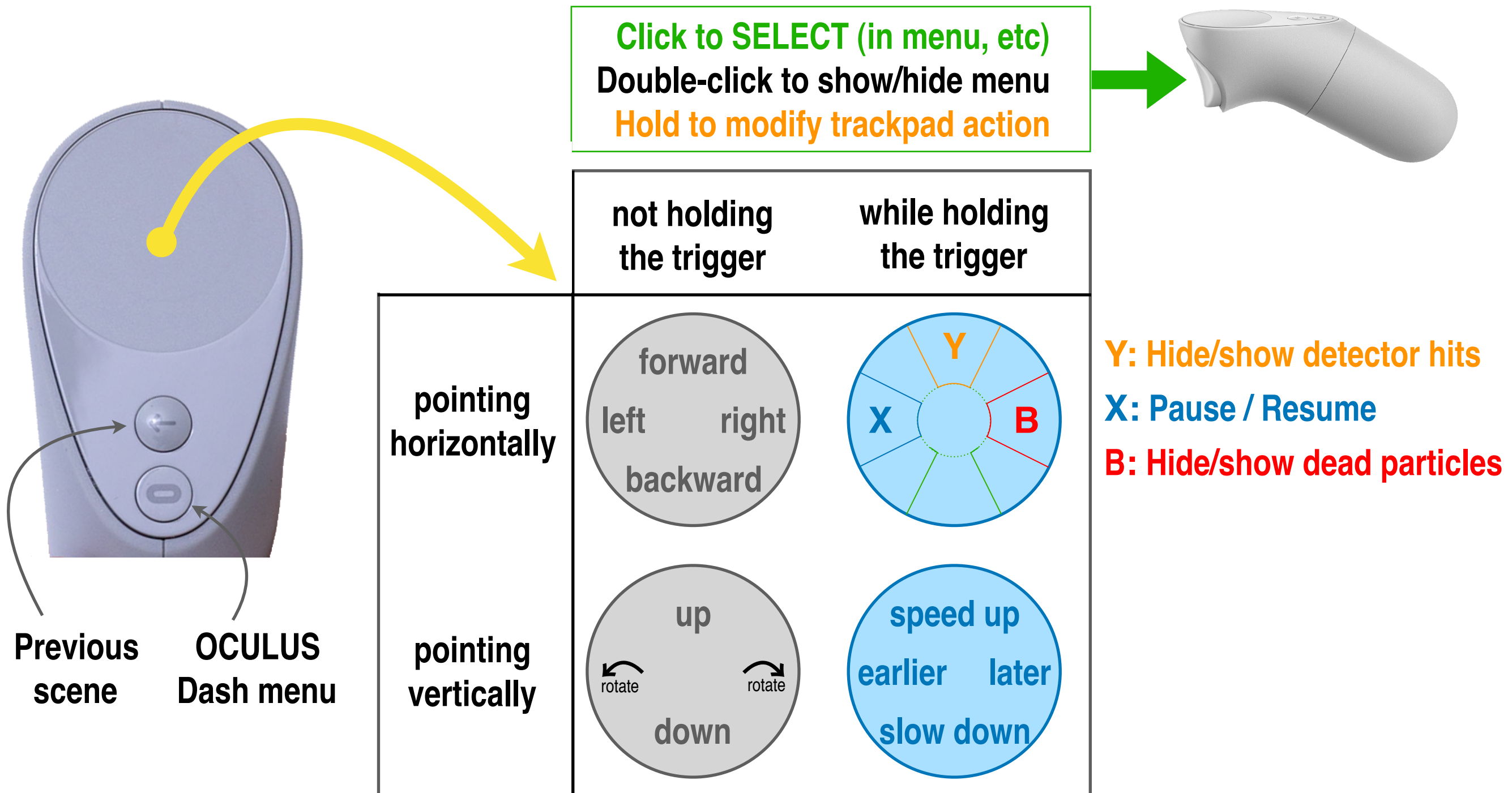
Belle II Virtual Reality Instructions: HTC Vive + Controllers

✓ Put on the Vive headset and pick up the controllers. Double-click the "Belle_II_VR_HTCVive" icon on the computer or select "Belle II VR" in the headset's menu. Wait for the VR world to appear.

✓ After the loading scene and an introductory fade-out of the Belle II structure, the animation will begin automatically. The first event is typically $e^+ e^- \rightarrow \mu^+ \mu^-$.
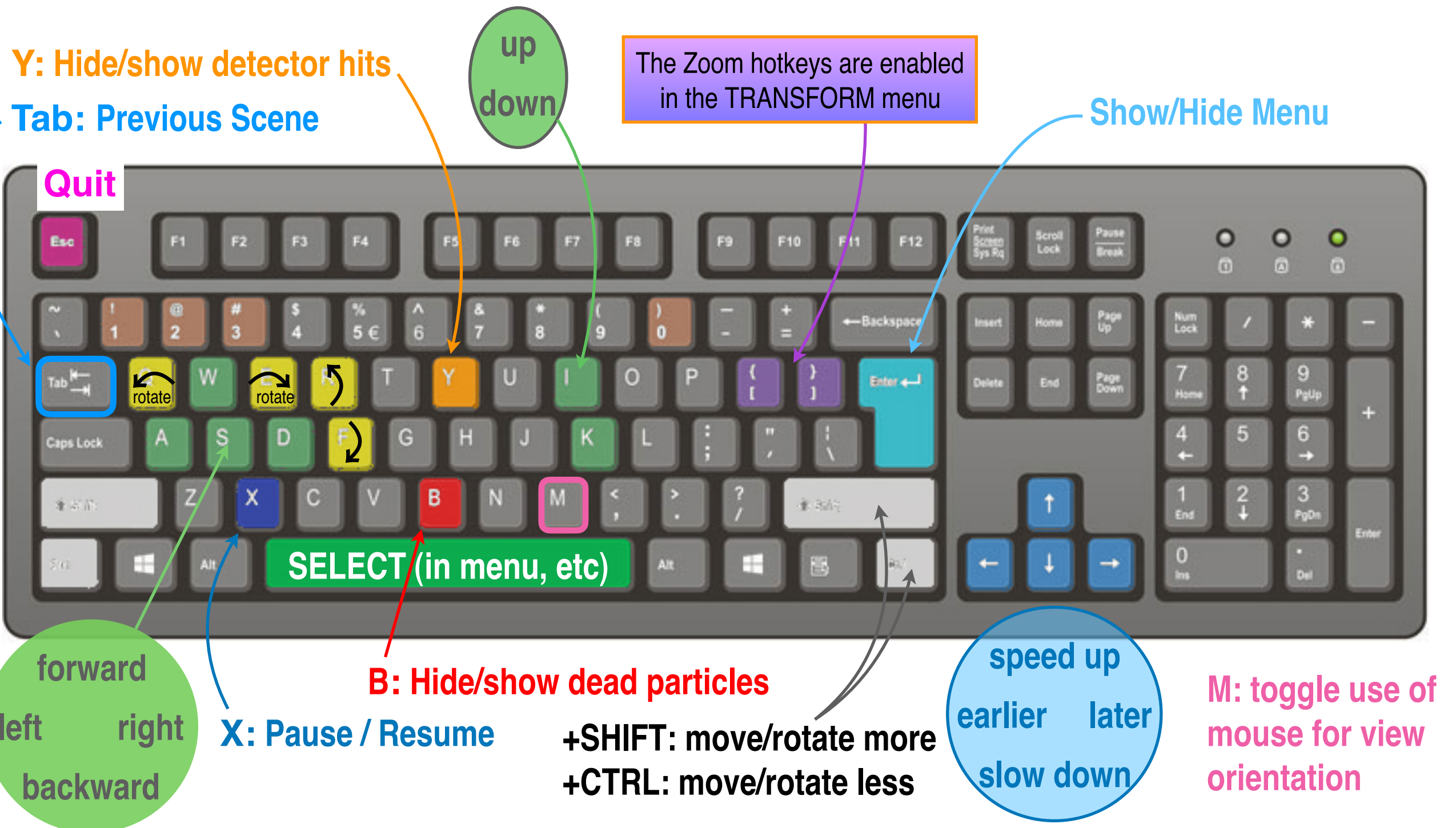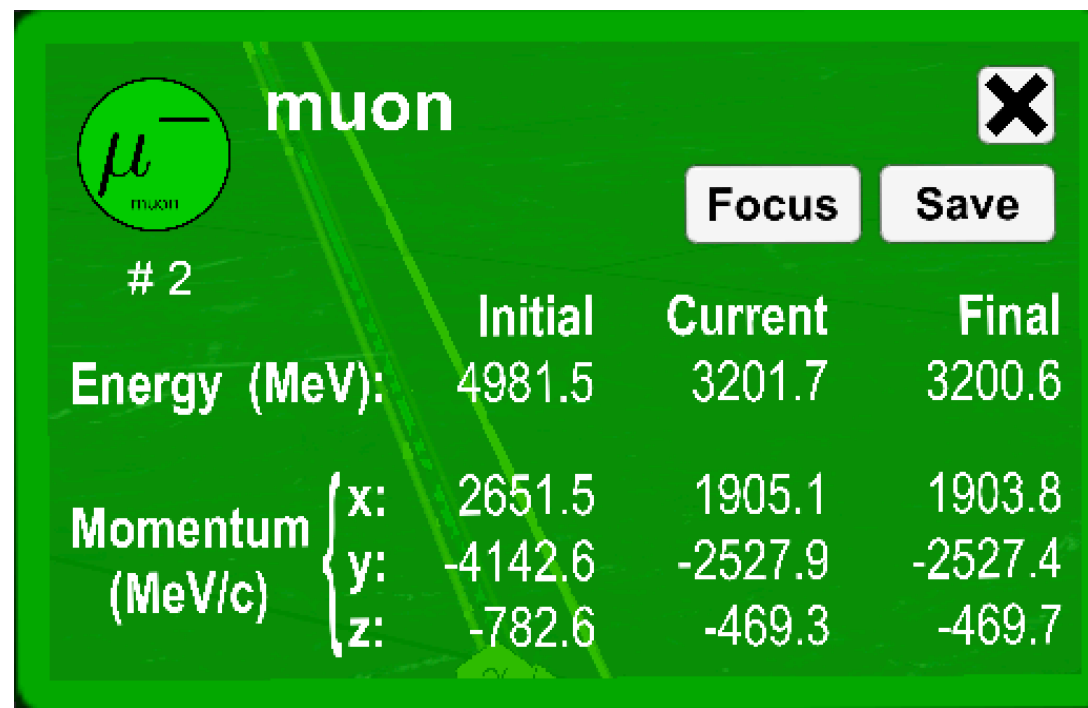
Previous Scene

Show/Hide Menu

forward

left   right

backward

up

↶ rotate   ↷ rotate

down

speed up (★)

earlier   later

slow down

(★) while pressing either side-grip

(★)

Y

X   B

A

Y: Hide/show detector hits

X: Pause / Resume

B: Hide/show dead particles

A: SELECT (in menu, etc)

SELECT (in menu, etc)
Zoom in/out (★)

The Zoom hotkeys are enabled in the TRANSFORM menu

Belle II in Virtual Reality: Computer Screen + Keyboard

✓ Double-click the "Belle_II_VR_Screen" icon on the computer. Wait for the VR world to appear on the computer screen.

✓ After the loading scene and an introductory fade-out of the Belle II structure, the animation will begin automatically. The first event is typically $e^+ e^- \rightarrow \mu^+ \mu^-$.

Y: Hide/show detector hits

Tab: Previous Scene

up

down

The Zoom hotkeys are enabled in the TRANSFORM menu

Show/Hide Menu

Quit

rotate

rotate

forward

left   right

backward

X: Pause / Resume

B: Hide/show dead particles

SELECT (in menu, etc)

+SHIFT: move/rotate more

+CTRL: move/rotate less

speed up

earlier   later

slow down

M: toggle use of mouse for view orientation

Belle II in Virtual Reality: Particle Information

✓ If you gaze at a particle and **SELECT**, an information panel appears.

✓ The panel's border is black if the particle is dead.

✓ If you gaze at **Focus** and **SELECT**, only this particle and its relatives are shown. *(If you then open another such panel, you can "Unfocus" this chain.)*

✓ If you gaze at **Save** and **SELECT**, this particle's information is saved to the panel on one wall of the room.

✓ You can sum selected entries on the wall display panel to test conservation of energy and momentum.
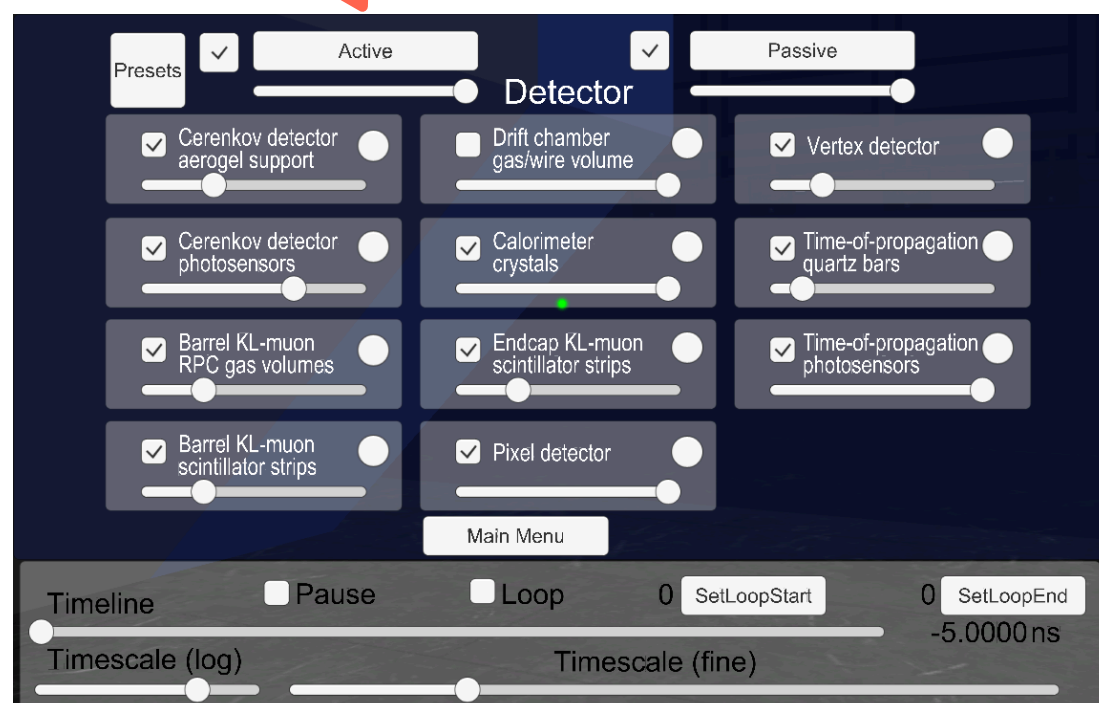
Belle II in Virtual Reality: In-game Menus

✓ Click the **Start button** to show the menu and the **Back button** to hide it.

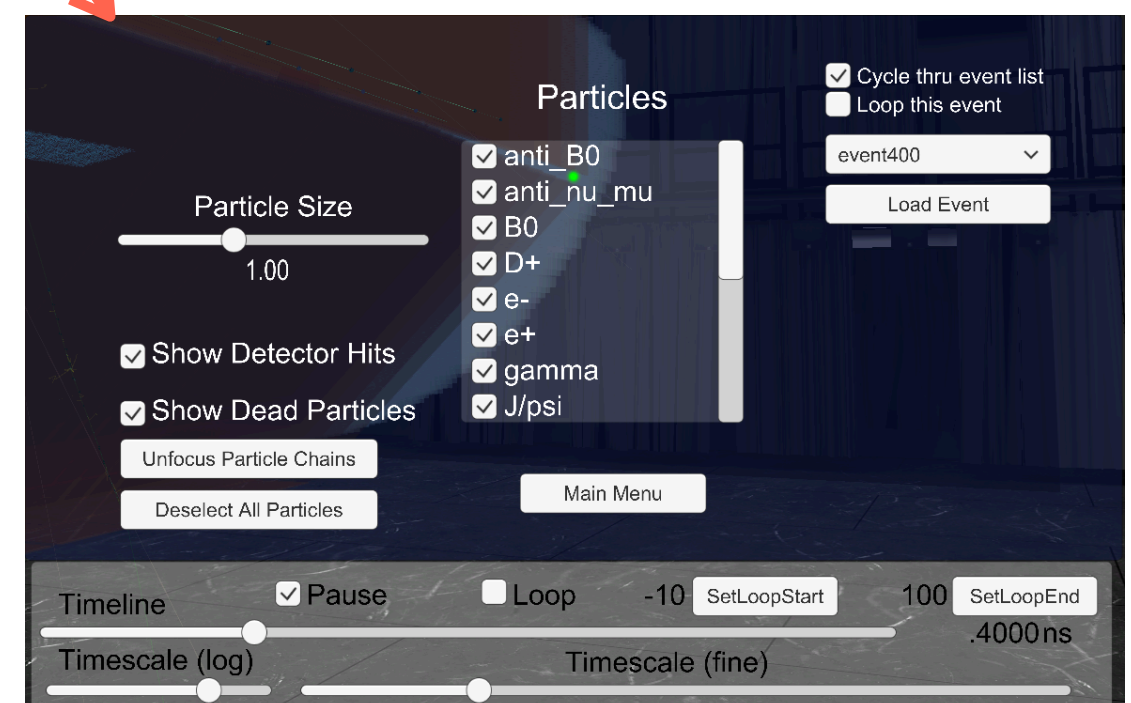✓ Move your gaze to place the green dot on an item then press **SELECT**.
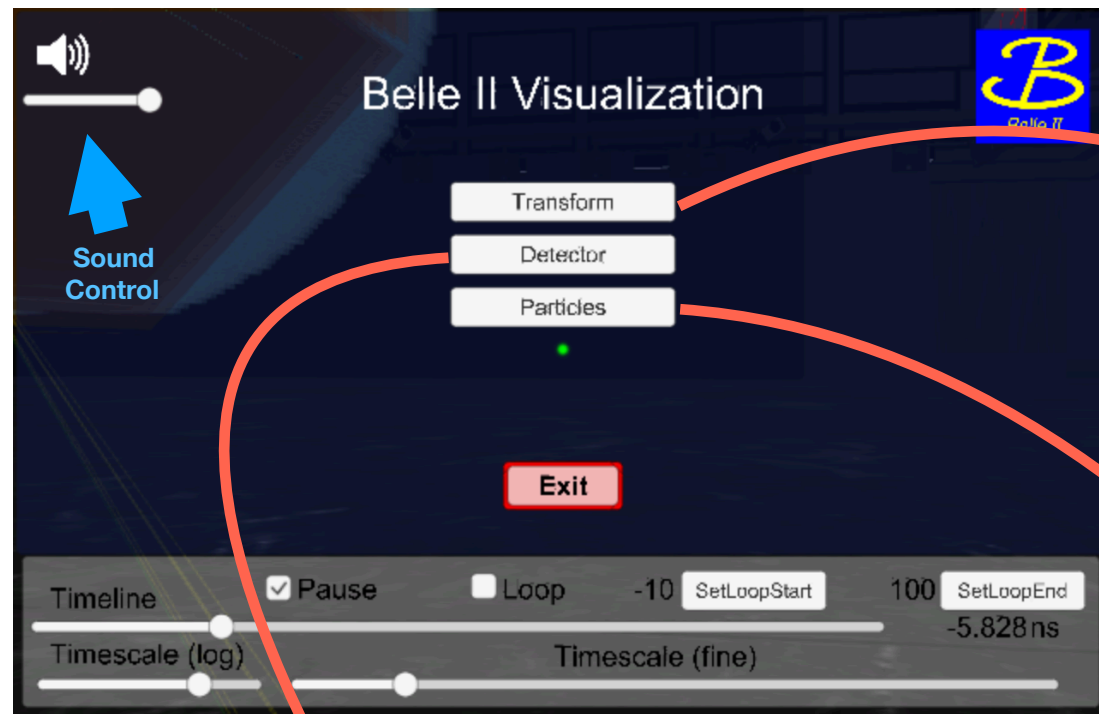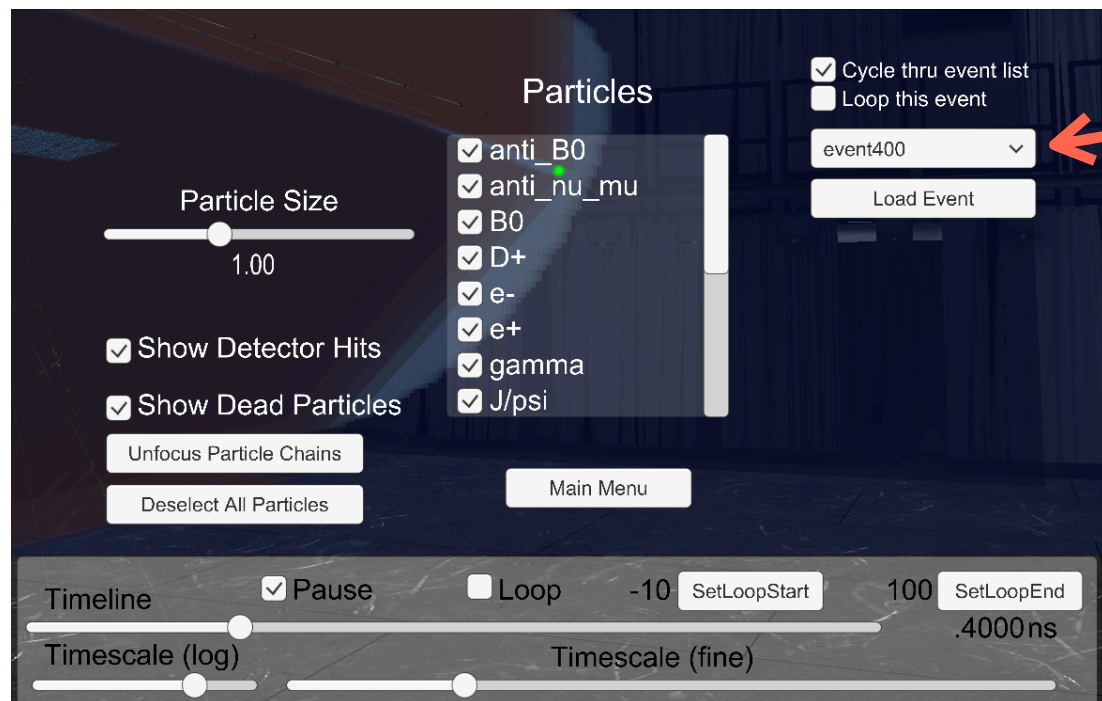

Main menu
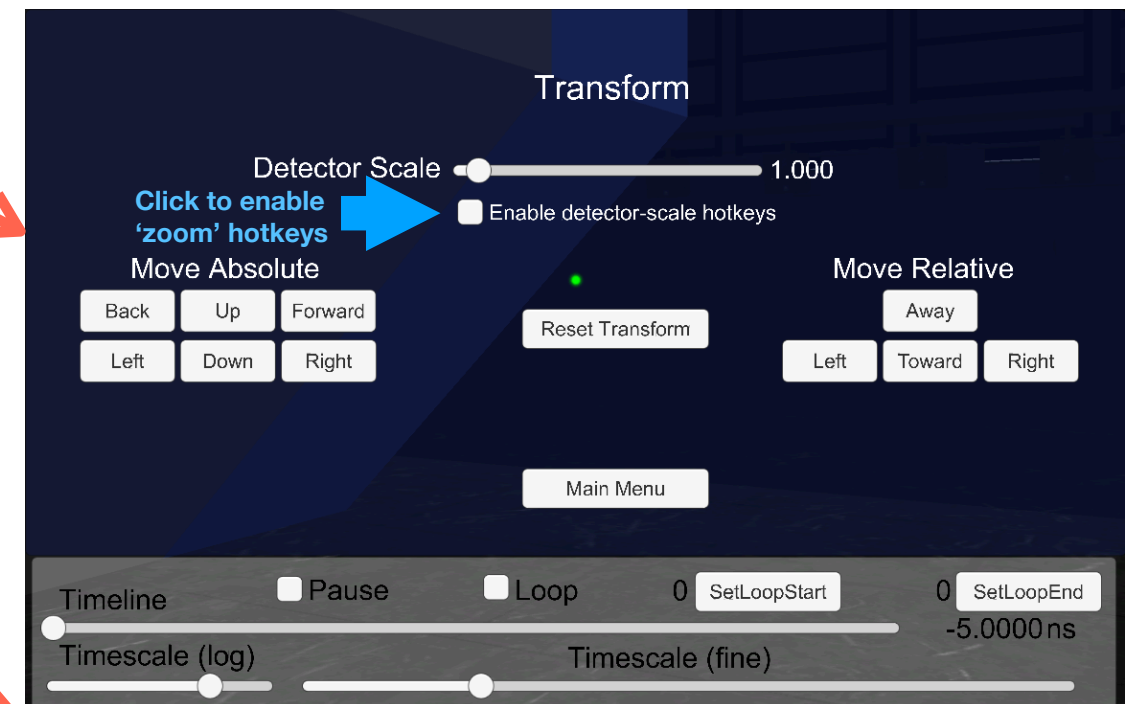
Transformation menu

Detector hide/show menu

Particles and events menu

Belle II in Virtual Reality: Event Selection

✓ In the **Particles** menu, select one of the events to animate.

✓ With your gaze, scroll the list to highlight the desired event then **SELECT**.

✓ With your gaze, highlight the "Load Event" button then **SELECT**.

✓ **Or wait:** the animation automatically skips to the next event

Event legend:

100-109: $e^+ \, e^- \rightarrow \mu^+ \, \mu^-$

110-119: $e^+ \, e^- \rightarrow \pi^+ \, \pi^-$

120-129: $e^+ \, e^- \rightarrow e^+ \, e^-$

130-139: $e^+ \, e^- \rightarrow \gamma \, \gamma$

140-149: $e^+ \, e^- \rightarrow K^+ \, K^-$

150-159: $e^+ \, e^- \rightarrow K_{\mathrm{S}} \, K_{\mathrm{L}}$

160-169: $e^+ \, e^- \rightarrow \Lambda \, \overline{\Lambda}$

170-179: $e^+ \, e^- \rightarrow p \, \overline{p}$

180-189: $e^+ \, e^- \rightarrow s \, \overline{s}$

190-199: $e^+ \, e^- \rightarrow c \, \overline{c}$

200-209: $e^+ \, e^- \rightarrow B^0 \, \overline{B}^0 \rightarrow (\mathrm{J}/\psi \, K_{\mathrm{S}})(D^+ \, \mu^- \, \nu)$

210-219: $e^+ \, e^- \rightarrow B^+ \, B^- \rightarrow (\tau \, \nu)(D^0 \, \pi^-)$

second B is hidden $\Big\{$ 220-229: $e^+ \, e^- \rightarrow B^0 \, \overline{B}^0 \rightarrow (\mathrm{J}/\psi \, K_{\mathrm{S}})(D^+ \, \mu^- \, \nu)$

230-239: $e^+ \, e^- \rightarrow B^+ \, B^- \rightarrow (\tau \, \nu)(D^0 \, \pi^-)$

Belle II in Virtual Reality: Event Customization

✓ You can choose which events appear in the **Particles** menu.
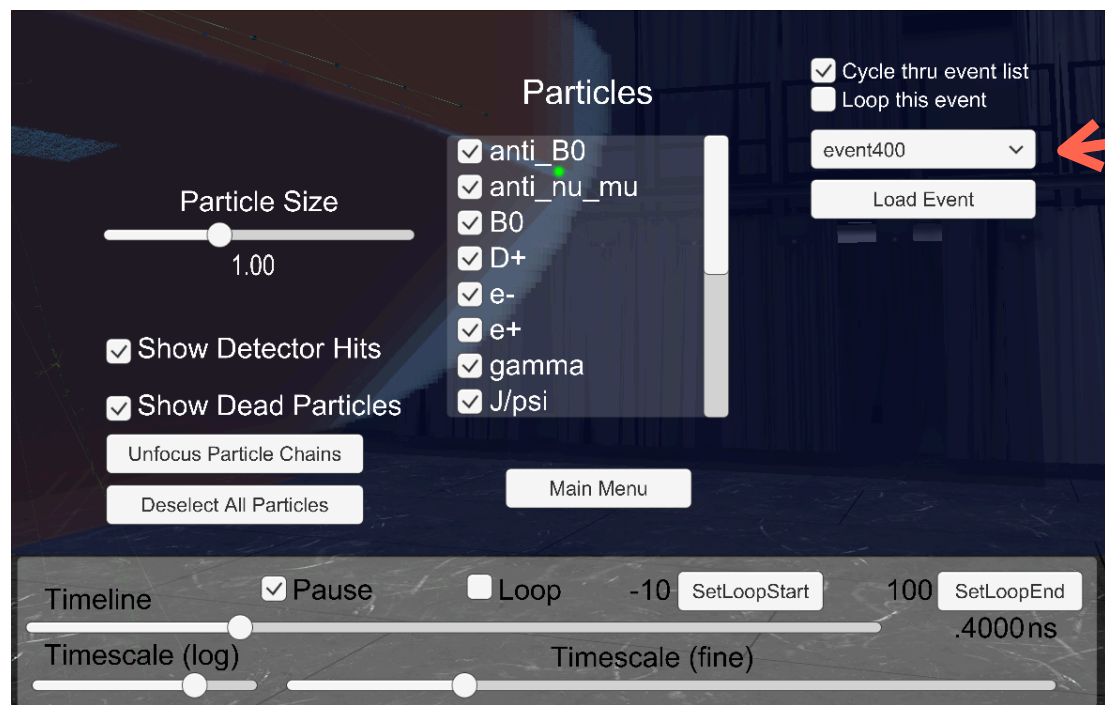
The simulated electron-positron collision events are stored in a folder named **events** at the same level as the app itself. You may modify the contents of this folder to suit your needs, according to the following rules.

The **events.lis** text file in the **events** folder specifies the sequence of event files that are fetched by the app. In your favorite text editor, you may comment out and/or reorder lines here to suit your preferences. Each event file is a plain text file that is exported from the basf2 GEANT4-based physics simulation of the Belle II detector.

If the **events** folder contains the text file **events.url** and this file specifies a valid web address (URL) then **events.lis** and the event csv files will be fetched from this web address instead of the **events** folder.

The event csv files may be gzipped (but should still be referenced by the original filename in **events.lis**).

If the above event-fetching mechanisms fail (due to syntax or file-corruption errors), the app will revert to displaying one of five baked-in events: $e^+ e^- \rightarrow B^0 \ \bar{B}^0 \rightarrow (J/\psi \ K_S)(D^+ \mu^- \nu)$, etc.