

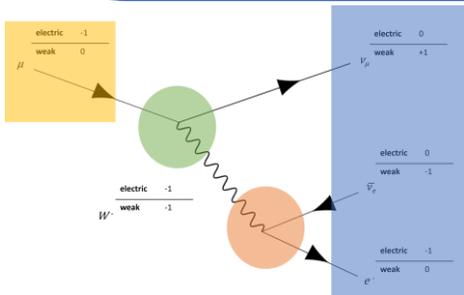
# Research-based instruction design for Feynman diagrams

## Motivation and Context

- Feynman diagrams (FD) as one of the most popular **forms of representation in particle physics**
- Long lasting **debate about its usage in physics education** (Passon et al., 2018)
- **Research-based instruction design** for a component as a MOOC on particle physics (currently under development at CERN)

## Theoretical Background

- FD example for **representation dilemma** (Rau, 2017)
- **Social Semiotics** (cf. Airey & Lindner, 2017): disciplinary vs. pedagogical affordance
- Representations with high disciplinary affordance need „**unpacking**“ (Fredlund et al., 2014)
- **Eye Tracking** as tool to inform instruction design (Jarodzka et al., 2017)
- **Model of educational reconstruction** (Duit et al., 2012): educational use vs. possible challenges



An example for an “unpacked” FD

## Expert Interviews

- FF1) Which opportunities for physics education on high school level is connected to Feynman diagrams according to experts?
- FF2) Which challenges are connected to teaching Feynman diagrams to high school students?

## First results Expert Interviews

### Opportunities

- Motivation of interaction particles
- Motivation of conservation laws
- Motivation of quantum mechanical concepts
- Motivation of computation tools

### Challenges

- Real particle exchange
- Space-time embedding
- Superficial view on particle physics
- Takes away lesson time from quantum mechanics

## Students

### Eye Tracking Study

- FF1) How is the visual attention of students distribute when reading Feynman diagrams to learn about conservation laws and interaction particles?

- FF2) Which elements make a Feynman diagram more accessible for students?

### Expert Eye Tracking Study

- FF1) How is the visual attention of experts examine Feynman diagrams compared to novices?

- FF2) Which visual chunks do experts deconstruct Feynman diagrams in mentally?

## Research-based Assessment-Instrument for Particle Physics

- Evaluation of the MOOC
- Based on expert interviews: concepts in particle physics which are connected to teaching of FD

## Research-based Instruction Design

- Based on model of educational reconstruction
- Informed by interviews and eye tracking studies
- Test of effectiveness with high school students at CERN

What do you think about instruction design for Feynman diagrams?

10/20

04/21

09/21

01/22

04/22

12/22