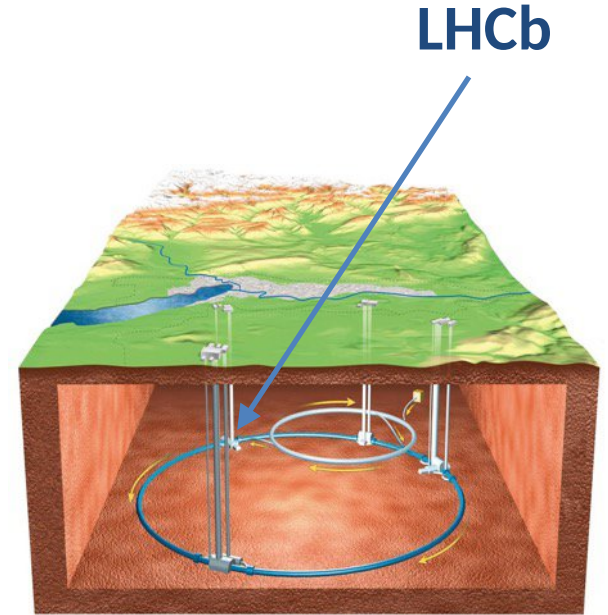
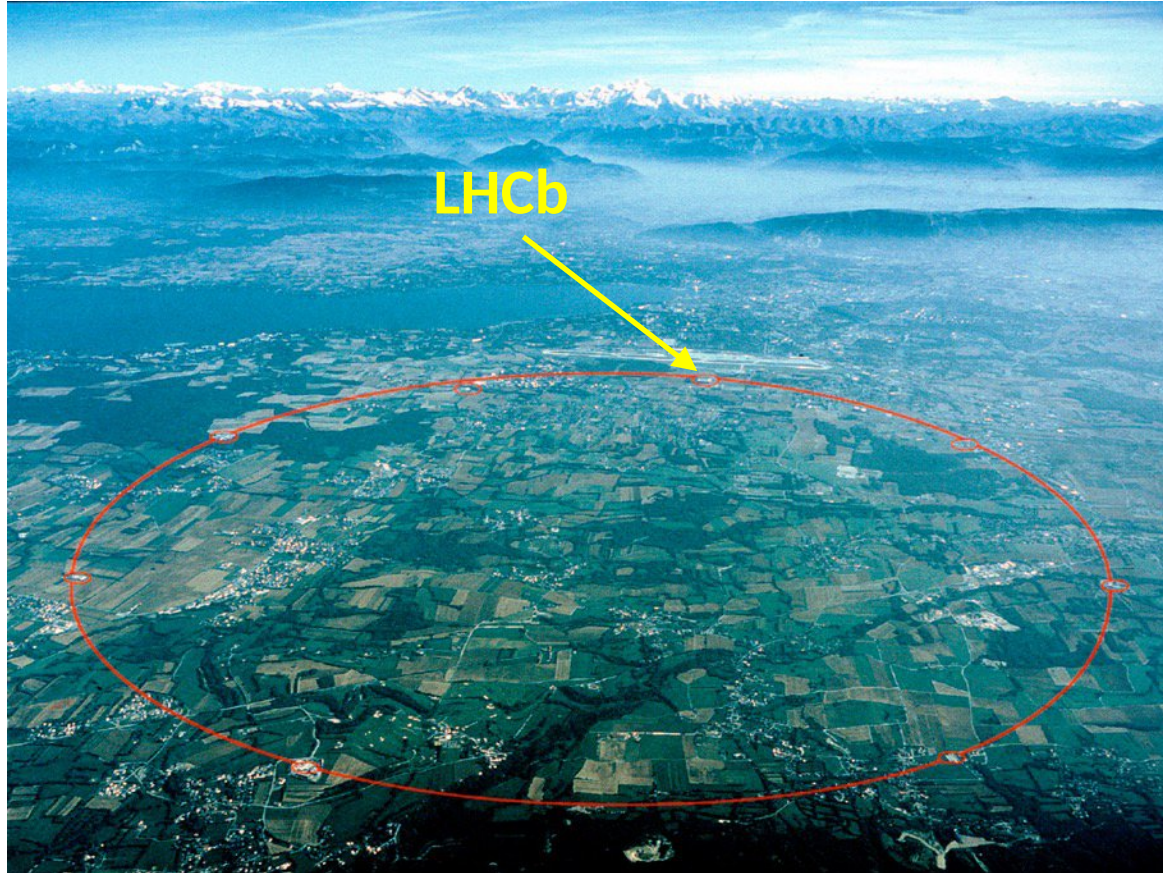


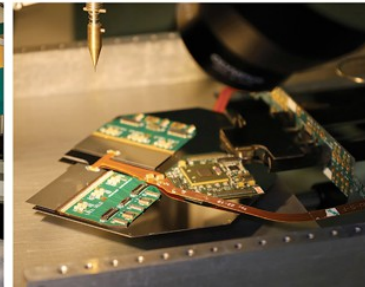
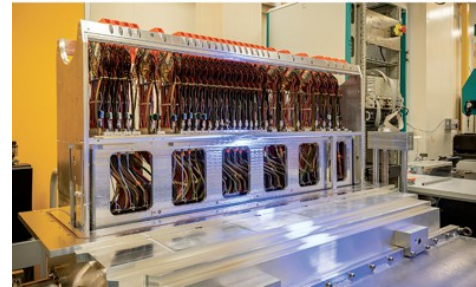
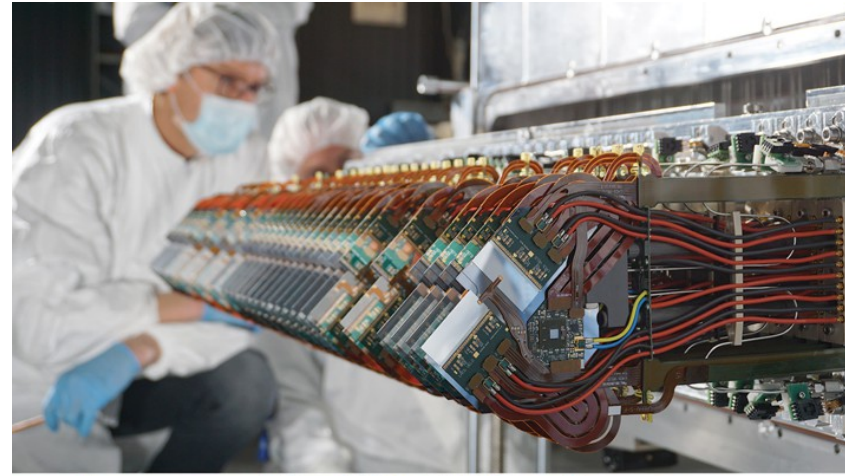
Master projects in LHCb



The LHCb experiment at CERN

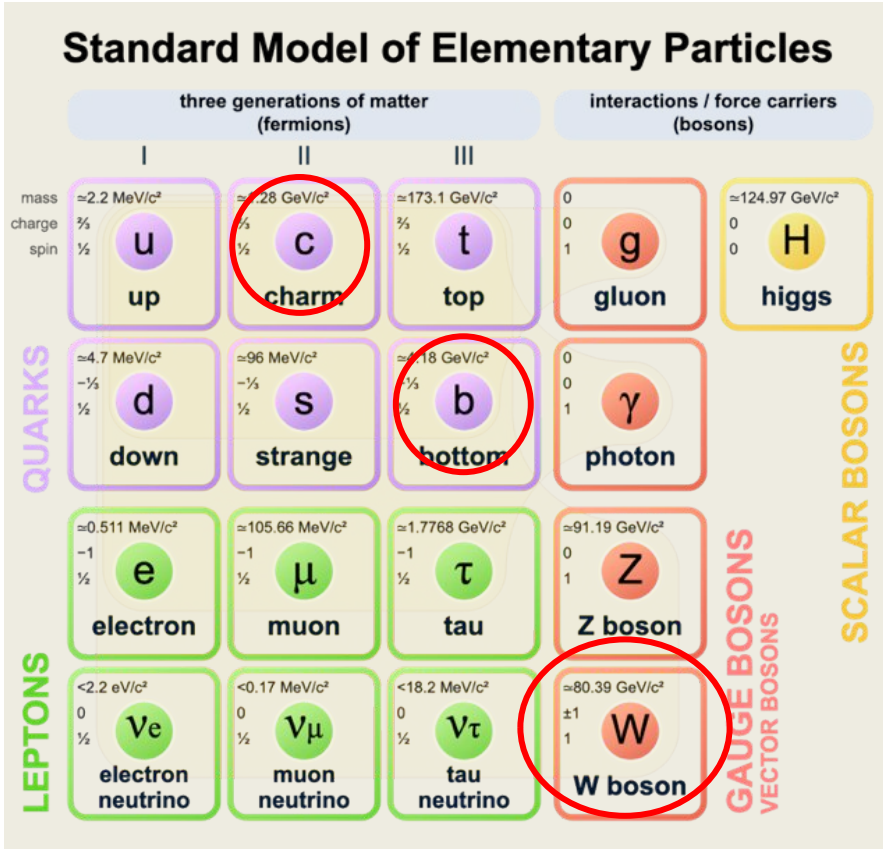


The LHCb experiment at CERN



- detector optimized for the study of ‘beauty’ and ‘charm’ quark decays
- about 1000 scientists from 18 countries

“The Standard Model of Elementary Particles”



- experiments at the LHC test this theory in high-energy collisions
- goal: understand what the universe is made of
- LHCb: ‘weak interaction’ processes
 - matter/anti-matter asymmetry
 - rare decays
 - meta-stable particles

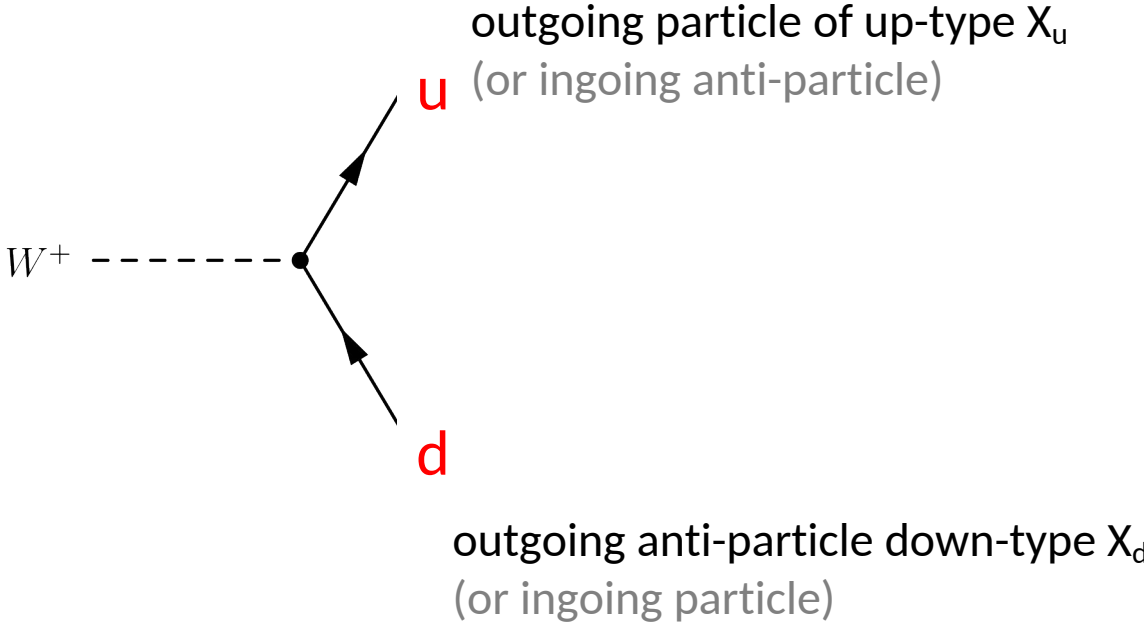
quark interactions

weak interaction: **interaction between different types of quarks**

mass
charge
spin

$\approx 2.4 \text{ MeV}/c^2$ 2/3 1/2	u up	$\approx 1.275 \text{ GeV}/c^2$ 2/3 1/2	c charm	$\approx 172.44 \text{ GeV}/c^2$ 2/3 1/2	t top
$\approx 4.8 \text{ MeV}/c^2$ -1/3 1/2	d down	$\approx 95 \text{ MeV}/c^2$ -1/3 1/2	s strange	$\approx 4.18 \text{ GeV}/c^2$ -1/3 1/2	b bottom

QUARKS



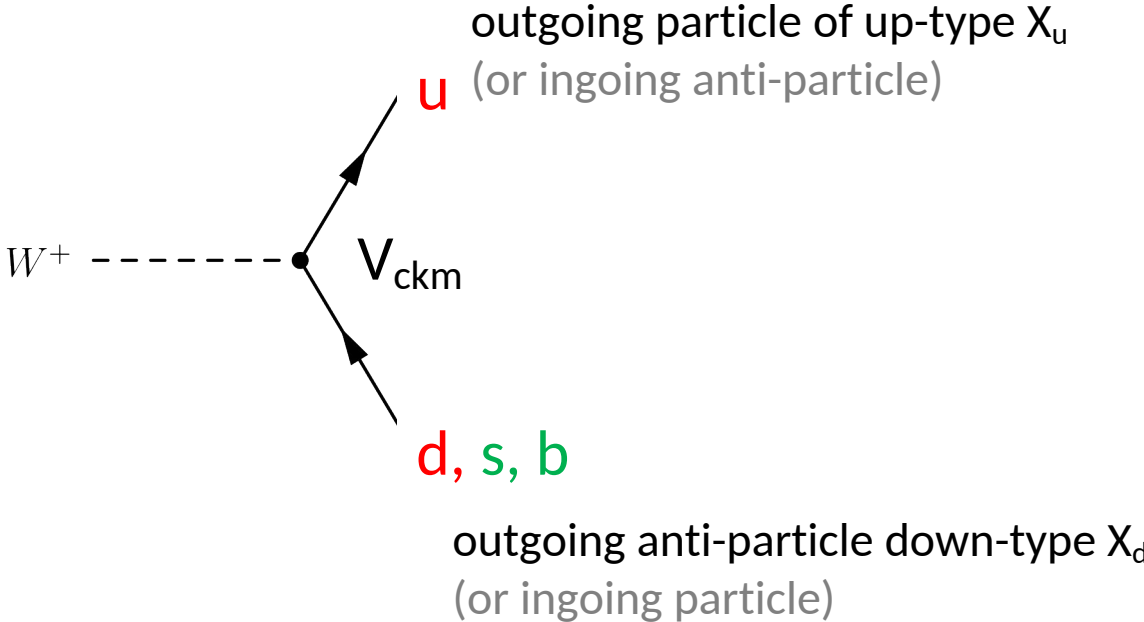
quark interactions

weak interaction: interaction between different types of quarks

mass
charge
spin

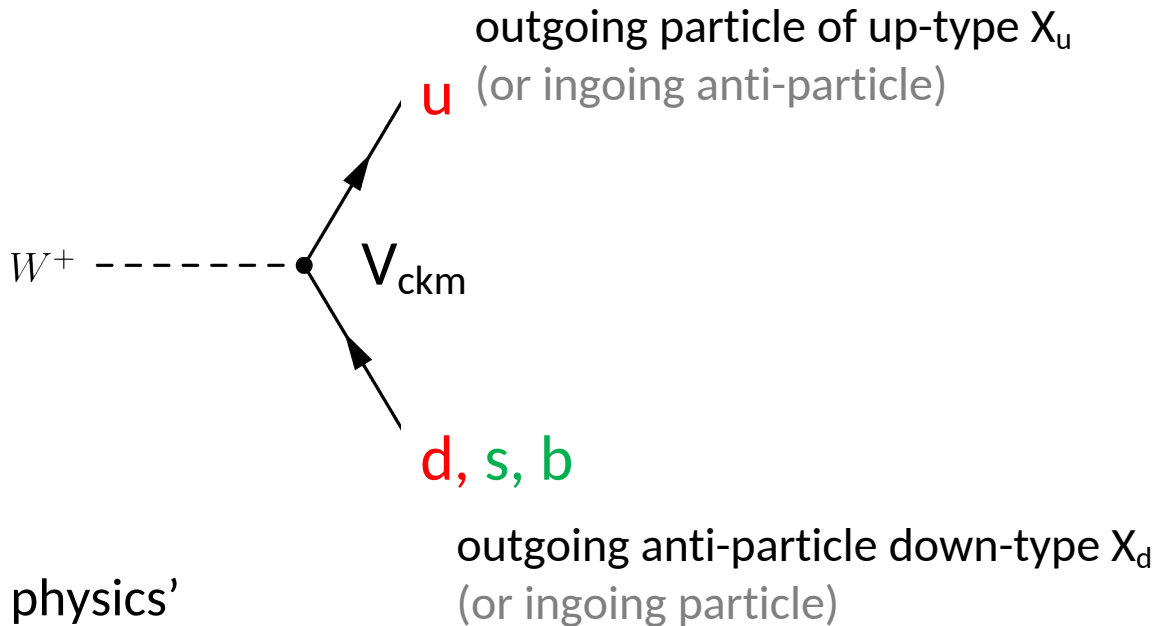
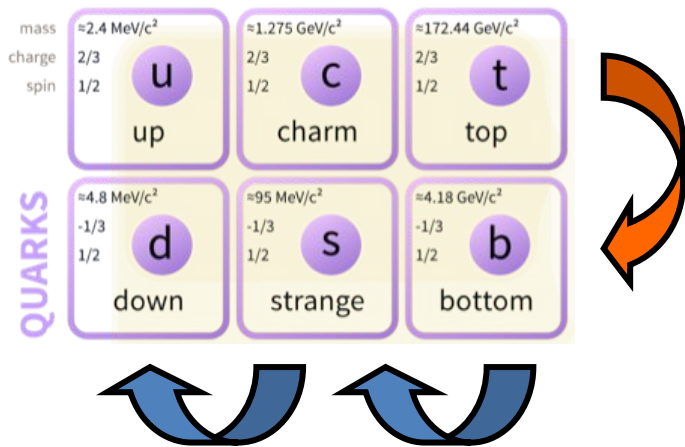
$\approx 2.4 \text{ MeV}/c^2$ 2/3 1/2	$\approx 1.275 \text{ GeV}/c^2$ 2/3 1/2	$\approx 172.44 \text{ GeV}/c^2$ 2/3 1/2
u up	c charm	t top
$\approx 4.8 \text{ MeV}/c^2$ -1/3 1/2	$\approx 95 \text{ MeV}/c^2$ -1/3 1/2	$\approx 4.18 \text{ GeV}/c^2$ -1/3 1/2
d down	s strange	b bottom

QUARKS



quark interactions

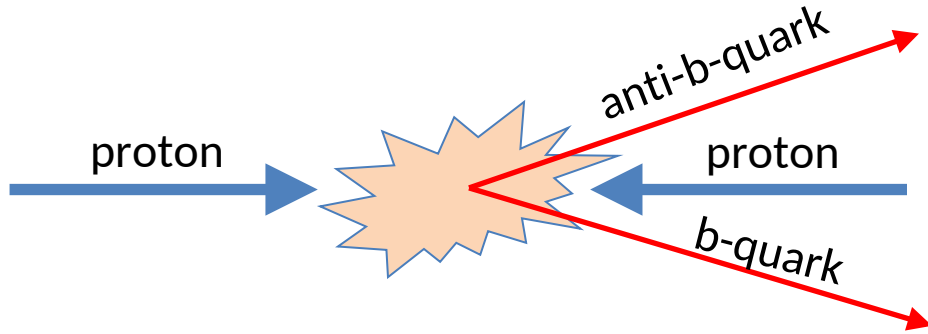
weak interaction: interaction between different types of quarks



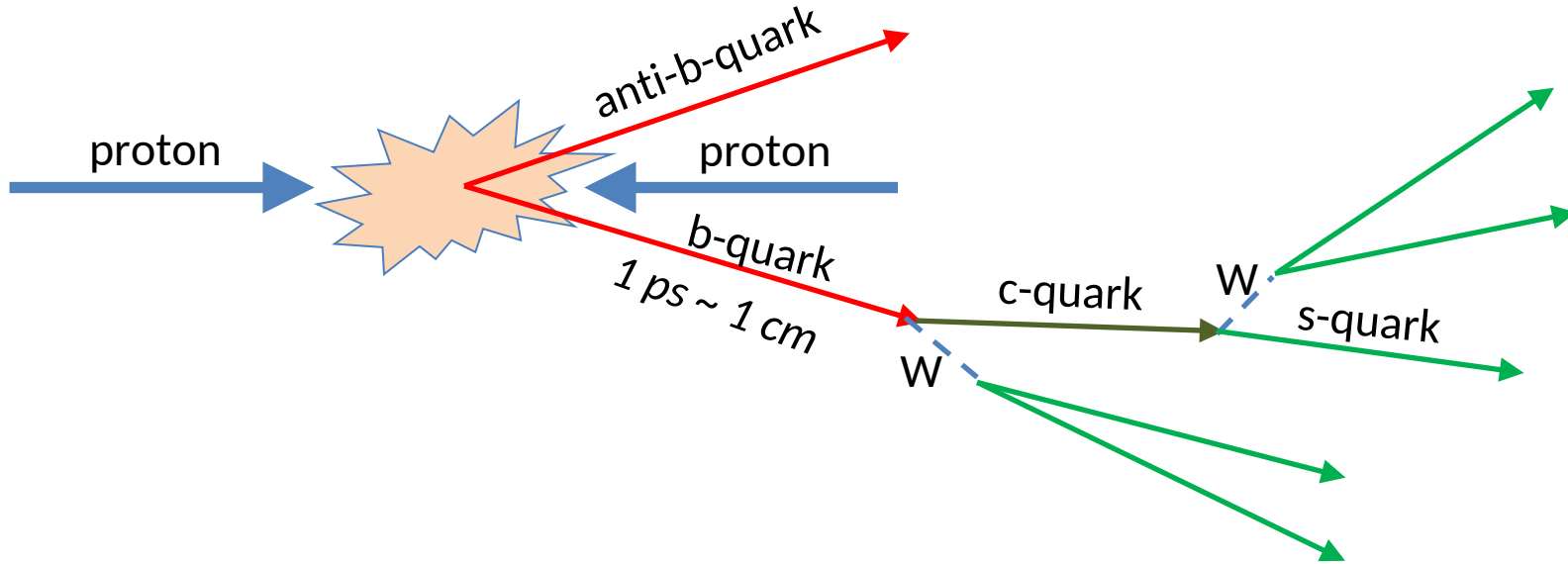
LHCb physics = 'quark flavour physics'

- test understanding of quark transitions
- concentrate on b and c hadron decays

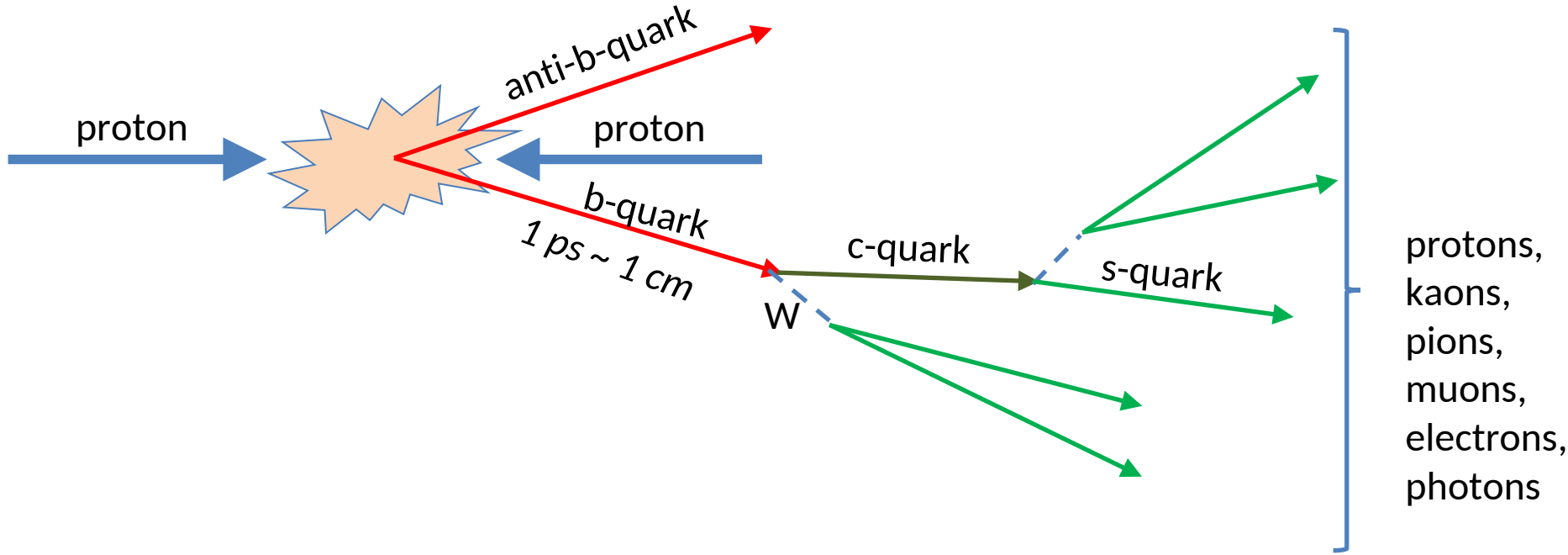
Studying heavy quarks at the LHC



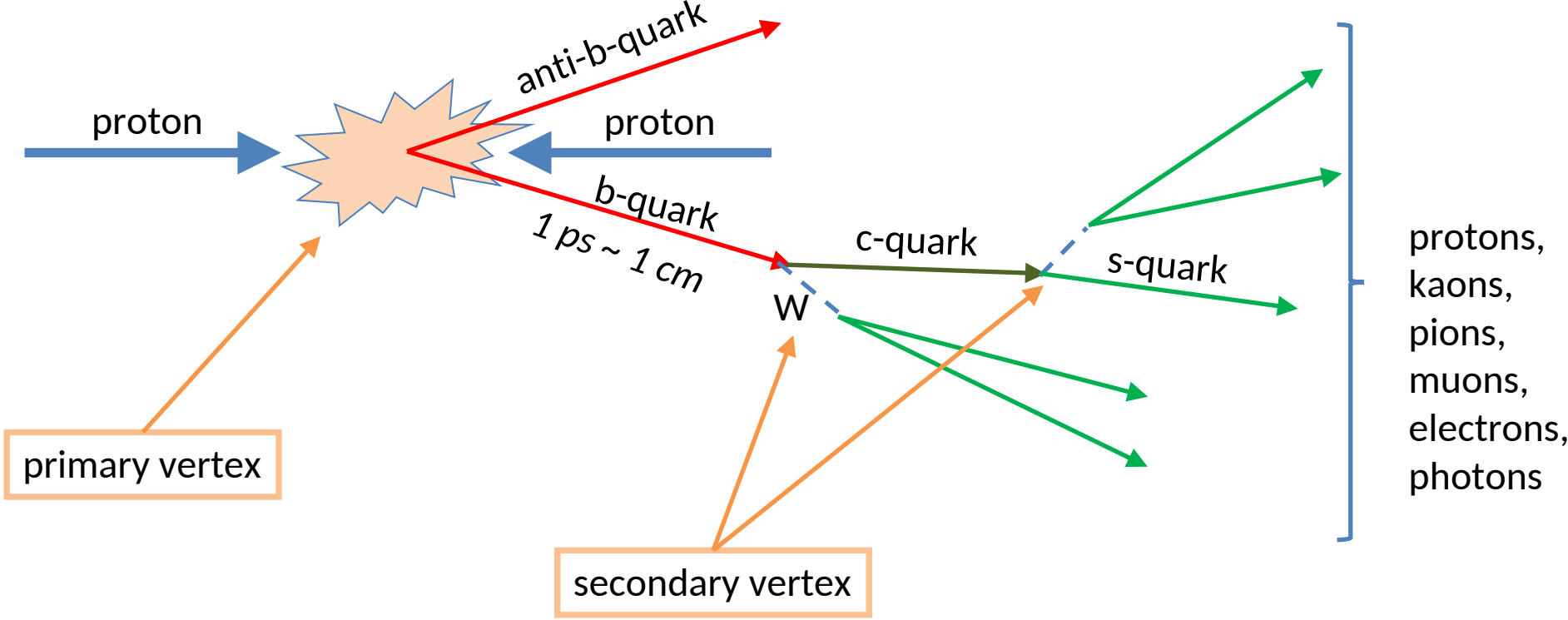
Studying heavy quarks at the LHC



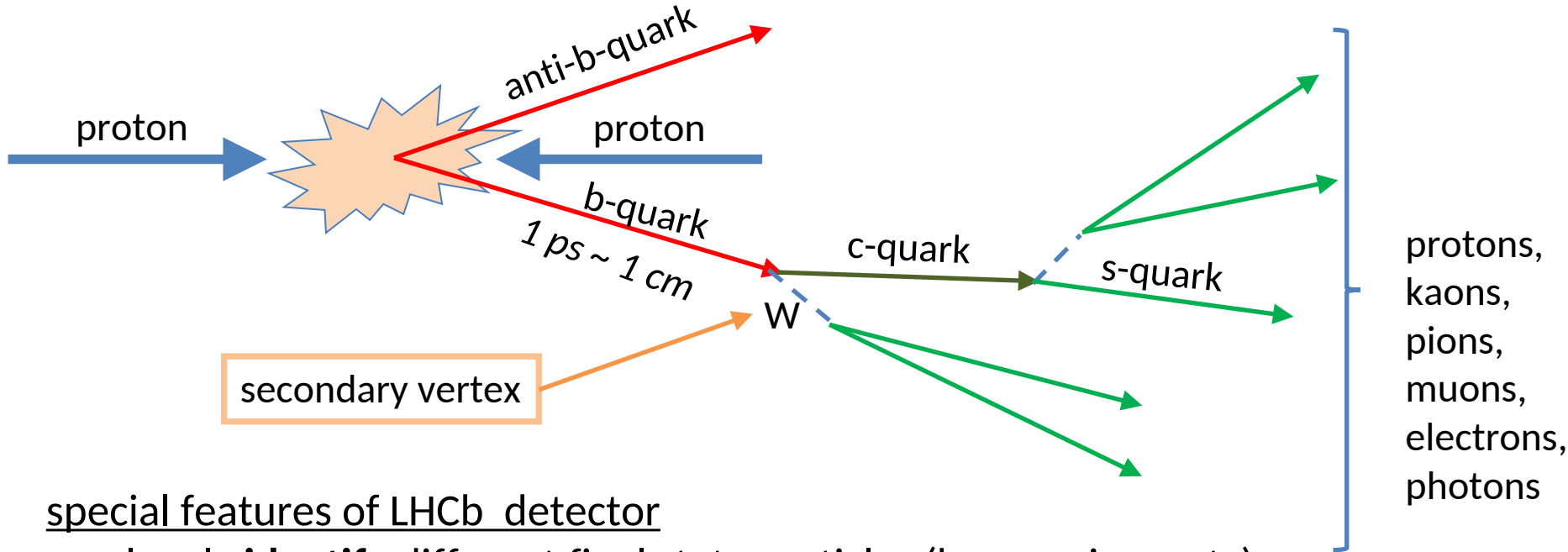
Studying heavy quarks at the LHC



Studying heavy quarks at the LHC



Studying heavy quarks at the LHC



special features of LHCb detector

- cleanly **identify** different final state particles (kaons, pions, etc)
- precisely measure heavy quark **decay vertices**
- precisely measure final state **particle energy**

The BFYS group at Nikhef



- second largest LHC group at Nikhef
- about 14 staff, 7 postdocs, 12 PhD students
- at four locations: Amsterdam, Groningen, Maastricht, CERN



1/2



1/2

LHCb projects

- see https://wiki.nikhef.nl/education/Master_Projects

[1.40 LHCb: Search for light dark particles](#)

[1.41 LHCb: Searching for dark matter in exotic six-quark particles](#)

[1.42 LHCb: New physics in the angular distributions of B decays to \$K^* e e\$](#)

[1.43 LHCb: CP violation in B \$\rightarrow\$ J/psi Ks decays with first run-3 data](#)

[1.44 LHCb: Optimization of primary vertex reconstruction](#)

Andrii

Patrick

Alice, Miriam,
Mara, Wouter

Wouter

- **beware: list is snap-shot!**
 - master student projects are embedded in ongoing research
 - topic and supervisors change over time
 - list is not complete: you may even bring your own project!
- if you are interested in LHCb, mail contact-person, or Mara, or Wouter
 - **or come by and talk!**

What to expect?

- **data analysis**
 - **studying physics:** papers, theses, etc
 - working with **large data sets**, either ‘established’ (run-1/2) or ‘new’ (run-3)
 - learning tools: root, **python** (scipy, hepml, tensorflow, ..), git, latex, **C++**, ...
- **supervision**
 - usually 1 PhD student or postdoc and one senior staff
- **meetings/events**
 - weekly “BFYS” meeting on **Friday morning at 10am**
 - remote meetings with ‘physics working group’ at CERN (usually bi-weekly)
 - travel to CERN (if useful for the project!)
 - **BFYS workshop** (2 days, once per year **at remote location**)