



# Flavour tagging & $CP$ violation measurements

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FSP meeting in Siegen, 5th October 2017

[See-ming Lee]

# Flavour Tagging

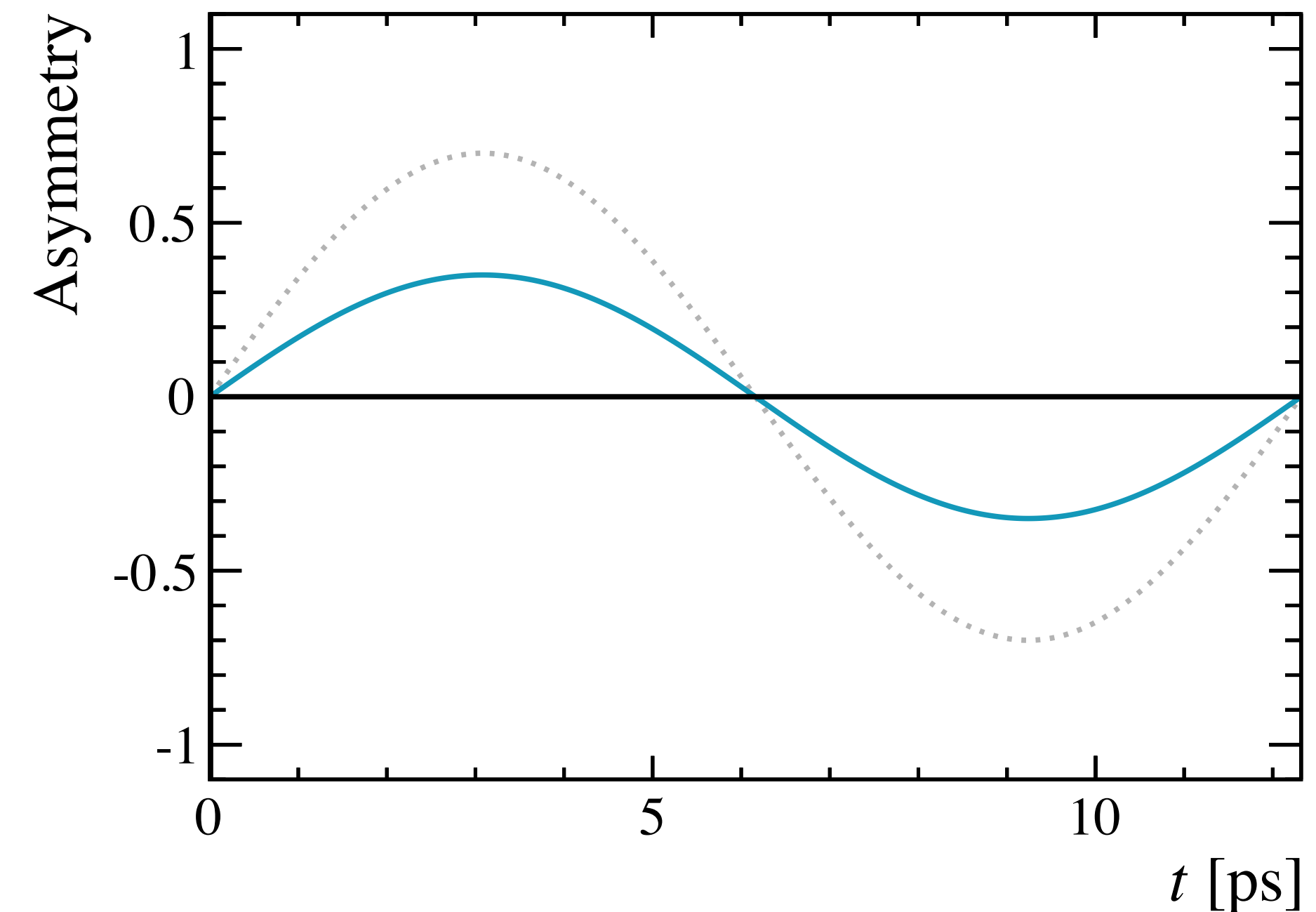
- ▶ knowledge of production flavour
- ▶ challenges:
  - not always successful
  - sometimes incorrect

$$\epsilon_{\text{tag}} = \frac{N_{\text{tagged}}}{N_{\text{tagged}} + N_{\text{untagged}}}$$

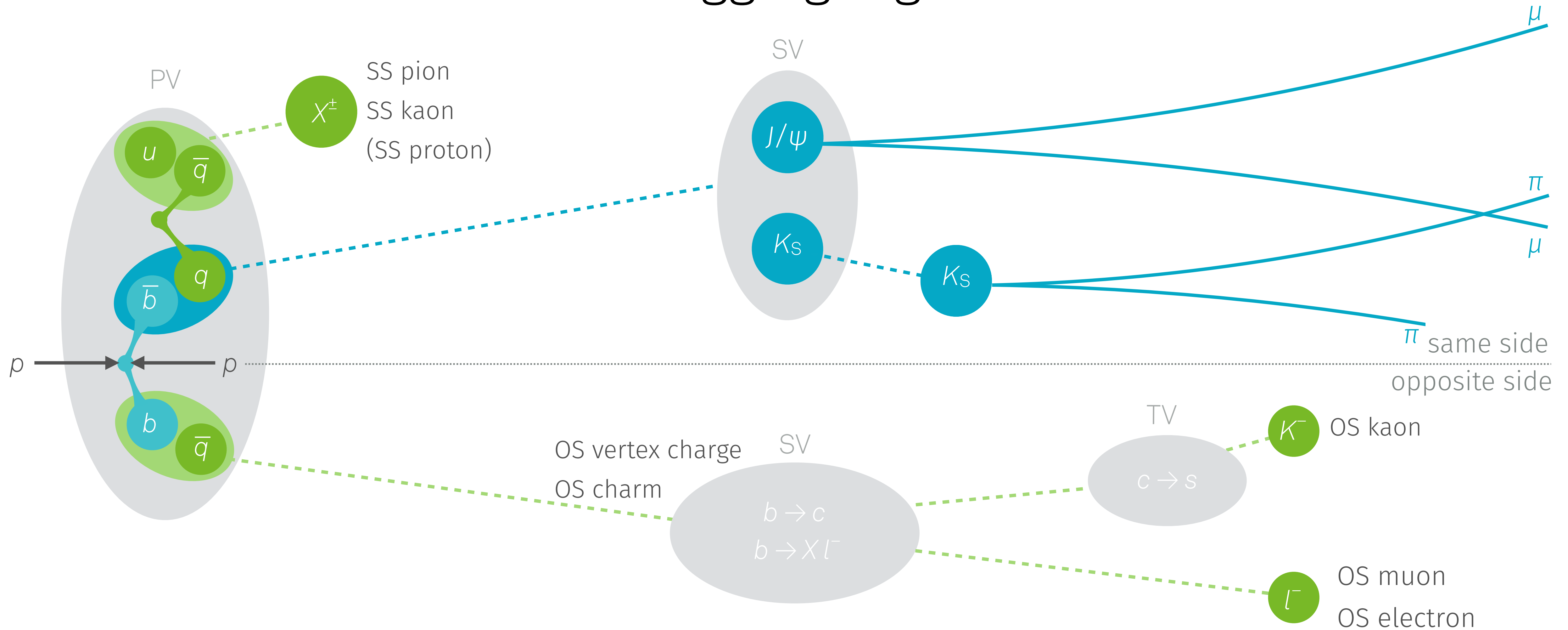
$$\omega = \frac{N_{\text{incorrect}}}{N_{\text{tagged}}}$$

- ▶ two per-event observables:
  - decision (tag)  $d$  on the initial  $b$  flavour
  - probability of the decision to be wrong (estimated mistag)  $\eta$
- ▶ dilution of tagged  $CP$  analyses samples

$$\epsilon_{\text{eff}} = \epsilon_{\text{tag}} D^2 = \epsilon_{\text{tag}} (1 - 2\omega)^2 \longrightarrow \sigma_{ACP} \approx \frac{1}{\sqrt{\epsilon_{\text{tag}} D^2 N}}$$

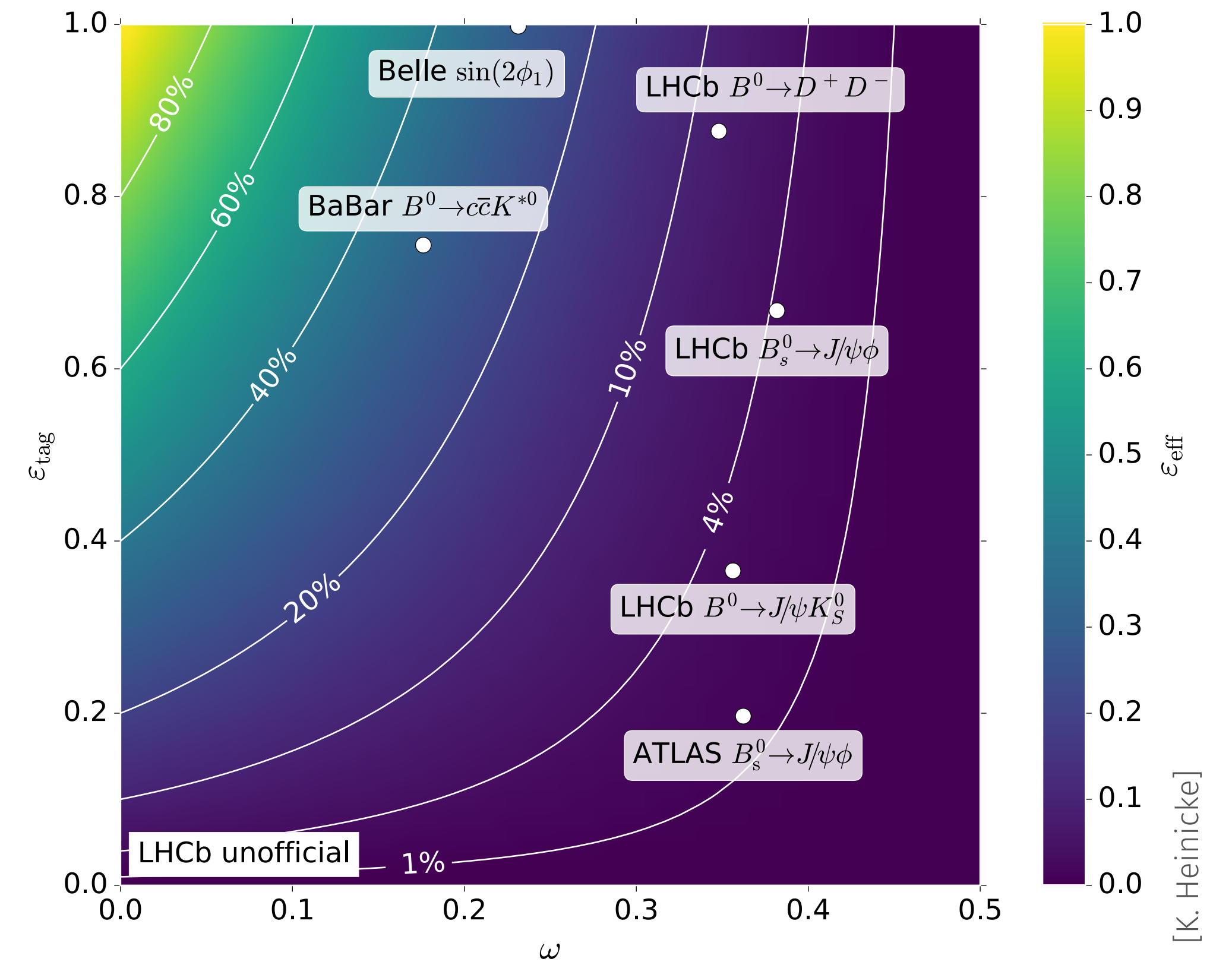
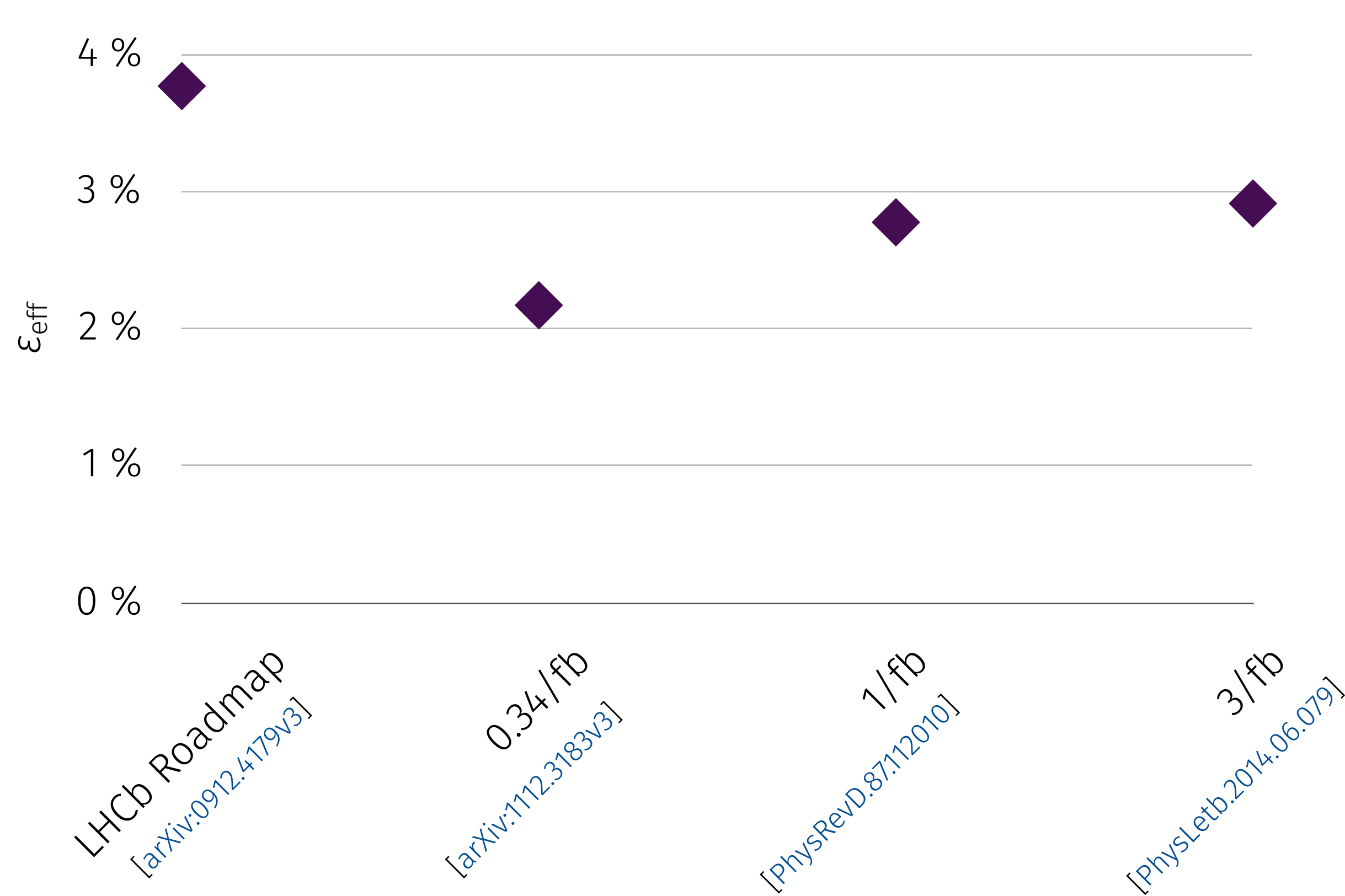


# Flavour Tagging Algorithms



# Flavour Tagging Performance

Performance of OS combination on  $B_s \rightarrow J/\psi \phi$



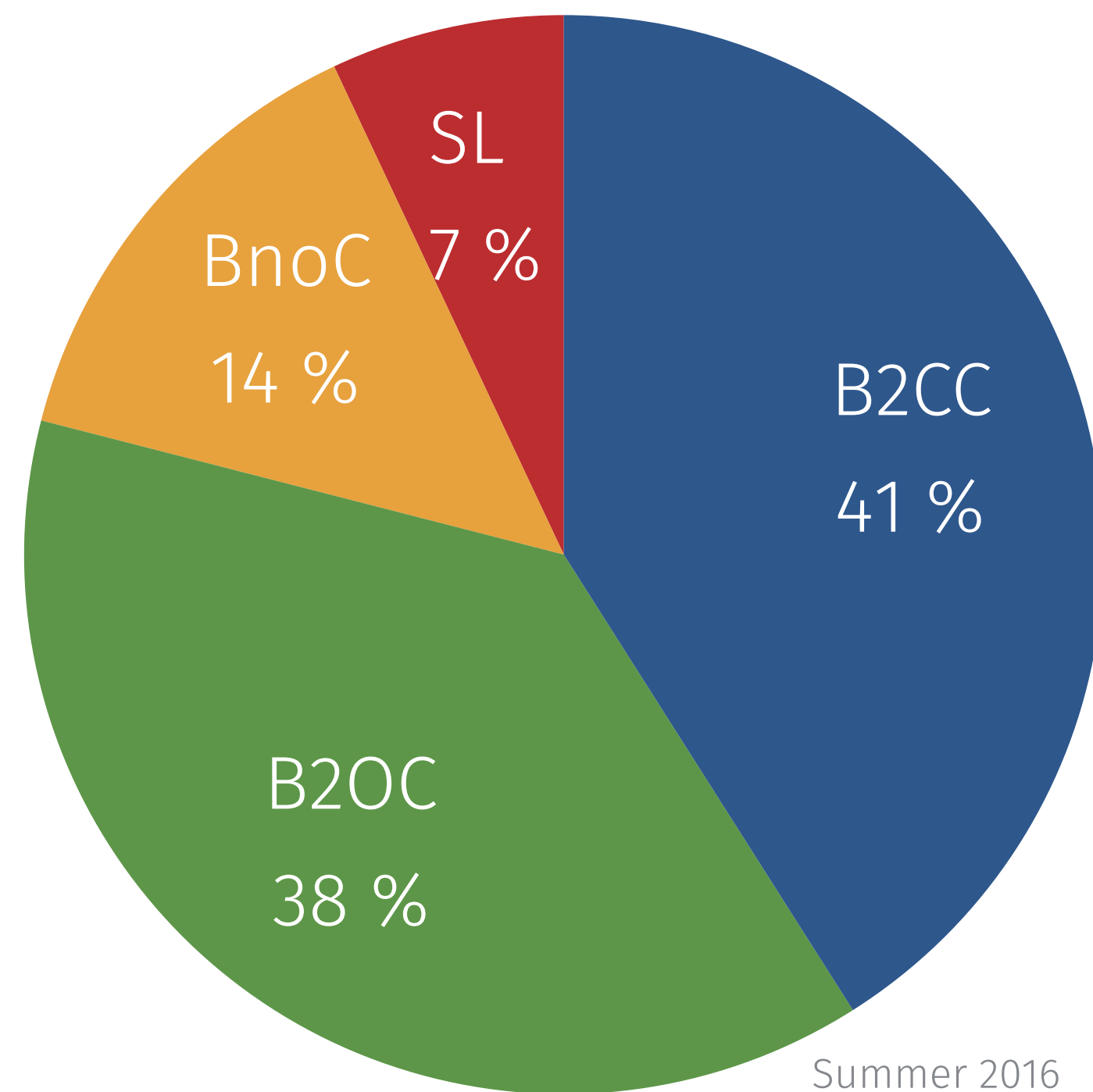
# How to improve?

- ▶ O(10%) relative drop of tagging power on Run II data
  - different momentum spectra of tagging particles and higher track multiplicities
- ▶ two main approaches:
  - optimise **existing** tagging algorithms
  - develop **new** tagging algorithms
- ▶ refactor existing code base
  - common framework for optimisation, calibration and development

# Flavour Tagging Clients?

▶ #PAPERS using FT ~ 30/300 = 10%

▶ distribution in WGs:



▶ market development:

- B2CC: updates of  $\beta$  and  $2\beta_s$ 
  - in  $B_s \rightarrow J/\psi\varphi$ ,  $B_s \rightarrow J/\psi f_0$ ,  $B^0 \rightarrow J/\psi K_S$
- B2OC: updates of  $\gamma$ 
  - in  $B \rightarrow D^{(*)}K^{(*)}$ ,  $B_s \rightarrow D_s K$
- BnoC: updates or first measurements of  $2\beta_s^{\text{eff}}$ 
  - in  $B_s \rightarrow \varphi\varphi$ ,  $B_s \rightarrow K^*K^*$ ,  $B^0 \rightarrow \varphi K_S$
- RD: first measurements of  $2\beta_s^{\text{eff}}$ 
  - in  $B^0 \rightarrow \varphi\gamma$

# Competitors?

▶ exploiting only ~ 3% of our data in tagged analyses

▶ others will have

- less data, but will profit from higher tagging power
- nothing compared to our tagging, but much more data



▶ to stay ahead

- improve tagging power → better exploitation of data
- deeper understanding of tagging = lower syst. uncertainties

# LHCb Flavour Tagging Group

- ▶ WG activities and responsibilities:
  - developing and optimising tagging algorithms
  - software and tools for analysts
  - tagging recipes for analysts
- ▶ organisation:

Bassem Khanji

Simon Akar

Vincenzo Battista

Davide Fazzini

Kevin Heinicke

Bassem Khanji

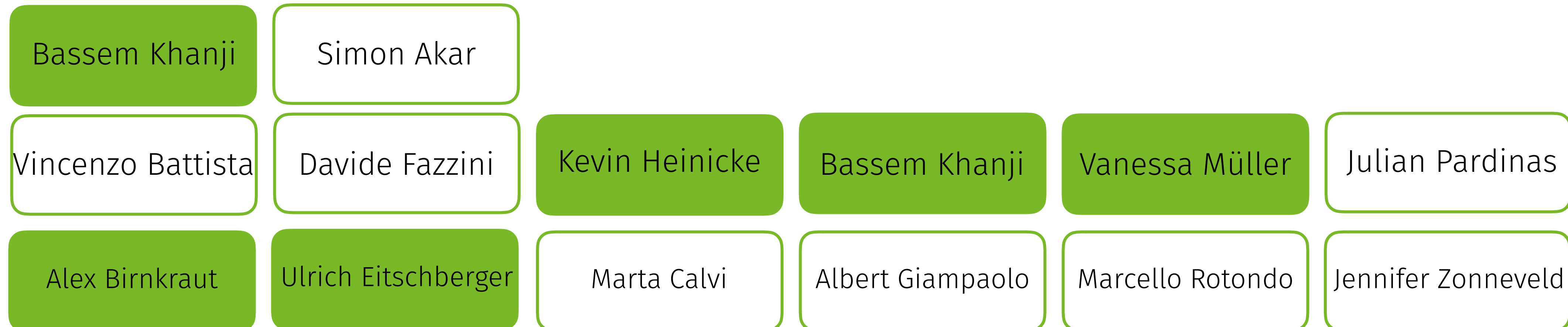
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Julian Pardinias



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# Discussion

- ▶ improving flavour tagging benefits dozens of analyses at LHCb
  - ▶ contribution by the German groups is significant (Heidelberg, Dortmund, ...)
  - ▶ However ... not enough person-power!
- ➡ How can we recruit more people to do service tasks for the collaboration?