



UNIVERSITY OF  
CAMBRIDGE



# Heavy Flavour at FCC-ee

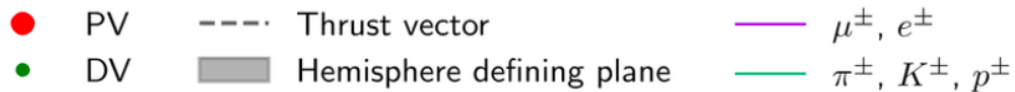
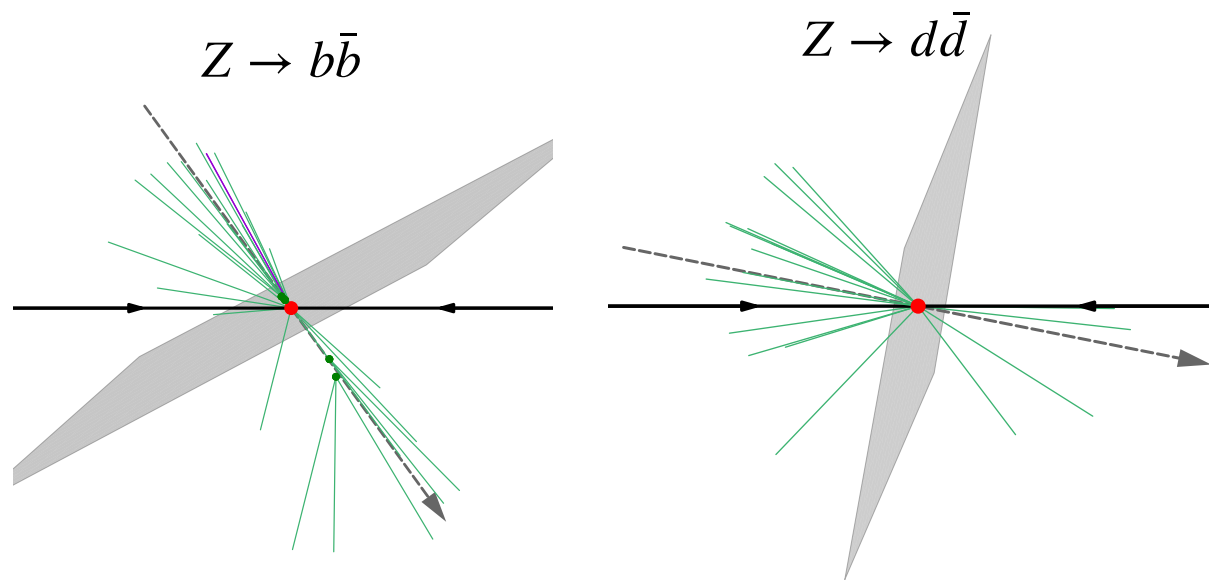
Cambridge FCC Group

---

**Matt Kenzie**

University of Cambridge

# Heavy Flavour at FCC



\*Not to scale

## KEY DATA

$$f_u = f_d = 0.4$$

$$f_s = 0.1$$

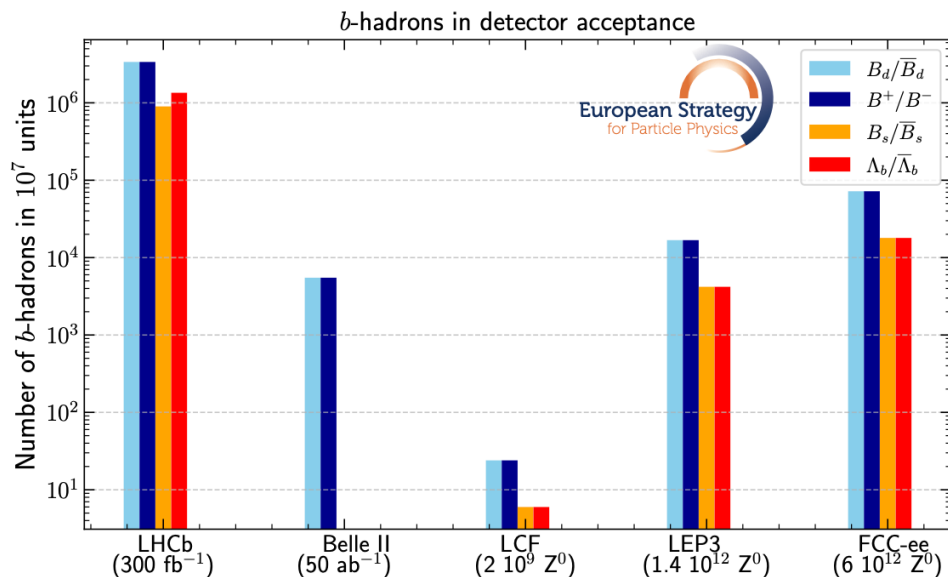
$$\langle E_B \rangle \approx 70\% \frac{m_Z}{2}$$

$$\beta\gamma = p/m \approx 6$$

$$c\tau \approx 3 \text{ mm}$$

$$\sigma(c\tau) \sim \mathcal{O}(10 \mu\text{m})$$

# FCC-ee as a flavour factory



Monteil, Wilkinson, [Eur.Phys.J.Plus 136 \(2021\) 837](#)

| Attribute                         | $\Upsilon(4S)$ | $pp$ | $Z^0$ |
|-----------------------------------|----------------|------|-------|
| All hadron species                |                | ✓    | ✓     |
| High boost                        |                | ✓    | ✓     |
| Enormous production cross-section |                | ✓    |       |
| Negligible trigger losses         | ✓              |      | ✓     |
| Low backgrounds                   | ✓              |      | ✓     |
| Initial energy constraint         | ✓              |      | (✓)   |

ESPPU Briefing Book, [CERN-ESU-2025-001](#)

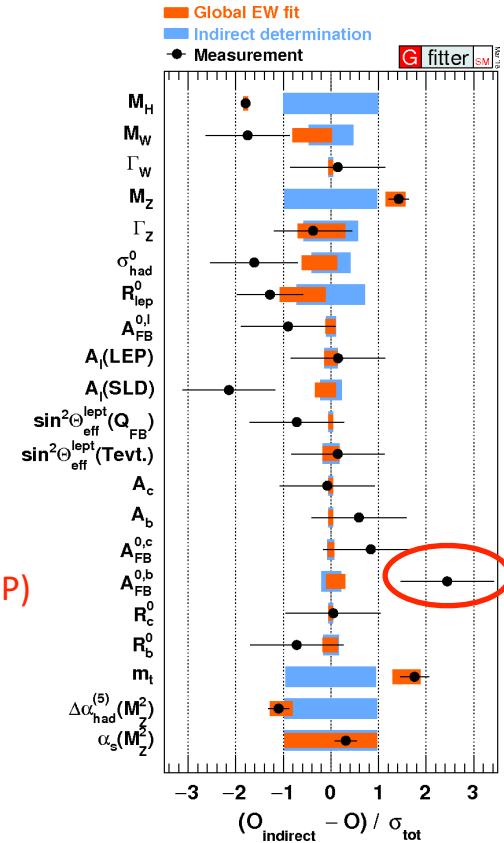
# Cambridge Efforts

- Partially invisible decays,  $b \rightarrow s\nu\bar{\nu}$ , MK
  - <https://inspirehep.net/literature/2700388>
- Totally invisible decays,  $B_{(s)}^0 \rightarrow \nu\bar{\nu}$ , MK, E. Wood, R. Mangrulkar
  - <https://inspirehep.net/literature/2957914>
- Flavour Tagging, MK, E. Wood
  - <https://indico.cern.ch/event/1644557/contributions/7097500/>
- Time-dependent CPV in “golden modes”, MK + PartIII Students
  - <https://indico.cern.ch/event/1644557/contributions/7097520/>
- Time-dependent CPV in  $b \rightarrow u$  transitions, MK + Oxford
  - <https://indico.cern.ch/event/1644557/contributions/7097520/>
- NP searches in  $B_{(s)}^0 \rightarrow \gamma\gamma$ , M. Monk

# Other opportunities?

- Semileptonic asymmetries,  $a_{SL}^d$  and  $a_{SL}^s$  : NP in mixing
- EW precision (particular FB asymmetry in Z  $\rightarrow b\bar{b}$ )
- Hardware? PID related?
  - ARC, Timing chamber at tracking exit?
- Links to pheno?

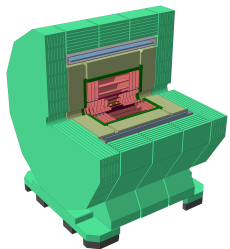
$\sim 2\sigma$  tension (LEP)



# Detector concepts

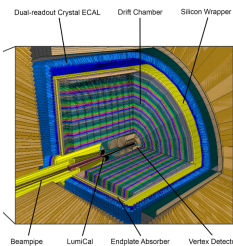
Expect FCC to have 4 IPs

## CLD



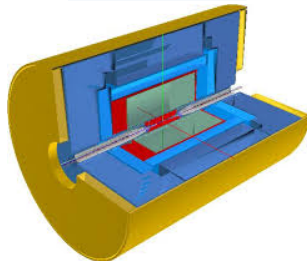
Si tracker  
CALICE-like CALO

## IDEA



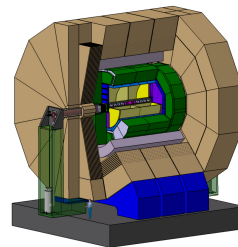
Ultra-light drift chamber  
Crystal ECAL  
Dual-readout fibre calo

## ALLEGRO



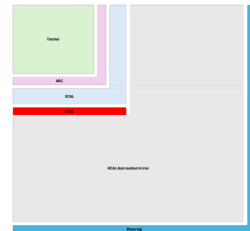
In early design phase  
Noble liquid ECAL

## ILD



Ported from ILC  
Large volume TPC

## ALFA



Low mass MAPS tracker  
Compact RICH system  
High-res ECAL

## Important considerations for flavour:

- Good vertexing -  $\mathcal{O}(10\mu m)$  required to resolve  $B_s^0$  oscillations
- Good quality tracking ( $\Delta p/p < 1\%$  across broad range)
- Particle ID (across broad range of momenta,  $\langle p_{K/\pi} \rangle \approx 1-5$  GeV (ToF,  $dE/dx$ ,  $dN/dx$ , CH)?
- High resolution calorimetry for neutrals and hermetic coverage for missing energy ( $\gamma$ ,  $\pi^0$ ,  $K_S^0$ ,  $K_L^0$ )
- Combining the above opens up potential for a serious programme with  $\tau$  s