

2026 UPDATE

OPEN SYMPOSIUM **European Strategy for Particle Physics**



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PPG: Flavour physics group discussion

Discussion leader: Tim Gershon

University of Warwick

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Should flavour physics still be considered as a key element of the European Strategy?

- **Answer must be yes**, if
 - we still believe there are new phenomena beyond the Standard Model to be unveiled at higher energy scales
 - virtual particles in quantum loops provide BSM sensitivity beyond the “direct” energy frontier
 - measurements are not limited by theoretical uncertainties or experimental systematics
- **This is certainly the case today**
- n.b. the above is a model-independent argument and aligns with an effective field theory approach → *many* operators to probe & therefore measurements of many different observables are necessary
 - focus on most theoretically clean and where largest improvements are possible
 - most experiments in B and D physics cover a broad range of observables
- **Understanding flavour crucial for several key open questions in our field**

What is best experimental scenario for flavour physics?

Theory
discussed
later

Full exploitation of the HL-LHC

- LHCb Upgrade II (300/fb)
- Enlarged flavour physics programme at ATLAS and CMS (3/ab)
- Data taking completed by ~2041

Completion of SuperKEKB/Belle II

- 50/ab e^+e^- collisions at $Y(4S)$ resonance (likely to require interaction region upgrade)
- Data-taking completed by ~2042

Full FCC programme

- FCC-ee with
 - significant Z pole run
 - ability to vary $\sqrt{s}$ $\uparrow$ and $\downarrow$
 - detectors optimised considering flavour
- FCC-hh with
 - dedicated flavour physics experiment
 - sufficient R&D lead-time

Complemented by dedicated kaon, pion, muon and EDM experiments

What would be lost without each of these elements?

Full exploitation of the HL-LHC

- Opportunity to exploit samples of $O(10^{15})$ beauty and charm hadrons
- Range of precision measurements that are not expected to be superseded until FCC-hh (if ever)

Completion of SuperKEKB / Belle II

- World-best measurements of B and D decays with neutrals &/or missing particles
- Opportunities to exploit quantum entanglement in $Y(4S) \rightarrow B\bar{B}$ pairs

Full FCC programme

- Probe of observables not covered by other facilities
- Significant improvement in some key observables (e.g. τ LFV, $b \rightarrow s\nu\bar{\nu}$, $b \rightarrow s\tau^+\tau^-$)
- New opportunities to study flavour with on-shell W decays

Dedicated kaon, pion, muon and EDM experiments

- Observables not covered by other facilities (e.g. $s \rightarrow d\nu\bar{\nu}$, π LFU, μ LFV, flavour-diagonal CPV)

What would be lost without each of these elements?

Full exploitation of the HL-LHC

Completion of SuperKEKB / Belle II

Full FCC programme

Depends of course on what it is replaced by:

- Other e^+e^- facility with similarly high lumi Z & WW programme
 - loss depends on lumi (including #IPs, and detector capability)
- Other e^+e^- facility with no or much lower lumi Z programme
 - large majority of flavour physics lost (still some interesting flavour physics with on-shell W & t)
- LHeC
 - similar to above (minimal discussion of flavour as yet)
- hh facility
 - depends on detector requirements (i.e. $\sqrt{s}$, pile-up, timescale and potential for detector R&D)
- μ collider
 - no Z programme but some new flavour opportunities

What do we need from theory?

- Support for continued theory improvements, in parallel to experiment, is essential
- Three key areas for flavour physics (and not only!)
 - **Lattice QCD calculations**
 - Interpretation of several measurements limited by knowledge of decay constants, form factors, ...
 - **Heavy flavour phenomenology**
 - Understanding uncertainties due to QCD effects, use and limitations of flavour symmetries, new ideas to make best use of experimental data
 - **Interpretation and global fits**
 - Use of flavour data to constrain BSM both in explicit models and model-independently.
 - Including combinations of flavour, Higgs and electroweak results – “multi-microscope physics”
 - Of course including possible interpretations of positive signals



Further discussion points

- What is the future for kaon physics in, or outside, Europe?
- What is the best route to a further step-change in sensitivity in μ LFV? Dedicated or multi-purpose experiments?
- What synergies are there with μ collider R&D in development of higher intensity μ beams for flavour experiments?
- What is the best approach to push the frontier in EDM sensitivities? Should novel concepts (e.g. quantum technologies) be prioritised over development of tried-and-trusted methods?
- Importance of Super Tau Charm Facility, for BSM searches, for auxiliary inputs to other flavour measurements, and for other areas beyond flavour
- Role of small(er) scale experiments to benefit scientific breadth and diversity of field