Beauty production measurements via (partial) reconstruction of secondary vertices

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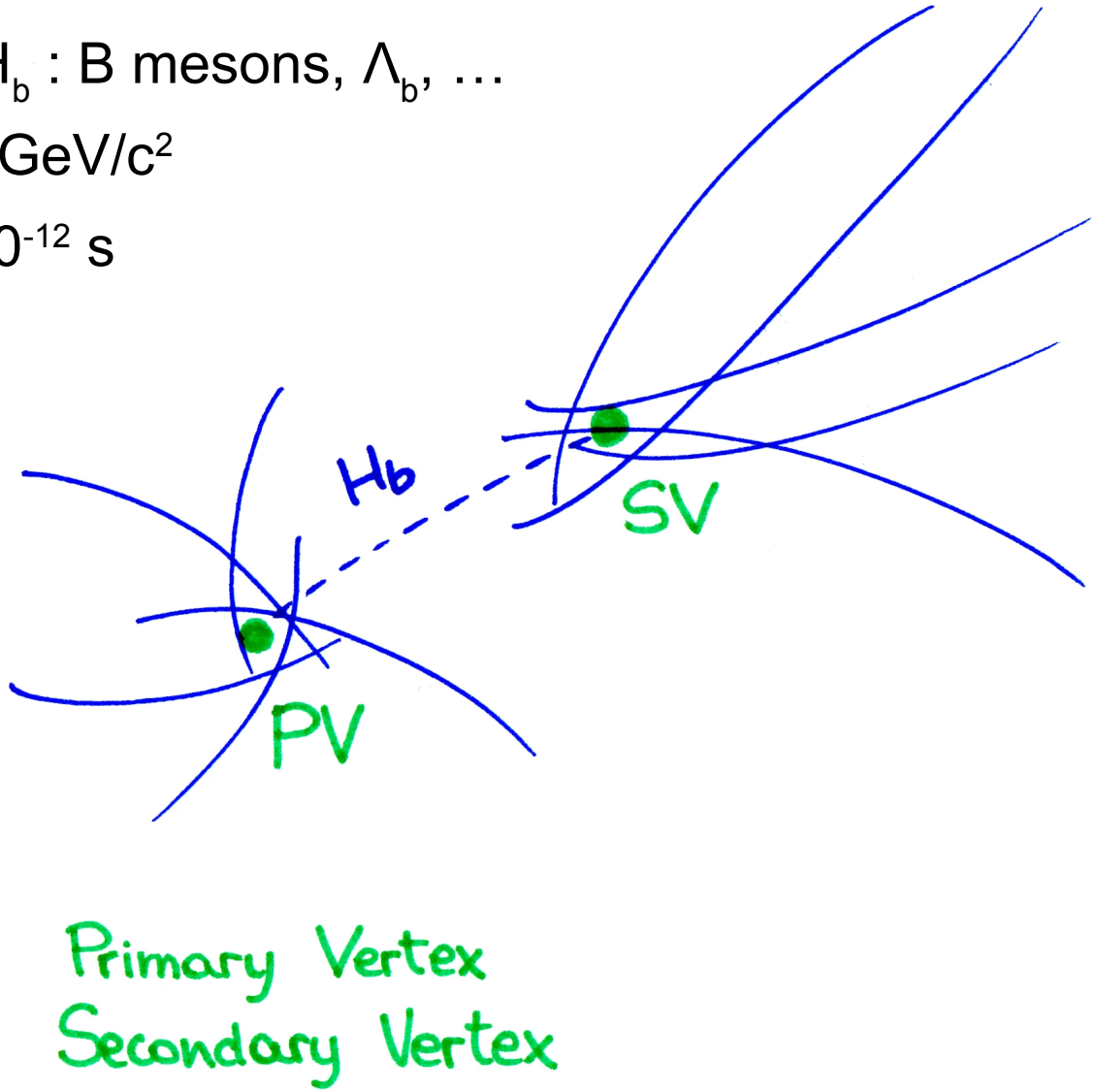
Decays of beauty hadrons

- Beauty hadrons H_b : B mesons, Λ_b, …
- Mass (H_b) > 5.27 GeV/c^2
- Lifetime ~ 1.5 x 10^{-12} s
  c tau ~ 500 μm



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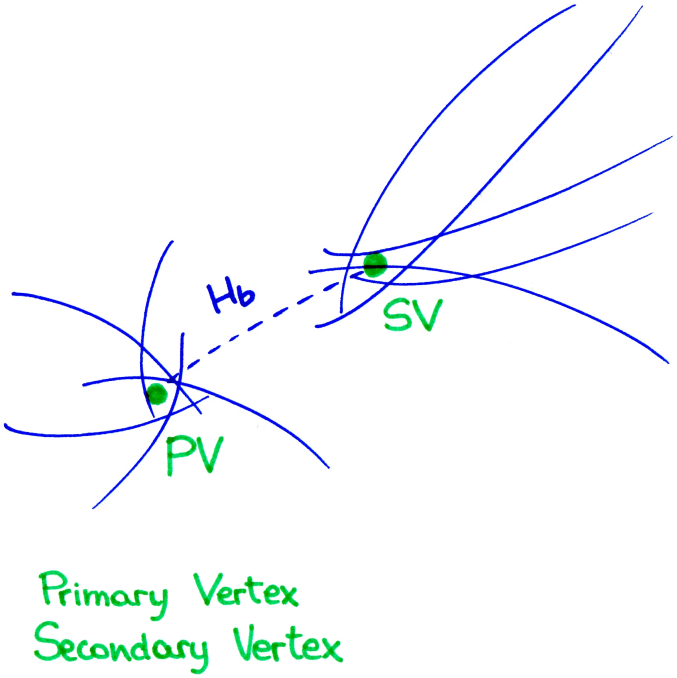

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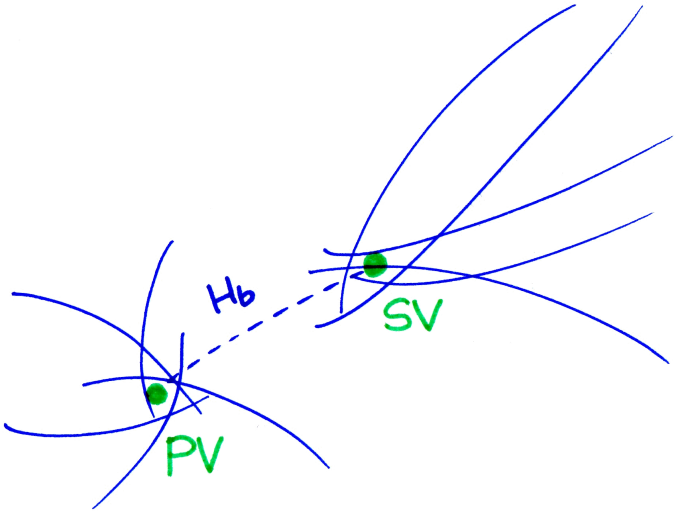

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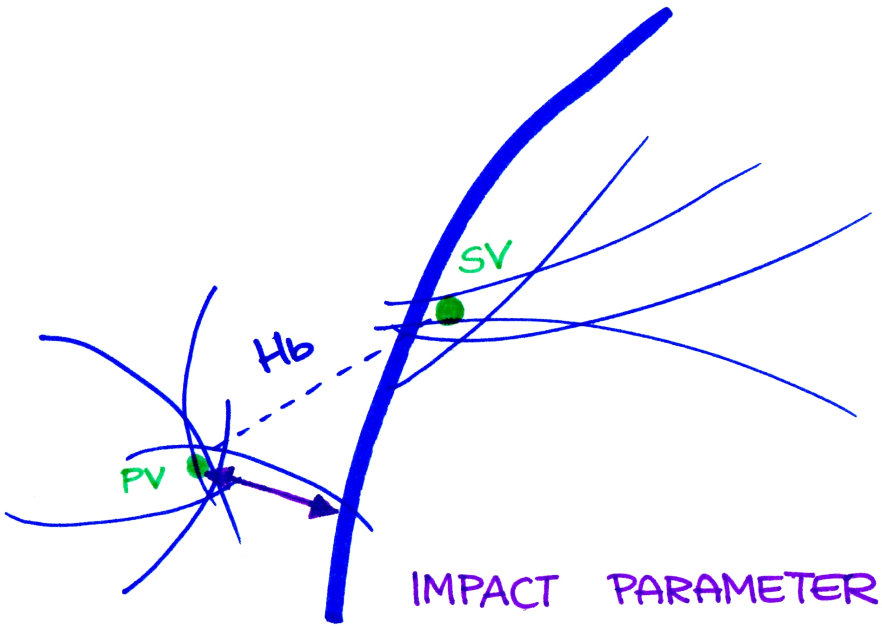

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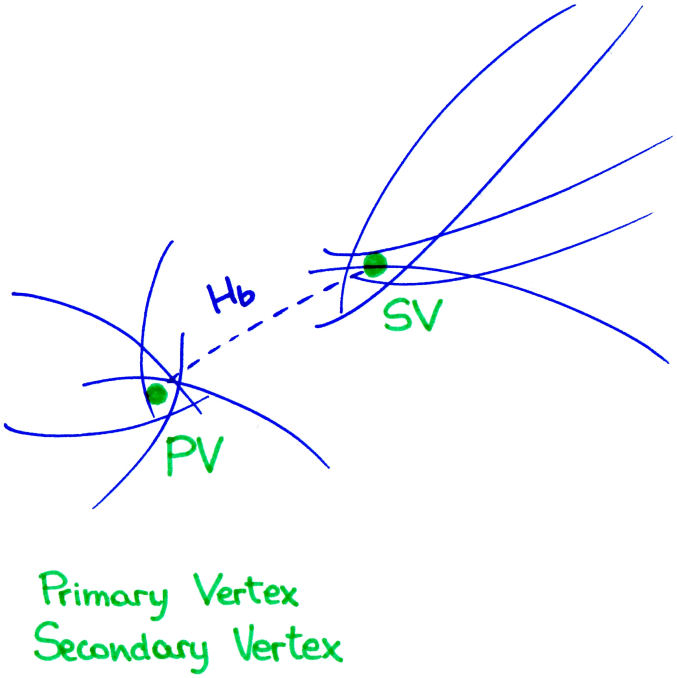

Relatively large number of decay daughters

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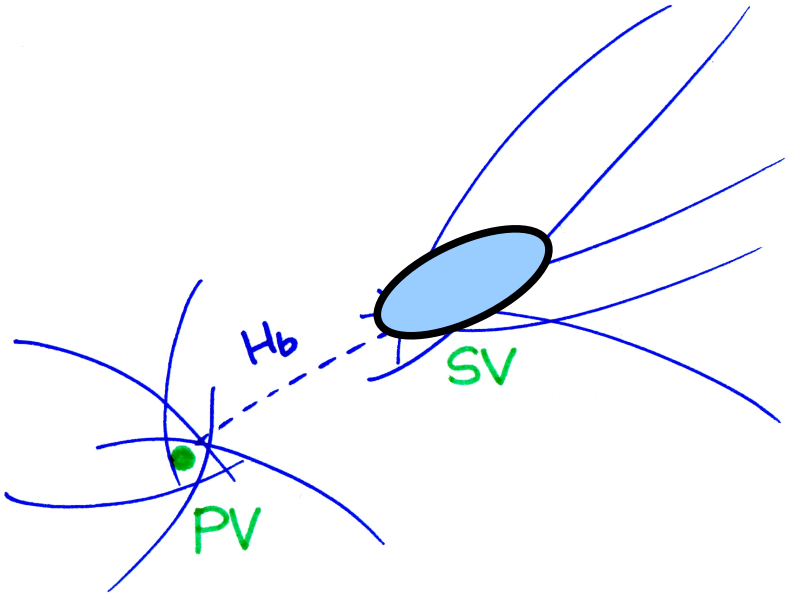
(Partial) secondary vertex: large mass!!

The idea - 1

Study beauty production via (partially) reconstructed secondary vertices

Partially = several daughters are not measurable (acceptance, low momentum tracks, neutrinos if semileptonic)



Statistical analysis using the following criteria:

- Impact parameter of some daughter
- Decay length
- Number of secondary prongs assigned to secondary vertex
- Mass calculated at the secondary vertex

The idea - 2

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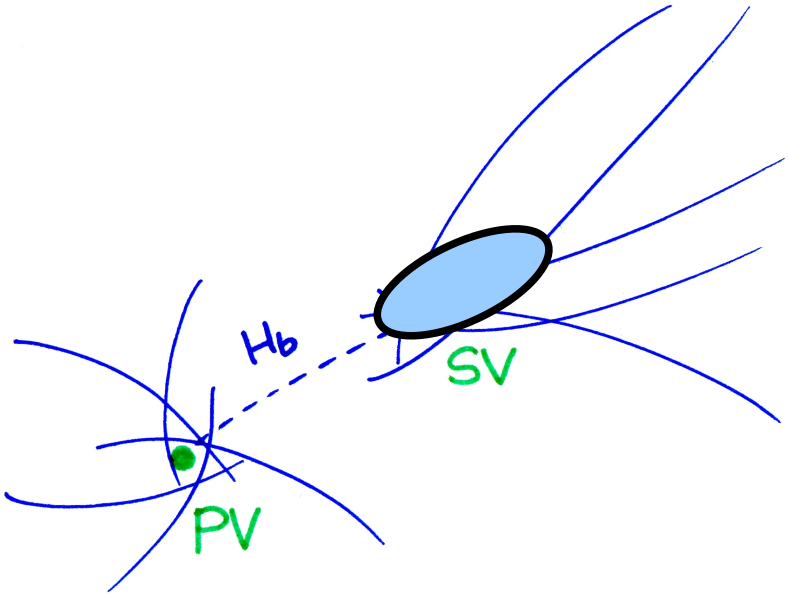


Specific goal in scope here:

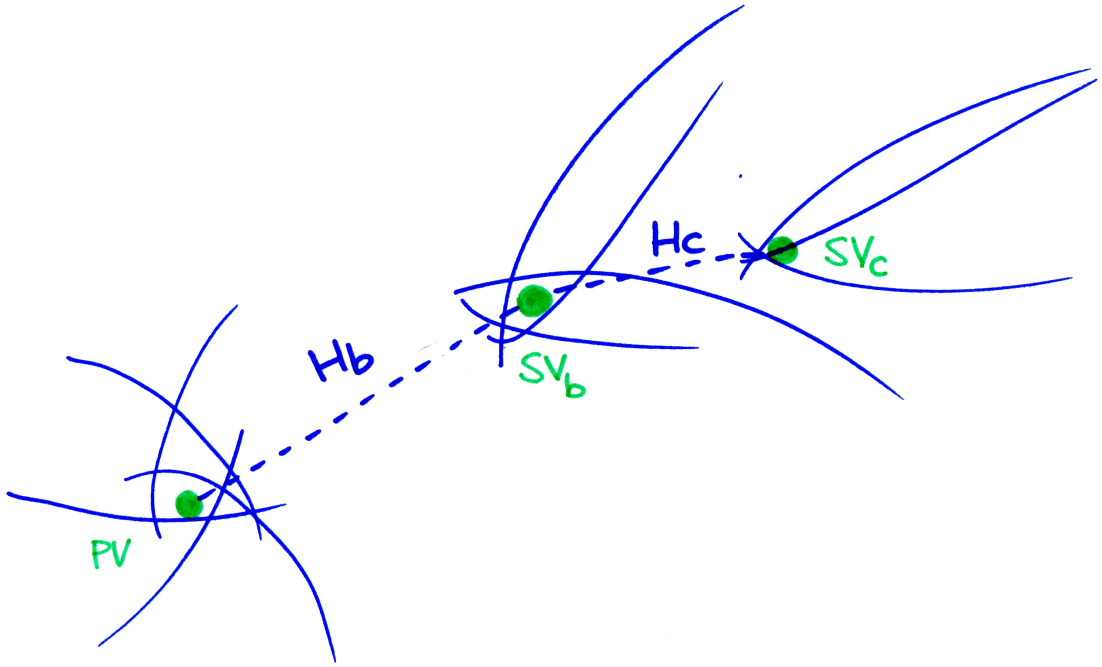
Current beauty based on the impact parameter analysis + cocktail subtraction "including" charm from D's

→ limited at low p_T and in precision !!!

Develop a new strategy to eliminate the charm background

“Generic” secondary vertex

- In most of the cases: $H_b \rightarrow H_c + X$
- The secondary vertex can very well include daughters from the decay of the charm hadron



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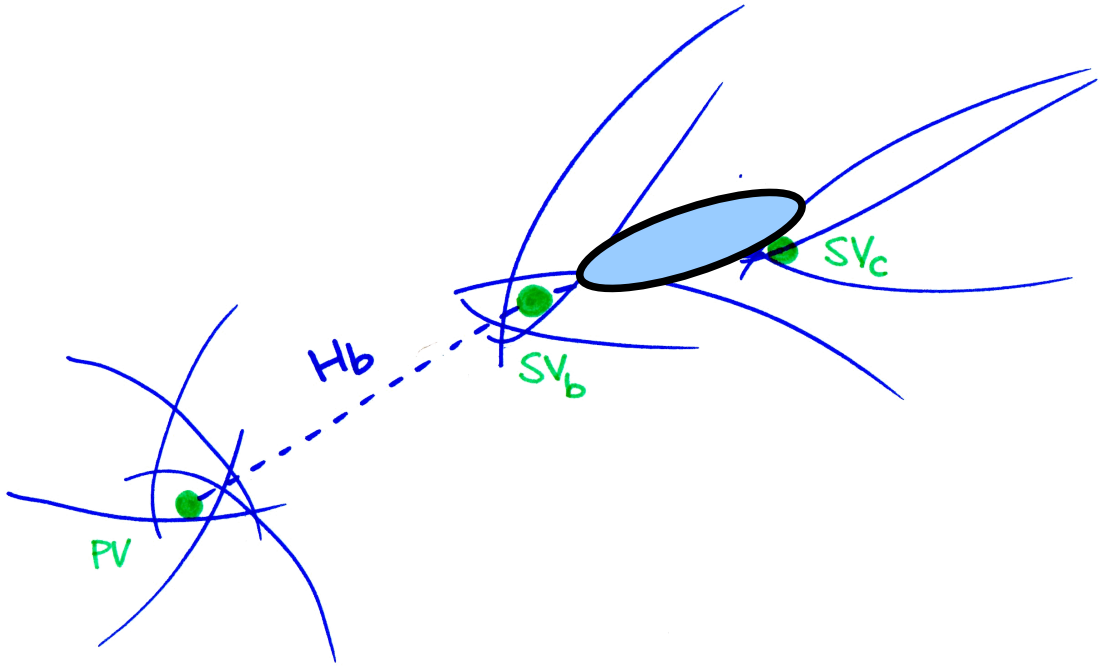
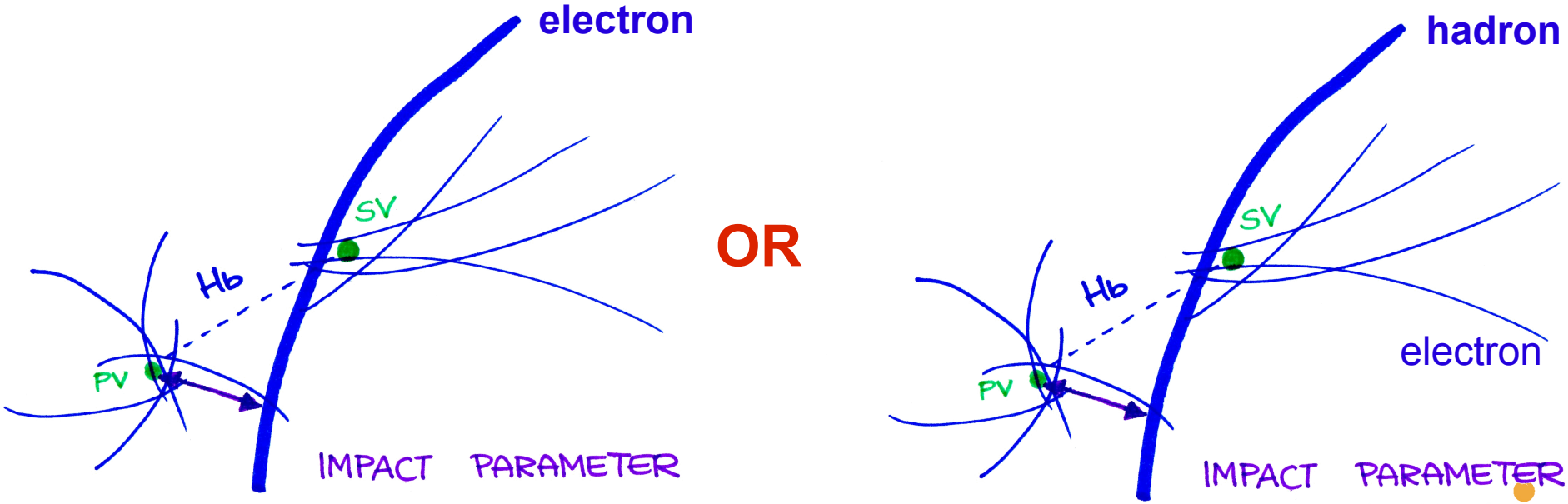


- Special attention is needed in the method to calculate efficiencies!
- Possible also to reconstruct BOTH (beauty and charm) decay vertices → this will be investigated in a second time

Semi-electronic decays

- Special role of the electron, much more rare than all hadrons
- ~10% BR (Hb → e+X) **PLUS** ~10% BR (Hc → e+Y)
  electrons from both decays can be “used”

- Require an electron
- Impose a minimum impact parameter cut, for the electron **OR** another track!!!



Bachelor thesis: Sebastian Hornung (Hd)

University of Heidelberg, Physics Institute, bachelor thesis, October 2014

"New criteria for distinguishing hadrons containing beauty from hadrons with charm in proton-proton collisions with $\sqrt{s}$ = 7 TeV at ALICE"

Feasibility study:

- pp 7 TeV MC: Pythia LHC10f6a minimum bias sample
- All decays considered (purely hadronic and semi-leptonic): no special role of the electron in the feasibility study
- MC true information used to a large extent:
  - Selection of daughters of the heavy-flavor decay chain
  - MC parameters used to assess if the particle is measurable
  - Particle identity (mass) taken from MC
  - No topological work on the track selection for the secondary vertex
- No p_T (H_b) dependence studied so far

Feasibility study: number of prongs

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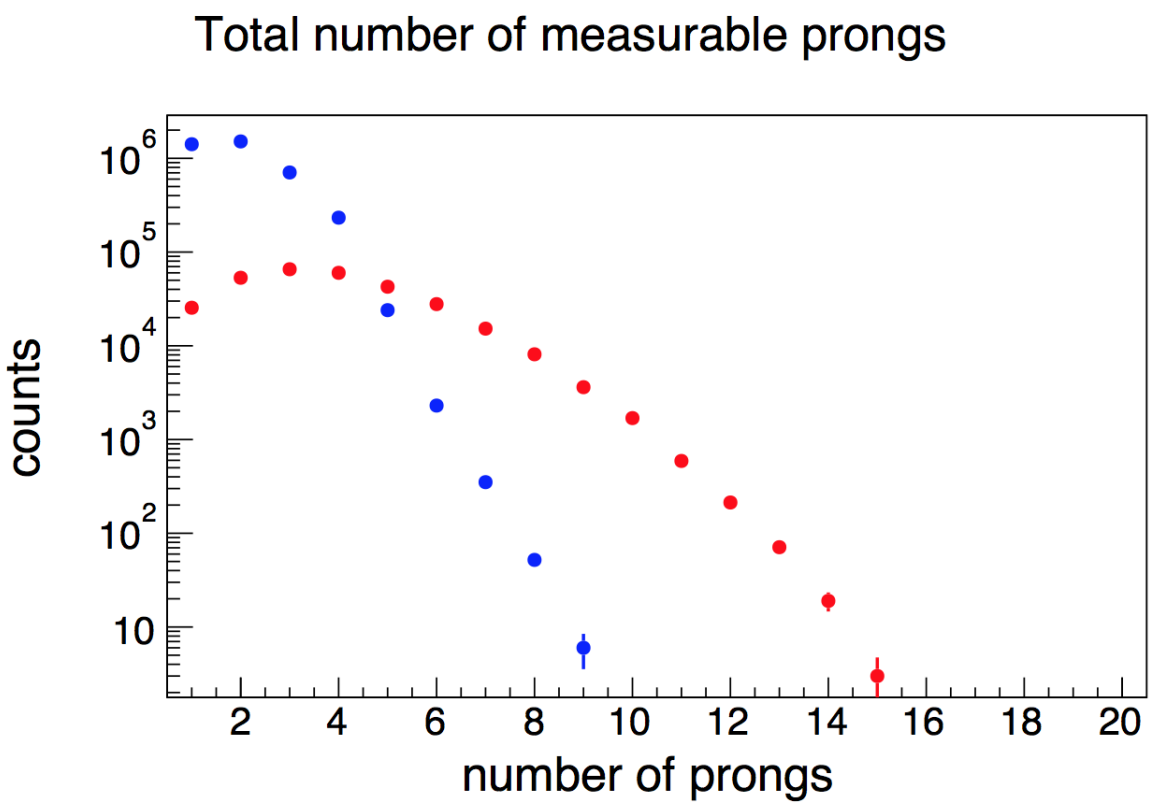

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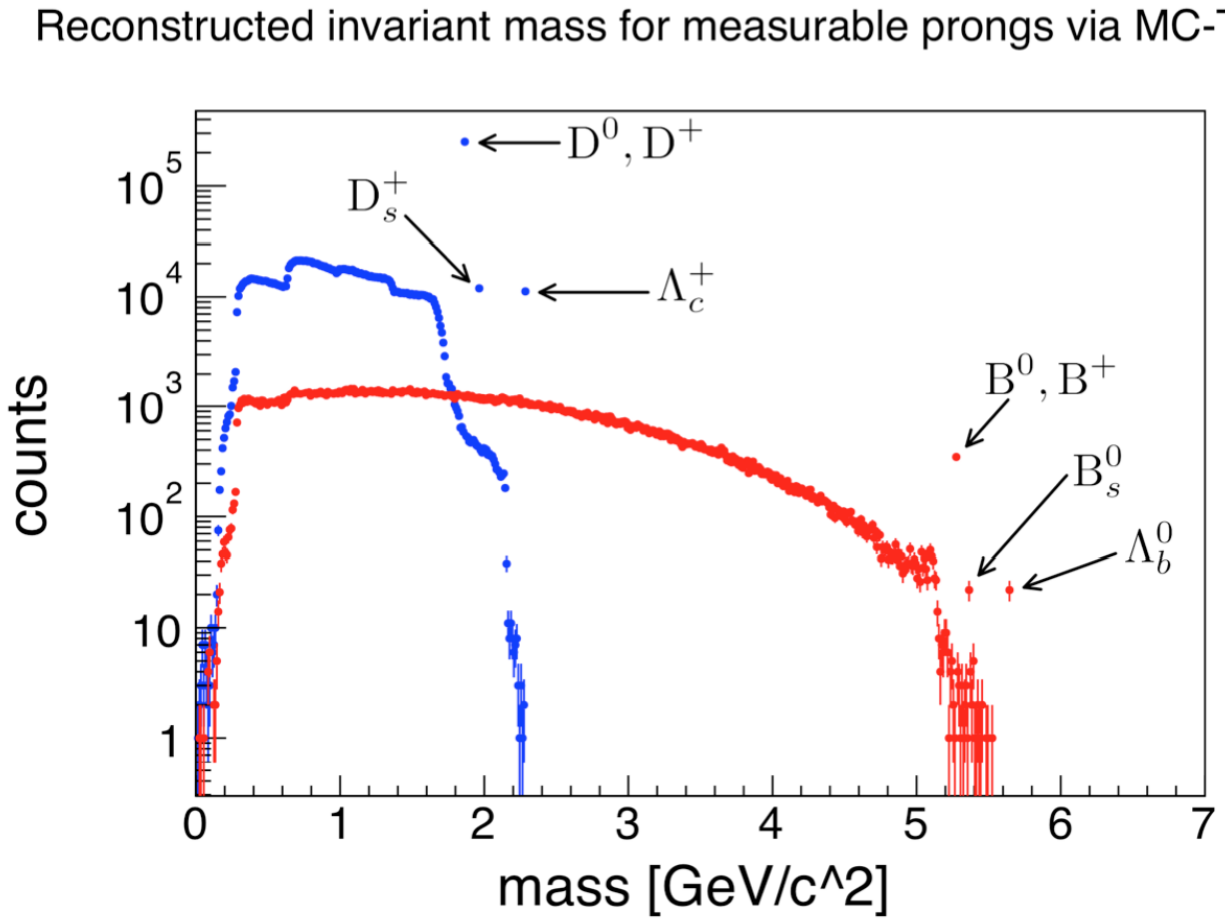
Feasibility study: reconstructed mass



Charm
Beauty

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- Above charm mass, about 14% beauty efficiency, with full purity (no contamination from charm decays)

Status and plans

- First attempt to develop an algorithm for data, starting from an electron with 4σ separation from the primary vertex, and at least one matching track → to be further developed

- New PhD student starting soon (1 week!!) can develop these ideas starting from pp collisions (Run1 data):
  - Develop the algorithm for the secondary vertexing
  - Study potential of the method versus pT
  - Aim at beauty cross section (full analysis)

  → prepare for Run2

  → consider p-Pb …

Tools and organization

KF vertexing package

- Fundamental tool to realize this analysis: KF vertexing package
- New version being (successfully) tested: Lukas Layer (bachelor, Hd)
- Possible further developments:
  - Heavy-flavor hadron decays including V0s
  - Detailed beauty feed-down studies
  - Rework of the primary vertex (remove secondary tracks). Correlated second heavy-flavor decay?
  - Systematics of secondary vertex ≠ systematics of N tracks !!!

Practical organization

- Certainly points in common with D2H and HFCJ
- Close contact will be kept in all cases
- Proposal: start continuing work in HFE, and reconsider as soon as new “team” is well established