SL recoil analyses and Bwd-EMC as a veto device

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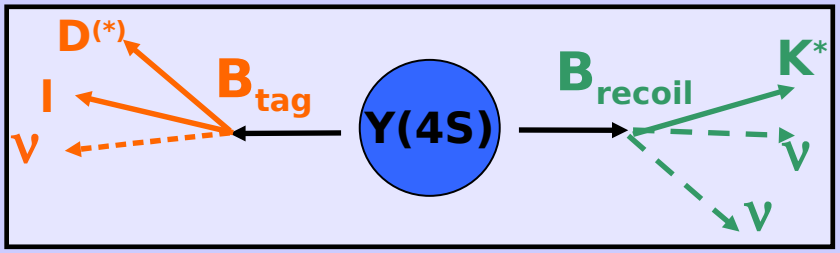
Outline

- Semi-leptonic Breco in FastSim (PacSemiLepRecoilUser)
- Bwd-EMC as a veto device
- Summary and outlook

Semileptonic Breco reconstruction philosophy

- Search for $B \to D^{(*)} l \nu$



- Reconstruction steps:
  - Reconstruct $D^{(*)} \to$ hadrons

$D^{*+} \to D^0 \pi^+$

~~$D^{*0} \to D^0 \pi^0$~~

$D^{*0} \to D^0 \gamma$

$D^0 \to K^- \pi^+$

$D^0 \to K^- \pi^+ \pi^0 (\gamma\gamma)$

$D^0 \to K^- \pi^+ \pi^+ \pi^-$

$D^0 \to K^0_S \pi^+ \pi^-$

$D^+ \to K^- \pi^+ \pi^-$

$D^+ \to K^- \pi^+ \pi^- \pi^0$

$D^+ \to K^0_S \pi^+$

$D^+ \to K^0_S \pi^+ \pi^- \pi^+$

$D^+ \to K^0_S \pi^+ \pi^0$

  - Use $D^{(*)}$ and add lepton ($e^{\pm}$,$\mu^{\pm}$) to form a $D^{(*)}l$ candidate

- Sample of 14 decay modes (charged + neutrals)
- Kinematics is unconstrained due to neutrinos
- Relatively high reconstruction efficiency ~2%

Semileptonic Breco in FastSim (I)

- **Semileptonic reconstruction implemented in FastSim V0.1.3: PacSemiLepRecoilUser**
- **Package based on BaBar BtauNuSemiLepUser code**
- **PacSemiLepRecoilUser contains:**
  - main analysis tcl to run executable
  - tcl for Dl reconstruction (BtoDlnuSequence_KplusNuNu.tcl)
  - tcl for tag-side reconstruction refinements
    (PslTagBReconstruction_Kpnunu.tcl, PslTagBSelection_Kpnunu.tcl)
  - tcl for PID lists: - for K, π, μ use tablebased selectors (BaBar run6-r24c PID tables)
    - for e use NoDeDxFirstElectronSelection (E/p cut based)
  - tcl and .cc/.hh for signal reconstruction and selection:
    $B \to K^+ \nu\nu$, $K^0_S \nu\nu$, $K^* \nu\nu$, $\tau\nu$ (one-prong) are now available
  - tcl for BtaTupleMaker settings
  - README
- **Package status:**
  - Fixed bugs memory leaks that prevented to be in Sep and Nov test productions
  - Need to implement validation code and to write documentation (README)

Semileptonic Breco in FastSim (II)

- **Latest code improvements:**
  - **Several decay channels can be now reconstructed and stored in same n-tuple:**

    $B \to K^+\nu\nu$, $K^0_S\nu\nu$, $K^*\nu\nu$, $\tau(\to e\nu\nu, \mu\nu\nu, \pi\nu)\nu$

  - **Added UsrData variable YsigBIsRecod which tells the reconstructed mode**

YsigBIsRecod = -1 ⇒ no signal candidate

0 ⇒ debugging

1,2,3,4,5 ⇒ τ modes ($\tau \to e\nu\nu, \mu\nu\nu, \pi\nu, \rho\nu, a_1\nu$)

6,7,8 ⇒ $K^{*+}\nu\nu$ modes ($K^{*+} \to K^0_S(\to\pi^+\pi^-)\pi^+, K^0_S(\to\pi^0\pi^0)\pi^+, K^+\pi^0$)

9,10,11 ⇒ $K^{*0}\nu\nu$ modes ($K^{*0} \to K^+\pi^-, K^0_S(\to\pi^+\pi^-)\pi^0, K^0_S(\to\pi^0\pi^0)\pi^0$)

12,13,14 ⇒ $K\nu\nu$ modes ($K^+\nu\nu, K^0_S(\to\pi^+\pi^-)\nu\nu, K^0_S(\to\pi^0\pi^0)\nu\nu$)

  - **Added UsrData variable YsigBMatchedTauMode with truth decay mode (similar values as YsigBIsRecod)**
  - **Added UsrData variable YSigBTruthMatchUp with different truth-matching levels. Useful for studying reconstruction effects (fake tracks and neutrals, SxF, ...)**

YsigBTruthMatchUp = 1 ⇒ Brec daughters do match MC-truth

2 ⇒ Brec daughters come from same true B

3 ⇒ rec and true decay modes match

4 ⇒ strict truth-match

Similar IsRecod and TruthMatch variables are defined for the tag-side

Bwd-EMC as a veto device (I)

- **Quite difficult to reconstruct π^0s with at least one photon from Bwd-EMC**

  (see Chih-hsiang talk at Frascati SuperB workshop, Dec 2009)
- **Previously:**
  - used Bwd-EMC as an extension of Barrel-Fwd-EMC, i.e. used neutrals from Bwd-EMC to reconstruct B_{tag} and B_{sig} candidates.
  - Obtained increase in signal efficiencies by adding badly reconstructed π^0s, and background efficiencies increased accordingly
- **Decided to use Bwd-EMC as a veto device. Define veto as follows:**
  - Do not used neutrals from Bwd-EMC to reconstruct B_{tag} and B_{sig} candidates.
  - Define to types of E_{extra} variables
    - E_{extra}(Barrel-Fwd) = Σ(extra neutrals on Barrel-Fwd EMC)
    - E_{extra}(Bwd) = Σ(extra neutrals on Bwd EMC)
  - Can used E_{extra}(Bwd) to cut on and E_{extra}(Barrel-Fwd) to perform a fit
  - Currently E_{extra}(Barrel-Fwd) use photons with E_{min} > 50MeV
  - Need to define a E_{min} cut (currently 30MeV) for Bwd-EMC photons (expected to depend on machine background), as well as a cut on E_{extra}(Bwd) (expected to be analysis dependent)
- **Question: how non-recoil analysis with neutral in the final state (e.g. $B^+ \to \pi^+\pi^0$) should use neutrals from Bwd-EMC?**

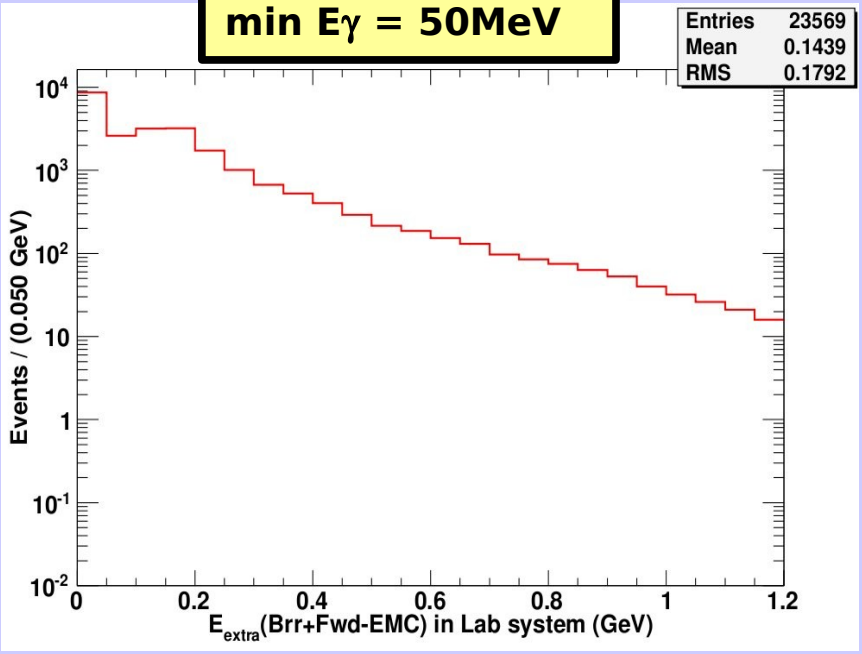
Bwd-EMC as a veto device (II)

- **Separating E_{extra} on Barrel-Fwd and Bwd has several advantages:**
  - If E_{extra}(Bwd) is not used on analysis is equivalent to not include Bwd-EMC ⇒ can test two detectors configurations at the same time: Bwd-EMC in/out!
  - Above statement is not completely true (but almost)
    - → Muon selectors performances should be modified due to additional material before Bwd-IFR. Currently not an issue as muon selector is implement as a TableBasedSelector.
    - → E/p cut based electron selector currently includes information from Bwd-EMC. It is only optimized for Barrel-Fwd, need to run a different optimization for the Bwd. Can the EMC people compare the selector performances for the Barrel-Fwd and Bwd?
    - → If the performances of electron selector are not good enough, can exclude from the selection electrons hitting the Bwd-EMC.
- **Vetoing by cutting on E_{extra}(Bwd)**
  - Need to understand machine backgrounds. How good is the machine background simulation in FastSim?
  - Veto is expected to be analysis dependent, as signal side can have different charged and neutral multiplicities. Plan just to define a cut which maximized significance.
- **Question: how advanced are the studies about Bwd-EMC timing for K/π separation?**

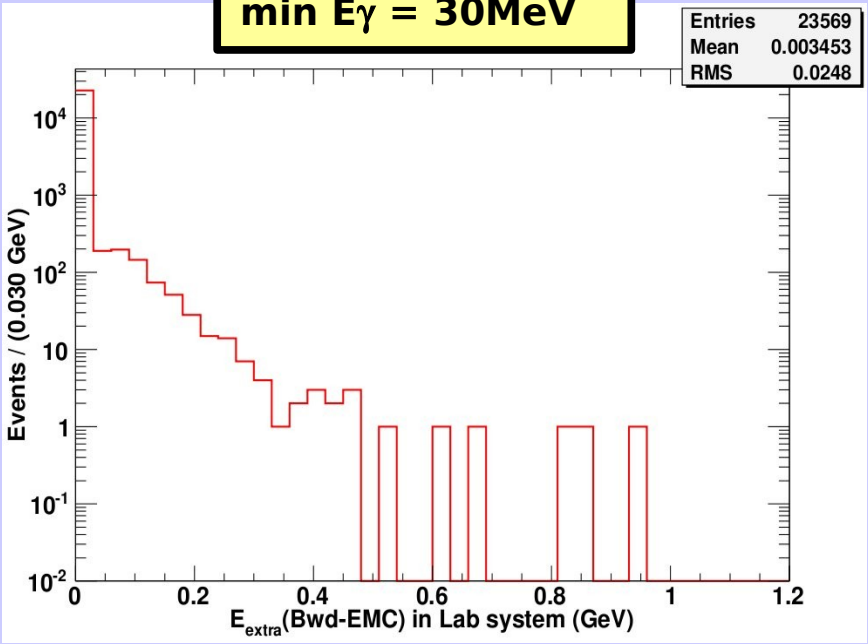
Bwd-EMC as a veto device (III)

- As an example generated a signal sample of $B^+ \to K^+ \nu\nu$

E_{extra}(Brr-Fwd)
min Eγ = 50MeV



E_{extra}(Bwd)
min Eγ = 30MeV



- Currently generating several modes ($B \to K^{(*)+/0} \nu\nu, \tau\nu$, double-SL (charged and neutral)) to perform signal efficiency and background rejection studies
- Expects to use February production to perform an extensive analysis of BB and qq backgrounds

Summary and outlook

- **PacSemiLepRecoilUser package is in V0.1.3**
- **The code has been debugged and cleaned from memory leak errors**
- **Several improvements have been performed:**
  - Several decay channels can be stored on the same n-tuple

  ⇒ Useful for performing background studies (e.g. BB and qq background)
  - Several levels of truth-matching implemented both on signal and tag sides

  ⇒ useful for studying reconstruction effects (fake tracks and neutrals, SxF,...)
- **It has been presented a proposition tu use the Bwd-EMC as a veto device.**

- **Still need to:**
  - test de code
  - finish to implement validation code inside PacQA
  - finish documentation inside README and FastSim web page

  (expects to finish by the beginning of next week)

- **The code is in a good shape for the February Production!**

Backup