Status of the Hadronic Recoil package
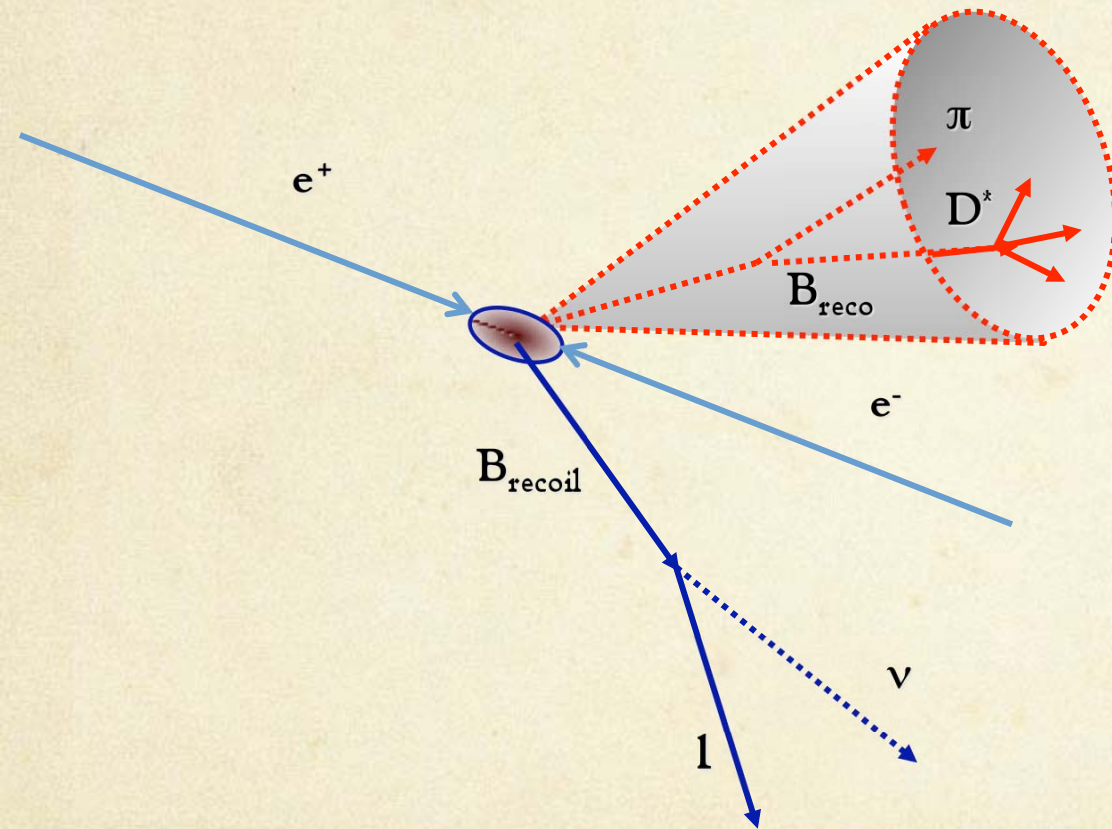
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Physics Tools Meeting, November 2nd 2011

Outline

- Hadronic B_{reco} analysis in a nutshell

- Hadronic B_{reco} in SuperB

- PacHadRecoilUser documentation

- To do list

- Conclusions

Hadronic recoil method in a nutshelll

e^+

π

D^*

B_{reco}

e^-

B_{recoil}

ν

l

○ Fully reconstruct one of the two Bs in hadronic modes...

○ ...and do it with "high" efficiency

○ The remaining of the event is the other B

○ Single B beam, search for rare B decays (i.e. invisible particles in the finale state)

n.b.: same applies to Semileptonic reconstruction in $B_{reco} \rightarrow D^{(*)} l\nu$ final states

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Hadronic Recoil method in SuperB

- Recoil method exploited at B-factories for many analysis requiring high statistic and clean samples

    - i.e. $B \to K^{(*)}\nu\nu$, $B \to l\nu$ (l= e,μ,τ), V_{ub} and V_{cb} measurements

- Some of the SuperB golden channels in the B sector, require the recoil technique

- `PacHadRecoilUser`: package , inherit from BaBar code, running in the SuperB FastSim framework

    - allow to study $B \to K^{(*)}\nu\nu$, $B \to \tau\nu$ in the Had recoil

    - code included in the past FastSim producition series

    - physics channels used in the DGWG studies to quantify impact of BWD EMC and FWD PID

    - `PacSemilepRecoilUser`: twin package for SL recoil analysis

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Documentation

○ `PacHadRecoilUser` code now documented in

http://mailman.fe.infn.it/superbwiki/index.php/FastSimDoc/Tutorial_PacHadRecoilUser

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2 Code Structure

3 N-tuple content

4 Variables used for DGWG studies

5 How to get the code

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7 Known problems

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Algorithm overview (I)

- Reconstruct $B_{reco} \to D^{(*)} n_1\pi\, n_2K\, n_3K_s\, n_4\pi^0$ with $n_1 + n_2 < 6$, $n_3 < 3$, and $n_4 < 3$
  - semi-exclusive reconstruction: don't mind about intermediate resonances of the hadronic final state
  - about 1000 B final states reconstructed (typical reconstruction efficiency for neat +clean+dirty modes : $O(10^{-3})$)
  - most discriminant variables from B_{reco} (closed) kinematics

$$\Delta E = E_{beam} - E_{B_{reco}}$$

$$m_{ES} = \sqrt{E_{beam}^2 - p_{B_{reco}}^2}$$

° data
c$\underline{c}$
uds
B$^+$B$^-$
B$^0\underline{B}^0$

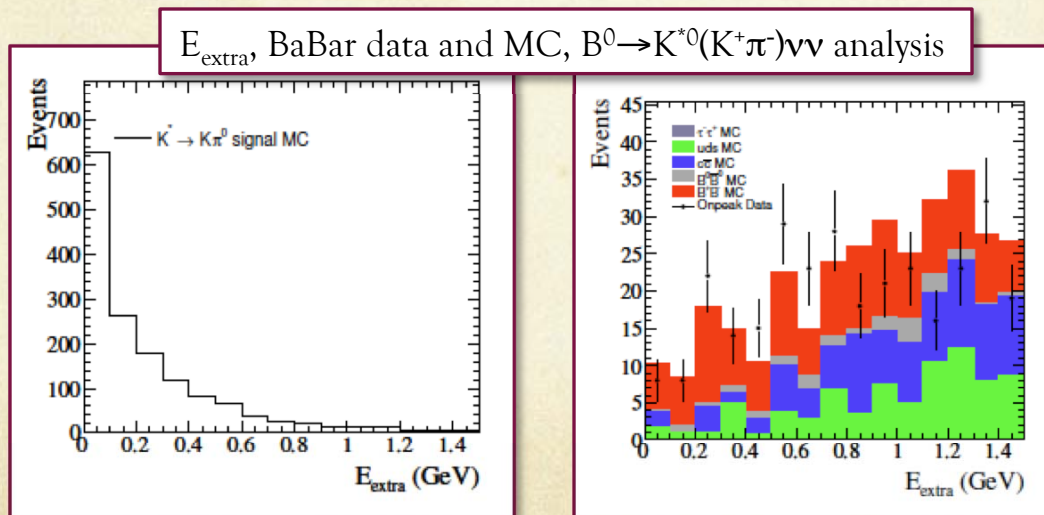m_{ES} for reconstrcted B^0_{reco}, BaBar data
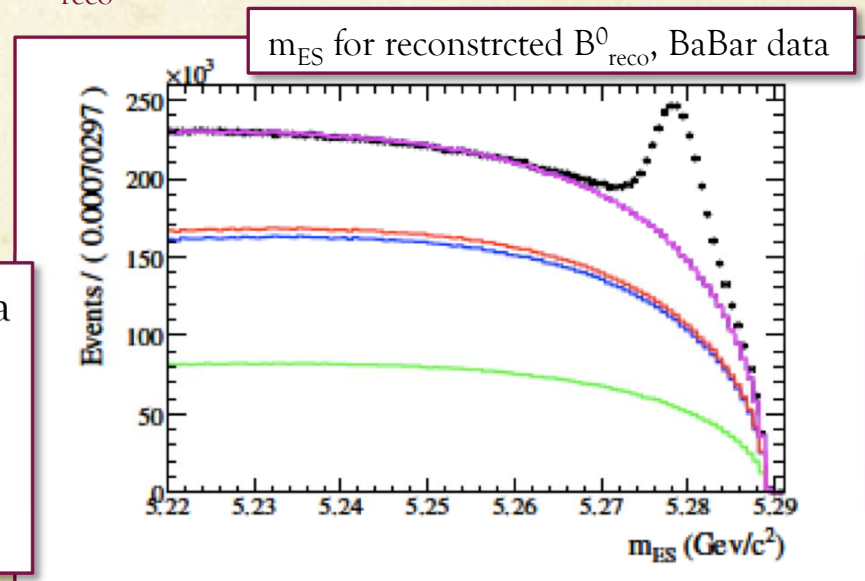
Algorithm overview (II)

- Search for the signal signature in the rest of the events

  - veto on extra-tracks

  - use extra-neutral to discriminate between signal and background

  - B_{sig} final states implemented so far:

    $B^+ \rightarrow K^+ \nu\nu$, $B^0 \rightarrow K_S \nu\nu$, $B^+ \rightarrow K^{*+}(K_S\pi^+, K^+\pi^0)\nu\nu$, $B^0 \rightarrow K^{*0}(K^+\pi^-)\nu\nu$

    $B^+ \rightarrow \tau^+(e^+\nu,\mu^+\nu,\rho^+\nu,a_1\nu,\pi\nu)\nu$, $B^+ \rightarrow e^+\nu$, $B^+ \rightarrow \mu^+\nu$

E_{extra}, BaBar data and MC, $B^0 \rightarrow K^{*0}(K^+\pi^-)\nu\nu$ analysis

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Code structure

○ Package hosted in the FastSim `User` repository and inspired to BaBar `BTauNuSemiExclUser` package

○ B_{reco} reconstruction

    ○ inspired to BaBar `BSemiExcl` skim

    ○ main tcl: `BSemiExclSequence.tcl`

    ○ define ad-hoc lists and sources `SimpleComposition`, `CompositionSequence` and `FilterTools` modules where the reconstruction is implemented

○ B_{sig} reconstruction

    ○ code contained in the package itself

    ○ tcl files for module configuration in `PacHadRecoilUser/ PsxAnalysis`

N-tuple content

- Managed by BtaTupleMaker

- Several particle blocks: Y, B, D, J/ψ, K_S, leptons, hadrons, gamma, MC info, ...

- Each block contains:

  and so on...

  - XMass[i] -> mass of the i-th X
  - Xp3[i] -> module of 3-momentum of the i-th X
  - Xp3CM[i] -> module of 3-momentum of the i-th X in the CM frame
  - Xd1Idx[i] -> index of the first daugther of the i-th X
  - Xd1Lund[i] -> LUND code of the first daugther of the i-th X
  - XMCIdx[i] -> if it is >= 0, a MC particle has been associated to X,

- UsrData variables implemented in the code (PacHadRecoilUser/ PsxAddUsrData*)
  - global event vars, B_{sig} and B_{reco} -related information

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Variables used for DGWG studies

○ The code allow to evaluate the impact of the BWD EMC and the FWD PID at analysis level

○ Bwd EMC: used a veto device
- ○ variable that allow to remove candidates reconstructed in the BWD EMC (YSigB_IsBwdEMC)
- ○ extra neutral energy and missing momentum computed separately for barrel+FWD and BWD calorimeter

○ Fwd PID:
- ○ main impact on Kaons from B_{reco} and B_{sig} sides
- ○ ntuples contain info to switch on/off FWD PID device and the same set of data can be used to evaluate efficiencies and physics reach w/o FWD PID

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How to get the code

○ To run the code, after the release has been set-up, one has to:

  ○ download the package trunk version:

`SvnTools/addpkg -t User/PacHadRecoilUser`

  ○ download the PacProduction package trunk version

`SvnTools/addpkg -t Production/PacProduction`

  ○ make the libraries and the executable

`gmake clean`

`gmake lib`

`gmake PacProduction.bin`

○ to look at pieces of code out of **PacHadRecoilUser**, one should download the related packages (see ReleaseFiles/Packages or ReleaseFiles/Patches_devel to find the repository):

`SvnTools/addpkg -t REPOSITORY/PACKAGENAME`

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How to run the code

○ The code is run through the `PacProduction` executable

○ A configuration file with the following params* should be set

```
#!/bin/csh -f
#
setenv RUNNUM 1010100
setenv DG DG_4
setenv NEVENTS 1000
setenv PRODSERIES 2010_September/
setenv GENERATOR B0B0bar_Kstar0nunu_Kpi
setenv SBDATA ./PacProd/
setenv PRODROOT ./PacProd/
setenv PRODSCRIPT BtoKstarNuNu
setenv BKGROOT /storage/gpfs_superb/prod/2010_july_bkg/
PacProductionApp ../PacProduction/MixSuperbBkg_NoPair.tcl
```

○ This will produce 10000 $B^0 \rightarrow K^{*0}(K^+\pi^-)\nu\nu$ MonteCarlo events using the DG_4 detector configuration and superimposing physics events to machine background (without pair production)

* see http://mailman.fe.infn.it/superbwiki/index.php/FastSimDoc/Production

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To do list and known problems

- To do list
  - refine documentation page
  - code clean-up: remove parts inherited from BaBar and inessential to SuperB purposes
  - code for validation: code to make histograms and efficiency computation to validate FastSim releases and pre-production cycles; part of the code already exists, needs to be refined
  - study Breco properties: changes wrt BaBar algorithm are needed?

- Known problems
  - no known problems up to now, once the code for validation will be finalized, SuperB FastSim and BaBar FullSim comparison will be performed

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Summary

- Hadronic recoil method largely used at B-factory and part of the SuperB physics program

- Algorithm implemented in `PacHadRecoilUser` package running in SuperB FastSim

- $B \rightarrow K^{(*)} \nu\nu$ and $B \rightarrow \tau\nu$ against HAD (and SL) recoil incorporated in previous FastSim production cycles and used for DGWG studies

- New `PacHadRecoilUser` documentation page

  http://mailman.fe.infn.it/superbwiki/index.php/FastSimDoc/Tutorial_PacHadRecoilUser

- Items with higher priority in the to do list: code clean-up and refinement up of validation tools

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