# A Babar Toolkit for Exploring b->sl+l- Sensitivities at SuperB

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# Motivation

- Preparation for TDR, physics book
  - Set benchmarks for full/fast sim SuperB studies
  - Explore BSM sensitivity of new observables and identify best opportunities to compete or complement other experiments

- Unique final states
  - electron(s)
  - inclusive decays

- Unique environment
  - Comparatively low backgrounds
  - Flavor + kinematic tag B reconstruction

# Assumptions

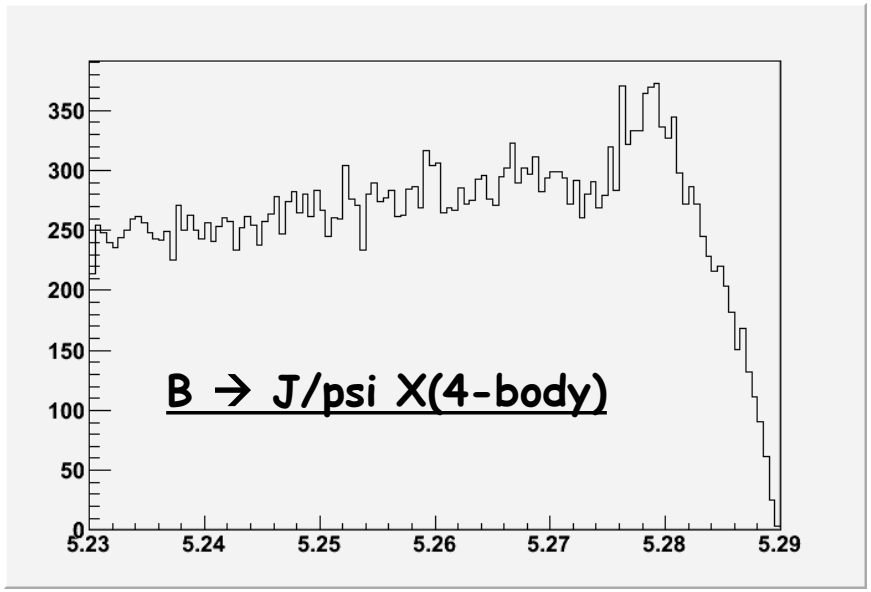
- Physics event generators
  - EvtGen (but no updates for a few years)
  - "latest" b->sll rate vs q2 from E. Lunghi (et al.)
    - used to reweight current generator (weights = 1 +/- few %)
- PEP-II, Babar detector, reconstruction
  - Babar detector model (GEANT 3)
  - R24 Babar event reconstruction
  - SuperB systematics may vary from Babar
    - Qualitatively similar, perhaps quantitatively different
    - **Machine backgrounds completely unknown (to me at least)**
- Physics Backgrounds
  - Semileptonic B decays **(presumably well modeled for SuperB)**
  - Contributions from double muon mis-ids expected to be small at SuperB and are ignored here
    - Can be estimated later from SuperB full sim if pertinent

# Datasets

- Signal models extracted from
  - Exclusive, inclusive J/psi and psi2s
  - Babar sll MC efficiencies
- Background models extracted from
  - Babar sll data in mES sideband
  - Babar Xemu data
    - crucial for angular analyses, much better than MC
- "Peaking" Physics backgrounds
  - Negligible at Babar, ignored here
- If there are SuperB models available that can be "ntuplized", these can be added at any time

# Fit Building Blocks: Kinematic Quantities

- Charmonium data provide high-statistics signal models for kinematic quantities uncorrelated with q2
  - mES, deltaE, K resonances masses, all sll final states
- Trivial variations expected between Babar/SuperB
  - Needs to be verified with full sim

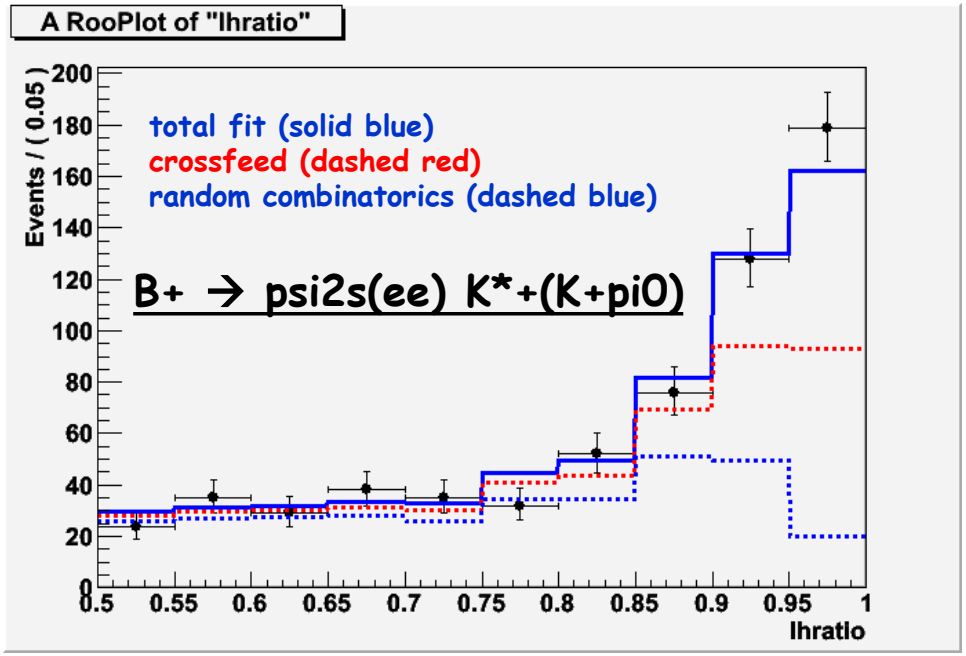



$$m_{ES} = \sqrt{\frac{s}{2} + \frac{(\mathbf{p}_0 \cdot \mathbf{p}_B)^2}{E_0^2} - \mathbf{p}_B^2}$$

- Modeling of crossfeed from other b->sll processes possibly different at SuperB
  - Differences in geometric and momentum acceptance of the detector can lead to differences in modeling of mis-reconstructed signal decays
- Perhaps also small changes due to updated generators

# Fit Building Blocks: Event Selection

- Exclusive and inclusive sll event selection at Babar is based on decision trees (BDTs) using 13-20 parameters
  - BDT response uncorrelated with any sll observables
  - Many BDTs trained and optimized in bins of
    - ee/mm/em, q2 bins, mass and multiplicity of recoiling X system




- Given the multiplicity of BDTs needed to select any particular dataset, they are used to construct a LH ratio which can be directly used in LH fits
- Reasonable expectation of as-good-as or better than Babar SuperB event selection
  - SuperB will certainly use similar MVA techniques, but made using the SuperB detector, machine and generator models

# Fit Building Blocks: Tagging

- Kinematic tagging as in K(*)nunubar, tau nu, etc. is done with semileptonic and/or fully reco'd tag B
  - Only meaningful physics background comes from semileptonic B decays, and a semileptonic tag should substantially reduce this background
  - Fully hadronic tag B final states much cleaner, but with less efficiency, than semileptonic tags
- Flavor tagging needed for
  - Inclusive angular analysis (+ kinematic tagging)
  - TDCPV analyses (e.g., B->KSpi0l+l-)
- Currently exploring new method(s) of tag reconstruction using ensembles of multivariate discriminants assembled as an Error Correcting Output Code (ECOC) incorporating information from tag and signal side
  - Work on this just starting ...

# Observables

- All observables measured
  - as a function of q2
- Split by
  - CP
  - lepton flavor
  - B charge

- Exclusive and inclusive versions of most observables

- Too much! Need to understand and identify what
  - is unique to SuperB,
  - has greatest possible BSM physics impact, and
  - has dependencies common with others (e.g., tagging).
  - This is a topic I'd like to follow up on in discussion

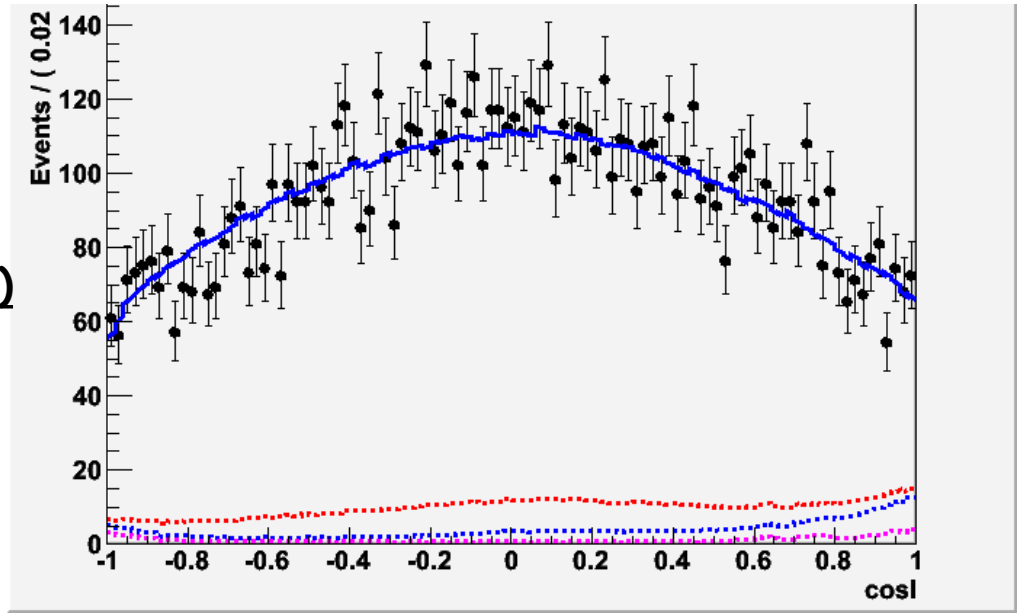
# An example: AFB in J/psi K* decays

- Just a demonstration of what one can do with toolkit
- Control fit for AFB in J/psi
- Simultaneous fit over six K* modes (excludes KSpi0)

| | J/psi K* |
|---|---|
| FL K*0 | 0.559 +/- 0.006 |
| FL K*+ | 0.528 +/- 0.009 |
| AFB | 0.000 +/- 0.006 |

**Fit Projection on J/psi(mm) K*0(K+pi-)**

total pdf (solid blue)
crossfeed (dashed red)
random combinatorics (dashed blue)
hadronic mis-id bkgd (dashed magenta)



# Conclusion

- Realistic optimized estimates of SuperB BSM reach for any SuperB integrated luminosity can be done within exisiting Babar analysis framework
  - Caveats: machine backgrounds, muon mis-id
- Can explore many observables, results of studies will provide focus and define precedence
- b->dll Babar analysis can be adapted in the near future
  - "Vtd/Vts" vs q2 from b→ (s/d)l+l-
- Other related non-sgamma radiative/EWK modes
  - B(s,d) → gamma gamma (very clean Vtd/Vts)
  - Y(5S) → phi l+ l- (angular analysis)
  - B → high mass K resonances l+l-