WGC Summary

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SuperB Physcs Workshop
Warwick
15 April 2009

Tools = Simulation

- SuperB ≠ BaBar
  - smaller beampipe, beamspot, layer0 ⇒ better vertex resolution
  - smaller boost, Bwd Emc ⇒ better hermiticity
  - Fwd PID, focusing DIRC, Sci IFR ⇒ better PID
- Reliable simulation needed for
  - Benchmark channel sensitivity (expt. error)
  - Detector optimization (relative changes)

SuperB Simulation tools

- Full Simulation (G4)
  - No digitization, reconstruction, or analysis interface
- Fast Simulation
  - Parameterized material and detector response
  - Easy to modify and introduce new detectors
  - Compatible with BaBar analysis interface
  - Fast (~25 Hz)
- Physics Tools
  - tagging, BReco, PID selectors, vertexing
  - Some new ideas (2ndary vertexing, ...)

Fastsim Goals from Orsay

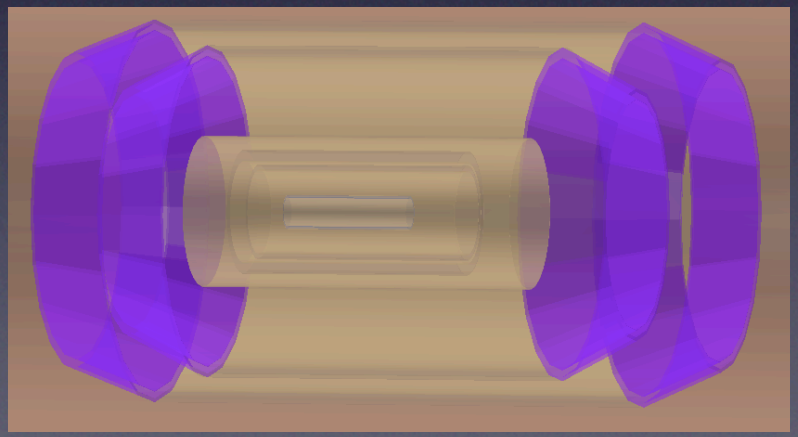
- Decays-in-detector
- Hadronic interaction daughter generation
- Cluster merging and splitting
- Hadronic showers tuning
- Add ‘time’ to PacSimHit (for TOF)
- Track hit confusion (pat. rec. simulation)
- background frame merging
- preliminary PID selectors
- **All achieved in release V0.0.3**

Ongoing Development

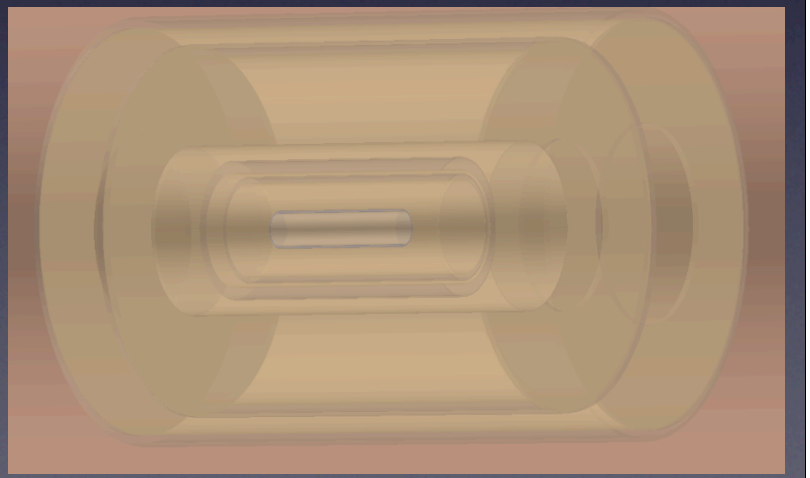
- Ifr response tuning
- N-agon geometry
- dE/dx simulation
- Trigger simulation
- Forward PID alternative measurements
- Physics tools
  - Realistic PID selectors
  - Tagging

SuperB SVT

- "Layer0" as described by G. Rizzo etal.
  - 1.5cm average radius, -3.5cm < Z < 9.5cm
  - 2x0.05 % (Si) + 0.35 % (CF) + 2x0.17% (Al + Kapton)
  - 10μm X 10μm resolution (+10% tails)
  - 95% efficiency, 1% overlap
- Outer layers an open question



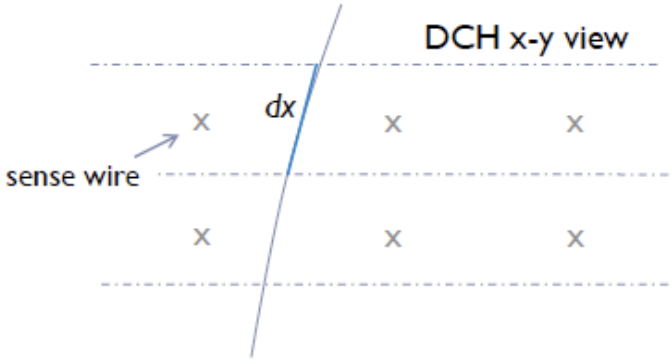
OR?



dE/dx of track hits

- Loop over the hits of the track, compute dE/dx for each hit and save it
  - PmcDeDx module (in PacMC/PmcDeDx.hh/cc):
    - loops over the 'measurement' PacSimHits of PacSimTrack
    - takes hit efficiency into account
    - computes the pathlength within each measurement layer (e.g., DCH cell) as a straight line
    - computes the mean <dE> and its fluctuation, saves dE/dx in the corresponding PacSimHit (dE/dx_i)
    - in current implementation PmcDeDx is called before PmcMergeHits and PmcReconstruct

$$-\frac{dE}{dx} = Kz^2\frac{Z}{A}\frac{1}{\beta^2}\left[\frac{1}{2}\ln\frac{2m_e c^2\beta^2\gamma^2 T_{\max}}{I^2} - \beta^2 - \frac{\delta(\beta\gamma)}{2}\right]$$



- In curren
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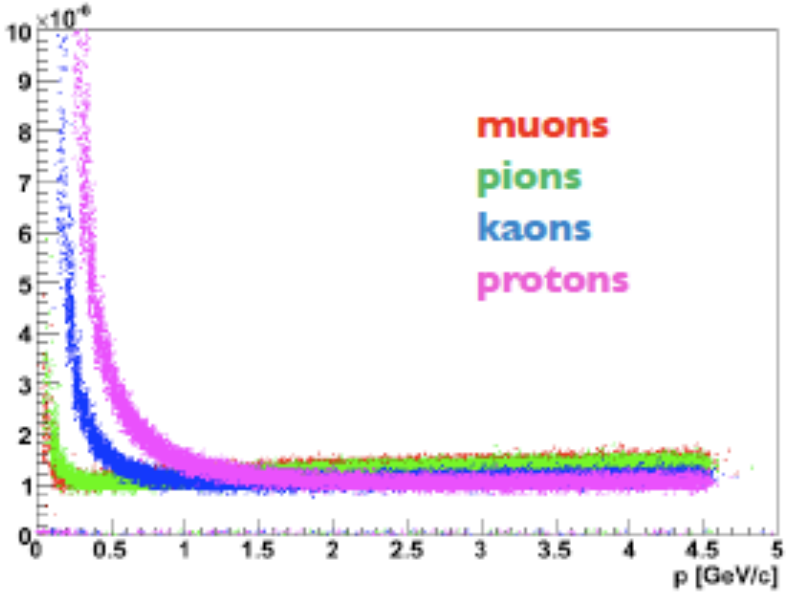
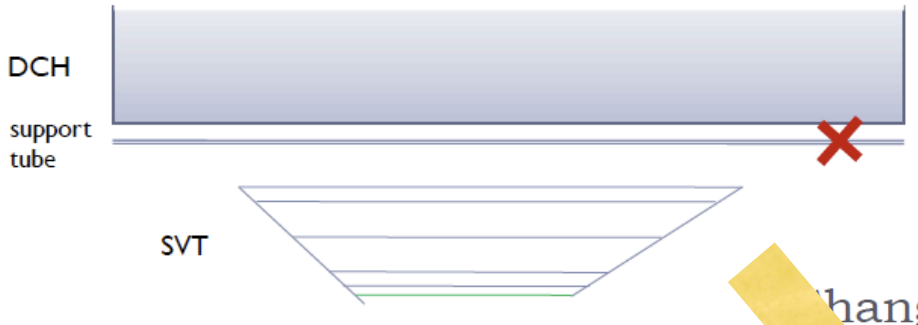
  - <dE_
    and p
  - dE_i
    whe
    para



Change of default DCH configuration

- Inner radius of BaBar DCH limited by the support tube (r = 21.7cm, carbon fiber, 0.79% X_0)
- No support tube in SuperB detector design: space can be used to match inner radius of DCH with outer radius of SVT



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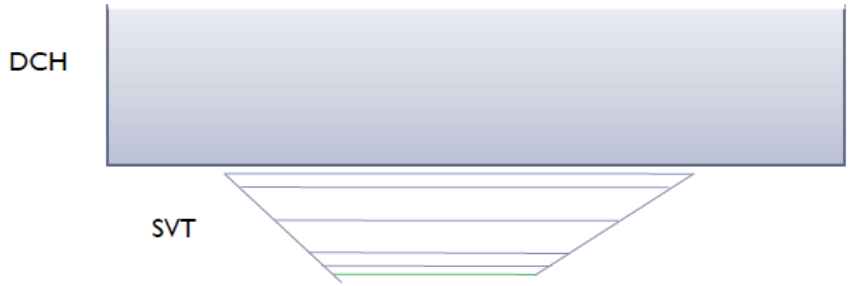
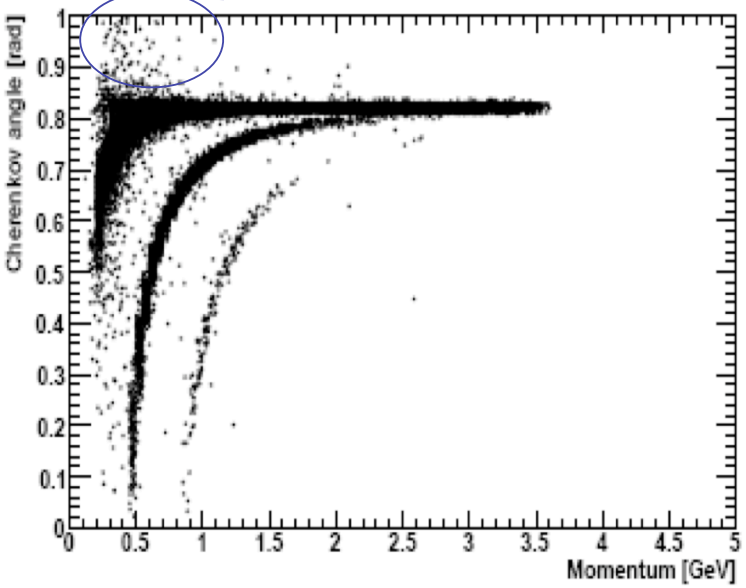
- radius of BaBar DCH limited by the support tube (r = 21.7cm, carbon fiber, 0.79%
- N tube in SuperB detector design: space can be used to match inner radius of DC uter radius of SVT
- perB.xmlV0.0.3 the support tube is removed but radii are BaBar-like. Plan to reduce inner radius of DCH and add wire layers (details to be defined in the DCH group). Scenario with larger SVT outer radius discussed in DGWG



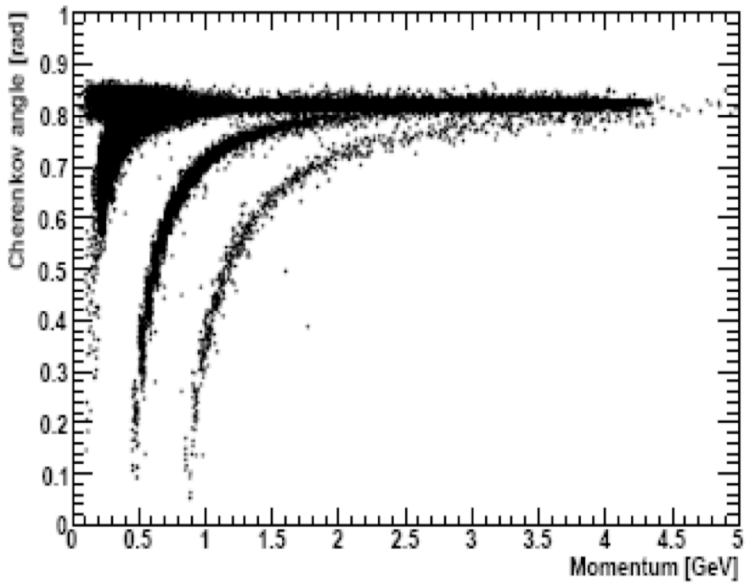
Comparison with Geant4 (Babar)

e^- – perhaps δ-rays

θ_c



θ_c

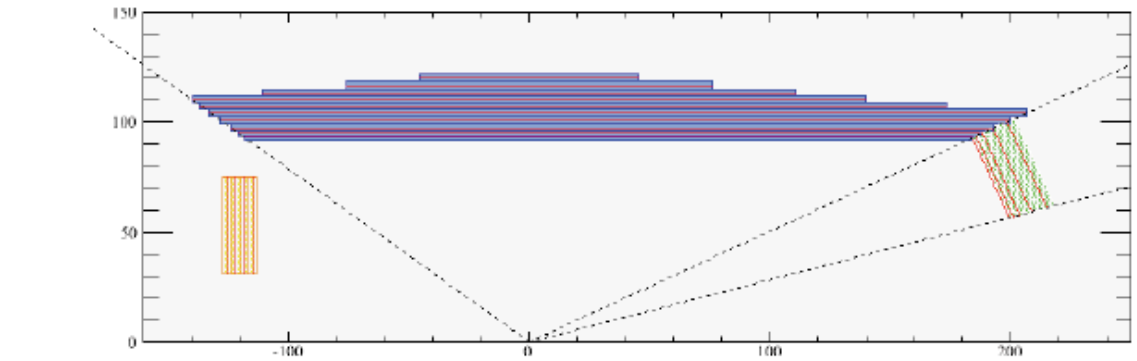


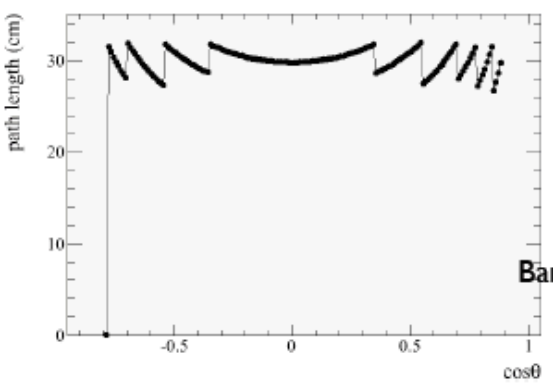
Momentum (GeV/c)

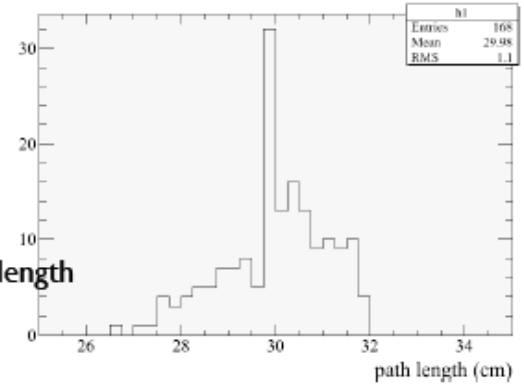
BaBar G4

FastSim

Multilayers to approximate thickness







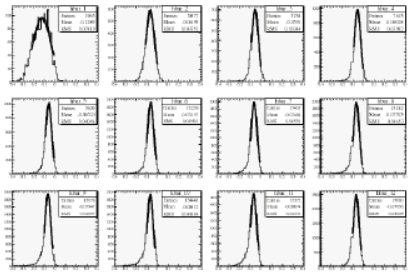
Barrel path length

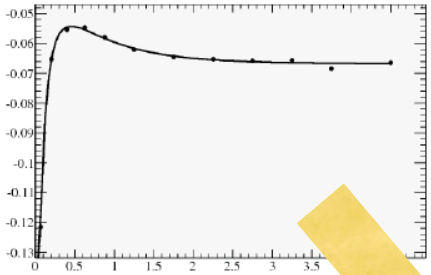
Chih-hsiang Cheng

3

Energy calibration

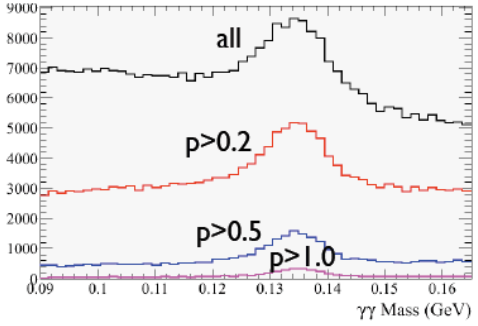
- Fit energy pull to a Gaussian in bins of cluster energy to an empirical function $p_0 + p_1 log(p_2 E) e^{-(p_2 E)^{P_3}}$ and correct for it.

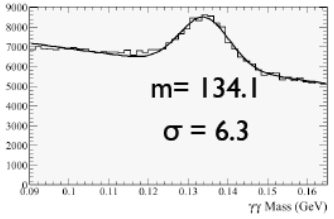




$\pi^0 \rightarrow \gamma\gamma$ mass

- ...g two "CalorNeutral" in V0.0.3, generic B decay.





Work in progress Nicolas Arnaud

- Simulation of the TOF detector
  → Orsay (Leonid Burmistrov *et al.*)
- Simulation of the aerogel detector
  → Novossibirk (Alexey Berdyugin *et al.*)
  work expected to take place during a visit to Padova scheduled for the first half of May

More manpower wouldn't hurt…

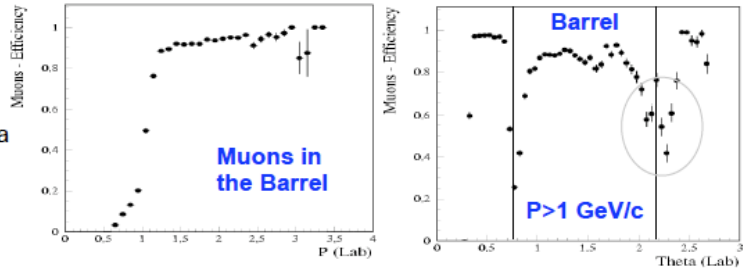
- Detector geometry & response studies needed
- Investigations to understand what is going on in forward region
  → Preliminary studies in Orsay seem to show that the fraction of reco. tracks in the forward PID region is (much) lower than expected
  → More work needed to find whether the effect is true or the signature of a problem (FastSim implementation and/or reco.)

Problem of EMC volume shadowing of Fwd. PID FIXED during the workshop (C. Cheng)

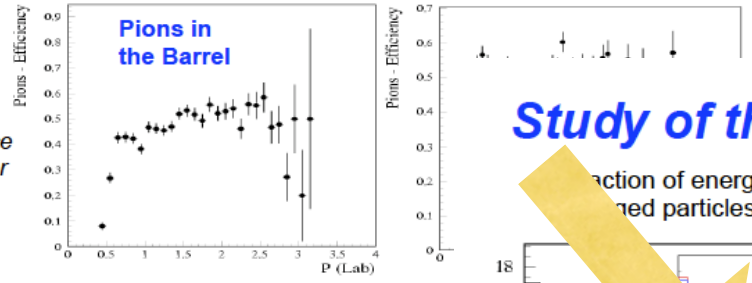
Performances (V02)

- *mu/pi separation based on the # of traversed layers in the Iron: N>9 Layers*

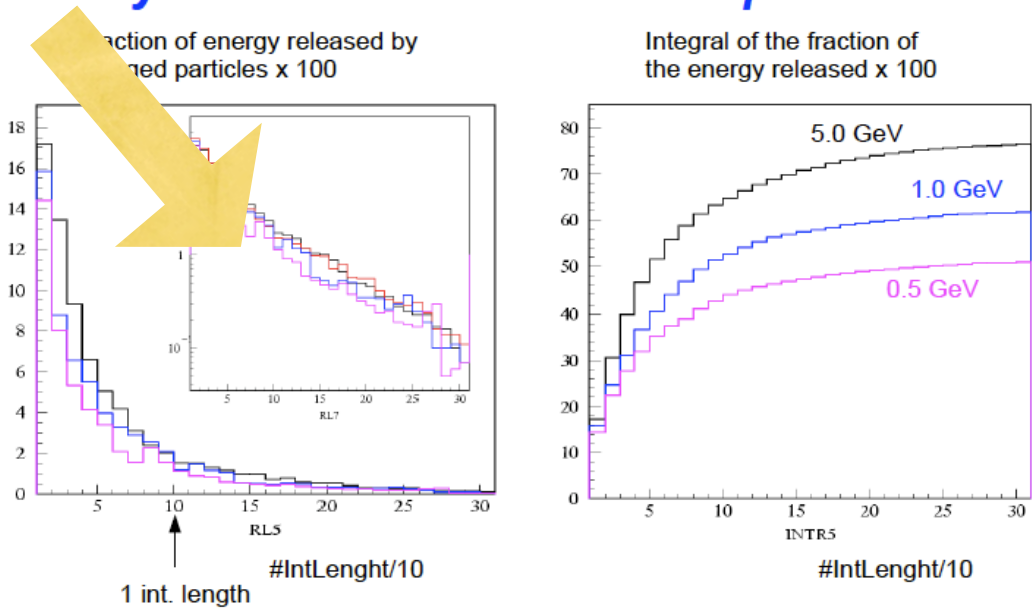
Muon efficiency too optimistic, but the general features (shape of the efficiency versus theta and p) are in reasonable good agreement with the expectation



Pions efficiency is too high!
We need to better simulate the IfrResponse when a hadronic shower is produced



Study of the transverse development



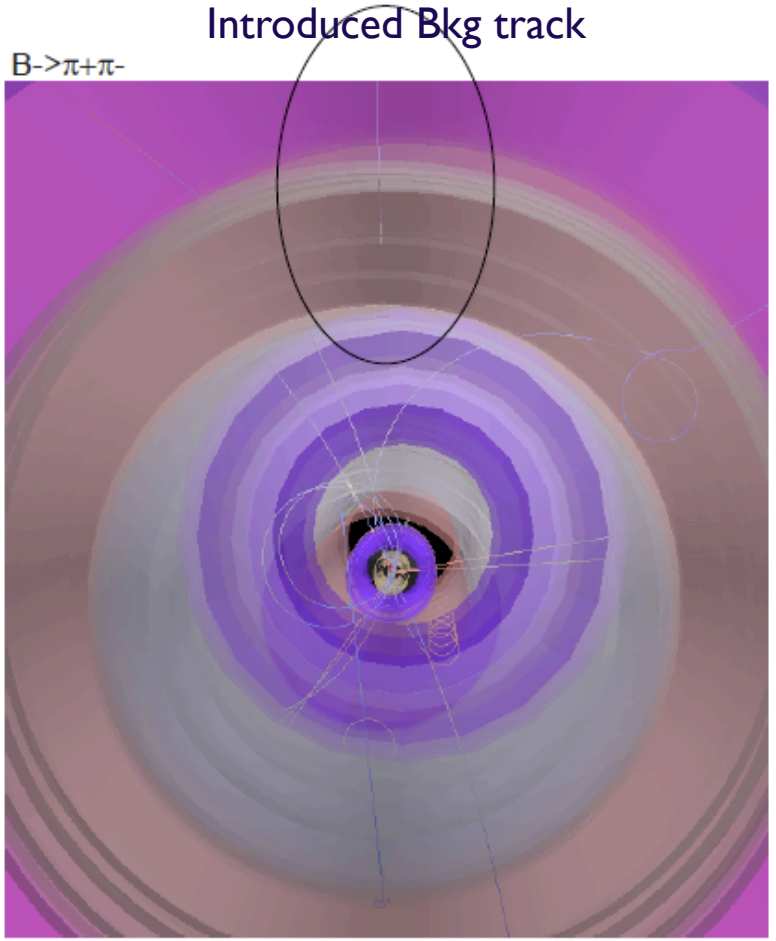
Possible parameterization (CERN-PPE/91-223)

$$\frac{dE}{dA} = \frac{B_1}{r} e^{-r/\lambda_1} + \frac{B_2}{r} e^{-r^2/\lambda_2^2}$$

Backgrounds (G. Simi)

Full Simulation

- Idea:
  - process background events in Bruno
  - save all particles that exit a predefined volume
  - load those particles into the fast-sim
  - continue the simulation using the fast-sim material
- Question: which volume to use?
  - To some extent depends on the type background
  - There might be too many particles passed to the fast simulation
  - Proposed scoring volume is currently the beam-pipe and the DCH end-plates.



Tagging (V. Lombardo)

Tag name	Network arch.	Discriminating variables	Training target
Electron	4:12:1	p^*, E^W_{90}, $\cos\theta_{miss}$, q	Classify B^0 versus $\overline{B}^0$
Muon	4:12:1	p^*, E^W_{90}, $\cos\theta_{miss}$, q	Classify B^0 versus $\overline{B}^0$
KinLep	3:3:1	p^*, E^W_{90}, $\cos\theta_{miss}$	Recognize leptons from direct decays
Kaon	5:10:1	$K1$, $K2$, $K3$, nK_s, ΣP_t	Classify B^0 versus $\overline{B}^0$
SlowPion	3:10:1	p^*, $\cos\theta_{thrust}$, $\mathcal{L}_K$	Recognize true slow pions
MaxPstar	3:6:1	p^*, $doca_{xy}$,$\cos\theta$	Recognize fast tracks
KPi	3:10:1	Kaon tag, SlowPi tag, $\cos\theta_{k,\pi}$	Recognize pairs of true kaons and slow pions
FSC	6:12:1	$\cos_{SlowFast}$, P^*_{Slow}, P^*_{Fast}, $\cos_{SlowThrust}$,$\cos_{FastThrust}$, $\mathcal{L}_{KSlow}$	Recognize fast-slow correlated tracks
Lambda	6:14:1	M_Λ, χ^2, $\cos\theta$, flight length, p_Λ ,p_{proton}	Recognize lambda decays
Tag04/Tag08	10:20:1	All af the above tags	Classify B^0 versus $\overline{B}^0$

To do List

-Adapte the B tagging code of BaBar for FastSim (work in progress)

- Use available "SuperB" PID Selectors to create the B Tagging Lists without any optimization on the tightness criteria

- Generate and reconstruct the usual MC events used to train the NN architecture of BaBar.

- Check if we can dump all the required variables to be used as input to the NN.

- Check if they look reasonable.

Existing selectors in PacPid

Nicolas Arnaud

- A few preliminary selectors already exist

→ Some examples not complete/optimized which **shouldn't be** used as such in analysis: the 'First' selectors

```
PacPidFirstElectronSelector
PacPidFirstKaonSelector
PacPidFirstPionSelector
```

either improve them or get inspired for your own powerful selectors

→ `PacPidTruthBasedSelector` is based on MC-truth and the 5 (mis-)id probabilities are set by the user in a tcl file

```
(…)
acceptProbaIfElectron set 0.01
acceptProbaIfMuon     set 0.01
acceptProbaIfPion     set 0.05
acceptProbaIfKaon     set 0.95
acceptProbaIfProton   set 0.01
(…)
```

What's missing

- A lot of things!
- Realistic selectors for all charged particles
  - → Inputs from dE/dx, calorimeter and muon detector
  - → Performances to be tuned on pure samples
- Area not much manpowered so far
  - → All contributions welcome
  - → Works with limited time duration can have big impact

New Ideas

Vertex Separation

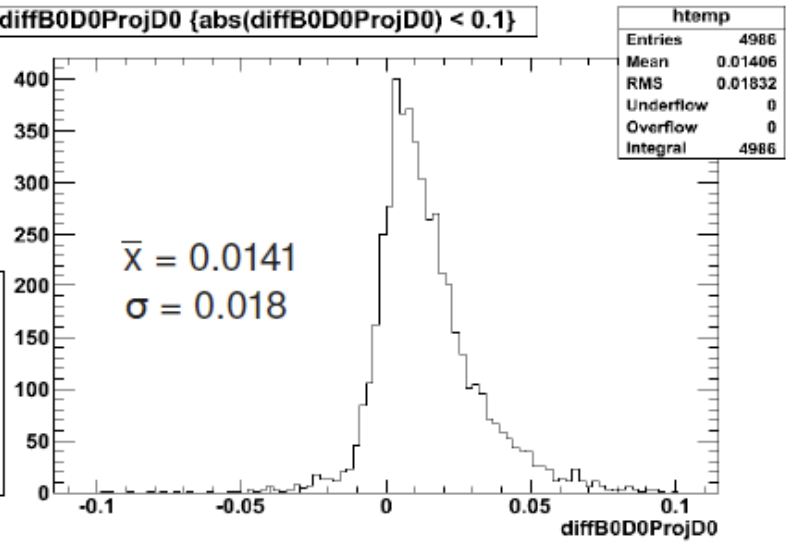
Analysis Decay Chain

$B^0 \rightarrow D^* K$

$D^0 \rightarrow \pi$

$K \pi$

(Simple Comp – MC)
Vertex Spread
~0.004 cm
for each composite particle



- February talk showed vertex of B° and D° was separated by ~3.5σ of detector resolution.
- → We can improve our single vertex algorithm to multiple vertex algorithm.

A. Stocchi

We could optimise on :

- Br(B → X_s γ)
- A_{CP} (B → X_s γ)
- Br(B → τ ν)
- Br(B → X_s l l)
- Br(B → X_s ν ν)
- S(K_s π^0 γ)
- β
- τ → μ γ

Recoil physics optimisation

K_s opimisation

K_L veto

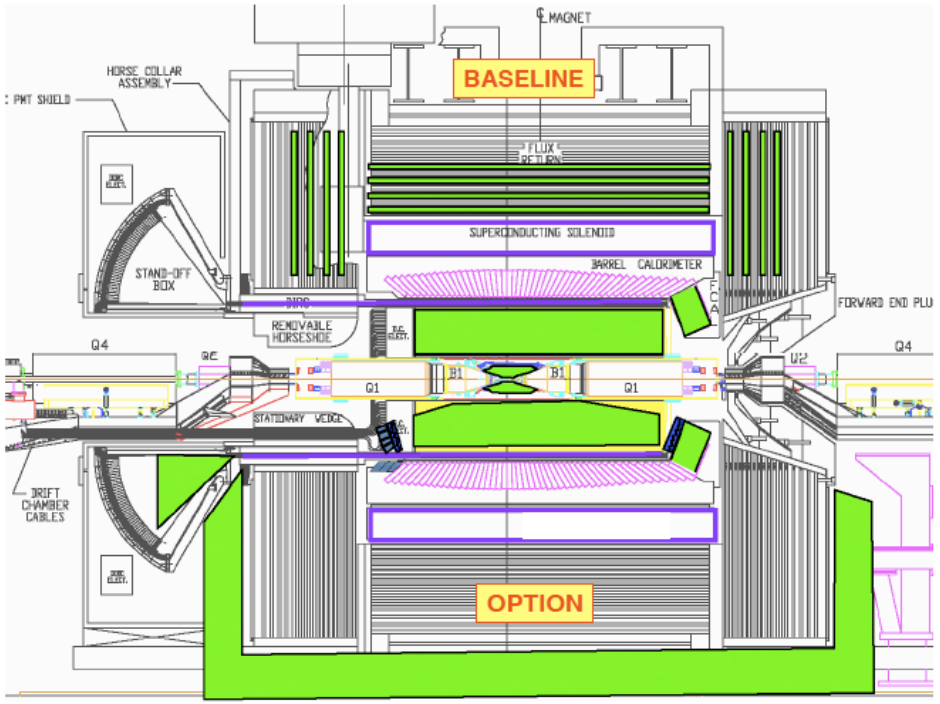
K/π PID

μ PID and μ/π sepration

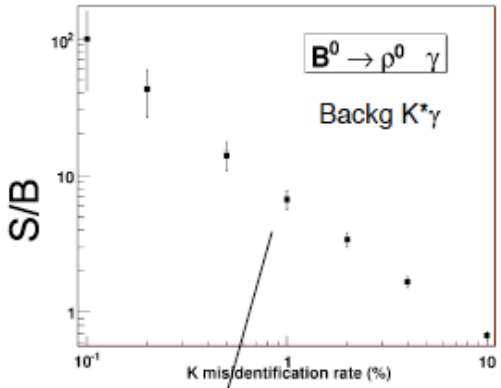
Calorimeter coverage

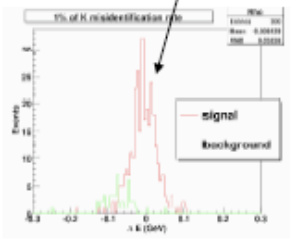
PID coverage

These are the golden modes for physics and also challenging ones from detector point of view !

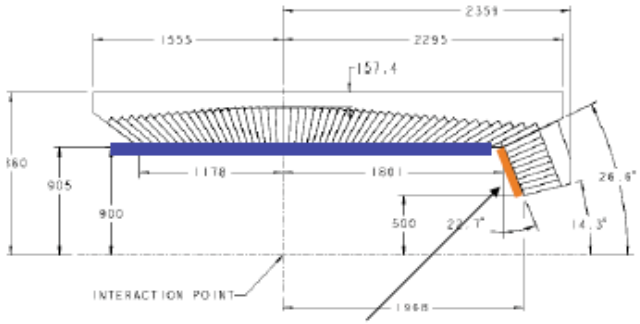


Example from Leonid talk $\rho\gamma$ analysis considering $K^*\gamma$ as the only irreducible backg..





Need 1% misid. for tracks with momentum 1<p<4GeV/c



8% extra coverage

Since both tracks has to be identified the gain is in fact larger and « preliminarly » estimated to an effective increase of 13% of events

Physics Feedback

SIMULATION NEEDS

- Valentina Santoro has agreed to run some simulations
- The goal is to have enough statistics to have unmistakable signals (full reco)
  - Relatively little dependence on detector performances
  - We just need to be sure nothing is worsened too much wrt BaBar
- Critical need: machine background
- Major worries: ISR reconstruction (missing mass) and neutrals
  - Choise of modes to simulate (~50K each):
    - $e^+e^- \rightarrow Y\gamma_{ISR}$, $Y \rightarrow D_s^{(*)}D_s^{(*)}$ [most interesting final state and testing ISR]
    - $B0 \rightarrow X^+K^-$, $X^+ \rightarrow J/\psi\pi^+\pi^0$ [testing PID and π^0 reco]
- Time scale: end of year

spectroscopy

ARM WORKING GROUP
following key "physics channels"

$\pi^+\pi^-$
K^+K^-
$)l\nu$

a "generic" mix of particles in the rest of the event,
se, at both the Y(4S) – from D* and at the $\psi(3770)$ (no
D*,
of course!) required for this sample.

Manpower/urgency: I think we cannot say there is much of either, just now, unfortunately.

Tools:
Dreco package (charm tagging)

Sample sizes:
1 ab^{-1} at $\psi(3770)$
75 ab^{-1} at Y(4S)

charm

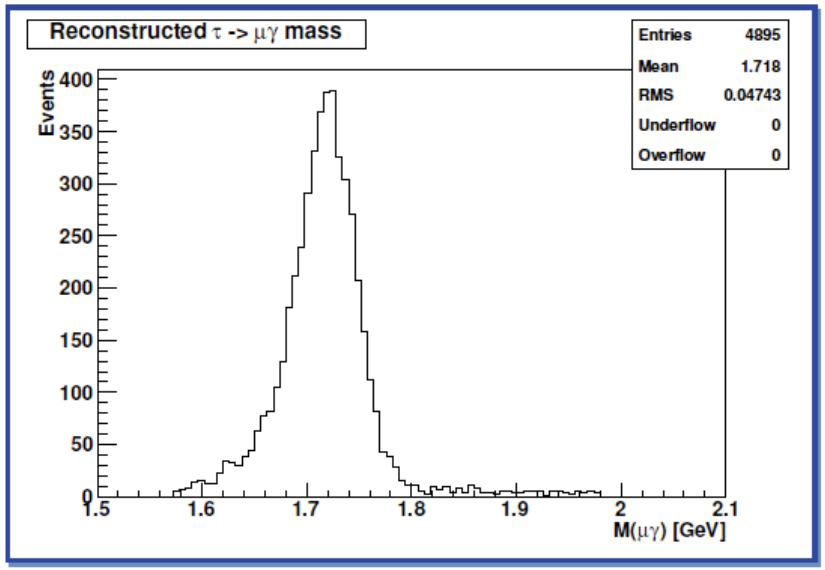
Computing Questions

- Is signal mode production necessary?
  - > 1M events/cpu-day with FastSim
- How many generics (B, udsc) are needed?
  - can we use hadronic cocktail for BReco?
  - is 1 detector geometry sufficient
  - can we filter events?
- What output format is needed?
  - is BetaTuple sufficient?
- Who will provide (filter, tuple) code for your mode?

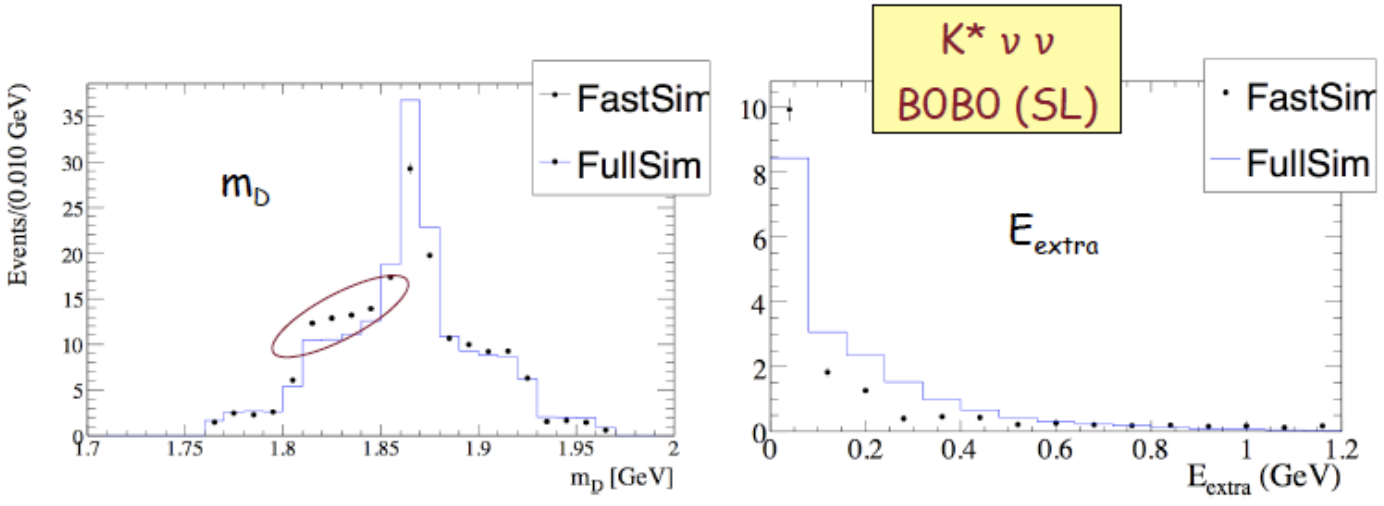
No clear case for centralized production yet
Monitor the situation closely

Recent progress on simulation: FastSim tau pairs generation

- tau pairs generation with KK2f+Tauola integrated with Super*B* FasSim (A.L.)
- PacTauUser package in FastSim repository, available for use
  - code & configuration for $\tau \to \mu\gamma$ generation, demo code for ntuple production & analysis



FastSim vs. Full Sim.



Some discrepancy in mD spectrum (high tails in FastSim)

Underestimated Production of low energy EMC deposits

F. Regna

10

Conclusions

- Tools development is following SuperB needs
- Physics groups are starting to use Simulation tools
  - Feedback loop is open
- Necessary precision for (pre) TDR document within reach