Report of DGWG

Matteo Rama (Frascati), Achille Stocchi (LAL)

SuperB Collaboration Meeting 19 June 2009

1st session dedicated to SVT-DCH + reduced boost implications

14:00->*15:30* **Parallel - Tracking (DGWG)** (Convener: Giuliana Rizzo (*PI*) , Giuseppe Finocchiaro (*INFN - LNF*) , Matteo Rama (*LNF*) , Achille Stocchi (*LAL - Univeriste Paris Sud and IN2p3/CNRS*) , David Brown (*Lawrence Berkeley National Lab*)) Evo phone bridge information; Meeting URL
Description:
Location: Room TRUMPET 4

14:00	Tracking Performance with the SVT baseline configuration (20') (Slides)	Nicola Neri (*Universita' di Pisa & INFN*)
14:20	Performance studies with different SVT and DCH configurations (20') (Slides)	Matteo Rama (*LNF*)
14:40	Simulated tracking efficiency (05') (Slides)	David Brown (*Lawrence Berkeley National Lab*)
15:00	Boost sensitivity on time dependent measurements (15') (Slides)	Nicola Neri (*Universita' di Pisa & INFN*)
15:15	B->Ks pi0 vs. SVT radius (15') (Slides)	Gabriele Simi (*UMD*)

2nd session dedicated to Forward PID

09:00->*10:30* **Parallel - DGWG I** (Convener: Achille Stocchi (*LAL - Univeriste Paris Sud and IN2p3/CNRS*) , Matteo Rama (*LNF*)) meeting URL; telephone numbers
Description:
Location: Room TRUMPET 1

EVO - Phone Bridge ID: 1071377

09:00	Forward PID studies (K*gamma/rho gamma) (20') (Paper)	leonid Burmistrov (*LaL*)
09:20	forward PID: K(*) nu nubar with semileptonic tag (20') (Slides)	Alejandro Perez (*LAL*)
09:40	Impact of forward PID on |Vub| measurement and possible momentum resolution improvement (20') (Slides)	Evgeniy Kravchenko (*Budker INP*) , Alejandro Perez (*LAL*)

3rd session on calorimeter and IFR

16:30->*18:00* **Parallel - DGWG II** (Convener: Achille Stocchi (*LAL - Univeriste Paris Sud and IN2p3/CNRS*) , Matteo Rama (*LNF*)) Meeting URL; phone bridge info
Description:
Location: Room TRUMPET 1

EVO - Phone Bridge ID: 1073683

See talk on EMC plenary

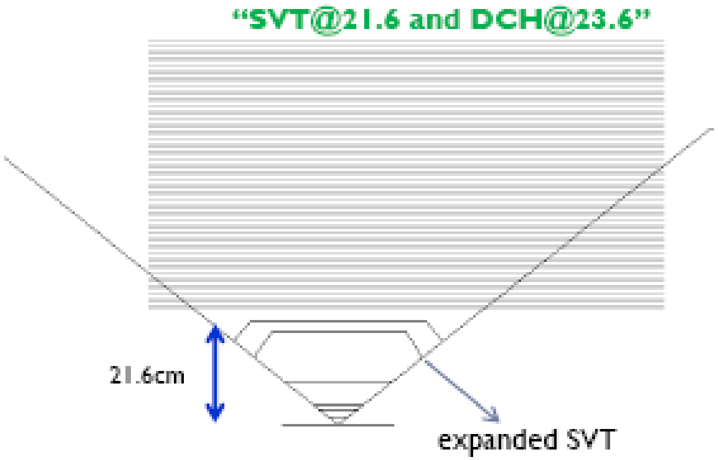
16:30	Study of photon detection in EMC barrel-endcap transition (20') (Slides)	Stefano Germani (*PG*)
16:50	Physics performance of backward calorimeter (20') (Slides)	Alexander Rakitin (*Caltech*)
17:10	IFR optimization (20') (Slides)	See talk on IFR plenary → Gianluigi Cibinetto (*FE*)
17:30	Time-dep CP parameters sensitivity vs. boost (20') (Slides)	Chih-hsiang Cheng (*Caltech*)

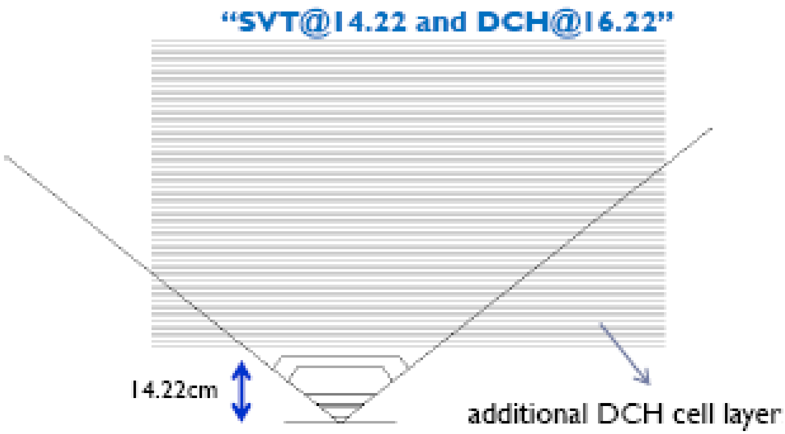
Evaluating the relative interest of extending
→ the DCH at lower radius versus
→ extending the SVT outer layer

Matteo Rama
(Frascati)

- DCH: Babar
  - 10 SuperLayers (BaBar)
  - inner wall: 23.6cm; spatial reso: 125μm
- SVT: nominal baseline with
  - L3: 5.92cm→**9.0cm**
  - L4:12.22cm→**19.6cm**
  - L5:14.22cm→**21.6cm**

- DCH:
  - 10 SuperLayers (Babar) **+ 4 cell layers**
  - inner wall: 23.6cm → **16.22cm**
  - Axial/Stereo+/Stereo- geometry
  - spatial reso: 125μm
- SVT: nominal baseline





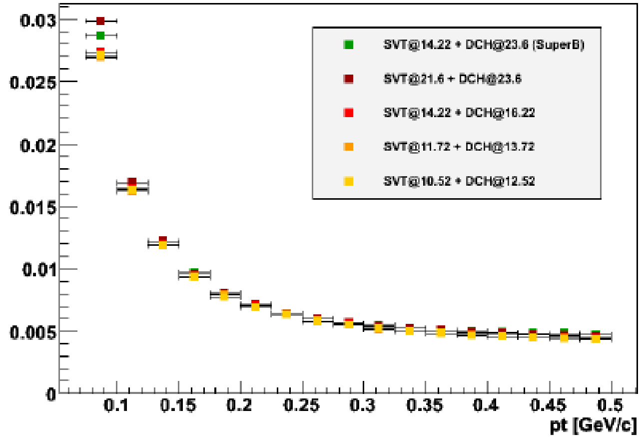
Also tested
DCH @13.72 SVT @11.72
DCH @12.52 SVT @10.52

single charged π particles with:

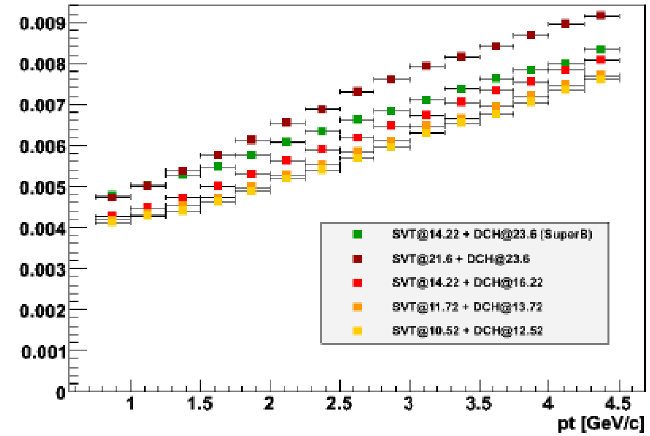
- pt in [0.05,4.5] GeV/c
- cosTheta in [-1,1]
- Phi in [0,2π]

σ(pt)/pt vs pt

Low momentum

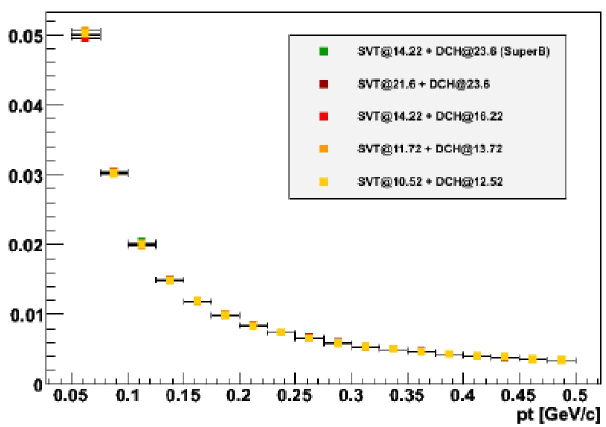


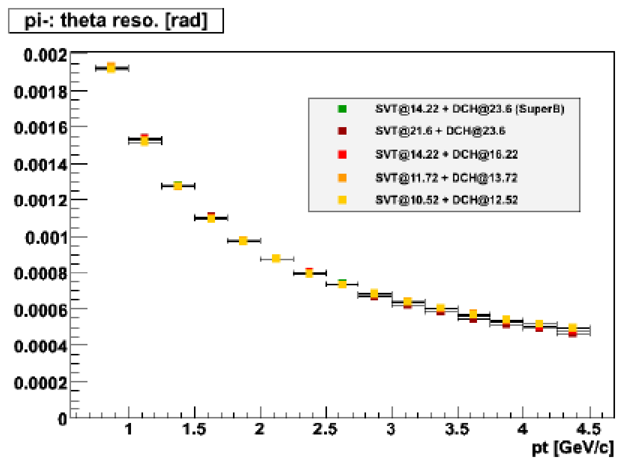
high momentum



The configuration with extended SVT @ 21.6 cm gives worst pt resolution

θ vs pt

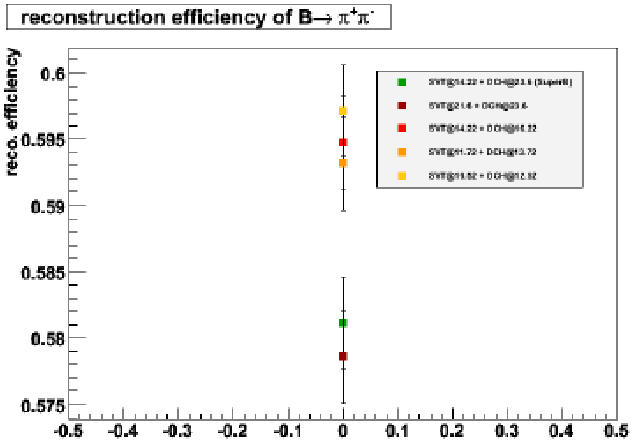


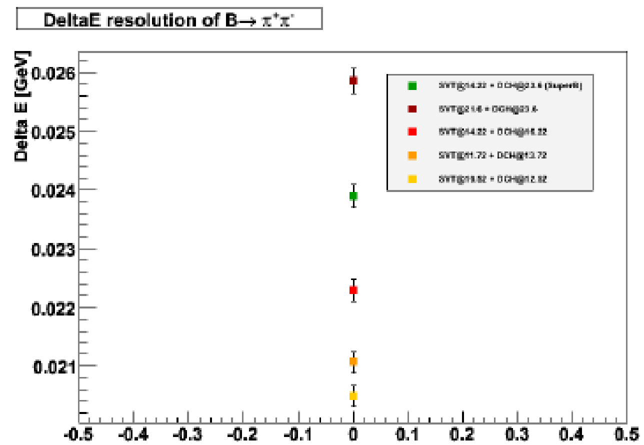


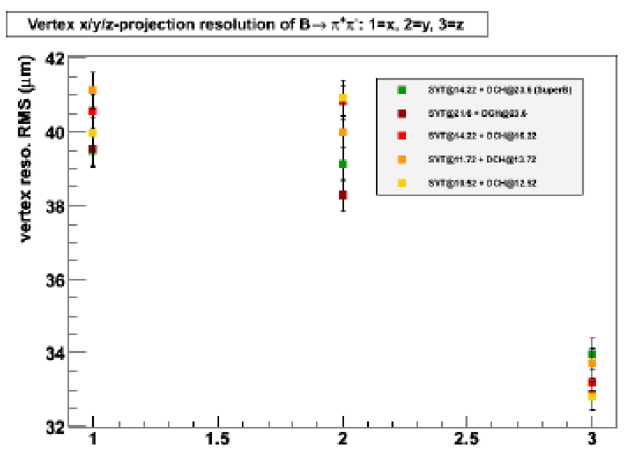
No significant differences for θ

Check on how the different configurations affect the B reconstruction
Example with two different channels

$B \rightarrow \pi^+\pi^-$: summary

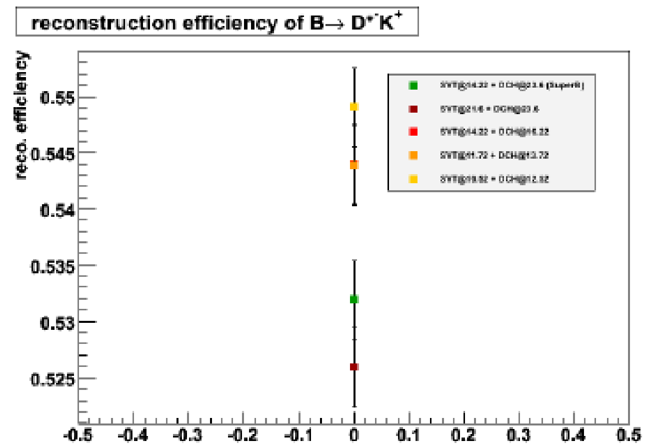


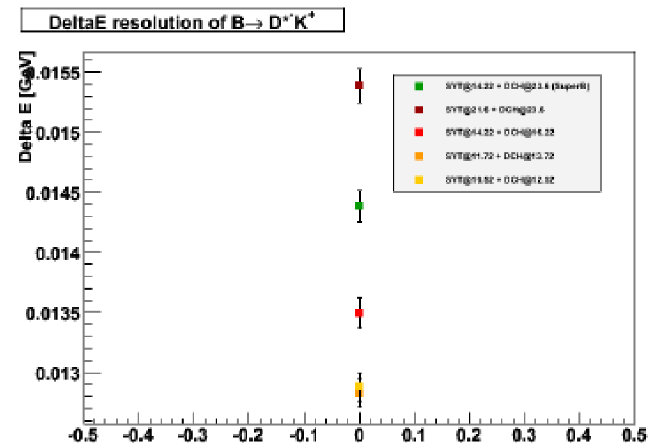


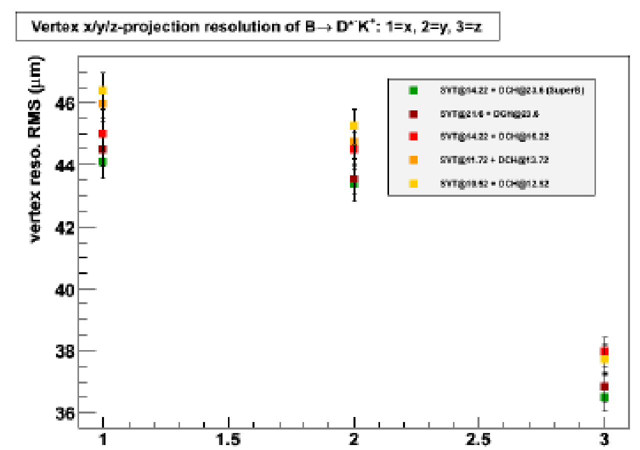


- best performance with small DCH inner radius:
  - ΔE resolution improves up to 25%
  - ~2% (absolute) reco. efficiency increase
  - vertex resolution variation negligible

B→D*⁻K⁺ : summary







- best performance with small DCH inner radius:
  - ΔE resolution improves up to 20%
  - ~2% (absolute) reco. efficiency increase
  - vertex resolution variation negligible

Nicola Neri
(Pisa)

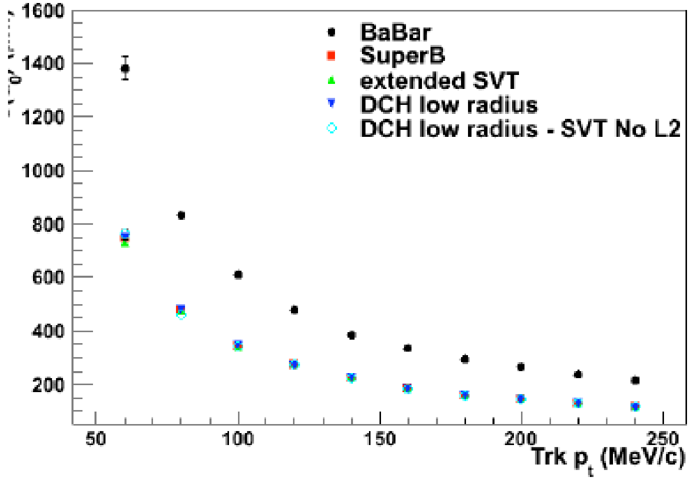
Further studies on the performances of different tracking configuration

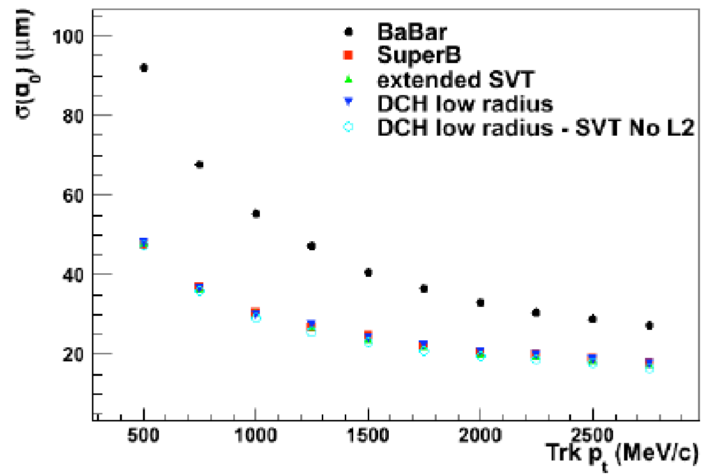
1. SuperB baseline:
   - SVT baseline: L0 (Hybrid Pixel) + L1-L5 strip detectors, ±300 rad angular coverage;
   - DCH baseline: 10 SuperLayers (4 cell layers per SL); inner radius 23.6 cm, spatial resolution 125 μm;
2. SuperB Svt Extended radius:
   - SVT baseline for L0-L2 with L3: 5.92cm →9.4cm, L4: 12.22cm →20.6cm, L5: 14.22cm →22.6cm; DCH baseline;
3. SuperB Dch Low radius:
   - SVT baseline; DCH baseline + inner SuperLayer with inner radius 17 cm;
4. SuperB Dch Low radius No L2:
   - equal to 3 but without SVT L2 (radius 4.02cm).

Low pT

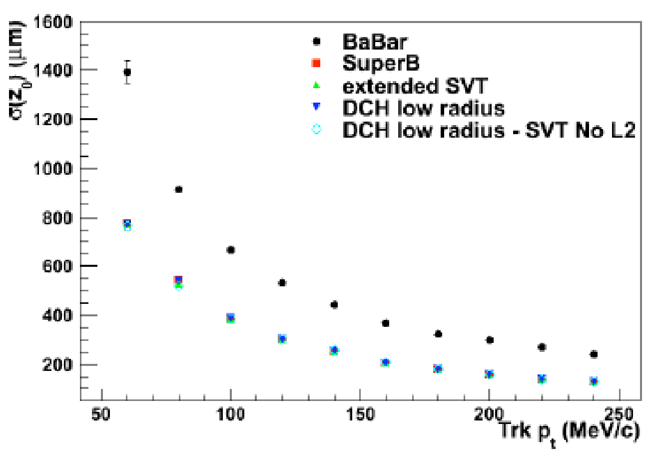
“High” pT

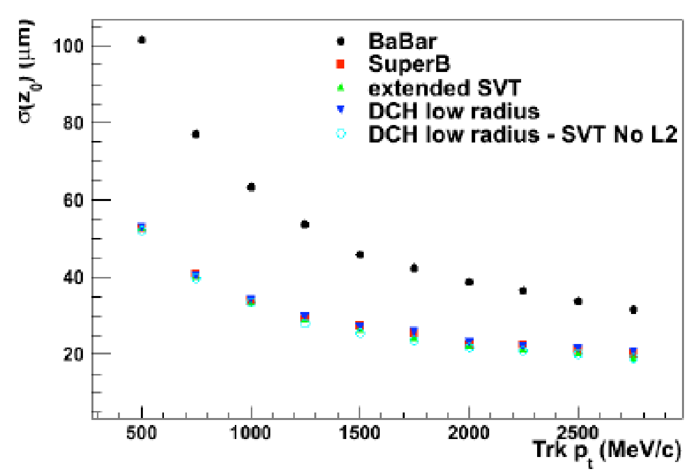
d_0 resolution





z_0 resolution

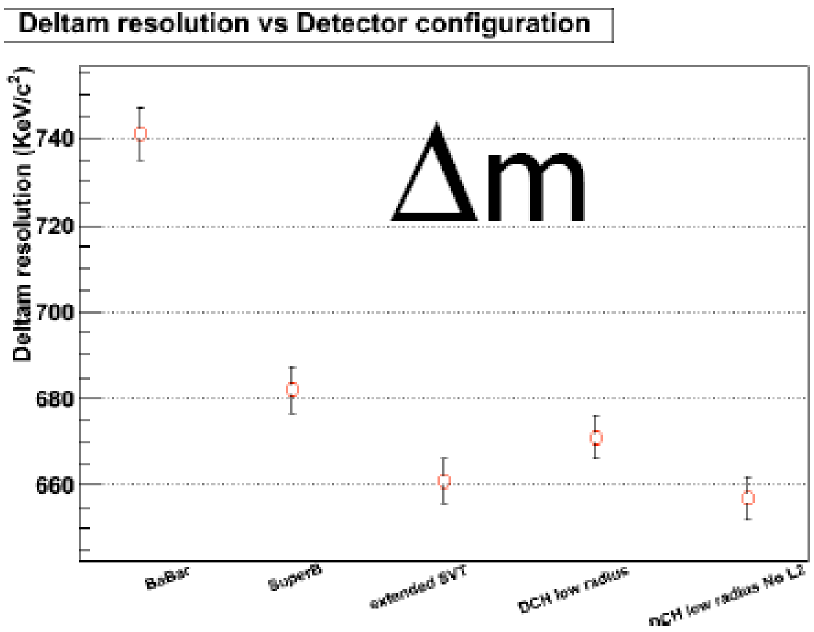


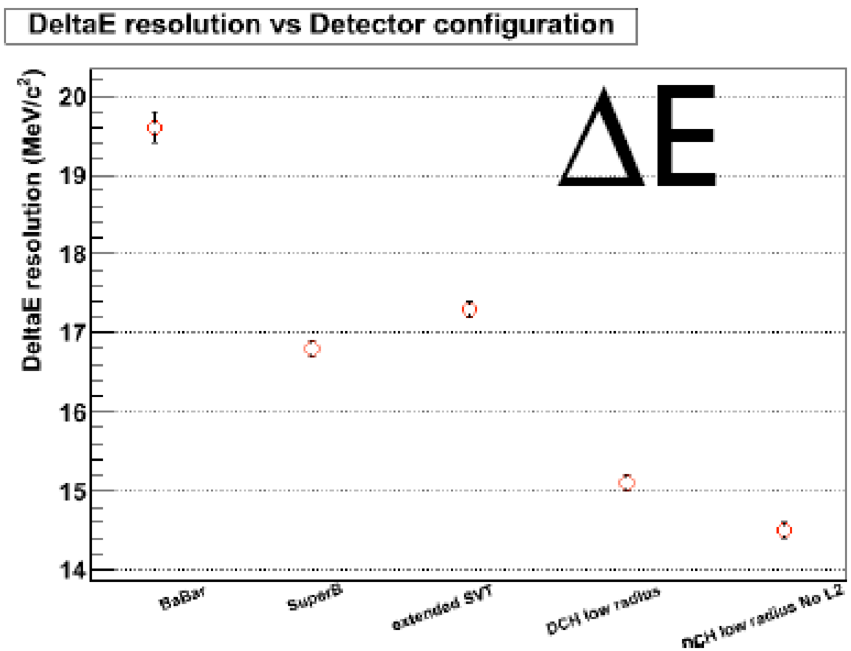


For tracking parameter : <u>factor 2 better due to the layer 0</u> (SuperB vs Babar) <u>no significant differences among the different SuperB configurations.</u>

For Pt similar results as the ones shown by Matteo

Reconstruct $B^0 \to D^{*-}K^+$ with $D^{*-} \to \bar{D}^0 \pi^-$

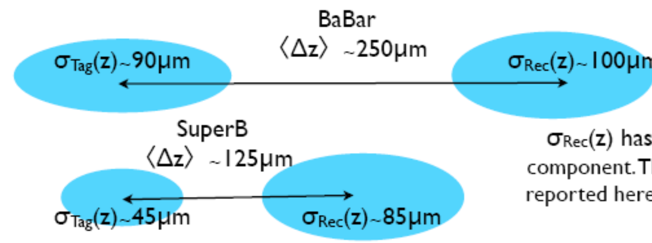




Δm (soft pion) resolution improves wrt BaBar configuration. ΔE resolution reflects the improvements in momentum reconstruction for DCH with lower radius.

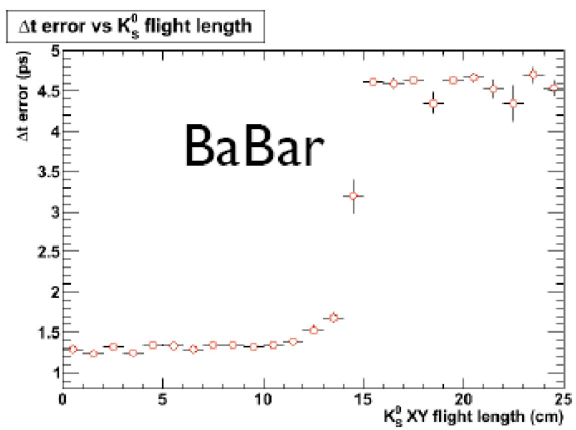
Looking if in particular cases we benefit of an extended SVT

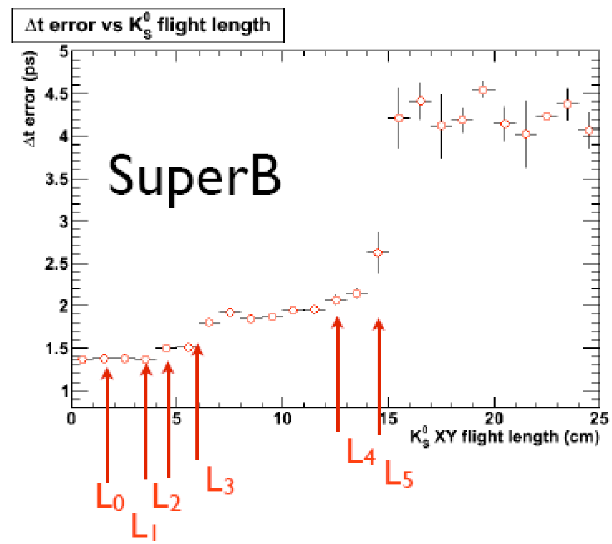
Reconstruct $B^0 \to K_S K_S$ with $K_S \to \pi^+\pi^-$

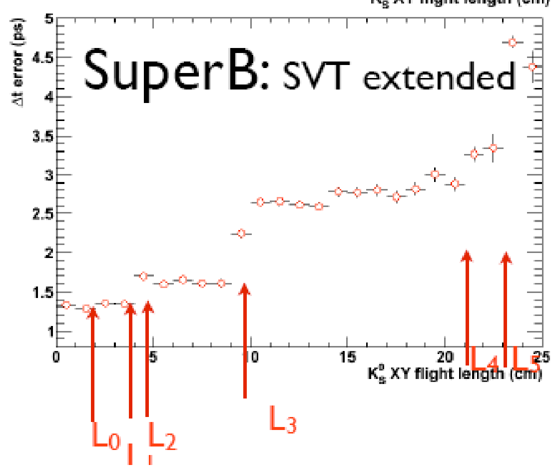


$\sigma_{Rec}(z)$ has an important tail component. The value for $\sigma_{Rec}(z)$ reported here is purely indicative.

Proper Time resolution vs Ks XY Flight length



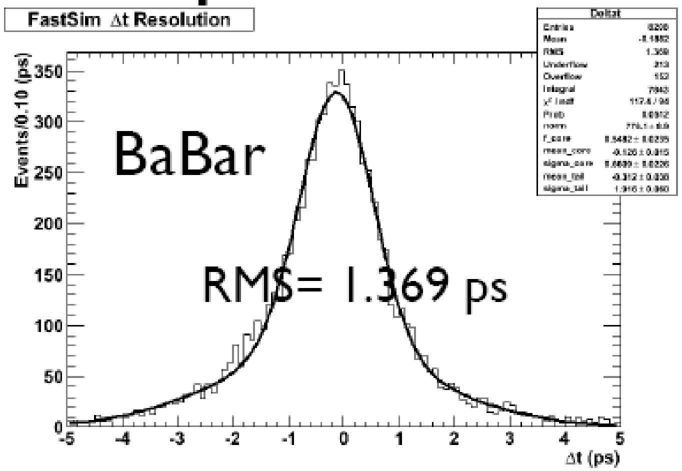


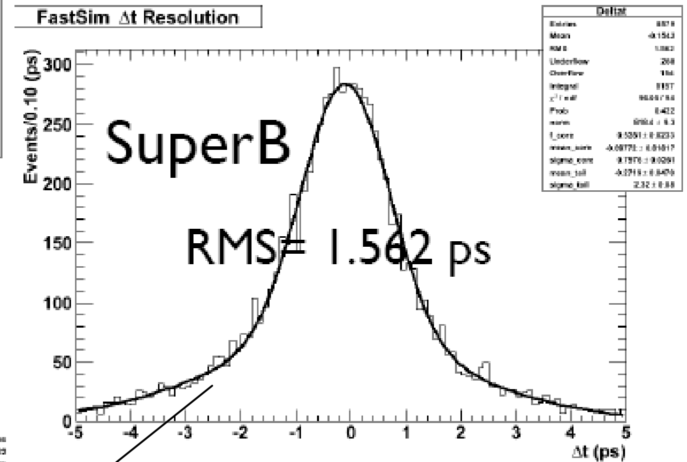


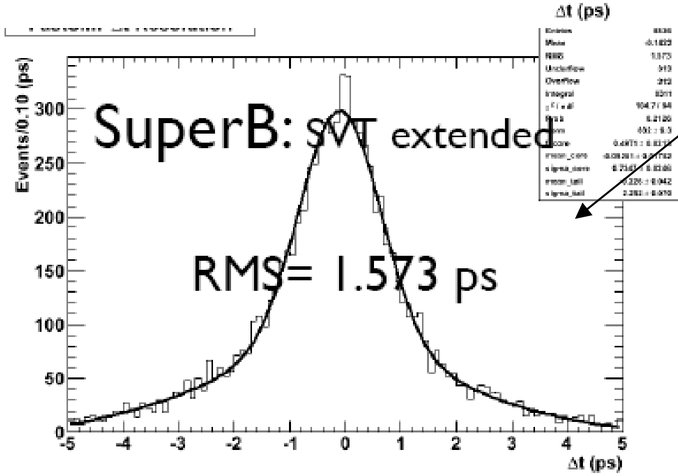
Extended SVT configuration has a smoother variation of the Δt error...

note: on x axis is reported the minimum Ks XY flight length of the event.

Proper Time Resolution $B^0 \rightarrow K_S K_S$







Overall the error
is similar

Which translate into

Toy MC results:
per Event Error on S

$\sigma_{BaBar} = 1.431$

$\sigma_{SuperB} = 1.608$ (+12%)

$\sigma_{ExtSVT} = 1.608$ (+12%)

No efficiency correction applied though SuperB has larger acceptance

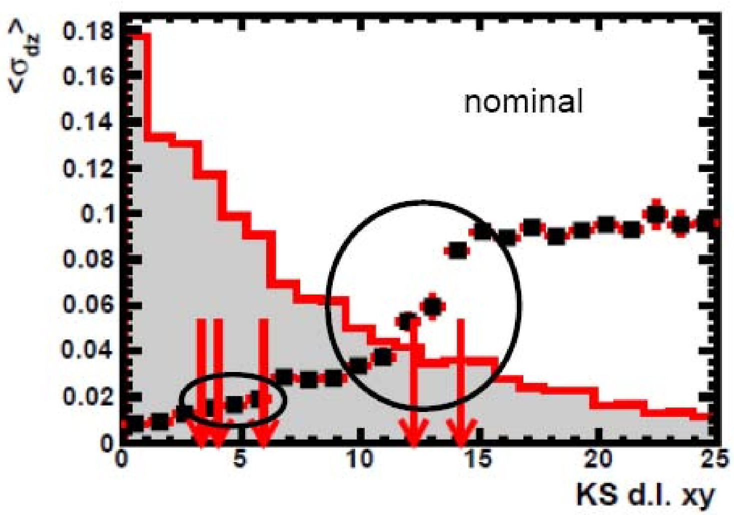
Reduction in sensitivity at high lumi is mitigated by the systematic error:

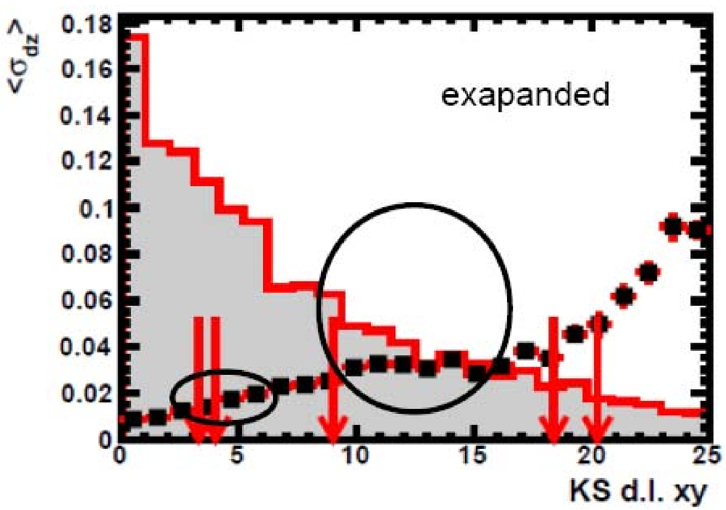
$\sigma = \sigma_{stat}/\sqrt{N} \oplus \sigma_{syst}$

Studies with Ks π^0 (γ)

Gabriele Simi
(Maryland)

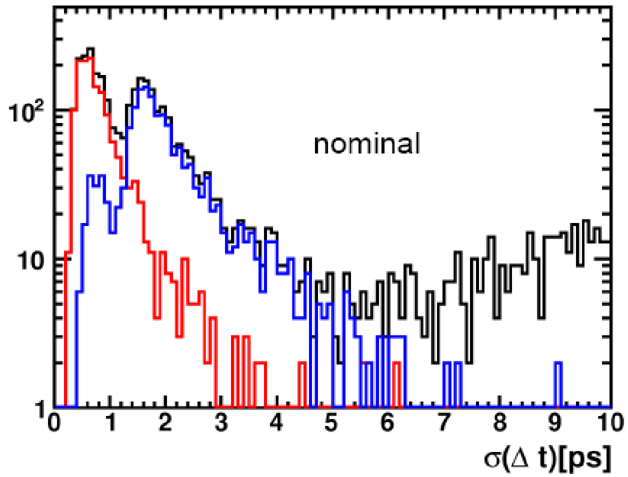
- Baseline SVT configuration as implemented by Nicola
  - L0 is now the hybrid pixel solution
  - Angular coverage increased down to 300mrad
  - Geometric acceptance goes from 89% to 95%
- Expanded configuration: L45 and L3 [N.Neri]
  - Layer 3: 5.9-> 9.4
  - Layer 4: 12.2->20.6

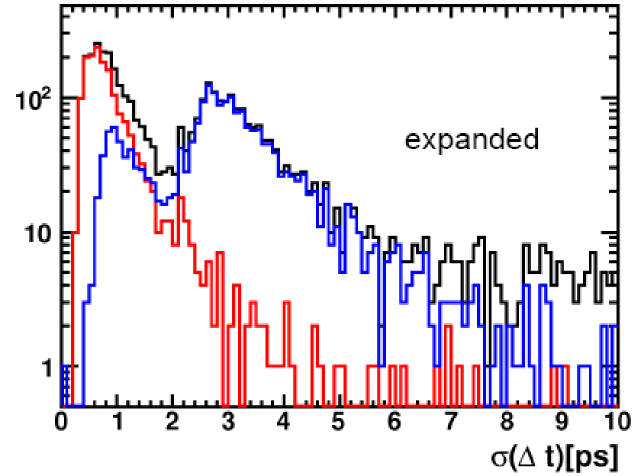




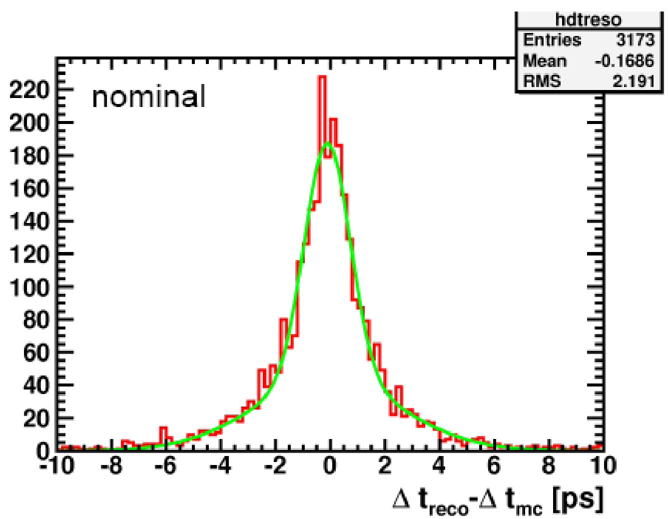
	Nominal	expanded
• Class I & II: used for dt fit	72%	88%
• [was	63%	73%]

Fraction
Of “good events”

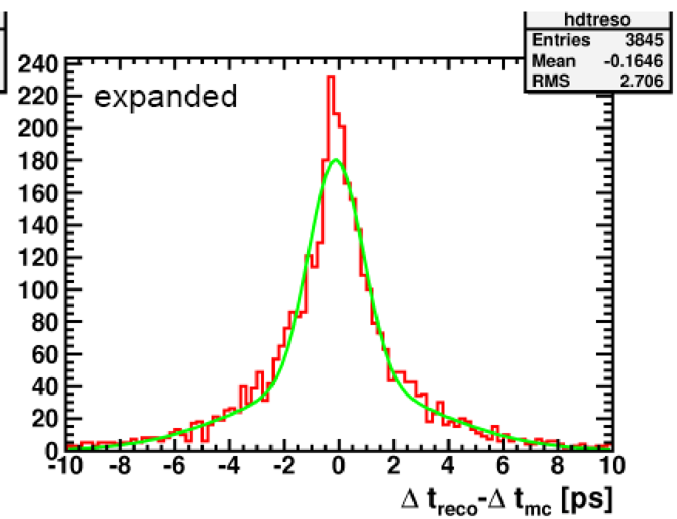




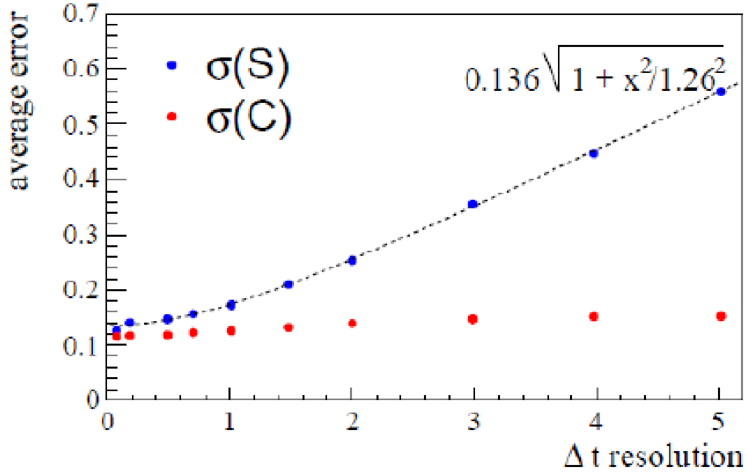
Δt
resolution



r.m.s.=2.19



r.m.s.=2.71



– $\sigma_S \sim \sqrt{[\,(1+\sigma_{\Delta t}^2/1.26^2)\,/\,f_{good}\,]}$

– $\sigma_C \sim \sqrt{[1\,/\,eff\,]}$

	rms[ps]	f_{good}[%]	$\sigma_S/\sigma_S^{nominal}$	$\sigma_C/\sigma_C^{nominal}$
babar	1.84	69	0.90	0.98
nominal	2.19	72	1	1
expanded	2.71	88	1.07	1.00

- Sensitivity in nominal configuration is comparable to BaBar (10% worse on S)
- Sensitivity in expanded configuration is 10% worse than nominal on S, the same on C

Some preliminary conclusions on this first part :

Comparison between the configuration with
DCH at lower radius
wrt
enlarging SVT radius:

- → Better momentum resolution
- → Better ΔE and Δm resolution
- → Better reconstruction efficiency
- → Similar resolution on the track parameters

In addition there is no evidence of improvements in enlarging the SVT raduis also for TD measurement in special modes as $B^0 \rightarrow$ KS KS and KS π^0 (γ)

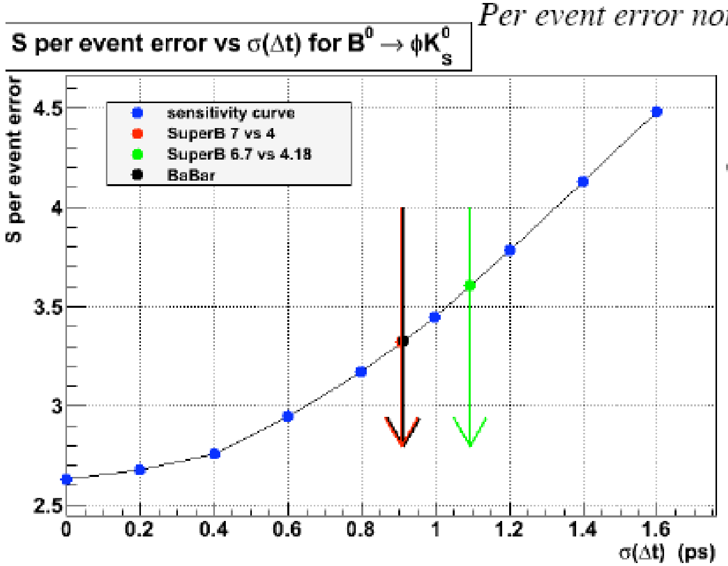
Effect of the reduced boost on S measurements

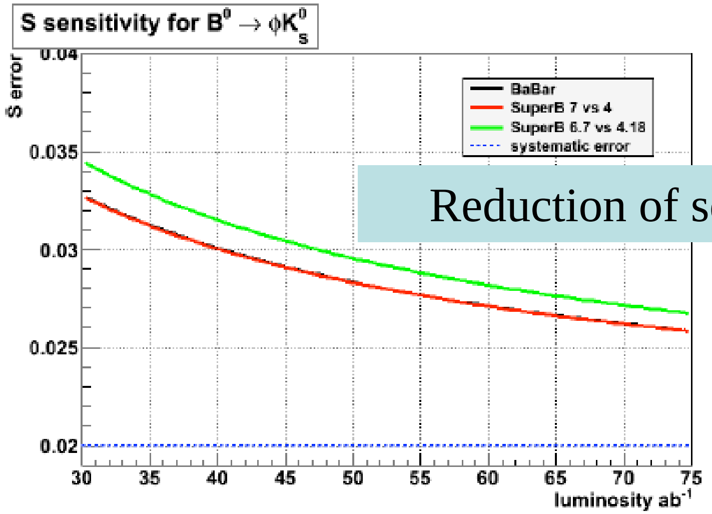
$\beta\gamma$ 0.280→ 0.238

Nicola Neri
(Pisa)

Sensitivity to S for $B^0 \to \phi K_S$

Per event error normalized to BaBar result.





Reduction of sensitivity of 6%.

Chih-hsiang Cheng
(CalTech)

$\beta\gamma$	0.283	0.238
S	0.70414 ± 0.00175	0.70325 ± 0.00187
C	-0.00105 ± 0.00122	-0.00289 ± 0.00125
b_core	-0.1158 ± 0.0038	-0.0929 ± 0.0034
b_tail	-0.8376 ± 0.0241	-0.7653 ± 0.0204
f_out	0.0078 ± 0.0004	0.0100 ± 0.0002
f_tail	0.1773 ± 0.0027	0.1779 ± 0.0023
s_core	1.1230 ± 0.0056	1.1314 ± 0.0049

- Resolution function is not perfect, but does not cause bias in uncertainty comparison.
- Error on S changes by +6.9%.

It does not change the result if we relax σ(Δt) cut in reduced boost so that #events in the fit are the same.

$B^0 \to K_S K_S$

ToyMC results:

Per Event Error on S

$\sigma_{BaBar} = 1.431$

$\sigma_{SuperB} = 1.608 \quad (+12\%)$

$\sigma_{RedBoost} = 1.689 \quad (+18\%)$

No efficiency correction applied though SuperB has larger acceptance

Reduction in sensitivity at high lumi is mitigated by the systematic error:

$\sigma = \sigma_{stat}/\sqrt{N} \oplus \sigma_{syst}$

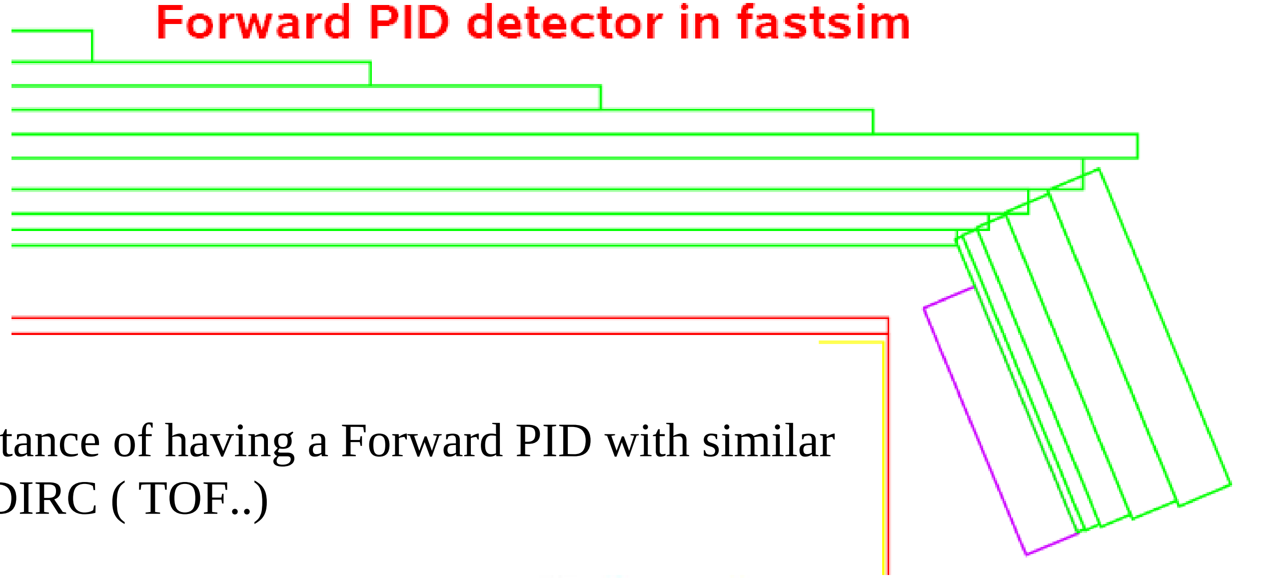
Same conclusion as before.
From Babar→ SuperB we loose already 12% on S sensitivity
With reduced boost lost on sensitivity from 12% → 18%

Conclusion of conclusions :
for the analyzed channels the reduced boost correspond to a reduction of ~15% on number of events.

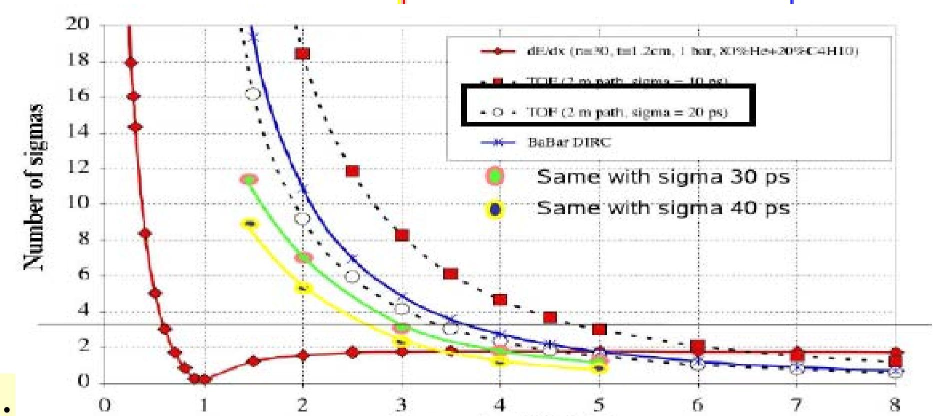
Do we desperately need a Forward PID ?

Leonid Burmistrov
LAL

Forward PID detector in fastsim

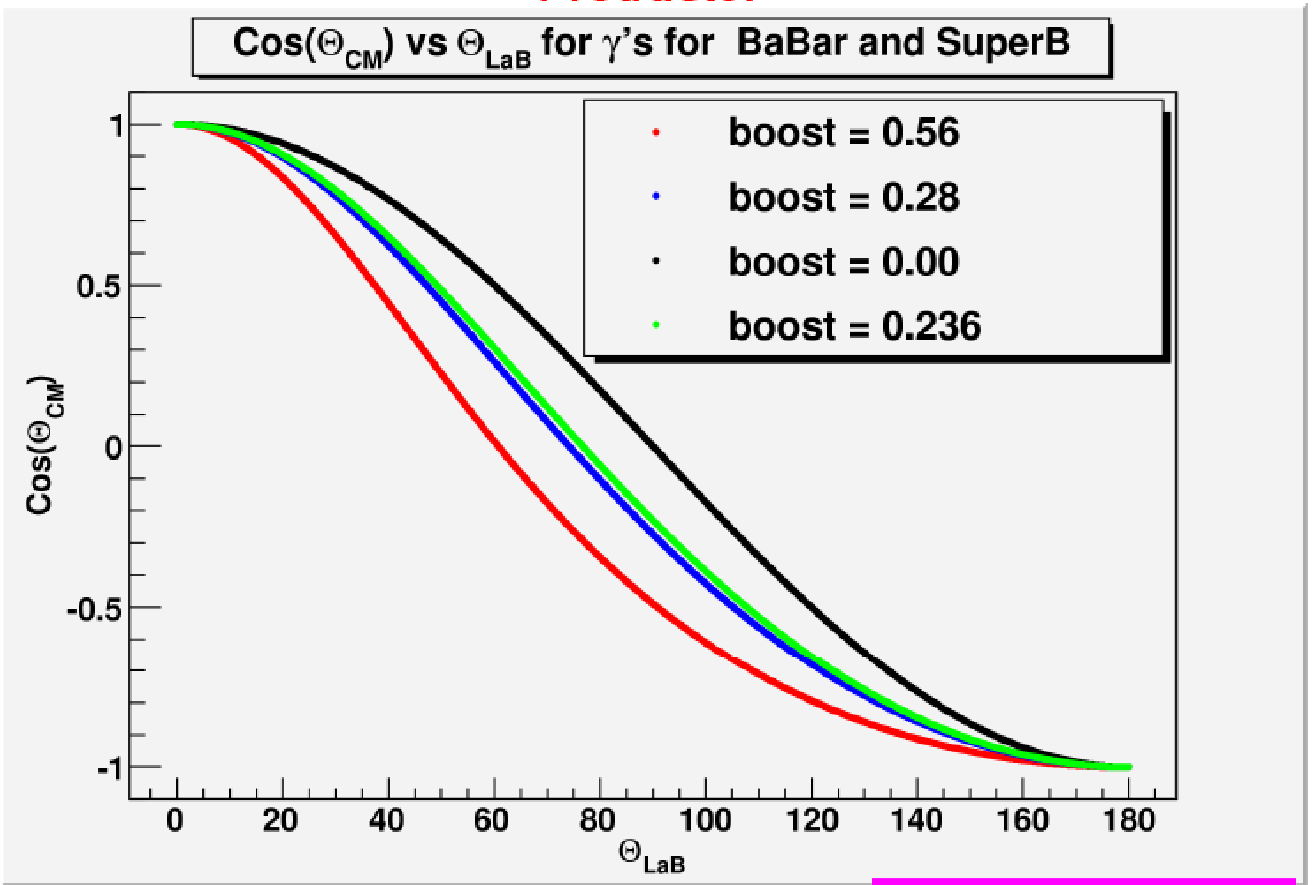


Testing the importance of having a Forward PID with similar performances as DIRC (TOF..)



Mainly two configurations have to be tested :
→ FPID : with the coverage of DCH
→ FPID : “TOF-like”

Protractor



DIRC	
boost 0.00	84.4%
boost 0.28	**85.5%**
boost 0.24	85.6%
boost 0.56	83.4%

mid DCH (20 layers)	
boost 0.00	92.6%
boost 0.28	**93.4%**
boost 0.24	93.3%
boost 0.56	92.5%

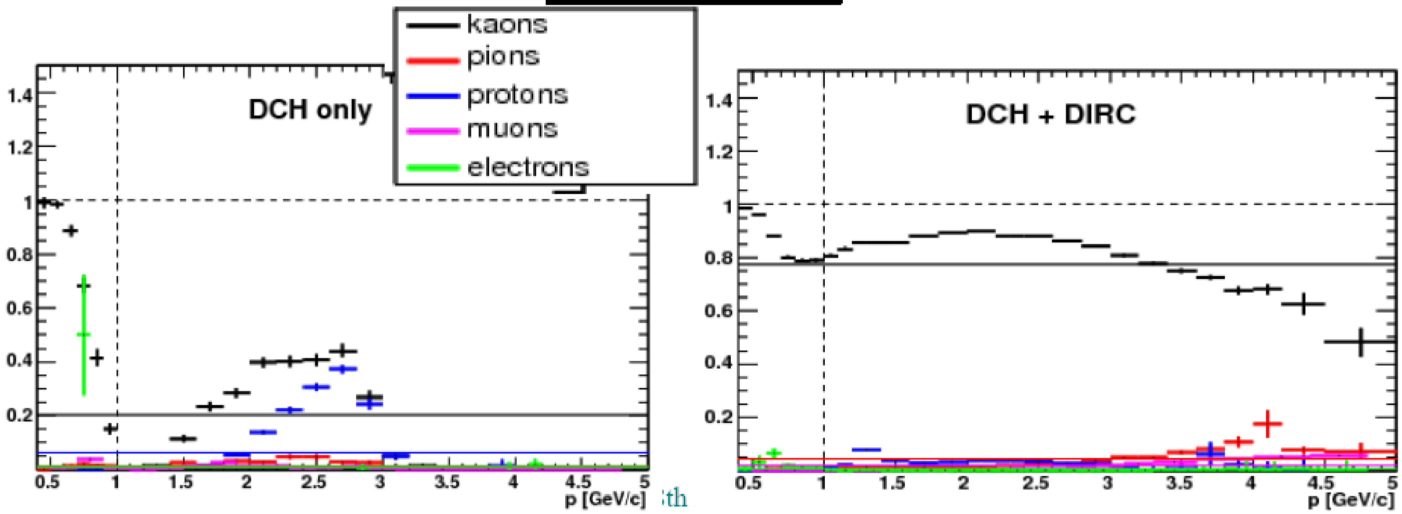
FWD TOF	
boost 0.00	2.8%
boost 0.28	**4.7%**
boost 0.24	4.4%
boost 0.56	7.3%

Important news :

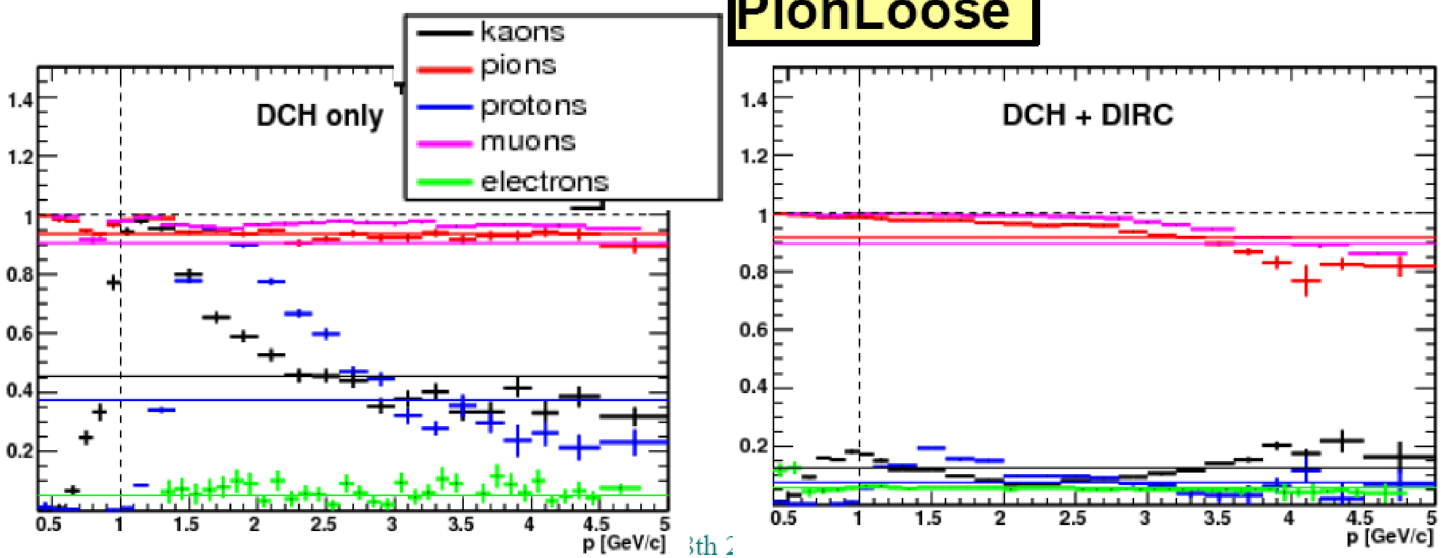
we have implemented PID vs momentun and in different polar angle region

(still truth based)

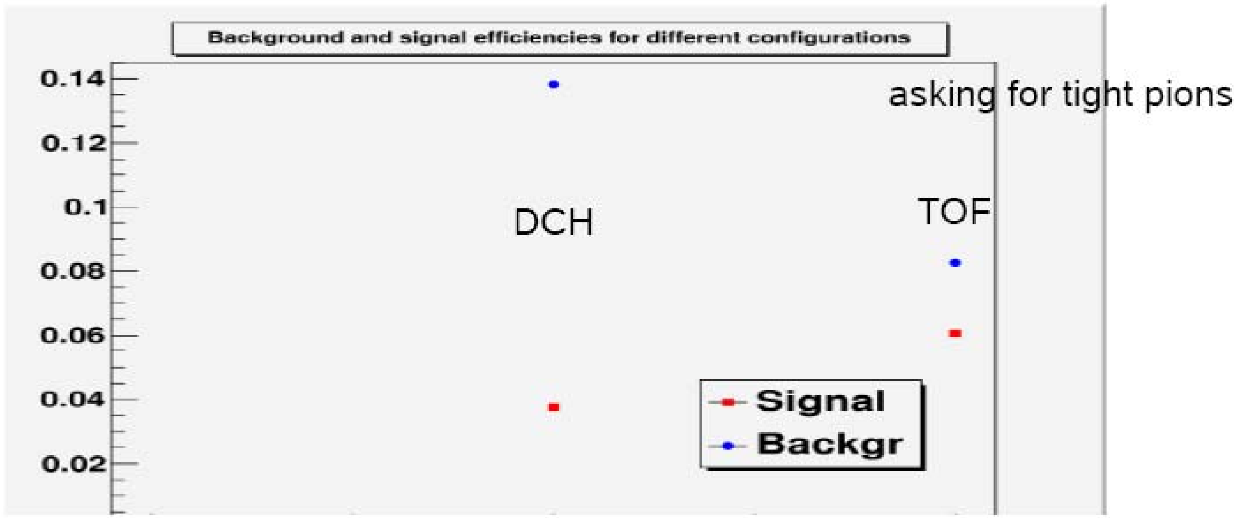
KaonTight

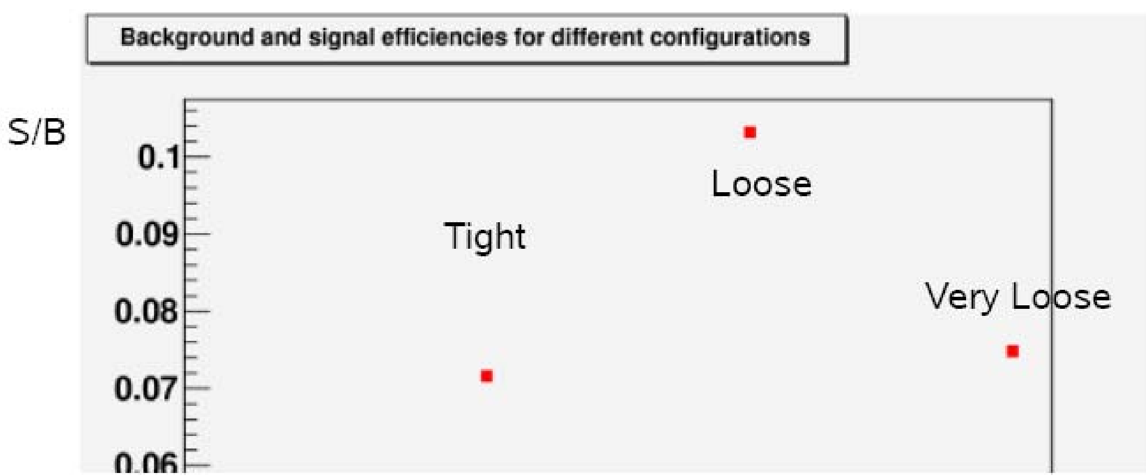


PionLoose



Example B→ ργ vs B→ K*γ (cosidered in this case as the only background)

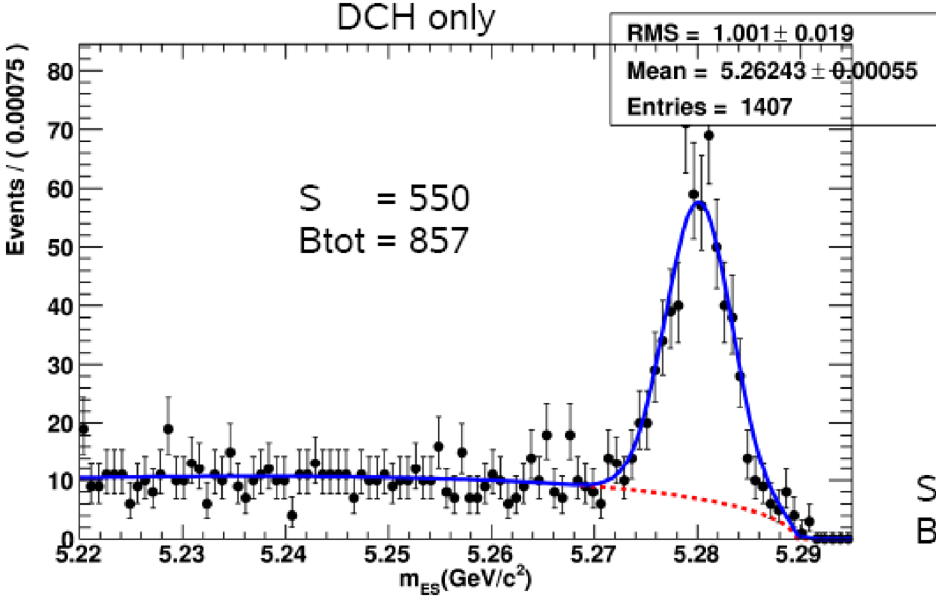




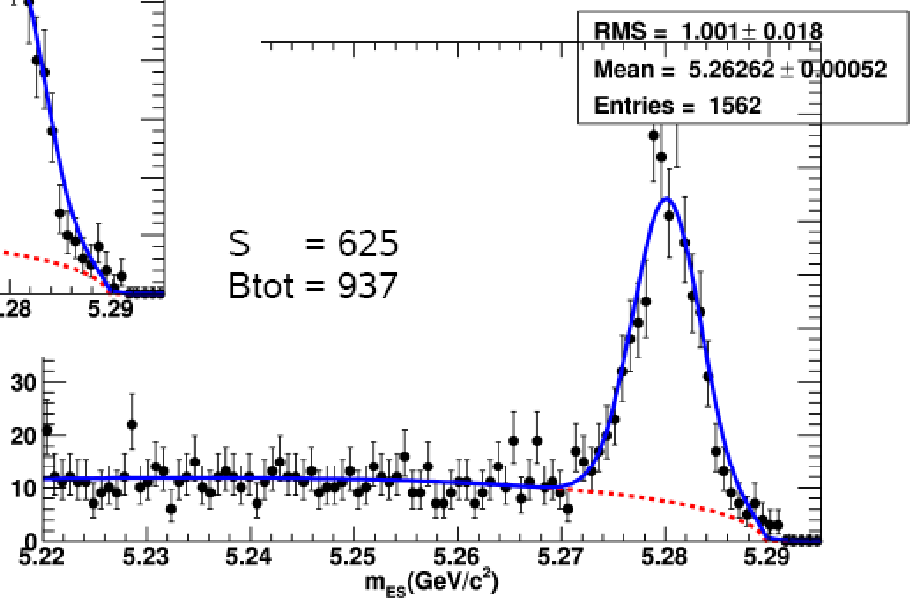
Another example with very high multiplicity

$B \to D^0 \pi \pi \pi, D^0 \to K \pi \pi \pi$

Forward just covered by DCH only



Forward TOF



Gain in efficiency
~ 13%

Similar studies are going on from Evgeniy Kravchenko

Studies of B→ K ν ν with semileptonic BRECO

Alejandro Perez
(LAL)

BRECO SIDE

- Look for $B^+ \to D^{0(*)} l \nu$ and $B^0 \to D^{+(*)} l \nu$ ($l = e/\mu$)
- D^0/D^+ reconstructed in 6 decays channels:
  - $D^0 \to K^-\pi^+, K^-\pi^+\pi^-\pi^+, K^-\pi^+\pi^0, K^0_S\pi^+\pi^-$
  - $D^+ \to K^-\pi^+\pi^-, K^0_S\pi^+$
- Also look also for D* decays:
  - $D^{*+} \to D^0\pi^+, D^+\pi^0$ (slow pions)
  - $D^{*0} \to D^0\pi^0, D^0\gamma$
- Form a $D^{(*)}l$ pair adding a hard lepton

+ Signal side B→ K νν

- $|\cos(K,Dl)| < 0.8$
- $|p^*_K| > 1.25$ GeV/c
- $E_{extra} < 250$ MeV/c^2
- Flavour correlation ($K^+ \leftrightarrow K^-(D^0)$ in tag side)
- Signal K inside PID system (we include Fwd DcH/PID)

Efficiency	BaBar FullSim	BaBar FastSim (v03)	BaBar FastSim (v09)
Tag-Side	0.00530	0.00543	0.00593
Signal-Side	0.217	0.210	0.229

Signal Sample: selection efficiency

Tagging efficiency

	BaBar	SuperB	
D^0 Dec. Channel	DIRC+FwdDch	DIRC+FwdDch	DIRC+FwdPiD
$K^-\pi^+$	0.001256	+9.7%	+7.6%
$K^-\pi^+\pi^-\pi^+$	0.001681	+4.9%	+9.6%
$K^-\pi^+\pi^0$	0.003307	+6.7%	+6.1%
$K^0_s\pi^+\pi^-$	0.000463	+11.0%	+7.2%
Average	0.006707	+7.1%	+7.3%

Signal efficiency

	BaBar	SuperB	
D^0 Dec. Channel	DIRC+FwdDch	DIRC+FwdDch	DIRC+FwdPiD
--------	0.227	+5.7%	+2.5%

A dedicated FPID allows a gain of ~10% on signal efficiency (BRECO+signal side)
Almost as much as we from the better acceptance due to the reduced boost

Performance of Backward EMC at SuperB

A. Rakitin, A. Chivukula
(CalTech)

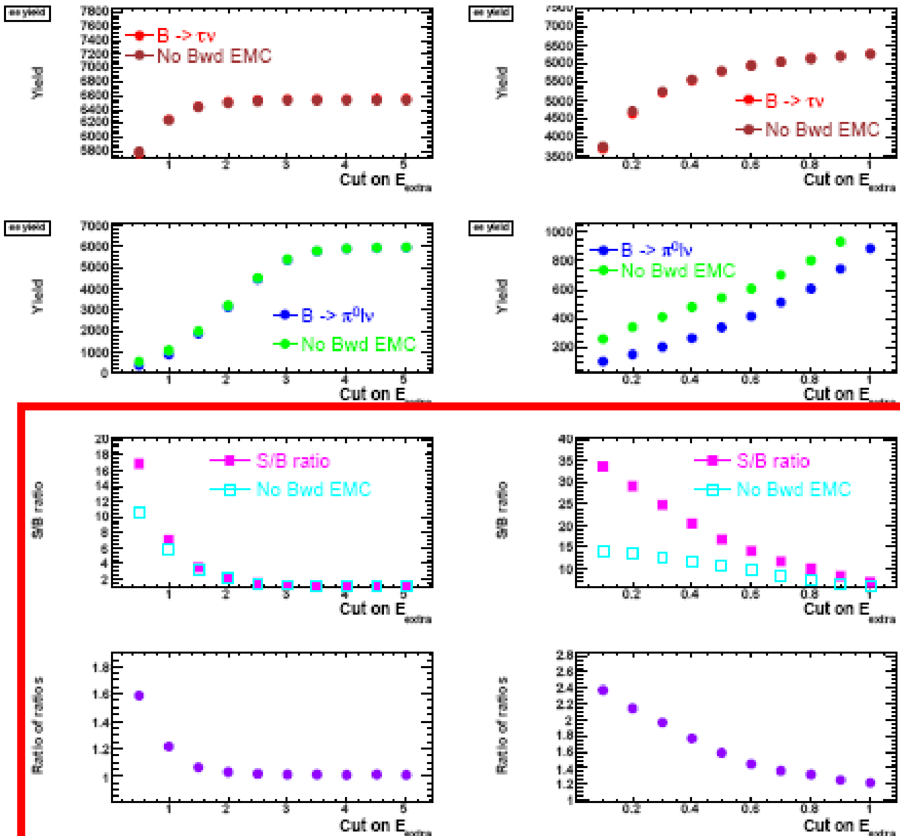
Using hadronic B→ τ ν with hadronic BRECO analysis

- Generate 10K signal events:
  - Tag $B^+ \to \overline{D^0}\pi, \overline{D^0} \to K^+\pi^-$ (simplest hadronic tag for the moment)
  - Recoil $B^- \to \tau^-\overline{\nu_\tau}$
    - ☞ $\tau^- \to e\overline{\nu_e}\nu_\tau$
    - ☞ $\tau^- \to \mu\overline{\nu_\mu}\nu_\tau$
    - ☞ $\tau^- \to \pi^-\nu_\tau$

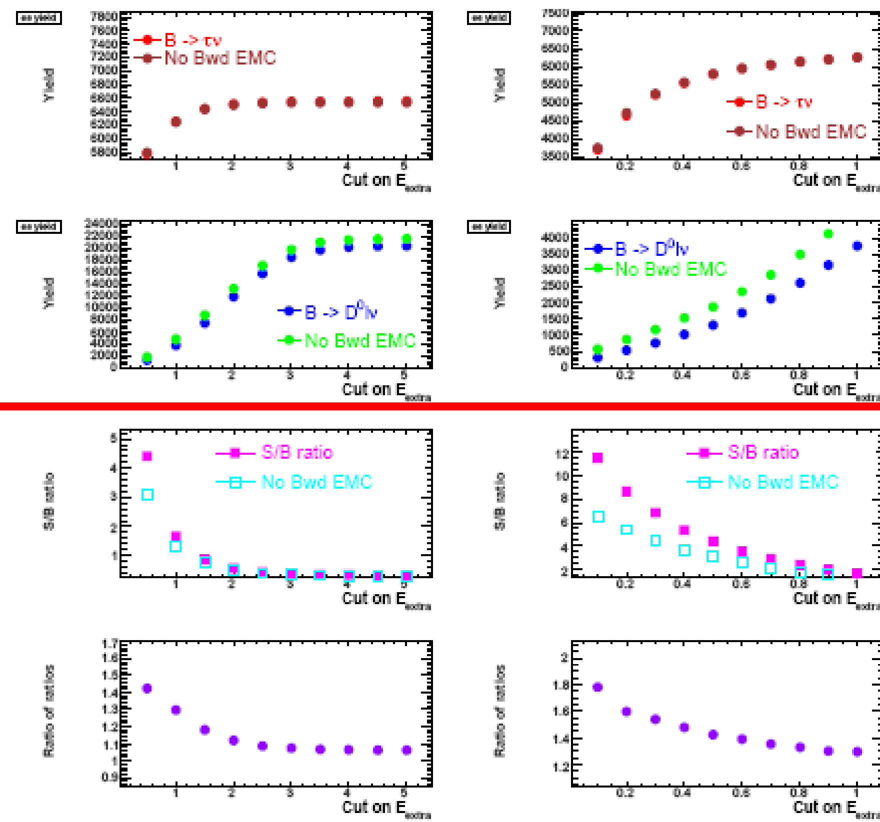
Many possible background :

Decay	Lost particles	BF	BF ratio
Signal $B^+ \to \tau^+\nu_\tau$	–	$(1.4 \pm 0.4) \times 10^{-4}$	1.00
$B^+ \to \overline{D^0}\ell^+\nu_\ell$	$\overline{D^0}$ decay product(s)	$(2.24 \pm 0.11)\%$	160
$B^+ \to \overline{D^{*0}}\ell^+\nu_\ell$	$\overline{D^{*0}}$ decay product(s)	$(5.68 \pm 0.19)\%$	406
$B^+ \to D^-\pi^+\ell^+\nu_\ell$	D^- decay product(s) and π^+	$(4.2 \pm 0.5) \times 10^{-3}$	30
$B^+ \to D^{*-}\pi^+\ell^+\nu_\ell$	D^{*-} decay product(s) and π^+	$(6.1 \pm 0.6) \times 10^{-3}$	44
$B^+ \to \overline{D^{**0}}\ell^+\nu_\ell$	$\overline{D^{**0}}$ decay product(s)	a few %	$\mathcal{O}(10^2)$
$B^+ \to \pi^0\ell^+\nu_\ell$	π^0 photon(s)	$(7.7 \pm 1.2) \times 10^{-5}$	0.55
$B^+ \to \eta\ell^+\nu_\ell$	η photon(s)	$(6 \pm 4) \times 10^{-5}$	0.43
$B^+ \to \eta'\ell^+\nu_\ell$	η' decay product(s)	$(1.7 \pm 2.2) \times 10^{-5}$	0.12
$B^+ \to \omega\ell^+\nu_\ell$	ω pion(s)	$(1.3 \pm 0.6) \times 10^{-4}$	0.93
$B^+ \to \rho^0\ell^+\nu_\ell$	ρ^0 pion(s)	$(1.28 \pm 0.18) \times 10^{-4}$	0.91
$B^0 \to D^-\ell^+\nu_\ell$	D^- decay product(s)	$(2.17 \pm 0.12)\%$	155
$B^0 \to D^{*-}\ell^+\nu_\ell$	D^{*-} decay product(s)	$(5.16 \pm 0.11)\%$	369
$B^0 \to \overline{D^0}\pi^-\ell^+\nu_\ell$	$\overline{D^0}$ decay product(s) and π^-	$(4.3 \pm 0.6) \times 10^{-3}$	31
$B^0 \to D^{**-}\ell^+\nu_\ell$	D^{**-} decay product(s)	a few %	$\mathcal{O}(10^2)$
$B^0 \to \rho^-\ell\nu$	ρ^- pion(s)	$(2.47 \pm 0.33) \times 10^{-4}$	1.76
$B^0 \to \pi^-\ell\nu$	π^-	$(1.34 \pm 0.08) \times 10^{-4}$	0.96

$B^+ \rightarrow \pi^0 \ell \nu$



$B^- \rightarrow D^{*0} \ell \nu$:



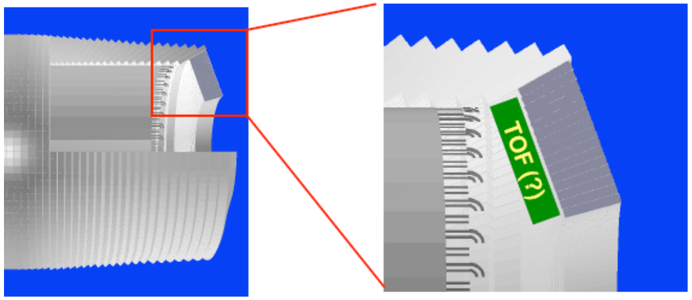
Significant gain with Backward calorimeter

EMC studies

Stefano Germani
(Perugia)

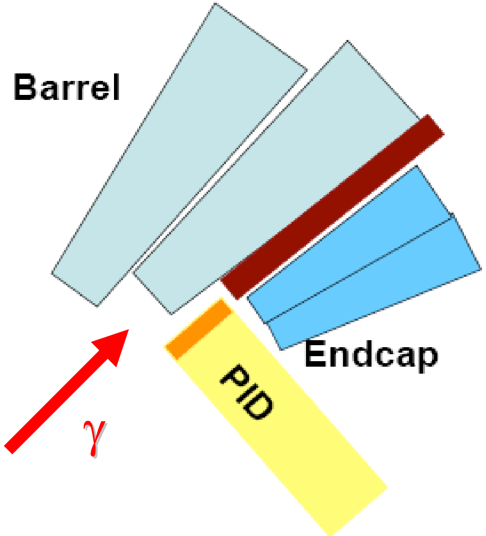
A study started (using full Simulation) on the impact on

- Effect of Barrel-Endcap transition region
- Effect of endcap position with respect to the barrel
- Effect of Forward PID material



→ Comparison between SuperB full simulation and standing alone one

→ First quick scan on theta angle to investigate
- -the FWD-BARREL transition region
- -the position of the FWD vs BARREL



Results expected in July

Gianlugi Cibinetto
(Ferrara)

IFR Optimisation

- Parameters to optimize
  - Number of active layers
  - Amount of absorber
  - Width of the scintillator bars
  - Evaluate the worst allowed time resolution

- What is needed: a full superB simulation + reconstruction code and tools.

- The plan is to generate single particle events (muons, pions and then also Kl) and events + background with Bruno and then write some reconstruction and what's needed to optimize the detector.

Needed to have a rough estimate of scintillators to be ordered