Detector Geometry WG summary

M. Rama and A. Stocchi for the DGWG
SuperB general meeting, Annecy 19 March 2010

sessions at this meeting

Wednesday 17 March

09:00->*10:30* Parallel - Detector Geometry WG (Convener: Matteo Rama (*LNF*) , Achille Stocchi (*LAL - Univeriste Paris Sud and IN2p3/CNRS*)) (Salle des Sommets) more information

09:00	Impact of bwd EMC on B->tau nu (30') (Slides)	Alexander Rakitin (*Caltech*)
09:30	Impact of bwd EMC and fwd PID on B->K(*)nu nubar (SL tag) (30') (Slides)	Alejandro Perez (*LAL*)
10:00	Impact of bwd EMC and fwd PID on B->K(*)nu nubar (had tag) (30') (Slides)	Elisa Manoni (*PG*)

16:00->*17:30* Parallel - Detector Geometry WG (Convener: Matteo Rama (*LNF*) , Achille Stocchi (*LAL - Univeriste Paris Sud and IN2p3/CNRS*)) (Salle des Sommets) more information

Description:

The session will start at 16:15

16:00	Tracking as a function of DCH wires configuration (30') (Slides)	Giuseppe Finocchiaro (*INFN - LNF*)
16:30	IFR optimization (30') (Slides)	marcello rotondo (*INFN Padova*)

$B \to K^{(*)}\nu\nu$ and $B \to \tau\nu$ studies

- results without the machine background
- effect of (rad)Bhabhas

$B \to \tau\nu$ as a function of bwd EMC: results without including machine bkg

A. Rakitin Dec09

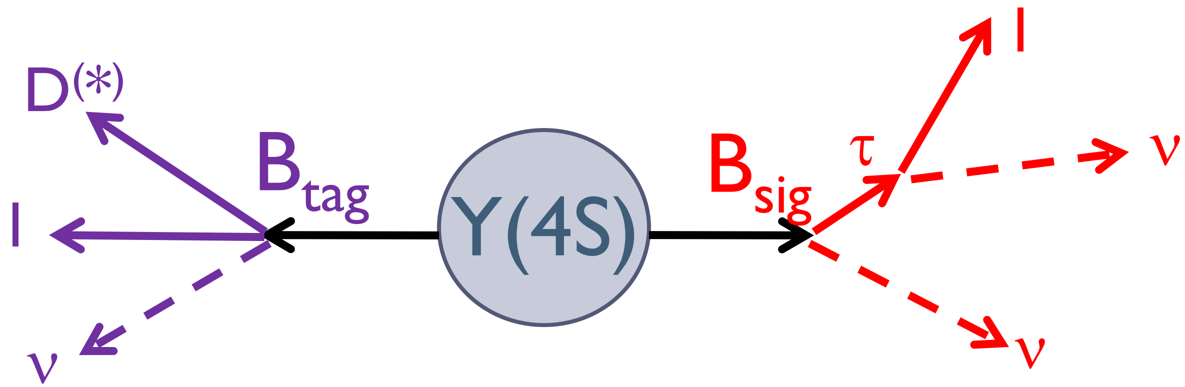
CONCLUSIONS:

$\tau \to \ell\nu\nu, \pi\nu$		$\tau \to \rho(\pi\pi^0)\nu$			$\tau \to \pi 2\pi^0\nu, a_1(3\pi)\nu, 3\pi\pi^0\nu$	
Mimicking decay	Rel. BF		Mimicking decay	Rel. BF	Mimicking decay	Rel. BF
$B \to D^{(*(*))0}\ell\nu$ $B \to D^{(*)}\pi\ell\nu$ $B \to$ non-charm $\ell\nu$	$\mathcal{O}(10^2\text{-}10^3)$ $\mathcal{O}(10^2)$ $\mathcal{O}(1)$	direct ρ	$B \to D^{(*(*))0}\rho$ $B \to J/\psi\rho$ $B \to$ non-charm ρ	$\mathcal{O}(10^2\text{-}10^3)$ 1.39 $\mathcal{O}(1)$	Anything with final state $\pi 2\pi^0$, 3π or $3\pi\pi^0$	???
		indirect ρ	$B \to$ stuff, stuff $\to \rho + X_{missed}$	???		
		π^0 + track	Anything with final state π^0 + track + X_{missed}	???		
			Special case: $B \to \pi^0\ell\nu$ (nothing is missed)	0.55		
Done, $\sim 8\%$ improvement in $S/\sqrt{S+B}$ due to bwd EMC		Partially done, $\sim 10\%$ imp. for direct ρ, need generic MC for the rest			Definitely need generic MC	

results with $B \to D^0\pi$ tag

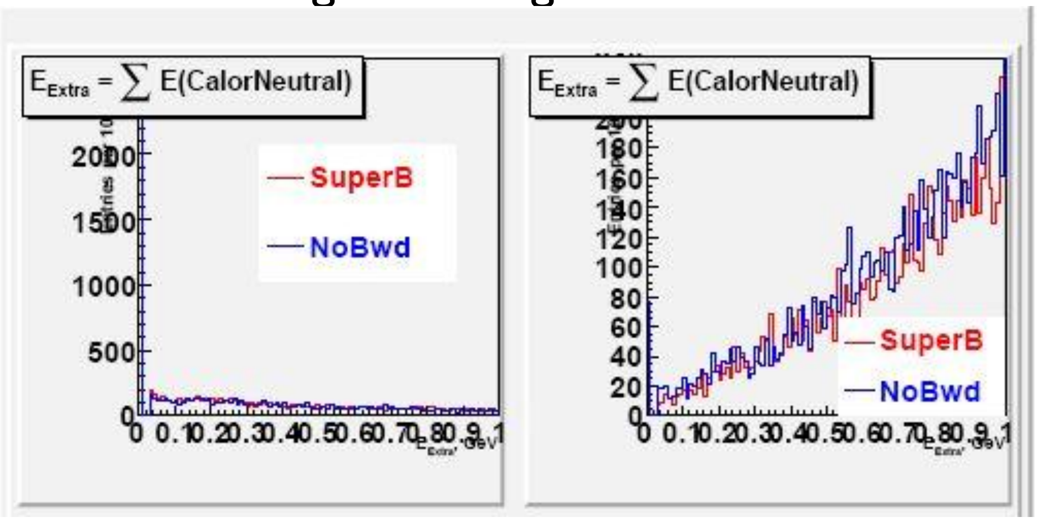
Next steps:
a) Include other signal modes and bkg decays
b) Include the main B tag modes (HAD+SL)

Brecoil technique



E_{extra}: sum of the energies of the EMC neutral clusters NOT used to reconstruct either the tag or the signal B

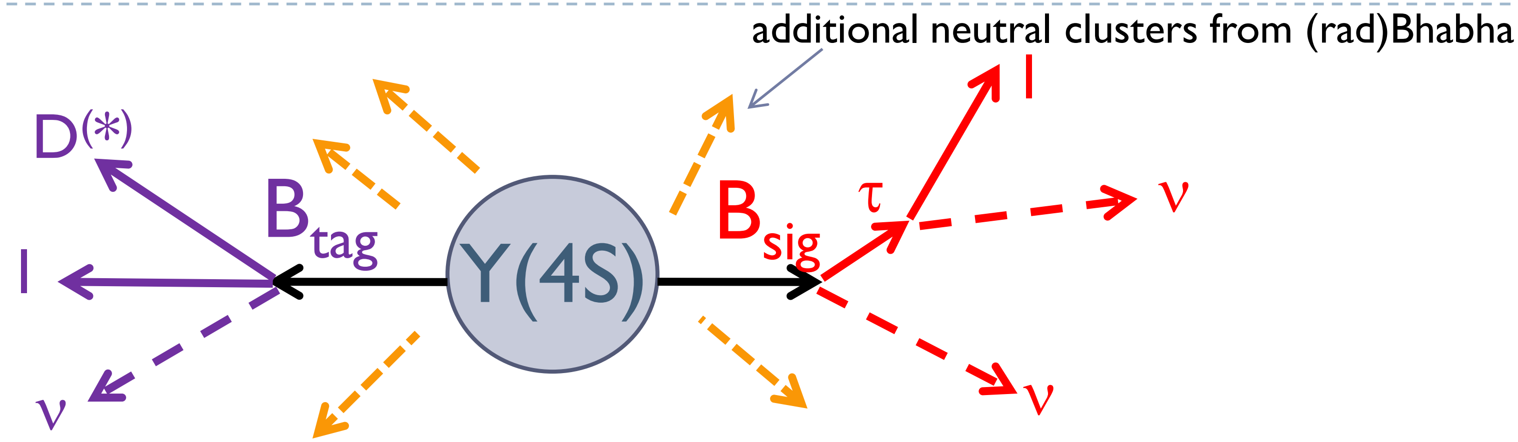
signal



A. Rakitin

generic background

Brecoil technique with high (rad)Bhabha rate



E_{extra}: sum of the energies of the EMC neutral clusters NOT used to reconstruct either the tag or the signal B

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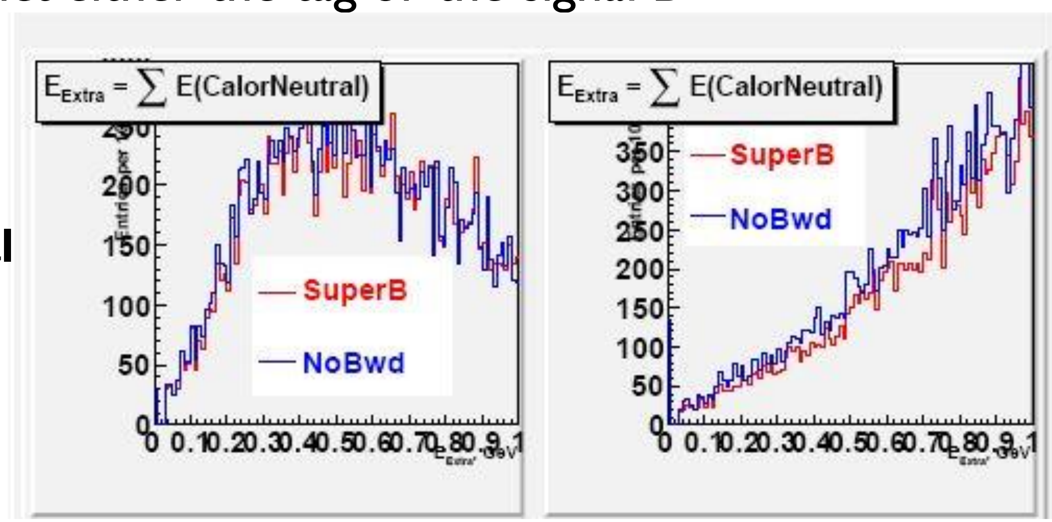
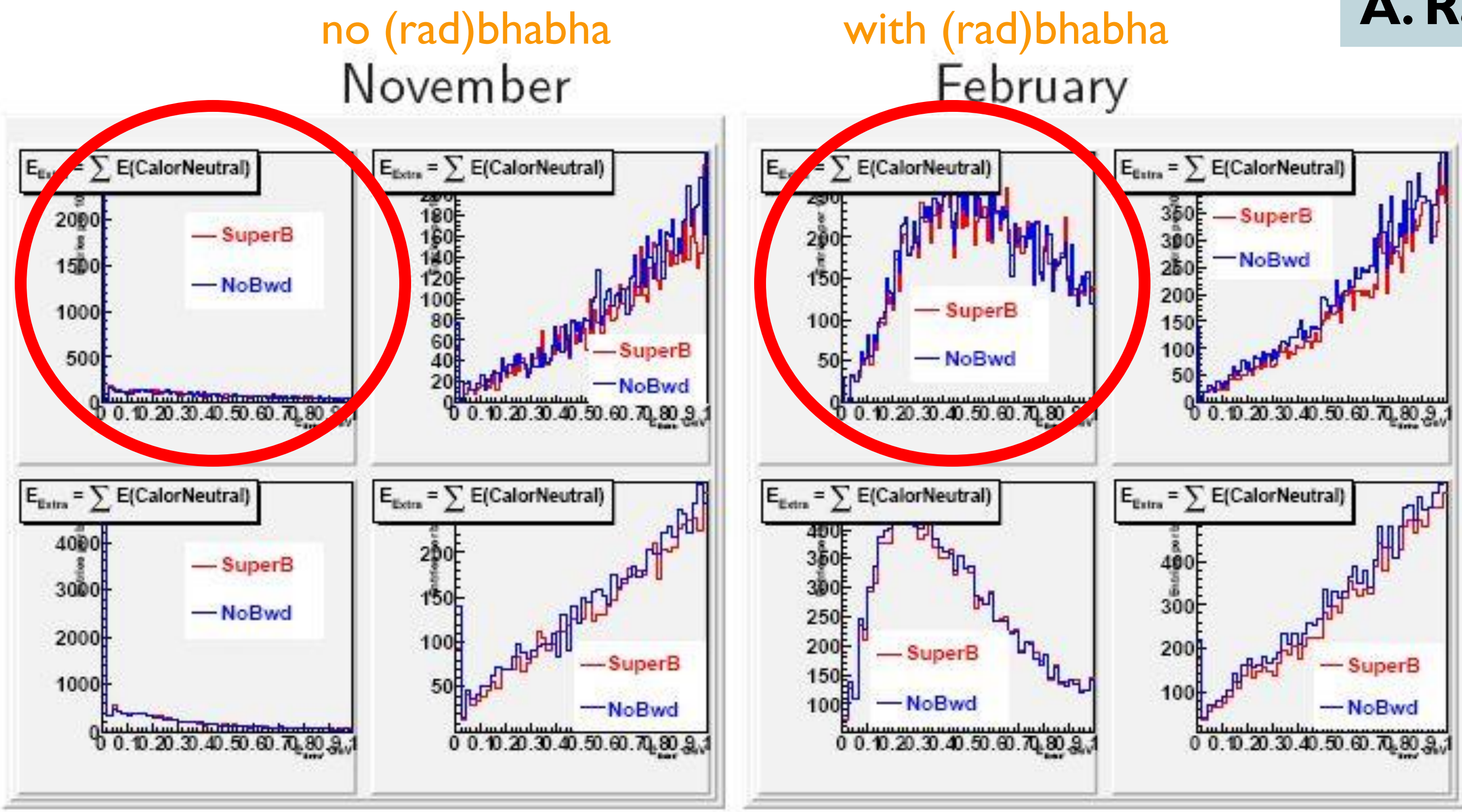


A. Rakitin

generic background

B→τν as a function of bwd EMC: what happens when (rad)Bhabhas are included

A. Rakitin



- Top: All B_{sig}, bottom: best B_{sig}
- Left: sig MC, right: generic MC

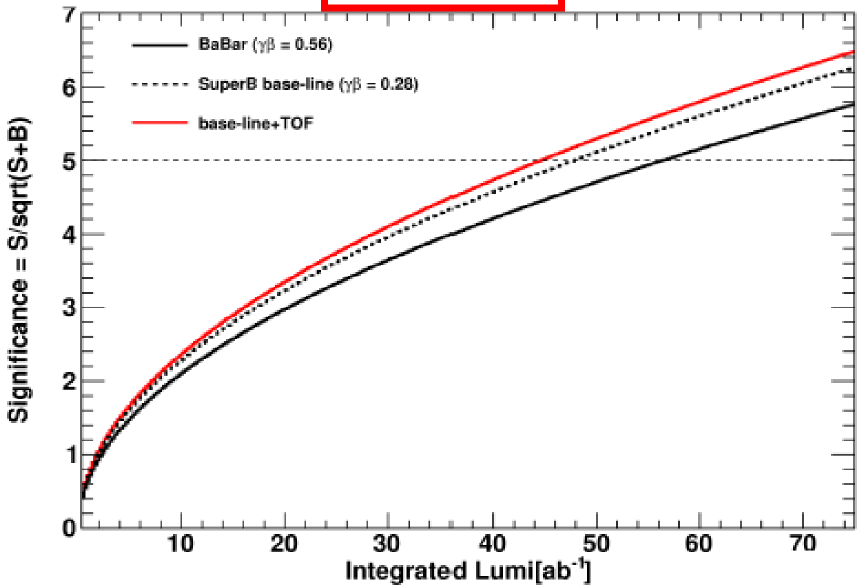
Note: bkg overestimated by a factor ~4 here

fwd PID (TOF) with $B \rightarrow K^{(*)}\nu\nu$: results without including (rad)Bhabhas

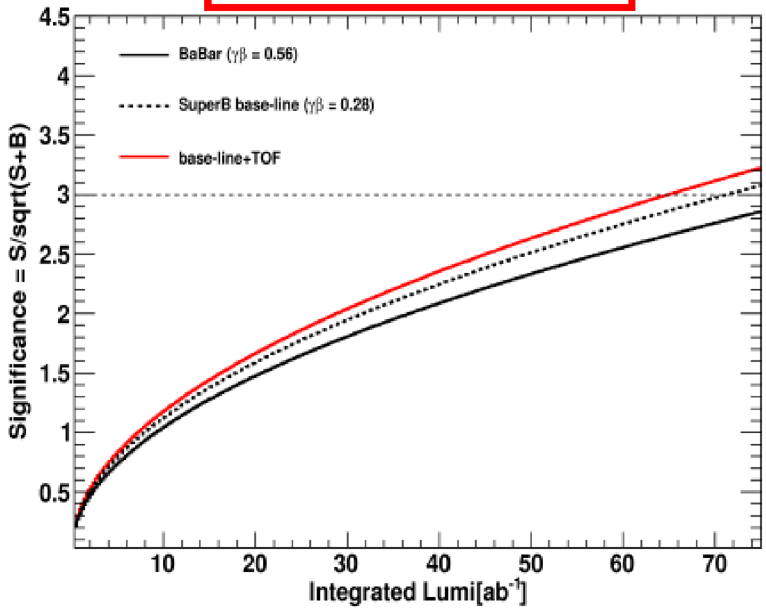
A. Perez
December 09

CONCLUSIONS:

$K^{+}\nu\nu$



Combined $K^{*(0,+)}\nu\nu$



5σ significance (stat-only):
- BaBar: ~55ab^{-1}
- SuperB-base line: ~48ab^{-1}
- +TOF: ~44ab^{-1}

Gain on S/sqrt(S+B):
boost ~ 7-8%
fwd PID ~ 5%

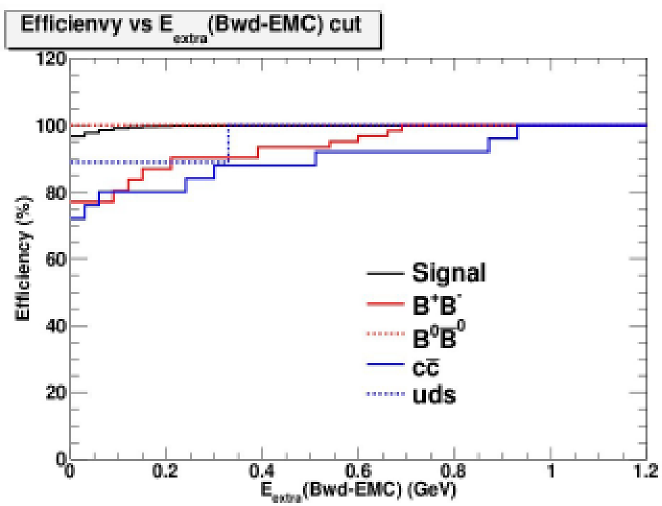
3σ significance (stat-only):
- BaBar: > 75ab^{-1}
- SuperB-base line: ~71ab^{-1}
- +TOF: ~64ab^{-1}

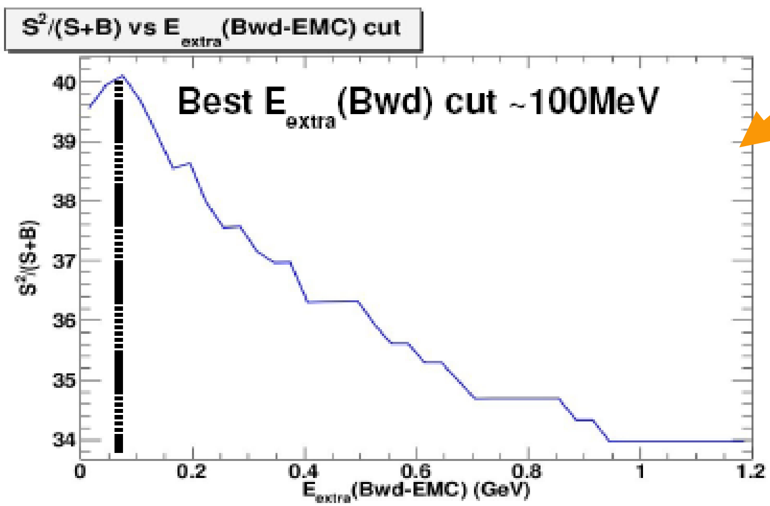
bwd EMC with B→K$^{(*)}\nu\nu$: results without including (rad)Bhabhas

A. Perez

- Study efficiency vs E_{extra}(Bwd) cut for all samples (signal and backgrounds)
- Optimize cut to maximize $S^2/(S+B) \Rightarrow E_{extra}$(Bwd) cut at ~100MeV
- Efficiencies after E_{extra}(Bwd) cut:
  - ~99% Signal
  - ~80% B^+B^- generic
  - ~99% B^0B^0 generic (almost no events)
  - ~80% ccbar
  - ~90% uds

S/sqrt(S+B) improves by ~8% when bwd EMC is used: this study needs to be redone with (rad)Bhabha included and with more stat



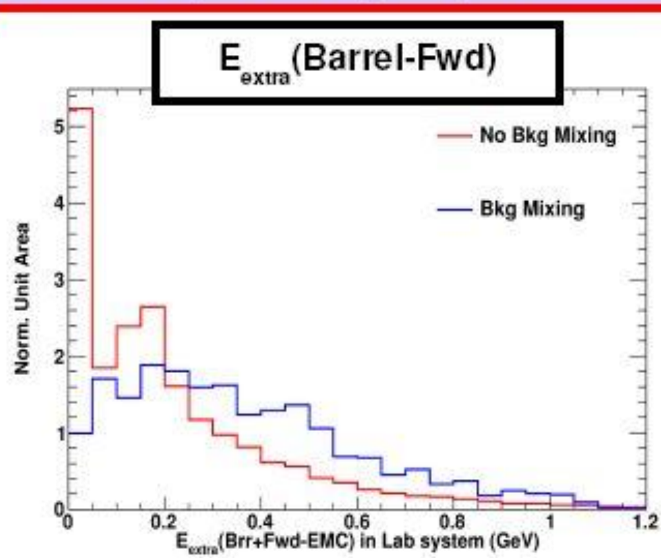


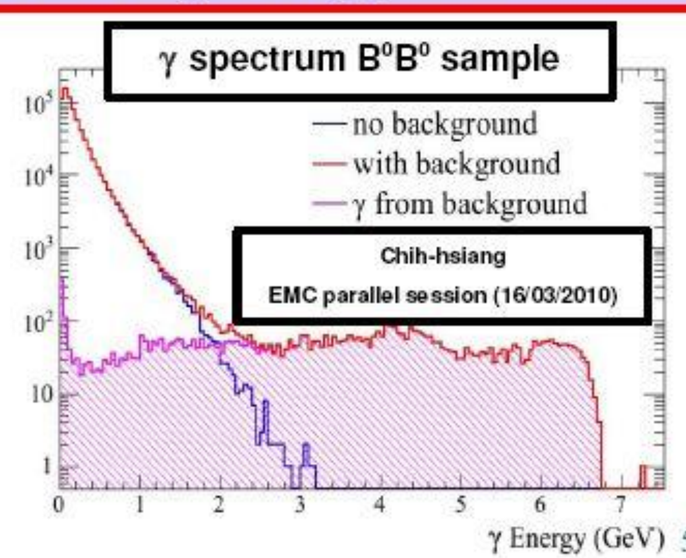
7th 2010

$B \to K^{(*)}\nu\nu$: what happens when (rad)Bhabhas are included

A. Perez

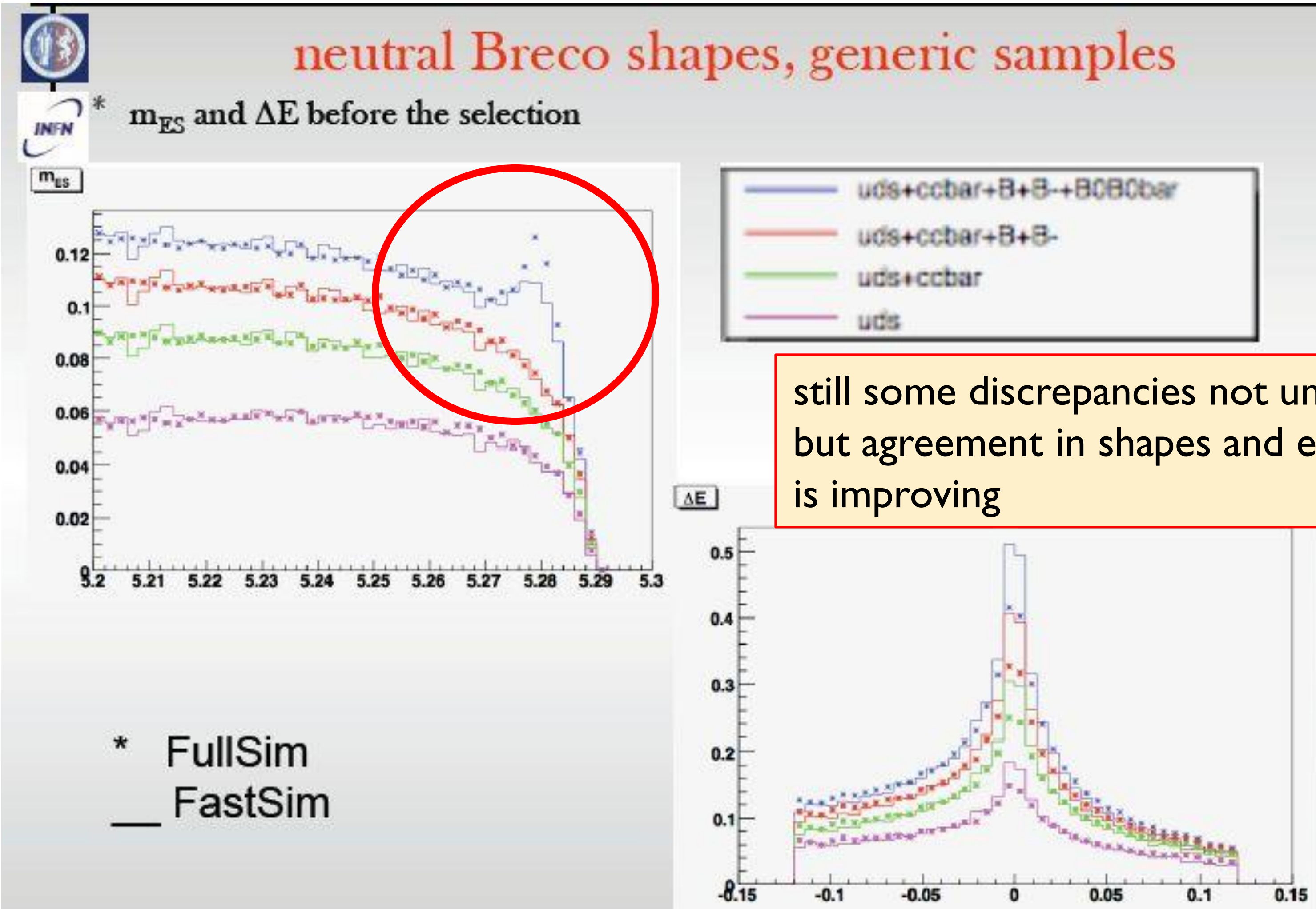
- **BaBar: negligible effect due to relatively low event rate**
- **SuperB: significant amount of high energy background γs from Bhabhas/Rad-Bhabhas**
  $\Rightarrow$ Bkg mixing samples spoiled
  - Significantly reduced signal efficiency due to number of neutrals cut (<15)
  - E_{extra}(Brr-Fwd) distribution modified
  - Similar effects seen by other analysis using Breco ($B \to K^{(*)}\nu\nu$ and $B \to \tau\nu$ Had-Breco)
- **Need to re-produce n-tuples with Bkg mixing removing number of neutrals cut**
- **Need separate Bkg component $\Rightarrow$ study discrimination against bkg gammas**





Breco hadronic tag: progress in setup and validation

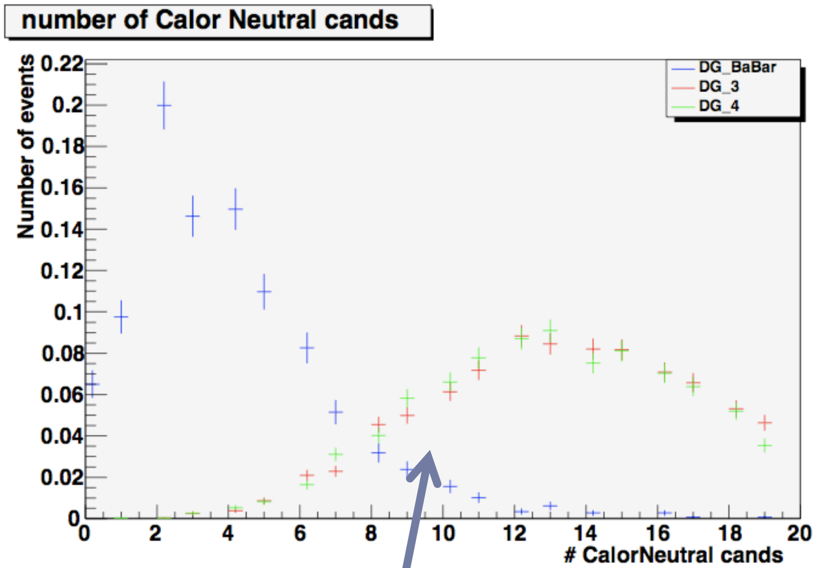
E. Manoni



still some discrepancies not understood, but agreement in shapes and efficiency is improving

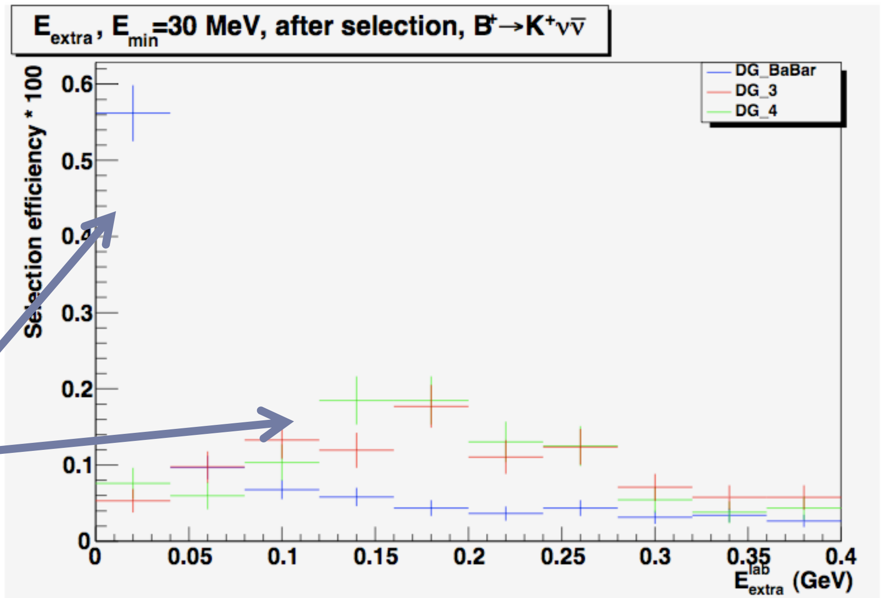
Effect of radBhabha+Bhabha on $B \rightarrow K^+ \nu\nu$: another study with HAD tag

E. Manoni



Note: bkg overestimated by a factor ~4

increased number of neutrals



signal E_{extra} no longer peaks at 0 when (rad)Bhabha is added

Next steps

- Can we trust the DGWG results obtained so far using FastSim without the machine backgrounds?
  - studies concerning SVT and DCH should be still valid at first order
  - results concerning the impact of the fwd PID on $B \to K^{(*)}\nu\nu$ should be still valid at first order, but the analysis will be redone
  - studies concerning the impact of the bwd EMC on $B \to K^{(*)}\nu\nu$ and $B \to \tau\nu$ will be redone
- What to do next
  - consolidate these fresh results
  - optimize the analyses according to the SuperB environment, which is different from the Babar one
  - understand what margins there are at the detector level
    - for example, how much can the EMC time windows be reduced, and what would be the impact on cluster reconstruction?
  - think about possible ways to speed up the production of the generic backgrounds to increase the size of the simulated samples
    - goal of Summer production: large samples (at least $1ab^{-1}$) of $B \to K^{(*)}\nu\nu$ and $B \to \tau\nu$ with the main machine background sources included

- DCH tracking studies
- IFR optimization

Cell and layer layout optimization

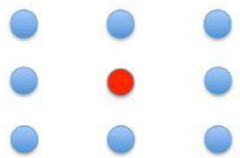
G. Finocchiaro

1. Number of axial vs. stereo measuring layers
2. Material in hexagonal vs. "square" (or rectangular) cell layouts, for different gas mixtures

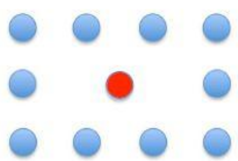
I. "Nominal": AUVAUVAUVA
II. "Axial": AAAAAAAAAA
III. "Stereo SL" : AUVUVUVUVA
IV. "Stereo layers" Auvuv.....uvuvA

conclusion: tracking does not seem to impose serious constraints to numbers and arrangement of stereo layers

✓ 3:1 field:sense ratio - 7972 sense 20μm⌀ wires, 1554 guard 80μm⌀ wires, 25150 field 80μm⌀ wires



✓ 4:1 field:sense ratio - 7972 sense 20μm⌀ wires, 2331 guard 80μm⌀ wires, 33739 field 60μm⌀ wires

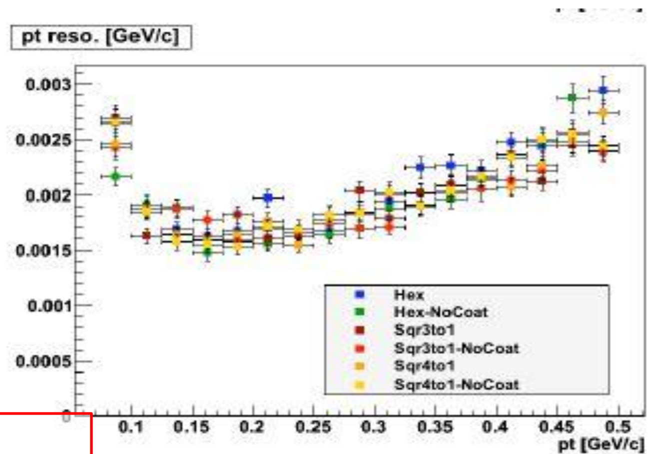


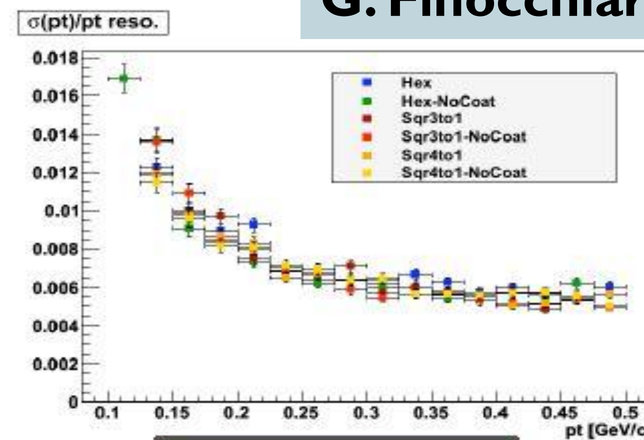
conclusion:
15-20% improved low pt resolution with lighter wire config, but more statistics is needed
NB: only effect of material evaluated here

Cell and layer layout optimization

G. Finocchiaro

low-pt resolution as a function of cell layout →



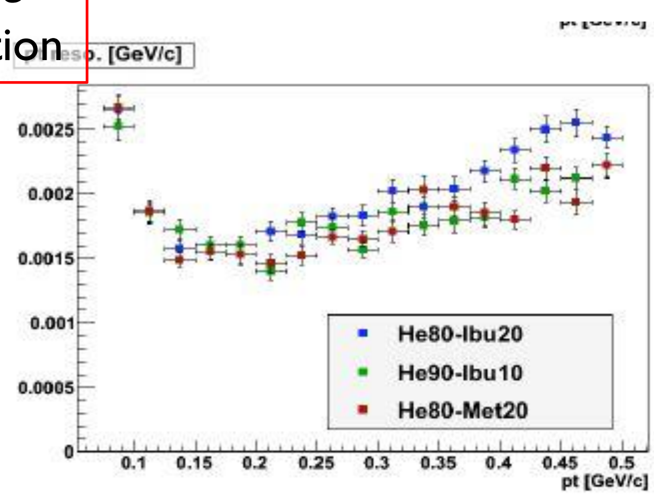


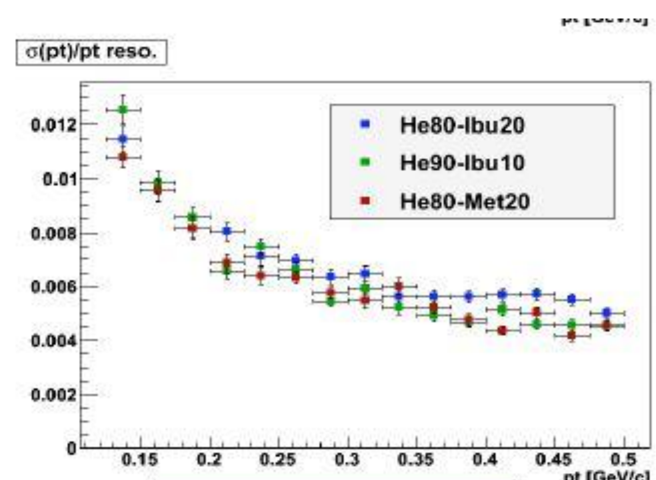
17/03/2010 G. Finocchiaro

80%He-20%iC_4H_{10}

NB configs differ for material but have same spatial resolution

low-pt resolution as a function of gas →





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Sqr 4:1 No Coating

IFR optimization

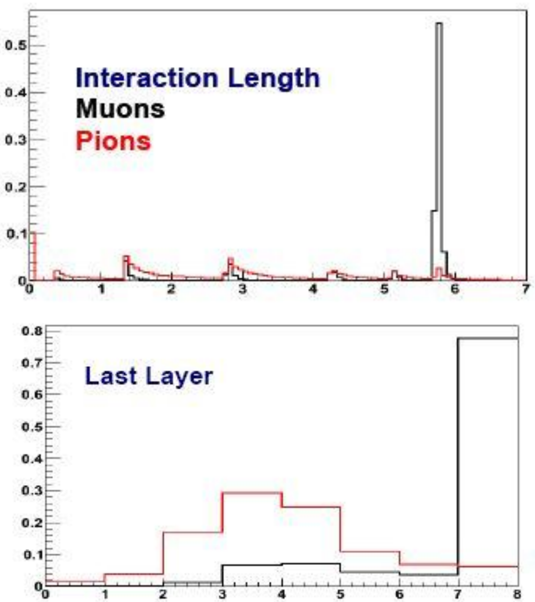
M. Rotondo

IFR configurations studied: (==: iron |: scintillator)

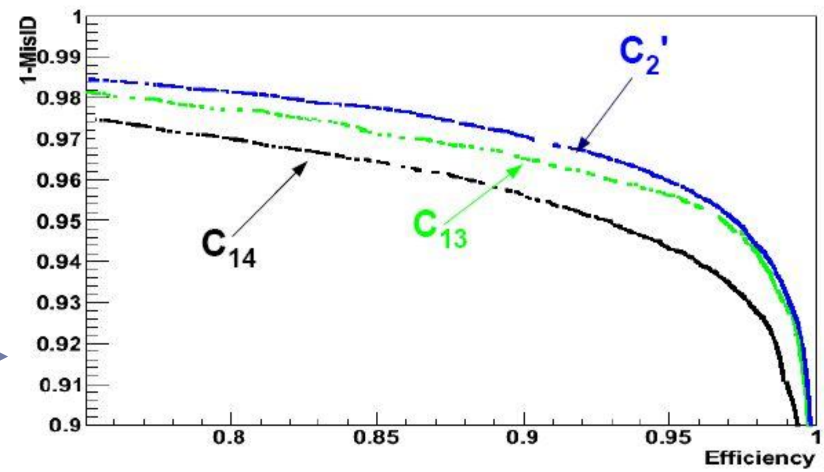
```
|=|=|========|============|============|=======|=====|   C2'  Fe 920mm
|2|2|   16   |     24     |     24     |  14   |  10 |

|=|=|========|========|========|========|=======|       C13  Fe 820mm
|2|2|   16   |   16   |   16   |   16   |  14   |

|=|=|======|======|======|======|=====|                 C14  Fe 620mm
|2|2|  12  |  12  |  12  |  12  |  10 |
```

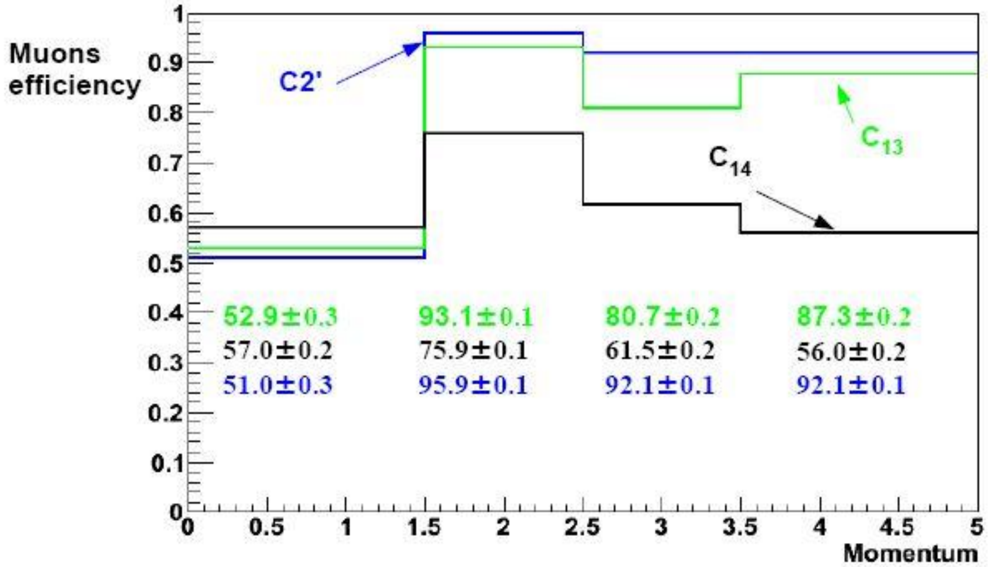


use these 2 quantities
+ other 6 to separate
muons and pions with
Boosted Decision Trees



IFR optimization

M. Rotondo



pion misID=2% in all bins

Next steps:

- Use realistic distribution for the machine bkgs from full Sim
- Explore different granularity
- Start study K_L identification

- *From the study the configuration C2' seems the best option*
- *At low momentum, the large gaps between active layers make some differences: C14 is better*
  - *Add a layer in a C2' like configuration?*
  - *The pion rejection at low moments can be increased using informations from EMC and DIRC*

Conclusions

- New studies regarding the fwd PID, bwd EMC, DCH and IFR have been presented
- The inclusion of (rad)Bhabha events in FastSim has shown that this background can have a significant effect on the measurement of decays such as $B \rightarrow K^{(*)}\nu\nu$ and $B \rightarrow \tau\nu$
- Several discussion have already taken place at this meeting to face this issue
- The det geom WG will produce a list of action items to be discussed with the computing and relevant subsystems
- The next big production is tentatively scheduled before August and would be mainly finalized to estimate the impact of a fwd PID and bwd EMC including the main sources of machine background

BACKUP

detector geometry WG main goals

The SuperB detector as described in the Conceptual Design Report has a number of options not yet defined that have a large impact on the overal detector geometry. As the MC simulation tools for the detector are rapidly maturing, we believe it is timely to set up a Detector Geometry Working Group (DGWG) to study the physics tradeoffs of the open CDR detector options with the goal of being able to finalize the global geometry and define the subsystems of the SuperB detector within a relatively short time frame, between six months and a year. The DGWG main task will be to examine critically the open questions detailed below and provide to the proto-technical board the information necessary to make the relevant decisions. The DGWG will be led by Matteo Rama and

- Main questions:
  - do we need a forward PID?
  - do we need a backward EMC?
  - SVT-DCH transition radius, internal geometry of SVT, DCH length
  - amount and distribution of material in IFR
- The activity of the DGWG involves three areas: detector, simulation and physics

Studies before this meeting

Summary of the main studies performed so far

System	Recent studies
SVT	▪ Time-dependent measurements as a function of the layer0 ▪ Tracking performance as a function of the SVT outer radius ▪ Time-dep meas. with B→KsKs as a function of the SVT outer radius ▪ Tracking performance as a function of the number of layers ▪ Degradation of sin2beta error when the boost goes from 0.28 to 0.238
DCH	▪ Tracking performance as a function of the DCH inner radius ▪ Tracking and dE/dx as a function of the DCH length
forward PID	▪ B→K(*) $\nu\nu$ SL tag with/without TOF ▪ B→K(*) $\nu\nu$ HAD tag with/without TOF (in progress)
EMC	▪ B→$\tau\nu$ with/without backward EMC ▪ E resolution of fwd EMC as a function of material in front of it (prel)
IFR	▪ Optimization of the muon selection

See also the DGWG wiki page:
http://mailman.fe.infn.it/superbwiki/index.php/Detector_Geometry_Working_Group_portal