Detector Geometry Working Group
status and goals of the meeting

Matteo Rama (LNF) – Achille Stocchi (LAL)
on behalf of the DGWG group

SuperB meeting, Perugia 16 June 2009

Detector Geometry working group

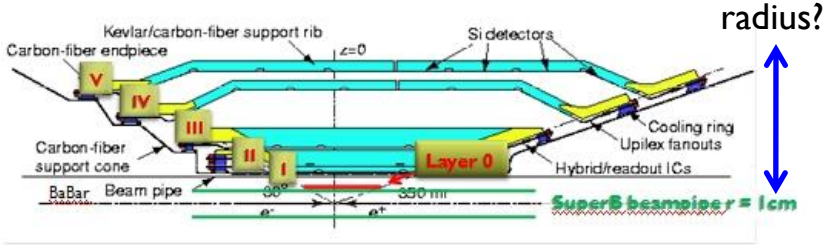
From the charge of the group:

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
  - amount and distribution of material in IFR
- The activity of the DGWG involves three areas: detector, simulation and physics

Main detector options

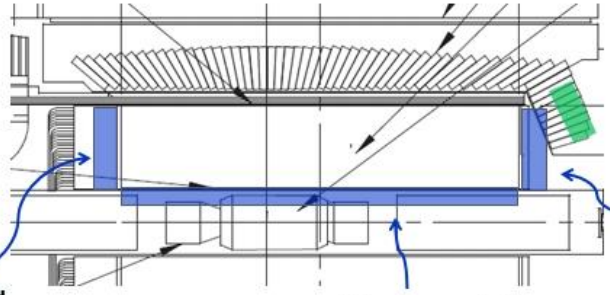
SVT



radius?

What outer radius?
What angular coverage?
How many layers?

DCH

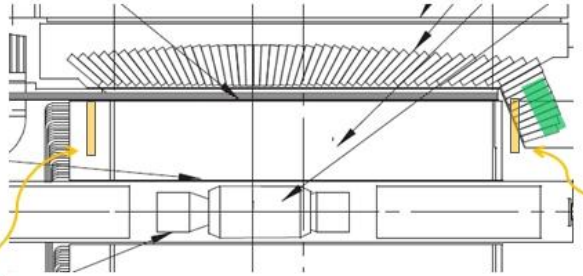


extended DCH
If NO bwd EMC/PID
and the DCH electronics
space is reduced w.r.t. Babar

What inner radius?

extended DCH
If LYSO fwd EMC
and NO fwd PID

PID

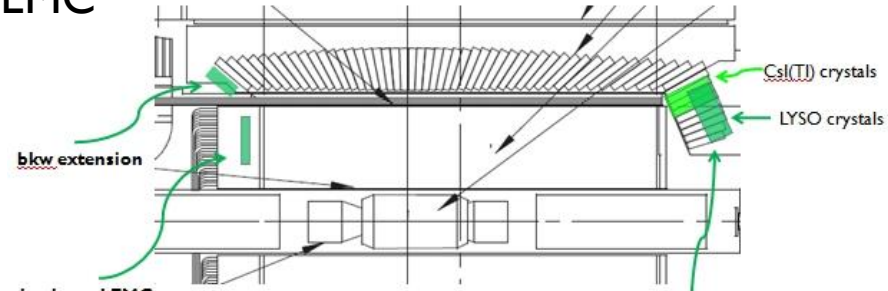


forward PID
If LYSO fwd EMC

backward PID
If NO bwd EMC
and the DCH electronics
space is reduced w.r.t. Babar

We're not considering it as a major option

EMC



CsI(Tl) crystals

LYSO crystals

bkw extension

backward EMC
If DCH electronics
space is reduced w.r.t. Babar

bwd EMC could be used as pion/kaon PID device (TOF) to some extent? Need evaluation

forward EMC
If all LYSO: additional space available
if CsI+LYSO: NO additional space available

Benchmark channels

- We want to evaluate the physics reach of a set of benchmark channels as a guideline for the optimization of the detector

work started on these channels

	H^+ high tanβ	Minimal FV	Non-Minimal FV (1-3)	Non-Minimal FV (2-3)	NP Z-penguins	Right-Handed currents
$\mathcal{B}(B \to X_s\gamma)$		■		●		●
$A_{CP}(B \to X_s\gamma)$				■		●
→ $\mathcal{B}(B \to \tau\nu)$	■ -CKM					
$\mathcal{B}(B \to X_s l^+ l^-)$				●	●	●
→ $\mathcal{B}(B \to K\nu\bar{\nu})$				●	■	
→ $S(K_S\pi^0\gamma)$						■
β			■ -CKM			●

→ + $\tau \to \mu\gamma$

■ Golden mode for a given scenario
● Non-golden, but still sensitive to deviations from the SM
-CKM requires high precision on CKM parameters (obtainable with SuperB)

+ possibly include channel at Psi(3770)

→ + "Breco": reconstruction of flavour-tagging B decays is crucial ingredient for SuperB physics program

Detector configurations for FastSim

- Set of reference detector configurations defined to test the performance of the benchmark channels
- Specific studies are being performed on specific configurations. In a second phase we could possibly test the sensitivity of each benchmark channel on several configurations

	SVT	DCH	PID	EMC	IFR
0	5 layers+L0	"babar" (**)	DIRC	fwd LYSO (*)	baseline
1	5 layers+L0	"babar"+bwd+fwd	DIRC	fwd LYSO	baseline
2	5 layers+L0	"babar"+bwd	DIRC+fwd	fwd LYSO	baseline
3	5 layers+L0	"babar"+fwd	DIRC	fwd LYSO+bwd	baseline
4	5 layers+L0	"babar"	DIRC+fwd	fwd LYSO+bwd	baseline
5	5 layers+L0	"babar"	DIRC	fwd CsI+LYSO+bwd	baseline
6	extended ang. coverage	extended ang. coverage	DIRC	fwd LYSO	baseline

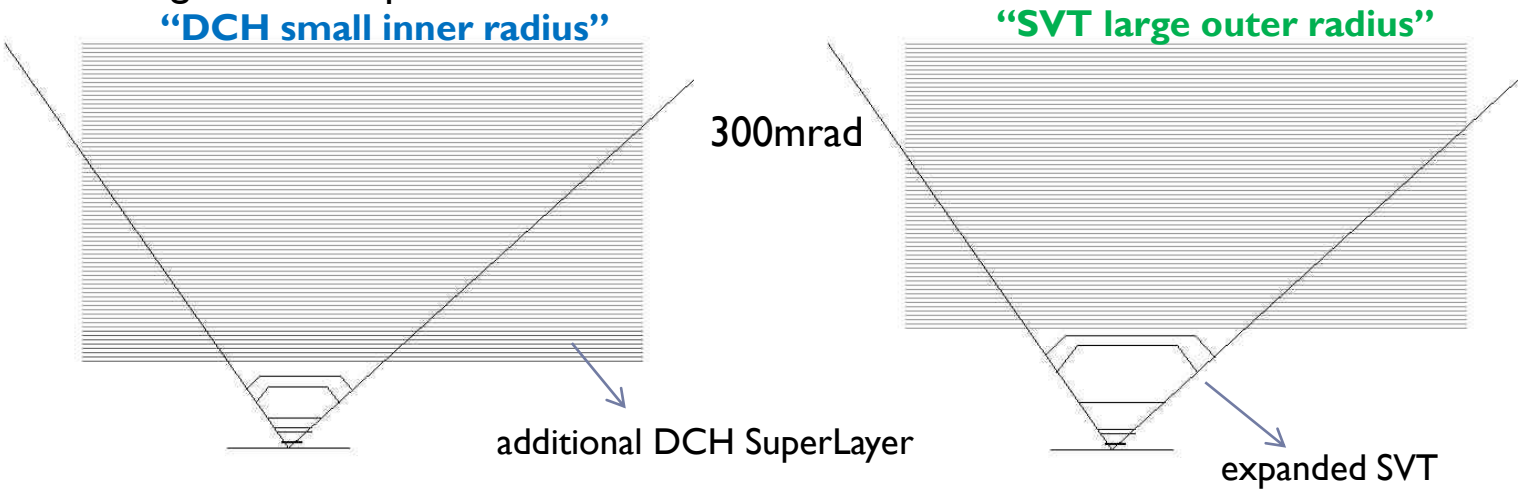
(*) more complex scenario for fwd EMC. See EMC slides later (**) DCH size examined separately

The tracker

- Updated baselines for SVT and DCH
  - including hybrid pixel SVT layer-0 and 300mrad angular coverage (fwd and bwd)
  - including additional DCH cell layers to fill the space left by the BaBar support tube removal
- Studies in progress to evaluate the tracking performance at different SVT-DCH transition radii
  - track reconstruction
  - vertex and Δt resolutions
  - Ks reconstruction

example of configurations explored

x and y axes have different scales

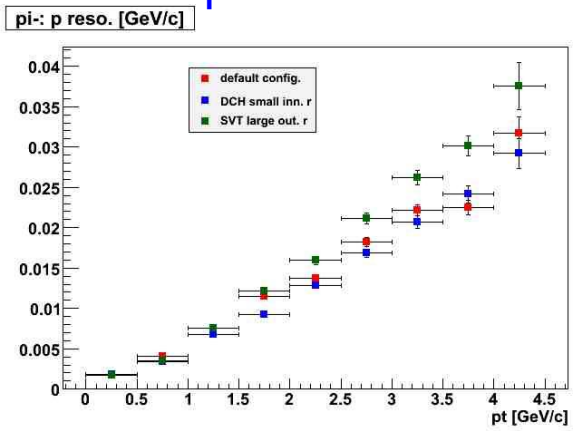


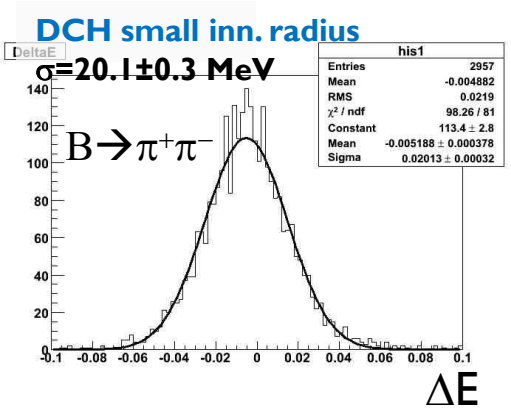
The tracking system

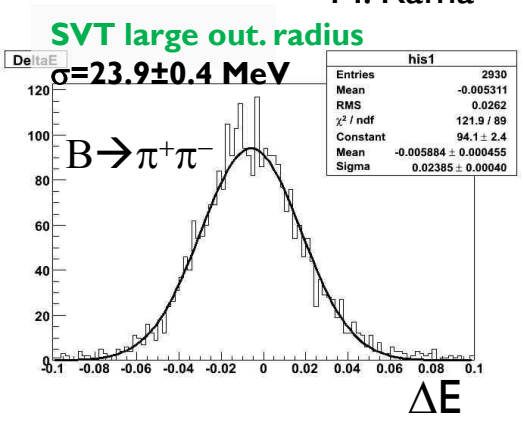
Examples of ongoing studies

track parameters resolution and B reconstruction vs. SVT/DCH radius

M. Rama

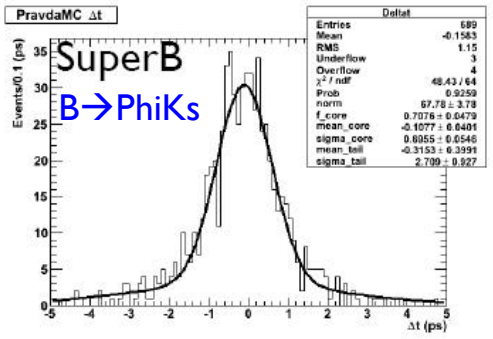




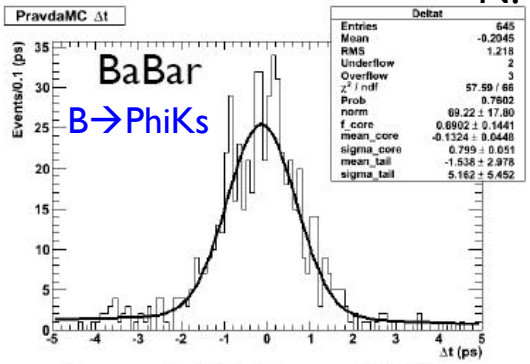


Δt resolution for "SuperB" and BaBar

N. Neri



f_{core} ~0.71 σ_{core}~0.70ps

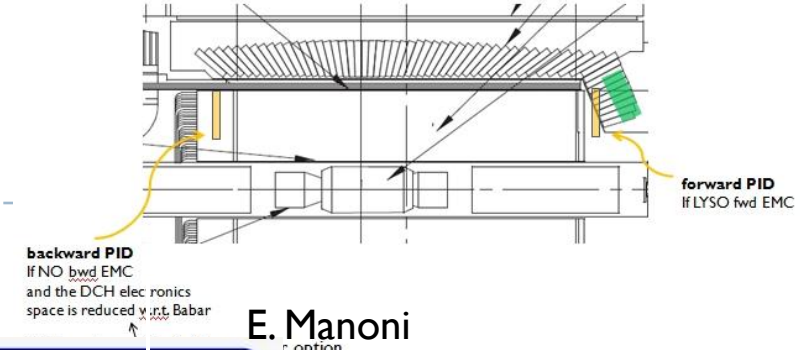


f_{core} ~0.69 σ_{core}~0.80ps

Goal for this meeting

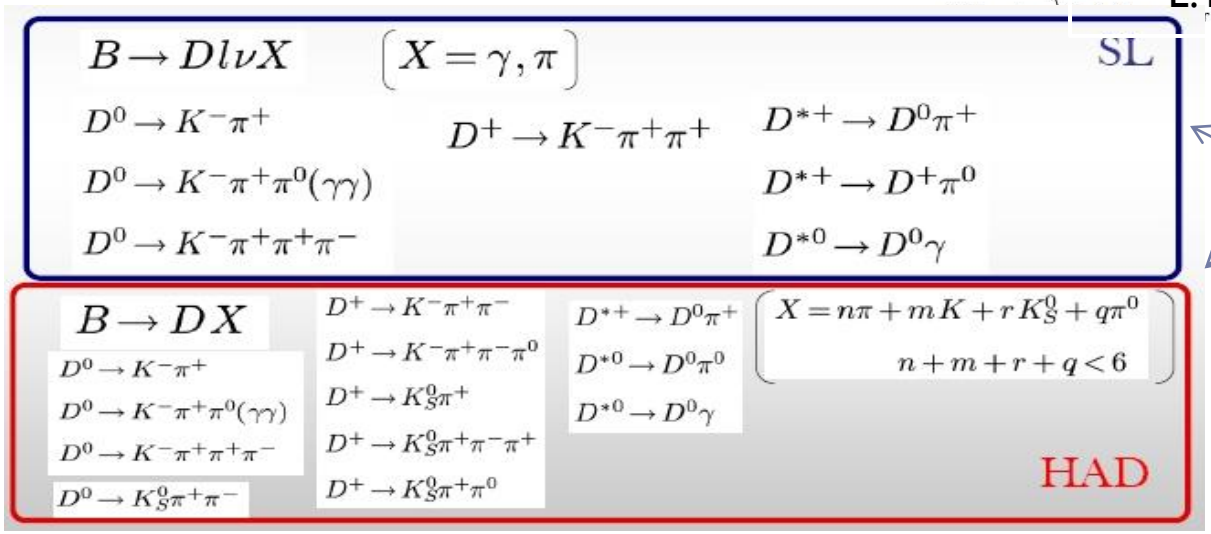
- Present new and updated studies on tracking performance vs. DCH and SVT geometries
- Compare pros and cons of different configurations
- Do we have already sufficient elements to draw conclusions on the optimal transition radius?
  - Probably not. A few open issues, including our currently poor knowledge of the machine backgrounds rates
- Give first evaluation of the impact of a boost reduction (see later)

(forward) particle Id



E. Manoni

- Impact of fwd PID on BReco:

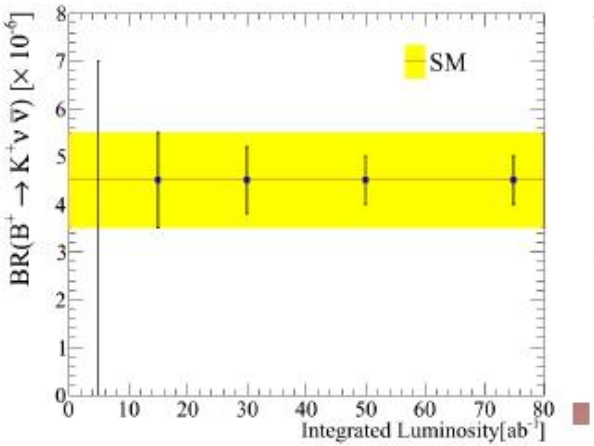


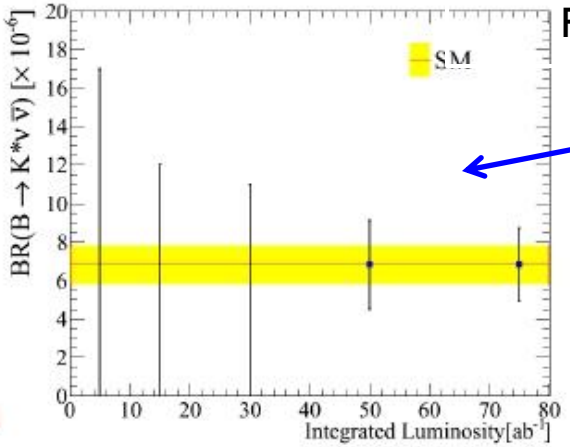
Brecoil analysis:
1- reconstruct one B (hadronic or semileptonic mode)
2- Search the signal in the rest of the event

- BRecoil tools under development, they will be used to study the benchmark channels
- Use 'MC truth-based' PID selectors
  - Development of realistic PID selectors in progress

forward PID

- Complete analysis of $B \to K^{(*)} \nu\nu$ benchmark channel





F. Renga

predictions with:
no fwd PID
no bwd EMC

plan to repeat the study with:
- fwd PID
- bwd EMC (later)

- At this meeting:
  - updated study of $B \to K^* \nu\nu$ with semileptonic tag
  - impact of fwd PID on $B \to K^* \gamma / \rho\gamma$

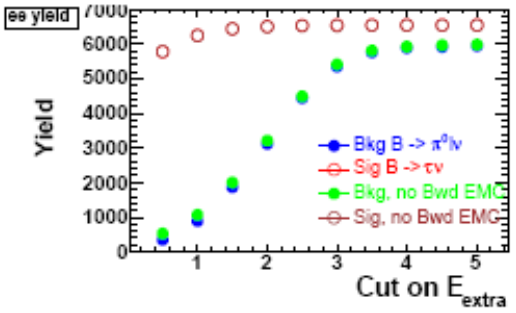
The impact of a backward EM calorimeter

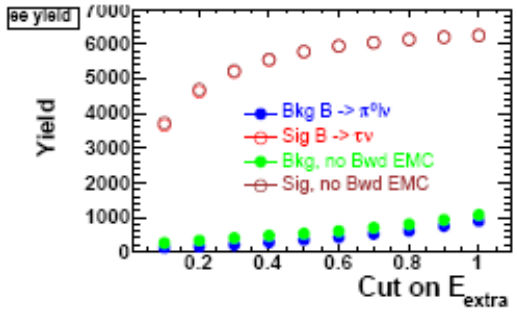
signal: $B \rightarrow \tau\nu$
bkg: $B \rightarrow \pi^0 l\nu$

tag side: BReco
($B \rightarrow D^0\pi$, $D^0 \rightarrow K\pi$)

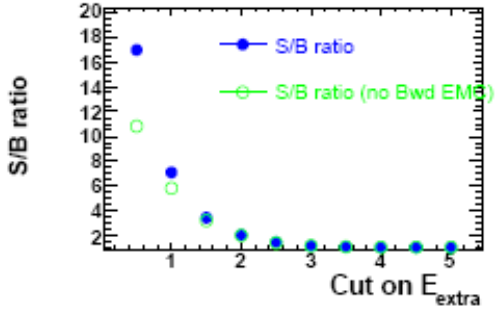
S/B as a function of E_{extra} cut

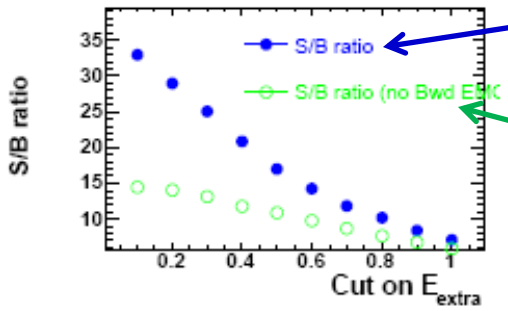
E_{Extra}= difference between the total energy in the calorimeter and the sum of the energies associated to each tracks





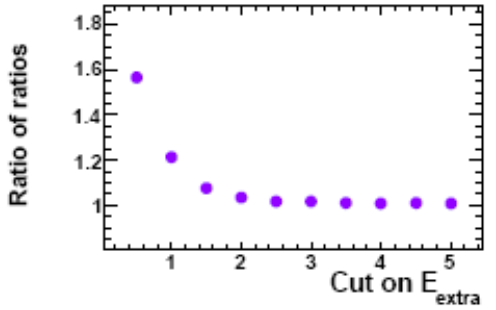
A. Rakitin

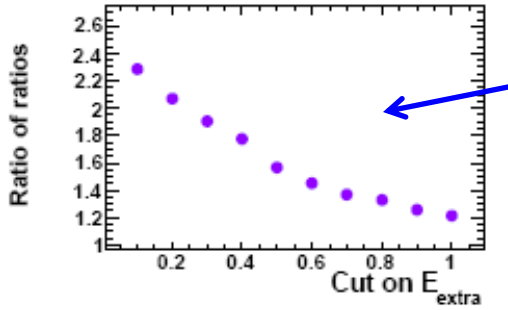




S/B (bwd EMC)

S/B (no bwd EMC)





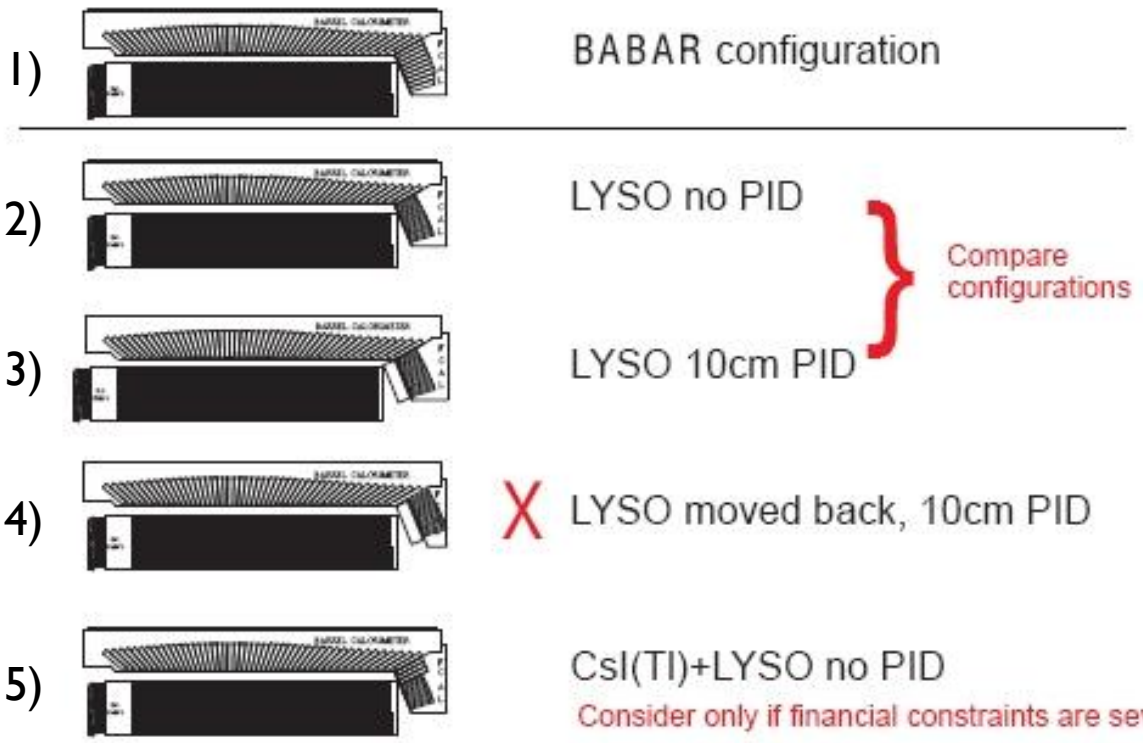
S/B (with bwd EMC) over S/B (w/o bwd EMC)

preliminary conclusion: improvement of S/B with bwd EMC

Position of forward endcap crystals

- proposal from EMC: LYSO not back of 10cm (see fig. 2):
  - alignment edge barrel/endcap could present performance problems
- …but this solution would take space from fwd PID and/or DCH
  - ➔plan to evaluate solutions 2) and 4), with and without fwd PID

C. Cecchi/D. Hitlin for EMC



Work in progress to
-)evaluate signal collection in endcap/barrel transition
-)evaluate impact of material in front of crystals

considered unlikely and therefore secondary at present

Goals

- Discuss the updated study of $B \rightarrow \tau\nu$ with and without the forward EMC
- Discuss preliminary Geant4 studies aiming to
  - evaluate the signal degradation due to material before the crystals – connected to the forward PID performance study –
  - quantify the response of the crystals in the barrel-fwd endcap transition region vs. the endcap crystals position

IFR

- IFR design optimization is independent of the other detectors: the inner dimensions are fixed
- IFR design optimization will not make use of FastSim

G. Cibinetto @ DGWG meeting
28 Apr 09

- Parameters to optimize
  - Number of active layers
  - Amount of absorber
  - Width of the scintillator bars
  - Evaluate the worst allowed time resolution
- Quantities to evaluate: muon ID, pion rejection, detection efficiency.
- What would be 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.

- Tight time constraint: need to place order for scintillators and iron for the prototype by the end of Summer

Impact of a reduced boost

- Recent proposal: lower the boost by ~20% ($\beta\gamma$=0.28→~0.23)
- Blair and Francesco have asked us to evaluate the impact on Physics
- main disadvantage: the Δt resolution worsens

what's the impact on the CP parameters in t-d measurements ?

two preliminary studies presented at this meeting

- Additional effects. Among others:
  - reduced impact of a forward PID device
  - increased impact of a backward EMC

Plan: discuss the proposal and if needed organize an effort to quantify pros and cons on a short time scale

DGWG sessions

Wed 17

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*))
Description:
Location: Room TRUMPET 4

14:00 Performance studies with different SVT and DCH configurations (20')	Matteo Rama (*LNF*)
14:20 Tracking Performance with the SVT baseline configuration (20')	Nicola Neri (*Universita' di Pisa & INFN*)
14:40 Boost sensitivity on time dependent measurements (15')	Nicola Neri (*Universita' di Pisa & INFN*)
14:55 B->Ks pi0 vs. SVT radius (15')	Gabriele Simi (*PI*)

Thu 18

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

09:00 Forward PID studies (K*gamma/rho gamma) (20')	leonid Burmistrov (*LaL*)
09:20 forward PID: K(*) nu nubar with semileptonic tag (20')	Alejandro Perez (*LAL*)

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

16:30 Study of photon detection in EMC barrel-endcap transition (20')	Stefano Germani (*PG*)
16:50 Physics performance of backward calorimeter (20')	Alexander Rakitin (*Caltech*)
17:10 Time-dep CP parameters sensitivity vs. boost (20')	Chih-hsiang Cheng (*Caltech*)

Summary

- Good amount of work done by people involved in the DGWG since the meeting in Orsay
- Performance studies in progress concern
  - internal geometry of SVT
  - DCH/SVT transition radius
  - Impact of forward PID on BReco (had and semilep) and on $B \rightarrow K(*)\nu\nu$
  - Position of fwd endcap EMC vs. fwd PID. Impact of material in front of crystals
  - Impact of backward EM on $B \rightarrow \tau\nu$
  - Effect of a reduced boost on the Physics reach
- Several new studies will be discussed at this meeting, spread over 3 parallel sessions

Many opportunities to contribute inside the detector geometry WG. Contact Achille and me if you're interested.

BACKUP

physics tools needed for DGWG studies

status to my knowledge

name	description	status in Orsay	current status
hit overlap	parametrization of effects given by pattern recognition	covered, work in progress	work done, needs tuning.
bkg merging	merging of bkg particles in FastSim events	---	covered, needs finalization and test
dE/dx	energy loss is simulated in FastSim, but not its measurement	not covered, but 1 person from next week!	work done, needs tuning.
tagging	need to setup it in FastSim and possibly implement new features	now ~1 person	need more manpower
PID selectors	needed to do analysis and optimization studies	work started, need complete set of PID info	basic infrastructure implemented, needs work to produce realistic selectors
tag vertex	see if we can exploit better vertex resolution		some related work started, but no specific. No person in charge yet
Vertex and kin. fits		ok	ok

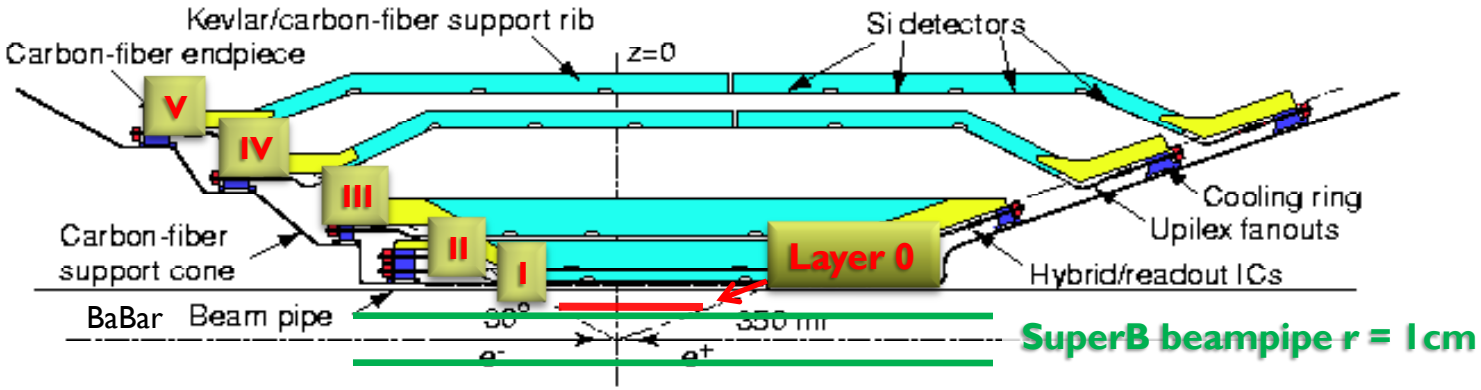
Measurement of physics channels

- The table summarizes only expression of intents (to my knowledge), and not active involvement
- Manpower is a problem
- B→Kνν studies have started and are relatively mature
- B→Ksπ^0 is also covered

name	expression of interest
B→Kνν	Orsay, Perugia
B→τν	Caltech, Napoli, Perugia
B->Xsγ	Caltech
B→Ksπ^0(γ)	U. Maryland, Pisa
B→Xsl+l-	Pisa
'beta'	---
τ→lγ	Caltech, Pisa

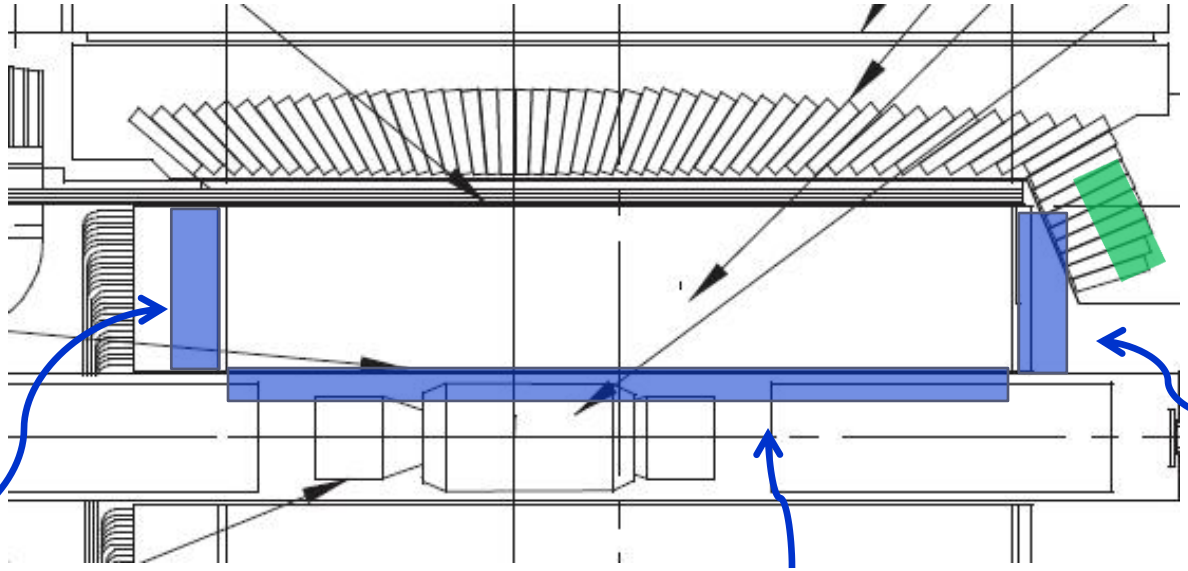
- Other channels: τ→3l (Caltech)

SVT



What outer radius?
What angular coverage?
How many layers?

DCH

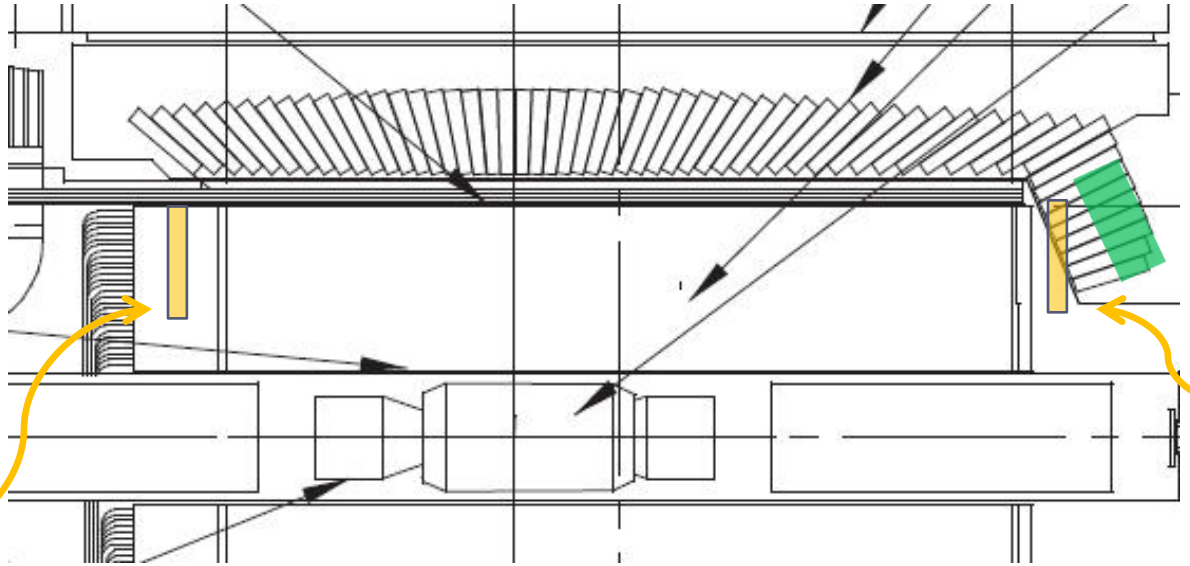


extended DCH
If NO bwd EMC/PID
and the DCH electronics
space is reduced w.r.t. Babar

What inner radius?

extended DCH
If LYSO fwd EMC
and NO fwd PID

PID

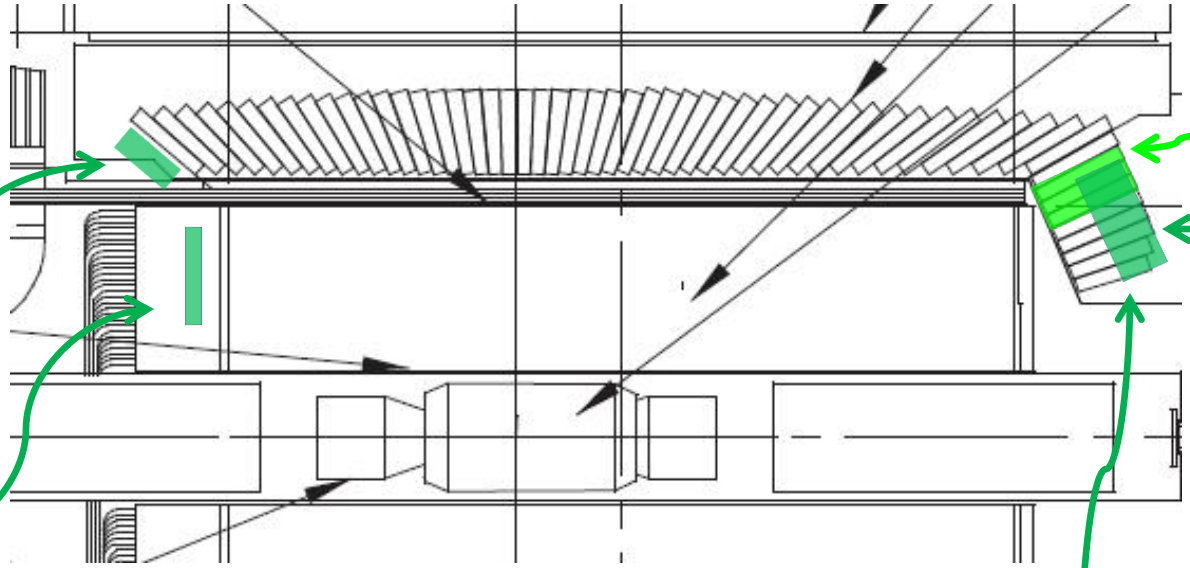


forward PID
If LYSO fwd EMC

backward PID
If NO bwd EMC
and the DCH electronics
space is reduced w.r.t. Babar

We're not considering it as a major option

EMC



backward EMC
If DCH electronics
space is reduced w.r.t. Babar

forward EMC
If all LYSO: additional space available
if CsI+LYSO: NO additional space available