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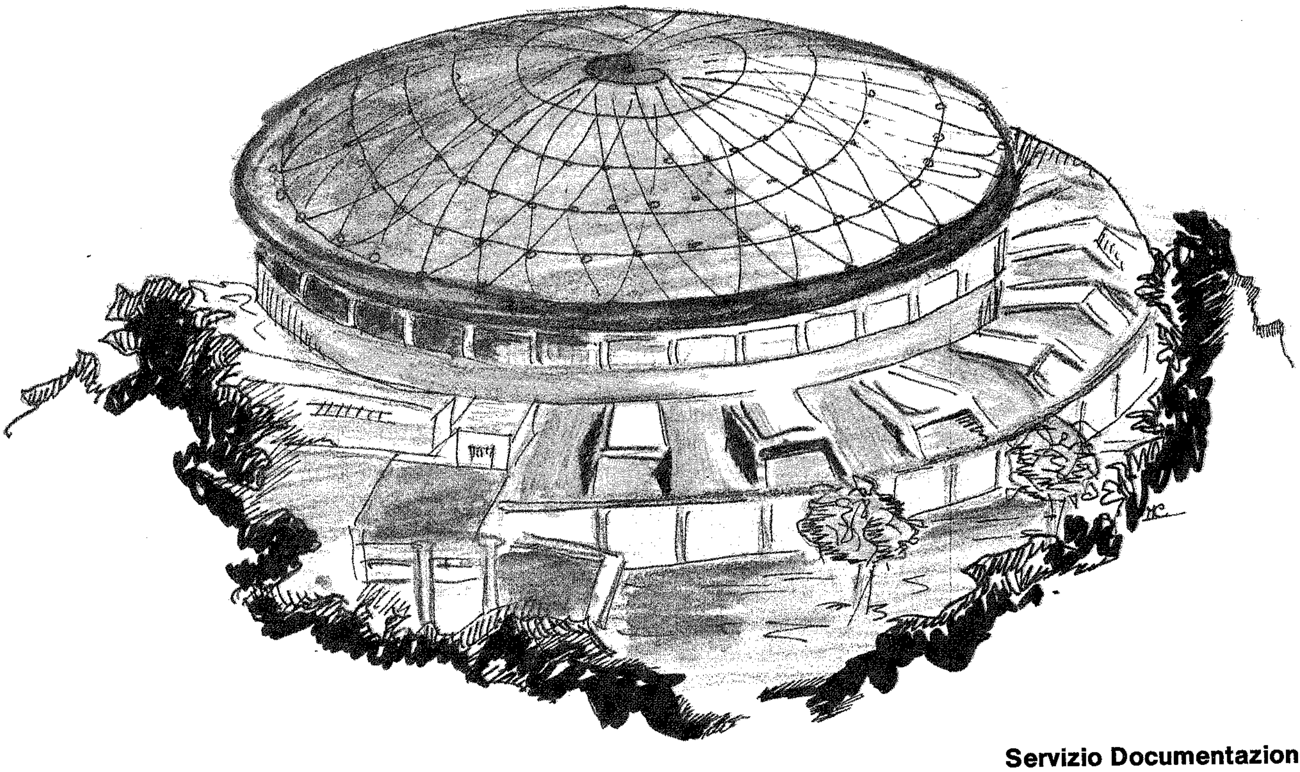
LNF-88/21(P)
11 Maggio 1988

I. Peruzzi:

# A B FACTORY: WHICH ENERGY IS THE BEST?

Presented at the Workshop on
Heavy Quarks Factory and Nuclear Physics Facility with Superconducting Linacs,
Courmayeur (Italy), December 14-18, 1987



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# A B FACTORY: WHICH ENERGY IS THE BEST?

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## ABSTRACT

Various energy choices are considered for studying B Physics at the Frascati project *ARES* ; the option of an *asymmetric* machine is particularly discussed and the pros and cons weighted. Results from a Montecarlo simulation in several energy configurations are presented.

# 1. INTRODUCTION

Most of our present knowledge on B Physics come from $e^+e^-$experiments; the great interest aroused by a number of recent measurements has resulted in several proposals[1] [2] [3] [4] for *dedicated* B factories, all of which are circular or linear $e^+e^-$colliders.

In this note we will briefly discuss the energy choice for such a facility, in a range which is presently realistic for a high luminosity machine, *i.e.*well below 100 GeV ; the aim being an attempt to assess the maximum energy desirable for the Frascati project.

This machine, in the present design,[5] consists of two stages; from the first one the beams emerge with an energy of 1.5 - 2.5 GeV ; the second one accelerates the beams to a maximum energy, which should be at least 5.3 GeV for producing the Υ(4S) and could be as high as 12 GeV , if the additional price to be paid in complexity and cost is justified by physics benefits.

Such a scheme has the flexibility of providing 4 possible modes of operation:

- as a *charm factory*, using the collisions of the two lower energy beams;
- at the Υ states, setting the $E_{beam}$ at one half the mass;
- as an *asymmetric machine* , using one beam from each stage;
- in the *continuum*, with collisions at maximum energy.

We will now discuss which of the last three options are the most desirable for B physics, the implications on the machine and on the experimental apparatus.

# 2. Threshold vs Continuum

## 2.1 BOTTOMONIUM STATES

In the $E_{cm}$ region between 9.6 and roughly 11.5 GeV , it is possible to study the $b\bar{b}$ states Υ's, both above and below the threshold for B mesons production. Six Υ states have been observed up to now; the first 3 are semibound $b\bar{b}$ mesons and provide the tool for studying the bottomonium, through their photon and hadron transitions to the radial excitations, which cannot be directly produced in $e^+e^-$ interactions.

The mass of the Υ(4S) is just above the threshold for B$\bar{B}$production and below the one for $B\bar{B}^*$ ; it decays essentially in B$\bar{B}$pairs , with a ratio of $B^+B^- : B^o\bar{B}^o \approx 55 : 45$. The cross section peak value is of about 1nb above the *continuum*, *i.e.* the non resonant production, and the total width is 24 MeV. The signal to the background ratio for $b\bar{b}$ production is .25, the highest available at any energy where B mesons can be produced.

Just above the Υ(4S) the hadronic cross section has a complicated behavior, due to the onset of the production of more B mesons: $B^*$ , $B_s$ etc. At least two more states have been clearly identified: the Υ(5S) and the Υ(6S), with masses of 10.86 and 10.95 GeV respectively and widths larger than the Υ(4S).

The present experiments (Cleo and Cusb at CESR, Argus at DORIS), will probably study this very interesting region with much more detail in the next few years, and may be able to disentangle more states. A very high luminosity machine will however be necessary to determine the nature of each peak ( or threshold *shoulder* ) since they are much less prominent than the Υ(4S).

The Υ(5S) and/or the Υ(6S) could be a good source of $B\bar{B}^*$ events and, even more excitingly, of $B_s\bar{B}_s$ pairs; the $B_s$ meson has not been discovered yet; its decay properties are very interesting especially for the study of the B$\bar{B}$mixing and a better understanding of the weak decay mechanism for B mesons.

Running at these resonances has several advantages:

- B cross sections are higher;
- the signal to the background ratio is higher;
- the B (or $B^*$ ) production is two-body, so the energy of each B is known and the *beam constraint* can be used as a powerful tool for the B reconstruction;
- the *prompt* lepton momentum distribution is separated quite well from that of the leptons from D decay (direct or cascade) or from background;
- the background subtraction is obtained, without any bias, by running just below the B threshold.

Although these features make this energy region a good choice for a B factory, there are some disadvantages, namely:

- decay products from the two B's are intermixed , so all tracks must enter the combinations to reconstruct each B;
- particles have low momentum, so multiple scattering severely limits the

momentum resolution and the lepton identification is more difficult;

- B decay paths are very small, so the method of using a vertex detector to *tag* b events can not be fully exploited;
- heavier B states ($B_c$ or the beauty Baryons), are not produced;
- since the Υ(4S) is a state with a definite spin-parity decaying into a $B\bar{B}$ pair, the mixing is smaller and some of the CP violating effects are not observable.

## 2.2 B PRODUCTION IN THE CONTINUUM.

B mesons (and baryons) are produced in the *continuum, i.e.* the non resonant energy region above the threshold, from the hadronization of the $b\bar{b}$ pairs, which account for ≈ 9% of the total hadronic rate. The fragmentation function has been measured both at PEP and PETRA, and it has been shown[6] that the B particles carry on the average more than 70 % of the total energy.

B's are produced together with other *primary* particles and their momentum varies; the relative production rate of the different B species has not been measured and inclusive measurements refer to this unknown mixture. In these conditions, the B reconstruction is quite difficult: 10 experiments at PEP and PETRA have collected between 100,000 and 300,000 multihadronic events each, but not a single reconstructed B meson has been reported!

As the $E_{cm}$ increases, jets are produced and the original direction of the quark pair is *recorded* by the final state hadrons; since the b quark is much heavier, $b\bar{b}$ events require more energy to become jet-like than light quarks events: at PEP and PETRA energies, a $b\bar{b}$ enriched sample can be obtained by requiring the thrust value to be lower than 0.8. In order to have two clearly defined b jets, so that B reconstruction can be attempted separately for each of them, higher energy is required.

Lifetime measurements have been performed at PEP and PETRA, where the decay distances are of the order of 700 $\mu$; in the absence of B identification, the method relies in a statistical *enrichment* of the sample and the result refers to the average lifetime for the produced B mixture.

Summarizing, the advantages of running in the region between the Υ's and the $Z^o$ are:

- more B species are produced

- B and $\bar{B}$ decay products are in two separated jets
- vertices are far apart

It is important however to consider that the latter two points are valid only when the $\beta$ of the b quarks approaches 1, *i.e.*at energy much higher than 11 GeV .

On the other end, the disadvantages of this energy region are quite clear:

- cross sections are lower
- the signal to the background ratio is worse
- the background subtraction relies on the MC simulation
- B's are produced with other particles and the reconstruction is very difficult

Some of these drawbacks disappear at the $Z^o$ peak where $\sigma_{b\bar{b}}$ jumps to 5 nb , the signal to background ratio increases to $\approx$ .2 and all the advantages of running at a higher energy can be fully exploited. SLC and LEP experiments will probably succeed in solving a number of open problems in B physics: separate B lifetimes and semileptonic branching ratios, $B_s$ mixing, ecc.

The physics goals of a dedicated B factory require a large number of reconstructed B's : a machine in the threshold region seems a better choice than one running in the continuum; we will not further discuss the possibilities of a high luminosity $Z^o$ factory , since it is beyond the intent of this paper.

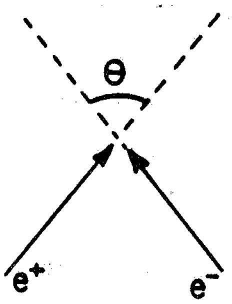
### 2.3 THE *boosted* MACHINE IDEA

In order to exploit all the advantages of running at the Y(4S) (or higher Y states) without suffering from the disadvantages listed in section 1.1, the building of an asymmetric machine has been proposed,[7] with a c.m. energy equal to the Y mass, but with a $\beta_{cm}$ different from zero.

This can be accomplished in two ways, either by colliding beams of a higher energy than the Y mass, at an angle $\theta$ :

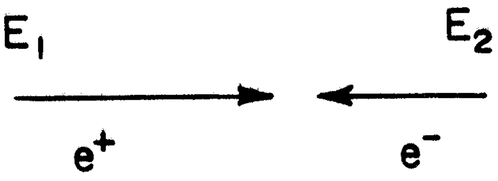
$$E_{beam} = \frac{M_{\Upsilon}}{2sin(\frac{\theta}{2})}$$

$$\beta_{cm} = cos(\tfrac{\theta}{2})$$



or by using asymmetric energy beams:

$$E_2 = \frac{M_\Upsilon^2}{4E_1}$$



$$\beta_{cm} = \frac{(M_\Upsilon^2 - 4E_1^2)}{(M_\Upsilon^2 + 4E_1^2)}$$

An $e^+e^-$machine with beams crossing at a large angle represents an interesting idea but has not been investigated enough to be considered practical, especially taking into account the high luminosity that is required from a B factory.

A simpler approach for a boosted machine is the use of asymmetric beams; this is hardly possible in a storage ring, where the beams share the same optics, but could be done in a linear collider , or in a hybrid machine (ring against linac)[8] , at the expense of some complications in the final focus region.

We have studied, using a MonteCarlo simulation , about 10,000 Υ(4S) events at different values of the $\beta_{cm}$, in order to understand if the boost helps overcome the drawbacks of working at the threshold. More detailed studies are based on 100,000 B's produced from two samples of 100,000 B's each produced from the Υ(4S) at rest and $E_1$=12 GeV respectively.

The boost cannot have any effect in some of the items of the *minus* list of the previous section: the tracks from the two B's stay mixed, and obviously the Υ(4S) quantum numbers do not change; on the other hand, the momenta get higher with the total energy and the decay paths increase as well.

The reconstruction of B mesons is essential for most of the Physics that B factories are called for: the rationale for a *boosted* machine is an increase of the reconstruction efficiency from vertex tagging. We will now discuss in more detail to what extent this can be accomplished with a *moderate* boost and which are the drawbacks.

## 3. MC study of the *moving* Υ(4S)

In order to study the effect of the relativistic boost on the decay products of the Υ(4S), we have used the LUND generator, modified so that the beams have a different energy, with $E_{cm} = M_Y$.

In order that the c.m. energy be equal to the Υ(4S) mass, the beam energies

$E_1$ and $E_2$ must satisfy the condition $4E_1E_2 = M_\Upsilon^2$. In Fig 1a $E_1$ is plotted versus $E_2$; Fig 1b shows the increase of $\beta_{cm}$ as a function of $E_1$, while Fig 1c shows the product $\beta\gamma$ which is the relevant quantity for the decay length.

Up to the maximum energy of the Frascati machine ($E_1 \approx 12 Gev$), the $\beta_{cm}$ rises steeply, while reaching a plateau for $E_1 > 20 GeV$; for this study we have used the values $E_1$= M/2 , 6.5 , 8.0 , 12.0 , 30 GeV , with the largest samples (50,000 events) at $M_\Upsilon/2$ and 12 GeV .

### 3.1 MOMENTUM AND ANGULAR DISTRIBUTIONS

The average photon or charged tracks momentum at the Y(4S) is quite low, due to the high multiplicity of the events; Figg. 2 to 4 show the momentum distributions of photons, pions and kaons from the Y(4S) at a *symmetric* machine, compared with *boosted* configurations; the average values are listed in Table I.

## Table I

**Average particles momentum ( GeV/c )**

| Particle type | $E_1 = M_\Upsilon/2$ | $E_1 = 6.5$ GeV | $E_1 = 8$ GeV | $E_1 = 12$ GeV | $E_1 = 30$ GeV |
|---|---|---|---|---|---|
| $\gamma$ | 0.21 | 0.21 | 0.23 | 0.28 | 0.61 |
| $\pi$ | 0.42 | 0.43 | 0.46 | 0.58 | 1.30 |
| $K$ | 0.62 | 0.64 | 0.71 | 0.96 | 2.33 |
| $p$ | 0.54 | 0.58 | 0.70 | 1.12 | 3.09 |

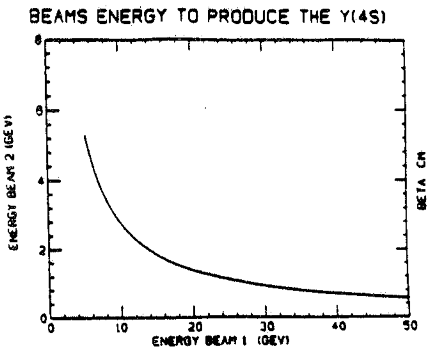


*Fig. 1a)*

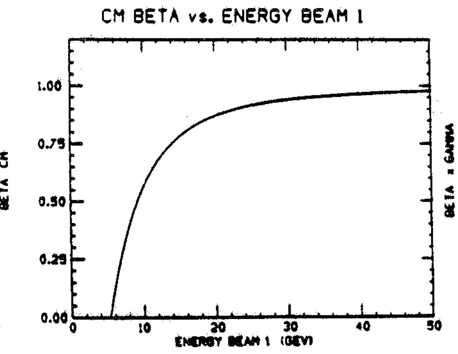


*Fig. 1b)*

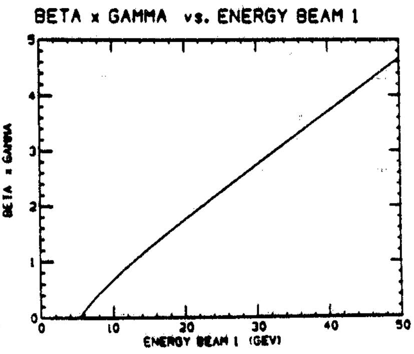


*Fig. 1c)*

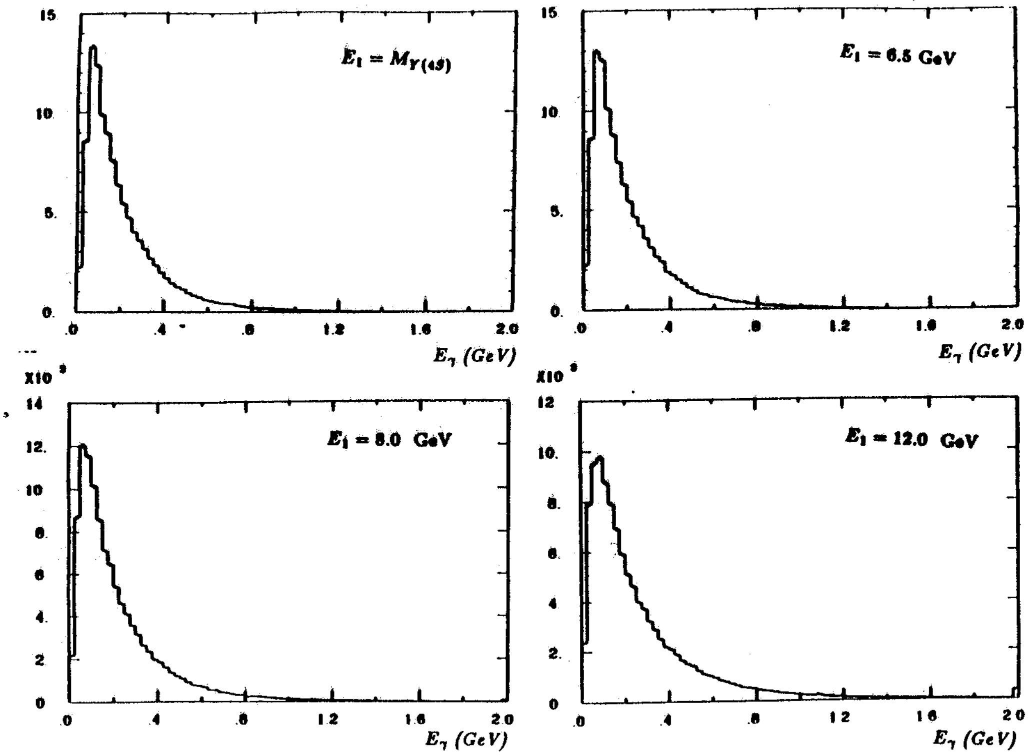


*Fig. 2 Energy distribution of photons from the $\Upsilon(4S)$*

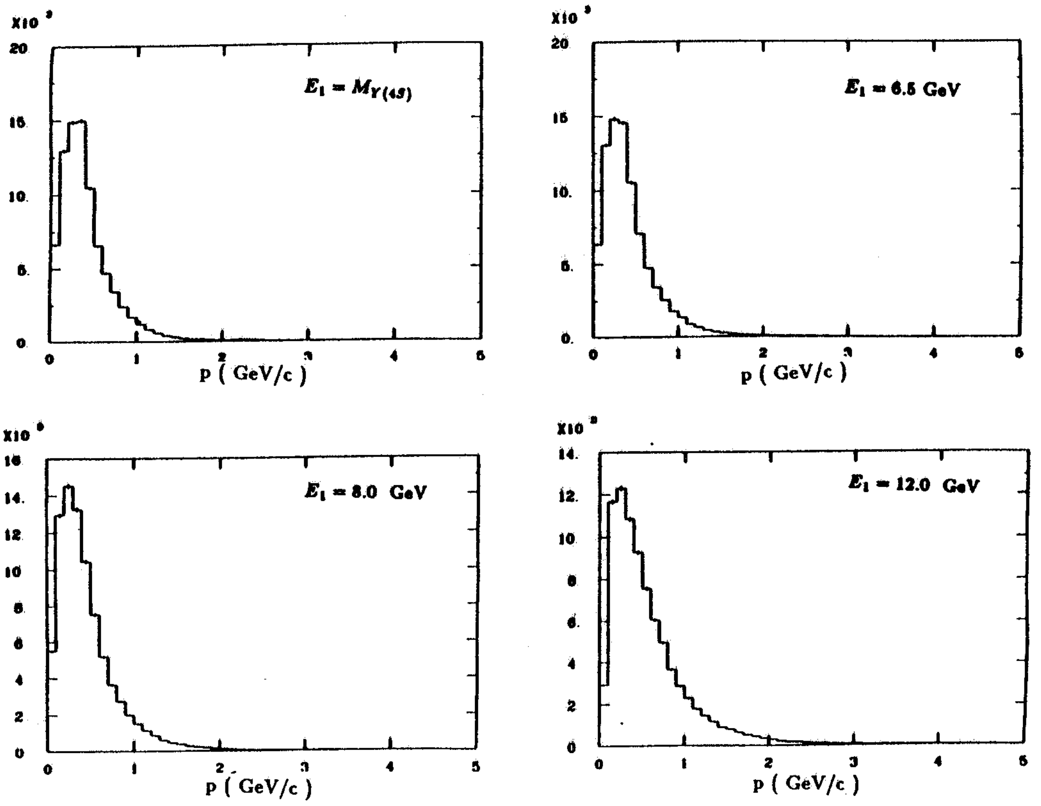


*Fig. 3 Momentum distribution of pions from the $\Upsilon(4S)$*

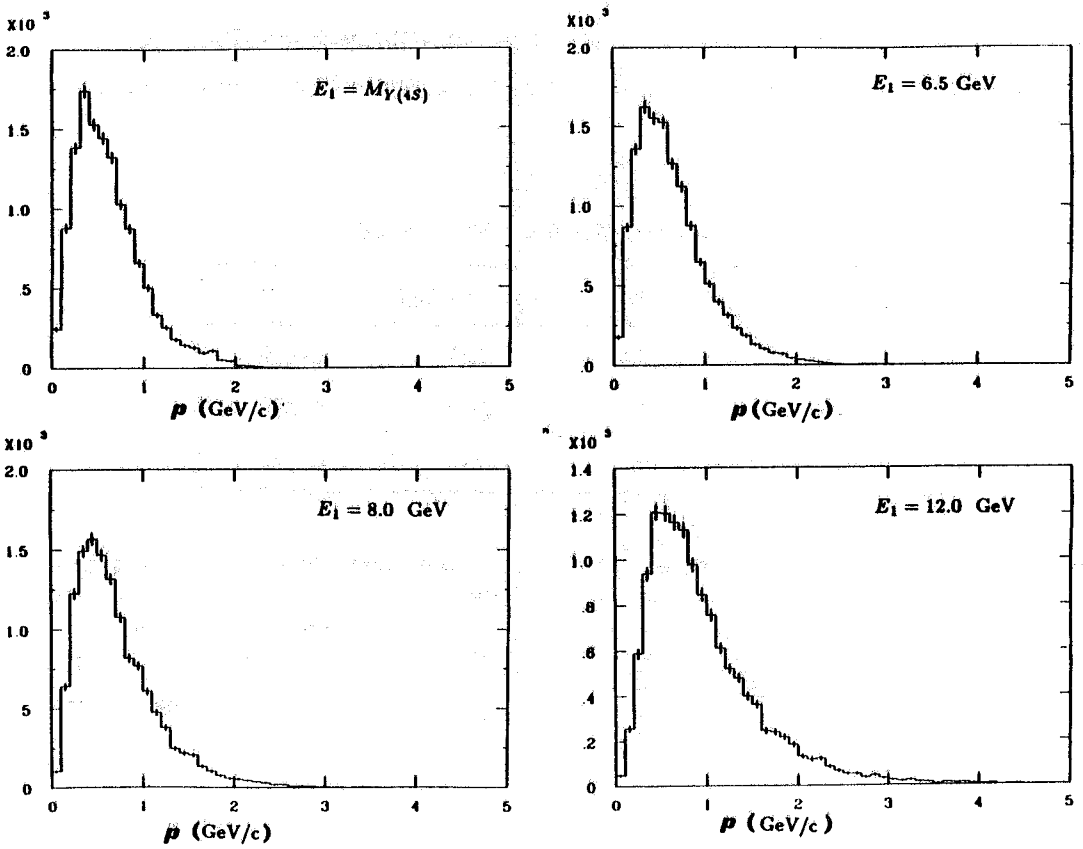


*Fig. 4 Momentum distribution of Kaons from the Y(4S)*

When $\beta_{cm}$ is $\leq 0.7$, the average momenta do not change that much; the photon and pion momenta, which make up most of the measured particles, increase the least, so all the detection problems related to low momentum tracks and gammas are not solved in any appreciable way by boosting the Y(4S).

Leptons are one of the most important tools for studying B physics: at the Y(4S) at rest, high momentum ( $p > 1.0\ GeV/c$ ) electrons and muons are a simple and efficient *tag* of $B\bar{B}$ events. The lepton spectrum from $b \rightarrow c$ transition has a characteristic steep decrease near the end point (see Fig 5), as opposed to the smoother tail of $b \rightarrow u$ events. The fit of the lepton distribution near the end-point is widely used to extract , though with some model dependence, the ratio $|V_{bu}|/|V_{bc}|$.

As the $\beta_{cm}$ increases, the separation between *soft* leptons from charm (direct D's or cascade B *rightarrow* D) and *hard* leptons from B's tends to disappear and the momentum distribution changes the end point shape, so that it becomes impossible to distinguish $b \rightarrow u$ and $b \rightarrow c$ from the analysis of the spectrum tail.

An other effect of the boost is the dramatic change in angular distributions of the produced particles, both charged and neutral; this effect is shown in Fig

6), for several values of $E_1$, while in Table II we compare the fraction of tracks from the Υ(4S) decay in the forward, central and backward angular regions.

## Table II
### Average number of tracks

| Angular region | $E_1 = M_\Upsilon/2$ | $E_1 = 12GeV$ | $E_1 = 30GeV$ |
|---|---|---|---|
| $cos(\theta) > 0.7$ | 15% | 57% | 93.3% |
| $\lvert cos(\theta)\rvert < 0.7$ | 70% | 41% | 6.6% |
| $cos(\theta) < -0.7$ | 15% | 2% | 0.1% |

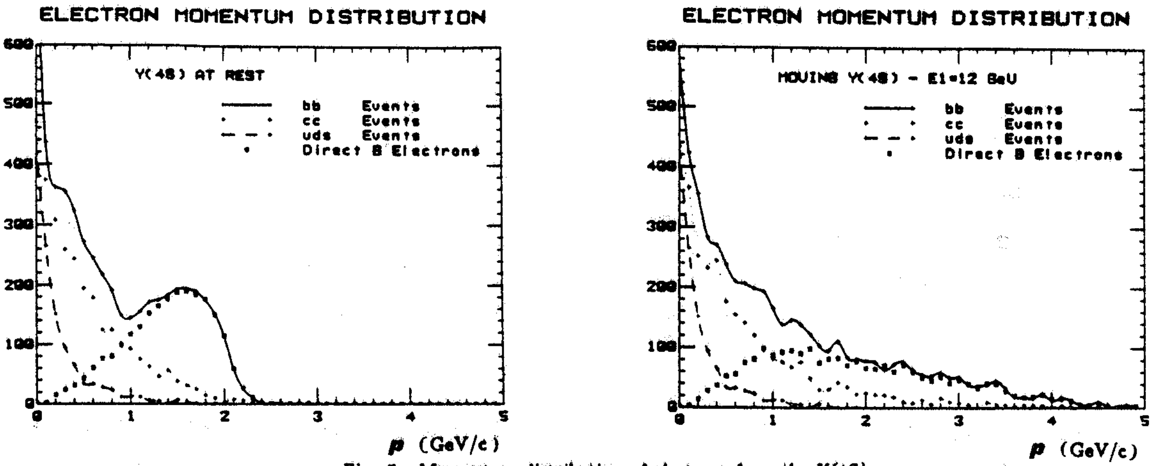


*Fig. 5 Momentum distribution of electrons from the Υ(4S)*

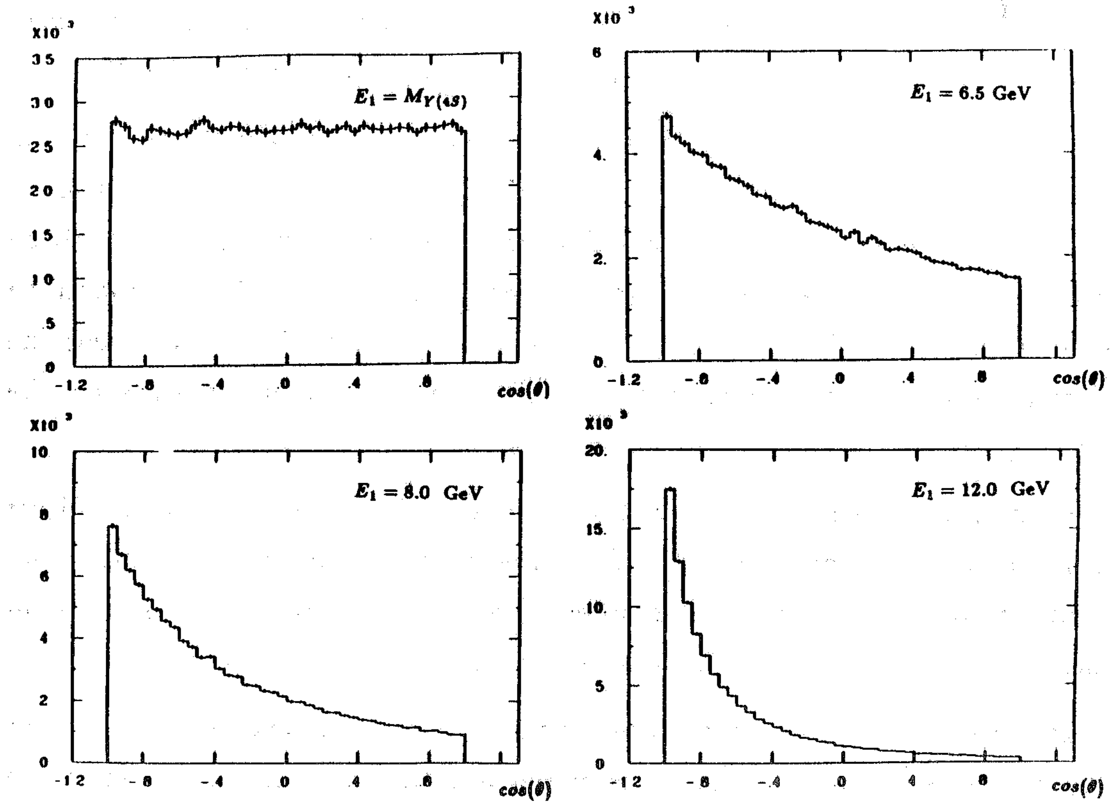


*Fig. 6 Charged tracks angular distribution at the Υ(4S)*

In the case of $E_1 = 12$ GeV , more than half of the B decay products crowd the forward region and the remaining are spread over a large fraction of the solid angle; this complicates the design of the experimental apparatus: a *standard* solenoidal detector is not well suited; it would be necessary to think in the style of a $p\bar{p}$ or Hera type device, in a situation where particles have very low momentum.

### 3.2 VERTEX DISTRIBUTIONS

The area in which one would expect a maximum gain from the relativistic boost is the vertex separation: a linear collider is particularly suited for a vertex detection, thanks to the small size of the beams, which allows the use of a beam pipe of 1 cm or possibly smaller.

The Y(4S) events have a complicate vertices structure, with 2 B's and 2 charmed particles decaying at some distance from the interaction point, plus long-lived particles, like $K_S$'s or $\Lambda$'s which generally decay further away.

In a standard (symmetric) machine , the average B vertex distance is of only 30 $\mu$, and the average impact parameter of tracks from B's is 4 $\mu$, a real challenge for any vertex detector, even one to be built few years from now. Charmed particles decay at an average distance of 110 $\mu$ from the I.P., so a considerable fraction of their vertices could be identified: even with modest vertex detectors and large beam pipes, both CLEO and ARGUS have been able to measure D mesons lifetimes (just below the Y(4S) where the average decay path is 235 $\mu$), with precision comparable to that of the PEP/PETRA experiments.

Vertex detection could be useful for *tagging* B events from the background, improving the 1:3 production ratio; actually, light quark events could be rejected, at the expense of some loss in efficiency. The identification of *secondary* vertices would also improve the chances for the B reconstruction, a major goal at a B factory, by reducing the combinatorial background in the invariant mass distributions for D decays identification.

This analysis technique can be used even at the symmetric machine, if a first rate solid state vertex detector can be used very close (1cm or less) to the I.P. What must be studied is how much can be gained from the relativistic boost, and if the price to be paid in statistics is worth the improved *cleanliness* of the B sample. Fig 7) shows the B decay path distribution, for several values of $\beta_{cm}$ : the average length goes from 30 $\mu$ when the Y(4S) is produced at rest, to 1 mm when $E_1 = 30$ GeV . However one must consider that the boost is along the beam axis, so only the z-component increases; in the z direction such decay distances can **not** be measured because of the size of the interaction region.

The only quantities that could be measured are the distances between two vertices; in a *symmetric* machine the 2 B's are emitted in opposite directions, so their distance is, on the average, twice the mean path, while in an *asymmetric* configuration both B's are produced very close to the z axis, so that their average vertex distance is equal to one mean path.

In Table III the mean decay lengths and the distances between vertices are reported for 3 cases, Y(4S) at rest, with a *medium* boost and with a truly relativistic boost. The distributions of the distance between the B vertices and between the B and the D vertices are shown in Fig. 8) , and Fig 9) respectively.

## Table III

### Average decay distances (microns)

| / | $E_1 = M_Y/2$ | $E_1 = 12$ GeV | $E_1 = 30$ GeV |
|---|---|---|---|
| $< L_B >$ | 30 | 350 | 1070 |
| $< L_D >$ | 110 | 520 | 1570 |
| $< d_{BB} >$ | 60 | 360 | 1080 |
| $< d_{BD} >$ | 85 | 180 | 504 |
| $< d_{DD} >$ | 170 | 470 | 1300 |

Impact parameters are not relevant for this discussion, since they can not be measured in a plane containing the beam axis because of the size of the I.P.

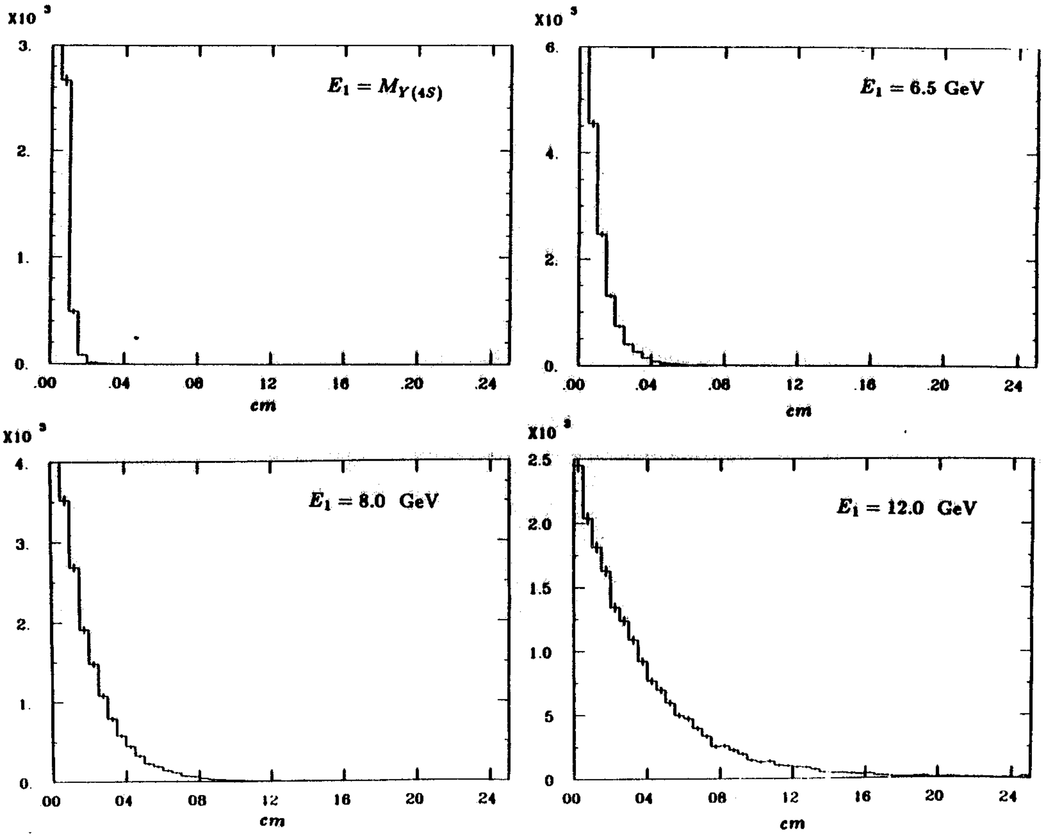


*Fig. 7 Decay path of B meson at the Y(4S)*

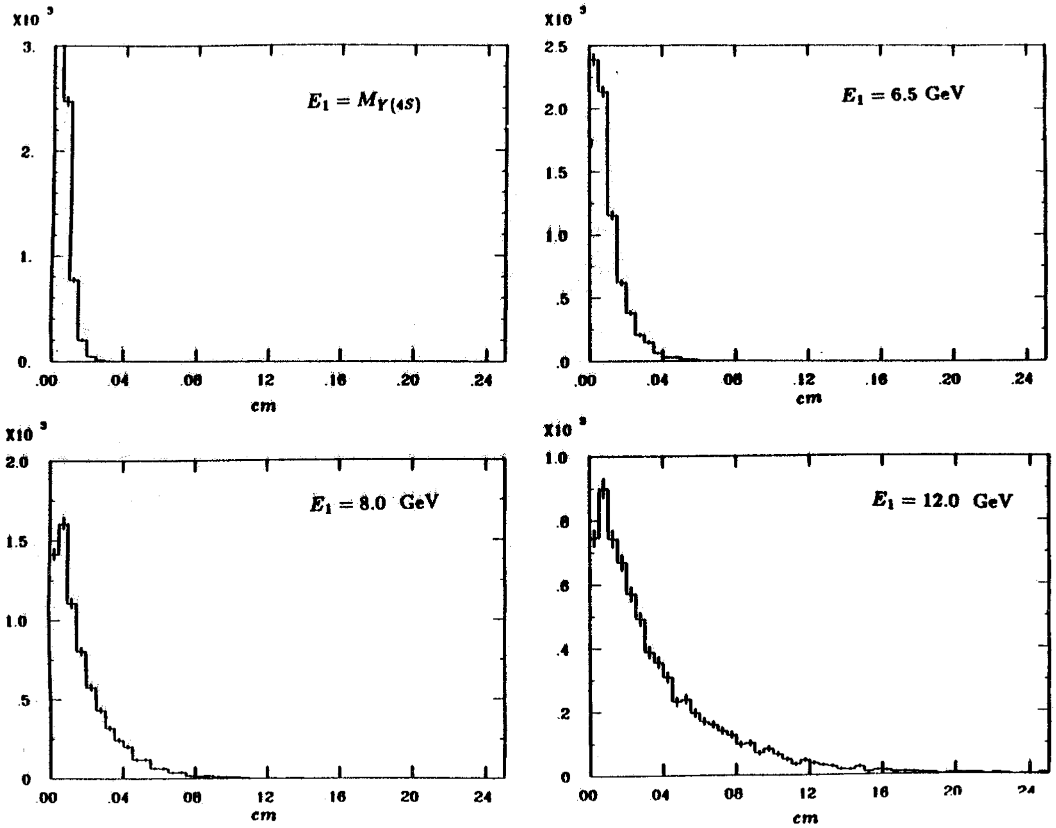


*Fig. 8 Distance between B vertices at the Y(4S)*

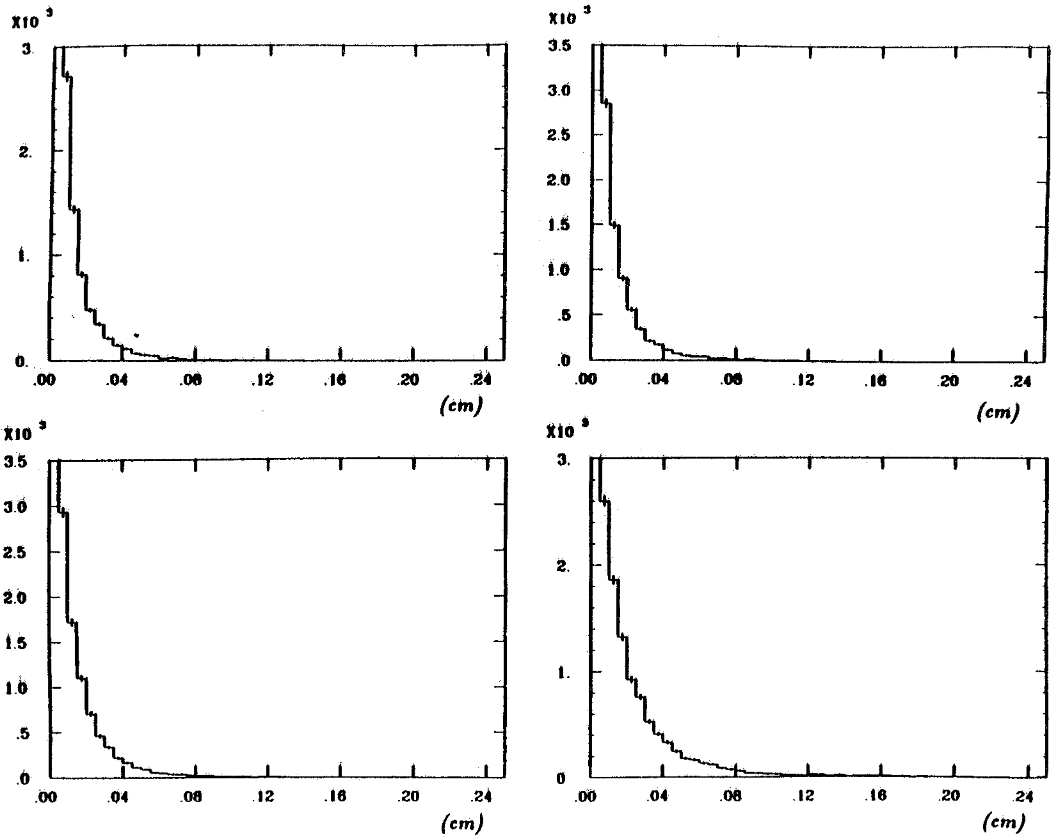


*Fig. 9 Distance between B and D vertices at the $\Upsilon(4S)$*

## 3.3 B RECONSTRUCTION

In order to evaluate realistic reconstruction efficiencies, a complete Monte-Carlo simulation including detector parameters and experimental effects (multiple scattering, measurement errors, decays in flight, etc) is required. It's possible however, to understand the effect of the c.m. boost on angular acceptances of charged tracks and gamma from the event topologies, using *ideal* detectors.

We have studied two samples of 50,000 $\mathrm{B\bar{B}}$events each, one produced with the same energy beams and one with 12 GeV against 2.5 GeV , using the same Lund generator. To begin with, it's interesting to consider how many B's can *in principle*, be reconstructed: $\approx$ 35% of the B's end up, after the decay chain, into particles that can be detected: electrons, muons,pions, kaons, protons or photons. The fraction of events in which both the $B$ and the $\bar{B}$ *could*, by the same definition, be reconstructed (double tag) is of 12%, while in 28.6% of the cases just one particle from the event escapes detection (double tag with a zero constraint fit) and 16.8% would have only one B possibly reconstructed (single tag).

For studying the effect of the boost, some minimal cuts have to be introduced, even for and *ideal* detector (efficiency 1, perfect resolution, no cracks): we set a cut of 75 MeV in the $p_\perp$ of the charged tracks and assumed 95% of the solid angle for the angle and momentum measurement. We assume that the photons can be detected, and their energy precisely measured, in 97.5% of the solid angle, provided that their energy isn't less than 50 MeV and that they are at a distance of at least 10 cm of each other ( $\approx$ 5 Molière radii for BGO), 80 cm away from the I.P.[9]

These cuts reduce the fraction of B's which would be reconstructed in an *ideal* detector down from 6.0% (Y(4S) produced at rest) to 2.2% ( $E_1 = 12$ GeV ; the possible *double tag* events are respectively 0.48% and 0.06%. These geometrical and kinematical cuts are not likely to be loosened, not even in a detector specifically designed for the *boosted* machine, so the starting sample of possible *single tag* B would be $\approx$ 3 times smaller and there would be *approx* 8 times less *double tag* candidates.

To offset this disadvantage, the identification of vertices should be very efficient; the environment, however, is quite hostile towards a vertex detector operation: 4 vertices, almost lined up along the z axis, with many low momentum tracks, mostly at small angles.

In comparing machine configurations, one should consider the ratio between the vertex distances and the experimental resolution; the latter will worsen with the boost for at least two reasons:

- a forward vertex detector will safely operate at a larger distance; a careful evaluation of the machine background would be needed to quantify this statement
- the multiple scattering is worse for particles crossing the vacuum chamber at a small angle

as the boost increase, the average opening angle between the tracks decreases, and this effect also will deteriorate the vertex resolution; the increase in the track momentum will only partially offset these disadvantages.

The fraction of the events which could be *tagged* with a clean vertex identification in a boosted machine can't be large: one needs to measure at least 2 vertices and identify them as B or D; since the lifetimes are comparable, the sequence along the z axis could in fact be B - B - D - D or B - D - B - D , and the zero point is unknown.

We suspect that a detector able to operate with enough resolution to disentangle these vertices, would also be able to substantially help the B reconstruction at a *symmetric* machine, by identifying D vertices in the x-y plane, where the interaction region is very small.

## 4. Summary

The present B detectors have experienced how difficult it is to completely reconstruct the B decay chain; CLEO and ARGUS have succeeded only with a handful of B's out of a sample of about 200,000 each; no B has been reported in the literature as completely identified by PEP or PETRA detectors, despite the huge amount of data recorded.

The upgraded CLEO detector (CLEO II) will be able to do better, probably raising the overall reconstruction efficiency of one order of magnitude to a few per thousands; the question is whch is the best handle an experimenter can use for increasing this efficiency, so critical for the physics output.

In some peculiar cases the luminosity is the most important requirement: some of the decay channels that one wishes to identify for CP violation studies are two-body modes ( $K^+\pi^-$, $\psi K_s$ , etc) and could be detected with high acceptance by any *standard* detector: they are just rare and need a lot of integrated luminosity.

For the bulk of the events, there are essentially two strategies for attacking the B reconstruction problem:

*a)* using the best possible momentum and angle resolution for both charged and neutral particles over as much of the solid angle as physically possible;

*b)* exploiting vertex tagging to isolate B events and to identify tracks belonging to charmed particles, reducing the combinatorial background in the invariant mass distributions

If a) is considered essential, the symmetric machine is a better choice, since particles are more uniformly spaced, on the average they have to sustain less multiple scattering and fewer are lost in the region near the beam pipe not accessible to the detectors.

For b) supporters a *boosted* machine would help in vertices identification; we have shown that the gain in vertex distances is substantial only for $\beta_{cm}$ approaching 1; in this case all the particles are emitted in a forward direction and the experiment would look like a fixed target one.

A 12 GeV against 2.5 GeV machine provides a moderate boost which will give some help in vertex tagging but is not likely to significantly increase the overall B reconstruction: only a small fraction of D's decay is in all charged tracks, and the key to high reconstruction efficiency both for D'a and B's is the $\pi^o$ reconstruction; from this point of view, the boost is a con, since the many photons in each event are squeezed into a smaller solid angle.

A detector optimized for a *boosted* machine would look quite different from a *standard* one, so the machine couldn't switch from one operation mode to the other, unless two detectors are built and operate alternatively. As a final point one should consider that a lot of interesting physics would be wiped out or severely hampered at a *boosted machine*, for example photon transitions between bottomonium states could not be studied, and $\tau$ physics would considerably suffer because the signature for $\tau$ pair production would not be as clean as in the standard machine; lepton tag in B analysis would also worsen for the higher background.

The main conclusion that we draw from this *explorative* study is that a modest boost as the one that could be obtained by running ARES with one 12 GeV beam against a 2.5 GeV , presents several problems, namely:

- A number of important items in bottomonium and $\tau$ physics could not be studied.
- The boost beeing along the z axis, the detector design becomes much more difficult.
- The $\pi^o$ reconstruction, the charged tracks momentum measurement and the *lepton tag* deteriorate.
- Since the B are not monochromatic in the Laboratory frame, the beam constraint can be applied only to full reconstructed decays, and not, for example, to semileptonic modes where just one neutrino escapes detection.

In order to establish if there is a net gain in overall B reconstruction, the increased decay paths should be weighted against these disadvantages; this would require a more detailed Montecarlo study. This preliminary survey suggests that the advantage of the boost may become significant only in the *very* asymmetric case, for example 30 GeV against 1 GeV (or maybe 50 against 0.5 ?), using a fixed target type detector.

A *symmetric* machine able to run with high luminosity in the bottomonium region seems to be the best choice for a B factory below the $Z^o$. The complexity of B events requires a state of the art apparatus; a sophisticated vertex detector would be extremely useful for a clean identification of D mesons, usually the first step to B reconstruction. The B decay path measurement would require a device with a resolution under 10 $\mu$m in the vertex measurement.

In order to maximize the physics output, the suggested energy range for the ARES machine is from the $J/\psi$ peak to the region were all b states thresholds are fully open, *i.e.*a beam energy from 1.5 to 7.5 GeV .

## REFERENCES

1. K.Wille: Design for an ideal B Meson Factory, Proceedings of the Int. Symposium on Production and decay of Heavy Hadrons, Heidelberg 1986
2. U.Amaldi and G.Coignet: Conceptual Design of a Multipurpose Beauty Factory Based on Superconducting Cavities, NIM A 260,7(1987
3. H. Aihara: B/Y Factory at KEK, in Proceedings of Tsukuba 1985 Future Plans for High Energy Physics
4. D. Cline: Possible High Luminosity $B\bar{B}$Factory using the confined super-pinch from submicron $e^+e^-$beams, UCLA-CAA-1-1988
5. prior to this meeting, the design was based on ref. 2
6. E.Fernandez *et al.*, P.R.L 50,2054 (1983)
7. see P. Oddone , Linear Collider $B\bar{B}$ Factory Conceptual Design, UCLA Workshop 26-30 Jan 1987, p. 423
8. P.Grosse-Wiesmann: Colliding a linear electron beam with a storage ring beam, SLAC-PUB 4545 (1988)
9. B.Borgia et al. Contribution to this Workshop