



L'avventura di BaBar: 1994-2008

Livio Lanceri, INFN Trieste

Simposio per Nando, Roma La Sapienza, 09.06.2023

prologo: CHARM

CERN, 1983
set-up per
oscillazioni di ν



Roma, 1984



Megeve, 1985



Trieste, 1986



CKM e violazione di CP nei decadimenti dei mesoni B

- Kobayashi & Maskawa: la violazione di CP può essere generata da una fase nella matrice (Cabibbo) di mixing dei quark, ma allora deve esistere una terza famiglia
- 1978: scoperta del quark b: $\Upsilon(9.46) = b\bar{b}$ al FNAL
- 1980: primi mesoni $B = b\bar{q}$ rivelati a Cornell, alla $\Upsilon(4S)$
- 1981: Bigi, Sanda: previsione “pulita” di grandi asimmetrie CP in decadimenti rari dei mesoni B, e discussione di possibili test sperimentali in una “B factory”
- 1983: vita media dei mesoni B (Mark II, MAC)
- 1987: $B_d^0\bar{B}_d^0$ mixing (ARGUS, UA1)
- test sperimentale di CKM nella CPV dei B? richiede un campione di almeno $10^7 - 10^8$ coppie $B\bar{B}$, in annichilazioni e^+e^- o in collisioni adroniche: un incremento di 3-4 ordini di grandezza rispetto ai campioni disponibili...

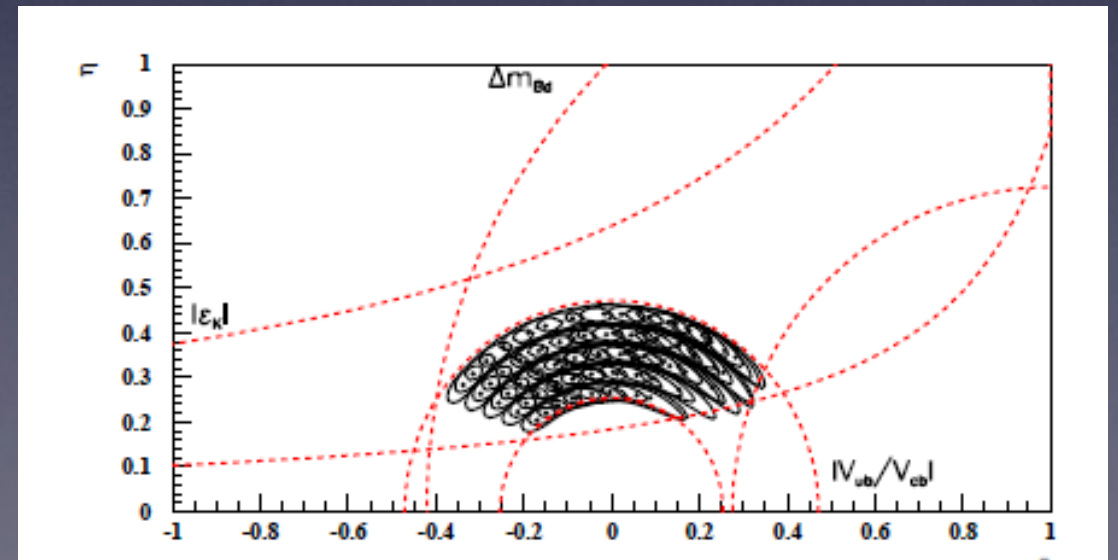
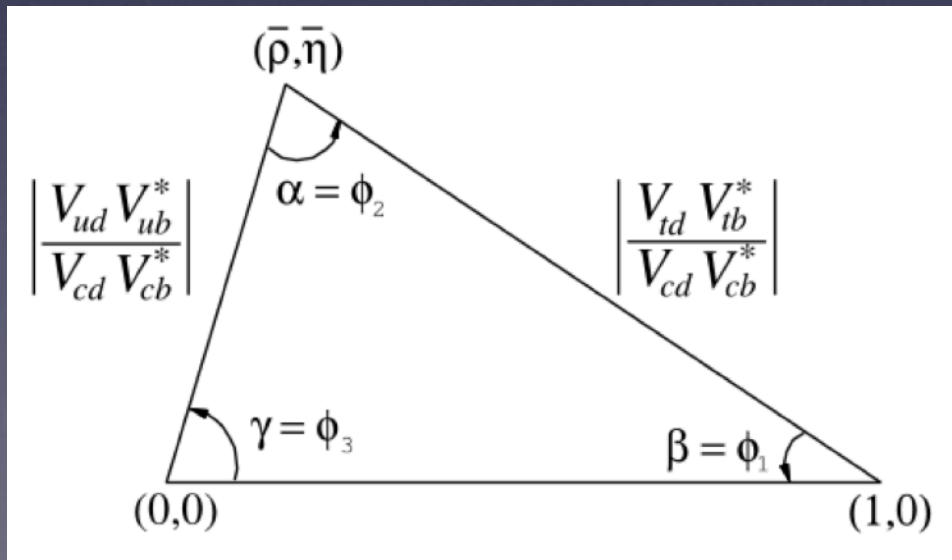
V_{CKM} , unitarietà

$$\begin{array}{l}
 u \\
 c \\
 t
 \end{array}
 V = \begin{pmatrix}
 1 - \frac{\lambda^2}{2} & \lambda & A\lambda^3(\bar{\rho} - i\bar{\eta}) \\
 -\lambda & 1 - \frac{\lambda^2}{2} & A\lambda^2 \\
 A\lambda^3(1 - \bar{\rho} - i\bar{\eta}) & -A\lambda^2 & 1
 \end{pmatrix} + \mathcal{O}(\lambda^4)$$

$$\begin{array}{ccc}
 & d & s & b
 \end{array}$$

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

$(\bar{\rho}, \bar{\eta})$ pre - B factories



$B \rightarrow DK$ $B \rightarrow J/\psi K_S^0$

asimmetrie CP(t)

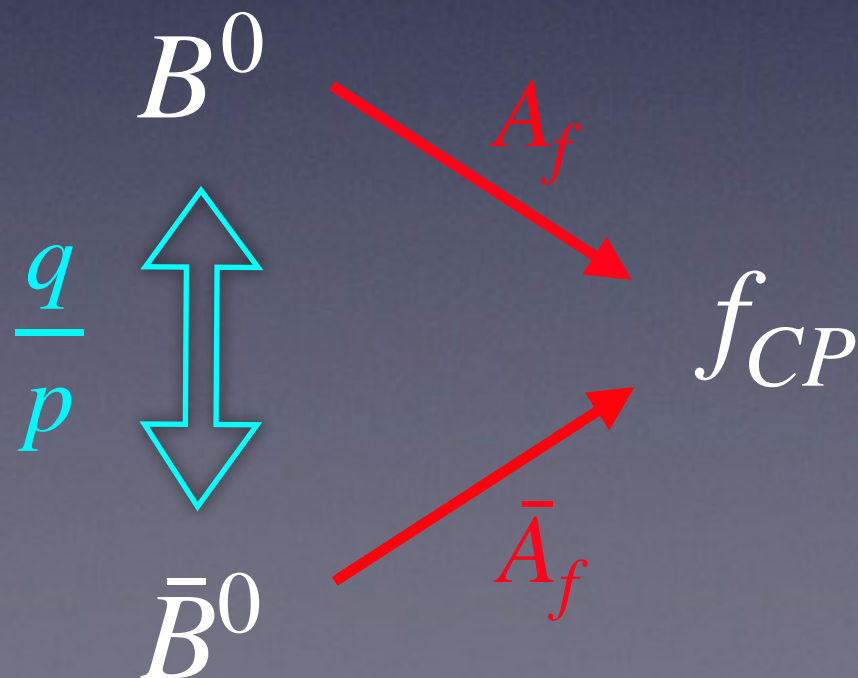
interferenza **mixing-decay** \Rightarrow tagged decay-time distributions

$$f(B_{phys}^0 \rightarrow f_{CP}, \Delta t) = \frac{\Gamma}{4} e^{-\Gamma|\Delta t|} [1 + S_f \sin(\Delta m \Delta t) - C_f \cos(\Delta m \Delta t)]$$

$$f(\bar{B}_{phys}^0 \rightarrow f_{CP}, \Delta t) = \frac{\Gamma}{4} e^{-\Gamma|\Delta t|} [1 - S_f \sin(\Delta m \Delta t) + C_f \cos(\Delta m \Delta t)]$$

↑
tag iniziale

$$S_f = \frac{-2\Im\lambda_f}{1 + |\lambda_f|^2}, \lambda_f = \eta_f \frac{q}{p} \frac{\bar{A}_f}{A_f}$$



esempio:

$$f_{CP} = J/\psi K_S^0$$

$$S_f \Rightarrow \sin 2\beta$$

sensibilità per le asimmetrie CP

Asimmetria osservata (diluita): $A_{obs} = DA_{CP}$

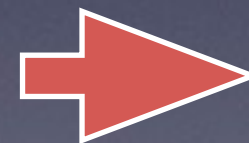
Incertezza su $A_{CP} = \frac{A_{obs}}{D}$:

$$\delta A_{CP} \simeq \frac{1}{D\sqrt{N_{obs}}} = \frac{1}{D\sqrt{\epsilon \cdot BR \cdot N_{prod}}}$$

eventi prodotti: $N_{prod} = \int Ldt \times \sigma_{bb} \times 2f_0$

Efficienze $\epsilon = \epsilon_{det} \cdot \epsilon_{CP} \cdot \epsilon_{tag}$

Diluizioni $D = d_{mix} \cdot d_{mistag} \cdot d_{bkgd}$



Fattori di merito:
luminosità L
sezione d'urto σ_{bb}
efficienze ϵ
diluizioni D

Proposte sperimentali

- fine '80 - inizio '90: intense discussioni, workshop dedicati, molte proposte; in alcuni casi, di laboratori che si giocano il futuro...
- 19 schemi basati su produzione “pulita” di coppie $B\bar{B}$ in annichilazioni e^+e^- alla $\Upsilon(4S)$
- 2 proposte di B factory in e^+e^- alla Z^0
- diverse proposte basate su produzione di beauty in collisioni adroniche, a bersaglio fisso o in “collider mode”: HERA-B a DESY, CDF-II e B-TEV al FermiLab, e al CERN: LHB, GAJET, COBEX
- Dalle conferenze e le riunioni INFN di CN1: ho conservato le tabelle dettagliate di confronto delle prestazioni sperate...

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 - 2 proposte
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piccola sezione d'urto $\sigma_{b\bar{b}} \Rightarrow$ alta luminosità L
alla $\Upsilon(4S)$: misura di Δt !?
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- 2 proposte

- diverse
adroniche
DESY,
COBEX

Difficoltà nelle collisioni adroniche:

rappporto segnale/fondo (migliora con l'energia)
efficienza e diluizione nel tag:

- Dalle conferenze e le riunioni INFN di CN1: ho conservato le tabelle dettagliate di confronto delle prestazioni sperate...

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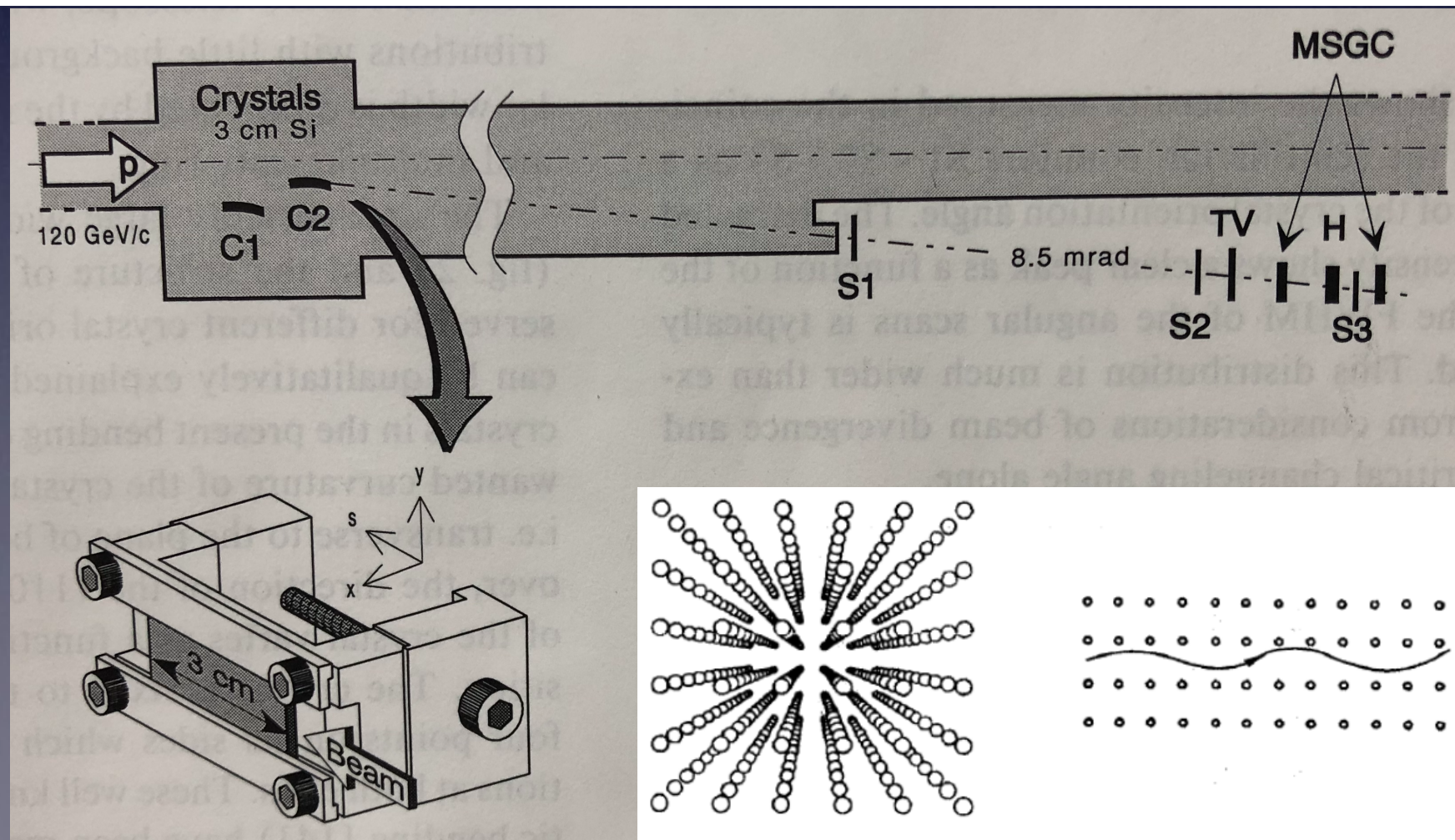
- diverse collisioni adroniche
DESY, COBEX
Difficoltà nelle collisioni adroniche:
rapporto segnale/fondo (migliora con l'energia)
efficienza e diluizione nel tag:

- Dalle collisioni conservate le tabelle
+ un breve inciso su LHB...
non conservato le collisioni sperate...

RD22

First results on proton extraction from the CERN-SPS with a bent crystal

H. Akbari^b, X. Altuna^b, S. Bardin^{b,1}, R. Bellazzini^f, V. Biryukov^{b,2}, A. Brez^f, M.P. Busa^h, L. Busso^h, A. Calcaterra^d, G. Carboni^f, F. Costantini^f, R. De Sangro^d, K. Elsener^b, F. Ferioli^b, A. Ferrari^b, G.P. Ferri^b, F. Ferroni^g, G. Fidecaro^b, A. Freund^c, R. Guinand^b, M. Gyr^b, W. Herr^b, A. Hilaire^b, B.N. Jensen^a, J. Klem^b, L. Lanceriⁱ, K. Maier^j, M.M. Massai^f, V. Mertens^b, S.P. Møller^a, S. Morganti^g, O. Palamara^e, S. Peraire^b, S. Petrera^e, M. Placidi^b, R. Santacesaria^g, W. Scandale^b, R. Schmidt^b, A.M. Taratin^{b,3}, F. Tosello^h, E. Uggerhøj^{a,b}, B. Vettermann^{b,4}, P.F. Vita^f, G. Vuagninⁱ, E. Weisse^b and S. Weisz^b





LARGE HADRON BEAUTY FACTORY

LETTER OF INTENT

LHB

sensibilità previste
in 10^7 s:

$$\sigma(\sin 2\beta) = 0.027$$

$$\sigma(\alpha) \simeq 0.04$$

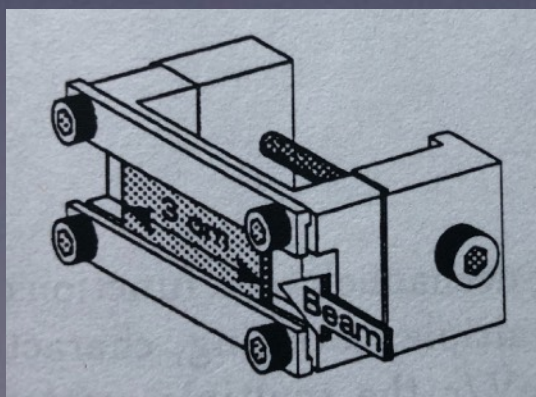
$$\sigma(\gamma) \simeq 0.08$$

B_s oscillations up to

$$x_s \simeq 40$$

Letter of Intent
Measurement of CP Violation
in B Meson Decays
with an Extracted LHC Beam
The LHB Collaboration

fascio estratto da LHC
con cristallo incurvato



LHB, GAJET, COBEX



From: VXCERN:UXUCLA: SCHLEIN 21-JUN-1994 13:34:32.09
To: VXCERN:VAXTS: LANCERI
CC: SCHLEIN
Subj: the recommendation *****

CERN/LHCC 94-26
LHCC M-6
8 June, 1994

MEMORANDUM

To: The Director General
From: LHCC
Subject: Recommendations of the LHC committee

Dedicated B experiments

The LHCC has examined the three letters of intent submitted for dedicated b-experiments with the understanding that such an experiment should be part of the basic LHC programme at start-up. At the time of the LHC start-up it is assumed that the first measurements of CP violation in the b-system will have been made at HERA-B, FNAL or the b-factories. The LHC experiment must therefore be considered a second generation CP violation experiment. At the LHC the capability exists to collect orders of magnitude more B decays than from the above and it will provide the ultimate experimental precision to those parameters capable of measurement in the foreseeable future.

Two of the experiments, GAJET and LHB, operate in fixed target mode with respectively either an internal or external target. The third, COBEX, has a forward spectrometer and works in collider mode at the full LHC energy.

The committee has been very impressed by the expertise shown by the proponents of all three experiments in answers to their requests. However it is clear that none of the collaborations currently has the necessary resources to conduct the type of experiment being proposed. In addition extraction by channelling cannot be guaranteed at this stage. The LHCC considers that the collider mode approach has the greater potential in view of the very high rate of b production, the much better signal/background ratio and the possibility of exploring other physics in the forward direction at 14 TeV.

Whilst the LHCC considers that a very close vertex detector in a Roman pot is a very desirable feature for a collider b-experiment it has not yet seen an adequately optimised spectrometer. A new design for the spectrometer should contain a trigger system capable of effectively exploiting the high b-rate at the collider.

The committee therefore encourages all participants from the three proposals to join together to prepare a new letter of intent for a new collider mode b experiment to be submitted to the LHCC. Should a collider experiment not prove to be feasible at an acceptable cost the committee will review this decision.

Whilst attempts to achieve a fully satisfactory design and a viable collaboration for a collider b-experiment are in progress the committee recommends that no further work should take place on the present proposals.

The committee would welcome a report of the progress made to form this collaboration at the 31 August meeting of the LHCC at which a time scale for the future will be established.

Guidelines for the New Letter of Intent

This letter of intent for the new experiment must establish the following. The viability of the triggering scheme, at levels 1, 2 and 3 for luminosities between 10^{31} and 10^{33} . Single particle electron, muon and hadron triggers and two particle triggers should be considered. The effectiveness of topological triggers as a function of luminosity should be assessed. The requirements of the technology assumed at all levels should be made clear.

The steps to be taken to minimise the effects of performance deterioration arising from the high levels of radiation, particularly for the vertex detectors.

Evidence that tracking devices in the spectrometer can handle the proposed rates, particularly those very close to the beam pipe.

A justification for the performance claimed for the particle identification devices. A justification for the performance of the calorimeters, both in terms of energy resolution and granularity.

The trade-off between the physics benefits and the consequent increase in cost of enlarging the aperture of the spectrometer.

A discussion of non CP violating physics which could be attempted with such an apparatus. The advantages of a special insertion for such an experiment should be addressed. The emerging collaboration must have the organisation and resources commensurate with the magnitude of the proposed experiment..

Background for the Research Board.

The committee first discussed the relative merits of the fixed target and collider mode approaches. The main differences between these are the rate of bb events and the signal to noise which both heavily favour the collider mode. However the fact that B's are not particularly heavy relative to the centre of mass energy means that triggering is more difficult as the typical transverse momenta from b decays are not so different from those from minimum bias events.

Overall the committee considered that the greater potential of the collider mode to be an over-riding advantage.

LHB

The vertexing capabilities of the LHB are the best of the three proposals. It is the only experiment in which points on charged B tracks will actually be observed. This good vertexing allows them to use reconstructed charged B's as a very effective tag and also gives the possibility of eliminating the background for a measurement of Bs to mu mu. The experiment has the best forward acceptance as well as a good overall acceptance.

The major problem concerns the feasibility of extracting a beam in the actual conditions of the LHC when the crystal would act as the primary collimator of the machine. The rates will also be limited unless the optimal conditions for extraction are met.

The collaboration is the strongest of the three and has provided extensive answers to the referees' questions.

GAJET

The technique proposed by GAJET is probably the safest of the three in that the effective luminosity is tuneable and the trigger system has

PEP-II e BaBar a SLAC

acceleratore

rivelatore

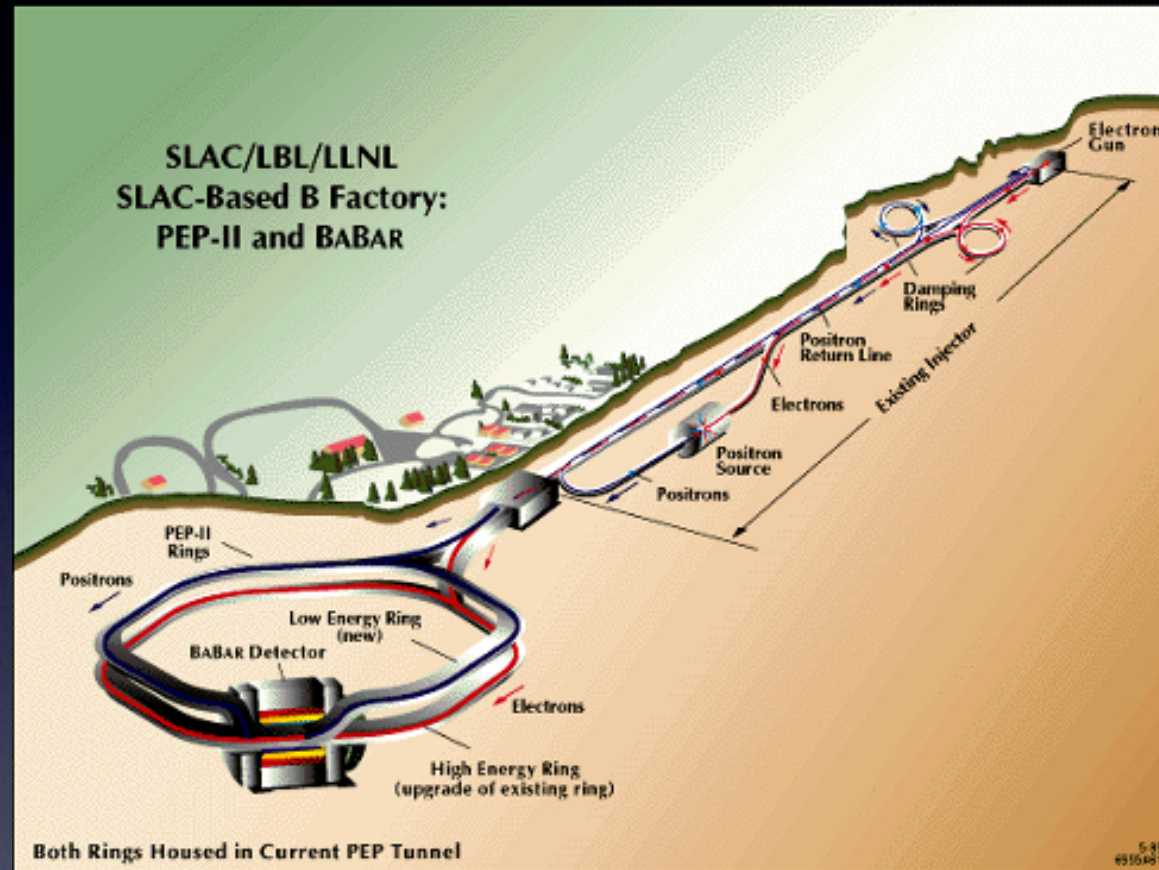
fisica

PEP-II e BaBar a SLAC

acceleratore

rivelatore

fisica



PEP-II e BaBar a SLAC

acceleratore

rivelatore

fisica

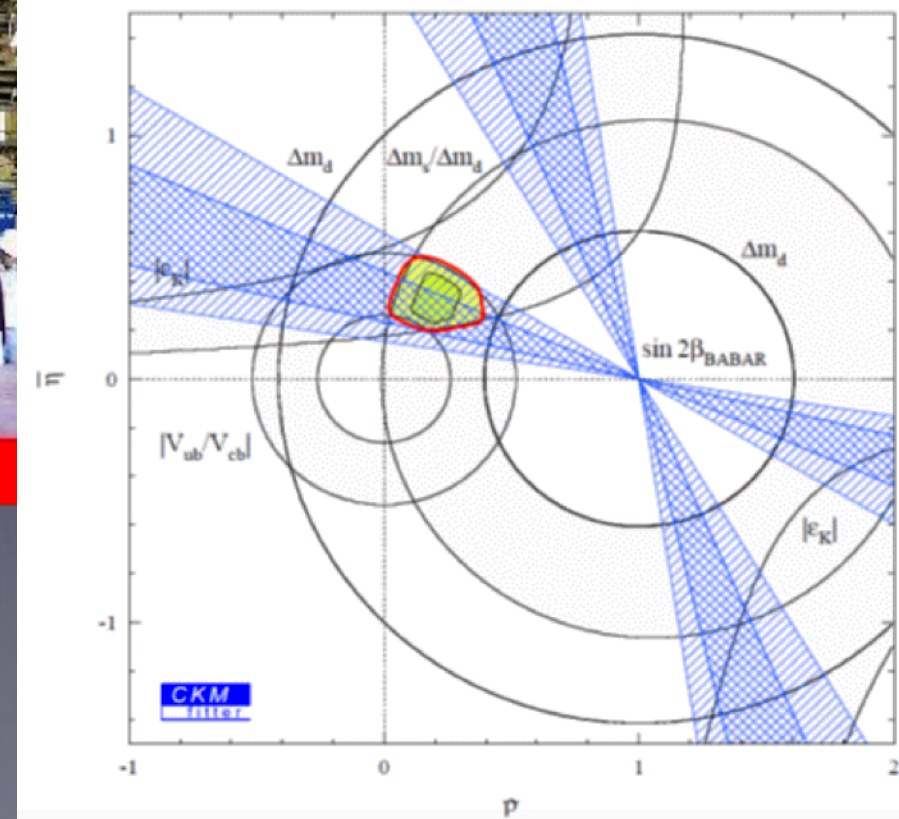
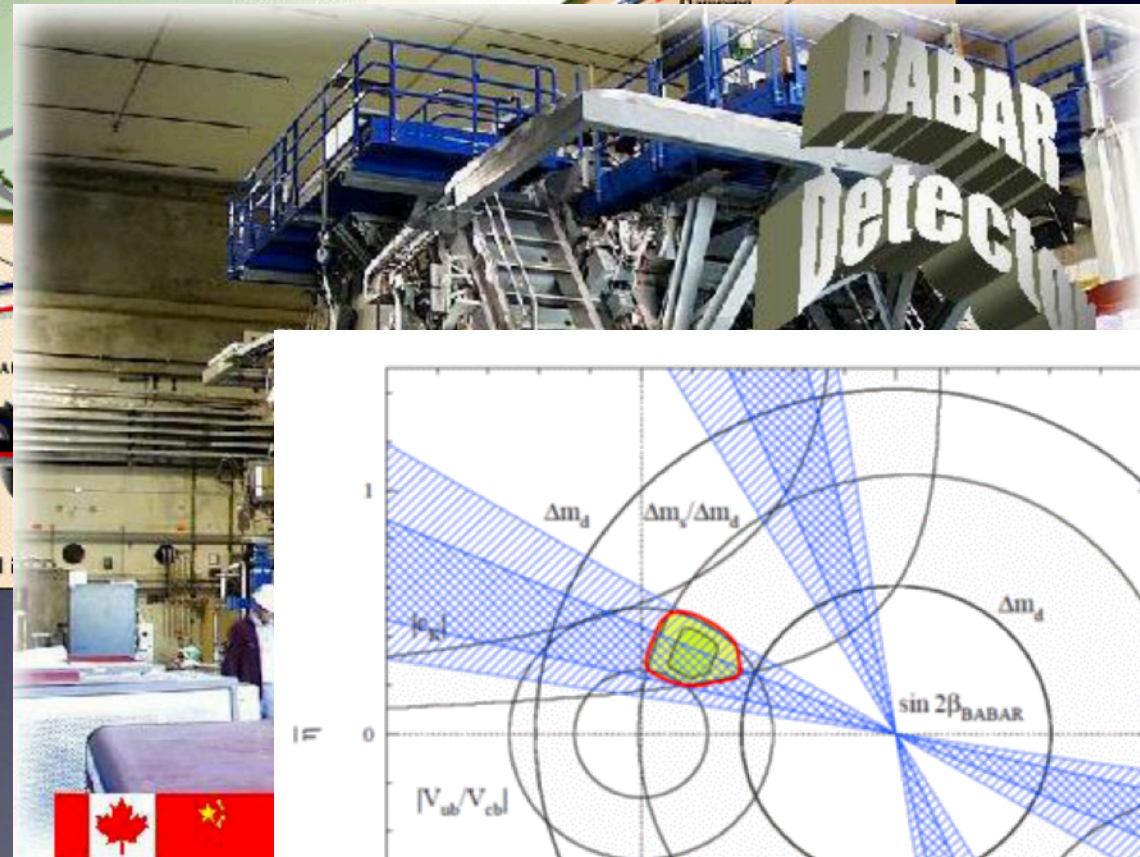
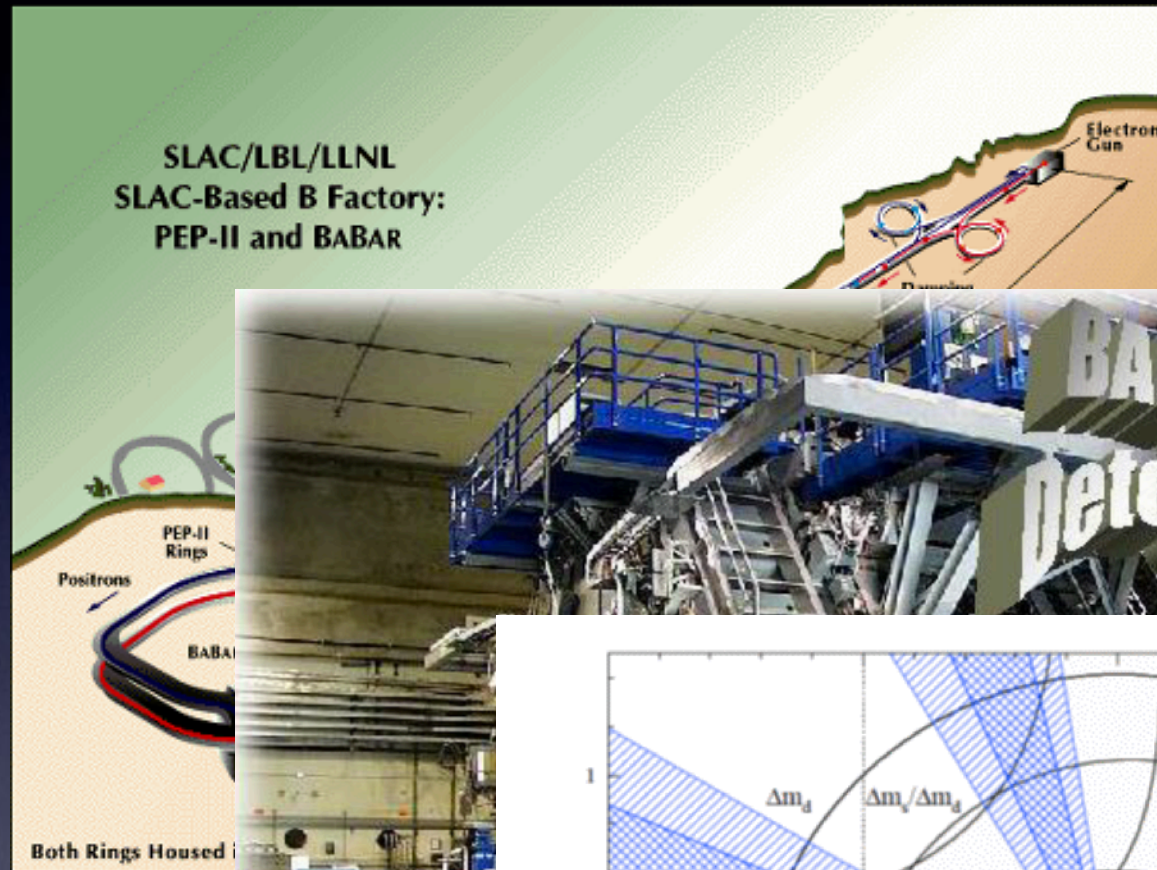


PEP-II e BaBar a SLAC

acceleratore

rivelatore

fisica



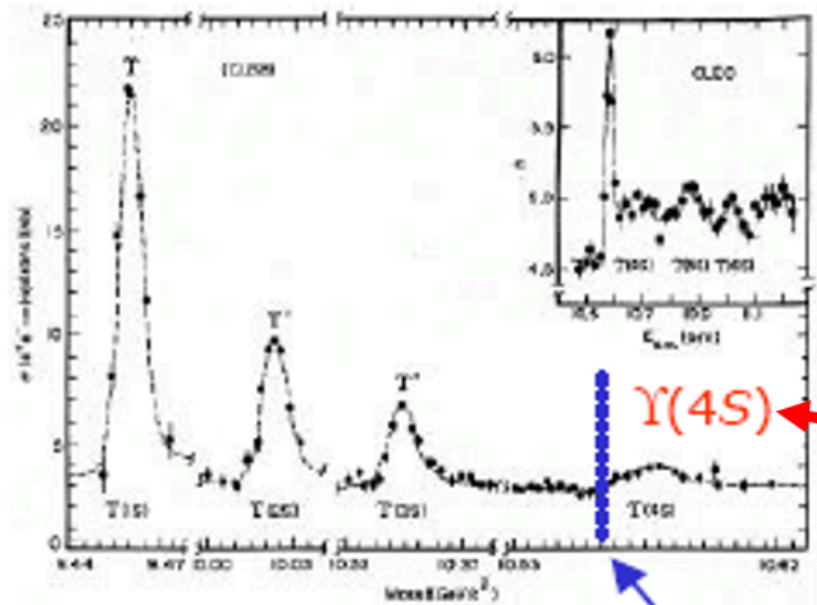
PEP-II a SLAC

- 1987: gli ingredienti di un nuovo collider e^+e^- :
 - due anelli separati \Rightarrow alta luminosità
 - $\Upsilon(4S)$: alta sezione d'urto e $B^0\bar{B}^0$ in stato coerente (entangled)
 - Pier Oddone: energia asimmetrica dei fasci: separazione dei vertici \Rightarrow misura di Δt
- 1989-1991: PEP-II, Conceptual Design Report (CDR)
- Dura competizione con Cornell, decisione finale in favore di SLAC
- 1994: Technical Design Report (TDR); inizia la costruzione
- 1997: commissioning del fascio di elettroni; 1998: positroni; 1999: inizio del run di fisica

le scelte per PEP-II

- CM energy = 10.580 GeV

Effective cross sections



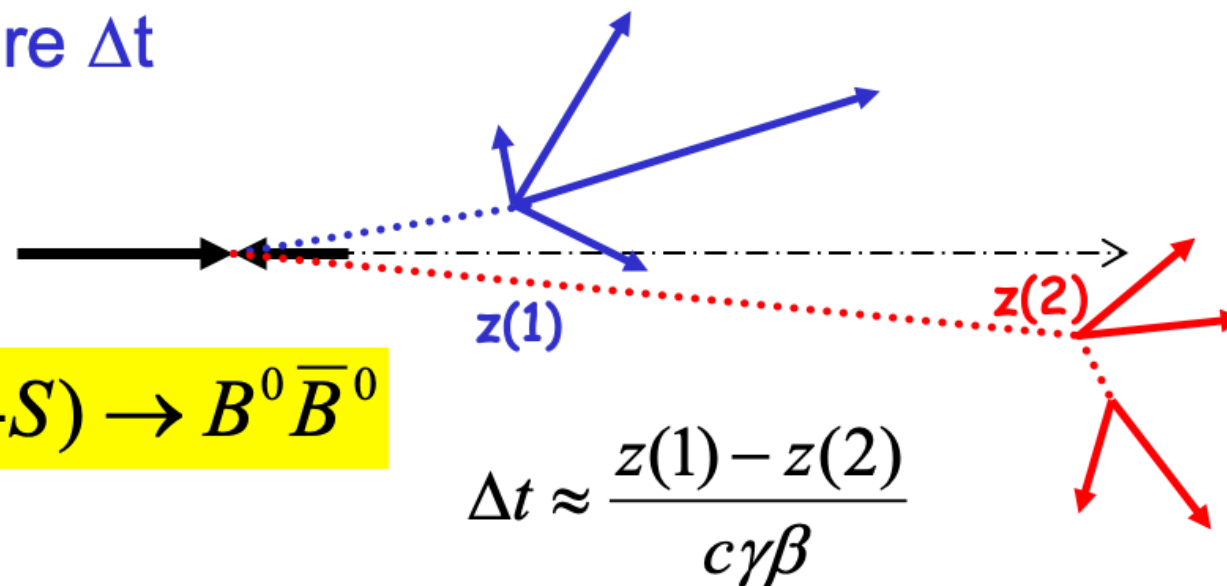
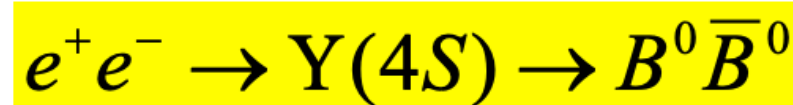
Favorable
Signal / Background:

$$\frac{\sigma_{bb}}{\sigma_{had}} \cong 0.28$$

$e^+e^- \rightarrow$	σ (nb)
bb	1.05
cc	1.30
ss	0.35
uu	1.39
dd	0.35
$\tau^+\tau^-$	0.94
$\mu^+\mu^-$	1.16
e^+e^-	≈ 40

$B\bar{B}$ threshold

- Asymmetric energy beams: boost the B pair to measure Δt



boost :

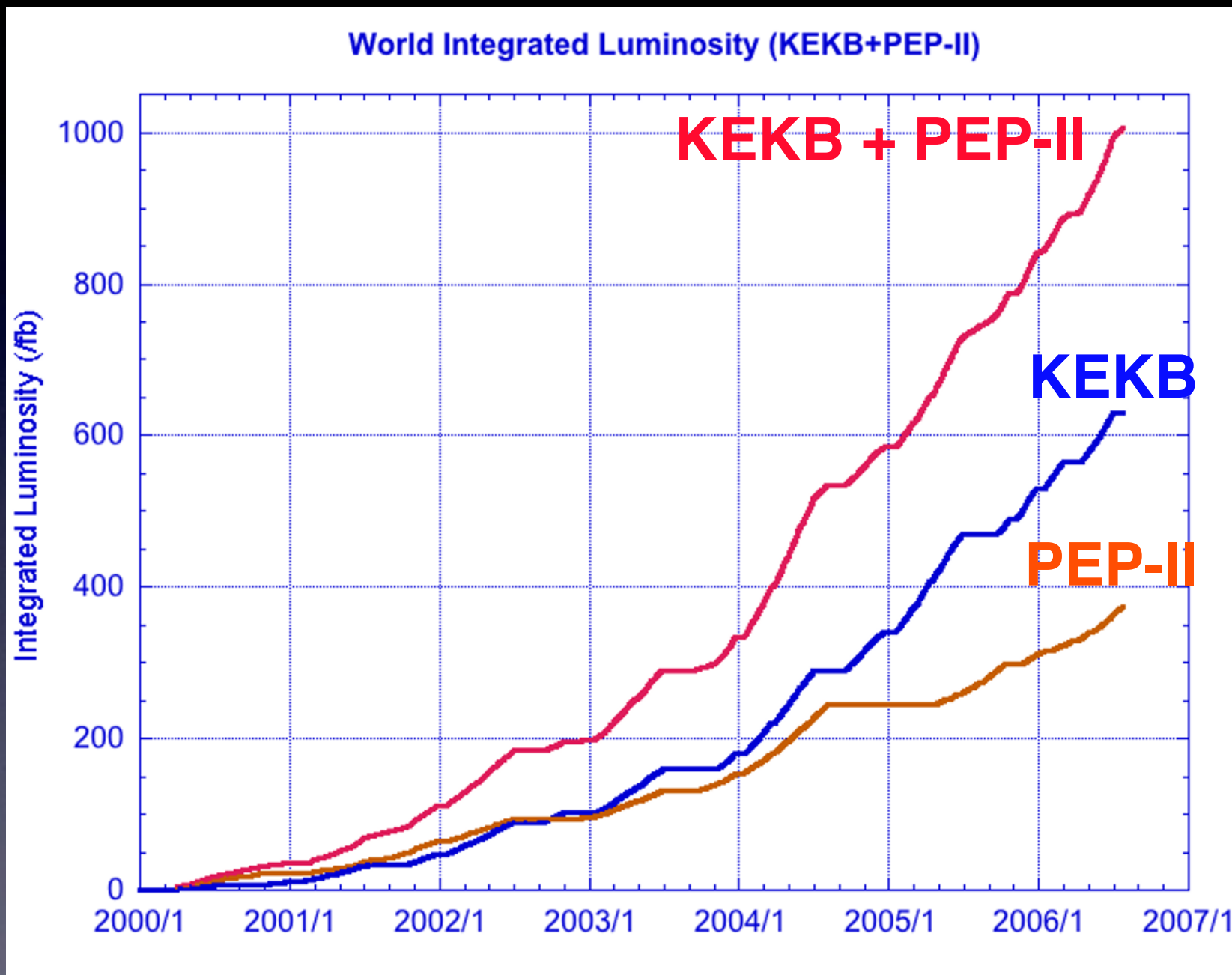
$$\gamma\beta \approx 0.56$$

for :

$$E(e^-) \approx 9 \text{ GeV},$$

$$E(e^+) \approx 3 \text{ GeV},$$

PEP-II e KEKB: luminosità



KEKB, 2010:
 $\approx 1000 / \text{fb}$
770M $B\bar{B}$ pairs

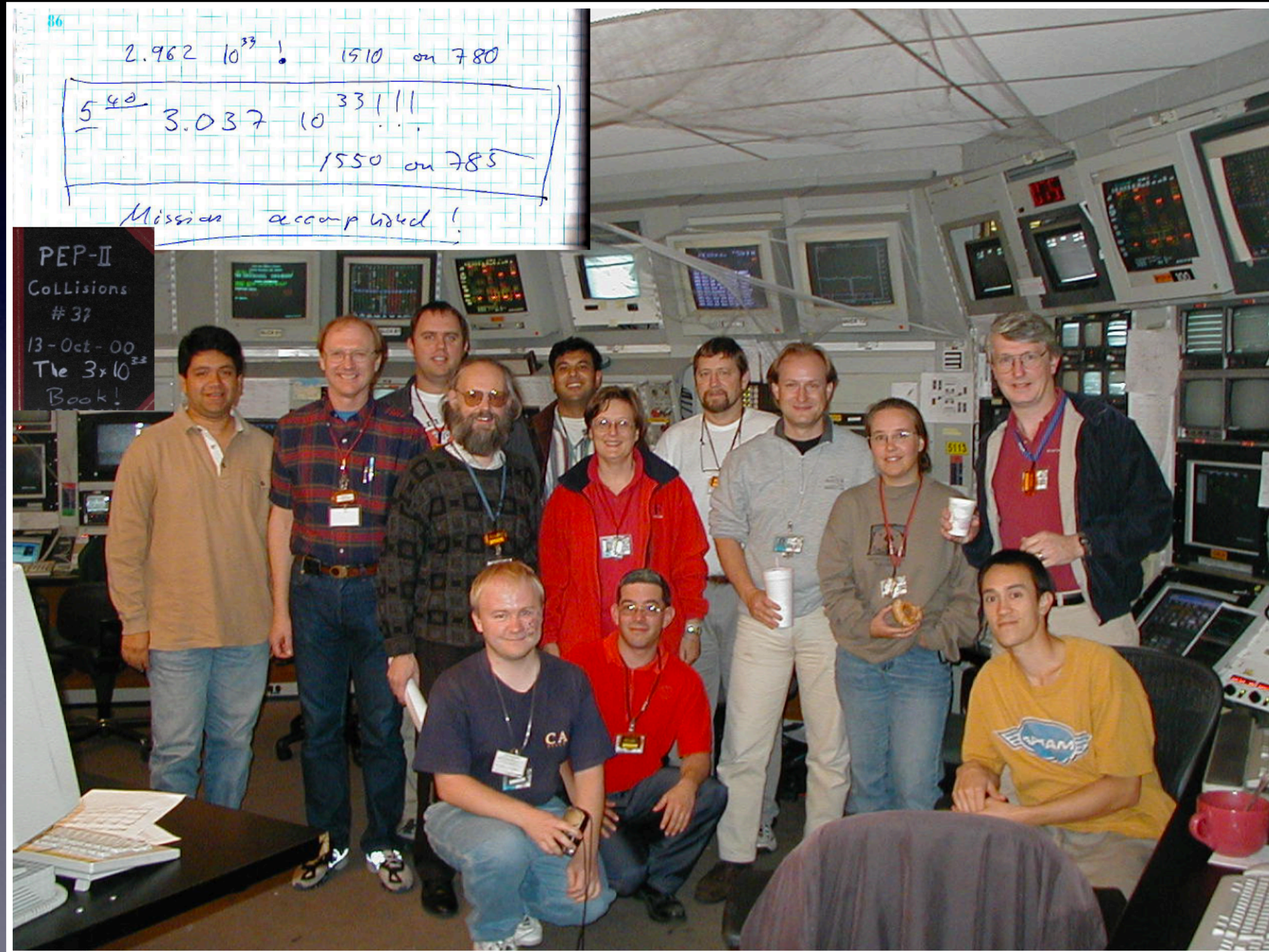
PEP-II, 2008:
 $\approx 560 / \text{fb}$
470M $B\bar{B}$ pairs

3×10^{33}

1.2×10^{34}

PEP-II lumi.
[$\text{cm}^{-2}\text{s}^{-1}$]

Ottobre 2000: già raggiunta la luminosità di progetto!



PEP-II: parametri finali

Parameter	Units	Design	Overall best
I+	mA	2140	3213
I-	mA	750	2069
Number bunches		1658	1732
β_y^*	mm	15-20	9-10
Bunch length	mm	15	10-12
ξ_y	tune shift	0.03	0.05-0.065
Luminosity	$\times 10^{33}$	3	12
Int lumi / day	pb ⁻¹	130	911

4 x design

7 x design

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Il team di PEP-II nel 2008

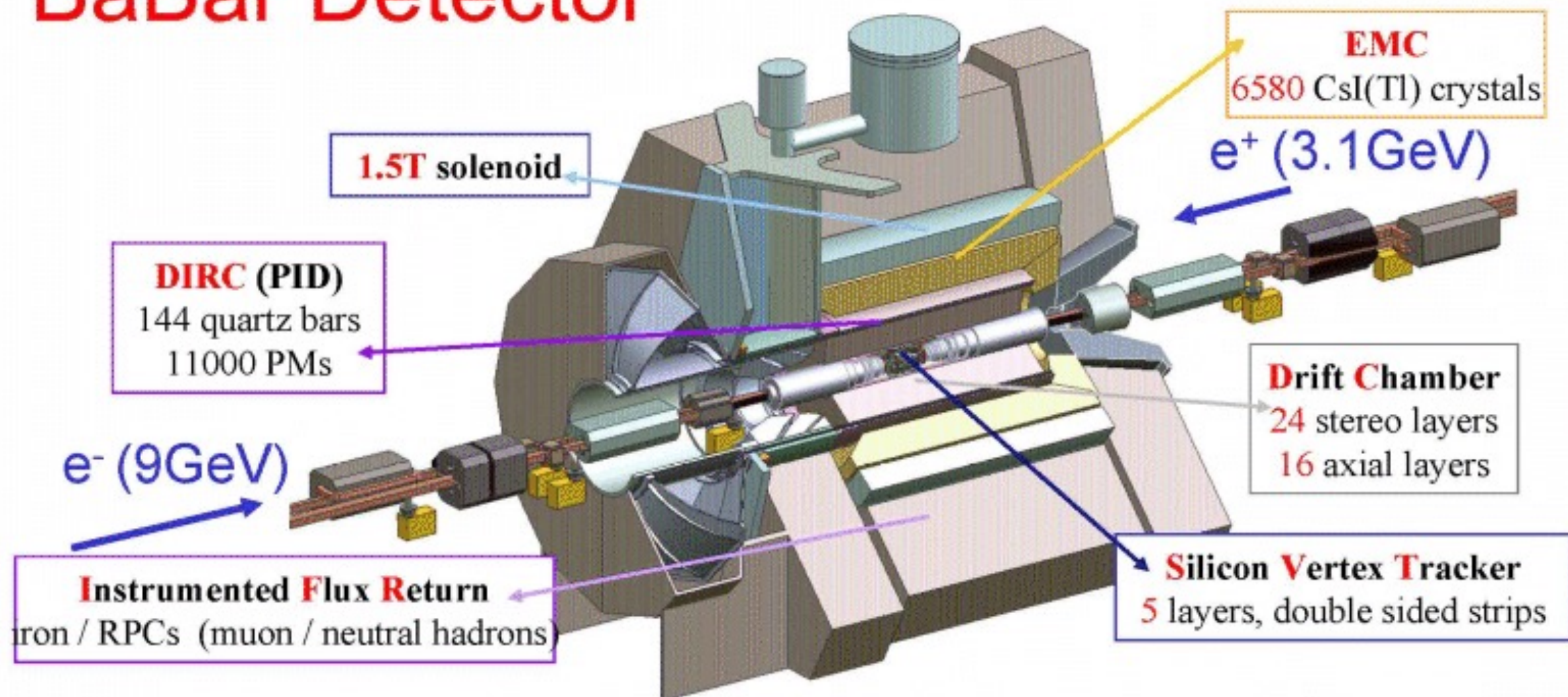


Il DOE decise la fine (prematura) di PEP-II nel 2008

PEP-II: breve prolungamento del run alle $\Upsilon(3S)$ e $\Upsilon(2S)$

Belle@KEKB in Giappone prese dati fino a giugno 2010

BaBar Detector



SVT: vertexing and tracking: crucial for Δt and low p_T tracks

DCH: main tracking device, also dE/dx for particle ID

DIRC: K - π separation $> 3.4\sigma$ for $P < 3.5\text{GeV}/c$

EMC: very good energy resolution; electron ID, π^0 and γ reco.

IFR: Muon and neutral hadrons (K^0_L) ID

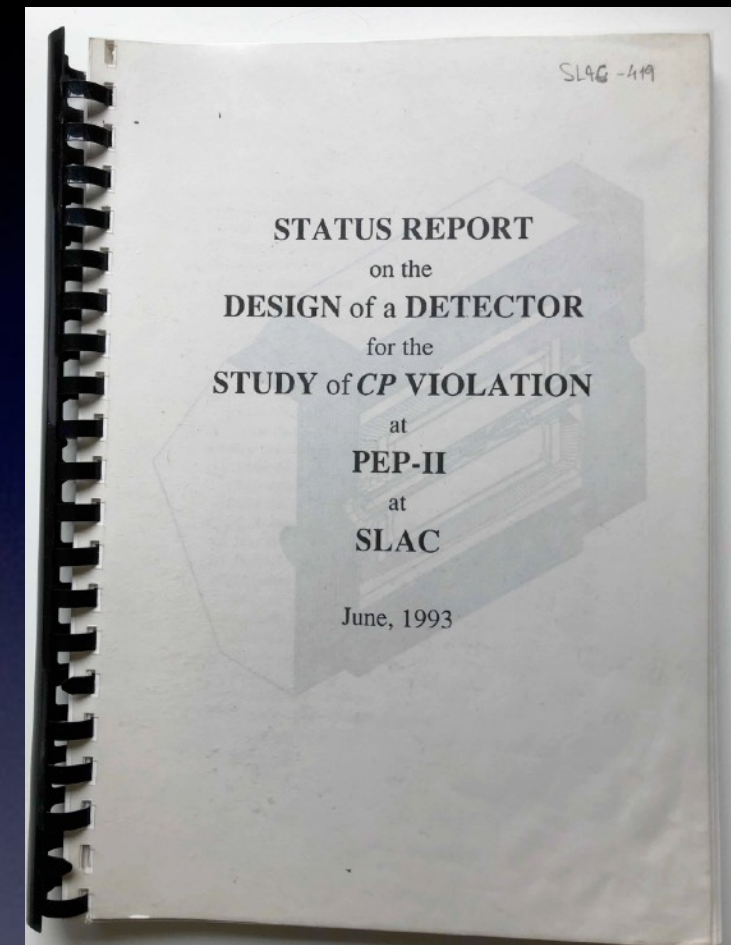


BaBar: la partecipazione italiana

- Uno Status Report (Giugno 1993) sintetizza tre anni di studi sul disegno di un possibile detector per PEP-II a SLAC, documentati da 104 note interne “BaBar”
- 1993-1994: Ida Peruzzi (LNF) e Marcello Giorgi (Pisa) stimolano e raccolgono le adesioni italiane, in contatto con il presidente INFN Luciano Maiani
- partecipanti da 12 sezioni INFN firmano la Lol (Giugno 1994) e poi il TDR (Marzo 1995)
- TDR: Bari(2), Ferrara(1), Frascati(6), Genova (13), Milano(8), Napoli(5), Padova(5), Milano+Pavia(4), Pisa(15), Sanità+Roma(7), Torino(4), Trieste(6)
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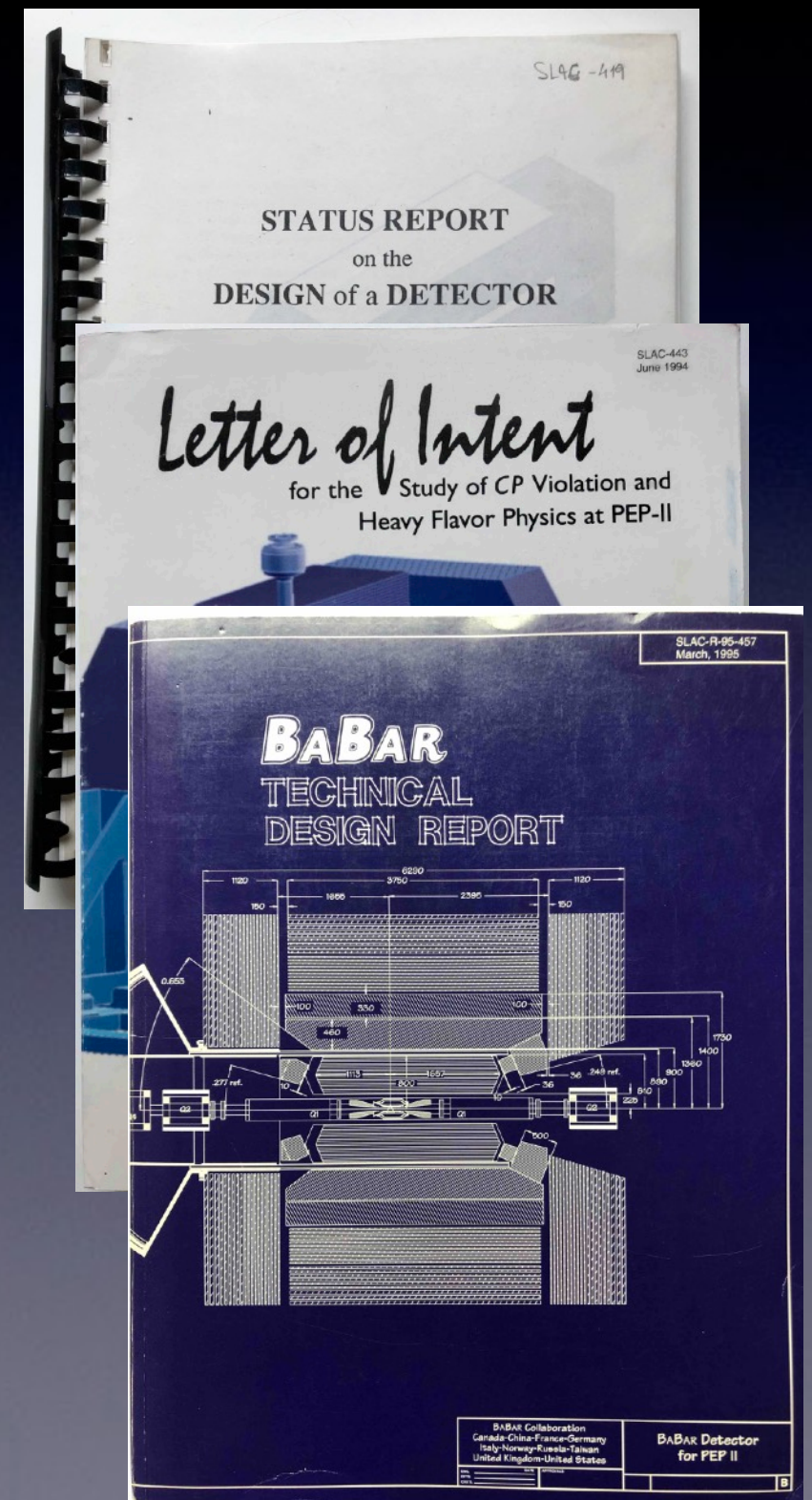
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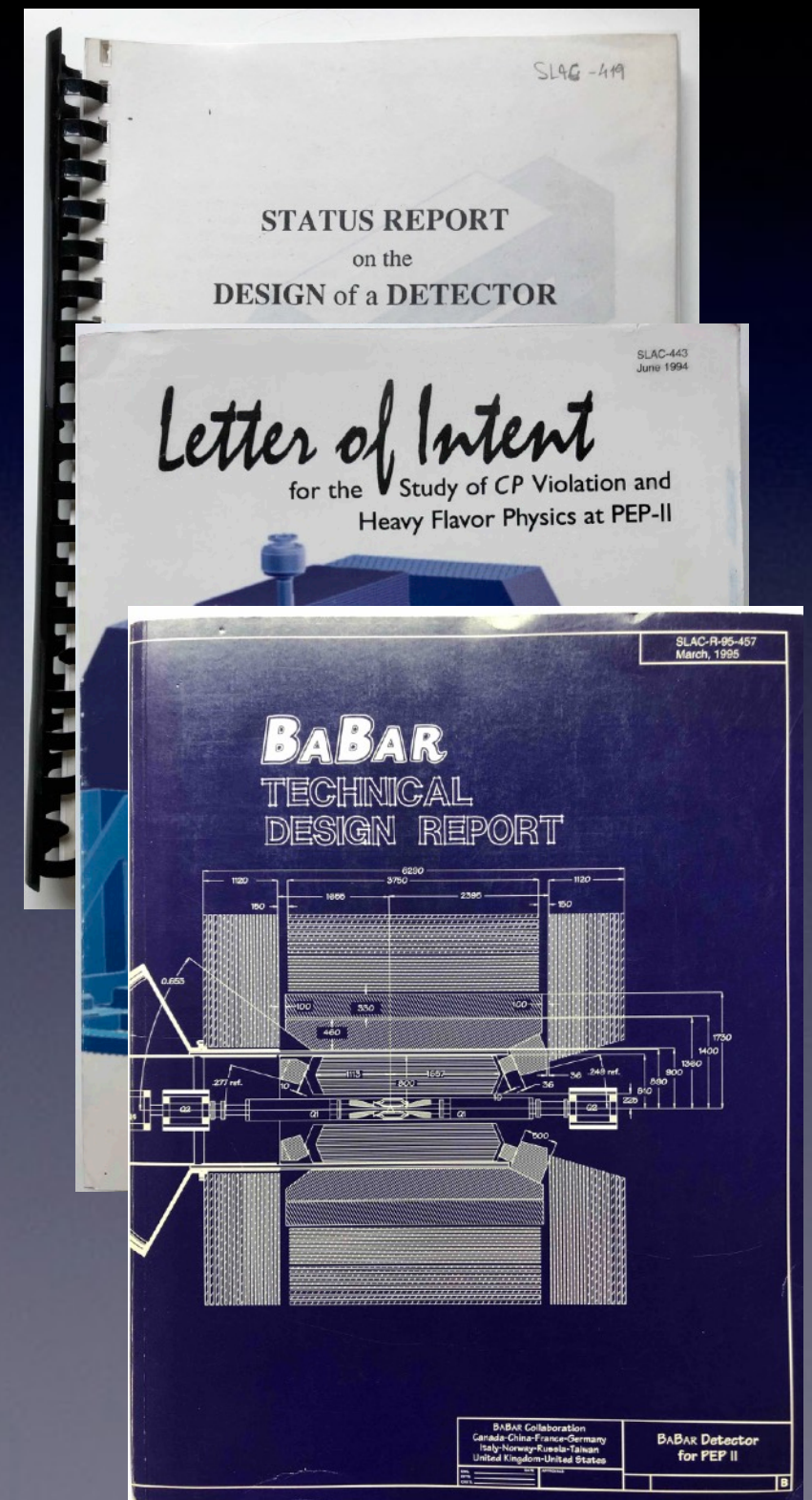
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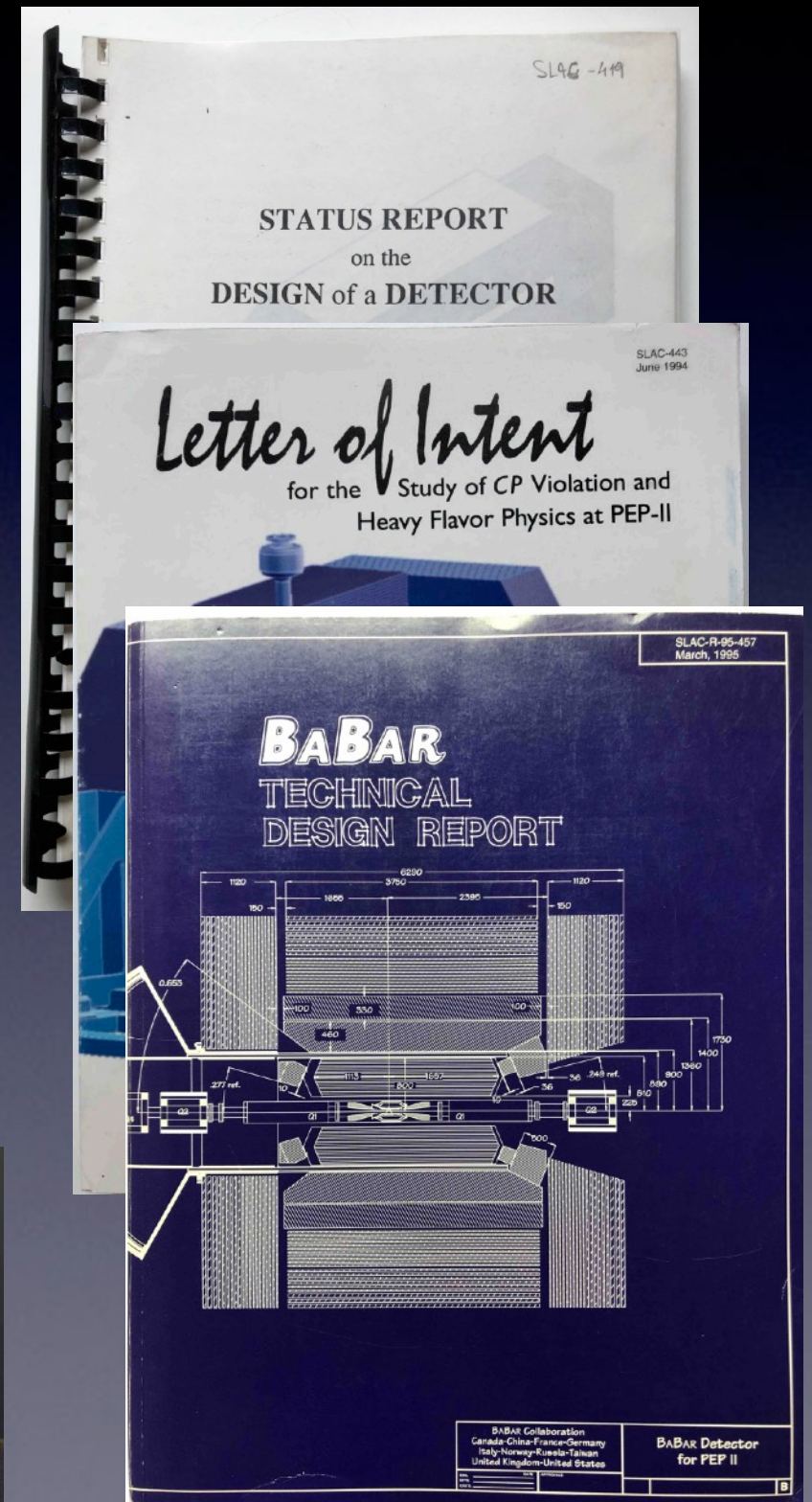
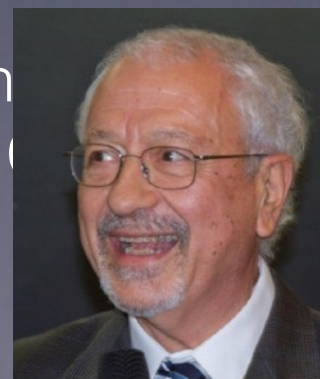
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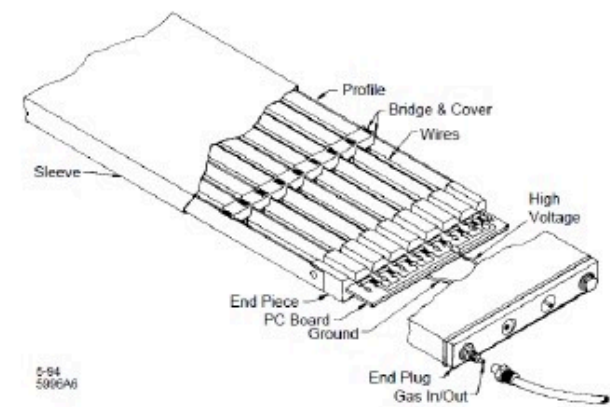
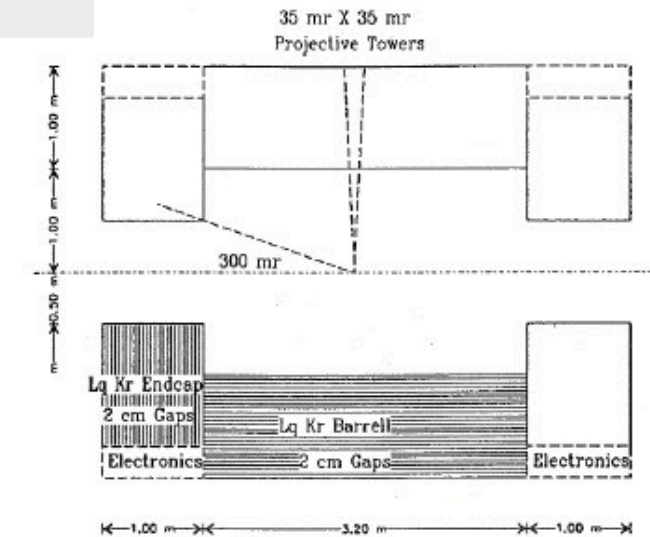
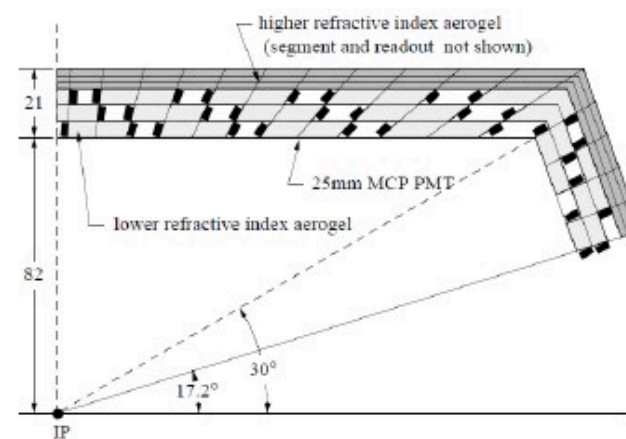
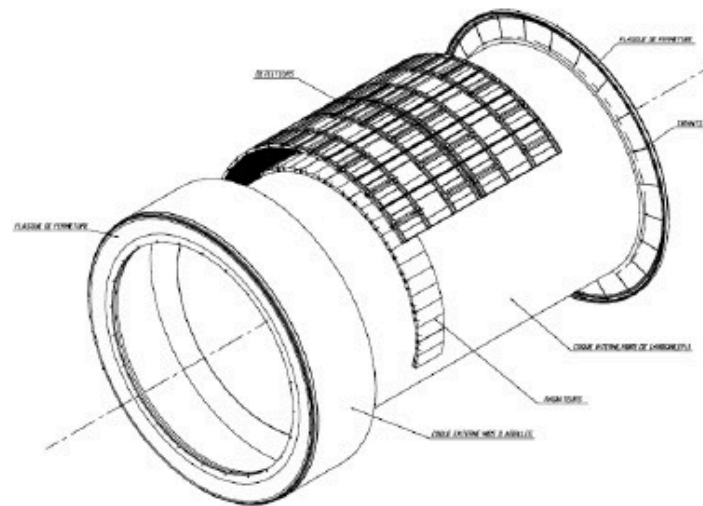
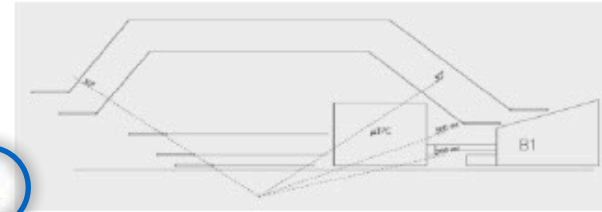
BaBar: la partecipazione italiana

- Uno Status Report (Giugno 1993) sintetizza tre anni di studi sul disegno di un possibile detector per PEP-II a SLAC, documentati da 104 note interne "BaBar"
- 1993-1994: Ida Peruzzi (LNF) e Marcello Giorgi (Pisa) stimolano e raccolgono le adesioni italiane, in contatto con il presidente INFN Luciano Maiani
- partecipanti da 12 sezioni INFN firmano la Lol (Giugno 1994) e poi il TDR (Marzo 1995)
- TDR: Bari(2), Ferrara(1), Frascati(6), Genova (13), Milano(8), Napoli(5), Padova(5), Milano+Pavia(4), Pisa(15), Sanità+Roma(7), Torino(4), Trieste(6)
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The LOI contained a variety of technical alternatives/options, reflecting R&D that had been done and the expertise of particular institutions

- ❑ Vertex: SVT, μ TPC
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- ❑ Calorimeter: **CsI(Tl)**, Pb/LKr
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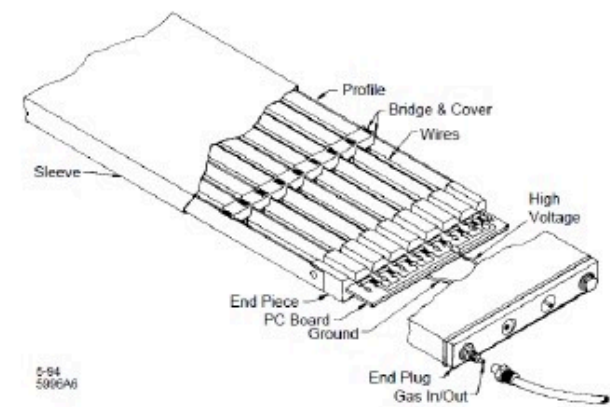
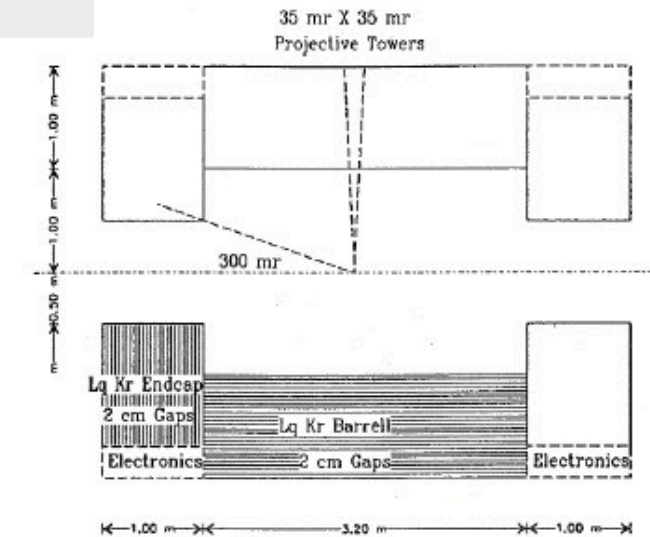
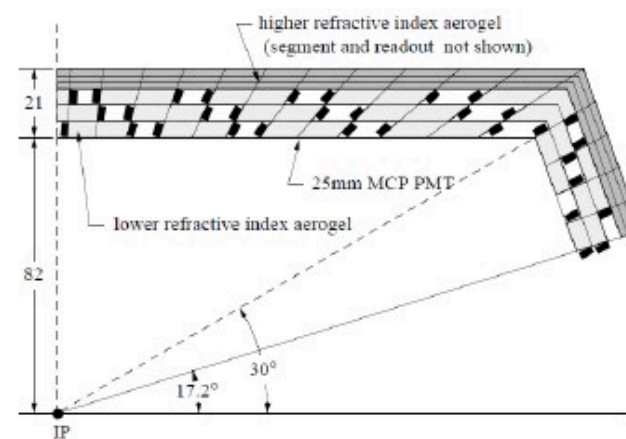
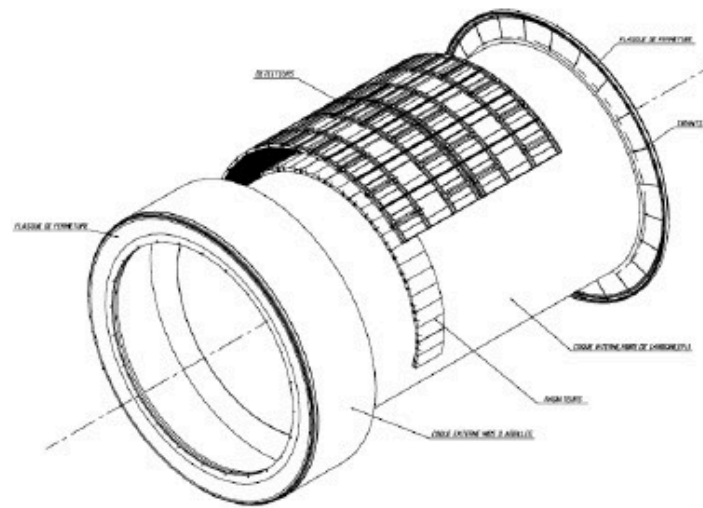
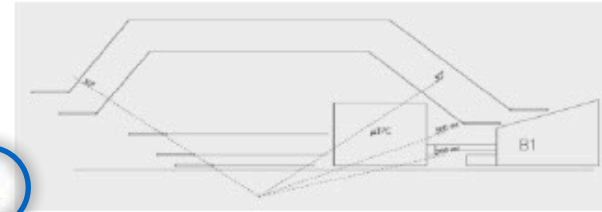


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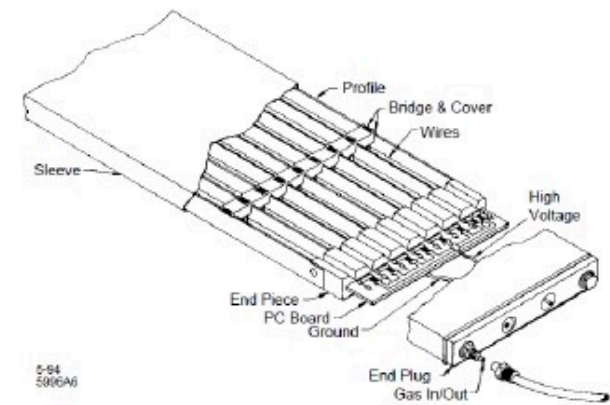
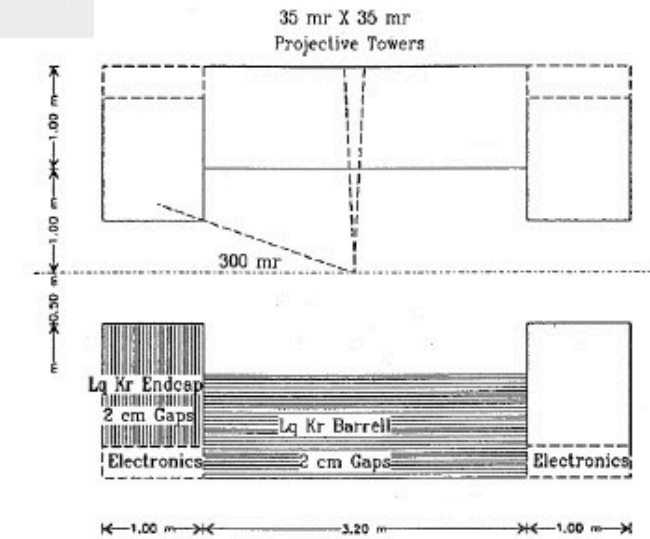
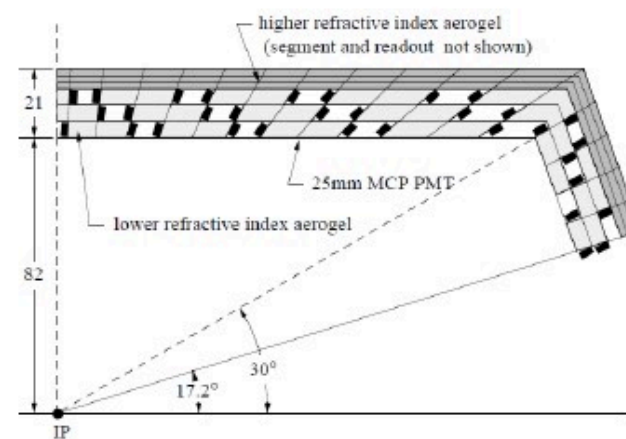
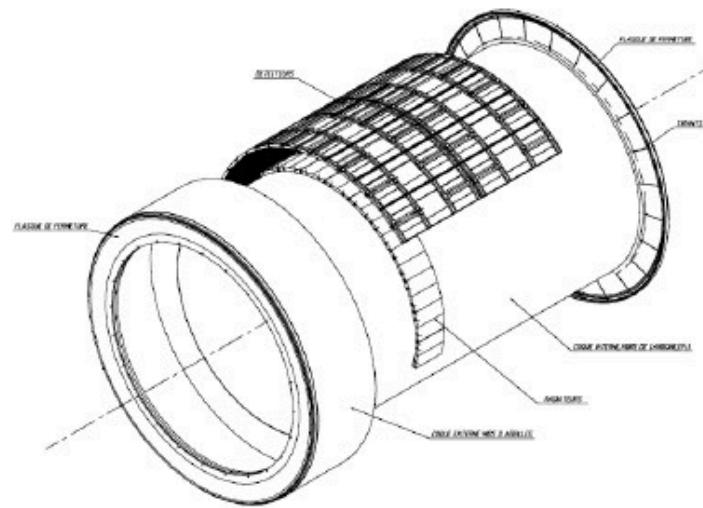
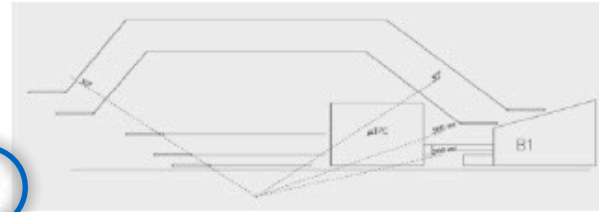


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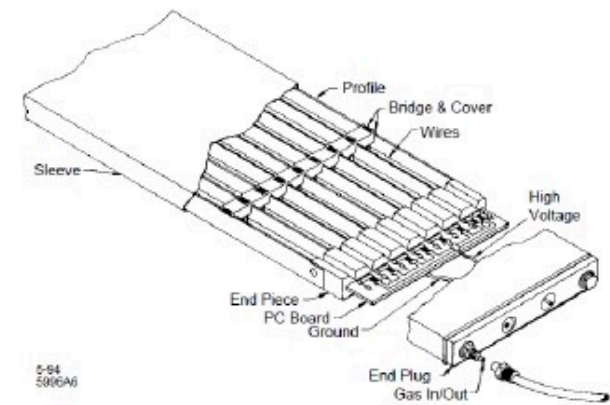
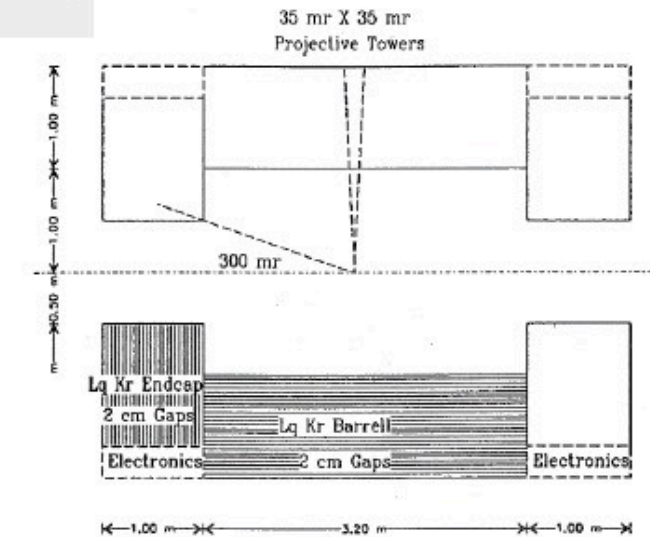
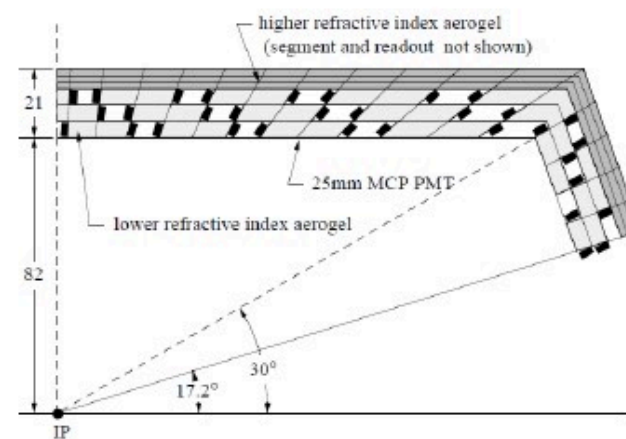
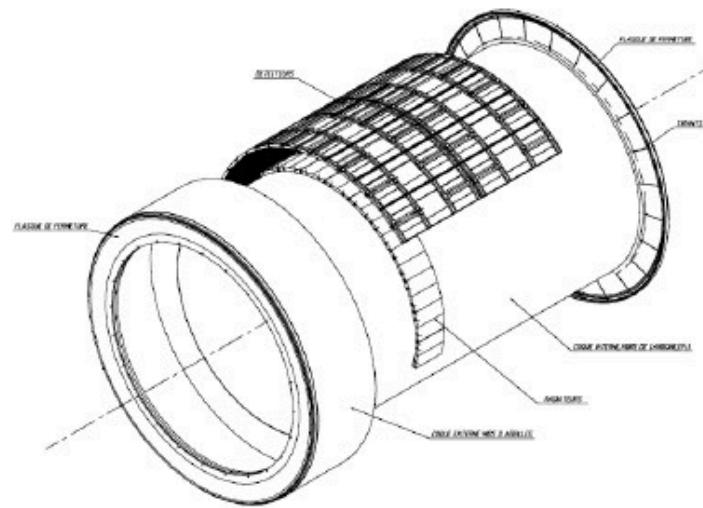
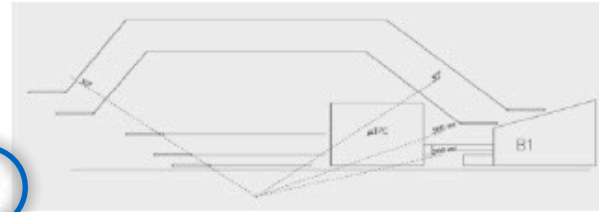


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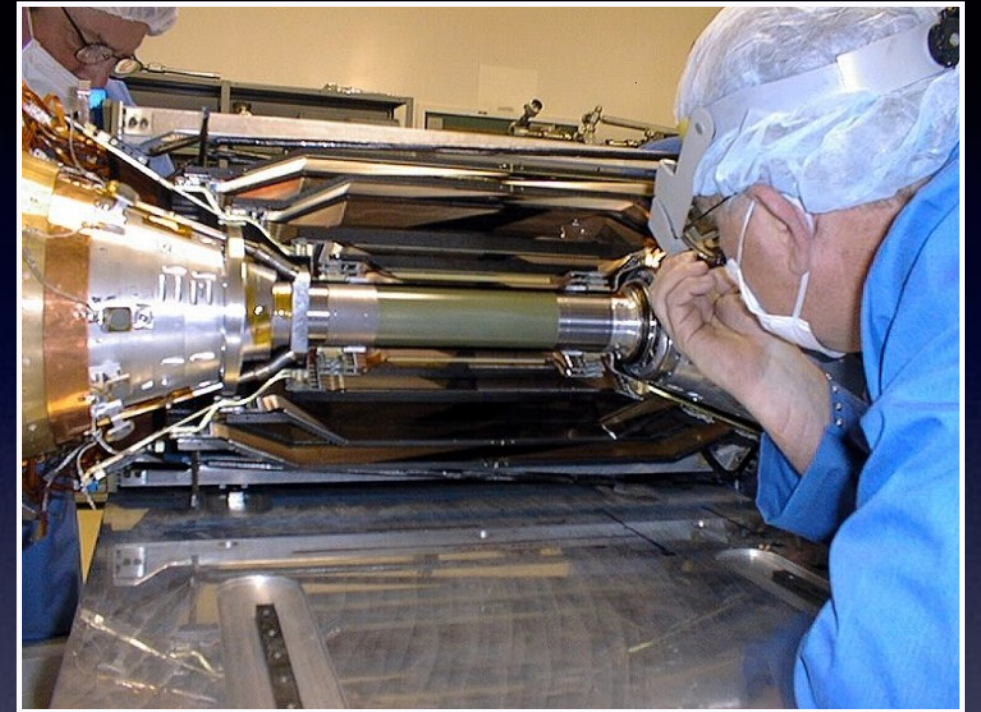
il solenoide superconduttore

- Costruito in Italia dall'Ansaldo e finanziato dall'INFN con un anticipo sui contributi al fondo di collaborazione
- I ritardi nella costruzione vennero compensati grazie al trasporto con un C5 dell'US Air Force, ottenuto avventurosamente da Sidney Drell risalendo da un generale amico fino ai massimi livelli dei generali a 4 stelle.
- Le foto mostrano il caricamento sull'aereo a Genova, sotto lo sguardo vigile di Marcello Giorgi, Pasquale Fabricatore, un ingegnere dell'Ansaldo, e un ingegnere di SLAC



Silicon Vertex Tracker

- un gioiello con 5 layer: essenziali per la fisica (ma faticoso convincere la CN1...)
- collaborazione italo-americana: Pisa-Trieste-Torino-Milano-Pavia-Ferrara, LBNL, UCSB, UCSD, Stanford
- rischi di ritardo nella costruzione (elettronica, circuiti ibridi, assemblaggi...), tenuti sotto controllo dall'efficace coordinamento di Francesco Forti e Natalie Roe
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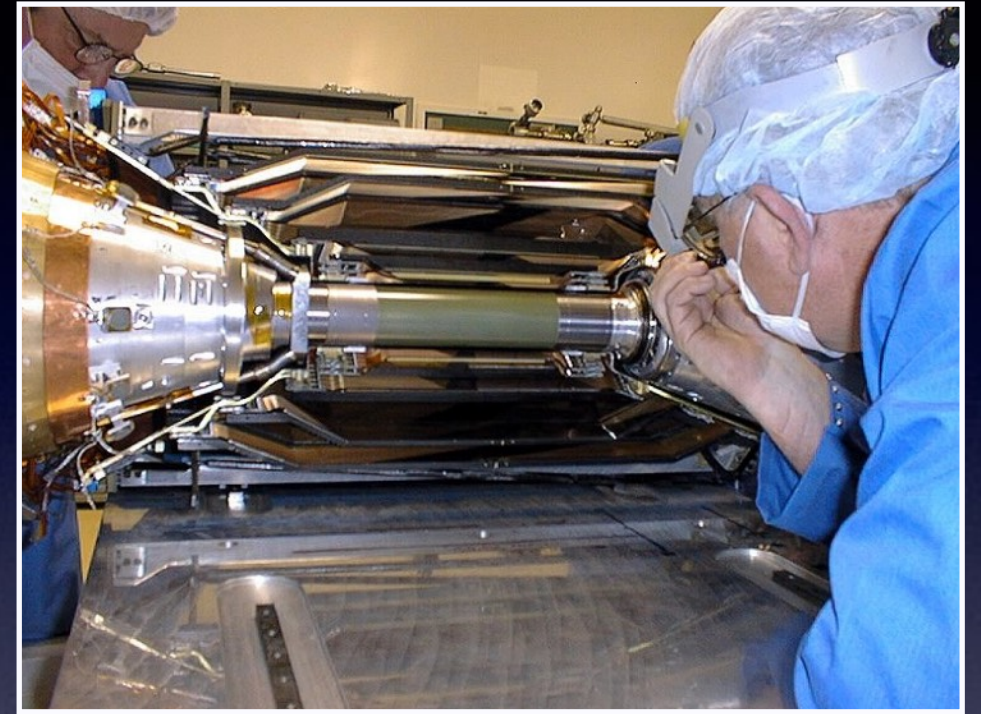
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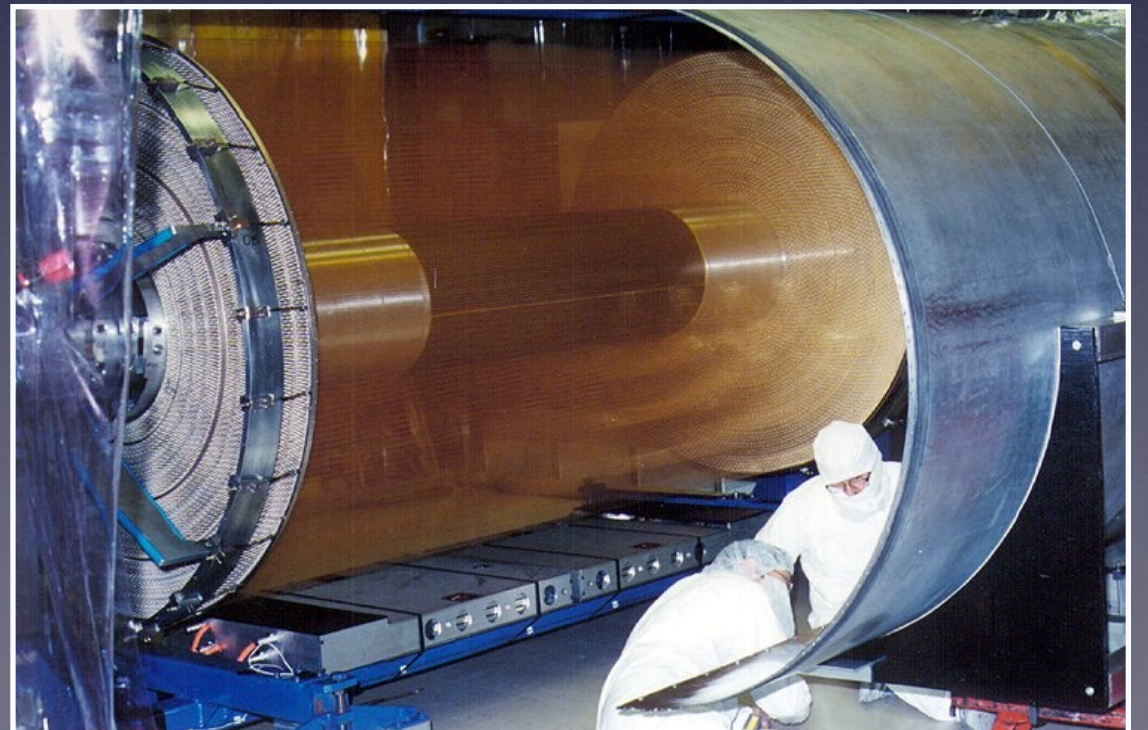
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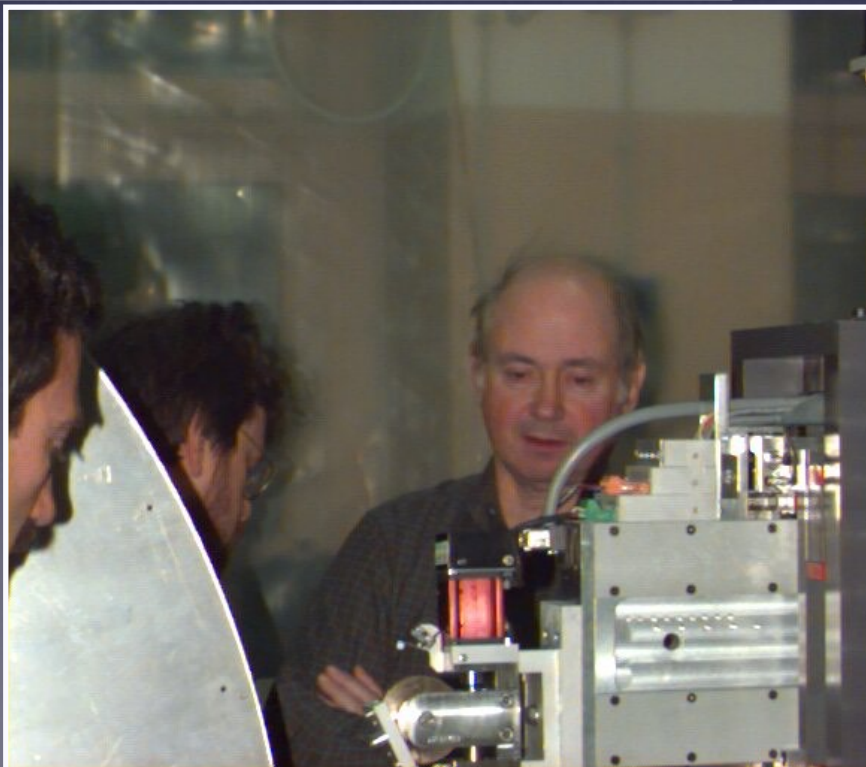
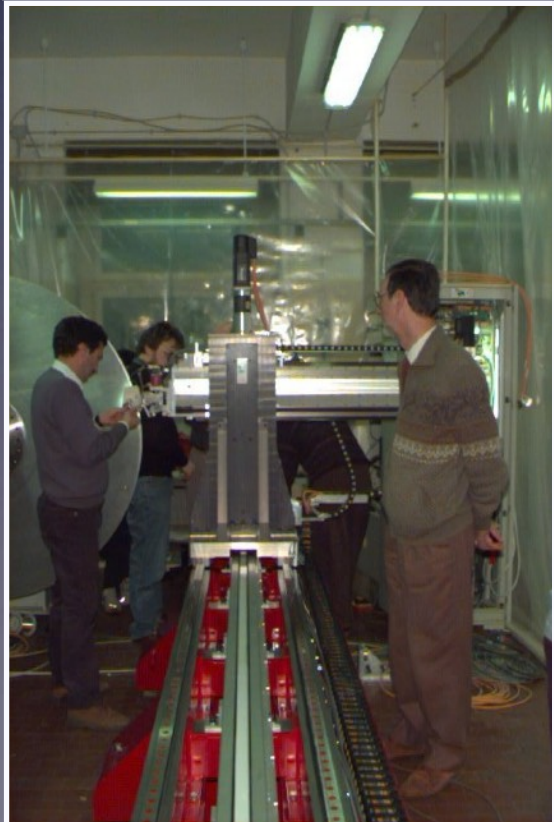
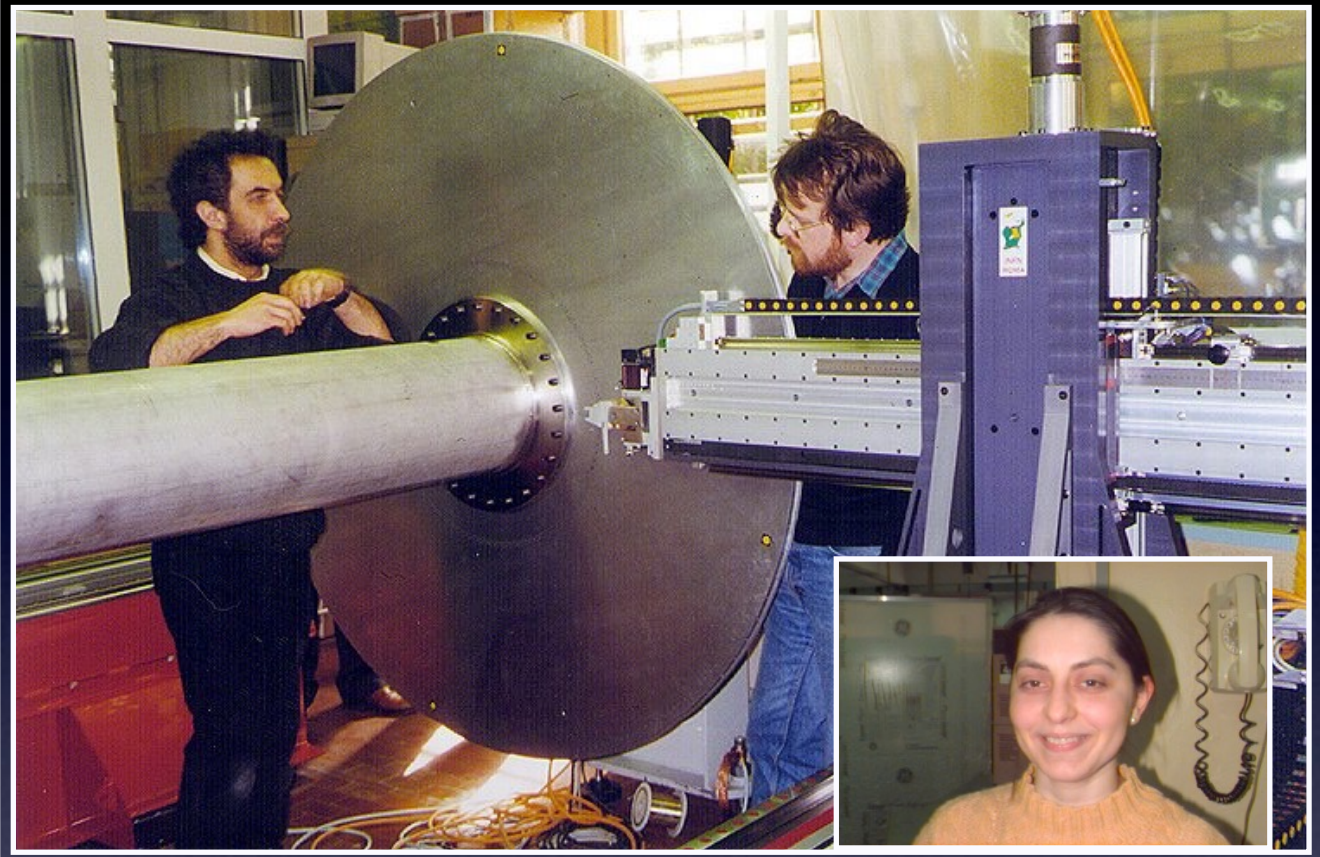
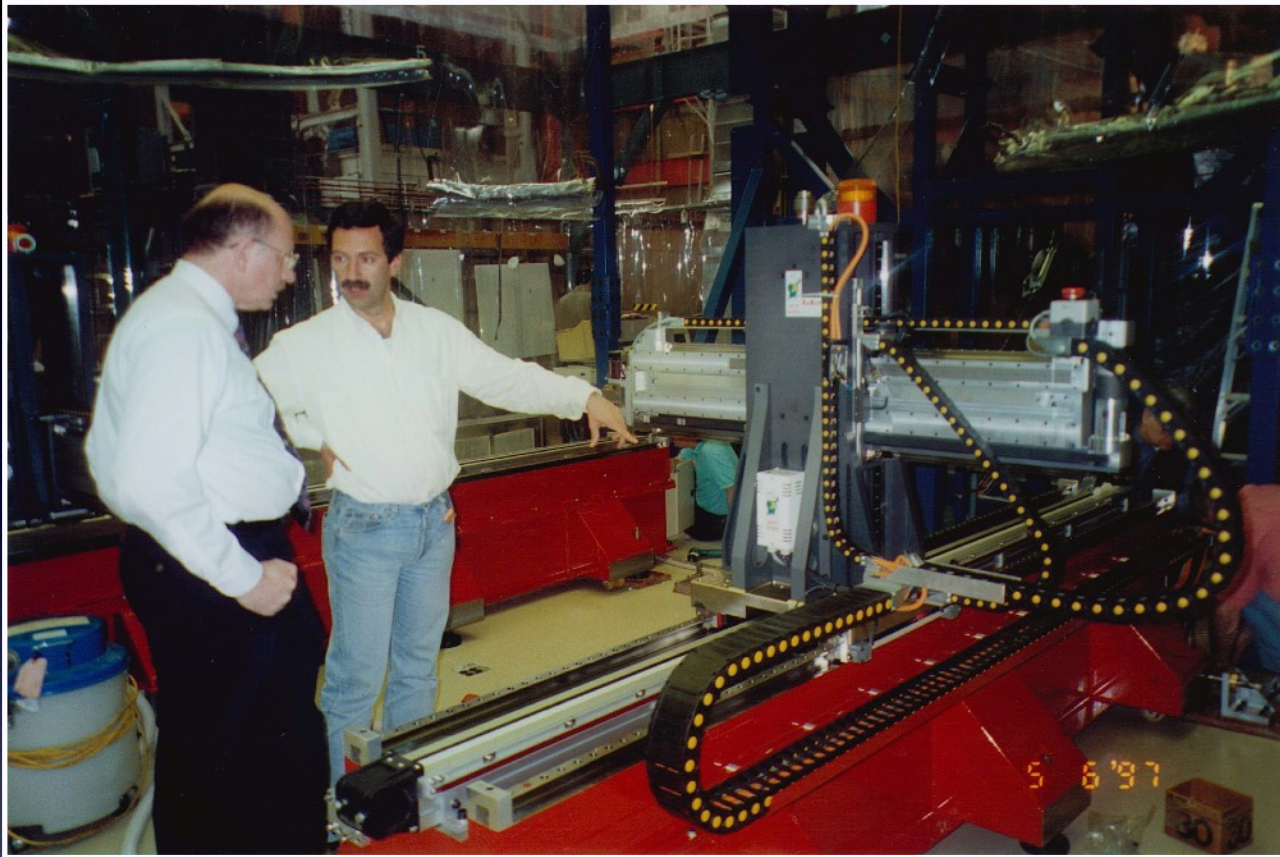


Drift Chamber

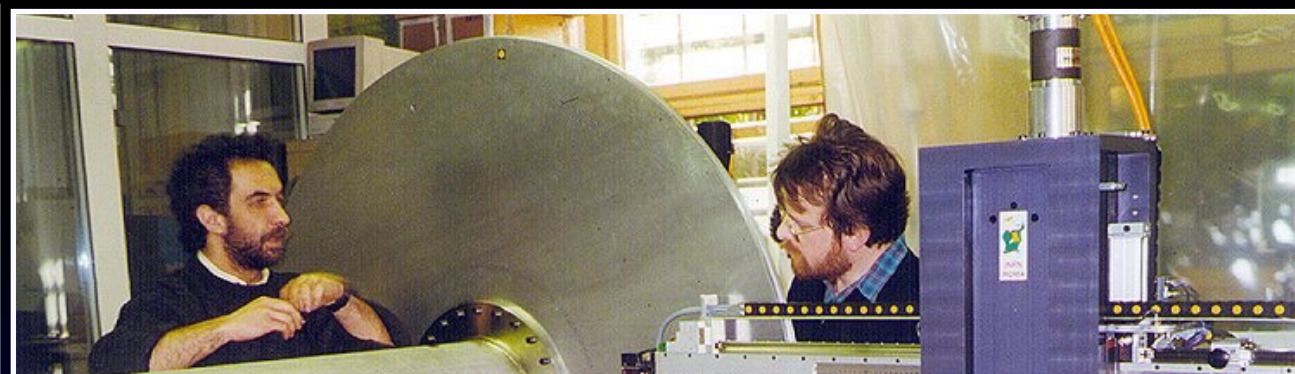
- Il progetto iniziale della DCH aveva seri problemi (...) che rischiarono di mandare in crisi l'esperimento (1 anno di ritardo?)
- L'emergenza fece entrare in campo Roma, Padova, e Princeton, per modificare il progetto e rimetterlo in carreggiata
- l'operazione ebbe successo, la costruzione fu completata in tempo e la DCH fornì regolarmente il tracciamento e il dE/dx previsti



DCH robot a Roma e al Triumph

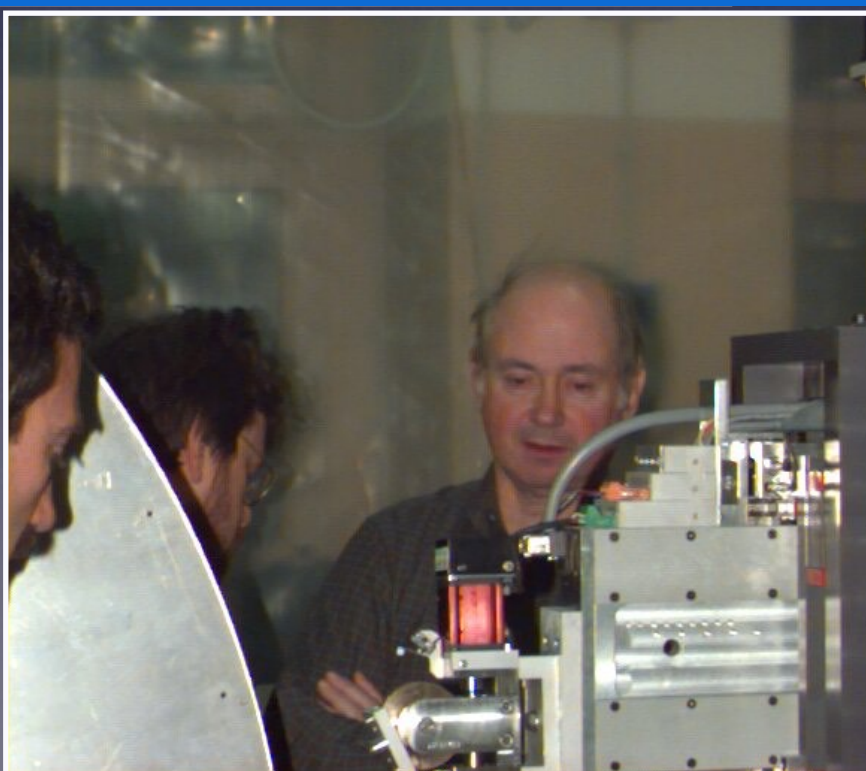
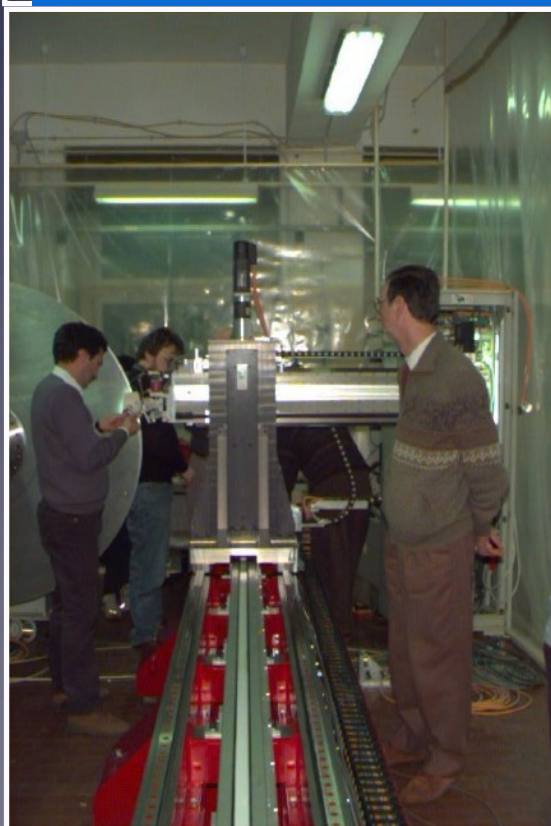


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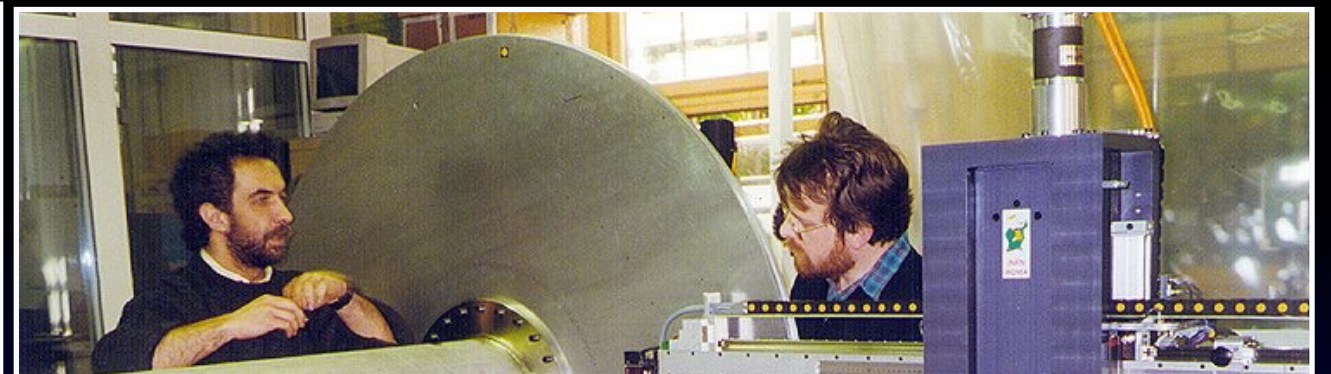
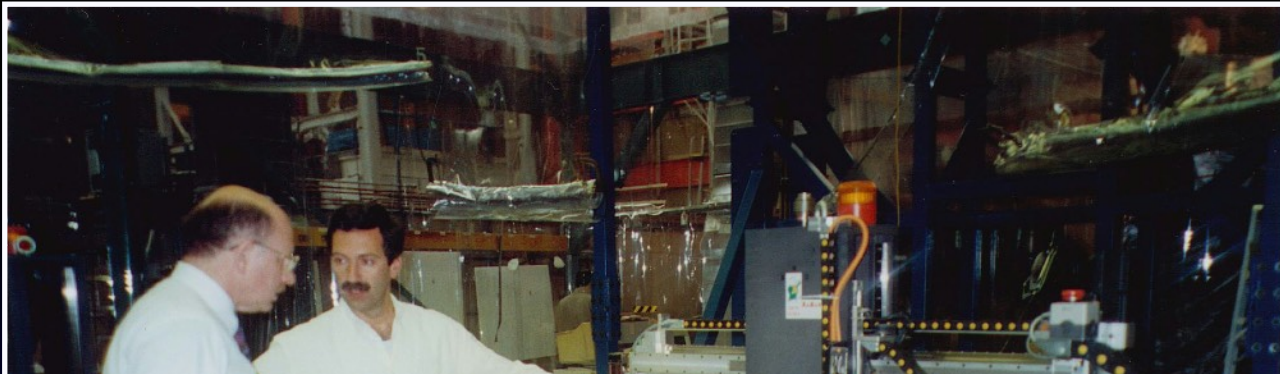


Un commento da Stew Smith (Princeton):

Without Nando and Mauro the revised Drift Chamber simply would not have succeeded: the robotic stringing system was a huge technical success and major time-saver, made possible only by their leadership and total commitment.



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In addition, Nando's help and statesmanlike support on the Drift Chamber Steering Committee was essential to creating our wonderful and capable team that built it. A prime example was the decision in 1996 whether to fabricate the endplates in the US or Italy. When a technical review recommended the US, Nando said to me: "OK. You have won. But if you fail, you must crawl away in shame." I was momentarily stunned, but then he smiled broadly and said "Let's go have some wine!" We've been the closest friends and colleagues ever since.

DIRC e aerogel (ATC)

- Il Detector of Internally Reflected Cherenkov light (DIRC) per l'identificazione di π e K nel *barrel* causò preoccupazioni per i ritardi nella costruzione, ma finalmente fu un successo americano e francese
- Il TDR prevedeva un'estensione della copertura in avanti con un anello di contatori Aerogel (ATC) nell'*end-cap* : ci lavorarono Roma, Padova e altri gruppi (Francia, Russia, USA), con Nando *project leader*
- Nell'evoluzione del progetto complessivo di BaBar, lo spazio per ATC si ridusse progressivamente, fino all'eliminazione per semplificare e liberare risorse per gli altri progetti



Studio di un rivelatore Cerenkov ad aerogel per l'esperimento BaBar
Marco Serra - relatori S.Morganti, F.Ferroni - A.A. 1996/97

 Nuclear Instruments and Methods in
Physics Research Section A: Accelerators,
Spectrometers, Detectors and Associated
Equipment 

Volume 385, Issue 1, 11 January 1997, Pages 74-80

Performance of a prototype aerogel counter readout by fine mesh photo-tubes

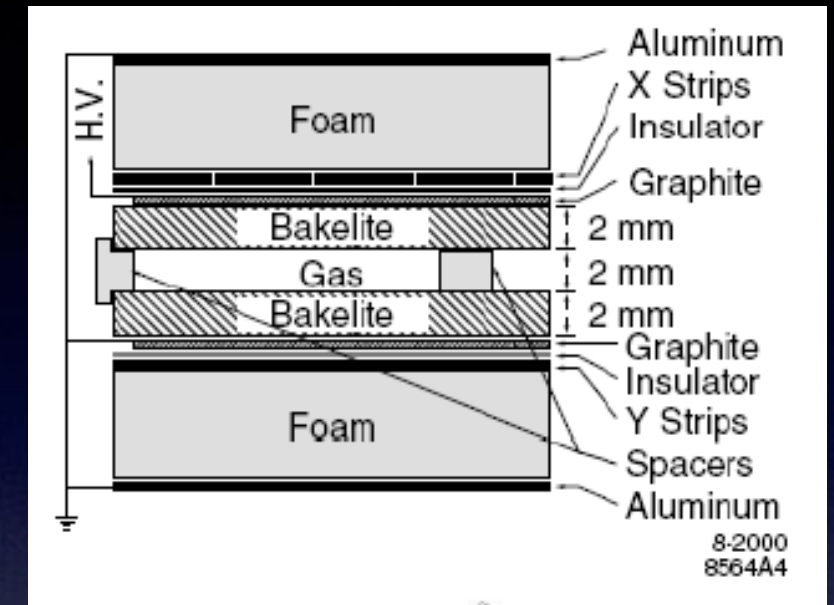
K Arisaka ^a, M Berthet ^c, E Borsato ^{b 1}, D Boutigny ^c, A Buzykaev ^d, F DalCorso ^{b 1}, I De Bonis ^c, J.M Dubois ^c, J Favier ^c, F Ferroni ^e, M Foucher ^f, S Ganzhur ^d, F Iacovella ^{b 1}, H Jawahery ^f, Y Karyotakis ^c, G Kolachev ^d, E Kravchenko ^d, R Lafaye ^c, M.A Mazzoni ^e, V Mikerov ^d, M Morandin ^{b 1}, S Morganti ^e, A Onuchin ^d, J Oyang ^g, P Petitpas ^c, G Piredda ^e, M Posocco ^{b 1}, R Santacesaria ^e, A Shamov ^d, R Stroili ^{b 1}, V Tayursky ^d, V Telnov ^d, E Torassa ^{b 1}, C Voci ^{b 1}

Instrumented Flux Return

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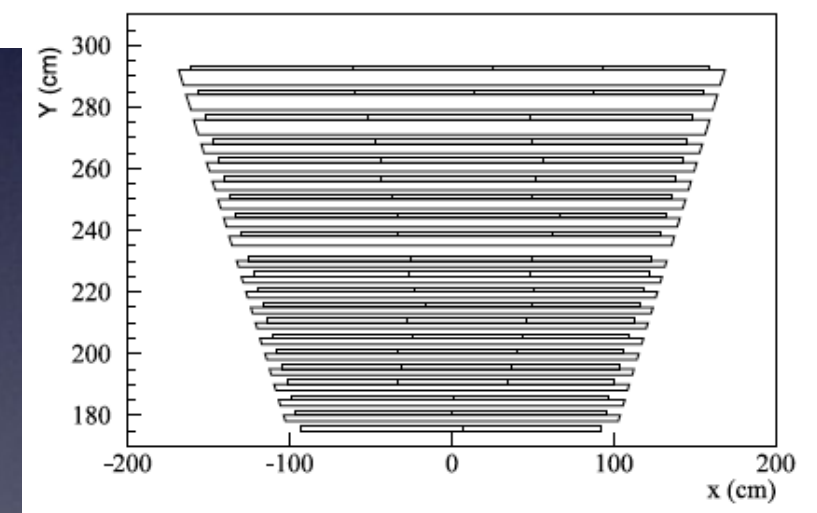
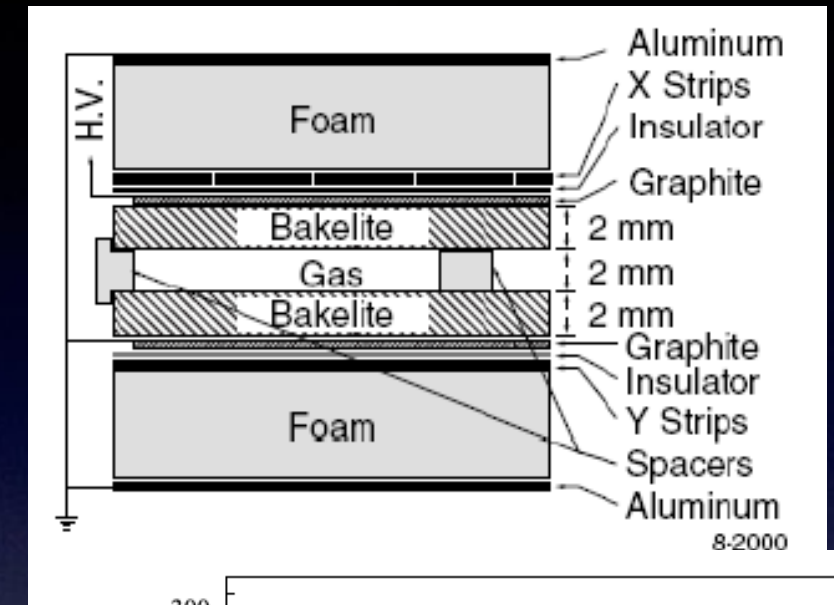
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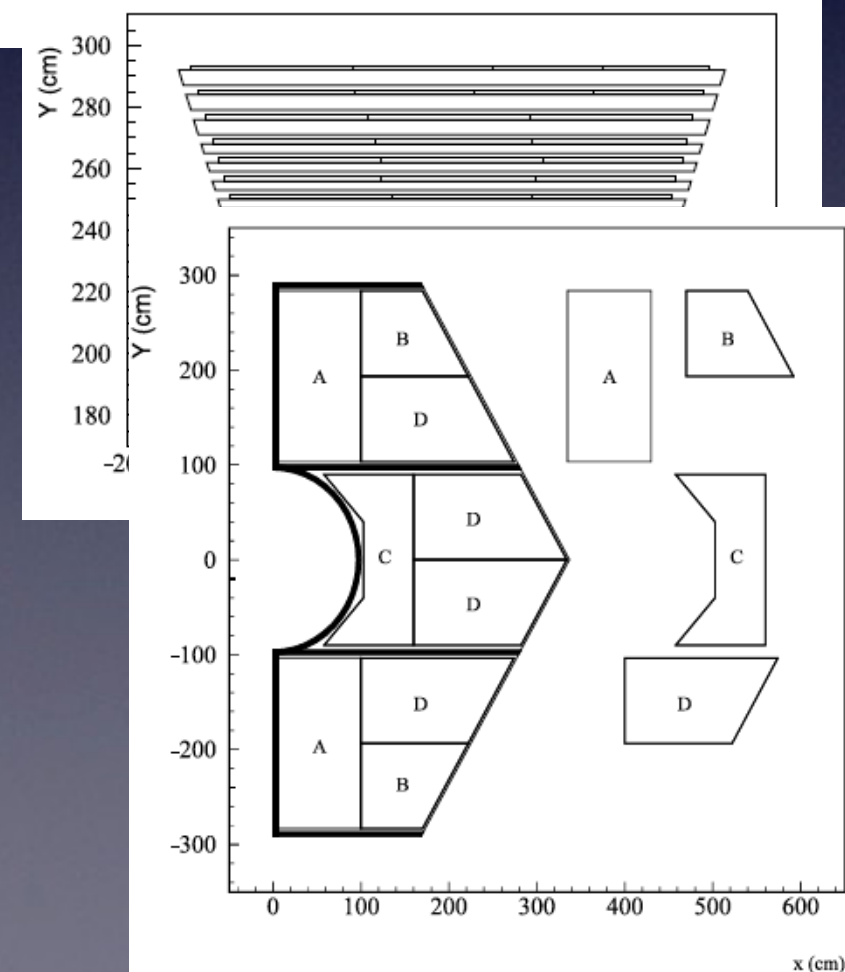
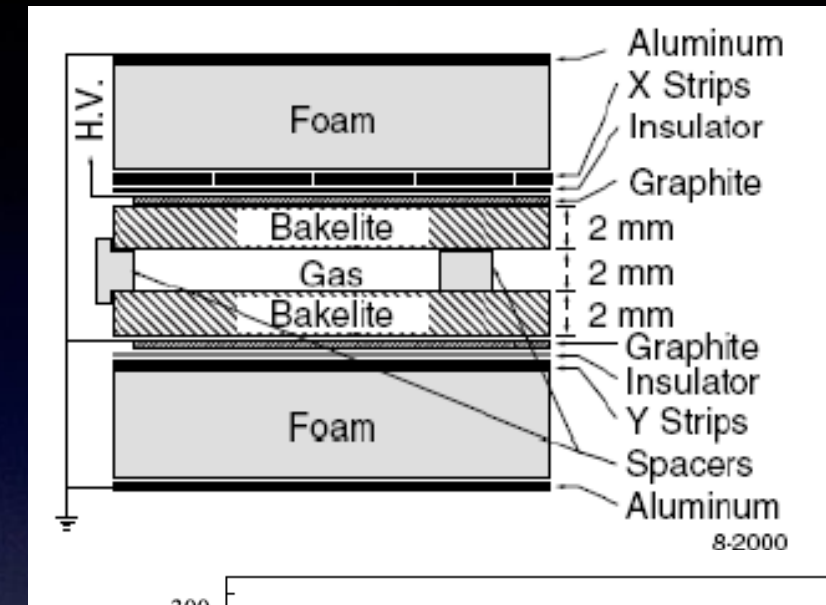
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IFR: diagnosi, rimedi, sostituzioni (2001-2003)

dai *technical report* di Nando al TB

Summer activities

Main project: FECap replacement. J. Krebs discusses the schedule
Main groups committed to provide manpower for this activity.

The system is sick. We have clearly diseases belonging to:

- HV domain
- FEC domain
- Gas domain
- S/W domain
- and yes, linseed oil realm

If we want to have a chance to keep this system going until 2004/5 we need to address all this problems. This is a huge amount of work and a non negligible amount of money.
WE NEED HELP.

Changes at GeneralTecnica

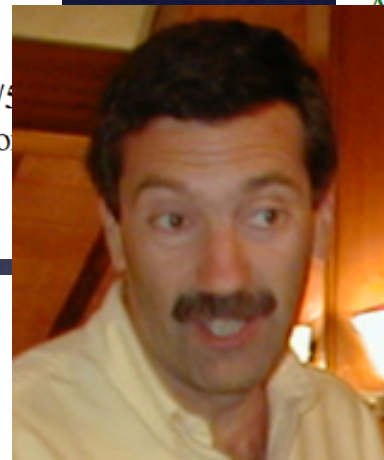
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The acces to the assembly room is resctricted

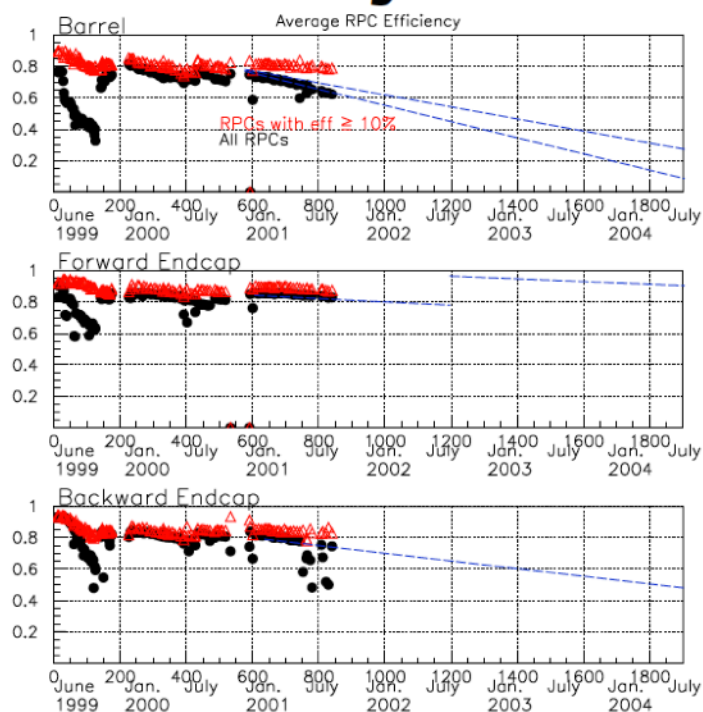
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Two BaBar people are on shift every day at GT

A database is used to collect all the QC/QA info during production.



RPC Efficiency 1999-2004(?)



Oct. 4, 2001

Henry Band - U. of Wisconsin

REPORT OF IFR UPGRADE REVIEW COMMITTEE

Chris Hearty, Hassan Jawahery, Georges London, Vera Luth, Daryl Oshatz, Natalie Roe

9th August 2001

1 INTRODUCTION

The IFR Upgrade is a retrofit of the existing forward IFR, replacing the chambers (some of which are rapidly deteriorating), and adding additional material to reduce the μ mis-identification while preserving as much as possible the existing K_L^0 identification. The proposed hardware change can be seen in <http://www.slac.stanford.edu/~ferronif/IFReviewJul24/ff.pdf>

We consider this project important and that its execution of high priority. We need to get it right this time!

The committee was impressed with the progress that has been made in a number of key areas by the IFR group since the last review: organization of the chamber construction and QA/QC at General Tecnica, identification of machine background as a serious problem for the outer chambers, understanding the origin of the IFR efficiency loss, remediation efforts on damaged chambers, and the organization of the installation in IR2, planned for summer 2002. Commendable steps also were taken to provide good documentation.

The management has made remarkable progress in clarifying the responsibilities of the different institutions. It could perhaps be strengthened by additional deputies for background and RPC remediation.

We proceed to go into some detail on each of these points, with some recommendations. In some cases, marked with a (*), these points are already in being implemented by the IFR group.

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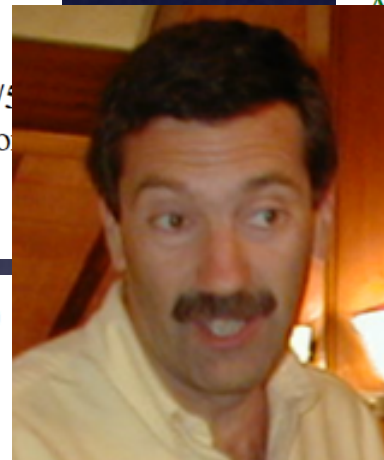
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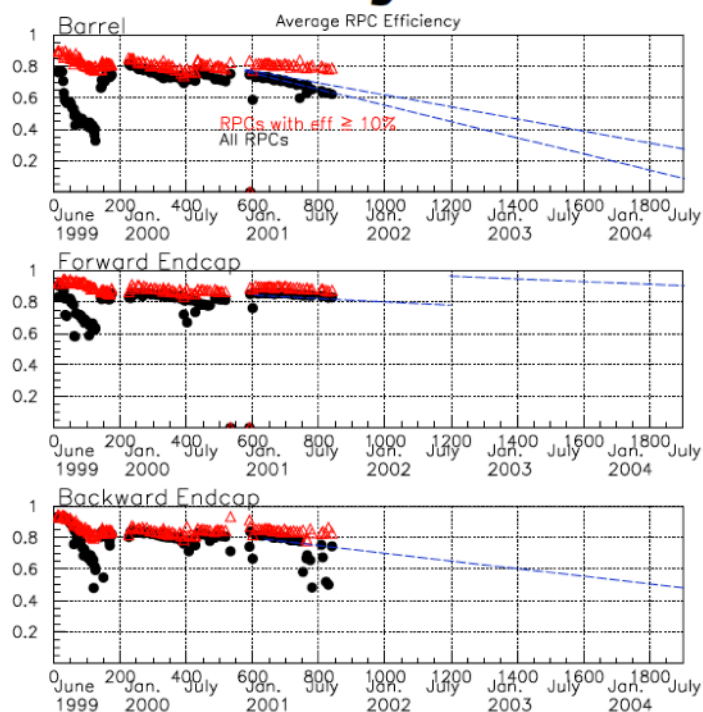
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9th August 2001

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The IFR Upgrade is a retrofit of the existing forward IFR, replacing the chambers (some of which are rapidly deteriorating), and adding additional material to reduce the μ mis-identification while preserving as much as possible the existing K_L^0 identification. The proposed hardware change can be seen in <http://www.slac.stanford.edu/~ferronif/IFReviewJul24/ff.pdf>

We consider this project important and that its execution of high priority. We need to get it right this time!

The committee was impressed with the progress that has been made in a number of key areas by the IFR group since the last review: organization of the chamber construction and QA/QC at General Tecnica, identification of machine background as a serious problem for the outer chambers, understanding the origin of the IFR efficiency loss, remediation efforts on damaged chambers, and the organization of the installation in IR2, planned for summer 2002. Commendable steps also were taken to provide good documentation.

The management has made remarkable progress in clarifying the responsibilities of the different institutions. It could perhaps be strengthened by additional deputies for background and RPC remediation.

We proceed to go into some detail on each of these points, with some recommendations. In some cases, marked with a (*), these points are already in being implemented by the IFR group.

IFR: diagnosi, rimedi, sostituzioni (2001-2003)

dai *technical report* di Nando al TB

Summer activities

Main project: FECap replacement. J. Krebs discusses the schedule
Main groups committed to provide manpower for this activity.

The system is sick. We have clearly diseases belonging to:

- HV domain
- FEC domain
- Gas domain
- S/W domain
- and yes, linseed oil realm

If we want to have a chance to keep this system going until 2004/5
we need to address all this problems. This is a huge amount of work
and a non negligible amount of money.
WE NEED HELP.

Changes at GeneralTecnica

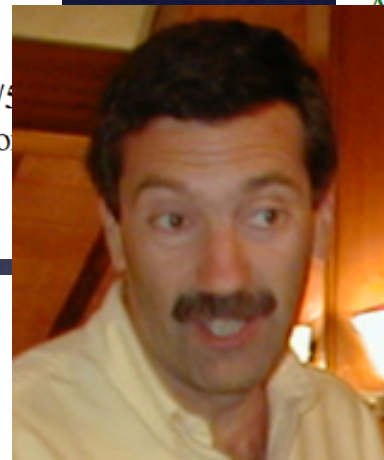
Silvio Morganti is the acting production Manager on behalf of INFN

The floor in the assembly room have been painted and cleaned
Operators wear gloves and the requested protections
The acces to the assembly room is restricted

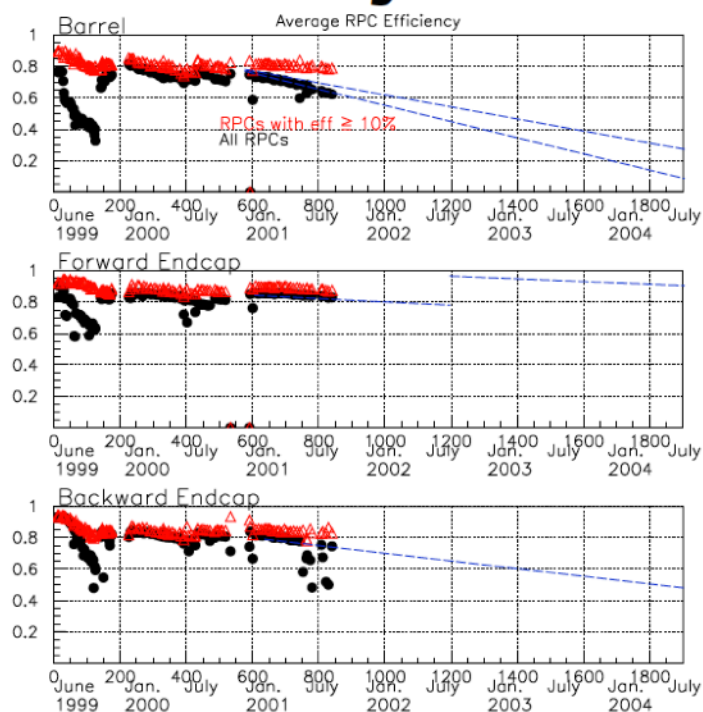
The filter and the pump are at GT
The inox tank has been cleaned last week
A fresh mixture of oil-eptane has been loaded

All QC/QA requests from Babar are adopted by all the 3 experiments
Two BaBar people are on shift every day at GT

A database is used to collect all the QC/QA info during production.



RPC Efficiency 1999-2004(?)



Oct. 4, 2001

Henry Band - U. of Wisconsin

REPORT OF IFR UPGRADE REVIEW COMMITTEE

Chris Hearty, Hassan Jawahery, Georges London, Vera Luth, Daryl Oshatz, Natalie Roe

9th August 2001

1 INTRODUCTION

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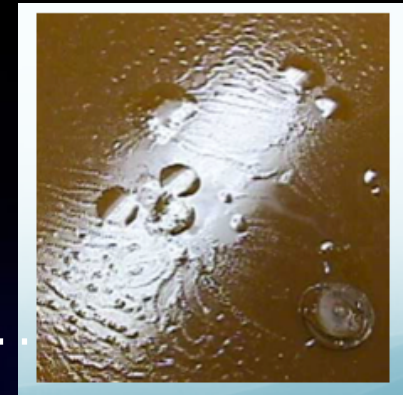
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IFR: diagnosi, rimedi, sostituzioni (2001-2003)



olio di lino:
purezza,
polimerizzazione,
temperatura, HV, ..



spacer in a "bad" area



spacer in a "good" area

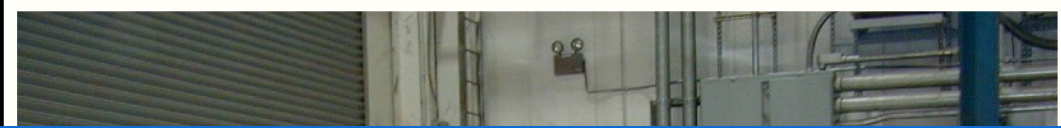


IFR Barrel: it is time to think

Fernando Ferroni
(strictly representing himself)

TechBoard, May 10, 2002

IFR: diagnosi, rimedi, sostituzioni (2001-2003)



olio di lino:
purezza



Stew Smith:

Nando partnered with Bill Wisniewski to replace the failing end-cap RPC's with new ones. As expected he and Bill did a superb job. He was not directly involved in the LST project.



IFR Barrel: it is time to think

Fernando Ferroni
(strictly representing himself)

TechBoard, May 10, 2002

intermezzo: gita a San Francisco



fisica: preparativi

SLAC-R-504
October, 1998

The **BABAR** Physics Book

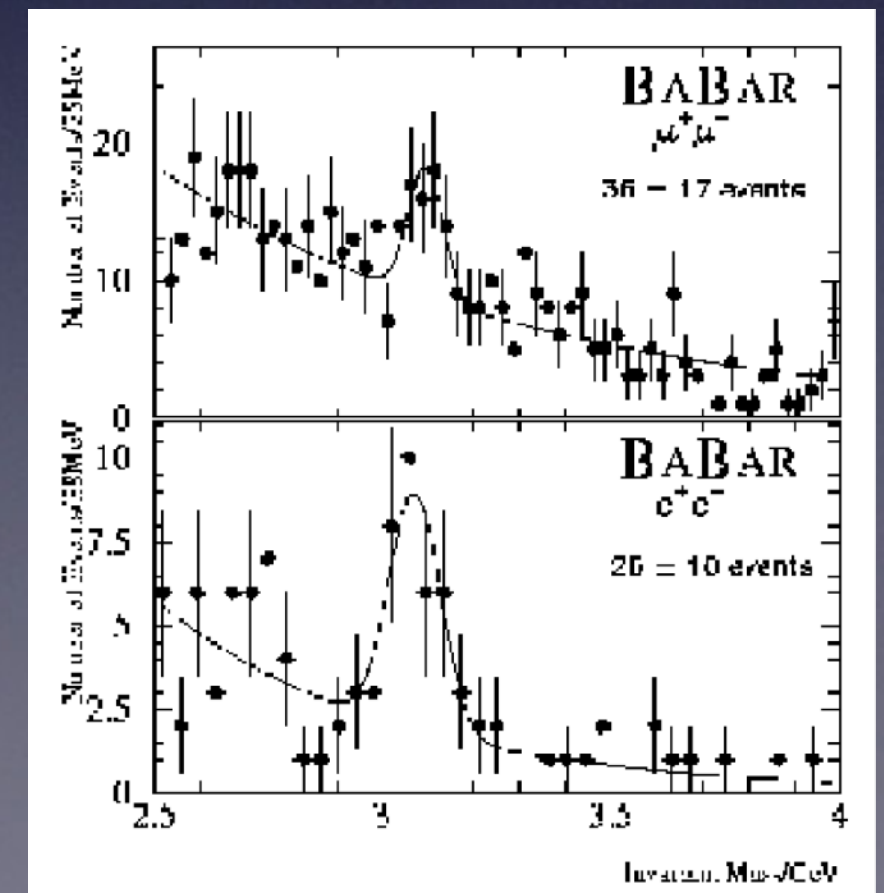
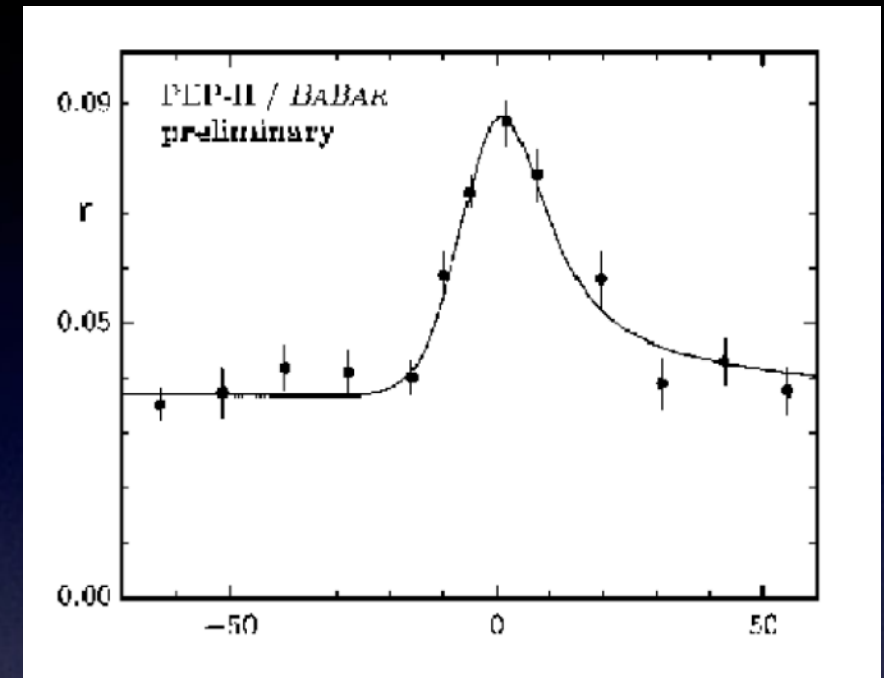
Rome	November 11-14, 1997
Princeton	March 17-20, 1998
Orsay	June 16-19
Caltech	September 22-25

Physics at an Asymmetric **B** Factory

P. F. Harrison and H. R. Quinn, Editors

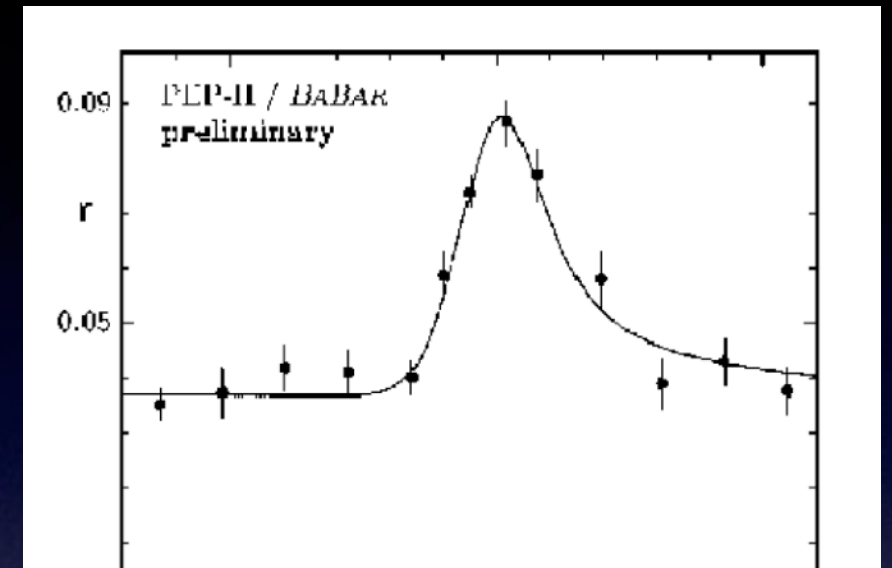
fisica: i primi dati, 1999

- luglio 1999: i primi 200 pb^{-1}
- agosto, Lepton Photon 1999 a SLAC: Jonathan Dorfan deve presentare i primi risultati di PEP-II e BaBar, in competizione con KEK
- disastro: il modello di calcolo basato su Objectivity è inceppato (prima di una serie di crisi del calcolo)
- Il Physics Analysis Coordinator (Nando!) fa intervenire Faccini et al. con una soluzione alternativa e mobilita studenti e postdoc per far produrre i risultati preliminari necessari; poi avvia il rimpiazzo di Objectivity



fisica: i primi dati, 1999

- luglio 1999: i primi 200 pb^{-1}
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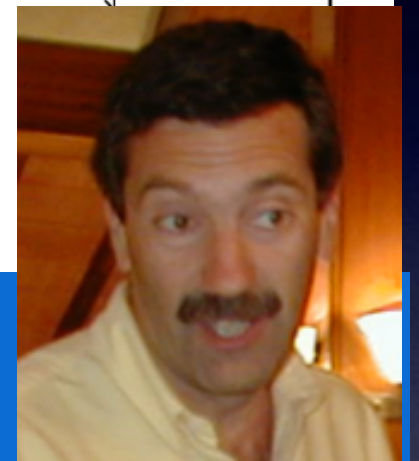
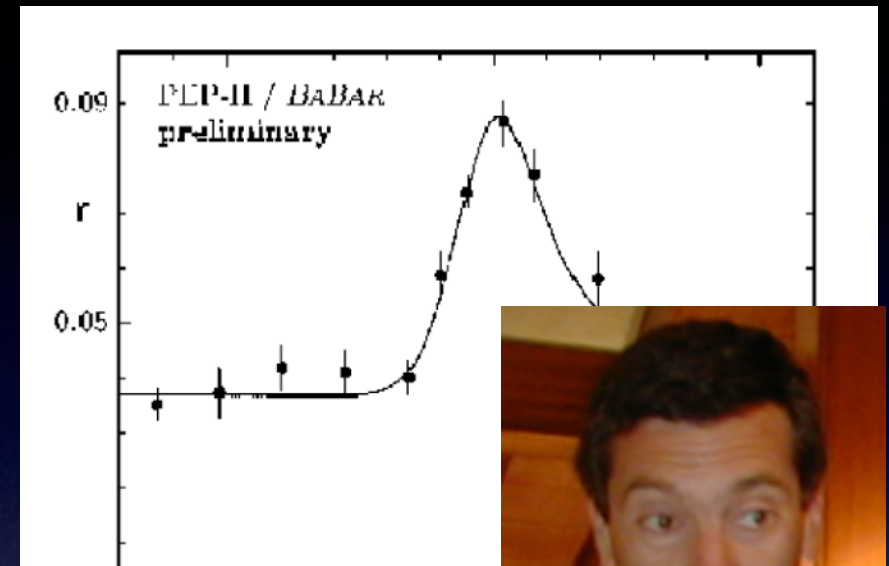
Stew Smith:

Nando also saved the reputation of the experiment in 1999. The first data arrived just before the Lepton-Photon conference at SLAC, but as you'll remember, BaBar computing was in terrible shape at the time and wasn't able to analyse this data in time to show anything. However, Nando somehow got the data to his people in Italy to produce a nice set of preliminary observations for the conference.

His group in Rome continued to shine in analysis as he developed his grad students and postdocs, many of whom have gone on to illustrious careers

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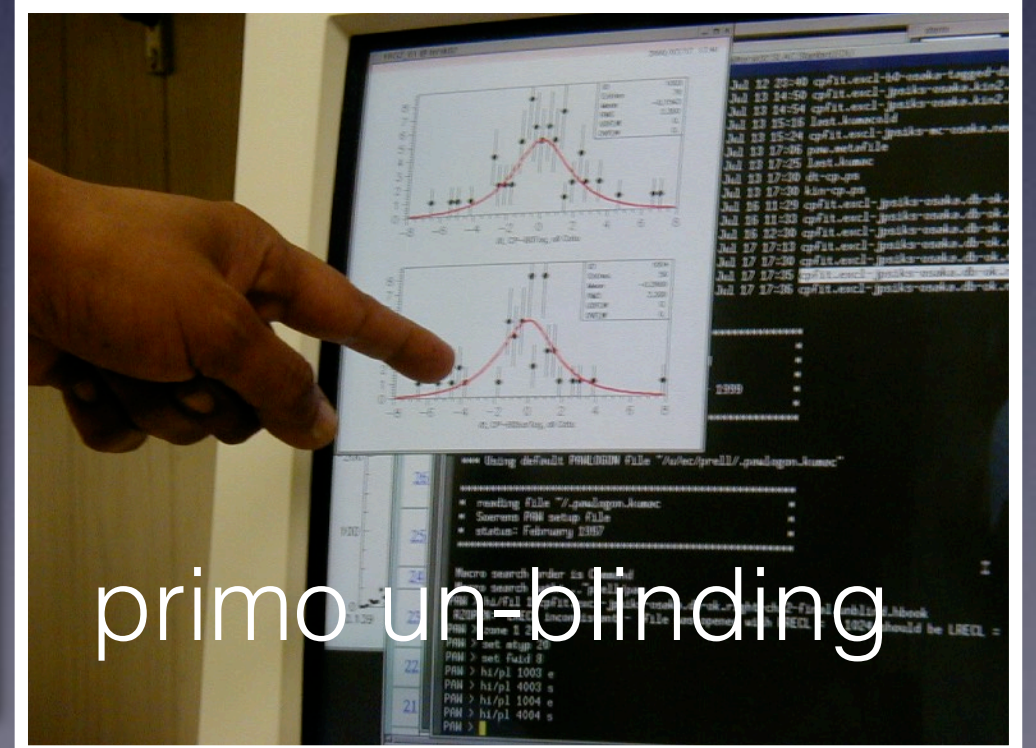
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violazione di CP, $\sin 2\beta(\phi_1)$

- ICHEP 2000
 - BaBar 9.8/fb, 15 papers
 - Belle 5.6/fb, 17 papers
- prime due pubblicazioni
 - BaBar: $\sin 2\beta$, PRL Feb. 2001
 - Belle: Δm_d , PRL Nov. 2000
- EPS 2001 & LP 2001; PRL, 27 Agosto, 2001
 - BaBar: $\sin 2\beta = 0.59 \pm 0.14 \pm 0.05$
 - Belle: $\sin 2\beta = 0.99 \pm 0.14 \pm 0.06$



transizione al "factory mode"

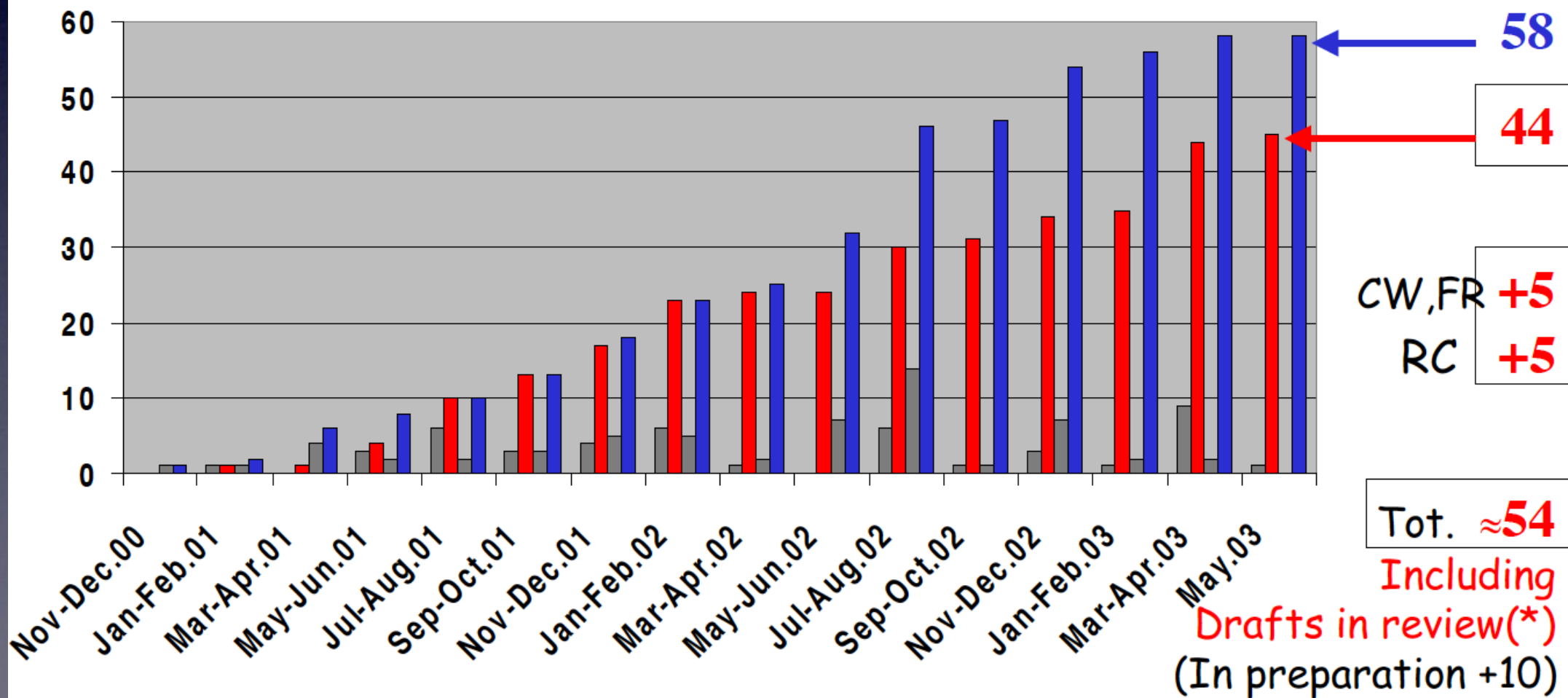
Journal submissions vs time

- BaBar vs Belle**

Journal Submissions

■ BaBar ■ BaBar sum ■ Belle ■ Belle sum

(*)Review:
FR=Final Reading
CW=Collab.Wide
RC=Review Comm.



15 gruppi di lavoro, molte analisi
 organizzazione, review, database, ...

EPS HEP2003 abstracts

AWG	"new" analyses submitted	Tot. Subm.
sin2beta	$\sin 2\beta(J/\psi \rightarrow \text{had}), \cos 2\beta(J/\psi K^{*0})$	6
charmonium	$B^0/B^+, m(B^0) - m(B^+), \text{excl.BF}$	3
charm	3body D decays, D_s spectroscopy	3
breco	$D^{(*)}K^{(*)}, D^{(*)}K_s^0, D_s^0\pi, \sin(2\beta + \gamma), \text{BF} \dots$	5
c-less 2b	(see LP03)	3
c-less q2b	$VV, \eta/\eta'/\omega h$	2
c-less 3b	$\rho^0\pi^0, KKK$	4
IHBD	$\sin(2\beta + \gamma)$	1
B mix. & lifet.		1
leptonic b & c	$l^+l^-, \tau\nu_\tau, K\nu\bar{\nu}$ updates	3
rad. penguins	inclusive $b \rightarrow s\gamma, b \rightarrow sl^+l^-$	3
inclusive SL	had.mom., SL BFs, e^- mom.& BF, c-less endpoint	5
exclusive SL	BFs, $ V_{cb} , V_{ub} $, form factors	3
tau-QED	$\tau \rightarrow \mu\gamma$	2
IHPS	$\text{BF}(B \rightarrow \phi X),$ inclusive had. spectra	2

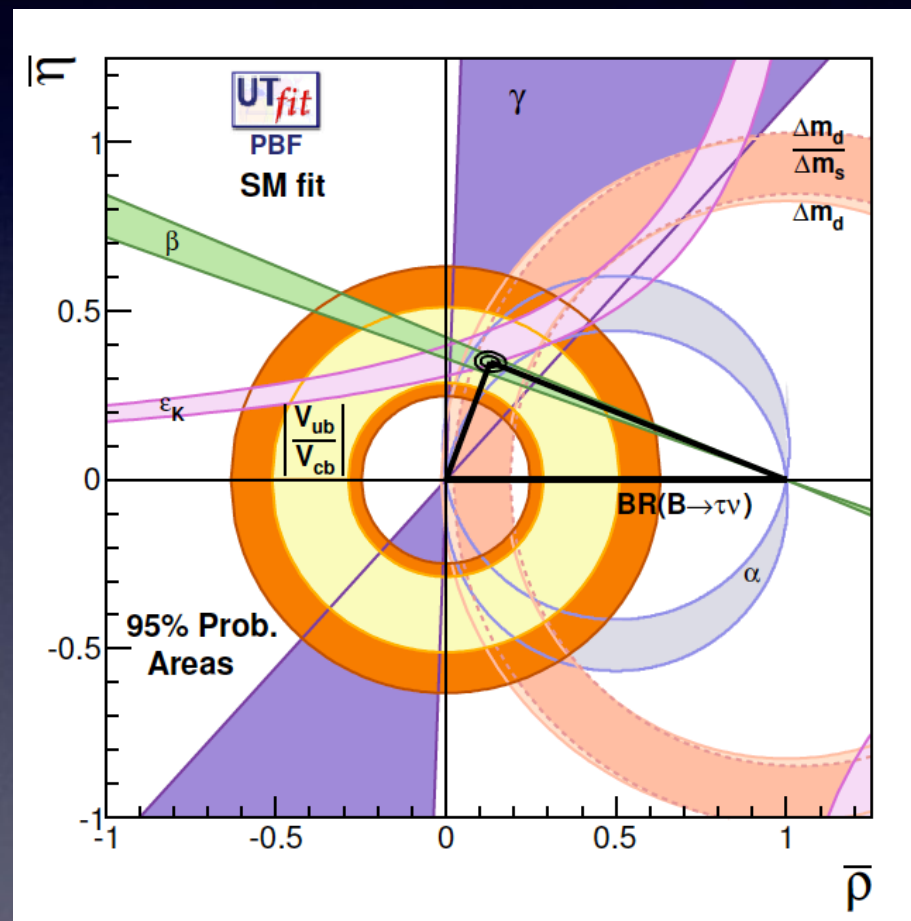


highlights

- naturalmente, triangolo CKM: angoli, lati
- tag adronico esclusivo per eventi rari con neutrini
- nuove famiglie di risonanze adroniche
- violazione di CP diretta (πK)
- osservazione delle oscillazioni del D^0
- scoperta dello stato η_b
- ...

The Physics of the B Factories

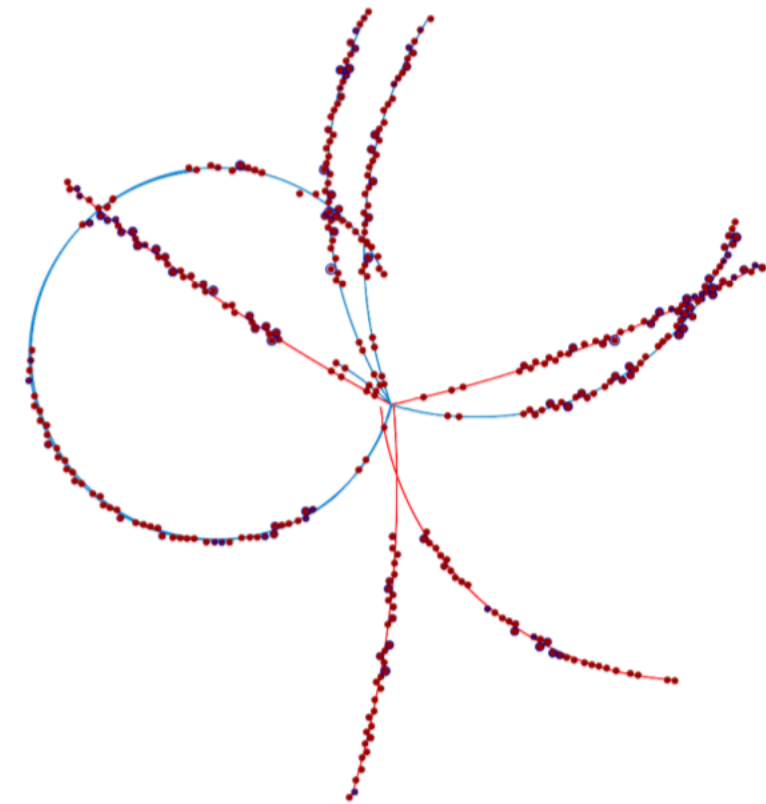
partendo dalla scoperta della CPV nei decadimenti $b \rightarrow c\bar{c}s$



validazione del meccanismo CKM e molta Fisica del Flavour

The Physics of the *B* Factories

Eur. Phys. J. C74 (2014) 3026



una referenza insostituibile, impresa comune di BaBar e Belle



tesi di dottorato

- A.A. 2008**
Measurement of $b \rightarrow u$ amplitude and CKM phase γ using $B^0 \rightarrow D^0 K^{*0}$ decays reconstructed with the Babar detector
Viola Sordini - relatori F.Ferroni, A.Stocchi - XXI ciclo
- A search for the rare decays $B \rightarrow K^* \nu \bar{\nu}$ with the Babar detector
Francesco Renga - relatori R.Faccini, G.Cavoto - XXI ciclo, ottobre 2008
- Search for $B_{+-} \rightarrow l_{+-} \nu$ at Babar with $l=(e,\mu)$ and phenomenological implications
Elisabetta Baracchini - relatori R.Faccini, G.Isidori, G.Piredda - ottobre 2008
- Studio fenomenologico della risonanza $Y(2175)$ e possibile interpretazione come stato a 4 quark
Nadejda Vassileva Drenska - relatori R. Faccini, A. Polosa, A.A. 2007-2008
- A.A. 2007**
Time dependent CP asymmetries and branching ratio measurements in charmless three body B decays at BaBar
Emanuele Di Marco - relatori F.Ferroni, G.Cavoto
Thesis submitted by E. Di Marco in partial fulfillment of the requirements for the degree of Doctor Philosophiæ, May/2007
- A.A. 2005/2006**
Time dependent analysis of $B^0 \rightarrow D^- K^0 \pi^+$ decays for the measurement of $2\beta + \gamma$ with the BABAR detector
Francesco Polci - relatori F.Ferroni, A. Stocchi - XIX ciclo, settore scientifico disciplinare FIS/04
- Measurement of the CKM matrix element $|V_{ub}|$ studying exclusive semileptonic decays on the recoil of fully reconstructed B 's with the BaBar detector
Alessia D'Orazio - relatore F.Ferroni, R. Faccini
- A.A. 2003/2004**
Time dependent Asimmetries in $b \rightarrow s$ decays in the Standard Model and beyond
Maurizio Pierini - relatore F.Ferroni, G.Martinelli - A.A. 2003/04
- A.A. 2002/2003**
Measurement of the $b \rightarrow s \gamma$ branching ratio studying the recoil of fully reconstructed B s with the BaBar experiment
Fabio Bellini - relatore F.Ferroni, R.Faccini - A.A. 2002/03
[full thesis in tar.gz available here]
- A.A. 2001/2002**
Measurement of V_{ub} studying inclusive semileptonic decays on the recoil of fully reconstructed B 's with the BaBar experiment
Daniele del Re - relatore F.Ferroni, R.Faccini - A.A. 2001/02
- CP violating asymmetry in $B \rightarrow D^{(*)} n$ decays with the BaBar detector
Cecilia Voena - relatore F.Ferroni, R.Faccini - A.A. 2001/02
- A.A. 2000/2001**
Measurements of Branching Ratios and CP violating asymmetries in $B \rightarrow n + \pi^-$ and $B \rightarrow K^{+/-} \pi^{-/+}$ decays with the BaBar experiment"
Gianluca Cavoto - relatore F.Ferroni - A.A. 2000/01
- A.A. 1999/2000**
Studio delle oscillazioni $B^0 \leftrightarrow B^0_{bar}$ nell'esperimento BaBar
Marco Serra - relatore F.Ferroni - A.A. 1999/00 - XIII ciclo dottorato

tesi di laurea - 1

TESI DI LAUREA

A.A. 2004/2005

Correzioni radiative ai decadimenti in due corpi del mesone B

Elisabetta Baracchini - relatore F. Ferroni - corelatori G. Isidori, G. Cavoto - 23 giugno 2005

Decadimenti del mesone B in tre pseudoscalari leggeri

Giacinto Piacquadio - relatore F. Ferroni - corelatori G. Cavoto, L. Silvestrini - 14 luglio 2005

Decadimenti B $\rightarrow D^0 K$ e violazione di CP

Viola Sordini - relatore F. Ferroni - corelatori R. Faccini, L. Silvestrini - 14 luglio 2005

A.A. 2003/2004

Misura dell'asimmetria di CP nelle transizioni $b \rightarrow s$ con l'esperimento BaBar

Marco Vignati - relatori F. Ferroni, G. Cavoto - A.A.2003/2004

Studio del decadimento $B^+ \rightarrow D^0(K_s^+ \pi^+ \pi^-)K^+$ con l'esperimento BaBar

Elisabetta Prencipe - relatori F. Ferroni, R. Faccini - A.A. 2003/2004

A.A.2002/2003

Studio del decadimento $B^0 \rightarrow K^0$ con l'esperimento BaBar

Emanuele di Marco - relatori F.Ferroni, R.Faccini - A.A.2002/2003

Studio dei decadimenti del mesone B in stati finali semileptonici e senza charm con l'esperimento BaBar

Silvia Pisano - relatori F.Ferroni, R.Faccini - A.A.2002/2003

Studio dei decadimenti del mesone B in D_p con l'esperimento BaBar

Marco Messineo - relatori F.Ferroni, R.Faccini - A.A.2002/2003

Studio del decadimento $B^{\pm} \rightarrow \phi (K_s K_l) K^{\pm}$ nell'esperimento BaBar

Massimiliano Mistura - relatori F.Ferroni, G. Piredda - A.A.2002/2003

Rivelazione di muoni in BaBar: $B^0 \rightarrow \mu^+ \mu^-$

Emmanuele Salvati - relatori F. Ferroni, G. Cavoto - A.A.2002/2003

A.A. 2001/2002

Ricerca dei decadimenti $B^+ \rightarrow D^{*0} K^0$ con l'esperimento BABAR

Francesco Polci - relatori F.Ferroni, R.Faccini - A.A.2001/2002

Studio dei decadimenti $B \rightarrow J/\psi K_{nn}$ con l'esperimento BaBar

Alessia D'Orazio - relatori F.Ferroni, R.Faccini - A.A.2001/2002

tesi di laurea - 2

A.A. 2000/2001

Decadimenti a due corpi del mesone B senza charm nello stato finale
Maurizio Pierini - relatori F.Ferroni, G.Martinelli - A.A. 2000/01

Misura di $B^- \rightarrow D^* \ell^- \bar{\nu}_\ell$ a BaBar
Antonino Sergi - relatore F.Ferroni - A.A. 2000/01

Ricostruzione ad alta efficienza dei mesoni B
Sergio Grancagnolo - relatore F.Ferroni - A.A. 2000/01

Studio del decadimento $B^+ \rightarrow D_0 \bar{h}^+ \ell^+$ a BaBar
Luigi Li Gioi - relatori F.Ferroni, R.Faccini - A.A. 2000/01

A.A. 1999/2000

Misura della massa della risonanza $\Upsilon(4S)$ e delle masse dei mesoni B_0 e B^+
Alessio Sarti - relatore F.Ferroni - A.A. 1999/00

Misura di $B_0 \rightarrow D^* \ell^- \bar{\nu}_\ell$ a BaBar
Francesca Bucci - relatori F.Ferroni, S.Morganti - A.A. 1999/00

A.A.1998/1999

Il Monte Carlo nella Fisica delle Particelle Elementari attraverso le nuove tecniche di programmazione. Una applicazione all'esperimento BaBar
Safai Tehrani - relatore E.Lamanna - A.A. 1998/99

La camera a deriva di BaBar: analisi in linea dei parametri di funzionamento
Daniele del Re - relatori F.Ferroni, S.Morganti - A.A. 1998/99

Realizzazione del sistema di controllo veloce per la camera a deriva dell'esperimento BaBar
Cecilia Voena - relatore F.Ferroni, S.Morganti - A.A. 1998/99

Studio di fattibilità del canale $B_0 \rightarrow K_0^*(\pi^0 \pi^0) J/\Psi(\mu^+ \mu^-)$
Marco Quaranta - relatore F.Ferroni - A.A. 1998/99

A.A. 1997/1998

Studio del decadimento $b \rightarrow s \ell^+ \ell^-$ in Babar
Marcello Rotondo - relatore F.Ferroni - A.A. 1997/98

Studio della perdita di energia per ionizzazione in miscele a base di Elio
Francesca Pastore - relatore F.Ferroni - A.A. 1997/98

Simulazione della camera a deriva dell'esperimento BaBar utilizzando nuove tecnologie di programmazione
Caterina Perri - relatore E.Lamanna - A.A. 1997/98

La camera a deriva dell'esperimento BaBar
Katia Fratini - relatore S.Morganti - A.A. 1997/98

tesi di laurea - 3

A.A. 1996/1997

Studio di un rivelatore Cerenkov ad aerogel per l'esperimento BaBar

Marco Serra - relatori S.Morganti, F.Ferroni - A.A. 1996/97

Studio della risoluzione della camera centrale a deriva nell'esperimento BaBar

Shahram Rahatlou - relatore E.Lamanna - A.A. 1996/97

Violazione di CP a BaBar: analisi di isospin per l'estrazione del $\sin 2\alpha$

Gianluca Cavoto - relatore F.Ferroni - A.A. 1996/97

Back-up

NOTES ON THE OBSERVABILITY OF CP VIOLATIONS IN B DECAYS

I.I. BIGI

Institut für Theor. Physik der RWTH Aachen, D-5100 Aachen, FR Germany

A.I. SANDA¹

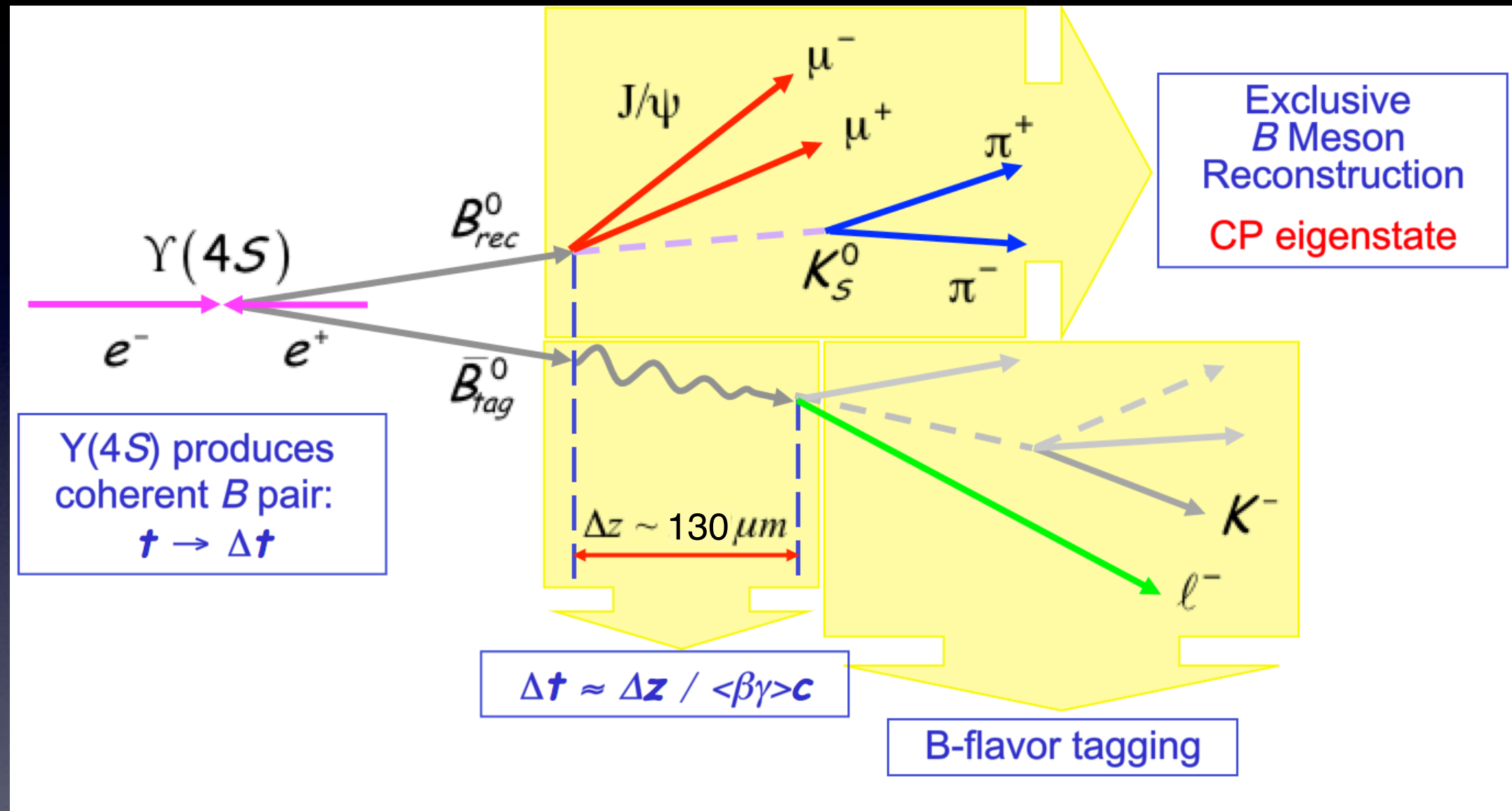
Rockefeller University, New York 10021, USA

Received 16 June 1981

We describe a general method of exposing CP violations in on-shell transitions of B mesons. Such CP asymmetries can reach values of the order of up to 10% within the Kobayashi–Maskawa model for plausible values of the model parameters. Our discussion focuses on those (mainly non-leptonic) decay modes which carry the promise of exhibiting clean and relatively large CP asymmetries at the expense of a reduction in counting rates. Accordingly we address the complexities encountered when performing CP tests with a high statistics B meson factory like the Z^0 (and a toponium) resonance.



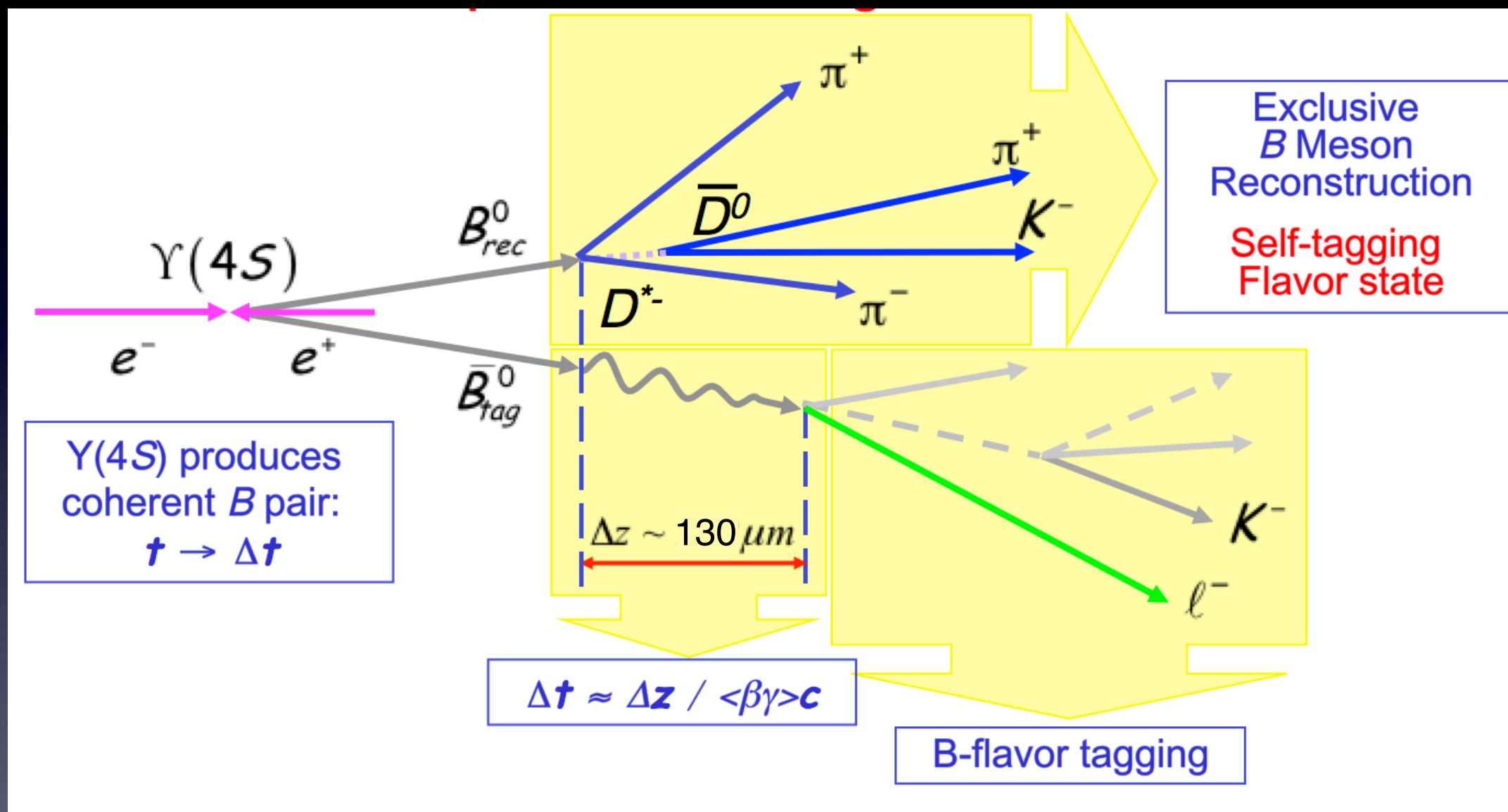
Time-dependent CP asymmetry



$Y(4S)$ decays into a coherent, entangled, anti-symmetric $B\bar{B}$ state

B-flavor tagging efficiency and Δt resolution function are obtained from data (measurement of mixing, with exclusively reconstructed self-tagging B states)

Time-dependent mixing



$\Upsilon(4S)$ decays into a coherent, entangled, anti-symmetric BB state

B-flavor tagging efficiency and Δt resolution function are obtained from data (measurement of mixing, with exclusively reconstructed self-tagging B states)

A tale of two B factories



BaBar @ PEP-II (SLAC)



Belle @ KEKB (KEK)

energy-asymmetric electron-positron colliders
mostly $E_{\text{CM}} = 10.580 \text{ GeV}$: $Y(4S)$

1999 - 2008

$> 560 \text{ fb}^{-1}$

470M $B\bar{B}$ pairs @ $Y(4S)$

1999 - 2010

$> 1000 \text{ fb}^{-1}$

770M $B\bar{B}$ pairs @ $Y(4S)$

collaborazione BaBar

Gathering at SLAC, July 2004 BaBar Collaboration

10 Countries
77 Institutions
593 Physicists
May 2004



August 11, 2004

L.Lanceri - CP Violation in B Decays - SSI 2004

24