The SuperB CDR What Now?

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Super$B$ Workshop - Paris

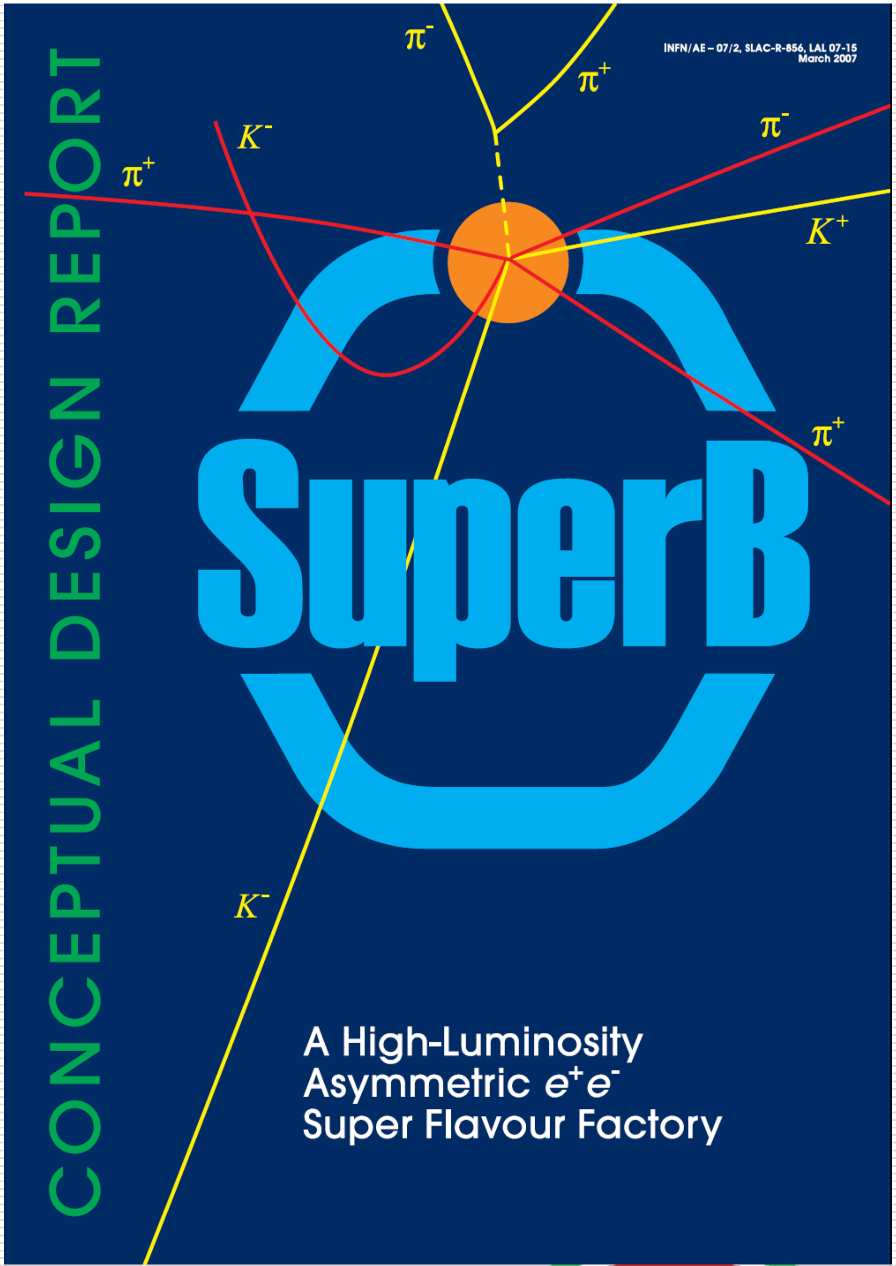
May 9, 2007

The Super*B* CDR is done !

- The CDR was written by a team of committed people, including important contributions from the theory community

~ 310 signers
~ 260 accelerator+experimental
~ 50 theorists

- What use do we make of it?
  - Primary input to the INFN Review of the project
  - Inform the larger HEP community
  - Plan an accelerator and detector R&D program
  - Begin to assemble an accelerator team and a physics collaboration



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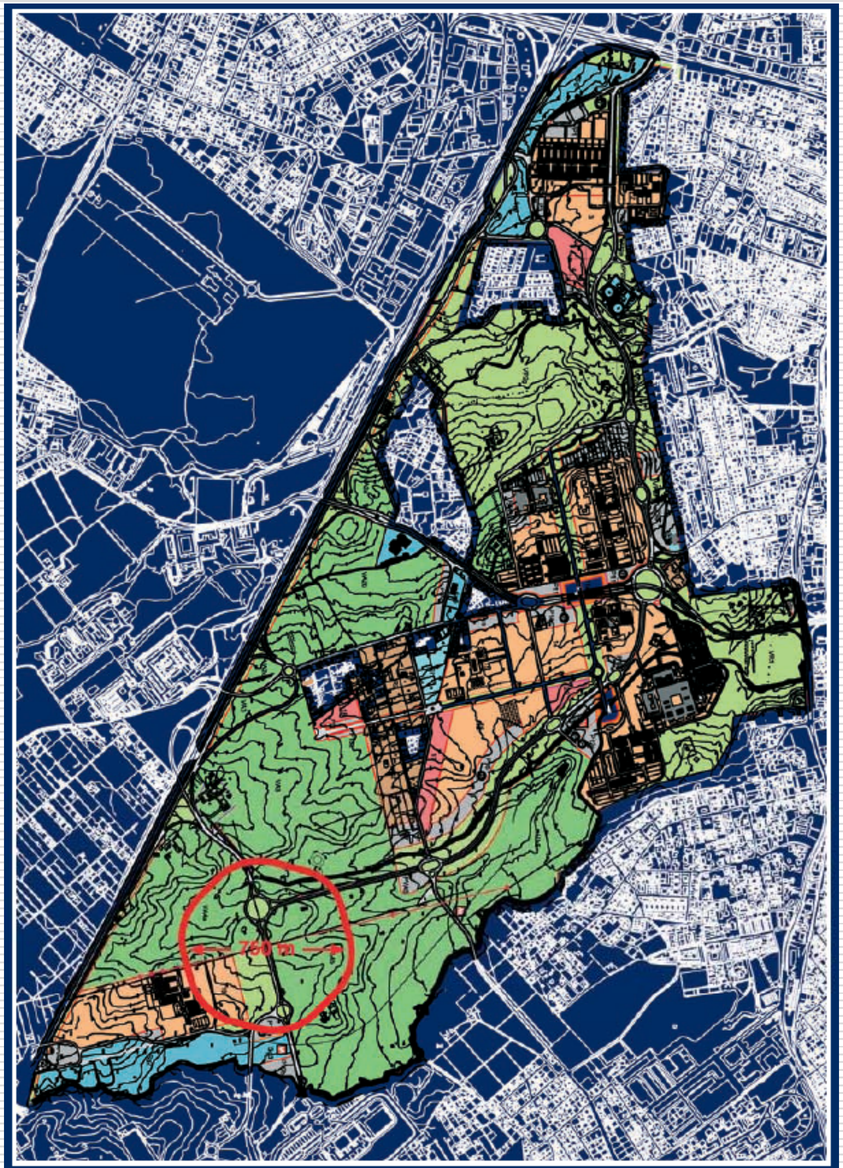
The site of Super*B* on the Tor Vergata campus

- Quite literally a “green field” site
- A lot of preparatory work is needed
  - Detailed siting study
  - Geological studies for tunnel
  - Ground vibration tests
  - Design and location of support buildings, including the interaction region
  - Provision of utilities
    - Electrical power
    - Chilled water
- Laboratory infrastructure
  - Human resources
  - Engineering
  - Health and safety
  - ....



The Super*B* accelerator on the campus of the Università di Roma Tor Vergata

Super*B* location on the Tor Vergata campus

Spreading the gospel

- It is important that we immediately tackle the job of convincing the community that an investment of this size in heavy flavor physics is worthwhile
- Due to the possible delay of the predicted physics start date of the ILC until the "mid-twenties", there will assuredly be a reexamination, in the US, Europe and Japan, of middle term physics opportunities, such as very high statistics heavy flavor studies
  - We must make the physics case carefully and well
  - As clearly demonstrated by *BABAR,* Belle and CLEO, a new facility will produce a great wealth of physics
    - This is NOT, however, in my opinion, the best route to making a convincing case
    - What we need is a "sound bite" justification

By this I mean a single, really good, rationale for Super*B* that can be stated in a few words

Choose your soundbite

"Determine the mechanism of SUSY-breaking that explains the new phenomena found at the LHC."

"Find the mechanism of *CP* violation beyond the Standard Model that can account for the matter-antimatter asymmetry of the universe."

"Search for beyond-the-Standard-Model phenomena that cannot be studied at the LHC."

"Explain why we live in a matter-dominated universe" (somewhat problematic due to dark matter, but we used it successfully for PEP-II/*BABAR*)

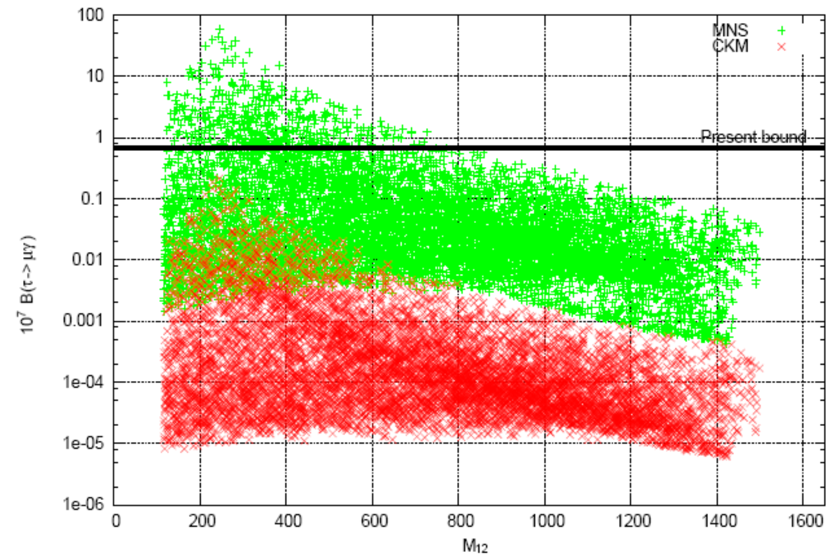
Additional soundbite suggestions are welcome, and needed

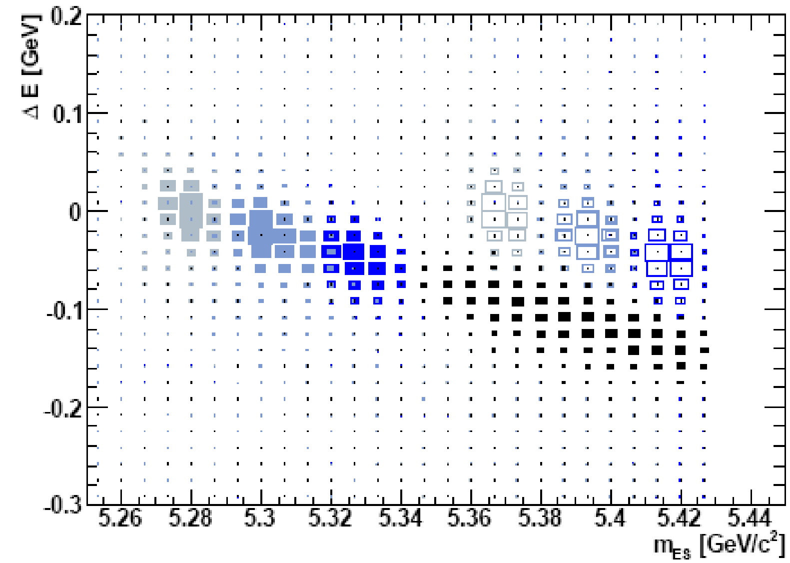
Outreach

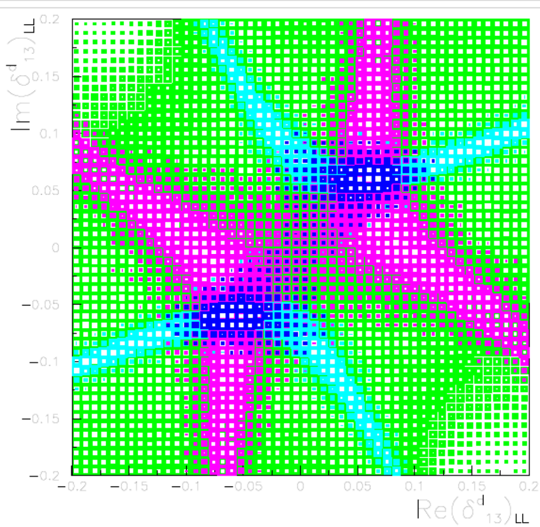
- We have discussed in the Steering Committee the need for explanatory material more likely to be read through by large numbers of people than the CDR
  - A document aimed at the scientific community (perhaps a shortened version of the CDR Introduction)
  - A document aimed at the general public
  - A "one-pager" that might be read by the very busy people that dispense money
- This must be done in a coherent way with input from all the countries that may have need of such material, and output that serves the needs of the different countries
- Neal Calder in the SLAC Public Information Office has been contacted– he will meet with his counterparts in other countries to plan a detailed campaign

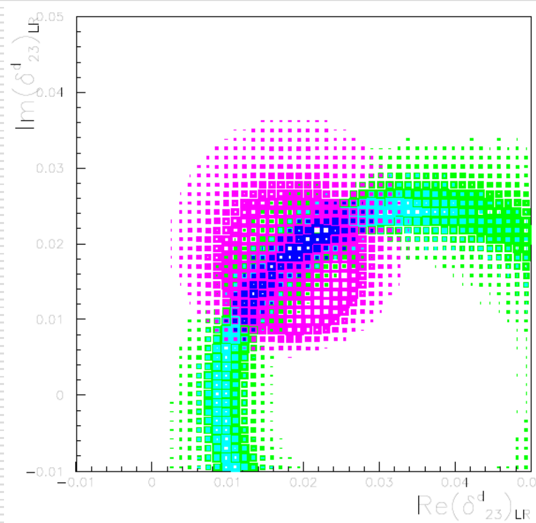
Physics

- The CDR reminds us, while we search for our soundbite, that Super*B* really is a Super Heavy Flavour Factory
- We can find the scale of new flavour physics using *B* decays
- Having polarized beams and studying τ and charm physics at high energies and near threshold will be unique and important

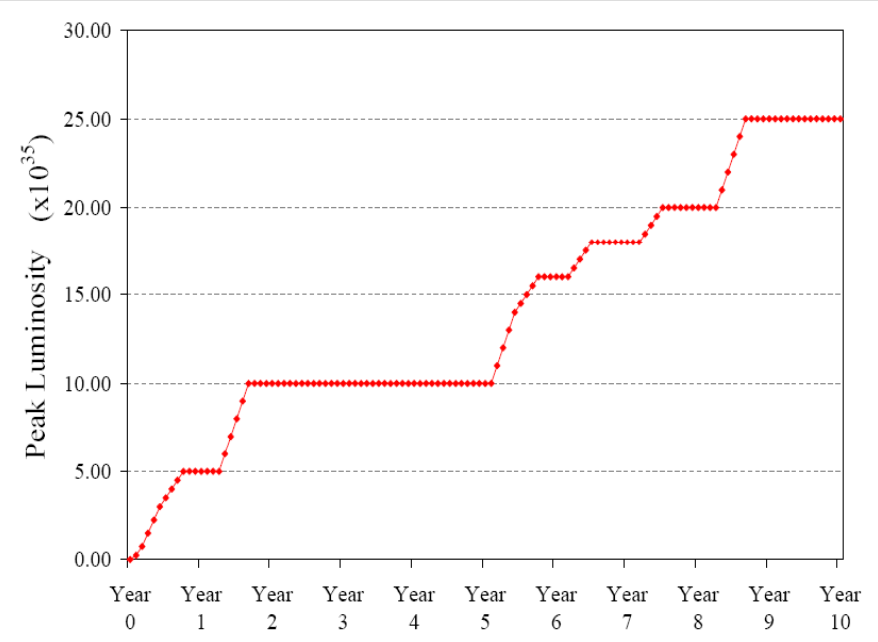


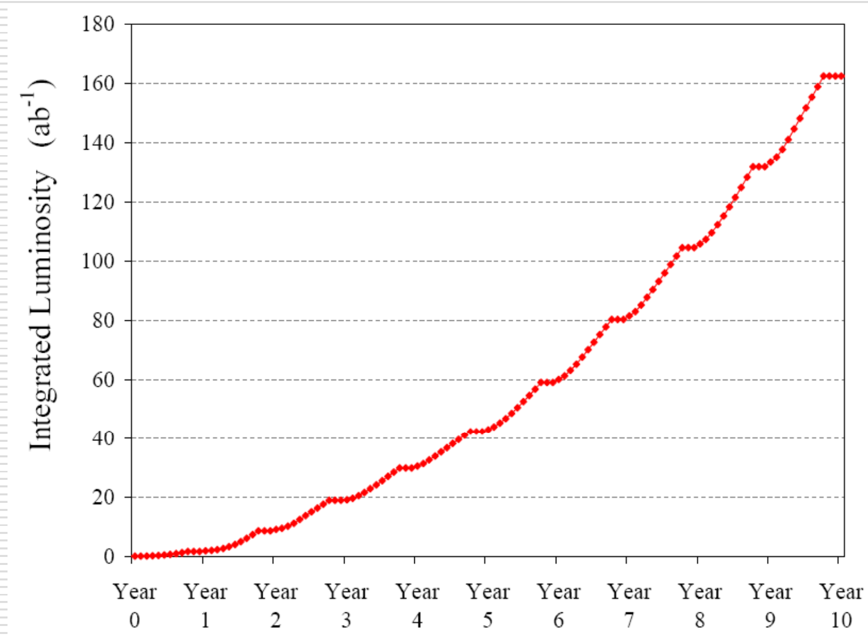


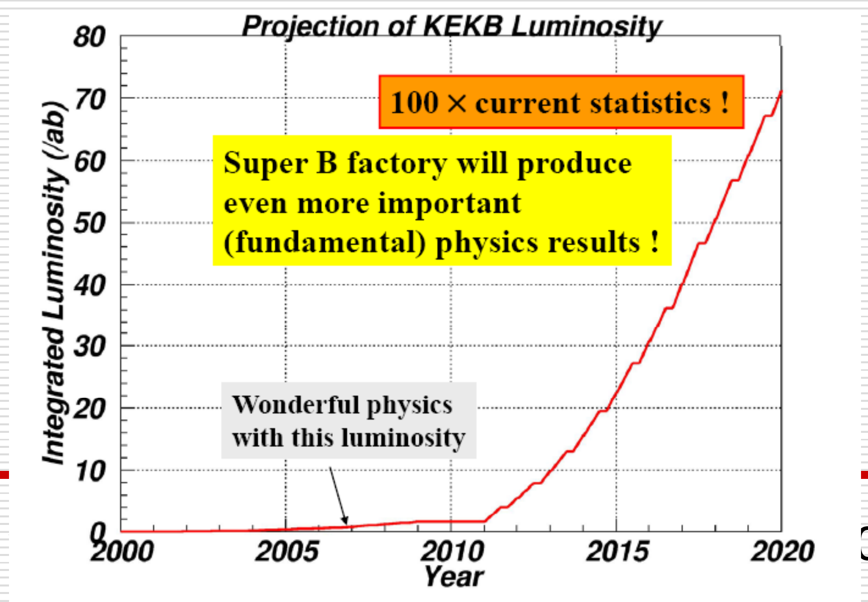




Scenario for data accumulation







Super*B*/ILC synergy

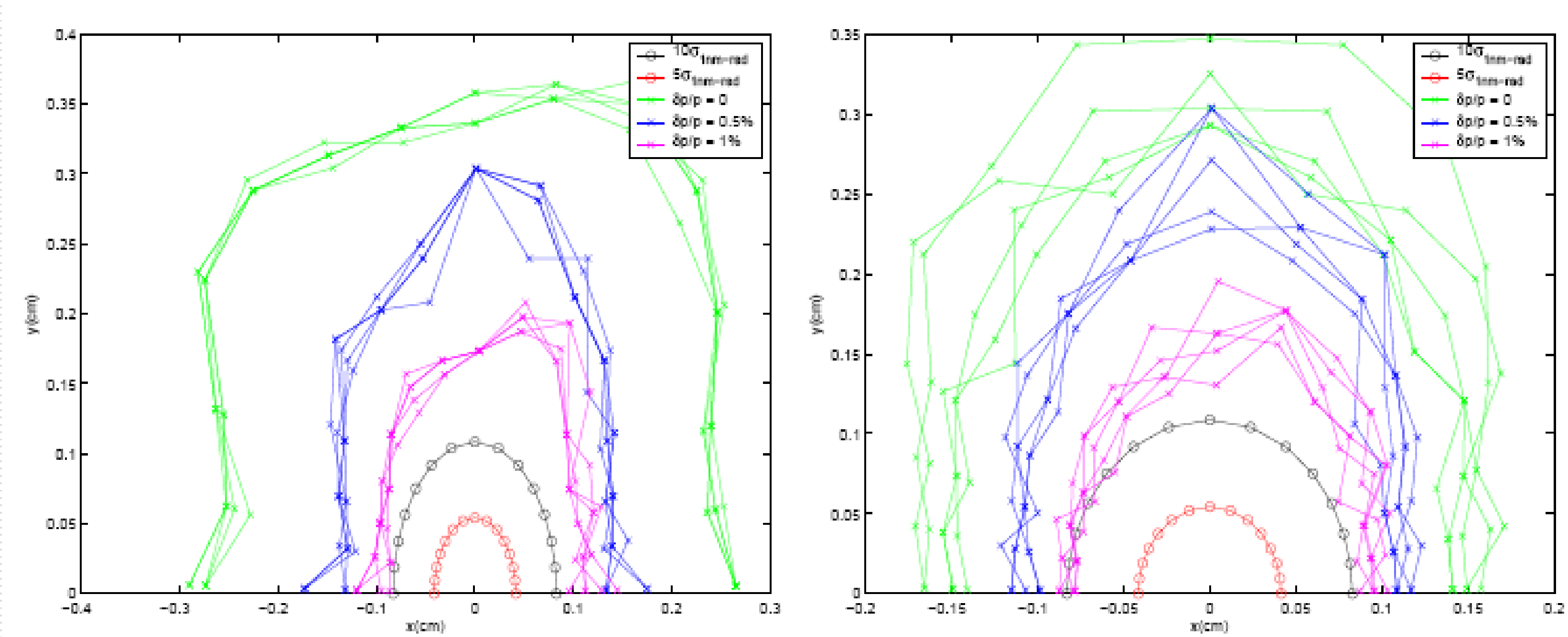
- Super*B* will be the first low-emittance, circular collider
  - Since the lattice is "wiggler-dominated", the circumference is flexible, as long as there is sufficient wiggler length to produced the required emittance
- The ILC Damping Ring design, which forms the basis of the Super*B* lattice, faces a nearly identical set of technical issues:
  - Low emittance: simulation, tolerances, feedback, injection, x-ray fan power density, …….
  - High currents: vacuum, cooling, feedback, …
  - Electron cloud – coatings, grooves, solenoids, …….
  - Polarization: production, acrobatics, preservation, …
- Super*B* does not face the significant problem of fast kickers
- [PEP-II and KEK-B have come closer to facing many of these issues than any other working machines]
- The synergy between Super*B* and ILC could be mutually beneficial

The Super*B* rings closely resemble the ILC damping rings

Unit	Super*B* LER	Super*B* HER	ILC DRs
Beam energy (GeV)	4	7	5
Circumference (m)	2249	2249	6695
Particles per bunch	6.16×10^{10}	3.52×10^{10}	2×10^{10}
Number of bunches	1733	1733	2767
Average current (A)	2.28	1.30	0.40
Horizontal emittance (nm)	1.6	1.6	0.8
Vertical emittance (pm)	4	4	2
Bunch length (mm)	6	6	9
Energy spread (%)	0.084	0.09	0.13
Momentum compaction	1.8×10^{-4}	3.1×10^{-4}	4.2×10^{-4}
Transverse damping time (ms)	32	32	25
RF voltage (MV)	6	18	24
RF frequency (MHz)	476	476	650

The dynamic aperture question

- The dynamic aperture studies in the CDR do not include the crabbed waist final focus sextupoles
  - Studies for SuperKEK-B have found problems with injection and dynamic aperture with the crabbed waist. This is not a general statement, but is particular to a specific lattice



- This calculation with crabbed waist sextupoles has now been done for Super*B*. We must document and propagate the result

A Super*B* repository

- Now that we have a baseline of information collected in the CDR, it is important that we set up a database as a repository for notes on new and ongoing work
  - We presumably need three series:
    - Accelerator
    - Detector
    - Physics
  - A repository for presentation materials, conference writeups, *etc.*, should also be established
  - Perhaps we can adapt the PEP-II/*BABAR* tools, rather than reinvent the wheel
  - Perhaps the program used to setup the Super*B* website already has such tools built in

The reuse of PEP-II and *BABAR* components

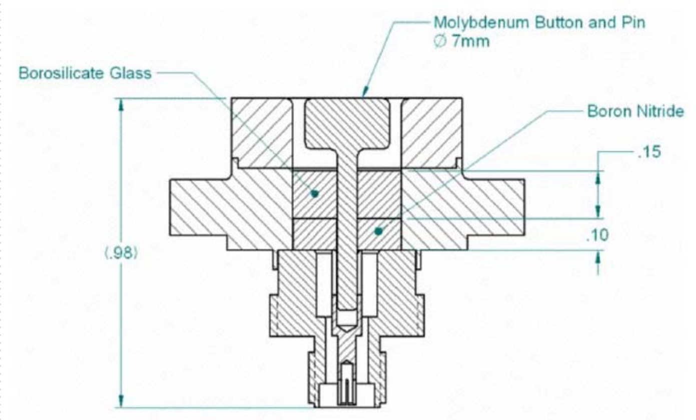
- Provides major cost and design effort savings
  Needs another round of detailed engineering studies to firm up the estimates of savings and to plan disassembly and refurbishment details

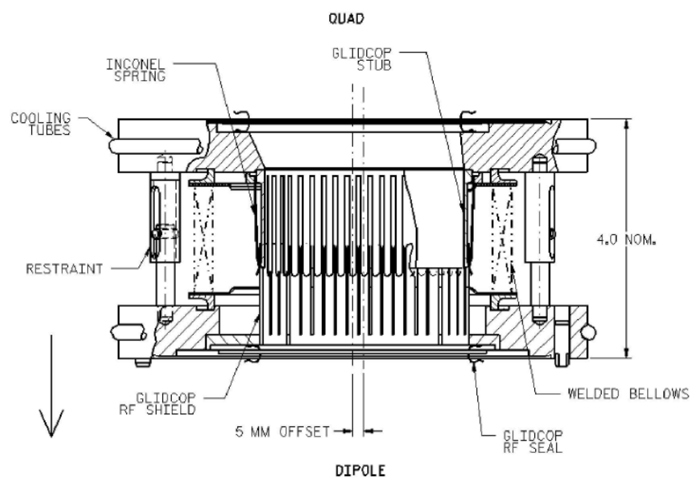
Table 3-40. Super*B* *magnet summary.*

Type	Length (m)	Required for Super*B*	Extant at PEP-II	Build new	Design
Dipole	0.45	144	194	0	
Dipole	0.75	144	0	144	PEP-II (lamin.)
Dipole	5.4	176	194	0	
Dipole	2	4	6	0	soft bends
Quadrupole	0.43	341	353	0	
Quadrupole	0.5	70	0	70	PEP-II or new
Quadrupole	0.56	255	202	53	PEP-II, new coil
Quadrupole	0.56	32	0	32	new (high field)
Quadrupole	0.73	138	81	57	PEP-II
Sextupole	0.25	452	188	264	PEP-II (2 coil configs.)
Sextupole	0.6	8	0	8	new

New PEP-II components

- The CDR discusses the use of newly developed PEP-II components, such as bellows shielding and BPM buttons in the Super*B* rings
  - This gives us a major headstart, but details must be looked at in the context of an overall engineering design, which does not yet exist



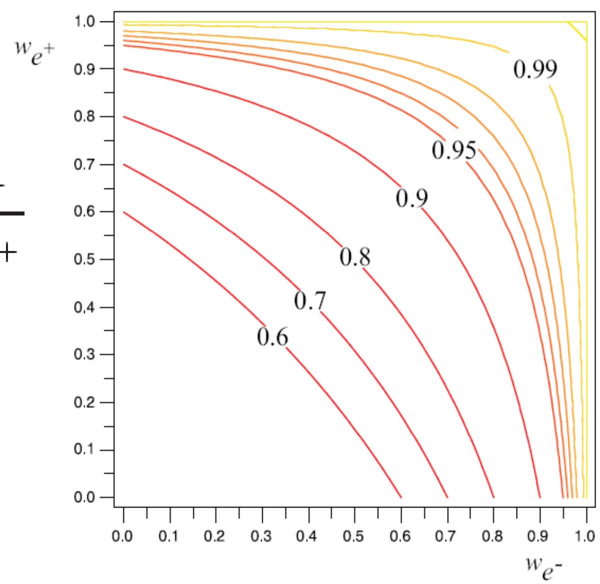


Polarization

- Having polarized τ's allows searches for a τ edm in production or CP violation in τ decay
- Having both polarized e^- and e^+ is advantageous, but polarizing the electron beam is far easier

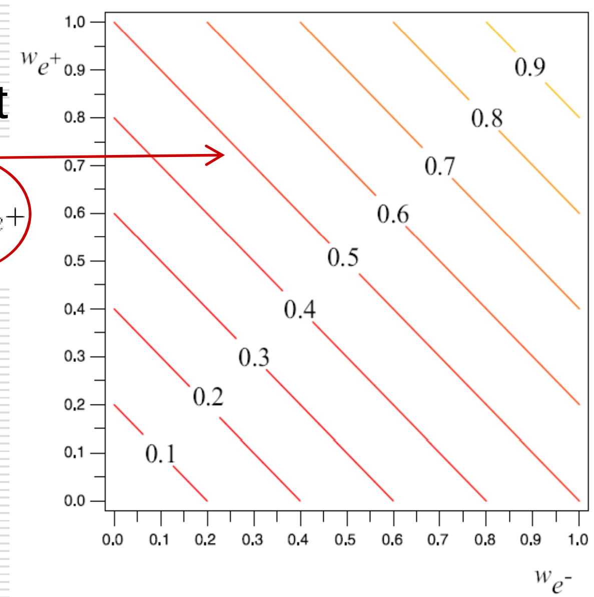
τ polarization

$$w = \frac{w_{e^-} + w_{e^+}}{1 + w_{e^-} w_{e^+}}$$



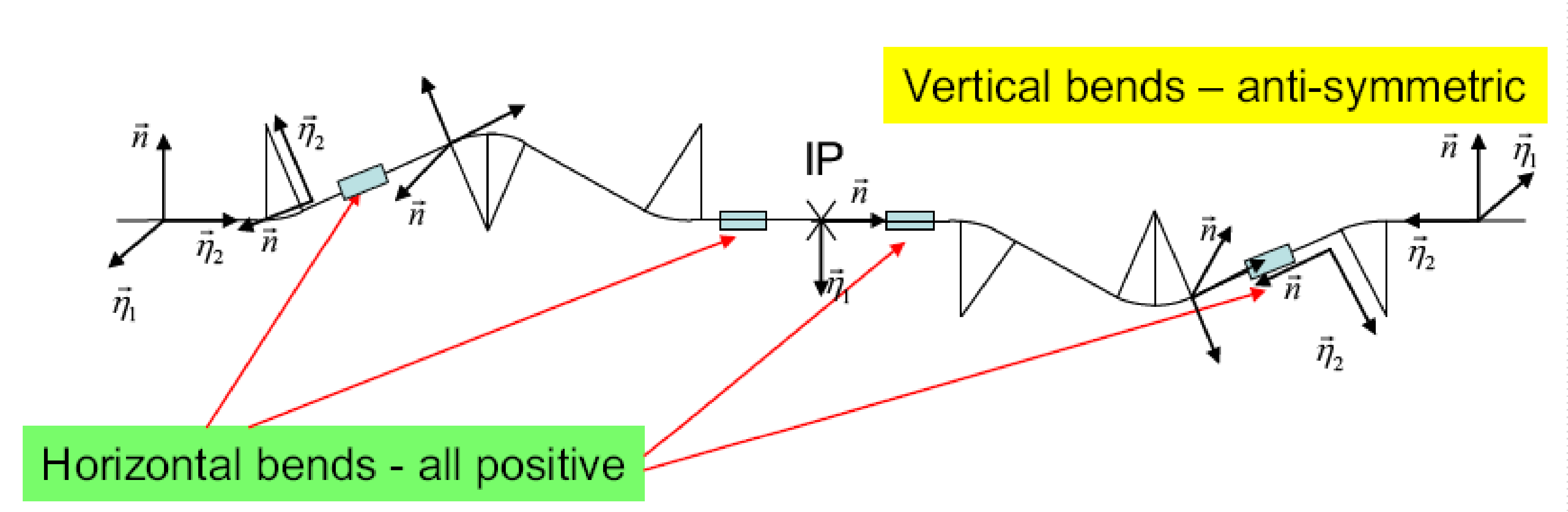
Luminosity enhancement

$$\frac{\mathcal{L}}{\mathcal{L}_0} = 1 + w_{e^-} w_{e^+}$$



Polarization schemes

- Several techniques of achieving longitudinal polarization at the IP are discussed in the CDR
  - This is a subtle and delicate problem
  - Schemes will work only in the 10 GeV region



- Production of polarized positrons is a substantial R&D project, and in fact, another area of synergy with ILC R&D

The ILC polarized positron source upgrade

- Produce polarized 20 MeV photons in a helical undulator
  - Double-wound superconducting solenoid
  - Rotated permanent magnet dipoles sections
- Laser Compton scattering

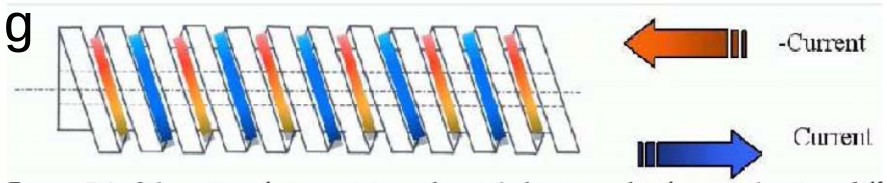


Figure 5.4: Schematic of wires wrapped in a helix around a former showing different current directions [193].

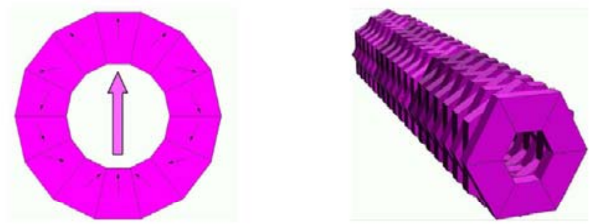
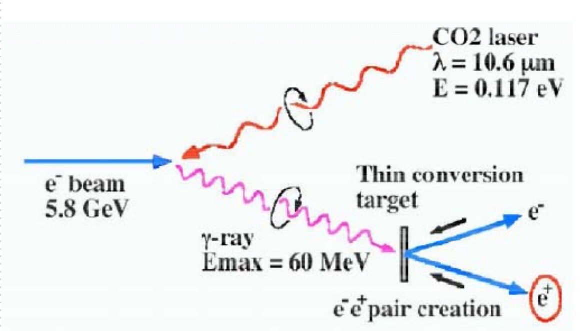
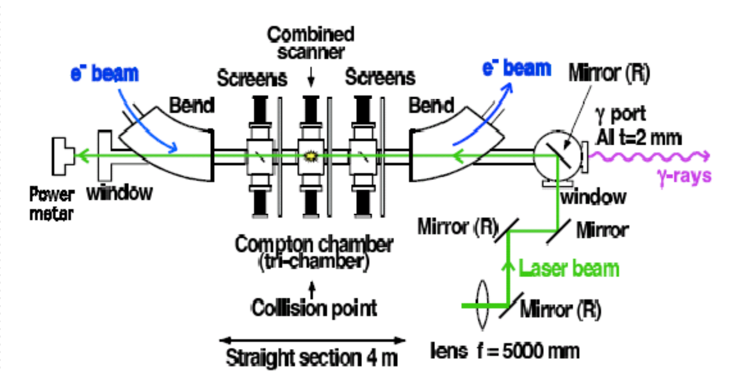
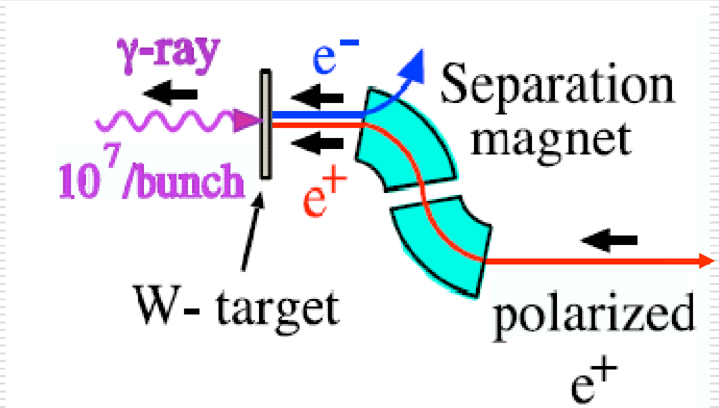


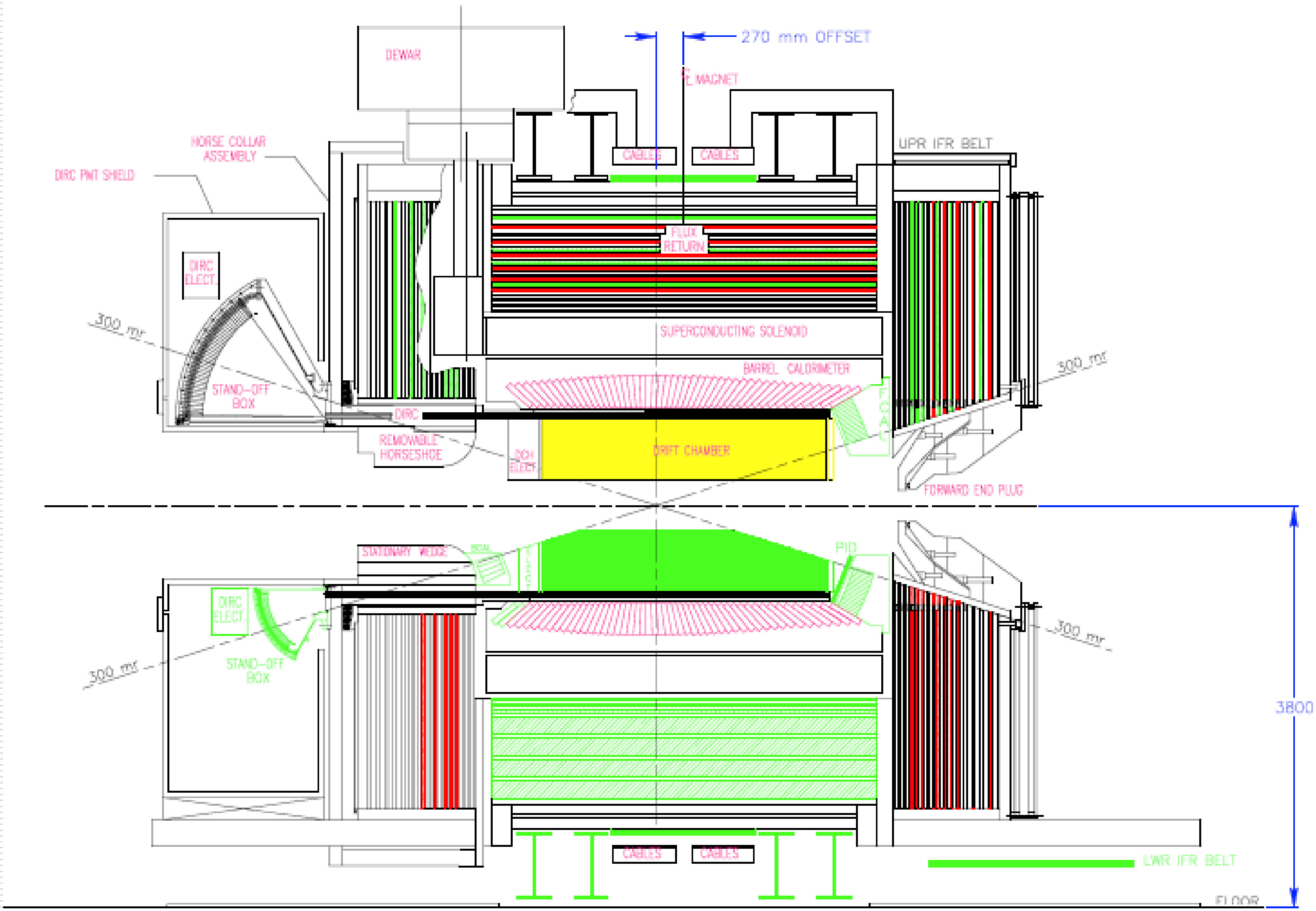
Figure 5.6: Dipole field created by many permanent-magnets (PM) blocks arranged in a ring. Many rings are stacked together and rotated to create the helical field [193].





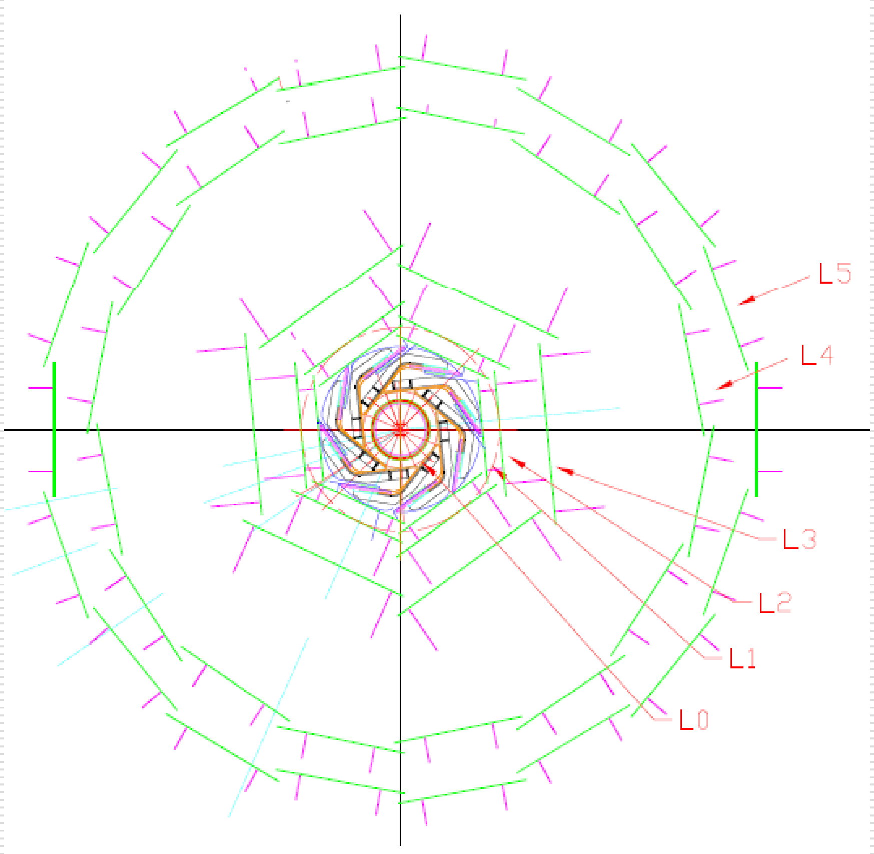


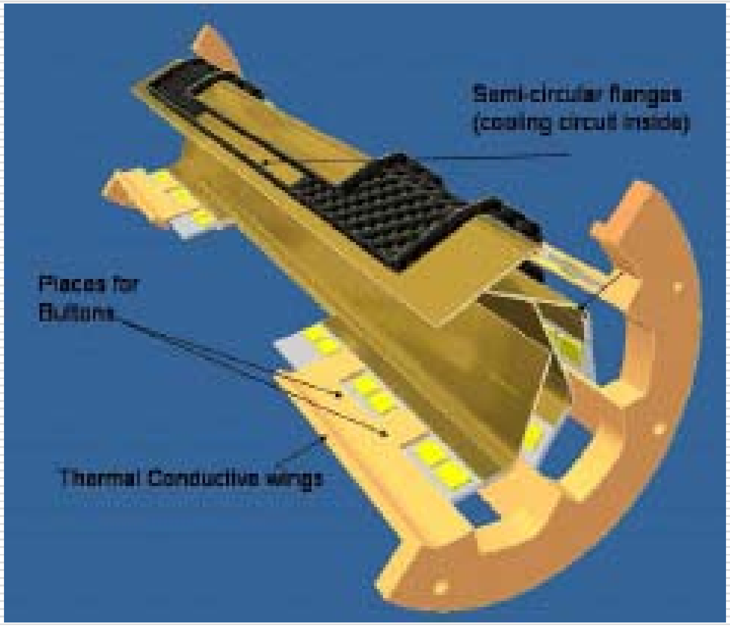
~60% polarization can be achieved



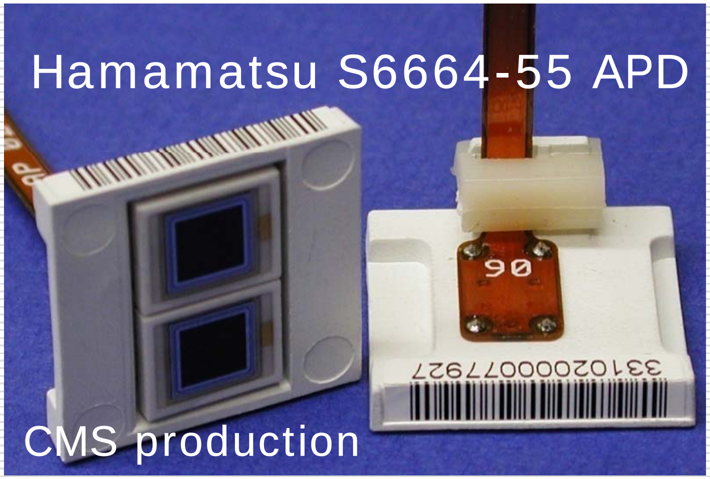
270 mm OFFSET
DEWAR
℄ MAGNET
HORSE COLLAR ASSEMBLY
DIRC PMT SHIELD
CABLES
CABLES
UPR IFR BELT
DIRC ELECT.
FLUX RETURN
300 mr
SUPERCONDUCTING SOLENOID
BARREL CALORIMETER
300 mr
STAND-OFF BOX
DIRC
REMOVABLE HORSESHOE
DCH ELECT.
DRIFT CHAMBER
FORWARD END PLUG
STATIONARY WEDGE
PID
DIRC ELECT.
300 mr
300 mr
STAND-OFF BOX
3800
CABLES
CABLES
LWR IFR BELT
FLOOR

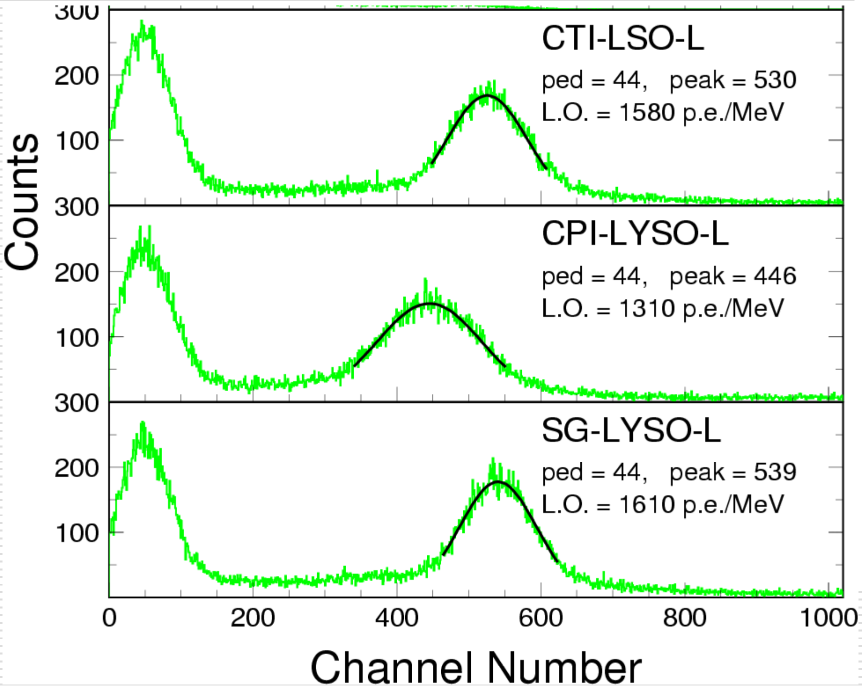
Layer Ø mechanics





Work is needed on LYSO development and mechanics

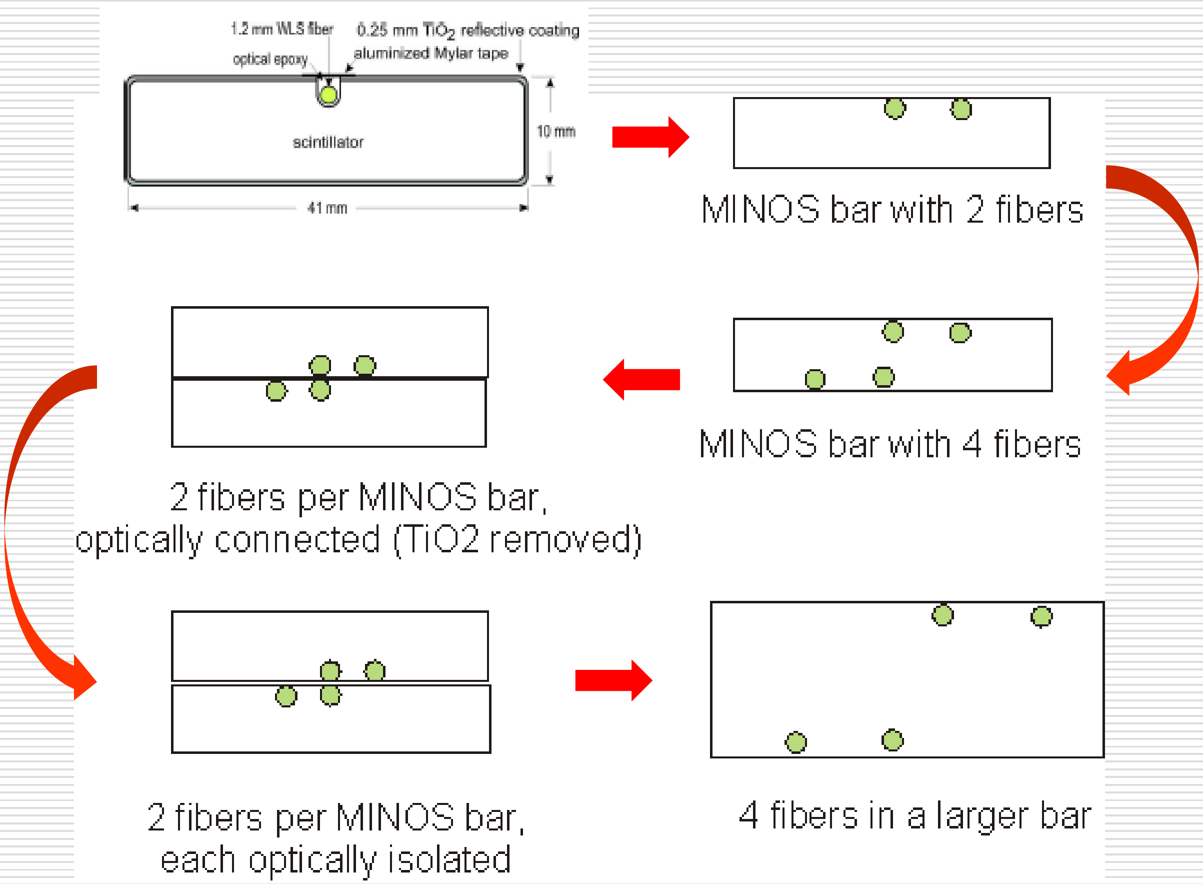


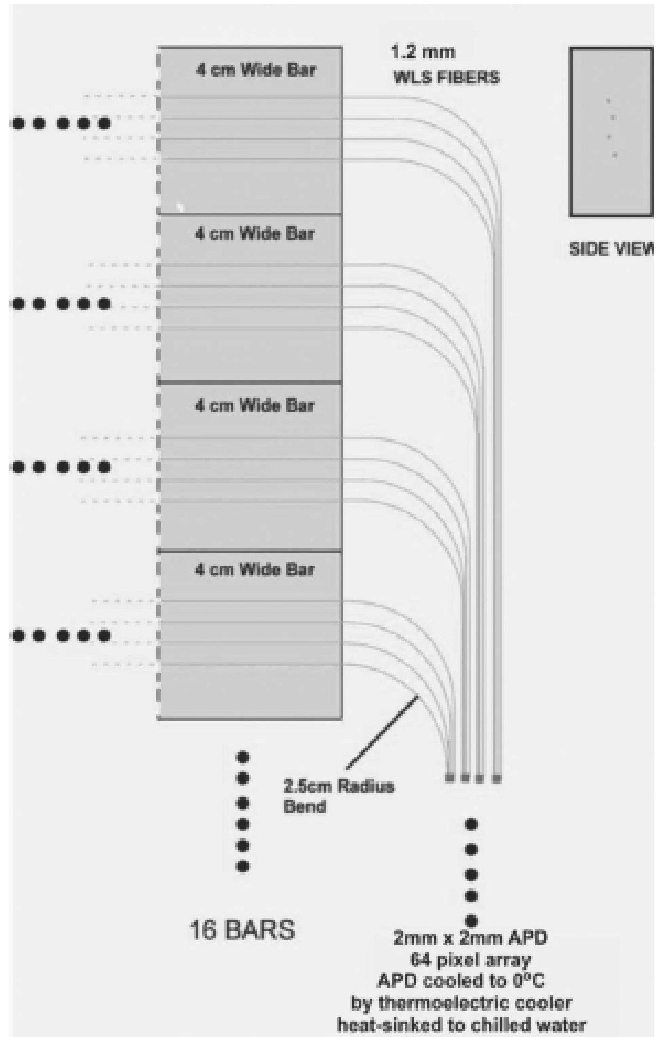


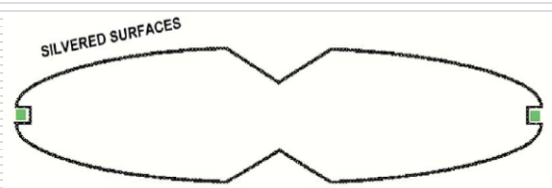
Ring in ϕ	Radius (mm)	Crystal Face (mm)	Crystal Volume (cc)	# Crystals
1	597-620	24.4× 31.9	171	120
2	620-643	24.4× 33.1	178	120
3	643-666	24.4× 29.4	158	140
4	666-689	24.4× 30.5	164	140
5	689-712	24.4× 27.5	148	160
6	712-735	24.4× 28.4	152	160
7	735-758	24.4× 26.1	140	180
8	758-781	24.4× 26.9	144	180
9	781-804	24.4× 24.9	134	200
10	804-827	24.4× 25.6	137	200
11	827-850	24.4× 23.9	128	220
12	850-873	24.4× 24.6	132	220
13	873-896	24.4× 23.2	125	240
14	896-919	24.4× 23.8	128	240

The Endcap IFR detectors: scintillator bars à la MINOS

Many configurations that can provide improved light collection







An R&D opportunity

P. Kim

How much?

Costs are presented "ILC-style", with replacement value for reusable PEP-II/*BABAR* components

	EDIA [my]	Labor [my]	M&S [k€]	Replacement value [k€]
Accelerator	452	291	191,166	126,330
Site	119	138	105,700	0
Detector	283	156	40,747	46,471

Value of reusable items from PEP-II and *BABAR*

Disassembly, crating, refurbishment and shipping costs are included in columns to the left

Conclusions

- We have just concluded a very successful CDR writing exercise
- We now need to use the CDR and other less weighty documents to convince our peers of the value of the Super*B* project over the next decade to the HEP community
- As we do this, we have to expand the base of the accelerator and experimental collaborations
  - R&D projects are a classic vehicle, but they require some seed money
  - At the same time, access to increased engineering resources is sorely needed