LCWS 2007 MDI Summary

Impressions, B. Parker

First some MDI statistics.

Thursday, 31 May 2007

[170] **GamCal, a device for beam diagnostics**
by Bill MORSE (BNL)
(DESY Auditorium: 14:00 - 14:20)

[171] **ILC beam diagnostics using BeamCal and GamCal**
by Dr. Andrey SAPRONOV (JINR)
(DESY Auditorium: 14:20 - 14:40)

[173] **Simulation studies and detector scenarios for an ILC polarimeter**
by Dr. Oleg EYSER (DESY)
(DESY Auditorium: 14:40 - 15:00)

[172] **Test stand measurements for an ILC polarimeter**
by Dr. Daniela KAEFER (DESY)
(DESY Auditorium: 15:00 - 15:20)

[116] **ESA program overview**
by Dr. Michael WOODS (SLAC)
(DESY Auditorium: 16:00 - 16:20)

[117] **Status report on design and engineering progress of the head-on IR scheme**
by Dr. Olivier NAPOLY (CEA)
(DESY Auditorium: 16:20 - 16:40)

[118] **Improved 2 mrad IR layout : current status and plans**
by Philip BAMBADE (Laboratoire de l''Accelerateur Lineaire (LAL) (IN2P3) (LAL))
(DESY Auditorium: 16:40 - 17:00)

[119] **Status of FONT4 IP intra-train feedback prototype at ATF**
by Prof. Philip BURROWS (Oxford University)
(DESY Auditorium: 17:00 - 17:20)

[120] **Results of the FONT@ESA IP feedback EM background experiment**
by Dr. Tony HARTIN (JAI, Oxford University)
(DESY Auditorium: 17:20 - 17:40)

[121] **Updates of GLD-MDI**
by Dr. Toshiaki TAUCHI (KEK)
(DESY Auditorium: 17:40 - 18:05)

[122] **Updates on SiD MDI**
by Dr. Thomas MARKIEWICZ (SLAC)
(DESY Auditorium: 18:05 - 18:30)

Friday, 01 June 2007

[123] **Status report on push-pull study**
by Dr. Andrei SERYI (SLAC)
(Main Tent: 09:00 - 09:15)

[124] **Extraction line design for push-pull**
by Yuri NOSOCHKOV (SLAC)
(Main Tent: 09:15 - 09:35)

[126] **Integration of force-neutral anti-solenoid into QD0 cryostat**
by Dr. Brett PARKER (BNL)
(Main Tent: 09:35 - 09:50)

[125] **IR systems integration issues relevant to push-pull**
by Dr. Brett PARKER (BNL)
(Main Tent: 09:50 - 10:20)

[127] **Discussion about IR engineering design workshop**
(Main Tent: 10:20 - 10:30)

[174] **Physics background as a systematic effect in luminosity measurement at ILC**
by Mila PANDUROVIC (Vinca Institute of Nuclear Sciences)
(SemRm 4b: 14:00 - 14:20)

[175] **Limitation on precision luminosity measurement from beam-beam effects**
by Dr. Cecile RIMBAULT (LAL)
(SemRm 4b: 14:20 - 14:40)

[176] **Update on the beam related backgrounds in the LDC detector**
by Mr. Adrian VOGEL (DESY)
(SemRm 4b: 14:40 - 15:00)

[177] **Detector impact of photon backscattering from the extraction line**
by Dr. Olivier DADOUN (LAL Orsay)
(SemRm 4b: 15:00 - 15:20)

[178] **Pair monitor studies**
by Dr. Yosuke TAKUBO (Tohoku University)
(SemRm 4b: 15:20 - 15:40)

[181] **Status of the GP++ beam-beam interaction simulation tool**
by Dr. Francois TOUZE (LAL)
(SemRm 4b: 15:40 - 16:00)

Saturday, 02 June 2007

[179] **ILC beam energy measurement using compton backcattering**
by Dr. Nickolai MUCHNOI (Budker INP)
(SemRm 4b: 14:00 - 14:20)

[180] **Energy measurement with Compton backscattering: updates**
by Dr. Michele VITI (DESY)
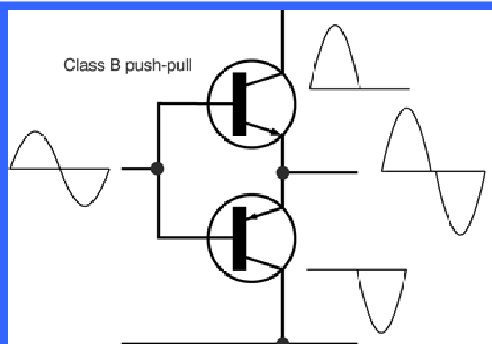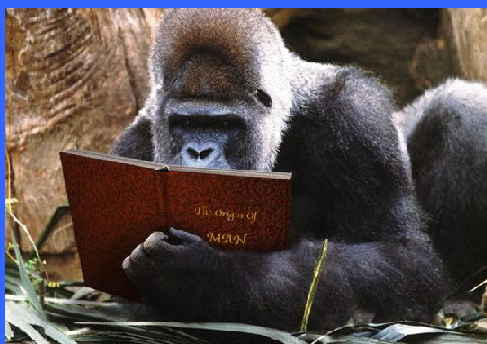(SemRm 4b: 14:20 - 14:40)

[451] **Progress report for the Energy Spectrometer test experiment at ESA**
by Dr. Bino MAIHEU (UCL)
(SemRm 4b: 14:40 - 15:00)

[182] **BeamCal performance**
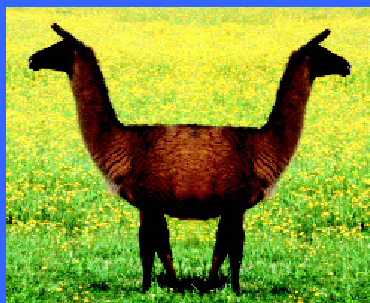by Uriel NAUENBERG
(SemRm 4b: 15:00 - 15:20)

Over the course of 3 days there were 25 presentations, 1 group discussion, and significant overlap with BDS.

I will give the flavor... for details go to the web!

Characterization of the MDI sessions.

Class B push-pull

THE FATE OF THE WORLD HANGS IN THE BALANCE AS KING KONG FIGHTS THE KING KONG ROBOT!

...two King Kongs fight to the DEATH!

ALL NEW!

KING KONG ESCAPES!

A lot of hard work on ILC baseline & alternatives was reported showing progress on many fronts. There is good news in that many results are now settling down (no new surprises). Unfortunately there does not seem to be a clear view of what push-pull will really look like... much less consensus on how well (or if) it can be made to work. Push-pull is MDI's 300 ton gorilla and machine/detector requirements seem to be automaticly in conflict.

"KING KONG ESCAPES" RHODES REASON
LINDA MILLER · MIE HAMA · AKIRA TAKARADA
Screenplay by WILLIAM J. KEENAN · Producer/Director ARTHUR RANKIN, JR. · A Rankin/Bass Production
A TOHO CO., LTD. PICTURE · A UNIVERSAL RELEASE in TECHNICOLOR®

Theme: Determining the Beam Properties.

GamCal, a device for beam diagnostics
by Bill MORSE (BNL)

ILC beam diagnostics using BeamCal and GamCal
by Dr. Andrey SAPRONOV (JINR)

Limitation on precision luminosity measurement
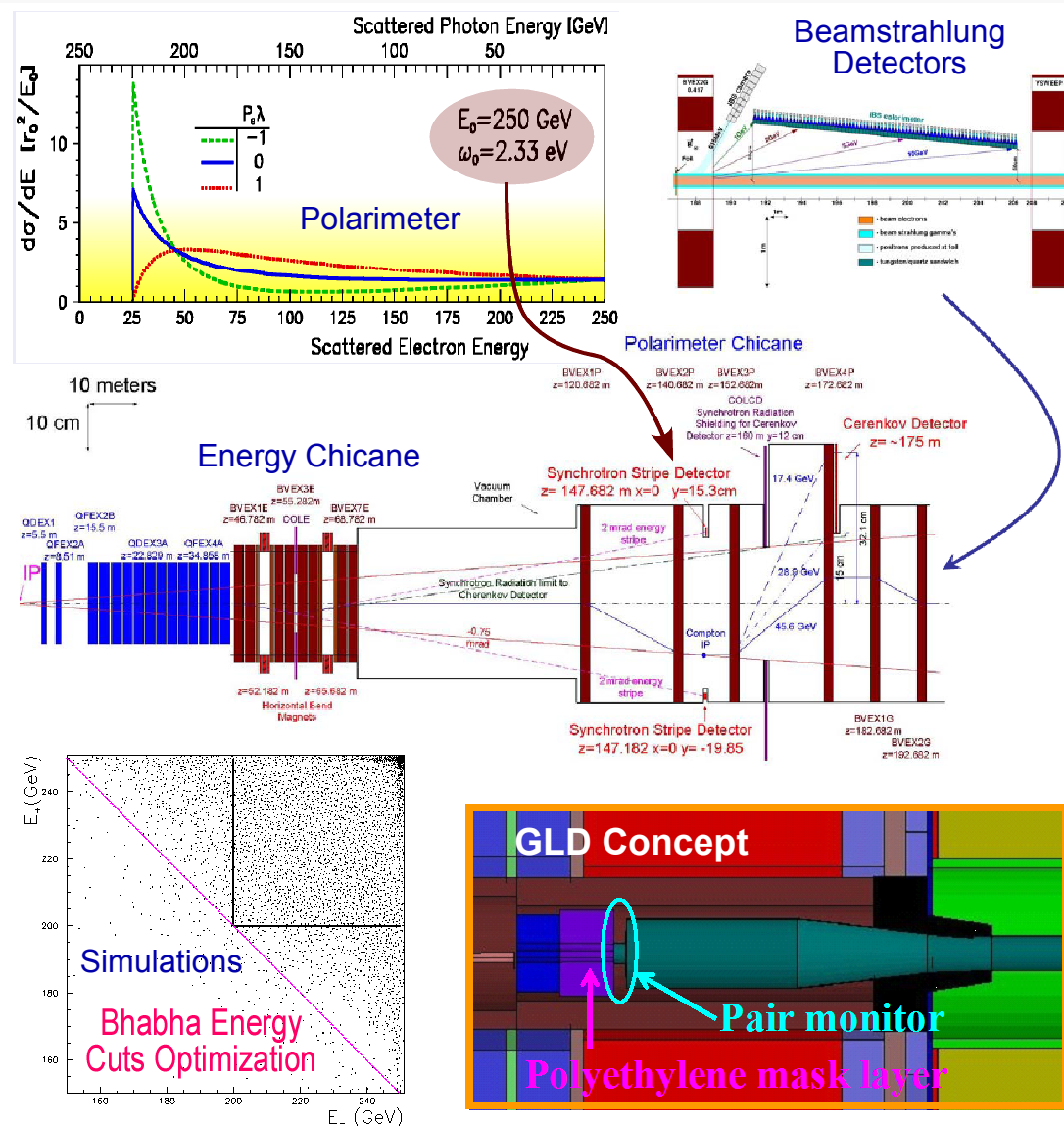from beam-beam effects
by Dr. Cecile RIMBAULT (LAL)

Pair monitor studies
by Dr. Yosuke TAKUBO (Tohoku University)

ILC beam energy measurement using
compton backscattering
by Dr. Nickolai MUCHNOI (Budker INP)

Energy measurement with Compton
backscattering: updates
by Dr. Michele VITI (DESY)

Progress report for the Energy Spectrometer
test experiment at ESA
by Dr. Bino MAIHEU (UCL)

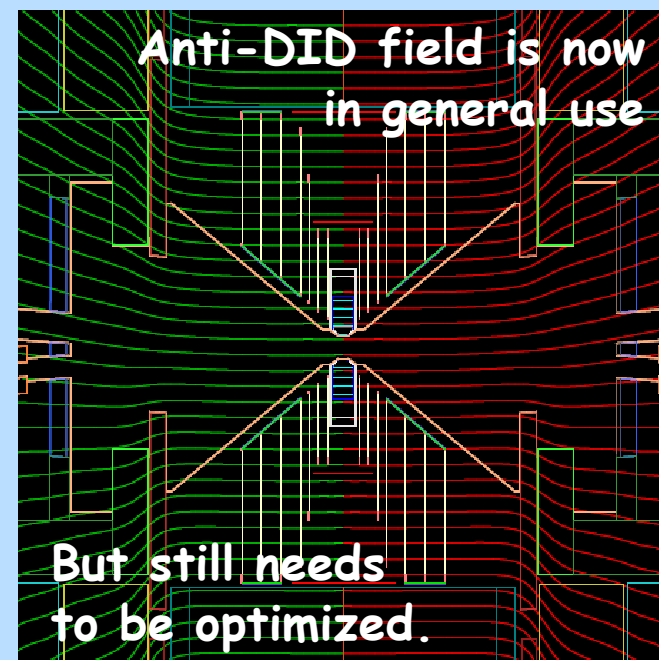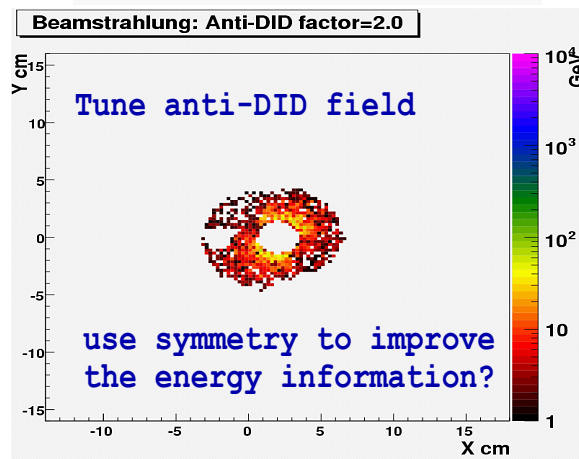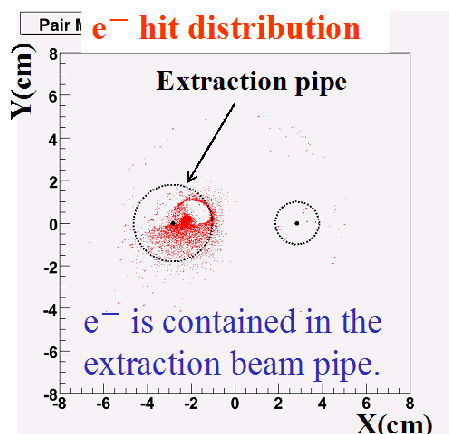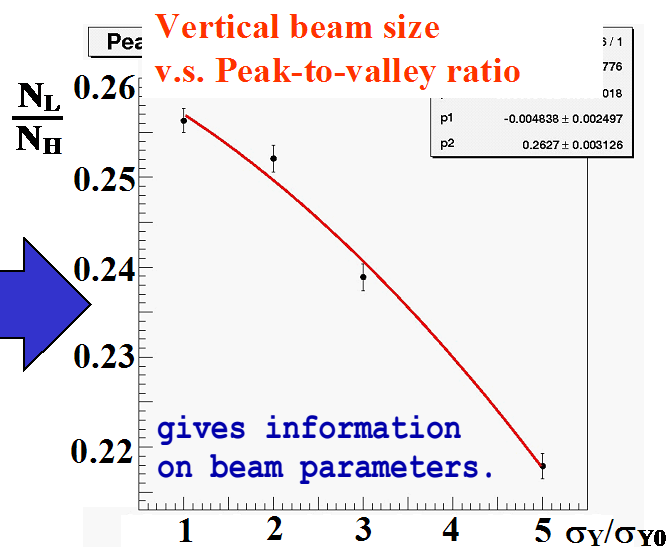BeamCal performance
by Uriel NAUENBERG

Beamstrahlung Detectors

Polarimeter

$E_0 = 250$ GeV
$\omega_0 = 2.33$ eV

Polarimeter Chicane

Energy Chicane

Simulations

Bhabha Energy Cuts Optimization

GLD Concept

Pair monitor

Polyethylene mask layer

Peak-to-valley ratio : $\dfrac{N_L}{N_H}$

r-ϕ distribution of e^+ with $\sigma_Y = \sigma_{Y0}$

Data from pair monitor

Vertical beam size v.s. Peak-to-valley ratio

p1	−0.004838 ± 0.002497
p2	0.2627 ± 0.003126

gives information on beam parameters.

e^- hit distribution

Extraction pipe

e^- is contained in the extraction beam pipe.

Beamstrahlung: Anti-DID factor=2.0

Tune anti-DID field

use symmetry to improve the energy information?

Anti-DID field is now in general use
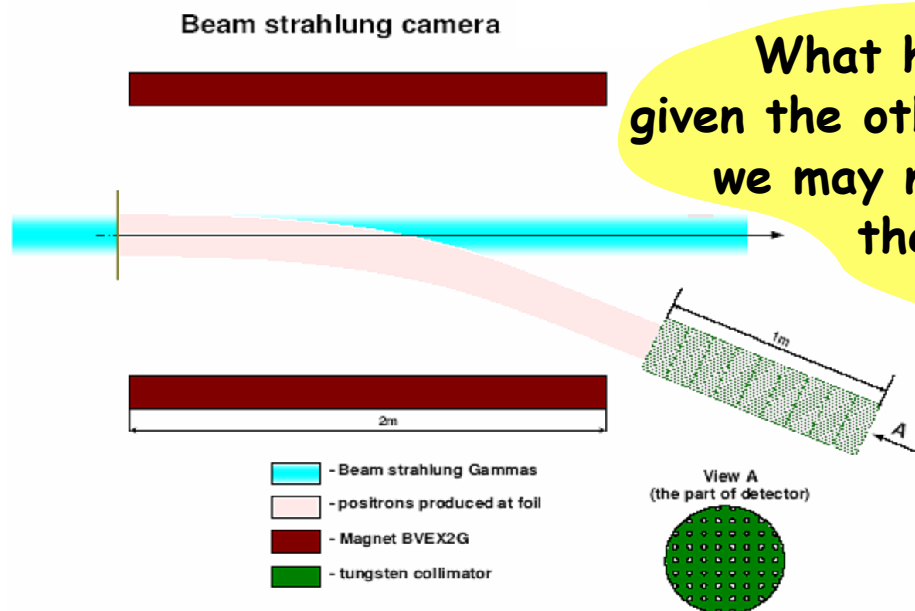
But still needs to be optimized.

14 mrad crossing angle with anti-DID field (1:10)

Optimize design to get information from pairs.

Minimize impact of pairs on energy & luminosity measurements.

Many efforts to make robust diagnostics.

Beam strahlung camera

- Beam strahlung Gammas
- positrons produced at foil
- Magnet BVEX2G
- tungsten collimator

View A
(the part of detector)

What happens when we aren't given the other 9 beam parameters we may need to help pin down the 10'th one that we are interested in?
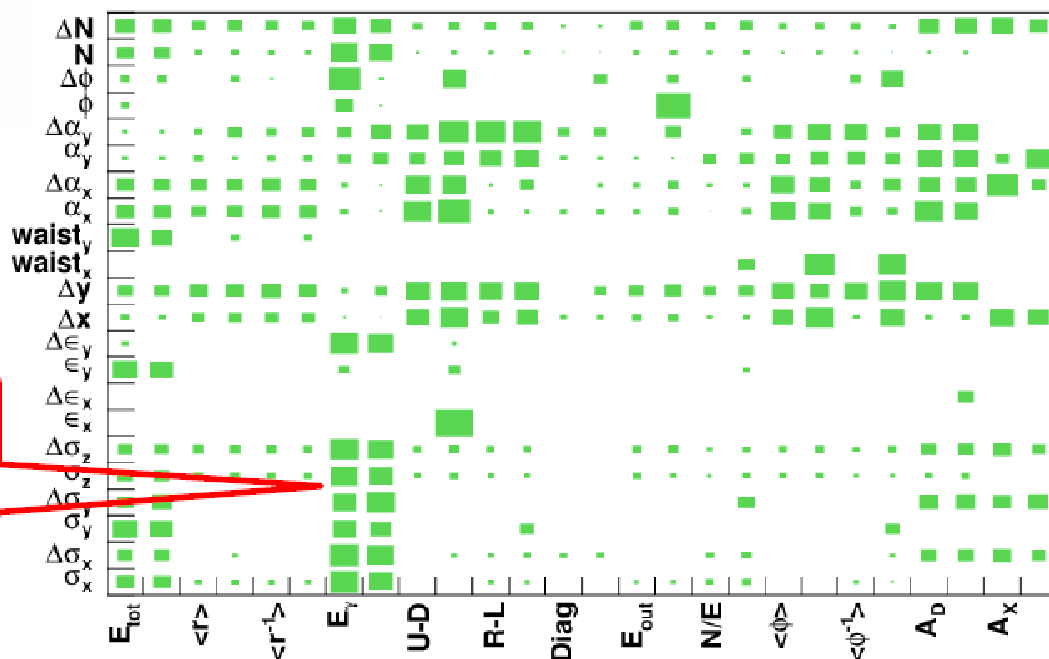
Need for diverse diagnostics!

Studies are launched of using B-gammas for luminosity & beam profile information.

High significance of information from gammas for bunch sizes reconstruction.

But resource limited! (10%)

Theme: From studies to real world tests.

Status of FONT4 IP intra-train feedback prototype at ATF
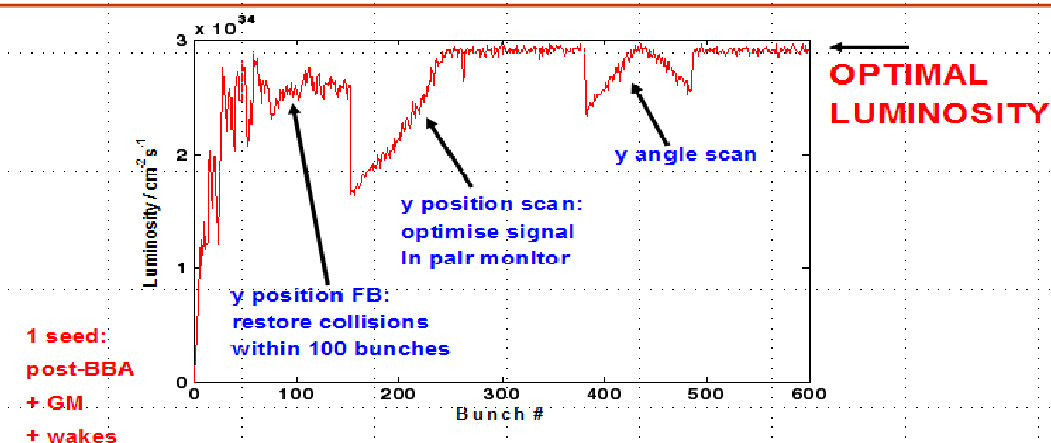by Prof. Philip BURROWS (Oxford University)

ESA program overview
by Dr. Michael WOODS (SLAC)

Test stand measurements for an ILC polarimeter
by Dr. Daniela KAEFER (DESY)

Progress report for the Energy Spectrometer test experiment at ESA
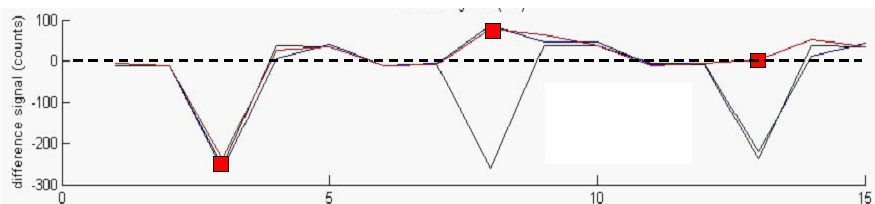by Dr. Bino MAIHEU (UCL)

Results of the FONT@ESA IP feedback EM background experiment
by Dr. Tony HARTIN (JAI, Oxford University)

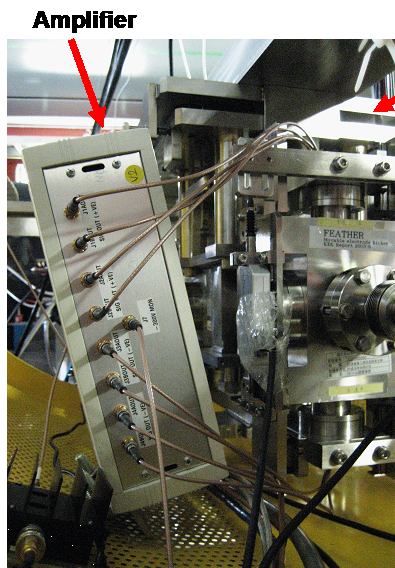## Intra-train y + y' IP feedback simulations

OPTIMAL LUMINOSITY
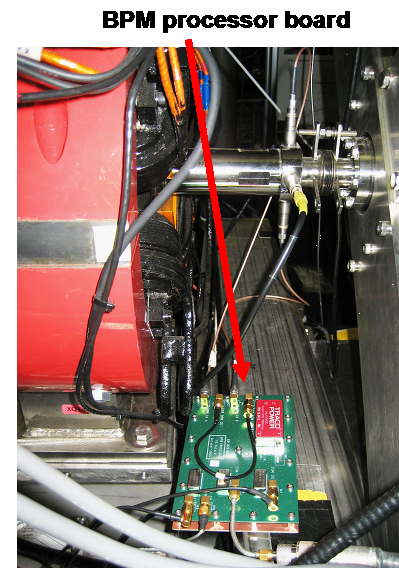
y angle scan

y position scan:
optimise signal
In pair monitor

y position FB:
restore collisions
within 100 bunches

1 seed:
post-BBA
+ GM
+ wakes

Luminosity/cm⁻²s⁻¹

Bunch #

FB on, with delay loop   **Latency ~ 135ns**

difference signal (counts)

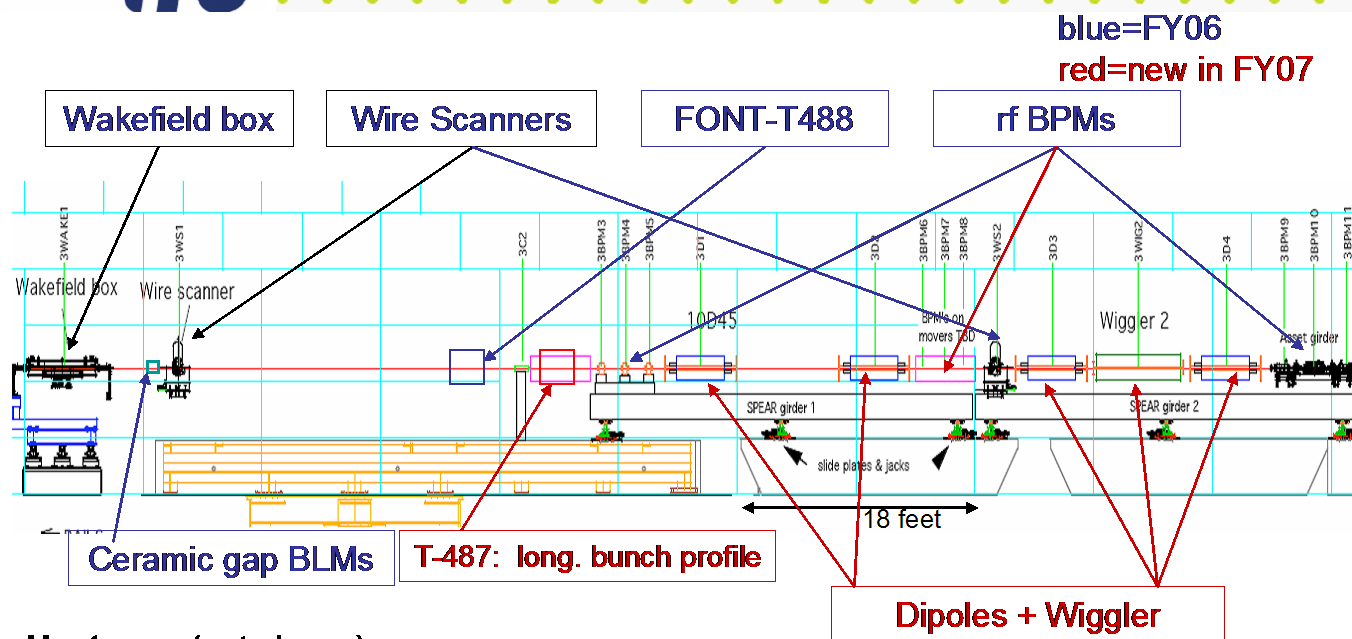**May 07: optimise gain, delay-loop setting, 1/Q ...**

Amplifier   FEATHER Kicker   BPM processor board

From studies to real world tests.

blue=FY06
red=new in FY07

Wakefield box | Wire Scanners | FONT-T488 | rf BPMs

Ceramic gap BLMs | T-487: long. bunch profile

Dipoles + Wiggler

18 feet

Upstream (not shown)

4 rf BPMs for incoming trajectory
Ceramic gap w/ rf diode detectors (16GHz, 23GHz, and 100GHz) and 2 EMI antennas

Downstream (not shown)

Ceramic gap for EMI studies
T475 Detector for Wiggler SR stripe

LiTrack Simulation $\Delta E/E$ [%]

Tail
Head

A-Line Synchrotron Light Monitor

→ first measurement of E-z correlation, using this technique!
Technique will be used by LCLS.

Middle of chicane

Future location of new UK BPM

Incident beam spot

BPMA net
Q = -2057

BPMC net
Q = -2848

BPMD net
Q = -2297

BPMB net
Q = -1908

YAGI Antenna (650-4000 MHz)
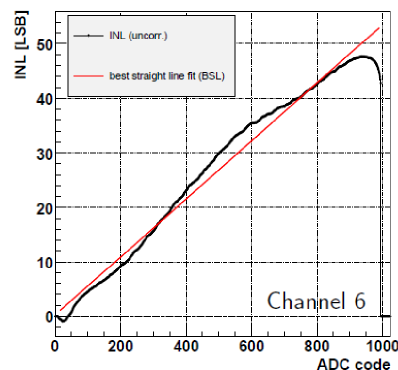
SLAC cavities

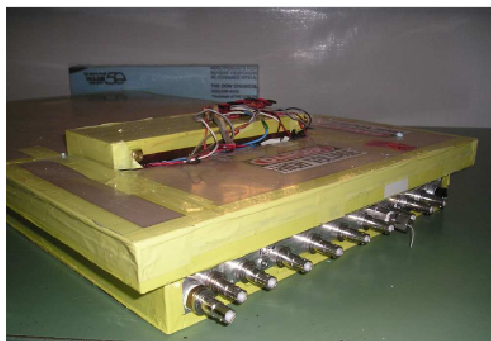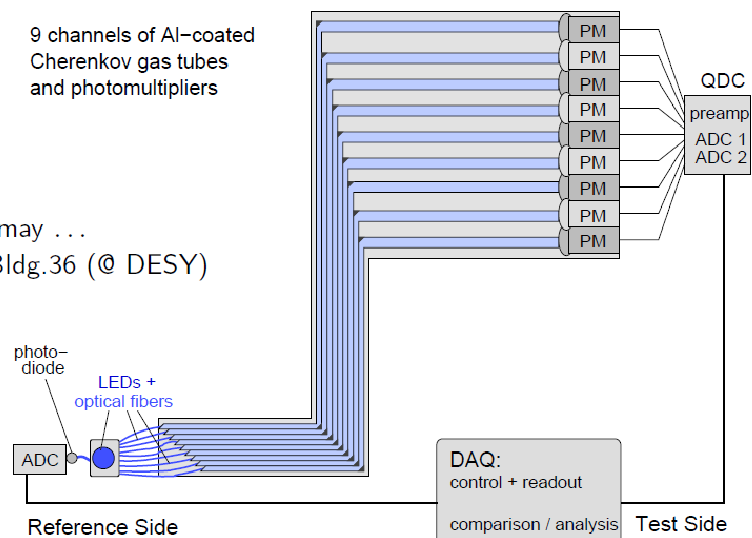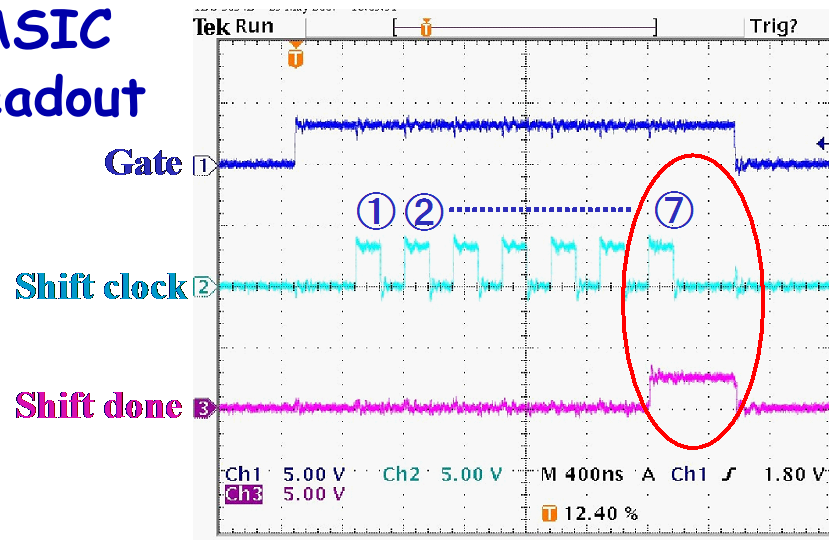# From studies to real world tests.

9 channels of Al–coated
Cherenkov gas tubes
and photomultipliers

As of early may . . .
located in Bldg.36 (@ DESY)

photo–
diode

LEDs +
optical fibers

ADC

QDC

preamp
ADC 1
ADC 2

PM
PM
PM
PM
PM
PM
PM
PM
PM

DAQ:
control + readout

comparison / analysis

Reference Side

Test Side

INL [LSB]

INL (uncorr.)

best straight line fit (BSL)

Channel 6

ADC code

4mm

4mm

Readout cells

MOSIS
T72Y-AB
1907

**ASIC
Readout**

Tek Run

Trig?

Gate ①

① ② · · · · · ⑦

Shift clock ②

Shift done ③

Ch1 5.00 V   Ch2 5.00 V   M 400ns A Ch1 ∫   1.80 V
Ch3 5.00 V

12.40 %
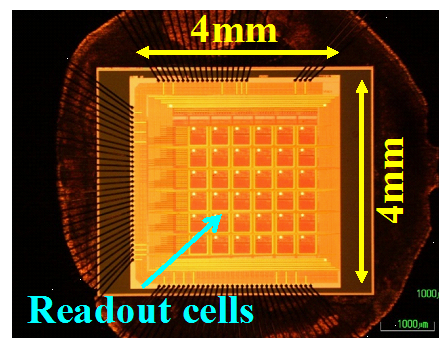
"End Station A Studies" after switch over from SLAC B-factory running?

Theme: Work on IR Scheme Alternatives.

Status report on design and engineering
progress of the head-on IR scheme
by Dr. Olivier NAPOLY (CEA)

Improved 2 mrad IR layout : current
status and plans
by Philip BAMBADE (Laboratoire de Accelerateur
Lineaire (LAL) (IN2P3) (LAL))

Detector impact of photon backscattering
from the extraction line
by Dr. Olivier DADOUN (LAL Orsay)

Certainly a lot of effort has been put into streamlining the two "head-on" IR schemes and a lot of progress has recently been made. The groups involved are continuing to develop expertise, training and collaborations to tackle quite thorny issues. The stated goals are to broaden the ILC program without taking resources away from the 14 mr baseline.
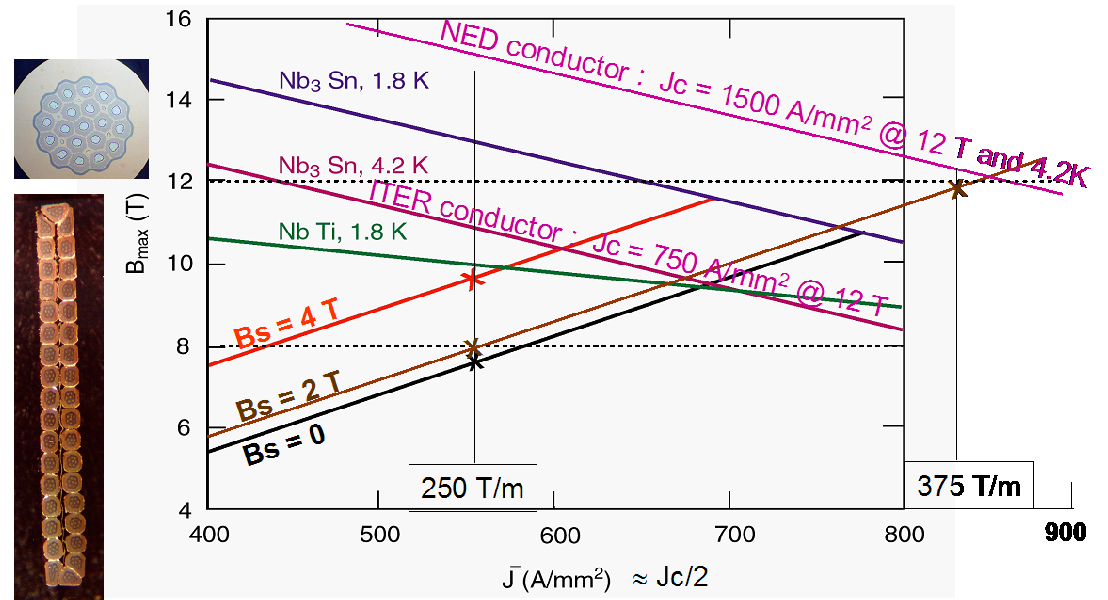
MQXB cross section
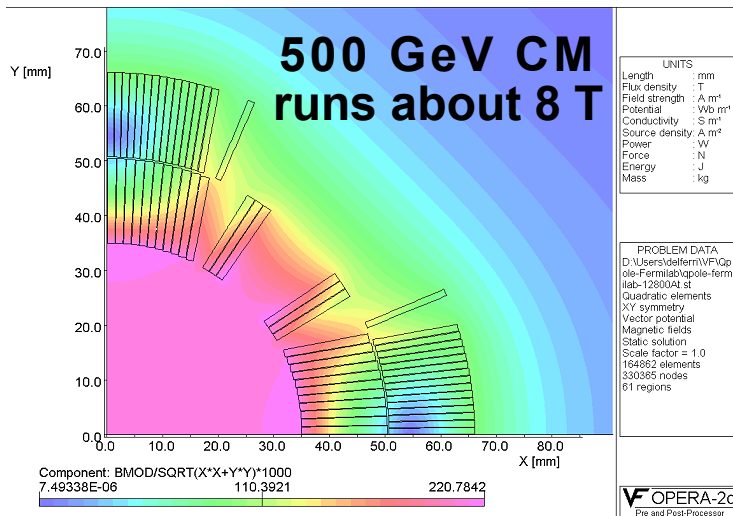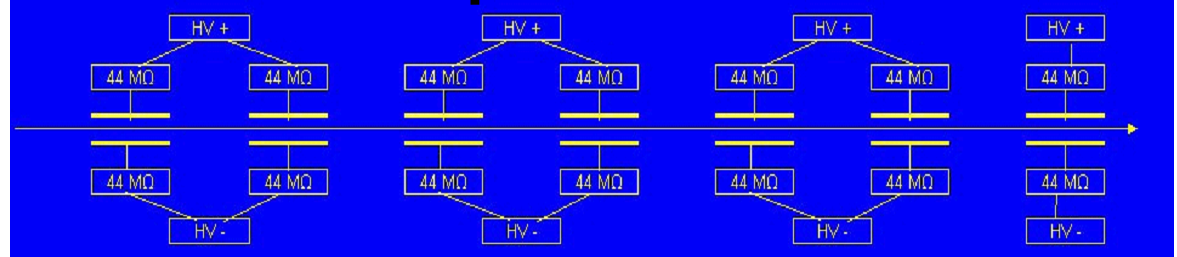

500 GeV CM runs about 8 T
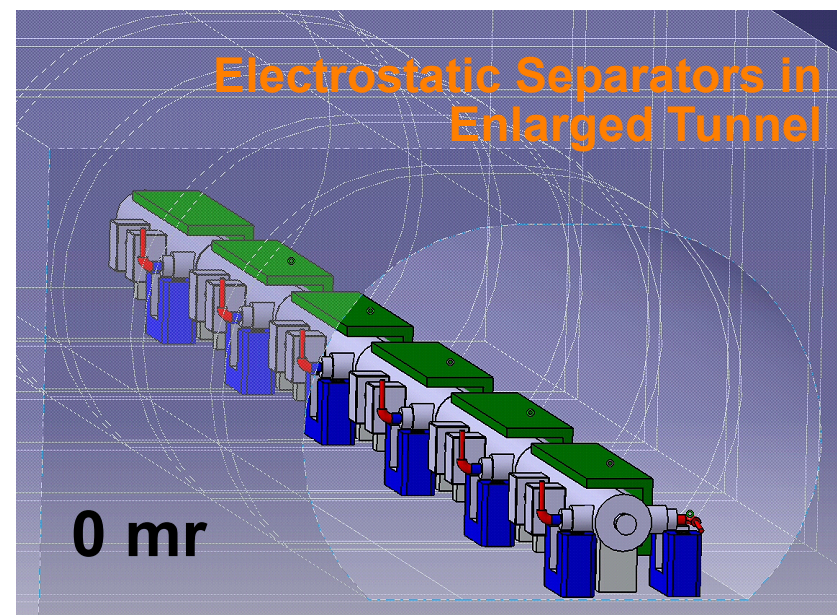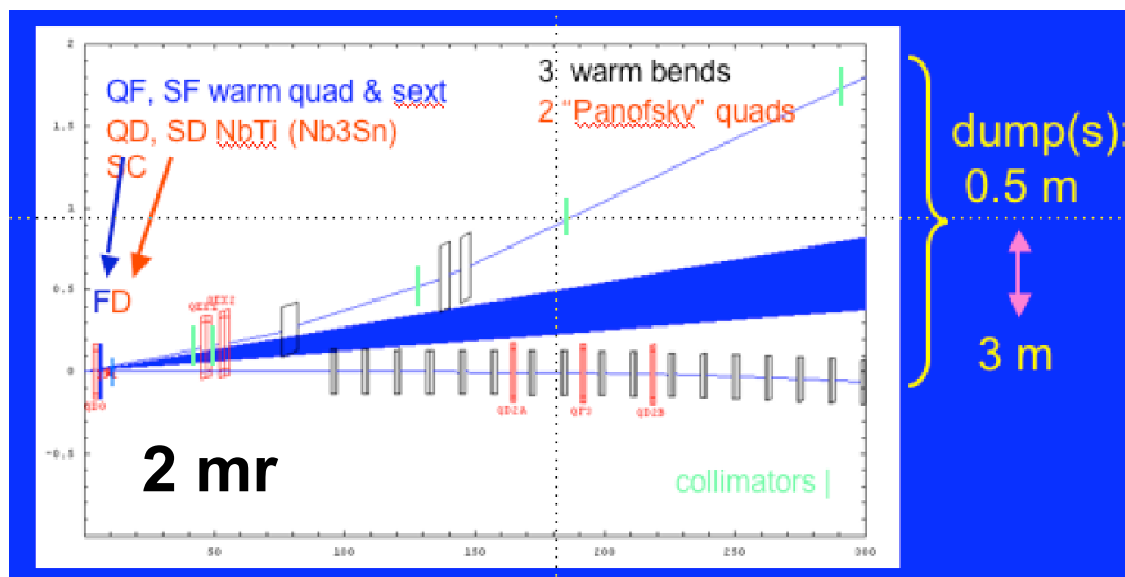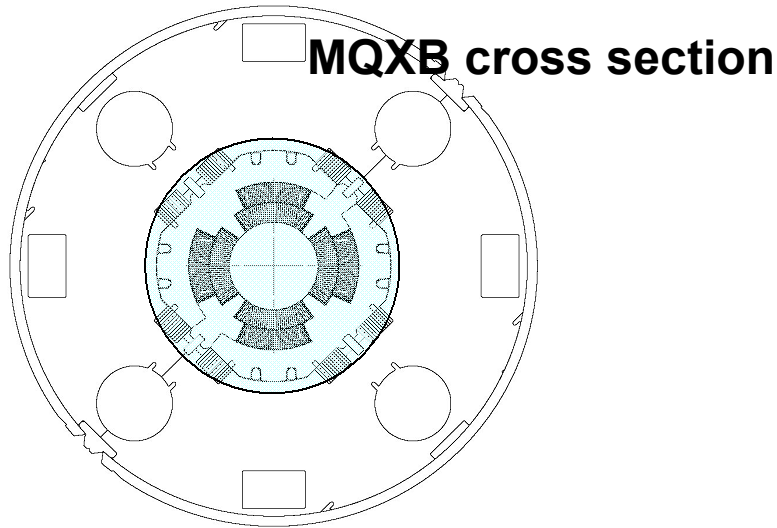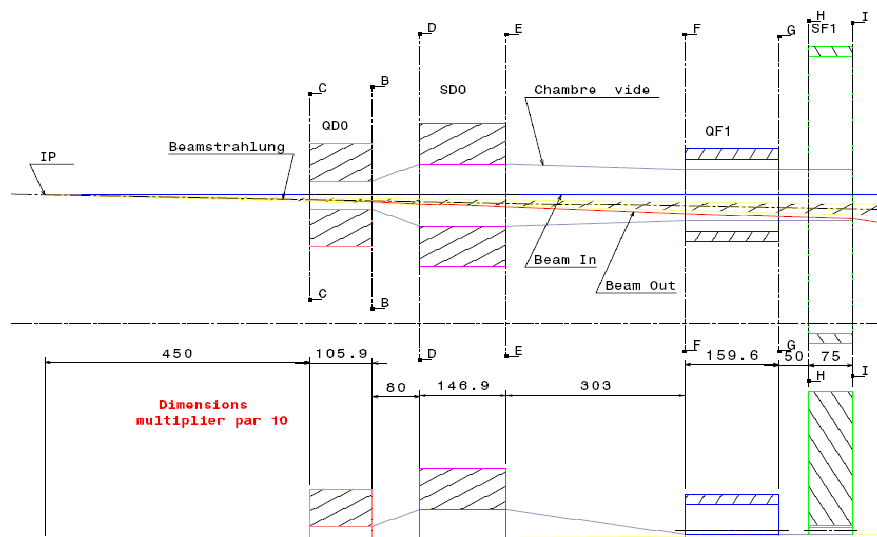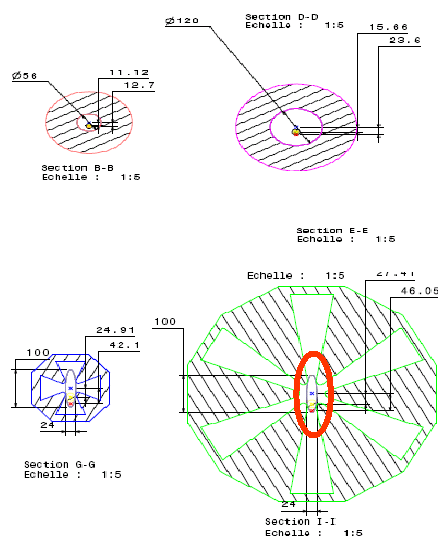
Final Doublet : 1 TeV upgrade

NED Nb3Sn conductor seems to allow safely a 50 % increase of the gradient

Work on E-Seperator Failure Modes

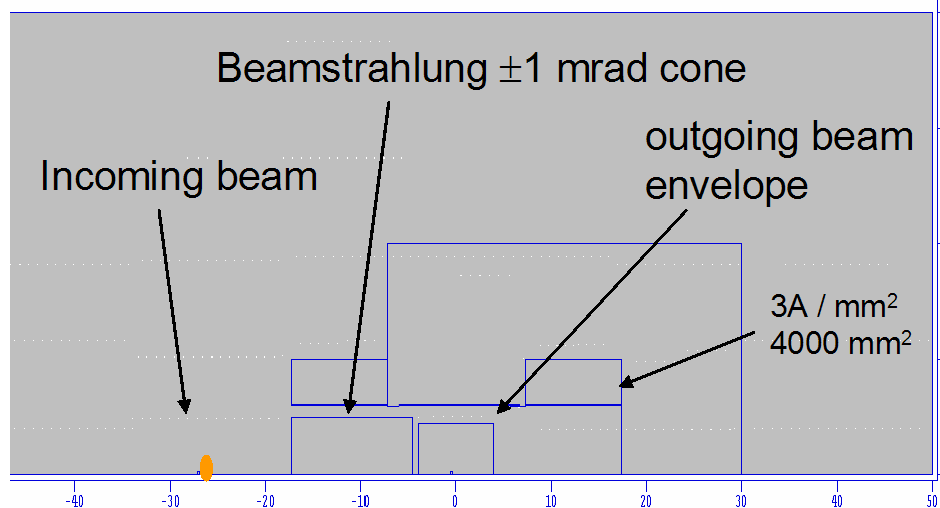# Head on Scheme (2 mr).

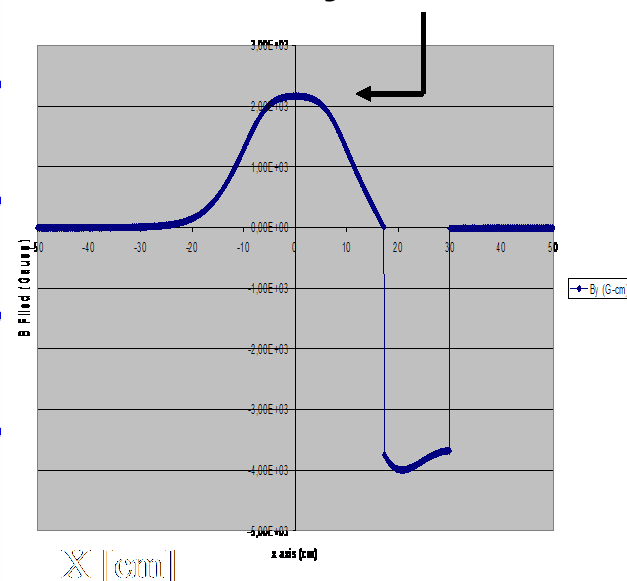**Work to reduce losses and to calculate the backgrounds; then look to reintroduce diagnostics by other means.**

POISSON

Incoming beam

Beamstrahlung ±1 mrad cone

outgoing beam envelope

3A / mm²
4000 mm²

By = 0.215 T

Status report on push-pull study
by Dr. Andrei SERYI (SLAC)

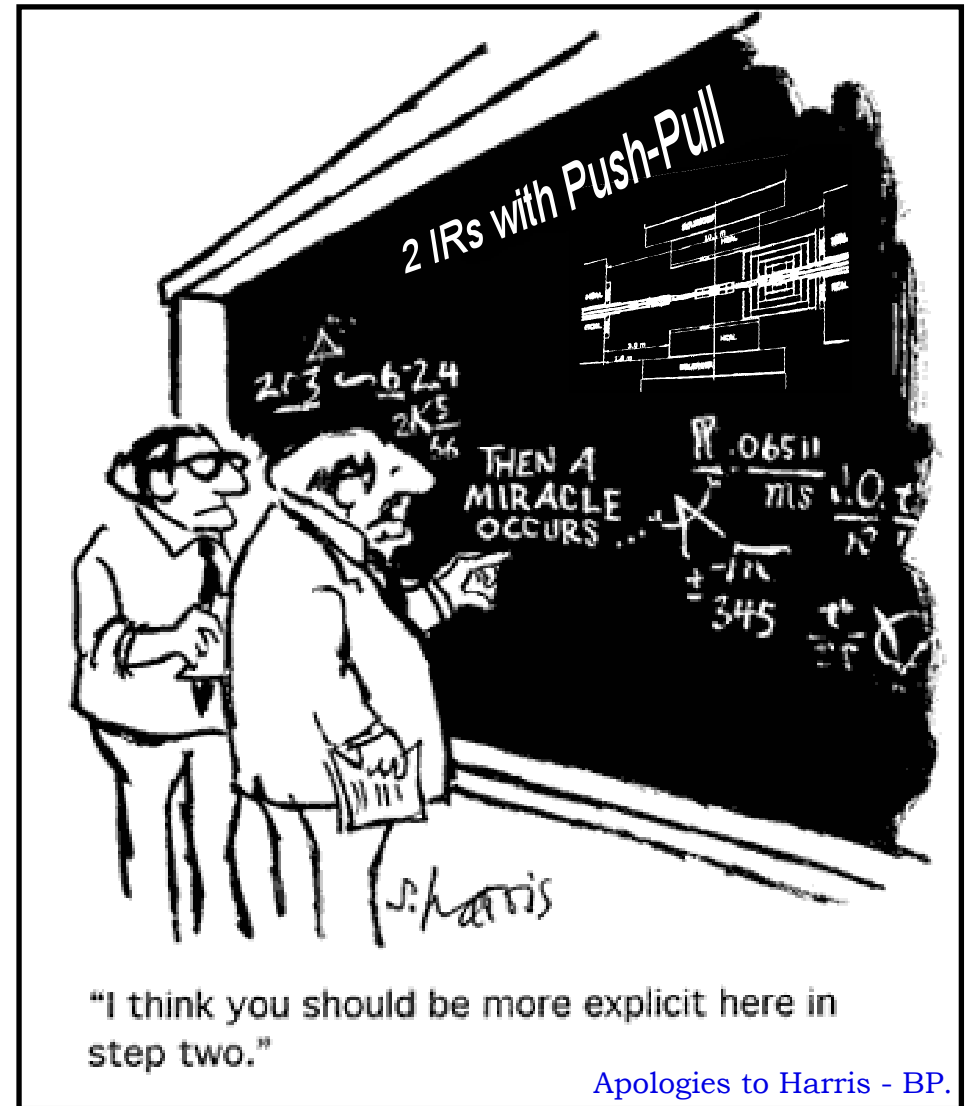**Extraction line design for push-pull**
by Yuri NOSOCHKOV (SLAC)

**Integration of force-neutral anti-solenoid
into QD0 cryostat**
by Dr. Brett PARKER (BNL)

**IR systems integration issues
relevant to push-pull**
by Dr. Brett PARKER (BNL)

Updates on SiD MDI
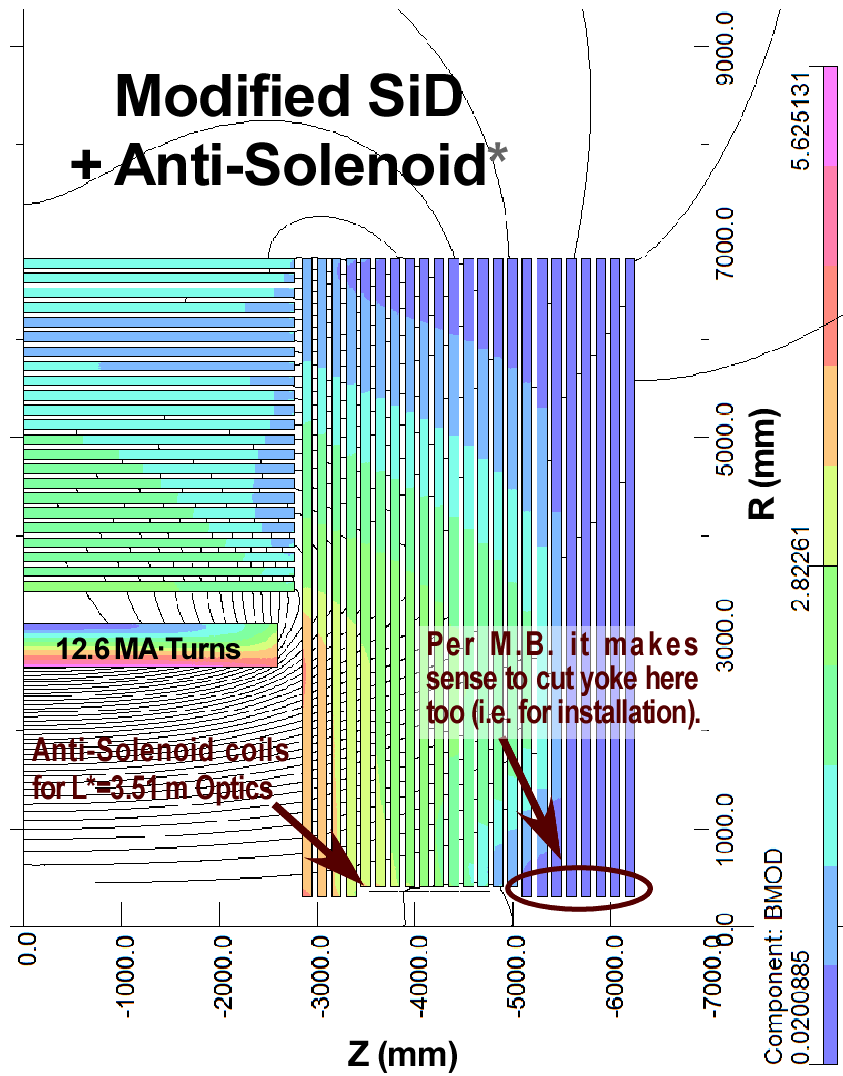by Dr. Thomas MARKIEWICZ (SLAC)

Updates of GLD-MDI
by Dr. Toshiaki TAUCHI (KEK)

Push-Pull is our ILC baseline. A lot of hard work and cooperation is needed to make it work. We cannot give up before we even try. Other ways of saving ILC value units may be even less appealing.
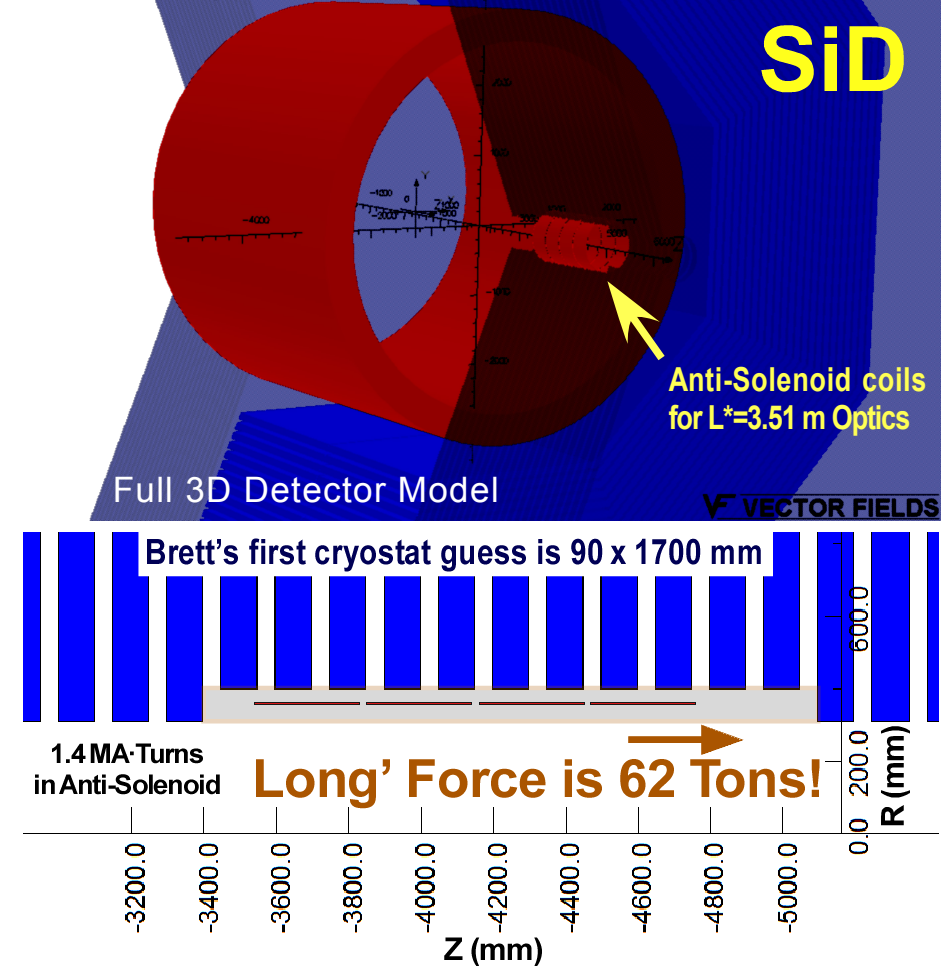

2 IRs with Push-Pull

"I think you should be more explicit here in step two."

Apologies to Harris - BP.

First Generation Anti-Solenoid Design (Some Design Features and Drawbacks).

Modified SiD + Anti-Solenoid*

12.6 MA·Turns

Per M.B. it makes sense to cut yoke here too (i.e. for installation).

Anti-Solenoid coils for L*=3.51 m Optics

R (mm)
9000.0
7000.0
5000.0
3000.0
1000.0

5.625131
2.82261

Component: BMOD
0.0200885

Z (mm)
0.0 -1000.0 -2000.0 -3000.0 -4000.0 -5000.0 -6000.0 -7000.0

*Anti-solenoid strength must be adjusted to meet optics requirements.

AS has major impact on endcap configuration.

SiD

Anti-Solenoid coils for L*=3.51 m Optics

Full 3D Detector Model

VF VECTOR FIELDS

Brett's first cryostat guess is 90 x 1700 mm

1.4 MA·Turns in Anti-Solenoid

Long' Force is 62 Tons!

R (mm)
600.0
200.0
0.0

Z (mm)
-3200.0 -3400.0 -3600.0 -3800.0 -4000.0 -4200.0 -4400.0 -4600.0 -4800.0 -5000.0

Too much force to share QD0 cryostat!

New Concept: The Force Neutral Anti-Solenoid.

For a loop of circumference C carrying current I the longitudinal force is proportional to Br, thus

We want

$$\sum_{j=1}^{N_1} (I_1 C_1 Br_1)_j + \sum_{k=1}^{N_2} (I_2 C_2 Br_2)_k = 0$$

Since $C \propto R$ and $Br \propto R$, so $CBr \propto R^2$ and for $I_1 = -I_2$ we have

$$N_1 \overline{A_1} = N_2 \overline{A_2} \text{ or } \phi_1 = -\phi_2$$

Two Coils; Different Radii

Reverse Polarity
Outer Coil

Inner
Coil

Force Neutral Anti-Solenoid
for SiD with L* = 3.51 m

**Anti-solenoid
goes inside QD0
cryostat without the
need for a dedicated
yoke cutout**

R (mm)

Z (mm)

We can arrange
for the sum of
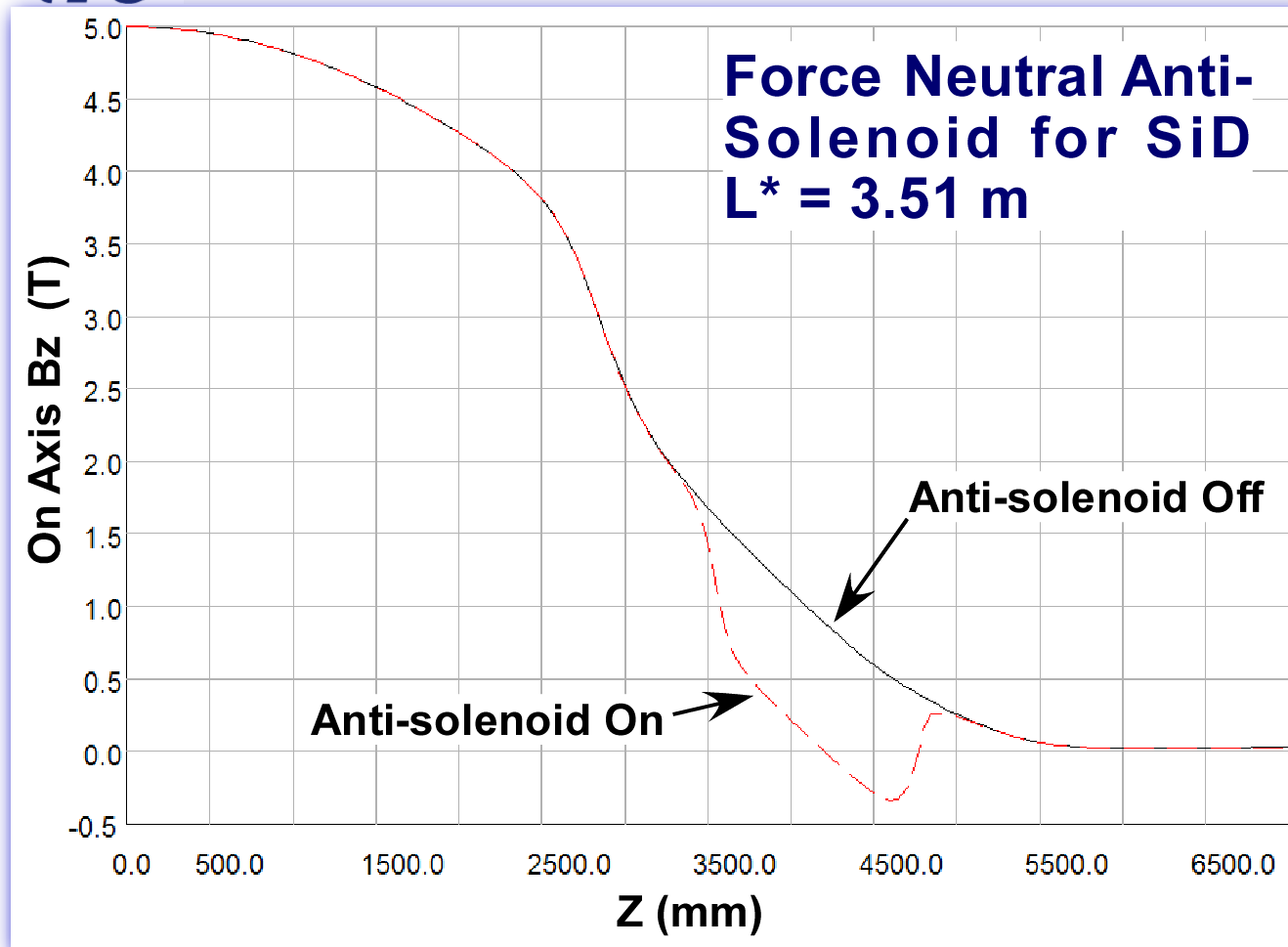the forces on
the inner and
outer coils to
fully cancel... but still have a net anti-solenoidal field inside the inner coil.
Note: This solution does not require detector changes for different L*.
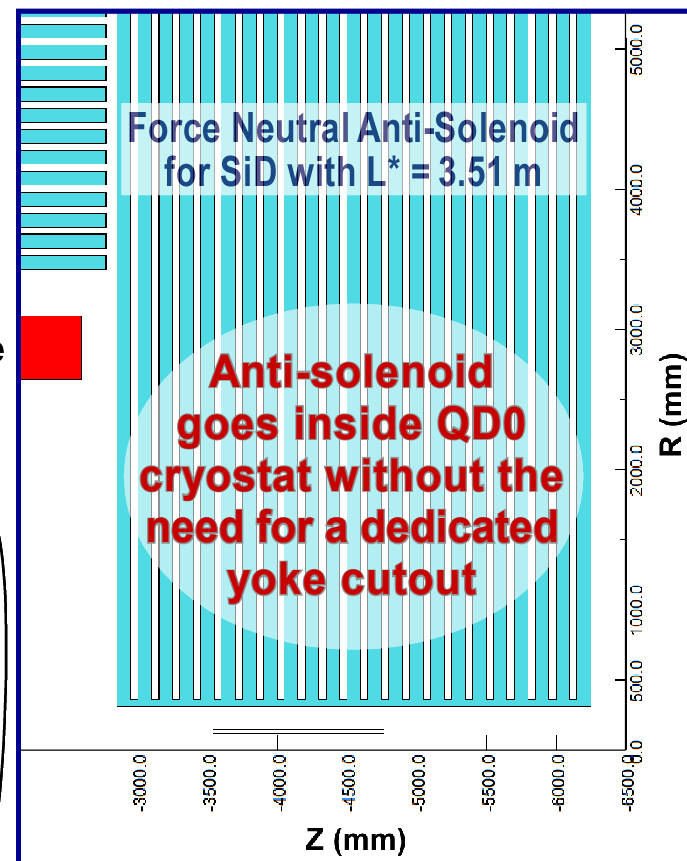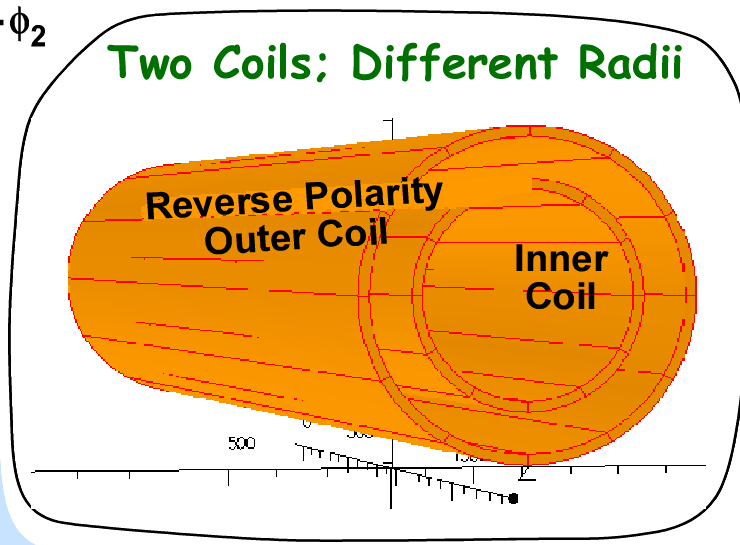
Force Neutral Anti-Solenoid: SiD, L* = 3.51 m (One Example).

Force Neutral Anti-Solenoid for SiD L* = 3.51 m

Thanks to cancellation between the external fields of the inner and outer coils, the force neutral anti-solenoid has very little impact on the detector field away from QD0.
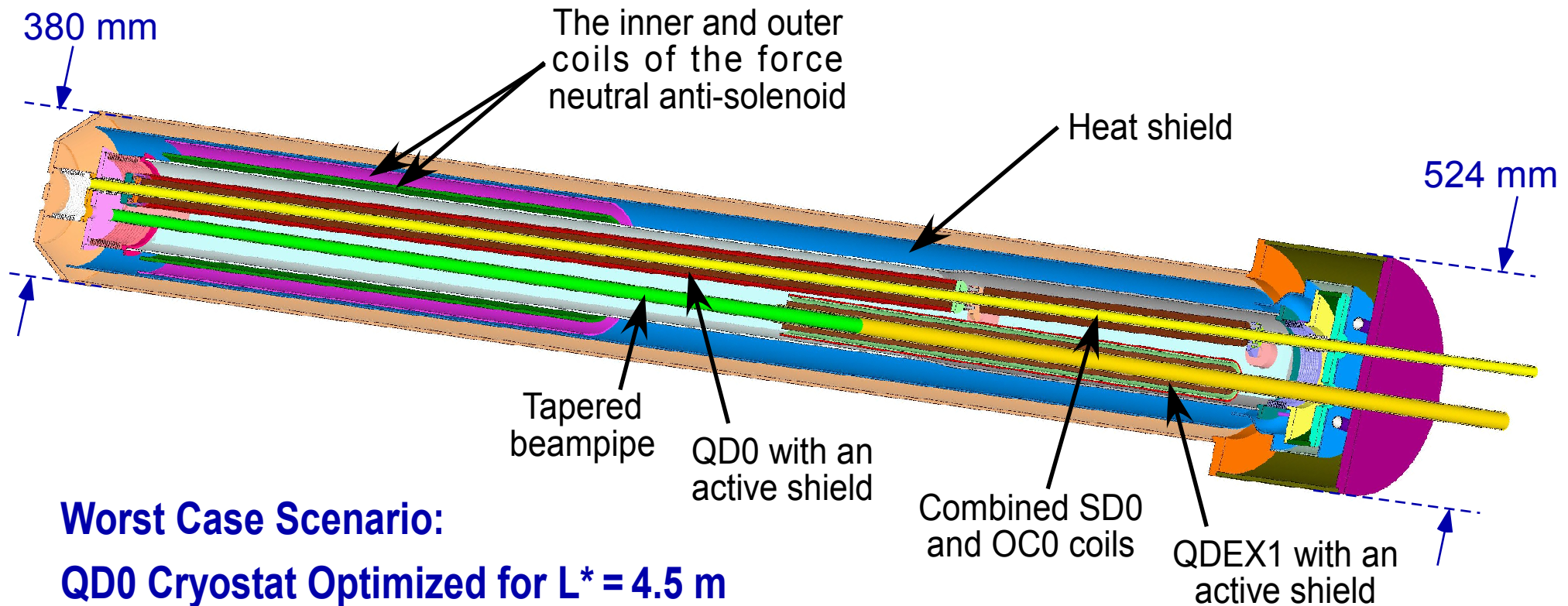
Note: we will use trim currents to fine tune the field shape for optics optimization while remaining force neutral.

This is a flexible configuration that can be adapted to various values of L*.

The force neutral anti-solenoid has very little external field, unlike the open coil first generation design.
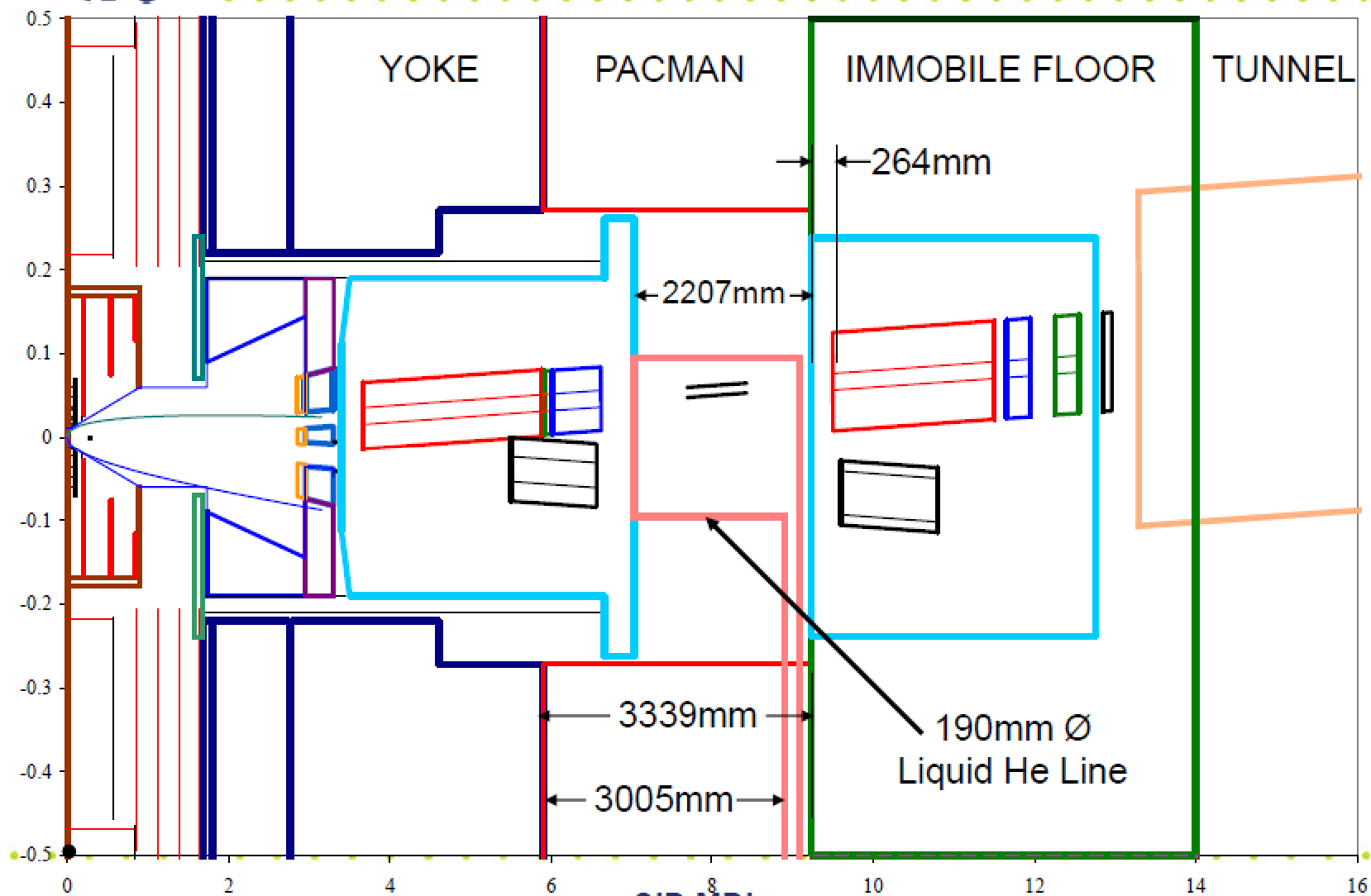
380 mm

The inner and outer coils of the force neutral anti-solenoid

Heat shield

524 mm

Tapered beampipe

QD0 with an active shield

Combined SD0 and OC0 coils

QDEX1 with an active shield

Worst Case Scenario:

QD0 Cryostat Optimized for L* = 4.5 m

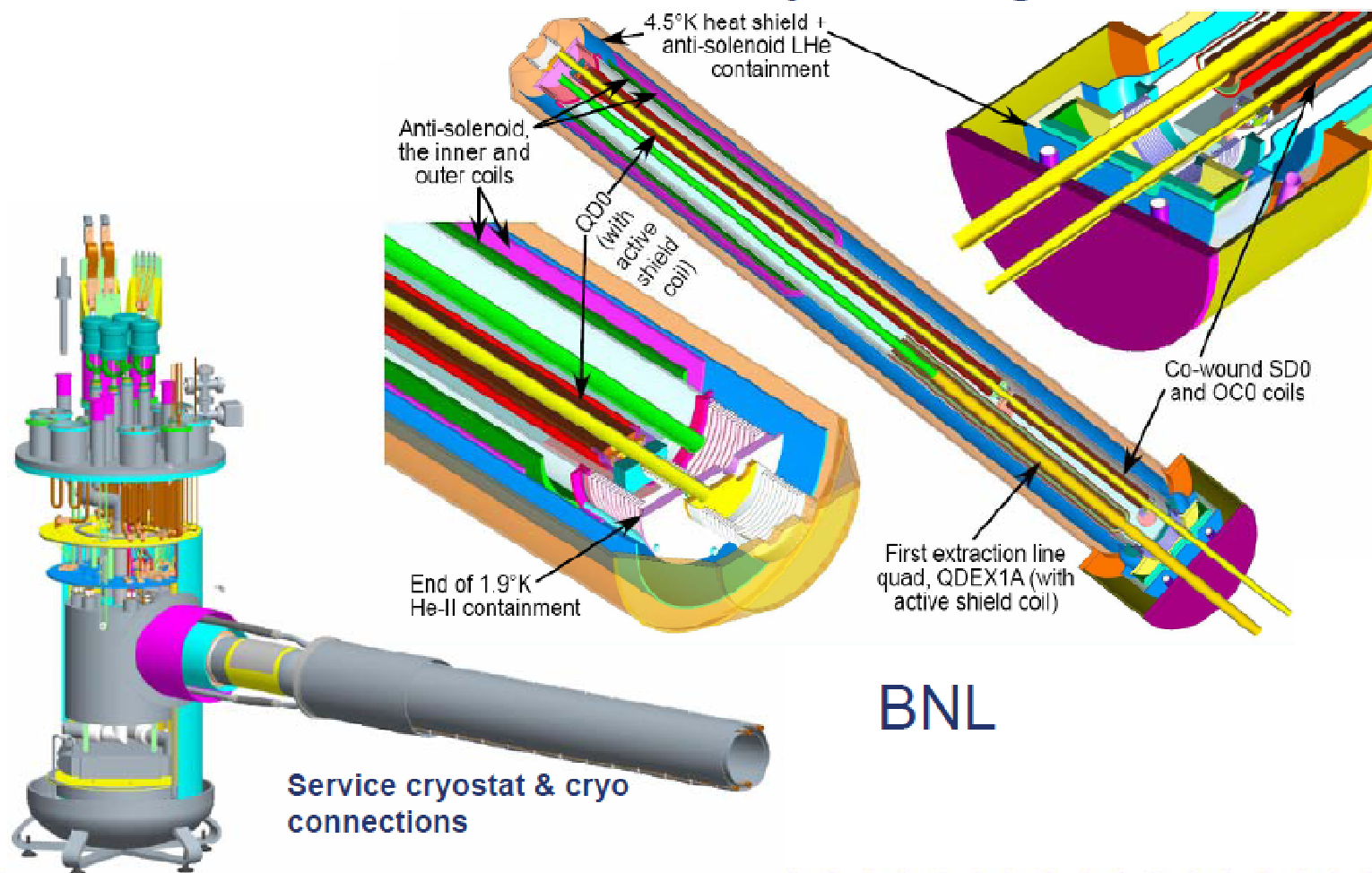# SiD r<50cm, L*=3.664m, 14mrad, Push-Pull, QF@9.5m, Door Closed

Theme: Systems Integration Issues.

FD & IR cryo design, start

4.5°K heat shield + anti-solenoid LHe containment

Anti-solenoid, the inner and outer coils

QD0 (with active shield coil)

Co-wound SD0 and OC0 coils

End of 1.9°K He-II containment

First extraction line quad, QDEX1A (with active shield coil)

BNL

Service cryostat & cryo connections

Topology proposed for push-pull to keep the path length between QD0 and the service cryostat to about 10 m...
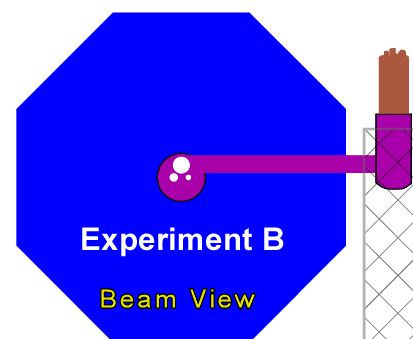
Impact on cryo of a net elevation change?

If/how each experiment opens up while at beam position?

Separate the recooler and current lead functionality?

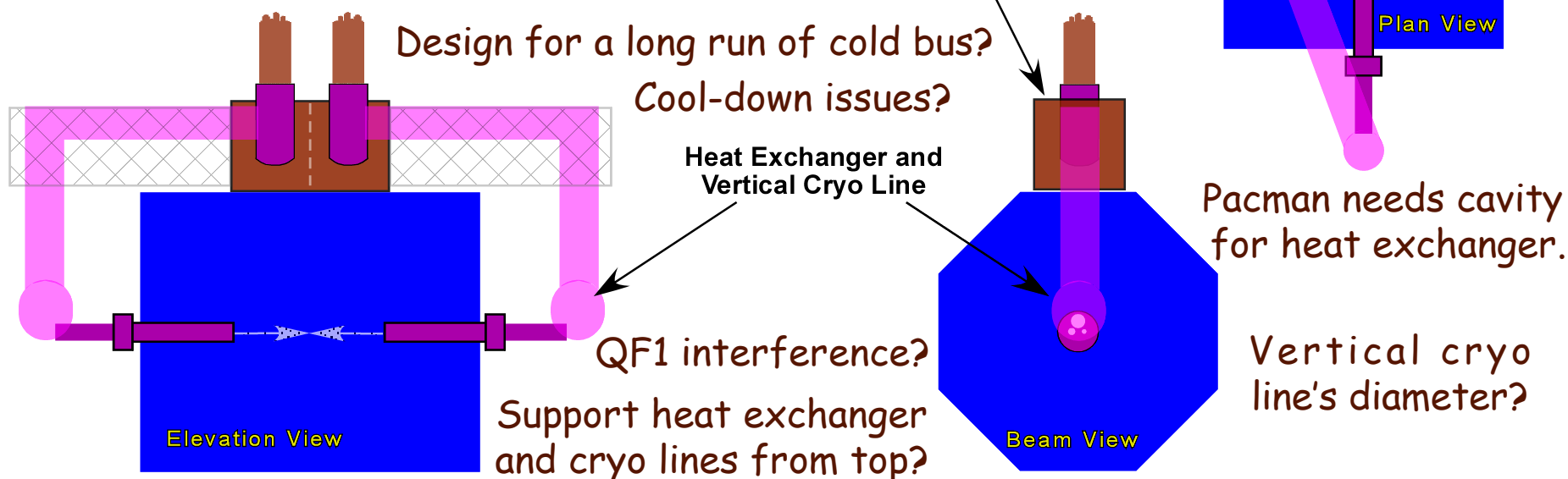Where is the interface box and connection to umbilical?

What about the pacman?

Service Cryostat

Connection Line to Service Cryostat

QD0 Cryostat

Interface Box

Experiment A

Plan View

Warm bus, vacuum and helium supply/return lines?

Interface Box

Experiment B

Experiment B

Beam View

while keeping heat exchanger's elevation close to that of QD0.

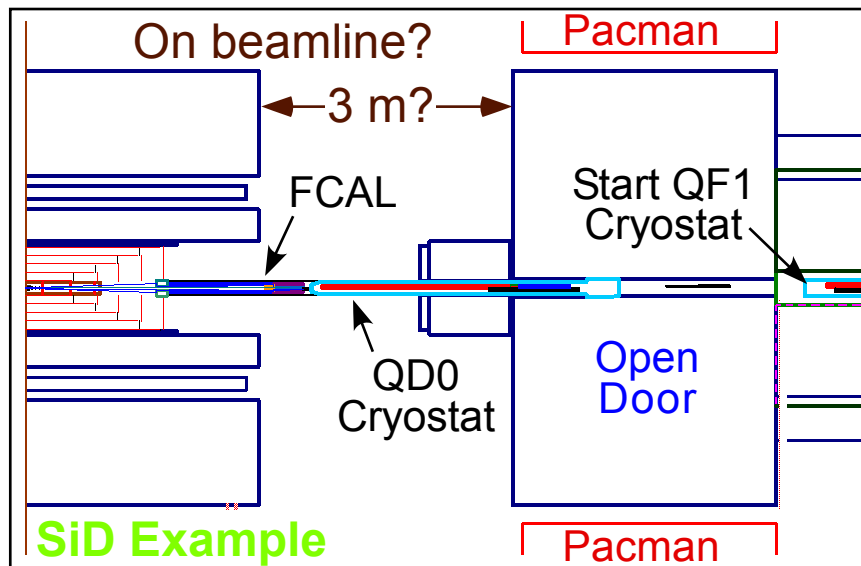# Homework Item #3': Path & Length Between QD0 and Service Cryostat.

With a different layout it may still be possible to keep the He-II heat exchanger close to the QD0 cryostat but run the cryogenic connection lines vertically so that the pacman shielding can separate horizontally instead of vertically.
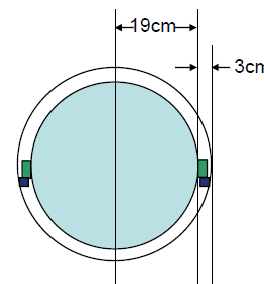
QD0 Cryostat

Control Box with Current Leads

Plan View

Design for a long run of cold bus?

Cool-down issues?

Heat Exchanger and Vertical Cryo Line

Pacman needs cavity for heat exchanger.

QF1 interference?

Support heat exchanger and cryo lines from top?

Elevation View

Beam View

Vertical cryo line's diameter?

Use "support tube," rails or something else?

On beamline?

Pacman

←— 3 m? —→

FCAL

Start QF1 Cryostat

QD0 Cryostat

Open Door

SiD Example

Pacman

Connector Bolts(?)

FCAL

QD0

Door

2cm x 4cm x 5m Support Bar

19cm

3cm
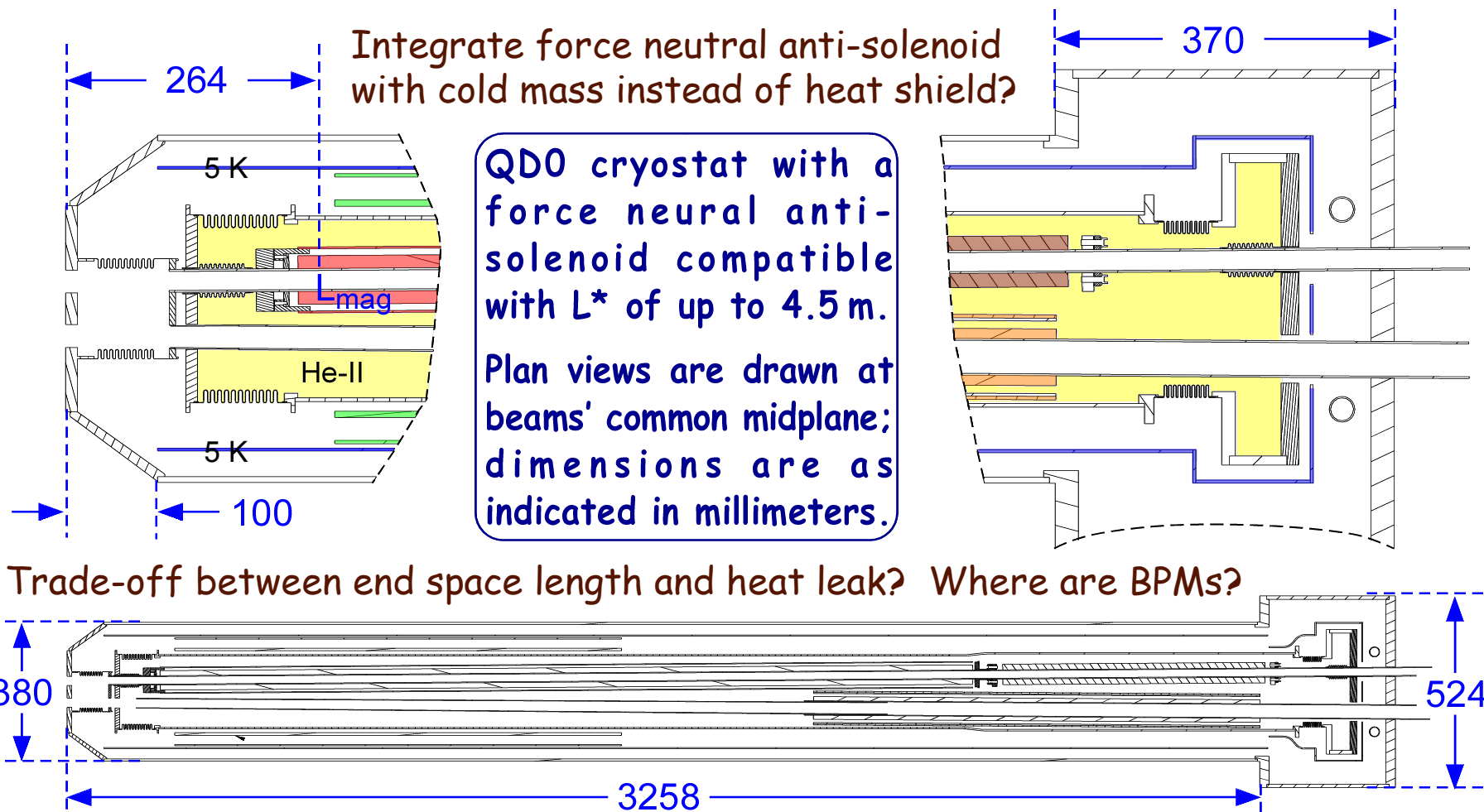
Door opens longitudinally or has a vertical split?

Interference with QF1, transfer line, pacman or service cryostat during access?
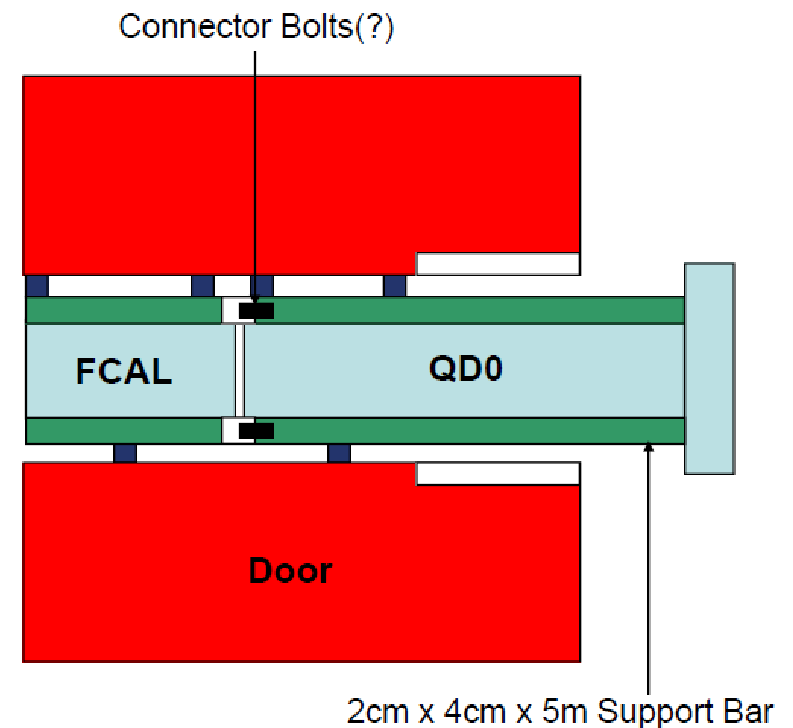
264

Integrate force neutral anti-solenoid with cold mass instead of heat shield?

370

5 K

Lmag

He-II

5 K

100

QD0 cryostat with a force neural anti-solenoid compatible with L* of up to 4.5 m.

Plan views are drawn at beams' common midplane; dimensions are as indicated in millimeters.

Trade-off between end space length and heat leak? Where are BPMs?

380

524

3258
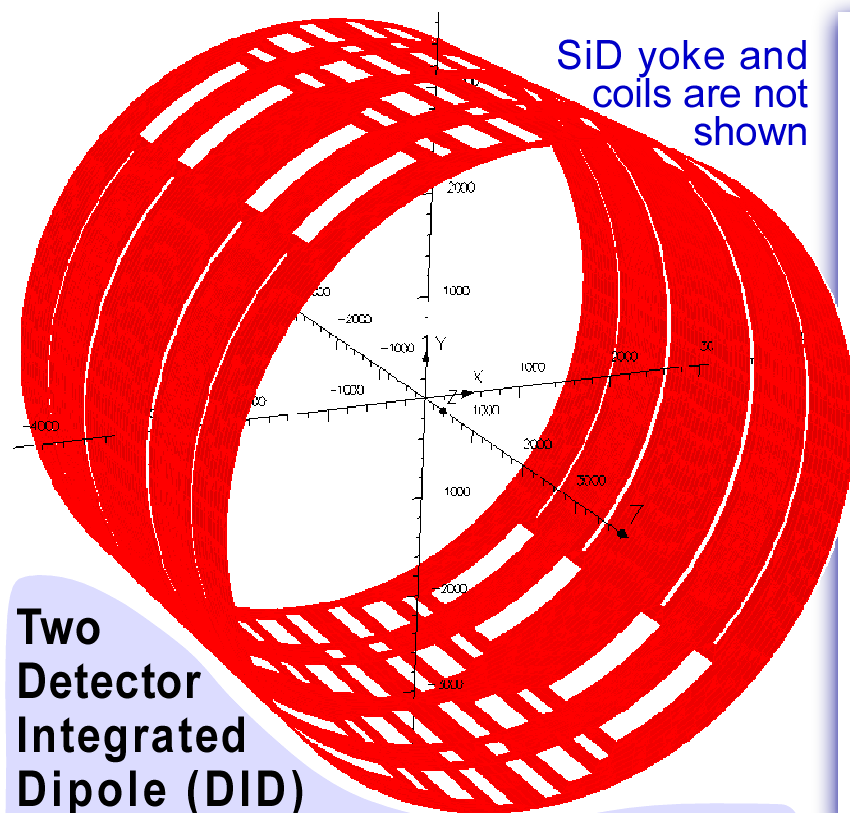
What is L*? Can all experiments agree upon the same L*? Use two different L*s?

Minimum cryostat diameter depends upon L*; worst case scenario, 4.5m is shown.

Digression... work is also in progress designing the anti-DID coil.

SiD yoke and coils are not shown

Result with simplified SiD yoke

Field from two opposing DID coils seen at detector axis

Bx (T)

IP

DID Coils & SiD Yoke (Solenoid Not Shown)

(mm)

Two Detector Integrated Dipole (DID) coils can be used to improve the field uniformity near the IP (important for TPC based detectors).
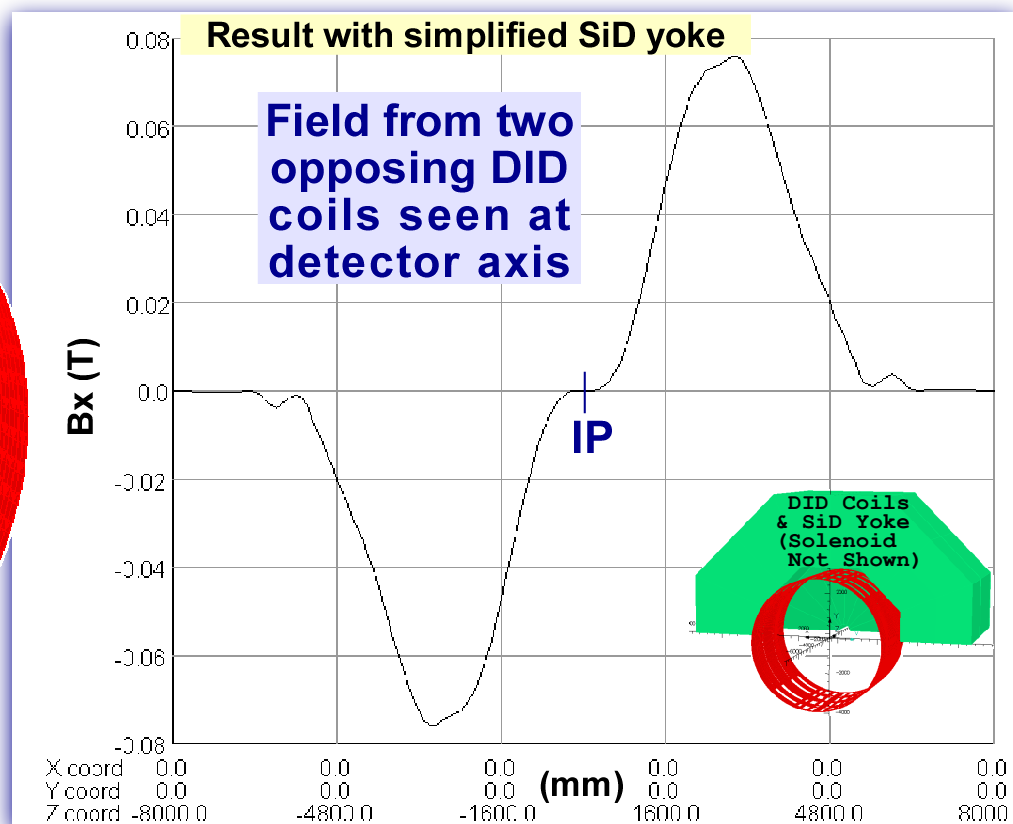
Long Term Goal: Generate field maps for the anti-solenoid and anti-DID for each detector concept.

Homework Item #7: All Detector Concepts!
Backgrounds & Magnet Energy Deposition.

Experiments are especially concerned with computing (minimizing) detector backgrounds. For the magnet system we need to understand the expected level of energy deposition in magnets.
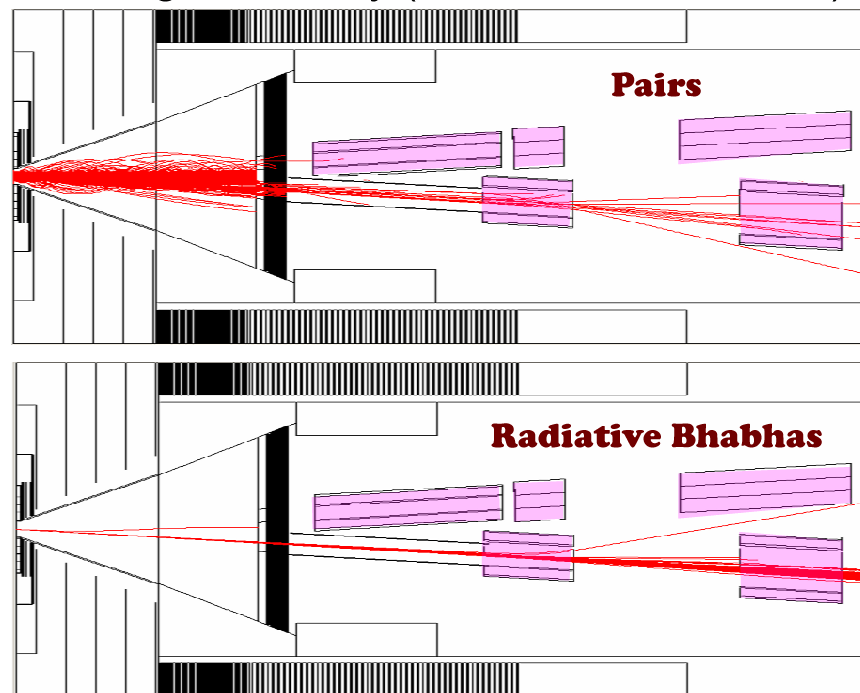
Optimized (anti)-DID field profile?

    Optimized anti-solenoid field profile?

Get ED results from tracking?

What about beam tuning or abnormal operating conditions? What are "safe" (but not too conservative) ED budgets?
(see Homework Item #2)

Pairs and Radiative Bhabhas in 14 mrad Crossing Geometry (interaction turned off).

Pairs

Radiative Bhabhas

"Detector Background Update for L*=3.51 m, L*(ext)=5.5m," Takashi Maruyama, BDS Weekly Meeting at SLAC.

Right now I (BP) can generate sample field profiles for the DID and anti-solenoid but to go further we need agreed upon requirements for each detector concept. Maintaining multiple L*s and layouts does increase the work to be done.
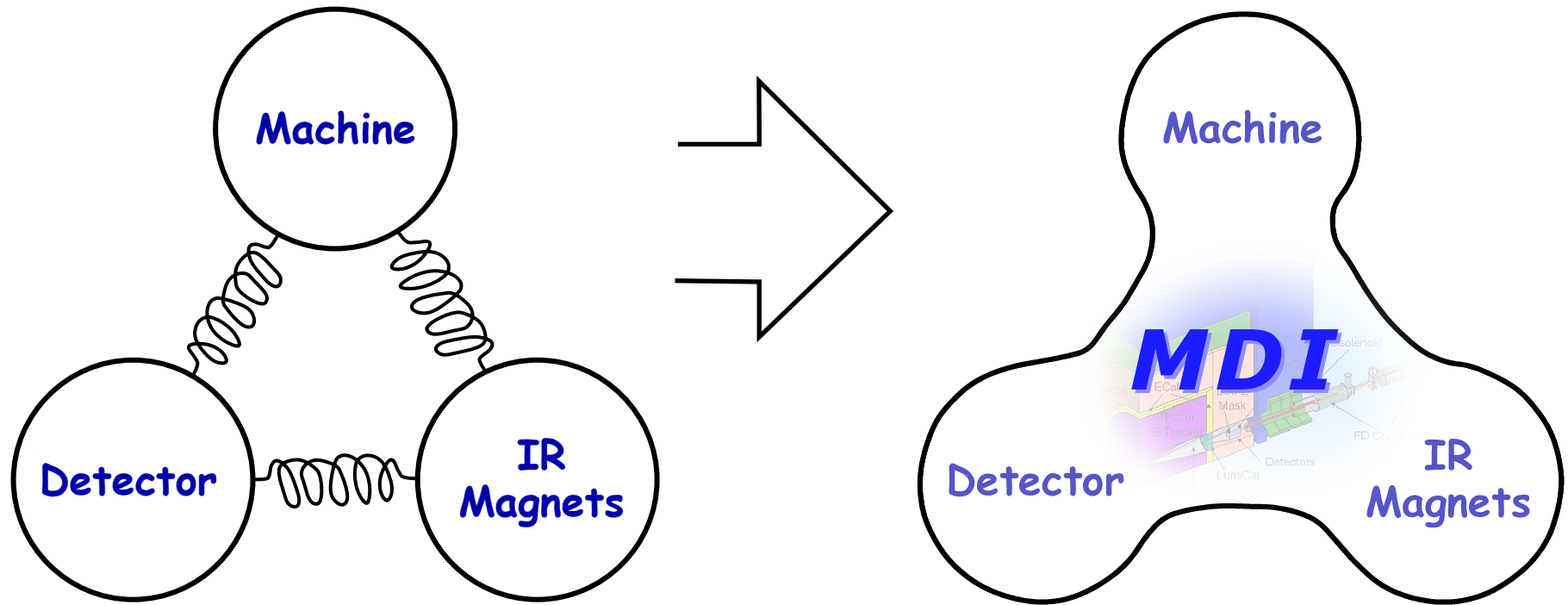
True systems integration is barely underway.

Workshop on ILC Interaction Region Engineering Design
SLAC, September 17-21, 2007

Thank you for your attention. - B. Parker

And a very big personal thank you to DESY for providing such a wonderful environment for LCWS'07 work.