

MDI

Machine

detector

interface

© Rey. Horí

Summary of MDI sessions

Tsunehiko OMORI(KEK)

LCWS06

tune-up

out-p

specillm.

13-Mar-2006 IISc Bangalore

We have 4 Sessions in total

2 Sessions GDE + WWS

2 Sessions WWS only

GDE + WWS : 2 sessions

1st Session(Mar/10): Overview

MDI Overview

IR Design for GLD

IR Design for LDC

IR Design for SiD

Discussions

Andrei Seryi

Tosiaki Tauchi

Karsten Buesser

Phil Burrows

2nd Session(Mar/11): Discussions

MDI for $\gamma\gamma$ Option

Overview: Klaus Moenig & V. Telnov

Discussions

1 IR vs 2 IR

Overview: Tom Markiewicz

Discussions

Detector Background Tolerance

Overview: Kasten Buesser

Discussions

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3rd Session(Mar/12): Lum Energy Pol + Forward Region + Detector Calib.

End station A R&D program

Energy Spectrometry (End station A)

Fast and precise Luminosity meas.

Systematic limitations to luminosity

BeamCal Veto performance for different ILC parameter sets

Physics Data for Detector Calibration at Ecm=91&500 GeV

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V. Drugakov

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4th Session(Mar12): Beam Diagnosis + Backgrounds + Experiments

The ATF laser wire system

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Stimulated Breit-Wheeler process as a source of background...

Particle tracking and beam losses in a 20 mrad extraction line...

Energy depositions in the extraction line for 2, 14, and 20 mrad

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Study on Low-Energy Positron Polarimetry

ILC Pol. e+ Source :E-166 Results (+ATF-Compton results)

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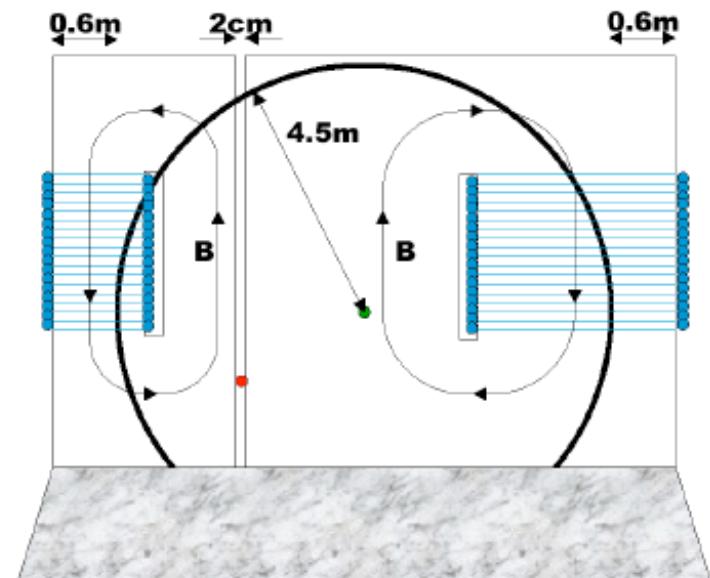
Detector Background Tolerance

Overview: Kasten Buesser

Discussions

- Muon walls and detector tolerance to muons
- Low E positron transport in BDS
- IR layout and radiation physics
- Concepts of upgrade to gg and back to e+e-
- Extraction lines & linac orientation
- Updates on IR magnet designs
- Updates on crab cavity developments
- Missing bends and E upgrade

BCD: two walls, 9m and 18m per branch, to reduce muon flux to less than 10muons/200bunches if collimate 0.001 of the beam



Tolerances in Detectors

Table 1: Tolerances for background in VTX, TPC and CAL.

Sources :	pairs	disrupted beams/pairs	beam halo
Detector	Hits	Neutrons	Muons
VTX	1×10^4 hits/cm ² /train	1×10^{10} n/cm ² /year	-
TPC	4.92×10^5 hits/50μsec	4×10^4 n*/50μsec	1.2×10^3 μ/50μsec
CAL	1×10^{-4} hits/cm ³ /100nsec	-	0.03 μ/m ² /100nsec

→ 1μ/30m²/bunch

* : The neutron conversion efficiency is assumed to be 100% in the TPC.

1 hit in TPC consists of 5 pads(1mmx6mm) × 5 buckets(50nsec)

A muon creates 1 pad × 2000 buckets in parallel to the beam line.

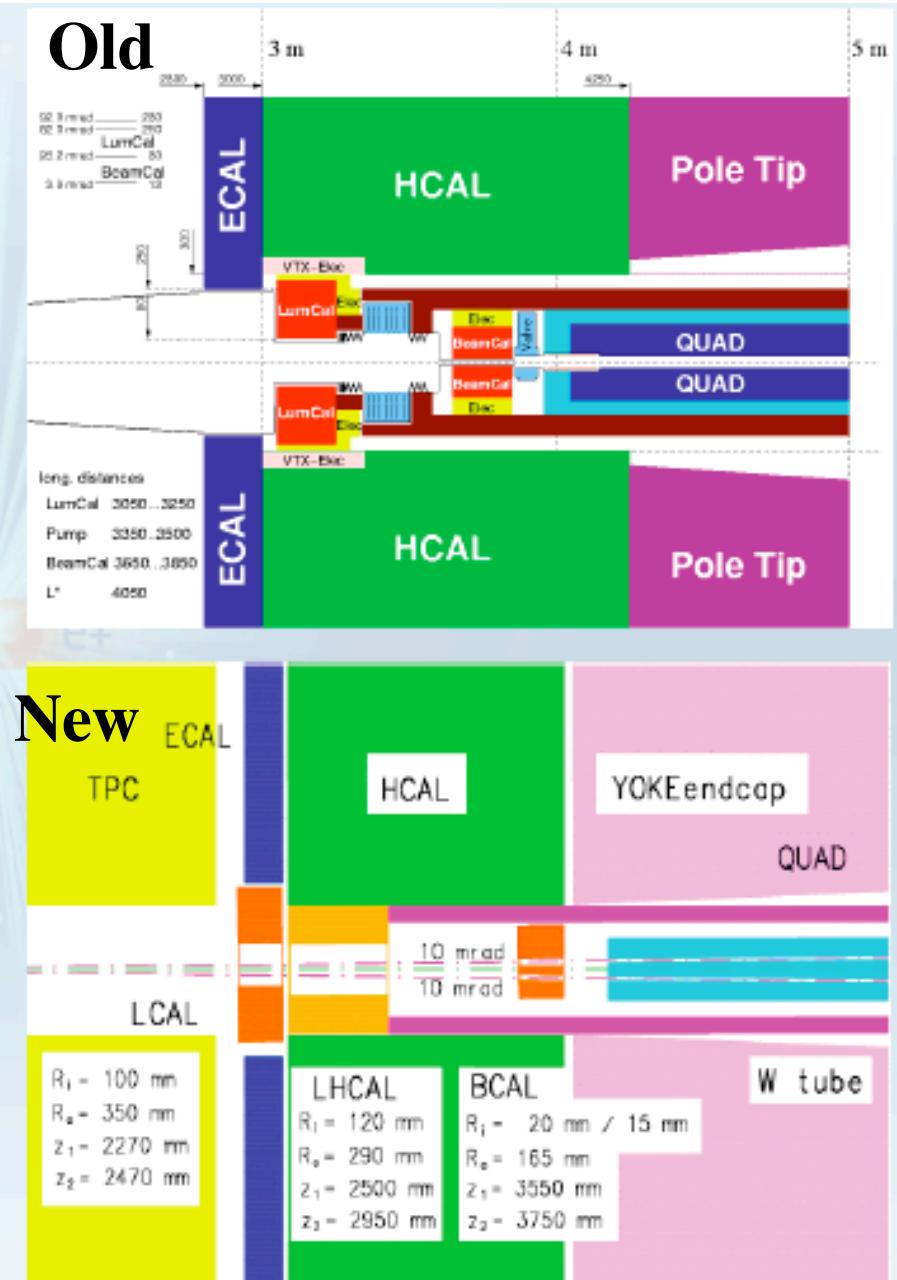
A neutron creates 10 hits in TPC.

Note : 0.005μ/bunch by two “tunnel fillers”
 → 0.8μ/150bunches

The 9 and 15m long spoilers at 660 and 350m from IP reduces muons by 10⁻⁴

Changes in Forward Reagion

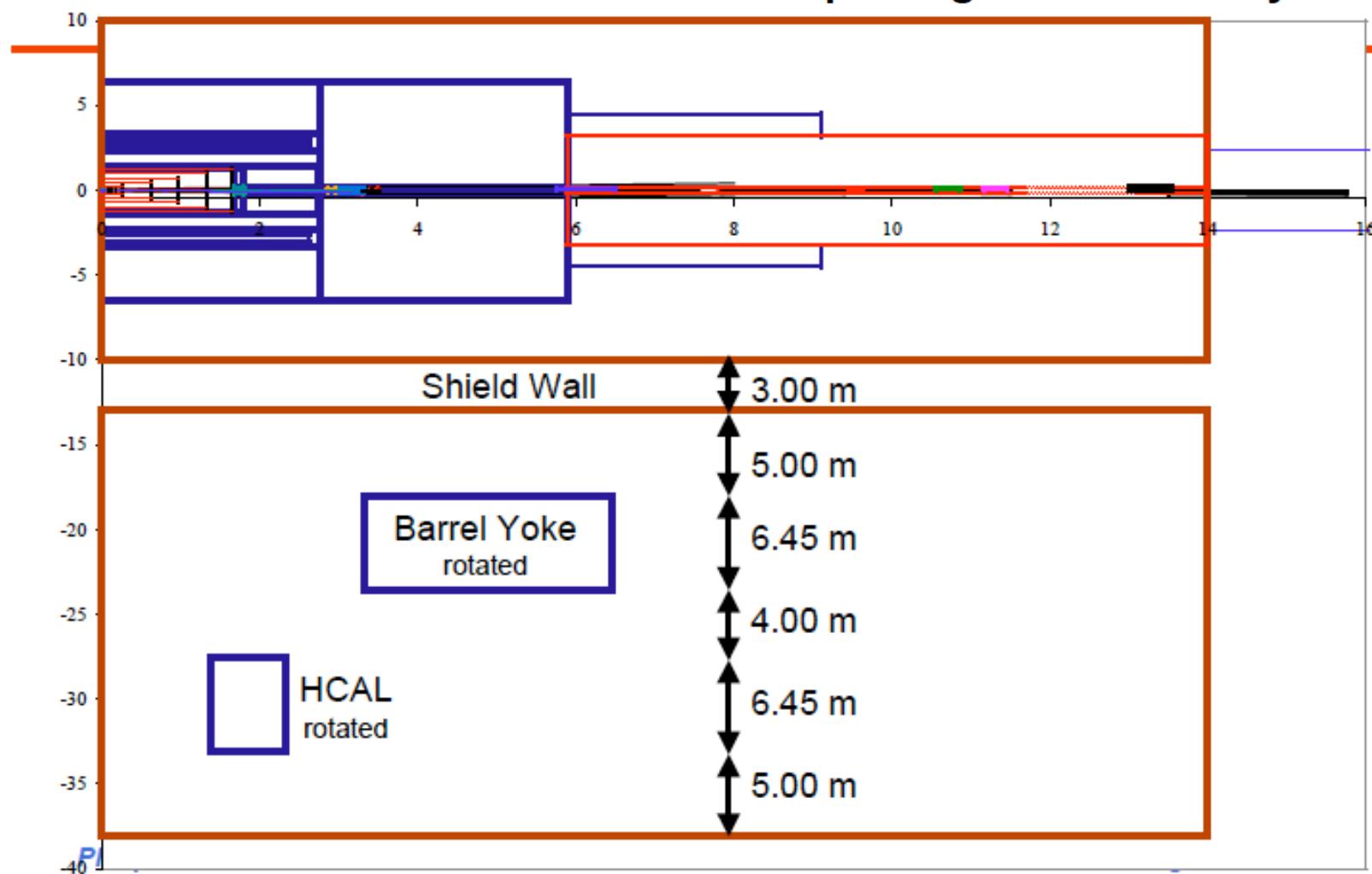
- L^* unchanged at 4.05 m
- LumiCal moves to ECAL front
→ Additional effect from the shortened TPC!
- BeamCal stays close to quad
- Increased space between LumiCal and BeamCal should absorb backscattering from BeamCal better
- LumiHCAL increases hermeticity for hadronic calorimetry
- Better detector opening concept
- Acceptance hole between ECAL and LumiCal needs attention



Barrel shortened -> Hall 82x30m

- **RDR cost driver:**
detector footprint
IR hall size + layout

- On-beamline configuration:
closed-up for beam running
open for access
- Assembly space
ground area for assembly/installation
pit height for assembly



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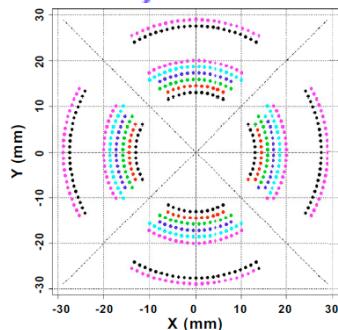
Discussion points

- When do we decide to go to $\gamma\gamma$?
- Does it make any sense in a 1IP scenario?
- Is it realistic to go back to e^+e^- in the $\gamma\gamma$ IP?
- What is the switchover time for the IP, the linac?
- Can we really use the same detector?

V. Telnov

X-angle

Principle design of the superconducting quad (B.Parker), only coils are shown (two quads with opposite direction of the field inside each other). The radius of the quad with the cryostat is about 5 cm.



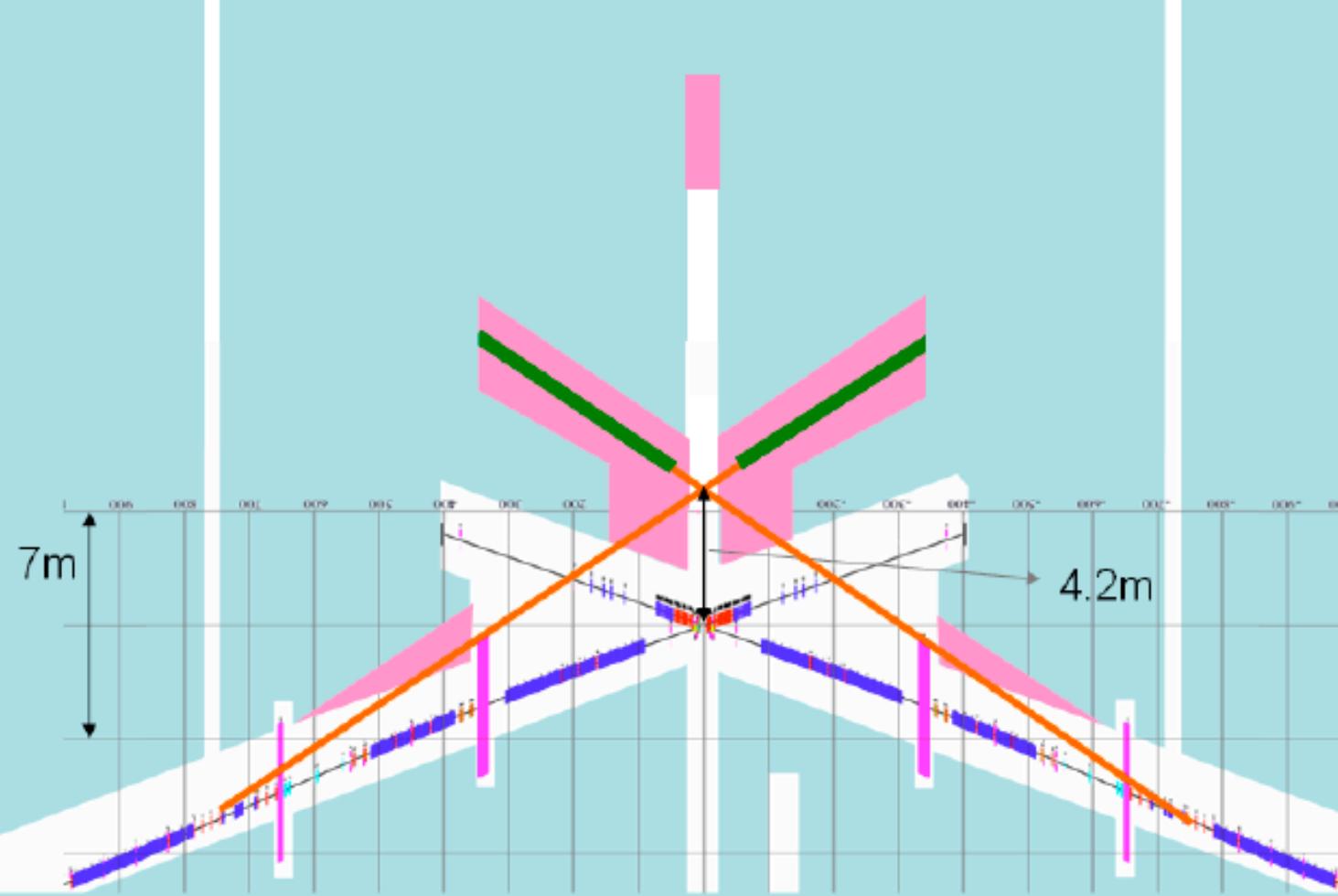
$$\begin{aligned} \text{X-angle} &= e^+e^- \text{ X-angle} + (10-14) \text{ mrad} \\ &= 25 \text{ mrad (or more)} \end{aligned}$$

How to go to $\gamma\gamma$ from e^+e^-

an example by Andrei

14mr => 25mr

Cost?
Technical Feasibility?



One IR Layout Issues

General Questions

- How to specify a one IR re-baseline this year that does not alienate either the 0-2mrad community, the 14-20mrad community or the $\gamma\gamma$ community?
- What is involved in designing one IR for two push-pull detectors?
- For any configuration (1 IR or 2 IRs or 1 push/pull IR), how do we specify the size, infrastructure facilities, etc. for costing purposes, given 4 detector concepts:
 - most demanding, least demanding, average ?

Discussions

Baseline 2 IRs & 2 Detectors

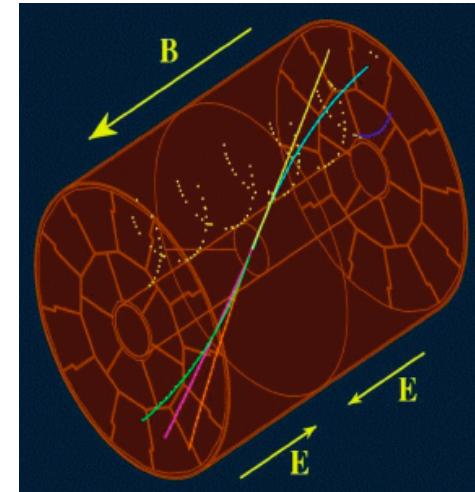
If Change is Necessary?

**Discussion & Decision should be done with
both
Physics/Detector community
&
GDE(Accelerator)
under
the leadership of ILCSC**

- Usually integral background numbers are given
- These can be compared to integral tolerance limits:

Background distributions are often not uniform!

- Background hits produce positively charged ions in the TPC gas which drift very slowly



- We probably need studies with **realistic background distributions** and **realistic reconstruction algorithms** (particle flow)

WWS only: 2 sessions

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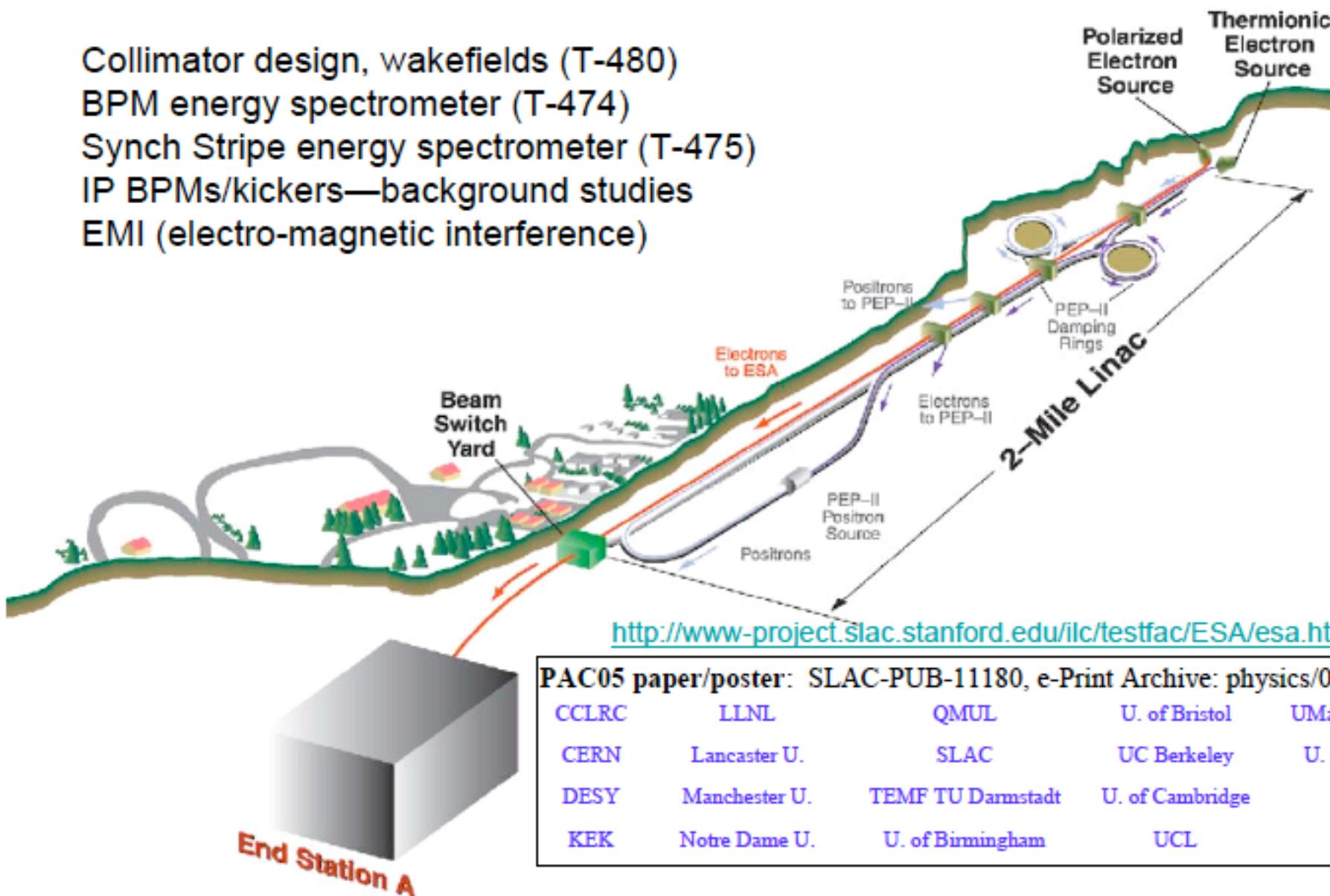
Paul Coe

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K. Laihem

ILC Beam Tests in End Station A

Collimator design, wakefields (T-480)
BPM energy spectrometer (T-474)
Synch Stripe energy spectrometer (T-475)
IP BPMs/kickers—background studies
EMI (electro-magnetic interference)



PAC05 paper/poster: SLAC-PUB-11180, e-Print Archive: physics/0505171

CCLRC	LLNL	QMUL	U. of Bristol	UMass Amherst
CERN	Lancaster U.	SLAC	UC Berkeley	U. of Oregon
DESY	Manchester U.	TEMF TU Darmstadt	U. of Cambridge	
KEK	Notre Dame U.	U. of Birmingham	UCL	

Tom Markiewicz/M. Wood

End Station A Energy Spectrometers

T-474 BPM Energy Spectrometer:

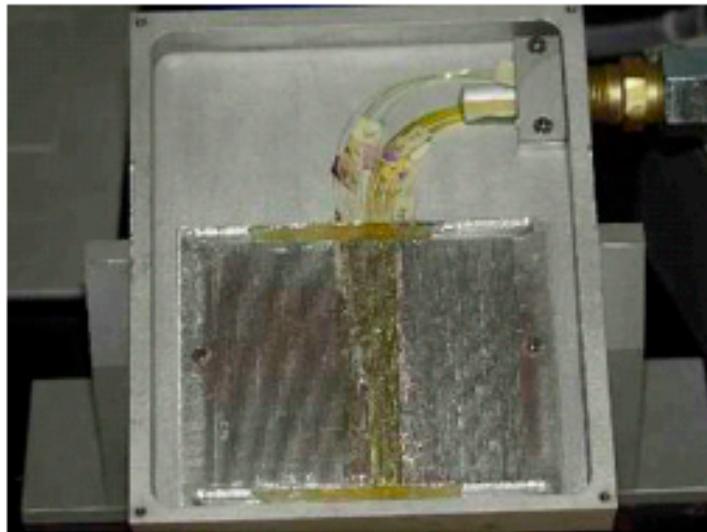
PIs: Mike Hildreth (U. of Notre Dame) & Stewart Boogert (RHUL, UK)

Collaborating Institutions: U. of Cambridge, Royal Holloway, SLAC, UC Berkeley, UC London, U. of Notre Dame

T-475 Synchrotron Stripe Energy Spectrometer:

PI: Eric Torrence (U. of Oregon)

Collaborating Institutions: SLAC, U. of Oregon

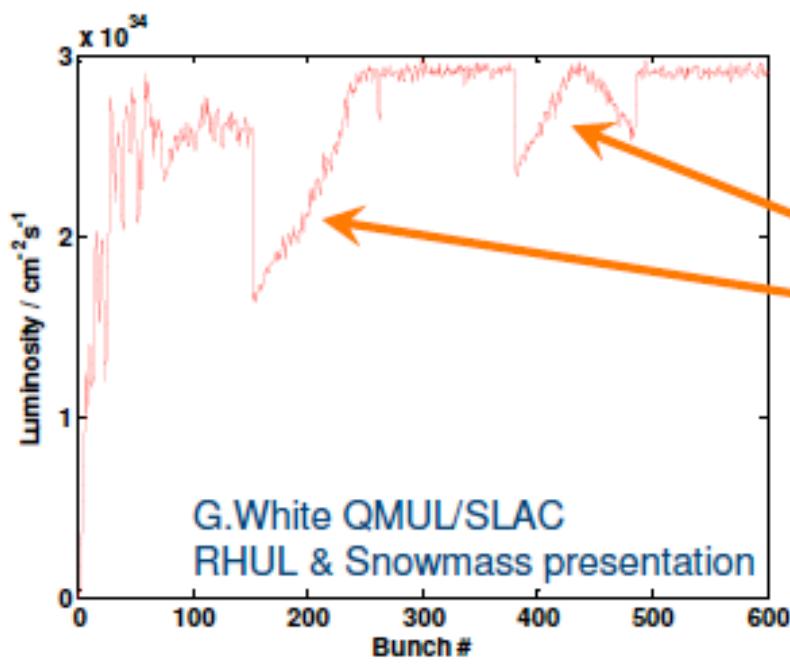


Prototype quartz fiber detector:

8 100-micron fibers + 8 600-micron fibers
w/ multi-anode PMT readout

Fast and Precise Luminosity Measurement at the ILC

- Why we need a fast signal from the BeamCal?
- We can significantly improve L !
- e.g. include number of pairs hitting BeamCal in the feedback system



Improves L by more than 12% (500GeV)!

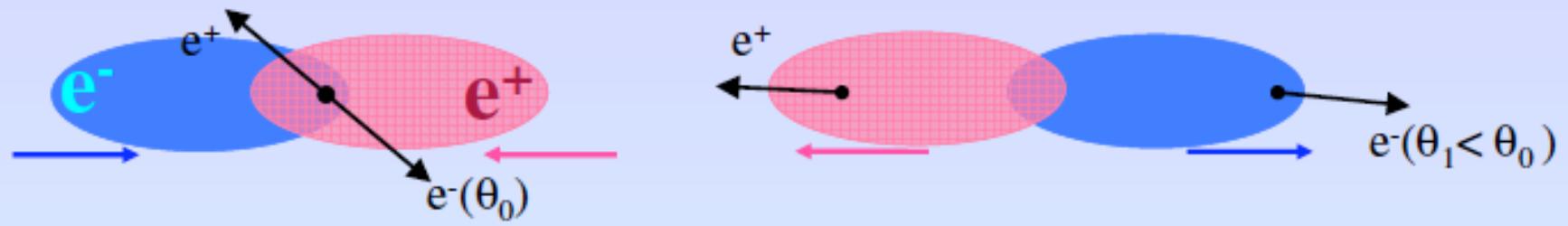
position and angle scan

Luminosity development during first 600 bunches of a bunch-train.
$$L_{\text{total}} = L(1-600) + L(550-600) * (2820-600) / 50$$

Systematic limitations to luminosity determination in the LumiCal acceptance from beam-beam effects

Bhabha scattering & electromagnetic deflections *Modification of final state*

Deflection of Bhabhas due to the field of the opposite beam



V. Drugakov

BeamCal Veto performance at different ILC parameter sets

$L = 500 \text{ fb}^{-1}$

Number of SUSY events ~ 20

Number of unvetoed 2-photon events:

Veto Energy Cut, GeV	75	50
Nominal	45	5
Low Q	40	0.1
Large Y	50	9
Low P	364	321
Nominal, 20mrad	396	349

Physics Data for Detector Calibration

at Ecm = 91 & 500 GeV

Are Z0 Calibration Runs Necessary?

--> may not be necessary

- How many particles are available for calibration from running at Ecm=500 GeV?
 - There are many processes with very large cross-sections at Ecm=500 GeV:

$$e^+ e^- \rightarrow e\nu W, eeZ, \gamma Z$$

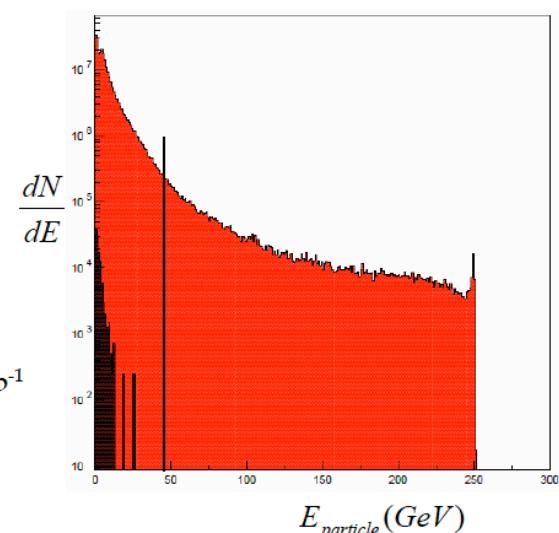
$$\gamma e \rightarrow \nu W, eZ$$



Ecm= 500 GeV All SM Processes 100 fb⁻¹

Ecm= 91 GeV Z → qq, μμ 1 fb⁻¹

Muons



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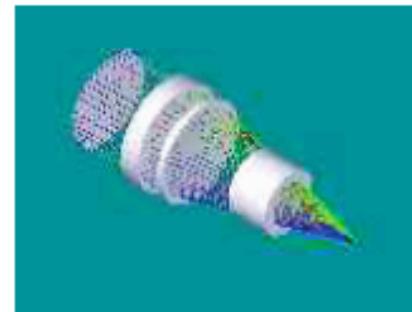
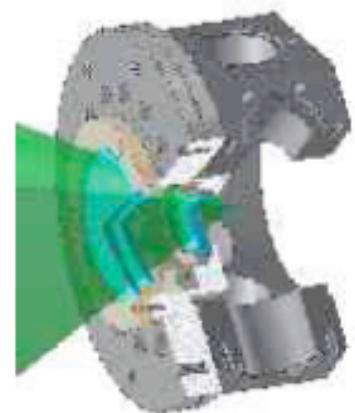
K. Laihem



Nicola

The ATF extraction line laser-wire

- Collaboration KEK/UK/SLAC
- Goal: achieve a resolution of ~1 micrometer
- Infrastructures installed last September
- Trying to have the two beams aligned vertically
=> need more diagnostic tools
- First scan expected by the end of the year



Laser system for ILC diagnostics

The laser system has to be an master oscillator followed by power amplifier/s (MOPA)

Laser oscillator choice:

A conventional mode-locked Nd:YLF (1047 nm/1053nm) or Nd: YAG (1064 nm) laser

A mode-locked fiber laser (1047/1053/1064 nm)

Laser Amplifier choice:

High power diode pumped Nd:YLF or Nd:YAG

Choice on 2nd harmonic crystal : LBO/BBO (250 nm – 500 nm)

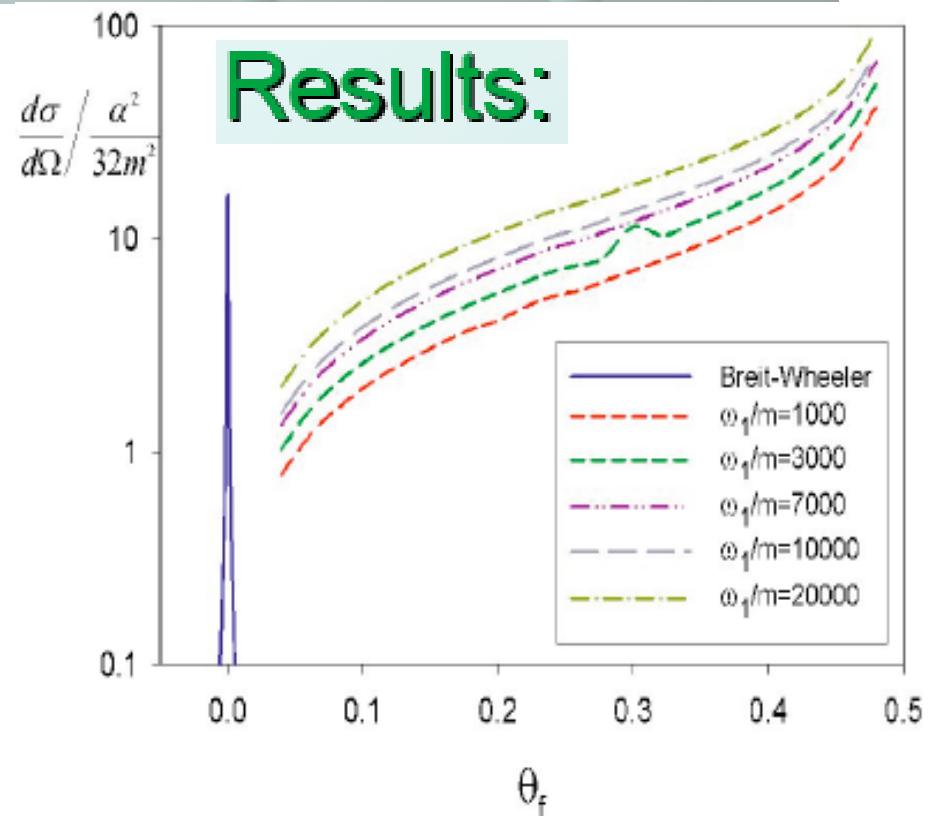
Attractiveness of Fiber laser baser oscillator-preamplifier systems

High quality beams: Diffraction limited divergence, excellent beam profiles, very low pointing jitter, pulse-width – from 100 fs to 10 ps, rep. Rate = KHz to 10s of MHz

Stimulated Breit-Wheeler process as a source of background pairs

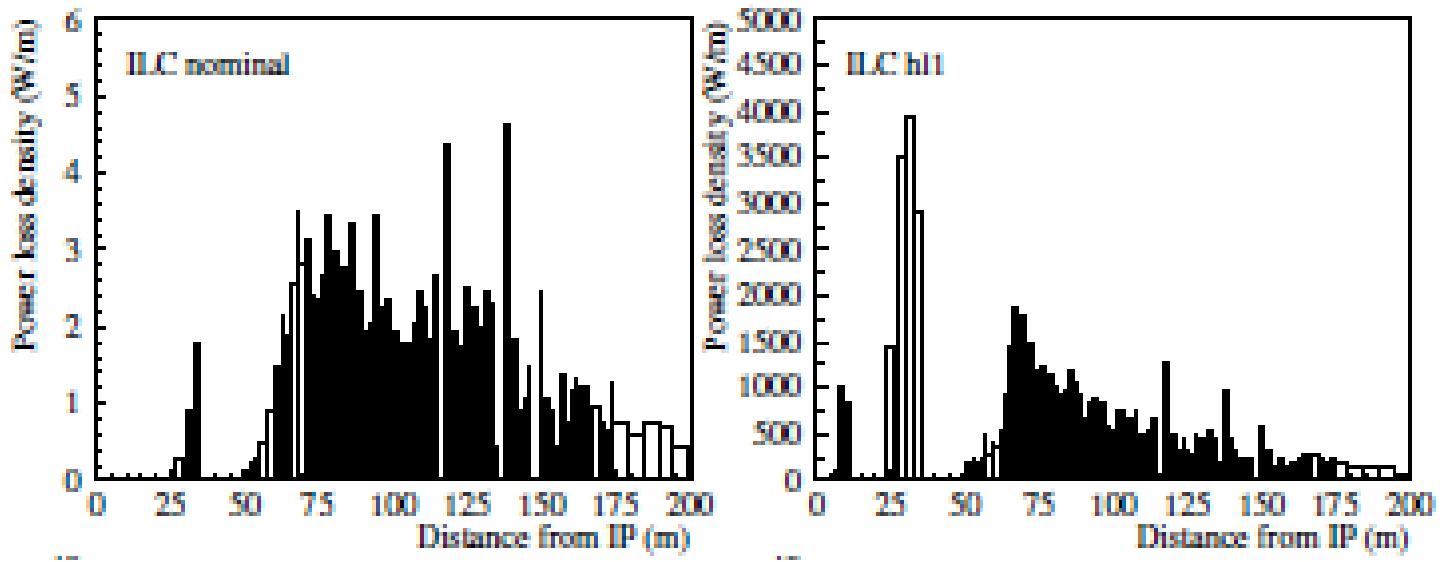
- Have the effect of intense beam fields been fully taken into account?
 - 1st order coherent pair production fully covered but 2nd order not
 - Why consider 2nd order coherent pair production?
- Resonances in the 2nd order IFQED processes
 - Moller process – Oleinik (1967), Bos et al (1979), Panek et al (2003)
 - Stimulated Breit-Wheeler in CIRCULARLY POLARISED field
 - Self Energy calculations in an external field

Stimulated Breit-Wheeler (Resonant)



Particle tracking and beam losses in the ILC 20 mrad extraction line

DIMAD



- In the nominal ILC configuration, the power losses seem to be acceptable. Also, the recently proposed ILC hl2 and hl3 configurations for reaching high luminosity should lead to acceptable losses. On the other hand, the power losses become too large in the ILC hl1 and CLIC configurations.

Extraction Line Power Losses for 2, 14 and 20 mrad designs

BDSIM,
GMAD,
Mokka

14mrad Losses - Charged Beam & Tail

		0.5 TeV Nom.	0.5 TeV Nom.	0.5 TeV High Lumi.	0.5 TeV High Lumi.
Total Ext. Power		11.03e6	10.89e6	10.53e6	10.18e6
Vert. Offset [nm]		0	200	0	120
Power Loss [W]	ECOL1	1.14 ± 0.62	2946 ± 45.5	38.0k ± 0.6k	1.01M ± 10.6k
	ECOL2	1007 ± 77.5	27.1k ± 0.7k	233k ± 3.5k	856k ± 8.0k
	ECOL3	527 ± 80.4	1863 ± 150	41.6k ± 1.0k	46.0k ± 0.8k
Max E-Loss Density [W/m]	SC Quads	0 < 0.11	0 < 0.11	0.92 ± 0.20	1.32 ± 1.32
	Warm Quads	0 < 0.13	0 < 0.13	28.5 ± 1.19	156 ± 16.0
	Bends	0 < 0.27	0.05 ± 0.05	27.8 ± 1.18	589 ± 36.7
Main Beam		640k	640k	625k	-
Tail		2 x 10k	2 x 25k	2 x 450k	2 x 500k

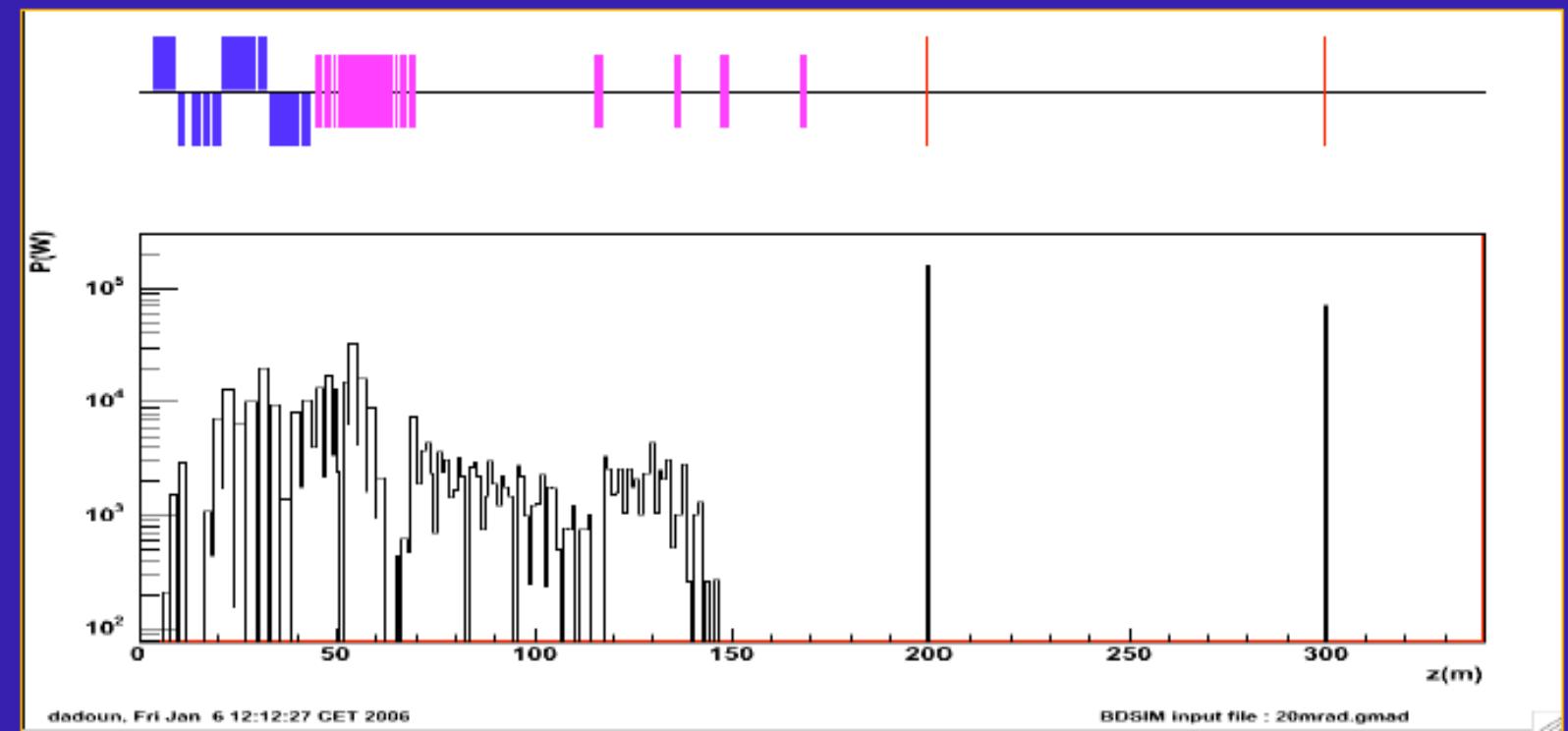
- The results show that more optimisation of the optics may be required for the extraction lines to be able to handle all the parameter sets.

Towards estimating backgrounds from beam losses along the ILC extraction line

Power losses : 20mrad extraction

Beam parameters:

High luminosity 1TeV e.c.m, 80 nm offset, $P \sim 18$ MW



Final doublet layouts and power densities for small crossing angle IR layouts

New magnet technology

- Re-optimisations will exploit higher gradients of new SC magnets

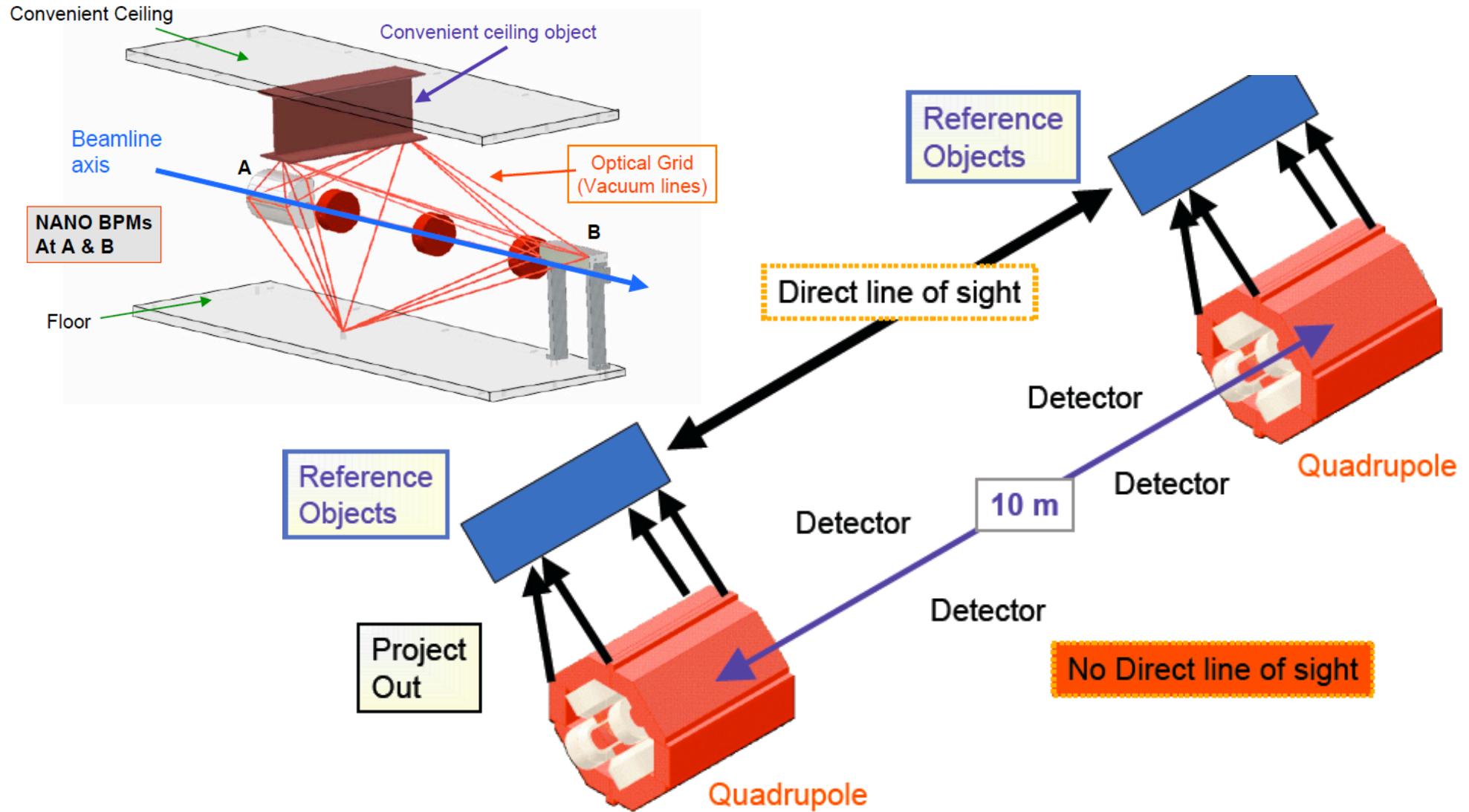
NbTi 500 GeV machine doublet

- The optimised machine parameters for 500 GeV CoM give a much shorter QD0. The beam power losses are then (in W):

Beam	QD0	SD0	QF1	SF1
Low P (cb)	0	0	0	0
Low P (rb)	0.05	0.1	0	0
High L (cb)	0	4.1	11.6	0
High L (rb)	0.13	0.25	0.13	0

The stabilisation of the final focus (StaFF) system

Example nano-BPMs at KEK / ATF



Compton Transmission polarimeter (employed in E166 and ATF) Principle

- ▶ reconversion of positrons to photons in Bremsstrahlung target
- ▶ transmission of photons in magnetized iron polarization dependent

Bhabha/Møller polarimeter

Principle

A. V. Grigoriev et al., EPAC-2004-THPLT106.

G. Alexander and I. Cohen, Nucl. Instrum. Meth. A 486 (2002) 552.

- ▶ scattering of positrons/electrons in a thin magnetized iron foil

Synchrotron radiation

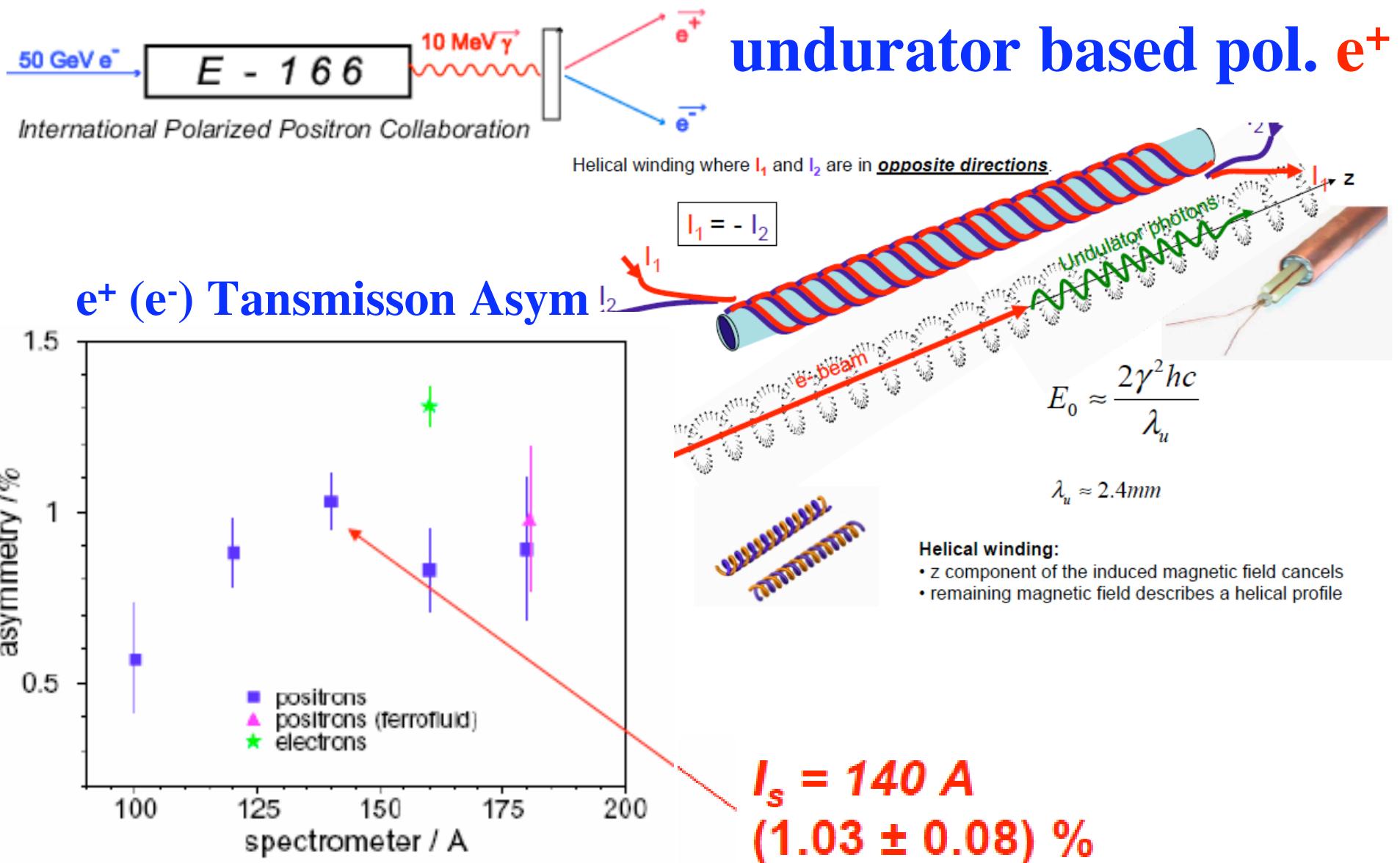
S. A. Belomestnykh et al., Nucl. Instrum. Meth. A 227

Principle

- ▶ transverse polarization needed
- ▶ angular asymmetries of synchrotron radiation in damping ring

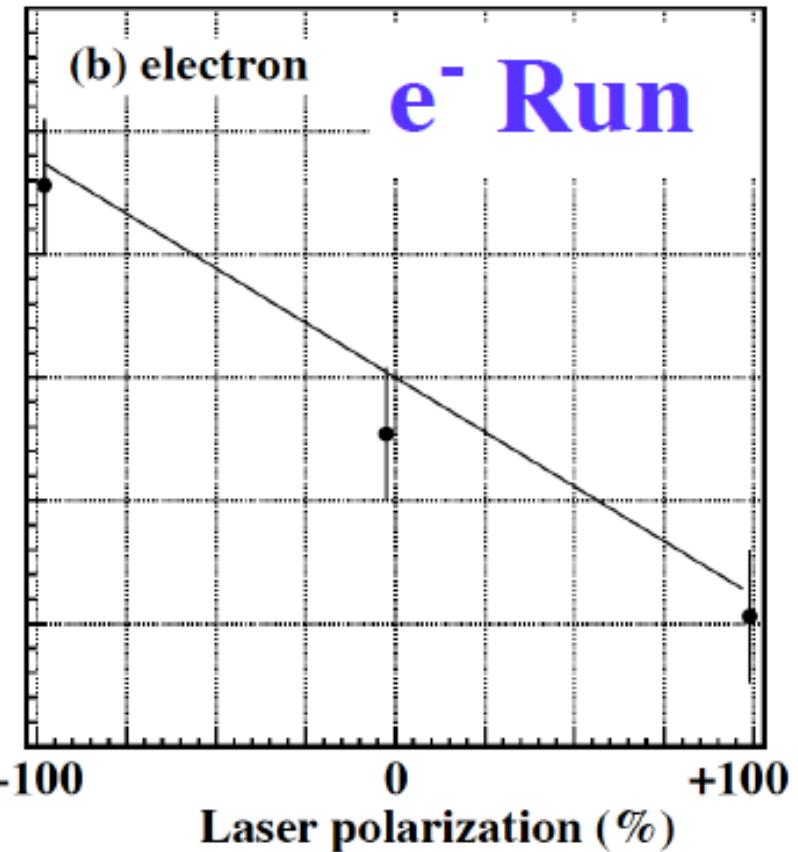
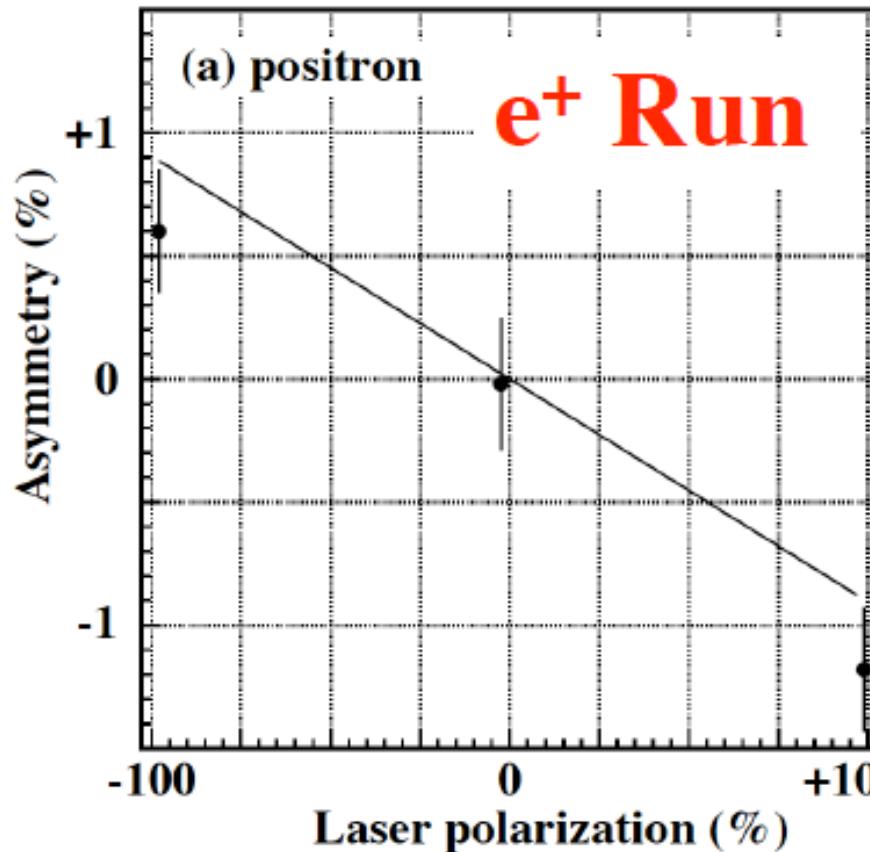
The E166 experiment

Development of a polarized positron source for the ILC.



Summary of e⁺ Run and e⁻ Run

T. Omori et al., arXiv:hep-ex/0508026 PRL accepted



$$\text{abs. } A = 0.90 \pm 0.18\%$$

$$Pe^+ = 73 \pm 15(\text{sta}) \pm 19(\text{sys})$$

$$\text{abs. } A = 0.89 \pm 0.19\%$$

$$Pe^- = 72 \pm 15(\text{sta}) \pm 19(\text{sys})$$

MDI Summary

Discussions

$\gamma\gamma$ option

2 IRs vs 1 IR

Reports

Many Progresses:

**Forward Detector, Background, Beam Delivery,
Detector Background Tolerance, Detector Hall,
Endcap Open/Close, Detector Assembly,
Power Deposit, Beam Diagnosis, Fast Feedback,
Position Stabilization, Luminosity Measurement,
Veto Efficiency, Polarimetry, Pol e⁺, , ,**