

# MDI Machine Interface

MDI detector

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Summary of MDI sessions

Tsunehiko OMORI (KEK)

LCWS06

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**

# WWS only: 2 sessions

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

End station A R&D program	T. Markiewicz
Energy Spectrometry (End station A)	T. Markiewicz
Fast and precise Luminosity meas.	C. Grah
Systematic limitations to luminosity	C. Rimbault
BeamCal Veto performance for different ILC parameter sets	V. Drugakov
Physics Data for Detector Calibration at Ecm=91&500 GeV	T. Barklow
... total 6 talks	

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

The ATF laser wire system	N. Delerue
Laser requirements	S. Dixit
Stimulated Breit-Wheeler process as a source of background...	T. Hartin
Particle tracking and beam losses in a 20 mrad extraction line...	A. Ferrari
Energy depositions in the extraction line for 2, 14, and 20 mrad	G. Blair/Carter/Ilya
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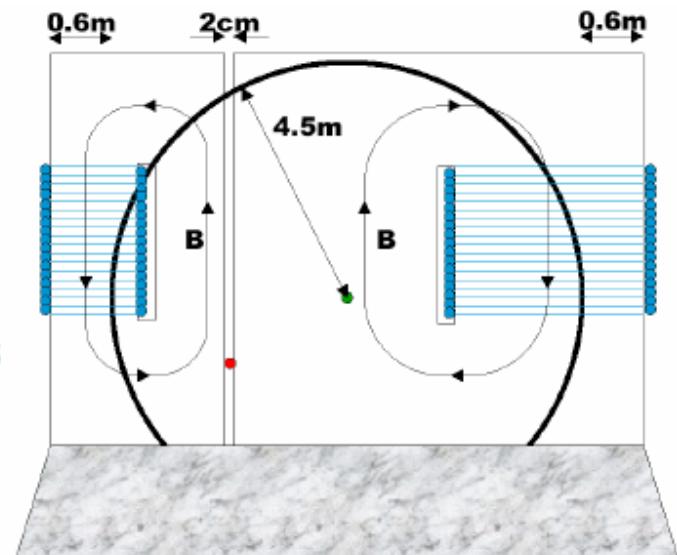
**Detector Background Tolerance**

**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	$1 \times 10^4$ hits/cm <sup>2</sup> /train	$1 \times 10^{10}$ n/cm <sup>2</sup> /year	-
TPC	$4.92 \times 10^5$ hits/50μsec	$4 \times 10^4$ n*/50μsec	$1.2 \times 10^3 \mu$ /50μsec
CAL	$1 \times 10^{-4}$ hits/cm <sup>3</sup> /100nsec	-	$0.03 \mu$ /m <sup>2</sup> /100nsec

→  $1\mu/30\text{m}^2/\text{bunch}$

\* : 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 :  $0.005\mu/\text{bunch}$  by two “tunnel fillers”**

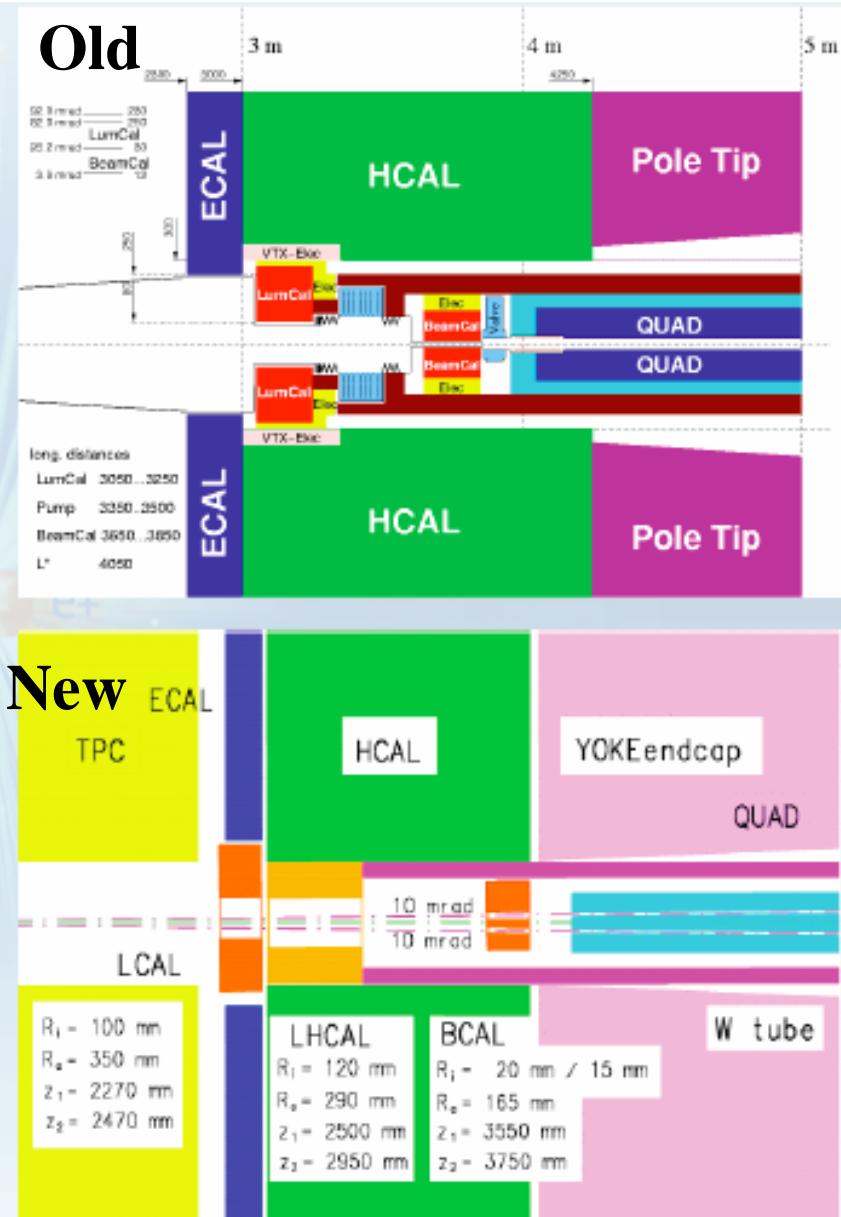
→  $0.8\mu/150\text{bunches}$

The 9 and 15m long spoilers at 660 and 350m from IP reduces muons by  $10^{-4}$

## Changes in Forward Reagion

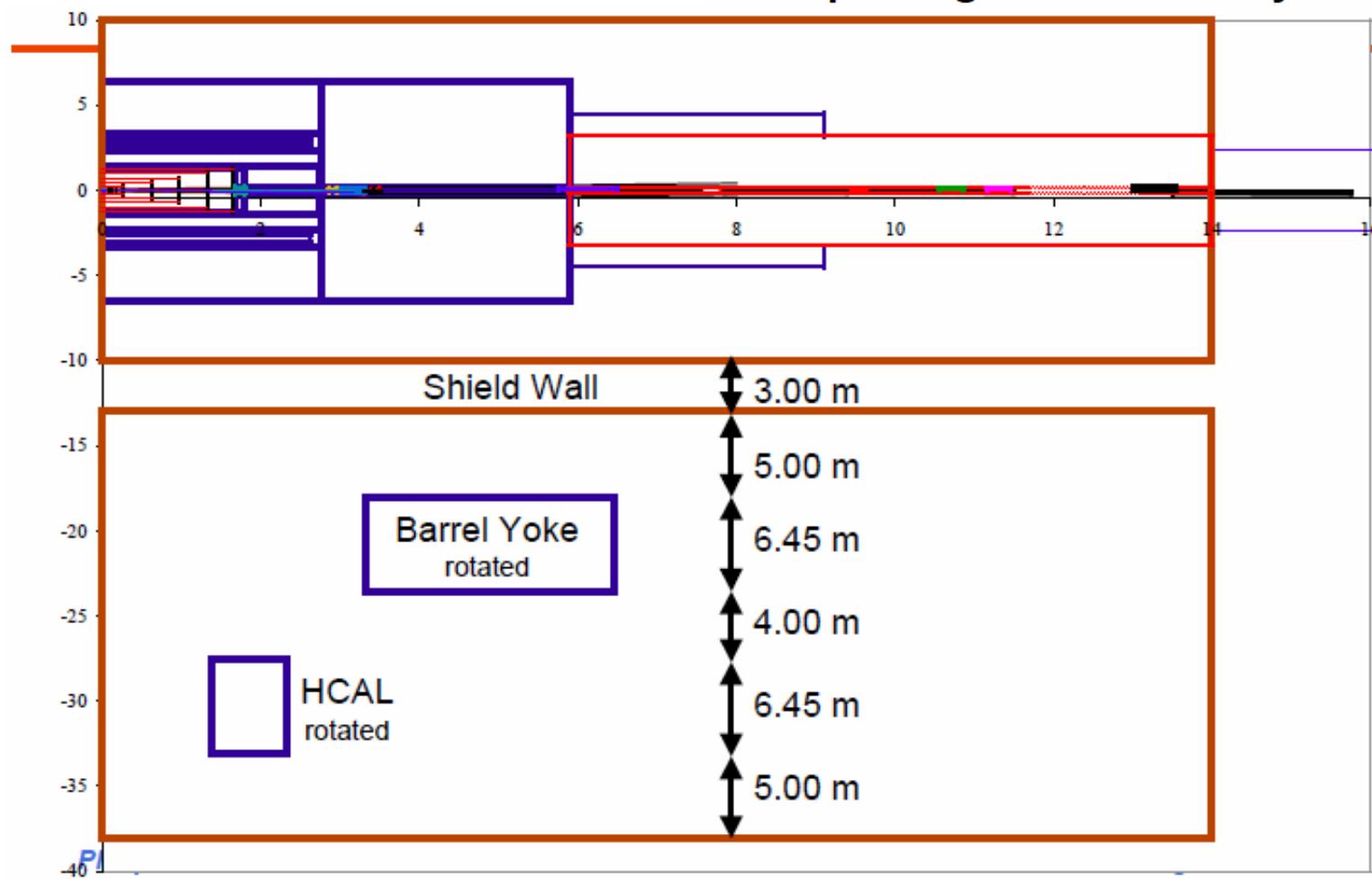
- $L^*$  unchanged at 4.05 m
- LumiCal moves to ECAL front
  - Additional effect from the shortened TPC!
- BeamCal stays close to quad
- Increased space between LumiCal and BeamCal should absorb backscattering from BeamCal better
- LumiHCAL increases hermeticity for hadronic calorimetry
- Better detector 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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K. Moenig

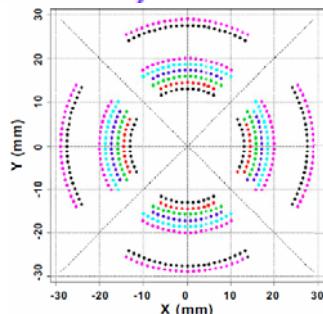
**Discussion points**

- 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.



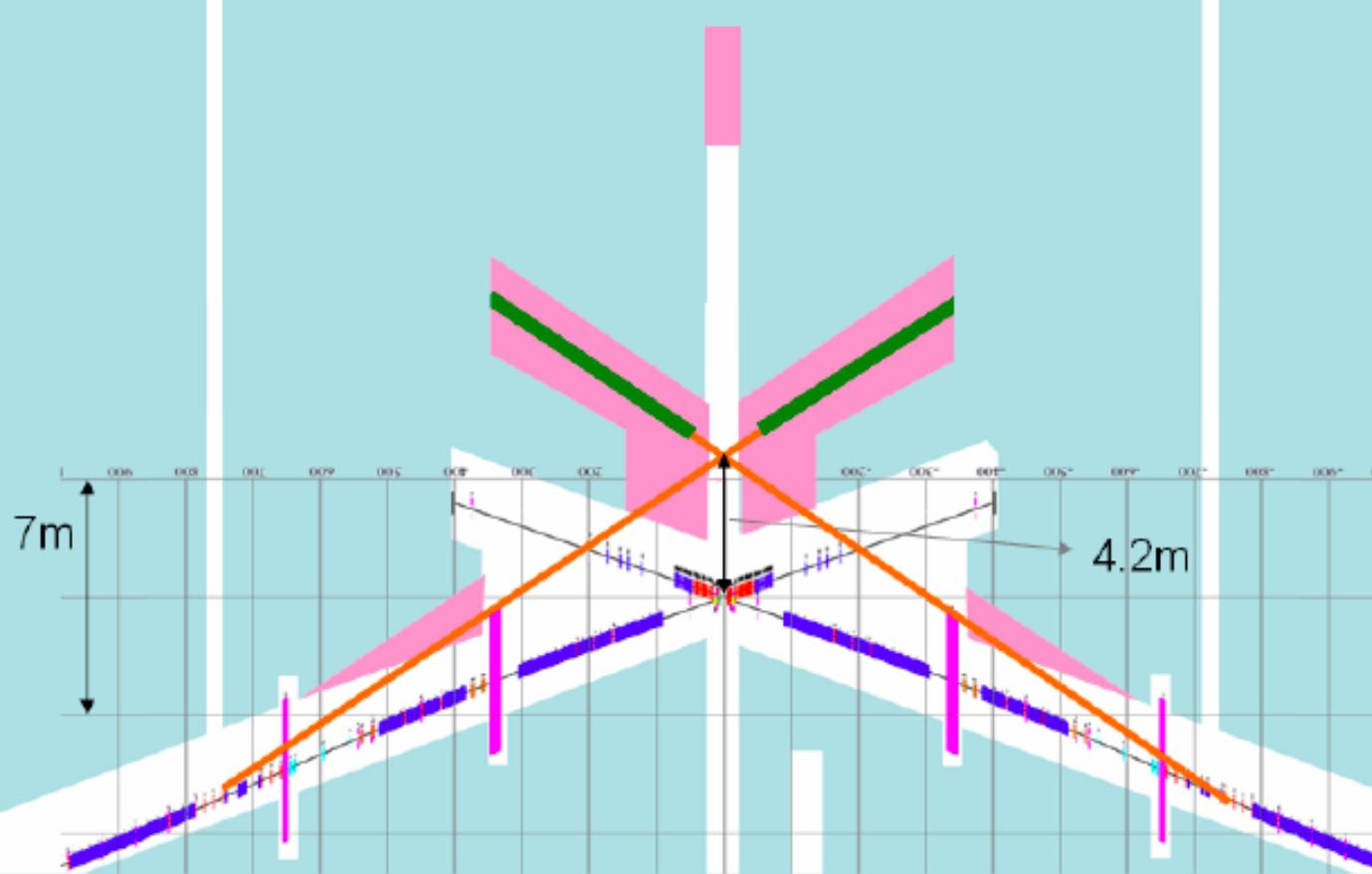
$$\begin{aligned} \textbf{X-angle} &= e^+e^- \text{-angle} + (10-14) \text{ mrad} \\ &= 25 \text{ mrad (or more)} \end{aligned}$$

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**

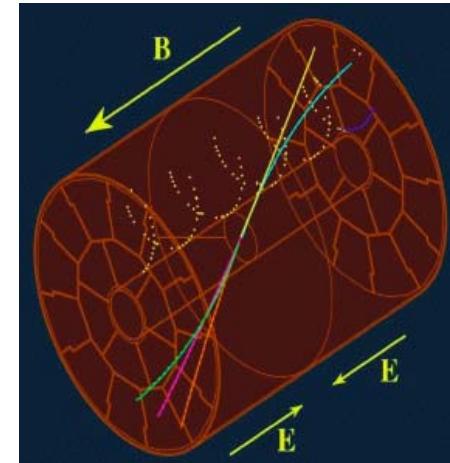
**If Change is Necessary?**

**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)

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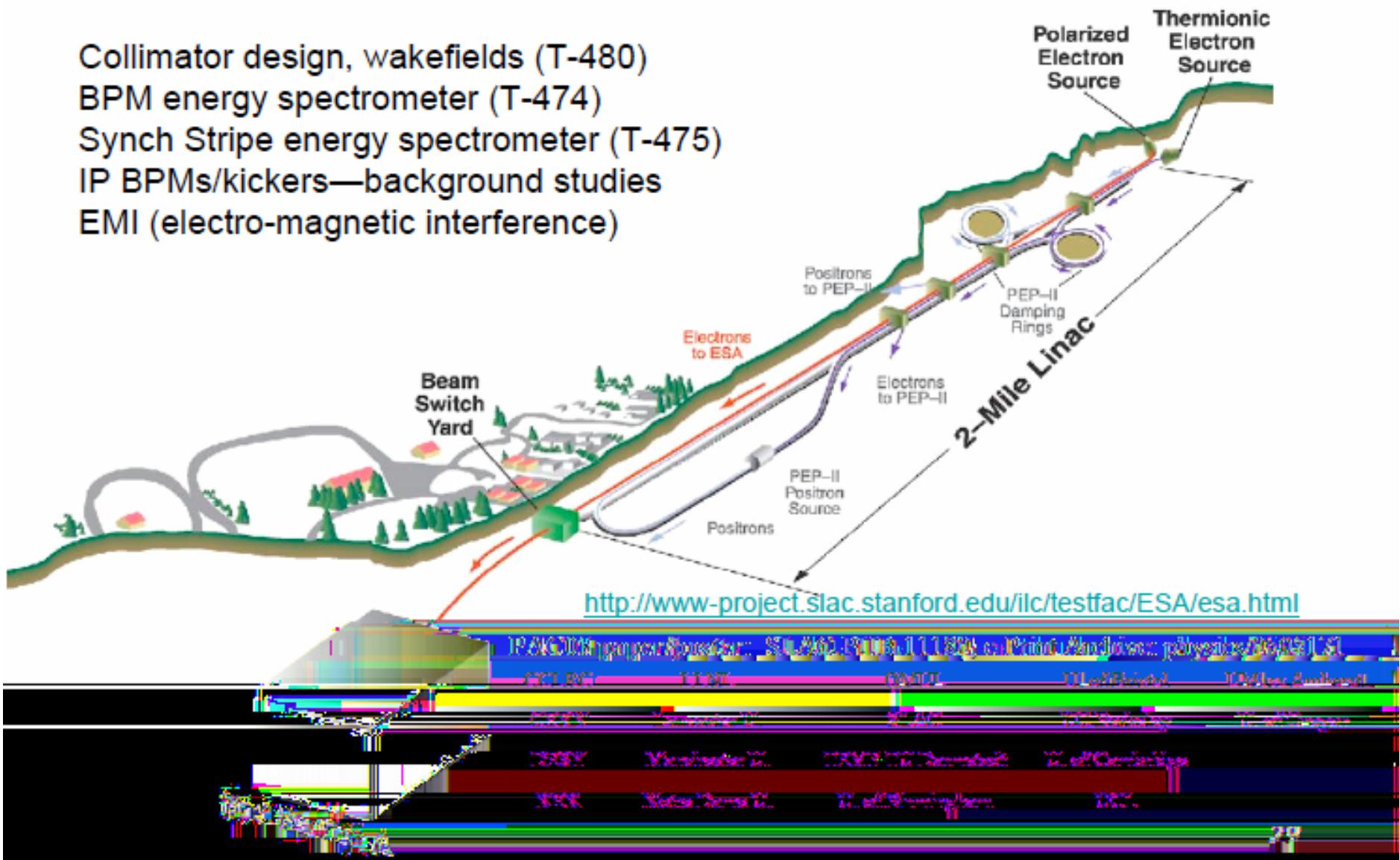
Paul Coe

A. Schalicke

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)



Tom Markiewicz/M. Wood

## End Station A Energy Spectrometers

### **T-474 BPM Energy Spectrometer:**

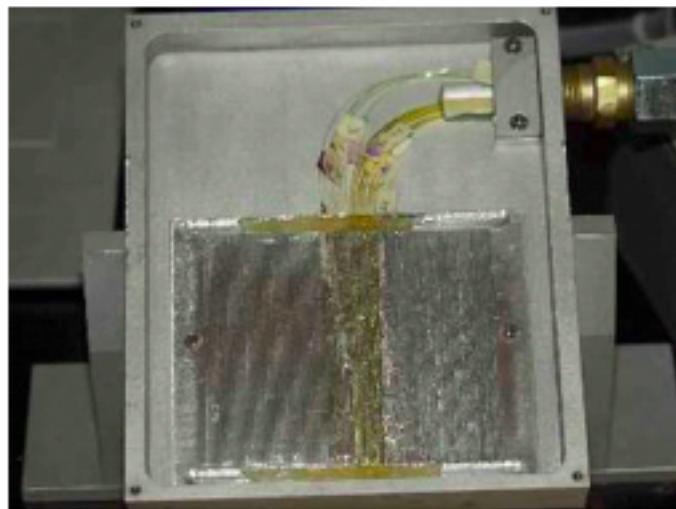
**PIs:** Mike Hildreth (U. of Notre Dame) & Stewart Boogert (RHUL,UK)

**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

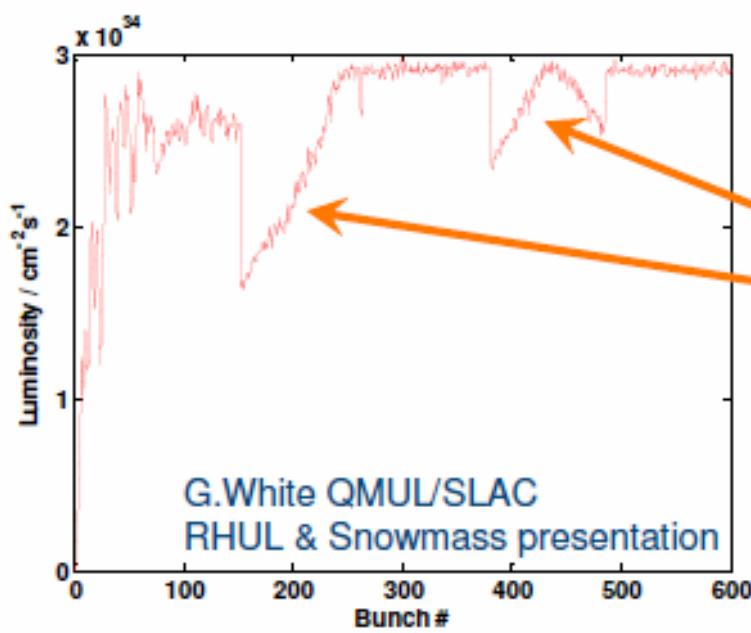


### **Prototype quartz fiber detector:**

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)!

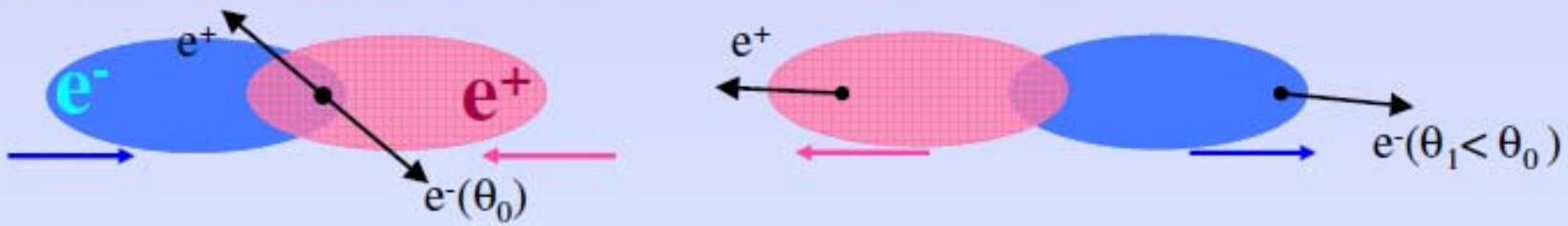
position and angle scan

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

Tim Barklow

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

## Are Z0 Calibration Runs Necessary?

--> may not be necessary

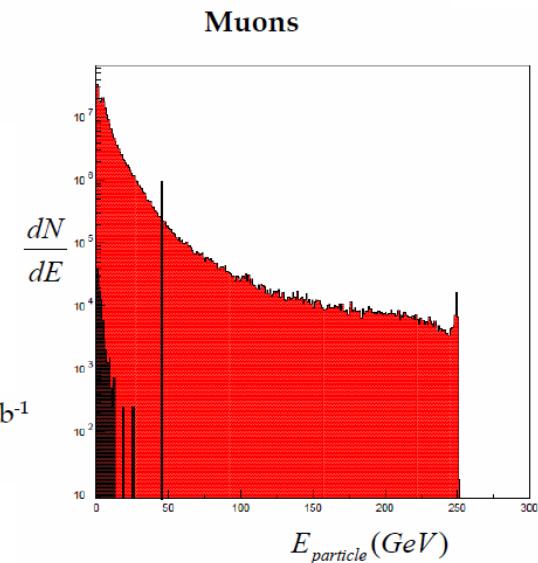
- How many particles are available for calibration from running at Ecm=500 GeV?
  - There are many processes with very large cross-sections at Ecm=500 GeV:

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

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



Ecm= 500 GeV All SM Processes 100  $\text{fb}^{-1}$   
Ecm= 91 GeV  $Z \rightarrow q\bar{q}, \mu\bar{\mu}$  1  $\text{fb}^{-1}$



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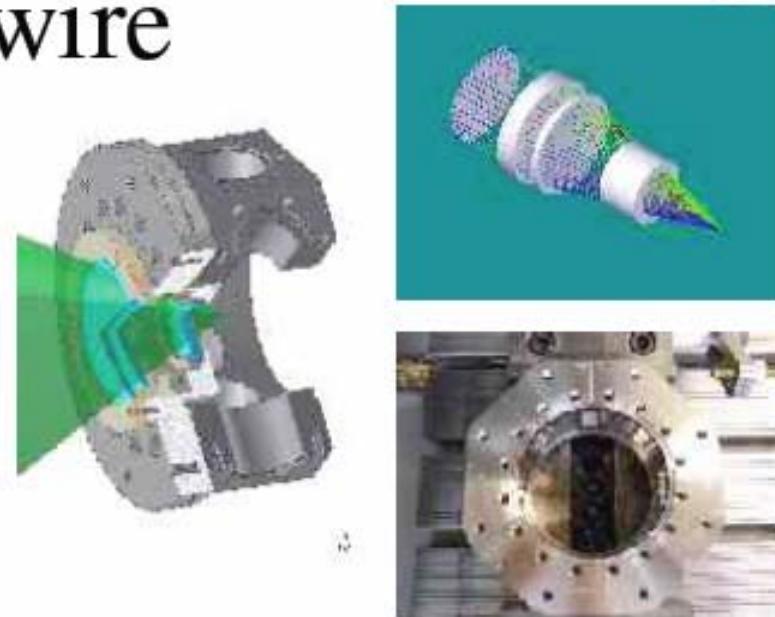
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# The ATF extraction line laser-wire

- 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

Nicola



## 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 2<sup>nd</sup> harmonic crystal : LBO/BBO (250 nm – 500 nm)

### Attractiveness of Fiber laser baser oscillator-preamplifier systems

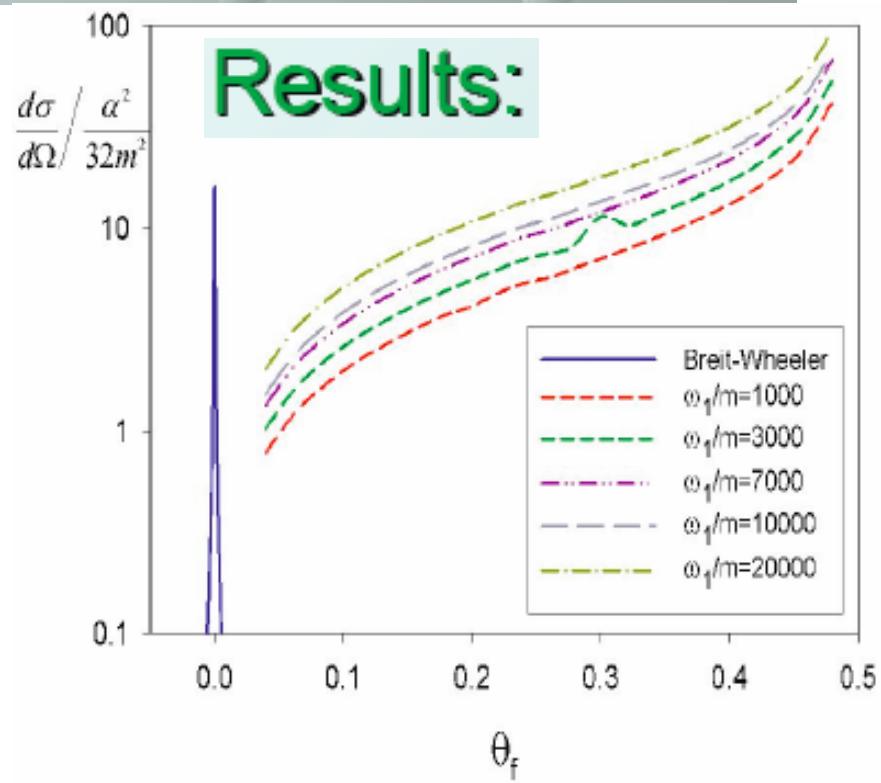
**High quality beams:** Diffraction limited divergence, excellent beam profiles, very low pointing jitter, pulse-width – from 100 fs to 10 ps, rep. Rate = KHz to 10s of MHz

Tony Hartin

# Stimulated Breit-Wheeler process as a source of background pairs

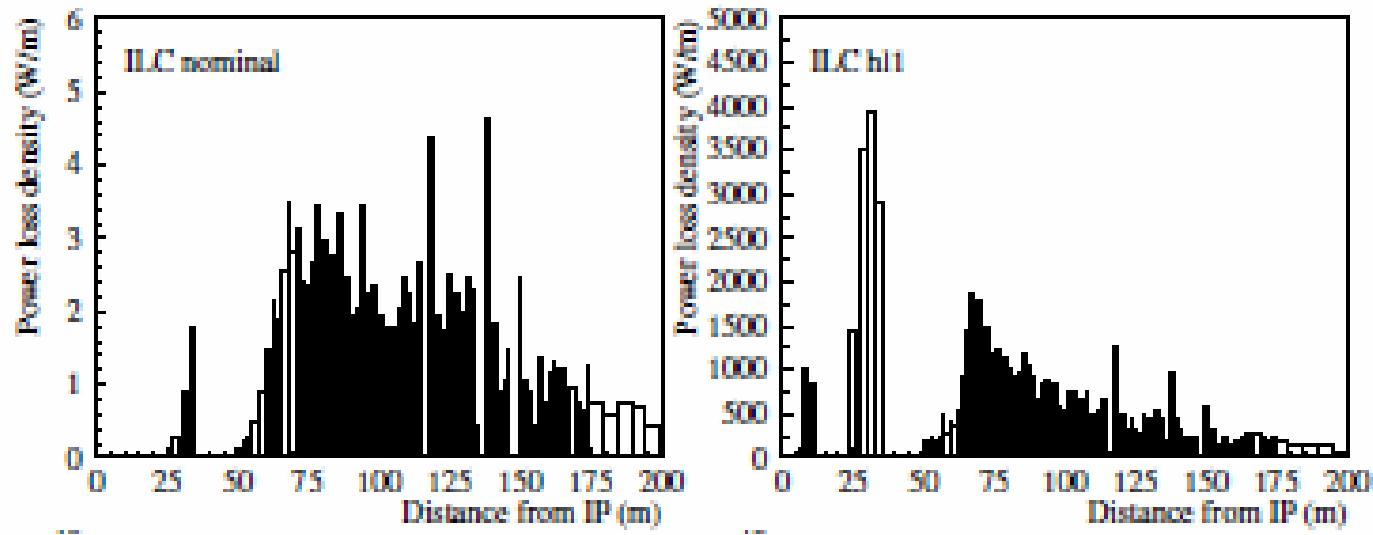
- Have the effect of intense beam fields been fully taken into account?
  - 1st order coherent pair production fully covered but 2nd order not
  - Why consider 2nd order coherent pair production?
- Resonances in the 2nd order IFQED processes
  - Moller process – Oleinik (1967), Bos et al (1979), Panek 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.

G. Blair/J. Carter/Ilya

BDSIM,  
GMAD,  
Mokka

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

## 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
	ECOL2	1007 ± 77.5	27.1k ± 0.7k	233k ± 3.5k
	ECOL3	527 ± 80.4	1863 ± 150	41.6k ± 1.0k
Max E-Loss Density [W/m]	SC Quads	0 < 0.11	0 < 0.11	0.92 ± 0.20
	Warm Quads	0 < 0.13	0 < 0.13	28.5 ± 1.19
	Bends	0 < 0.27	0.05 ± 0.05	27.8 ± 1.18
Main Beam	640k	640k	625k	-
Tail	2 x 10k	2 x 25k	2 x 450k	2 x 500k

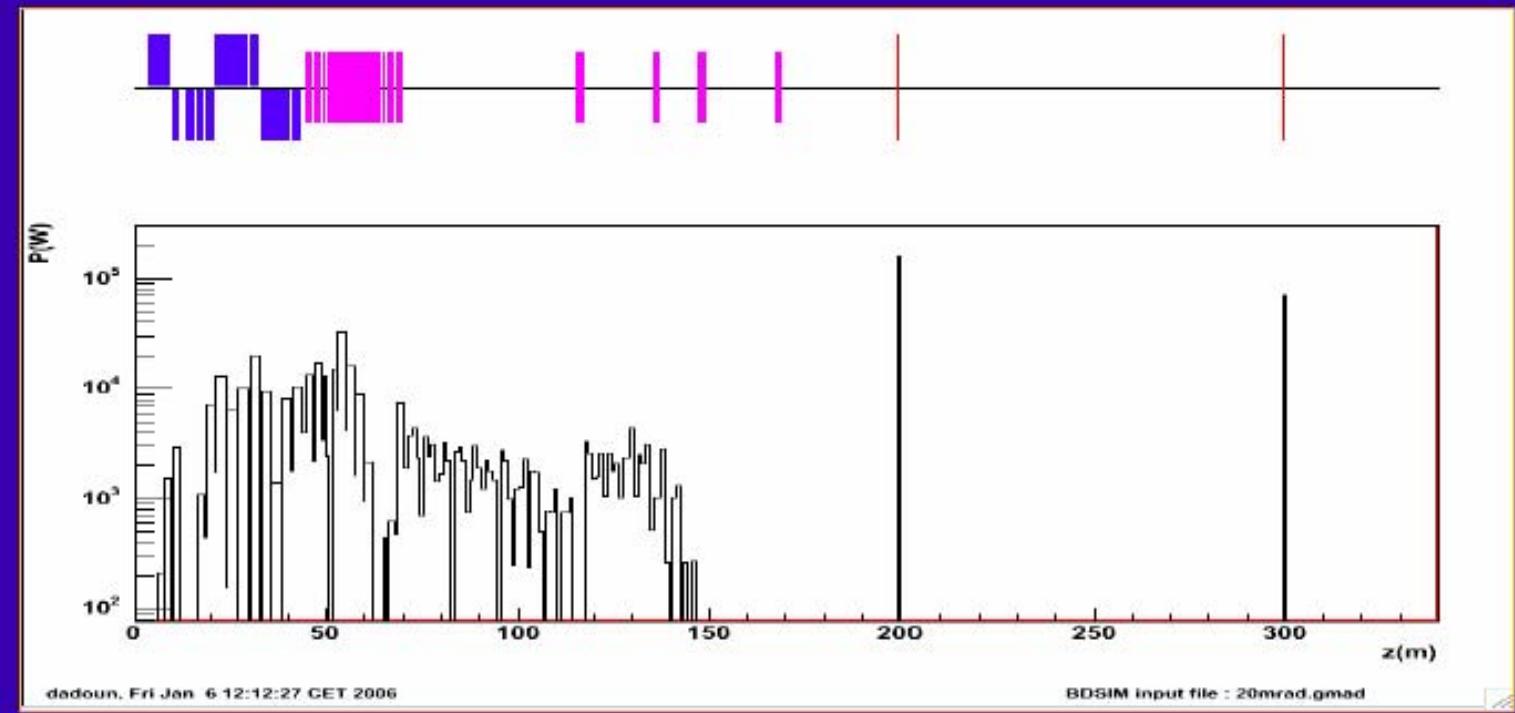
- The results show that more optimisation of the optics may be required for the extraction lines to be able to handle all the parameter sets.

# 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

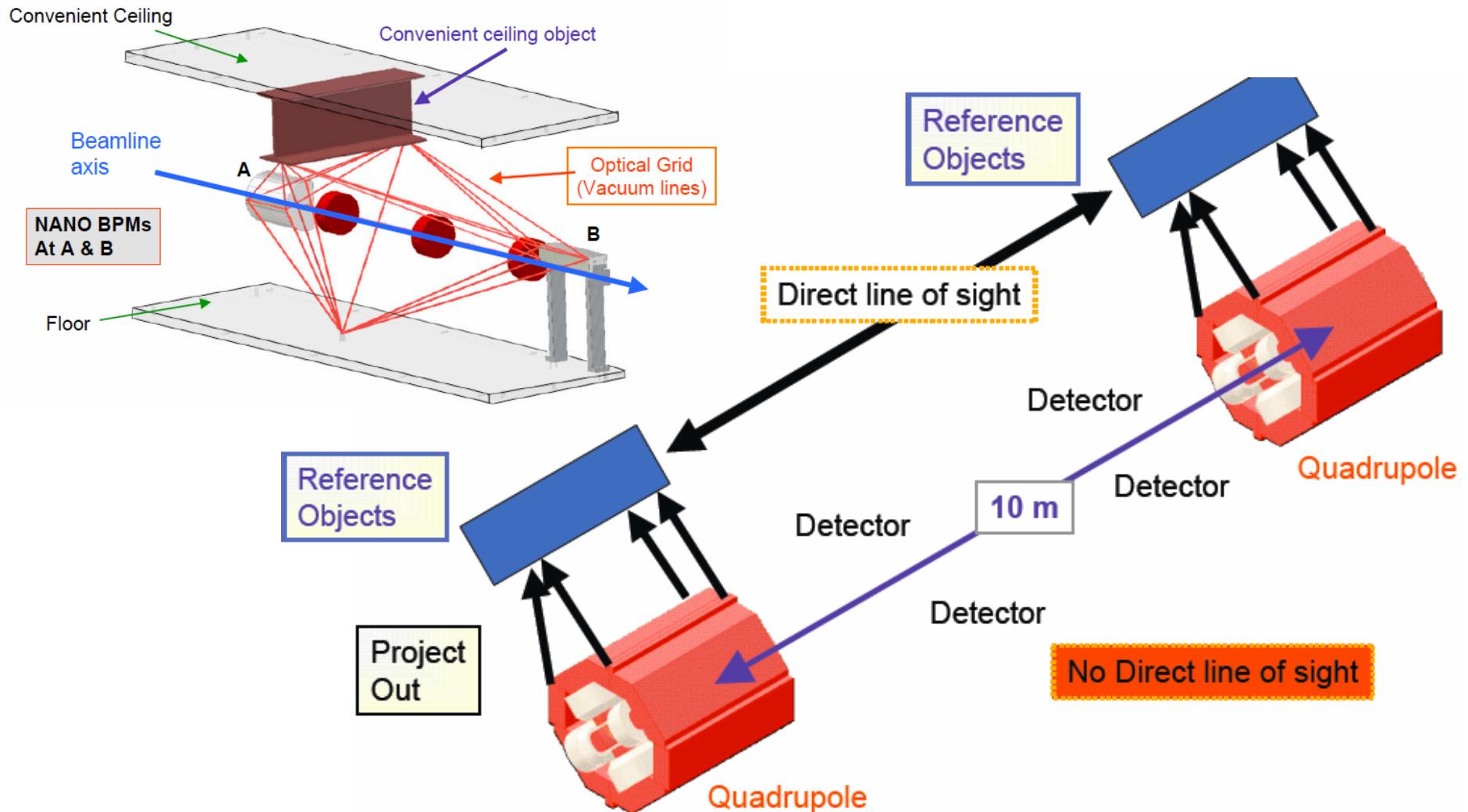
### NbTi 500 GeV machine doublet

- 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



## Low-Energy Positron Polarimetry

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

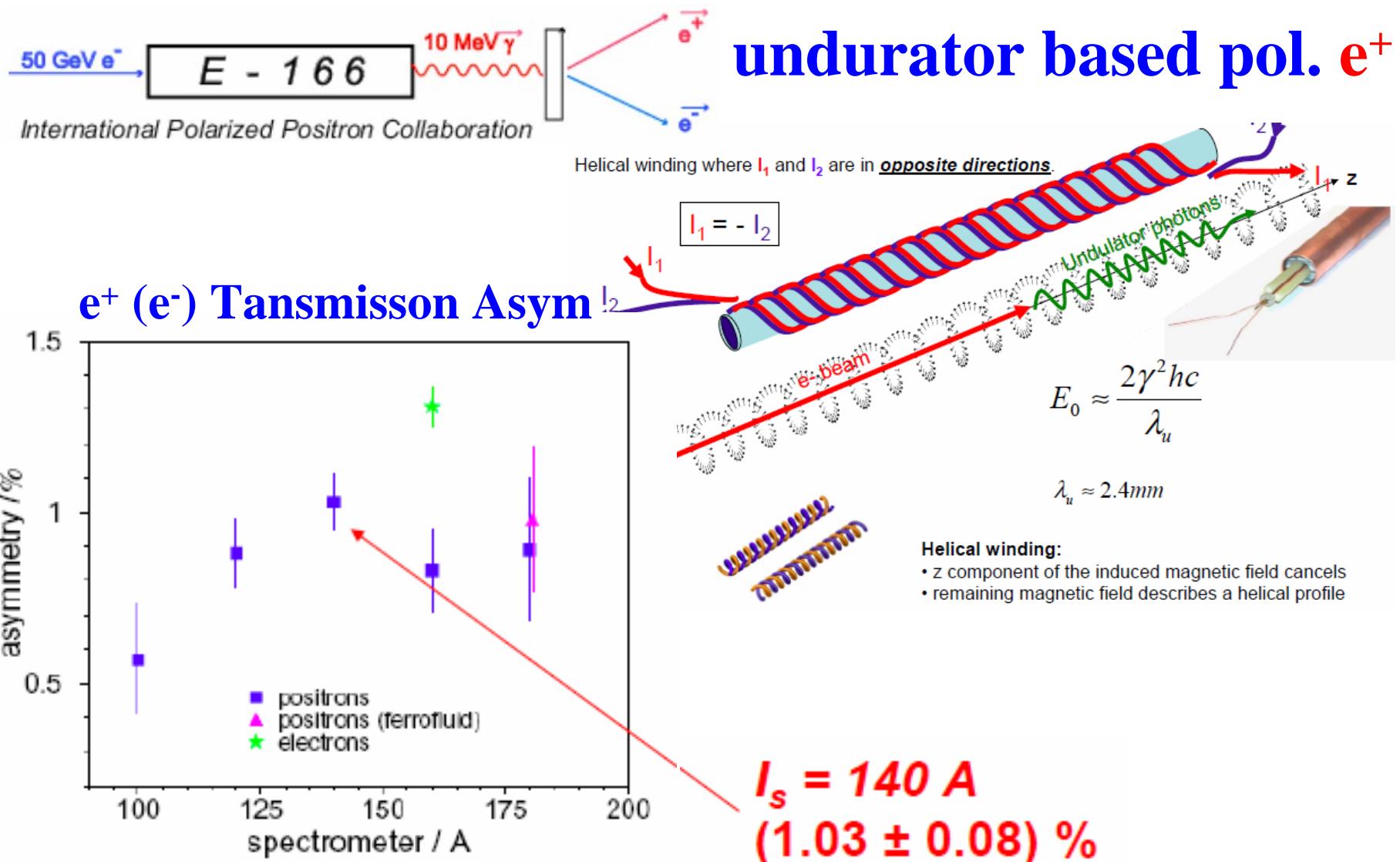
Principle

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

Karim Laihem

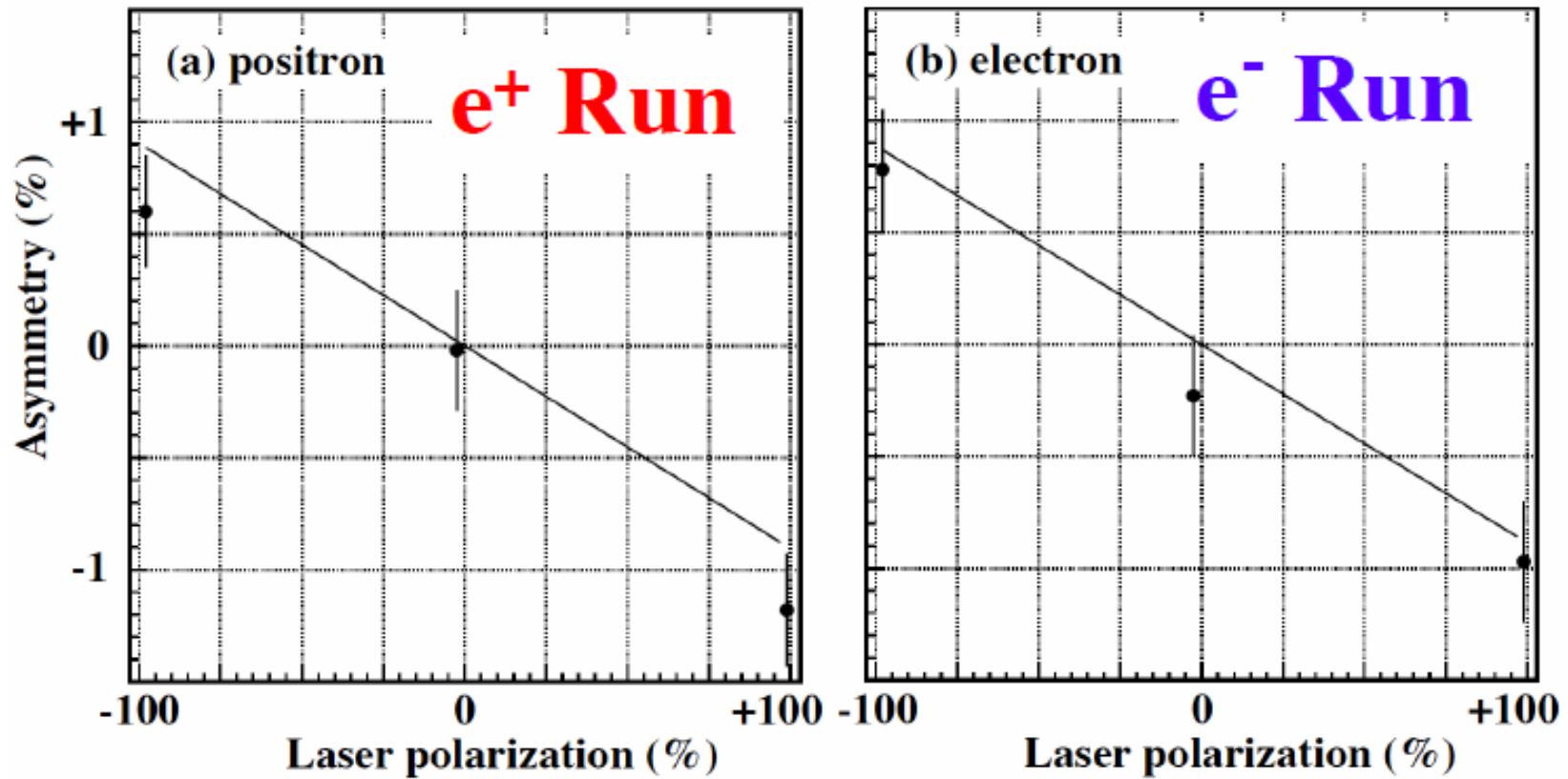
# The E166 experiment

## Development of a polarized positron source for the ILC.



# Summary of e<sup>+</sup> Run and e<sup>-</sup> 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<sup>+</sup>, , ,**