Highlight at the BDIR Workshop

T. Tauchi, KEK
The 8th ACFA Workshop on Physics and Detector at the Linear Collider, EXCO, Daegu, Korea, 12th July 2005
A one-week ILC European Regional meeting will be hosted by the Oxford/RHUL John Adams Institute at Royal Holloway, University of London, UK from 20-23 June, 2005. The meeting will support in parallel the following international workshops:

- ILC-BDIR WG4 Interim Workshop
- Annual EUROTeV Workshop
- CARE/ELAN Workshop

**Last minute information** on how to get to RHUL, location of meetings etc.

**Payment instructions**

**Photos**

- Introduction + workshop aims
- Agenda
- List of Participants

Computing facilities: There will be wireless for all, though you will need to bring your own laptop with wireless capability.
ILC-BDIR WG4 Interim Workshop

The charge will be to build on the first ILC-BDIR WG4 meeting and to study:

- Critical design issues; emphasis on BDIR.
- The impact on luminosity of the beam transport from DR to IP including luminosity performance simulations and instrumentation.
- Critical beam instrumentation; design, location and performance implications.
- Tuning strategy.
- Backgrounds; modelling, impact on design and machine performance.
- Alignment; static and dynamic imperfections and their mitigation.
- Wake-fields; calculations and impact
- Failure modes and machine protection.

Annual EUROTeV Workshop (www.eurotev.org)

Several parallel sessions will be dedicated to the seven technical working packages of the EUROTeV programme:

- Beam Delivery System*
- Damping Rings
- Polarised Positron Source
- Diagnostics*
- Integrated Luminosity Performance Studies*
- Metrology and Stabilisation*
- GANMVL

* strong overlap with BDIR Workshop sessions

A primary goal of the EUROTeV sessions will be to review the activities since the start of the programme...
As might be expected, the text of the Magna Carta of 1215 bears many traces of haste, and is clearly the product of much bargaining and many hands. Most of its clauses deal with specific, and often long-standing, grievances rather than with general principles of law. Some of the grievances are self-explanatory: others can be understood only in the context of the feudal society in which they arose. Of a few clauses, the precise meaning is still a matter of argument.
Total 134 participants

From 113 Institutes

In 11 countries

France, Germany, Italy, Japan, Korea, Poland, Spain, Sweden, Switzerland, UK, USA

Across 3 regions

America, Asia, Europe

26 planary + 118 parallel talks
A challenge: fitting in with the detector.
IR layouts for 20 and 2 mrad with SiD and $L^*=3.5$

- Compact SC quads
- Solenoid compensation (for both 20 & 2 mrad) not yet included in Geant model.

CHALLENGES: Affect of detector’s solenoid field on sc quad performance; mechanical stability of quads; room for magnet movers; access to detector without moving quads. Knowing which detector to interface with (multiple magnet designs?).
ILC IR and Extraction Line Magnet Magnet CHALLENGES

Two possible extraction schemes (with SiD)

Disrupted beam

Incoming beam

20 mrad

SiD detector

Mostly superconducting magnets

Disrupted beam

Incoming beam

2 mrad

Various types of magnets

Disrupted beam

Incoming beam

SF1 shown as a SC

These boxes represent just apertures. ~0.1m between the 2 beams

Cherrill Spencer, SLAC and Brett Parker, BNL
Side-by-side compact superconducting quads for 20mr

Each quad in own cryostat

Incoming beam in QD0

Extracted beam in QFEX1A

Section AA, at $Z = 4.4$ m, has only 88 mm beam separation. Note even this far from the IP there is very little space for the cryostat. Nearer the IP end the cryostat transitions to an elliptical shape. QD0 & QEX are supported inside the anti-solenoid cryostat that is firmly attached to the experimental detector.

Cherrill Spencer, SLAC and Brett Parker, BNL
**Nb₃Sn Quadrupole Magnet Project**

**CEA/Saclay**

**Nb₃Sn Quadrupole Program Main Goals**

- Build a 1-m-long model, 56-mm single aperture with no magnetic yoke
- Model design based on the design of LHC arc quadrupole magnets

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Gradient</td>
<td>211 T/m</td>
</tr>
<tr>
<td>Current</td>
<td>11870 A</td>
</tr>
<tr>
<td>$B_{\text{peak}}$</td>
<td>8.3 T</td>
</tr>
</tbody>
</table>

Cross sectional view of the assembly

Maria Durante, Olivier Delferrière, Olivier Napoly
Possible solution for the QF1 magnet in 2mr scheme

By the time the extracted beam reaches QF1 it & photons are ~9cm wide. Leave space for them in the coil pocket of a regular iron-core quad.

Computer model of one-eighth of QF1

Incoming beam is on-center, and extracted beam is at an angle and off-center in FF magnets near IP. In QF1 quad with 1cm aperture, extracted beam travels through aperture of a coil pocket in a significant field. It has been tracked through this field in TURTLE model.

Cherrill Spencer, SLAC and Brett Parker, BNL
Possible solution for QFEX1 in 2mr scheme. “Panofsky-style” quad. Needs much further study to prove feasibility.

Cherrill Spencer, SLAC and Brett Parker, BNL
A “last-resort” SC option for QFEX1 in 2mr scheme. Likely to be harder to protect from synchrotron radiation than Panofsky septum quad. Detailed engineering study is needed to establish true feasibility.

Cherrill Spencer, SLAC and Brett Parker, BNL
What might a crab cavity system look like?

- Require up to 15 cells (11.5cm long)
- Need to split cells into several cavities
- Need space for cryostat, input/output couplers, tuning mechanisms...

Philippe Goudket
Disrupted beam losses for 20mrad extraction line

- Collimators 1 and 2 are at s=200m and 300m and have round aperture of r=8.8cm and 13.2cm, to reduce beam size at the dump (round window r<15cm)

<table>
<thead>
<tr>
<th>$E_{CM}$</th>
<th>y-offset (nm)</th>
<th>e-loss in collimators (kW)</th>
<th>$\gamma$-loss in collimators (kW) (results by L. Keller)</th>
<th>Max. e-loss density in magnets (W/m)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Coll. 1</td>
<td>Coll. 2</td>
<td>Coll. 1</td>
</tr>
<tr>
<td>0.5 TeV nominal</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>200</td>
<td>0</td>
<td>0</td>
<td>0.15</td>
</tr>
<tr>
<td>0.5 TeV high lumi</td>
<td>0</td>
<td>47.4</td>
<td>74.5</td>
<td>2.8</td>
</tr>
<tr>
<td></td>
<td>120</td>
<td>47.2</td>
<td>95.3</td>
<td>151</td>
</tr>
<tr>
<td>1 TeV nominal</td>
<td>0</td>
<td>0.85</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>100</td>
<td>4.8</td>
<td>0.11</td>
<td>0</td>
</tr>
<tr>
<td>1 TeV high lumi</td>
<td>0</td>
<td>64.1</td>
<td>43.6</td>
<td>1.5</td>
</tr>
<tr>
<td></td>
<td>80</td>
<td>129</td>
<td>15.4</td>
<td>69</td>
</tr>
</tbody>
</table>

* After increasing aperture in QDEX1C and QFEX2A to r = 25 and 36 mm, respectively.
Diagnostics chicane for 20 mrad

Diagnostics chicane for 2 mrad

Talk by E. Torrence on behalf of Ken Moffeit
## Comparative Summary

<table>
<thead>
<tr>
<th>Graphite-Copper Dump</th>
<th>Water Dump</th>
<th>Noble Gas Dump</th>
</tr>
</thead>
<tbody>
<tr>
<td>2m x 2m, 5m long</td>
<td>Ø1.5m, 10m long</td>
<td>Ø1.2m, 1km long (extra? tunnel)</td>
</tr>
<tr>
<td>heat conductivity &amp; intense slow sweep</td>
<td>adequate water flow, no slow sweep</td>
<td>heat conductivity, no slow sweep</td>
</tr>
<tr>
<td>radiation degradation of heat conductivity of graphite?</td>
<td>explosive radiolysis gases in a highly activated system</td>
<td>no dissociation of one atomic gas</td>
</tr>
<tr>
<td>cyclic stress in C tolerable</td>
<td>transient pressure in water</td>
<td>gas buffers transient expansion</td>
</tr>
<tr>
<td>window Ø2m, unless not put upstream of sweeping</td>
<td>vac./water window Ø20cm, challenging design</td>
<td>vacuum/gas window Ø8cm, design ~exists</td>
</tr>
<tr>
<td>need increased spot size (fast sweep) to limit energy density</td>
<td>applicable for smaller spot sizes and therefore as γ/γ-dump</td>
<td></td>
</tr>
<tr>
<td>total tritium inventory ~300TBq, ~30% in water, rest in C-Cu</td>
<td>tritium inventory factor 10 less and 98% bound in a solid</td>
<td></td>
</tr>
<tr>
<td>maintenance complicated</td>
<td>easier maintenance</td>
<td></td>
</tr>
<tr>
<td>high activated components, dismantling costs not negligible</td>
<td>activation of 1km tunnel</td>
<td></td>
</tr>
</tbody>
</table>

Technically not practicable for high power applications

Principally feasible, but inherent risks will make it difficult to „sell“ it as reliable, safe and robust.

Attractive new idea, which should be investigated in more detail.

Talk by M. Schmitz
Plan proposed by ILC-BDIR WG conveners

Pre-Snowmass Reference Design Report (DRAFT)

The Reference Design Report is based on assumption of two interaction regions. It is understood that particle physics output and cost of two IRs vs single IR will be evaluated in details.

<table>
<thead>
<tr>
<th>BDS Baseline</th>
<th>Baseline R&amp;D</th>
<th>Option and Option R&amp;D</th>
</tr>
</thead>
<tbody>
<tr>
<td>One of IRs with 20+mrad crossing, separate incoming and extraction lines</td>
<td>Many. See specific items below.</td>
<td>15-25mrad</td>
</tr>
<tr>
<td>One of IRs with ~2mrad crossing, first FD magnets shared</td>
<td>Many. See specific items below.</td>
<td>Head-on with electrostatic separator or RF kicker; Or same 20mrad for 2nd IR</td>
</tr>
<tr>
<td>Compact SC direct wind quads for 20mrad, separate cryostats for QD0 &amp; QEXF</td>
<td>Prototype compact SC QD0</td>
<td>Common cryostat SC quads, other technology?</td>
</tr>
<tr>
<td>FF optics based on local chromatic correction</td>
<td>Get experience with compact FF at AFT2</td>
<td>Traditional FF with non-interleaved sextupole pairs</td>
</tr>
<tr>
<td>2mrad extraction beamline with E and polarization diagnostics, with separation of e+ and γ after first extraction line doublet</td>
<td>Prototype SC super septum quads or Panofsky style septum quads</td>
<td>Other ideas for magnets?</td>
</tr>
<tr>
<td>Large bore SC magnets for 2mrad, minimal external size, with antisolenoid and movers inside?</td>
<td>Prototype needed?</td>
<td>Alternative SC materials which allow larger aperture, but brittle in manufacturing</td>
</tr>
</tbody>
</table>
Machine-detector interface

- Need consistent, detailed bds+detector models
  - FNAL+SLAC will produce 2/20 mrad cases for SiD (aim: 1st results by Snowmass)
  - BDSIM+Mokka integration in progress
  - LCBDS+JUPITER in preparation

- From background origins to sub-detector response: proof of principle

- Short term plan, complete integration ultimate dream
Average and RMS of VXD hits over 20 bunches

Barrel VXD

- ~10% more hits in 20 mrad
- But the difference is small compared to the bunch-to-bunch fluctuation.
- ~30% more hits if no lowz.
- 300 hits/BX (layer #1)
  0.027 hits/mm²/BX
  77 hits/mm²/Train

T.Maruyama and T.Markiewicz
Detector - Beam Delivery Interfacing

John Carter¹, Adrian Vogel²

1. Royal Holloway University of London
2. DESY, FLC Group

- Motivation
- Mokka
- BDSIM
- Geometry Model of the IR
  - A first step towards unifying our descriptions
- Conclusions & Outlook

22nd June 2005
ILC - BDIR
Both BDSIM and Mokka - two independent codes - can produce the same geometries using the same input files/description.
Neutron Production – Cross Section

Origins of neutrons (blue ones reach the TPC)
Neutron Production – Distances

Origins of neutrons…

…reaching the TPC

Adrian Vogel  ILC European Regional Meeting, London, 2005-06-21
Hits on the Vertex Detector with Solenoid Field

Büßer

20 mrad crossing in LDC

- 2 mrad for comparison
- Small effect of the changed graphite radius
- ‘Pictures’ from the holes produce asymmetries
Hits on the Vertex Detector with Solenoid+DID

20 mrad crossing in LDC

2 mrad for comparison

DID field removes asymmetries

No realistic fieldmap yet!
Simple solution $B_x=0.01 B_z$
Hits in the TPC Summary

- 2 mrad
- 20 mrad, solenoid, ro=2.4-2.4
- 20 mrad, solenoid, ro=2.4-2.0
- 20 mrad, serpentine, ro=2.4-2.4
- 20 mrad, serpentine, ro=2.4-2.0
- 20 mrad, modified fw region

solenoid + “DID”
Conclusion

- DID fields (with the current detector design)
  - remove asymmetries from vertex detector backgrounds 😊
  - produce in other SI tracking devices background comparable to pure solenoid field configurations 😊
  - increase backgrounds in the TPC (and the forward chambers) by a factor of 4 compared to pure solenoid field configurations, this is a factor of 6 above the 2 mrad case and a factor of 10-12 above the TDR head-on case 😞😞😞
  - a quick fix to the geometries of the forward region brings no substantial improvement

- To be done
  - include realistic field maps for the solenoid and the DID
  - cross-check with GEANT4 (→ see Adrian Vogel’s talk)
  - invent a clever solution to heal the TPC background problem
  - understand detector tolerances
What can be done?
- Move BeamCal further away from the IP → increase $L^*$ 😞
- Shorten the whole detector 😞
- Move the LumiCal closer to the IP → TDR like masking 😊
- Invent something new

Task for the Large Detector Concept Study
Main results on IPC GuineaPig/CAIN/BDK comparison

- Total IPC cross section: CAIN 12% less than GuineaPig
- VD background cross section: CAIN 40% less than GuineaPig
- LL process: GuineaPig ~ BDK; CAIN ~ 1/3 BDK in VD
- ≠ between GP & CAIN: due to ≠ virtuality limit $Q_{\text{max}}^2$
- GuineaPig predictions more conservative than CAIN