Appendices

Personnel developments

Some recent developments with respect to the personnel working on the LCFI project are briefly discussed in this section of the report.

Sonja Hillert has taken over the management of WP1 from Dave Jackson, who left the Collaboration in April. Sonja is continuing to spend 100% of her time on LCFI. The physics group was joined by Victoria Martin, a lecturer at Edinburgh University, who is currently working also with CDF: her involvement with LCFI will grow in the next few years. Recent progress has relied strongly on the work of three graduate students: Ben Jeffery of Oxford is involved at the 90% level; Erik Devetak, also of Oxford, who has taken up physics work at the 80% level recently and Mark Grimes of Bristol, who is spending 50% of his time on WP1.

In January 2006, Andrei Nomerotski (Oxford University) replaced Johan Fopma as the manager of WP4. Johan continues to provide significant and valuable support to the project.

Tuomo Tikkanen has joined the Liverpool group and is currently working on the establishment of a test set-up for radiation hardness studies as part of WP5.

Joel Goldstein has taken up a position as senior lecturer at Bristol University. He will continue to work within the LCFI Collaboration and will lead the Bristol group and continue to manage WP6.

Liverpool, Oxford and Rutherford are in the process of appointing new Research Associates to work on the LCFI programme and Rutherford will appoint a replacement for Joel Goldstein. Oxford are appointing a new engineer to support their WP4 activities.

Review of progress against latest reported milestones

LCFI-1 (WP1): Perform first studies of benchmark physics processes with strong sensitivity to vertex detector parameters. (Aug 1)

Delayed due to delays in hiring new personnel. Expect work to be completed in spring 2007.

LCFI-2 (WP1): Develop and distribute C++ version of vertex finder ZVTOP. (Sep 30)

On target for completion by scheduled date. This task remains on schedule due to increases in assigned personnel.

LCFI-3 (WP2): Receive double-metal (busline-free structure) CPC-2 sensors from e2v technologies. (July 25)

On target for completion by scheduled date.

LCFI-4 (WP2): Complete design of CPC-T1 test devices and submit for manufacture. (Oct 8)

On target for completion by scheduled date. Due to the wealth of good ideas being incorporated in this submission, we are considering pushing the submission date back to allow more time to study the devices we wish to include.

LCFI-5 (WP2): Complete design specification document for second generation ISIS device in conjunction with semiconductor foundry. (Sept 29)

Not yet started. Delays in hiring have caused personnel shortages that have prevented us from fully engaging with the design work.

LCFI-6 (WP3): Finish design of CPD-1 and submit for manufacture. (Oct 8)

Ahead of schedule. Submission is scheduled for July 24.

LCFI-7 (WP3): Complete stand-alone tests of CPR-2 and publish results in an LCFI note. (Jul 30)

Stand-alone tests completed. Full documentation is likely to be a little delayed.

LCFI-8 (WP3): Finish design of CPR-2a. (Oct 29)

Not yet started. Start is likely to be delayed by hiring delays in both testing and PC board construction, and in bump-bonding.

LCFI-9 (WP4): Deliver motherboard for testing bump-bonded CPC-2 devices. (Feb 25)

Complete. Three revisions have been made, the latest delivered May 2006.

LCFI-10 (WP4): Test transformer drive circuitry with busline-free CPC-2. (Feb '07)

Not yet started, but should be early.

LCFI-11 (WP5): Test CPC-2 with single-level and double-level metal. (Jan '07)

On target for completion by scheduled date.

LCFI-12 (WP5): Finish tests of ISIS-1, with light and X-ray source. (Feb 25)
Complete. Presented at conferences such as LCWS06 in Bangalore.

LCFI-13 (WP5): Establish test-rigs for studying radiation hardness of column-parallel CCDs. (Jul 1)
On target for completion by scheduled date.

LCFI-14 (WP2): Assess the radiation hardness of the DALSA process by testing a CCD with non-overlapping polysilicon gates. (Jun 25)
Progressing steadily, but delayed by roughly one month.

LCFI-15 (WP5): Bump bond CPC2/CPR1/CPR2. Receive bump-bonded sensors from VTT for testing. (Nov 22)
Ahead of schedule. (Needs to occur earlier than date previously reported, as this work feeds in to milestone LCFI-8 above).

LCFI-16 (WP6): Complete detailed tests with RAL cooling test stand, integrating heating elements and cross-checking with simulation. (Jul 27)
On target for completion by scheduled date.

LCFI-17 (WP6): Complete basic ladder support studies with RVC and SiC foams. (May 30)
Delayed somewhat due to delays in purchase of thinned silicon and in the purchase of characterisation equipment (laser).

LCFI-18: Help to organise the UK-wide LC activities through LCUK and the "Cosener's Forum", and present LCFI results in international conferences. (Not in Gantt, but Forum scheduled for May, and LCWS is next week.)

Milestones for period July-December 2006

LCFI-1 (WP1): Complete and distribute C++ version of LCFI Vertex Package (ZVTOP, flavour tag, vertex charge reconstruction). (September)

LCFI-2 (WP1): Compare the performance of Vertex Package tools when provided with input from SGV and from MarlinReco (fast and full simulation/reconstruction, respectively). (January)

LCFI-3 (WP1): Perform first studies of benchmark physics processes with strong sensitivity to vertex detector parameters. (February)

LCFI-4 (WP1): Use ghost track algorithm to improve flavour tag and to extend quark charge determination to short-lived B_d^0 hadrons. (April)

LCFI-5 (WP2): Complete design of CPC-T1 test devices and submit for manufacture. (October)

LCFI-6 (WP2): Complete design specification document for second generation ISIS device in conjunction with semiconductor foundry. (December)

LCFI-7 (WP3): Finish design of CPD-1 and submit for manufacture. (July 24)

LCFI-8 (WP3): Finish design of CPR-2a. (January)

LCFI-9 (WP4): Test transformer drive circuitry with busline-free CPC-2. (December)

LCFI-10 (WP5): Test CPC-2 with single-level and double-level metal. (January 07)

LCFI-11 (WP5): Bump bond CPC2/CPR1/CPR2. Receive bump-bonded sensors from VTT for testing. (September)

LCFI-12 (WP6): Complete basic ladder support studies with RVC and SiC foams. (September)

LCFI-13 (WP6): Complete tests with RAL cooling test stand and tuning of simulations. (December)

LCFI-14: Help to organise the UK-wide LC activities through LCUK and present LCFI results in international conferences and workshops.

Financial report in June 2006

April – December 2005

During the period from April to December 2005, LCFI was funded through two separate "bridges" which provided a total of £627k. The breakdown of the budget and spend is shown in Table 1. It should be noted that the budgeted distribution of recurrent funds represents the plan before the deferral of the last instalment of the CPC-2 payment to e2v into this period.

	Approved Apr-Dec05	**Actual Apr-Dec05**	**Variance**
Bristol	8.0	8.0	0.0
Lancaster	8.0	8.0	0.0
Liverpool	4.0	4.0	0.0
Oxford (RG)	144.0	144.0	0.0
Oxford (SLA)	21.0	25.1	4.1
University Subtotal	185.0	189.1	4.1
RAL PPD Effort	262.0	239.9	-22.1
RAL ED/ID Effort	31.0	63.9	32.9
Recurrent			
WP1	0.0	0.0	0.0
WP2	5.0	58.8	53.8
WP3	0.0	0.0	0.0
WP4	30.0	3.3	-26.7
WP5	75.0	19.2	-55.8
WP6	30.0	5.9	-24.1
WP8	0.0	0.0	0.0
Travel	9.0	6.9	-2.1
Total	149.0	94.1	-54.9
Total	**627.0**	**582.9**	**-40.0**

Table 1 LCFI Financial Breakdown April – December 05 in £k (£20k commit excluded).

The under-spend includes £20k committed to bump-bonding at VTT. The remainder is considered to be the repayment of the over-spend incurred in FY02-05.

January 2006 – December 2008

LCFI is now in an approved three-year grant period, with a total budget (including working allowance and contingency) of £6 049k. This figure also includes the new funding arrangements for university staff from 1/10/06 in which 80% of the full economic cost of all research effort is paid, including that of academics. The breakdown of this three-year budget, reflecting actual spends to the end of May 2006, is shown in Table 2.

	Approved (excluding contingency) (1)	Spend 2005/06 Actual (2)	Spend to date 2006/07 Actual (3)	Spend to date 2006/07 Projected (4)	Latest estimate of future requirement (5) 2007/08	Latest estimate of future requirement (5) 2008/09	Total Actual (2+3+5) (6)	Total Projected (2+4+5) (7)	Variance Actual (6-1)	Variance Projected (7-1)
University: Bristol	497.0	13.0	9.0	100.0	210.0	174.0	406.0	497.0	-91.0	0.0
Glasgow	71.7	0.0	0.0	15.7	32.0	24.0	56.0	71.7	-15.7	0.0
Liverpool	500.0	28.0	19.0	120.0	200.0	152.0	399.0	500.0	-101.0	0.0
Oxford (RG)	1444.0	53.9	36.0	453.0	497.5	439.6	1027.0	1444.0	-417.0	0.0
Oxford (SLA)	84.0	7.2	5.0	36.0	40.8	0.0	53.0	84.0	-31.0	0.0
Sub-Total	2596.7	102.1	69.0	724.7	980.3	789.6	1941.0	2596.7	-655.7	0.0
RAL PPD Effort	1122.5	85.7	45.7	360.0	382.0	294.8	808.2	1122.5	-314.3	0.0
RAL ED/ID Effort	454.8	51.0	26.8	128.1	154.1	121.6	353.5	454.8	-101.3	0.0
Equipment: WP1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
WP2	531.0	0.0	0.0	343.0	0.0	188.0	188.0	531.0	-343.0	0.0
WP3	95.0	0.0	0.0	75.0	20.0	0.0	20.0	95.0	-75.0	0.0
WP4	32.0	4.0	0.0	23.0	5.0	0.0	9.0	32.0	-23.0	0.0
WP5	42.0	0.0	0.0	42.0	0.0	0.0	0.0	42.0	-42.0	0.0
WP6	92.0	0.0	18.9	65.0	27.0	0.0	45.9	92.0	-46.1	0.0
WP8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sub-Total	792.0	4.0	18.9	548.0	52.0	188.0	262.9	792.0	-529.1	0.0
Consumables: WP1	6.0	0.0	0.0	4.0	2.0	0.0	2.0	6.0	-4.0	0.0
WP2	209.0	0.0	0.0	209.0	0.0	0.0	0.0	209.0	-209.0	0.0
WP3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
WP4	75.0	6.8	0.0	42.2	17.0	9.0	32.8	75.0	-42.2	0.0
WP5	40.0	0.0	0.3	35.0	3.0	2.0	5.3	40.0	-34.7	0.0
WP6	43.0	2.0	0.0	18.0	20.0	3.0	25.0	43.0	-18.0	0.0
WP8	4.0	0.0	0.0	2.0	1.0	1.0	2.0	4.0	-2.0	0.0
Sub-Total	377.0	8.8	0.3	310.2	43.0	15.0	67.1	377.0	-309.9	0.0
Travel	122.0	4.4	3.3	49.6	40.0	28.0	75.7	122.0	-46.3	0.0
Total	**5465.0**	**256.0**	**164.0**	**2120.6**	**1651.4**	**1437.0**	**3508.4**	**5465.0**	**-1956.6**	**0.0**
Working allowance	264.0									
Contingency	320.0									
Total Award	**6049.0**									

Table 2 LCFI Funding Breakdown 2006-2008

Recent budgetary changes

There have been some inevitable changes to the distribution of the £6 049k award since the proposal was written in 2005. The largest of these is the increase in effort at Bristol, which is explicitly shown in Table 3, including the total costs at 80% FEC. This financial addition to the Bristol portion of the grant is balanced by reductions elsewhere. The management of WP6 will stay with Goldstein and become Bristol's responsibility, with Head taking a leading rôle in the global mechanical design studies (task 6.3) as these ramp-up towards the end of the period.

	05/06	**06/07**	**07/08**	**08/09**	**TOTAL COST**
Goldstein	0	0.4	0.6	0.4	£112k
Head	0	0	0.3	0.5	£40k

Table 3 Increase in Bristol Effort (FTE).

Risk register

Ref	Risk Description	Potential impact on project	Inherent Risk			Existing Controls	Mitigating factors	Residual risk			Comment / Proposed Action
			L	I	LxI			L	I	LxI	
WP1	Drastic reduction of WP1 scope due to lack of funding or personnel.	Reduced feedback into WP2, 3	3	2	6	Utilising student effort, adding collaborators.	None	2	2	4	Adding new institutes with interest in physics studies.
WP2	Low mass CPD drive cannot be realised.	CPCCD unlikely to be candidate VXD technology	2	4	8	Design of CPD1 starting now.	Explore alternate technologies	2	4	8	More effort going to CPD early in project.
WP2	Substantial delay in ISIS due to technical challenges.	Delay in ISIS testing	3	3	9	Consulting with vendors (i.e. Dalsa).	Work with experts or hire consultants.	2	3	6	Explore several possible manufacturers, test DALSA CCDs.
WP2	150mm wafers not available at e2v.	CPC3 cannot be full size	1	3	3	None	Progress at e2v in installing 150mm production line.	1	3	3	Actively monitoring progress at e2v.
WP2,3	Failure or significant delay of an ASIC production run.	Delay in schedule, reduced time for testing	4	3	12	Meeting often with vendors (i.e. e2v technologies).	Simulate and review designs, hire consultants to interface with fab.	4	3	12	Delays in CPC2 fab and in delays in hiring manpower for, testing and WP4.
WP2,3	Significant change in exchange rate.	Increased cost for non-UK items	3	2	6	None	ASIC costs usually flat with time (for given technology).	3	2	6	Negotiate planned run as soon as technology and vendor selected.
WP2,5	Delays in initial RA appointments due to lack of funding or suitable candidates.	Delay in design and testing of prototypes	4	3	12	Proceeding with RAL and Liverpool hire.	Funding approval obtained in June.	3	3	9	Failed to appoint RAL RA in first attempt.
WP3	Unavailability of multi-project fabrication.	Delay in production, increased cost	2	2	4	None	CERN now has MPW plan. RAL utilising vendor-based MPW.	2	2	4	RAL group gaining experience with non-CERN multi-project runs.
WP4	Problems with vendor or university turn-around time.	Delay in testing and feedback to WP2, 3	3	3	9	New WP manager.	Hire new engineer when funding approved.	2	3	6	Involve other group in PCB work. Outsource.
WP5	Testing site overbooked, unavailable or inadequate.	Delay in testing and feedback to WP2,3	2	3	6	Building second test stand (RAL).	Plan test stand and testing work at other institutions.	1	3	3	Can reduce risk if online soon.
WP5	Failure of bump-bonding run.	Delay in module construction and testing	2	3	6	None	We/VTT have learned from past failures.	2	3	6	Unforeseen delay due to VTT fire
WP6	Failure to find suitable support technology.	Delay in prototype module construction	2	3	6	Testing many new materials.	Compromise on material budget.	2	3	6	Work more closely with detector concept groups.
WP2-6	Loss of critical staff or WP leaders.	Experts and leaders become overloaded	2	3	6	None	RA recruitment should help.	2	3	6	
WP7	Test-beam time not available or insufficient.	Inability to test devices	2	2	4	Working with EUDET.	None	2	2	4	FNAL may be more promising location for testing.

L = Likelihood on scale of 1...4, where 1 is low, I = Impact on scale of 1...5, where 1 is low: a score greater than 8 represents high risk.

Presentations

Listed are presentations made in the period January to June, 2006.

A Vertex Detector for the ILC, Schloss Ringberg, Germany, May 28th-31st

- Sonja Hillert, "The Vertex Detector in the LDC Concept"
- Konstantin Stefanov, "LCFI Status Report: Sensors for the ILC"
- Joel Goldstein "LCFI Mechanical Studies"

UK HEP Forum, Abingdon, May 6th-7th

- Andrei Nomerotski, "CCD based technology for LCFI"
- Tim Greenshaw, "LCFI Physics Studies"

ILC Software and Physics Meeting, Cambridge, April 4th-6th

- Sonja Hillert, "Overview of the LCFI Vertex Package"
- Ben Jeffery, "Towards a C++ based version of ZVTOP"

LCWS06, Bangalore 9th-13th March

- Konstantin Stefanov, "LCFI Status Report: Sensors for ILC Vertex Detector"
- Alex Finch, "LCFI Vertex Detector Design Studies"
- Steve Worm, "LCFI Status Report: Physics and Mechanics for ILC Vertex Detector"

Publications

Listed are publications produced in the period January to June, 2006.

K. D. Stefanov *et al*, "CCD developments for particle colliders", Nuclear Instruments and Methods in Physics Research Section A. *In Press*, Proof Available online 12 June 2006.

S. Hillert *et al*, "Recent results from R&D towards a vertex detector at the International Linear Collider", Nuclear Instruments and Methods in Physics Research Section A, Volume 560, Issue 1, 1 May 2006, Pages 36-39.

K. Stefanov et al, "Overview of CCD Vertex Detectors", submitted to Nucl. Inst. and Meth. A, 2005.

S. Worm et al, "Vertex detector sensors for the international linear collider", submitted to Nucl. Inst. and Meth. A, 2006.