Summary and Results of LCTW09

The authors ...

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Abstract

This note summarises the workshop LCTW09 held between the 3.11.2009 and 5.11.2009 at LAL Orsay. The workshop was dedicated to discuss the Linear Collider Detector Test-beam needs in the years 2010 up to 2013. The document underlines the rich and highly interesting R&D program of the detectors for the Linear Collider in the coming years. Large synergies were identified in the level of DAQ and software systems. Considerable synergy effects are expected from the establishment of semi-permanent beam lines for Linear Collider Detector R&D at major centres like CERN and FNAL. Reproducing an ILC beam structure would clearly enhance the value of the obtained beam test results. All groups would however exploit such a feature if it is available.

Please note that this is a preliminary version which can be shown to interested colleagues. The final document will be prepared for the 30/4/2010

1 Executive Summary (2 pages - R. Pöschl)

Testbeams are the first occasion for detector concepts to face the truth about their design, and an optimal opportunity to train young physicist on real data. Recently, 40 experts (two from Asia, five from North America and the rest from Europe) met at the Laboratoire de l'Accélérateur Linéaire (LAL) at Orsay to review the needs for testbeams for the R&D on detectors in the future. The goal of this workshop was to collect the needs and to coordinate the activities of the various collaborations active in the field: CALICE, FCAL and SiD groups on calorimetry, LCTPC on gaseous tracking as well as SiLC for the various silicon tracking devices. Representatives of the current major test beam facilities, CERN, DESY and Fermilab, presented their sites and actively took part in the discussions. Many other facilities available in the world were discussed: J-Parc, IHEP Bejing, Tohoku, KEK in Asia, IHEP/Protvino, Dubna in Russia, and it was noticed that SLAC would restore test beams and create a new facility in its end station A by 2010. The successful testbeam efforts prior to the Letters of Intent (LOI) for detectors were reviewed followed by vivid discussions on what is needed to improve these testbeams for the next phase. This document covers the years 2010-2013 which to a large extent coincides with the preparation of the Detector Baseline Document (DBD) in which mature detector technologies are to be presented. The testbeam efforts have to support this goal. Large scale systems of all detector components are expected to be tested in this phase. The succesful conduction of the testbeams is naturally vital for a well founded document. Apart from the fact that the detector developpers have to be ready in time, the community has to make sure that enough beam time is available, in particular in the period 1/2011 - 2/2012 in which most of the activities described in this note can be anticipated. The needs of the LC detector community in terms of particles comprises low energy electron test beams as well as high energy hadron test beams In addition to the beamlines itself, the Linear Collider Detector R&D requires specific equipment such as large bore high-field magnets (up to 6 T). The Table 1 gives a general overview on the activities planned by the various detector components. Another important issue of the detector R&D is to find the optimal balance between high beam rates to conduct physics motivated studies and the fact that e.g. the readout electronics is primarily designed for low rates as in first approach expected at a Linear Collider. The establishment if a dedicated ILC beamstructure would render the results more applicable to prospects on the operation at the International Linear Collider. This is particularly true for the general time structure, i.e. "macro-structure" of the beam. This means that a relatively short pulse of about 1 ms will be followed by a longer interval of up to 199 ms without beam. All the R&D groups would make use of such a possibility to test their hardware under the most realistic conditions. There is no strong requirement to reproduce the micro-structure of the ILC beams. The distribution of particles within the 1 ms spill needs however still to be adapted to the limited buffer depths of the front end electronics of the different devices. The community therefore encourages the site operators to continue efforts to establish an ILC like beam structure. Given the limited time line and manpower situation the LC Detector community will establish a light coordination of the testbeam activities to foster synergies and avoid overlaps in terms of beam times and facilities.

Project	2010/2	Site	2011/1	Site	2011/2	Site	2012/1	Site	2012/2	Site
Calo	xx	**CERN**	xx	**CERN**	xx	**CERN**	xx	**CERN**	xx	**CERN**
		FNAL		**FNAL**		**FNAL**		**FNAL**		**FNAL**
		SLAC		**SLAC**		**SLAC**		SLAC		SLAC
Needs	Magnet		Magnet		Magnet		Magnet		Magnet	
	Particle Types: e, π, p, Energies: 1-120 GeV, Low Rates $\approx$ 100 Hz									
Gas/TPC	xx		xx	CERN	xx	CERN	xx	CERN	?	CERN
		DESY		**DESY**		**DESY**		**DESY**		**DESY**
				FNAL		FNAL		FNAL		FNAL
Needs	Magnet		Magnet		Magnet		Magnet		Magnet	
	Particle Types and rates: e as available at DESY. Hadron beam test not planned but possible.									
SiTrack	x	Various (see Tab.4)	x	Various	x	Various	x	Various	x	Various
Needs	Magnet/Telescope		M./T.		M./T.		M./T.		M./T.	
	Particle Types: e, π, p, Energies: 1-120 GeV, High Rates $\approx$ 10 kHz for short periods									

Table 1: The table indicate the envisaged testbeam activities until the end of 2012. The symbol – means "no activity planned", The symbol **x** means "Test of small units can be expected", The symbol **xx** means "Large Scale Testbeam planned". Tentative sites are given in *alphabetical* order. Bold face letters means "preferred site".

2 World wide LC Beam Test Coordination and Review (2 pages - J. Yu)

The situation of the efforts on the International Linear Collider was picking up its pace after the creation of the Global Design Effort (GDE) in 2004. Along with the global effort on the accelerator front, many detector development groups that have been performing beam test before were intensifying their activities. These efforts, however, were fragmented and were not coordinated at all. Given the anticipated intensity of beam test efforts in the coming few years, it was necessary for the community and the facilities to be able to provide necessary beam capabilities to detector R&D groups. The facilities, however, needed to know what the requirements for the community are. As an effort to convey the upcoming needs, the calorimeter and muon R&D groups have put together a read map document to FNAL in 2005, following a presentation to the Physics Advisory Panel (PAC). This document [1] and the need for more concerted effort led to the implementation of a working group structure and prompted the need for a world-wide ILC test beam workshop to collect and compile the requirements of most, if not all, R&D groups within the community. This was to provide a forum to share ideas and needs between many different groups within the LC community and to make sure that the limited facilities can be used effectively.

2.1 LC Test Beam Workshop 2007 (IDTB07) at FNAL

The goals of the first LC Test Beam workshop held at FNAL in Jan. 2007, were as follows:

- To review and assess the current status, capabilities and plans of facilities
- To review and assess the current and planned detector test beam activities
- To identify requirements for test beams to meet adequately the detector R&D needs
- To plan and discuss for the future beam test activities :
  - What have we learned from LHC beam tests?
  - What can we learn from existing LC test beam activities?
  - What should the future beam test activities focus?

2.2 R&D Groups' Needs Identified at the IDTB07

As a result of three days of presentations and discussions, following requirements have been identified:

- Large bore, high field magnet (up to 5T).
- ILC beam time structure (1ms beam + 199ms blank) **Contradiction to finding in this doc!!!!!!**.
- Mimicking hadron jets.
- Common DAQ hardware and software.
- Common online and offline software.
- Common reconstruction and analysis software infrastructure.
- Tagged neutral hadron beams.

Detectors	N Groups	Particle Type	Momentum/GeV	Magnetic Field/T	Weeks/yr	ILC Time structure	Note
BI&MDI	2E+8ESA +1F+2C +3BC	e	up to 100 GeV	Not specified	64	–	low Energy e
Vertex	10	e, p, π μ	up to 100 GeV .	1-3	40	Yes	
Tracker	3TPC +2SI	e, p, π μ	up to 100 GeV	1.5-5	20	Yes	
Calo	5Ecals +3DHCALs +5AHCALs	e, n, p K, π, μ	up to 120 GeV	Not specified	30-60	Yes	
Muon/ TCMT	3	e, p, μ	up to 120 GeV	Not specified	12	–	

Table 2: Summary of requirements of the R&D Groups as formulated at the IDTB07 at FNAL. Note that most of the calorimeter efforts are part of the CALICE collaboration project. **Do we need this table????**

The Table 2 summarises the needs of R&D groups as formulated at the IDTB07.

The outcome of the IDTB07 workshop resulted in a roadmap document [2] that was released to the LC leadership and facility managers in summer 2007. Many of the improvements made in facilities in subsequent years were based on the requirements and the roadmap laid down in this roadmap document.

3 Subdetector Testbeam Plans

3.1 Calorimeter (3-4 pages - V. Boudry, J. Hauptman)

As will be outlined in this section the calorimeters may put the highest demands in terms of space and availability of beam test areas. Many projects feature projects of about 1 mm^3 and need high statistics for the conduction of physics programs during the beam test campaigns.

DISCLAIMER: The plans of the Dual calorim., FCAL and MUON R&D groups are entirely missing.

3.1.1 CALICE plans

The Table 3 gives an overview on past, present and future calorimeter prototypes. For details on the CALICE program, the reader is referred to [7].

Each project has developped or is developping prototype(s) classified as *physics*, used to demonstrate the physics performances of the technique, or *technological*, used to study the solutions to the technological constraints arising from the integration in a large ILC detector[1], or both. One remaining detector which is yet to complete a physics prototype detector is the Digital ECAL [DECAL]; this is expected to be achieved by 2012. More than it the case for other projects, the concrete plans of this effort do however suffer substantially from the insecure funding situation in the United Kingdom.

Two generation of DAQ system have been developped: a first version, more dedicated to physics prototypes, has been running for a few years, and version 2, suited for technological prototypes, at the end of its development phase, see also Section 3.4.

[1]heating, integration, compactness, embedded FE electronics, power-pulsing

Project	Absorber	Sensitive Part	Completion Date
Physics Prototype AHCAL	Stainl. Steel	Scintillator	Completed
Technological Prototype AHCAL	Stainl. Steel	Scintillator	2012
Physics Prototype TCMT	Stainl. Steel	Scintillator	Completed
Physics Prototype DCHAL	Stainl. Steel	RPC	2010
		partially GEM	
Prototype SDHCAL	Stainl. Steel	RPC	2011
Physics/Technological		partially Mmegas	
Physics Prototype W Hcal	W	Scintillator	2011
		partially Mmegas	
		partially GEM	
Physics Prototype SiW Ecal	W	Si	Completed
Technological Prototype SiW Ecal	W	Si	2012
		partially Scintillator	
Physics Prototype ScW Ecal	W	Scintillator	Completed
Prototype DECAL	W	Si	?

Table 3: Overview on calorimeter prototypes as have been or will be operated by the CALICE collaboration.

Physics Prototypes The years 2010-11 will see the finalisation of the main physics prototype phase. A physics prototype of a digital hadron calorimeter, DHCAL, based on thin RPCs, will be completed in the first half of 2010. As for previous beam tests including the analogue hadron calorimeter, AHCAL, there will be data taking in combination with the physics prototype of the electromagnetic silicon tungsten calorimeter SiW ECAL, if funding permits, and the Tail Catcher and Muon tracker [TCMT], as well as standalone DHCAL data taking. Including commissioning and calibration phases altogether 14 weeks of test beam time will be requested from FNAL. Within these 14 weeks, CALICE should be the primary beam user for about 8 weeks. The other 6 weeks can be spent with parasitic running or the setup of the experiment. The physics program to be conducted will be largely similar to the corresponding data taking in the years 2006-09 with the AHCAL. In the combined running, the emphasis will be put on energy ranges in which it is expected to see signals in the electromagnetic part and the hadronic part (plus tail catcher). In the standalone running also low energy hadrons are to be collected as well as electrons. Priorities would have to be defined later on but the data which were already taken give good guidelines. It is also envisaged to replace a few layers of the DHCAL with GEMs as sensitive detectors. This may happen towards the beginning of 2011. This effort might face the constraint that due to customs regulations, the CALICE stage currently at FNAL is required to be shipped back to Europe in April 2011; a procedure has been started to extend the stay at FNAL[2], if this fails the tests could be completed at CERN.

A new initiative, dubbed W-HCAL, has been started within CALICEin order to study the properties of tungsten as aborber material, primarily for an HCAL at a multi-TeV collider, but possibly also for the ILC. In the versatile structure, featuring 40 absorbers of 16 mm of Tungsten, of the physics prototype the steel absorber plates can be replaced by tungsten plates. Tests with existing scintillator layers are planned for end of 2010 and 2011, tests with gaseous layers as they become available.

Technological Prototypes The CALICE collaboration is entering a new phase of R&D in which readout technologies and mechanical designs do meet already many requirements of the operation in a detector for a Linear Collider. Several groups of the collaboration are already

[2]oral information from M. Demarteau @ CALICE week at Arlington

quite advanced and new full scale prototypes are expected towards the end of 2010. The finalisation of these prototypes will be preceded by a number of larger and smaller testbeam efforts which will allow for maturing the newly developed technologies. Examples for these test beam efforts are:

- Testbeams with 1 m^2 units of the technical prototype of the SDHCAL (both GRPC and micromegas variants). These units might already be part of the production of the entire prototype scheduled for the end of 2010.
- For the analogue hadron calorimeter it is envisaged to have a smaller scale testbeam in 2009 to prepare for electronics commissioning followed by a so-called horizontal test in 2010 and a vertical test in 2011. This means the available equipment will be arranged to allow for the measurement of electromagnetic showers.
- The Si-W ECAL is planning to make tests with single ASU towards the end of 2010 in an electron testbeam. Further tests beams stand-alone and combined with the SDHCAL are foreseen in 2011-2012.

It has to be stressed that the primary goal of these prototypes is to study technological solutions for the calorimetry at the ILC. The strategy for the coming years should take this into account. Here the main keywords are power pulsing, with a duty-cycle of typically 1 % and the limited depth of the buffers in the front end electronics. Due to this the provided particle rates should not exceed 1000 Hz during a spill. Due to its comparatively large recovery time the RPCs can only tolerate rates of not larger than 100 Hz. In case of data taking with RPCs the beam rate must not exceed about 100 Hz. In addition to the pure technological issues a physics program is to be pursued. This physics program is derived from those of the physics prototypes, taking the technical constraints into account. It requires the operators of testbeam sites to actively respond to the needs of the CALICE (LC) testbeam data taking at an very early stage. As it is foreseeable that potential high statistics physics runs will take a considerable amount of time, this will require the deployment of remote control at the experimental sites. As some prototypes may use **flammable gas???**, the topic of security will have to be address at a very early stage.

A first large scale testbeam with a fully equipped technical prototype of an SDHCAL can be expected towards spring 2011. It is still to be clarified in what proportion this SDCHAL will be equipped with the two technologies under study, namely using GRPCs or micromegas as sensitive devices. This is currently pondered on the basis of experience gained with the two technologies by laboratory studies and during test beam campaigns of the year 2009.

Ideally, the SDHCAL will be joined by an SiW ECAL technological prototype by the end of 2011. The running of an AHCAL technical prototype alone and together with the SiW ECAL technical prototype is to follow. During the year 2010 mechanical interfaces between the different detector types will have to be defined. More general year 2010 is to be used to integrate the detector components with the newly developed DAQ systems in order to provide an efficient data taking.

The program requires a high availability of testbeam areas. The CALICE management and the CALICE TB together with the corresponding ILC R&D panels will work out until summer 2010 whether ILC detector R&D can occupy consecutively testbeam areas for a time of two or more years starting with the beginning of 2011. Such a high availability of testbeam areas would also allow for an easier conduction of smaller testbeam programs as for example with the DECAL. In addition a well functional infrastructure would facilitate the testing of a prototype for the electromagnetic calorimeter based on scintillating tiles (ScW ECAL) of which one layer can be expected towards the end of 2012. Finally, technological prototype layers with timing capabilities should also be used in a beam test with a tungsten absorber structure.

3.1.2 SiD ECAL

The Silicon-Tungsten ECAL developed specifically for SiD features 30 longitudinal sampling layers composed of hexagonal high resistivity silicon wafers divide in small hexagonal cells ($13\,\mathrm{mm}^2$). The readout of 1024 channels is performed by a single KPiX chip bump-bonded directly on the wafer. The chip is connected to the DAQ by flat polyimide cables. The R&D on components is almost completed and a compact stack prototype (30 layers of one wafers, $15 \times 15\,\mathrm{cm}^2$) is being build and should be ready for test beam in **??? beginning of 2011 ??**.

The ideal test beam for initial test is a 5–10 GeV (or more) electron beam, well localised and controllable, with a LC-like time structure (for KPiX electronics). A small number of electrons (**mean of** $\sim 1-2$ **for a beam of** $2 \times 2\,\mathrm{cm}^2$ **wide**) per bunch is a must.

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Q? to Rey: Have you made the calculation of acceptable
 - mean distance between electrons ?
 - data throughput for the DAQ ?
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Such a beam is possibly available at SLAC.

The data taking is planned for 2011, preferably at SLAC if a beam exists by then (the current expectation is to have SLAC test beam available around winter 2011). In **2012-2013???**, combined tests with a HCAL prototype with a hadron beam are desirable.

3.1.3 Muons

By Gene

3.1.4 DREAM and Dual Readout Calorimetry

Complete TB program....

3.1.5 Forward Calorimetry

3.1.6 Summary on tentative sites and special Requirements

The beam test campaigns for the CALICE physics prototypes of will be conducted initially at FNAL in 2010 and continued at CERN in 2011. The natural preferred site for the beam tests to be conducted with the technological prototype is CERN since most of the R&D groups involved in these prototypes are based in Europe. As it is currently however difficult to predict fully the availability of the CERN facilities, FNAL remains a serious option for a test beam site. The prototypes of the CALICE collaboration will not need a dedicated ILC like beam structure. Rather it is desirable to obtain beams with a relatively long flat top with an intensity of not much more than 1000 Hz Such a configuration would reply to the layout of the front end electronics which is designed for low occupancy. The validation of the power pulsing technique will however need the availability of a large bore magnet with a field strength between 3 and 5 T. In addition beam telescopes with an excellent point resolution should be part of the beam line equipment.
Testbeams with the prototype of the SiD Ecal will initially be conducted at SLAC with the option to move to FNAL for beam tests with hadrons **true?**.

`Integrate summary from SiD ECAL, Muons, Dream, FCAL`

Group	Technology	Goals	Test Beam
SID Tracking (SLAC)	Multi-metal strips + KPIX Chip	SID Outer Tracker	FNAL
DEPFET Collaboration (MPI Munich)	Depletion mode FET	ILC Vertex	CERN
MIMIOSA (INPE Strasburg)	CMOS MAPS development	ILC Vertex	DESY, CERN
SPYDR (Bristol U.)	CMOS MAPS, deep n-well	Tracking and Vertex	?
3D (FNAL)	3D detector/electronics integration	ILC Vertex	FNAL
APSEL (INFN)	CMOS MAPS triple well, 3D	ILC Vertex	CERN
CAPS (Hawaii)	CMOS MAPS + SOI	ILC Vertex, Belle 2	FNAL
Thinned MAPS (LBL)	CMOS MAPs thinning	ILC Vertex, RHIC	FNAL
SiLC (Paris)	Silicon Strips	ILC (ILD) Tracking	CERN
FPCCD (Japan?)	Fine Pixel CCD	ILC Vertex	KEK?
ISIS (LCFI-UK)	CCD with in-pixel storage	ILC Vertex	?
CPCCD (LCFI-UK)	Column-parallel CCD	ILC Vertex	?
Chronopixel (Yale)	CMOS MAPS	SID Vertex	?

Table 4: Overview on the projects and testbeam plans of the various groups working on Silicon and Vertex Tracking.

3.2 Silicon Tracking (4 pages - M. Vos, R. Lipton, T. Nelson)

Silicon-based tracking and vertexing is continuing to develop over a broad front. Silicon tracking detectors are well-placed to take advantage of rapid development in silicon technology. These new technologies need to be developed, tested, and validated in test beams. Some technologies, like the DEPFET have already demonstrated resolution less than 5 microns and require high momentum beams and sophisticated telescopes to make proper measurements. In parallel tracking detectors are testing larger and more realistic "ladder" designs and will need realistic infrastructure such as pulsed power, ILC-like beam structure, magnetic field, and low mass supports.

There is a broad range of work on vertex and tracking technology. Table 4 summarizes some of the technologies being studied for ILC tracking and vertex.

3.2.1 Beam Properties and Structure

The ILC has a very distinct time structure, with a train of 2820 bunches separated by 337 ns followed by a $\approx 1ms$ gap. Such a structure is difficult, but not impossible to mimic in a test beam. Depending on the application, the ILC structure could be mimicked by appropriate trigger electronics or offline analysis. How well this works depends on the details of the detector integration time, time stamping ability, and saturation effects. Many aspects of pulsed powering could be tested independent of beam conditions. History has shown that detailed tests in an environment as close as possible to actual operation are invaluable

Other beam properties are also important. High energy beams are the only way to unambiguously test detector resolution with minimal multiple scattering. However lower energies are also important to quantify the scattering and validate Monte Carlo models of the detector response. Beams should be able to simulate the rates seen at the inner radius of the vertex detector.

Two-track resolution needs to be studied, both for normal and for glancing incidence. This can be done in a high rate beam, using multiple tracks which pass through the detector within the integration time, or by a secondary target which mimics the interaction vertex. In the case of a secondary target all relevant tracks in the event need to be reconstructed. The momenta also probably have to be measured. This makes for a much more complex setup with a significant magnetic field.

3.2.2 Beam Instrumentation

A high quality beam telescope, such as the one developed for the EUDET program, will be crucial for measurements of high resolution pixel detectors. [add discussion of AIDA, other options ...]

A flexible readout system will also be important for testing the large variety of devices being brought to the beams. One example is the CAPTAN system, developed by FERMILAB, and designed a a flexible, FPGA-based readout system for a variety of devices. To date the CAPTAN has been used to read out the BTeV FPIX chip, the CMS pixel chip, the VIKING strip chip, and will be used for the VICTR CMS track trigger chip. [other developments?]

Small area trigger can be provided by a version of the VICTR chip, which has a array of 64 $1\,\mathrm{mm} \times 100\,\mu\mathrm{m}$ strips with a fast output and maskable pixels. The chip is designed (for LHC upgrade triggering) for a coincidence with a second detector 1-2 mm away.

3.3 Gaseous Tracking (2 pages - T. Matsuda)

Physics at the International Linear Collider (ILC) or the Compact Linear Collider (CLIC) will require a detector of high precision. A tracking system of the detector has to achieve a high momentum resolution $\delta(1/p_t)$ of a few $10^{-5}\,(\mathrm{GeV/c})^{-1}$ [1]. This resolution surpasses by 10 times the best momentum resolution achieved by the experiments at LEP. The tracking system should also provide a high tracking efficiency down to a few GeV/c to ensure a good jet-energy measurement by the Particle Flow Algorithm (PFA) in an environment of high beam-induced backgrounds.

To meet with these requirements, a large Time Projection Chamber (TPC) with using Micro Pattern Gas Detectors (MPGD) is proposed as a central tracker of the International Large Detector (ILD) [2]. The ILD TPC is to be located in a large superconducting solenoid of 3.5 T. It measures each track at 220 space points with an $r\phi$ spatial resolution of 100μm or better in the whole drift volume of 2.2 m long. This performance of TPC is only achievable with the MPGD technology [3,4]. At this moment we consider three candidates of MPGD detectors; Bulk MicroMEGAS with resistive anode readout, GEM with narrow pad readout, and, in a somewhat longer time scale, a digital TPC with Ingrid TimePix or a semi-digital TPC using GEM readout by TimePix.

3.3.1 TPC R&D by the LC TPC collaboration

The LC TPC collaboration has been carrying out R&D of the MPGD TPC for ILC (ILD) in three stages;

1. Demonstration phase.
2. Consolidation phase.
3. Design phase.

At each phase for the last several years, we have performed a multitude of beam tests.

In the demonstration phase (2004-2007) a basic evaluation of the properties of the MPGD gas amplification was made, demonstrating that the requirements for the linear collider (ILD) could be met. For an example, we have shown though a beam tests of small TPC prototypes that the $r\phi$ space resolution of $100\,\mu$m could be

possible both by MicroMEGAS with the resistive anode readout and GEM with the narrow pad readout [?].

In the current consolidation phase (2007-), we have been successfully operating a TPC Large Prototype 1 (TPC LP1) at a low energy electron 5 GeV/c test beam at DESY, T24-1. The goals of the LP1 beam test are to confirm the results from the demonstration phase for a larger scale TPC [?], and to show that the excellent momentum resolution is actually achievable for the LC TPC. In 2010 we plan to perform beam tests with the LP1 endplate which will be equipped with four to seven MPGD modules, and we have been developing a new TPC tracking code for non-uniform magnetic field. In this phase, in addition to the development of the different MPGD TPC readout modules, we also study basic engineering issues for the LC TPC. Good examples are the construction of a thin LP1 field cage and the development of a low noise, high-density TPC pad readout electronics using S-ALTRO.

And we are now entering the design phase (2010-) where we work for a basic conceptual design of the LC TPC.

3.3.2 LC TPC R&D and Beam Tests in 2010-2012

In the design phase of 2010-2012, beside the overall design of the LC TPC, we have two major hardware R&D issues; (a) a design of a TPC endplate of the thickness of 15% radiation length or less, and (b) a choice of the ion gating device. We have started our study of a light mechanical structure of the TPC endplates, and also the so-called advanced end-plate TPC modules with power pulsing and an efficient cooling such as the two-phase CO2 cooling. We plan to build a new LP1 endplate structure mounted with the advanced TPC modules with S-ALTRO (and also modules of the digital TPC), and test it in a test beam for the ILD-DBD (Detail Baseline Design) in 2012. For this R&D phase we have not yet a full scope of funding. In 2011, we plan to modify the magnet PCMAG to make it a superconducting magnet without liquid He supply. The modification will take about 6 months.

3.3.3 Test beam before 2012 and the ILC beam structure

In the current prospect of our R&D budget and support, and in the situation where the availability of a higher energy hadron test beam in 2011 seems to be not very clear, we plan that our TPC LP with PCMAG stays at the T24-1 beam line at DESY until to the end of 2012. We may perform some optional and small scale beam tests at high-energy hadron test beams and in a higher magnetic field using small prototypes.

At the DESY test beam, there is no plan to simulate the ILC beam bunch structure. We plan to test the power pulsing of the advanced TPC modules with the beam without the ILC bunch structure. We think that we do not really need beam to test the power pulsing. The functional test of the power switching of the advanced TPC modules in a higher magnetic field will be necessary. To demonstrate how our ion gating device works, we may need a proper device, either a laser or a flash lamp, to simulate beam backgrounds at ILC according to the beam bunch structure.

3.4 Data Acquisition (2 pages - M. Wing)

In general, a given ILC sub-detector develops its own data acquisition (DAQ) system to suit its needs, depending on a multitude of technical issues such as data rates, number of channels to read out, etc.. The DAQ system consists of the hardware—various electronics boards using various standards to get the data from the detector head to a PC—and software to control the flow of data from the detector and commands to the detector. The requirements can then lead to a DAQ system which is conceptually new or is strongly based on an existing system in use for another detector; both of which are reasonable approaches. This therefore results in very different systems when developed in isolation as is the case for several of the ILC sub-detectors; a brief review of some of the systems is given below.

Were sub-detectors to continue in isolation a programme of verification in a beam-test, then bespoke development is a sensible approach. However, should any sub-detectors wish to have combined beam-tests with another sub-detector, then more thought and planning is needed. Therefore any issues with regard to DAQ systems depend crucially on whether combined beam-tests of several sub-detectors will happen. Alternatively, given extra resources such as those which may be provided by the AIDA project, a common approach to DAQ systems could be pursued now such that a final system for a final ILC detector will be easier to manage and integrate when it becomes a reality. Careful planning now could lead to significant benefits, with reduced risk, in the future. As a DAQ system serves a given sub-detector or detector, it is not a driver for individual or common beam tests which is dictated by the detectors themselves. As a separate goal, more generic aspects of DAQ system can be developed for future sub-detector use which will save on effort in the long-run.

3.4.1 Example DAQ systems

CALICE DAQ

Most of the focus for the new CALICE DAQ system has been on the hardware development and firmware to control it [8, 9]. The system consists of several layers of concentrator cards to get the data from the detector head to a PC and storage. Given that the CALICE programme includes several different types of calorimeter, the first layer of electronics needs to convert the sub-detector-specific data into a generic structure which is then passed to the next layer. As such, the hardware system needs to be suitably generic and could in principle be used for various sub-detectors and not just calorimeters. The DAQ and slow control software are less advanced. Initially the approach was to use existing software designed to cope with large-scale systems; the programmes DOOCS [10] and XDAQ [11] have been used so far. In light of possible combined beam-tests, a survey of available software is being performed.

EUDAQ system for vertex and tracking detectors

A DAQ system developed to read out the EUDET [12] pixel telescope has been developed [13, 14]. The telescope is a relatively small-scale detector and is read out via a VME-based hardware system. Major effort has been invested in writing a flexible DAQ software framework, called EUDAQ, which has been successfully used for the pixel telescope in numerous beam tests. The code is written in `C++`, is freely available and was fully developed by the main authors. The software has been used by several other groups when performing beam tests in conjunction with the pixel telescope. Indeed the LC-TPC collaboration are using it for their work on a TPC sub-detector [15]. Any new sub-detector just needs to write a producer and the EUDAQ authors should be able to integrate on the time-scale of a few days.

3.4.2 Towards a common DAQ system

As sub-detectors will at some point be used together, say as a complete detector slice-test, the data will have to be merged at some point. The extremes are : to develop one data acquisition system, both hardware and software, which is able to read out all sub-detectors; or for sub-detector DAQ systems to all be developed in parallel and data merged at the final opportunity when it is stored. The former is unlikely given the various logistical problems whilst the latter is undesirable, potentially leading to wasted effort and a lack of coherency in the final data samples. The reality will lie somewhere in between with some common hardware used and even more so, common software. From the examples given above, the CALICE hardware could in principle be used for other sub-detectors, although this would have significant costs associated to it. The EUDAQ software may be a viable solution for CALICE calorimeters, although this needs to be demonstrated given its current use for a much smaller system. As DAQ systems for all sub-detectors are relatively well advanced, adapting to common solutions will require extra effort and will require e.g. the funding of AIDA to make it possible.

Taking a middle ground on common aspects of a DAQ system, some of the questions and issues which need to be addressed are listed below. These should be addressed if the AIDA project is funded.

Common Hardware

Although the hardware used for the CALICE calorimeters and the CAPTAN [16] project are relatively generic and could be used for other sub-detectors, it is unlikely that such an approach is possible. However, there are various common items amongst the various sub-detector groups which could be used :

- Hardware which provides a trigger or a clock such as the Trigger Logic Unit [13] or Clock and Control Card [8] developed for the pixel telescope and CALICE calorimeters, respectively, could be used by all sub-detectors. These would uniquely identify each trigger.
- A proposed "Beam Interface Card" [9] could be used to monitor beam conditions taking data from e.g. scintillators, hodoscopes, etc.. Its exact form is to be designed.

Common Software

There are a multitude of DAQ software frameworks developed for previous or existing experiments. A critical review of these needs to be done :

- Large software frameworks such as XDAQ, DOOCS, TANGO [17], etc. have been developed with large-scale, diverse apparatus in mind. Presumably they then have the necessary functionality and flexibility to provide the framework for the ILC sub-detectors. This needs investigation and the various software compared;
- The EUDAQ software has been shown to work successfully with a number of different sub-detectors. However, its efficacy for reading out large systems such as the CALICE calorimeters, with thousands of channels, must be verified;
- Information needed to decide on the nature of the read-out path is the data volume, zero suppression, compression, data format etc.;
- It is generally agreed that all data should be converted into the common ILC offline software format, currently LCIO.

In summary, commonality between the DAQ systems of the various sub-detectors should be sought at an early stage so as to ease integration later. Should the AIDA project be funded, this will give the necessary support of this effort in which a critical review of current DAQ hardware and software is carried out leading to a more coherent framework for future ILC detector beam tests.

3.5 Software (2 pages - F. Gaede, N. Graf)

Software development for ILC test beam experiments has a large potential for collaboration, as typical computing tasks in high energy physics event data processing have a high degree of similarity from experiment to experiment. For example every experiment needs a way to store and retrieve the conditions data, defining the experimental setup at the time of data taking. In order to avoid duplication of effort, most of the current test beam collaborations are already using a common set of core software tools. This desirable development has been greatly fostered by the EUDET [12] project during which already existing software tools have been improved and combined into a common framework, referred to as ILCSoft [18]. The same software framework is also used by the ILD detector concept, the CLIC detector working group and in parts by the SID detector concept. These groups work on the development and optimization of the global detector concepts, based on Monte Carlo simulations and results from the R&D test beams. Having a joint software framework thus provides synergies for both communities, as code and knowledge can be shared easily and provide for the necessary feedback of realism into the full simulation.

3.5.1 ILCSoft tools

ILCSoft is based on LCIO [19], which is a persistency file format for ILC studies and defines a hierarchical event data model for full detector simulation and dedicated raw data classes for beam test experiments. The core of the ILCSoft framework is defined by Marlin, a modular C++ application framework that uses LCIO as its transient and persistent event data model. Marlin is complemented by a number of software tools: GEAR which provides the high level view other detector geometry and materials as needed during reconstruction and analysis, LCCD a conditions data toolkit that provides access to the conditions data and CED a fast 3D event display. The simulation of the detector response is performed in the geant4 application Mokka [20]. The geometry description in Mokka is interfaced to GEAR for reconstruction and analysis. Fig. 1 shows an overview of the main tools used in ILCSoft. The core framework

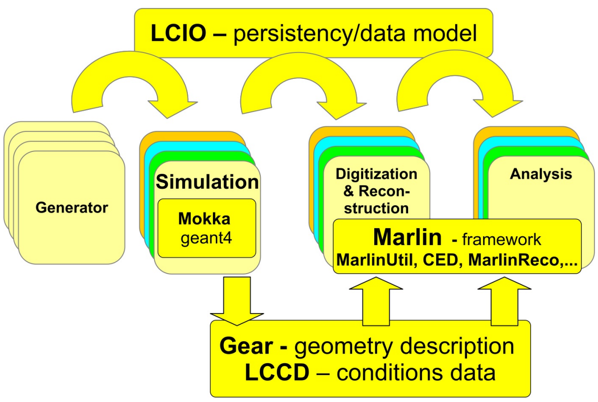

Figure 1: Schematic overview of the ILCSoft framework tools.

is completed through a number of auxiliary tools, such as RAIDA for histograming and the utility package MarlinUtil and depends on a small set of external packages like ROOT, gsl and CLHEP.
The following planned developments and improvements for LCIO are currently ongoing:

- direct access to events
- splitting of events and partial reading of event data
- streaming of user defined classes

Using ROOT I/O for the implementation of these new features is under investigation. Another area of possible improvement is the geometrical description of the detector. While the current system ensures one leading source of the geometry, the Mokka simulation, it could be made more flexible by having a standalone tool that feeds into simulation, reconstruction and event displays. The development of such a flexible system is foreseen in the proposed AIDA project. This would also include mis-alignment and integration with conditions data as the distinction between geometry and conditions data is not always perfectly well defined.

3.5.2 Calice and LC-TPC Software

The Calice collaboration was the first test beam group to adopt the ILCSoft framework. Calice has been using the complete framework for their past data taking campaigns and provided very useful feedback that led to the improvement of the software tools in particular in the context of the EUDET project. Calice is not using LCIO as their raw data format, but are converting their data to LCIO within hours of the data acquisition. This 'duplication' of raw data has proven to be less than optimal and having one raw data format only would be desirable for future beam tests [22].
Also LC-TPC was an early user of the common core software tools. They are currently working on completion of their reconstruction and analysis package MarlinTPC [23]. In that process they improved the geometry description of the TPC in GEAR in order to meet the requirements. An example for the fruitful interplay between core software group and users. LC-TPC also suggested improvements for LCCD, namely to store the conditions data in data base tables, that can be queried using MySQL tools.

3.5.3 Grid computing

Large computing resources for high energy physics data processing will be available only on the Grid. All the test beam data that has been accumulated so far is stored on Grid storage elements and major Grid sites did provide so far sufficient computing resources for their analysis. This was partly facilitated due to the delay of the LHC, for which massive resources had been allocated. With the LHC now running it is important to make the Grid sites aware of the computing needs of upcoming ILC beam tests so that they can plan accordingly.

3.5.4 Remote control and communication tools

Besides data analysis software for beam tests, control and communication tools are an important aspect that can foster collaboration and reduce travel expenses. A nice example is the Calice control room that was recently set up at DESY [21] and is fully functional from the start. This room was realized for comparatively small budget, that paid off in a short period of time through savings in travel cost.

With improvements in audio and video technologies, increased band widths and lower cost, modern communication tools and remote control centers will become more widespread and are likely to change the way experiments are run.

4 Sites (4 pages - F. Sefkow, J. Yu, K. Kawagoe, V. Vrba

4.1 CERN - by L. Linssen

CERN offers a broad range of test beam facilities with beams originating both from the Proton Synchrotron (PS) and Super Proton Synchrotron (SPS) accelerators. At the CERN PS East Hall, there are two test beam lines, T9 and T10, delivering hadrons, electrons and muons of up to 15 GeV/c and 7 GeV/c momentum respectively. During a spill length of 400 ms, occurring typically every 33 s, up to 106 particles can be delivered. Recent studies have indicated that an ILC-like beam structure can be produced at the PS. In the SPS North Area hall EHN1 there are four test beam lines (H2, H4, H6, H8) with several experimental areas each. The H2, H4 and H8 lines can provide secondary hadrons, electrons or muons of up to 400 GeV/c or primary protons of up to 450 GeV/c. The H6 line has a maximum momentum of 205 GeV/c. Up to 2×10^8 particles per spill can be delivered. Spill lengths vary from 4.8 to 9.6 s, while spills are repeated every 14 to 48 s, depending on the number of SPS users. Together with the beams themselves, CERN provides some adjacent infrastructures, such as basic beam instrumentation. These comprise beam spectrometers for precise momentum definition, wire chambers to measure beam profiles, as well as threshold Cherenkov counters and Cedar counters for particle ID. On request a scanning table can be provided and some beam lines are equipped with magnets, which can surround the equipment under test. In 2010 the PS and SPS are scheduled to provide 28 weeks of beam. Since many years, the CERN test beams have been used extensively by the linear collider detector community. This tradition continues. In 2010 a total of 28 days are scheduled for linear collider-related tests at the PS T9 beam, 34 days at the SPS H4 beam and 48 days at the SPS H6 beam. The linear collider users represent several CALICE HCAL technology tests, SiLC tests and various vertex technology tests. For the following years, the PS and SPS test beam schedules are expected to have some dependency on the LHC schedule, with most likely a similar availability of test beams in 2011 and potentially a somewhat shorter duration in 2012. Users have two ways to apply for beam time. For short beam tests, ¡2 weeks at the PS or ¡1 week at the SPS, requests are addressed directly to the SP/SPS coordinator (sps.coordinator@cern.ch) by submitting a form. These requests are normally collected towards the end of the year for the following year. For beam tests of longer duration a formal request has to be addressed to the SPSC committee. Some user groups have semi-permanent test beam installations. Examples are the CMS experiment in the H2 line, the ATLAS experiment in the H8 line and the RD51 collaboration in the H4 line. Following approval by the SPSC, these installations have been built up through a common effort by the collaborations involved. What concerns the linear collider activities, the establishment of semi-permanent ILC beamline at CERN, should be requested latest by mid-2010 in order to have it available by middle of 2011.

4.2 DESY - to be completed by F. Sefkow

- High availability, but small room for improvements
- 1-6 GeV energy, 2 KHz rate
- Very flexible, 4 areas, arrangement on short notice possible

A lose Brain Storming by C.Hast (SLAC) and N. Meyners (DESY): XFEL and ILC timestructure (XFEL is little ILC). Potential for a hadron testbeam at DESY (could be established around 2015, maybe not realistic).

4.3 Further European Sites - to be completed by F. Sefkow, V. Vrba

- IHEP/Protvino, e between 1-45 GeV,
- Dubna, neutron beams, good neutron yield

4.4 FNAL - Erik Ramberg

Crucial to many detector development projects is the ability to test real life operations of the device in a high energy particle beam. Only a few such facilities exist in the world. The United States' only high energy detector test beam facility is the one at Fermilab. The Meson Test Beam Facility (MTest) gives users from around the world an opportunity to test the performance of their particle detectors in a variety of particle beams. A plan view of the facility is shown in Figure 2. The web site for the MTest facility can be found at `http://www-ppd.fnal.gov/MTBF-w/`.

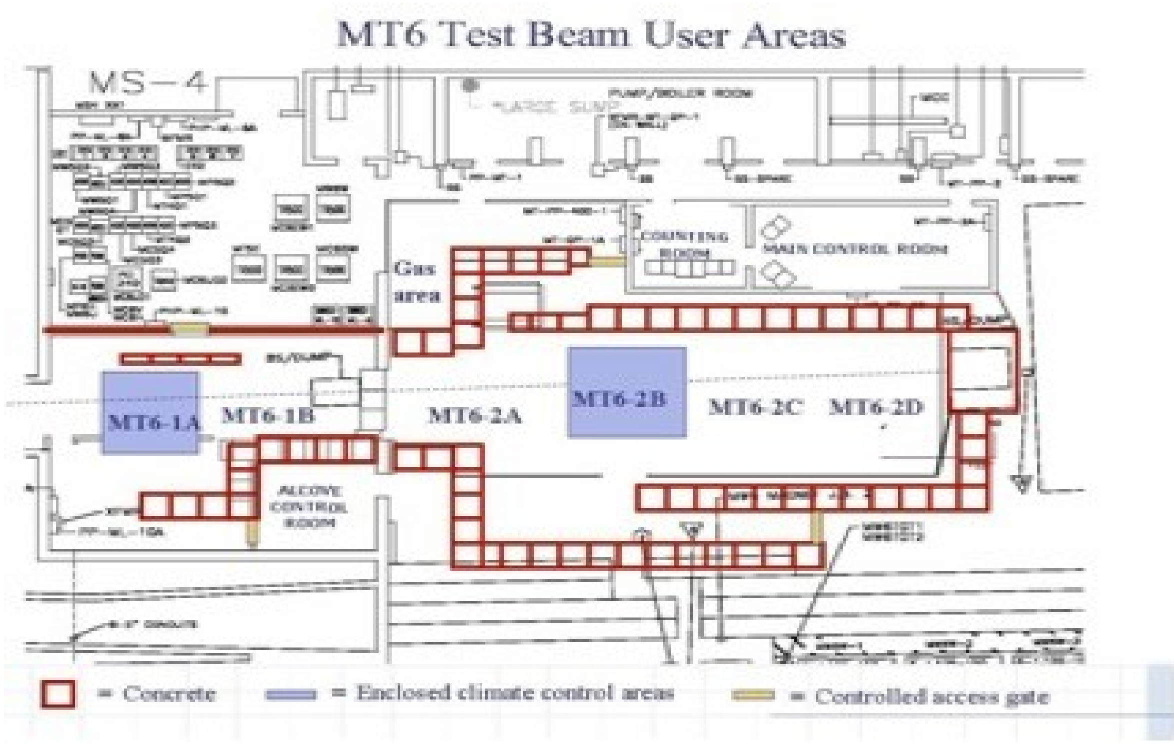

Figure 2: *Plan view of the Meson Test Facility at FNAL.*

4.4.1 Details of the beam

The test beam originates from the resonant extraction of at least one Booster batch inside the Main Injector (MI). This batch usually consists of 10-60 RF 'buckets', with buckets separated by 19 ns. Thus the batch is anywhere from 0.2-1.2 μs long. The batch is accelerated to 120 GeV, circulates around the MI, and is slowly extracted over a macroscopic slow spill using a resonant quadrupole called QXR. The full circumference of the MI is about 11 microseconds, giving a large gap between extractions. The length and duty cycle of the spill is determined by the Accelerator Division (AD), with guidance from the Office of Program Planning. For most operations there is a single 4 second long spill per minute, for a maximum of 14 hours per day. The AD has setup a procedure for easily changing from this 4 second spill to a 1 second spill. This shorter spill can then be delivered more frequently for commissioning purposes and for those groups who are data-acquisition buffer limited. The AD has also commissioned a "pinged" beam operation where beam is extracted using a pulsed operation of the QXR, with up to 4 pings per spill, each with a tunable width from 1 to 5 ms. The 120 GeV proton beam has an approximate 0.3% momentum spread and can be focused to a 7 mm RMS spot size in the user area. In addition to delivering primary protons, there are two targets on movable stages that can act as secondary beam production areas. The magnets downstream of those targets can then be tuned to deliver any secondary momentum from 0.5 GeV to 60 GeV. The momentum spread of these secondary beams depends on the energy and the details of the collimation and can range between 1-10%, with the poorer resolution beam occurring for the lower momenta. The physical size of the beam is approximately 2-5 cm rms for the lower momenta. The Table 5 shows the rate of beam delivered to the user area for some selected momenta.

Beam Energy/GeV	Rate at Entrance to MT6 (per spill)	Rate at Exit to MT6 (per spill)	% π/μ at Exit of MT6
16	132000	95000	82%
8	89000	65000	42%
4	56000	31000	26%
2	68000	28000	$<$ 20%
1	69000	21000	$<$ 10%

Table 5: Rate of beam delivered to the MT6 user facility for 1 × 1011 protons in the Main Injector. Remainder of beam is identified as electrons.

As part of the improvement in extending momentum range of the beam line, the MINERVA experiment (T977) proposed to install an entire new tertiary beamline in the user facility so that it can deliver 300 MeV/c pions onto their test apparatus. This beamline was begun in the US FY2008 and has recently been completed. After the completion of the MINERVA tests, this beamline will be available for other users. The target and collimator can be rolled quickly aside so that the facility can operate normally.from them as well.

4.4.2 The future of test beam at Fermilab

The Meson Test Beam Facility will be in operation for the foreseeable future, since it has demonstrated a wide variety of modes of operation. Because the facility is in heavy use, it is likely that additions and upgrades to the equipment at MTest will be incremental, with no large update at any given time. In addition to the Meson Test beamline, Fermilab will be starting a new test beam facility in the Meson Center beamline. This facility will be known as the Meson Center Test Facility, or MCenter, and will be used as an adjunct to the MTest facility. The two beamlines are virtually identical, while the user areas are complementary. While the MTest facility has a large variety of user installation areas, and a crane to support them, the MCenter facility is tighter, but has two spectrometer magnets that could be used for a variety of calorimetry studies. Currently the MIPP experiment's apparatus occupies the downstream location in MCenter. This apparatus could be used to perform tagged neutron studies, as well as support tracking for more advanced installations. With the help of a thin target a "jetty" environment could be mimicked for future testbeams. Fermilab has begun efforts to provide for a user facility in MCenter to support detector R&D. With a very successful MTest beamline, and a second MCenter beamline to augment it, then Fermilab's test beam facilities will remain in the forefront of detector support in the United States for quite some time.

4.5 SLAC - Carsten Hast

End Station Test Beam (ESTB) is a approved and funded SLAC project to use a small fraction of the 13.6 GeV electron beam from the Linac Coherent Light Source (LCLS) to restore test beam capabilities in End Station A (ESA), as shown in the schematic diagram in Figure 3. Four new kicker magnets will be installed in the Beam Switch Yard (BSY) to divert 5 Hz

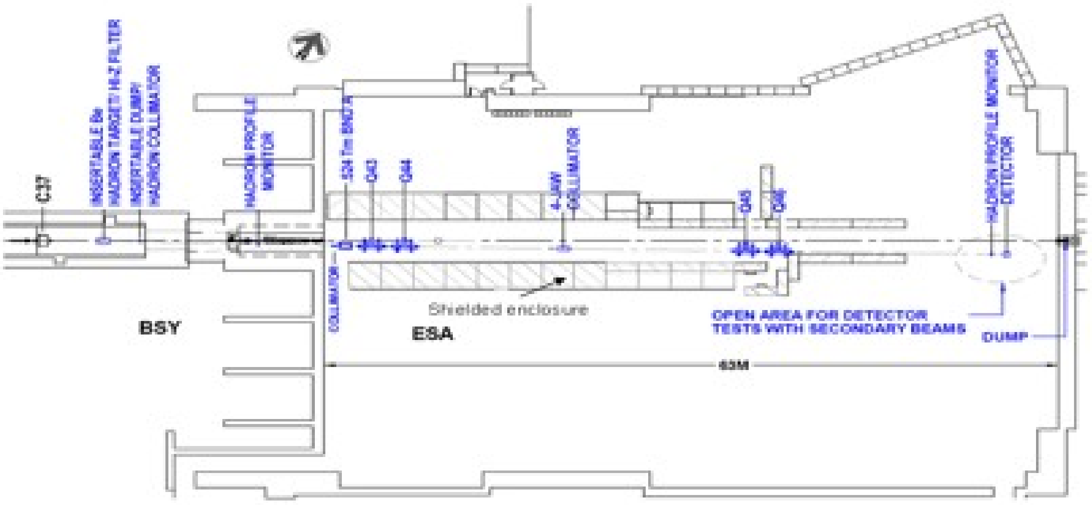

Figure 3: *End Station A Facility configuration. Primary beam experiments will be conducted along the primary beamline inside the shielded enclosure. The primary beam terminates in the beam dump shown in the ESA east wall. Secondary beam tests for detector studies will take place in an open region at the end of ESA. The proposed hadron beamline components and the new beam dump are shown in blue, overlaid onto the existing ESA setup.*

of LCLS beam to the A-line. This beam can be transported all the way to ESA for beam instrumentation and accelerator physics studies at full electron beam intensity. Alternatively, it can be directed against a thin screen in the A-line, to produce secondary electrons or positrons with energies up to the incident energy, and a wide range of intensities including single particles per pulse suitable for detector studies. The installation of a secondary hadron target and a hadron beam line in ESA is a possible upgrade for 2011. This beam will produce pions and kaons over a broad range of momenta, suitable for particle physics and astrophysics detector development or calibration in ESA. Besides the four new kicker magnets, a new Personnel Protection System (PPS) and a new beam dump in the ESA East wall need to be installed. For the hadron target a new beam line with bend and quadrupole magnets and acceptance collimator needs to be designed and installed. The ESTB is a unique resource in all of High Energy Physics for studies requiring high energy, high intensity, low emittance electron beams in a large experimental area. These studies include accelerator instrumentation, linear collider accelerator and machine-detector interface (MDI) R&D, development of radiation-hard detectors, material damage studies, and astroparticle detector research. As summarized in Table 6, ESTB also provides moderate energy (E=13.6 GeV) secondary beams of electrons and hadrons for detector R&D. Electron beams of exceptional purity, momentum definition, and small size can be delivered. The time structure of the test beams is that of the SLAC linac, and is unique in delivering picosecond pulses at known times. This makes triggering and data collection very convenient at ESTB. A tagged photon beam could also be provided. At a later stage pions are available up to about 12 GeV/c at an intensity of 1 particle/pulse, and kaons at a 1/10 of the pion rate. ESTB utilizes the existing ESA, a large experimental hall 60 meters in length with 15 and 50-ton overhead cranes and excellent availability of utilities, cable plant, and components for mounting experiments. ESA is ideal for detector development and testing large scale prototypes or complete systems with high energy particles. Figure 4 shows the secondary particle yield per LCLS beam intensity in nC as a function of secondary particle energy. Funding for the four kicker magnets, new beam dump and a new PPS system is available in early 2010. We have already started with designs. The biggest task is the new PPS for ESA, where we expect the completion in early 2011, after which operation can commence. Funding for the hadron beam line is expected through 2011.

Parameters	BSY	ESA
Energy/GeV	13.6	13.6
Repetition Rate/Hz	5	5
Charge per Pulse/10^{10} nC	0.15-0.6	0.15-0.6
Energy Spread, $\sigma/_E E$	0.058%	0.058%
Bunch length, rms/**m ???**	10	280
Emittance, rms$(\gamma\epsilon_x, \gamma\epsilon_y)/10^{-6}$ mrad	1.2, 0.7	4, 1
Spot Size at waist, $\sigma_{x,y}/$ µm	-	10
Momentum Dispersion, η and η'/mm	-	< 10
Driftspace available for experimental apparatus/m	-	60
Driftspace available for experimental apparatus/m	-	5×5

Table 6: *ESTB primary electron beam parameters and experimental area at the BSY and in ESA.*

4.6 Asian Facilities - by K. Kawagoe

There are several low energy testbeam facilities in Asia, where test of small units can be performed.

4.6.1 J-PARC

The 50 GeV proton synchrotron started its operation at 30 GeV in 2009. In the hadron physics facility, there are several beam lines. The K1.1 beam line will be available in 2010, where hadrons with momentum 0.5∼1.1 GeV/c and good enough particle yields are available . This beam line can be used for testbeam experiments until preparation of the main experiment at K1.1 is started. The K1.8BR beam line is dedicated to the testbeam experiments, and hadrons with momentum 0.5∼1.5 GeV/c are available. This beam line also will be ready in 2010. However, the particle yields are expected to be very low at the bегininng to be used for the experiments. until the intensity of the proton syncrotron becomes close to the design value (100 MW).

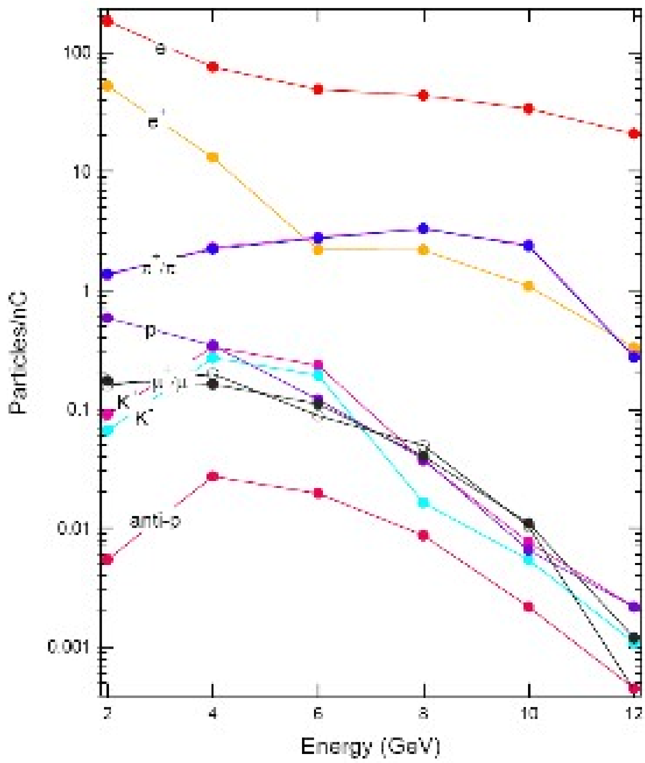

Figure 4: *Secondary particle yields in ESA per nC of LCLS beam incident on the 0.87 r.l. Be target. The production angle is 1.50 degrees, the acceptance is 5?sr, and the momentum bite $\Delta p/p = 1\%$. LCLS beam energy is 13.6 GeV. For expected operating conditions, the yields at the end of ESA are roughly a factor of 4 lower.*

4.6.2 KEK

FTBL (Fuji Test Beam Line) utilizes synchrotron photons radiated from KEKB electron beam to make electron beams with momentum 0.4∼3.4 GeV/c. FTBL has been used for many testbeam experiments, including ILC activities, since FTBL started its operation in 2007. FTBL is not curently available because of the shutdown (2010∼2012) for the upgrade of KEKB. ATF (Accelerator Test Facility) for the ILC can be in principle used for testbeam activities. The electron beam with momentum 1.4 GeV has a bunch strucure (2.8 ns). and the particle yield is 10^{10}/s.

4.7 IHEP, Beijing

BTF (Beijing Testbeam Facility) provides primary electron beam with momentum 1.1∼1.5 GeV/c and secondary beams with momentum 0.4∼1.2 GeV/c. BTF is now under a long shut down (2008-2010) for its upgrade.

4.8 Tohoku LNS

Laboratory of Nuclear Science (LNS) at Tohoku University in Japan has a testbeam facility providing electrons with momentum 300 MeV/c and 1.2 GeV. The availability of the facility is very high.

5 Permanent Beam Lines and Combined Testbeams (2 pages - R. Pöschl, G.Fisk)

The establishment of beamlines mainly dedicated to Linear Collider Detector R&D has been an important topic at the workshop. In general it is felt that the establishment of those beam lines would lead to important synergies. This leads from practical issues like "knowing where the trigger counters are" to the possibility to install infrastructural components like communication services at the beam test sites. The main advantages of permanent beam lines are listed in the following

- The use of a permanent beam line will allow the sharing of experience with the usage of a beam line. Hence, the data taking can be much more efficient as the sometimes tedious period of getting up and running can be much shorter.
- The existance of a permanent beam line would foster the development of common DAQ interfaces which after all would also facilitate the data taking a lot. This can go as far that manning of shifts can be shared by different detector types, simply because the interfaces to the detectors are familiar. This in turn safes travel money and man power. Clearly, it has to be made sure that in particular young students can still be trained at beam test sites.
- A permanent beam line will facilitate a situation in which one subsystem is the main user while another one acts as a secondary user to e.g. take calibration data or for long term studies. A general familiarity with a given beam line would render such a configuration much easier and allows for flexible switches between detector components if circumstances demand it.
- A common remote control system may allow for data taking even if no expert of a subsytem is on-site. This clearly has to be coordinated with safety aspects of the various beam test sites.

- A permanent beam line would naturally lead to a mutual better understanding of other detector components. The fact that a common DAQ system at an early stage may facilitate the system integration in the real detector is also not to be underestimated.

In order to underline the need of permanent beam lines beam requests could be transmitted to sites in a coordinated way by the spokespersons of the detector R&D collaborations at given dates in a year. By that several requests from the community arrive at the same time which may naturally lead to an assignment of only a few beam lines to the requests. The placing of the requests to the sites will be preceeded by a brief meeting of the spokespersons in order to have an idea of schedules which could then also be streamlined. The step to a common request is not that long in that case. A short meeting on coming beam test activities will become a standing item at each LC workshop.

All beam test efforts will be monitored by a light monitoring system. In practice, this will be a simple date base where the groups enter the date and the purpose of the test as well as the beam line they use. This is a simple mean to facilitate communication beyond different detector system. It is very light weight and easy to implement at any computing centre (FNAL, DESY, CERN, CC IN2P3). The data base can be brought in operation during the summer of 2010.

Another question is whether the community should plan for combined beam tests, i.e. combining different detector technologies. The workshop could not identify a clear project of a major combined testbeam for the period 2010-2013. There are, however, occasions at which a combination at a smaller level seems to be feasible. Calorimeters for example need very often a good point resolution. This requirement is very much met by the EUDET Telescope. It could however be imagined that such a task can be realised by a Silicon tracking device conceived for Linear Collider Detectors

6 Conclusion, Outlook , Recommendations and Requests (1-2 pages - R. Pöschl, All)

This document witnesses the large amount of challenging activities in the R&D for Linear Collider Detectors. All proposed technologies need considerable testbeam resources in the coming 2-3 years. Given the fact that the "imminent" aim are the DBDs at the end of 2012, a high availability of beam test sites in the coming 2 1/2 is of utmost importance. In this sense the plans of the FNAL management to shutdown the MTEST area in 2012 might bear a considerable risk for all the projects. Herewith the community formulates the clear request to maintain the facility open at least for the first half of 2012. Based on this document the community will be able to negociate with the management of the beam test sites to establish permanent beam lines. This is in particular true for CERN where a large scale calorimeter beam tests can be expected. On the other hand the community is encouraged to exploit the wealth of available sites and prepare for alternatives if their "preferred" site is not available. The document indicates that availability is of larger importance than efforts for a dedicated ILC beam structure. If such a structure is however available this would be very welcomed by the community. The success of the R&D program depends crucially on the interplay between the community the laboratories running beam test facilities and the funding agencies in order to come to high quality results and well understood detectors.

7 Appendix

Primary contacts for site managers:

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These persons may serve as a primary contact in case of additional questions on project plans and will establish the contact to the various groups.

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