

# MOA and Addendum

General idea:

1. Short ("loose") MOA giving
  - basic motivation - why TPC for an LC detector
  - reason for collaboration - TPC R&D
  - rules/structure of the collaboration
  - which groups / signatories
2. Addendum, regularly updated, giving
  - RC-CB-TB names (which will be changing)
  - changes in the groups
  - details about R&D planning and its evolution

Finances to be handled seperately....

## Memorandum of Agreement on the Formation of the LCTPC Collaboration

October 2007

### 1 Introduction

#### 1.1 Preamble

(motivation)

Several detector concepts for the International Linear Collider (ILC) foresee a time projection chamber (TPC) as the central tracker in a tracking system of high precision and fine granularity combined with a calorimeter system of very fine granularity. The detector is being designed for precision measurements in the electroweak sector and of new HEP-phenomena which might be discovered. One aspect of precision experiments requires the measurement of charged tracks with an order of magnitude better accuracy than at previously built collider-detectors. Another aspect requires the detector to be optimized for the reconstruction of multi-jet final states. The jet energy resolution using the particle-flow technique is best when the reconstruction of individual particles in jets is as complete as possible, meaning efficiency in reconstructing charged tracks is more important than momentum precision. A TPC central tracker is being developed to meet these requirements in concert with the other subdetectors. The issues for the TPC performance within the ILC framework have been described many times, most recently in LC Note LC-DET-2007-005 at <http://flcweb01.desy.de/lcnotes/>. The formation of an R&D collaboration to address these issues is the purpose of this document.

## 1.2 Scope of the Collaboration (reason for MOA)

The groups signing this Memorandum of Agreement (MOA) express their interest to contribute to the development, prototyping and design of a TPC for an experiment at the ILC. This MOA describes the main goals and the structure of the LCTPC Collaboration. The MOA enters into effect upon signature by a majority of partners; it can be terminated with the formation of the ILC detector collaboration or with dissolution by its members.

An overview of R&D strategy is given in Section 2.1, the structure of the LCTPC collaboration is explained in Section 2.2. General policies on new groups, finances and publications are covered in Sections 2.3, 2.4 and 2.5. The groups and the signatories of this MOA are listed in Section 3. The names of the responsible persons in the collaboration and a more detailed description of the R&D program are provided in an *Addendum* which will be updated regularly as the collaboration and tasks evolve.

## 2 The LCTPC collaboration

### 2.1 R&D Strategy

(general strategy)

The R&D work is proceeding in three phases:

- (1) **Demonstration Phase:** Finish the on-going exploratory work using “small” ( $\phi \sim 30\text{cm}$ ) prototypes (SP), built and tested by several of the LCTPC groups. This work provided a basic evaluation of the properties of a TPC with Micropattern Gas Detector (MPGD) gas amplification, demonstrating that the requirements for the ILC can be met.
- (2) **Consolidation Phase:** Design, build and operate a “Large Prototype” (LP) at the Eudet facility using low-energy (Desy) and high-energy (Cern, Fermilab) beams. By “Large” is meant  $\sim 1\text{m}$  diameter, so that: first iterations of TPC-design details for the LCTPC can be tested, larger area readout systems can be operated and tracks with a large number of measured points are available for analysis and correction procedures. The tasks have been divided into workpackages listed in Section 2.2.
- (3) **Design Phase:** Start work on an engineering design for the final detector. This work in part will overlap with the R&D for the LP, and the final design will start after the LP/SP results allow decisions on technical options.

## 2.2 Organizational Structure (structure)

The LCTPC structure consists of management and workpackage bodies.

The main governing body of the collaboration is the collaboration board (CB) in which each member institution is represented by one person and one vote. All major decisions are taken by the CB which meets at least twice per year. A quorum for a CB meeting exists if at least 50% of its members are present, and decisions are taken by simple majority. In urgent cases, the CB can take decisions also by phone/video conference or by e-mail vote. The CB can delegate decision power on certain issues to other boards. In particular to the Regional Coordinators, described next, will be charged with the day-to-day management of the collaboration.

Three regional coordinators (RC), one each from the Americas, Asia and Europe, are elected for two-year periods by the CB members of the corresponding region. The R&D planning and the collaboration meetings are organized by the RCs. They are responsible for tracking the progress of the collaboration, preparing decisions and reporting regularly to the CB. To expedite their work, the three RCs will choose one of their members to be the LCTPC Spokesperson who will organize/summarize workpackage meetings and chair the collaboration meetings.

For day-to-day running, the RCs will work closely with the technical board (TB). The TB consists of the leaders of the different workpackages defined below. They are charged with coordinating within their respective workpackages, and report on this regularly to the RC and the CB. At the time of writing this MOA the following workpackages were set up, and changes to the structure of the work packages can be decided by the CB at any time:

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Workpackage (0) TPC R&D Program

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Workpackage (1) Mechanics

- a) LP endplate structure with panels
- b) Fieldcage
- c) GEM panels
- d) Micromegas panels
- e) Pixel panels
- f) Panels with charge-dispersion-anode

(structure)

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Workpackage (2) Electronics

- a) Standard RO/DAQ system for LP
- b) CMOS RO electronics
- c) Electronics for LCTPC

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Workpackage (3) Software

- a) LP software +simul./reconstr.framework
- b) LCTPC simulation/perf./backgrounds
- c) Full detector simulation/performance

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Workpackage (4) Calibration

- a) Field map for the LP
  - b) Alignment
  - c) Distortion correction
  - d) Radiation hardness of materials
  - e) Gas/HV/Infrastructure for the LP
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### 2.3 New groups

(rules)

The LCTPC collaboration is open to new members. A new group should apply for membership to the CB and will be accepted into the collaboration by a vote of the CB.

### 2.4 Finances

The work of the LCTPC collaboration is funded through the individual budgets of its members. Items of common expense will be shared between the collaborators based on a case-by-case agreement. Collaborators agree to provide financial information to the RCs. The information will be treated confidentially if so requested.

### 2.5 Publications

All results obtained from the work within the LCTPC collaboration will be openly available to all members, and data obtained using common prototypes or common equipment will belong to all collaborators. The groups agree that they will not publish or make otherwise public any information belonging to LCTPC without obtaining prior agreement of the collaboration. Results from the collaboration will be published under the name "LCTPC Collaboration". The CB will install a proper editorial process before releasing material to the public. In case of a conflict the collaborators agree to accept the decision of the CB as final.

### 3 Institutes

Groups in the three regions which have signaled interest in participating in the LCTPC R&D are listed here. The signatories of the MOA are compiled in Section 4.

#### *Americas*

Carleton Univ & TRIUMF, Ottawa, ON K1S 5B6, Canada  
Univ. de Montreal, Montreal, PQ H3C 3J7, Canada  
Univ. of Victoria & TRIUMF, Victoria, BC V8W 3P6, Canada  
Cornell Univ., Ithaca, NY 14853-5002, USA  
Indiana Univ., Bloomington, IN 47405, USA  
Lawrence Berkeley National Lab., Berkeley, CA 94720-8153, USA  
Louisiana Tech Univ., College of Eng.&Science, Ruston, LA 71272, USA

(groups)

#### *Asia*

Tsinghua Univ., Beijing 100084, China  
Hiroshima Univ., Higashi-Hiroshima, Hiroshima 739-8526, Japan  
KEK, Tsukuba, Ibaraki 305-0801, Japan  
Inst. of Space&Astron.Science, Jap.Aerosp.Expl.Ag., Kanagawa 229-8510, Japan  
Kinki Univ., Higashi-Osaka, Osaka 577-8502, Japan  
Kogakuin Univ., Hachiohji, Tokyo 192-0015, Japan  
Saga Univ., Faculty of Science and Engineering, Honjo, Saga 840-8502, Japan  
Tokyo Univ. Agriculture and Technology, Koganei, Tokyo 184-8588, Japan  
Univ. of Tokyo, ICEPP, Tokyo 113-0033, Japan  
Univ. of Tsukuba, Tsukuba, Ibaraki 305-8577, Japan  
Mindanao State Univ., Iligan City 9200, Philippines

#### *Europe*

IHE (Inter-university Institute for High Energies) ULB-VUB, B-1050 Bruxelles  
LAL, IN2P3 and Univ. de Paris-Sud, F-91898 Orsay, France  
IPN, IN2P3 and Univ. de Paris-Sud, F-91405 Orsay, France  
CEA Saclay, DAPNIA, F-91191 Gif-sur-Yvette, France  
RWTH Aachen, D-52056 Aachen, Germany  
Univ. Bonn, D-53115 Bonn, Germany  
DESY Hamburg, D-22603 Hamburg, Germany  
EUDET, D-22603 Hamburg, Germany  
Albert-Ludwigs Univ., D-79104 Freiburg, Germany  
Univ. Hamburg, D-22603 Hamburg, Germany  
Univ. Karlsruhe, D-76128 Karlsruhe, Germany  
Max-Planck-Inst. für Physik, D-80805 Munich, Germany  
Univ. Rostock, D-18051 Rostock, Germany  
Univ. Siegen, D-57068 Siegen, Germany  
NIKHEF, NL-1009 DB Amsterdam, Netherlands  
Budker Inst. of Nuclear Physics, RU-630090 Novosibirsk, Russia  
Petersburg Nuclear Physics Inst., St. Petersburg, RU-188300 Gatchina, Russia  
Dept. of Physics, S-22100 Lund, Sweden  
CERN, CH-1211 Geneva 23, Switzerland



## 4 Signatories (signatures)

The following page is the MOA Form to be signed by a responsible authority in each institute.  
The pages thereafter contain the compilation of those signatures.

### LCTPC Collaboration Member

Institute:

Address:

(one page per group)

Represented by:

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Date, Signature of this MOA

# LCTPC R&D Groups Oct2007

symbols: ✓ = signed, + = working

## Americas

Carleton  
Montreal  
Victoria  
+Cornell  
✓Indiana  
+LBNL  
Louisiana Tech

## Observer groups

Iowa State  
MIT  
Purdue  
Yale  
TU Munich  
UMM Krakow  
Bucharest

21/10/2007

## Asia

✓Tsinghua  
+CDC:  
+Hiroshima  
+KEK  
+Kinki U  
+Saga  
?Kogakuin  
?Tokyo UA&T  
?U Tokyo (ICEPP)  
?U Tsukuba  
?ISAS  
?Minadano SU-IIT

## Europe

✓Brussels  
LAL Orsay  
IPN Orsay  
+CEA Saclay  
Aachen  
Bonn  
DESY  
U Hamburg  
✓EUDET  
Freiburg  
Karlsruhe  
+MPI-Munich  
Rostock  
Siegen  
+NIKHEF  
Novosibirsk  
St.Petersburg  
Lund  
+CERN

# MOA NB

Note that:

Cornell, KEK and Nikhef (and perhaps others) may request changes to the MOA text, once their administrations have finished studying it. If these changes are small, then we should converge rather fast; if not...

# Addendum

## Addendum to the LCTPC MOA: R&D Progress Report October 2007

### Overview

Responsibilities, structures and plans 2007 are outlined in this document. All issues for the TPC performance within the ILC framework have been described at several reviews since 2001, most recently for the WWS R&D review in LC Note LC-DET-2007-005 at <http://flcweb01.desy.de/lcnotes/>. The names of LCTPC members is kept up to date at <https://wiki.lepp.cornell.edu/wws/bin/view/Projects/TrackLCTPCcollab>.

### 1 Responsibilities 2007

#### 1.1 Collaboration Board (CB)

The groups and, in bold, the **CB members** are listed in the following.

–Americas–

Carleton:

Montreal:

Victoria:

Cornell:

Indiana:

LBNL:

Louisiana Tech:

–Asia———

Tsinghua:

For the CDC groups:

Hiroshima

KEK

Kinki

Saga

Kogakuin

Tokyo U A & T

U Tokyo

Tsukuba

Mindanao

–Europe———

Inter U Inst for HEP(ULB-VUB):

LAL Orsay/IPN Orsay:

CEA Saclay:

Aachen:

Bonn:

DESY/UHamburg:

EUDET:

Freiburg:

Karlsruhe:

MPI-Munich:

Rostock:

Siegen:

Nikhef:

Novosibirsk:

St.Peterburg:

Lund:

CERN:

**Madhu Dixit**

**Jean-Pierre Martin**

**Dean Karlen**

**Dan Peterson**

**Rick Van Kooten**

**Dave Nygren**

**Lee Sawyer**

**Yuanning Gao**

**Akira Sugiyama**

**Xavier Janssen**

**Vincent Lepeltier**

**Paul Colas**

**Stefan Roth**

**Klaus Desch**

**Ties Behnke**

**Joachim Mnich**

**Andreas Bamberger**

**Thomas Müller**

**Ariane Frey**

**Henning Schroeder**

(deputy:**Alexander Kaukher**)

**Ivor Fleck**

**Jan Timmermans**

**Alexei Buzulutskov**

**Anatoliy Krivchitch**

**Leif Jonsson**

**Michael Hauschild**

(deputy:**Lucie Linsen**)

### **1.1.1 New groups**

This first Addendum was written at the same time as the LCTPC MOA, September 2007, thus there are no new groups to report at this time. The changes in the group structure will appear here in future Addenda.

### **1.1.2 Observers**

Groups or persons that could not sign the MOA but want to be informed on the progress will appear here.

## 1.2 Regional Coordinators (RC)

The RCs, after selection of candidates by search committees in each region and were elected on by the CB members of the respective region, are

–Americas: **Dean Karlen**

–Asia: **Takeshi Matsuda**

–Europe: **Ron Settles** (who requests to continue for only one year) followed by **Jan Timmermans**.

Spokesperson selection: The RCs decided not to have a predetermined rotation of RCs as their chairperson and spokesperson for the collaboration; he/she will be chosen by the RCs once per year, and the reasoning for the choice will be explained to the collaboration. For the first year, Ron Settles was chosen to be Chairperson/Spokesperson.

### 1.3 Technical Board (TB)

The present workpackage structure is presented here; the **TB members** are the conveners of the workpackages and are listed in bold) in the following table. Preliminary information (to be confirmed) about the interests of the groups for the different workpackages is also shown; details of which group does what is in the process of being specified.

<b>Workpackage Convener</b>	<b>Groups involved</b>
Workpackage (0) TPC R&D Program	LCTPC collaboration
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Workpackage (1) Mechanics	
a) LP design, incl. endplate structure <b>Dan Peterson</b>	Cornell,Desy,MPI,IPNOrsay, +contribution from Eudet
b) Fieldcage, laser, gas <b>Ties Behnke</b>	Aachen,Desy,St.Petersburg, +contribution from Eudet
c) GEM panels for endplate <b>Akira Sugiyama</b>	Aachen,Carleton,Cornell,Desy/HH, Kek/CDC,Victoria
d) Micromegas panels for endplate <b>Paul Colas</b>	Carleton,Cornell,Kek/CDC, Saclay/Orsay
e) Pixel panels for endplate <b>Jan Timmermans</b>	Freiburg,Nikhef,Saclay,Kek/CDC, +contribution from Eudet
f) Charge-dispersion-foil for endplate <b>Madhu Dixit</b>	Carleton,Kek/CDC,Saclay/Orsay
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Workpackage (2) Electronics	
a) Standard RO/DAQ sytem for LP <b>Leif Joensson</b>	Aachen,Brussels,Cern,Desy/HH,Lund, Montreal,Rostock,Tsinghua, +contribution from Eudet
b) CMOS RO electronics <b>Harry van der Graaf</b>	Freiburg,Nikhef,Saclay, +contribution from Eudet
c) Electronics for LCTPC <b>Luciano Musa</b>	Aachen,Cern,Desy/HH,Lund,Rostock, Montreal,St.Petersburg,Tsinghua, +contribution from Eudet



### Workpackage (3) Software

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- |   |   |
|---|---|
| a) LP software +<br>simul./reconstr.framework<br><b>Peter Wienemann</b> | Desy/HH,Freiburg,Carleton,Victoria,<br>+contribution from Eudet         |
| b) LCTPC simulation/perf./backgrounds<br><b>Stefan Roth</b>             | Aachen,Carleton,Cern,Cornell,Desy/HH,<br>Kek/CDC,St.Petersburg,Victoria |
| c) Full detector simulation/performance<br><b>Keisuke Fujii</b>         | Desy/HH,Kek/CDC,LBNL  |

### Workpackage (4) Calibration

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- |   |   |
|---|---|
| a) Field map for the LP<br><b>Lucie Linsen</b>                            | Cern+contribution from Eudet                |
| b) Alignment<br><b>Takeshi Matsuda</b>                                    | Cern,Kek/CDC                                |
| c) Distortion correction<br><b>Dean Karlen</b>                            | Victoria                                    |
| d) Radiation hardness of materials<br><b>Anatoliy Krivchitch</b>          | St.Petersburg                               |
| e) Gas/HV/Infrastructure for the LP<br><b>Klaus Dehmelt, Peter Schade</b> | Desy, Victoria,<br>+contribution from Eudet |
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## 2 Next R&D Steps, the LP and SPs

### 2.1 What has been learned

Before addressing plans, a brief overview of what has been learned in the past few years is needed. As described in the MOA, the R&D is proceeding in three phases: (1) Small Prototypes-SP, (2) Large Prototypes-LP and (3) Design.

Up to now during Phase(1),

- about 4 years of MPGD experience has been gathered,
- gas properties have been well measured,
- the best possible point resolution is understood,
- the resistive-anode charge-dispersion technique has been demonstrated,
- CMOS pixel RO technology has been demonstrated,
- the proof of principle of TDC-based electronics has been shown and
- design work has started for the LP.

### 2.2 Next steps

The Phase(2) LP and SP work is expected to take about four years and will be followed by Phase(3), the design of the LCTPC. A scenario for the options is presented in Table 1 which will be updated in future Addenda as the planning progresses.

Regular bi-weekly WP phone meetings started in May 2006 where details for the LP design are being worked out and next R&D steps are being developed. The LP is underway, and the groups agree that over the next three years there will be an evolution of endplates towards a true prototype for the LCTPC. These stages are symbolized by LP1, LP1.5, LP2 in the table. Supplemental testing with the SPs, which have been used extensively to date as witnessed by Section 2.1, will continue, since there are still several issues to be explored which can be performed more efficiently using small, specialized set-ups. The small-prototype work is driven to a large extent by the needs of the individual labs, whereby certain issues will be studied; example as seen in the following table.

Table 1: LCTPC R&D Scenarios for Large Prototype and Small Prototypes.

Large Prototype R&D		
Device	Lab(years)	Configuration
LP1	Desy/Eudet(2007-2009)	Fieldcage $\oplus$ 2 endplates: GEM+pixel, Micromegas+pixel  <i>Purpose: Test construction techniques using <math>\sim 10000</math> Alice/Eudet channels to demonstrate measurement of 6 GeV/c beam momentum over 70cm tracklength, including development of correction procedures. The use of a Cern test beam with ILC time structure in 2009 is under study.</i>
LP1.5	Fermilab/Eudet(2010)	Fieldcage $\oplus$ 2 endplates: GEM+pixel, Micromegas+pixel  <i>Purpose: Continue tests using 10000 Alice/Eudet channels to demonstrate measurement of 100GeV beam momentum over 70cm tracklength, in a jet environment, including use of corrections procedures developed for LP1.</i>
LP2	Fermilab/Eudet(2011)	Fieldcage $\oplus$ endplate: GEM, Micromegas, or pixel  <i>Purpose: Prototype for LCTPC including gating and other options, demonstrate measurement of 100GeV beam momentum over 70cm tracklength, and in jet environment, test prototype LCTPC electronics.</i>
Small Prototype R&D		
Device	Lab(years)	Test
SP1	KEK(2007-2008)	Gas tests, gating configurations
SP2,SP3	Fermilab(2008-2009)	Performance in jet environment
SPn	LCTPC groups(2007-2009)	Performance, gas tests, dE/dx measurements, continuation of measurements in progress by groups with small prototypes

# Back-up slides

21/10/2007

Ron Settles MPI-Munich/DESY  
LCTPC Collaboration Meeting Fermilab  
21 October 2007

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21/10/2007

Ron Settles MPI-Munich/DESY  
LCTPC Collaboration Meeting Fermilab  
21 October 2007

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The CB members are:

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--Americas-

Carleton: Madhu Dixit  
Montreal: Jean-Pierre Martin  
Victoria: Dean Karlen  
Cornell: Dan Peterson  
Indiana: Rick Van Kooten  
LBNL: Dave Nygren  
Louisiana Tech: Lee Sawyer

--Asia-

Tsinghua: Yuanning Gao

For the following CDC groups: Akira Sugiyama

Hiroshima

KEK

Kinki

Saga

Kogakuin

Tokyo U A&T

U Tokyo

Tsukuba

Mindanao

--Europe-

Brussels: Xavier Jensson\*

LAL Orsay/IPN Orsay: Vincent  
Lepeltier\*

Aachen: Stefan Roth\*

Bonn: Klaus Desch\*

Desy/UHamburg: Ties Behnke\*

Eudet: Joachim Mnich\*

Freiburg: Andreas Bamberger\*

Karlsruhe: ????

MPI-Munich: Ariane Frey\*

Rostock: Henning Schroeder\*

(deputy: Alexander Kaukher)

Siegen: Ivor Fleck\*

Nikhef: Jan Timmermans\*

Novosibirsk: Alexei Buzulutskov\*

St.Peterburg: Anatoliy Krivchitch\*

Lund: Leif Jonsson\*

CERN: Michael Hauschild\*

(deputy: Lucie Linsen)

--Groups with Observer status-

Iowa State: John Hauptman

Purdue: Ian Shipsey

TU Munich: Bernhard Ketzer

--Replies still missing from:

MIT

Yale

Krakow

Bucharest

The TB members are:

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- |   |                            |
|---|----------------------------|
| 1) Workpackage Mechanics                | Ron Settles                |
| a) LP design (incl. endplate structure) | Dan Peterson               |
| b) Fieldcage, laser                     | Ties Behnke                |
| c) GEM panels for endplate              | Akira Sugiyama             |
| d) Micromegas panels for endplate       | Paul Colas                 |
| e) Pixel panels for endplate            | Jan Timmermans             |
| f) Resistive foil for endplate          | Madhu Dixit                |
| 2) Workpackage Electronics              | Leif Jonsson               |
| a) "Standard" RO/DAQ system for LP      | Leif Jonsson               |
| b) CMOS RO electronics                  | Harry van der Graaf        |
| c) Electronics for LCTPC                | Luciano Musa               |
| 3) Workpackage Software                 | Peter Wienemann            |
| a) LP SW, simul./reconstr.framework     | Peter Wienemann            |
| b) TPC simulation, backgrounds          | Stefan Roth                |
| c) Full detector simulation             | Keisuke Fujii              |
| 4) Workpackage Calibration              | Dean Karlen                |
| a) Field map                            | Lucie Linssen              |
| b) Alignment                            | Takeshi Matsuda            |
| c) Distortion correction                | Dean Karlen                |
| d) Radiation hardness of materials      | Anatoliy Krivchitch        |
| e) LP Gas/HV                            | Klaus Dehmelt+Peter Schade |

21/10/2007

Ron Settles MPI-Munich/DESY  
LCTPC Collaboration Meeting Fermilab  
21 October 2007

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