TPC in the ILD-TDR

TPC phone meeting 18 January in preparation for

ILD collaboration meeting Paris, 26-30 January 2010

Summary for “where are we?”:

- All aspects covered in TPC chapter of the LOI
- Adequate performances wrt point-, 2-hit-, and momentum-resolution in Table 5 have been already demonstrated by SP studies.

4.1 RD/IDAG Workplan

General statements can be made as to the RD's workplan in Section 1.2. With regard to "demonstration of proof of principle on critical components and definition of a feasible baseline with options", these have already been demonstrated using the Small Prototypes, are being verified using the Large Prototype, and have been presented in the ILD LOI. The LCTPC performance parameters presented in the LOI are reproduced below (Table 5).

The remaining points mentioned in Section 1.2, "completion of mechanical design and development of a realistic simulation", are the subjects of Workpackage 5 in Sections 2.3 and 3.3.2 and belong to the category "work in planning". Preliminary solutions to these points have also been included in the ILD LOI, and details will be further developed in 2010.

Performance table in the ILD LOI

Performance and design parameters for an LCTPC with standard electronics are recalled here. Understanding the properties and achieving the best possible point resolution have been the object of R&D studies of Micro-Pattern Gas Detectors, MicroMegas and GEM, and results from this work used to define the parameters in Table 5. The parameters in this preliminary design represent the best technical solution at the moment and have been agreed upon by the LCTPC Collaboration in 2009.

Table 5

Performance/Design

Size	$\phi - 3.6$m, L $-$ 4.3m outside dimensions
Momentum resolution (3.5T)	$\delta(1/p_t) \sim 9 \times 10^{-5}$/GeV/c TPC only ($\times$ 0.4 if IP incl.)
Momentum resolution (3.5T)	$\delta(1/p_t) \sim 2 \times 10^{-5}$/GeV/c (SET+TPC+SIT+VTX)
Solid angle coverage	Up to $\cos\theta \simeq 0.98$ (10 pad rows)
TPC material budget	$\sim 0.04 X_0$ to outer fieldcage in r
	$\sim 0.15 X_0$ for readout endcaps in z
Number of pads/timebuckets	$\sim 1 \times 10^6$/1000 per endcap
Pad size/no.padrows	$\sim$ 1mm$\times$4–6mm/$\sim$200 (standard readout)
σ_{point} in $r\phi$	$< 100\mu$m (average over $L_{sensitive}$, modulo track ϕ angle)
σ_{point} in rz	$\sim$ 0.5 mm (modulo track θ angle)
2-hit resolution in $r\phi$	$\sim$ 2 mm (modulo track angles)
2-hit resolution in rz	$\sim$ 6 mm (modulo track angles)
dE/dx resolution	$\sim$ 5 %
Performance	$>$ 97% efficiency for TPC only ($p_t >$ 1GeV/c), and
	$>$ 99% all tracking ($p_t >$ 1GeV/c)
Background robustness	Full efficiency with 1% occupancy
Background safety factor	Chamber will be prepared for 10 $\times$ worse backgrounds
	at the linear collider start-up

Summary for “where do we want to go?”:

- “To do” list of critical R&D for 2010 to mid-2012, in a nutshell:
  - Develop calibration/correction/alignment techniques, confirm resolution at LP at Desy
  - Develop advanced endcap (15%X_0, S-Altro, cooling, mechanics, power pulsing, gating) and fieldcage
  - Develop detector-integration engineering
  - Improve software model
  - Confirm alignment procedure for ILC

Table 2

Workpackage	Convener
Workpackage (0) TPC R&D Program	LCTPC collaboration
Workpackage (1) Mechanics	
a) LP endplate structure, design	**Dan Peterson**
b) Fieldcage, laser, gas	**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 anode for endplate	**Madhu Dixit**
Workpackage (2) Electronics	
a) Standard RO/DAQ sytem for the Large Prototype	**Leif Joensson**
b) CMOS RO electronics	**Harry van der Graaf**
c) Standard electronics for LCTPC	**Luciano Musa**
Workpackage (3) Software	
a) LP software + simulation/reconstruction framework	**Christoph Rosemann**
b) LP DAQ	**Gilles De Lentdecker**
c) LCTPC simulation/performance/backgrounds	**Keisuke Fujii**
Workpackage (4) Calibration	
a) Field map for the LP	**Lucie Linsen**
b) Alignment	**Takeshi Matsuda**
c) Distortion correction	**Dean Karlen**
d) Outgassing properties of materials	**Anatoliy Krivchitch**
e) Gas/HV/Infrastructure for the LP	**Klaus Dehmelt**

To prepare for the TDR, this structure will be supplemented with fifth workpackage:

Workpackage (5) LCTPC preparations for TDR	**Convener**
a) Advanced endcap mechanics + alignment	**Dan Peterson**
b) Advanced endcap with SAltro, cooling, power pulsing	**Luciano Musa**
c) Gating device	**Akira Sugiyama**
d) Fieldcage	**Klaus Dehmelt**
e) ILD TPC Integration	**Robert Volkerborn/ Michael Carty**
f) LCTPC Software	**Christoph Rosemann**
g) Testbeams	**Takeshi Matsuda**

Coveners of the new workpackages overlap significantly with the previous structure because the issues are closely related. The new workpackages are meant to specifically guide the TDR preparations; more explanation is presented in Section 3.3.2.

These “critical” R&D projects are WIP by WP#5

What we should decide now is the format for the WP#5 meetings:

-once every two or four weeks?

-separate from normal WP (LP) meetings?

-or combined?

-who chairs the meetings?