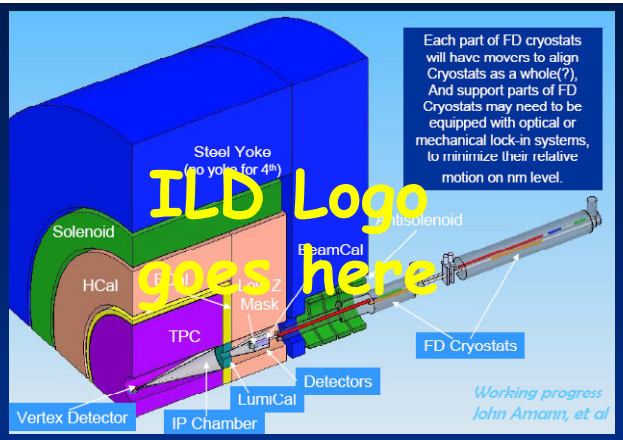
Worldwide Study of the Physics and Detectors for Future Linear e^+e^- Colliders

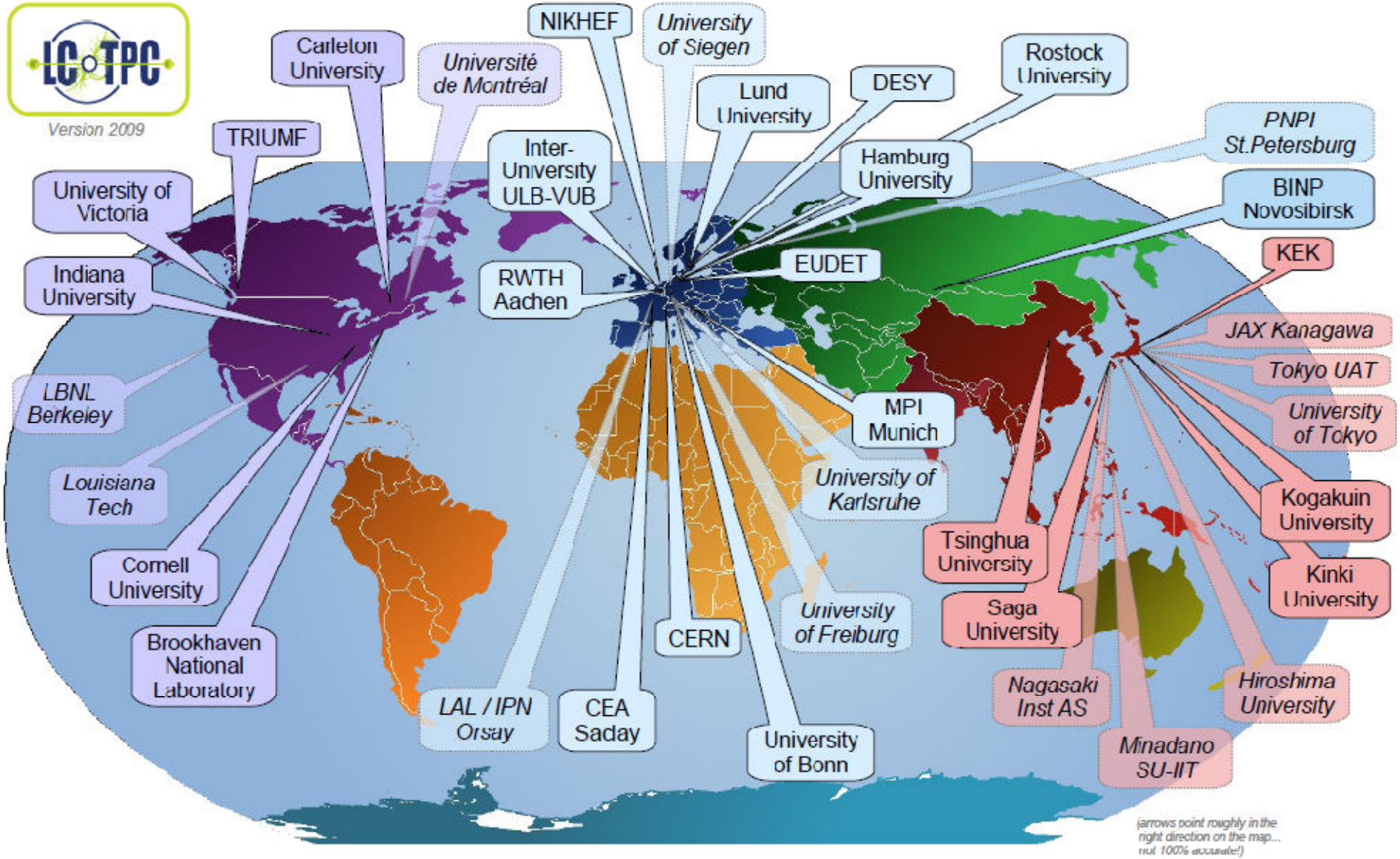


ILD Logo goes here

TimeProjectionChamber/SiEnv. R&D for an LC Detector

(see Marcel Stanitzki's Monday talk, testbeam and tracking sessions for other subdetectors)

TPC Collaboration 2009



TPC R&D Planning

- 1) Demonstration phase
  - Continue work with small prototypes on mapping out parameter space, understanding resolution, etc, to improve the design of an MPGD TPC.
- 2) Consolidation phase
  - Build and operate the Large Prototype (LP), Ø ~ 90cm, drift ~ 60cm together with SIT prototype, with EUDET infrastructure as basis, to test manufacturing techniques for MPGD endplates, fieldcage, electronics. The LP has been built now and testing of the options is underway.
- 3) Design phase
  - During phase 2, the decision as to which endplate technology to use for the LC TPC will be taken and final design started.

TPC R&D summary to date

- Now several years MPGD experience gathered
- Gas properties rather well understood
- Limit of resolution understood
- Resistive foil charge-spreading demonstrated
- CMOS RO demonstrated
- Work in progress with the Large Prototype (LP)

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

Testbeam Options		
Lab	Beams	Availability
CERN SPS	10-400GeV e, h, μ	LHC absolute priority
DESY	1-6.5GeV e	$>$ 3 months per year
Fermilab	1-120GeV e, h, μ	Continuous (5%), except shutdown
IHEP Protvino	1-45GeV e, h, μ	One month, twice per year
KEK Fuji	0.5-3.4GeV e	From fall 2007, 240 days per year
SLAC	28.5GeV e (primary)	Parasitic to PepII,
	1-20GeV e, h (secondary)	non-concurrent with LCLS

This list is a couple of years old, being updated at this workshop (see next slide)…

...have to study the options carefully...

Large Prototype TPC

TPC Large Prototype Facility

Klaus Dehmelt
DESY
LCTPC collaboration meeting
21-September-2009

Main objective: Large Prototype (LP) of a TPC.

Consisting of

- Field cage
- Readout electronics
- DAQ and Monitoring
- Gas-/HV-system
- Common Software
- SiLC envelope
- End plate
- MPGD detector modules
- Cosmic/beam trigger

Magnet (PCMAG) + infrastructure
T24 Test beam

Key:

present
partially missing
missing

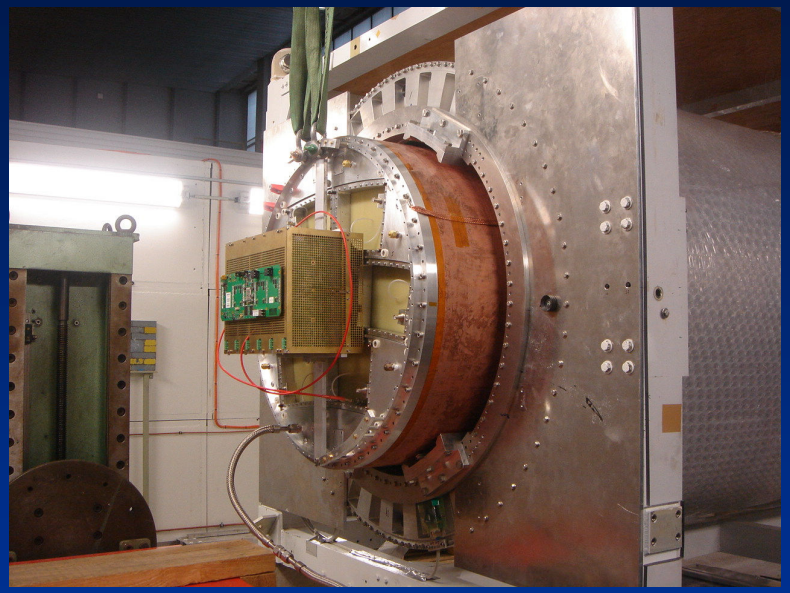
LP Subsystem meeting in Feb-2008 Requirements

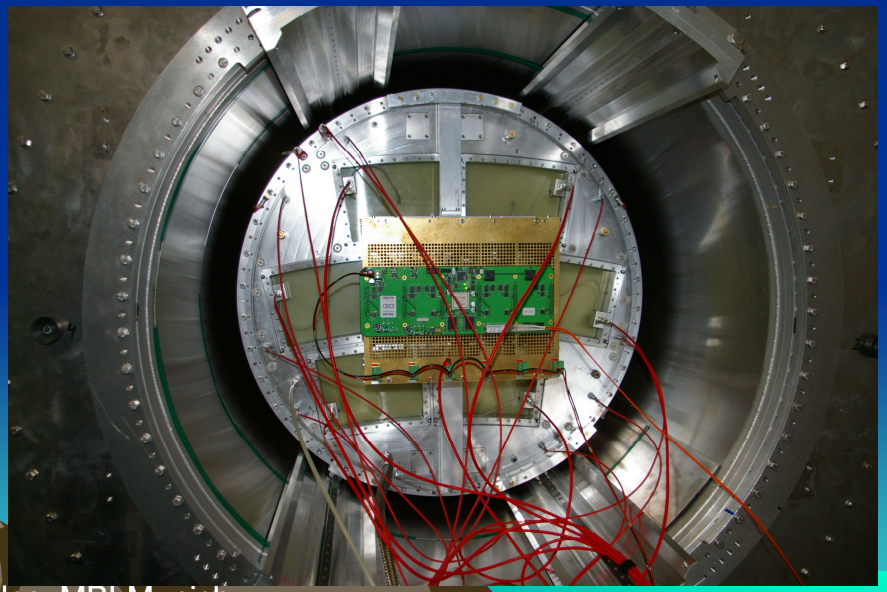
- LP needs
  - **The detector itself**
    - FC 
    - Cathode 
    - Endplate 
    - Amplification panels 

Hardware: build together and have a TPC 

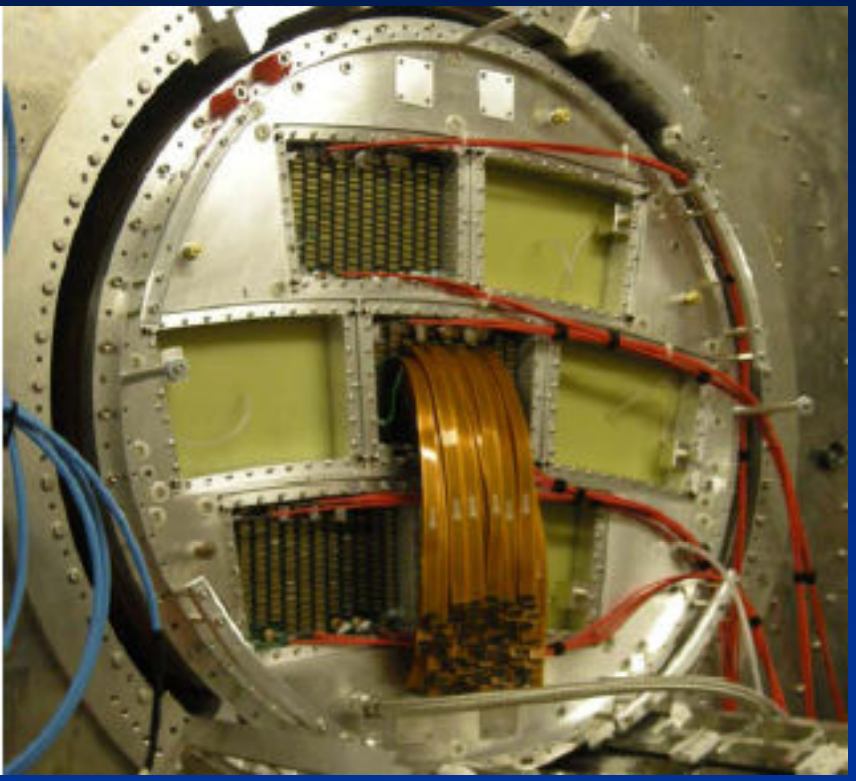
For details, see talks in alcpg09-tracking session Wednesday afternoon and Friday morning: Klaus, Hirotoshi, Jan, Aurore, Winfried, Alberto, Steve, Takeshi.

LP - MicroMeGaS



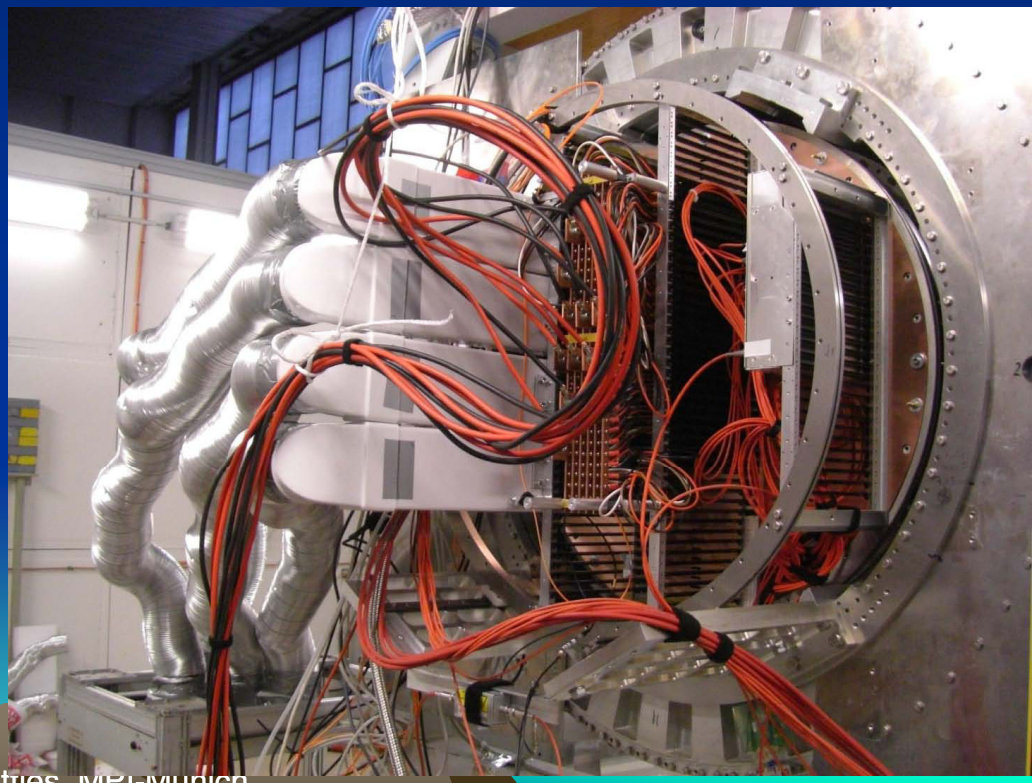


Double GEM



About 3200 channels readout electronics (Altro/Alice) CERN&Lund

(10000 channels later in 2009)



HEPHY
Institut für Hochenergiephysik

For details, see talks in alcpg09-tracking session Wednesday afternoon and Friday morning: Klaus, Hirotoshi, Jan, Aurore, Winfried, Alberto, Steve, Takeshi.

LPTPC Silicon Envelope Status & Plans

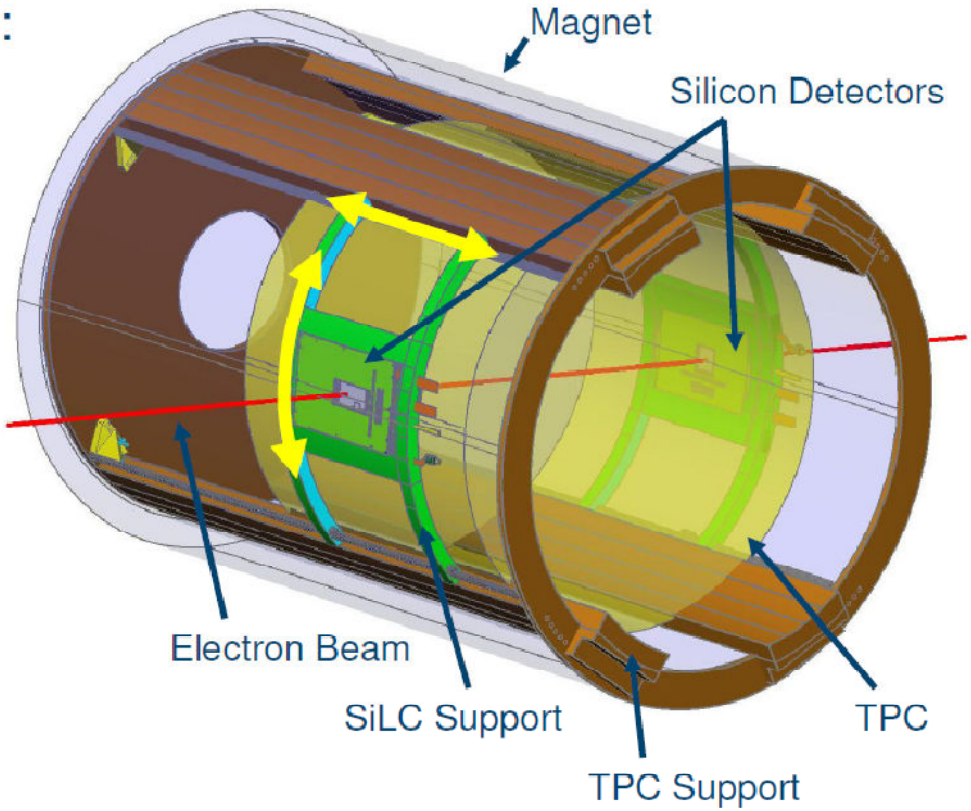
HEPHY+Karlsruhe

This work is performed within the SiLC R&D coll

Introduction

the idea is known:

Improve the resolution of the Large Prototype TPC by adding a precise measured point of the track (order of 10µm), inside the gap, between magnet and TPC, on both sides of the TPC.

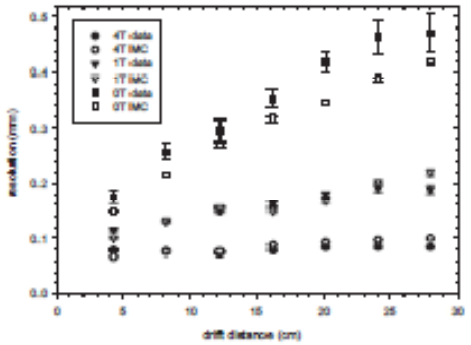


21.09.2009 Stephan Hänsel – LCTPC collaboration meeting 2009 2

Next steps, from the LOI:

- 2009-12 Continue R&D on technologies at LP, SP, pursue simulations, verify performance goals (see next slide)
- 2009-11 Plan and do R&D on advanced endcap; power-pulsing, electronics and mechanics are critical issues.
- 2011-12 Test advanced-endcap prototype at high energy and power-pulsing in high B-field.
- 2013-18 Design and build the LCTPC.

At the beginning of the period 2012-18, the selection must be made from the different technological options – GEM, MicroMegas, resistive anode, pixel, electronics, endcap structure – to establish a working model for the design of the LCTPC. This design will be used for the ILD proposal in 2012 and include pad segmentation, electronics, mechanics, cooling and integration, so that performance, timeline and cost can be estimated reliably. [2] For the technology selection, a scenario could be that questions must be answered as to which options give the best performance based on R&D results from LP, SP, electronics and endcap studies. Main performance criteria could be endcap thickness and σ_{point}, double-hit and momentum resolution for single tracks and for tracks in a jet environment. Choice of criteria to use will be decided over the next two years.



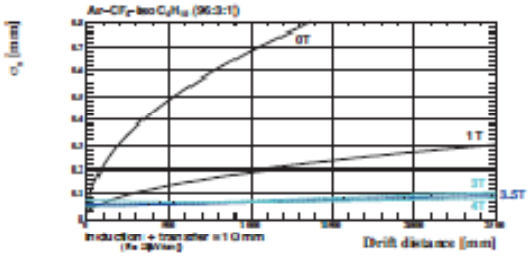
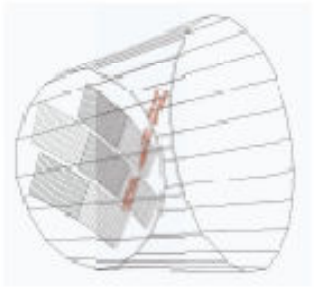
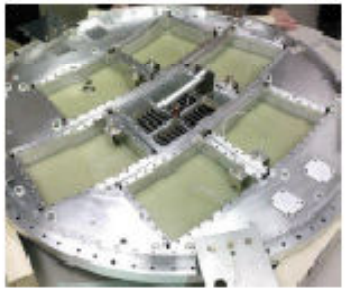
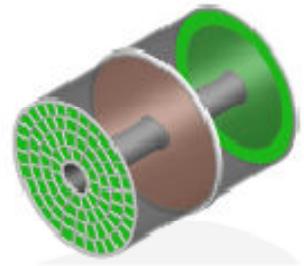


FIGURE 4.3-5. (left): Example of resolution results from a small prototype [92] measurements with TDR gas, $ArCH_4CO_2$ (95-3-2); other candidate gases are e.g. P5 and $ArCF_4$Isobutane. (Right): Theoretical resolution for $ArCF_4$Isobutane (96-3-1) gas (right), based on an algorithm [79] verified during SP studies.







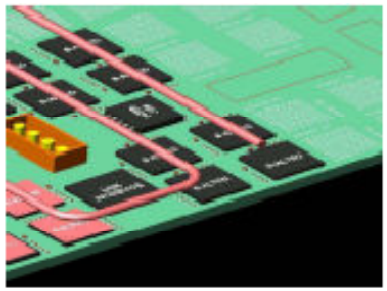


FIGURE 4.3-6. (Top left): Event display from the LP beam tests. (Top right) View of the Endcap subdivision as used for the Large Prototype. (Bottom left)Conceptual design of enplate for LCTPC. (Bottom right) Possible layout of PCB, electronics and cooling for the LCTPC.

RD next steps:

2009 /06 /02
Updated 2009/08/20

Work plan after validation till 2012

We plan that each validated detector group will produce detailed baseline design by 2012. To this end the following items need to be accomplished.

1. Demonstrate proof of principle on critical components
   When there are options, at least one option should be advanced to a level of maturity which verifies feasibility.

2. Define a feasible baseline design. While a baseline will be specified, options may also be considered.

3. Complete basic mechanical integration of the baseline design accounting for insensitive zones such as the beam holes, support structure, cable, gaps or inner detector material.

4. Develop a realistic simulation model of the baseline design, including identified faults and limitations.

5. Develop a push-pull mechanism, workout the moving procedure, time scale, alignment and calibration scheme in cooperation with the relevant groups.

6. Develop a realistic concept of integration with the accelerator including the IR design.

7. Simulate and analyse updated benchmark reactions with the realistic detecgtor model. Include the impact of detector dead zones and updated background conditions.

8. Simulate and study some reactions at 1 TeV, including realistic higher-energy backgrounds, demonstrating detector performance.

9. Develop an improved cost estimate.

Bottom line:

We LCTPC have to make certain decisions and write them up by the end of 2012…

TPC R&D Priorities

1a) advanced endplate studies (max. 15% X0 including cooling)
1b) continue tests in electron beam for correction procedures
2a) future tests in hadron beam
    a) for momentum resolution
    b) for two-track resolution in a jet environment
2b) powerpulsing/cooling tests, both on LP and SP
3) ion backflow studies:
    a) simulations of ion sheets for Gem, Micromegas
    b) design/test gating device

Design team being set up after discussions at LCTPC collaboration meeting last week

TPC design/performance discussion at LCTPC collaboration meeting 20090921

Overview — Ties Behnke

Mechanics design
- ---overall mechanics
  - tolerances for — Dan Peterson
  - alignment — Ron Settles
- ---fieldcage — Peter Schade
- ---advanced endcap — Dan Peterson
- ---overall structure — Robert Volkerborn, Michael Carty
- ---mpgd+gate — Akira Sugiyama
- ---cooling — CO2 from Nikhef?

Electronics
- ---sAltro — Luciano Musa, Magnus Mager, Antoine Junique
- ---power-pulsing etc — Takahiro Fusayasu

R&D steps(incl. beam)2009-2012
- ---LP issues/plans — Klaus Dehmelt
- ---engineering R&D — LOI + more discussion

How to make technical choices in 2012 — First ideas in LOI

Road map for test beams

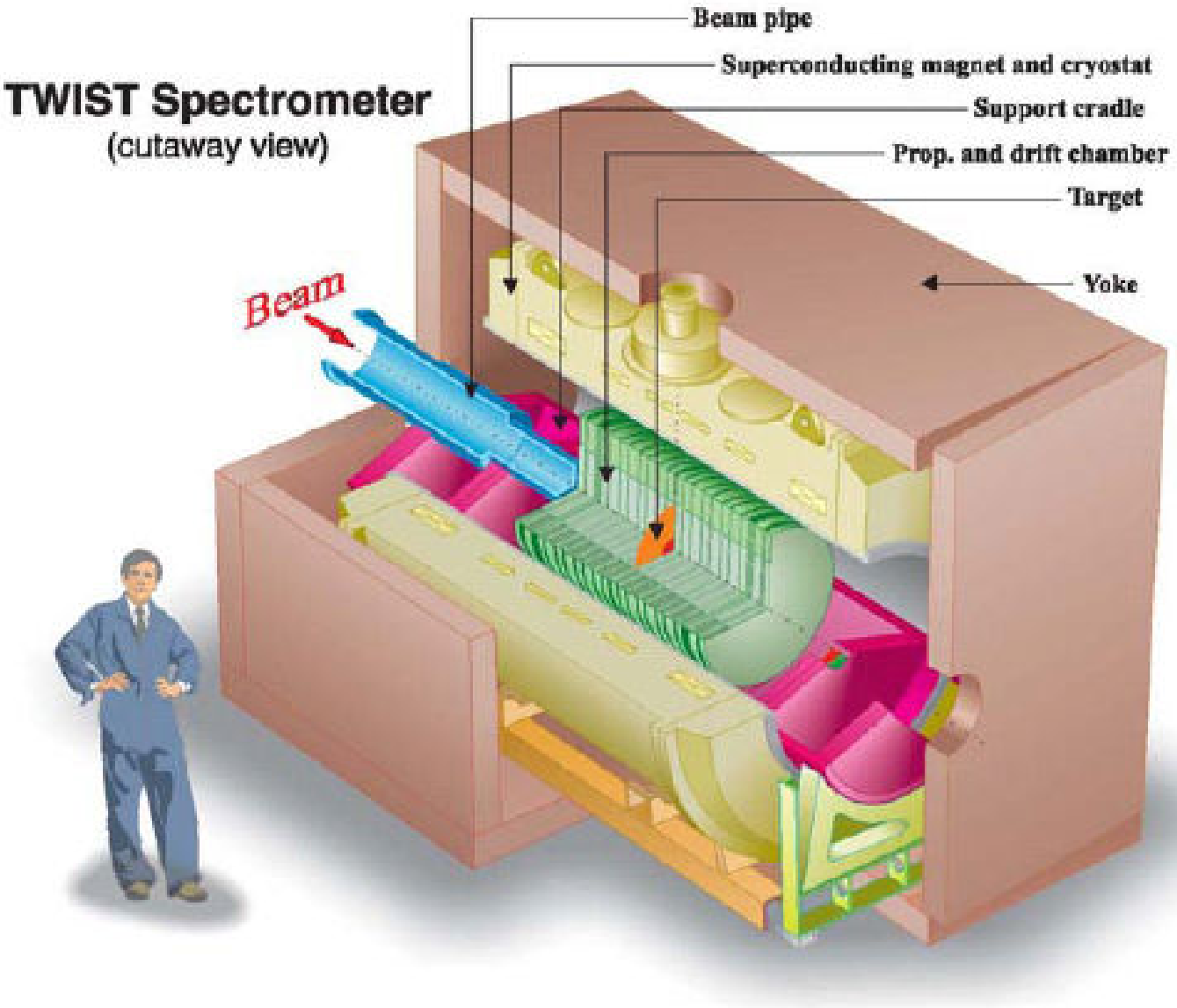
Table 1: LCTPC R&D Scenarios for Large Prototype and Small Prototypes.

Large Prototype R&D		
Device	Lab(years)	Configuration
LP1	Desy/Eudet(2007-2010)	Fieldcage⊕2 endplates: GEM+pixel, Micromegas+pixel
Purpose: Test construction techniques using ~10000 Altro or T2K channels to demonstrate measurement of 6 GeV/c beam momentum over 70cm tracklength, including development of correction procedures.		
LP1.5	FLorCern/Aida?(fp7)	Fieldcage⊕2 endplates: GEM+pixel, Micromegas+pixel
Purpose: Continue tests using 10000 Altro or T2K channels to demonstrate measurement of 100GeV beam momentum over 70cm tracklength, in a jet environment and with ILC beam structure using LP1.		
LP2	FLorCern/Aida?(fp7)	Fieldcage⊕endplate: GEM, Micromegas, or pixel
Purpose: Prototype for LCTPC including gating and other options, demonstrate measurement of 100GeV beam momentum over 70cm tracklength, and in jet evironment and ILC beam structure, test prototype LCTPC electronics/PP.		

Small Prototype R&D Examples		
Device	Lab(years)	Test
SP1	KEK(2007-2009)	Gas tests, gating configurations
SP2,SP3	FLorCern(2009-2011)	Performance in jet environment
SPn	LCTPC groups(2007-2012)	Performance, gas tests, dE/dx measurements, continuation of measurements in progress by groups with small prototypes

Possible Magnets

- PCMAG
- Triumf (Twist) Magnet (Madhu Dixit)
  - 2 T
  - 1m φ, 2.2m length
  - Available?
- KeK (Amy) Magnet (Takeshi Matsuda)
  - 3 T
  - 2.4m φ, 1.6m length
  - Available now (in principle)
- ~3 T magnet from CERN?


TWIST Spectrometer
(cutaway view)
Beam pipe
Superconducting magnet and cryostat
Support cradle
Prop. and drift chamber
Target
Yoke
Beam

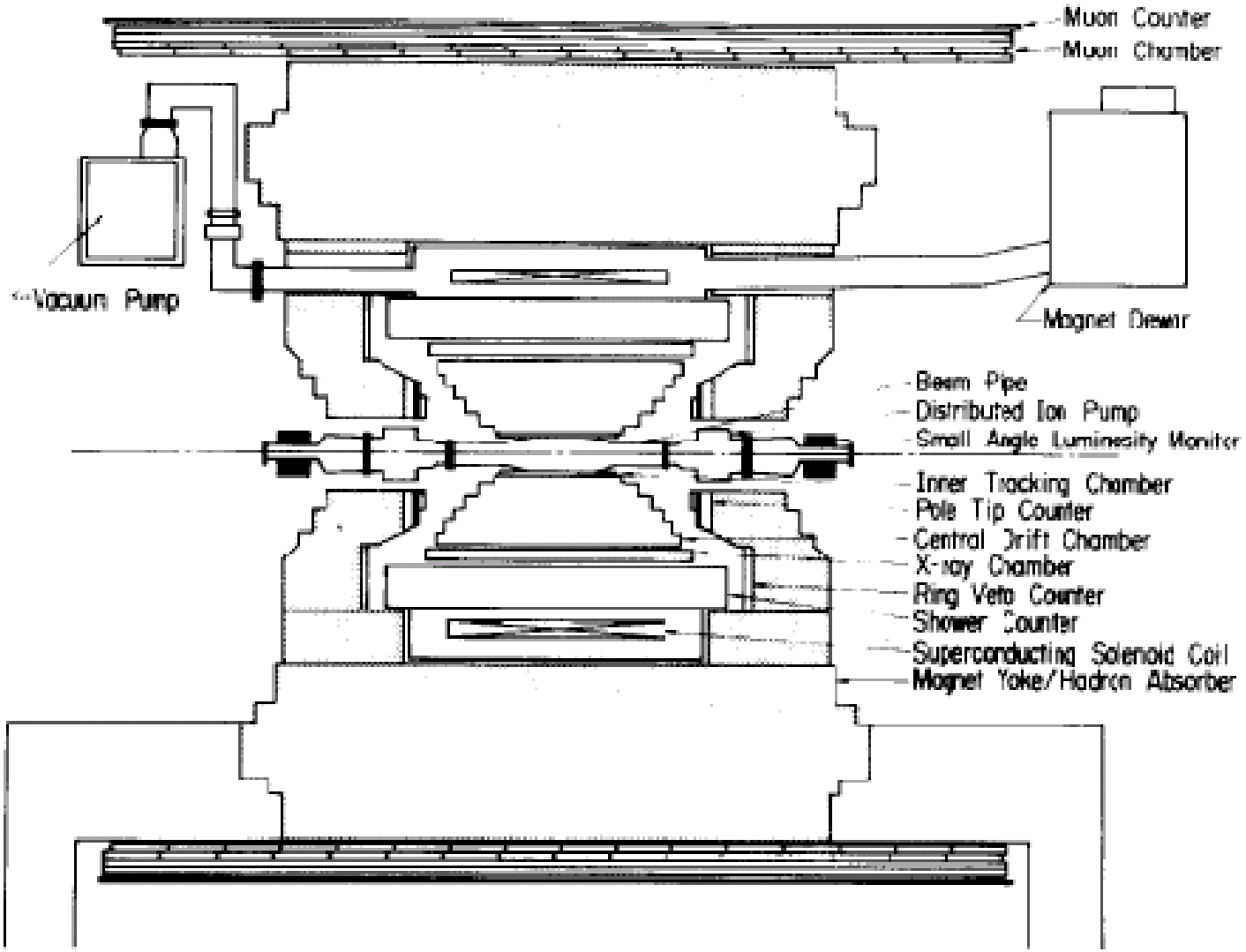


Fig. 1. A cross-sectional view of the AMY detector.

Bottom line for testbeam: move LP to hadron beam end of 2010

Conclusions:

None