Gaseous Tracking (TPC) Summary

LCWT09
Nov. 5, 2009
LAL, Orsay

Takeshi MATSUDA
DESY/FLC

Wednesday 04 November 2009 top

08:45->*10:15* Plans of Subdetectors - Gaseous Tracking
(Convener: Yulan Li (*Tsinghua University*) , Matsuda Takeshi (*IPNS/KEK*))

08:45	TPC large prototype beam test and the future (40')	Klaus Dehmelt (*DESY FL*
09:25	Test beam and test beam facility for TPC R&D (20')	Ron Settles (*Max-Planck-Institut fu Phys*
09:45	Discussion (30')	

R&D Phases

1. **Demonstration Phase**: Small prototype tests still going!

   Provide a basic evaluation of the properties of an MPGD TPC and demonstrate that the requirement (1-b,c) can be met using small prototypes.

1. **Consolidation Phase**: LP1: 2007-2010 & LP2 2010 –

   Design, build and operate a "Large Prototype" (of large number of measured points) at the EUDET facility in DESY comparing tecnologies and demonstrating (1-a) in a way.

1. **Design Phase**:

   Start working on an engineering design for aspects of the TPC at ILC.

(LC TPC collaboration: MOU)

At each phase, we perform beam tests probably with different purposes.

Options of MPGD for ILC TPC

Based on the studies with small MPGD TPC Prototypes

Analog TPC: Immediate options if the current ILC schedule

(1) Multi layer GEM + Narrow (1mm wide) pad readout:
- Defocusing by multilayer GEM
- Narrow (1mm) pads → Larger readout channels
- Effective No. of electrons (Neff):

(2) MicroMEGAS + Resistive anode pad (2-3mm wide)
- Widening signal by resistive anode
- Wider pads → Less readout channels
- Neff:

Digital TPC:

(3) Ingrid-MicroMEGAS + Timepix: Digital TPC
- Digital → Free from the gas gain fluctuation
  More information from primary electrons and
  Thus better position resolution (to be demonstrated)

(4) Multilayer GEM + Timepix: More an analog TPC?
- Need to improve the efficiency for primary electrons

TPC Large Prototype Beam Test (LP1)

LP1 at DESY T24-1 beam area

TPC Large Prototype Tests: LP1

2008:	
Nov-Dec	**MicroMEGAS modles w/ resistive anode (T2K electronics)**
2009:	
Feb-Apr	**3 Asian GEM Modules w/o Gating GEM (3,000ch ALTRO electronics)**
Apr	**TDC electronics with an Asian GEM Module**
Apr-May	**Maintenance of PCMAG**
May-Jun	**Micromegas w/ two different resistive anodes (New T2K electronics)**
	Setup and test of laser–cathode calibration
Jun	**GEM+Timepix (Bonn)**
Jun	**Installation of PCMAG lifting stage and Si support structure**
July	**TDC electronics with an Asian GEM module**
	ALTRO electronics study w/ an Asian GEM module
July-Aug	**Installation of PCMAG lifting stage**
Aug	**MicroMegas w/o resistive anode with laser-cathode calibration**
Sept	**A Bonn GEM module (A small aria GEM with ALTRO electronics)**
2010:	(see next page)

Please see for current LP results Klaus Dehmelt talk.

TPC Large Prototype Beam Test: LP1 in 2010

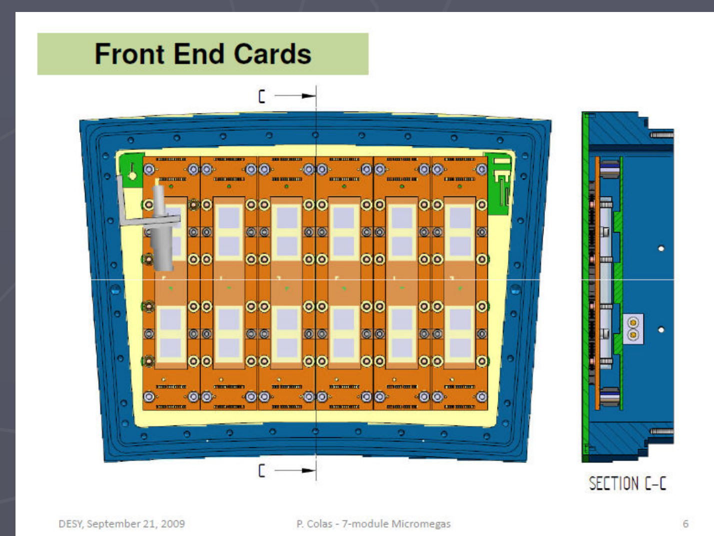
"Demonstrate full-volume trucking in non-uniform magnetic field, trying to provide a proof for the momentum resolution at LC TPC"

2010:

Spring 4 Asian GEM Modules w/ gating GEM (10,000ch ALTRO electronics)
DESY GEM modules (w/ wire gating) (10,000ch ALTRO electronics)

Fall 7 MicroMEGAS modules w/ resistive anode (12,000ch T2K electronics)

New MicroMEGAS modules in 2010



TPC Large Prototype Beam Test (LP2) from 2011

2011 Move to a high momentum hadron beam

high momentum: 10 - 100 GeV/c

← **Limitation using electron beam to measure momentum**

→ **Discussion to be made in LC TPC collaboration based on the information at LCWT09**

Most probable option: Move the current TPC large prototype with PCMAG.

Also Possible beam tests with the TPC small prototypes for the ion issue and gating, the double track separation, etc.

Location and the question if the bunch structure.

Two Other Important R&D Issues in 2010-2012

Advanced endplate:

Requirement: thickness 15% Xo

Thin endplate
High density, low power electronics to match small pads (1 x 4mm) surface-mounted directly on the back of pad plane of MPGD detector module
Power delivery, power pulsing and cooling

LP2 beam tests with Advanced endplate (budget)

Ion Feed back and Ion disks:

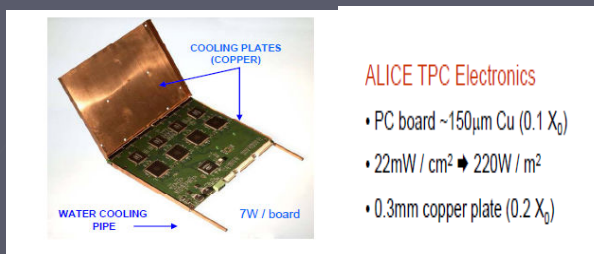
Ion feed back ration and beam backgrounds

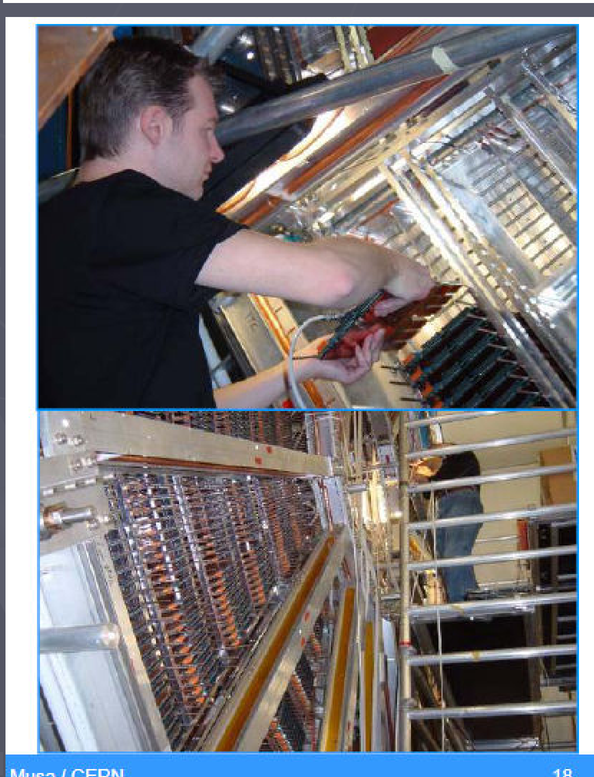
Estimate distortion due to the ion disks (simulation)
Options of gating device: Wire gating, GEM gating
Methods of calibration

S-ALTRO Team
LC TPC collbaoration

Advanced Endplate: S-ALTRO

High density, low power , low material electronics for TPC





ALICE TPC

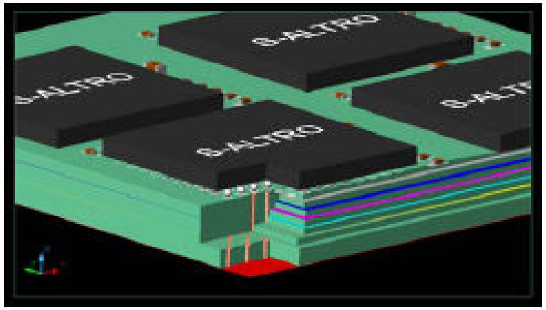
ILC (ILD) TPC

Advanced Endplate: S-ALTRO

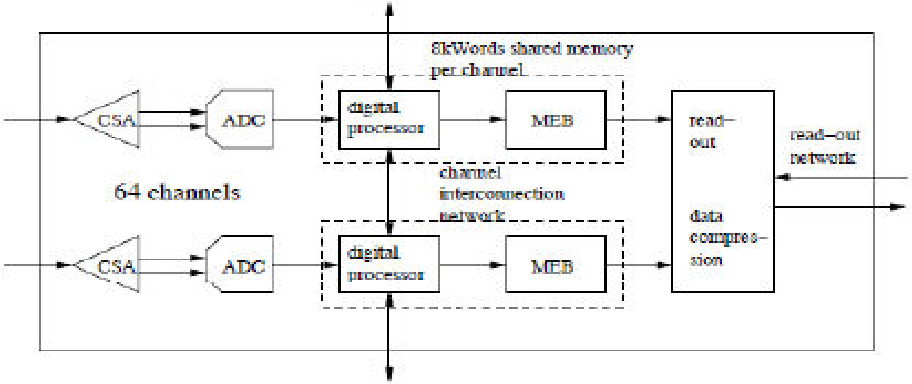
High density, low power electronics for TPC

A multi purpose readout chip for TPC detectors

A multi-purpose readout chip for TPC detectors



- 64 complete readout channels (from detector pad to data link)
- programmable charge sensitive amplifier
  - sensitivity to a charge in the range ~10^2 - ~10^6
  - programmable shaping time in the range 30 to 300ns
- 10-bit 40 MSPS ADCs
- 8k multi acquisition memory per channel (dynamically allocated)
- digital signal conditioning (4th order IIR filter and FIR filter) for baseline correction
- 3-D zero suppression
- lossless data compression
- readout net work controller
- output bandwidth 160 Mbyte/sec



Advanced Endplate: S-ALTRO

L. Musa

Chip size and Power consumption

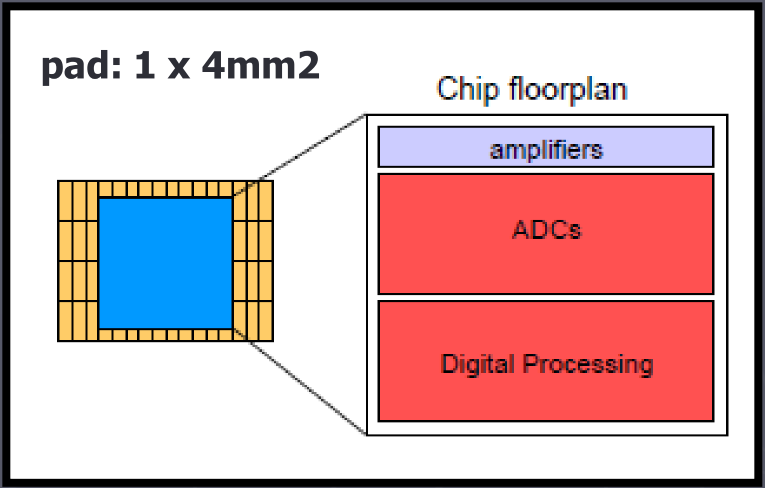
Chip size: (*estimate)

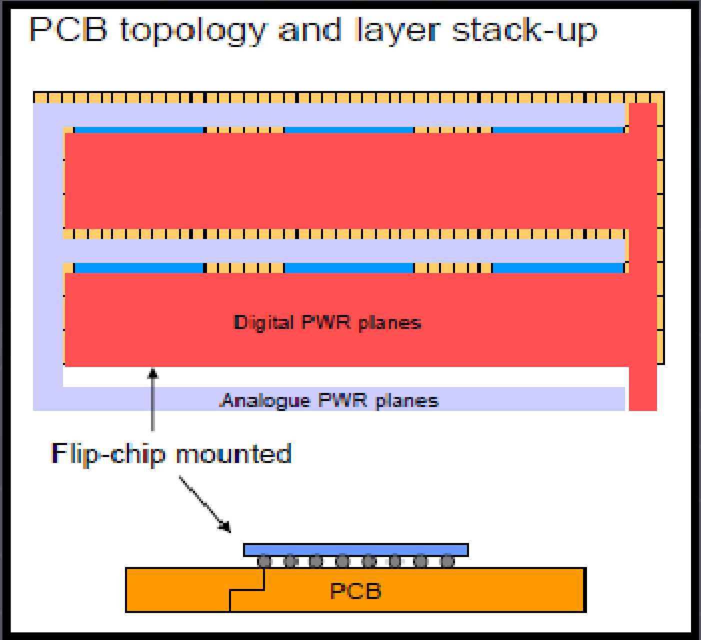
Shaping amplifier 0.2 mm^2
ADC 0.7 mm^2 (*)
Digital processor 0.6 mm^2 (*)
When 1.5mm^2/channel
64 ch/chip ➡ ~ 100 mm^2

PCB board ~ 27 x 27 cm^2
⇨ ~16400 pads or 256 chips/board
Bare die flip-chip mounted or chip scale package
Minimum-size capacitors (0.6x0.3x0.3mm3)
Standard linear voltage regulators
Data link based on ALICE SPD GOL MCM

Power consumption: (*) 10 -40MHz

Amplifier	8 mW/channel
ADC	12-34 mW/channel (*)
Digital Proc	4 mW/channel
Power reg.	2 mW/channel
Data links	2 mW/channel
Power reg. eff.	75%
Total	32-60mW/channel (*)
Duty cycle:	1.5% (Electrical duty)
Average power	0.5 mW / channel
	100 -200W/m2 (*)





Advanced Endplate: S-ALTRO
Status and Schedule

Status & Plans

Status

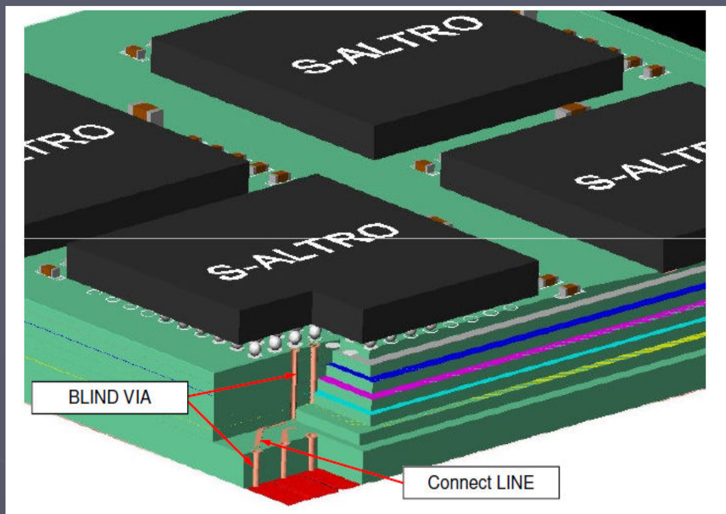
- 2006 12-channel prototype of CSA (no programmability)
- 2007 16-channel prototype programmable (1000 chips for LPTPC @ Desy)
- 2009 2-channel ADC prototype (samples expected in June)
- 08/09 specifications digital blocks and design entry (Verilog) of data processor
- 2009 first design of readout board

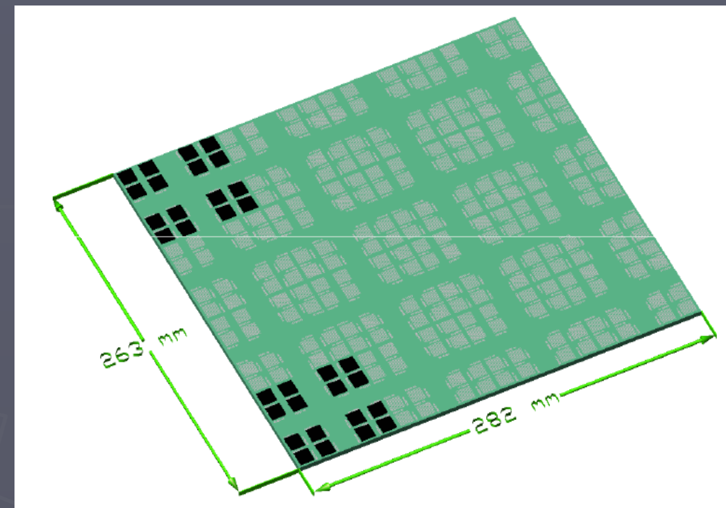
Plans

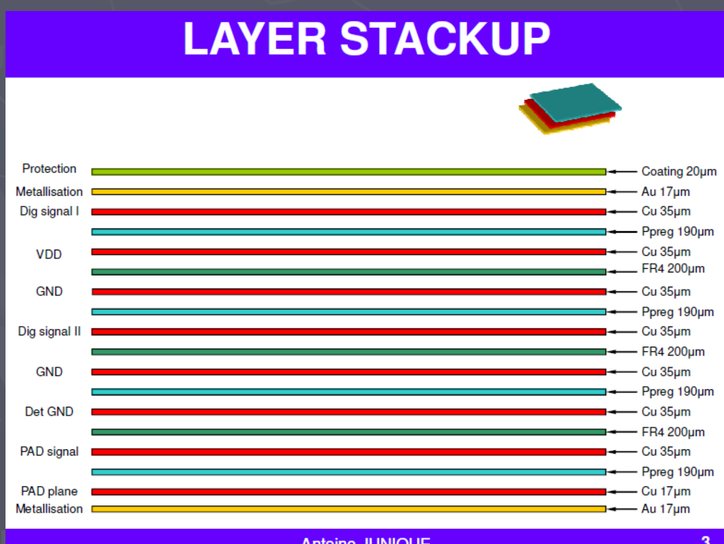
- 2009
  - characterization of ADC samples (Jul – Aug)
  - optimization of ADC design or ADC IP (S3) and migration to IBM 130nm
  - design of 16-channel of complete readout chain (with simplified digital processor)
- 2010
  - characterization of 16-channel prototype
  - decide how to continue the project according to the results achieved

Advanced Endplate: S-ALTRO

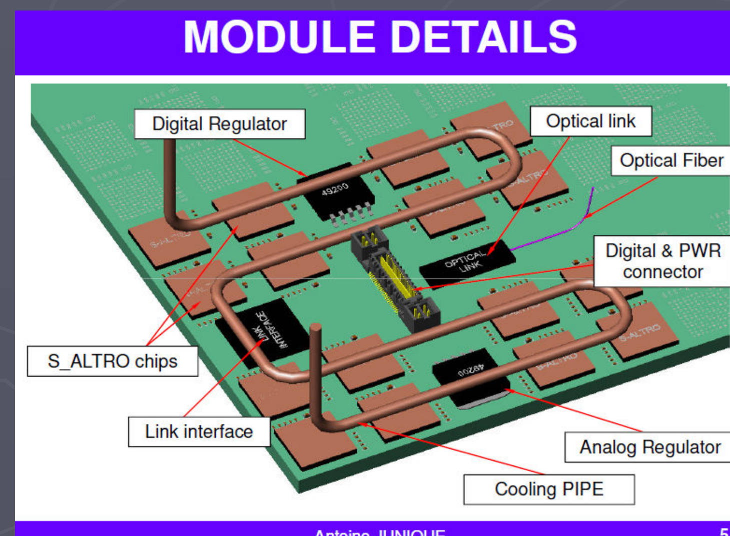
Design of Pad Board







18 layer PAD PCB



Option of Cooling: 2-phase CO_2 cooling/traditional H_2O cooling

Advanced Endplate: PCB Test

Test with a Pad PCB model

S-ALTRO Team
LC TPC groups

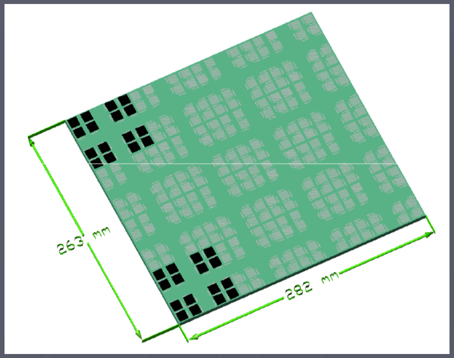
Test:

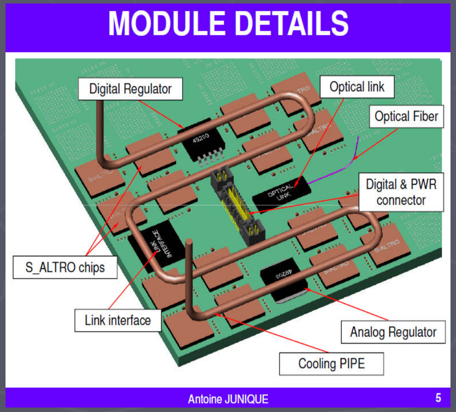
Power switching
Power delivery
Cooling:
Thermo-mechanical test
In a high field (DESY 5T magnet, PCMAG, etc.)

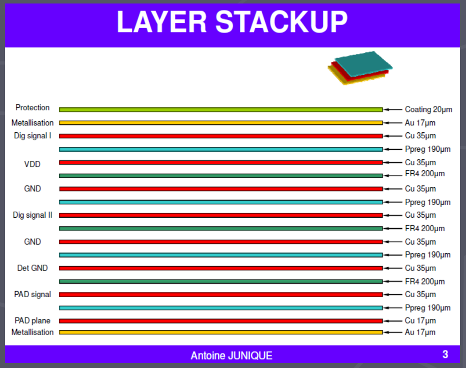
Pad PCB model:

Realistic design of pad PCB with all components
64ch S-ALTROs replaced by proper FPGAs and
OP amp/ADC as current load and heat source.
Connect pads to the FPGA analog outputs
Try cooling by the 2-phase CO_2 cooling
(AMS and LHCB: Bart Verlaat/Nikhef)
Test also digital software model/communication in FPGA
Test in high magnetic field

Schedule: 2010



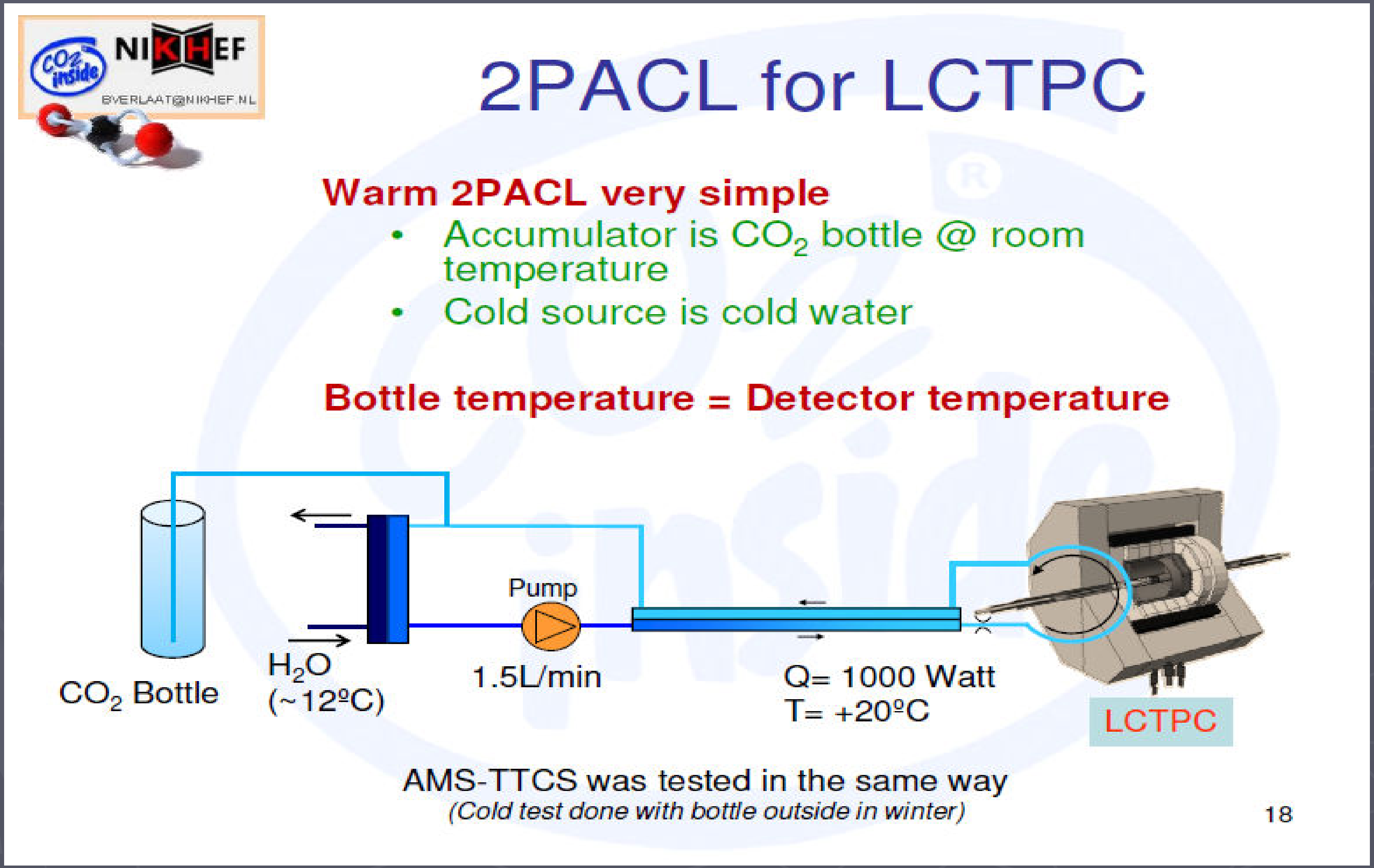




Bart Verlaat/Nikhef

Advanced Endplate: Cooling

Option of the 2-phase CO2 cooling



Applied to AMS and LHCb

Bart Verlaat/Nikhef

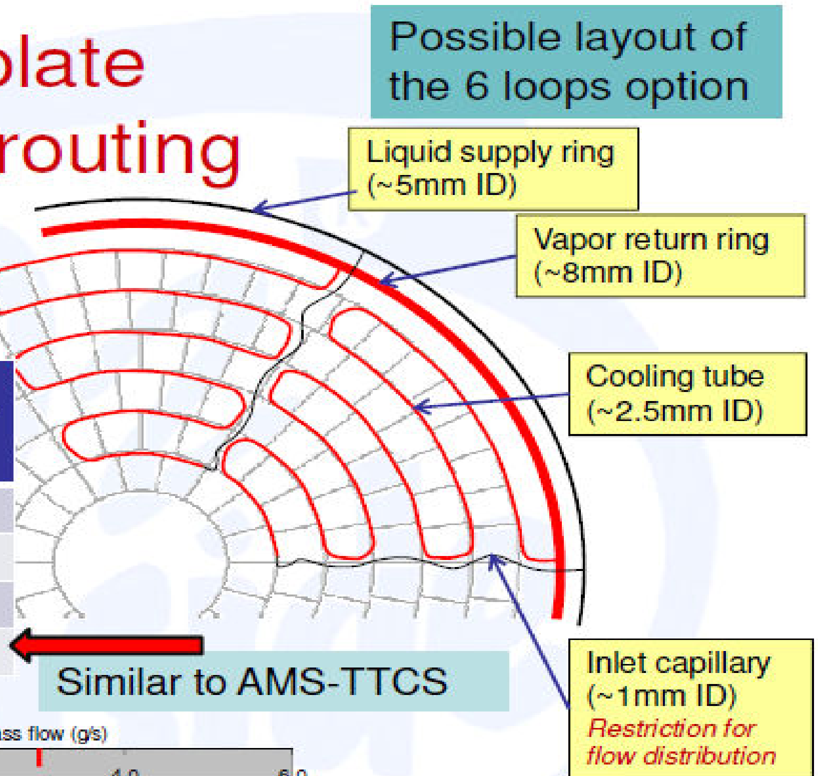
Advanced Endplate: Cooling

Preliminary Design Consideration for ILC TPC
Advantage of thin piping (high pressure)

BVERLAAT@NIKHEF.NL

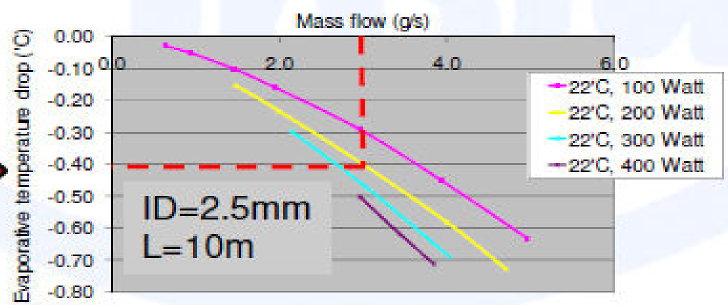
TPC end plate cooling tube routing

	Qty Frames / loop	Heat load per loop (W)	Tube length (m)	Inner diameter (mm)
1 loop	200	1000	48m	6.2
2 loops	100	500	24m	4.3
4 loops	50	250	12m	3
6 loops	34	171	8m	2.2



Similar to AMS-TTCS

AMS test data (2001)
0.4ºC temperature gradient



Conclusions

MPGD TPC options at ILC (ILD) TPC provide a large number of space points (200) with the excellent point resolution down to 100microns over 2m drift distance. It is a truly-visual 3D tracker works in high magnetic filed providing the performance necessary for the experimentation at ILC.

The TPC Large Prototype test at DESY (LP1) by LC TPC collaboration using the EUDET facility is being carried out successfully since November 2008.

We look forward to performing momentum measurement in non uniform magnetic field of PCMAG with full length tracks in the multi modules setup in 2010.

From 2011 we plan to perform beam tests with a high energy hadron beam.

There are important engineering issues to realize MPGD TPC for ILC (ILD): R&D for the advanced endplate and R&Ds for ion feed back/gating devices.