LC TPC R&D

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A Proposal to the DESY PRC for LC TPC R&D

- Objective
  $\longrightarrow$ develope a high-perfomance TPC for the LC detector
- Motivation
  $\longrightarrow$ reasons for a TPC as central tracking detector
- R&D Issues
  $\longrightarrow$ towards achieving the ulitmate performance
- Plans
  $\longrightarrow$ overview of the groups' efforts, priorities, timescale

TPC central tracker

- high measuring performance needed: $e^+e^- \to \mathrm{HZ} \to \mathrm{Hll}$
- high momenta, complex topologies: $\sqrt{s} \approx 100 - 1000$ GeV
- higher backgrounds than Lep $\Rightarrow$goals:
  - achieve finest possible granularity, as near as possible to the diffusion limit of drifting electrons
  - micropattern gas detectors?
  - very large-scale integration of readout electronics

Motivation

- large volume $\sim$ 40 m^3 $\rightarrow$ cost-effective way to instrument large volume
- continuous tracking $\sim$ 200 space pts./track $\rightarrow$ 95% tracking efficiency in high backgrounds
- mininimize material for $\sim 10^3\gamma$/BX $\sim$ 3% (30%) X_0 barrel (endcaps)
- timing precision $\sim$ 2 ns for BX i.d.
- happy with large B field (drift $\parallel$ $\vec{B}$)
- good V^0 detection for energy flow
- good dE/dx ($\sigma \sim 5\%$) for energy flow
- gate to eliminate ion feedback from gas-amplification region
- easy to maintain
- caveat: drift time integrates over 150 BX
  - therefore maximize granularity: $1.5 \cdot 10^6$ readout pads
  - diffusion limit of single electron e.g. $\phi \sim$ 2mm for P10 gas in 4T field $\Rightarrow 8.5 \cdot 10^6$

TPC R&D Issues (1)

- backgrounds
  - simulations imply $< 1\%$ occupancy,
  - but be ready for 20 $\times$ more
- gas amplification
  - MPGD (micropattern gas detectors) GEM or Micromegas promise better granularity than wires
    * detect drifting electrons directly
    * no prf (pad response function) of wire-to-pad induced signal
    * no $\vec{E} \times \vec{B}$ wire effect
  - are they robust? $\Rightarrow$ our R&D programme
  - wire chamber backup
- gas, fieldcage
  - Ar + which quencher?
    * CH_4 sensitive to neutron background
    * CO_2 slow
    * CF_4 fast but aggressive
  - influences operation and field-cage design

TPC R&D Issues (2)

- electronics
  - rϕ:
    - $\sim 1.5 \cdot 10^6$ pads $\approx 10\times$ Star
    - massive integration wanted with less material
  - z: faster sampling
    - $>$ 20 MHz (Star type)
    - $>$ 100 MHz (ATWD) if use induction signal for GEM
- pad structure
  - "pads partout"
  - if arriving e$^-$ cloud hits only one pad (short drift dist. for MPGD), resolution degraded:
  - how to "spread the charge"?ideas...
    - chevron pads?
    - conductive glass?
    - resistive coating?
    - capacitive coupling?
    - pad-induction signals (ATWD)?
    - ...?

TPC R&D Issues (3)

- gating, distortions
  - gating plane to eliminate $\oplus$ ion feedback from amplification region
  - devise techniques to keep systematics $< 10\mu$m ($3\times$ smaller than lep)
- mechanics
  - goal:
    - $3\%X_0$ in r, $30\%X_0$ in z
    - non-trivial (start now)
  - roll back TPC to work on inner detectors
- cooling
  - for large number of channels non-trivial
  - TESLA operation allows to ramp off between trains
  - $\Rightarrow\sim$ kW per side

Plans(1) G=GEM, M=Micromegas, B=Gem, Micromegas or Wires

Topic	Aachen	Berkeley	DESY/Hamburg	Karlsruhe	Krakow	MIT	MPI-Munich	NIKHEF	Novosibirsk	Orsay /Saclay	Carleton/Montreal	Rostock
MPGD development	G			G					G	M		
MPGD operation	G	B	G	G					G	M	B	
MPGD signal pickup	G	B	G							M	B	
Si readout								G				
MPGD ageing				G		G				M		
MPGD tower			G							M		
MPGD ion feedback	G		G	G					G	M	B	
MPGD B-field behaviour			G	G						M		
MPGD 2-track resolution			G							M		
Gas studies					B	B	B			B		
Gas system					B							
Electronics		B					B			B		B
Endplate Design		B	G				B					
Cooling		B					B					
Mechanics			G				B					
Fieldcage Design			B				B					
Calibration												
- MPGD Simulation	G									M	B	
- Pad simulation			B							B	B	
- Alignment			B				B	B		B		
- Laser		B					B					
Software			G							B		

Plans(2)

- Priorities
  - compile information/knowhow on MPGDs
  - begin electronics/fieldcage studies
- Timescale
  - make decisions based on R&D toward realistic MPGD or wire prototype within 2 years
  - design/build this prototype following year, then start serious testing