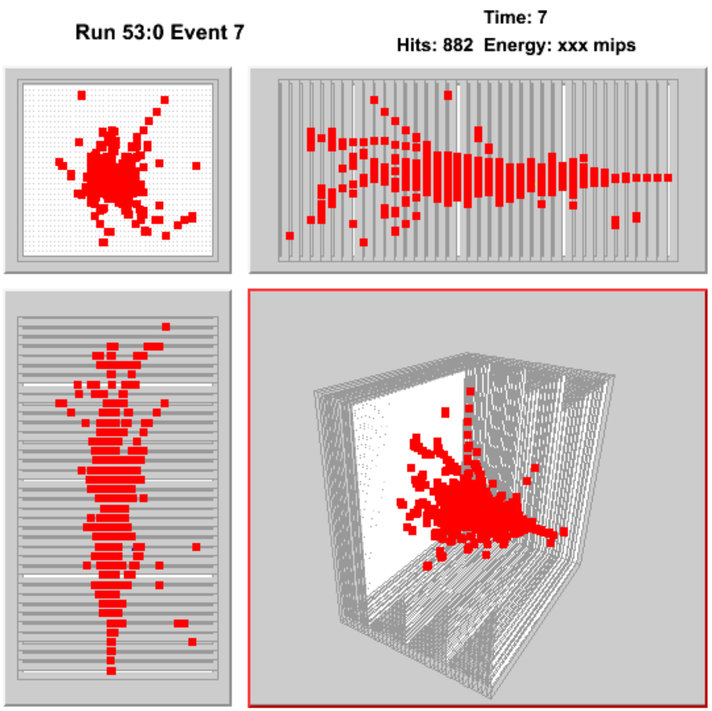
Overview of the RPC DHCAL Project



José Repond
Argonne National Laboratory

SiD Meeting
International Linear Collider Workshop 2010
Institute of High Energy Physics
Beijing, People's Republic of China
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RPC DHCAL Collaboration

Calorimeter for ILC

Argonne

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RED = Electronics Contributions
GREEN = Mechanical Contributions
BLUE = Students
BLACK = Physicist

Argonne NATIONAL LABORATORY

BOSTON UNIVERSITY

Fermilab

Institute of High Energy Physics
Chinese Academy of Sciences

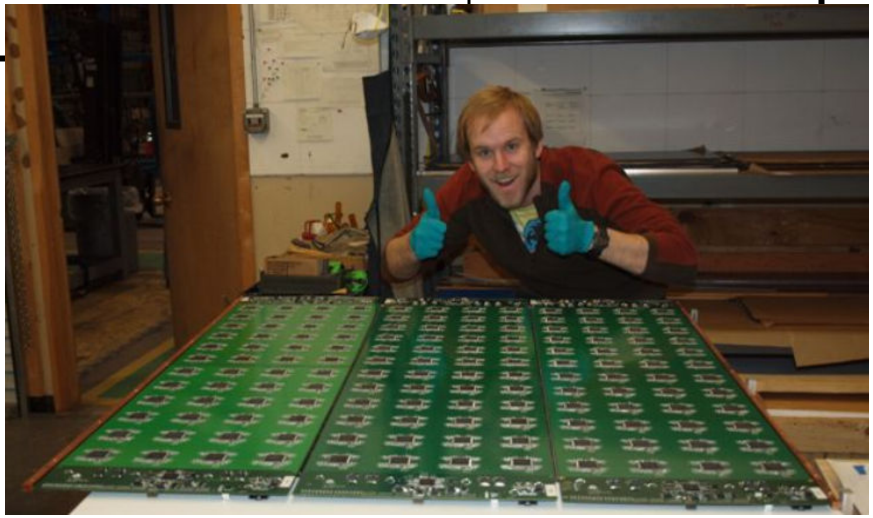
The University of Iowa

McGill

The University of Texas ARLINGTON

Current status

R&D phase	Refereed papers	Status
Initial RPC studies with analog readout	1 Nucl. Instr. Meth.	Completed
Vertical slice test with digital readout	5 JINST (last paper published on February 24, 2010) 1st PhD thesis completed	Completed
Physics prototype	-	Ongoing
Technical prototype R&D	-	Nothing much yet



Physics prototype construction status

Task	Status	Comment
RPC construction	40% done	Much more tedious than anticipated
Cassette construction	Design complete 1st prototype assembled Material in hand, design not yet blessed	Costly, but not very labor intensive
Front-end electronics	Prototypes fully debugged Boards in fabrication	Pursued a very conservative approach
Back-end electronics	DCOL 100% done New TTM in fabrication	
Low voltage	Power supplies in hand 1st distribution box assembled and tested Parts for all units on order	
High voltage	Units in hand Computer controlled program completed	
Gas system	Gas mixer completed and tested Decision to built 2nd distribution rack Parts on order (partly in hand)	
DAQ software	Implemented into CALICE framework 99% complete	
Event builder and display	Event building started Event display complete	
Data analysis	Started to reconstruct tracks in CR data	Lots of experience from VST
Simulation	RPC response simulated Implementation of DHCAL into MOKKA ongoing	

Construction steps and quality assurance

Assembly of RPC

→ Measurement of gas tightness
→ Measurement of chamber thickness
→ Assembly of HV connection
→ High voltage tests
→ Measurement of noise rate, efficiency and pad multiplicity

Installation into cassettes

→ Cosmic ray testing of completed cassettes

→ Test gluing joints (noise run)
→ Gluing of pad- and front-end boards
→ Testing of readout-boards

Assembly of readout-boards

Construction: a few early comments…

RPC assembly

Very labor intensive (not expected to be so bad)
Precision at < 100 μm level needed
Glass is cheap, but also breaks (we are learning)
Glass spraying has been a struggle

Current assembly technique not viable for ILC type calorimeter (x 100 larger)

But current activity invaluable for the development of future assembly techniques

Electronic readout

Worry about being overwhelmed with rare errors in large system (400,000 channels)
Opted for VERY conservative approach
Detailed (torture) tests at every step in the design and prototyping process
Confident that this will pay off

Unless you build a larger system you'll never know where the real problems are
It is not possible to foresee every problem

Physics prototype plans

Task	Dates	Comments
Construction	Complete by June 30th	Should not slip much more…
Cosmic ray testing of cubic meter	April through August	
Installation into Mtest	in September	
1st data taking period	October	DHCAL standalone (with TCMT)
2nd data taking period	December	Combined with ECAL
3rd data taking period	Early in 2011	DHCAL standalone or combined
Disassembly and shipping of stage	March 2011	Hard deadline

Officially on Mtest schedule

Maybe not so hard

Simulation

RPC response

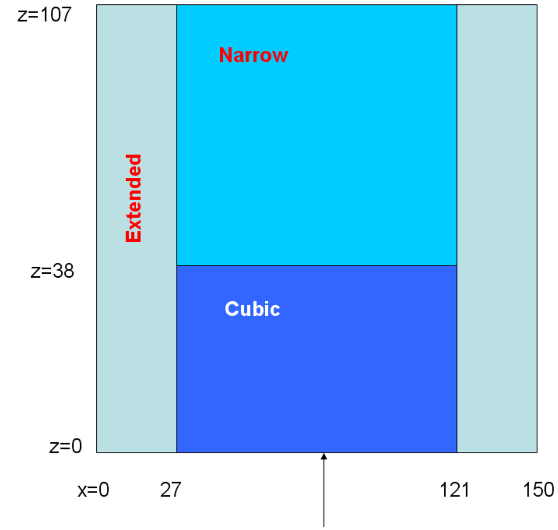
Detailed simulation in standalone program

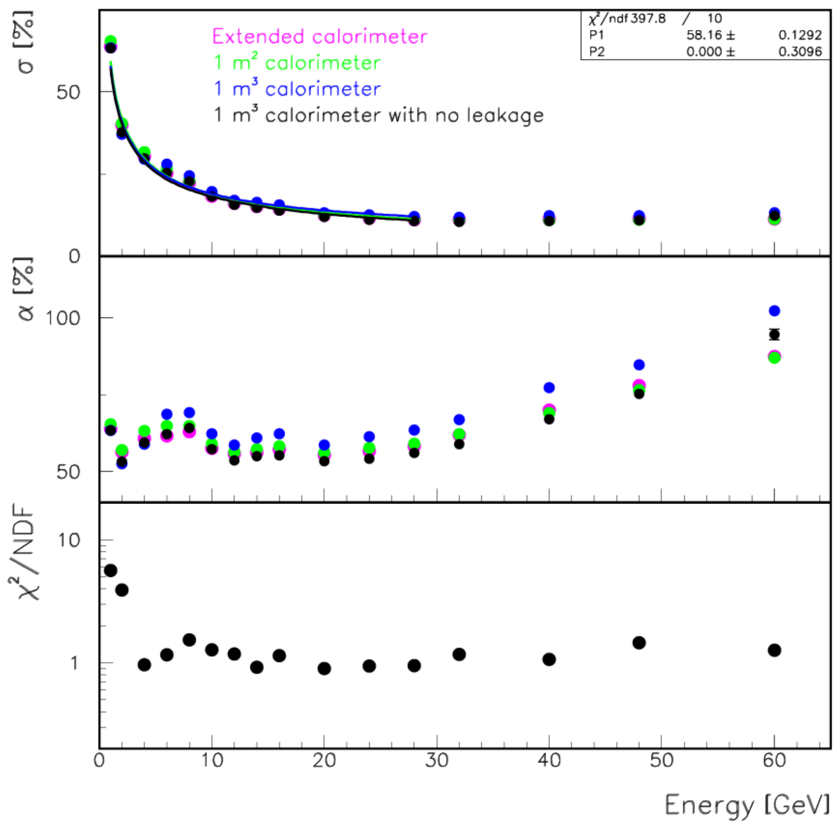
Cubic meter response

Studied under various conditions

Predicted resolution

For contained events expect 58%/√E up to 28 GeV
Resolution degrades at higher energies due to staturation (smaller than 1 x 1 cm^2 pads needed)
To 1st order resolution does not depend on efficiency and pad multiplicity





R&D beyond the physics prototype

1-glass RPCs

Will built a few prototypes with current electronics

Next version of DCAL chip

Complete redesign envisaged
Explore recent developments of ultra-low power consumption circuitry
Most likely will not pursue power pulsing (low efficiency for cosmic rays, CLIC?)

High/low voltage supply and distribution

Nothing concrete yet

Gas flow/recycling …

Gas recycling

Our preferred gas

Gas	Fraction [%]	Global warming potential (100 years, CO_2 = 1)	Fraction * GWP
Freon R134a	94.5	1430	1351
Isobutan	5.0	3	0.15
SF_6	0.5	22,800	114

Physics prototype

Gas volume ~ 40 liters
Need approximately 10 volume changes/day → 400 liters/day
Testbeam: Operate for say 4 months → 48,000 liters of mixed gas
Corresponds to 45,000 liters or 190 kg of Freon R134a which corresponds to 275 tons of CO_2
275 tons of CO_2 are emitted from 30,000 gallons of gasoline
Assuming 25 mpg, our emmission corresponds to driving your average car 30 times around the globe

This is not good, but also not disastrous

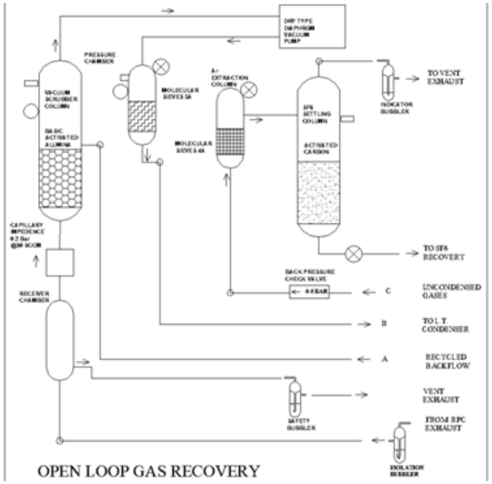
ILC detector type hadron calorimeter

Gas volume → x 100
Data taking: Operate for say 6 years → x 20
Our emmission will correspond to driving 50,000 cars around the globe

Obviously we need recycling, also to contain the cost

Two approaches to recycling

Closed circuitry adopted by LHC community
Open circuitry investigated by INO (Indian Neutrino Observatory)



Closed circuitry

Capture the gas, filter out toxins, and reuse
Currently not succesful, due to additional contaminants introduced by filters

Open circuitry

Freeze out Freon, Isobutan and SF_6 using different condensation temperatures, remix and use
Complicated system!!!!
Currently problems with plumbing (air in the system)
We have established some contact and hope to be able to collaborate in the future