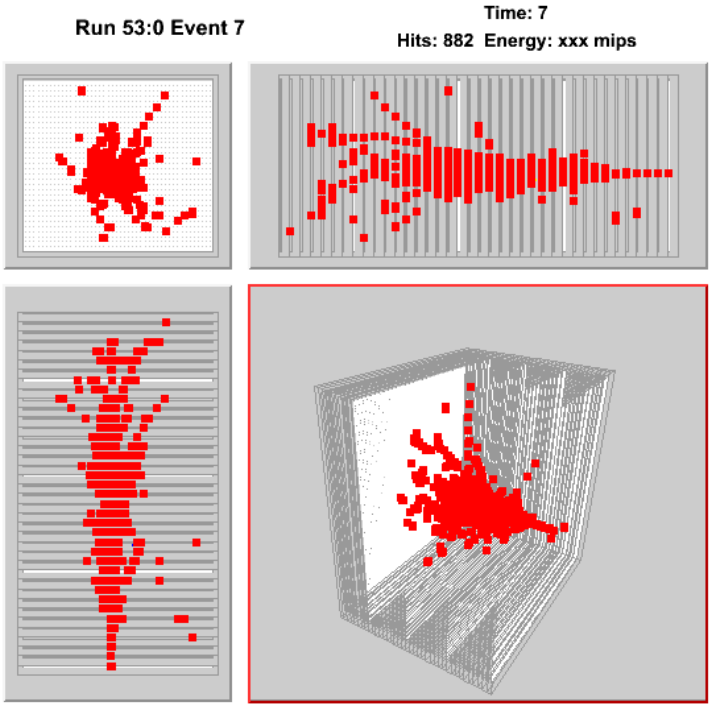
Overview of the RPC DHCAL Project



José Repond
Argonne National Laboratory

CALICE Collaboration Meeting
University of Texas at Arlington
March 10 – 12, 2010

RPC DHCAL Collaboration

Argonne

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François Corriveau
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UTA

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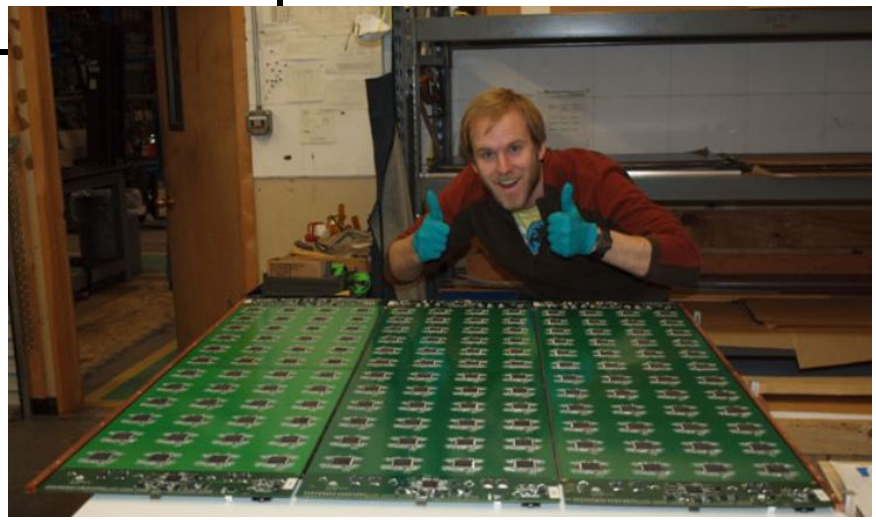
RED = Electronics Contributions
GREEN = Mechanical Contributions
BLUE = Students
BLACK = Physicist

Current status

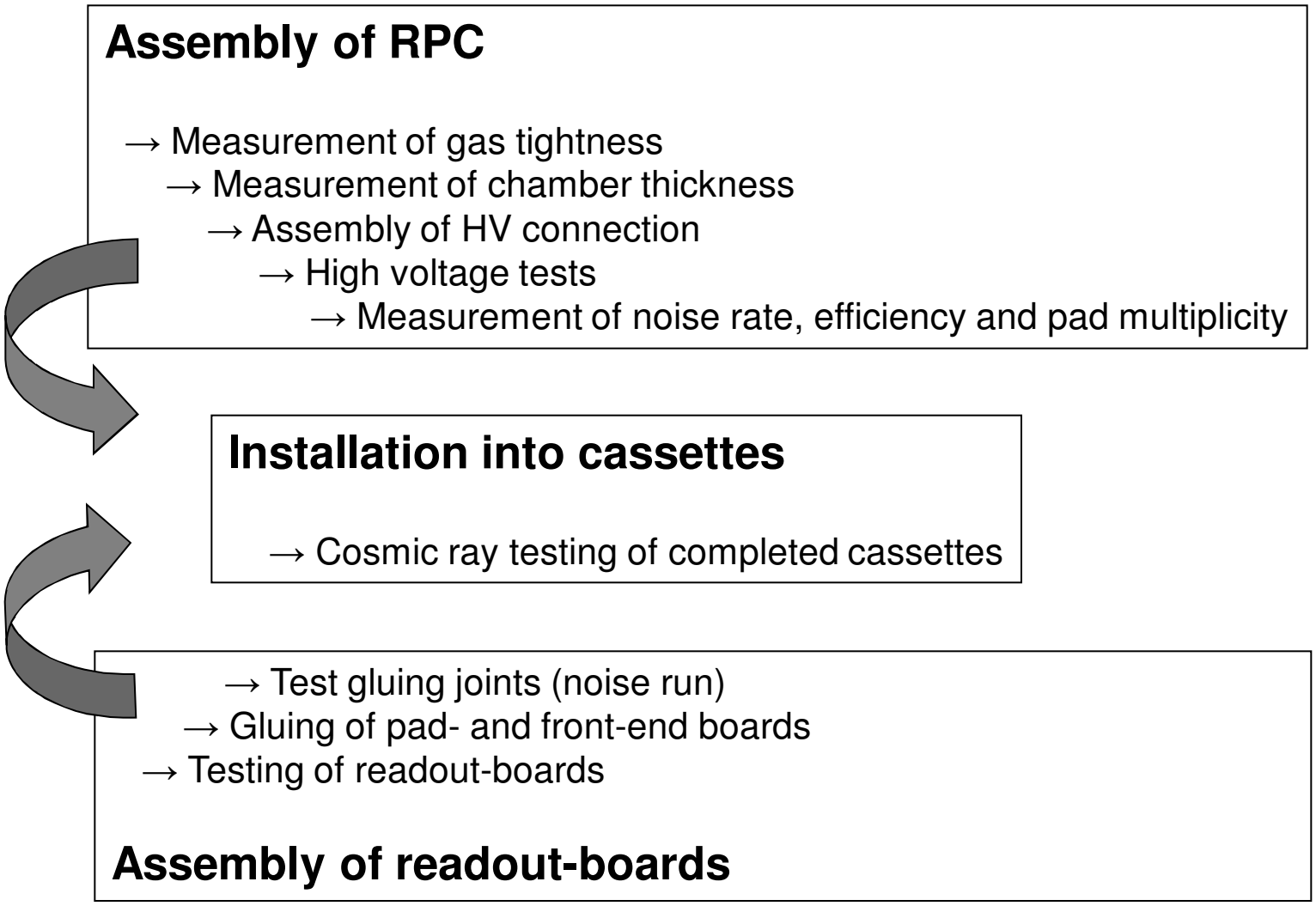
R&D phase	Refereed papers	Status
Initial RPC studies with analog readout	1 Nucl. Instr. Meth.	Completed
Vertical slice test with digital readout	5 JINST (last paper published on February 24, 2010)	Completed
Physics prototype	-	Ongoing
Technical prototype R&D	-	Nothing much yet



Physics prototype construction status

Task	Status	Comment
RPC construction	30% done	Much more tedious than anticipated
Cassette construction	Design complete 1st prototype assembled Material on order	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	
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



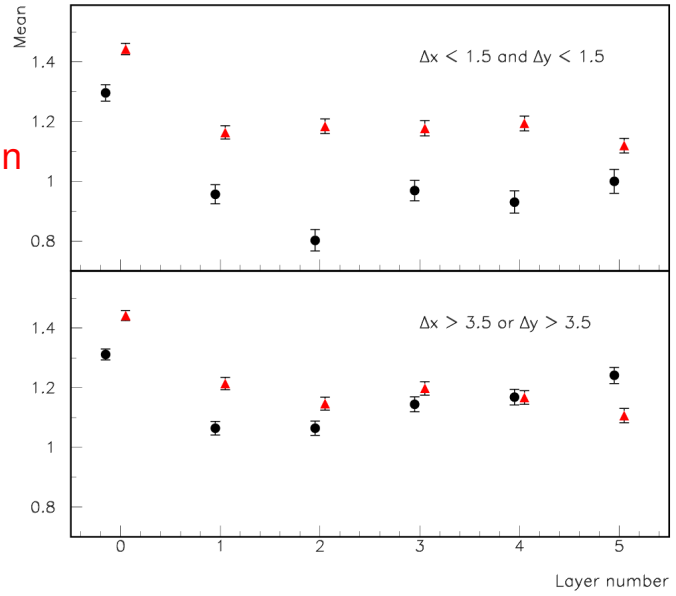
Physics prototype plans

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	Early September	
1st data taking period	September - 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

Rate considerations

'Efficiency'

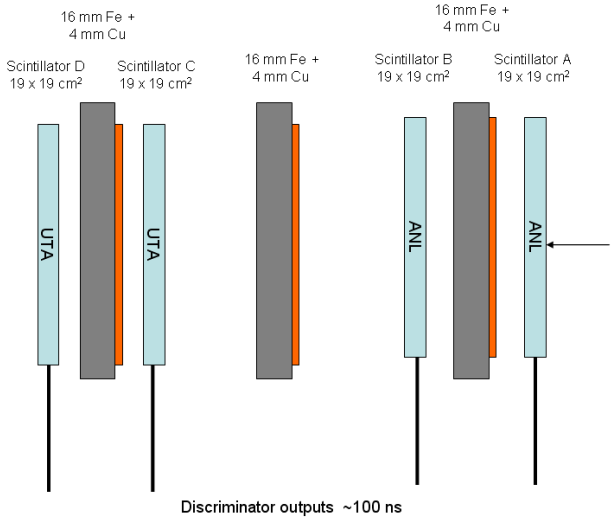
VST π data
MC simulation



VST: rate limitations observed
effect not compatible with low charged particle intensities and shower simulation

Dedicated measurements at MTBF

4 scintillation counters, absorbers and scalers



No indication of photons at p = 8 and 16 GeV/c

Convincing evidence of photons at 1, 2, and 4 GeV/c with

$R = N_\gamma/N_{charged}$ ~ 33, 26, 12 %

With Pb converter inserted, the rate of photons decrease to

$R = N_\gamma/N_{charged}$ ~ 11, 13, 5 %

Simulations needed (not sure will find time to do)

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)

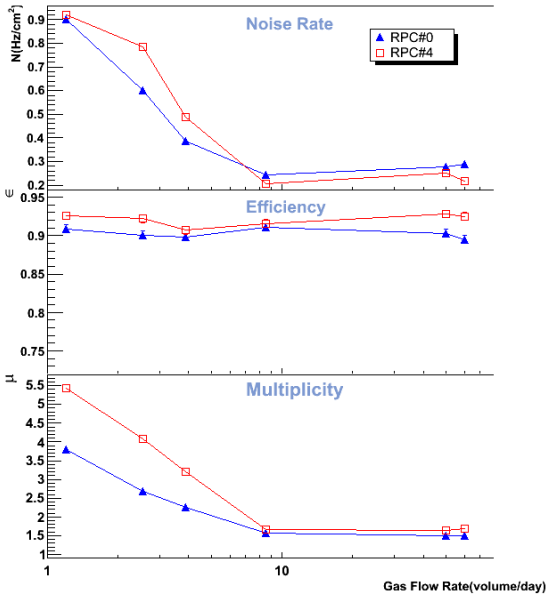
High/low voltage supply and distribution

Nothing concrete yet

Gas flow/recycling …

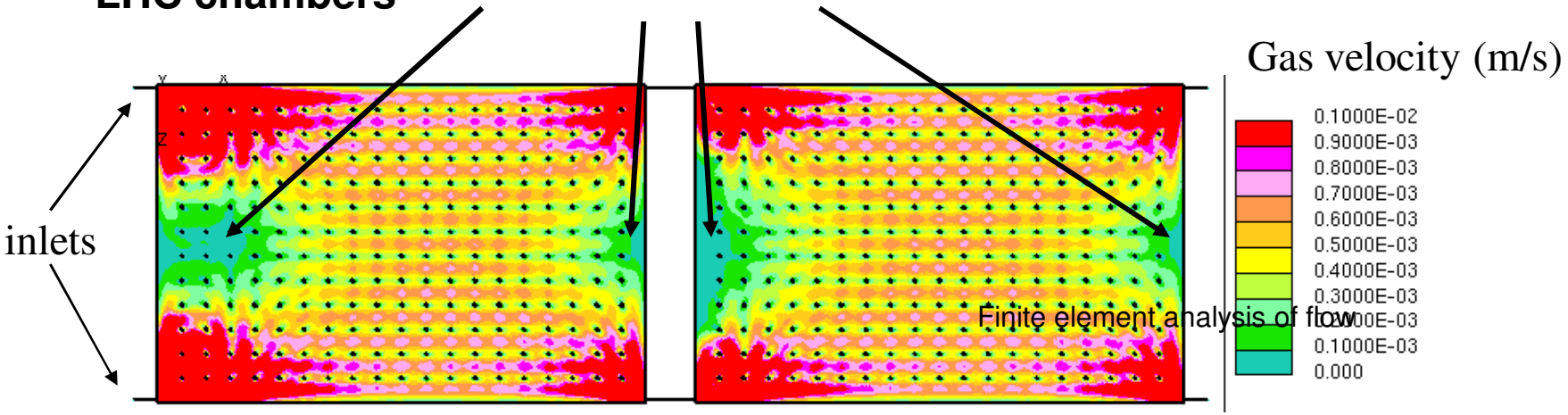
Published as Q.Zhang et al., 2010 JINST 5 P02007

Gas flow



Gas flow needed to purge toxins created in avalanches
Diffusion of gas in general a poor approach
Flow needs to be adjusted to rate of avalanches
Required overall flow defined by region of chamber with lowest flow

LHC chambers



RPC2010 workshop: R.Guida

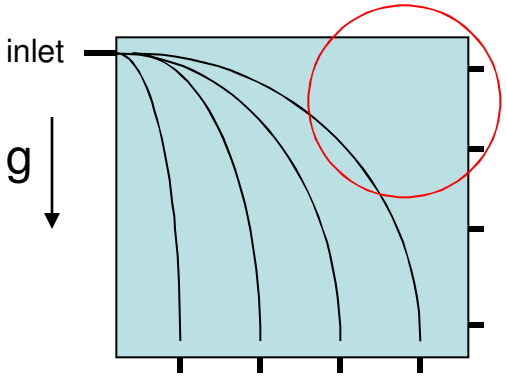
"This can lead to a local accumulation of impurities, affecting the overall RPC performance. We are studying realistic ways to optimize the flow gas distribution."

This is not the only problem…

The gases in our standard mixture are heavy
The flow of gases will be different in a horizontal and a vertical chamber

	UNIT	R134a ($C_2H_2F_4$)	ISOBUTANE (C_4H_{10})	SULPHUR HEXA FLUORIDE(SF_6)	AIR
GAS DENSITY	**kg/m^3**	**4.25**	**2.82**	**6.27**	**1.205**

Chamber without Gas pass



Accumulation of lighter toxins

We have solved this problem a long time ago!!!!!

Use fishing lines both as spacers and as chicane for the gas

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

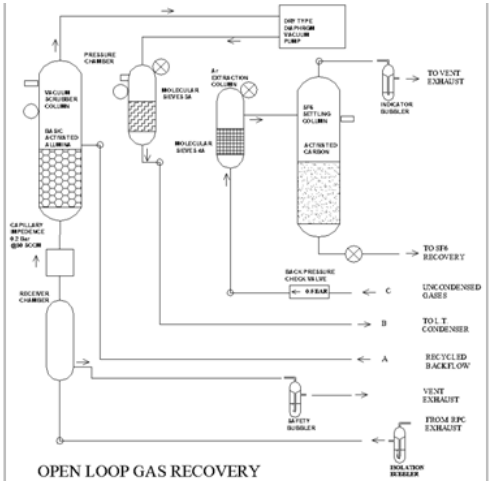
ILC detector type hadron calorimeter

Gas volume → x 100
Data taking: Operate for say 3 years → x 10
Our emmission will correspond to driving 25,000 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)



OPEN LOOP GAS RECOVERY

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

Last comment…

Order for the HARDROC2b chip has been placed

→ A 2nd cubic meter DHCAL with RPCs will be built

The **Silicon ECAL** is lacking funding/manpower

→ Slow progress on solving guard ring problem
→ No funds for combined tests with RPC – DHCAL at FNAL

We will have **2 (two!) RPC – DHCAL** cubic meter prototypes
(right, there are differences, but they are not overwhelmingly significant)

Inadequate effort in solving technical issues for RPC based DHCAL

Despite effort on being compatible with DAQ, there will be no combined testing at FNAL

We are **falling behind** in developing a Silicon ECAL