DHCAL Construction Status

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ALCPG2009, Albuquerque

1 m^3 – Physics Prototype

Description

40 layers each ~ 1 x 1 m^2
Each layer with 3 RPCs, each 32 x 96 cm^2
Readout of 1 x 1 cm^2 pads with one threshold (1-bit)
~400,000 readout channels
Layers to be inserted into the existing AHCAL structure

Purpose

Validate DHCAL concept
Gain experience running large RPC system
Measure hadronic showers in great detail
Validate hadronic shower models

Status

Started construction in fall 2008

RPC Construction

Not yet on critical path

RPC design

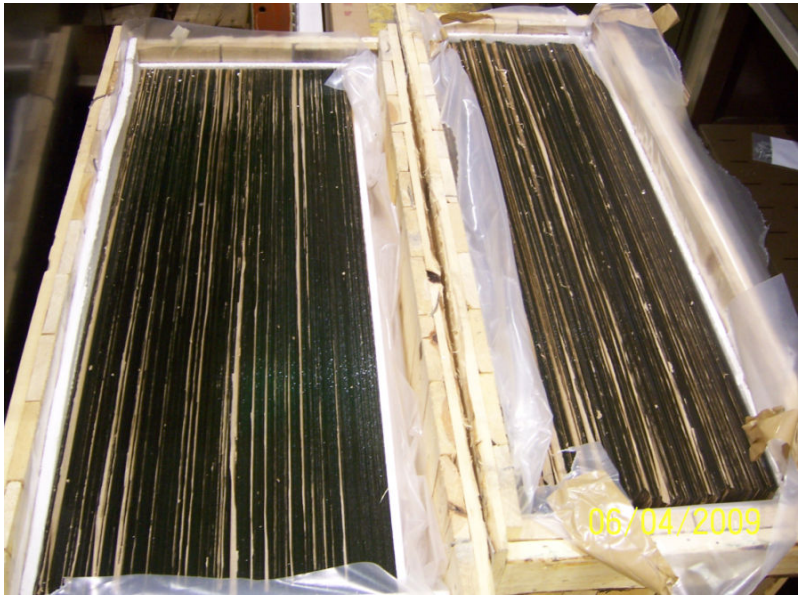
2 – glass RPCs
1 – glass RPCs (developed by Argonne)

Chambers needed

114 + spares

Material

Glass in hand for 300 chambers
Kilometers worth of channels for rim in hand
Kilometers worth of fishing line in hand
~50% of resistive paint in hand



Assembly steps

Spraying of glass plates with resistive paint
Cutting of frame pieces
Assembly of chamber
Gluing of glass plates
Mounting of HV cable

Spraying of the glass sheets

Challenge

Produce a uniform layer with $R_{\square} = 1 - 5\ M\Omega$
(value only critical for thin plate, large plate can be lower)

Previously used paint (LICRON)

Not useful anymore

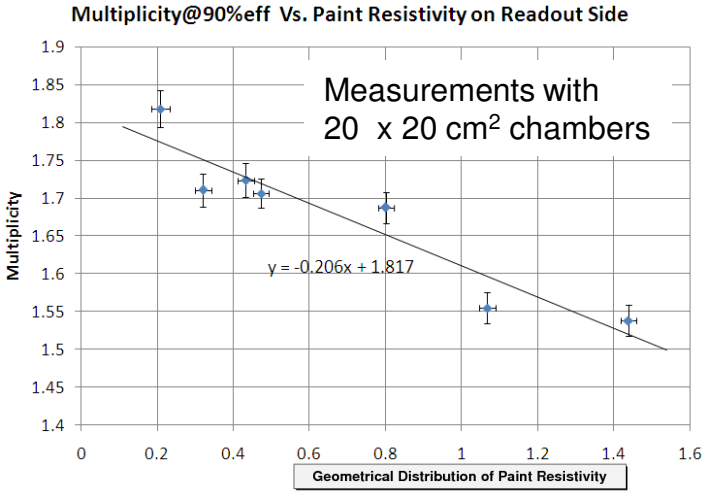
New paint (artist paint) identified

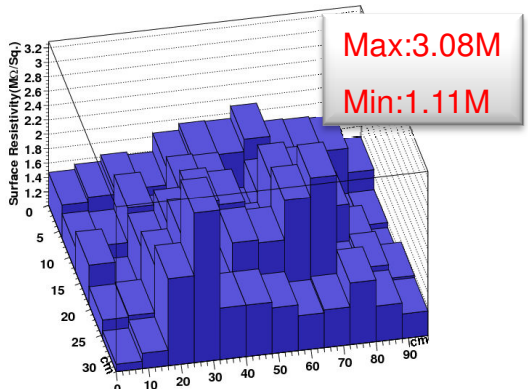
Reasonably cheap
Non toxic
2 component mixture
Needs to be sprayed

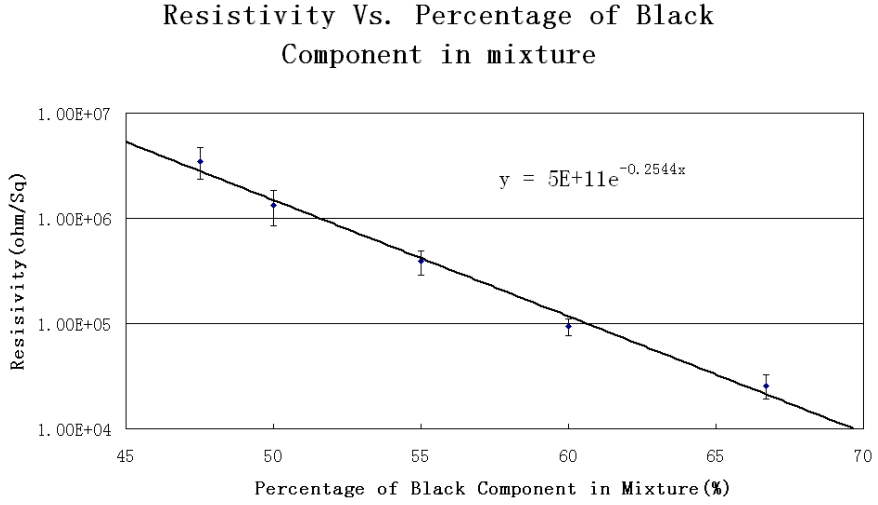
Time needed

Prepration ~ 25 min
Spraying ~ 10 min/plate
Cleanup ~ 10 min

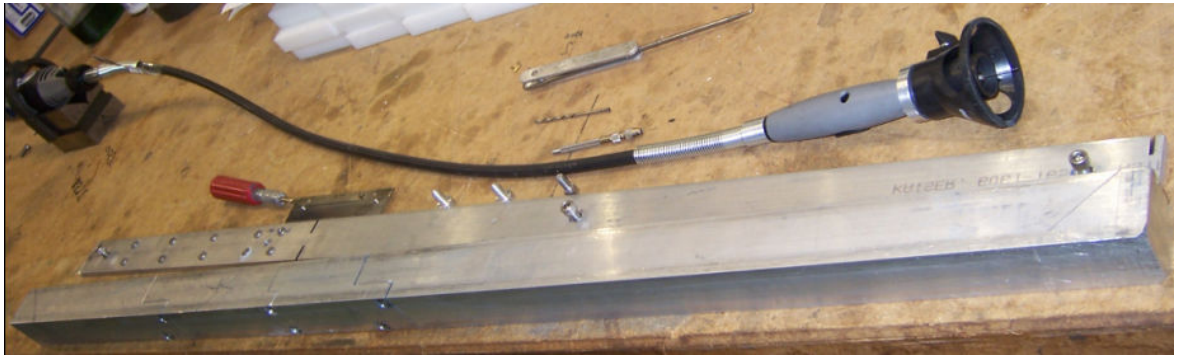
Can do several plates in one go…







Cutting of frame pieces



Challenge

Need to cut pieces with a precision of 0.2 mm
Need to drill holes with a precision of 0.2 mm

Fixture

Assembled and tested

Time needed

~ 15 minutes/frame

Assembly of Chambers

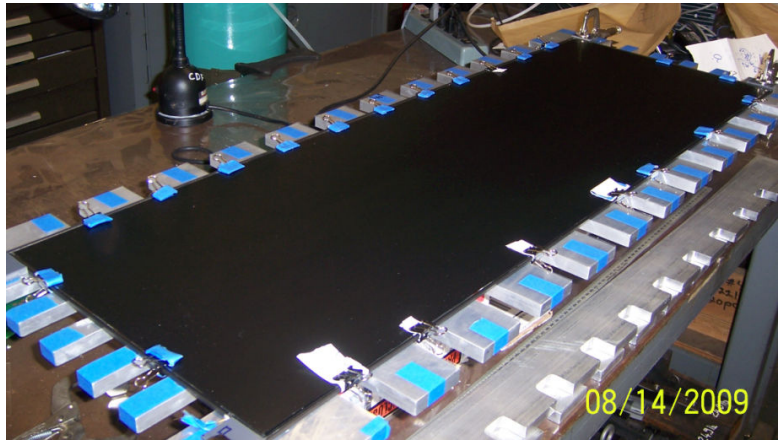
Jig for gluing glass and frame

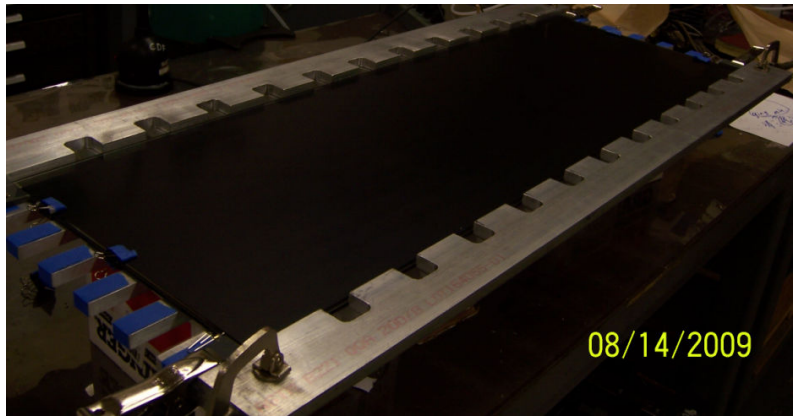
Jig designed and built
2nd jig (different design) being built

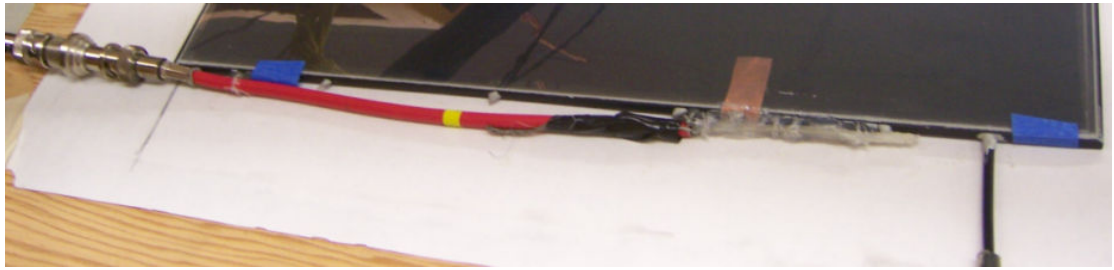
Time needed

Approximately 4 - 8 hours/chamber
(not counting curing time)

1.5 technicians trained for assembly



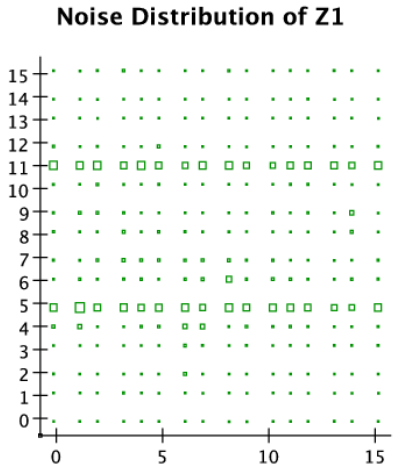




Assembly Status

# of RPCs	Label	# of glass plates	Glass thickness [mm]	Size [cm]	Conductive Paint	Status	Tests	Problems
~15		2	1.1	20 x 20	Old licron	built	2 years	None
1		1	1.1	20 x 20	Old licron	built	2 years	None
1+3		2	1.2/1.2	32 x 96	Old licron	built	10+ month	High pad multiplicity ~2.1 (mainly due to lower resistivity)
3		1	1.1	20 x 20	Old licron	built	4 months	None
8	**LR001**	**2**	**0.85/1.10**	**32 x 96**	**White paint (brushed)**	**built**	**6+ months**	**None**
	LR002				**Black Paint (brushed)**	**built**	**6+months**	**None**
	LR003				**Black Paint (Sprayed)**	**built**	**~ 2 months**	**None**
	LR004					**built**	**~ 2 months**	**None**
	LR005					**Built with Jig**	**1 month**	**None**
	LR006					**Built with Jig**		**None**
	LR007					**being built with Jig**		

Quality Assurance



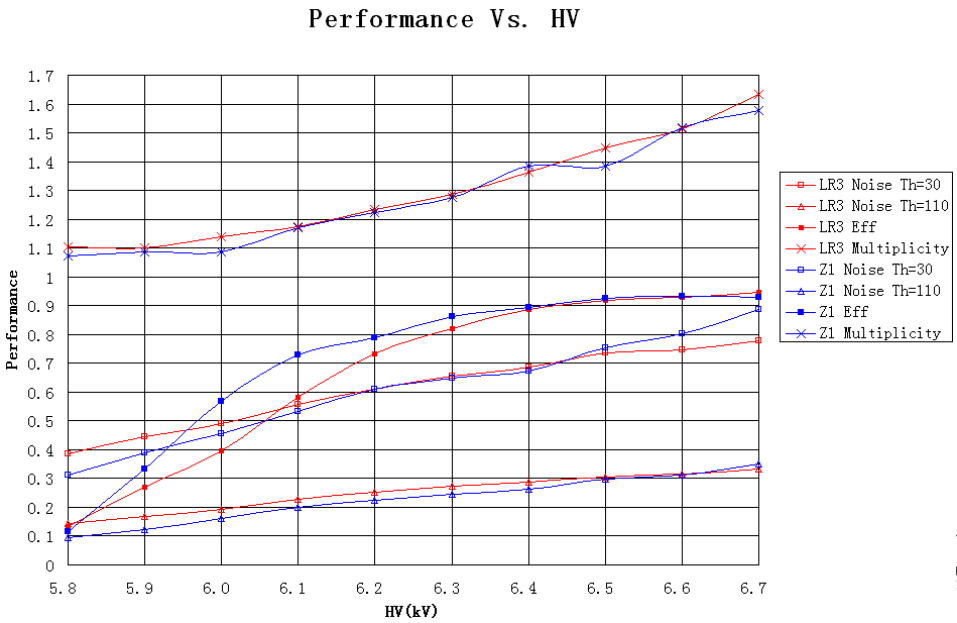
Currently

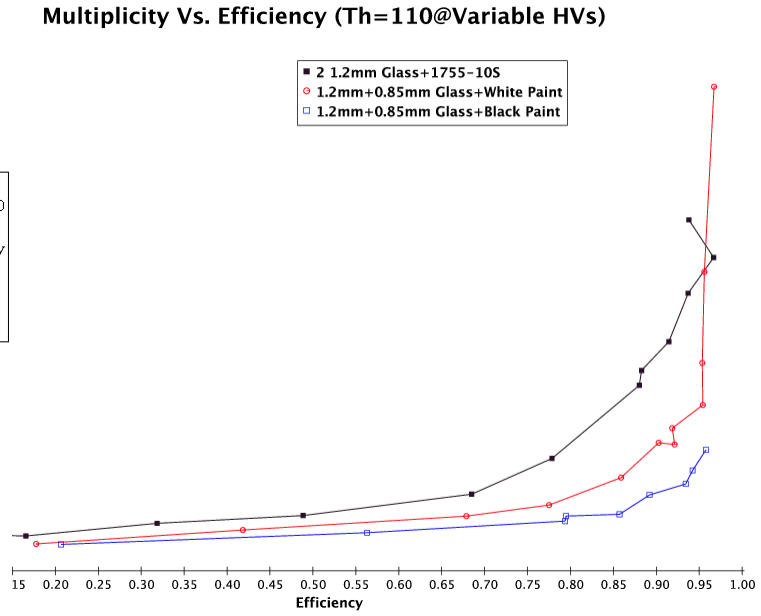
Use old electronics to check out chambers

Future

A) Will measure each chamber with new electronics and VST (for tracking)

B) Will measure cosmic rays with completed cassettes in hanging file structure





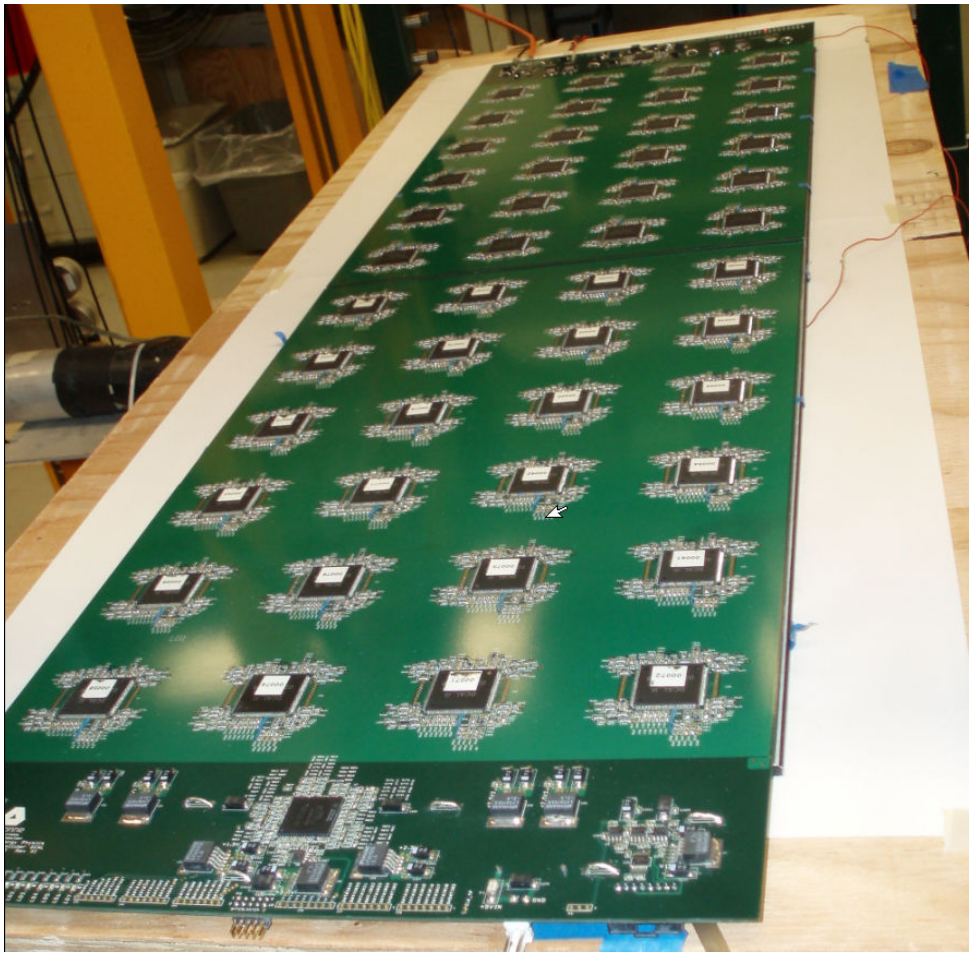
First cosmics with new board

Setup

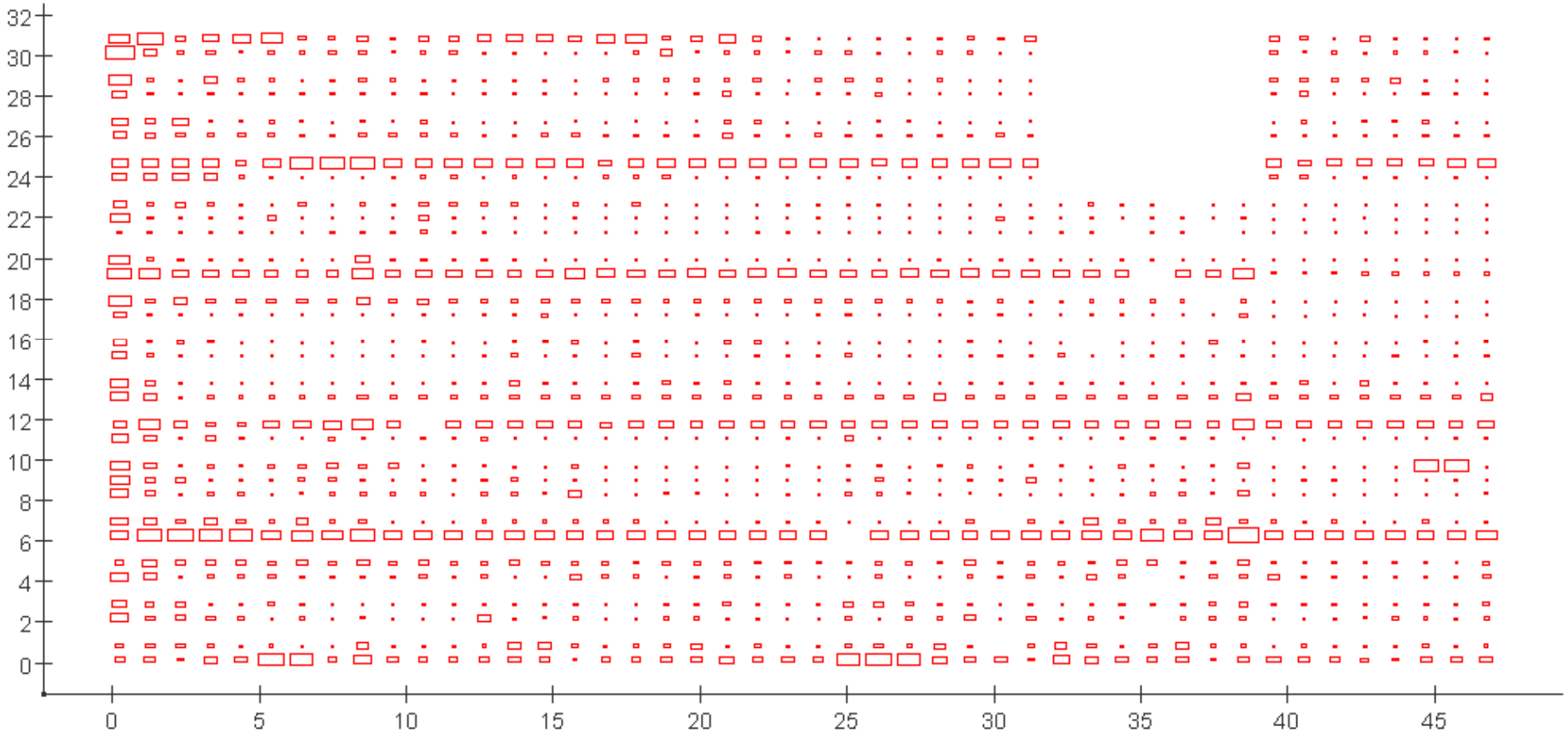
Uses 7 chambers from VST
1 large chamber with 1 board

Data taking

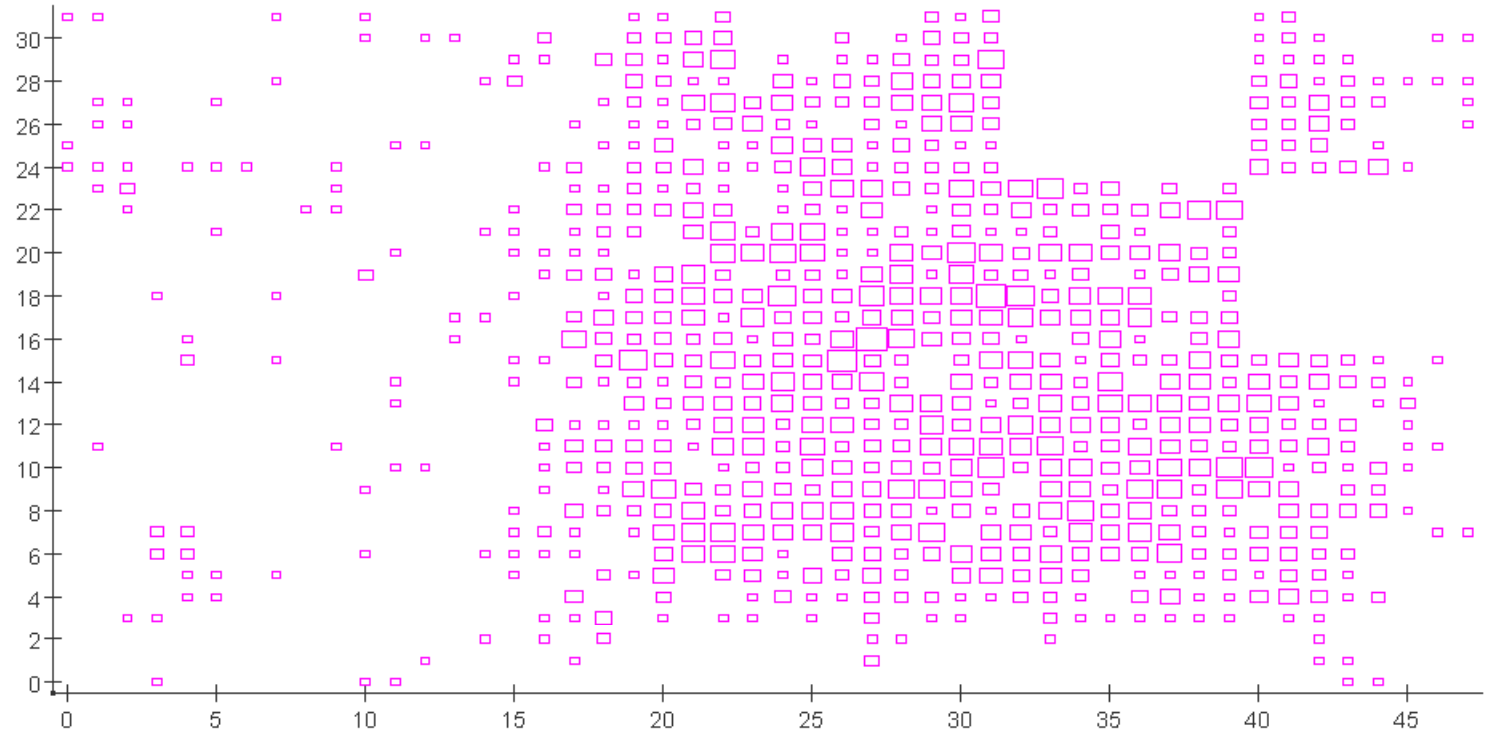
First events on 9/11/2009



First Run of Large FEB(Noise Run)



All Hits(First Run of FEB, Cosmic-ray Run)



file #0 16-bite data with timestamp out of range (without DCON errors): 2
file #0 16-bite data with wrong timestamp (in range, without DCON errors): 7
file #0 16-bite data with time matching problem (ambiguity in event building: 0
Events built out of data: 3471 Events with building error: 0
Selected Events: 2252 Events with building error: 0

Layer 8
 projected hits from good tracks: 509
 found matching clusters: 352
 efficiency = 0.6915520628683693
 multiplicity = 1.2954545454545454
 68.9(1.26) 67.3(1.38) 75.5(1.28)
 66.7(1.39) 77.6(1.21) 68.8(1.32)
 60.8(1.19) 73.5(1.36) 66.0(1.20)

Cassettes

Purpose

Protect RPCs, cool front-end ASICs, compress RPCs

Design

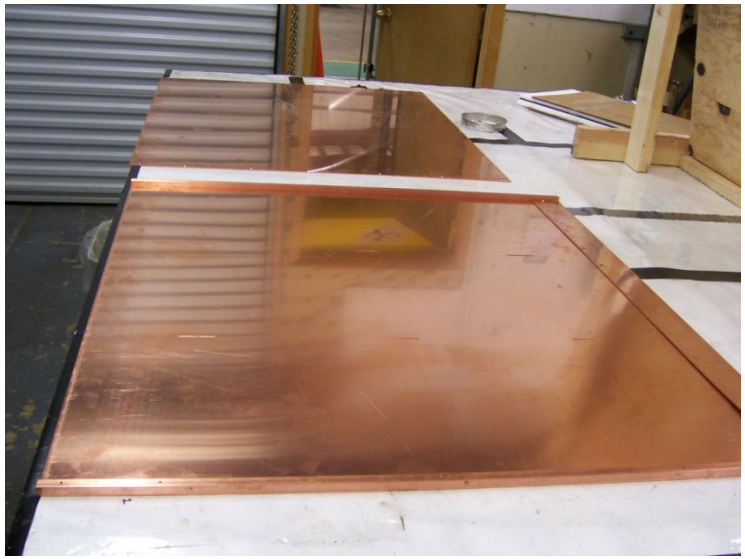
2 x 2 mm^2 copper sheets + cooling tube on top
Will fit into CALICE AHCAL structure

Prototypes

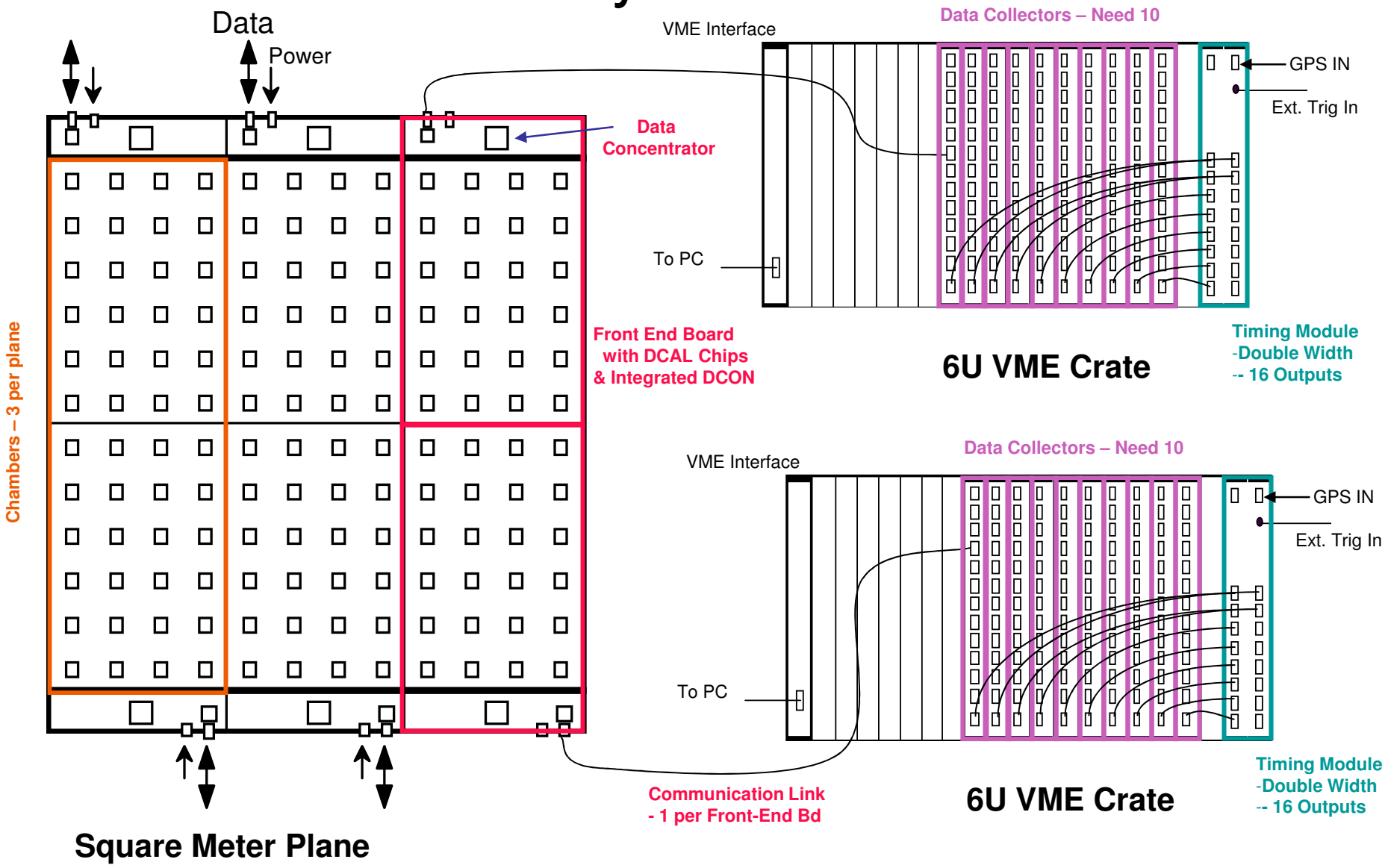
First one built some time ago
2nd prototype to be built shortly (material in hand)

Assembly

Not expected to be labor-intensive

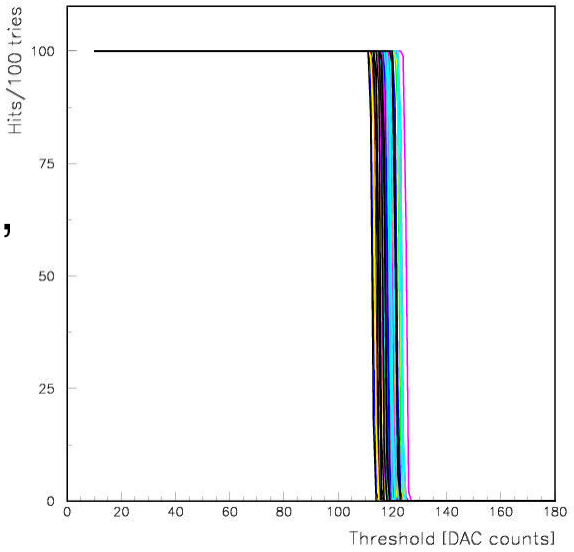


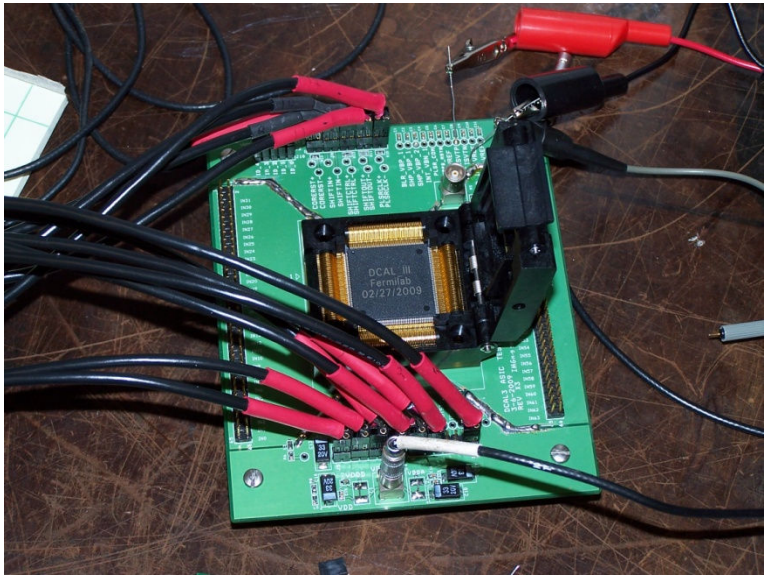
Readout system overview

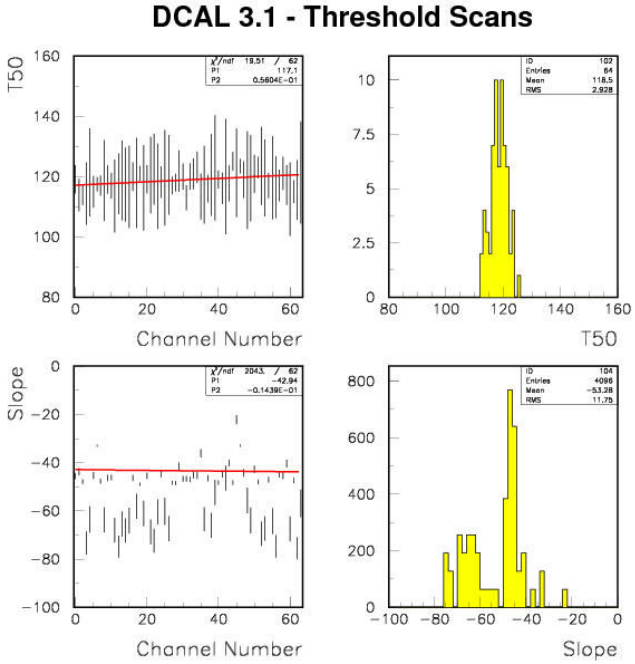


DCAL III production

- DCALIII fixed a few minor bugs in DCALII
- Status of Production:
  - 11 wafers, 10,300 chips, fabricated, packaged, in-hand
  - Bench tests at Argonne
    - Basic performance is the same
    - Only problem: performance in socket not as good as when soldered onto PCB → OK for most tests

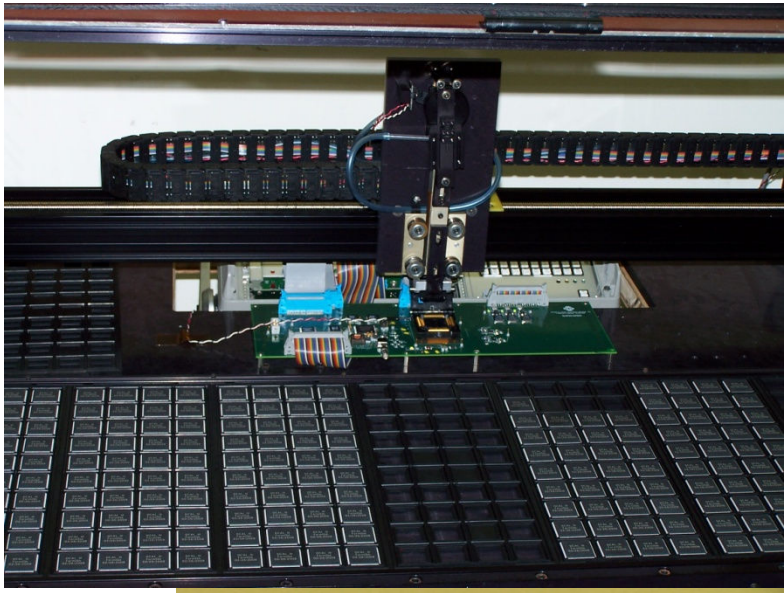


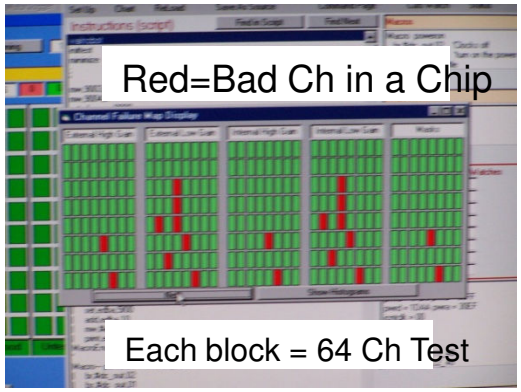


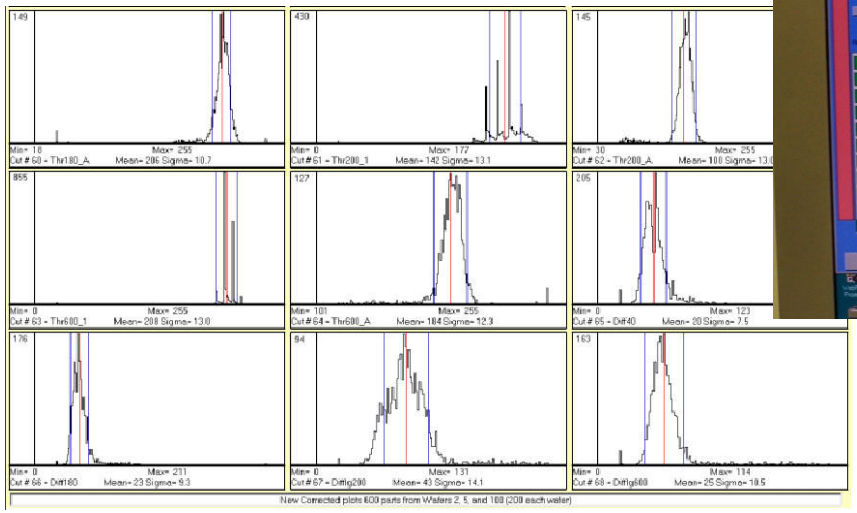


DCAL III testing at Fermilab

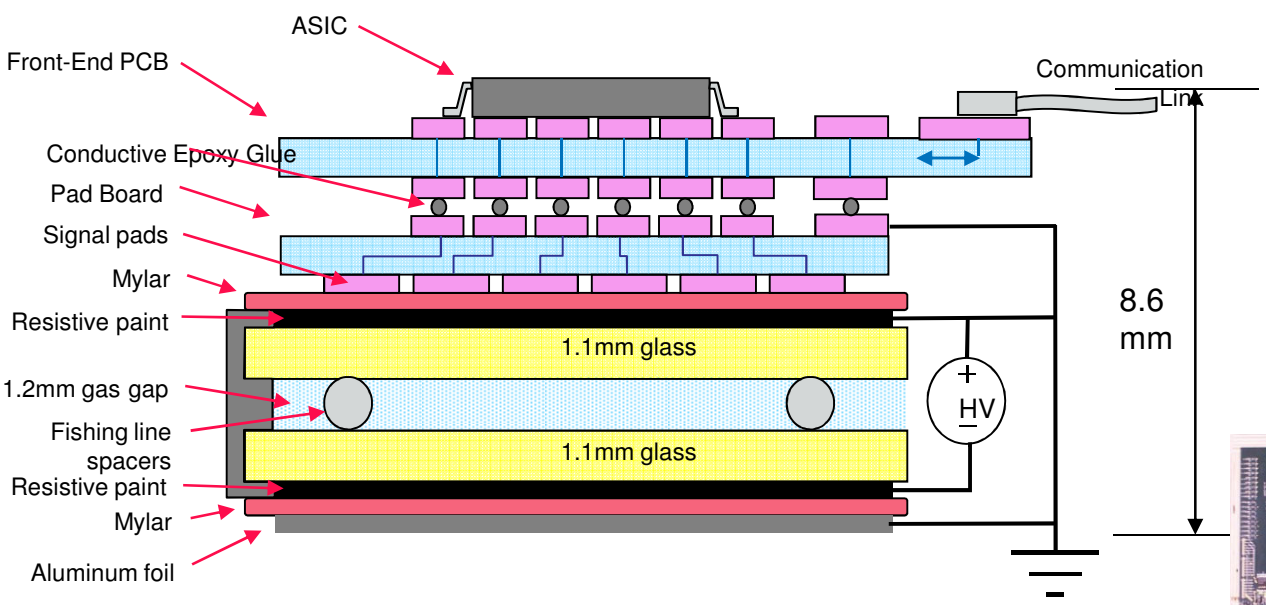
- Fermilab Chip-Testing Robot
  - 78 parameters measured per chip
  - Test mode:
    - No cuts applied, Measure parameters
  - Checkout mode
    - Apply cuts, Robot sorts
  - Robots sorts good chips & bad chips into trays
  - ~1 minute per chip, ~400chips/day
- Results so Far:
  - Checked 800 chips
  - Yield 68% (→ 80%)
- Wafer checkout performed
  - One bad wafer (out of 11, and the one started with!)
  - Other wafers looks great
    - >200 chips/wafer sample size
    - Yield as high as up to 95 – 96%

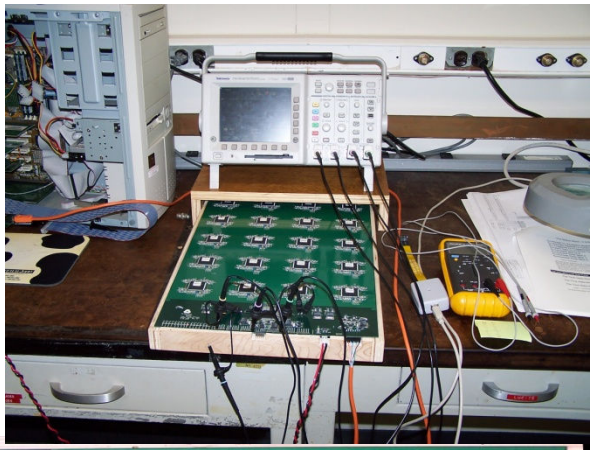


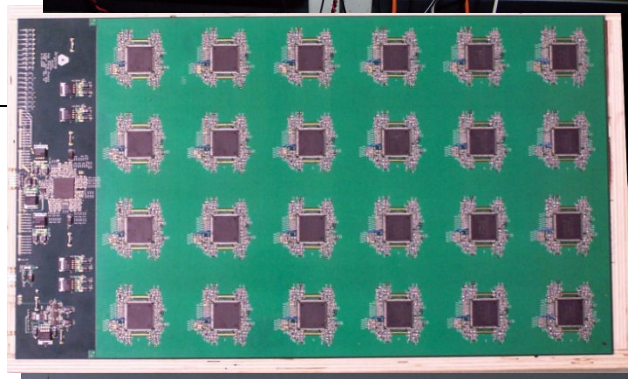


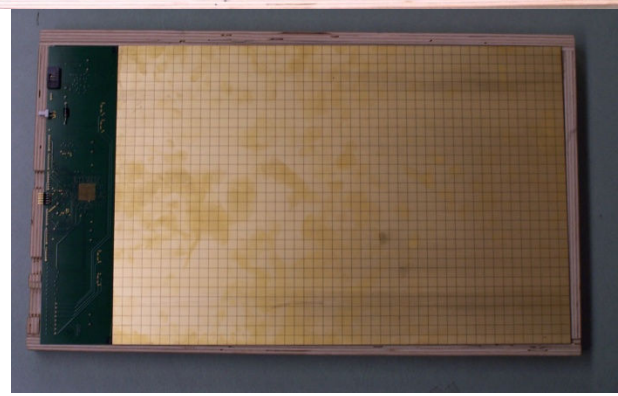


FrontEnd/DCON board + Pad board





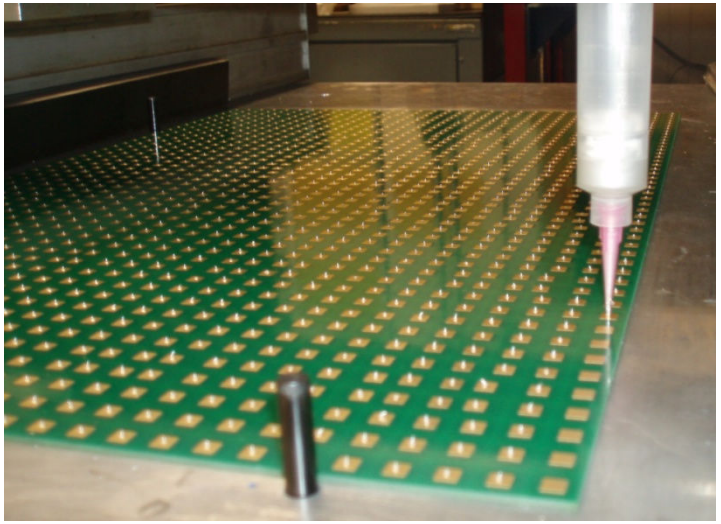




- Have built & checked out 2 boards.
- Have glued 1 pad board
- Testing in progress
- Cosmic ray tests have begun

Gluing fixture for Pad- and FE-boards

1536 glue dots in less than 3 hours



Fixture

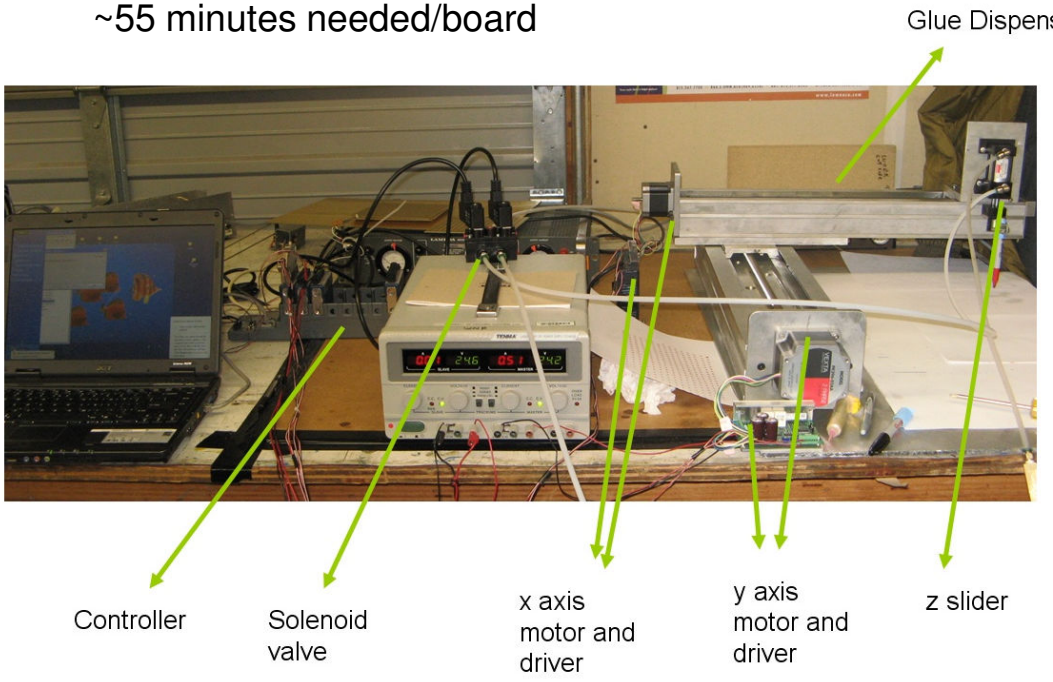
Designed, built and commissioned

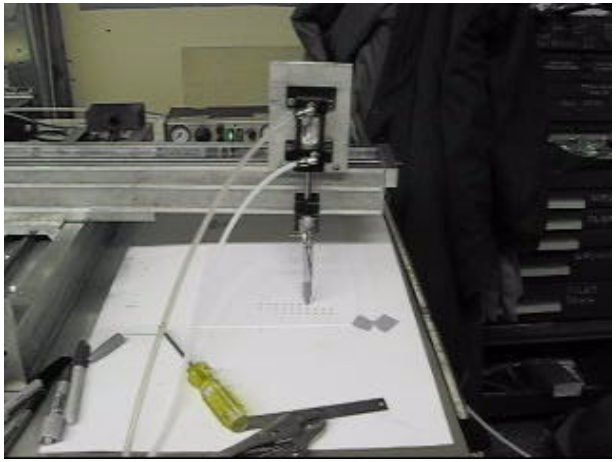
Practise

Glued a few 16 x 16 cm^2 boards

New front-end boards

First board successfully glued
~55 minutes needed/board





Low Voltage System

Need +5 Volts for front-end boards

System

Consists of power supplies and distribution boxes
Fits into one rack

Wiener power supplies

7 units in hand

Distribution boxes

Design finalized: individual switches for each front-end board
Parts for 1 unit ordered
To be assembled first week of October

Cables

To be cut later

Gas and HV systems

Gas mixing system

Provides flow for entire 1 m^3
Designed, assembled and tested
RPC performance very similar to pre-mixed gas

Gas distribution system

Re-use system from Vertical Slice Test
Need to add 12 outputs (scheduled for October 10 – 20)

Chamber leak tester

Useful for testing completed RPCs
Will be provided by September 29

HV system

Two full systems available
Control software written
System currently in use

DAQ software

Not on critical path

Implemented into CALICE DAQ framework
New readout architecture and geometry implemented
Readout of mixed system (VST + new boards) debugged
Remaining issue with maximum record size to be sorted out

OFFLINE software

Not on critical path

Working on event builder (Jacob Smith)

Agreement to use standard LCIO – Marlin – LCCD – Mokka chain

Test Beam Plans

Start with standalone DHCAL program (including TCMT!)

- Broadband muons for calibration
- Positrons 1 – 16 GeV
- Pions 1 – 66 GeV
- Protons 120 GeV

Followed by data taking with Silicon-Tungsten in front

Time scale still uncertain

- Realistic goal of data taking starting in spring 2010

DHCAL Construction Overview

Item	Status	Outstanding problems/tasks	Critical path
RPC construction	Several chambers built	Test of full-scale 1-glass chambers (requires final front-end board) Develop production procedure	(November - ?)
DCAL chips	Being tested	Yield?	Until ~ October 1
Front-end boards	Final design	1 additional round of prototyping?	~May - November
Back-end	DCOL being tested TTM being re-designed	None	No
Gas system	Being assembled	None	No
HV system	Completed	None	No
DAQ software	Being modified	Record length limitation	No
OFFLINE software	Being developed	None	No