

DHCAL Progress Report



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Outline

Slice Test

Test of ~8 chambers with complete electronics
At MTBF in early 2007

- Mechanical
- DCAL2 chip
- Pad and Front-end boards
- Data concentrators
- Data collectors
- DAQ software
- Beam telescope, HV, gas

Prototype Section Measurements

Measurements with complete 1m³ section
Hopefully starting in early 2008

Funding

Slice Test

Slice test: RPCs and GEMs

Uses the 40 DCAL ASICs from the 2nd prototype run

Equip ~8 chambers with 4 DCAL chips each

256 channels/chamber
~2000 channels total

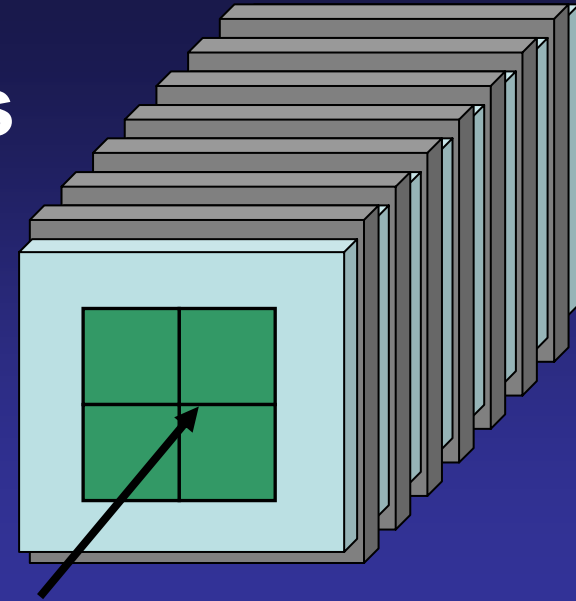
Order additional DCAL ASICs to equip GEM prototypes

Chambers interleaved with 20 mm copper - steel absorber plates

Electronic readout system (almost) identical to the one of the prototype section

Tests in MTBF beam planned for March 2007

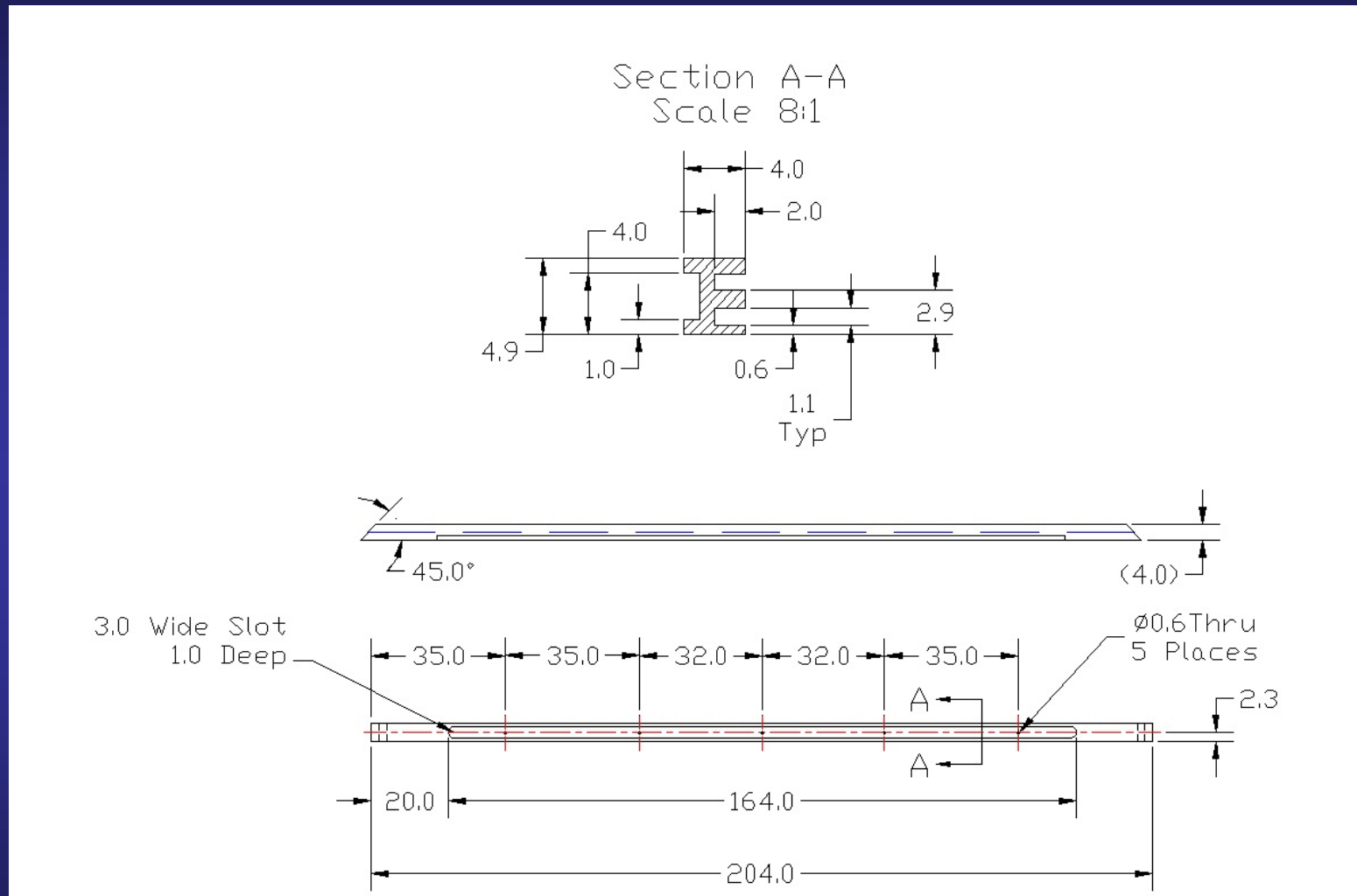
- Measure efficiency, pad multiplicity, rate capability of individual chambers
- Measure hadronic showers and compare to simulation



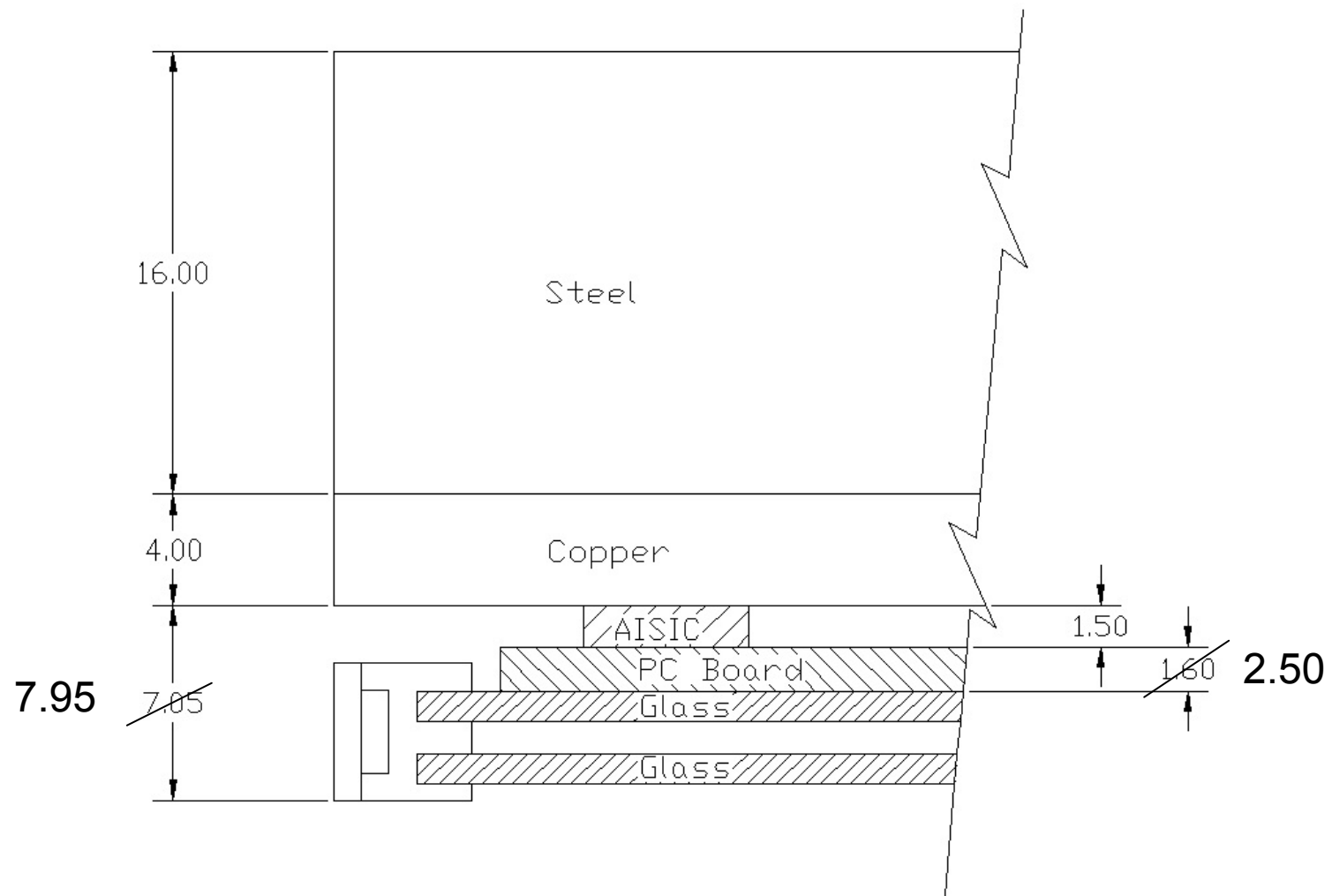
Validate RPC/GEM approach to calorimetry

Validate concept of electronic readout

Mechanical: RPC design

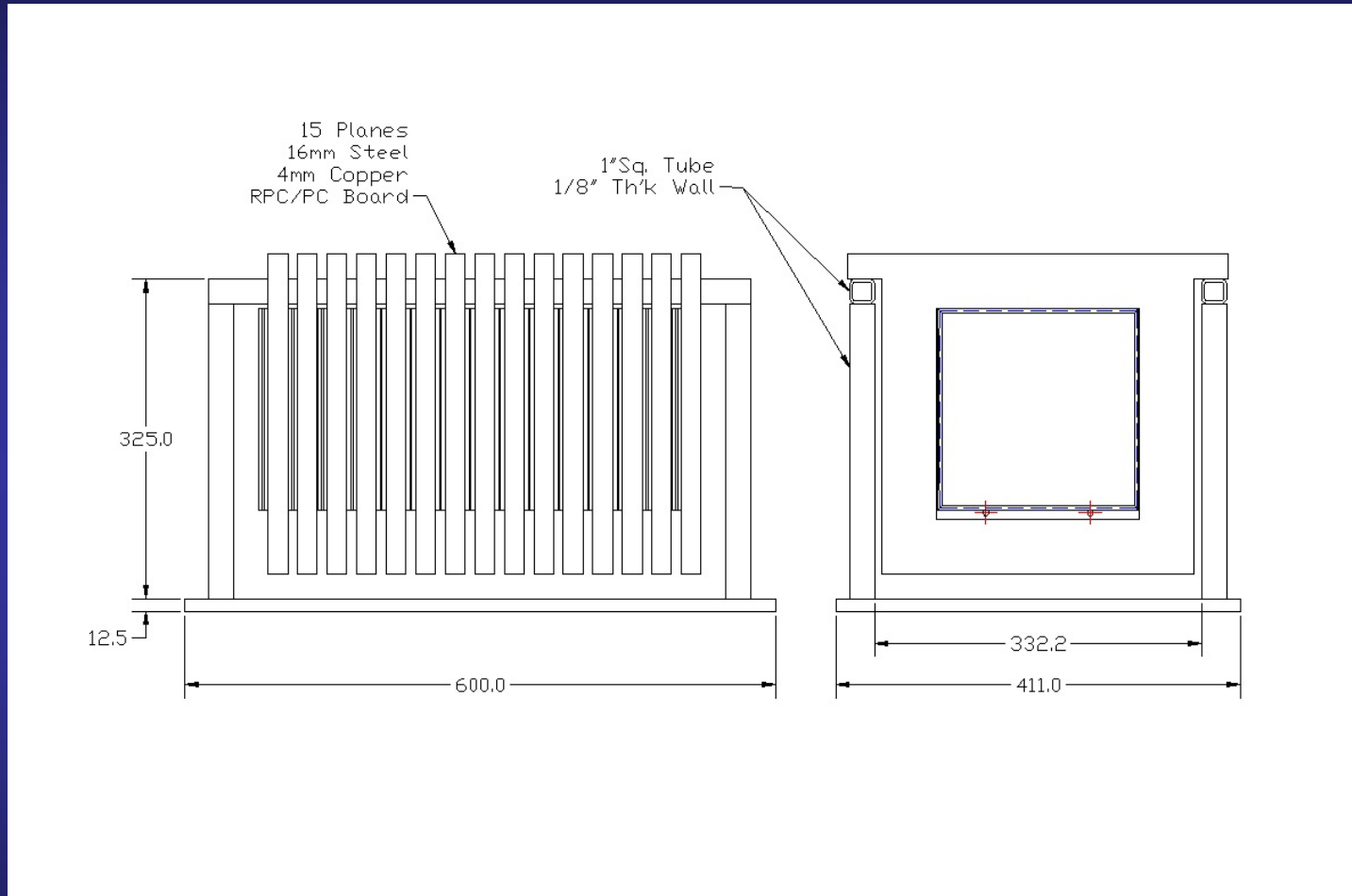


All chambers: channels, resistive paint, glass in hand
1st chamber → being assembled



PC board attached to copper plate with screws (glued onto board) and spacers?
 Chamber held onto copper plate with c-clips (minimize distance to PC board)

Mechanical: Stack



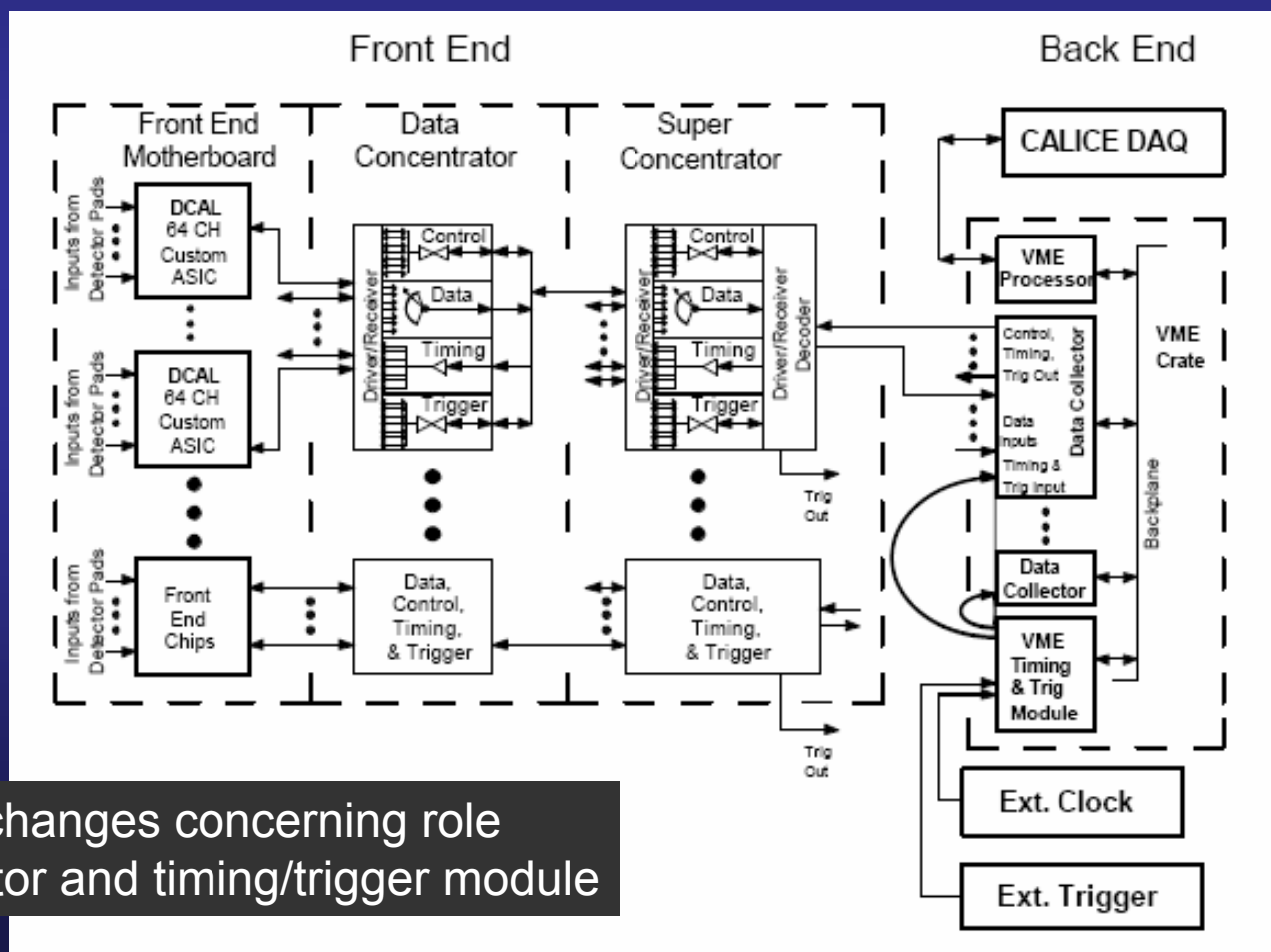
Design accommodates 20 x 20 cm² RPCs as well as 30 x 30 cm² GEMs
All parts in hand, stack will be assembled shortly

Electronic Readout System for Prototype Section

40 layers à 1 m² → 400,000 readout channels

More than all of DØ in Run I

- I Front-end ASIC and motherboard
- II Data concentrator
- III Super Concentrator
- IV VME data collection
- V Trigger and timing system



Some recent changes concerning role of data collector and timing/trigger module

DCAL chip

1st version

- extensively tested with computer controlled interface
- all functions performed as expected

Redesign

- decrease of gain by factor 20 (GEMs) or 100 (RPCs)
- decoupling of clocks (readout and front-end)

2nd version

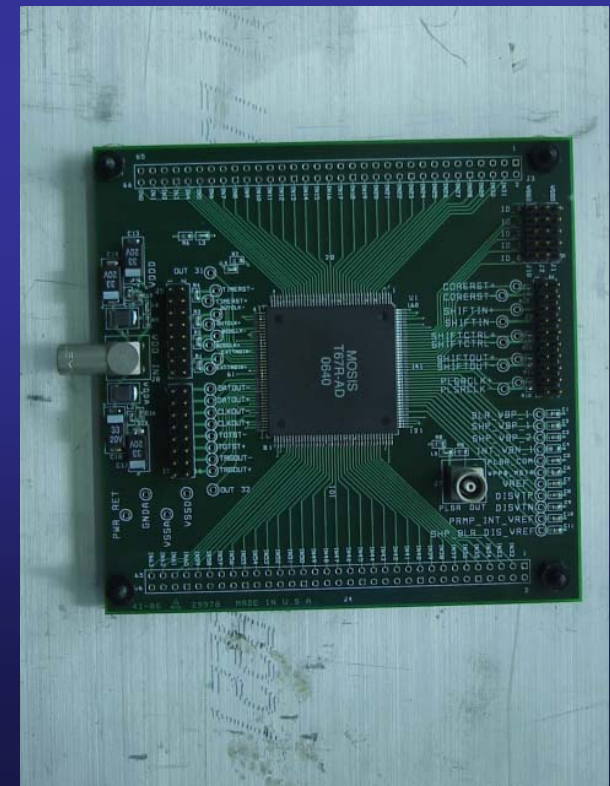
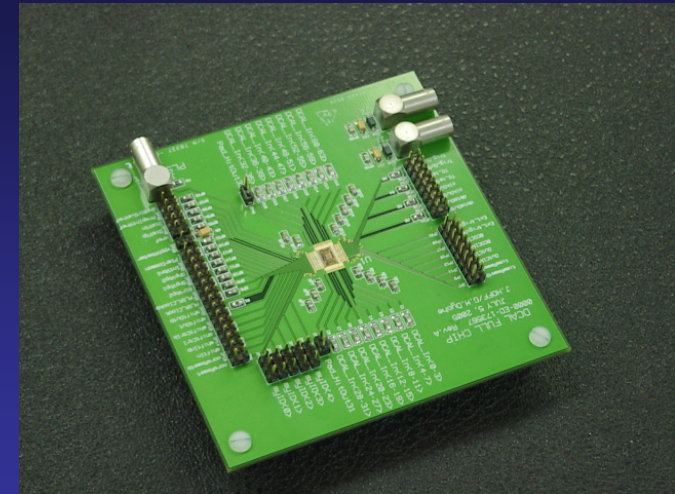
- submitted on July 22nd
- 40 chips (packaged) in hand

Test board

- redesign of test board (changes in pin layout etc.) complete
- boards fabricated
- chip mounted on test board

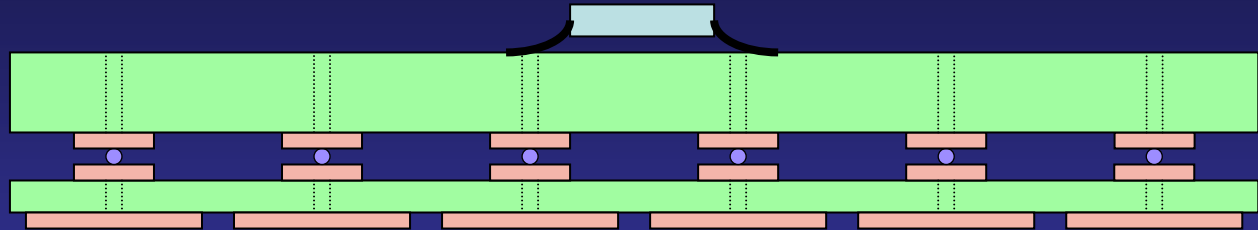
Testing (2/40)

- all software written
- unless serious problems: tests complete by mid-November



Pad and front-end boards

New concept

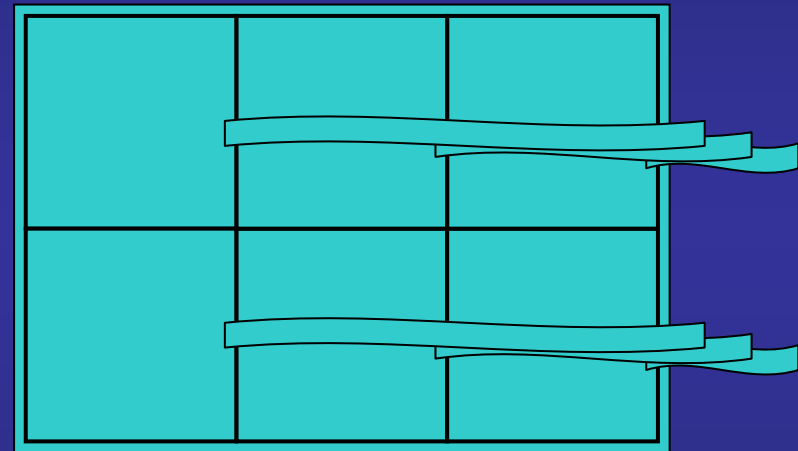


Pad boards

two-layer board containing pads
can be sized as big as necessary
cheap and simple
conductive epoxy to fill vias

Front-end boards

multi-layer board
16 x 16 cm²
contain all transfer lines, houses DCAL chip
expensive (blind and buried vias) and tough to design



Connections

board to board with conductive glue on each pad (being tested)
cables for connection to data concentrators

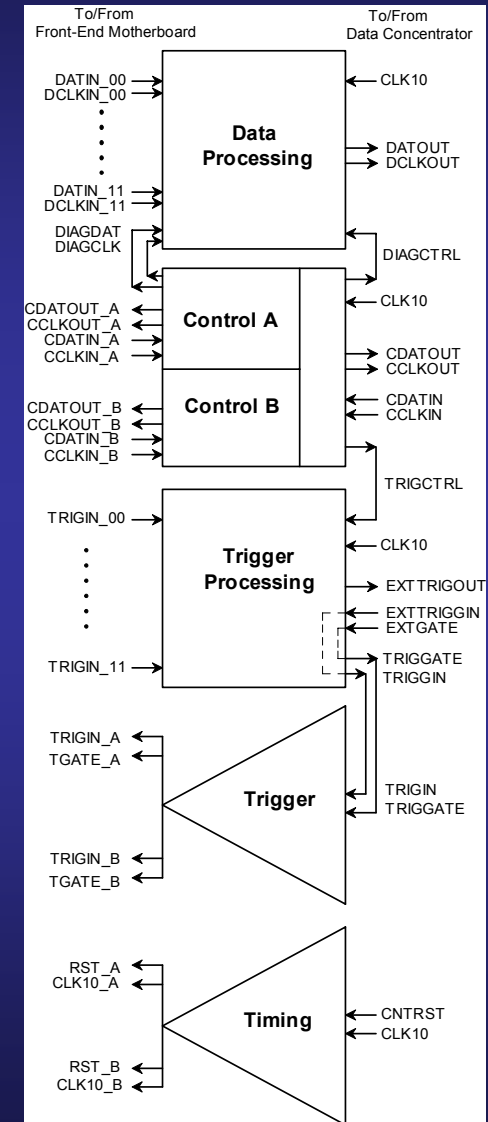
Prototypes of pad boards
expected by next week

Data concentrator boards

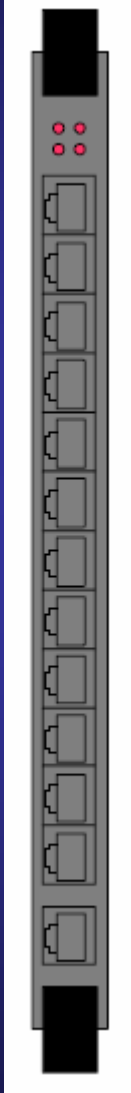
Functionality defined
 Protocol to data collector defined
 Being designed

Timing and trigger module

Functionality defined
 Possibly to be designed by Chicago



Data collector boards



Three options considered

- **Re-use of CRC boards (CALICE)**

Difficult to obtain
Not matched to our application (trigger)
Not considered anymore

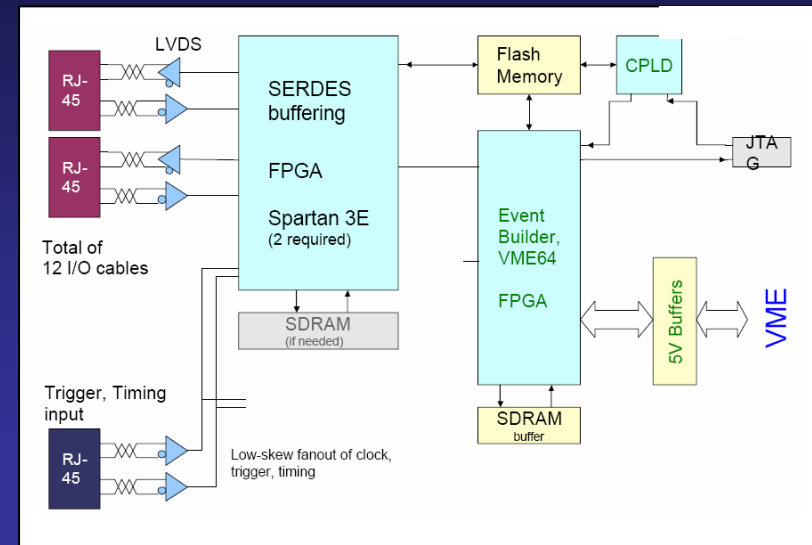
- **Re-use of CMS boards (Boston)**

Possible, but many drawbacks (availability)
Costly (~ \$70k for prototype section)
Main advantage: could be ready in 3 months

- **New design**

Not much more expensive (~\$80k for prototype section)
(~\$60k for slice test)

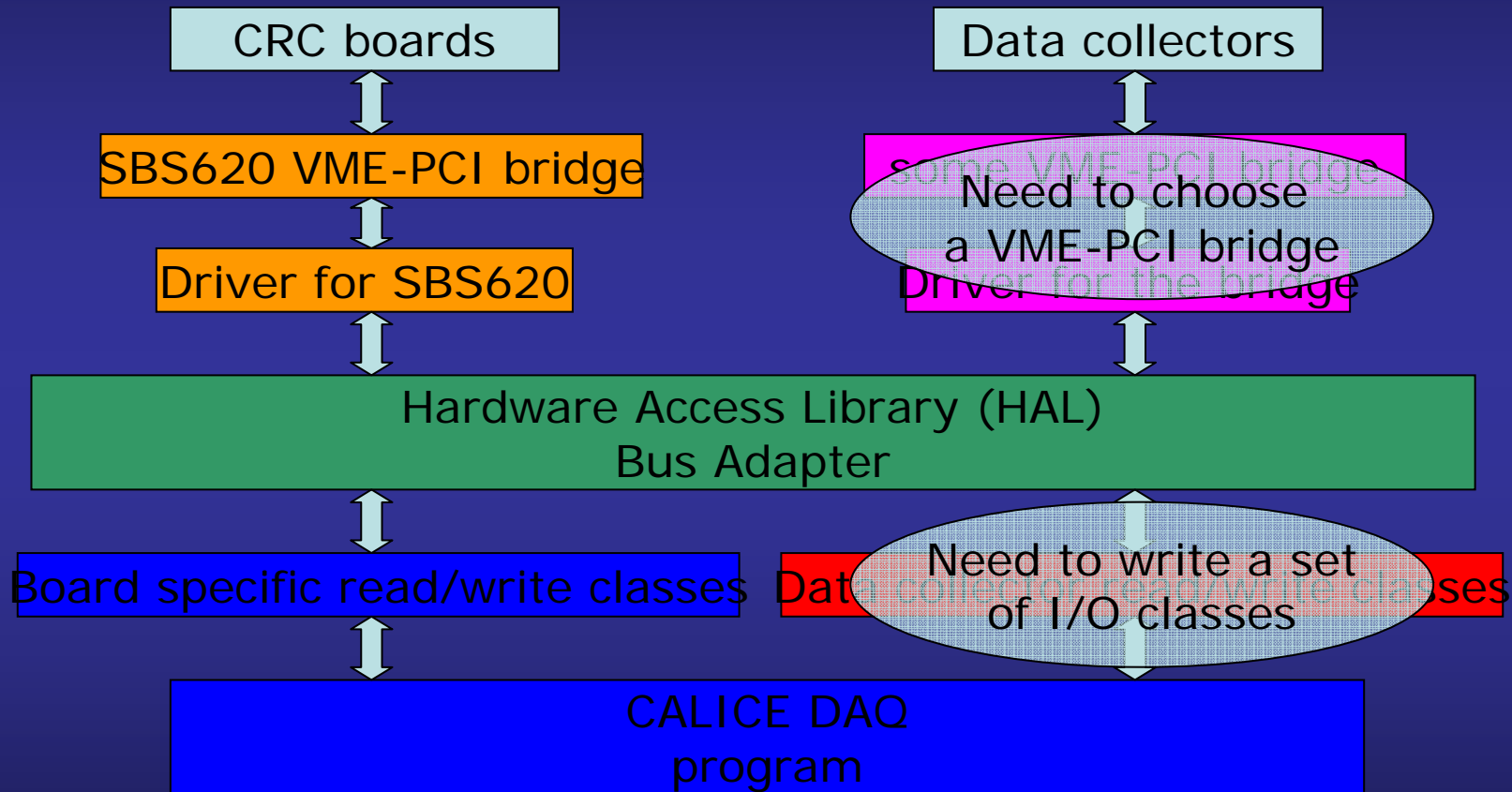
Will be exactly what we want
Time needed ~ 6 months



Decided to go for new design
→ contribution of Boston University
Interface meeting on September 22nd
Design work started

DAQ software

Particular challenge to be compatible with CALICE software



CALICE

Slice test

Will acquire SBS618 VME-PCI bridge next week

Beam telescope, HV, and gas

Beam telescope

J Li, A White, J Yu (UTA)

6 counters (3 x (1 x 1 cm²) + 1 x (4 x 4 cm²) + 2 x (19 x 19 cm²))

Mounted on rigid structure

In production

HV modules

E Norbeck (Iowa)

Need separate supplies for each chamber

Modules (from FNAL pool) being tested

With additional RC-filter perform similarly to our
Bertran unit in analog tests (RABBIT system)

Still need to perform tests with digital readout

Gas system

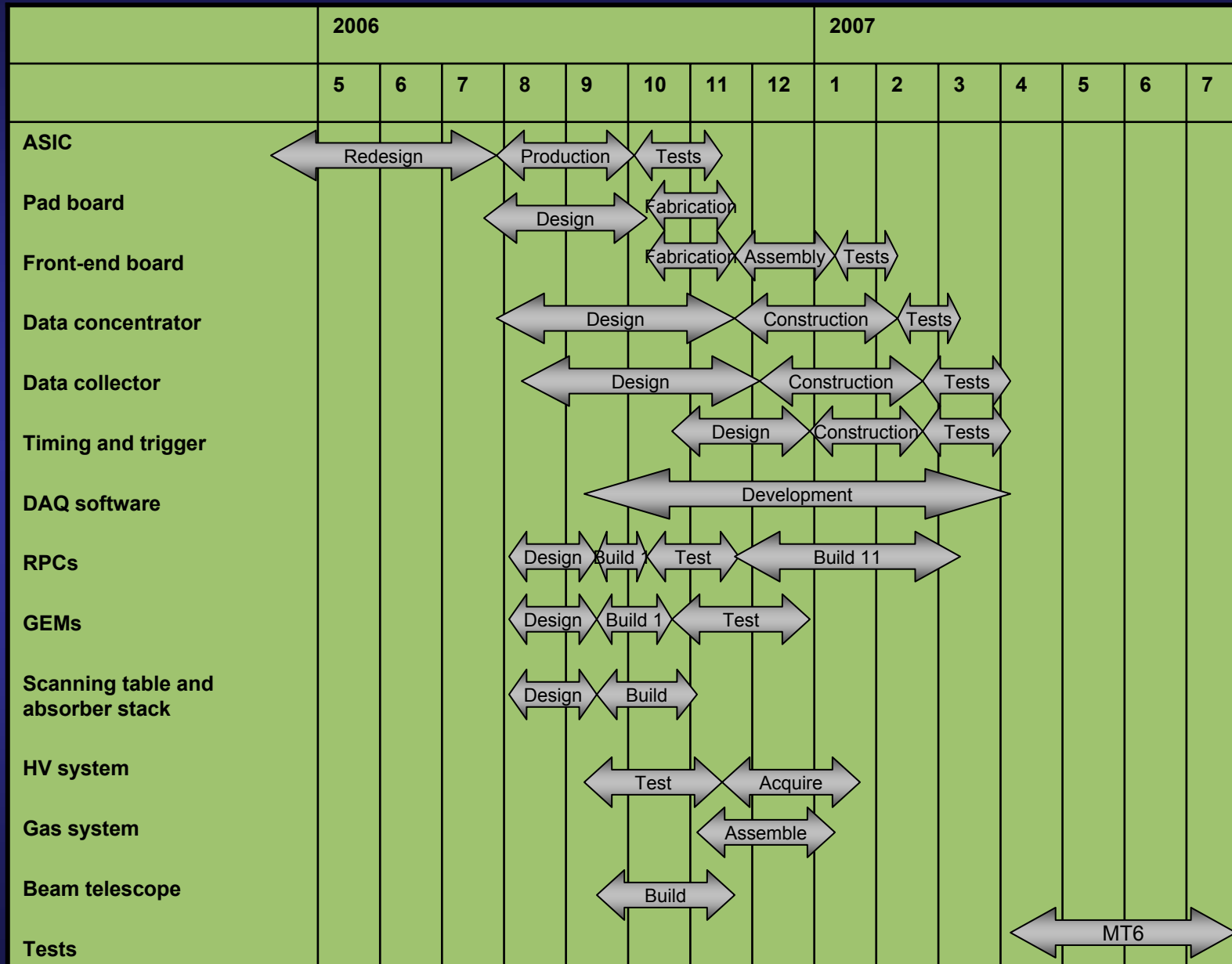
E Norbeck (Iowa)

Need manifold for 10 chambers (in hand! Thanks to D Northacker)

Need approval for gas tanks (safety issue)



Time scales



1 m³

Prototype Section

Costs and Funding

A) Slice test is funded by LCDRD06, LDRD06 and ANL-HEP, and Fermilab funds

B) Prototype section not yet funded, but...

Stack	Item	Cost	Contingency	Total
RPC stack	M&S	607,200	194,600	801,800
	Labor	243,075	99,625	342,700
	Total	850,275	294,225	1,144,500
GEM stack*	M&S	400,000	165,000	565,000
	Labor	280,460	40,700	321,160
	Total	680,460	205,700	886,160
Both stacks	M&S	1007,200	359,600	1366,800
	Labor	523,535	140,325	663,860
	Total	1,530,735	499,925	2,030,660

* Reusing most of the RPC electronics

Proposal for supplemental funds for \$500k/year over two years submitted to DOE Help from ANL (LDRD), ANL-HEP, FNAL expected...

Funding

LCRD funds for 2006

RPCs (ANL, Boston, Chicago, Iowa)	\$98k
GEMs (UTA, Washington)	\$60k

Supplemental LCRD funds for 2006/7

Available funds \$1,200k/year?

Submitted pre-proposal for RPC/GEM DHCAL

Requested \$1,200k for 2006
~\$800k for 2007

2006	build RPC-DHCAL continue R&D on GEMs
2007	test RPC-DHCAL at MTBF build GEM stack
2008	test GEM-stack

DOE asked us to submit proposal for \$500k/year (done)