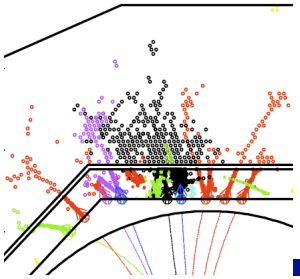
Calorimeter test beam needs

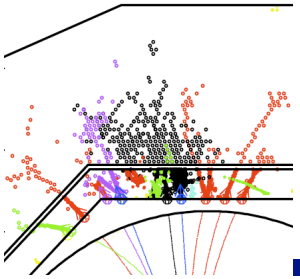
Felix Sefkow

ALCPG 11
Eugene, OR, March 19-23, 2011



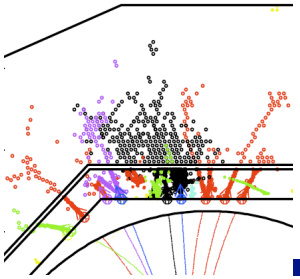
Outline

- General issues
- Projects
- Near and far future



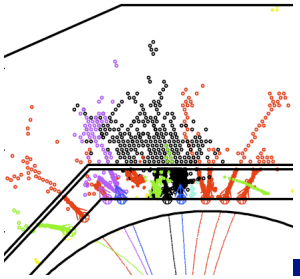
Activities

	ILD	SiD
Vertex	Vertex R&D Groups	
Tracking	LC-TPC	SiD - Si
	SILC	
ECAL	CALICE	SiD - EM
HCAL	CALICE	TA Dual readout
Coil	ILD – Coil	SiD – Coil
Muon	ILD - μ	SiD - μ
Forward	FCAL	
Testbeams	CERN – DESY – FNAL – SLAC	

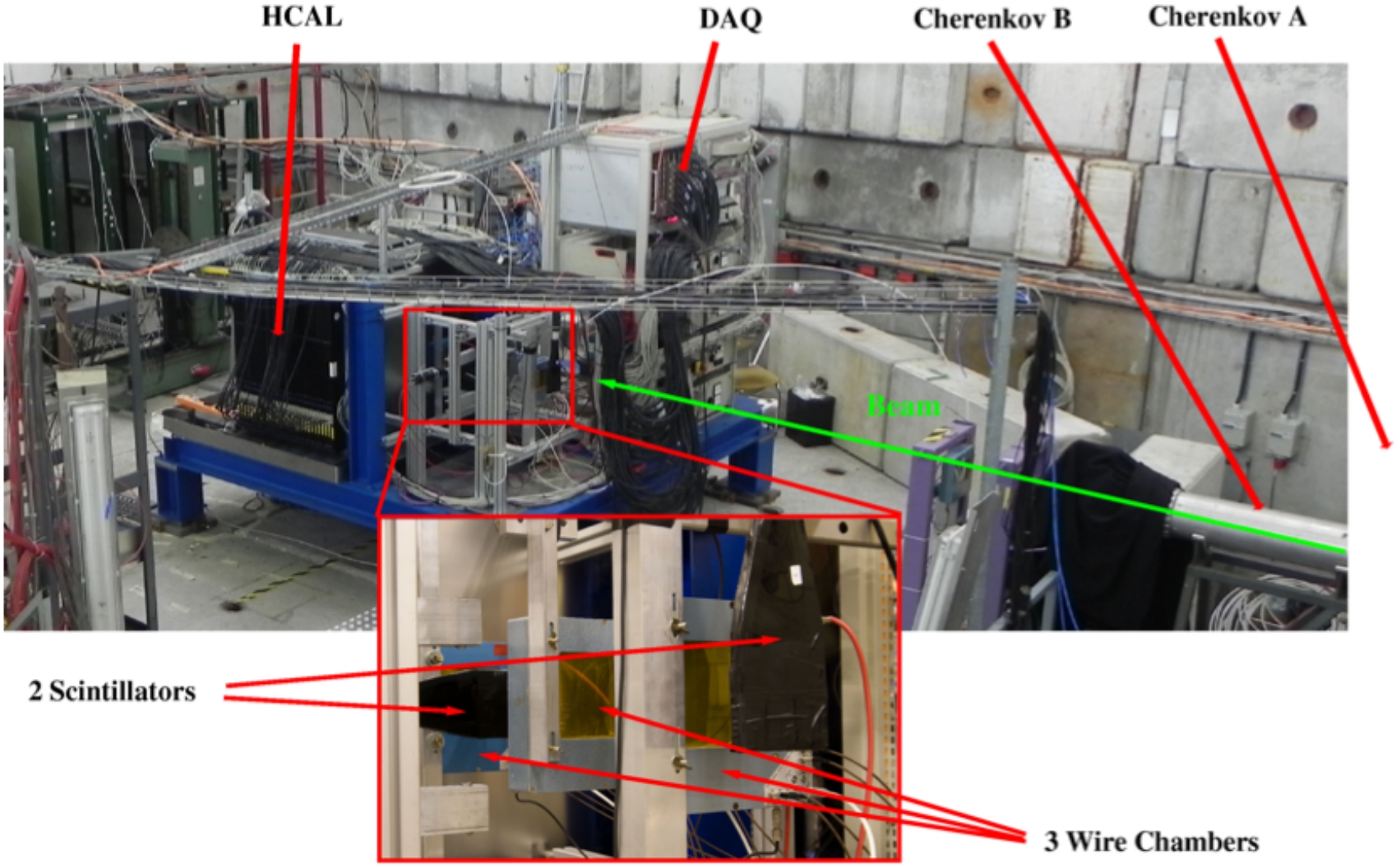


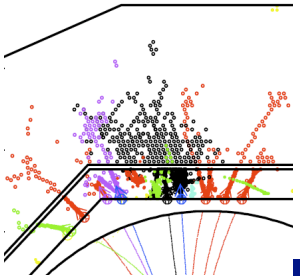
General remarks

- Extensive review and planning at LC test beam workshops at Fermilab Jan 2007 and LAL Nov 2009
  - written document, here short update
- Goals are two-fold
  - test the new technologies, performance, operational experience
  - acquire large physics data sets for test and development of hadron shower simulation and PFA reconstruction
- Consequently
  - large set-ups
  - complex installations with multiple sub-detectors
    - trigger, tracking, particle ID, ECAL, HCAL, tail catcher
  - large phase space of particle energies and types
  - large data sets
  - large running times (rate limitations)



Typical installation: WHCAL





Typical schedule: DHCAL

- (1st test beam was November 2010)

2nd test beam: **Broadband muons** for calibration

Calorimeter not rotated
Trigger with 2 x (1 x 1 m^2 Scintillator paddles)

Energy scans (separation of positrons and pions offline using Cerenkov)

Calorimeter not rotated
Into center of calorimeter
Trigger with coincidence of 2 x (19 x 19 cm^2 Scintillator counter)

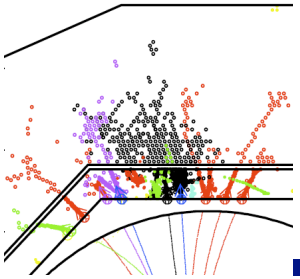
1, 2, 4, 6, 8, 12, 32, 40, 48, 60, 66 GeV/c

Will start 4 GeV/c run on Friday

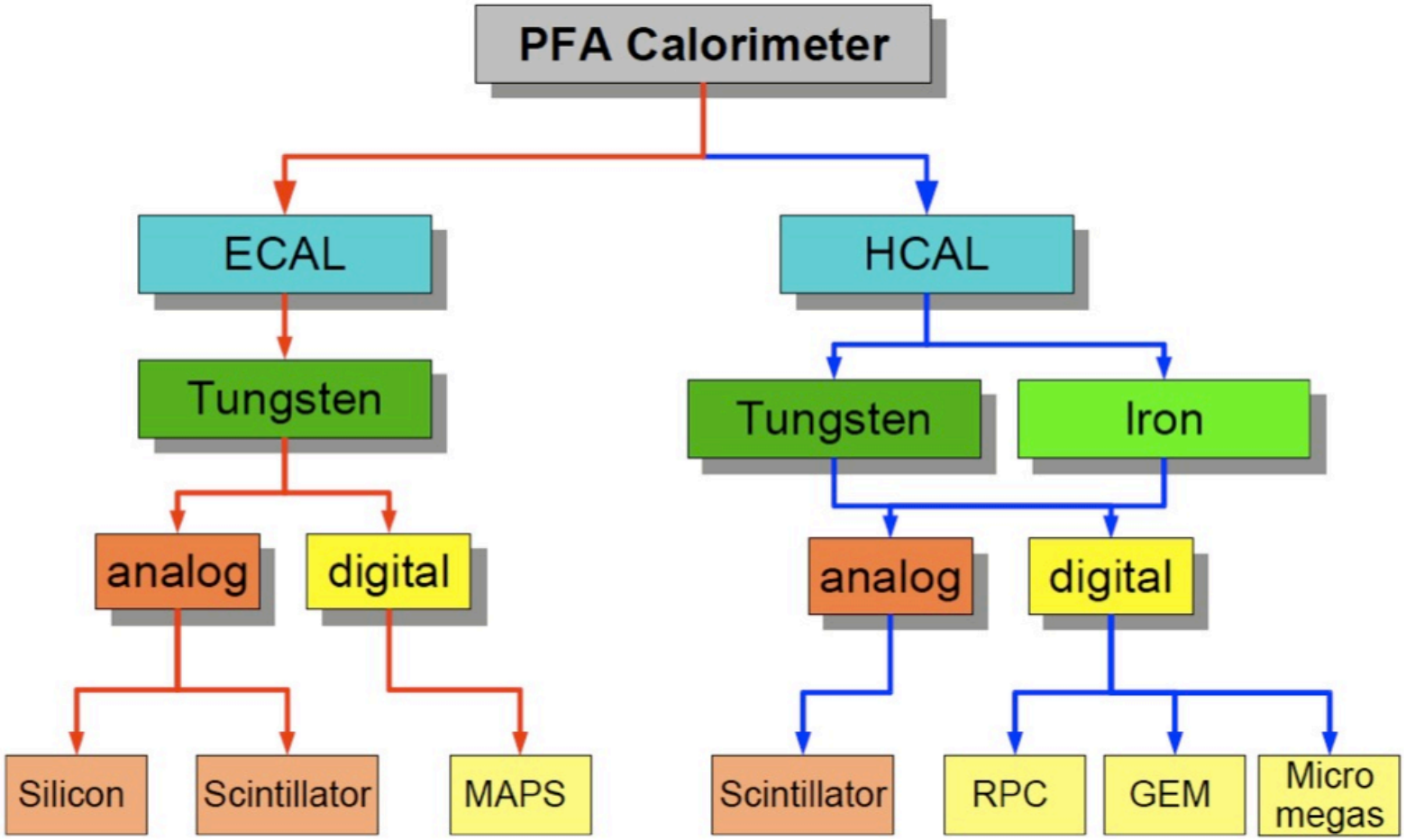
Have been offered an extra week. Will most likely accept…

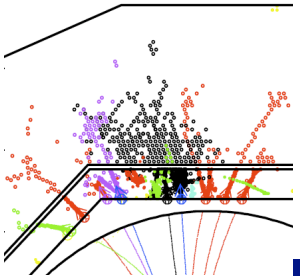
3rd test beam: April 2011 (ECAL + DHCAL + RPC-TCMT)

4th test beam: June 2011 (DHCAL + RPC-TCMT)



Technologies

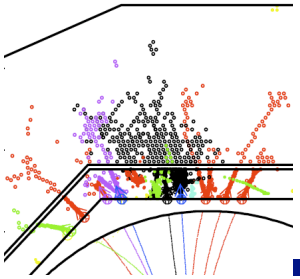




Score card

- Completed:
  - CALICE SiW ECAL, Scint W ECAL, Scint Fe AHCAL
- Ongoing:
  - CALICE Scint W AHCAL, RPC Fe DHCAL
- Underway:
  - CALICE RPC Fe SDHCAL, W DHCAL
  - SiD SiW ECAL
- Future:
  - CALICE 2nd generation Si/Scint W ECAL, Scint W/Fe HCAL

- Ongoing, underway and in future:
  - individual or few layer tests with all technologies
    - GEMs, micormegas
    - 2nd generation CALICE ECAL, scint HCAL
    - funding driven



ECAL plans: Si & Scint

Tests of first layer in 2011 @ DESY
- DAQ system, previous ASIC (SPIROC2), si sensor
- Hardware-level tests – low energy electron beam

Test with SKIROC2 chip 1st half 2012 (@ DESY ?)
- Hardware-level tests – low energy electron beam

Multi-layer tests end 2012, 2013 (@ CERN ?)
- Muons for calibration
- Electrons with wide energy range

CALICE Calorimeter for ILC

Si/W ECal R&D Collaboration

M. Breidenbach, D. Freytag, N. Graf, R. Herbst, G. Haller, J. Jaros, T. Nelson

SLAC National Accelerator Center

- KPiX readout chip
- downstream readout
- mechanical design and integration

J. Brau, R. Frey, D. Strom,
P. Radloff (grad student),
undergraduates

U. Oregon

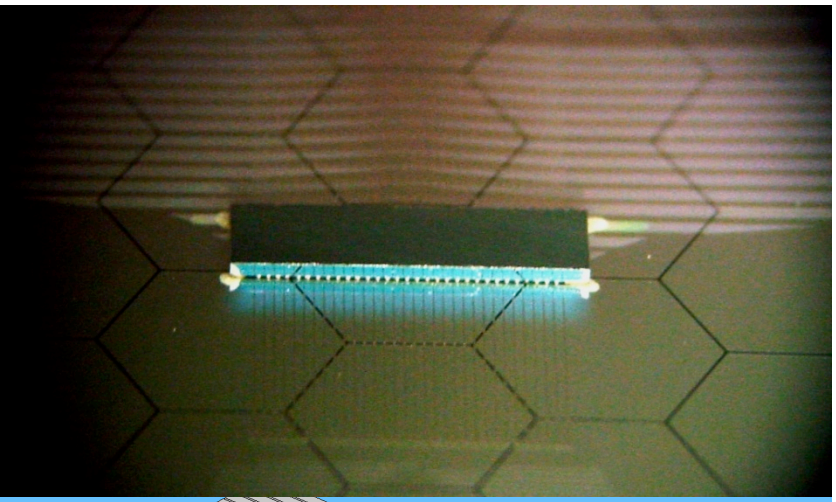
- detector development
- readout electronics

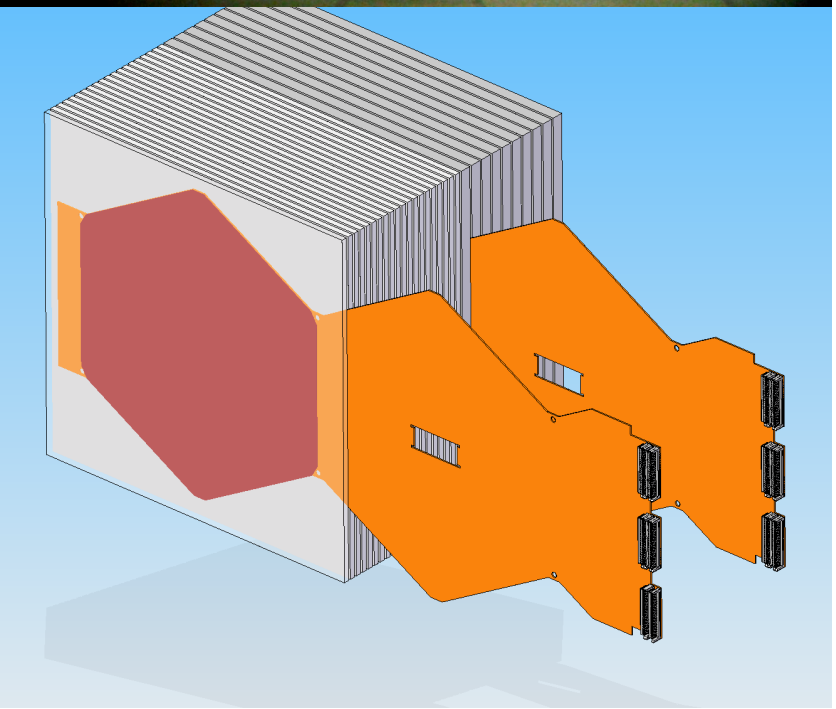
B. Holbrook, R. Lander, M. Tripathi,
M. Woods (grad student)

UC Davis

- cable development
- bump bonding

Test beam for Silicon-Tungsten R&D test beam module





R&D project goal: Produce full-depth (30 layer) module which uses the technologies for a full LC ECal.

- 1024-channel KPiX chips (30)
  - in hand, testing
- 1024 pixel silicon sensors (30)
  - in hand
- KPiX bump-bonded to Si sensors
  - in progress
- Tungsten
  - in hand

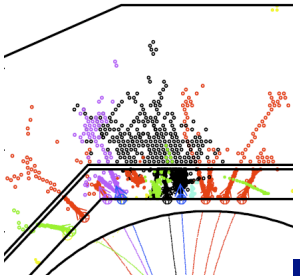
- The test module is 15cm x 15cm x 30 layers; 30 short readout cables carrying one digitized data stream
- Should be ready to characterize in a test beam ~ summer 2011

test beam requirements and plans

- Initial test beam studies: An electron beam like that which should be starting up at SLAC would be ideal:
  - Small number of (simultaneous) electrons per bunch:
    - zero,1,2,… electrons per bunch
  - 5-10 GeV or more
  - Well localized and controllable beam
  - LC-like time structure (for KPiX)

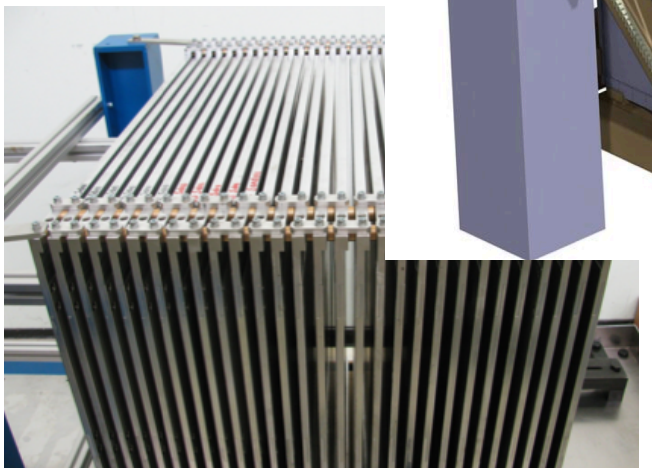
- Our test module and the SLAC test beam are both due to be ready Summer 2011

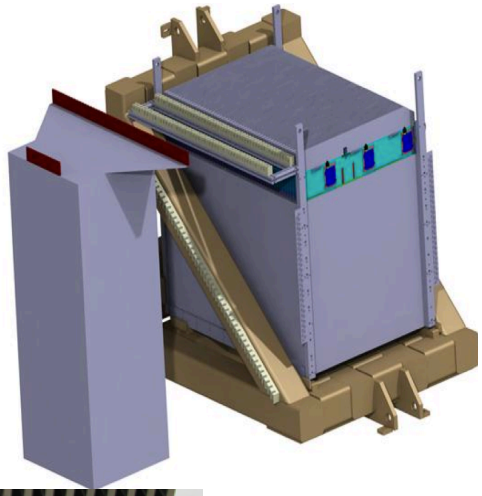
- Would assume prototype to be incorporated in a beam with hadrons with and without an HCal prototype at a later stage
  - The initial hadron shower in such a highly-segmented detector is possibly interesting in itself and also in comparison to hadron shower simulation codes

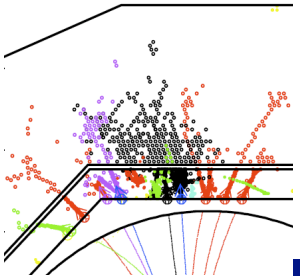


HCAL plans

- Beyond 2011: to be discussed
- Certainly: SDHCAL, combined with ECAL
- Available structures:
  - DESY Fe stack and stage, at FNAL till end 2011
  - CERN W stack, 40 layers in 2011
  - CIEMAT Fe structure
- CALICE and SiD ECALs







CERN schedule 2011 (not final!)

19-Mar-2011

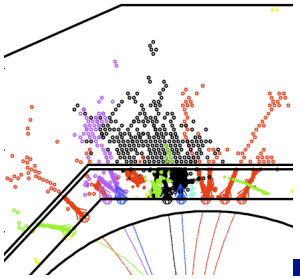
2011 SPS Fixed Target Programme

Version 1.0

Colour code: blue (dark shading) = not yet allocated ; yellow (light shading) = not allocatable or Machine Development

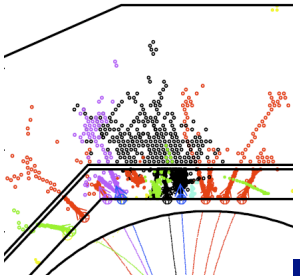
W HCAL SDHCAL Micromegas SDHCAL W HCAL

	P1	P2	P3	P4	P5	P6
	35 26 Apr 31 May	35 31 May 5 Jul	35 5 Jul 9 Aug	35 9 Aug 13 Sep	35 13 Sep 18 Oct	34 18 Oct 21 Nov
T2 -H2	NA Setup 4 · 22	NA61 TR 10 · 0 · CALICE SDHCAL 25	CMS PLT 10 · CMS CALO 14 · NA61 Protons 11	NA61-Protons 35	NA61 Protons 6 · CMS SiBT 14 · CREAM 9 · CMS CALO 6	CMS CALO 10 · NUCLEON 10 · NA61 Ions+3weeks 14
T2 -H4	NA Setup 4 · H4IRRAD 22	CMS ECAL 10 · H4IRRAD 0 12 · ALICE PIDRICH 5 · RD51 8	PHOTAG 9 · H4IRRAD 11 · CMS ECAL LHCb 9 · CALICE MMEGAS 6	RD51 11 · NA63 Electrons 13 · CALET 10	PANDA 7 · SOIPIX 9 · PEBS 12 · FAIR 7 · RD5 7 · CMS ECAL 7 · LHCf 7	14
T4 -H6	NA Setup 4 · SiLC 7 · 3 · NA62 STRAW 12	MONOPIX 9 · ALICE SPD 0 11 · CERF RD42 9 · RD42 6	DEPFET RD42 8 · APPS AMMEGAS 12 · ATLAS ALIBAVA 7 · ABCM RD42 7	AIDA TK 14 · SiLC 7 · ATLAS ALFA AFP 7 · ATLAS BCM PPS 7 · BELLE ARICH 7	SuperB 7 · ATLAS IBL 7 · BELLE II SVD 7 · MONOPIX AMMEGAS 8 · 3 · NA62 CEDAR GTK 10 · MEDIPIX 7	14
T4 -H8	NA Setup 4 · ATLAS IBL 22	LHCb 6 · ARPC A3DSi DREAM 7 0 · LHCb (CALICE) 16 · CDHERENT 6	TOTEM UA9 6 · RD50 7 · DREAM ARPC A3DSi 14 · AMDT AsTGC 8	AMDT AsTGC 6 · ARPC APPS 7 · ARPC A3DSi 7 · TOTEM UA9 7 · UA9 8	CALICE 13 · LHCb 16 · CALICE 6	CALICE 13 · DREAM 7 · UA9 IONS 14
T4 -P0	NA Setup 4 · 22	0 35	35	35	35	6 · NA62 14 · 14
T6 -M2	NA Setup 4 · COMPASS 22	COMPASS 0 35	COMPASS 35	COMPASS 35	COMPASS 35	COMPASS 20 · 14
CNGS CNGS 27	CNGS 35	CNGS 0 35	CNGS 35	CNGS 35	CNGS 35	CNGS 34



Future

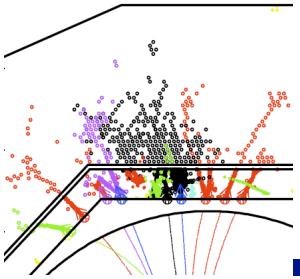
- Large scale test beams will continue
- Technolgical 2nd generation prototypes need to undergo full system tests
- Special issues
  - power gating, requires magenets
  - ILC like beam structure: interesting reality test
- Integration with large tracking systems
  - DAQ and software system integration necessary at some stage
  - physics potential very limited



Dual readout

- Total absorption: small tests with crystals and SiPMs

- DREAM and SuperDREAM:
  - 4-6 weeks per year
  - electrons and hadrons, 3-200, 3-350 GeV



Conclusion

- Calorimeter test beams at large scale will continue to present high demand to test beam facilities over the next 4 years
- Many smaller tests in addition
- SLAC facility highly welcome
  - beam structure
  - increased emphasis on ECAL in near future

Back-up slides

Future data taking

Scheduled runs

April 2011

Combined run with CALICE Silicon-Tungsten ECAL

June 2011

DHCAL + RPC_TCMT standalone
High energy run (32,40,48,60,66 GeV/c)

Additional runs (not yet scheduled)

Fall 2011/Winter 2012

DHCAL with Tungsten absorber plates (from CERN) + RPC_TCMT

2012 or 2013

No test beam at FNAL ???

DHCAL without absorber plates (only 4 mm Fe/Cu covers)
Tertiary beam at 0.2 – 2 GeV/c

GEM DHCAL Plans

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- Phase I (Through late 2011) ➔ Completion of 30cm x 30cm characterization and DCAL chip integration
  - Perform beam test with 30cm x 30cm double GEM chambers, one with KPiX9 and two with DCAL
  - Completion of 33cmx100cm large foil evaluation
  - TGEM chamber beam tests at CERN

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- Phase II (late 2011 – early 2013): 33cm x 100cm unit chamber development and characterization
  - Begin construction of 2 unit 100cmx33cm chambers, one with kPiX and one with DCAL
  - Bench test with sources and cosmic rays and beam test
  - Construction of 100cmx100cm plane

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- Phase III (Early 2013 – mid 2014): 100cmx100cm plane construction
  - Construct 6 unit chambers with DCAL for two 100cmx100cm planes
  - Characterize 100cmx100cm planes

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  - Construct 6 unit chambers with DCAL for two 100cmx100cm planes
  - Characterize 100cmx100cm planes
- Phase III (Mid 2014 – late 2015): 100cm x 100cm plane GEM DHCAL performances in the CALICE stack
  - Complete construction of five 100cm x 100cm planes inserted into existing CALICE calorimeter stack and run with either Si/W or Sci/W ECALs, and RPC or other technology planes in the remaining HCAL

MICROMEGAS semi-DHCAL

LAPP, Annecy

(3) Project roadmap

From small chambers to a technological HCAL prototype

2008-09

Caracterisation of small size chambers
Hit efficiency > 97 % with non-uniformity of 1%, multiplicity < 1.1

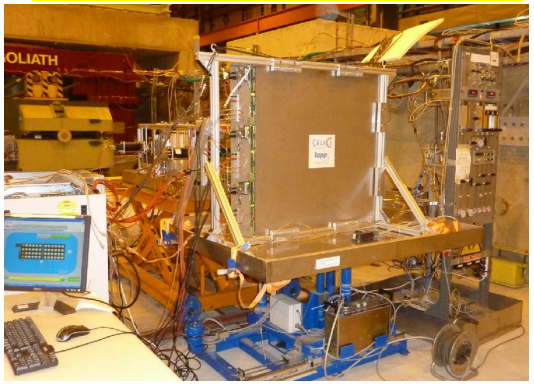
2010

Fabrication and test of first 1 m^2 prototype with HARDROC2 ASIC
Successful operation with power-pulsing in muon beam
Also tested inside W-structure:
→ Development of AHCAL/MICROMEGAS synchronisation

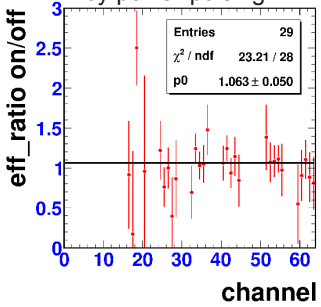
2011-...

Participation in the CALICE DAQ v2 effort
Fabrication of more prototypes with MICROROC ASIC
Test beam: standalone and inside CALICE steel or W structure

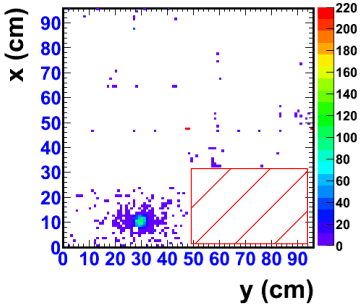
Standalone test in June 2010 SPS/H4



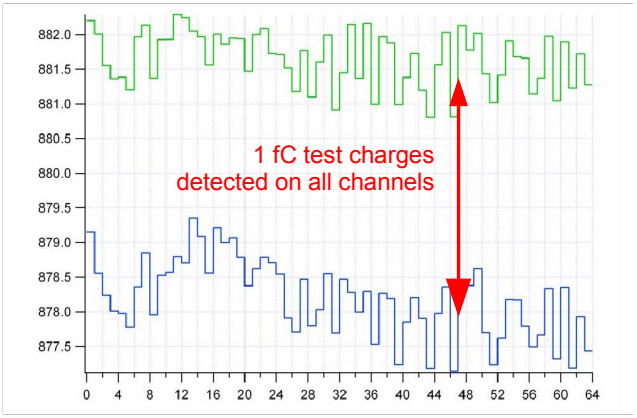
Hit efficiency unchanged by power-pulsing



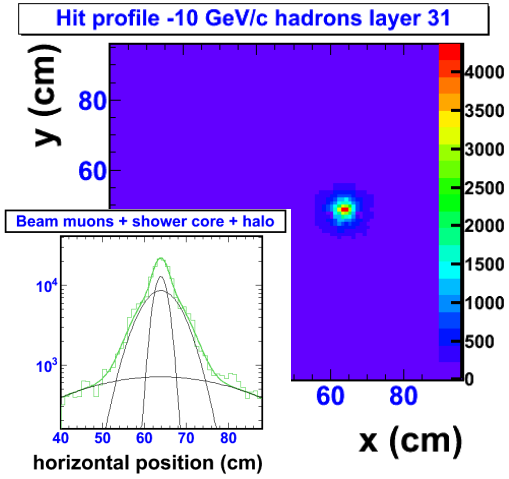
Hit profile, power-pulsing 150 GeV/c muons



Pedestals & charge response of new ASIC MICROROC



Sampling of showers with 1 cm^2 granularity



Joined W-AHCAL test in Nov 2010 PS/T9