

Calorimetry Hot spots

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LM



Overview

6 + 1 Presentations:

- CALICE ECAL [D. Jeans]
- SpiDer DECAL [J. Velthuis]
- SiD ECAL [J. Repond]
- CALICE HCAL & TCMT [M. Chefdeville]
- Muons SiD
- DREAM & Dual readout [J. Hauptmann]
- FCAL [S. Kulis]

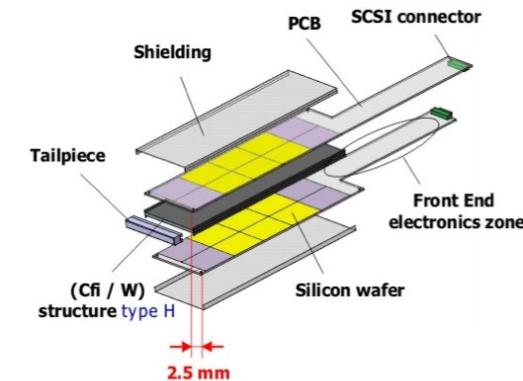
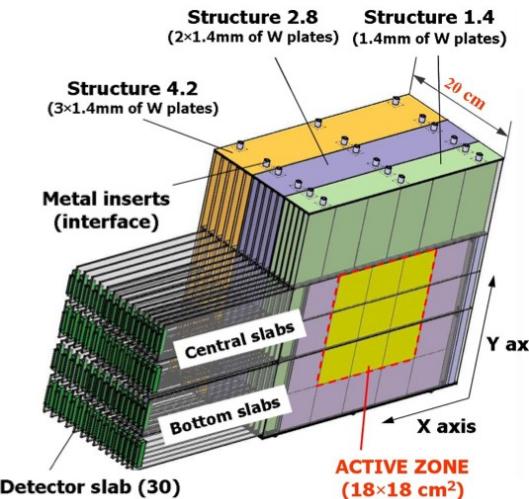
Calorimeter	Project	Lead institution
ECAL	Silicon-Tungsten (CALICE)	LAL, LLR
	Silicon-Tungsten (US)	SLAC, Oregon
	Scintillator-Tungsten	Shinshu
	Digital ECAL	Bristol, Imperial, Oxford
HCAL	Scintillator-Steel AHCAL	DESY
	RPC-Steel (CALICE)	ANL
	GEM-Steel (CALICE)	UTA
	RPC or μ MEGAS-Steel (CALICE)	IPNL / LAPP / LLR
Muon-detectors/tail catcher	Scintillator-Steel (CALICE)	NIU/DESY/FNAL
	Scintillator-Steel	FNAL/UCD/IU/ NIU/ Notre Dame
	RPC-steel	Princeton / Wisconsin

Tested ECAL

- CALICE Si-W ECAL
 - ▶ Physical prototype
 - ◆ heavily tested in beam
 - CERN, DESY, FNAL
 - Alone & combined test
 - ◆ (can be used in setup*)

- CALICE Sc-W ECAL
 - ▶ Physical prototype
 - ◆ Combined test
 - FNAL 2009, 2010...

Silicon – W ECAL physics prototype



30 layers

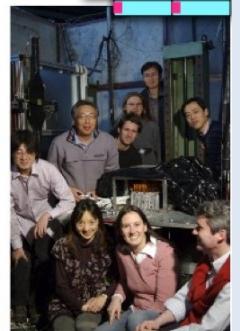
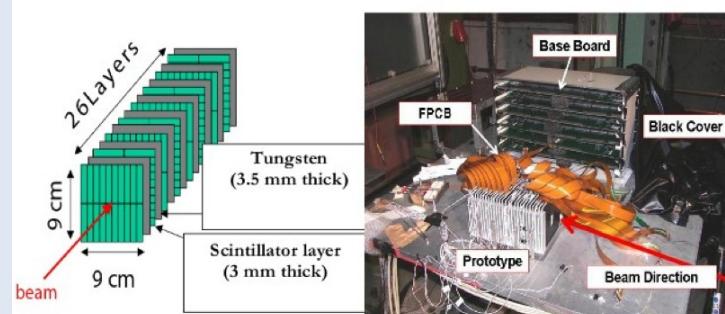
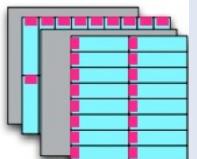
- W absorber
- Silicon detectors
- 10X10mm² PIN diodes
- ~10k readout channels
- Carbon Fibre composite mechanical structure

Finer sampling in first layers

- help low E photon identification
- keep cost under control

scECAL at DESY

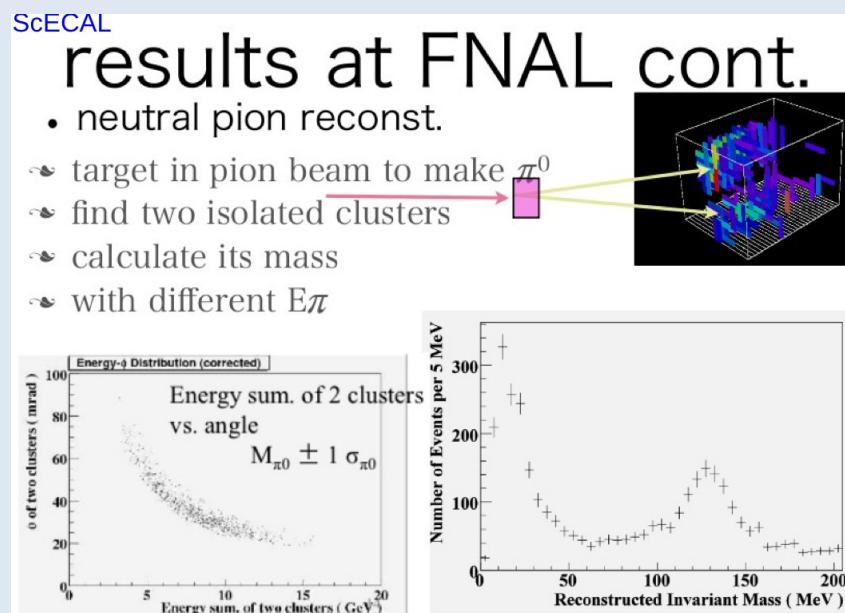
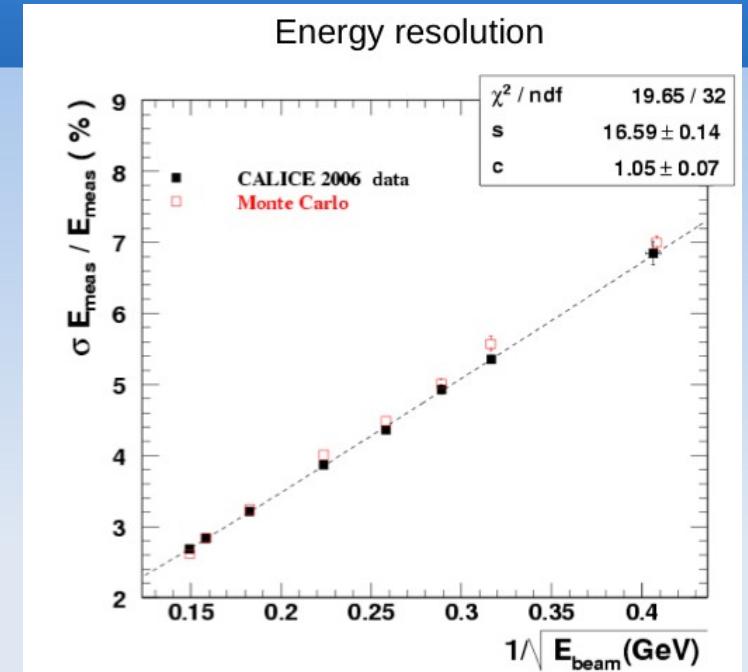
- 2007
- scintillator strips pf 1 x 4.5 x 0.3 cm³
 - 2 x 9 in a layer x 26 = 468 ch
 - tungsten absorber of 3.5 mm thick



Test different types of scintillator

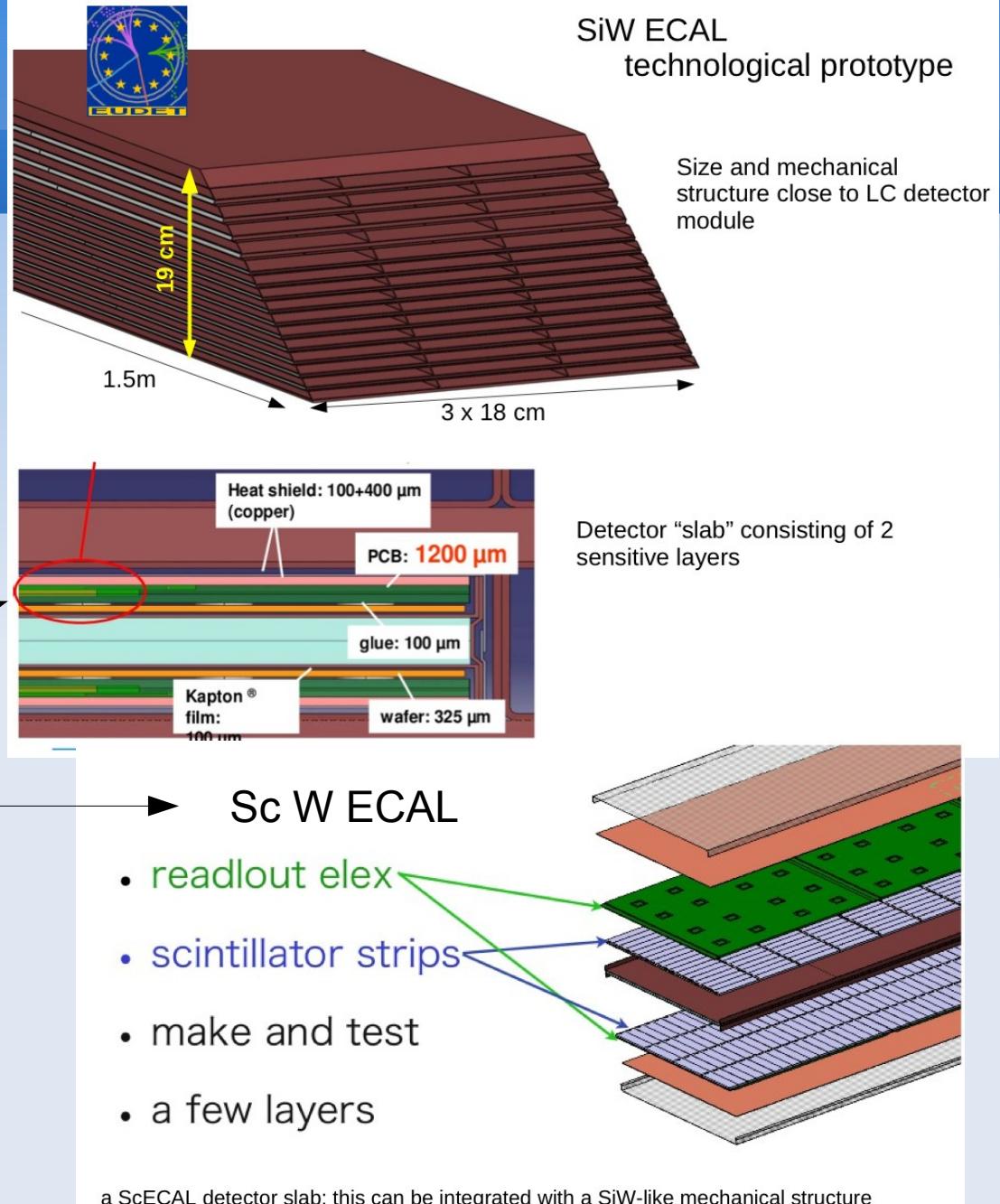
Results

- 10's millions events taken
 - ▶ Debugging (square events)
 - ▶ Linearity, Resolution,
 - ▶ Shower profiles, MC tuning
- Special set-ups
 - ▶ π^0 reconstructions



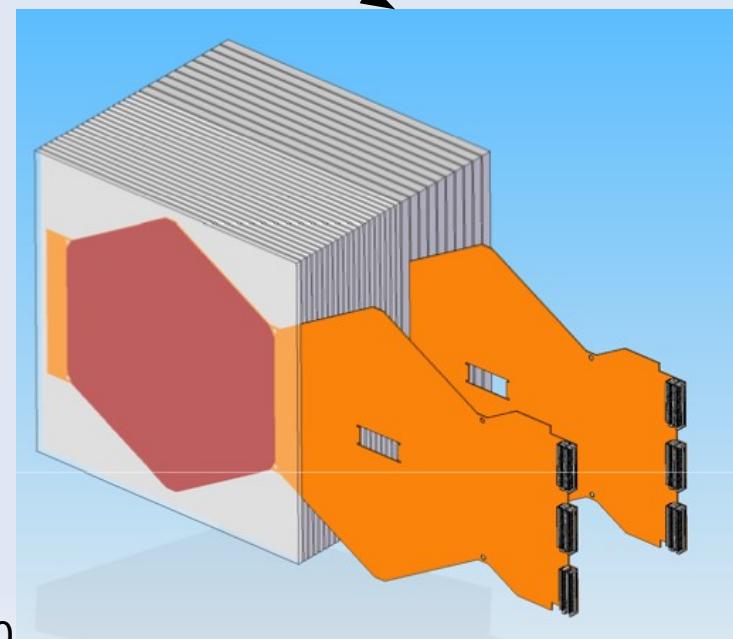
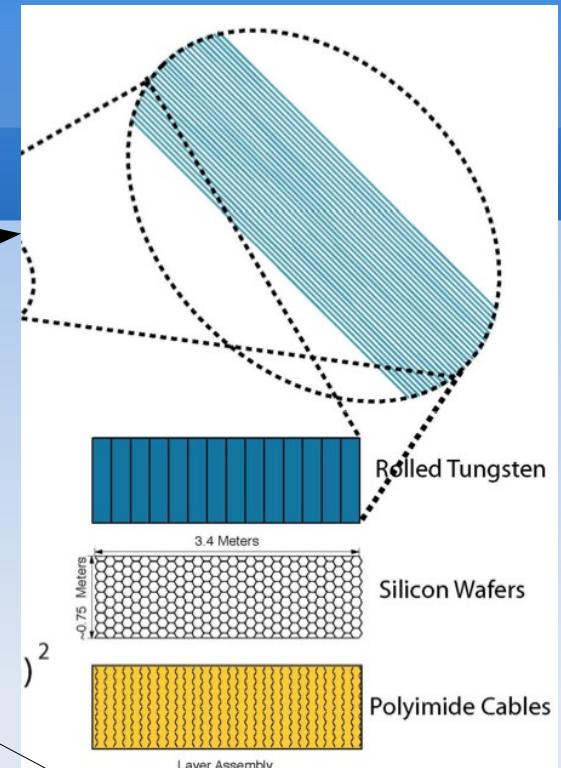
Future ECALS

- CALICE Si-W technological prototype
 - ◆ Embedded RO electronics
 - ◆ Thermal constraints
 - ◆ Power pulsing
 - ◆ Large structure
- W Structure +
 - ▶ 15 SLAB Si/W/Si
 - ▶ a few SLAB Scint/W
- In TB in
 - ▶ ≥ 2011
 - ▶ few layers then all
 - ▶ Combined with HCALs



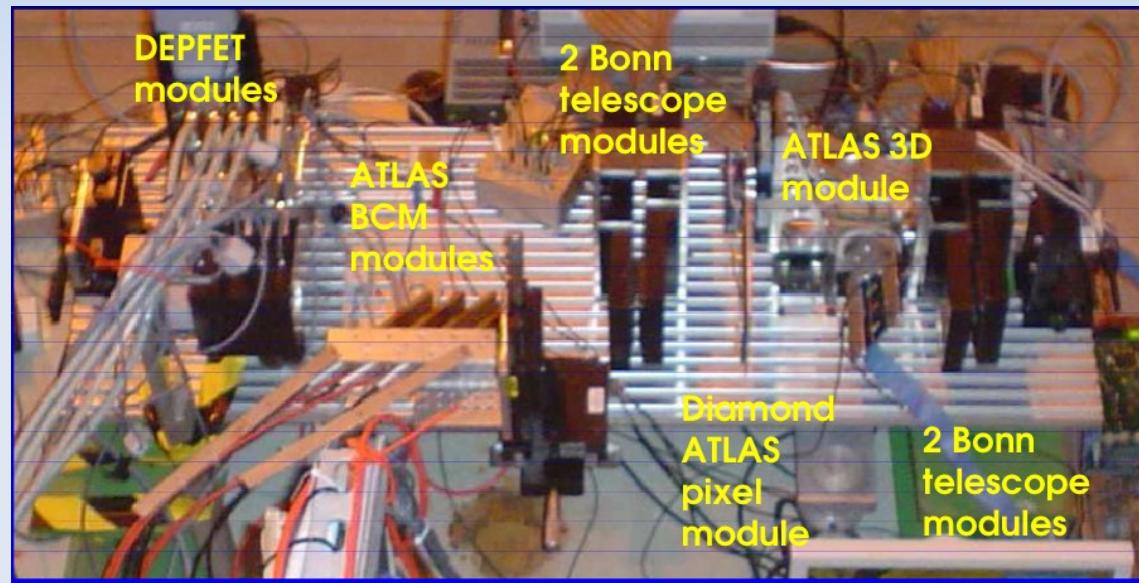
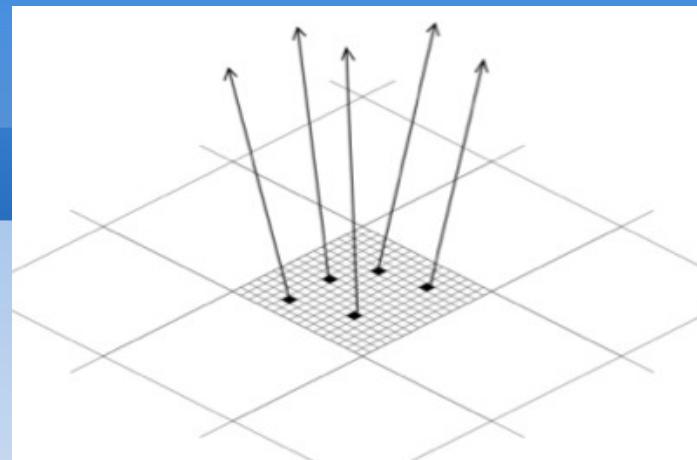
Future ECALs (2)

- SiD ECAL
 - ▶ Minimize the gap size → ≤1mm
 - ▶ Unpackaged chips
- Prototype
 - ▶ 30 layers of 1 chip (1000 channels)
 - ◆ 15×15 cm
 - ▶ chip v8 (256 ch) → 512 ch in nov'09 → 1024 in march'10
 - ▶ W alloy (92%) → much cheaper
- Request
 - ▶ e beam 5-10+ GeV
 - ◆ localized and controlled beam
 - ◆ LC-like small number of e- per bunch
 - ◆ ≥2011 (SLAC is possible) or FNAL; DESY



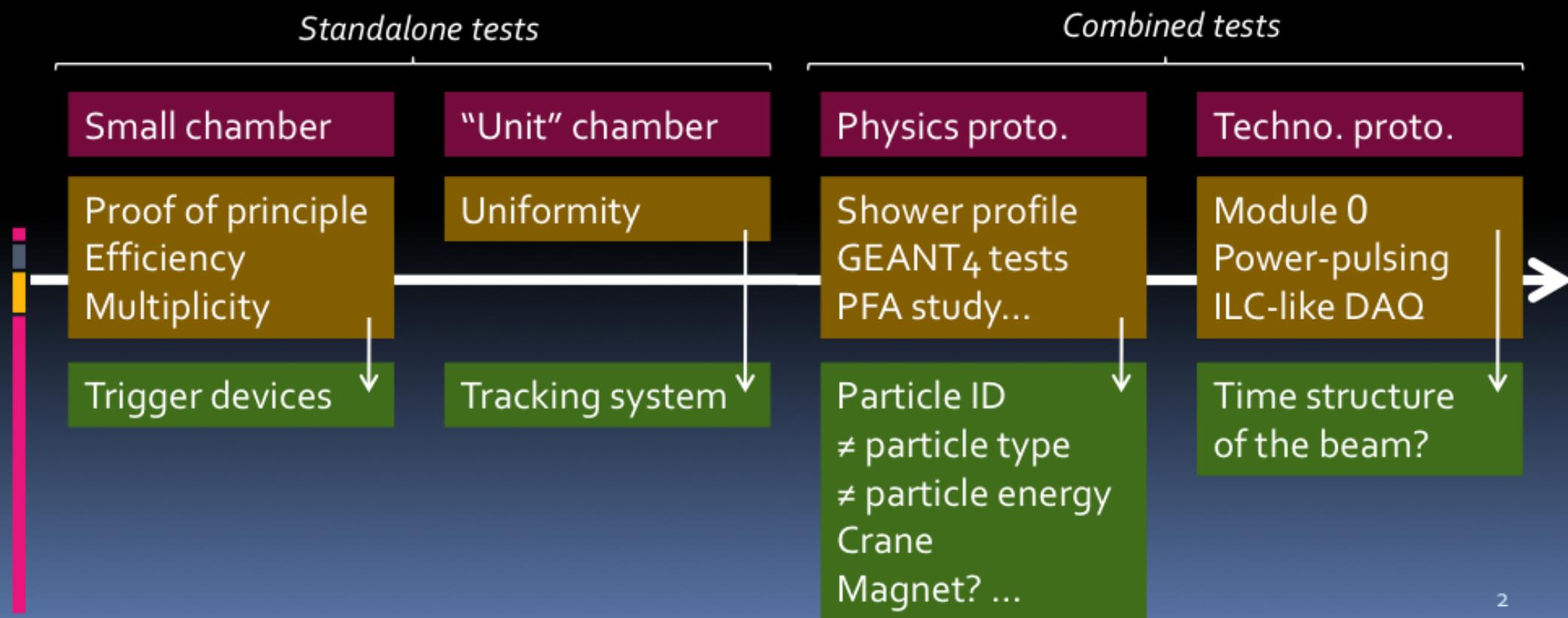
Digital ECAL

- SpiDer collaboration (\subset CALICE)
 - ▶ new funding (\rightarrow 2012 ✓)
- MAPS
 - ▶ \rightarrow Tera Pixel ECAL
 - ◆ track counting
 - ◆ $50 \times 50 \mu\text{m}^2$ pixels
 - ▶ CMOS MAPS sensors with \int readout
 - ◆ $1 \times 1 \text{ cm}^2$ TPAC sensors
- TB \rightarrow efficiency tests
 - ▶ CERN'09: H. En. e & π ✓
- DECAL chips \rightarrow stack for proof of principle
 - ▶ $6 \times 6 \text{ cm}^2 \times 30$ layers ($24 X_0$)
 - ▶ TB scheduled for 2012



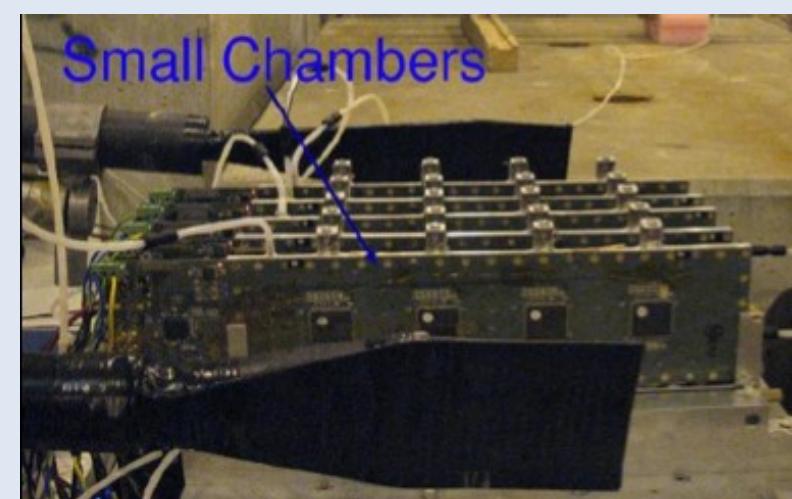
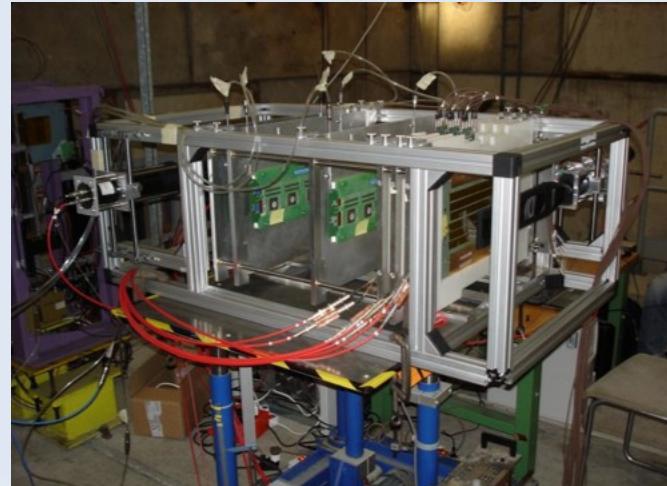
HCAL concepts & Test beams

- Several HCAL concepts
 - AHCAL & TCMT
 - RPC DHCAL
 - GEM/GRPC/MICROMEGAS DHCAL
- Specific TB plans/needs however common story-line



Past TB

- Successful @ CERN, FNAL, DESY
 - ▶ SiW ECAL + AHCAL + TCMT combined TB
 - ◆ many physics results
 - ◆ improvement of G4...
 - ▶ RPC DHCAL slice test
 - ▶ DHCAL RPC & GEM, SDHCAL RPC & μ MEGAS small (and no so small) test chambers



Combined CALICE beamtests

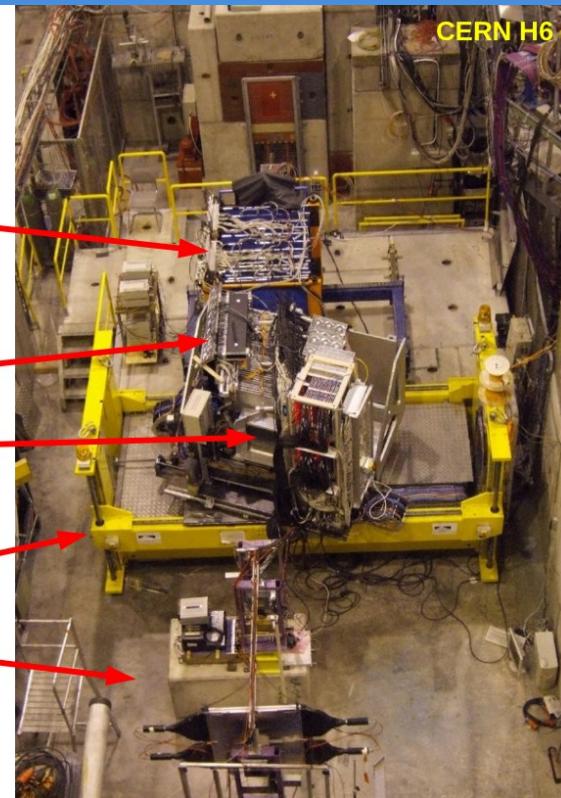
Tail Catcher/Muon Tagger (TCMT)

AHCAL

SiW or ScW ECAL

Movable stage

Beamline instrumentation:
scintillator triggers & vetos
drift chambers
cerenkov triggers



Experience in TB

- Usually “happy” with services & cooperation
 - ▶ CERN (examples) : infrastructure, gas systems, beam equipments & tutorials, beam intensity
- Some pts
 - ▶ instabilities (@ CERN)
 - ▶ suspicion of γ contamination in π beam @ FNAL
 - ▶ **General/Combined** wish list
 - ◆ Documentation
 - ◆ more equipment
 - ◆ Beam line simu
 - ◆ ...
- Other wishes (collab wide)
 - ▶ Remote Control room (DECAL)
→ saves travel money

Wish list

More reliable connection to beam parameters data base

Reliable, well documented beam instrumentation:

High precision tracking system

Dedicated high speed triggering system with veto walls

Differential Cerenkov detectors for $\pi/p/K/e$ separation over large E range

More documentation on usage of beam instrumentation

i.e. Cerenkov pressure curves vs energy

More info on muon energy spectrum/multiplicity (requires simulation of beamline)

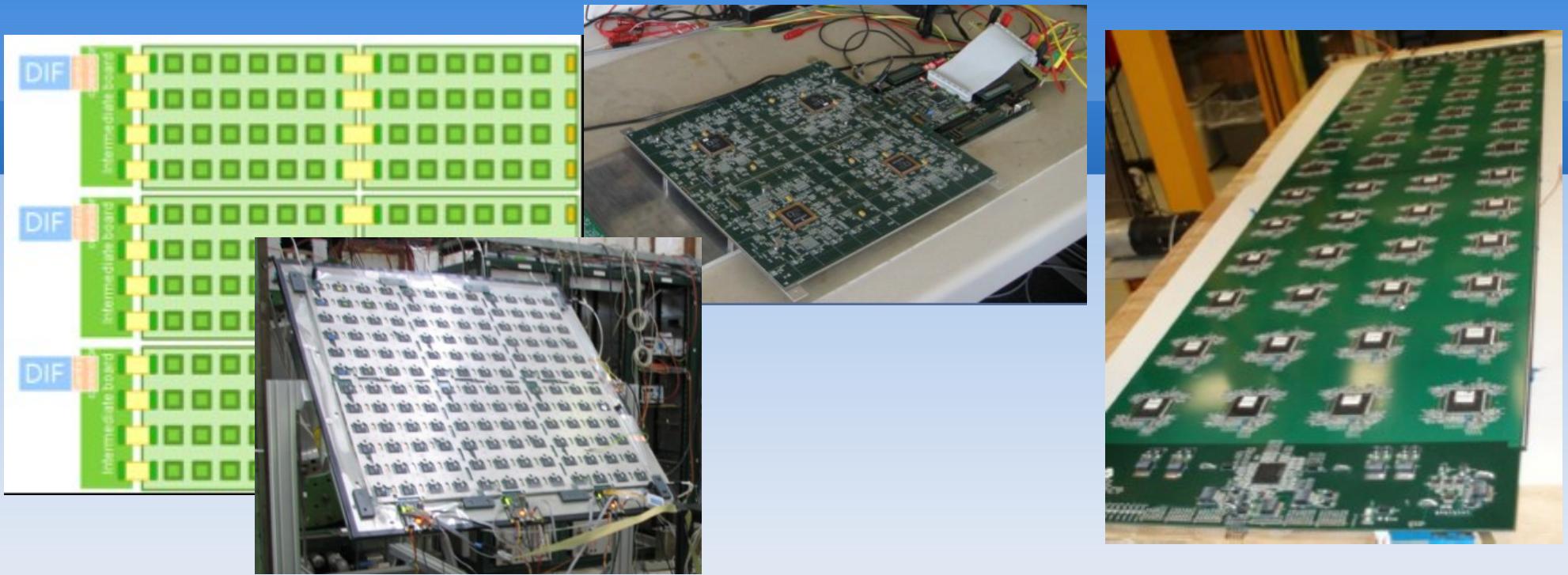
High hadron rate at low energy:

> 5 Hz @ 1-6 GeV (FNAL achieved rates)

G4 model of beam line and instrumentation

High duty cycle

Large bore magnet



CALICE proto	Now	Then	Later
ϕ DHCAL RPC	$0.2 \times 0.2 \text{ m}^2 \times 10$	Feb'10: 1m^2	Spring'10: $1\text{m}^3 = 1\text{m}^2 \times 40$
ϕ DHCAL GEM	$1 \times 0.3 \text{ m}^2$	mid'10-11: $1\text{m}^2 \times \sim 5$	
τ SDHCAL RPC	$1 \text{ m}^2 +$	mid '10: $1\text{m}^2 \times 3$	end'10: 1m^3 $= 1\text{m}^2 \times 40$
τ SDHCAL μ Megas	many $0.1 \times 0.3 \text{ m}^2$	beg '10: 1m^2	
AHCAL	$\phi 1\text{m}^3$	'10: τ layer	?? : τ multi-layers
TCMT	16 layers	improvem ^t of strips	
All...			≥ 2012 : W structure

ϕ = Physics proto; τ = technol proto

Pseudo PFA test

Scheme of the TB with CMS-T

12 layers of $10 \times 10 \text{ cm}^2$ Si strips

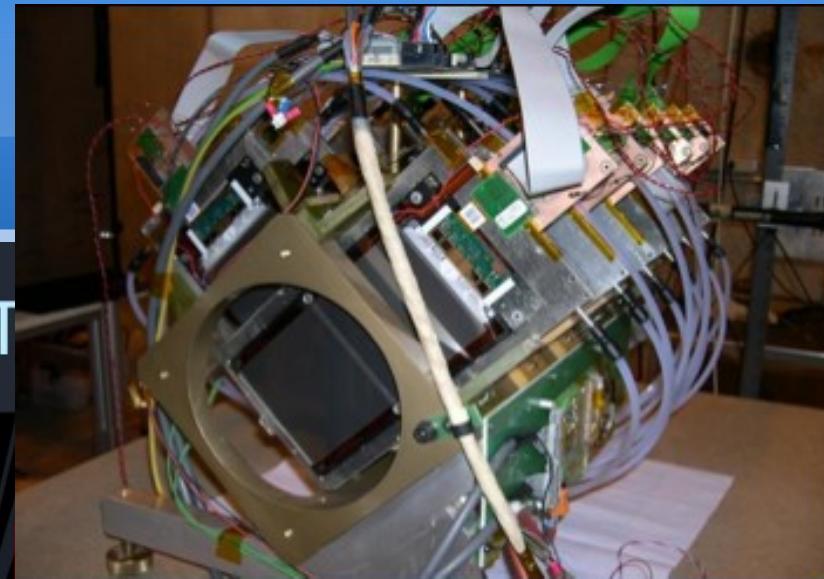
6X+6Y, 30 μm resolution/layer



Simple case of PFA study can be achieved at low cost by combining existing/future calorimeters with existing tracker telescope

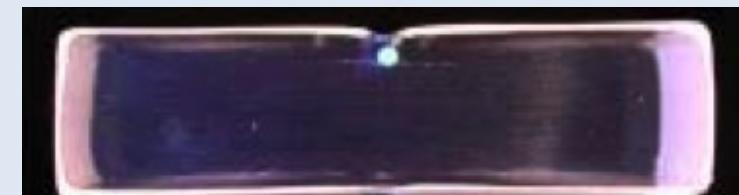
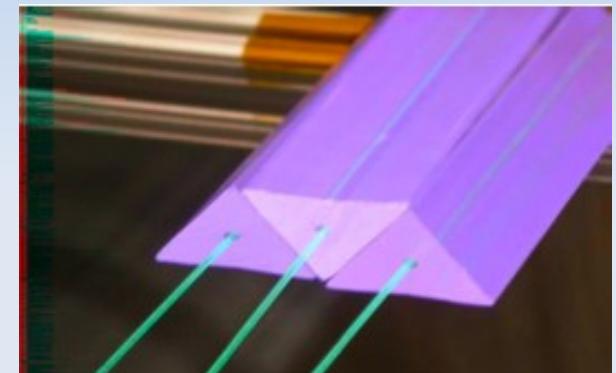
More advanced PFA study needs more sophisticated setup.
Complete PFA test on "pseudo-jet" remains very difficult.

A combined, modular test is not a new idea but it becomes now necessary to validate concepts and options.



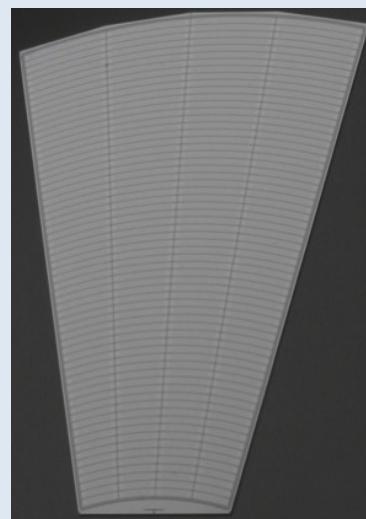
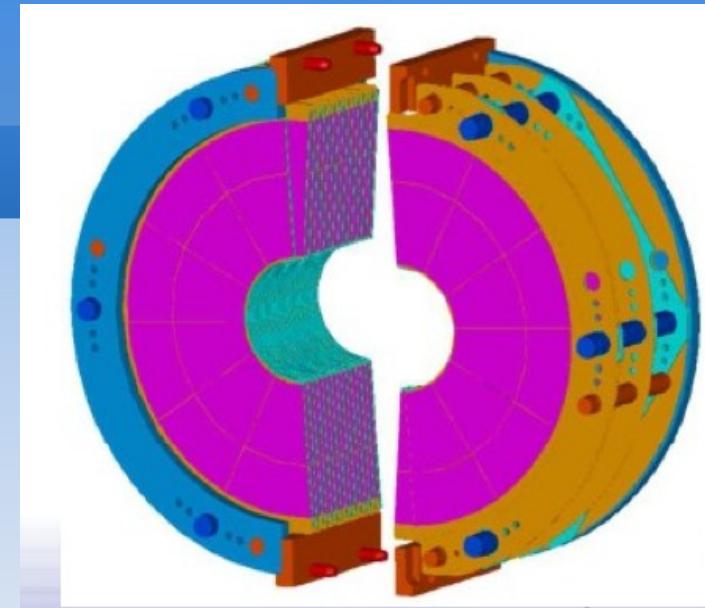
SiD Muons

- RPC
 - ▶ IHEP bakelite, double gap, kpix readout
 - ◆ aging studies (2 groups: Princeton & Wisconsin)
 - ▶ 2009-11
 - Cosmics ray → no plans yet for TB
Should come...
- Extruded scintillators
 - ▶ up to 5 m long bands & various geometry
 - ▶ 2006: SiPM
 - ◆ test @ FNAL
 - ▶ new electronics ready to go to TB
 - ◆ test a few channels ($4 \times 1 \text{ cm}^2 \times 6\text{m}$) strips + SiPM in TB
 - ◆ beam needs: Mips ($10^2\text{--}10^4 /s$), limited beam spot size (tracking)
 - ▶ $\geq 2011?$ construction of complete module → Combined TB



Fwd Calorimeters

- FCAL collaboration
 - ▶ LumiCal
 - ▶ BeamCal : GaAs
- Test elements ready:
 - ▶ Silicon sensors (320 µm, Hamamatsu)
 - ▶ Captions
 - ▶ FE electronics
 - ▶ ADC
- TB:
 - ▶ no yet: meas. chain in prep
 - ▶ will need EUDET telescope
 - ▶ → TB mid '10: e
 - ▶ No special requir^t



Discussions

- What is ILC-like ?
 - ▶ time structure 300-740 ns ?
 - ▶ beam intensity
 - Is it really needed ?
 - ▶ vs source, electronics calibration
 - ▶ vs continuous beam + tagging devices
 - ◆ Is Beam time an issue ?
 - ◆ What duty cycle can Technol. proto stand
 - Test of ECAL & HCAL in high B by 2012 ?
 - ▶ Electronics & mechanics tests
 - ▶ Hadronic dev^t in B field
 - Physics case for SiLC + ECAL test
 - ▶ only useful in combined test ?
- Remarks:
 - ▶ Many request of EUDET telescope
 - ◆ maybe with higher speed
 - ▶ Remote Control to save travel money (DECAL)

TB Calorimeters menu

Calorimeter	Date	Type	Specials
ScEcal (ϕ)	'09 → '12	e (all E), low E π	target (π^0 's)
RPC DHCAL m ³ (ϕ)	\geq mid'10	All types; combined TB	—
GEM DHCAL (ϕ)	\geq mid'10	low E e, μ , π	—
μ M, RPC layers SDHCAL m ³ (τ)	'09 → end '10 \geq end '10	low E e, μ , π All types	ILC like
ScEcal (ϕ)	'09 → '12	e (all E), low E π	target (π^0 's)
CALICE ECALs (τ)	\geq '11	e (all E), low E π	ILC like
Combined CALICE (τ)	\geq '11-'12	All types	ILC like Magnet for PFA ?
W HCAL structure	\geq '12	All types; Combined TB	ILC like ?
SiD SiW ECAL	\geq '11	e 5-10 GeV SLAC (DESY)	beam local ⁿ ILC like (0,1,2 e/Bunch)
DECAL	Sensor → DESY '10 Stack \geq 2012	e (all E), CERN & DESY	telescope large XY table
SiD Muons	\geq 2011?	High E had. Combined test	—
FCAL	\geq 2010	electrons + mips	telescope