progress report

- Silicon wafers for the prototype
- Mechanics
- PCB for prototype
- VFE electronics
- DAQ
- Simulation and analysis

and

first mip measurement with a complete chain of detector slab
Who is doing CALICE-ECAL

LAL, LLR, LPC, PICM
VFE, PCB, mechanics, DAQ, Assembling
+ amorphous silicon

Imperial College, UCL, Cambridge, Birmingham, Manchester, RAL
DAQ, Physics studies

ITEP, IHEP, MSU
Tungsten, Silicon wafers

Prague (IOP-ASCR)
Silicon wafers

SNU, KNU
DAQ, PCB, Physics

Report prepared by J-C. Briant
Further Collaboration are welcome

Free alveoli for R&D (new detector slab, cooling, ...)

1st structure (1.4mm of W plates)
2nd structure (2×1.4mm of W plates)
3rd structure (3×1.4mm of W plates)
Multi-layer W-Si prototype:
- 3 independent C-W alveolar structures according to the thickness of tungsten plates
- 30 detector slabs which are slit into central and bottom cells of each structure
- Active zone: 3×3 silicon wafers

Note the density

M. Merkin, A. Savin, A. Voronin
MSU-Moscow

High quality silicon wafers
- low leakage current (<10nA/pad)
- only 3 guard rings/wafer
- good (very good ?) prod. rate

Similar production will start soon in Prague
V. Vrba (IOP-ASCR)
**Mechanics R&D and production**

**Prototype**

- Structure 1 and 2 produced
- Support (type H) produced for stack 1,2

**to do**
- Structure-3 (4.2 mm)
- Support H for stack 3

Dead area Inter-alveoli is only 0.4 mm

**structure 1**

2 active layers and one layer of tungsten

**R&D**

- Thermal simulation
- Cooling design
- Large scale module CFi-W
- etc…

M. Anduze, J. Badier, A. Busata, F. Dohou, H. Videau

G. B. Kim, M. Nam-Il Baik

**and ITEP, IHEP which make a VERY NICE production of good quality tungsten sheet**
1x1 cm pads

PCB 14 layers, 2mm
(LAL, SNU, KNU)

VFE
(LAL)

Silicon Matrix
(LLR, MSU, ASCR-Prague)

DAQ
(ICL, UCL, RAL, Manchester, et LLR, SNU)

Mechanics
(LLR)

For test only, Scale ½
First test at LLR

S. Chollet, F. Gastaldi, A. Karar, J-Ch. Vanel
LLR

J. Fleury
LAL

Noise
About ¼ MIP with FLC-PHY1 (signal not diff.)

Signal
First mip observation on a full chain

Silicon – Glue – PCB – VFE – DAQ
PCB for the prototype

14 layers, class 6 PCB

Thickness 2.08 mm
3 boards delivered @LAL 6 nov 03
12 FLCPHY2 chips + 2 Calib chip

Area without silicon wafer
(physics and funding reasons)

D.W. Kim, M. Naim-Ii Baik
KNU

J. Fleury
LAL

Designed at LAL

Produced in KNU
VFE - ECAL

B. Bouquet, J. Fleury, C. de La Taille, G. Martin-Chassard
LAL Orsay
G. Bohner, J. Lecoq, S. Manen
LPC Clermont

• Signal (Gain 1, $C_f=1.6\text{pF}$)
  - Amplitude = $364\text{mV/pC} \pm 7.8\text{mV} = 2.33\text{mV/MIP} \pm 2\%\text{rms}$
  - Peaking time = $213\text{ns} \pm 1\text{ns rms}$
  - Pedestals = $-3759\text{mV} \pm 4.9\text{mV rms}$

• Noise
  - $C_d = 0\text{pF}$ : $V_n = 191\text{µV} \pm 1.8\text{µV}$
  - $C_d = 68\text{pF}$ : $V_n = 500\text{µV}$

• Crosstalk : $< 0.2\%$

• Linearity measured on all preamp gains
  - $C_f = 0.2, 0.4, 0.8, 1.6, 3\text{pF}$
  - Well within $\pm 0.2\%$

• Dynamic range (G1)
  - Max output : $1.4\text{V (in 50Ω)} = 600\text{MIPS @ } C_f = 1.6\text{pF}$
  - Noise (in 50Ω):
    - $200\text{µV (Cd = 0)}$
    - $500\text{µV (Cd = 68pF)}$
  - Dynamic range:
    - $7000\text{ (13 bits) @ Cd = 0}$
    - $2500\text{ (11 bits) @ Cd = 68 pF}$
  - Can be extended by using the bi-gain outputs
FLC-PHY2 Measured performances

1 channel

VFE schematic view

ENC = f(Cd)

y = 28,766x + 3244,2

 transient output versus gain

Signal uniformity G1
ADC - DAQ board (VME) for the prototype

A. Baird (RAL), P. Dauncey (ICL), M. Warren (UCL), O. Zorba (ICL)

Starting from this CMS board

Multiplexed signal to DAQ

Production of Test board
December 2003

96 analog input signal \(\rightarrow\) 96 VFE’s (each with 18 channels)

Test with overall detector slab in January – February 2004
ECAL prototype – 2004 and after

**Cosmic test bench – March 2004**
- « debug » the overall and Intercalibration of the 10K channels
- Noise, Xtalk, etc....

**test beam at DESY - October 2004** (low energy electrons E<6 GeV)
- First real test, (resolution, stability, noise,...)
- validation of the e.m. simulation in border region (guard ring,...)

**test beam at FNAL/IHEP en 2005-2006** (electrons/pions/protons up to 80 GeV)
- Validation of the overall calo. (ECAL+HCAL)
- TEST of GEANT4 e.m. and **hadronic showers** simulation
- Validation of the HCAL digital concept
- comparison with the tile HCAL

Performances with real data on the calorimeter **ECAL+ HCAL**
Old version of the ECAL prototype exist already within MOKKA
New and more detailed version foreseen before LCWS04
First work in comparing geant3/geant4
First work in trying to understand geometrical effect

5 GeV e⁻

E_{HCAL}/E_{total}

reconstructed energy

border between 2 wafers for projective geometry

nominal electron energy is 10 GeV

electron position
Prototypes for test beam are good milestones for R&D

- On the technical test and choice
- On the detector concept
  DHCAL, hadronic shower in GEANT4, performances ECAL+HCAL, ...

In parallel, R&D on the full scale detector are in progress

Subdetector collaboration in CALICE-ECAL fulfilled the above recommendation
More results in PARIS