



# LED notched fibre system at AHCAL

### **Calibration system for SiPM**

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- 1. Notched fibre light distribution systems
- 2. A Set-up, with provisional fibre layout
- 3. Toroidal inductor at PCB
- 4. LED optical power
- 5. Plans for 2010
- 6. Conclusions

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### Requirements to calibration system for SiPM based detectors

Generate uniform near-visible UV flashes

controllable in amplitude 0 to max = twice SiPM saturation

pulse width a few ns

enabling each LED individually

optical feedback from LED to PIN-PD signal channel

LED triggering from DAQ

Readout temperature from sensors placed in the scintilator plane (12bits minimum)

Some (USB, CANbus,...) interface to Slow-control

Stability in magnetic field



# Flashing UVLED - 2 methods

 Light distributed by notched fibres



 Light distributed directly by microLED to the scintillator
 distributed LEDs



Institute of Physics ASCR, Prague, (= FZU) Shinshu University DESY Hamburg UNI Wuppertal

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# Notched fiber system

 advantage – tuneable amplitude of LED light from 0 to 50 mips

- Variation of LED amplitude does not affect the SiPM response readout
- LED circuit and vEDs anable optical pulses with around ons width
  Spread of light intensity from notches call be kent under 20%
- disadvariage LED with control unit outside the detector volume

Notched fibre production is not trivial

Notched fibre routed at HBU0, taps illuminates the scintillators via special holes



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### Notched fiber layout on HBU0 at DESY dec2009

- Picture: Notched fiber was illuminated by small pocket spotlight.
- Most of 12 notches are above alignment pins



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# Setup QMB6 (QRLED system) + HBU0



From HBU0 (calib board):

> signal T-calib LVDS only

60ns Delay

- power +15V/0.16A
- CANbus slowcontrol

One UVLED 5mm

One Notched fibre

#### Control: LabView 8.2 exe-file, One PC with DAQ, USB --> CAN

Almost plug and play

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## Control panel of QMB6 in LabView 8.2



### QMB6 ON/OFF test

**ON** means T-calib on, LED off

**OFF** means +15V power off



# Single p.e. spectrum



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### Single photoelectron spectra with **CMB** and **QRLED** LED light 400nm to

Counts

800

600

400

200



More info about CMB can be found at:

http://www-

hep2.fzu.cz/calice/files/ECFA\_Valencia.lvo\_CMB\_Devel\_nov06.pdf

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**CMB** in tuning

**TB 2007 CERN** 

position at

AHCAL



### Next day we found a misalignment of the fibre

#### Electrical tape and bent fibre is not the right combination!



# Linearity test (it means a saturation curve)

#### More details in talk of J. Kvasnicka, CALICE 2010 Arlington



Settings:

Cf = 400fF Low gain mode

• We do not see saturation effect, yet.

• Better optical coupling alignement is a must. – strong misaligment effect

• Higher LED pulse can be made with larger pulse-width  $(3.7 \rightarrow 7ns)$ 

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## Conclusions to common test HBU0 with QMB6

- Easy implementation, almost **plug and play** installation
- Both methods of light distribution are tested in HBU0 EUDET prototype
- With QMB6 we can see a nice single p.e. spectra, similar to distributed LEDs
- We do not see saturation of SiPM yet, better optical coupling is a must. We have to focus on this detail.
- We would like to make more tests in the future, focusing on the optical coupling
- We can integrate a few QRLED to new version of HBU
- Special thanks to Mathias Reinecke and FLC group.
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   2010 MAR29

#### **GET more light!**



#### Larger pulse $\rightarrow$ Larger inductor



#### Less RFI, not sensitive to magnetic field – tested up to 4T





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14

# Test PCBs with toroidal inductor

- 1. Test mechanical dimension, thickness of PCB on inductance
- 2. test GND-plane influence

#### 30 x 60 mm^2 4 layers

CAM350 V 10.2.0 : Tue Mar 23 15:38:55 2010 - (Untitled)

3 PCB thicknesses: 0.65, 1.6, 3.2mm



← 11 turns

← 9 turns

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# Ground plane, an effect of different coupling to the coil

CAM350 V 10.2.0 : Tue Mar 23 15:35:07 2010 - (Untitled) : CopperInner1

Inner layer 1



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### Top layer, pads at right are for smd capacitors

1. First to measure resonant frequency of parasitic capacitors, only.

2. To get value of L, we add larger parallel C, all 100pF with tolerance 1%, And measure the resonance frequency by GDO meter.

CAM350 V 10.2.0 : Tue Mar 23 15:35:07 2010 - (Untitled) : CopperTop



GDO = Grid Dip Meter, handy instrument to measure resonant frequency of LC circuit

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# **Toroidal inductor test PCB**

Data is missing here, 🛞

...delayed PCB delivering, to be tested in April

stay tuned !



### LED, optical power test DC and pulsed

Optical Power Meter PM100D with Si sensor S130D by Thorlabs

#### Prague, March 2010

#### Some LEDs intended to calibration





### Optical Power transformation efficiency at "old CMB" 400nm LED 5mm



0.01

0.1

DC current [mA]

### •Results

-Flashing with 3ns pulses does not drastically affect the efficiency of transformation of electrical pulse to optical (compared to DC)

–Peak pulse optical power is ~70x higher than DC

-Optical energy in pulse ~2nJ ~ $\rightarrow$  4x10^9 photons

#### Test setup: Optical Power Meter PM100D with Si sensor S130D by Thorlabs

More informations on LED can be found at http://wwwhep2.fzu.cz/calice/files/ECFA\_Valencia.lvo\_CMB\_Devel\_nov06.pdf

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10

100

# Plans for the 2010

Main focus: Increase of the optical performance:

- Extend the pulse width from current 3.5 ns
- improve optical coupling from LED into the fiber
- improve the transmission to the scintillation tile

New QR LED driver prototype (Q3/2010)

- 1 channel per board
- different onboard inductors for different pulse width in range of 4 ~ 10 ns
- 3cm PCB width to match the tile size

Notched fiber production (Q4/2010)

- 6 new notched fibers with 72 notches each
- dimensions of the notches need to be synchronized with HBU



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# Conclusion

- Prague group is working further on notched fibre calib system.
- Two optical methods for SiPM calibration in AHCAL under investigation

Notched fibres

Distributed LEDs

For each method UVLED driver has been developed, still recent optimizing to be done

- QRLED driver has tunable light amplitude and generates clear p.e. spectra
- QRLED driver is not sensitive to magnetic field in the range 0 ÷ 4 T
- Both methods will be tested in HBU0 EUDET prototype

# Back up

Ref: 1. http://www-hep2.fzu.cz/calice/files/ECFA\_Valencia.lvo\_CMB\_Devel\_nov06.pdf

2. http://www-hep2.fzu.cz/calice/files/Polak-ALCPG09.lvo\_calibLED\_ALCPG09e.pdf

# 6-LED QR driver Main Board = QMB6



Consists:

- 6 QR LED drivers
- 2 PIN PD preamps

- CPU + communication module, CANbus

- Voltage regulators
- temperature and voltage monitoring

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# Details of distributed LEDs

