Calibration system of CALICE AHCAL detector

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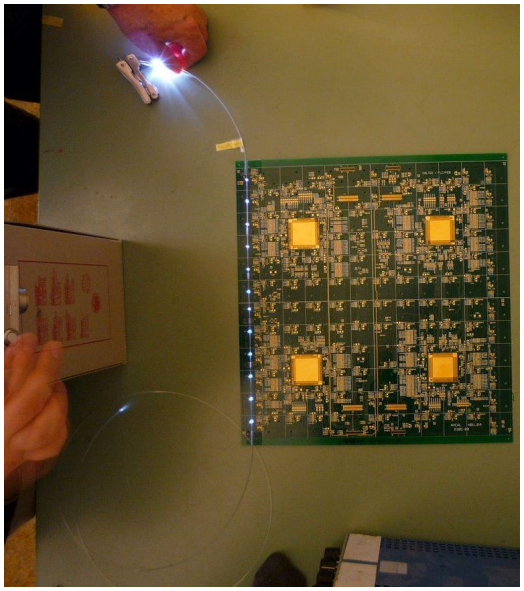
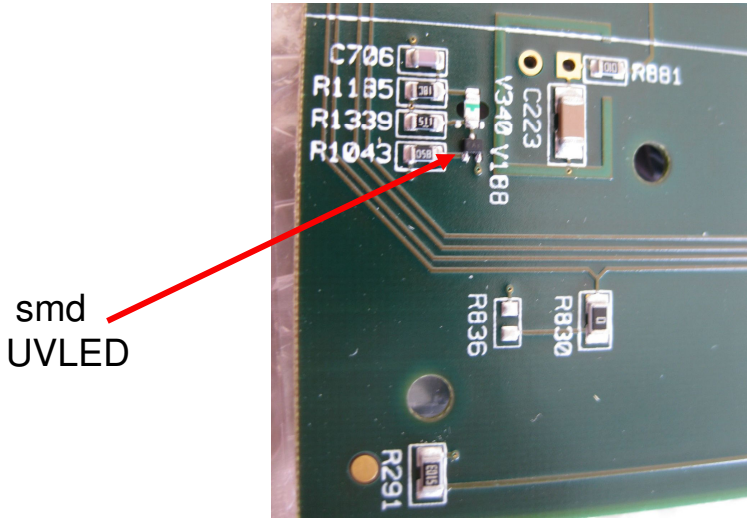
1. **Two calibration light distribution systems**
2. **QRLED driver photoelectron spectra**
3. **QRLED driver behaviour in strong magnetic field**
4. **Conclusions**

Flashing UVLED - 2 methods

- Light distributed by notched fibres



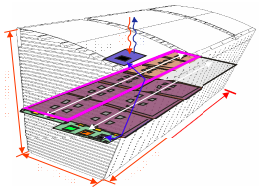
- Light distributed directly by microLED to the scintillator - distributed LEDs

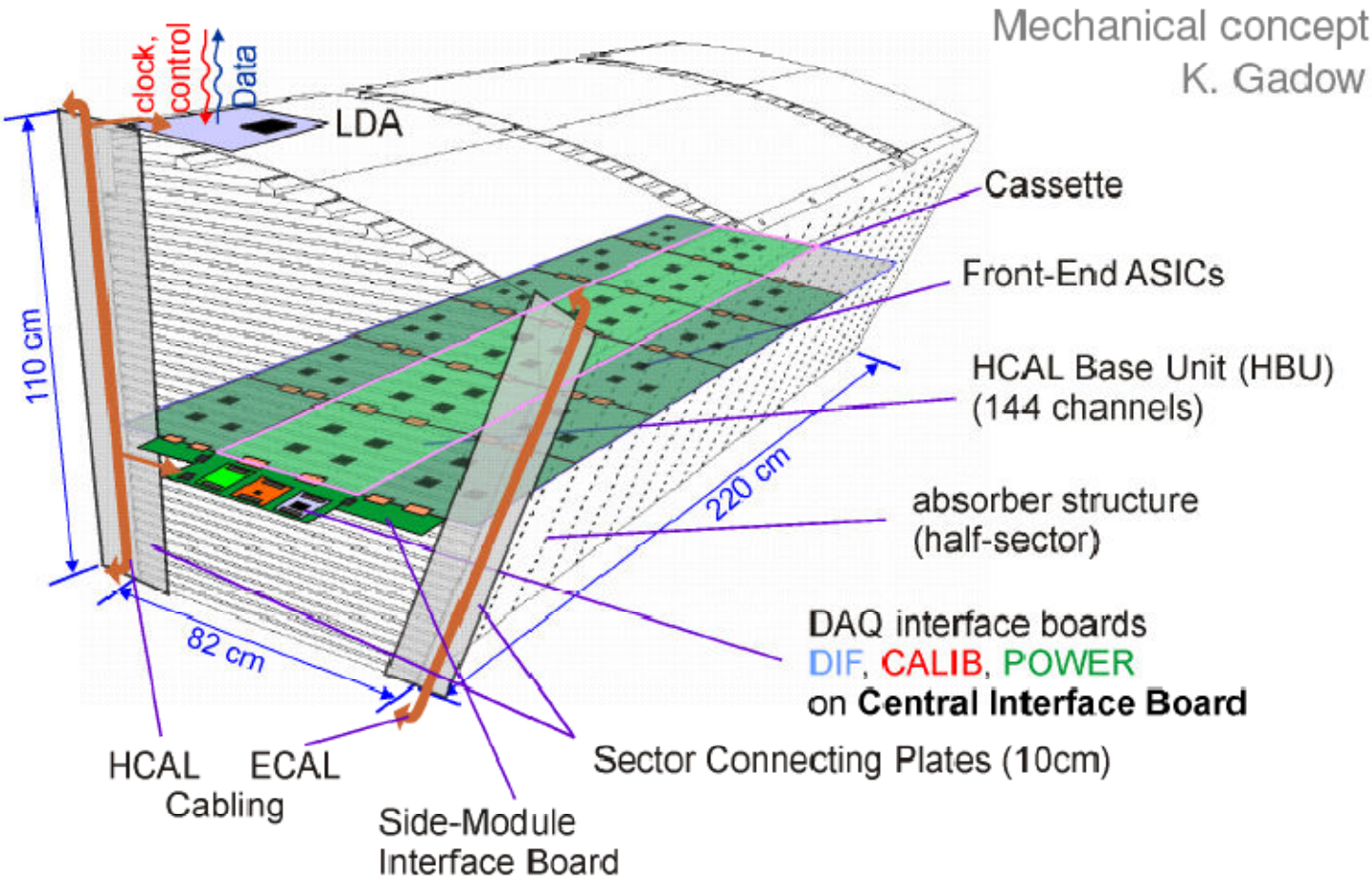


Institute of Physics ASCR, Prague, (= FZU)
Kobe University

DESY Hamburg
UNI Wuppertal

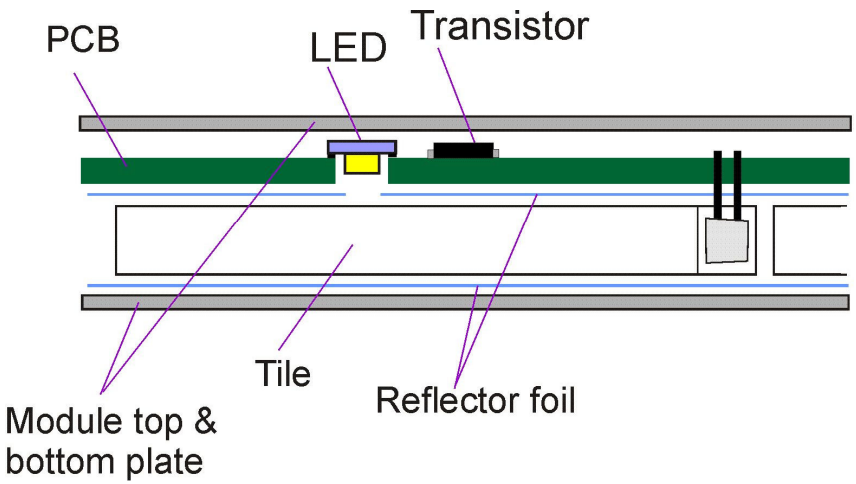
General mechanical concept AHCAL EUDET module





Details of distributed LEDs

Small UV LED, smd size 1206 and 0603



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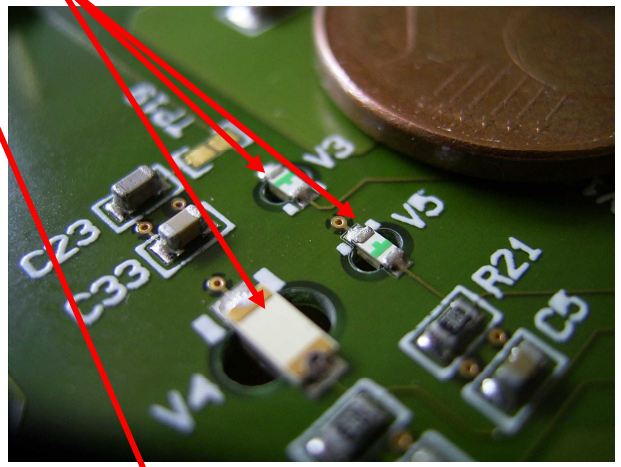

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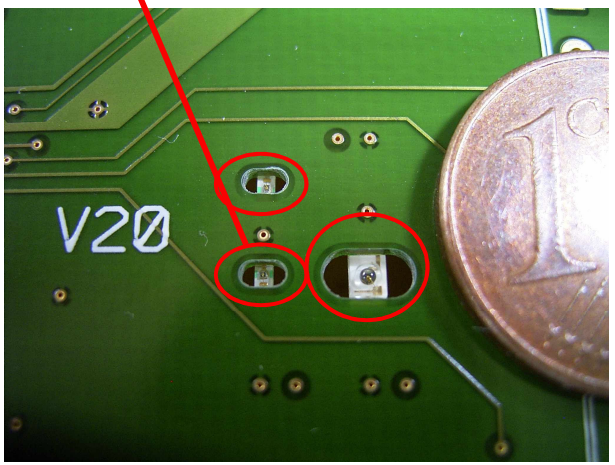
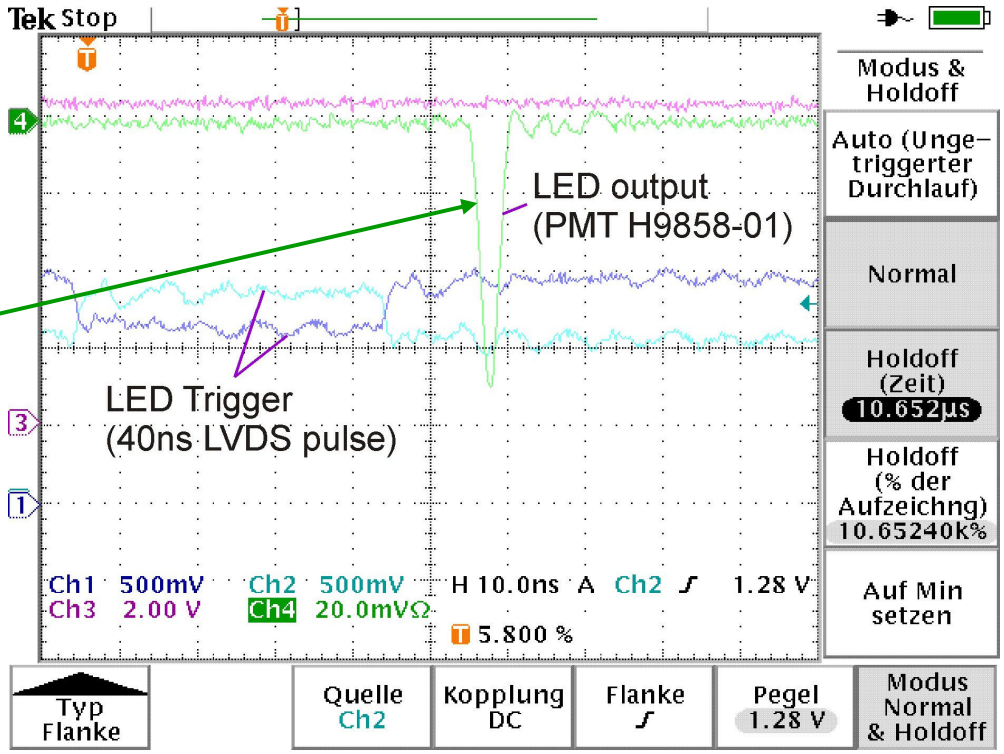


Distributed LEDs

- **advantage** - you don't have to distribute the light (no fibres)
- Fast LED trigger is distributed as LVDS (small crosstalk to tiles)
- LED circuit and LEDs enable optical pulses with around 5ns width (screenshot, measured on the HBU).
- **disadvantage** - LED to LED component spread of the optical output
- LED light intensity is limited to the level of a few MIPs

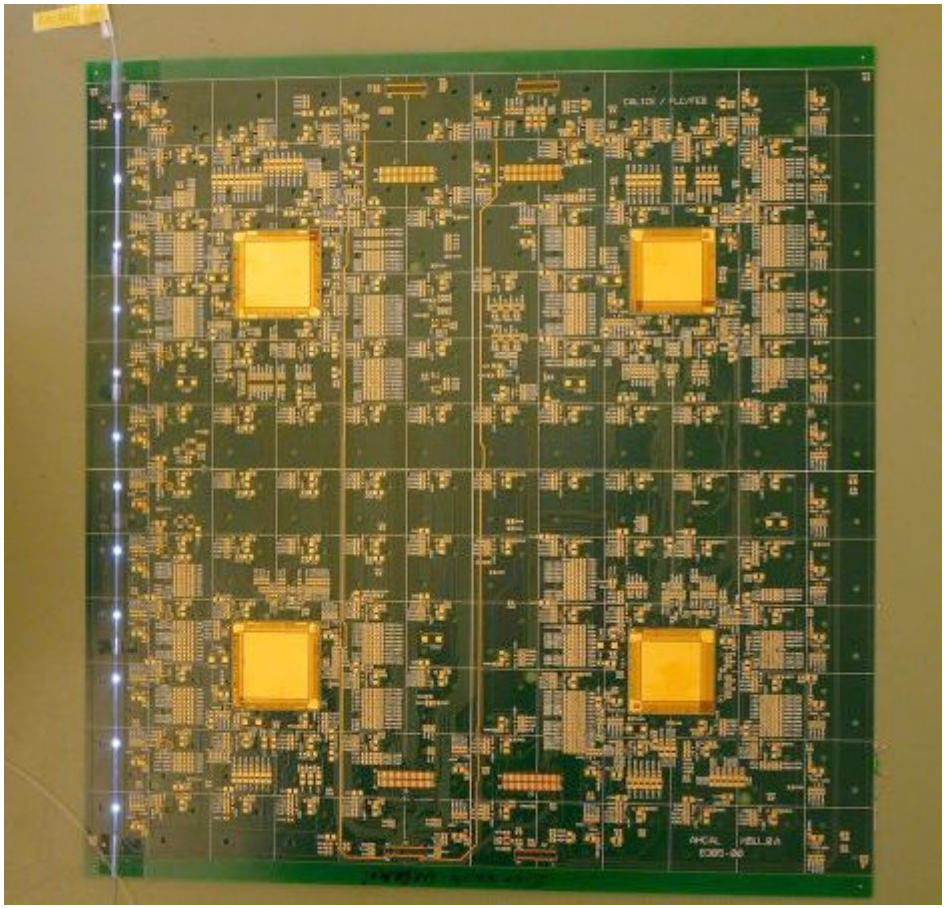
Short pulse (3ns) LED →PMT



Notched fiber system

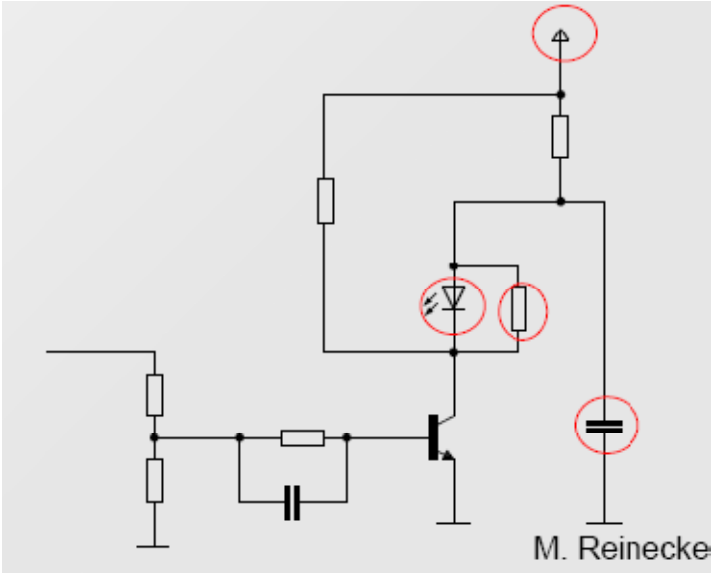
- **advantage** – tuneable amplitude of LED light from 0 to 50 mips
- Variation of LED amplitude does not affect the SiPM response readout
- LED circuit and LEDs enable optical pulses with around 5ns width
- Spread of light intensity from notches can be kept under 20%
- **disadvantage** LED with control unit outside the detector volume
- Notched fibre production is not trivial

Notched fibre routed at HBU0



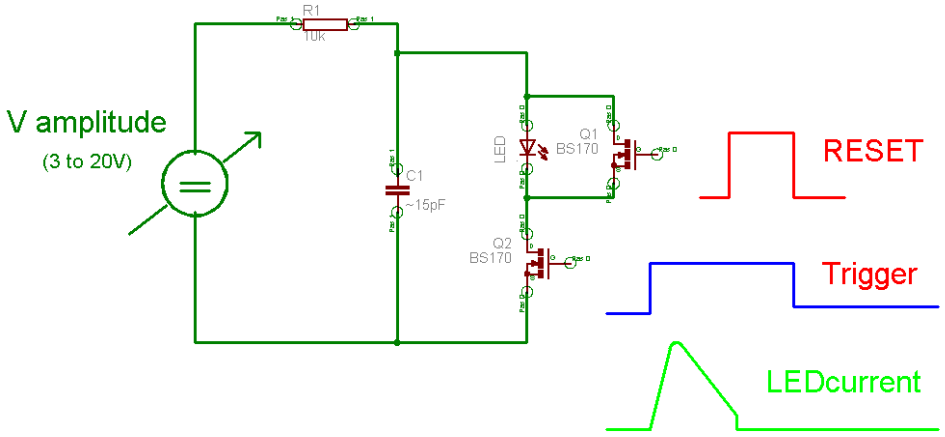
Classic “old style” LED driver

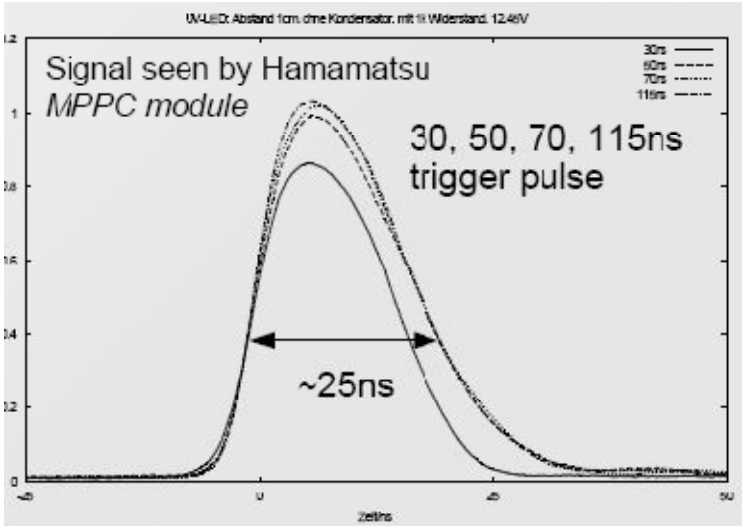
- A few components
- Optimizing at Uni Wuppertal by S. Weber
- Original design at DESY FE by Mathias Reinecke for HBU0 (distributed LEDs) 5ns achieved
- One long Trigger signal is needed



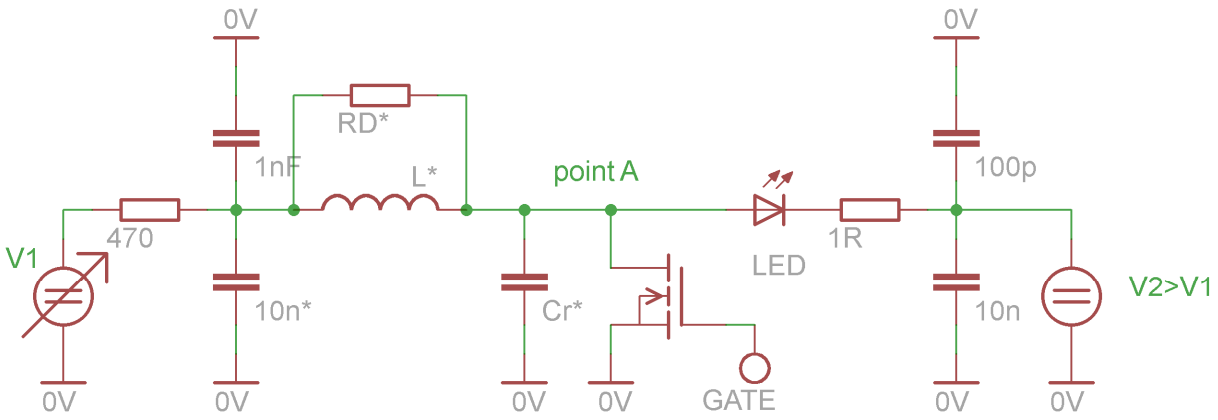
Blue LED *Osram LB M47C*

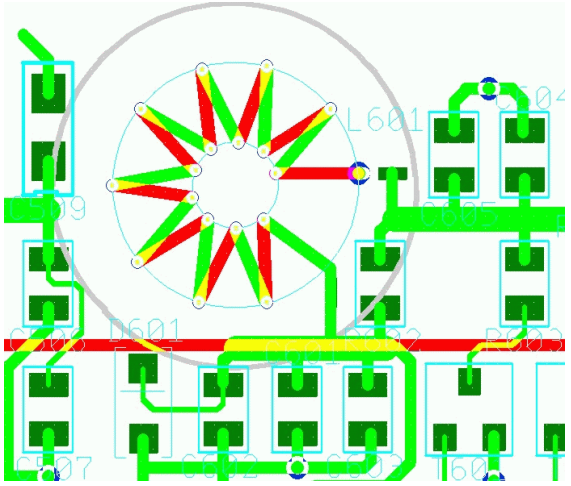
- Good results in signal shape and timing behavior
- Not the case for other blue LEDs



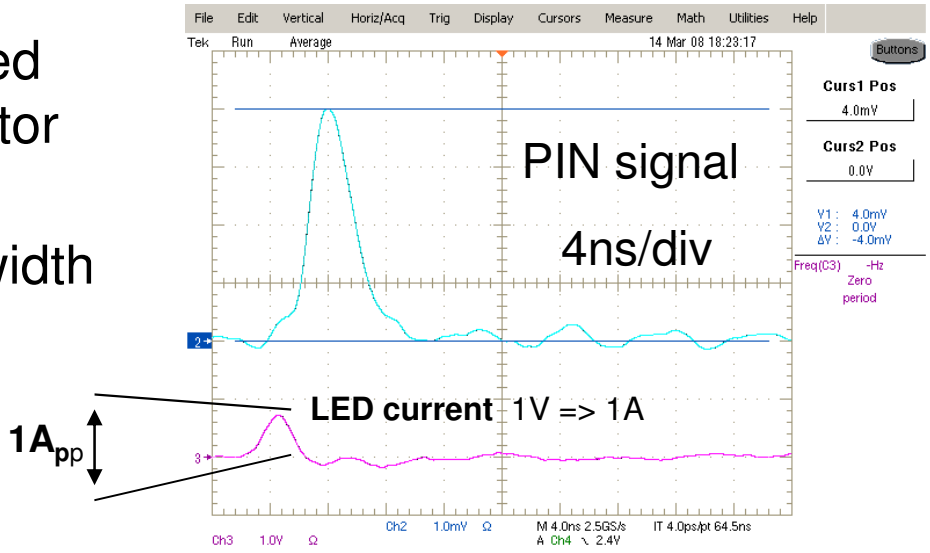


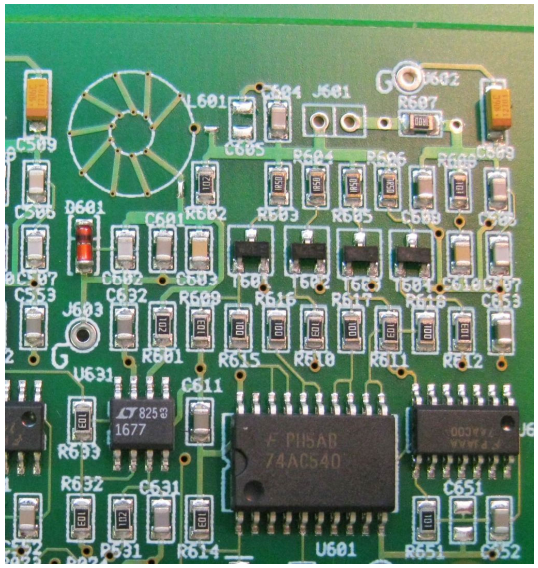
Quasi-Resonant LED driver



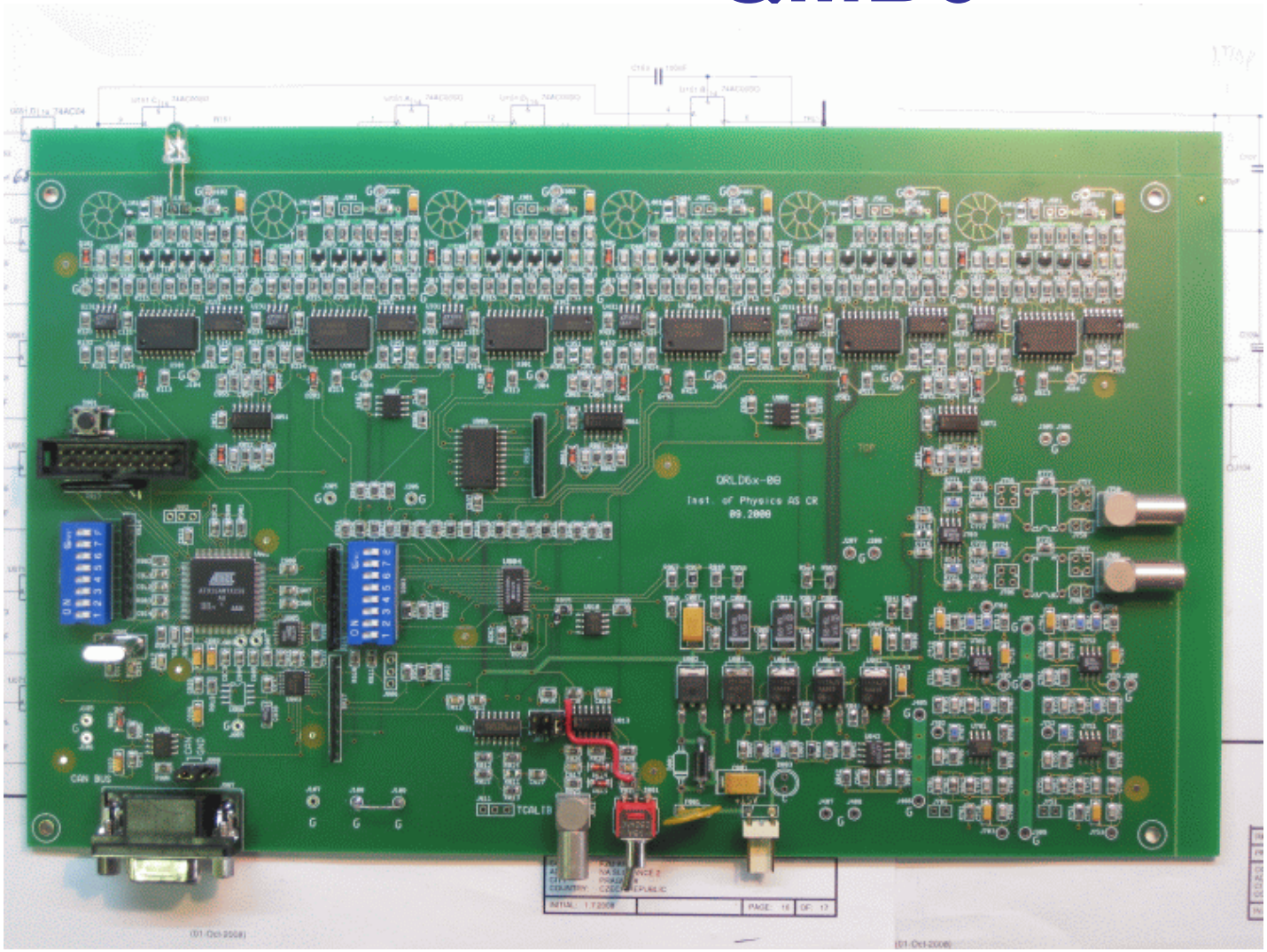


- Less RFI
- PCB integrated toroidal inductor (~35nH)
- Fixed pulse-width (~4ns)





6-LED QR driver Main Board = QMB6

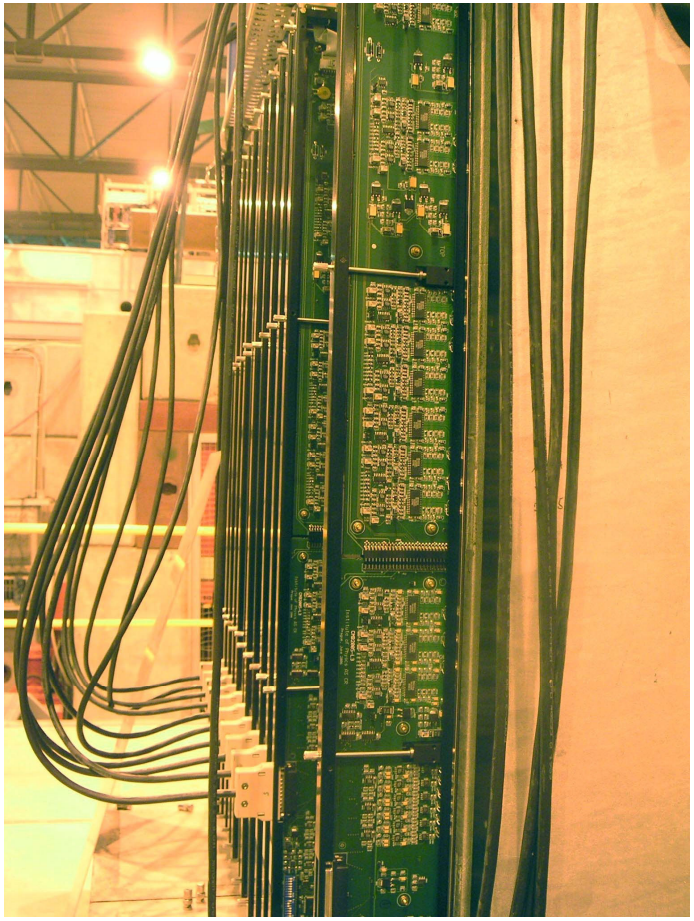


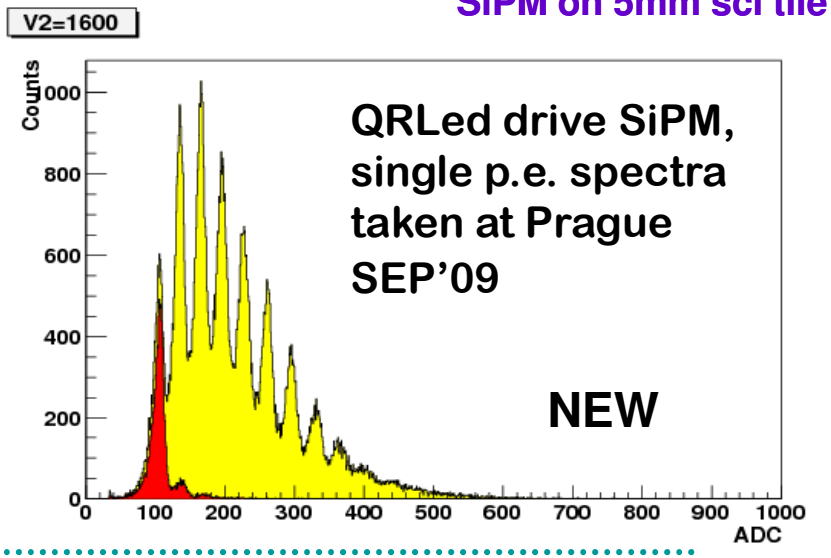
Consists:

- 6 QR LED drivers
- 2 PIN PD preamps
- CPU + communication module, CANbus
- Voltage regulators
- temperature and voltage monitoring

Single photoelectron spectra with **CMB** and **QRLED**

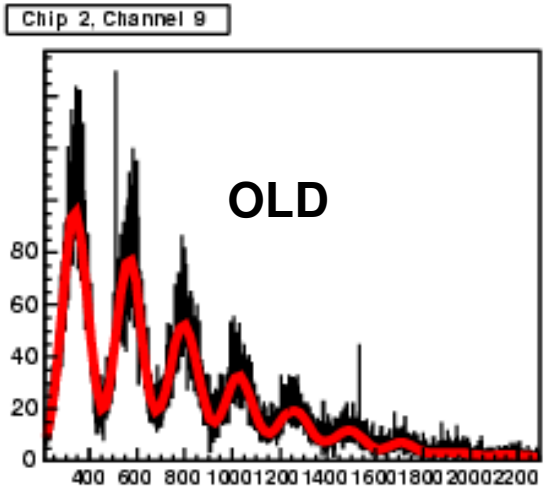
LED light 400nm to SiPM on 5mm sci tile





←CMB in tuning position at AHCAL TB 2007 CERN

one of the single p.e. spectra →



More info about CMB can be found at:

http://www-hep2.fzu.cz/calice/files/ECFA_Valencia.Ivo_CMB_Devel_nov06.pdf

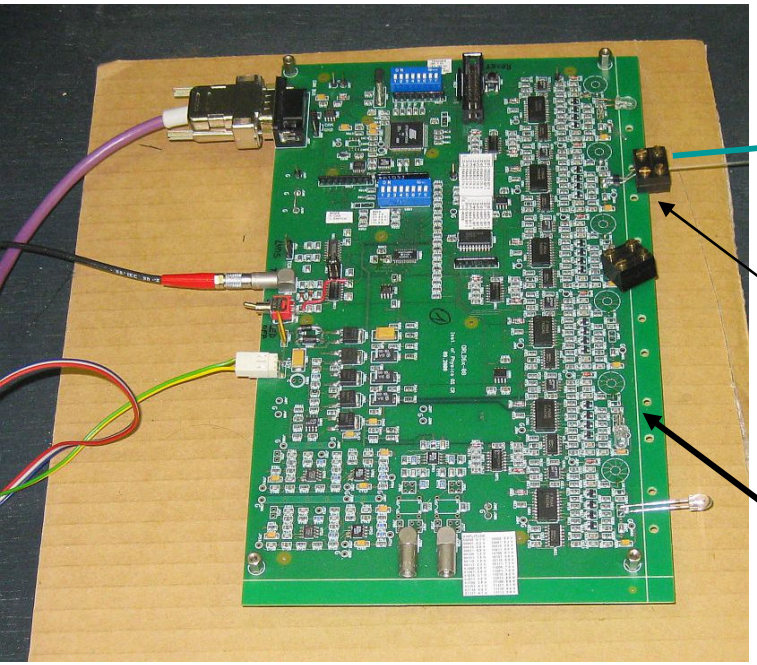
Setup for taking single p.e. spectra with notched fibre

Light tight box

Notched fibre is laying on scintillator and taped on position.

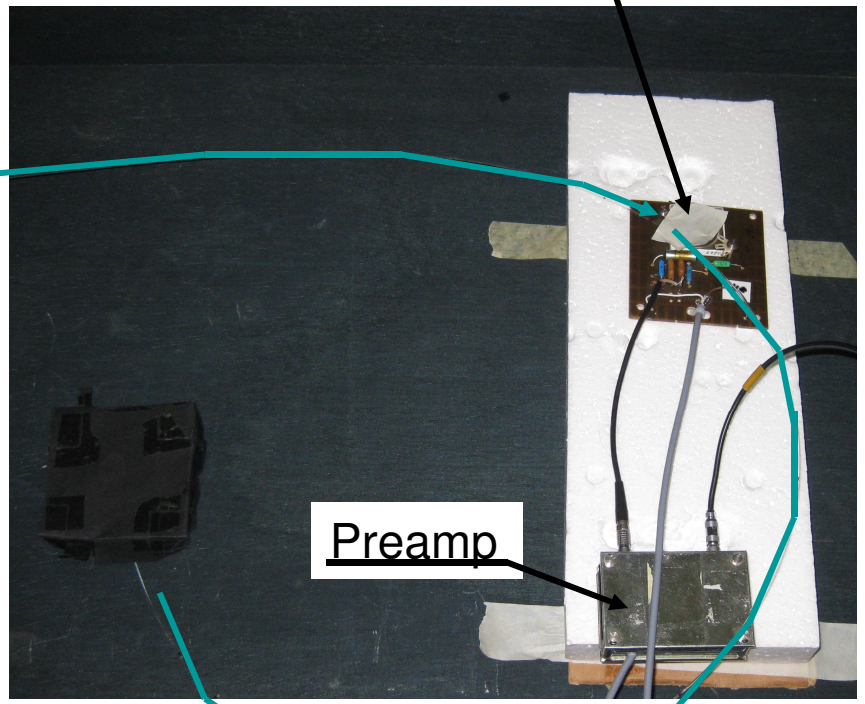
Sci + SiPM

fiber



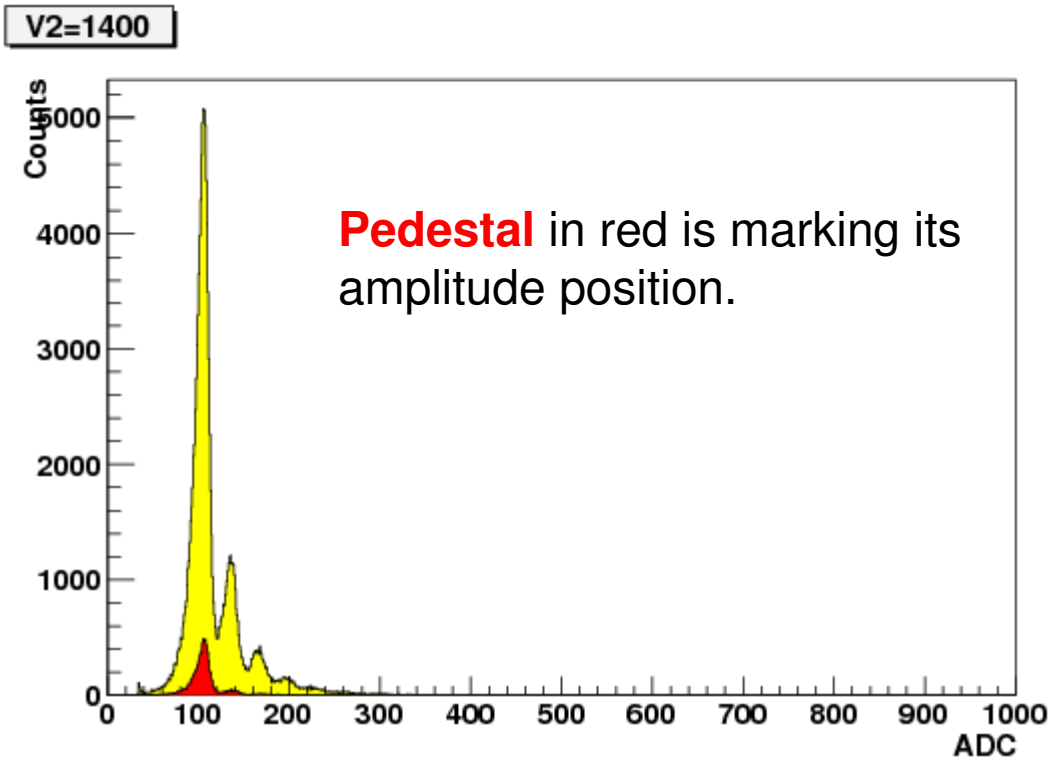
LED

QMB6

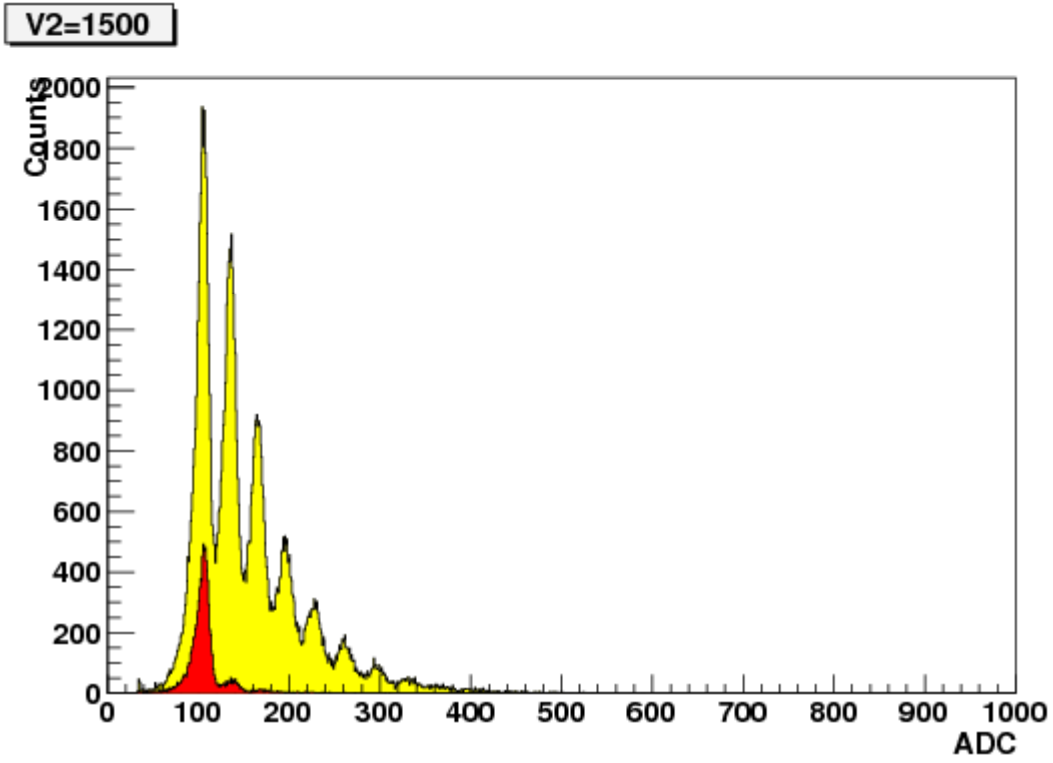


Preamp

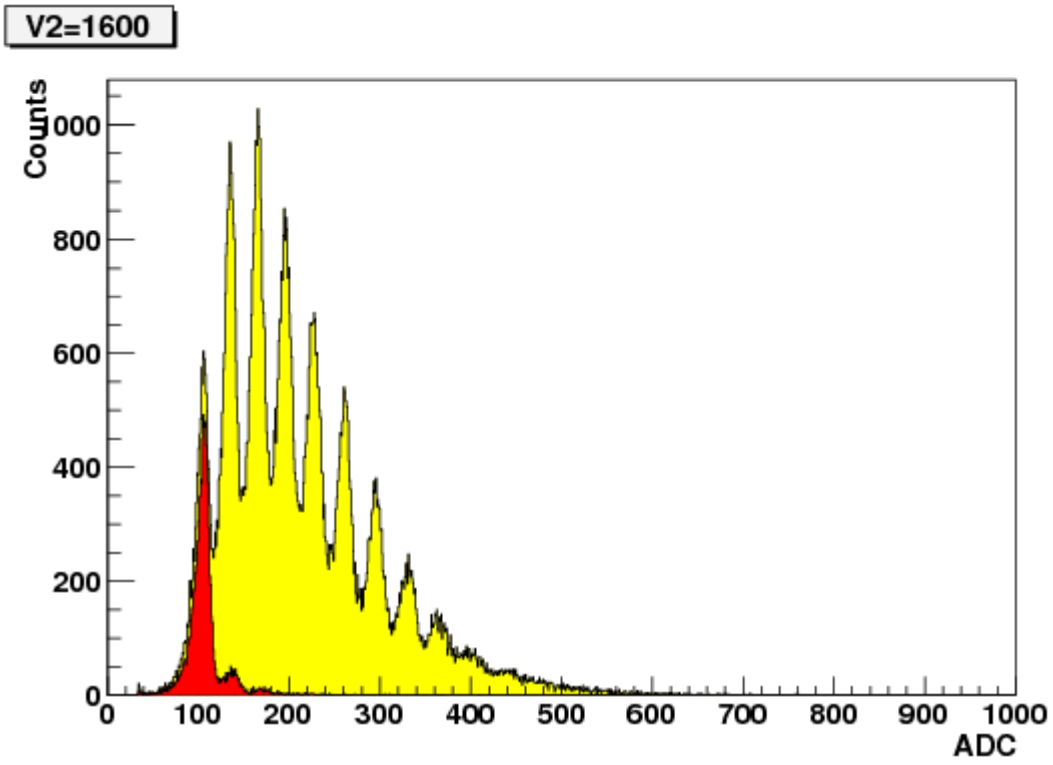
P.E. spectra with increasing QRLED amplitude V2



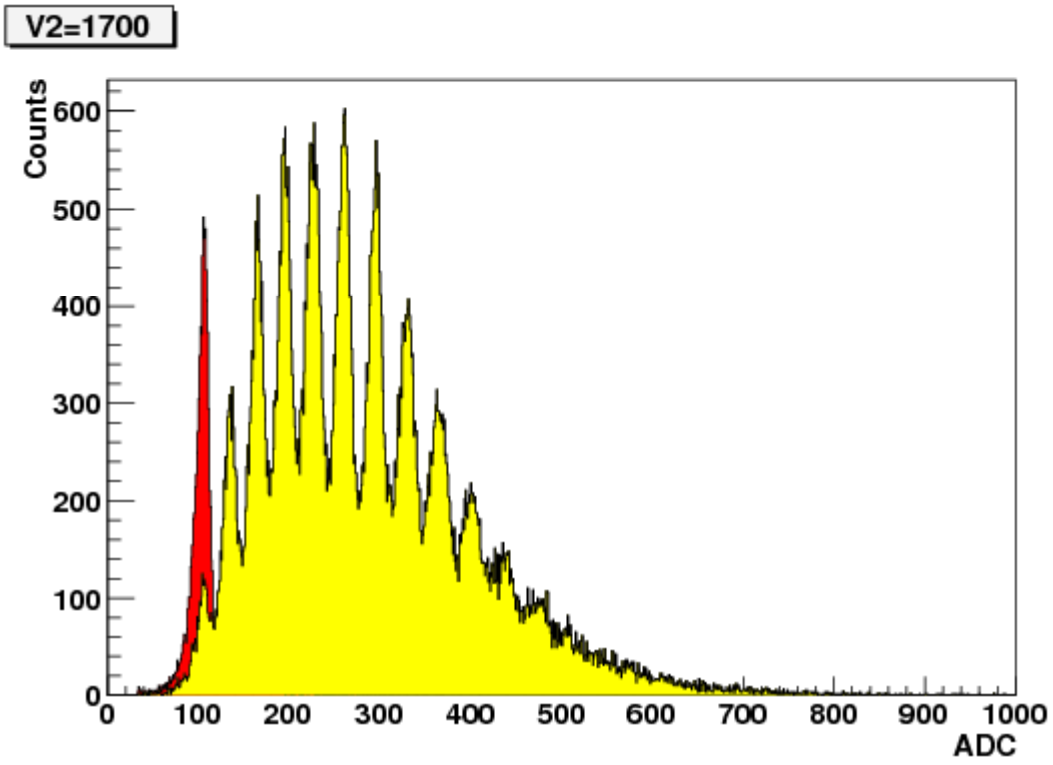
P.E. spectra with increasing QRLED amplitude V2



P.E. spectra with increasing QRLED amplitude V2



P.E. spectra with increasing QRLED amplitude V2



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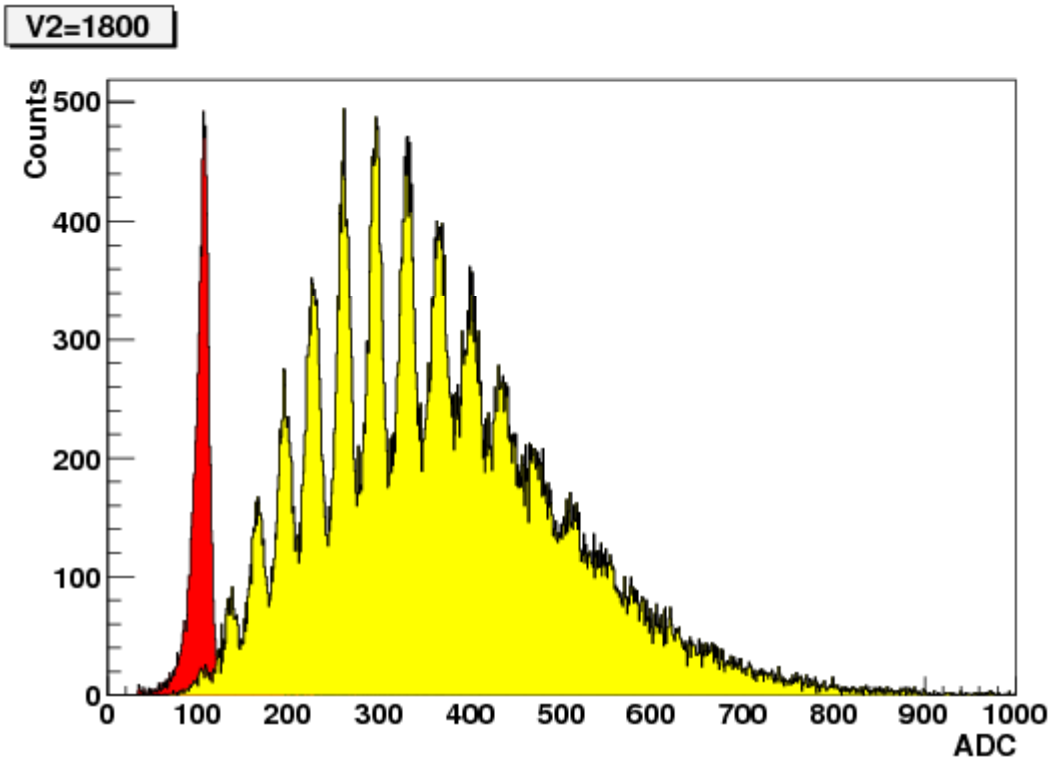

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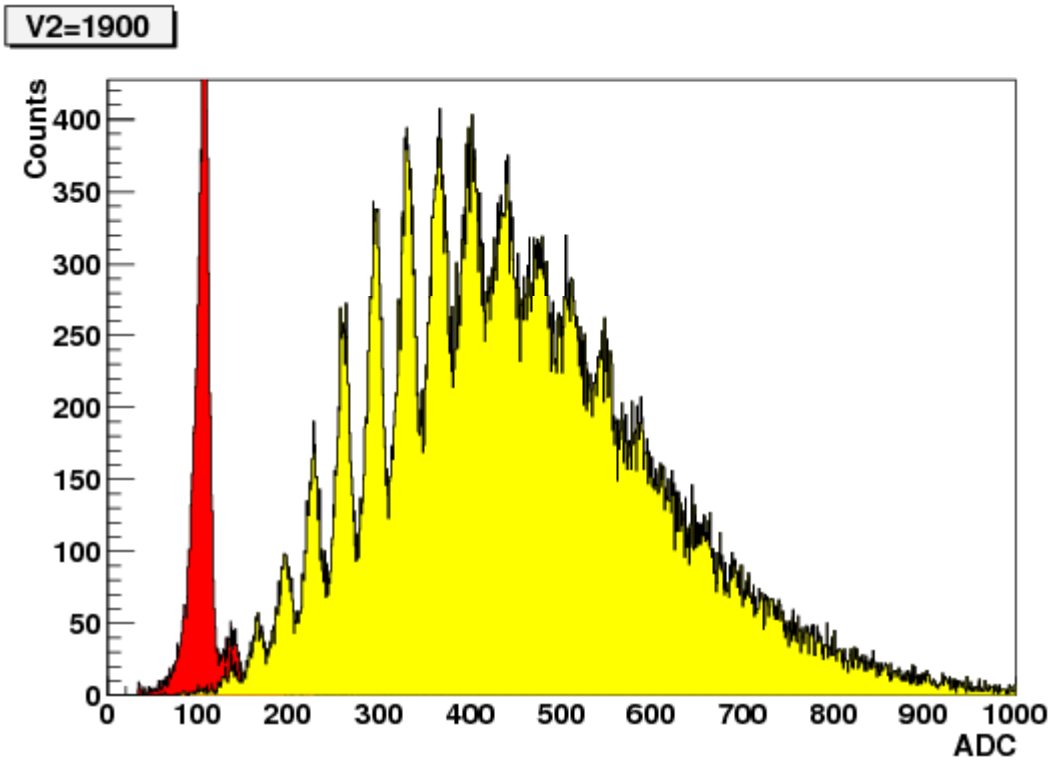
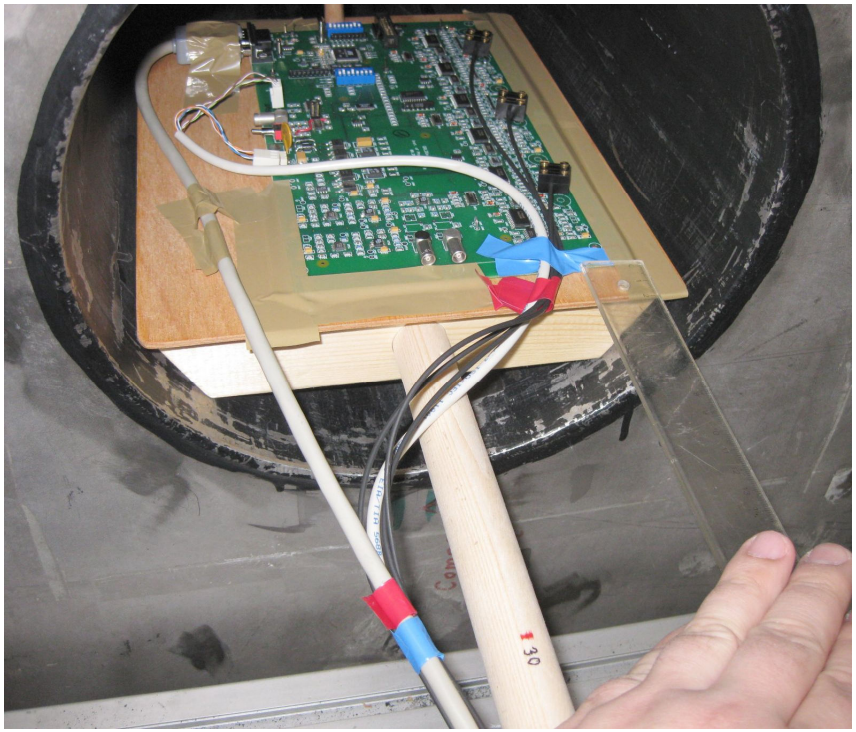


QRLED generates a nice p.e. spectra at SiPM

QMB6 in superconductive solenoid

(magnetic field 0 to 4T) DESY Hamburg, March 2009



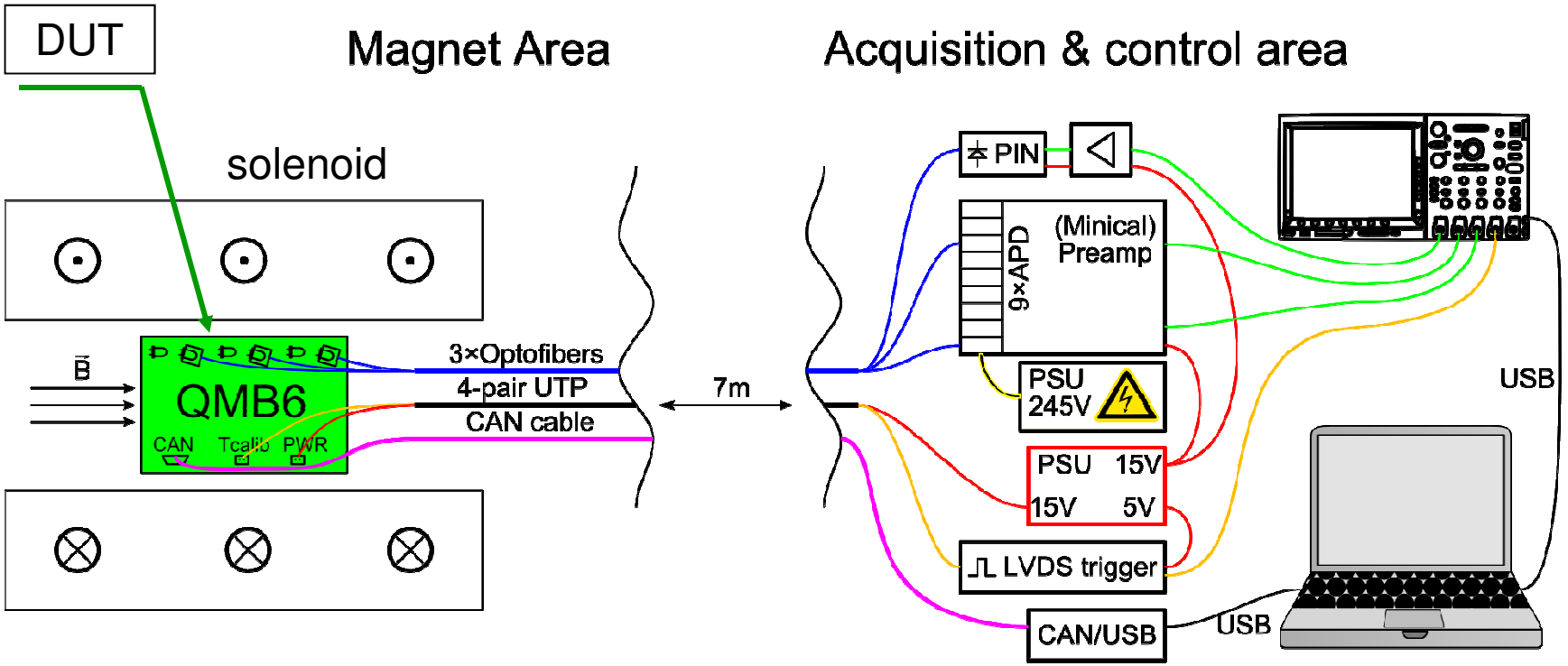
Details of 4T Magnetic test can be found at

http://www-hep2.fzu.cz/calice/files/magnet5.jara_29.pdf

- Air core inductor can be sensitive to external magnetic field
- we performed tests of QMB6 in variable magnetic field

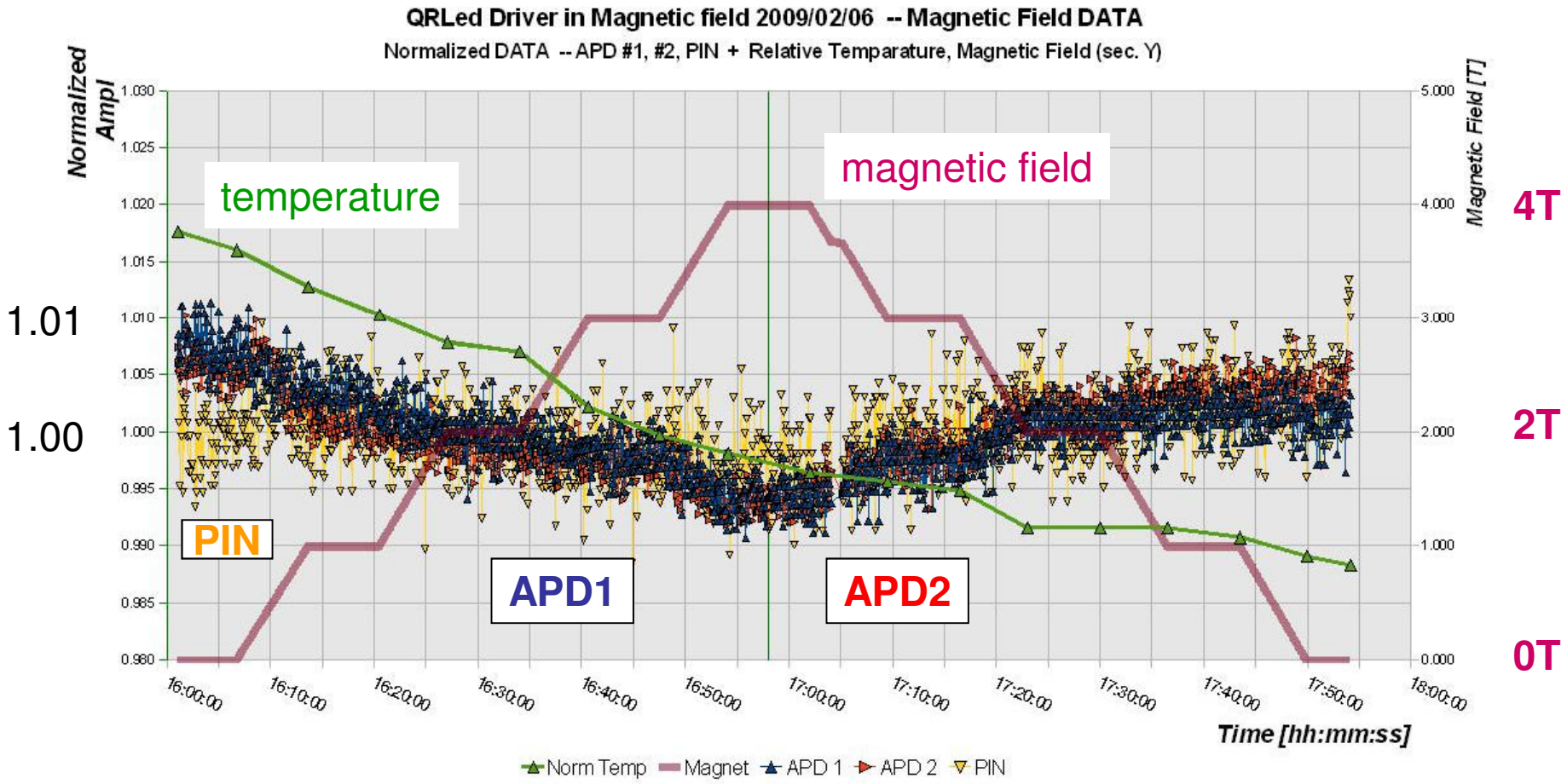
- 3 LED flashed into 3 fibre cables
- CANbus cable and T-calib + Power in other cable
- The setup was mounted on non-magnetic wooden paddle, to be moved in/out of solenoid bore.
- Two black end-cups were used to optically screen the setup.

A schema of QMB6 setup in 4T magnet



Magnet control is not shown.

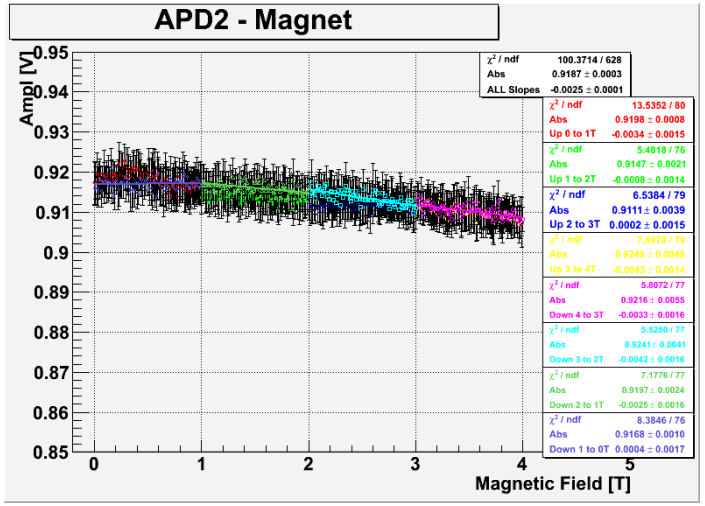
QRLED response to magnetic field 0 ÷ 4T

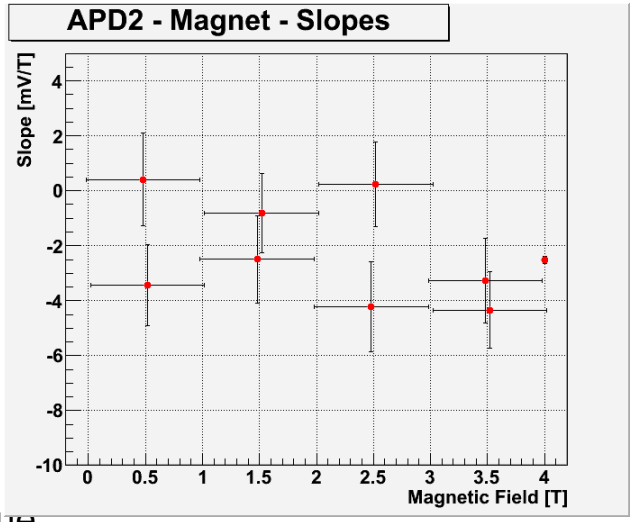


Implications of the observed light intensity on B

- Amplitude decreases linearly with *B* increase
- The same dependence for ramping up/down $(\Delta A/A)/\Delta B \sim -0.2\%/T$
- Assuming magnetic field stability in ILD magnet at the level 5×10^{-4} (accuracy of the CMS magnetic field) → relative light ampl. change $\sim 10^{-6}$
- Assuming magn. field homogeneity (CMS solenoid) ~ 0.3T/4T = 7.5% → calibration light amplitude variation ≤ 2×10^{-4} in the magnet volume
- Compare to typical calibration light variation at the level of 10^{-1} (optical contacts)

QMB6 has negligible sensitivity to B !!! ☺



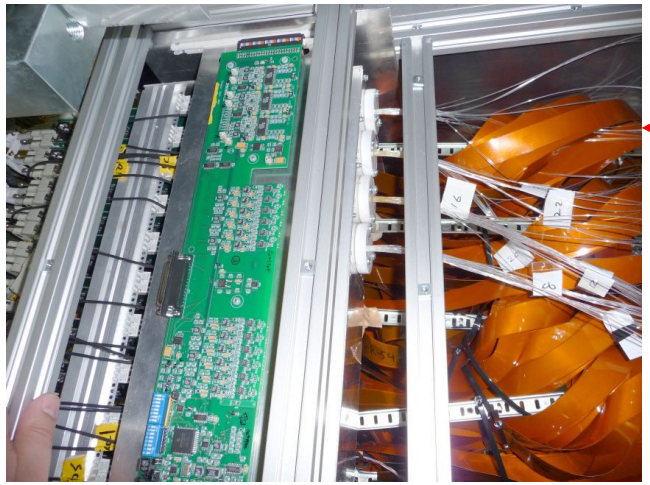


Conclusions

- Two optical methods for SiPM calibration in AHCAL under investigation
  - Notched fibres
  - Distributed LEDs
- For each method UVLED driver has been developed
- 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

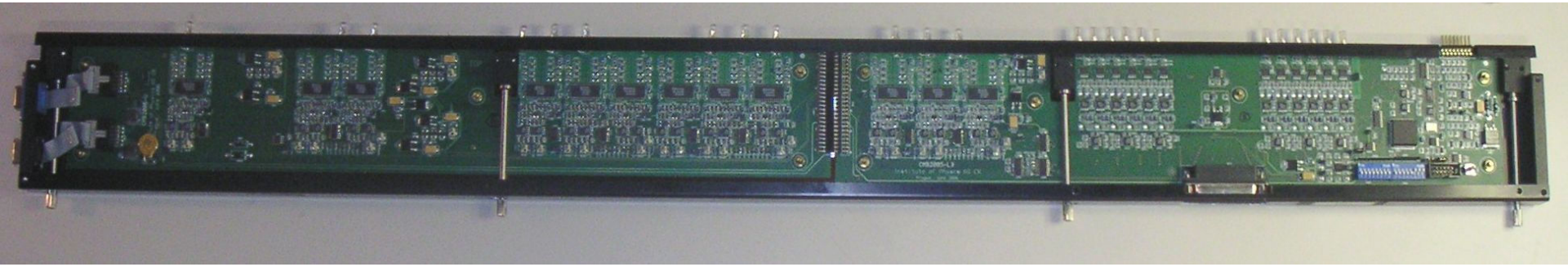
Back up

CMB = Calibration Monitoring Board



- CMB used in AHCAL 1m^3 prototype
- 38 layers in AHCAL detector at at three TB facilities DESY/CERN/FNAL (2006 to 2009)
- One CMB used in Japanese SciECAL detector (TB 2009)
- 12 LEDs / 12PIN PD
- Steering of amplitude and pulse width of LED by T-calib and V-calib signals
- Rectangular pulse width 2 ÷ 100ns can be tuned
- Temperature and voltage readout in slow control, CANbus control

- Relevant links:
- http://www-hep2.fzu.cz/calice/files/ECFA_Valencia.Ivo_CMB_Devel_nov06.pdf



QRLED Pedestal UVLED →SiPM