Calibration UV LED system for CALICE scintillator based Tile Hadron Calorimeter

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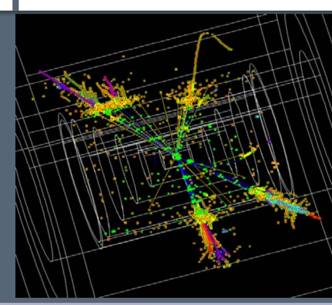
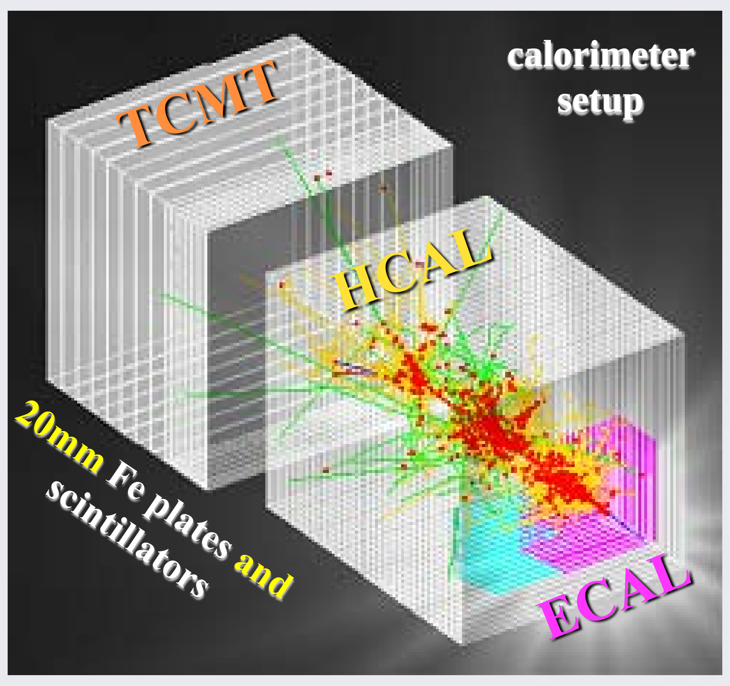


EXPERIMENT CALICE

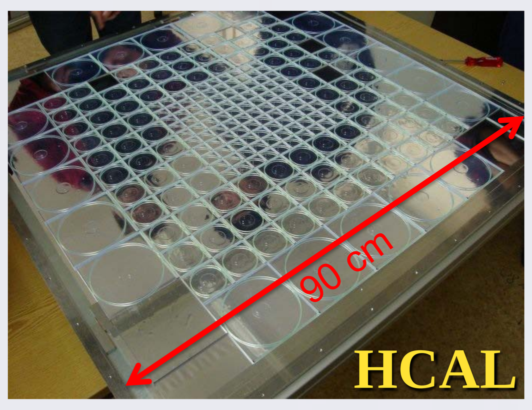


Prototype of calorimeters tested at accelerators of CERN and FERMILAB

- Si-W electromagnetic calorimeter (ECAL)
- Scintillator tile hadronic calorimeter (HCAL)
- muon tail-catcher (TCMT)

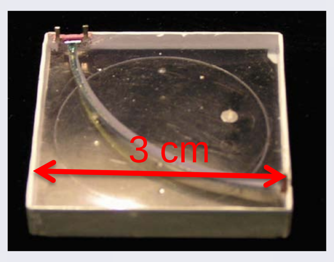
Our Prague group has responsibility for flashing calibration system for HCAL

1 m^3 SCINTILLATOR CALORIMETER HCAL



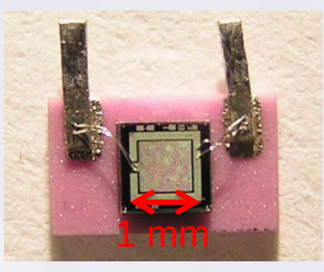
2005 till 2010, now as WHCAL at CERN

- 38 layers, 2 cm Fe absorbers + 5mm scintillator tiles
- 7608 photo detectors SiPM
- A layer 216 scintillator tiles, 3x3, 6x6, 12x12 cm^3, 5mm thick
- Calibration system with 12 LEDs monitored by PIN-Photo Diodes
- Optical flash is distributed by fibre bundle to each scintillator
- 5 temperature sensors per layer - integrated circuits LM35



One scintillator tile consists:

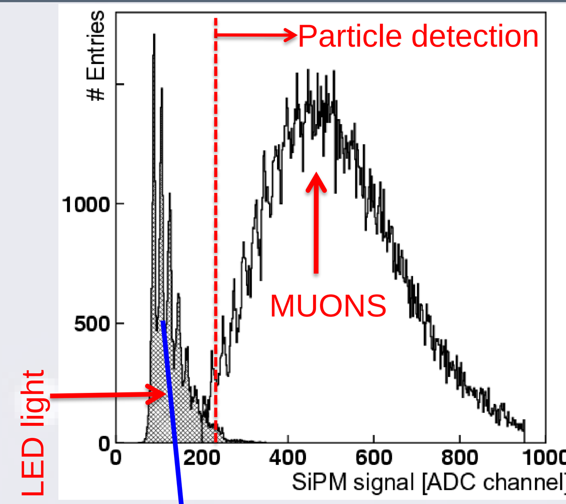
- WLS fibre (~380nm to ~500nm)
- SiPM photodetector



Photodetector:

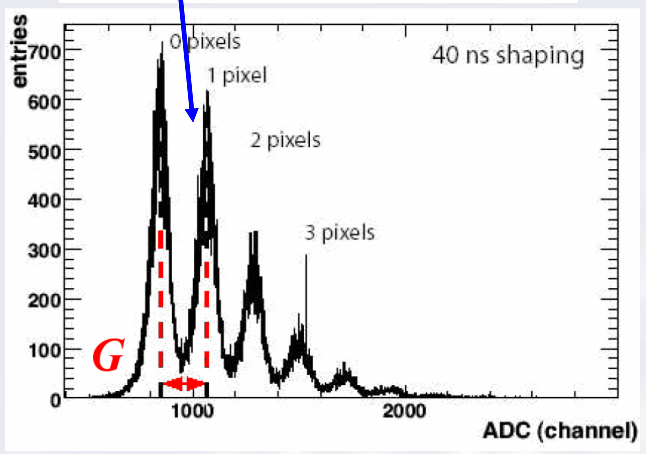
- silicon photomultiplier SiPM
- 1156 pixels, each works in the Geiger mode
- Gain of SiPM ~10^5 to 10^6

Calibration procedure



Physical: cosmics or beam muons

LED: flashes with small amplitude

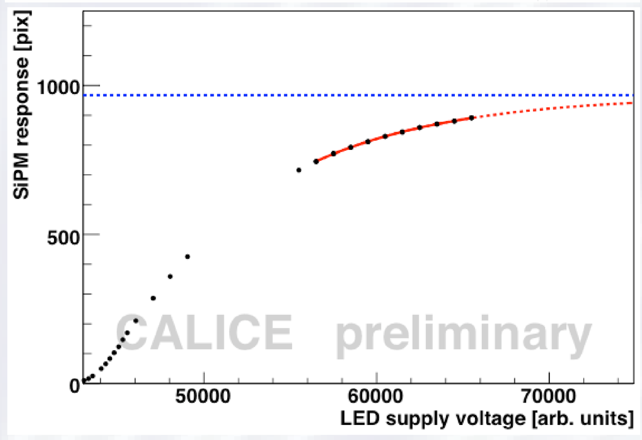


LED flashes generate a clear single p. e. spectra

Gain is proportional to the distance between peaks

Gain is independent on the number of photons

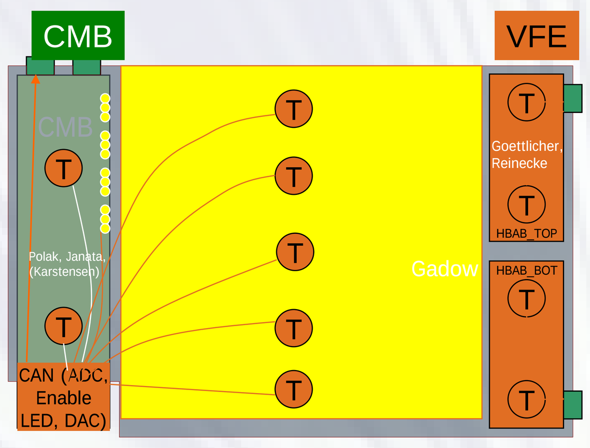
We can compensate the temperature and operational voltage influences



Non-linear or saturation curve of SiPM

Offline, we correct for the nonlinearity of SiPM

Requirements to GENERATOR

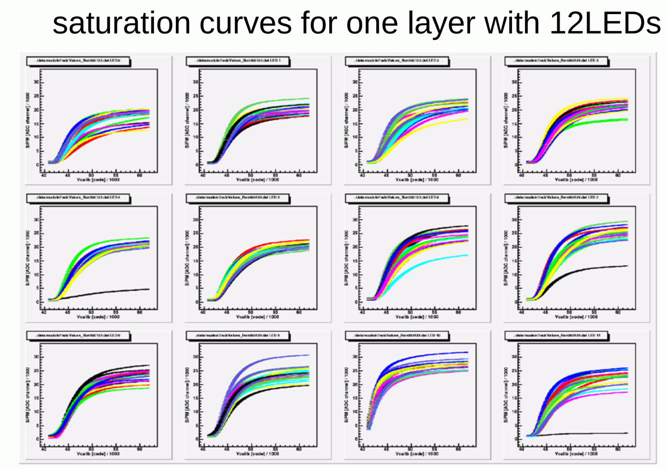


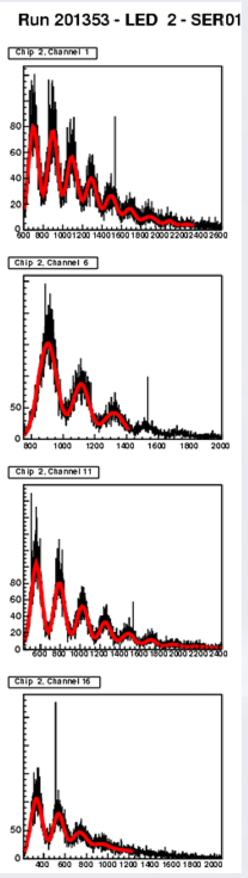
Generate uniform near-visible UV flashes

- controllable in amplitude 0 to max = twice SiPM saturation
- adjustable pulse width (a few ns)
- enabling each LED individually
- repetition rate up to hundreds of kHz

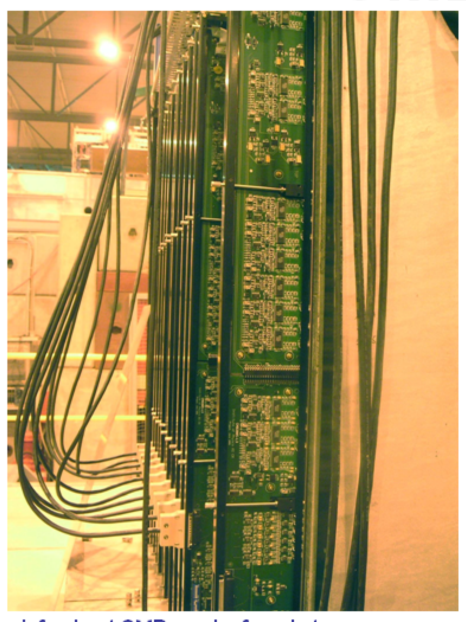
- long term and temperature stability
- LED triggering from DAQ
- temperature readout from 5 sensors placed in the scintillator plane (12bits minimum)
- CANbus interface to Slow-control

saturation curves for one layer with 12LEDs



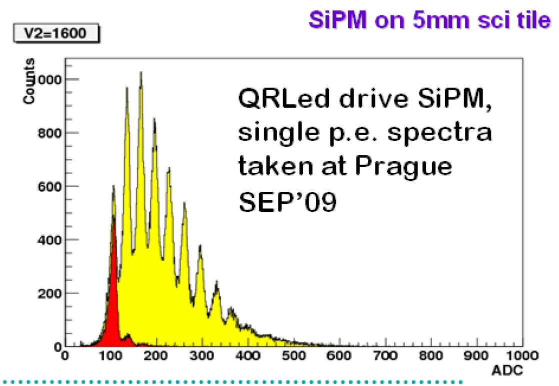


Single photoelectron spectra with CMB and QRLED



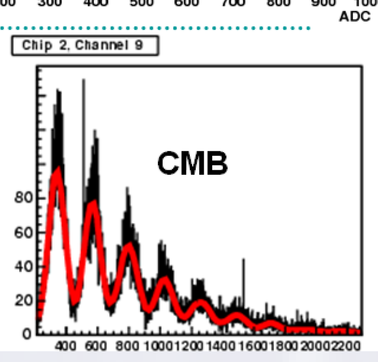
More info about CMB can be found at:
http://www-hep2.fzu.cz/calice/files/ECFA_Valencia.Ivo_CMB_Devel_nov06.pdf

LED light 400nm to SiPM on 5mm sci tile

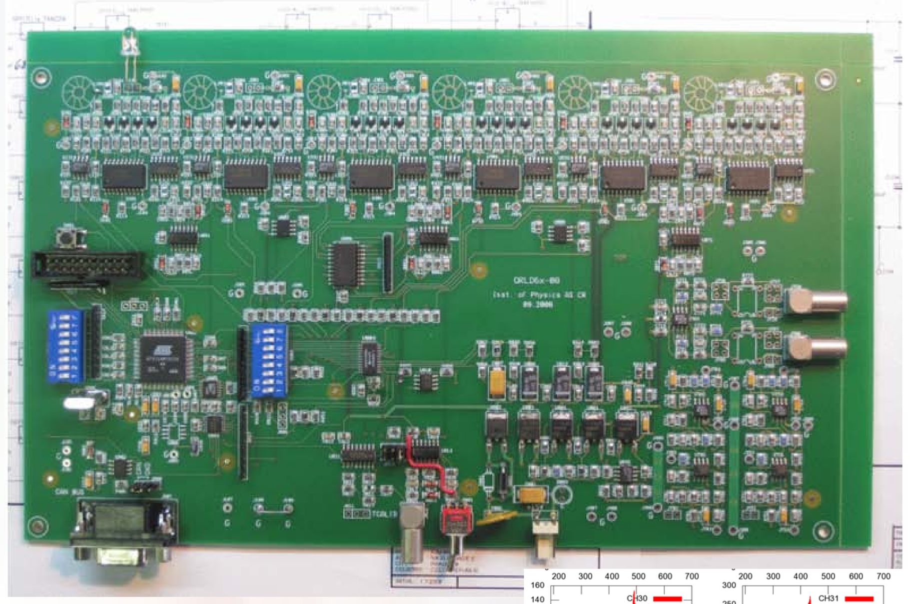


←CMB in tuning position at AHCAL TB 2007 CERN

one of the single p.e. spectra →

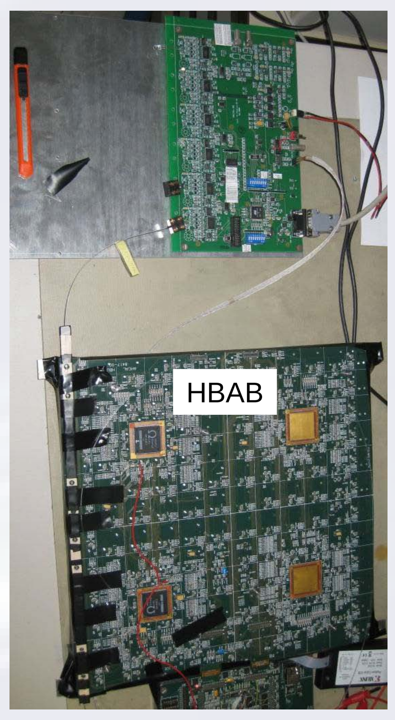


6-LED QR driver Main Board = QMB6

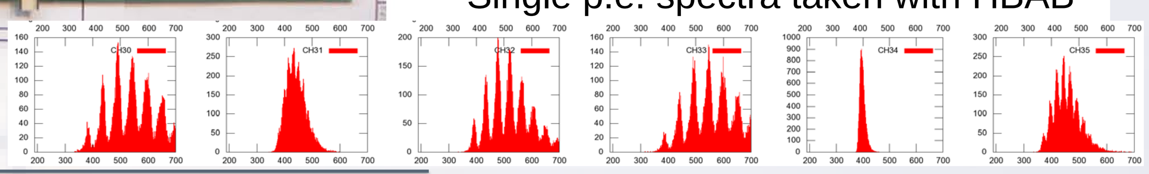


Consists:

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



Single p.e. spectra taken with HBAB



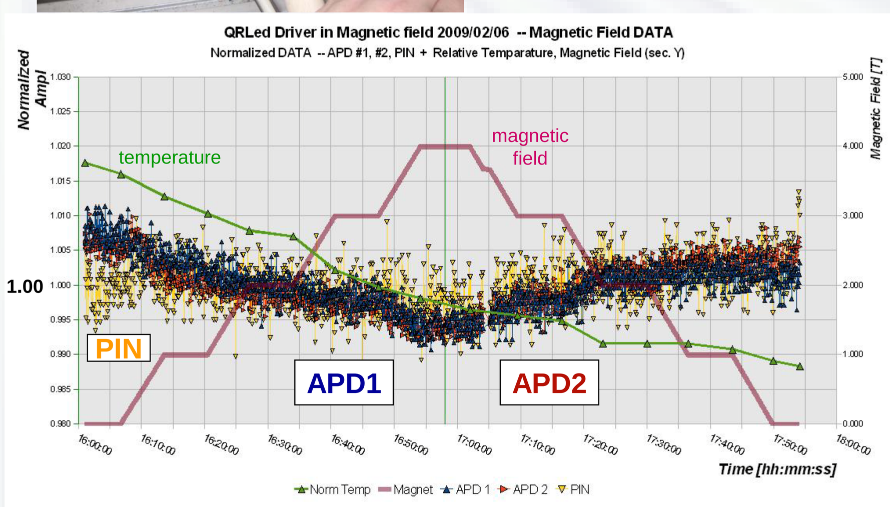
DESY Hamburg, March 2009

QMB6 in superconductive solenoid (DC magnetic field 0 to 4T)

Air core inductor can be sensitive to external magnetic field.
We performed tests of QMB6 in variable magnetic field. EFFECT < 1%

3 LED flashed into 3 fibre cables; CANbus cable and T-calib + Power in other cable.

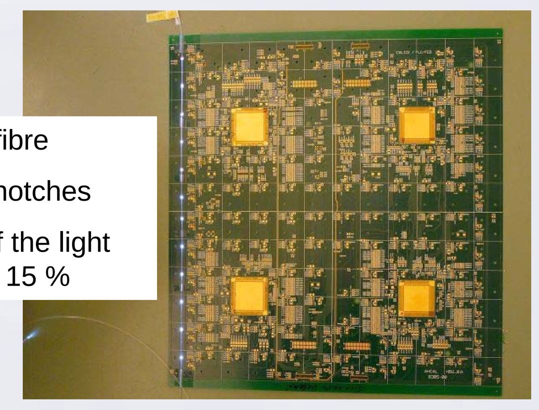
The setup was mounted on non-magnetic wooden paddle, to be moved in/out of solenoid bore.



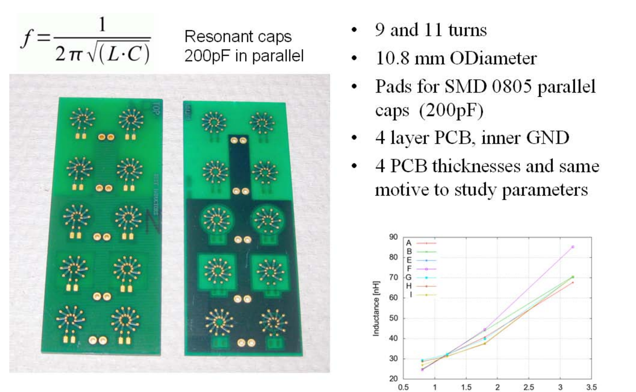
Notched fibre

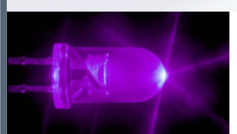
12 or 24 notches

Spread of the light on taps < 15 %

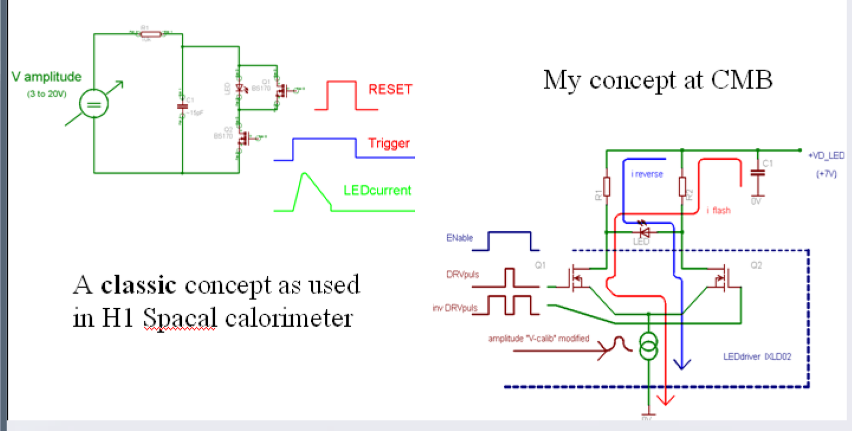


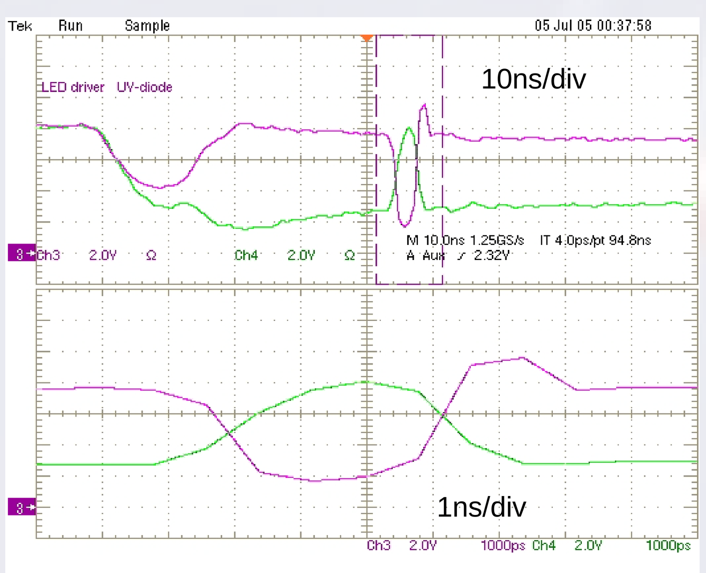
Resonance test PCB with toroidal inductors with GDO



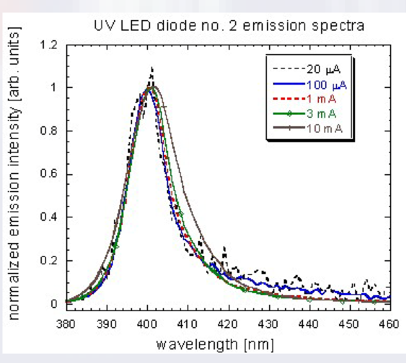


Principal schema of LED-driver

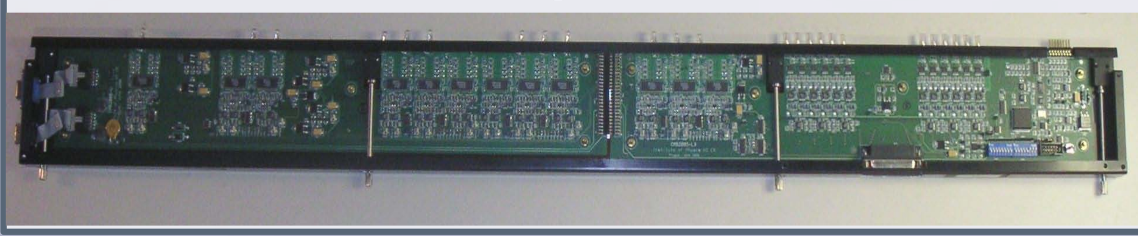




UV – LED optical spectra



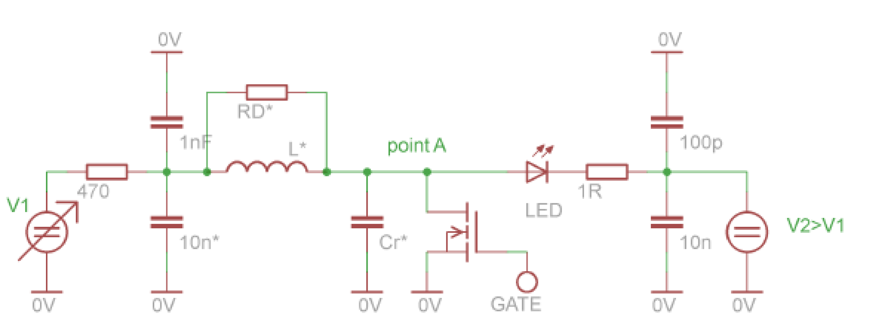
Calibration Monitoring Board

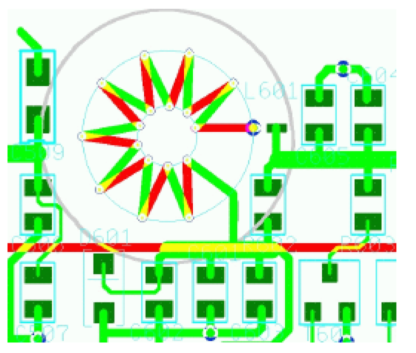


CMB consists of:

- 2 LVDS inputs T-calib and V-calib
- 12 LEDs with drivers
- 12 PIN-PhotoDiode preamplifiers
- Temperature readout
- CANbus controller
- MicroController and all is powered by single 12V

Quasi-Resonant LED driver





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