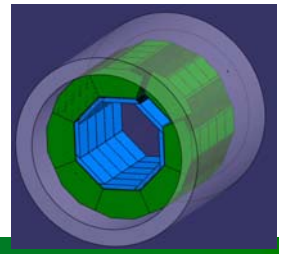
HCAL task

Felix Sefkow

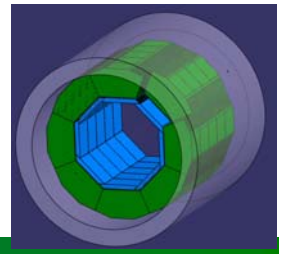
EUDET ExtSC Meeting
September 1,2008

Topics



- HCAL mechanics
- HCAL calibration system
- HCAL electronics integration
- Personnel and finances

Mechanics

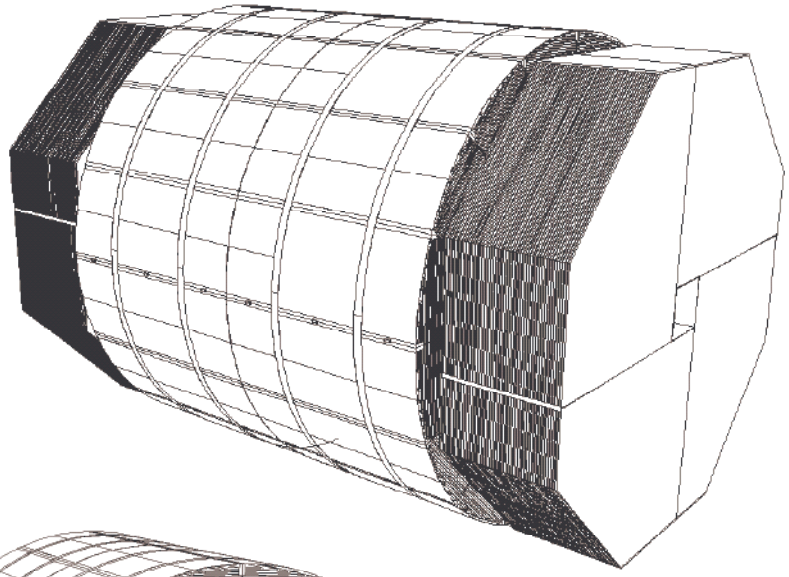


- Goal: a realistic absorber structure for tests of novel readout techniques
- Realistic: compact and scalable
- No full cubic metre needed, but should be extendible
- Started only recently, after filling engineering position at DESY
- Realistic implies linl with detector concepts, here ILD

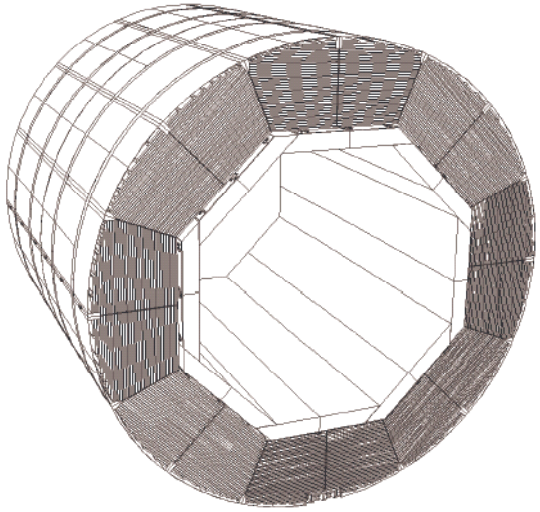
ILD detector

-Mechanical concept-

Slides from K.Kschioneck



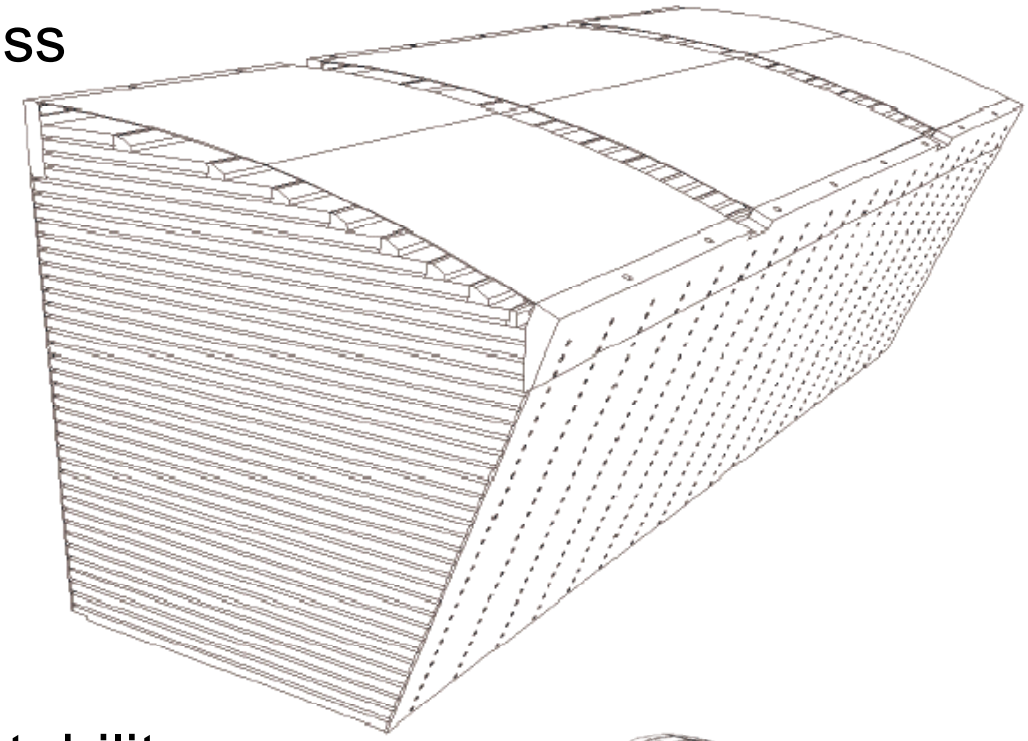
- TESLA/ ILD detector:
  Similar absorber structure
- TESLA concept existed:
  learning from TESLA concept



- Height/ length of barrel: 5.6 m/ 4.6 m
- Weight of one module: ≈ 14 t
- Weight of HCAL: ≈ 450 t
- Weight of HCAL + chambers + ECAL: ≈ 790 t

Calorimeter module

⇨ Side panel: 3 mm thickness
⇨ Screw size: M6

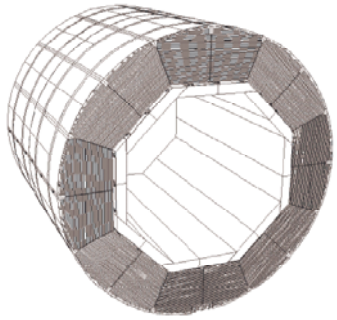


<u>Advantage</u>

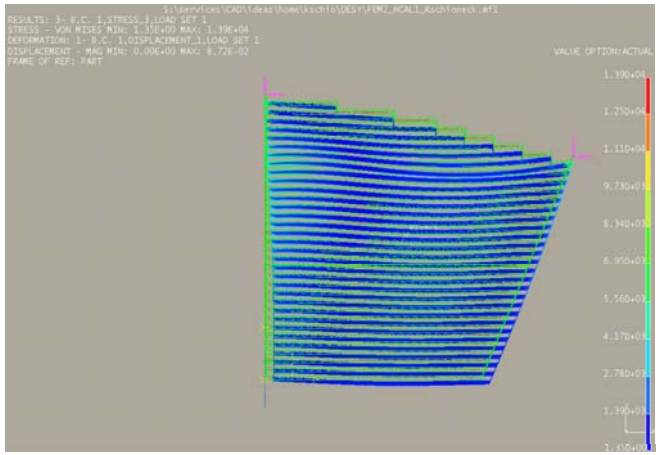
• Slim support structure (small amount of φ-cracks)

<u>Disadvantages</u>

• Uncertainties regarding stability
• High tolerance requirements (e.g. holes for screws, flatness of absorber plates)

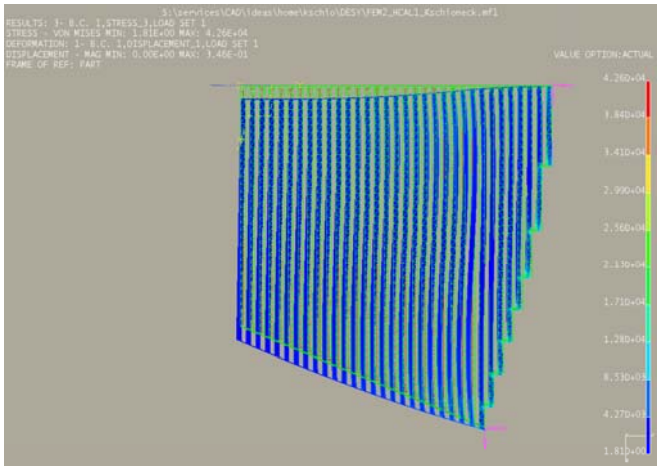


HCAL module



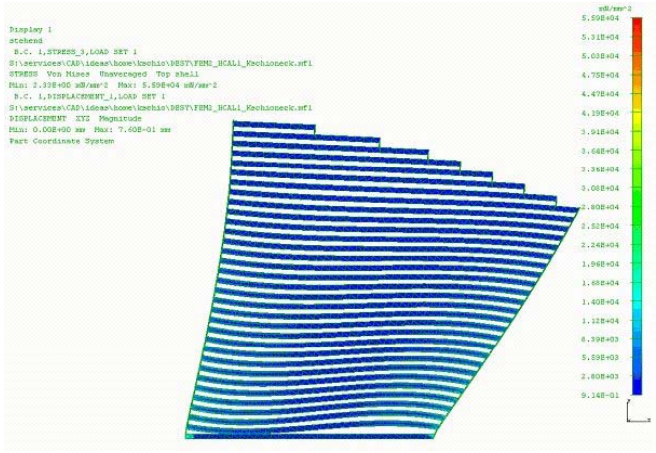
Horizontal hanging

Maximum deformation: 0.09 mm



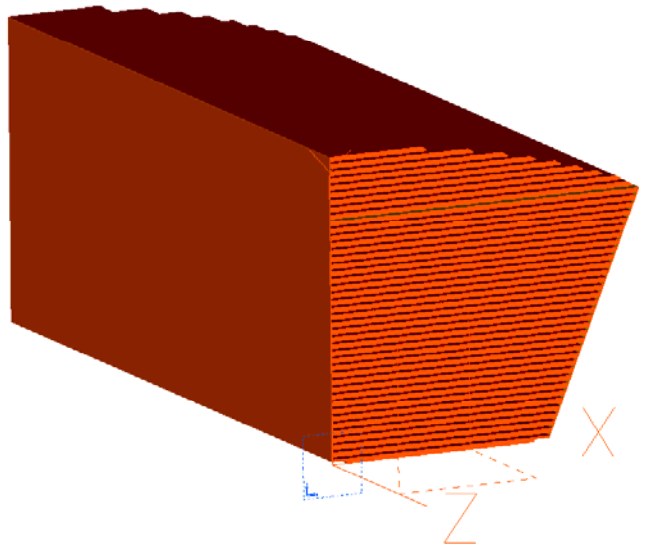
Vertical hanging

Maximum deformation: 0.35 mm

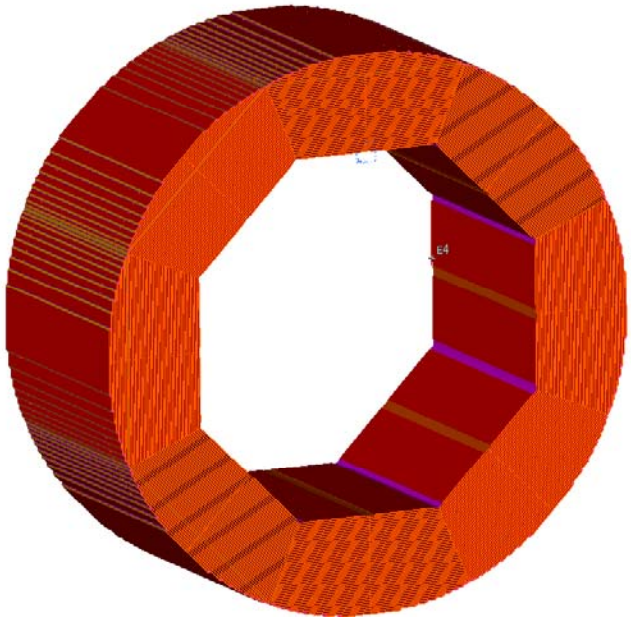


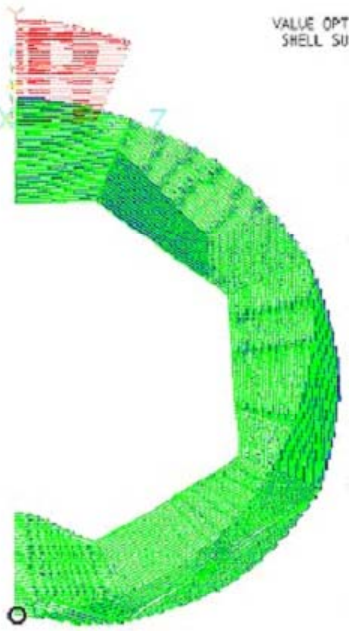
Module standing

Maximum deformation: 0.7 mm



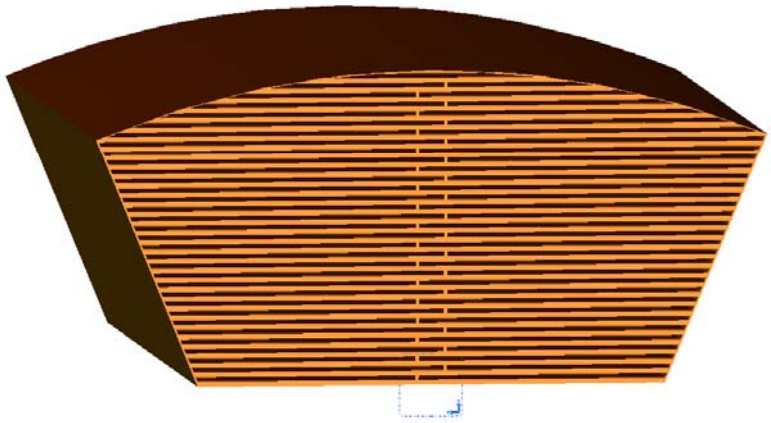
Barrel -16 modules-

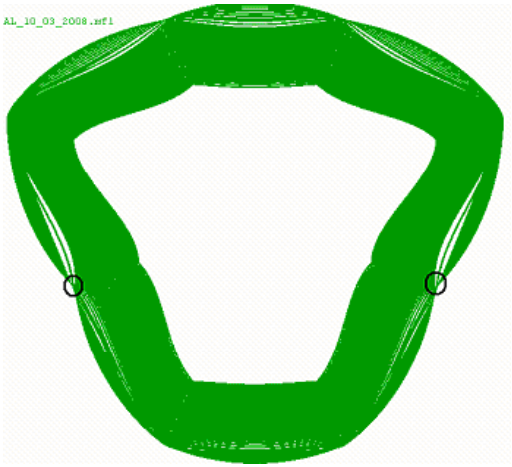




	stainless steel 1.4404		brass CuZn38Pb2
	standing	support 4	support 4
Max. deformation [mm]:	18.5	2.9	6.35

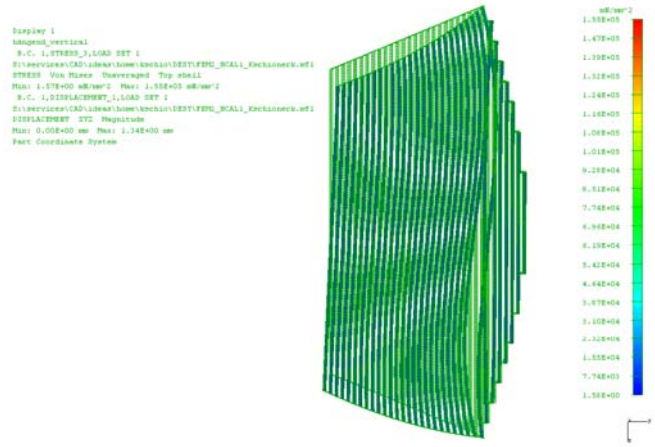
Barrel -8 modules-
-with staggered spacer/ gap 7 mm-

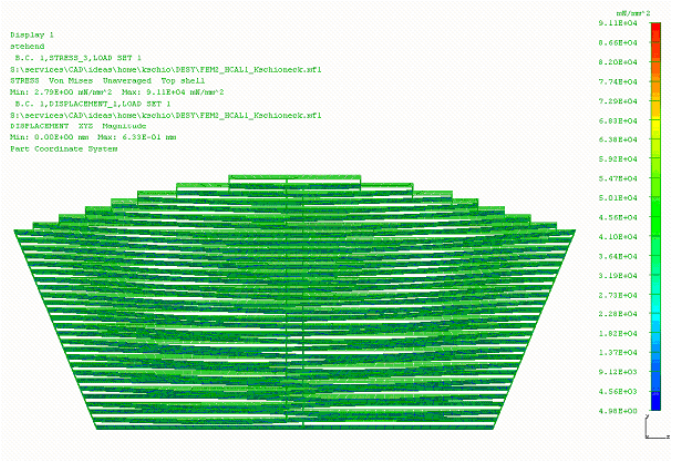




	stainless steel 1.4404		brass CuZn38Pb2
	standing	support 4	support 4
Max. deformation [mm]:	42	2.64	5.78

HCAL module -with staggered spacer/ gap 7 mm-



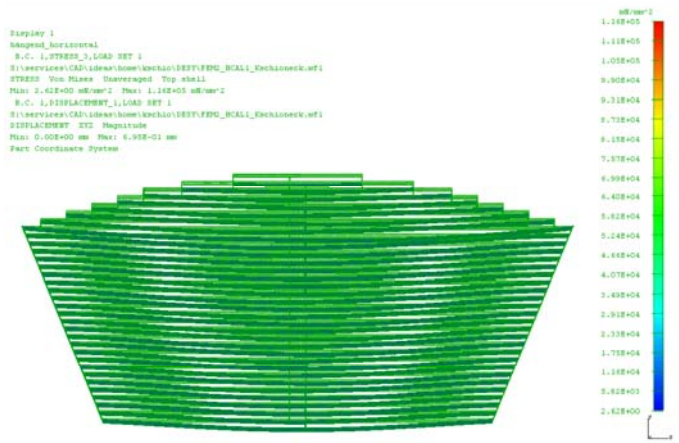


<u>Horizontal hanging</u>

Maximum deformation: 0.7 mm

<u>Vertical hanging</u>

Maximum deformation: 0.4 mm



<u>Module standing</u>

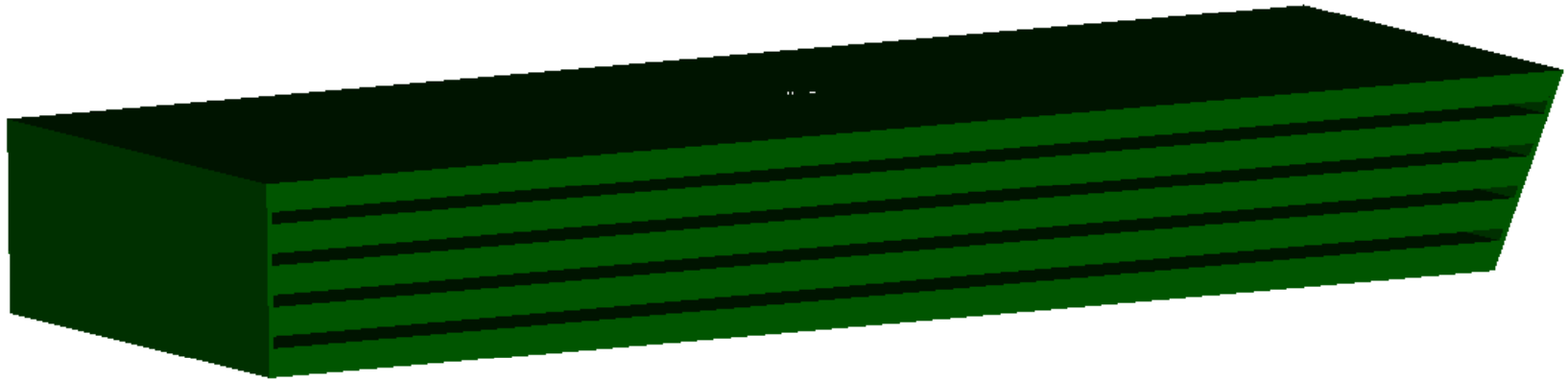
Maximum deformation: 0.6 mm

Effects of changed parameter

	displacement	stress
Bigger side panel (3 mm → 5 mm):	↓	↓
Spacer no → yes	↓	↓
From steel to brass:	↑	↑
Smaller gap (14 mm → 7 mm):	↑	↓
Pointing yes → no	↑	↑

↑: big change
↑: moderate change
↑: small change

Next step:
Proof of Principle

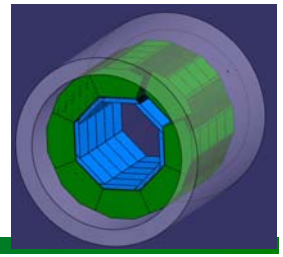


Building of a model: 4 x 5 absorber plates with side panel
- 2 x with welded connection for the side panel
- 2 x with screwed connection for the side panel

Learning something about:
- side panel connection
- connection between modules

- *Verify calculations*
- *Tolerances at realistic cost*
  - *incl. machining*
- *Cassette integration*
- *Ready Sep 09*

Calibration system



- Goal: scalable system addressing the needs we determine in the ongoing test beam experiment
- Many procedures developed during last year's analysis, but not finally proven yet
- Stability of saturation still an issue -> need dynamic range

- Two approaches: optical or electrical signal distribution
  - Central driver plus fibres, or one LED / tile
- LED on board looks promising, further optimization in the hands of Wuppertal group
- Differences inside the active gap, but same external interfaces

Multichannel LED driver for the AHCAL prototype

1. Introduction
2. Technical details
3. Deliverable definition

Introduction

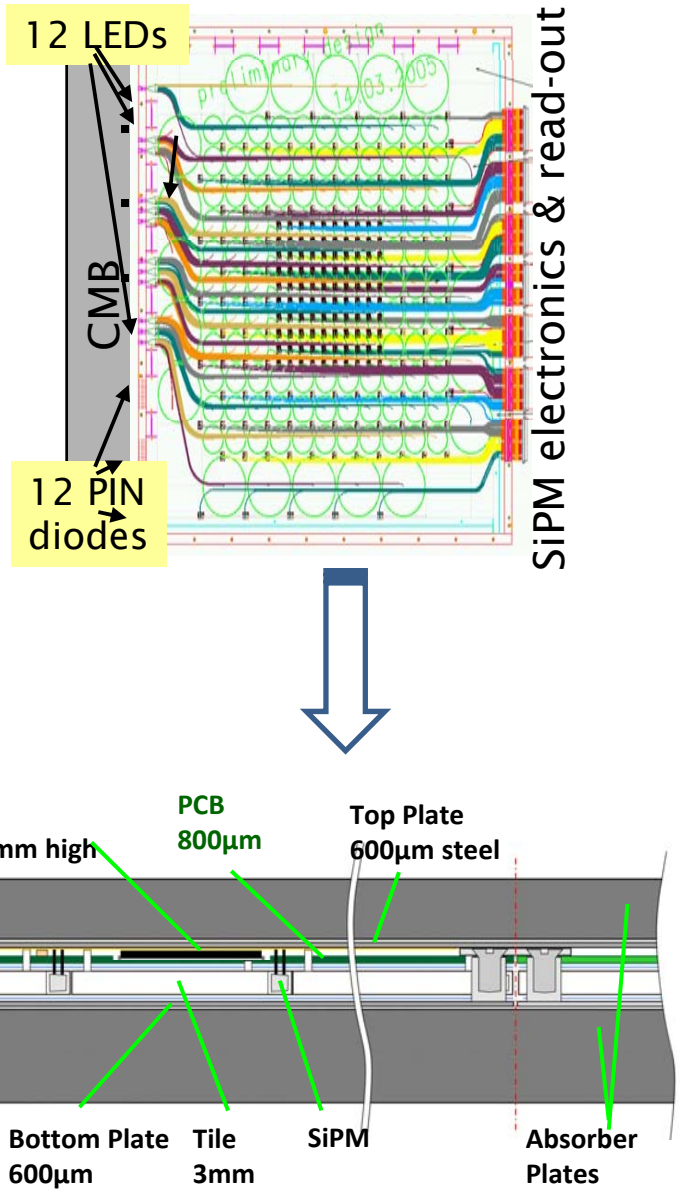
New calibration system

- EUDET prototype significantly more compact
- New ideas for the calibration system for SiPM photodetectors

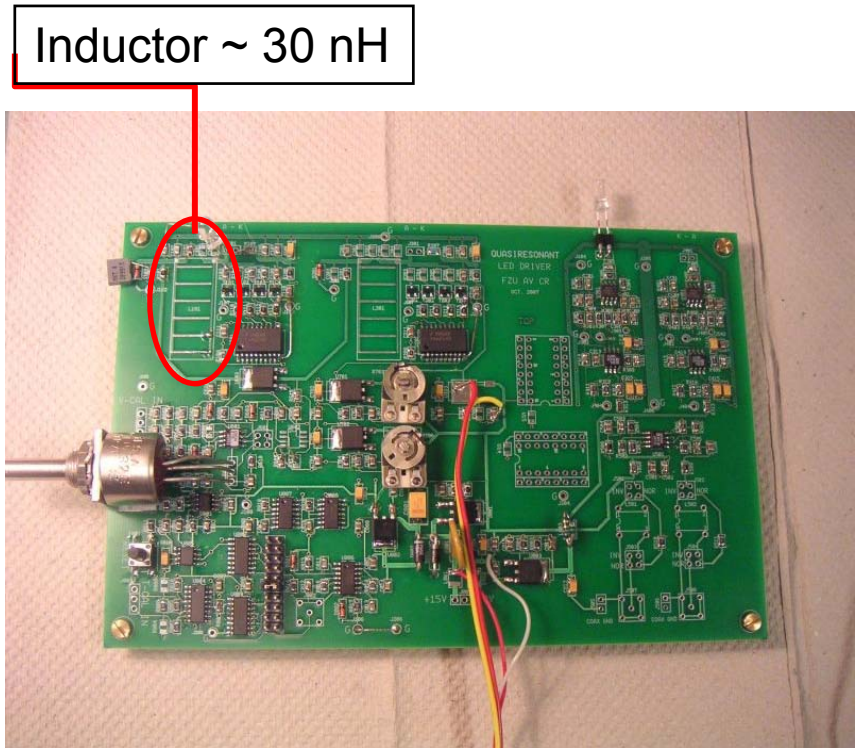
- Fixed light amplitude - low amplitude for gain calibration (DESY)
- Tuneable calibration light in the range 0 to 50-100 MIP (as in existing prototype) – for gain and efficiency monitoring (Prague)

- 1 LED above each tile

- A simplified optical system: one LED -> a fibre above 1 row of scintillator tiles (~ 60 tiles)



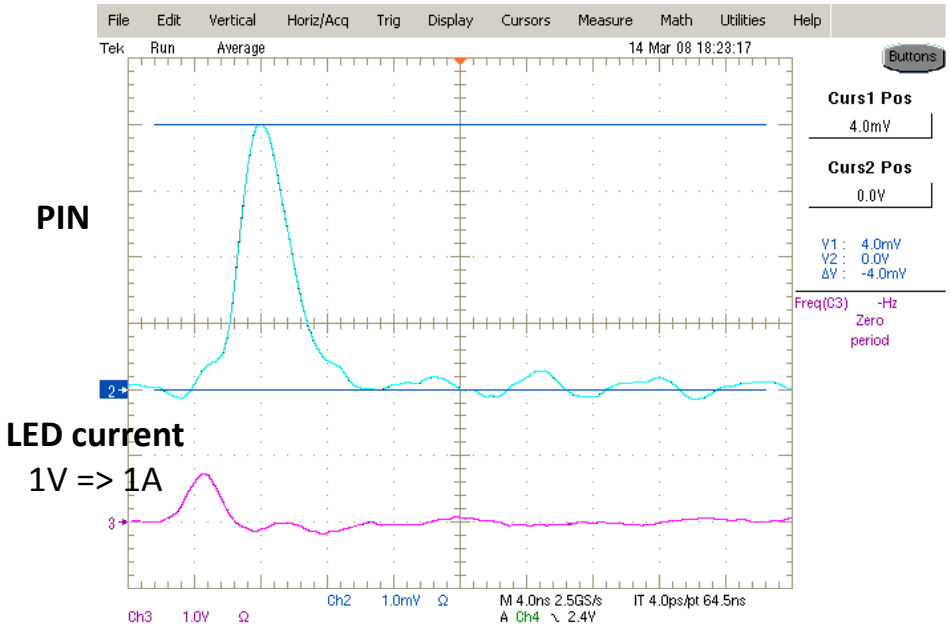
Deliverable 2007 – single channel LED prototype (ILC-DET-2007-024)



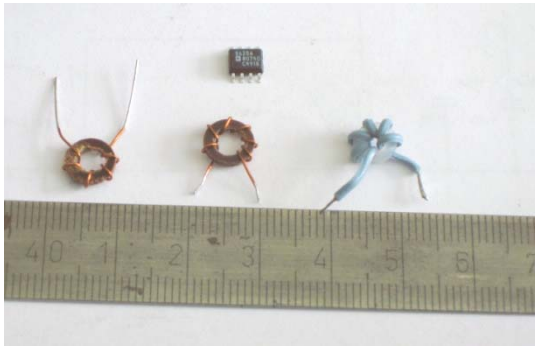
Ivo Polák, Milan Janata

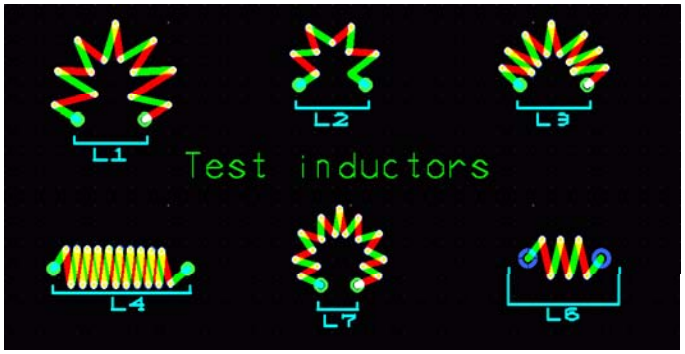
- Double sided PCB
- 2 quasi-resonant (QRLed) drivers
- 2 PIN photodiode preamp
- Rate generator 1 Hz to 10 kHz
- Voltage regulators
- Amplitude control
- V-calib and T-calib interface

PIN PD response to UV LED



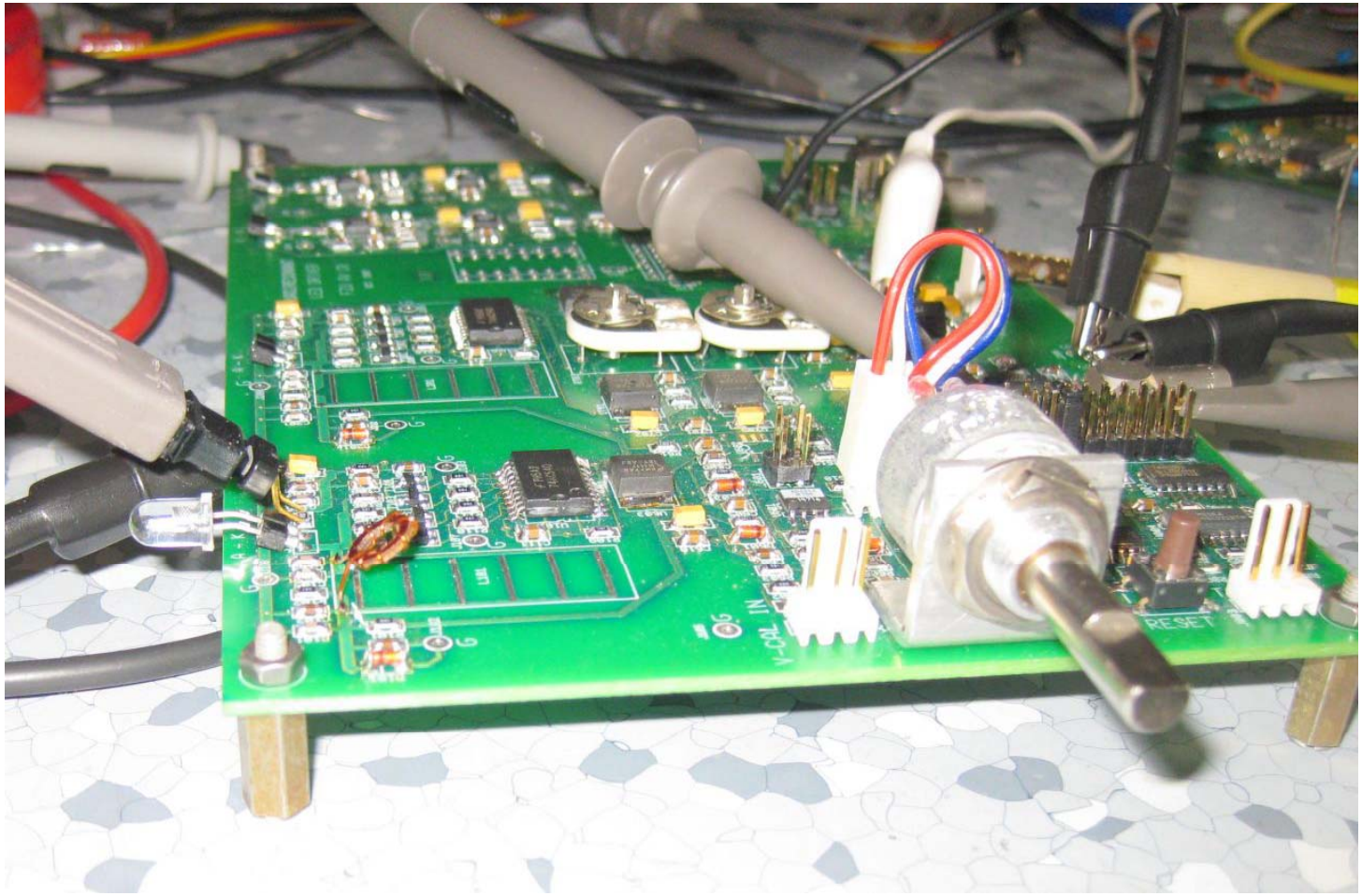
- Tunable LED pulse amplitude
- Pulse width ~ 2 ns
- At higher LED current - afterpulsing
- Needs adjustment to different LED types
- Being investigated
- Plane inductor → toroidal inductor (less sensitivity to external interference, produces less radiation)
- No other changes in the design needed





Toroidal inductor soldered

Compare the thickness of PCB and of the inductor

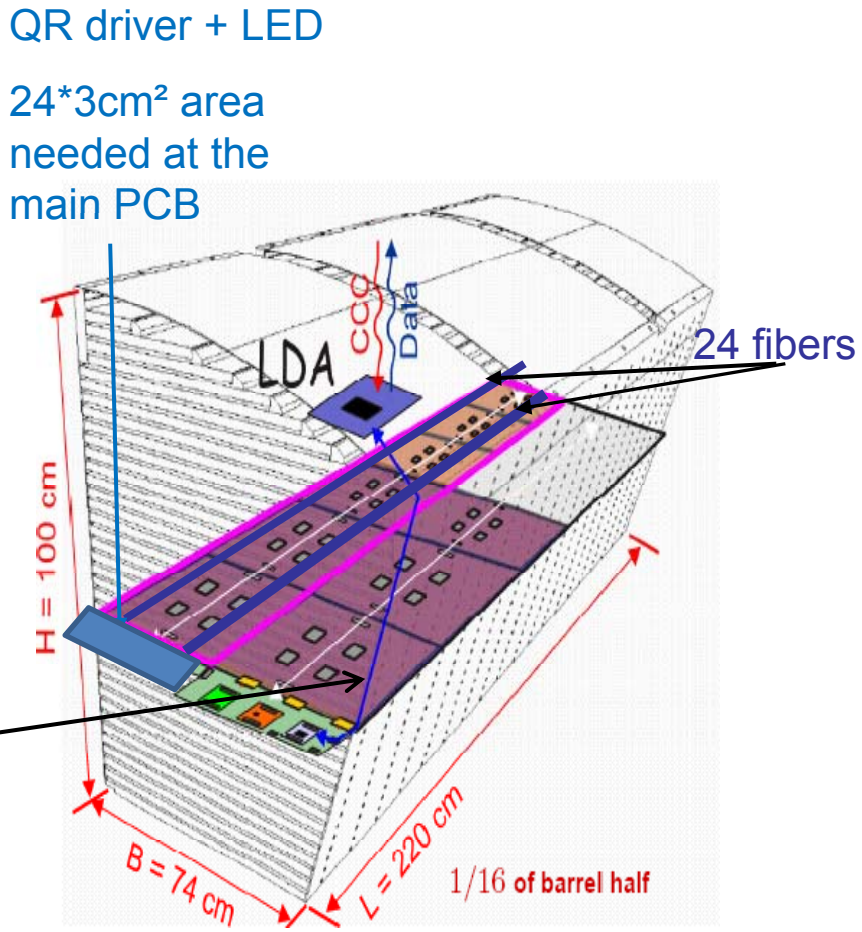


Toroid will be made in the PCB volume – no additional space needed

We consider 2 scenarios of calibration system for EUDET AHCAL

1. **Fiber emmiting light** for one row of tiles, QRLed driver sitting outside of module (endcap) → development of the light distribution system (our main effort in 2008)

2. **QRLed driver** is sitting at HBU above the **scintillator**



Light distribution system

a) Side-emitting fibres

Thin fibres (~1mm) needed, unknown parameters, not common → *FiberTech (SLS600 series)*

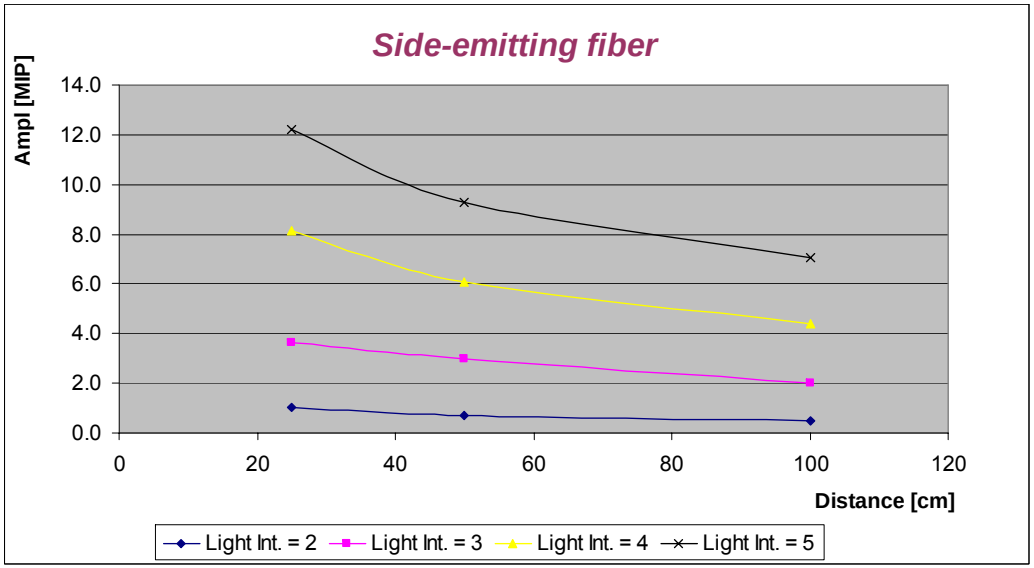
b) 'Notched' fibres

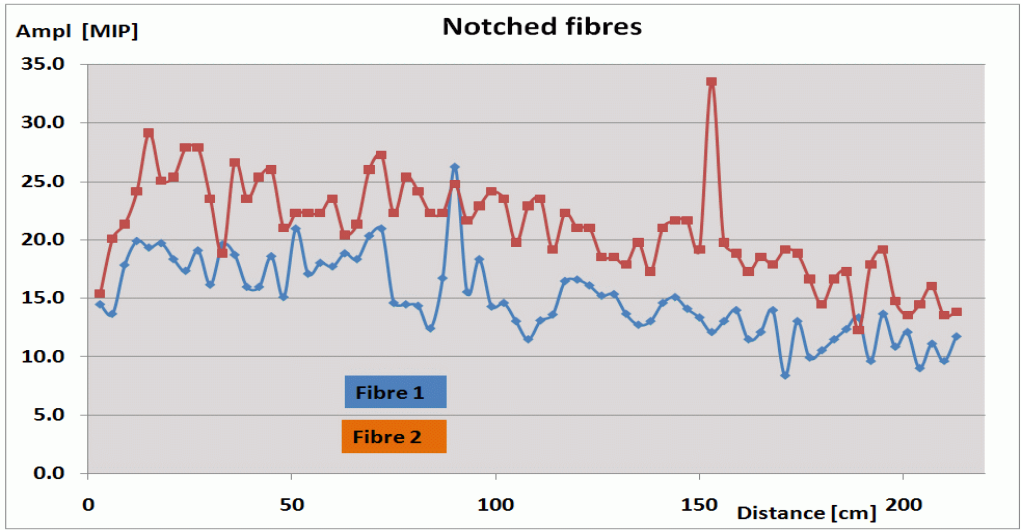
Making notches on fibres requires a specialized firm → *Safibra comp.*

c) Focusing LED light into fibre → *Optical lab of the CU Prague*

Notched fibres appear promissing:

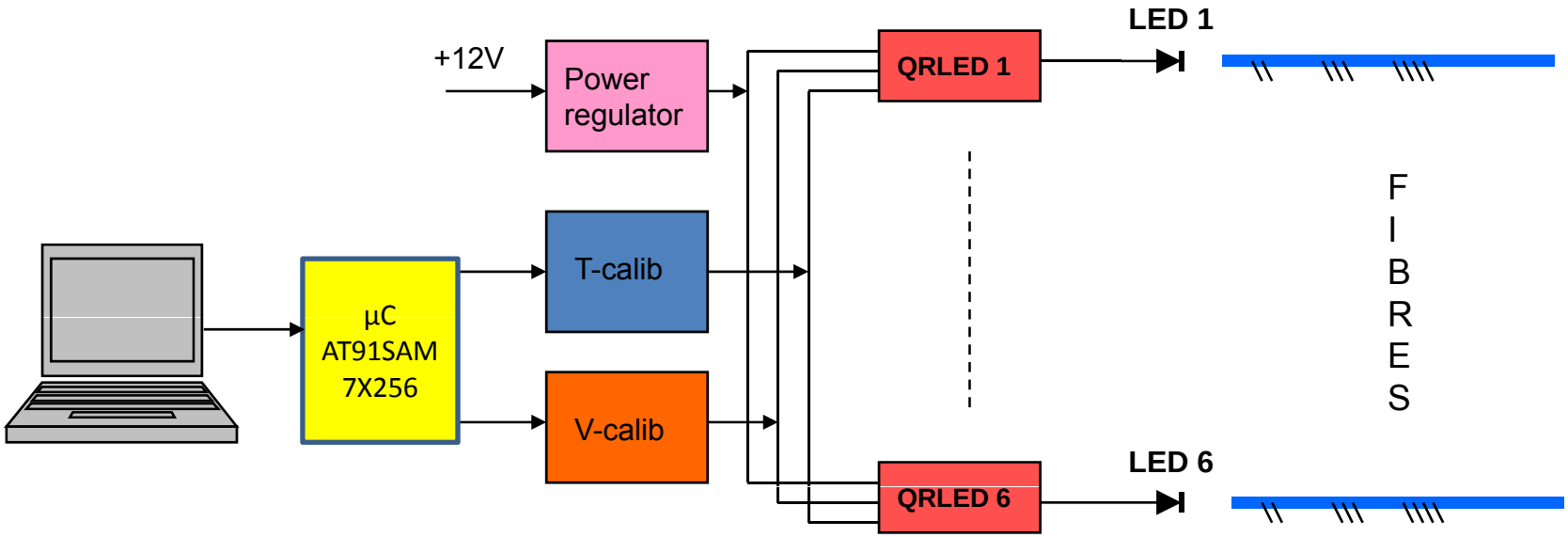
- **Response over 2.2m length drops linearly by 40%, RMS ~ 14%**
- **Light output from notched fibers > 2.7 times higher**





How we understand the „Deliverable at the month 33 : Multichannel LED driver“

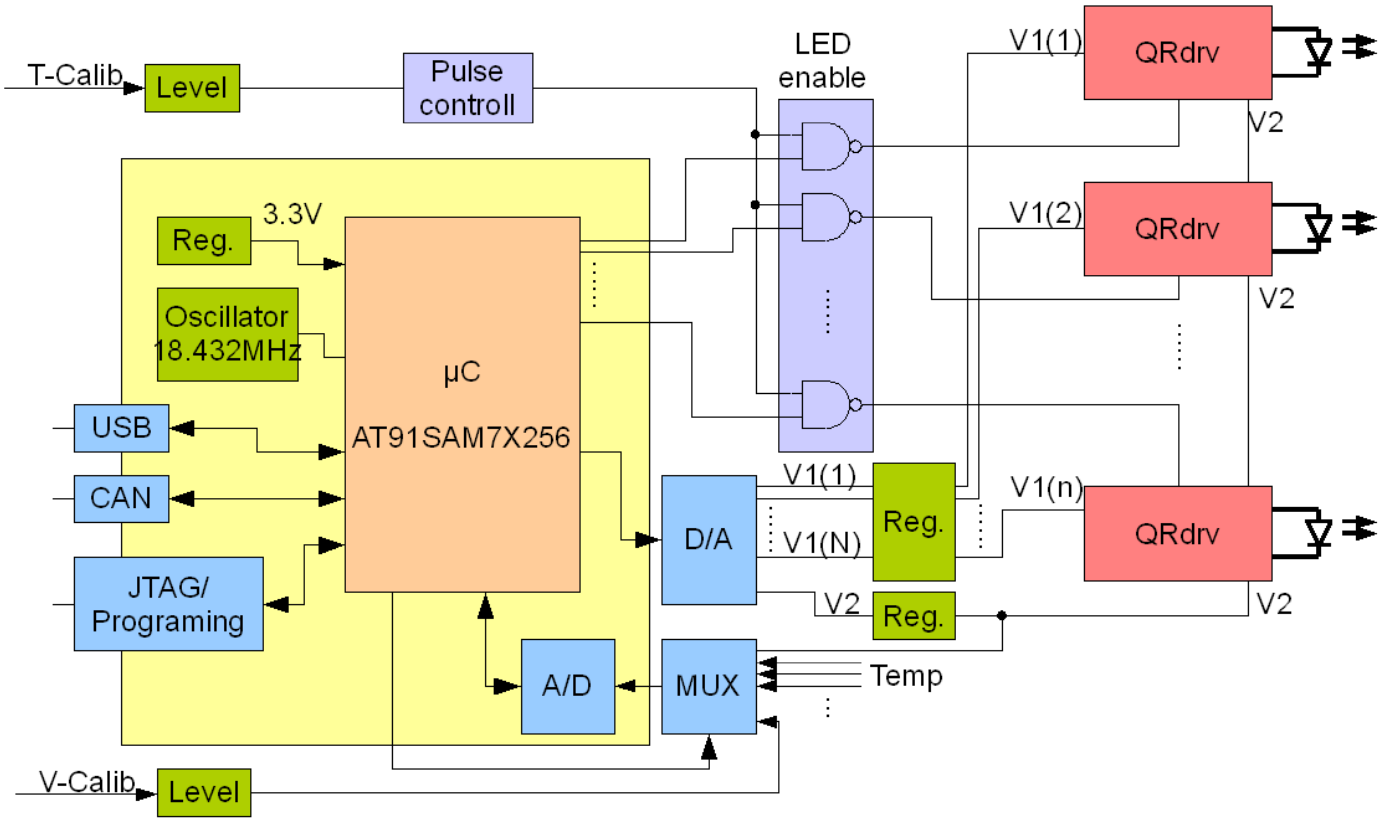
- 1 PCB with the communication module µC, power regulator, 4-6 channels of QRLed driver
- The communication module communicate with the PC via CAN bus or USB
- The communication module communicates with the analog part via SPI (GPIO?)
- LED pulse width is ~ 5 ns is fixed, the tunable amplitude in range up to 50-100 MIPs is controlled by the V-calib signal



Jiří Kvasnička, Ivo Polák, Milan Janata

What should be done?

- Communication module is ready → the final design of PCB for the digital part starts in July
- Optimization of the QRLed driver (tests of the linearity, adjustment for another LED type) - July
- Design of PCB for the analog part will be done in August
- PCB production – September
- In parallel – innovation of the optical system
- PCB tests – October, Report – November
- Time schedule is tough but no principal problems encountered

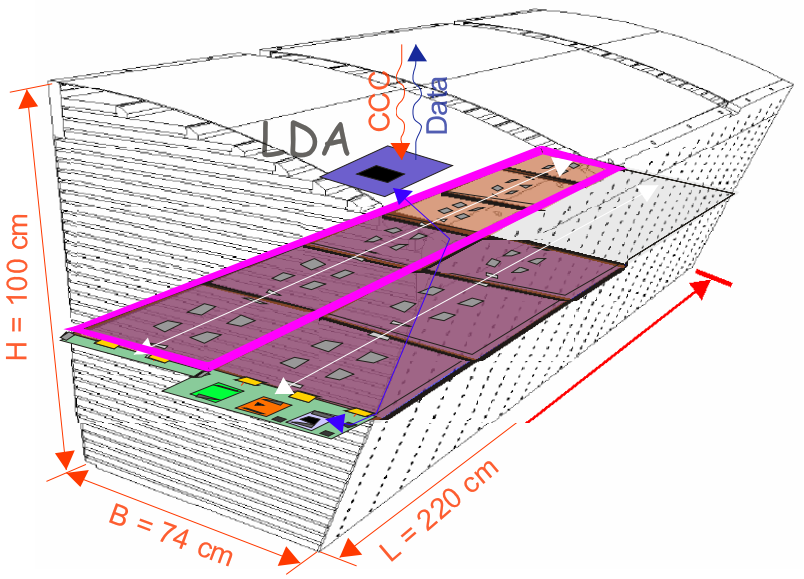


View of the calibration electronics with the digital part (left) and analog part with LEDs (right)

Next prototype: Architecture

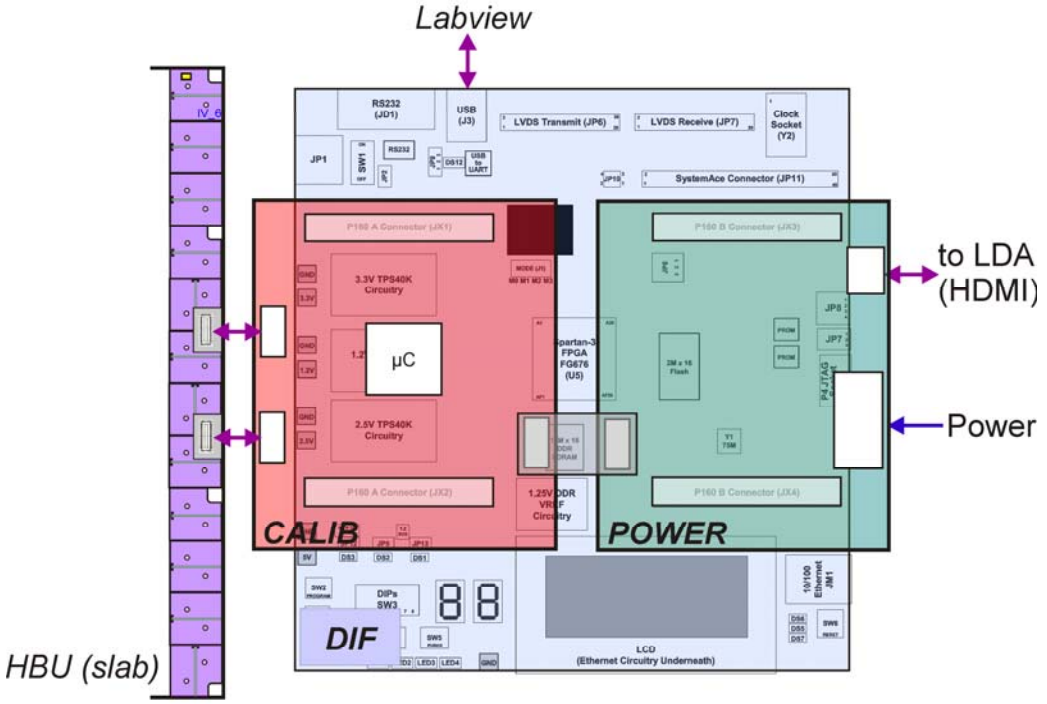
FE

the future …



Slides from M.Reinecke

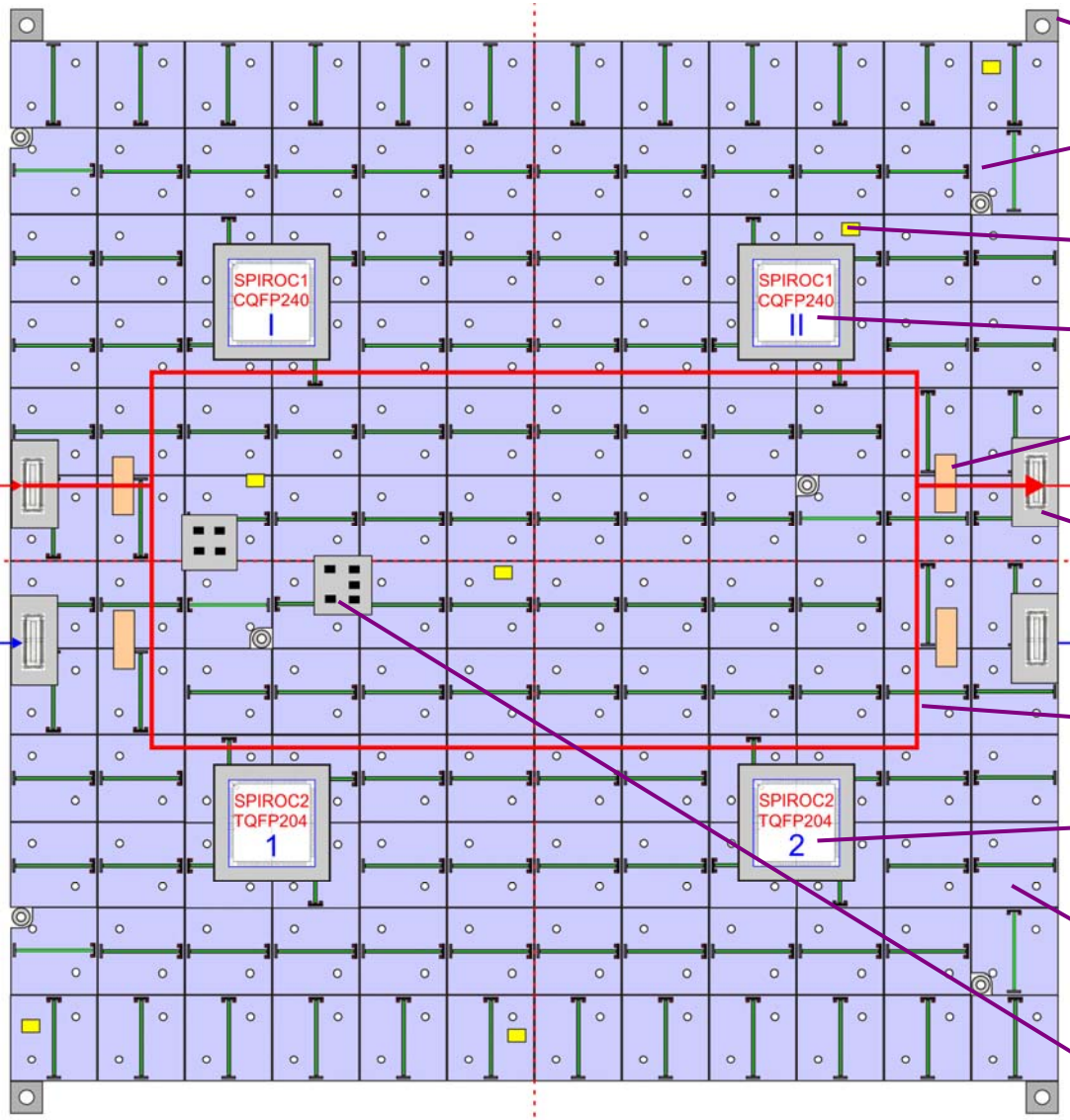
1st EUDET Prototype (**1st step**)



Commercial DIF, new mezzan.
(CALIB, POWER), 1HBU (later: 6)

HCAL Base Unit (HBU0)

FE



Signal IN

Power IN

Cassette fixation

Mechanics Tile

Temp. Sensor

SPIROC1

Debug Conn.

Flexlead Conn.

Two signal paths

SPIROC2

Prototype Tile

Calibration Electr.
(LED + Charge Inj)

HBU0 Status

FE

-Integration concept fixed
-Schematic (Mentor Graphics CAD) finished
-Layout is waiting for tile geometry information
-Critical parts (connectors) ordered.

-Layout is complex (1-2months), PCB manufacturing and assembly: 1-2months => realization in 2008 already critical!

Design progress is interrupted due to missing tile information.

HBU schematic top layer

HBU Interconnection (Flexleads)

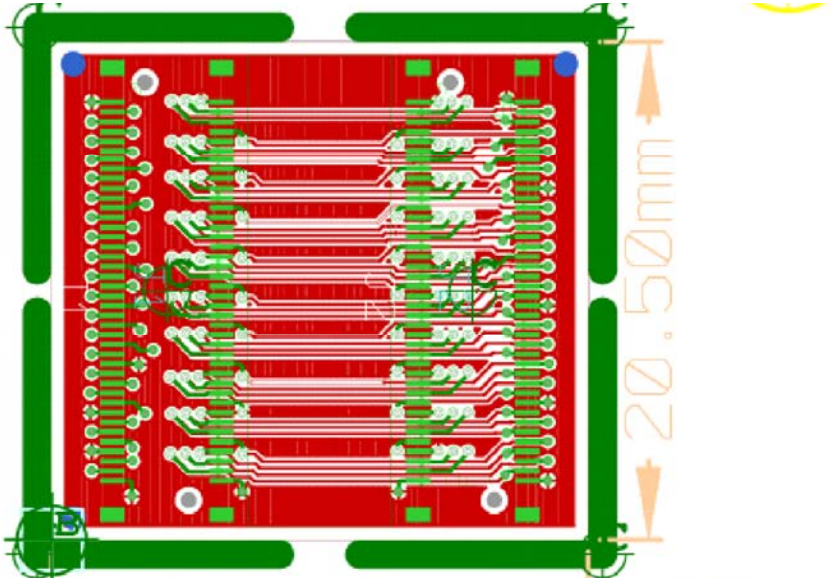
FE

-Two types of Flexleads (for Signals, Power) have been designed (CAD)

-Flexleads allow +/-100µm displacement of connecting modules

-Magnet-field tests have proven connector suitability up to 5T

-Flexleads can be ordered now!



Flexlead CAD Layout

DIF Status

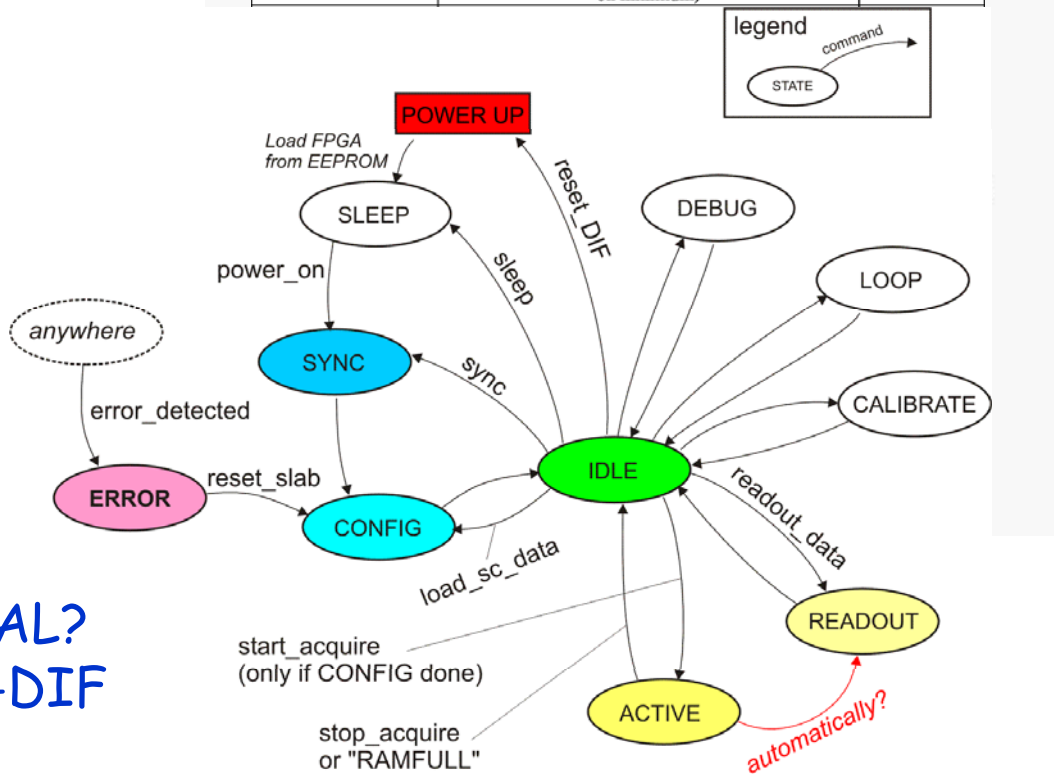
FE

-Based on commercial FPGA (Spartan3-1500) board

-Command list and DIF state diagram in preparation

-VHDL code generation soon (prototype firmware for USB access in 2008)

Command	Function and Parameters	Change DIF State?
power_on	turn slab power on / off (maybe partly?)	no
reset_DIF	reset of DIF electronics (not: slab)	yes
reset_slab	reset of slab (ASICs). Not: DIF	yes
reset_BCID	synchronize data taking by resetting bunch counter	no
sleep	puts DIF and slab into SLEEP state (powered down)	yes
sync	synchronization LDA all DIFs	yes
idle	puts DIF into idle state (DIF power on, slab power on minimum)	yes



DIF state diagram

Firmware status of ECAL/DHCAL?
Reference documents for LDA-DIF interface (also: DAQ group)?
Firmware development needs closer coordination.

CALIB Status

FE

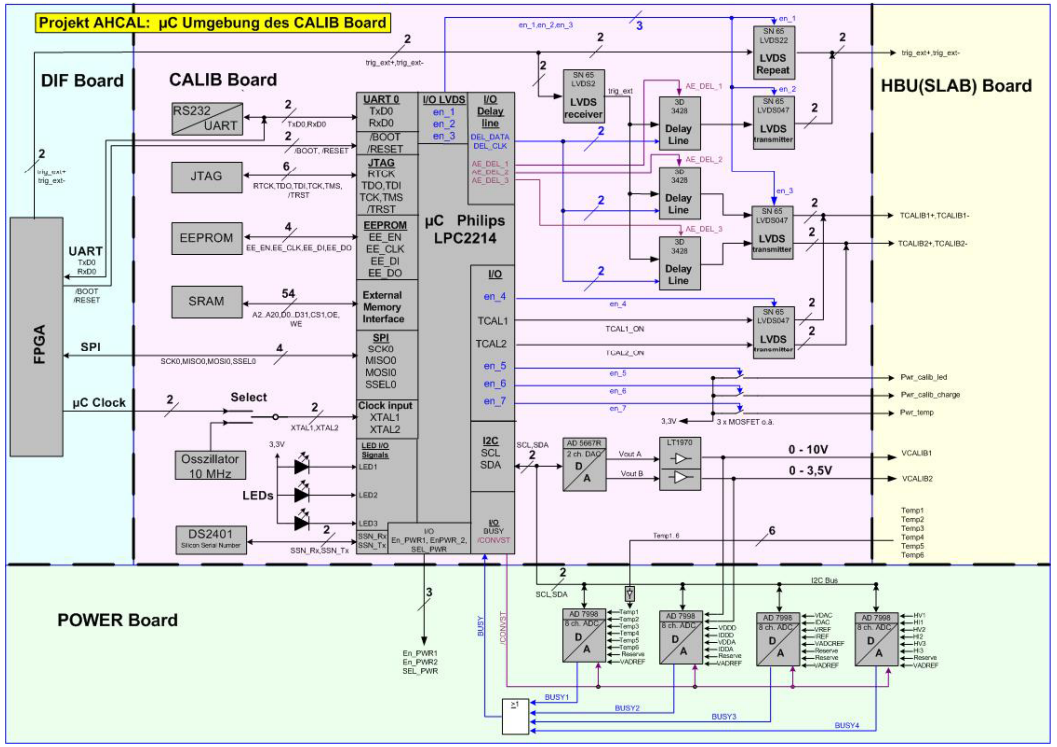
„AHCAL Calibration System“
(UV-LED and Charge Injection)

-Concept fixed, schematic finished

-µController software dev. ongoing (good progress)

-Layout (CAD) starts now, expected to be finished: End of September.

-Module should be available: November/December 08



POWER Status

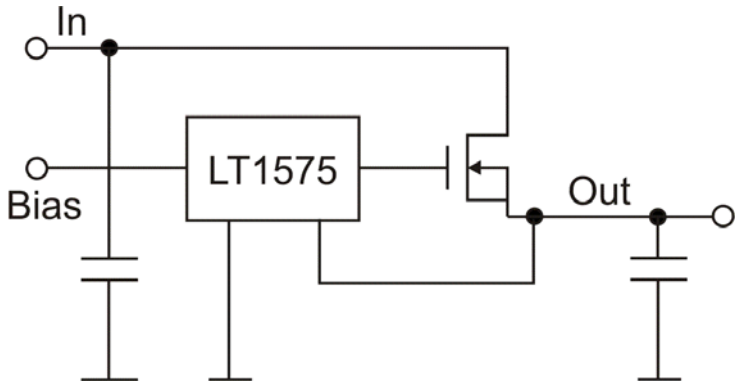
FE

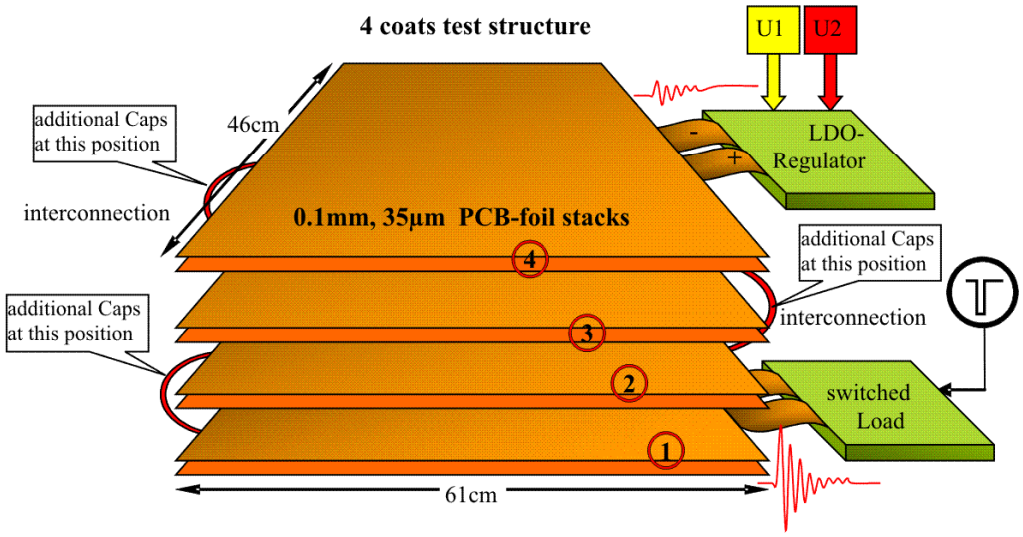
„AHCAL Slab Power Regulators"

-Regulator setup fixed, schematic finished

-Suitable for ILC-like power cycling

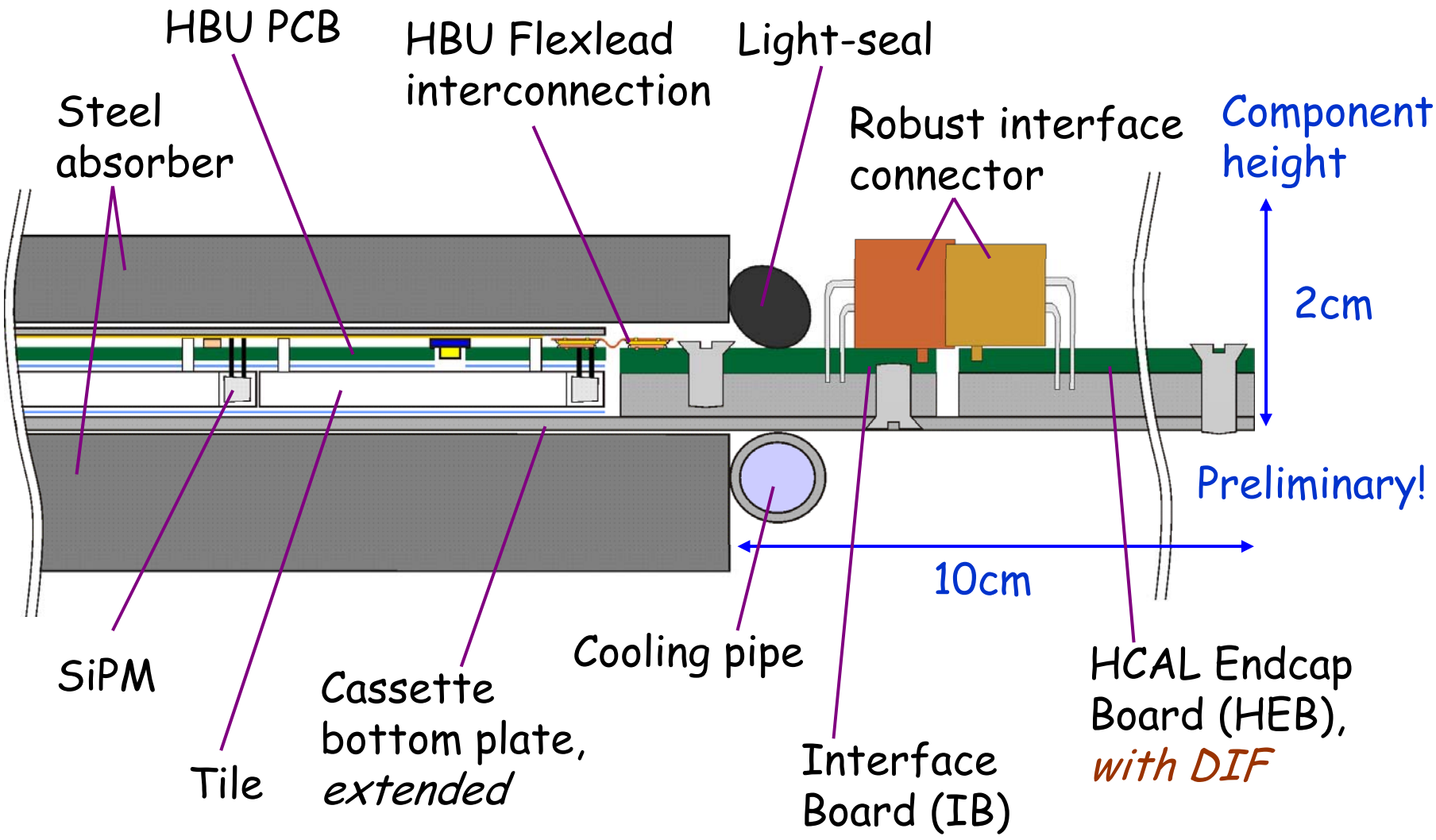
-Layout and production probably in 2009 (module can be replaced initially by bench-top power supplies)





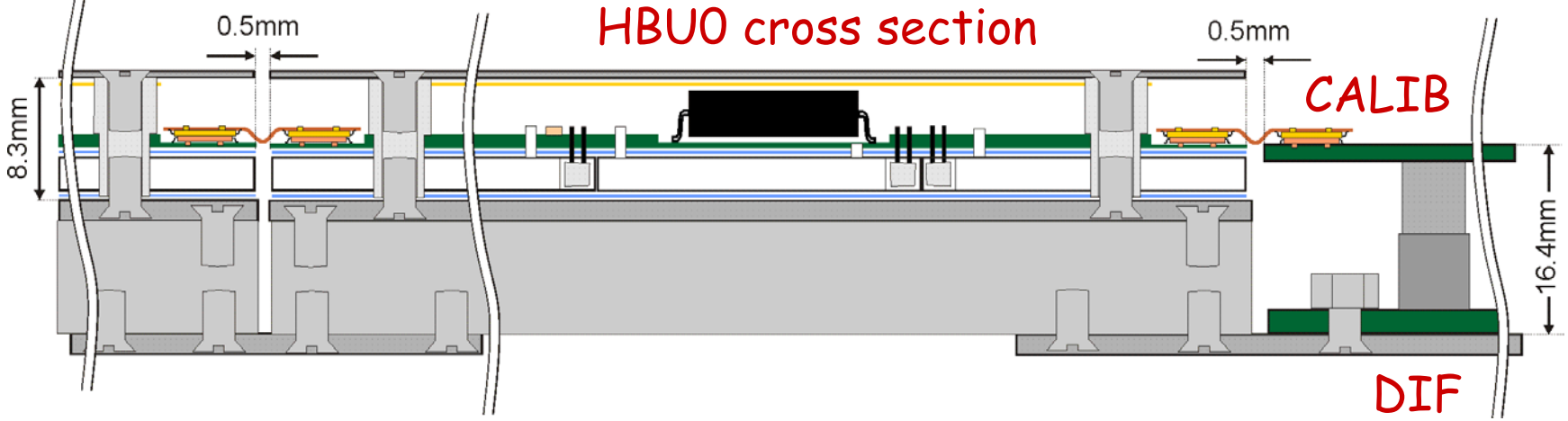
AHCAL Slab Interface (Mech.)

FE



Mechanics Status

Next HBU0



- Mechanical proposal (cassette, interface to DIF) has been set up for the AHCAL prototype (HBU0, DIF as commercial board).

-The necessary mechanical parts are currently designed within CAD tool => production within 2008

Conclusions

FE

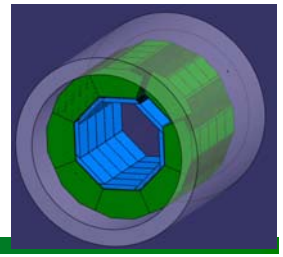
-AHCAL technical prototype (TP) does not cover a full slab, but ~150 channels (2 HBU0s, tile-prototypes).

-Eudet module (detector layer) requires HBU redesign. A full slab (and detector layer) is expected for summer/autumn 2009.

-timeline for TP is defined by HBU0 (tile geometry missing).

-development of the modules CALIB and DIF (firmware) in 2008 possible. But for HBU0 we need the tile information to proceed.

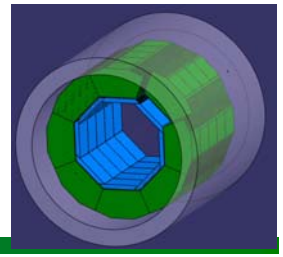
Next milestones



- Calibration multi-channel prototype 9/2008
  - Optical version: in production
  - Electronics version: late 08/early 09, but already integrated
- HCAL production readiness review 12/2008
  - paperwork
- Mechanical design 12/2008
  - Converging, in phase with ILD

- Outlook: HCAL integration prototype in 9/09

Resources

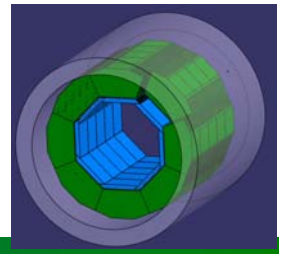


- DESY
  - Engineering position filled 10/07 , 27 ppm -> end 09
  - Spending of committed funds started
    - Electronics ~ 20k in 2008
    - Mechanics ~ 40k in 2008

- UHAM
  - Only travel money for test beam support and meetings
  - Transferred to DESY, because PhD position largely not filled

- UPASCR Prague
  - See information from Cvach, peak spending slightly later, no problem

Conclusion



- Schedule is tight
  - No wonder, as everyone else is slowing down
- Electronics integration suffering from too close link to users
  - standardized interface under intensive discussion
- Calibration: two solutions
- Mechanics late due to late recruiting, but catching up
  - Additional manpower entering now, after completion of test beam set-up and HERA dismantling