Backward Calorimetry For SuperB

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Introduction

- Since in SuperB the asymmetry of beam energies is reduced to 4 GeV×7 GeV from 3.1 GeV×9 GeV, the rear region of the detector gains more importance than in BABAR

  ➔ need a more hermetic 4π detector than BABAR

- In addition, one important physics goal in SuperB is to exploit the recoil of fully reconstructed B decays

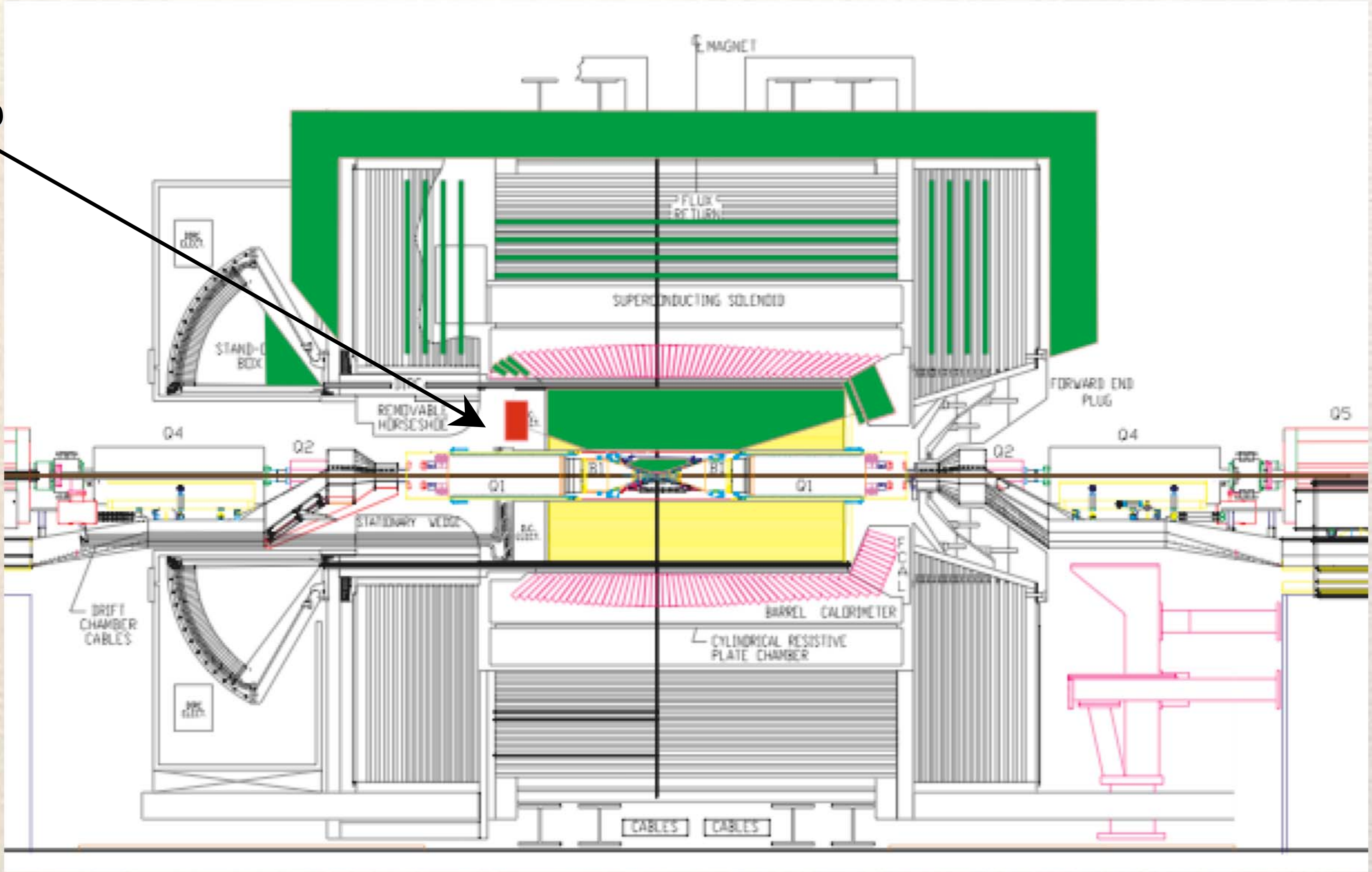
- Analyses like $B \to K^{(*)}\nu\bar{\nu}$ and $B \to X_s \ell\ell$ profit significantly from a hermetic detector, since E_{miss} is improved

- For inclusive $B \to X_s\gamma$ the π^0 veto is improved

- Thus, an endcap calorimeter for the backward region is an important improvement

SuperB: Baseline Design

Rear endcap



Rear Endcap EM Calorimeter

- In the barrel add three CsI(Tl) crystals layers
- Behind DCH I propose to place Pb-scintillator sampling calorimeter
  - 2.8 mm thick Pb plates ➔ 1/2 X_0
  - 3.0 mm thick scintillator tiles
  - Sizes vary from 3.8 cm × 3.8cm → 7.8 cm × 7.8 cm (R_M ~6.0 cm)
  - cylindrical geometry, r_i=0.31 m, r_a=0.75 m

    ➔ coverage~ 300mr

    Pb: R_M=1.5 cm
  - 24 planes with thickness of $12X_0$
  - scintillator is segmented into tiles, size increasing outwards

    ➔ total: 11,520 channels
  - Scintillator tiles are read out with WLS fibers (Y11) coupled to a SIPM

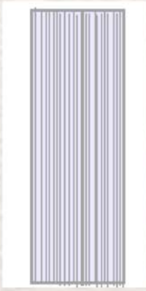
Rear Endcap EM Calorimeter

- Use cylindrical geometry, split calorimeter into 2 halves

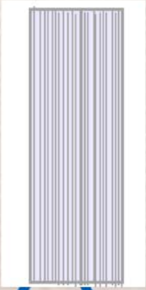
r-φ view

z view

- Pb plates:



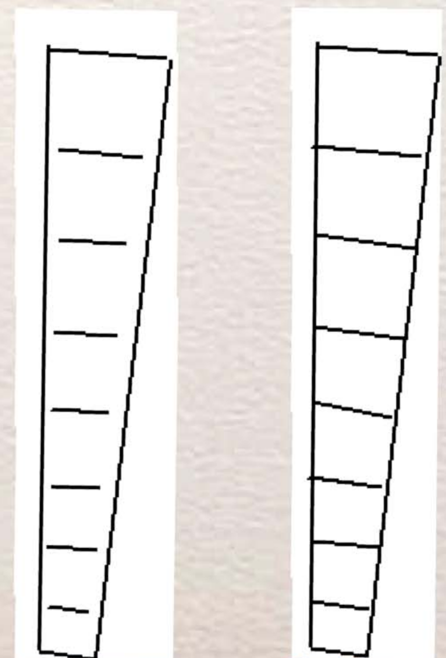
- Scintilator plane:



Rear Endcap EM Calorimeter

- Use half ring-shaped Pb plates, 2.8 mm thick, 48 identical plates
- Build two halves for easy mounting in IR
- Fabricate scintillator planes from 30 identical wedges per half plane
  ➔ simplifies mechanical construction
  - cut slits to produce tile structure, or grooves
    ➔ get light cross talk between neighboring tiles
    (probably small, need simulation)
  - Fill slits or groove with white diffuse reflector
  - Covers all sides with white diffuse reflector
  - (in AHCAL we have used matting process)

slits grooves

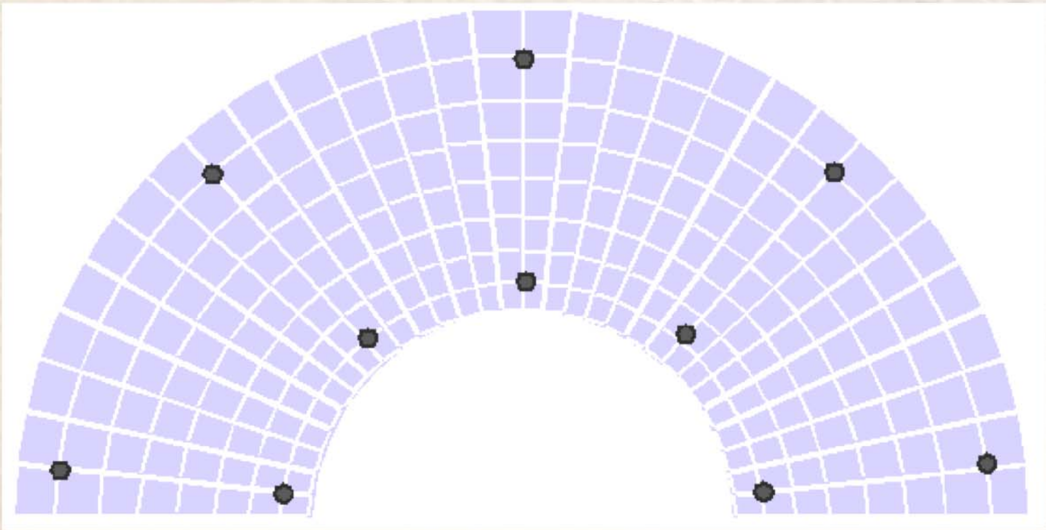


grooves (side view)

or alternating grooves

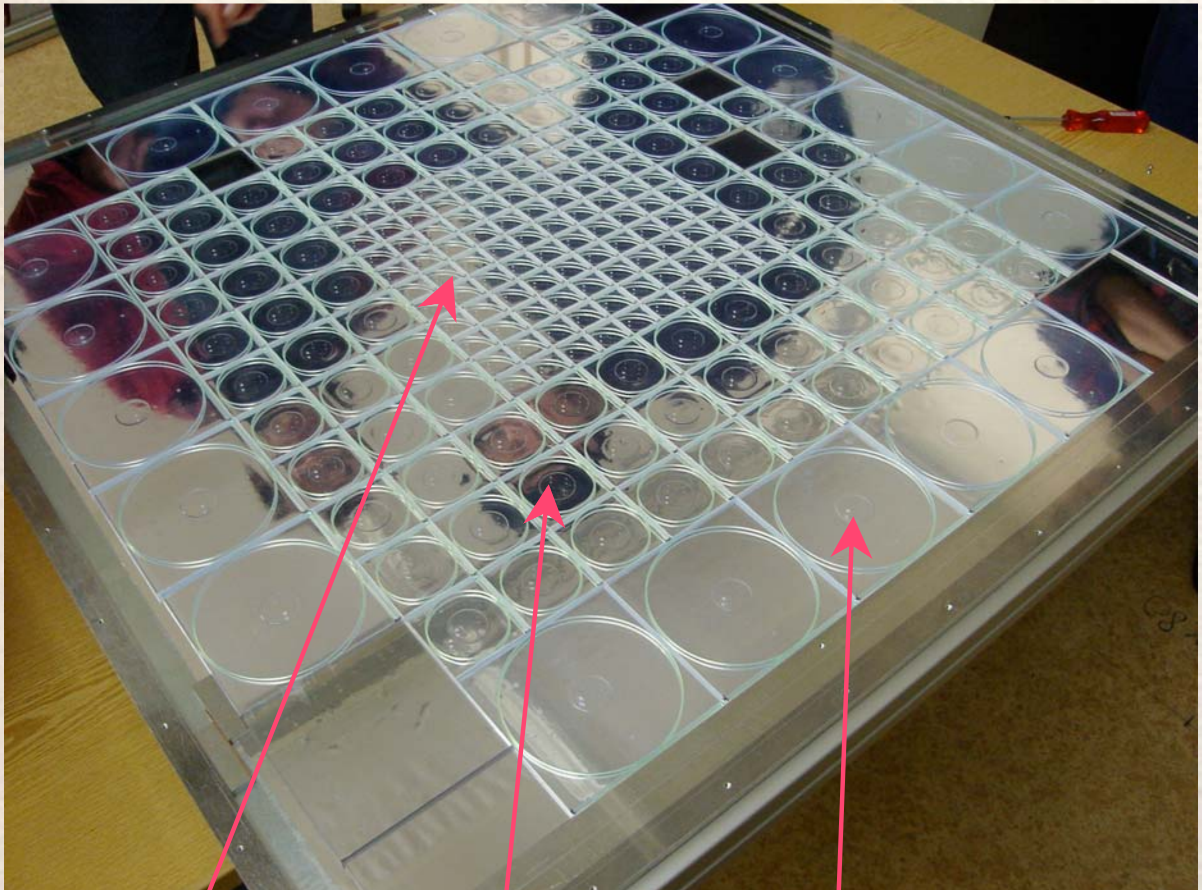
Rear Endcap EM Calorimeter

- Cover top and bottom of scintillator plane with 3M reflector
- Solder SiPM pins to flexible strips (for stress relief) that in turn are soldered to traces on thin board taking out signal to VFE board
- Use a strong back to hold Pb plates and scintillator planes use bolts or fix at outside by bolts



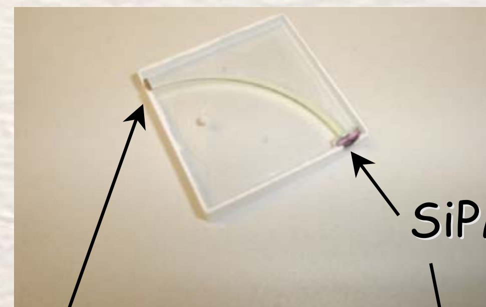
Tile Readout

- Example of a scintillator layer for an analog hadron calorimeter



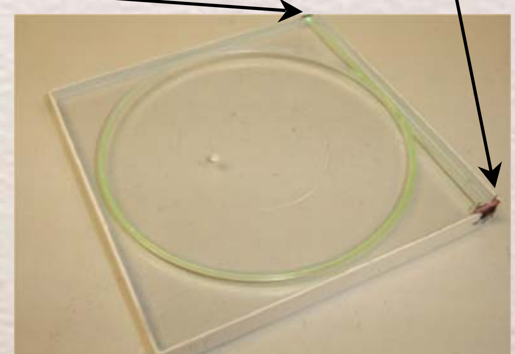
3×3 cm^2 6×6 cm^2 12×12 cm^2

- Propose same types of tile-fiber-SiPM couplings



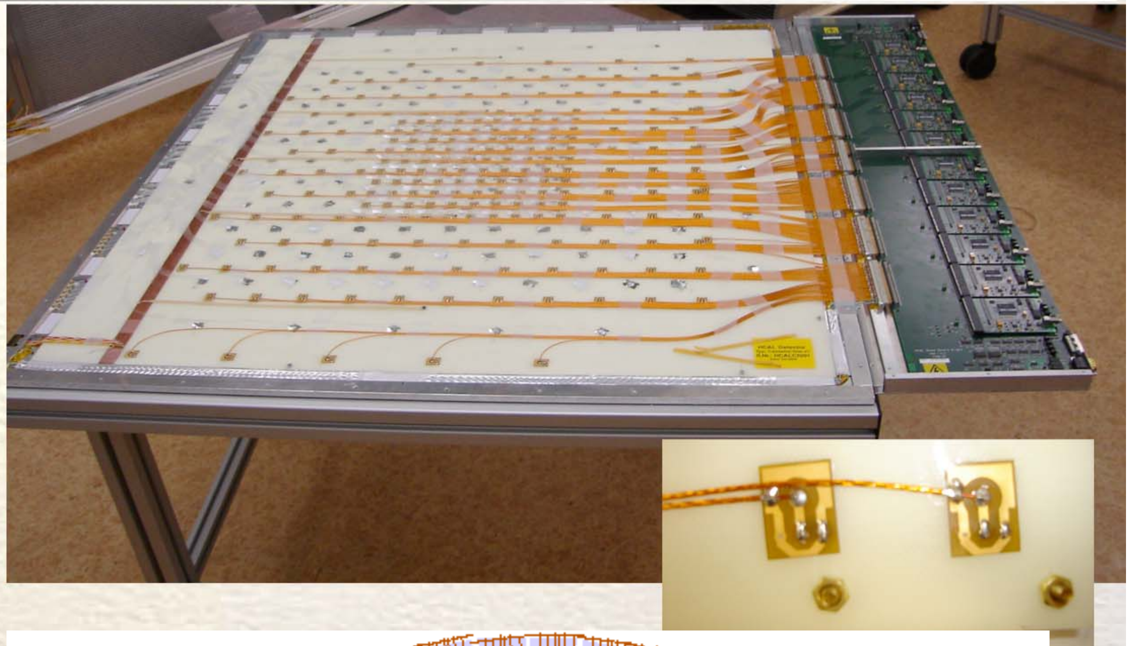
SiPM

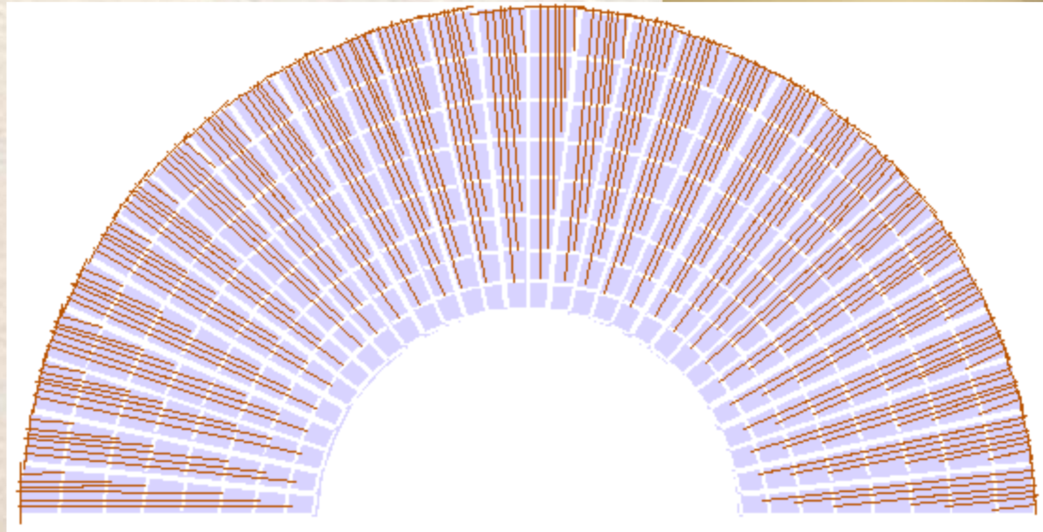
3M reflector



Routing of Fibers and Wires

- In AHCAL we used cables to transport SiPM signals to VFE
- For next prototype a specially designed board is planned
- For rear endcap I also propose a thin board with 8 traces per sector
- The SiPM pins need to be attached to a stress relieved pad that is connected to the traces





Conclusion

- The experience in Calice with the scintillator-tile AHCAL and the scintillator-strip ECAL prototype provide a useful starting point for the design and construction of a rear endcap calorimeter for SuperB
- These prototypes provide a proof of principle
- Several design components can be taken with small modifications e.g. VFE electronics, calibration/monitoring system
- Design details can be decided upon simulation studies
- However, it is desirable to test the final design in a small prototype

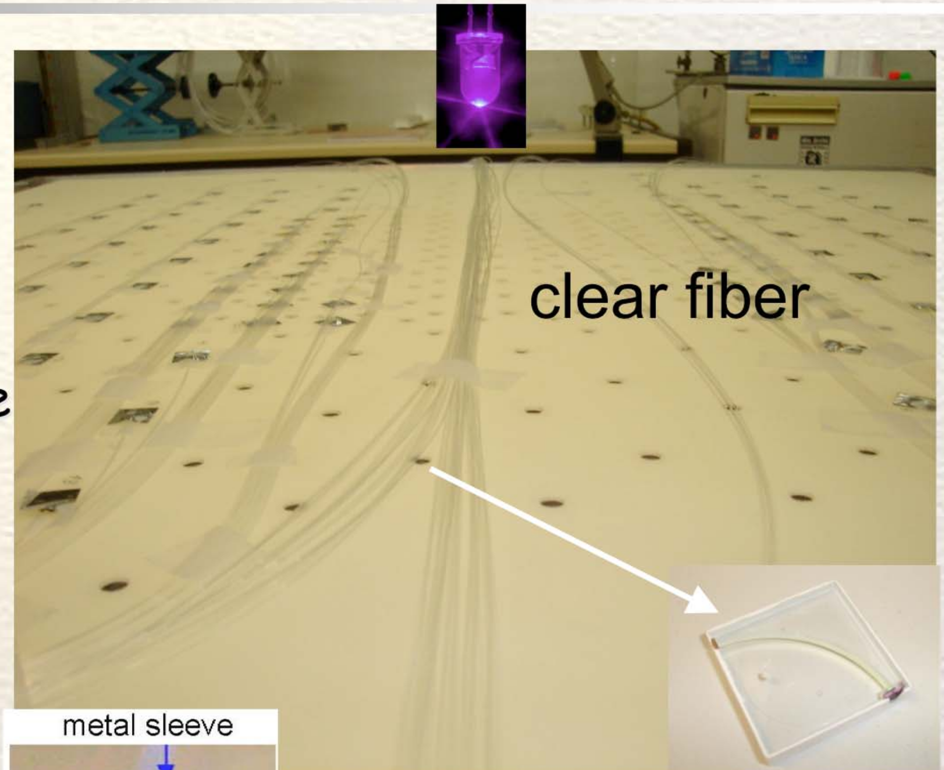
Calibration-Monitoring System

- Monitor stability of tile-fiber-SiPM system between MIP calibrations with fixed LED intensities
- Perform gain calibration
- Measure SiPM response function
- Determine intercalibration constants
- Temperature and voltage dependence of SiPM
  - dG/dT ~ -1.7% / K
  - dG/dV ~ 2.5% / 0.1V
- Temperature and voltage dependence of light yield at fixed light intensity
  - dQ/dT ~ -4.5% / K
  - dQ/dV ~ 7% / 0.1V

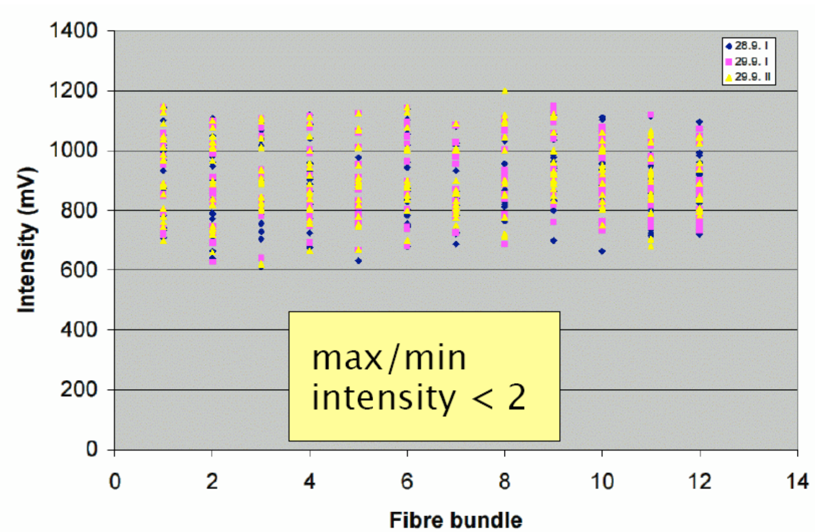
→ stability of LED system after PIN diode correction <1%

Calibration-Monitoring System

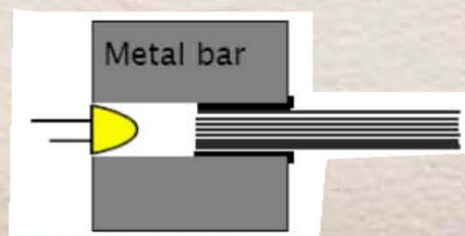
- Use system similar to that of AHCAL
- Provide UV light to each tile via clear fiber
- Monitor each LED with PIN diode
- Record temperature & voltage with slow control system



Light Uniformity in Test Module



bundle of 19 fibers
18 → tiles, 1 → PIN diode

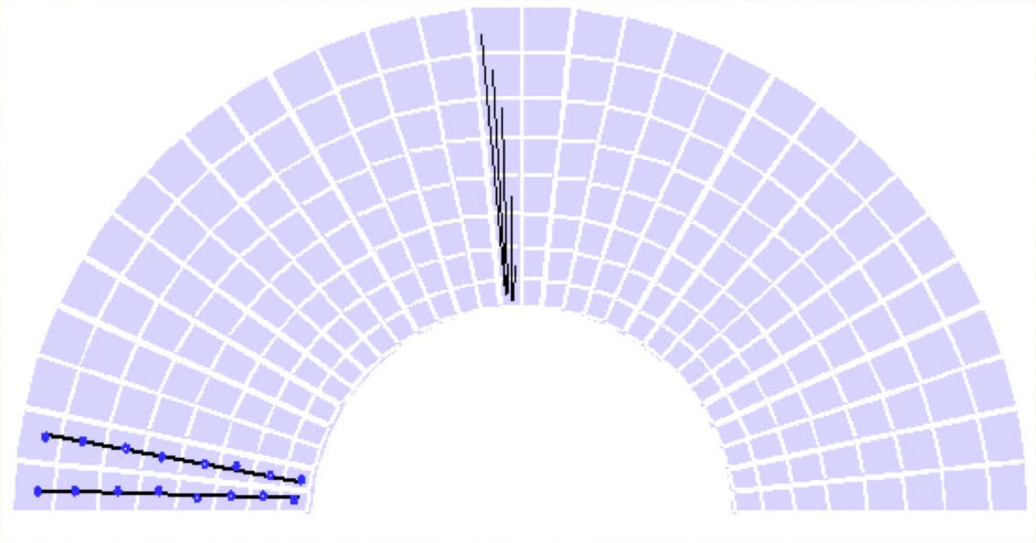


LED fiber coupling

Layout of Monitoring System

- If a single fiber gives enough light for 8 tiles, one could combine 6 fibers two adjacent in 3 planes to one LED

➔ need 240 LED & 240 PINs



- If we need one fiber per tile combine 16 fibers of 2 adjacent sector to LED

➔ need 720 LED & 720 PINs

- Work is ongoing at DESY to simplify the monitoring system and to reduce the number of LEDs