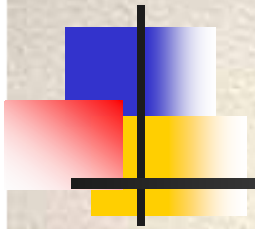


Backward Calorimeter

Update

G. Eigen, U. Bergen

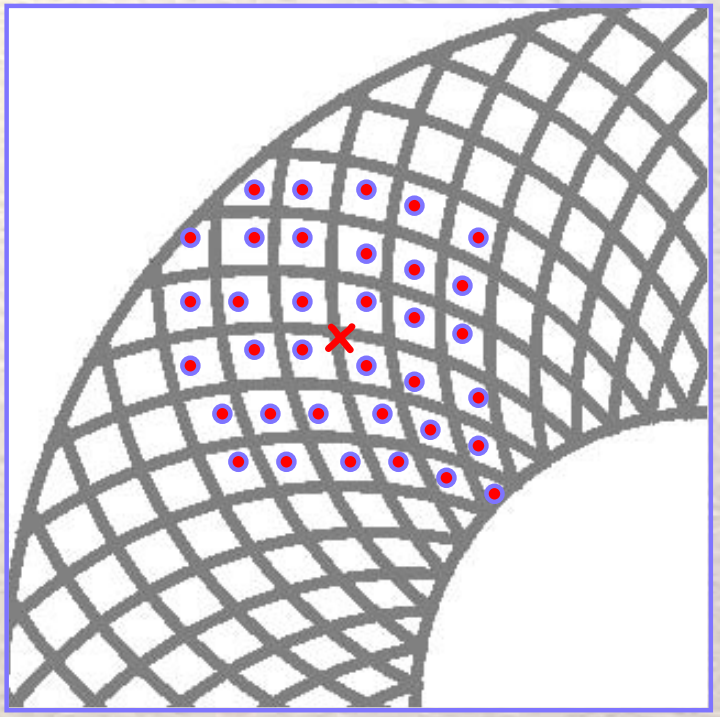
SuperB meeting, Annecy 3-17, 2010

Outline

- Present design and preparations
- New idea on strip production
- Order status
- Calibration/monitoring
- Revisions on mechanical support structure
- Alternative readout
- Uniformity and cross talk measurements
- Summary and next steps

Prototype Design

- Use 75 cm × 75 cm scintillator plates (24 layers)
- Use 75 cm × 75 cm lead plates (24 layers)
- Cut outer and inner circular edges
- Cut boundaries of the 6 strips
- Cut 6 grooves for fibers
- Instrument 6 strips in each layer with Y11 fiber and MPPC
- Insert UV light via clear fiber at inner edge
- Place temperature sensor near MPPC



➔ In this setup, scintillator & PB plates can be reused for full detector

Prototype Preparations

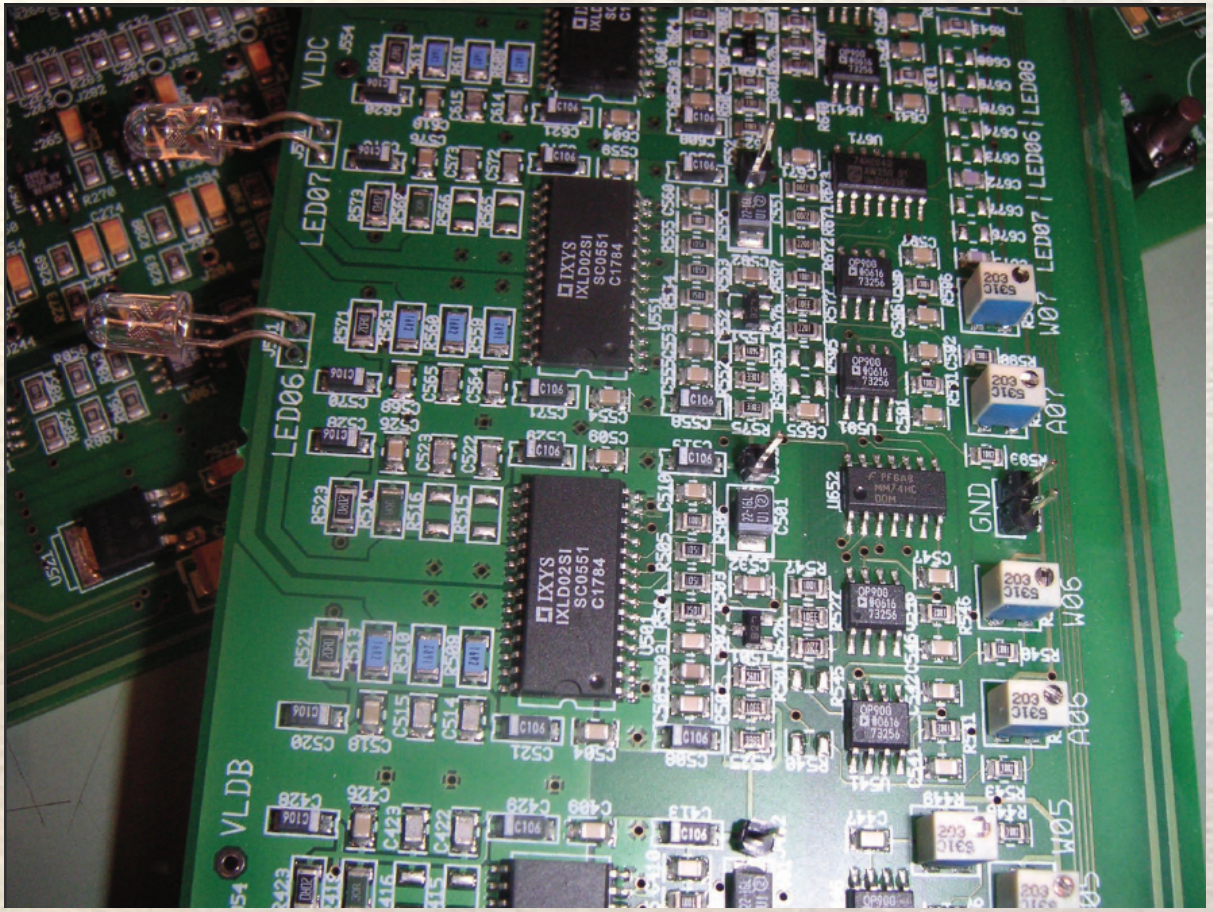
- I ordered 25 BC 404 scintillator sheets (75 cm x 75 cm x 0.3 cm) from St Gobain, which will arrive at CERN March 26, 2010 to be shipped to Bergen
- I ordered 160 MPPCs (CHF 60 each), 20 arrive at CERN on Monday, the remaining 140 will be shipped April 19
- I contacted German company for quote on hardened PB (no response)
- I received quotes from Kuraray for 500 m (35k Yen) and 700 m (50k Yen) Y11 fiber
- I can borrow one CMB board from Prague with 12 LEDs and fibers
  ➔ need to couple each to 13 clear fibers, 12 to tiles one to reference PIN diode
- Two engineers from LAL will set up SPIROC chip readout in Bergen first week of April right after Easter

Scintillator Strip Production

- 4 weeks ago, I talked to Vishnu Zutshi at CERN who suggested an alternative technique for producing optically decoupled strips
  ➔ this procedure was used for strip production in the CALICE tail catcher
  - Cut strips from one side 1.5 mm deep
  - Fill gap with TiO_2 epoxy
  - Cut remaining 1.5 mm from other side and fill gap with TiO_2
  - Develop procedure to ensure uniform light collection
- The advantage is that all strips are physically separated but are still connected into a mechanically rigid structure
- Thus, here inter-strip cross talk is no issue any longer
- Disadvantage is that one needs to be careful not to spread epoxy onto the surface

Calibration and Monitoring

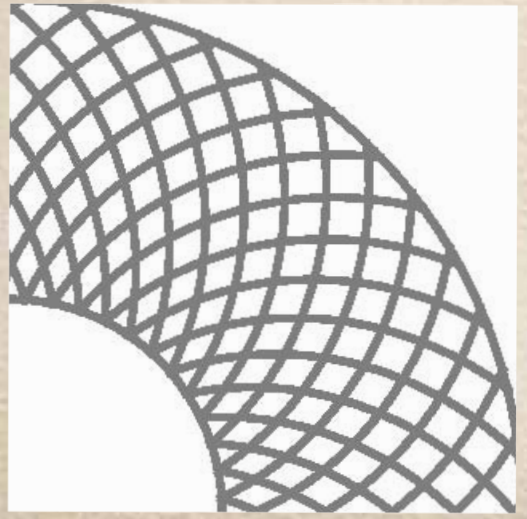
- Use calibration and monitoring board of the AHCAL prototype
- It has 12 LEDs that could be coupled to 19 clear fibers
- Since we have 144 channels just need 12+1 per LED
- Advantage: Use spare board

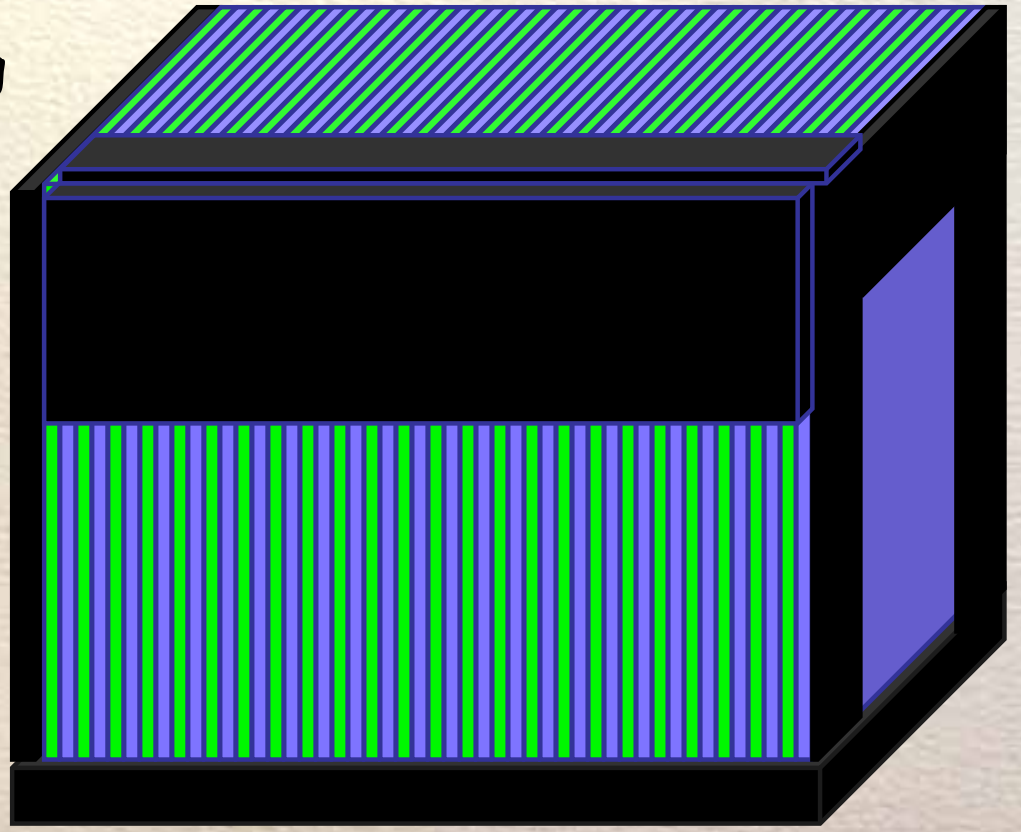


- Disadvantage: Need to deal with 158 clear fibers

Mechanical Support Structure

- Build Al frame to hold layers ➔ leaves holes to get to MPPCs, RO
  - Bottom: solid base plate with full coverage
  - Back: solid back plate with full coverage
  - Front: 2 side and top bars
  - Top: bar near left
  - Left: plate covering top part
  - Right: bar near bottom **back**



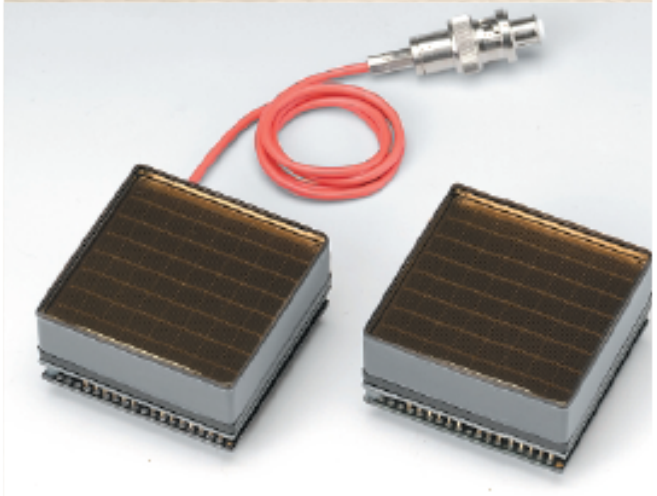


Mounting Procedure

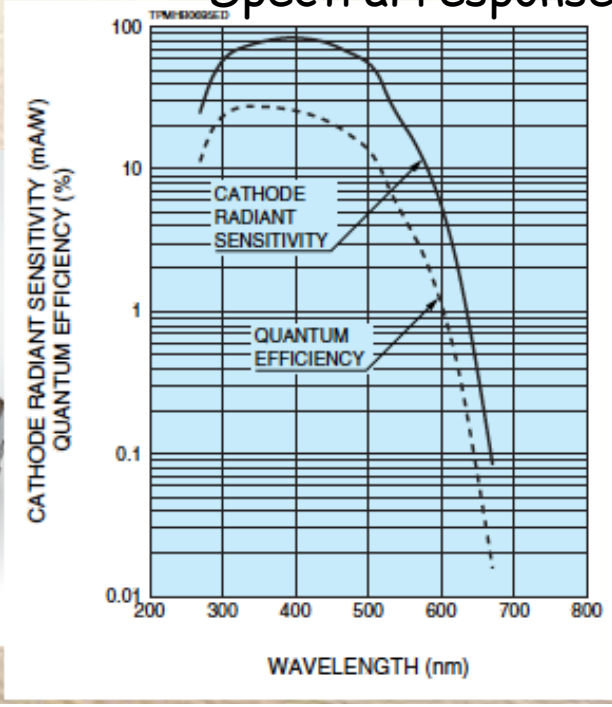
- Start with frame consisting of base plate, back plate and left-hand side plate
- Stack Pb plates and scintillator plates
- Close front side with 2 side bars and a top bar
- Place bar on top towards LHS
- Place bar on RHS near bottom
- For transport to CERN place frame into wooden box
- Drive to CERN with rental car

Fall-Back Solution for RO

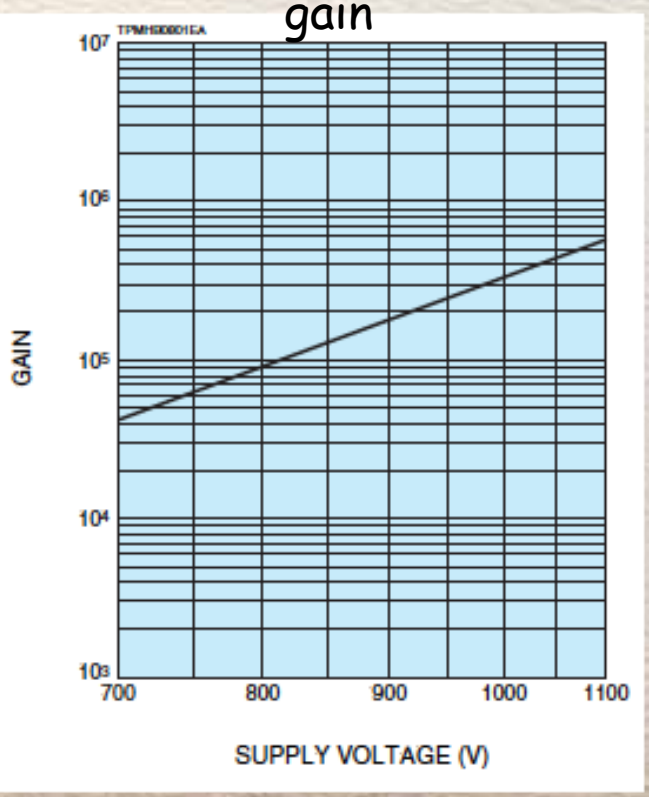
- One ongoing issue is the neuron flux in the detector
- The MPPC's can be operated in stable mode for n flux < 3×10^9 n/cm^2
- If simulations confirm that the n flux is too high for stable MPPC operation, we could modify the calorimeter using smaller-size APDs or new pixelated PMs coupled to clear fibers
- New PMs have 64 pixels



Spectral response

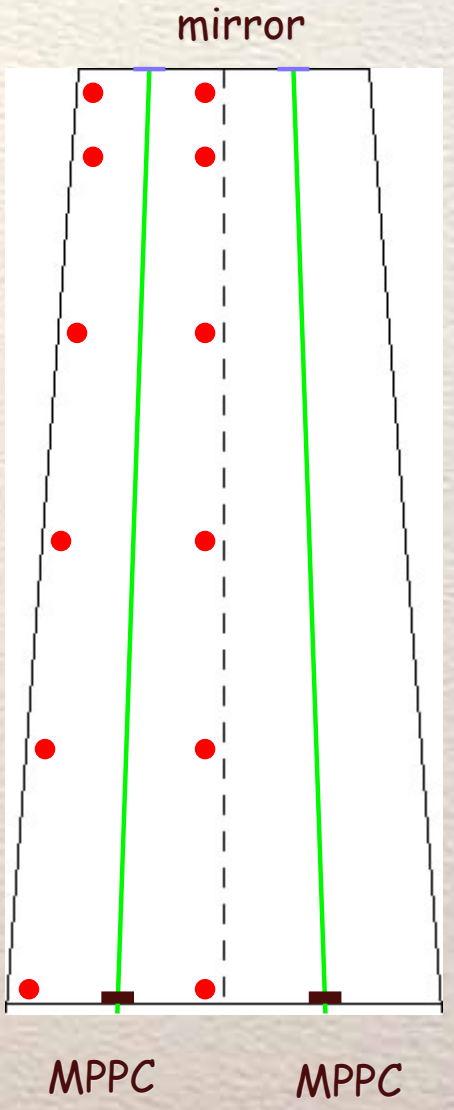


gain



Cross & Homogeneity Talk Measurements

- Read out 2 tapered strips simultaneously that are separated by cuts
- Shine LED light via a clear fiber on 12 fixed positions located on both sides of Y11 fiber
- Define cross talk fraction as ratio of MIP peaks of far tile to that of near tile
- Start with ~50% cuts (bridges) and measure cross talk, average several measurements
- Remove bridges down to 2% in steps to establish a relation of cross talk vs size of bridges ➔consider points: 50%, 25%, 10%, 5%, 2%

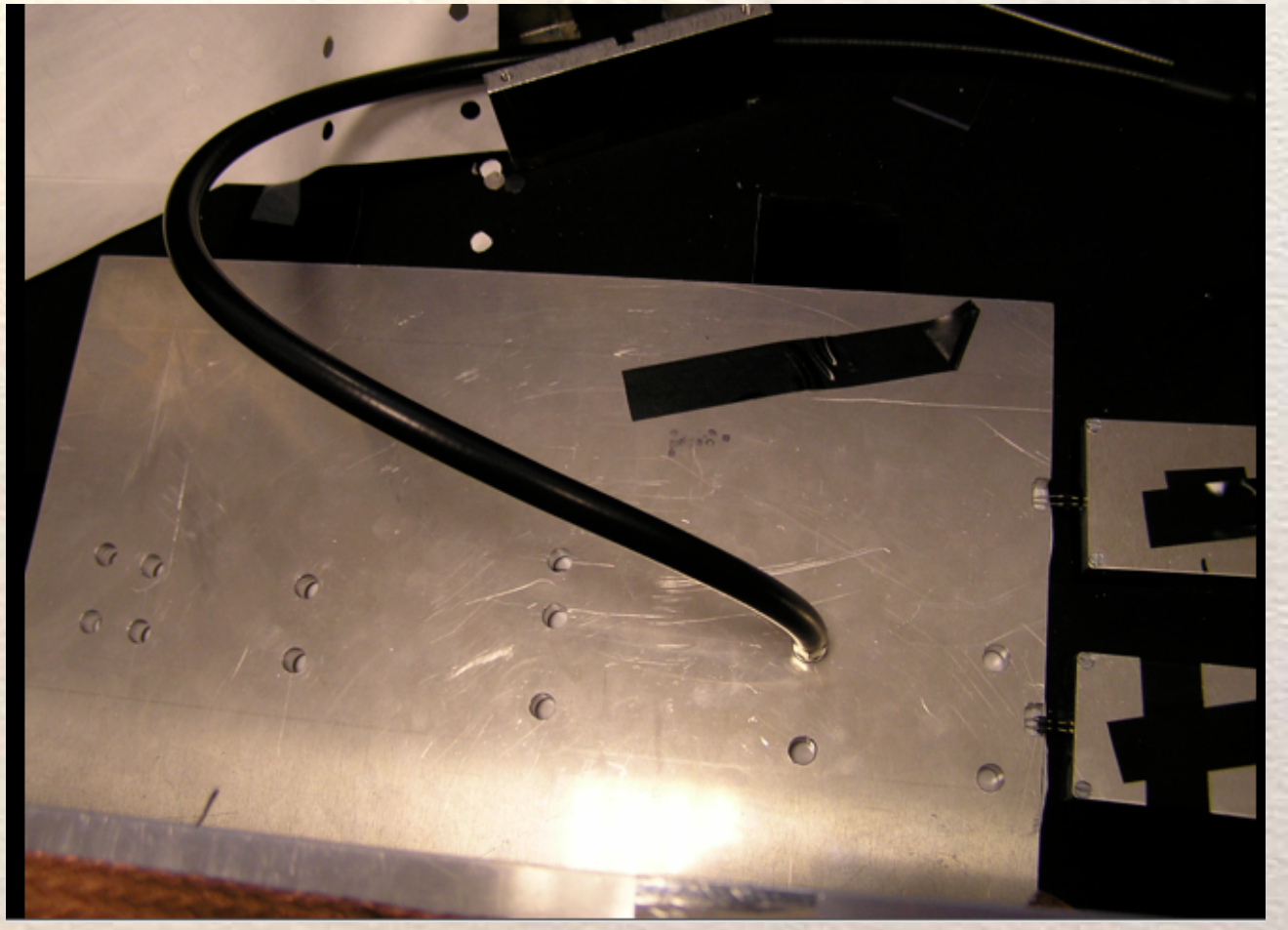


Setup for Cross Talk Measurements

- Using 2 independent readout chains simplifies measurement considerably

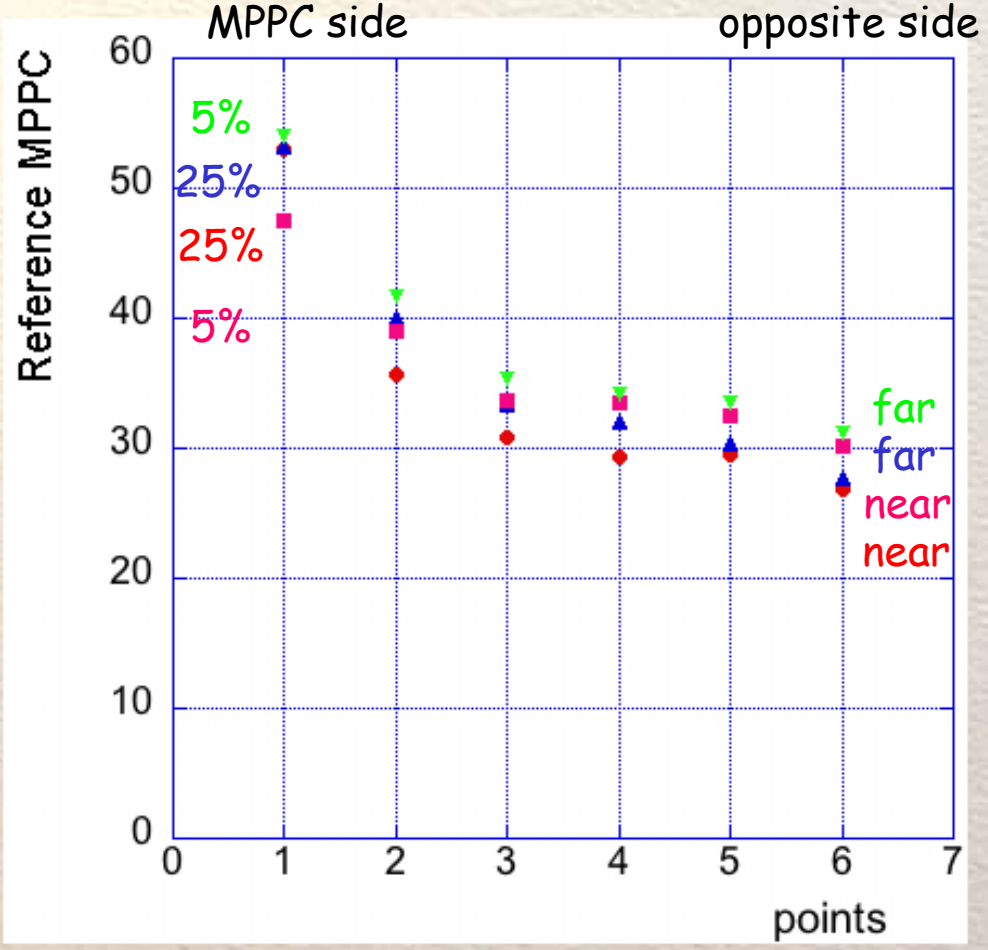
➔ Reduces systematics

- Before each set of 12 measurements MPPCs are recalibrated



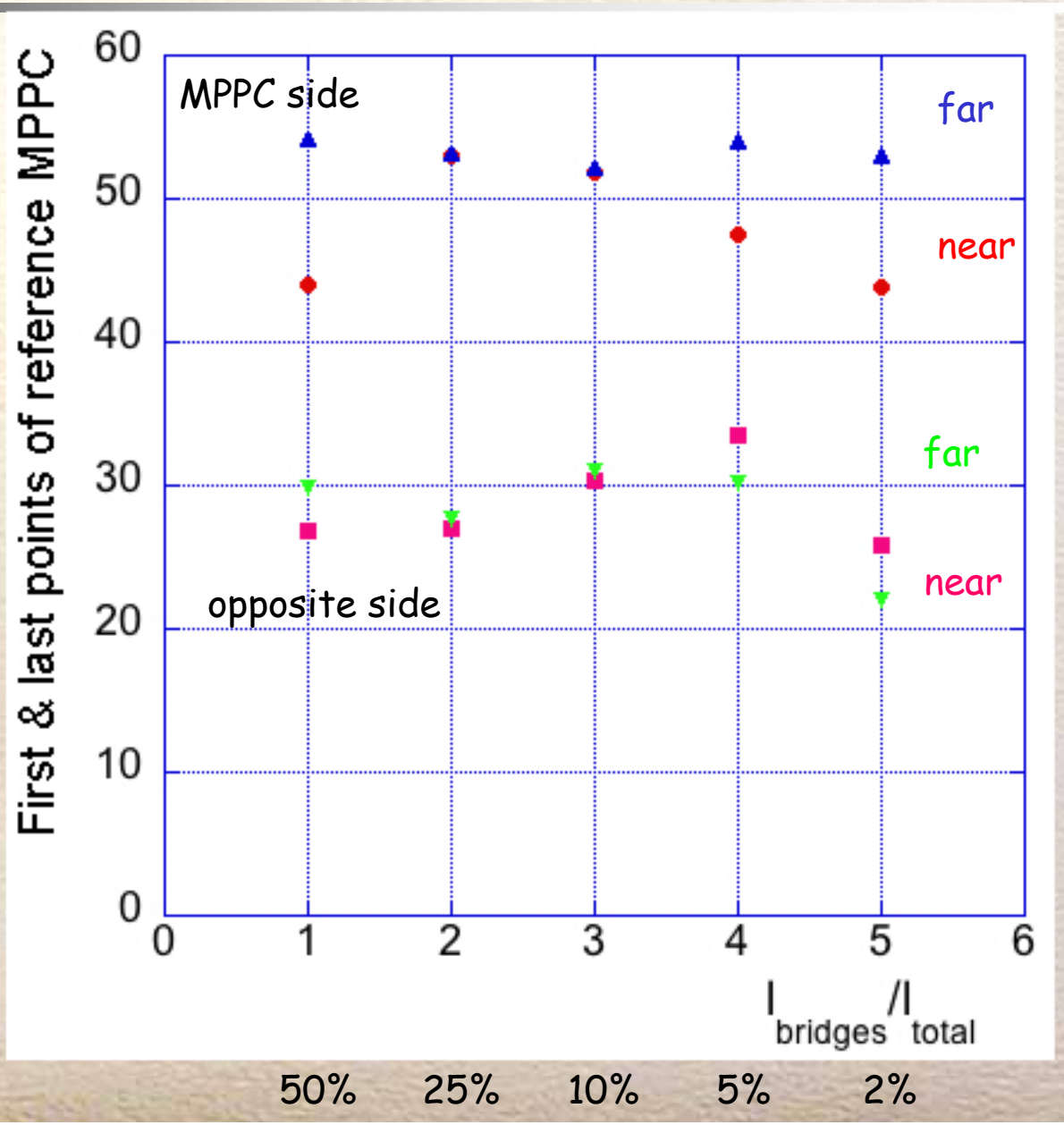
Homogeneity Measurements

- Use pulse heights in reference MPPC to look at homogeneity
- Due to tapered shape would expect non homogeneity
  ➔ higher light yield near large face (MPPC side)
- We need to study this with strip dimensions used in prototype
- We need to look at homogeneity of spiral strips
- Develop method to produce homogeneous light output



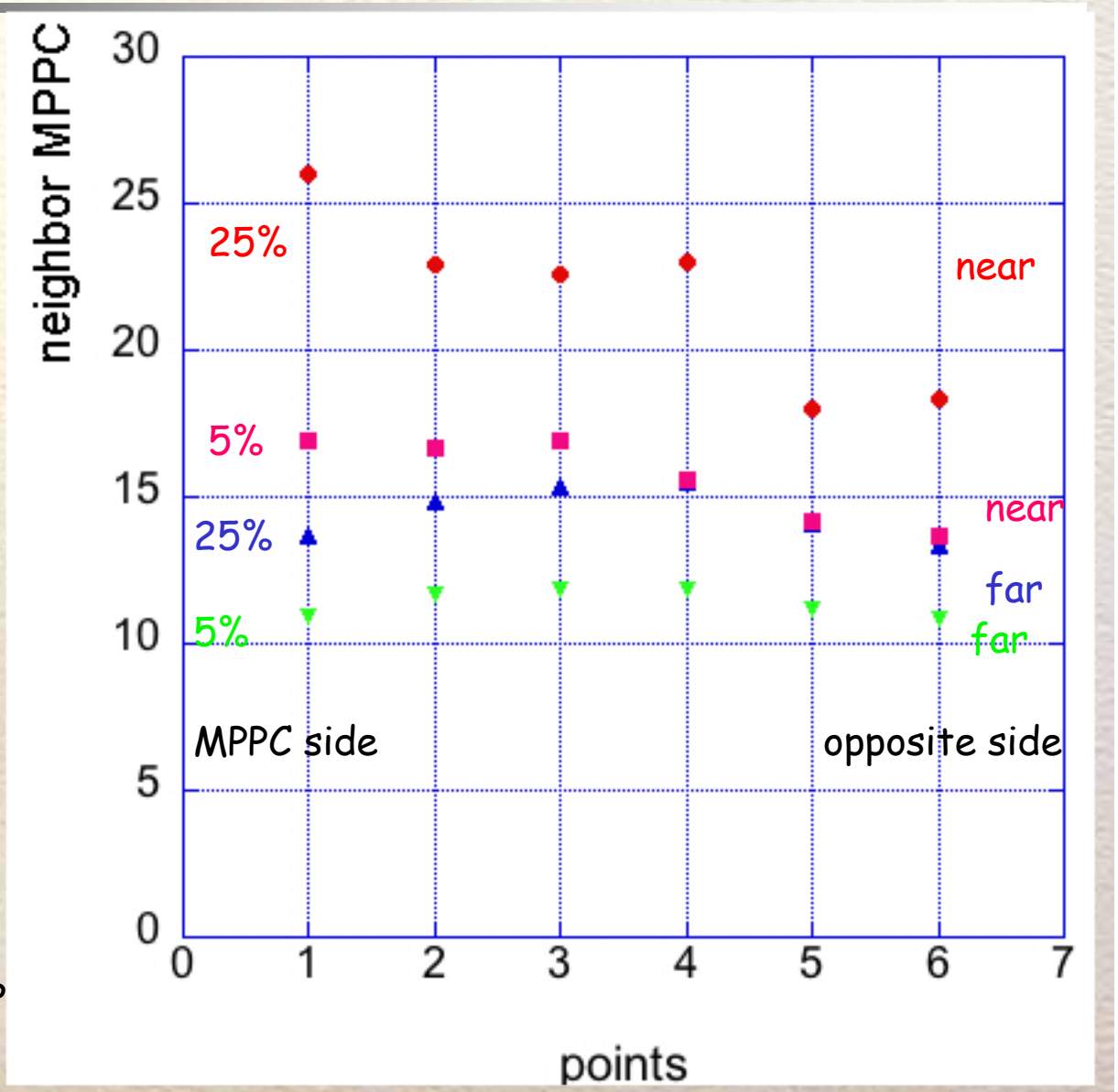
Homogeneity Measurements

- Measurements in reference MPPC on far side and near side at both ends of strip
- Expect uniform distribution for each set of points, also for far and near side
- Fluctuations show systematic effects in reproducibility



Homogeneity Measurements

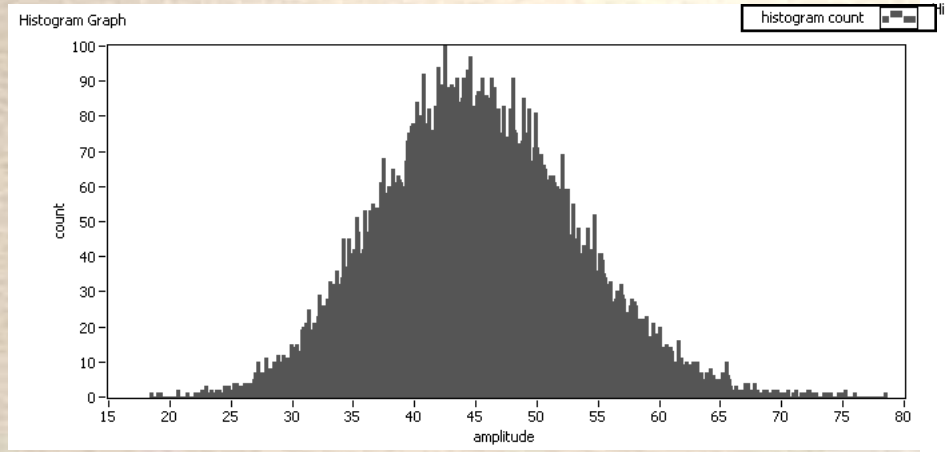
- Measurement of the neighbor MPPC
- Light yield shows only small position dependence
- Drop from 25% to 5% is less than expected
- Student forgot to add reflector in the gaps
- I ask him to repeat 2% points with Tyvec in gaps and with a source



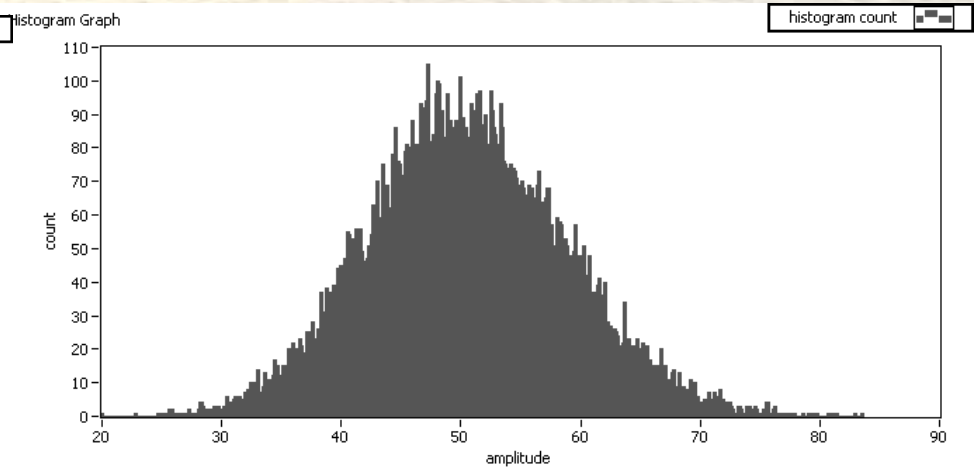
LY Distributions

- Light yield distributions look fine

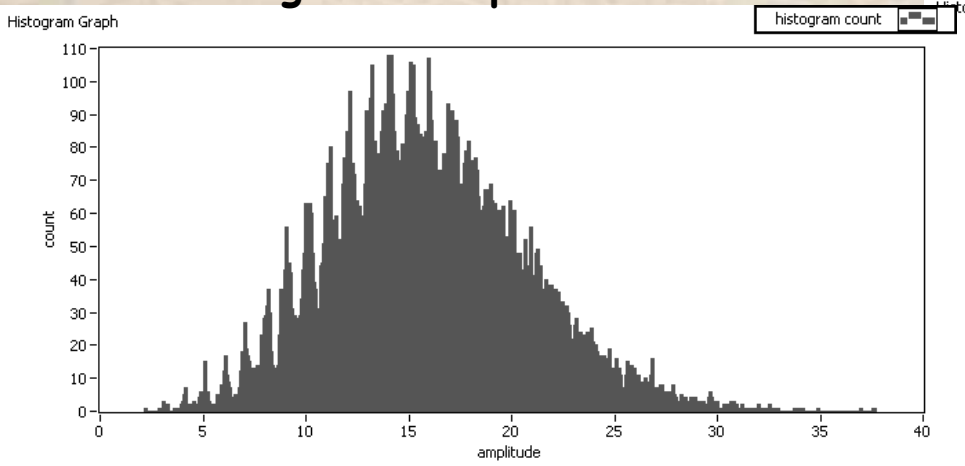
Reference near side



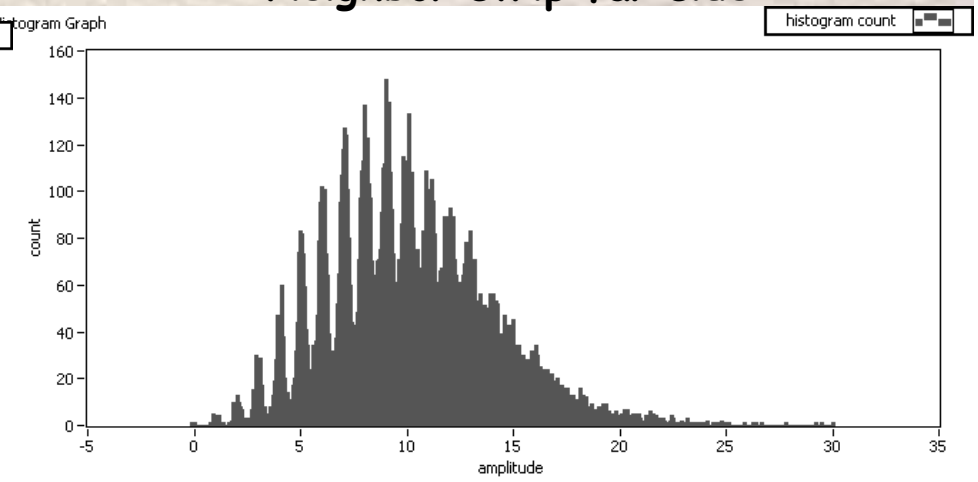
Reference far side



Neighbor strip near side

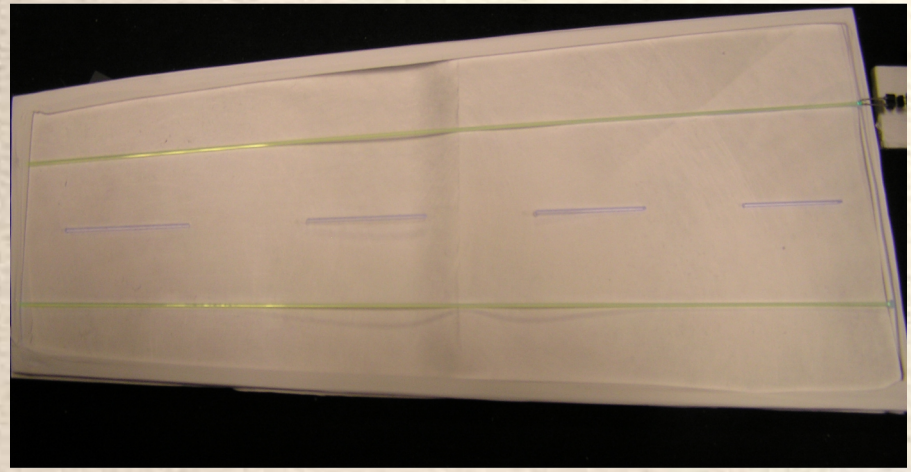


Neighbor strip far side

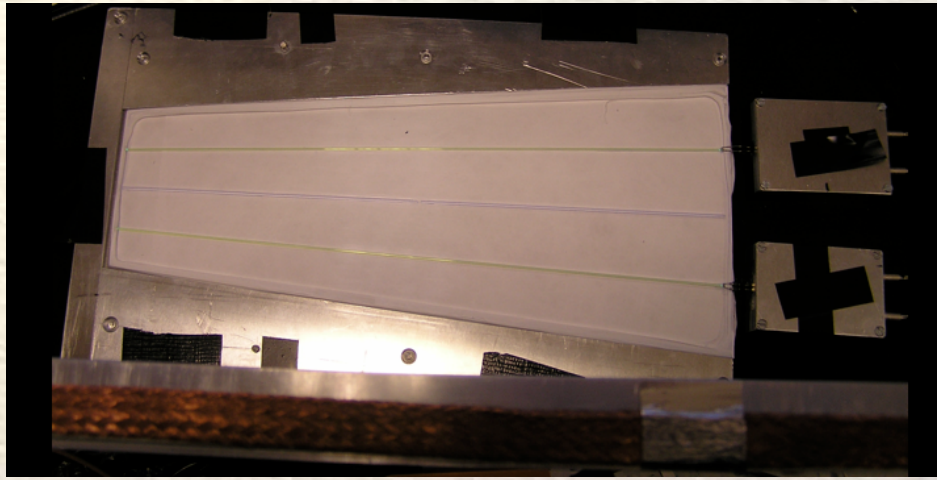


Setup for Cross Talk Measurements

- Layout for 50%



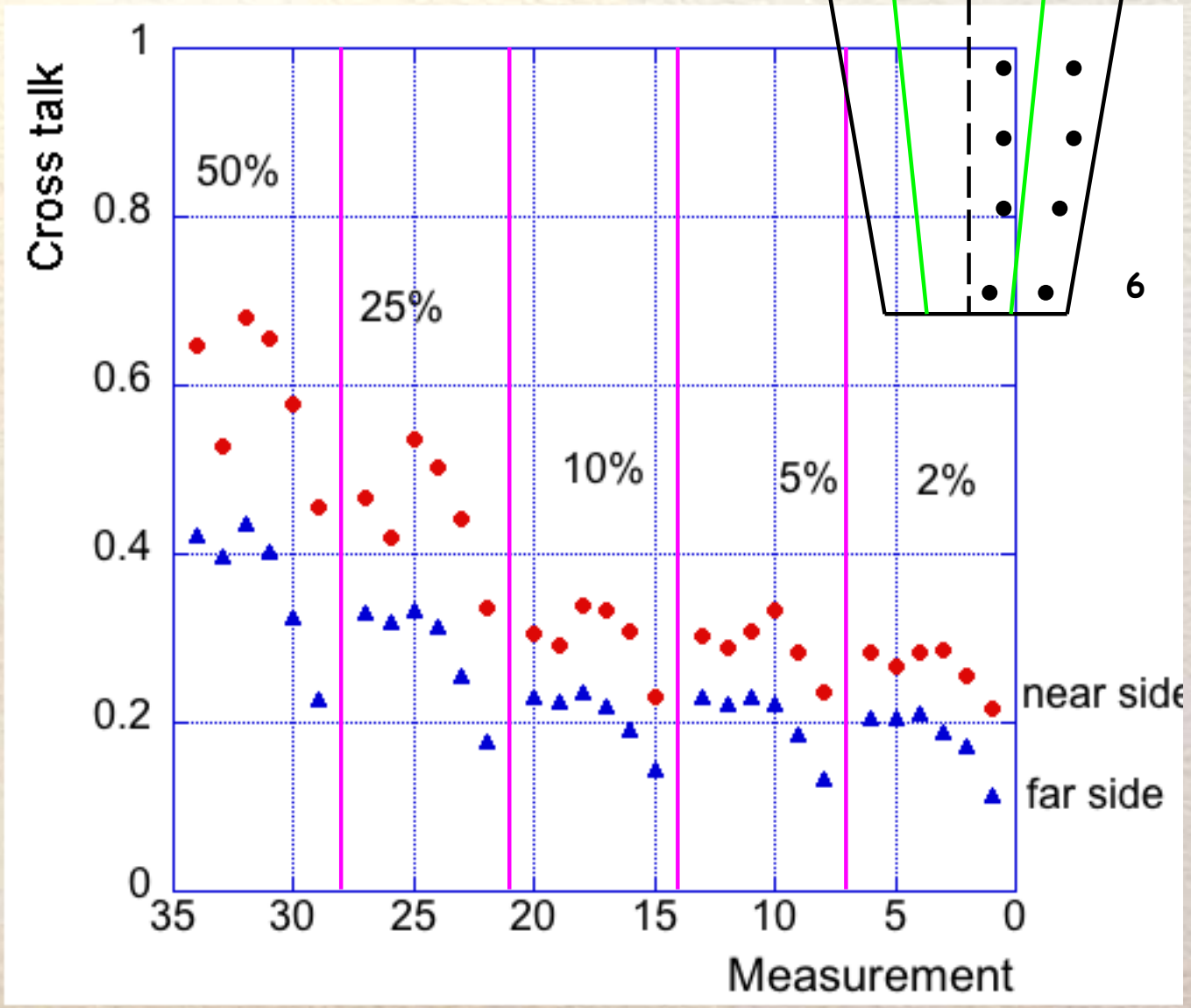
Layout for 2%



- 2 connected scintillator strips
- Bridges are clearly visible
- Strips are covered with Tyvec sheets edges are wrapped withTeflon

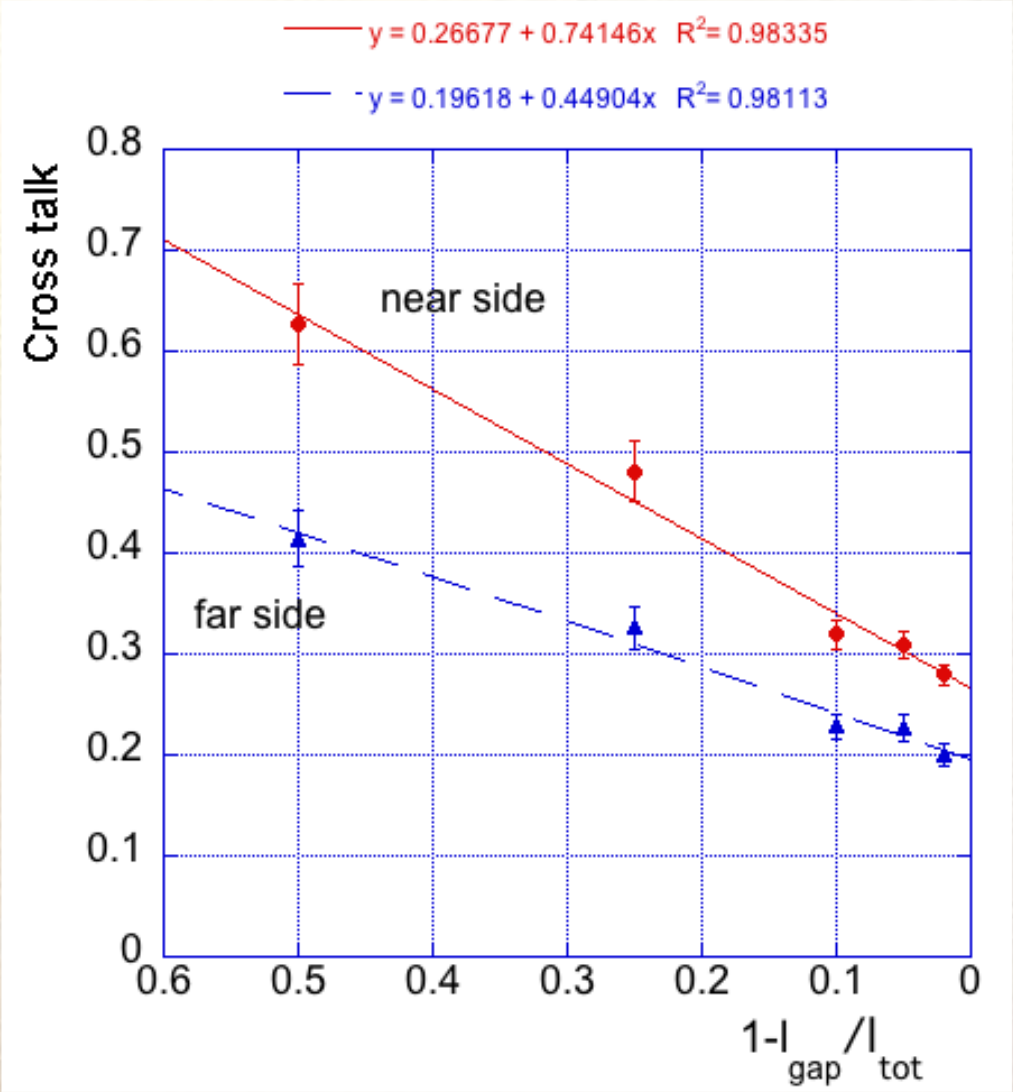
Cross Talk Measurements

- Sizable cross talk which is ~ 50% larger for near side than for far side
- Cross talk is smaller on MPPC side



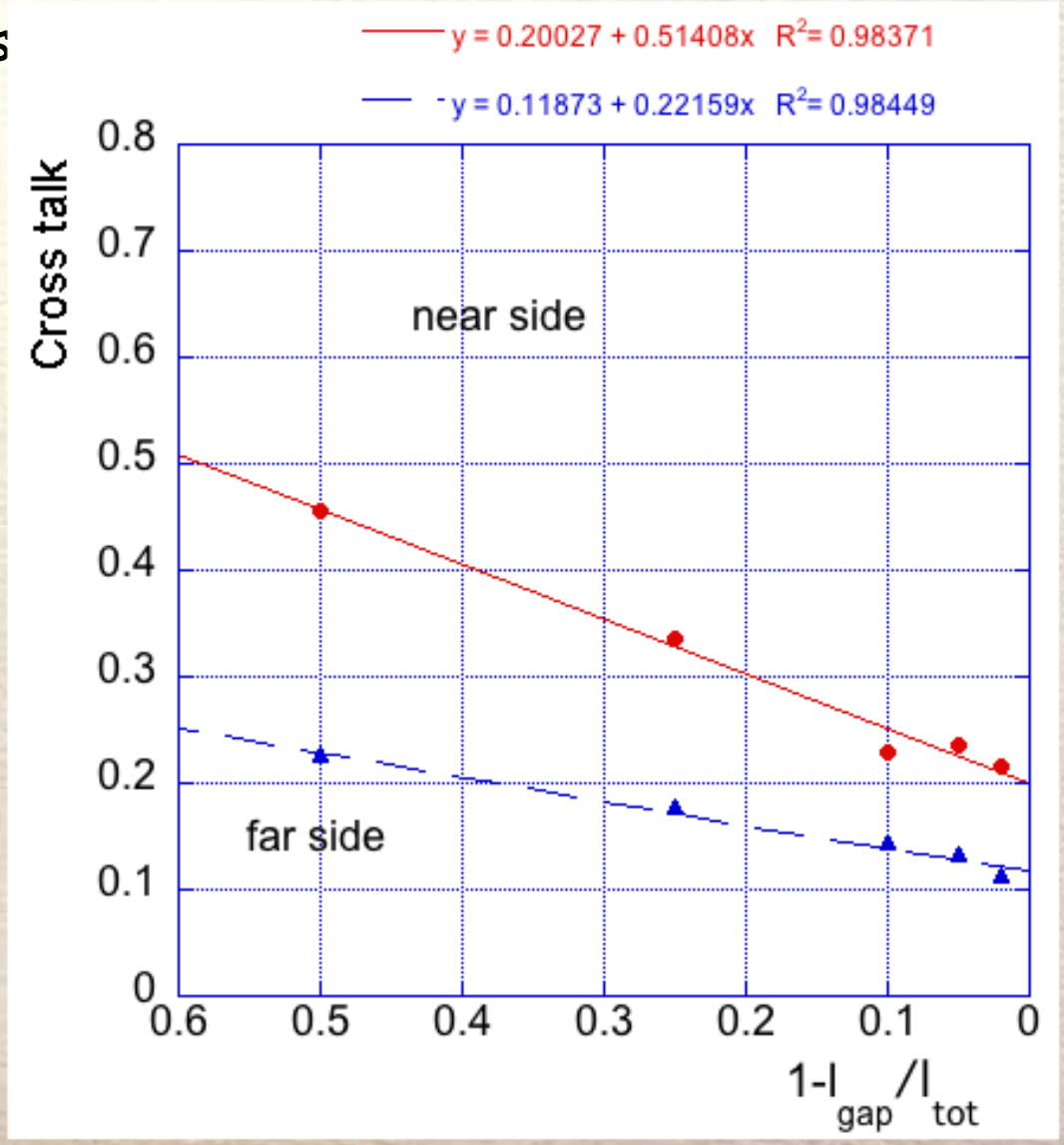
Cross Talk Dependence on Gap Size

- Average the six positions of far side and near side
- Cross talk dependence on gap size is smaller than expected
- Missing reflector may be reason



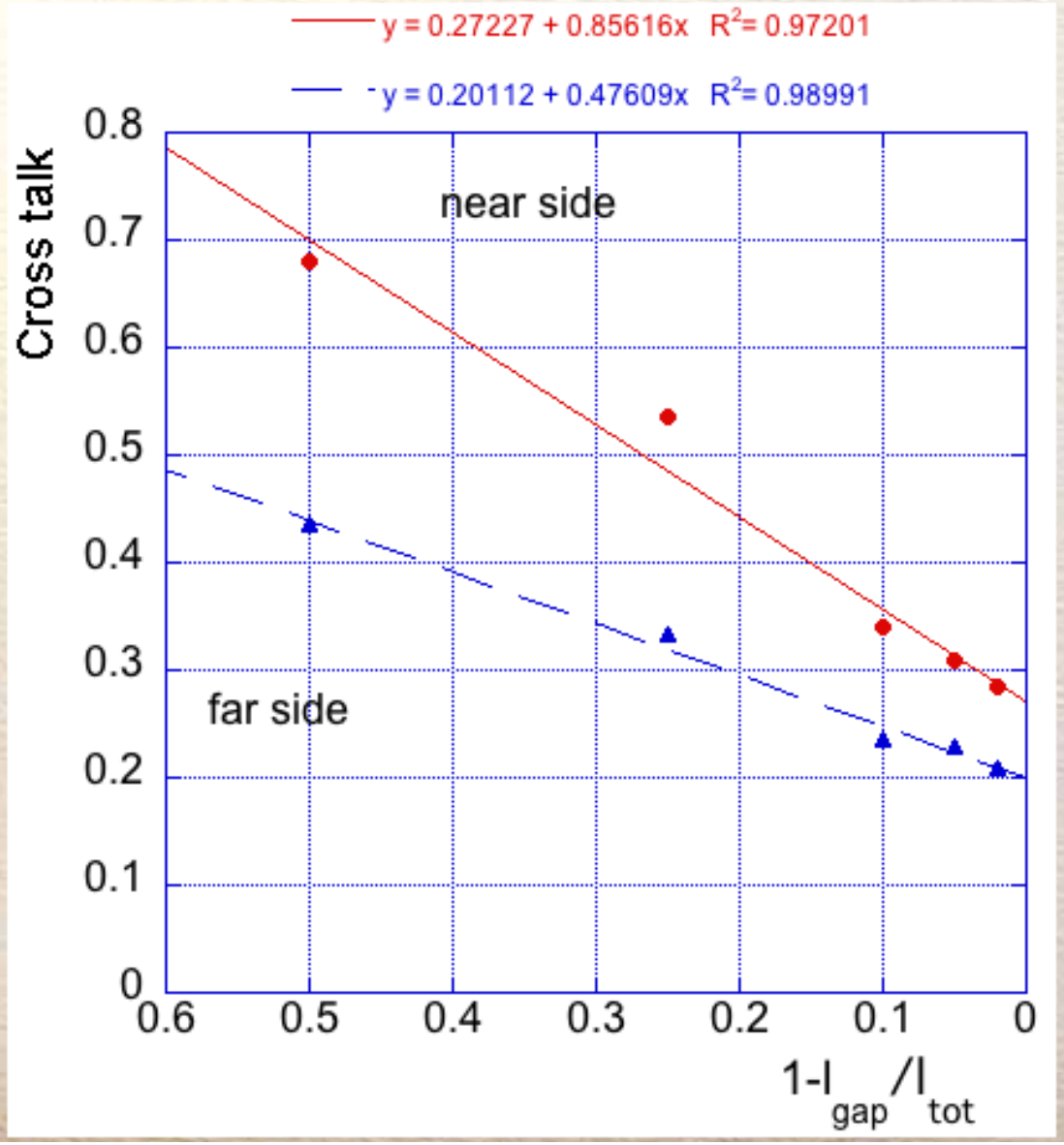
Cross Talk Measurements

- Average the four positions of far side and near side excluding two points on MPPC side
- Cross talk dependence on gap size is shallower



Cross Talk Measurements

- Plot cross talk of point closest to MPPC
- Cross talk dependence on gap size becomes steeper
- Overall cross talk is too high
- Check measurement with reflectors in gaps and using a source



Summary

- Most expensive items are ordered (scintillator, MPPCs), arrive soon
- I received a quote for the Y1 fiber, no response on Pb sheets yet
- I can use spare CMB board from Prague
- SPIROC chip testing will be setup in early April
- I have a fall-back RO scenario in case of too high n fluxes
- Revision of mech. support structure, started talks with machine shop
- Uniformity measurements indicate that we need to develop procedure
- Cross talk measurements with connected tiles look discouraging despite possible problem light coupling through air gap
- We are looking into a new technique for producing physically separated but still connected strips ➔ this introduces no cross talk

Next Steps

- I will start to order 500 m Y11 fiber this week, temperature sensors, TiO_2, and diffuse reflector soon (I got 20k CHF from instrumentation budget)
- If SPIROC chip looks right for this application we still need to worry about DAQ
- We will redo cross talk measurements for full-size sector strip
- We need to study light yield and uniformity of spiral strips and the arrangement of two strip segments connected via one Y11 fiber
- We need to do some more detailed shower simulations
- Evaluation of AIDA got 14.5/15 ➔ high probability that we get EU funds ➔ I will be able to hire postdoc or PhD student to work on the prototype apart from AIDA commitments