

Backward Calorimeter For SuperB

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SuperB meeting Frascati, December 2, 2009



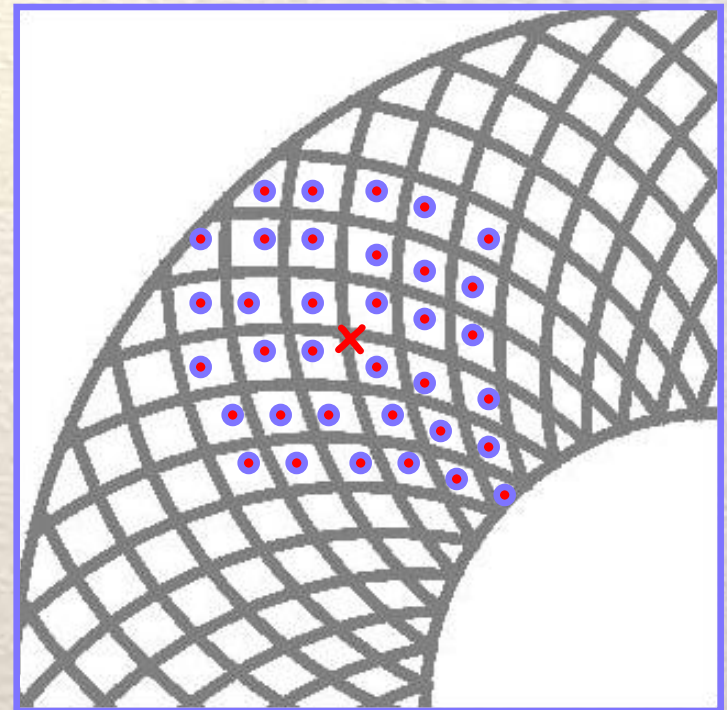


Outline

- Prototype Design
- Cost Estimate for Prototype
- Comparison of Direct Readout with Fiber Readout
- Cross Talk Measurements
- Summary and next steps

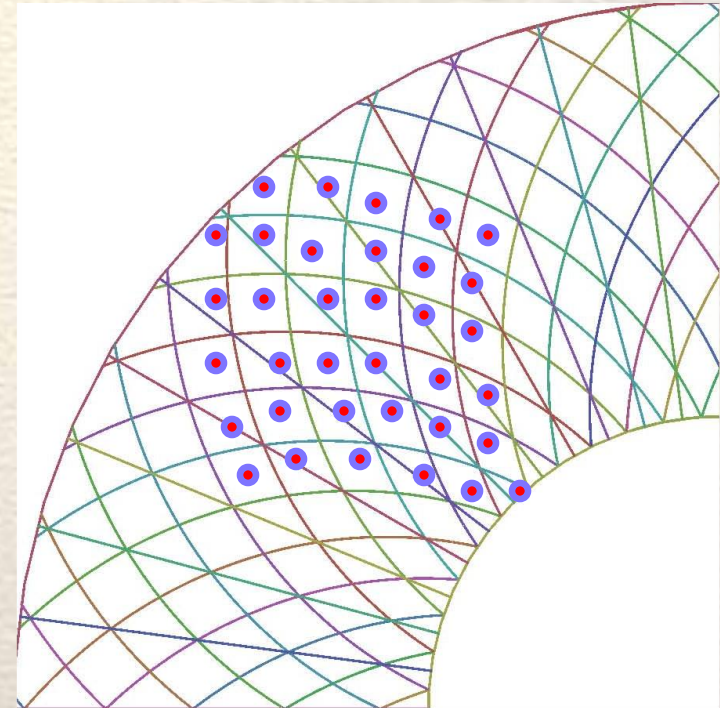
Prototype Design

- Use 75 cm x 75 cm scintillator plates (24 layers)
 - Use 75 cm x 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
 - Place UV LED at inner edge
 - Place temperature sensor near MPPC
- In this setup, scintillator & PB plates can be reused for full detector



Cluster Positions in the 3 Layers

- Tile sizes vary from 4 cm at the inner edge to 9.8 cm at the outer edge
- Since the Molière radius is 1.6 cm most particles hit one strip
→ shower is contained in the 6 strip arrangement





Cost Estimate for Prototype

- Scintillator material: St Gobain BC 404 sheets: 75 cm x75 cm \$980 ea → 24 k\$
- Pb sheet:
→ 24 sheets, size 75x75 cm² → 2.5 k\$
- Labor: 100 h for cutting rings → 3 k\$
- MPPCs: 1152 detectors, 90 \$ (w/o tax) → 11.2 k\$
- Fiber: 1 mm Y11 fiber, 500 m → 3 k\$
- Reflector → 3 k\$
- Frontend electronics:
100\$/channel → 1
- Support structure, Al? →
- Total → ~66.7 k\$



Prototype Preparations

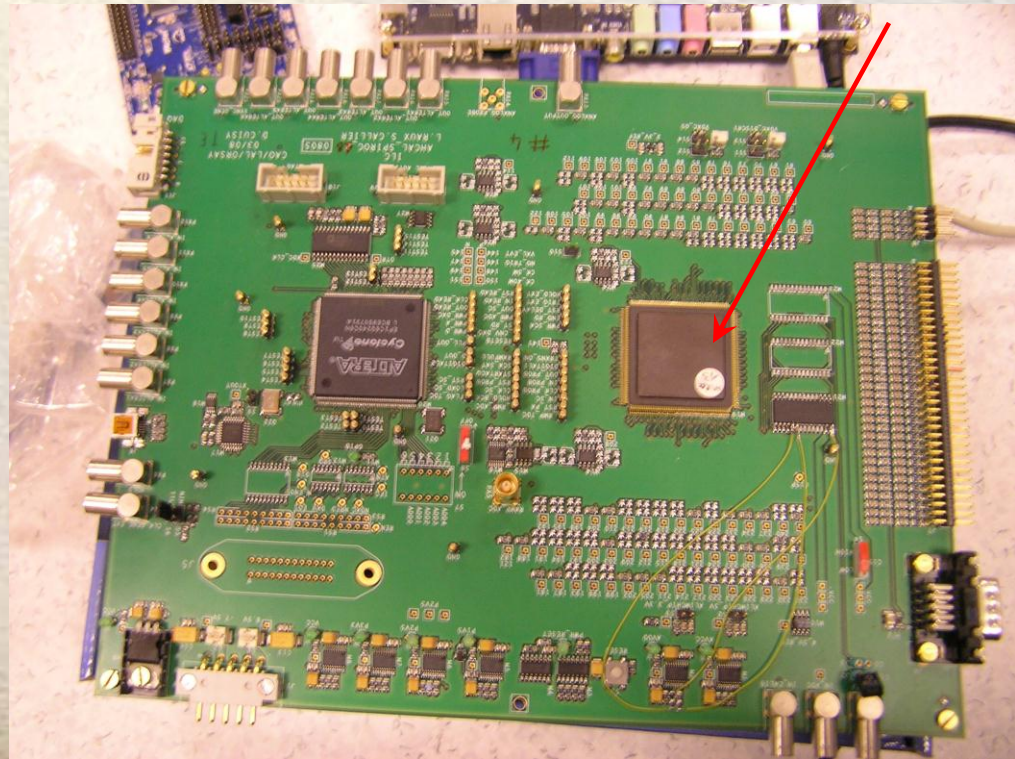
- I have ~34 k\$ that need to be spent this year
- In addition, I can use 16 k\$ from our instrumentation budget
- So I am missing about 18 k\$
- Spend money on readout components first
 - scintillators (3-4 months delivery time)
 - Y11 fiber
 - ~ 144 MPPCs
 - diffuse reflector
- 1 Preamplifier (1100 \$)
- I want to order components through CERN to avoid taxes
- Order will go out latest next week

SPIROC Chip Test Board

- I brought back a test board for SPIROC chip from DESY
- However, it is rather complicated to set it up
- Various drivers are needed (presently setup in Windows) but it is more advantageous to set it up in LINUX

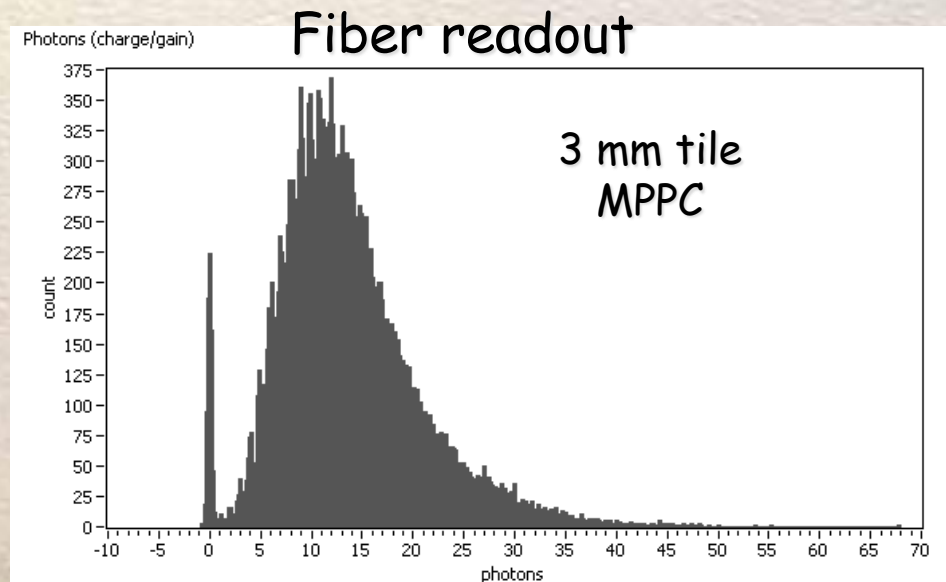
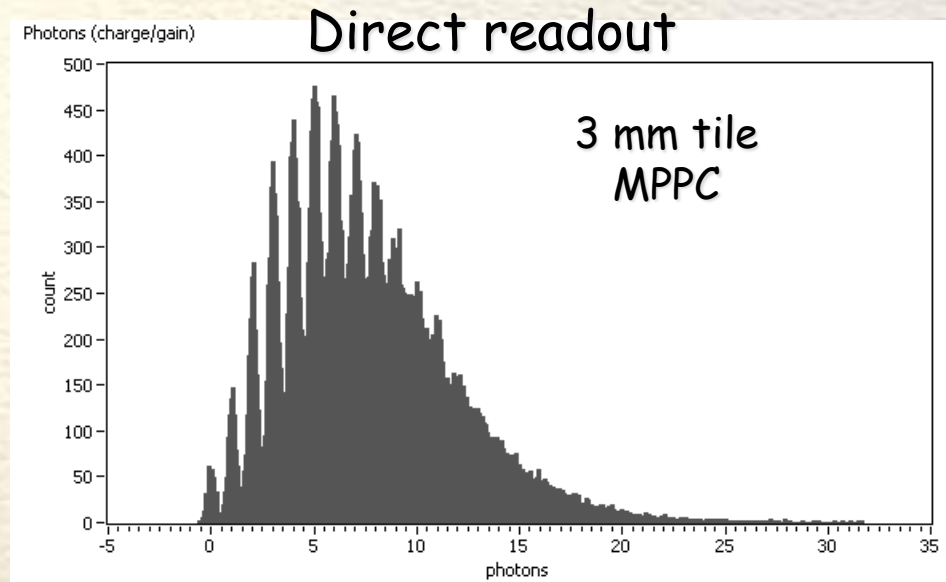
SPIROC 1

- After the holidays somebody from LAL will visit us and help us with setting up the test board
- I hope to get a newer board with SPIROC 2 as well



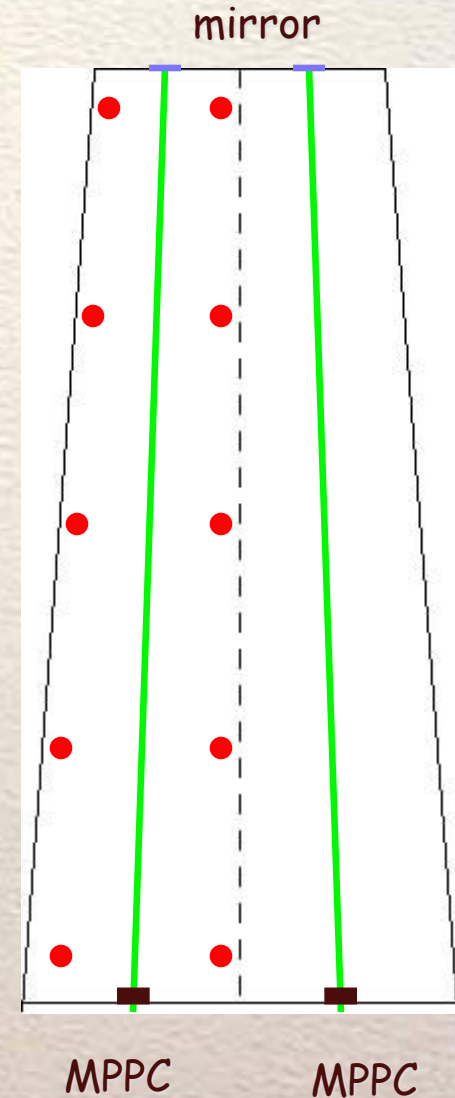
MPPC Readout of 3mm Thick Tiles

- Use ^{90}Sr source to measure MIP position
- Trigger on scintillator below tile read out with PM
- MIP peak is ~ 6 pixels for direct readout
- MIP peak is ~ 11 pixels for fiber RO
- Extrapolation from 5 mm tile yields 8-9 pixels



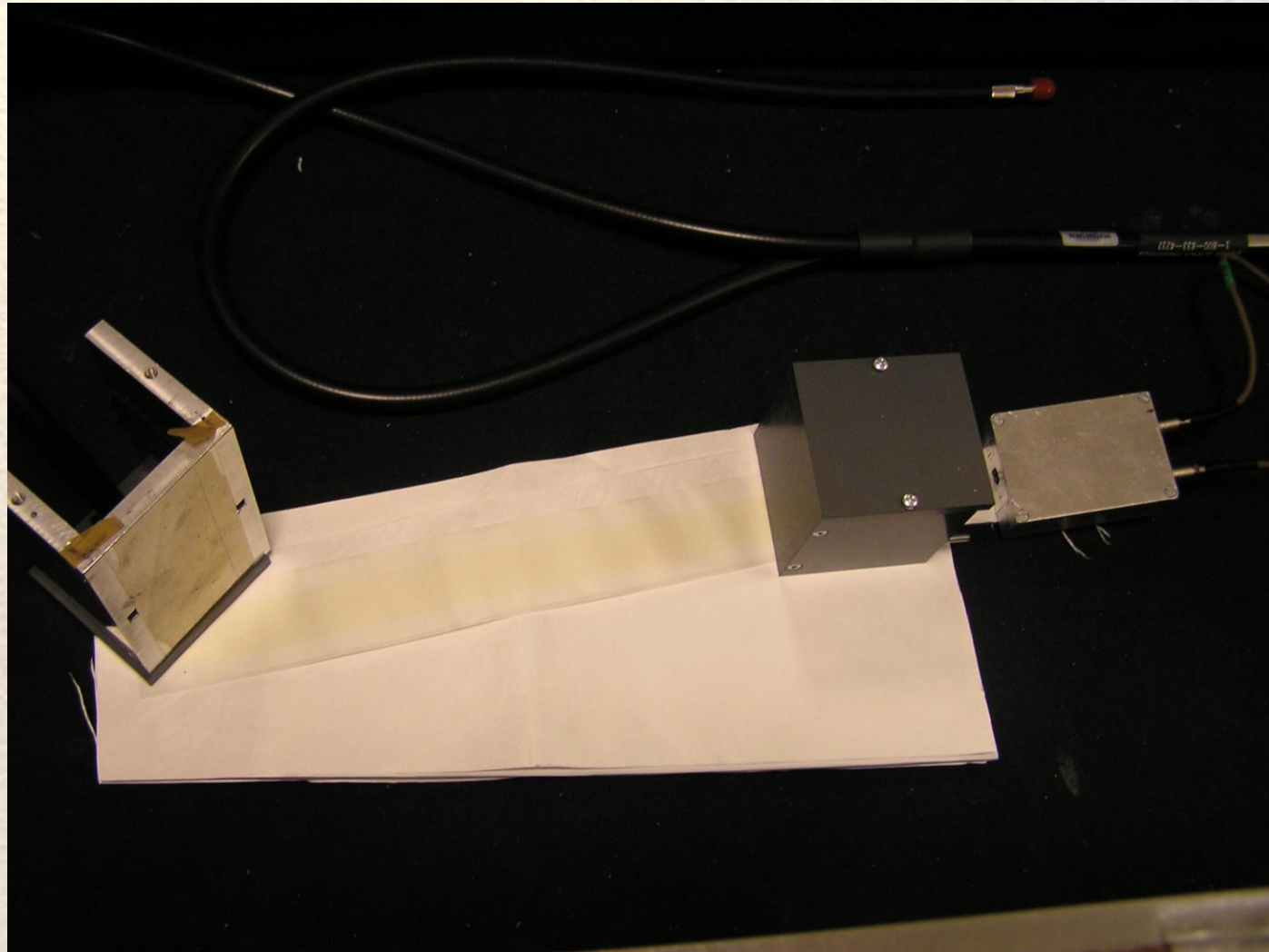
Cross Talk Measurement

- Machine two tapered strips that are separated by cuts
- Start with ~50% bridges and measure cross talk, average several measurements and take ratio
- Shine LED light via a clear fiber on 10 positions to check homogeneity and measure cross talk
- Remove bridges down to 1-2% in steps to establish a relation of cross talk vs size of bridges → consider points: 50%, 25%, 15%, 10%, 5%, 2%, 1%
- Redo this for spiral strips



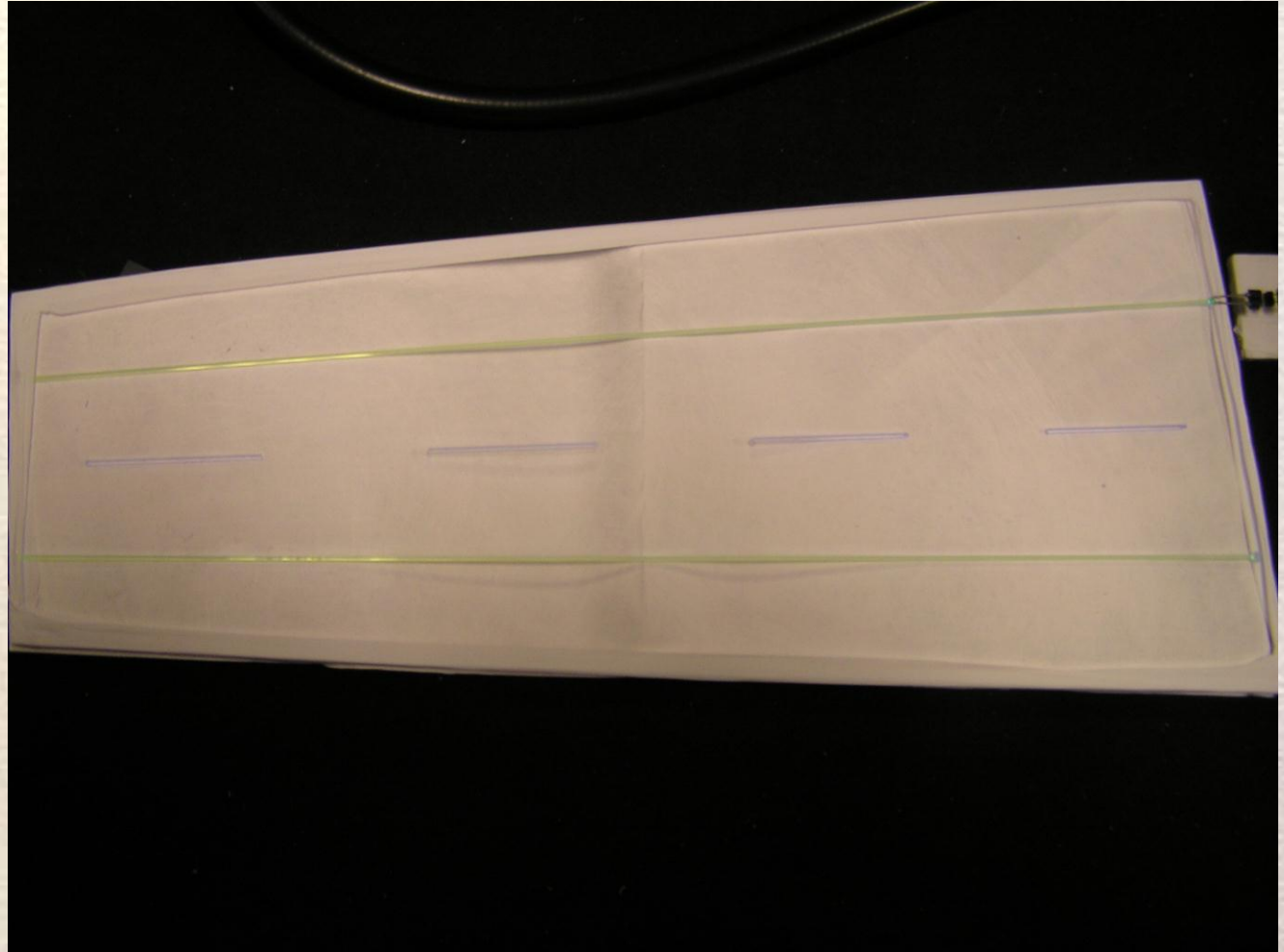
Setup for Cross Talk Measurements

- Use UV LED
- Fiber is held by Al fixture
- Since we have only 1 preamp we presently use the same MPPC for both strips
→ introduces systematics
fiber-MPPC matching
- Try to get another preamp



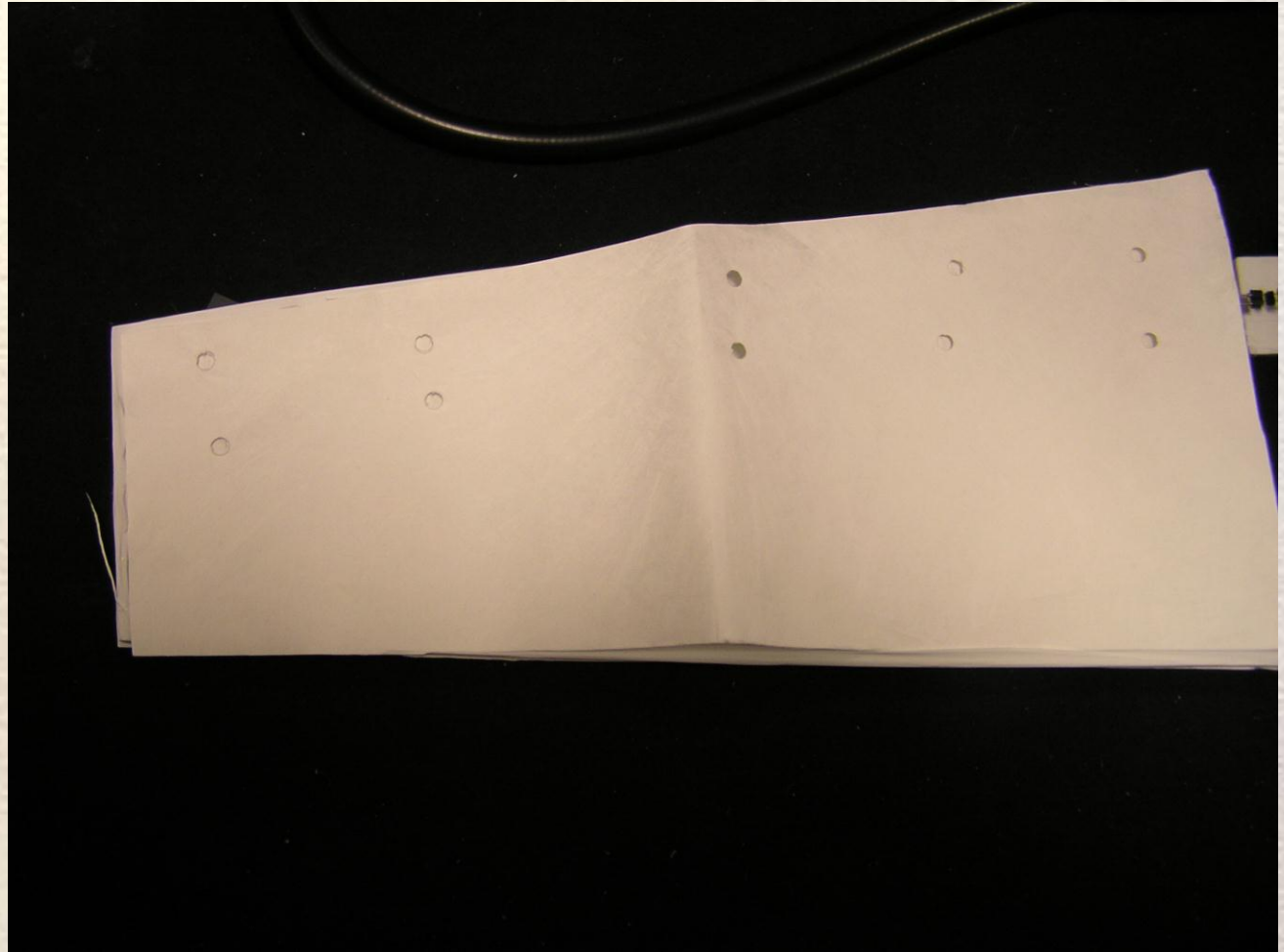
Setup for Cross Talk Measurements

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



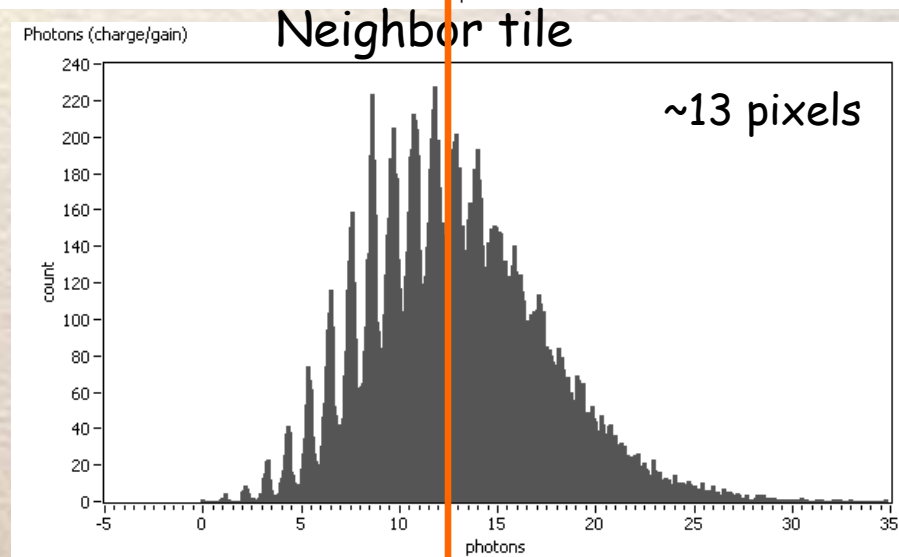
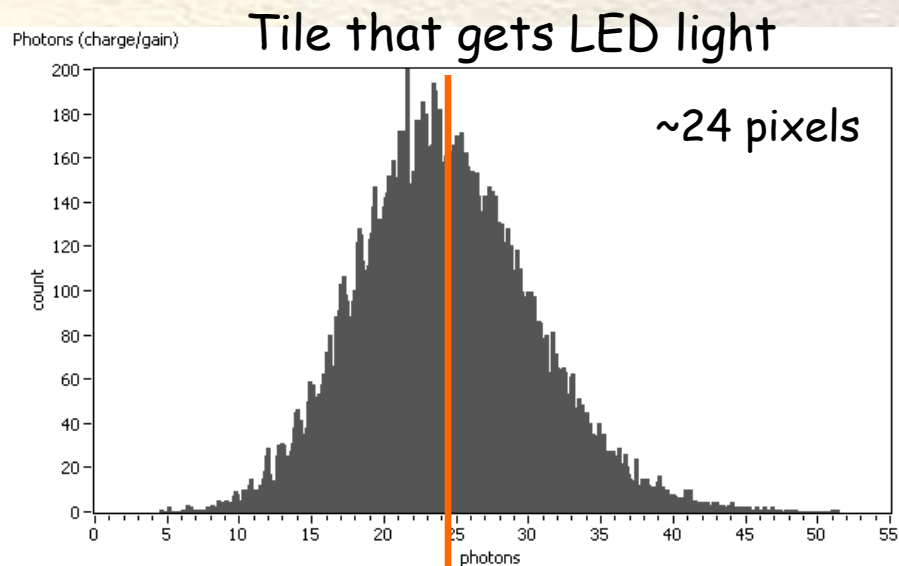
Setup for Cross Talk Measurements

- Tyvec sheet with 10 holes to insert clear fiber



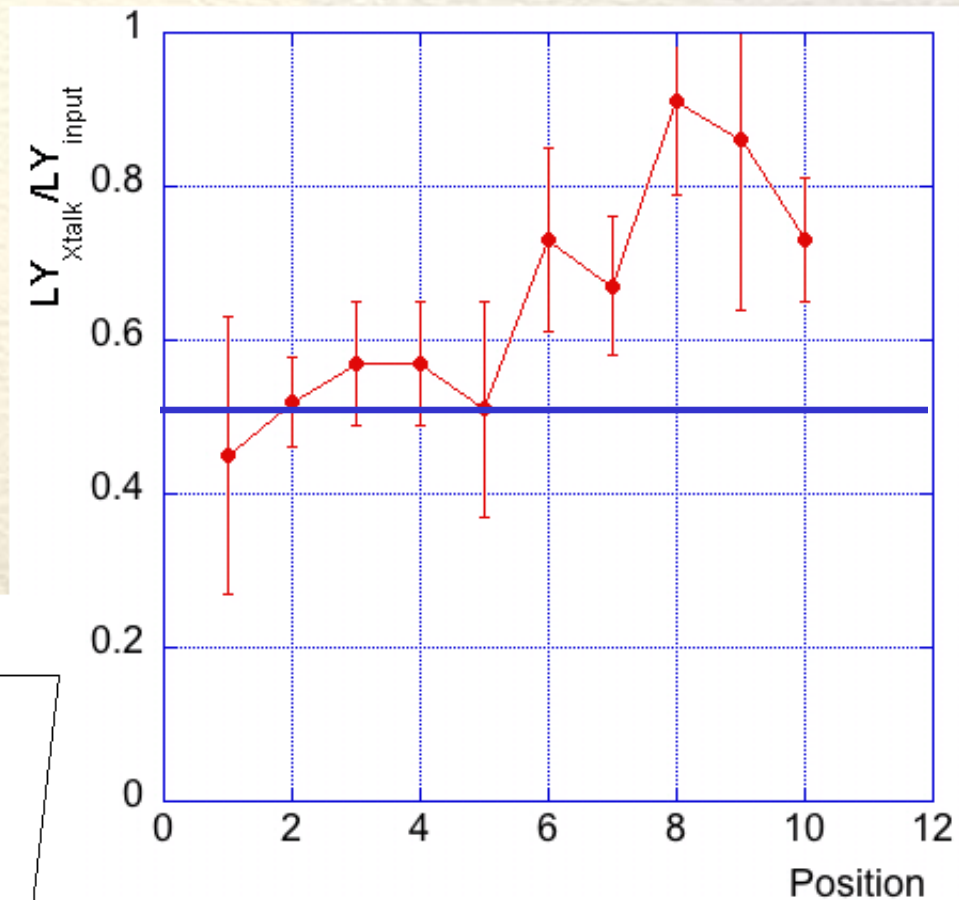
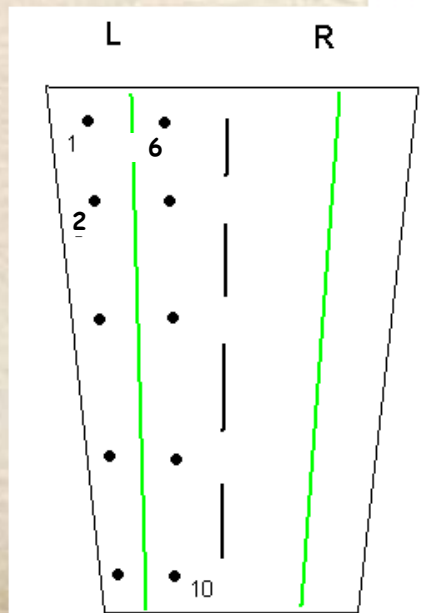
Cross Talk Measurements

- The 2 tiles are connected by bridges that cover 50% of the total length
- Total length is 12' (Eljen scintillator)
- We shine light from an LED via a clear fiber onto tile at the outer broad side
- We measure with the same detector first light from tile that is illuminated and then neighbor tile
- We have repeated these measurements a few times
 - ➔ systematic effect, groove for MPPC is too large to reproduce optimal MPPC-fiber matching



Cross Talk Measurements

- Plot cross talk for 10 measurements at 10 points
- For light far from neighbor we get results consistent with 50% expectation
- For light close to neighbor we get results consistent that are $\sim 70\%$ which are much higher than the expectation
- So maybe the bridges should be at the top and bottom





Summary

- One quadrant with 6 instrumented strips are sufficient for prototype
→ advantage that both Pb plates and scintillators can be reused in the full backward EC EMC
- I have allocated nearly 75% of the costs for the prototype and will start ordering components soon
- We have SPIROC test board and experts from LAL will come to Bergen in January
- Cross talk measurements have started → for light inserted on the far side we see agreement with expectations, while for light inserted on the nearside the cross talk is almost 50% larger
- In $3\text{ cm} \times 3\text{ cm}$ tiles fiber read out yields ~ 11 pixels/MIP, this is better than extrapolated from AHCAL (scintillator? reflector?)



Next Steps

- We will continue cross talk measurements down to 1-2% bridges
note: 1% corresponds to total length of 4 mm, may not be feasible?
We need to reduce the systematic from fiber-MPPC coupling
(reduce groove holding MPPC, keep readout fixed by using 2 MMPCs)
- ➔ At DESY I heard that the AHCAL prototype has a cross talk problem at a few % level probably caused by the reflector sheets
- ➔ this has annoying effects in the energy reconstruction and resolution
- ➔ maybe we need separate strips?
- If connected strip remain a realistic scenario, we need to study the cross talk of connected spiral strips
- We need to study light yield in spiral strips and that of two strip segments connected via one Y11 fiber
- We need to do some more detailed shower simulations



Search for Collaborators

- I presented the backward EC EMC to the ILC calorimeter group at DESY 2 weeks ago
- The talk was well received
- At the end I invited the DESY group to join SuperB, helping us with the backward EC EMC
 - ➔ they are interested, but I have to find a German University group too, since the role of DESY has changed to that of supporting lab