
Backward Calorimeter
Update
G. Eigen, U. Bergen
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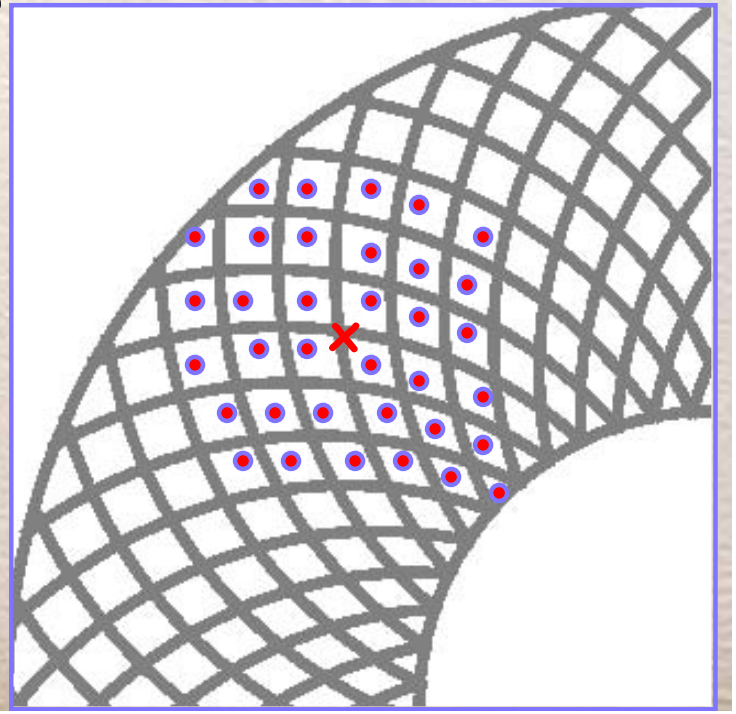
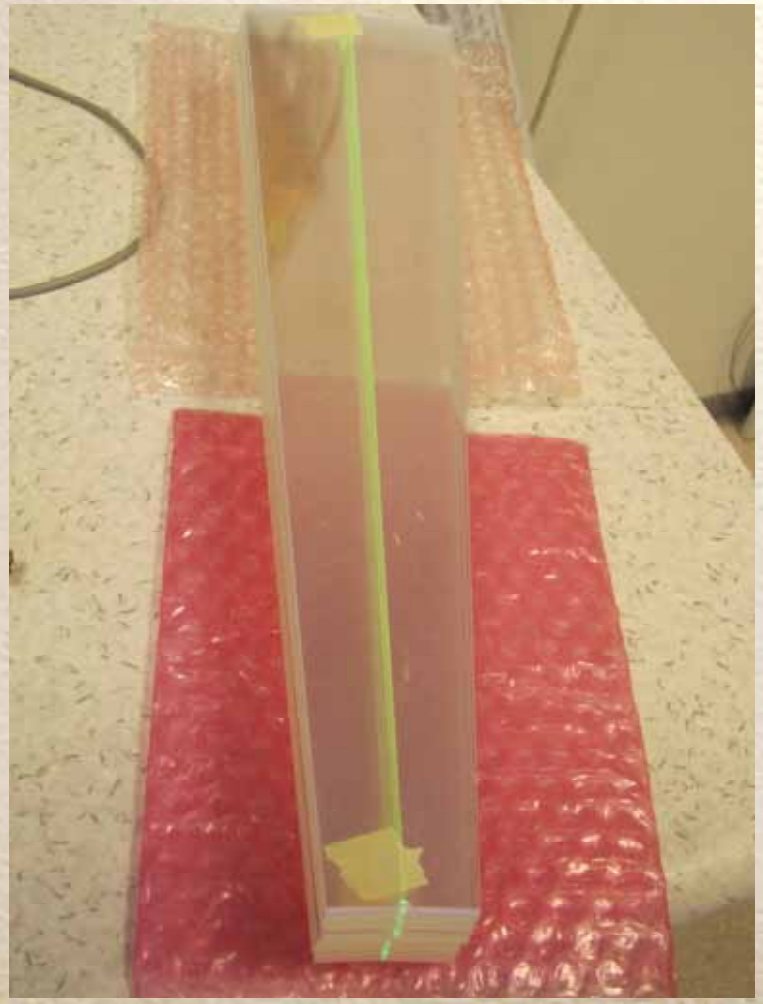
Introduction

- The backward endcap EMC prototype consists of 24-layers of Pb plates and scintillator strips ➔full depth is 12 X_0
- Pb plates are 2.8 mm thick ring segments
- Scintillator strips are 3 mm thick left-handed spirals, right-handed spirals radial segments that alternate eight times
- It is sufficient read out 6 strips per layer since strip sizes are larger (4.1-9.8 cm) than one Molière radius (3.8 cm)
  ➔ total of 144 readout channels
- Each scintillator strip is read out with a WLS Y11 fiber positioned in a groove in the center of the strip and coupled to an MPPC at the outer rim

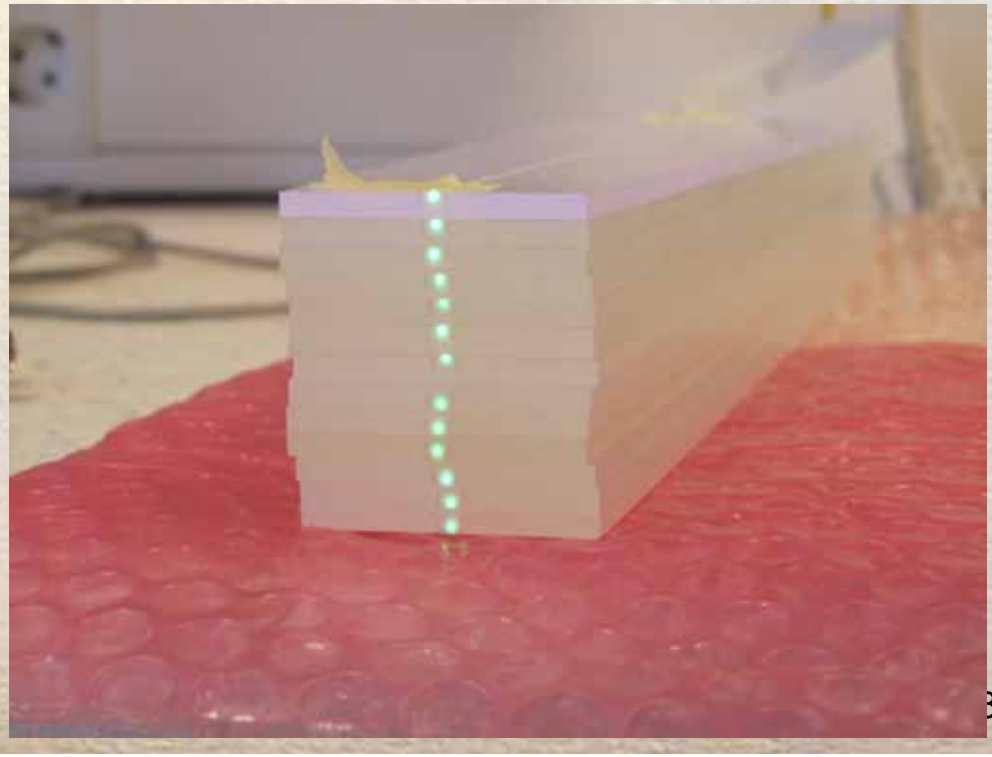


Status of Prototype Preparations

- 14 out of 48 sector strips have been produced in our workshop with the old milling machine



- Machinist said that rest will be before summer vacation
- Spiral strip will be cut with new milling machine



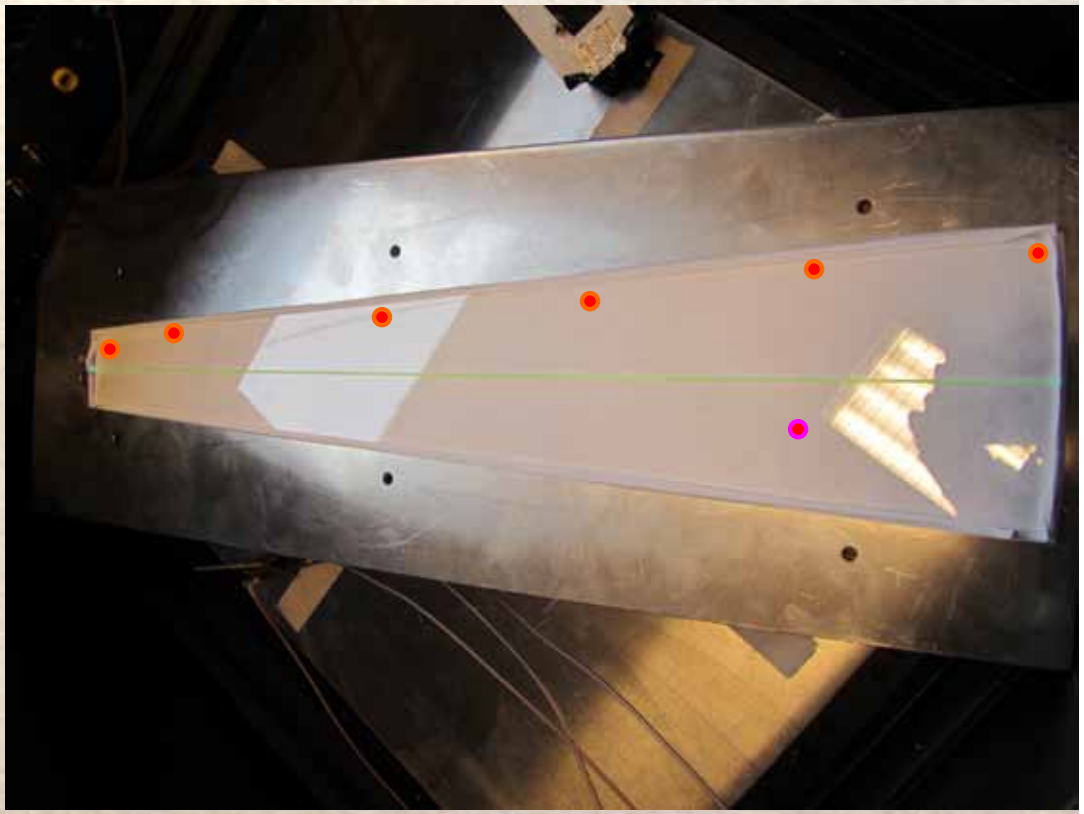
Status of Prototype Preparations

- The Pb plates have been at Bergen for several months

- I am negotiating with DESY to help out with cutting the logarithmic spiral strips
- Since the strips need to be held at a fixed position in each layer, I need to buy plastic filler material that need to be cut to the right shape
  ➔ 48 additional pieces
- Missing components:
  - 3 mm thick plastic filler material
  - 30m Y11 fiber
  - Diffuse reflector sheets and paint
  - Temperature sensors
  - Get 3 more SPIROC boards from LAL
  - Get calibration board and clear fibers from Prague

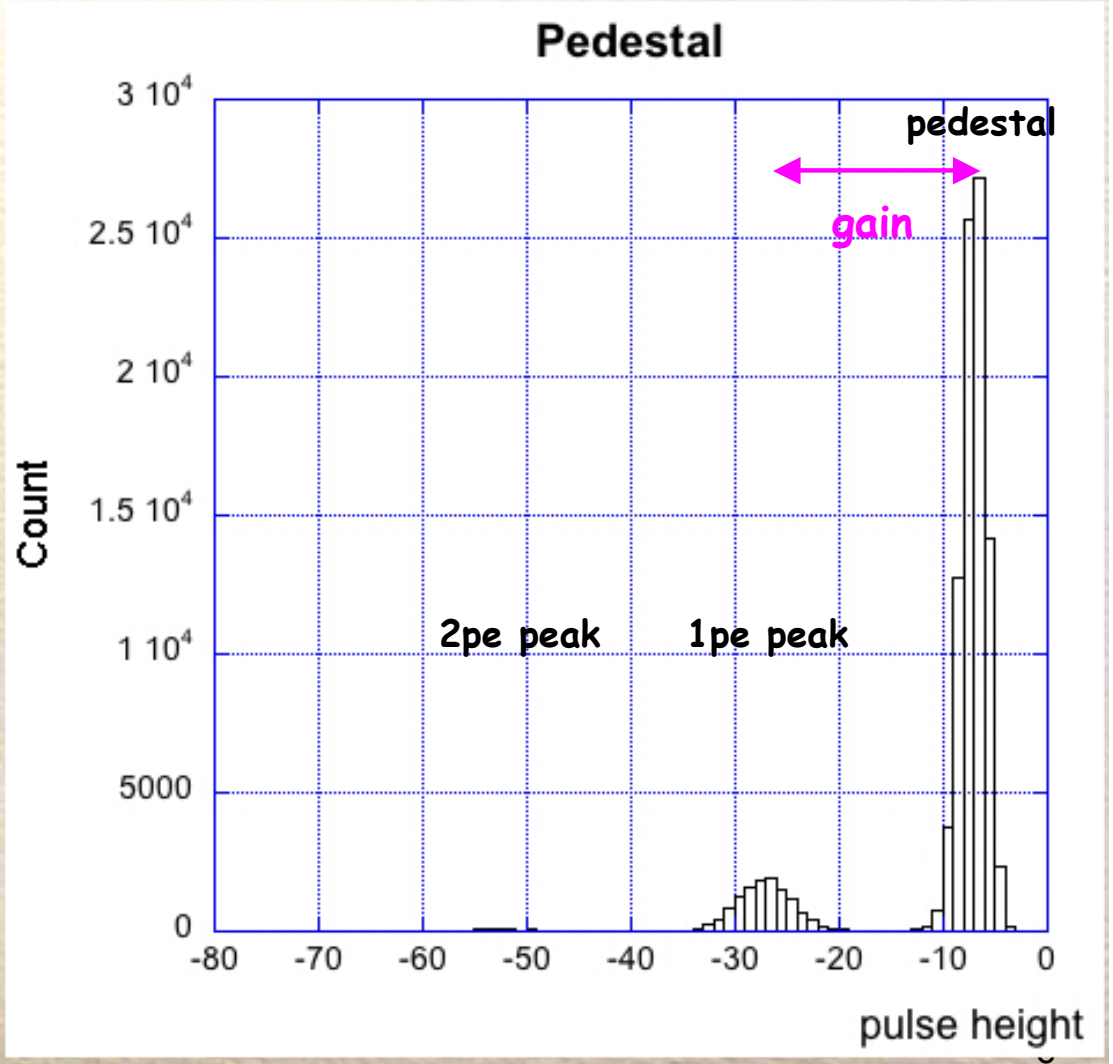
Light Yield and Uniformity Measurements

- Use first sector strip with Y11 fiber positioned in the center read out with MPPC at outer end (RHS)
- Top and bottom faces are covered with TYVEC
- Side faces are covered with Teflon tape
- Measure light yield with ^{90}Sr source
- Measure non-uniformity with light pulser at 6 positions half a cm off outer and inner end plus four points separated from position outer position by 10 cm steps
- Measure both peak and area (charge)



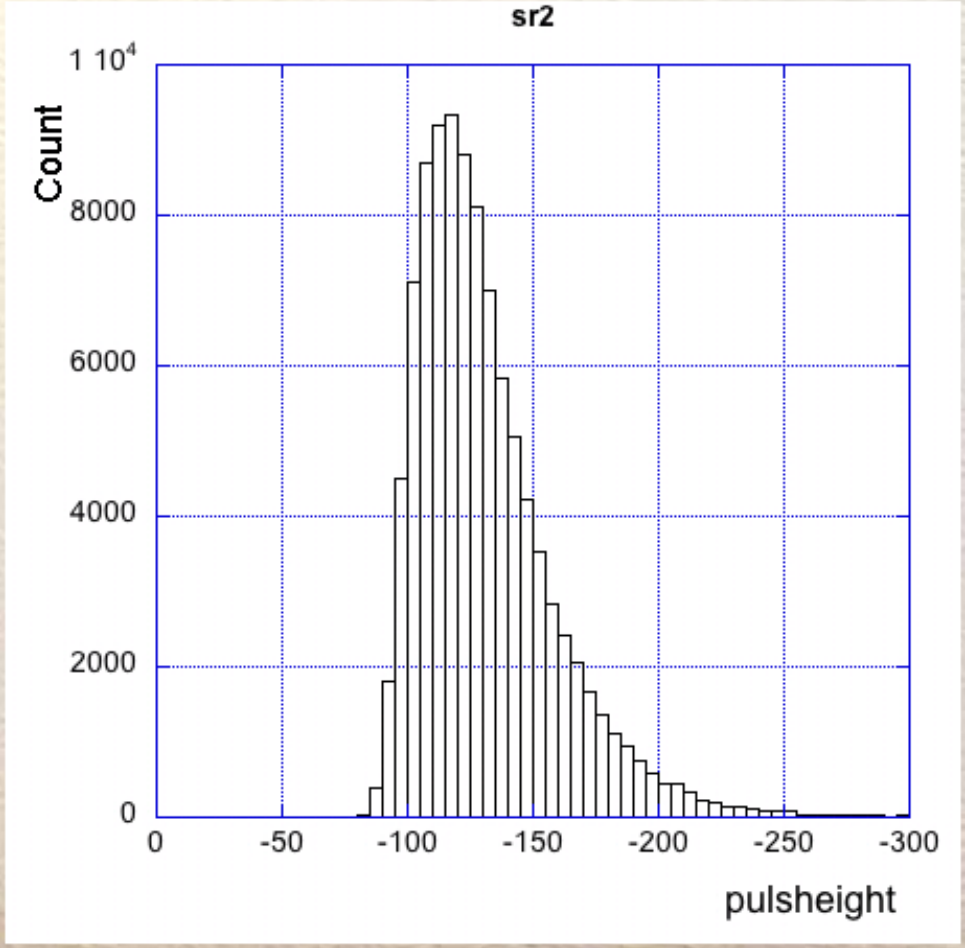
Light Yield Measurements

- Use random triggers to measure position of pedestal and that of single p.e. peak
- Set threshold at zero bins
- Pedestal is at bin 6.5
- Single pe peak is at bin 26.5
- Gain is 20 bins



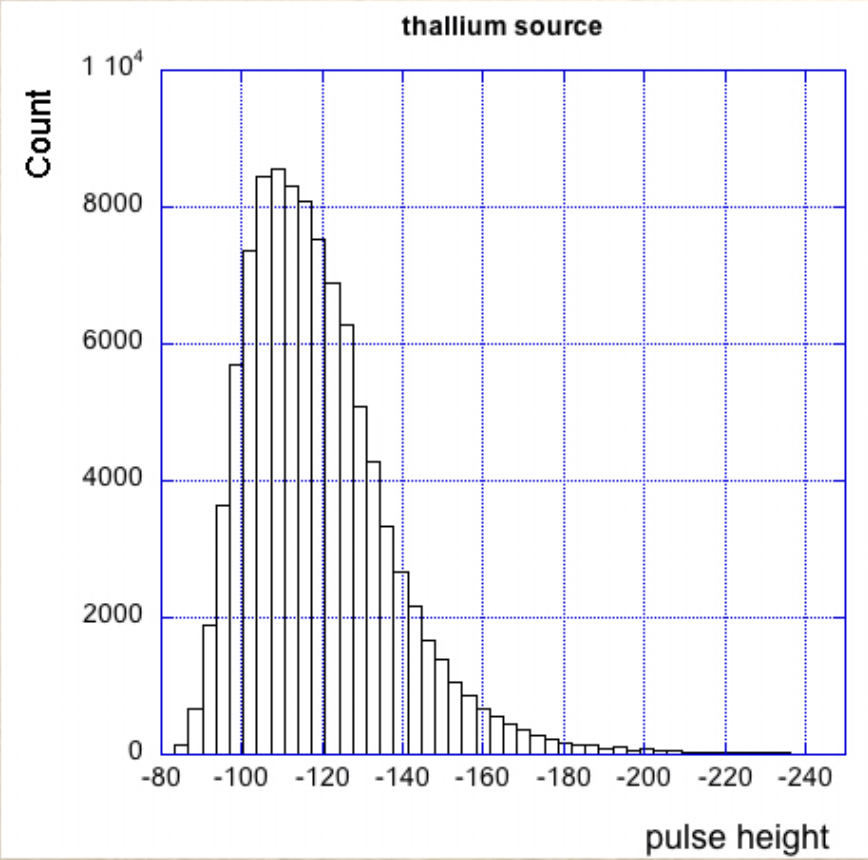
Light Yield Measurements

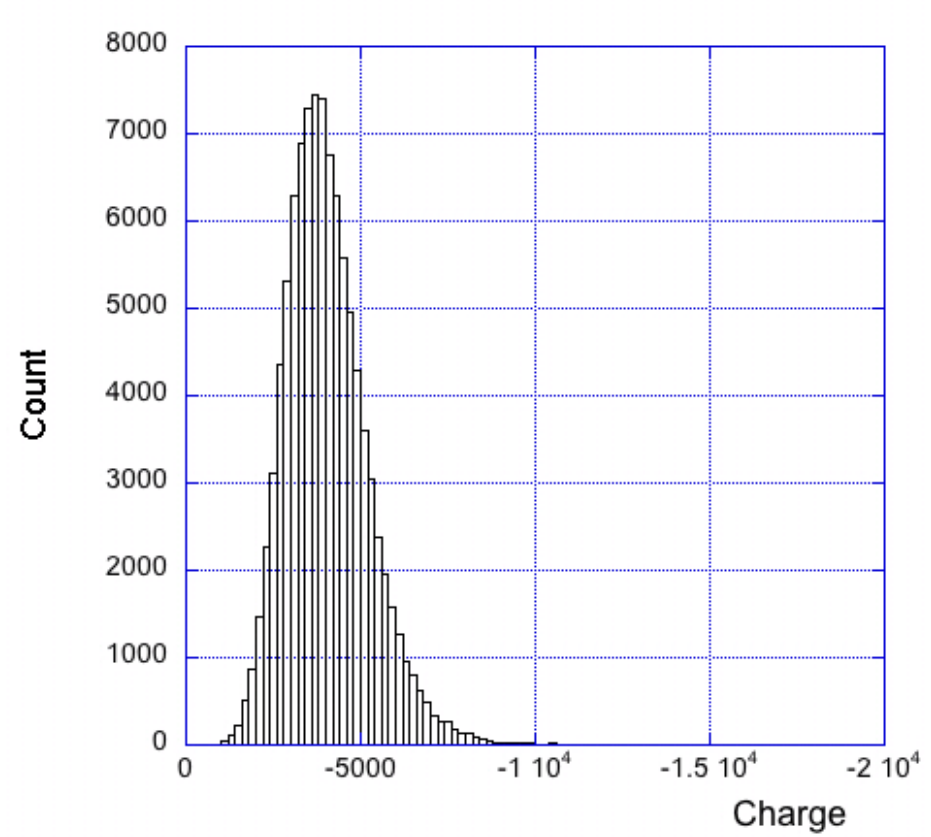
- Measure absolute light yield with ^{90}Sr source placed in lower third of the strip directly on top of the strip (point source in AL housing)
- Endpoint energy is 2.283 MeV
- Set threshold at -75 bins to enhance source triggers
- For time reasons, I did not install a trigger counter below the strip
- Thus, electrons have variable path lengths (not just 3 mm) some stop inside scintillator others may be under an angle
- MIP peak is in bin 117.5 which corresponds to 5.9 p.e.
- For ^{204}Tl measure 5.6 p.e. at position further up



Light Yield Measurements

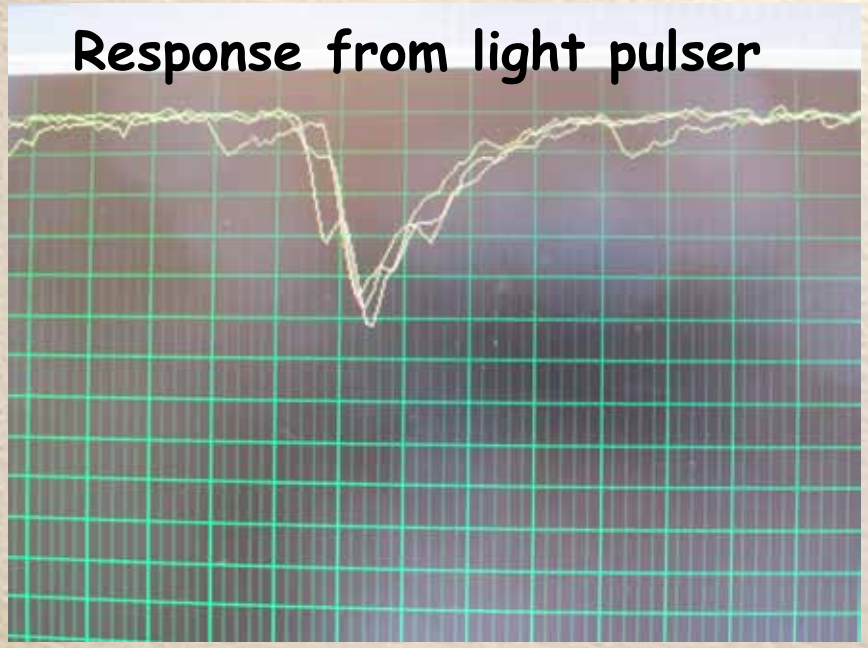
- Charge distribution looks good, but gain calibration is complicated, since distributions for pedestal and single p.e. overlap

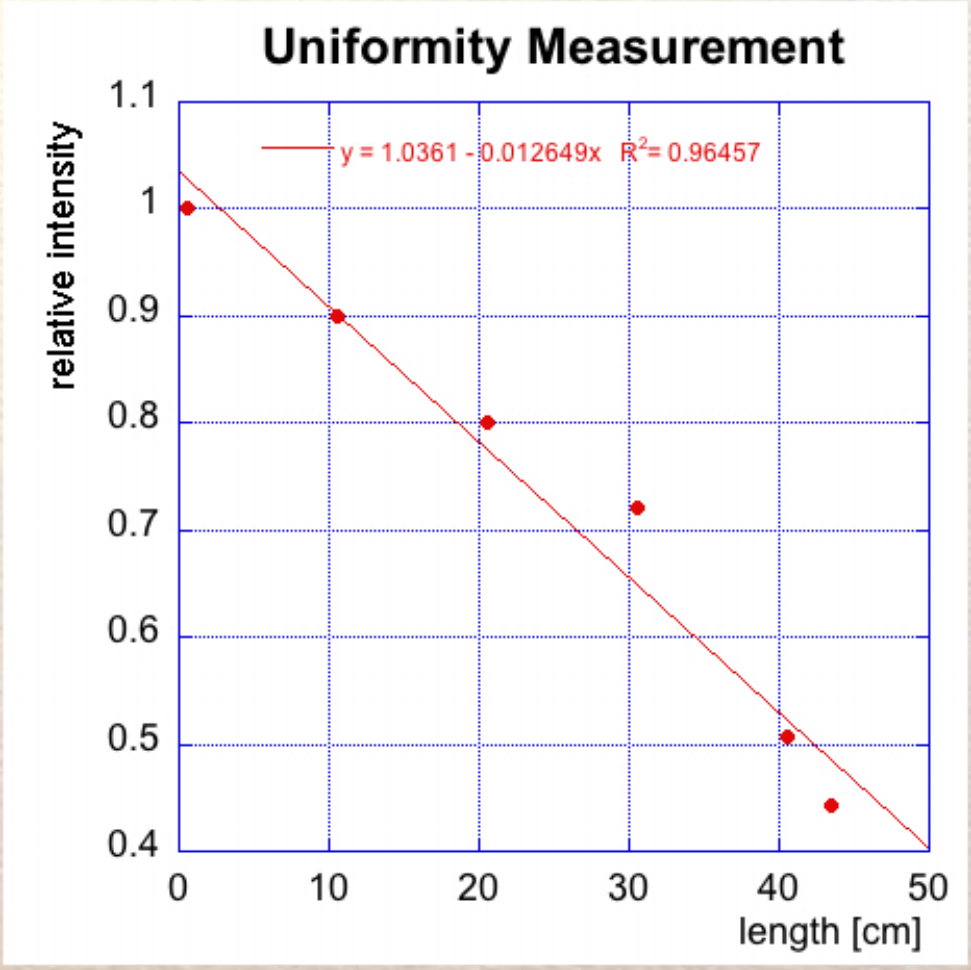




Uniformity Measurements

- The light yield clearly drops from the broad end to the narrow end
- The ratio of the 2 sides is 0.41
- See a slightly higher yield





Light Yield Adjustments

- In the prototype, the side faces will be painted white
- We will perform reflectivity studies for the top and bottom faces
  ➔ due to past experience TYVEC seems to be a good choice for reasonable price
- We need to compensate for the non-uniformity effects
  ➔ develop pattern with e.g. black and white dots
- Light yield can be increased by removing air gap between fiber and MPPC (glue MPPC)
- To keep a high dynamic range MIP should be clearly visible but as low as possible
  ➔ MIP peak corresponds to 0.523 MeV at normal incidence
  ➔ so dynamic range is 270 MIPs or 142 MeV
  ➔ I can increase MIP to around 10 pe at broad end yielding dynamic range of 180 MIPS
  ➔ after making light yield uniform expect MIP around 5 pe and a dynamic range of 90 MIPS (in 24 layers 1.1 GeV observed energy)

Manpower Issues

- The AIDA project has officially started,
  - ➔ I will get a postdoc who will work 50% on the backward EC EMC prototype with target starting date August/September
  - ➔ We have to apply for funding of subatomic physics from NFR for 2012-2017 period in September (3 projects)
- One of my ATLAS master students has built a preamplifier, he is interested in helping me with strip testing and prototype construction
- A Chinese master student has been accepted by UiB, he will join me in August to work on the prototype
- Valerie Saveliev from Moscow said he was interested in SuperB, in particular calorimetry, (he is involved in the analog hadron calorimeter in ILD)
- A reorganization at the department will pour more technical students into the HEP group ➔may get another student in the fall

Cost Estimate

- Scintillator material: 10^5 cm^3 (89 Kg), St Gobain BC 408 sheets: 75 cm x75 cm $876 ea ➔140k$
- Labor: 1152 h for cutting sides and grooves ➔ 60k$
- Pb sheet: 10^5 cm^3, (1120 Kg), 20$/Kg ➔ 48 half-ring shapes (cut to rght size) ➔ 16k$
- MPPCs: 1152 detectors, 30 € (w/o tax) ➔ 50k$
- Fiber: 1 mm Y11 fiber, 800 m ➔ 4k$
- Support structure, Al ➔ 30k$
- Thermocouples, cables, reflector, paint ➔ 5k$
- Power supplies ➔ 20k$
- Frontend electronics: LAL SPIROC chip? 1 LED/strip plus driver 100$/channel ➔ 115k$
- DAQ ➔ 10k$
- Total ➔~450k$

I am working on locating funding for the Backward EC EMC

Conclusions

- We have 14 radial sector strips, remaining 34 will be cut before middle of July
- Strip production is still the bottleneck and hopefully DESY will help out with production of logarithmic spiral strips
- The manpower situation will improve after the summer
- I made first light yield and uniformity measurements of radial sector strip
- I am trying to recruit new collaborators (DESY, Moscow)
- I am working on securing 450k$ funding for the backward EC EMC

Next Steps

- Need to read out strip with SPIROC chip
- Need to measure light yield with trigger counter underneath the strip
- Need to measure different positions with source
- Test all cut strips and mount MPPC
- It may be useful to use custom-made preamp that sits at MPPC and move SPIROC out behind calorimeter
- Need to investigate backgrounds to decide if strips need to be split into 2 pieces to deal with occupancy due to backgrounds
- Measure properties of 2 strip segments connected via one Y11 fiber
- Measure non-linearity of MPPC in strip arrangement
- Perform reflectivity studies