EMC Summary

- Test Beam
- Backgrounds
- Radiation
- Backward Calorimeter Mechanical
- Electronics

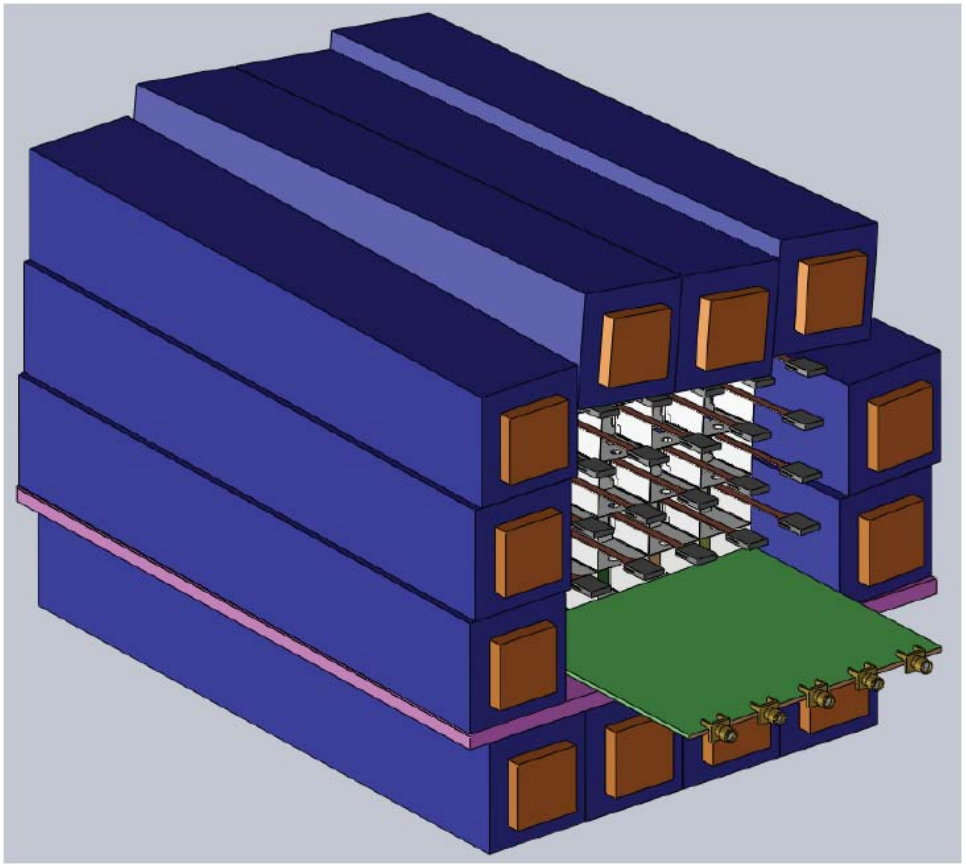
(Summary only from talks and discussion in EMC sessions)

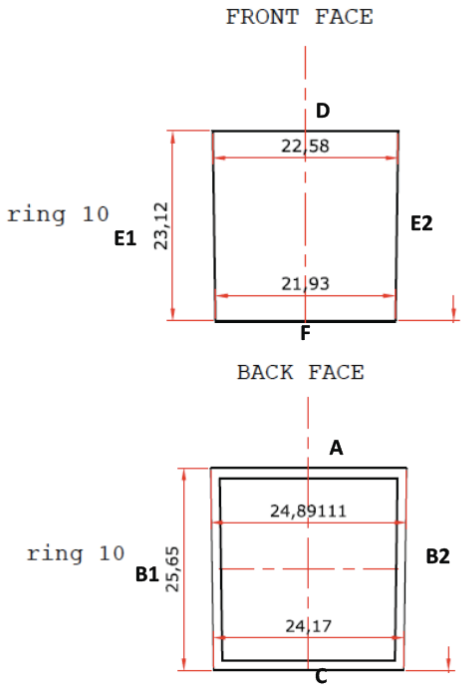
Test Beam

- Frascati: June 7-26
- CERN: October 11-31
- Prototype aveolar delivery mid-April
- First five Saint-Gobain cystals all within $\pm 100 \mu$m tolerance, except one with one measurement slightly over.
- SIPAT crystal production delayed, first two full-size samples had low light output. Final delivery now projected at May 20.
- SIPAT difficulty making tapered crystals, very time-consuming. Have recently tested a diamond wire saw.

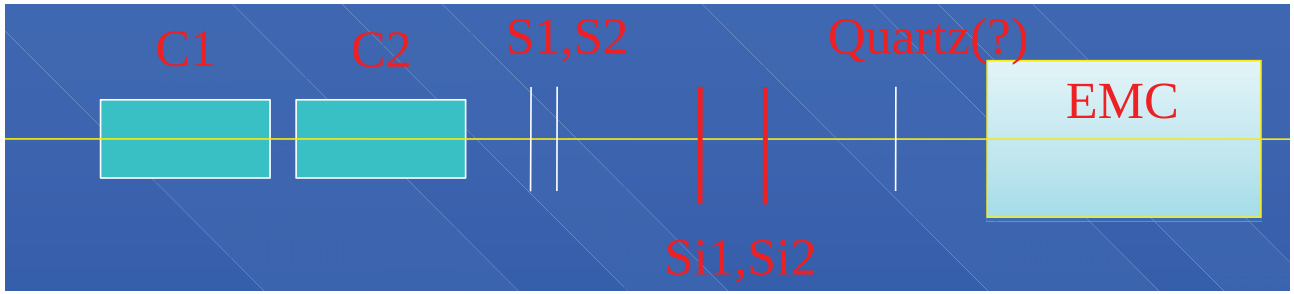
Test beam module, Saint-Gobain crystal measurments

[Pasquale Lubrano]





Test Beam (continued)



S1/S2 : two 10cm X 10cm X 1cm plastic scintillators, to be used in the trigger and to synchronize the two independent DAQ systems, @LNF and @CERN. NOT YET READY

C1/C2 Cerenkov counters, CERN setup: the detectors are provided by CERN in the beam line, two channels, electron/pion separation, radout via ADC VME system. DAQ system integrated with beam telescope and new electronics channels . @LNF we do not have/need external particle identification.

The beam telescope (2 X-Y planes, Fermi sensors, single sided detectors, they are nearly 10x10 cm^2, 50 micron strips, 225 micron pitch, 384 strips per wafer, 400 micron silicon) is ready.

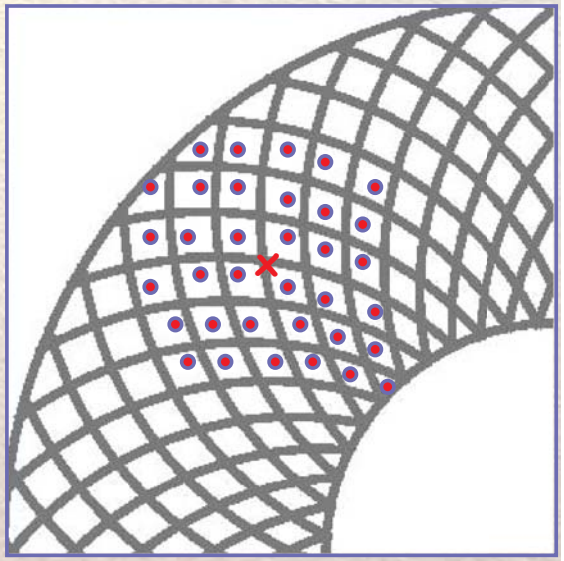
They have been assembled and pre-tested in Mipot (Trieste) and will get back to Perugia tonight. In the next couple of weeks tests with cosmic rays and development of DAQ software.

Test Beam (CERN) – Backward prototype

[Gerald Eigen]

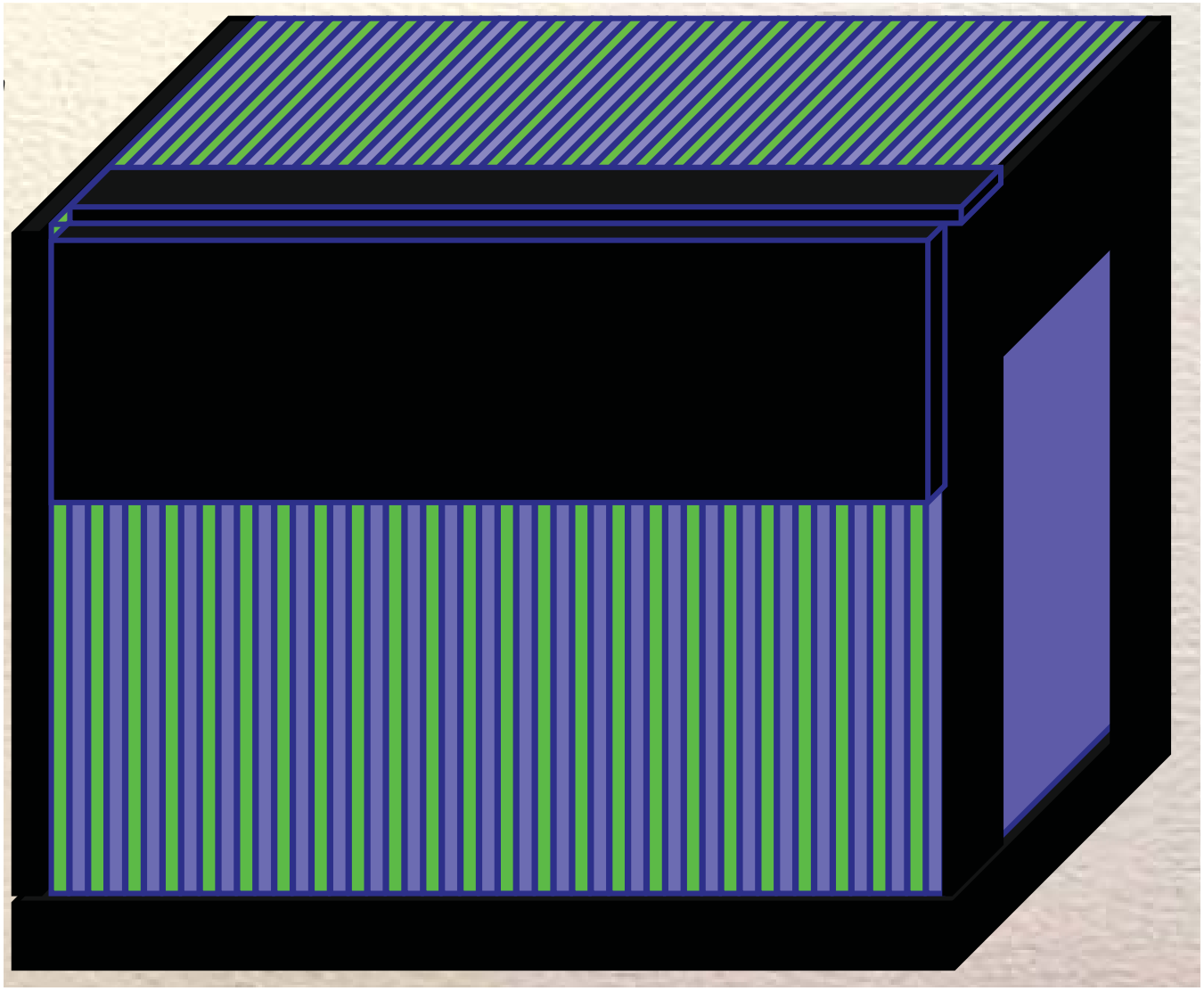
Prototype Design

- 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

Bacward prototype assembly



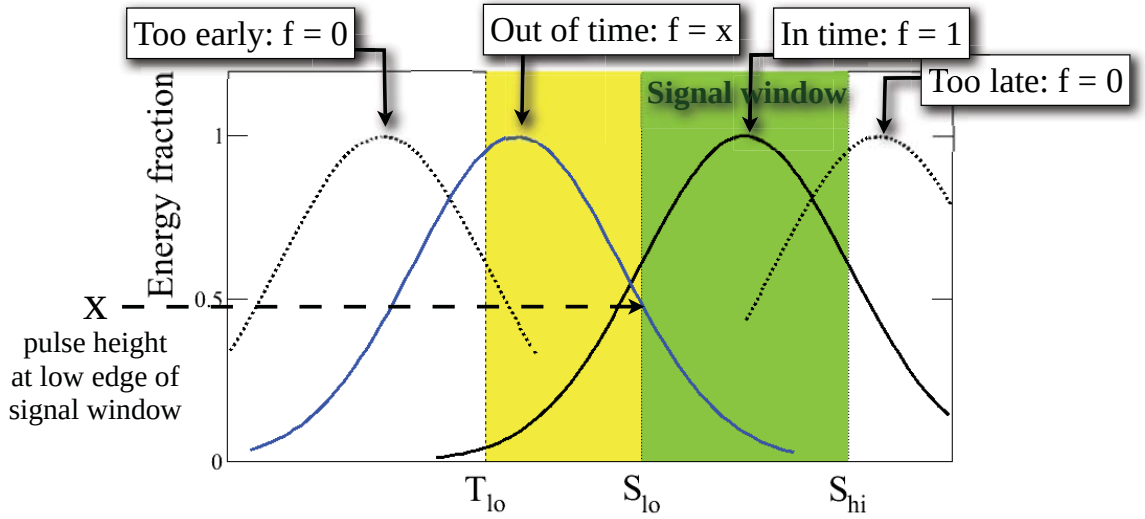
Bhabha background studies

Remarks:

- The Bhabha background studies here are "worst case" scenarios [but are only part of the background]. BaBar reconstruction places an additional ± 120 ns selection. The t_0 for this is determined by an energy-weighted average over the EMC crystals.
- We should add such a selection in future background studies.
- Will need to look out for backgrounds pulling t_0 too far from the actual value. This is already seen in BaBar when a Bhabha happens near in time to an $e^+e^- \to \mu^+\mu^-$ event, and the muon calorimeter energy is lost. This seems likely to be worse at SuperB. May need to use t_0 from tracking.

Fastsim time model

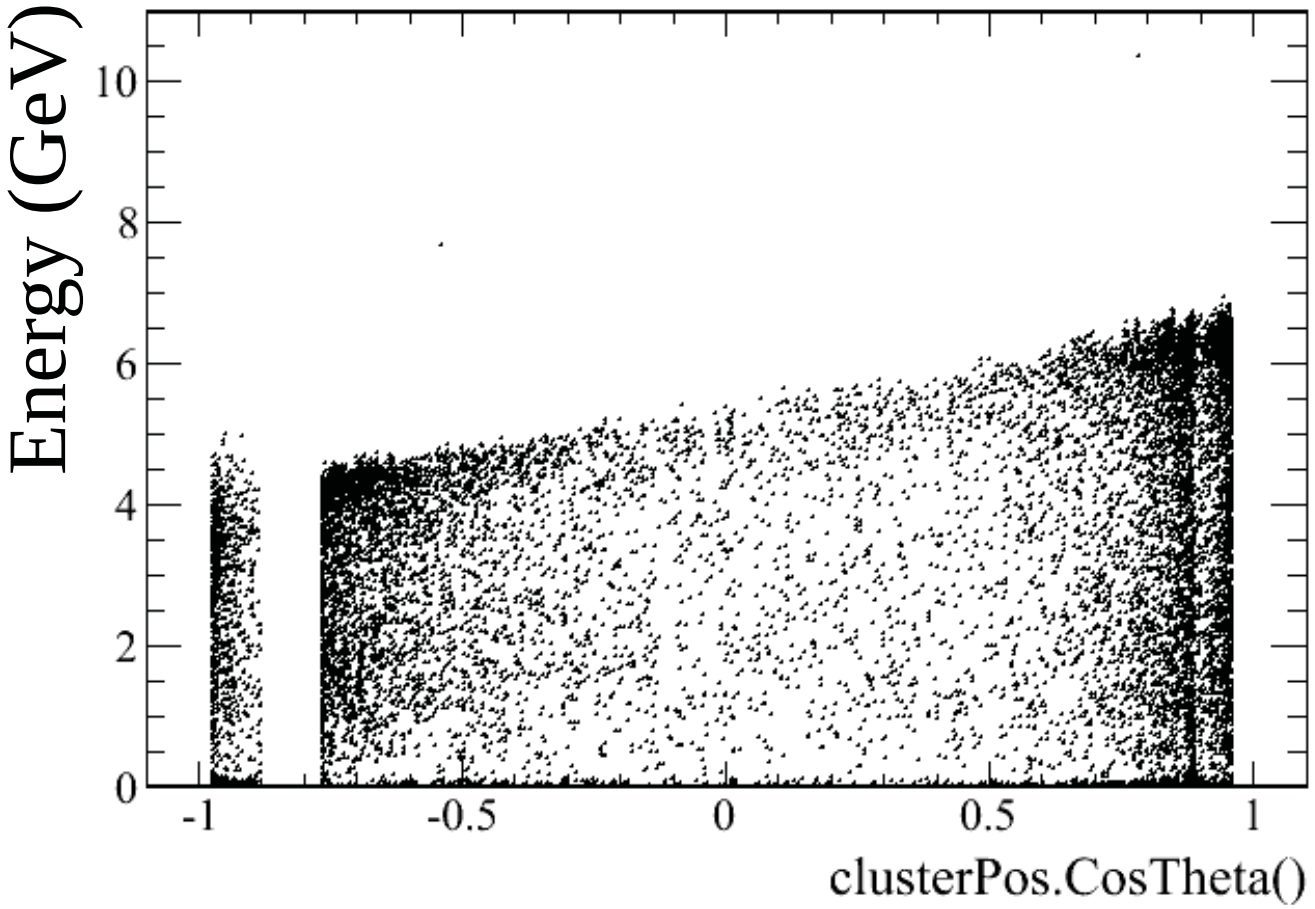
[Chih-hsiang Cheng]



unit = ns	Fwd	Barrel	Bwd	
σ	100	500	10	
S_hi	100	500	10	+1σ
S_lo	−100	−500	−10	−1σ
T_lo	−250	−1250	−25	−2.5σ

Large angle Bhabhas

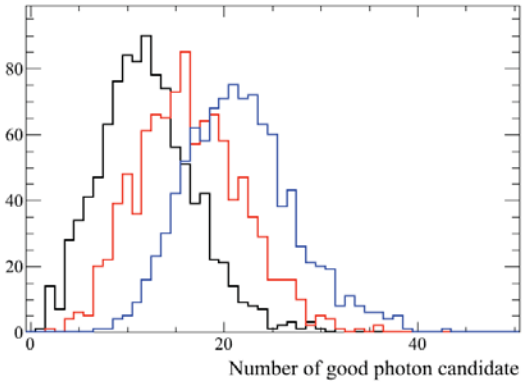
Contributes average background of 0.13 clusters/event

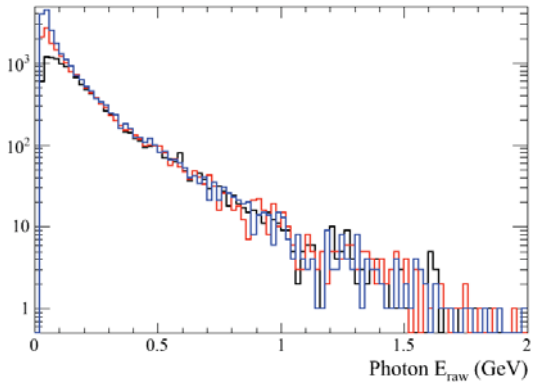


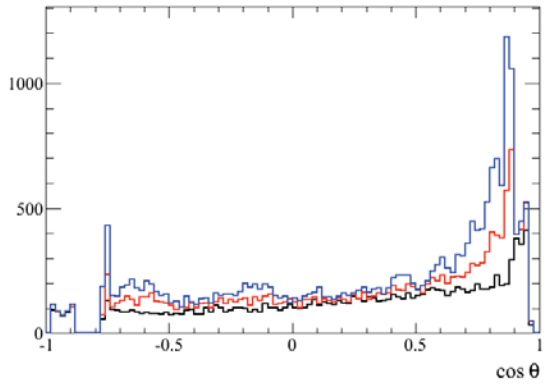
Small angle BhaBhas, generated with fullsim

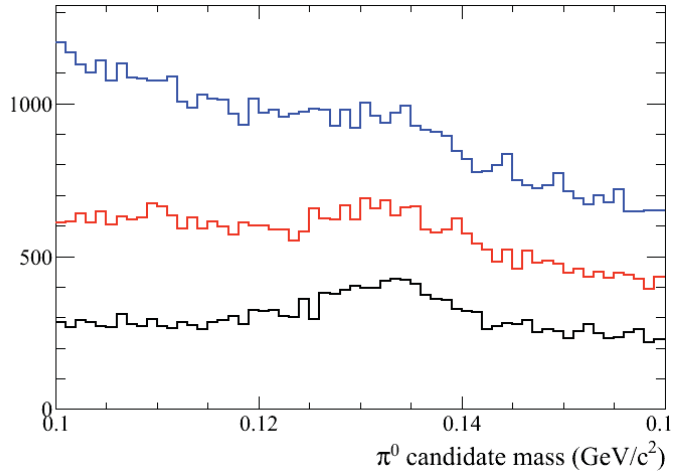
Effect on Generic $B^0\bar{B}^0$

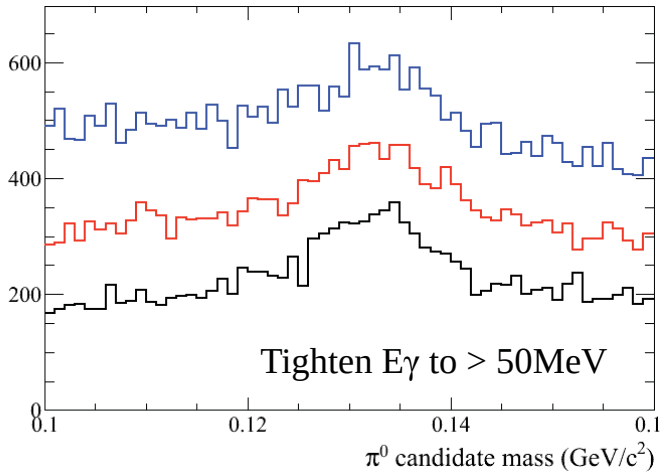
Good photon is $E > 30$ MeV; $0.01 <$ Lat < 0.8







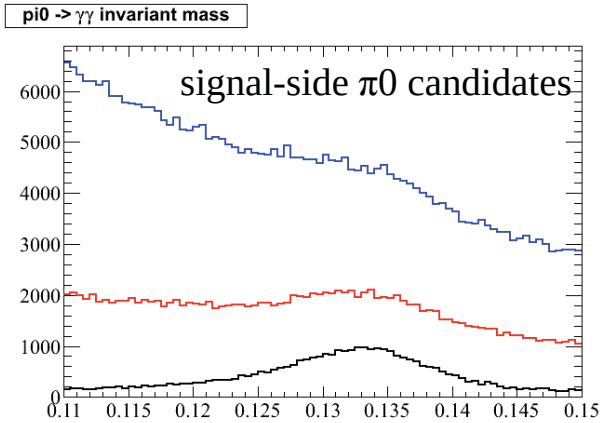




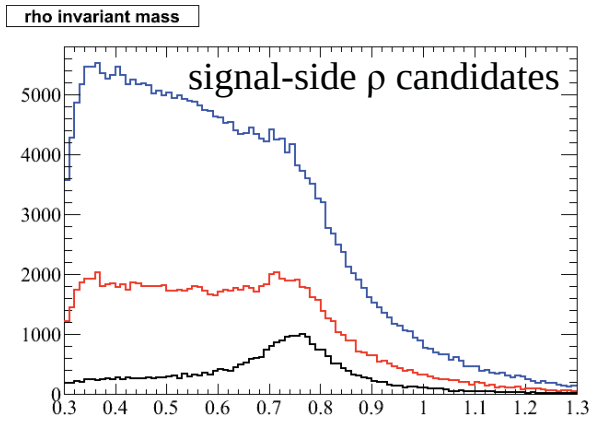
no bkg
±500 ns
±1000 ns

$B \to \tau\nu,\ \tau \to \rho\nu,\ \rho^- \to \pi^-\pi^0$

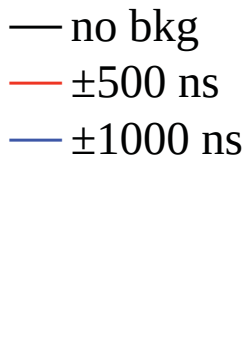
Including both large and small angle Bhabha backgrounds



$m_{\gamma\gamma}$

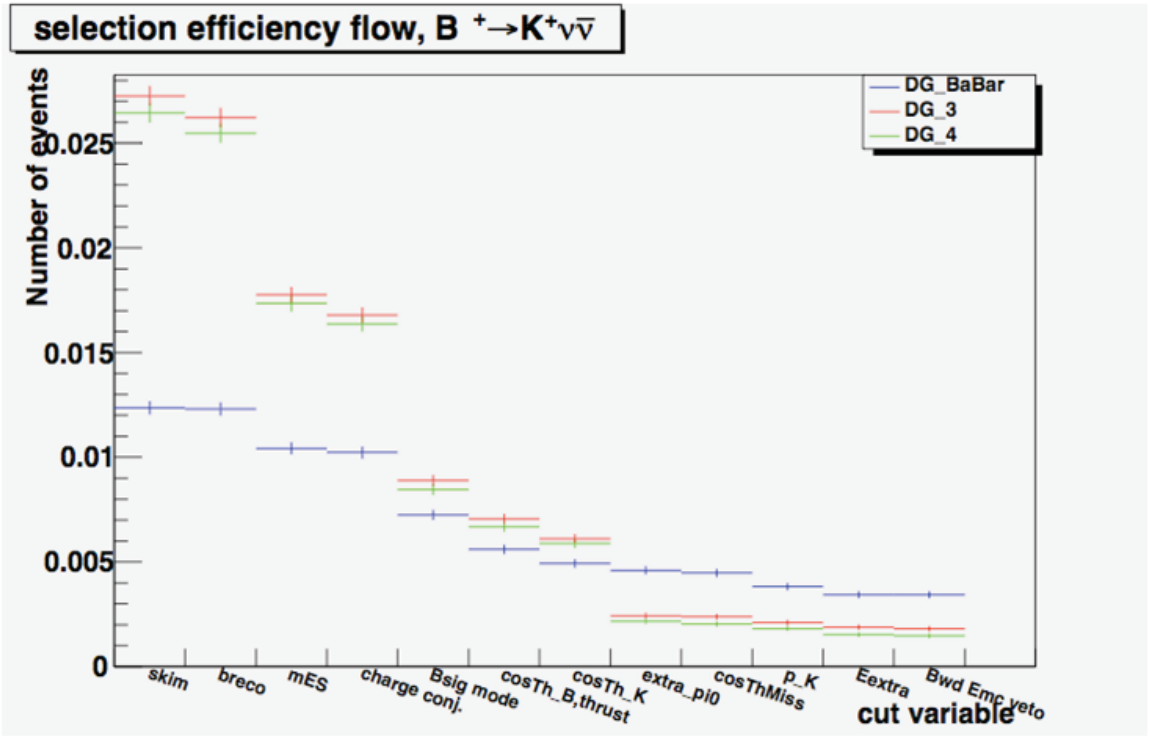


$m_{\pi^\pm\pi^0}$



Study of Bhabha background on Hadronic BRECO against $B \to K^{(*)}\nu\bar{\nu}$

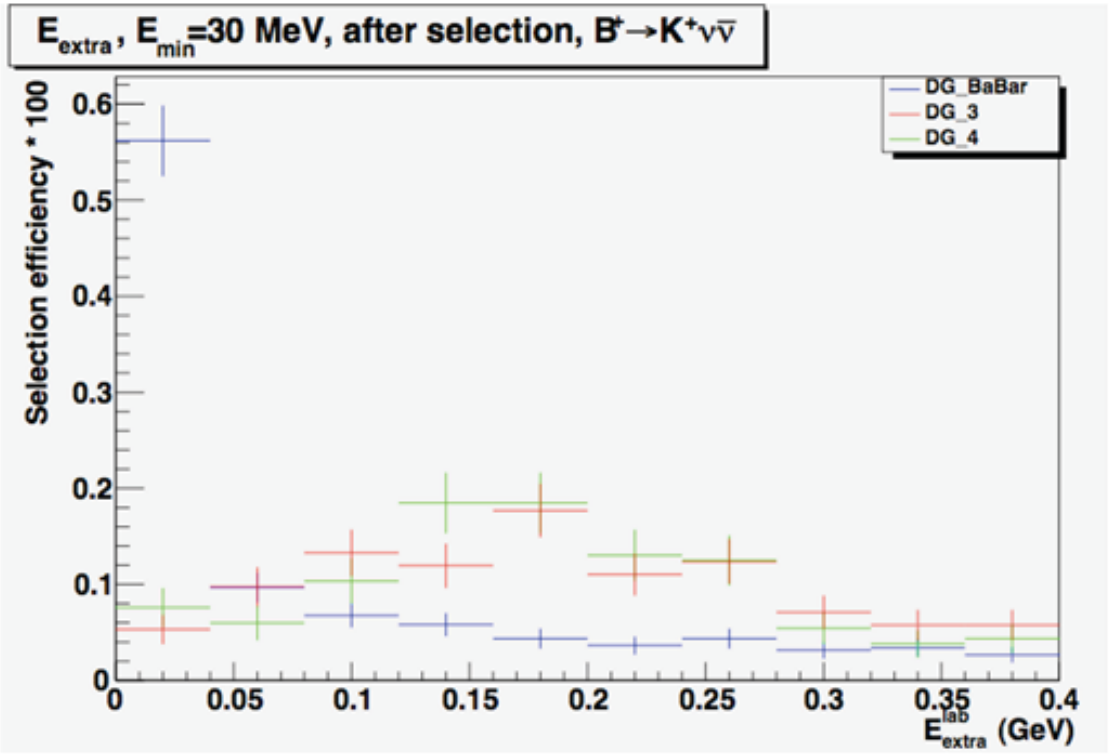
[Elisa Manoni]



Many B decay modes in $B \to D^{(*)}X$, $X = (n\pi^{\pm})(mK)(pK_S)(q\pi^0)$,

$$n + m + r + q < 6$$

Hadronic BRECO against $B \to K^{(*)}\nu\bar{\nu}$ (continued)



- Radiative Bhabha background increases neutral multiplicity and affects $E_{\rm extra}$ shape
- DG_4 (forward PID) and DG_3 (long DCH) seem to be equivalent [DG_4 may have lower efficiency]
- Not enough statistics to evaluate impact of backward EMC

How does the background affect electronics?

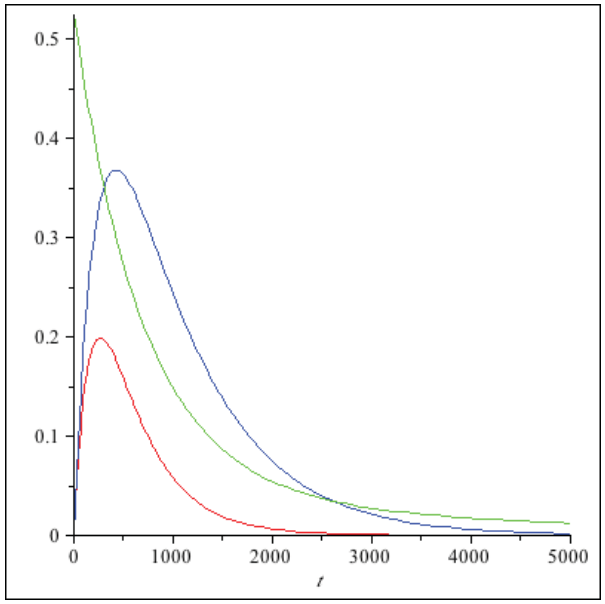
- Need to understand further the background problem:
  - Does anything (preamps) saturate from pile-up? The barrel preamp integration time in the first stage is ~ 100 μs. Changing the integration time could mitigate. But need to determine energy deposit in 100 μs, as a function of position.
  - How often do background energies overlap with event energies? Changing shaping and/or pattern recognition on digitized waveform could mitigate.
  - If the only problem is extra clusters, then timing could be the whole answer. Might need changes to shaping, faster digitization, and/or TDC's to accomplish the required resolution.

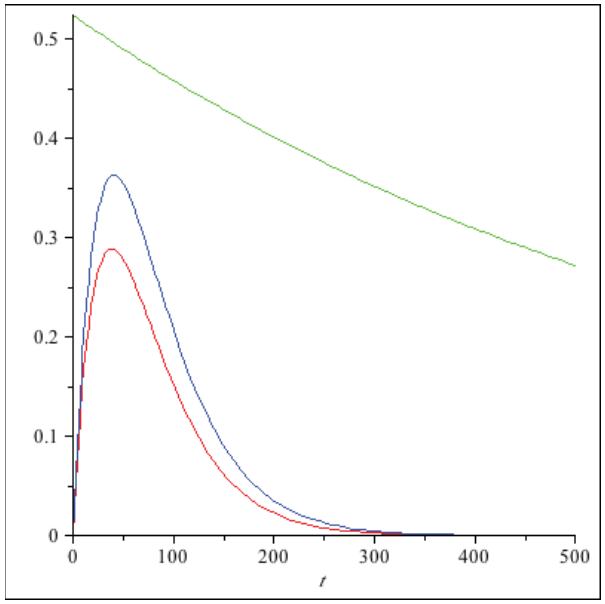
Shaping Time

[David Hitlin]

Starting to investigate trade-offs of sampling time, light collection, and electronic noise; motivated by large background predictions.

CsI(Tl) readout





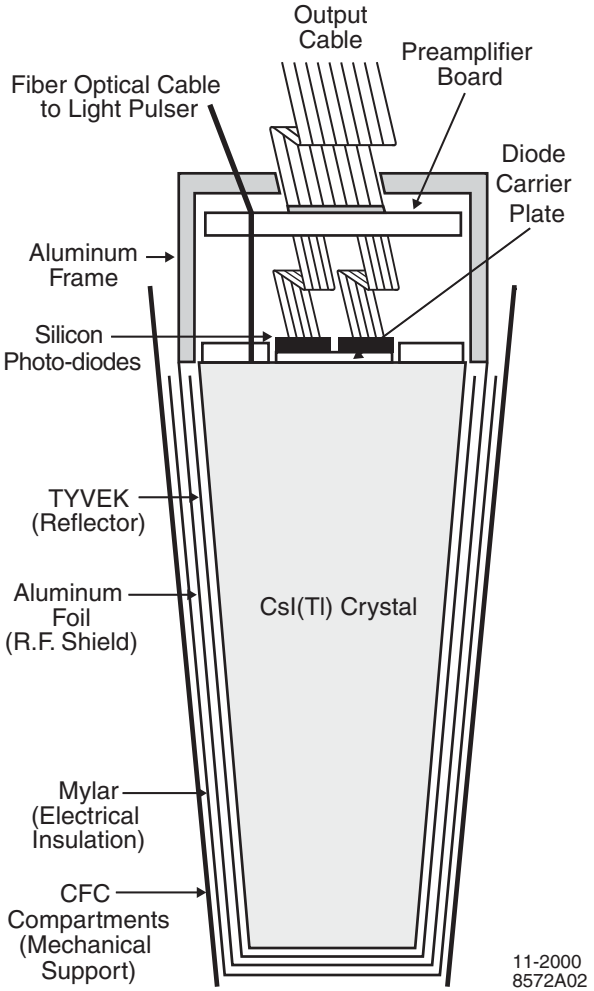
$\tau_d = 680$ ns, $\tau_i = 250$ ns

"BaBar" shaping

$\tau_d = 40$ ns, $\tau_i = 40$ ns

Shortened shaping times

Changing Barrel Preamps?



Big question: Do we need to change the shaping in the barrel? This means redoing the preamps for the barrel. A crystal exists at SLAC in this configuration, so we can check how delicate an operation this would be. If the glue comes off, lose 30% of light.

Radiation

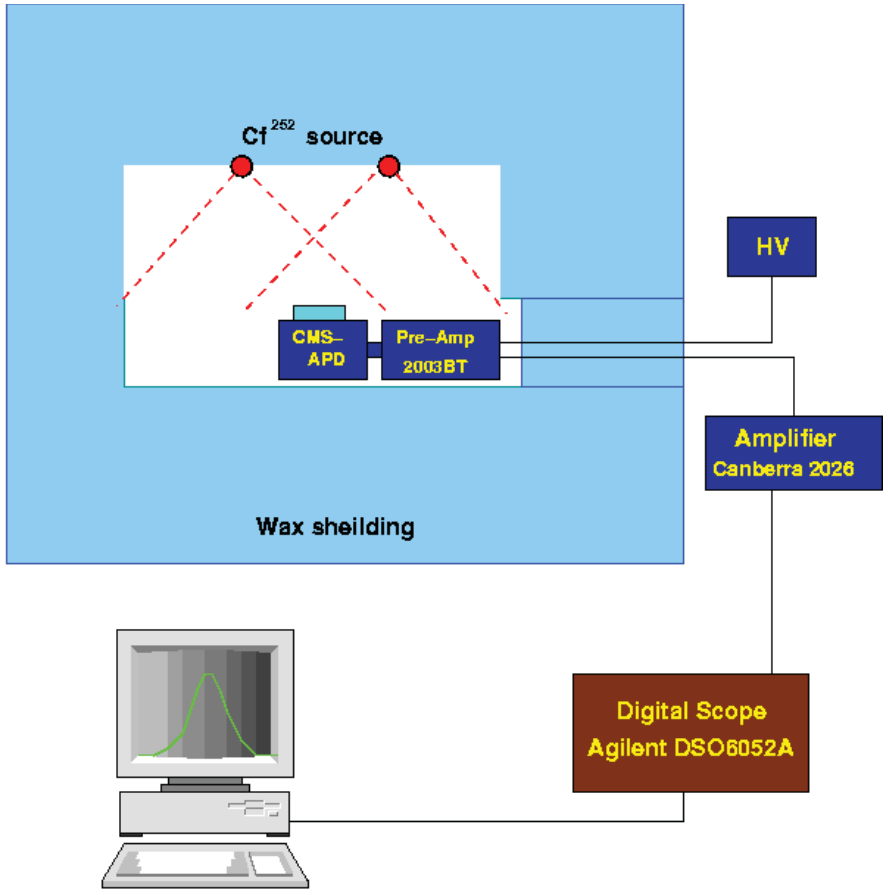
- MPPC's in backward EMC OK for neutron doses less than 3×10^9 neutrons/cm^2. Fall-back solutions might be 64-pixel PMs or APDs.

- APD nuclear counter effect. Study for CMS by Rihua Mao, Liyuan Zhang, and Ren-yuan Zhu. Will repeat for PIN diodes.

Setup for studying nuclear counter effect

[Ren-yuan Zhu]

The ^{252}Cf Setup



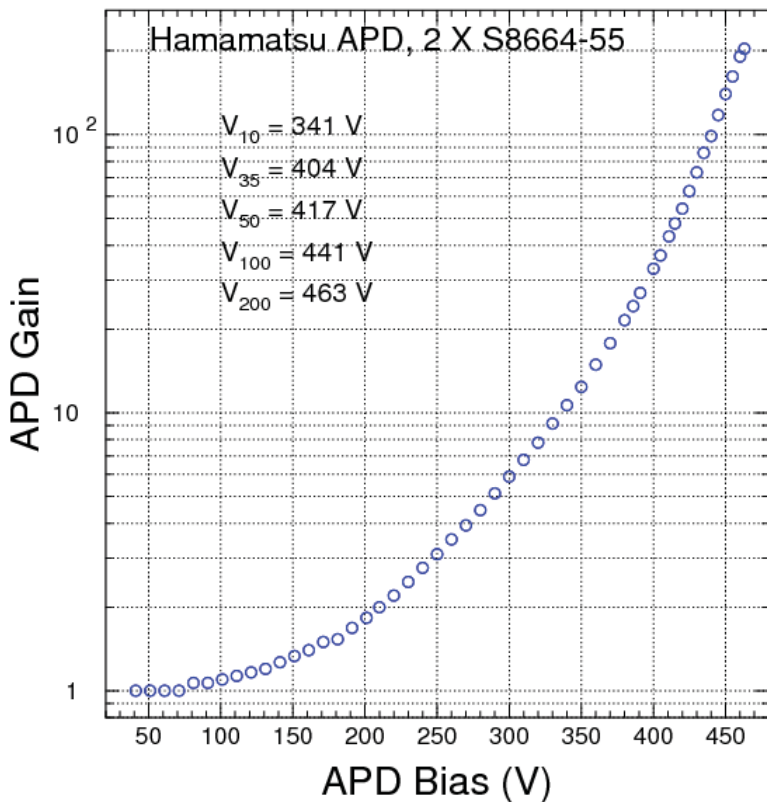
A pair of Hamamatsu APD in a capsule (33102000077940) placed at 8 cm from a pair of ^{252}Cf sources with neutron flux of 1.4×10^4 n/cm^2/s at the APD surface.

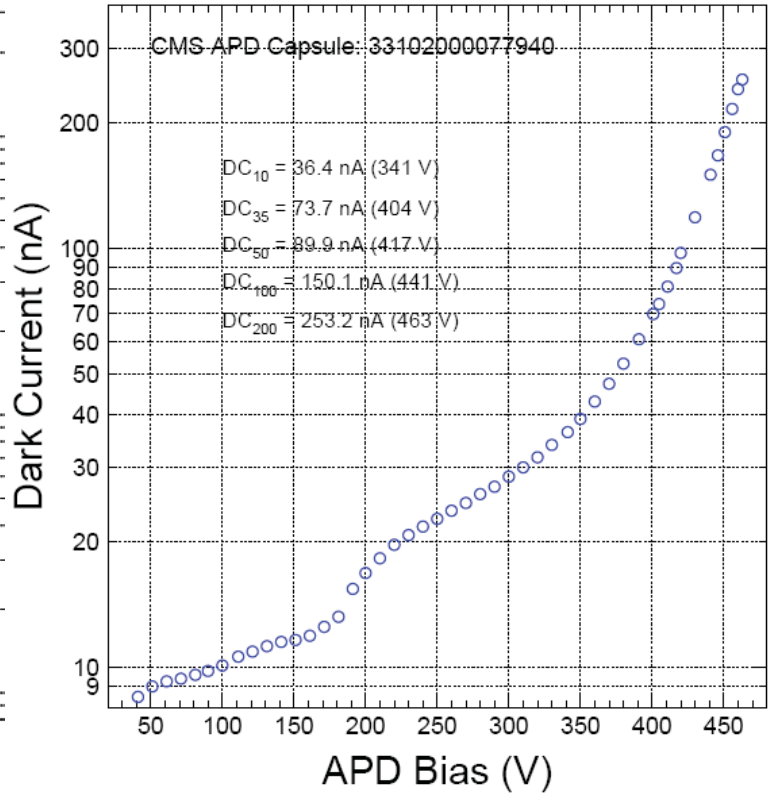
The APDs were biased for gains of 10, 35, 50, 100 and 200.

The readout of the APDs consists of a preamplifier, (Canberra 2003 BT) a shaping amplifier (Canberra 2026), and a DSO (Agilent 6052A).

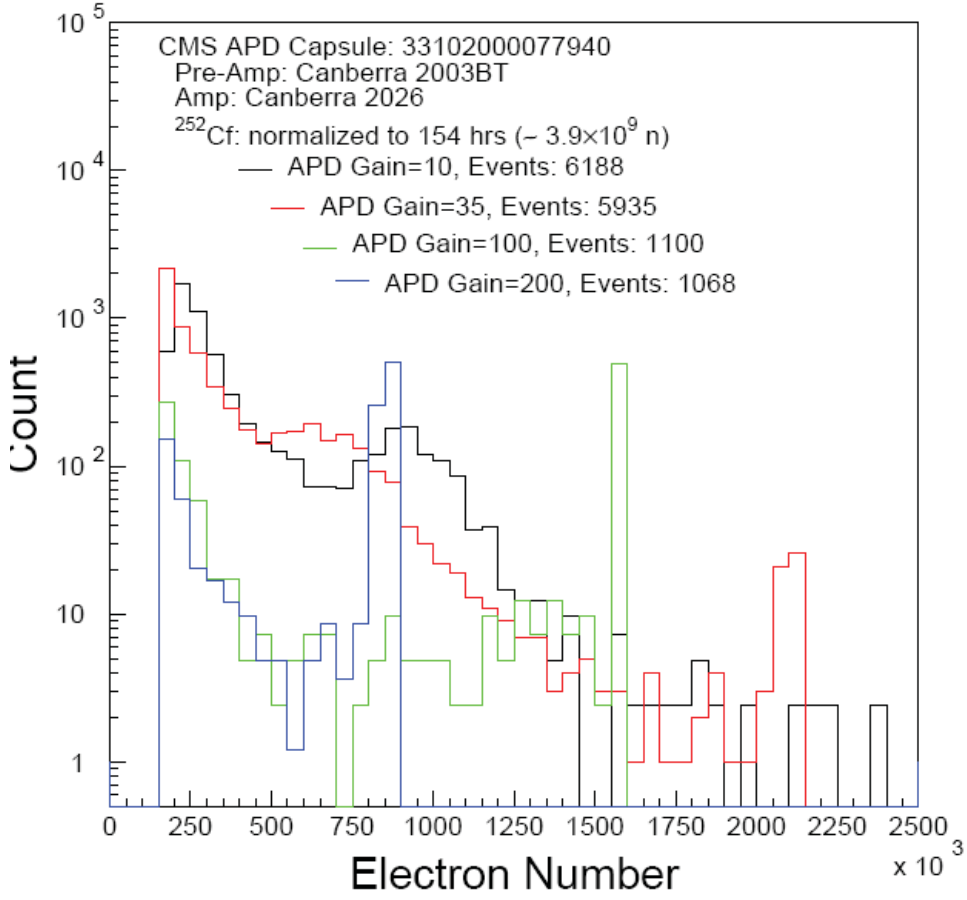
APD characteristics

Actual APD gain measured with LED





APD response to neutrons



Evidence that MeV neutrons deposit entire energy in APD

Energy-equivalent decreases as gain is increased.

Energy-equivalent in LYSO could be of order GeV.

Backward Calorimeter Mechanical

[Gerald Eigen]

Backward EMC scintillator mechanical design: Plan so far to keep large sheets intact with segmentation by cutting slots. Issue is cross-talk via connecting plastic, and measurements are underway. Initial results are discouraging.

New idea (CALICE) is to cut a groove halfway through, fill with reflective epoxy, then cut grove from other side the remaining half and fill with epoxy.

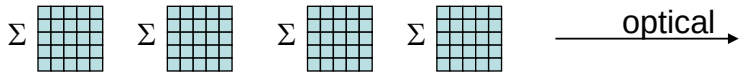
Electronics

[Valerio Bocci]

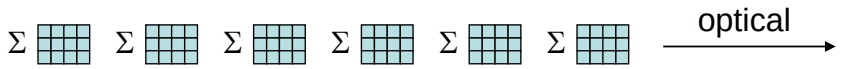
Push architecture (as in BaBar) with full granularity results in too many links (> 1000 at 1.6 Gbit/s/link). So, planning a pull architecture with summing in front end boards producing trigger primitives.

EMC trigger primitive

- Towers of 25 crystals for the forward => 4 towers per trigger link



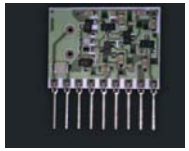
- Towers of 12 crystals for the Barrel => 6 towers per trigger link



Charge Sensitive Preamps, VFE board

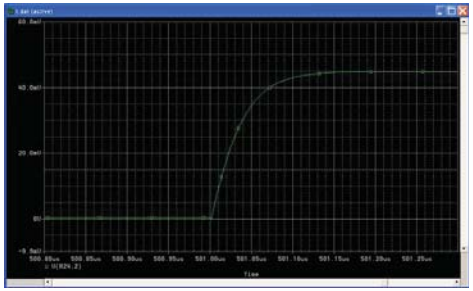
Cremat 1.4 V/pC

Hamamatsu 1 V/pC



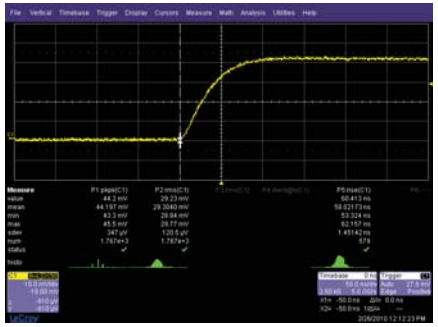
Homemade 1 V/pC

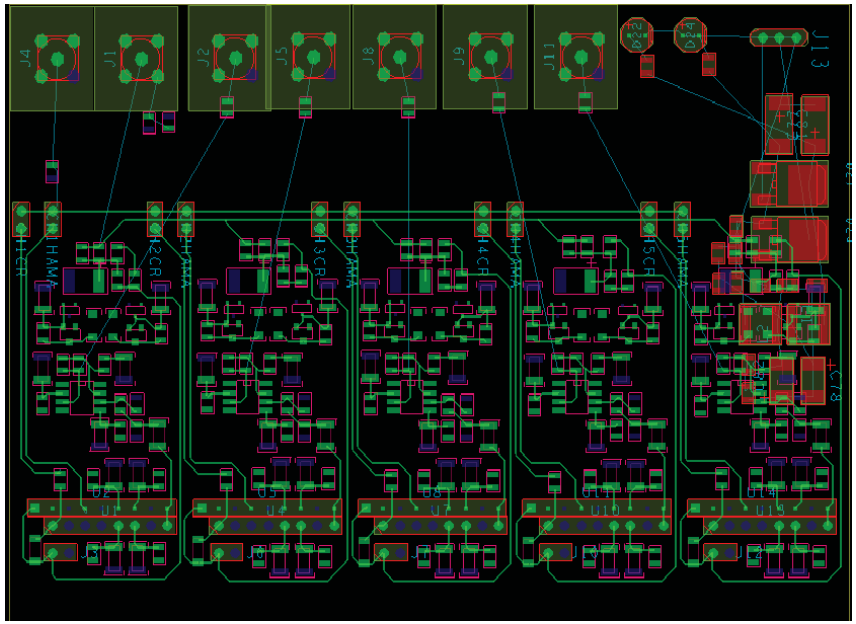
Simultation



Luigi Recchia preliminary measuraments

Real





Conclusions

The worries

- Meeting first test beam schedule very tight (not just SIPAT delay; EMC manpower is limited).
- Backgrounds are serious considerations.
- Neutron flux – large APD signals; radiation damage to SiPM's

The bright spot

- Simulation tools are well-along; already relying heavily on them.