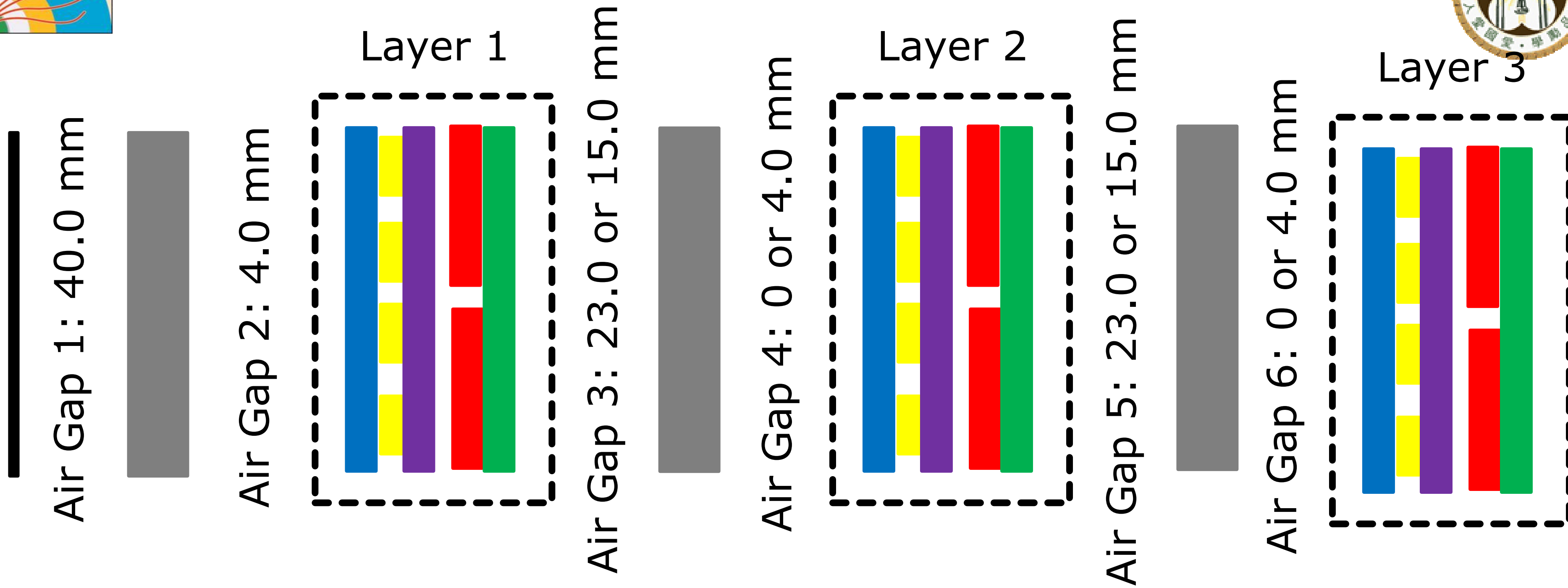
Detector Configurations - Digitization

S. Paganis, A. Psallidas, L. Tzu-Lu
National Taiwan University (NTU)

BT2015 Analysis meeting
10 February 2016

Detector sketch



Front Wall
Fe: 3.3 mm

Plexiglas: 18.0 mm

PCB: 1.6 mm

W: 0, 2.4, 4.2, 8.4 mm

SKIROC (PVC) 4x4:
Thickness: 1.1 mm
Width/height: 17 mm

Aluminium: 25.0 mm

Si 2x2:
Thickness: 0.325 mm
Width/height: 88 mm
Gap: 0.1 mm (no pixel gap)

Only one air gap in layers for the glue dots: 0.2 mm

10/02/2016

Open issues in geometry

- Plastic plate and kapton behind silicon sensor in each layer are missing.
  What type of plastic is behind the silicon sensor?
  How much (percent) is PVC or polystyrole? What material to use?
  What are the thicknesses of plastic plate and kapton?
- When using iron absorber (two configs: 200 mm, 300 mm)
  it is placed with the first W absorber.
  It should be placed before front wall.
  How much is the air gap between the end of the
  iron absorber and the front wall of the box.

- Two last detector configurations with angle. What is the
  position of the beam line with respect to the box?
- Naming convention for the different setups in the code:
  SiWECAL_B{N_1}X0_I{N_2}X0_A{N_3} where
  N_1: W,Fe absorber thicknesses as an integer before the layers
  N_2: W,Fe absorber thicknesses as an integer inside the layers
  N_3: Angle of the setup.
  We want to change this to: SiWECAL_B{N_1}_I{N_2}_A{N_3}
  Any other suggestion on this?
- Anything else that you observe?

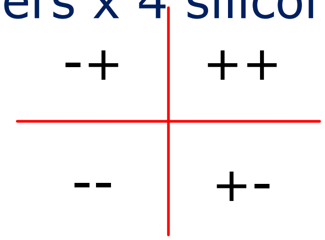
Digitization procedure: Timing Cut

- The read out electronics have a defined time window. Late energy depositions might escape this time window. In order to reproduce this effect, a time cut must be applied in simulations.
- The readout/deadtime is 50 msec while data taking/spill is 150 msec. This data taking period is divided in 400 ns bunch crossings. In this case an event is something triggered within 400 ns.
- There is a shaping time inside SKIROC, which is about 300 nsec. Probably the response is not uniform in time (ie. signal is not exactly == integral over 300 nsec, to be discussed with chip developers), but maybe 300 nsec can be used as a first approximation.
- The variable that is kept in simulation is time since the beginning of the event and is related to the particle gun beam position. So,

  time_sim - (beamtofrontwalldistance/speedoflight) < 300 nsec
- Any other delay to the time of arrival time_sim?

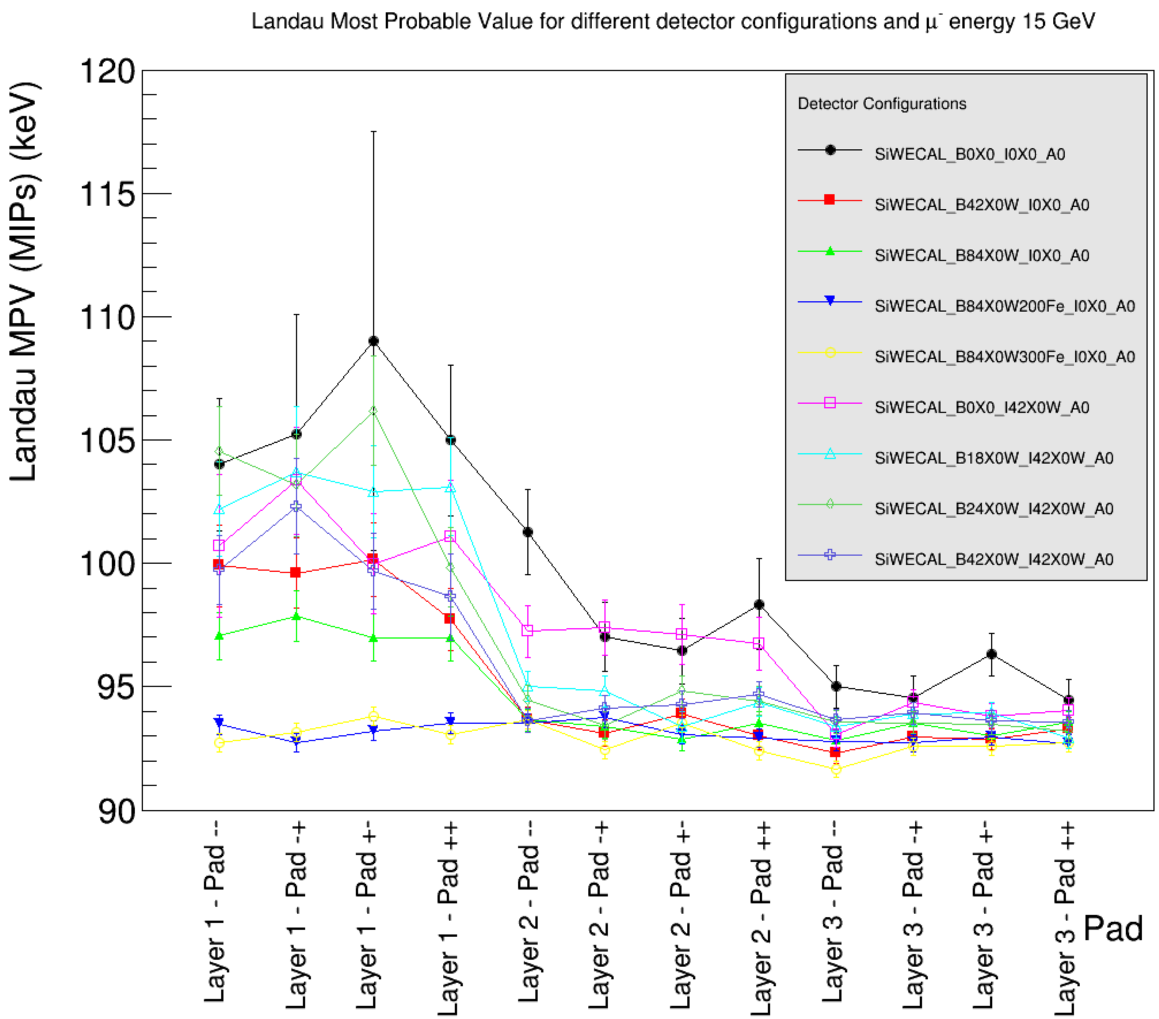
Digitization procedure: MeVToMIP (I)

- Convert SimHits G4 energy (MeV) to MIPs.
- In silicon, we expect about 75 electron holes per µm for a MIP.
  So, a MIP in 325 µm of silicon leads to a most probable charge of about n=24375 pairs or total energy loss ~87 keV.
- We want to monitor peak evolution as function of the layer/pad.
  Simple algorithm finding most probable value using a Landau fit.
- One layer is a 2x2 array of Si pad sensors. So, 3 layers x 4 silicon pads with plus/minus for the place of a pad in xy plane.



- SimHits: Energy is saved in 5.5 x 5.5 mm^2 cells. One sensor is a matrix of 16x16 pixels, so in total 88 mm width each pad (ignoring gap between pixels 30 µm).

MIP Evolution - SimHits



10/02/2016

Digitization procedure: MeVToMIP (II)

- According to the results in the previous slide, the mean MPV value for the detector configurations of the test beam are:

SiWECAL_B0X0_I0X0_A0: 0.099725 MeV/MIP

SiWECAL_B42X0W_I0X0_A0: 0.0952127 MeV/MIP

SiWECAL_B84X0W_I0X0_A0: 0.0945979 MeV/MIP

SiWECAL_B84X0W200Fe_I0X0_A0: 0.0931116 MeV/MIP

SiWECAL_B84X0W300Fe_I0X0_A0: 0.0928548 MeV/MIP

SiWECAL_B0X0_I42X0W_A0: 0.0974076 MeV/MIP

SiWECAL_B18X0W_I42X0W_A0: 0.0969714 MeV/MIP

SiWECAL_B24X0W_I42X0W_A0: 0.09705 MeV/MIP

SiWECAL_B42X0W_I42X0W_A0: 0.095989 MeV/MIP

Digitization procedure: Granularity and noise

- Create collection of RecHits with the desired granularity. Virtual cells of SimHits same size as RecHits: 5.5 x 5.5 mm^2 pads.
- Add noise in MIPs everywhere, including empty cells.
- From a muon run MIP is at about 60 ADC channels for high gain and 6 ADC channels for low gain (highest energies).
- MIP = 60 ADC channels, so MIPToADC = 60
- Pedestal RMS = 3...3.5 ADC channels
- Signal/Noise = 18
- Noise = (1 / 18) MIP

Digitization procedure: SKIROC, threshold, intercalibration, ADCToMIP

- There are 12 bits (4096 ADC channels) but the saturation starts at about 2000 ADC channels.
  Should we use this average number for maxADC and ignore spread of the saturation curves from chip to chip?

- Do not apply threshold 5sigma cut (Zero suppression) :
  5 x noise ~ 17 ADC channels.
  Offline only to study the impact of noise.

- Convert ADC counts back to MIPs and produce RecHits. What intercalibration factor to use in order to smear the ADCToMIP value?

Absorber weights

- Weights for all detector setups (as it is in previous slides) $\frac{{X_0}^i}{{X_0}^1}$:

SiWECAL_B0X0_I0X0_A0: (1,0.599457,0.599457)

SiWECAL_B42X0W_I0X0_A0: (1,0.060193,0.060193)

SiWECAL_B84X0W_I0X0_A0: (1,0.0316874,0.0316874)

SiWECAL_B84X0W200Fe_I0X0_A0: (1,0.0138785,0.0138785)

SiWECAL_B84X0W300Fe_I0X0_A0: (1,0.0108341,0.0108341)

SiWECAL_B0X0_I42X0W_A0: (1,9.55837,9.55837)

SiWECAL_B18X0W_I42X0W_A0: (1,1.97506,1.97506)

SiWECAL_B24X0W_I42X0W_A0: (1,1.56198,1.56198)

SiWECAL_B42X0W_I42X0W_A0: (1,0.959781,0.959781)

SiWECAL_B24X0W_I42X0W_A48: (?,?,?)

SiWECAL_B0X0_I0X0_A90: (?,?,?)