LCWS physics analysis work

Paul Dauncey

Programme of studies

- The list shown previously
  - Detailed sensor level simulation
  - Understanding of sources of resolution
  - Variation of resolution with parameters
  - Linearity and resolution
  - PFA “no harm” confirmation
  - PFA improvements using fine granularity
- Not many volunteers; need to assign names today
  - Work needs to be done by at latest the weekend before LCWS

Sensor simulation

- Needed to decide on the spacing size
  - Yoshi fixed a Mokka version
  - Anne-Marie did spacing study and found no threshold to GEANT4 small subpixel bug
  - Decided to stay with 5μm spacing
- Now allows
  - Giulio to proceed with sensor simulation
  - Nigel to proceed with Mokka simulation production for single photons
  - Marcel to proceed with Mokka simulation of $q\bar{q}$ and K_L,n events
- Assume the simulation is independent of pixel circuit type (shaper/sampler, etc)
  - Simulation will then be some "average" of the two?

Parameter dependence

- How does the resolution depend on the parameters of the simulation?
- Want to evaluate the resolution as a function of
  - Noise
  - Threshold
  - Charge diffusion values
  - Dead area
  - Cluster algorithm
  - Pixel size (?)
- We should determine the “standard” values to use for these
- Noise: complicated by scale discrepancy
  - GEANT4 deposits ~3.2keV in epitaxial layer; Giulio’s simulation gives 1300e^-
  - This corresponds to ~2.5eV/ e^-, known silicon value ~3.6eV/ e^-
  - E.g. take 30e^- noise as 30/1300 ~ of MIP or assume 3200/3.6 ~ 900e^- total so noise is 30/900 if MIP?
  - Also, use shaper or sampler noise? What are the “best” values?

Understanding resolution

- Want to build up from SimCalorimeterHits to fully digitised MAPS in stages
  - See where the resolution comes from
- Want to also compare with diode pads option
  - If different, need to understand why
  - Ideally, would do this comparison on the same simulated events; removes fluctuations from showers, etc.
  - Would be possible if energy deposits in bulk silicon are stored (as planned); is this done?
- Should be done with “standard” set of parameters and cuts
- Determine resolution for at least one representative energy
  - SimCalorimeterHits analogue sum (i.e. only sampling fraction and shower fluctuations); this will be different for MAPS (using 15μm) and diode pads (using 300 or 500μm) of silicon. It is independent of cell size
  - Digitized diode pads analogue sum, with reasonable threshold
  - SimCalorimeterHits discriminated hit count, for MAPS, with and without clustering
  - Digitised MAPS hit count, with and without clustering

Linearity and resolution

- Response as a function of energy
  - From 0.5GeV to 500GeV
- Non-linearity from binary readout important
  - Can do as a function of pixel size? At least for multiples of 50μm?
- Both linearity and resolution will depend on clustering
  - Expect higher rate of 8-neighbour hits at high energies
  - Value assigned to cluster containing these pixels will have big influence
  - Could potentially optimise clustering for linearity or resolution; not both?
- Leakage into HCAL important also; how to handle this?
  - Just look at ECAL? Worse resolution
  - Try to include HCAL? Confuses what is due to MAPS and what not

PFA studies

- "No harm" check
  - Need to ensure MAPS used like diode pads does not degrade PFA results
- Do a check which ignors benefits of MAPS
  - Worse case; can only improve later
  - Sum pixels (with clustering; adds complications at boundaries?) over area equivalent to diode pads
  - Make faked-up CalorimeterHits from sums, with energy proportional to number of clusters
  - These feed directly into PandoraPFA with no further changes (except truth-reco mapping needed?)
- Also, try to use benefits of MAPS in PFA directly
  - Need to adapt PFA algorithm to benefit from finer granularity
  - Large study so may not be possible in time available