Sensitive Detector Segmentation

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Problem Statement

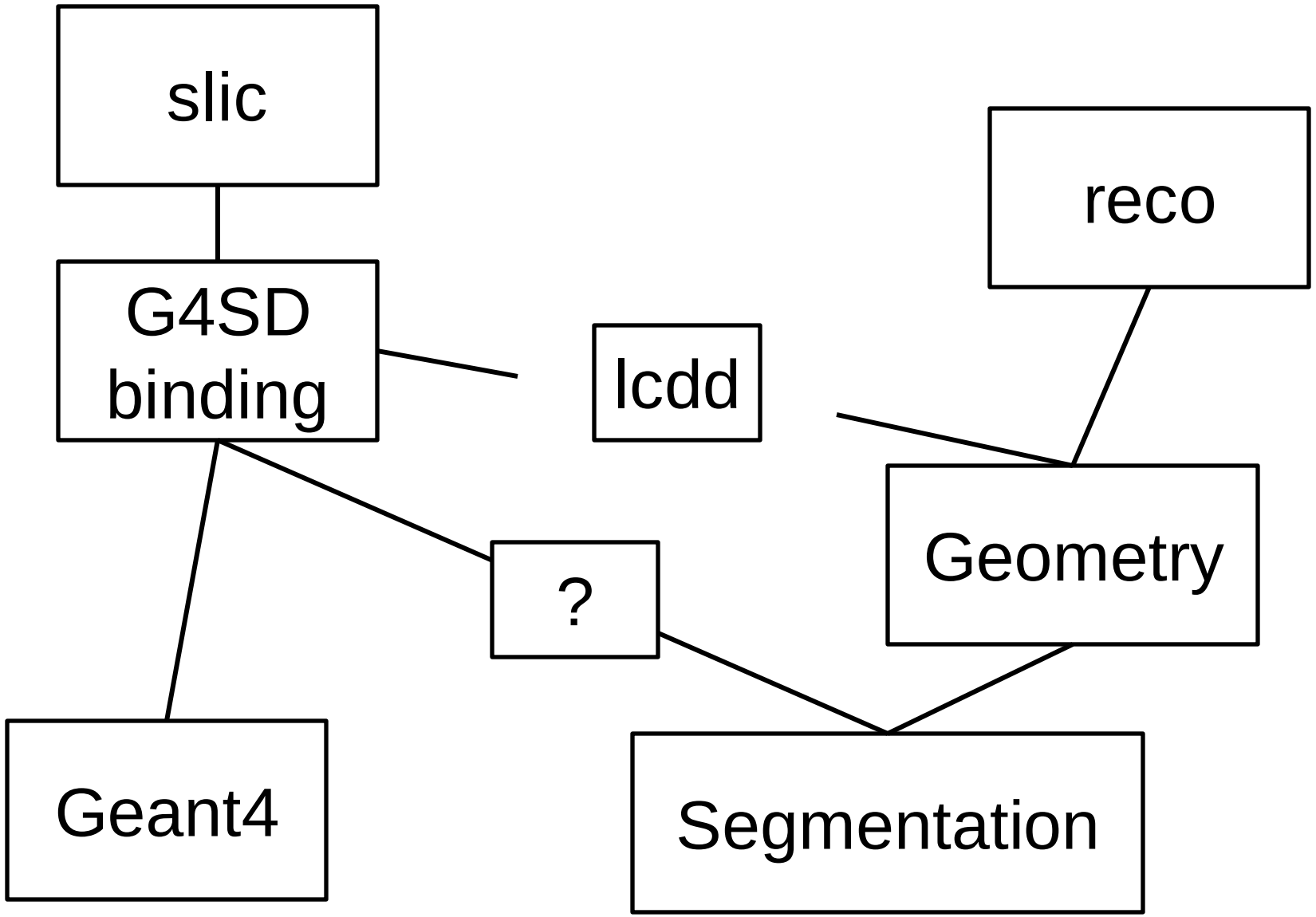
- LC Detectors being considered for the ILC and CLIC are highly segmented, resulting in hundreds of millions to billions of readout channels.
- Implementing each readout channel as a separate volume in Geant4 is impractical.
- Define Sensitive Detectors as larger volumes and use "virtual segmentation" to define readouts, e.g.
  - Tracking sensitive detector is silicon wafer, virtual segmentation returns pixels or strips.
  - TPC sensitive detector is full endplate, virtual segmentation returns pads
  - Calorimeter sensitive detector is scintillator sheet, or gas volume, virtual segmentation returns cells.

Functionality

- Given local position, return cell ID
- Given cell ID, return local position
- Given cell ID, return list of neighboring cell IDs
- Return cell size (allows energy density clustering)

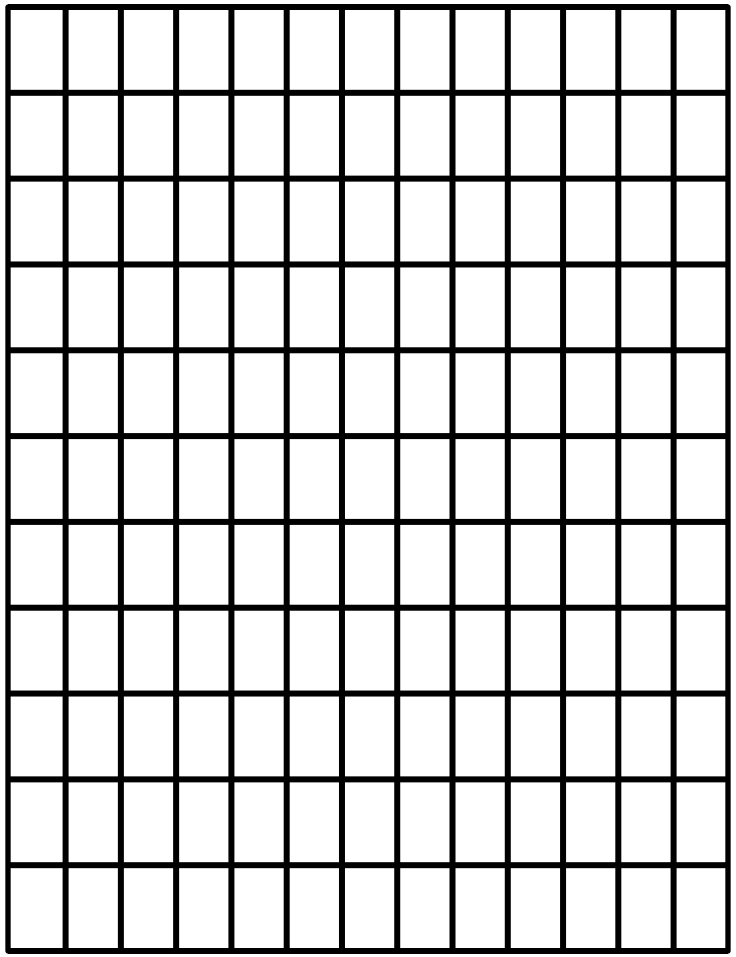
Dependencies

- Need to have a separate package containing segmentation classes on which both the simulation and reconstruction packages depend.
- Do not want to couple the reconstruction to Geant4.
- Also don't want to have two separate implementations of segmentors.


slic
reco
G4SD
binding
lcdd
Geometry
?
Geant4
Segmentation

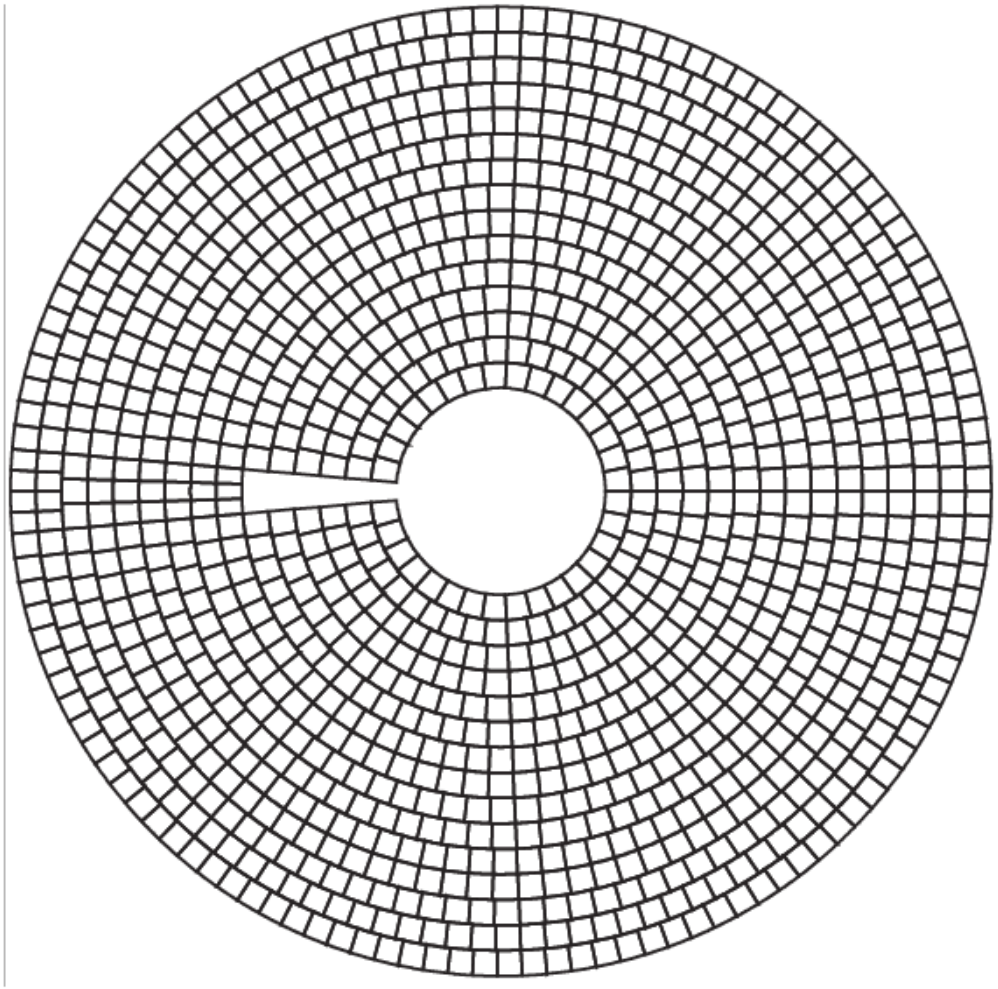
Cartesian Grid

- For each grid
  - x
  - deltaX
  - y
  - deltaY
- Allows for effective gaps in between pads



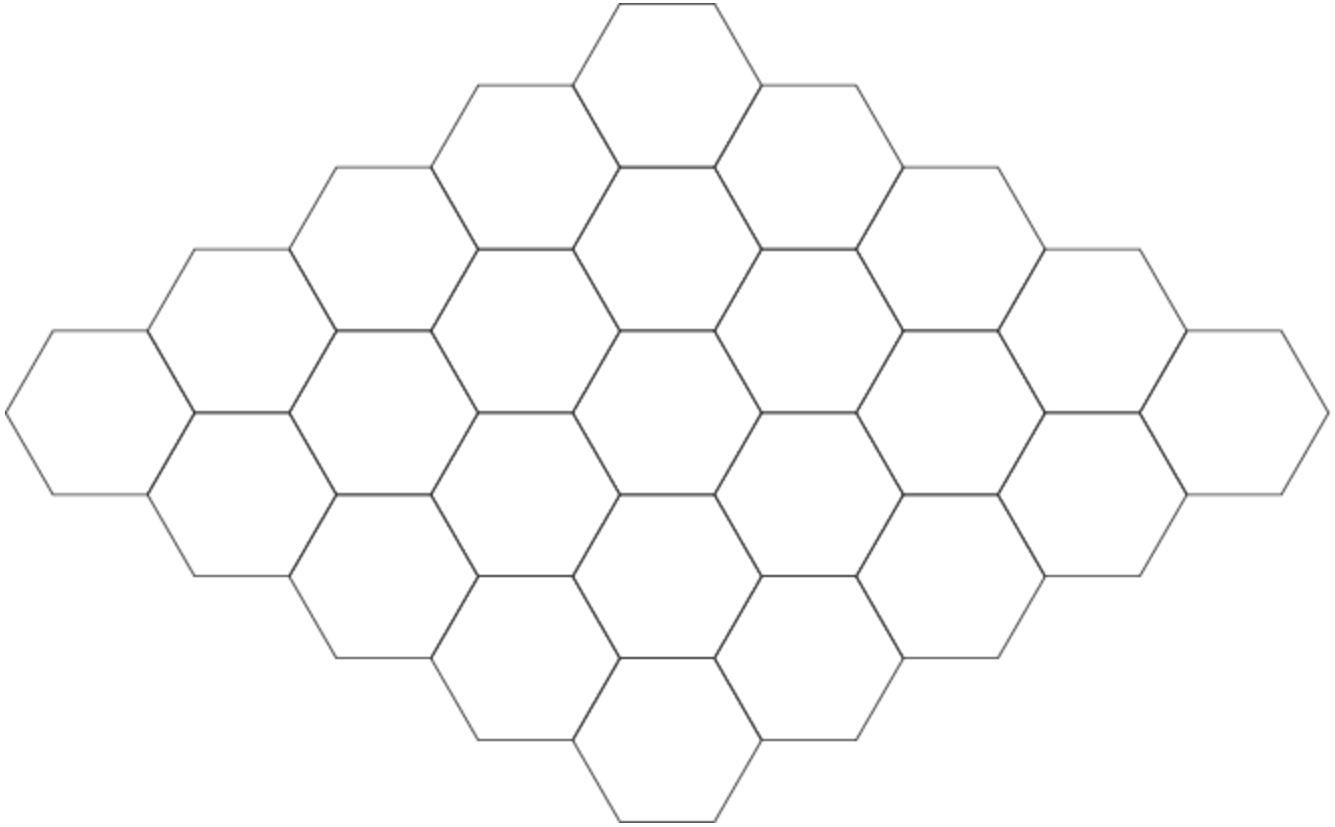
R-Phi Readout, e.g. BeamCal

- For each annulus:
  - rmin
  - rmax
  - nCells
  - phi0
  - deltaPhi
- Allows for effective gaps in both radius and phi
- Allows for staggered cells



Hexagons

- Define hexagon “radius”
- Can define effective gaps between cells using two “radii”



Attaching Segmentation Class to Volume

- Need the ability to specify location of origin and orientation of segmentation coordinates with respect to sensitive geometric volume.

Issues

- In calorimeters, how to handle Geant4 steps which straddle cell borders or cross “gaps”
- How to handle edges of segmentation classes
  - irregular cell sizes and shapes
  - missing neighbors
- Semi-Digitization
  - How to handle position-sensitive digitization such as charge-sharing across boundaries (e.g. RPC) or efficiency of light collection in scintillator readout.

Software Architecture

- Segmentation classes should be closely related to Geant4 primitive volumes for efficiency in defining, implementing and utilizing them.
- Do not want reconstruction to depend on Geant4
- Standalone package upon which both simulation and reconstruction classes depend.
- Runtime binding via plugin mechanism might lead to problems of provenance.
- Prefer compile-time binding of classes, run-time definitions for parameters.