Report on the UCSC/SCIPP BeamCal Simulation Effort

FCAL Clustering Meeting
24 June 2015

Bruce Schumm
UC Santa Cruz Institute for Particle Physics

The SCIPP FCAL Simulation Group

The group consists of UCSC undergraduate physics majors

• Christopher Milke (Lead)*	Physics
• Alix Feinsod	Math/Computer Science
• Olivia Johnson	Physics
• Luc D'Hauthuille	Physics

Plus interest from two more students (one in mathematics) that may join soon

Lead by myself, with technical help from Norman Graf

*Supported part time by our Department of Energy R&D grant

The SCIPP Reconstruction Algorithm

Nomenclature:

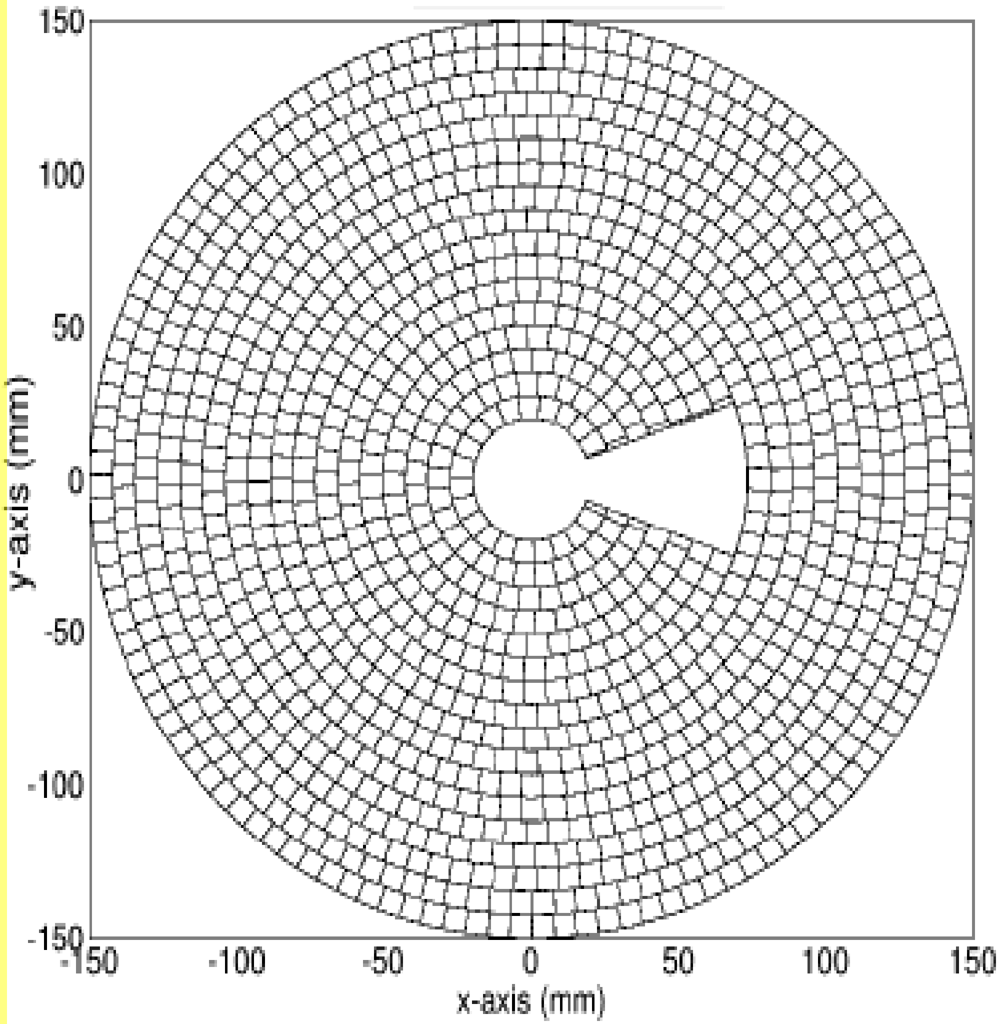
Tile: An individual BeamCal segment

Palette: A collection of tiles within a layer, centered on a given tile and including some number of neighbors

“P0” = tile alone

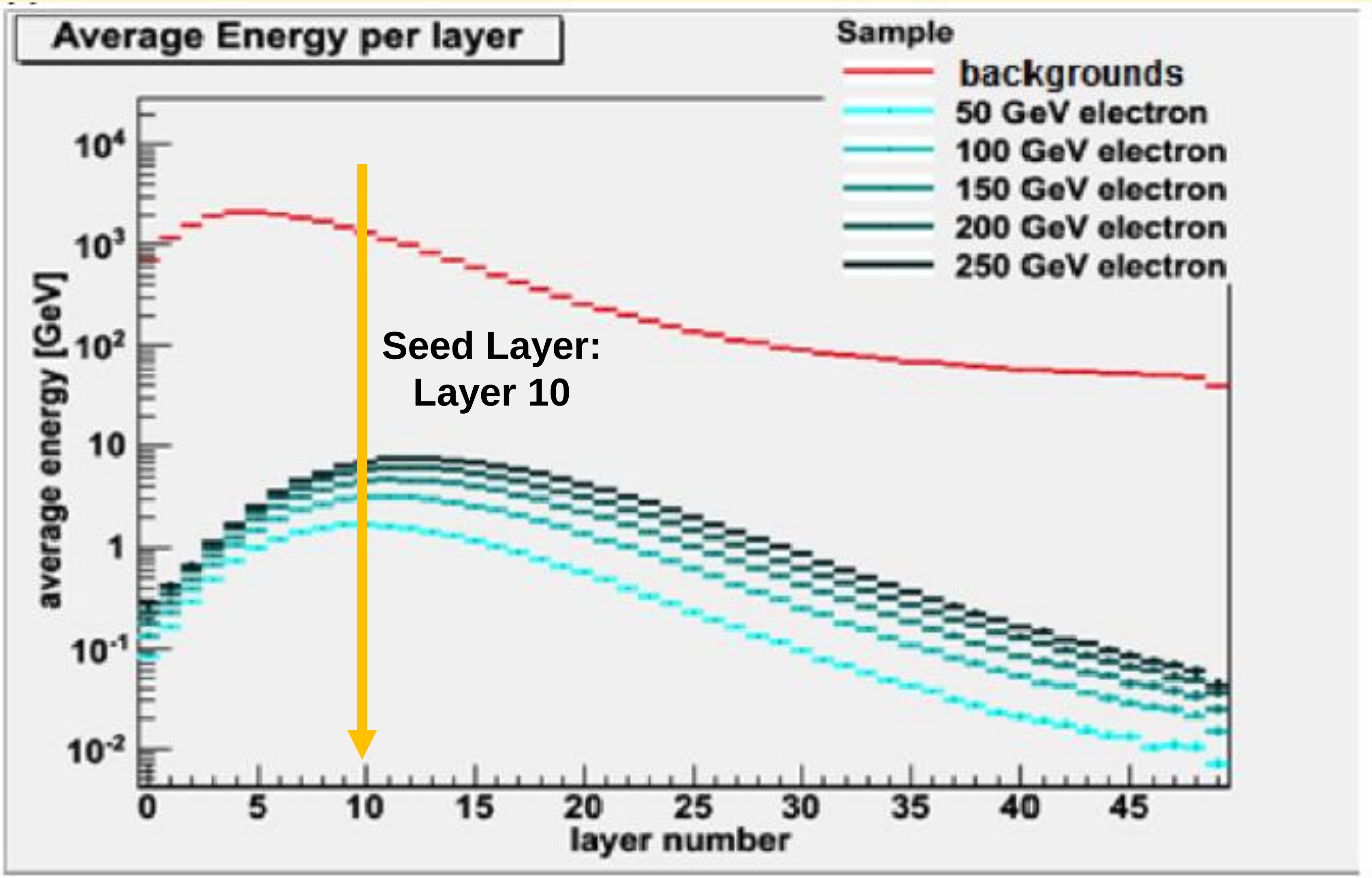
“P1” = tile + nearest neighbors

“P2” = P1+next-to-nearest neighbors



Cylinder: A palette extended through the depth of the BeamCal

First Issue: Where to Start the Search



Details of the SCIPP Reconstruction Algorithm

For any given segmentation strategy and scale, we don't know which palette choice will be optimal (P0, P1, P2,…)

➔ Explore efficiency/purity with several choices and take best for that segmentation scheme

For each palette choice, perform the following event-by-event

- Subtract mean background from each palette
- Seed reconstruction with 50 most energetic palettes
- Extend these 50 palettes into cylinders, summing energy along the way
- Accept as signal candidate any event for which the most energetic cylinder is greater than a cut ("sigma cut") expressed in terms of the rms width of the mean-subtracted background in that cylinder

More Details of the SCIPP Reconstruction Algorithm

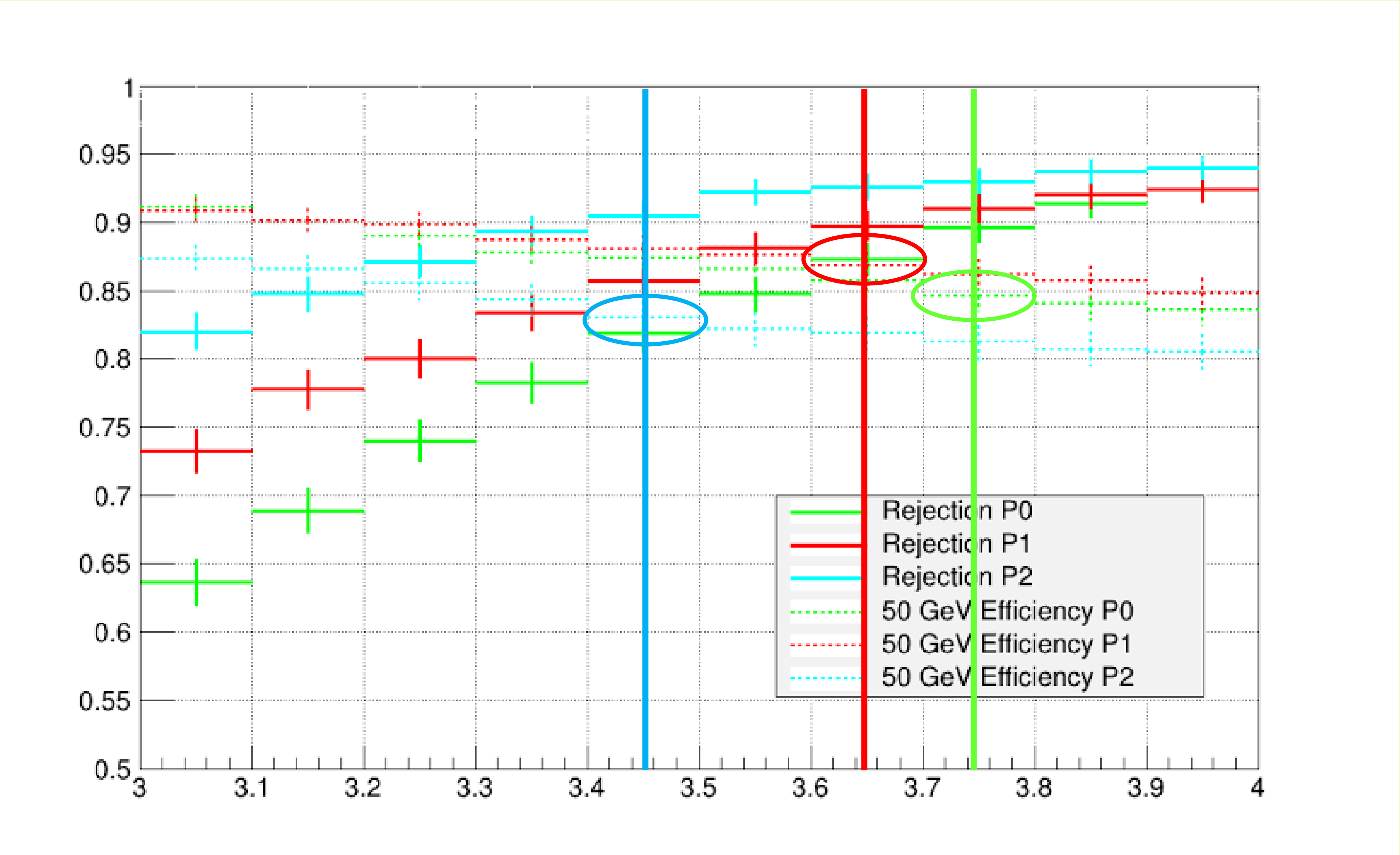
Choice of the value of the sigma cut

- BeamCal used to detect electrons/positrons from low-Q^2 two-photon event that can mimic degenerate SUSY scenarios
- SUSY signal events will have no forward e^+ or e^- so it will look like a "background" event in the BeamCal
- The fraction of BeamCal background events mistakenly identified as BeamCal signal events (and thus rejected) is a SUSY-signal inefficiency
- The sigma cut is selected to mis-identify 10% of BeamCal background events as BeamCal signal events

With this cut established, the efficiency of the BeamCal reconstruction algorithm can be explored as a function of radius

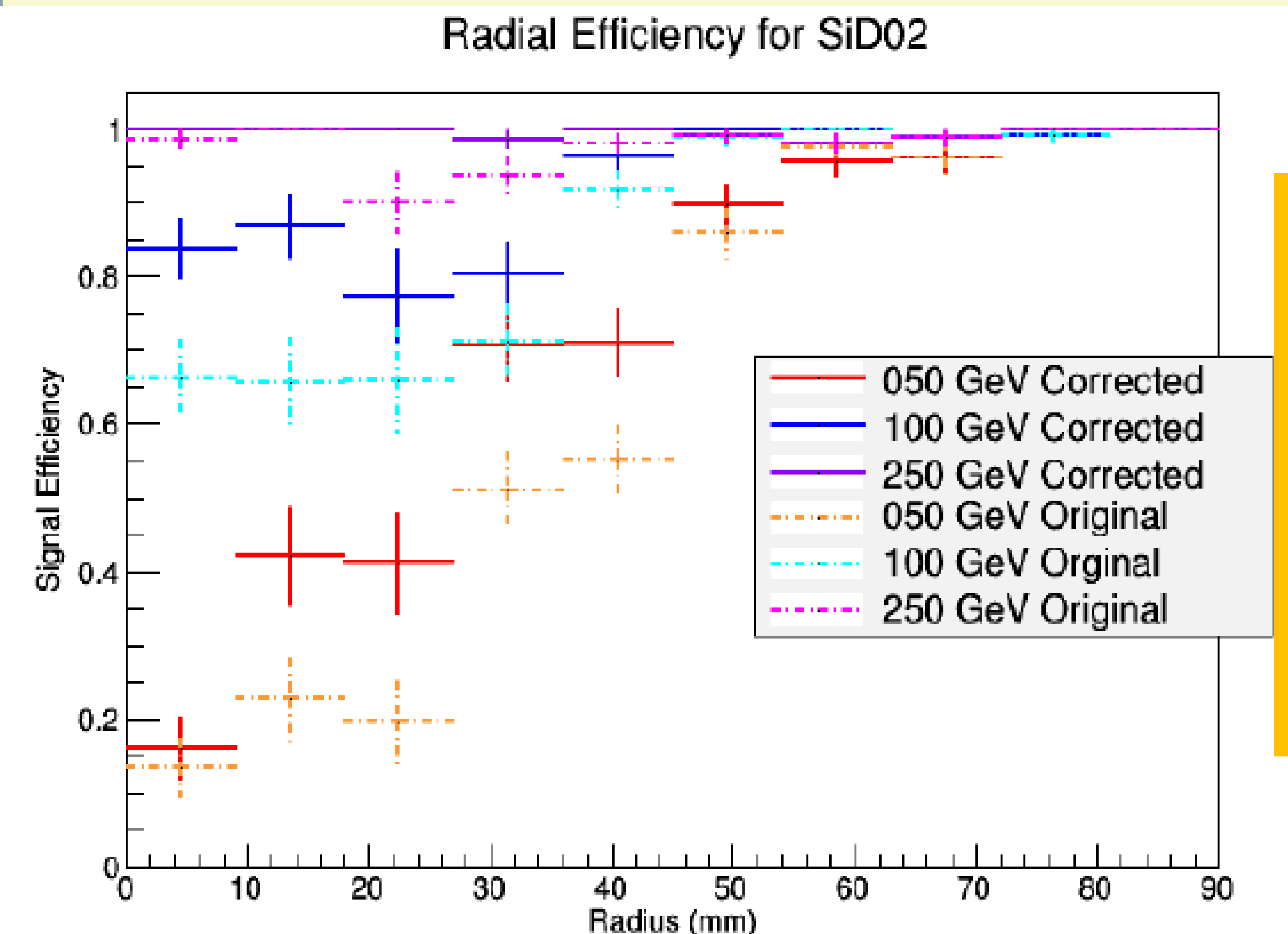
“Palette” Size Selection

Optimize 50GeV reconstruction efficiency@10% fake rate



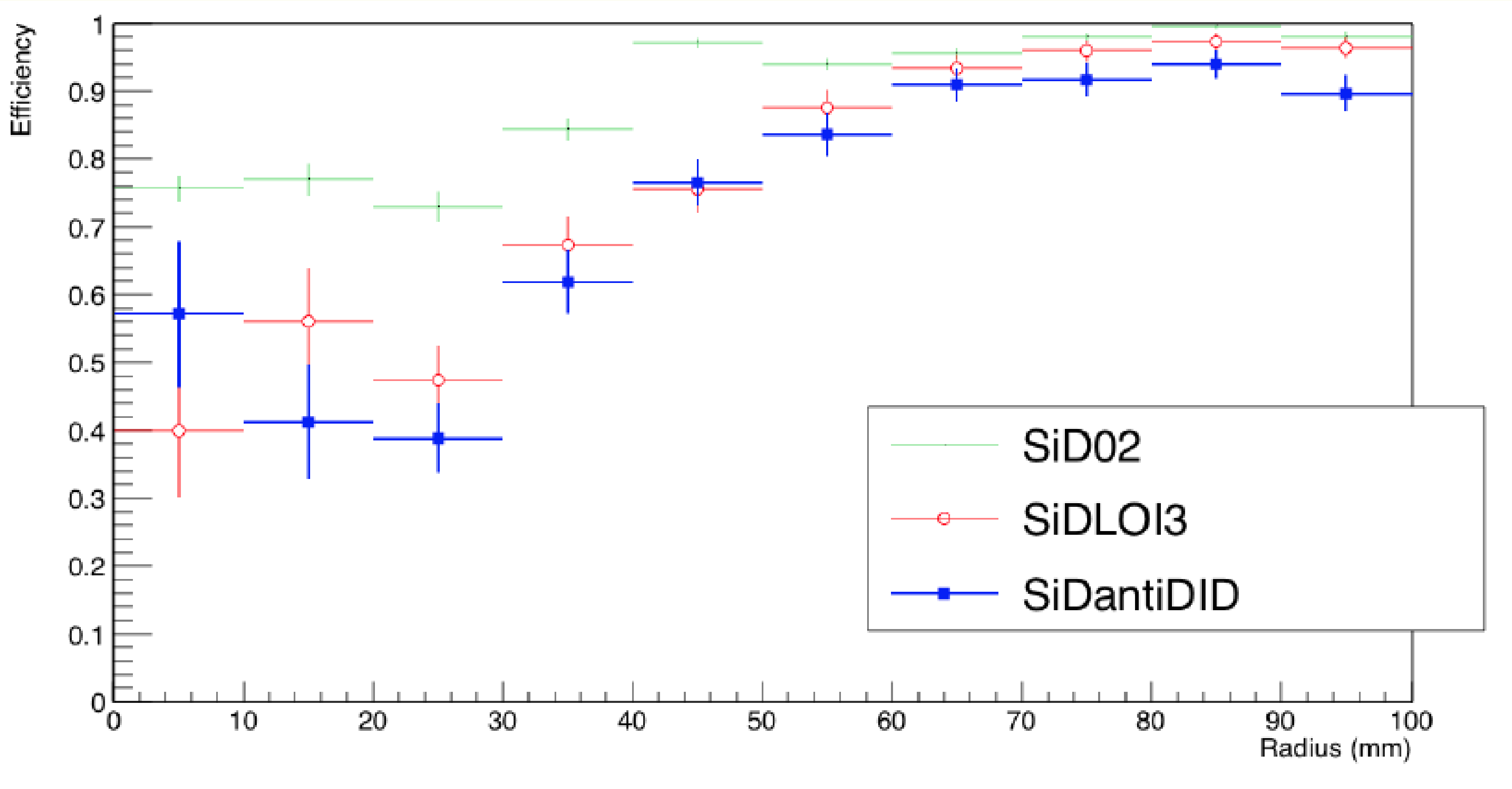
Effect of S/N on BeamCal Reconstruction Performance I

x2 background achieved by overlaying the two (±z) halves of the BeamCal ("Original" in plot)



- **Model is SiD02, no anti-DID**
- **So "Original", with the x2 background, is close to SiDLoi3 no anti-DID (most conservative of all models)**

Efficiency/Purity Plots (e.g. effect of AntiDiD Field)



Next Simulation Development

Current approach uses fixed palette templates for radius 0,1, 2 shapes

Working on moving to dynamic formation of palettes (similar to Andre's approach)

Begins with "local" determination of backgrounds rather than (very large) set of fixed cylinders whose mean backgrounds are calculated before any events are analyzed

Being done by Alix, who will be working in Rome on another project over the summer.

Not our highest priority

Quick List of Ongoing Projects

Re-do BeamCal geometry to center it on exhaust beam

- explore several exit-hole possibilities, including removal of "plug"
- Explore effect of BeamCal z-position in SiD context

Implement full B-field grid with and without AntiDiD field; redo studies

Explore contribution of Bhabhas to "signal rejection"

Re-do degenerate stau/chi^0 analysis with

- more realistic BeamCal simulation
- Simplified model with stau mass and stau/chi splitting as free parameters
- might radiative e+e- ➔ stau+ stau- γ provide effective alternative?
- Explore consequences of different hole geometry