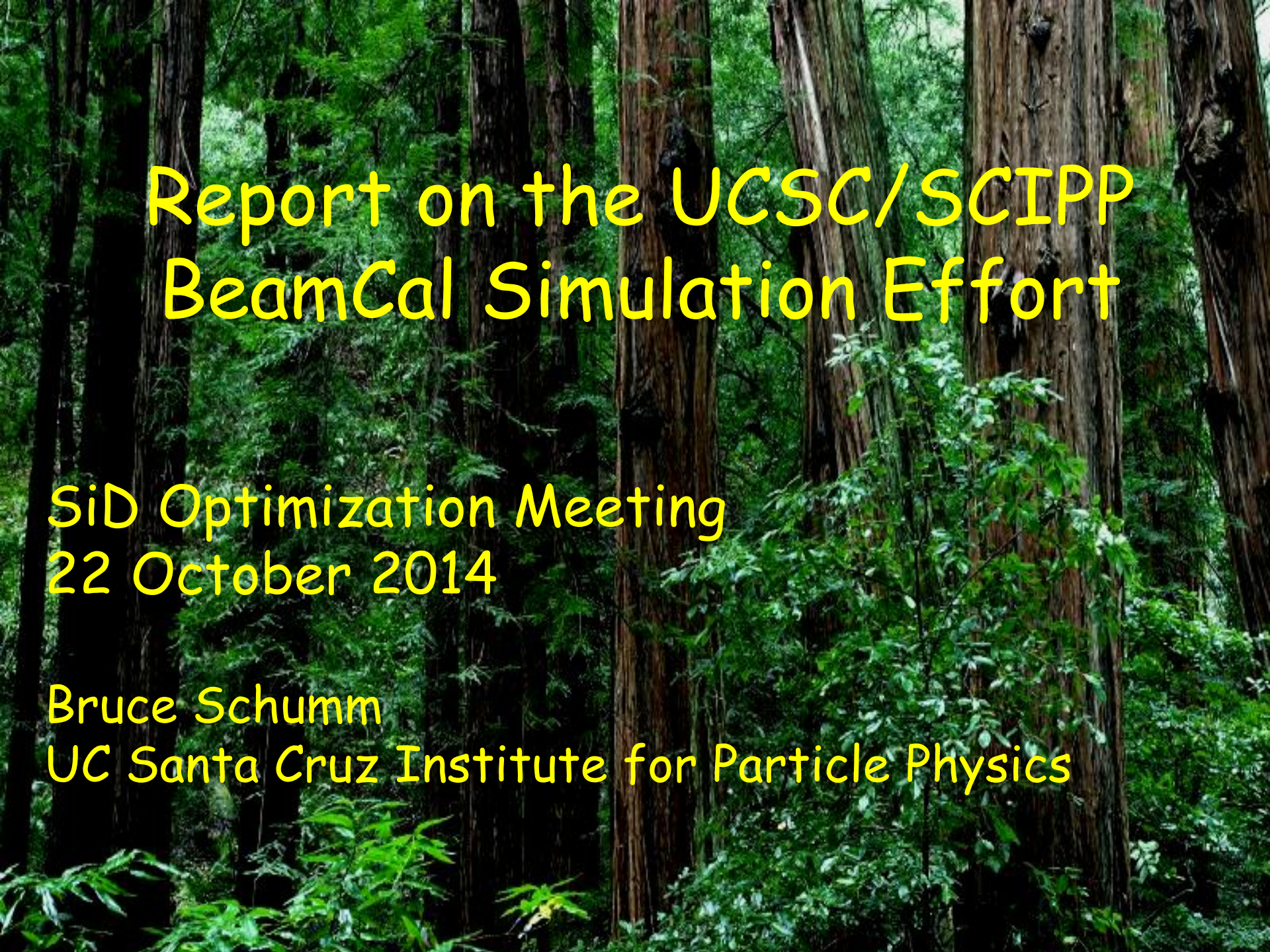


Report on the UCSC/SCIPP BeamCal Simulation Effort

SiD Optimization Meeting
22 October 2014

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)* — 4th year (will stay for 5th)
- Bryce Burgess — 4th year
- Olivia Johnson — 2nd year

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

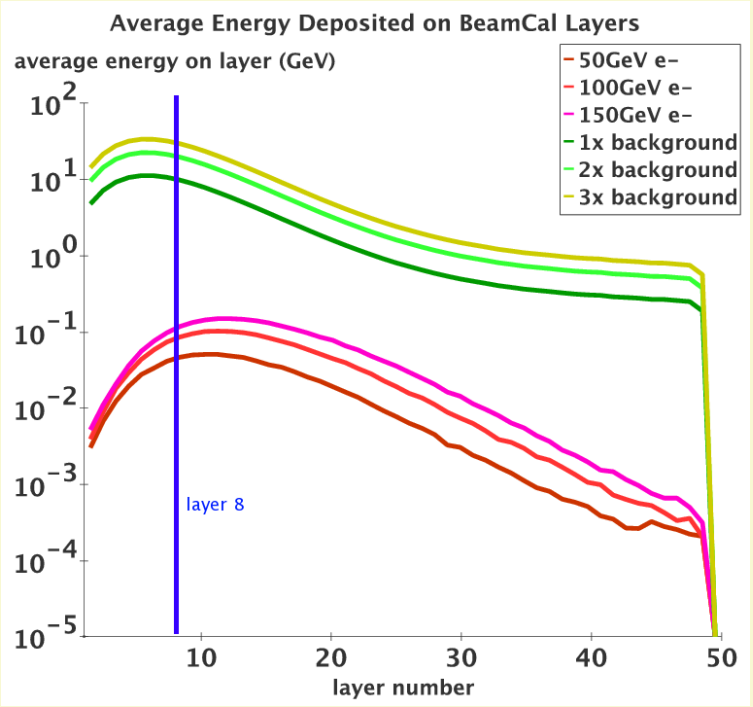
First Issue: Differing Views on BeamCal S/N

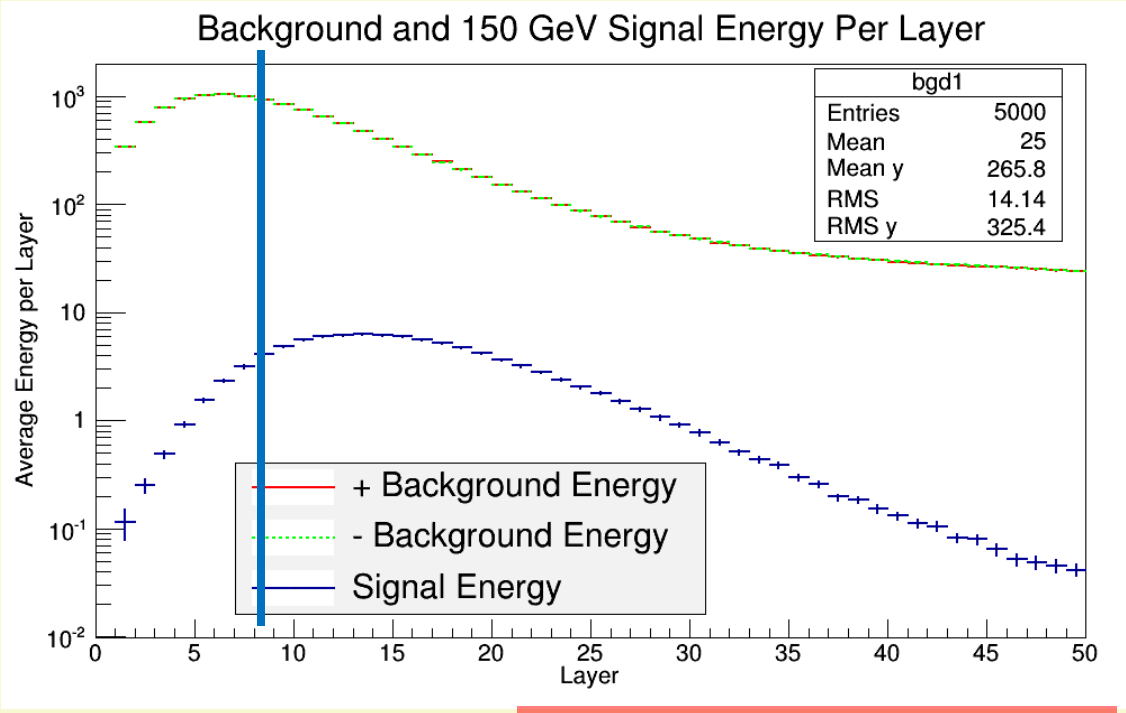
Several groups have presented layer-by-layer mean deposition for BeamCal signal and background

- University of Colorado (DBD studies)
- DESY (Lucia Bortko)
- SCIPP/SLAC (“official” SiD version)
  - SiD02
  - SiDLoi3
  - SiDLoi3 with anti-DID fields

There are noticeable differences

SiD02 S/N: Colorado vs. SCIPP/SLAC





Small (~50%) difference between frameworks

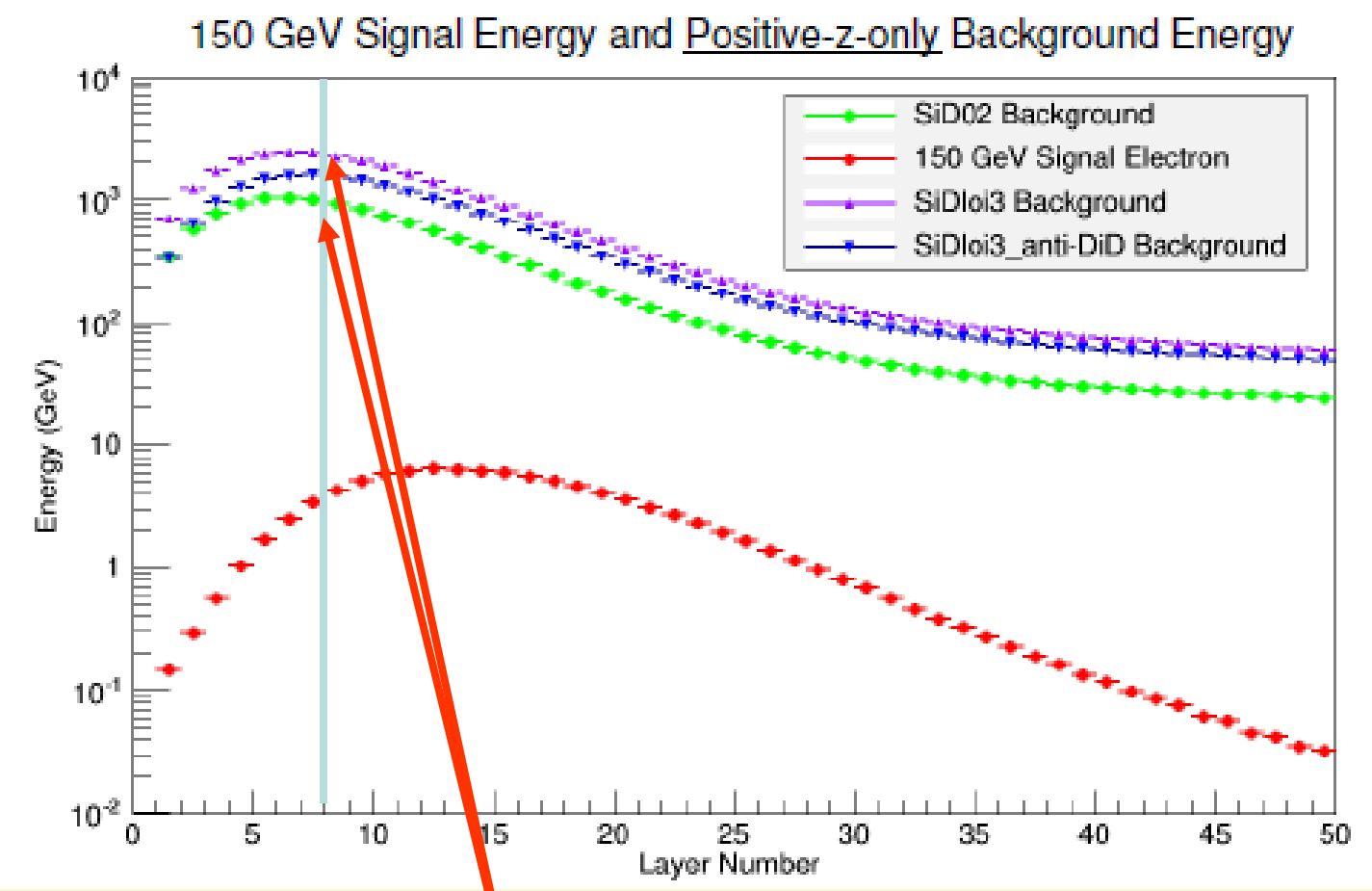
Compare at layer 8

Colorado: S/N = 1/100 (with anti-DID field)

SCIPP/SLAC: S/N = 1/250 (without anti-DID field)

SCIPP/SLAC: S/N = 1/150 (estimate of effect of anti-DID field)

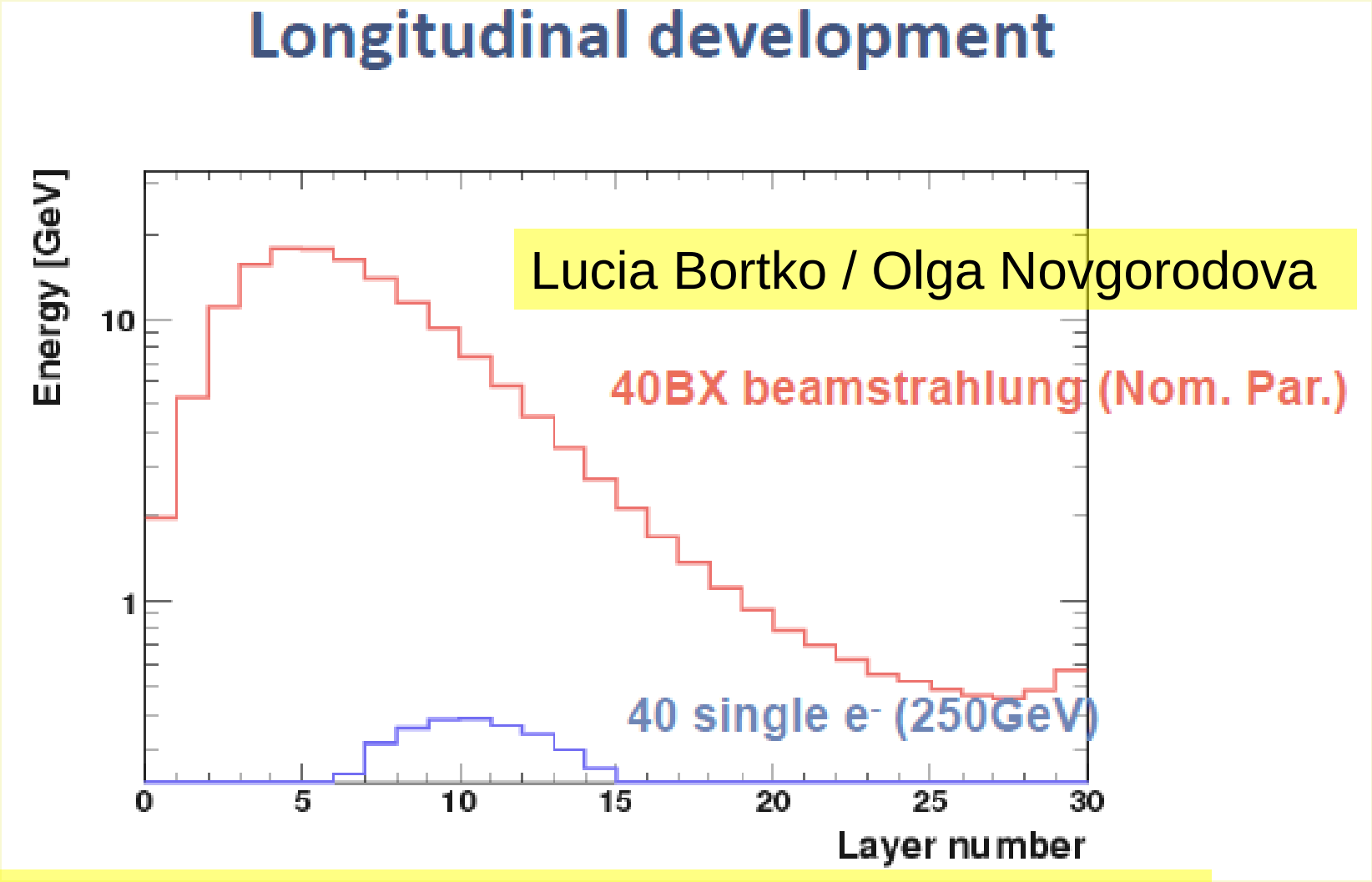
SiD02 vs. SiDLoi3 (SCIPP/SLAC Only)



SiD02 → SiDLoi3 leads to x2.5 increase in backgrounds

Cause under study

The European Perspective



- **From 2009**
- **Similar to Colorado results (1/100) (anti-DiD?)**
- **But different L*, right?**

The SCIPP Reconstruction Algorithm and Background Sensitivity

Nomenclature:

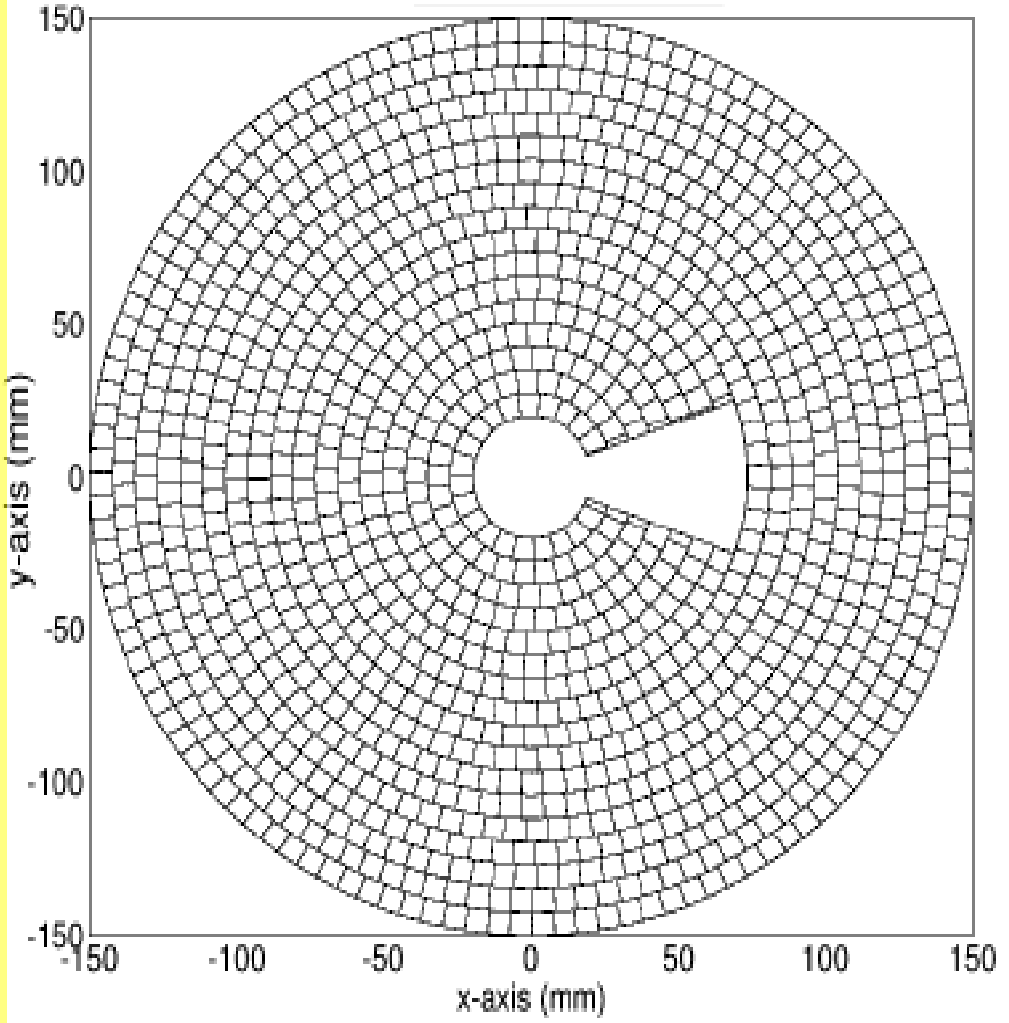
Tile: An individual BeamCal segment

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

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

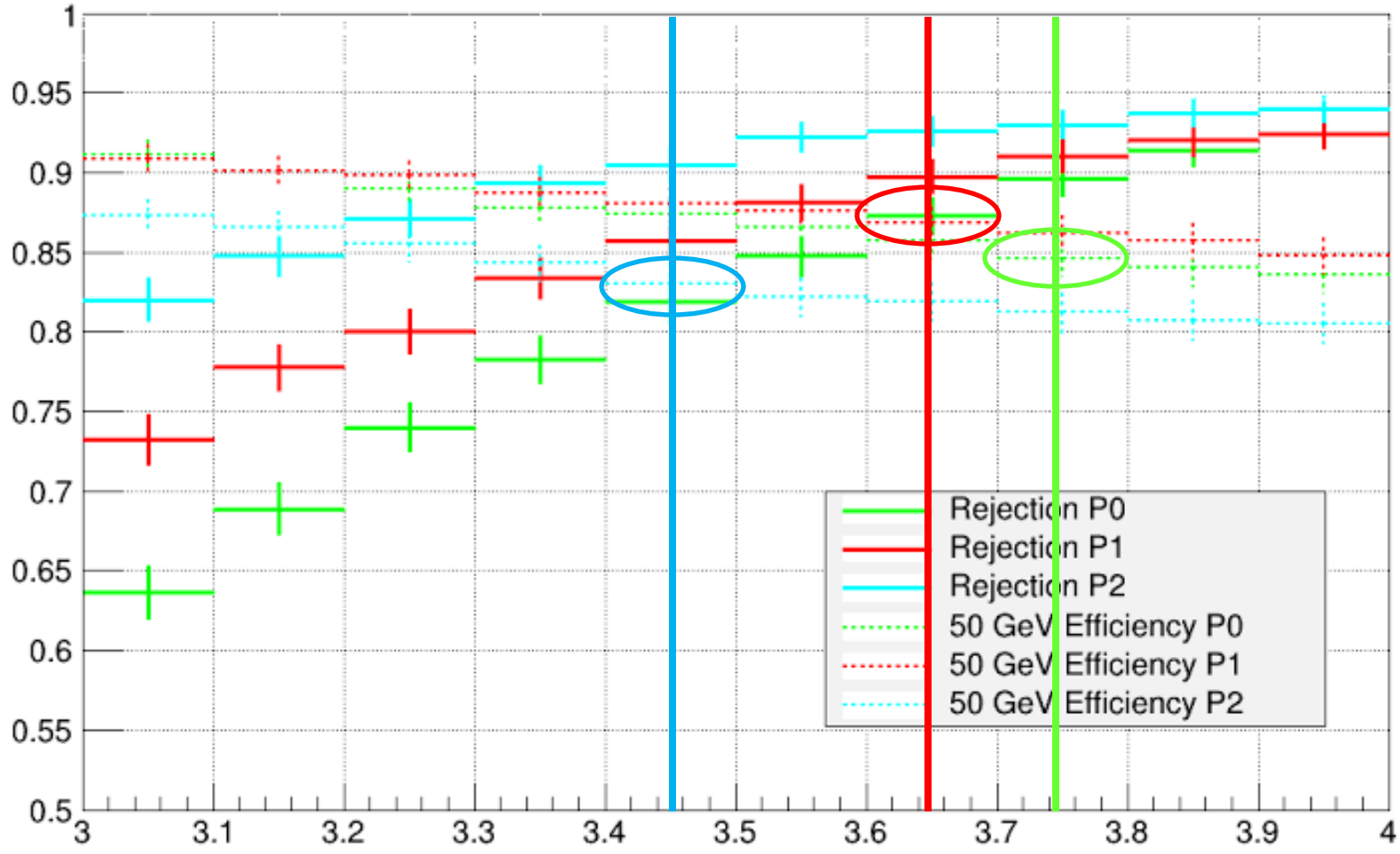
Choice of the value of the sigma cut

- 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

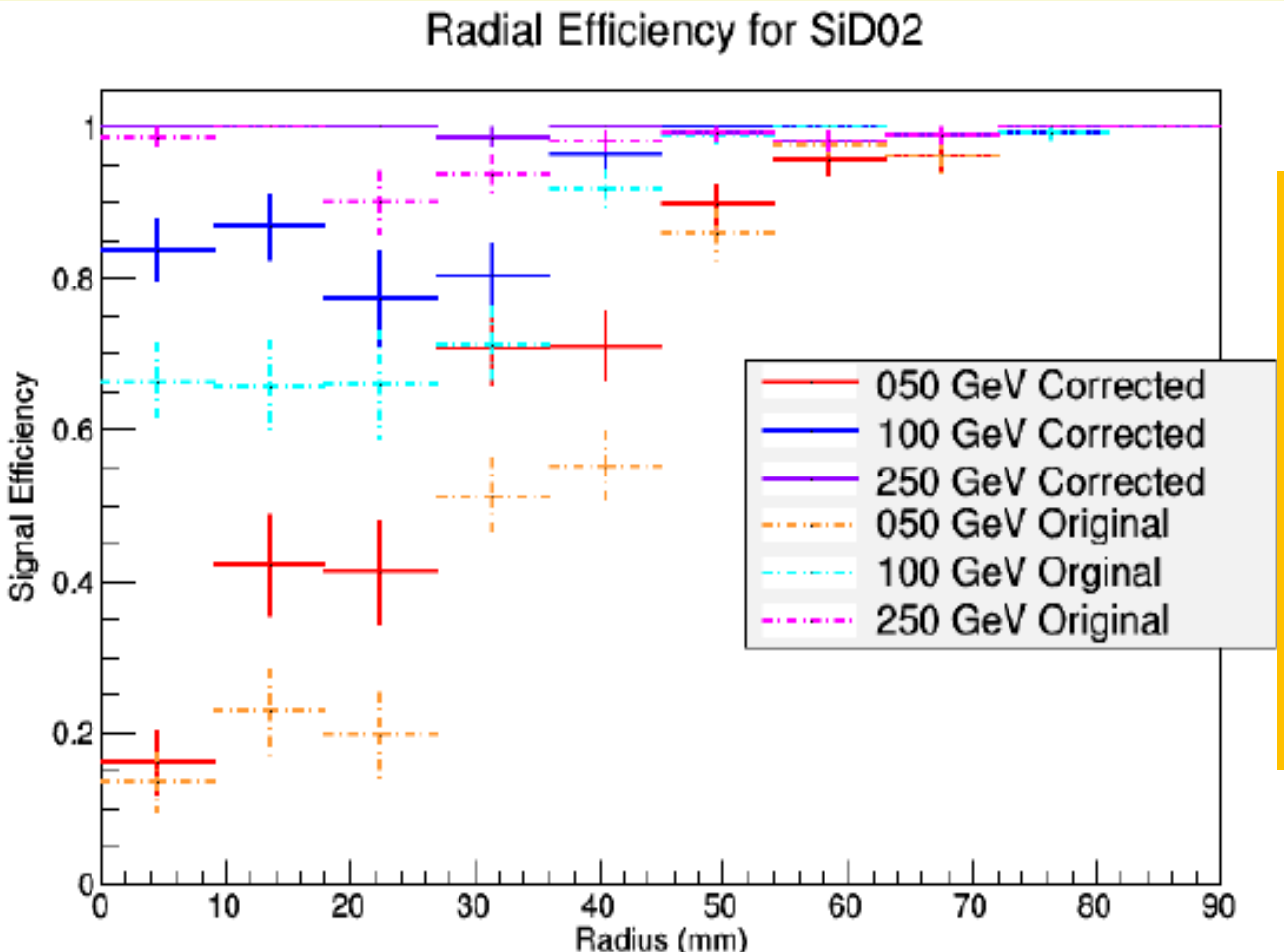
“Palette” Size Selection

Optimize 50GeV reconstruction efficiency@10% fake rate



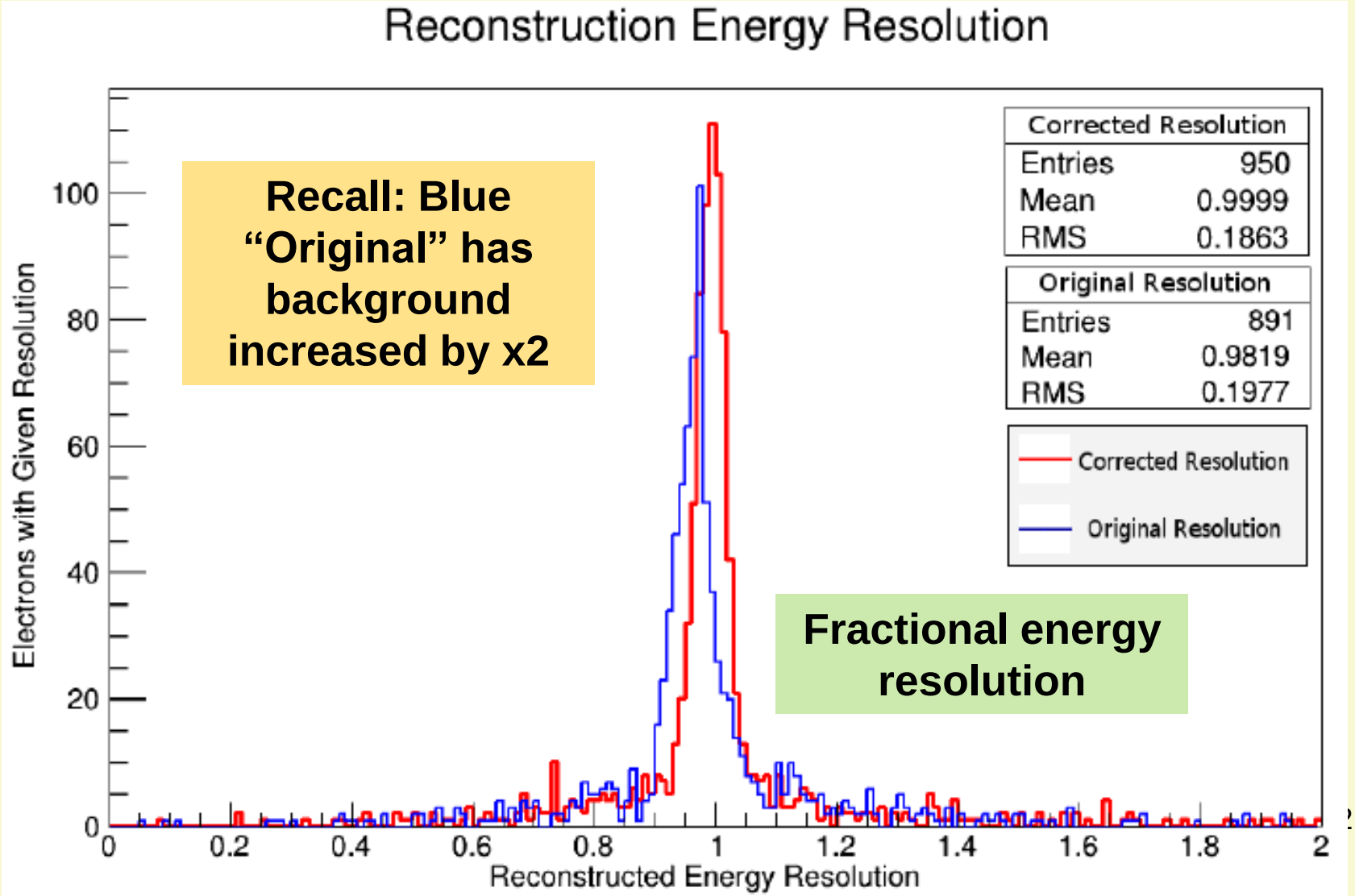
Effect of S/N on BeamCal Reconstruction Performance I

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

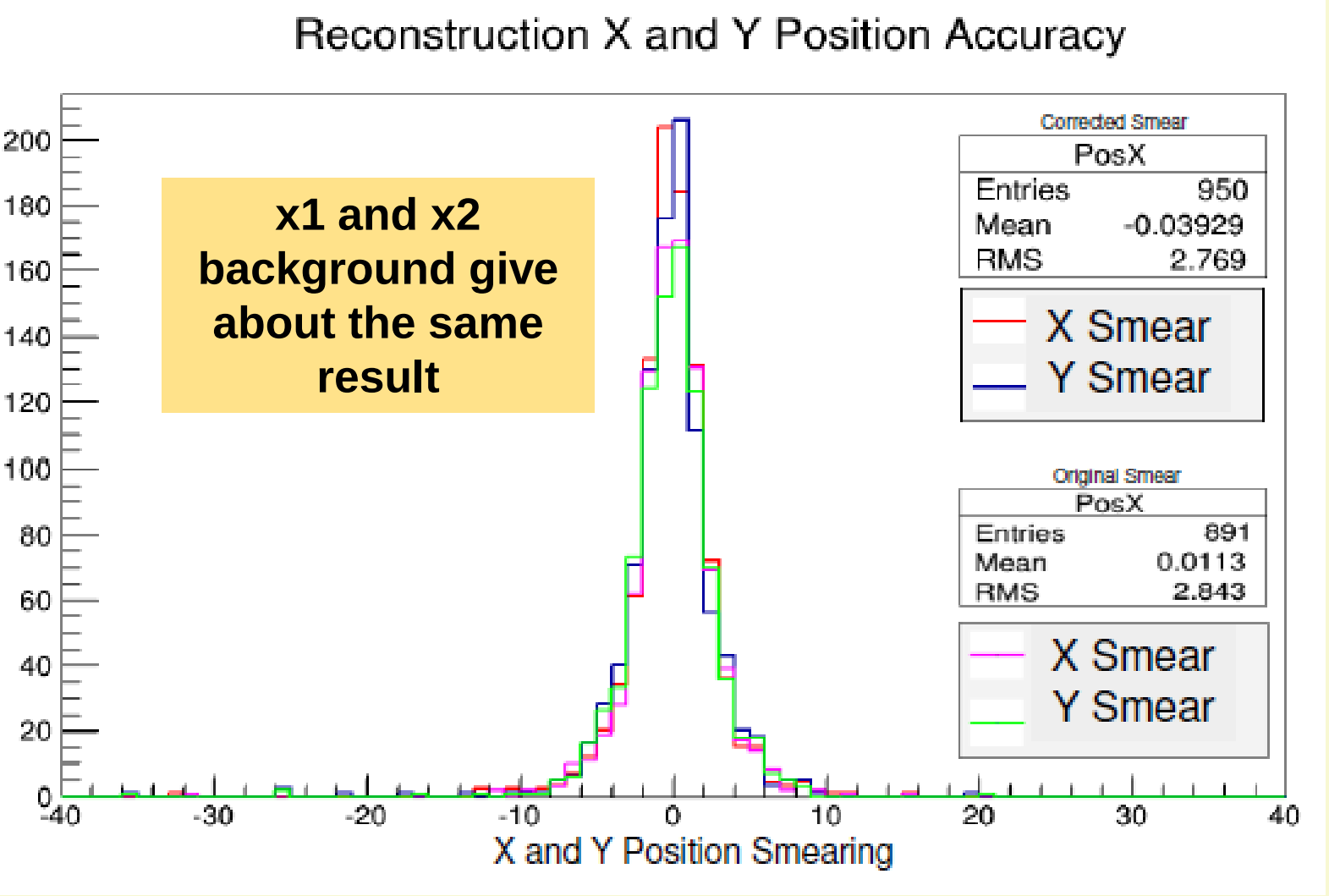


- **Model is SiD02, no anti-DID**
- **So "Original", with the x2 background, is close to SiDLoi3 no anti-DID (most conservative of all models)**

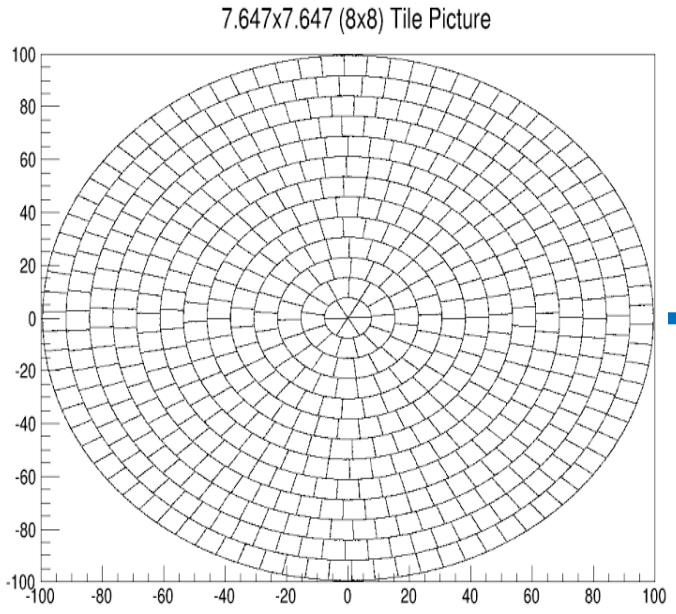
Effect of S/N on BeamCal Reconstruction Performance II



Effect of S/N on BeamCal Reconstruction Performance III

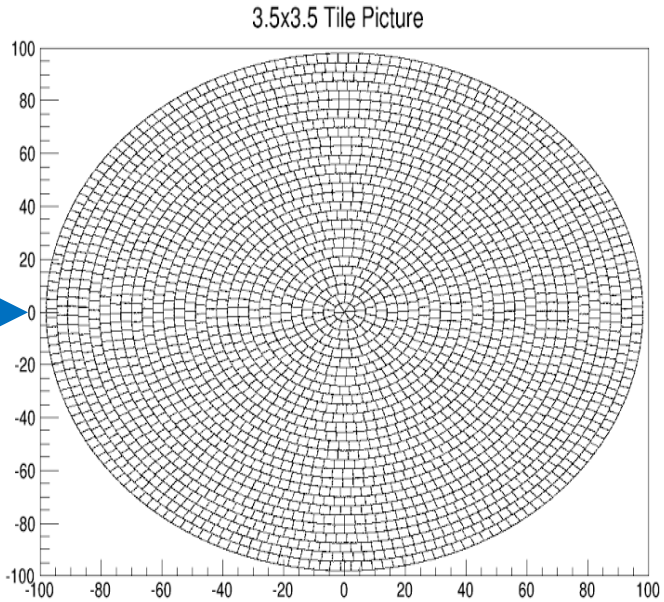


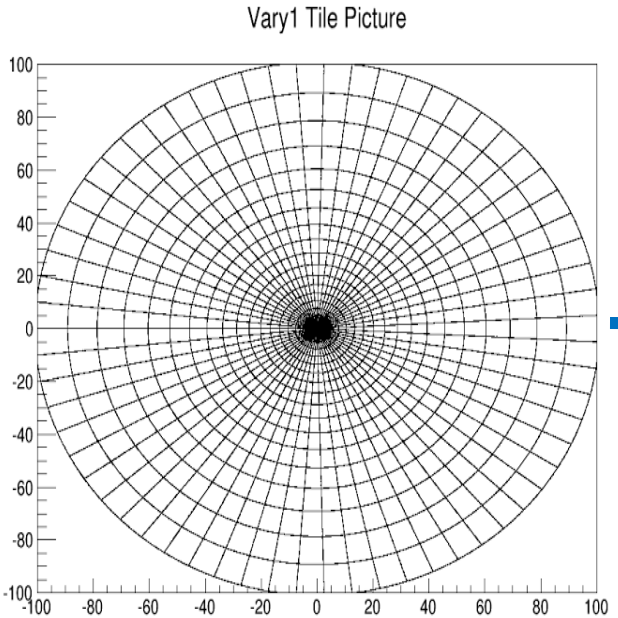
Tiling strategy and granularity study



Constant

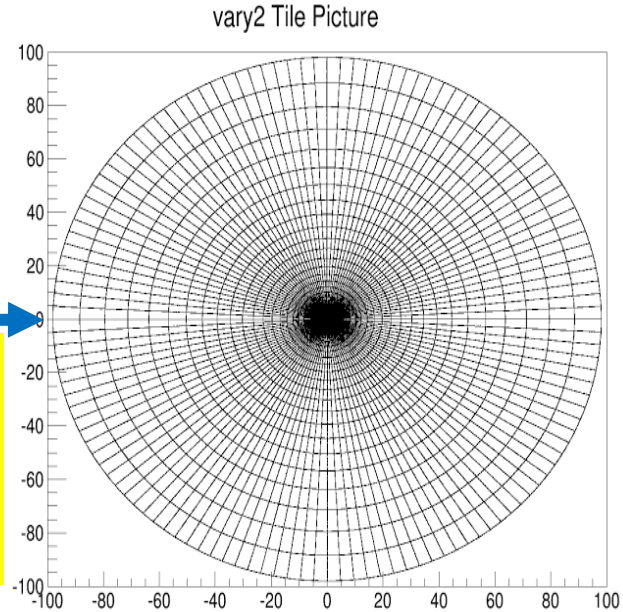
7.6x7.6
5.5x5.5
3.5x3.5



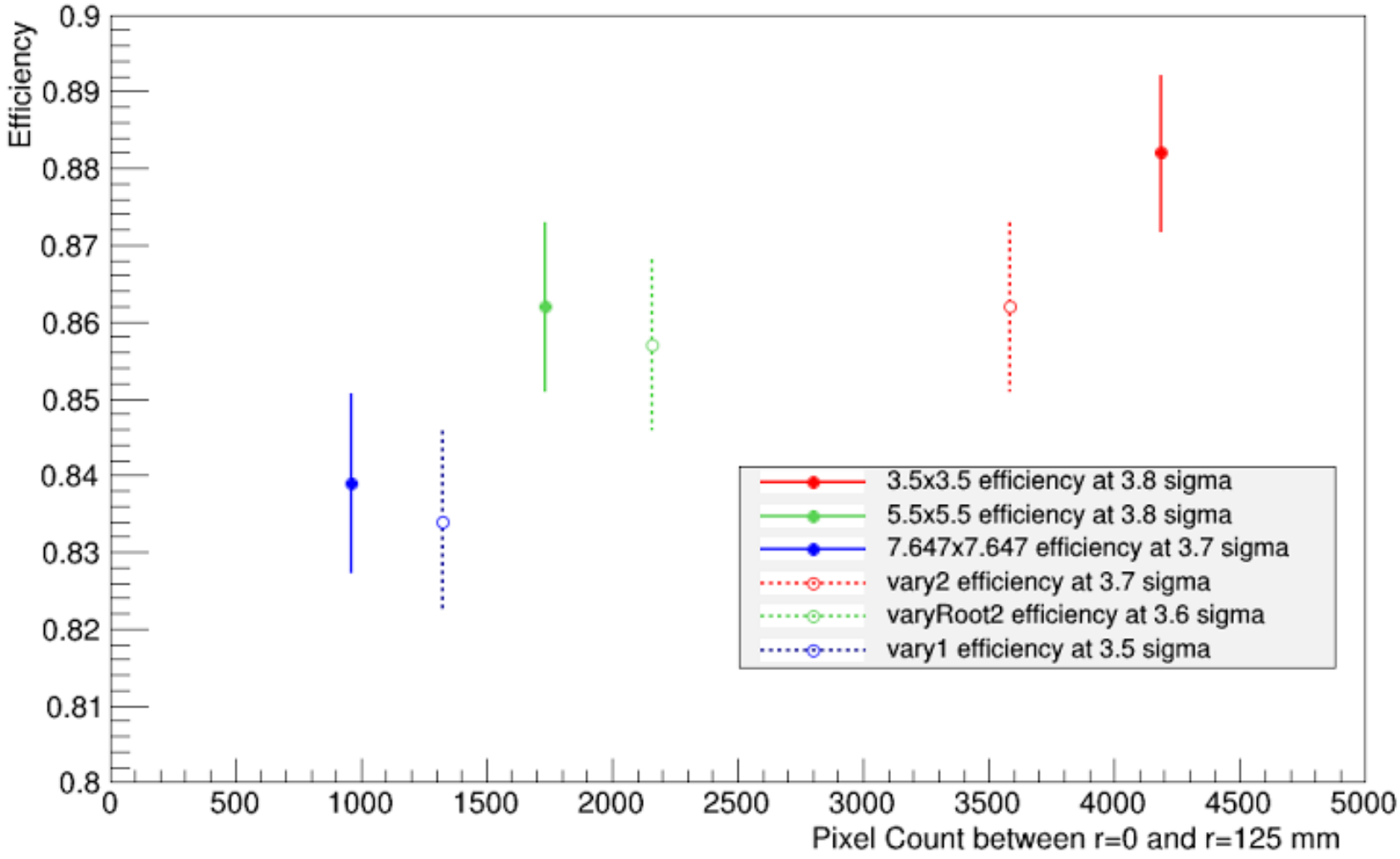


Variable

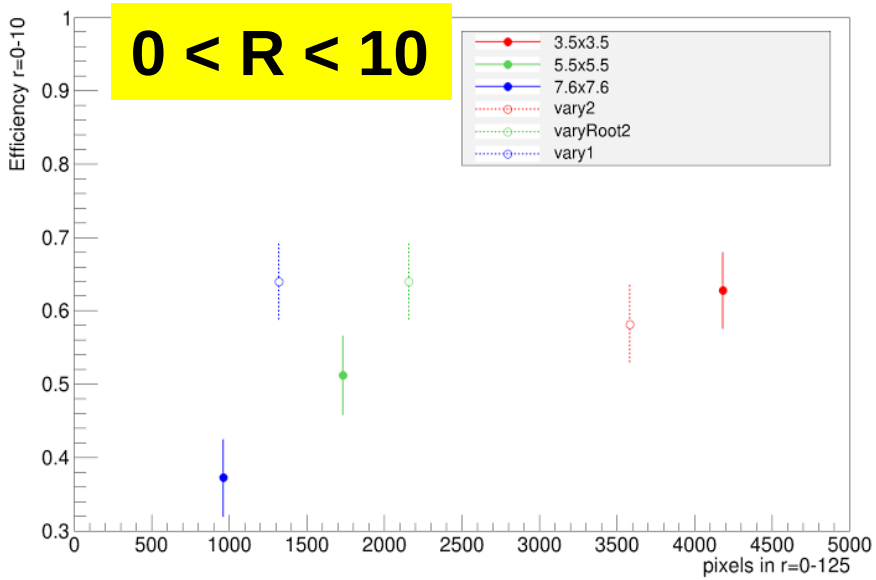
Lucia nom.
(Lucia nom.)/√2
(Lucia nom.)/2

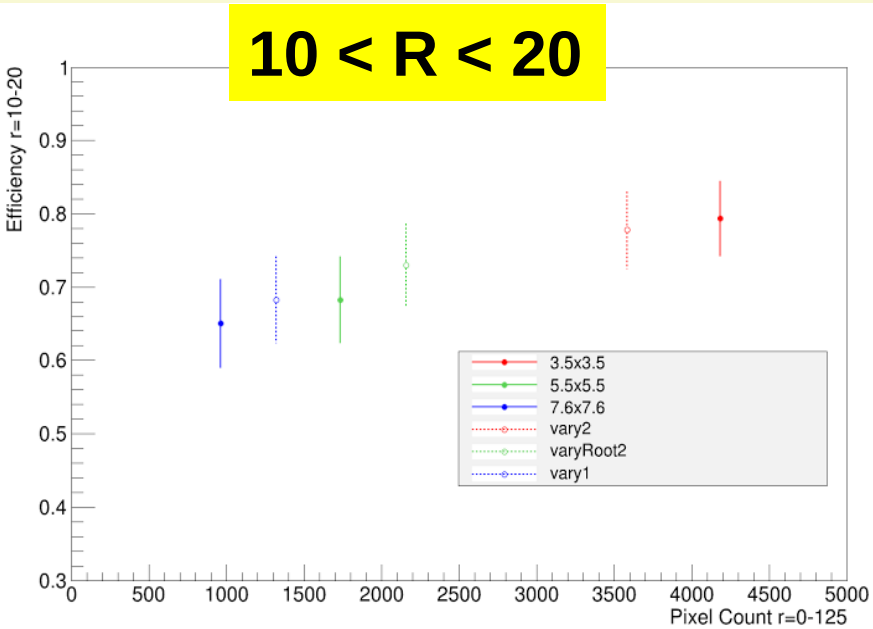


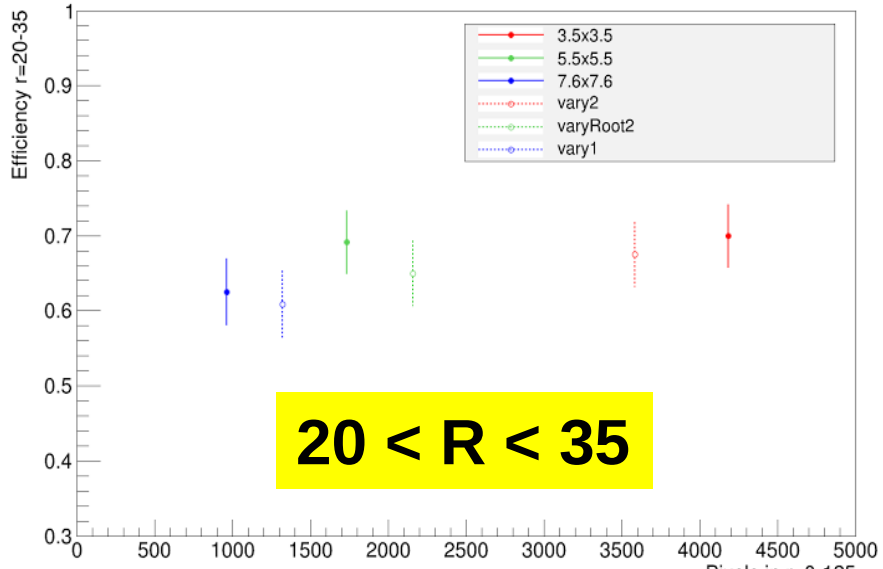
Comparison of Segmentation Schemes Overall Efficiency vs. # of pixels

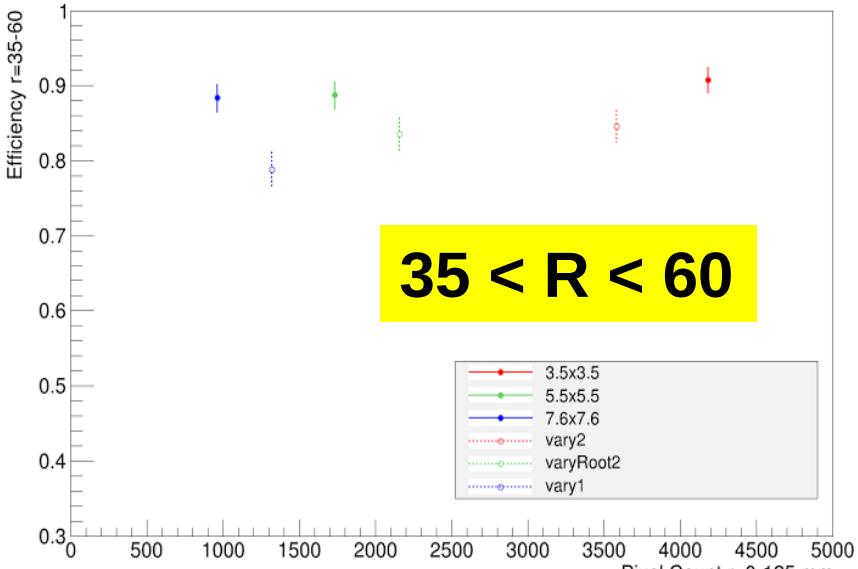


Efficiency v. #pixels in radial slices (50 GeV)





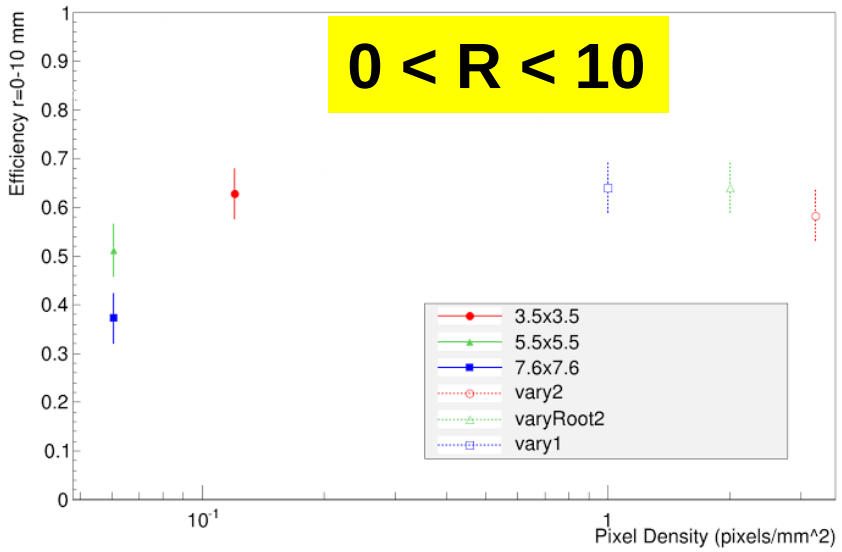


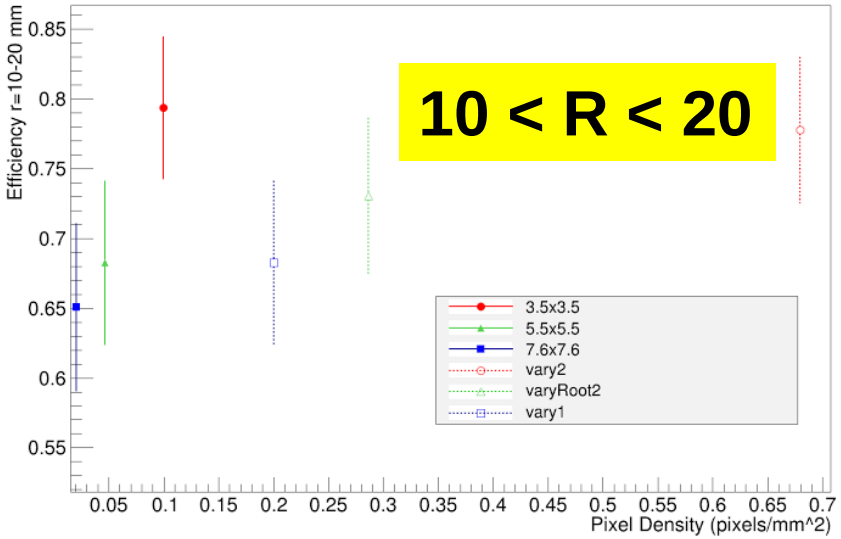


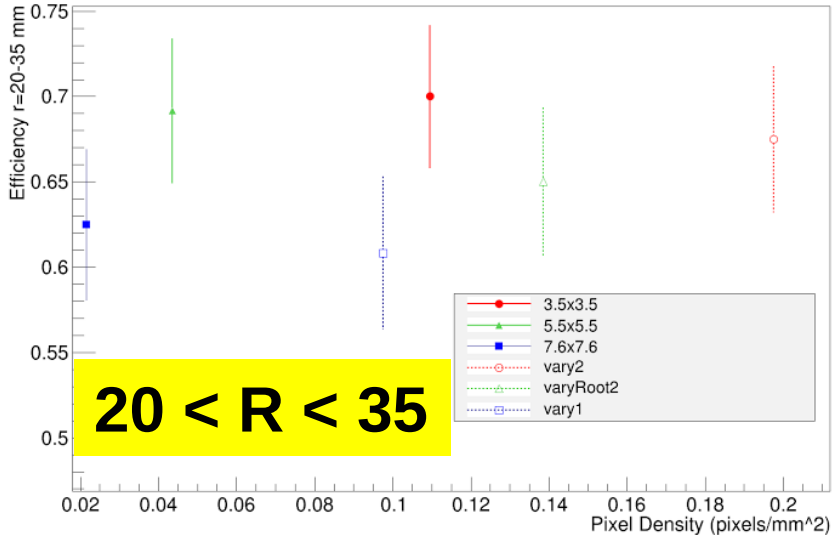
Next Steps

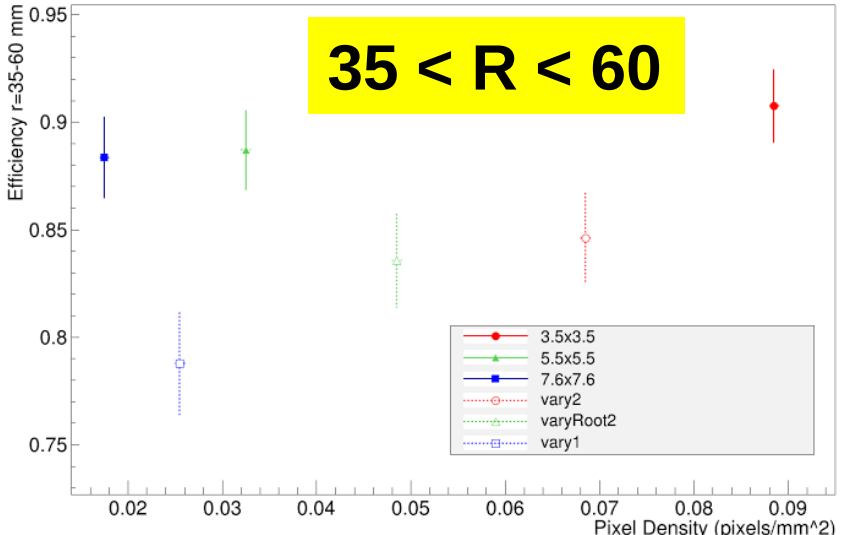
- The SCIPP BeamCal reconstruction is up and running
- We have produced some preliminary optimization studies, but are just now beginning to think about how to proceed
- Next major step is to compare different reconstruction algorithms against the same simulation to come up with best-for-now algorithm (Sailer, Bortko, SCIPP/Colorado)
- Sailer less active, Bortko turning towards physics studies (Ph.D. thesis) ➔ We may be major contributor to simulations
- With expansion of group, want to consider entering into physics studies. Have some rather energetic new students

Efficiency v. pixel density in radial slices



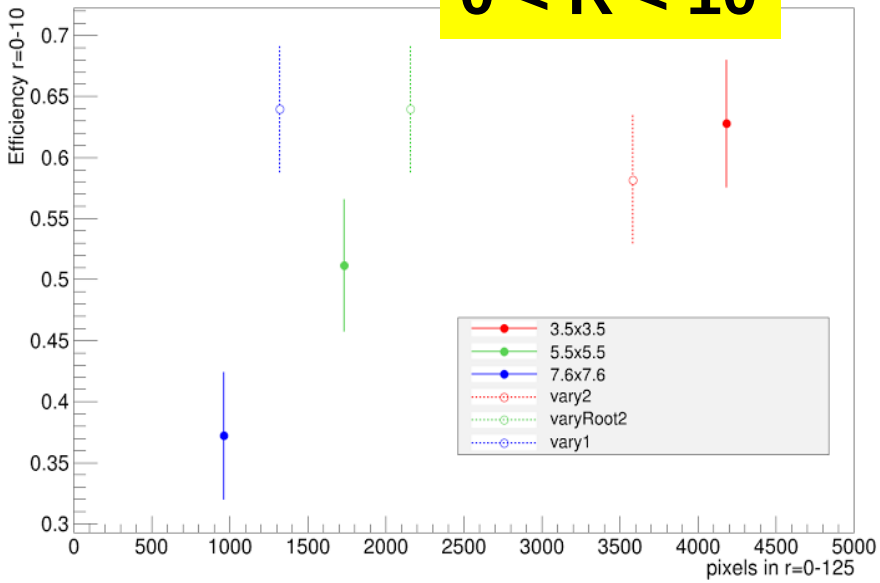




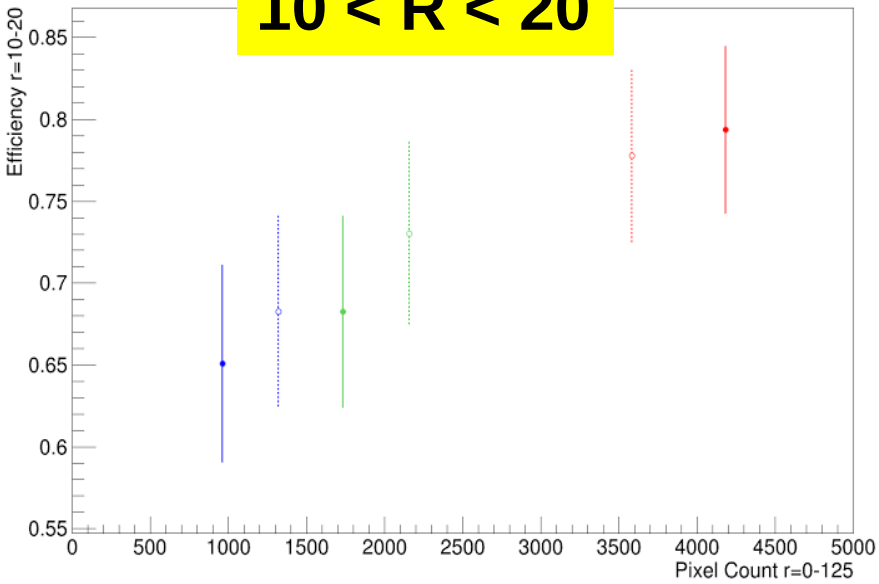


Efficiency v. #pixels in radial slices (50 GeV)

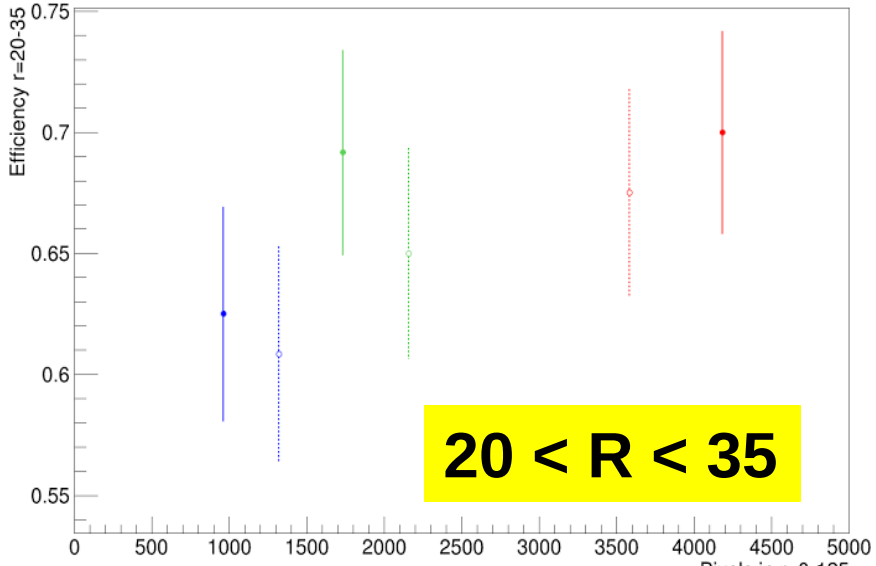
0 < R < 10



10 < R < 20



20 < R < 35



35 < R < 60