# Performance and occupancies in a CCD vertex detector with endcaps

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# Introduction

- Motivation:

  Extend barrel tracking philosophy forward

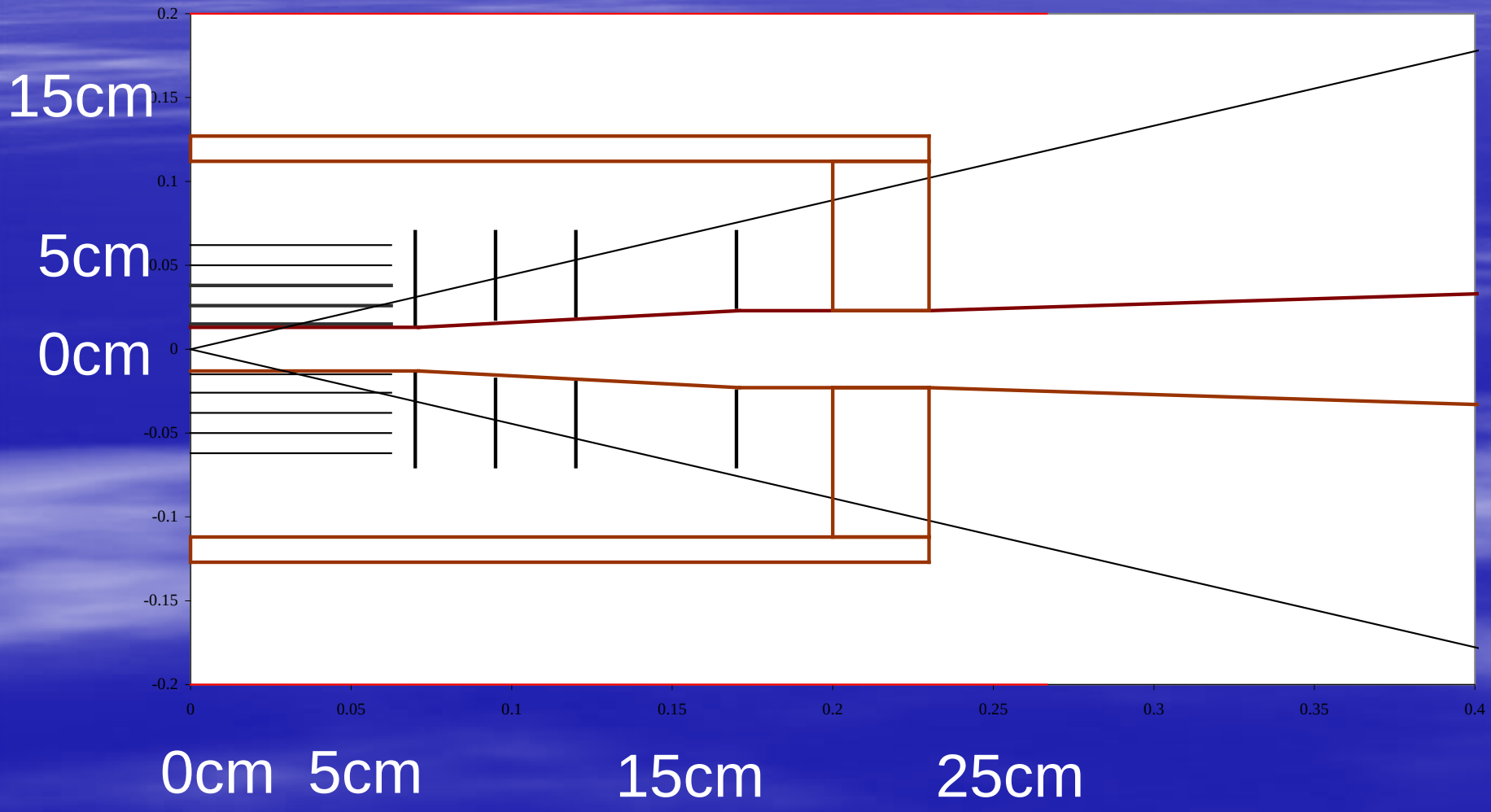
  1. Better vertexing at forward region
  2. Extrapolate tracks to forward disks for momentum measurement and reliable extrapolation to the calorimetry.
  3. Pattern Recognize in 5 Layers of CCD
  4. Global Pattern Recognition to follow

# Current working issue

- We need to make sure the feasibility of this idea.
- At this point, we are working on the following issues.

1. Endplate layout
2. Performance
3. Occupancies and radiation damage

# Endplate layout



# Design concept

- Extend 5 layer tracking over max Ω

  →Ω Coverage

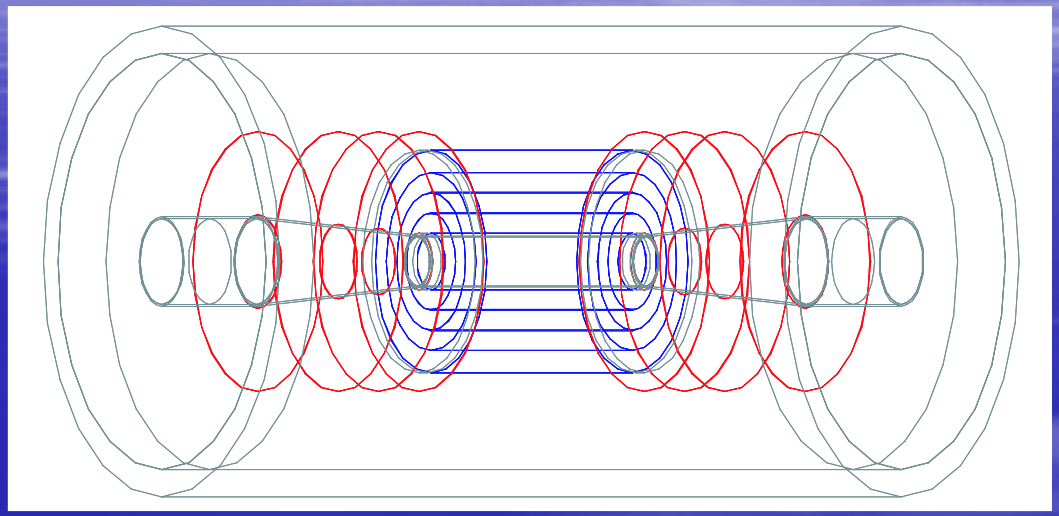
  5 CCD layers .97 (vs. .90 TDR VXD)

  4 CCD layers .98 (vs. .93 TDR VXD)
- Minimize CCD area/cost

  → Shorten Barrel CCDs to 12.5 cm (vs. 25.0cm)
- Thin the CCD barrel endplate

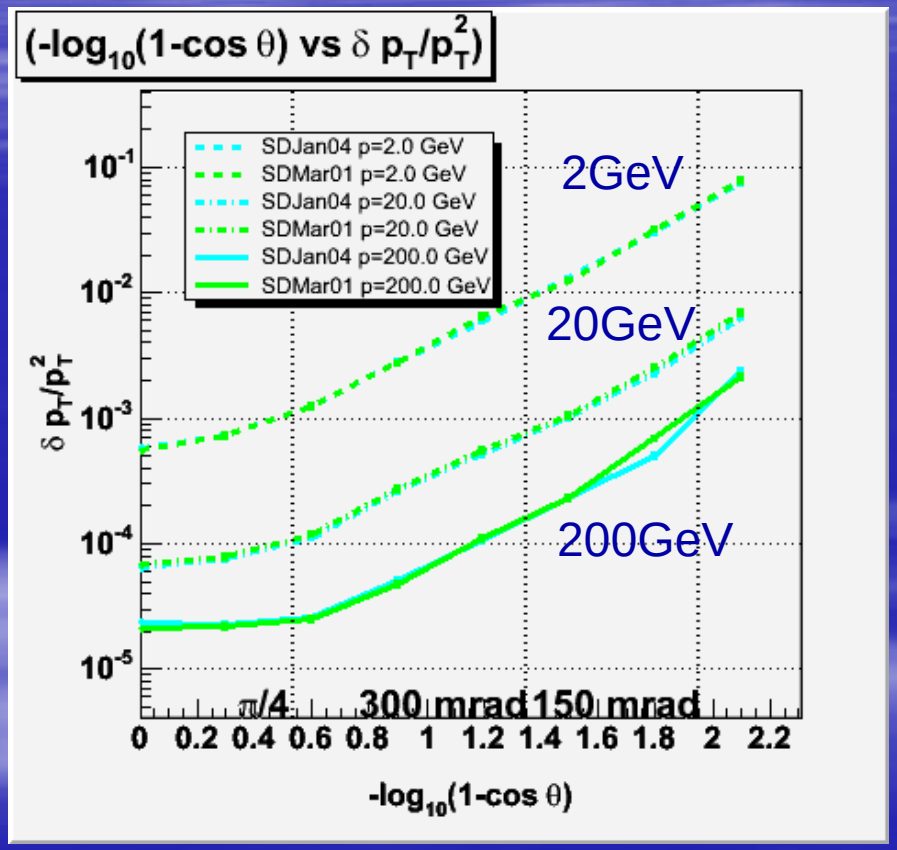
  → a single 300 μm Si disk for self supporting

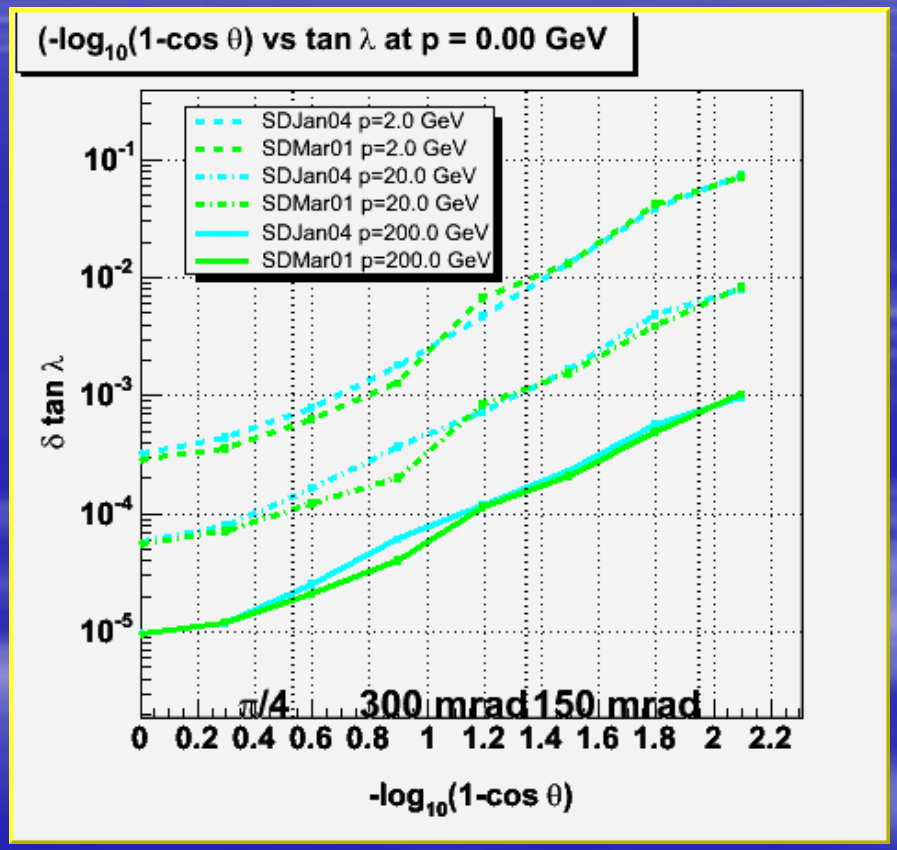
# Performance study



- Full detector simulation for reality.
- Generate single muon track for 2GeV, 20GeV, and 200GeV as a function of cos$\theta$.
- Do Kalmann filter fit.
- Study momentum resolution, impact parameter resolution, and dip angle resolution.

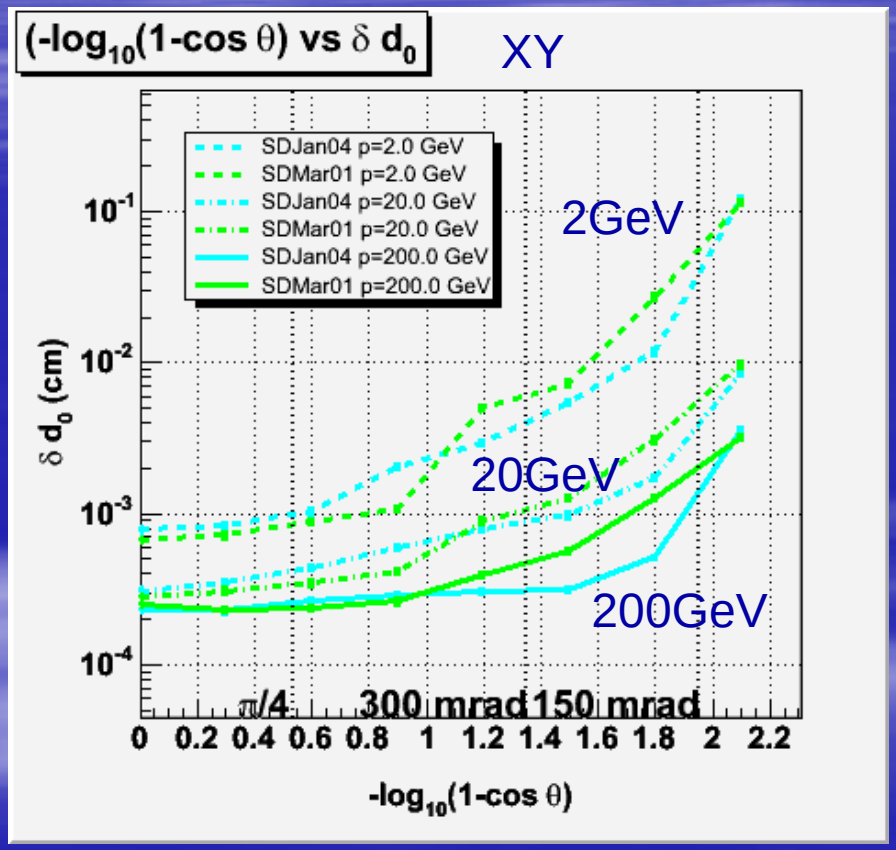
# Momentum and dip angle resolution

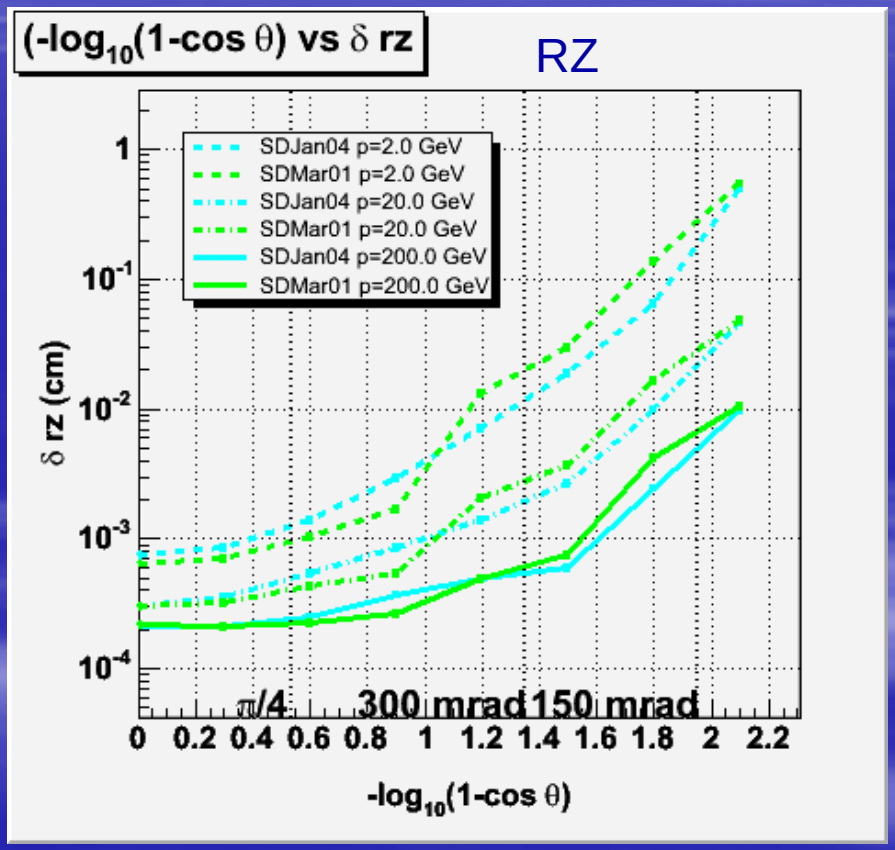



Almost same performance.

# Impact parameter resolution




Better performance at the forward region.

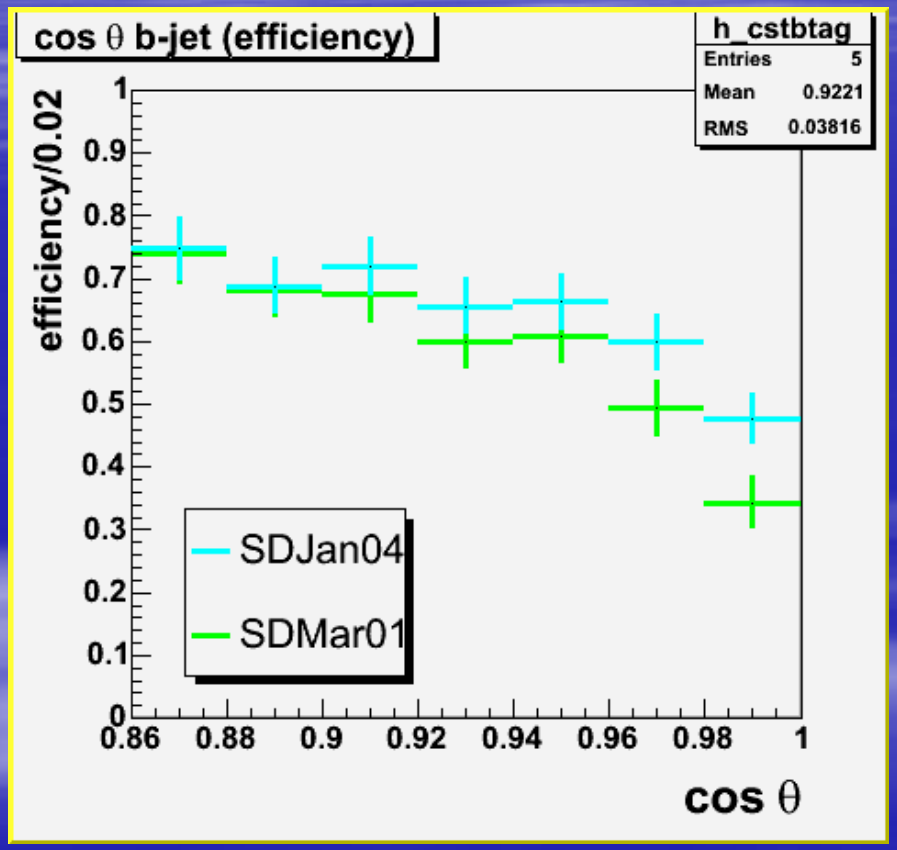
# Tracking performance with endplate

- Momentum and dip angle resolutions are same as previous design.

  → These resolutions are dominated by lever arm than VXD.
- Impact parameter resolutions are significantly improved both of low and high momentum region.

  →Do we get better heavy flavor jet tagging at forward region than before?

# B-tag performance



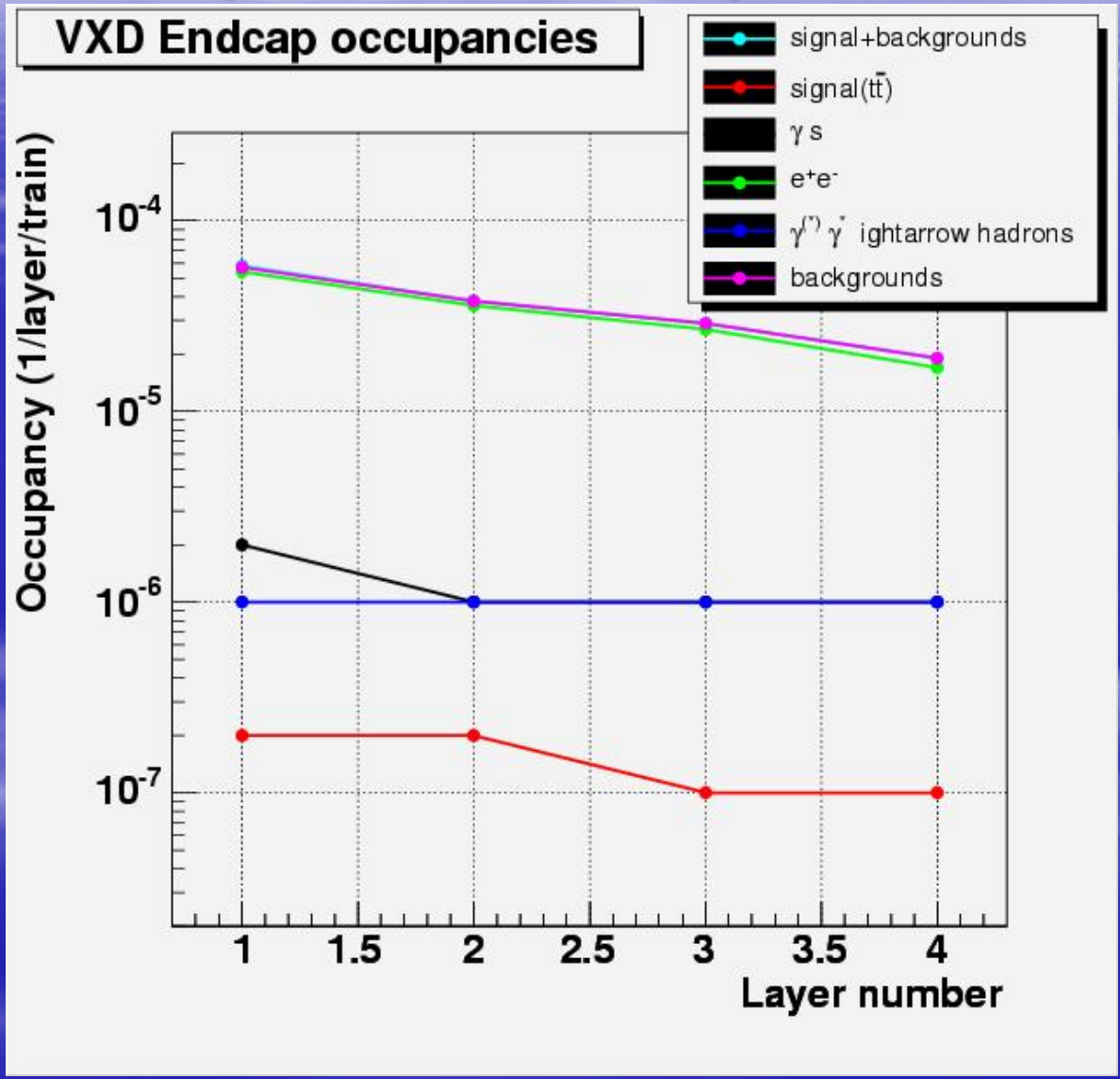

- $Z^0 \rightarrow$ q q-bar @Ecm~91GeV
- Topological vertexing + $P_T$ corrected mass tag (no optimization)
- Better b-tag performance at the forward region

# Occupancy study setup

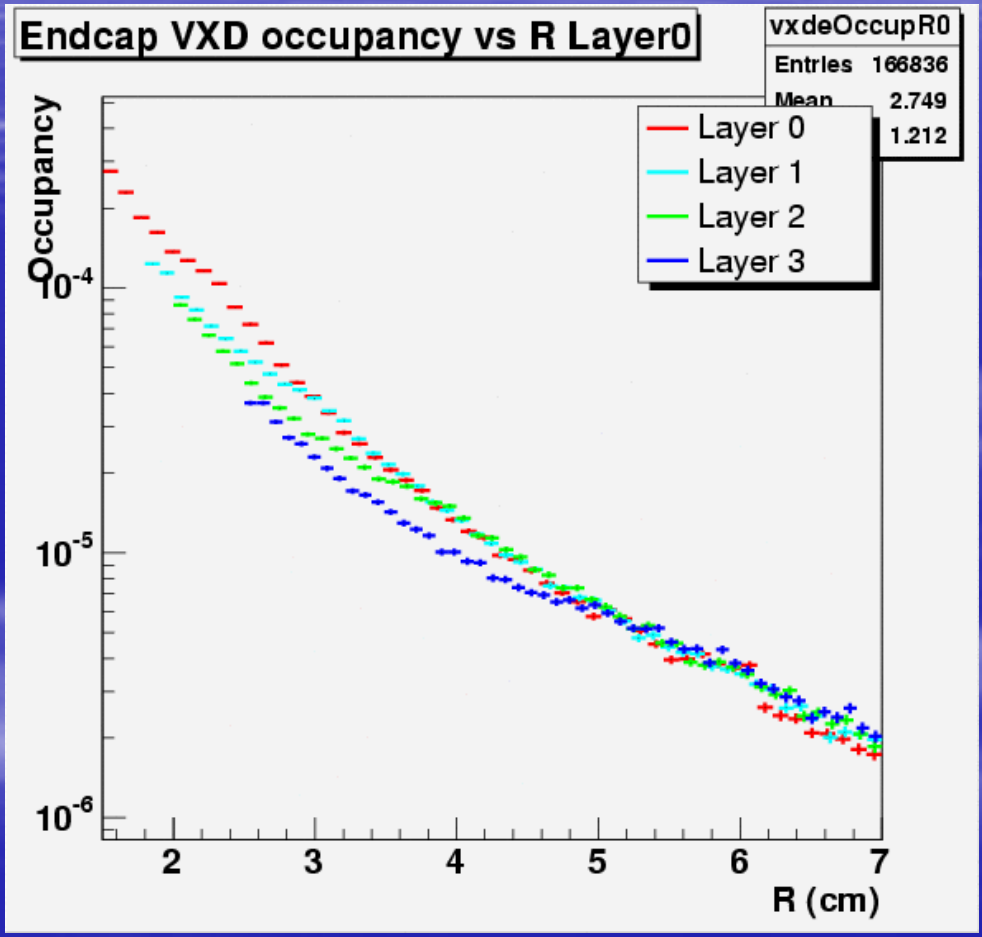
- One big question for endplate vertex detector is occupancy (and S/N ratio).
- We study it taking account to the following signal and backgrounds at $\sqrt{s}$=500GeV:
  1. $e^+e^-$ → t t-bar (Pandora Pythia)
  2. Photons (Takashi)
  3. $e^+e^-$ pairs (Takashi)
  4. $\gamma(*)\gamma(*)$ → hadrons (Tim)

  (Backgrounds are overlaying per a train.)
- We use full detector simulation with NLC beam condition (192 bunches per train).

# Endplate occupancies



# Occupancies vs. R




$10^{-3}$ at inner radius

# Occupancy with endplate

- Good news:

  Occupancy rate (~$10^{-5}$ and $10^{-3}$ at inner radius) is not terrible.

  (Thanks to very fine granularity of CCD)
- Bad news:

  S/N ratio is very small.

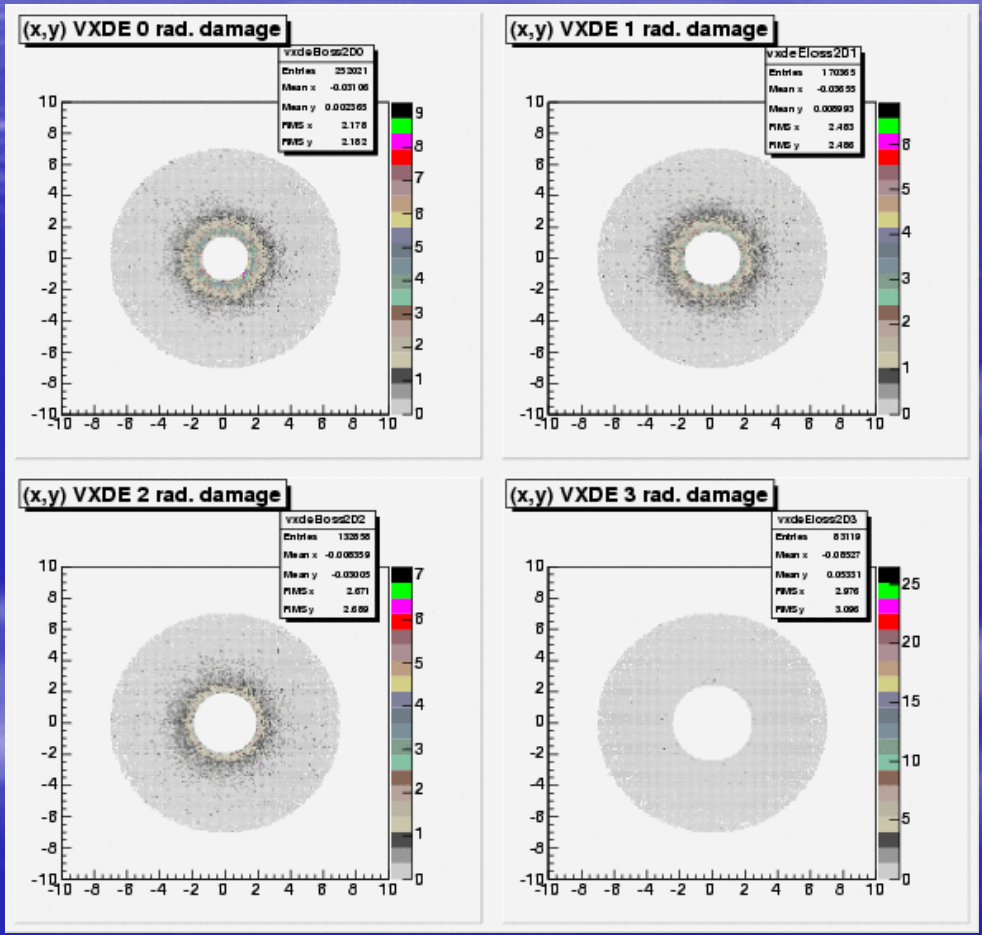
  (Small number of signal tracks and most of backgrounds are $e^+e^-$ pairs which are real tracks.)

  → How difficult detector understanding?

  How cost track finding?

  How pollute signal tracks?

# Radiation damage per month




About ~5Gy/month at inner radius

# How severe is it?

- I have collected opinions by two vertex detector experts.

1. First opinion : John → Green light.
2. Second opinion : Chris → Grey…

   (should be careful about machine environment, clock time, etc…)

- Currently we can not say 5Gy/month indicates green, yellow, or red light.

  We need more opinion about it.

# Summary

- We just start a study of vertex detector with endcaps.
- The endcaps significantly contribute to improve impact parameter resolution and b-tag performance at forward region.
- The occupancy is not a problem but S/N ratio. (Is time stamp needed?)
- We are looking forward to hear expert's opinion about radiation damage.