SiD Tracker Occupancies

Motive:

- Do occupancies in SiD Trackers compromise pattern recognition?

Topics:

- What is impact of "new" 2-photon backgrounds?
- Can SiD tracking handle Warm RF? (Integrating 192 bunch crossings/300ns)

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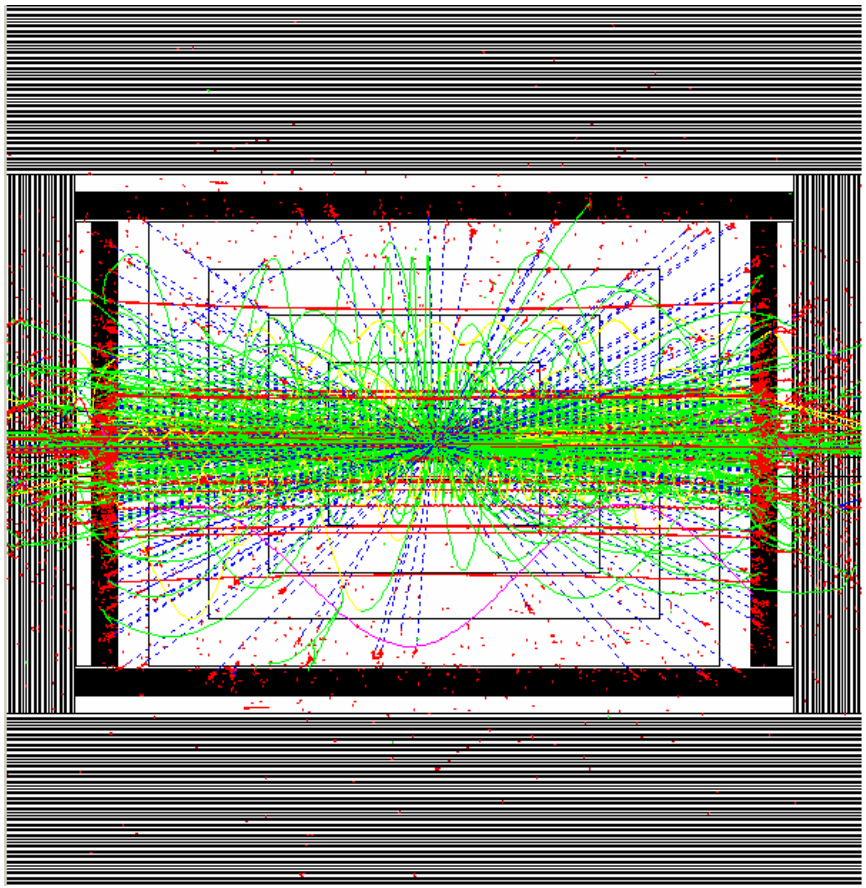
LCWS 04 Paris
April 22, 2004

Update on Backgrounds

New estimates of $\gamma\gamma \rightarrow$hadrons yield 56 events/ NLC train (192 bunches).

(T. Barklow SLAC ALCPG 1/04)



<u>Occupancies/Train</u>

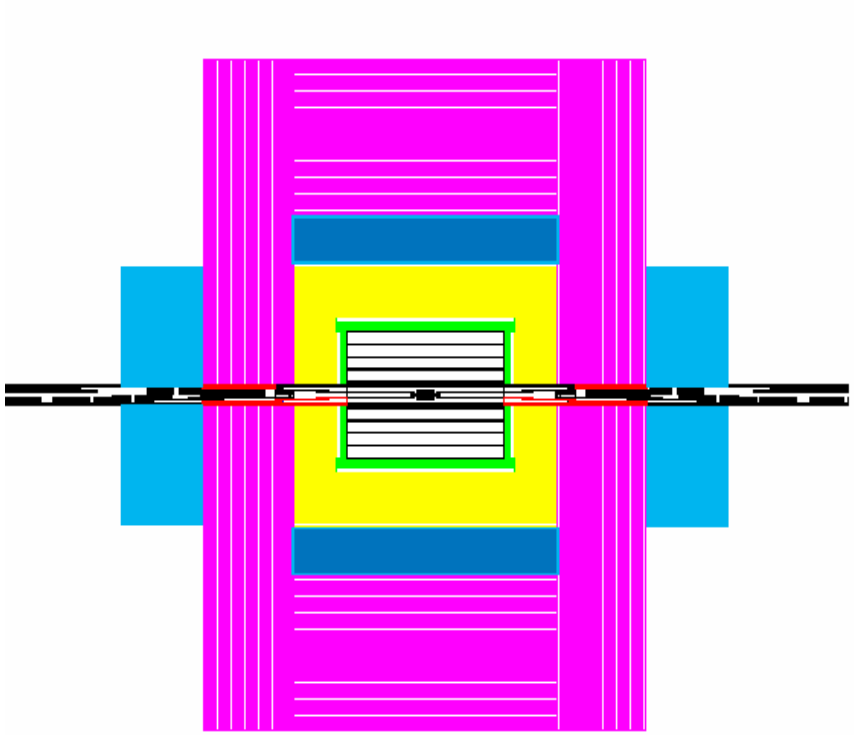
8600 e^+e^- pairs

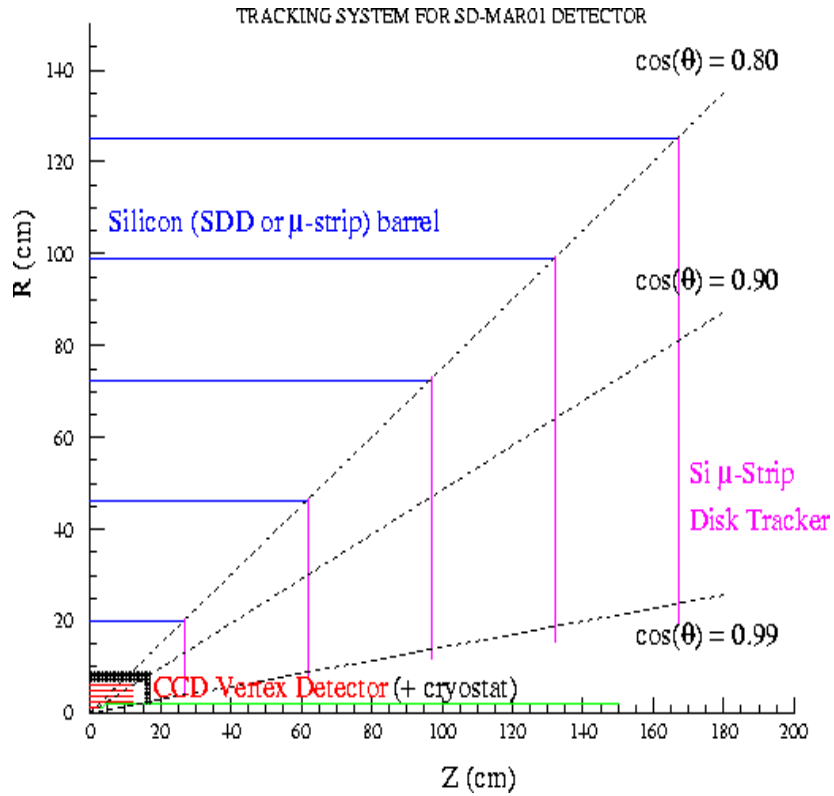
35k γ's (~MeV)

154 $\mu^+\mu^-$ pairs

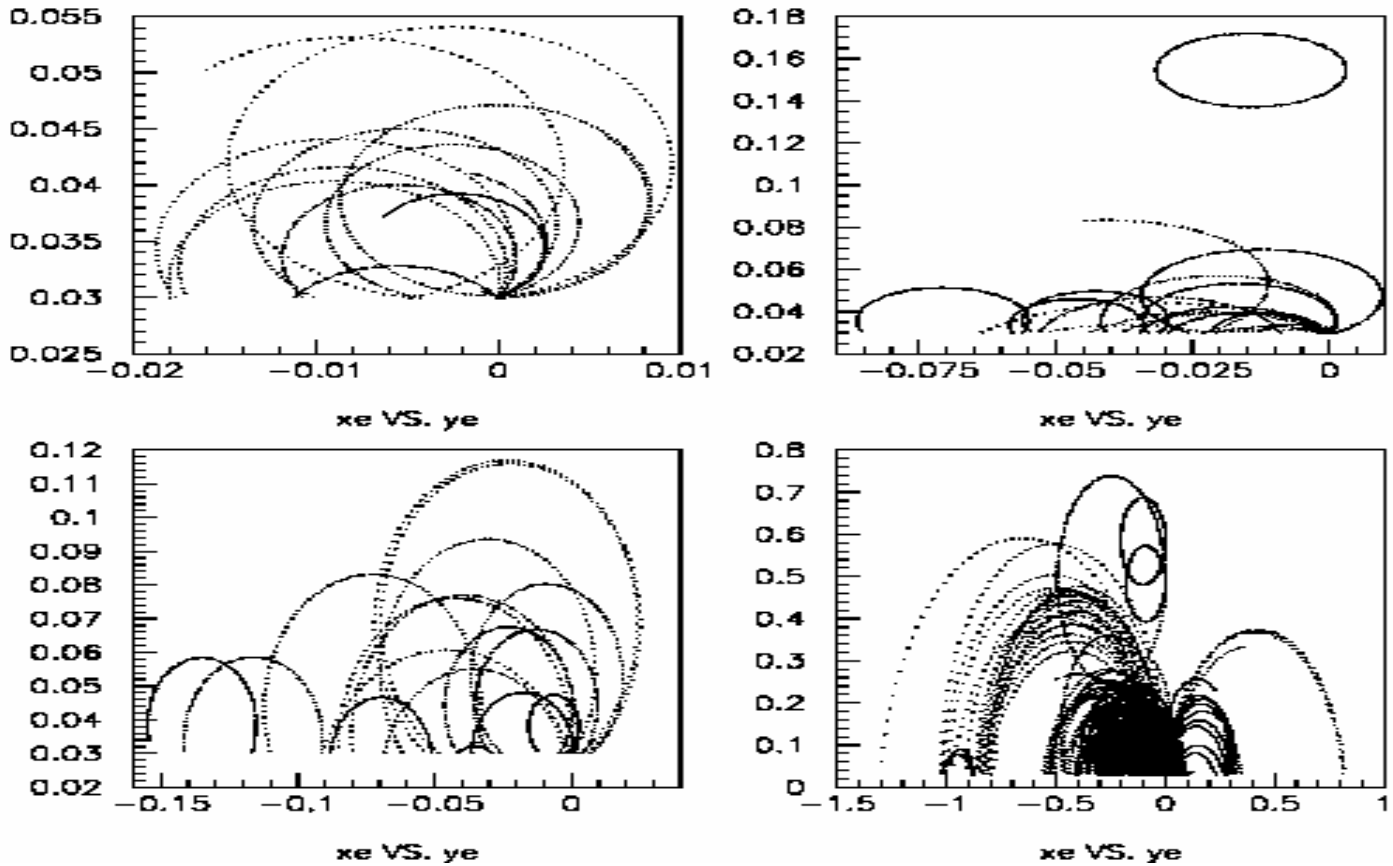
56 had events

Baseline SiD Detector/Tracker





Understand Photon Interactions in Si with Geant 3 Simulation



- Beam pipe, Mask, VXD and detector materials are in the simulation.
- 300 μm Si with 50 μm strip width in 5T field for photon interactions.

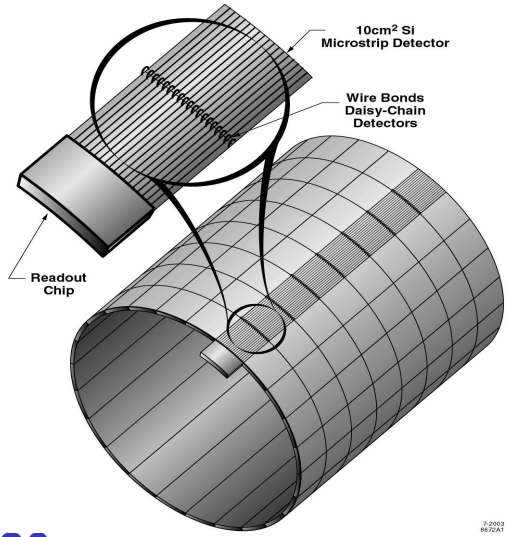
Occupancy from Photon Conversions

Barrel Occupancy

Layer 1 0.42%

(r=20 cm; 50 μm; Δz=25cm)

Occ ~ 1/r



Forward Occupancy

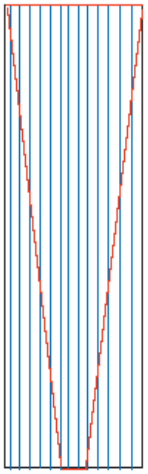
Layer 1 0.09% →

(z=25 cm; 50 μm; Δr=16 cm)

Layer 5 0.10%

(z=168 cm; 50 μm: Δr=105cm)

Occ ~ constant

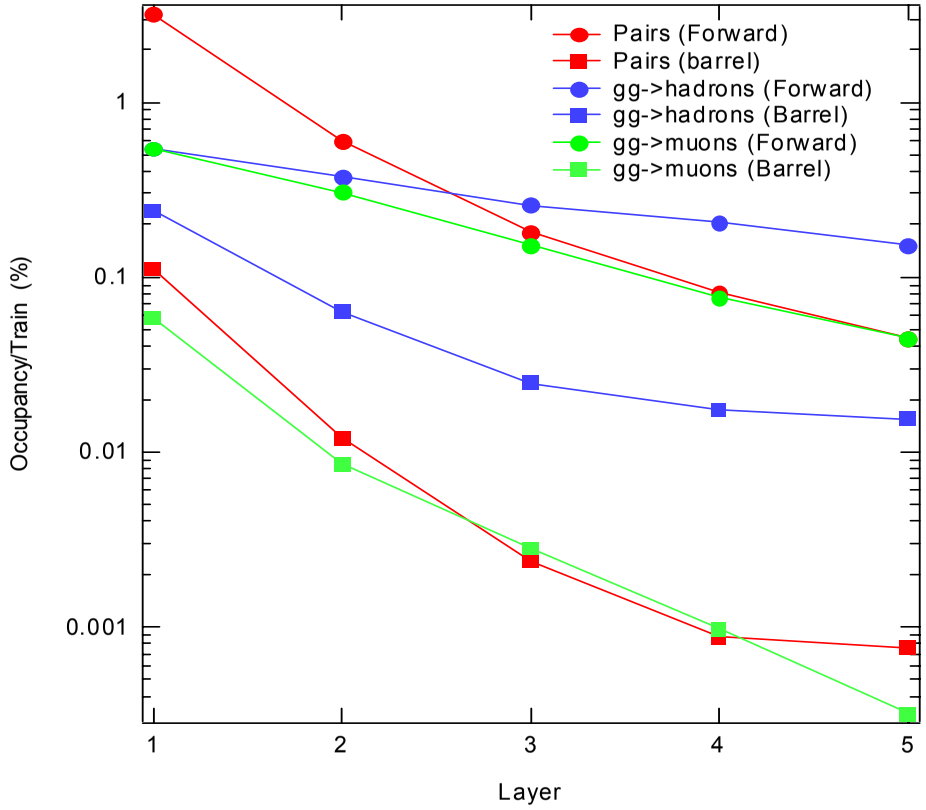


r = 20 cm

r = 4 cm

Photon Conversion Occupancy Low ~ .1-.4%

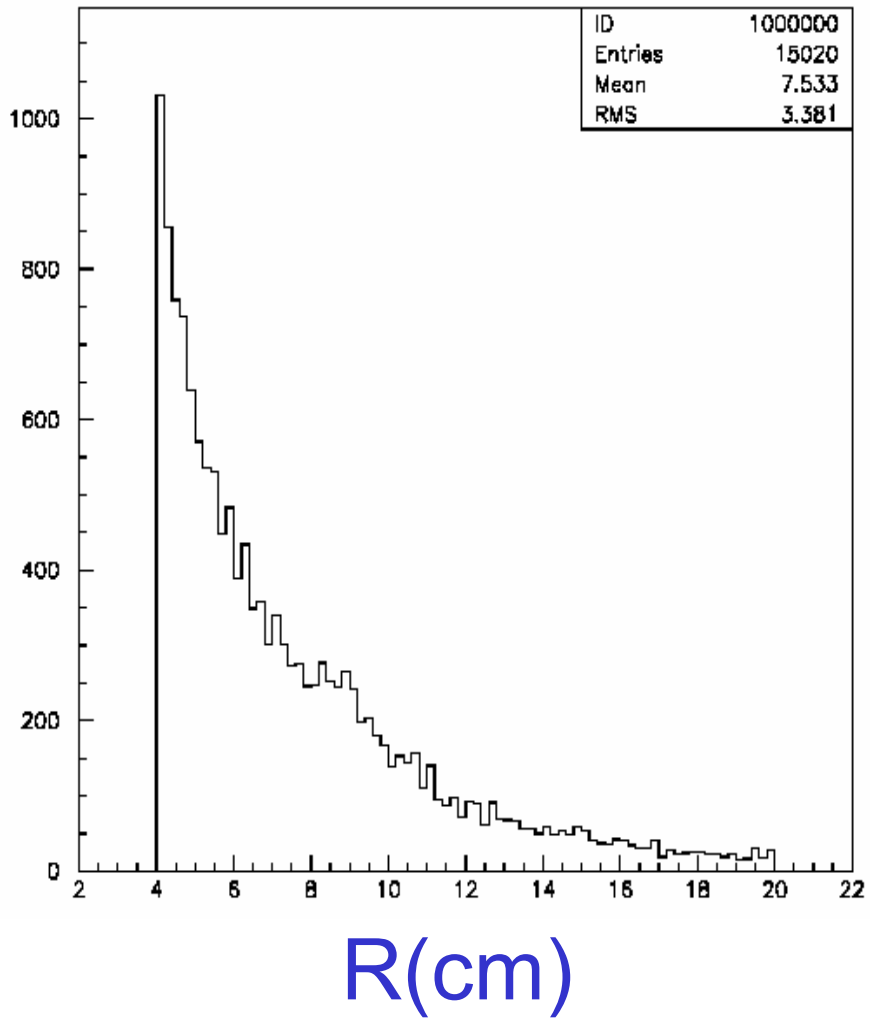
Charged Particle Occupancies/Train



- Pairs and $\gamma\gamma \rightarrow$hads dominate. Most are < 1%.
- Worst Case: Pairs forward occupancy ~3% in Layer 1 at smallest radii.

Forward e^+e^- Hit Distribution

- Most hits in the forward detectors are at small radii
- Segmenting radially would guarantee low occupancy for most of the detector



Hit Occupancies/Train are Low

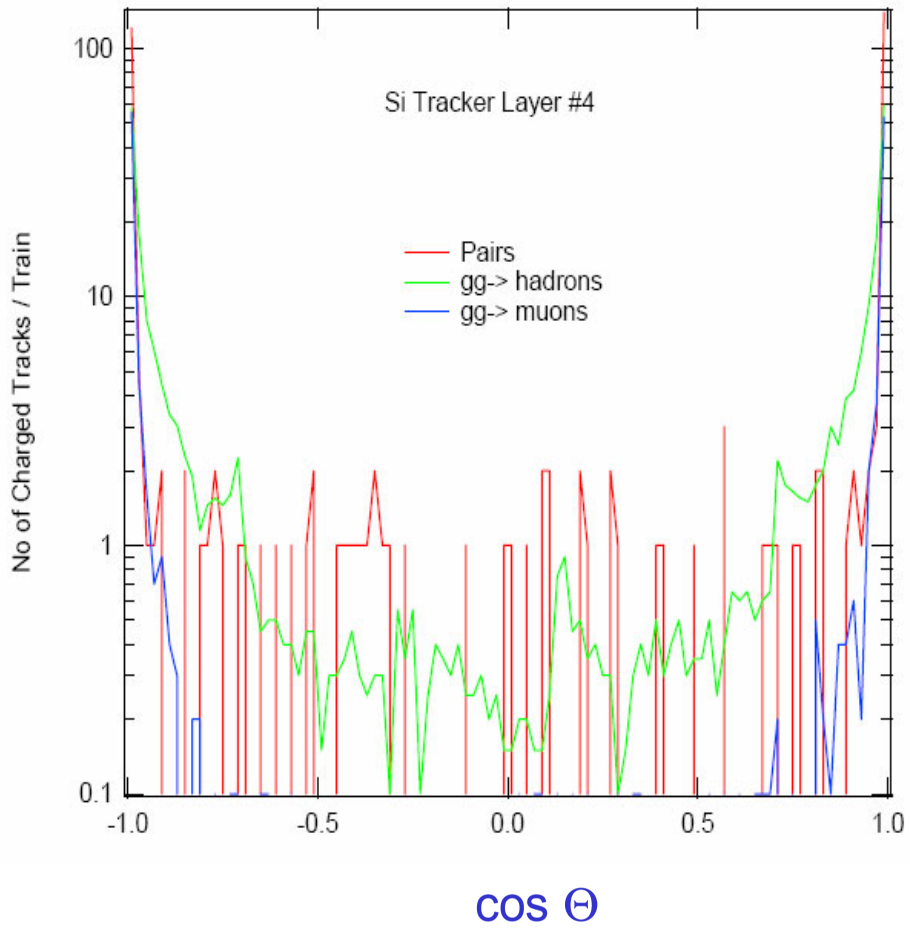
- **Pattern recognition in SiD trackers should be OK.**
  (see talk by S. Wagner)

- **Adding timing capability to Si channels is possible.** This allows track hits to be associated with particular bunch crossings within the train. Noise hits won't obscure timing information.

Track Occupancies per Train
$\gamma\gamma \rightarrow ee$, $\mu\mu$, hadrons

Barrel
($|\cos\Theta| < .80$)
48 tracks/train
~ $N_{physics}$

Fwd+Bwd
($.80 < |\cos\Theta| < .995$)
390 tracks/train
10 X $N_{physics}$



Barrel's not bad; Forward's not good.

Lowering Hit and Track Occupancies

- **Shorter Microstrips.** Could revert to 10cm (in z) microstrip detectors. Reduction factor X 3 in Layer 1 hit occupancies.

- **Si Drift Detectors.** Intrinsically 3-d, effective pixels ~ 250 X 2500 μms but 500 μm thick. Reduction factor X 6 in Layer 1 hit occupancies.

- **Track occupancies can be substantially reduced by timing.**
  σ_{track} ~ 1 ns => Reduction factor 192/4 = 48 X fewer background tracks.

Timing Reduces Track Occupancies

- **How well can Si timing be done?**
  BaBar SVT 20ns/strip (operating)
  Atlas Tracker 8ns/strip (prototype?)
  SiD Cal 5ns/pixel (design)

- **Now:** $\sigma_t \sim t_{rise}/(S/N)$ **ns = 50 ns/ 10 = 5ns**

  Future: $\sigma_t \sim$ **2.5 ns (?)**
  Pulsed Power permits more power to amp, better bandwidth, headroom. **R&D Required.**

- **Track Timing:** $\sigma_t/\sqrt{N}$
  1.1 - 2.2 ns (N=5 tracker layers)
  0.45- 0.9 ns (N=30 Ecal layers)

- **Identify track time within 2 – 4 NLC bunch crossings, to reduce physics backgrounds significantly** (~ 1 – 2 Tesla crossings)

SiD Occupancy Conclusions

- Warm hit occupancies/ train are typically ≤ 1% and manageable.
- Track Occupancies are high in the forward direction.
- Timing the microstrips or Si ECAL pixels can yield ~ 1ns track resolution, and X 50 – X100 reductions in track backgrounds. This would simplify forward tracking significantly, and remove almost all physics backgrounds.