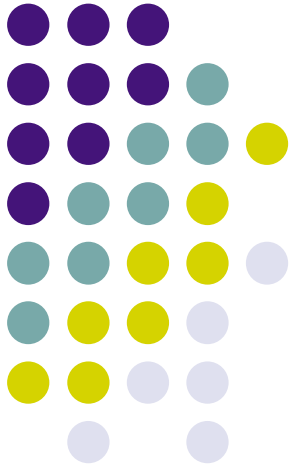
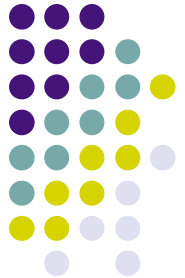
Pair background simulation for Vertex detector at ILC

Y. Sugimoto (KEK)
T. Fujikawa (Tohoku U.)
Jan. 6. 2005
@MDI WS at SLAC

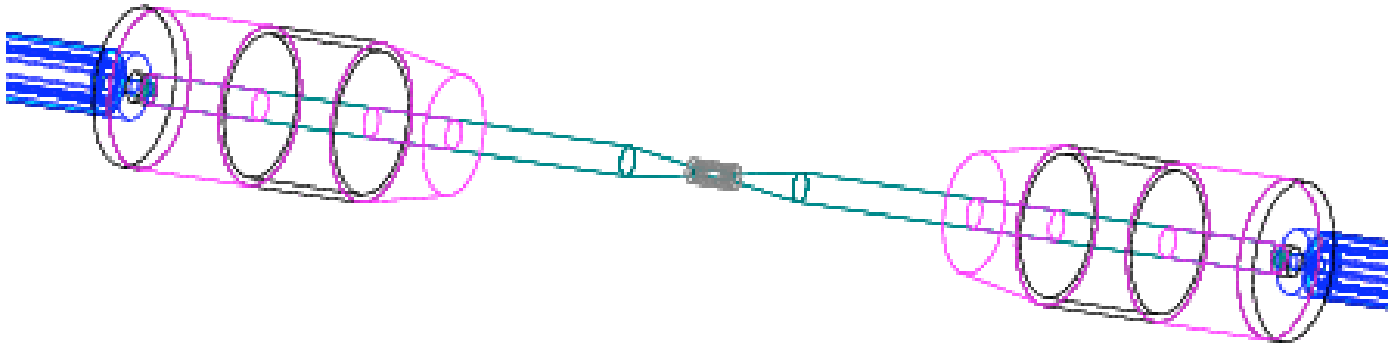


Tools



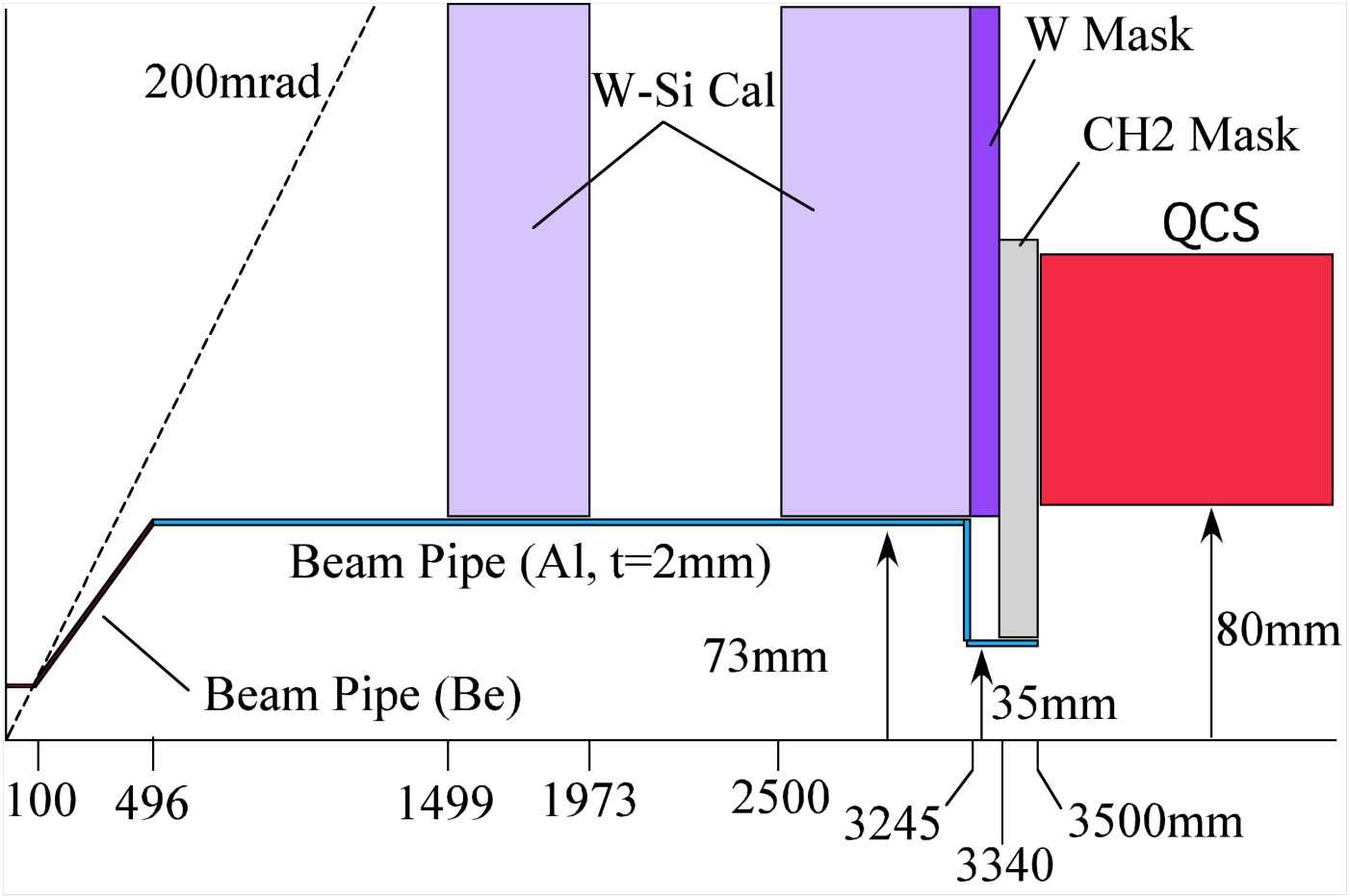
- Generator: CAIN
- Simulator: JUPITER
  - GEANT4 based full simulator
- Parameters
  - E_{CM}=500 GeV, Ne=2.0x10^{10}/BX
  - $\gamma\varepsilon_x$=10 μm, $\gamma\varepsilon_y$=0.03 μm
  - σ_x=553 nm, σ_y=5 nm, σ_z=0.3 mm
  - L=3.4x10^{34}/cm^{2}s
  - Crossing angle = 7 mrad

Detector Configuration



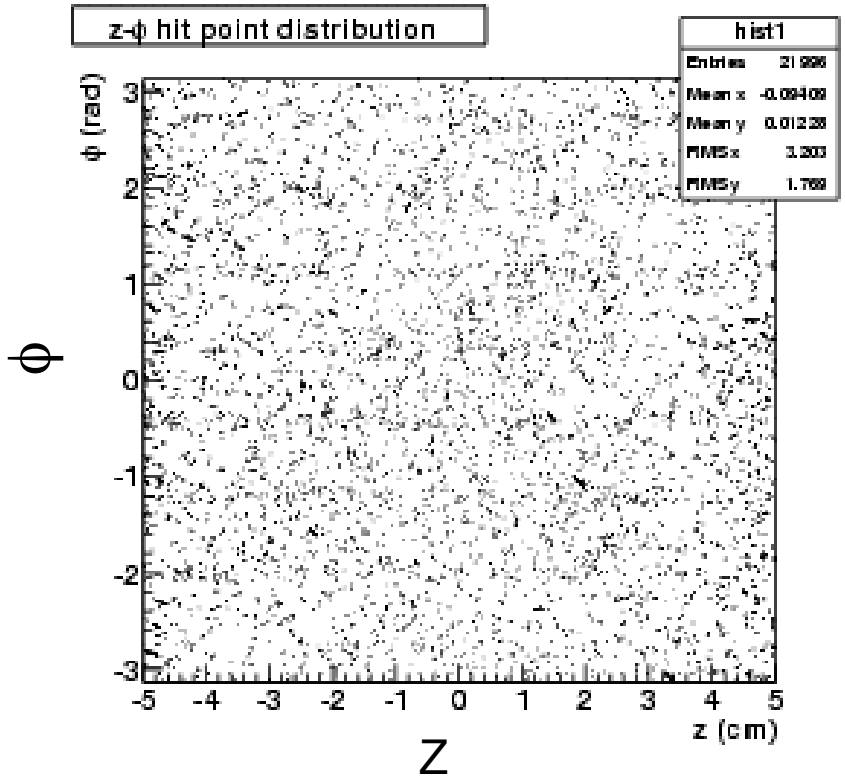
- B=3, 4, 5 T
- Large bore super-conducting Q-magnet, l*=3.5m
- No beam-calorimeter
- Radius of the innermost layer of VTX (R1) as a parameter
  - Be beam pipe radius is 0.4 cm smaller than R1
  - 4 layers of 300 μm thick Si
  - Distance between adjacent layers is 1.2 cm
  - VTX angular coverage : $|cos\theta|<0.9$

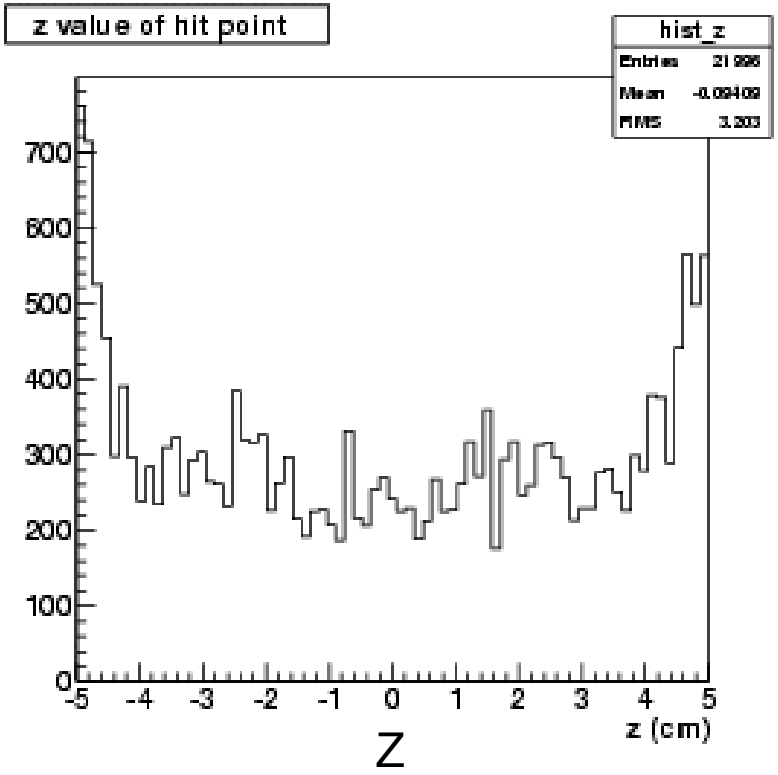
Detector Configuration



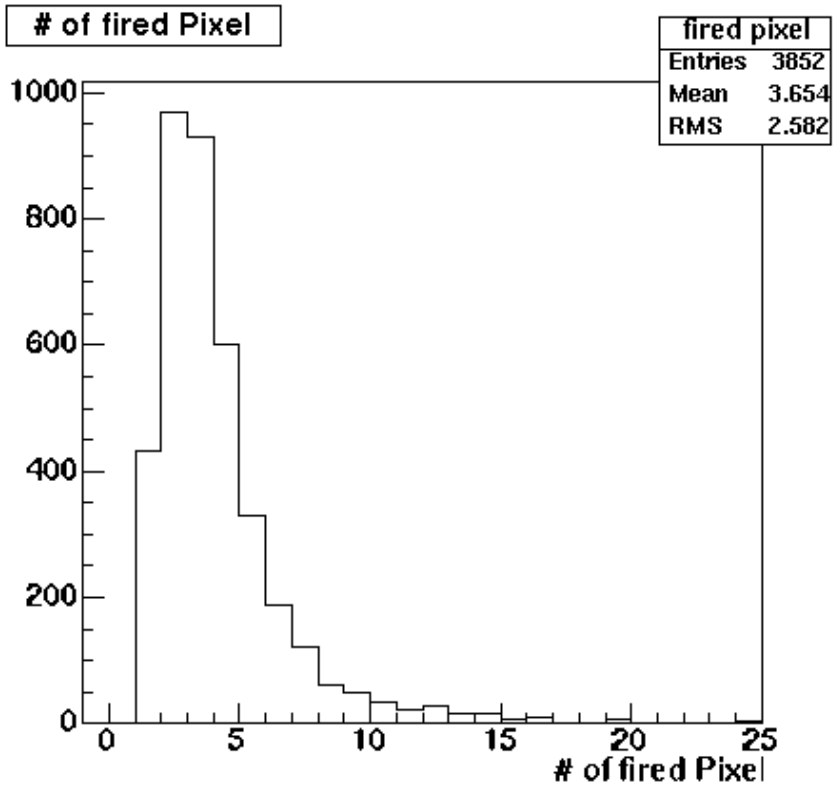
Background hit uniformity

- B=3T, R1=1.2cm





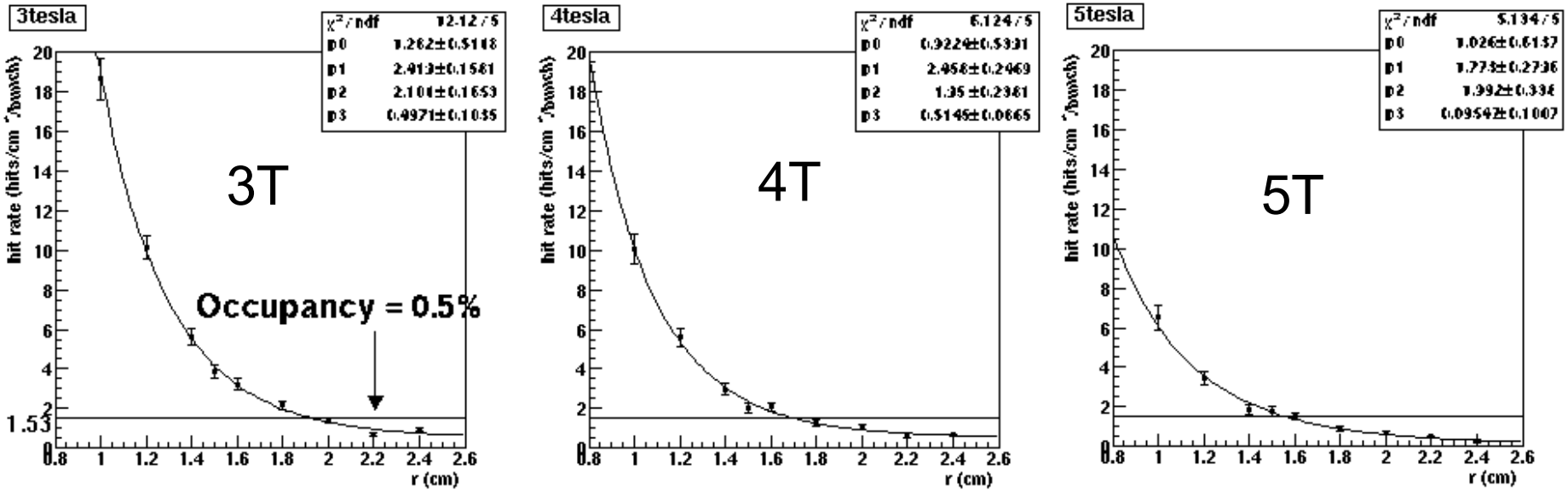
Number of fired pixels per track hit



- Pixel size:25x25μm^2
- Active layer: 30μm
- Diffusion not included

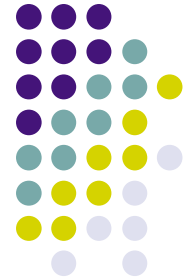
➔Number of fired pixels per track hit = 3.7

Hit rate vs. B



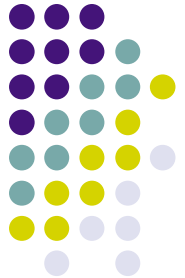
- Fit function: $f(x) = p0 \cdot \exp(-p1(x - p2))/x + p3$
- When 1/20 train is accumulated, 0.5% pixel occupancy at
  - R=1.92 cm @3T
  - R=1.69 cm @4T
  - R=1.55 cm @5T

Comparison with other studies



- With B=4T, R=15mm
  - Our study: ~2.5 hits/cm^2/BX
  - By K. Buesser: ~3.5 hits/cm^2/BX
    - CAIN ⇔ Guinea Pig ?
    - Geometry? (Thickness of sensitive layer)
    - Back scattering? (very few b.s. in our geom.)
    - Statistics?

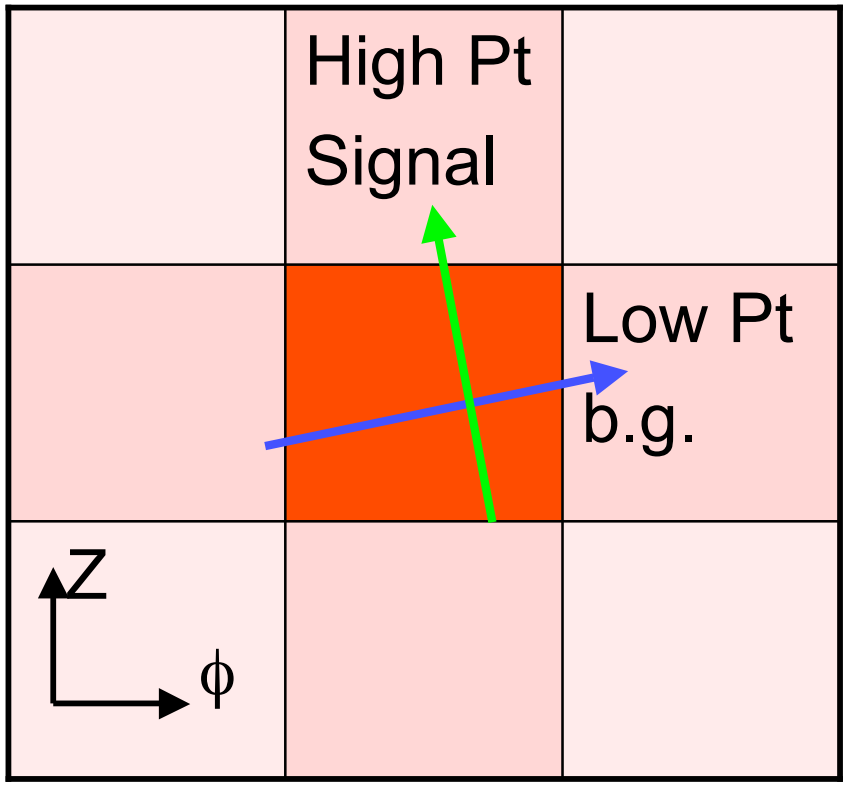
Summary



- Pair background at ILC has been studied using CAIN and JUPITER
- B-dependence of hit rate at fixed R is large, but B-dependence of R at fixed hit rate is not so large: ~20% difference between 3T and 5T
- Pixel occupancy of ~0.5% can be achieved with R=1.92cm@3T, 1.69cm@4T, and 1.55cm@5T
- Some discrepancy between K.Buesser's result
- Future plan
  - Different geometry (longer l*, beam-CAL, different X-angle)
  - Simulation for Fine Pixel CCD Vertex Detector

Fine Pixel CCD

- Standard CCD



- Fine Pixel CCD