ALCPG 2004 Winter Workshop
January 8, 2004

Background Studies

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OUTLINE

- Pair background
  - Pair background in forward detector
  - High energy electron detection
  - Radiation environment
- Other backgrounds
  - Beam-gas scattering (Keller)
  - $\gamma\gamma \rightarrow$ hadrons (Barklow)
- Background in Central Tracker
- Summary

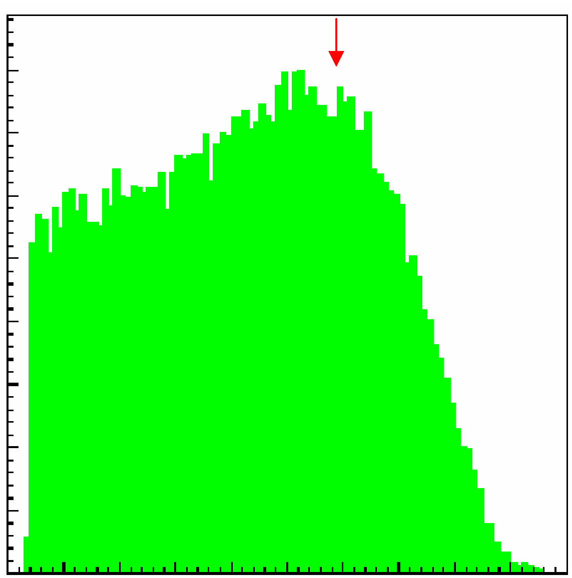
e+ e- Pairs from e+ e- Collisions

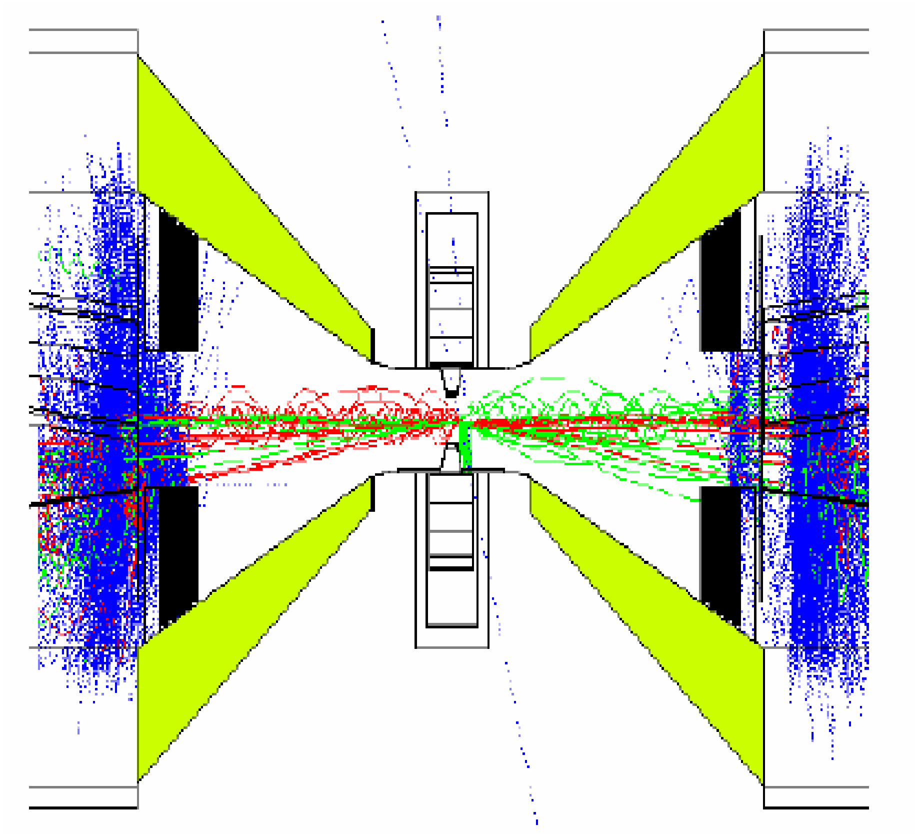
With Current NLC IP Beam Parameters:

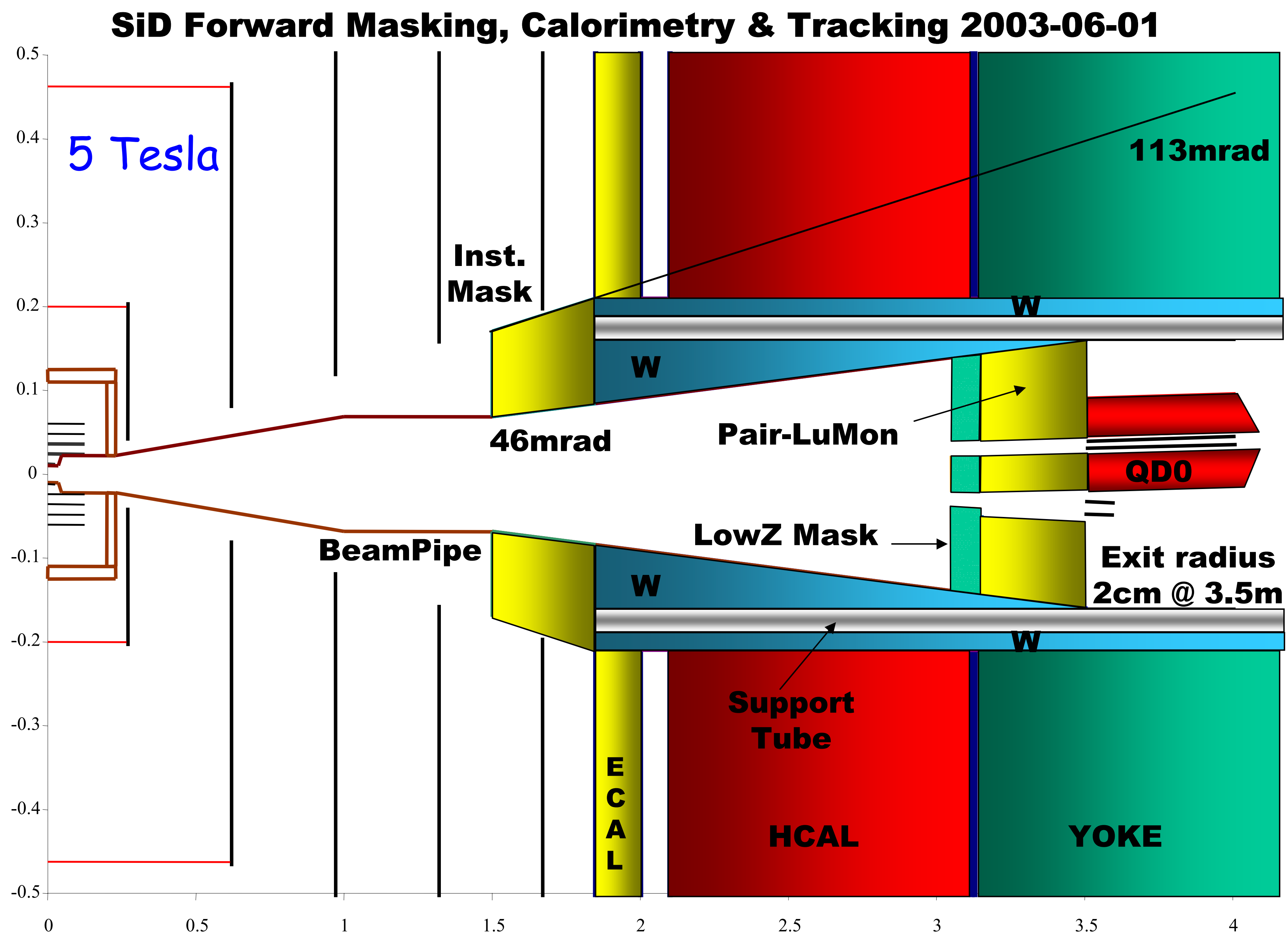
e+ or e- = 49,000/bunch

<E> = 4.1 GeV

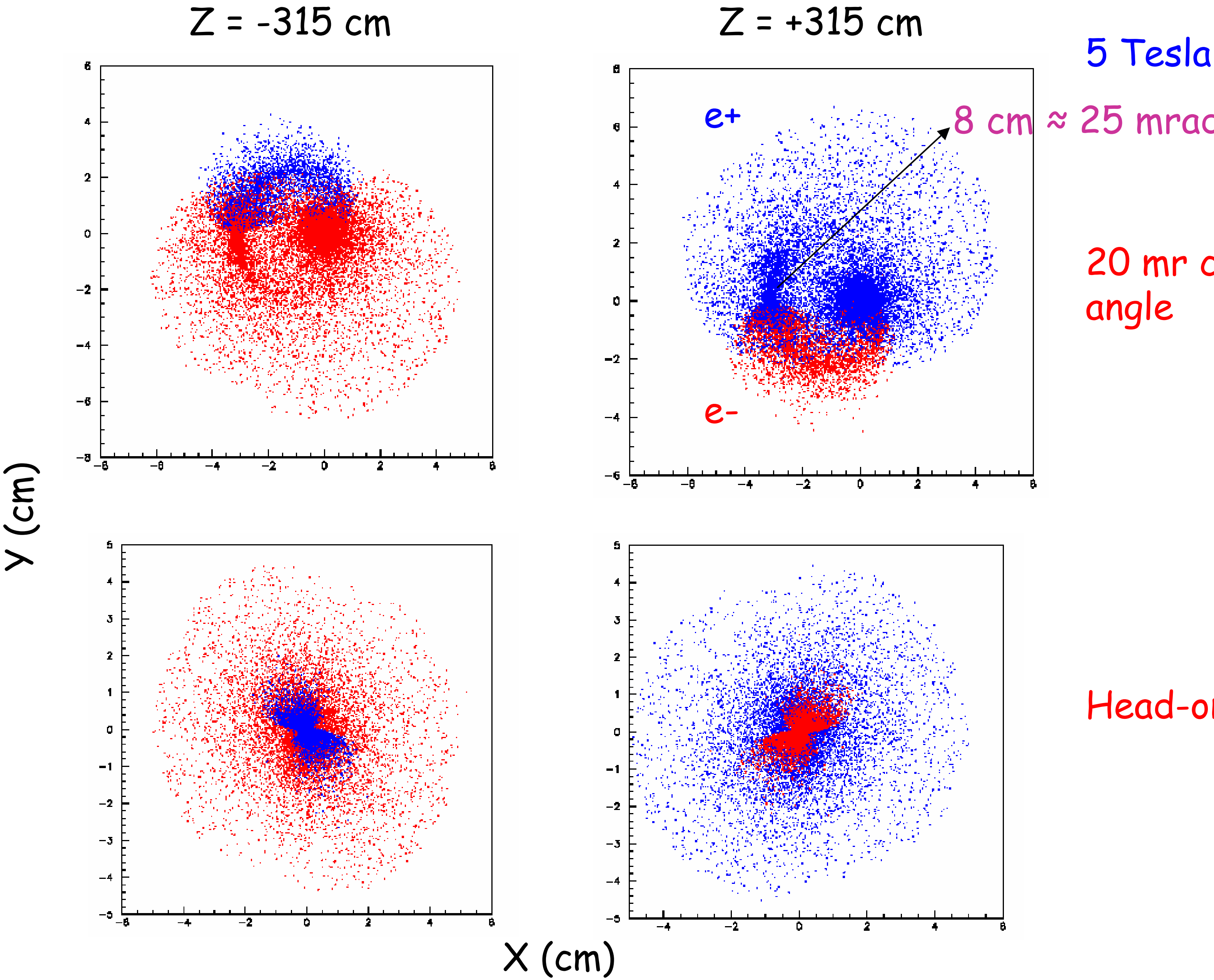
E_total = 199,000 GeV






SiD Forward Masking, Calorimetry & Tracking 2003-06-01
5 Tesla
Inst.
Mask
113mrad
W
W
46mrad
Pair-LuMon
QD0
LowZ Mask
BeamPipe
W
Exit radius
2cm @ 3.5m
W
Support
Tube
E
C
A
L
HCAL
YOKE
0.5
0.4
0.3
0.2
0.1
0
-0.1
-0.2
-0.3
-0.4
-0.5
0
0.5
1
1.5
2
2.5
3
3.5
4

Pair Distribution

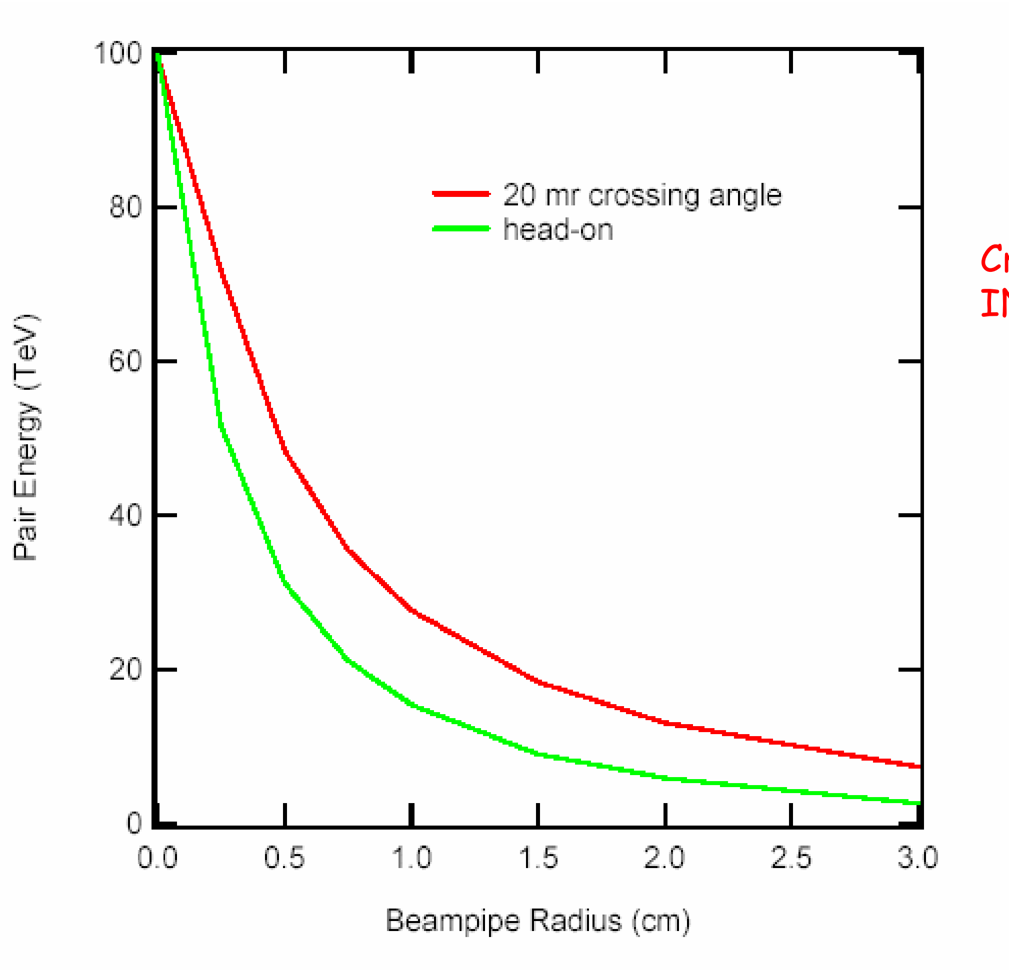


5 Tesla

20 mr crossing angle

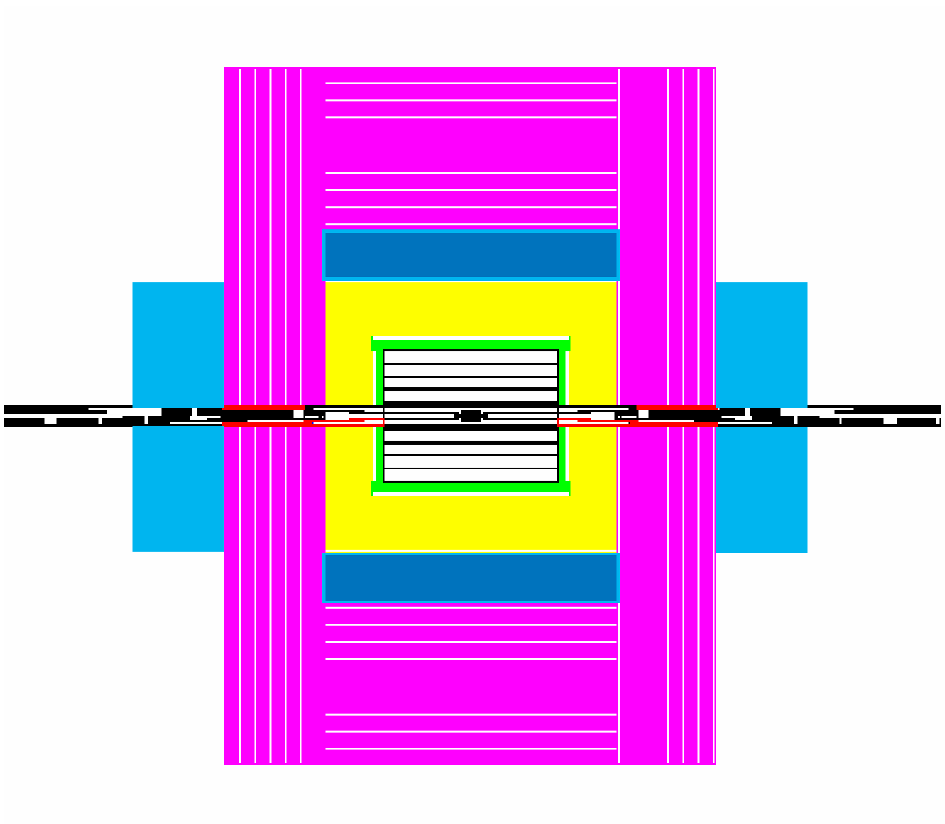
Head-on

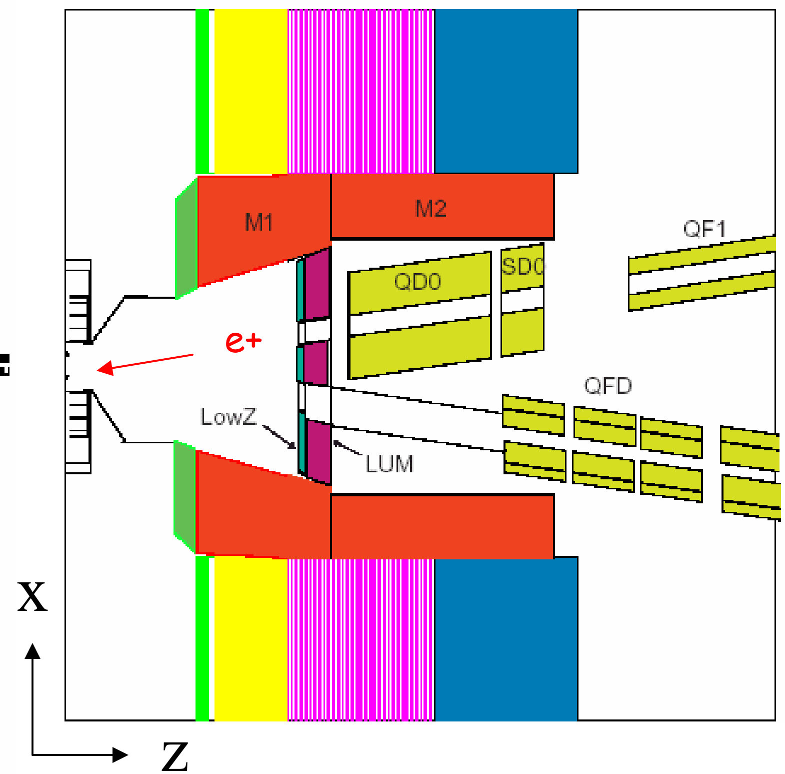
Pair Energy vs. Beampipe Radius



Crossing angle case:
IN Beampipe radius = 1 cm

LCD SiD Detector in GEANT 3





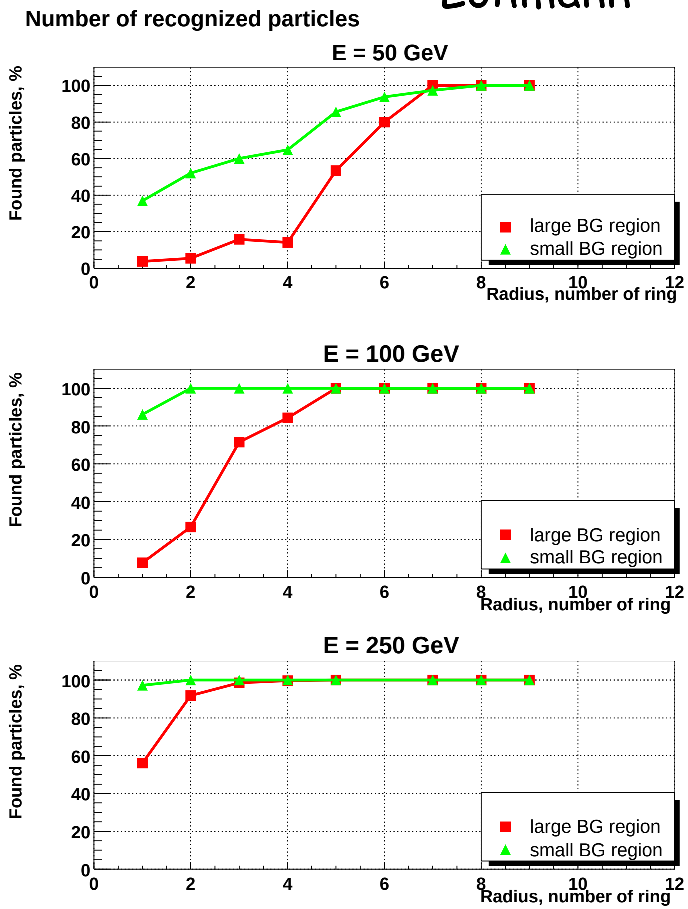
5 Tesla Field Map (not constant field)

High Energy Electron Detection

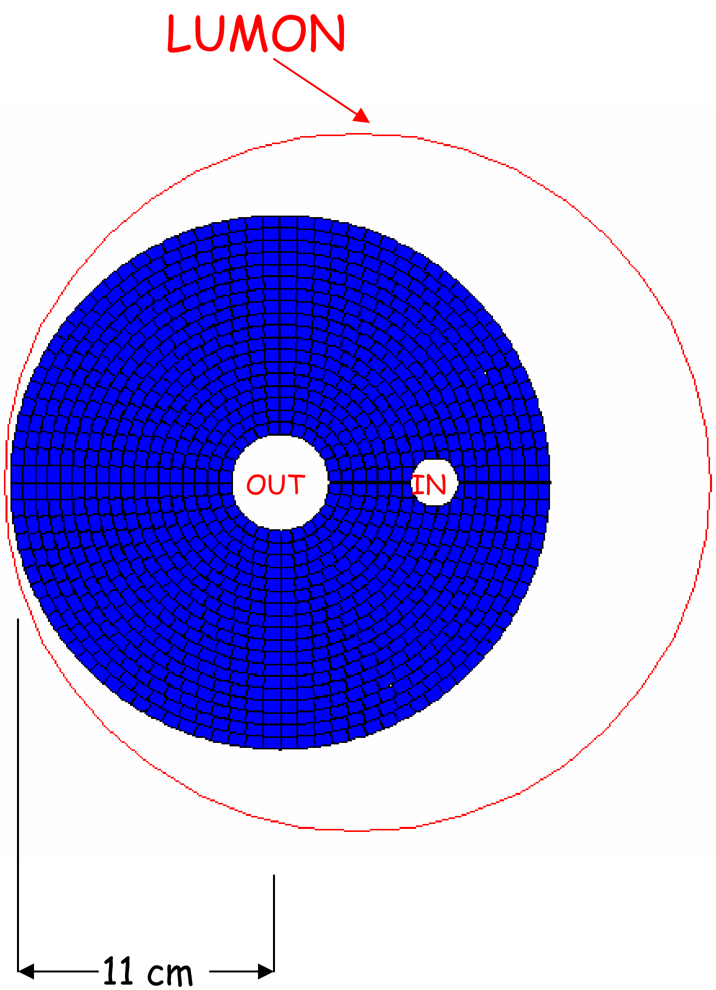
- Veto for $\gamma^*\gamma^*$ is essential for SUSY searches (Colorado).
- Pair background is confined within 8 cm of the beamline at 5 Tesla. Veto capability to 25 mrad is relatively easy.
- Big question is whether we can detect high energy electrons inside the pair background
- DESY-Zeuthen group studied for TESLA, Drugakov (Amsterdam), Lohmann (Montpellier).

  High energy electrons can be detected inside the pair background, thus extending the veto capability to ~6 mrad.
- This is a first attempt at detecting high energy electrons for NLC.

Lohmann



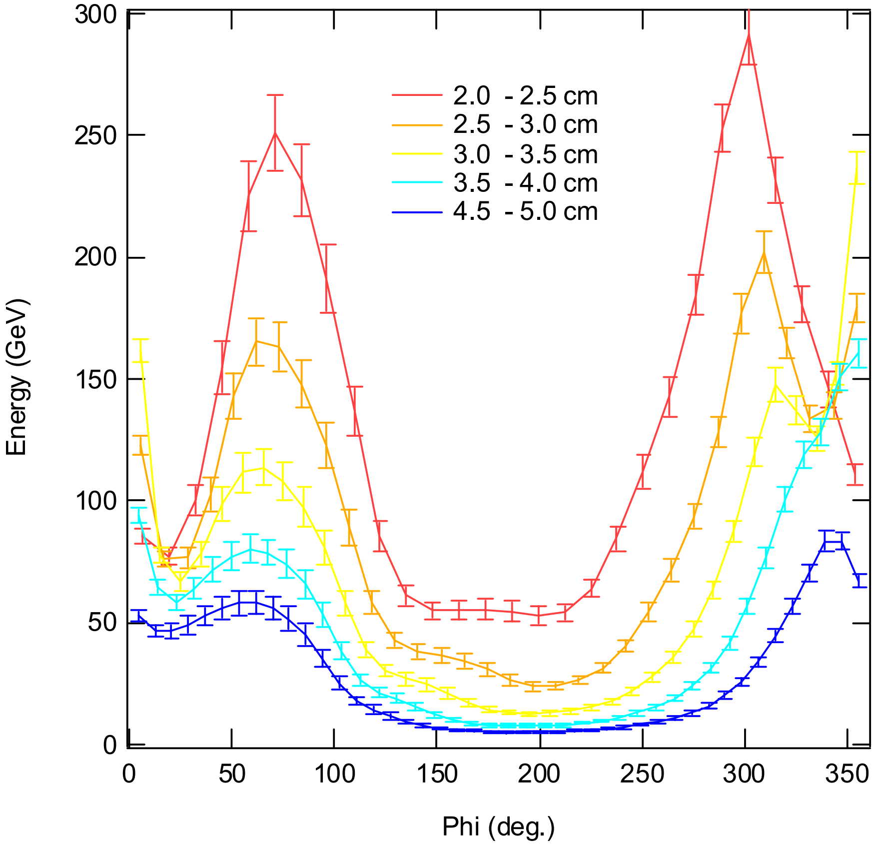
High Energy Electron Detection in LUMON



- Beampipe radius: IN 1 cm, OUT 2 cm
- Detector:
  - 50 layers of 0.2 cm W + 0.03 cm Si
  - Zeuthen R-ϕ segmentation

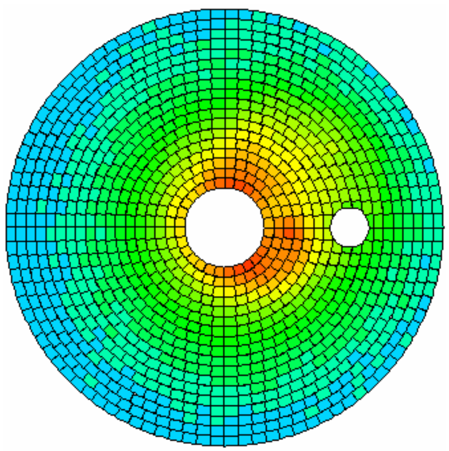
- Generate 200 bunches of pair backgrounds.
- Pick 10 BX randomly and calculate average BG in each cell, $\langle E \rangle_{background}$
- Pick one BX background and generate one high energy electron.
- $E_{BG} + E_{electron} - \langle E \rangle_{background}$, in each cell
- Apply electron finder.

Pair Energy/bunch and RMS

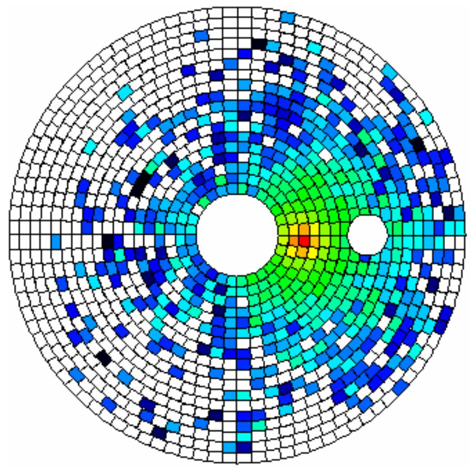


High Energy Electron Detection

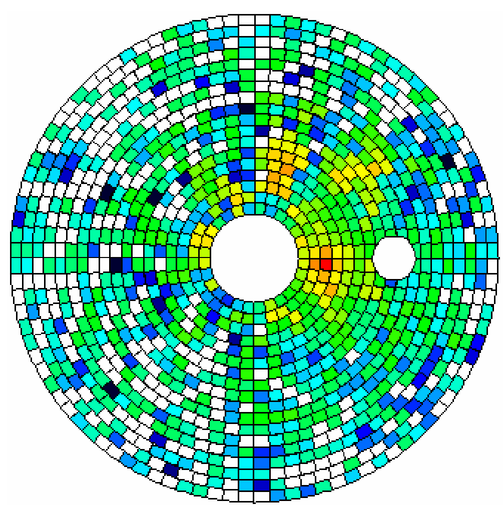
Pair Background

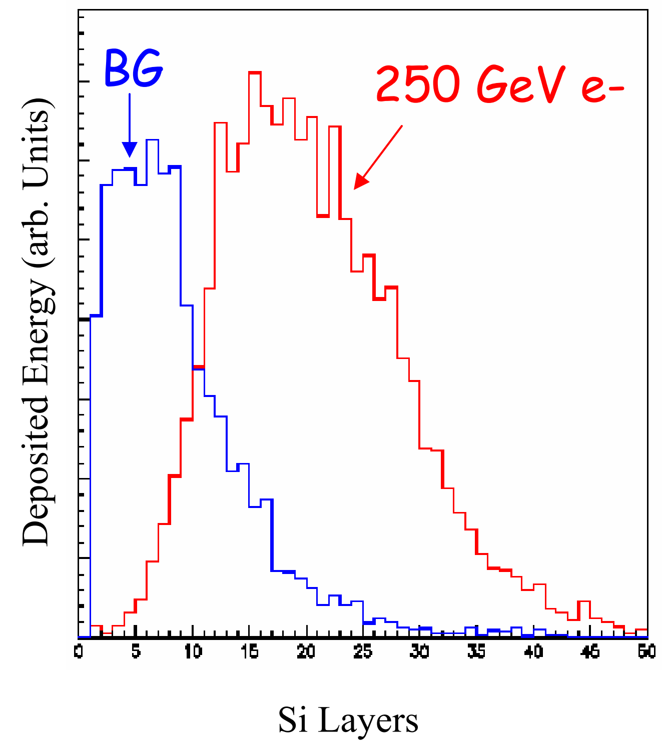


250 GeV Electron

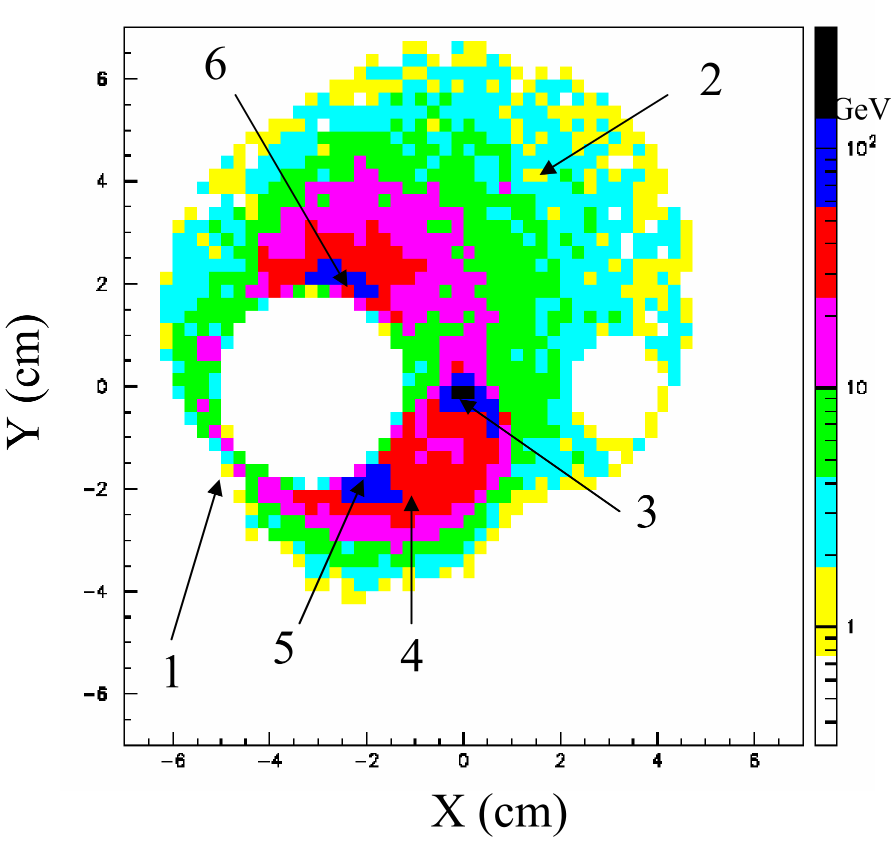


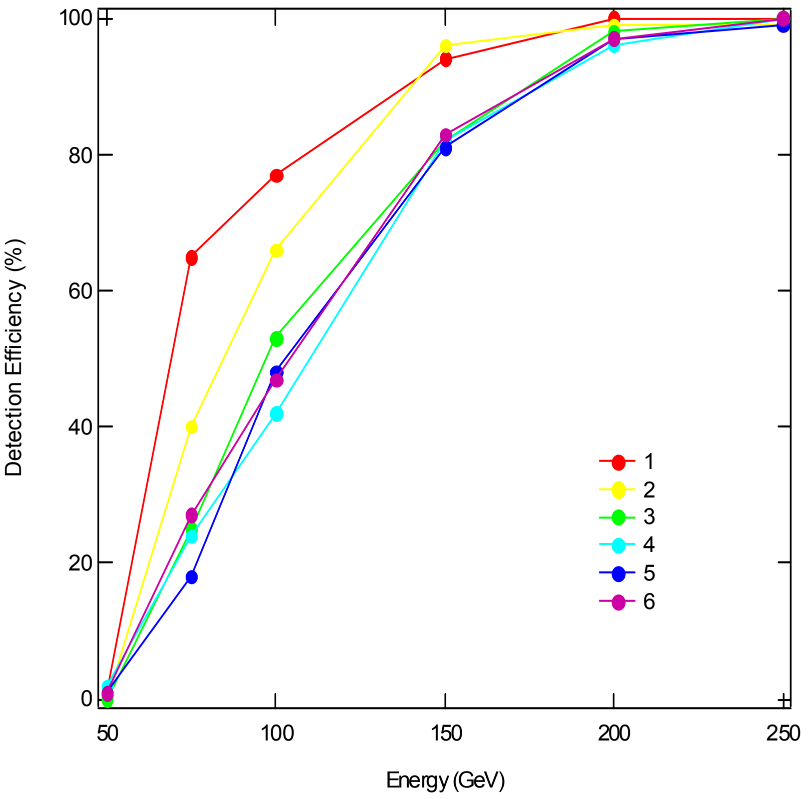
$E_{bg} + E_{electron} - \langle E_{bg} \rangle$





Electron Detection Efficiency





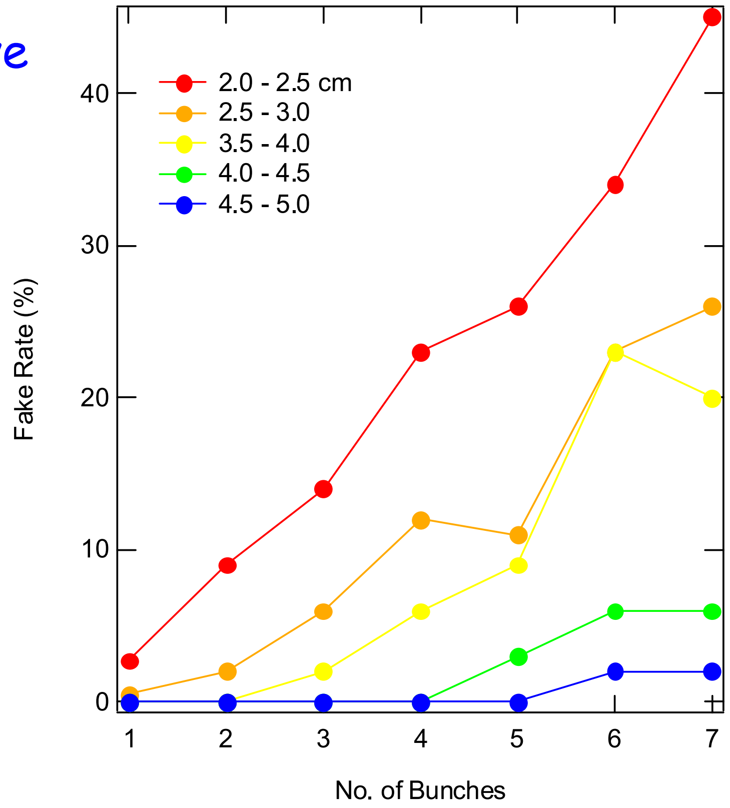
Background Pileup

What happens if we do not have single bunch time resolution?

The detection efficiency does not degrade quickly, but the fake rake shoots up.

Fake rate:

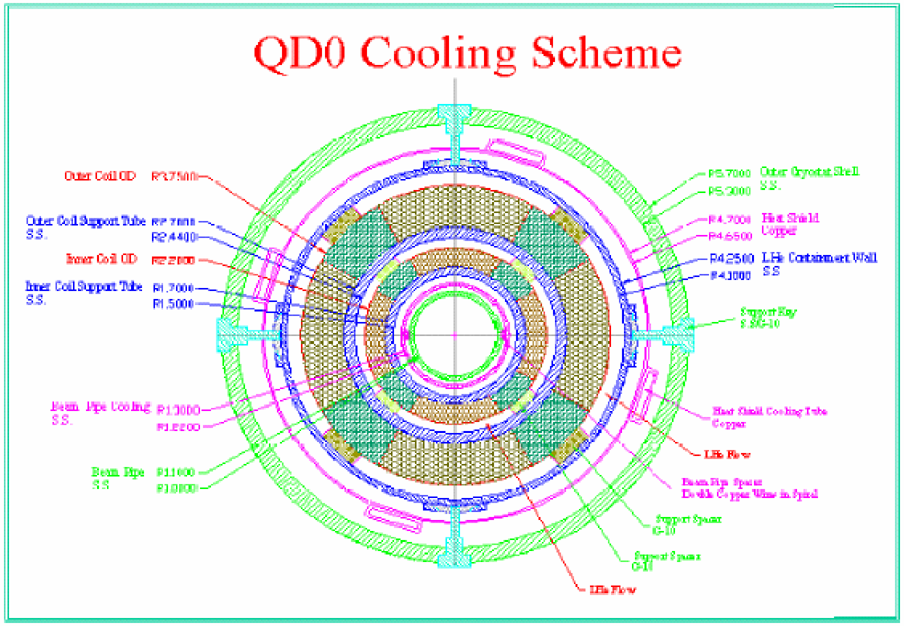
1 bx	3.2%
2	11
3	22
4	41



Energy Flow and Radiation DOSE Rate

- Study radiation environment for beam line elements.
- Identify hot spots.

IR Quads are 5.7 cm radius BNL SC magnet.



Pair Energy Flow
(e+e-, 20mrad X, SC Magnets)

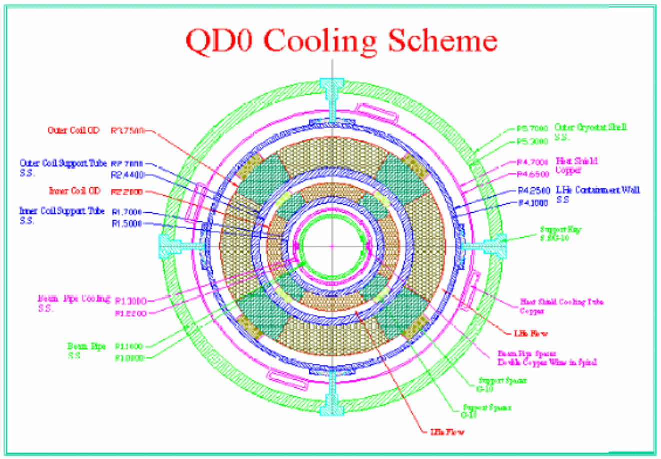
Detector	GeV	mW	%
QDF1-A	74909.1	276.4902	37.58%
Escape	57783.6	213.2797	28.99%
LUMON	26265.8	96.94732	13.18%
QDF1-B	11457.8	42.29085	5.75%
QDF1-C	11113.7	41.02083	5.58%
PACMAN	10342.7	38.17509	5.19%
M2	2983.87	11.01347	1.50%
QD0	2059.58	7.601915	1.03%
LOWZ	1286.89	4.749903	0.65%
SD0	555.73	2.051204	0.28%
QF1	364.764	1.346347	0.18%
M1	166.624	0.615011	0.08%
Endcap MUON	40.964	0.151198	0.02%
Instr. Mask	0.466	0.00172	0.00%
S.S. Beampipe	0.271	0.001	0.00%
Be Beampipe	0.196	0.000723	0.00%
Endcap EM	0.164	0.000605	0.00%
Endcap HAD	0.146	0.000539	0.00%
Barrel EM	0.117	0.000432	0.00%
VXD	0.08	0.000295	0.00%
TOTAL	199333	735.7383	100.00%

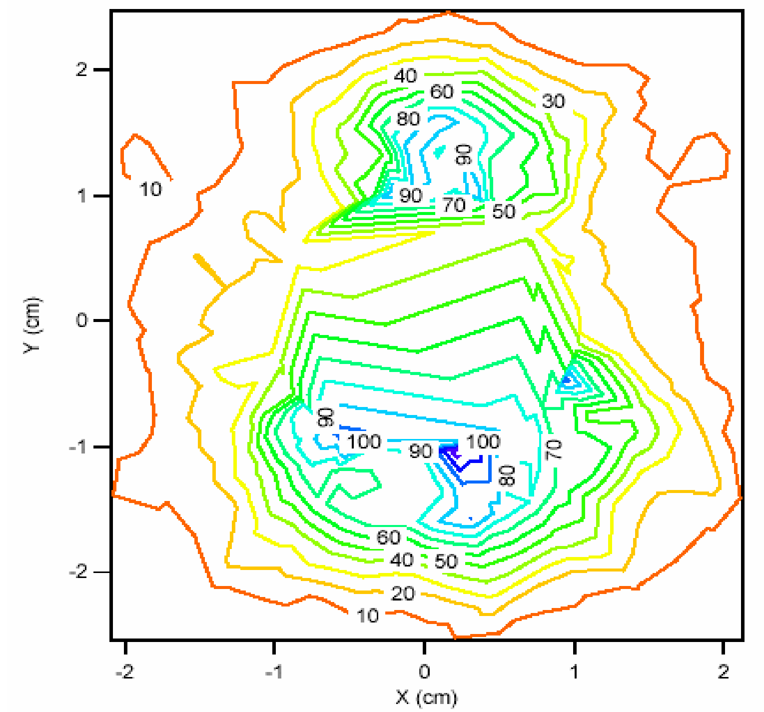
QDF1-A Detail

Detector	GeV	mW	%
QDF1-A	74909.1	276.4902	37.58%
S.S. Beampipe	14136.6	52.17827	18.87%
S.S. BP cooling	10457.6	38.5991	13.96%
S.S. Coil support	15281.3	56.40346	20.40%
Inner Coil	14939.7	55.14262	19.94%
G10 support	1249.34	4.611309	1.67%
Inner Liq. He	80.796	0.298219	0.11%
G10 Liq. He	271.492	1.002079	0.36%
S.S. Coil support	6307.23	23.28003	8.42%
Outer Coil	7275.19	26.85278	9.71%
G10 support	819.179	3.023596	1.09%
Outer Liq. He	36.84	0.135977	0.05%
G10 Liq. He	125.983	0.465004	0.17%
S.S. support	1563.19	5.76975	2.09%
Heat shield	376.997	1.391499	0.50%
Cryostat shell	1987.66	7.336473	2.65%

Energy/bunch

Max. DOSE Rate in QDF1





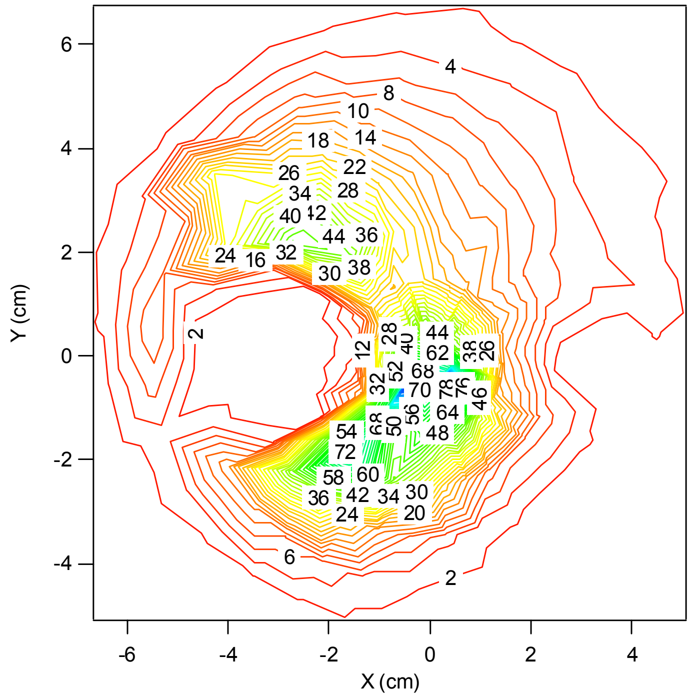
QDF1 examined in 7.5° ϕ, 2 cm z cells; maximum dose plotted

Max. DOSE rate ~100 MRad/year

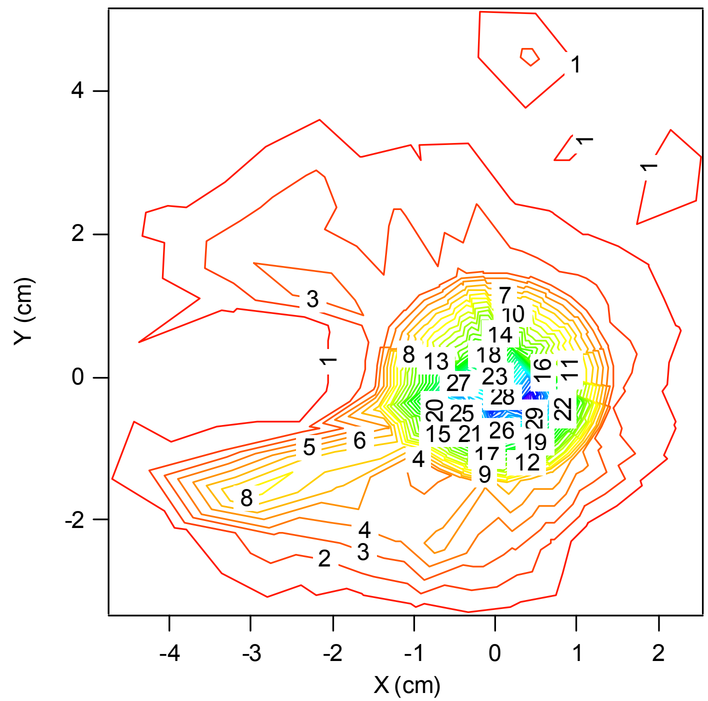
Solenoid field sweeps e+e- pairs UP and DOWN.

Max. DOSE Rate in LUMON and LOW-Z

LUMON



LOW-Z



Max. DOSE rate ~70 Mrad/year

Max. DOSE rate ~30 Mrad/year

Other Backgrounds

- Particles reaching IP from beam-gas scattering (Keller)

Bremsstrahlung	#/train	<E> (GeV) @ 1 nT Vacuum
Electron	0.2	125
Photon	0.032	45
Coulomb Scattering		
Electron	0.036	250

- $\gamma^*\gamma^* \to$ Hadrons (Barklow)

  56 events/train

Energy Flow from $\gamma\gamma \to$hadrons and beam-gas

$\gamma\gamma \to$hadrons

Detector	GeV	mW	%
Escape	27322.7	0.5246	52.91%
Endcap HAD	8107.22	0.1557	15.70%
PACMAN	3845.27	0.0738	7.44%
M1	2458.65	0.0472	4.76%
Endcap EM	1763.65	0.0339	3.42%
M2	1723.7	0.0331	3.33%
LUMON	1642.53	0.0315	3.18%
Endcap MUON	1607.65	0.0309	3.11%
Instr. MASK	1021.74	0.0196	1.98%
Barrel EM	729.228	0.014	1.41%
QDF1-A	572.856	0.011	1.11%
QD0	337.682	0.0065	0.65%
Barrel HAD	337.511	0.0065	0.65%
LOW-Z	54.991	0.0011	0.11%
SD0	24.652	0.0005	0.05%
Ext. Beampipe	21.014	0.0004	0.04%
QF1	20.814	0.0004	0.04%
QDF1-B	16.292	0.0003	0.03%
VXD	13.393	0.0003	0.03%
Barrel MUON	6.758	0.0001	0.01%
S.S. Beampipe	4.376	0.0001	0.00%
Solenoid	2.953	0.0001	0.00%
QDF1-C	2.734	0.0001	0.00%
Be Beampipe	2.171	0	0.00%
TOTAL	51640.55	0.9915	100

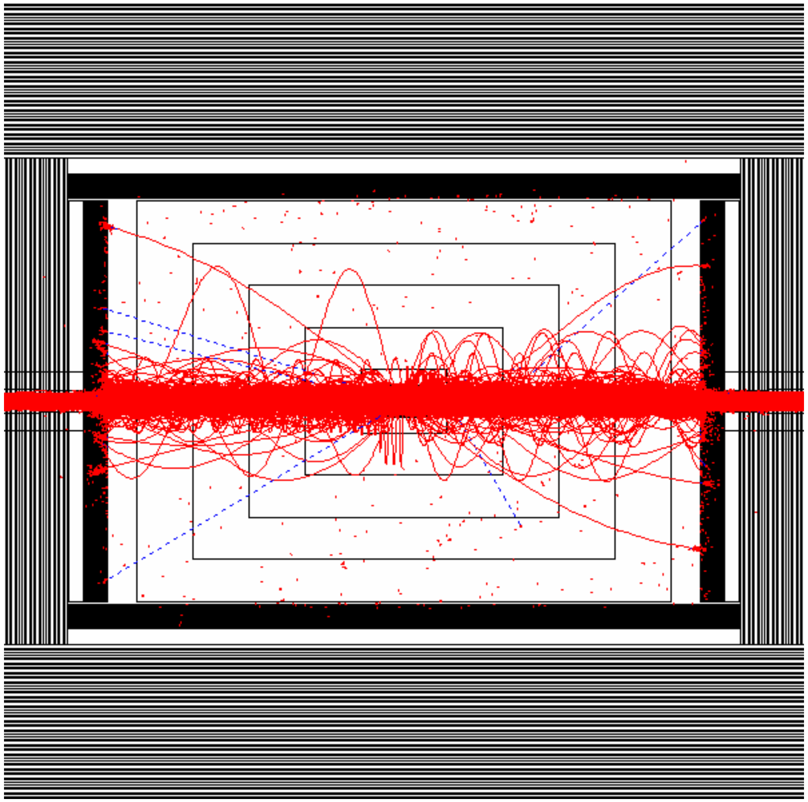
beam-gas

Detector	GeV	mW	%
QDF1-A	39.902	0.00077	62.50%
LUMON	11.74	0.00022	18.4
PACMAN	4.3	0.00008	6.74%
Escape	3.126	0.00003	4.90%
BPEX	1.654	0.00002	2.59%
QD0	0.877	0.00002	1.37%
M2	0.867	0.00001	1.36%
QDF1-B	0.451	0.00001	0.71%
SD0	0.308	0	0.00%
M1	0.179	0	0.00%
QDF1-C	0.143	0	0.00%
Instr. Mask	0.117	0	0.00%
QF1	0.06	0	0.00%
Endcap EM	0.035	0	0.00%
S.S. Beampipe	0.012	0	0.00%
VXD	0.006	0	0.00%
Barrel EM	0.006	0	0.00%
Be Beampipe	0.005	0	0.00%
Endcap MUON	0.005	0	0.00%
Endcap HAD	0	0	0.00%
TOTAL	63.794	0.0012	100.00%

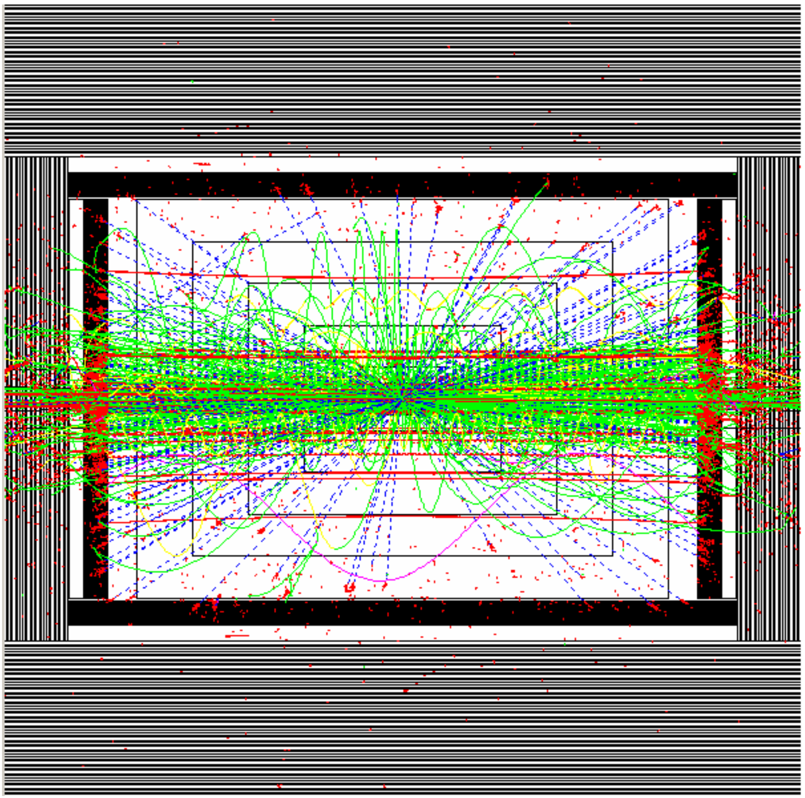
Energy/train

Background in Central Tracker

~8600 e+/e- / train



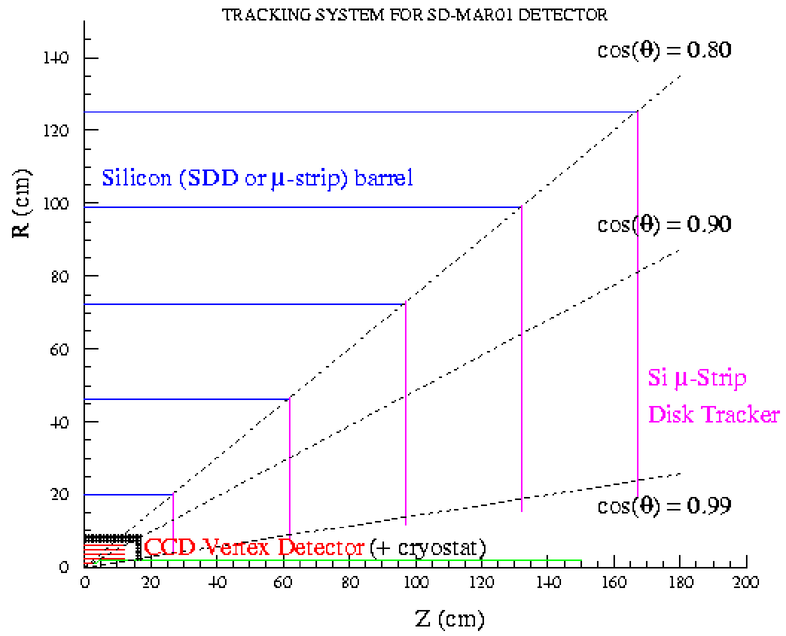
$\gamma\gamma\rightarrow$ hadrons   56 events / train

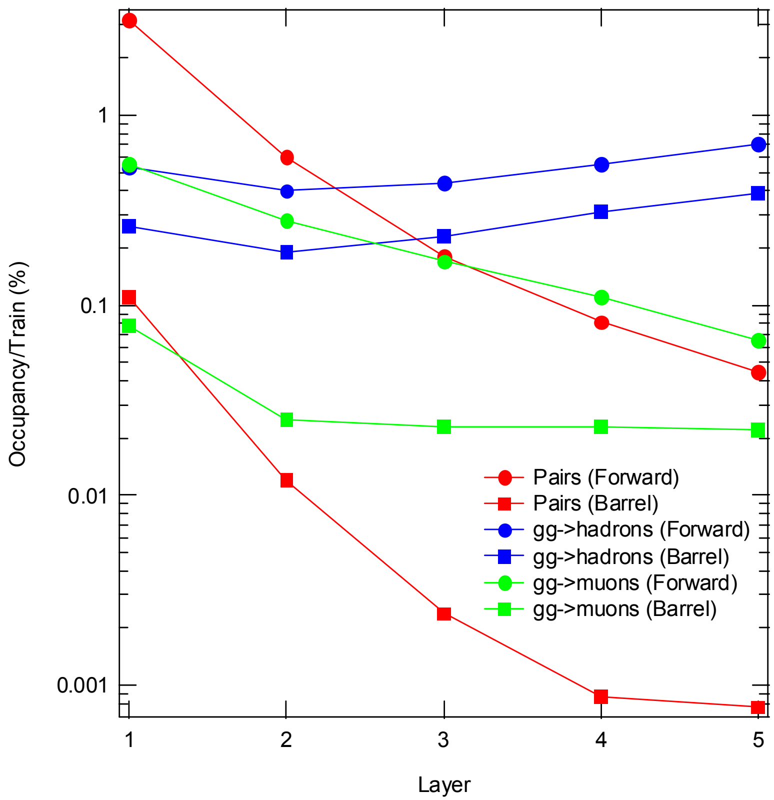


Charged Particle Occupancy in Si Tracker

Occupancy = #hits/train / # channels

Si strip width = 50 μm





Summary

- High energy electron can be identified in the pair background if single bunch time resolution is achieved, extending the veto capability to ~7 mrad.
- If multi-bunches are integrated, the fake rate becomes intolerable in ~3 bunches.
- Radiation level is 70 Mrad/year; Radiation hard detector must be developed.
- Energy flow analysis has not found any problems so far.
- > 0.1% occupancies in the central tracker from pairs and $\gamma^*\gamma^*$ events.