Study of beamstrahlung background r-tuples in the DCH (6.1μs of "beamstrahlung”)

beam-strahlung137137.root
beam-strahlung137139.root
beam-strahlung137140.root
beam-strahlung137141.root
beam-strahlung137142.root
beam-strahlung137143.root
beam-strahlung137144.root

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Introduction

	Cross section	Evt/bunch xing	Rate
Beam Strahlung	~340 mbarn ($E\gamma/Ebeam > 1\%$)	~680	0.3THz
e^+e^- pair production	~7.3 mbarn	~15	7GHz
e^+e^- pair (seen by L0)	~0.1 mbarn	~0.2	0.1GHz
Elastic Bhabha	$O(10^{-4})$ mbarn (Det. acceptance)	~200/Million	100KHz
$\Upsilon(4S)$	$O(10^{-6})$ mbarn	~2/Million	1 KHz
	Loss rate	Loss/bunch pass	Rate
Touschek (LER)	4.1kHz / bunch (+/- 2 m from IP)	~3/100	~5 MHz

E. Paoloni, e.g. in
https://lists.infn.it/sympa/arc/superb-fullsim/2009-05/msg00012/Bkg_Mixing.pdf

Several background sources can contribute. "Beamstrahlung" is the emission of a hard photon from one of the beams, which then gets deviated, possibly in the apparatus.

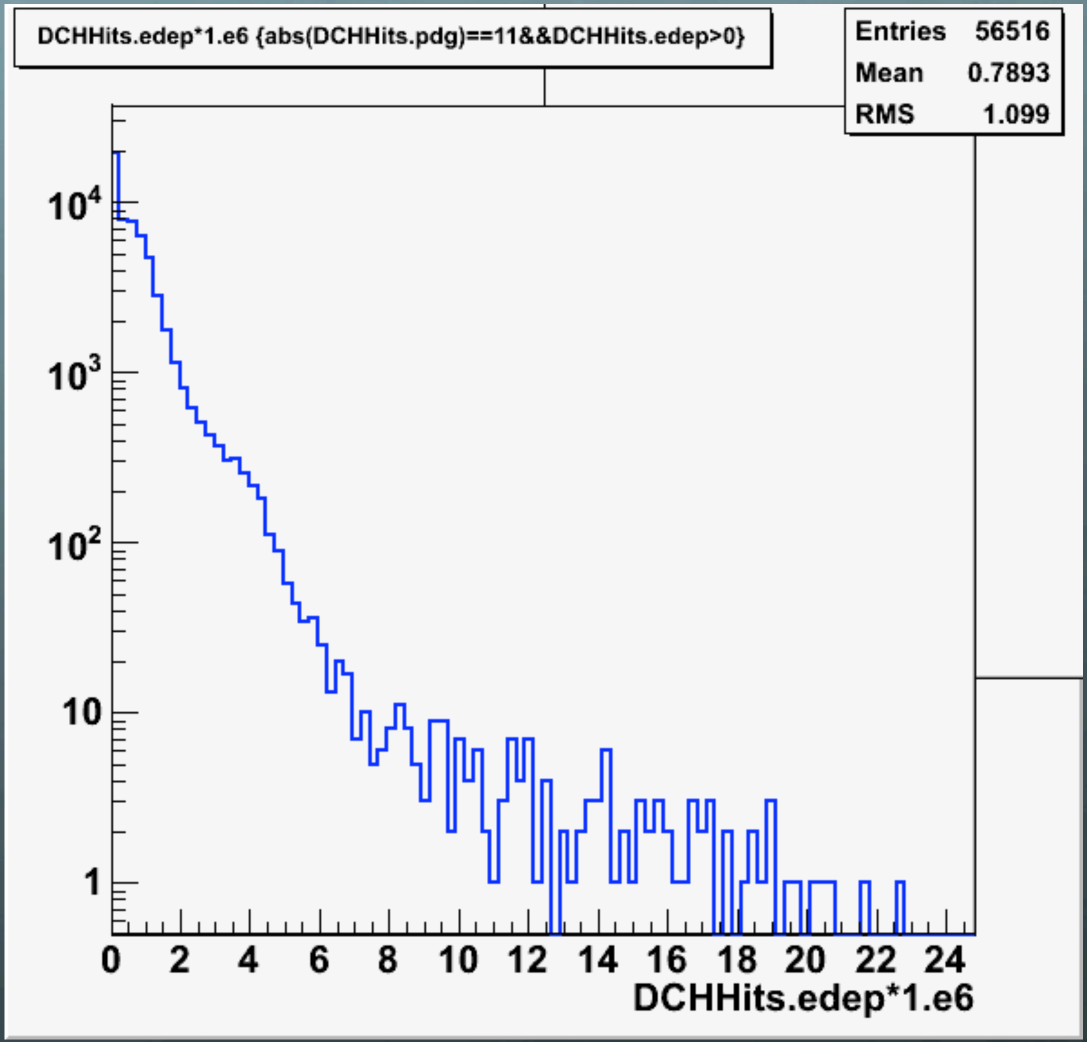
Running generator **BBBREM** I get the following X-sections:

$E_\gamma/E_{beam} > 1\ 10^{-2}$ **σ=265± 4 mbarn**

$E_\gamma/E_{beam} > 1\ 10^{-4}$ σ=599±14 mbarn

$E_\gamma/E_{beam} > 5\ 10^{-2}$ σ=155±1 mbarn.

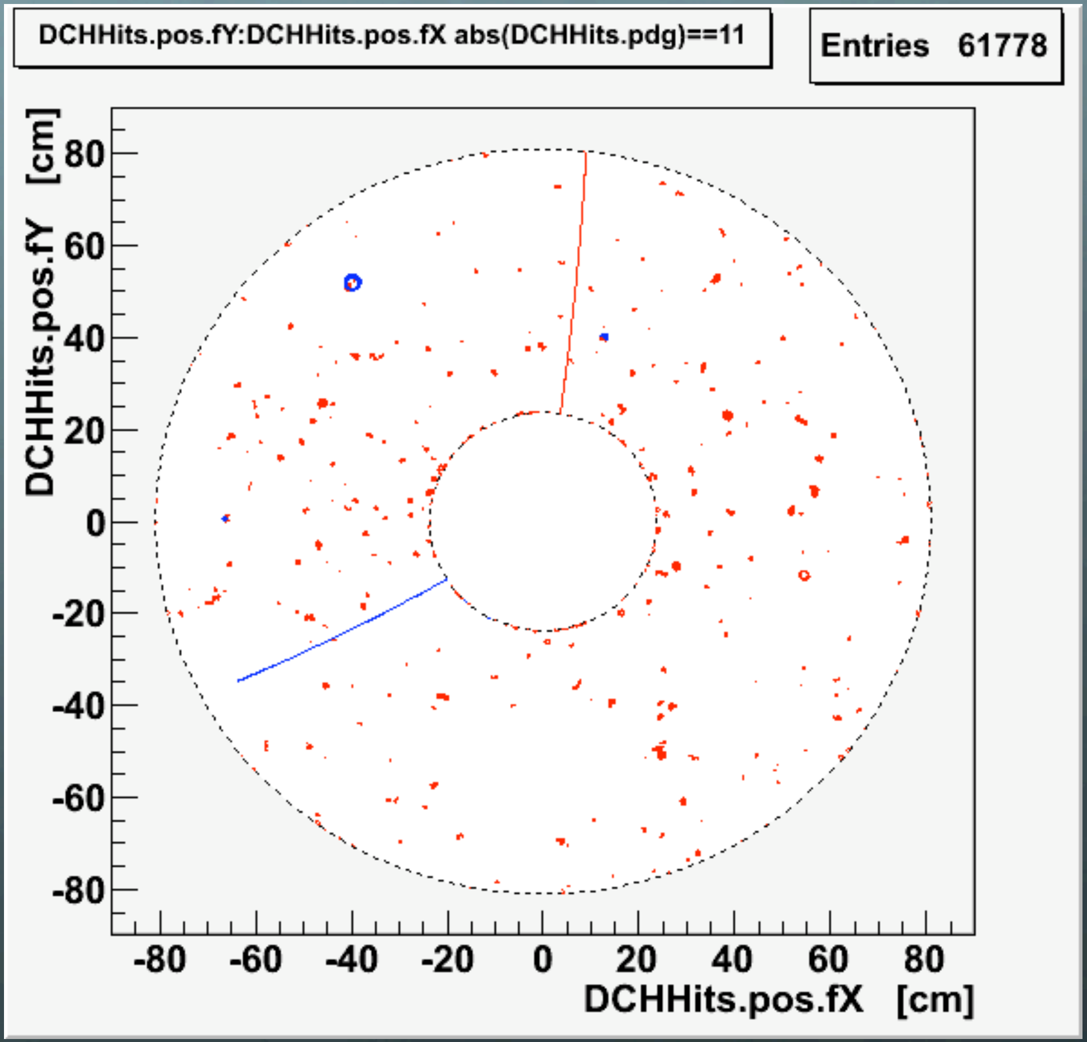
Energy deposited (in keV) for e^+e^-

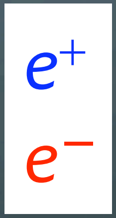


Average e^+e^- energy loss is ~ 0.79/0.45 = 1.75keV/cm

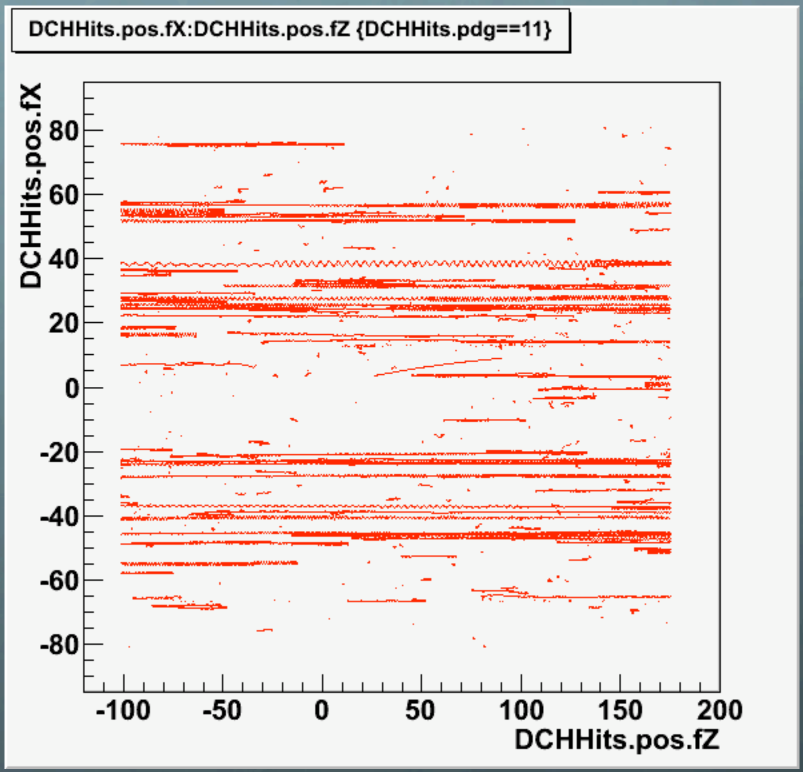
ρ~10^{-3} gr/cm^3 ➔ consistent with a m.i.p.

Position of e^+e^- hits (Y vs X)

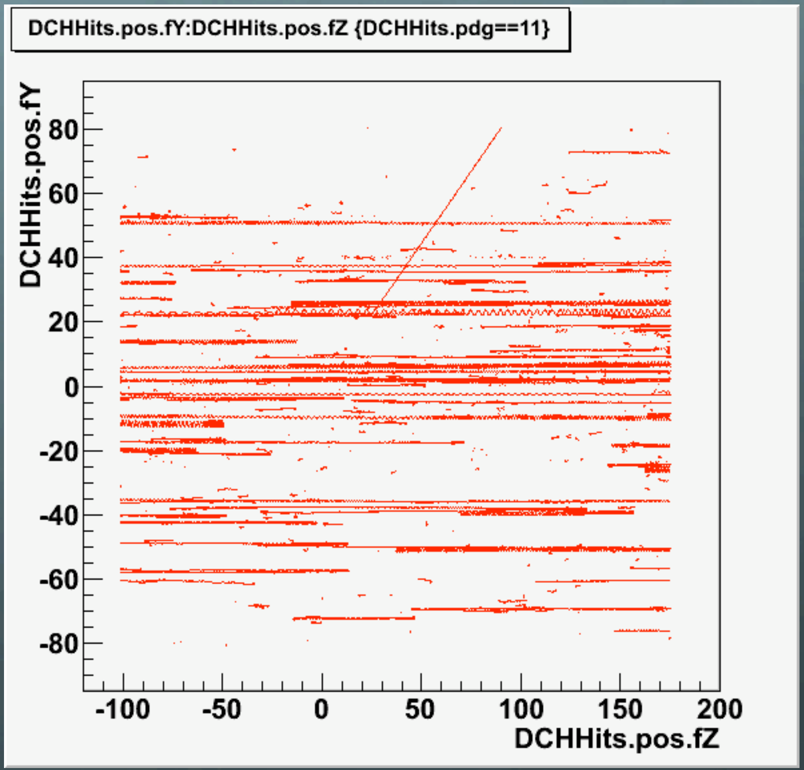




Position of electron hits

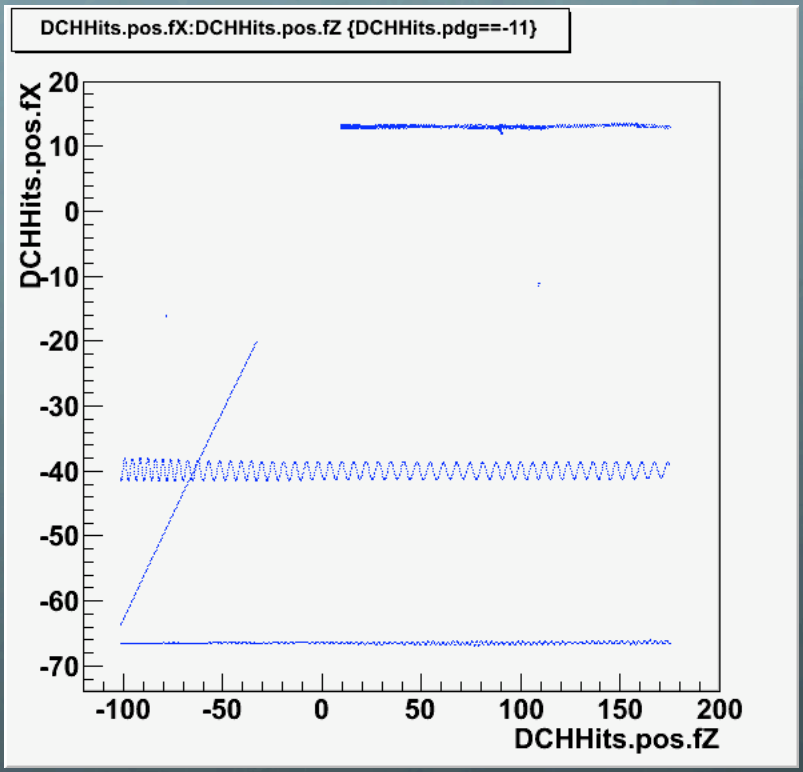


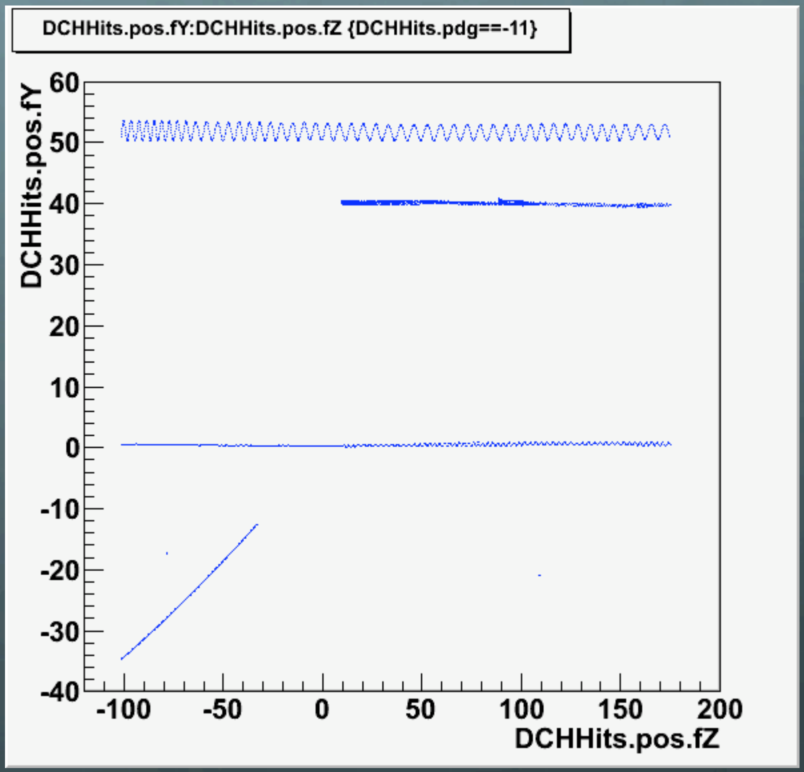
X vs Z



Y vs Z

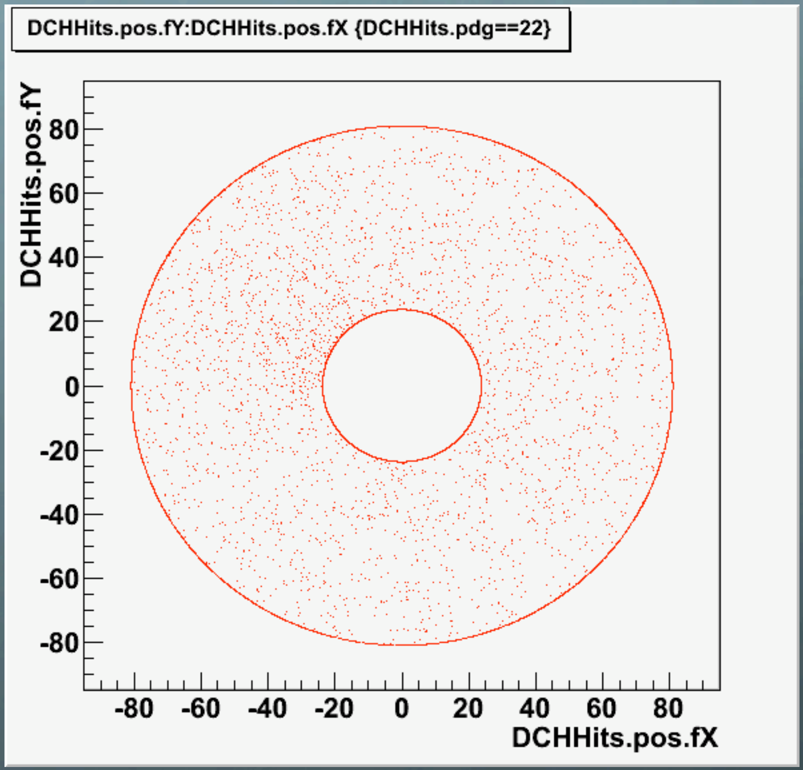
Position of positron hits

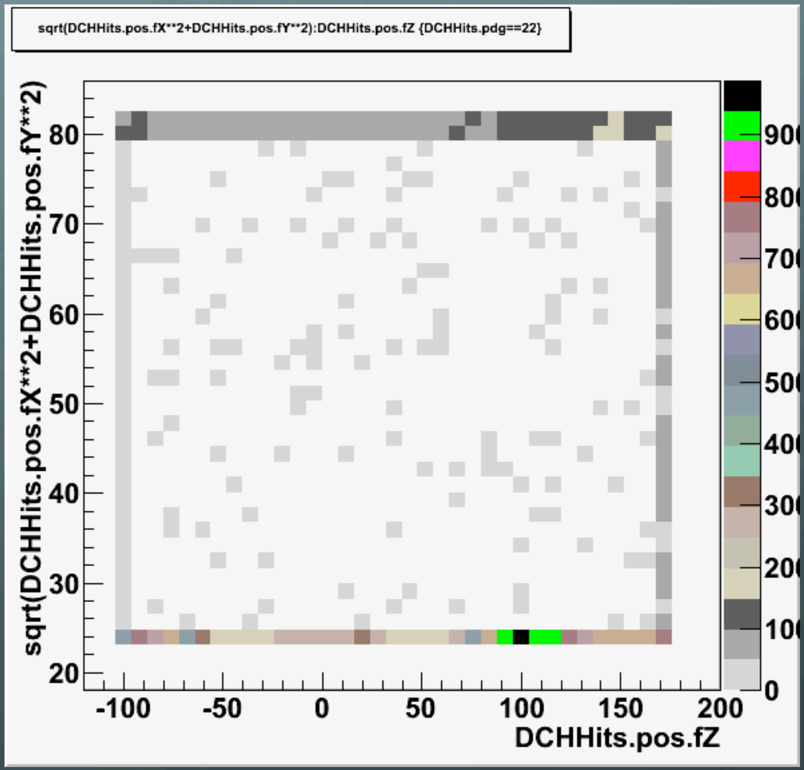




X vs Z **Y vs Z**

Position of photon hits

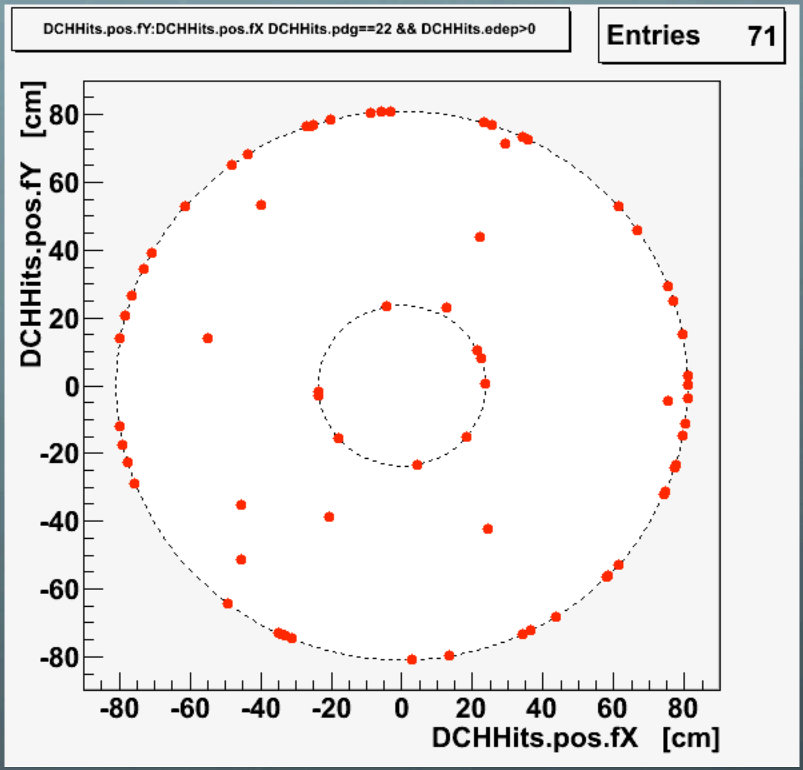


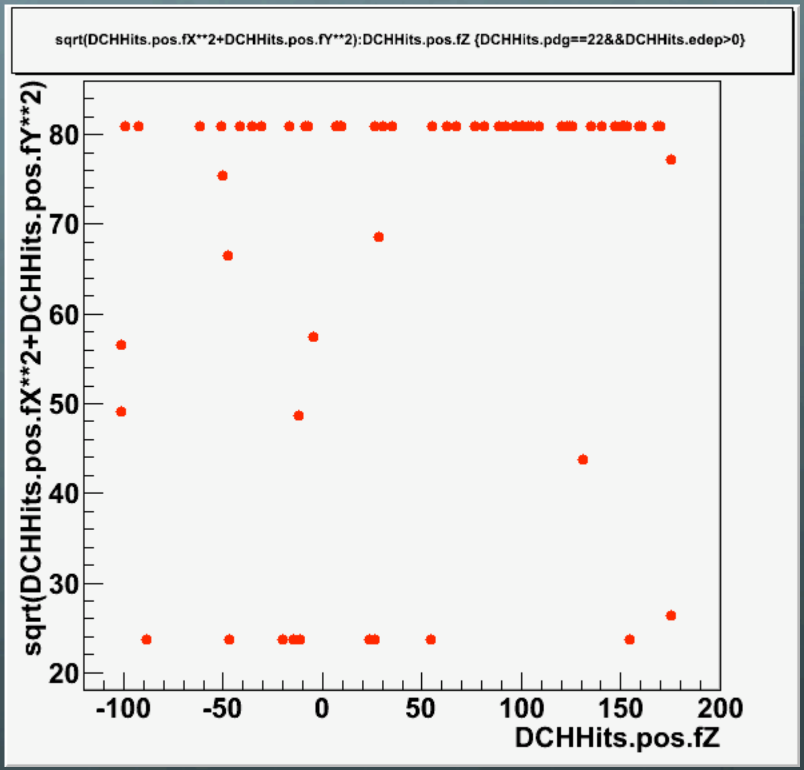


Y vs X, 25696 entries

R vs Z, 25696 entries

Position of photon hits with $E_{dep}>0$



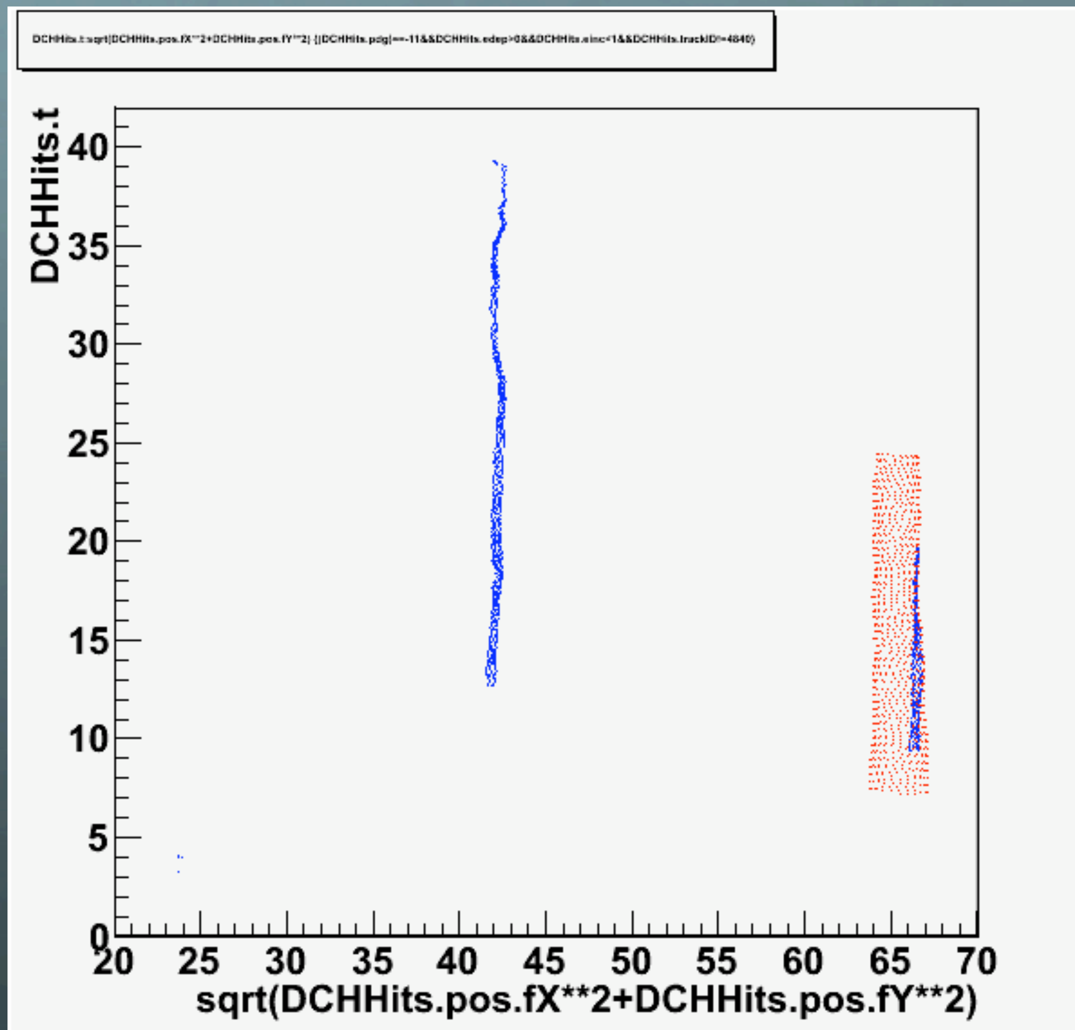


Y vs X, 71 entries

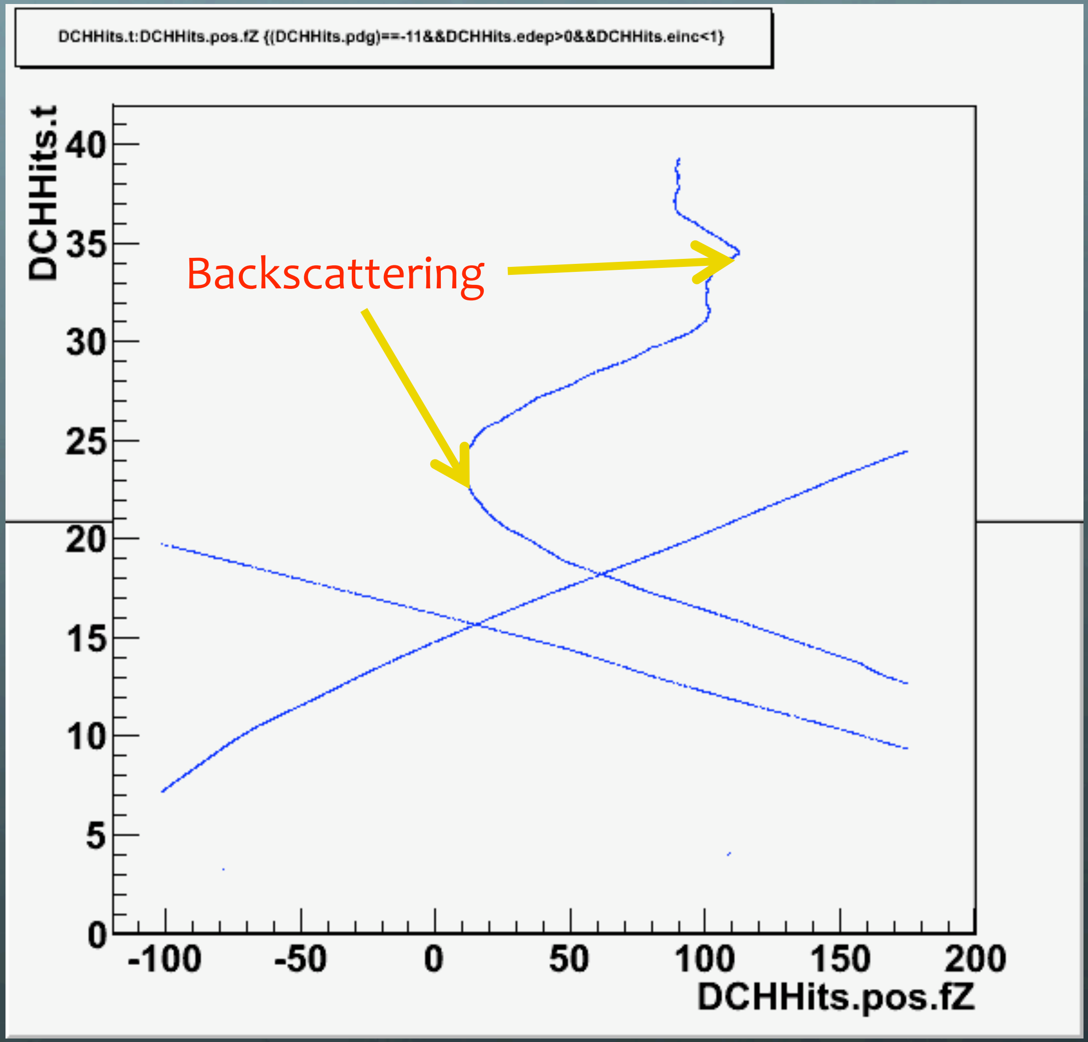
R vs Z, 71 entries

Time of hits

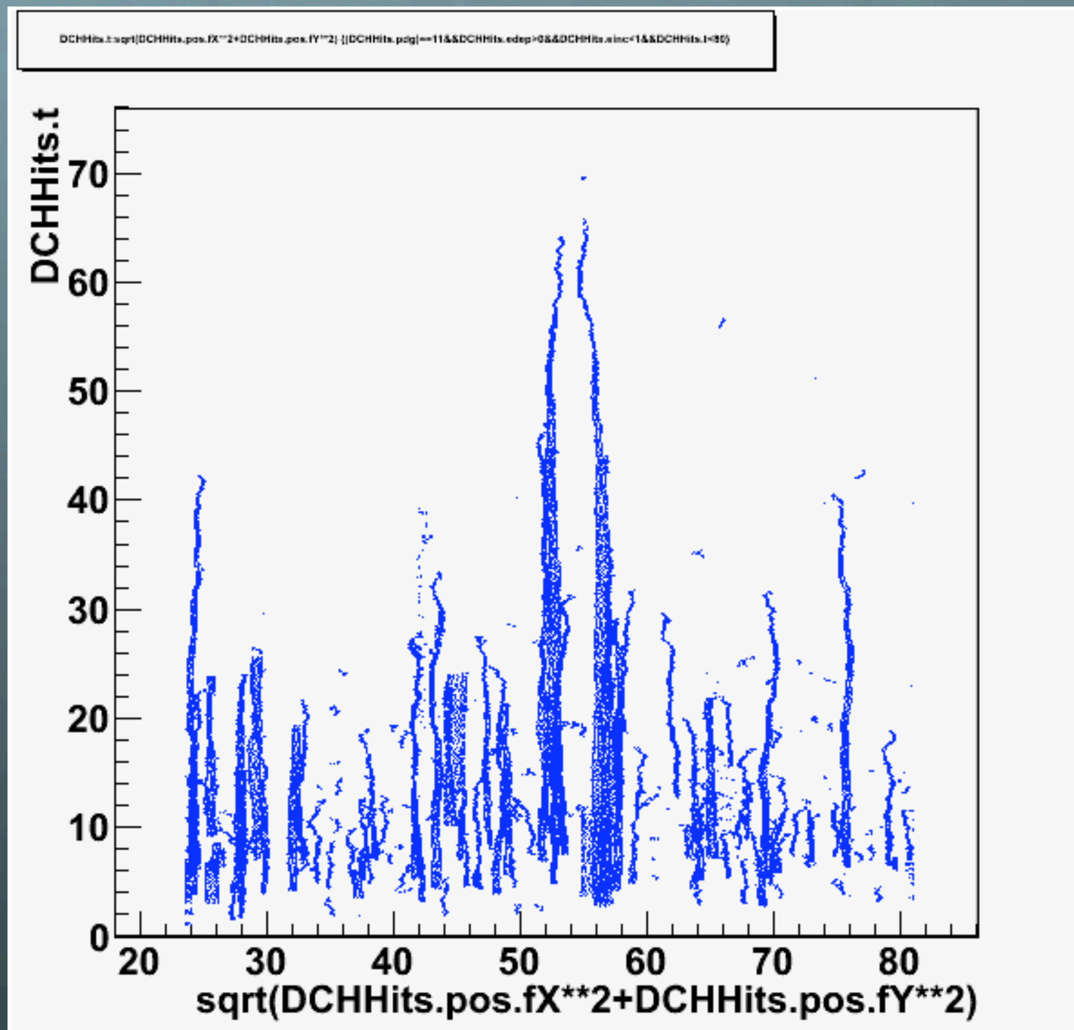
Time vs. R of positron hits



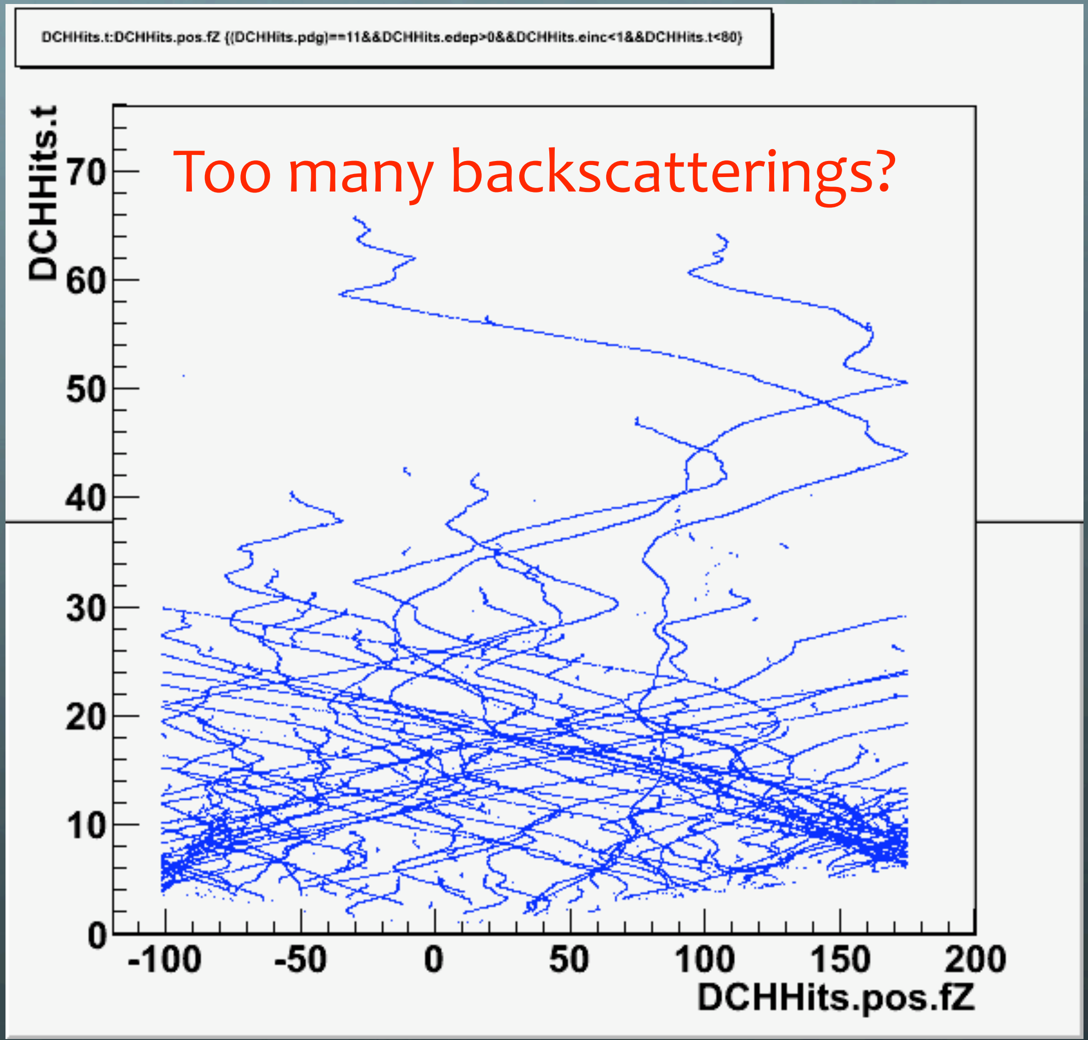
Time vs. z of positron hits



Time vs. R of electron hits



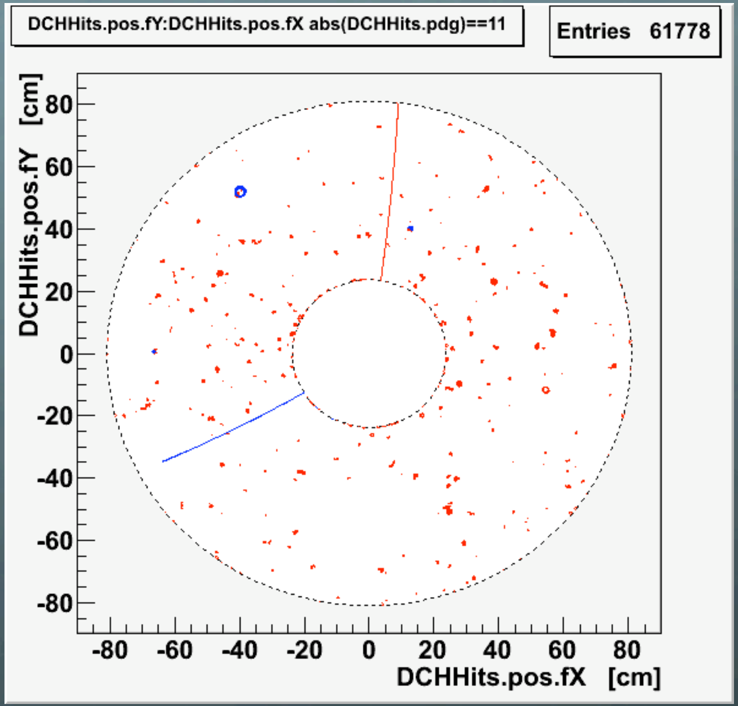
Time vs. z of electron hits



Rates

Hit rates

- Preliminary estimate of the rates in the DCH counting the number of spiraling e^+e^- tracks in the X-Y hit distribution.



- I count 232 low energy spirals (plus the 2 high PT tracks)
  - N.B. in the exercise shown at the previous DCH meeting I had counted 213 spirals
    - accuracy of "by eye" estimate is probably ~10%
    - unfortunately, for a typo I had reported "213" as "113" and used that for the rate estimates

Hit rates

1. Assuming for simplicity that each spiral only traverses just one cell (spirals with sufficiently large PT will actually cross more than one cell), the fraction of hit cells averaged over the whole drift chamber in 1 μs is

$$f_{axial} = N_{spirals}/N_{cells}/time$$

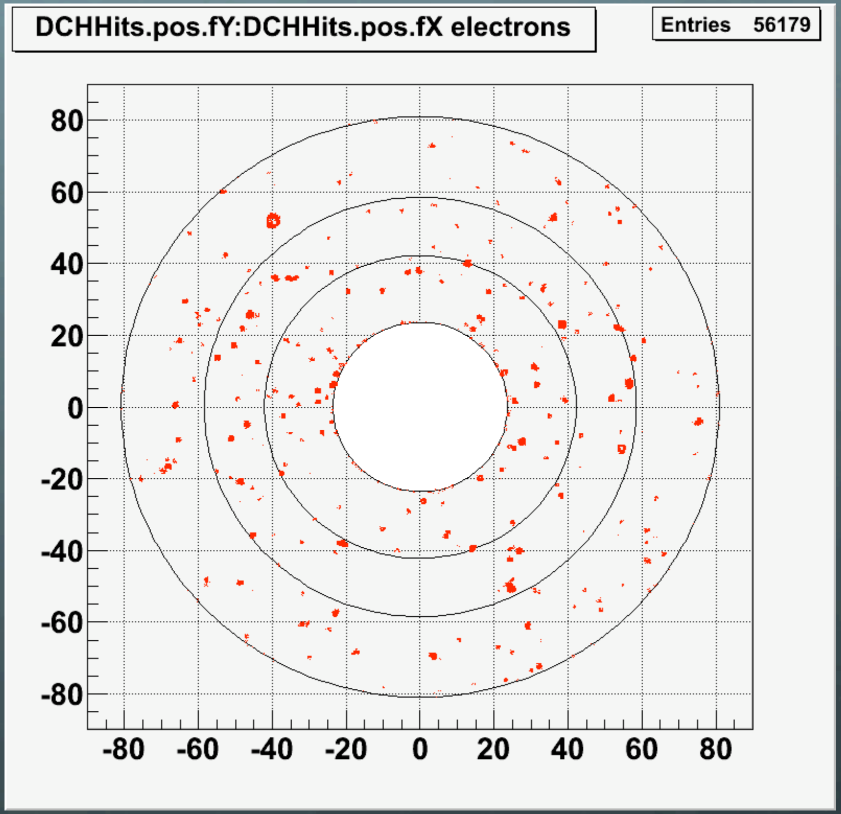
- In this case $f_{axial} = 232/7104/6.1\mu s = 0.54\%$

1. Considering the stereo angle, ranging from 45 to 80mrad, on average a spiralizing electron crosses 9.1 cells (in an all-stereo chamber) → **rate=4.9%**

- We should add the two high PT tracks (80 more hits added to 232), but the error on that number is probably too high.

Hit rates: rates vs. R

- Divide the DCH in 3 radial regions, corresponding to Superlayers (SL) 1-3, 4-6, 7-10 respectively.



- Count spirals separately in each radial region

Hit rates: rates vs. R

- Number of cells, cell widths and average stereo angles as in BABAR

SL	# of cells	Radius (mm)	Width (mm)	Angle (mrad)
1	96	260.4	17.0–19.4	0
2	112	312.4	17.5–19.5	45–50
3	128	363.4	17.8–19.6	−(52−57)
4	144	422.7	18.4–20.0	0
5	176	476.6	16.9–18.2	56–60
6	192	526.1	17.2–18.3	−(63−57)
7	208	585.4	17.7–18.8	0
8	224	636.7	17.8–18.8	65–69
9	240	688.0	18.0–18.9	−(72−76)
10	256	747.2	18.3–19.2	0

$$N_{stereo} = L_{DCH}/w_{cell} * stereo\_angle$$

Hit rates: rates vs. R

- N_{stereo} is calculated for an *all-stereo chamber*. Figures for n. of crossed cells are 30-50% smaller for an axial+stereo chamber

- On the other hand, see remark #1 on page 16.

SLs	f_{axial}	$\langle N_{stereo} \rangle$	f_{stereo}
1,2,3	76/1344/6.1=0.93%	2764/18.2*0.051= 7.7	0.93%*7.7 = 7.2%
4,5,6	64/2048/6.1=0.51%	2764/18.2*0.060= 9.1	0.51%*9.1 = 4.6%
7,8,9,10	92/3712/6.1=0.41%	2764/18.2*0.071=10.8	0.41%*10.8=4.4%
1-10	232/7104/6.1=0.54%	2764/18.2*0.051= 9.1	0.54% *9.1=4.9%

- Observed radial dependence apparently not very strong
  - due to averaging over 3/4 SLs (12/16 layers)]
    - e.g. ⟨rate(layer1)⟩~2x⟨rate(SL1)⟩~4x⟨rate(SL1-3)⟩
- Effect further counterbalanced by the increase of stereo angle with R

Hit rates: some remarks

- Figures shown in this presentation much less comforting than those at last DCH meeting
- Numbers still to be checked, digested, and rechecked
- Compare with independent estimates from R. Cenci (next presentation)
- Is there a z dependence?
  - background hits from this particular source (low PT spirals traversing the whole chamber length) would not indicate large correlations with z
- Are there other dangerous background sources?
- What safety factor should we add (x3, x5 …)?