Importance of the Low Angle BeamCal

New addition to an earlier study

"Experimental Implications for a Linear Collider of the SUSY Dark Matter Scenario"

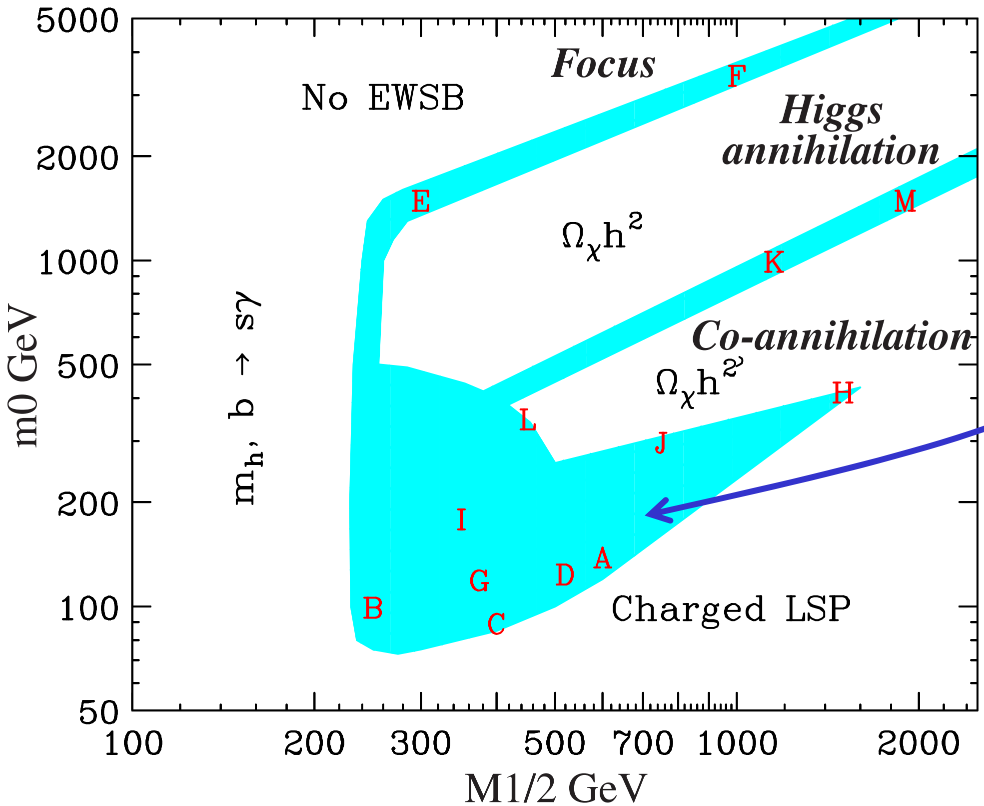
by
P. Bambade, M. Berggren, F. Richard, Z. Zhang

[hep-ph/0406010] & contribution to LCWS'04

Reminder of That Earlier Study

Addresses detection issues for stau mainly for benchmark point D both in head-on collisions and collisions with a 10 mrad half X-angle

Battaglia-De Roeck-Ellis-Gianatti-Olive-Pape, hep-ph/0306219



χ stau (sτ) annihilation

Important when

$\Delta M = m_{s\tau} - m_{\chi}$ is small

(5 GeV for point D)

➔ The precision on SUSY DM prediction depends on ΔM

Need to measure $m_{s\tau}$ and m_{χ} with best possible precision

Main Challenges for the Stau Analyses

$e^+e^- \rightarrow stau^+ stau^- \rightarrow \chi^0\tau^+ \chi^0\tau^-$

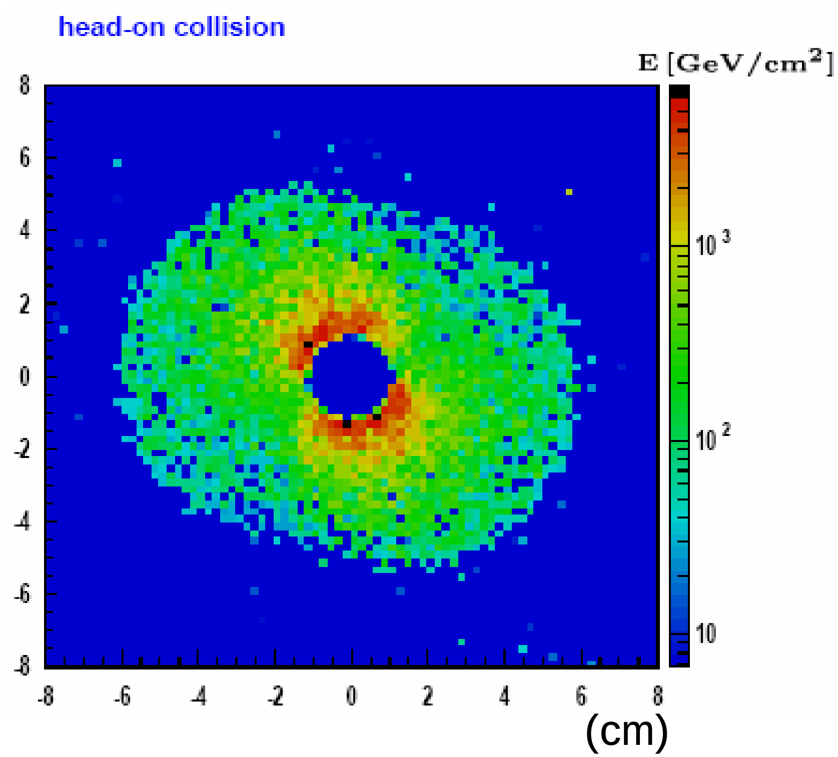
Cross sections: 10fb @ 500GeV, 4.6fb @ 442GeV

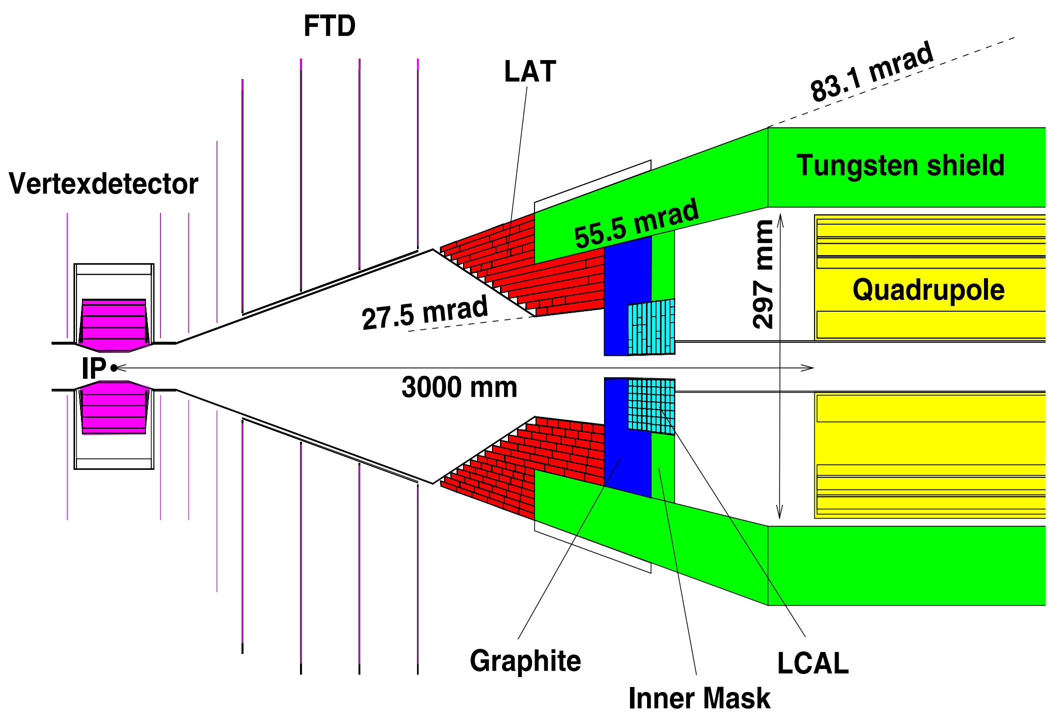
- **Missing energy and soft final state**
  - → Additional missing energies from neutrinos in tau decay
  - → Final state particles very soft:
    due to small $\Delta M<10$GeV & little Lorentz boost
- **SM backgrounds are many orders of magnitude larger**
  - ➔ Need very efficient veto at low angles
- **Additional complication if crossing-angle collisions**

Vetoing Against Energetic e^+/e^- from $\gamma\gamma$ out of Huge Number Soft Beamstrahlung Background

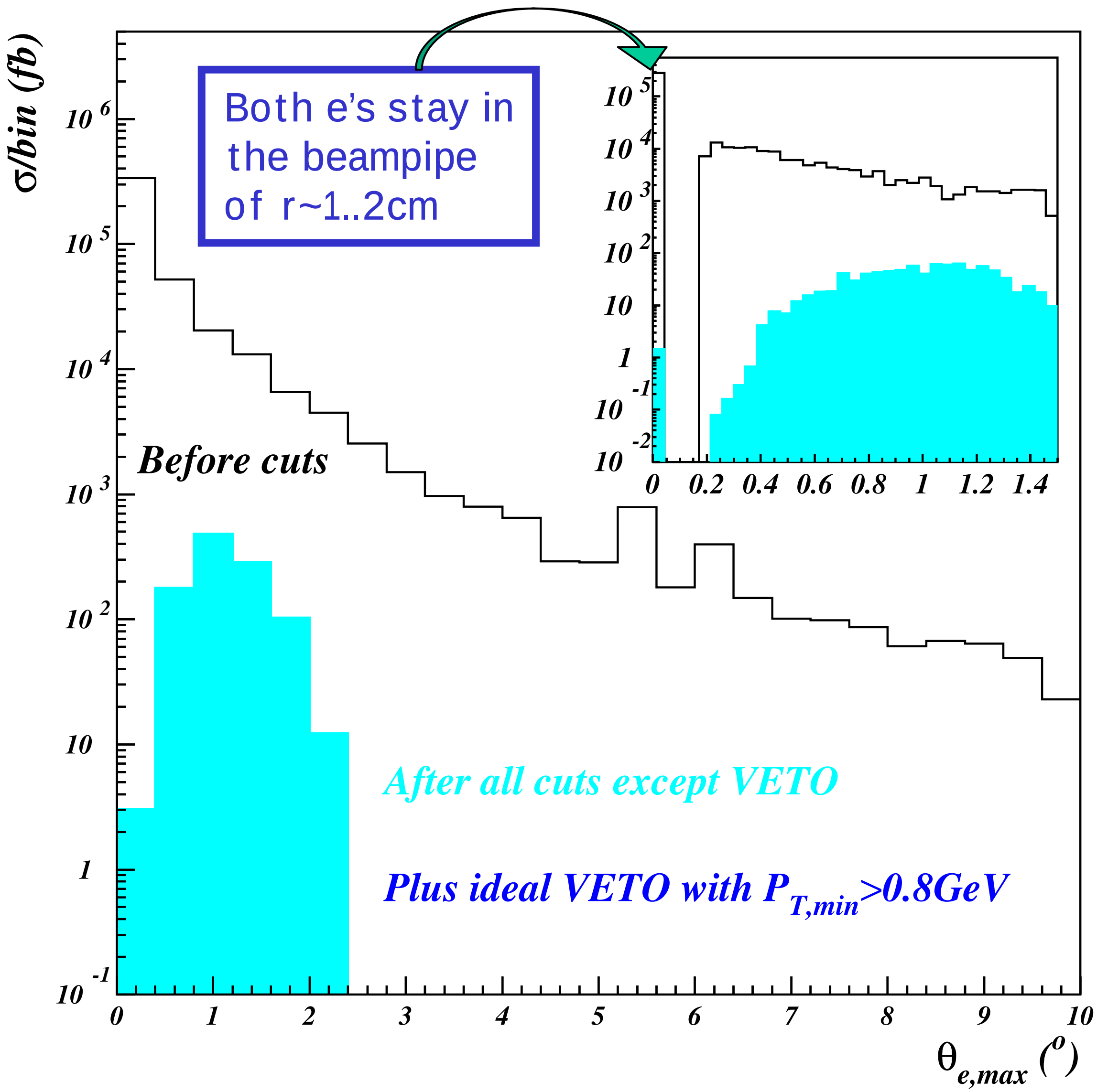
- **e^+/e^- from ee→eeff:** Few e's per event but energetic
- **Beamstrahlung background:** Huge number e,γ/event but soft

e.g. the energy density/event in LCAL @ z=3.7m simulated by K. Buesser





Low Angle Veto in Head-on Collisions



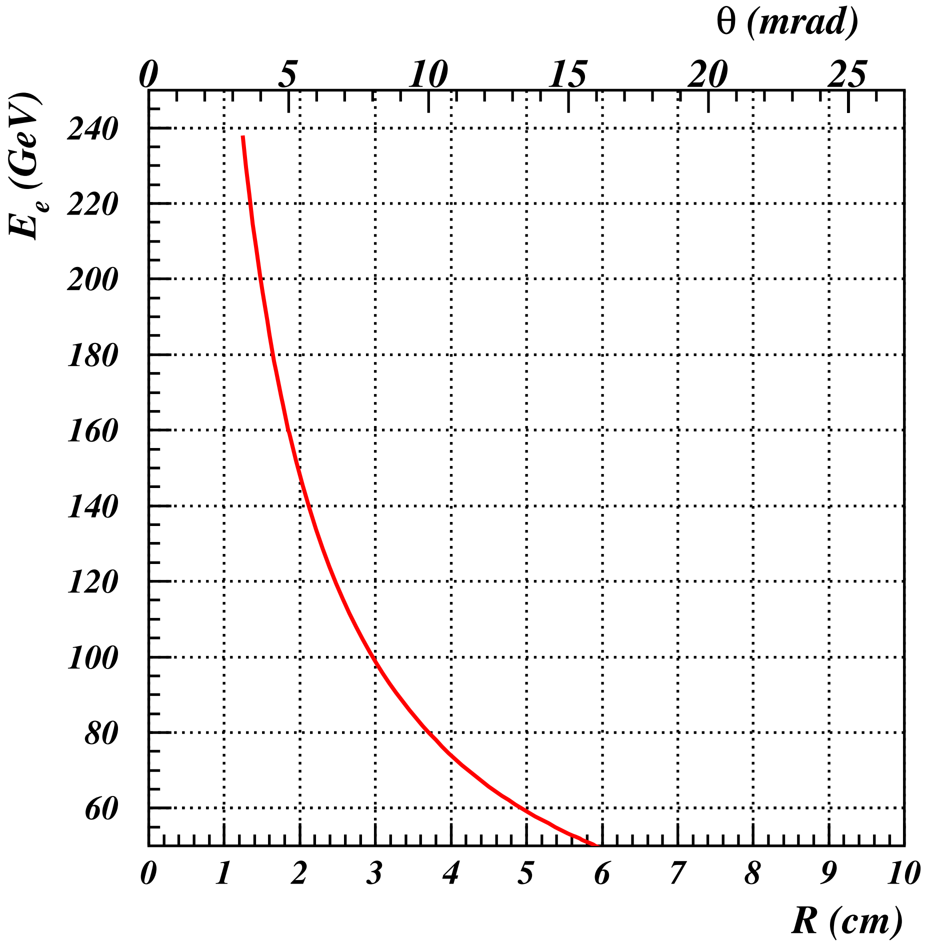
Angular distribution of the spectator e from ee→eeττ

Total σ ~ 0.43x10^6 fb of which 3/4 with both e's staying in the beampipe corresponding to the peak at zero in the inset

Analysis cuts reject most of the background

An ideal veto with
$P_{T,min}$>0.8GeV
is sufficient to suppress all remaining γγ→ττ background events except those with energetic μ/π at low angles

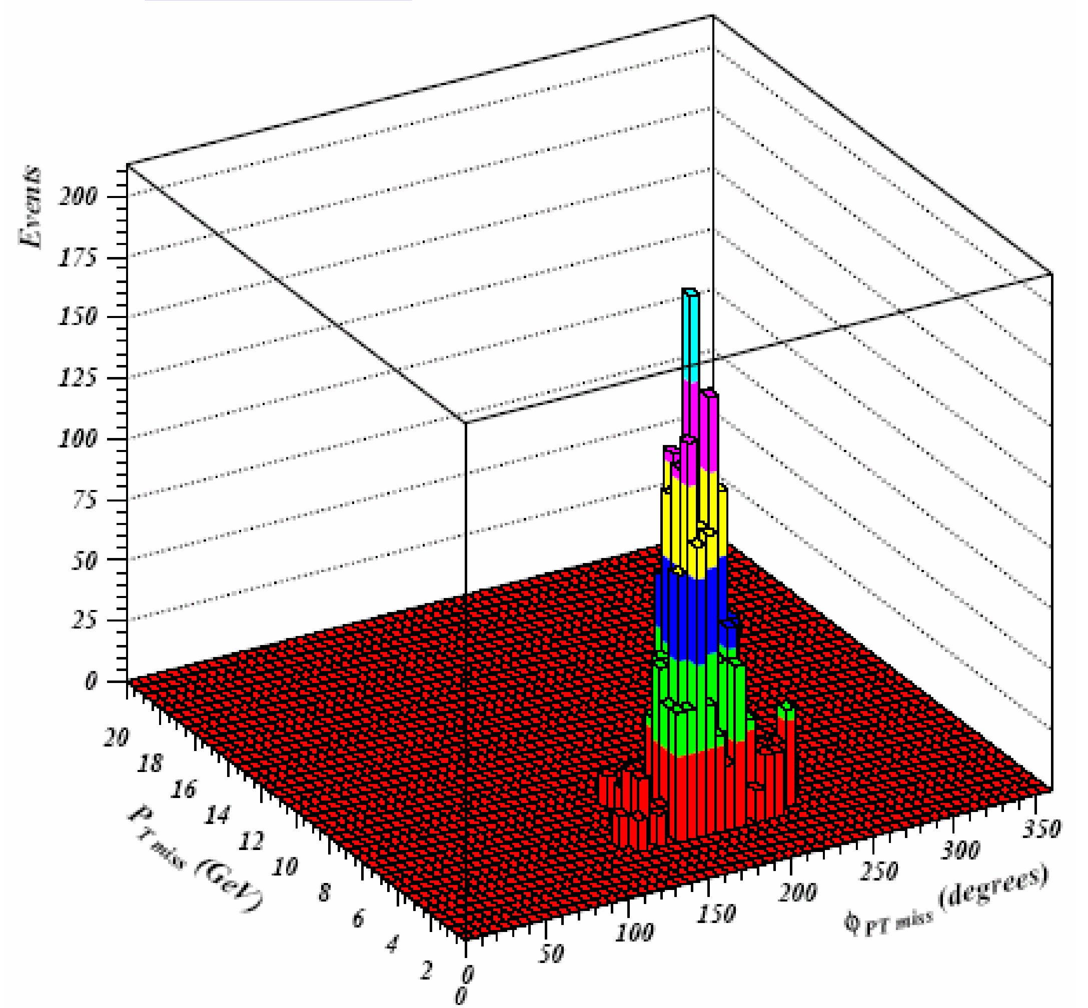
Full Veto Efficiency for P_T>0.8GeV?



It is clearly
a big challenge
if not unrealistic

Remaining Background in Cross-Angle Mode

ee→eeττ



10mrad half crossing angle

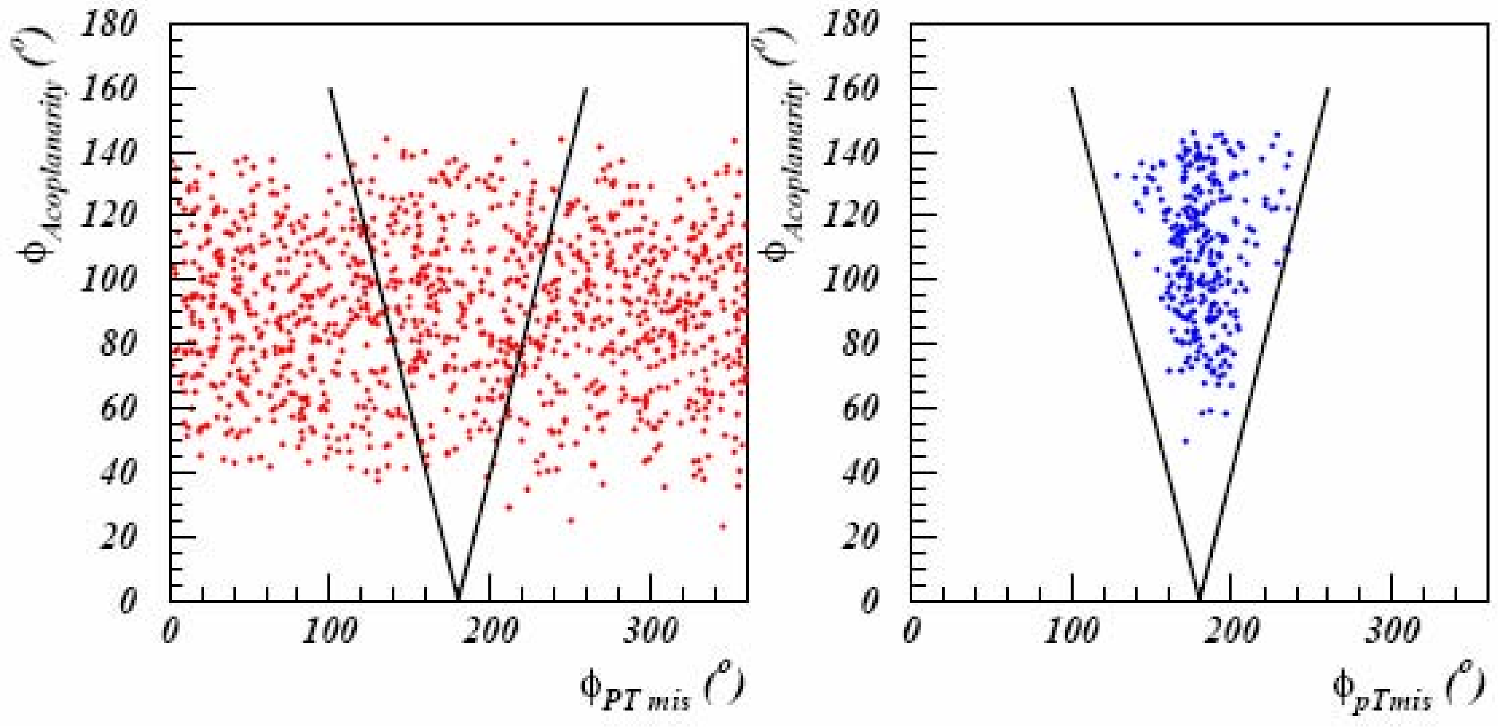
For an incoming beam hole of r=1.2cm the probability for a spectator e+/e- to enter the hole is 10^{-3}.

Remaining background events correspond (mainly) to those with e+/e- goes into the incoming beam hole.

Additional cuts remove essentially all these events.

A price to pay however:
25% efficiency reduction
e.g. for benchmark point D @ Ecm=442GeV
from ~5.7% to ~4.3%

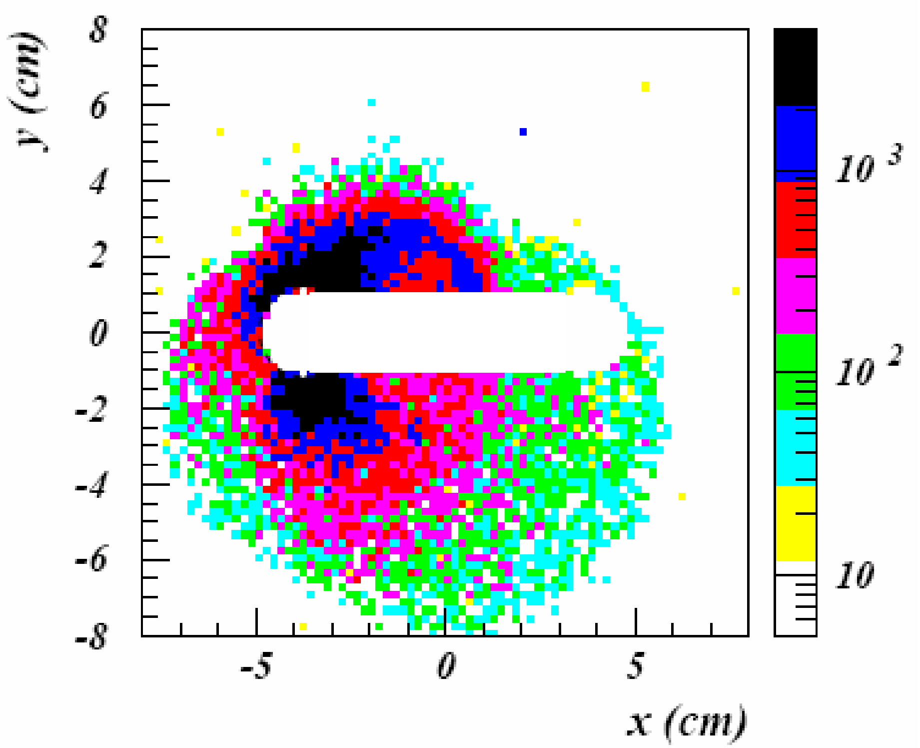
Additional Cuts for X-angle



What happens if Larger Inefficient Region?

1) If beam hole radius increases from 1.2cm to 1.5cm

2) If additional blind region



Question:

What's the consequence for the stau analysis?

Answer:
The additional cuts need to be modified introducing larger inefficiency from 25% to 30% w.r.t. the head-on analysis

Summary

- **BeamCal essential in vetoing huge SM background events**
  ➔ need to maximize the e ID and veto efficiency

- **Head-on or small x-angle mode more favorable than large x-angle mode**

- **Close interplay between machine/detector design and physics capability studies**