Comparison of BeamCal performance at Different ILC Designs

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Introduction

Physics motivation:

- in some models, amount of DM in the Universe depends on difference between $\tilde{\chi}$ and $\tilde{\tau}_1$ masses

-> one needs to **measure $\tilde{\tau}$ mass** precisely

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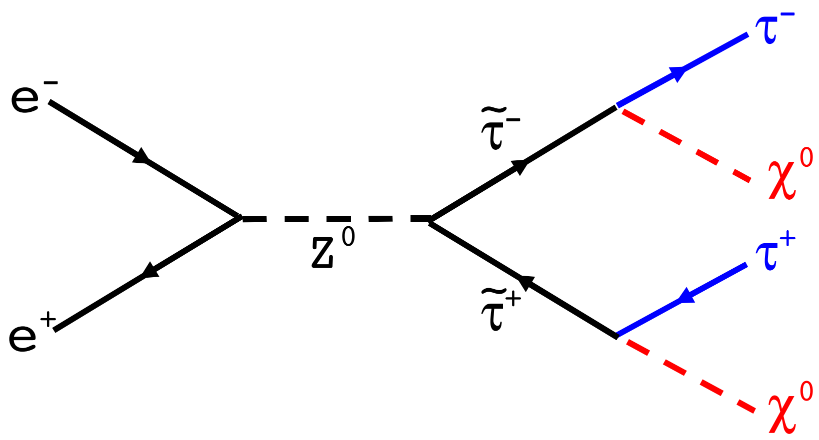
Physics background:

- $\gamma\gamma$ events with 4-fermion final states
- eliminating strategy:
  - **cut on $\tau\tau$ acoplanarity** if $p_t(e)$ is low
  - **electron veto** when $p_t(e)$ is high

New Particle Searches



The Physics:

stau pair production

Signature:

$\tau^+ \tau^-$ + missing energy

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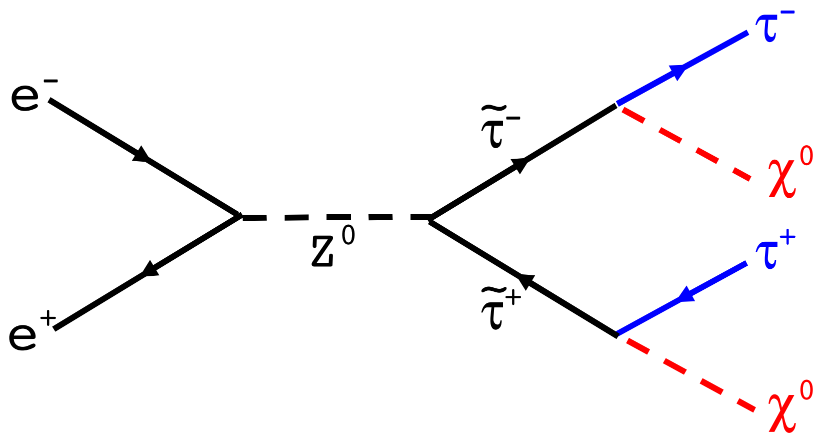

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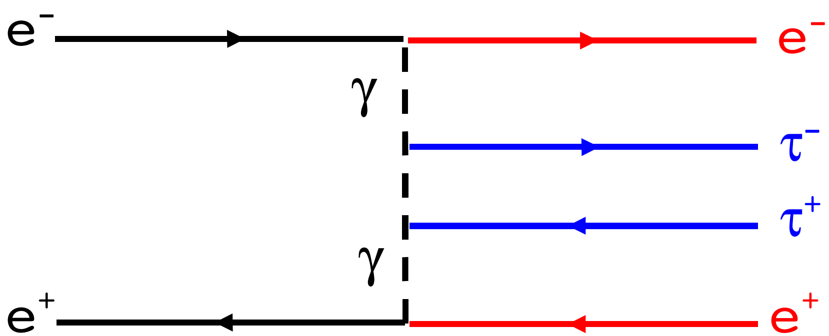

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two-photon events

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(if electrons are not tagged)

i.e. mimic SUSY event

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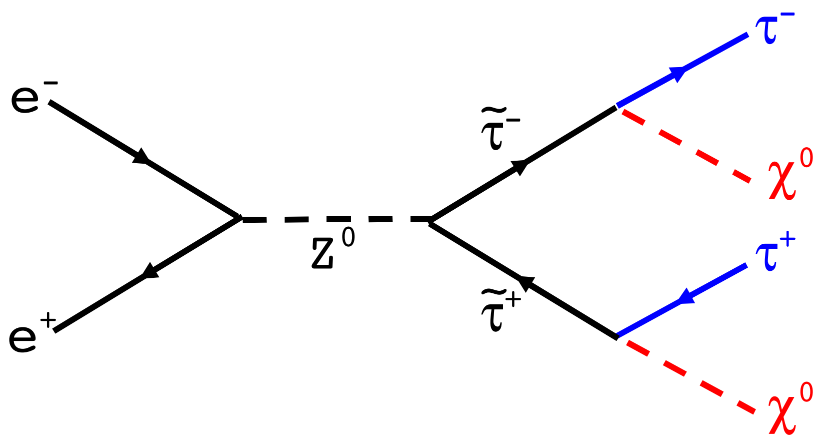

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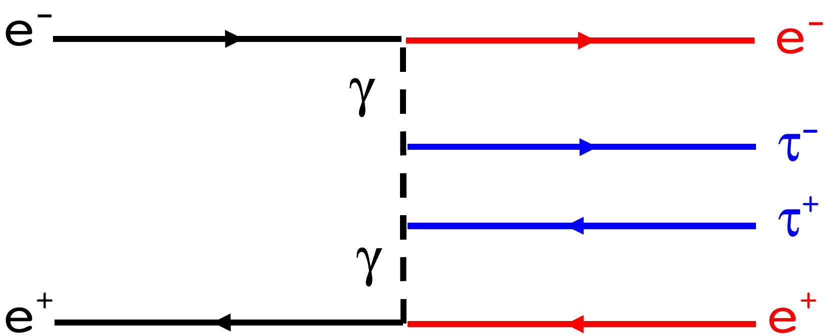

The Background:
two-photon events
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strategy:
- e^+e^- in BP: cut on $\tau\tau$ acoplanarity
- e hits BeamCal: electron veto is vital

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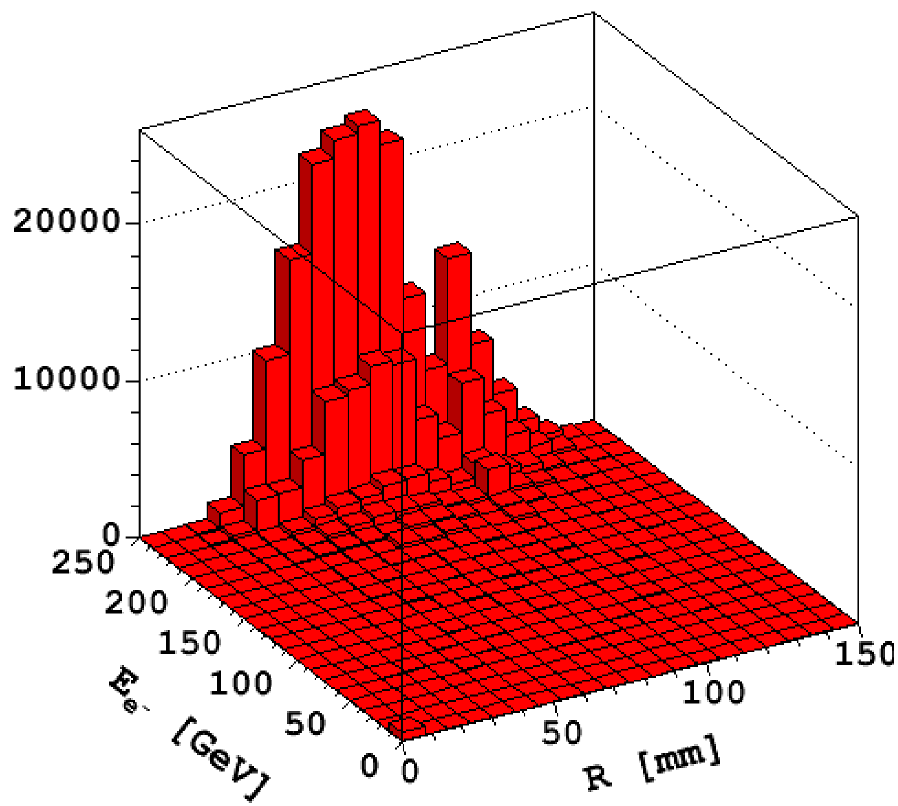
Electron veto:

- **problematic near BP**, due to superposition with the beamstrahlung remnants

Veto requirements and performance

the electrons from γγ events
passed all cut except veto



ntuple provided by Z.Zhang (LAL)

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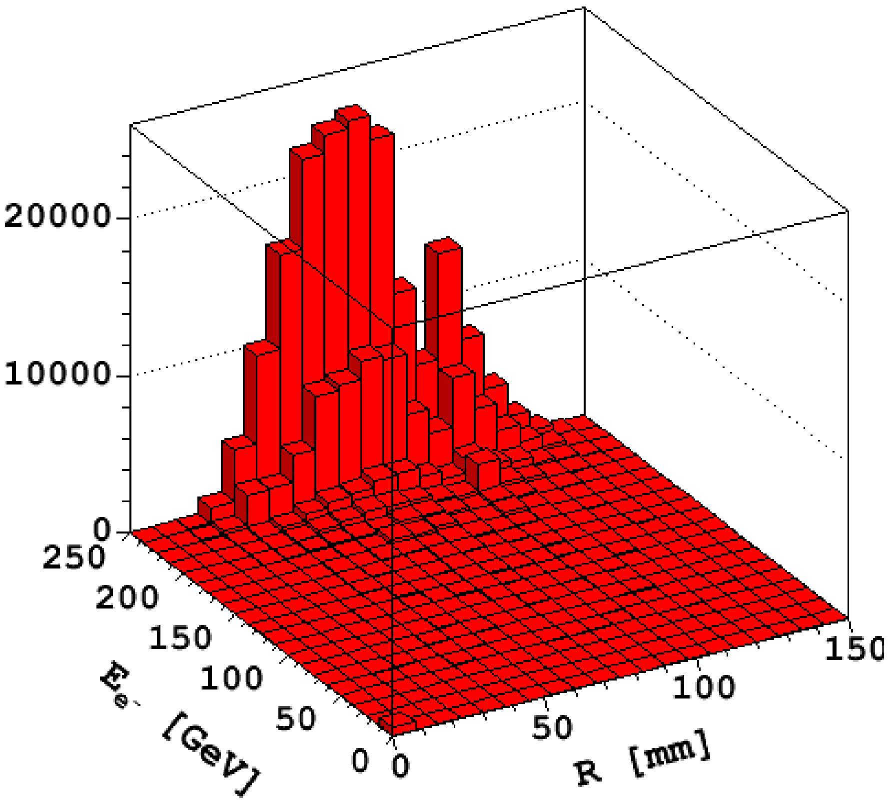
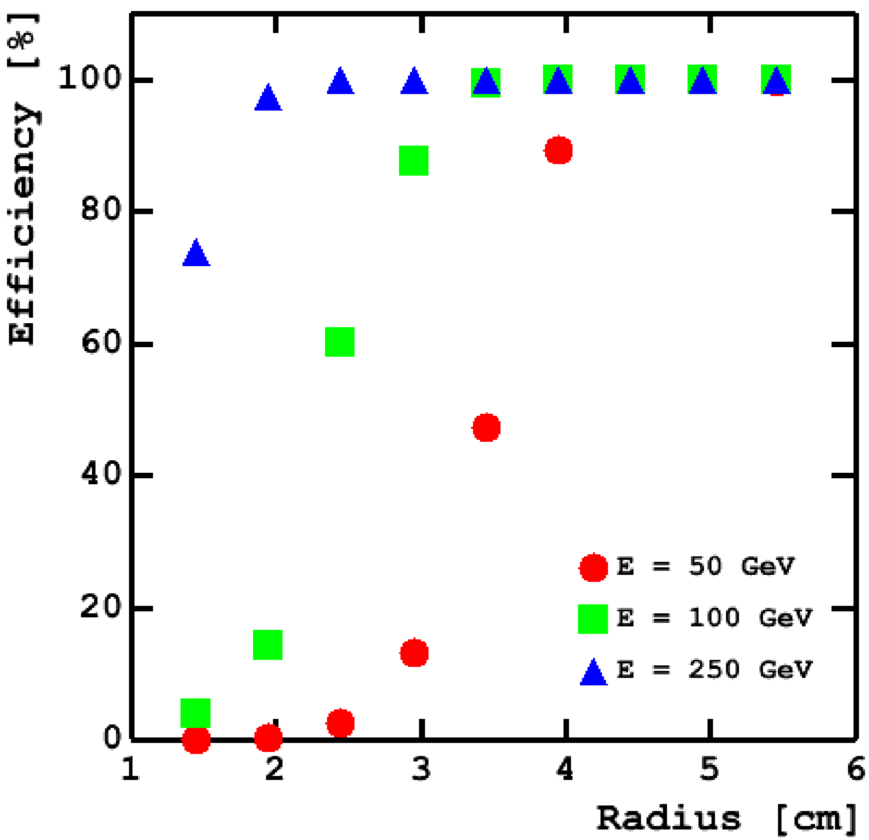


BeamCal veto performance



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Electron veto:

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Study:

- S/N is benchmark in **comparison of different designs**

Strategy

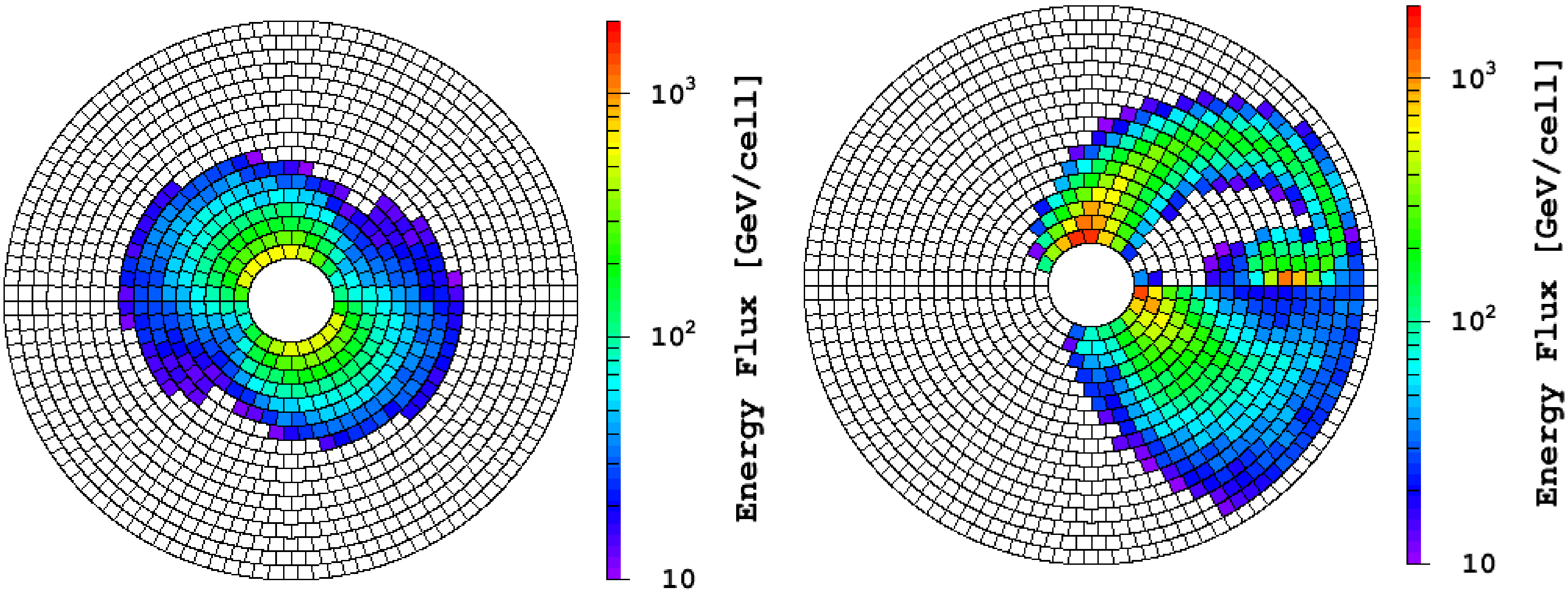
Physics program:

- **head-on** vs. 20 mrad **X-angle**

X-angle

head-on

X-angle



Strategy

Physics program:

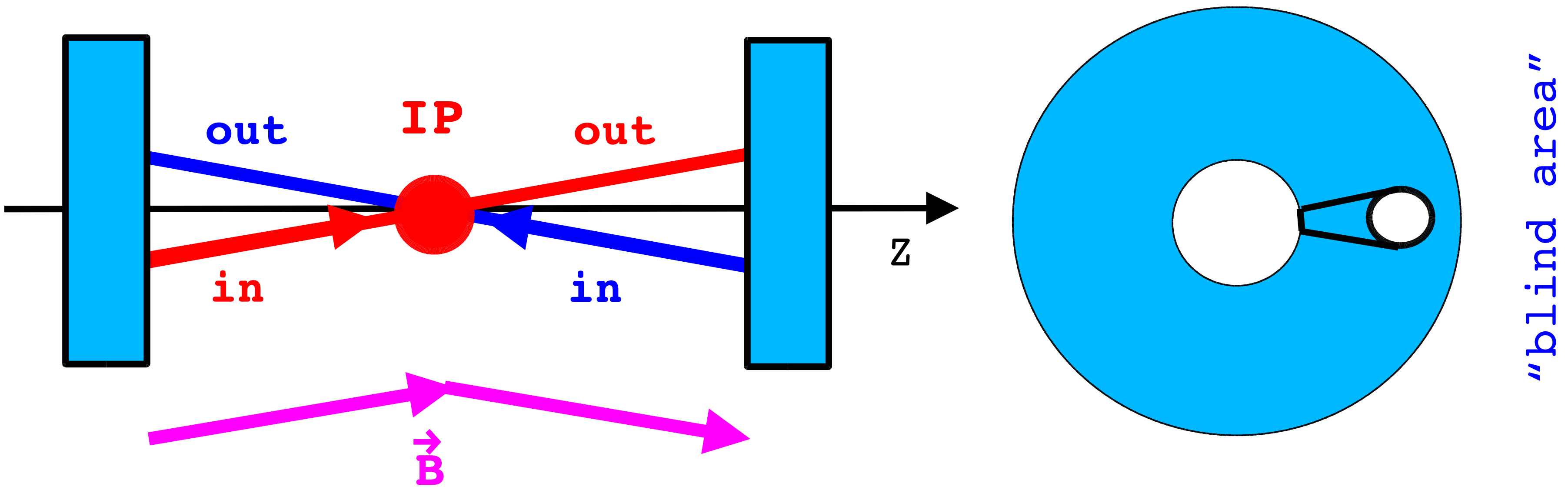
- head-on vs. 20 mrad X-angle

Strategy:

- calculate veto efficiency table for each design
  - full simulation chain to be done for each design
- include this MC into stau analysis

(to be done by LAL group)

Benchmark Geometry

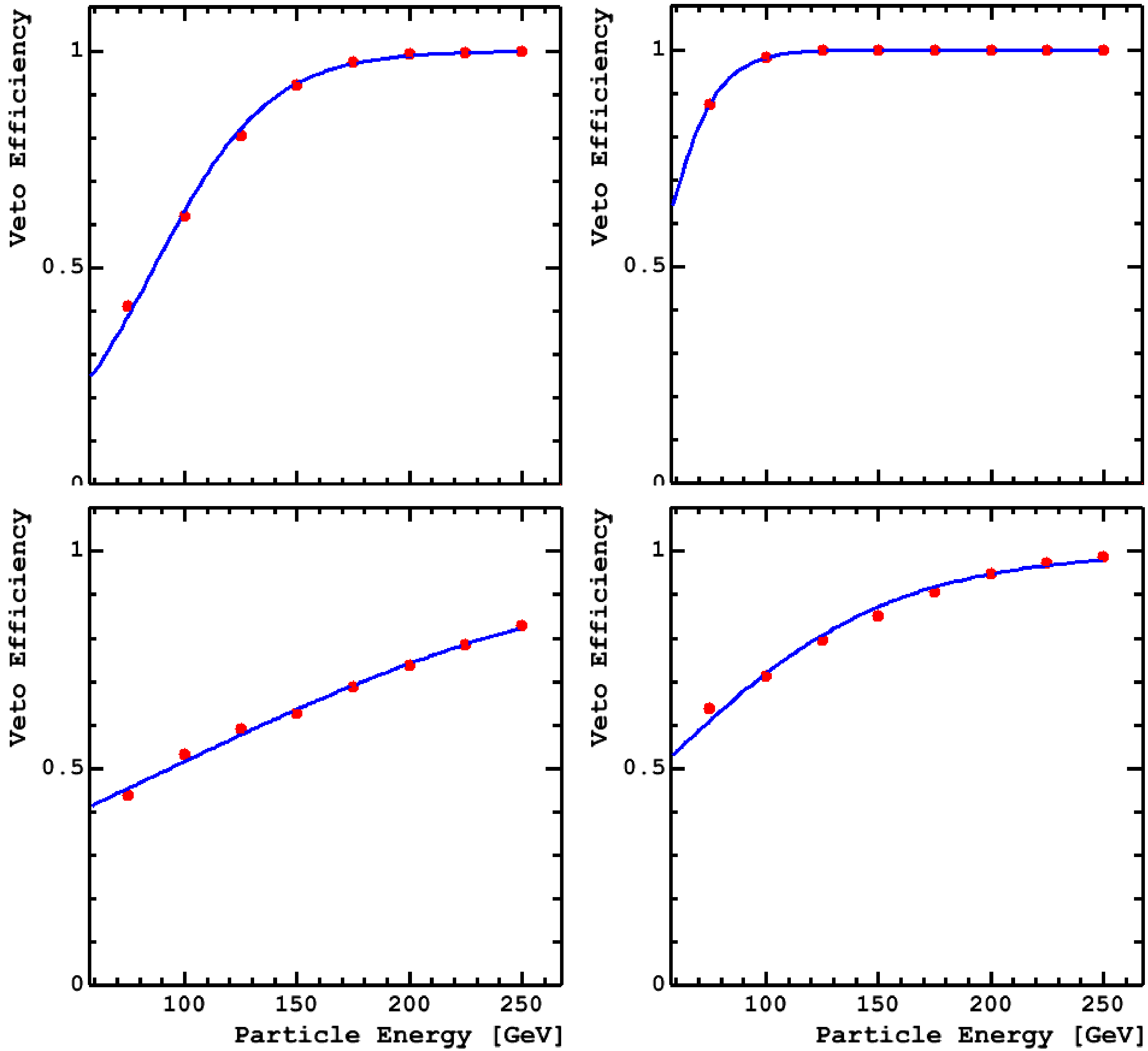


X-angle, mrad	0	20
blind area	–	+
L, cm		
Rmin, cm	1.5	2

Results

Head-On

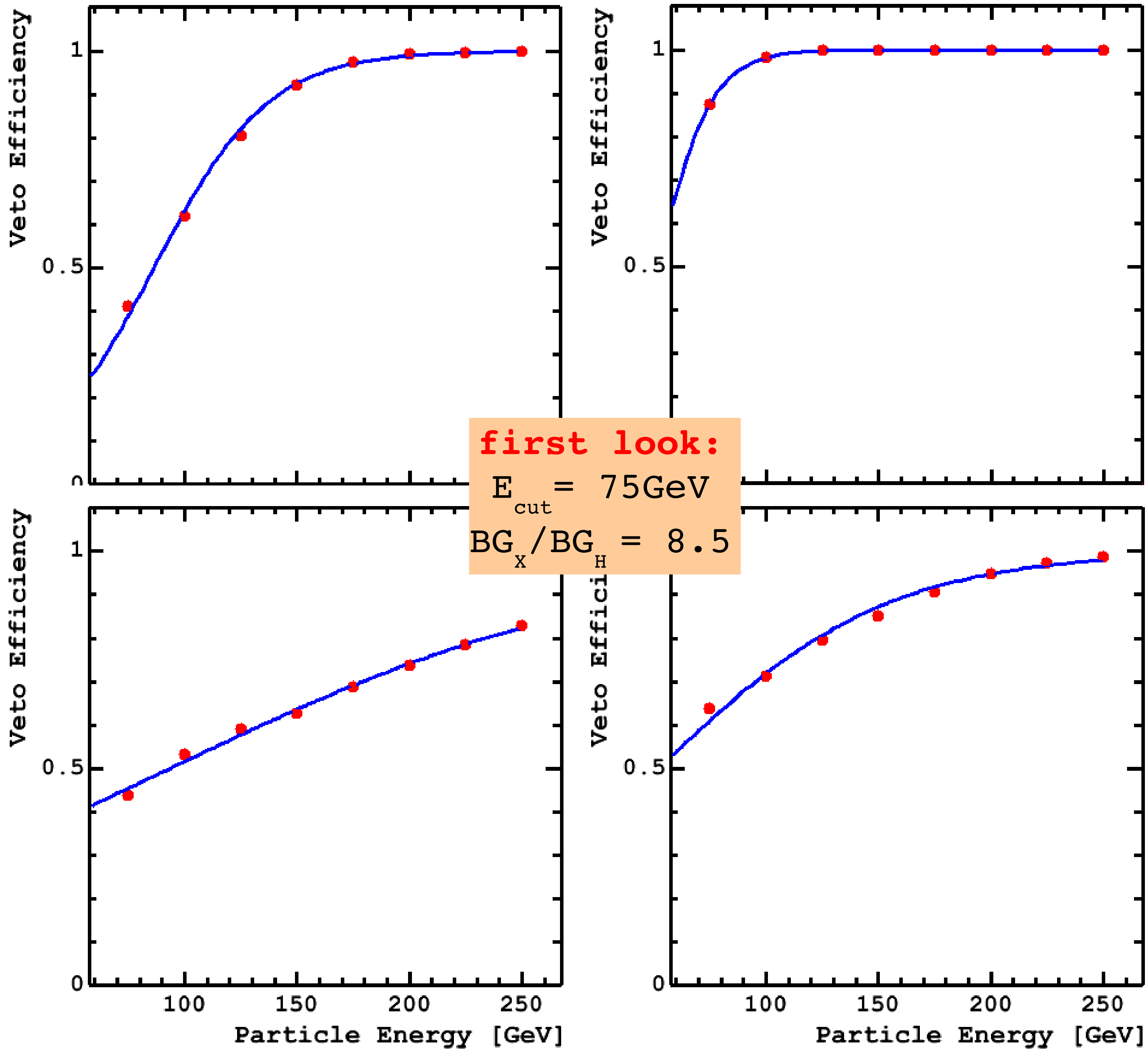
X-angle



Results

Head-On

X-angle



Bhabha Background

Bhabha scattering:

- $e^+ + e^- \rightarrow e^+ + e^- + (n\gamma)$
- $\partial\sigma/\partial\theta \quad 1/\theta^3 \rightarrow$ high probability at very small angles

  $\equiv$ BeamCal is the most hit sub-detector

Veto rate:

- incomplete reconstructed events will be vetoed

Incomplete reconstruction:

- kinematics, i.e. γ-radiation deflects particles
- reconstruction problem on top of the beamstrahlung remnants

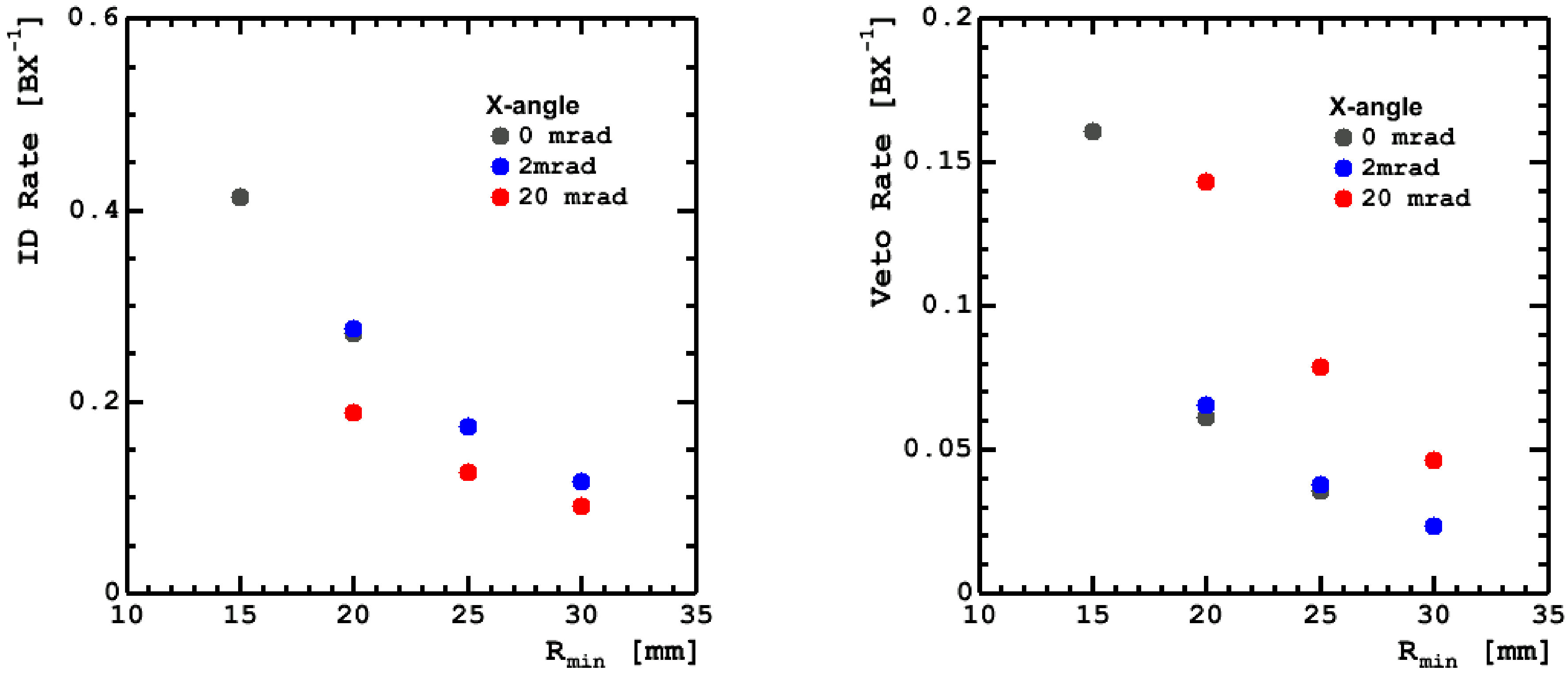
Study:

- impact of bhabha events on veto rate for different crossing angles

Results

Note:

- Energy cut = 150GeV
- energy resolution is not included



Conclusions:

- appreciable contribution to veto rate
- 2 mrad scheme: insignificant rise
- 20 mrad scheme: double rise

Summary

- new veto efficiency functions are obtained for head-on and 20mrad crossing angle schemes

  -> the results must be included into stau analysis

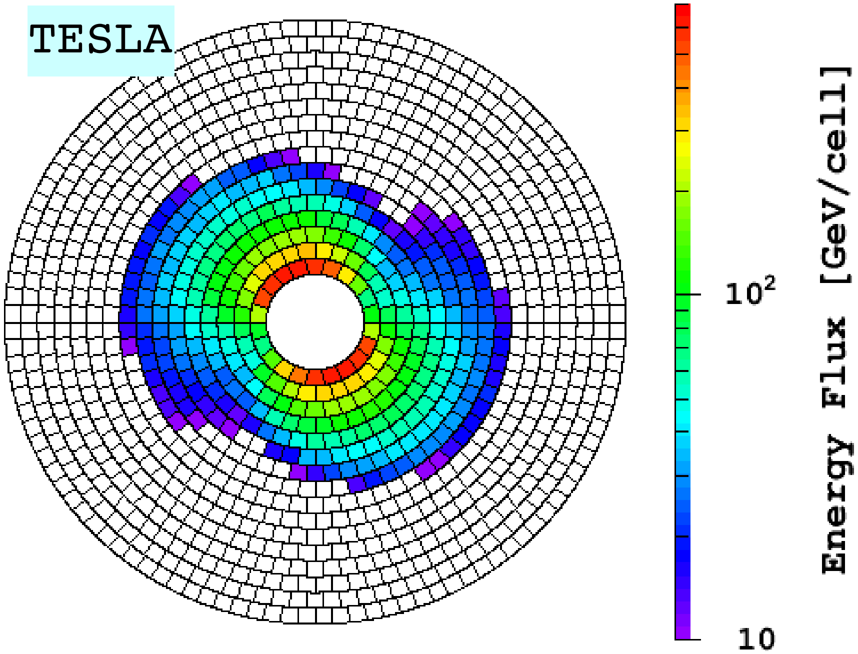
- large X-angle badly affects BeamCal performance

Future Plans

There are discussions to re-optimize the parameter sets
("Suggested ILC Beam Parameter Range" Rev. 2/28/05)

- compare different **beam parameter sets**

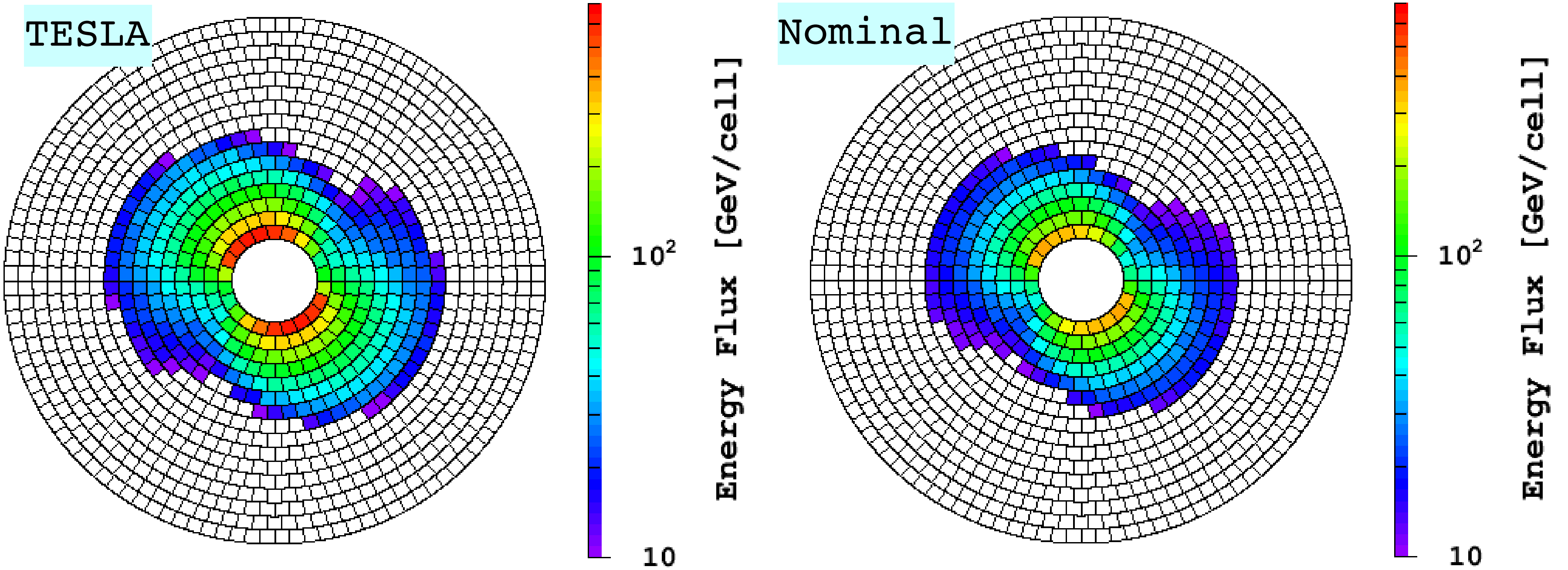
Beam Parameter Sets



TESLA – TDR beam parameters

$L = 3 * 10^{34}\ cm^{-2}s^{-1}$

Beam Parameter Sets



TESLA – TDR beam parameters

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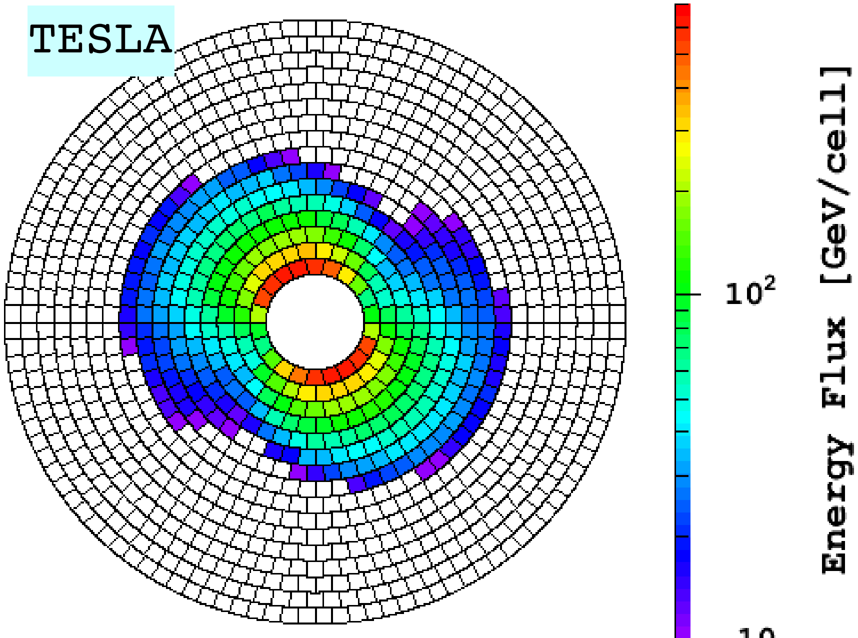
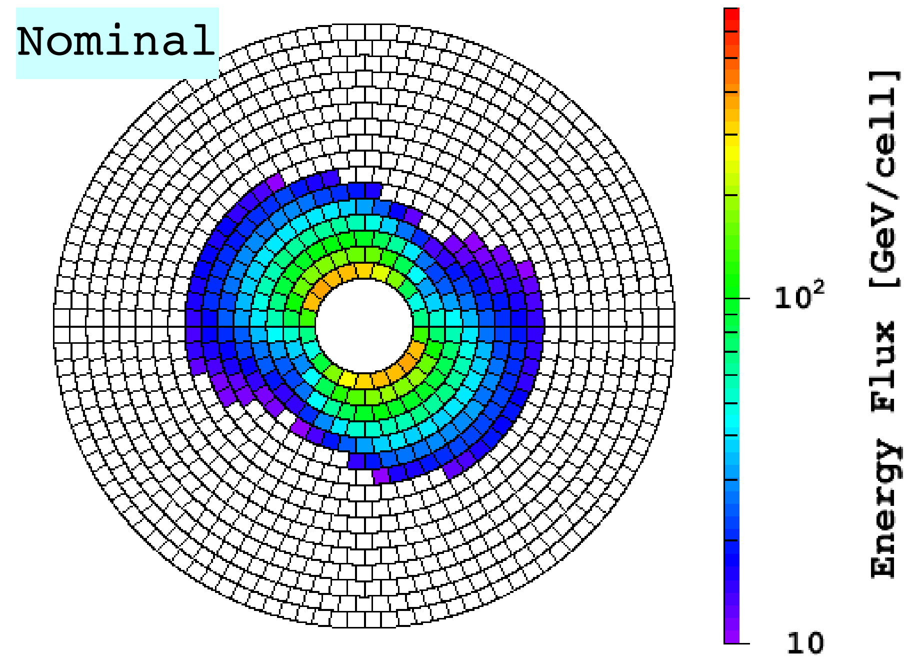
Nominal – new beam parameters

$L = 2*10^{34}\ cm^{-2}s^{-1}$

Beam Parameter Sets

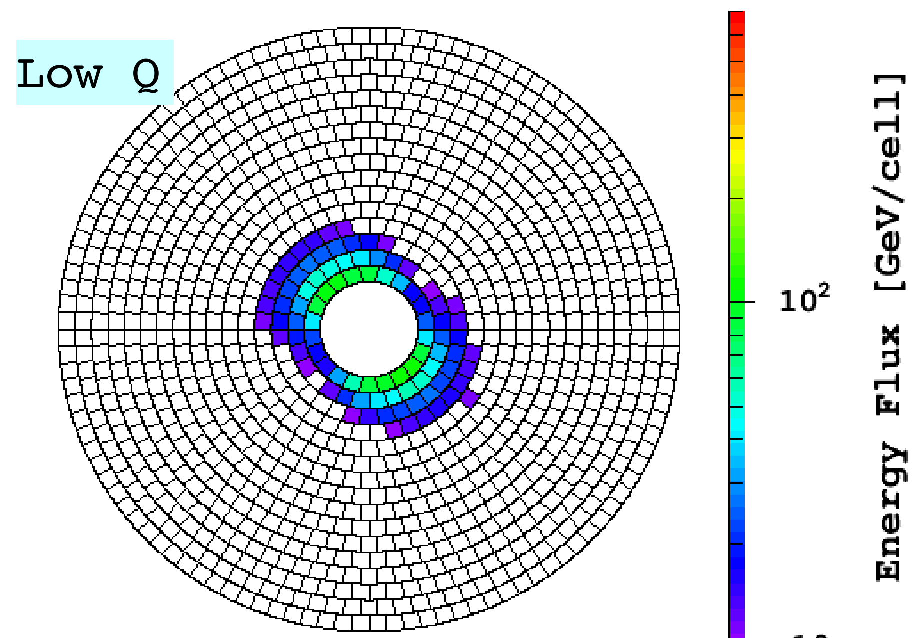




TESLA – TDR beam parameters
$L = 3*10^{34}\ cm^{-2}s^{-1}$

Nominal – new beam parameters
$L = 2*10^{34}\ cm^{-2}s^{-1}$

Low Q - ½ charge
$L = 2*10^{34}\ cm^{-2}s^{-1}$

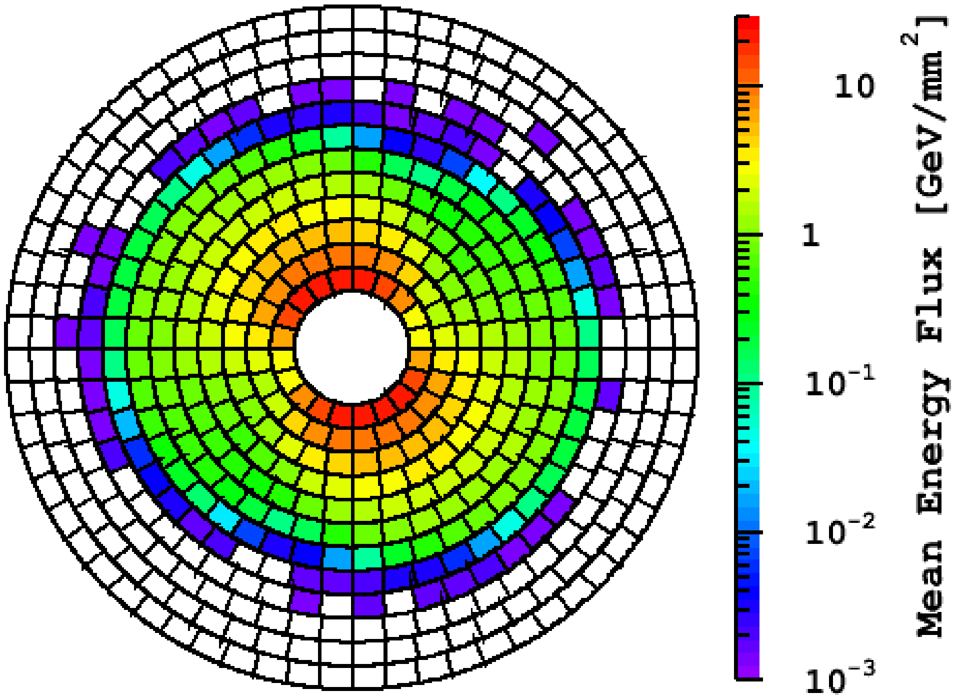


Spare Slides

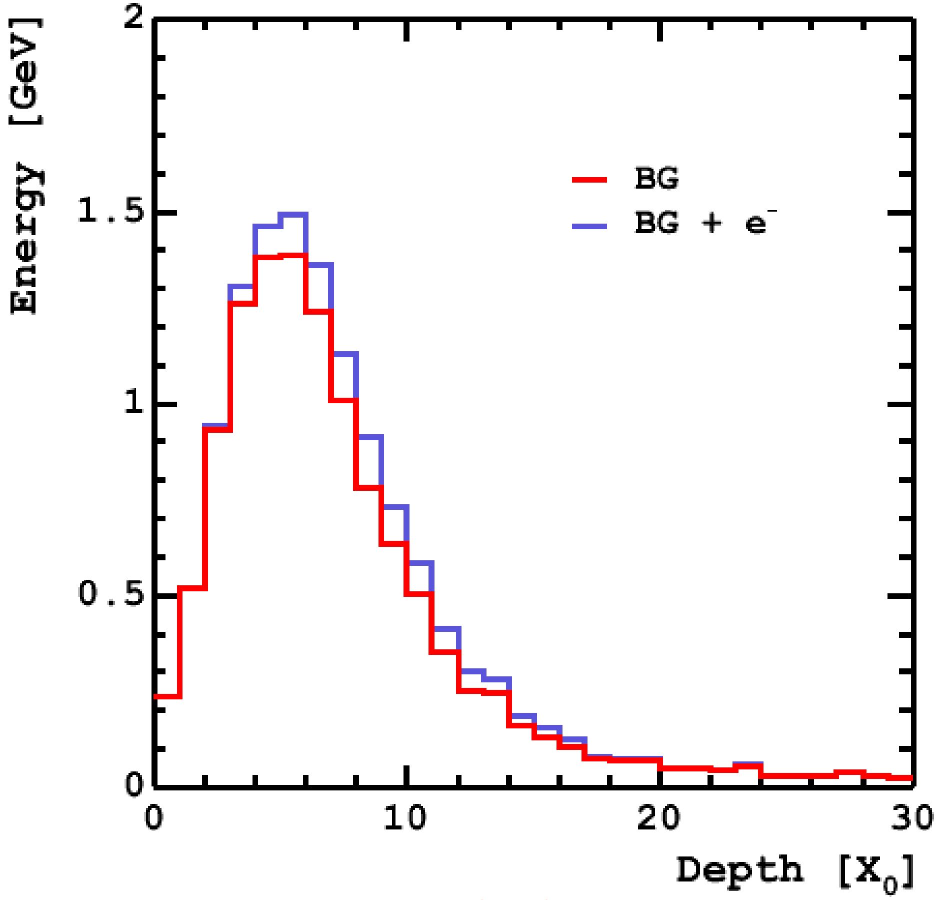
Beamstrahlung remnants. Pairs

BeamCal will be hit by beamstrahlung remnants carrying about 20 TeV of energy per bunch crossing.

the distribution of this energy per bunch crossing at $\sqrt{s}$ = 500GeV



100GeV electron on top of beamstrahlung



Severe background for electron recognition

Simulation Features (Veto)

- "nominal" **beam parameter** set

- **tracking:** GEANT4 instead of GEANT3
  -> more **powerfull** tool
  -> more **flexible**
  -> much **faster**

- **geometry:**
  - head-on: $\mathbf{R}_{min}$=15mm; X-angle: $\mathbf{R}_{min}$=20mm
  - **blind area:** –15 degree < ϕ < 15 degree; this blind area is **excluded** from the efficiency calculation

- pairs from **500BX** are simulated for head-on and X-angle

- **algorithm** tuned with common energy threshold and fake rate (5%) for head-on and 20 mrad (may not be fully optimal)

- **efficiency calculation:** per ring instead of per cell
  -> smaller **statistical error**

Simulation Procedure (Bhabha)

Benchmark geometry:

- 3 designs

Generation:

- BHLUMI + TEEGG

4-momenta recalculation:

- Lorentz boost for finite X-angle designs

Tracking in magnetic field:

- GEANT4

Detection efficiency for each particle:

- parametrization routines

Calculation of probabilities:

- lost
- incomplete reconstruction ≡ veto
- full reconstruction