Beam Induced Backgrounds at TESLA for Different Mask Geometries with and w/o a 2*10 mrad Crossing Angle

Karsten Büßer

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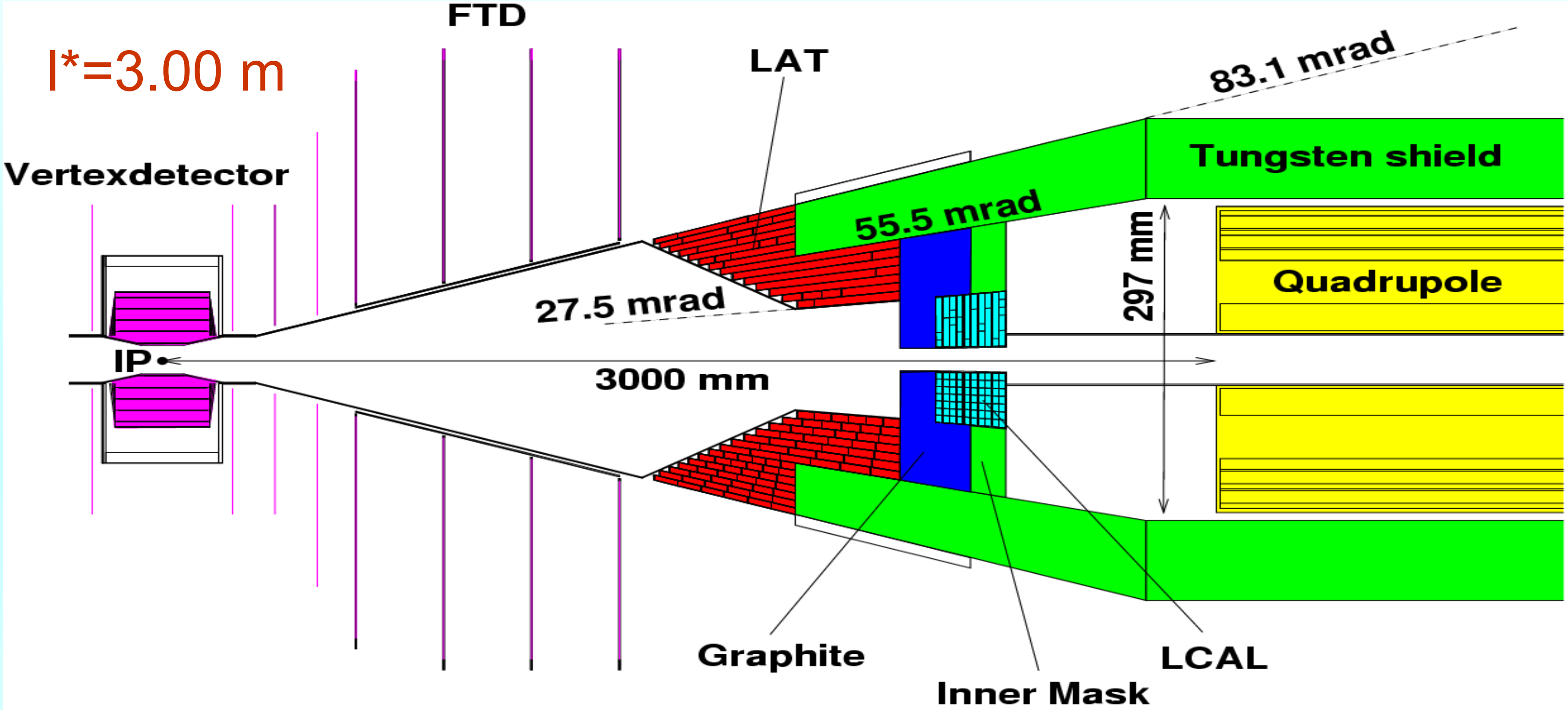
The TDR Mask



Tasks:

- Shielding of the detector from direct and backscatterd beam induced backgrounds
- Provide instrumentation for luminosity measurement, fast feedback system and hermeticity

Problems

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- Mask tips are inside the tracking system
- LAT has a conical surface
  - Envisaged precision in the luminosity measurement using Bhabha scattering (**$\Delta L/L \approx$** 10^{-4}) will be extremely challenging
- Quadrupoles are inside the detector solenoid

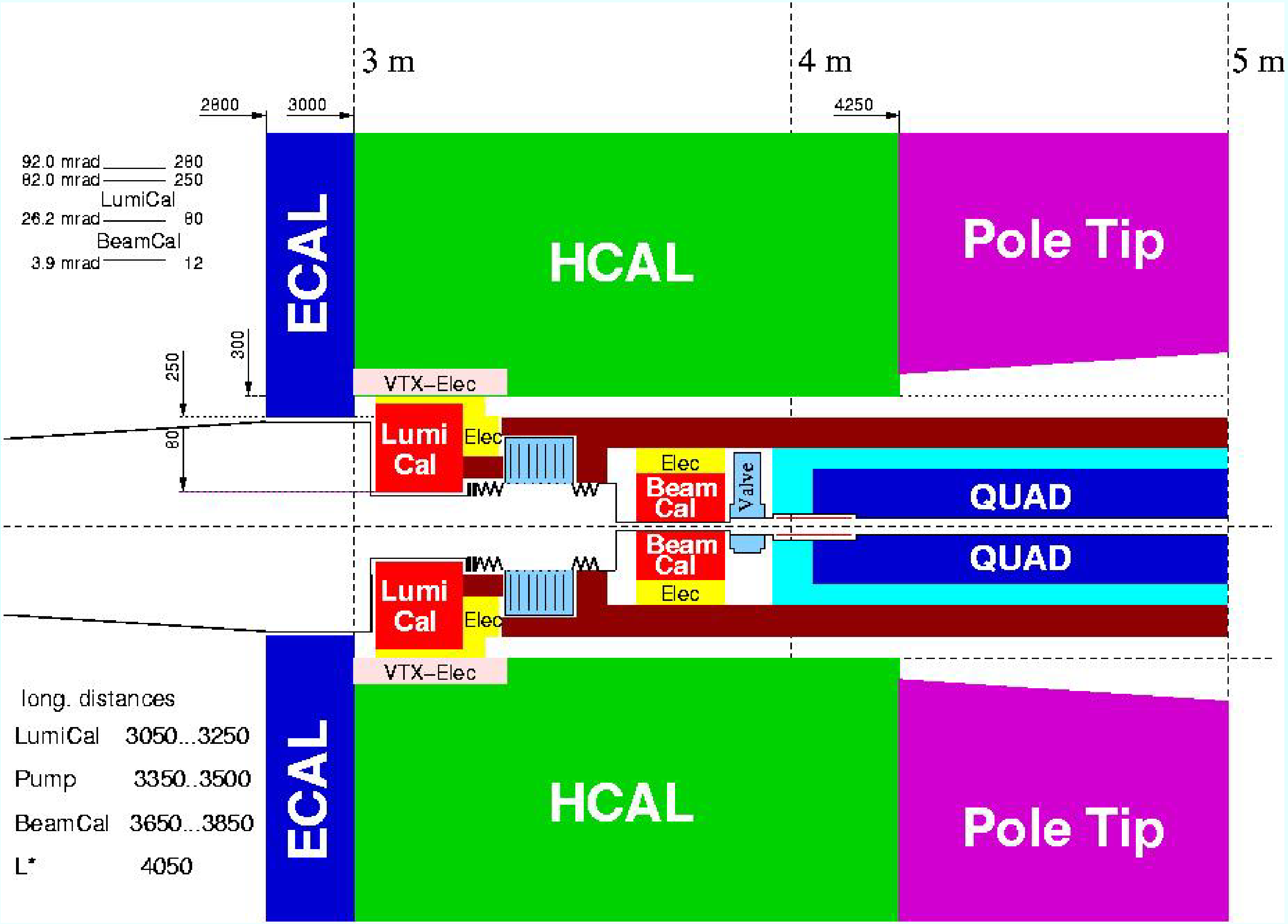
Challenges

- New optical design with l*>4m
- Crossing angle or not ?

First Try

- Try to find for a minimal l* a mask design with a flat LAT geometry (in the head-on collision scheme)
- Extend this design to crossing angle geometries

Proposed Design for l* ≥ 4.05 m



Design by Achim Stahl

New Mask Design

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Advantages

- Flat LAT geometry
- LumiCal is behind ECAL, no scattering of particles off the LumiCal edge into the ECAL
- Mask moved out of the tracking system
- Vacuum situation much better

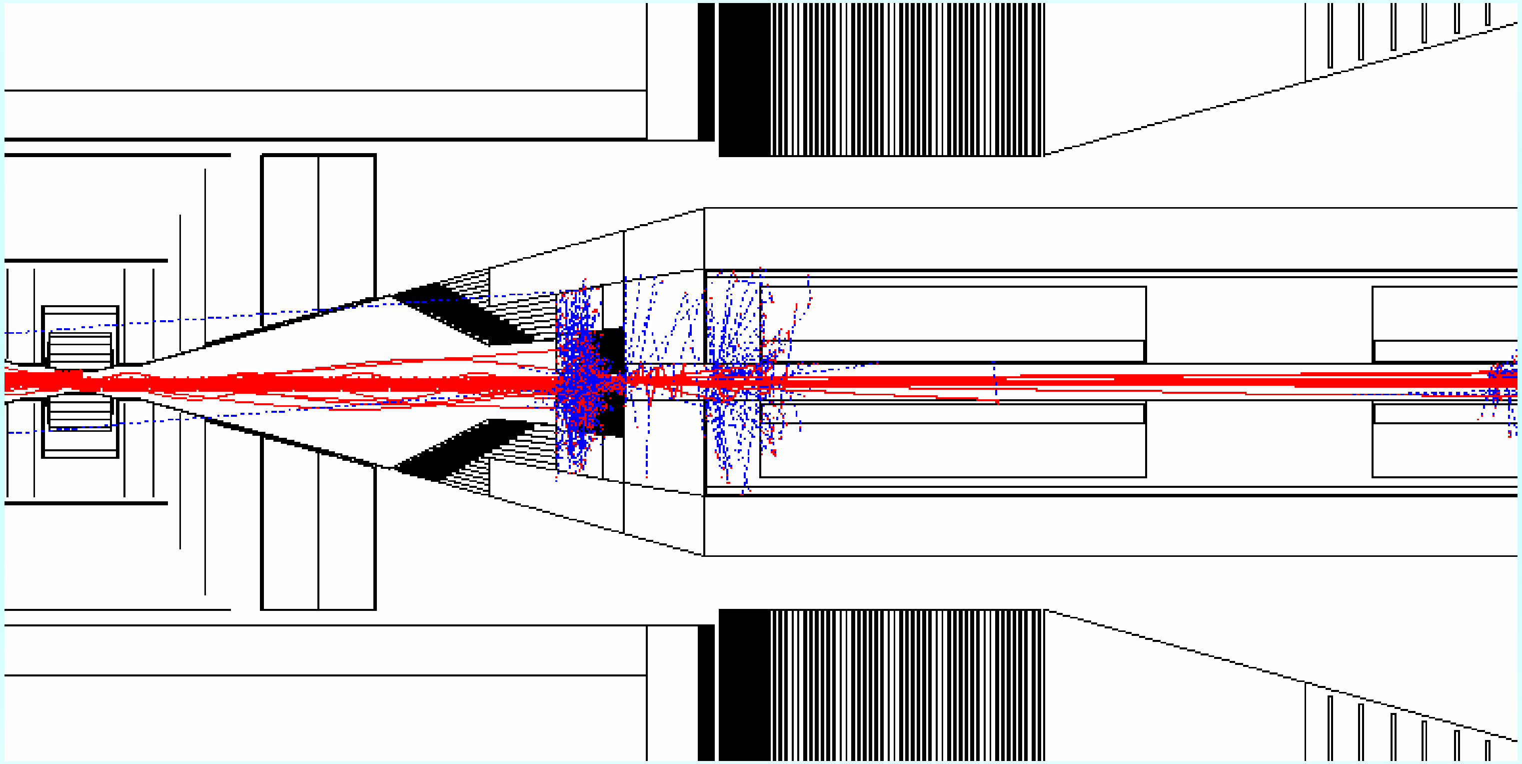
Questions

- How is the background situation ? (this talk)
- How is the performance of the LumiCal/BeamCal ?

Mask Geometries in MC

TESLA

TDR Mask (l^*=3.00 m)

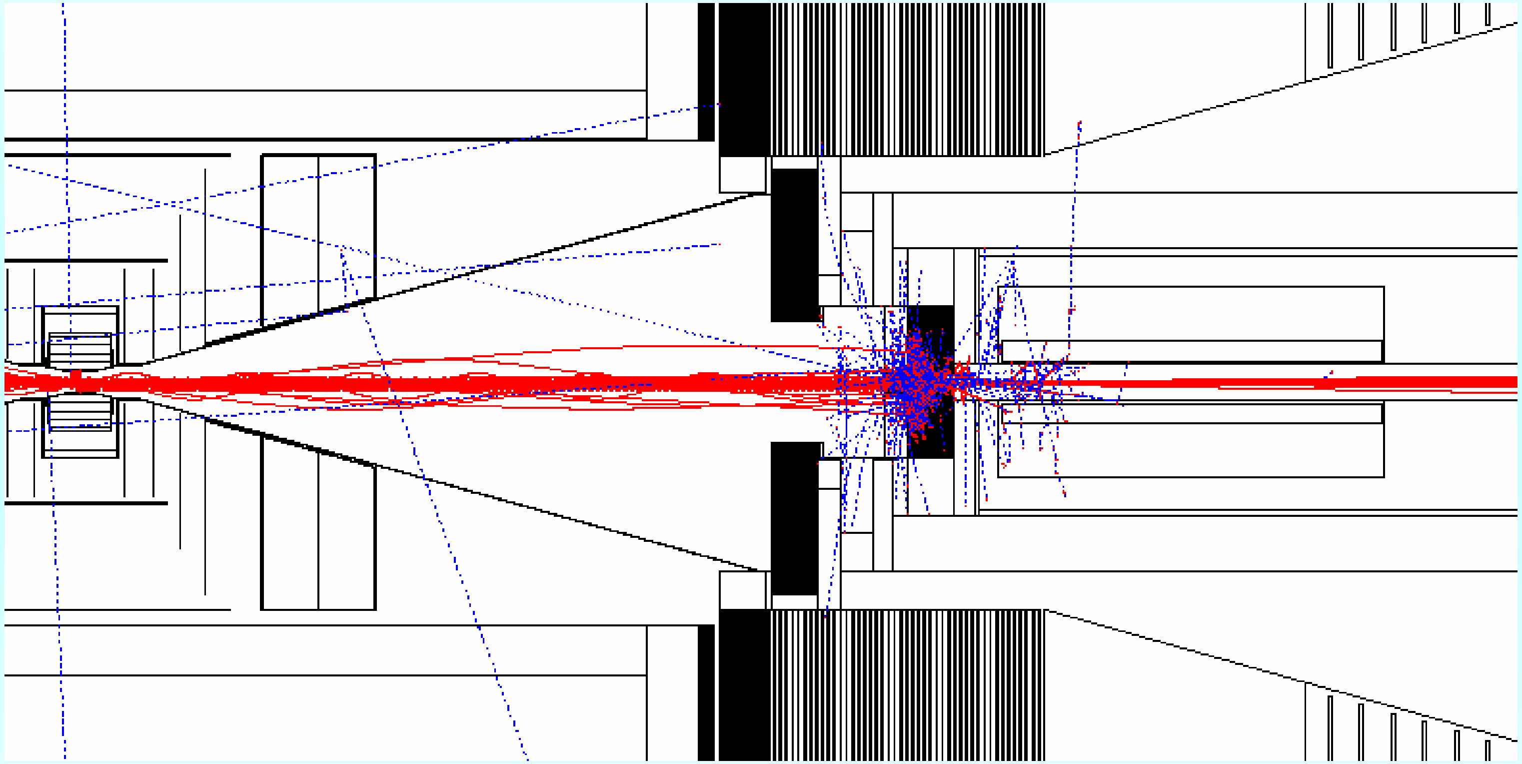


100 pair particles from beamstrahlung in BRAHMS
(GEANT3 based full detector MC)

Mask Geometries in MC

TESLA

New Mask Design (l*=4.05 m), Head-On Collisions

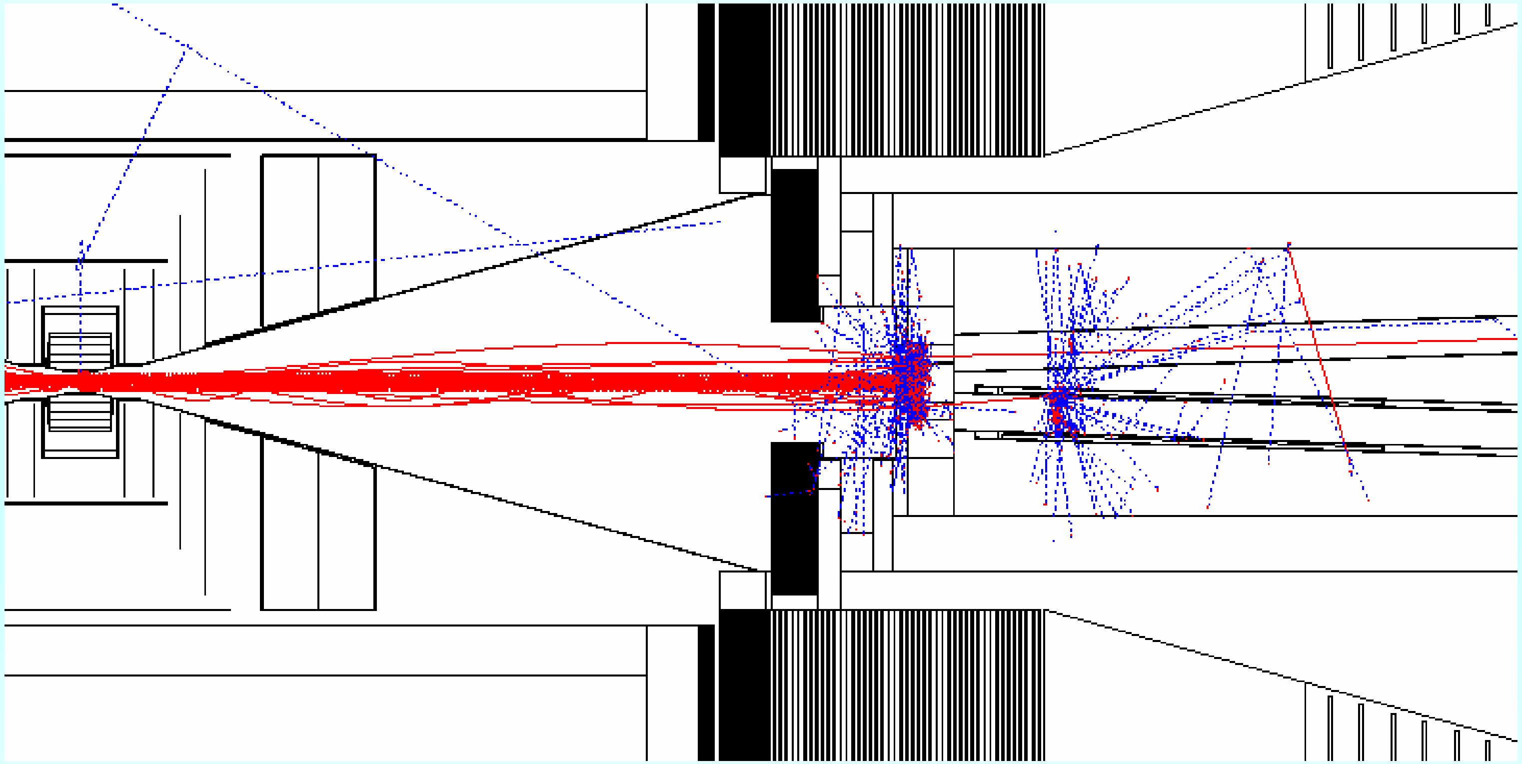


100 pair particles from beamstrahlung in BRAHMS
(GEANT3 based full detector MC)

Mask Geometries in MC

TESLA

New Mask Design (l*=4.05 m), 2*10 mrad X-Angle



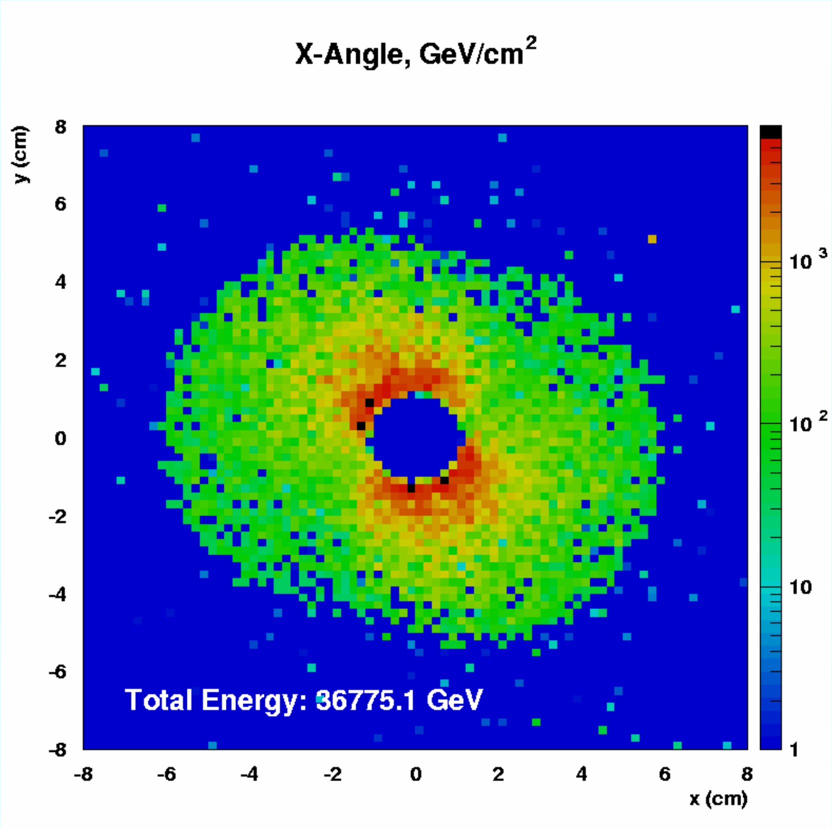
100 pair particles from beamstrahlung in BRAHMS
(GEANT3 based full detector MC)

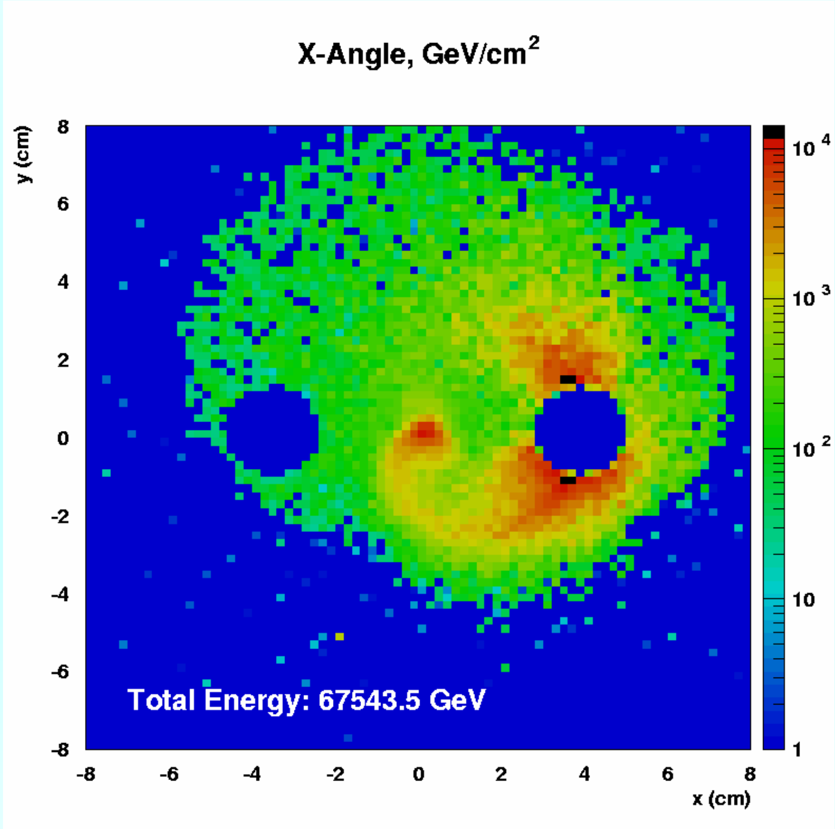
Background Sources

TESLA

- Beam induced backgrounds have been studied in detail for the TESLA TDR
- For this study only pairs from beamstrahlung have been taken into account so far
- Pairs were generated with GUINEA-PIG
- GEANT3 based full detector MC BRAHMS
- Statistics based on 100 bunch crossings (BX) for ideal beam parameters

Energy Deposition per 1 BX in the Forward Region

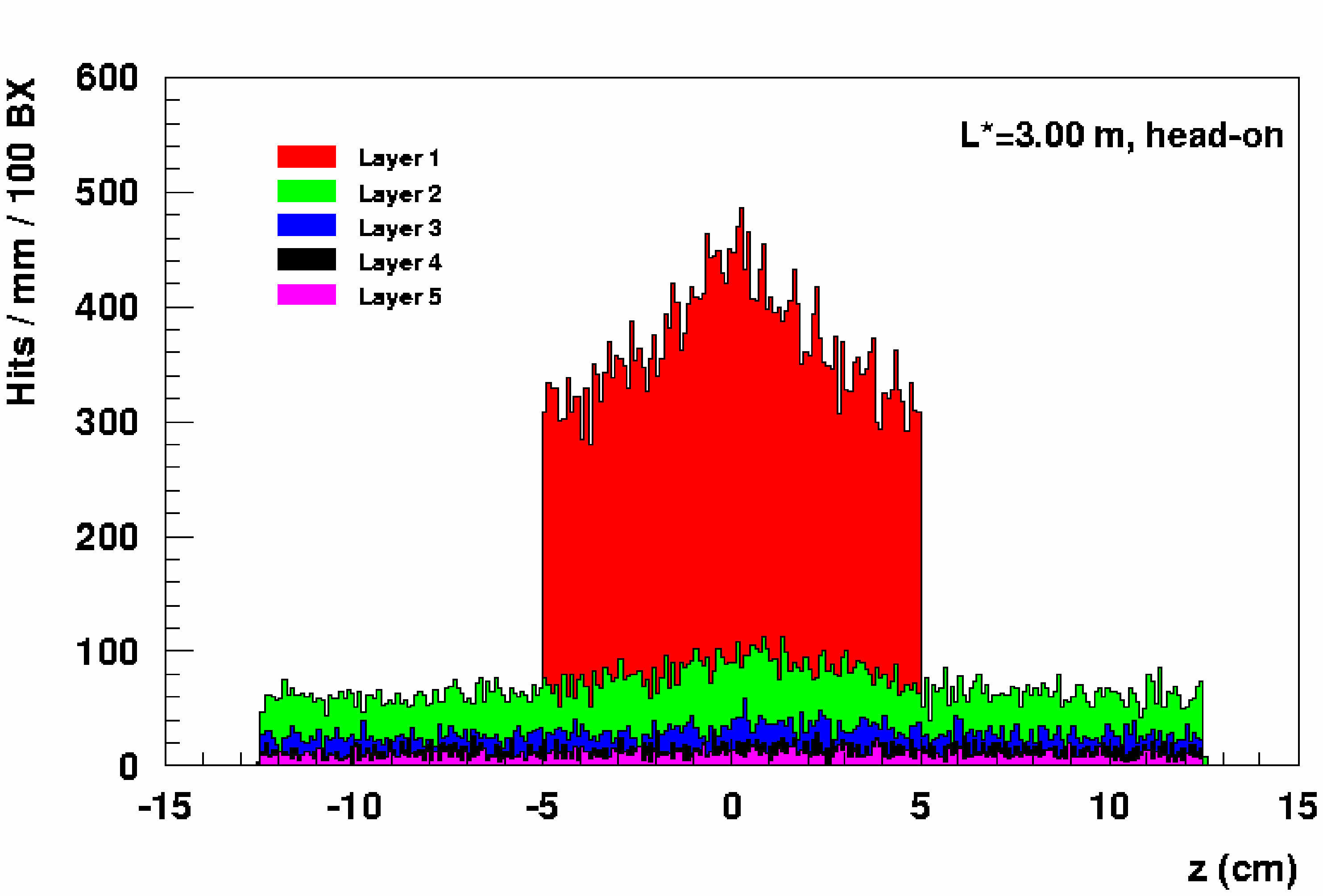




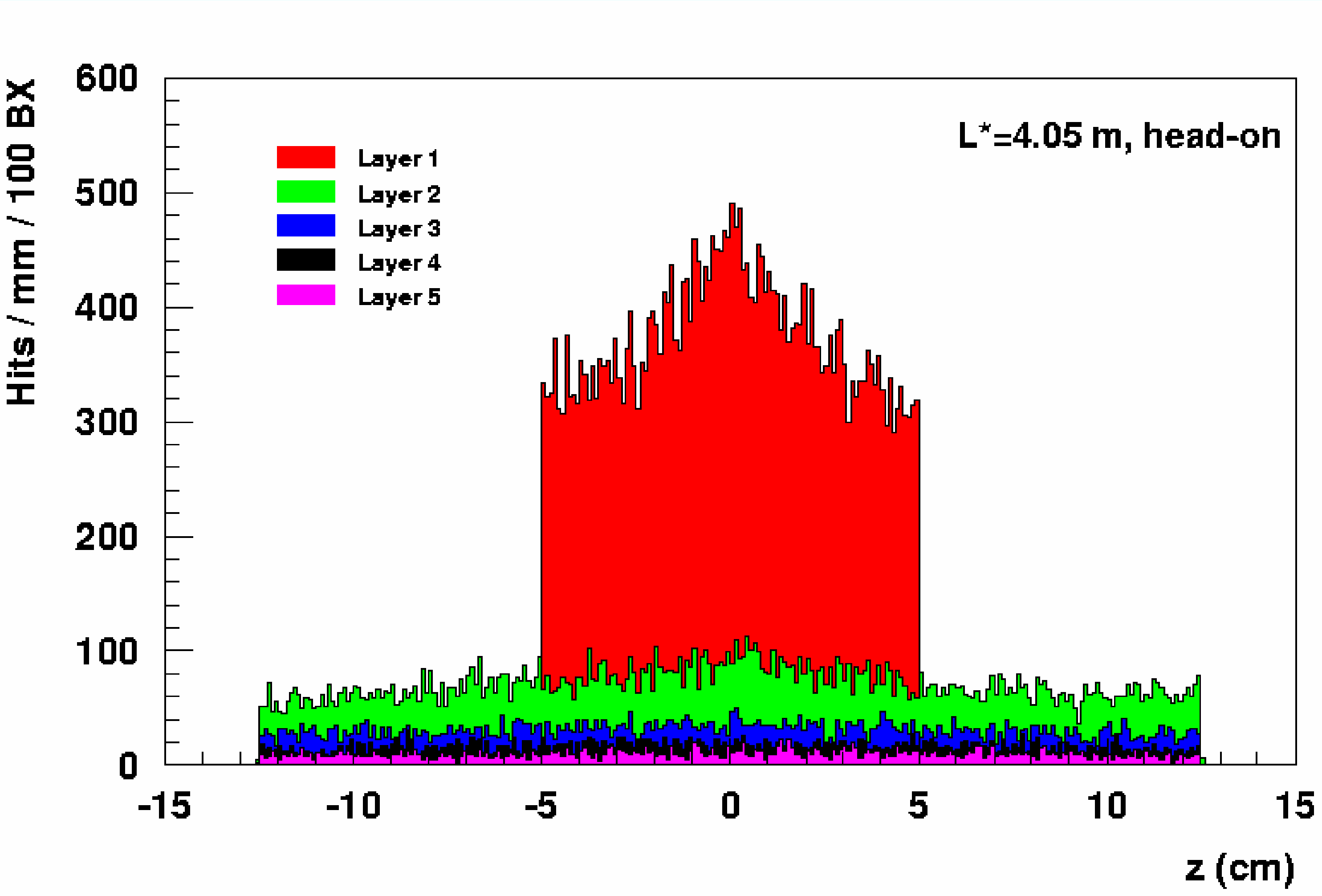
- Examples here for l*=4.05 m
- Beampipe radius: 1.2 cm for incoming and outgoing beam
- Energy deposition is twice as large in the x-angle case

Hits on the Vertex Detector

TESLA

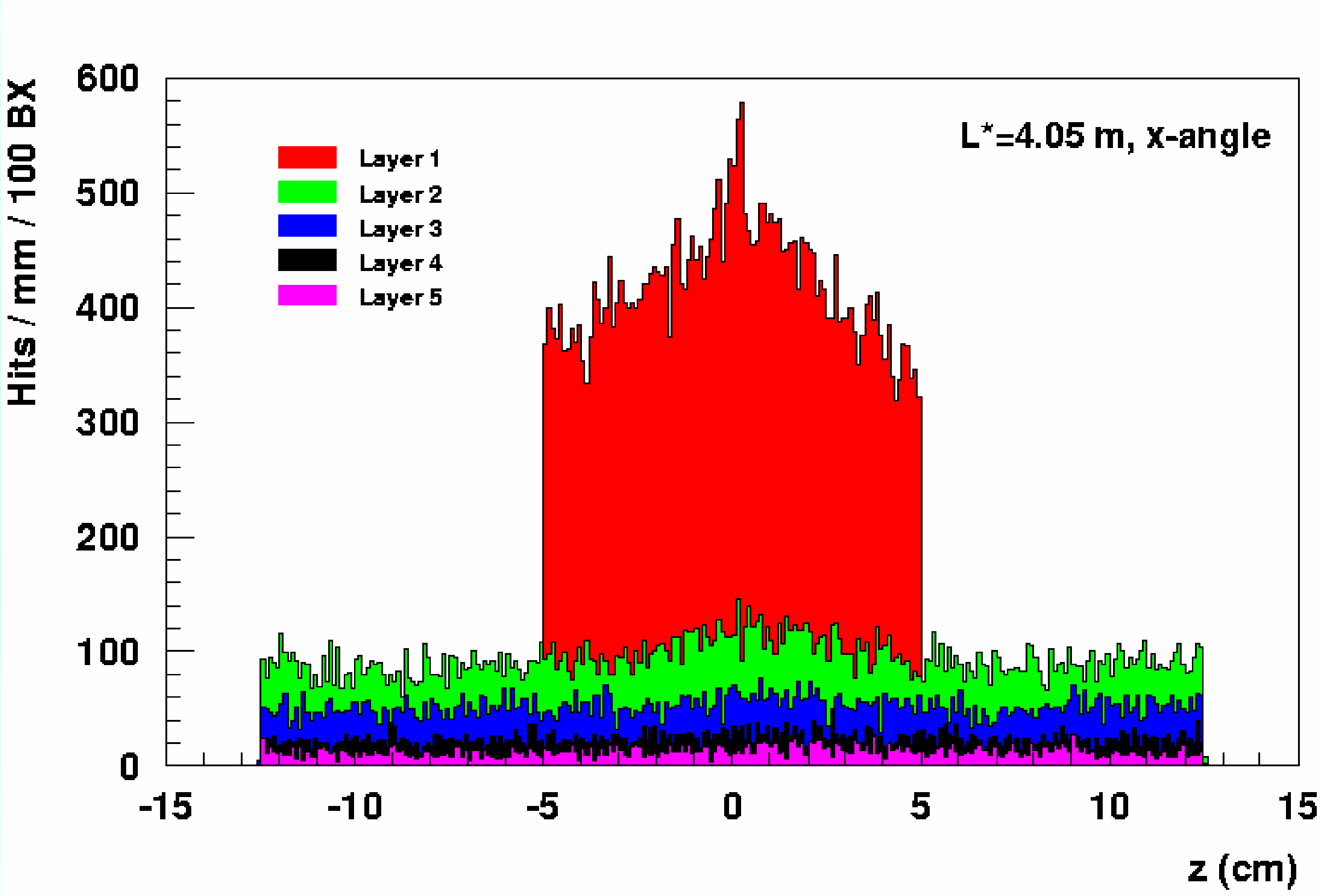


Hits on the Vertex Detector

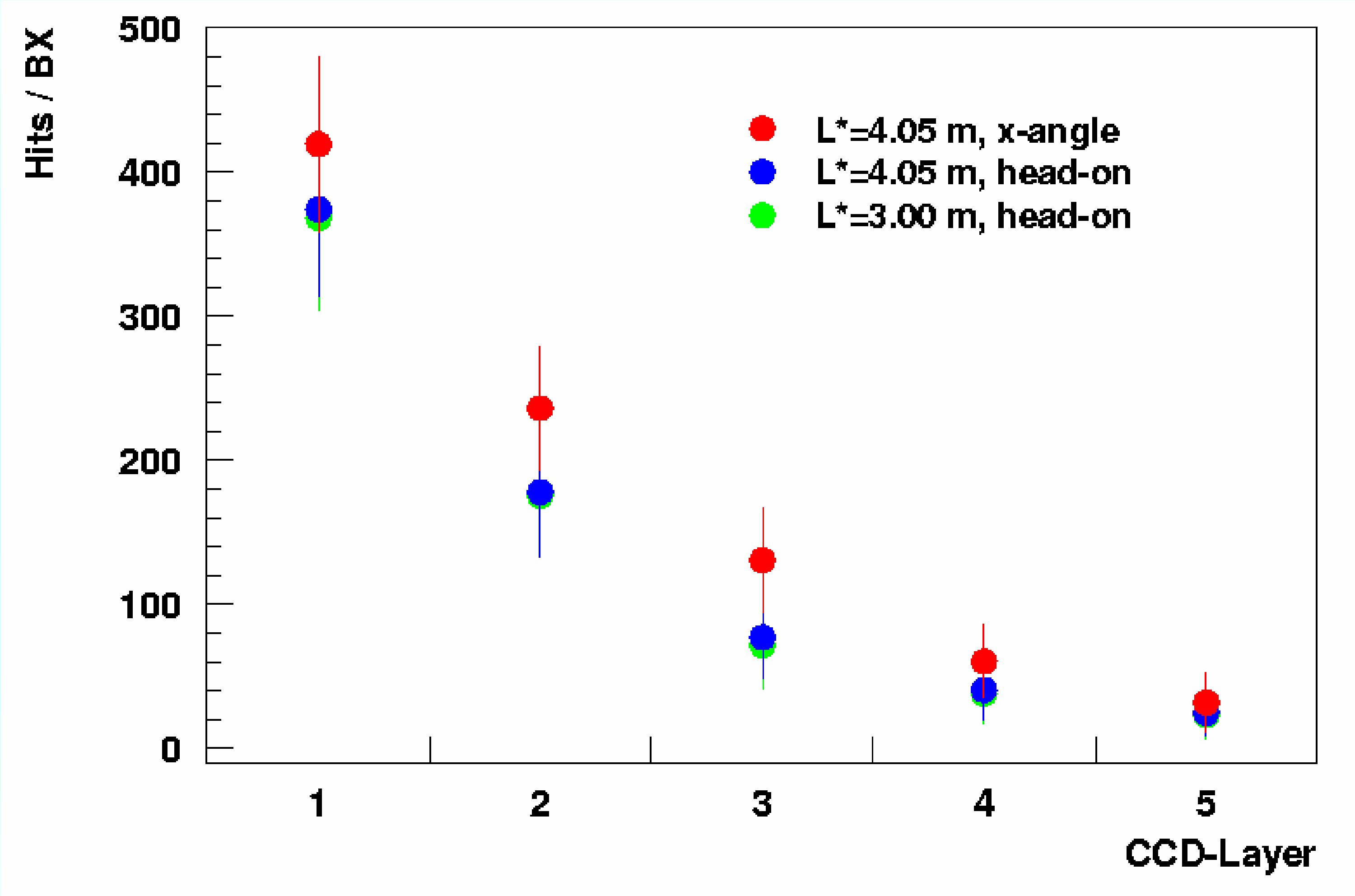


Hits on the Vertex Detector

TESLA



Hits on the Vertex Detector

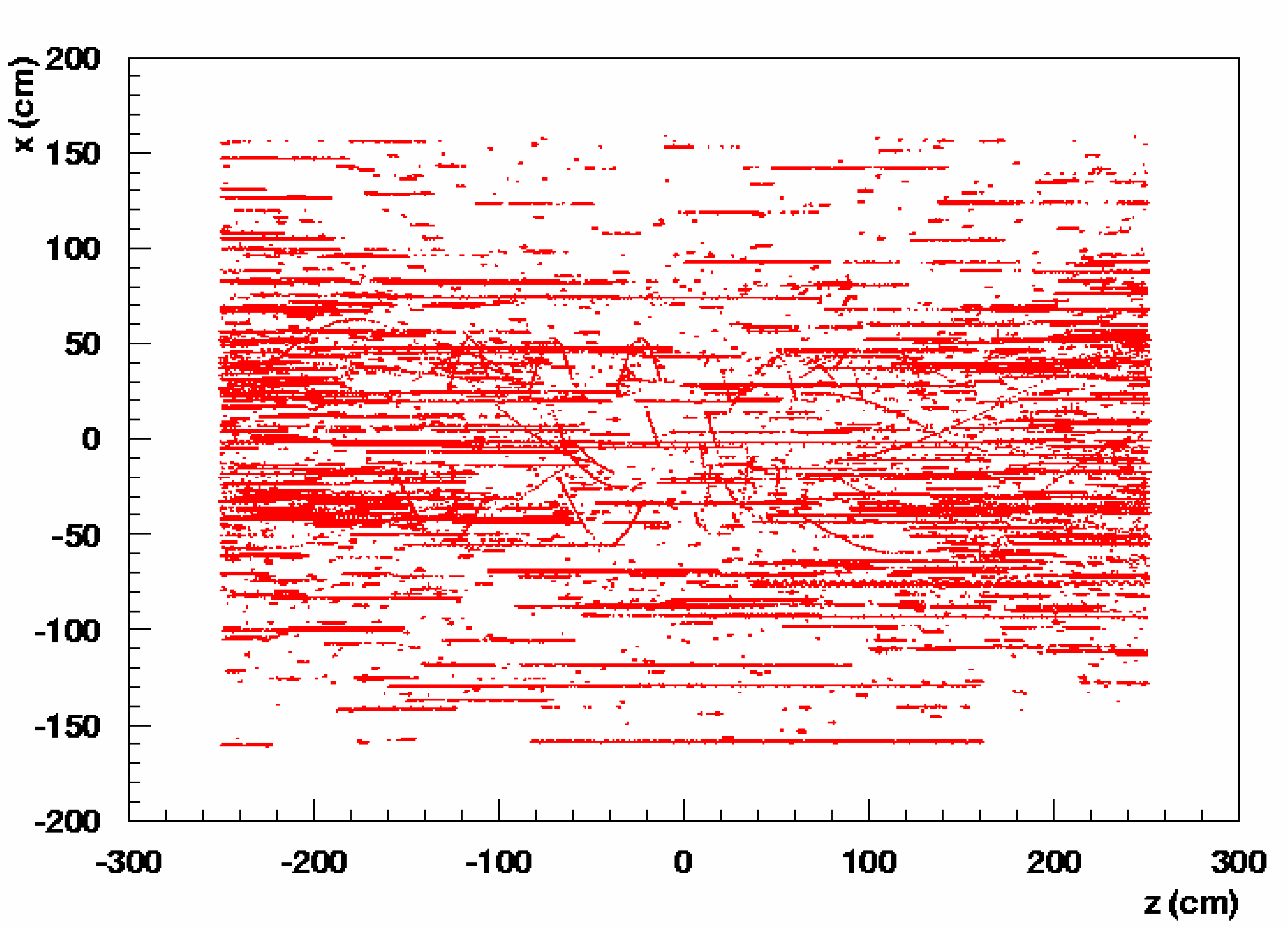


Hits in VTX are dominated by direct hits from pairs with larger p_t

3D Hits in the TPC

TDR geometries (l*=3.00 m), plot shows hits from 100 BX overlaid

Average: 1383.2 ± 534.0 3D-Hits per 1 BX



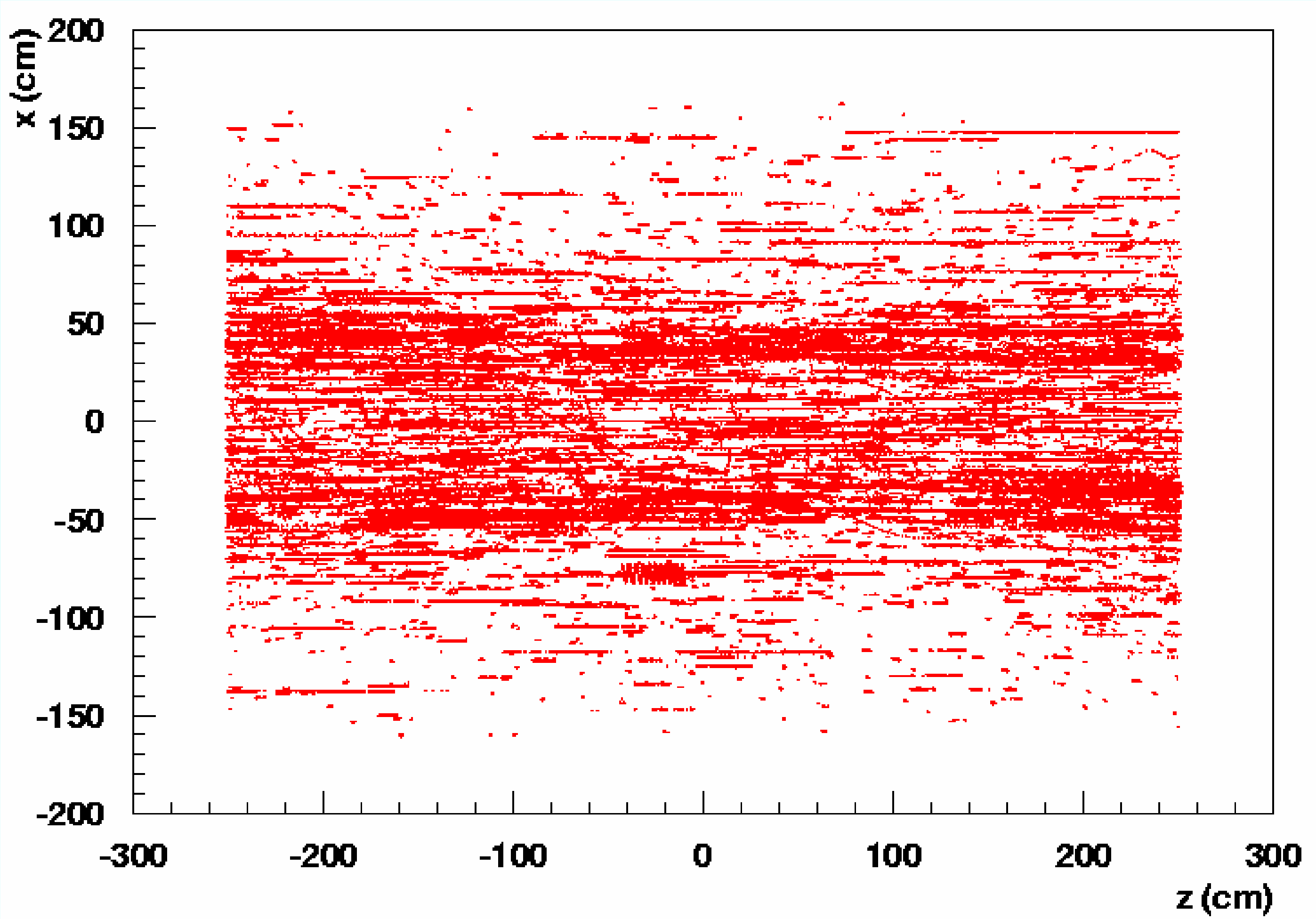
Hits in TPC are dominated by converted backscattered photons

3D Hits in the TPC

TESLA

Head-on collisions (l*=4.05 m), plot shows hits from 100 BX overlaid

Average: 2264.0 ± 651.8 3D-Hits per 1 BX

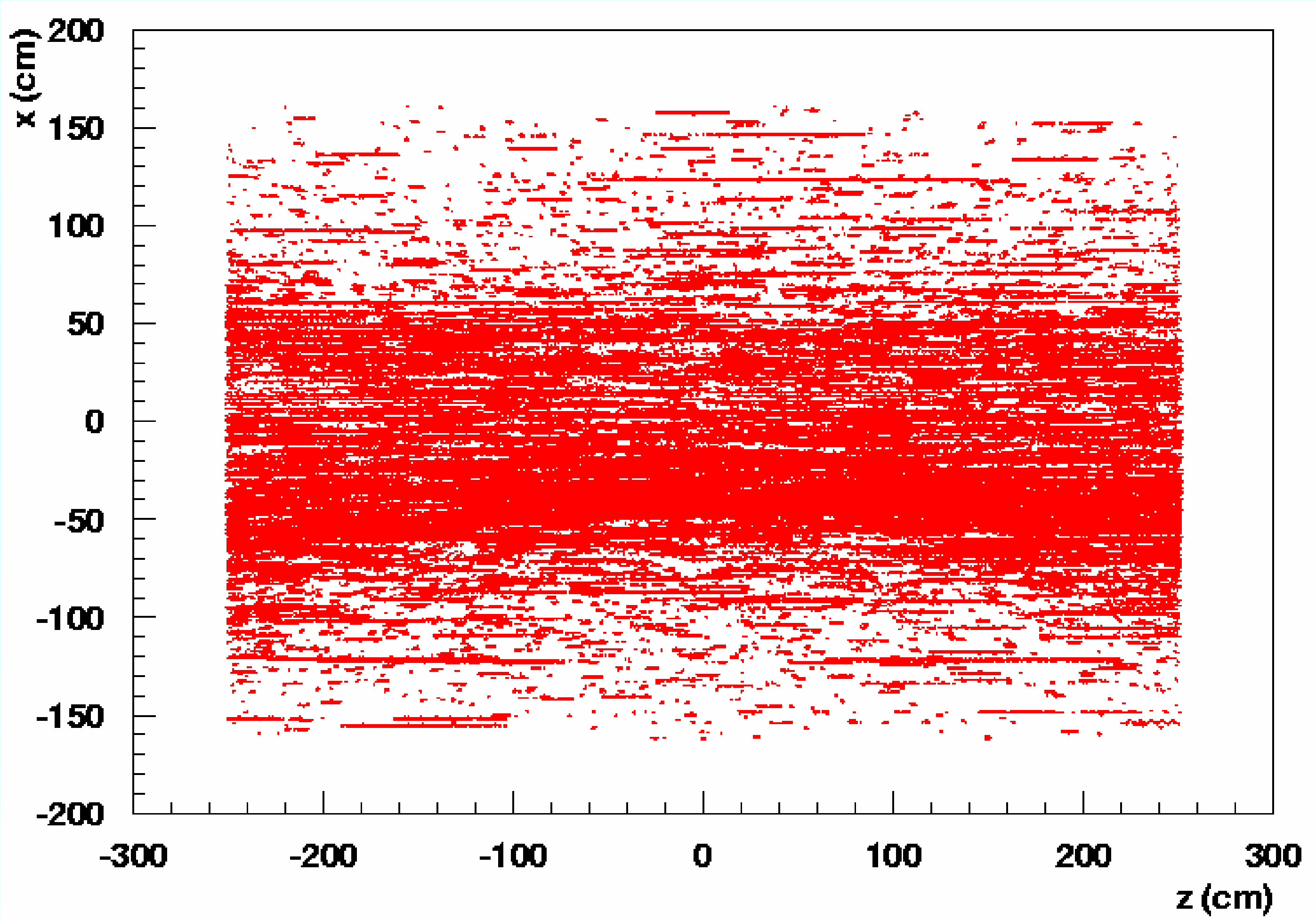


Hits in TPC are dominated by converted backscattered photons

3D Hits in the TPC

X-Angle collisions (l*=4.05 m), plot shows hits from 100 BX overlaid

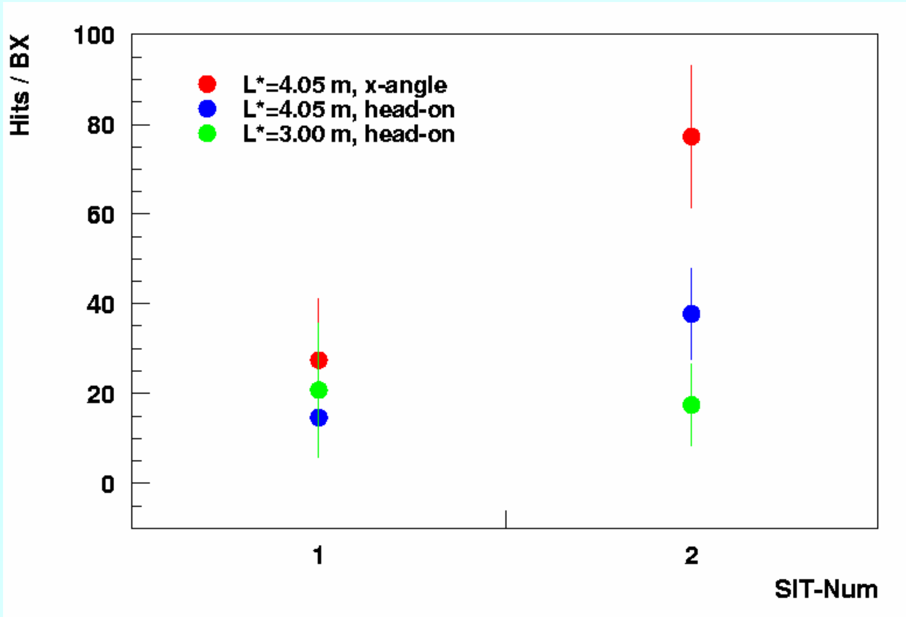
Average: 5117.9 ± 1021.8 3D-Hits per 1 BX



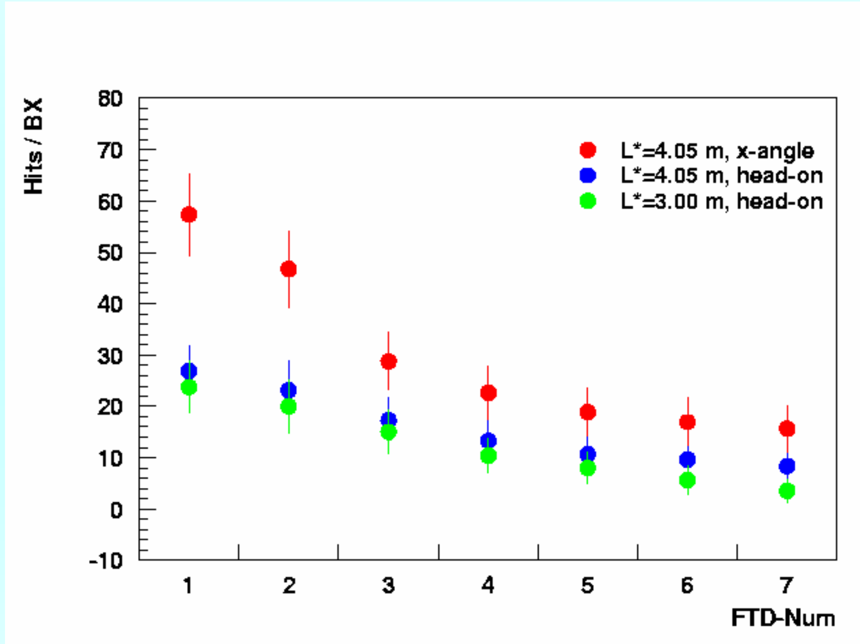
Hits in TPC are dominated by converted backscattered photons

Hits in the Si Tracking Devices

Silicon Intermediate Tracker SIT



Forward Tracking Disks FTD



Asymmetric Backgrounds

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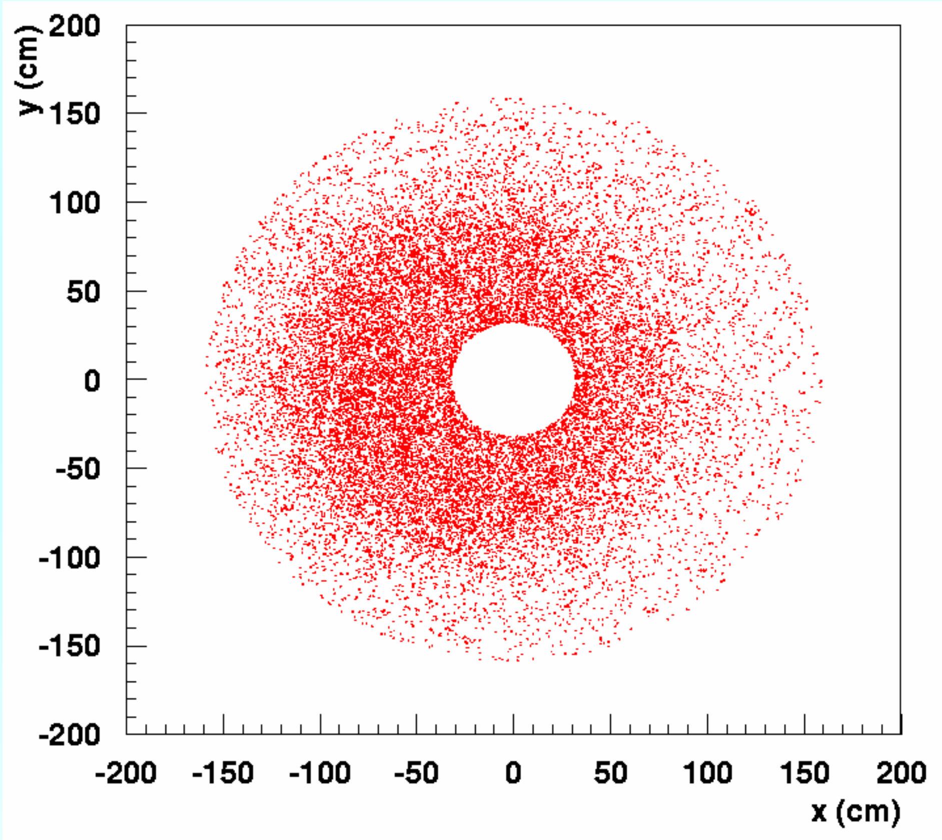
Background distributions get asymmetric in the crossing angle geometry.
Example: Forward Chambers (behind TPC endplate):

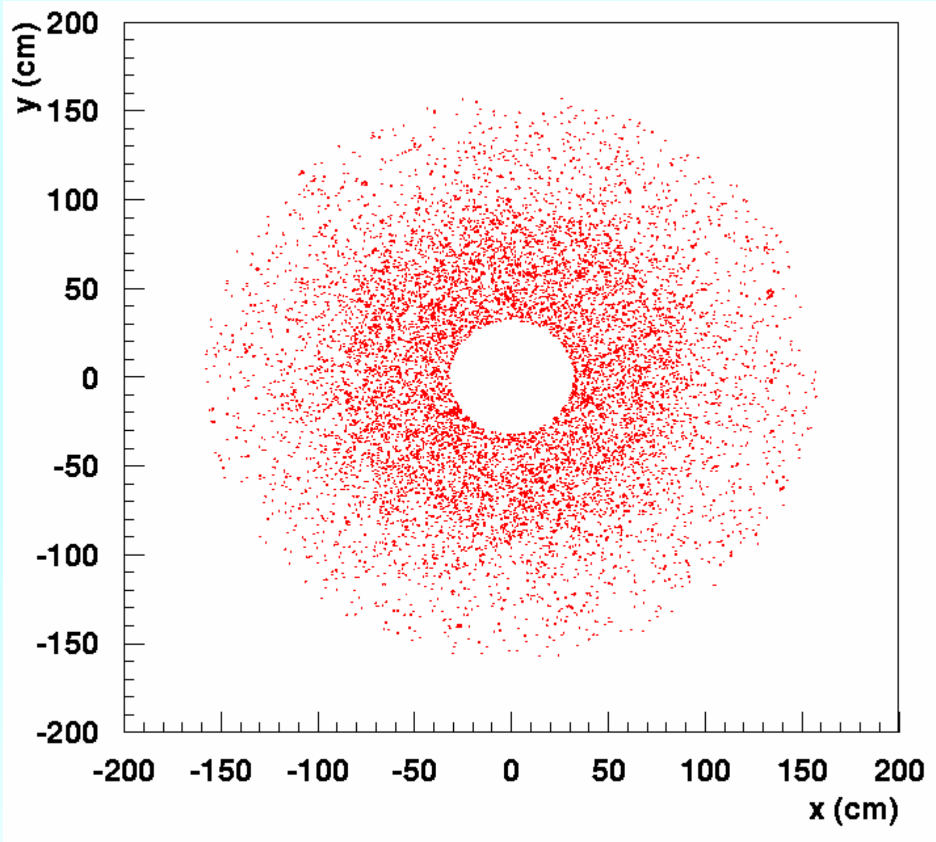


Hits from 100 BX on all layers of the forward chambers at +z.

Asymmetric Backgrounds

TESLA

For comparison: hit distribution for head-on collsions (l*=4.05 m):

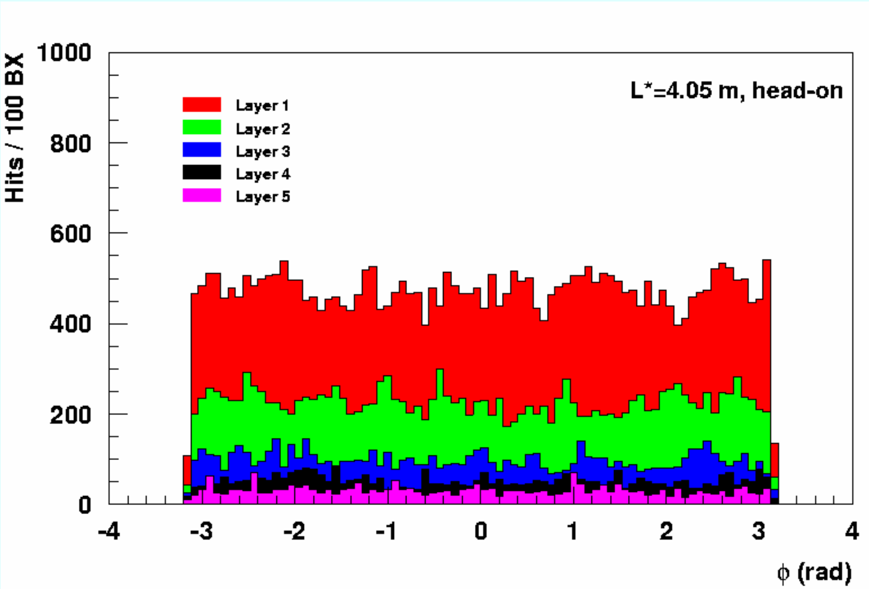


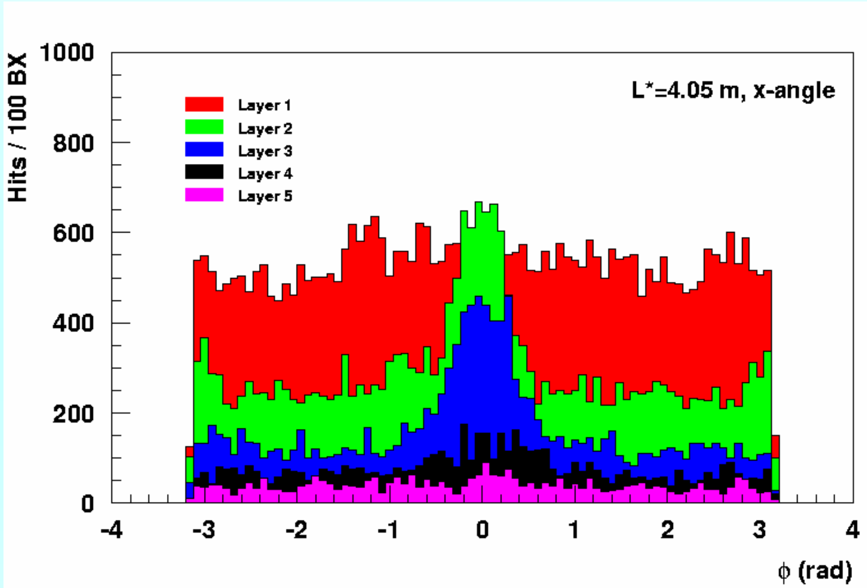
Hits from 100 BX on all layers of the forward chambers at +z.

Hot Spots

TESLA

Azimuthal hit distributions in the Vertex Detector





- Distributions for x-angle geometries show a peak of hits in the horizontal plane
- Peak is just visible in Layers 2 and 3 (maybe also in 4).

Hot Spots

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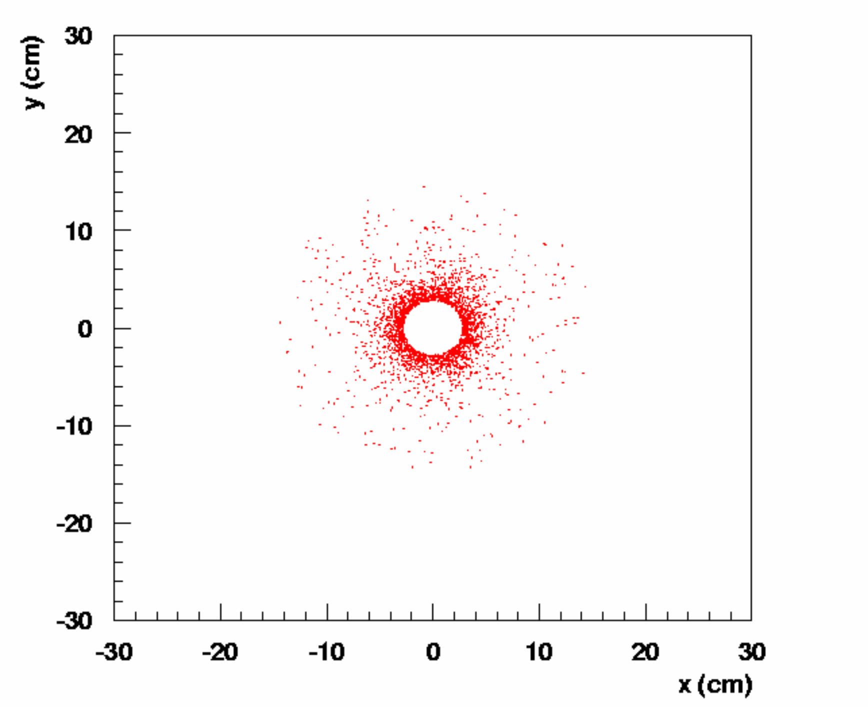
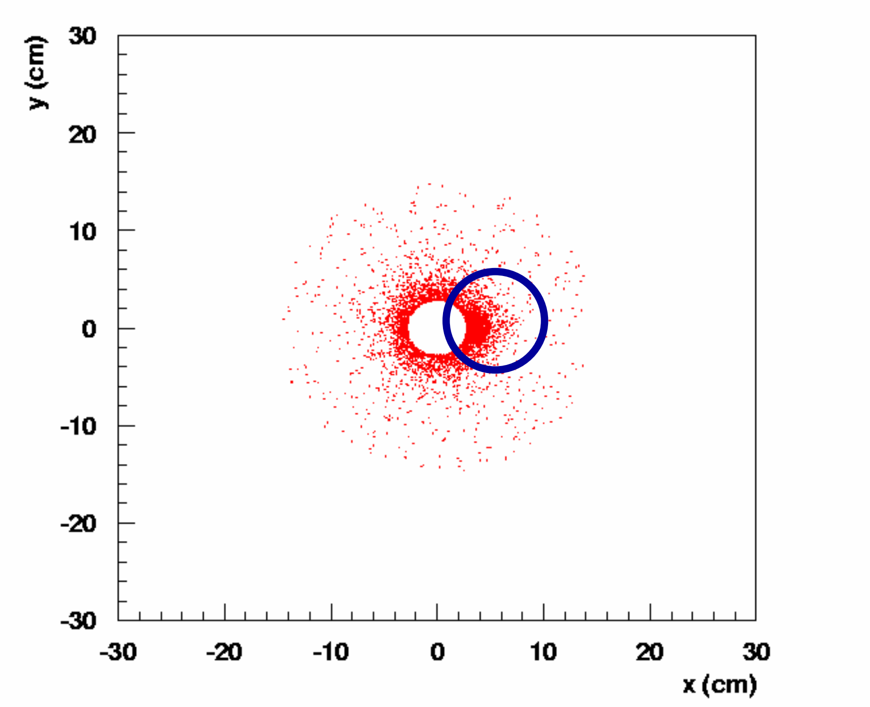
Also visible on the Forward Tracking Disks

Disk No 1 (closest to IP)





Head-on (l*=4.05 m)

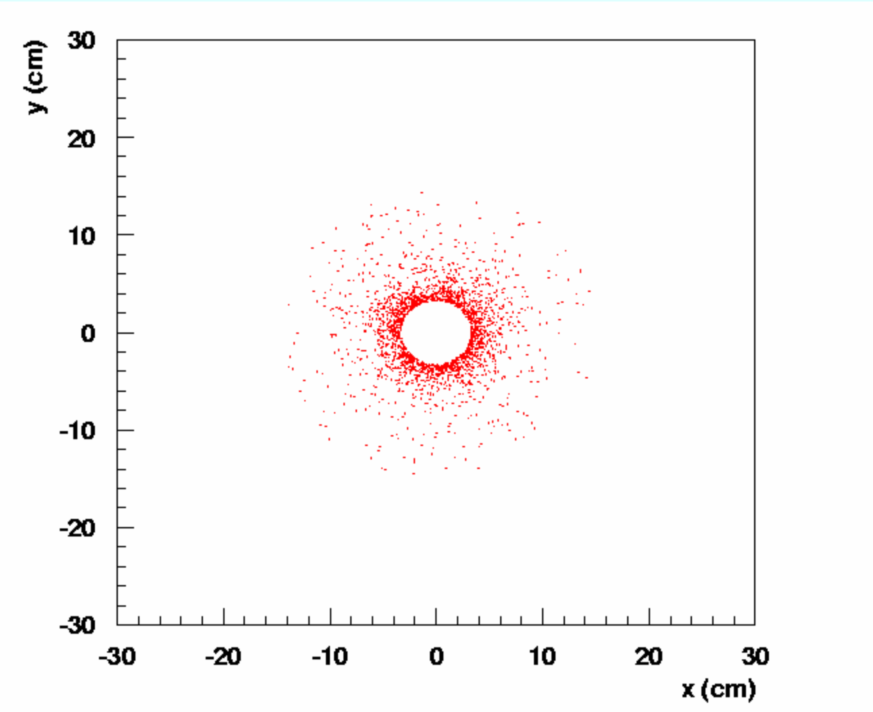
X-Angle (l*=4.05 m)

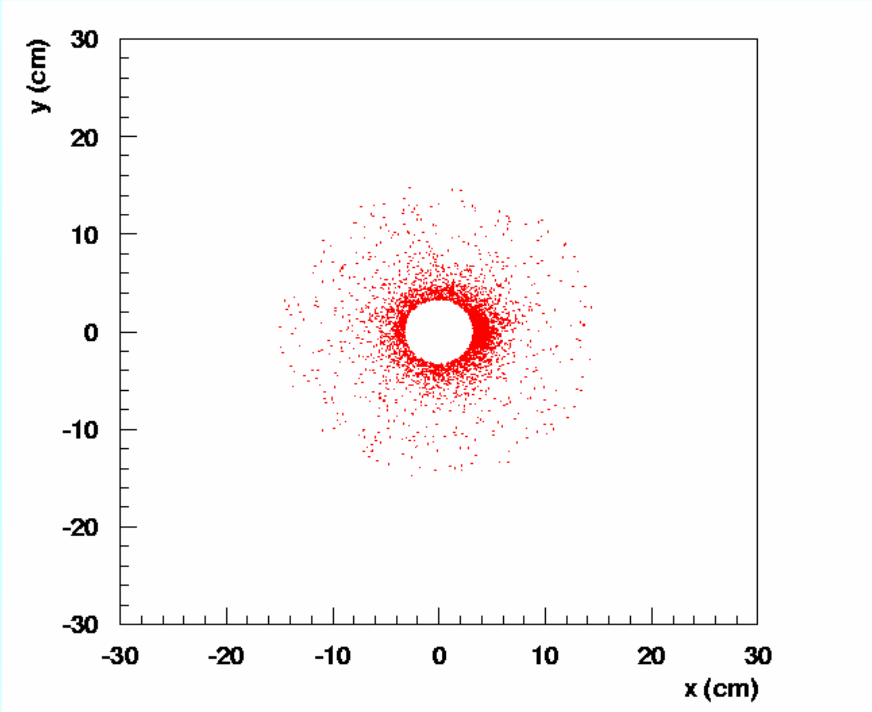
Backgrounds from 100 BX overlaid

Hot Spots

TESLA

Disk No 2





Head-on (l*=4.05 m)

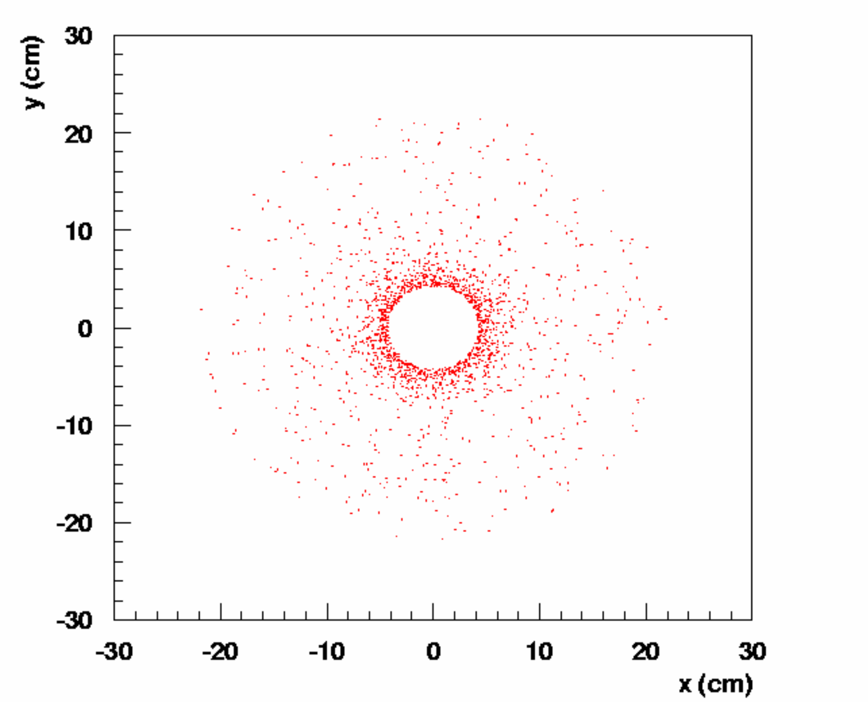
X-Angle (l*=4.05 m)

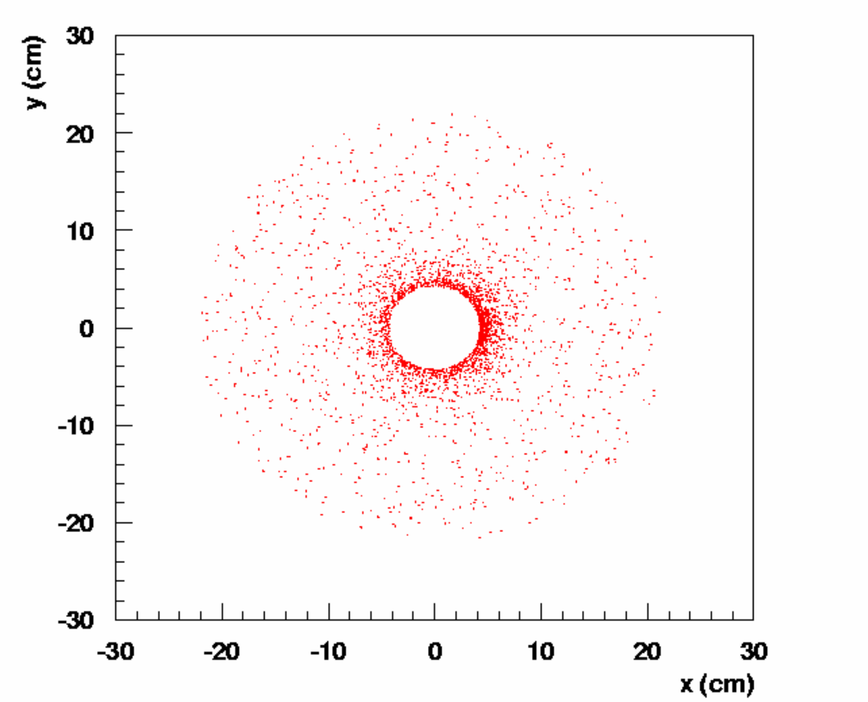
Backgrounds from 100 BX overlaid

Hot Spots

TESLA

Disk No 3





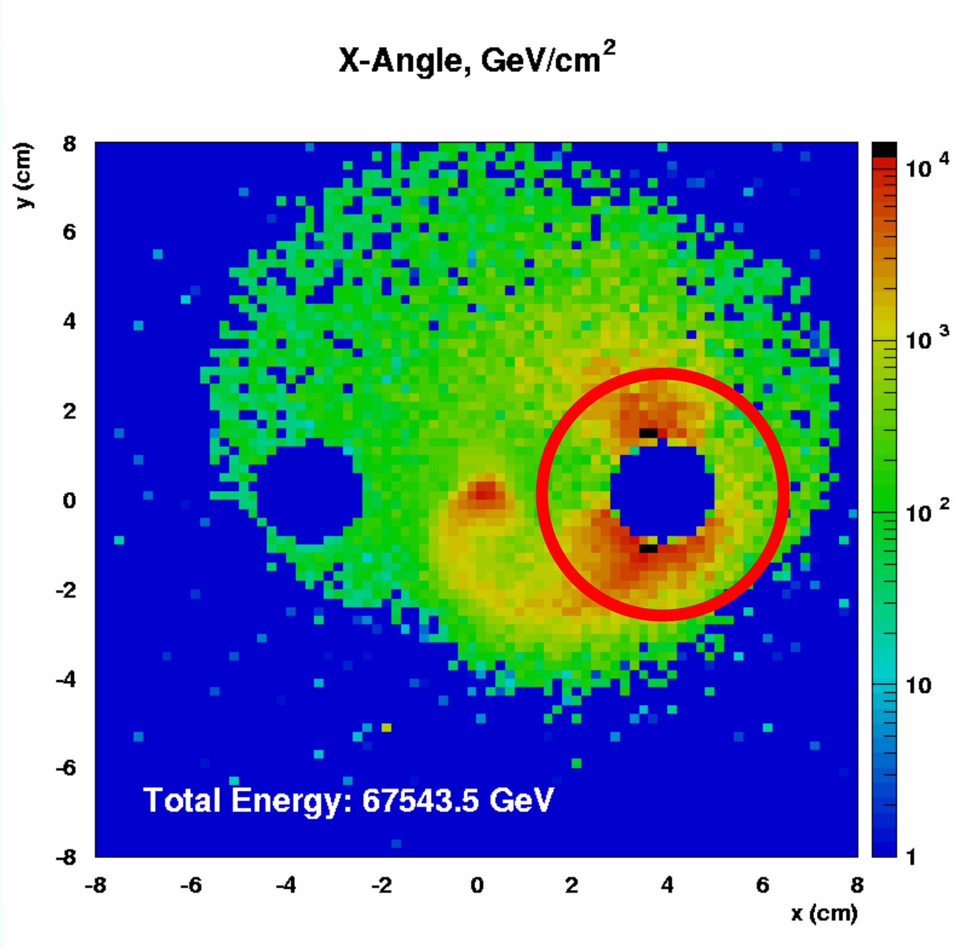
Head-on (l*=4.05 m)

X-Angle (l*=4.05 m)

Backgrounds from 100 BX overlaid

Hot Spots Origin

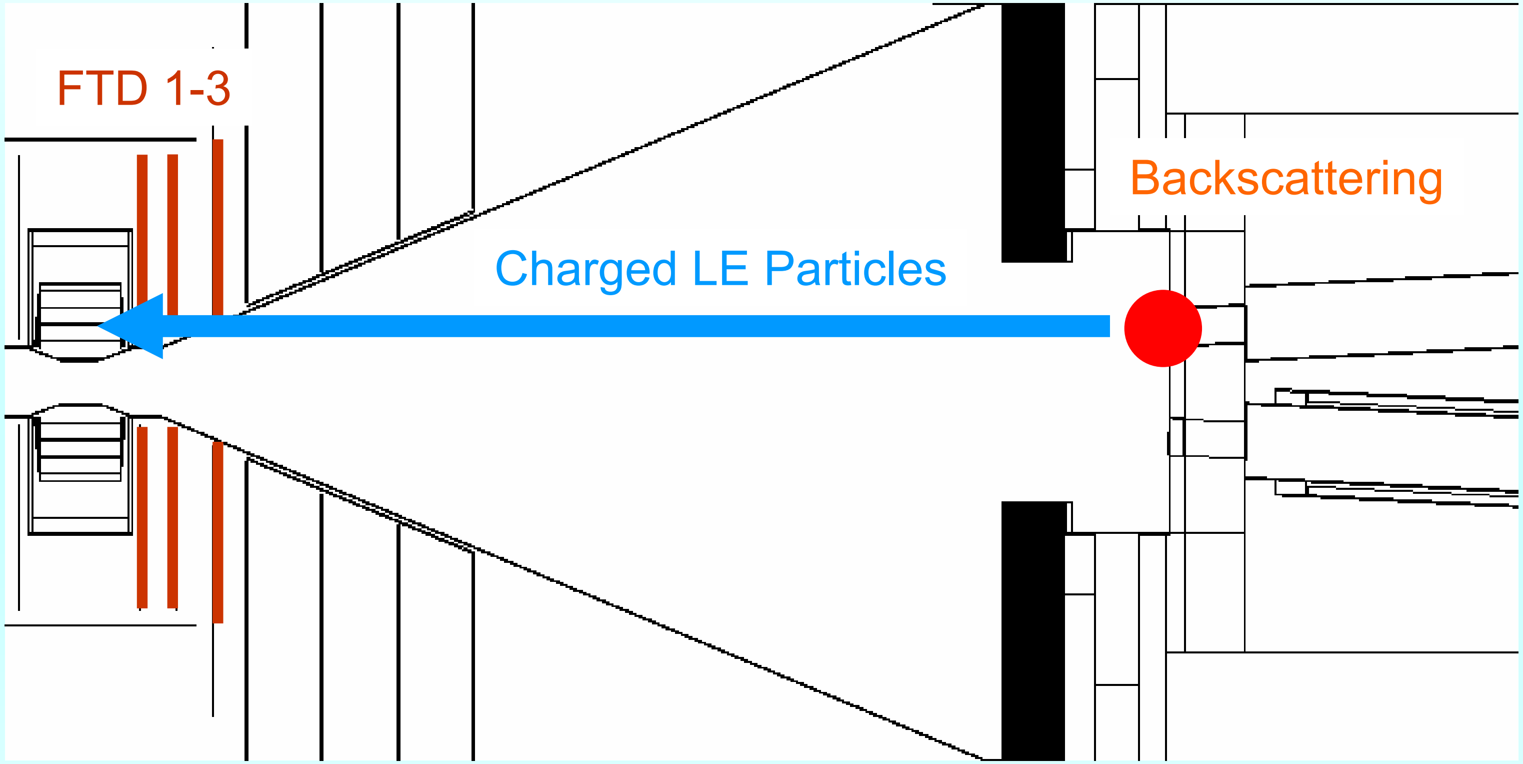
TESLA



For x-angle geometries, a large amount of backscattering comes from the region of the beam exit hole.

Hot Spots Origin

TESLA



Low energetic charged particles, created in the hot spot around the beam exit hole, are focused by the solenoidal magnetic field and drift back to create the hot zones in the VTX layers and on the FTDs.

Conclusions

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- Mask for TDR optics (l*=3.00 m) works, but has shortcomings w.r.t. performance of the mask calorimeters
- New design for l* ≥ 4.05 m has been proposed to be used for head-on or x-angle collisions
- Mask geometries have no influence on direct hits from pair particles with large p_t (as in the VTX), but have significant influence on background from backscattered particles (as in the TPC)
- Backgrounds in the new design are larger than in TDR geometry. Reasons not yet fully understood, possible explanations:
  - Less low-z material in front of BeamCal (5 cm graphite instead of 10 cm in TDR geometry)
  - Same beampipe radius (1.2 cm) at larger z results in smaller minimal polar angles → less pairs escape through the beampipe, so more energy is deposited on the BeamCal and produces backscattering
  - New Mask design not yet optimised to reduce backscattering

Conclusions (cont.) and Outlook

TESLA

- Backgrounds from backscattering in crossing angle geometries are
  - about a factor of 2 larger than in the head-on case
    - but mask design is not yet optimised to reduce backscattering
  - produce asymmetric azimuthal distributions
  - produce hot spots in the Vertex Detector and the Forward Tracking Disks

- All backgrounds so far studied are still on tolerable levels
- X-Angle imposes the largest challenges to the detector tolerances

To Do:

- Optimisation of the new mask design to reduce backscattering in both head-on and x-angle geometries
- Other background sources have to be studied:
  - radiative Bhabhas (Bremsstrahlung)
  - Neutrons
  - Synchrotron Radiation
  - (…)