Beam-Induced Backgrounds in the LDC Detector

Dirty Business at Low Angles

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DESY FLC

Background at the ILC

e^+e^- pairs are a main source of background

- created through beam-beam interaction
- crash into forward calorimeters (BeamCal) and magnets of the beam delivery / extraction line
- create neutrons, photons, and charged particles

Different kinds of impact on the detector

- direct hits from primary e^+e^-
- indirect hits from backscattered secondaries
- radiation damage from particle fluence (esp. neutrons)

Simulation Tools

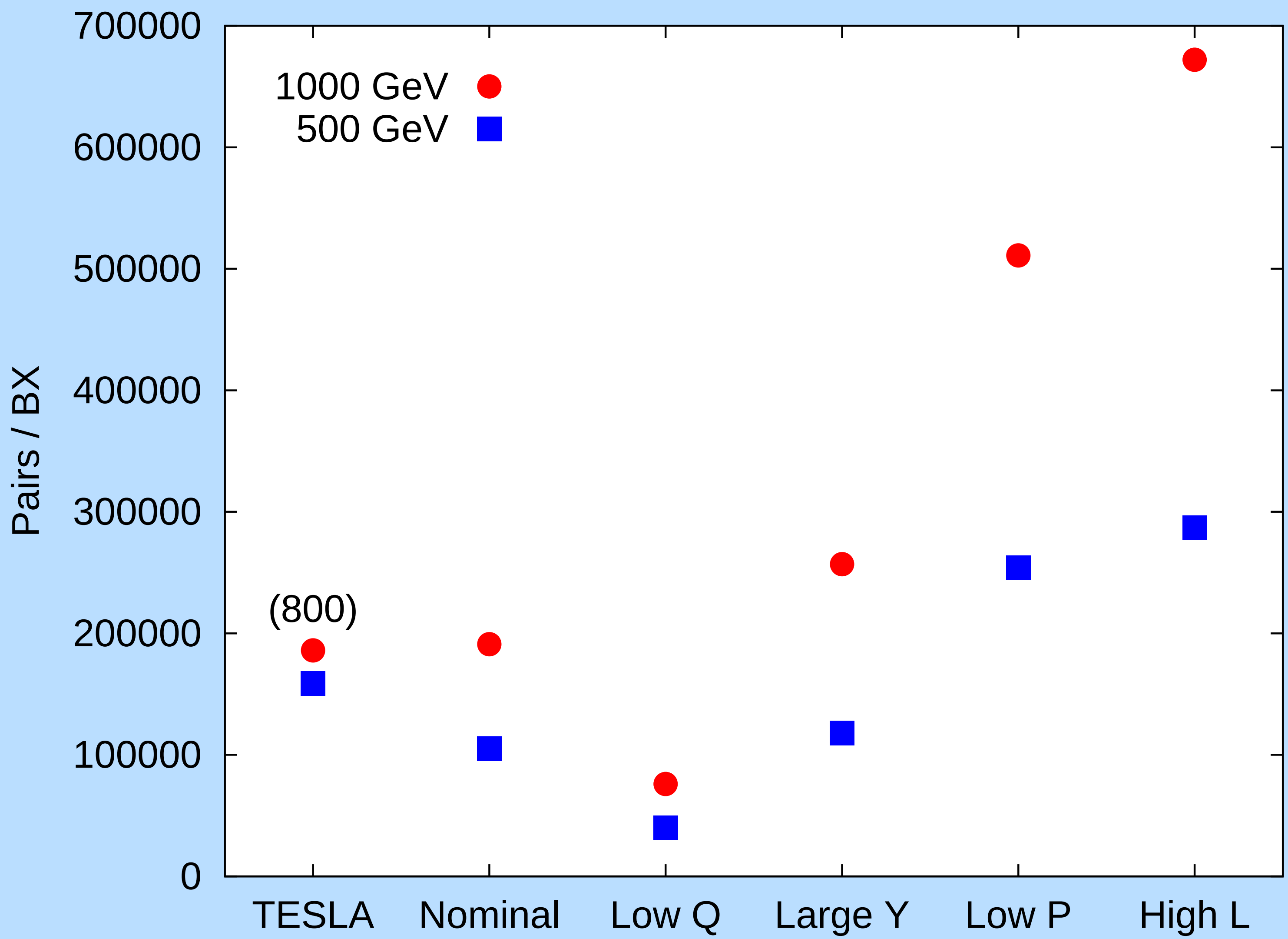
Guinea Pig (e^+e^- pairs generator)

- used with different ILC beam parameter sets
- gives $\mathcal{O}(10^5)$ background particles per BX

Mokka (full detector simulation)

- version: 06-02 pre-release with Geant 4.8.1.p01
- physics list: `QGSP_BERT_HP` (Geant 4 built-in) with high-precision neutron models, using isotopes
- geometry: “small” LDC design with new forward region (14 mrad crossing angle with anti-DID field map)
- simulated 100 BX for each parameter set

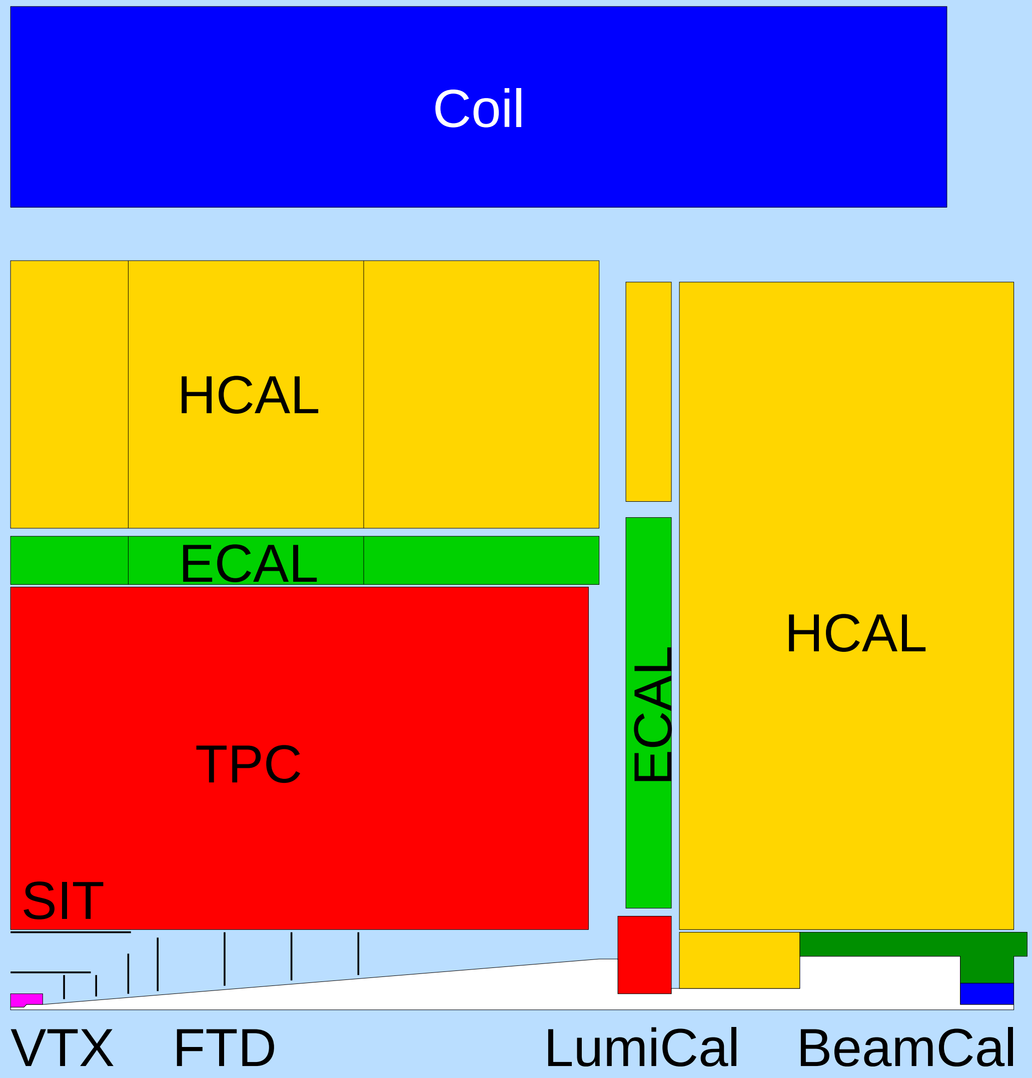
ILC Beam Parameters



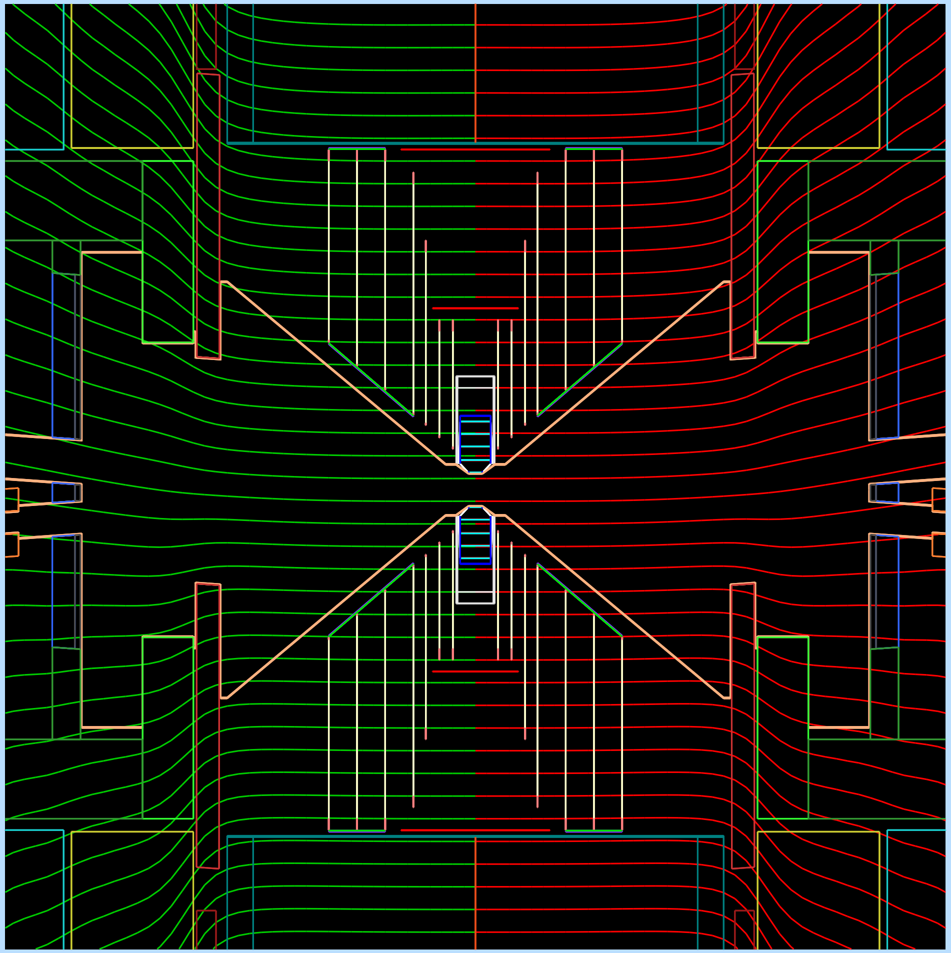
S. Gronenborn (EUROTeV-Memo-2005-003-1)

"Small" LDC Detector Design

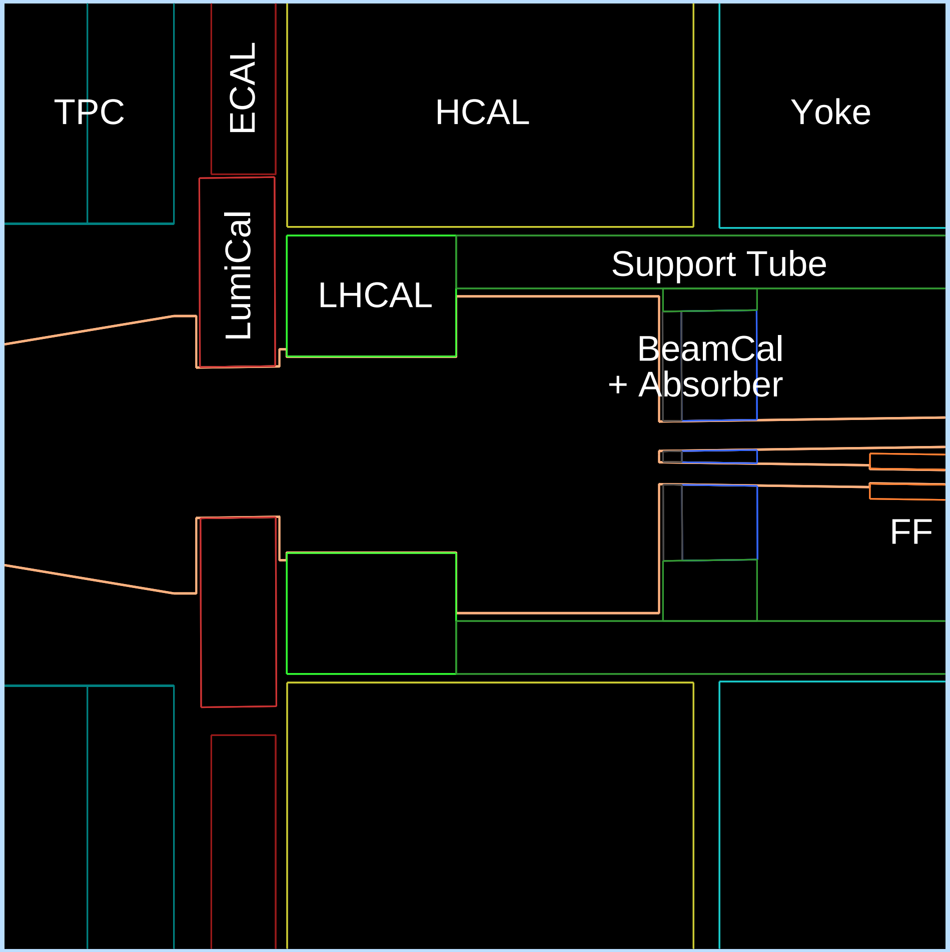
- Coil and TPC have been shortened
- ECAL and LumiCal have been pulled towards the IP
- FF at $L^* = 4.05\,\mathrm{m}$ remains unchanged
- BeamCal stays where it was
- New layout of the forward region



LDC Detector Geometry



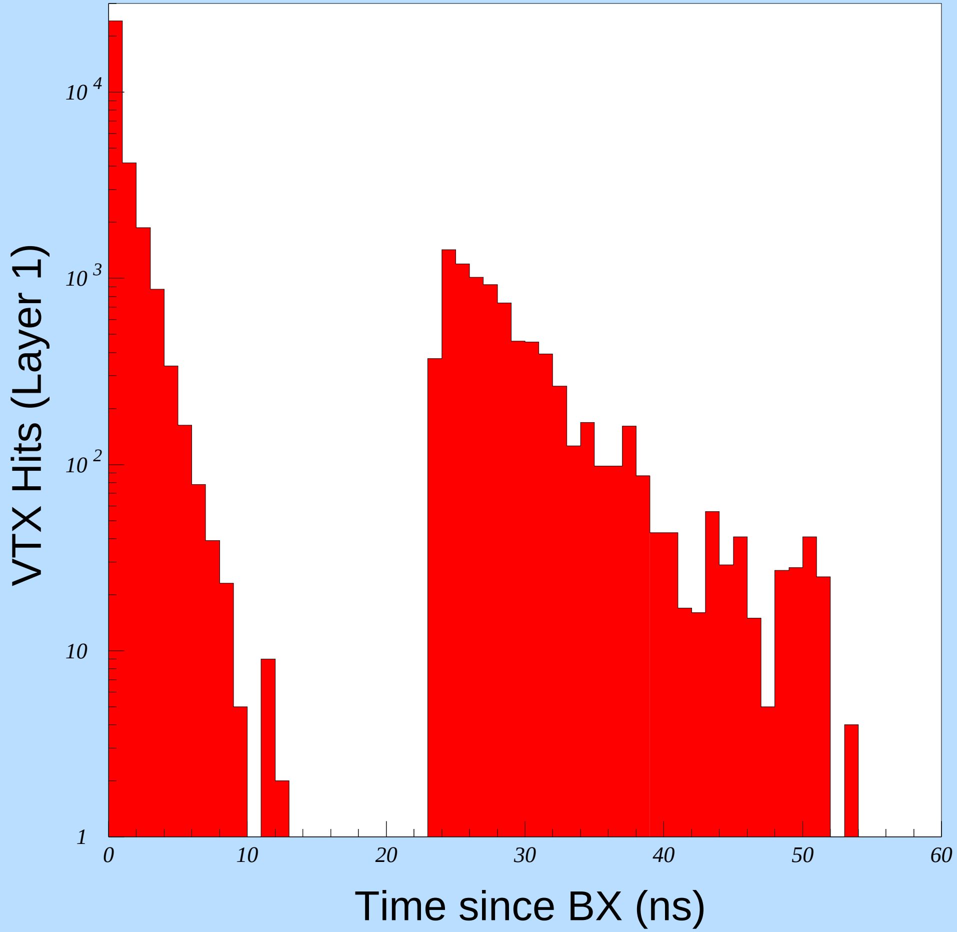
14 mrad crossing angle
with anti-DID field (1:10)



Forward region design
(compressed view 1:2)

VTX Hits – Time Structure

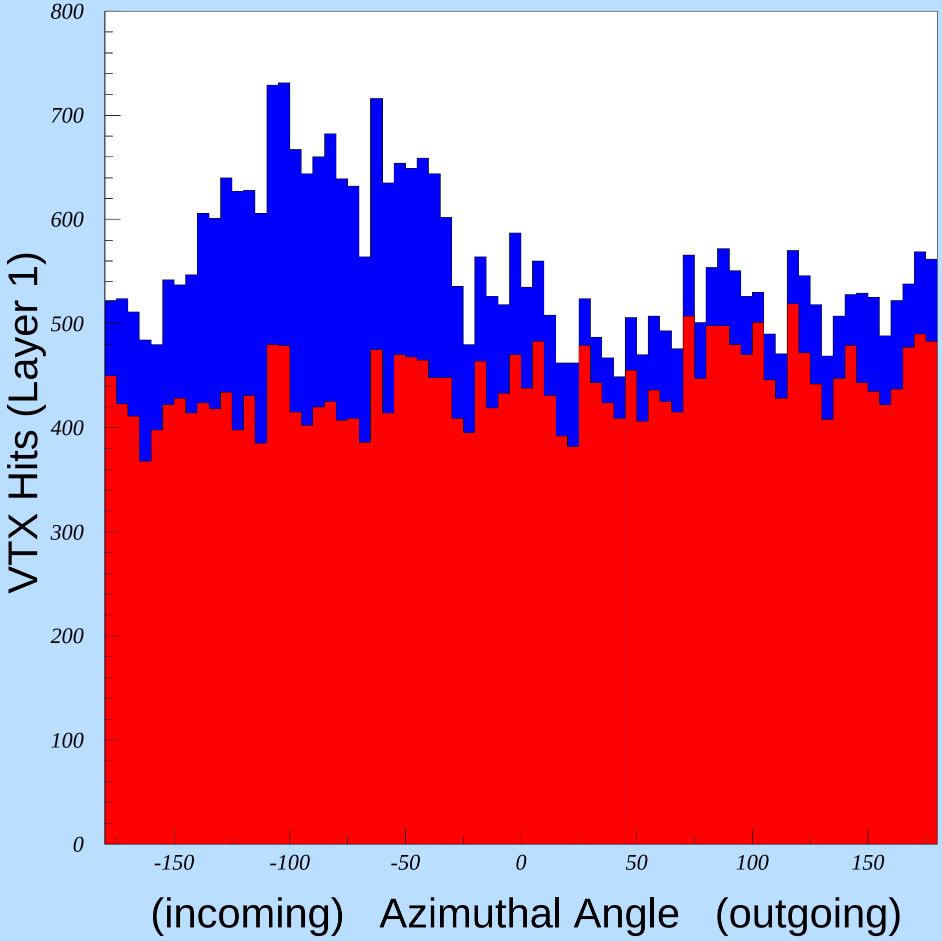
- Clear separation between direct hits and backscattered particles
- $t \approx 23$ ns corresponds to a distance of 7.0 m (3.5 m in each direction)
- Most backscatterers come from the BeamCal



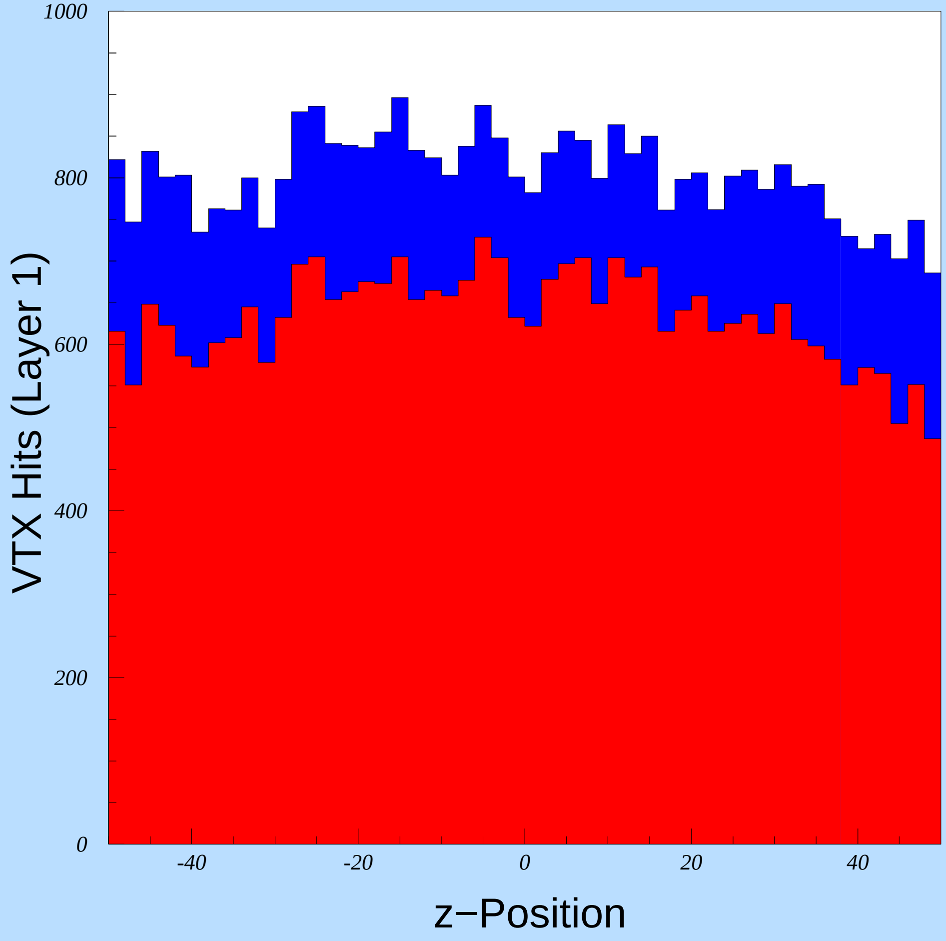
Note the log scale:
Most hits are direct

VTX Hits – Spatial Distribution

Separation of immediate hits (red) and backscatterers (blue)

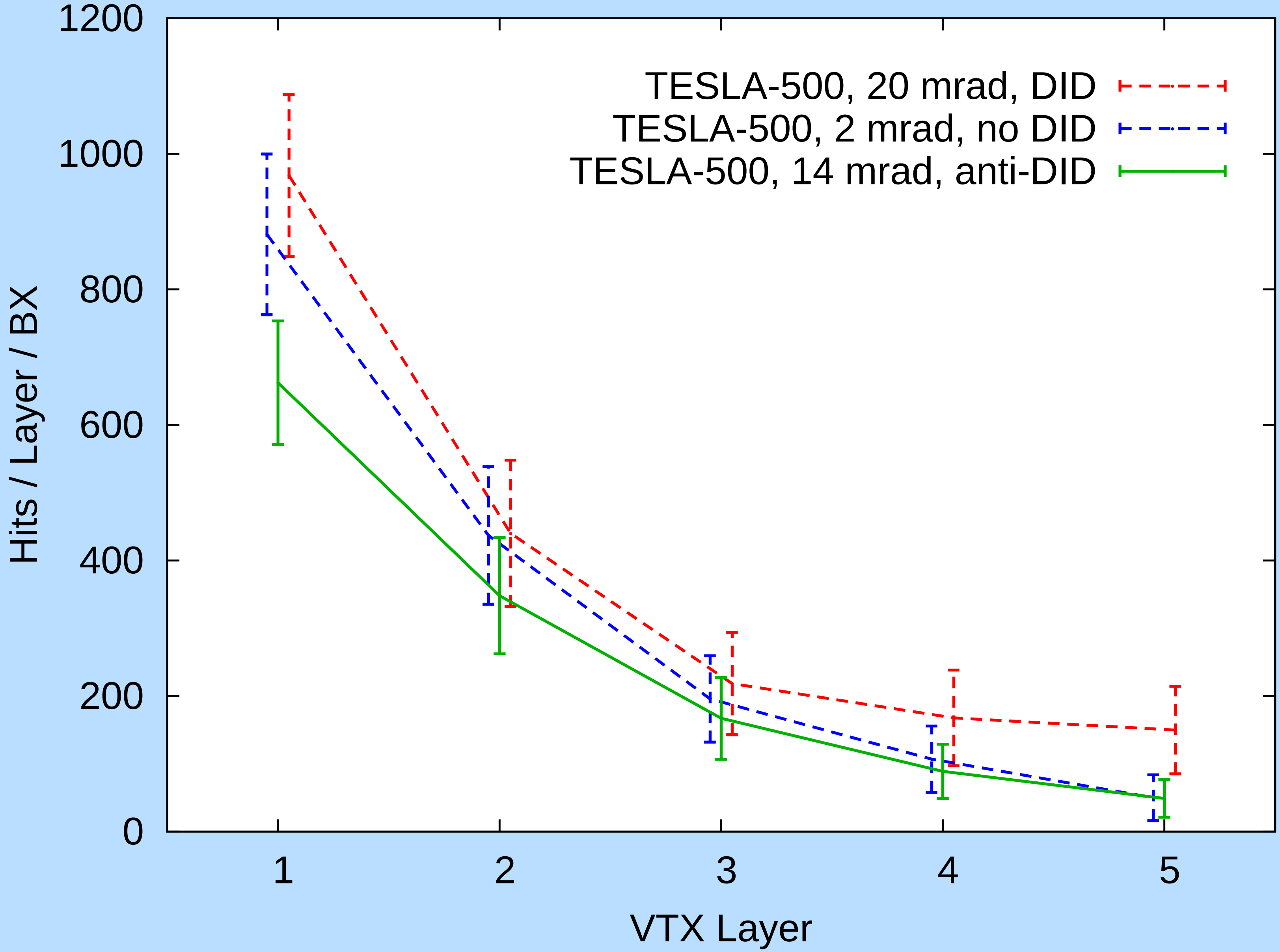


Azimuthal distribution

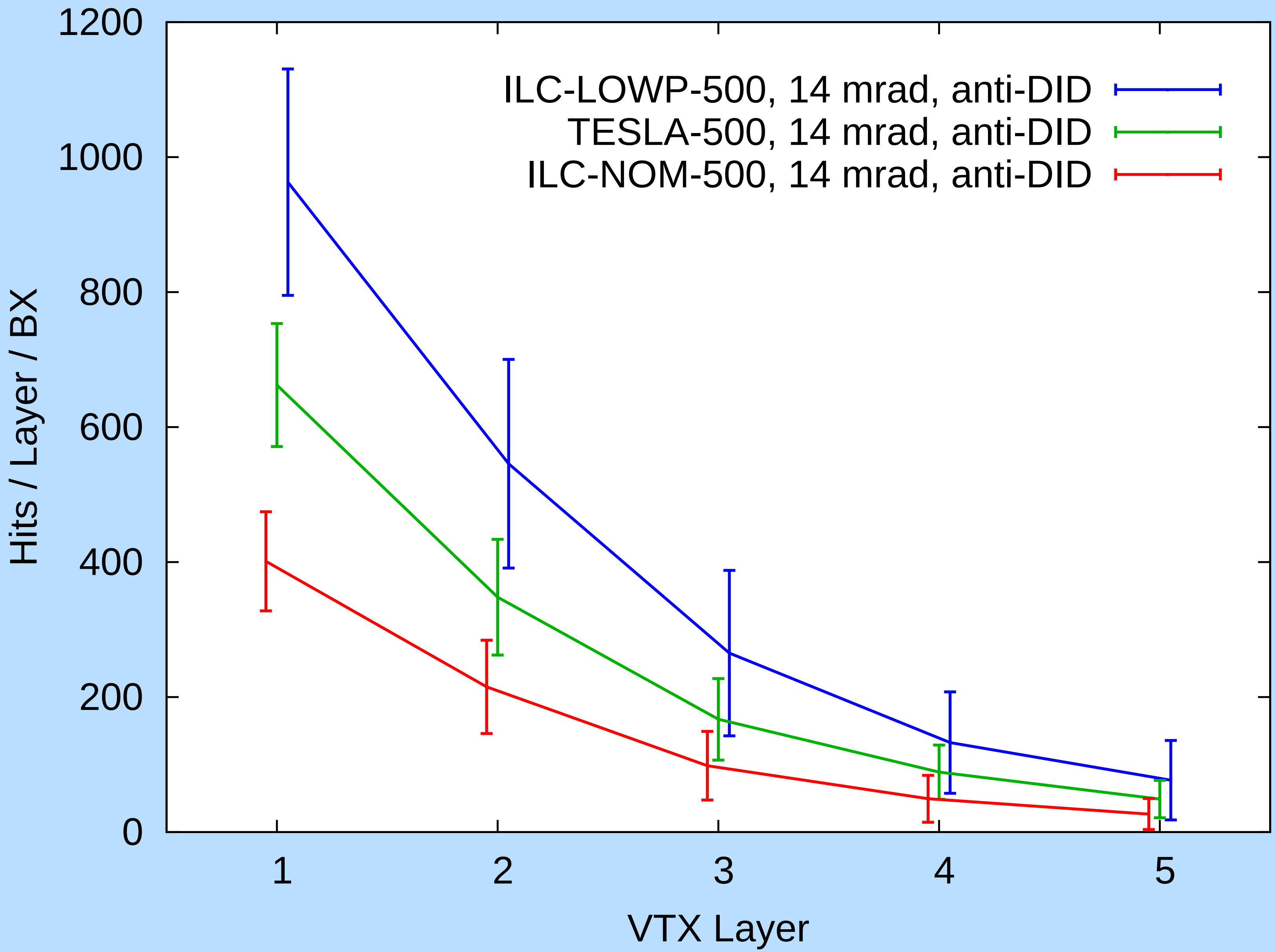


Longitudinal distribution

VTX Hits – Geometries

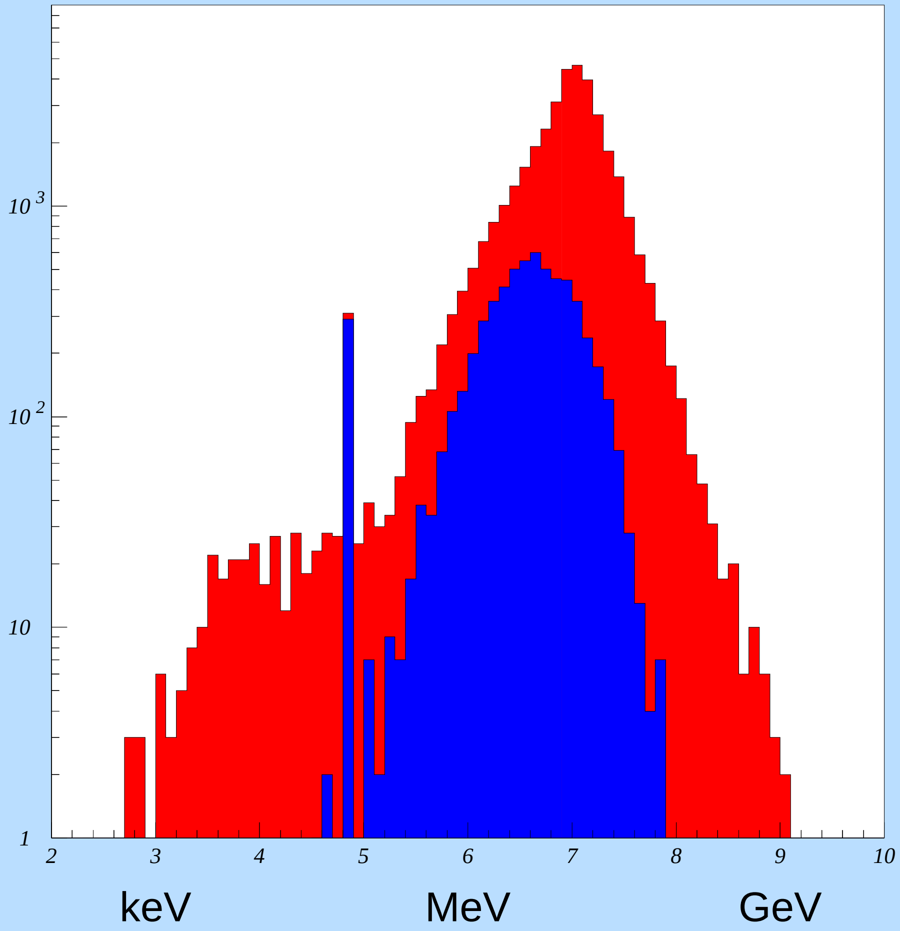


VTX Hits – Beam Parameters

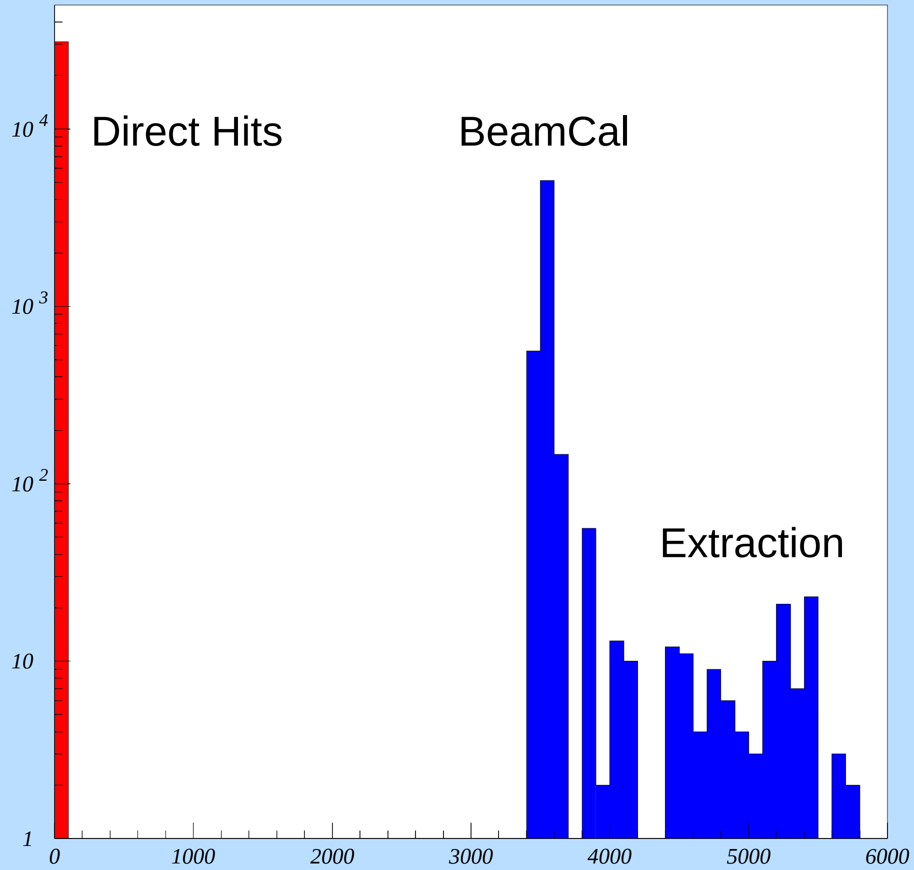


VTX Transitions – Charged Particles

Separation of near (red) and distant (blue) sources



Energy spectrum



Origins of particle tracks

VTX Transitions – Neutron Fluence

Neutrons passing any VTX layer (with double counting)

- 1.7 ± 2.9 per BX for ILC-NOM-500
- 8.6 ± 10.4 per BX for ILC-LOWP-500

Normalisation per unit area (total surface is $2.8 \cdot 10^3\,\mathrm{cm}^2$)

Normalisation per nominal run time with $\int \mathcal{L}\,dt = 500\,\mathrm{fb}^{-1}$

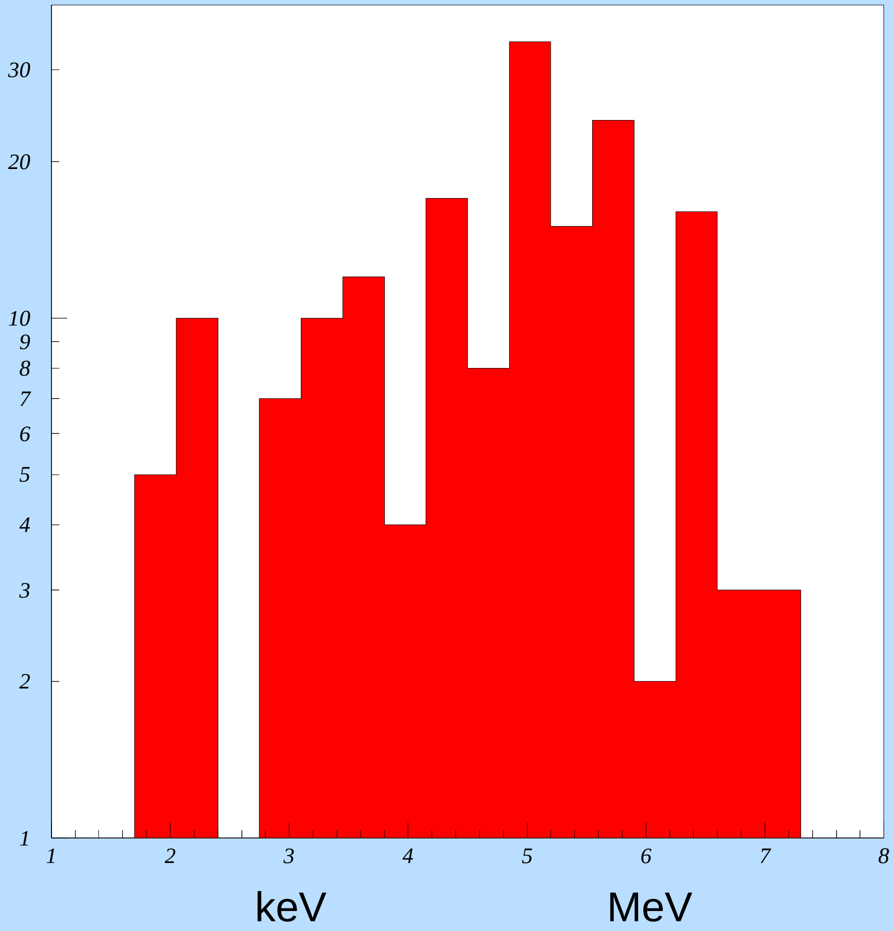
- $3.9 \cdot 10^{11}$ BX in total for ILC-NOM-500
- $2.0 \cdot 10^{11}$ BX in total for ILC-LOWP-500

Neutron fluence (no NIEL scaling applied yet)

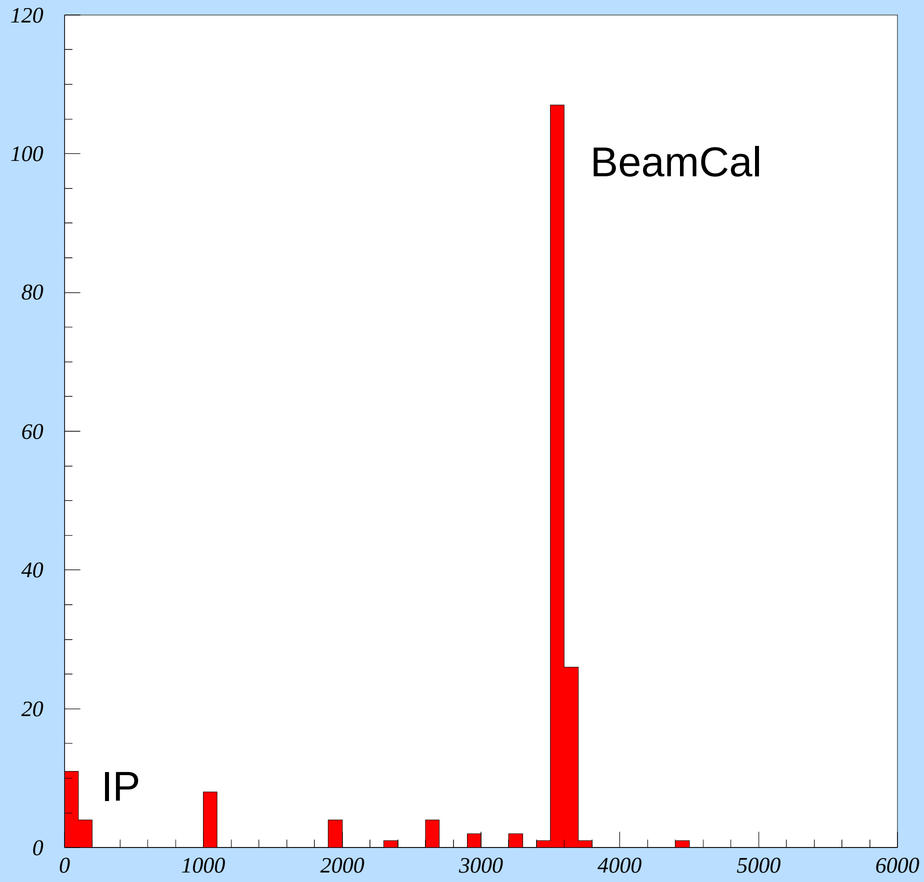
- $(2.3 \pm 4.0) \cdot 10^8$ neutrons / cm^2 for ILC-NOM-500
- $(6.1 \pm 7.4) \cdot 10^8$ neutrons / cm^2 for ILC-LOWP-500

VTX Transitions – Neutrons

Statistics for neutrons are rather low . . .



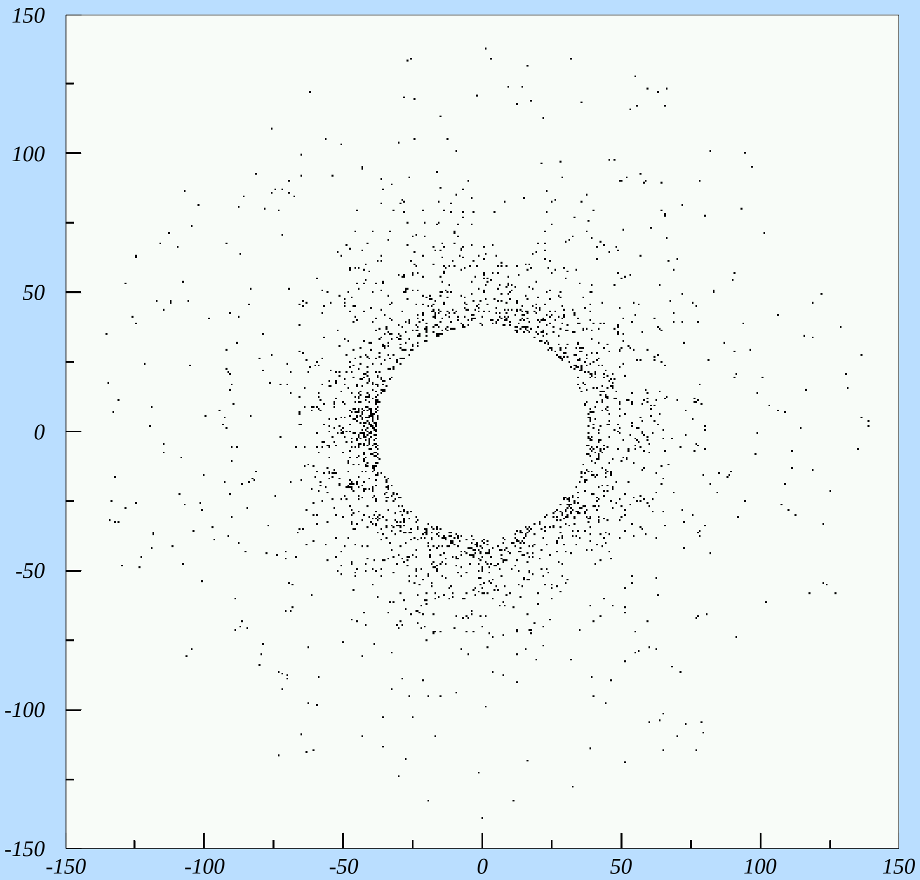
Energy spectrum



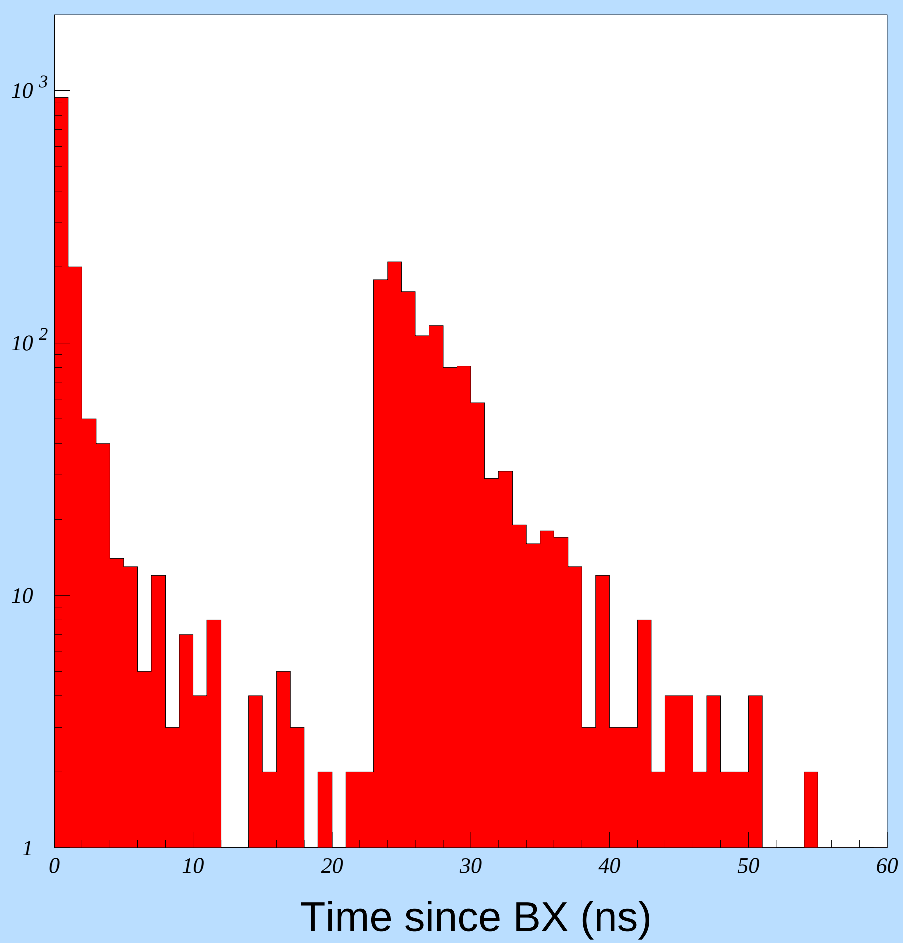
Origins of particles

FTD Hits – Distributions

Mokka hits on the innermost FTD (overlay of 100 BX)

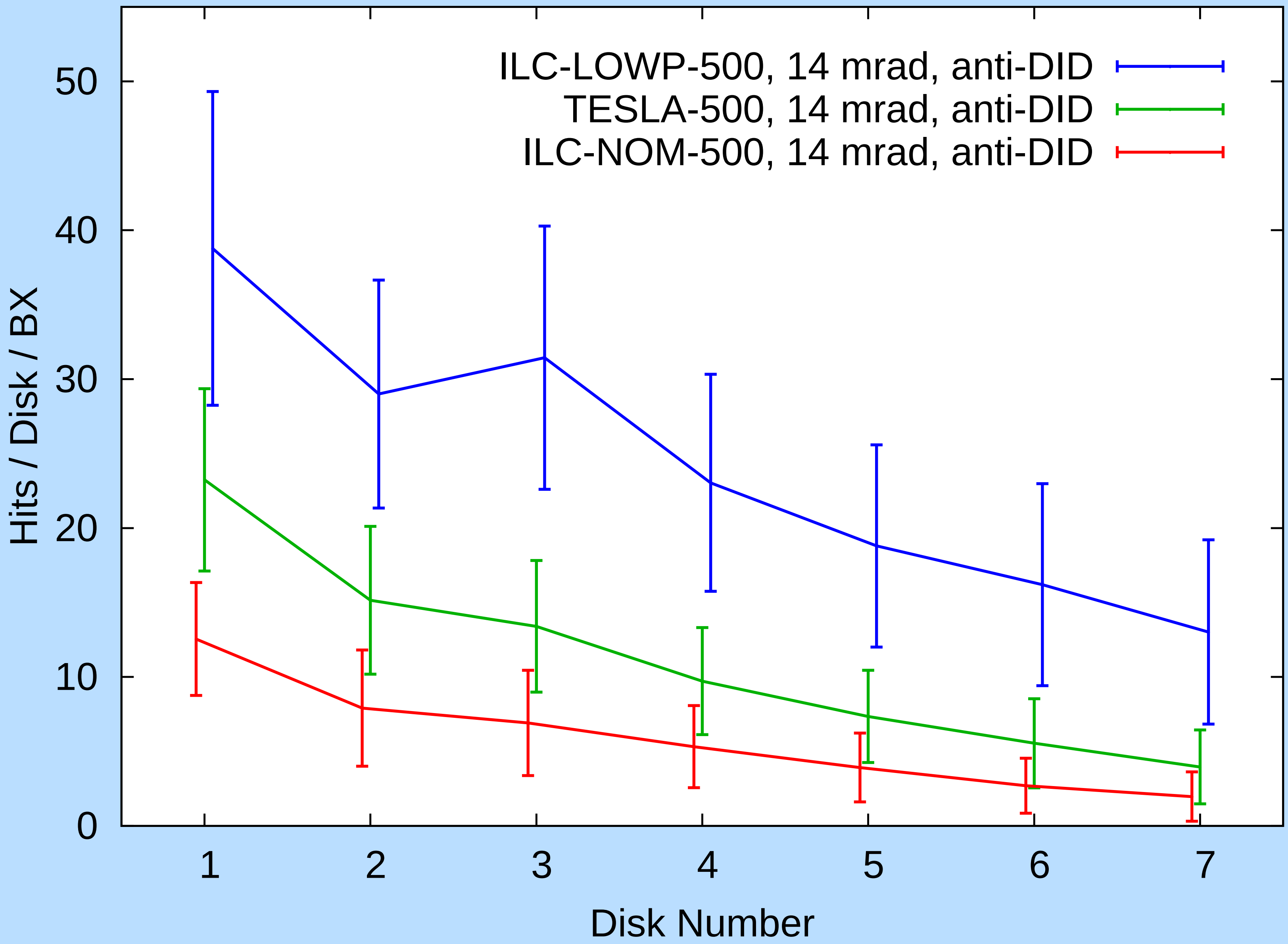


Spatial Distribution



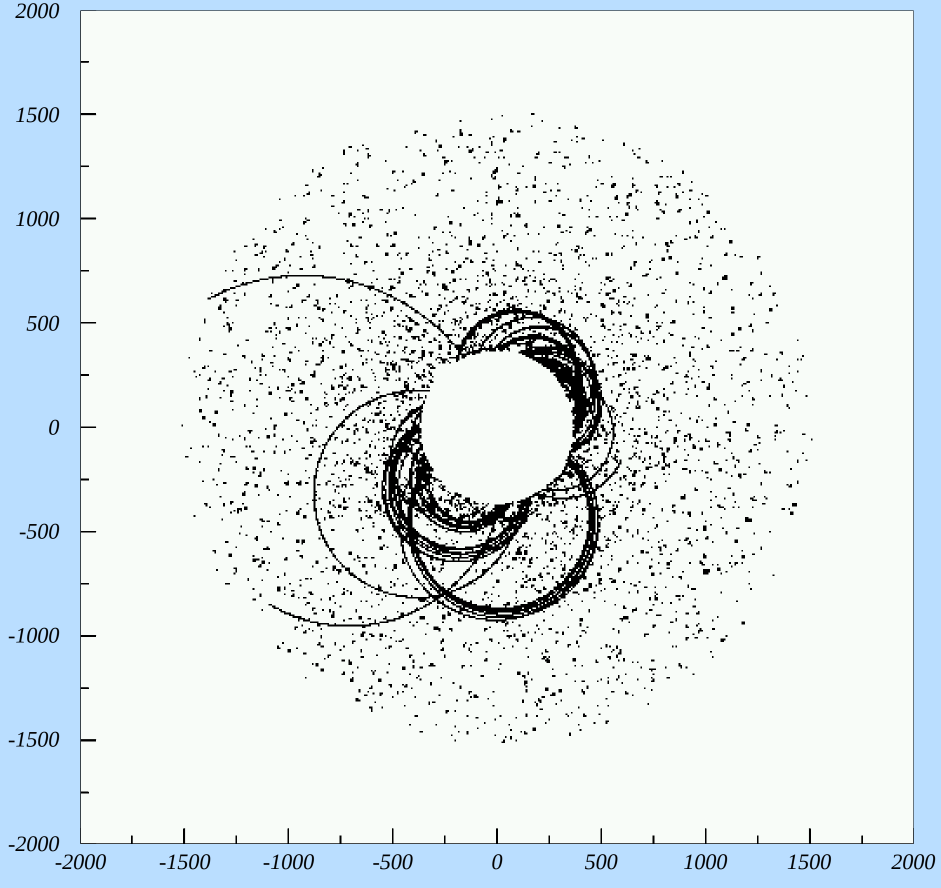
Time structure

FTD Hits – All Disks

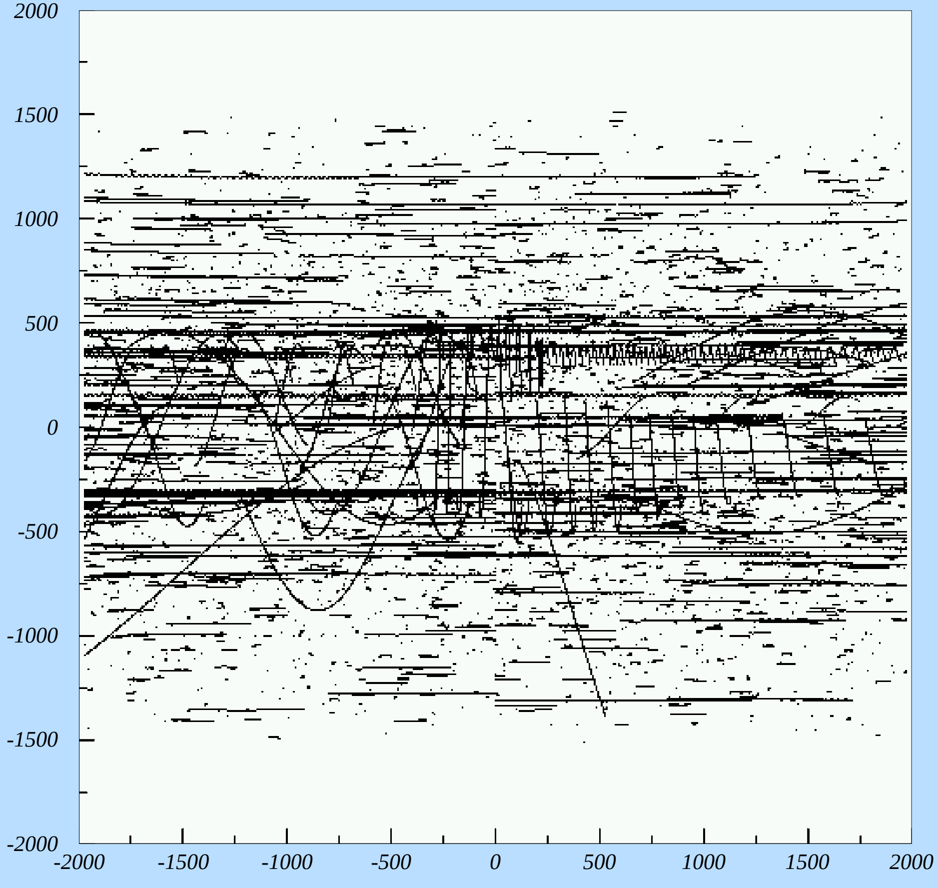


TPC Hits – “Salt and Pepper”

Mokka hits in the TPC (overlay of 100 BX)



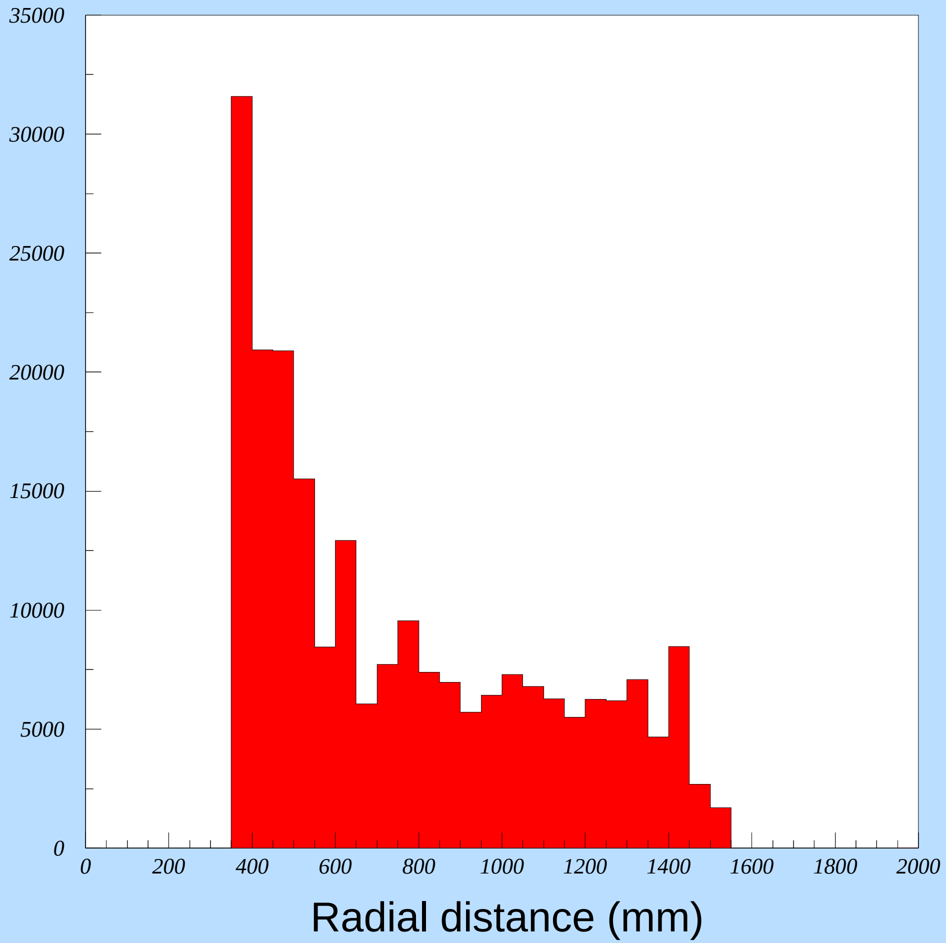
Front view



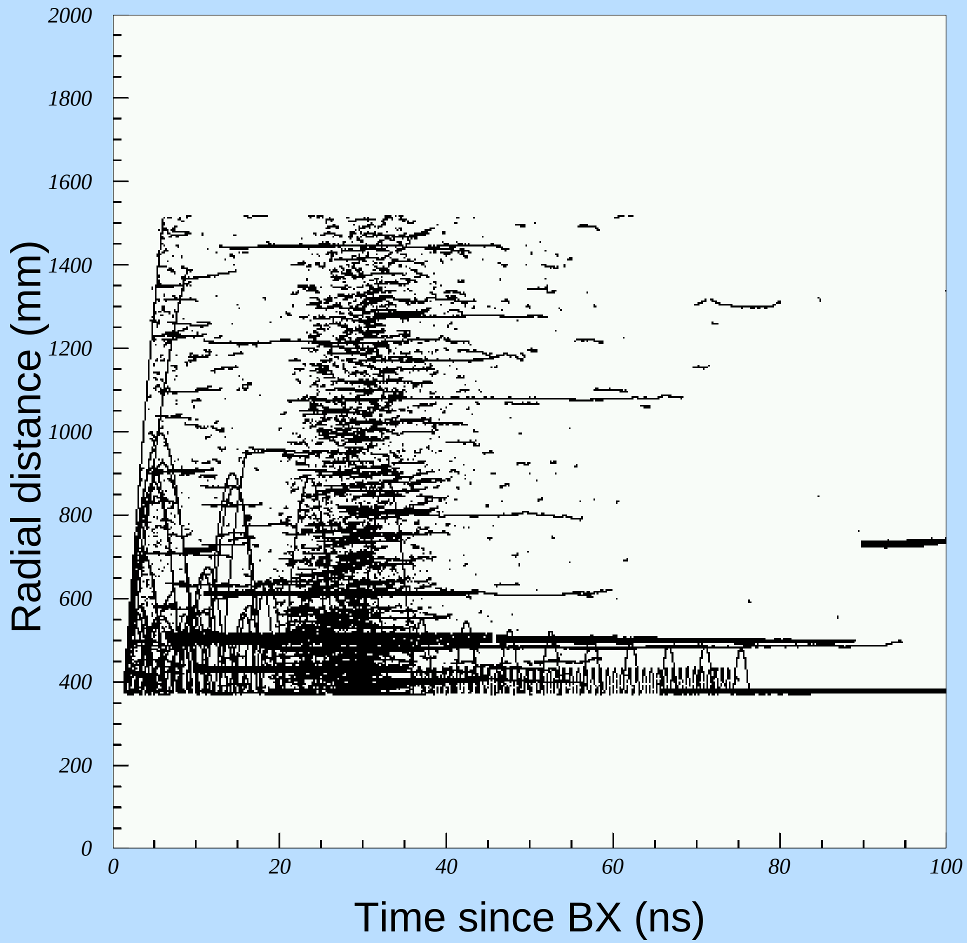
Side view

TPC Hits – Distributions

Mokka hits in the TPC (overlay of 100 BX)



Radial distribution



Time structure

Particles in the TPC

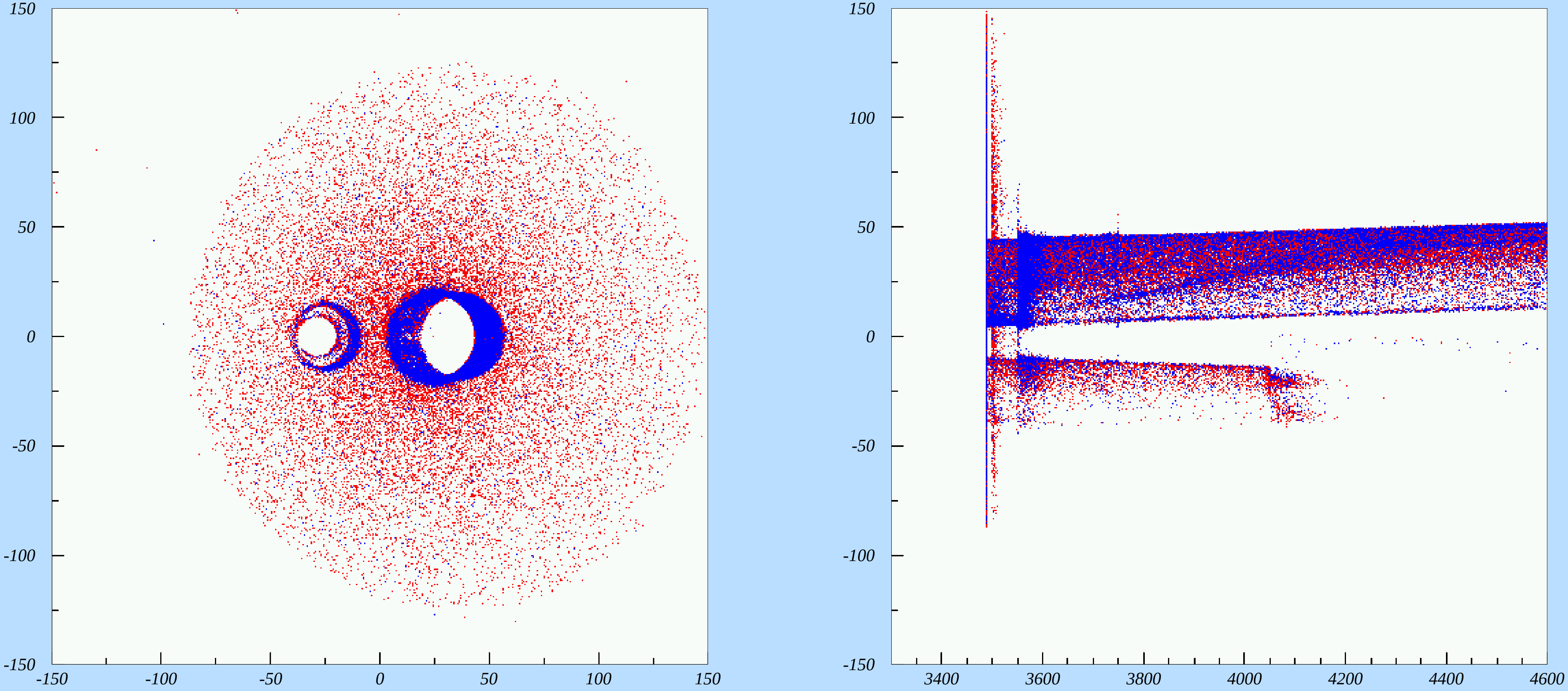
- Particles entering the TPC (per BX)

	Nominal	Low P
Neutrons	142 ± 20	590 ± 68
Photons	947 ± 57	3108 ± 148
Electrons	6 ± 13	30 ± 32

- Particles created in the TPC (per BX)

	Nominal	Low P
Electrons	292 ± 130	1596 ± 344
Protons	2 ± 2	9 ± 4

Backscattering Sources



Origins of backscattered electrons and positrons which enter the inner parts of the detector

Summary and Outlook

Backscattering is a non-negligible contribution

- may be reduced by optimisation of geometries
- small modifications (e. g. radii) can have large effects
- work is in progress (in collaboration with FCAL)
- 50 mm low-Z absorber looks good (S. Niehage)
- apply low-Z cladding to the inside of the BeamCal?

Simulation effort is going on

- this talk contains data from more than 1 CPU-year
- jobs were run on the Grid (approx. 150 nodes)
- the parameter space is large and multi-dimensional

Summary and Outlook

Other background sources

- backscattering from losses in the extraction line
- beam halo from the main linac
- can be studied with tools like BDSim

Background signals in the tracking detectors

- direct hits cannot be avoided
- anti-DID can significantly reduce backscattering
- how much background will we be able to handle?
- beware: background studies are no percent business!